OPERATOR'S MANUAL

AQD29/200, MD29

VOLVO
PENTA

Foreword

Before you start using your new Volvo Penta marine engine, we recommend that you read this instruction book carefully. It contains all the instructions you need to run and service your engine in the best possible way. If you follow the advice and instructions given here, then your engine with marine equipment will satisfy all the demands concerning economical running and outstanding performance you have every right to make on such a high-quality engineering product.

Do not wait until something goes wrong before you hastily consult this book for advice. Read it now. The short time this takes is well worth while. The better you know your engine, the more pleasure you will be able to get out of it. Even for those of you with extensive experience, this instruction book might contain some information of value that you have not come across before.

This book does not claim to be a comprehensive technical manual nor does it claim to make the reader into an expert mechanic. It will, however, tell you how the engine and outboard drive should be serviced in order to avoid future trouble.

Finally we would like to express our thanks for the confidence you have shown us in choosing a Volvo Penta marine engine. We are convinced that the demands you make on the engine will be fully satisfied, that you will enjoy running your Volvo Penta and that it will serve you faithfully during many pleasant boat trips.

AB VOLVO PENTA
Technical Information Department

VOLVO PENTA

Instruction book

AQD 29/200, MD 29

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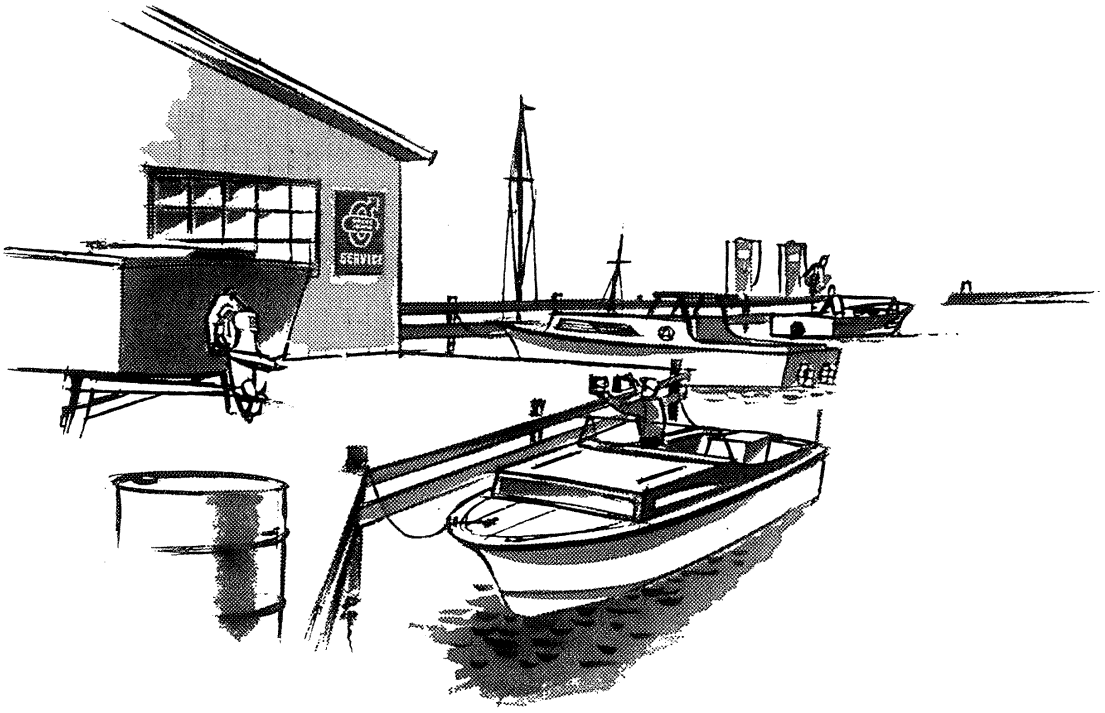
Volvo Penta Service



Your Volvo Penta marine engine consists of a large number of component parts running in close co-operation with each other, and regular servicing and inspection is necessary to ensure the best running. In order to make this possible, Volvo Penta has built up an extensive service network. In all larger towns all over the world you will find modern workshops with specially-trained personnel at your service.

Volvo Penta dealers and service stations are equipped with the necessary special tools and also have comprehensive stocks of spare parts, which is your guarantee for genuine Volvo Penta spare parts.

Guarantee

Every engine is accompanied by a warranty booklet which provides the original purchaser with a guarantee against any fault in manufacture or assembly. The extent of the guarantee is set out in the warranty certificate, which we would ask you to study closely. In order for our guarantee to be valid, however, maintenance directions given in this instruction book must be complied with and in case of any doubt we would ask you to contact our authorized dealer.

To ensure prompt service, always state type designation and serial number of engine and gear unit. (See rear cover inside of this book)

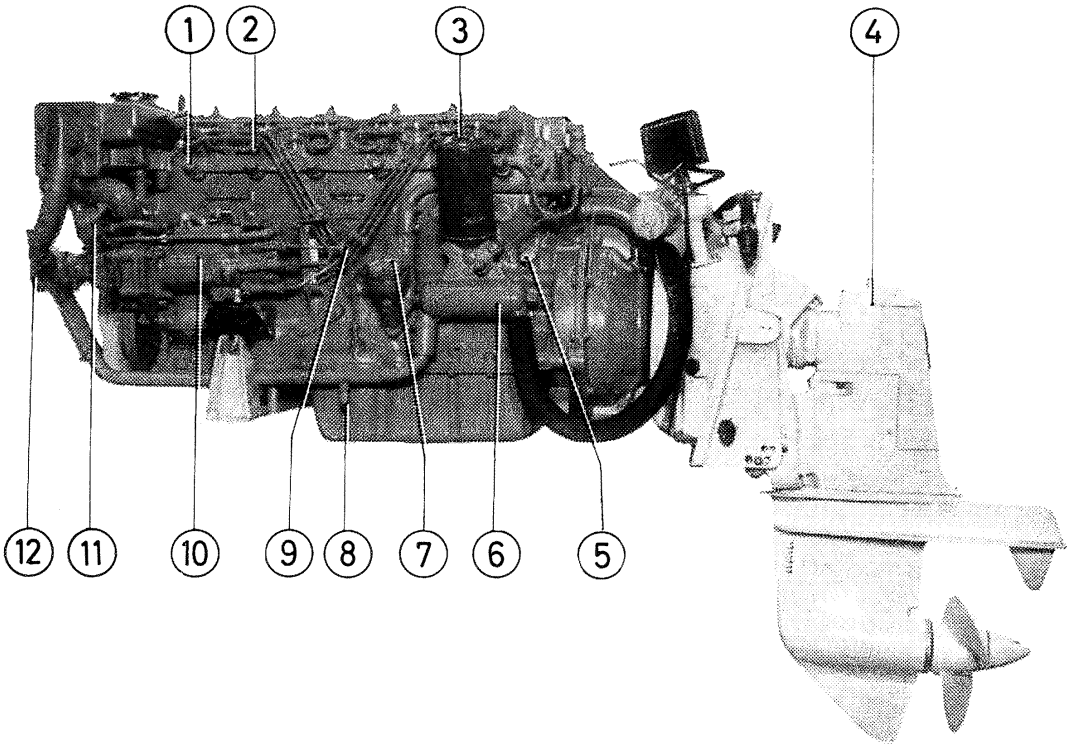


Fig. 1. Engine AQD 29/200

1. Glow plug
2. Injector
3. Oil filter
4. Outboard drive
5. Water drain cock
6. Oil cooler
7. Oil filler cap, engine
8. Water drain cock
9. Delivery pipe
10. Injection pipe
11. Sending unit for tachometer
12. Sea-water pump

AQD 29/200 and MD 29 are 6-cylinder, 4-stroke marine diesel engines with overhead valves. The combustion chambers are of the swirl-type with glow plugs. The total displacement is 2.92 liters (178 cu.in.).
Engine and marine equipment are designed for maximum length of life and reliability. During the production all parts have been subjected to a most severe inspection with highest demands on quality.

The engine is equipped with a heat exchanger for thermostat-controlled fresh-water cooling of cylinder block and cylinder head. The sea-water circuit in the cooling system cools the fresh-water system through the heat exchanger as well as the oil cooler and exhaust manifold.

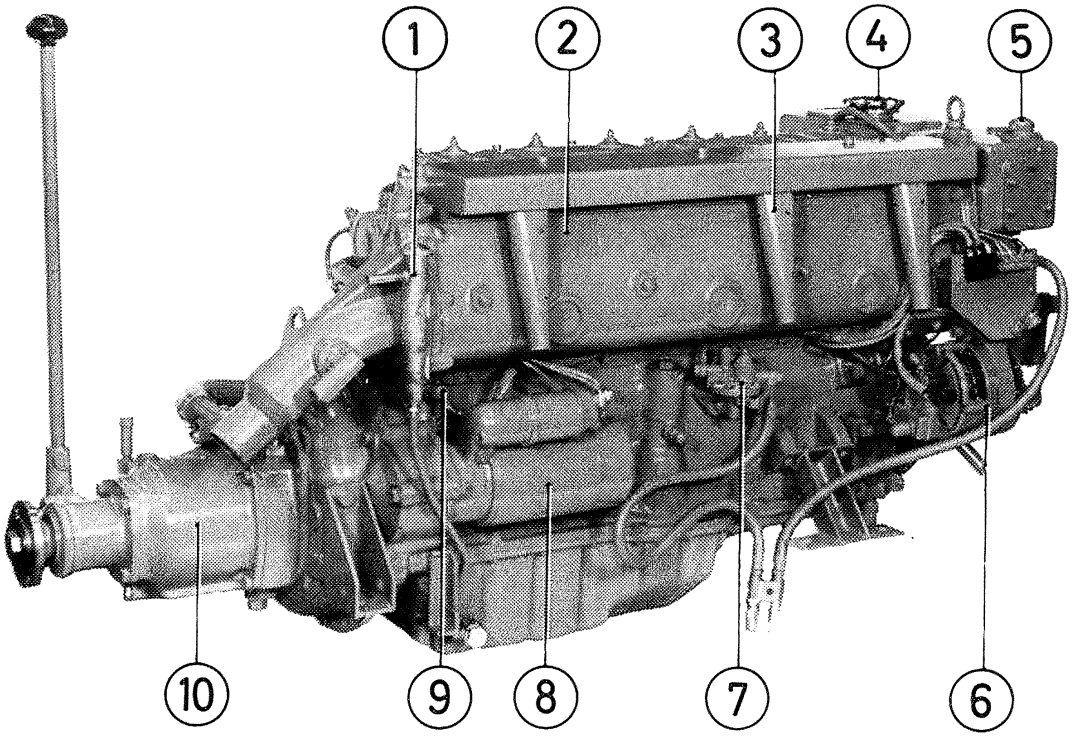


Fig. 2. Engine MD29

1. Oil drain pump (only MD29)
2. Water-cooled exhaust and intake manifold
3. Intake silencer
4. Filler cap, fresh-water
5. Over-pressure valve
6. Alternator
7. Fuel feed pump
8. Starter motor
9. Water drain cock
10. Reverse and reduction gear, type RB

The engine is lubricated through a pressure lubricating system where an oil pump delivers the correct amount of lubricating oil to all lubricating points at any given RPM.

The fuel system is well protected against interruptions in running through an efficient, replaceable fine filter. The low fuel consumption has been accomplished by an efficient injection equipment in combination with well adapted combustion chambers and induction channels. The engine has wet-type cylinder liners which are easily replaceable, like all other wearing parts.

AQD29/200 is rubber mounted in a shield, which is bolted to the transom of the boat, and in addition a supporting mount is fitted at the front end of the engine.

The outboard drive has a built-in forward and reverse gear. The gear mechanism consists of the Volvo Penta patented cone clutch, which makes possible quick and silent engagement.

MD29 can be equipped either with reverse gear type RB, which has a built-in reduction gear with ratio 1.91:1, or Warner Gear hydraulically operated reverse and reduction gear with reduction ratio 2:1 or 3:1.

Instruments

Instrument panel

Certain functions of the engine such as oil pressure, cooling water temperature, etc., are registered by instruments and warning lamps. Make a habit of glancing at the instruments and warning lamps to check the readings immediately after starting the engine as well as now and then when running. Should an instrument show an abnormal reading or a warning lamp light up, stop the engine immediately and locate the cause.

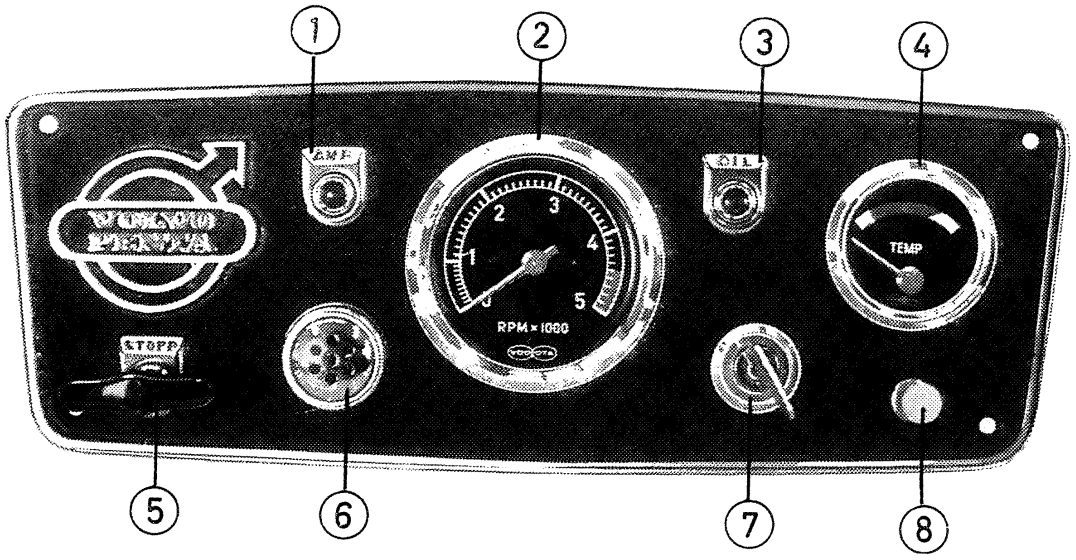


Fig. 3. Instrument panel (See explanation of figures on next page)

Instruments

(The figures refer to Fig. 3)

① Charging control lamp

The charging control lamp should be out when running.
If the lamp is lighted, this indicates that the alternator is not working, and there is something wrong in the electrical system.

② Tachometer

The tachometer scale shows the engine RPM (number of revolutions per minute). The reading should be multiplied by 1000.

③ Warning lamp for oil pressure

This lamp lights up when the oil pressure in the engine becomes too low. When the engine is running, the lamp should be out. If the lamp lights up, stop the engine immediately and find out what is wrong.

④ Coolant thermometer

The thermometer indicates the temperature of the coolant and thereby the operating temperature of the engine.
The coolant temperature should normally be 60–90° C (140–195° F), which corresponds to a reading within the green sector of the gauge. Should the thermometer show an excessive temperature for any length of time – stop the engine and determine the cause.

⑤ Stop control

The engine is stopped by pulling out the stop control.

⑥ Control resistance

The control resistance is connected to the glow plug circuit and starts to glow at the same time as the ignition spirals in the glow plugs, thus indicating when these are warm. When the starter motor is switched on, the control resistance is cut out, and the glow wire in this cools down gradually during the starting period.

⑦ Key switch

The key switch has four positions:

1. Neutral position.
2. Running position.
3. Connection of glow plugs.

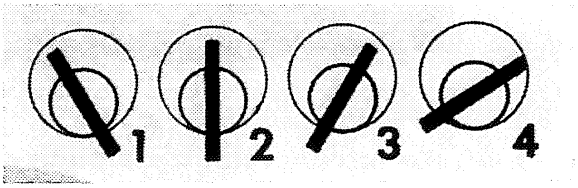


Fig. 4. Key switch

4. Starting position. When the control resistance (6, Fig. 3) starts to glow, the key is pushed inwards and turned to position (4, Fig. 4), at which the starter motor is engaged. As soon as the engine has started, release the key which then automatically returns to the running position.

(8) Switch for instrument lighting

When the switch is on, the instruments are indirectly lighted.

Controls for AQD 29/200 and MD 29 with Warner Gear reverse gear

Controls of make Morse, models MW 335, M335, MT and MT Twin should be used. Engine speed and gear shifting are controlled by the same lever (1, Fig. 5). The controls are also fitted with a device (2) which disengages the shifting mechanism so that the control lever only acts as a throttle. In this way the engine can be run at different speeds in neutral position, for example when warming up.

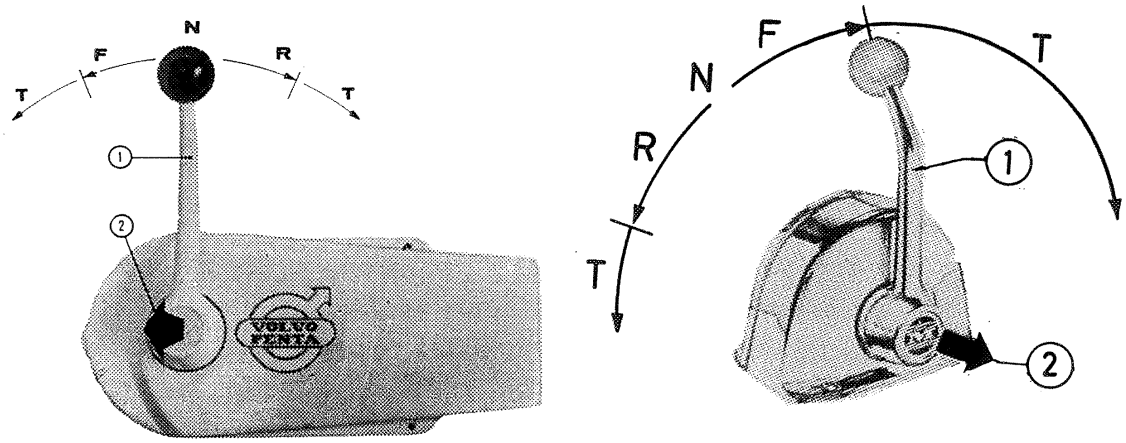


Fig. 5. Single lever controls, make Morse

1. Control lever
2. Disengaging device

N = Neutral position
F = Control lever in "Forward" position
R = Control lever in "Reverse" position
T = Throttle

Remote control to reverse gear

If a remote control is used for the RB reverse gear, this must not be done in such a way that the maneuvering parts of the reverse gear are under constant load. When "Forward" or "Reverse" is engaged, the remote control should be completely unloaded to ensure that the cones in the reverse gear can be kept in engaged position by the propeller thrust.

Running instructions

Procedure before starting

1. Check the coolant level in the fresh-water system (See "Servicing", point 19).
2. Check the oil level in the engine (See "Servicing", point 1). When necessary, top up with diesel lubricating oil, grade "Service DS".
3. Check the fuel level in the tanks and open the cock for fuel supply to the engine. At the same time, check fuel cocks, pipes and connections for leakage.
4. Check that all drain cocks on the engine are closed. Open the sea-cock for the cooling water intake (MD 29).
5. Check the oil level in the reverse gear (MD29) by means of the oil dipstick (See "Servicing", point 3). When necessary, top up.
6. Lower the outboard drive (AQD 29/200) by means of the electro-mechanical lift.

NOTE. Do not start the engine with the drive in tilted-up position. The drive must be lowered until the warning lamp goes out. Otherwise the boat cannot be run in reverse.

7. Make sure that fire extinguisher, life vests, anchor, mooring lines and other safety equipment are on board.
8. Switch on the master switch for the electrical system (AQD 29, see 4 Fig. 18).

Starting

When the engine is new or after it has been reconditioned, it must not be raced immediately after starting. During the first 2 minutes warming up, the engine speed must not exceed 1000 r.p.m. This also applies in connection with oil change and oil filter replacement.

1. Put the reverse gear control in neutral position (MD29). When a Morse speed and clutch control is fitted, the control lever is moved to neutral position. Then disengage the shifting mechanism by pulling out the control lever sideways. After this, the control lever will only act as a throttle. Move the control lever fully forwards. NOTE. When the control lever is moved back to the neutral position, it automatically re-engages the shifting mechanism.
2. Make sure that the stop control is pushed in and that the stop lever rests against its stop on the injection pump. Otherwise the output will be reduced.

3. Turn the starting key to position 2, running position, see Fig. 4. Check that the charging control lamp and oil pressure warning lamp light up.
4. Turn the starting key to position 3 and keep it in this position until the control resistance (6, Fig. 3) glows. The time required for preheating varies with the engine temperature but is normally 40—60 seconds. When starting a warm engine, no preheating is required.
5. Push in the starting key and turn it to position 4, at which the starter motor is engaged.
6. Release the starting key as soon as the engine has started. The key automatically returns to the running position.
   Do not let the starter motor run for longer periods than 10—15 seconds at a time. If the engine does not start or stops after starting, apply further preheating before making a new starting attempt.
7. Move back the control lever immediately the engine has started so that the engine does not run up into excessive speeds. Warm up the engine at high idling speed (about 1000 r.p.m.).

Note. Do not switch off the master switch when the engine is running. This will burn out the charging regulator.

Procedure after starting

1. Check that the warning lamps for charging and oil pressure are out. If either of these lamps does not go out, the engine should be stopped immediately and the cause of this determined.
2. Check cooling water circulation after the engine has started by making sure the temperature gauge does not show an abnormally high value.
3. After the engine has reached its normal operating temperature, check that the idling speed is correct in accordance with "Technical data". NOTE. If the idling speed is higher than this figure, it must be adjusted (see "Servicing", point 14).

Maneuvering, AQD 29/200

Move the control lever to neutral position. At this, also the shifting mechanism is engaged so that the lever now actuates this as well as the engine speed.

