Workshop manual

Group 21-26

D
2(0)

D5A T, D5A TA
D7A T, D7A TA, D7C TA

Workshop manual

Marine engines
D5A T, D5A TA, D7A T
D7A TA and D7C TA

Contents

Safety information

Introduction

This workshop manual contains technical data, descriptions and repair instructions for the Volvo Penta products or product variants listed in the table of contents. Make sure you are using the correct workshop manual.

Read this safety information and the "General information" and "Repair instructions" in the workshop manual thoroughly before starting any servicing.

Important

The following special warning symbols are used in this workshop manual and on the product:

⚠ **WARNING!** Warns of a risk of injury, serious damage to the product or property, or that serious malfunctions could occur if the instruction is not followed.

⚠ **IMPORTANT:** Is used to draw attention to things that could cause damage to or malfunction of the product or property.

Note! Is used to draw attention to important information to facilitate procedures or handling.

In order to give you an overview of the risks that are always present and the safety measures that should always be performed, we have listed them here:

⚠ Prevent the engine from being started by switching off the electrical supply using the main switch(es) and locking it (them) in the off position before carrying out servicing. Put up a warning sign at the driving position.

⚠ All servicing should normally be carried out with the engine stationary. However, some jobs, for example certain adjustments, require the engine to be running. Approaching a running engine is a safety risk. Bear in mind that loose, dangling clothes or long hair can get caught in rotating parts and lead to serious injury. If you are working near an engine that is running, a careless movement or dropped tool could result, in the worst case, in injury. Be careful of hot surfaces and hot fluids in pipes and hoses of an engine that is running or has just been stopped. Refit all protective devices that were removed during servicing, before you start the engine.

⚠ Ensure that the warning and information stickers on the product are always visible. Replace any stickers that have been damaged or painted over.

⚠ Engines with a turbocharger: Never start the engine without the air filter fitted. The rotating compressor wheel in the turbo could cause serious injury, and foreign objects entering the inlet pipe could cause damage.

⚠ Never use start spray or similar substances to help start the engine. There could be an explosion in the inlet pipe, which could cause injury.

⚠ Avoid opening the coolant filler cap (freshwater-cooled engines) when the engine is hot. Steam or hot coolant could spurt out as the pressure is released. Open the filler cap slowly and release the pressure in the cooling system. Be extremely careful if you have to remove a cock, plug or coolant hose when the engine is hot. Steam and hot coolant can spurt out in unexpected directions.

⚠ Hot oil can cause burns. Avoid skin contact with hot oil. Ensure that the oil system is unpressurized before opening it up. Never start or run the engine with the oil filler cap removed, due to the risk of oil being thrown out.

⚠ Stop the engine and close the sea cock before opening up the cooling system.

⚠ Start the engine only in a well ventilated area. When running in an enclosed area, exhaust gasses should be led out of the engine room or workshop area.

⚠ Always use protective goggles when there is a risk of splinters, grinding sparks, acid splashes or other chemicals. The eyes are particularly sensitive; an accident could cause you to lose your sight.

⚠ Avoid skin contact with oil. Long-term or repeated skin contact with oil can lead to the skin losing its natural oils, resulting in irritation, drying, eczema and other skin problems. From a health point of view, used oil is more hazardous than new oil. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before meals. Use barrier cream to counteract drying and make it easier to get your skin clean.

⚠ Most of the chemicals intended for use with the product (e.g. engine and transmission oils, glycol, gasoline and diesel) and chemicals for workshop use (e.g. degreaser, lacquers and solvents) are dangerous to health. Read the instructions on the packaging carefully. Always follow the safety instructions (e.g. the use of respiratory protective equipment, protective goggles, gloves etc.). Ensure that other personnel are not inadvertently exposed to substances that are dangerous to health, for example by inhalation. Provide good ventilation. Handle used and leftover chemicals in the prescribed manner.

⚠ Take the utmost care when searching for leaks in fuel systems and testing fuel injectors. Wear goggles. The jet from a fuel injector is at extremely high pressure and has a very high penetrative force. The fuel can penetrate deep into body tissues and cause serious injury. There is a danger of blood poisoning.

⚠ Like many chemicals, all fuels are highly flammable. Ensure that open flames or sparks are not able to start a fire. Gasoline, certain thinners and hydrogen gas from batteries are, in the correct mixture with air, extremely flammable and explosive. No smoking! Provide adequate ventilation and take the necessary safety precautions before doing any welding or grinding nearby. Always have a fire extinguisher handy.

⚠ Ensure that rags that are soaked with oil or fuel, and used fuel and oil filters, are stored safely. In certain conditions, oil-soaked rags can spontaneously combust. Used fuel and oil filters are environmentally hazardous waste and should be taken to a waste disposal center to be destroyed, along with used lubricating oil, contaminated fuel, paint residues, solvents, degreaser and washing residues.

⚠ Batteries should never be exposed to an open flame or electric spark. Never smoke near the batteries. The batteries produce hydrogen gas during charging, which forms oxyhydrogen gas when it mixes with air. This gas is highly flammable and very explosive. A spark, which can be created if the batteries are connected incorrectly, is sufficient to cause a battery to explode, causing injury and damage. Do not disturb the connections when trying to start the engine (it could cause sparks) and do not lean over any of the batteries.

⚠ Always make sure you connect the positive and negative leads to the correct terminals when you are fitting the batteries. If you get them mixed up, it could cause serious damage to the electrical equipment. Check the wiring diagram.

⚠ Always use protective goggles when charging and handling batteries. The battery electrolyte contains highly corrosive sulfuric acid. If the electrolyte comes into contact with the skin, wash with soap and plenty of water. If battery acid gets into your eyes, rinse straight away with water and contact a doctor immediately.

⚠ Stop the engine and switch off the electrical supply using the main switch(es) before working on the electrical system.

⚠ Adjustments and connections should be done with the engine stationary.

⚠ Use the lifting eyes that are fitted to the engine/reverse gear when lifting the drive unit. Always check that all lifting devices are in good condition and that they have the right capacity for the lift (the weight of the engine with any reverse gear and extra equipment).

For safe handling and to avoid damaging components fitted to the top of the engine, the engine should be lifted using a lifting beam that is either specially designed for the engine or is adjustable. All chains or cables should run parallel with one another, and as perpendicular as possible to the top of the engine.

If extra equipment that is fitted to the engine alters its center of gravity, special lifting devices might be required to obtain the right balance and safe handling.

Never work on an engine that is supported only by the lifting device.

⚠ Never work alone when removing heavy parts, even when using a safe lifting device like a lockable block and tackle. Even when using a lifting device, two people are usually needed, one to operate the lifting device and the other to make sure the parts are not jammed and do not get damaged in the lift. When working onboard a boat, always make sure in advance that there is sufficient space available to allow dismantling in situ, without causing any danger of injury or damage.

⚠ Components in the electrical, ignition (gasoline engines) and fuel systems of Volvo Penta products are designed and manufactured to minimize the risk of explosion and fire. The engine should not be used in explosive environments.

⚠ Always use Volvo Penta recommended fuel (see the instruction manual). Using lower quality fuel can damage the engine. In a diesel engine, poor fuel can lead to the control rod seizing and the engine running too fast, with a danger of both mechanical damage and injury. Poor quality fuel can also lead to higher maintenance costs.

General information

About the workshop manual

This workshop manual contains descriptions and repair instructions for the following marine diesel engines: D5A T, D5A TA, D7A T, D7A TA and D7C TA.

Always quote the engine designation and number in all correspondence about any of the products. The engine model and number are shown on the identification plate.

This workshop manual is primarily intended for Volvo Penta workshops and their trained personnel. It is assumed, therefore, that anyone using the manual posses basic knowledge of marine drive systems and can carry out the necessary mechanical and electrical work.

AB Volvo Penta is continually developing its products, which is why we reserve the right to make changes. All of the information in this handbook is based on product data available at the time of going to press. Information about any important changes that are made to the product or servicing methods after the manual went to press will be made available in the form of Service Bulletins.

Flat Rate (Standard times)

In instructions where operation numbers are found in the headings, this is a reference to the Volvo Penta Flat Rate list.

Spare parts

Spare parts for the electrical and fuel systems conform to various national safety regulations. Volvo Penta Original Spare Parts conform to these regulations. All forms of damage resulting from the use of non-original Volvo Penta spare parts in the product will not be covered by the warranty provided by Volvo Penta.

Certified engines

For engines that have been certified as complying with national and regional legislation, the manufacturer binds itself to ensure that both new engines and those in use meet the environmental requirements. The product must be equivalent to the example that was approved for certification. In order for Volvo Penta, as the manufacturer, to be able to guarantee that engines that are in operation meet the environmental requirements, the following conditions for servicing and spare parts must be observed:

- The maintenance and service intervals recommended by Volvo Penta must be followed.
- Only Volvo Penta Original Spare Parts intended for the certified engine model may be used.
- Servicing of injector pumps, pump settings and injectors should always be performed by an authorized Volvo Penta workshop.
- The engine should not be rebuilt or modified, except for accessories and service kits that Volvo Penta has approved for the engine.
- No changes may be made to the installation of the engine-room exhaust pipes or air intake ducts.
- Seals should not be broken by anyone other than authorized service personnel.

⚠ **IMPORTANT:** When spare parts are required, use only Volvo Penta original parts.

The use of non-original spare parts will result in AB Volvo Penta no longer being able to be responsible for the engine corresponding to the certified specification.

Volvo Penta will not cover any damage or costs arising from this.

Repair instructions

The working methods described in this workshop manual are applicable in a workshop; that is to say, the engine has been removed from the boat and is mounted on an engine stand. Overhauling that does not require the engine to be lifted out is done in situ, using the same procedures unless stated otherwise.

The warning symbols that are used in the workshop manual (see **"Safety Information"** for meaning)

WARNING!

IMPORTANT:

Note!

are not totally comprehensive, as it is obviously impossible to foresee every eventually when servicing is carried out in very varied conditions. Consequently, we can only point out the risks that we think could arise if the wrong procedures are used in a well-equipped workshop, using working methods and tools that we have tried and tested.

The procedures in this workshop manual are described using special Volvo Penta tools, whenever they exist. The special tools are designed to make the procedures as safe and efficient as possible. For this reason, anyone using tools or working methods other than those that we recommend, must make certain that there is no risk of injury or damage, and that it could not result in incorrect operation.

In certain cases, there are special safety regulations and instructions for use for the tools and chemicals specified in the workshop manual. These regulations and instructions should always be followed, and there are no special instructions regarding them in the workshop manual.

Most risks can be avoided by taking certain elementary precautions and using common sense. A clean workplace and a clean engine eliminate many risks of both injury and incorrect operation.

It is of the outmost importance that dirt and foreign particles do not get into the engine, especially when working on the fuel system, lubrication system, inlet system, turbo unit, bearings and seals, otherwise it could lead to malfunctions or more frequent repairs.

Our joint responsibility

Every engine is made up of many systems and components working together. A component that differs from the technical specification can dramatically increase the environmental impact from an otherwise satisfactory engine. Consequently, it is of the utmost importance that the specified wear tolerances are adhered to, that systems that are adjustable are kept correctly set and that Volvo Penta Original Parts are used for the engine. The times specified in the maintenance schedule for the engine must be followed.

Certain systems, for example components in the fuel system, can require special knowledge and special test equipment. For various reasons, including environmental regulations, certain components are sealed at the factory. Do not tamper with components that are sealed, unless you are authorized to carry out the particular type of work.

Remember that most chemical products, if used incorrectly, can damage the environment. Volvo Penta recommends using biodegradable degreaser for all cleaning of engine components, unless stated otherwise in the workshop manual. When working onboard a boat, take particular care to ensure that oil, washing residues etc. are taken for destruction and do not accidentally end up in the environment, along with the bilge water for example.

Tightening torque

The tightening torques for critical fixings that have to be tightened using a torque wrench are listed in "Technical data: Tightening torque" and are given in the descriptions of the procedures. All of the torque settings given apply to clean threads, bolt heads and mating surfaces. The torque settings apply to lightly oiled or dry threads. If lubricant, locking compound or sealant is required for the threads, the type is specified in the description of the procedure and in "Tightening torque." For fixings for which no particular torque is specified, the tightening torques in the table below apply. These are guideline values, and the fixing does not have to be tightened with a torque wrench.

Size	Tightening torque	
	Nm	lbf.ft.
M5	6	4.4
M6	10	7.4
M8	25	18.4
M10	50	36.9
M12	80	59
M14	140	103.3

Torque-tightening angle

With torque-tightening angle, the screw fixing is tightened to a specified torque and then turned further through a specified angle. For example, for a 90° tightening angle, the fixing is tightened an additional ¼ turn after the specified torque has been reached.

Locknuts

Locknuts that have been removed should not be reused. New locknuts should always be used, as the locking ability is reduced or lost with repeated use. For locknuts with a plastic insert, e.g. Nylock®, the specified tightening torque should be reduced if the Nylock® nut is the same height as a standard, solid metal, hexagonal nut. The torque is reduced by 25% for bolts 8 mm or larger. For Nylock® nuts that are higher (where the metal thread is the same height as a standard hex nut), the torque specified in the table applies.

Tensile strength classes

Bolts and nuts are divided into different tensile strength classes. The class is shown by a number on the head of the bolt, the higher the number, the higher the tensile strength of the material. For example, a bolt marked 10-9 is stronger than a bolt marked 8-8. Because of this, it is important to replace bolts in their original locations. When fitting new bolts, refer to the spare parts catalogue to ensure that you get the same type.

Sealants

Several different types of sealant and locking compound are used in the engine. The products have different properties, and they are intended for different joint strengths, temperature ranges, resistance to oil and other chemicals, and for the different materials and gap widths found in the engine.

For satisfactory servicing, it is important to use the correct type of sealant or locking compound for the fixings and joints that need them.

In the relevant sections of the workshop manual, we have specified the products that are used in our engine production.

When servicing the engine, the same products should be used, or another brand that has the same properties.

When using sealants and locking compounds, it is important that the surfaces are free of oil, grease, paint and anti-rust compound, and are dry.

Always follow the manufacturer's instructions regarding permitted temperature range, hardening time etc. for the product.

Two basic types of compound are used for the engine, and characteristic of these are:

RTV compound (Room Temperature Vulcanizing). Usually used in combination with gaskets, for example, sealing gasket joints or spread on gaskets. RTV compound can easily be seen when the part has been removed. Old RTV compound must be removed before the joint is resealed.

The following RTV compounds might be specified in the workshop manual: Loctite® 547, Permatex® No. 3 and Permatex® No. 77. Old sealant can be removed with denatured alcohol.

Anaerobic compounds. These compounds harden (cure) in the absence of air. The compounds are used when two solid parts, e.g. castings, are fitted together without a gasket. Other common uses are for securing and sealing plugs, stud threads, cocks, oil pressure switches etc. Cured anaerobic compound is like glass, so a color is added to make it visible. Cured anaerobic compound is highly resistant to solvents, and old compound can not be removed. When refitting parts, it is important to first degrease them thoroughly and then apply new sealant.

The following anaerobic compounds might be specified in the workshop manual: Loctite® 572 (white) and Loctite® 241 (blue).

Note! Loctite is a registered trademark of the Loctite Corporation; Permatex is a registered trademark of the Permatex Corporation.

Safety instructions for fluorocarbon rubber

Fluorocarbon rubber is a common material, for example in axle sealing rings and O-rings.

When fluorocarbon rubber is subjected to high temperatures (over 572°F (300°C)), **hydrofluoric acid** can be produced, which is highly corrosive. Splashes in the eyes can cause burns. Inhaling fumes can damage the airways.

⚠ **WARNING!** Take great care when working on engines that might have been subjected to high temperatures, for example overheating due to seizing or in a fire. Seals should never be burned off during dismantling, or burned later in an uncontrolled manner.

- Always use neoprene gloves (gloves for handling chemicals) and goggles.
- Handle a seal that has been removed in the same way as corrosive acid. All residues, even ash, can be highly corrosive. Never use compressed air for cleaning.
- Put the remains in a plastic container, seal it and apply a warning label. Wash the gloves under running water before taking them off.

The following seals will almost certainly be made of fluorocarbon rubber:

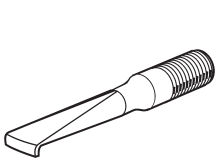
Seals for the crankshaft, camshaft and counter shafts.

O-rings, wherever they are fitted. O-rings for sealing cylinder liners are almost always fluorocarbon rubber.

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

Special tools

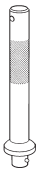
The following special tools are used when working on the engine. The tools can be ordered from AB Volvo Penta on the number given.



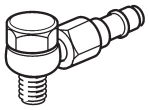
888341

885490

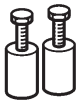
942352



999 2000

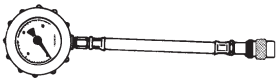


999 6066

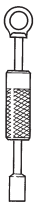


999 6394

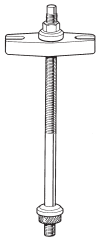
999 6395



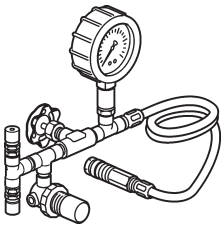
999 6398



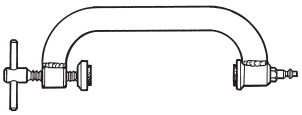
999 6400



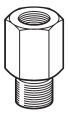
999 6645



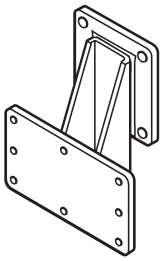
999 6662



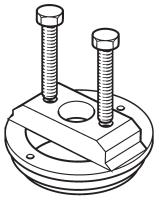
999 6685



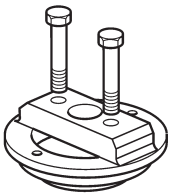
999 8007



999 8671

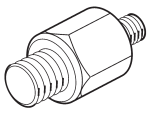


999 8672



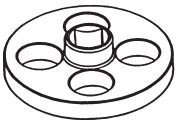
999 8673

Tool	Name – use
885341	**Extractor**, changing crankshaft seal, used with 999 6400
885490	**17 mm spanner**, fuel pressure pipes
942352	**Plug**, pressure testing the oil cooler
999 2000	**Standard handle**, drifts
999 6066	**Nipple**, for measuring fuel and lubricating oil pressure, used with 999 6398
999 6394	**Spacer**, x2, for 999 6645
999 6395	**Spacer**, x2, for 999 6645
999 6398	**Manometer**
999 6400	**Slide hammer**, for injectors and the system pressure valve
999 6645	**Puller**, for cylinder liners
999 6662	**Pressure testing unit**, lubricating oil cooler
999 6685	**Pressure testing clamp**, for the lubricating oil cooler
999 8007	**Connector for removing injectors**, used with 999 6400
999 8671	**Engine fixture**, for the engine stand
999 8672	**Fitting/removing tool**, rear crankshaft seal
999 8673	**Fitting/removing tool**, front crankshaft seal

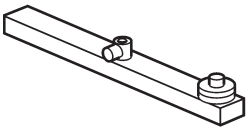


999 8674

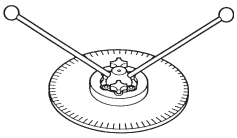
999 8675



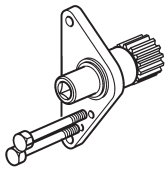
999 8676



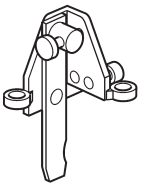
999 8678



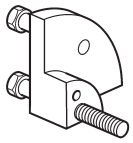
999 8679



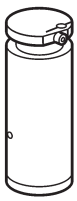
999 8681



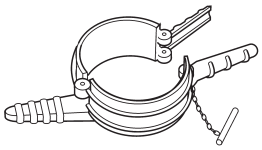
999 8682



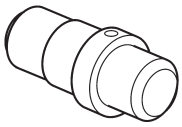
999 8684



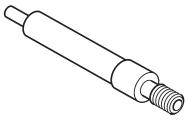
999 8685



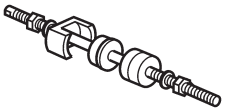
999 8687



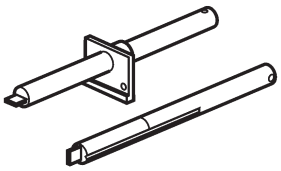
999 8692



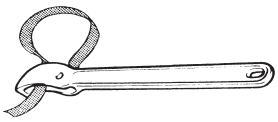
999 8694



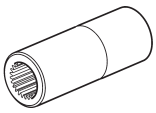
999 8695



999 8696



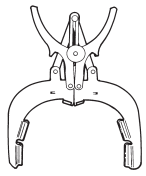
999 9179



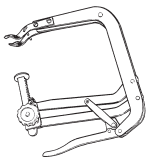
11668403

Tool	Name – use
999 8674	**Adapter**, for pressure regulation valve, used with 999 6400
999 8675	**Puller plate**, for cylinder liners, used with 999 6645
999 8676	**Turning tool**, crankshaft
999 8678	**Measuring bar**, with spacers, for determining cylinder head gasket
999 8679	**Protractor**, 360 degrees
999 8681	**Turning tool**, flywheel
999 8682	**Pressure tool**, for locking the control rod
999 8684	**Measuring tool**, for measuring and locking the control rod
999 8685	**Measuring tool**, for injector pumps
999 8687	**Piston ring compressor**, for fitting pistons into the block
999 8692	**Fitting tool**, for piston pin bushings
999 8694	**Adapter**, for testing compression
999 8695	**Fitting tool**, for camshaft bearings
999 8696	**Fitting tool**, for control rod sleeves
999 9179	**Filter wrench**
11668403	**Socket**, for fitting injector pumps

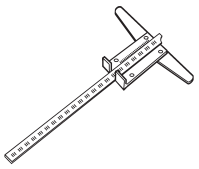
Other special equipment



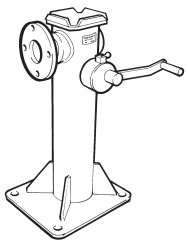
998 5423



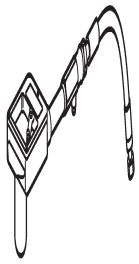
998 5468



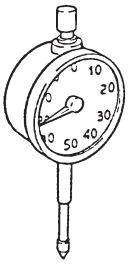
998 5471



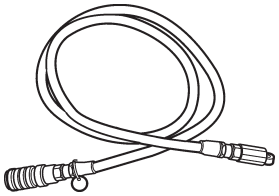
998 6485



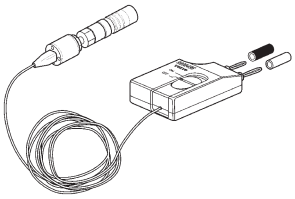
998 8539



998 9876



999 8493



999 8496

Tool	Name – use
998 5423	**Piston ring pliers**, removing/fitting piston rings
998 5468	**Valve spring compressor**, removing/fitting valve cotters
998 5471	**Rule depth gauge**, for the control rod
998 6485	**Rotatable stand**, for engines
998 8539	**Compression tester**
998 9876	**Dial gauge**
999 8493	**Hose**, used with 999 8496
999 8496	**Pressure transducer module**, used instead of 999 6398, and in combination with a multimeter

Other equipment

180211

969011

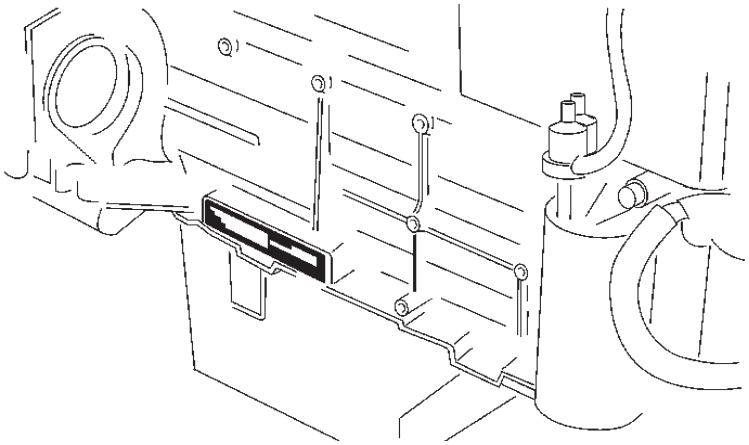
1678297

180211	**Banjo bolt**, used with 999 6066
969011	**Copper washer**, for testing pressure
1678297	**Spacer**, used when checking oil pressure, together with 180211

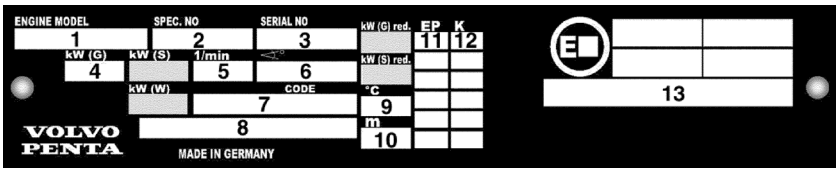
Description of the engine

Location of the engine identification plate

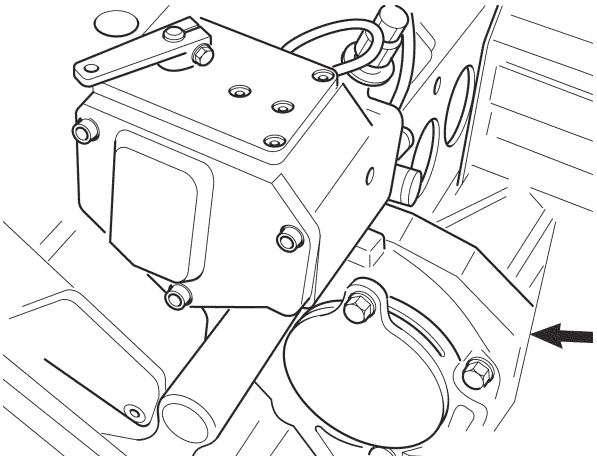
The engine identification plate is attached to the engine block. There is normally a second plate attached to the top of the engine cowling.



Engine identification plate

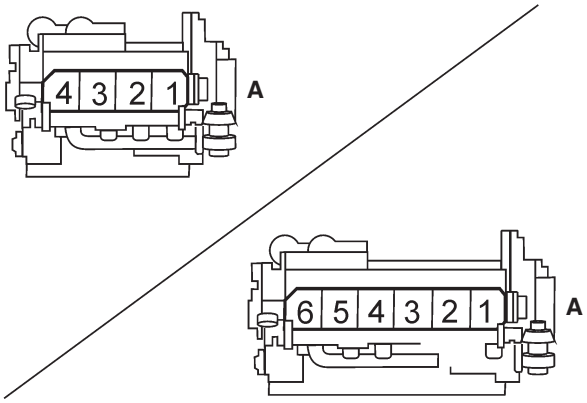


1. Engine model .....
2. Product number.....
3. Serial number.....
4. Engine power
5. Engine speed
6. Injection angle and type of camshaft
7. Indication of standard and/or specification
8. Production number
9. Air temperature in °C, as specified in ISO 3046
10. Height above sea level in meters, as specified in ISO 3046
11. EP code, code for injector pumps (cylinder 1 at top)
12. Piston class
13. Additional information



Engine serial number

The engine serial number is stamped into the engine block. The serial number consists of 10 figures. Only the last eight figures are stamped into the engine block.

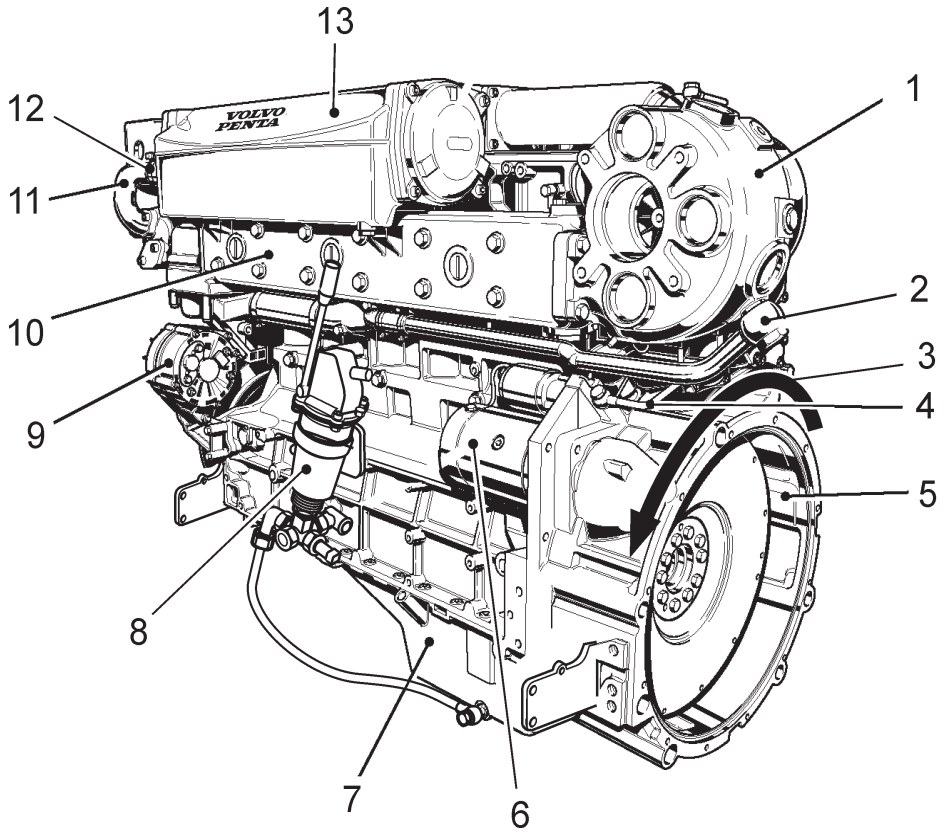


Cylinder numbering

A = flywheel

Engine, locations of components

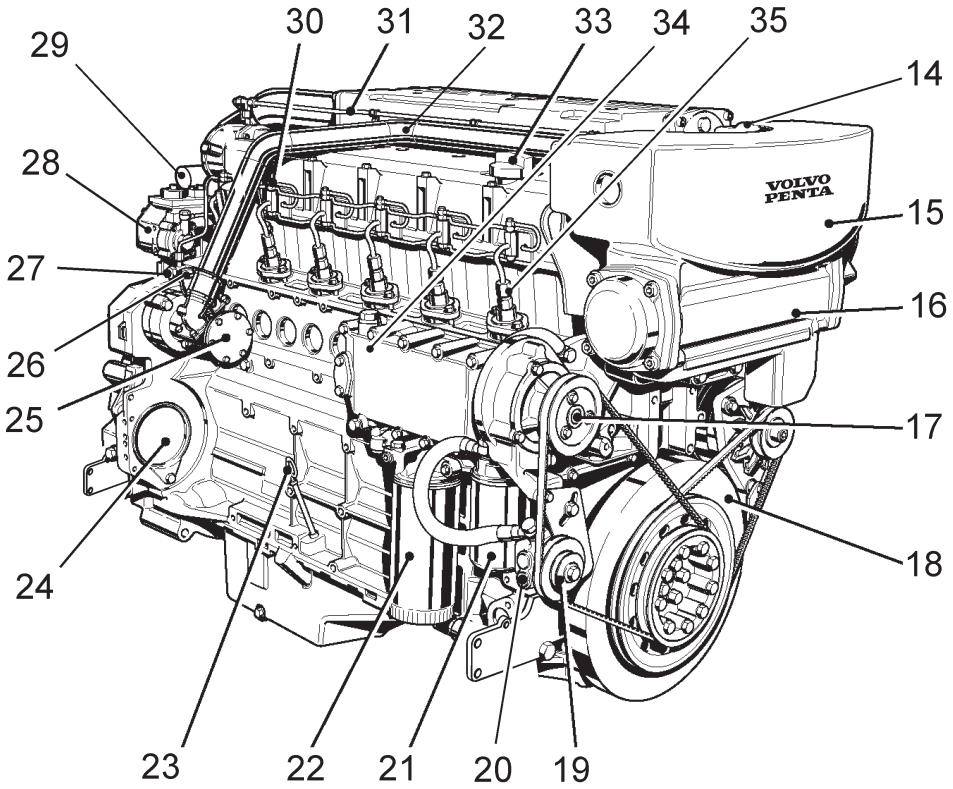
Starter motor side



Example: D7A TA

1. Turbo
2. Coolant pipe to turbo
3. Direction of rotation of engine, counterclockwise
4. Engine-oil pipe, from turbo
5. SEA-housing/flywheel
6. Starter motor
7. Oil sump
8. Oil drain pump
9. Generator
10. Exhaust manifold
11. Coolant pipe to charge air cooler
12. Seawater outlet
13. Charge air cooler

Service side



Example: D7A TA

14. Coolant filler cap
15. Expansion tank
16. Heat exchanger
17. Coolant pump
18. Vibration damper
19. Fuel pump
20. Fuel inlet
21. Fuel filter
22. Engine oil filter
23. Oil dipstick
24. PTO for hydraulic pump or compressor
25. Seawater pump
26. Seawater inlet
27. Fuel bypass valve
28. Engine speed regulator
29. Stop solenoid
30. Fuel pressure pipe
31. Air bleed pipe, from turbo to expansion tank
32. Seawater pipe to charge air cooler
33. Oil filler pipe
34. Oil cooler
35. Injector pumps

*** Engine speed regulator (Heinzmann)**

The speed regulator fitted to engines in the D5/D7 series is made by Heinzmann. It is a mechanical, variable-speed model with centrifugal weights.

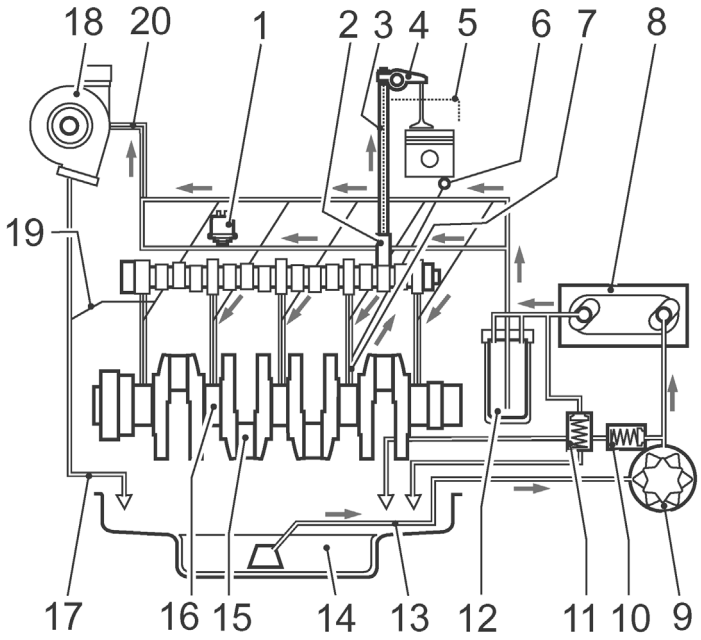
Every regulator fitted to these engines is specially installed for the individual engine. This means that the regulator can not be swapped between engines.

An incorrectly set regulator can lead to the engine not meeting the specified emission and performance requirements.

Always quote the engine model, serial number, engine power and rated speed (rpm) when ordering a regulator as a spare part.

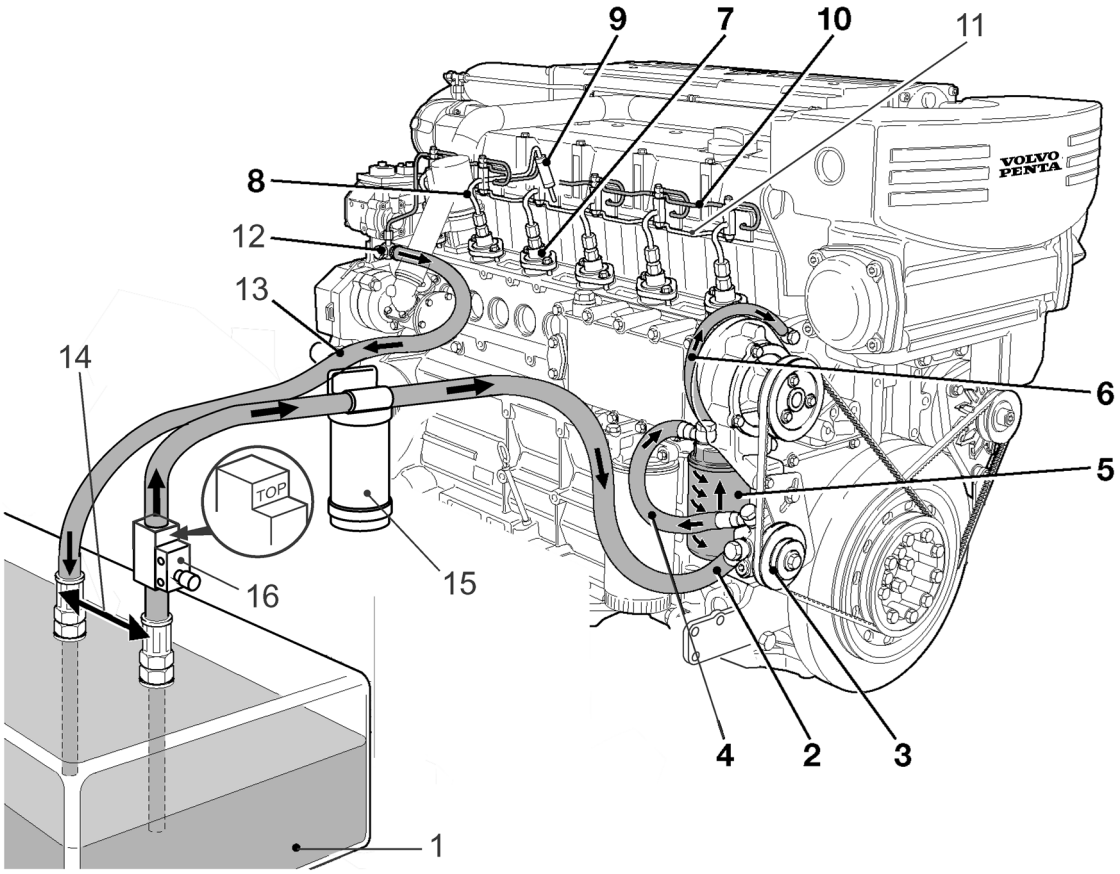
Only specially trained personnel should adjust the regulator.

Lubrication system



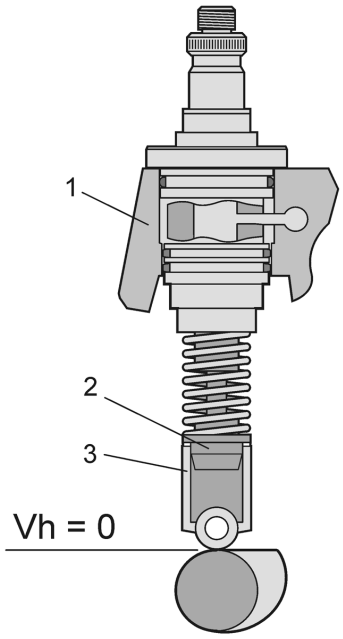
1. Oil pressure sensor
2. Valve tappet
3. Push rod
4. Rocker arm
5. Return oil channel
6. Piston cooling
7. Oil pipe to piston cooling jet
8. Lubricating-oil cooler
9. Lubricating-oil pump
10. Safety valve
11. System pressure valve
12. Lubricating-oil filter
13. Oil suction pipe
14. Oil sump
15. Big-end bearing
16. Crankshaft bearing
17. Return flow from turbo to crankcase
18. Turbo
19. Return flow to oil sump
20. Oil pipe to turbo

Fuel system



1. Fuel tank
2. Pipe to fuel pump
3. Fuel pump
4. Pipe to fuel filter
5. Fuel filter
6. Pipe to fuel pumps
7. Injector pump
8. Pressure pipe to injector
9. Injector
10. Fuel return pipe
11. Fuel leak-off pipe
12. Bypass valve with valve screw
13. Return pipe to fuel tank
14. Fuel pipes, minimum distance 12 in (300 mm)
15. Prefilter, with water separation
16. Hand pump with non-return valve (accessory)*

* Fit with “TOP” facing upwards. It does not work on its side.



Setting the injection angle, Fb

The engine has a separate injection pump for each cylinder. This means that the injection angle, **Fb**, has to be adjusted separately for each pump unit. The injection angle is adjusted by placing a shim between the tappet and injector pump. The thickness of the shim is calculated using a mathematical formula.

When changing just one injector pump, the formula $\mathbf{T_s=(L_0+A/100)}$ is used, as shown in “Calculation 1” in “Technical data.”

If the engine block, camshaft or roller tappet have been changed, a new corrected fitting measurement, $\mathbf{E_k}$, and a new **EP code** must be calculated, as shown in “Calculations 2 and 3” in “Technical data.”

The new EP code must also be recorded on the engine plate, so that the calculations will be correct if the injector pump is changed in the future.

Fuel pressure pipes

⚠ **IMPORTANT:** The fuel pressure pipes must be scrapped if they are removed.

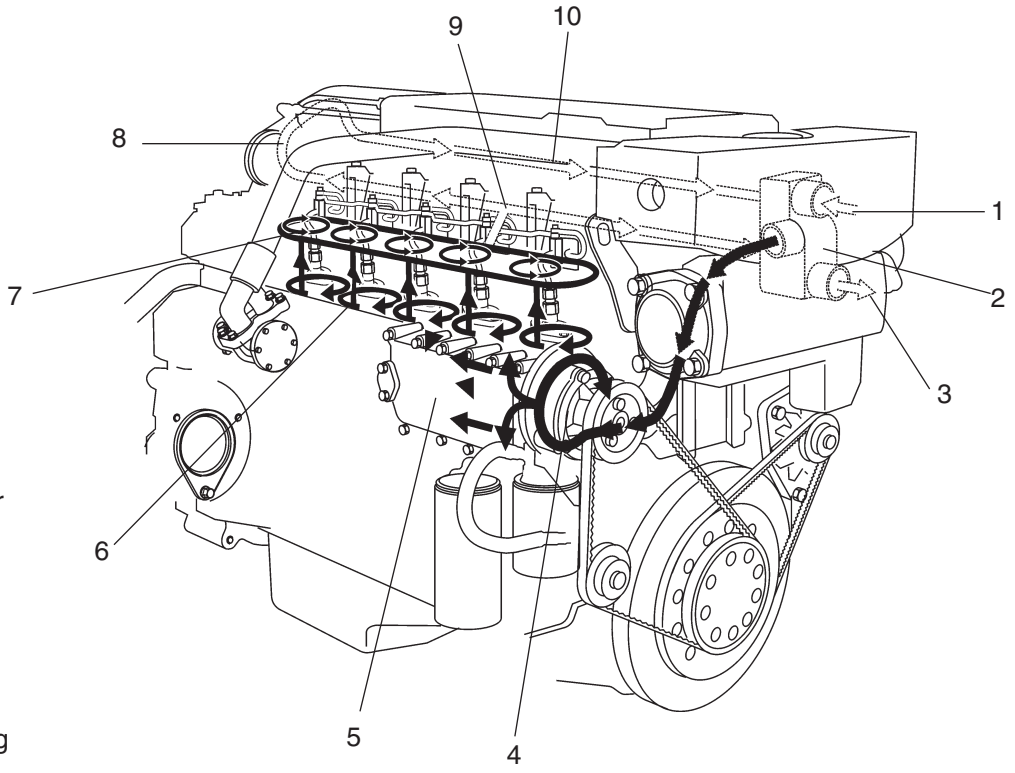
The pressure pipes are deformed when they are tightened, and all of the pressure pipes must be tightened to the same torque.

If they are tightened to different torques, the cylinders can be unequally loaded.

If the pipes are reused, the engine might not produce full power.

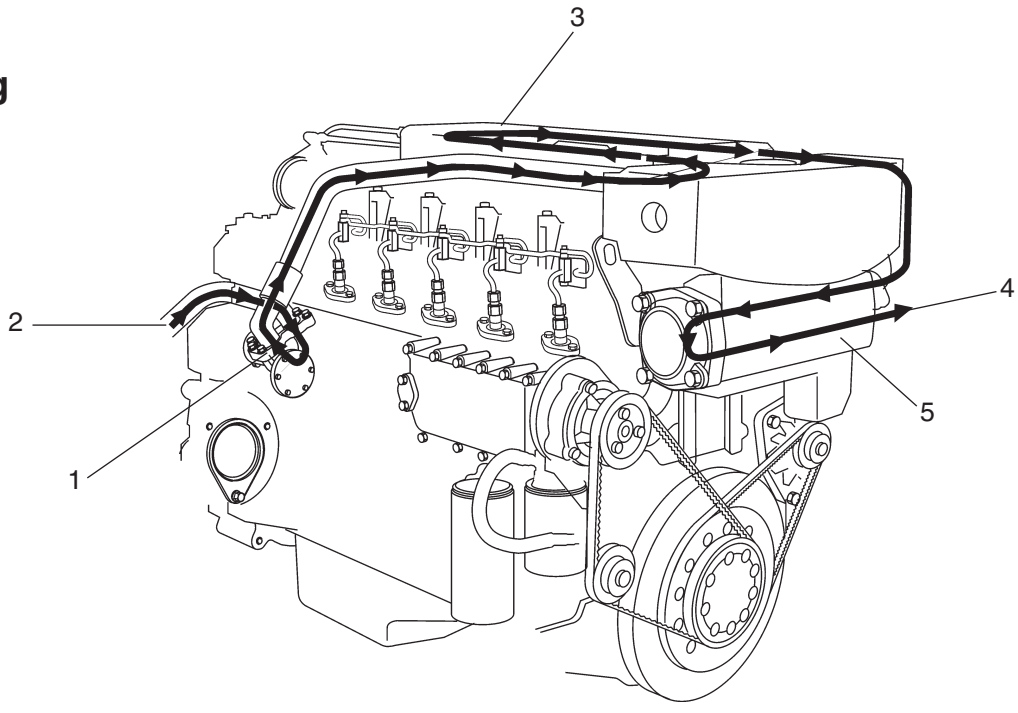
If the pressure pipes have been damaged, for example during transport, they should not be straightened. They should be replaced with new ones.

Cooling system



1. From heat exchanger
2. Thermostat housing
3. To heat exchanger
4. Coolant pump
5. Lubricating-oil cooler
6. Cylinder cooling
7. Cylinder head cooling
8. Cooling, turbo
9. Coolant pipe
10. Exhaust manifold

Seawater cooling



1. Seawater pump
2. Seawater inlet
3. Charge air cooler
4. Seawater outlet
5. Heat exchanger

Technical data

General

Engine model	D5A T	D5A TA	D7A T	D7A TA	D7C TA
Direction of rotation, seen from flywheel end	Counter-clockwise	Counter-clockwise	Counter-clockwise	Counter-clockwise	Counter-clockwise
Number of cylinders	4	4	6	6	6
Cylinder diam. (in. (mm))	4.25 (108)	4.25 (108)	4.25 (108)	4.25 (108)	4.25 (108)
Stroke (in. (mm))	5.12 (130)	5.12 (130)	5.12 (130)	5.12 (130)	5.12 (130)
Cylinder vol. (in^3 (dm^3))	4.76.(290)	4.76.(290)	7.15 (436)	7.15 (436)	7.15 (436)
Number of valves	8	8	12	12	12
Compression ratio	17.6:1	17.6:1	17.6:1	17.6:1	17.6:1
Firing order	1-3-4-2	1-3-4-2	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Engine power, kW (hp)					
Rating 1, 1900 rpm	72 (98)	89 (121)	108 (147)	130 (177)	146 (198)
Rating 1, 2300 rpm	81 (110)	102 (139)	123 (167)	148 (201)	166 (226)
Rating 2, 1900 rpm	83 (113)	103 (140)	126 (171)	153 (208)	169 (230)
Rating 2, 2300 rpm	95 (129)	118 (160)	129 (175)	174 (237)	195 (265)
Torque, Nm (lbf.ft.)					
Rating 1, 1900 rpm	362 (267)	447 (330)	543 (400)	653 (482)	729 (538)
Rating 1, 2300 rpm	336 (248)	424 (313)	511 (377)	614 (453)	689 (508)
Rating 2, 1900 rpm	417 (308)	517 (381)	633 (467)	769 (567)	849 (626)
Rating 2, 2300 rpm	394 (291)	490 (361)	602 (444)	722 (532)	810 (597)
Slow idle speed (rpm)	775	775	750	750	750
Max. permitted backward lean when running, standard sump	15°	15°	15°	15°	15°
Dry weight (lbs (kg))	510 (1124)	525 (1157)	670 (1477)	690 (1521)	690 (1521)

Determining shim thickness when changing an injector pump

Mathematical formula for new shim thickness: $T_S = Ek – (L_0 + A/100)$
Actual shim thickness, S_S, is obtained from table 2. $S_S \rightarrow T_S$

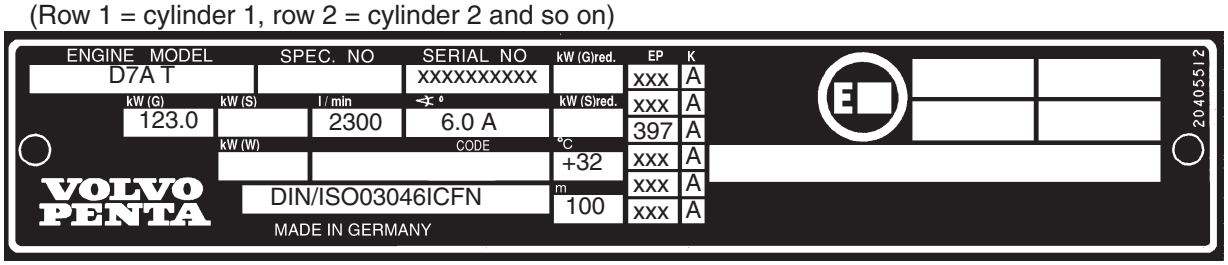
Note! This formula is applicable when changing JUST an injector pump.

Calculation 1 Explanation	Factor		Ex	D5A T, D5A TA, D7A T, D7A TA, D7C TA					
Cylinder no.:	XXX			Cyl: 1	Cyl: 2	Cyl: 3	Cyl: 4	Cyl: 5	Cyl: 6
Serial number of injector pump	XXX								
EP code:	**EP**		397						
Corrected installation meas., see table 3	E_k		146.9						
Basic meas. for injector pump, see table 1	L_0	-	143						
Manufacturing tol., see injector pump	**A/100**	-	0.63						
Theoretical shim thickness	T_S	=	3.27						
Actual shim thickness, see table 2	S_S	~	3.3						

(100 mm = 3.937”)

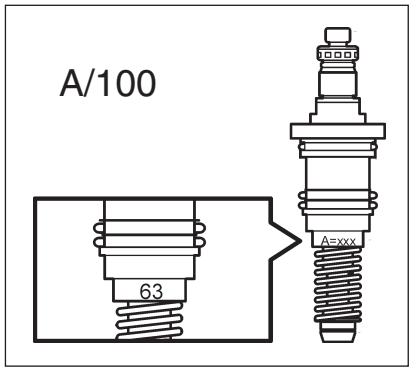
Example: Changing the injector pump for cylinder 3 on a D7A T engine.

1. Read the EP code for cylinder 3 from the “EP” column of the engine plate, for example, 397.
(Row 1 = cylinder 1, row 2 = cylinder 2 and so on)



2. Using the EP code for the injector pump, read the corrected value, E_k, from table 3.
Example: EP code = 397 $\rightarrow$ E_k = 146.9 mm.

3. Read the manufacturing tolerance for the length, **A**, of the injector pump on the new injector pump, Example 63 (see diagram)
Note! If the value is not legible, remove any dirt **without** scraping.
Tolerance A is divided by 100 in calculations.



4. Read the standard measurement for the injector pump, L_0, from table 1.
Example: 143 mm.

5. Work out the theoretical shim thickness, T_S, using the formula: $T_S = E_k – (L_0 + A/100)$
(see also the example in “Calculation 1”)
Example: T_S = 146.9 mm – (143 mm + 0.63 mm) = 3.27

6. Select the shim thickness, S_S from table 2.
Example: T_S = 3.27 mm $\rightarrow$ S_S = 3.3 mm

Determining shim thickness for when an injector valve should open

Done when changing the engine block, camshaft or roller journal.

