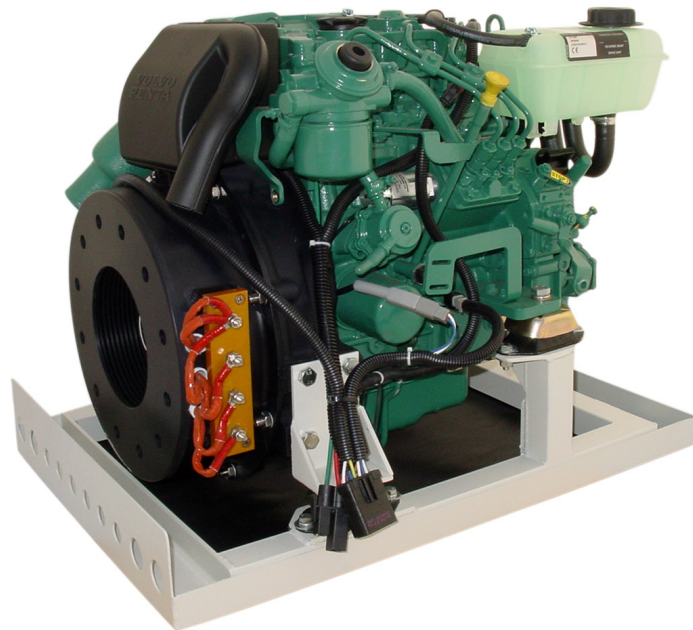




Workshop Manual

Volvo Penta - Engine

Part B



Welcome Aboard

Polar DC Generators and Volvo Penta marine engines are used all over the world today. They are used in all possible operating conditions for professional as well as leisure purposes.

Polar DC Marine is becoming a symbol of reliability, technical innovation, performance and long service life. We also believe that this is what you demand and expect of your Polar DC Marine generator .

Please read this operator's manual thoroughly and consider the advice we provide on operation and maintenance before you cast off on your voyage so that you will be ensured of fulfilling your expectations.

Cylinder head, installation

Special tools: 998 9876, 999 5192

1

Check the piston height with tools 9989876 and 9995192. Select a new cylinder head gasket, please refer to "Technical data".

Check that the valve lifters are in place.

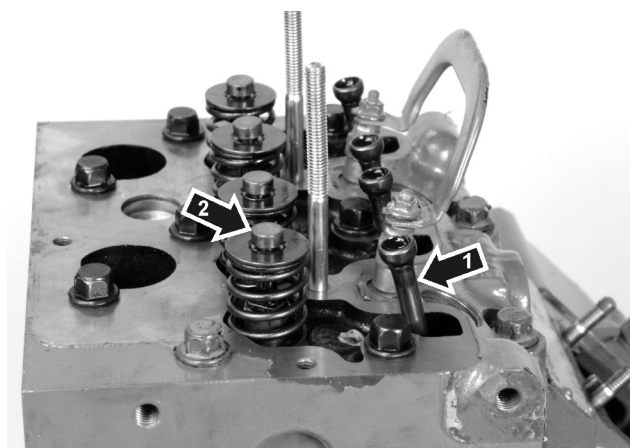
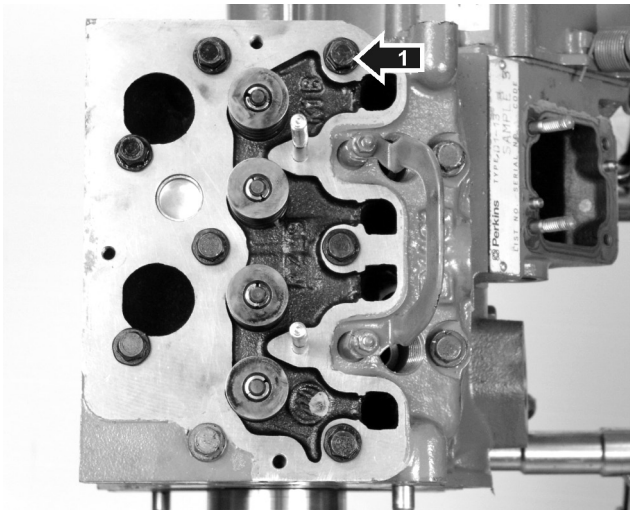
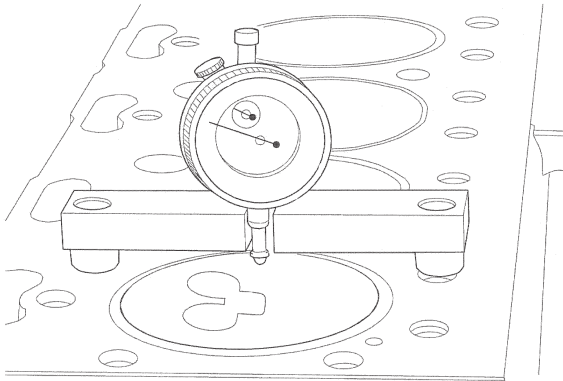
2

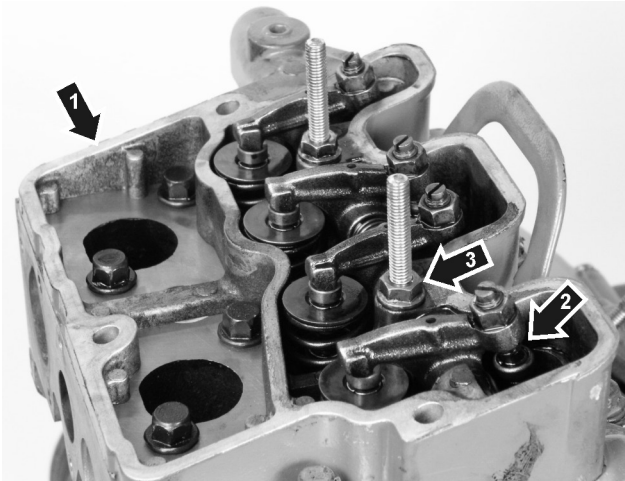
Check that the engine block guide pins for the cylinder head are in place. Install a new cylinder head gasket with the marking upwards.

Put the cylinder head in place. Insert the screws (1) and torque them as in the tightening schedule, to the torque specified in "Technical Data".

3

Install the push rods (1) and valve caps (2).

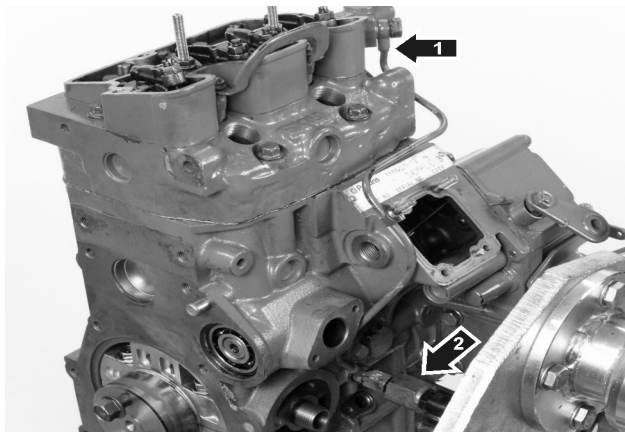




4

Install a new seal on the rocker arm bridge (1). Install a new rocker arm bridge. Make sure that the push rods and rocker arms (2) are correctly aligned.

Tighten the nuts (3) evenly to the specified torque, please refer to the "Technical Data" chapter.



5

Install the oil supply pipe (1) on the cylinder head with new seals.



6

Installing the injectors:

Apply sealant part. no. 840879 to the threads of the two lowest screws (1).

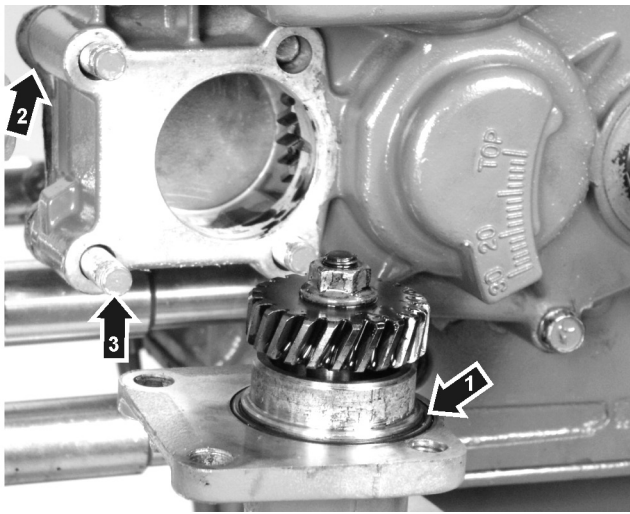
Put new copper seals on the bottom of the cylinder head.

Install the injectors and tighten them evenly to the specified torque, please refer to the "Technical Data" chapter.

Timing gear, removing

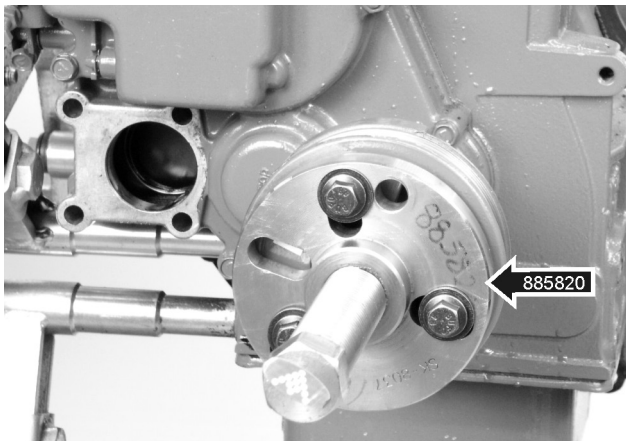
Cylinder head removed

Special tools: 885820, 885 822



1

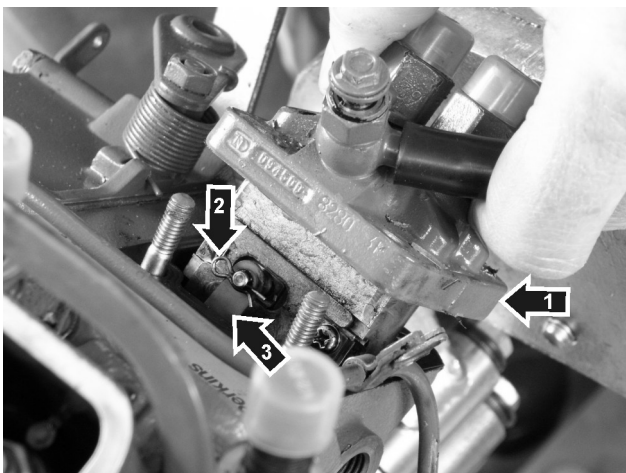
Unscrew the seawater pump (1). Remove the end panel (2) and the screws (3).



2

Unscrew the centre nut from the pulley. Install tool no. 885820 on the pulley and remove it.

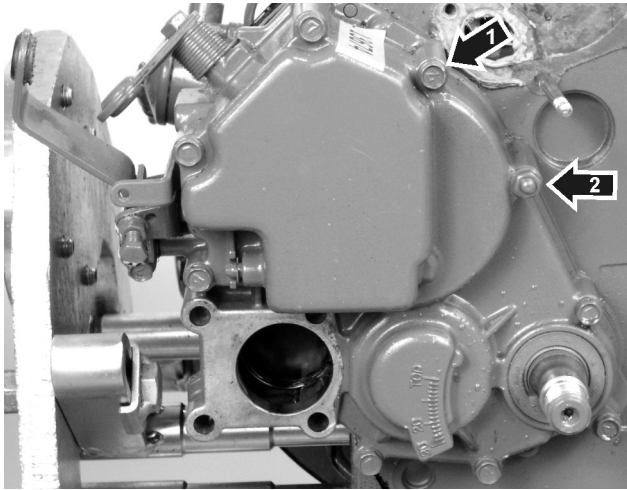
Remove the Woodruff key from the groove in the shaft



3

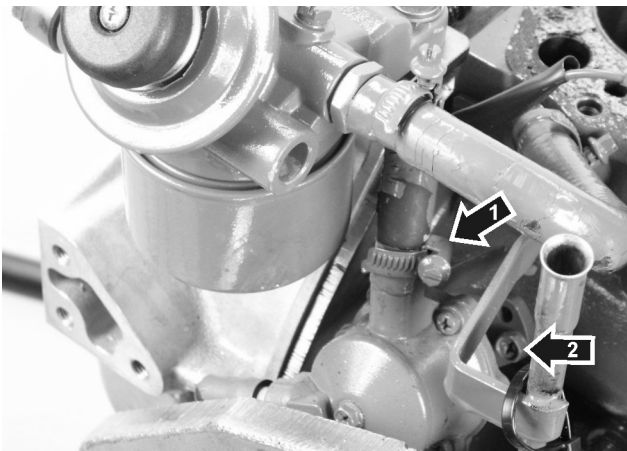
Unscrew the injection pump (1). Lift it up until the lock clip (2) is accessible. Undo the clip and release the control rod (3).

4



Unscrew the timing gear cover screws (1) and nut (2). Remove the cover.

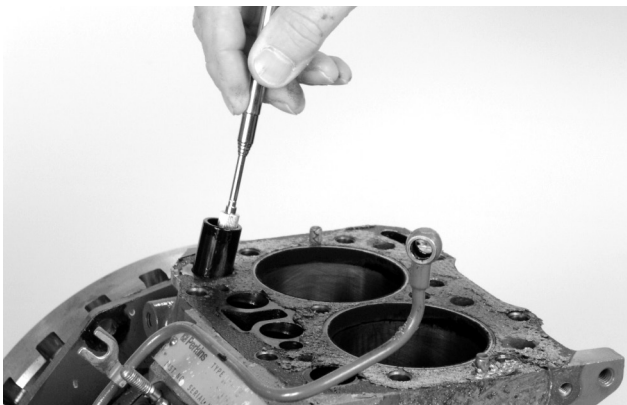
5



Undo the fuel pipe from the fuel filter (1).

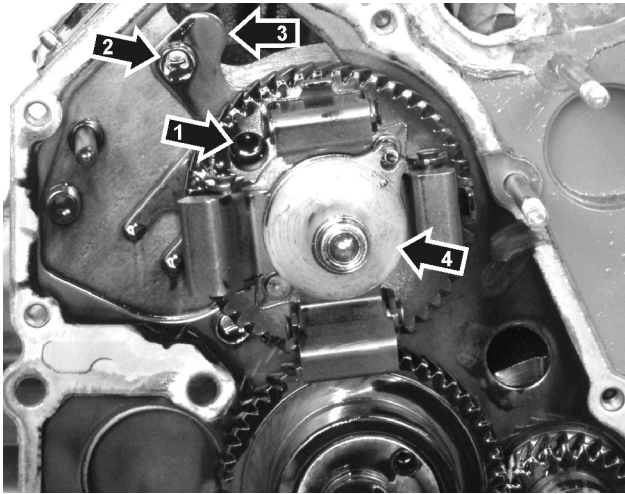
Unscrew the fuel feed pump (2). Wipe up the fuel that has run out.

6



Remove the valve lifters with magnetic tool 885822.

⚠ IMPORTANT! Mark the valve lifters so that they are put back in the same positions. The D1-20 and D2-40 engines have some valve lifters which are chamfered off.



7

Rotate the camshaft until the socket cap screw (1) becomes visible in the hole in the camshaft drive gear. Unscrew the socket cap screw and hex head screw (2). Remove the lock plate (3).

Remove the camshaft regulator sleeve (4).

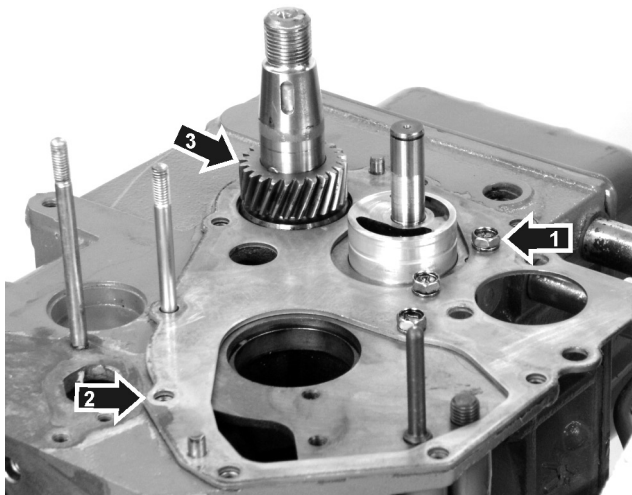
Pull the camshaft out carefully.

⚠ IMPORTANT! There is a risk that the inner camshaft bearing can be damaged by a camshaft lobe if it is pulled out with force.



8

Remove the circlip (1) on the oil pump shaft. Remove all components of the oil pump. Note the spacer washer (2) inside the oil pump gear.

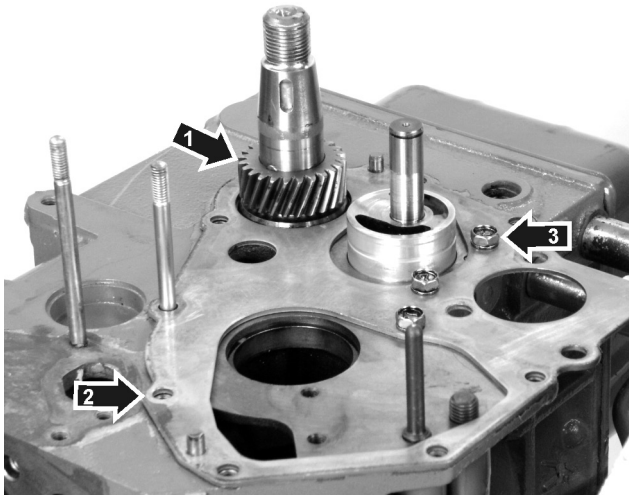


9

Unscrew the remaining screws (1). Remove the timing gear plate (2).

