Workshop Manual

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Group 20-26

**TD520GE, TAD520GE, TD520VE,
TAD520VE, TAD530/531/532GE,
TD720GE, TAD720GE, TD720VE, TAD720VE
TAD721GE, TAD721VE, TAD722GE, TAD722VE,
TAD730/731/732/733GE**

Workshop Manual

Industrial Engines

TD520GE, TAD520GE, TD520VE, TAD520VE, TAD530/531/532GE, TD720GE, TAD720GE, TD720VE, TAD720VE, TAD721GE, TAD721VE, TAD722GE, TAD722VE, TAD730/731/732/733GE

Contents

Safety information

Introduction

The workshop manual contains technical data, descriptions and repair instructions for specified products or product configurations from Volvo Penta. Make sure you use the correct workshop documentation.

Read the safety information, as well as "General information" and "Repair instructions" carefully before you start any servicing.

Important

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

⚠ **WARNING!** Warns of a risk of injury, extensive damage to the product or property, or that dangerous operational faults could occur if you do not follow the instruction.

⚠ **IMPORTANT!** Is used to draw attention to something that could cause damage to, or faults in, the product or property.

NOTE! Is used to draw attention to important information, in order to facilitate working procedures or handling.

In order that you can get an overview of the risks and safety measures that you should always bear in mind or carry out, we have listed them here:

⚠ Prevent the engine from being started by switching off the main switch(es) to remove the supply, and locking it (them) in the off position before you start work. Put up a warning sign at the engine control point.

⚠ All servicing should normally be performed on a stationary engine. However, the engine needs to be running for some tasks, such as certain adjustments. Approaching a running engine is dangerous. Remember that loose, hanging clothing or long hair can get caught in rotating parts and cause serious injury.

⚠ If you work close to an engine that is running a careless movement or a dropped tool could lead to injury. Watch out for hot surfaces (exhaust pipe, turbo, boost pipe, start element etc.) and hot liquids in pipes and hoses on an engine that is running or has just been stopped. Refit all protective devices that you removed during servicing, before you start the engine.

⚠ Make sure the warning or information labels on the product are always easily visible. Replace labels that have been removed or painted over.

⚠ Never start the engine without the air filter fitted. The rotating compressor wheel in the turbo can cause serious injury. Foreign objects in the inlet pipe can also cause mechanical damage.

⚠ Never use start spray or similar products to help to start the engine. An explosion could occur in the inlet pipe. Danger of injury.

⚠ Start the engine only in a well ventilated area. When running in a confined space, exhaust and crankcase gases should be lead out of the engine room or workshop area.

⚠ Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant can squirt out as the pressure that has built up is released. If necessary, open the filler cap slowly and release the pressure in the cooling system. Be particularly careful if you need to remove the cock, plug or coolant pipe when the engine is hot. Steam or hot coolant can flow out in unexpected directions.

⚠ Hot oil can cause burns. Avoid skin contact with hot oil. Make sure the oil system is not pressurized before you start work. Never start or run the engine when the oil filler cap is removed, as there is risk that oil could be thrown out.

⚠ Stop the engine before you work on the cooling system.

⚠ Always use protective goggles when there is a risk of metal fragments, grinding sparks, or splashes of acids or other chemicals. The eyes are extremely sensitive. An injury can lead to you losing your sight!

⚠ Avoid skin contact with oil. Extended or repeated skin contact with oil can lead to the natural oil being removed from your skin, resulting in irritation, drying eczema and other skin complaints. Used oil is more dangerous to health than new oil. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before meals. Use a skin cream designed for the purpose, to counteract drying and to make cleaning the skin easier.

⚠ Most of the chemicals used for the product (e.g. engine and transmission oils, glycol and diesel oil) or chemicals for use in workshops (e.g. degreaser, lacquers and solvents) are injurious to health. Read the instructions on the packaging carefully. Always follow the safety instructions (using a mask, protective goggles, gloves etc.). Ensure that other staff are not unknowingly exposed to substances that are dangerous to health, via inhalation for example. Provide good ventilation. Handle used and left over chemicals in the prescribed manner.

⚠ Be extremely careful when you are looking for leaks in the fuel system and testing the fuel injector. The jet from the fuel injector is at very high pressure and has great penetrative force; the fuel can penetrate deep into body tissues and cause serious injury. There is a risk of blood poisoning.

⚠ **WARNING!** Never re-bend the delivery pipes. Replace damaged pipes.

⚠ All fuel is highly flammable, as are many chemicals. Ensure that open flames or sparks cannot start a fire. Certain thinners and hydrogen gas from batteries are highly flammable and explosive when they combine with air at a certain concentration. No smoking! Provide good ventilation and take the necessary safety measures before starting work such as welding or grinding near the engine. Always have a fire extinguisher easily accessible in the workplace.

⚠ Make sure that rags soaked with oil and fuel, and used fuel and oil filters are kept safely. Under certain conditions, oil-soaked rags can self-ignite. Used fuel and oil filters are environmentally hazardous waste, which you should take to a disposal center for destruction, along with used oil, contaminated fuel, leftover paint, solvent, degreaser and cleaning residues.

⚠ Never expose batteries to open flames or sparks. Never smoke near the batteries. The batteries produce hydrogen gas when they are being charged, which forms oxy-hydrogen gas when it mixes with air. This gas is highly flammable and very explosive. You can create a spark if you connect the battery incorrectly, and this is enough to cause a battery to explode, causing injury and damage. Don’t disturb the connections while you are trying to start the engine (there is a risk of sparking), and don’t stand leaning over the batteries.

⚠ Never swap the positive and negative terminals when you are fitting the battery. This could cause serious damage to the electrical equipment. Check with the wiring diagram.

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

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

⚠ Connect and disconnect cables with the engine stationary.

⚠ Use the lifting eyes fitted to the engine when lifting the drive unit. Always check that all lifting equipment is in good condition, and that it has the correct capacity for the lift (the weight of the engine plus the gearbox (if fitted) and any extra equipment). For safe handling and to avoid components mounted on the top of the engine being damaged, you should lift the engine using a lifting beam that is specially designed for the engine, or is adjustable. All chains or cables should run parallel with one another and as square as possible to the top of the engine. If other equipment that has been connected to the engine alters its center of gravity, you might need special lifting equipment to achieve the right balance and safe handling.

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

⚠ Never work alone when you are removing heavy components, even when using secure lifting devices such as lockable cables. Even when using a hoist, it is usually preferable to have two people, one to operate the hoist and one to see that components are clear and don't get damaged during the lift.

Always make sure in advance that there is enough room available to enable you to carry out the dismantling without causing a risk of injury of damage.

⚠ **WARNING!** Components in the electrical and fuel systems of Volvo Penta products are designed and manufactured to minimize the risks of explosion and fire. Do not run the engine in environments with an explosive atmosphere.

⚠ Always use the fuel that ABVolvo Penta recommends; see the instruction manual. Using fuel of a lower quality can damage the engine. Poor fuel in a diesel engine can lead to the control rod binding and the engine overreving, with the risk of mechanical damage and injury. Poor fuel can also lead to higher maintenance costs.

⚠ Observe the following when cleaning with a high-pressure washer: Never direct the water jet onto seals, rubber hoses, electrical components or the radiator. Never use the high-pressure function to clean the engine.

General information

About the workshop manual

This workshop manual contains descriptions and repair instructions for the standard configuration of TD/TAD 520, 530, 531, 532, 720, 721, 722, 730, 731, 732 and 733 engines.

The engine model and number are shown on the engine identification plate (see ”Engine information”).

Always state the engine model and number in correspondence about the engine.

The workshop manual is primarily intended for AB Volvo Penta service workshops and their qualified staff. It is assumed therefore that people using the manual have basic knowledge and can carry out the mechanical and electrical work involved.

AB Volvo Penta is continually developing its products, so we reserve the right to make changes. All information in this manual is based on product data available when the manual went to print. Information about any substantial changes to the product or service methods that occur after this date will be distributed as Service Bulletins.

Flat rate

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

Spare parts

Spare parts for the electrical and fuel systems are subject to various national safety requirements. AB Volvo Penta Original Spare Parts fulfil these requirements. All forms of damage that result from the use of parts that are not original AB Volvo Penta spare parts for the product in question will not be covered by the guarantee from AB Volvo Penta.

Certified engines

For engines that are certified for national and regional environmental legislation, the manufacturer binds itself to meet the environmental requirements for both new engines and those already in service. The product must correspond with the example approved when the certification took place. In order for Volvo Penta as the manufacturer to be able to be responsible for engines in operation meeting the environmental requirements, the following requirements for servicing and spare parts must be met:

- The service intervals and maintenance procedures that AB Volvo Penta recommends must be followed.
- Only AB Volvo Penta Original Spare Parts intended for the certified engine configuration may be used.
- Servicing of injection pumps, pump settings and injectors should always be carried out by an authorized AB Volvo Penta workshop.
- The engine may not be rebuilt of modified in any way, except for accessories and service kits that AB Volvo Penta has developed for the engine.
- Changes may not be made to the exhaust pipes and intake air ducts for the engine room.
- Unauthorized persons may not break any seals.

⚠ **IMPORTANT!** When you need spare parts, use only AB Volvo Penta original parts.

Using non-original parts leads to AB Volvo Penta no longer being responsible for the engine corresponding to the certified design.

AB Volvo Penta will not cover any damage or costs arising from the use of non-original Volvo Penta spare parts for the product in question.

Repair instructions

The working methods described in this workshop manual apply to the workshop environment, so you lift the engine out and mount it in an engine stand. Repairs that don't require the engine to be lifted out are done on site, using the same working methods, unless otherwise indicated.

The warnings used in the workshop manual (see **"Safety information"** for meaning)

WARNING!

IMPORTANT!

NOTE!

are by no means comprehensive, as we can't of course anticipate everything due to the fact that servicing is carried out in the most varied circumstances. So we can only point out the risks that we think can arise when work is carried out incorrectly in a well-equipped workshop using working methods and tools that we have tested.

The descriptions in the workshop manual are based on Volvo Penta special tools being used for all tasks for which they exist. The special tools are specially created to give the safest and most efficient working methods. It is therefore the responsibility of anyone using tools or working methods other than those recommended to make sure that there is no risk of injury or damage, and that it will not result in incorrect operation.

In certain cases there are special safety instructions and user directions for the tools and chemicals mentioned in the workshop manual. You should always follow these instructions, and there are no special instructions for them repeated in the workshop manual.

You can guard against most risks by taking certain elementary measures and using common sense. Having a clean workplace and cleaning the engine will eliminate many risks of injury and malfunction.

It is extremely important that dirt or other foreign objects don't enter when you are working on the fuel system, lubrication system, air inlet system, turbo, bearings and seals, as this could result in malfunction or a reduced engine service life.

Our joint responsibility

Each engine consists of systems and components working together. If one component deviates from the technical specification it can dramatically increase the environmental impact of an otherwise good engine. It is therefore most important that the stated wear tolerances are observed, that systems that have adjustments are set correctly and that Volvo Penta Original Parts for the engine are used. You should follow the time intervals given in the maintenance schedule.

Certain systems, components in the fuel system for example, can require special expertise or special test equipment. For environmental and other reasons, some components are factory-sealed. You should not tamper with sealed components unless you are authorized to do that type of work.

Remember that most chemicals are harmful to the environment if used incorrectly. Volvo Penta recommends that you use biodegradable degreaser to clean engine components, unless stated otherwise in the workshop manual. Make sure oil, cleaning residues etc. are taken for destruction, and don't unintentionally end up in the environment.

Tightening torque

The torque wrench settings for vital fixings are listed in "Technical data: Tightening torque" and given in the procedures in the workshop handbook. All torque settings apply to clean threads, bolt heads and contact surfaces. The torque settings are for lightly oiled or dry threads. If lubricant, locking compound or sealant is required for the screw fixing, the type is given in the procedures and "Tightening torque." For fixings for which no specific torque is given, the general torque values in the following table apply. The torque is a guideline and it is not necessary to use a torque wrench.

Size	Torque	
	Nm	**lbf.ft**
M5	6	4.4
M6	10	7.4
M8	25	18.4
M10	50	36.9
M12	80	59.0
M14	140	103.3

Torque-tightening angle

For torque-tightening, the bolt is tightened to a given torque and then turned through an additional specified angle. For example: for a 90° tightening angle the bolt is tightened an additional ¼ of a turn after the specified torque has been reached.

Locknuts

Locknuts that have been have been removed should be discarded and replaced with new ones, as the locking properties are reduced or lost with reuse. For locknuts with a plastic insert, such as Nylock®, the torque in the table should be reduced if the Nylock® nut has the same nut height as a standard, all-metal, hex nut. Reduce the tightening torque by 25% for bolt sizes 8 mm and larger. For Nylock® nuts with a higher nut height, where the metal section of the thread is the same as a standard hex nut, the torque values in the table apply.

Tensile strength classes

Bolts and nuts are divided into different tensile strength classes, indicated by a marking on the head of the bolt. The higher the number the higher the tensile strength. For example, a bolt marked 10-9 has a higher tensile strength than one marked 8-8. For this reason it is important that bolts that have been removed are refitted in their original positions. Consult the spare parts catalogue when you are replacing bolts, in order to keep the correct type.

Sealant

Several different types of sealant and locking compound are used on the engine. Their properties are different and they are intended for different fixing strengths, temperatures, resistance to oil and other chemicals, and to the various materials and gap widths in the engine.

In order for servicing to be satisfactory, it is important therefore that you use the correct type of sealant and locking compound for the joint, where required.

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

When carrying out servicing you should use the same compound, or one with equivalent properties, but of a different make.

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

Always follow the manufacturer's instructions regarding temperature for use and setting time, as well as any other instructions for the product.

Two basic types of compound are used for the engine and their characteristics are:

RTV compound (Room Temperature Vulcanizing). This is usually used in combination with gaskets, e.g. sealing gasket joints or to make a gasket more effective. RTV compound is quite visible when the joint has been dismantled; you must remove the old sealant before you reseal the joint.

The following RTV compounds might be referred to in the workshop manual: Loctite® 574, Permatex® No. 3 and Permatex® no. 77. In all cases old sealant can be removed with denatured alcohol.

Anaerobic compounds. These harden (set) without air being present. The compounds are used when two solid parts, e.g. castings, are fitted together without a gasket. Other common uses are to fix and seal plugs, stud threads, cocks, oil pressure gauges etc. Anaerobic compound is like glass when it has set, so it is colored to make it visible. Once set, anaerobic compound is very resistant to solvents and can not be removed. When refitting, degrease the surfaces thoroughly then apply new sealing compound.

The following anaerobic compounds might be referred to in the workshop manual: Loctite® 572 (white), 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 commonly used for shaft sealing rings and O-rings.

When fluorocarbon rubber is subjected to high temperatures (above 300°C (572°F)), highly corrosive **hydrofluoric acid** can be produced. Skin contact can cause severe burning. Splashes in the eyes can produce ulcers. Inhaling the fumes can damage the lining of the lungs.

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

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

The following seals are very probably made of fluorocarbon rubber:

Sealing rings for crankshafts, camshafts and intermediate shafts.

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

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

Special tools

The following special tools are used when working on the engine. You can order them from AB Volvo Penta using the numbers shown.

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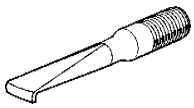
942352



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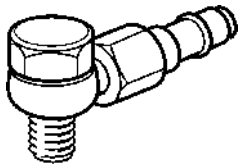

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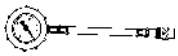

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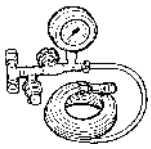

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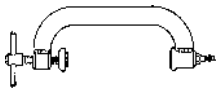

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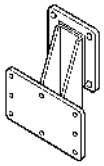

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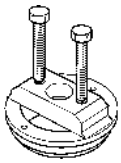

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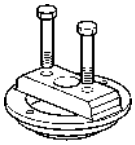

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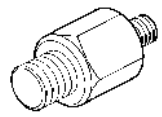
Tool	Name, use
885490	17 mm wrench, delivery pipe
942352	Plug, oil cooler
9990192	Extractor, crankshaft seal, used with 999 6400
999 2000	Standard shaft, drifts
999 6066	Nipple, used with manometer 999 6398
999 6394	Support, for 999 6645
999 6395	Support, for 999 6645
999 6398	Manometer
999 6400	Slide hammer, for injectors and reduction valve
999 6645	Extractor, cylinder liners
999 6662	Pressure-testing equipment for oil cooler
999 6685	Clamp for oil cooler
999 8007	Socket for injector removal, together with 999 6400
999 8671	Engine fixture for aggregate stand
999 8672	Fitting/Removal tool, rear crankshaft seal
999 8673	Fitting/Removal tool, front crankshaft seal



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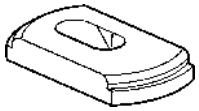

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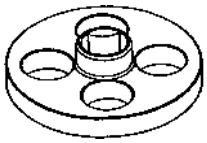

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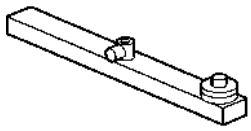

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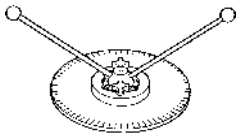

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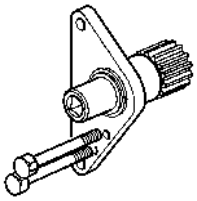

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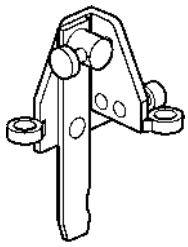

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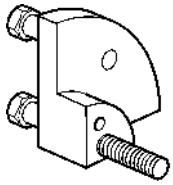

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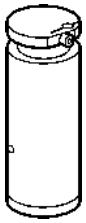

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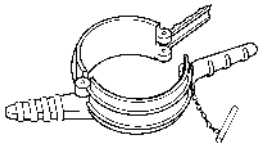

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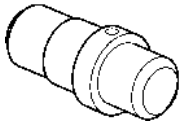

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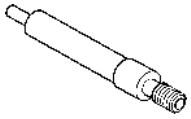

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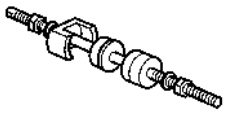

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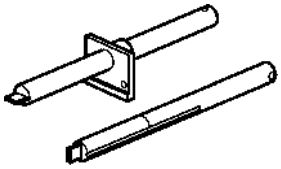

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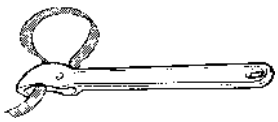

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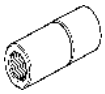
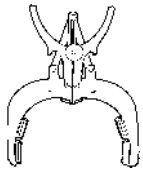


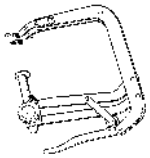
11668403

Tool	Name, use
999 8674	Adapter, pressure regulating valve. Used together with 999 6400
999 8675	Extractor plate, for cylinder liners used together with 999 6645
999 8676	Rotating tool, crankshaft
999 8678	Measuring bar, with spacers for determining of cylinder head gasket
999 8679	Protractor, 360 degrees
999 8681	Cranking tool, flywheel
999 8682	Pressure tool, for locking of the control rod
999 8684	Measuring fixture, to measure and lock the control rod
999 8685	Measuring fixture, for the injection pump unit
999 8687	Piston ring compressor, installing pistons in the block
999 8692	Fitting tool, for gudgeon pin bushing
999 8694	Adapter, for compression testing
999 8695	Fitting tool, camshaft bearings
999 8696	Fitting tool, for control rod sleeves
999 9179	Filter wrench, removing filter
11668403	Socket, for injection pump assembly

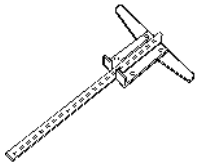
Other special equipment



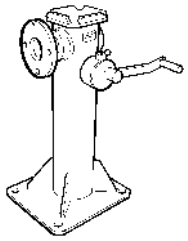
998 5423



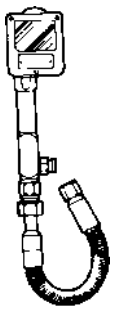
998 5468



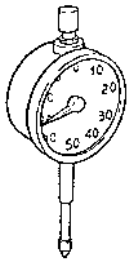
998 5471



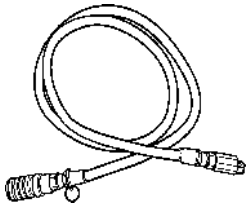
998 6485



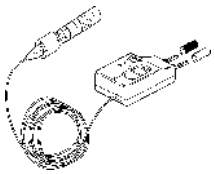
998 8539



998 9876



999 8493



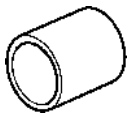
999 8496

Tool	Name, use
998 5423	Piston ring pliers**,** remove/replace piston rings
998 5468	Valve spring compressor, remove/replace valve retainers
998 5471	Rule depth gauge, for control rod
998 6485	Engine repair stand
998 8539	Compression tester
998 9876	Dial gauge
999 8493	Hose, used with 999 8496
999 8496	Electrical pressure gauge, used instead of 999 6398 and together with a multipurpose instrument

Övrig utrustning

180211

969011



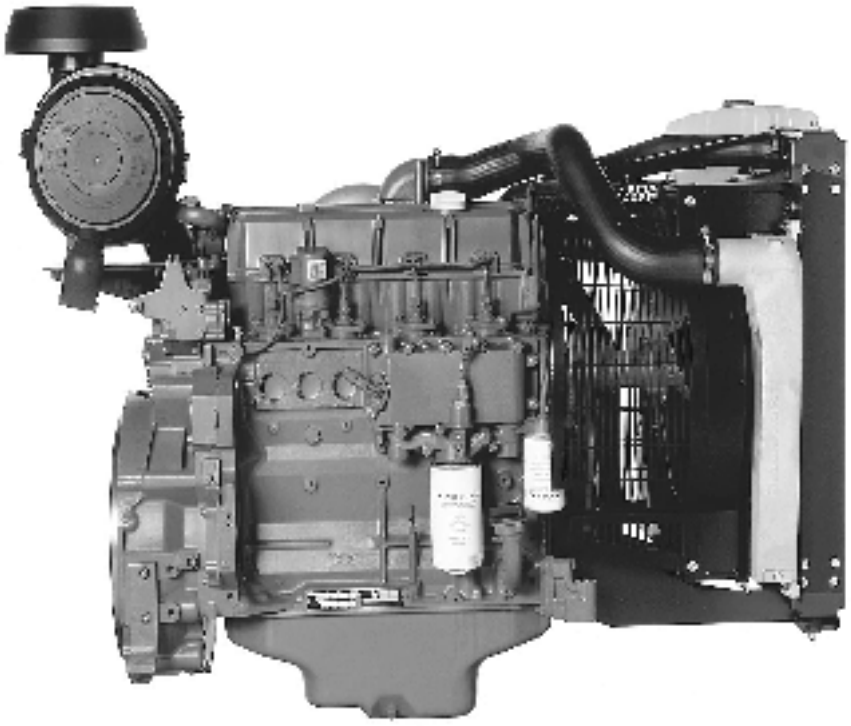
1678297

Tool	Name, use
180211	Long, hollow screw, used together with 999 6066
969011	Copper washer, fuel supply pressure check
1678297	Spacer, oil pressure and charge air pressure check. Used together with 180211.

Engine description

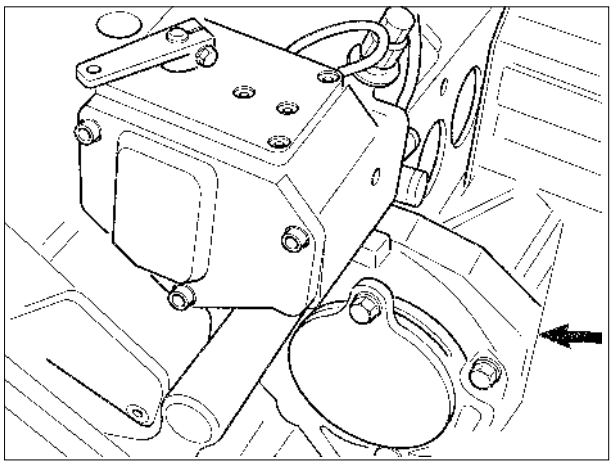
Location of the engine identification plate

Each engine is supplied with two identical identification plates, of which one is mounted on the right side of the cylinder block and the other one should be mou-nted in a suitable location adjacent to the engine.



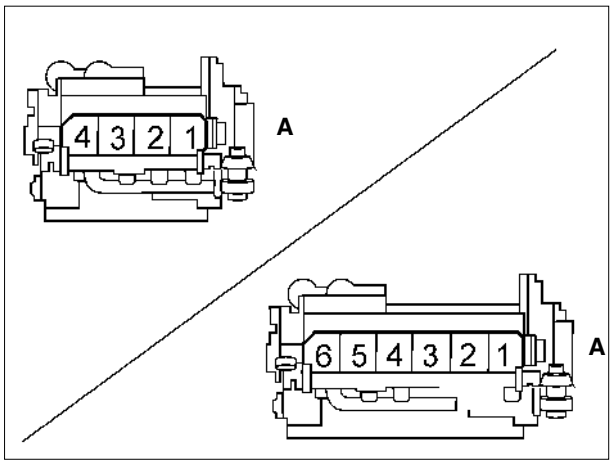
Identification plates

1. Engine model
2. Engine specific number
3. Engine serial number (10 digits)
4. Engine output without fan
5. Rated engine speed
6. Injection timing and type of camshaft
7. Manufacturers identification code
8. Indication of standard and /or regulation
9. Reference test conditions, according to ISO 3046
10. Reference test conditions, according to ISO 3046
11. Injection pump code (EP code), cylinder 1 on top
12. Piston class
13. Extra information



Engine serial number

The engine serial number is stamped into the engine block and engine identification plate. The serial number is a ten-digit number. Only the last eight digits are stamped into the engine block.

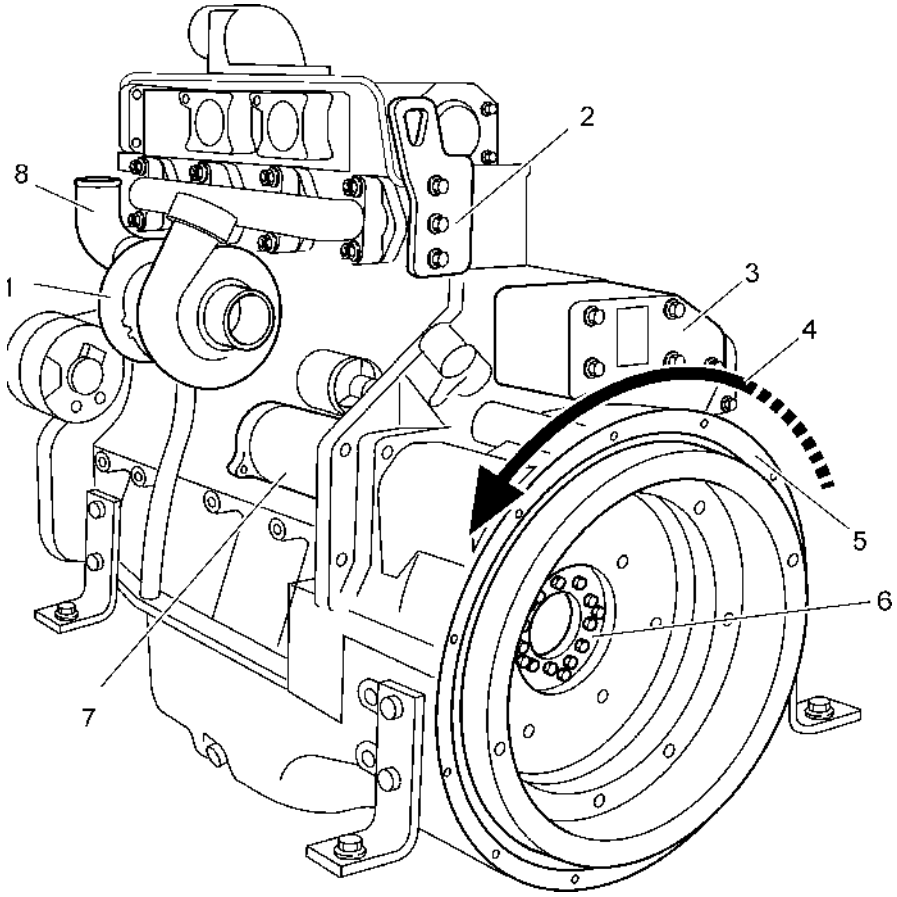


Cylinder numbering

(**A** = flywheel)

Engine, location of components

Starter motor side



1 Turbocharger
2 Lifting eye
3 Engine speed governor*
4 Rotation direction (counter-clockwise)
5 Flywheel housing
6 Flywheel
7 Starter motor
8 Coolant outlet pipe

*** Governor (Heinzmann)**

The governor for T(A)D 520, 530/532/720-722, 730-733GE/VE series engines is a mechanically variable speed governor with a Heinzmann centrifugal measuring unit.

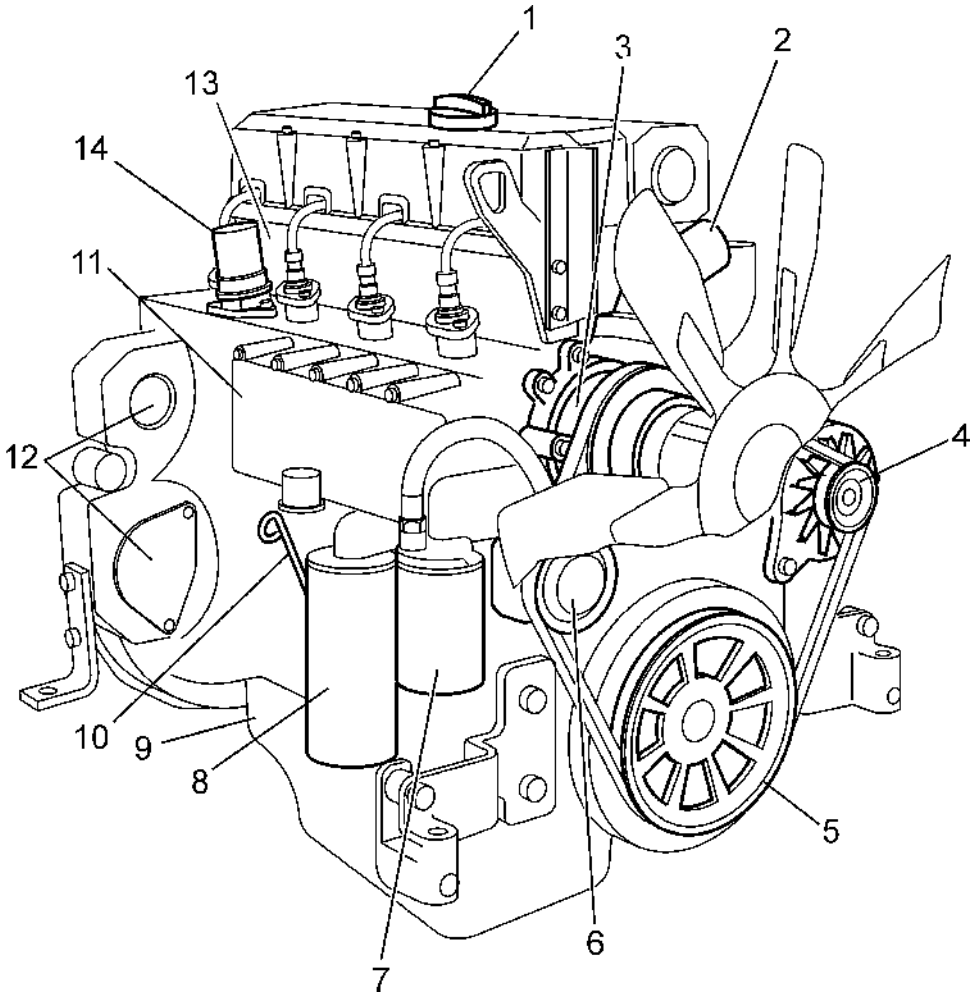
The governor for the engines above are uniquely prepared for each engine individual. This means that the governor can not be exchanged between different engines.

An incorrect adjusted governor can result in that the engine will not fulfill the regulations for emission and performance.

When ordering a governor as a spare part always state engine types serial number and rated speed (rpm).

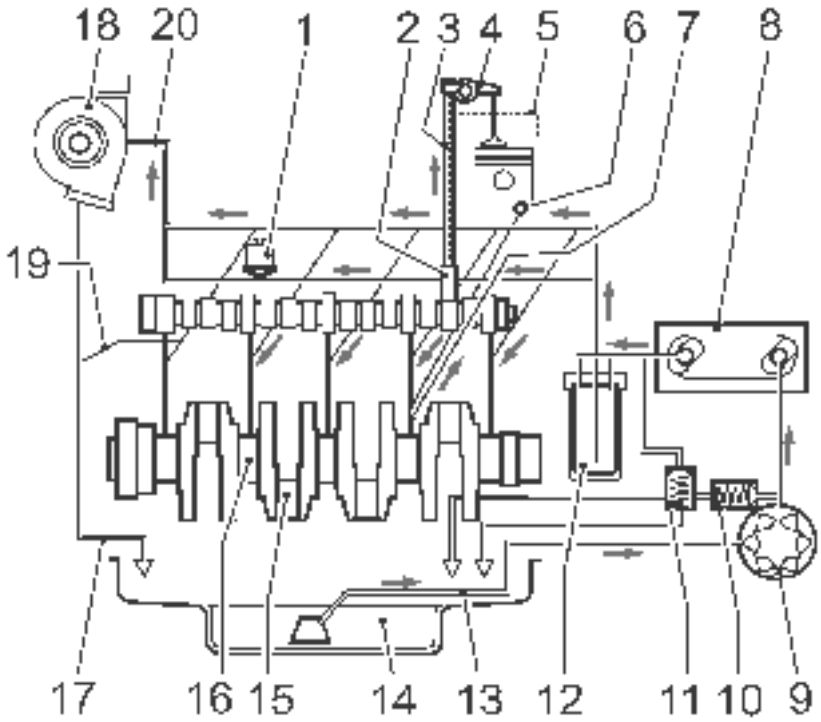
Only trained personnel should make adjustments to the governor.

Service side



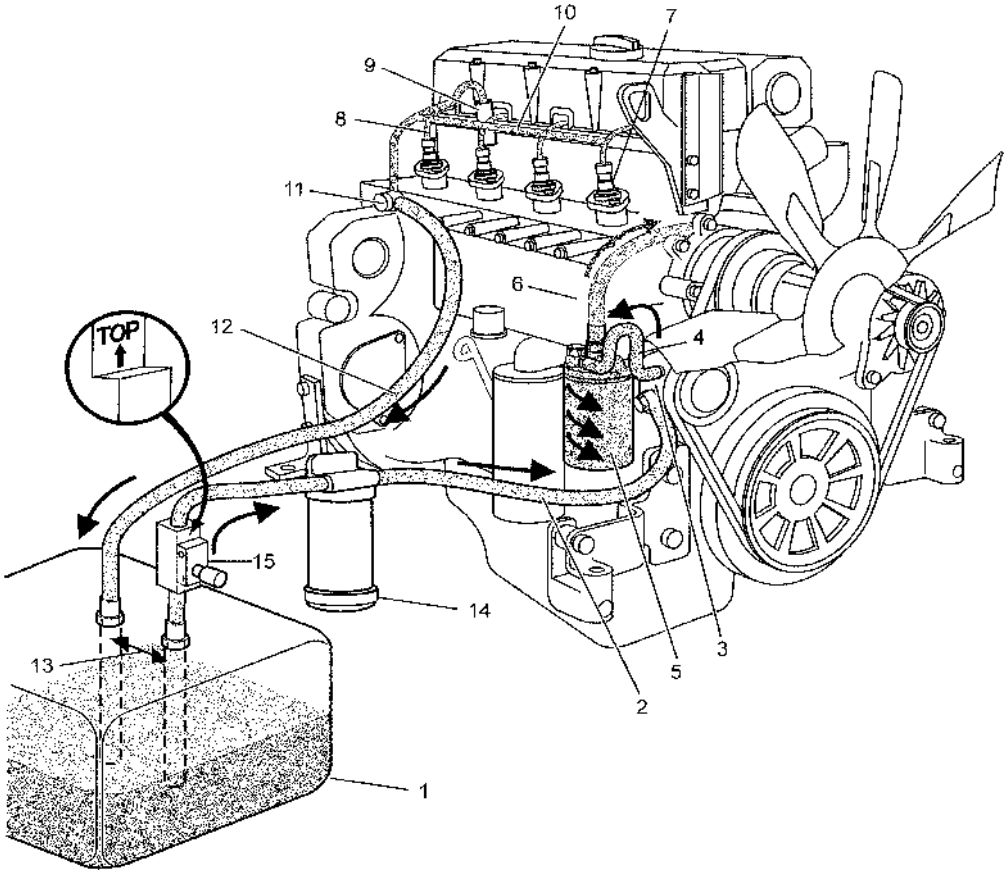
1 Oil filler cap
2 Coolant inlet pipe
3 Coolant pump
4 Alternator
5 Crankshaft pulley
6 Fuel pump
7 Fuel filter
8 Lubricating oil filter
9 Oil sump
10 Oil dipstick
11 Lubricating oil cooler
12 Power socket for hydraulic pump, air compressor etc.
13 Cylinder head
14 Stop solenoid

Lubrication system



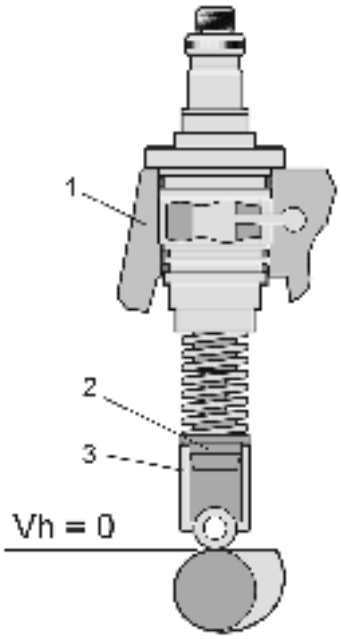
1 Oil pressure sender
2 Valve tappet with rocker arm lubrication
3 Oil suction pipe
4 Rocker arm
5 Return to oil sump
6 Spray nozzle for piston cooling
7 Oil channel to piston cooling nozzle
8 Lubricating oil cooler
9 Lubricating oil pump
10 Safety valve (pressure regulating valve)
11 Reduction valve
12 Lubricating oil filter
13 Push rod, oil feed to rocker arm lubrication
14 Oil sump
15 Connecting rod bearing
16 Crankshaft main bearing
17 Return flow from turbocharger to crankcase
18 Turbocharger
19 Return flow to oil sump
20 Oil line to turbocharger

Fuel system



1 Fuel tank
2 Line to fuel pump
3 Fuel pump
4 Line to fuel filter
5 Fuel filter
6 Fuel line to fuel duct
7 Injection pump
8 Delivery pipe to injector
9 Injector
10 Fuel return line
11 Overflow valve with air ventilation screw
12 Return line to fuel tank
13 Fuel pipes[1]
14 Pre-filter, water separating
15 Hand pump (accessory)[2]

[1)] **NOTE!** Minimum distance 300 mm.
[2)] **NOTE!** Does not work laying down. Must be turned right (TOP).



Commencement of delivery, Fb

The engine is equipped with a separate injection pump for each cylinder. This means that the commencement of delivery, **Fb**, when necessary, has to be adjusted separate for each pump unit. The commencement of delivery, **Fb**, is adjusted with a shim, placed between lifter and injection pump.

To exchange only the injection pump, the formula $\mathbf{T_s=(L_0+A/100)}$ is used, according to “Calculation 1” in “Technical data”

If engine block, camshaft or roller tappet are exchanged, the corrected fitting size, $\mathbf{E_k}$, and new **EP-code** must also be calculated, according to “Calculation 2 and 3” in “Technical data”.

New **EP-code** must also be is indicated on the identification plate, in order for calculations during future replacement of injection pump to be correct.

Delivery pipes

⚠ **IMPORTANT!** The delivery pipes must be disposed of after disassembling.

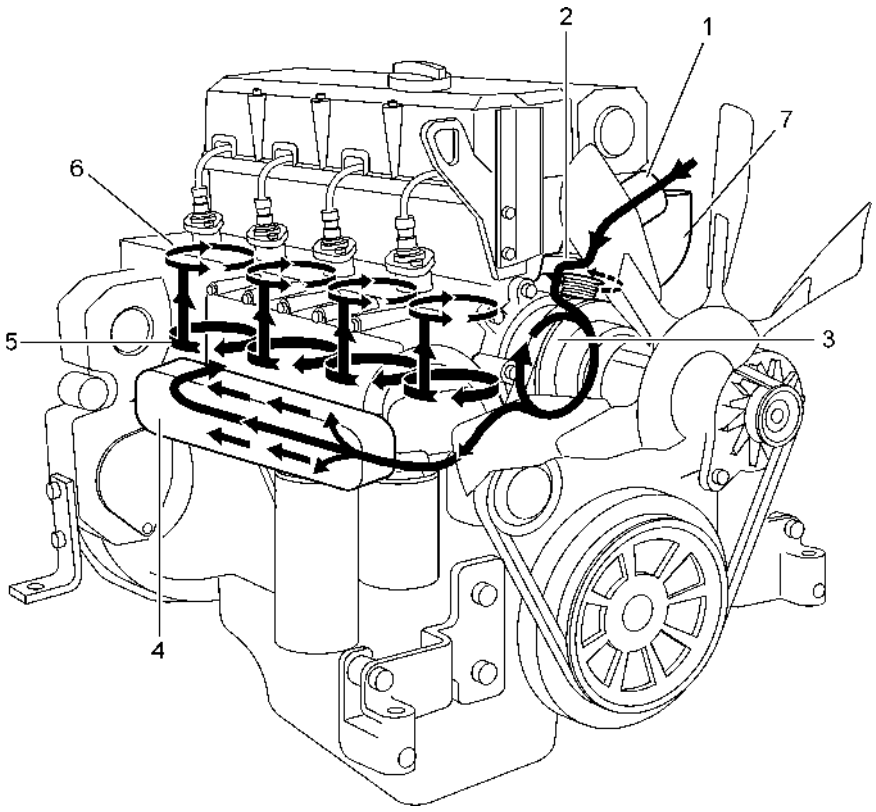
The delivery pipes are deformed when tightened and all delivery pipes must be tightened with the same tightening torque.

If they are tightened with different tightening torque, the cylinders may take different load.

Reuse of delivery pipes may mean that the engine power is not complete.

If the delivery pipes for some reason have been damaged, for example during transport, they may not be bent right, but must be replaced.

Cooling system



1 Coolant connection (inlet)
2 Thermostat housing
3 Coolant pump
4 Lubricating oil cooler
5 Cylinder cooling
6 Cylinder head cooling
7 Coolant connection (outlet)

Technical data

Engine

Engine	TD 520GE	TAD 520GE
Engine weight, according to DIN 70020–A	Approx. 550 kg (1212 lbs)	Approx. 575 kg (1268 lbs)
Engine displacement	4760 cm³ (290.4 in³)	4760 cm³ (290.4 in³)
Bore	108 mm (4.25”)	108 mm (4.25”)
Stroke	130 mm (5.12”)	130 mm (5.12”)
Rotation direction	Counterclockwise	Counterclockwise
Rated speed	1500/1800 rpm	1500/1800 rpm
Minimum idling speed	800-950 rpm	800-950 rpm
Operating cycle	Four stroke diesel	Four stroke diesel
Combustion system	Direct injection	Direct injection
Compression ratio	17.5:1	17.5:1
Firing order	1-3-4-2	1-3-4-2
Valve clearance, inlet exhaust	0,35 /0,55 mm ±0,05 mm	0,35 /0,55 mm ±0,05 mm
	(0.014"/0.022"±0.0039)	(0.014"/0.022"±0.0039)
Lubricating oil pressure at low idle, temperature approx. 120°C, oil SAE 15W/40	Min. 150 kPa (21.7 psi)	Min. 150 kPa (21.7 psi)
Thermostat starts to open/fully open	83°C/95°C (181°F/203°F)	83°C/95°C (181°F/203°F)

Engine	TD 520VE	TAD 520VE
Engine weight, according to DIN 70020–A	Approx. 430 kg (948 lbs)	Approx. 432 kg (952 lbs)
Engine displacement	4760 cm³ (290.4 in³)	4760 cm³ (290.4 in³)
Bore	108 mm (4.25”)	108 mm (4.25”)
Stroke	130 mm (5.12”)	130 mm (5.12”)
Rotation direction	Counterclockwise	Counterclockwise
Rated speed	1800 rpm	2000-2300 rpm
Minimum idling speed	800-950 rpm	800-950 rpm
Operating cycle	Four stroke diesel	Four stroke diesel
Combustion system	Direct injection	Direct injection
Compression ratio	18.4:1	18.1:1
Firing order	1-3-4-2	1-3-4-2
Valve clearance, inlet exhaust	0,35 /0,55 mm ±0,05 mm	0,35 /0,55 mm ±0,05 mm
	(0.014"/0.022"±0.0039)	(0.014"/0.022"±0.0039)
Lubricating oil pressure at low idle, temperature approx. 120°C, oil SAE 15W/40	Min. 150 kPa (21.7 psi)	Min. 80 kPa (11.6 psi)
Thermostat starts to open/fully open	83°C/95°C (181°F/203°F)	87°C/102°C (188°F/215°F)

Type designation	TAD530GE	TAD531GE	TAD532GE
Direction of rotation (seen from flywheel)	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	4	4	4
Cylinder bore mm (inch)	108 (4.25”)	108 (4.25”)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)	130 (5.12”)	130 (5.12”)
Cylinder volume liter (inch ³)	4.76 (290)	4.76 (290)	4.76 (290)
No. of valves	8	8	8
Compression ratio:			
EPA1			
EPA2			18.0:1
EU2	18.0:1	18.0:1	
Injection sequence	1-3-4-2	1-3-4-2	1-3-4-2
Engine power:			
At 1500 rpm kW (hp)	89 (139)[1)]	102 (139)[1)]	129 (139)[1)]
At 1800 rpm kW (hp)	95 (150)[1)]	110 (150)[1)]	136 (150)[1)]
Torque Nm (lbf.ft)	567 (479)	649 (479)	821 (479)
At engine speed rpm	1500	1500	1500
Torque Nm (lbf.ft)	504 (430)	584 (430)	722 (430)
At engine speed rpm	1800	1800	1800
Low idle rpm	800 – 950	800 – 950	800 – 950
Highest full load speed rpm	1500/1800 [1)]	1500/1800 [1)]	1500/1800 [1)]
Weight, dry (lb)	575 (1268) [2,3)]	575 (1268) [2,3)]	575 (1268) [2,3)]
Gross weight, dry (lb)	606 (1336) [2,3)]	606 (1336) [2,3)]	606 (1336) [2,3)]

[1)] See engine plate for specifications.
[2)] Weight according to DIN 70020-A
[3)] Extra weight TAD530/31/32GE SAE 2 (1800 rpm) 36 kg (80 lb)
[4)] Including clutch and frame

Engine	**TD720GE**	**TAD720GE**
Engine weight, according to DIN 70020–A	ca. 750 kg (1653 lbs)	ca. 760 kg (1676 lbs)
Engine displacement	7150 cm³ (436.3 in³)	7150 cm³ (436.3 in³)
Bore	108 mm (4.25”)	108 mm (4.25”)
Stroke	130 mm (5.12”)	130 mm (5.12”)
Rotation direction	Counterclockwise	Counterclockwise
Rated speed	1500/1800 rpm	1500/1800 rpm
Minimum idling speed	800-950 rpm	800-950 rpm
Operating cycle	Four stroke diesel	Four stroke diesel
Combustion system	Direct injection	Direct injection
Compression ratio	17.1:1	17.1:1
Firing order	1-5-3-6-2-4	1-5-3-6-2-4
Valve clearance, inlet exhaust	0,35 /0,55 mm ±0,05 mm	0,35 /0,55 mm ±0,05 mm
	(0.014"/0.022"±0.0039)	(0.014"/0.022"±0.0039)
Lubricating oil pressure at low idle, emperature approx. 120°C, oil SAE 15W/40	Min. 150 kPa (21.7 psi)	Min. 150 kPa (21.7 psi)
Thermostat starts to open/fully open	83°C/95°C (181°F/203°F)	83°C/95°C (181°F/203°F)

Engine	**TAD721GE**	**TAD722GE**
Engine weight, according to DIN 70020–A	ca. 785 kg (1731 lbs)	ca. 785 kg (1731 lbs)
Engine displacement	7150 cm³ (436.3 in³)	7150 cm³ (436.3 in³)
Bore	108 mm (4.25”)	108 mm (4.25”)
Stroke	130 mm (5.12”)	130 mm (5.12”)
Rotation direction	Counterclockwise	Counterclockwise
Rated speed	1800 rpm	2000-2300 rpm
Minimum idling speed	800-950 rpm	800-950 rpm
Operating cycle	Four stroke diesel	Four stroke diesel
Combustion system	Direct injection	Direct injection
Compression ratio	18.1:1	18.1:1
Firing order	1-5-3-6-2-4	1-5-3-6-2-4
Valve clearance, inlet exhaust	0,35 /0,55 mm ±0,05 mm	0,35 /0,55 mm ±0,05 mm
	(0.014"/0.022"±0.0039)	(0.014"/0.022"±0.0039)
Lubricating oil pressure at low idle, emperature approx. 120°C, oil SAE 15W/40	Min. 80 kPa (11.6 psi)	Min. 80 kPa (11.6 psi)
Thermostat starts to open/fully open	87°C/102°C (188°F/215°F)	87°C/102°C (188°F/215°F)

Type designation	**TAD730GE**	**TAD731GE**	**TAD732GE**	**TAD733GE**
Direction of rotation (seen from flywheel)	Anti- clockwise	Anti- clockwise	Anti- clockwise	Anti- clockwise
No. of cylinders	6	6	6	6
Cylinder bore mm (inch)	108 (4.25”)	108 (4.25”)	108 (4.25”)	108 (4.25”)
Stroke mm (inch)	130 (5.12”)	130 (5.12”)	130 (5.12”)	130 (5.12”)
Cylinder volume liter (inch ³)	7.15 (436.3)	7.15 (436.3)	7,15 (436)	7,15 (436)
No. of valves	12	12	12	12
Compression ratio:				
EPA1		17.1:1		
EPA2	17.1:1	17.1:1	18,0:1	18,0:1
EU2	18.0:1			
Injection sequence	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Engine power:				
At 1500 rpm kW (hp)	129 (208)[1)]	153 (208)[1)]	201 (273)[1)]	201 (273)[1)]
At 1800 rpm kW (hp)	136 (222)[1)]	163 (222)[1)]	225 (306)[1)]	225 (306)[1)]
Torque Nm (lbf.ft)	821 (718)	974 (718)	1280 (944)	1280 (944)
At engine speed rpm	1500	1500	1500	1500
Torque Nm (lbf.ft)	722 (638)	865 (638)	1193 (880)	1193 (880)
At engine speed rpm	1800	1800	1800	1800
Low idle rpm	800 – 950	800 – 950	800 – 950	800 – 950
Highest full load speed rpm	1500/1800 [1)]	1500/1800 [1)]	1500/1800[1)]	1500/1800[1)]
Weight, dry (lb)	760 (1674) [2)]	760 (1674) [2)]	785 (1731)[2)]	785 (1731)[2)]
Gross weight, dry (lb)	804 (1773) [2)]	804 (1773) [2)]	826 (1821)[2)]	826 (1821)[2)]

[1)] See engine plate for specifications.
[2)] Weight according to DIN 70020-A
[3)] Extra weight TAD530/31/32GE SAE 2 (1800 rpm) 36 kg (80 lb)
[4)] Including clutch and frame

Engine	**TD720VE**	**TAD720/721/722VE**
Engine weight, according to DIN 70020–A	ca. 570 kg (1257 lbs)	ca. 572 kg (1261 lbs)
Engine displacement	7150 cm^3 (436.3 in^3)	7150 cm^3 (436.3 in^3)
Bore	108 mm (4.25”)	108 mm (4.25”)
Stroke	130 mm (5.12”)	130 mm (5.12”)
Rotation direction	Counterclockwise	Counterclockwise
Rated speed	1800 rpm	2000-2300 rpm
Minimum idling speed	850-950 rpm	800-950 rpm
Operating cycle	Four stroke diesel	Four stroke diesel
Combustion system	Direct injection	Direct injection
Compression ratio	18.4:1	18.4:1 (stage 1), 19.0:1 (stage 2)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4
Valve clearance, inlet exhaust	0,35 /0,55 mm ±0,05 mm (0.014"/0.022"±0.0039)	0,35 /0,55 mm ±0,05 mm (0.014"/0.022"±0.0039)
Lubricating oil pressure at low idle, emperature approx. 120°C, oil SAE 15W/40	Min. 150 kPa (21.7 psi)	Min. 80 kPa (11.6 psi)
Thermostat starts to open/fully open	83°C/95°C (181°F/203°F)	87°C/102°C (188°F/215°F)

Coolant

Volvo Penta glycol (antifreeze) mixed 45/55 with clean water

Anti-corrosion agent

Used only in markets where there is no risk of freezing, mixed with water[3)].

[3)] The anti-corrosion agent must not be mixed with glycol or other types of anti-corrosion fluid as this could result in negative consequences.

Water quality specification:

To avoid the risk of clogging in the cooling system, the coolant should be mixed with pure water to ASTM D4985. If any doubt about the purity of the water, distilled water or ready-mixed coolant should always be used instead

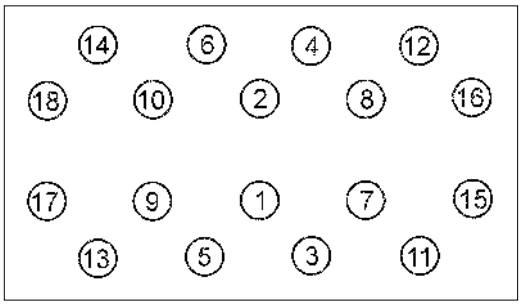
Lubrication

Engine

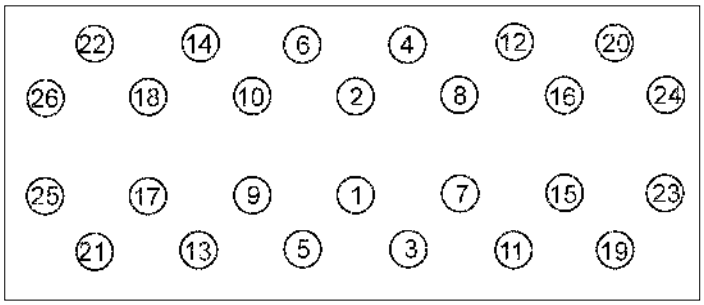
Lubrication	Forced circulation lubrication
Oil SAE	15W 40
Oil temperature in sump	Normal 80°C (176°F) Max. 125°C (257°F)
Oil pressure at rated speed:	
TAD530-532	450-480 kPa
TAD730-733	480-520 kPa
TD520GE/TAD520GE (1500 rpm)	280 kPa (40 psi)
TD520/GE/TAD720GE (1800 rpm)	330 kPa (48 psi)
TD520VE	440 kPa (64 psi)
TAD520VE	390 kPa (56 psi)
TD720GE/TAD720/721/722GE	400 kPa (58 psi)
TD720VE	450 kPa (65 psi)
TAD720VE/TAD721VE	350 kPa (51 psi)
Shut down switch setting:	
520/720/721/722 GE, 732, 733	200 kPa (29 psi)
520/720/721/722 VE, 530, 531, 730, 731, 532	50 kPa (7 psi)
Oil volume including filter:	
TD520GE/TAD520GE	10 litre (2.64 US gallon)
TD520VE/TAD520VE	13 litre (3.43 US gallon)
TD/TAD720, TAD721/722VE, TAD730/731GE	20 litre (5.28 US gallon)
TAD721/722GE, TAD732/733GE	34 litre (8.98 US gallon)

Tightening sequence for cylinder head screws

Manifold side TD/TAD 520
TAD530-532



Manifold side TD/TAD 720-722
TAD730-733



Tightening torque

Screws to cylinder head are reusable only five times.