NOTE. To shift into reverse, the retaining pawl has to be engaged, which is done by means of the switch for the electro-mechanical lift. The switch is held towards "Down" until the control lamp goes out. To make sure that the drive kicks up and reduce the risk of damages in case it hits the bottom, the retaining pawl should be released when running forward. The retaining pawl is released by holding the switch for the electro-mechanical lift towards "Up" until the control lamp lights up and then about 3 seconds longer.

Maneuvering from full speed ahead directly to full speed in reverse can be carried out if the retaining pawl is engaged. However, such maneuvers are recommended only in case of emergencies, when it is a matter of saving the boat from getting wrecked, etc.

Warning when shifting into reverse

The warning lamp for the electo-mechanical lift must always be out when shifting into reverse. If the lamp is on, the drive may "float" up.

Operating the Warner hydraulic reverse gear on MD 29

The following procedure applies when Morse single lever controls are fitted. If another similar control is used, the instructions apply in principle.

Move the control lever to the neutral position. Continued movements of the lever then regulates forward and reverse shifting as well as the engine speed.

All control movements should be carried out quickly and decisively. Change over from full speed forward to full speed in reverse should be carried out as follows.

Move the control lever to the idling position "Forward" and let the boat lose most of its speed. Move the lever distinctly back to the neutral position and pause for a moment.

Then move the lever distinctly to the "Reverse" position and increase the engine speed.

NOTE. Do not operate the reverse gear when boat is running at high speed, since the propeller is then rotating even if the engine is disengaged.

Operating the Volvo Penta RB mechanical reverse gear on MD 29

The gear should only be operated when the engine is running at idling speed.

Move the control lever decisively, and not too slowly, from the neutral position to the "Forward" position for running ahead and the "Reverse" position for running in reverse. Do not increase the engine speed until the gear has been completely engaged.

Do not operate the gear when the boat is running at high speed, since the propeller is then rotating even if the engine is disengaged.

Engine speed

Pleasure boats and other installations in planing boats

Maximum permissible operating engine speed operation during a short period of time is 4000 r.p.m. When cruising, the maximum engine speed should be reduced by 200 r.p.m. under maximum operating speed attained.

In order for our guarantee to be valid, it is a condition that the propeller is selected to give an engine speed of 4000 r.p.m. with a normally loaded boat.

Work boats

Maximum permissible operating engine speed for heavy duty operation in work boats is 3000 r.p.m. When cruising, the maximum engine speed should be reduced by 200 r.p.m. under maximum operating speed attained.

Stopping

1. Move the control lever to the neutral position and let the engine run a few minutes at idling speed before it is stopped.
   Note. Do not switch off the master switch when the engine is running. This will burn out the charging regulator.
2. Pull out the stop control. This cuts off the fuel injection and the engine stops.
3. Turn the starting key to the neutral position.
4. Tilt up the outboard drive (AQD 29).
5. Close the fuel cock and turn off the master switch, AQD 29 see 4 Fig. 18, in case the engine is not to be used for any length of time.
6. When there is risk of frost, the cooling system should be drained or anti-freeze added, see "Precautions in case of frost" page 12.

Running-in

When your Volvo Penta engine is new or after it has been reconditioned, it must be run with particular care. The reason for this is that during this first period all parts wear in together. Therefore do not take out full engine output for more than short periods during the first 25 hours. Also remember that when the engine is new, or after it has been reconditioned, it must not be raced immediately after starting. During the first 2 minutes warming up, the engine speed must not exceed 1000 r.p.m. This also applies in connection with oil change and oil filter replacement.

It is particularly important to ensure that the engine is not run at full load for longer periods. It is recommended that the engine speed should not exceed 75 % of the maximum. Always keep an eye on the coolant thermometer and oil pressure warning lamp.

Before the engine and outboard drive left the factory, we made sure, through careful test running and checking procedures, that bearings and tolerances were correct. For this reason we cannot accept any responsibility for damages resulting from careless running-in.
During the running-in period the lubricating oil must be changed more often than is necessary later on. The oil in the engine and the oil filter should be changed after 20 hours running. In this connection we would like to point out that in order for our guarantee to be valid, all servicing procedures specified have to be carried out at the correct time.

Precautions in case of frost

When there is risk of frost, the sea-water and fresh-water circuits of the cooling system should be drained in order to prevent cracks in the cooling jackets and pipes. It is advisable to add anti-freeze to the fresh-water cooling system of the engine. In that case only the sea-water system has to be drained.

Draining the fresh-water system

In order to drain the fresh-water system the filler cap is unscrewed, and the cock at the rear on the port side (5 Fig. 1) of the cylinder block as well as the cock on the underside (1 Fig. 6) of the heat exchanger are opened. Check carefully that all the water runs out.

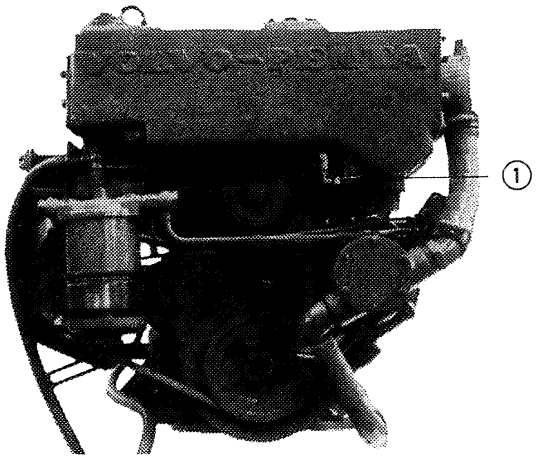


Fig. 6
Drain cock for fresh-water

Draining the sea-water system

1. Close the sea cock (MD 29) or block the suction pipe (AQD 29) and open the drain cock or plug on the underside of the exhaust manifold (9 Fig. 2).
2. Loosen the cover on the sea-water pump and make sure that the pressure pipe for the cooling water is drained.
3. Open the cock (8 Fig. 1) on the water pipe between the oil cooler and the sea-water pump.

4. If the engine is fitted with model RB reverse gear, the water in the cooling jacket of the reverse gear is drained off by unscrewing the plug 4, see Fig. on page 42. If hydraulic reverse gear is fitted, unscrew the plug on the oil cooler of the reverse gear.

When the boat is taken into use again, proceed as follows:

1. Check that the sea-water pump impeller is not frozen fast due to remaining moisture. Open the sea cock (MD 29) or connect the suction pipe (AQD 29).
2. Close all the drain cocks mentioned earlier.
3. Fill up with fresh-water (See "Servicing", point 19).
4. Check cooling water circulation after the engine has started by making sure the temperature gauge does not show an abnormally high value.

Anti-freeze for the engine fresh-water system

During the cold season a suitable anti-freeze solution should be added to the fresh-water system. In this connection we would draw your attention to the risk involved in using unsuitable anti-freeze fluids, since some of these can cause serious corrosion attacks in the engine. Only ethylene glycol with inhibitors in accordance with B.S. 3151 must be used. We recommend the use of Volvo original ethylene glycol, which has correctly balanced additives for neutralizing corrosion-forming substances in the cooling water. Methylated spirit should not be used, since this evaporates quickly when the engine has reached normal operating temperature. In addition, methylated spirit increases the risk of corrosion in the cooling system.

Freezing points of ethylene glycol and water mixtures.

Volume % of ethylene glycol	Freezing point
35	–20° C (– 4° F)
45	–30° C (–22° F)
50	–35° C (–31° F)

The capacity of the fresh-water system is about 12 liters (2.65 Imp.galls. =3.15 US galls.).

Flush the whole cooling system before adding anti-freeze fluid, check all hoses and connections, and correct any leakage that is found. After the cold season, the whole system should be drained and well flushed before filling up with fresh-water.

NOTE. We advise against using the same anti-freeze solution for more than one winter season.

Adjusting the trim of the boat (AQD 29)

To get the maximum possible speed out of the boat it is most important to make sure that the outboard drive is in the correct trim position. Therefor there are three holes in the bracket on the transom shield. The rear hole is counted as no. 1 (see Fig. 7). When the transom forms an angle of 78° with the bottom of the boat, the adjusting pin should normally be placed in hole no. 2, where the most favourable angle for the universal joint is obtained. If the transom angle is not 78° or if the weight distribution on board and the shape of the hull is such that the boat does not assume the correct position for maximum speed, this can be adjusted by moving the adjusting pin to one of the other holes in the shield as follows:

If the boat is "stern-heavy", this is corrected by moving the adjusting pin to hole no. 3, and if the boat is "nose-heavy", the adjusting pin is moved to hole no. 1.

Trailing (AQD 29)

To prevent that the outboard drive is shaking down from its tilted-up position when trailing, the equipment includes a retaining clamp which is fitted as follows:

Tilt up the drive to its maximum tilting position and place the clamp handle against the yoke. Press together the lower part of the clamp so that both the pins can be placed in the holes in the transom shield just above the adjusting pin.

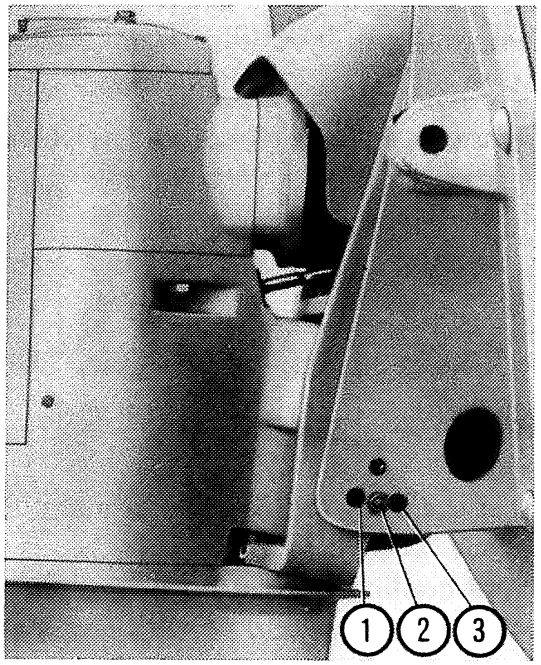


Fig. 7. Holes for the adjusting pin

1. Position to correct "nose-heavy" tendency
2. Normal position
3. Position to correct "stern-heavy" tendency

Engine unit

Cylinder block

The cylinder block is made of cast iron and is integral with the upper part of the crankcase. It is fitted with replaceable, wet-type cylinder liners. The cylinder liners have an upper flange, which is locked in its position by the cylinder head. To prevent coolant from penetrating into the crankcase, the cylinder liners are provided with a rubber sealing ring at the bottom. At the top, they are sealed by the cylinder head gasket.

For the lubrication of the engine there are channels drilled to the main and connecting rod bearings, camshaft bearings and auxiliary drive gears.

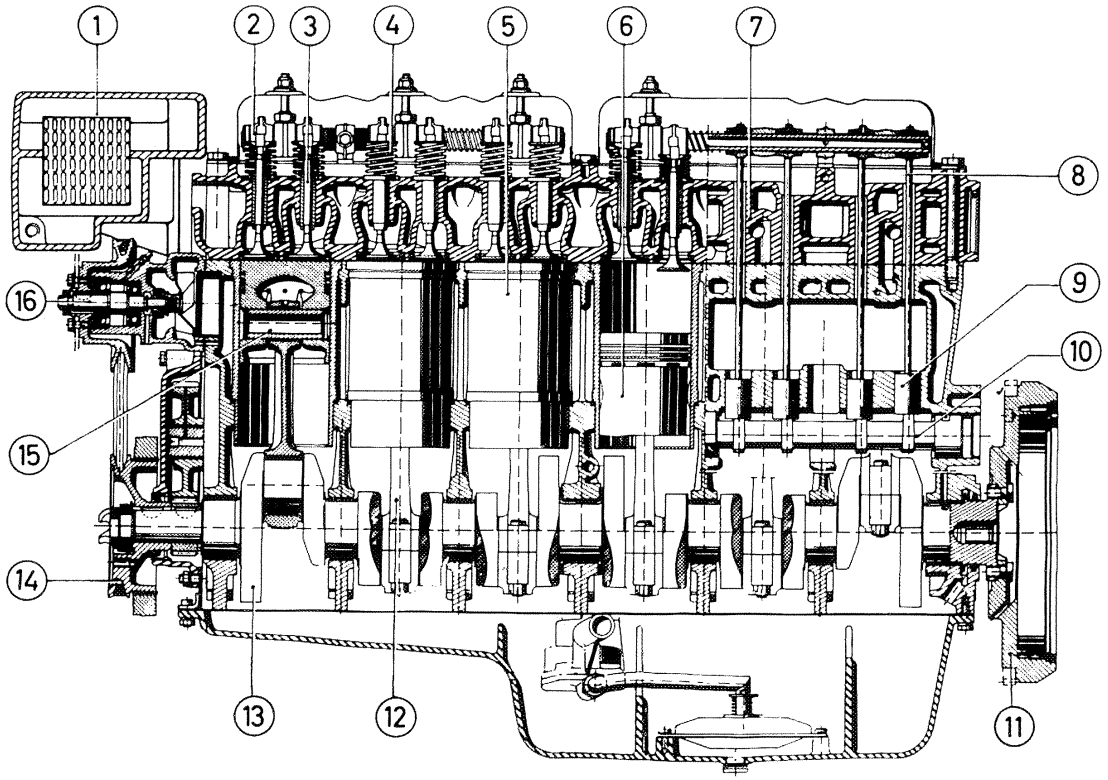


Fig. 8. Cross-section of the engine

1. Heat exchanger
2. Rocker arm
3. Valve
4. Valve spring
5. Cylinder liner
6. Piston
7. Cylinder head
8. Push rod
9. Valve tappet
10. Camshaft
11. Flywheel
12. Connecting rod
13. Crankshaft
14. Pulley
15. Piston pin
16. Fresh-water pump

Cylinder head

The cylinder head is made of cast aluminium alloy and has replaceable valve seat inserts and guides. The valves, swirl chambers with injectors and glow plugs are also fitted in the cylinder head.

Crankshaft

The crankshaft is made of drop-forged steel. It is carried in seven main bearings. The centre bearing serves as a pilot bearing. In the crankshaft, oil channels are drilled for feeding the lubricating oil from the main bearings to the connecting rod bearings. The bearing cups, which are replaceable, consist of a steel shell lined with indium-plated lead-bronze.

Camshaft and auxiliary drive gears

The camshaft and injection pump are driven by means of gears from the crankshaft. The crankshaft gear and the intermediate gear are made of steel, whereas the injection pump and camshaft gears are made of cast iron. The camshaft is made of special-alloy cast iron.
The valve tappets are actuated directly by the camshaft. They are fitted in ground holes in the cylinder block above the camshaft and transmit the movement to the valves through push rods and rocker arms.

Connecting rods, pistons, piston rings

The connecting rods are made of drop-forged steel and are at the top fitted with bushes as bearings for the piston pins.
The pistons are made of aluminium alloy and have three compression rings and one oil scraper ring.

Lubricating system

The engine is provided with a complete pressure lubrication system which is shown schematically in Fig. 9. The pressure is produced by means of a gear pump which forces the oil through channels out to the lubricating points. The pump is driven by a worm gear from the camshaft.

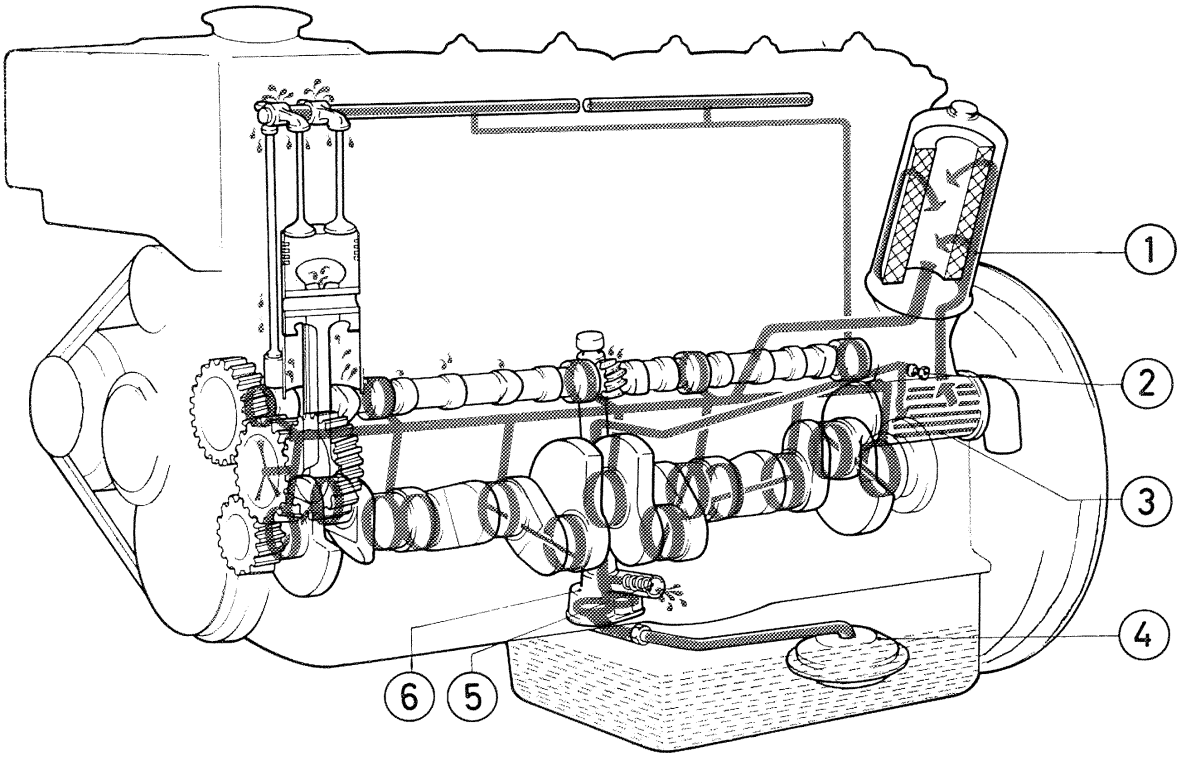


Fig. 9. Lubricating system

1. Oil filter
2. By-pass valve
3. Oil cooler
4. Oil strainer
5. Reducing valve
6. Oil pump

The oil filter is of the full-flow type and is replaceable as a complete unit. It is connected to the oil cooler on the port side of the cylinder block and is fitted with a by-pass valve.

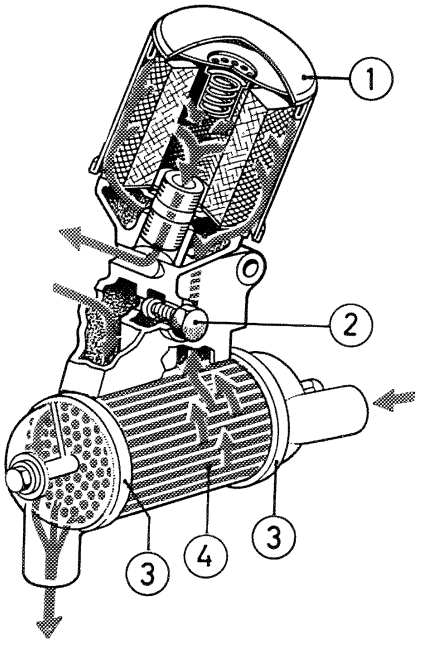


Fig. 10. Combined oil filter and oil cooler

1. Oil filter
2. By-pass valve
3. End cover
4. Oil cooler

The oil cooler is of the tube type in which the sea-water passes through the longitudinal tubes while the lubricating oil circulates around the tubes. When the oil is cold, a by-pass valve (2, Fig. 10) opens and lets the oil by-pass the oil cooler and go directly to the oil filter in order to allow the oil to reach the various lubricating points quickly when the engine is started from cold.

Oil from the oil pan is drawn up through the oil pump strainer and then fed through a reducing valve built into the pump. The oil is then fed through the oil cooler and oil filter out into a channel which branches off to all main, connecting rod and camshaft bearings, and through a branch up to the valve mechanism. An oil pressure warning lamp is connected to the lubricating system.

Fuel system

The fuel system consists of a fuel feed pump with pre-filter, fine filter with water separator, injection pump of the distributor type, injectors and fuel lines.

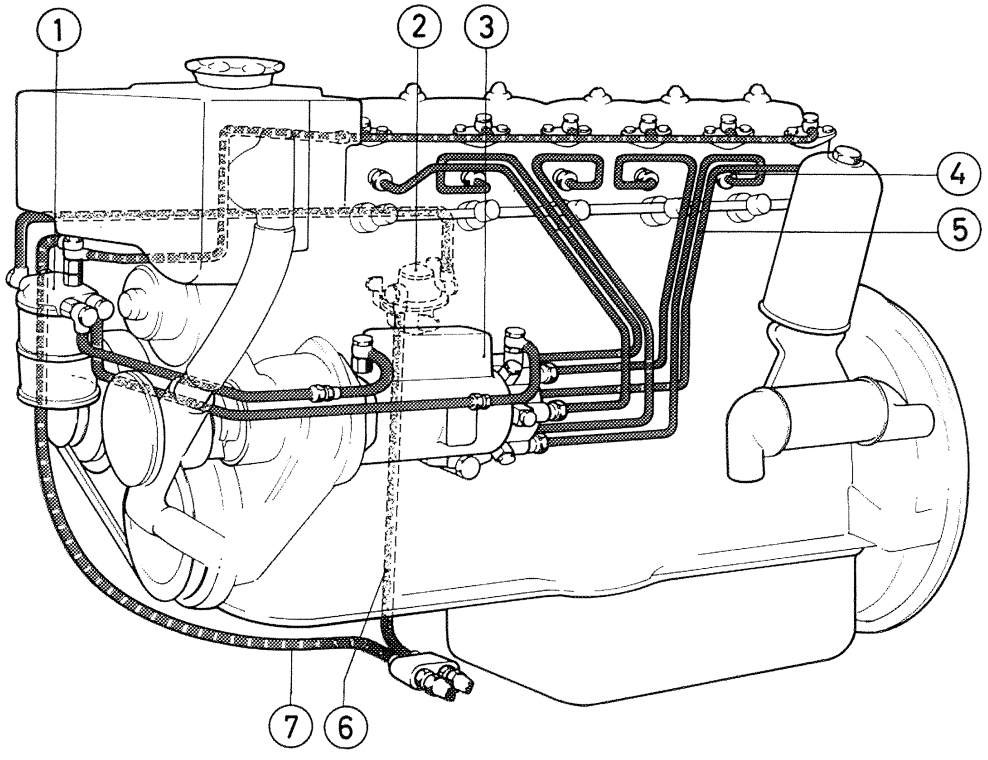


Fig. 11. Fuel system
Broken lines indicate return lines.