Undo the crankshaft gear (3) with a puller. Remove the gear wheel and its Woodruff key.

Timing gear, installation

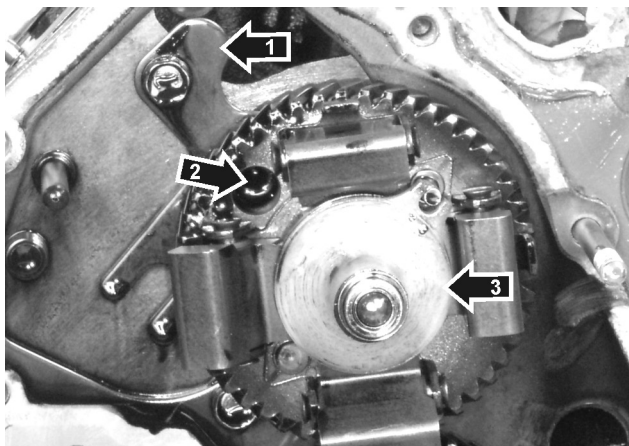


1

Put the gear wheel (1) and its key on the crankshaft. Tap the gear wheel on.

Install a new gasket and timing gear plate (2).

Tighten the inner screws (3) on the timing gear plate.



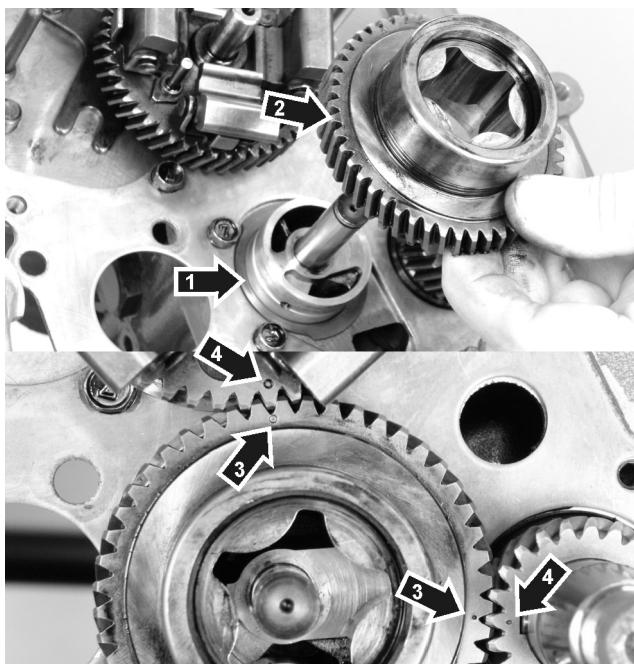
2

Carefully insert the camshaft.

⚠ IMPORTANT! If you force the camshaft in, there is a risk that one of the cam lobes will damage an internal bearing.

Put the lock plate (1) in position. Rotate the camshaft until the screw hole for the socket cap screw (2) becomes visible in the hole in the camshaft drive gear. Screw the lock plate down.

Install the camshaft regulator sleeve (3).

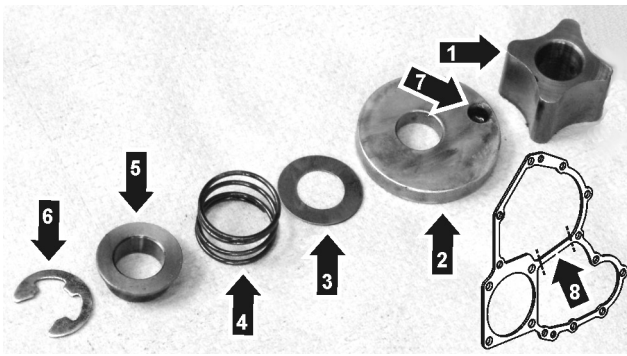


3

Fit the thrust washing (1) in place.

Put the oil pump gear wheel (2) in place. Make sure that the markings (3) on the gear wheel line up with the markings (4) on the other gear wheels.

Check the gear flank clearance, please refer to "Gear flank clearance, checking".



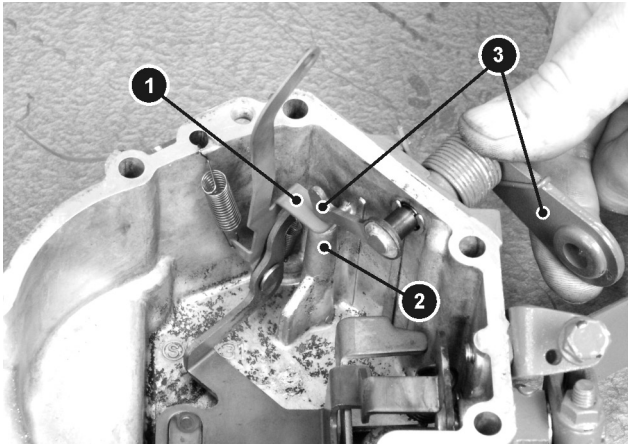
4

Install the pump gear (1), end washer (2), shims (3), spring (4) and bush (5) in the oil pump gear. Put the circlip (6) on the shaft.

NOTE! Note that the end washer (2) has a hole (7) which must mate up with the guide pin in the timing gear cover.

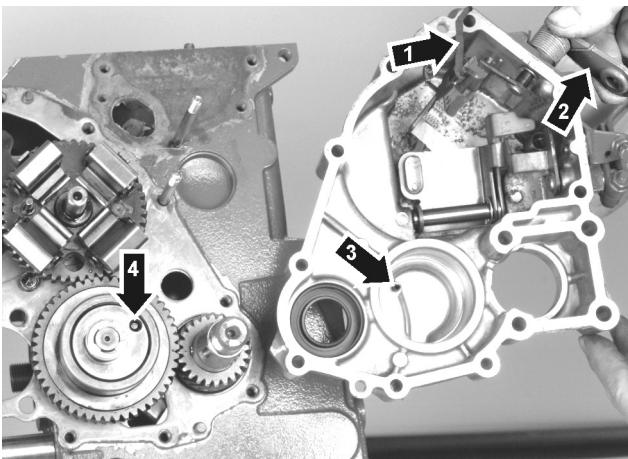
Install a new gasket on the timing cover.

NOTE! If the gasket has a center section (8), this must be cut away.



5

Put the control rod (1) on the heel (2) in the timing gear cover. Turn the stop arm (3) round so that the control rod is held against the heel.

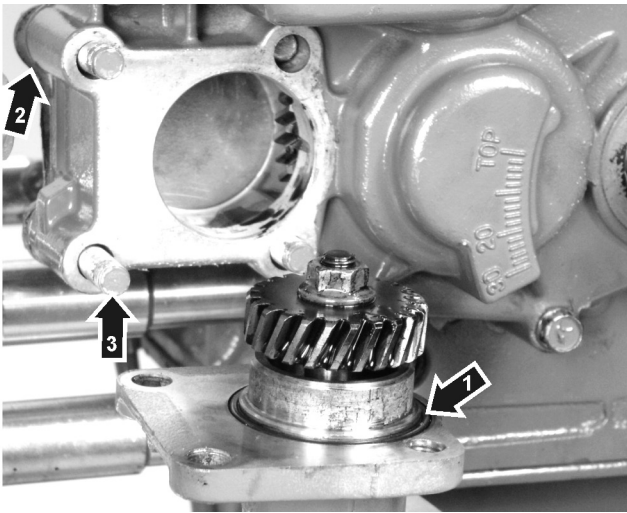


6

Install the timing gear cover at the same time as the control rod (1) is held fixed by the stop arm (2).

Put the timing gear cover in place. Make sure that the control rod ends up in the correct position and that the pin (3) engages in the hole (4) in the oil pump end washer.

Screw the timing gear cover down.



7

Put a new O-ring (1) in the groove in the seawater pump.

Install the rear end piece (2) with a new gasket and its four screws (3).

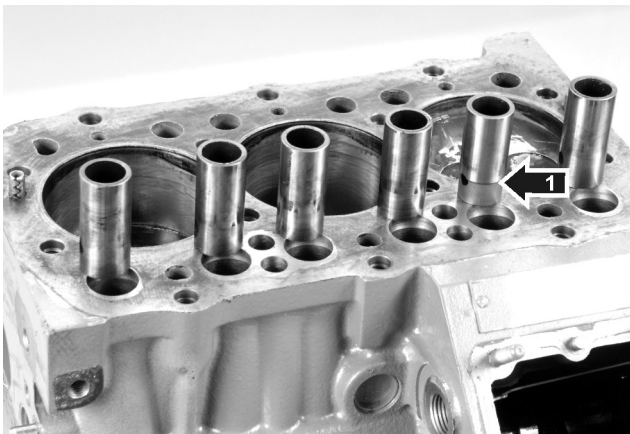
NOTE! The longest screws must be put on the outside (D1-13, D1-20).

Install the seawater pump and screw it in place.

8

Install the pulley key on the crankshaft.

Install the pulley and tighten it to the specified torque with the center nut, please refer to the "Technical Data" chapter.



9

Put the valve lifters in place as marked.

⚠ IMPORTANT! All valve lifters must be put back in their old places. Not that on engine D1-20, valve lifter no. 2 for cylinder 1 has one chamfer (1). On engine D2-40, both valve lifters for cylinder 1 have one chamfer.

D1-20 A

Pistons, removal

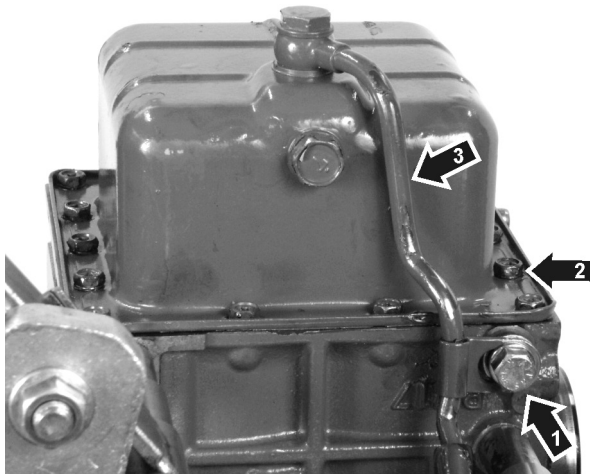
Engine oil drained. Cylinder head removed.

1

Turn the engine upside down. Undo the oil drain pipe anchorage (1) on the cylinder head.

Unscrew the sump (2) and remove it together with the oil drain pipe (3).

2

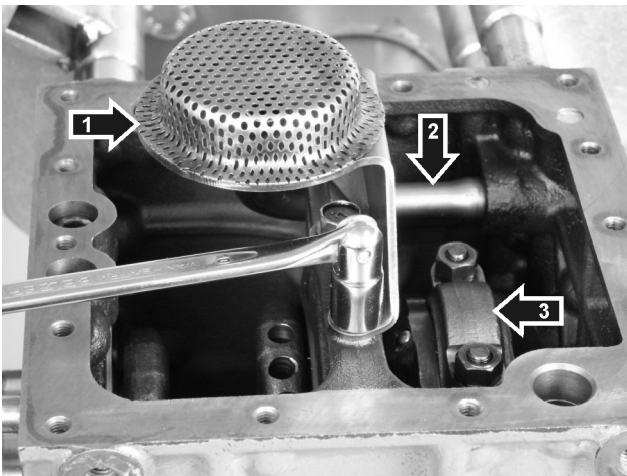


Unscrew the oil suction strainer (1). Remove the suction pipe (2) with its O-ring.

Unscrew the bearing caps (3) for the con rods.

⚠ IMPORTANT! Note the markings on the bearing caps and their locations.

3

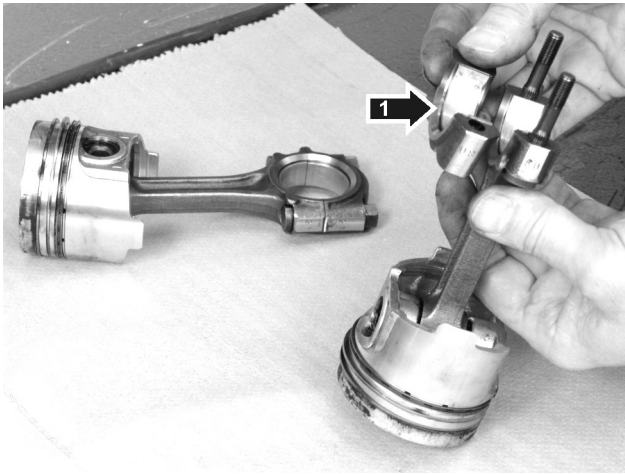


Press the pistons out.

NOTE! There might be a soot deposit on the top of the cylinder bores. Remove the deposit to make it easier to press the pistons out.

Big end bearing, change

Pistons, removed

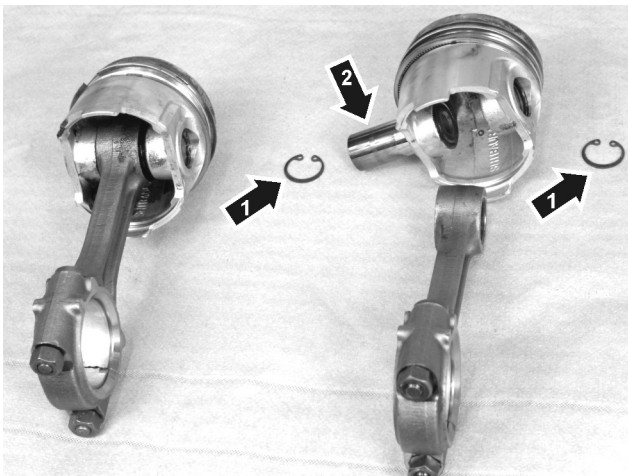


1

Remove the big end bearings (1) and put the new ones in position.

Flat Rate: 21320

Pistons, change



1

Note the positions of the pistons in relation to the crankshaft.

Remove the circlips (1) and press the gudgeon pin out (2).

2

Clean the gudgeon pin bushing and check it.

3

Install a new piston in the correct position.

Press the gudgeon pin in.

Install the circlips with the lugs facing upwards.

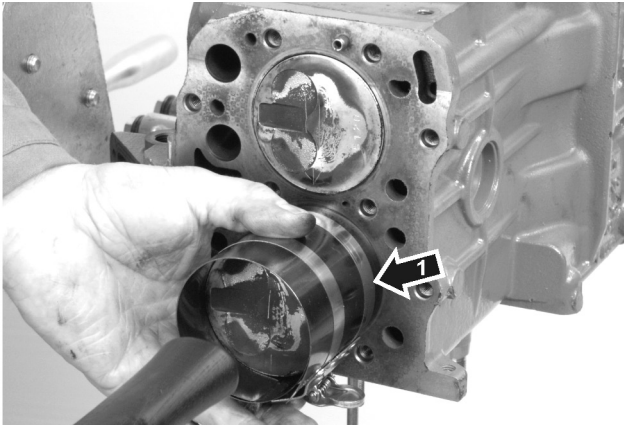
Pistons, installation

1

Also refer to “Assembly of pistons, piston rings and con rod”.

Install a piston ring compressor on the piston.

Lubricate the con rod bearing shells and studs with engine oil.



2

Turn the crankshaft round so that the big end bearing is in the lowest position for the piston to be installed.

Install the piston (1) in the bore and carefully tap it down. The piston marking “SHIBAURA” must face the injection pump side.

⚠ IMPORTANT! Make sure that the con rod studs to not strike the crankshaft when driven down.

3

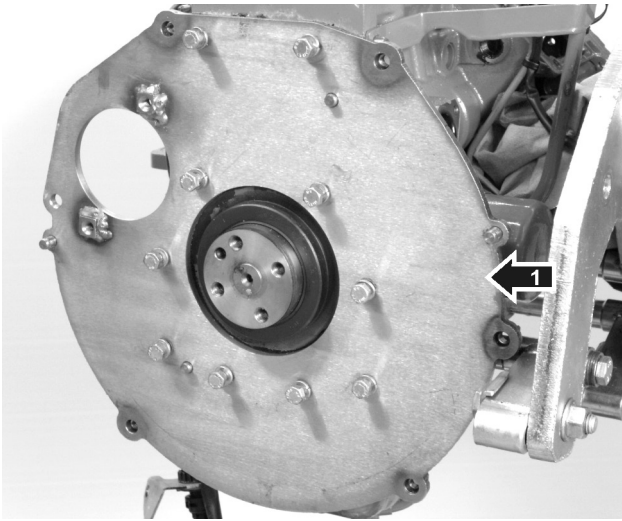
Install the big end bearing cap as marked. Torque to 23 Nm (D1-13, D1-20 or 32 Nm (D1-30, D2-40).

Check the movement of the big end bearing.

Repeat the procedure to install the remaining pistons.

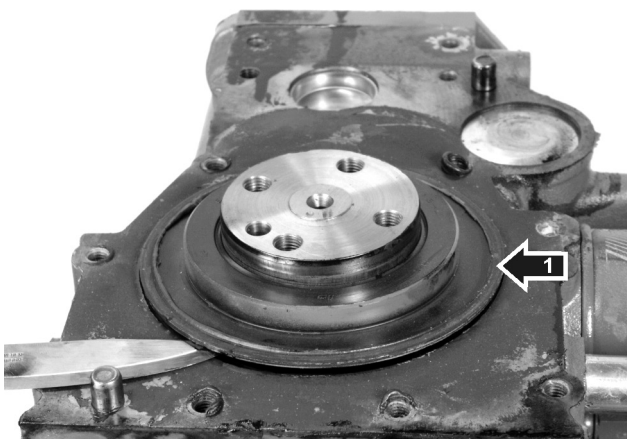
Crankshaft, remove

Removed pistons, flywheel and timing gear



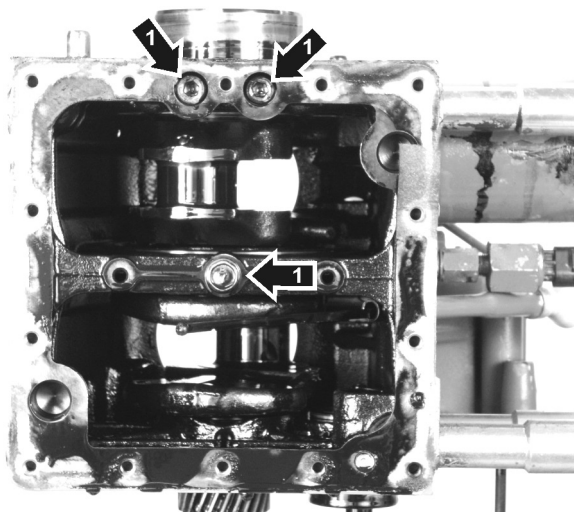
1

Unscrew the inner timing gear plate (1).