Mathematical formula for the new shim thickness:
T_S = L-[(Fb_{act}-Fb_{nom})x Vh_{corr}+Vh_{nom}+L_O+ A/100)]

The actual shim thickness is obtained from table 2. $T_S \rightarrow S_S$

Note! After determining shim thickness, a new EP code MUST ALWAYS be produced using "Calculation 3," so that any later pump changes will be done correctly.

Calculation 2.1 Explanation	**Factor**		**Ex**	**D5A T, D5A TA, D7A T, D7A TA, D7C TA**					
Cylinder no.:	XXX		XXX	**Cyl: 1**	**Cyl: 2**	**Cyl: 3**	**Cyl: 4**	**Cyl: 5**	**Cyl: 6**
Serial number of injector pump	XXX		XXX						
Injection angle, measured with a protractor	**Fb_{akt}**		5.5						
Injection angle, see engine plate ∠°	**Fb_{nom}**	**-**	6						
Total 1 (Fb_{akt}- Fb_{nom})	**S1**	**=**	-0.5						
Preload correction factor, see table 1	**Vh_{korr}**	**x**	0.14						
Total 2 (S1x Vh_{korr})	**S2**	**=**	-0.07						
Camshaft lift, see table 1	**Vh_{nom}**	**+**	6.11						
Basic meas. for injector pump, see table 1	**L_0**	**+**	143						
Manufacturing tol., see injector pump	**A/100**	**+**	0.63						
Total 3 (S2+ Vh_{nom}+L_o+A/100)	**S3**	**=**	149.67						

(100 mm = 3.937")

Calculation 2.2 Explanation	**Factor**		**Ex.**	**Cyl: 1**	**Cyl: 2**	**Cyl: 3**	**Cyl: 4**	**Cyl: 5**	**Cyl: 6**
Distance between block and roller journal	**L**		152.18						
Total 3 (S2+ Vh_{nom}+L_0+A/100)	**S3**	**-**	149.67						
Theoretical shim thickness (L-S3)	**T_S**	**=**	2.55						
Actual shim thickness, see table 2	**S_S**	**~**	2.6						

(100 mm = 3.937")

FACTOR	**UNIT**	**EXPLANATION**
Fb_{akt}	ºC/A	Injection angle, measured with a protractor as described in the method
Fb_{nom}	ºC/A	Injection angle, obtained from the engine plate
Vh_{korr}	mm/ºC/A	Preload, correction factor, obtained from table 1
Vh_{nom}	mm	Camshaft lift, nominal, obtained from table 1
L	mm	Distance measured between block and roller journal, as described in the method
L_0	mm	Basic measurement of injector pump
A/100	mm	Manufacturing tolerance, written on the injector pump
T_S	mm	Theoretical shim thickness
S_S	mm	Actual shim thickness
S (1, 2, 3)	xxx	Total of calculations
EP	xxx	Code obtained from table 3 or the engine plate
E_k	mm	Total of EP code calculations

Determining the corrected fitting measurement, E_k, and EP code for an injector pump

When changing the engine block, camshaft or roller journal, the corrected fitting measurement, E_k, must be determined again and the EP code on the engine plate must be changed.

Mathematical formula for the corrected fitting measurement, E_k:
$E_k = L - [(Fb_{act} - Fb_{nom}) \times Vh_{corr} + Vh_{nom})]$

The new EP code is obtained from table 3.2 $E_k \rightarrow$ EP code

Calculation 3.1 Explanation	Factor		Ex	D5A T, D5A TA, D7A T, D7A TA, D7C TA					
Cylinder no.:	XXX		XXX	Cyl: 1	Cyl: 2	Cyl: 3	Cyl: 4	Cyl: 5	Cyl: 6
Serial number of injector pump	XXX		XXX						
Injection angle, measured with a protractor	Fb_{akt}		5.5						
Injection angle, see engine plate ∠°	Fb_{nom}	-	6						
Total 1 (Fb_{akt}- Fb_{nom})	S1	=	-0.5						
Correction factor, see table 1	Vh_{korr}	x	0.14						
Total 2 (S1x Vh_{korr})	S2	=	-0.07						
Camshaft lift, see table 1	Vh_{nom}	+	6.11						
Total 3 (S2+ Vh_{nom})	S3	=	6.04						

(100 mm = 3.937")

Calculation 3.2 Explanation	Factor		Ex	Cyl: 1	Cyl: 2	Cyl: 3	Cyl: 4	Cyl: 5	Cyl: 6
Distance between block and roller journal	L		152.22						
Total 3 (S2+ Vh_{nom})	S3	-	6.04						
E_k (L- S3= E_k)	E_k	=	146.18						
E_k rounded to the nearest value in table 3	E_k	~	146.175						
EP code ($E_k \rightarrow$ table 3 $\rightarrow$ EP code)	EP	=	344						

(100 mm = 3.937")

Table 1

Injection angle Fb_{nom}	Camshaft type	Pre-stroke Vh_{nom}	Pre-stroke Corr. factor, Vh_{korr}	Length of pump basic measurement L_0 (mm)
[ºC/A BTDC]		[mm]	[mm/ºC/A]	[mm]
5	A	6,32	0,14	143 (L_o)
6		6,11		
7		5,9		
8		5,7		
9		5,5		
10		5,31		
2	S	6,2	No information available	143 (L_o)
2,5		6,11		
3		6,02		
3,5		5,93		
4		5,84		
4,5		5,75		
5		5,66		
5,5		5,58		
6		5,49		

(100 mm = 3.937")

Table 2

Theoretical thickness "T_s" , (mm)	Shim thickness "S_s", (mm)	Theoretical thickness "T_s", (mm)	Shim thickness "S_s", (mm)
0.95–1.049	1.0	3.05–3.149	3.1
1.05–1.149	1.1	3.15–3.249	3.2
1.15–1.249	1.2	3.25–3.349	3.3
1.25–1.349	1.3	3.35–3.449	3.4
1.35–1.449	1.4	3.45–3.549	3.5
1.45–1.549	1.5	3.55–3.649	3.6
1.55–1.649	1.6	3.65–3.749	3.7
1.65–1.749	1.7	3.75–3.850	3.8
1.75–1.849	1.8	3.85–3.949	3.9
1.85–1.949	1.9	3.95–4.049	4.0
1.95–2.049	2.0	4.05–4.149	4.1
2.05–2.149	2.1	4.15–4.249	4.2
2.15–2.249	2.2	4.25–4.349	4.3
2.25–2.349	2.3	4.35–4.449	4.4
2.35–2.449	2.4	4.45–4.549	4.5
2.45–2.549	2.5	4.55–4.649	4.6
2.55–2.649	2.6	4.65–4.749	4.7
2.65–2.749	2.7	4.75–4.849	4.8
2.75–2.849	2.8	4.85–4.949	4.9
2.85–2.949	2.9	4.95–5.049	5.0
2.95–3.049	3.0		

(100 mm = 3.937")

Table 3

E_k (mm)	EP-code	E_k (mm)	EP-code	E_k (mm)	EP-code	E_k (mm)	EP-code	E_k (mm)	EP-code
144.5		145.1		145.7	349	146.3	373	146.9	397
144.525		145.125		145.725	350	146.325	374	146.925	398
144.55		145.15		145.75	351	146.35	375	146.95	399
144.575		145.175		145.775	352	146.375	376	146.975	400
144.6		145.2		145.8	353	146.4	377	147.0	401
144.625		145.225		145.825	354	146.425	378	147.025	
144.65		145.25		145.85	355	146.45	379	147.05	
144.675		145.275		145.875	356	146.475	380	147.075	
144.7		145.3		145.9	357	146.5	381	147.1	
144.725		145.325		145.925	358	146.525	382	147.125	
144.75		145.35	335	145.95	359	146.55	383	147.15	
144.775		145.375	336	145.975	360	146.575	384	147.175	
144.8		145.4	337	146.0	361	146.6	385	147.2	
144.825		145.425	338	146.025	362	146.625	386	147.225	
144.85		145.45	339	146.05	363	146.65	387	147.25	
144.875		145.475	340	146.075	364	146.675	388	147.275	
144.9		145.5	341	146.1	365	146.7	389	147.3	
144.925		145.525	342	146.125	366	146.725	390	147.325	
144.95		145.55	343	146.15	367	146.75	391	147.35	
144.975		145.575	344	146.175	368	146.775	392	147.375	
145.0		145.6	345	146.2	369	146.8	393	147.4	
145.025		145.625	346	146.225	370	146.825	394	147.425	
145.05		145.65	347	146.25	371	146.85	395	147.45	
145.075		145.675	348	146.275	372	146.875	396	147.475	

(100 mm = 3.937")

Tightening torque

General tightening torques	Nm	(lbf.ft.)
M6: Standard bolt	10	(7)
M8: Standard bolt	25	(18)
M10: Standard bolt	50	(37)
M12: Standard bolt	80	(59)
M14: Standard bolt	140	(103)

Group 21: Engine

Engine mountings	260	(192)
Starter motor	70	(52)
Timing gear cover	21	(15)

Main crankshaft bearings

Note! The bolts for the main bearing caps can be reused only three times.

Stage 1:	50	(37)
Stage 2:	60° angle tightenting	
Stage 3:	60° angle tightenting	

Big-end bearings

Note! New bolts should be used every time a bearing cap is refitted.

Stage 1:	30	(22)
Stage 2:	60° angle tightenting	
Stage 3:	60° angle tightenting	

Flywheel

Note! The bolts for the flywheel can be reused only five times.

Stage 1:	30	(22)
Stage 2:	60° angle tightenting	
Stage 3:	60° angle tightenting	

Flywheel housing

M12	99	(73)
M16	243	(17)

Drive belt pulley

Note! The bolts for the pulley can be reused only three times.

Stage 1:	45	(33)
Stage 2:	60° angle tightenting	
Stage 3:	60° angle tightenting	
Vibration damper	70	(52)

Valve cover

Bolts, valve cover	11	(8)
Valve adjuster nuts	20	(15)
Rocker-arm bridge	21	(15)
Crankcase ventilation bolt	9	(7)

Tightening torques Nm (lbf.ft.)

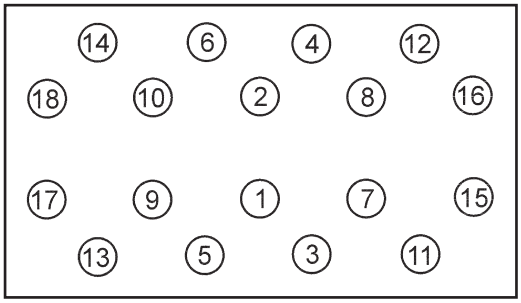
Cylinder head

Note! The bolts for the cylinder head can be reused only five times.

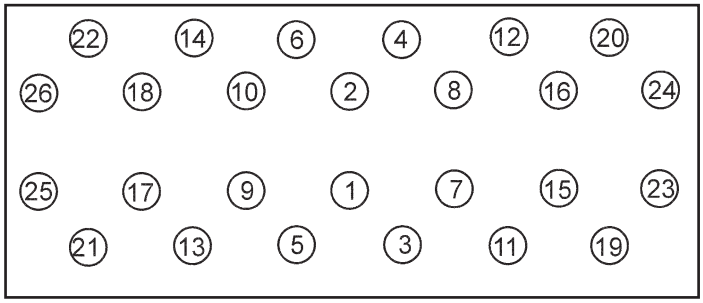
Stage 1:	50	(37)
Stage 2:	130	(96)
Stage 3:	90° angle tightenting	

Tightening sequence for cylinder head bolts

D5A T / D5A TA



D7A T / D7A TA / D7C TA



Group 22: Lubrication system

Oil cooler, fixing bolts	21	(15)
Oil cooler, banjo bolt		
Stage 1:	80	(59)
Stage 2:	160	(118)
Oil cooler, screw plug	80	(59)
Front cover/oil pump housing	21	(15)
Oil suction pipe	21	(15)
Oil sump	21	(15)
Oil pressure pipe to turbo	22	(16)
Oil pressure pipe to engine block	34	(25)
System pressure valve	8-9	(6-7)
Return pipe, lubricating oil	22	(16)

Tightening torques	Nm	(lbf.ft.)

Group 23: Fuel system

Bolt, regulator, intermediate gear	21	(15)
Bolt, control rod sleeve	10	(7)
Bolt, engine speed regulator	17	(12)

Flange bolt, injector pump

Stage 1: Initial tightening	5	(4)
Stage 2:	Slacken 60° counterclockwise	
Stage 3: Turn injector pump to stop position	Counterclockwise	
Stage 4:	60° clockwise	
Stages 5-7 alternately:		
Stage 5:	7	(5)
Stage 6:	10	(7)
Stage 7:	30	(22)
Jet retainer	19	(14)
Jet nut	45	(33)

Pressure pipes

Note! The jet pipes should not be bent, and must be changed every time they are removed.
Note! Ensure that you tighten all of the fuel pressure pipes to the same torque.

Pressure pipe nuts		
Stage 1	5	(4)
Stage 2	25	(18)
Bypass valve	30	(22)
Banjo bolts, fuel return/leak-off pipes	12	(9)
Nut, fuel return pipe	14	(10)

Stop solenoid

Bracket	22	(16)
Locknuts	10	(7)

Fuel lines

Banjo bolts	34	(25)

Group 25: Inlet and exhaust systems

Inlet pipe	11	(8)
Bolts, exhaust manifold	60	(44)
Connection point, D5, to inlet pipe	22	(16)
Turbo, to exhaust manifold	40	(29)
Intake pipe, air filter	22	(16)
Hose clip, air filter	12	(9)

Tightening torques	Nm	(lbf.ft.)

Group 26: Cooling system

Thermostat housing	42	(31)
Thermostat holder	21	(15)
Level switch, coolant	25	(18)
Coolant housing	21	(15)
Pulley, coolant pump	21	(15)
Coolant pipe, T-piece to engine body	20	(15)
Coolant pipe, to thermostat housing	20	(15)
Coolant pipe, D5, to exhaust manifold	20	(15)
Coolant pipe, D7, to turbo	101	(74)
Retainer, coolant pipe, D7	20	(15)

Heat exchanger

Screw plugs	15	(11)
End plate, rear	21	(15)
Connector	21	(15)
Bolts, upper/lower, heat exchanger	42	(31)

Charge air cooler

Charge air pipe	22	(16)
Screw plugs in rear end plate	15	(11)
Rear end plate	21	(15)
Front end plate	21	(15)
Screw plug, guide hole	38	(28)
Connector	13	(10)
Bolts, top of charge air cooler	22	(16)

Seawater pipes

Bolts, retainer (-TA)	20	(15)
Bolts, retainer (-T)	22	(16)
Connection to heat exchanger	42	(31)
Hose clips (-T)	5	(4)
Locking bolt, impeller housing	8.5	(6.3)

Seawater pump

Bolt, cover plate	21	(15)
Nut, gear wheel	80	(59)
Bolts, seawater pump	42	(31)
Bolts, end plate	5	(4)
Connection point	20	(15)

Tests and adjustments

Compression test

21002

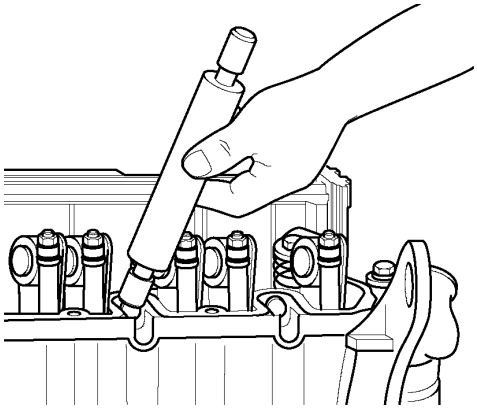
Special tools:

Adapter for compression test..... 999 8694
Compression gauge 998 8539

The compression that is measured depends on the engine speed when the test begins, and the surrounding air pressure.

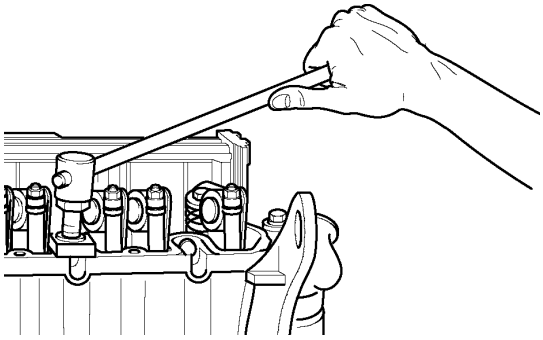
It is difficult to give precise figures for the effect of the surrounding air pressure. We recommend that the measurements of compression pressure be used to compare the compression in the different cylinders in an engine.

If the difference in pressure is greater than 15%, the cylinder in question should be dismantled in order to ascertain the cause.

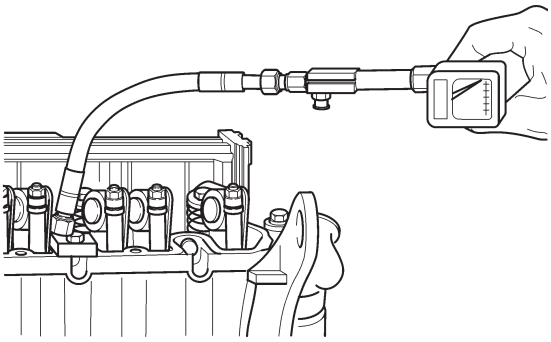


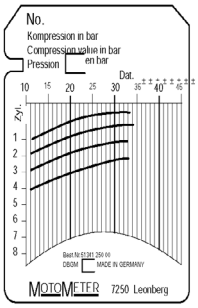
Note! The injectors have been removed and the valve clearances have been checked.

1. Fit the adapter (999 8694).



2. Use the existing jet retainer and tighten the bolt to.....**19 Nm** (14 lbf.ft.)





3. Connect the compression tester, 998 8539.
   Turn the engine over with the starter motor.
   Compression: ..... **30 – 38 Mpa** (3 – 3.8 bar)

Note! Check that the control rod is in the stop position (no injection).

4. Insert the injector with a new copper gasket and tighten it to.....**19 Nm** (14 lbf.ft.)

5. Attach the new fuel pressure pipe and tighten it in two stages:
   1..... **5 Nm** (4 lbf.ft.)
   2..... **25 Nm** (18 lbf.ft.)

⚠ **IMPORTANT:** All of the pressure pipes must be tightened to the same torque.

6. Tighten the valve cover to ..... **11 Nm** (8 lbf.ft.)

Note! The fuel leak-off pipes must always be refitted if they have been removed.

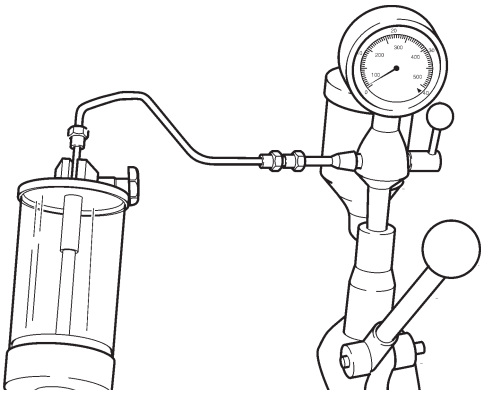
Injectors, checking / adjusting

23712, 23713

Note! The utmost cleanliness is required when working on the injection system.
Use only clean test oil that meets ISO 4113 specification for testing the injectors.

Note! Get an authorized workshop to test and adjust the injectors. The test requires special equipment that Volvo Penta does not sell.

⚠ **WARNING!** Take the utmost care when working with the jet of fuel from an injector. The jet can penetrate deep into the skin tissue and cause blood poisoning.

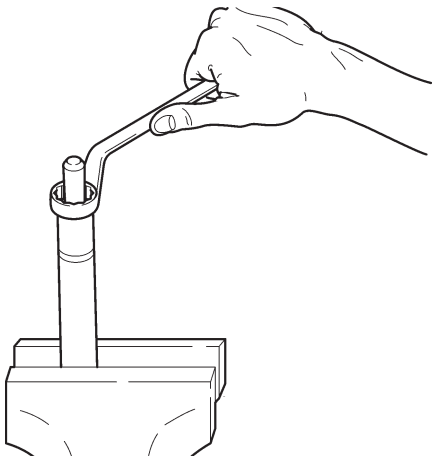


1. Connect the injector to the pressure tester.

2. Check the opening pressure. For the correct opening pressure, see “Technical data.”

Note! There are different opening pressures for used and new injectors or springs.

3. Check the seal after the injector has opened. The pressure should drop by no more than 50 bar/5 seconds.
   Check that no drips come out by maintaining a constant pressure (20 bar below opening pressure) for 10 seconds.



Adjusting the injector opening pressure

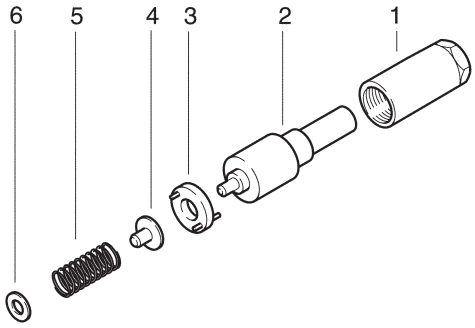
⚠ **IMPORTANT:** Extreme cleanliness and care are required to ensure that the parts do not get mixed up.

4. Unscrew the jet nut and remove all of the parts.

5. Clean the parts in an ultrasound cleaner, benzene or Vanolen.

6. Inspect the parts of the jet under a jet microscope.

7. Dip the parts in benzene before reassembling them.



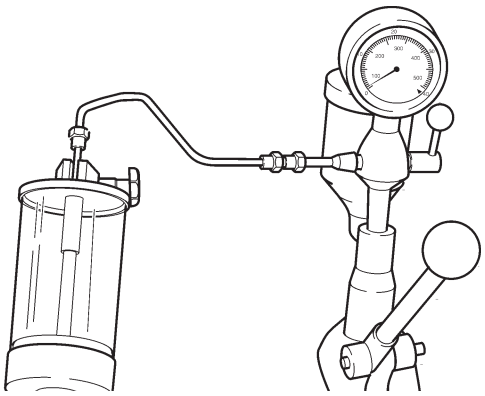
Remove the parts in the following order:

1. Jet nut
2. Jet
3. Locator with locating pins
4. Pressure stud
5. Spring
6. Shim

8. Adjust the pressure by selecting a suitable shim. A thicker shim increases the opening pressure.

   Tighten the jet nut..... **45 Nm** (33 lbf.ft.)

   Recheck the injector in the pressure tester.



9. Check for leaks:
   Dry the jet, jet nut and jet housing – blow out with compressed air. Press down the lever on the test unit until the pressure reaches around 20 bar below the opening pressure measured previously.

Example: Reading on the pressure gauge: 255 bar

	–20 bar
set to:	235 bar

For opening pressure, see “Technical data” (1 MPa = 10 bar)

10. The jet is sealing if nothing drips from it within 10 seconds.
    If it does drip, the jet must be dismantled and cleaned to rectify the leak. If this does not stop the leakage, a new jet must be fitted. Reuse is not permitted.

11. Squeak and spray pattern test.

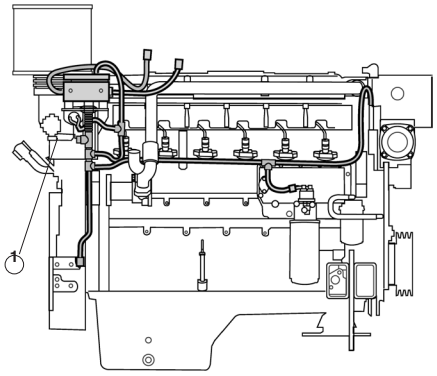
Note! The gauge on the pressure tester should be turned off before this test.

The squeak test provides an audible check of how easily the jet needle is able to move in the injector. New injectors make a different sound from used injectors. The sound degrades due to wear in the needle seat. If an injector does not squeak, despite having been cleaned, it must be changed.

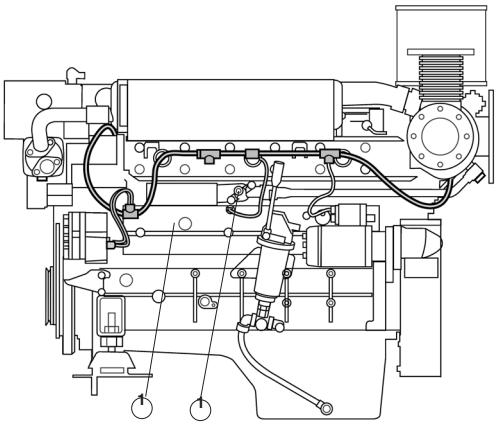
A used injector should produce a definite squeak when the lever is moved quickly, and produce a well-distributed spray pattern. It is difficult to determine the condition of an injector solely from the spray pattern.

Note! An incorrect spray pattern can damage the engine.

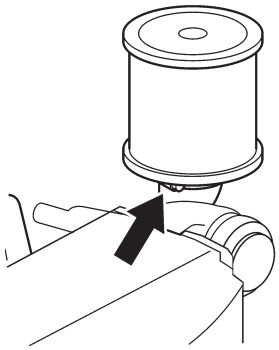
Exposing the engine



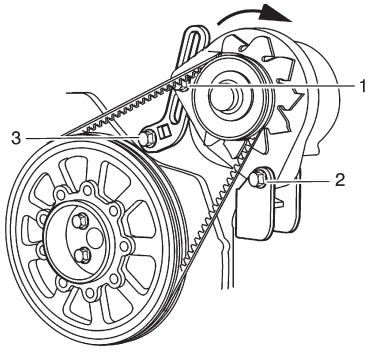
1. Mark and detach all cables and connection boxes.
   Detach the exhaust bend.



2. Drain out and collect any remaining oil and coolant (1), and dispose of them in the correct way.



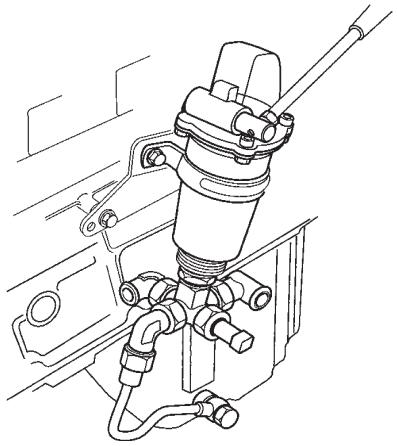
3. Loosen the hose clip under the air filter and lift off the filter.



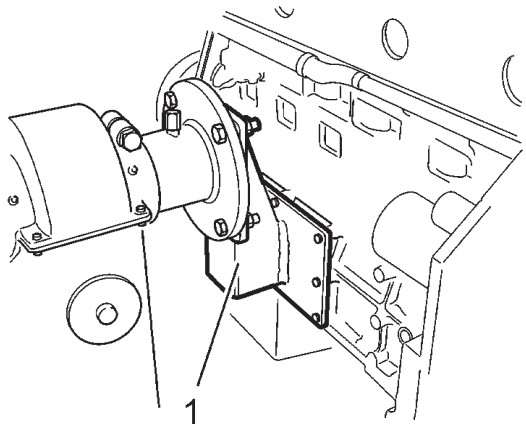
4. Remove the generator drive belt (see “Drive belts, changing”), the generator and the bracket.

   Remove any extra equipment, the PTO, for example.

Attaching the fixture



1. Remove the oil drain pump, complete with hoses and bracket.



2. Attach engine fixture 999 8671 (1) to the engine, and tighten the bolts to ... **25 Nm** (18 lbf.ft)

Note! Use the bolts that come with the fixture; they have a greater tensile strength than standard bolts.

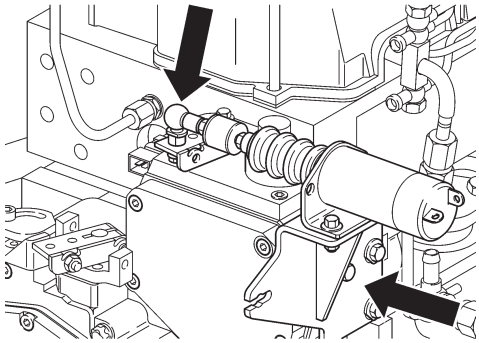
3. Clamp the engine onto the rotatable engine stand 998 6485.

Dismantling, complete engine

Special tools:

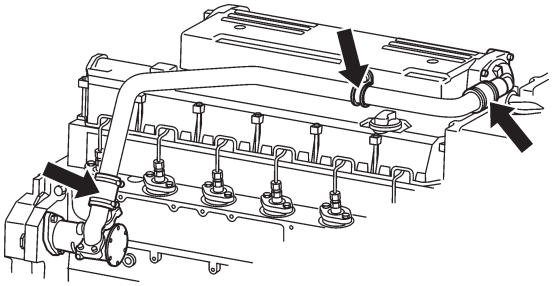
Spacer 999 6395
Puller, injector 999 6400
Stand 998 6485
Puller, cylinder liner 999 6645
Connector, injector.....999 8007
Engine fixture.....999 8671
Puller plate.....999 8675
Turning tool, flywheel 999 8681
Pressure tool, control rod 999 8682
Filter wrench 999 9179

Note! The repair procedures described in this chapter apply to the standard specification, that is to say, components in specially manufactured engines are not shown.



Stop solenoid

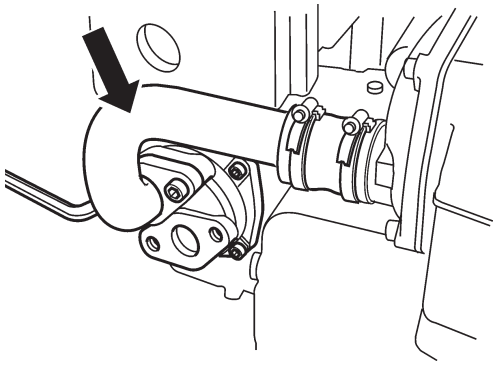
1. Remove the circlip from the pivot retainer and remove the stop solenoid complete with holder and bracket.



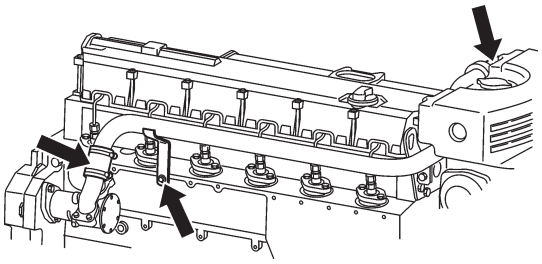
Seawater pipes

2. **D5/D7 TA**

   Remove the seawater pipe between the seawater pump and charge air cooler.

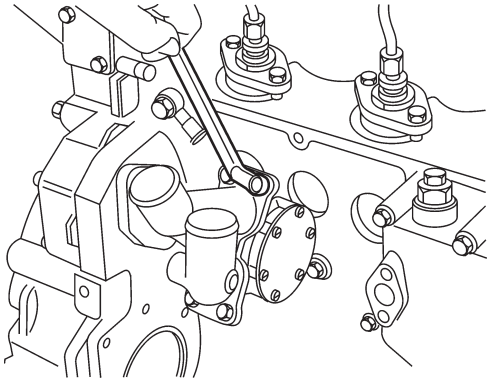


3. Remove the seawater pipe between the charge air cooler and heat exchanger.



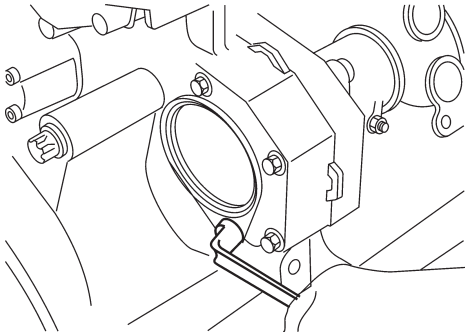
4. **D5/D7 T**

   Remove the seawater pipe between the seawater pump and heat exchanger.

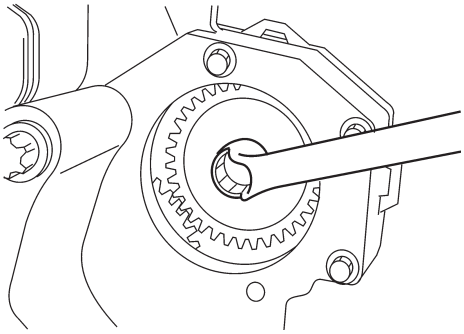


Seawater pump

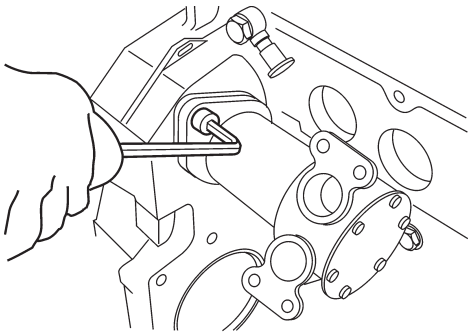
5. Remove the connection tube.



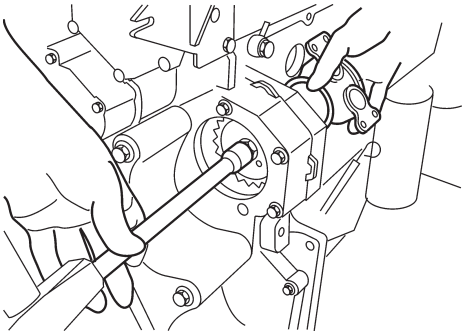
6. Remove the cover.



7. Unscrew the nut holding the drive gear to the seawater pump, until it is level with the end of the shaft.

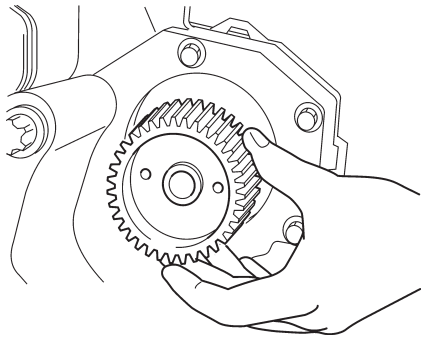


8. Remove one of the bolts holding the seawater pump. Slacken the other bolt, but leave it in place to support the pump.



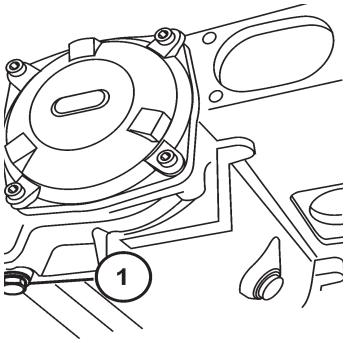
9. Release the drive gear from the shaft using a drift, and remove the pump.

Note! To remove the drive gear without damaging the shaft, the nut must be level with the end of the shaft.

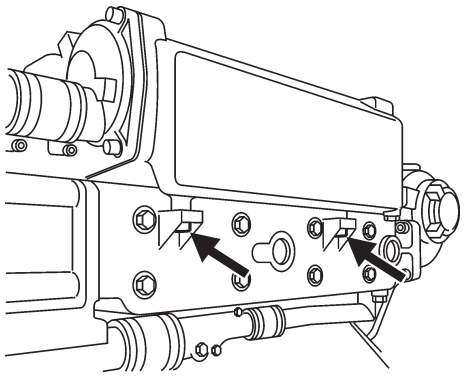


10. Remove the drive gear from the seawater pump.

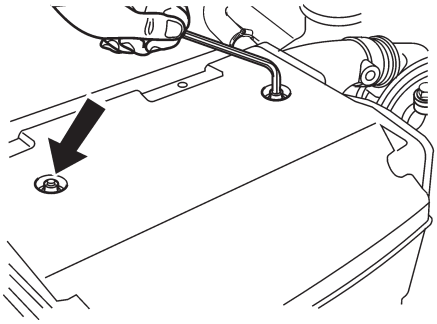
Charge air cooler (-TA)



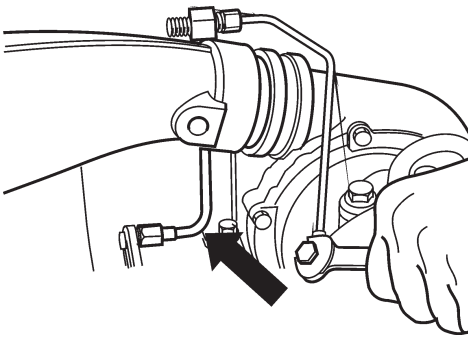
11. Remove the plug from the underside of the charge air cooler (1) and drain out the condensation.



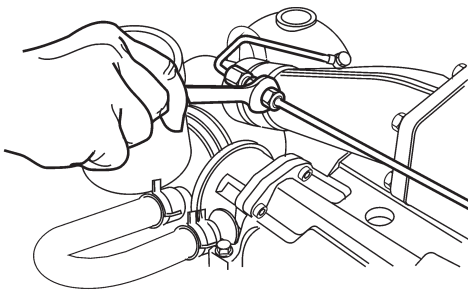
12. Remove the bolts that hold the charge air cooler to the exhaust manifold.



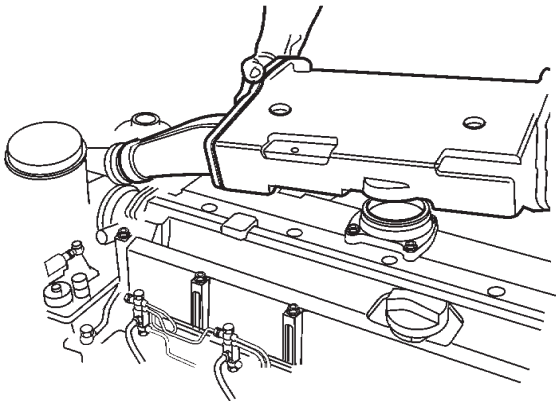
13. Remove the bolts from the top of the charge air cooler.



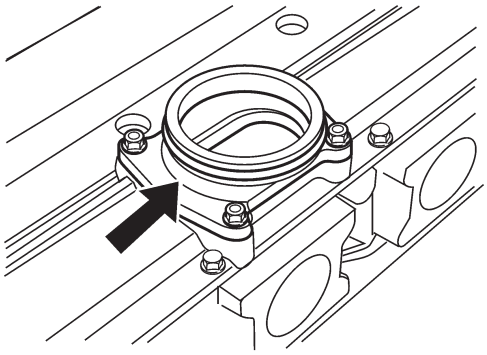
14. Remove the air bleed pipe from the turbo and cylinder head.



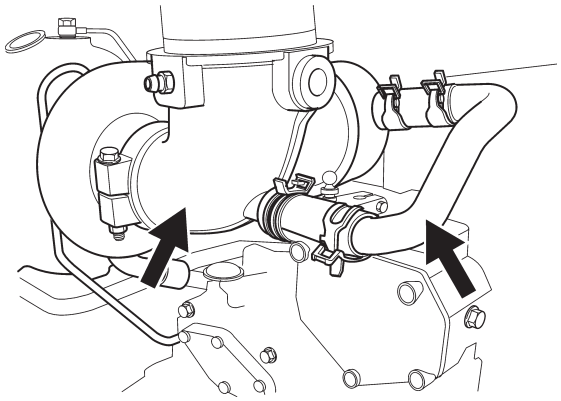
15. Remove the air bleed pipe between the T-connector and heat exchanger.



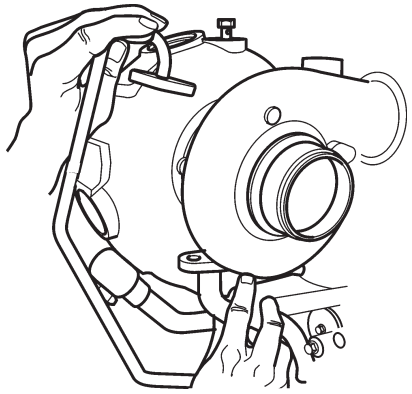
16. Lift the charge air cooler straight upwards and pull it free from the turbo connector.



17. Remove the connection ring to the inlet pipe

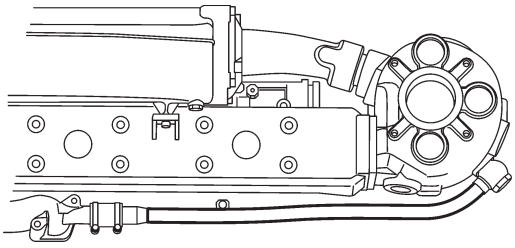


18. Remove the intake pipe from the air filter and the crankcase ventilation pipe from the oil trap.

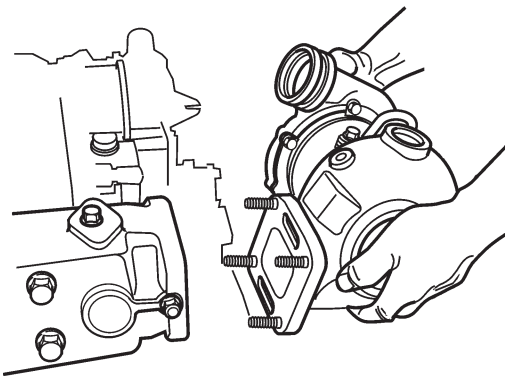


Turbo

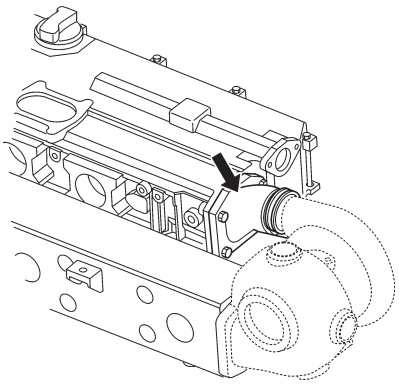
19. Remove the oil pressure pipe and return pipe from the turbo.



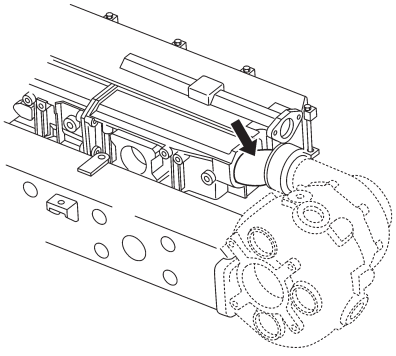
20. **D7:** Remove the coolant pipe from the turbo.



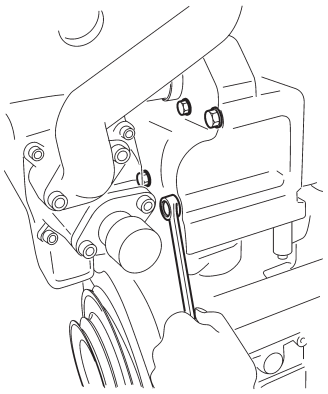
21. Remove the turbo fixing bolts and remove the turbo.



22. **D5:** Pull off the connecting pipe and remove the connection tube.

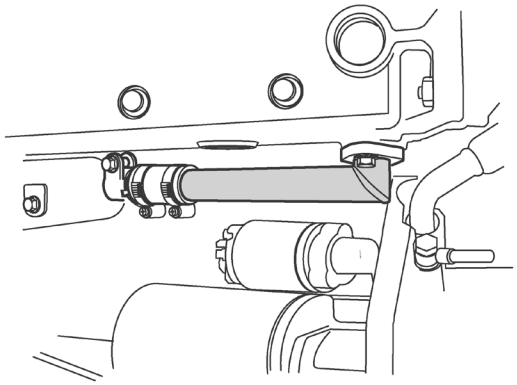


23. **D7:** Pull off the connecting pipe.

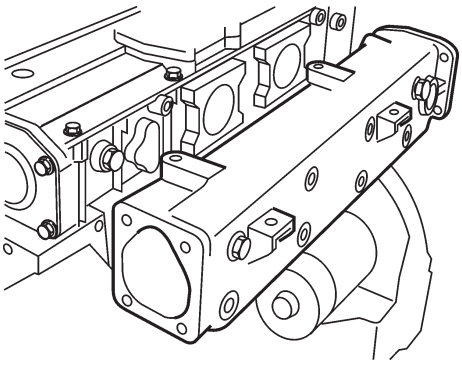


Exhaust manifold

24. Remove the four bolts that hold the thermostat housing to the exhaust manifold.

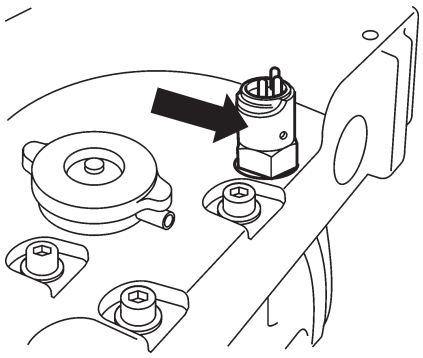


25. **D5:** Detach the coolant pipe from the exhaust manifold.



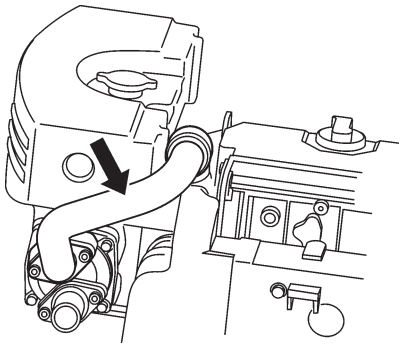
26. Remove the twelve exhaust-manifold fixing bolts and remove the manifold.

Note! The manifold is heavy.



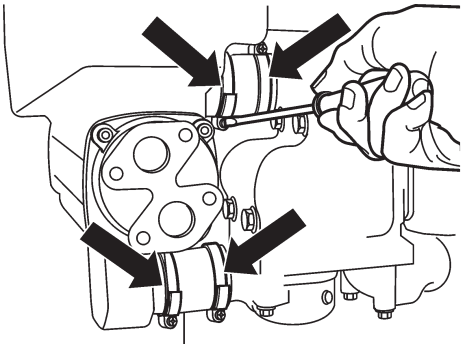
Coolant level switch

27. Remove the level switch.

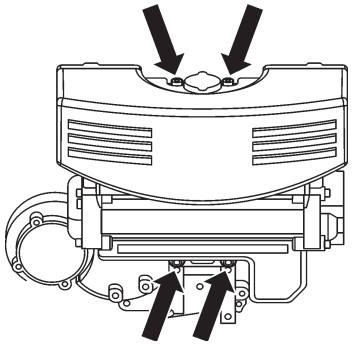


Heat exchanger

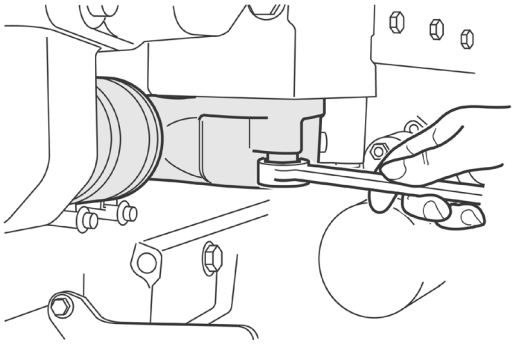
28. Remove the connection pipe going to the heat exchanger.



29. Loosen the hose clips.

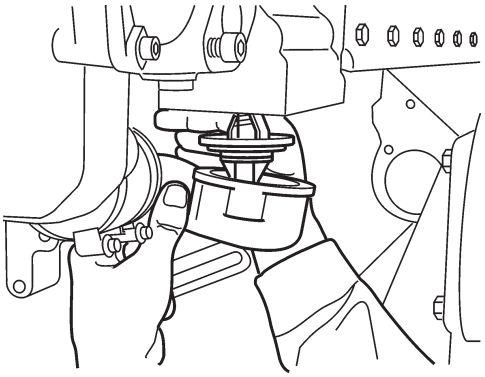


30. Remove the bolts from the top and bottom of the heat exchanger and lift it off.



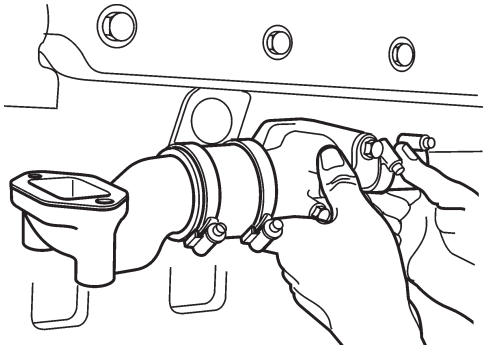
Thermostat

31. Remove the thermostat cover.



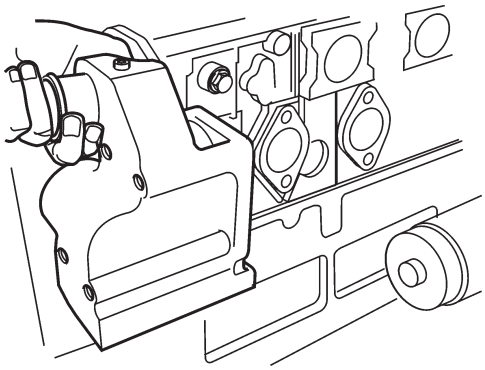
32. Take out the thermostat.

Coolant pipe

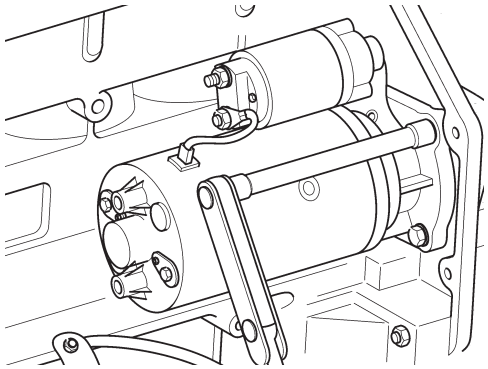


33. Remove the coolant pipe between the thermostat housing and engine body.

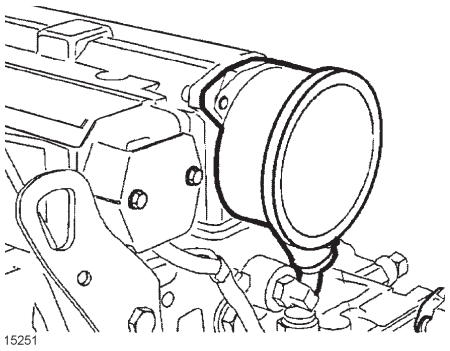
Thermostat housing



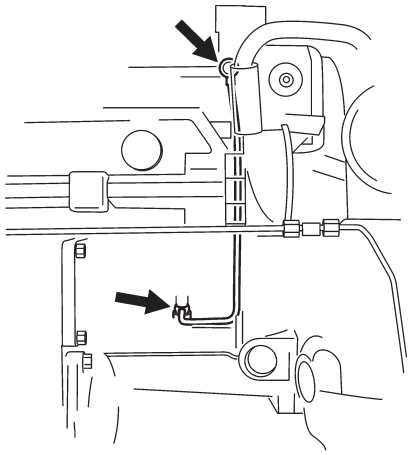
34. Pull off the thermostat housing and remove the connecting pipe.



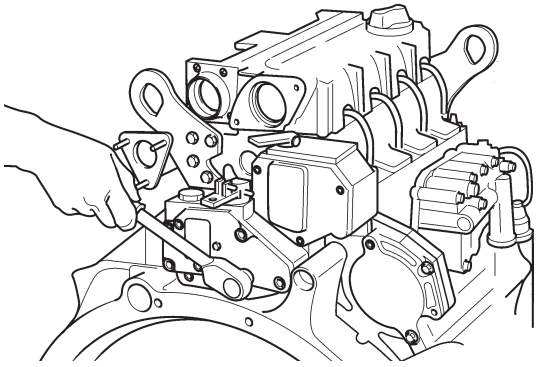
35. The starter motor can be removed at this stage, but it is easier to leave it in place and remove it along with the timing gear housing.



36. Remove the crankcase-ventilation oil trap. Collect any oil and dispose of it correctly.



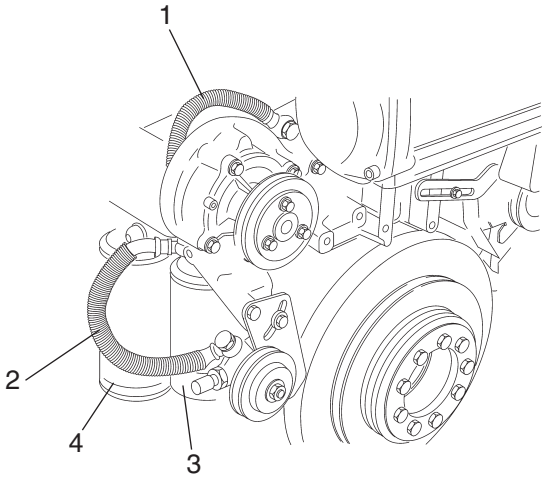
37. Remove the pipe for the smoke limiter, between the inlet pipe and regulator.