1. Fine filter
2. Feed pump
3. Injection pump
4. Injector
5. Delivery pipe
6. Fuel line from tank
7. Return line

Injection pump CAV Roto-Diesel DPA

Description

In the main the distributor pump consists of a distributor rotor with two plungers working against each other, a distributor housing with transfer pump and a governor. See Fig. 12. The pump, which is driven by a shaft provided with splines, is flange mounted. It is made as a closed fueltight unit and does not have any special lubricating system. When running, the pump housing is completely filled with fuel oil under pressure, which provides good lubrication for all components in the pump. This pressure also prevents dust and dirt from entering, as well as the forming of air locks.

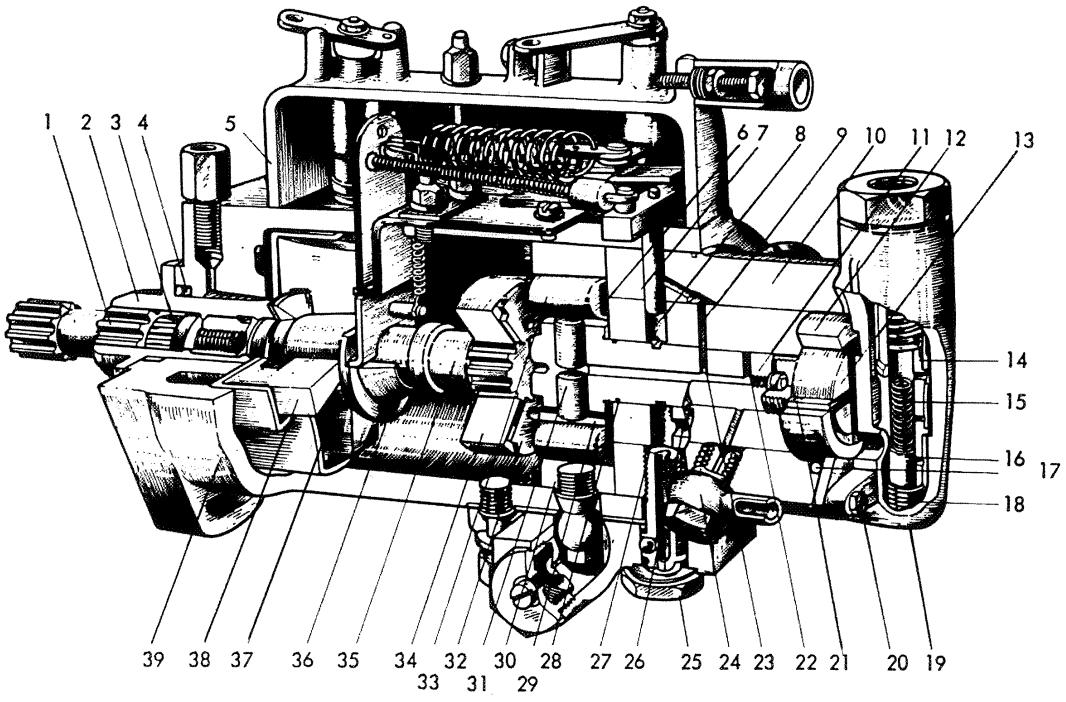


Fig. 12. Cross-section of injection pump

1. Outer drive shaft
2. Drive hub
3. Lock screw
4. Sealing ring
5. Governor housing
6. Inner adjusting plate
7. Metering valve
8. Fuel channel
9. Inlet channel
10. Hydraulic head
11. Distributor rotor
12. Eccentric ring
13. Transfer pump hub
14. Regulating spring sleeve
15. Regulating spring
16. Regulating piston
17. Sealing ring
18. Hand feeding spring
19. Regulating valve housing
20. Screw
21. Pump wing
22. Distributor channel
23. Inlet channel
24. Pressure pipe connection
25. Drilled bolt
26. Fuel channel
27. Groove
28. Groove
29. Roller guide
30. Camring
31. Pump plunger
32. Outer adjusting plate
33. Roller
34. Drive plate (Rotor)
35. Drive shaft
36. Pressure sleeve
37. Weight carrier
38. Governor weight
39. Pump housing

Pumping of the high pressure fuel is done by two plungers working against each other which are cross-mounted in the rotor, which also serves as a distributor of the high pressure fuel to the injectors. The amount of fuel is governed by a metering valve, which is actuated by a governor. Thus a correctly balanced amount of fuel is distributed under high pressure to the respective injectors through channels in the distributor rotor and the hydraulic head.

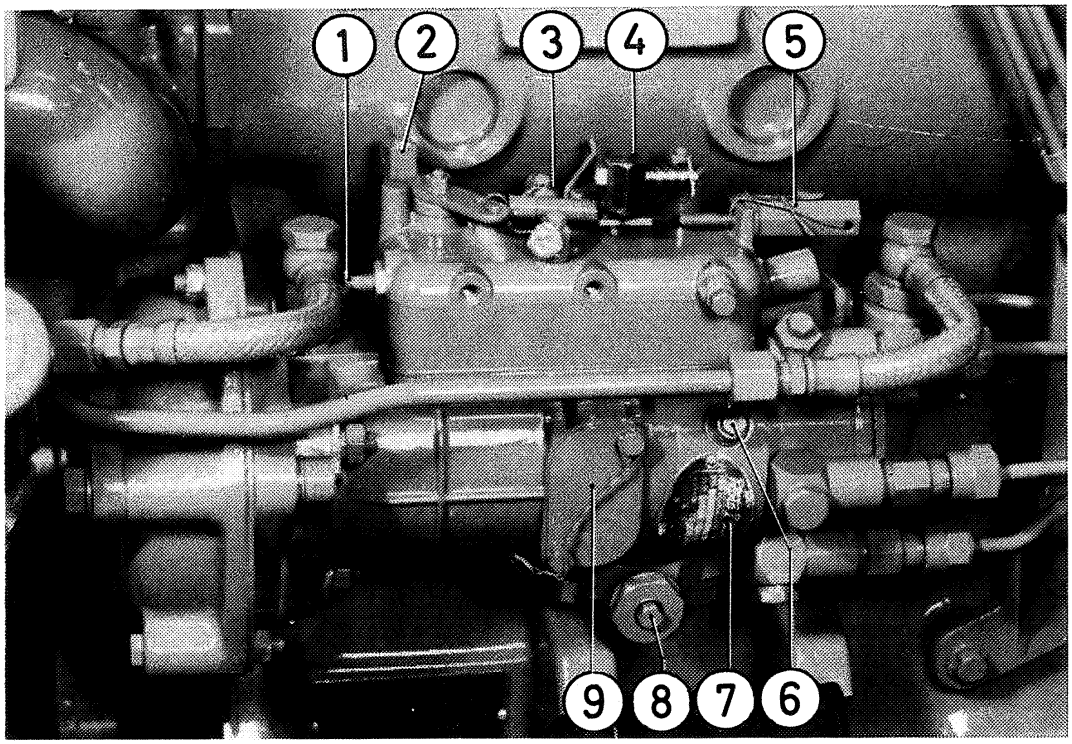


Fig. 13. Outer view of injection pump

1. Anti-stalling device
2. Connection for stop control cable
3. Idling screw
4. Connection for throttle control cable
5. Stop screw for maximum RPM
6. Air vent screw
7. Data plate
8. Automatic advance
9. Cover

The pump is equipped with a mechanical governor and an automatic speed advance mechanism, which varies the timing for the beginning of the injection, whereby the best possible engine performance is obtained.

The separate feed pump delivers fuel to a filter, which is equipped with a water separator. From the filter the fuel is fed on to the transfer pump. The transfer pump impeller is fitted in the rear end of the distributor rotor. This transfer pump delivers fuel to the pump plungers in the distributor rotor via the metering valve. The capacity of the transfer pump is several times bigger than the requirement of the injection pump. The surplus fuel is led back to the suction side of the transfer pump via the metering valve.

The transfer pump pressure is controlled partly by the spring pressure in the regulating valve, partly by the RPM.

The metering valve is shaped as a cylindrical shaft in which a groove is cut. By turning the shaft, the fuel flow is governed. The position of the metering valve is controlled by the spring force acting from one side and the governor force acting from the other side. The valve always assumes a position where there is balance between these forces. The spring force is changed by means of the throttle control.

From the metering valve the fuel goes to the inlet channel of the hydraulic head and from there into the distributor rotor. The pump plungers then press the fuel out to the injectors via the distributor channel and delivery pipes.

Some of the fuel never passes through the metering valve but is fed out into the pump housing via grooves in the distributor rotor and lubricates the components in the pump.

Injectors

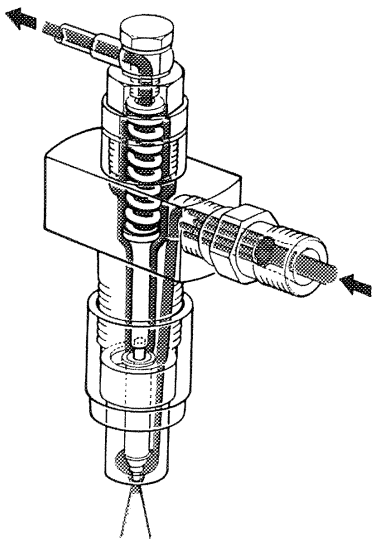


Fig. 14. Injector

The purpose of the injectors is to "atomize" the fuel and to supply the combustion chamber with the exact amount of fuel governed by the injection pump. In order to "break down" the fuel effectively, injection takes place under high pressure. The fuel from the injection pump (shown in red in Fig. 14) is fed through a passage in the nozzle holder to the fuel chamber in the lower part of the nozzle. When the pressure of the fuel fed from the pump has increased sufficiently to lift the nozzle needle, which is held against its seat under spring pressure through the push rod, the fuel is injected under high pressure through the nozzle into the combustion chamber in the form of a mist.

The spring force is adjusted by means of washers in order to obtain the correct injection pressure. It is most important for the correct functioning of both the injectors and the engine that each nozzle is adjusted to the opening pressure specified in "Technical data".

The leak-off oil (shown in blue in Fig. 14), which penetrates past the needle, rises up through the hole in the centre of the retainer for the leak-off oil line connection, through which it is then led off. The leak-off oil is necessary for cooling and lubricating the nozzle needle.

Fuel filter

The engine is equipped with two fuel filters, a relatively coarse pre-filter, which is built into the fuel feed pump, and a fine filter.

The pre-filter consists of a metal net in which the more coarse impurities are separated.

The fine filter, combined with water separator, consists of an upper part fitted with a paper insert and a lower, transparent container.

When the fuel passes through the paper insert, the small solid impurities, which may have passed the pre-filter, are separated. The water drops, which may be in the fuel, are precipitated on the outside of the insert and collected in the lower container. The filtered fuel passes through the centre pipe up to the cover and then on to the injection pump.

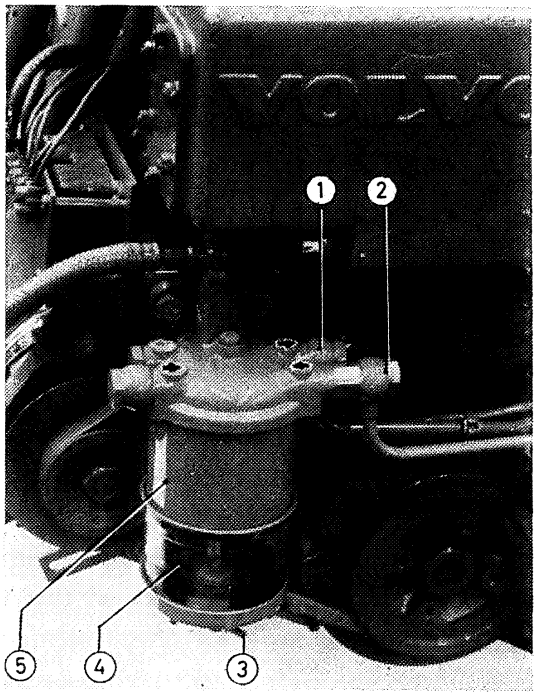


Fig. 15. Fine filter

1. Outlet to injection pump
2. Inlet for return fuel from pump
3. Drain cock
4. Container
5. Filter (replaceable as a complete unit)

Cooling system

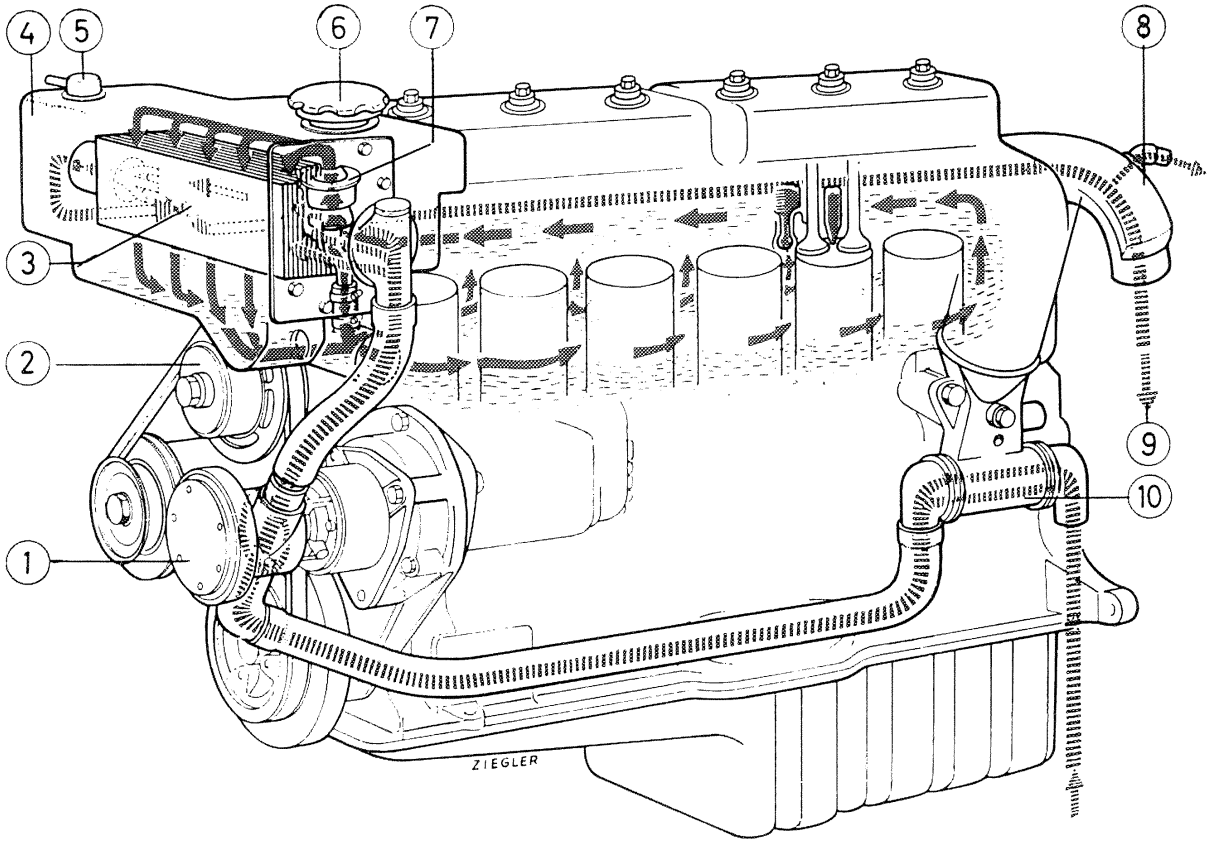


Fig. 16. Cooling system

- - - - - - broken line=sea-water
——— unbroken line=fresh-water

1. Sea-water pump
2. Circulation pump, fresh-water
3. Sea-water inlet to exhaust manifold cooling jacket
4. Heat exchanger
5. Over-pressure valve
6. Filler cap
7. Thermostat
8. Water-cooled exhaust bend
9. Outlet, cooling water
10. Oil cooler

In order to ensure efficient cooling of the engine under different operating conditions, the cooling system is divided into two separate systems, a fresh-water system and a sea-water system.

Fresh-water system

The coolant circulation takes place by means of a pump fitted on the front of the engine (2, Fig. 16). The pump draws coolant from the lower part of the heat exchanger and forces it into the cylinder block. In the cylinder block the coolant first cools the cylinder liners and then passes to the cylinder head. The coolant then flows through a thermostat (7) to the upper part of the heat exchanger. In the heat exchanger (4) the coolant passes down through a tubular system, where it is cooled down by the sea-water.

As long as the coolant is cold, the thermostat keeps the passage to the heat exchanger closed. Instead, the coolant passes through a by-pass line directly back to the suction side of the pump. This means that the engine quickly reaches operating temperature and at the same time the engine temperature is prevented from becoming too low during cold weather.

The fresh-water system is provided with an over-pressure valve (5) which permits a positive pressure to be maintained in the system. This raises the boiling point of the water and reduces evaporation.

Sea-water system

The sea-water pump (1) is fitted on the transmission cover and is driven by the injection pump gear wheel through a dog clutch. The pump housing is made of bronze throughout. The shaft is made of stainless steel and is carried in double, totally enclosed ball bearings. The impeller is made of neoprene rubber. The function is shown in Fig. 17.

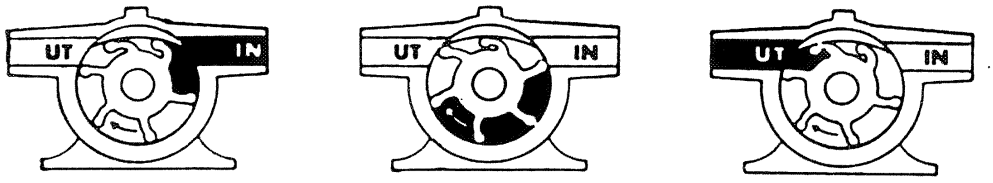


Fig. 17. Function of sea-water pump

The sea-water pump draws cooling water through the engine oil cooler and then feeds it through the heat exchanger and exhaust manifold cooling jacket to the exhaust bend (8, Fig. 16). Part of the outgoing water passes through the exhaust line for cooling this, and part is led through separate outlets.

In order to protect the material that comes into contact with sea-water from corrosion due to galvanic currents, zinc electrodes are built into the heat exchanger. When the electrodes have been used up, they must be replaced with new ones (see "Servicing", point 20).

Electrical system

The voltage of the electrical system is as standard 12 V. The system includes a current and voltage regulated alternator which is driven from the crankshaft by means of a V-belt.

The starter motor is a four-pole series motor. Engagement is done by means of a sliding pinion which is controlled by a solenoid fitted on the starter motor which also cuts in the starting current.
The engine is provided with glow plugs, the purpose of which is to warm up the combustion air in the swirl chambers, thereby facilitating starting when the engine is cold. The glow plugs are single-pole and connected in parallel.