2

Remove the rear crankshaft seal (1) from the crankshaft.



3

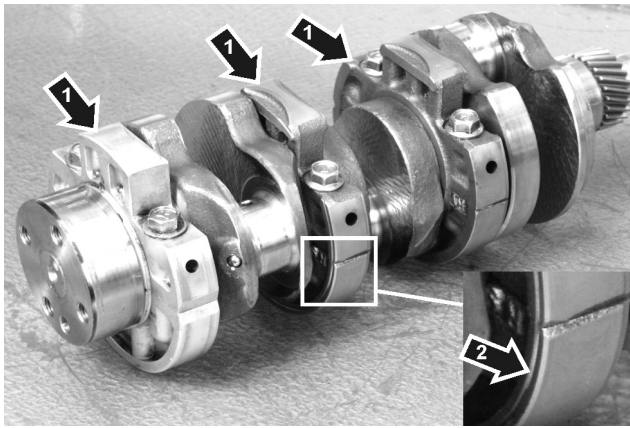
Unscrew the oil pressure reduction valve.

4

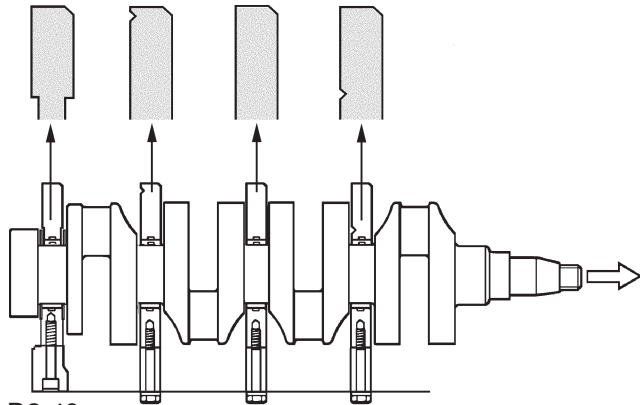
Undo the screws (1) which hold the main bearing caps.

Lift the crankshaft out.

NOTE! Tape the crankshaft gear teeth to protect the bearing when the shaft is pulled out.



D1-20, D1-30



D2-40

Main bearings, change

Crankshaft, removed

1

Unscrew the main bearing retainers (1) and pull them off the crankshaft.



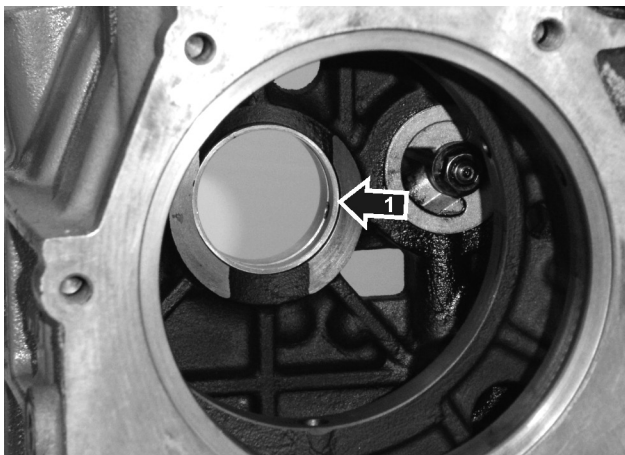
IMPORTANT! The marking (2) on all main bearing retainers for D1-20, D1-30 and D2-40 must be carefully noted to prevent incorrect positioning during assembly. Also note the oil holes (3) in the bearing caps.

2

Drive out the main bearing bush (1) located in the engine block. Use a suitable mandrel and tap the bushing out from inside the crankcase.

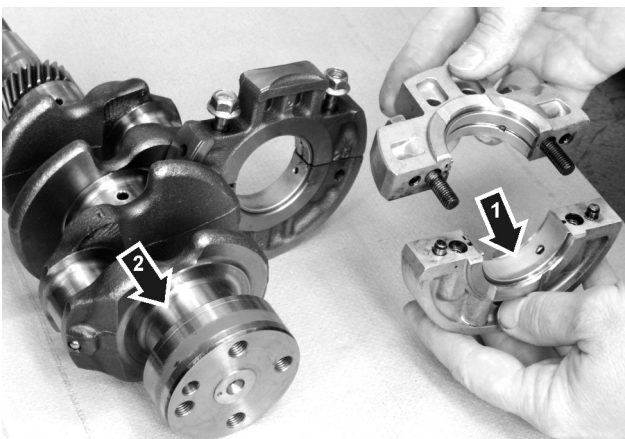
3

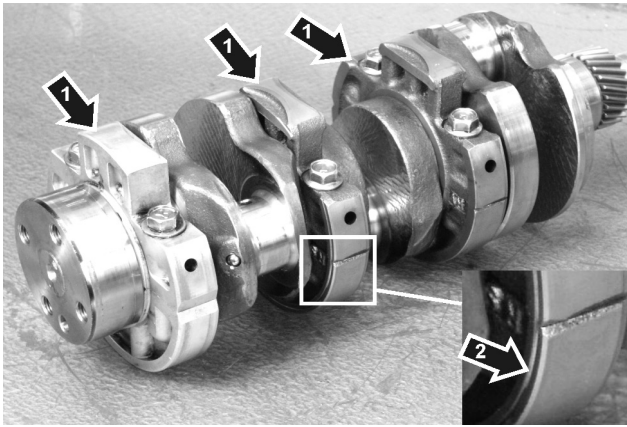
Inspect all main bearings (1). Remove them from



their holders.

Check and measure the bearing surfaces (2) on the crankshaft, please refer to "crankshaft inspection".





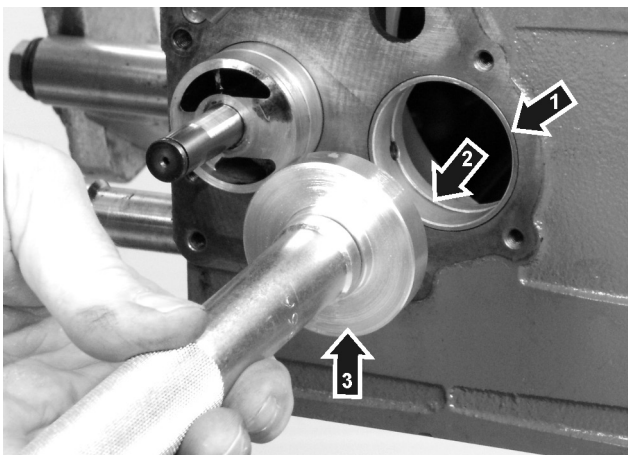
4

Install the new main bearings and lubricate them with engine oil.

Install the main bearing retainers (1) on the crankshaft in accordance with the markings (2). Torque the screws to 23 Nm.

⚠ IMPORTANT! Put the main bearing retainers back in their original places. The oil holes (3) must face the corresponding holes in the engine block.

5



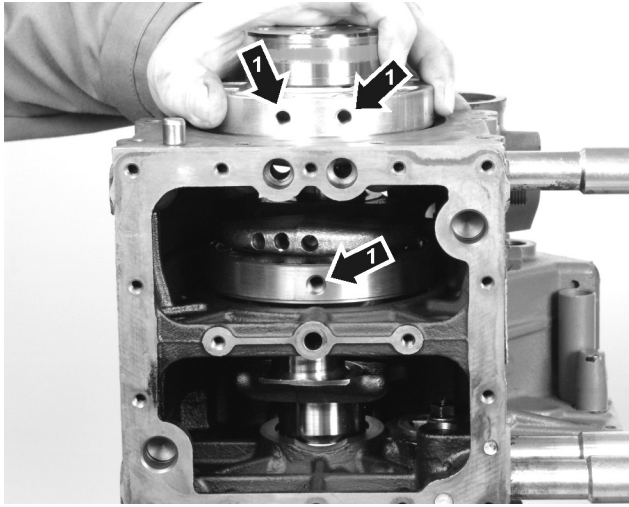
Install the main bearing bush (1) in the engine block.

⚠ IMPORTANT! Position the bushing so that its oil hole is correctly aligned in the engine block. The oil groove (2) in the bushing must be furthest in.

Tap the bushing in with a suitable mandrel (3) until it lines up with the engine block.

Check that the oil duct is open after pressing in. Also check the internal diameter of the bushing. For dimensions, please refer to "Technical Data".

Crankshaft, assembly



1

Lift the crankshaft into place.

Align the main bearing retainer screw holes (1) before the crankshaft is pressed into place.

2

Carefully tap the crankshaft into place if necessary, and torque the main bearing retainers to 27 Nm.

Check that the crankshaft can be turned easily.

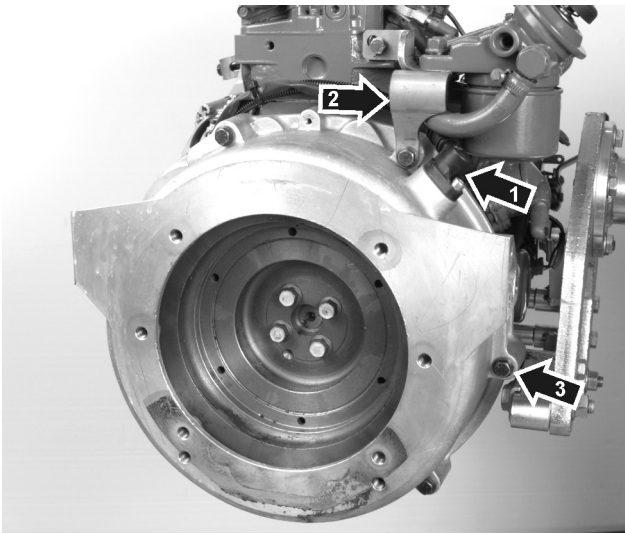
3

Install the oil pressure reduction valve with a new seal. Torque to 64 Nm.

Install a rear crankshaft seal, please refer to "Rear crankshaft seal, changing".

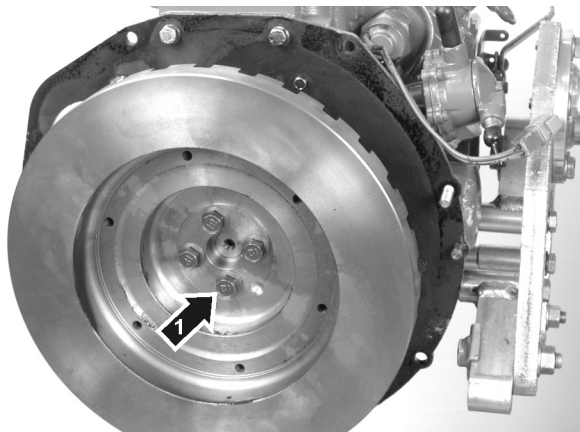
Flat Rate: 21661

Flywheel, change

**1**

Remove the engine speed sensor (1) and filter housing bracket (2).

Remove the flywheel cover (3) and flexible coupling.

**2**

Unscrew the flywheel (1) and remove it.

Clean and check the crankshaft seal.

3

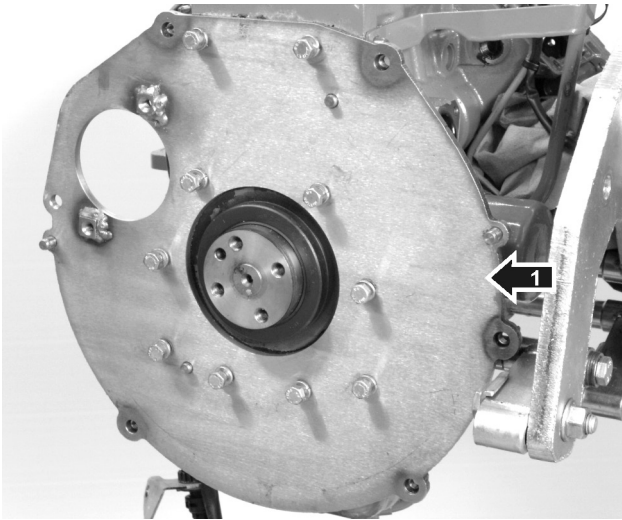
Carefully clean the crankshaft and flywheel.

Install the new flywheel and tighten it to the specified torque, please refer to the "Technical Data" chapter.

Install the flexible coupling, flywheel housing, filter housing bracket and engine speed sensor.

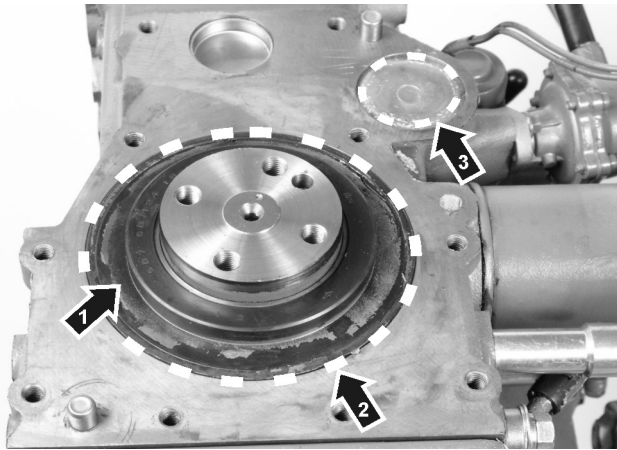
Crankcase seal rear, change

Flywheel removed



1

Unscrew the inner timing gear plate (1).



2

Remove the rear crankshaft seal (1).

Check that the area for the crankshaft seal on the engine block, the crankshaft and the inner flywheel housing are cleaned.

Lubricate the lip of the seal on the new crankshaft seal with engine oil and put the seal in place.

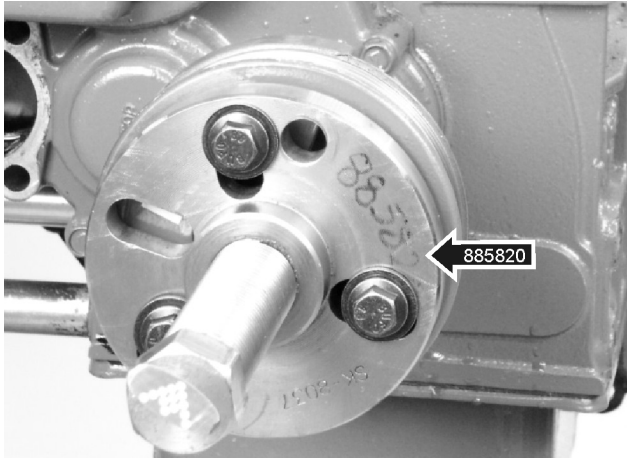
Apply sealant part no. 840879 all round the crankshaft seal (2) and the camshaft cover (3).

Fix the inner flywheel plate.

Flat Rate: 21672

Crankshaft seal, front, change

Special tools: 885820, 9995919

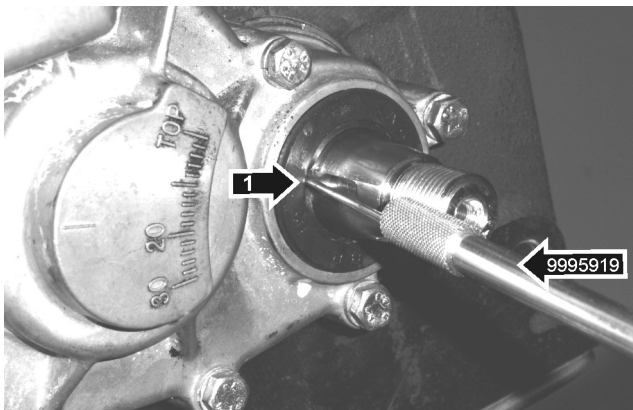


1

Undo the drive belt.

Unscrew the centre nut from the crankshaft pulley. Install tool no. 885820 on the pulley and remove it.

Remove the Woodruff key from the groove in the shaft



2

Insert tool no. 9995919 under the lip of the crankshaft seal (1) and pull the seal out.

Clean the crankshaft and seal surfaces. Tape the key groove on the crankshaft to avoid damaging the new seal during assembly.

3

Lubricate the new crankshaft seal with engine oil and put it on the crankshaft. Drive the seal into place with a suitable mandrel.

Remove the tape.

4

Install the pulley key on the crankshaft.

Install the pulley and tighten it to the specified torque with the center nut, please refer to the "Technical Data" chapter.

Install and adjust the drive belt.

Flat Rate: 21403

Valves, adjustment

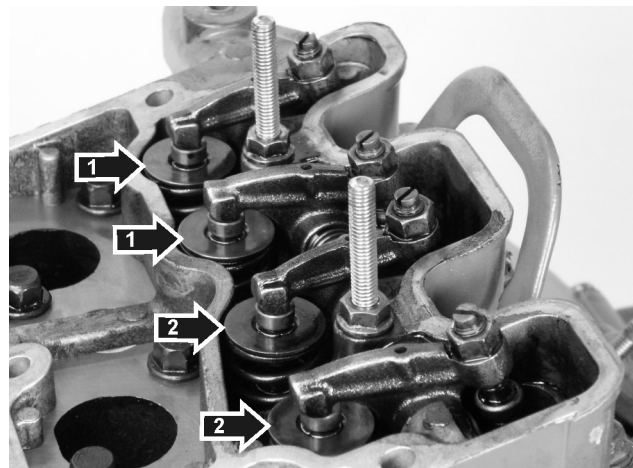
Stationary, cold engine



1

Remove the air filter housing (1) and valve housing (2).