38. Remove the engine speed regulator. Use an E10 Torx tool (5 bolts).

    Drain the fuel out of the engine fuel channel by removing the banjo bolt at the front of the engine block, the bypass valve and the fuel return pipe.

    Remove the bolt at the rear of the engine block.



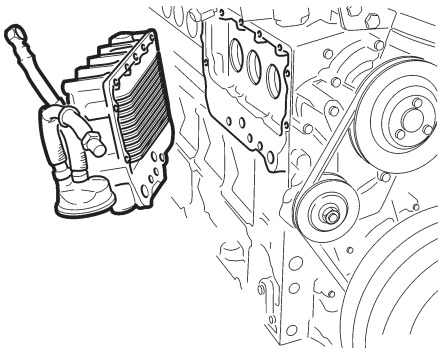
Fuel filter, oil filter and oil cooler

Note! Dispose of any remaining oil and fuel in accordance with applicable environmental legislation.

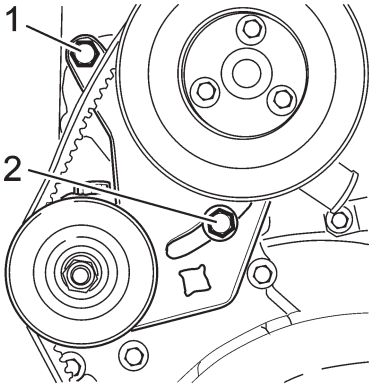
39. Disconnect the hose from the fuel pipe (1).

    Disconnect the hose from the fuel pump. (2).

    Remove the fuel filter (3) and lubricating oil filter (4) using tool 999 9179.

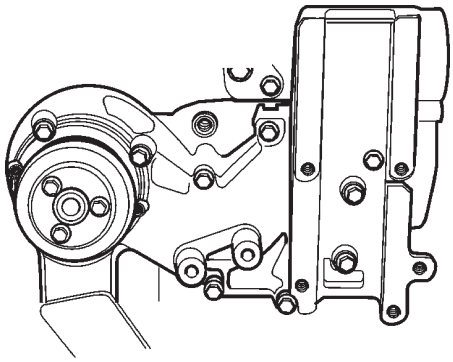


40. Remove the oil cooler (13 bolts).

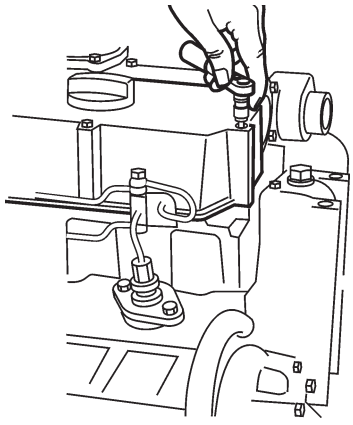


Fuel pump and coolant pump

41. Remove the drive belt for the fuel and coolant pumps by slackening the bolts (1) and (2).
    Remove the fuel pump.



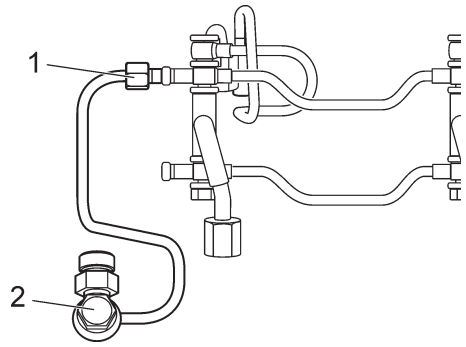
42. Remove the coolant pump together with the coolant housing (7 bolts).



Valve cover

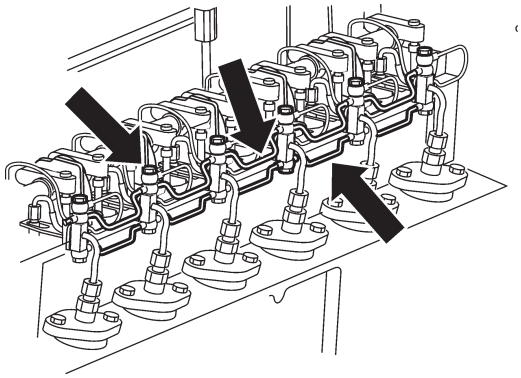
Note! Make sure that any dirt between the inlet pipe and valve cover does not get down into the engine. Clean the area thoroughly before removing the valve cover.

43. Remove the bolts and take off the cover and gasket.



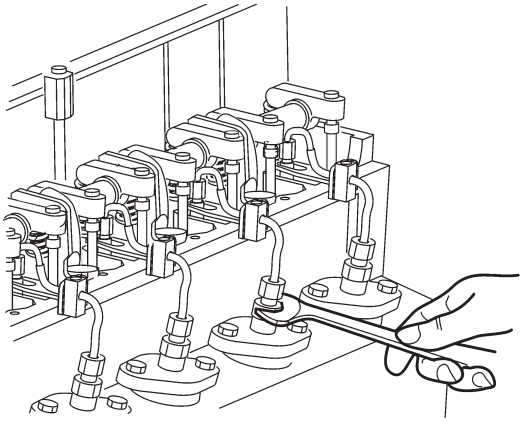
Fuel return pipes

44. Remove the fuel return pipe (1) that goes to the bypass valve (2). Remove the valve bolt.



45. Remove the banjo bolts. Remove the fuel return pipes and fuel leak-off pipes.

Note! Collect any fuel that leaks out and dispose of it in accordance with applicable environmental legislation.



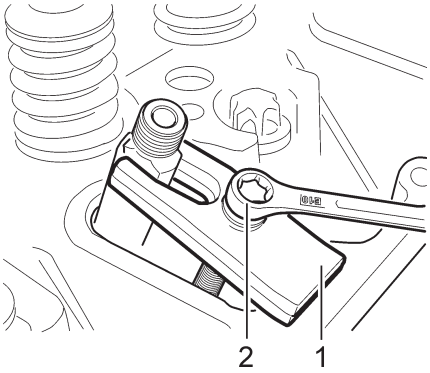
Pressure pipes

46. Unscrew the nut and remove the pressure pipe.

Note! Scrap the pipes and plug the connection holes in the injector pumps and injectors.

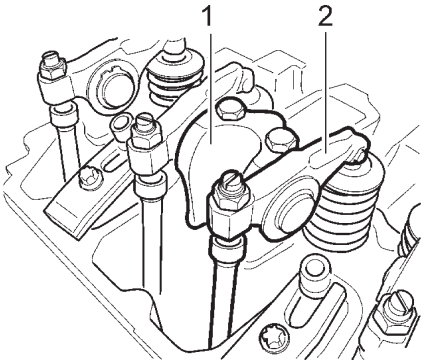
Injectors

Note! Clean the area around the injector before removing it, so that dirt and water do net get down into the injector hole.

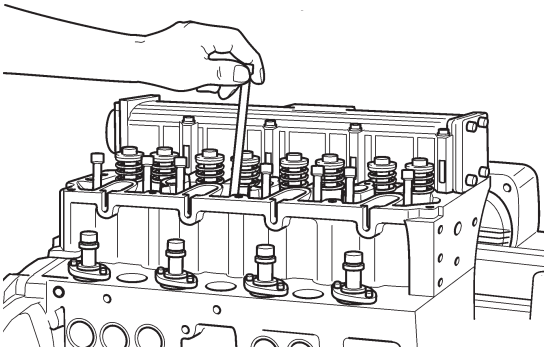


47. Remove the jet retainers (1), using an E10 Torx tool (2).

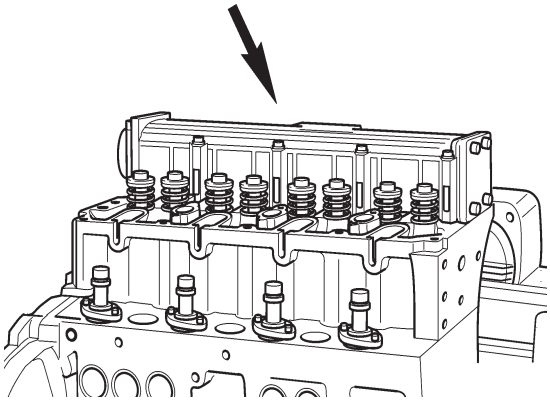
    Remove the injectors. Use puller 999 6400 with connector 999 8007 if the injector is stuck in the cylinder head.



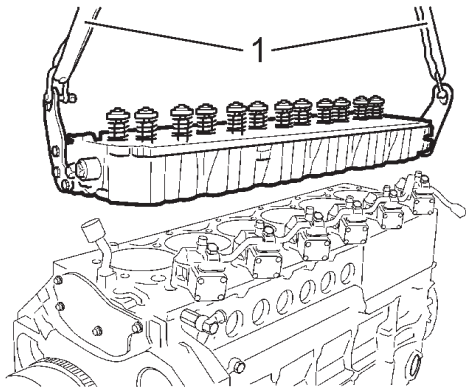
48. Number the rocker-arm bridges (1) and remove them, along with the rocker arms (2).



49. Remove the push rods and number them.



50. Remove the inlet pipe and gasket.



Cylinder head

51. Remove the cylinder head bolts using an E18 Torx tool.

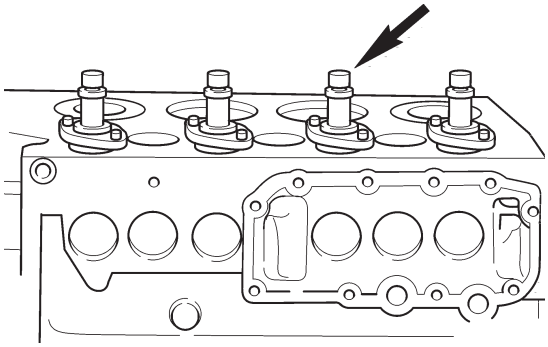
    Attach the lifting straps to the lifting eyes (1) and lift off the cylinder head.

Note! The cylinder head weighs around 80 kg.

Injector pumps

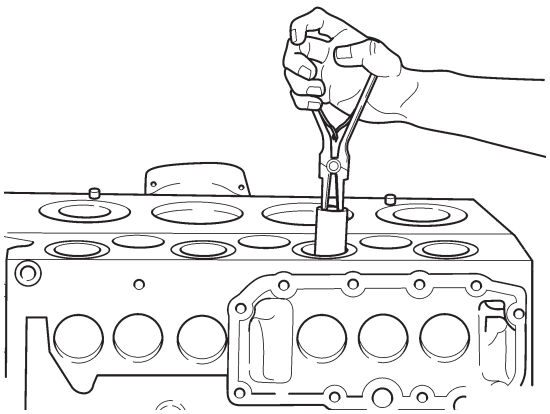
Note! When an injector is removed, the injector pump roller tappet must be on the base circle of the camshaft.

Note! Mark all of the parts as they are removed, to ensure that there are the correct number of parts when refitting.



52. Remove the injector pumps, starting with the bolt nearest the flywheel. Place them in a stand to protect them from dirt.

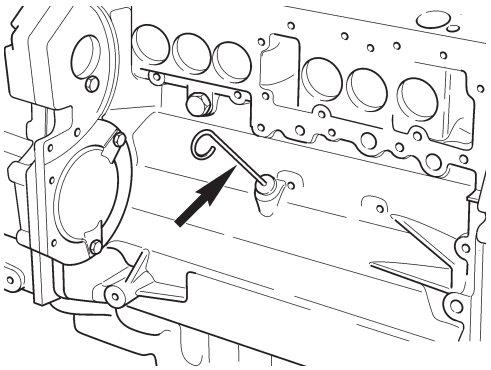
Note! Make sure you keep the shim with the pump.



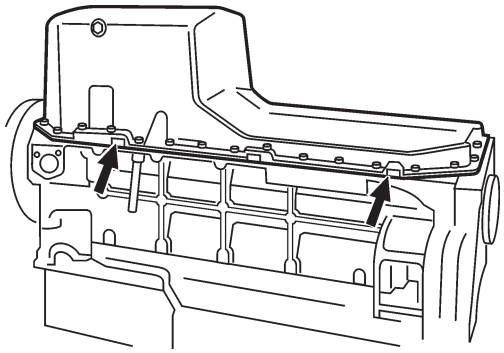
53. Lift up the roller tappets, using a pen magnet or pliers.

    Number the roller tappets, together with their shim and pump.

Note! The shims should be attached to their respective pumps.



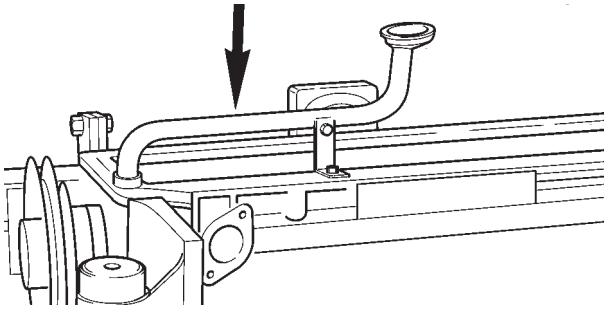
54. Pull out the oil dipstick.



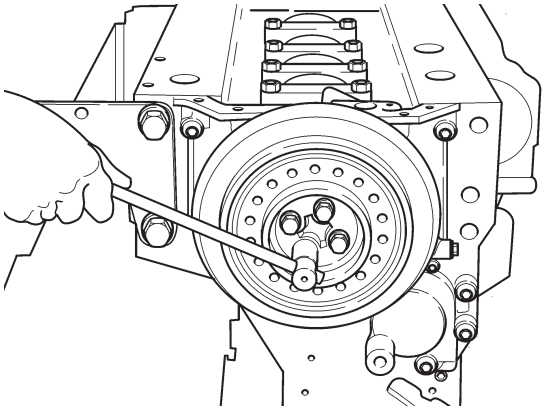
Oil sump

55. Remove the oil sump.

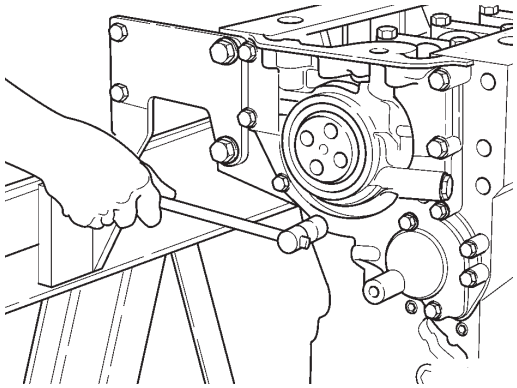
Note! The oil sump is fitted with a liquid gasket. Use a pry bar in the recesses provided.



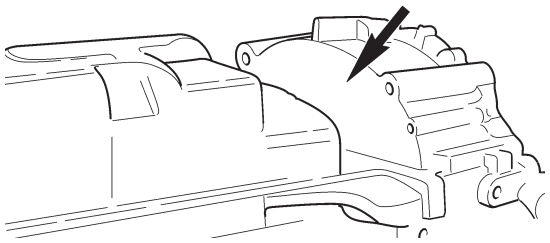
56. Remove the oil suction pipe.



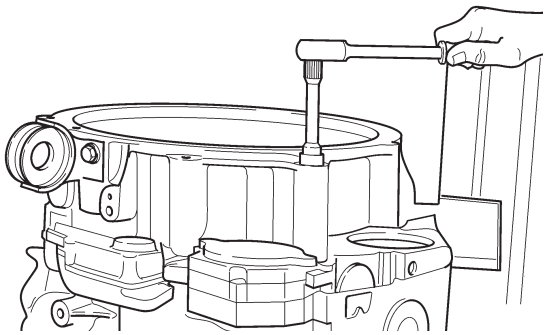
57. Remove the pulley and vibration damper. Use an E20 Torx tool.



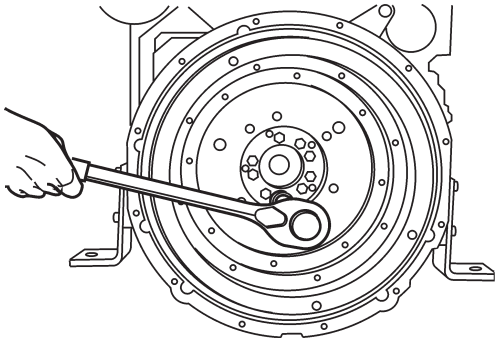
58. Remove the oil pump/front cover.



59. Remove the cover plate from the flywheel housing.



60. Remove the flywheel housing. Use E20 and E14 Torx tools.

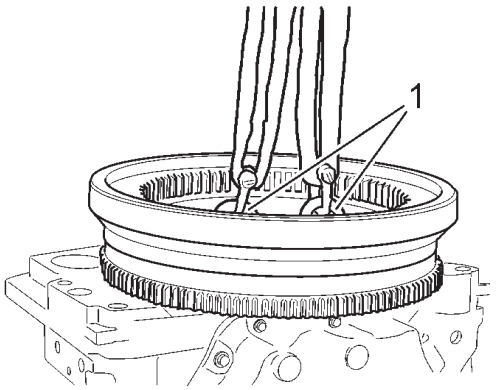


61. Turn the engine through 90°.

Remove the plastic plugs between every other bolt that locks the flywheel bolts.

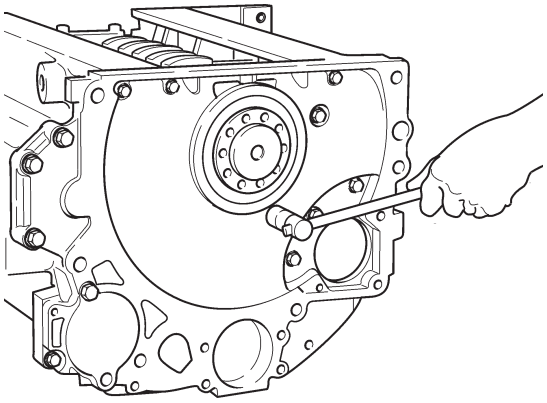
Slacken the flywheel bolts, but do not remove them.

Use turning tool 999 8681 to prevent the flywheel from turning.

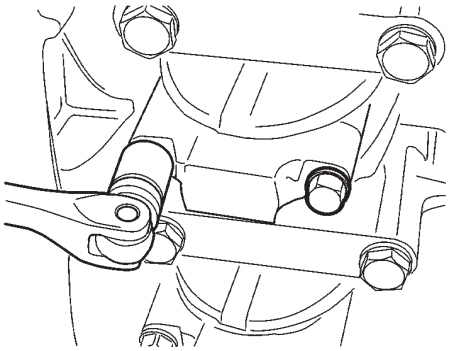


62. Attach M10 lifting eyes (1) and lifting straps.
Lift off the flywheel.

Note! The flywheel weighs 55 kg (121 lbs).

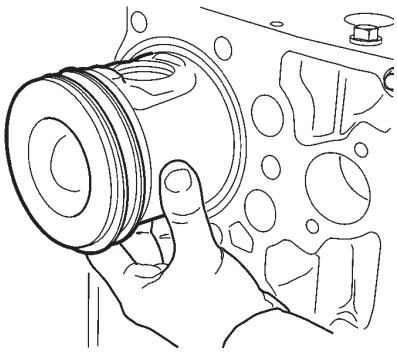


63. Remove the timing gear housing together with the starter motor, unless the starter motor was removed earlier.

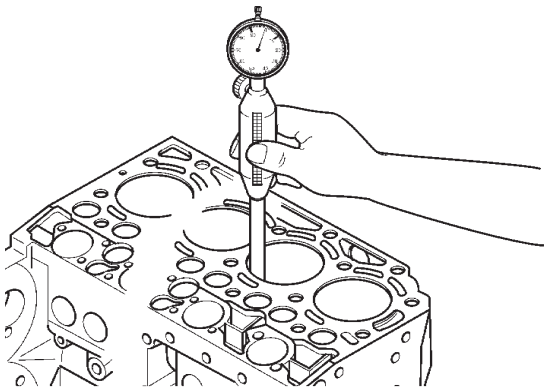


Pistons / Connecting rods

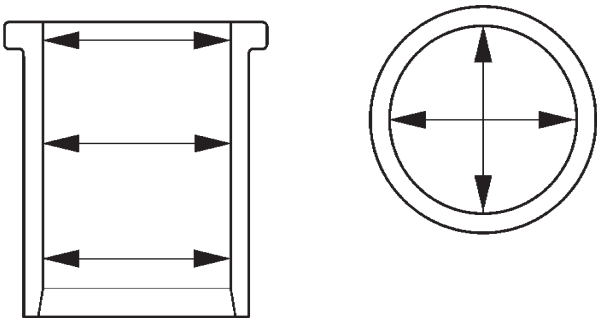
64. Turn the engine through 90°.
Mark the big-end bearing caps and remove the bolts.
Remove the bearing caps and bearing shells.
Keep the shells with their respective caps.



65. Remove the pistons, complete with connecting rod.
Measure the liners before removing the crankshaft bearings.

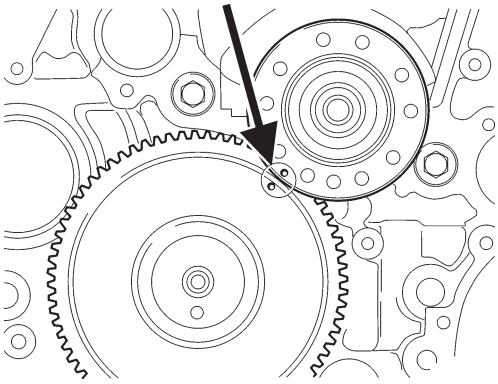


66. Turn the engine through 90°.
Set the dial gauge to .....**4.25 in** (108 mm)

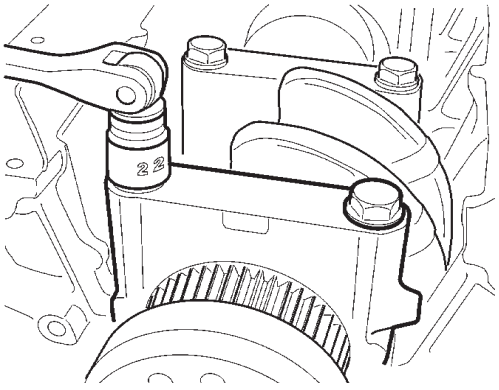


67. Check that the liner has no cracks or other damage.
Measure the inside diameter of the cylinder liner.
Take measurements at three different depths, as shown in the diagram, in both the longitudinal and transverse directions.
Diameter.....**108 mm** (4.25 in)
Wear limit .....**108.1 mm** (4.256 in)

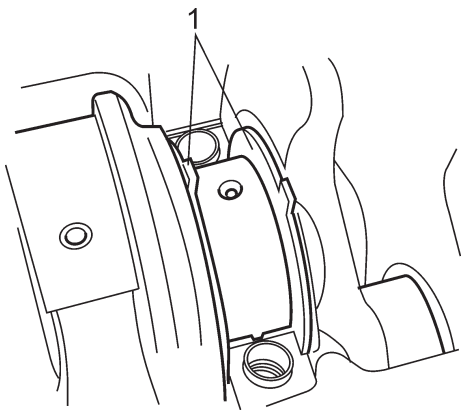
Crankshaft



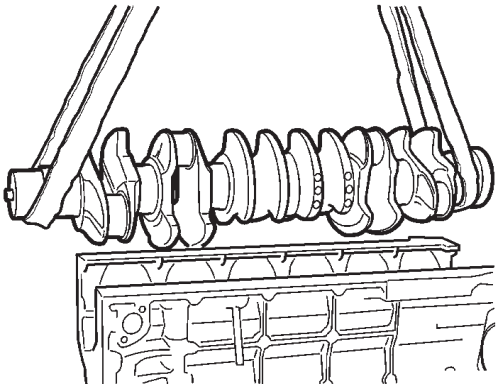
68. Turn the engine so that the crankshaft is at the top.
Check that the camshaft and crankshaft drive gears are marked.



69. Check that the crankshaft bearing caps are marked.
Remove the fixing bolts, then the bearing caps and shells.

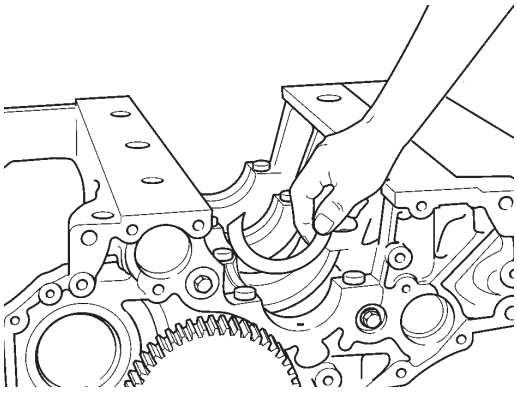


70. Remove the thrust washers (1) from the 2nd crankshaft bearing (the axial bearing) from the flywheel.



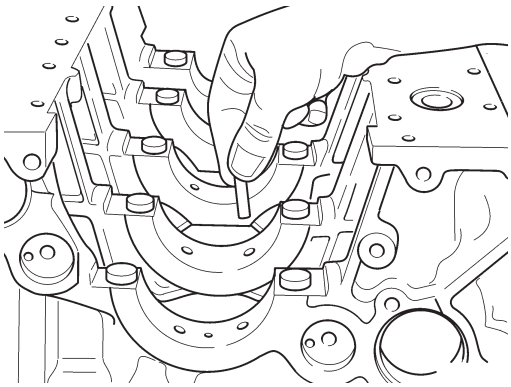
71. Lift the crankshaft out of the engine block. Use a soft lifting strap.

Note! The crankshaft weighs around 75 kg (165 lbs).

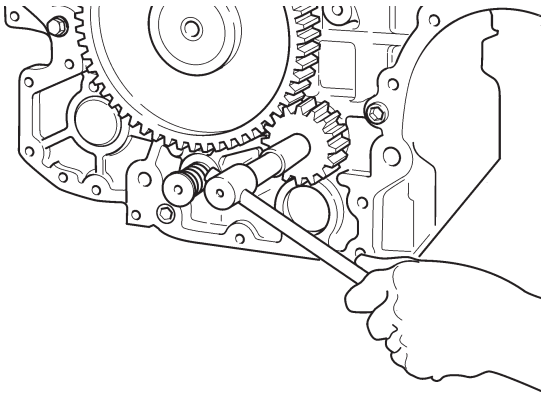


72. Remove all of the bearing shells, and the thrust washers from bearing number 2.

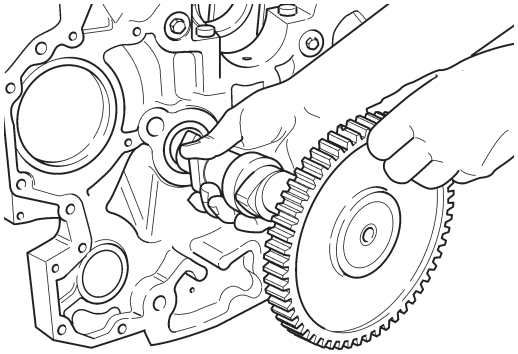
Note! Mark the bearing shells if they are to be reused.



73. Press out the piston cooling jets.

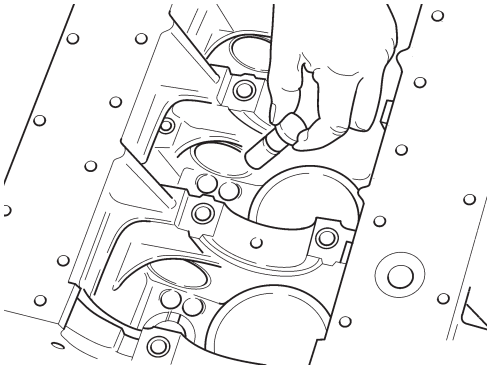


74. Remove the regulator intermediate gear.

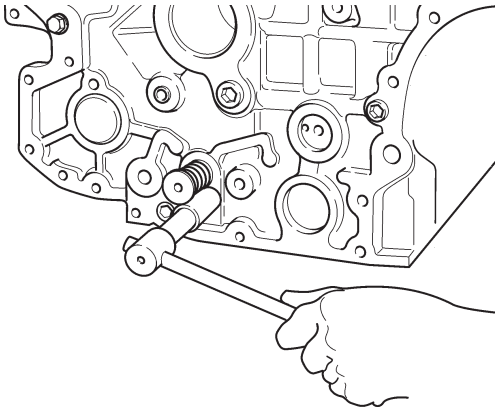


75. Pull out the camshaft.

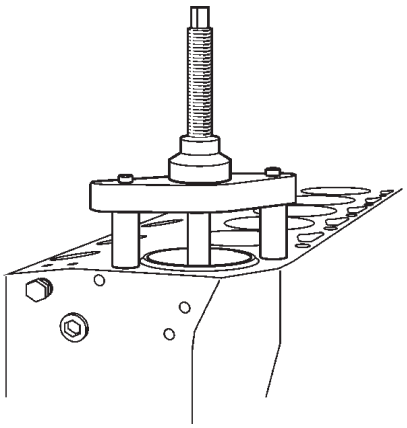
Note! Pull it out carefully, so it does not damage the bearings.



76. Remove the valve tappets and mark them if they are to be reused.



77. Remove the locking bolt and pull out the control rod.



Cylinder liners

78. Remove the cylinder liners. Use the puller plate (999 8675) together with the cylinder liner puller (999 6645) and spacers (999 6394/6395).

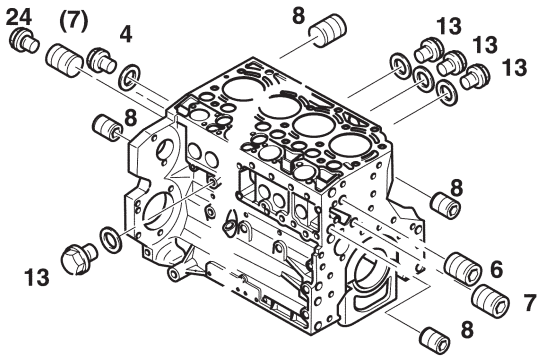
Note! Mark the liners if they are to be reused.

⚠ **WARNING!** If fluorocarbon rubber seals have been subjected to high temperatures, hydrofluoric acid can be produced, which is highly corrosive. Be extremely careful, see “Repair instructions; Safety instructions for fluorocarbon rubber.”

Assembling, complete engine

Special tools:

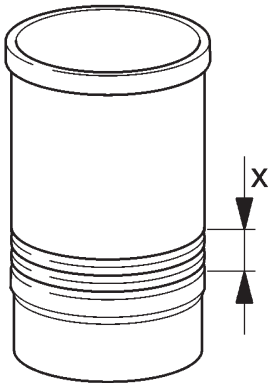
Rule depth gauge 998 5471
Dial gauge 999 9876
Measuring bar, with spacers.....999 8678
Protractor.....999 8679
Turning tool, flywheel.....999 8681
Pressure tool, locking the control rod 999 8682
Measuring tool, locking the control rod.....999 8684
Measuring tool, injector pump 999 8685
Piston ring compressor.....999 8687



1. **Note!** Tighten the screw plugs as specified below.

   Use new copper sealing washers for items 4 and 13. Use locking compound (P/N 1 161 053-2) when fitting item 24.

   Item 4 ..... **35 Nm** (26 lbf.ft.)
   Item 6 ..... **95 Nm** (70 lbf.ft.)
   Item 7 ..... **65 Nm** (48 lbf.ft.)
   Item 8 ..... **35 Nm** (26 lbf.ft.)
   Item 13 ..... **35 Nm** (26 lbf.ft.)
   Item 24 ..... **10 Nm** (7 lbf.ft.)



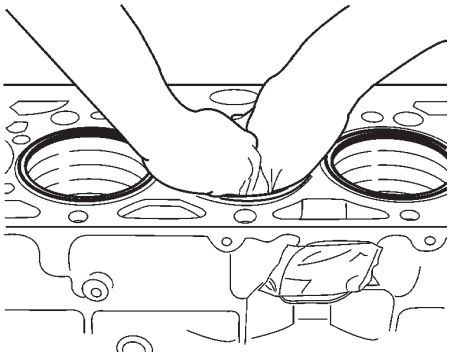
Cylinder liners, fitting

2. Make sure that the cylinder liner fitting area and sealing surfaces are completely clean.

3. Oil the area of the cylinder liner marked X in the diagram.

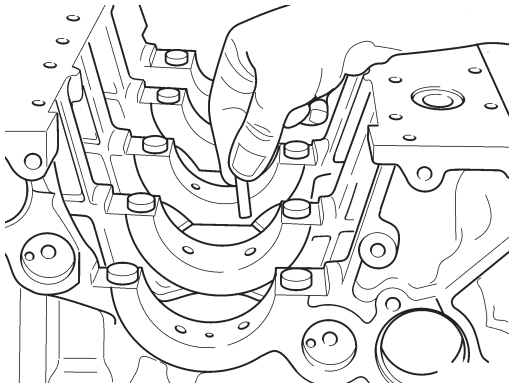
   Fit new O-rings.

Note! Check that cylinder liner is correctly located in the engine block. Measure the height of the cylinder liner above the engine block; see “Technical data.”



⚠ **IMPORTANT:** Do not use sealant. The cylinder liner should be dry and thoroughly clean.

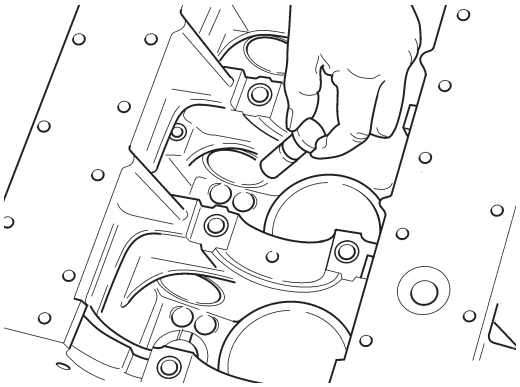
4. Insert the cylinder liner in the correct position in the engine block. Push it down as far as it will go.



Piston cooling jets

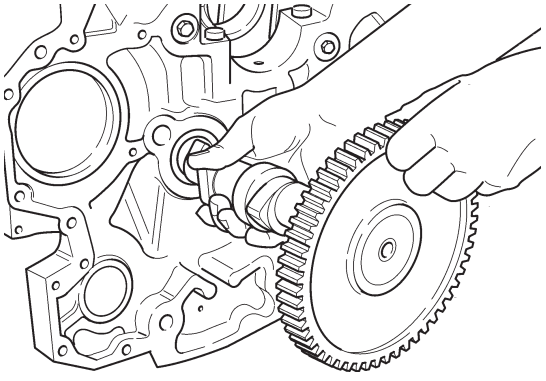
5. Check that the oil channels are not blocked.

   Fit the piston cooling jets in the correct position in the engine block. Press them in as far as they will go.



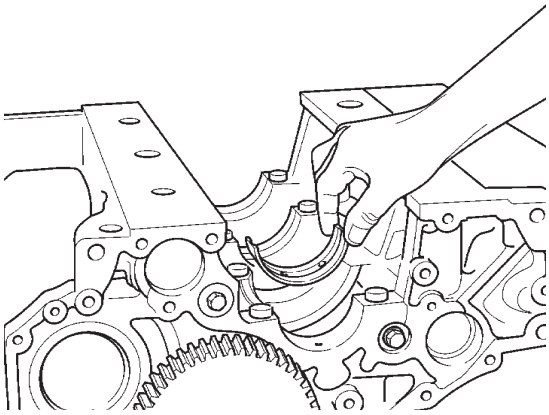
Cams / Camshaft

6. Insert the valve tappets, lightly oiled.

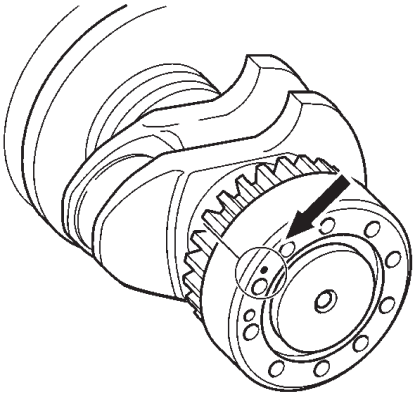


7. Insert the camshaft.

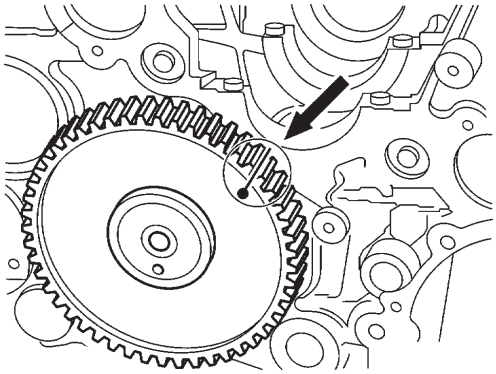
Note! Insert it carefully, so it does not damage the bearings.



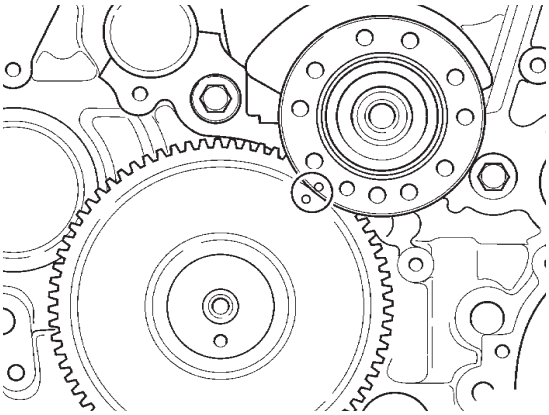
8. Fit the bearing shells into the engine block.



9. If necessary, mark the crankshaft to make fitting easier.

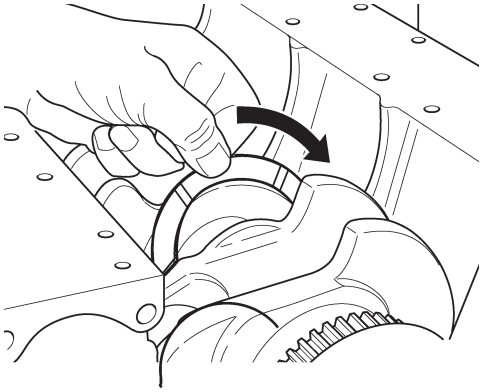


10. Mark the camshaft, If necessary, and put it in the correct position.



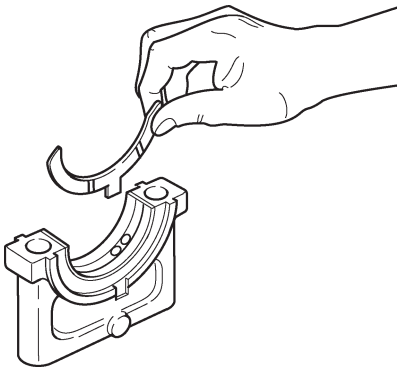
Crankshaft

11. Insert the crankshaft. The marks must be in line. Use a ruler to check that the marks are aligned between the centers of the crankshaft and camshaft.



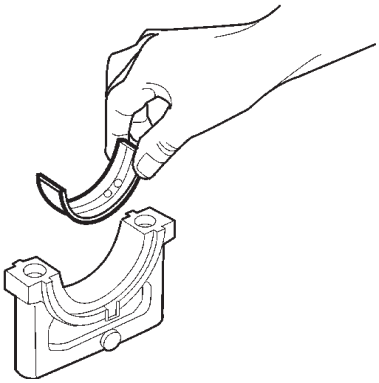
12. Insert the axial bearing halves that do not have a lug.

Note! The bearing face of the thrust washers must be facing the crankshaft.



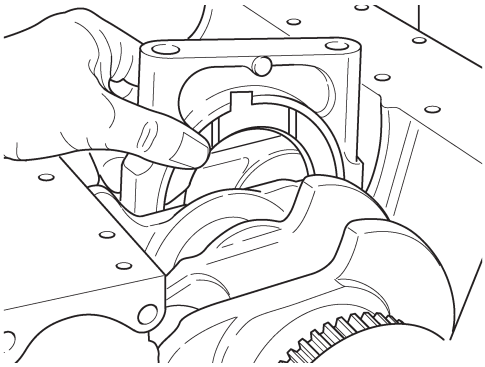
13. Secure the thrust washer halves that have a lug to the thrust bearing caps, by putting a little grease on the lug.

Note! The bearing face of the thrust washers must be facing the crankshaft.



14. Fit the bearing shells into the bearing caps and oil them.

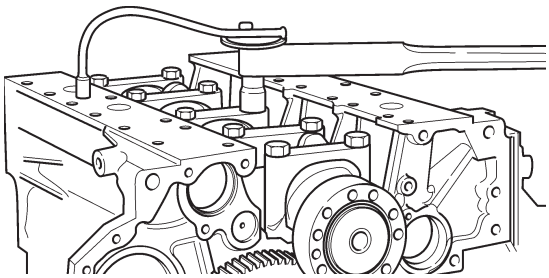
Note! Maintain absolute cleanliness.



15. Oil the crankshaft bearing caps and fit them in accordance with their markings.

Note! The crankshaft bearing caps are numbered 1-5 or 1-7, depending on the engine model.
Bearing cap 1 is nearest the flywheel end.

Note! Mare sure the thrust washers in the cap are correctly aligned with the washers in the block.



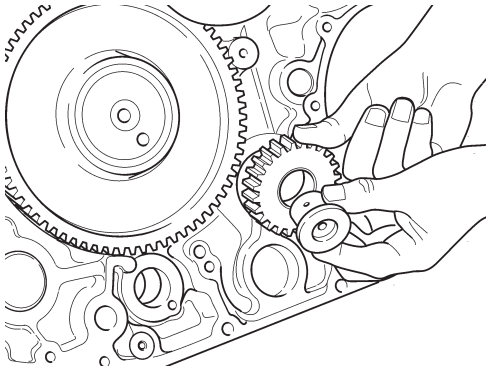
16. Tighten the crankshaft bearing cap bolts as follows:

    Initial tightening torque ..... **50 Nm** (37 lbf.ft.)

    1st tightening angle .....**60°**

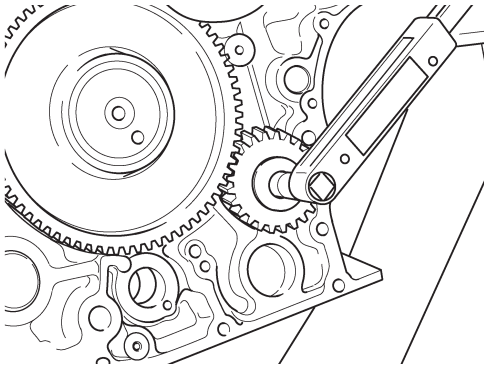
    2nd tightening angle.....**60°**

Note! The bolts should be used only three times (if you know how many times they have been used). Make a center punch mark on the bolts every time they are refitted.

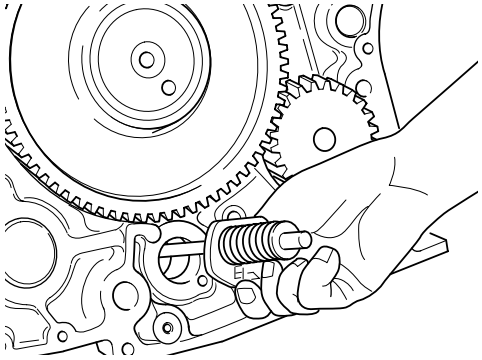


Regulator intermediate gear

17. Fit the regulator intermediate gear, complete with bearing journal.

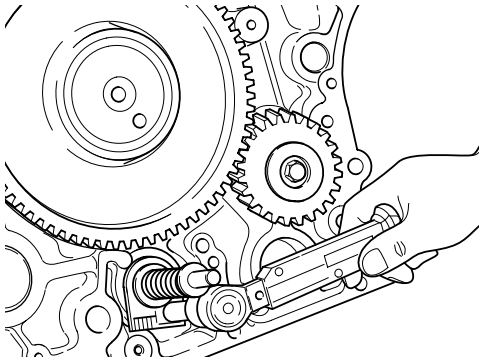


18. Apply locking compound (P/N 1161053-2) to the bolts and tighten them to.. **21 Nm** (15 lbf.ft.)

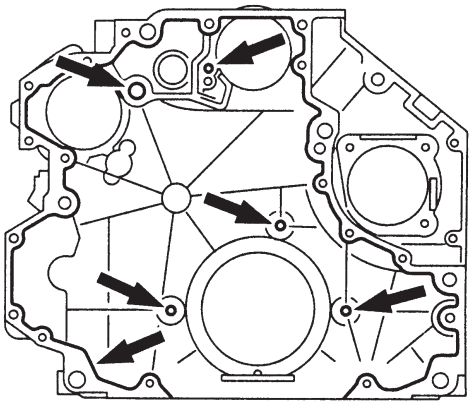


Control rod

19. Fit the control rod, complete with guide sleeve.



20. Apply locking compound (P/N 1161053-2) to the bolt and tighten it to..... **10 Nm** (7 lbf.ft.)

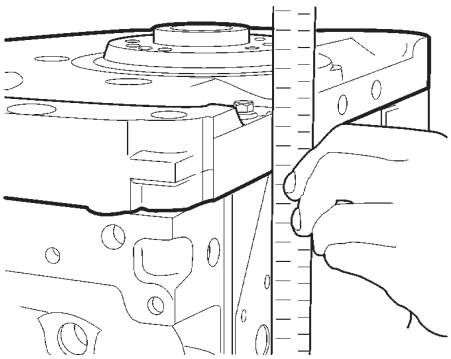


Timing gear housing

Note! The timing gear housing and starter motor can be fitted together.

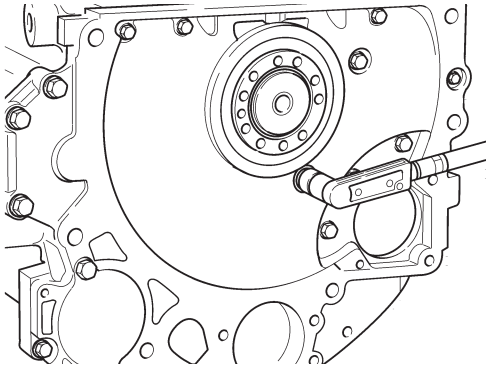
21. Apply silicone (P/N 1161231-4) to the sealing surfaces of the timing gear housing, as shown in the diagram.

    Lightly oil the crankshaft seal.

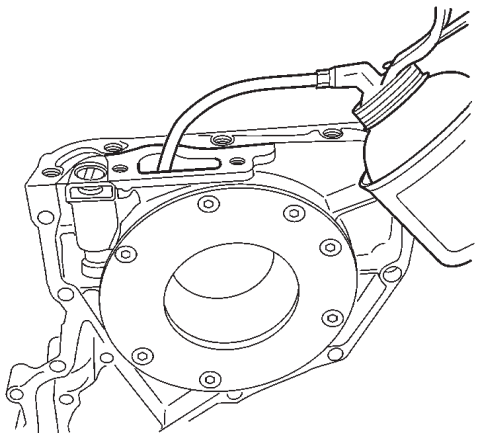


22. Fit the timing gear housing, without tightening the bolts.

⚠ **IMPORTANT:** Align the timing gear housing with the sealing surface of the oil sump.

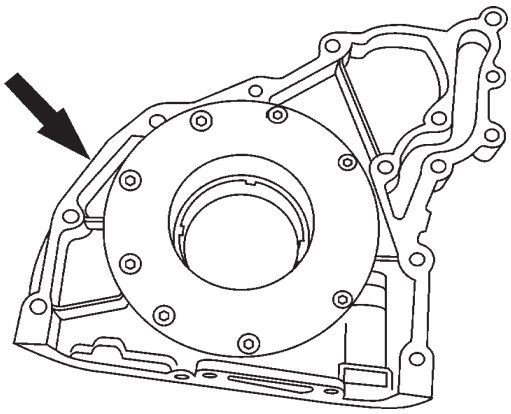


23. Tighten the bolts to.....**21 Nm** (15 lbf.ft.)

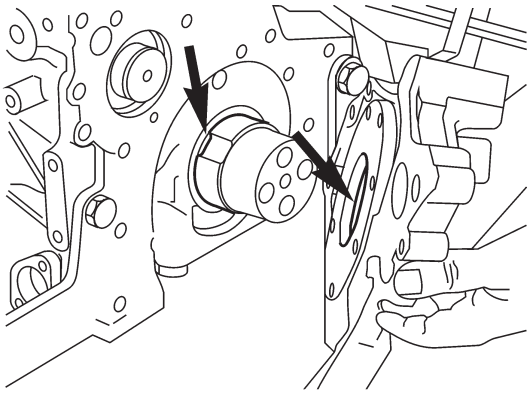


Front cover with oil pump

24. Lightly oil the oil pump rotor.

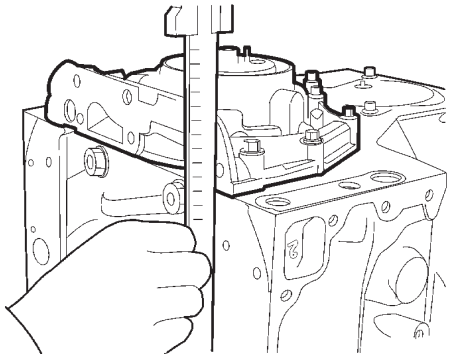


25. Attach the gasket to the oil pump/cover with a little grease.



26. Put the oil pump rotor onto the crankshaft.

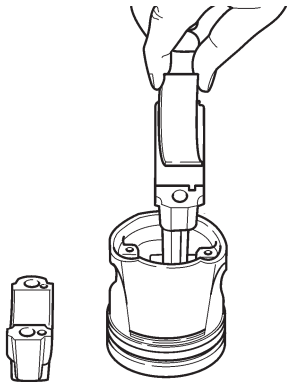
Note! It fits in only one position.



27. Fit the oil pump/cover, without tightening the bolts.

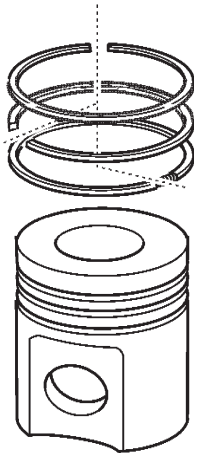
⚠ **IMPORTANT:** Line up the top of the cover with the sealing surface of the oil sump.

28. Tighten to .....**21 Nm** (15 lbf.ft.)

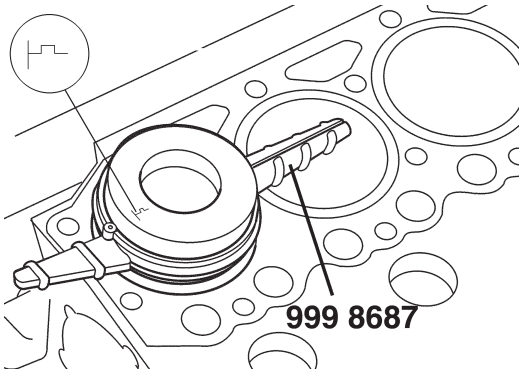


Pistons, complete with connecting rods

29. Fit the bearing shells into the connecting rod and bearing cap, and then oil them.



30. Offset the piston ring gaps by **120**°.

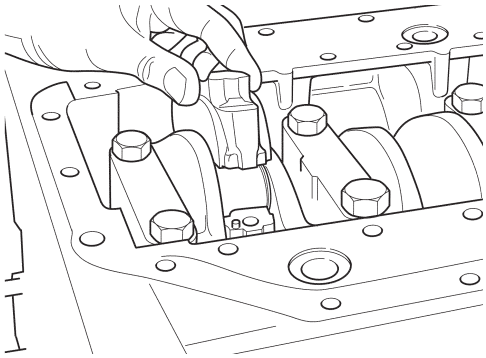


31. Use piston ring compressor 999 8687 and push the piston, complete with connecting rod, into the engine block.

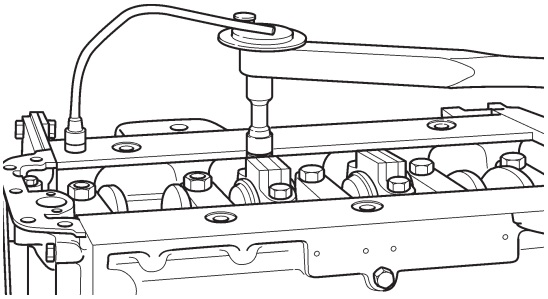
⚠ **IMPORTANT:** Be careful, the scraper rings are delicate and easily damaged.

Do not open the piston ring compressor after it has been fitted to the piston, otherwise the piston rings could be damaged. Always push the piston out before opening the tool.

Note! The Flywheel symbol that is punched into the top of the piston, and the locating pin on the connecting rod, should be facing the flywheel.