Step 1:	50	(37 lbf.ft)
Step 2:	130	(96 lbf.ft)
Step 3:	90° angle tightening	

Tightening torque

These tightening torques apply to oiled bolts and nuts. Parts that have been degreased (washed) should be oiled before they are fitted.

Special tightening torque's	Nm / angle tightening	(lbf.ft)
Group 21 Engine		
Engine mounting	**260**	(**192** lbf.ft)
Starter motor	**70**	(**51.6** lbf.ft)
Gear casing	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Main bearing caps		
Screws to main bearing caps are reusable only three times.		
Step 1	**50**	(**37** lbf.ft)
Step 2	tighten angularly **60°**	
Step 3	tighten angularly **60°**	
Connecting rod big-end bearing		
Use new screws every time.		
Step 1	**50**	(**22** lbf.ft)
Step 2	tighten angularly **60°**	
Step 3	tighten angularly **60°**	
Flywheel		
A) Flywheel with screws of max 30 mm length		
Step 1:	**20 – 30**	(**15 – 22** lbf.ft)
Step 2:	tighten angularly **60°**	
Step 3:	tighten angularly **30°**	
B) Flywheel with screws up to 45 mm length		
Step 1:	**20 – 30**	(**15 – 22** lbf.ft)
Step 2:	tighten angularly **60°**	
Step 3:	tighten angularly **60°**	
C) Flywheel with a screw length between 50 – 85 mm		
Step 1:	**30 – 40**	(**22 – 30** lbf.ft)
Step 2:	tighten angularly **60°**	
Step 3:	tighten angularly **60°**	
Flywheel housing		
M12	**99**$^{(\pm 10)}$	(**73**$^{\pm 7}$ lbf.ft)
M16	**243**$^{(\pm 25)}$	(**179**$^{\pm 18}$
lbf.ft)		
Cylinder head		
See previous page.		
V-belt pulley		
Screws to V-belt pulley are reusable only three times.		
Step 1:	**45**$^{(\pm 5)}$	(**33** ±3.7 lbf.ft)
Step 2:	tighten angularly **60°**	
Step 3:	tighten angularly **60°**	
Vibration damper	**70**	
Screw, rocker cover	**11**$^{(\pm 1)}$	(**8**$^{\pm 0.7}$ lbf.ft)
Lock nut, valve clearance adjusting screw	**20**$^{(\pm 2)}$	(**14.5**$^{\pm 1.5}$ lbf.ft)
Screws, rocker arm fixing	**21**	(**15.5** lbf.ft)
Screws, crankcase ventilation	**9**$^{(\pm 1)}$	(**6.6**$^{\pm 0.7}$ lbf.ft)

Tightening torques	Nm / angle tightening	(lbf.ft)
Group 22 Oil system		
Oil cooler, screws	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Oil cooler, hollow screw		
Step 1:	**80**	(**59** lbf.ft)
Step 2:	**160**	(**118** lbf.ft)
Oil cooler, screw plug	**80**	(**59** lbf.ft)
Front/oil pump housing	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Oil suction pipe	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Oil sump	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Oil pressure pipe turbo	**29**$^{(\pm 3)}$	(**21.4**$^{\pm 2.2}$ lbf.ft)
Oil pressure pipe engine block	**39**$^{(\pm 4)}$	(**29**$^{\pm 3}$ lbf.ft)
Screws, oil return pipe turbo		
A) with tube fitting	**40**$^{(\pm 2)}$	(**29.5**$^{\pm 1.5}$ lbf.ft)
B) with flange fitting	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Screws, oil return pipe engine block	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Oil pressure switch	**18**$^{(\pm 2)}$	(**13**$^{\pm 1.5}$ lbf.ft)
Group 23 Fuel system		
Screw, governor, idler gear:	**21**	(**22.1** lbf.ft)
Screw, control rod socket	**10**$^{(\pm 2)}$	(**7**$^{\pm 5}$ lbf.ft)
Screw, governor	**17**$^{(\pm 1.5)}$	(**12.5**$^{\pm 1}$ lbf.ft)
Flange screws, Injection pump		
Step 1: Torque	**5**	(**3.7** lbf.ft)
Step 2: Loosen screws for injection pump flange	**60°** (counterclockwise)	
Step 3: Turn injection pump to stop	Counterclockwise	
Step 4:	tighten angularly **60°**	
Step 5:	**7**	(**5** lbf.ft)
Step 6:	**10**	(**7.4** lbf.ft)
Step 7:	**30**	(**22** lbf.ft)
Flange screw, injector	**19**$^{(\pm 2)}$	(**14**$^{+1.5}$ lbf.ft)
Injector cap nut	**40 – 50**	(**30 – 37** lbf.ft)
Delivery pipe		
NOTE! Use a new delivery pipe after every disassembly **NOTE!** Make sure that you use the same tightening torque for all delivery pipes		
Step 1:	**5**	(**3.7** lbf.ft)
Step 2:	**25**$^{(+3.5)}$	(**18.4**$^{\pm 2.6}$ lbf.ft)
Screw, stop magnet	**21**	(**15.5** lbf.ft)
Overflow valve	**30**	(**22** lbf.ft)
Group 25 Inlet and exhaust system		
Exhaust manifold nuts	**25**$^{(\pm 2.5)}$	(**18.5**$^{\pm 1.8}$ lbf.ft)
M8 Nuts, turbo to exhaust manifold	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
M10 Nuts, turbo to exhaust manifold	**40**$^{(\pm 4)}$	(**29**$^{\pm 3}$ lbf.ft)
Screws, Inlet manifold	**11**$^{(\pm 1)}$	(**8**$^{\pm 0.7}$ lbf.ft)
Group 26 Cooling system		
Thermostat housing	**30**	(**22.1** lbf.ft)
Temperature sensor	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)
Coolant pump	**21**$^{(\pm 2)}$	(**15.5**$^{\pm 1.5}$ lbf.ft)

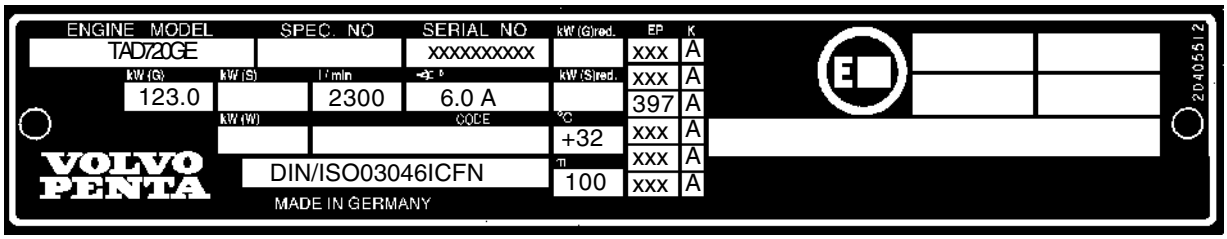
Determination of shim thickness when changing the injection pump.

Mathematical formula for new shim thickness: $T_s = Ek - (L_0 + A/100)$
Actual shim thickness, S_s, can be found in Table 2. $S_s \rightarrow T_s$
NOTE! This formula is applicable when changing the injection pump ONLY.

Calculation 1 Explanation	**Factor**		**Ex**	**TD/TAD 520/720/721/722**					
Cylinder no.	XXX			**Cyl: 1**	**Cyl: 2**	**Cyl: 3**	**Cyl: 4**	**Cyl: 5**	**Cyl: 6**
Injection pump manufacturing number	XXX								
EP code:	**EP**		397						
Corrected fitting size, see table 3	**E_k**		146.9						
Basic meas. of inj. pump, see table 1	**L_0**	-	143						
Manufacturing tolerance, see inj.pump	**A/100**	-	0.63						
Theoretical shim thickness	**T_s**	=	3.27						
Shim thickness, see table 2	**S_s**	~	3.3						

Example: Change of injection pump for cylinder 3 on a TAD 720 engine.

1. Read the EP code for cylinder 3 from the engine identification plate, in the “EP” column, e.g. 397. (Sequence from top: row 1 = cyl. 1, row 2 = cyl. 2 etc.).



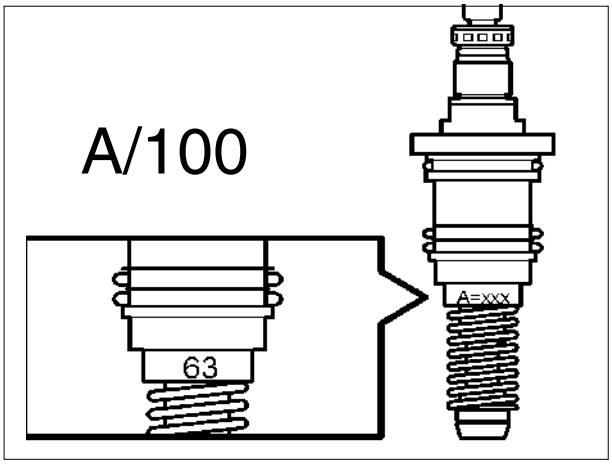
2. Using the EP code, read the corrected fitting size (E_k) for the injection pump from Table 3.
Ex. EP code = 397 → E_k = 146.9 mm.

3. Take the manufacturing tolerance for the injector pump length, **A**, from the new injector pump,

   Ex. 63 (see figure)

   NOTE! If the value is not visible, remove possible dirt, **without** scraping.

   The tolerance value A is divided by 100 in calculations.



4. Take the standard size for the injector pump, **L_0**, from Table 1.
Ex. 143 mm.

5. Determine the theoretical shim thickness, **T_s**, according to the formula: **$T_s = E_k – (L_0 + A/100)$**
(Also see examples in “Calculation 1”)
Ex. T_s = 146.9 mm – (143 mm + 0.64 mm)
T_s = 4.54

6. Select shim thickness, **S_s** , from Table 2.
Ex. T_s = 4.54 mm → S_s = 4.5 mm

Determination of shim thickness when the injection valve opens

Performed when replacing engine block, camshaft, or roller tappet.

Mathematical formula for the new shim thickness:

$T_s = L-[(Fb_{akt} - Fb_{nom})x\ Vh_{korr} + Vh_{nom} + L_o + A/100)]$

The actual shim thickness can be found in Table 2. $S_s \rightarrow T_s$

NOTE! After determining the shim thickness, a new EP code **MUST ALWAYS** be determined, according to "Calculation 3", in order for changing of pump to be correct at a later point in time.

Calculation 2.1 Explanation	**Factor**		**Ex**	**TD/TAD 520 GE, TD/TAD 720 GE**					
Cylinder no.	XXX		XXX	Cyl. 1	Cyl. 2	Cyl. 3	Cyl. 4	Cyl. 5	Cyl. 6
Injection pump manufacturing number	XXX		XXX						
Injection angle, meas. on protractor.	**Fb_{akt}**		5.5						
Injection angle, see engine id. plate ∠°	**Fb_{nom}**	-	6						
Total 1 (Fb_{akt}- Fb_{nom})	**S1**	=	-0.5						
Pre-stroke, corr.factor, see Table 1	**Vh_{korr}**	x	0.14						
Total 2 (S1 x Vh_{korr})	**S2**	=	-0.07						
Pre-stroke, see Table 1	**Vh_{nom}**	+	6.11						
Basic meas. of inj. pump, see Table 1	**L_0**	+	143						
Manufacturing tolerance, see inj.pump	**A/100**	+	0.63						
Total 3 (S2+ Vh_{nom}+L_0+A/100)	**S3**	=	149.67						

Calculation 2.2 Explanation	**Code**		**Ex.**	**Cyl. 1**	**Cyl. 2**	**Cyl. 3**	**Cyl. 4**	**Cyl. 5**	**Cyl. 6**
Length between block and roller tappet	**L**		152.18						
Total 3 (S2+ Vh_{nom}+L_0+A/100)	**S3**	-	149.67						
Theoretical shim thickness (L - S3)	**T_s**	=	2.55						
Shim thickness, see Table 2	**Ss**	~	2.6						

FACTOR	**UNIT**	**EXPLANATION**
Fb_{akt}	ºC/A	Injection angle, measured on protractor according to method.
Fb_{nom}	ºC/A	Injection angle, see table 1.
Vh_{korr}	mm/ºC/A	Pre-stroke, correction factor see table 1.
Vh_{nom}	mm	Pre-stroke, nominal, see table 1.
L	mm	Measured length between block and roller tappet.
L_0	mm	Basic measurement of injection pump.
A/100	mm	Manufacturing tolerance, written on injection pump.
T_s	mm	Theoretical shim thickness.
S_s	mm	Shim thickness.
S (1, 2, 3)	xxx	Total of calculation.
EP	xxx	Code value, see table 3 or engine identification plate.
E_k	mm	Total of calculation. Only applicable when determining EP code.

Determination of the corrected fitting size, E_k, and EP code for an injection pump.

NOTE! When you change the engine block camshaft or roller tappet, you must determine the corrected fitting measurement, E_k, and change the relevant EP code on the engine identification plate.

Mathematical formula for the corrected fitting size, E_k:

$E_k = L - [(Fb_{akt} - Fb_{nom}) \times Vh_{korr} + Vh_{nom})]$

New EP code is found in Table 3.2 $E_k \rightarrow$ EP code

Calculation 3.1 Explanation	Factor		Ex	TD/TAD 520 GE, TD/TAD 720 GE					
Cylinder no.	XXX		XXX	Cyl. 1	Cyl. 2	Cyl. 3	Cyl. 4	Cyl. 5	Cyl. 6
Injection pump manufacturing number	XXX		XXX						
Injection angle, meas. on protractor.	Fb_{akt}		5.5						
Injection angle, see eng. id. plate ∠°	Fb_{nom}	-	6						
Total 1 (Fb_{akt} - Fb_{nom})	S1	=	-0.5						
Corr. factor, see Table 1	Vh_{korr}	x	0.14						
Total 2 (S1x Vh_{korr})	S2	=	-0.07						
Pre-stroke, see Table 1	Vh_{nom}	+	6.11						
Total 3 (S2+ Vh_{nom})	S3	=	6.04						

Calculation 3.2 Explanation	Factor		Ex	Cyl. 1	Cyl. 2	Cyl. 3	Cyl. 4	Cyl. 5	Cyl. 6
Length between block and roller tappet	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 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 $F_{b_{nom}}$	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		
4	B	5,7	0,14	143 (L_o)
4,5		5,6		
5		5,5		
5,5		5,4		
6		5,31		
7		5,1		
8		4,9		

(100 mm = 3.937")

Table 2

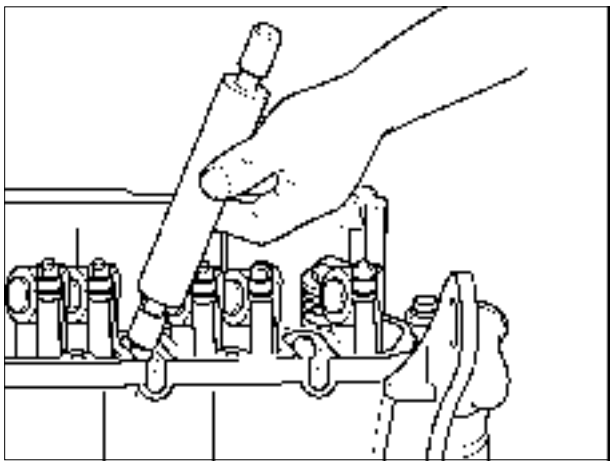
Theoretical thickness "T_s" (mm)	Shim thickness "S_s" (mm)	Theoretical thickness "T_s" (mm)	Shim thickness "S_s" (mm)
0.95–1.049	1.0	3.05–3.149	3.1
1.05–1.149	1.1	3.15–3.249	3.2
1.15–1.249	1.2	3.25–3.349	3.3
1.25–1.349	1.3	3.35–3.449	3.4
1.35–1.449	1.4	3.45–3.549	3.5
1.45–1.549	1.5	3.55–3.649	3.6
1.55–1.649	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		

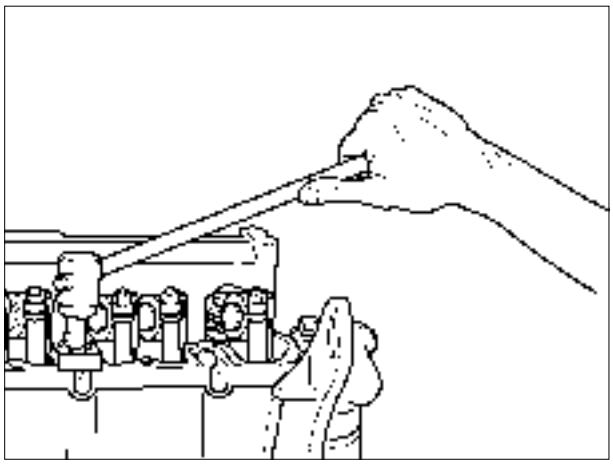
(100 mm = 3.937")

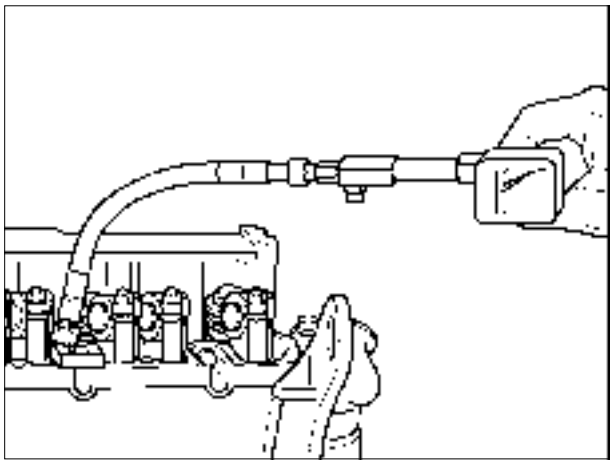
Table 3

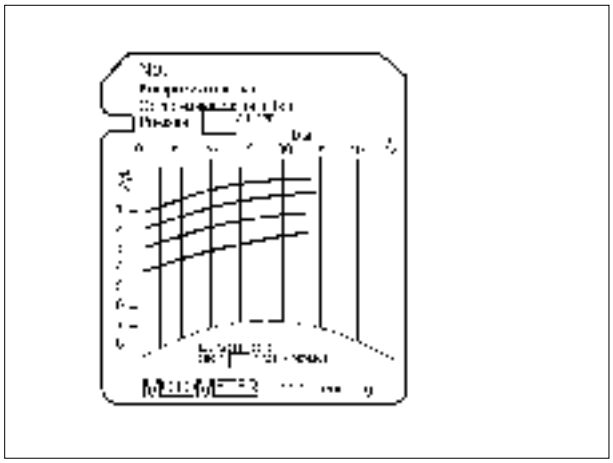
E_k (mm)	EP code	E_k (mm)	EP code	E_k (mm)	EP code	E_k (mm)	EP code	E_k (mm)	EP code
144.5		145.1		145.7	349	146.3	373	146.9	397
144.525		145.125		145.725	350	146.325	374	146.925	398
144.55		145.15		145.75	351	146.35	375	146.95	399
144.575		145.175		145.775	352	146.375	376	146.975	400
144.6		145.2		145.8	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")









Checks and adjustments

Compression test
(21002)

Special tools:

Adapter for compression testing 999 8694

Compression gauge 998 8539

The injectors have been removed, the valve clearance has been checked.

1. Fit adapter 999 8694.
2. Use the existing injector yoke.
   Tighten the screw to ..... **19** ±2 **Nm** (14 $^{\pm 1.5}$ lbf ft).
3. Connect the compression tester, 998 8539.
   Turn the engine over with the starter motor. Compression: **3-3.8 MPa** (435-551 psi).

NOTE! Make sure that the fuel control rod is in the no fuel position (stop position).

The measured compression depends on the engine speed during the measuring process and the ambient air pressure.

It is difficult to give an exact limit value due to the ambient air pressure. We recommend that the compression test is to compare the cylinders of the engine. **If the pressure difference is greater than 15% the cylinder in question should be dismantled to determine the cause.**

NOTE! Refit the injector with a new copper gasket and tighten to **19** ±2 **Nm** (14 $^{\pm 1.5}$ lbf ft).
Fit the new fuel delivery pipe and tighten in two stages **5** Nm and **25** $^{+3.5}_{0}$ **Nm** (19 $^{+2.5}_{0}$ lbf ft).

⚠ **IMPORTANT!** All delivery pipes must be tightened with the same tightening torque.

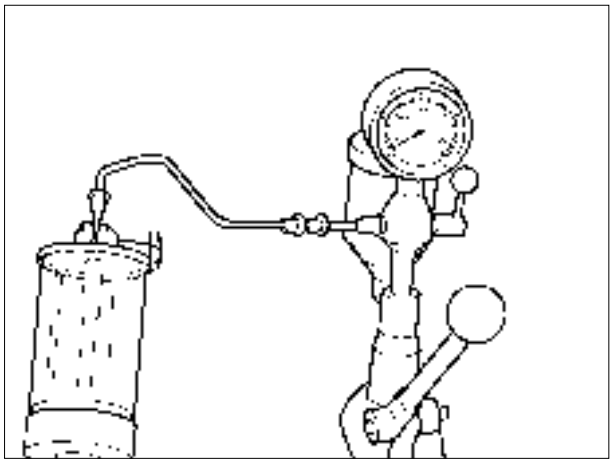
Tighten the rocker cover to **11** ±1 **Nm** (6.6 ±0.7 lbf ft).

NOTE! The fuel leakage lines must always be replaced if removed.

Injectors, checking/adjusting (23712, 23713)

NOTE! You must observe the utmost cleanliness when working on the injection system. Use only clean test oil that meets ISO 4113 or clean diesel to test the injector.

NOTE! Let an authorized workshop do the tests and adjustments. The test requires equipment not sold by AB Volvo Penta.



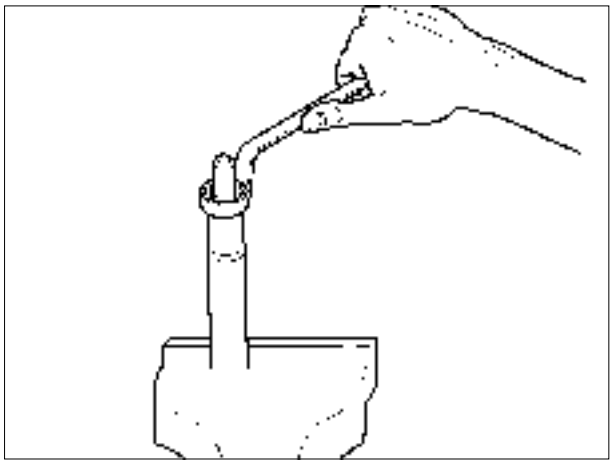
⚠ **WARNING!** Be very careful when working with the fuel injector nozzle. The fuel pressure jet can penetrate deep into the skin tissue and cause blood poisoning.

1. Connect the injector to the nozzle tester.
2. Check the opening pressure.
   For control value for the opening pressure, see “Technical data”.

NOTE! The opening pressure is different depending on if the injector or spring is new or used.

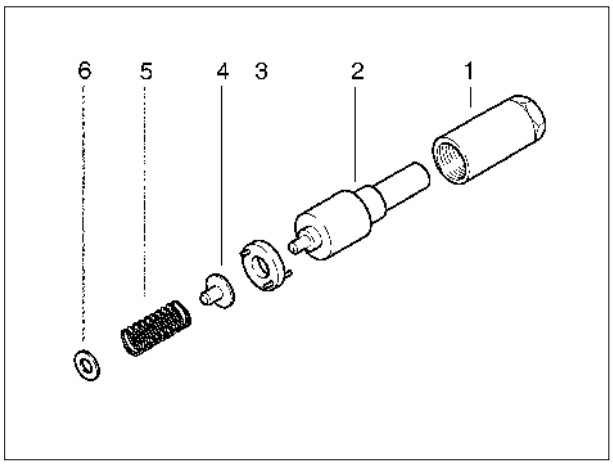
3. Check the density after the injector has opened. The pressure may, at the most, drop to 5 MPa (725 psi) /5 sec.

   By keeping the pressure constant, 2 MPa (290 psi) below opening pressure for 10 seconds, make sure that no drips occur.



Set the opening pressure for the injector

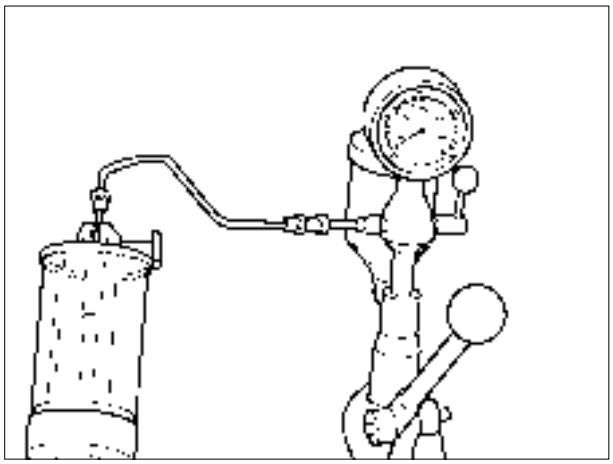
4. Take off the cap nut and remove all parts.
5. Wash the details in an ultrasonic cleaner, alternatively washing petrol or Vanolen.
6. Inspect the injector details, using an injector microscope.
7. Dip the parts in oil before assembly.



The order for removing parts is:

1 Cap nut
2 Injection nozzle
3 Adapter
4 Pressure pin
5 Compression spring
6 Shim

8. Set the pressure by selecting an appropriate shim. (A thicker shim increases the opening pressure.) Tighten the cap nut to **40** ±5 **Nm** (33 ±3.7 lbf ft). Recheck the injector in the nozzle tester.



9. Check the seal

   Dry the nozzle and nozzle holder with compressed air. Press down the tester handle until you obtain a pressure of around 2.0 MPa below the previously measured opening pressure.

   Example: Pressure gauge reading: 27.5 MPa (3988 psi) -2.0 MPa (-290 psi)
   set to: 25.5 MPa (3698 psi)

   For opening pressure, see Technical Data (1MPa = 145 psi).

10. If no leaks appear within 10 seconds the nozzle is sealed.
11. If the nozzle is leaking, dismantle and clean the injector to prevent it from leaking. If the nozzle still is leaking, replace the injector. Reuse is not permitted.
12. Chatter characteristic and spray pattern tests.

NOTE! Shut off the tester pressure gauge, for this test.

The chatter test provides an audible check of how easily the nozzle needle is moving in the nozzle body. New injectors give a different sound compared with used injectors. It worsens due to wear in the needle seat area. If an injector nozzle does not make the chatter noise despite having been cleaned, it must be replaced.

A used injector chatters clearly when the handle is moved quickly, and shows a well-distributed spray pattern. The condition of the nozzle is difficult to establish concerning spray pattern.

Incorrect spray pattern may cause engine damage.

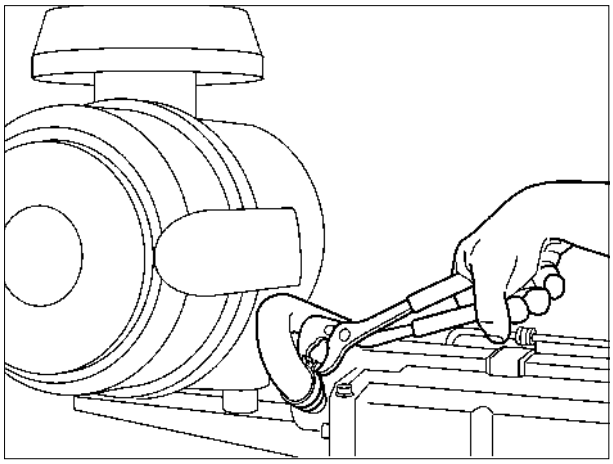
Disassembly, complete engine

Special tools:

Stand for mounting engine (Unit stand) 998 6485
Engine fixture 999 8671
Puller 999 6400
Socket for injector removal 999 8007
Filter wrench 999 9179
Pressure tool (control rod) 999 8682
Filter wrench 999 9179

The repair methods that are shown in this chapter apply to the standard specification only, i.e. components in specially smanufactured engines are not shown.

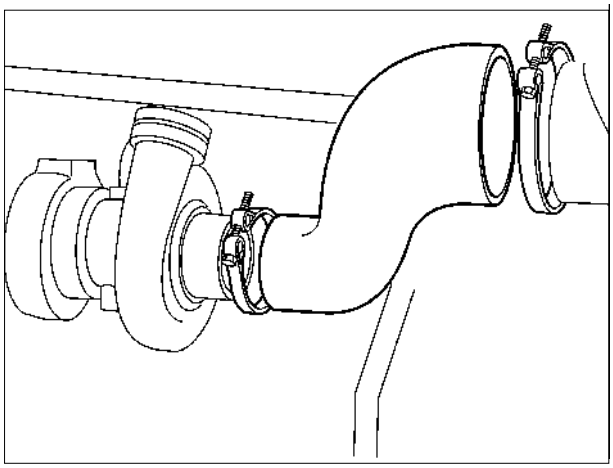
Exposure of engine



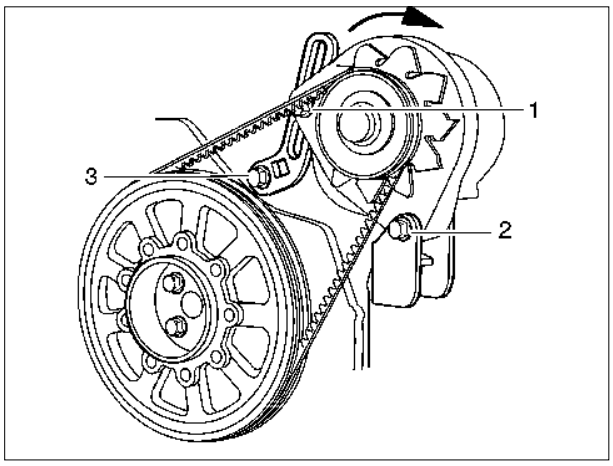
1. Mark up and loosen all cabling and terminal boxes.
   Loosen the exhaust bend.

2. Drain and collect the remaining oil and coolant, and dispose of them in accordance with applicable environmental regulations.

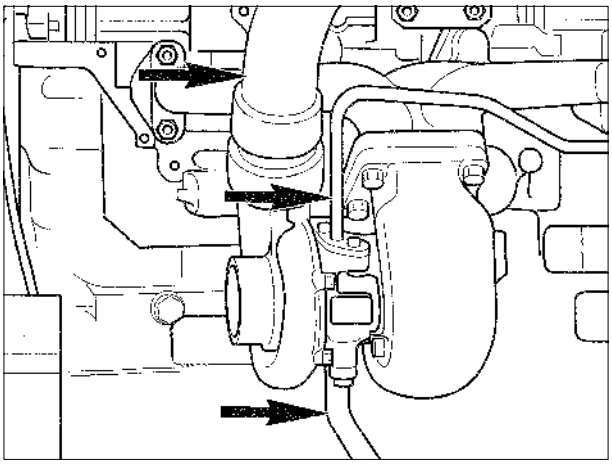
3. Remove the air filter and crankcase ventilation hose.



4. Remove the hose between the turbocharger and the air filter.



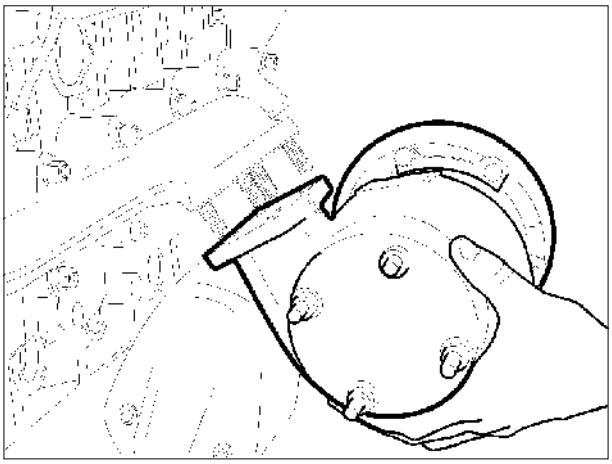
5. Remove tha alternator as well as extra power sources, alternator belt and bracket, see “Drive belts, adjusting and replacing”.



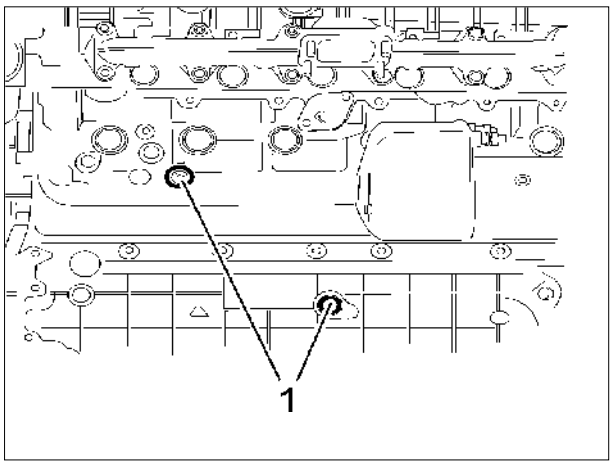
Fitting of fixture

Turbo charger, remove

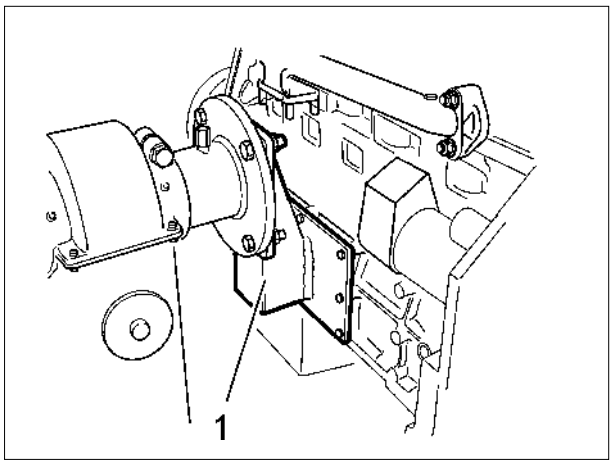
1. Remove the oil pressure pipe, oil return pipe, and charger air pipe.



2. Remove the mounting nuts and the turbo charger.



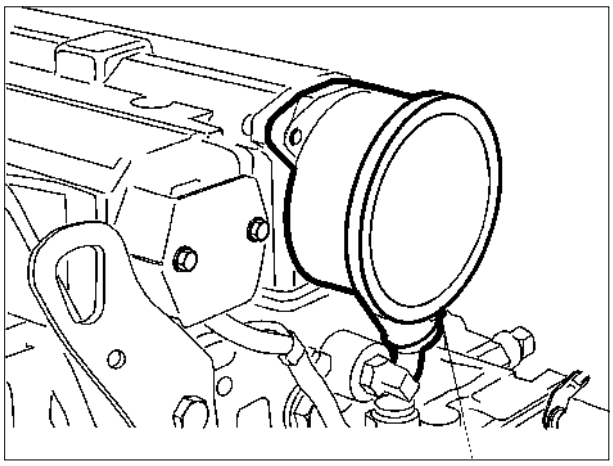
3. Plug (**1**) the turbo and the connections for the oil return and the oil pressure pipes in the engine block.



4. Attach the engine bracket 999 8671 (**1**) to the engine and tighten to **25 Nm** (18.5 lbf ft).

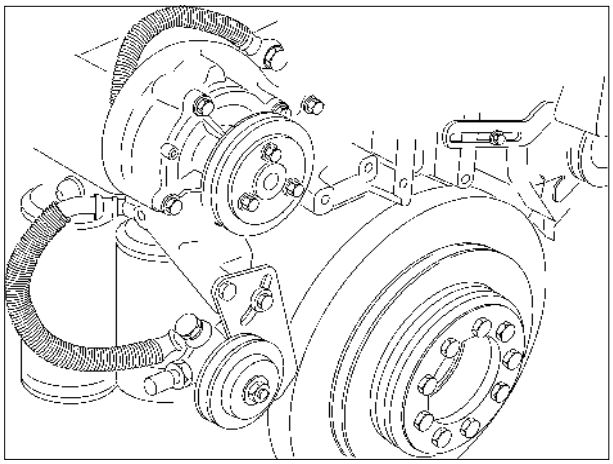
NOTE! Use the accompanying screws, since their strength is higher than that of standard screws.

5. Tighten the engine firmly in the engine repair stand 999 6845.



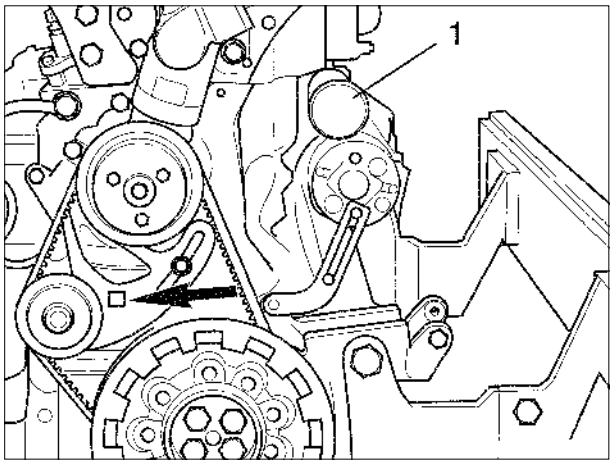
Engine, disassembly

1. Remove the oil-trap housing for the crankcase ventilation (see picture).
2. Catch any remaining oil and dispose of it in accordance with the environmental regulations.

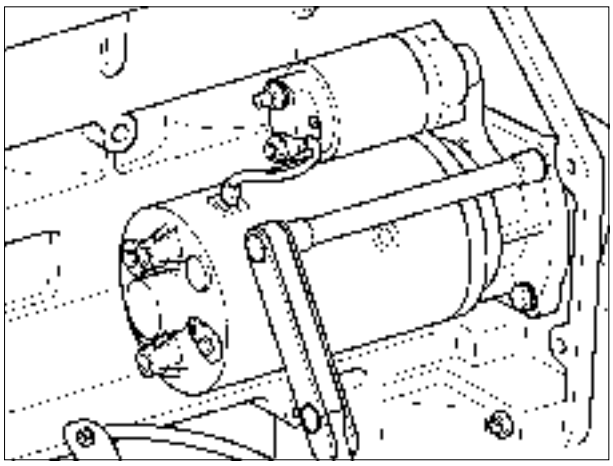


3. Loosen the fuel hose between filter and fuel pump. Remove the fuel pump, belt and bracket. Remove the fuel line between filter and fuel duct.

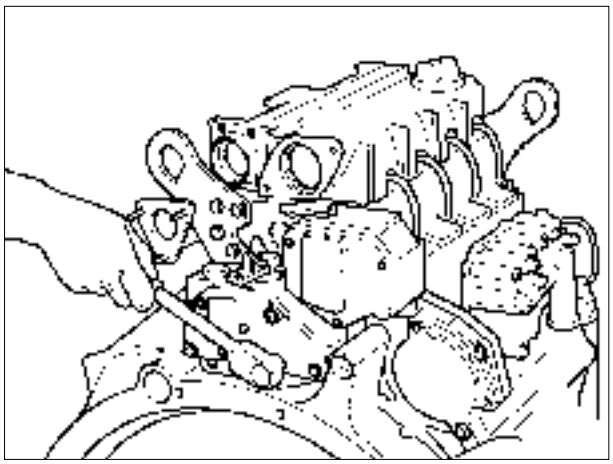
NOTE! Plug the fuel system so that dirt can not enter.



4. Remove the coolant outlet pipe (**1**) if required (see picture).

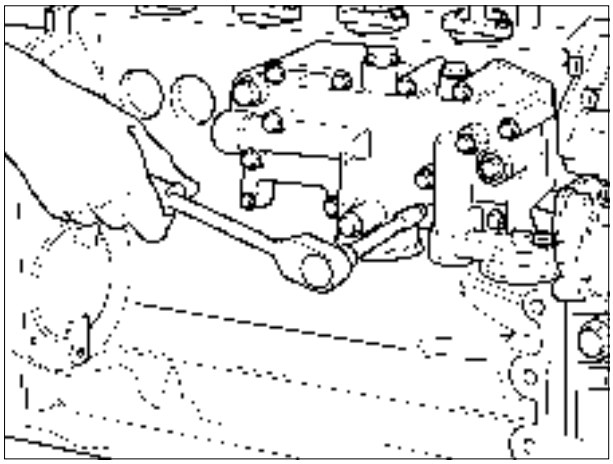


5. The starter motor can be removed at this stage, but it is easier to leave it on and remove it together with the transmission cover.

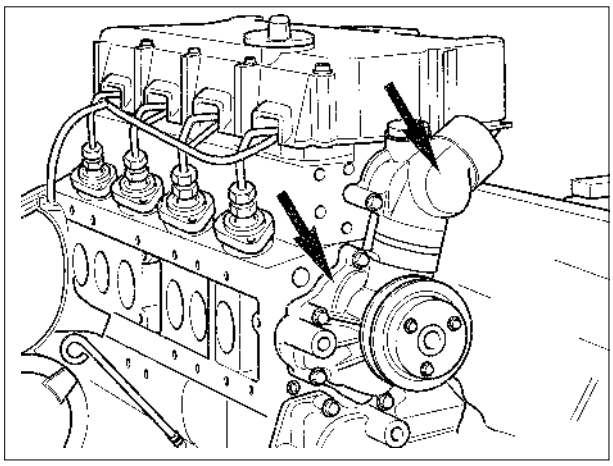


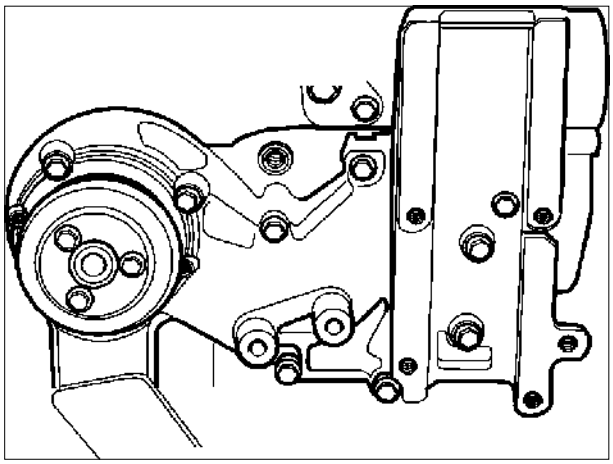
6. Remove the engine speed governor. Use a Torx socket E 10 (for electronic governors, use Allen key 6).

7. Drain the fuel from the fuel duct in the engine by removing the hollow screw at the front of the engine block and the overflow valve and fuel return vent. Remove the screw at the rear of the engine block. Remove the fuel and oil filters using tool 999 9179.



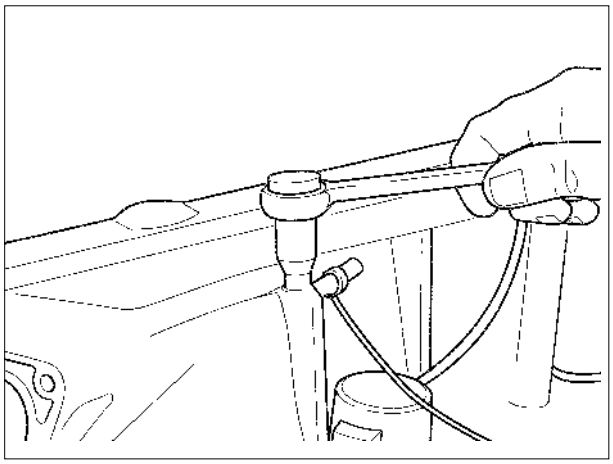
8. Remove the cooler housing.





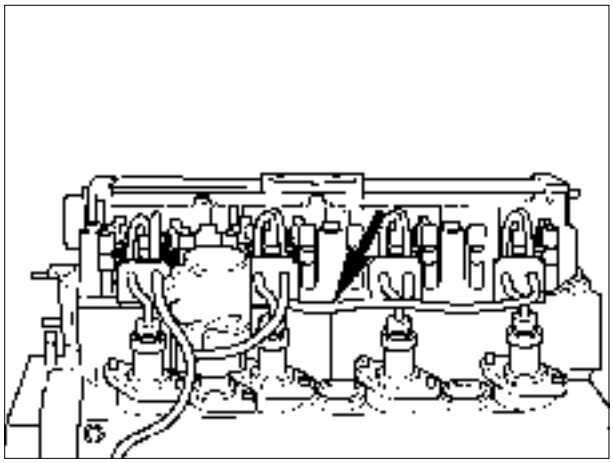
9. Remove the coolant pump and coolant housing, according to one of the pictures, depending on coolant pump model.

   The lower model is removed with 7 screws. First remove the bearing bracket for the intermediate pulley.

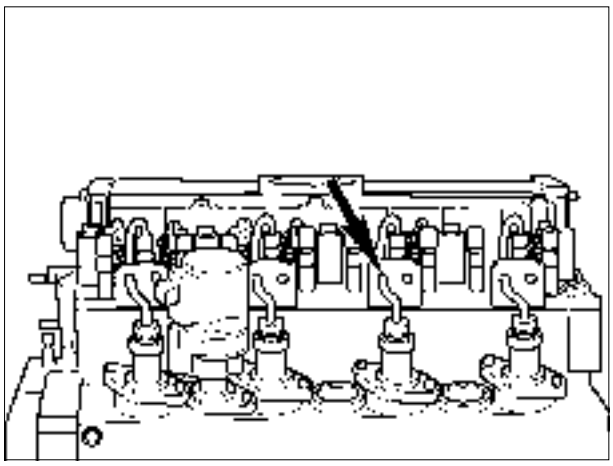


10. Loosen the screws and remove the rocker cover and the gasket.

NOTE! Make sure that dirt trapped between the inlet manifold and the rocker cover does not fall down into the engine. Clean thoroughly before removing the rocker cover.

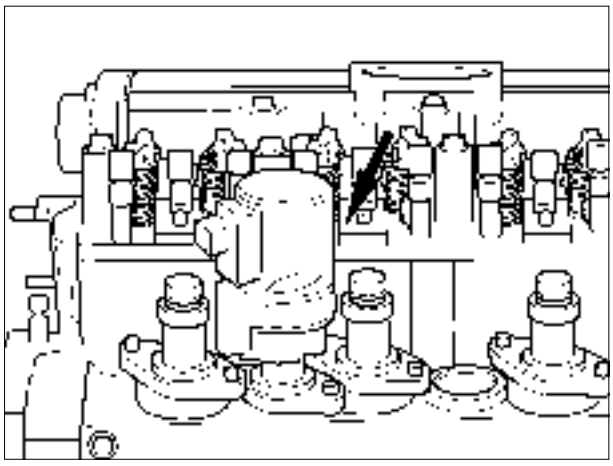


11. Remove the fuel return lines together with the overflow valve and air vent screw.



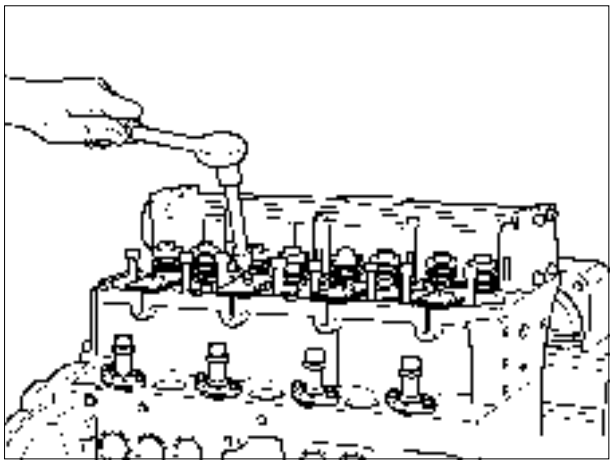
12. Remove the delivery pipes, complete with the rubber seals.

NOTE! Cover the injector and injector pump openings.



13. Remove the stop solenoid (alternatively the plug if the governor is electronic).

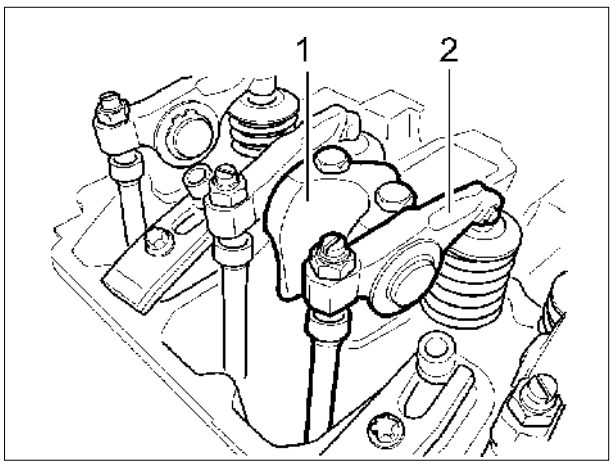
NOTE! Be careful not to damage the control rod. Install 999 8682 to keep the control rod in the protected "stop" position.



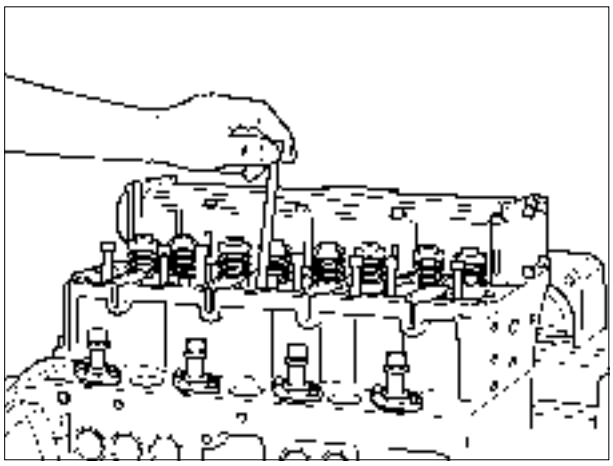
14. Remove the injectors. Use a Torx socket E 10.

    Use puller 999 6400 together with socket 999 8007 if any injector is stuck in the cylinder head.

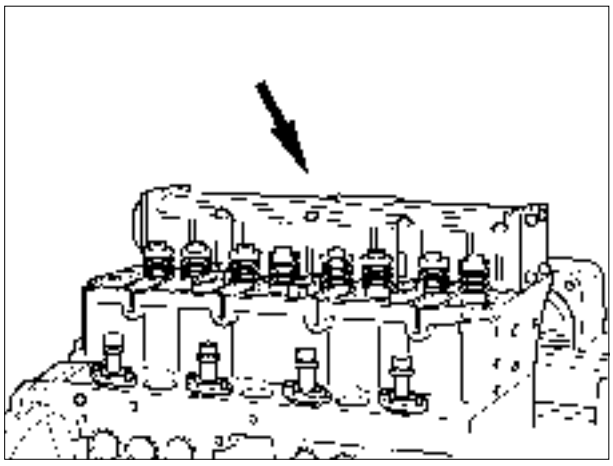
NOTE! To prevent dirt and water coming in the injector hole, make sure to clean well around the injector before removing it.



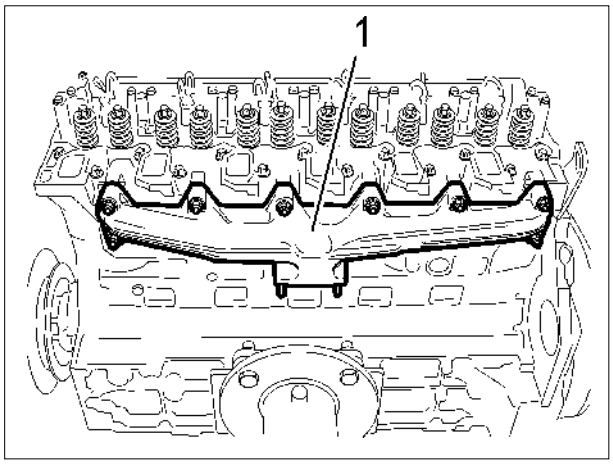
15. Mark up the rocker arm brackets (**1**) and remove them together with the rocker arms (**2**).



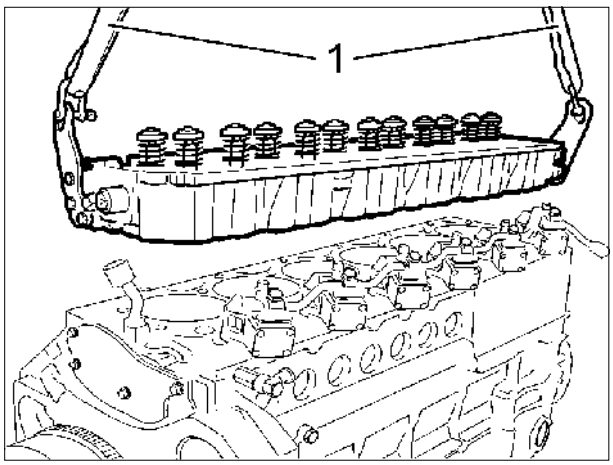
16. Remove and mark up the push rods.



17. Remove the inlet manifold and gasket.



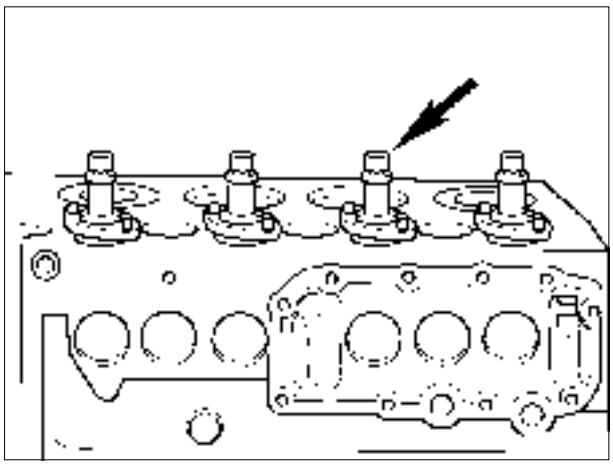
18. Remove the exhaust manifold (**1**).



19. Loosen the screws to the cylinder head, using the torx socket E18.

    Connect lifting wires to the lifting eye bolts and remove the cylinder head.

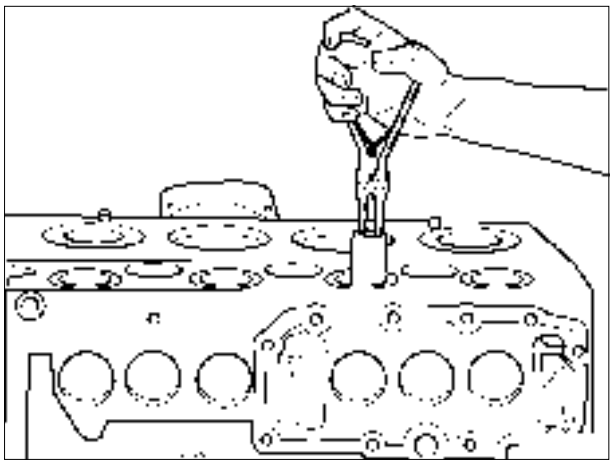
NOTE! Weight is approx. 80 kg (720-722).