2

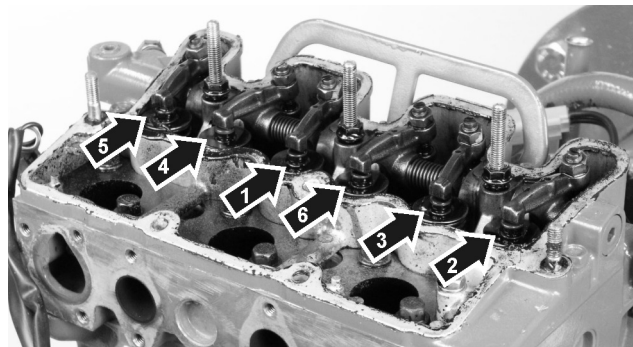


D1-13

Crank the engine clockwise until the valves (1) for no. 1 cylinder shift position. Then crank the engine exactly one more turn. You can now adjust the valves for no. 1 cylinder. Please refer to item 3 for the adjustment procedure.

Crank the engine until the valves (2) for no. 2 cylinder shift position. Then crank the engine exactly one more turn. Adjust the valves for no. 2 cylinder.

D1-20, D1-30



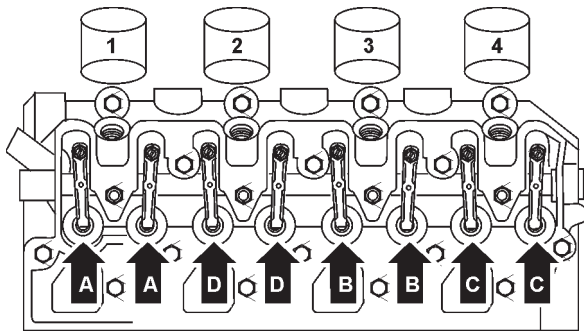
Crank the engine clockwise until the valves for no. 1 cylinder shift position. Adjust no. 2 inlet valve (1) and no. 3 exhaust valve (2). Please refer to item 3 for the adjustment procedure.

Crank the engine clockwise until the valves for no. 2 cylinder shift position. Adjust no. 3 inlet valve (3) and no. 1 exhaust valve (4).

Crank the engine clockwise until the valves for no. 3 cylinder shift position. Adjust no. 1 inlet valve (5) and no. 2 exhaust valve (6).

D2-40

Crank the engine clockwise until the valves for no. 4



cylinder shift position. Adjust no. 1 inlet and exhaust valve (A). Please refer to item 3 for the adjustment procedure.

Crank the engine clockwise until the valves for no. 2 cylinder shift position. Adjust no. 3 inlet and exhaust valve (B).

Crank the engine clockwise until the valves for no. 1 cylinder shift position. Adjust no. 4 inlet and exhaust valve (C).

Crank the engine clockwise until the valves for no. 3 cylinder shift position. Adjust no. 2 inlet and exhaust valve (D).

3

Adjustment

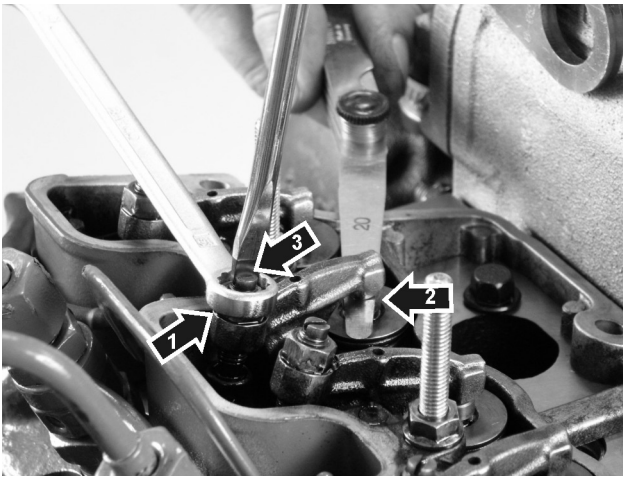
Undo the locknut (1) with a ring wrench. Measure the valve clearance (2) with a feeler gauge. Adjust the valve clearance with the adjustment screw (3).

The correct valve clearance for all valves and engines is 0.2 mm.

When the correct valve clearance has been reached, tighten the locknut (1).

4

Install the valve cover with a new seal.

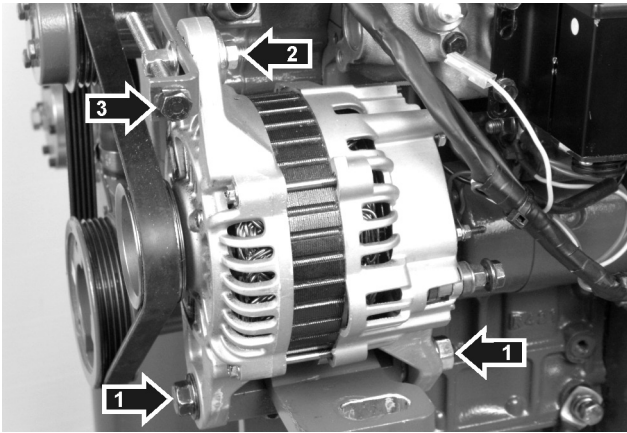


Install the air filter housing.

Test run the engine and check that no oil leakage occurs.

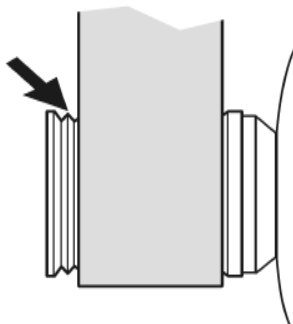
Flat Rate: 23641

Drive belt, change

**1**

Lightly loosen the lower fixing screws (1) on the alternator. Loosen the upper fixing nut (2).

Loosen the tension screw (3) and slacken the drive belt. Remove the drive belt.



D1-30, D2-40

2

Install a new drive belt. Tension the belts with tensioner screw. Check the tension.

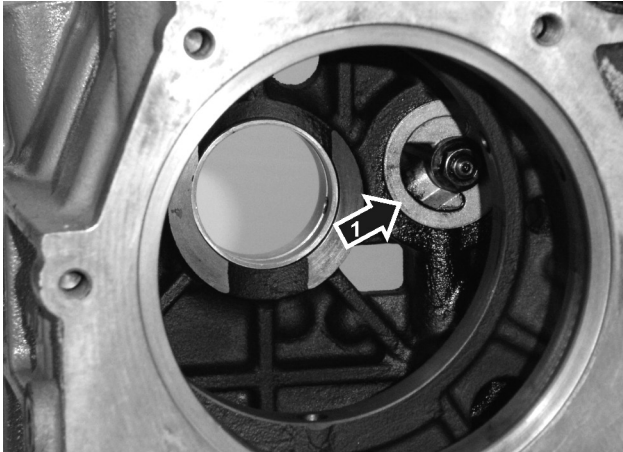
Tighten the alternator fixing nut and fixing screws.

⚠ IMPORTANT! D1-30, D2-40: Be careful to ensure that the alternator belt is placed in the groove closest to the alternator.

Oil pump bearing, changing

Timing gear and crankshaft removed

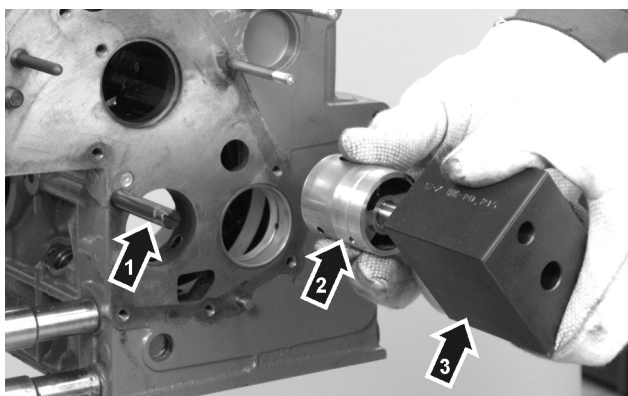
Special tools: 384 9639 (D1-13, D1-20), 384 9640 (D1-30, D2-40)



1

Drive out the oil pump bearing section (1) located in the engine block. Tap it out from inside the crankcase.

2



Use special tool 384 9639 for D1-13 and D1-20, 384 9640 for D1-30 and D2-40.

First screw the guide pin (1) for the tool into the engine block.

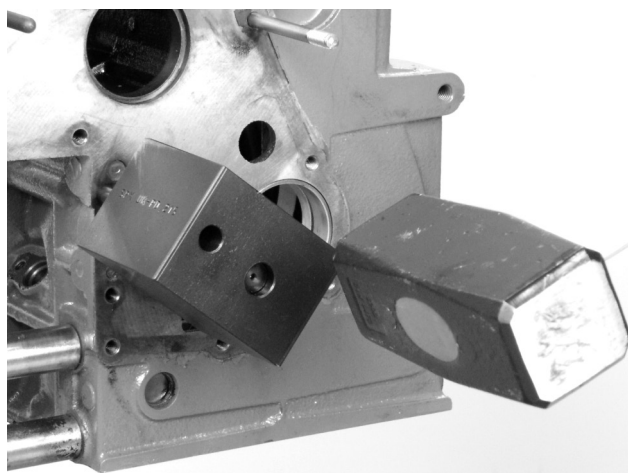
Then put the new oil pump bearing (2) into the tool block (3).

NOTE! It is important that the engine block surface touching the tool is clean and even. The tool block must be oiled.

3

Place the tool block with the bearing in place, using the guide pin.

Tap the bearing into place until the tool bottoms on the cylinder head.



Injection pump, changing

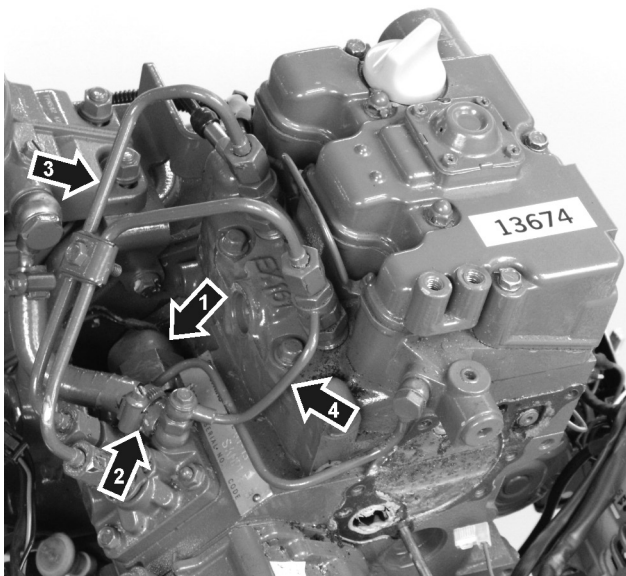
1

Unscrew the stop solenoid (1).

Undo the supply pipe (2) to the injection pump.

Undo the supply pipes (3) and return fuel pipe (4).

⚠ IMPORTANT! Seal all openings in the fuel system with protective caps.

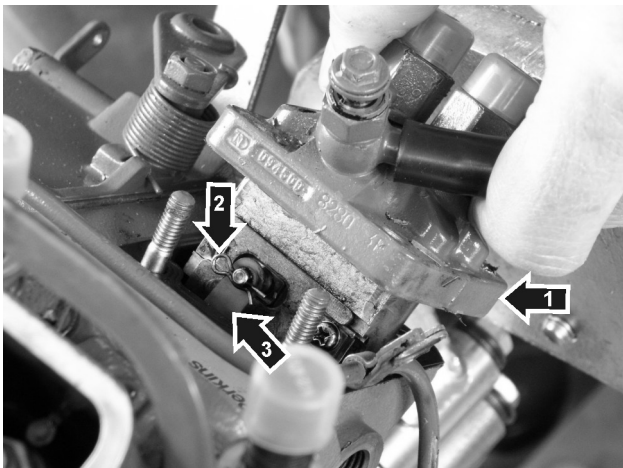


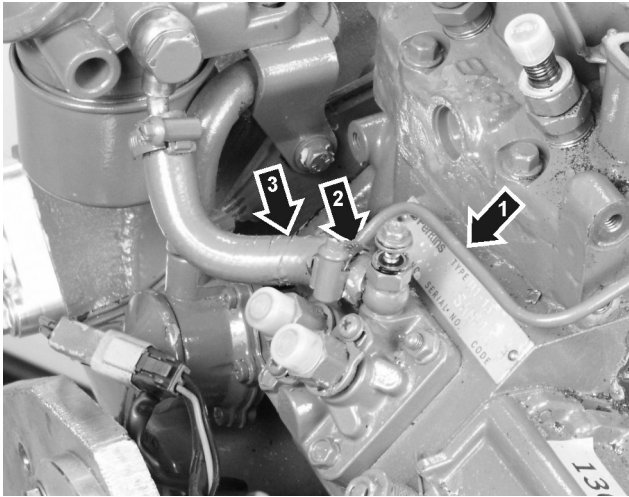
2

Unscrew the injection pump (1). Lift it up until the lock clip (2) is accessible. Undo the clip and release the control rod (3).

Lift the injection pump out and remove the shim.

3



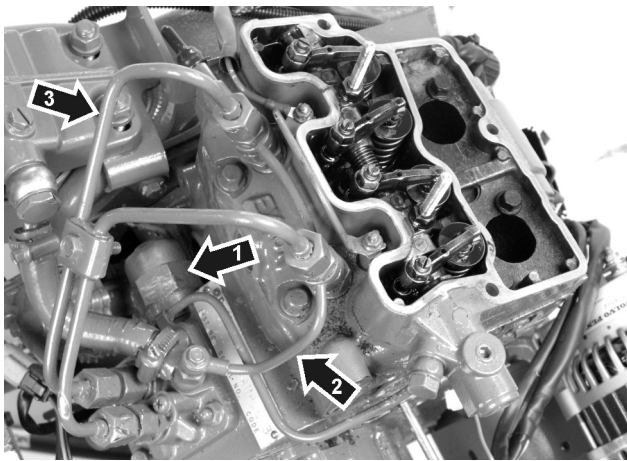


Put a new shim of the same thickness on the pump housing. Insert the new injection pump into the housing and fix the control rod with the lock clip.

Fix the oil supply pipe (1) on one of the studs (2). Tighten the injection pump to the specified torque, please refer to "Technical Data".

Install the supply pipe (3).

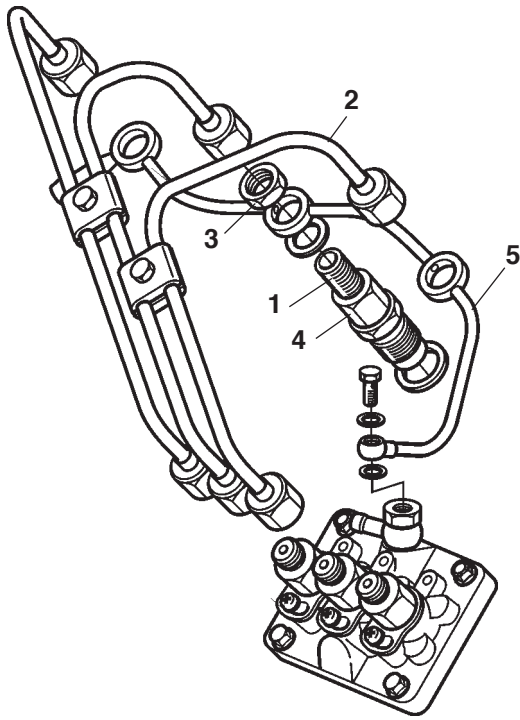
5



Install the stop solenoid (1) with a new seal.

Install the fuel return pipe (2).

Install the fuel supply pipes (3) and tighten to the specified torque, please refer to the "Technical Data" chapter.



Flat Rate: 23710

Injectors, changing

1

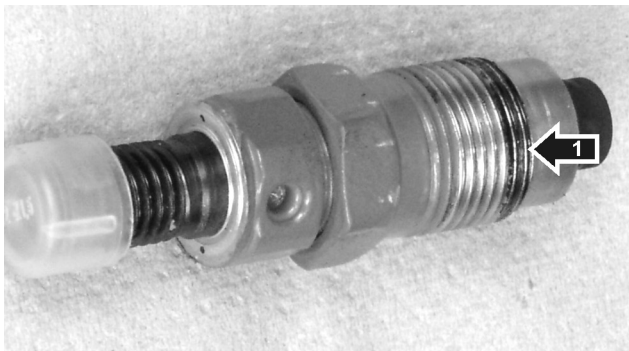
Clean round the injectors (1).

Undo the fuel supply pipes (2) by the injection pump and the injectors. Lift the fuel supply pipes away together.

Remove the nut (3) at the top of each injector, use the nut (4) underneath the fuel return pipe (5) to avoid kinking the pipe. Lift the return fuel pipe away.

Unscrew the injectors. Remove the copper seals under the injectors.

⚠ IMPORTANT! Seal all openings in the fuel system with protective caps.



2

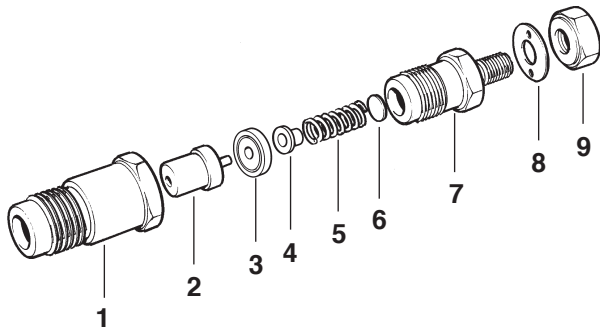
Install the new injectors with new copper seals. Apply sealant, part no. 840 879 to the two lowest threads (1). Tightening torque, please refer to the "Technical Data" chapter.

Install the new return fuel pipe, use the nut underneath the fuel return pipe to avoid kinking the pipe.