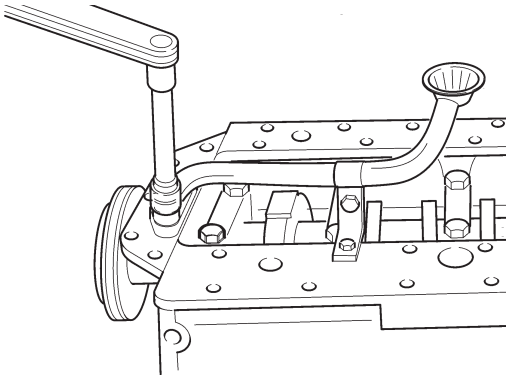
32. Lightly oil the big-end bearing journal.
Push the connecting rod onto the journal.
Fit the big-end bearing cap in accordance with the marking.



33. Tighten the new big-end bearing bolts as follows:
Initial tightening torque ..... **30 Nm** (22,14 lbf.ft.)
1st tightening angle .....**60°**
2nd tightening angle.....**60°**

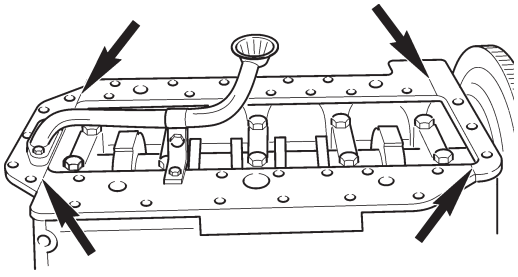
Note! Use new big-end bearing bolts every time the cap is refitted.

34. Turn the crankshaft to check that the pistons and bearings are running freely.



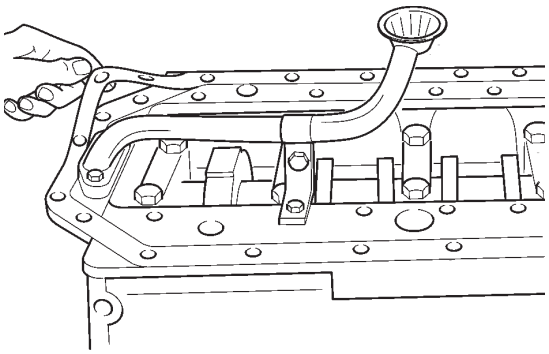
Oil suction pipe / Oil sump

35. Fit the oil suction pipe to the oil pump housing, using a new gasket.
Tighten to .....**21 Nm** (15 lbf.ft.)



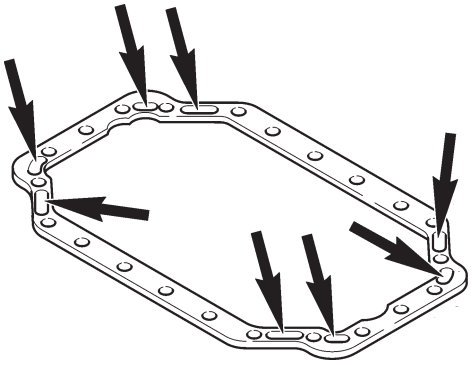
36. Cut off the protruding part of the gasket.
Fill the joints in the sealing surface of the oil sump with silicone (P/N 1161231).

Note! Do not pull off dried silicone that is sticking out.

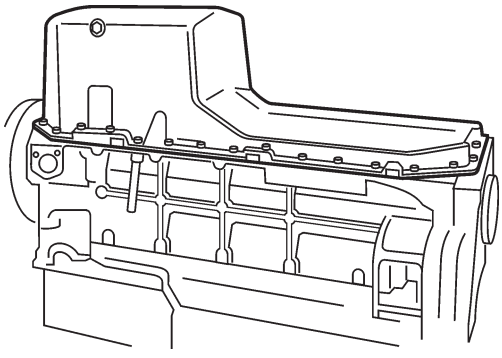


37. Put the new gasket onto the engine block.

Note! The gasket is in four pieces.

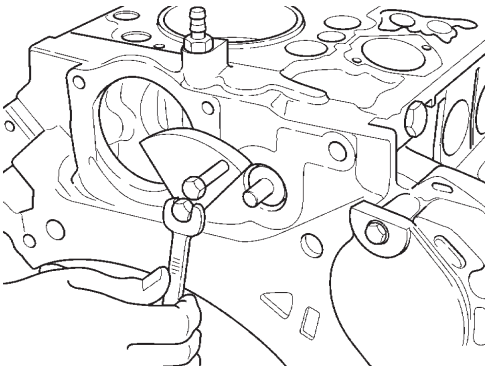


38. Fill the indentations in the gasket with silicone (P/N 1161231).



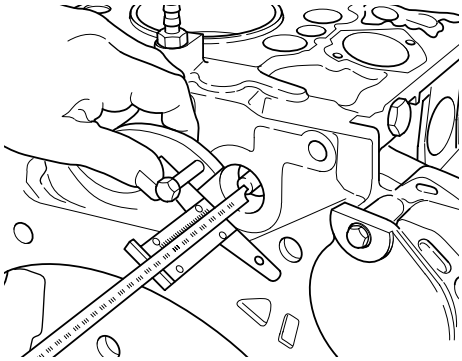
39. Fit the oil sump.
Tighten to .....**21 Nm** (15 lbf.ft.)

Control arm, measuring

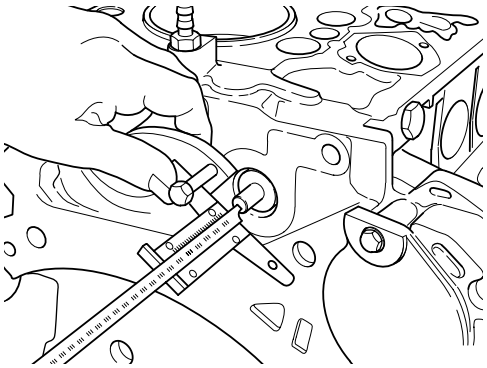


Note! The injector pumps are **not** fitted.

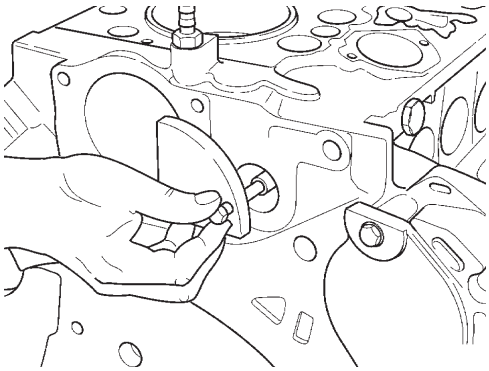
40. Turn the engine through 180°.
    Attach measuring tool 999 8684 to the front of the engine.



41. Measure from the measuring tool to the stop position of the control rod, see diagram.
    Use rule depth gauge 998 5471.



42. Measure from the measuring tool to the start position of the control rod. Use rule depth gauge 998 5471.
    The difference between the start and stop positions is the stroke of the control rod.
    Permitted range = 17.0 mm – 17.5 mm
    (**0.669 – 0.689 in**)
    Example:
    Stop position = 30.7 mm
    Start position = 13.4 mm
    30.7 - 13.4 = 17.3
    The stroke of the control rod = 17.3 mm



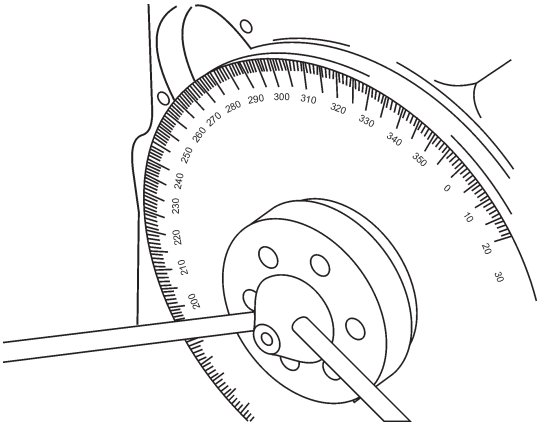
43. Turn the measuring tool as shown in the diagram.
    Push the control rod to the stop position by hand, using the stop screw.

Note! The stop screw should only be pulled gently by hand.

Determining the injection angle and shim thickness, and fitting injection pumps

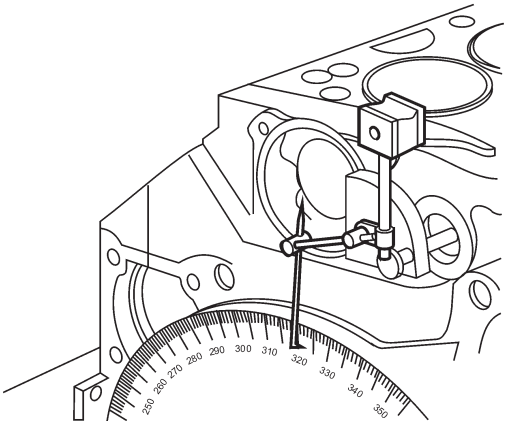
The injection angle and type of camshaft are shown on the engine identification plate. The procedure described below is necessary only after changing the engine block, camshaft or a roller tappet.
For instructions on refitting existing pumps, see "Injector pumps, fitting" in this chapter.

If only the injector pump is being changed, see the section entitled "Injector pumps, changing."

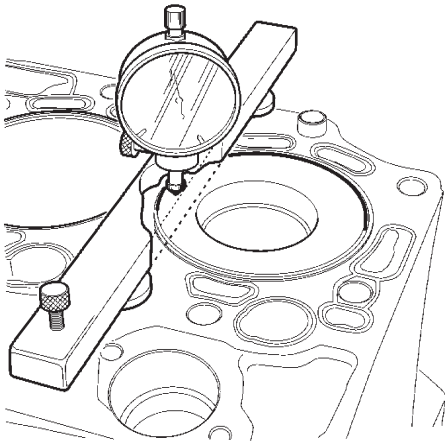


44. Put the protractor (999 8679) onto the flywheel flange on the crankshaft.

Note! Tighten the bolts sufficiently to ensure that there is no play.



45. Attach a pointer, using the magnetic stand.



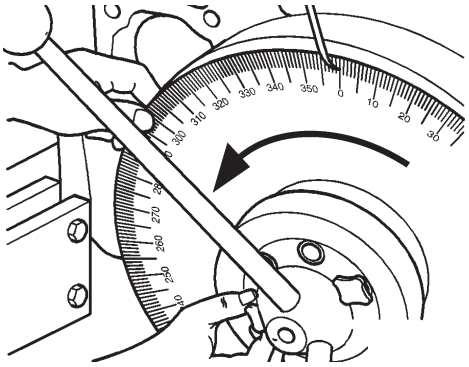
46. Position the measuring bar (999 8678) with spacers on the engine block, over the piston for the injector pump for which the injection angle is to be determined.

Turn the crankshaft in the running direction until the pointer of the dial gauge has reached its turning point, TDC.

Zero the dial gauge.

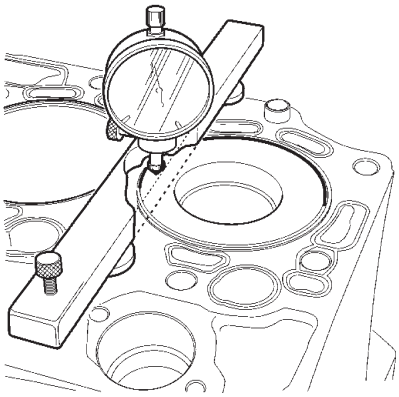
⚠ **IMPORTANT:** The dial gauge should be positioned on the centerline of the piston pins.

At TDC, the piston stops at approximately 1°. To find the actual TDC, the method described below must be used.



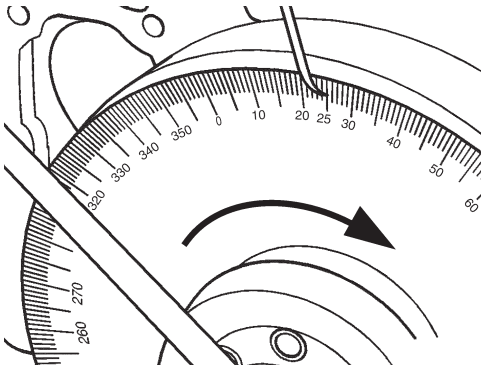
47. Turn the crankshaft approximately 350° in the running direction, until **8 mm** (0.31 in) before TDC (the turning point of the dial gauge).

    Zero the dial gauge.



48. Turn the crankshaft approximately 350° in the opposite direction, until **8 mm** (0.31 in) before TDC (the turning point of the dial gauge).

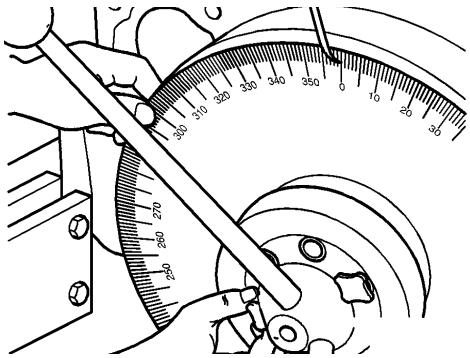
    Read off the value.
    Example: 50°



49. Turn the crankshaft to half of the value obtained.

    Example: (0° + 50°)/2 = 25° = ACTUAL value.

    This corresponds to TDC, and should be the same as TDC on the dial gauge.



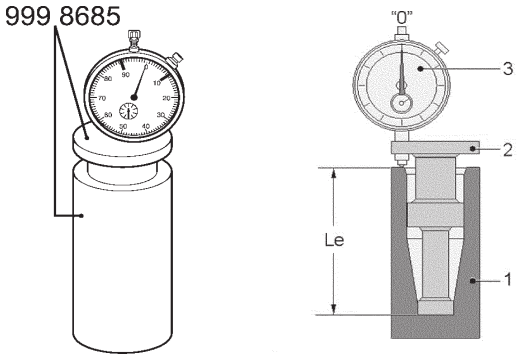
50. Zero the dial gauge.

Note! Leave the protractor in place for the next stage, continuing to determine the injection angle.

Determining the injection angle

Measuring the deviation from tolerance of the engine block

(We suggest making copies of tables 1, 2 and 3, and calculations 2 and 3 in "Technical data.")



51. Put the dial gauge (998 9876) on measuring tool 999 8685 and set a preload of **5 mm** (0.2 in).

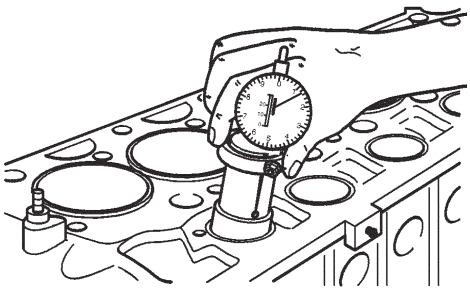
    Zero the dial gauge.

    The set value (Le) is **150 mm** (5.9 in) (see diagram).

    1. Gauge, 999 8685

    2. Measuring tool, 999 8685

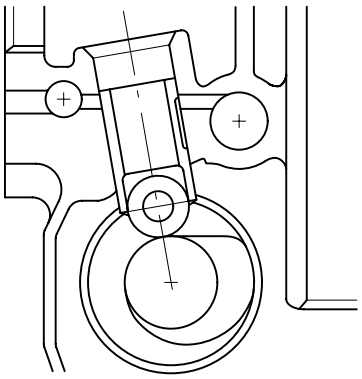
    3. Dial gauge, 998 9876



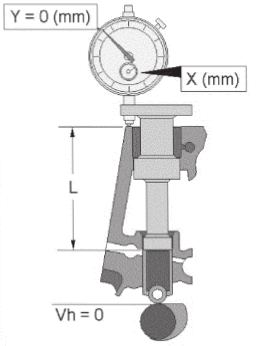
52. Place the roller tappet (for the injector pump that is being set) on the base circle of the camshaft.

    Carefully put the measuring tool into the injector pump hole.

Note! Make sure the locating pin on the roller tappet is in the groove in the block.



53. Turn the crankshaft until you are certain that the roller tappet, with the measuring tool, is resting on the base circle.

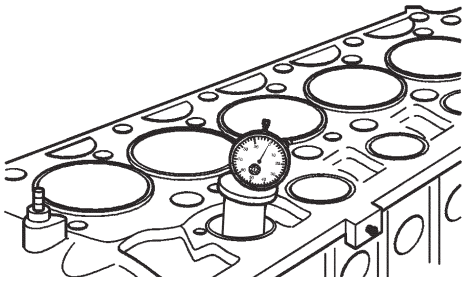


54. Measure distance "**L**" (Le + dial gauge X in/mm).

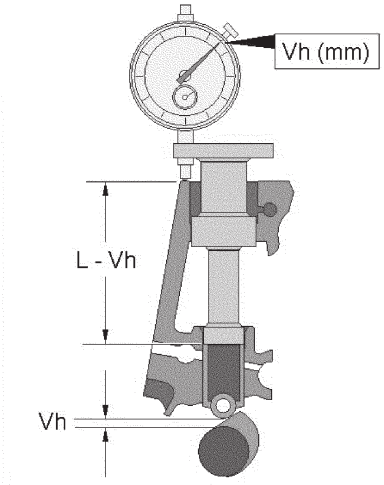
    Enter the value in "Calculation 2.2" and "Calculation 3.2" in Technical data.

    Example:
    Measuring tool, Le: 150 mm
    Dial gauge (X mm): 2.18 mm
    Example: **L** = 150 + 2.18 = **152.18 mm**

Measuring the deviation from tolerance of the roller tappets and camshaft



55. Zero the dial gauge.



56. Read off the injection angle, **Fb_{nom}**, from the engine plate.

    Read off "camshaft lift," **Vh_{nom}**, from Table 1 in Technical data.

    Enter the two values in calculations 2.1 and 3.1 in Technical data.

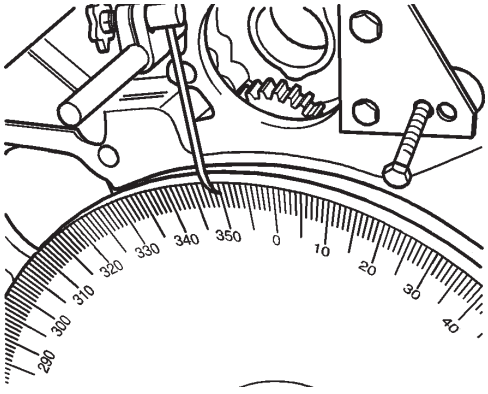
    Example:
    Fb_{nom} = injection angle = 6.0°
    Camshaft = A
    Vh_{nom} = forwards stroke = 6.11

57. Turn the crankshaft in the running direction until the dial gauge reads (-) Vh_{nom}.

    Example:
    The dial gauge was zeroed at 7 mm preload.

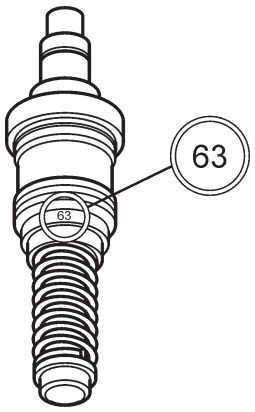
    7 - 6.11 = 0.89

    Turn the camshaft. When the dial gauge reads 0.89, you have reached Vh_{nom}.



58. You can now read off (from the protractor) when the injector valve should have opened.
    Example: 360 - 354.5 = 5.5

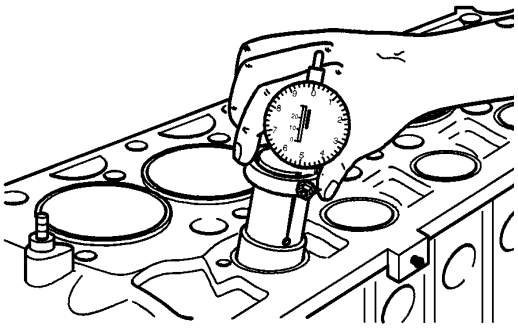
    Enter the value in calculations 2.1 and 3.1 in Technical data.
    Example: **Fb_{act}** = 5.5°



59. Read the manufacturing tolerance, “**A**”, for the injector pump, which is written on the pump.

    Enter the value in “Calculation 2.1” in Technical data.

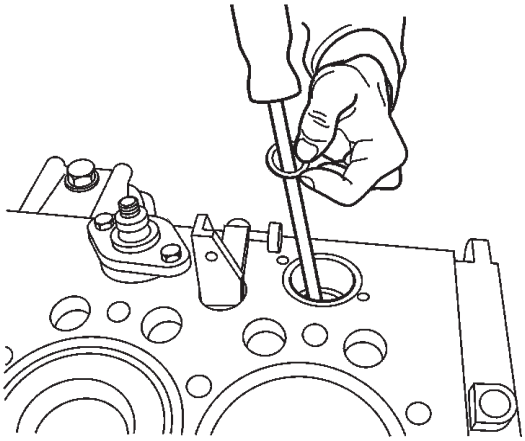
    Example: A/100 = 0.63 mm



60. Remove the measuring tool and dial gauge.

    Complete the calculations for determining shim thickness in “Calculation 2.2” in Technical data.

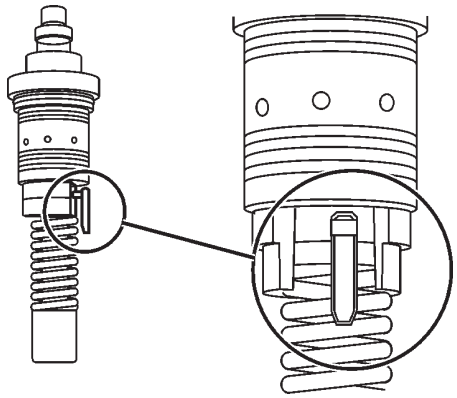
Note! Do not forget to change the EP code on the engine plate.



61. Let the shim slide down a screwdriver and into place over the roller tappet.

Note! Repeat the measuring procedure in points 51 – 61 for every injector pump.

Injector pumps, fitting

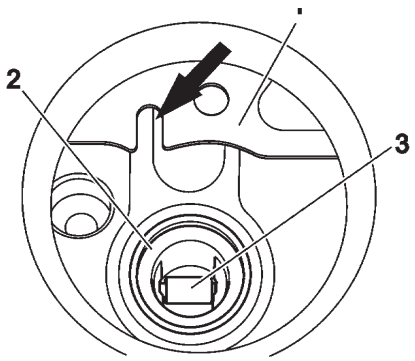


62. When refitting pumps, insert the existing roller tappets with their correct shims.

63. ⚠ **IMPORTANT:** Turn the injector pump linkage to the center position.

    Check that the injector pump cam for the cylinder in question is on the base circle. Turn the engine using tool 999 8681 or the protractor 999 8679.

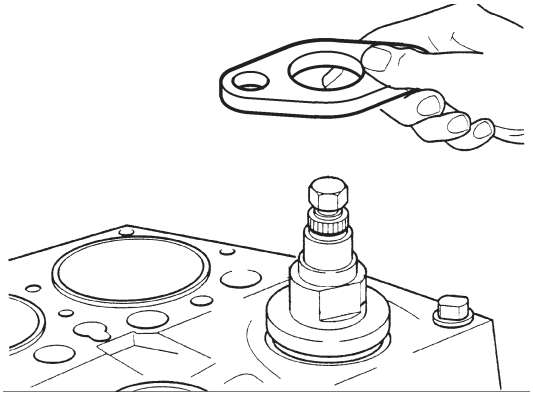
Note! The control rod must be locked in the stop position with tool 999 8682 or 999 8684



64. Lightly oil (P/N 1141699) the injector pump O-rings and carefully push in the injector pump.

⚠ **IMPORTANT:** Check that the injector pump linkage is in the slot in the control rod before pushing it down.

1. Control rod
2. Shim for pump
3. Roller tappet for pump



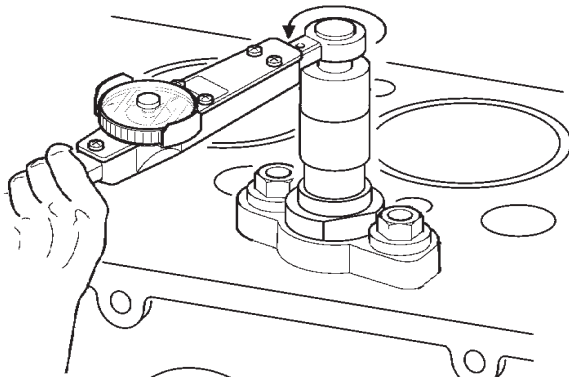
65. Put on the pump flange, with the chamfer facing the body of the injector.

    Lightly oil the bolts.

    Tighten them evenly to ..... **5 Nm** (4 lbf.ft.)

    Back off the bolts (counterclockwise) through ..... **60°**

66. Turn the injector pump carefully counterclockwise. Use a torque wrench with a dial, and socket 11668403.



Stop turning when the pump reaches its stop position and the turning torque has increased by..... **1 Nm** (1 lbf.ft.)

Note the torque shown on the dial, which is required to turn the injector pump, for example, **3.5 Nm**.

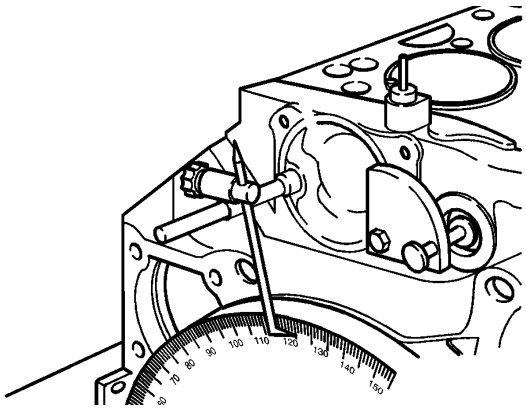
Example: 3.5 + 1 = 4.5 Nm

67. Tighten the bolts..... **60° clockwise** and then alternately to ..... **7, 10 and 30 Nm** (5.17, 7.38 and 22.14 lbf. ft.)

Note! Start with the bolt furthest from the flywheel.

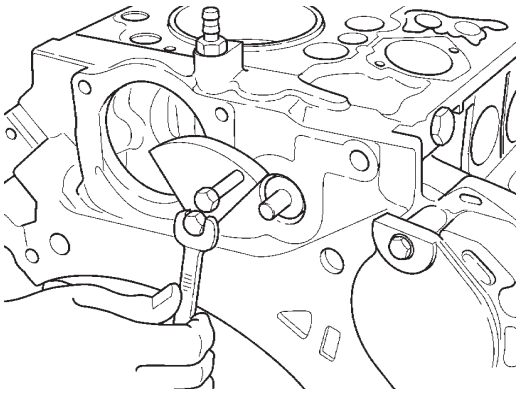
68. Repeat points 62 – 67 for every pump.

Note! Check that the control rod can move easily after fitting each injector pump.

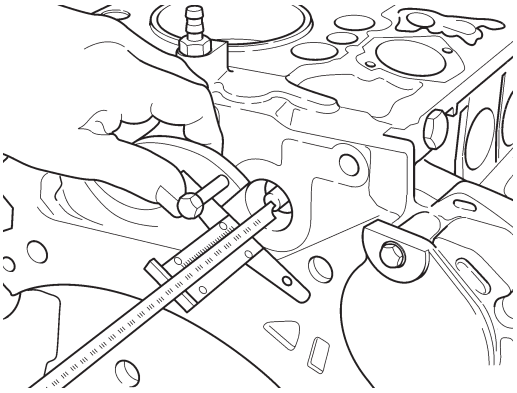


69. Remove the protractor (if it had been fitted). Leave tool 999 8684 in place.

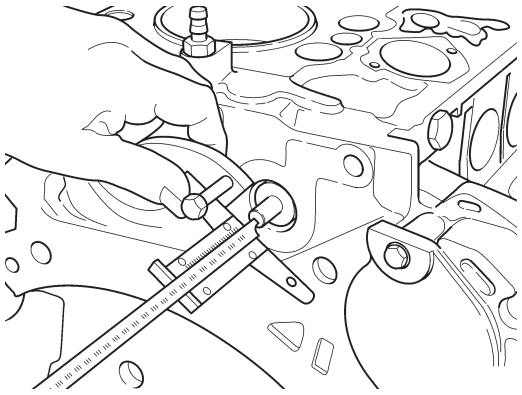
Measuring the stroke of the control rod, <u>with</u> the injector pumps fitted



70. Slacken the bolt of the measuring tool and turn the tool away from the control rod.
    Tighten the measuring tool bolt in the measuring position.



71. Measure from the measuring tool to the stop position of the control rod.
    Example: 30.5 mm



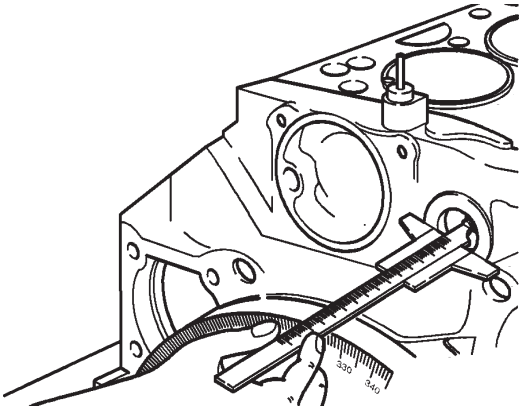
72. Measure from the measuring tool to the start position of the control rod.
    Example: 13.6 mm
    Remove the measuring tool.

The difference between the start and stop positions is the stroke of the control rod.

Minimum control rod stroke .....**16,8 mm** (0,66190 in)

Example:
Stop position = 30.5 mm
Start position = 13.6 mm
Control rod stroke: 30.5 – 13.6 = **16.9 mm**

Measuring the x measurement for the control rod

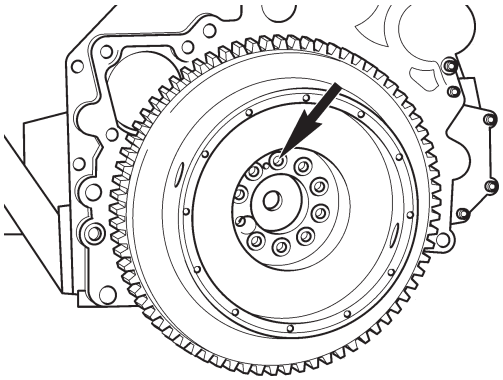


73. Measure the x measurement for the control rod from the surface of the timing gear housing to the stop position.

Note! The x measurement must be determined after changing the engine block, control rod or timing gear housing.

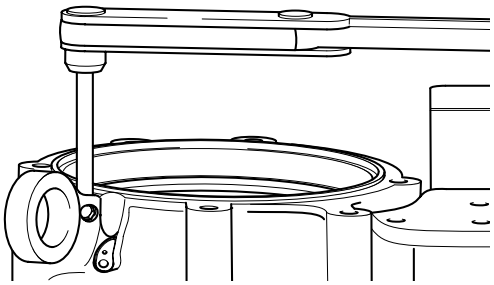
Note! When changing the control rod, The regulator must always be adjusted. Only a qualified specialist should perform the adjustment, on a regulator test bench.

Flywheel



74. Lift the flywheel into position and tighten the bolts by hand.

Note! The flywheel weighs around 55 kg (121 lbs).



75. Fit the flywheel housing.

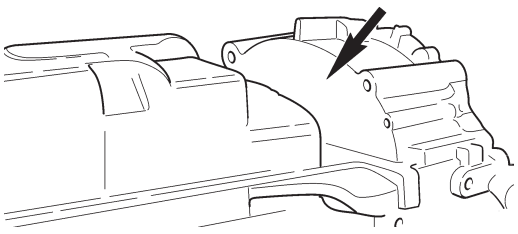
Note! Check that the guide bushings are in the correct position.

Tighten the bolts as follows:

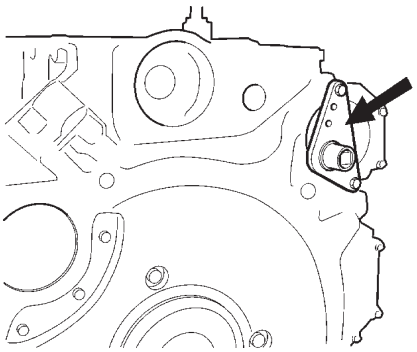
M12 bolts:..... **99 Nm** (73 lbf.ft.)

M16 bolts:..... **234 Nm** (179 lbf.ft.)

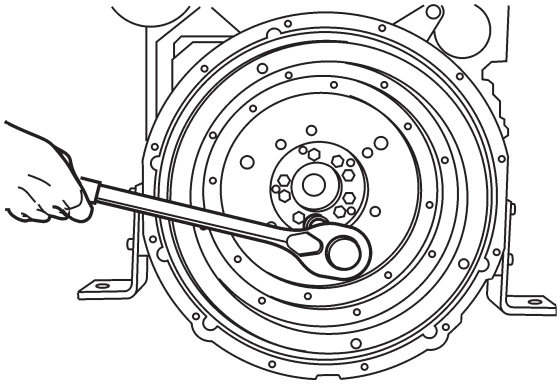
Note! Use E14 and E20 Torx tools.



76. Fit the cover plate to the flywheel housing.



77. Attach turning tool 999 8681 to the flywheel side.



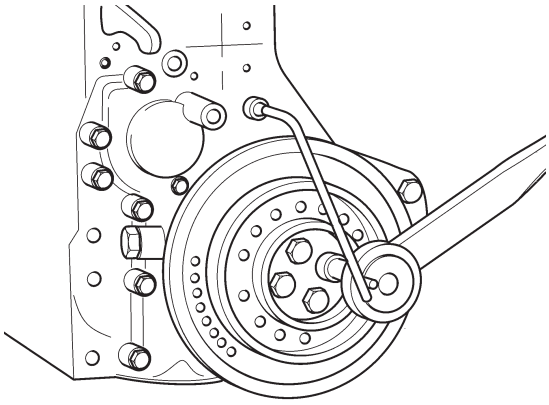
78. Hold the flywheel stationary with turning tool 999 8681.

Tighten the bolts as follows:

Initial tightening torque ..... **30 Nm** (22 lbf.ft.)
1st tightening angle
M10x1x45 bolts .....**60°**
2nd tightening angle
M10x1x45 bolts .....**60°**

Note! The bolts should be used only five times.

Fit the plastic plugs that lock the flywheel bolts.



79. Fit the pulley and vibration damper.

Tighten the bolts as follows:

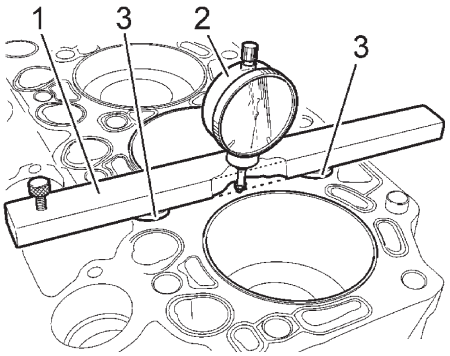
Note! Hold the pulley and vibration damper stationary with turning tool 999 8681.

Initial tightening torque ..... **45 Nm** (33 lbf.ft.)
1st tightening angle .....**60°**
2nd tightening angle.....**60°**
Vibration damper..... **70 Nm** (52 lbf.ft.)

Note! Use an E 20 Torx tool.

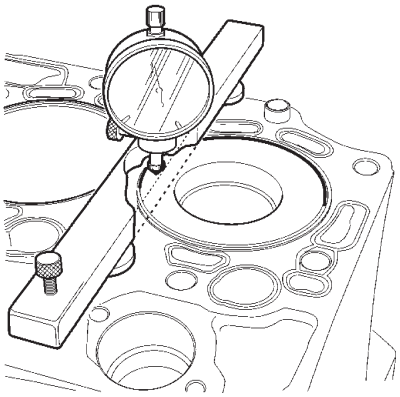
Note! The bolts should be used only five times.

Cylinder head gasket



80. Place the spacers (3) and measuring bar 999 8678 (1) on the sealing surface of the cylinder head.

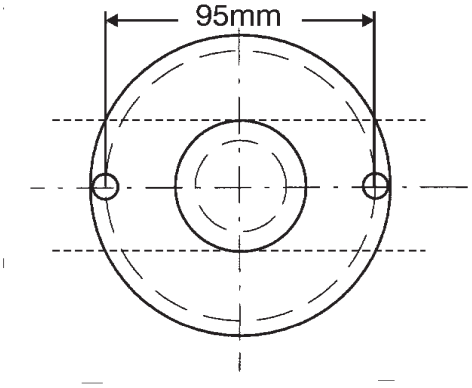
    Zero the dial gauge (2).



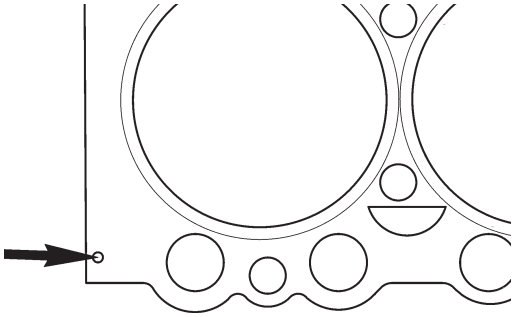
81. Place the dial gauge on the piston at the measuring points

    Read and note the value on the dial gauge at the highest position of the cylinder, TDC.

Note! All of the pistons should be measured at TDC, in line with the piston pin.

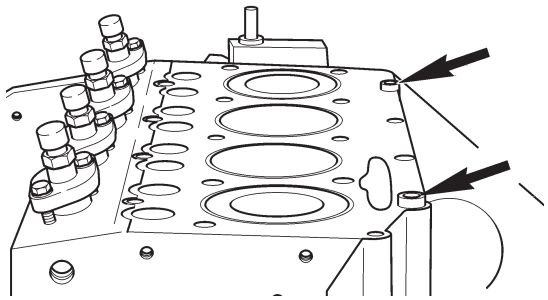


Note! Take care when selecting the measuring points, as the piston surface is spherical. Use a steel rule to find the highest point (in line with the piston pin).



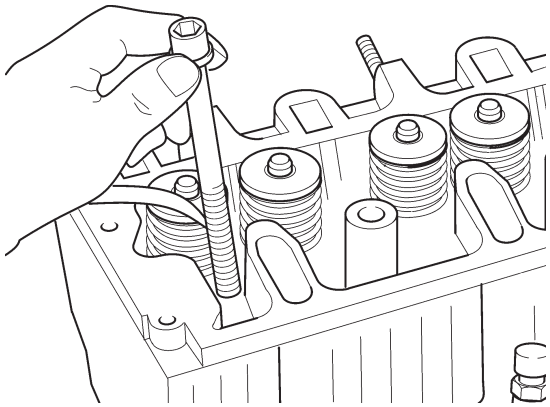
82. Compare the highest value found with the table below, and select a suitable cylinder head gasket.

Piston height	Identification holes in cylinder head gasket
0.28 – 0.53 mm (0.011 – 0.0209 in)	1 hole
0.54 – 0.63 mm (0.0213 – 0.0248 in)	2 holes
0.64 – 0.75 mm (0.0252 – 0.0295 in)	3 holes



83. Fit the cylinder head gasket with the numbers on the top and the identification hole(s) nearest the flywheel.

Note! The sealing surfaces of the cylinder head and engine block should be clean and free of oil. Pay particular attention to the guide bushings.

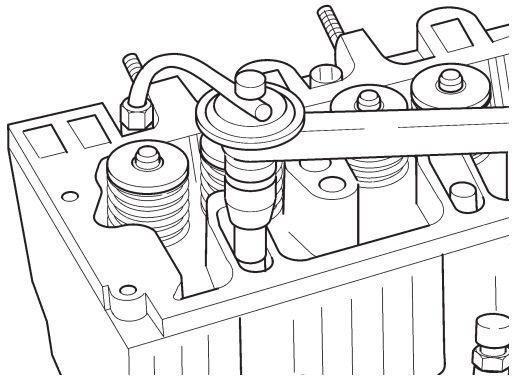


Cylinder head with valve gear

84. Lift the cylinder head into place.

    Oil the cylinder head bolts, let the excess oil drip off and tighten them finger tight.

Note! The cylinder head bolts should be used only five times (as long as you are certain how many times they have been used). Make a center punch mark on the head every time they are reused.

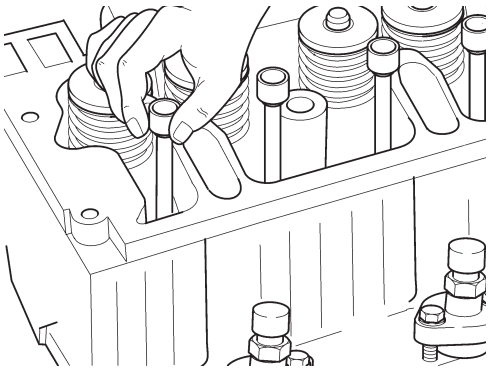


85. Tighten the bolts in three stages, as shown in “Tightening sequence for cylinder head bolts” in Technical data.

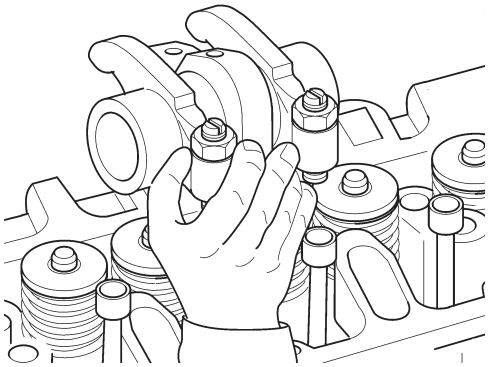
    1st ..... **50 Nm** (37 lbf.ft.)

    2nd ..... **130 Nm** (96 lbf.ft.)

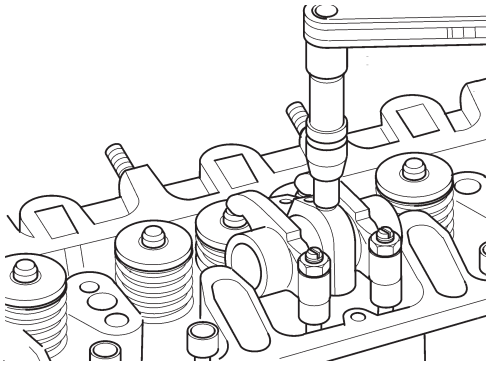
    Tightening angle.....**90°**



86. Insert the push rods, using the numbers that were applied when they were removed.

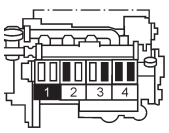


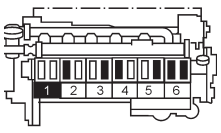
87. Fit the rocker arm bridges, using the numbers applied when they were removed, and align them with the push rods and valves.



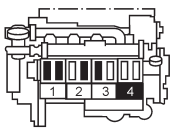
88. Tighten the bolts to..... **21 Nm** (15 lbf.ft.)

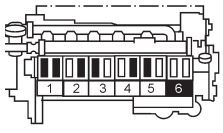
1





2



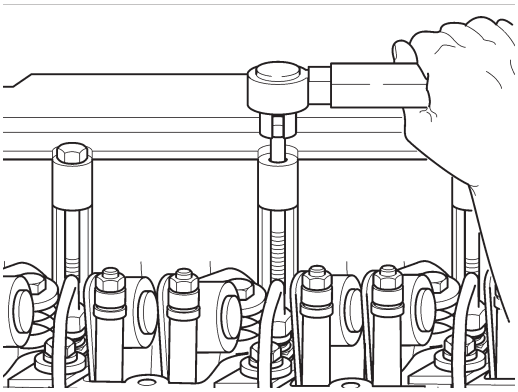


89. Adjust the valve clearance, (see “Valve clearance, checking/adjusting” in the chapter entitled “Repair procedures.”

Inlet.....**0.35 mm** (0.014 in)

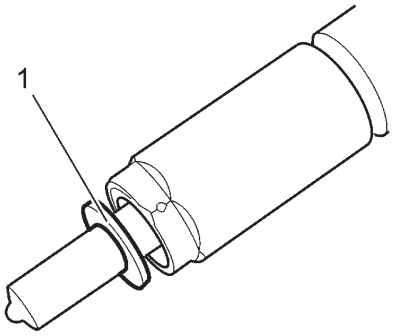
Exhaust .....**0.55 mm** (0.022 in)

90. Remove the turning tool.



Inlet pipe

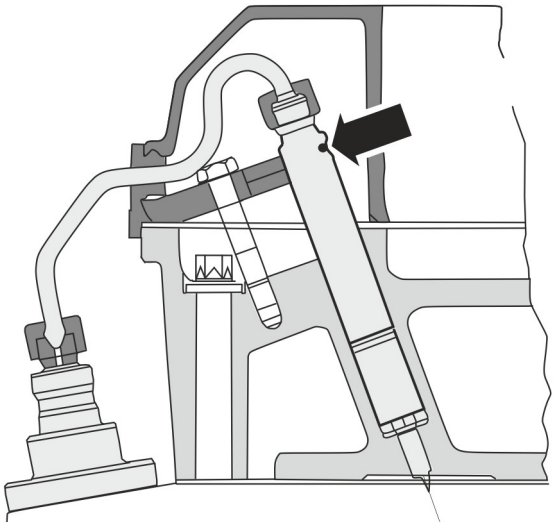
91. Fit the inlet pipe, using a new gasket.
Tighten the bolts to..... **11 Nm** (8 lbf.ft.)



Injectors

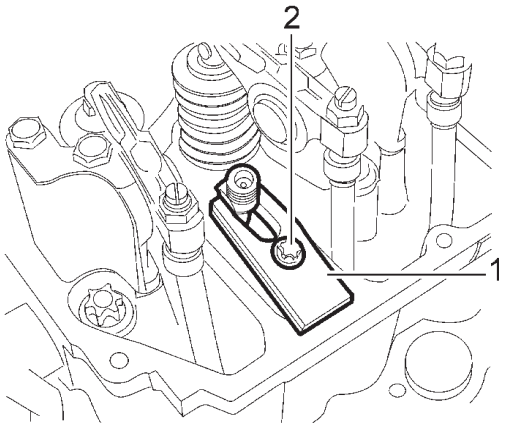
92. Push a new copper sealing washer over the injector (with the help of a little high temperature paste (1161035)) and fit the injector.

Note! The connector for the fuel return pipe must be on the exhaust side.



NOTICE! Injectors without return line have a marking, which must be directed towards the exhaust side.

Install the injector for correct injection angle according to the illustration.



93. Fit the jet retainers (1) in the correct position, but do not tighten the bolts fully. Use an E 10 Torx tool (2).

Pressure pipes

⚠ **WARNING! Do not bend the pressure pipes**

The pressure pipes must not be reused.

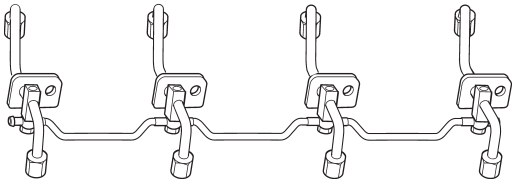
Note! The pressure pipes are deformed when they are tightened, and all of the pressure pipes must be tightened to the same torque.

If they are tightened to different torques, the cylinders might be unequally loaded.

If the pipes were to be reused, the engine might not produce full power.

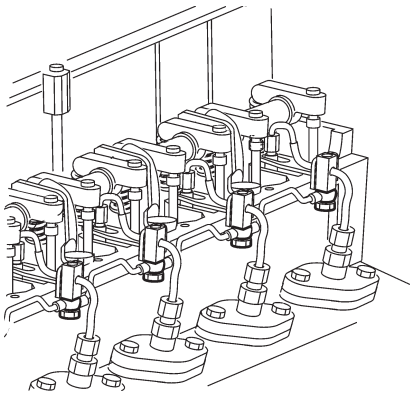
Note! The injector retainers should still be loose

Note! When connecting the pressure pipes, the sealing cones must fit precisely into the pump and injector.



94. Preassemble new pressure pipes with the lower fuel leak-off pipe.

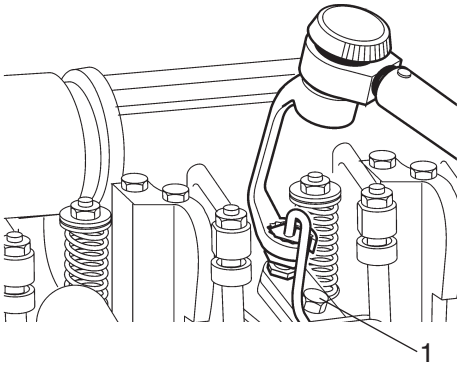
Note! Use new sealing rings and new rubber gaskets.



95. Fit the pressure pipes

Tighten the pressure pipe nuts finger tight at both ends.

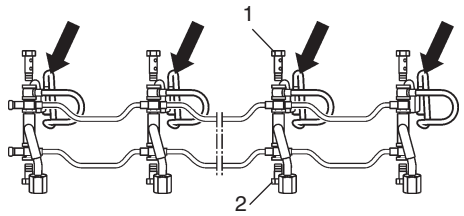
Note! The sealing cones must be located precisely above one another.



96. Tighten the jet yoke (1)
bolts to..... **19 Nm** (14 lbf.ft.)

97. Tighten the pressure pipe nuts in two stages:
1 ..... **5 Nm** (4 lbf.ft.)
2 ..... **25 Nm** (18 lbf.ft.)

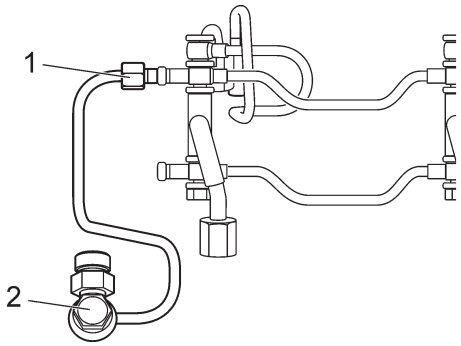
Note! Make sure you tighten all of the pressure pipe nuts to the same torque.



98. Fit the upper fuel return pipe to the pressure pipe, together with the return pipe from the injector.

Note! Use new copper washers.

Tighten the banjo bolts on the fuel return pipes (1) and fuel leak-off pipe (2) ..... **12 Nm** (9 lbf.ft.)

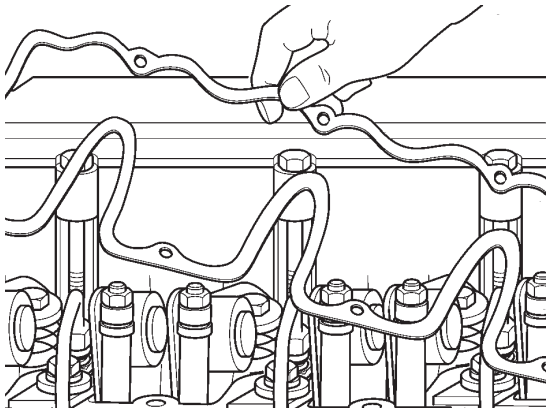


99. Fit the fuel return pipe into the pressure valve holder and new sealing washers.

Tighten the nuts for the fuel return pipe (1) and bypass vale (2) as follows:

1 ..... **14 Nm** (10 lbf.ft.)

2 ..... **30 Nm** (22 lbf.ft.)

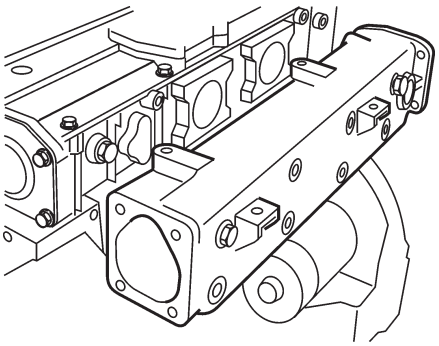


Valve cover

100. Fit the valve cover, using a new gasket.

Note! Make sure the rubber gaskets are correctly located in the groove in the valve cover.

101. Tighten the valve cover bolts..... **11 Nm** (8 lbf.ft.)

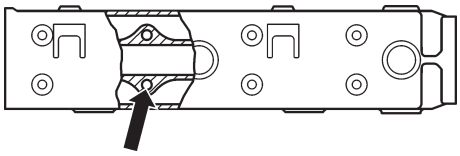


Exhaust manifold

102. Fit the exhaust manifold, using new gaskets.
The lip on the gaskets should be towards the cylinder head.
Tighten the exhaust manifold bolts to ..... **60 Nm** (44 lbf.ft.)