NOTE! Make sure that the injection pump tappet is on the base circle when removing the pumps

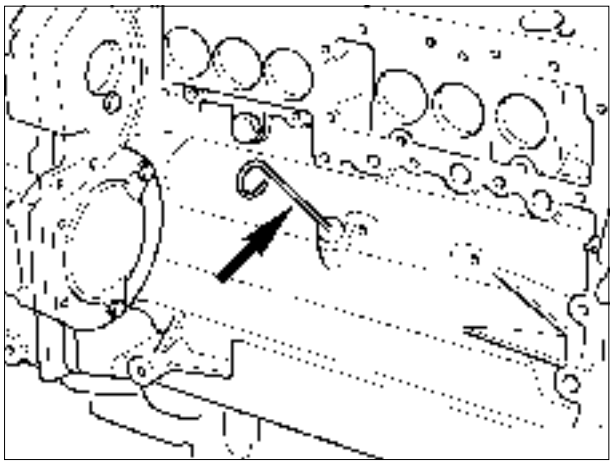
NOTE! Mark up all parts when removing to make sure the components match and will be fitted to the correct position.

20. Remove the injection pumps. Start with the screw closest to the flywheel. Put them in a stand to protect them from dirt.



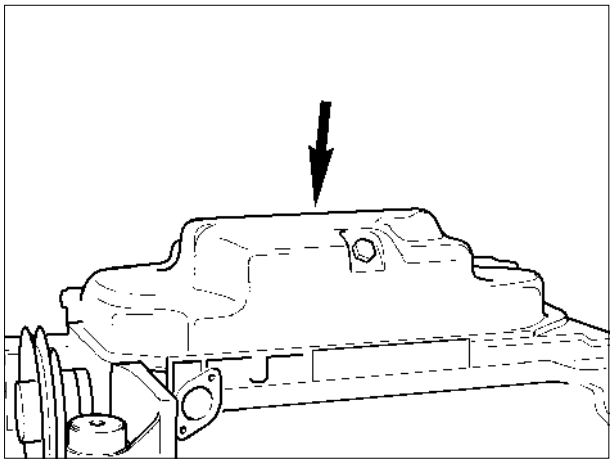
NOTE! Be careful with the loose shim.

21. Using pliers or a pen magnet, lift out and mark the roller tappets together with the shim.



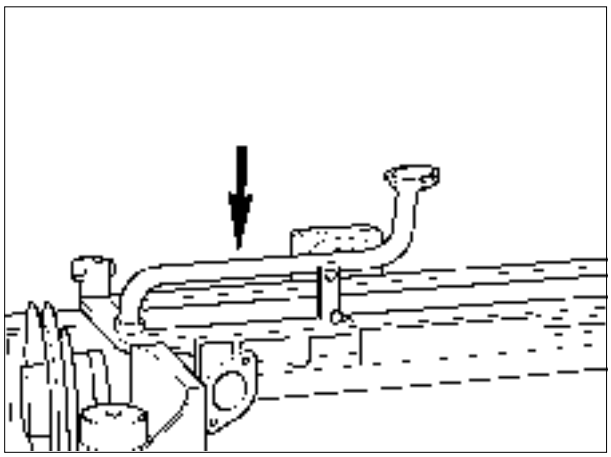
NOTE! Attach the shim firmly to its respective injection pump.

22. Pull out the dipstick.

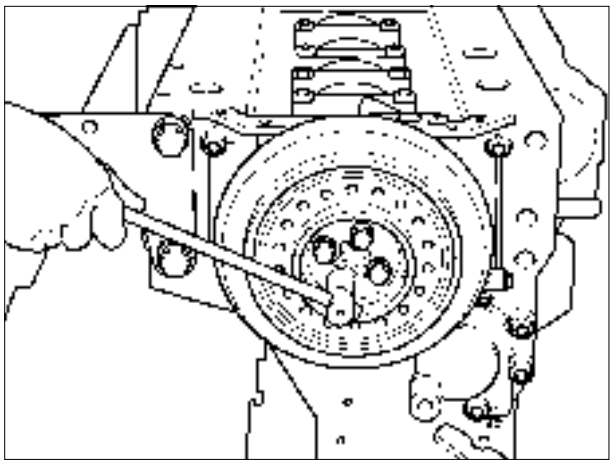


23. Remove the oil sump.

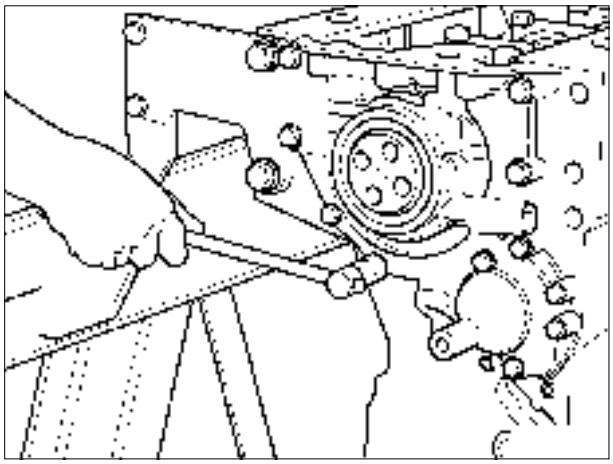
NOTE! The oil sump is mounted with a fluid gasket and may be stuck. Use a bending bar in the referring grooves.



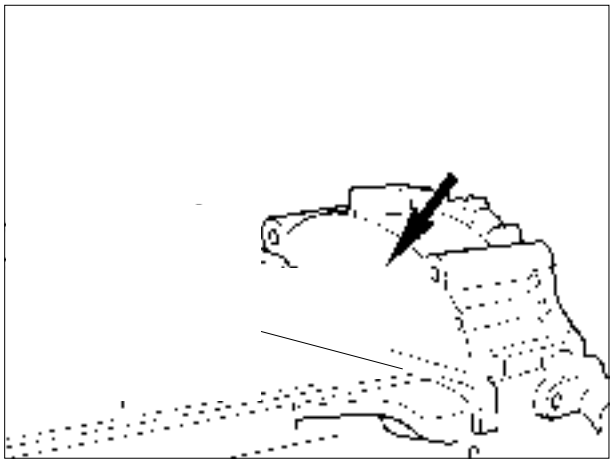
24. Remove the oil suction pipe.



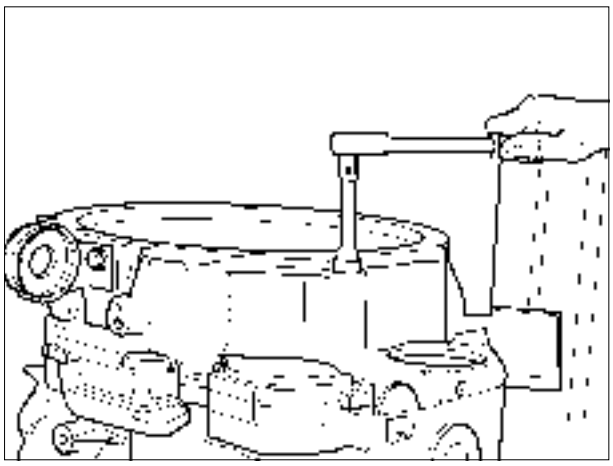
25. Remove the crankshaft pulley and damper (if installed).
Use a Torx socket E20.



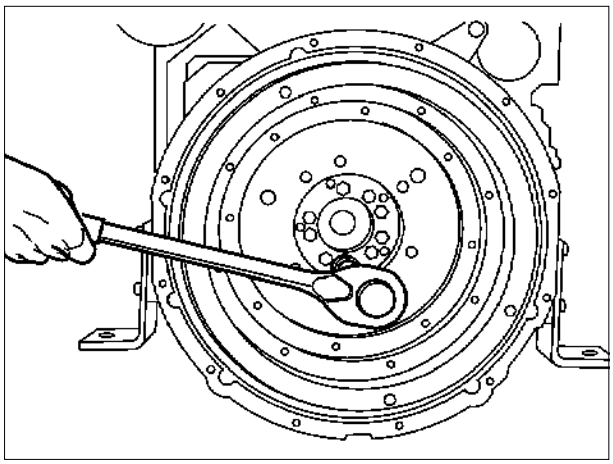
26. Remove the oil pump/front cover.



27. Remove the cover plate on the flywheel housing.



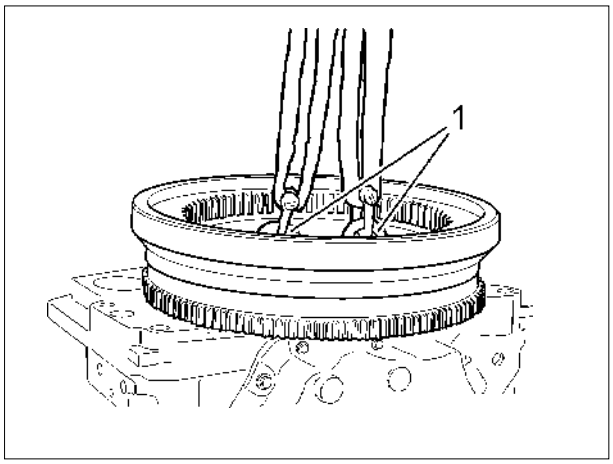
28. Remove the flywheel housing.
Use Torx sockets E20 and E14.



29. Turn the engine through 90°.

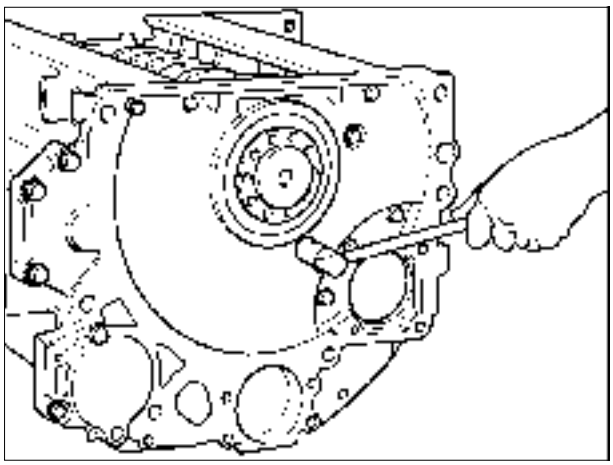
Remove the plastic plugs between every second screw, which are a locking device for the flywheel screws.

Loosen the screws on the flywheel, but let them stay in place.
Use 999 8681 to block the flywheel.

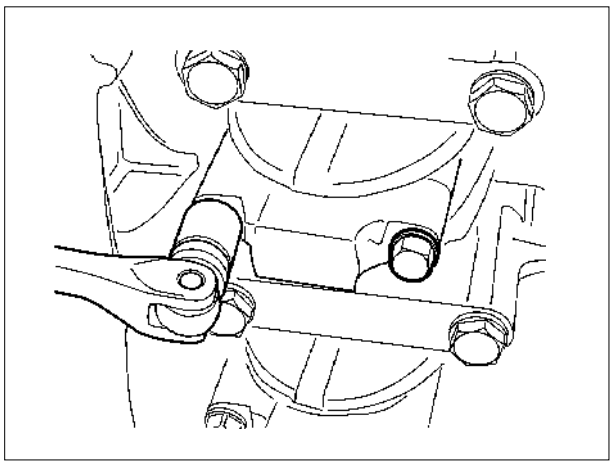


30. Connect lifting eye bolts M10 (**1**) and lifting wire. Remove the flywheel.

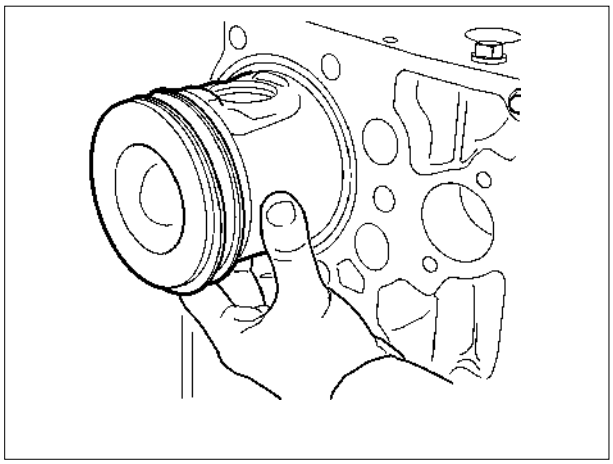
⚠ **WARNING!** Be careful when removing the flywheel as it is very heavy.



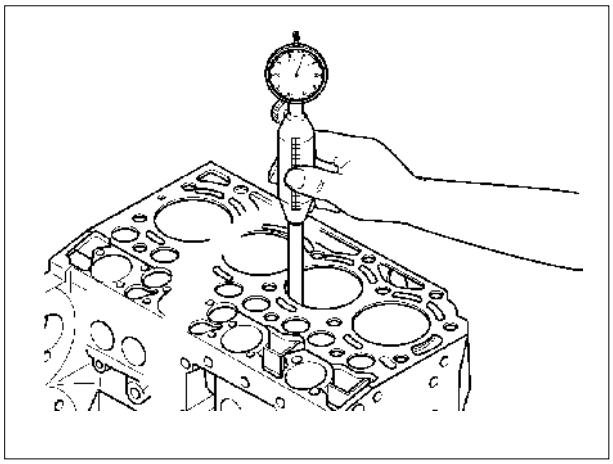
31. Remove the transmission housing if this has not been removed before.



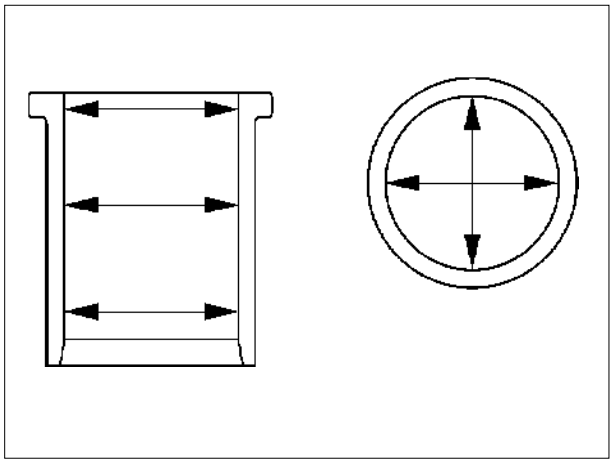
32. Turn the engine through 90°.
Mark up the the bearing caps of the connecting rods and loosen the screws.
Remove the bearing caps and the bearing halves.
Take care of the bearing halves.



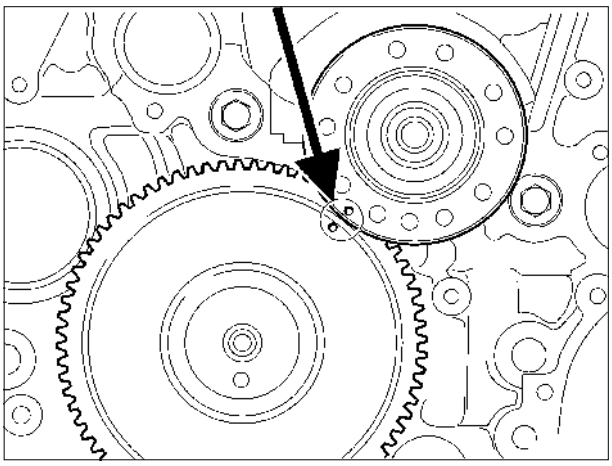
33. Remove the pistons, complete with connecting rods.
Measure the liners before the main bearings are loosened.



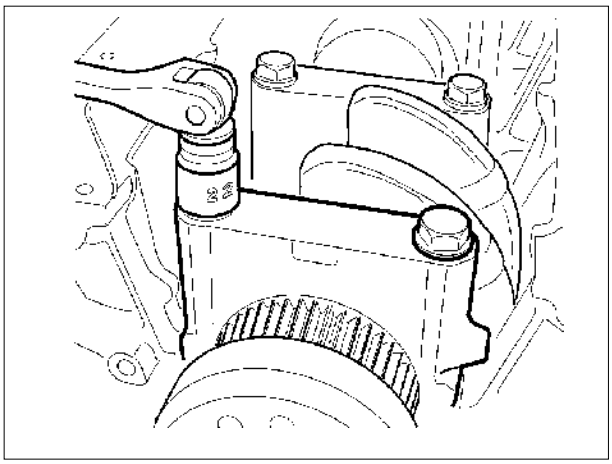
34. Turn the engine through 90°.
Set the dial gauge to ..... **108 mm** (4.25")



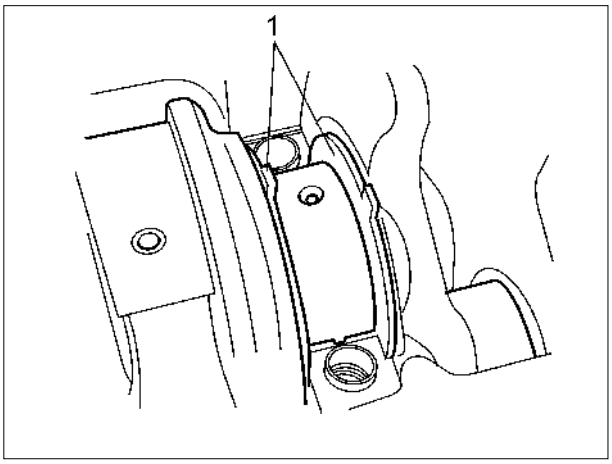
35. Make sure that the liners are not damaged or cracked.
Measure the inside diameter of the cylinderliners. Measure at three different levels, according to the picture, both in the longitudinal and in the transverse axis.
Diameter: ..... **108** $^{+0.02}$ **mm** (4.252 $^{+0.001}$")
Wear limit: ..... **108.1 mm** (4.256")



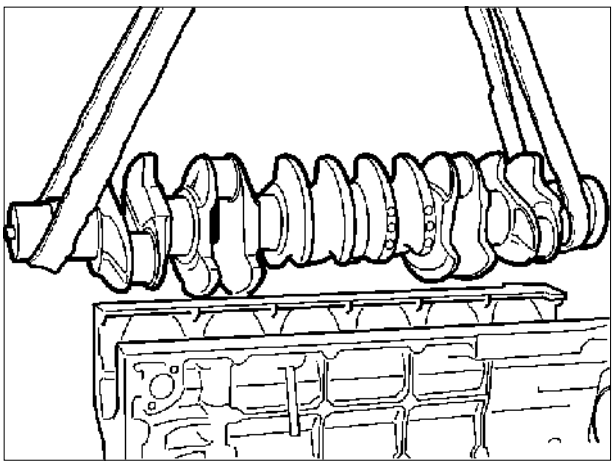
36. Turn the engine so that the crankshaft is directed upwards.
    Make sure that the camshaft and crankshaft gears are marked.



37. Make sure that the crankshaft bearing caps are marked. Remove the securing screws and remove the bearing caps and the main bearing halves.

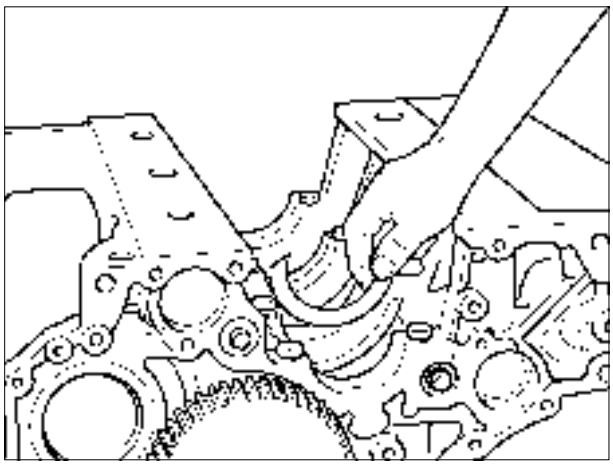


38. Remove the thrust washers (**1**) at main bearing cap 2 (the thrust bearing pivot).
    Bearing cap 1 nearest the flywheel end.



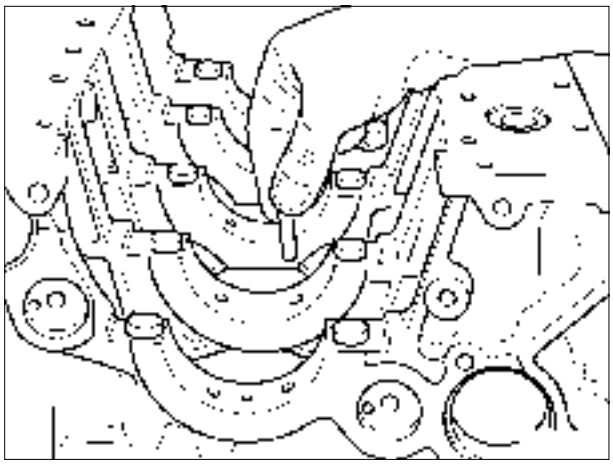
39. Lift the crankshaft out of the engine block.

NOTE! The crankshaft is heavy (approx. 75 kg, 720-722, 730-733). Use a soft strap to lift it out.

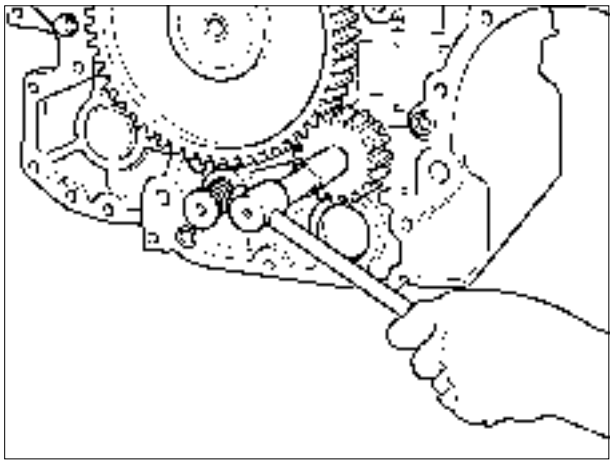


40. Remove the thrust washers and bearing shells at main bearing cap 2

NOTE! Mark up the bearing halves if they are to be used again.

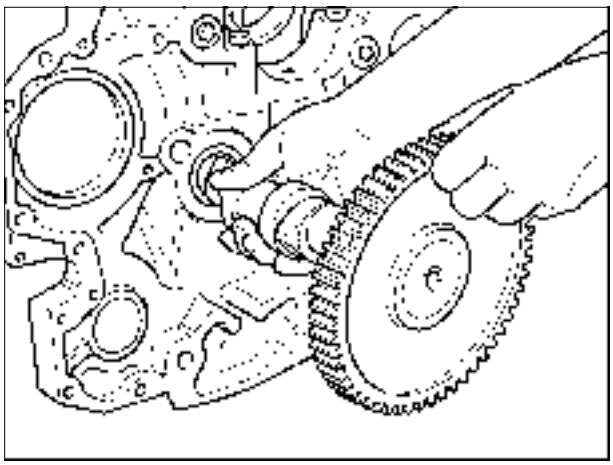


41. Press the piston cooling nozzles out.



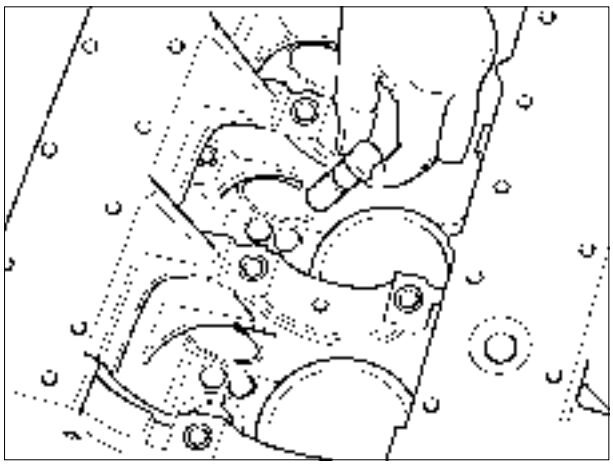
42. Remove the idler gear.

NOTE! Does not apply to electronic governor.

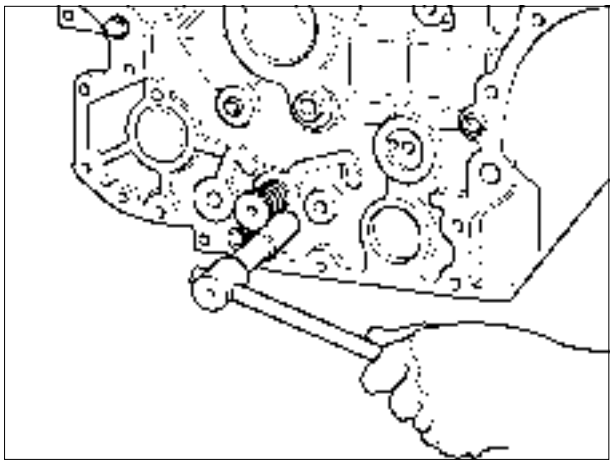


43. Pull out the camshaft.

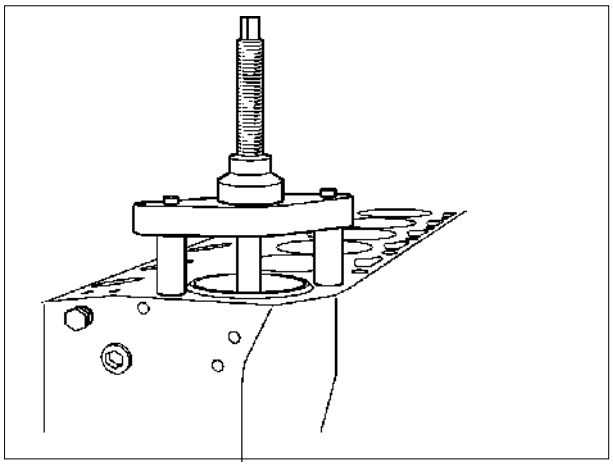
NOTE! Be careful when removing the camshaft to prevent damaging the bearings.



44. Remove the valve tappets and mark them if they are to be used again.



45. Remove the securing screw.
Pull out the control rod.



46. Remove the cylinder liners.

Use extractor plate 999 8675 together with liner extractor 999 6645 and supports 999 6395 and 999 6394.

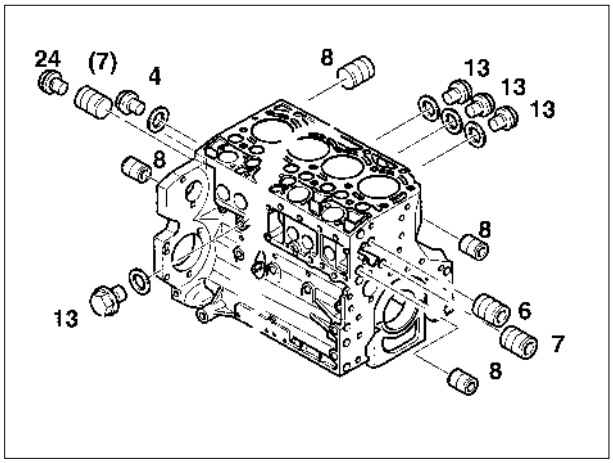
NOTE! Mark up the liners if they are to be used again.

⚠ **WARNING!** When fluorocarbon rubber is subjected to high temperatures highly corrosive **hydrofluoric acid** can be produced. Skin contact can cause severe burning. Be very careful and see “Safetyinstructions for fluorocarbon rubber”.

Assembly, complete engine

Special tools:

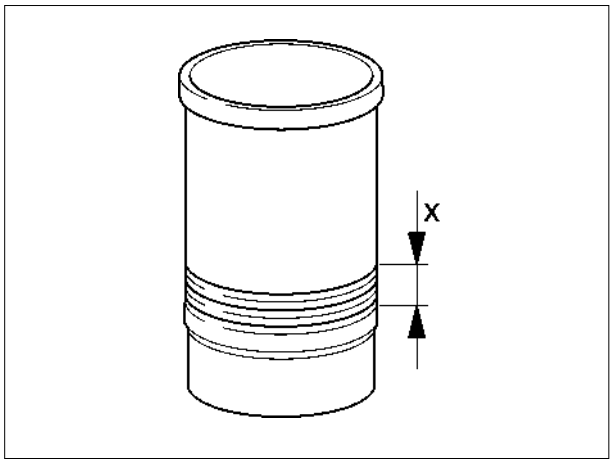
Rule depth gauge 998 5471
Engine repair stand 998 6485
Dial gauge 998 9876
Measuring/clamping instrument for control rod 999 8684
Measuring tool 999 8685
Measuring bar with spacers 999 8678
Protractor 999 8679
Cranking tool, flywheel 999 8681
Pressure tool, for locking of the control rod 999 8682
Piston ring compressor 999 8687



NOTE! Tighten the screw plugs as stated.

Use new copper seals for items 4 and 13. Insert item 24 with locking compound (part no1 161 053-2).

Item	4	=	35 ±3.5 Nm (26 ±2.6 lbf ft)
Item	6	=	95 ±9.5 Nm (70 ±7.0 lbf ft)
Item	7	=	65 ±6.5 Nm (48 ±4.8 lbf ft)
Item	8	=	35 ±3.5 Nm (26 ±2.6 lbf ft)
Item	13	=	35 ±3.5 Nm (26 ±2.6 lbf ft)
Item	24	=	10 ±2.0 Nm (7.4 ±1.5 lbf ft)



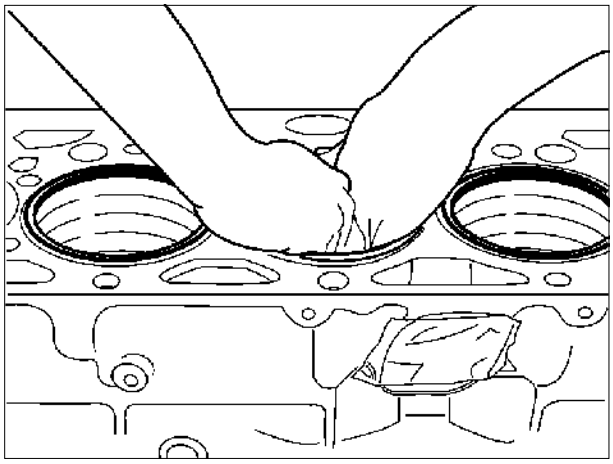
Engine, assembly

Cylinder liner, installing

1. Ensure that the cylinder liner area and linersealing surfaces are completely clean.
2. Oil the engine block and cylinder liner in the areas marked X in the diagram.
   Fit new O-rings.

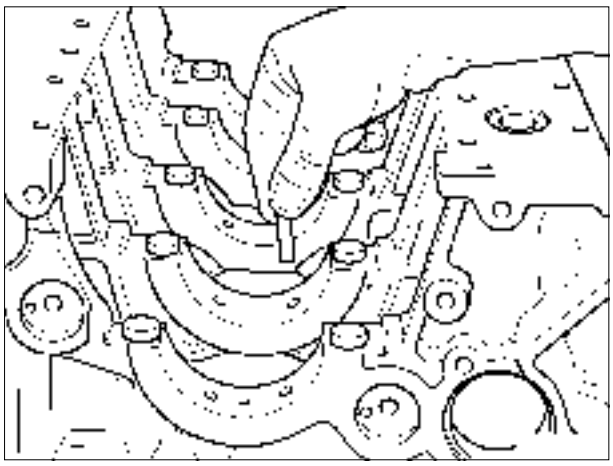
NOTE! Make sure the cylinder liner is correct mounted in the engine block, compare the liners height compare to the engine block, see "Technical data".

NOTE! Before insertion,



⚠ **IMPORTANT!** Fit it without sealer, well cleaned and dry.

3. Fit the cylinder liner in to the correct position in the engine block. Drive it in as far as possible.

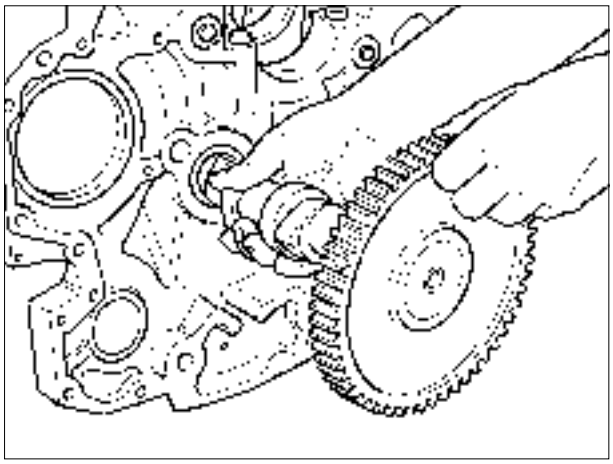


Piston cooling nozzles

4. Check that the oilways are not blocked. Fit the piston cooling nozzles in the correct position in the engine block. Press the piston cooling nozzles in as far as they will go.

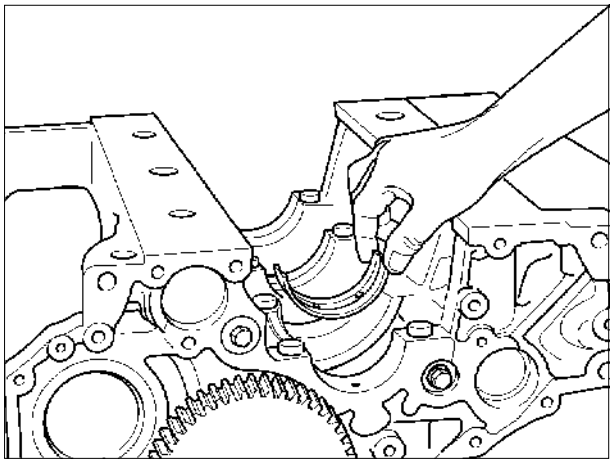
Cams/camshaft

5. Insert the valve tappets (lightly oiled).

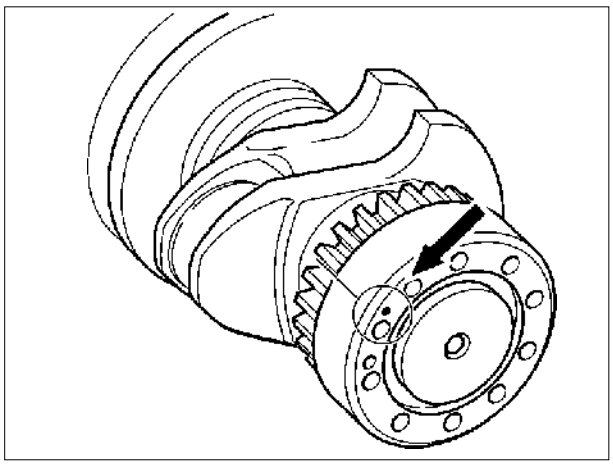


6. Fit the camshaft.

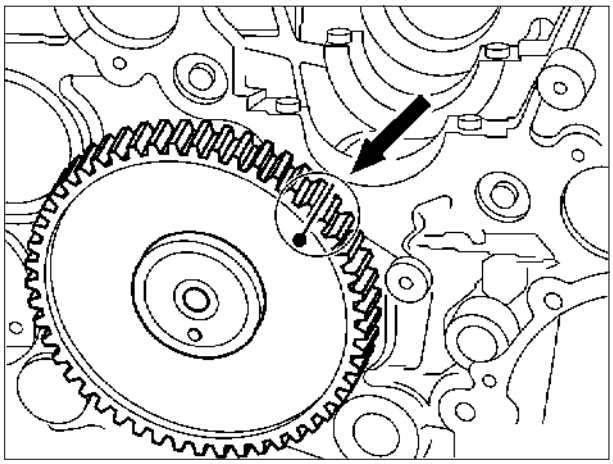
NOTE! Be careful when fitting the camshaft to prevent damaging the bearings.



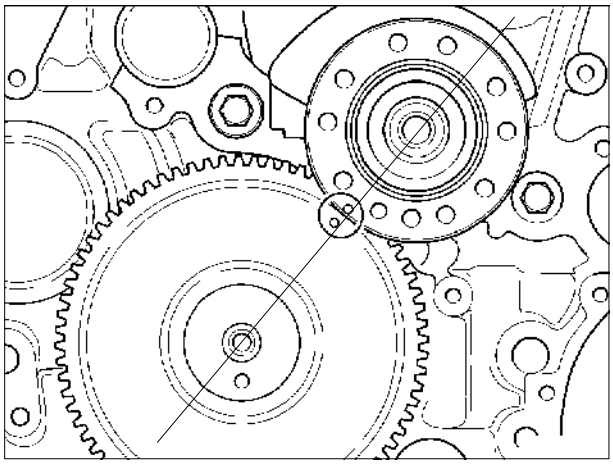
7. Fit the main bearing shells into the engine block.



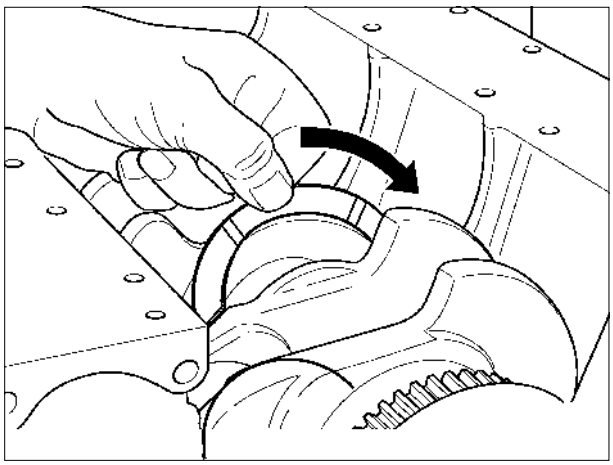
8. Mark the crankshaft if necessary (to make fitting easier).



9. Mark the camshaft, if necessary, and put it in place.

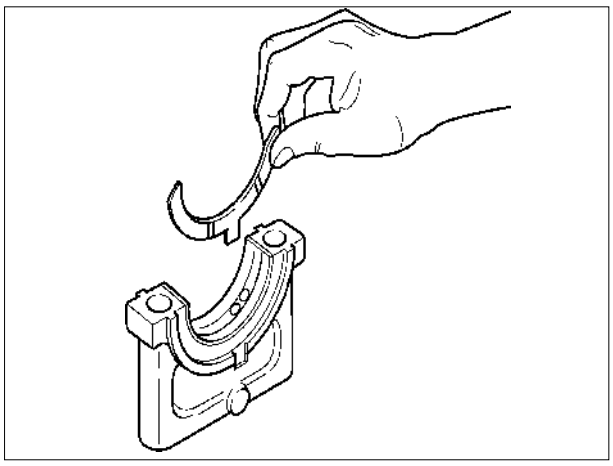


10. Insert the crankshaft. The marks must line up. Use a ruler and make sure that the marks line up through the centre of the crankshaft and camshaft.



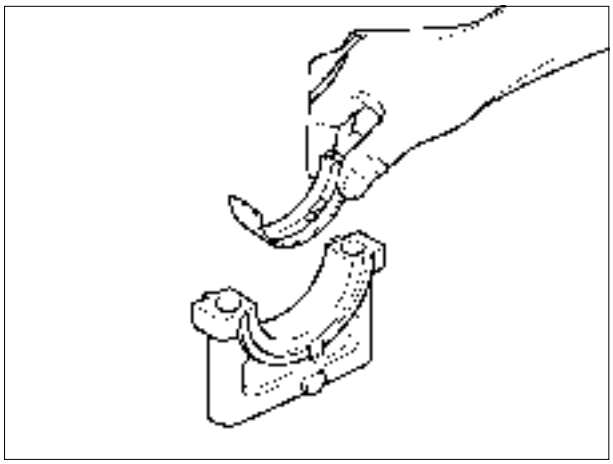
11. Insert the half thrust bearing without lug.

NOTE! The thrust bearing running face must be towards the crankshaft.

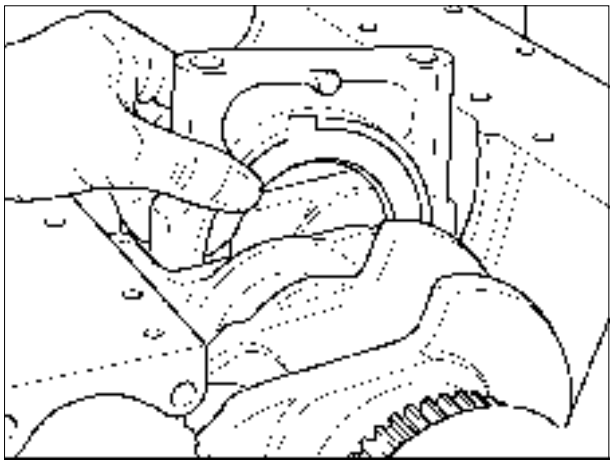


12. Fasten the half thrust bearing with lug to the thrust bearing caps (using a little grease).

NOTE! The thrust bearing running face must be towards the crankshaft.



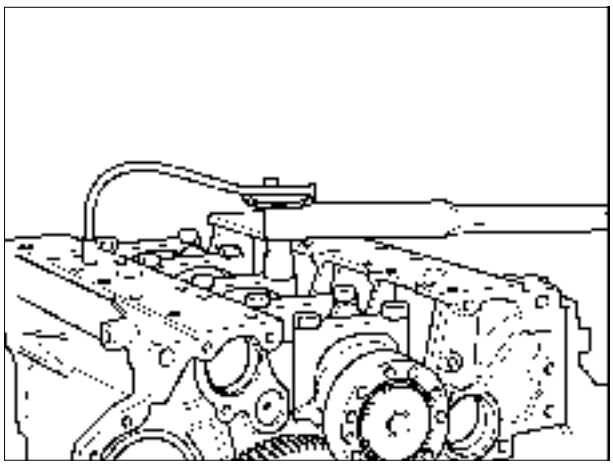
13. Fit the bearing shells into the main bearing caps and lightly oil them.



14. Oil the main bearing caps and put them in place.

NOTE! The main bearing caps are numbered 1-5 or 1-7 depending on engine type. Bearing cap 1 nearest the flywheel end.

NOTE! Make sure that the thrust washers on the bearing caps fit the washers in the block.



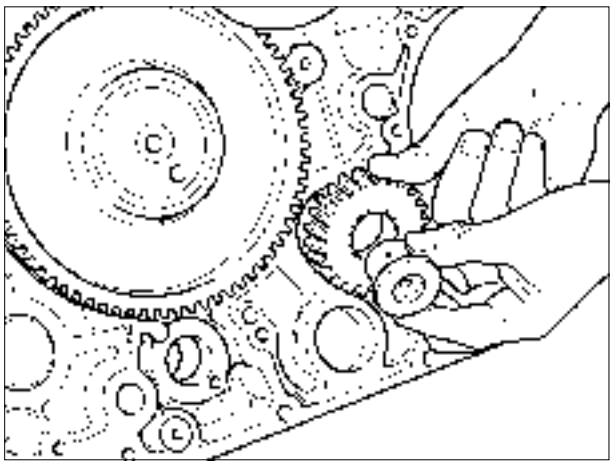
15. Tighten the main bearing cap screws as follows:

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

    1st tightening angle: ..... **60°**

    2nd tightening angle: ..... **60°**

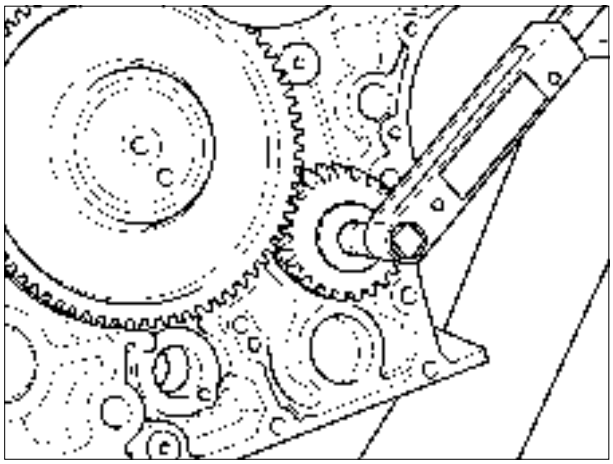
NOTE! You can use the bolts three times, if you know how many times they have been used. (Make a punch mark for each of the following usages.)



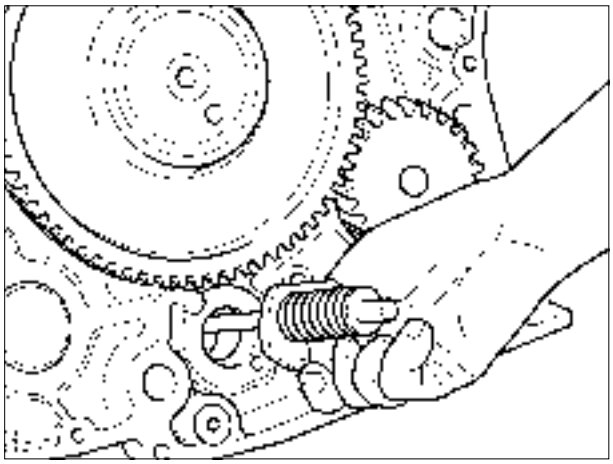
Govenor idler gear (mechanical governor)

NOTE! Electronic governors do not have an idler gear.

16. Fit the govenor idler, complete with bearing journal.

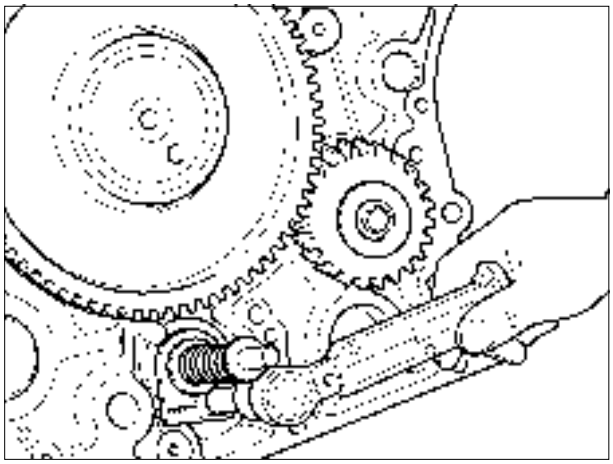


17. Using locking compound, insert the screw and tighten it, using thread sealer (1161053-2) to ..... **21 Nm** (15 lbf ft).

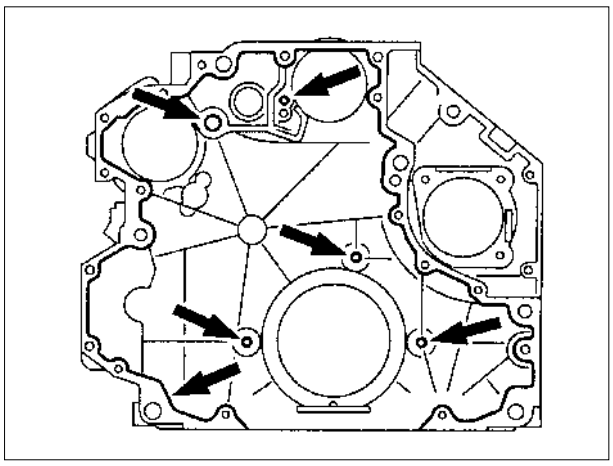


Control rod

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



19. Put thread sealer (1161053-2) on the screw and tighten to ..... **10** $^{+2}_{0}$ **Nm** (7.4 $^{+1.5}_{0}$lbf ft).

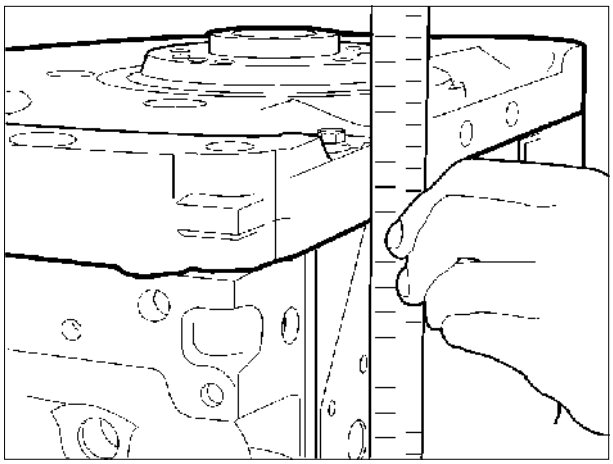


Transmission housing

NOTE! The transmission cover and starter motor can be installed together.

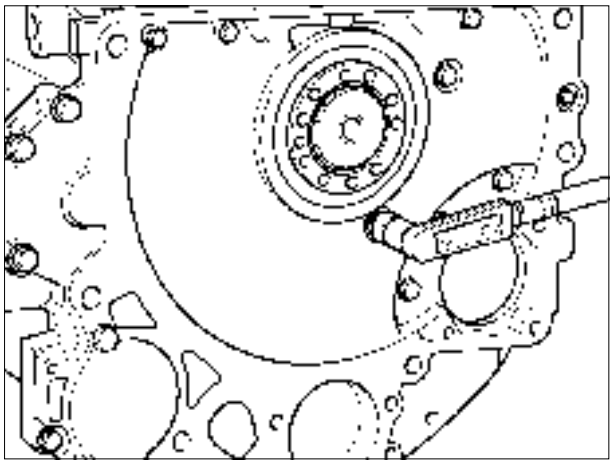
20. Apply silicon sealing compound (1161231-4) as shown in the diagram to the sealing surface for the transmission housing.

    Lightly oil the crankshaft seal.

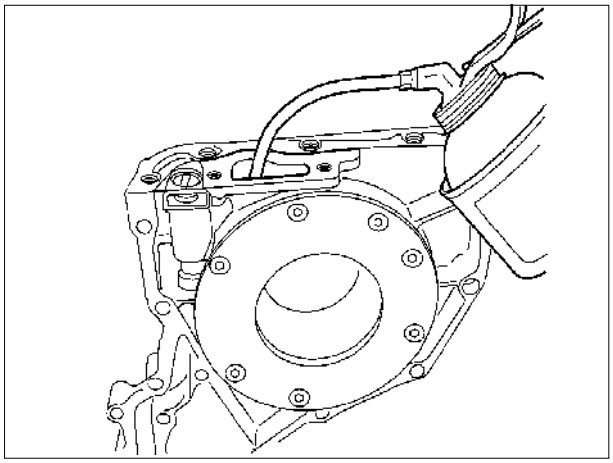


21. Fit the transmission cover, without tightening the screws.

NOTE! Line it up with the oil sump sealing surface.

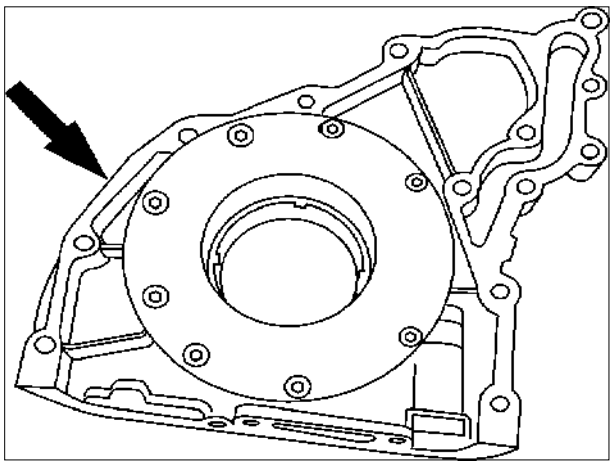


22. Tighten the screws to ..... **21** ±2 **Nm** (15 ±1.5 lbf ft).

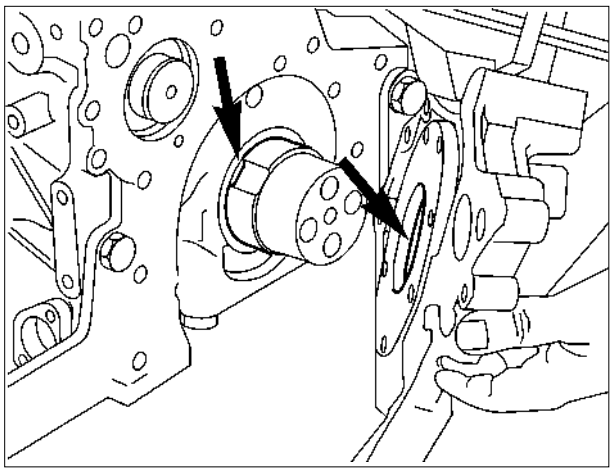


Oil pump/cover

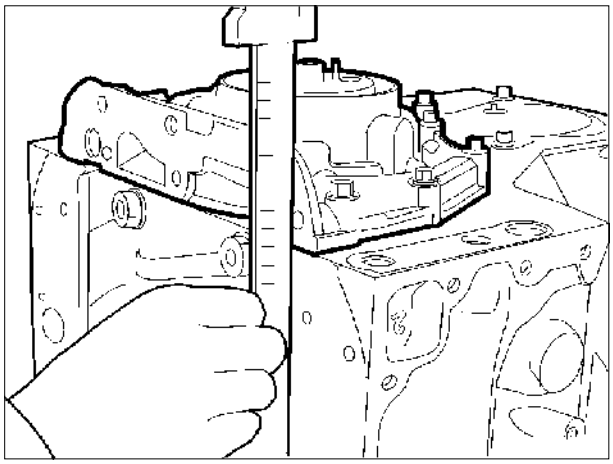
23. Lightly oil the oil pump rotor.



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



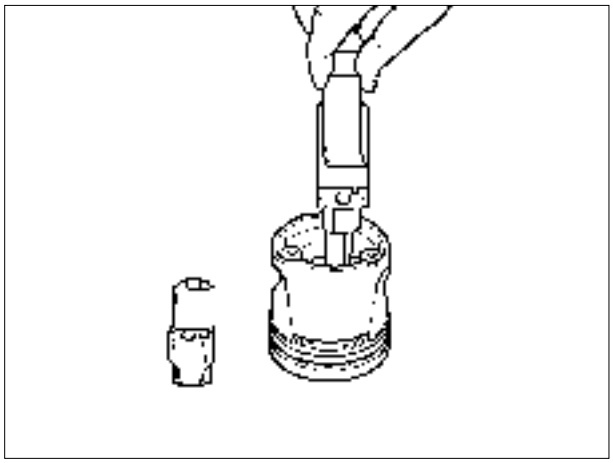
25. Fit the oil pump rotor onto the crankshaft. (It will only go in one position).



26. Fit the oil pump/cover without tightening the bolts.

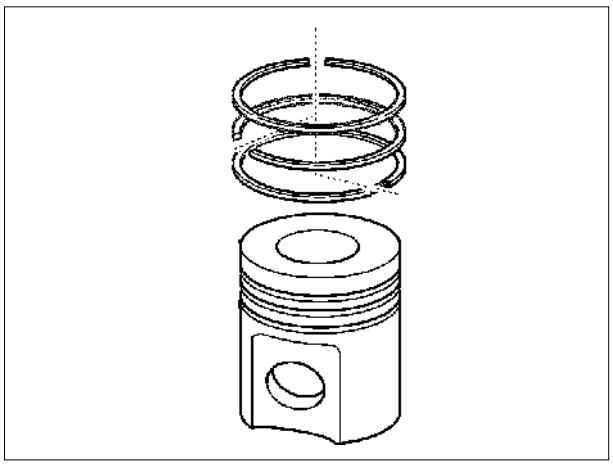
⚠ **IMPORTANT!** Push the cover upwards and align it with the oil sump sealing surface.