Install the fuel supply pipes. Check that they do not come out of alignment, and tighten the nuts. Tightening torque, please refer to the "Technical Data" chapter.

3

Start the engine and check that no leakage occurs.



- | | |
|----------------------|-----------------------|
| 1. Injector nut | 6. Adjustment washers |
| 2. Injectors | 7. Injector holder |
| 3. Joining piece | 8. Washer |
| 4. Compression screw | 9. Nut |
| 5. Spring | |

Flat Rate: 23701

Renovating the injectors

1. Clean the outside of the injector.
2. Fix the injector (holder) in a vise. Unscrew the injector nut and take the injector apart.

Note. Be careful that the injector nozzle does not fall out during disassembly.

3. Pull the injector nozzle out of the injector sleeve and put the components in cleaning petrol (gasoline).

Note. Make sure that the injector needles and injector sleeves which belong with each other, and fit together, are not mixed up if several injectors are cleaned at the same time. To avoid mixing up, the injectors should be put in an injector stand or in different compartments.

4. Check each injector carefully with an illuminated magnifier or an injector microscope. Also check the other components.

5. When you install a **new injector**, it is important that conservation oil is washed off the injector needle and sleeve before the injector is assembled (avoid skin contact with the sliding surfaces of the needle).

Clean the components in chemically pure petrol (gasoline). Check that the injector needle slides in the sleeve, with no tendency to binding.

6. Dip the injector components in pure Diesel or testing oil, and fit the components together. Use the original thickness of adjustment washer(s) to set the opening pressure.
7. Check the opening pressure, jet pattern and sealing in an injector tester.

Injectors, testing

Testing is done in an injector tester. During the test, the opening pressure and sealing are the most important things. The spray pattern is more difficult to assess, and does not give a reliable indication of the injector's status.

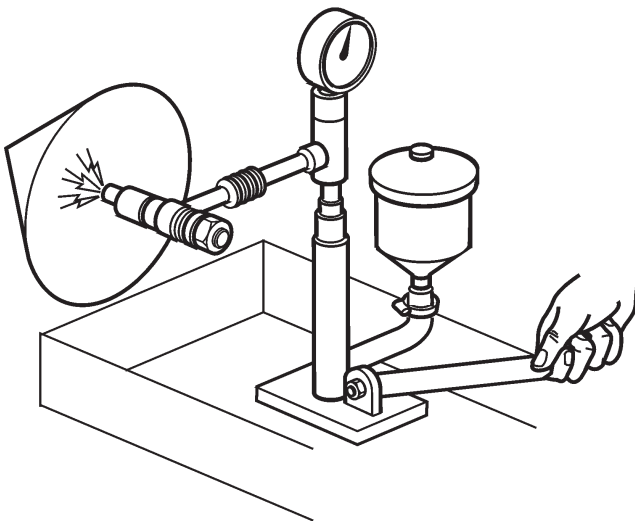
⚠ WARNING! Be careful when testing injectors, avoid getting the fuel jet from an injector on unprotected parts of your body. The jet has such powerful penetration ability that it can force its way in under your skin and cause blood poisoning (septicemia).

Opening pressure

With the pressure gauge connected, press the injector tester lever down slowly until the injector opens and releases fuel. Read off the opening pressure at the opening instant.

If the value read does not coincide with the specified value, the setting must be changed. This is done with washers.

Note. The opening pressure is increased or reduced by about 1 MPa by a change in thickness of the spacer by 0.1 mm.



Injectors, check

Spray pattern

1. Pump the injector tester, special tool 9999 772, and check the injector spray pattern. The fuel jet should be conical and in line with the centerline of the injector. Fuel drops must not occur in the jet.
2. Check that the fuel jet has a circular cross section.

Sealing

When sealing is checked, investigate the fuel leakage which can occur between the injector nozzle seat and the tapered sealing surface in the injector sleeve.

1. Wipe the injector nozzle tip dry.
2. Pump the pressure up to about 2 MPa below the opening pressure of the injector (please refer to Technical Data). Keep the pressure constant for about 10 sec. and check that no fuel drips out from the tip of the injector. Damp injectors can be approved.

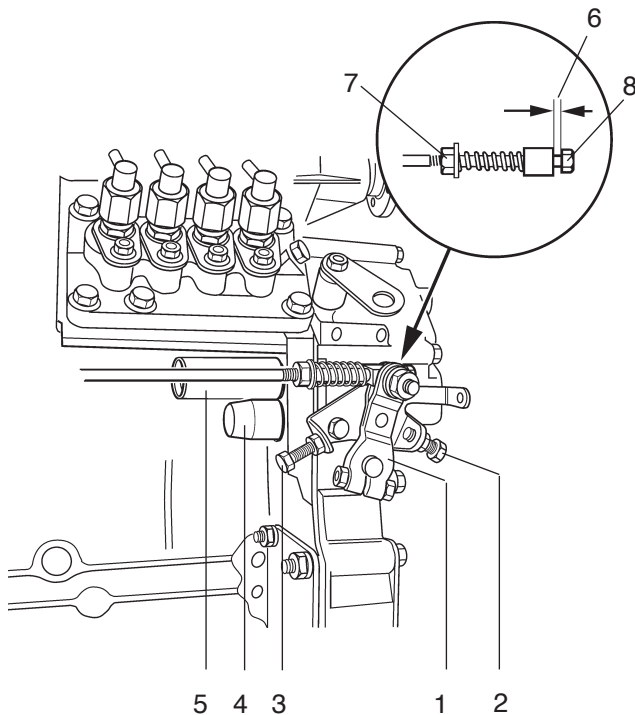
Install protective caps on the injector pipe couplings and over the injector nozzle tips, if the injectors will not be used at once.

Setting the engine speed

Check that the accelerator control functions normally, i.e. the actuator arm (1) is pressed against the low idle stop (2) when the accelerator control is at idle, and is pressed against the full throttle screw (3) when the accelerator control is at full throttle. Adjust the control if necessary. Also check that the air filter is not blocked, and that the air inlet is not blocked.

⚠ IMPORTANT! The engine's fuel volume and speed are set at the factory to give highest power and least environmental impact. These settings must not be disturbed.

NOTE! Seals on injection equipment may only be broken by authorized personnel. Seals which have been broken must be re-sealed.



1. Actuator arm
2. Adjustment screw, low idle
3. Stop screw, full throttle
4. Adjustment screw, racing speed
5. Adjustment screw, max. fuel volume
7. Lock nut

Low idle

1. Check that the gap (6) is about 3 mm when the accelerator is in the idle position. If necessary: Undo lock nut (7) and adjust screw (8) to give the correct gap.
2. Warm the engine up and check the idling speed with a tachometer (please refer to Technical data for correct idling speed).
3. Use adjustment screw (2) to adjust to give the correct idling speed.
4. Check the gap (3) again as in item 1.

Racing speed (high idle)

Warm the engine up and check the racing speed with a workshop tachometer when the engine is unloaded at full throttle (please refer to "Technical data" for correct racing speed).

Adjust the following as necessary

1. Loosen the stop screw (3) so that it does not limit the movement of the actuator arm (1).
2. Run the engine without load at full throttle and adjust the racing speed to the correct value with adjustment screw (4). Remember to seal the screw afterwards.
3. Adjust stop screw (3) to give a clearance of 0.1 mm between stop screw (3) and the actuator arm (1) when the throttle control is at the full throttle position.

Flat Rate: 23311

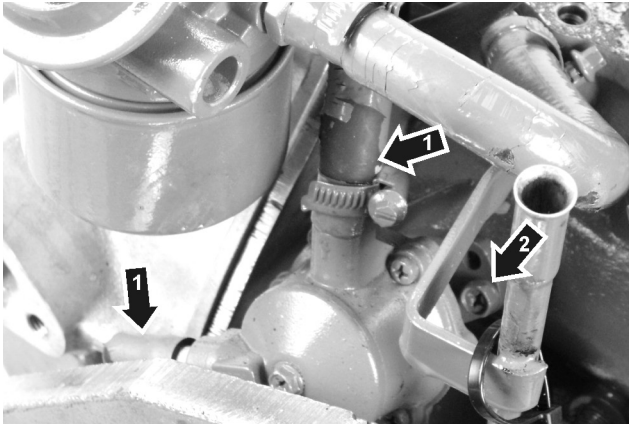
Feed pump, changing

1

Put a rag under the feed pump to collect spilled fuel.

Undo the unions (1) on the feed pump.

Unscrew the feed pump (2).

**2**

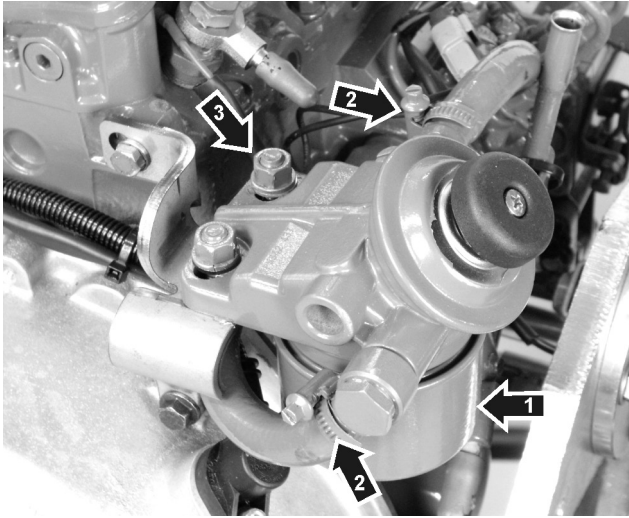
Put a new O-ring in the feed pump.

Install the feed pump and screw it in place.

Install the fuel unions on the feed pump.

Flat Rate: 23341

Hand pump, changing



1

Put a rag under the filter housing bracket to collect spilled fuel. Undo the secondary filter (1). This must be sorted as environmentally hazardous waste.

Undo the fuel unions (2).

Unscrew the hand pump (3) and remove it.

2

Put a new secondary filter in the new hand pump.

Install the hand pump on the bracket.

Screw the fuel unions tight.

Vent the fuel system, please refer to "Fuel System, Venting".

Flat Rate: 23080

Fuel system, venting

1

Open the vent screw (1) located above the fuel filter bracket.

NOTE! Check whether the copper washer on the vent screw needs to be changed.

2

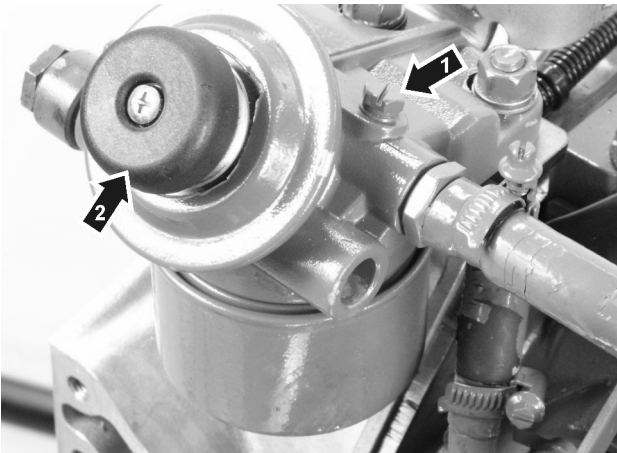
Press the hand pump (2) located on the fuel filter bracket until fuel with no air bubbles comes out of the vent screw. Keep pumping at the same time as the vent screw is closed.

Pump another 10 strokes.

3

Wipe up the fuel that has run out.

Start the engine and check sealing.



Coolant

Mixing

⚠ WARNING! All glycol is hazardous and pollutes the environment. Flammable. Do not swallow it!

Mix:
40% "Volvo Penta Coolant" (conc. coolant)
60% water

This mixture prevents against internal corrosion, cavitation and frost bursting down to about -28°C . (At 60% glycol concentration, the freezing point is lowered to -54°C .) Never mix more than 60% concentrate (Volvo Penta Coolant) in the coolant. This will give reduced frost protection and poorer cooling effect, with a consequent risk of overheating.

⚠ IMPORTANT! The coolant must be mixed with **pure water**, use **distilled – de-ionized water**.

⚠ IMPORTANT! It is extremely important that the correct concentration of coolant is put in the system. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.

Filling the coolant

Flush the cooling system clean before new coolant is added.

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

The engine must be stationary when the cooling system is filled, and must not be started until the system is vented and completely filled. If a heating unit is connected to the engine cooling system, the heat control valve should be fully opened and the installation vented during filling.

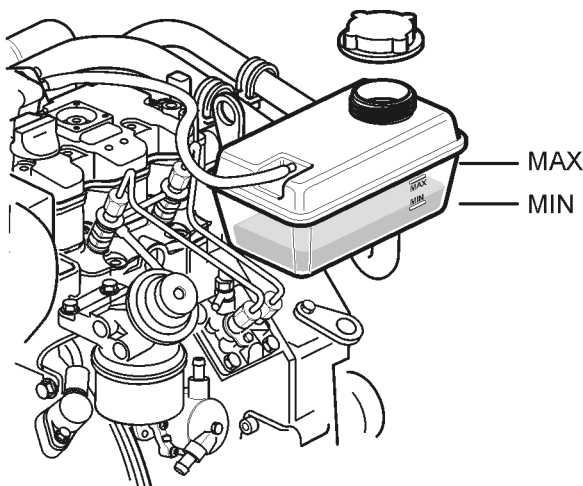
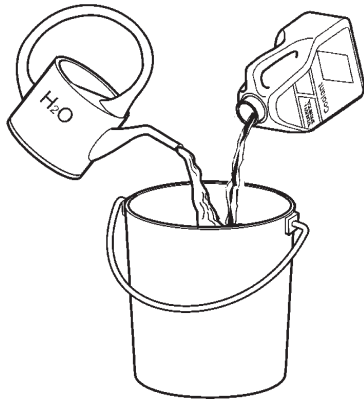
Check all hoses and joints, and rectify any leaks.

Fill the system slowly! Filling must not be done so fast that air locks are formed in the system. The air should be allowed to flow out through the filling opening. Check the coolant level after the engine has been run for about an hour. Top up with coolant as necessary.

Checking the coolant level

⚠ WARNING! Do not open the filler cap when the engine is warm, except in emergencies. Steam or hot fluid could spray out.

Turn the filler cap to the first stop and allow any excess pressure to hiss out before removing the cap completely. Top the coolant up as necessary. The level must be between the MAX and MIN markings.



Pressure valve in filler cap, checking

Special tools: 9996662

1. Drain some of the coolant and connect the pressure testing device to a nipple or other plugged hole in the cooling system.
2. Extend the drain hose from the filler pipe with a hose which ends up in a water - filled vessel.
3. Increase the pressure and read the pressure gauge when the valve opens (water bubbles into the vessel with the drain hose). The valve should open at 0.075 MPa.
4. Remove the test equipment. Install the plug and fill the engine up with coolant.

Fault causes, cooling system

Too low coolant temperature

Low coolant temperature can be caused by:

- Faulty thermostat.
- Faulty temperature sensor or instrument.
- Low engine loading.

Excessive coolant temperature

Excessive coolant temperature (warning lamp lights up) can be caused by:

- Blocked sea water inlet or sea water filter.
- Defective impeller in the sea water pump.
- Too low coolant level, air in the fresh water system.
- Slipping or broken vee belt for the coolant pump.
- Faulty thermostat, temperature sensor or instrument.
- Blocked cooling system.
- Incorrectly set injection advance in the injection pump.
- Filler cap gasket does not seal.

Coolant losses

There are two types of coolant losses:

- Coolant losses during operation.
- Coolant losses after stopping a hot engine.

Coolant losses during operation can be caused by poor sealing in the cooling system, or that air or combustion gases are forced into the cooling system and force coolant out through the pressure cap.

Flat Rate: 26271

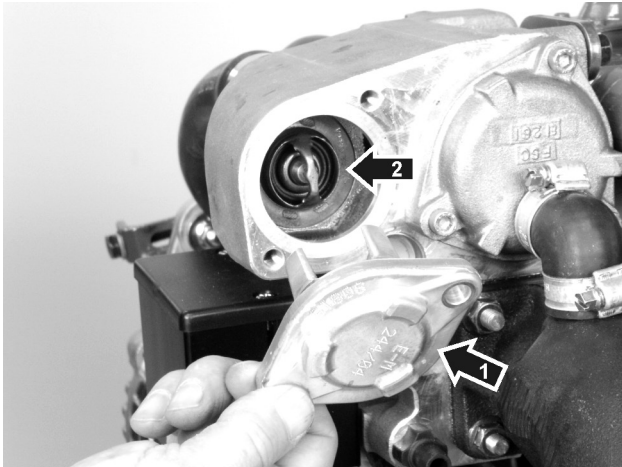
Thermostat, change

1

Drain the coolant.

Undo the thermostat housing (1). Remove the O-ring from the cap.

Remove the thermostat (2) and seal.

2

Install a new thermostat and seal.

Install the thermostat housing cover with a new O-ring. Tighten the screws to the specified torque, please refer to "Technical Data".

3

Fill up with coolant.

Warm up, and check the sealing and coolant level.

Heat exchanger, cleaning

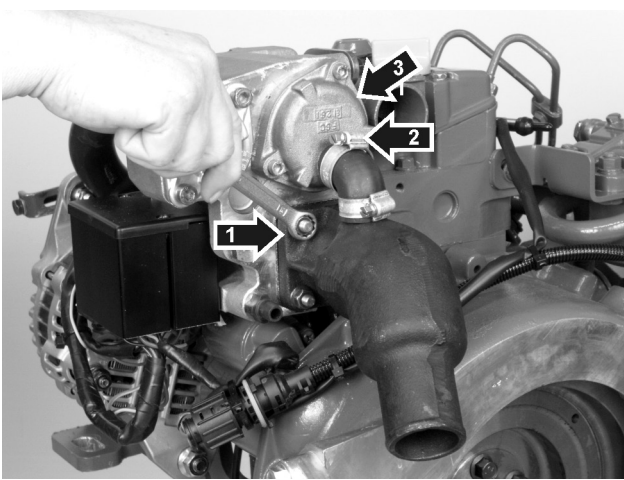
Drained cooling system and sea water. Air filter housing removed. Expansion tank and bracket removed (D1-30 and D2-40)

1

Undo the heat exchanger end wall on the alternator side.