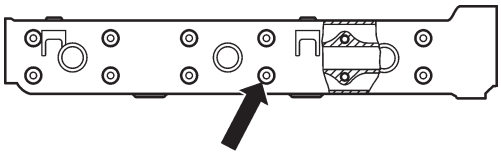
Note! Use high temperature paste (1161035) on the bolts. A drill bit can be used as an alignment aid.

D5

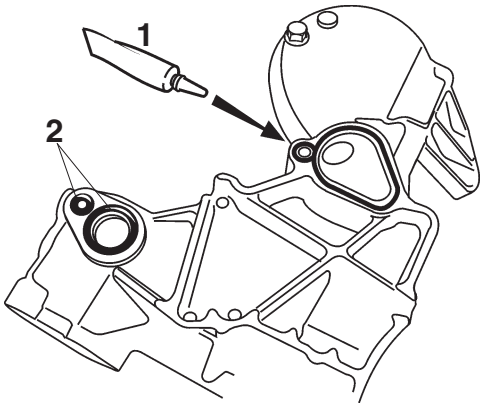


103. Position of the alignment drill bit for a **D5**

D7

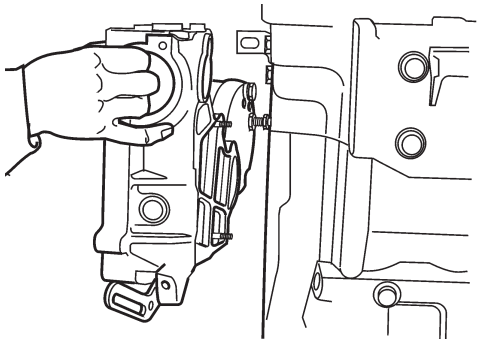


104. Position of the alignment drill bit for a **D7**

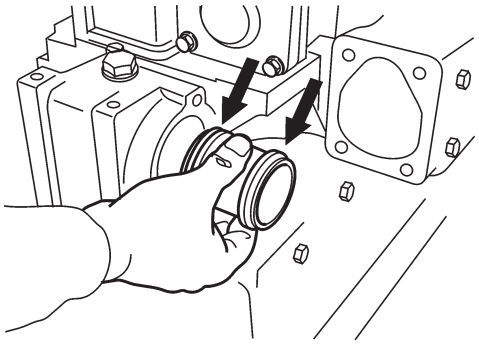


Coolant pump

105. Fit the control rod plug.
Apply sealant (1), 1161277 or 1161231, and new O-rings (2) to the coolant housing.

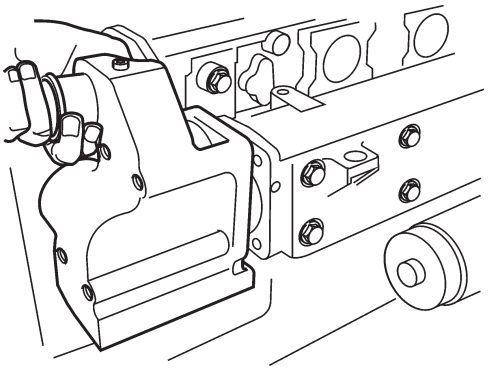


106. Fit the coolant housing complete with coolant pump.
Tighten the bolts to.....**21 Nm** (15 lbf.ft.)

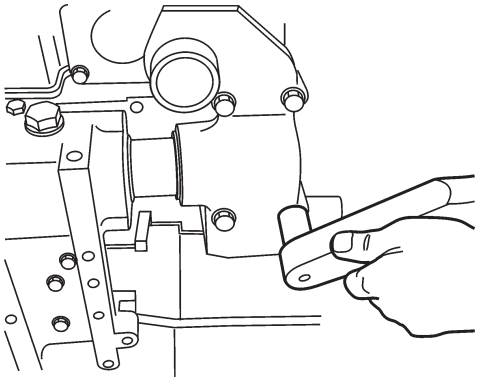


Thermostat housing

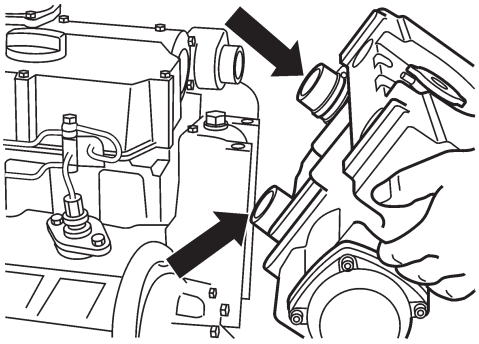
107. Fit new O-rings to the connecting pipe.



108. Fit the thermostat housing, with a new gasket.

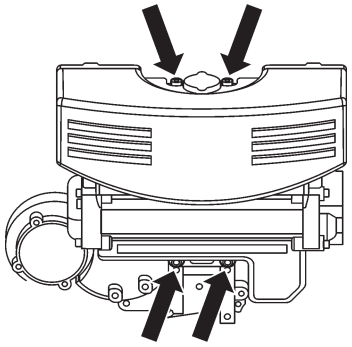


109. Tighten the thermostat housing bolts to..... **42 Nm** (31 lbf.ft.)

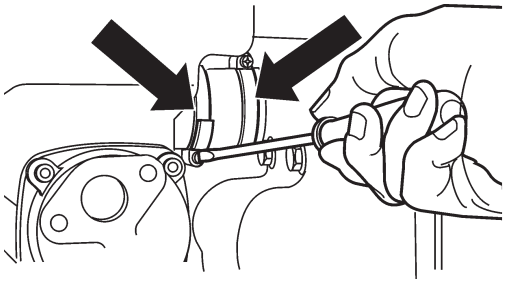


Heat exchanger

110. Fit rubber couplings and hose clips to the heat exchanger and lift it into position.

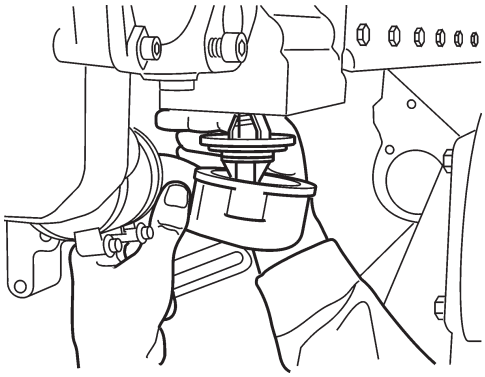


111. Tighten the bolts at the top and bottom of the heat exchanger to..... **42 Nm** (31 lbf.ft.)



112. Put the hose clips between the heat exchanger and thermostat housing in their correct positions.

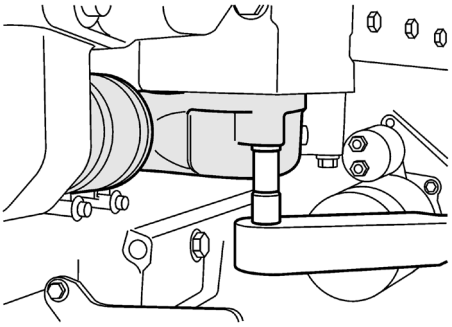
Tighten to ..... **4.5 Nm** (3.3 lbf.ft.)



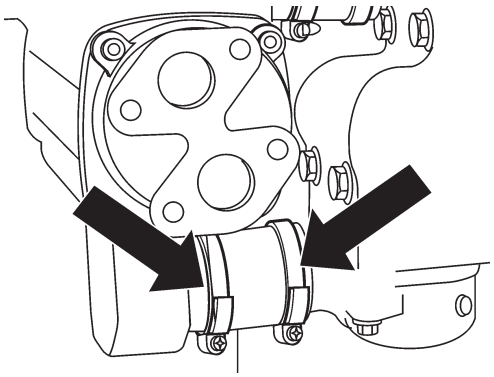
Thermostat housing

113. Fit the thermostat and thermostat holder, using a new gasket.

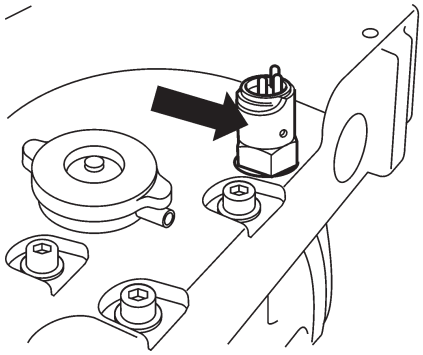
Note! Make sure you fit the thermostat the right way round.



114. Tighten the thermostat holder bolts to.....**21 Nm** (15 lbf.ft.)

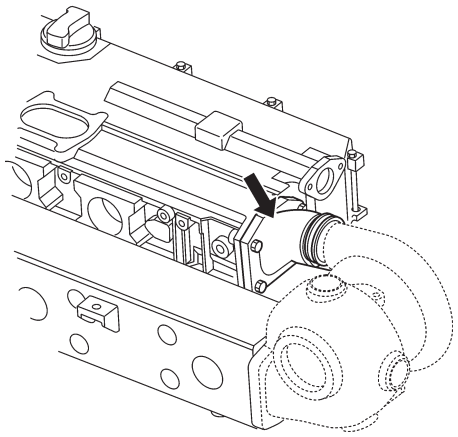


115. Put the hose clips between the heat exchanger and thermostat housing in their correct positions.
Tighten to ..... **4.5 Nm** (3.3 lbf.ft.)



Level switch, coolant

116. Fit the level switch, using a new sealing ring.
Tighten to ..... **25 Nm** (18 lbf.ft.)

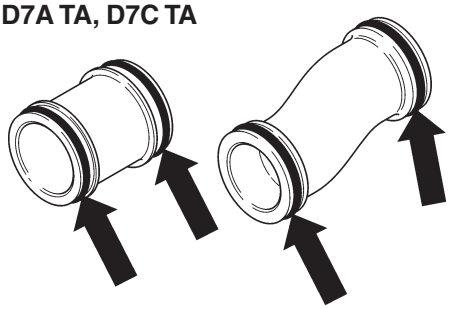


Turbo

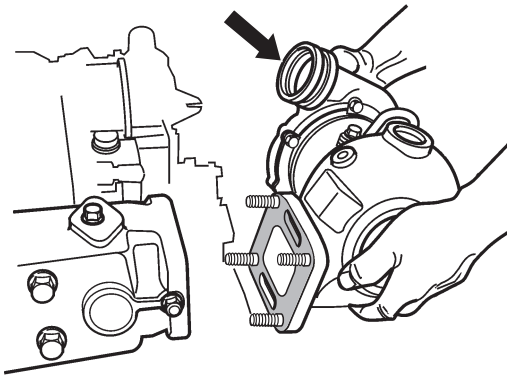
117. **D5:** Fit the connection tube, using a new gasket.
Tighten to **..... 22 Nm** (16 lbf.ft.)

D5A T/TA
D7A TA, D7C TA

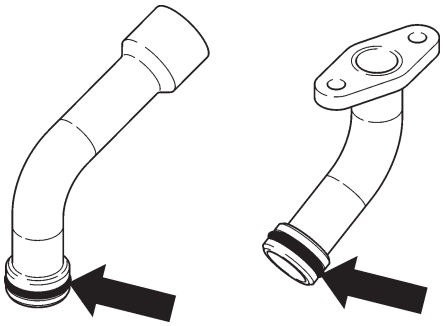
D7A T



118. Fit new O-rings to the connecting pipe for the turbo and apply a little Forminol (1141699).

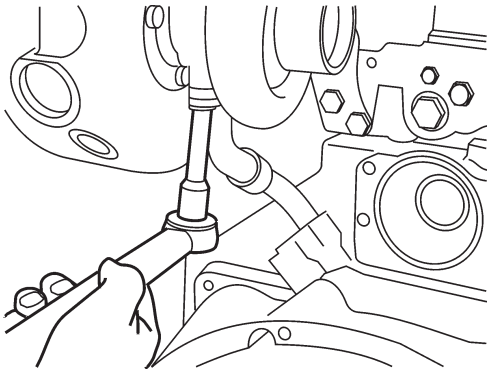


119. Push the connection pipe into the turbo.
Fit the turbo to the exhaust manifold, with a new gasket.
Tighten the bolts and nuts
to .....**40 Nm** (29 lbf.ft.)

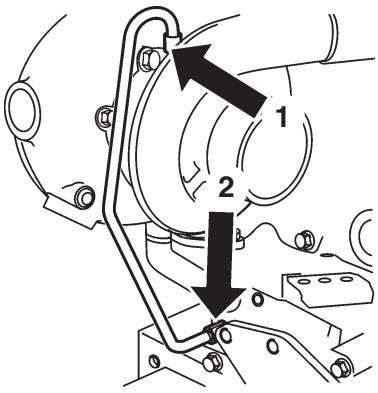


Lubricating oil pipe for the turbo

120. Fit new O-rings to the lubricating-oil return pipe.

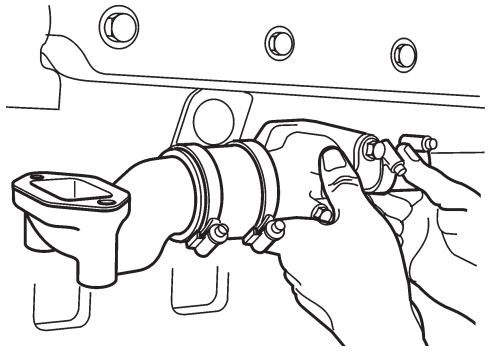


121. Fit the return pipe, with a new gasket.
Tighten to ..... **22 Nm** (16 lbf.ft.)

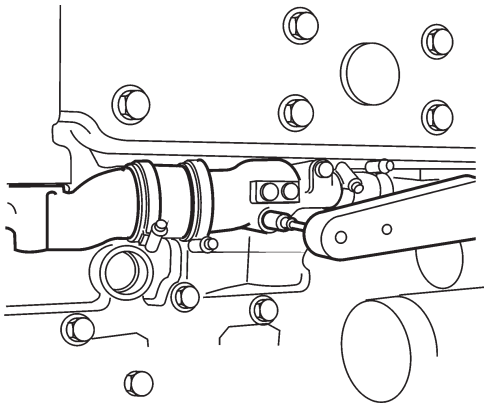


122. **Note!** Pre-oil the turbo by putting a drop of oil into the pressure pipe entry hole to the turbo.
Fit the lubricating-oil pressure pipe, using a new gasket and new sealing rings.
Tighten the bolts to:
1 ..... **22 Nm** (16 lbf.ft.)
2 ..... **34 Nm** (25 lbf.ft.)

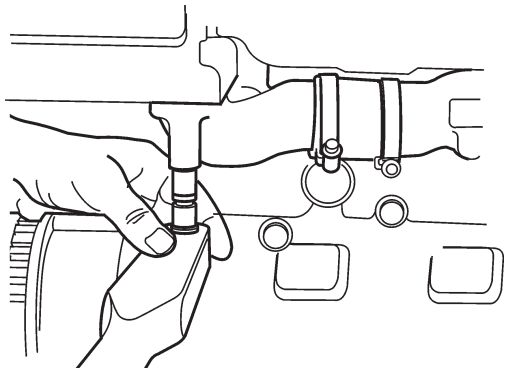
Coolant pipes



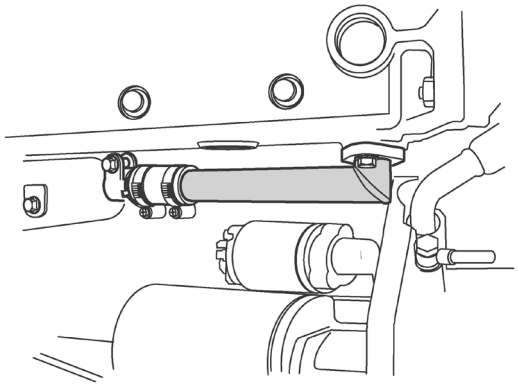
123. Fit the coolant pipe between the thermostat housing and engine body, using a new gasket.



124. Tighten the T-piece bolts to .... **20 Nm** (15 lbf.ft.)

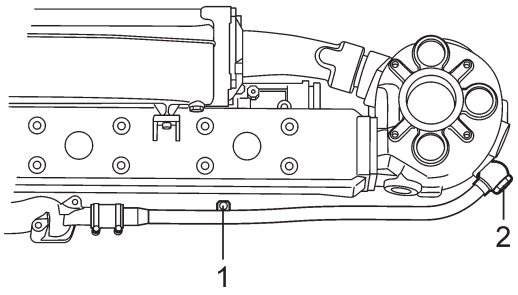


125. Tighten the bolts for the connector to the thermostat housing to..... **20 Nm** (15 lbf.ft.)



126. **D5:** Fit the coolant pipe to the exhaust manifold, using a new gasket

Tighten the bolts to..... **20 Nm** (15 lbf.ft.)

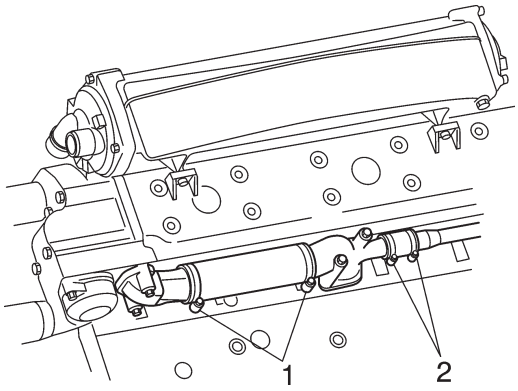


127. **D7:** Fit the coolant pipe to the turbo, using new seals.

Screw in the bolts for the retainer and the banjo bolt. Tighten to:

1 ..... **20 Nm** (15 lbf.ft.)

2 ..... **101 Nm** (74 lbf.ft.)

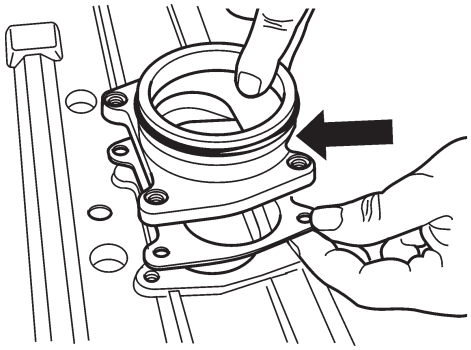


128. Position the hose clips and tighten to:

1 ..... **4.5 Nm** (3.3 lbf.ft.)

2 ..... **3.5 Nm** (2.6 lbf.ft.)

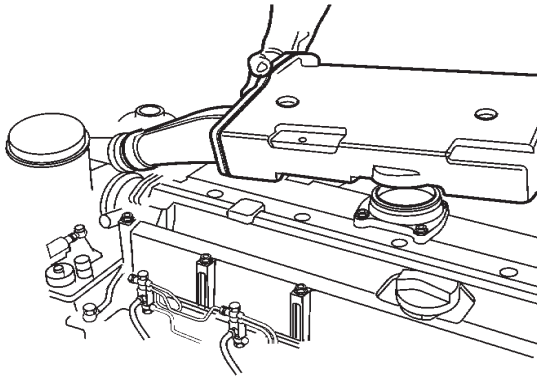
Charge air cooler (-TA)



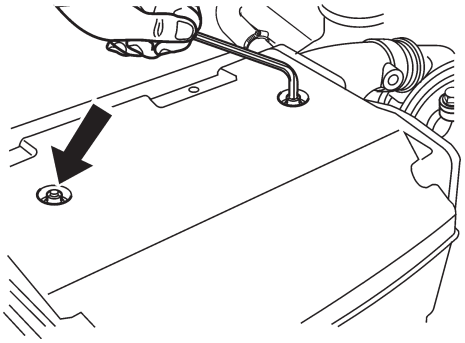
129. Fit the connector, using a new gasket.

Note! The chamfered side of the connector should be towards the exhaust side.

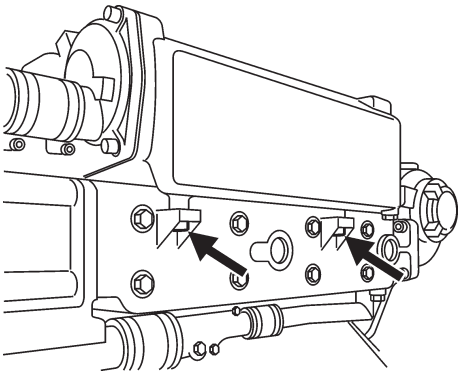
130. Tighten the connector bolts to ..... **13 Nm** (10 lbf.ft.)



131. Fit the charge air cooler.

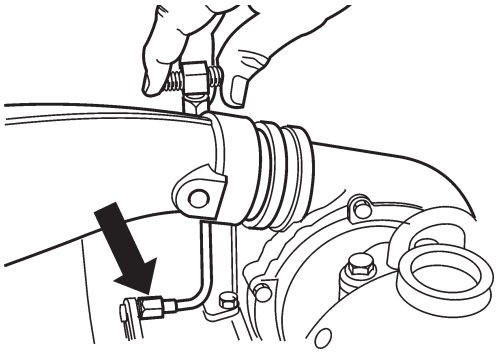


132. Tighten the bolts on the top of the charge air cooler to..... **22 Nm** (16 lbf.ft.)



133. Tighten the bolts that hold the charge air cooler onto the exhaust manifold.

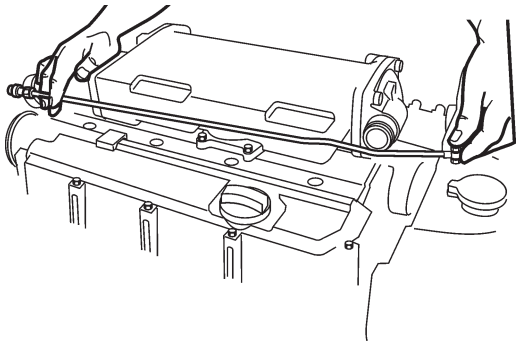
Coolant air bleed pipe



134. Fit the air bleed pipe loosely to the cylinder head.

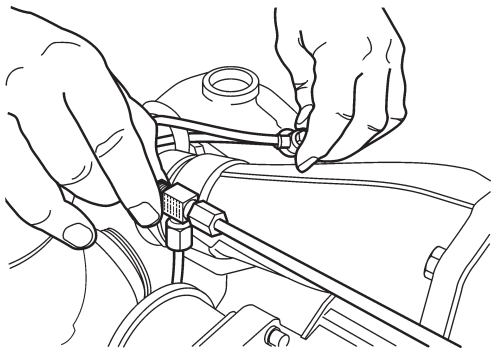
    Screw the T-piece loosely onto the bleed pipe.

Note! Use new copper washers for the banjo bolts.

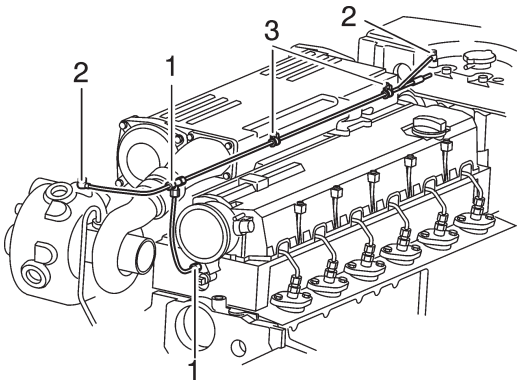


135. Loosely fit the air bleed pipe between the T-piece and heat exchanger, using new sealing rings.

Note! On engines with keel cooling, the bleed pipe is directly connected to the T-piece.

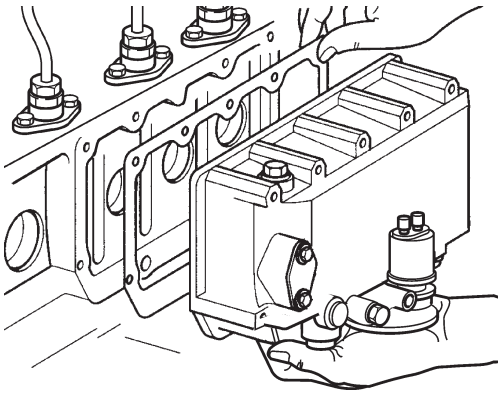


136. Loosely fit the air bleed pipe from the turbo to the T-piece, using new sealing rings.



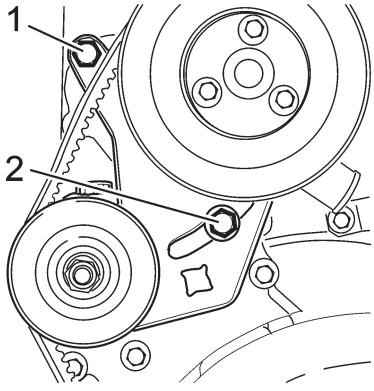
137. Tighten the bleed pipe nuts and bolts to:
1 ..... **25 Nm** (18 lbf.ft.)
2 ..... **18 Nm** (13 lbf.ft.)
3 ..... **14 Nm** (10 lbf.ft.)

Note! Number 3 apples only to engines that have a charge air cooler.



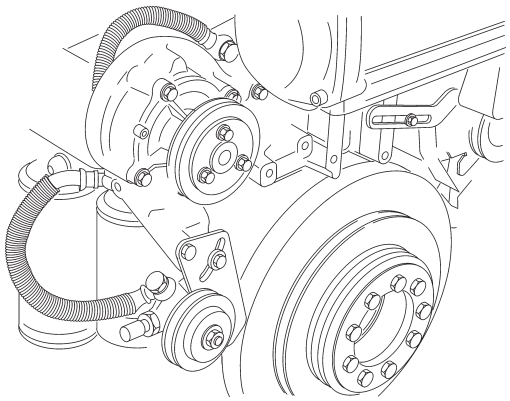
Oil cooler

138. Fit the lubricating oil cooler, using a new gasket.
Attach the gasket with a little grease.
Tighten the bolts to.....**21 Nm** (15 lbf.ft.)

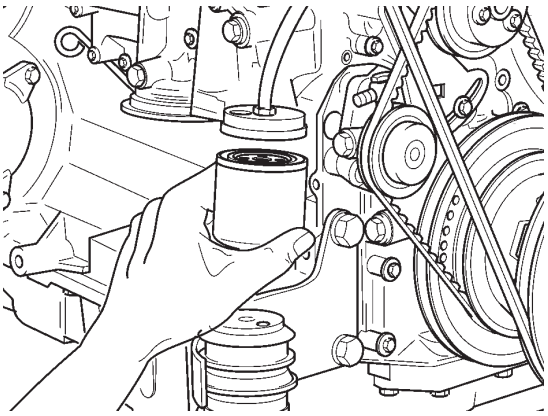


Fuel pump

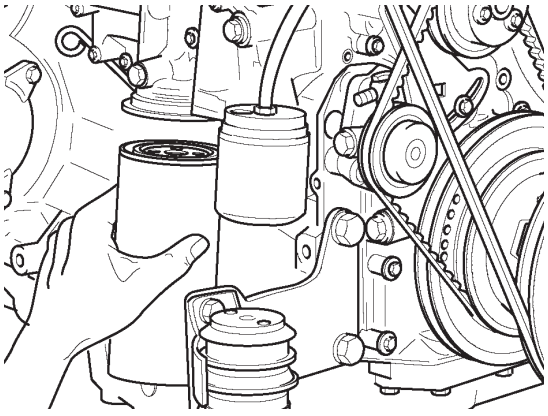
139. Fit the fuel pump and tighten the bolts (1 and 2).



140. Connect the fuel pipes.
Tighten the banjo bolts to..... **34 Nm** (25 lbf.ft.)

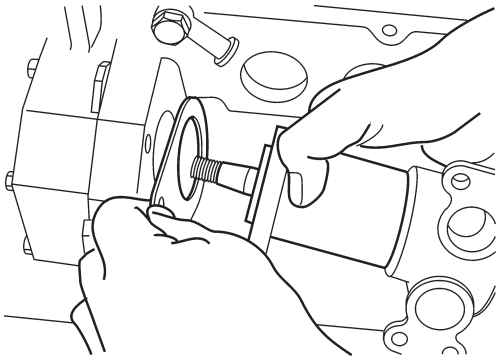


141. Lightly oil the fuel filter gasket.
Tighten the filter by hand until it makes contact with the mating surface. Tighten an additional half turn, no more.

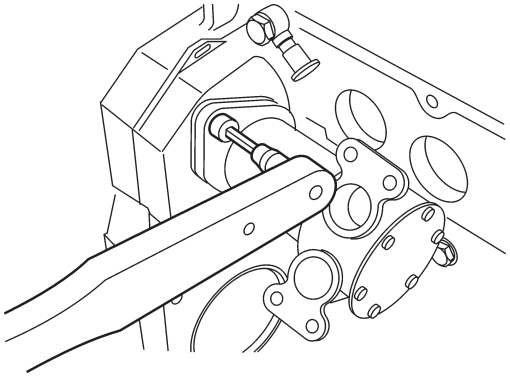


142. Lightly oil the oil filter gasket.
Tighten the filter by hand until it makes contact with the mating surface. Tighten an additional half turn, no more.

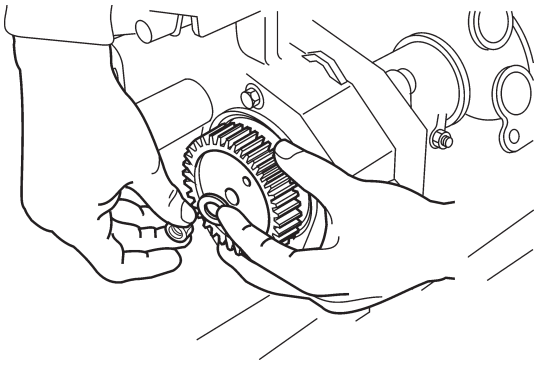
Seawater pump



143. Fit the seawater pump, using a new gasket.



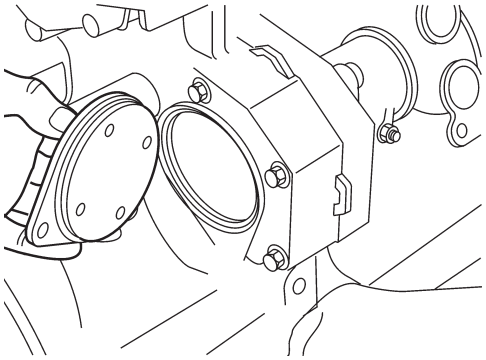
144. Tighten the seawater pump bolts to ..... **42 Nm** (31 lbf.ft.)



145. Fit the gear wheel onto the key on the shaft of the pump. If necessary, take out the impeller and turn the shaft.

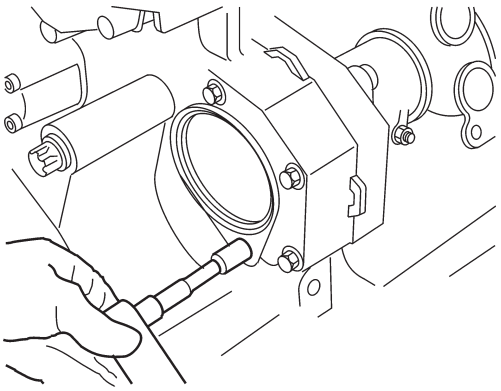
Tighten the nut to ..... **80 Nm** (59 lbf.ft.)

Note! Check that the teeth and pump shaft are undamaged. The shaft of the pump must be clean and free of lubricant.

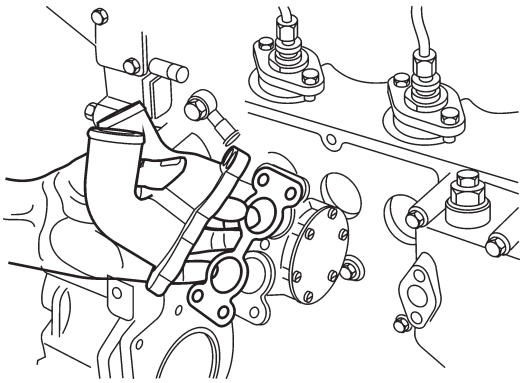


146. Fit the cover plate, using a new O-ring.

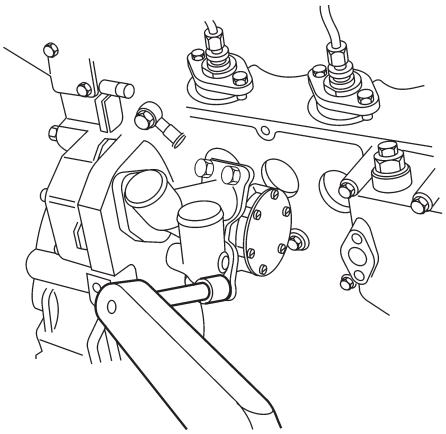
Note! Lightly oil the O-ring.



147. Tighten the cover plate bolts
to ..... **21 Nm** (15 lbf.ft.)

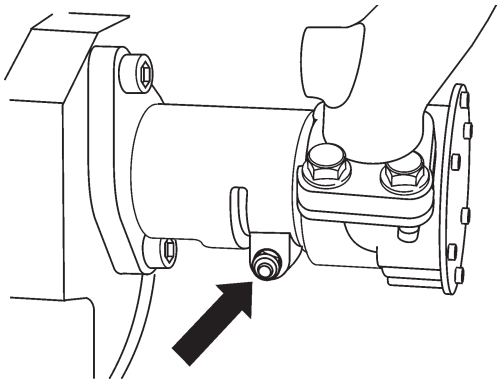


148. Fit the connection tube, using a new gasket.

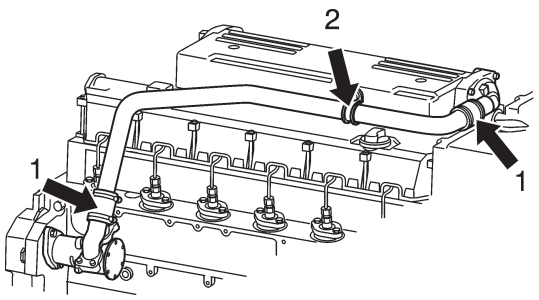


149. Tighten the connection tube bolts
to ..... **20 Nm** (15 lbf.ft.)

Seawater pipes



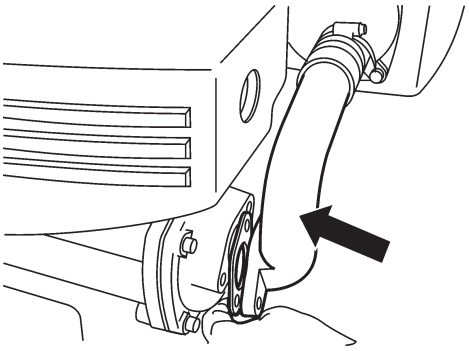
150. Slacken the clamping bolt between the impeller housing and seawater pump.



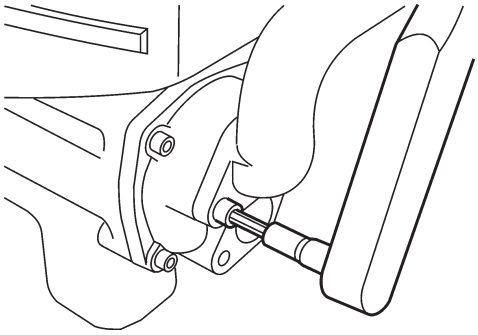
Points 151-154 apply to engines that have a charge air cooler (-TA).

151. Fit the seawater pipe from the pump to the charge air cooler.
Tighten the bolts and hose clips to:
1 ..... **4.5 Nm** (3.3 lbf.ft.)
2 ..... **20 Nm** (15 lbf.ft.)

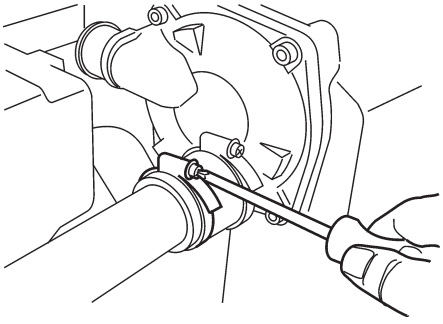
Note! Turn the impeller housing so it is lined up with the seawater pipe.



152. Fit the seawater pipe from the charge air cooler to the heat exchanger, using new gaskets.

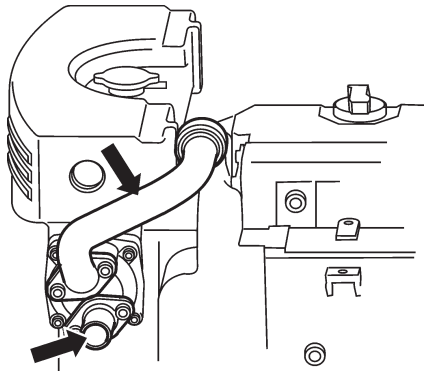


153. Tighten the seawater pipe bolts..... **42 Nm** (31 lbf.ft.)



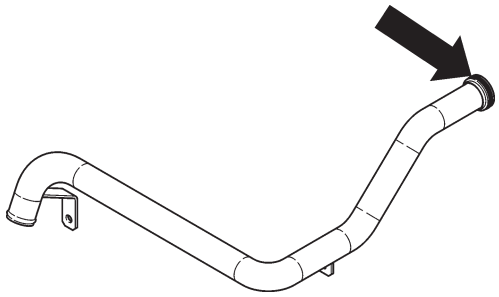
154. Position the hose clips.
Tighten them to ..... **4.5 Nm** (3.3 lbf.ft.)

Points 155-158 apply to engines that do not have a charge air cooler (-T).

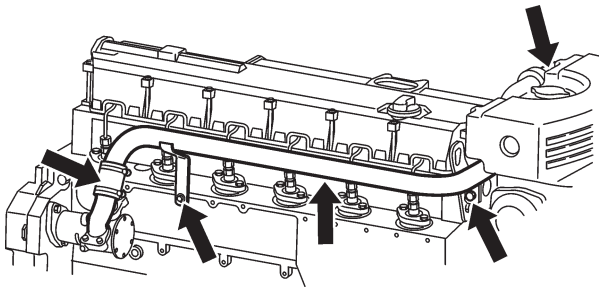


155. Fit the heat exchanger connector pipe, using new gaskets.

Tighten the bolts..... **42 Nm** (31 lbf.ft.)



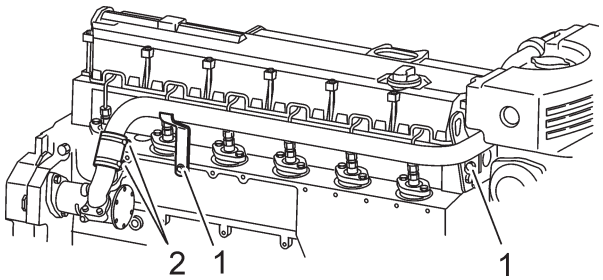
156. Fit new O-rings to the seawater pipe and apply a little Forminol (1141699).



157. Fit the seawater pipe from the seawater pump into the connector pipe from the heat exchanger.

Fit rubber couplings and hose clips to the seawater pump.

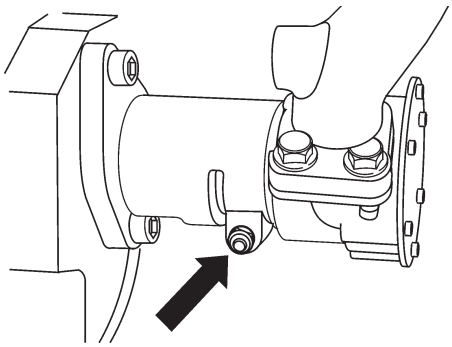
Note! Turn the impeller housing so it is lined up with the seawater pipe.



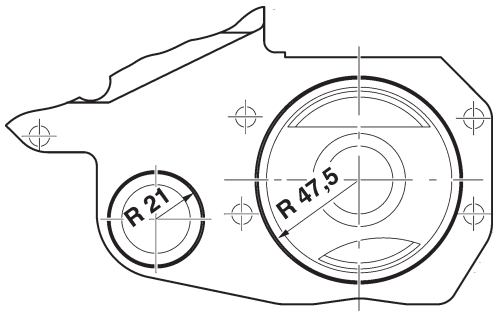
158. Position the hose clips and insert the bolts for the retainers. Tighten them to:

1 ..... **22 Nm** (16 lbf.ft.)

2 ..... **5 Nm** (4 lbf.ft.)



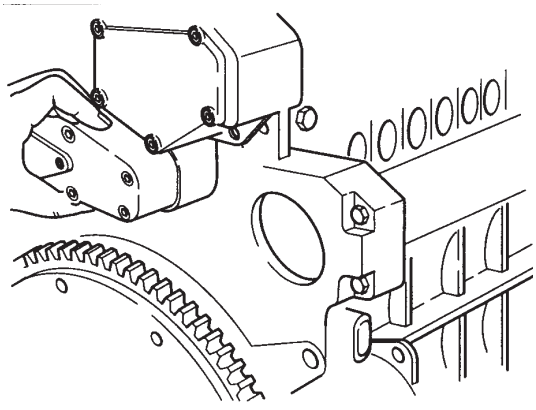
159. Tighten the clamping bolt for the seawater pump impeller housing to ..... **8.5 Nm** (6 lbf.ft.)



Engine speed regulator

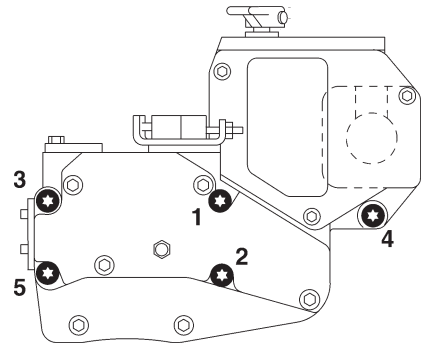
Note! The sealing surface must be free of oil and grease.

160. Apply sealant (1161231) to the groove in the cover.
Diameter of sealant bead,
Ø.....**1.5 mm** (0.06 in)

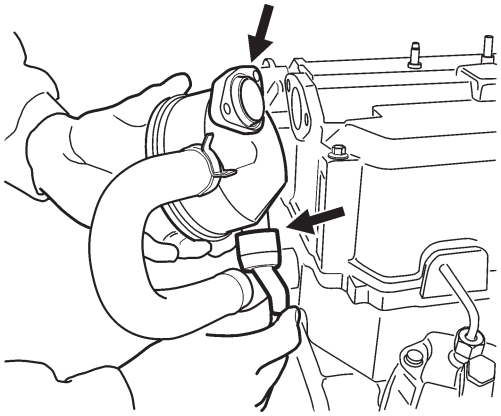


161. Fit the engine speed regulator.

⚠ **IMPORTANT:** Every regulator fitted to these engines is specially installed for the individual engine. This means that the regulator can not be swapped between engines.
An incorrectly set regulator can lead to the engine not meeting the specified emission and performance requirements.
Always quote the engine model, serial number, rated speed (rpm) and x measurement when ordering a regulator as a spare part.



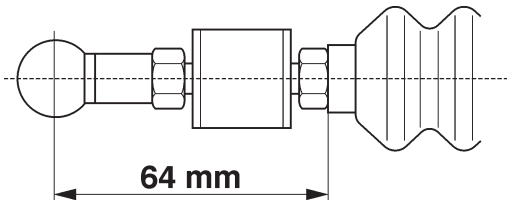
162. Tighten the Torx bolts as shown in the diagram.
Use an E 10 Torx tool ..... **17 Nm** (12 lbf.ft.)



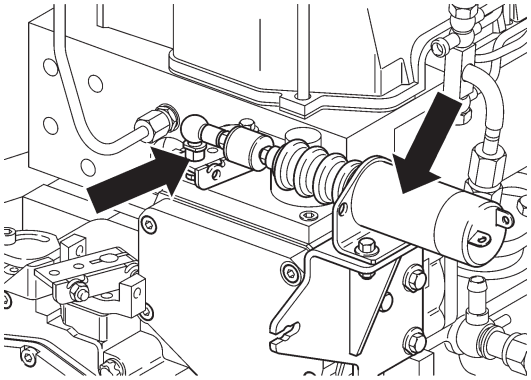
163. Fit a new gasket into the groove in the oil trap.
Fit the oil trap connector into the oil pipe.
Bolt it into the valve cover..... **9 Nm** (7 lbf.ft.)

Note! Use a 5 mm (0,197 in) Allen key.

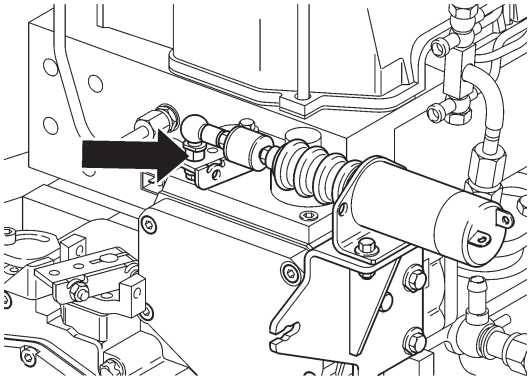
Stop solenoid



164. Preassemble the coupling to approximately .....64 mm (**2.5 in**)

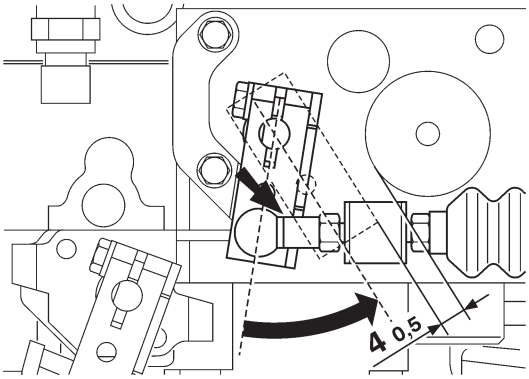


165. Fit the stop solenoid, complete with retainer and bracket.
Press the socket down onto the ball of the pivot bolt.
Tighten the bracket bolts to .... **22 Nm** (16 lbf.ft.)



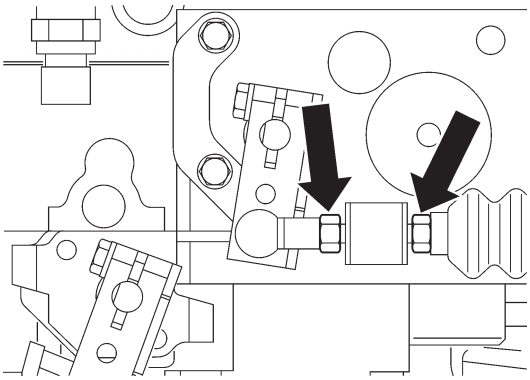
166. Check that the pivot bolt is at 90° to the shaft of the stop solenoid.

Secure the swivel socket with the circlip.

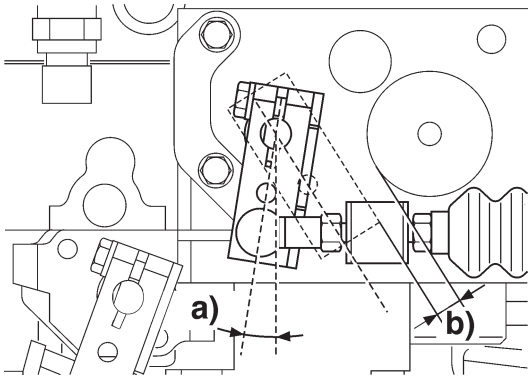


167. Activate the stop solenoid and adjust the distance between the stop lever and the upper part of the regulator, by turning the rubber section.

Setting .....**4 mm** (0.16 in)



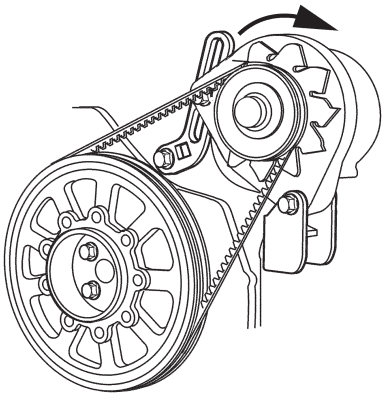
168. Tighten the nuts to..... **10 Nm** (7 lbf.ft.)



169. Perform the following checks:

a) When the stop solenoid is activated, check that there is still free play to the stop in the regulator.
a = 8.5°

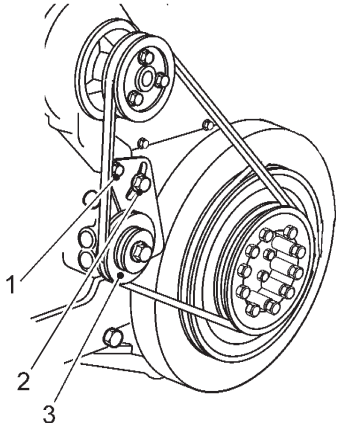
b) When test running, check that the engine stops correctly when the stop solenoid is activated.
b = **4 mm** (0.16 in)



Generator

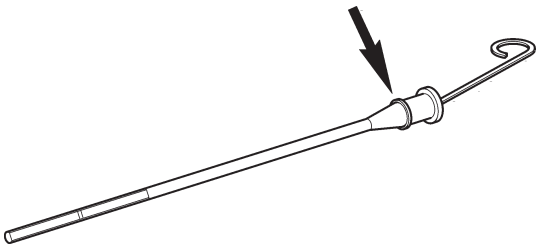
170. Fit the generator mounting and generator.
Tighten the bolts to..... **30 Nm** (22 lbf.ft.)
Fit the drive belt
Adjust the belt tension by pressing the generator in the direction of the arrow until the tension is correct.

Note! The belt is correctly tensioned when it can be pressed in approximately 10 mm (0.4 in) midway between the pulleys.



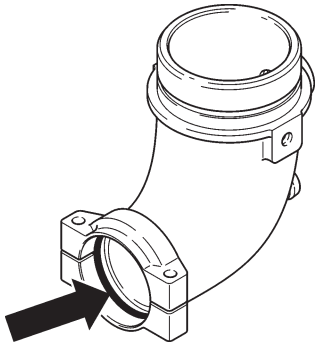
Drive belts, fuel and coolant pumps

171. Push the fuel pump (3) to the right and fit the belt.
Push the fuel pump to the left until the belt tension is correct (see above).
Tighten the bolts (1 and 2)
to ..... **21 Nm** (15 lbf.ft.)



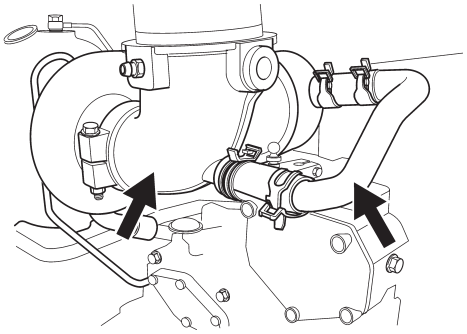
Oil dipstick

172. Fit a new O-ring to the dipstick and insert it.

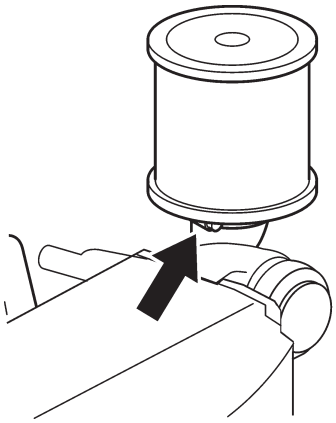


Air filter

173. Fit a new O-ring to the air filter intake pipe.

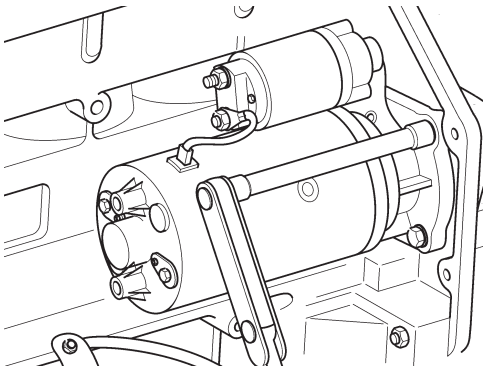


174. Fit the air filter intake pipe and air bleed pipe to the oil trap.
Tighten the intake pipe bolts to ..... **22 Nm** (16 lbf.ft.)

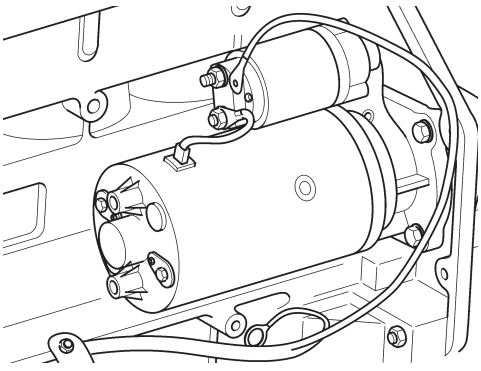


175. Fit the air filter and tighten the hose clip to ..... **12 Nm** (9 lbf.ft.)

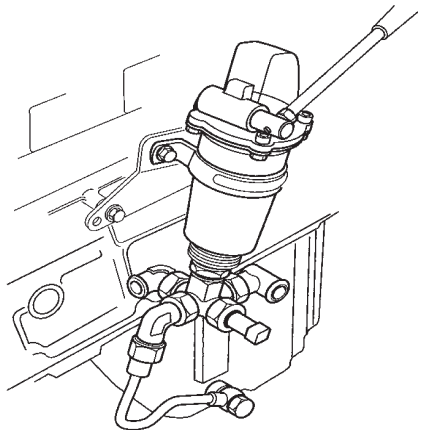
Starter motor



176. Fit the starter motor, unless it was fitted earlier with the timing gear housing.
Tighten the bolts to..... **70 Nm** (52 lbf.ft.)