27. Tighten the oil pump/cover screws to ..... **21** ±2 **Nm** (15 ±1.5 lbf ft).

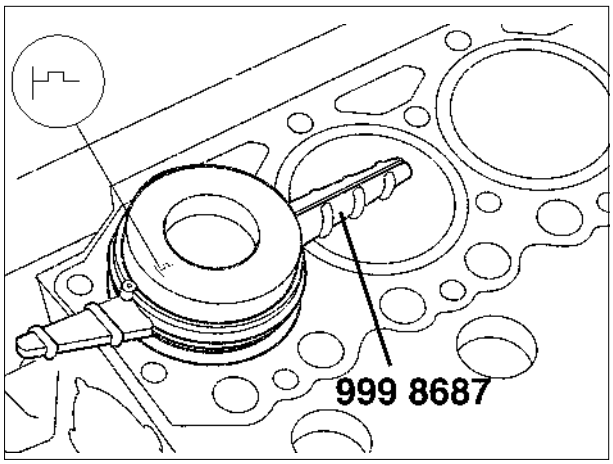


Piston complete with connecting rod

28. Fit the bearing shells into the connecting rod and cap. Lightly oil.



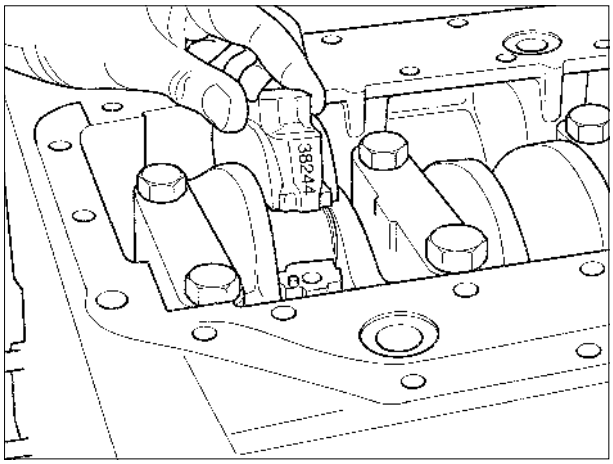
29. Position the piston ring gaps **120**° apart.



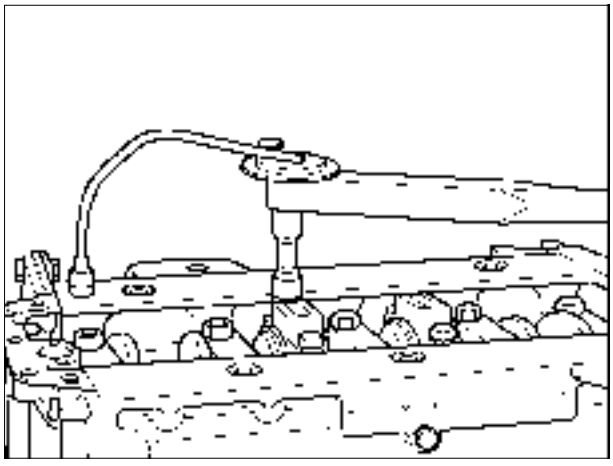
30. Use piston ring compressor 999 8687 and push the piston (complete with connecting rod) into the engine block.

⚠ **IMPORTANT!** Be careful, the piston rings are frail and can easily be damaged.
The piston ring compressor may not be opened after the piston has been placed in the tool, since the piston rings then can be damaged. Always push out the piston before the tool is opened.

NOTE! The flywheel symbol (punched into the top of the piston and the guide pins on the connecting rod) must point towards the flywheel.



31. Lightly oil the crank pin. Press the connecting rod onto the crank pin. Fit the big end bearing cap (in accordance with the marking).



32. Tighten the new big end bearing screws as follows:

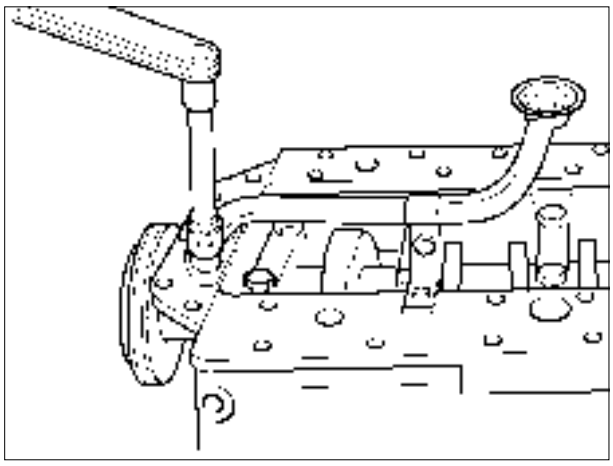
    Initial torque: ..... **30 Nm** (22 lbf ft)

    1st tightening angle: ..... **60**°

    2nd tightening angle: ..... **60**°

NOTE! You should renew the big end screws every time you remove them.

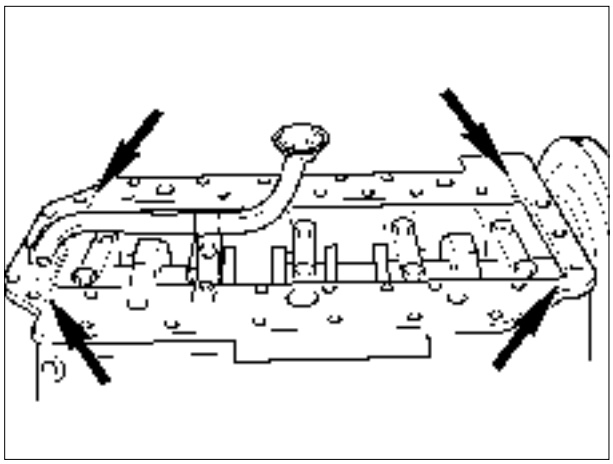
33. Turn the crankshaft to check that the connecting rods are running freely on the connecting crank pins.



Oil suction pipe/oil sump

34. Fit the oil suction pipe with a new gasket.

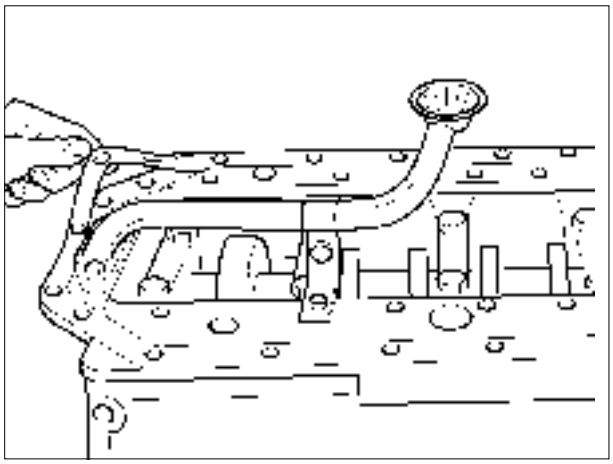
35. Tighten the oil suction pipe to the oil pump housing. Tighten to ..... **21** ±2 **Nm** (15 ±1.5 lbf ft).



36. Cut off the protruding gasket.

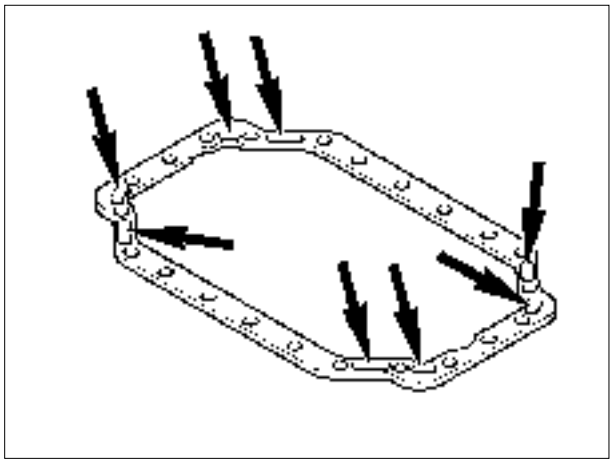
NOTE! Do not pull away protruding dried silicone.

Fill the joints in the oil sump sealing surface with silicone (part no. 1161231).

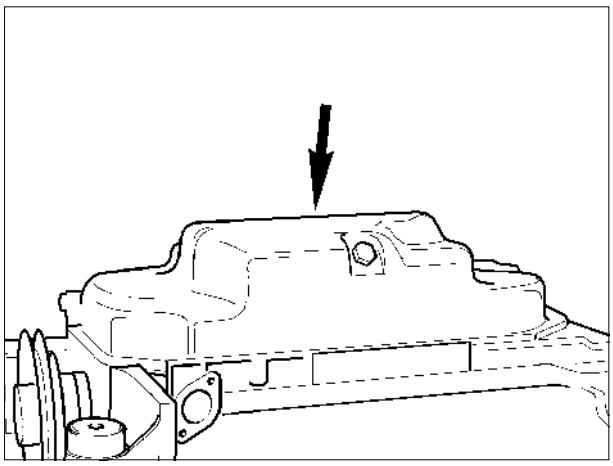


37. Position the new gasket on the engine block.

NOTE! The gasket consists of four parts.

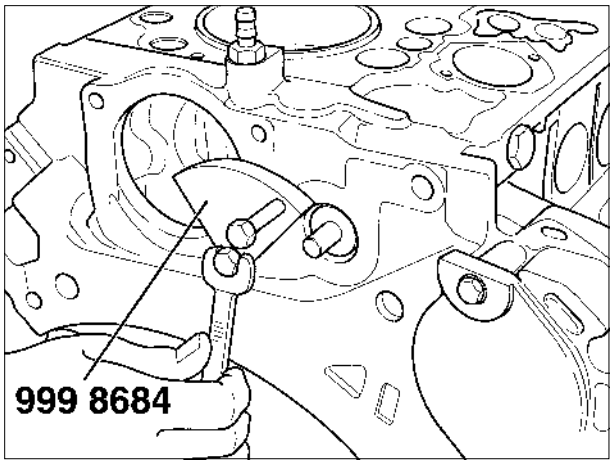


38. Fill the indentations in the gasket with silicon (part no. 1161231).



39. Fit the oil sump. Tighten to ..... **21** ±2 **Nm** (15.5 ±1.5 lbf ft).

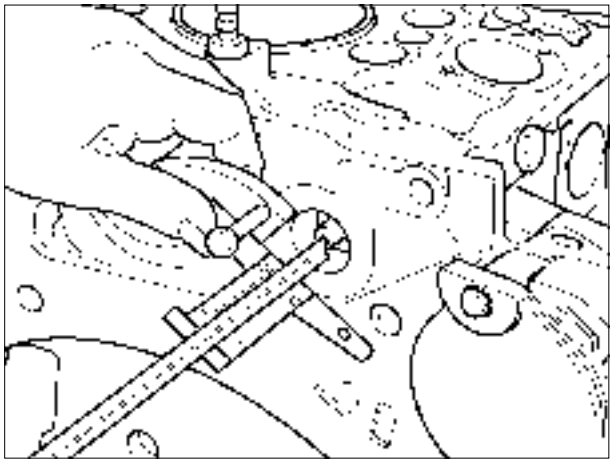
Control rod, measuring



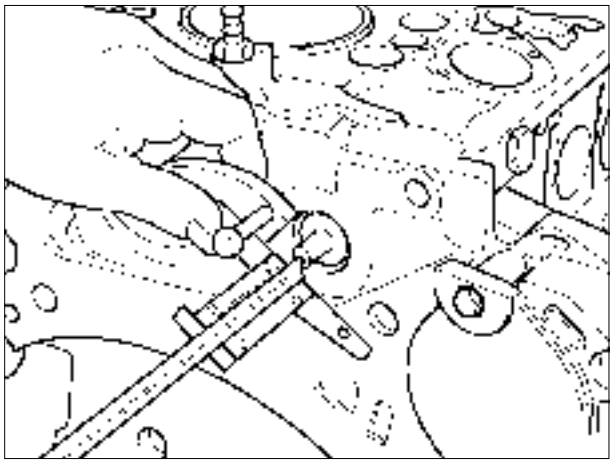
NOTE! Measure the control rod (fuel rack) travel **without** the injection pumps fitted.

40. Turn the engine through 180°.

    Attach the control rod (fuel rack) measuring fixture 999 8684 on the leading edge of the engine.



41. Measure from the measuring fixture to the control rod (fuel rack) stop position (see diagram). Use rule depth gauge 998 5471.

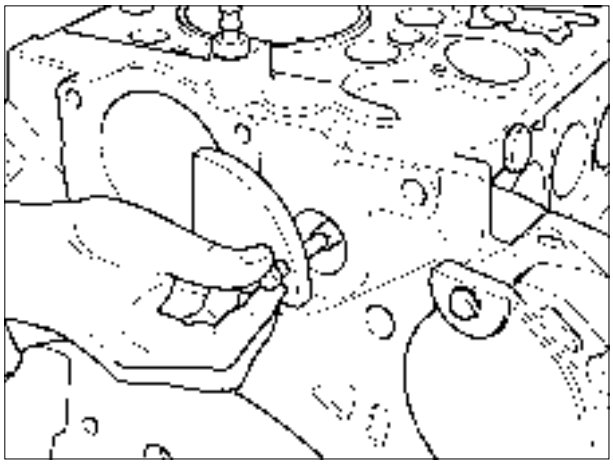


42. Measure from the measuring fixture to the control rod (fuel rack) start position. Use rule depth gauge 998 5471.

    The difference between the start and stop positions is the control rod (fuel rack) travel.

    Stated measurement = **17.0 mm - 17.5 mm** (0.67" - 0.69")

    Example:
    Stop position = 30.7 mm (1.21")
    Start position = 13.4 mm (0.53")
    Control rod travel = 17.3 mm (0.68")



43. Turn the measuring fixture (see diagram). Push the control rod (fuel rack) to the stop position by hand, using the stop screw.

NOTE! Only tighten the stop screw gently by hand.

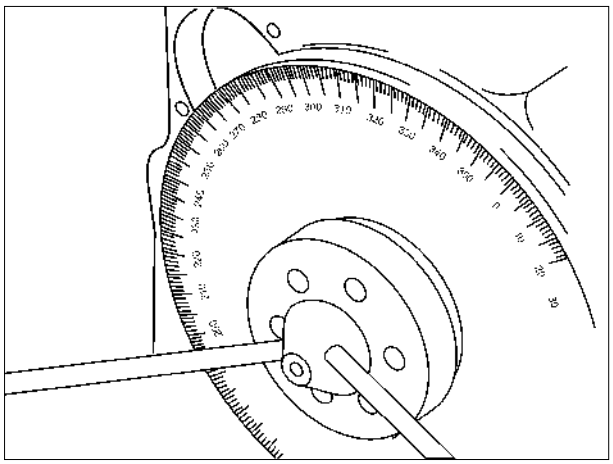
Determining the injection angle, shim thickness, and fitting of injection pumps

NOTE! The injection angle and type of camshaft is stated on the engine identification plate.

To follow the procedure described below, is only required if the engine block, camshaft or a roller tappet has been replaced.

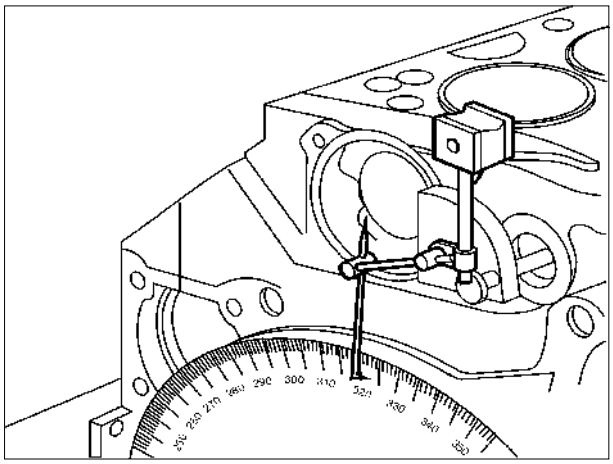
When fitting existing injection pumps see section “Injection pump installation” in this chapter.

When changing an injection pump only, see chapter "Changing injection pump".

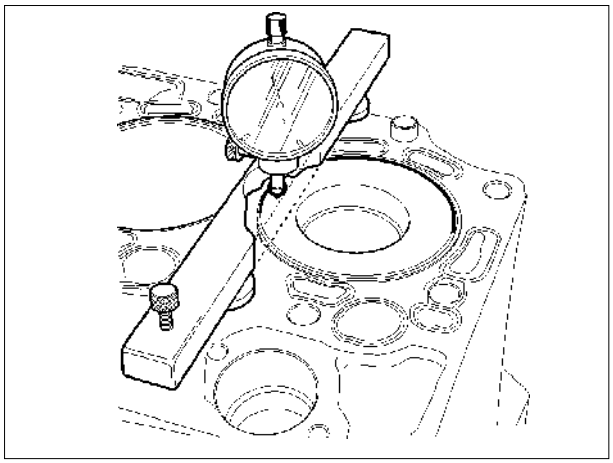


44. Fit the protractor (999 8679) to the flywheel flange on the crankshaft.

NOTE! Make sure that you tighten the screws so that there is no play.



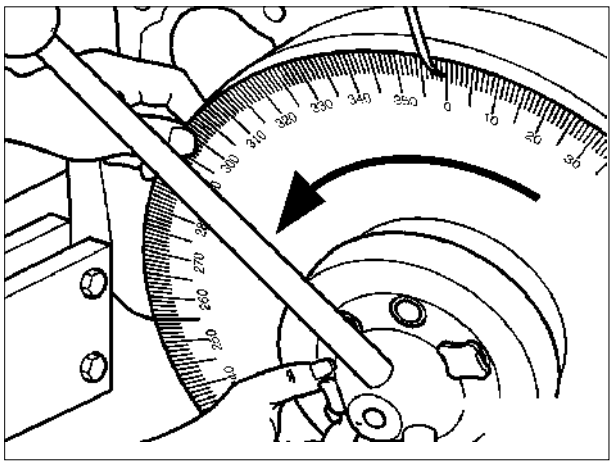
45. Attach a pointer.
Use a magnetic stand.



46. Position the measuring bar (999 8678) with spacers on the engine block over the piston belonging to the injection pump for which you are setting the timing.

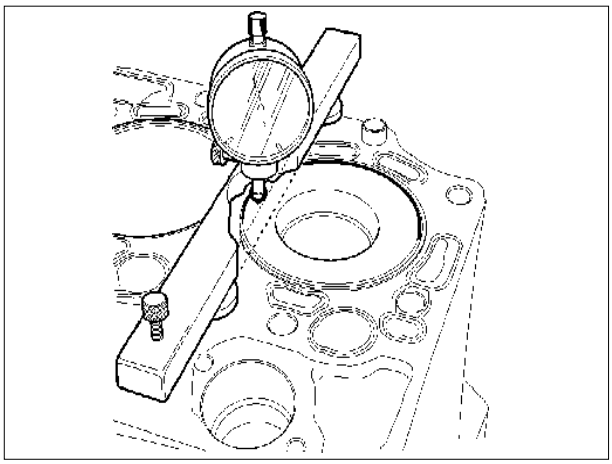
Turn the crankshaft in the direction of engine rotation until the dial gauge has reached its turning point. Set the dial gauge to “**0**”.

⚠ **IMPORTANT!** The dial gauge must be placed in the center of the gudgeon pin direction.



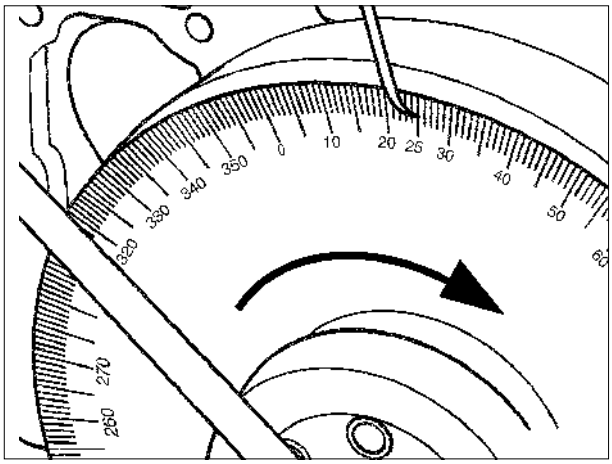
At top dead center the piston is still approx. 1°. To find the top dead center, the procedure below must be performed.

47. Turn the crankshaft through **350**° in the engine rotation direction until **8 mm** (0.32") before top dead centre (dial gauge turning point). Set the protractor to "**0**".



48. Turn the crankshaft through **350**° in the opposite engine rotation direction until **8 mm** (0.32") before top dead center (dial gauge turning point). Read the value.

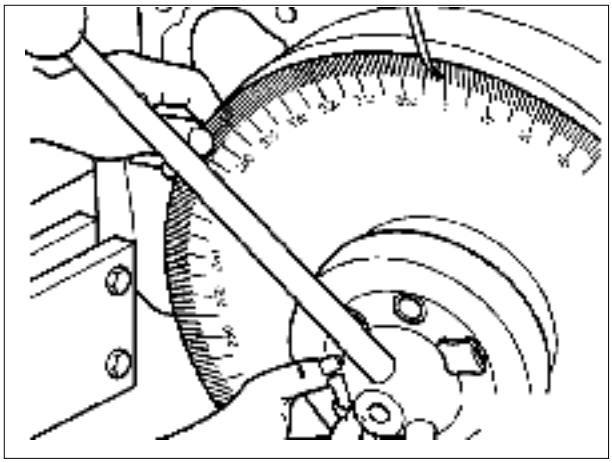
    Example: 50°.



49. Turn the crankshaft until you reach half of the value you have determined on the protractor.

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

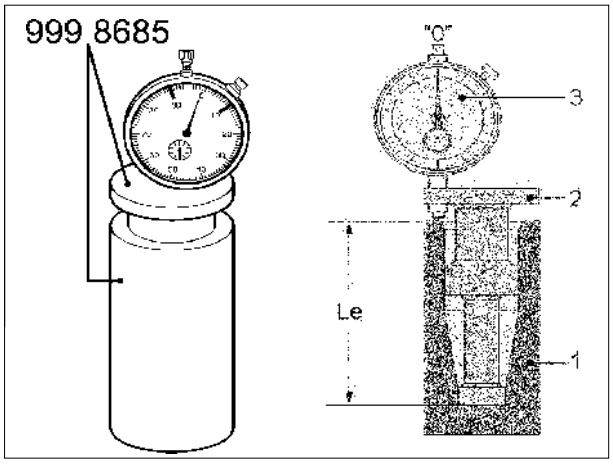
    This is the same as the top dead centre and should correspond with the top dead center on the dial gauge.

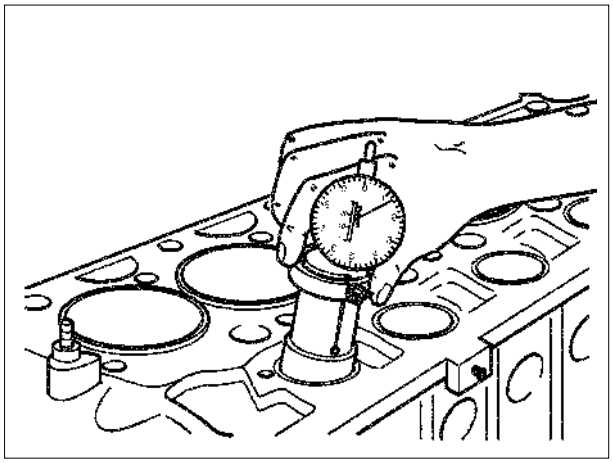


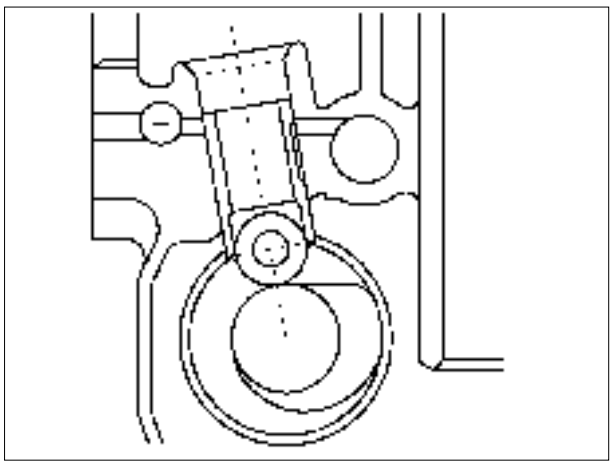
50. Set the protractor to "**0**".

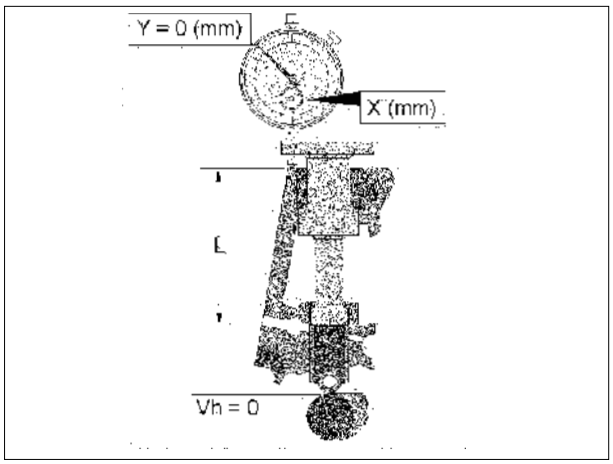
NOTE! Leave the protractor on for the next phase, in order to determine the injection angle.

Determining the injection angle









Measuring of permissible variation, engine block.

(We suggest that Tables 1, 2, and 3 as well as Calculations 2 and 3 from section"Technical data" in this book are photocopied.)

51. Install the dial gauge 998 9876 in the measuring fixture 999 8685 with a preload of **5 mm** (0.2"). Zero the dial.
    The set value (Le) is **150 mm** (5.9") (see figure).

    1 = Gauge 999 8685

    2 = Depth gauge 999 8685

    3 = Dial gauge 998 9876

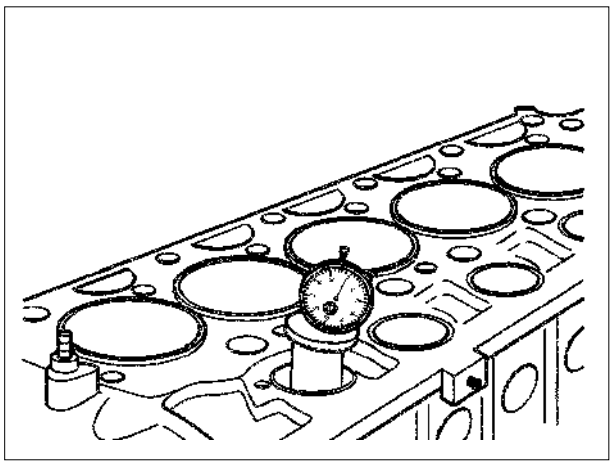
52. Position the roller tappet, without shims, for the injector pump in question on the base circle of the camshaft.
    Insert the depth gauge carefully in the injection pump hole.

NOTE! Make sure that the guide on the roller tappet ends up in the groove in the material.

53. To do this, turn the crankshaft through **180**° against the direction of rotation, until you are certain that the roller tappet is placed on the base circle.

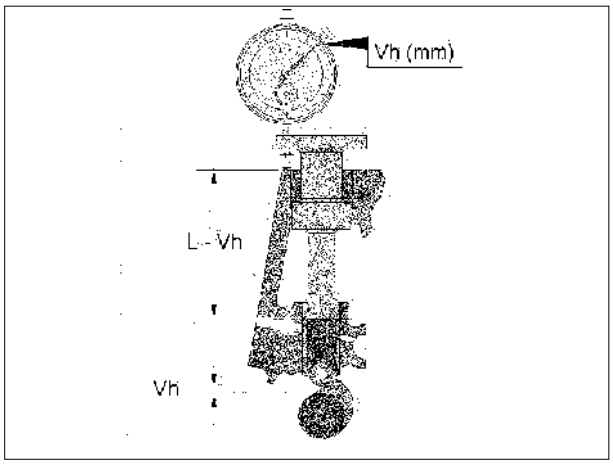
54. Take measurement "**L**" and enter it in "Calculation 1" in "Technical data".

    Depth gauge: 150 mm (5.9")
    Dial gauge (X mm): 2.18 mm (0.086")
    L = 150 + 2.18 = 152.18 mm
    (12.75 + 0.086 = 12.83")



Measuring of permissible variation, roller tappet and camshaft.

55. Zero the dial gauge.



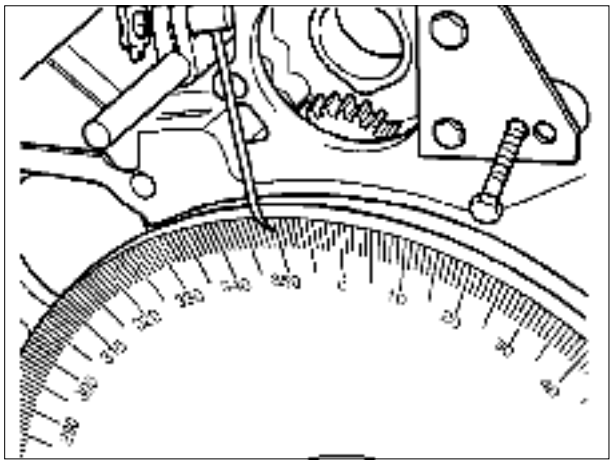
56. Read the injection angle, Fb_{nom}, on the engine identification plate.

    Read pre-stroke, Vh_{nom}, in Table 1 in "Technical data".

    Enter both values in calculations 2.1 and 3.1 in "Technical data".

    Example:

    Fb_{nom} = injection angle = 6.0°
    Camshaft = A
    Vh_{nom} = pre-stroke = 6.11



57. Turn the crankshaft in the direction of engine rotation until the dial gauge shows (-) Vh_{nom}.

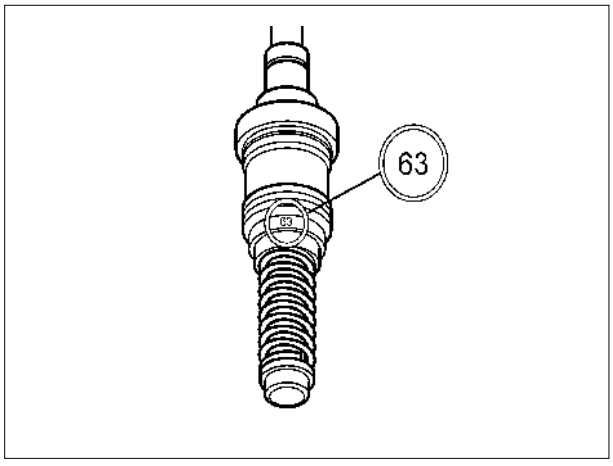
    Example:
    7-6,11 = 0,89
    The dial gauge was zeroed at 7 mm pre-stroke and when it shows 0.89 in the example, you have reached Vh_{nom}.

58. You can now, on the protractor, read the value (eg. 354,5°) for when the injection valve should have opened.

    Example: 360 - 354.5 = 5.5

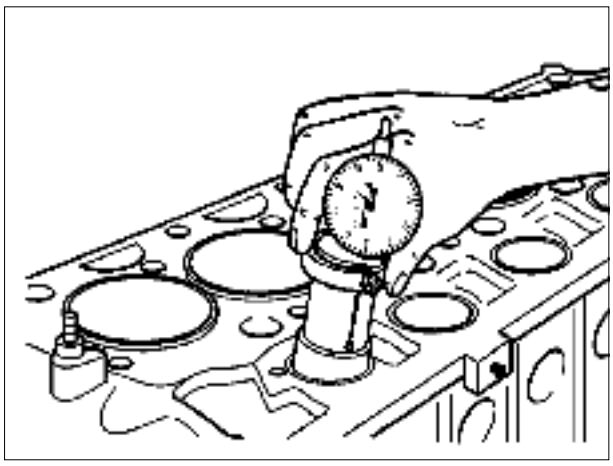
    Enter it into calculations 2.1 and 3.1 in "Technical data".

    Example: $F_{B\ akt}$ = 5.5°



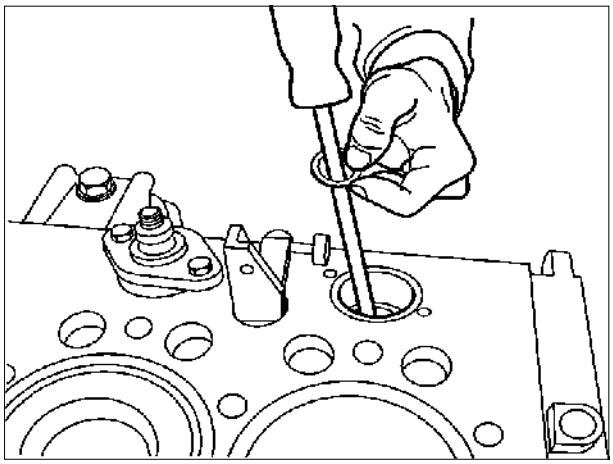
59. Read off demension "**A**" = the code for the injection pump length and enter it into "Calculation 2.1" in "Technical data".

    Example: A/100 = 0.63 mm (0.025")



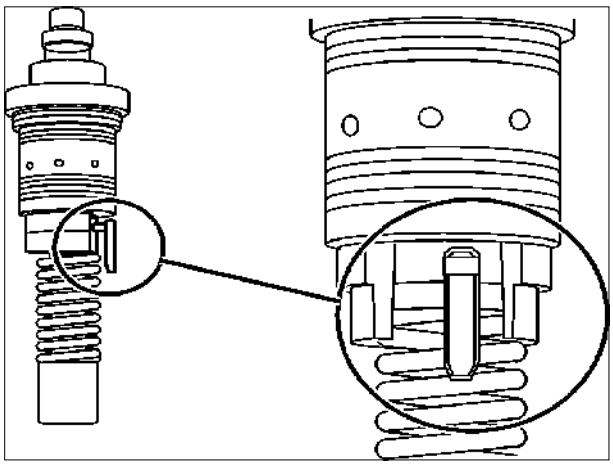
60. Remove the depth gauge with the dial gauge. Complete the calculations for shim thickness in “Calculation 2.2” in “Technical data”.

NOTE! Don’t forget to change the EP-code on the engine identification plate.



61. Slide the shim in place along a scewdriver into the roller tappet.

NOTE! Perform the measurement procedure in steps 51-61 above for each injection pump.



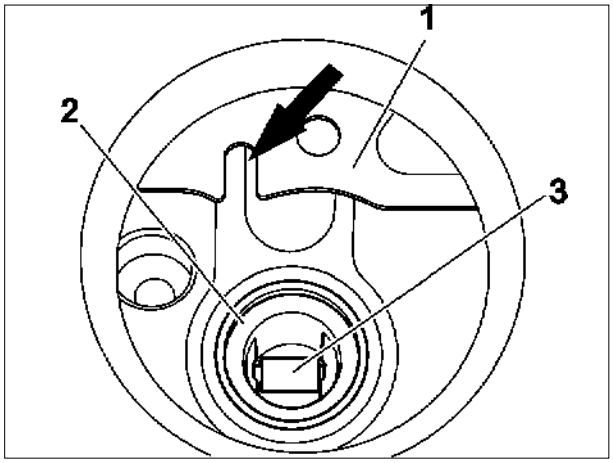
Injection pump Installation

62. When refitting pumps: place the existing roller tappets with their belonging shims.

63. ⚠ **IMPORTANT!** Turn the injection pump linkage lever to middle position.

64. Make sure the injection pumpcam, for the cylinder in question, is on the base circle.
Turn the engine, using tool 999 8681 or protractor 999 8679.

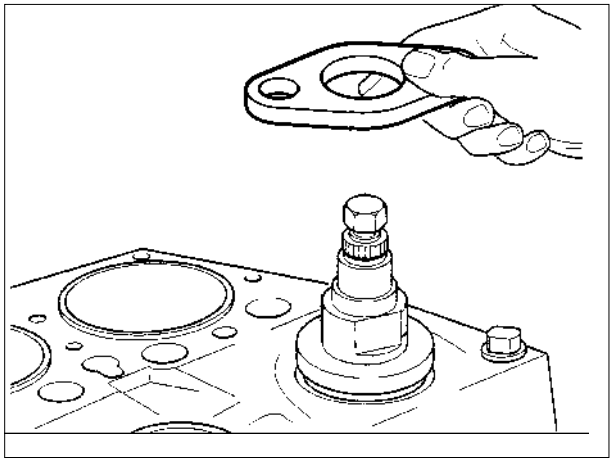
NOTE! Make sure that the control rod is still in the stop position, held in place with the tools 999 8682 or 999 8684.



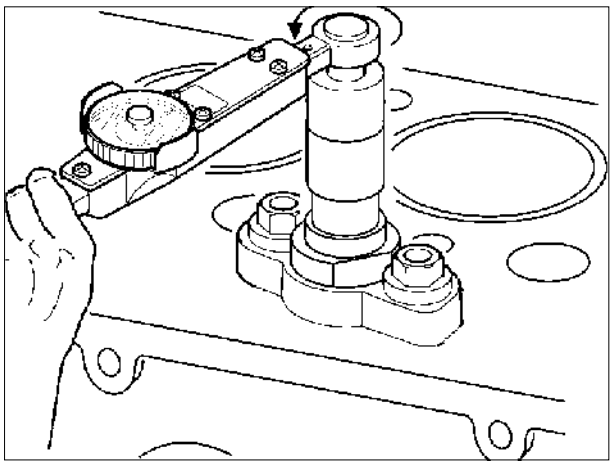
65. Lightly oil the O-rings, using lubricant 1141699, on the injection pump and carefully insert the pump.

⚠ **IMPORTANT!** Make sure that the injection pump linkage lever has entered the slot in the control rod before pushing it down.

1. Fuelrack
2. Shim for pump element
3. Roller tappet for pump element



66. Put the pump flange in place with the camfered hole side facing the pump.
Oil the screws lightly and tighten the screws evenly to ..... 5 **Nm** (3.7 lbf ft).
Back she screws off ..... **60**°.

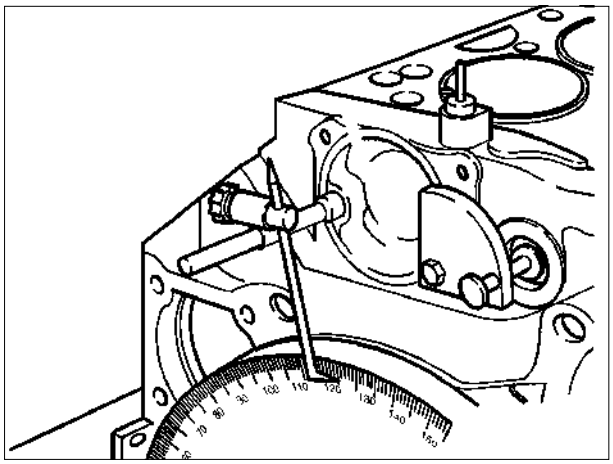


67. Turn the injection pump carefully counter-clockwise.
    Use a torque wrench with gauge and 11668403.

    Stop turning when the pump has reached its stop position and the torque is increased by**1Nm** (0.74 lbf ft).

    Observe the torque required on the torque wrench gauge to turn the injection pump, e. g. **3.5 Nm** (2.6 lbf ft).
    Example: 3.5 + 1 = 4.5 Nm

68. Tighten the screws ..... **60° clockwise** then alternately with a torque of **7**, **10** and **30 Nm** (5.2, 7.4 and 22.2 lbf ft) .



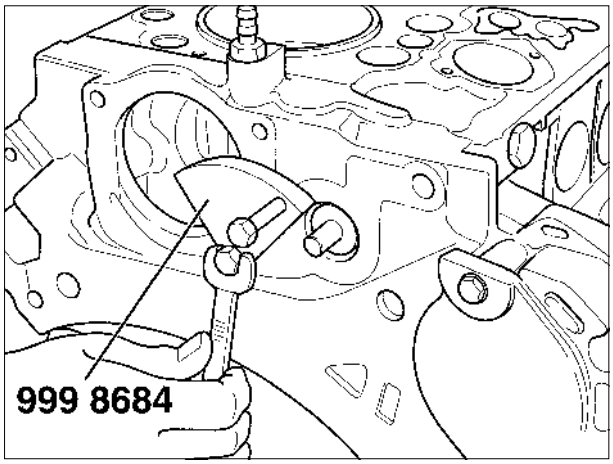
NOTE! Start with the screw furthest away from the flywheel.

NOTE! Check that the control rod (fuel rack) is moving freely after each injection pump has been installed.

Repeat the steps above for each pump.

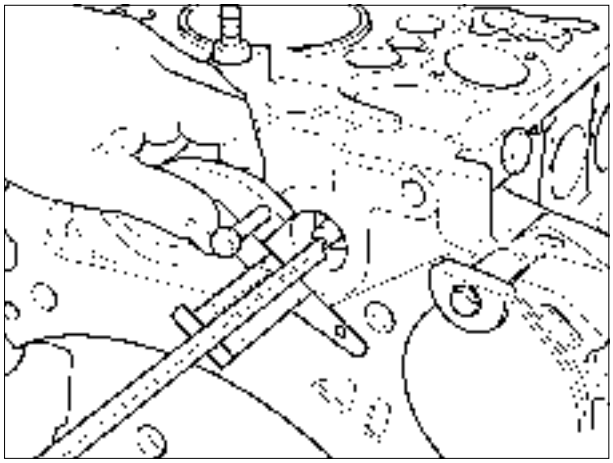
69. Remove the indicator 999 8679, if it has been fitted.

    Let tool 999 8684 stay in place.



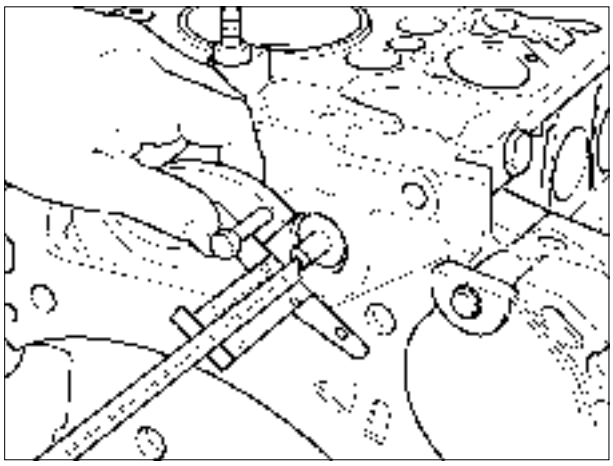
Measure the control rod (fuel rack) travel <u>with</u> the injection pumps installed

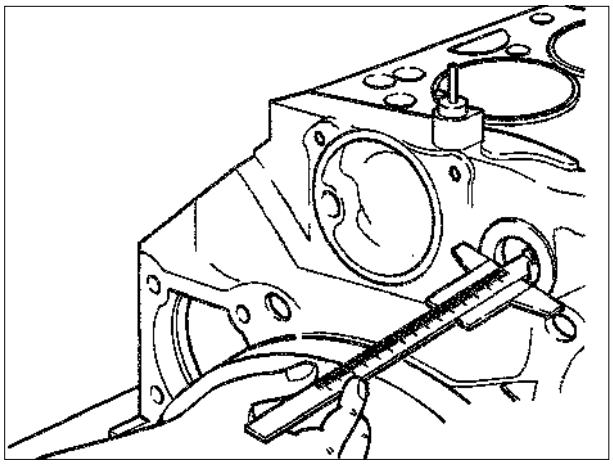
70. Loosen the measuring fixture screw and turn it from the control rod and tighten the measuring fixture screw at the measuring position.

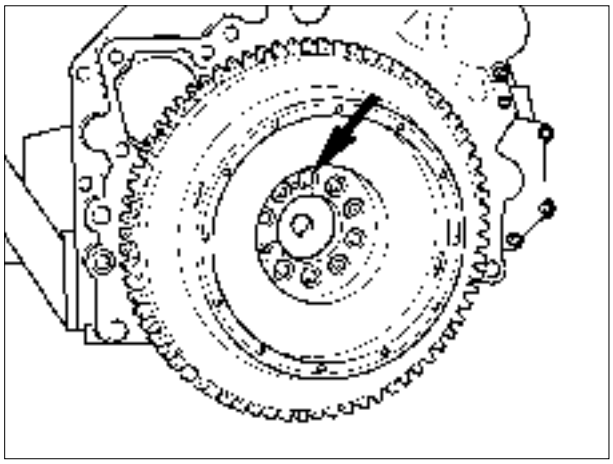


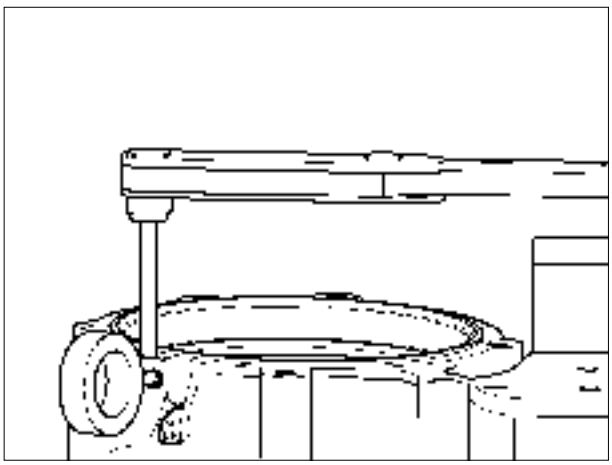
71. Measure from the measuring fixture to the control rod stop position.

    Example: 30.5 mm (1.2”).









72. Measure from the measuring fixture to the control rod (fuel rack) start position.

    Example: 13.6 mm (0.53”).

    Remove the measuring fixture.

    The difference between the start and stop positions is the control rod (fuel rack) travel.

    Minimum control travel is 16.8 mm (0.66")

    Example:

    Stop position = 30.5 mm (1.2")
    Start position = 13.6 mm (0.53")
    Control rod (fuel rack) travel = 16.9 mm (0.67")

Measuring of the control rod’s x-measurement.

73. Measure the control rod’s x-measurement from the transmission housing surface to the stop position.

NOTE! You must indicate the determined x-measurement when the engine block, control rod or gear case has been replaced.

For electronic governors (EDC 4) the x-measurement value is entered into the trigger unit.

NOTE! When replacing the control rod, the governor must always be adjusted. Only trained personnel should make adjustments to the governor, using a governor test bench.

Flywheel, fitting

74. Fit the flywheel.Tighten the srews by hand.

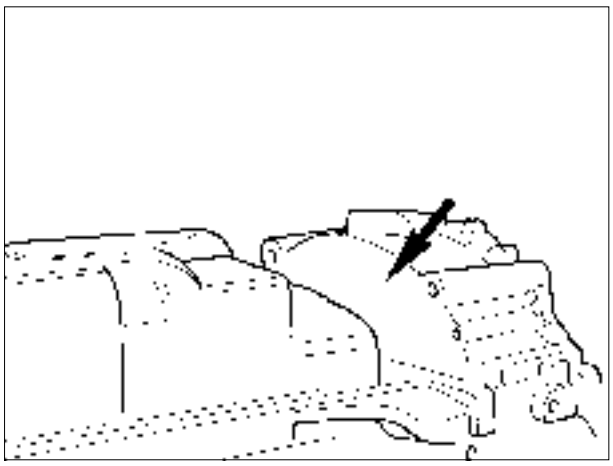
⚠ **WARNING!** The flywheel is heavy, approx.55 kg (720-722).

75. Install the flywheel housing.

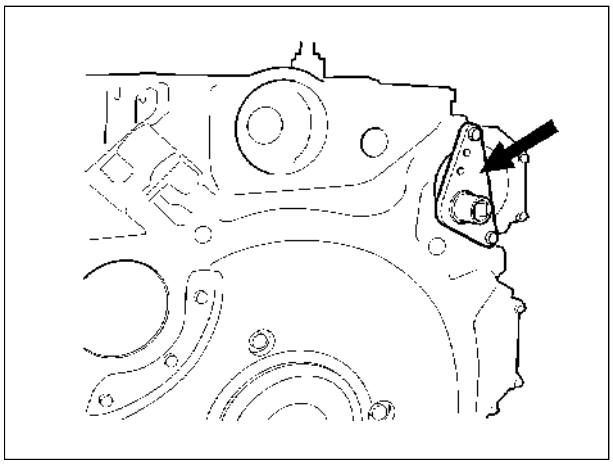
NOTE! Make sure the guiding sleeves are in place.

Tighten the screws as specified:
M12 screws : ..... **99** ±10 **Nm** (73.3 ±7.4 lbf ft).
M16 screws : ..... **243** ±25 **Nm** (179.9 ±18.5 lbf ft).

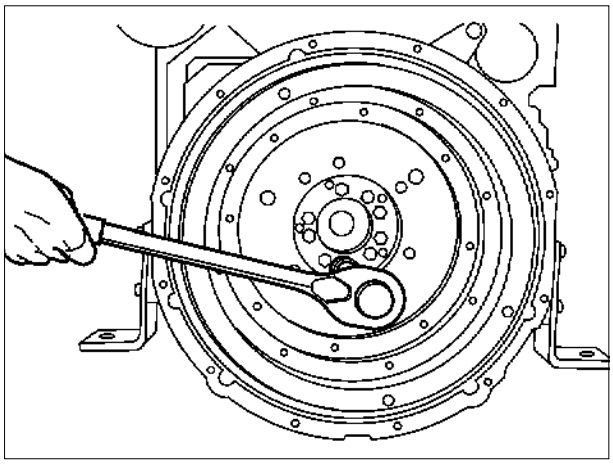
NOTE! Use Torx sockets E14 and E20.



76. Fit the cover plate on the flywheel housing.



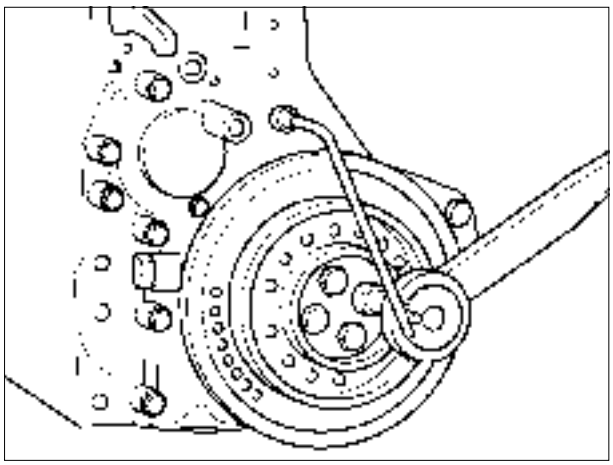
77. Fit cranking tool 999 8681 on the flywheel side.



78. Block the flywheel, using cranking tool 999 8681. Tighten the screws as specified in “Technical Data”.

NOTE! There are several screw lengths. Screws may be used 5 times.

Fit the plastic plugs that are used as a locking device for the flywheel screws.



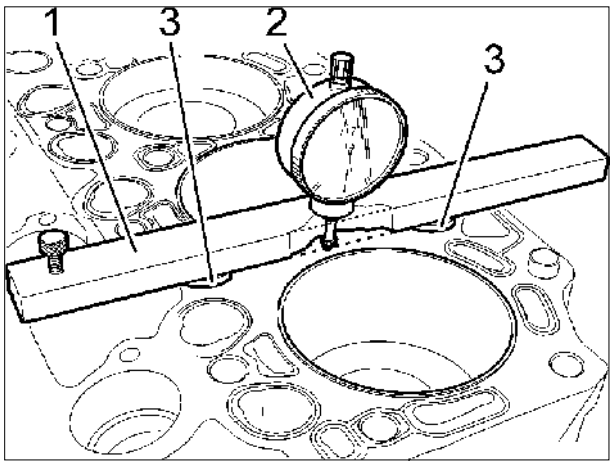
79. Fit the crankshaft pulley and vibration damper and tighten the screws as specified below:

NOTE! Use tool 999 8681 to block the flywheel.

Initial torque: ..... **40** ±5 **Nm** (33 ± 3.7 lbf ft).
1:st tightening angle: ..... **60°**
2:nd tightening angle: ..... **60°**

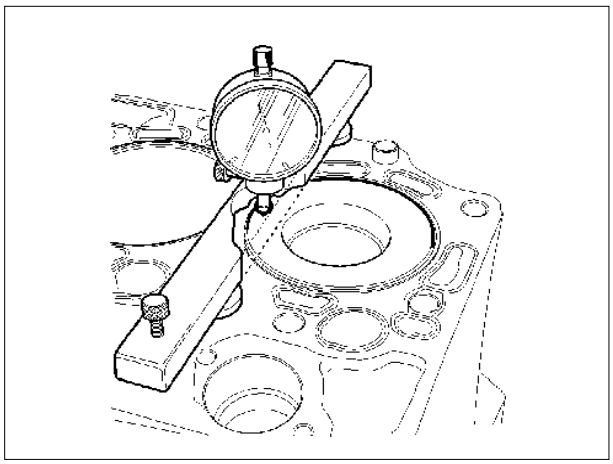
NOTE! Use Torx socket E 20.

NOTE! The screws can be used 5 times.



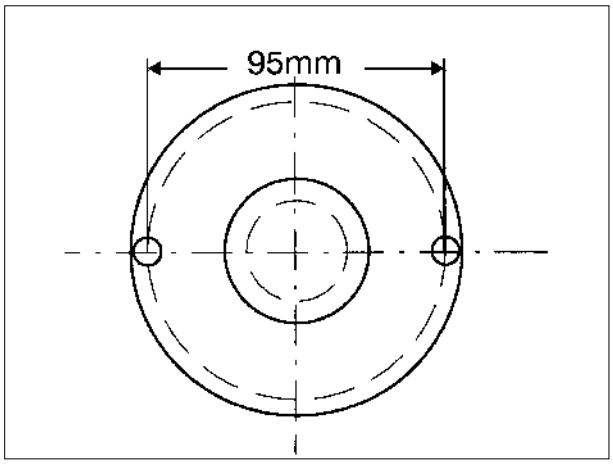
Cylinder head gasket

80. Determine the thickness of the cylinder head gasket. Put spacers (3) and measuring bar 999 8678 (1) on the sealing face of the engine block and set the dial gauge (2) to "**0**".

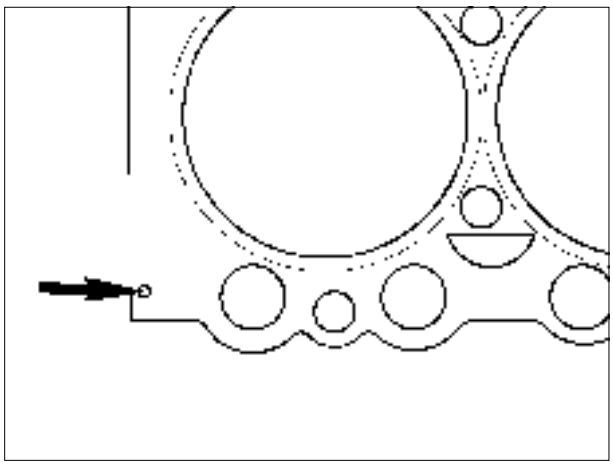


81. Put the dial gauge on the piston at the measuring points and determine the greatest piston height.

NOTE! You need to measure all pistons at T.D.C.

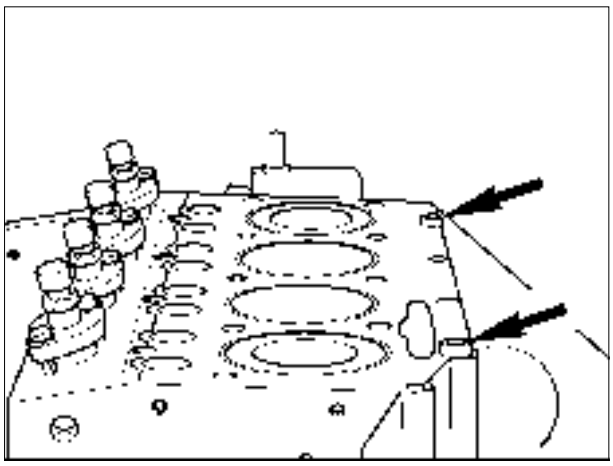


NOTE! Take note of the measuring points, since the surface of the piston is spherical. Use for example a steel ruler to find the highest point (in the direction of the gudgeon pin).



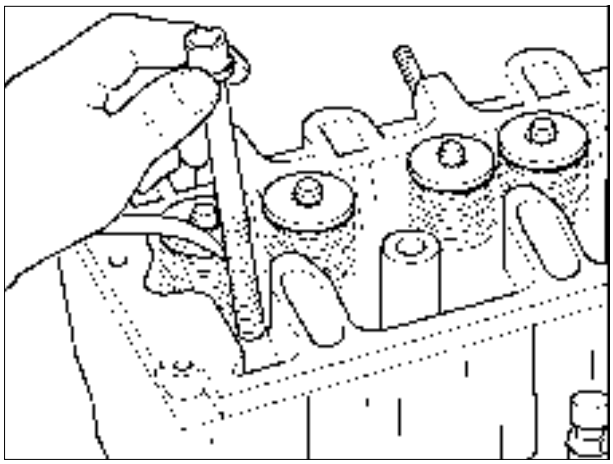
82. Compare the largest values with the table and determine a suitable cylinder head gasket.