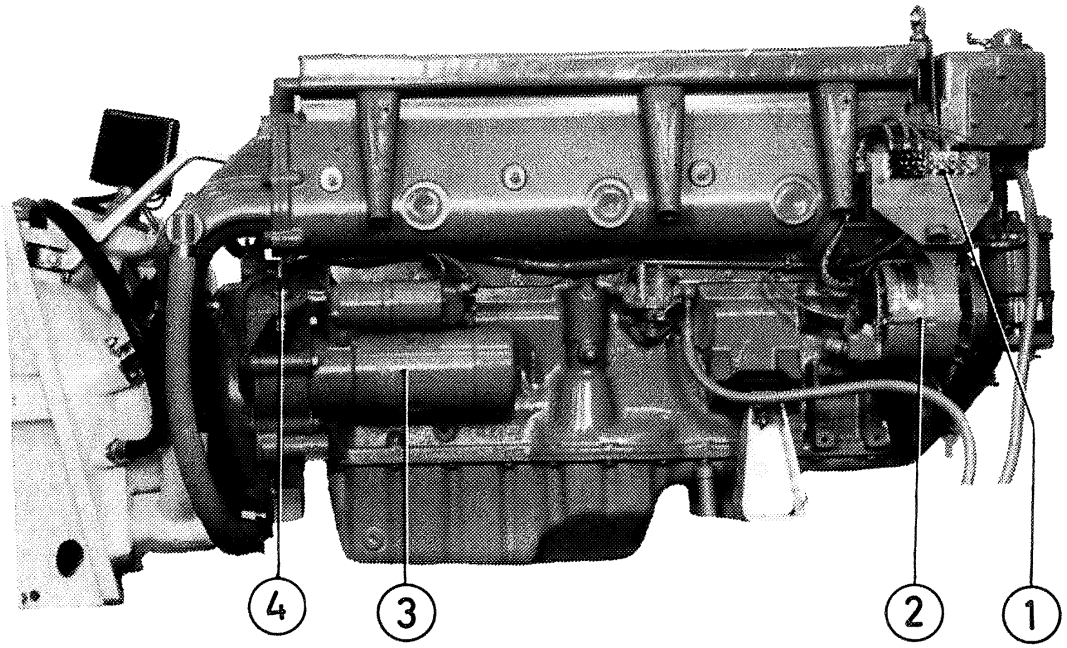


Fig. 18. Electrical equipment

1. Terminal board
2. Alternator
3. Starter motor
4. Master switch (only AQD 29/200)

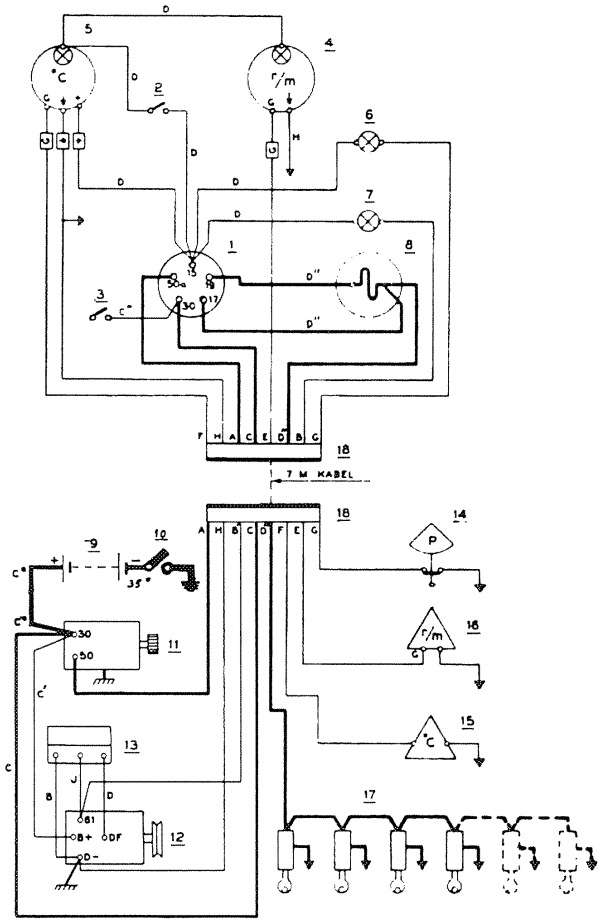


Fig. 19. Wiring diagram Engine

KEY TO WIRING DIAGRAM

1. Key switch
2. Switch for instrument lighting
3. Switch (reserve)
4. Tachometer (VDO)
5. Coolant thermometer
6. Warning lamp for "low oil pressure"
7. Charging control lamp
8. Control resistance
9. Battery
10. Master switch (only AQD29/200)
11. Starter motor
12. Alternator "MOTOROLA"
13. Charging regulator "MOTOROLA"
14. Oil pressure sending unit
15. Temperature sending unit
16. Engine speed sending unit
17. Glow plug
18. Plug-in connector

CABLE MARKINGS

Marked	Color	Sq.mm
A	Ivory	6
B	Black	0.6
B'	Black	2.5
C	Red (+)	16
C'	Red (+)	4
C''	Red (+)	1.5
C*	Red (+)	50
D	Green	0.6
D''	Green	16
E	Grey	1.5
F	Yellow	1.5
G	Brown	1.5
H	Blue (–)	2.5
J	Red	0.6

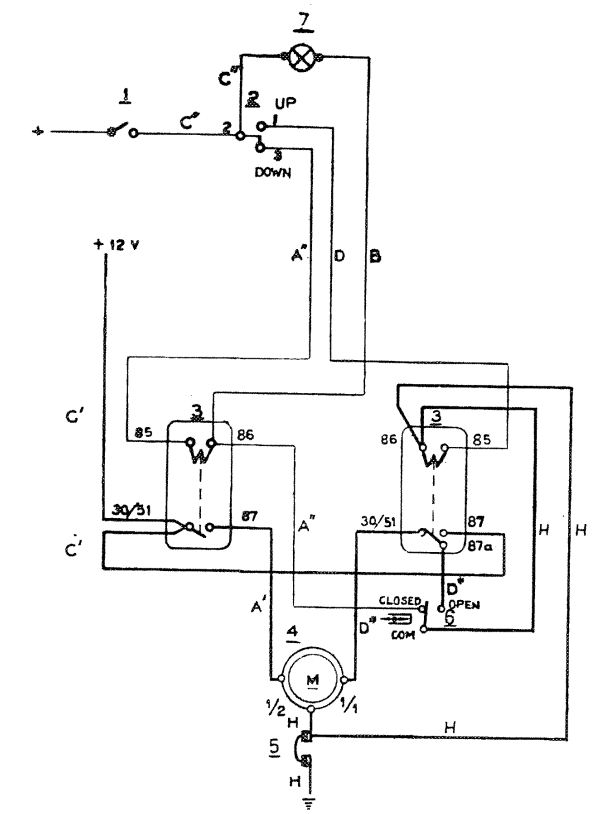


Fig. 20. Wiring diagram Electro-mechanical lift

KEY TO WIRING DIAGRAM

1. Key switch
2. Switch
3. Relay
4. Electric motor
5. Motor cut-out
6. Switch
7. Warning lamp

CABLE MARKINGS

Marked	Color	Sq.mm
A'	Ivory	2.5
A''	Ivory	1.5
B	Black	1.5
C'	Red (+)	2.5
C''	Red (+)	1.5
D*	Green	2.5
D	Green	1.5
H	Blue	2.5

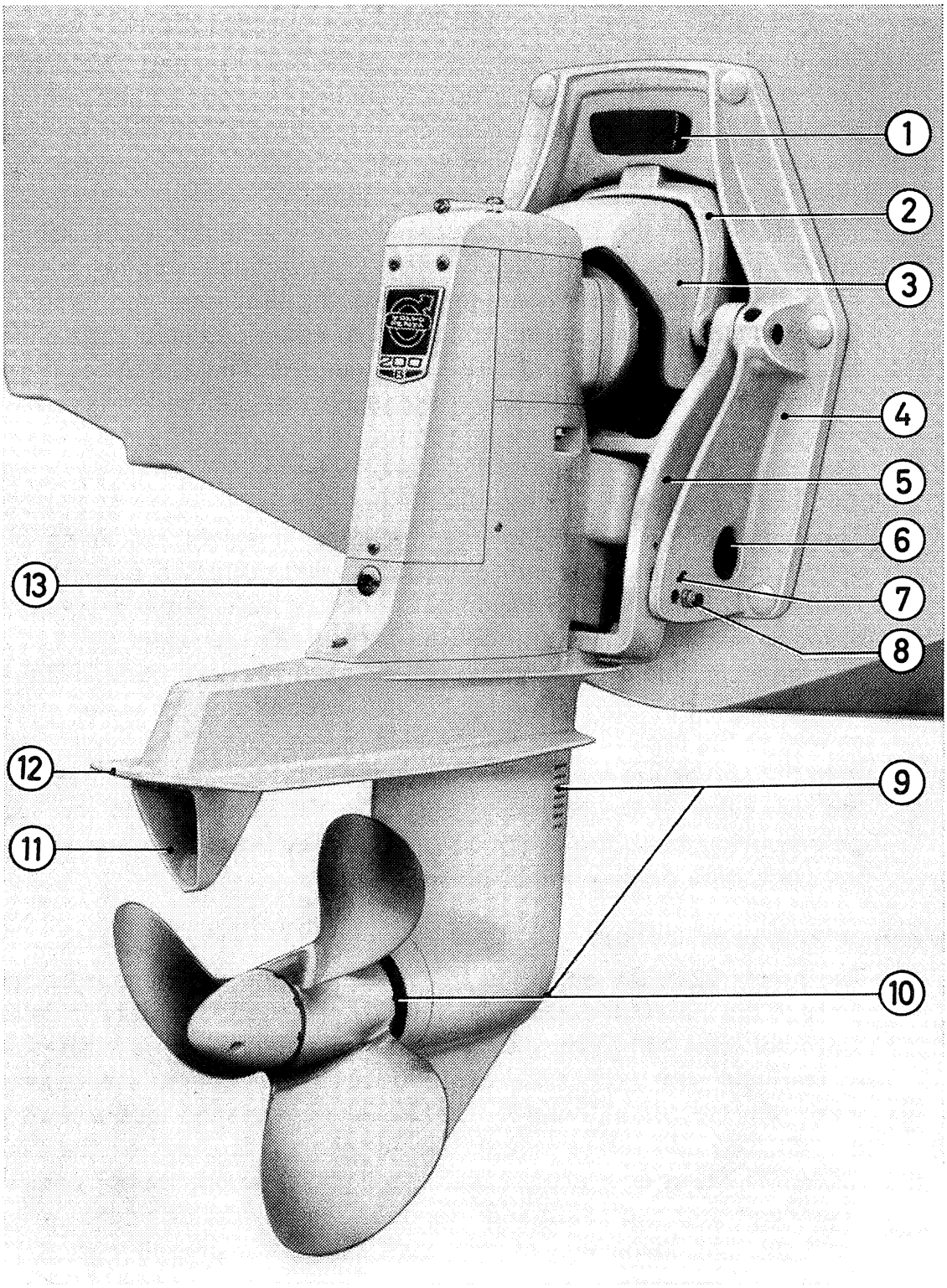


Fig. 21. Model 200 outboard drive

1. Tilting shock absorber
2. Steering fork
3. Steering casing
4. Transom shield
5. Suspension fork
6. By-pass for cooling water
7. Hole for retainer clamp
8. Adjusting pin
9. Cooling water intake
10. Zinc ring
11. Exhaust outlet
12. Cavitation plate
13. Oil filling

General description, model 200 outboard drive

The drive consists of an outboard drive with a mounting shield to be bolted on the outside of the boat transom. The drive functions as a propeller gear for the engine which is mounted on the inside of the transom. The outboard drive and the engine are mounted in the transom shield by means of vibration-damping rubber rings fitted in the shield. The power from the engine is transmitted via a double universal joint which permits the drive to be swivelled both vertically and horizontally. The drive includes taper gears for "Forward", "Reverse" and "Neutral". The shift mechanism consists of the Volvo Penta patented cone clutch, which ensures smooth and silent engagement. The clutch is of type "Silent-Shift" with self-adjusting friction cones and servo disengagement.

This mechanism is operated by a single lever control which is synchronized with the engine throttle control system.

The outboard drive housing and the transom shield are made of a special aluminium alloy with outstanding anti-corrosion properties. A zinc ring is fitted on the lower gear housing behind the propeller in order to eliminate corrosion caused by galvanic currents.

The transom shield contains all the connections and through-fittings for the engine cooling water intake, exhaust and cooling water outlets as well as the control cable for the shift mechanism. The exhaust gases from the engine are led through the outboard drive and pass out under the rear edge of the cavitation plate. On the front edge of the lower gear housing there are a strainer and, further down also a small hole for the engine cooling water intake.

Power transmission

The power from the engine is transmitted to the upper gear housing through the vibration damper (20, Fig. 22), the shaft (18) and the double universal joint (4). From the universal joint the power is transmitted to the input gear (1, Fig. 23) of the reverse gear, which is in constant mesh with the gears (2 and 7). These gears are carried on the shaft (8) so that they can rotate independant of the shaft. Between the gears (2 and 7) there is a cone clutch (7, Fig. 22) which makes possible disengagement and reversal of the direction of rotation of the vertical shaft (8). The lower end of this shaft drives the propeller shaft (12) through taper gears.

Shifting

The vertical shaft (8, Fig. 23) is provided with a thread between the forward and reverse gear wheels (7 and 2) and on this thread the engaging sleeve (3) can be moved up and down by means of the control mechanism (5).

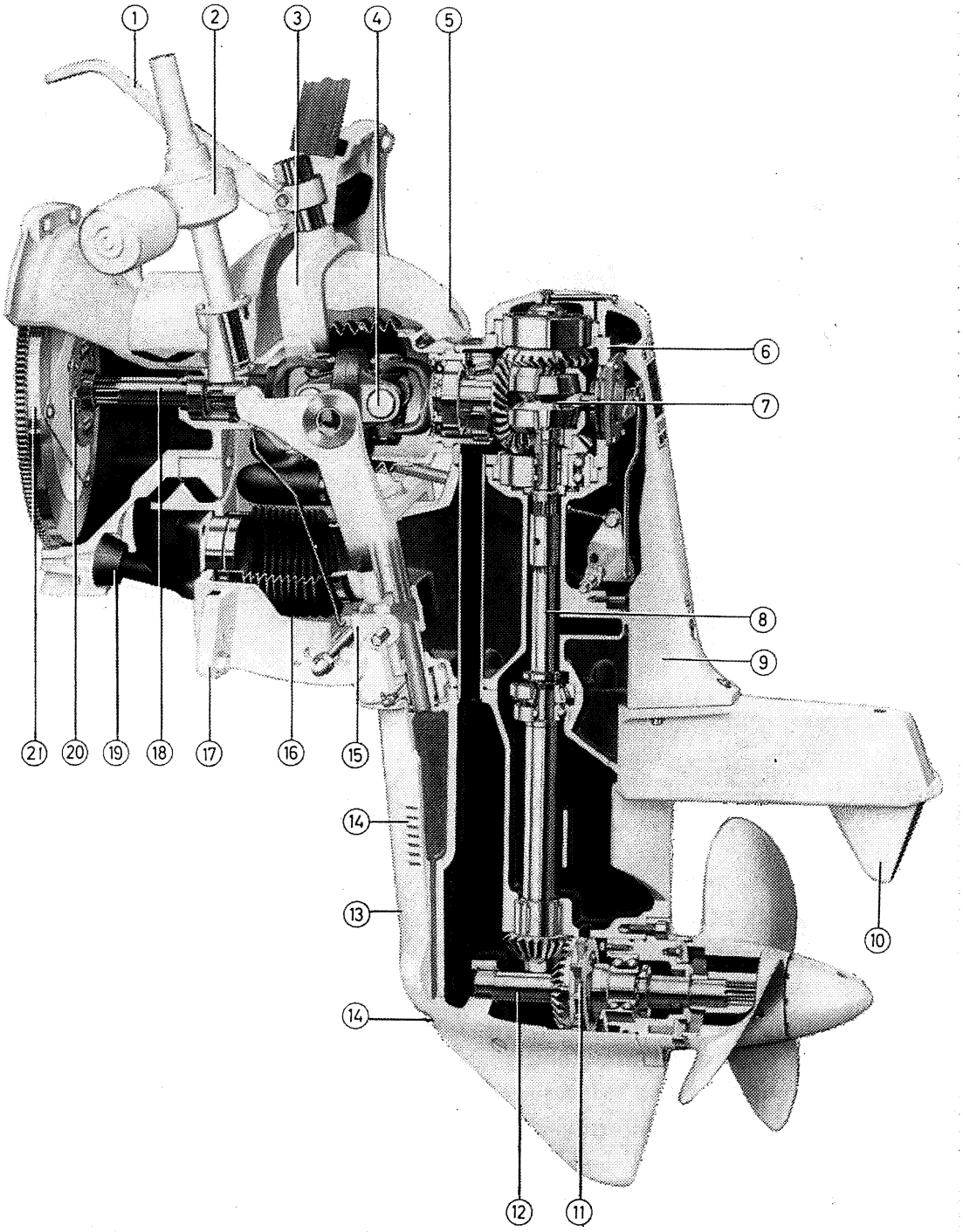


Fig. 22. Cross-section of the outboard drive

1. Steering arm
2. Lift device
3. Steering fork
4. Universal joint
5. Steering casing
6. Upper gear housing
7. Cone clutch
8. Vertical shaft
9. Intermediate housing
10. Exhaust outlet
11. Oil pump
12. Propeller shaft
13. Lower gear housing
14. Cooling water intake
15. Retaining pawl
16. Exhaust bellows
17. Transom shield
18. Drive shaft
19. Rubber support
20. Vibration damper
21. Flywheel

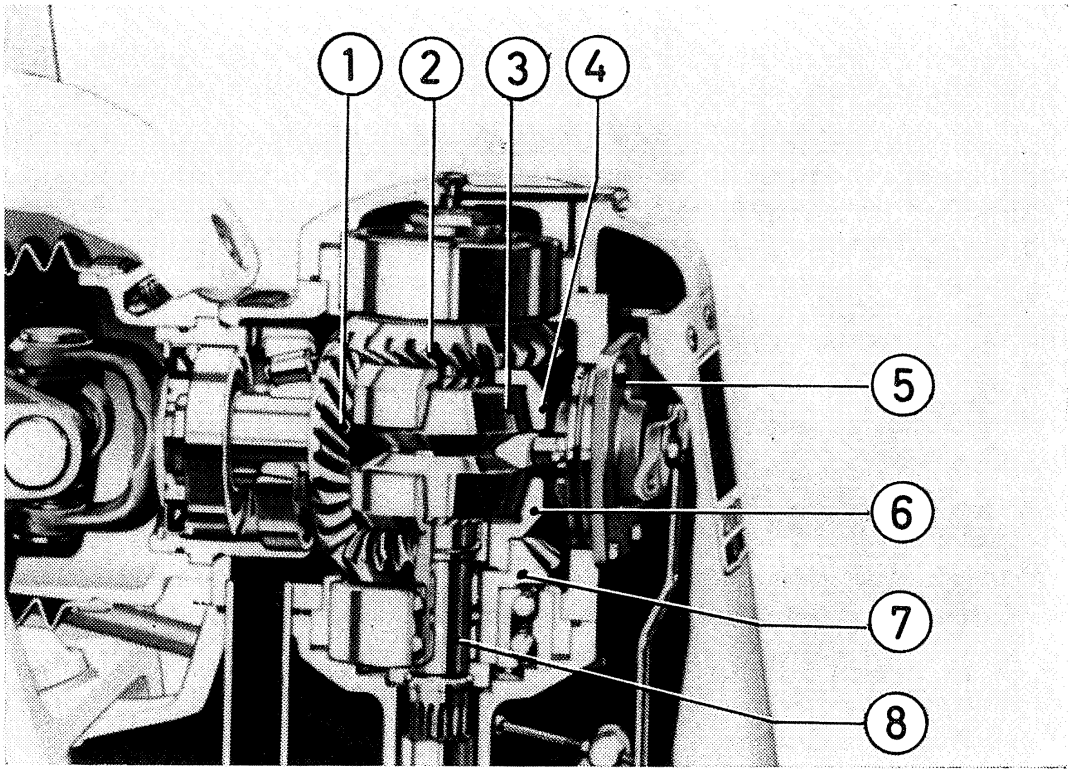


Fig. 23. Upper gear housing

1. Input gear
2. "Reverse" gear
3. Engaging sleeve
4. "Reverse" cone
5. Control mechanism
6. "Forward" cone
7. "Forward" gear
8. Upper intermediate shaft

Both ends of the engaging sleeve are tapered so that when the sleeve is moved upwards or downwards, the tapered surfaces engage with the corresponding cones (4 and 6) which are screwed on to the forward and reverse gears. Since the engaging sleeve (3) is carried on the thread of the vertical shaft, increased transmission torque from the engine causes the engaging sleeve to press harder against the cone, which results in increased friction and more positive engagement.
When the control lever is moved to the "Forward" position, the engaging sleeve (3) engages with the cone (6) on the lower gear so that the vertical drive shaft (8) is locked in engagement with the gear. The propeller will then rotate for running forward. When the control lever is moved to the "Reverse" position, the engaging sleeve is moved upwards until it engages with the cone (4) on the upper gear, whereby the opposite direction of rotation is obtained. In the neutral position, the engaging sleeve is retained in an intermediate position so that both the gears rotate freely. The gear arrangement described above gives standard propeller shaft rotation, which means a propeller with left hand thread.

In the case of opposite propeller rotation, the upper gear (2) functions as forward gear and the lower (7) as reverse gear.
When running in reverse, the outboard drive is kept in its normal position by means of a retaining pawl (15, Fig. 22).

Steering

The steering of the outboard drive is obtained by transmitting the steering wheel movements through a steering arm (1, Fig. 22), which is located inside the transom and attached to the steering fork (3). The steering arm is independent of the tilting of the drive. The lower parts of the fork arms are carried in a steering casing (5) which is, in its turn, bolted to the upper part of the outboard drive. The steering angle of the outboard drive is about 30° from the neutral position. Since the direction of the propeller driving force is altered when the drive is turned, this gives the boat excellent steering properties.

Lift device

In order to facilitate the tilting-up of the drive, this is fitted with an electro-mechanical lift device (2, Fig. 22) which is operated from the driver's seat. The lift device is mounted on the inside of the transom shield and consists of an electric motor which actuates the suspension fork with a push rod via a worm gear. The push rod releases the retaining pawl and pushes the drive into tilted-up position. The electric motor stops automatically when the drive has reached its fully tilted as well as its fully lowered position. When the drive is being tilted up, it is automatically centered independent of the position of the steering wheel. The maximum tilting angle is about 65°.

Lubricating system

The drive has an oil system which is common to both the upper and the lower gear housing. The oil is circulated to all gears and bearings by means of a circulation pump (11, Fig. 22) fitted on the gear in the lower gear housing. The water which flows past the lower part of the outboard drive cools the oil.
A dipstick to check the oil level is fitted in the cover on the upper gear housing of the drive. The oil level is checked with the drive in the driving position. The double universal joint is lubricated for life and requires no periodical servicing. The drive shaft is supported by a bearing in the flywheel housing and is lubricated with grease through a grease cup located on the upper side of the flywheel housing. The lower bearing of the steering shaft is lubricated with grease through a lubricator located on the suspension fork.

Reverse and reduction gear

Volvo Penta RB

Volvo Penta reverse and reduction gear type RB has a built-in reduction gear with ratio 1.91:1. "Forward" or "Reverse" is engaged through self-adjusting cones which are kept in engaged position partly by means of the propeller thrust. In the reverse gear housing there is a cooling jacket for sea-water cooling.

When "Forward" is engaged, the output shaft and its cone are moved forwards and interlocks with the front cone. The power from the engine is transmitted from the gear on the crankshaft to the inner gear ring on the front cone.

When "Reverse" is engaged, the output shaft is moved backwards and the rear cone is interlocked. This is driven through an intermediate gear and the rotation of the output shaft is thus reversed.