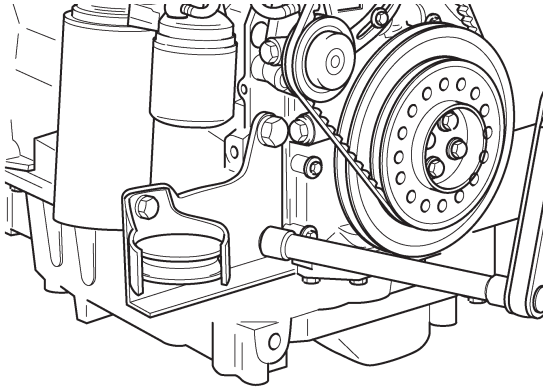


177. Connect the cable and fit the clips.



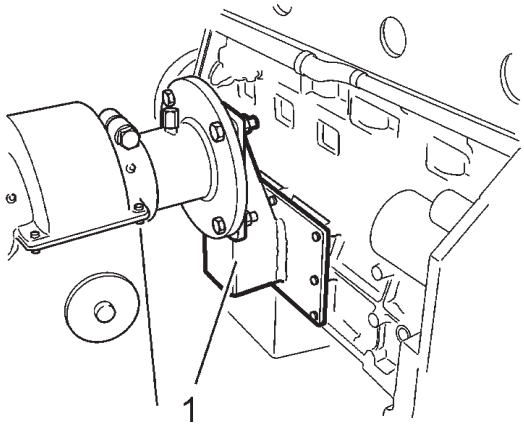
Oil drain pump

178. Fit the oil drain pump, complete with hoses and bracket.



Engine mounting

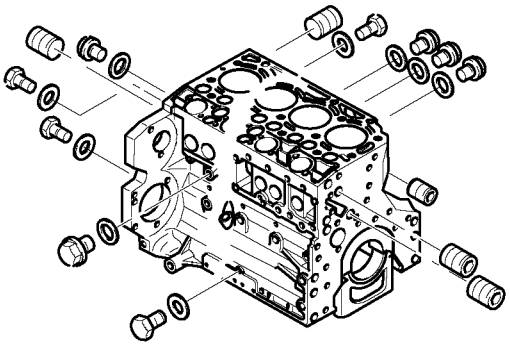
179. Fit the engine mounting and tighten to ..... **260 Nm** (192 lbf.ft.)



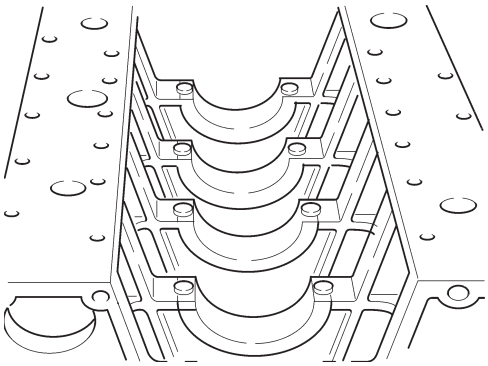
180. Take the engine off the stand and remove the fixture (1).

Checks and measurements

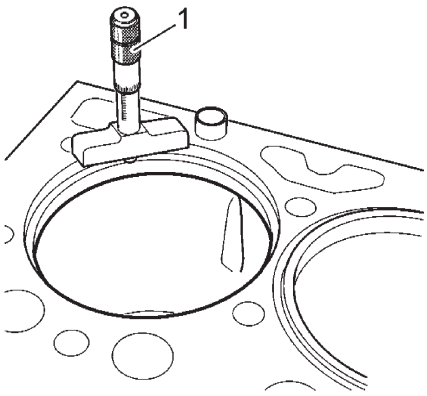
Engine block



1. Remove the screw plugs.
   Check that the oil channels are not blocked.

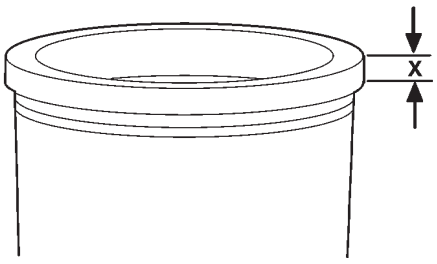


2. Clean the engine block and check that it is not damaged.



3. Use a depth micrometer to measure the distance between the liner collar seat and the face of the engine block. Measure at several points on every cylinder.
   Maximum depth.....**8.92 mm** (0.3512 in)

Note! Neither the liner collar nor the seat can be re-machined. If the measurement is incorrect, change the cylinder liners and engine block.

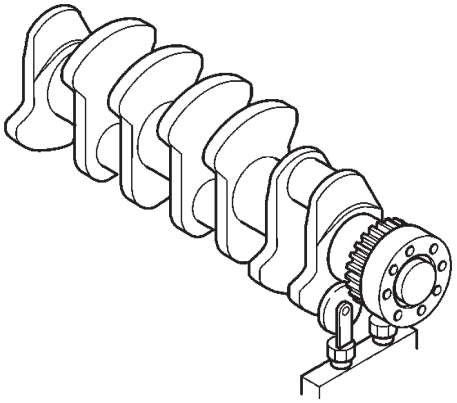


4. Inspect the liner collar and measure the height of the collar at several points around the periphery.
   Minimum collar height .....**9 mm** (0.35 in)

Crankshaft, measuring

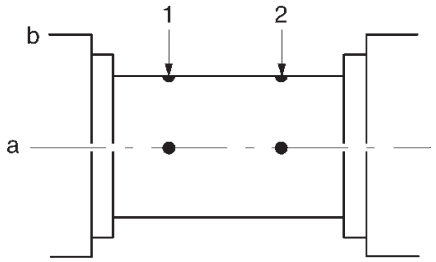
Special tools:

Dial gauge 999 9876



Main bearings

1. Put the crankshaft on a stand.

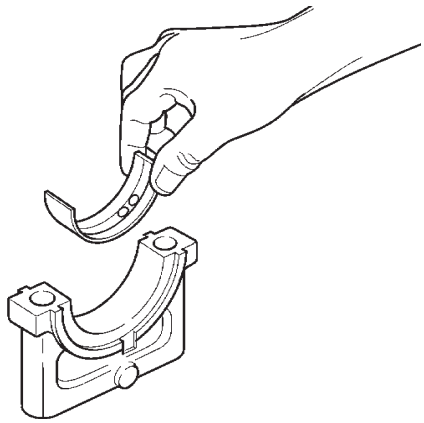


2. Procedure or measuring the main bearing journals at points “**1**” and “**2**” in planes “**a**” and “**b**”.

   Bearing journal
   diameter .....**85.00 mm** (3.3464 in)

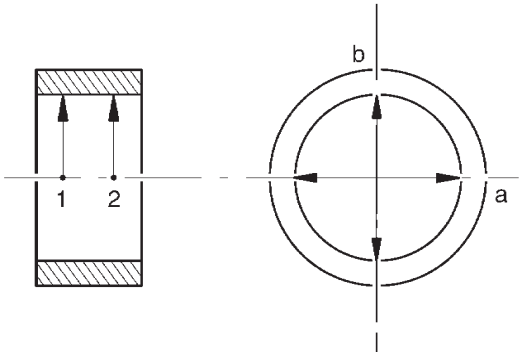
   Undersize:
   0.01” (0.25 mm).....**84.75 mm** (3.337 in)
   0.02” (0.5 mm).....**84.50 mm** (3.327 in)

   Wear limit:
   Bearing journal ovality.....**0.01 mm** (0.0004 in)
   Conicity.....**0.01 mm** (0.0004 in)



Main bearing shells

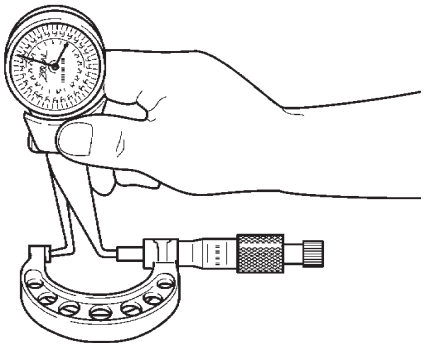
3. Fit the bearing shells into the bearing caps and fit the caps into the engine block.



4. Measure the main bearing diameter at points "**1**" and "**2**" in planes "**a**" and "**b**".

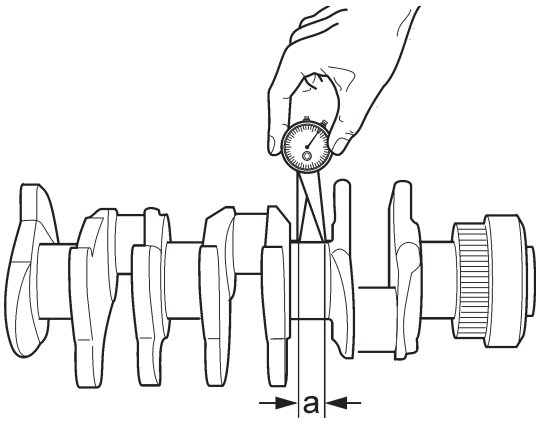
   Inside diameter, Ø .....**85.03 mm** (3.348 in)

   Oversize:
   0.0098 in
   (0.25 mm).....**84.78 mm** (3.3378 in)
   0.02 in
   (0.5 mm).....**84.53 mm** (3.3279 in)



Thrust bearings

5. Set the dial gauge to 38 mm (**1.5 in**).



6. **Note!** Before machining the crankshaft, measure the width for the new thrust bearing, see point 8.

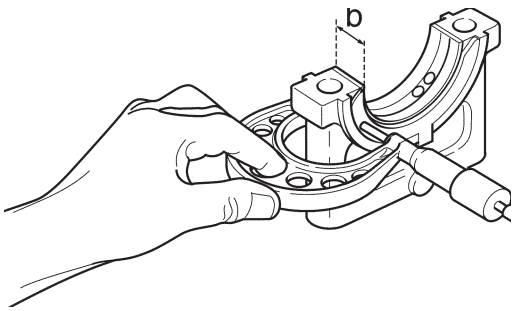
   Measure the width of the axial bearing journal. (Use a dial gauge designed for measuring "inside" dimensions.).

   Width of bearing journal .....**38 mm** (1.5 in)

   Oversize
   0.016 in (0.4 mm).....**38.4 mm** (1.51 in)

7. Measure the width of the crankshaft thrust bearing journals and note measurement "a".

   Example
   Measurement "a" = 38.02 mm

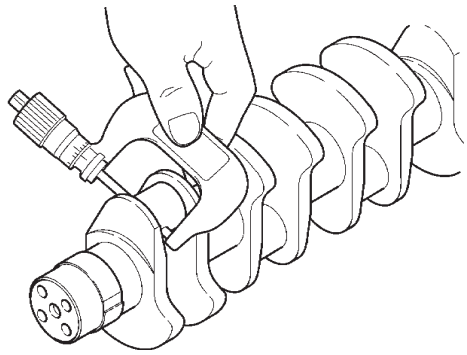


8. Determine the thickness of the thrust bearing halves for the bearing cap. Measure and note width "**b**".

9. Determine the axial play:

   Example
   Measurement "**a**" **= 38.02 mm**
   Measurement "**b**" **= 37.90 mm**
   "a" – "b" = 0.12 mm = axial play
   Permitted axial play = **0.1 – 0.3 mm**

Big-end bearings

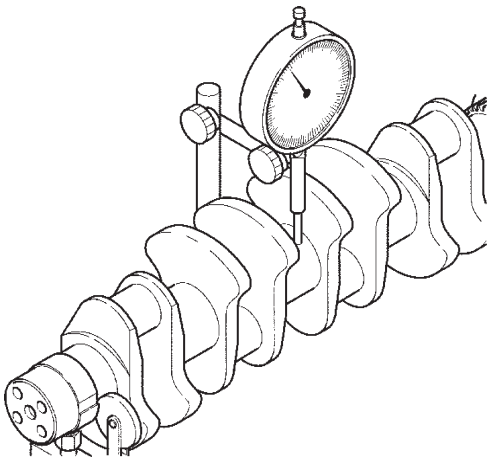


10. Measure the big-end bearing journals

    Big-end bearing journal
    diameter .....**68 mm** (2.68 in)

    Undersize
    0.0098 in
    (0.25 mm) .....**67.75 mm** (2.6673 in)
    0.02 in (0.5 mm) .....**67.50 mm** (2.6575 in)

    Wear limit:
    Big-end bearing journal
    ovality .....**0.01 mm** (0.0004 in)
    Conicity.....**0.01 mm** (0.0004 in)



11. Check the straightness of the crankshaft with a dial gauge.

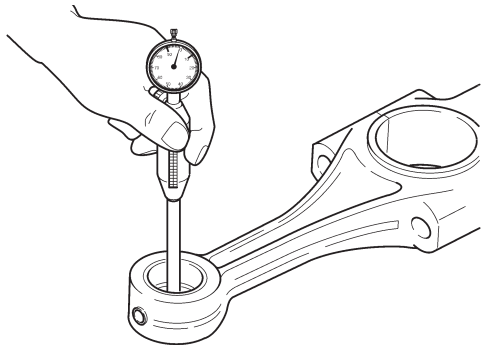
    Maximum cast at the center bearing:

    D5: .....**0.07 mm** (0.0028 in)
    D7: .....**0.1 mm** (0.004 in)

Connecting rods, measuring

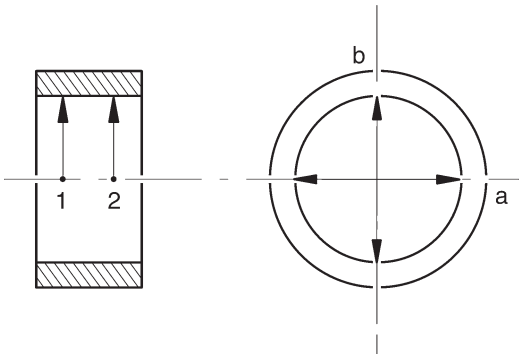
Special tools:

Dial gauge 999 9876
Fitting tool, connecting rod bushing..... 999 8692



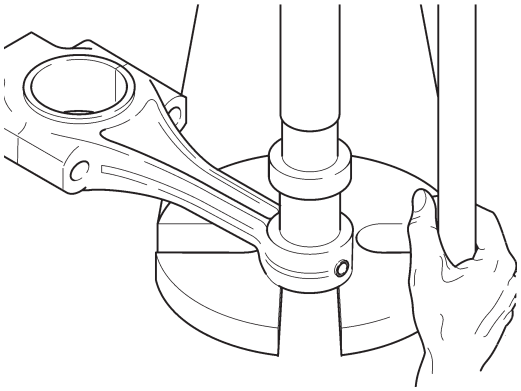
Connecting rod bushing

1. Set the dial gauge to .....**42 mm** (1.65 in)



2. Measure the connecting rod bushing at points "**1**" and "**2**" in planes "**a**" and "**b**".
   Inside diameter of bushing .....**42.04 mm** (1.655 in)
   Wear limit ..... **42.12 mm** (1.6583 i**n**)

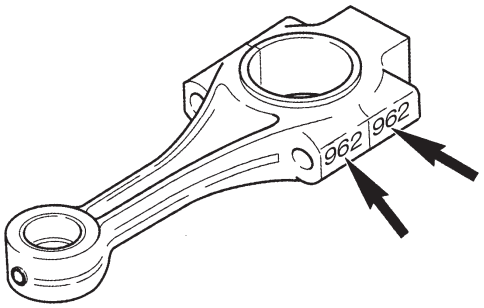
3. Change the bushing if the wear limit is exceeded.
   Diameter of hole in connecting rod.....**45.5 mm** (1.79 in)
   Outside diameter of bushing.....**45.58 mm** (1.794 in)



4. Press the bushing in until it is level with the surface of the connecting rod, using fitting tool 999 8692.

Note! The lubrication holes in the bushing and connecting rod must be lined up with one another.

5. Precision ream the bushing after pressing it in.....**42.04 mm** (1.655 in)

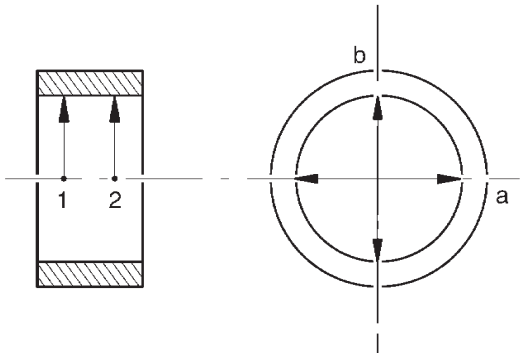


Big-end bearings

6. Make sure the bearing cap matches the connecting rod. The numbers must be identical and facing the same way.

Note! Make sure there are locating pegs fitted.

7. Fit the big-end bearing cap.
   Tighten the bolts as specified:
   Initial tightening torque ..... **30 Nm** (22 lbf.ft.)

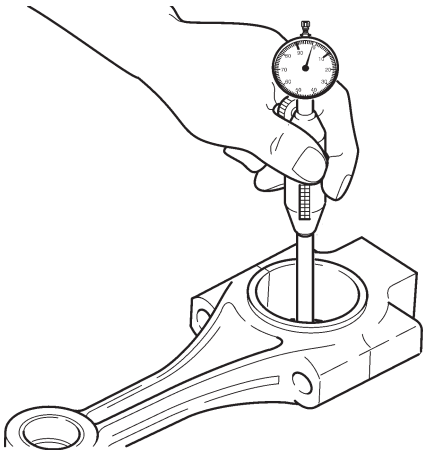


8. Set the dial gauge to .....**72.5 mm** (2.854 in)

9. Measure the diameter of the big-end bearing at points "**1**" and "**2**" in planes "**a**" and "**b**".
   Big-end bearing
   diameter .....**72.5 mm** (2.854 in)

Note! If the measurements are only slightly outside specification, take additional measurements when new bearing shells have been fitted.

10. Remove the big-end bearing cap and fit new bearing shells.
    Refit the bearing cap.
    Tighten the bolts as specified:
    Initial tightening torque ..... **30 Nm** (22 lbf.ft.)

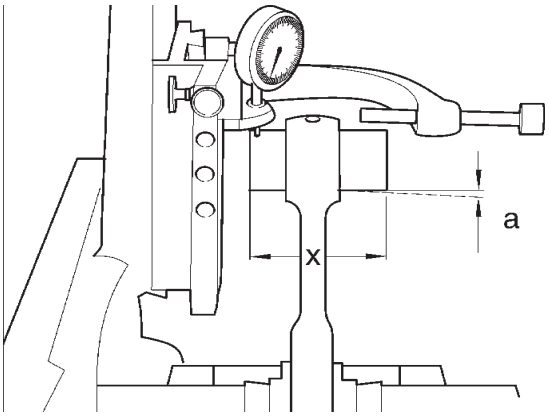


11. Measure the bearing shells at points "**1**" and "**2**" in planes "**a**" and "**b**".
    Big-end bearing shells:
    Inside diameter
    Ø.....**68.03 mm** (2.678 in)
    Oversize:
    0.0098 in
    (0.25 mm).....**67.78 mm** (2.668 in)
    0.02 in
    (0.5 mm).....**67.53 mm** (2.659 in)
    Wear limit:
    Radial play for big-end
    bearings .....**0.12 mm** (0.0047 in)

Note! If the wear does not exceed the bearing tolerances by more than **0.015 mm** (0.00059 in), the connecting rod can still be used. If the limit is exceeded, change the connecting rod.

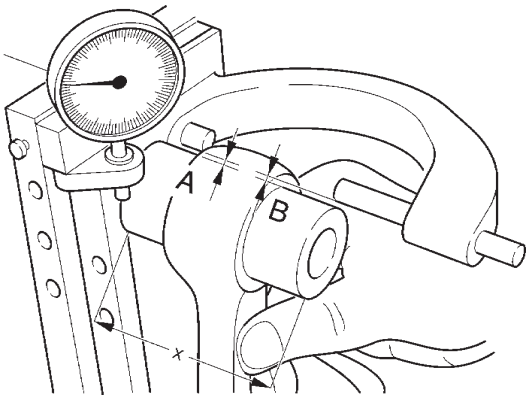
If you suspect that one of the connecting rods might be bent or twisted, check the connecting rods in the connecting rod test jig.

Note! Check the connecting rods without bearing shells.



12. Use a piston pin to measure the straightness of the connecting rod.

    Permitted tolerance a = **0.05 mm** (0.002 in) over a distance (x) of 100 mm (3.94 in).



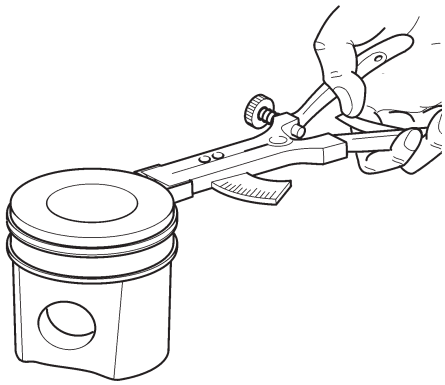
13. Use a piston pin to measure the twist of the connecting rod.

    Permitted tolerance a = **0.05 mm** (0.002 in) over a distance (x) of 100 mm (3.94 in).

Pistons

Special tools:

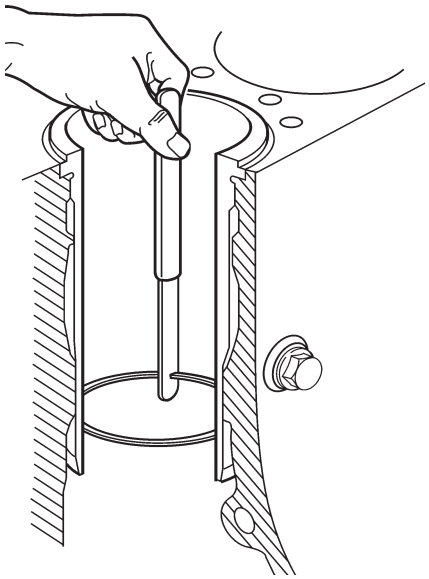
Piston ring pliers..... 998 5423



1. Remove the circlip.
   Remove the piston pin.

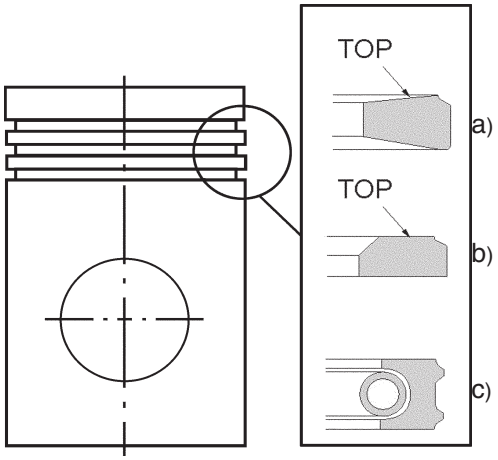
2. Remove the piston rings, using the piston ring pliers (998 5423).

Note! Clean and inspect the piston and piston ring grooves.



3. Check the piston ring gaps, see the diagram. To take the measurement, push the piston down **below the BDC point** using a piston. Measure the ring gap with a feeler gauge.
   Maximum wear limits:
   Upper compression ring .....**0.8 mm** (0.031 in)
   Lower compression ring .....**2.5 mm** (0.098 in)
   Oil scraper ring.....**1.15 mm** (0.045 in)

4. Clean and inspect the piston, including the ring grooves.

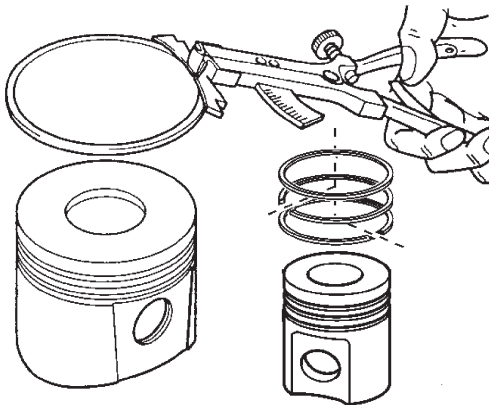


Order and positions of piston rings

5. Fit the oil scraper ring (c).

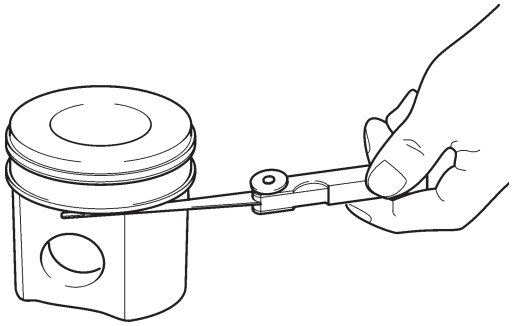
6. Fit the chamfered compression ring (b) with the word “Top” facing the combustion chamber.

7. Fit the keystone compression ring (a) with the word “Top” facing the combustion chamber.



8. Check that the displacement between the ring gaps is.....**120°**

Note! The joint in the spring inside the oil scraper ring should be displaced by 180° from the ring gap.



9. Measure the piston ring clearance axially, using a feeler gauge.

   Wear limits:

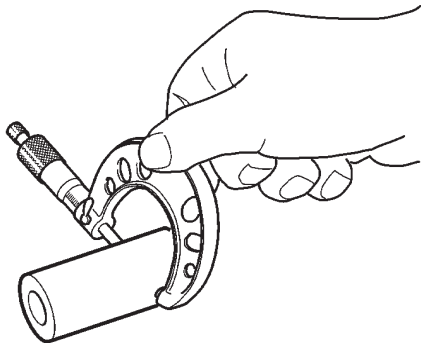
   Upper compression ring ..... Keystone

   Lower compression ring ....**0.17 mm** (0.0067 in)

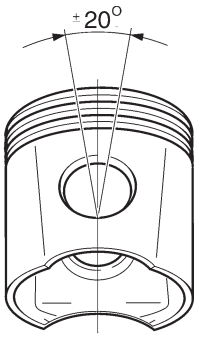
   Oil scraper ring.....**0.1 mm** (0.004 in)

10. Inspect the piston pin for wear.

    Piston pin diameter.....**42 mm** (1.65 in)

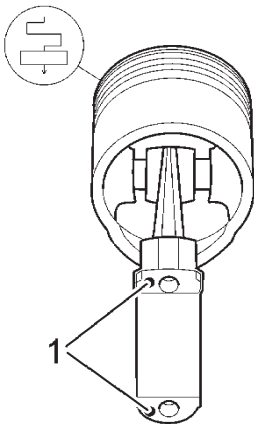


Assembling connecting rods and pistons



Note! The gaps in the circlips must be facing the top of the piston.

1. Fit one of the circlips in the correct position.



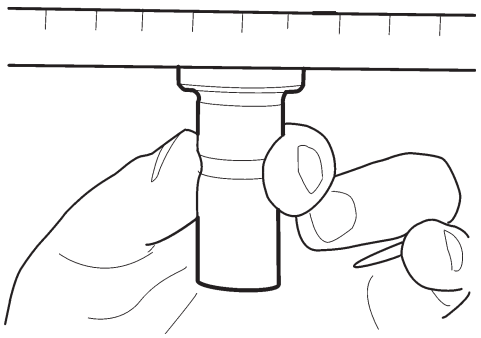
2. Fit the connecting rod to the piston. The fly-wheel symbol on the piston and the locating pins (1) on the connecting rod must be on the same side.

3. Fit the other circlip in the correct position.

Camshaft

Special tools:

Dial gauge 999 9876
Fitting tool, camshaft bearings..... 999 8695



Camshaft and valve tappets, checking

Use a steel rule to check that the surface that the camshaft runs on is convex or flat. If the surface is concave, change the tappet.

If the tappet is worn across the running surface, it should be changed. The “groove” indicates that the tappet has not being rotating.

A dark ring around the edge of the running surface, on the other hand, indicates that the surface is not excessively worn. The condition of the tappets determines whether it is necessary to check the camshaft for wear.

Check that the running surfaces of the camshaft and tappets are not badly pitted. Pitting can have various causes. The damage is caused by small fragments of metal coming loose from the hardened surface. A camshaft and tappets with only moderate pitting can be used. Pitting damage rarely gets worse.

Check that the camshaft bearing surfaces and cams are not worn abnormally. For example, the cams can be worn at an angle in the axial direction. In mild cases, this can be corrected by honing.

Change the camshaft if it is badly damaged or worn.

Note! If the camshaft is changed, all of the tappets must also be changed.

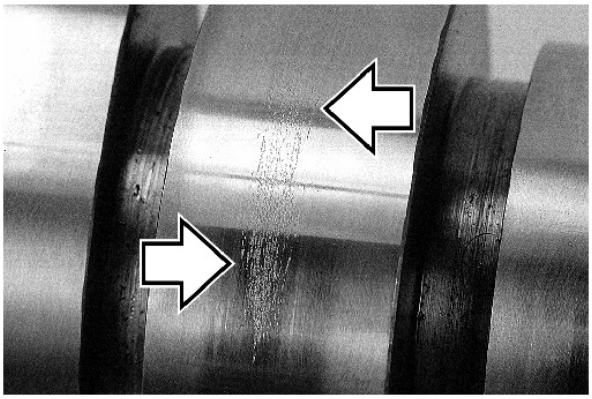
Guidelines for changing

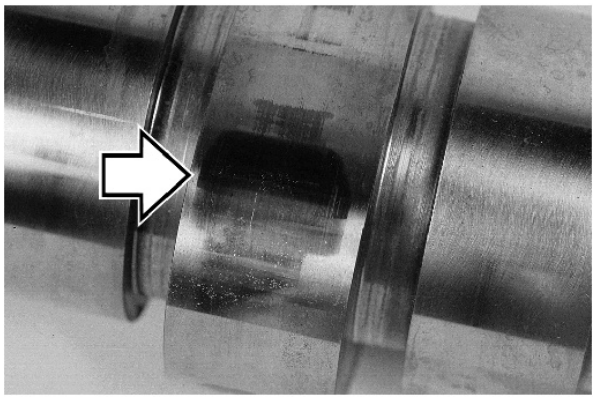
Under normal running conditions, the surfaces of the camshaft cams can become uneven. This does not mean that the camshaft has to be changed. These marks have no negative effect on either engine performance or the life expectancy of the engine and its components.

Below are examples of acceptable and unacceptable wear.

Acceptable wear

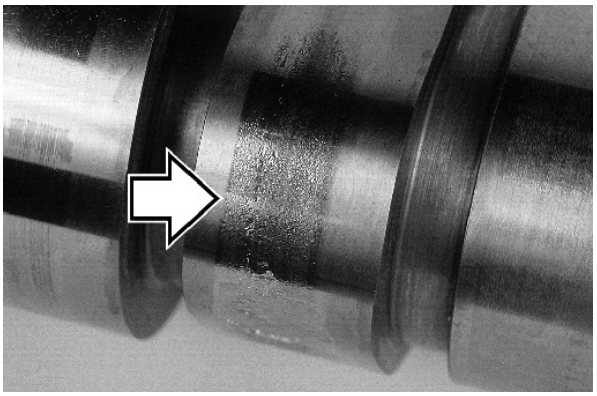
These camshafts do not need to be changed.

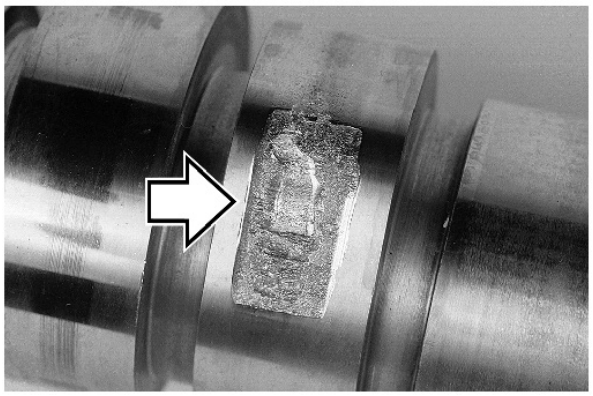




Unacceptable wear

Note! These camshafts and their rocker arms must be changed.

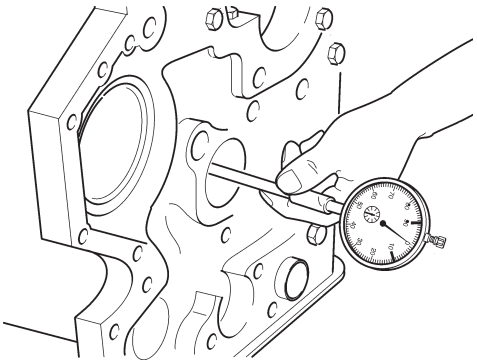




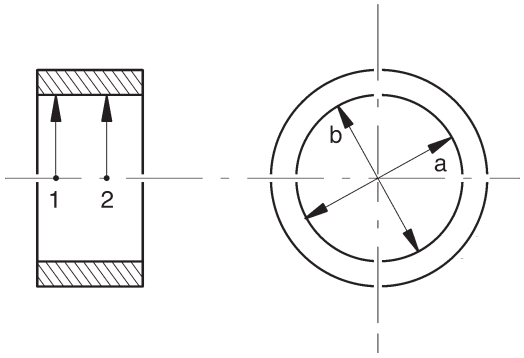
Camshaft bearings, checking

Special tools:

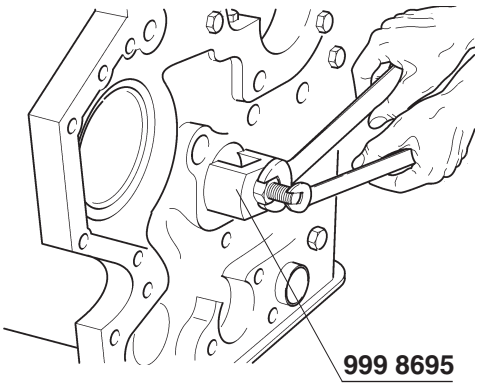
Camshaft bearing fitting tool..... 999 8695
Dial gauge 998 9876



1. Set the internal dial gauge .....**65 mm** (2.56 in)

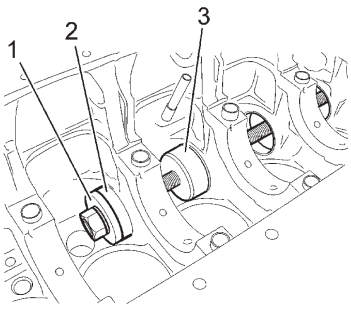


2. Measure the bushings at points “**1**” and “**2**” in planes “**a**” and “**b**”, see diagram
   Inside diameter.....**65 mm** (2.56 in)
   Wear limit .....**65.08 mm** (2.5622 in)

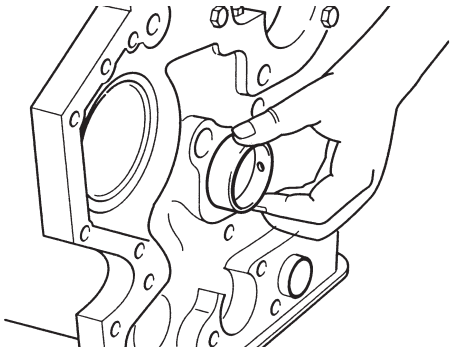


Camshaft bearings, changing

1. Remove the bearings, they can be pulled out in either direction.
   Use tool 999 8695.

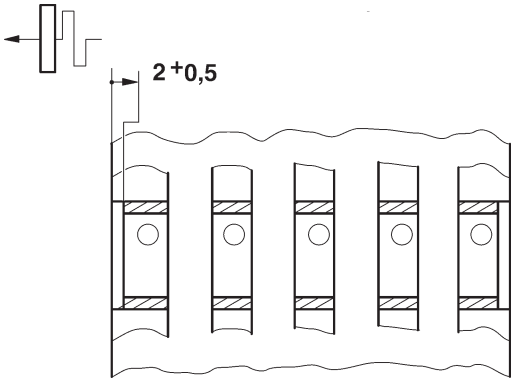


1. Guide tube
2. Bushing
3. Press tube

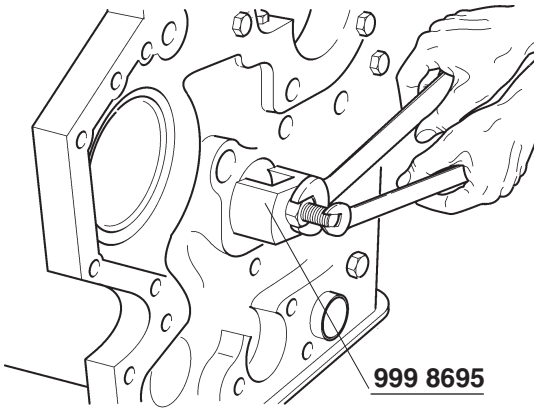


2. Position a new bearing.

Note! The lubrication holes must be aligned with the oil channels in the bearing seats.



Note! The widest bearing, 27 mm (1.06 in), should be at the flywheel end.

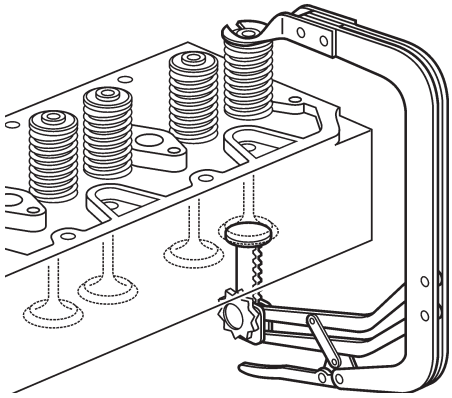


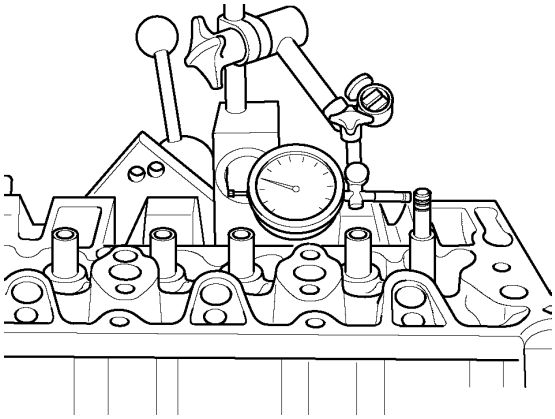
3. Press in the bearings using tool 999 8695.

Cylinder head

Special tools:

Valve spring compressor 998 5468





1. Put the cylinder head in a vice.
2. Remove the valve cotters, valve disc, valve spring and valve using the valve spring compressor (998 5468).
3. Remove the valve stem seal.
4. Clean the cylinder head and inspect it for damage.
5. Lower the valve a little so that it is not in the seat.
6. Measure the play between the valve stem and valve guide.

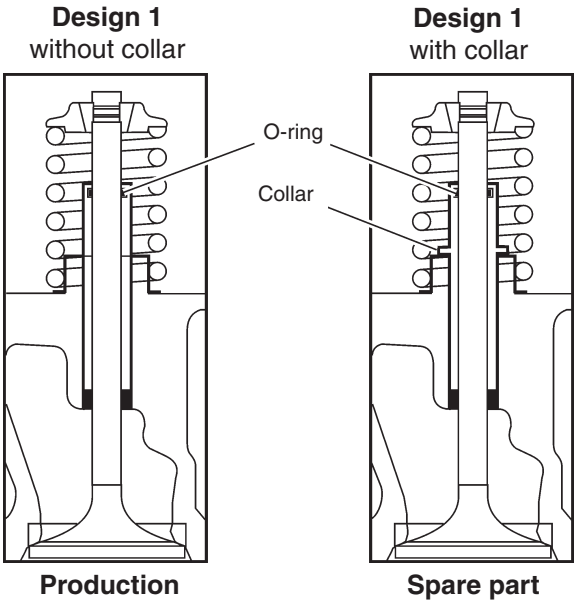
   Wear limits:

   Inlet.....**0.1 mm** (0.004 in)

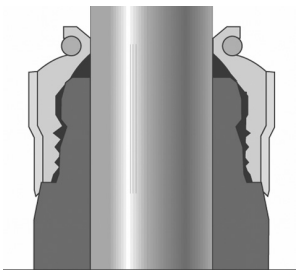
   Exhaust .....**0.13 mm** (0.005 in)

Note! Take the measurements with a new valve. Change the valve guide if it is excessively worn.

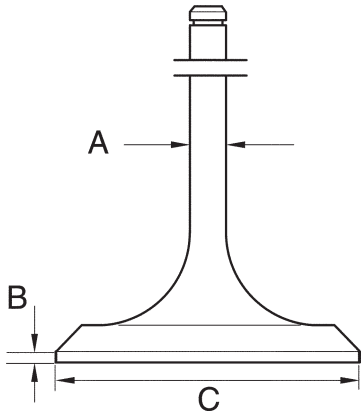
There are different designs of valve guide, depending on whether they are spare parts of factory-fitted, see the diagrams below.



Design 2



On later versions, the O-ring seal has been replaced by a valve stem seal, as shown above.

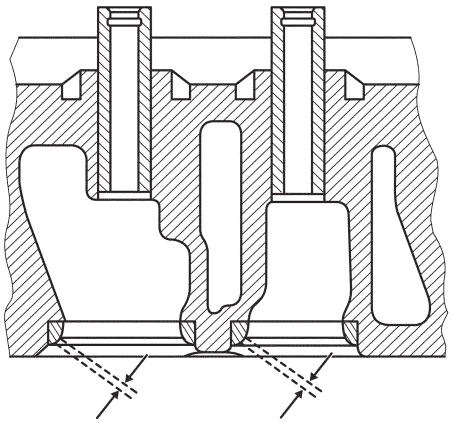


7. Inspect the valves and measure them.

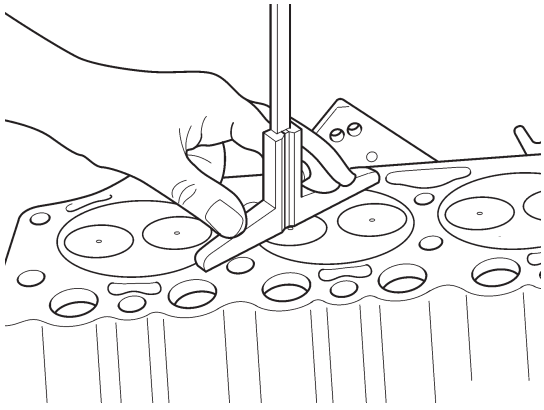
A - Valve stem diameter, Ø, standard:
Inlet.....**8.98 mm** (0.3535 in)
Exhaust .....**8.96 mm** (0.3527 in)

B. - Edge of valve head:
Inlet, min.....**2.1 mm** (0.08 in)
Exhaust, min.....**1.8 mm** (0.07 in)

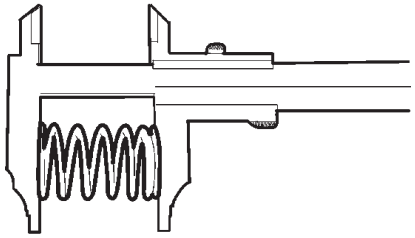
C. - Valve head diameter:
Inlet.....**48 mm** (1.89 in)
Exhaust .....**42 mm** (1.65 in)



8. Check the valve seat rings and valve seat.
Width of valve seat:
Inlet.....**2.8 mm** (0.11 in)
Exhaust .....**2.2 mm** (0.09 in)



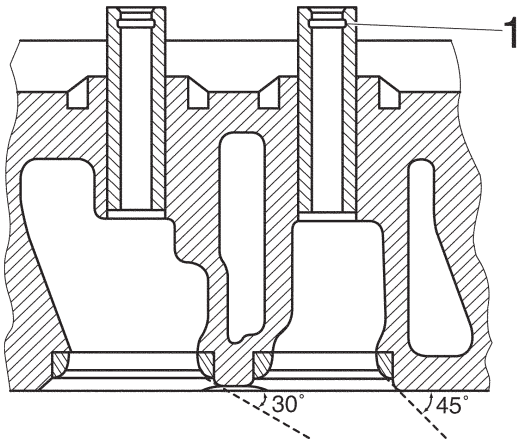
9. Measure the distance between the center of the valve head and the face of the cylinder head.
Inlet/exhaust.....**1.5 mm** (0.06 in)



10. Measure the length of the valve spring with the spring unloaded. Use a vernier caliper.
    Length unloaded.....**64.7 mm** (2.547 in)

11. Correct the angle of the valve seats in the cylinder head with the milling tool.
    Inlet.....**30º**
    Exhaust **45º**
    Width of valve seat:
    Inlet.....**2.8 mm** (0.11 in)
    Exhaust .....**2.2 mm** (0.09 in)

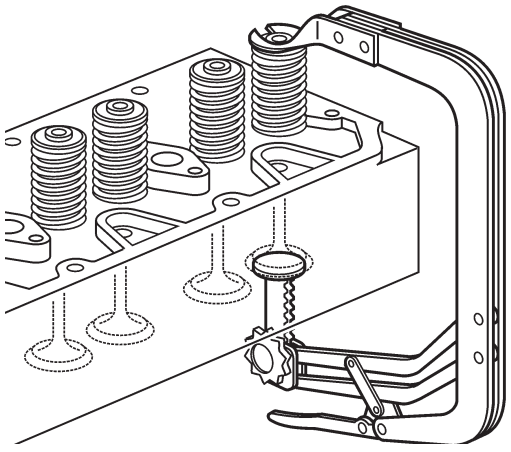
Note! Remeasure the depth of the valve seat in the cylinder head after the valve seats have been milled



12. Fit the valve stem seal (**1**).

13. Fit the valves, valve springs and valve discs.

Note! Oil the stems of the inlet and exhaust valves Carefully insert the valves, using a slight turning motion. The O-ring (**1**) is very thin and easily damaged.



14. Use the valve spring compressor (998 5468) to compress the springs.
    Insert the valve cotters.

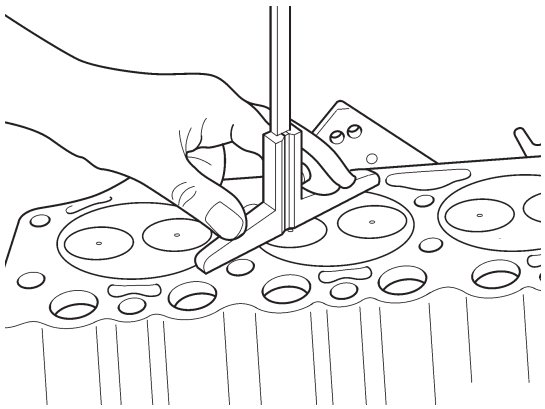
Valve seats, changing

21405, 21406

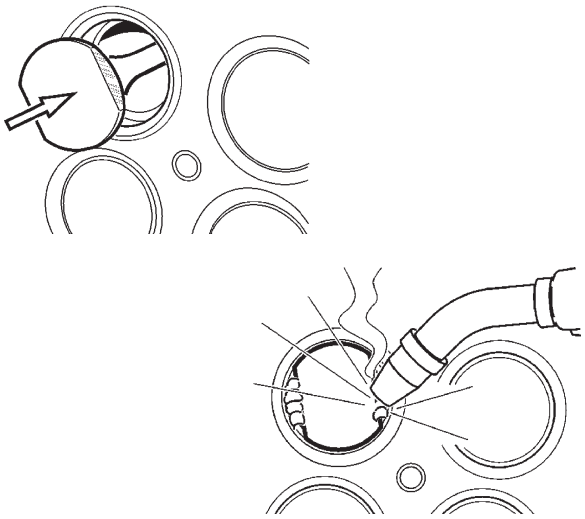
Special tools:

Dial gauge 999 9876

With the cylinder head removed

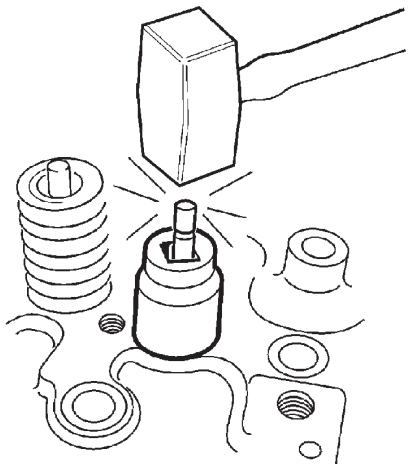


1. The valve seats should be changed when the measurement between the head of the valve and the face of the cylinder head exceeds the specification, or when they are not sealing properly. Maximum 1.5 mm (0.059 in).



2. Grind down the head of an old valve and weld it onto the valve seat. Use a MAG welder or a conventional arc welder (with a stainless steel welding rod).

⚠ **IMPORTANT:** Cover other areas of the cylinder head, so that welding spatter does not become attached.



3. Place a suitable tube around the valve/valve guide and **carefully** knock out the valve seat.

Note! Take care to avoid damaging the cylinder head.

4. Clean the valve seat recess thoroughly and inspect the cylinder head for cracks.

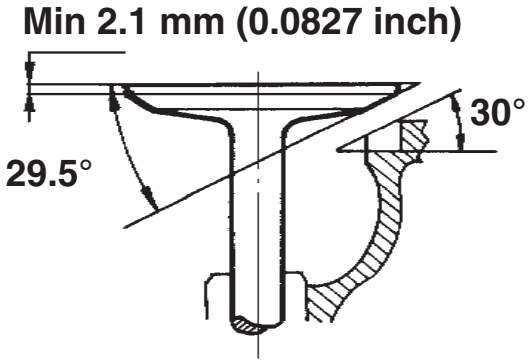
5. Measure the diameter of valve seat recess. Determine whether a standard size or oversize seat will have to be used.
Machine the valve seat recess, if necessary (see “Technical data”).

6. Cool the seat in dry ice to between -60°C and -70°C (-76°F and -94°F) and warm the cylinder head with hot water, by pouring it over or in some other way.
Press in the valve seat with a drift.

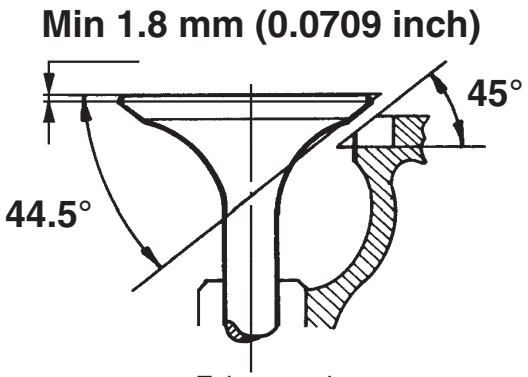
Note! The seating chamfer of the seat should be facing the drift.

Valve seats, grinding

21405, 21406



Inlet valve



Exhaust valve

Note! The valve seats supplied as spare parts are pre-machined, and should not require further grinding.

1. Before grinding the valve seats, the valve guides should be checked, and changed if the wear tolerances are exceeded.

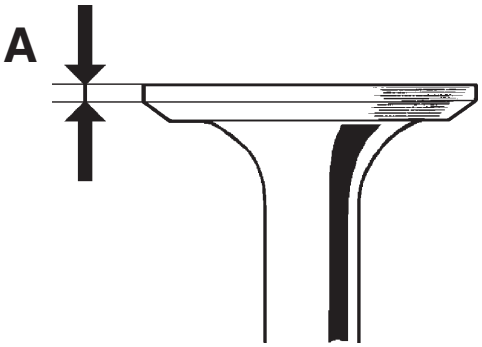
2. When grinding the valve seats, the minimum of material necessary to give the seat the correct shape and the valve head a good mating surface should be removed.

3. Grind the valve seat down until the measurement between the face of the cylinder head and the surface of the valve head is as specified.

4. Check the angle of the valve seat with a valve seat gauge, after first applying a thin layer of marking blue to the mating surface of the seat.

Valves, grinding

21401, 21402



See “Technical data” for the angles of the valve sealing surfaces.

Note! The valves supplied as spare parts are premachined, and should not require further grinding.

1. The sealing surface should be ground as little as possible, but sufficiently to remove all damage.

2. Check the measurement (A) at the edge of the valve head. Change the valve if the measurement is less than the wear tolerance specified in “Technical data.”