Remove the exhaust pipe elbow (1) and hose clamp (2) from the heat exchanger end wall. Remove the exhaust pipe elbow.

Undo the other end wall (3) from the heat exchanger.



2

Take the insert out (1) and scrap it.



3

Install new O-rings (1) on the insert end wall.

Slide the insert in from the alternator side. Screw the end wall onto the heat exchanger.

4

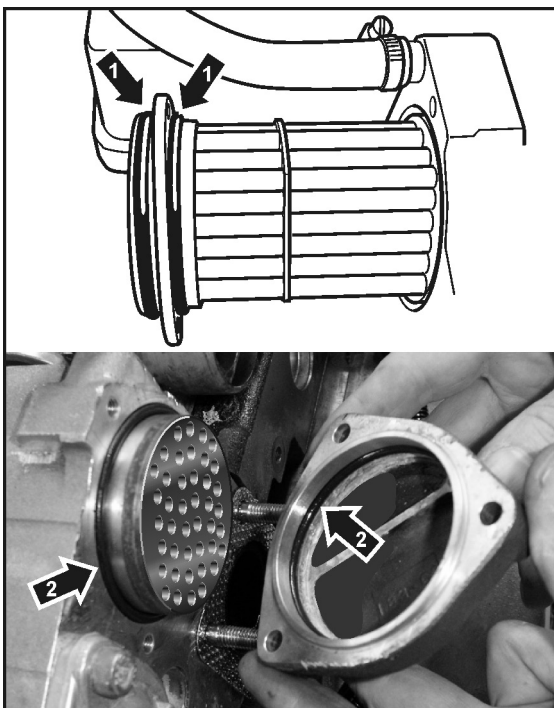
Install new O-rings (2) on the insert and end wall.

Screw the end wall onto the heat exchanger.

Install the exhaust pipe bend.

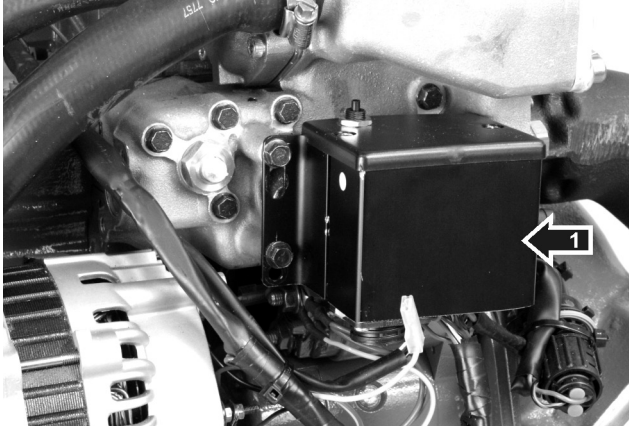
5

Fill up with coolant. Check the fluid level and sealing after warming up.



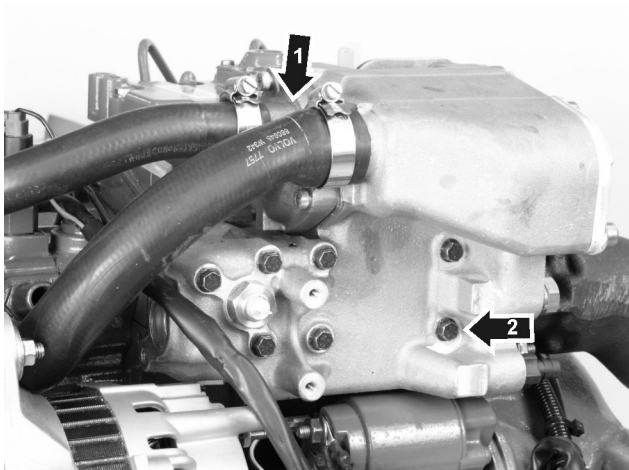
Heat exchanger/exhaust manifold, changing

Current cut off with the main switch. Drained cooling system and sea water. Expansion tank and bracket removed (D1-30, D2-40).



1

Undo the hose union on the exhaust pipe elbow.
Unscrew the distribution box (1) and fold it to one side.



2

Undo the hose connections (1).
Undo the screws (2) and carefully prise the heat exchanger/exhaust manifold away.
Remove the gasket.

3

Clean the sealing surfaces of the cylinder head.
Transfer the exhaust pipe elbow to the new heat exchanger/exhaust manifold.
Install the new heat exchanger/exhaust manifold and gasket. Start to tighten the screws from the center and then outwards. Torque to 10 Nm.
Install the distribution box on the exhaust manifold.

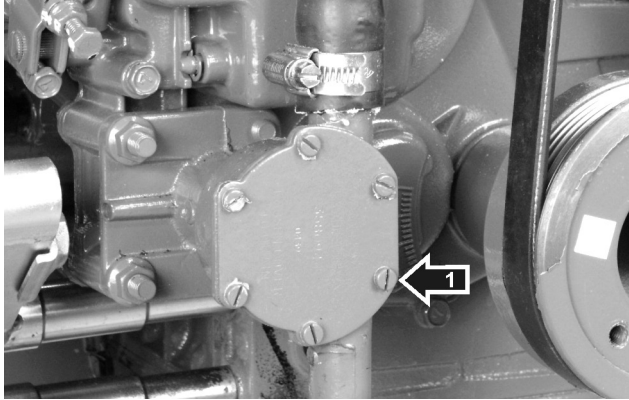
4

Install the hose unions and junction to the exhaust pipe elbow.
Fill up with coolant.
Warm up, and check the sealing and coolant level.

Flat Rate: 26652

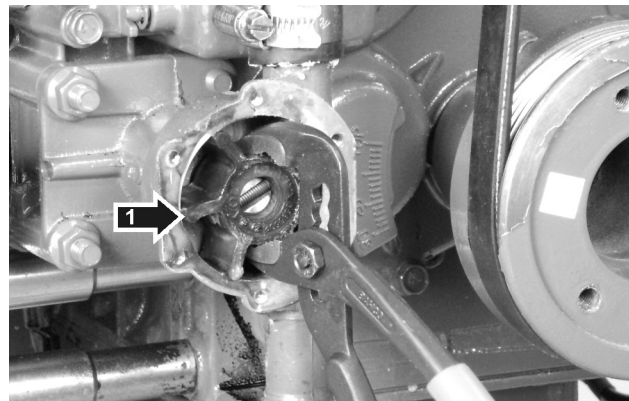
Seawater pump, impeller change

Close sea cock



1

Unscrew all screws on the cover (1).



2

Remove the impeller (1) with water pump pliers.

3

Clean the pump housing and sealing surfaces.

4

Grease the new impeller and housing. Put the impeller and a new gasket in the housing.

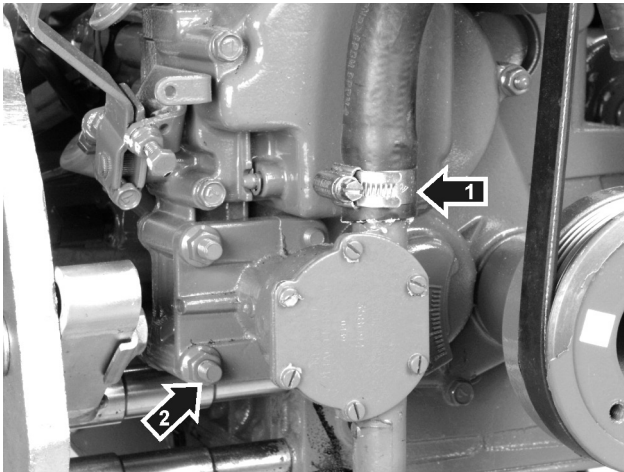
Screw the cover down.

Open the sea cock and start the engine. Check the sealing.

Flat Rate: 26612

Sea water pump, change

Close sea cock



1

Undo the hose connections (1) for the seawater pump.

Undo the four screws (2) which hold the seawater pump.

2

Remove the seawater pump and the O-ring.

Check the mating surfaces.

NOTE! Check the seawater pump gear wheel. If it is damaged, the idler gear must be changed as well.

3

Install a new sea water pump and O-ring.

Install the screws and hose unions.

Open the sea cock and run the engine. Check the sealing.

Flat Rate: 26211

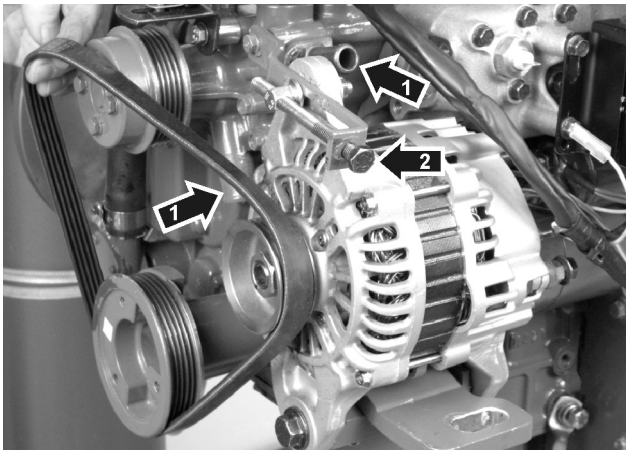
Coolant pump, change

1

Drain the coolant.

Undo the hose connections (1) for the coolant pump.

Loosen the tension (2) on the drive belt and remove it.



2

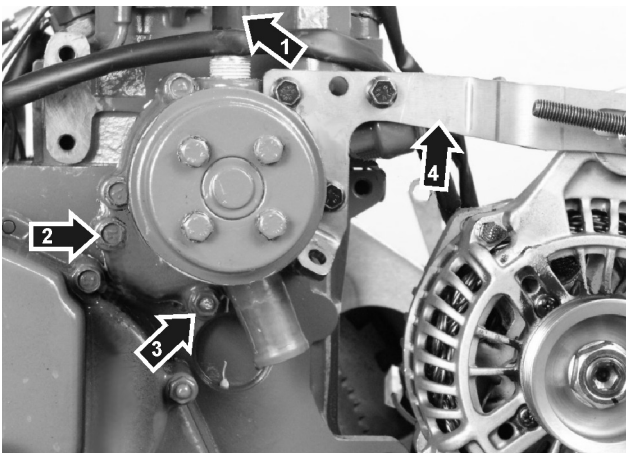
Undo the temperature sensor connector (1).

Loosen the screws (2) and nut (3) which hold the coolant pump and alternator stay (4).

Remove the coolant pump and alternator stay.

D1-13:

Also remove the spacer which is located between the coolant pump and engine block.



3

Clean the sealing surfaces.

Transfer the temperature sensor, hose union and pulley to the new coolant pump.

4

Install the new coolant pump with new seals, spacer (D1-13) and alternator stay.

Install and tension the drive belt.

Install the hose connections.

5

Fill up with coolant.

Warm up, and check the sealing and coolant level.

Flat Rate: 32111

Alternator, changing

Current cut off with the main switch

1

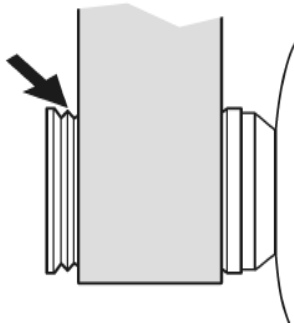
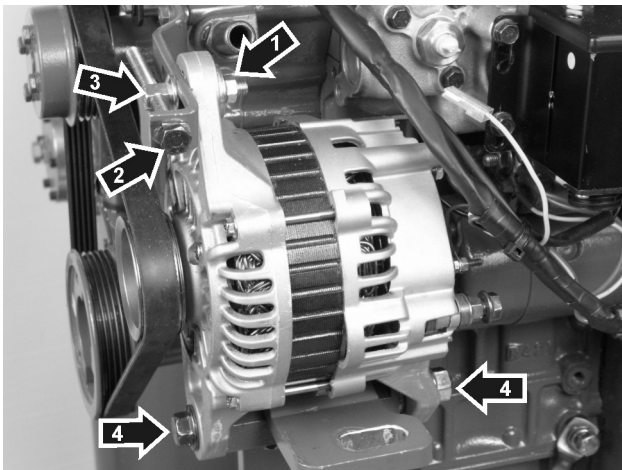
Mark and undo all electric connections to the alternator.

2

Loosen the upper fixing nut (1).

Undo the tension screw (2) to release the upper fixing screw (3) for the alternator.

Unscrew the lower fixing screw (4) and remove the alternator.



D1-30, D2-40

3

Put the new alternator in position and tighten the lower fixing screw. Tighten it loosely.

Put the upper fixing screw in position and lightly tighten the upper fixing nut. Screw the tension screw into the fixing screw.

Put the drive belt in place and tension it with the tension screw.

⚠ IMPORTANT! D1-30, D2-40: Be careful to ensure that the alternator belt is placed in the groove closest to the alternator.

4

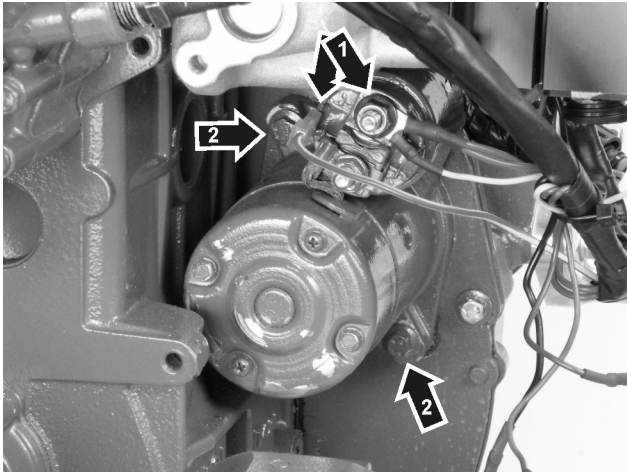
After checking the drive belt tension, tighten the lower fixing screw and upper fixing nut.

Install the electric connections on the alternator.

Flat Rate: 33111

Starter motor, changing

Current cut off with the main switch. Alternator removed (D1-13).



1

Undo all electric connections (1) to the start solenoid.

2

Undo the screws (2) which hold the starter motor.

Lift the starter motor out.

3

Put the new starter motor in position and fix it with the screws.

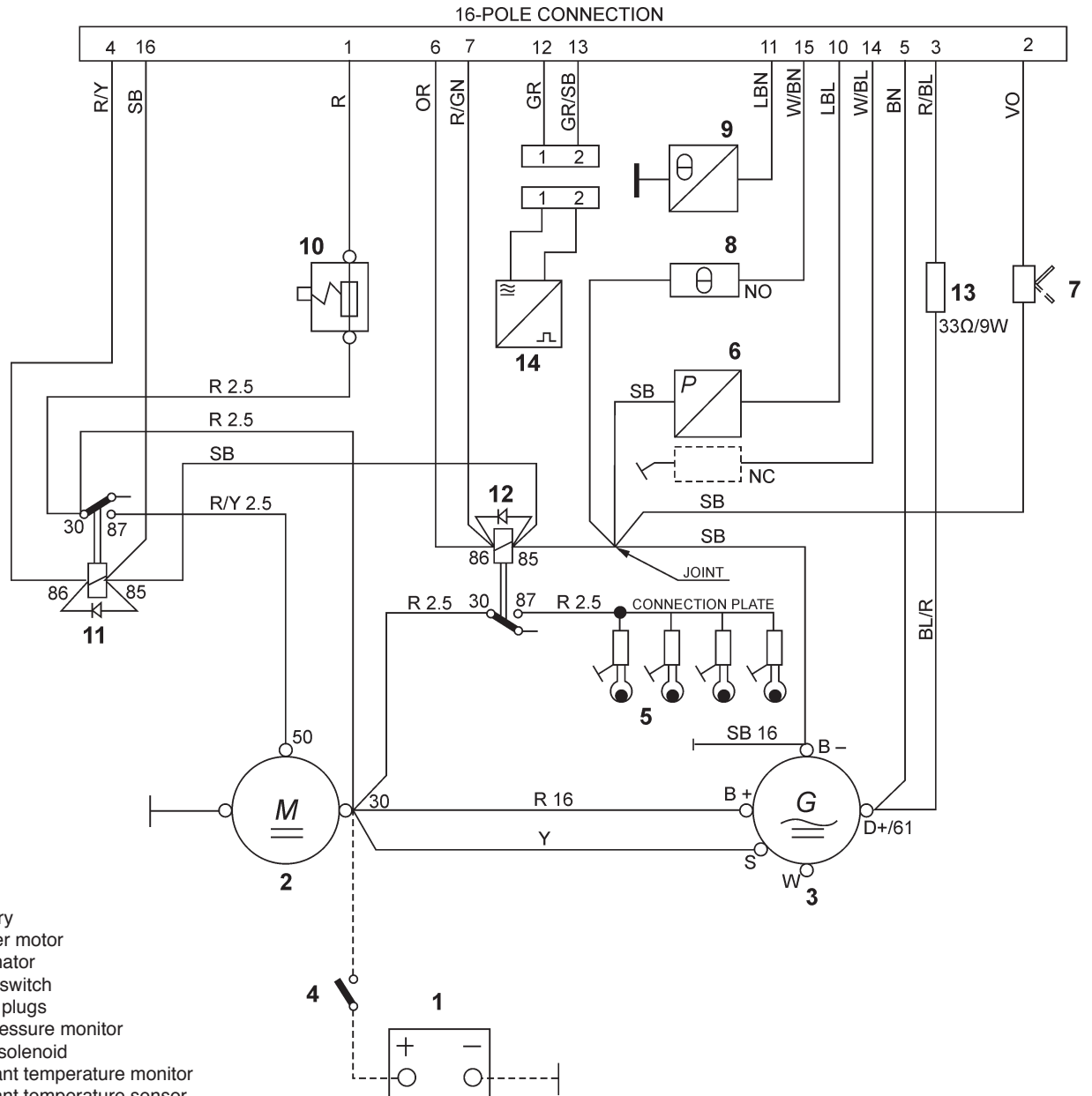
Install the electric connections on the starter motor.