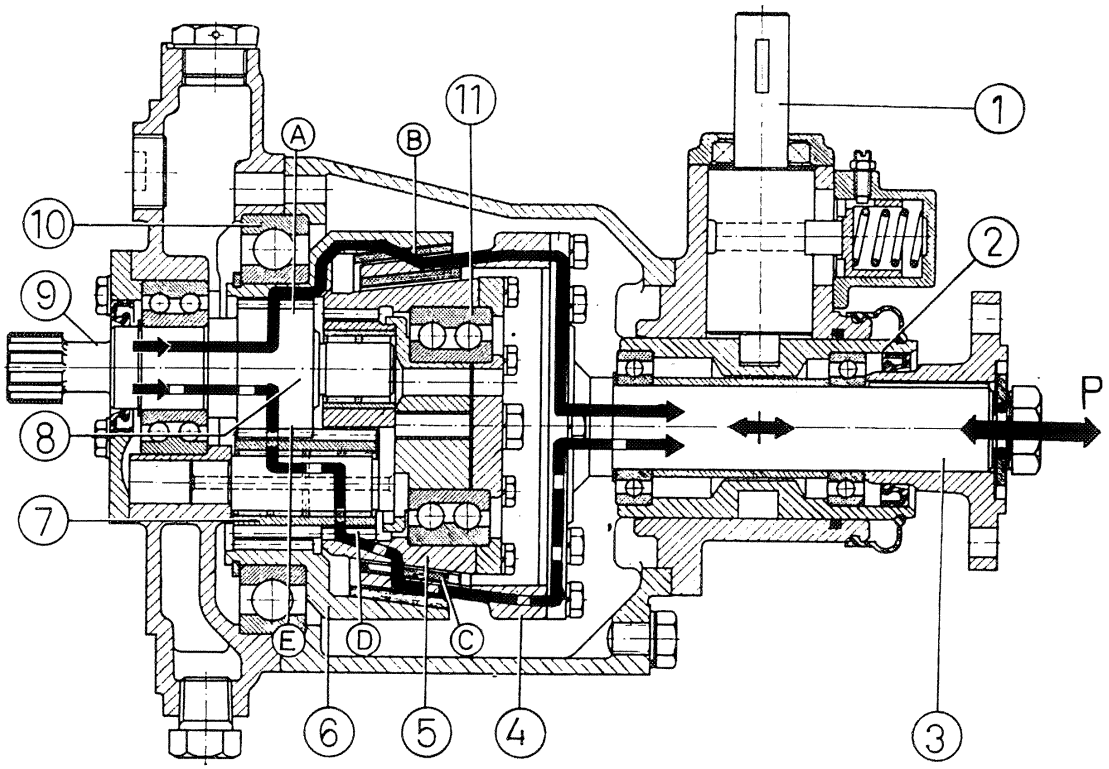


Fig. 24. Reverse and reduction gear RB (ratio 1.91:1)

"Forward" =Thick red umbroken line
"Reverse" =Thick red broken line
P =Propeller thrust

1. Control lever
2. Bearing sleeve
3. Output shaft
4. Cone
5. Gear with cone
6. Gear with cone
7. Reverse gear
8. Input shaft gear
9. Input shaft
10. Ball bearing
11. Ball bearing

Warner Gear (Velvet Drive)

This reverse gear is hydraulically operated and fitted with a separate oil cooler. For running "Forward", the reverse gear is fitted with a multi-disc clutch, the discs of which are held in engaged position by means of oil under pressure. Reversal of the direction of rotation is done through planetary gears which are also engaged hydraulically.
The input shaft is provided with splines and connected to the engine flywheel through a spring-loaded damper hub.
The reduction gear consists of a planetary gear unit with helical gears, and the gear wheels are carried in needle bearings. The unit is lubricated through pressure lubrication and splash lubrication.

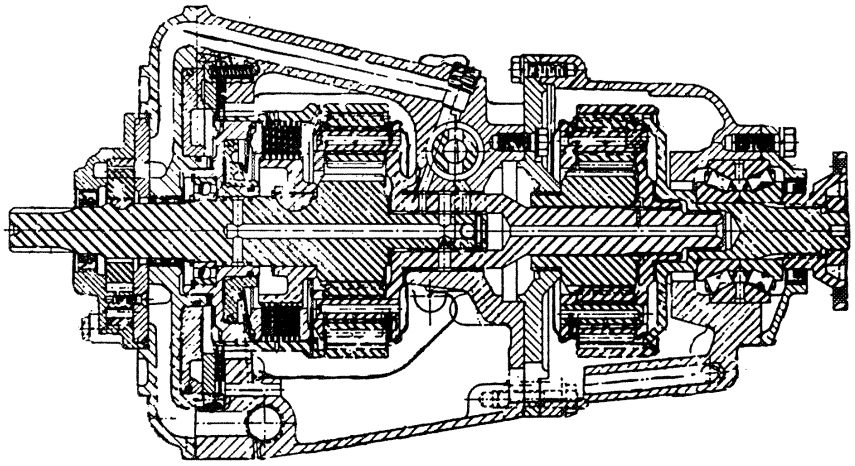


Fig. 25. Hydraulically operateed reverse gear, make Warner Gear

Running "Forward"

In the "Forward" position, the oil is directed by the control valve through a drilled channel in the input shaft to a pressure plunger which compresses the disc assembly. The drive shaft from the engine thereby locks the input shaft to the reduction shaft, since the planetary gears are forced to function merely as a carrier. The maximum pressure of the oil is limited by means of a reducing valve.

Running "Reverse"

When "Reverse" is engaged, the disc assembly for running "Forward" is disengaged but the planetary gear housing is locked by the oil being directed to a plunger which compresses the discs which are connected with splines to the planetary gear housing.

The planetary gears are thus forced to rotate round their own shafts. Since the planetary gears work through an idler gear, the direction of rotation is reversed.

Lubricating oils and fuels

Engine lubricating oils

Modern high-speed marine Diesel engines require high-quality Diesel lubricating oils to ensure maximum operating economy and top performance with a minimum of running interruptions. It is therefor an absolute condition that the correct grade of lubricating oil is used. For these engines only Diesel lubricating oil of grade "Service DS" in accordance with the API system must be used.

Fuel

The fuel to be used for the engine must be of a suitable composition and above all free from impurities. Therefor only use fuel oils of a well-known make.

Suitable fuels are the special Diesel fuel oils for high-speed engines which are available from the different oil companies. Never use fuels of inferior quality, as these easily cause functional disturbances in the injection pump and injectors.

Installation instructions

The following installation instructions refer to MD29 but can also be applied to AQD 29/200 as regards fuel tanks and fuel lines. As to installation of the model 200 C outboard drive we refer to a separate installation handbook for this.

General

If your marine engine is to meet the demands concerning good running results you have every right to make on a top quality product, it is of utmost importance that the installation is carried out properly. Therefor, do not permit anybody but a shipyard with skilled and responsible personnel to carry out the installation. Our extensive experience of service work has shown that the causes behind most faults are due to bad or careless installation. Therefor make sure that the advice and instructions given in the following are carefully followed. If the installation is carried out properly to start with, you avoid later modifications which could be very expensive to you.

Make sure that the installatoin is carried out in accordance with the following instructions and the recommendations issued by boat builder and boating associations or similar organizations in your country.

Engine bed

The engine bed should be made as steady as possible and the attaching bolts must be distributed over as large an area of the hull as possible. If possible, the bed frame should be made of oak and bolted to the hull by means of bolts passing through the hull.

Make sure there is enough space between the propeller and the rudder. The distance between these should be at least 100 mm (4″) to permit removal of the reverse gear. Furthermore there has to be enough clearance between the propeller and the stern bearing so that the propeller cannot press against this.

NOTE. To enable operation of the RB reverse and reduction gear, the propeller must be able to move in the direction of the propeller shaft minimum 7 mm (0.28″) in each direction counted from the position of the propeller shaft when the reverse gear lever is in neutral position.

The engine must not be tilted more than 15° when the boat is under way.

Before the engine is bolted to the engine bed, all engine mounting brackets must be checked to ensure that they are in even contact with the bed frame. If this is not the case, steel or brass shims must be added between the brackets and the engine bed. All attaching bolts must pass through the bed frame.

Great carefulness must be devoted to the alignment of the engine.

Flexible propeller shaft line

If the engine is rubber mounted, the propeller shaft has to be fitted with so called Cutless inserts and rubber mounted stuffing box. The propeller shaft can also be equipped with a flexible shaft coupling that absorbs axial pressures. If the propeller shaft sleeve is rubber mounted, check carefully that there is enough clearance between the shaft and the sleeve tube. **Universal joints must not be used in the propeller shaft line when the engine is equipped with RB reverse and reduction gear.** Also in other installations universal joints should be avoided in the propeller shaft line, since these can easily cause vibrations in case of faulty installation.

Engine alignment

When the boat has been launched, a check should be carried out to make sure there is no variance between the propeller shaft and the engine due to changes in the form of the hull. Repeat this check after 2 to 3 days and then at regular intervals.

Poor alignment between engine and propeller shaft is often the reason for other faults. It may cause vibrations and changes in the hull, rapid wear of shaft and stern fittings as well as severe damages to the reverse gear.

The alignment is carried out as follows: Loosen all bolts in the coupling flange, then rotate the propeller shaft a full turn while the clearance between the flanges is checked with a feeler gauge. This clearance must not exceed 0.05 mm (0.002″).
When the boat has been taken up on a slip or up on land for winter storage, the propeller shaft should be disconnected from the engine in order to avoid stresses in the shaft.

Fuel system installation

Fuel tanks

The fuel tank should be made of stainless steel sheet or of ungalvanized steel sheet with all joints welded. All types of fuel tanks should be fitted with splash plates. The fuel tank should be designed and manufactured to resist an internal pressure of 0.2 kg/cm² (3 lb/sq.in.) without leakage and before being installed it should be pressure tested with at least that pressure.

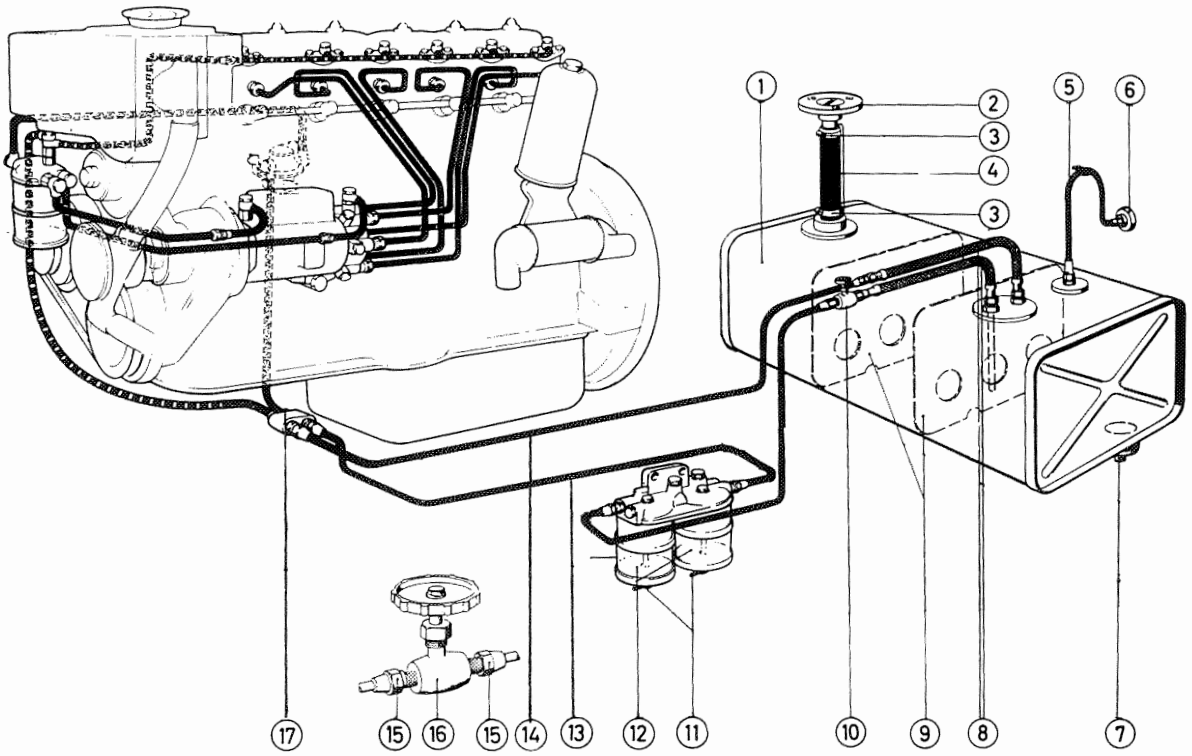


Fig. 26. Suggestion for fuel system installation

1. Fuel tank
2. Deck fitting
3. Pipe clamp
4. Synthetic rubber hose
5. Air-venting pipe
6. Flame arrester
7. Drain plug
8. Flexible fuel hose
9. Splash plate
10. Shut-off cock of needle valve type
11. Drain cock
12. Water separator
13. Fuel line from tank
14. Fuel line to tank
15. Nut for flanged pipe connection
16. Shut-off cock of needle valve type (10)
17. Attaching clamp

Filler connection

The fuel filler should always be located above deck to prevent that fuel is spilled inboard while filling. The inner diameter of the filler pipe should be at least 38 mm (1½″). If possible, the filler pipe should be located in such a way that the contents of the tank can be measured through it. The connection between the filler fitting and the fuel tank can consist of a hose of synthetical material and in that case it should enclose each pipe end to a length of 75 mm (3″) and be fastened by amply dimensioned clamps at each pipe end (see Fig. 26). A ground connection between the filler fitting and the tank should be arranged, for instance by means of a copper wire.

Air-venting pipe

An air-venting pipe should be drawn from the top of the tank to a protected place overboard. For this, a hose of synthetic rubber or copper pipe could be used. The pipe should have an inner diameter of 10—14 mm (about ½″) and at the end it should be bent into a "U", see Fig. 26, to prevent water from penetrating into the tank.

The connection at the tank should be airtight. The outlet should be fitted with a flame arrester, consisting of metal clothing, rolled together and pushed into the pipe end, or a specially shaped flame arrester.

Ventilation

If the fuel tank is built-in, ventilation must be arranged for the enclosure. It should have at least one inlet and one outlet for the air. These in- and outlets should be located outboard, well protected and provided with protective covers. The opening for the inlet should be turned forward and that for the outlet astern. The air outlet should be fitted with a hose with the same cross-sectional area as the inlet. The hose should reach down to the bottom of the enclosure, where gases may accumulate.

Fuel lines

The fuel lines can be made of copper piping, steel piping of type "Bundy" or reinforced rubber hose of approved type. When copper pipes are used, these should be annealed, for instance every other year, to prevent pipe cracks. The fuel lines should normally have a diameter of 5/16″. If the distance between tank and engine exceeds 5—6 meters (15—20 ft.), 3/8″ pipes should be used instead.

The fuel lines should be connected to the upper part of the tank, the suction line through a fuel cock of the needle valve type. Ordinary plug cocks must not be used as shut-off cocks, since these after a period of use may cause fuel leakage. The connection at the tank should consist of flexible fuel hose of a type approved for use with fuel. All connections on the fuel line should be swaged with special tools. If flanges are used, these must be brazed to the pipes.

NOTE. Loose olive type connections or soft soldered flanges must not be used in the fuel lines under any conditions.

Water separator

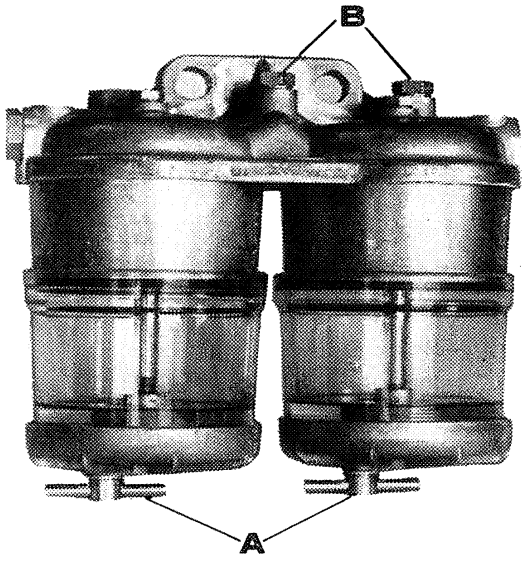


Fig. 27. Dual water separator

A=Drain cocks
B=Air-vent screws

For the engines there is a dual water separator (see Fig. 27) available as extra equipment, which is intended to be fitted on the fuel line between the tank and the pipe clamp (17, Fig. 26).

The water separator should be mounted separately on a bulkhead or bracket beside (not on) the engine.

The line from the tank should be connected to the filter at connection 1, and the line to the engine at connection 3. If 3/8″ steel pipes are used, nipples and nuts have to be exchanged.

Exhaust installation

The exhaust line should be drawn with as few bends and as wide bends as possible.

The engine is as standard fitted with a water-cooled exhaust bend in which part of the outgoing cooling water is mixed with the exhaust gases so that the exhaust line is cooled very efficiently. Therefor the exhaust lines, to advantage, can be made of so called industrial rubber hose with an inner diameter of 57 mm (2¼″) in accordance with Fig. 28.

The outlet of the exhaust line (5) should be located lower than the engine exhaust manifold. Special attention should be paid to ensure that the exhaust outlet is located in such a height position that the water cannot penetrate into the line even when the boat is rolling heavily. This means that at certain installations the exhaust line should be made with an extra upward bend (so called riser) at the through-hull fitting.

When installing an exhaust line of steel or copper a jacketed pipe is usually taken from the engine to a silencer. The cooling water from the jacket is led into the silencer and passes overboard together with the exhaust gases. A connection at the end cover of the exhaust manifold with 2″ pipe thread is available as extra equipment.

NOTE. When the engine is rubber mounted, the exhaust line should always be made flexible by using rubber hose for part of the line or all the way through.

Cooling water installation

The cooling water lines should be made of 1⅛″ rubber hose of a type that cannot be sucked together.

The cooling water intake in the bottom of the boat should be protected by an outside strainer which at the same time serves as water pick-up.

NOTE. The intake end of the strainer should always be turned forward towards the bow of the boat.

When a sea-cock is fitted, this has to be of such a design that it cannot shut itself off. The cock should also be drilled in such a way that in one position it will drain the suction pipe.

Part of the outgoing cooling water passes through the exhaust line in order to cool this, and part is led overboard, see Fig. 28 and 16.

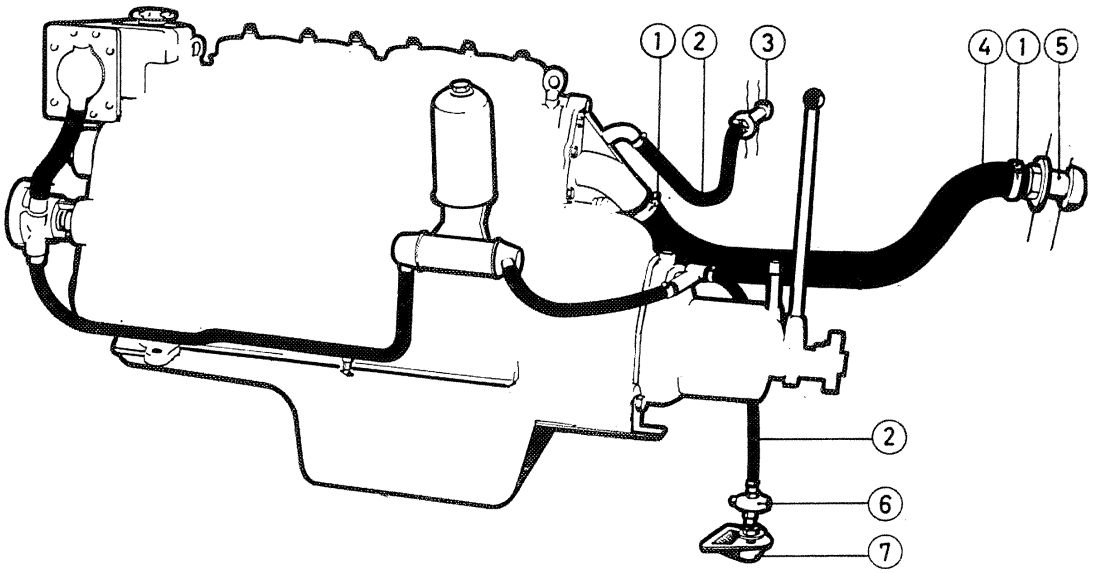


Fig. 28. Suggestion for exhaust and cooling water installation

1. Hose clamp
2. Rubber hose with cord core
   Inlet – 1⅛″ hose
   Outlet – 1″ hose
3. Hull fitting
4. Exhaust rubber hose,
   inner diameter 57 mm (2 ¼″)
5. Hull fitting, R 2 ¼″
6. Sea-cock
7. Outside strainer

Electrical installation

Mount the instrument panel in a suitable place at the driver's seat.
The wiring harness should be drawn in such a way that it is well protected against oil, dirt and mechanical damages. The connection is done in accordance with the wiring diagram, see page 26.
The battery should be located in an easily accessible place as close to the engine as possible. Make a battery box and attach it firmly. The battery box should also be provided with steel straps to ensure that the battery is properly secured in the box.
Connect the cables for navigation lights and other additional power-consuming units at the master switch if such a switch is fitted.