Piston height	Marking on cylinder head gasket
0.28– <0.53 mm (0.011– <0.021")	1 hole
0.54– <0.63 mm (0.021– <0.025")	2 holes
0.64–0.75 mm (0.025–0.029")	3 holes



83. Position the cylinder head gasket correctly (with the numbers facing upwards and the marking holes towards the flywheel).

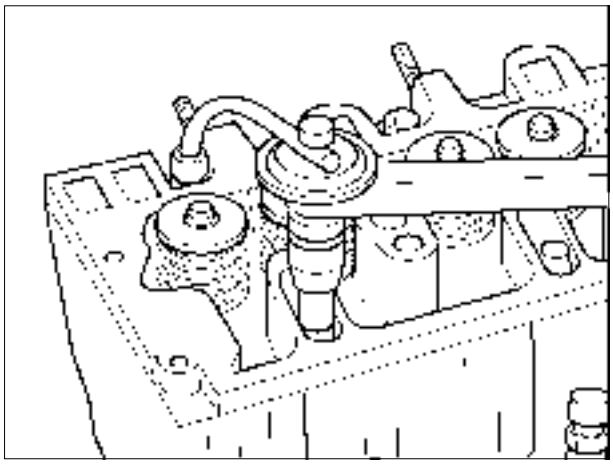
NOTE! The cylinder sealing surfaces must be clean and free of oil. Pay particular attention to the dowel sleeves.



Cylinder head with valve gear

84. Fit the cylinder head. Oil the cylinder head bolts (but let the oil drip off) and screw them in finger tight.

NOTE! You can use the cylinder head bolts up to 5 times if you know how many times they have been used. (Make a punch mark for each of the following usages.)



85. Tighten the cylinder head bolts as specified below:

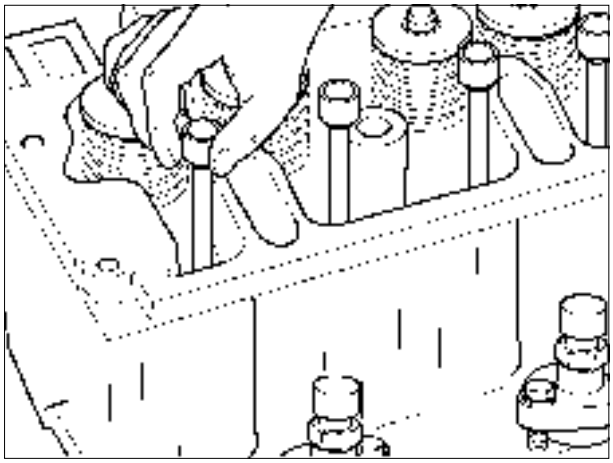
NOTE! Follow the tightening sequence for the cylinder head, see “Tightening sequence for cylinder head screws”.

Tighten the bolts in three stages:

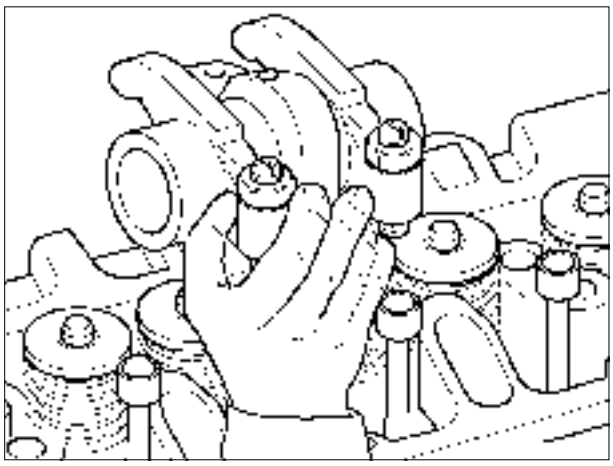
1st stage: ..... **50 Nm** (37 lbf ft)

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

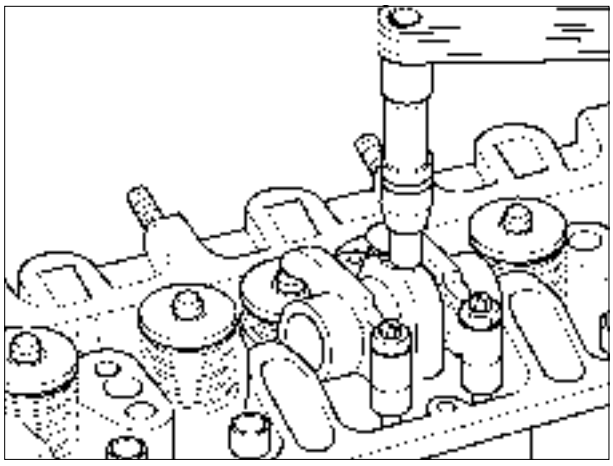
3d stage, tightening angle: ..... **90**°



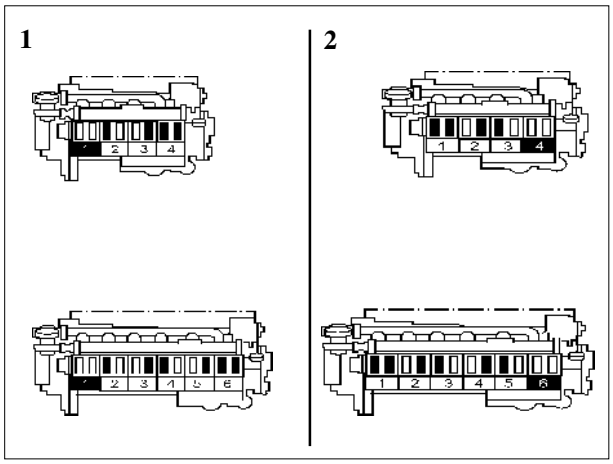
86. Insert the push rods, according to the mark up during disassembly.



87. Install the rocker arm brackets, according to the markings, and align them with the push rods/ valves.



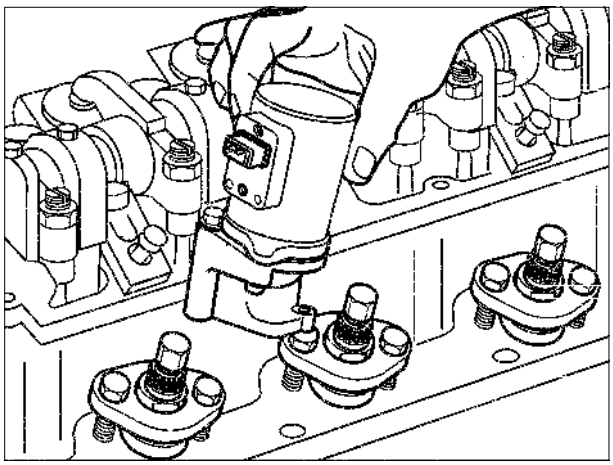
88. Tighten the screws to ..... **21 Nm** (15 lbf ft).



89. Set the valve clearance, see “Valve clearance, adjusting” in the Repairing components chapter.

Inlet ..... **0.35** ±0.05 **mm** (0.01±0.002”)
Exhaust ..... **0.55** ±0.05 **mm** (0.02±0.002”)

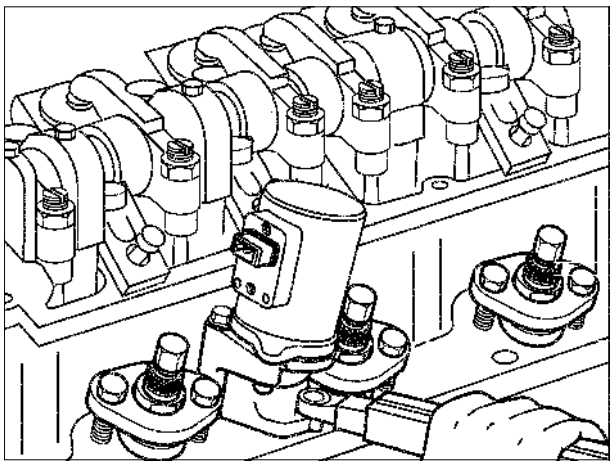
90. Remove the cranking tool.



91. Fit the stop solenoid with a **new** O-ring. With the control rod (fuel rack) in stop position, put the stop solenoid into place.

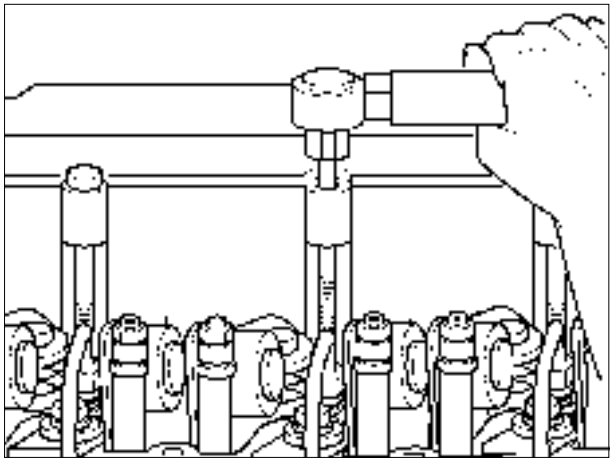
NOTE! For engines with electronic governor, fit the plug with a **new** O-ring.

NOTE! Lightly oil the O-ring.



92. Tighten the screws to ..... **21 Nm** (15 lbf ft).

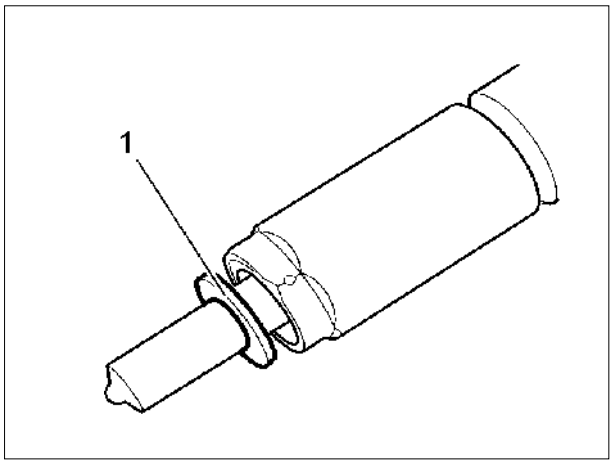
NOTE! This does not apply to EDC 4 (electronic governor).



Inlet pipes

93. Fit the inlet pipe with a new gasket.

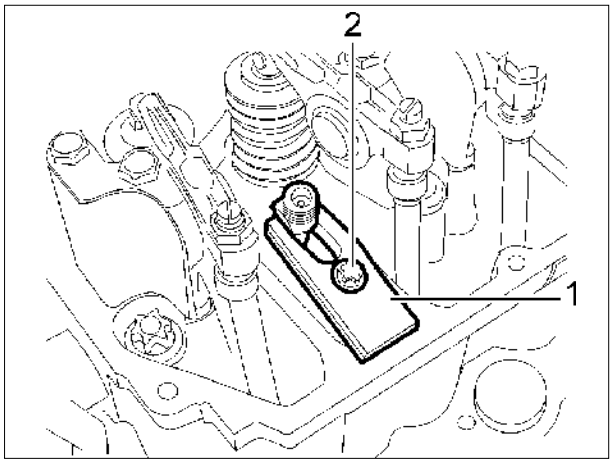
    Tighten the screws to ..... **11** ±1 **Nm** (8.1 ±0.7 lbf ft).



Fitting of injectors / delivery pipes

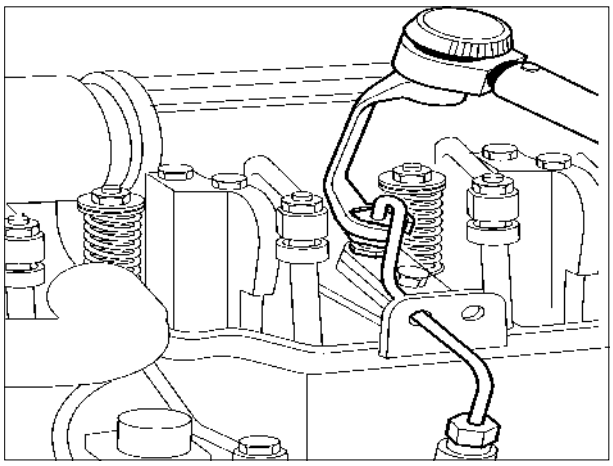
94. Using a little high temperature paste (1161035), fit a **new** copper gasket (**1**) on the injector and fit the injector.

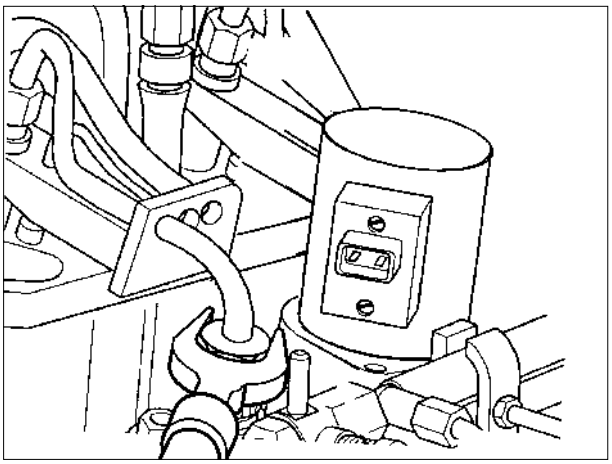
NOTE! The connection for the fuel return line must be towards the exhaust side.

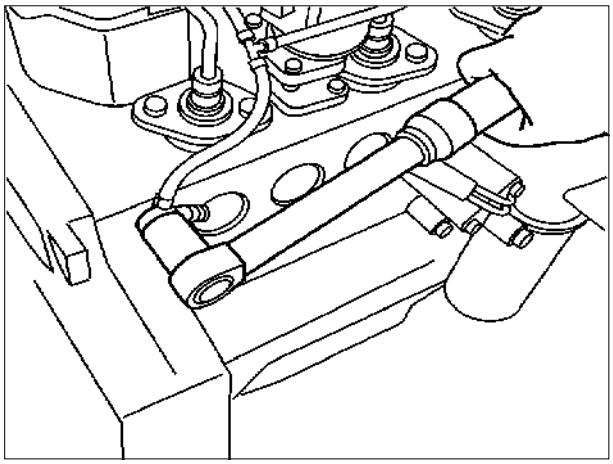


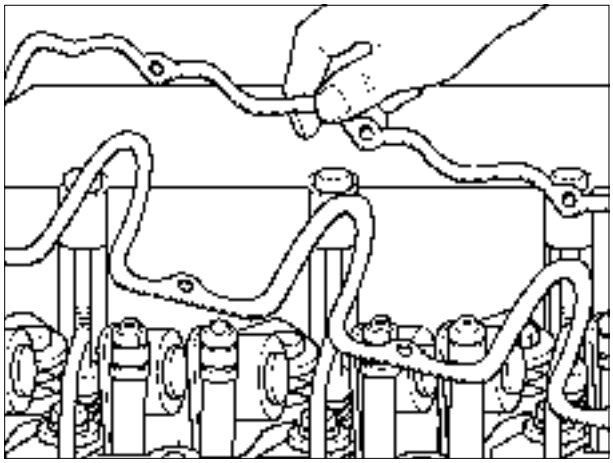
95. Put the injector yokes (**1**) in place and tighten the screws lightly.

    Use Torx socket E10 (**2**).









96. Fit a new delivery pipe and rubber seal. Use tool 885490. Tighten the nuts by hand.

NOTE! When you install the delivery pipes, the sealing cones must fit exactly in the pump and injector.

⚠ **WARNING! Do not bend the pressure pipes. The pressure pipes can be used only once.**

NOTE! The delivery pipes are deformed when tightened and all delivery pipes must be tightened with the same tightening torque.

If they are tightened with different tightening torque, the cylinders may take different load.

Reuse of delivery pipes may mean that the engine power is not complete.

97. Tighten the screws for the injector yokes to ..... **19** ±2 **Nm** (14 ±1.5 lbf ft).
98. Pre-tension the delivery pipe nuts in two stages:
    1. Tighten to ..... **5 Nm** (3.7 lbf ft)
    2. Tighten to ..... **25** ±3.5 **Nm** (22 ±2.6 lbf ft)
99. Fit the fuel leakage line and push it through the rubber seal.

NOTE! Always replace the leakage line.

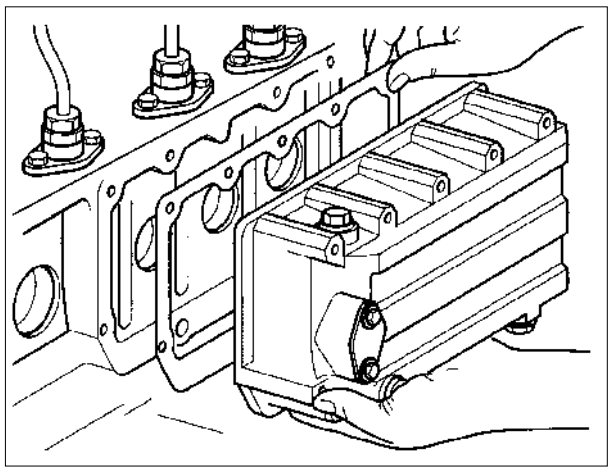
100. Fit the overflow valve with new copper gaskets. Tighten to ..... **30 Nm** (22.2lbf ft).

Rocker cover

101. Fit the rocker cover with a new gasket.

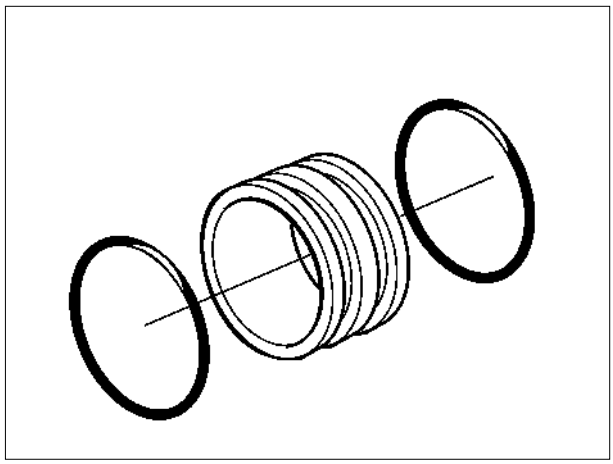
NOTE! Make sure that the gasket is placed correctly in the grooves of the rocker cover.

102. Fit the rocker cover. Tighten the screws to ..... **11** ±1 **Nm** (8 ±0.7 lbf ft).



Oil cooler

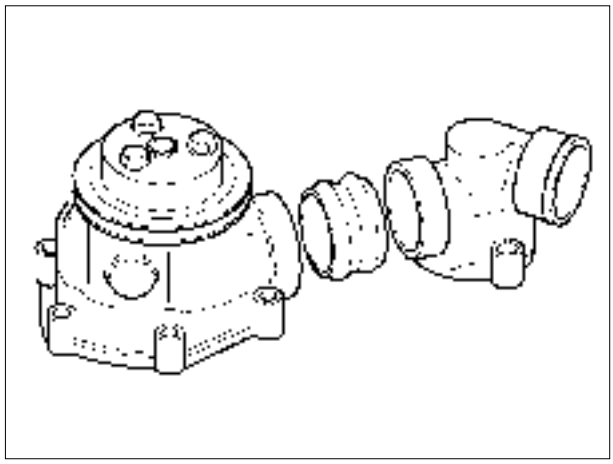
103. Fit the oil cooler with a new gasket.
Tighten the screws to ..... **21** ±2 **Nm** (15.5 ±1.5 lbf ft).



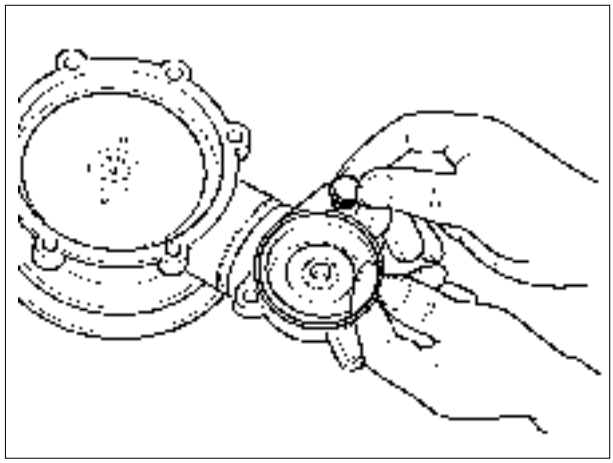
Coolant pump

104. Fit the O-rings to the intermediate pipe.

NOTE! To make it easier to fit, put some lubricant (part no 1 141 699) on the O-rings.

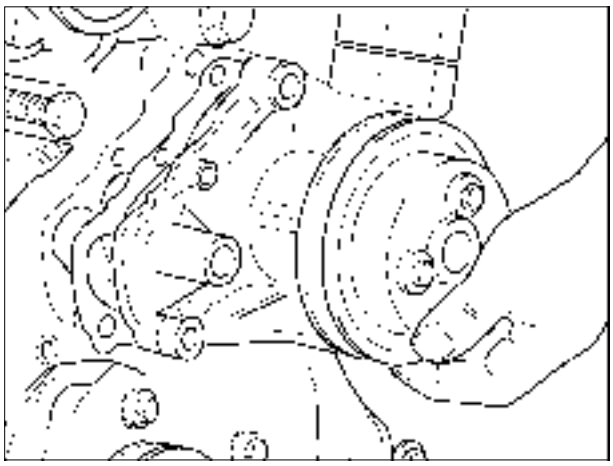


105. Press the intermediate pipe into the thermostat housing and coolant pump.

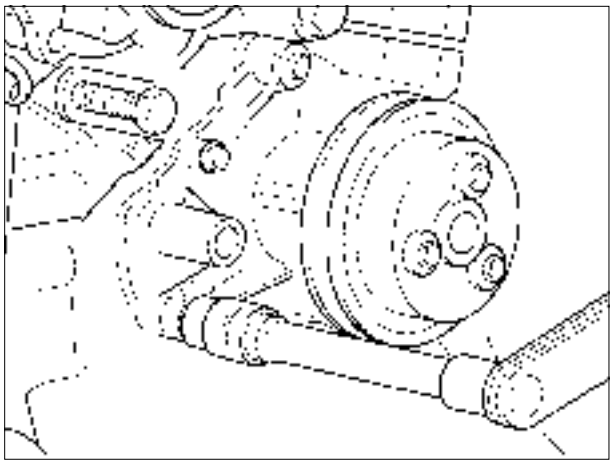


106. Fit the O-ring into the thermostat housing.

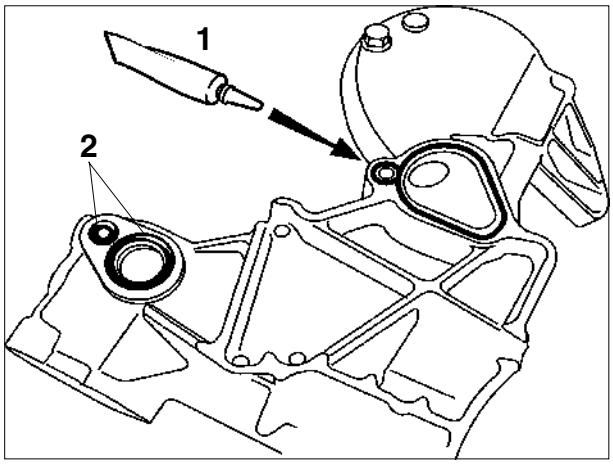
NOTE! To make it easier to fit, put some lubricant (part no 1 141 699) on the O-rings.



107. Fit the coolant pump with thermostat housing and use a **new** gasket.

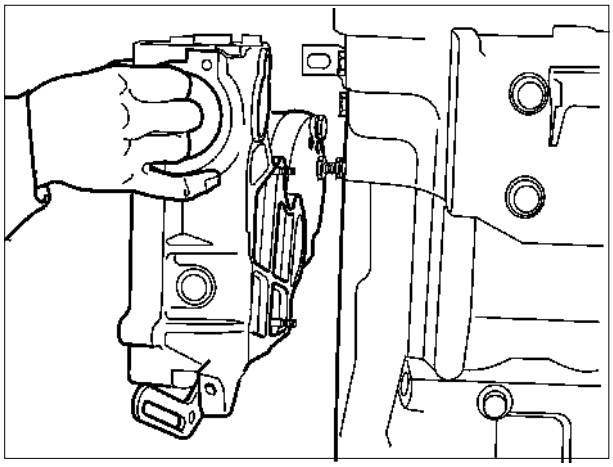


108. Tighten the screws alternately to: ..... **21** ±2 **Nm** (15 +1.5 lbf ft).

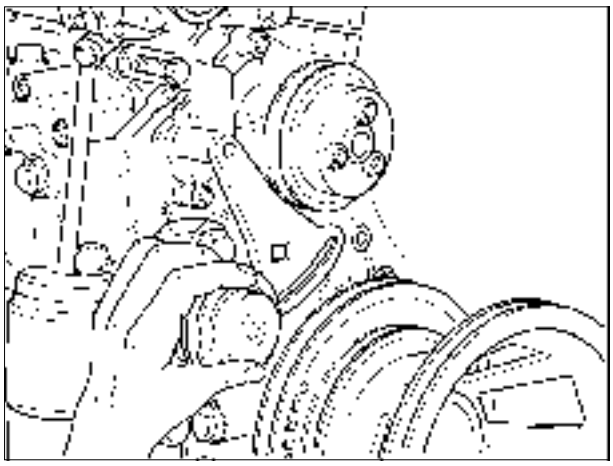


Alternative assembly (depending on coolant pump model):

109. Fit the plug for the control rod.
Apply sealing compound (**1**), 1161277 or 1161231, and **new** O-rings (**2**) on the cooling pump house.

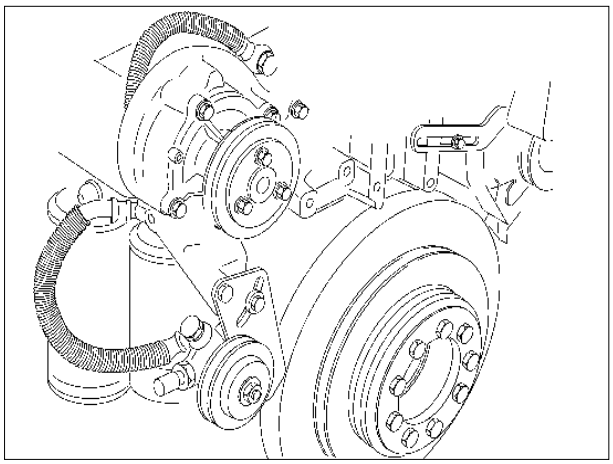


110. Fit the coolant housing with the coolant pump.
Tighten the screws to ..... **21** ±2 **Nm** (15 +1.5 lbf ft).

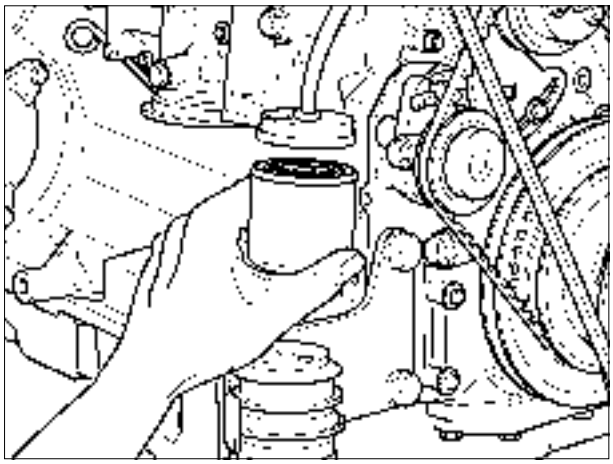


Fuel pump

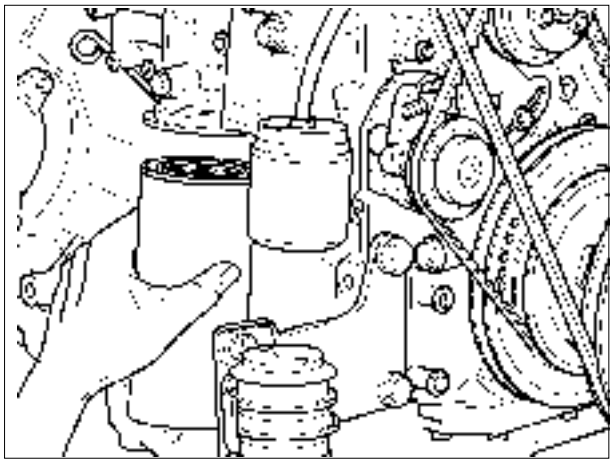
111. Fit the fuel pump.



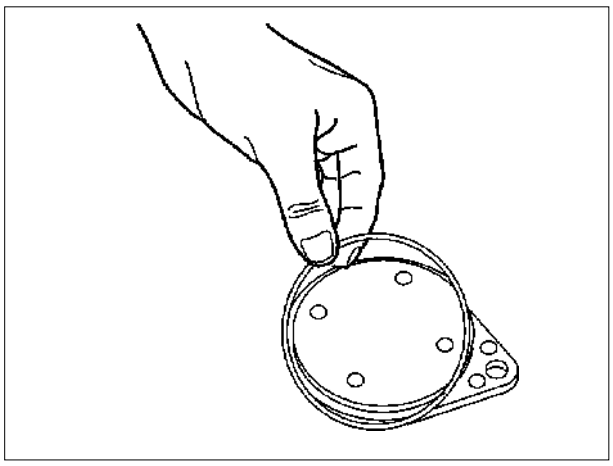
112. Fit the fuel lines. Tighten the hollow screws to .....**34 Nm** (25 lbf ft).



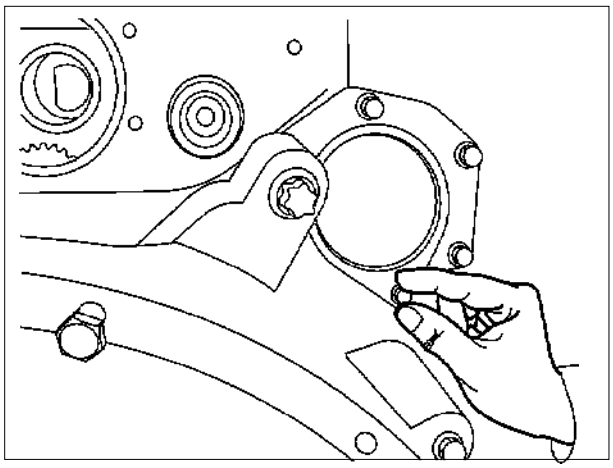
113. Lightly oil the fuel filter gasket. Tighten the fuel filter by hand until it touches the contact surface. Turn another half a turn, no more.



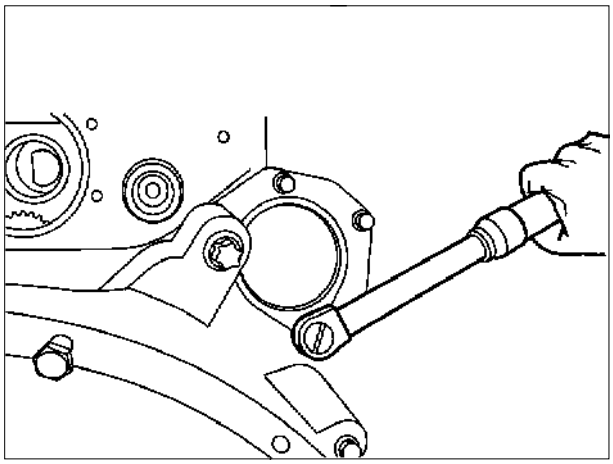
114. Lightly oil the oil filter gasket. Tighten the oil filter by hand until it touches the contact surface. Turn another half a turn, no more.



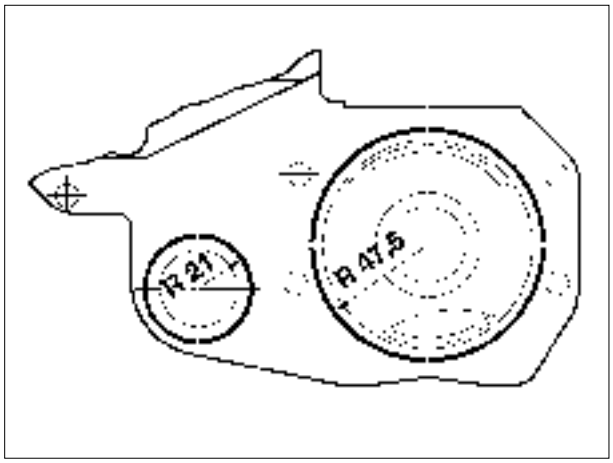
115. Fit a **new** O-ring to the cover and lightly oil it.



116. Fit the cover.



117. Tighten the screw to ..... **21** ±2 **Nm** (15 ±1.5 lbf ft).

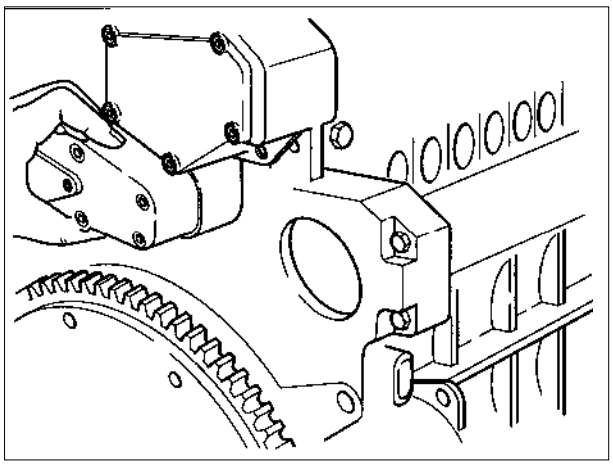


Speed govenor

118. Apply silicone sealing compound (1161231) to the govenor.

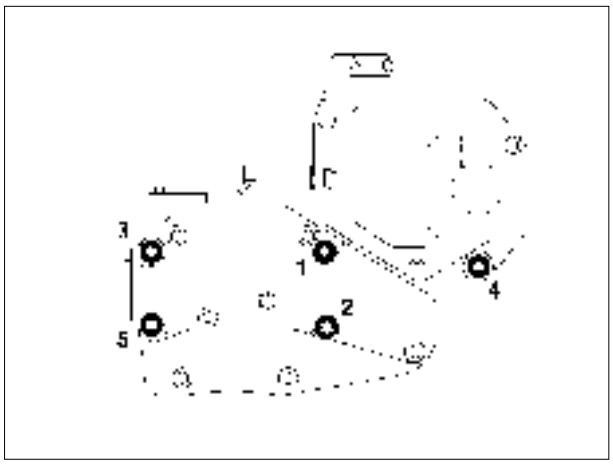
Sealant bead diameter ..... Ø **1.5** $^{+0.5}_{0}$ **mm** (0.06" $^{+0.02}_{0}$").

NOTE! The sealing surface must be free from oil and grease.



119. Install the speed governor.

⚠ **IMPORTANT!** The governor is uniquely prepared for each engine. This means that the governor can not be exchanged between different engines.
An incorrect adjusted governor can result in that the engine will not fulfill the regulations for emission and performance.
When ordering a governor as a spare part always state engine type's serial number, rated speed (rpm), and x-measurement.

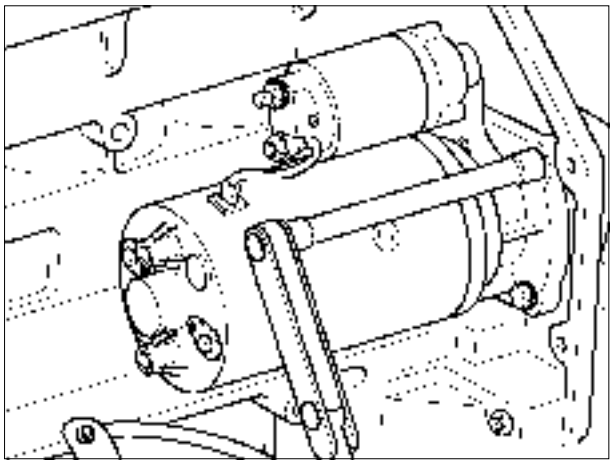


120. Tighten the torx screw in the sequence 1-2-3-4-5 using torx socket E 10. Tighten to .. **17** ±1.5 **Nm** (12 ±1 lbf ft).

NOTE! For electronic governors the x-measurement is entered as a value into the trigger unit. An electronic governor is not unique with a calibrated x-measurement.

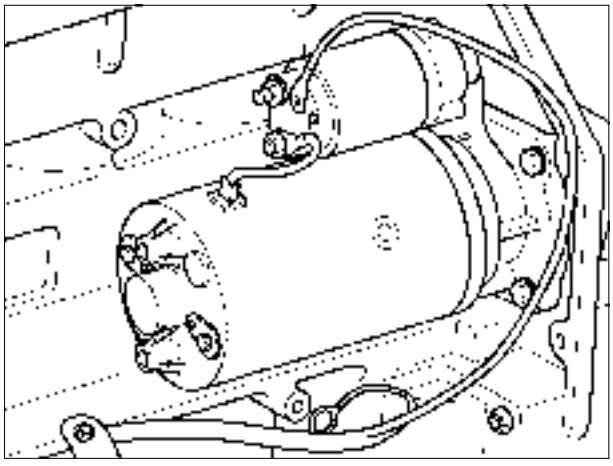
121. For electronic governors, the following applies for the 5 M8 screws:

1-2 = 70 mm
3-5 = 55 mm
Tighten the screws to ..... **24 Nm**

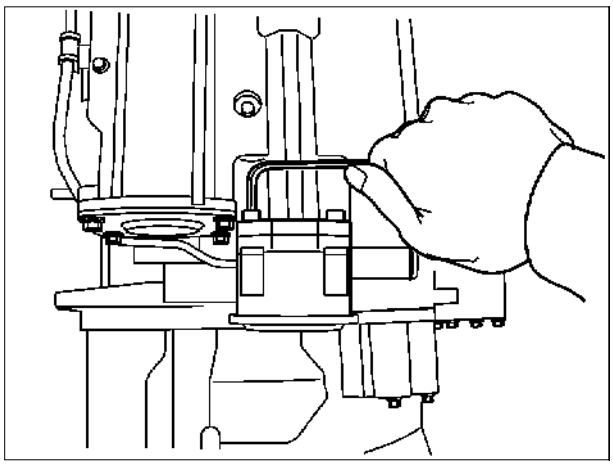


Starter motor

122. Fit the starter motor, if it has not been fitted together with the transmission housing.
Tighten the screws to ..... **70 Nm** (52 lbf ft).

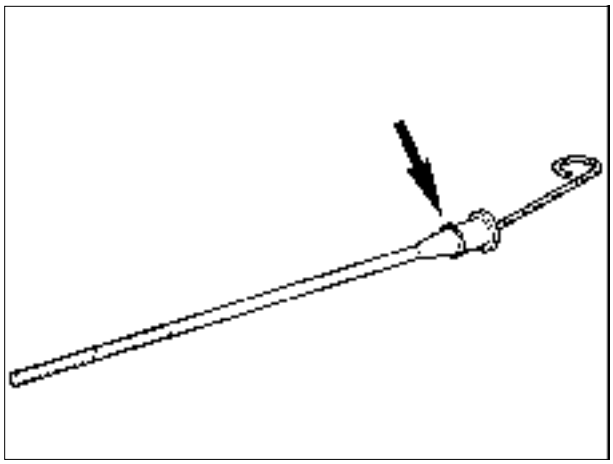


123. Fit the cable and fixing clips.



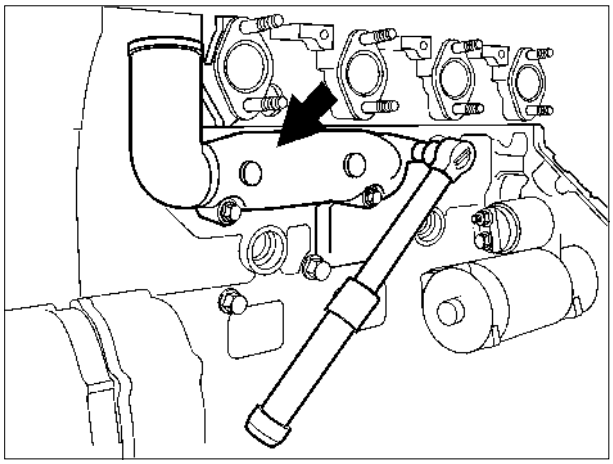
124. Fit the crankcase vent.

NOTE! Use an 5 mm Allen key.

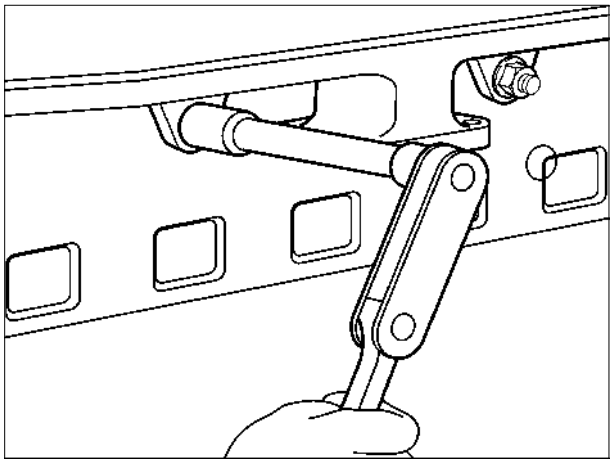


Oil dipstick

125. Slide on the **new** O-ring.



126. Fit the outlet coolant pipe with a **new** gasket and sealant. Tighten the screws to ..... **21** ±2 **Nm** (15.5 ±1.5 lbf ft).



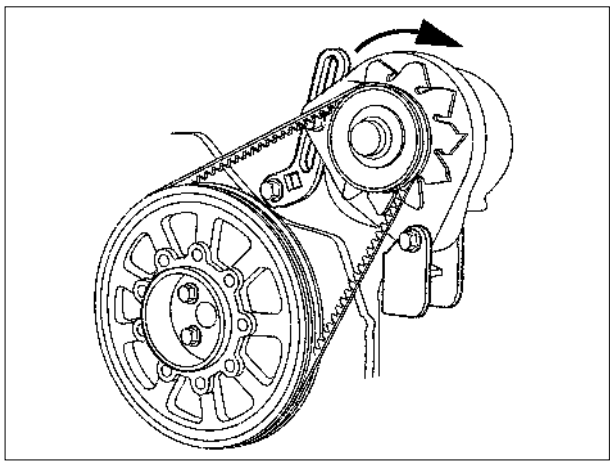
Exhaust manifold

127. Fit the exhaust manifold with **new** gaskets.

The gasket flange should be directed towards the cylinder head.

Tighten the exhaust manifold nuts with a torque to..... **25** ±2.5 **Nm** (18 ±1.8 lbf ft).

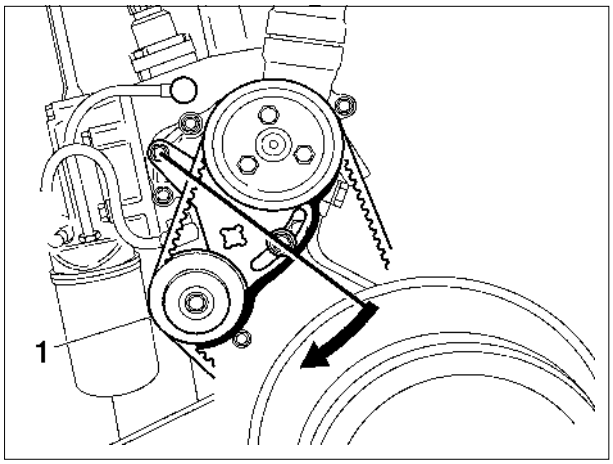
NOTE! Use high temperature paste (1161035) on the screws.



Alternator

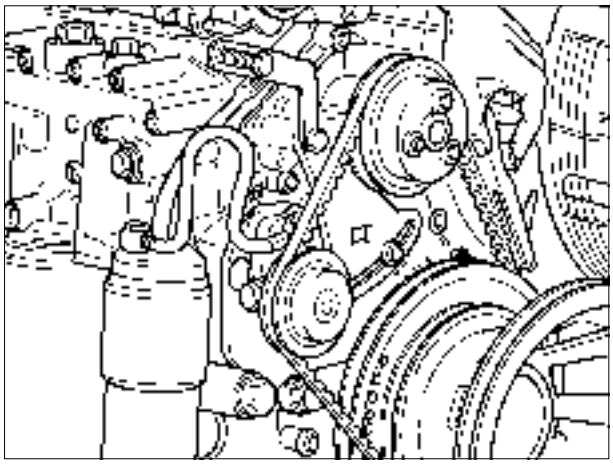
128. Fit the alternator bracket and alternator.
Fit the V-belt.
Adjust the position of the alternator by pushing it in the direction of the arrow until you obtain the correct belt tension.
Tighten the screws to ..... **30 Nm** (22 lbf ft).

NOTE! The belt is correctly tensioned when you can press it down 10 mm (0.4") between the pulleys.



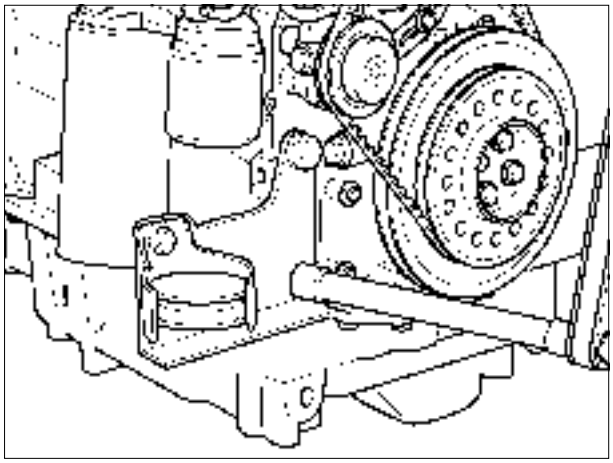
129. **Fit the belt and tension it.**
    1. Push the fuel pump (**1**) in the direction of the arrow until you obtain the correct belt tension.*
    2. Tighten the screws to ..... **21** ±2 **Nm** (15.5 ±1.5 lbf ft).

***NOTE!** The belt tension is correct when you can press them down **10 mm** (0.4") midway between the pulleys.



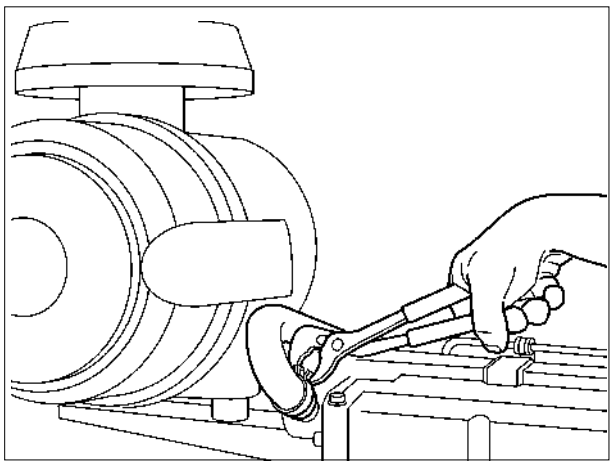
Check the belt tension, coolant/fuel pump

130. The belt is correctly tensioned when you can press it down **10 mm** (0.4") between the pulleys.



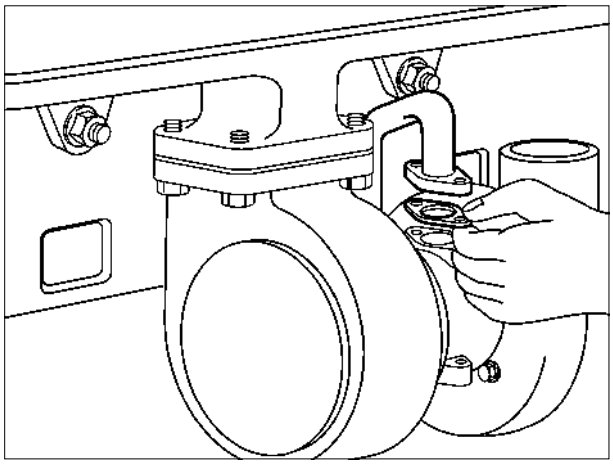
Engine mounting

131. Fit the engine mounting. Tighten to ..... **260 Nm** (192 lbf ft).

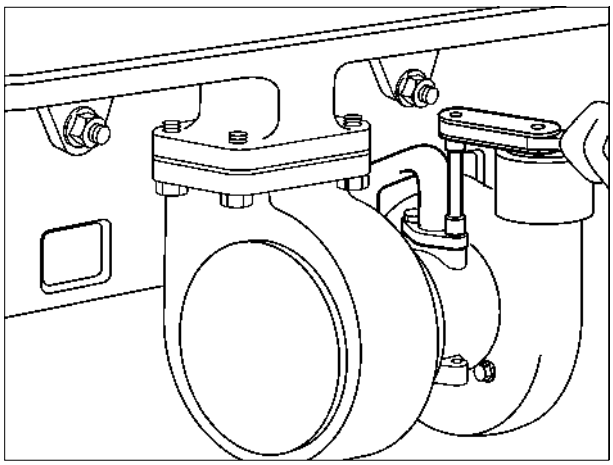


132. Re-install air filter bracket, air filter and crankcase ventilation hose.

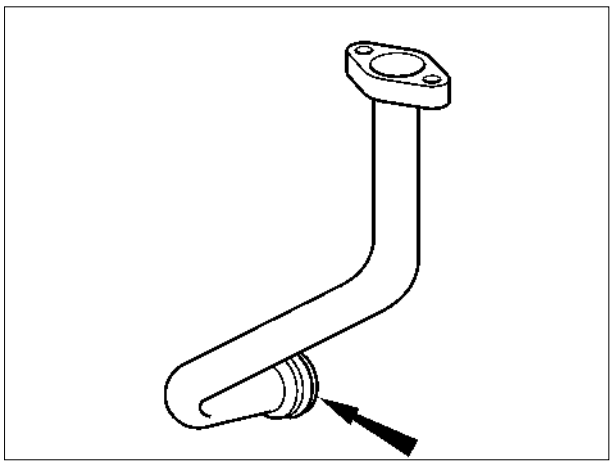
133. Remove the engine from the engine repair stand, then loosen the engine fixture.
134. Install the turbo.



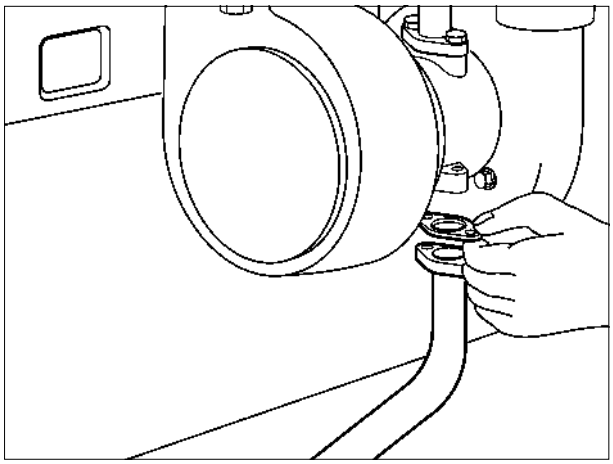
Oil pressure pipe/oil return pipe
135. Fit the oil pressure pipe with a **new** gasket



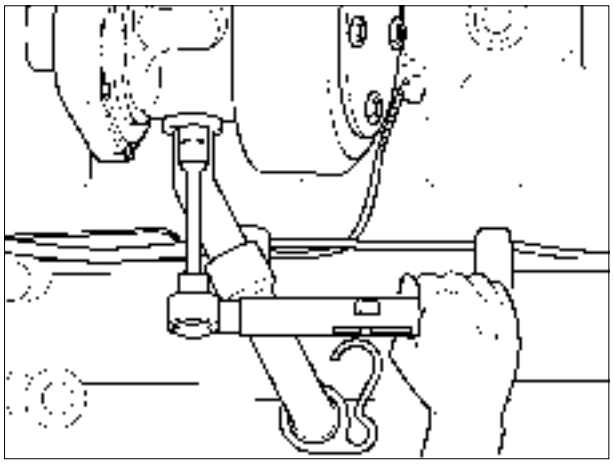
136. Tighten the screws to ..... **21** ±2 **Nm** 515.5 ±1.5 lbf ft).



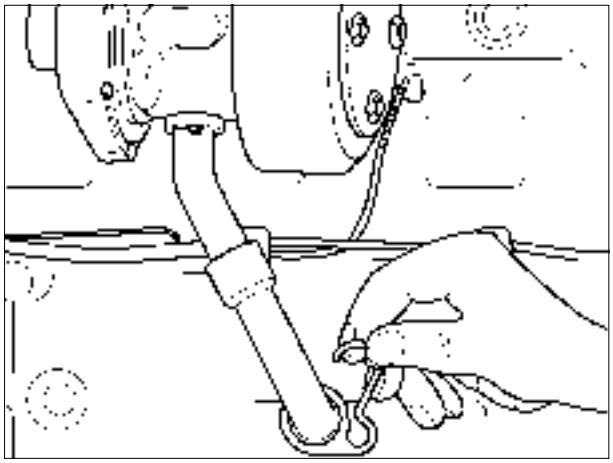
137. Fit a **new** O-ring to the return pipe. Oil lightly.



138. Fit the oil return pipe with a **new** gasket.



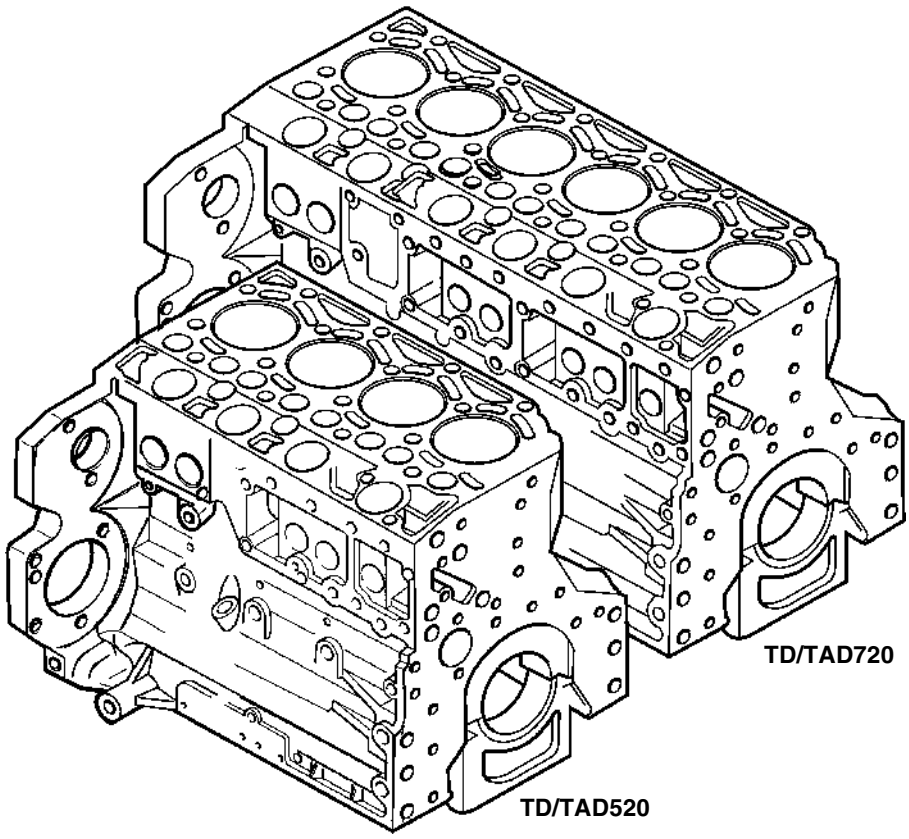
139. Tighten the screws to ..... **21** + 2 **Nm** (15.5 +1.5 lbf ft).