4

Switch the current on and check the starter motor function.

Wiring diagram

Engine



1. Battery
2. Starter motor
3. Alternator
4. Main switch
5. Glow plugs
6. Oil pressure monitor
7. Stop solenoid
8. Coolant temperature monitor
9. Coolant temperature sensor
10. Circuit breaker, 16 A
11. Starter relay
12. Glow plug relay
13. Charge sensing resistor, 33 Ohm/9W
14. Engine speed sensor

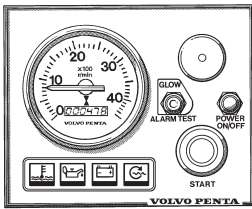
Cable colors

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

Cable areas in mm² are specified after the color code in the wiring schedule.

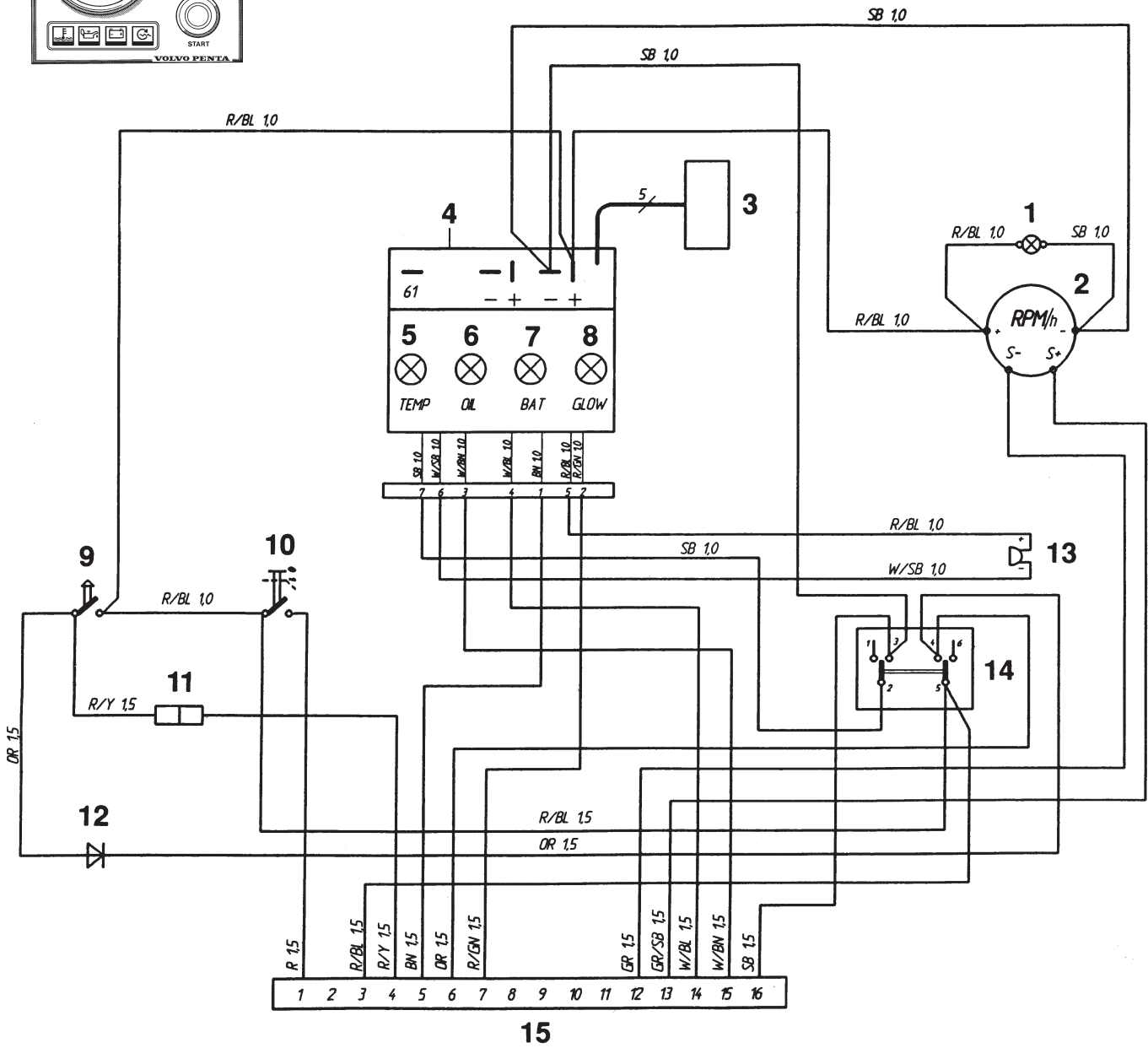
Cable areas not specified = 1.5 mm².

Cables shown with broken lines are not supplied by Volvo Penta.



Instrument panel, alternative "A" *

* (without starter switch)

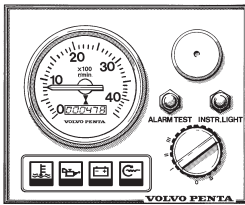


1. Instrument illumination
2. Tachometer with build-in hours counter (optional)
Or blanking plug
3. Connector for connecting extra warning display (optional equipment)
4. Electronic unit (alarm)
5. Warning lamp, coolant temperature
6. Warning lamp, oil pressure
7. Charge warning lamp
8. Indication lamp, glow plugs
9. Starter button
10. Press switch. Instrument panel, On/Off
11. Connector for connecting extra neutral position switch (optional equipment)
12. Semiconductor diode
13. Alarm
14. Tumbler switch. Glow plugs – Alarm test/Acknowledgment
15. 16-pin connector

Cable colors

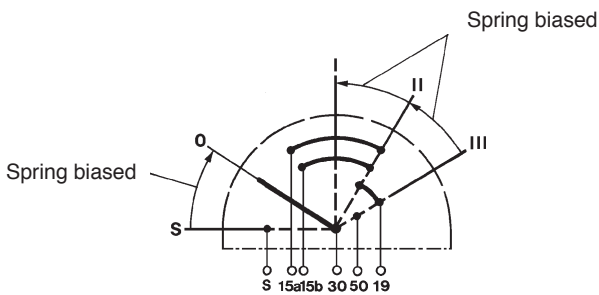
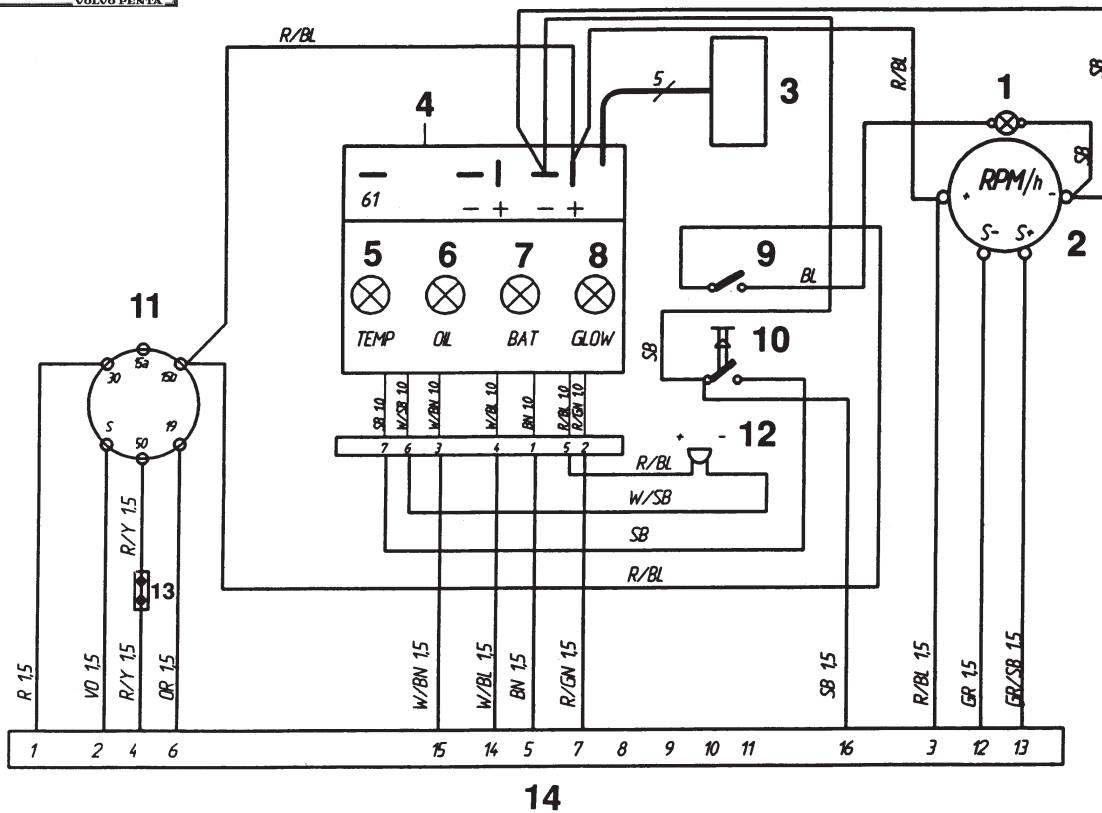
- BL = Blue
- BN = Brown
- GN = Green
- GR = Gray
- OR = Orange
- PU = Purple
- R = Red
- SB = Black
- W = White
- Y = Yellow

Cable areas in mm² are specified after the color code in the wiring schedule.



Instrument panel, alternative "B" *

* (with starter switch)



Cable colors

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

1. Instrument illumination
2. Tachometer with built-in hours counter (optional)
Or blanking plug
3. Connector for connecting extra warning display (optional equipment)
4. Electronic unit (alarm)
5. Warning lamp, coolant temperature
6. Warning lamp, oil pressure
7. Charge warning lamp
8. Indication lamp, glow plugs
9. Switch, instrument lighting
10. Switch - Alarm test/Acknowledgment
11. Key switch
12. Alarm
13. Connector for connection of neutral position switch (optional equipment)
14. 16-pin connector

Cable areas in mm² are specified after the color code in the wiring schedule.

Group 20 Technical data

General

	D1-13-A	D1-20-A	D1-30-A	D2-40-A
Engine designation.....	2	3	3	4
Number of cylinders.....	67 (2.64)	67 (2.64)	77 (3.03)	77 (3.03)
Cylinder diameter, mm (in)	72 (2.83)	72 (2.83)	81 (3.19)	81 (3.19)
Stroke length, mm (in)	0.51 (31)	0.76 (46.5)	1.13 (69.1)	1.51 (92.1)
Displacement, total litres (cu.in)	See sales literature			
Power	850 ±25			
Idling speed, rpm	3200			
Rated speed, rpm.....	23.5:1	23.5:1	23:1	23.5:1
Compression ratio	2450 (355)			
Compression at 250 rpm, repair limit, kPa (psi)	1-2	1-2-3	1-2-3	1-3-
Firing order (highest cyl. No. closest to flywheel).....	4-2			
Direction of rotation see from front	Clockwise			
Max. forward inclination.....	0°			
Max. permissible angle backwards during operation.....	25°			
Max. side angle during operation	35°			
Valve clearance, idle cold engine:				
inlet and outlet, mm (in)	0.20 (0.008)			
Weight, engine without oil and water, kg (lb).....	96 (212)	118 (260)	127 (280)	148 (326)
Permitted backpressure in exhaust line, kPa (psi)	20 (2.9)			

Pistons

Material.....	Aluminium Alloy			
Diameter, mm (in)				
D1-13-A, D1-20-A.....	66.9375 – 66.9525 (2.6353 – 2.6359)			
Service limit.....	66.7 (2.6260)			
D1-30-A, D2-40-A.....	76.932 – 76.947 (3.0288 – 3.0294)			
Service limit.....	76.7 (3.020)			
Piston clearance to the cylinder, mm (in)				
D1-13-A, D1-20-A.....	0.048 – 0.082 (0.0019 – 0.0032)			
Service limit.....	0.25 (0,010)			
D1-30-A, D2-40-A.....	0.0525 – 0.0865 (0.00210 – 0.00340)			
Service limit.....	0.25 (0,010)			
Front marking	The "SHIBAURA" name on the inside of the piston must be facing the fuel pump			
on assembly				

Piston rings

Compression ring, number	2
Oil ring, number	1
Top compression ring:	
Clearance between groove and ring, all engines, mm (in)	0.06 – 0.10 (0.0024 – 0.0039)
Service limit, all engines , mm (in).....	0.25 (0.0098)
Gap of piston ring, mm (in)	
D1-13-A, D1-20-A.....	0.13 – 0.25 (0.0051 – 0.0098)
D1-30-A, D2-40-A.....	0.15 – 0.27 (0.0059 – 0.0106)
Service limit, allengines, mm (in).....	1.0 (0.039)
2nd compression ring:	
Clearance between groove and ring, all engines, mm (in)	0.05 – 0.09 (0.0020 – 0.0035)
Service limit, all engines, mm (in).....	0.25 (0.0098)
Gap of piston ring, mm (in)	
D1-13-A, D1-20-A.....	0.10 – 0.22 (0.0039 – 0.0087)
D1-30-A, D2-40-A.....	0.12 – 0.24 (0.0047 – 0.0094)
Service limit, all engines, mm (in).....	1.0 (0.039)

Oil ring:	
Clearance between groove and ring, all engines, mm (in)	0.02 – 0.06 (0.0008 – 0.0024)
Service limit, all engines.....	0.15 (0.0059)
Gap of piston ring, mm (in)	
D1-13-A, D1-20-A.....	0.10 – 0.30 (0.0039 – 0.0118)
D1-30-A, D2-40-A.....	0.20 – 0.35 (0.0079 – 0.0138)
Service limit, all engines.....	1.0 (0.039)

Piston pins

Diameter, mm (in)	
D1-13-A, D1-20-A.....	18.998 – 19.002 (0.7480 – 0.7481)
Service limit.....	18.98 (0.7472)
D1-30-A, D2-40-A.....	20.996 – 21.002 (0.8266 – 0.8269)
Service limit.....	20.98 (0.826)
Clearance between hole and pin, all engines, mm (in).....	–0.004 to +0.004 (–0.00016 to +0.00016)
Service limit.....	0.02 (0.0008)

Cylinder block

Diameter of the bore in the cylinder block, mm (in):	
D1-13-A, D1-20-A.....	67.000 – 67.019 (2.6378 – 2.6385)
Service limit.....	67.200 (2.6457)
D1-30-A, D2-40-A.....	77.000 – 77.019 (3.0310 – 3.0320)
Service limit.....	77.200 (3.0390)
Flatness of the top of the cylinder block, mm (in).....	Less than 0.05 (0.002)
Service limit.....	0.12 (0.005)

Cylinder head

Distortion of the cylinder head, mm (in).....	0.00 – 0.05 (0.000 – 0.002)
Max. service limit, mm (in).....	0.12 (0.005)
Max. limit for regrinding the cylinder head, mm (in).....	0.15 (0.006)
Selection of cylinder head gasket:	
Piston height above top face of cylinder block, mm (in).....	0.55 – 0.64 (0.0217 – 0.0252)
Choose gasket with thickness, mm (in).....	1.2 (0.047)
Piston height above top face of cylinder block, mm (in).....	0.65 – 0.75 (0.0256 – 0.0295)
Choose gasket with thickness, mm (in).....	1.3 (0.051)

Rocker shaft

Diameter of the rocker shaft, mm (in):	
D1-13-A, D1-20-A.....	9.950 – 9.968 (0.3917 – 0.3924)
Service limit.....	9.87 (0.3886)
D1-30-A, D2-40-A.....	11.65 – 11.67 (0.4587 – 0.4595)
Service limit.....	11.57 (0.4555)
Rocker arm clearance on the rocker shaft, mm (in):	
D1-13-A, D1-20-A, Min. permissible clearance.....	0.032 – 0.065 (0.00126 – 0.00260)
D1-30-A, D2-40-A, Min. permissible clearance.....	0.032 – 0.068 (0.00126 – 0.00268)
Max. permissible clearance, all engines.....	0.2 (0.008)

Crankshaft

Thrust washers:

Standard thickness, mm (in).....	21.85 – 21.95 (0.8602 – 0.8642)
Service limit	21.60 (0.8504)

NOTE! The thrust washers is machined into the holder for the main bearing

Crankshaft end play, mm (in).....	0.10 – 0.30 (0.0040 – 0.0118)
Service limit	0.50 (0.0197)

Crankshaft deflection, mm (in).....	0.30 or less (0.0011)
Service limit	0.06 (0.0023)

Front crankshaft bush, diameter in mm (in), bearing journal :

Standard, D1-13-A and D1-20-A.....	42.964 – 42.975 (1.69150 – 1.69193)
Service limit	42.90 (1.6890)

Standard, D1-30-A and D2-40-A.....	47.965 – 47.975 (1.88830 – 1.88880)
Service limit	47.90 (1.8858)

NOTE! No undersize bush bearing journals are available

Main bearing journals

D1-13-A

Diameter in mm (in), standard, bearing journal

No. 1	42.964 – 42.975 (1.69150 – 1.69193)
Service limit	42.90 (1.6890)

No. 2	45.948 – 45.959 (1.80897 – 1.80941)
Service limit	45.90 (1.8071)

NOTE! No undersize main bearing journals are available

D1-20-A

Diameter in mm (in), standard, bearing journal

No. 1 and 2	42.964 – 42.975 (1.69150 – 1.69193)
Service limit	42.90 (1.6890)

No. 3	45.948 – 45.959 (1.80897 – 1.80941)
Service limit	45.90 (1.8071)

NOTE! No undersize main bearing journals are available

D1-30-A

Diameter in mm (in), standard, bearing journal

No. 1 and 2	47.965 – 47.975 (1.88830 – 1.88880)
Service limit	47.90 (1.8858)

No. 3	47.954 – 47.965 (1.88800 – 1.88830)
Service limit	47.90 (1.8858)

NOTE! No undersize main bearing journals are available

D2-40-A

Diameter in mm (in), standard, bearing journal

No. 1, 2 and 3	47.965 – 47.975 (1.88830 – 1.88880)
Service limit	47.90 (1.8858)

No. 4	47.954 – 47.965 (1.88800 – 1.88830)
Service limit	47.90 (1.8858)

NOTE! No undersize main bearing journals are available

Clearance between the main bearing and the main bearing journal, standard clearance:

D1-13-A, Journal No. 1	0.035 – 0.088 (0.0014 – 0.0035)
------------------------------	---------------------------------

D1-13-A, Journal No. 2	0.039 – 0.092 (0.0015 – 0.0036)
------------------------------	---------------------------------

D1-20-A, Journals No. 1 and 2	0.039 – 0.106 (0.0015 – 0.0042)
-------------------------------------	---------------------------------

D1-20-A, Journal No. 3	0.039 – 0.092 (0.0015 – 0.0036)
------------------------------	---------------------------------

D1-30-A, D2-40-A.....	0.039 – 0.106 (0.0015 – 0.0042)
-----------------------	---------------------------------

Service limit, all engines	0.20 (0.0079)
----------------------------------	---------------

Connecting rod bearing journals

D1-13-A, D1-20-A

Diameter in mm (in), bearing journal

Standard.....	34.964 – 34.975 (1.3765 – 1.3770)
Service limit.....	34.90 (1.3740)

NOTE! No undersize rod bearing journals are available

D1-30-A, D2-40-A

Diameter in mm (in), bearing journal

Standard.....	40.964 – 40.975 (1.6128 – 1.6132)
Service limit.....	40.90 (1.6102)

NOTE! No undersize rod bearing journals are available

Clearance between the connecting rod bearing and the connecting rod bearing journal, standard clearance:

D1-13-A, D1-20-A.....	0.031 – 0.079 (0.00122 – 0.00311)
D1-30-A, Journals No. 1 and 2.....	0.039 – 0.092 (0.00150 – 0.00360)
D1-30-A, Journal No. 3.....	0.029 – 0.082 (0.00110 – 0.00320)
D2-40-A.....	0.039 – 0.092 (0.00150 – 0.00360)
Service limit, all engines.....	0.20 (0.0079)

Connecting rods

Piston pin bearing:

Clearance between the piston pin and the piston pin bearing, mm (in).....