Maintenance scheme

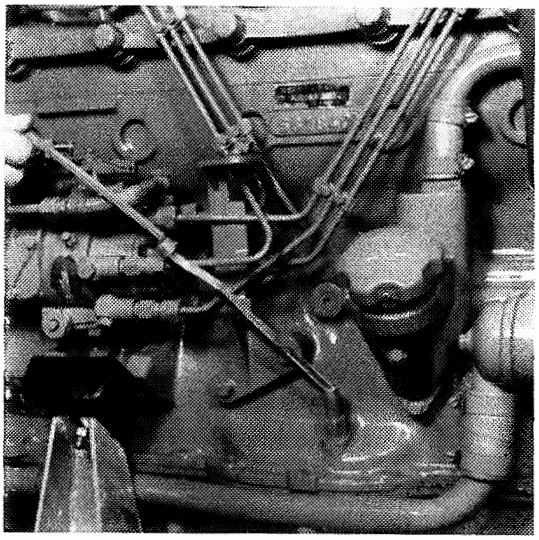
In the following maintenance scheme, consecutive numbers have been assigned to the servicing procedures, and these numbers refer to detailed descriptions on the following pages. Some of the operations require professional experience and special tools, and should therefor be carried out by authorized service personnel.

See point	Operation	To be carried out: Daily before starting for first time	After[1]) 50 hours running	After[1]) 100 hours running
	Lubrication			
1	Check oil level in engine	●		
2	Check oil level in outboard drive	[7]) [8])		
3	Check oil level in reverse gear	●		
4	Change oil in engine		●	
5	Lubricate fresh-water pump		●	
6	Change oil in reverse gear			●
7	Change oil in outboard drive			●
8	Lubricate drive and steering shaft bearings		●	
9	Change oil filter			●
	Engine			
10	Check V-belt		●	
11	Re-tighten delivery pipe clamps		●	
12	Re-tighten cylinder head bolts			●
13	Check valve clearances			●
	Fuel system			
14	Check idling speed		●	
15	Service fine filter	●		
16	Clean pre-filter		●	
17	Change fine filter and air-vent fuel system			[2])
18	Check injectors			[3])
	Cooling system			
19	Check coolant level	●		
20	Check zinc electrodes in heat exchanger		●	
21	Check and clean cooling system			●
22	Check and clean oil cooler			●
	Electrical system			
23	Check electrolyte level in battery	[7])		
24	Check state of charge of battery			●
25	Check glow plugs			●
26	Check alternator and starter motor			[4])
	Reverse gear			
27	Check reverse gear			[2])
	Outboard drive unit			
28	Check zinc ring	●		
29	Check and adjust shift and retaining pawl linkage		●	
30	General inspection			●
	General maintenance instructions			
31	Check and overhaul injection pump			[5])
32	Compression test			[5])
33	Preparing engine and equipment for storage			[6])

[1]) Or once each season if this should occur first. [2]) After 300 hours or once each season. [3]) After 500 hours or once each season. [4]) After 300 hours or every third year. [5]) After 1000 hours or every third year. [6]) When necessary. [7]) Once every 14 days. [8]) Also check the oil level in the outboard drive before launching of a boat equipped with a new or reconditioned AQD 29/200.

Lubrication

❶ Check oil level in engine



Check the oil level every day before starting for the first time. This is done by using the dipstick on the port side of the engine. Before measuring, wipe the dipstick with a clean rag to avoid a faulty reading. The oil level should be between the two marks on the dipstick. Never allow the oil level to fall below the lower mark on the dipstick but do not let it rise above the upper mark either, since this will result in excessive oil consumption. When necessary, top up with new oil through the filling hole which is located on the port side of the engine. Concerning choice of oil grade and viscosity, see point 4.

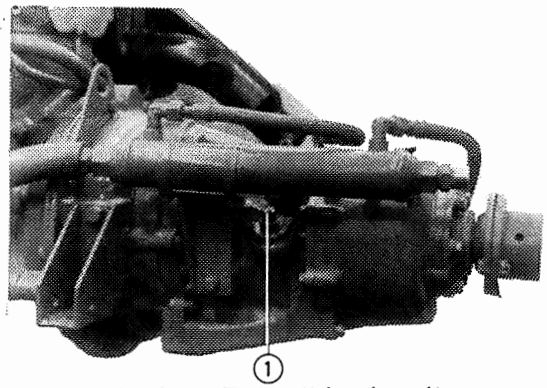
❷ Check oil level in outboard drive (AQD 29)

Once every 14 days, the oil level must be checked. This is done with the drive in its fully lowered running position by using the oil dipstick in the cover on the upper gear housing.

The oil level should be between the mark and the end of the dipstick. The dipstick should not be screwed down during this check. If necessary, fill up with oil of the correct grade and viscosity. This can be done through the hole for the oil dipstick if the additional amount of oil required is very small. (See point 7).

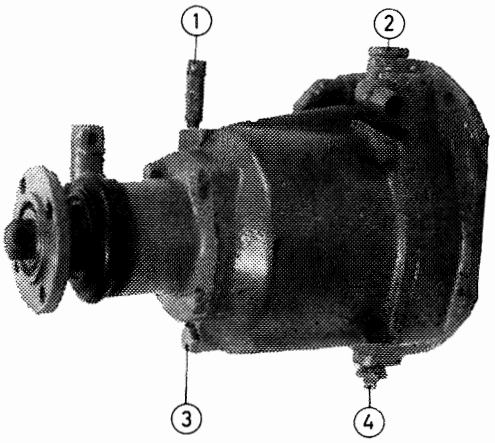
Note the washer under the dipstick!

❸ Check oil level in reverse gear (MD 29)



Warner "Velvet Drive" hydraulic gear

1. Oil filler plug, oil dipstick



Volvo Penta RB mechanical gear

1. Oil dipstick
2. Oil filler plug
3. Oil drain plug
4. Cooling water drain plug

The oil level in the reverse gear should be checked daily before the engine is started for the first time. This is done by means of the oil dipstick. The oil level should be between the level marks on the dipstick. When necessary, top up with oil of the same type and grade already being used in the reverse gear (see point 6).

4 Change oil in engine

The engine oil must be changed after every 50 hours running or at least once a season. During the running-in period, the oil should be changed more frequently (see "Running-in", page 12).

Before changing the oil, the engine must be run warm. The oil is drawn up from the crankcase by means of a crankcase pump. Draining can also be done through the plug in the oil pan if this is accessible.

Never use flushing oil.

For these engines lubricating oil **"Service DS"** in accordance with the classification designations of the API system must be used. See also the paragraph dealing with lubricating oils on page 34.

NOTE.

When the engine is new or after it has been reconditioned, it must not be raced immediately after starting. During the first 2 minutes warming up, the engine speed must not exceed 1000 r.p.m. This also applies in connection with oil change and oil filter replacement.

ENGINE TYPE	GRADE	VISCOSITY			OIL CAPACITY including oil filter
		Below −7° C (20° F)	Between −7° and +15° C (20° and 60° F)	Above + 15° C (60° F)	
AQD 29 MD 29	Service DS	SAE 10 W	SAE 20/20 W	SAE 30	5–6.5 liters[1]) (4.4–5.7 Imp. qts 5.3–6.9 US qts.)

[1]) The oil capacity varies depending on the engine inclination.

NOTE. Always fill up to the maximum mark on the oil dipstick when changing oil. Check the oil level again immediately after the engine has been run warm.

5 Lubricate fresh-water pump

The ball bearing of the fresh-water pump should be lubricated every 50 hours running with a few drops of engine oil. The lubricator is accessible under the heat exchanger from the starboard side of the engine. The lubrication is facilitated by connecting the lubricator and the oil can with a rubber hose.

6 Change oil in reverse gear (MD 29)

Volvo Penta RB reverse gear

Change oil in the reverse gear after every 100 hours running or at least once every year. Draining is done through the plug (3, see Fig. page 42)

if this is accessible. Otherwise the oil is sucked up by means of an oil drain pump through the dipstick hole. Oil filling is done through the plug (2) on the top of the reverse gear.

OIL GRADE	VISCOSITY	OIL CAPACITY
Service DS (same as in engine)	SAE 20	approx. 0.5 liter (1 pint)

Warner reverse gear

The reverse gear should be flushed out and the oil changed after every 100 hours of operation or at least once every year. The oil is drained off through the reduction gear bottom plug or sucked up by means of an oil drain pump through the dipstick hole. When filling oil, the reverse gear should be filled up to the upper level mark on the oil dipstick. Then start the engine and run it for a few minutes at idling speed so that the reverse gear oil cooler is filled with oil. Stop the engine and check the oil level again. Top up with additional oil if necessary. Use only hydraulic oil of grade "Automatic Fluid type A" according to the table below.

OIL GRADE	OIL CAPACITY
Automatic Transmission Fluid, type A*)	approx 3 liters (2.6 Imp. qts.= approx. 3.2 US qts.)

*) Esso Automatic Transmission Fluid 55, Shell Donax T6 or corresponding.

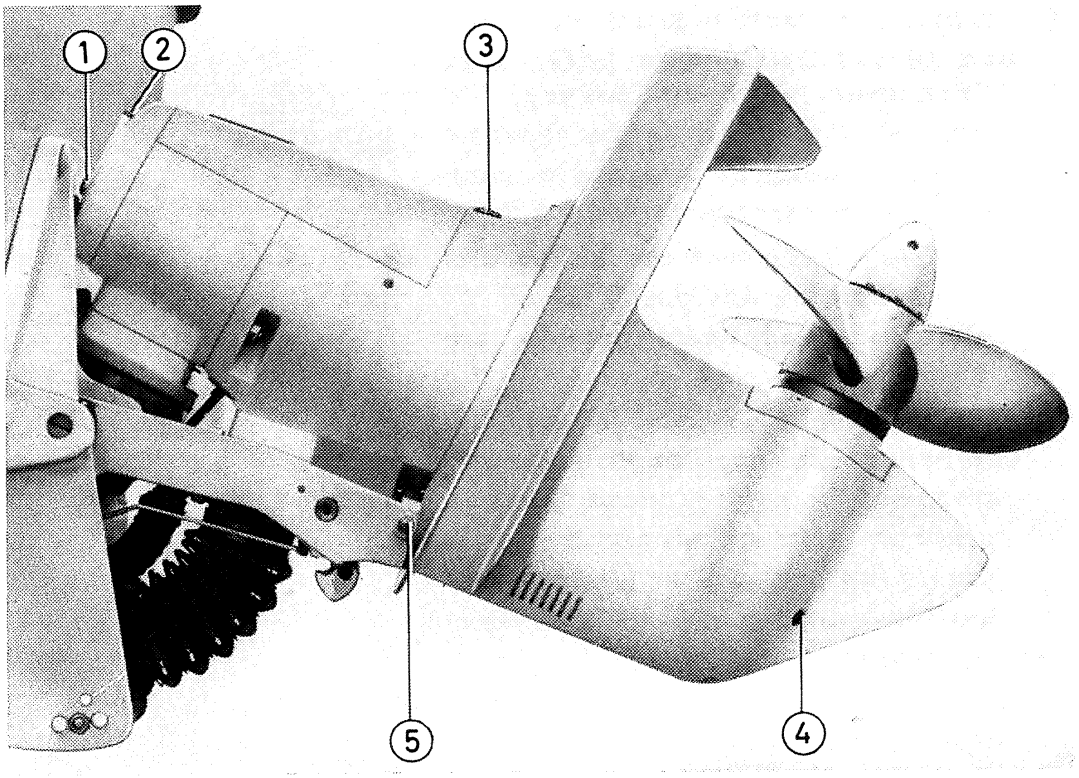
7 Change oil in outboard drive (AQD 29)

The oil in the outboard drive should be changed after every 100 hours running or at least once every season.

The oil is drained off through the plug (4). To facilitate the oil draining, unscrew also the plug (2). Oil filling is done through the oil filler hole (3). Oil filling must take place with the drive in the tilted-up position by means of a pump according to Fig. The capacity of the oil system is about 2 liters (1¾ Imp. quarts = approx. 2 US quarts).

Concerning the correct grade and viscosity, see the table. Lower the drive fully, unscrew the oil dipstick on top of the drive and wait a moment to allow the oil to rise in the centre of the drive. Wipe the dipstick clean and dip it as far as it goes without screwing it down, then lift it up and read off the oil level. If refilling is necessary, this can be done through the hole for the dipstick. Screw on the dipstick and replace the plug in the cover on the upper drive housing. Note the washers!

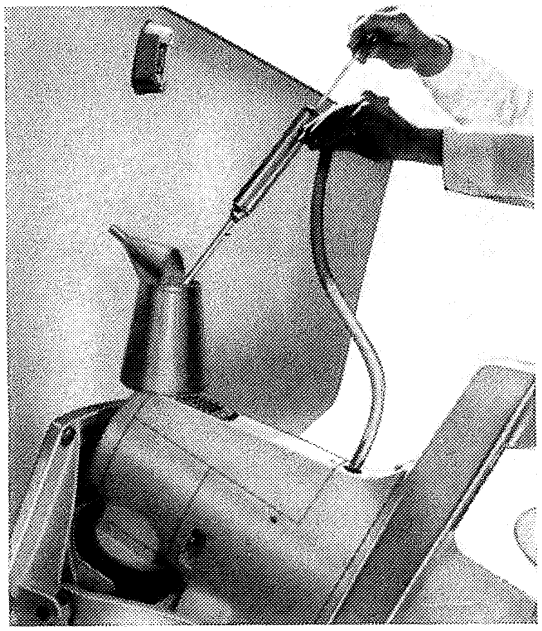
NOTE. The oil level must never be allowed to exceed the maximum mark on the dipstick.



1. Oil dipstick
2. Air hole
3. Oil filling
4. Drain hole
5. Lubricator

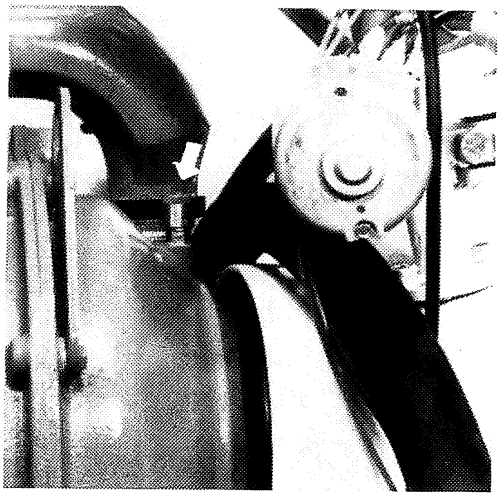
Oil recommendations for outboard drive

Make	Grade
Lubriplate	Marine 90
BP	EP 90
Caltex	Universal Thuban 90
Castrol	OB or Hypoy 90
Esso	Gear oil GP 80–90
Gulf	Multi-Purpose Gear Lubricant SAE 90
Mobiloil	Mobilube GX 80–90
Shell	Spirax 90 EP



Never use oil with higher viscosity than SAE 90.

8 Lubricate drive and steering shaft bearings (AQD 29)

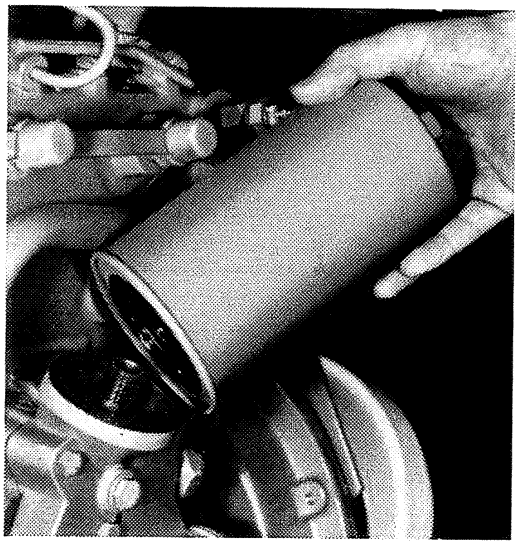


After every 50 hours running, the drive shaft bearing in the flywheel housing should be greased through the grease cup (see arrow). Fill the cup with multi-purpose grease and screw it all the way down.

After every 50 hours running, the lower steering shaft bearing in the fork should be greased through the lubricator (5, Fig. page 45). Use grease of the multi-purpose type and press in so much grease that it is forced out at the wear washer located between the fork and the intermediate housing.

9 Change oil filter

When the engine is new or after it has been reconditioned, it must not be raced immediately after starting. During the first 2 minutes warming up the engine speed must not exceed 1000 r.p.m. This also applies in connection with oil change and oil filter replacement.

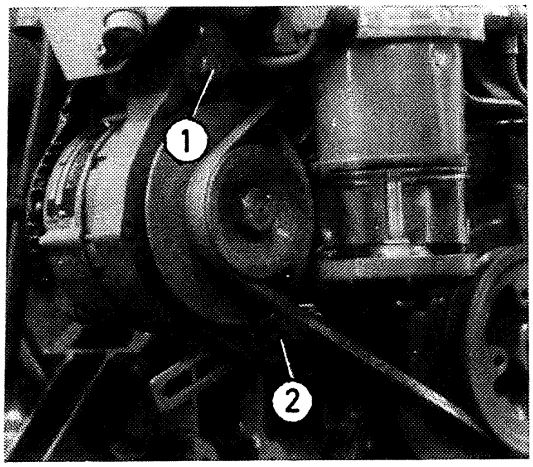


The oil filter with insert and by-pass valve is screwed as a single unit onto the oil cooler on the cylinder block. **It should be replaced after every 100 hours of operation at the same time as the oil is changed.** When the engine is new or reconditioned, the oil filter should be changed for the first time after 20 hours running (see "Running-in").

1. Screw off the old oil filter.
2. Coat the rubber gasket of the new filter with oil and make sure that the contact surface for the filter is free from dirt. Screw on the oil filter by hand until it just contacts the oil cooler.
3. Tighten the oil filter a further half turn but absolutely no more. Start the engine and check for leakage round the joint. Then check the oil level in the engine.

Engine

⑩ Check V-belt



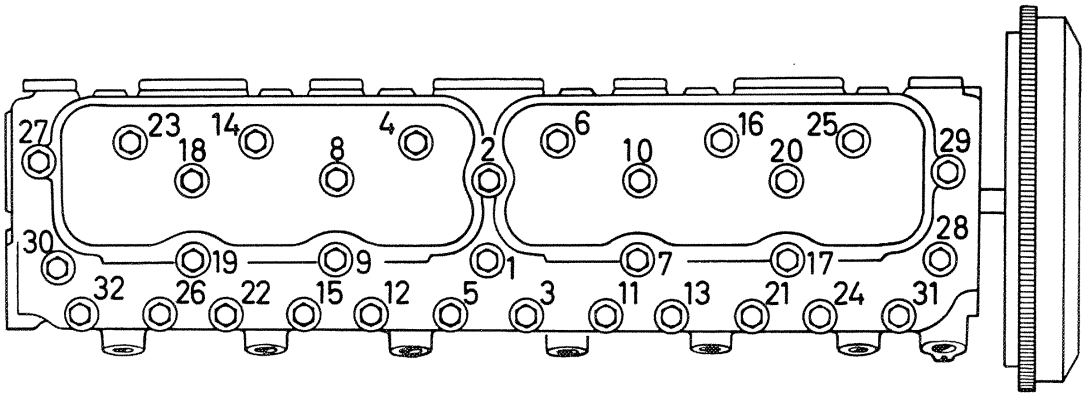
After every 50 hours running the V-belt should be checked to ensure that it is correctly tensioned. Due to wear or dirt, the belt can start slipping and cause poor alternator output.
The vee-belt should be tensioned so hard so that it is just possible to move the pulley by pushing with one finger against the generator fan vanes.
If the belt is poorly tensioned, loosen the adjusting bolt (2) and the bolt (1) at the alternator attaching point. Then pull the alternator outwards and tighten the bolts.

⑪ Re-tighten delivery pipe clamps

After every 50 hours running, the tightening of the delivery pipe clamps should be checked. If the clamps are poorly tightened or missing completely, the life of the delivery pipes will be reduced.

⑫ Re-tighten cylinder head bolts

With a new engine, or an engine that has had the cylinder head removed, the cylinder head bolts must be re-tightened after about 20 hours running while the engine is cold. The bolts should also be re-tightened once every season. A torque wrench should be used both when tightening and re-tightening the cylinder head. The tightening sequence for the cylinder head bolts is shown in the picture. As regards the tightening torque, see "Technical data". Valve clearance should always be adjusted after the cylinder head bolts have been tightened.



⑬ Check valve clearances

The valve clearances should be checked after every 100 hours running or once every season. Too small valve clearances can easily cause burned valves and valve seats.

When adjusting the valves, the engine should be cold, i.e. it must not have been run for at least six hours.

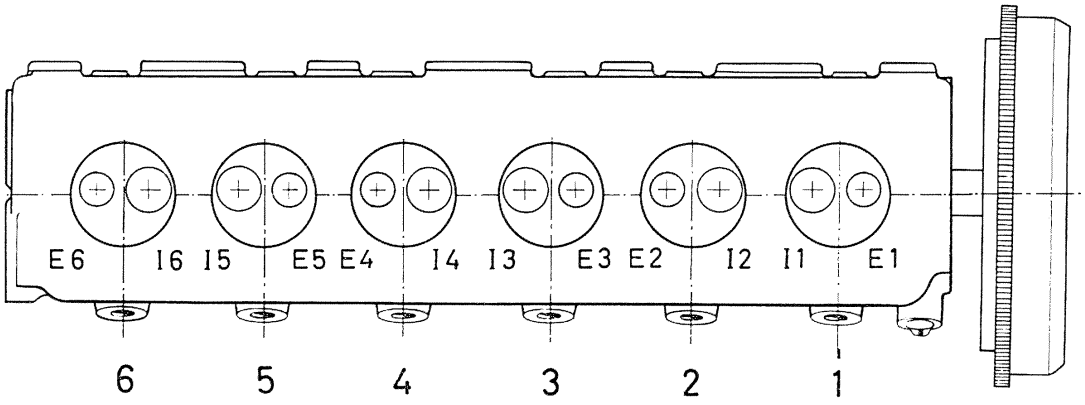
The valves must not be adjusted when the engine is running. The valve clearances should be:

Inlet valves:

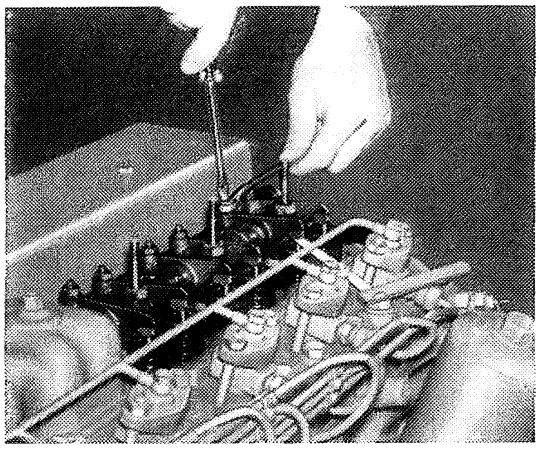
0.15 mm (0.006″), designation I in accordance with the sketch.