140. Fit the clamping yoke.

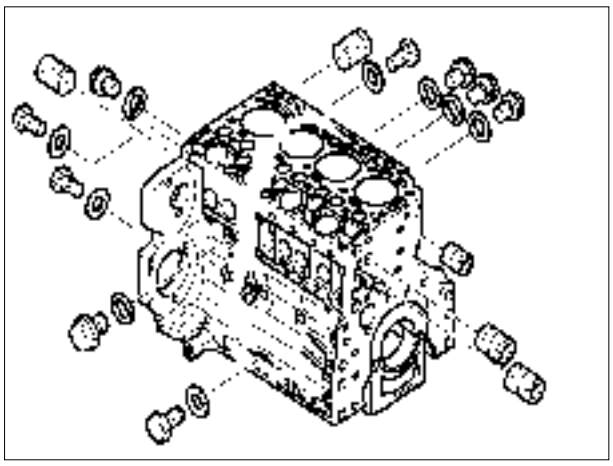
Checks and adjustments

Engine block

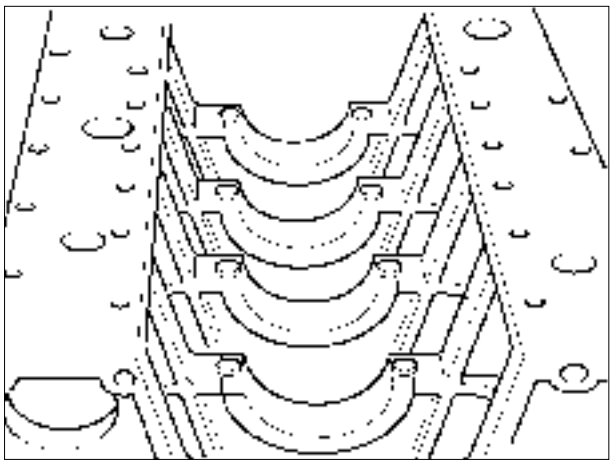


Special tools:

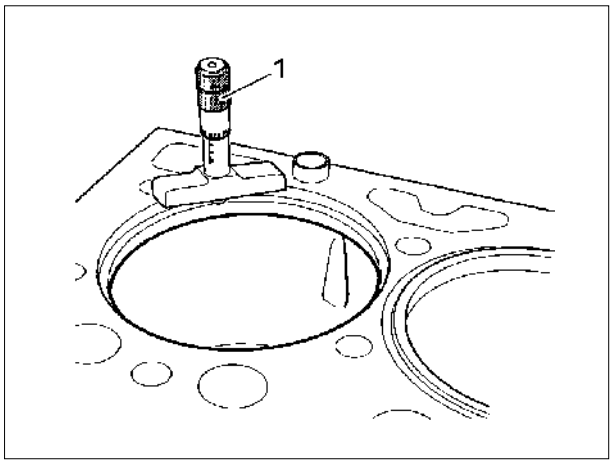
Cylinder liner extractor with support	999 6645, 999 6395
Fitting tool for camshaft bearings	999 8695
Fitting tool for control rod sleeves	999 8696
Cylinder extractor plate	999 8675
Standard shaft	999 2000



1. Remove the screw plugs. Check that the oil channels are free.

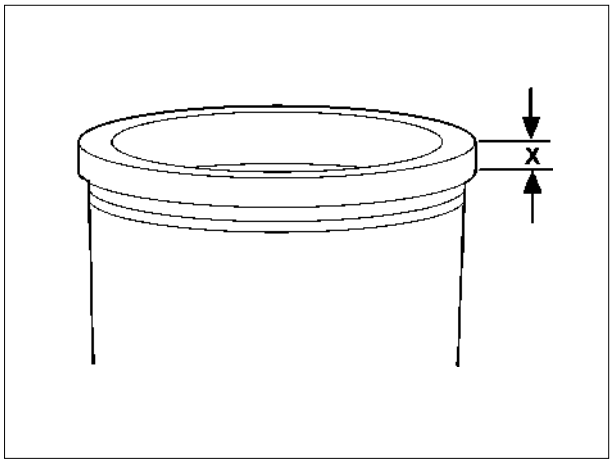


2. Clean the engine block and check that it has no damages.



3. Using a depth micrometer, measure the distance between the liner collar seat and sealing surface in the engine block. Measure in several places at each cylinder.
   Max. depth: ..... **8.92** $^{+0.03}_{0}$ **mm** (0.35$^{+0.002"}_{0}$)

NOTE! Liner collar height or collar seat depth can not be re-machined. Replace liner and engine block if required.



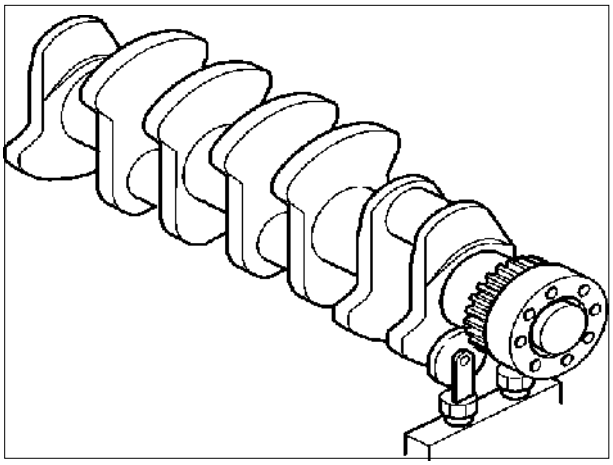
4. Inspect the liner collar and measure the height of the collar in several spots on the circumference.

NOTE! Min. collar height : ..... **9** $^{-0.02}$ **mm** (0.354$^{-0.001"}$)

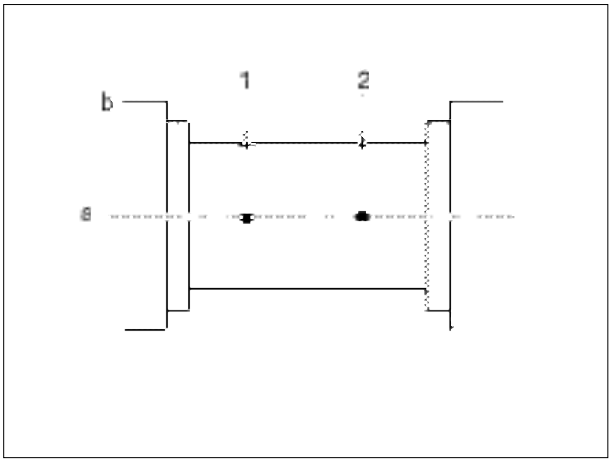
Crankshaft, measuring

Special tool:

Dial gauge 998 9876

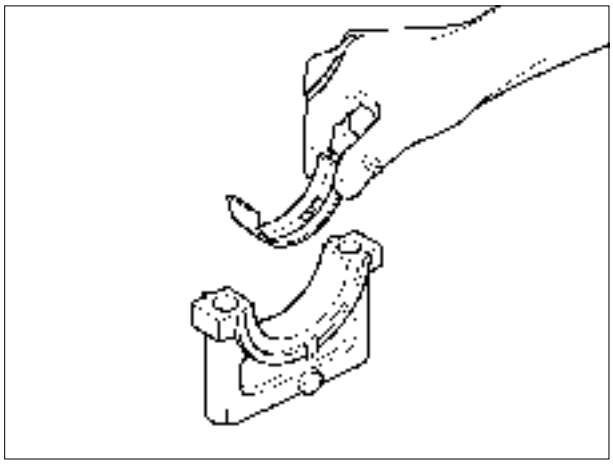


1. Place the crankshaft on the support stand.



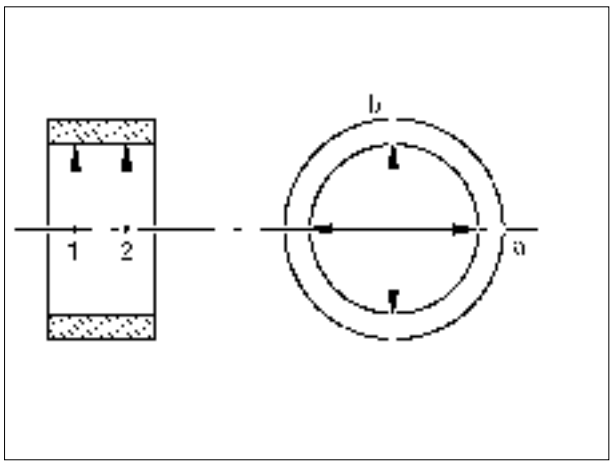
2. Procedure for measuring the main bearing journals at planes "**1**" and "**2**" in points "**a**" and "**b**".

   Bearing main diameter: ..... **85.00** $^{-0.02}$ **mm** (3.35" $^{-0.008}$")
   Undersize:
   0.25 mm ..... **84.75** $^{-0.02}$ **mm** (3.337 $^{-0.001}$")
   0.50 mm ..... **84.50**$^{-0.02}$**mm** (3.327$^{-0.001}$")
   Wear limit:
   Bearing journal oval: ..... **0.01 mm** (0.0004")
   Conicity: ..... **0.01 mm** (0.0004")



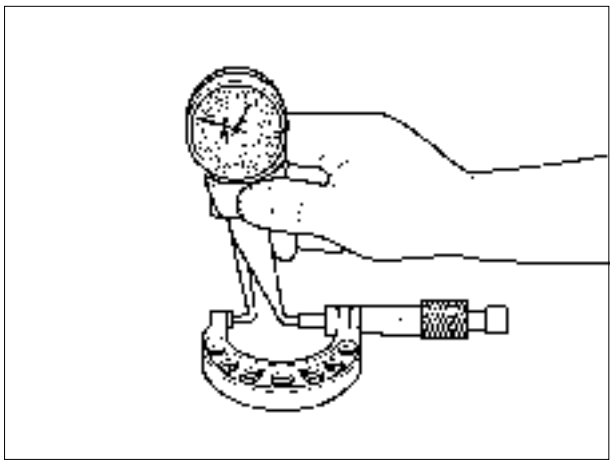
Main bearing caps

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



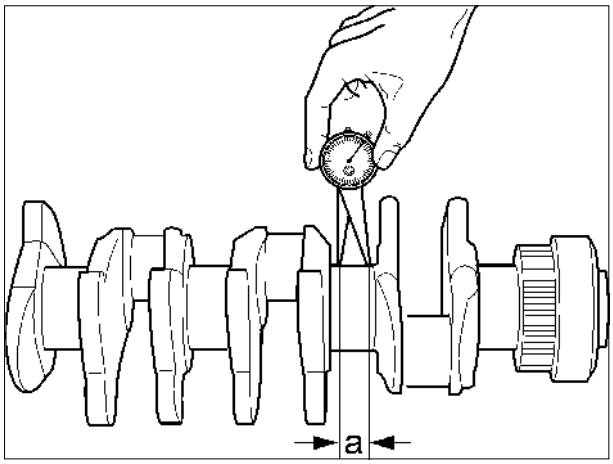
4. Measure the main bearing diameter at points "**1**" and "**2**" in planes "**a**" and "**b**".
   Inner diameter, Ø ..... **85,03**$^{+0.036}$ **mm** (3.347$^{+0.001}$")

   Oversize:
   0.25 mm ..... **84,78**$^{+0.036}$ **mm** (3.338$^{+0.001}$")
   0.50 mm ..... **84,53**$^{+0.036}$ **mm** (3.328$^{+0.001}$")



Crankshaft bearings

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

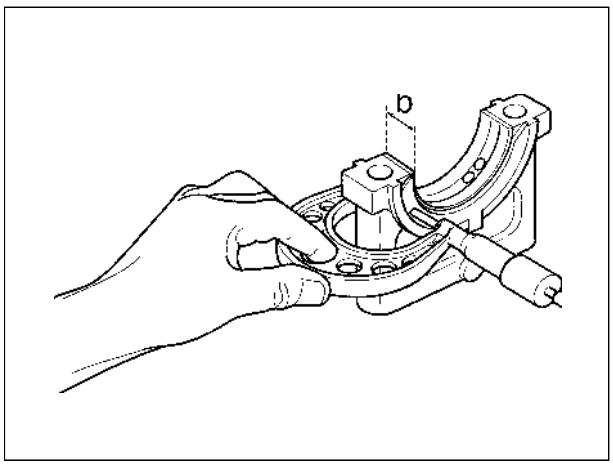


6. **NOTE!** Before working on the crankshaft, measure the width of the new crankshaft bearings, see step 8.

   Measure the width of the thrust bearing journal (use an internal dial gauge).

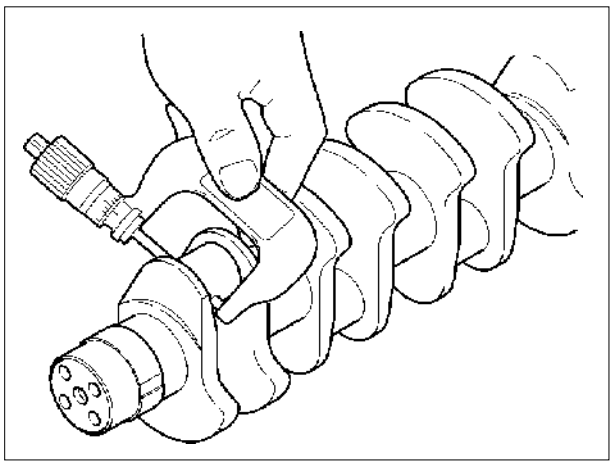
   Bearing journal width: ..... **38.00** $^{+0.06}$ **mm** (1.5" $^{+0.002}$")
   Oversize:
   0.40 mm ..... **38.40** $^{+0.06}$ **mm** (1.512$^{+0.002}$")

7. Measure the width of the crankshaft thrust bearing journal and note of measurement "**a**".
   Example:
   Measurement "**a**" = 38.02



8. Locate the half thrust bearings on the main bearing cap. Measure and note the width, measurement "**b**".
9. Determine the axial clearance.

   Example:
   Measurement "**a**" = **38.02 mm** (1.5")
   Measurement "**b**" = **37.90 mm** (1.49")
   "**a**" – "**b**" = axial clearance = **0.12 mm** (0.005")
   Permitted axial clearance = **0.10 - 0.30 mm** (0.004" - 0.018")

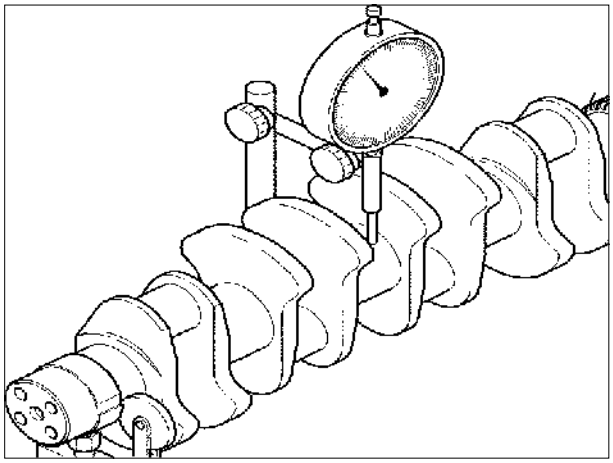


Crankshaft journals

10. Measure the big-end bearing journals.

    Crankshaft journal
    diameter: ..... **68.00 $^{-0.02}$ mm** (2.68 $^{-0.001}$")
    Undersize:
    0.25 mm ..... **67.75$^{-0.02}$ mm** (2.67$^{-0.001}$")
    0.50 mm ..... **67.50 $^{-0.02}$ mm**(2.66$^{-0.001}$")

    Wear limit:
    Crankshaft journal
    oval ..... **0.01 mm** (0.0004")
    Conicity ..... **0.01 mm** (0.0004")



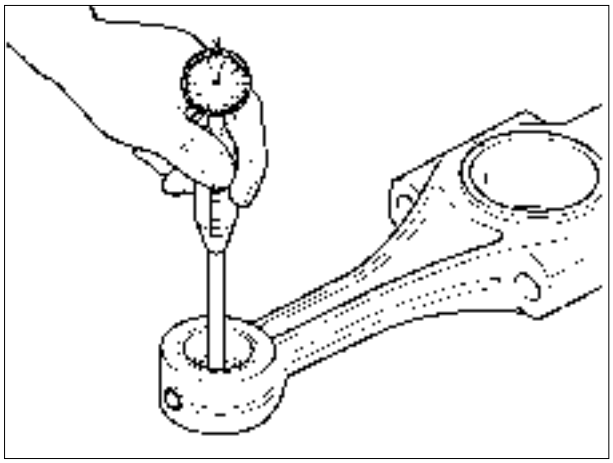
11. Check that the crankshaft runs evenly (use a dial gauge).

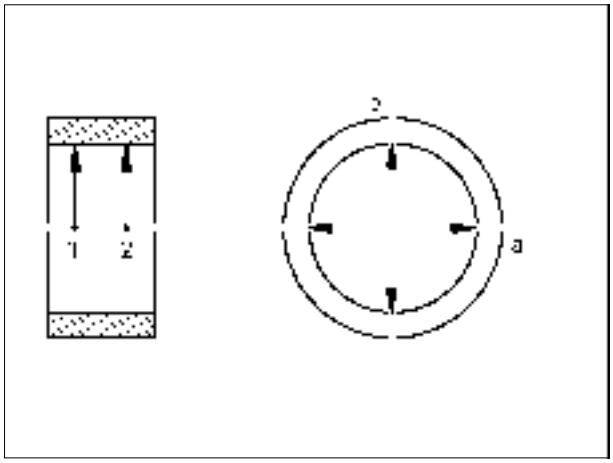
    Max. deviation:
    520: ..... **0.07 mm** (0.0027")
    720/721/722: ..... **0.10 mm** (0.0039")

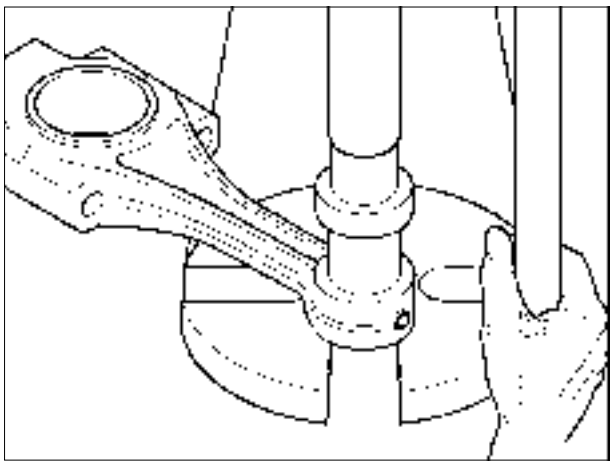
Connecting rods, measuring

Special tools:

Dial gauge 998 9876
Fitting tool crankshaft bushing 999 8692







Crankshaft bushing

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

2. Measure the bushing in the upper connecting rod end at planes "**1**" and "**2**" in points "**a**" and "**b**."

3. The bushing in the upper connecting rod end, pressed in

   Specified value: ..... **42.04** $^{+0.01}$ **mm** (1.65 ^{002}")

   Wear limit:
   Play for bushing in upper connecting rod end: ..... **42.12 mm** (1.66")

4. Change the bushing in the upper connecting rod end if necessary.

   Hole diameter for the bushing in the upper connecting rod end: ..... **45.50** $^{+0.02}$ **mm** (1.79 $^{+0.001}$")

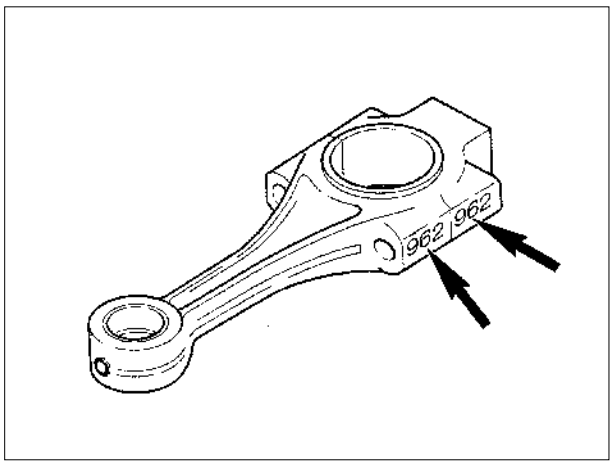
   Outside diameter for the bushing in the upper connecting rod end: ..... **45.50** $^{+0.04}$ **mm** (1.79 $^{+0.002}$")

5. Press the bushing into the upper connecting rod end so that it is level with the surface.

   Use tool: 999 8692.

NOTE! The lubricating oil holes in the bushing and the connecting rod must be aligned with one another.

6. After you have pressed the bushing in, ream it to the exact size: ..... **42.04** $^{+0.01}$ **mm** (1.65 $^{+0.0004}$")



Crankshaft journals

6. Check that the big-end bearing cap matches the connecting rod so that hte number markings are turned towards each other and are identical.

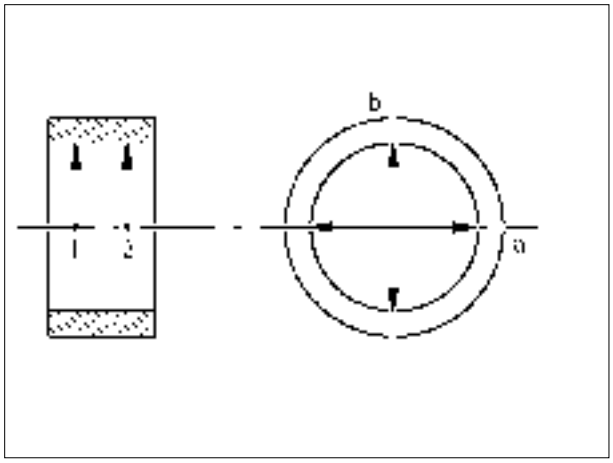
NOTE! Make sure the locating pegs are in place.

7. Fit the big-end bearing cap. Tighten the screws according to specification.

   Initial torque: **30 Nm** (22 lb ft)

NOTE! Only when measuring.

8. Set the dial gauge to ..... **72.5 mm** (2.85").



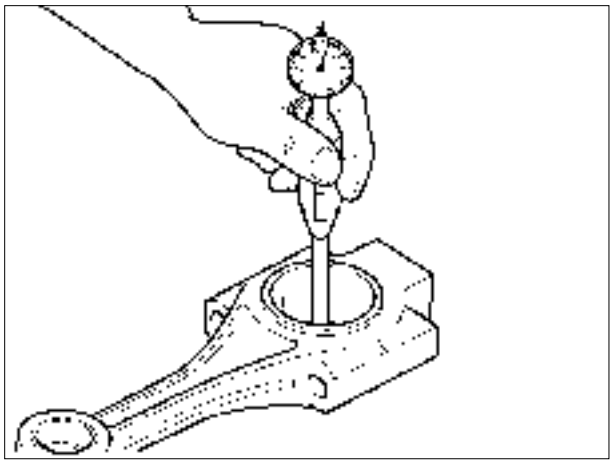
9. Procedure for measuring the big-end bearing diameter at planes "**1**" and "**2**" in points "**a**" and "**b**".

   Big-end bearing diameter: ..... **72.5** $^{+0.02}$ (2.854 $^{+0.002}$")

NOTE! If the measured values are just a little out, take additional measurements when new bearing shells have been fitted.

10. Remove the bearing cap and fit new bearing shells. Replace the bearing cap. Tighten the screws according to specification.

    Initial torque: ..... **30 Nm** (22 lb ft)



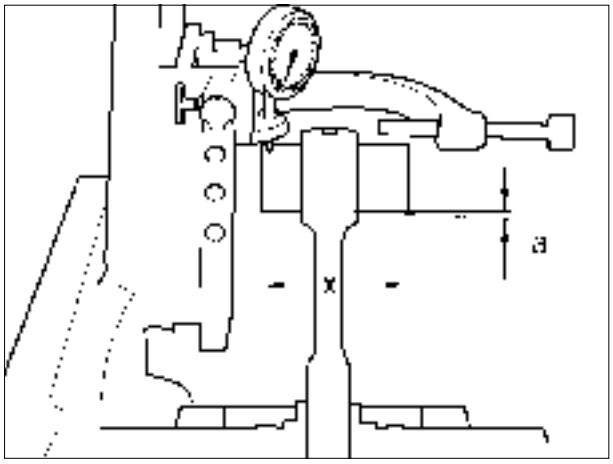
NOTE! Only when measuring.

11. Set the dial gauge. Measure the bearing shells at planes "**1**" and "**2**" in points "**a**" and "**b**".

    Big-end bearing shells
    Inside diameter: ..... **68.03**$^{+0.04}$ **mm** (2.68$^{+0.002}$")
    Oversize:
    0.25 mm ..... **67.78**$^{+0.04}$ **mm** (2.67$^{+0.002}$")
    0.50 mm ..... **67.53**$^{+0.04}$ **mm** (2.66$^{+0.002}$")

    Wear limit:
    Radial play for big-end bearings: ..... **0.12mm** (0.005")

NOTE! If the wear does not exceed the bearing tolerances by more than **0.015 mm** (0.0006"), you can still use the connecting rod. If the limit value is exceeded, change the connecting rod.

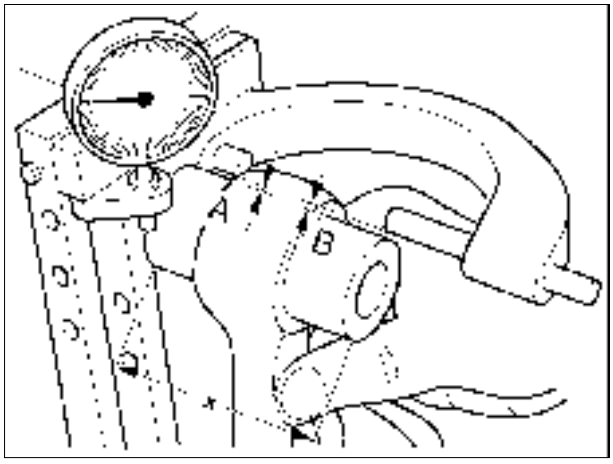


If there is any reason to suspect a bent or twisted connecting rod, they should be checked on the connecting rod tester.

NOTE! Check the connecting rods without bearing shells.

12. Use a gudgeon pin to measure the connecting rod for straightness.

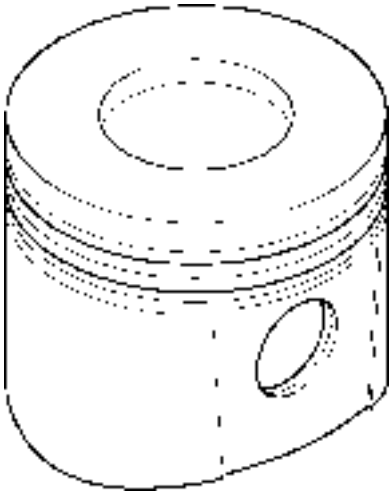
    Max. deviation a = **0.05 mm** (0.002") over a distance (x) of 100 mm (3.9").



13. Use a gudgeon pin to measure the connecting rod for torsion.

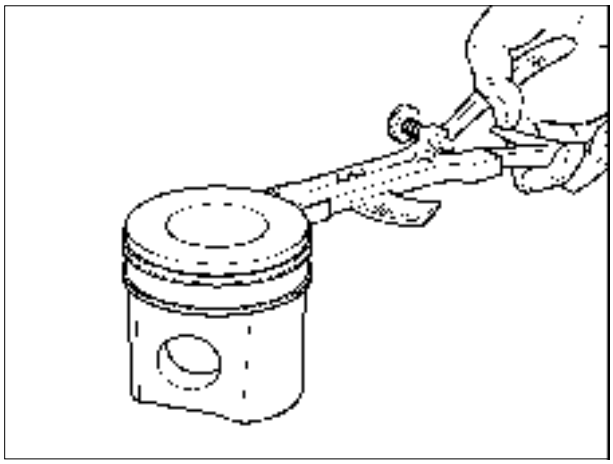
    Max. deviation a = **0.05 mm** (0.002") over a distance (x) of 100 mm (3.9").

Pistons



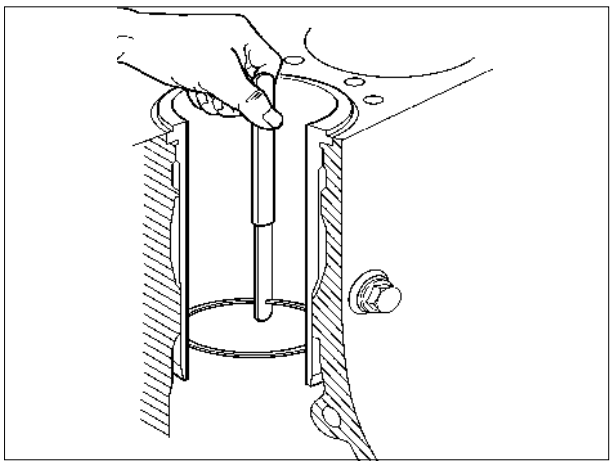
Special tool:

Piston ring pliers 998 5423



1. Remove the circlip. Remove the gudgeon pin.
2. Remove the piston rings using the piston ring pliers 998 5423.

NOTE! Clean and inspect piston and ring grooves.

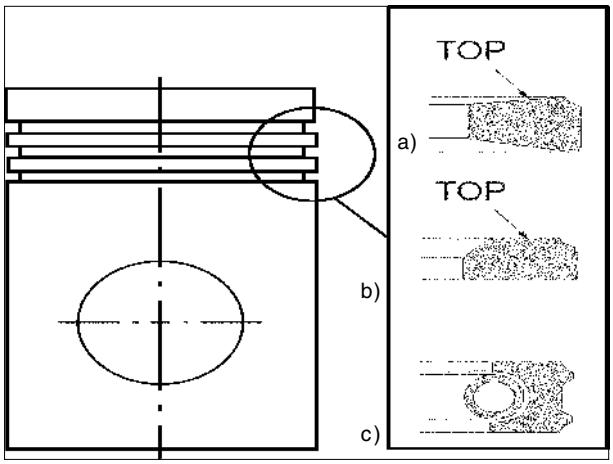


3. Check the piston ring gap (see diagram). When taking the measurement, use a piston to push the ring down **below** the lower dead center position. Measure the ring gap with a feeler gauge.

   Wear limits:

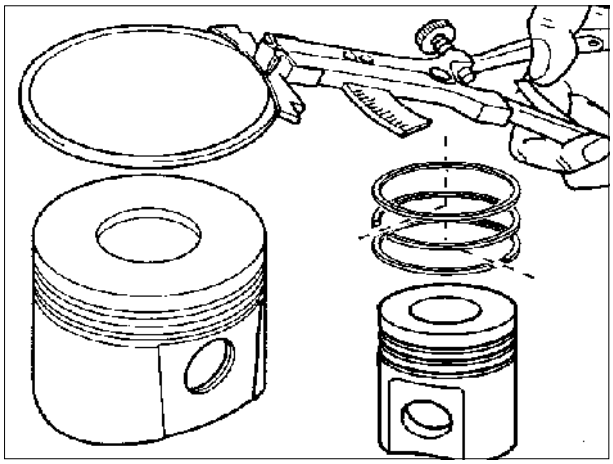
   1st ring gap **0.8 mm** (0.03")
   2nd ring gap **2.5 mm** (0.1")
   3rd ring gap **1.15 mm** (0.045")

4. Clean and check the piston and the piston's ring-shaped grooves.



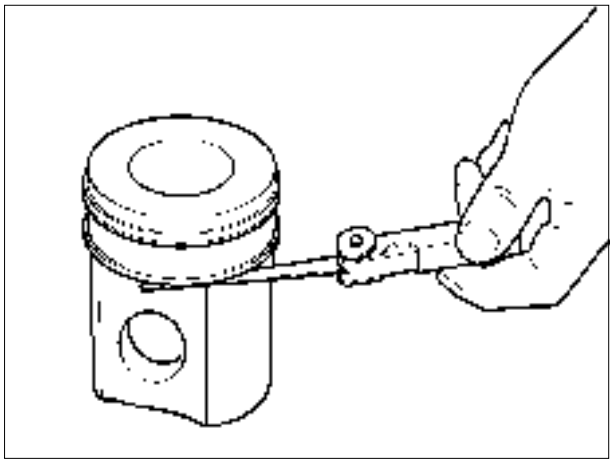
Order and positions for the piston rings:

5. Fit the oil control ring (**c**).
6. Fit the tapered compression ring (**b**) with text "Top" towards combustion chamber.
7. Fit the conical compression ring (**a**) with text "Top" towards combustion chamber.



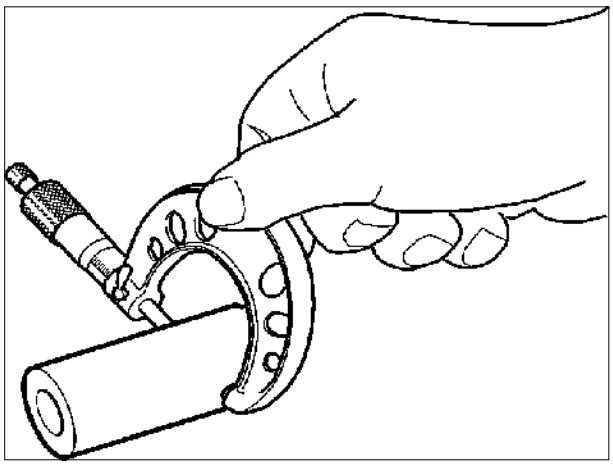
8. Fit the piston rings as the instructions in step 5 shows and then make sure that the ring gap is 120° between them.

NOTE! The joint of the inside spring of the oil control rings should be moved 180° in relation to the ring gap.



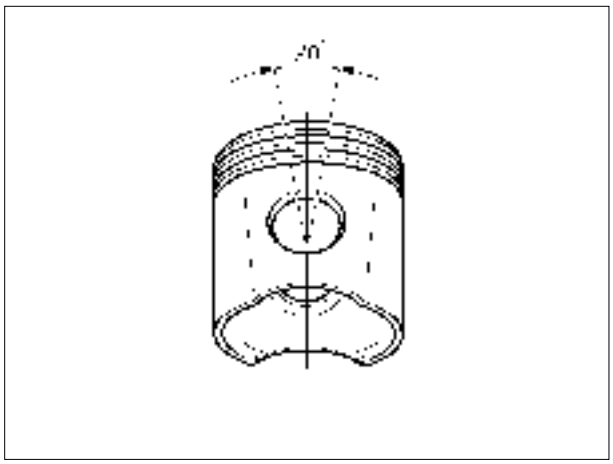
9. Measure the clearance of grooves with a feeler gauge.

   Wear limits:
   axial play 1st ring "keystone" ring (conical compression ring)
   axial play 2nd ring 0.17 mm (0.007")
   axial play 3rd ring 0.10 mm (0.004")



10. Check the gudgeon pin for wear.

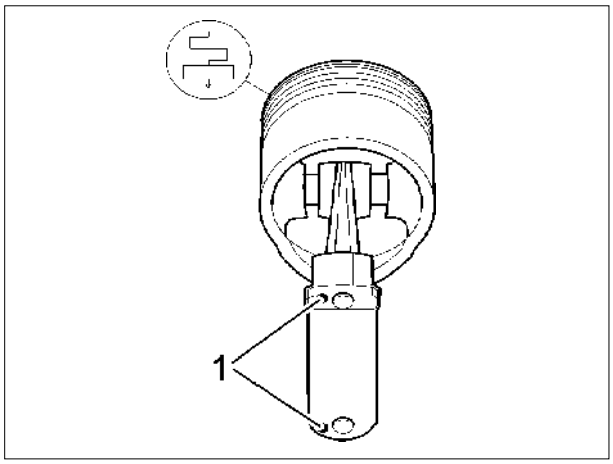
    Gudgeon pin
    diameter: ..... **42** $^{-0.006}$ **mm** (1.654 $^{-0.002"}$)



Joining the connecting rod and piston

NOTE! The gap in the ring must be facing the top of the piston.

11. Insert one of the circlips.



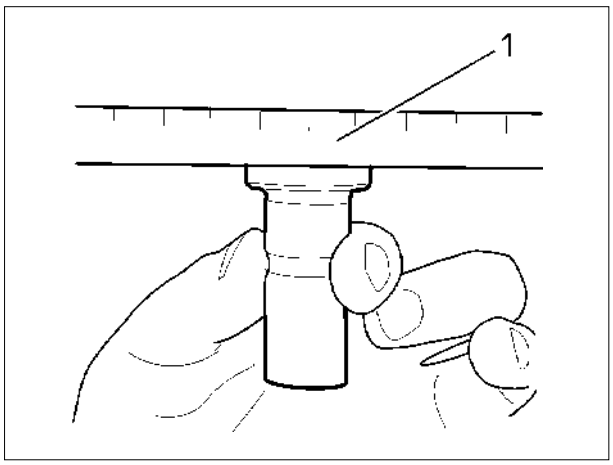
12. Put the piston onto the connecting rod. The flywheel symbol on the piston and the cylindrical pegs on the connecting rod (**1**) must be on the same side.
13. Insert the other circlip in the right position.

Camshaft

Special tools:

Dial gauge 998 9876

Fitting tool, camshaft bearings 999 8695



Camshaft and valve tappets, checking

Using a steel ruler (**1**), make sure that the contact surface between the valve tappets and the camshaft is convex or level. If the surface is concave, replace the valve tappets.
If the valve tappet is worn across the lifting surface, the tappet should be disposed of. ”The ditch” shows that the tappet has not rotated.

A dark stripe farthest out on the lifting surface, however, shows that the surface is not worn.
The condition of the valve tappets determines whether the camshaft should be checked for wear or not.

Make sure that the lifting surfaces on the camshaft and the valve tappets do not have great pitting damage. Pitting damage can appear for different reasons. The damage consists of small metal pieces being broken off the hardened surface. Tappets and camshaft with minor pitting damages can be used. Pitting damages are rarely worsened.

Make sure that the bearing race and cam curves of the camshaft are not abnormally worn. For example the camshaft lifters may be obliquely worn axially. This can, in mild cases, be adjusted by honing.

If there are greater damages and wear, replace the camshaft.

NOTE! If the camshaft is replaced, all valve tappets must also be replaced.

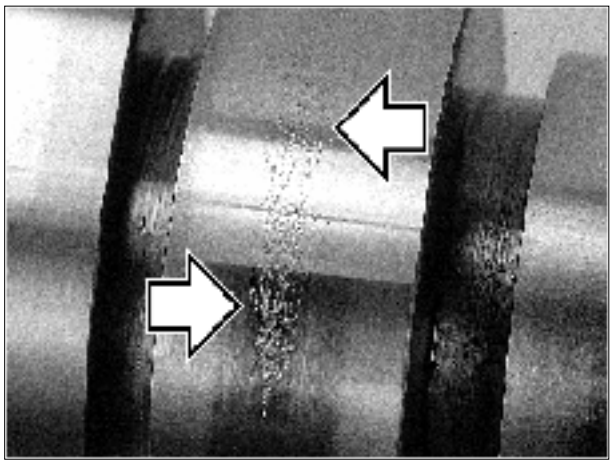
Guiding principles for replacement

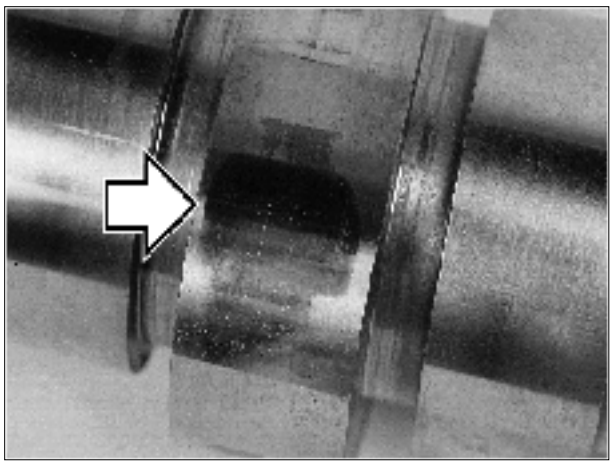
Under normal circumstances there may be unevennesses on the surface of the camshaft ridges. This means that the camshaft must be replaced. These markings have no negative effect neither on the engine prestanda nor on the strength of the engine or its components.

Below, you can see examples of acceptable wear and unacceptable wear.

Acceptable wear

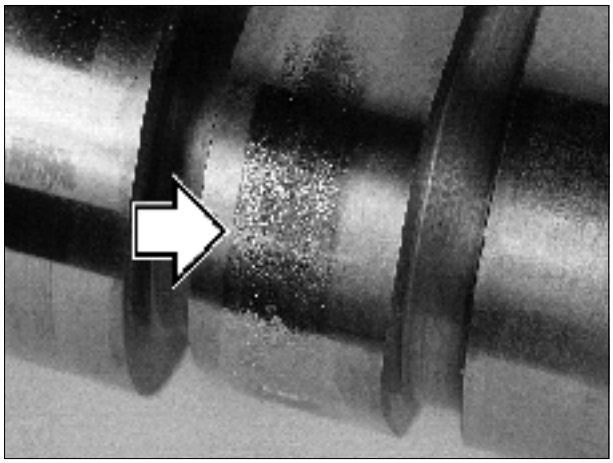
The camshaft does not need to be replaced.

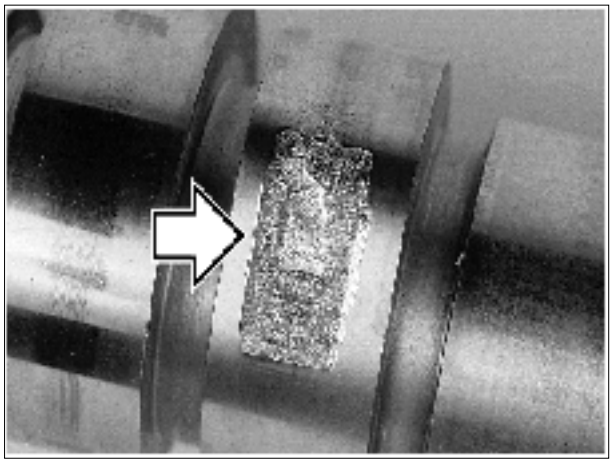




Unacceptable wear

NOTE! The camshaft and its belonging rocker arms must be replaced.



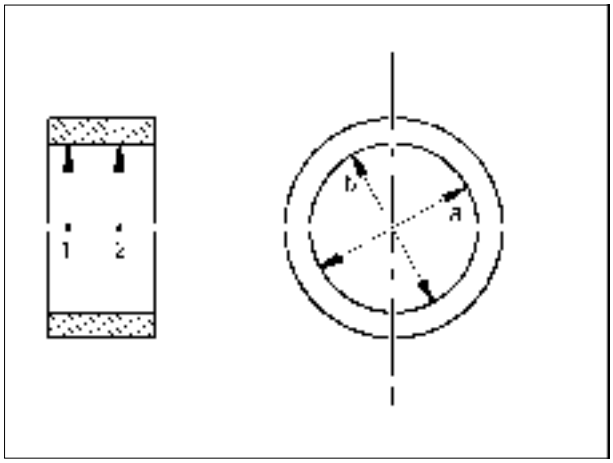


Camshaft bearings

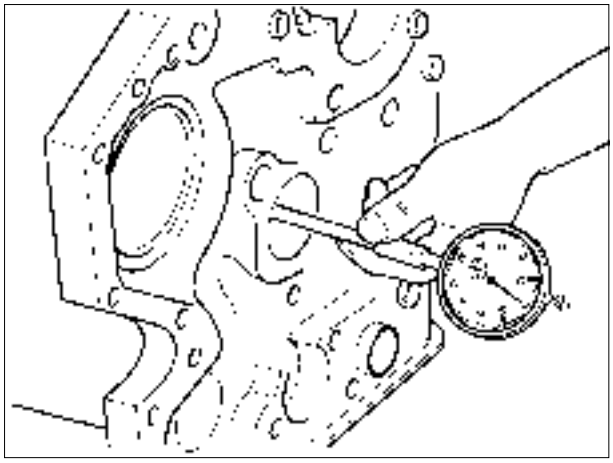
Special tools:

Dial gauge 998 9876

Fitting tool, camshaft bearings 999 8695

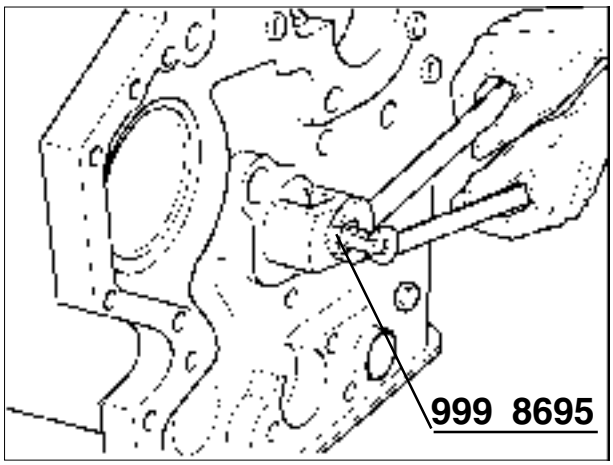


1. Set the internal dial gauge to **65 mm** (2.56").
2. Procedure for measuring the bushes at planes **1** and **2** in points "**a**" and "**b**" (see figure).



3. Measure the bushes, replace if necessary.

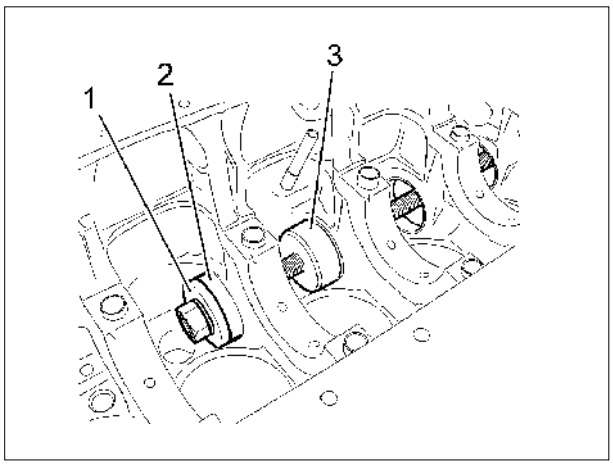
   Inside diameter: ..... **65.00** $^{+0.054}$ **mm** (2.56 $^{+0.002}$")
   Wear limit: ..... **65.08 mm** (2.562")



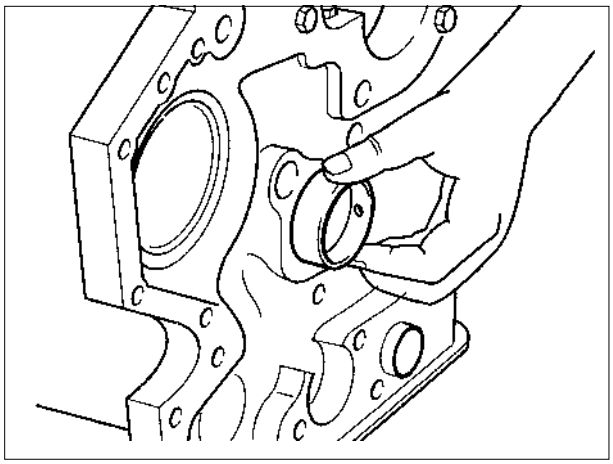
Bearings, replacing

4. Remove the bearings. They can be removed in both directions.

   Use tool 999 8695.

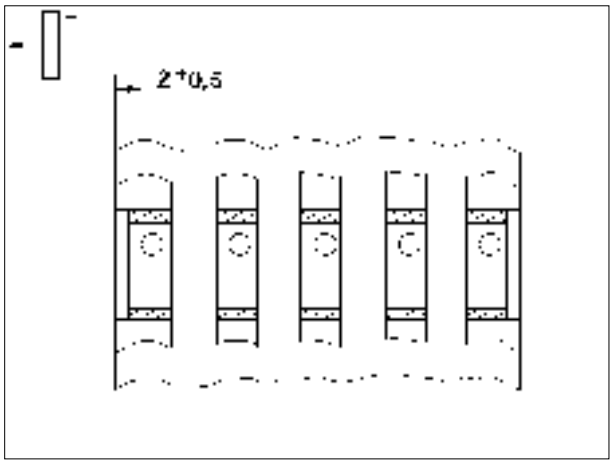


1) Styrhylsa
2) Lagerbussning
3) Presshylsa

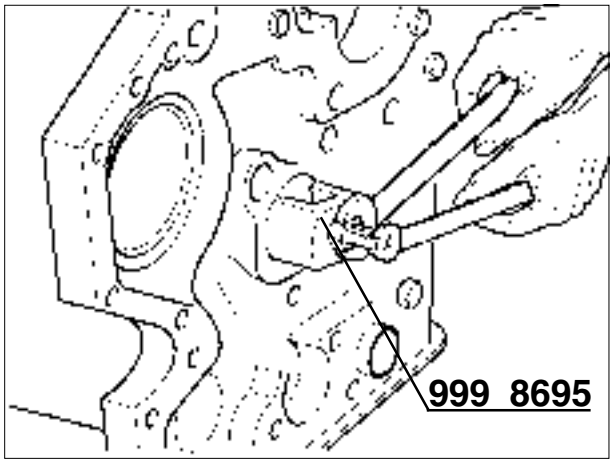


5. Position the new bearing.

NOTE! The widest bearing, 27 mm (1.06”), should be palced at the flywheel end.



NOTE! The lubrication holes must fit the oil duct in the bearing positions.

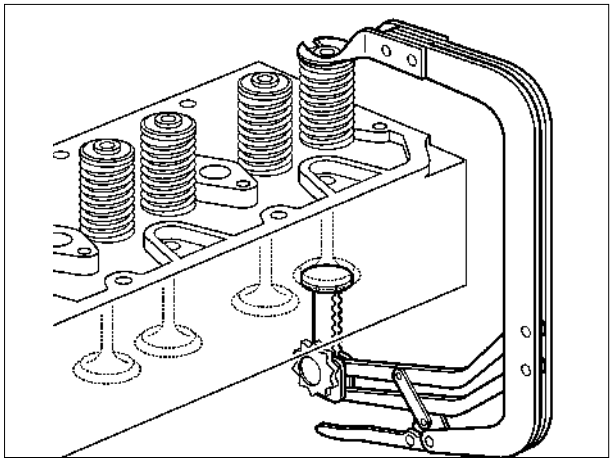


6. Fit the bearings.
   Use tool 999 8695.

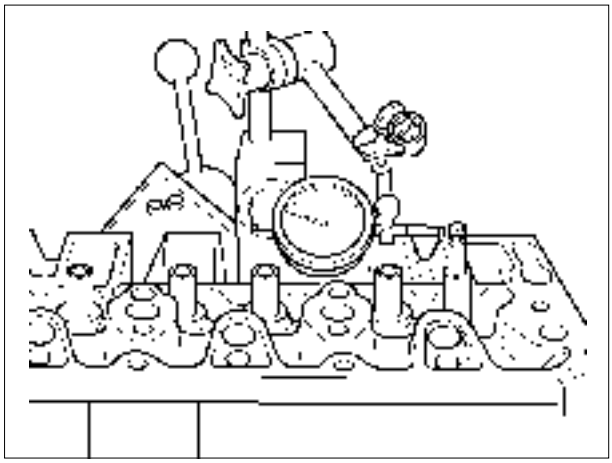
Cylinder head

Special tool:

Valve spring compressor 998 5468



1. Put the cylinder head in a vice.
2. Remove valve retainers, valve discs, valve springs and valves, using valve spring compressor 998 5468.



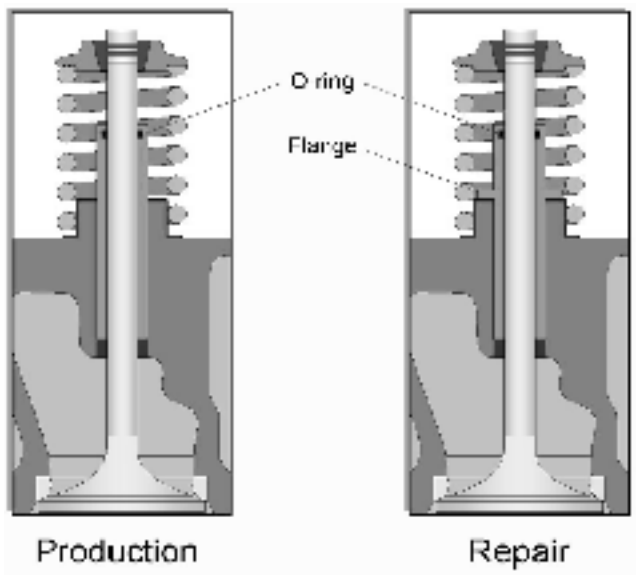
3. Remove the valve stem seals.
4. Clean the cylinder head and check it to ensure there is no damage.
5. Move the valve down a bit so that it is not positioned in the seat.
6. Measure the valve stem clearance in the valve guide.

   Wear limits:
   Inlet valve: ..... **0.10 mm** (0.004")
   Exhaust valve: ..... **0.13 mm** (0.005")

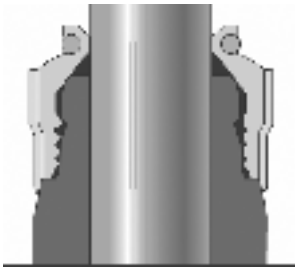
NOTE! Measured with a new valve. Replace valve guide if worn. The valve guides are different as a spare part, compared to the production part. See fig.

Design 1
without flange

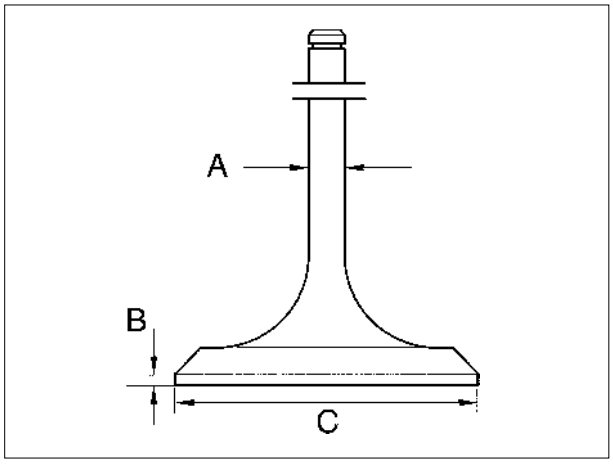
Design 1
with flange

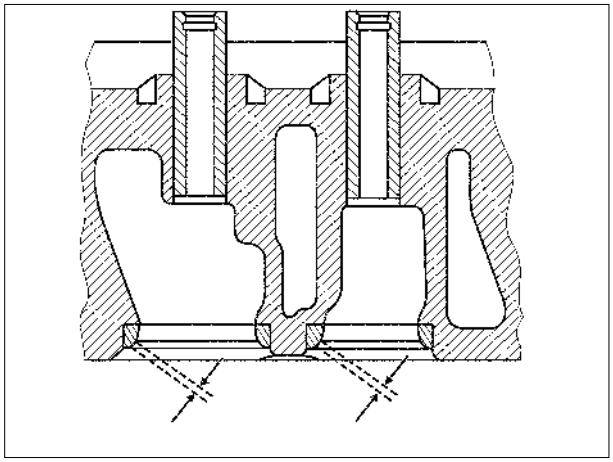


Design 2



On later designs, the o-ring is exchanged for a valve rod seal, according to the picture for design 2.