   Always change a valve that has a bent stem.

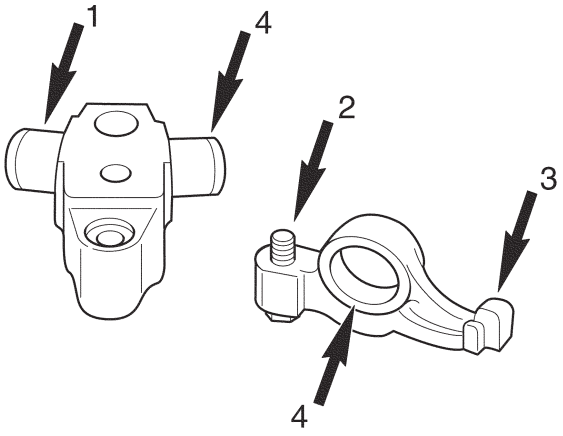
3. Check whether the valve is sealing properly, using marking blue.

   If it is not sealing properly, grind the seat more (but not the valve), and then recheck the seal.

   When a good seal has been achieved by grinding, the valve and seat can be lapped together with a fine rubbing paste.

Rocker-arm bridge

21451, 21452



Dismantling / checking / assembling

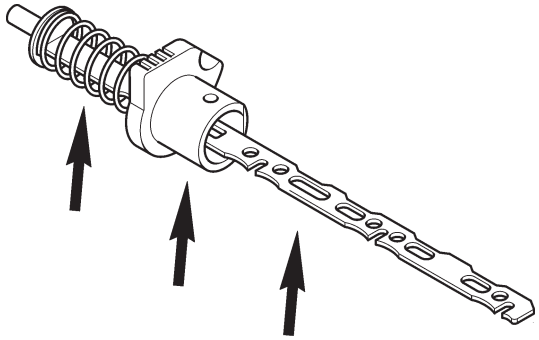
1. Dismantle the rocker arm and rocker-arm bridge.

2. Inspect for wear:
   1. Bearing journal
   2. Adjusting screw
   3. Rocker arm contact surface
   4. Diameter
   Change if there is abnormal wear.

3. Check that the oil channels are clear.

4. Assemble the rocker arm and rocker-arm bridge.
   Fit the circlips.

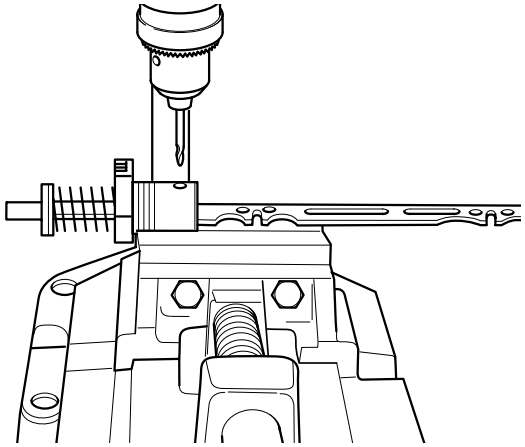
Control rod



Inspect the control rod

1. Inspect the control rod and change any damaged parts.

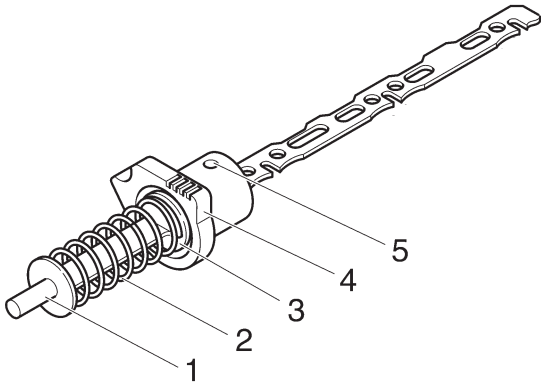
Note! When changing the control rod, The regulator must always be adjusted. Only a qualified specialist should perform the adjustment, on a regulator test bench.



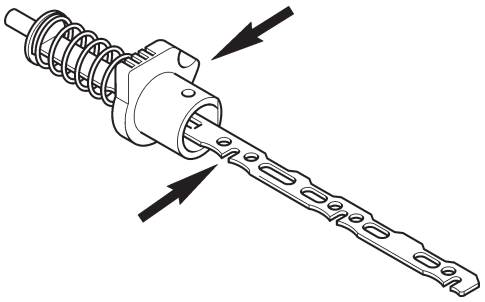
Dismantling

2. Drill out the spring tension pin in the guide bushing and remove them.

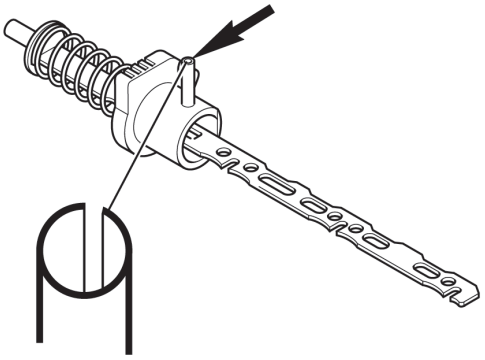
Note! Always change the guide bushing and spring tension pin when dismantling the control rod.



3. **Assembly sequence:**
   - **1.** Control rod
   - **2.** Compression spring
   - **3.** Washer
   - **4.** Guide bushing
   - **5.** Spring tension pin



4. Make sure the control rod is the right way round in the guide bushing.

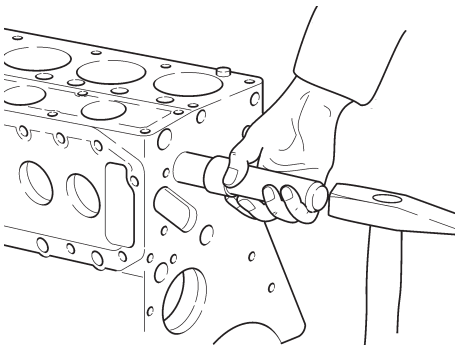


5. Insert the spring tension pin as shown in the diagram. Press the pin in as far as it will go.

Control rod guide bushings

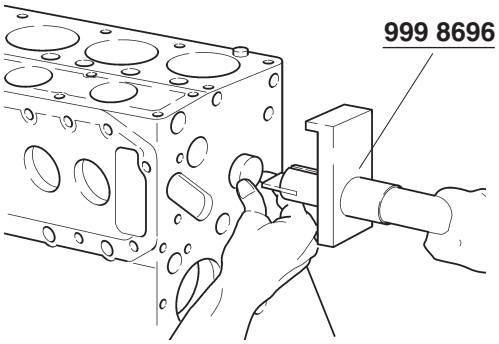
Special tools:

Fitting tool for control rod bushings..... 999 8696
Standard handle 999 2000

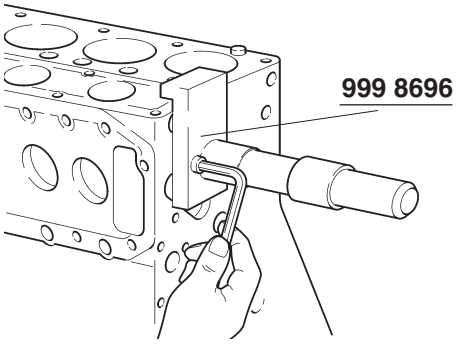


1. Remove the plug at the front end and drive out the guide bushing.

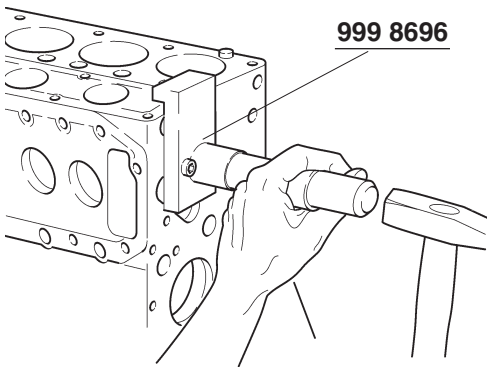
   D7: Also drive out the guide bushing at the flywheel end.



2. Place the guide bushing on the drift, with the chamfer towards the crankcase.



3. Place fitting tool 999 8696, together with the drift, against the engine block and secure it with a bolt.



4. Drive the guide bushing in until the short drift (999 8696) bottoms against the holder.

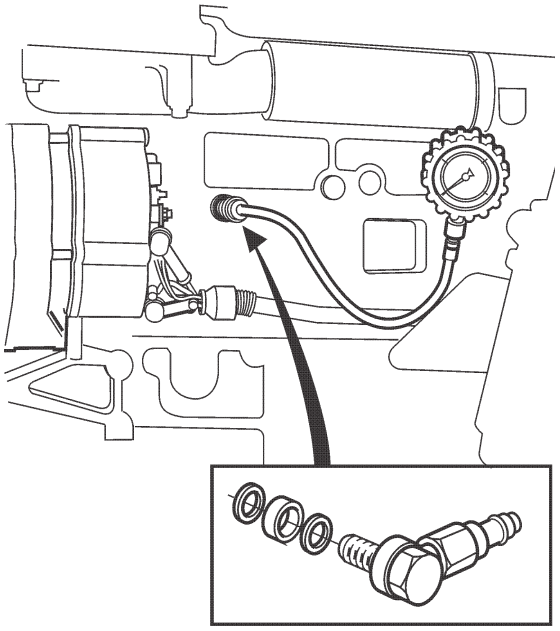
5. **D7:** Drive the guide bushing in the from the flywheel end. Repeat points 1 – 4, using the long drift.

Lubricating oil pressure

22002

Special tools:

Manometer 999 6398
Nipple 999 6066
Spacer ..... P/N 1678297
Banjo bolt..... P/N 180211
Alternative:
Pressure transducer module 999 8496
with hose 999 8493



1. Measure the lubricating oil pressure on the starter motor side, using a manometer, nipple and spacer, as shown in the diagram.

   Minimum oil pressure with engine warm and idling:

   D5..... 90 kPa (**0.9 bar**)
   D7..... 80 kPa (**0.8 bar**)

   At operating speed, see “Technical data.”

Repair procedures

Group 21: Engine

Valve clearance, checking / adjusting

21403

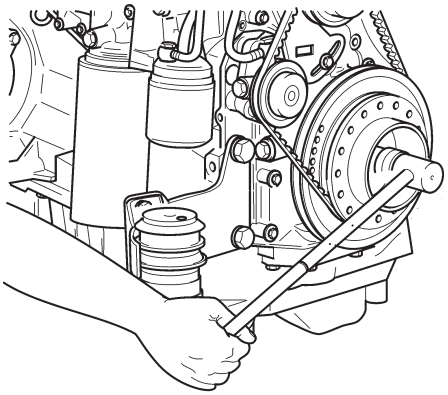
Special tools:

Turning tool, crankshaft 999 8676
Turning tool, flywheel 999 8681

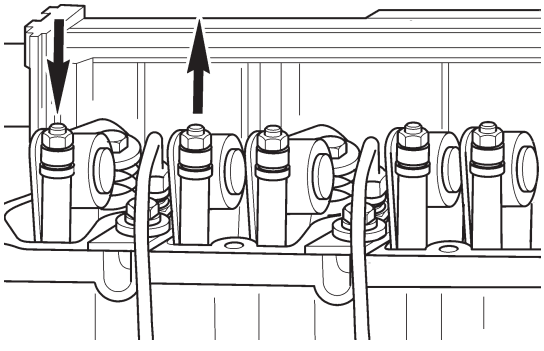
With the valve cover, crankcase ventilation, seawater pipe and charge air cooler removed

Note! Normally, the valve clearance is adjusted when the engine is cold or has cooled down for at least half an hour.
Oil temperature ≤ 80°C (≤ 176°F).

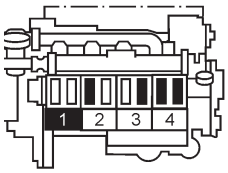
Note! The valve clearance should be at the high limit when the cylinder head gasket has been changed, and at the low limit after the engine has run for 50 hours.



1. Turn the crankshaft until the two valves for cylinder 1 are passing one another, that is to say, the exhaust valve is closing and the inlet valve is opening.



Note! It should not be possible to rotate either of the push rods for the cylinder in question in this position.



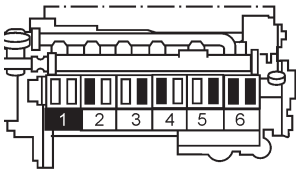
2. Adjust the valve clearance for the particular cylinder, as shown by the **black marks**.

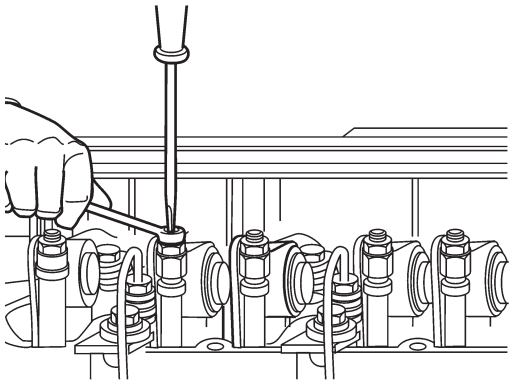
   Put a chalk mark on the rocker arm when a valve has been adjusted.

   Valve clearance:

   Inlet.....**0.35 mm** (0.014 in)

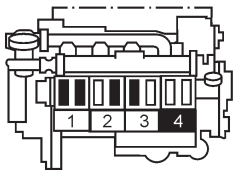
   Exhaust .....**0.55 mm** (0.022 in)





3. Tighten the locknut to ..... **20 Nm** (15 lbf.ft.)

   Recheck the clearance with the feeler gauge.



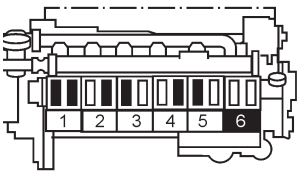
4. Turn the crankshaft round one complete rotation (360°).

   Adjust the valve clearance for the relevant cylinder, with the feeler gauge, as shown by the **black marks**.

   Put a chalk mark on the rocker arm when a valve has been adjusted.

5. Tighten the lock nut to ..... **20 Nm** (15 lbf.ft.)

   Recheck the clearance with the feeler gauge.



6. Fit the valve cover, using a **new** gasket.

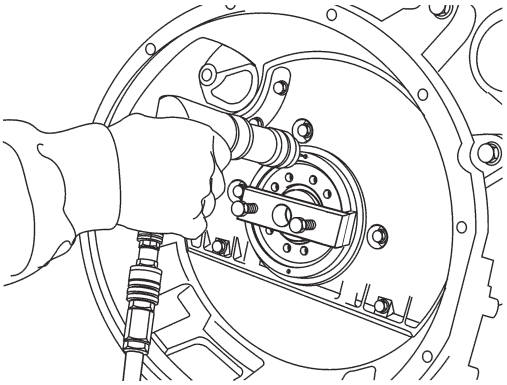
Crankshaft seals, changing (complete engine)

Special tools:

Standard handle, drifts 999 2000
Fitting/removing tool, rear 999 8672
Fitting/removing tool, front 999 8673
(Timing gear housing, flywheel end)

Rear crankshaft seal, changing

21671



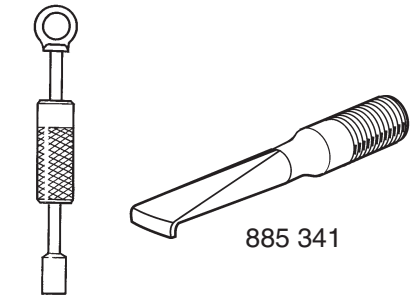
1. Remove the flywheel.

Note! The flywheel weighs around 55 kg (121 lb).

2. Remove the crankshaft seal from the timing gear housing using tool 999 8672.

3. Drill two **3.5 mm** ($^{9}/_{64}$ in) holes into the seal, through the predrilled holes in the tool.

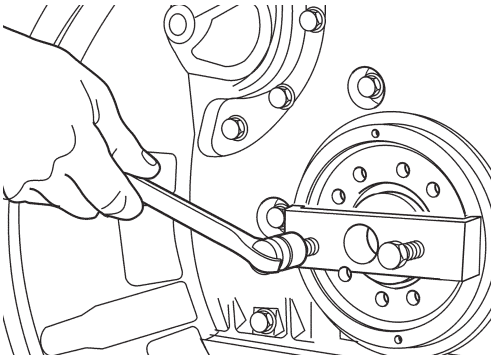
Note! Drill no deeper than **8 mm** (0.3 in).



999 6400

Alternative:

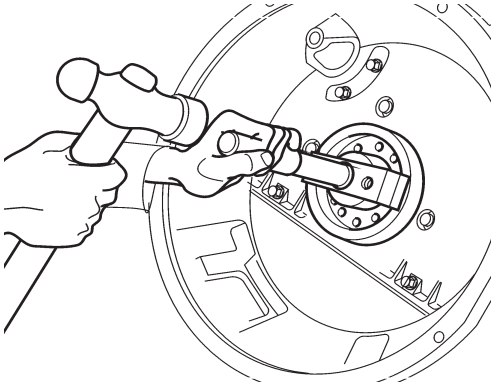
Use extractor 885 341 attached to slide hammer 999 6400.



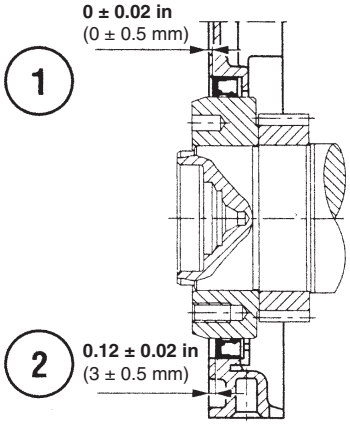
4. Screw a self-tapping screw into each of the two drilled holes.

Note! Maximum screw length **40 mm** (1.5 in).

5. Pull out the seal using the bolts in the tool.



6. Lightly oil the sealing lip of the new seal and put it on tool 999 6872 with the lip towards the crankshaft.



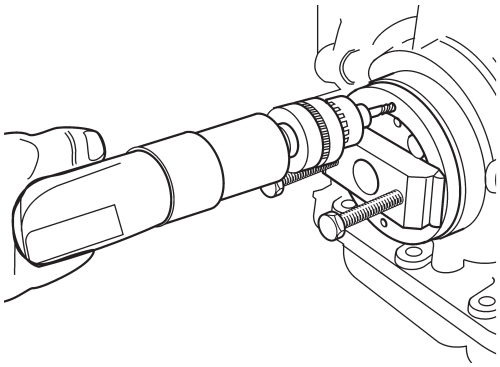
Note! The original fitting position of the seal is position **1**, see diagram.

The fitting position (2) of the tool is when the crankshaft has measurable wear in position (1).

Use a drift to drive the seal carefully into the desired position

Front crankshaft seal (front housing), changing

21672

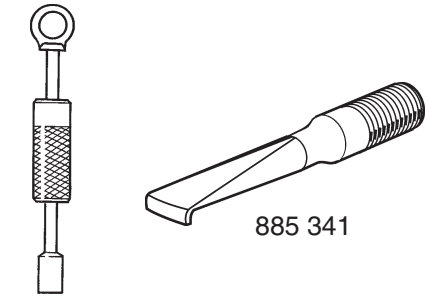


1. Remove the crankshaft pulley and vibration damper.

2. Remove the crankshaft seal from the front housing, using tool 999 8673.

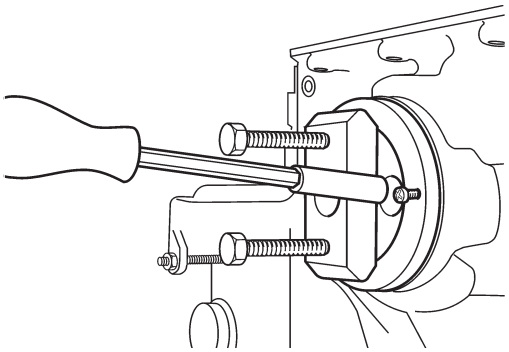
   Drill two **3.5 mm** ($^{9}/_{64}$ in) holes into the seal, through the predrilled holes in the tool.

Note! Drill no deeper than **7.5 mm** (0.3 in).



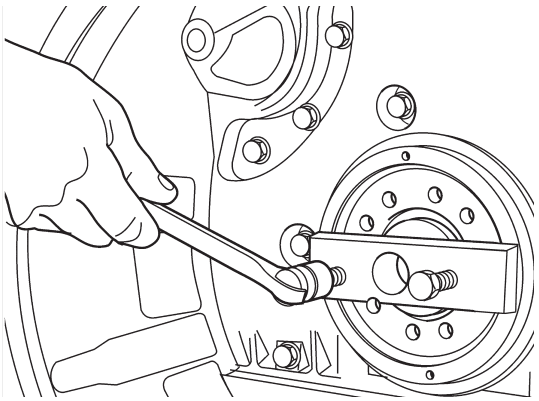
Alternative:

Use extractor 885 341 attached to slide hammer 999 6400.

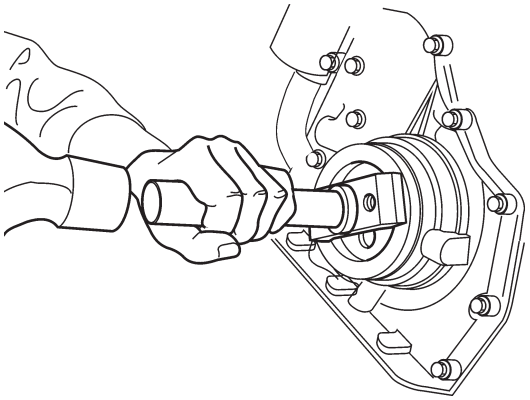


3. Screw a self-tapping screw into each of the two drilled holes.

Note! Maximum screw length **32 mm** (1.3 in).



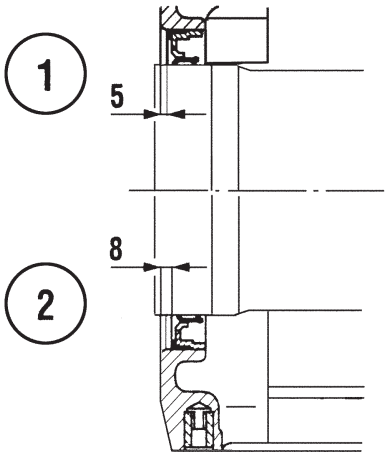
4. Pull out the seal using the bolts in the tool.



5. Lightly oil the sealing lip of the new crankshaft seal and put it onto tool 999 6873.

   The sealing lip should be towards the crankshaft.

   Use standard handle 999 2000 and carefully drive the seal into the correct position.



Note! The original fitting position of the seal is position **1**, see diagram.

The fitting position (2) of the tool is when the crankshaft has measurable wear in position (1).

Use a drift to drive the seal carefully into the desired position.

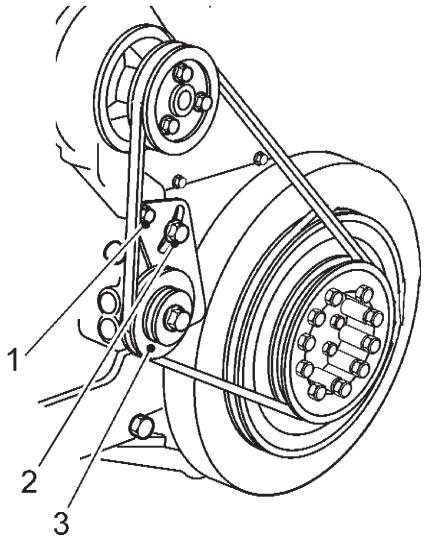
Drive belts, adjusting

26342

⚠ **IMPORTANT:** Check, tension or change drive belts only when the engine is stationary. Replace the belt guard.

Note! Change belts that are oily, worn or damaged in some other way.

Note! The belts are correctly tensioned when the belt can be pressed in **10 mm** (0.4 in) midway between the pulleys.

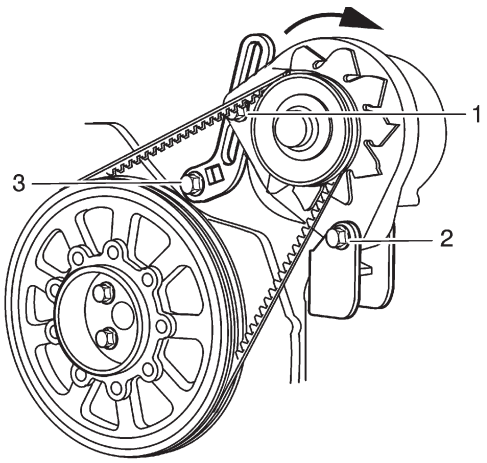


Coolant pump / fuel pump

1. Slacken bolts 1 and 2.
2. Press the fuel pump to the **left** until the belt tension is correct.

⚠ **IMPORTANT:** Do not tension the belt too much, as this can damage the bearing in the fuel pump.

3. Tighten bolts 1 and 2.



Generator

1. Slacken bolts 1 and 2.
2. Press the generator to the **right** until the belt tension is correct.
3. Tighten bolts 1 and 2.

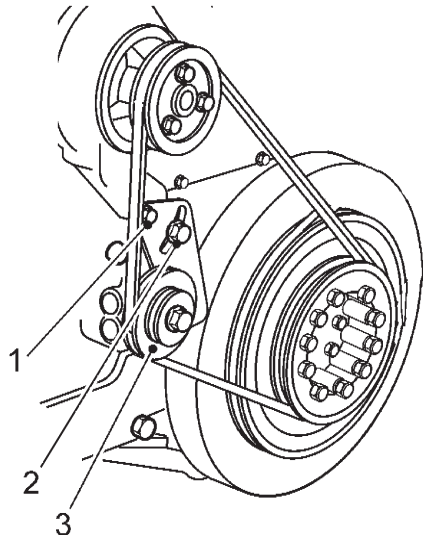
Drive belts, changing

26341

⚠ **IMPORTANT:** Checking, tensioning or changing of drive should be done only when the engine is stationary. Replace the belt guard.

Note! Change belts that are oily, worn or damaged in some other way.

Note! The belts are correctly tensioned when the belt can be pressed in **0.4 in** (10 mm) midway between the pulleys.

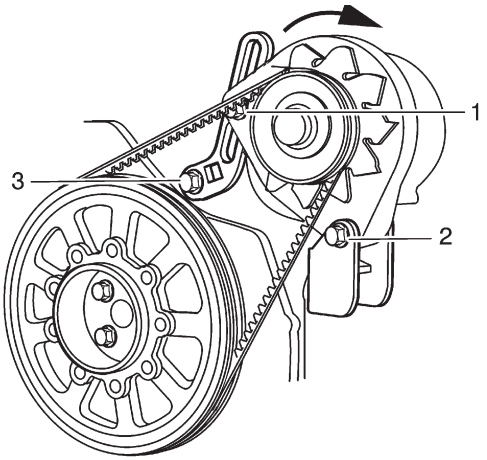


Coolant pump / fuel pump

1. Slacken bolts 1 and 2.
2. Move the fuel pump (**3**) to the **right**.
3. Remove the old belt and inspect the pulleys for wear.
4. Fit the new belt.
5. Press the fuel pump to the **left** until the belt tension is correct.

⚠ **IMPORTANT:** Do not tension the belt too much, as this can damage the bearing in the fuel pump.

6. Tighten bolts 1 and 2.

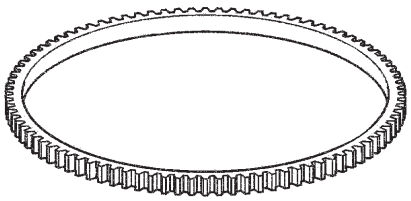


Generator

1. Slacken the coolant pump/fuel pump drive belt as described above.
2. Slacken bolts 1 and 2.
3. Move the generator to the **left** and remove the old belt.
4. Fit the new belt and press the generator to the **right** until the belt tension is correct.
5. Tighten bolts 1 and 2.

Flywheel ring gear, changing

21687

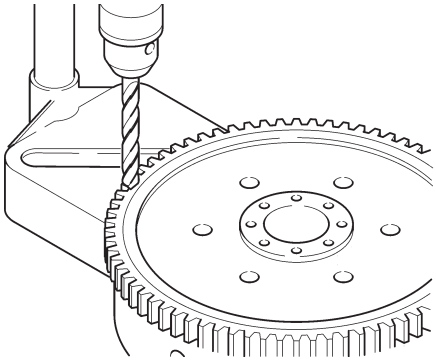


1. Heat the new ring gear to a maximum of 210°C (410°F).

Use an oven or gas welding torch.

If you use an oven, begin by putting the new ring gear in the oven.

If you use a welding torch, heat the ring gear immediately before fitting it.

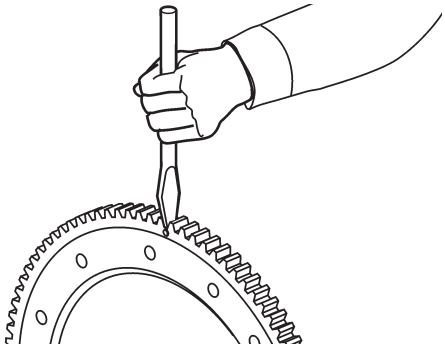


2. Drill a hole between two of the teeth

Use a 10 mm (**$^{25}/_{64}$ in**) drill.

Drill a 9 mm (**0.3 in**) deep hole.

⚠ **IMPORTANT:** Do not drill into the flywheel, as it could become unbalanced.

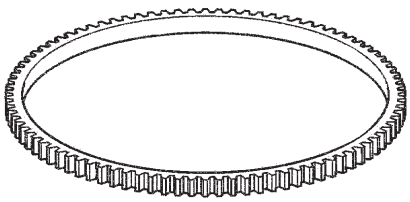


3. Remove the ring gear

Clamp the flywheel in a vice with soft jaws.

Pry the ring gear off with a screwdriver. If necessary, split the ring gear at the drilled hole.

Clean the mating surfaces of the flywheel.



4. Fit the new ring gear

Check the temperature.

Put the ring gear in position, so that it bottoms against the flange on the flywheel.

If necessary, tap the ring gear down to the bottom with a brass drift.

Let the ring gear cool.

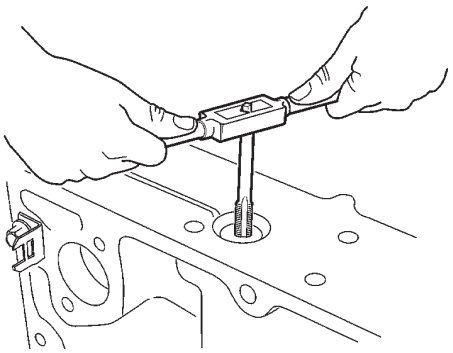
Group 22: Lubrication system

System pressure valve

22020

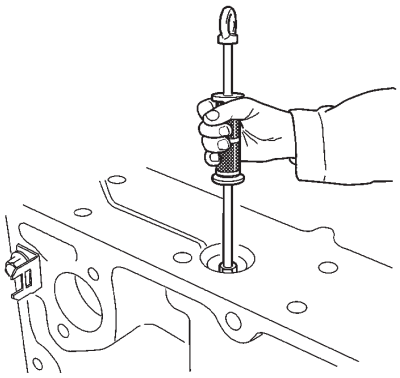
Special tools:

Adapter 999 8674
Puller 999 6400

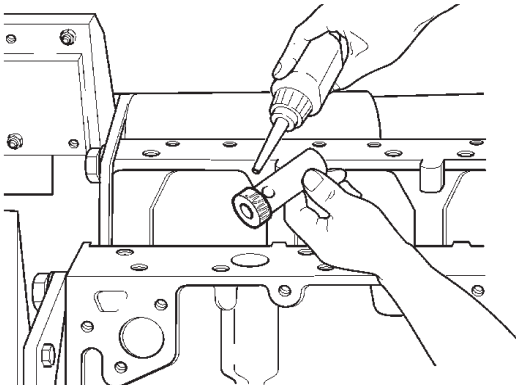


Removing

1. Cut a thread in the hole in the pressure regulation valve, using an M8 tap.



2. Pull out the pressure regulation valve using tool 999 6400 and adapter 999 8674.



Fitting

3. Apply locking compound (1161351-0) to the new pressure regulation valve.

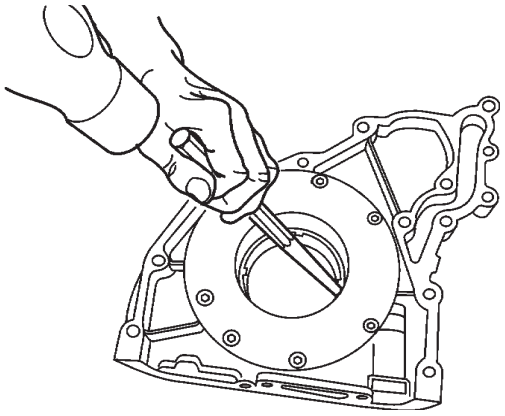
4. Drive in the pressure regulation valve, using a brass drift.....**20 mm** (0.79 in)

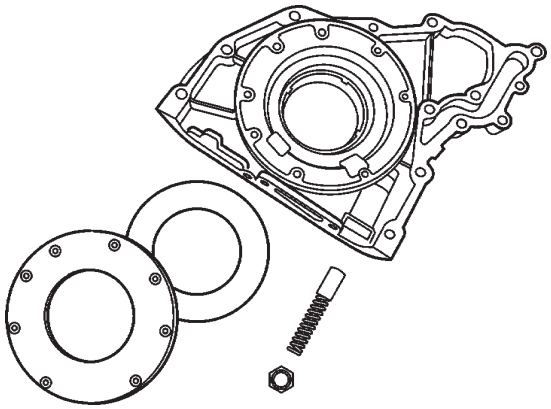
Front housing, oil pump

22111

Special tools:

Standard handle 999 2000
Fitting/removing tool 999 8673





Removing

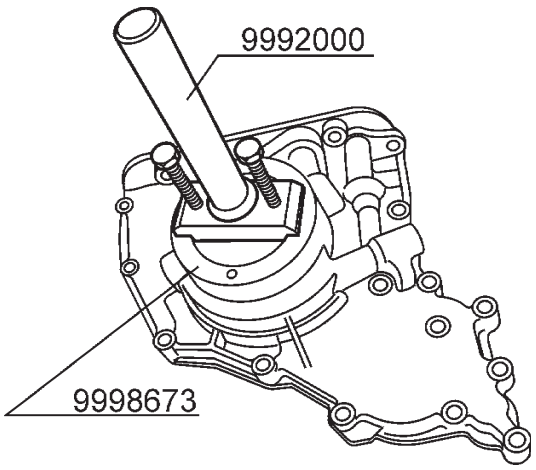
1. Drive out the crankshaft seal, using a drift.

2. Remove the oil pump and system pressure valve.
   Clean the front housing.

3. Press down the compression spring and remove the retaining plate.
   Remove the spring and valve for inspection. Also check the valve seat in the housing.

Note! Be careful, the spring is very strong. A good quality spring compressor is required.

4. Remove the gear assembly and inspect it for abnormal wear.
   If necessary, fit a new gear assembly, lightly oiled.
   Tighten the bolts to..... **8-9 Nm** (6-7 lbf.ft.)



Fitting

5. Fit the system pressure valve and spring.

6. Press down the compression spring and fit the retaining plate.

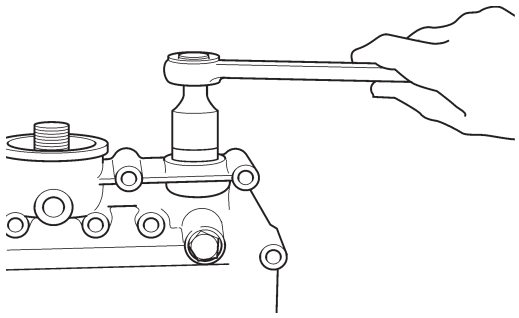
Note! Make sure the spring retaining plate is firmly in place. Lubricate it with a thin coating of oil before fitting it.

7. When the front housing has been fitted to the engine, fit the crankshaft seal, using fitting tools 999 8673 and 999 2000.

⚠ **WARNING!** Make sure you use the correct oil pump. The pumps for the D5 and D7 engines are different, see the “Spare parts catalogue.”

Oil cooler, inspecting / changing

22311

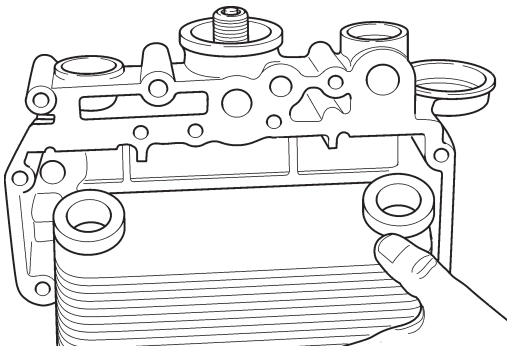


Inspecting

1. Remove the socket-head plugs (17 mm).

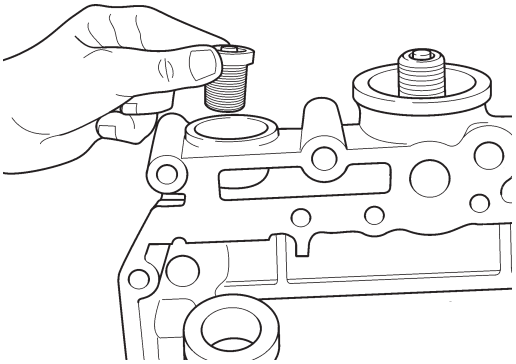
2. Remove the socket-head banjo bolts (17 mm) that hold the oil cooler.

3. Inspect all of the parts. If you suspect that there might be a leak, pressure-test the oil cooler (following page) and change it if necessary.



Changing

4. Put the radiator core into the cooler housing.



5. Put a new aluminum washer on the socket-head banjo bolt. Coat the threads with locking compound (1161053-2).

6. Tighten the banjo bolt in two stages:
   1 ..... **80 Nm** (59 lbf.ft.)
   2 ..... **160 Nm** (118 lbf.ft.)

7. Fit a new O-ring to the socket-head plug and oil it lightly.

8. Tighten the plug to..... **80 Nm** (59 lbf.ft.)

9. Bolt on the oil cooler, using a new gasket.

Oil cooler, testing for leaks

22312

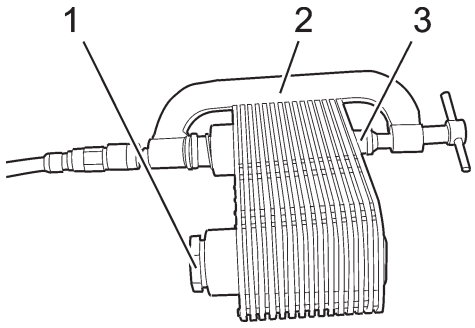
Special tools:

Pressure testing unit 999 6662
Pressure testing clamp 999 6685
Plug, M26 x 1.5 ..... P/N 942352
Spacer, 30 mm ..... P/N 912130

Note! The inside of the oil cooler core should be as dry as possible when the test is performed, as remaining water can have a sealing effect on any splits. It is also important to ensure that water does not get into the cooler element during the test.

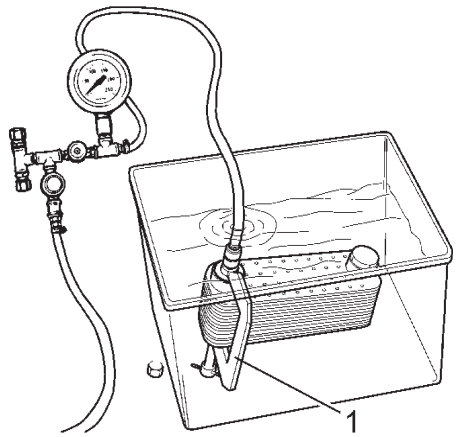
Note! Avoid starting or stopping the ventilation system, or letting air into or out of the room, as the air pressure in the room will then change, and can be misinterpreted as a leak.

Note! During the test, the oil cooler core should be at ambient temperature. Do not repair the core.



1. Attach the pressure testing clamp (2) to the cooler core, with a spacer (3), as shown in the diagram. Ensure that it is sealing fully.

2. Screw the plug (1) into the other connection.



3. Connect the pressure-testing unit.

4. Lower the oil cooler core into a water bath.

5. Adjust the pressure to 100 kPa (1 bar). Check for air bubbles coming from the core.

6. Raise the pressure to 500 kPa (5 bar). Maintain the pressure for 1 minute. The pressure should not drop.

Note! If the pressure drops during the test, there is a leak. Change the oil cooler.

Group 23: Fuel system

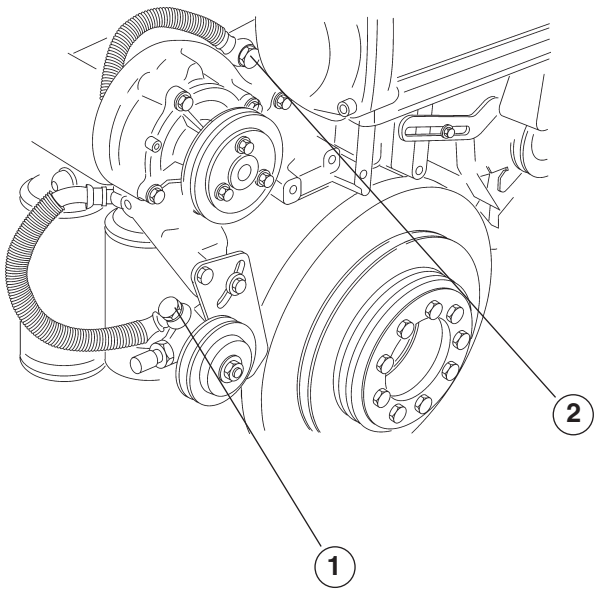
Fuel pump

Fuel feed pressure, checking

23315

Special tools:

Manometer 999 6398
Nipple 999 6066
Banjo bolt..... P/N 180211
Copper washer ..... P/N 969011
Alternative:
Pressure transducer module 999 8496
with hose 999 8493
Banjo bolt..... P/N 180211
Copper washer ..... P/N 969011



⚠ **IMPORTANT:** Clean the nipple and hose thoroughly before connecting them to the fuel system. The unit injectors are delicate and can easily be damaged by contaminants.

1. Measure the fuel pressure before and after the fuel filter. Use the manometer and nipple with a banjo bolt (P/N 180211) and new copper washers (P/N 969299).

   Feed pressure:

   1. after the pump: ..... 0.5 MPa / 5 bar

   2. after the filter:
   at 1,500 rpm: ..... **0.28 MPa / 2.8 bar**

Injector pumps, changing
23611

Before fitting the new injector pump, read "Injector pumps, fitting."

Note! Before fitting a new injector pump, check that the loss of power is really due to an injector pump and not to a damaged pressure pipe. Check the inside diameter of the pipe; it should be **0.07 in** (1.8 mm) for all D5 and D7 engines.

When fitting a new injector pump, the thickness of the shim under the pump must be calculated, in order to produce the correct injection time.

Perform the following procedure:

1. Thoroughly clean the engine before removing the rocker-arm cover. Dirt usually accumulates between the inlet pipe and valve cover.

2. Remove the plug between the first and second injector pumps, and attach special tool 999 8684.

3. Put the control rod in the stop position.

4. Check that the roller tappet for the pump in question is on the base circle of the camshaft.

   Slacken the pump retaining bolts a couple of turns and carefully tap the pump to see if it will move upwards.

Note! The pump is spring-loaded, which means that if the roller tappet is not on the base circle, the force of the spring can damage the threads in the engine block when the bolts are removed.

5. Take the shim off the roller tappet. Cover the hole to prevent dirt getting into the engine.

6. Read the **EP code** for the particular cylinder from the engine plate. Enter the figure in "Calculation 1, Technical data."

7. Read the corresponding corrected fitting measurement, **Ek**, from Table 3. Enter the figure in "Calculation 1, Technical data."

8. Read the length of the pump (basic measurement), $\mathbf{L_0}$, from Table 1. Enter the figure in "Calculation 1, Technical data."

9. Read the manufacturing tolerance for the pump, **A**, from the injector pump. Enter the value **A/100** in "Calculation 1, Technical data."

10. Calculate the theoretical shim thickness, $\mathbf{T_S}$, using the formula $\mathbf{T_S = Ek – (L_0 + A/100)}$. See "Calculation 1, Technical data."

11. Read the actual shim thickness $\mathbf{S_S}$, from Table 2.

12. Let the shim slide into place, for example down a screwdriver.

Note! Use only one shim.

13. Check that the roller tappet for the cylinder in question is on the base circle of the camshaft.

14. Turn the pump linkage to the center position, oil the O-rings for the pump and insert the pump.

Note! Check that the pump link arm is correctly entered into the slot for the fuel regulator before pushing the pump down.

15. Fit the pump flange with the chamfer facing the pump and tighten the bolts to an initial torque of ..... **5 Nm** (4 lbf.ft.)

    Back off the bolts through.....**60°**

16. Turn the injector pump carefully counterclockwise. Use socket 11668403 and a torque wrench.

    Note the torque that is required to turn the injector pump, for example **3.5 Nm** (**2.6 lbf.ft.**).

    Stop turning when the pump reaches its stop position and the turning torque has increased by.....**1 Nm** (0.7 lbf.ft.)

    Example: 3.5 + 1.0 = 4.5 Nm (3.3 lbf.ft.)

17. Tighten the pump flange bolts.....**60°**

    Then tighten them alternately, starting with the bolt furthest from the flywheel, to **7, 10 and 30 Nm** (5, 7 and 22 lbf.ft.).

18. After fitting the pump, Remove the special tool (999 8684) and check that the control rod can move freely.

19. Pretension the pressure pipe in two stages:

    1 ..... **5 Nm** (4 lbf.ft.)

    1 ..... **25 Nm** (18 lbf.ft.)

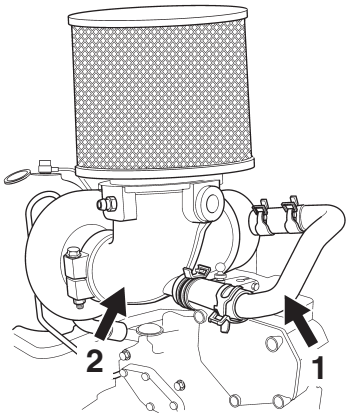
Note! A pressure pipe that has been removed must be scrapped and a new pipe used.

20. Fit the valve cover, using a new gasket.

    Tighten the bolts to..... **11 Nm** (8 lbf.ft.)

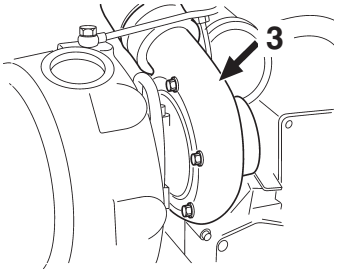
Group 25: Inlet and exhaust system

Compressor, cleaning

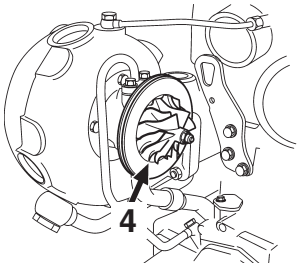


When using mineral oil as lubricant, soot must be removed from the compressor and the compressor housing.

1. Loosen the ventilation pipe (1) from the air intake (2) and remove the air filter together with the air intake.



2. Loosen the screws on the compressor housing (3) and remove it carefully.



3. Clean soot from the housing and the compressor wheel (4); use a soft rag and degreasing agent.

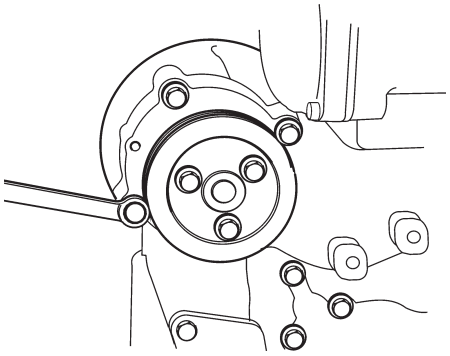
NOTE! Be very careful not to damage anything.

4. Install the compressor house and tighten the screws equally.
5. Check that the compressor wheel can turn easily; if not, the housing is not in its right position.
6. Reinstall the air filter together with the air intake.
7. Fit the ventilation pipe to the air intake.

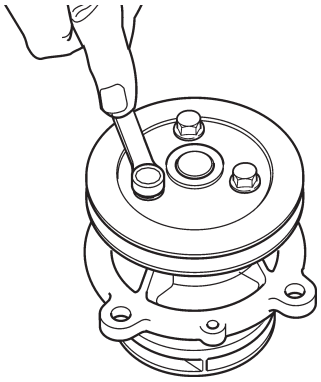
Group 26: Cooling system

Coolant pump, checking / changing

26211

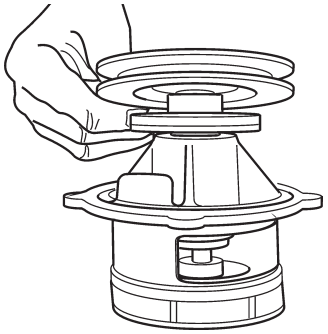


1. Detach the coolant pump from the housing.

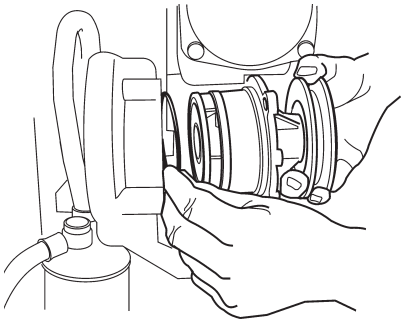


2. Remove the pulley.

3. Check the coolant pump and seal for leaks. Change the coolant pump if necessary.
   Make sure the weep hole for the shaft seal is not blocked.



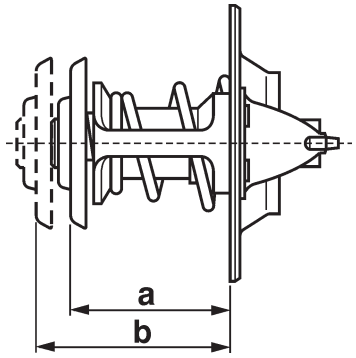
4. Fit the pulley and tighten the bolts to ..... **21 Nm** (15 lbf.ft.)



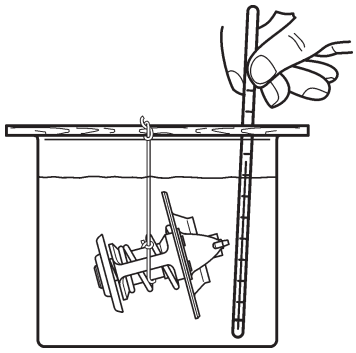
5. Refit the coolant pump into the housing, using a new gasket.

Thermostat

26273

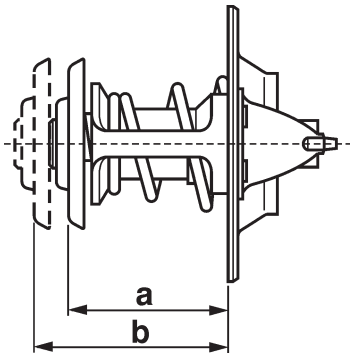


1. Measure distance “a” on the thermostat.
   “a” = thermostat starts to open..... **83°C** (181°F)
   “b” = thermostat fully open..... **95°C** (203°F)



2. Warm the thermostat in a water bath.

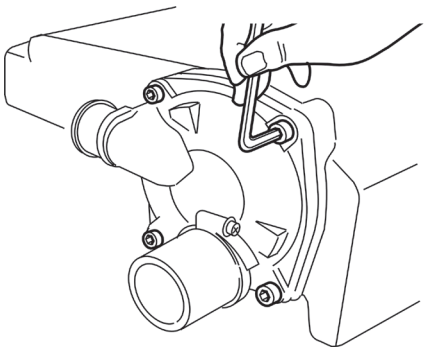
Note! To obtain the exact opening temperature, measure as close to the thermostat as possible without touching it. Stir the water continuously, so that the temperature will be as even as possible. The temperature should not rise by more than 1°C (2°F)/min, or the opening point will be delayed.



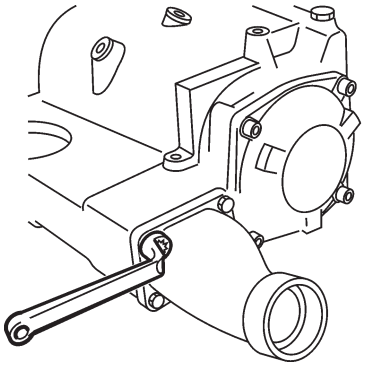
3. Measure distance “b” on the thermostat.
   When the thermostat is fully open, 95°C (203°F), the difference between “a” and “b” should be at least 8 mm (**0.31 in**).