Exhaust valves:

0.25 mm (0.010″), designation E in accordance with the sketch.



	For adjusting valves	Open fully valve
AQD 29 MD 29	I 5 and E 3	E 1
	I 3 and E 6	E 5
	I 6 and E 2	E 3
	I 2 and E 4	E 6
	I 4 and E 1	E 2
	I 1 and E 5	E 4



The valve clearances are adjusted as follows:

1. Turn round the engine so that the respective exhaust valve in accordance with the table is fully open. The valves indicated in the table are then adjusted. Checking is done by means of a feeler gauge.
2. It should be barely possible to insert the feeler gauge into the space between the pressure surface of the rocker arm and the valve. If the opening is too narrow

or too wide, the lock nut is loosened after which the adjusting screw is turned so that the feeler gauge can be withdrawn with some resistance, when the lock nut has been re-tightened (see Fig.).

3. Wash the valve covers clean and fit them with new gaskets. Check that there is no oil leakage.

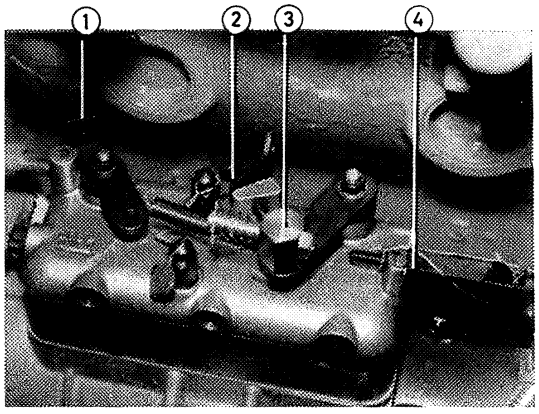
Fuel system

⑭ Check and adjust idling speed

After every 50 hours running the engine idling speed should be checked. The idling speed must not exceed the figures stated in "Technical data". Please note that no seals must be broken. All warranty becomes void if seals are broken by other than personnel from authorized diesel workshops. The idling speed is adjusted as follows:

1. Run the engine warm until it reaches normal operating temperature. Put the control lever in the neutral position and make sure that the stop control is completely pushed in.
2. Loosen the lock nut, then turn the screw (2) so that the correct idling speed is obtained.
3. Re-tighten the lock nut while holding the nut (2) firm.

After a few rapid accelerations, the engine must not stop when the control lever is quickly moved back to the neutral position.



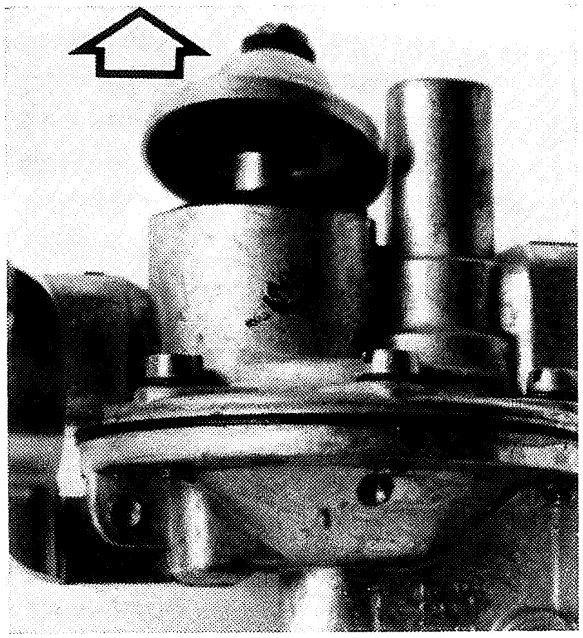
1. Connection for stop cable
2. Idling screw
3. Connection for throttle control cable
4. Screw for max. engine speed (sealed)

⑮ Service fine filter

The lower housing should be drained when necessary. **Each day before starting, check if any water has accumulated in the bottom of the housing.** In the affirmative case this is drained off through the drain cock.

At the same time, feed fuel by means of the hand primer so that no air enters into the system.

16 Clean pre-filter



The pre-filter should be cleaned after every 50 hours running or at least once every season.

1. Wash the outside of the feed pump.
2. Remove the cover and lift out the strainer.
3. Wash the strainer in fuel oil and put it back. Check the gasket and tighten the cover.
4. Feed fuel by using the hand primer and air-vent the fuel system, see page 51.

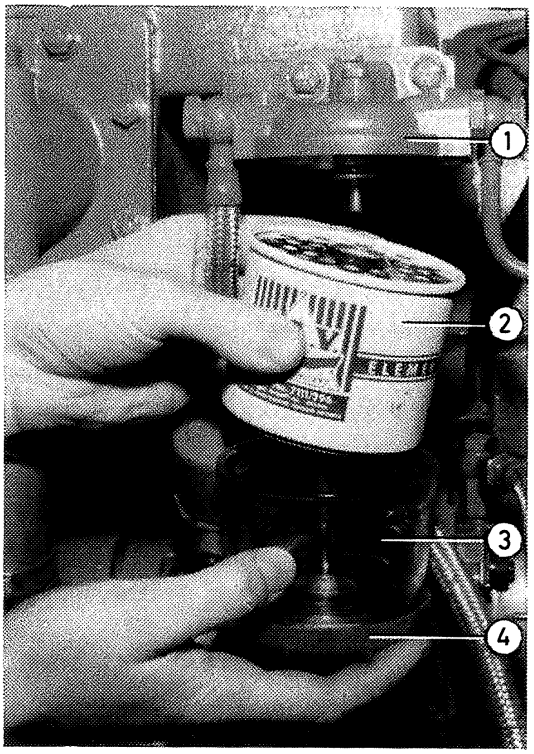
17 Change fine filter. Air-venting

The fuel filter element should be changed after every 300 hours running or at least once every season.

1. Clean the whole filter housing carefully on the outside. Unscrew the centre bolt on the cover and remove filter housing and filter.

2. Clean the filter housing carefully internally. Check that all gaskets are undamaged or replace them.

3. Make sure that all gaskets are located correctly and fit a new filter element. The old element should be destroyed. It must not be cleaned and used again under any circumstances.

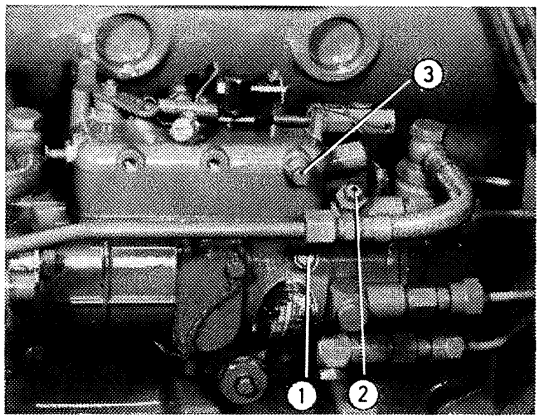


1. Bracket
2. Fine filter
3. Filter housing
4. Cover

Air-vent fuel system

Air-venting has to be carried out only after the engine has been installed or when the engine has been out of operation for a longer period of time or if, for some reason, air has entered into the system, for instance if the tank has been emptied.

1. Open the air-vent screw (1) on the injection pump. Pump by means of the hand primer until fuel flows out. Make sure the engine is in such a position that the hand primer arm can be moved so that its full stroke is obtained. When necessary, prize the engine.
2. Open the air-vent screw (2) on the pump and run the engine with the starter motor until fuel is flowing out from both the air-vent screws. Tighten the screws.



Fuel injecion pump with air-venting screws.

3. Loosen the delivery pipes at the injectors and run the engine by means of the starter motor. The control lever should be in the position for wide open throttle. Tighten the delivery pipe nuts when the fuel flowing out is free from air.
4. The air-vent screw (3) should be vented when the engine has been run for a few minutes.

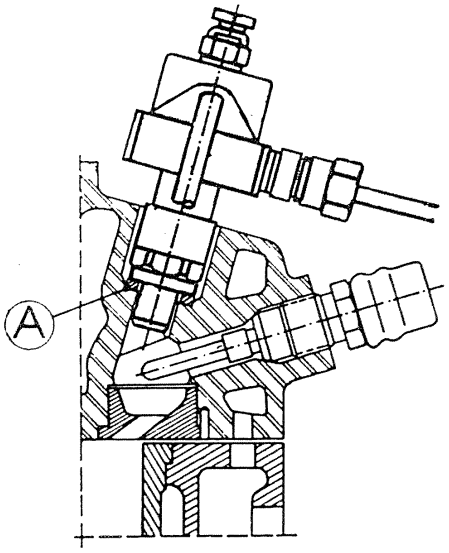
NOTE. Starting attempts must not be made under any circumstances before the system has been air-vented, since the injection pump can then be destroyed.

18 Check the injectors

All the injectors should be removed at regular intervals and taken to a Diesel workshop for cleaning and a check on opening pressure, leakage and spray pattern. **We recommend an interval of about 500 hours or once every season of operation between these inspections.**

Removing

1. Clean the injector, delivery pipe and cylinder head around the injector.
2. Disconnect the delivery pipe and leak-off oil line fom the injector. Fit protective caps.
3. Unscrew the two nuts over the yoke which retains the injector to the cylinder head and lift up the injector.



Fitting

1. Check that the contact surface against the injector is clean. Use new copper washers 2.2 mm (0.087″) thick, see A in Fig., when fitting. Use only original washers.
2. Push down the injector into position and fit the yoke but do not tighten the nuts.
3. Connect the delivery pipes. Make sure that the pipe flange comes in correct position. If the flange is tightened when incorrectly located, the delivery pipe will break after some time due to the stresses caused. Do control that all clamps are in position — otherwise the delivery pipes will not last long.
4. Tighten the retaining nuts on the yoke. The tightening torque should be 1.5–2.5 kgm (11–18 lb.ft.). Connect the return line.

Cooling system

⑲ Check the coolant level

The coolant level in the fresh-water system should be checked every day when starting the engine for the first time.

Always use clean fresh-water.

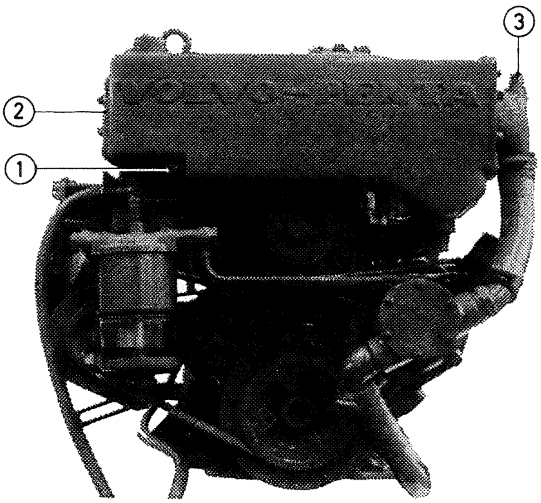
When there is risk of frost, the fresh-water system should be drained or anti-freeze solution added (see "Precautions in case of frost, page 12).

20 Check zinc electrodes in heat exchanger

In order to protect the material from corrosion due to galvanic currents, zinc electrodes are built into the heat exchanger.

The zinc electrodes should be removed and checked after every 50 hours running.

If there are deposits on the zinc electrodes, these should be scraped off. If the electrode is used up by more than 50 % of its original size, it must be replaced.



1. Zinc electrode for the fresh-water system
2. Zinc electrode for the sea-water system
3. Zinc electrode at the sea-water inlet in the heat exchanger

When re-fitting the electrode, it is most important that good metallic contact is obtained between the electrode and the material of the heat exchanger. Therefor make sure that the zinc electrode is firmly located in its screw plug and clean carefully the connection between the plug and heat exchanger before fitting.

21 Check and clean cooling system

The cooling system should be checked at regular intervals or at least after every 100 hours running for leakage, blockage, etc.

In order to function effectively, the cooling system must be clean and all passages in the engine and heat exchanger must be free from deposits and impurities. Deposits are formed by the salts which are found in regular water. To keep the cooling system clean, it should be flushed regularly with water, in severe cases with chemical solutions. This cleaning should preferably be carried out in connection with filling or draining anti-freeze in the spring and autumn respectively. If necessary, however, it should be cleaned more often. Always use clean water in the cooling system preferably with the addition of Volvo Penta original anti-freeze fluid which also contains anti-corrosion additives, see page 13.

For draining off the coolant, see "Precautions in case of frost", page 12.

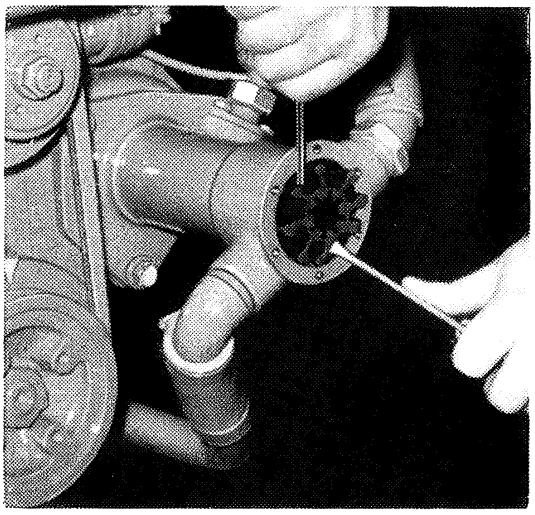
Coolant temperature

The hand of the temperature gauge shall normally be in the green background when running. If the temperature rises and if the hand is in the red background, the cooling system should be examined. In that case, check first that the reason for the temperature rise is not

too low coolant level or insufficient tension in the V-belt to the fresh-water pump.
Excessive temperature can also be due to clogged water intakes, closed sea-cock (MD 29), broken impeller in the sea-water pump or defective pump carrier. Furthermore it can be due to clogs in the coolant passages or oil cooler of the reverse gear (MD 29) and engine. Also examine the thermostat and temperature gauge for defects. If it is suspected that the thermostat is faulty, remove it from the heat exchanger and inspect it.

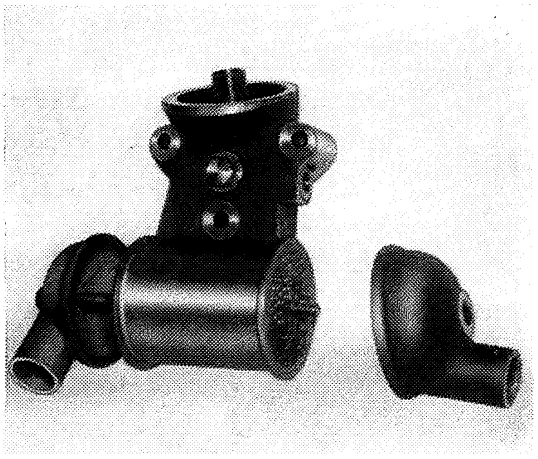
Changing impeller in the sea-waterpump

When the impeller has to be replaced, proceed as follows:
Unscrew the slotted screws on the cover and remove this. Insert two screwdrivers and force out the impeller by exerting leverage on the pump housing (see Fig.). Remove any pieces of the impeller that may be left in the housing.
Press in the new impeller and do not forget to fit the sealing washer in the impeller hub after this has been pressed in. Fit the gasket and cover. Make sure that there is always a spare impeller on board.



22 Check and clean oil cooler

Every 100 hours, or whenever necessary, the oil cooler should be removed for checking and cleaning. Use new sealing rings and gaskets when fitting.



Electrical system

㉓ Check electrolyte level in battery

If the battery is to operate without trouble, the electrolyte level has to be checked at regular intervals. **This check should be carried out once every 14 days.** The electrolyte level should be 5—10 mm (3/16—3/8″) above the cell plates.

Add distilled water when necessary. Never add too much, since this can cause the electrolyte to splash over and cause damages. Never check the level by using a lighted match, as the gas formed in the cells is explosive.

㉔ Check state of charge of battery

The state of charge of the battery should be checked after every 100 hours running. This is done by using a hydrometer showing the specific gravity of the electrolyte, which varies with the state of charge (see "Technical data").

If the specific gravity has fallen to the lowest value stated, the battery must be re-charged at a charging station.

During the winter it is particulary important to ensure that the battery does not become discharged, since the electrolyte in a discharged battery freezes at about –20° C (–4° F). When examining the state of charge, also check that the cable ends and terminal bolts are well-tightened and coated with vaseline. If necessary, they should be wiped with a piece of rag or brushed with a wire brush, and then a fresh coating of grease or vaseline should be applied.

Only use the starter motor for short periods when starting. High and prolonged loading will shorten the life of the batteries considerably.

㉕ Check glow plugs

Check the glow plugs once a year, when any carbon deposits, etc., should be removed.

Fault-tracing table

Engine	Control resistance	Glow plug
Runs normally Easily started	Dark red or yellow	In good condition
1 Difficult to start	Glows only slightly or not at all	Glow spiral on one or more plugs damaged
2 Does not start	Is incandescent and in a melting condition	Short-circuit in the electrical system or plugs

Checking procedures

1. The glow spiral of the plug does not function.
   If the glow spiral on one or more plugs is thought to be damaged, disconnect the connecting cable, after which a control lamp is connected in series with the plug. If the lamp lights, the plug is intact. If the lamp does not light, the plug is damaged.
2. Short-circuit in plug.
   Remove the plugs, one at a time. Connect a 12 V battery to the plug by putting one clamp on the plug jacket, the other on the terminal post. If the holder becomes warm, the plug is undamaged. Then check the rest of the plugs. Before the glow plugs are re-fitted, the threads should first be lubricated with graphite grease, which will facilitate removing the plugs in the future.

26 Check alternator and starter motor

Starter motor

After about every 300 hours running, the carbon brushes and commutator should be checked. First disconnect the battery cable from the negative terminal. Remove the protective casing from the starter motor and lift the springs on the brushes by means of hooks. The brushes are pulled out. They must move easily in their holders. Dirty or sticking brushes should be cleaned with a clean rag moistened with gasoline. Shiny spots, caused by wear, must not be worked on with emery, knives or files. Replace brushes which are damaged or too worn with new ones. The brush holders should be blown clean thoroughly. The collector should have an even, smooth, dark grey surface without scratches, and must be free from oil and grease. If the collector is scratched or uneven, it has to be overhauled in a workshop for this kind of work. Emery or files must not be used on the commutator under any circumstances.

Alternator

In order for the alternator and its regulator to function without trouble, **it is most important that the following instructions are followed in detail.**

Cables

Battery, battery cables and terminals must be checked regularly. **A very important detail is to clean and tighten the battery terminal clamps and posts, and coat them with vaseline.** (NOTE. Do not confuse the + and – poles of the battery when this is connected).
This procedure is particularly important to ensure good alternator performance. Otherwise the current in the battery circuit may easily be cut off, whereby the regulator is destroyed and, if worse comes to worse, also the alternator.

Brushes

When replacing the brushes, loosen the two screws in the cover which is marked DF (Field) and the connection screw on this cover. When the two screws in the brush holder have been loosened, this can be removed. Check brushes and brush holders. The projecting brush length should be at least 5 mm (1/5″).

The brushes are to be replaced complete with holders. Also check the slip rings. These should be free from scratches.

NOTE THE FOLLOWING

1. **Never** break the circuit between the alternator and the battery while the engine is running. **This causes an immediate short-circuit in the charging regulator which is then destroyed and has to be scrapped.** If a master switch is fitted, this must **never** be switched off before the engine has stopped completely.
   In case of twin installation, change-over between the two batteries must never be carried out while either engine is running unless this is done with a switching device which cannot break the charging circuits in any position.
2. Never use a quick-charging device while the alternator is connected to the battery. This can destroy the alternator rectifier diodes.
3. The two battery poles must never be confused. The terminal posts are stamped + and — respectively. Faulty polarity destroys the alternator rectifier at once.
4. When starting with a spare battery, proceed as follows:
   Allow the standard battery to remain connected. Connect the spare battery to the standard battery with + to + and — to —. When the engine has started, remove the spare battery but never break the connections to the standard battery. Check that the spare battery or other source of power has the same voltage as the standard battery.
5. Check the belt tension regularly.
6. Always disconnect **both** battery cables before carrying out any work on the alternator equipment.

Reverse gear (MD 29)

27 Check reverse gear

Volvo Penta RB

The reverse gear is self-adjusting. In other words, no adjustments are necessary on the brake linings to compensate for wear.

The reverse gear should be checked regularly for oil leakage, abnormal noise level or excessive operating temperature. Once every season the reverse gear cooling jacket should also be cleaned from impurities.

After every third year or about 300 hours running, a general inspection of the reverse gear should be carried out by an authorized workshop.

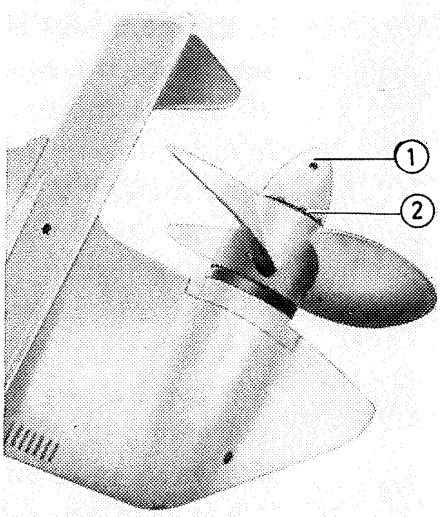
Warner Gear (Velvet Drive)

The disc assembly for running "Forward" and "Reverse" is operated hydraulically and requires no adjusting work to compensate for wear. In order for the reverse gear disc assembly not to slip it is a condition that the correct control pressure is supplied by the built-in oil pump. Check once every season by means of a pressure gauge that the oil pressure is 8.5—10 kg/cm² (120—140 lb/sq.in.).