7. Check and measure the valves.

A. – Valve stem diameter: standard

Inlet valve: ..... **8.98** $^{-0.015}$ **mm** (0.03535"-0.0006")

Exhaust valve: ..... **8.96** $^{-0.015}$ **mm** (0.3528"-0.0006")

B. – Valve edge thickness

Wear limits:
Inlet valve: ..... **2.1 mm** (0.08")
Exhaust valve: ..... **1.8 mm** (0.07")

C. – Valve head diameter:

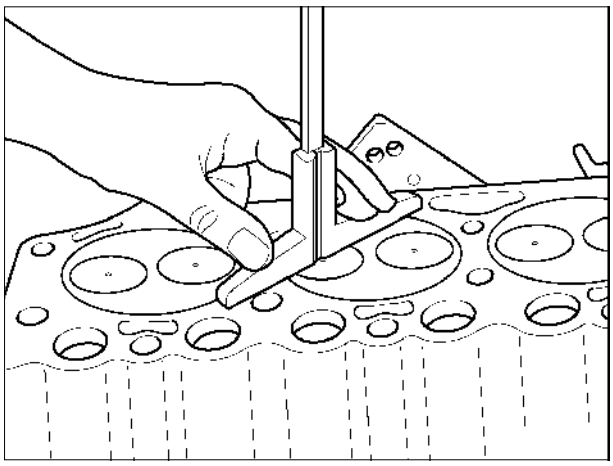
Inlet valve: ..... **48.0** ±0.1 **mm** (1.89 ±0.004")

Exhaust valve: ..... **42.0** ±0.1 **mm** (1.65 ±0.004")

8. Check the valve seats rings and wear limits.

Wear limit for valve seat width.
Inlet valve: ..... **2.8 mm** (0.11")

Exhaust valve: ..... **2.2 mm** (0.09")



9. Measure the distance between the center of the valve head and the cylinder head mating surface.

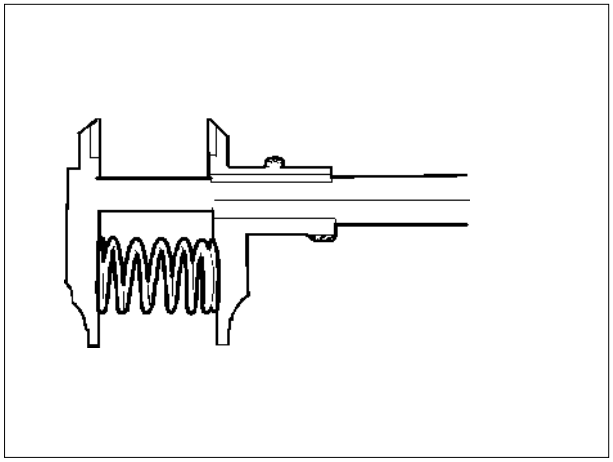
   Depth of valve in cylinder head:

   Measurement between valve disc and cylinder head face**:**
   Inlet/Exhaust ..... Max **1.5 mm** (0.06")

10. Measure the length of the valve spring using a sliding caliper and with the spring unloaded.

    Unloaded length, standard

    64.70 ±1.3 **mm** (2.55" ±0.05")



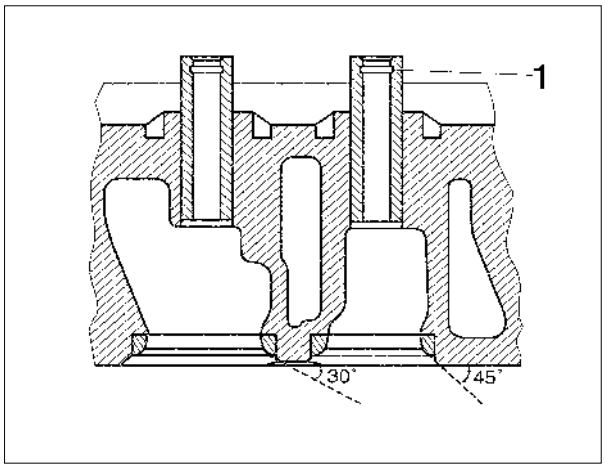
11. Use the grinding tool to grind the valves into their seats and correct the seat angle.

Valve seat angle	Inlet	Exhaust
	30°	**45°**

Valve seat width, maximum

Inlet	Exhaust
2.8 mm (011")	**2.2 mm** (0.09")

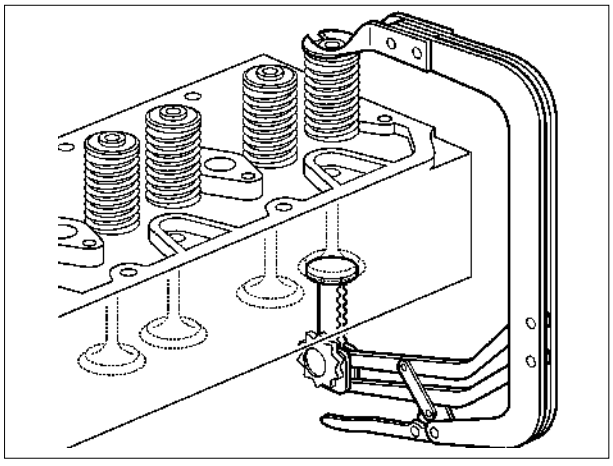
NOTE! Measure the depth of the valve in the cylinder-head again after you have ground in the valves.



12. Insert the valve steam seal (**1**)

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

    NOTE! Oil the stems of the inlet and exhaust valves. Push the valves in gently, with a slight twisting motion. The o-ring (**1**) is very thin and can easily be damaged.

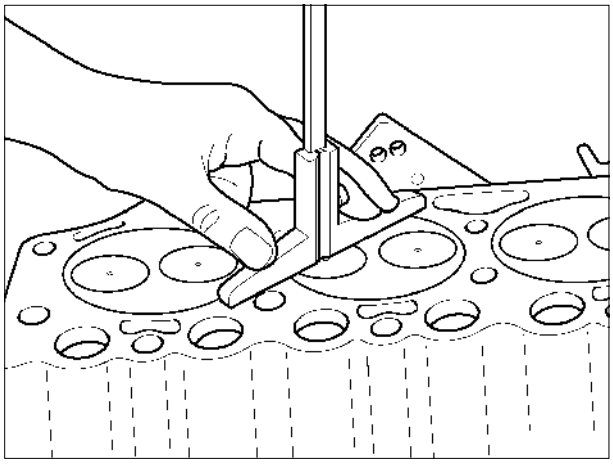


14. Use valve spring compressor 998 5468 for the valve springs. Insert the valve retainers.

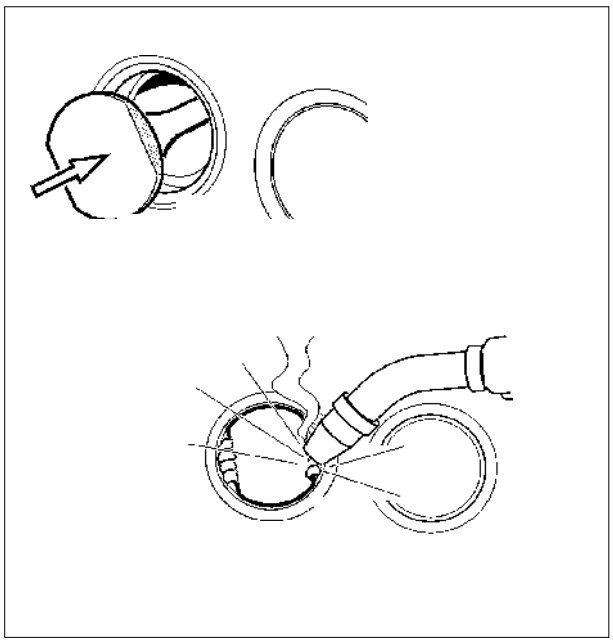
Valve seat, changing

(21405, 21406)

Cylinder head removed



1. The valve seats shall be changed when the measurement between the valve disc and cylinder head face exceeds the value given in the specification or when the tightness is not satisfactory. Max. 1.5 mm.

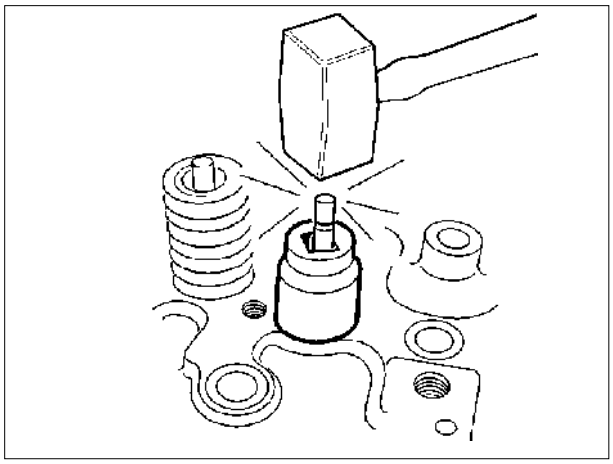


2. Cut off the face of an old valve and weld it to the valve disc. Use a MAG-weld or alternatively a conventional arc welder (with a stainless welding electrode).

⚠ **IMPORTANT!** Carefully cover other surfaces on the cylinder head so that possible welding sparks can not stick.

3. Place a suitable socket over the valve/valve guide and **carefully** knock out the valve seat.

NOTE! Be careful so that the cylinder head is not damaged.

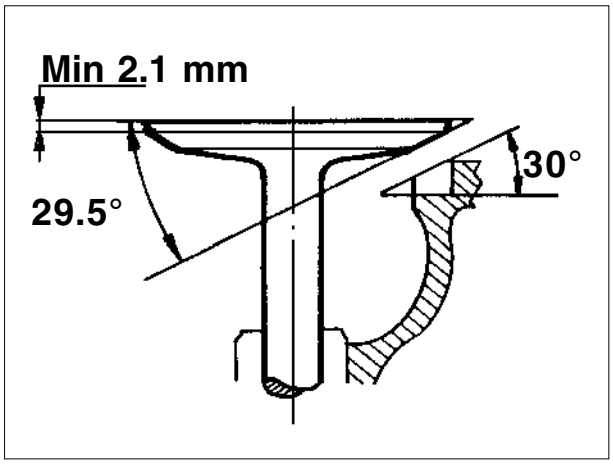


4. Clean the location of the seat carefully and check the cylinder head for cracks.
5. Measure the diameter of the valve seat location. Check whether a seat of standard size or an oversize seat should be used. Perform possible work to the location of the valve seat, see “Technical Data”.
6. Cool the seat, using carbon dioxide snow, to between -60°C (-76°F) and -70°C (-94°F) and heat the cylinder head, for example by running hot water over it.
   Using a drift, press in the valve seat.

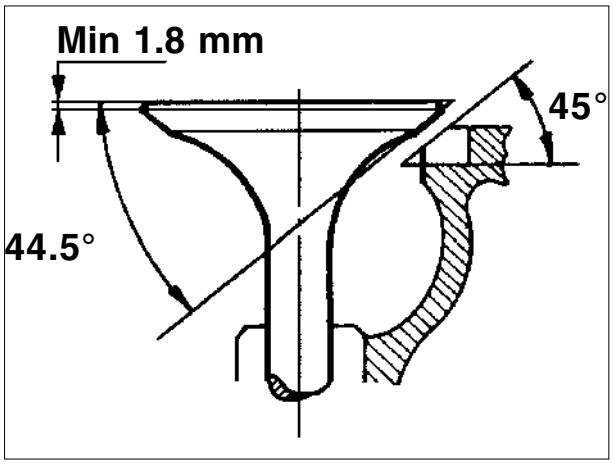
NOTE! Turn the seat so thet the seat angle faces the tool.

Valve seat, grinding

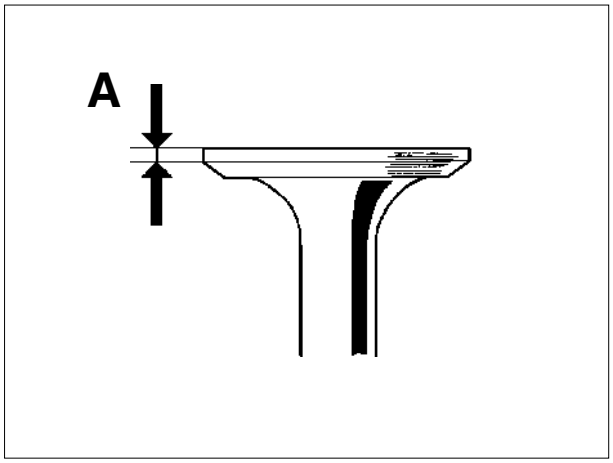
(21405, 21406)



Inlet valve



Exhaust valve



NOTE! As a spare part the valve seats are finish-machined and should not need further grinding.

1. Before grinding the valve seats, the valve guides should be checked and repalced, if the permissible variation of wear is exceeded.

2. When grinding the valve seats, make sure that not too much material is removed; only so much material that the valve seat gets the right shape and that the valve disc gets a good contact surface.

3. The valve seat is grinded down so that the measurement between the cylinder head face and the valve disc is according to specification.

4. The valve seat angle is checked, using a valve seat gauge, when the seat surface has been coated with a thin layer of indelible ink.

Valves, grinding

(21401, 21402)

For valve tightening angles, see “Technical data”.

NOTE! As a spare part the valves are finish-machined and should not need further grinding.

1. The faying surface should be grinded as little as possible, however so much that all the damages are removed.
2. Check the measuremant (**A**) on the edge of the valve disc. If the measurement is smaller than the permissible variation of wear, according to the specification, the valve should be replaced. See ”Technical Data”.

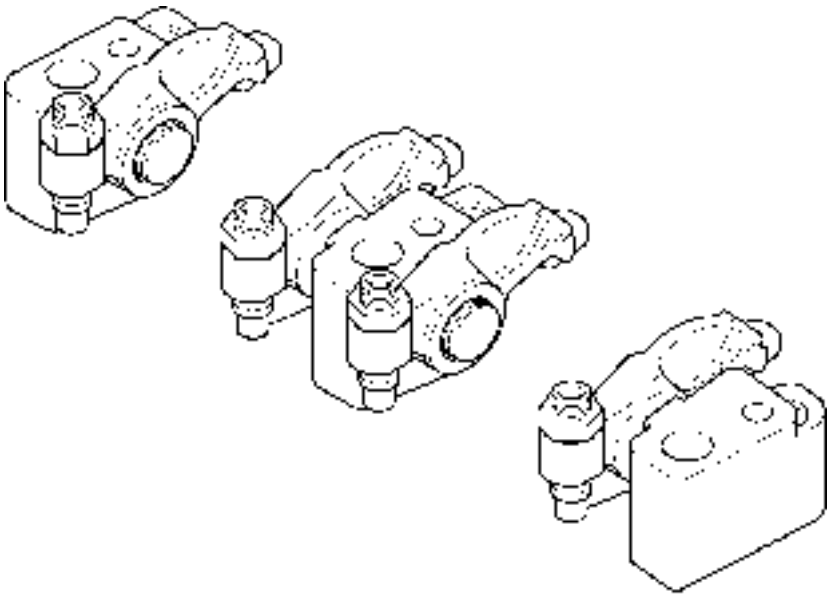
Always replace a valve with a crooked valve spindle.

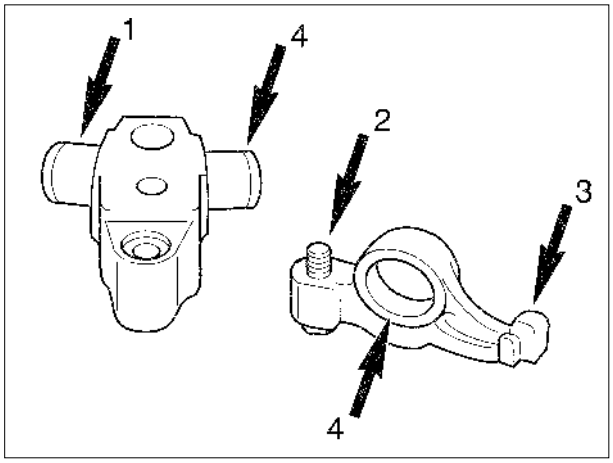
3. Check the tightness of the valves, using indelible ink.

   If there’s a leakage, yet another grinding of the valve seat is done, however not on the valve. After this, yet another check is performed. When the grinding result is satisfactory, the valve and seat kan be “lapped” together, using a fine grinding paste.

Rocker arm bracket

(21451, 21452)



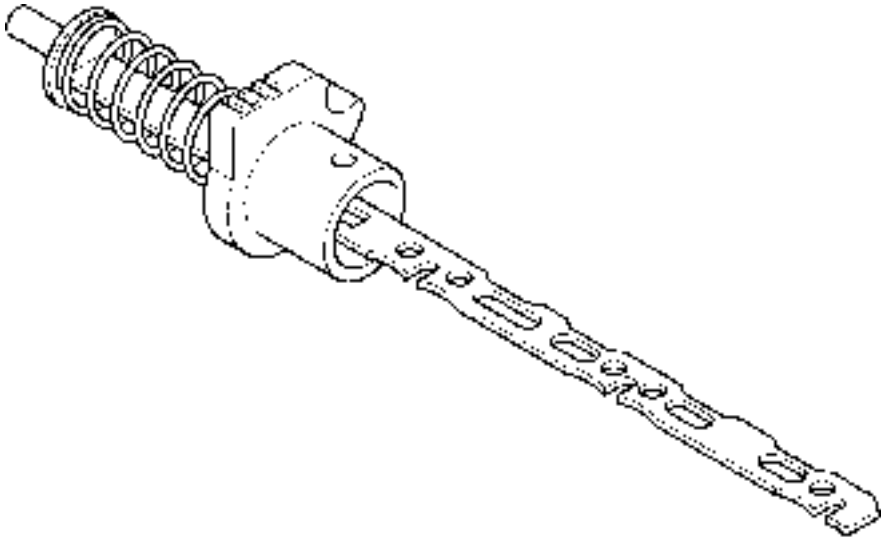


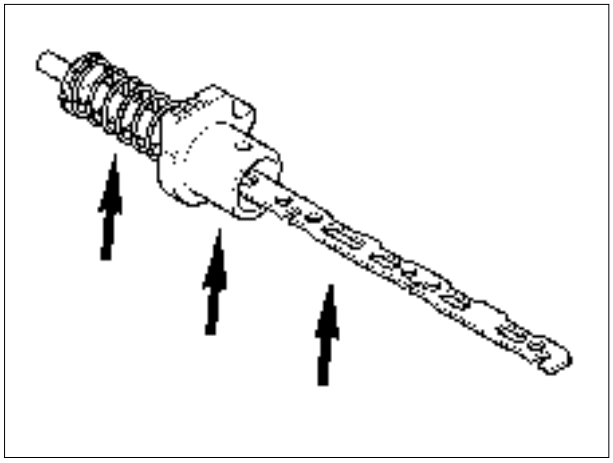
Rocker arm bracket, disassembly/checking/ assembly

1. Disassemble the rocker arm and rocker arm bracket.
2. Check for wear.
   (**1**) Shaft pivots
   (**2**) Adjusting screw
   (**3**) Rocker arm contact surfaces
   (**4**) Diameter

   Replace if the wear is abnormal.
3. Check that the oilways are clear.
4. Assemble the rocker arm and rocker arm bracket. Fit the circlips.

Control rod



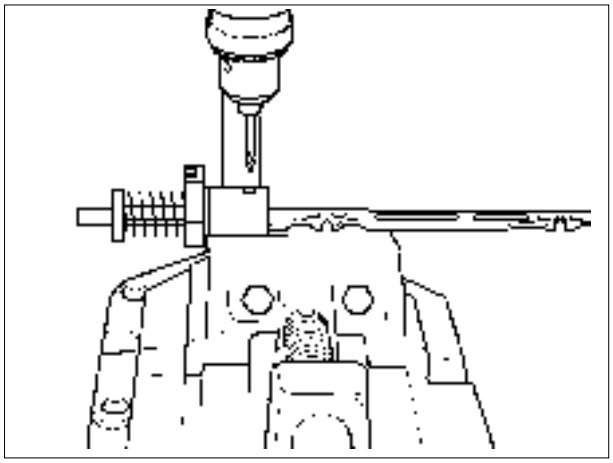


Check the control rod

1. Check the control rod and replace any damaged parts.

NOTE! The governor must always be re-set when you have changed the control rod. A trained specialist should perform the setting, on a governor test bench.

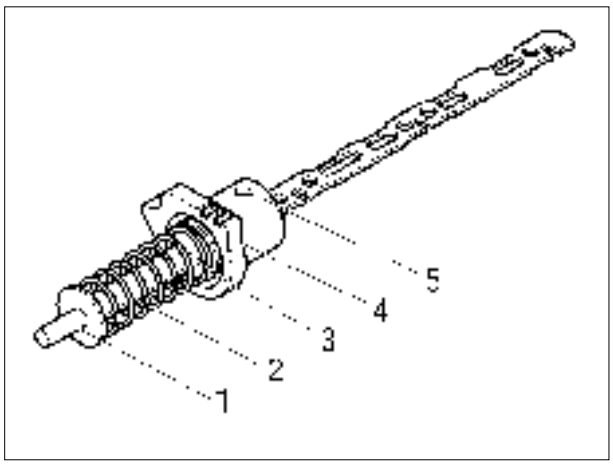
NOTE! With an electronic governor, the new x-measurement must be entered into the trigger unit.



Dismantling

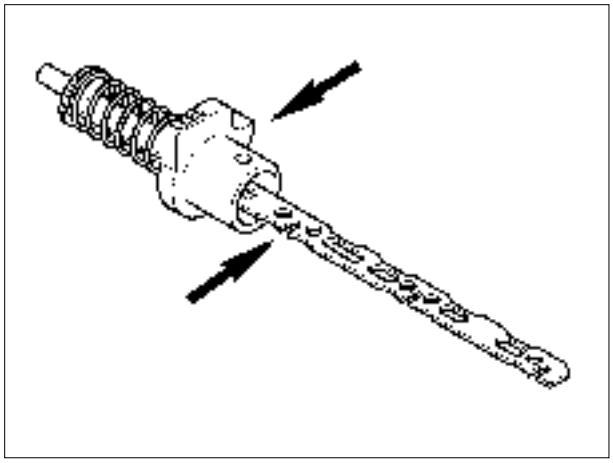
2. Drill out the tension pin on the guide sleeve and remove it.

NOTE! Always renew the guide sleeve and the tension pin when you dismantle the control rod.

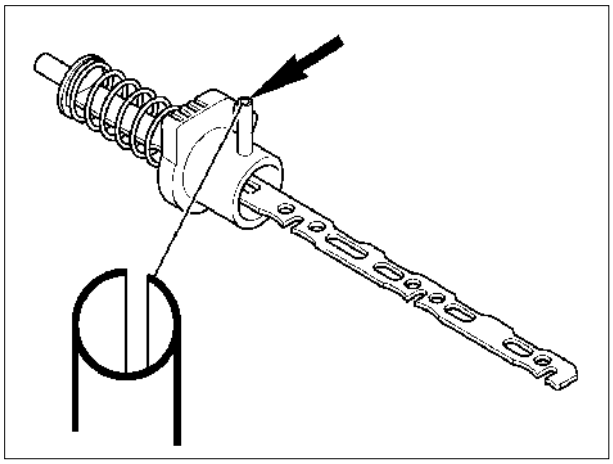


3. **Assembly sequence:**

   1. Control rod
   2. Compression spring
   3. Washer
   4. Guide sleeve
   5. Tension pin

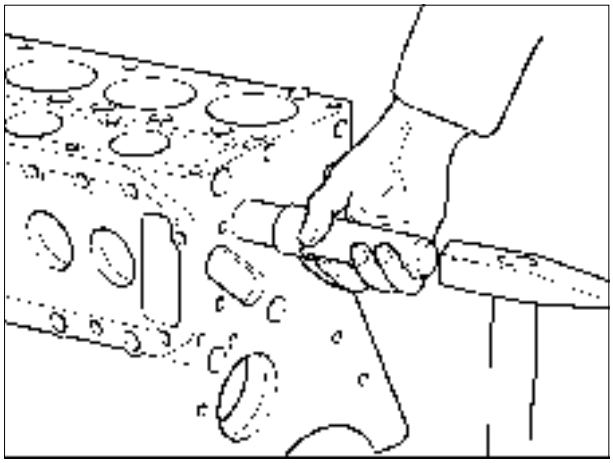


4. Pay attention to the alignment of the control rod in relation to the guide sleeve.



5. Insert the tension pin according to fig.
6. Press the tension pin in as far as it will go.

Control rod guide sleeves

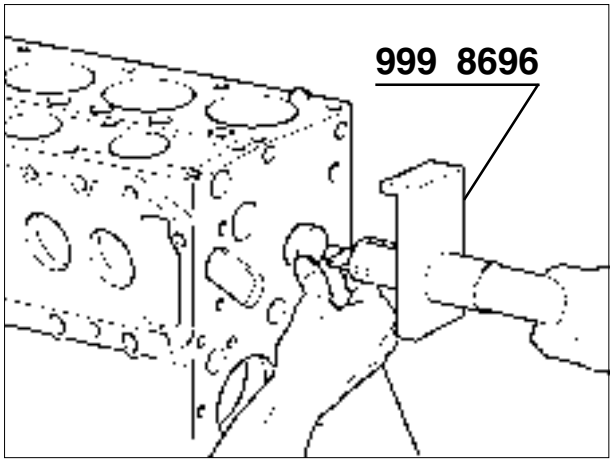


Special tools:

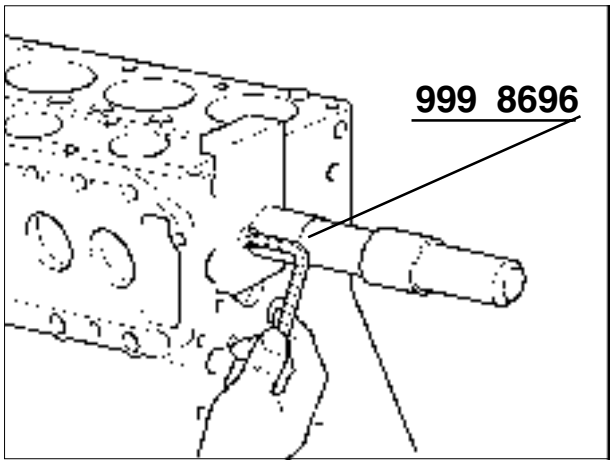
Fitting tool, control rod sleeves 999 8696

Standard shaft, drifts 999 2000

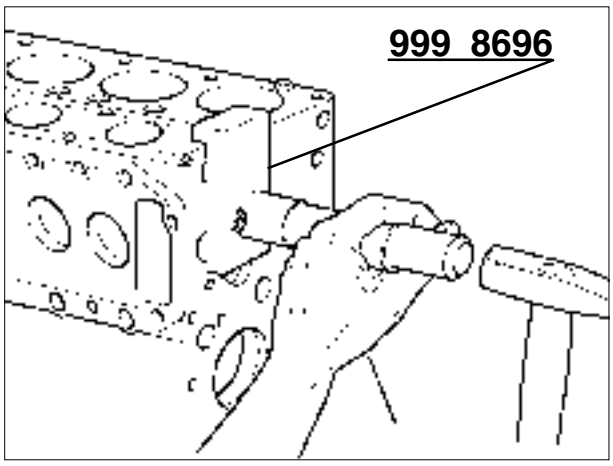
1. For engines 520/720/721/722, remove the plug, then drive out the guide sleeve at the front end. On engines 720/721/722 also drive out the guide sleeve at the flywheel end.



2. Position the guide sleeve on the drift with the chamfer towards the crankcase.



3. Put the fitting tool 999 8696 and the drift against the engine block and lock it in place with a screw.



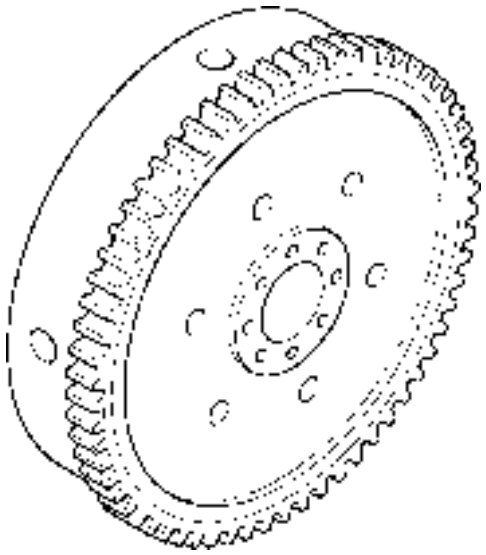
4. Drive in the guide sleeve until the drift 999 8696 bottoms in the socket.

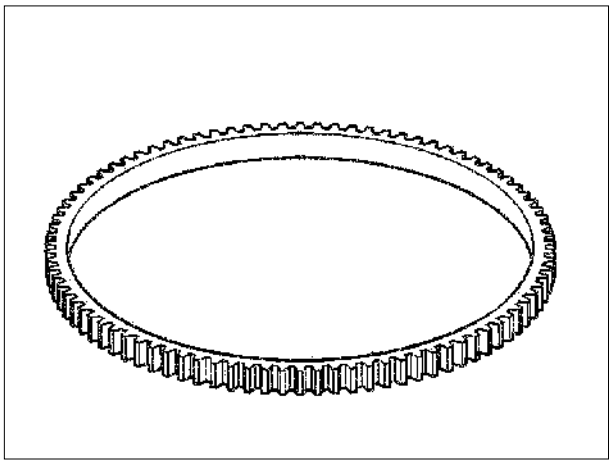
5. For engines 720, 721, 722, drive in guide sleeve from flywheel end. Repeat the procedure as above. Use the longer drift.

Repairing components

Group 21 Engine

Flywheel ring gear, changing
(21687)



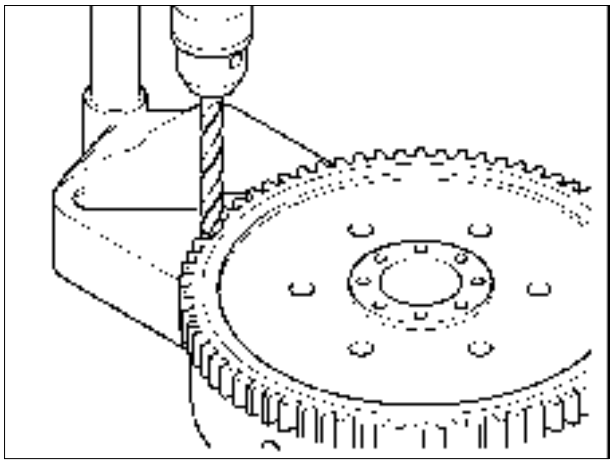


1. **Heat the new ring gear to Max 210°C (410°F)**

   Use an oven or gas torch.

   If you use an oven, put in the new ring gear in advance.

   If you use a gas torch, heat the ring gear immediately before you install it.

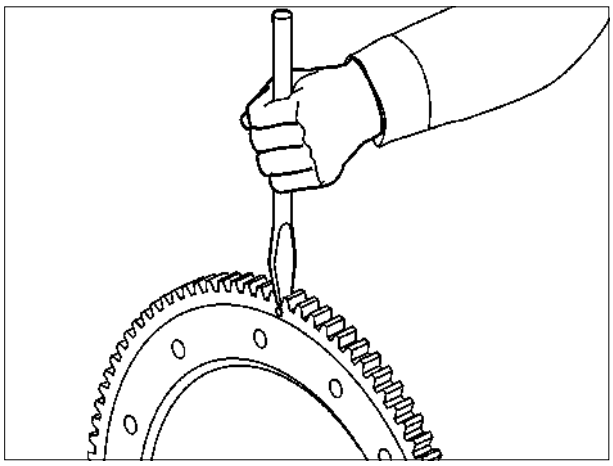


2. **Drill a hole between two teeth.**

   Use a **10 mm** (0.4") drill.

   Drill a **9 mm** (0.35") deep hole.

⚠ **IMPORTANT!** Be careful not to drill on the flywheel, if you do it will loose its balance.

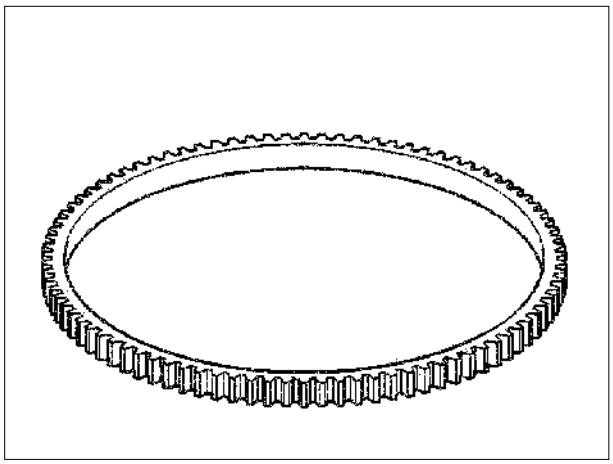


3. **Remove the flywheel ring gear**

Hold the ring gear firmly in a soft-faced vice.

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

Clean the contact surfaces of the flywheel.



4. **Fit the new ring gear**

Check the temperature.

Position the ring gear so that it meets the flywheel flange.

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

Let the ring gear cool.

Valve clearance, checking/adjusting

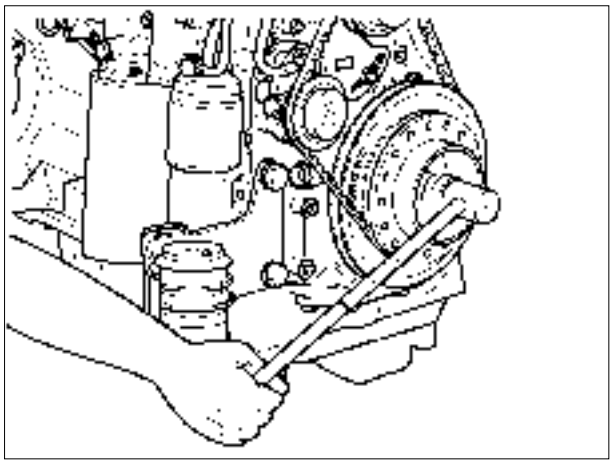
(21403)

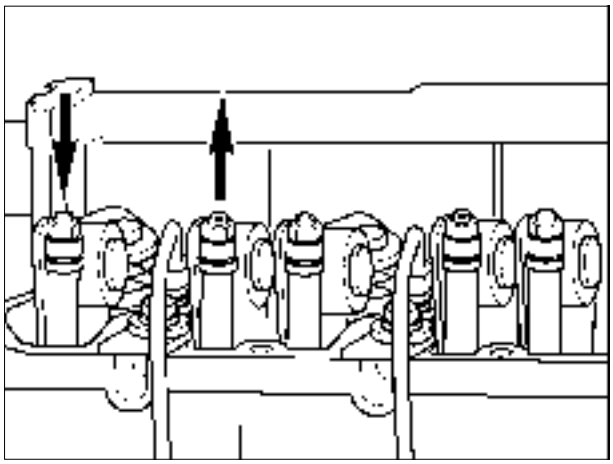
Special tools:

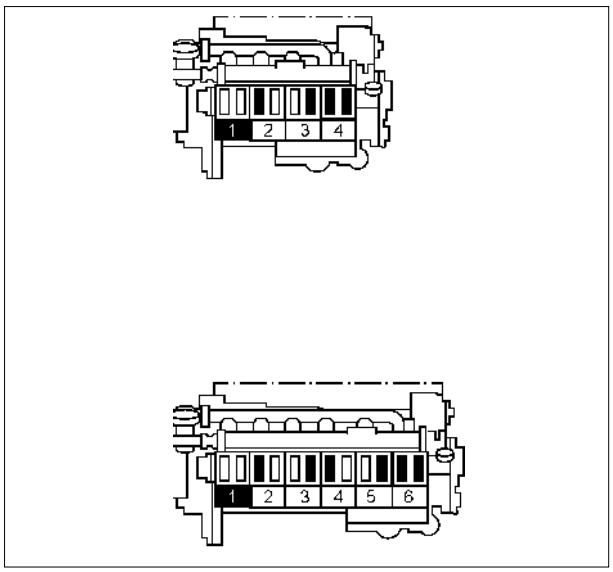
Rotating tool, crankshaft 999 8676

Cranking tool, flywheel 999 8681

NOTE! The normal valve clearance is set 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 highest permissible variation when the cylinder head gasket is changed and at the lowest permissible variation after 50 hours running.

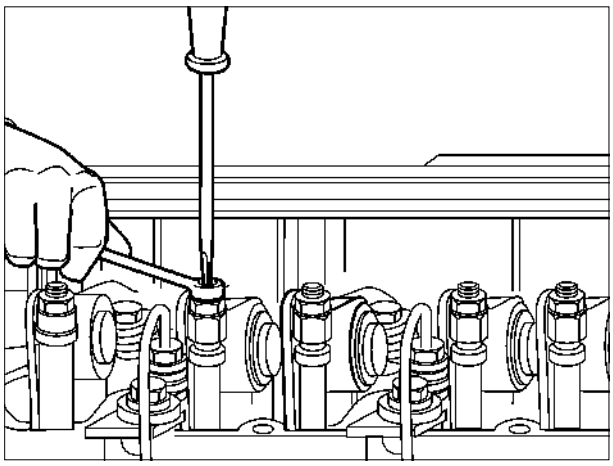
1. Rotate the crankshaft until the valves for no. 1 cylinder overlap.

NOTE! The valves overlapping means: The exhaust valve is closing. The inlet valve is opening. Neither of the push rods can be turned in this position. (Number 1 cylinder is nearest the flywheel).

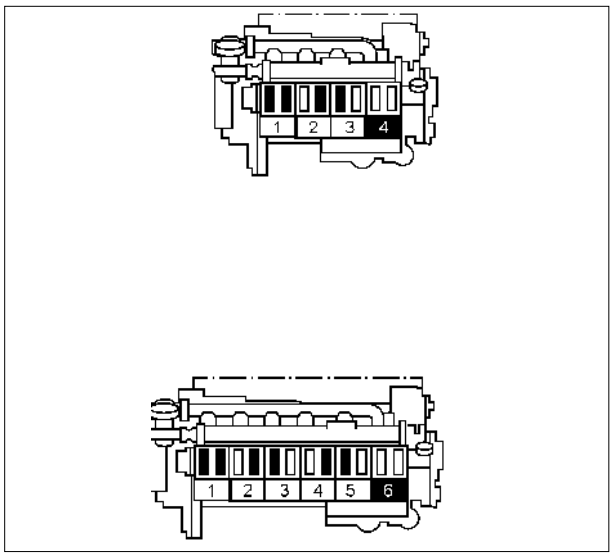
2. Set the valve clearance for each cylinder using a feeler gauge, according to the **black markings**.

   Mark up the rocker arm on each set cylinder, using a chalk.

   Inlet valve clearance: ..... **0.35** ±0.05 **mm** (0.01±0.002”)
   Exhaust valve clearance: ..... **0.55** ±0.05 **mm** (0.02±0.002”)



3. Tighten the locknut to ..... **20** ±2 **Nm** (15 lbf ft).
Recheck the setting with the feeler gauge.



4. Rotate the crankshaft another revolution (360°).
Set the valve clearance for each cylinder using a feeler gauge, according to the **black markings**.
Mark up the rocker arm on each set cylinder, using a chalk.

5. Tighten the locknut to ..... **20** ±2 **Nm** (15 lbf ft).
Recheck the setting with the feeler gauge.

6. Fit a **new** rocker cover gasket.

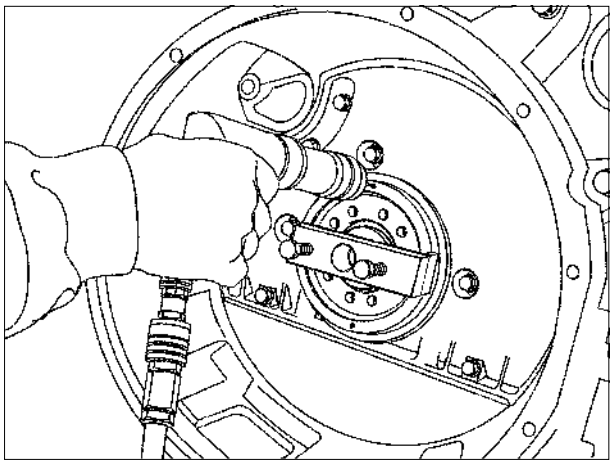
Crankshaft seals, changing (complete engine)

Special tools:

Standard shaft, drifts 999 2000
Fitting/Removal tool, rear 999 8672
Fitting tool/Removal, front 999 8673
(Transmission housing, flywheel end)

Rear crankshaft seal, changing

(21671)

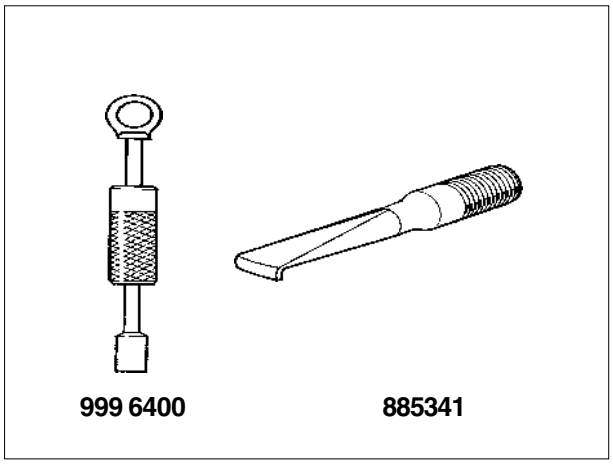


1. Remove the flywheel.

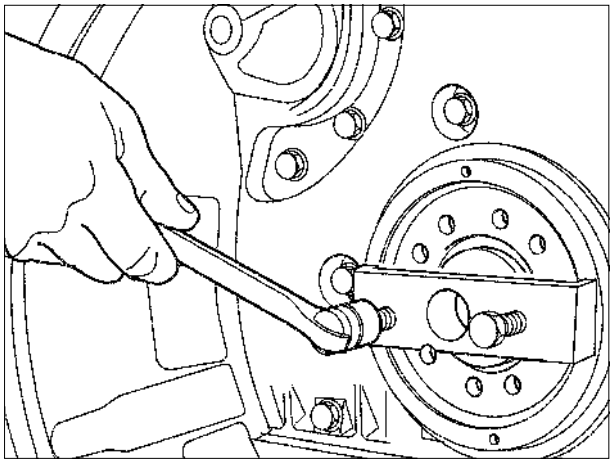
NOTE! The flywheel is very heavy.

2. Remove the crankshaft seal from the transmission housing using tool 999 8672.
3. Drill two **3.5 mm** (0.14") holes in the seal, through the pre-drilled holes in the tool.

NOTE! Max. depth ..... **8 mm** (0.31")



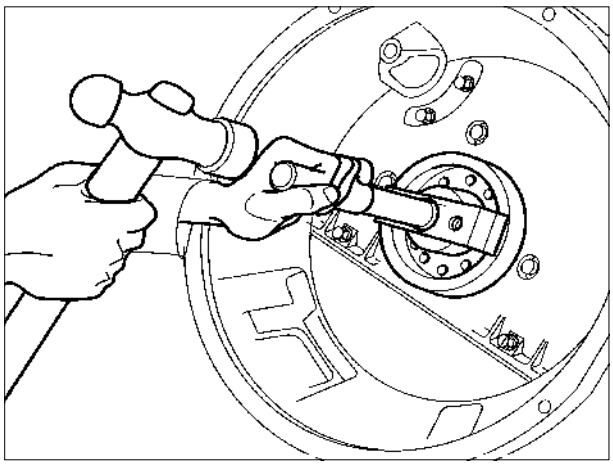
Alternatively:
Use extractor 885341 together with slide hammer 999 6400.



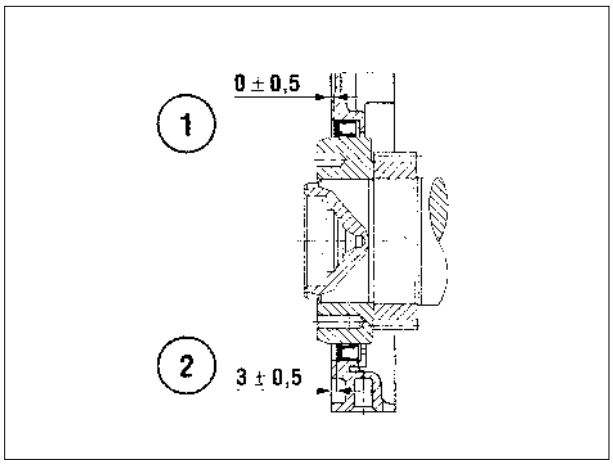
4. Screw two self-tapping screws in the drilled holes.

NOTE! Max. screw length ..... **40 mm** (1.6").

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



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

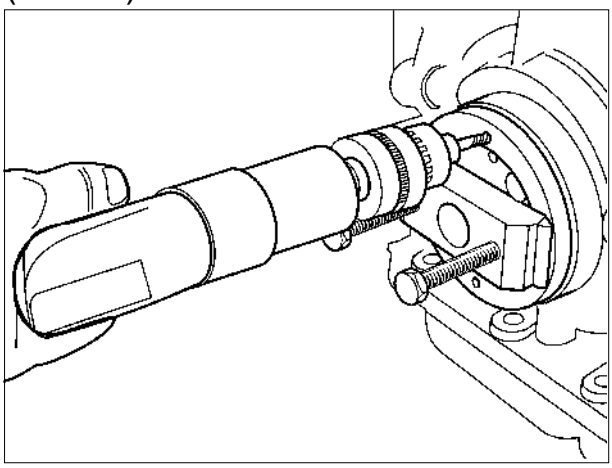


NOTE! The seal is originally installed in position (**1**), see fig.

The tool's installation position (**2**) is when the crankshaft has a measurable wear, in position (**1**).

Use a drift and gently knock the seal into required position.

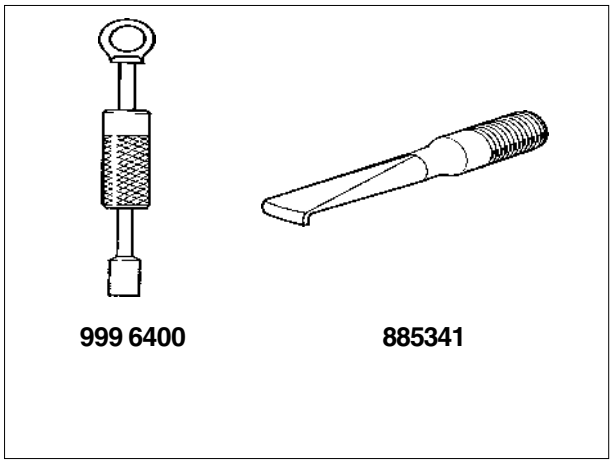
Front crankshaft seal, changing (Front housing)
(21672)



1. Remove the crankshaft pulley and vibration damper if fitted.
2. Remove the crankshaft seal from the front housing using tool 999 8673.

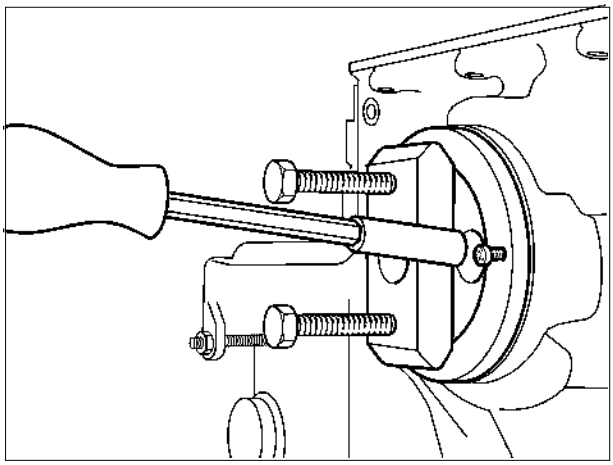
   Drill two **3.5 mm** (0.14") holes in the seal, through the predrilled holes in the tool.

NOTE! Max. depth ..... 7.5 mm (0.3").



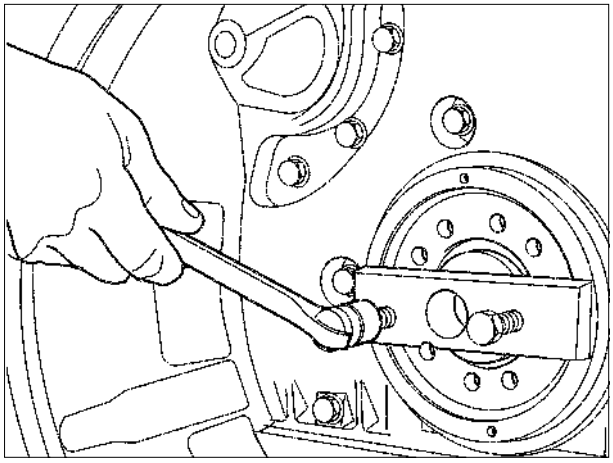
Alternatively:

Use extractor 885341 together with slide hammer 999 6400.

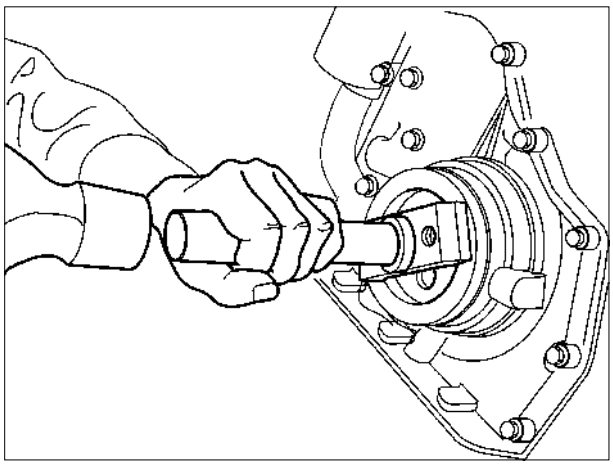


3. Screw two self-tapping screws in the drilled holes.

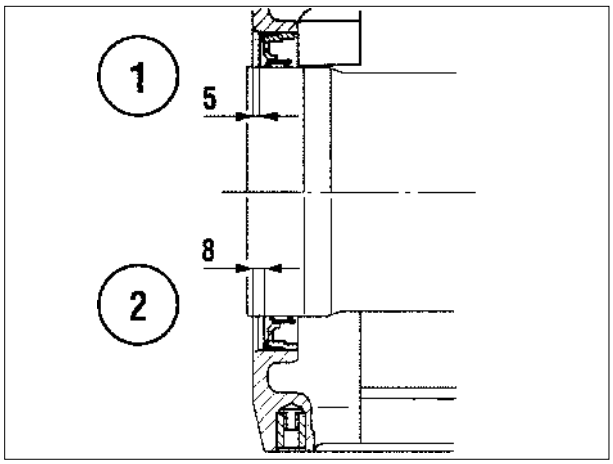
NOTE! Max. length of screws ..... 32 mm (1.28").



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



5. Lightly oil the sealing lip of the new crankshaft seal and put it on the tool 999 8673. The sealing lip to face the crankshaft. Use standard shaft 999 2000, and carefully nock the seal in place.



NOTE! The seal is originally installed in position (**1**), see fig.

The tool's installation position (**2**) is when the crankshaft has a measurable wear, in position (**1**).

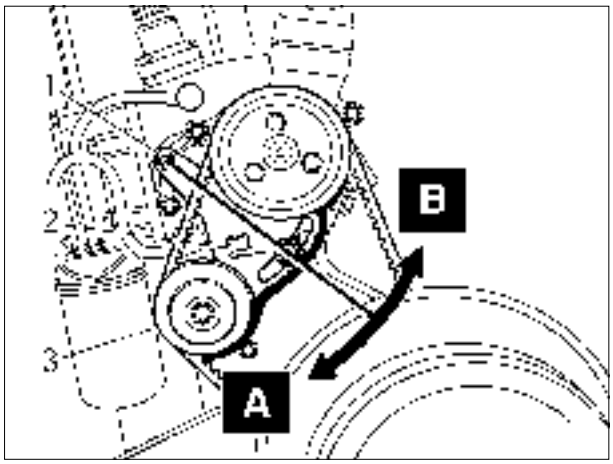
Use a drift and gently knock the seal into required position.

Drive belts, adjusting and replacing
(26341)

⚠ **IMPORTANT!** Only check/tension or change the drive belt when the engine is stopped. Replace the drive belt guard.

NOTE! Replace drive belts that are oily, worn or damaged in some other way.

NOTE! The belt tension is correct when you can press them down **10 mm** (0.4") between the pulleys.



Coolant / fuel pump

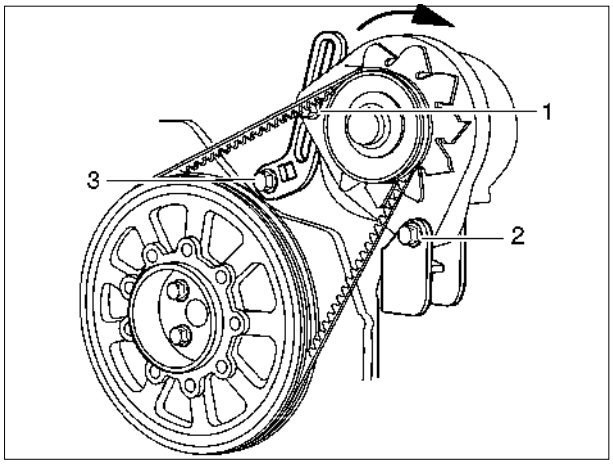
Drive belts, adjusting

1. Loosen the screws (**1** and **2**).
2. Push the fuel pump (**3**) in the direction (**A**) of the arrow until you obtain the correct* belt tension.
3. Retighten the screws (**1** and **2**).

Drive belts, replacing

1. Remove the alternator drive belt, see "Alternator".
2. Loosen the screws (**1** and **2**).
3. Push the fuel pump (**3**) in the direction of the arrow (**B**).
4. Remove the old belt, clean and check the belt pulleys for wear.
5. Fit the new belt.
6. Push the fuel pump in the opposite direction to the arrow (**A**) until you obtain the correct* belt tension.
7. Retighten the screws (**1** and **2**).

⚠ **IMPORTANT!** Do not over-tighten the belt, as it might damage the bearing in the fuel pump.



Alternator

Drive belts, adjusting

1. Loosen the screws (**1**, **2** and **3**).
2. Push the alternator in the direction of the arrow until you obtain the correct belt tension.
3. Retighten the screws (**1**, **2** and **3**).

Drive belts, replacing

1. Loosen the screws (**1**, **2** and **3**).
2. Remove the old drive belt.
3. Fit the new belt.
4. Adjust the alternator until you obtain the correct* belt tension.
5. Retighten the screws (**1**, **2** and **3**).