.....	0.010 – 0.025 (0.00040 – 0.00099)
Service limit, D1-13-A, D1-20-A.....	0.10 (0.004)
Service limit, D1-30-A, D2-40-A.....	0.08 (0.0031)

Connection rod bearing:

Clearance between the connecting rod bore and the connecting rod bearing, mm (in).....

.....	0.10 – 0.30 (0.004 – 0.012)
-------	-----------------------------

Service limit.....	0.70 (0.0276)
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Camshaft

Drive	Gear Wheel
Height of the camshaft lobe for the inlet and outlet valves, all engines, mm (in)	26.955 – 27.010 (1.0612 – 1.0634)
Service limit	26.5 (1.0430)
Height of the camshaft lobe for the fuel injection pump, all engines, mm (in)	39.900 – 40.100 (1.5709 – 1.5787)
Service limit	39.8 (1.5669)
Height of the camshaft lobe for the fuel priming pump, all engines, mm (in)	27.900 – 28.000 (1.0984 – 1.1024)
Service limit	27.0 (1.0630)

Valves

Inlet

Spindle diameter in mm (in).....	6.955 – 6.970 (0.27382 – 0.27441)
Service limit	6.89 (0.271)
Valve disc edge in mm (in)	0.925 – 1.075 (0.03642 – 0.04232)
Service limit	0.5 (0.02)
Valve depth below the cylinder head face in mm (in)	0.65 – 0.95 (0.0256 – 0.0374)
Service limit	1.8 (0.071)
Clearance in mm (in), valve spindle guide.....	0.025 – 0.052 (0.0010 – 0.0020)
Service limit	0.2 (0.008)
Seat angle in cylinder head	45°
Seat contact face in cylinder head.....	1.70 – 2.10 (0.0670 – 0.0830)
Service limit, mm (in)	2.5 (0.098)
Valve lash in mm (in), cold engine.....	0.20 (0.008)

Outlet

Spindle diameter in mm (in).....	6.940 – 6.950 (0.27323 – 0.27362)
Service limit, mm (in)	6.84 (0.269)
Valve disc edge in mm (in)	0.925 - 1.075 (0.03642 - 0.04232)
Service limit, mm (in)	0.5 (0.02)
Valve depth below the cylinder head face in mm (in)	0.85 – 1.15 (0.0335 – 0.0453)
Service limit, mm (in)	1.8 (0.071)
Clearance in mm (in), valve spindle guide.....	0.045 – 0.072 (0.0020 – 0.0030)
Service limit, mm (in)	0.25 (0.010)
Seat angle in cylinder head	45°
Seat contact face in cylinder head.....	1.70 – 2.10 (0.0670 – 0.0830)
Service limit, mm (in)	2.5 (0.098)
Valve lash in mm (in), cold engine.....	0.20 (0.008)

Valve springs

Length in mm (in) uncompressed	35.0 (1.377)
Length in mm (in) with 79.4 N (58.56 ft.lbf) compression.....	30.4 (1.196)

Gear group

Max. backlash for all gears, mm (in).....	0.25 (0.010)
Min. backlash for all gears, mm (in).....	0.08 (0.003)

Lubrication system

Oil pressure in kPa (psi), hot engine at high idle	196 – 441 (28.4 – 64)
Oil pressure in kPa (psi), hot engine at low idle	>48 (7)
Relief valve, opening pressure in kPa (psi)	
D1-13-A, D1-20-A	352 – 448 (51 – 65)
D1-30-A, D2-40-A	304 – 500 (44 – 73)
Oil pump:	
Clearance, in mm (in), inner – outer rotor.....	0.01 – 0.15 (0.0004 – 0.0059)
Service limit	0.25 (0.0098)
Axial clearance between the face of oil pump cover	
and the face of the idler gear, in mm (in)	0.01 – 0.15 (0.0004 – 0.0059)
Service limit	0.20 (0.008)
Shims available for adjusting the axial clearance, mm.....	0.10, 0.15, 0.20, 0.50
Oil quality as per API system.....	VDS-2 ACEA E5 API CH-4
Viscosity at -5 to +50°C* (+23 to +122°F)*	SAE 15W/40 SAE 20W/50
Max. oil volume excl. oil filter, no engine tilt, litres (US gal):	
D1-13-A	1.9 (0.50)
D1-20-A	2.8 (0.74)
D1-30-A	3.5 (0.92)
D2-40-A	6.5 (1.72)
Oil change interval	
D1-13-A, D1-20-A, D1-30-A	200 h or 12 months
D2-40-A	500 h or 12 months

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

Fuel system

Feed pump max. suction height in m (ft)	0.8 (2.62)
Feed pressure in kPa (lbf/in ²)	15 – 25 (2.1 – 3.6)

Fuel injection pump

Type	In-line cassette			
Start of injection, crankshaft position, B.T.D.C				
D1-13-A, D1-20-A, D1-30-A	20° ±1°			
D2-40-A	22° ±1°			
	D1-13-A	D1-20-A	D1-30-A	D2-40-A
Pump element, diameter in mm (in)	5 (0.1968)	5 (0.1968)	6 (0.2362)	5.5
(0.2165)	Stroke length in mm (in)			6.5
(0.2559)	6.5 (0.2559)	6 (0.2362)	6 (0.2362)	
Axial clearance between the face of oil pump cover				
and the face of the idler gear, in mm (in)	0.01 – 0.15 (0.0004 – 0.0059)			
Service limit	0.20 (0.008)			
Shims available for adjusting the axial clearance, mm.....	0.10, 0.15, 0.20, 0.50			

Injector

Opening pressure (checking), MPa (psi)	
D1-13-A, D1-20-A, D2-40-A	11.77 (1707)
D1-30-A	14.71 (2133)
Jet angle	4°

Exhaust system

Permitted Max. back pressure in the exhaust line at rated speed, all engines, kPa (psi)	20 (2.9)
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Cooling system

Type	Overpressure, closed cooling system
Fresh water system volume, approx, litres (US gal)	
D1-13-A	2.7 (0.71)
D1-20-A	3.0 (0.79)
D1-30-A	4.1 (1.08)
D2-40-A	6.4 (1.69)
Thermostat, number	1 st
Thermostat begins to open at	90°C (194°F)
fully open at	105°C (221°F)
Coolant, Glycol/water, mixing ratio	40/60

Electrical system

System voltage	12 V
Fuse (automatic)	16 A
Battery capacity (starter battery)	
D1-13-A, D1-20-A, D1-30-A	70 Ah
D2-40-A	88 Ah
Glow plug:	
rated voltage	11V
current	11A

Alternator

Output voltage at +20°C (+68°F)	14,2 ±0,15 V
Max. current	115 A
Suppressor capacitor	2.2 mikroF

Starter motor

Starter motor, power approx.	
D1-13-A, D1-20-A	0.8 kW
D1-30-A	1.1 kW
D2-40-A	1.4 kW

Tightening torque in Nm (ft.lbf)

Cylinder head*	
D1-13-A.....	36.5 (26.9)
D1-20-A.....	36.5 (26.9)
D1-30-A.....	51 (37.6)
D2-40-A.....	51 (37.6)
Main bearing:	
Bolts of the holder for the main bearing	23 (16.9)
Retaining bolts for the crankshaft.....	27 (19.9)
Connecting Rod:	
D1-13-A, D1-20-A.....	23 (17)
D1-30-A, D2-40-A.....	32 (23.6)
Front housing.....	10 (7.4)
Flywheel backplate:	
D1-13-A, D1-20-A.....	25 (18.4)
D1-30-A, D2-40-A.....	50 (36.9)
Flywheel housing.....	25 (18.4)
Flywheel	74 (55)
Crankshaft pulley:	
D1-13-A, D1-20-A.....	93 (68.6)
D1-30-A, D2-40-A.....	123 (90.7)
Flexible coupling.....	8.5 – 11.5 (6.3 – 8.5)
Suction strainer, oil pump	11 (8)
Sump	11 (8)
Drain plug, sump	34 (25)
Camshaft, setscrews for retainer plate.....	11 (8)
Rocker shaft housing:	
D1-13-A, D1-20-A.....	9.5 (7)
D1-30-A, D2-40-A.....	23 (17)
Valve mechanism cover:	
Setscrews.....	11 (8)
Cap nuts.....	10 (7.3)
Rocker arm locknut.....	14 (10)
Fuel injection pump:	
Mounting nuts and screws	6 (4.4)
Delivery valve holders	42 (31)
Pressure oil pipe (cylinder block–cylinder head)	12 (9)
Injector.....	64 (47.2)
Delivery pipe:	
D1-13-A, D1-20-A, D2-40-A.....	20 (14.8)
D1-30-A.....	23 (17)
Lock screw (max. fuel volume).....	13 – 16 (9.6 – 11.8)
Lock screw (speed)	13 – 16 (9.6 – 11.8)
Exhaust manifold	10 (7.3)
Fuel shutoff solenoid	17 (13)
Fuel pump:	
Adjustment screw.....	2.5 (1.8)
Mounting screws	6 (4.4)
Glow plug.....	11.5 (8.5)
Oil pressure switch and adapter.....	11 (8)
Coolant temperature switch.....	27 (20)
Coolant drain plug (plastic).....	3 (2.2)
Coolant thermostat housing.....	14 (10)
Oil relief valve	64 (47)
Starter motor, contacts	9.8 – 11.8 (7.2 – 8.7)

* The tightening torque given is the final tightening torque.

The cylinder head should be tightened in three stages and in the correct sequence. See tightening procedure.

On assembly lubricate cylinder head setscrews with clean oil.

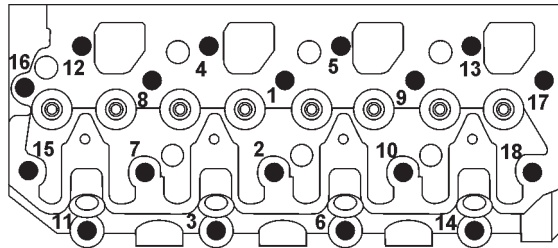
General tightening torques in Nm

M5.....	5 Nm
M6.....	10 Nm
M7.....	17 Nm
M8.....	24 Nm
M10.....	50 Nm
M12.....	80 Nm
M14.....	130 Nm

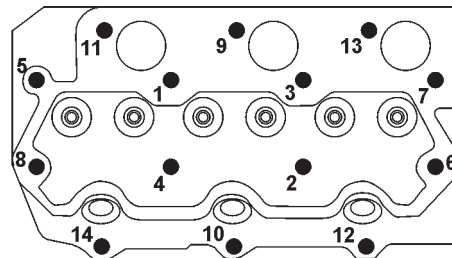
Tightening sequence

Cylinder head

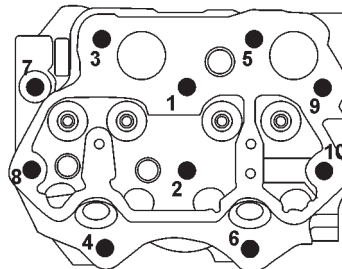
D2-40



D1-20, D1-30



D1-13



Conversion table

Metric to American or UK units:

American or UK to Metric units:

	To convert from	To	Multiply by	To convert from	To	Multiply by
Length	mm	inch	0.03937	inch	mm	25.40
	cm	inch	0.3937	inch	cm	2.540
	m	foot	3.2808	foot	m	0.3048
Area	mm ²	sq.in.	0.00155	sq. in.	mm ²	645.2
	m ²	sq. ft.	10.76	sq. ft.	m ²	0.093
Volume	cm ³	cu. in.	0.06102	cu. in.	cm ³	16.388
	liter, dm ³	sq. ft.	0.03531	cu. ft.	liter, dm ³	28.320
	liter, dm ³	cu. in.	61.023	cu. in.	liter, dm ³	0.01639
	liter, dm ³	imp. gallon	0.220	imp. gallon	liter, dm ³	4.545
	liter, dm ³	U.S. gallon	0.2642	U.S. gallon	liter, dm ³	3.785
	m ³	cu. ft.	35.315	cu.ft.	m ³	0.0283
Power	N	lbf	0.2248	lbf	N	4.448
Weight	kg	lb.	2.205	lb.	kg	0.454
Power	kW	hp (metric) ¹⁾	1.36	hp (metric) ¹⁾	1.36	0.735
	kW	bhp	1.341	bhp	kW	0.7457
	kW	BTU/min	56.87	BTU/min	kW	0.0176
Torque	Nm	lbf ft	0.738	lbf ft	Nm	1.356
Pressure	Bar	psi	14.5038	psi	Bar	0.06895
	MPa	psi	145.038	psi	MPa	0.006895
	Pa	mm Wg	0.102	mm Wg	Pa	9.807
	Pa	in Wc	0.004	in Wg	Pa	249.098
	kPa	in Wg	4.0	in Wg	kPa	0.24908
	mWg	in Wg	39.37	in Wg	mWg	0.0254
Energy	kJ/kWh	BTU/hph	0.697	BTU/hph	kJ/kWh	1.435
Work	kJ/kg	BTU/lb	0.430	BTU/lb	kJ/kg	2.326
	MJ/kg	BTU/lb	430	BTU/lb	MJ/kg	0.00233
	kJ/kg	kcal/kg	0.239	kcal/kg	kJ/kg	4.184
Fuel consumption	g/kWh	g/hph	0.736	g/hph	g/kWh	1.36
	g/kWh	lb/hph	0.00162	lb/hph	g/kWh	616.78
Inertia	kgm ²	lbft ²	23.734	lbft ²	kgm ²	0.042
Flow, gas	m ³ /h	cu.ft./min.	0.5886	cu.ft./min.	m ³ /h	1.699
Flow, fluid	m ³ /h	US gal/min	4.403	US gal/min	m ³ /h	0.2271
Speed	m/s	ft./s	3.281	ft./s	m/s	0.3048
	mph	knot	0.869	knot	mph	1.1508
Temp.	°F=9/5 x °C+32			°C=5/9 x (°F-32)		

1) All power noted in the catalogue refers to metric horsepower.

Notes

A series of horizontal dotted lines for writing notes.

Notes

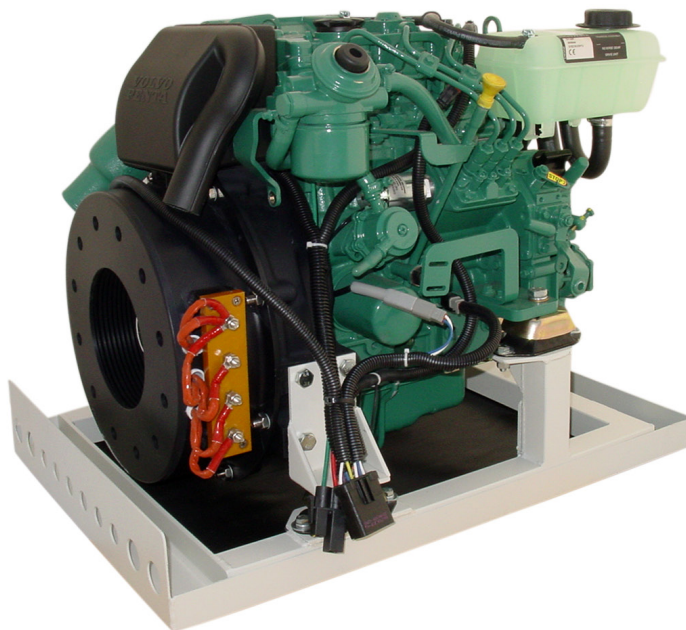
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Workshop Manual

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