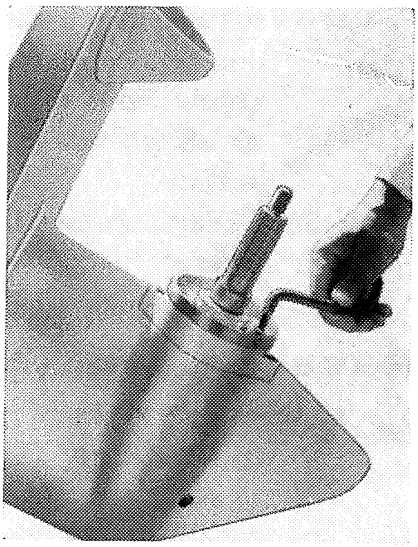
The reverse gear oil cooler should be pressure-tested once every season for leakage.

Outboard drive unit (AQD29)

28 Check zinc ring



A zinc ring is fitted inside the propeller to prevent galvanic corrosion on the outboard drive. Since this zinc ring is subjected to corrosion, it should be checked regularly. The intervals between the inspections vary, depending on the salt content of the water and the amount of contamination. **Check the amount of corrosion on the ring every day when starting the engine for the first time.** Replace the ring when it has been corroded away to 50 % of its original size. The zinc ring is replaced in the following way:



1. Bend up the tabs on the lock washer (2) for the propeller cone (1) and unscrew the cone.
2. Pull off the propeller and loosen the two screws retaining the zinc ring (see Fig.). The ring can then be removed from the propeller housing. Scrape the contact surface against the bearing housing until it is clean.
3. Fit a new zinc ring in the reverse order to that used when removing. Make sure that there is good metallic contact between the zinc ring and the propeller housing.

NOTE. Do not forget to lock the propeller cone with the lock washer.

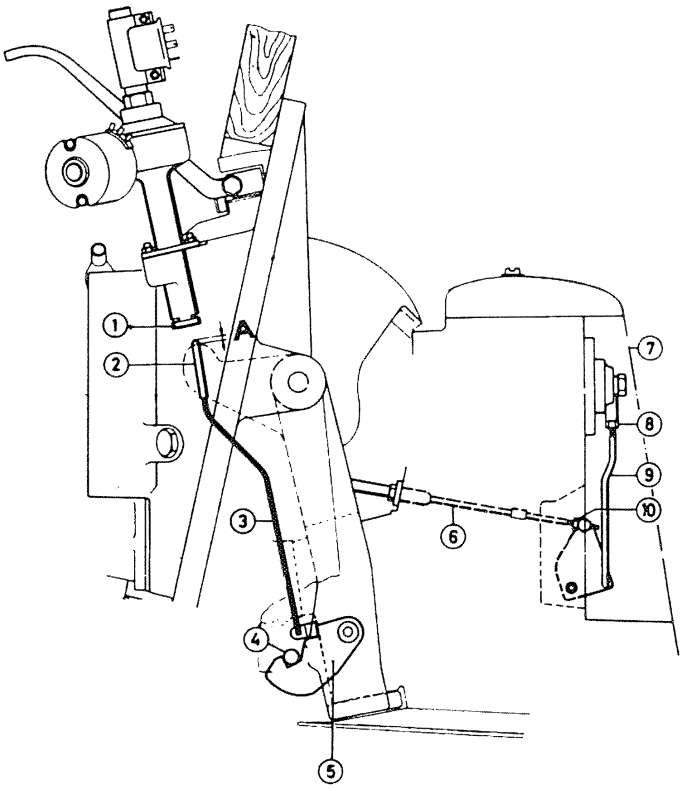
29 Check and adjust shift and retaining pawl linkage

Check and adjust the shift linkage as follows:

1. Remove the protective cover (7) over the shift linkage. Put the control lever in neutral position.
2. The bearings of the shift rod (9) and the control cable (6) must not be pinched in the lever arms in "forward", "reverse" and "neutral" position.
3. The lever arm has to be adjusted so that it does not come into contact with the housing in the "forward" position. Adjustments can be made at (8) and (10).

The function of the push rod (3) is to release the retaining pawl (5). The push rod is checked and adjusted as follows:

1. Pull the drive backwards so that the retaining pawl has a firm grip on the adjusting pin (4).
2. Check that the adjusting sleeve (2) in the upper part of the rod sticks up 3.5–4.0 mm = 0.14–0.16" ("A"-measure) above the lift lever.
3. Press down the adjusting sleeve (2) evenly with the top of the lift lever and check that the drive is released from the adjusting pin (4).
4. If necessary, turn the adjusting sleeve so that sufficient stroke is obtained.



30 General inspection

After every 100 hours running or at least once every season a general inspection of the outboard drive should be carried out. Wash the drive on the outside and touch up any damage on the paintwork. Be particularly careful with the joints and at the plugs for oil filling and drainage.

NOTE. Do not paint the zinc ring.

At the same time, check that there is no oil leakage, that the rubber bellows is undamaged and in good condition, and that there is no abnormal wear on the link arms for the control mechanism. Also check that the retaining pawl is not chafing on its pins.

General maintenance instructions

31 Check and overhaul injection pump

1. Wash the injection pump thoroughly as well as the pipes and the engine around the pump.
2. Disconnect the delivery pipes and fuel lines at the pump, as well as throttle and stop controls. Fit protective caps.
3. Unscrew the bolts for the injection pump mounting plate at the transmission cover. NOTE. Not the screws in the flange integral with the pump.
4. Turn the pump outwards and remove it by pulling it backwards.

NOTE. Repairs which necessitate disassembly of the internal parts of the injection pump and which may change its setting, must only be carried out by personnel at authorized Diesel workshops with the necessary tools and test devices at their disposal. **Any guarantee made becomes null and void if the seals are broken by unauthorized persons.**

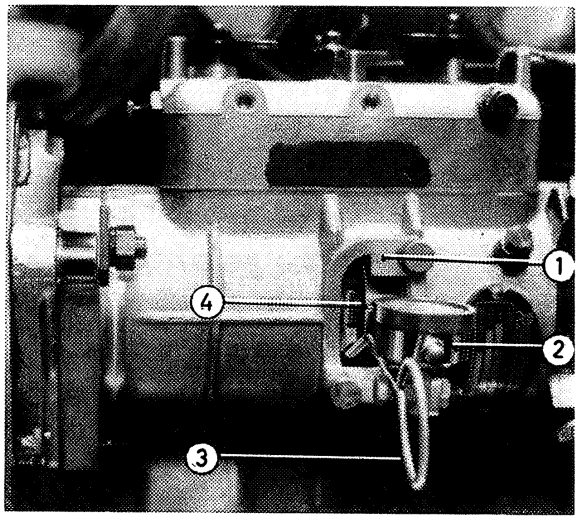
Fitting the pump

The special tools needed for fitting the pump and which are mentioned in the following are included in a tool kit which is available from AB Volvo Penta.

1. Remove the valve cover. Turn the crankshaft in the correct direction of rotation until the exhaust valve on cylinder no. 1 is open and the inlet valve closed. **The rear cylinder nearest the flywheel is counted as no. 1.** Then turn the crankshaft in the direction of rotation until the first mark on the belt pulley is opposite the mark on the transmission cover. This is the position when injection should begin in cylinder no. 6 (16° B.T.D.C.). Re-fit the valve cover.
2. Remove the sea-water pump cover so that the impeller can be turned. At the same time, the dog coupling for the sea-water pump should be turned so that engagement with the injection pump gear wheel can be obtained later, when the pump is fitted.
3. Remove the inspection cover on the side of the pump.
4. Turn the pump shaft so that the groove on the rotor (4) is right under the ear on the indicator ring.
5. Mount the indicator gauge and turn the pump shaft so that the point of the indicator gauge pin slides down in the groove on the rotor. This position occurs when the needle shows maximum reading or reaches the turning point.
6. Fit the pump on the engine. Tighten the attaching plate while checking that the timing is correct (16° B.T.D.C.). Turn the sea-water pump impeller so that the dog engages. Eliminate the play in the transmission and pump parts by means of the tool (3).

Insert the point between the shaft and the screw head, then pull the eye upwards and hitch the lever onto the screw under the indicator gauge. When necessary, turn the pump after its attaching bolts (in the mounting flange) have been loosened. Tighten the pump with the rotor in the correct position according to point 5.

7. Remove the lever (3), crank the engine 90° backwards and then slowly to firing position. Re-fit the lever (3). When the setting is correct, the indicator gauge should show maximum reading, turning point, when the timing is set for injection at 16° B.T.D.C. Adjust the setting if necessary.
8. Fit delivery pipes and other parts in the reverse order to that of removing.



Measuring gauge, fitted on the pump.

1. Bracket for indicator gauge
2. Indicator gauge
3. Lever for eliminating play
4. Groove on pump rotor

32 Compression test

A simple and reliable way to determine the condition of the engine is to carry out a compression test which indicates the degree of sealing in the cylinders. The test should be carried out when the engine is cold. The injectors are removed (see point 18) and each cylinder is tested in turn. During the test the speed control should be pulled out while the engine is turned round by the starter motor. The battery must be in good condition to ensure that the starter motor is capable of turning the engine with sufficient speed. The compression pressure is shown under "Technical data".

33 Preparing engine and equipment for storage

Inhibiting

Even insignificant rust attacks on the precision-manufactured parts of the engine and marine equipment can mean serious impairment of the general condition of the engine.

If the engine is not to be used for **less than a month,** it should be started after 14 days and run warm.

If the engine is not to be used for **more than a month,** inhibiting in accordance with the following points is recommended.

1. Run the engine warm after which it is stopped and the lubricating oil in the engine is pumped out with the help of a crankcase oil pump.
2. Fill up the engine with inhibiting oil to the lowest mark on the dipstick. Suitable inhibiting oils are Esso Rust Ban 623, Shell Ensis Oil 20 or corresponding oils of other makes.
3. Drain off the fuel oil in the fuel filter and disconnent the fuel lines from the tank at the connection to the flexible hoses. Place the hoses in a can containing 1/3rd Esso Rust Ban 623 and 2/3rds fuel oil.
4. Air-vent the fuel system and start the engine. Run the engine at rapid idling for about 15 minutes.
5. Stop the engine, pump out the inhibiting oil from the oil sump and then re-connect the fuel lines.
6. Remove the glow plugs and inject about 20 c.c. (2/3 fl.oz.) of inhibiting oil into each cylinder. Crank the engine a few turns, **watch out for oil splashes,** then re-fit the glow plugs.
7. Open all drain cocks on the engine and reverse gear (if such a gear is fitted) so that the sea-water system is drained.
8. Drain the fresh-water system of the engine completely or add anti-freeze solution consisting of ethylene glycol with anti-corrosion inhibitors (see table on page 13).
   The engine must not then be cranked until it is taken into use again. Attach a tag which clearly indicates that the oil and cooling water have been drained and also the date on which it was inhibited.
9. Clean the engine externally with white spirit or similar and touch up any scraped-off spots with paint. Protect the engine by coating it with anti-rust oil.
10. Remove the battery from the boat and hand it in to a charging station. It must be maintained in a good state of charge in order not to be ruined.
11. As to AQD 29/200, drain off the oil from the outboard drive unit and fill it up with inhibiting oil. Clean the outboard drive on the outside, first with fresh-water and then with white spirit. Remove all marine growths and deposits. Touch up any damaged paint-work with the special paint available from AB Volvo Penta.
    NOTE. The zinc ring must not be painted. Protect the outboard drive externally by coating it with anti-rust oil.

If the outboard drive has been removed from the boat, a protective muff **must** be fitted on the rubber bellows and the projecting part of the flywheel housing to keep out dirt, etc.

12. Coat the metal parts of the control equipment, cable attachments and cable connections with anti-rust oil.

Preparing engine for use again

1. Fill up the fresh-water system with clean fresh-water.
2. Fit a new oil filter and a new fuel filter. Fill up engine and outboard drive unit (AQD 29/200) or reverse gear (MD 29) with lubricating oil (See "Servicing", points 4, 6, 7, 9 and 17).
3. Take the battery on board and connect the battery cables. Coat the battery terminals with vaseline after tightening.
4. Remove the glow plugs and turn the engine round with the starter motor so that any inhibiting oil remaining on the piston tops is blown out. **Watch out for oil splashes.** Clean, inspect and fit the glow plugs.
5. Check-tighten all bolts on the engine.
6. Fill up with fuel and carefully inspect the tank and lines to make absolutely sure that there is no leakage. Wipe up any spilled fuel and "air" the engine compartment, etc.
7. Air-vent the fuel system (see "Servicing", point 17) and close all water drain cocks.
8. Start the engine but do not allow the engine speed to exceed 1000 r.p.m. Check the cooling water and that there is no leakage in the water lines, etc. Check the maneuvering and steering controls.
9. Check the supply of spare parts on board. Make sure that there is always a spare impeller for the sea-water pump as well as extra glow plugs on board.

TECHNICAL DATA

General

Type designation	AQD 29/200
Prod. no.	9841
Type designation	MD 29
Prod. no.	9843, 9844
Basic engine designation	Indenor XDP 6/88
Type	4-stroke Diesel engine with swirl chambers
Number of cylinders	6
Valve system	Overhead valves
Max. output, pleasure boats, SAE	92 h.p. at 4000 r.p.m.
Max. output, other installations in planing boats, SAE	83 h.p. at 4000 r.p.m.
Max. output, work boats, SMMT	67 h.p. at 3000 r.p.m.
Max. intermittent torque	18.2 kgm (132 lb.ft.) at 2000 r.p.m.
Bore	88 mm (3.465″)
Stroke	80 mm (3.150″)
Displacement	2.92 liters (178 cu.in.)
Compression ratio	21:1
Compression pressure at 150–160 r.p.m.	35–40 kg/cm² (498–570 lb./sq.in.)
minimum	24–25 kg/cm² (340–356 lb./sq.in.)
Order of injection, cylinder no. 1 nearest the flywheel	1–5–3–6–2–4
Direction of rotation, viewed from forward end of engine	Clockwise
Cylinder liners	Wet-type, replaceable
Max. inclination in boat while running	
AQD 29/200	7°
MD 29	15°
Weight of engine with RB reverse gear	about 320 kg (704 lb.)
Weight of engine wtih hydraulic gear	about 360 kg (794 lb.)
Weight of engine with outboard drive (AQD 29/200)	about 350 kg (770 lb.)

Engine speed

Pleasure boats and other installations in planing boats

Max. permissible operating speed during a short period of time	4000 r.p.m.[1])
Max. speed, without load on engine	4350 r.p.m.
Idling speed	650 r.p.m.

Work boats

Max. operating speed	3000 r.p.m.[1])
Idling speed	650 r.p.m.
Max. speed, without load on engine	3400 r.p.m.

Valves

Valve clearances, cold engine	
Inlet valves	0.15 mm (0.006″)
Exhaust valves	0.25 mm (0.010″)

1) When cruising the max. engine speed should be reduced by 200 r.p.m. under maximum operating speed attained.

Lubricating system

Engine	
Oil grade	Service DS
Oil viscosity, below –7° C (20° F)	SAE 10W
between –7° and +15° C (20° and 60° F)	SAE 20/20W
above +15° C (60° F)	SAE 30
Oil capacity including oil filter	5.0–6.5 liters (4.4 Imp.qts.=approx. 5.3 US qts.–5.7 Imp.qts.=approx. 6.9 US qts)[1])
Volvo Penta RB reverse gear	
Oil grade	Service DS
Viscosity	SAE 20
Oil capacity	about 0.5 liter (1 pint)
Warner reverse gear	
Oil grade	Automatic Transmission Fluid, type A[2])
Oil capacity	about 3 liters (2.6 Imp.qts=approx. 3.2 US qts.)
Outboard drive (model 200)	
Oil grade	Hypoid oil (marine type if possible)
Oil viscosity	SAE 90
Oil capacity	about 2 liters (1¾ Imp.qts.=approx. 2 US qts.)

Fuel system

Injection pump, make and designation	CAV ROTO-DIESEL DPA
Fine filter, make and designation	CAV/DES 583–6100
Timing, injection begins	16° B.T.D.C.
Injectors	RKB 35 S 5246
Injector nozzles	RDN OSD 21
Injector opening pressure	120±5 kg/cm² (1705±70 lb./sq.in)
Marking on injection pump data plates	
Pleasure boats	R-34-62-031-6/88-4350
Other installations in planing boats	R-34-62-031-6/88-D4350
Other installations	R-34-62-031-6/88-3400

Cooling system

Capacity, including heat exchanger	about 12 liters (2.65 Imp.galls. =approx 3.15 US galls.)
Thermostat begins to open at	68–72° C (154–162° F)

Electrical system

Voltage	12 V
Alternator output	450 W
Starter motor output	3 h.p.
Battery capacity, standard	114 Ah
Battery electrolyte specific gravity:	
Fully charged battery	1.275–1.285
Battery to be re-charged at	1.230
Glow plugs, Bosch	KE/GSA 10/1

[1]) The oil capacity varies depending on the engine inclination.

NOTE. Always fill up to the maximum mark on the oil dipstick when changing oil. Check the oil level again immediately after the engine has been run warm.

[2]) Esso Automatic Transmission Fluid 55, Shell Donax T6 or corresponding.

TECHNICAL DATA

Reverse gear

Mechanical reverse gear	
Type designation	Volvo Penta RB
Direction of rotation for	Left hand propeller
Reduction ratio, "Forward"	1.91:1
Hydraulic reverse gear	
Type designation	Warner "Velvet Drive" AS1 70 CR
Reduction ratio	2:1 (2.1:1) (left hand propeller)
" "	2:1 (1.91:1) (right hand propeller)
" "	3:1 (2.91:1) (left hand propeller)

Outboard drive

Type designation	Aquamatic 200 C
Reduction ratio ("Forward" and "Reverse")	1.85:1

Tightening torques

Cylinder head nuts	6.5–7.5 kgm (47–54 lb.ft.)
Main bearing bolts	9.5–10.5 kgm (69–76 lb.ft.)
Connecting rod bolts	5.5–6.5 kgm (40–47 lb.ft.)
Flywheel	6–7 kgm (43–50 lb.ft.)
Vibration damper	16–18 kgm (116–130 lb.ft.)
Injector retaining nuts	1.5–2.5 kgm (11–18 lb.ft.)
Glow plugs	4–5 kgm (29–36 lb.ft.)

Instructions för changing from left hand to right hand propeller

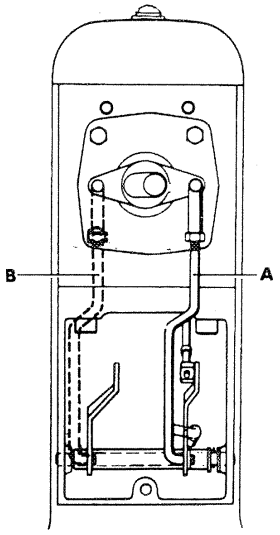
The gear in the upper gear housing of the outboard drive is designed in such a way that it does not have to be altered when changing from left hand to right hand propeller.

At standard rotation, left hand propeller, the lower gear wheel functions as forward gear and at right hand propeller the upper gear wheel.

To obtain opposite rotation, move the shift rod between the yoke on the control mechanism and the lever arm as follows:

1. Remove the cover over the shift mechanism.
2. Move the shift rod from location "A" to location "B" as shown in Fig.

Location of shift rod when right hand propeller is to be used.



Location of shift rod when left hand propeller is to be used.

Irrespective of the propeller rotation the control cable is pushing when shifting into "Forward". Check and adjust the shift linkage in accordance with "Servicing, point 29".

Personal information

Name .....

Address .....

Phone .....

Nearest Volvo Penta dealer

Name .....

Address .....

Phone .....

Engine data

Engine type .....

Product number.....

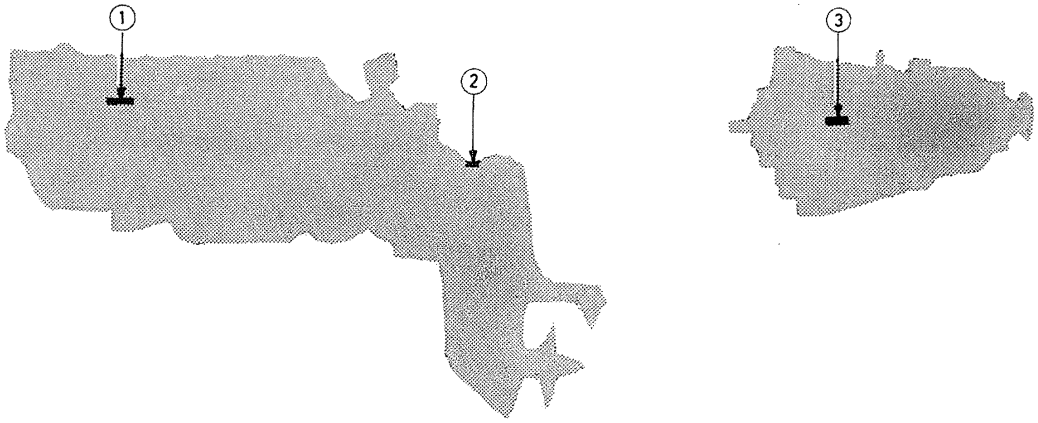
Serial number, engine .....

Serial number, outboard drive .....

Propeller size .....

Reverse gear type .....

Serial number, reverse gear .....



1. Serial number, engine
2. Serial number, outboard drive
3. Serial number, Warner reverse gear

The specifications and technical details stated in this instruction book are not binding. We reserve the right to make modifications without previous notification.

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