Charge air cooler

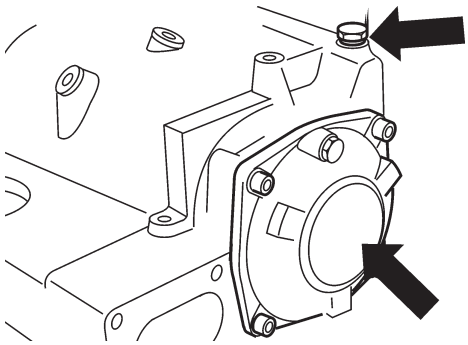
25061



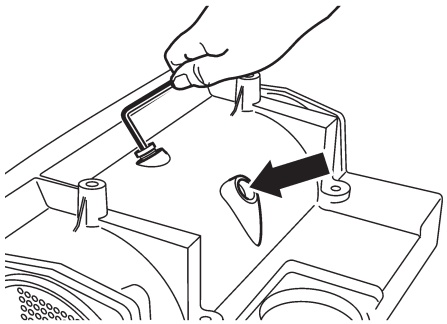
1. Remove the front end plate.



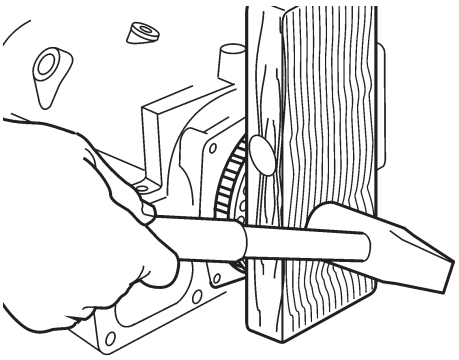
2. Remove the charge air pipe.



3. Remove the rear end plate and take out the screw plugs.

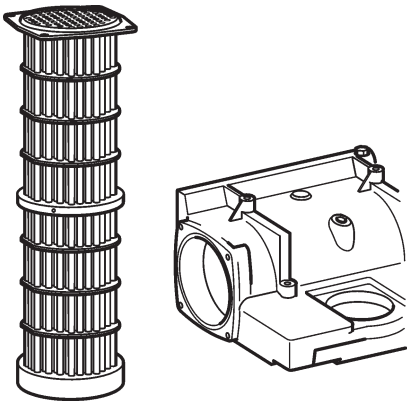


4. Remove the locating balls.

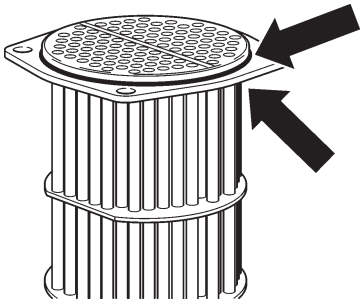


5. Push out the insert.

Note! When the insert is pushed out, two O-rings and a sealing flange come out with it.

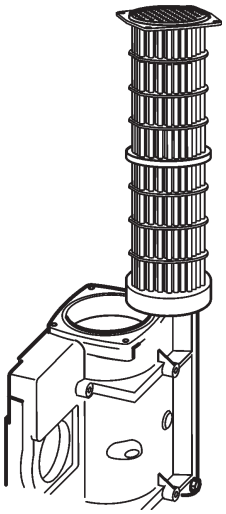


6. Clean the insert and housing. Check for cracks and other forms of damage. If there are any, change the charge air cooler.

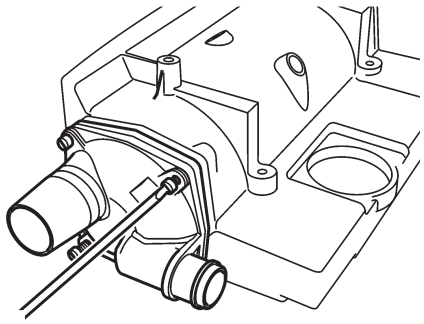


Fit the insert

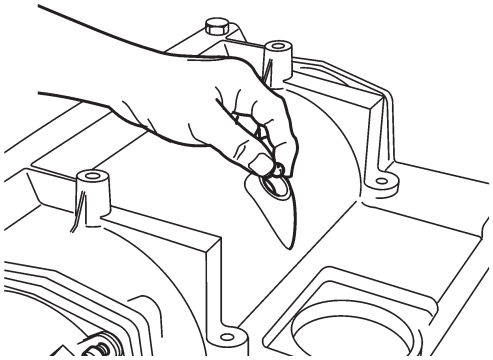
7. Fit **new** O-rings, one before and one after the sealing flange.



8. Slide the insert in from the opposite end from the end that the air comes in.



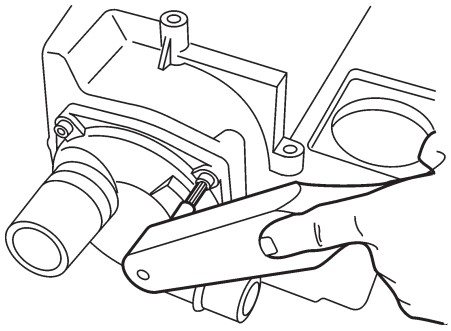
9. Fit the front end plate.
   Tighten the bolts then take them out again.



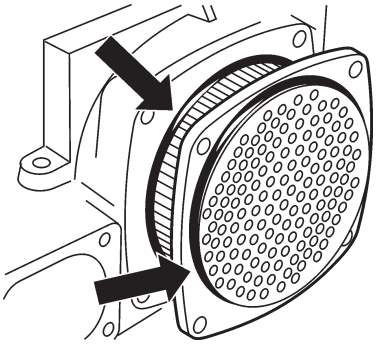
10. Place a locating ball in each threaded hole, to align the insert.

Note! Make sure the indentation in the insert is visible in the center of the holes.

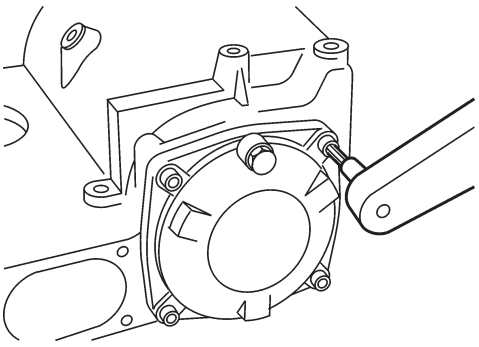
11. Tighten the screw plugs to ..... **38 Nm** (28 lbf.ft.)



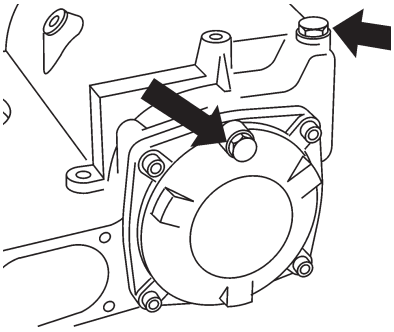
12. Fit the front end plate and tighten to ..... **21 Nm** (15 lbf.ft.)



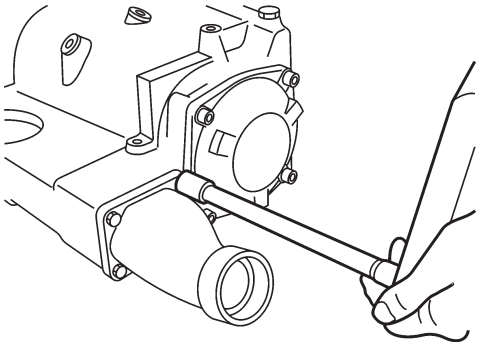
13. Fit new O-rings, one before and one after the sealing flange.



14. Fit the rear end plate and tighten to ..... **21 Nm** (15 lbf.ft.)



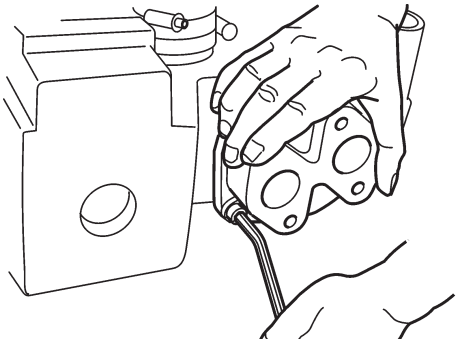
15. Fit the screw plugs, using new washers. Tighten to ..... **15 Nm** (11 lbf.ft.)



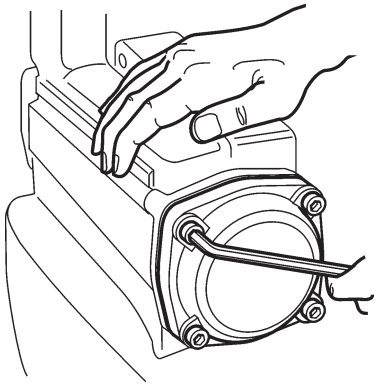
16. Fit the charge air pipe, with a new gasket. Tighten to ..... **22 Nm** (16 lbf.ft.)

Heat exchanger, cleaning / changing

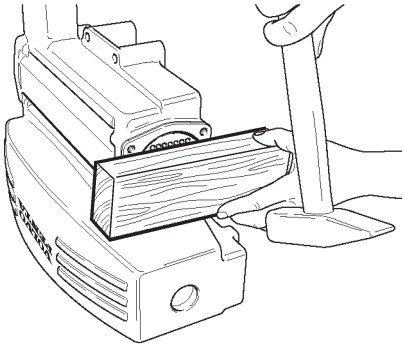
26114



1. Remove the connector.

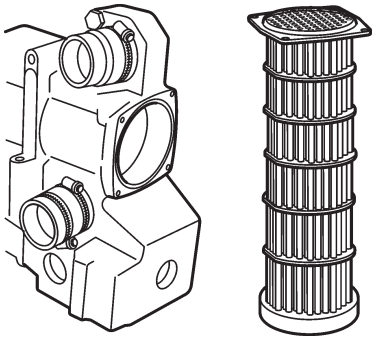


2. Remove the end plate.

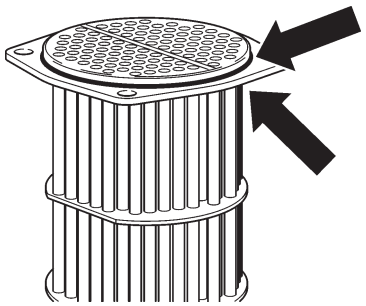


3. Push out the insert.

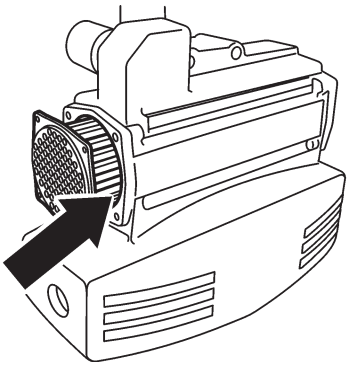
Note! When the insert is pushed out, two O-rings and a sealing flange come out with it.



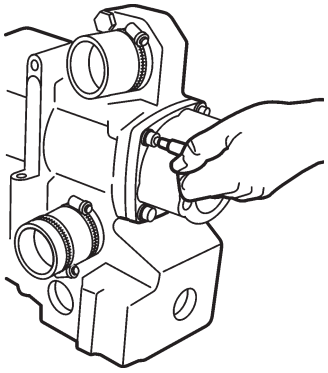
4. Clean the insert, heat exchanger housing and mating surfaces.
Check for cracks and other forms of damage. If there are any, change the heat exchanger



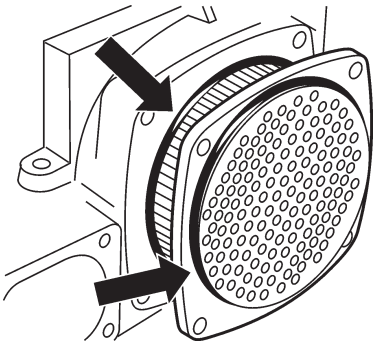
5. Fit new O-rings to the insert, one before and one after the sealing flange.



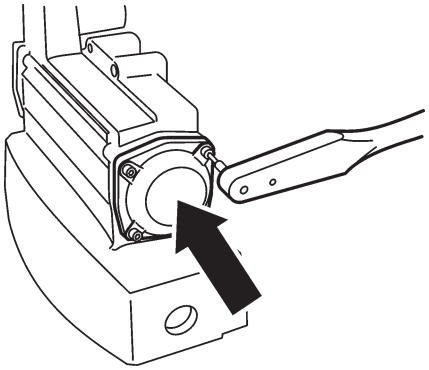
6. Slide the insert in from the connection end.



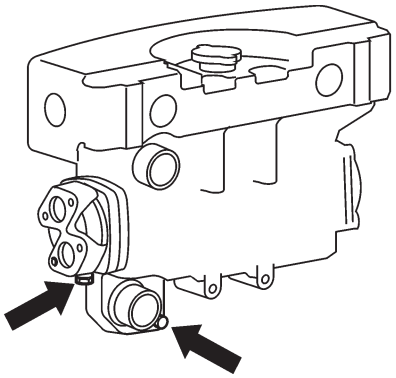
7. Fit the connector and tighten to ..... **21 Nm** (15 lbf.ft.)



8. Fit new O-rings to the insert, one before and one after the sealing flange.



9. Fit the rear end plate and tighten the bolts to ..... **21 Nm** (15 lbf.ft.)

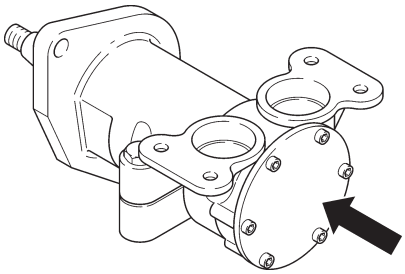


10. Fit the plugs, with new sealing rings, and tighten to ..... **15 Nm** (11 lbf.ft.)

Seawater pump, changing the impeller

26215

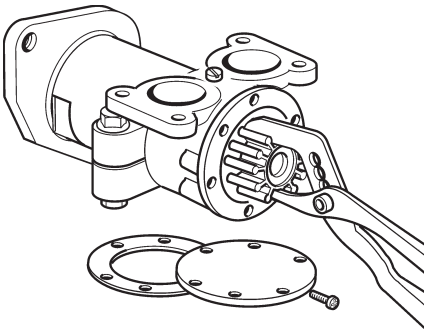
Note! The impeller should be changed after 1,000 operating hours or if it is damaged.



Removing

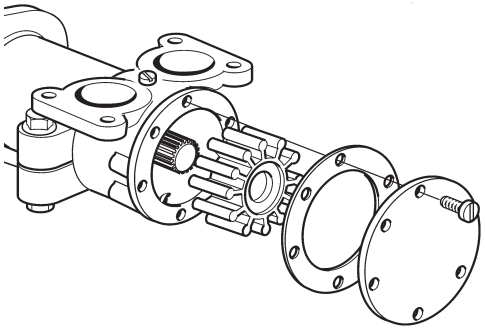
1. Close the sea cock and drain the water out of the seawater system.

2. Remove the end plate and seal.



3. Pull out the impeller using a pair of adjustable pliers.

4. Clean the inside of the housing. Coat the pump housing and the inside of the end plate with a little grease (828250).



Fitting

5. Fit the new impeller by turning it clockwise into the housing.

   Put the impeller in warm, soapy water to make it easier to fit.

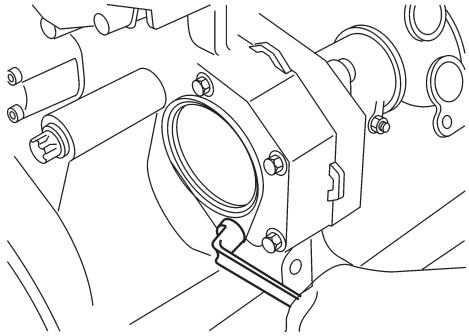
6. Fit the end cover, with a new gasket, and tighten the screws to ..... **5 Nm** (4 lbf.ft.)

7. Close the drain cocks and open the sea cock.

   Start the engine and check for leaks.

Seawater pump, changing

26213

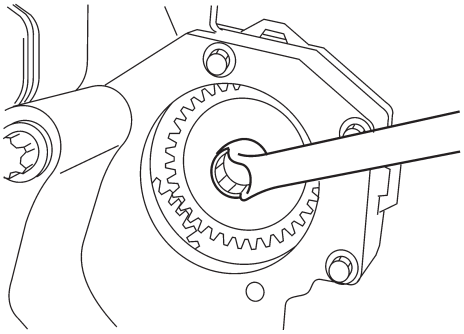


Removing

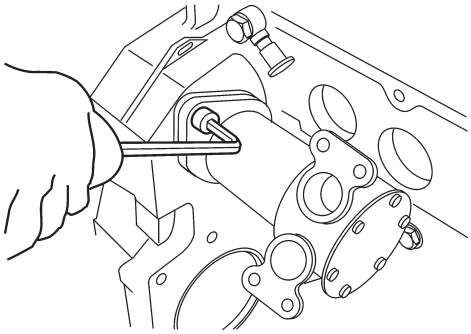
1. Close the sea cock and drain the water out of the seawater system.

2. Disconnect the pipes.

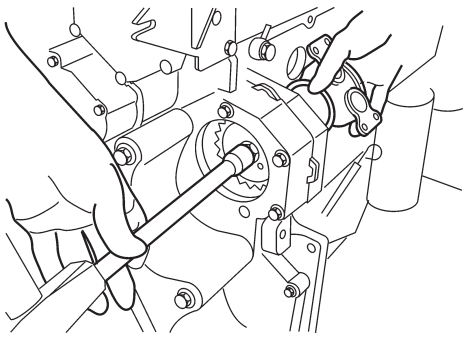
3. Remove the cover plate.



4. Unscrew the nut holding the drive gear to the seawater pump, until it is level with the end of the shaft.

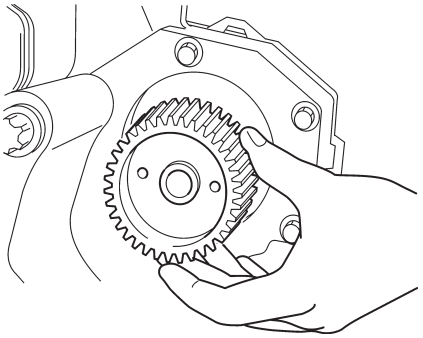


5. Remove one of the bolts holding the seawater pump. Slacken the other bolt, but leave it in place to support the pump.

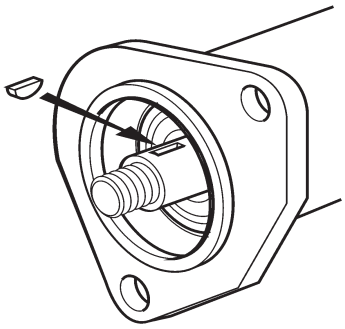


6. Release the drive gear from the shaft using a drift, and remove the pump.

Note! To remove the drive gear without damaging the shaft, the nut must be level with the end of the shaft.

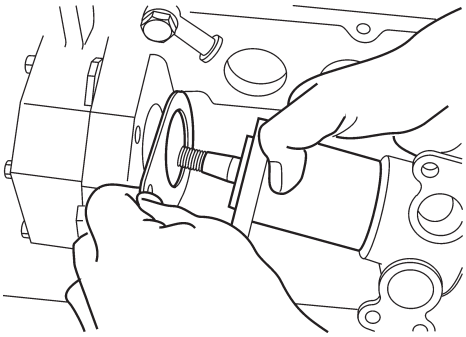


7. Remove the drive gear from the seawater pump.

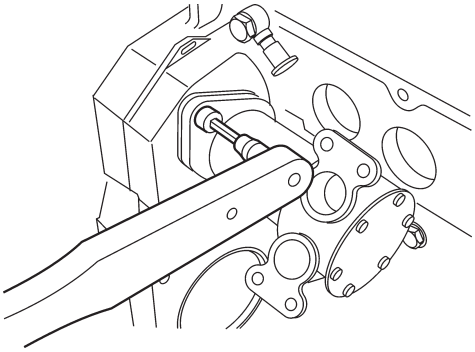


Fitting

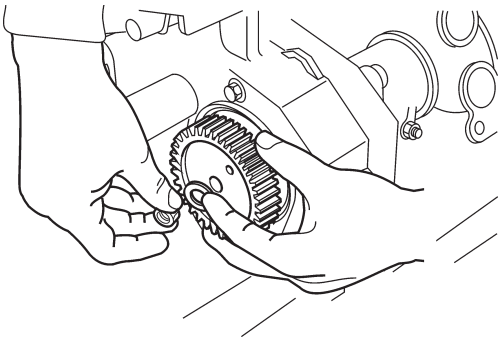
8. Place the key in its keyway in the shaft.



9. Fit the seawater pump, using a new gasket.



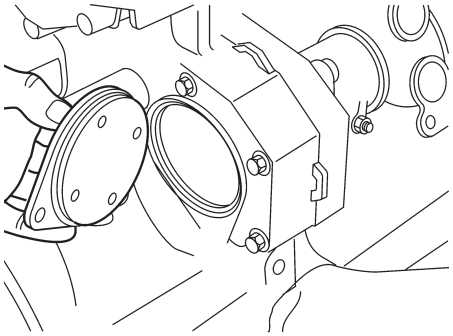
10. Tighten the seawater pump bolts to ..... **42 Nm** (31 lbf.ft.)



11. Fit the gear wheel onto the key on the shaft of the pump. If necessary, take out the impeller and turn the shaft.

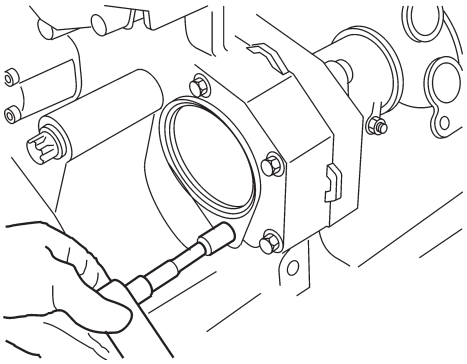
    Tighten the nut to ..... **80 Nm** (59 lbf.ft.)

Note! Check that the teeth and pump shaft are undamaged. The shaft of the pump must be clean and free of lubricant.



12. Fit the cover plate, using a new O-ring.

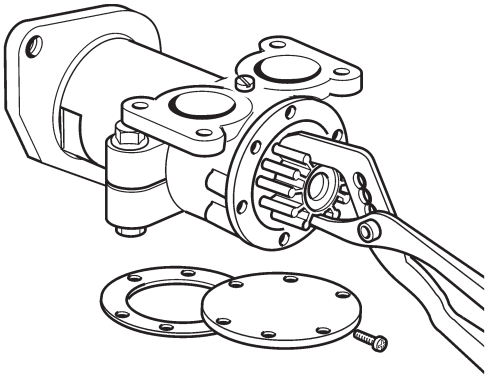
Note! Lightly oil the O-ring.



13. Tighten the cover plate bolts to ..... **21 Nm** (15 lbf.ft.)

Seawater pump, overhauling

26214

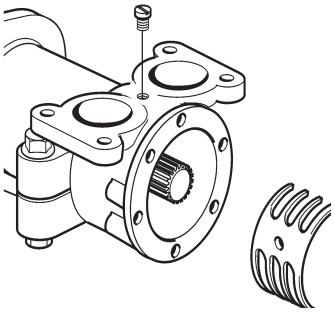


Dismantling

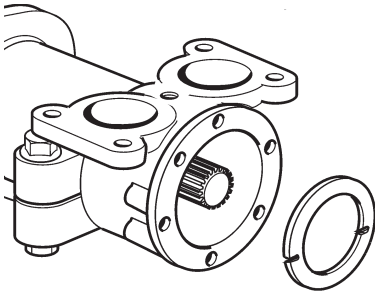
1. Remove the seawater pump from the engine, see “Seawater pump, changing.”

2. Clamp the pump in a vice with soft jaws.

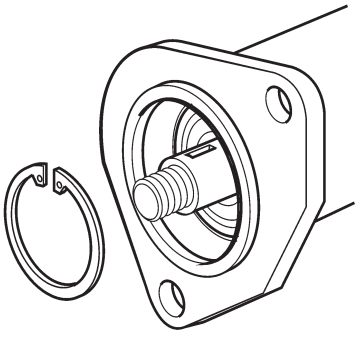
3. Take the cover plate off the impeller housing. Pull out the impeller using a pair of adjustable pliers.



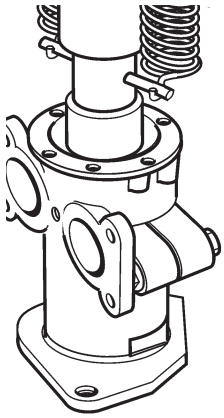
4. Remove the cam screw and take out the cam. Remove the sealant from the cam and inside the pump housing.



5. Remove the wear ring from the pump.



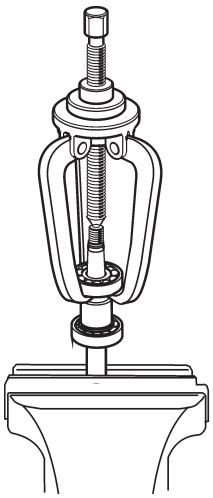
6. Remove the large circlip.



7. Remove the small circlip.

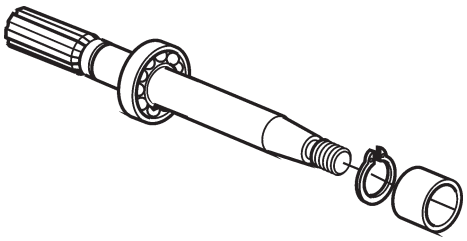
8. Put the pump in a press and press the shaft out of the pump.

9. Separate the impeller housing and bearing housing. Mark their relative positions to aid re-assembly.

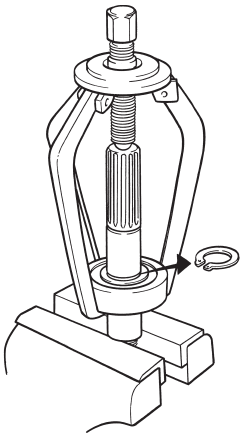


10. Drive the oil seal and ceramic seal out with a drift.

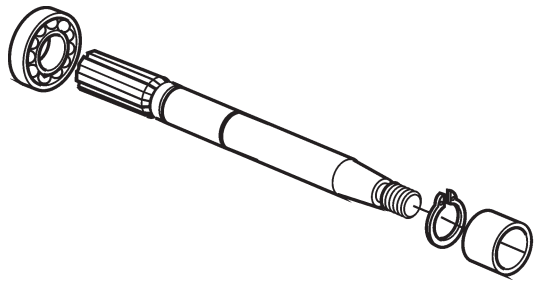
11. Clamp the shaft in a vice with soft jaws.
Pull the bearing off the gear wheel end of the shaft using a puller.



12. Remove the spacer and circlip.



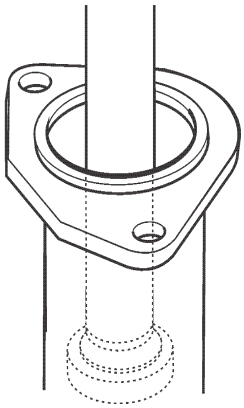
13. Turn the shaft round and pull the bearing off the impeller end.



Assembling

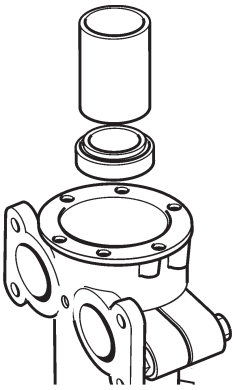
14. Fit the circlip into the bearing groove.
    Press the first bearing onto the impeller end.

15. Fit the spacer and press on the other bearing.



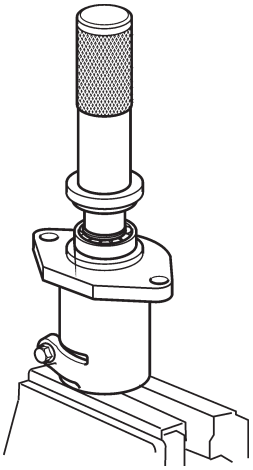
16. Fit the seal for the oil side.

Note! The spring ring in the seal should be facing the bearing.

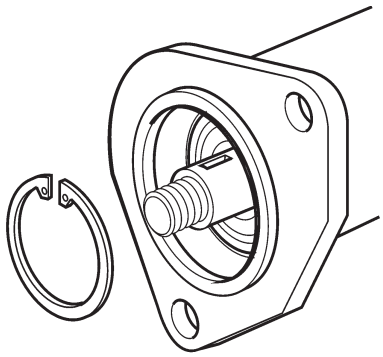


17. Fit the ceramic part of the seal using a drift.

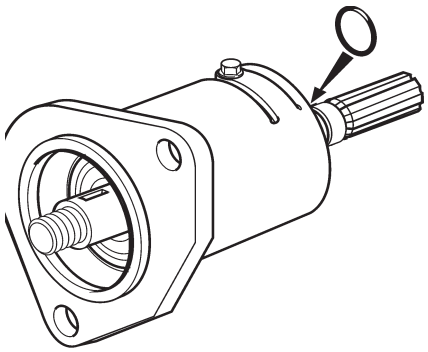
Note! Put some plastic film over the ceramic part, to protect it from grease.



18. Press the shaft down into the bearing housing, using a drift.

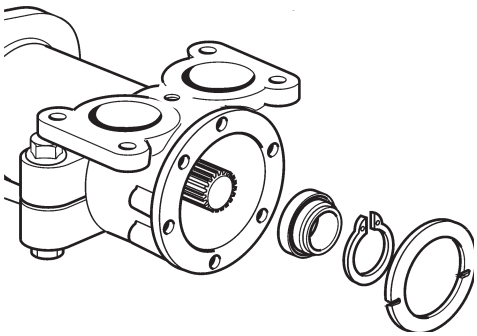


19. Fit the large circlip.



20. Fit the O-ring, between the seal for the oil side and the ceramic seal.

21. Fit the impeller housing and bearing housing together.

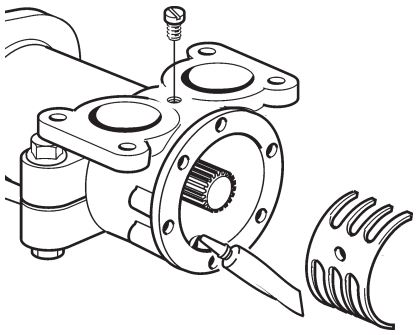


22. Fit the spring-loaded outer seal with the carbon track facing the ceramic seal.
The easiest way to fit it is with a drift.

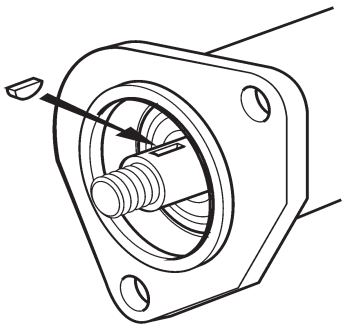
Note! Make sure the carbon track does not come into contact with grease.

23. Fit the small circlip. Press it into place with a drift

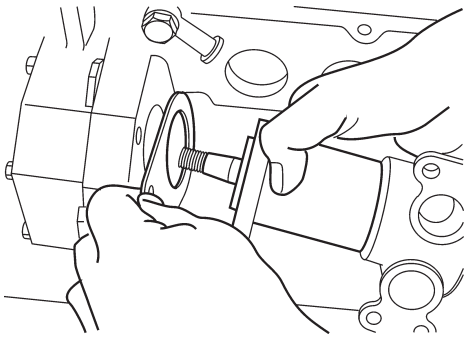
24. Fit the wear ring. Make sure the locating pin in the housing is in the notch in the ring.



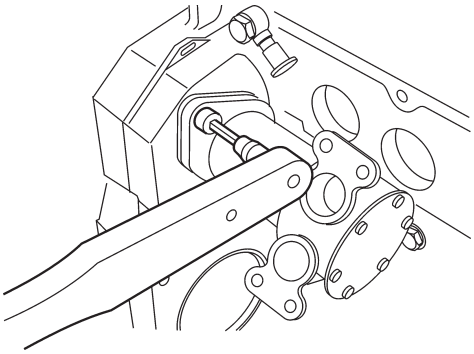
25. Apply sealant 1141570 or Permatex® No. 77 around the screw hole on the top of the cam.



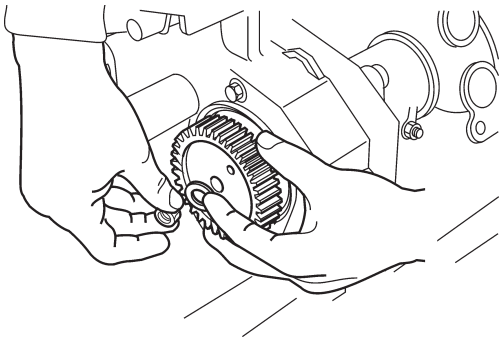
26. Put the key into the keyway.



27. Fit the seawater pump, using a new gasket.



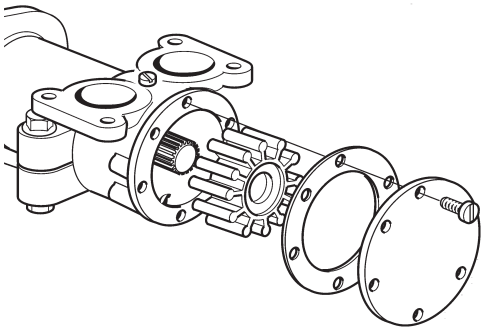
28. Tighten the seawater pump bolts
to ..... **42 Nm** (31 lbf.ft.)



29. Fit the gear wheel onto the key on the shaft of the pump. If necessary, take out the impeller and turn the shaft.

Tighten the nut to ..... **80 Nm** (59 lbf.ft.)

Note! Check that the teeth and pump shaft are undamaged. The shaft of the pump must be clean and free of lubricant.



30. Grease the shaft and fit the impeller by turning it clockwise into the housing.

    Put the impeller in warm, soapy water to make it easier to fit.

Wiring diagram

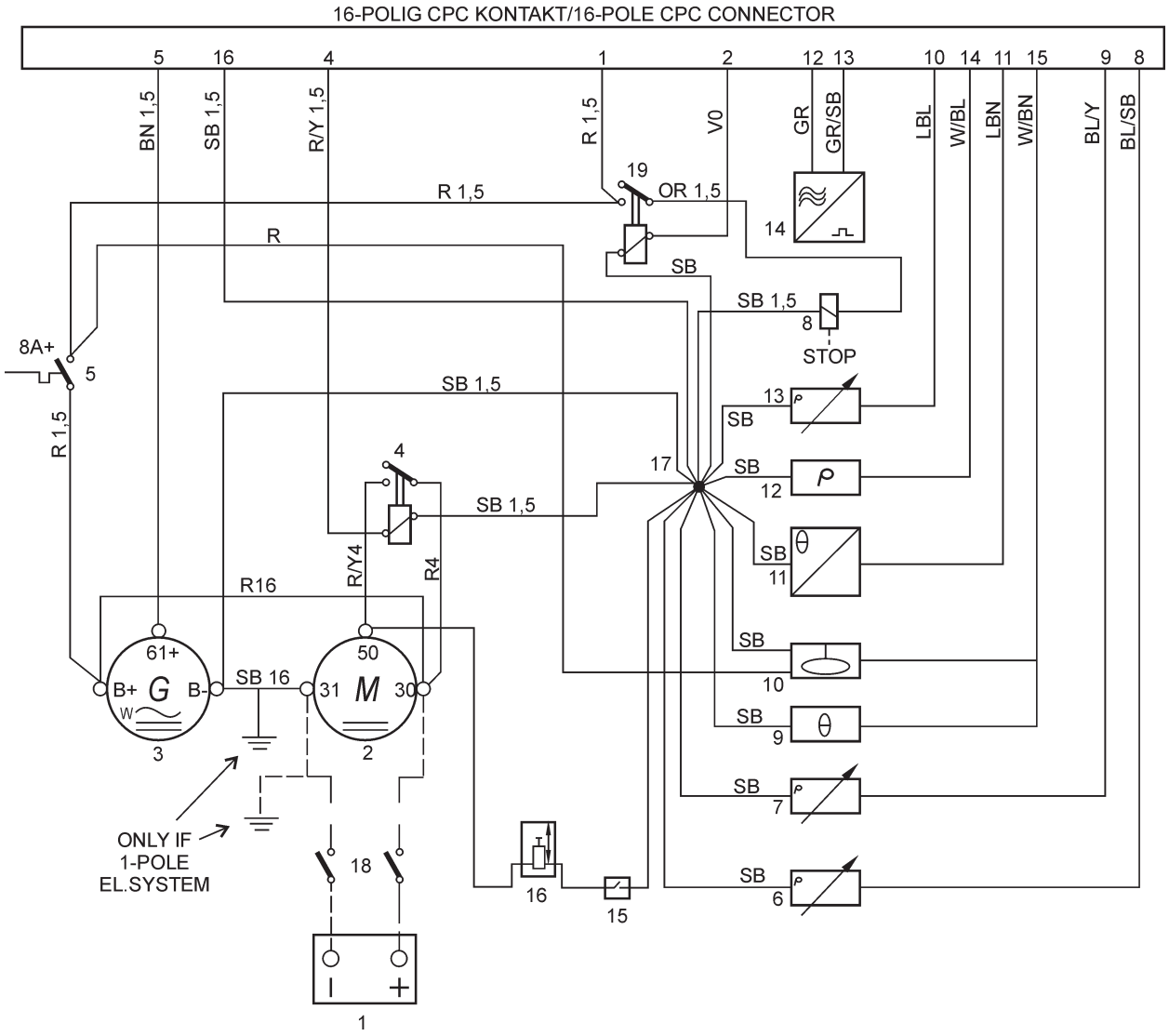
1. Battery
2. Starter motor
3. Generator
4. Start relay
5. Circuit breaker
6. Pressure sensor – reverse gear
7. Pressure sensor – turbo
8. Stop solenoid
9. Temperature switch – coolant water
10. Level switch – coolant water
11. Temperature sensor – coolant water
12. Oil pressure switch – engine
13. Oil pressure sensor – engine
14. Engine speed sensor
15. Temperature switch – regulator
16. Cold start regulator
17. Joint
18. Main switch
19. Stop relay

Conductor area

Unspecified cables have an area of 1 mm² (0.0015 in²).

Cables and components shown with a dashed line are not supplied by Volvo Penta.

All switches are normally open.



VOLVO PENTA

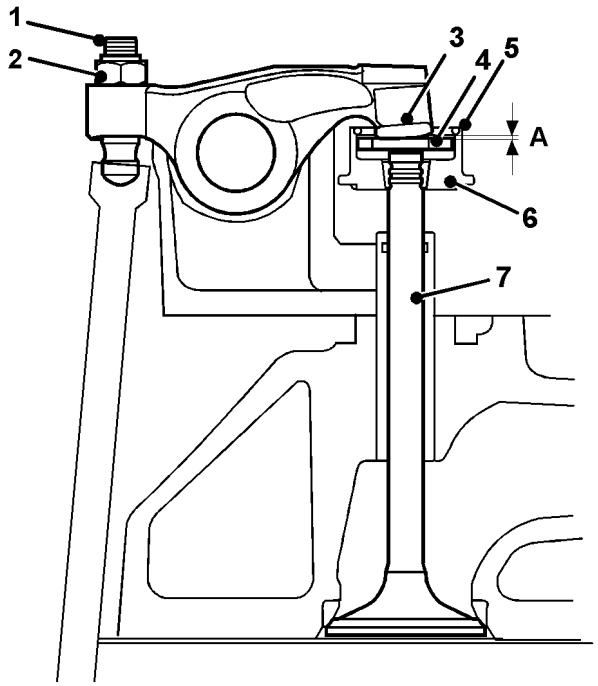
AB Volvo Penta
SE-405 08 Göteborg
Sweden

Service Bulletin

Group	Number	Version
21-4	**33**	**1**

Valve Clearance Adjustment

Marine Diesel D7 ,TAD532GE, TAD732GE, TAD733GE



P0014533

1 Adjuster screw
2 Locking nut
3 Rocker
4 Thrust washer
5 Retainer ring
6 Valve spring collar
7 Valve stem
A Valve clearance

The method applies to D7A-A T engines from and including engine # 010705993.
The method applies to D7B-B TA, D7C-B TA, TAD532GE, TAD732GE and TAD733GE engines from the beginning of the production runs.

A new method of valve clearance adjustment has been introduced following a change in valve mechanism design.

The method of adjusting valve clearance that has been in use hitherto can no longer be used after the applicable serial numbers, and from the beginning of the production runs of the above mentioned engine designations.

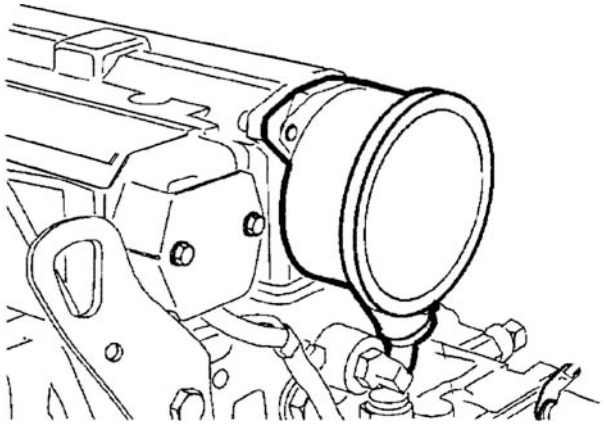
Valve clearance can only be adjusted with the aid of 885812 angle gauge on engines fitted with thrust washers above the valve spring washers.

NOTICE! Normal valve clearance is set when the engine is cold, or when it has been left to cool for at least a half hour. Oil temperature < 80 °C.

IMPORTANT!

Carefully clean before dismantling.

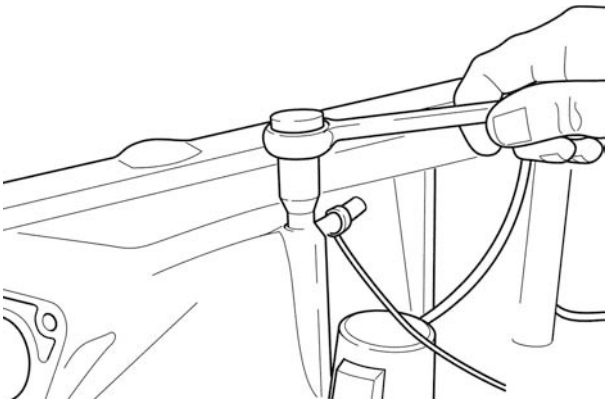
Removal



P0014631

1 **NOTICE!** Be prepared to gather up fluid.

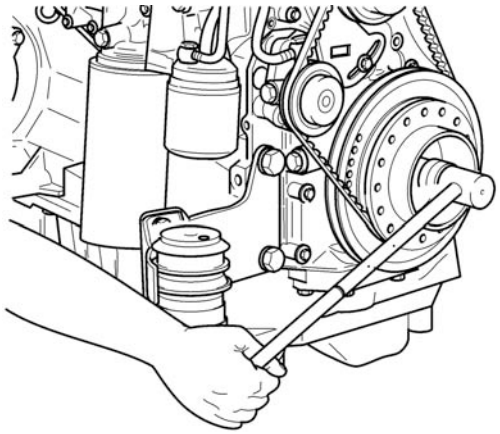
Remove the crank case ventilation oil trap.



P0014629

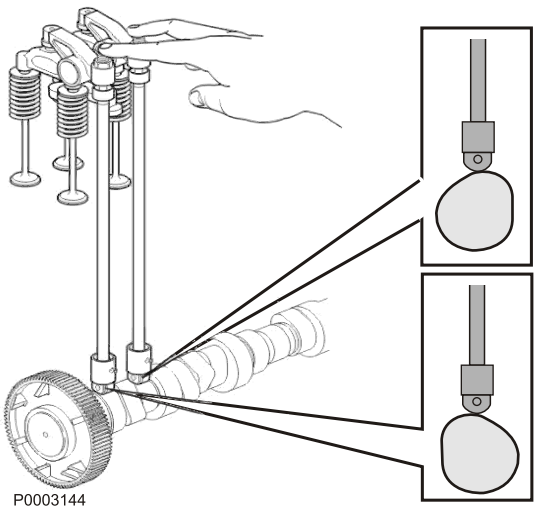
2 **IMPORTANT!**
Carefully clean before valve cover removal.

Remove the valve cover.



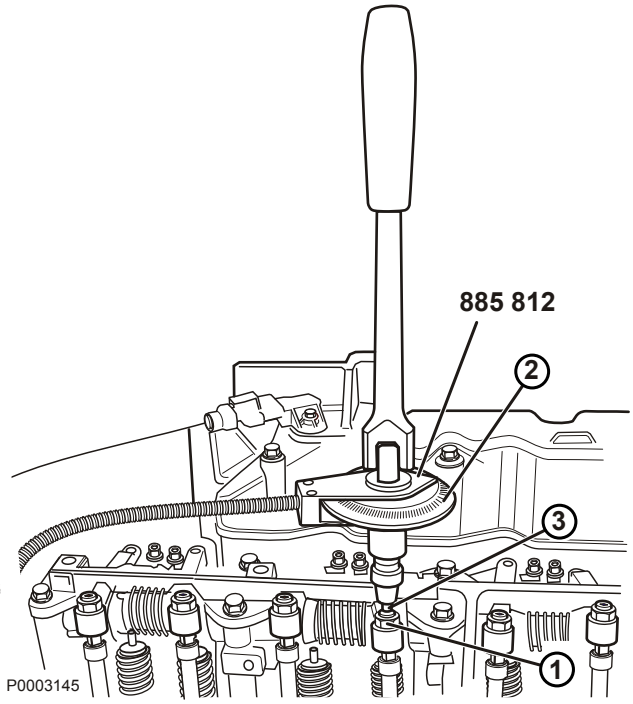
P0014630

3 Crank the crankshaft until the valves on cylinder # 1 overlap.


P0003144

4 **Set valve clearance (cylinder 1 overlapping)**
Rotate the crankshaft so that piston # 1 is at TDC and the exhaust and inlet valves overlap on cylinder # 1.

None of the push rods for this cylinder should be rotatable in this position.



P0003145

5 Adjust the valve clearance for each cylinder according to the angle reading.

1 Loosen the adjuster screw locking nut (**1**) on the rocker arm.

2 Fit 885812 angle gauge (**2**) to the adjuster screw (**3**).

3 Turn the adjuster screw (**3**) until zero clearance is obtained between the rocker arm and the valve.

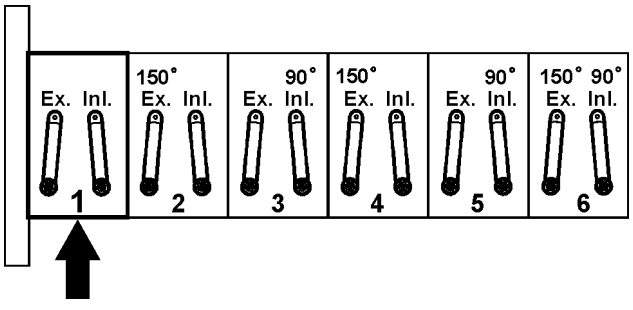
4 Zero the protractor.

5 Turn the adjuster screw (**3**).

- Counter clockwise 90 ° (cyl. 3, 5, 6) for inlet valves
- Counter clockwise 150 ° (cyl. 2, 4, 6) for exhaust valves

6 Hold fast the adjuster screw (**3**) while tightening the locking nut (**1**).

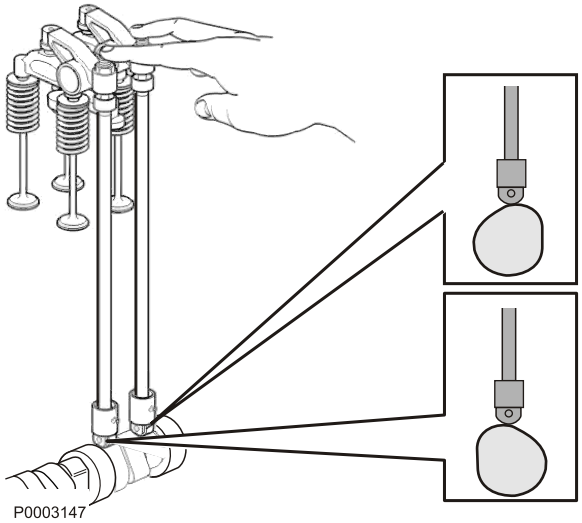
Tightening torque: 20 Nm (14.8 lbf.ft.)



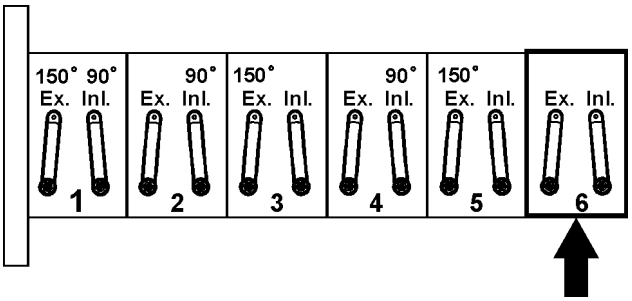
P0014632

6 **Valve clearance (cold engine), settings**
Set the valve clearance for each cylinder according to the illustrated angles.

Inlet: Counter clockwise 90 ° (cyl. 3, 5, 6)
Exhaust: Counter clockwise 150 ° (cyl. 2, 4, 6)


P0003147

7 **Set the valve clearance for the other valves (cylinder no. 6 overlapping)**
Crank the crankshaft 360° (one revolution) until the exhaust and inlet valves on cylinder # 6 overlap.
None of the push rods for this cylinder should be rotatable in this position.

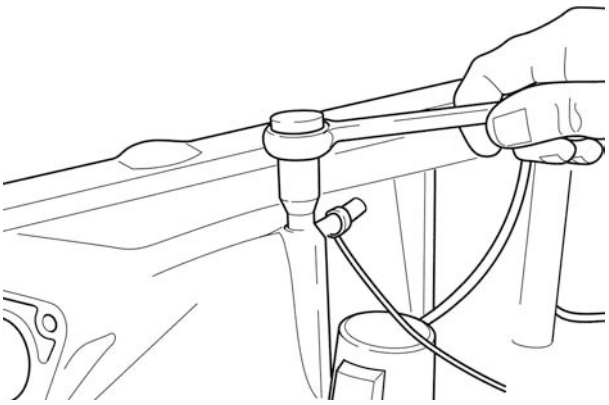


P0014633

8 Set the valve clearance for each cylinder according to the illustrated angles.

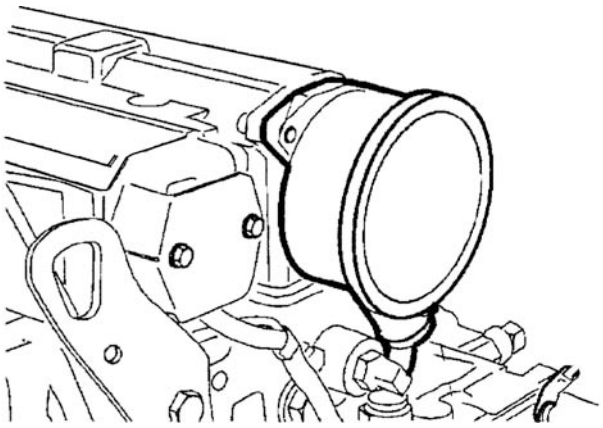
Inlet: Counter clockwise 90 ° (cyl. 1, 2, 4)
Exhaust: Counter clockwise 150 ° (cyl. 1, 3, 5)

Installation


P0014629

9 Install a new valve cover gasket.

Install the valve cover.
Tightening torque: 11 Nm (8.1 lbf.ft.)



P0014631

10 Install the oil trap.

Index

Notes

Notes

Report form

Do you have any comments or complaints about this manual? Please take a copy of this page, write your comments on it and send it to us. The address is at the bottom. We would appreciate it if you were to write in English or Swedish.

From: .....

.....

.....

.....

Refers to publication: .....

Publication no: ..... Date of issue: .....

Suggestion/Motivation: .....

.....

.....

.....

.....

.....

.....

.....

.....

Date: .....

Name: .....

AB Volvo Penta
Global Aftermarket
Dept. CB22000
SE-405 08 Göteborg
Sweden