***NOTE!** The belt tension is correct when you can press them down **10 mm** (0.4") between the pulleys.

Group 22 Oil System

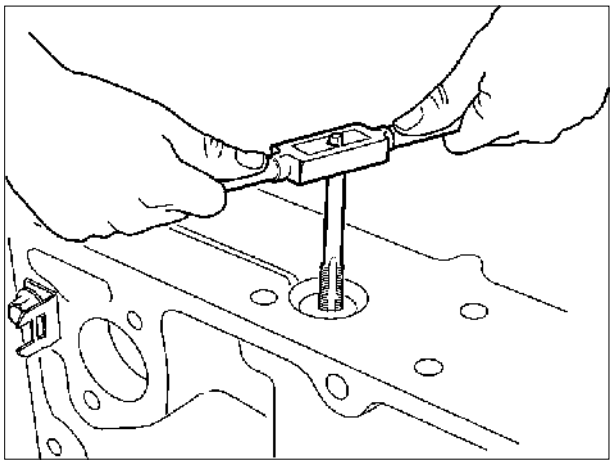
(22020)

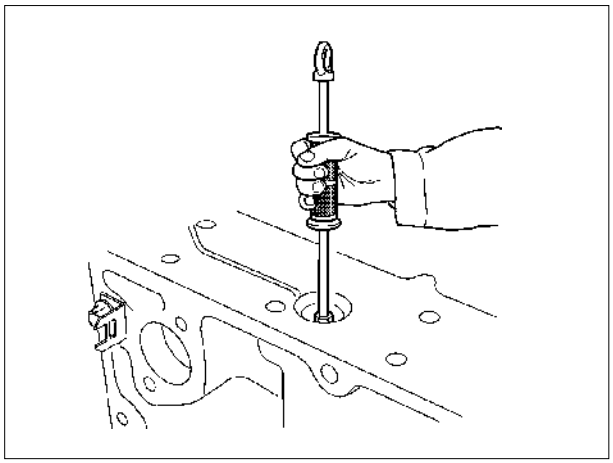
Reduction valve

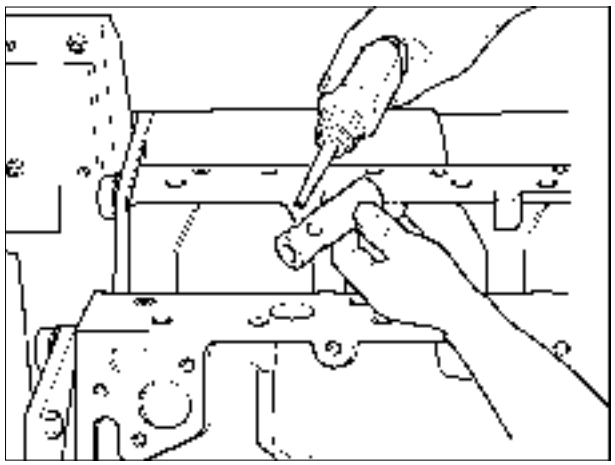
Special tools:

Adapter, oil pressure valve 999 8674

Slide hammer 999 6400







Removing

1. Drill a Ø **6.7 mm** hole (early engines), and tap an M8 thread in the reduction valve.

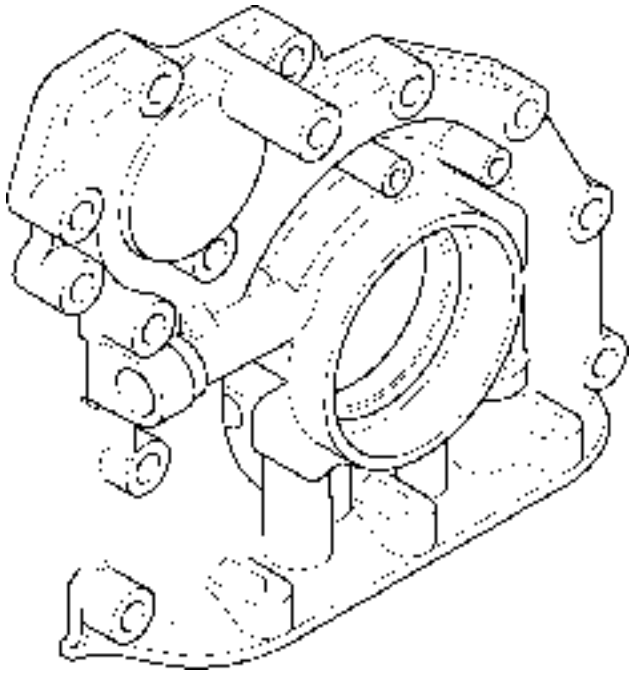
2. Use tool 999 6400 together with adapter 999 8674. Pull out the reduction valve.

Inserting

3. Apply locking compound (part no. 1161351-0) to the new reduction valve.

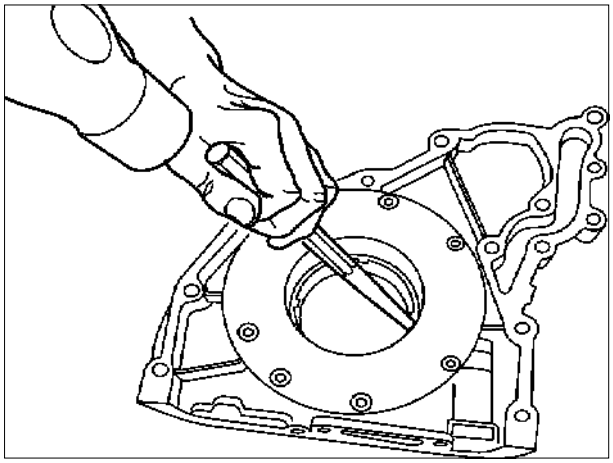
4. Drive in the reduction valve using a brass drift ≈ Ø **20 mm** (0.8")

Front housing, oil pump
(22111)



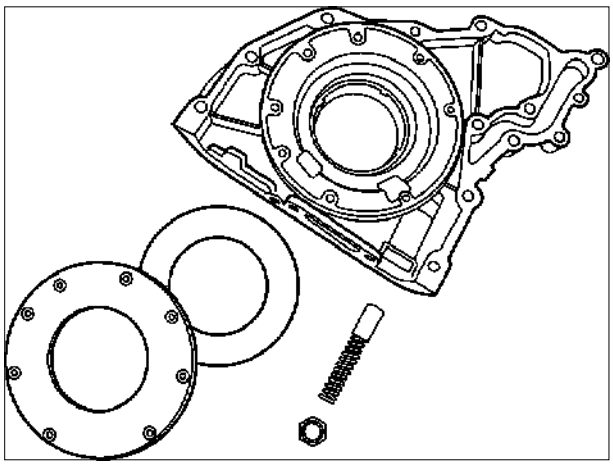
Special tools:

Standard shaft, drifts 999 2000
Fitting/removal tool, front crankshaft seal ... 999 8673



Removing

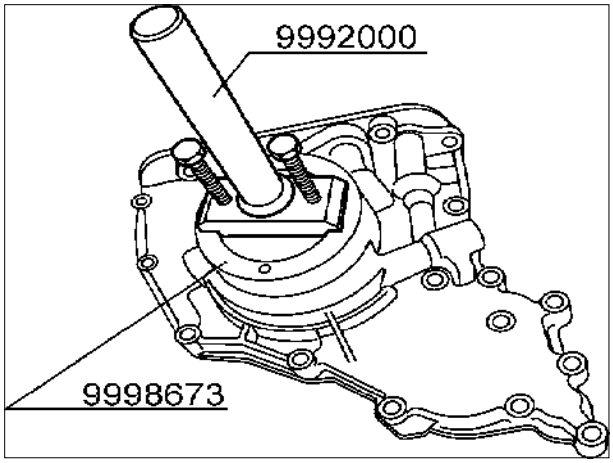
1. Use a drift to drive out the crankshaft seal.



2. When cleaning the front cover remove the oil pump and reduction valve first.
3. Press down the compression spring and remove the retaining washer. Remove the spring and valve for inspection. Also inspect the valve seat in the housing.

NOTE! Be careful, as the spring load of this valve is very high. A good quality spring compressor is required.

4. Take out the gear assembly and check for abnormal wear. Fit a new gear assembly if necessary and oil lightly.
   Tighten the screws to: ..... **8-9 Nm** (6-6.6 lb.)



Fitting

5. Insert the reduction valve and spring.
6. Press down the compression spring and insert the spring retaining washer.

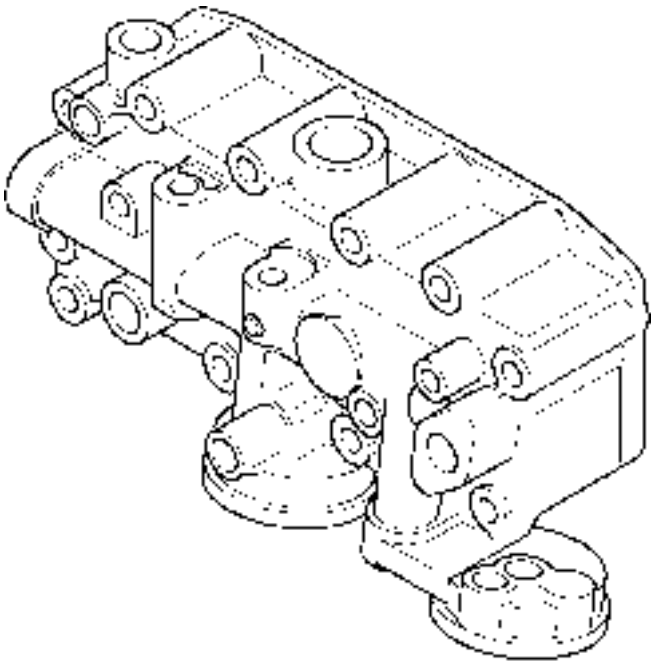
NOTE! Make sure the retaining washer is firmly in place.

Lubricate with a thin coating of oil before fitting.

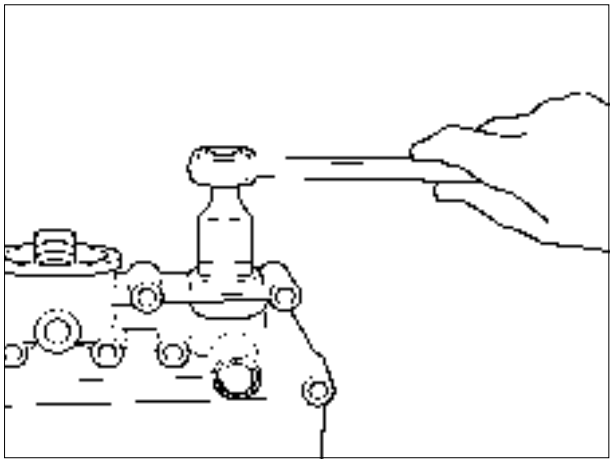
7. Insert the crankshaft seal using fitting tool 999 8673 and 999 2000.

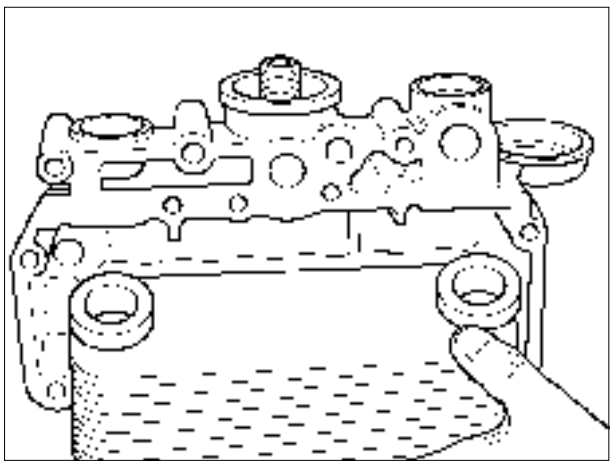
⚠ **WARNING!** Make sure the correct oilpump is used for the engine in question. The pumps are different between the 520 and the 720/721/722 engines.
See “Parts catalogue”.

Engine oil cooler



Oil cooler, check (replace)
(22311)



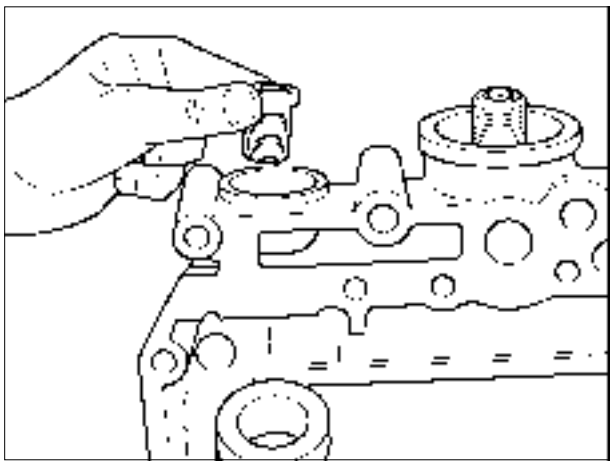


Check

1. Remove the Allen key plugs (17 mm).
2. Remove the hollow Allen key screws (17 mm) that hold the oil cooler.
3. Check all individual parts. If you suspect a leak, pressure-test the oil cooler and change if necessary.

Replace

4. Put the oil cooler into the oil cooler housing.



5. Fit a **new** aluminium washer on the hollow Allen key screw. Use thread-sealing compound (1161053-2) for the threads.
6. Tighten the hollow screw in two steps.
   Initial torque: ..... **80 Nm** (66.6 lbf ft)
   Final torque: ..... **160 Nm** (118.4 lbf ft)
7. Fit a **new** O-ring on the Allen key plug and oil lightly.
8. Tighten the plug to: ..... **80 Nm** (66.6 lbf ft)
9. Fit the oil cooler with a **new** gasket.

Oil cooler, leakage check
(22312)

Special tools:

Pressure-testing equipment 999 6662

Clamp for cooler 999 6685

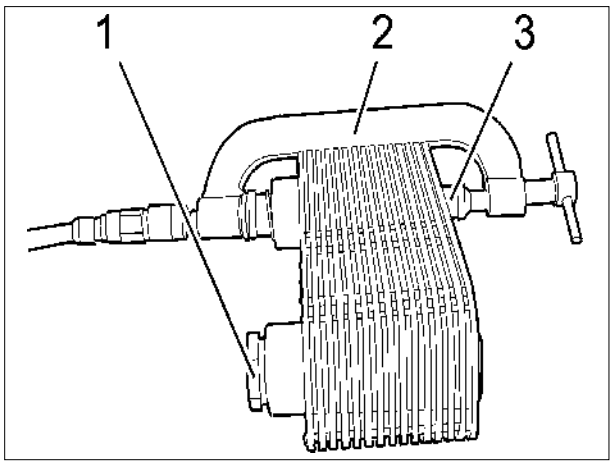
Plug M26x1.5 ..... part no. 942352

Spacer 30 mm (eg. socket 10 mm)

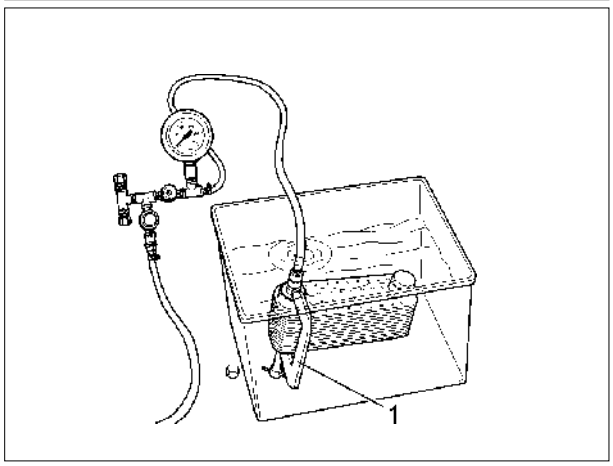
NOTE! During the check, the oil cooler should be as dry as possible within, since remaining water may have a sealing effect on a possible crack. Also, water may not seep into the oil cooler during the check.

NOTE! Avoid starting or stopping the ventilation system or letting air in or out of the premises during the check. This would change the air pressure in the premises, which may be misinterpreted as leakage.

NOTE! The oil cooler should, during the check, have the same temperature as the surroundings. It may not be repaired.



1. Place a clamp (**2**) on the oil cooler (**3**), as shown in the picture. Make sure that it is properly tightened.
2. Plug the other connection (**1**).



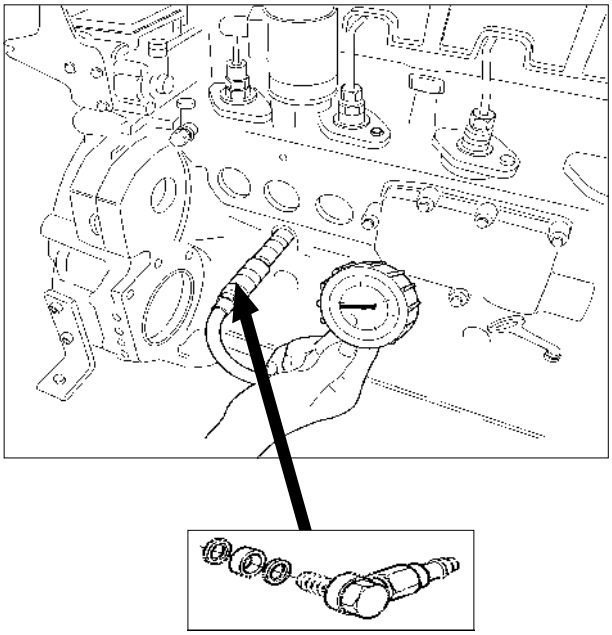
3. Connect the pressure-testing equipment.
4. Place the oil cooler in a tub of water.
5. Set the air pressure to 100 kPa (14.5 psi). Check if there are air bubbles coming from the oil cooler.
6. Increase the pressure to 500 kPa (72.5 psi). Hold the pressure for 1 minute. The pressure may not drop.

NOTE! If the pressure drops during the check, there is a leakage and the oil cooler must be replaced.

Lubricating oil pressure
(22002)

Special tools:

Manometer 999 6398
Nipple 999 6066
Spacer ..... art.nr. 1678297
Alternately:
Electrical pressure gauge 999 8496
together with hose 999 8493



1. Measure the lubricating oil pressure on the start motor side of the engine, as in picture, using the manometer together with nipple and spacer.

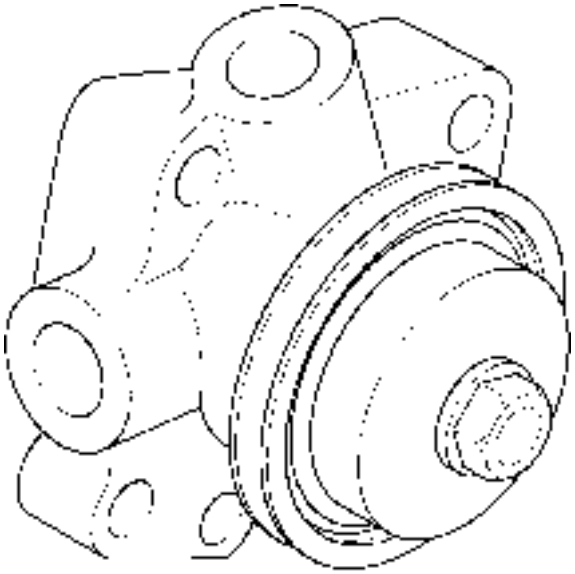
   Minimum oil pressure at operation temperature and idle speed:

   520, 530-532: ..... **90 kPa** (13.1 psi)
   720, 721,722, 730-733: ..... **80 kPa** (11.6 psi)

   At rated speed, se Technical Data.

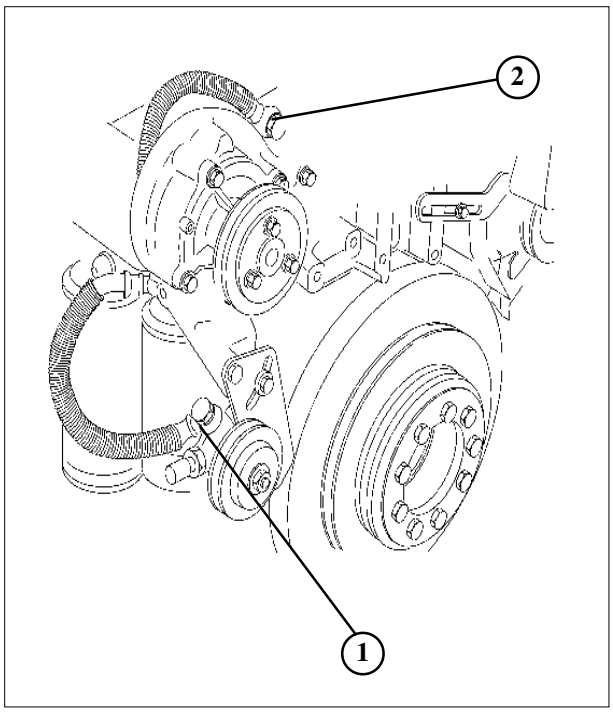
Group 23 Fuel System

Fuel pump



Special tools:

Nipple 999 6066
Manometer 999 6398
Hollow screw ..... art. no. 180211
Copper washer ..... art. no. 969011
Alternatively:
Electrical pressure gauge 999 8496
Hose 999 8493



Fuel supply pressure, checking.
(23315)

⚠ **IMPORTANT!** Clean the nipple and hose thoroughly before connecting them to the fuel system. The injewctors are sensitive and may easily be damaged by contamination.

1. Check the fuel pump and replace if necessary.

2. Measure the supply pressure before (**1**) and after (**2**) the fuel filter.
   Use manometer 999 6398, nipple 999 6066 with a long hollow screw (art. no. 180211) and new copper washers (969011).

   Supply pressure:

   1) after pump: ..... **0.5 MPa / 5 bar**

   2) after filter:

   at 1500 rpm ..... **0.28 MPa / 2.8 bar**

Changing injection pump

(23611)

Before installing the new injection pump: See chapter "Injection pump installation"

NOTE! Before replacing the injection pump, make sure that the reason for the power loss is due to an injection pump and not due to a damaged delivery pipe. Check the inner diameter of the pipe. It should be **1.8 mm** (0.07") for all 520/720/721/722 engines.

When installing a new injection pump, the shim thickness under the pump must be calculated to give the correct injection timing.

Follow the procedure below:

1. Clean the engine thoroughly before removing the rocker cover. A lot of dirt is usually trapped between the inlet manifold and the rocker cover.
2. Remove the plug and install tool 999 8684.
3. Adjust the control rod to stop position.
4. Make sure that the roller tappet for the pump is on the camshaft base circle.

   Loosen the screws holding the pump (a couple of turns) and tap the pump gently to see if it is popping up.

NOTE! The pump is spring-loaded and if the tappet is not on the base circle, the force from the pump spring can damage the threads in the engine block when removing the screws.

5. Remove the shim in the roller tappet.Cover up the hole to protect from any dirt getting into the engine.
6. Read the **EP-code** on the engine name plate for the cylinder in question. Enter the value in “Calculation 1, Technical data”.
7. Read off the corresponding corrected dimension, **Ek**,from Table 3. Enter the value in “Calculation 1, Technical data”.
8. Read off the length of the pump, $\mathbf{L_0}$, from Table 1. Enter the value in “Calculation 1, Technical data”.
9. Read off the manufacturing tolerance, **A**, on the injection pump. Enter the value **A/100** in “Calculation 1, Technical data”.
10. Calculate the theoretical shim thickness, $\mathbf{T_s}$, according to 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. Slide the shim along e. g. a screwdriver into place.

NOTE! Only one shim should be used.

13. Make sure the roller tappet for the pump in question is on the camshaft base circle.
14. Turn the pump likage lever into middle position, oil the O-rings on the pump and insert the pump.

NOTE! make sure the pump linkage lever is introduced properly in the slot of the control rod before pushing the pump down.

15. Install the pump flange with the chamfered hole side facing the pump and pre-load the screws to ..... **5 Nm** (3.7 lfb ft).
    Thereafter slacken the screws ..... **60°**.
16. Use socket 11668403 and a torque wrench with gauge to turn the injection pump CCW slowly and gently while observing the torque on the gauge, required to turn the injection pump, e. g. **3.5 Nm** (2.6 lbf ft).
    Stop turning when the pump has reached its stop position and the reading on the gauge has gone up .....**1 Nm** (0.7 lbf ft)
    Example: 3.5 + 1 = 4.5 Nm (2.6 + 0.7 = 3.3 lbf ft).
17. Tighten the screw on the pump flange ..... **60°**. Then tighten them alternately, start with the screw remote of the flywheel with **7 Nm - 10 Nm - 30 Nm** (5.2 - 7.4 - 22.2 lbf ft).
18. After installation of the pump, remove the special tool 999 8684 and check that the fuel tack is moving freely.
19. Pre-tension the delivery pipe in two stages:
    1 ..... **5 Nm** (3.7 lbf ft)
    2 ..... **25** ±3.5 **Nm** (18.5 ±2.6 lbf ft).

NOTE! A delivery pipe which has been removed, should be replaced with a new one.

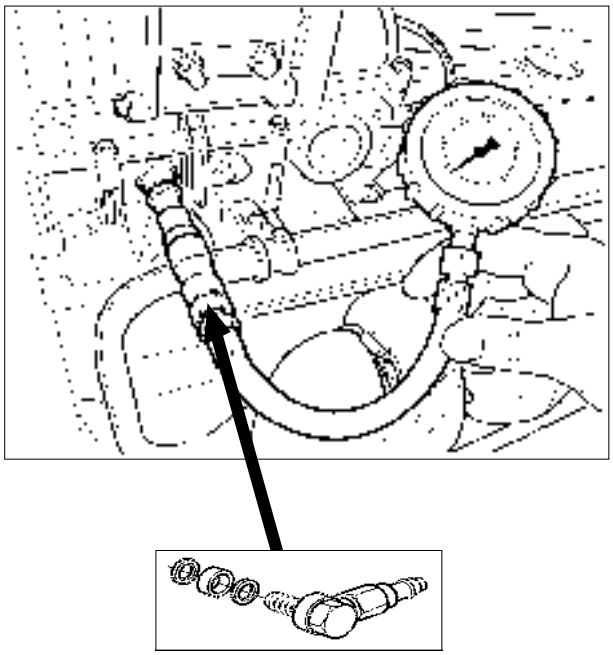
20. Fit a new rocker cover gasket and the rocker cover.
    Tighten the screws to .....**11** ±1 **Nm** (8.1 ±0.7 lbf ft).

Group 25 Inlet and exhaust system

Boost pressure
(25502)

Special tools:

Manometer 999 6398
Nipple 999 6066
Spacer ..... art.nr. 1678297
Alternately:
Electrical pressure gauge 999 8496
together with hose 999 8493



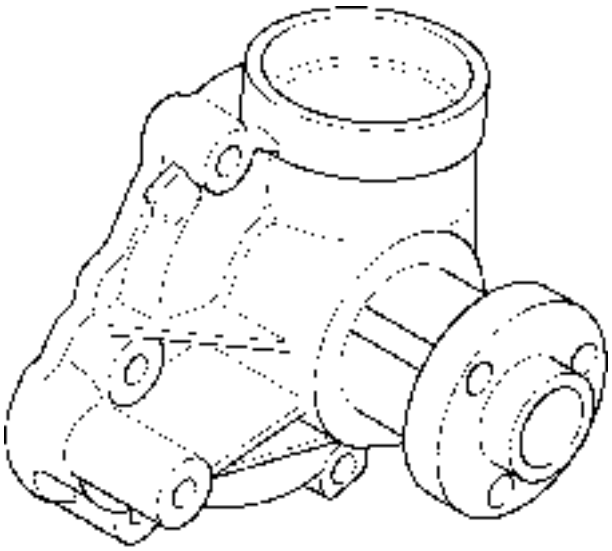
1. Measure the turbocharger boost pressure, as in picture, using the manometer together with nipple and spacer.

   For boost pressure, see “Technical Data”.

Group 26 Cooling System

Coolant pump, check / replace

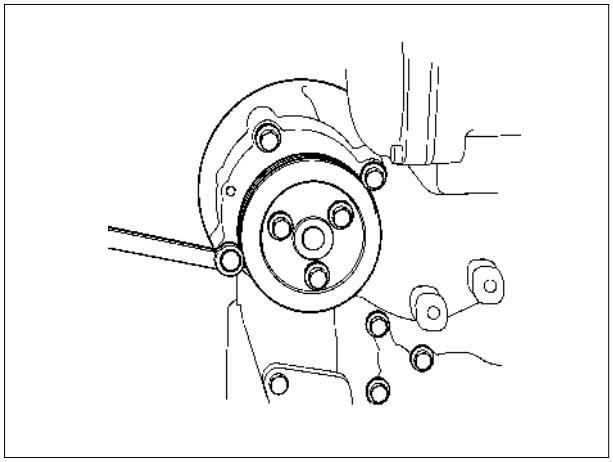
(26211)



Depending on which coolant pump model that is installed, follow one of the procedures below.

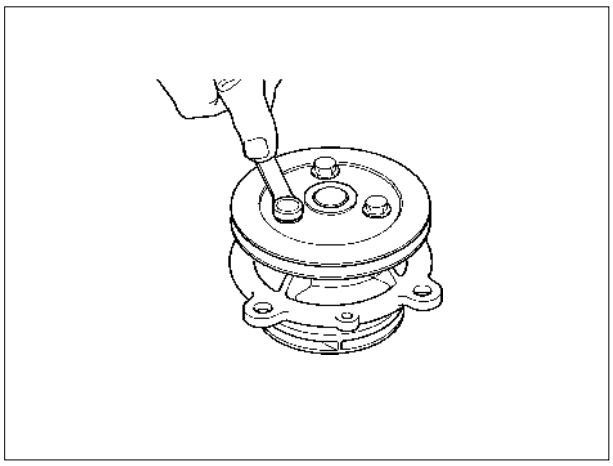
Modell 1:

1. Remove the coolant pump from the housing.
2. Remove the V-belt pulley.
3. Check coolant pump and sealing for leaks, replace the coolant pump if necessary.
4. Fit the V-belt pulley.
   Tighten the bolts to..... **21 Nm** (15 lbf ft).
5. Fit the coolant pump in the housing with a new gasket.

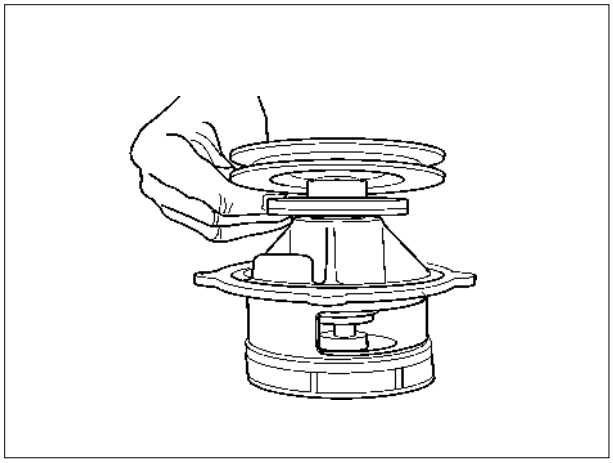


Model 2:

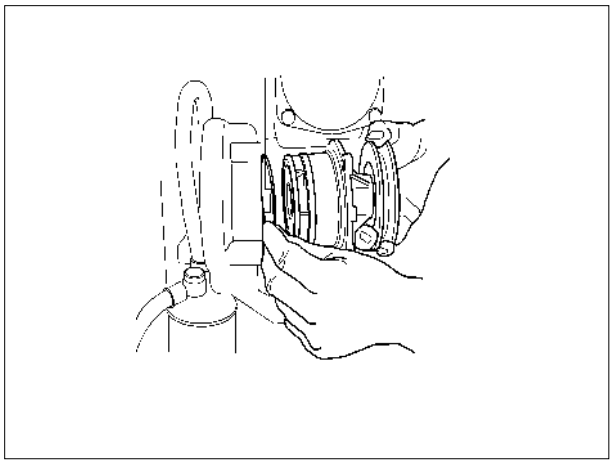
1. Loosen the coolant pump from the house.



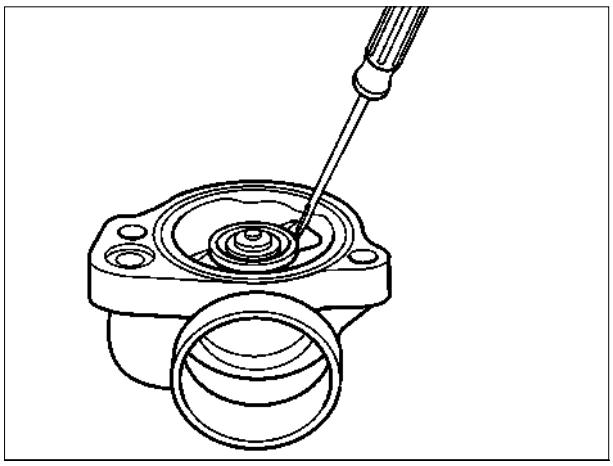
2. Remove the V-belt pulley.
3. Check coolant pump and sealing for leaks, replace the coolant pump if necessary.
   Make sure that the overflow hole for the spindle seal is not filled up.



4. Fit the V-belt pulley.
   Tighten the bolts to..... **21 Nm** (15 lbf ft).



5. Fit the coolant pump in the housing with a **new** gasket.



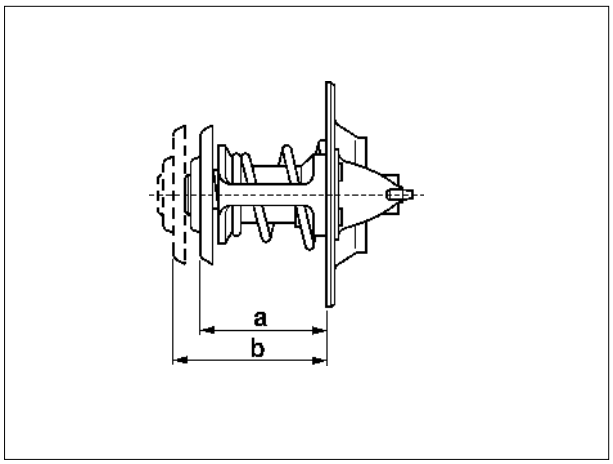
Thermostat

(26273)

Thermostat, checking

1. Push the thermostat down, then turn it and take it out of the thermostat housing.
2. Test the thermostat function and replace if necessary.
3. Push the thermostat down into the thermostat housing and turn it.

NOTE! The securing yoke must engage with the thermostat housing.

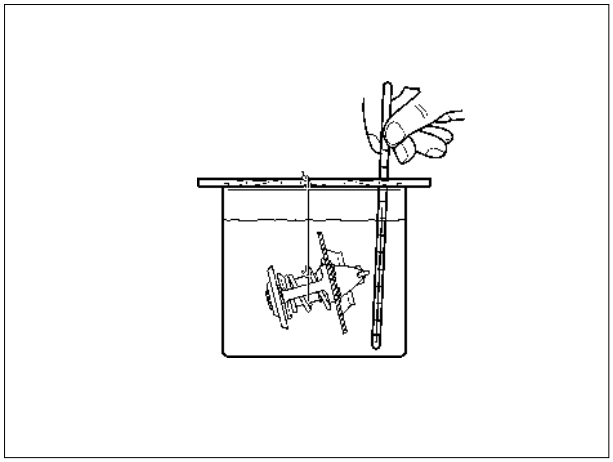


Thermostat, function check

1. Measure the measurement “a” on the thermostat.

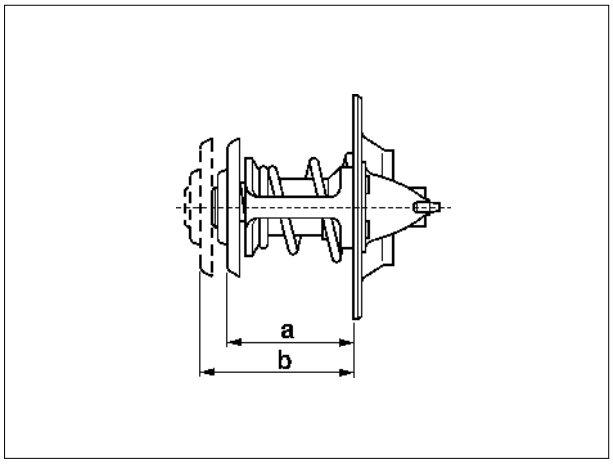
   “**a**”= the thermostat starts to open ..... **83°C**

   “**b**”= the thermostat is completely open ..... **93°C**



2. Heaten the thermostat in a water bath.

NOTE! To get the exact opening temperature, measure as close to the thermostat as possible without touching it. Stir the water unceasingly to get an even temperature distribution. The temperature should not rise more than 1°C/min, or the time of opening is delayed.



3. Measure the measurement “b” on the thermostat.

   When the thermostat is completely open, 95°C, the difference between “a” and “b” should be at least 8 mm.

   “a”-”b”= **min 8 mm.**

Wiring diagrams

NOTE! The wiring diagrams on this and the following pages are examples of wiring diagrams. The engines are **not** fitted with an electrical system in the factory.

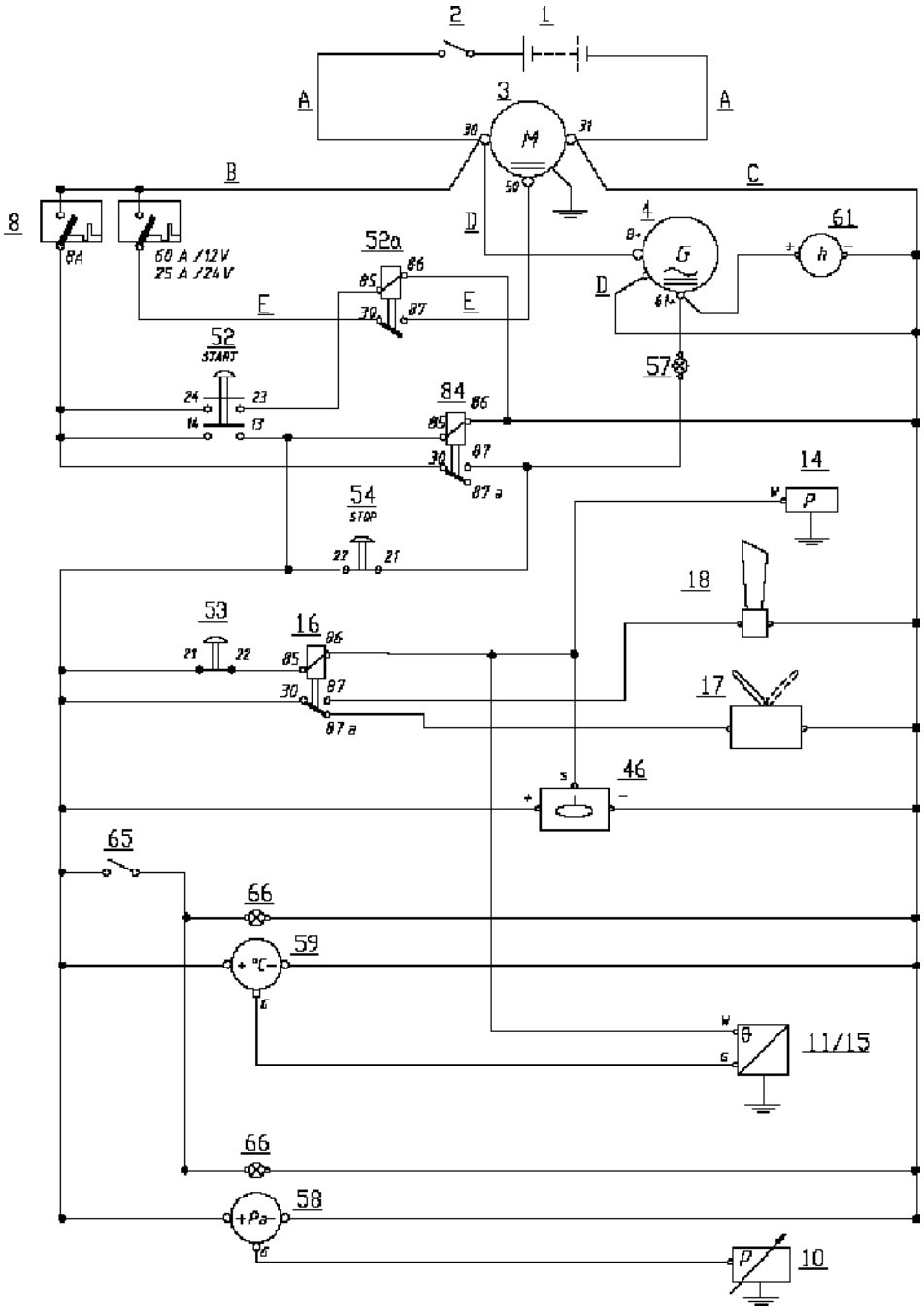
Wiring diagram (TD/TAD 520, 720, 721, 722 GE stage 1 engines)

1. Battery
2. Main switch
3. Starter motor
4. Alternator
8. Fuse
10. Oil pressure sender
11. Temperature sender/engine connector
14. Oil pressure connector
15. Temperature sender/engine connector
16. Relay
17. Stop solenoid
18. Horn
46. Water level connector (720 models)
52. Start connector
52a. Start relay
53. Interlock button
54. Stop button
57. Charge warning lamp
58. Oil pressure gauge
59. Water temperature gauge
61. Hour counter
65. Instrument illumination connector
66. Instrument illumination
84. Holding relay

Conductor area

	12V		24V	
A.	90 mm²	(0.140 in²)	70 mm²	(0.109 in²)
B.	10 mm²	(0.016 in²)	2.5 mm²	(0.004 in²)
C.	2.5 mm²	(0.004 in²)	2.5 mm²	(0.004 in²)
D.	10 mm²	(0.016 in²)	6 mm²	(0.009 in²)
E.	6 mm²	(0.009 in²)	2.5 mm²	(0.004 in²)

Unspecified area 1 mm² (0.002 in²)



Wiring diagram (TD/TAD520, 720, 721, 722 VE stage 1 engines with start-/ stop button activation)

1. Battery
2. Main switch
3. Starter motor
4. Generator
5. Hourmeter
6. Fuse
7. Start button
8. Start relay
9. Holding current relay
10. Charging control lamp 3W
11. Stop button
12. Switch for instrument light
13. Revolution counter
14. Instrument light
15. Preheating time control unit
16. Glow plugs
17. Tachometer (sender)
18. Preheater lamp
19. Temp switch excessfuel solenoid
20. Excessfuel solenoid
21. Stop solenoid
22. Signal horn
23. Water temperature gauge
24. Temp sender/switch engine
25. Alarm lamp cool water
26. Oil pressure gauge
27. Oil pressure sender/switch
28. Alarm lamp oil pressure
29. Alarm lamp water level
30. Water level switch
31. Relay
32. Diode
33. Supply button

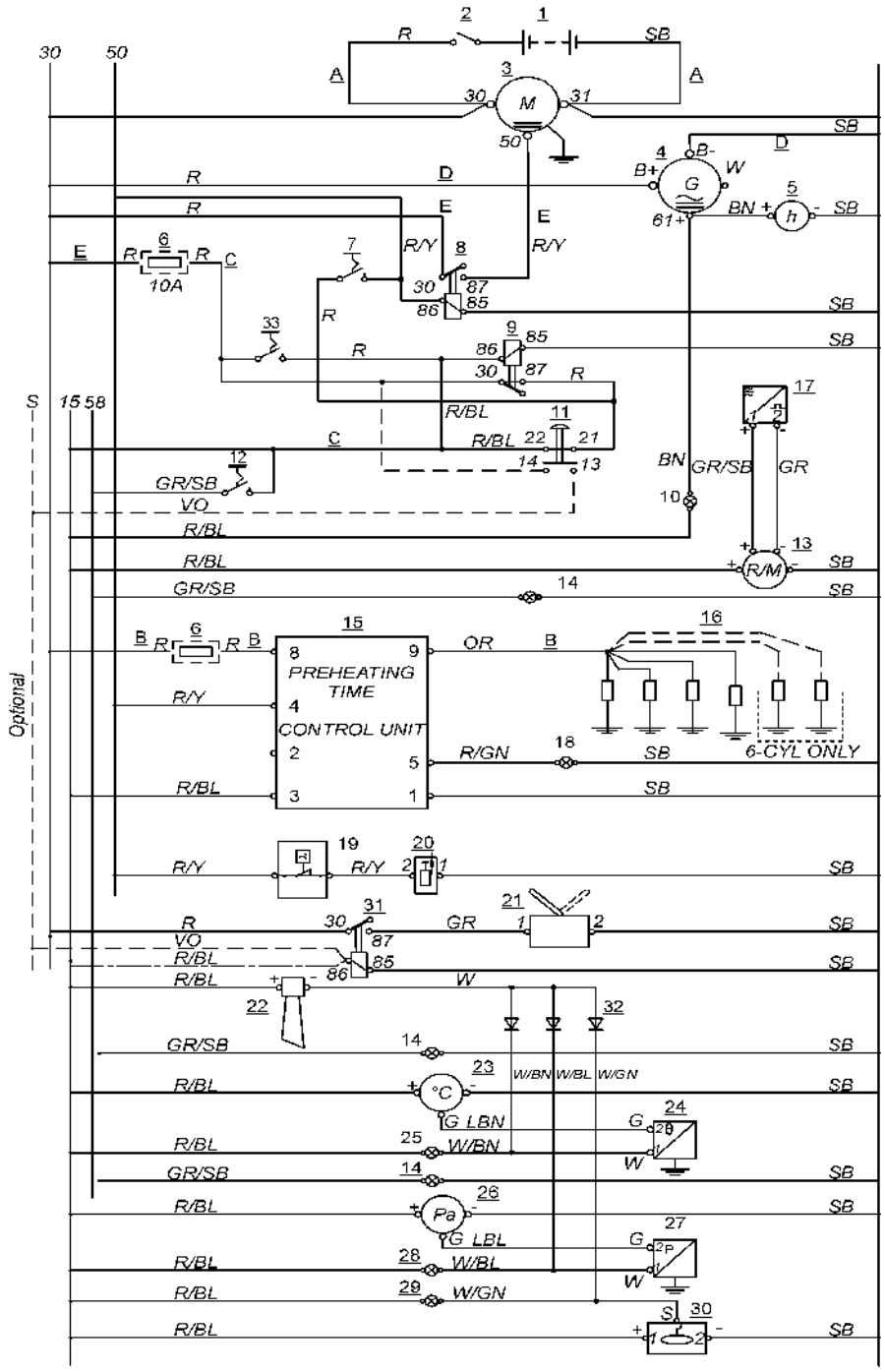
Conductor area

	12V	24V
A.	90 mm² (0.140 in²)	70 mm² (0.109 in²)
B.	10[1] mm² (0.016 in²)	6[2] mm² (0.009 in²)
C.	25 mm² (0.04 in²)	25 mm² (0.04 in²)
D.	50 mm² (0.08 in²)	25 mm² (0.04 in²)
E.	6 mm² (0.009 in²)	25 mm² (0.04 in²)

Unspecified area 15 mm² (0.023 in²)

[1] For 6-cylinder = 16 mm² (0.025 in²)

[2] For 6-cylinder = 10 mm² (0.016 in²)



Wiring diagram (TD/TAD520, 720, 721, 722 VE stage 1 engine with key activation)

1. Battery
2. Main switch
3. Starter motor
4. Generator
5. Hourmeter
6. Fuse
7. Key switch
8. Start relay
9. Switch for instrument light
10. Charging control lamp 3W
11. Revolution counter
12. Instrument light
13. Preheating time control unit
14. Glow plugs
15. Preheater lamp
16. Temp switch excessfuel solenoid
17. Excessfuel solenoid
18. Stop solenoid
19. Signal horn
20. Water temperature gauge
21. Temp sender/switch engine
22. Alarm lamp cool water
23. Oil pressure gauge
24. Oil pressure sender/switch
25. Alarm lamp oil pressure
26. Water level switch
27. Alarm lamp water level
28. Relay
29. Diode
30. Tachometer (sender)

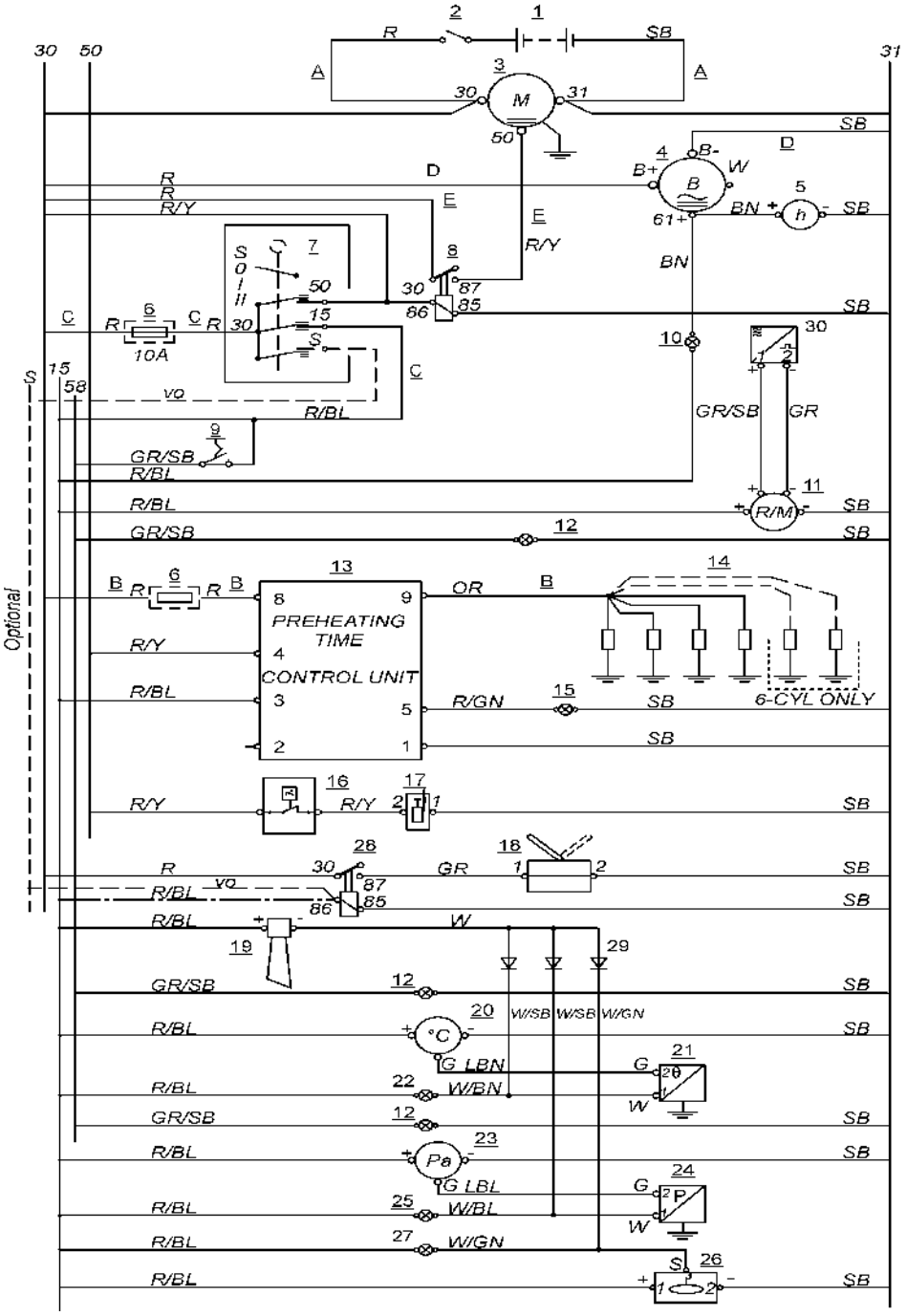
Conductor area

	12V	24V
A.	90 mm² (0.140 in²)	70 mm² (0.109 in²)
B.	10[1] mm² (0.016 in²)	6[2] mm² (0.009 in²)
C.	25 mm² (0.04 in²)	25 mm² (0.04 in²)
D.	50 mm² (0.08 in²)	25mm² (0.04 in²)
E.	6 mm² (0.009 in²)	25 mm² (0.04 in²)

Unspecified area 15 mm² (0.023 in²)

[1] For 6-cylinder = 16 mm² (0.025 in²)

[2] For 6-cylinder = 10 mm² (0.016 in²)



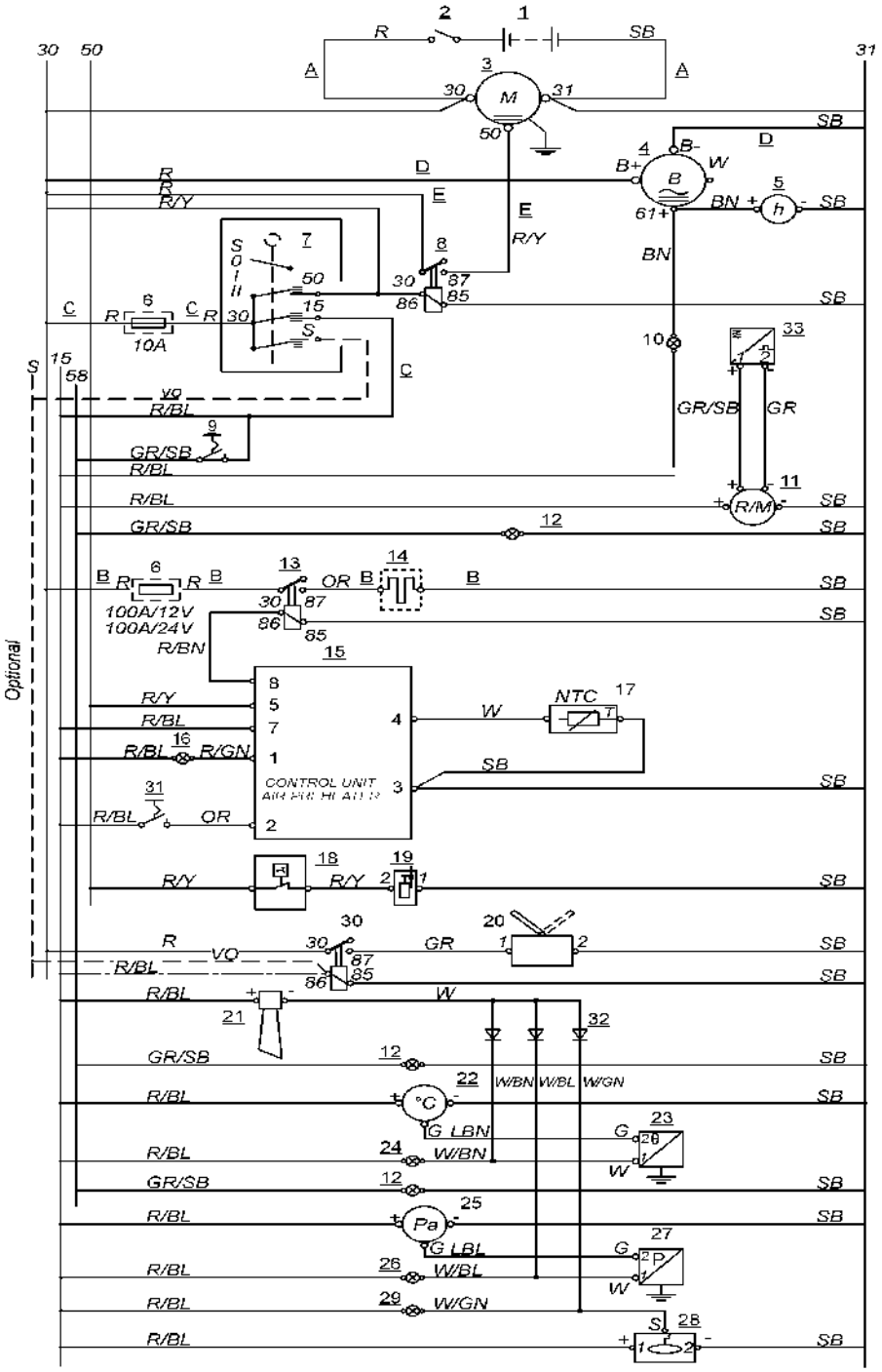
Wiring diagram (TD/TAD520, 720, 721, 722 VE stage 2 engines key activation)

1. Battery
2. Main switch
3. Starter motor
4. Generator
5. Hourmeter
6. Fuse
7. Key switch
8. Start relay
9. Switch for instrument light
10. Charging control lamp 3W
11. Revolution counter
12. Instrument light
13. Power relay
14. Heating flange
15. Control unit air preheater
16. Preheater lamp
17. Resistor NTC
18. Temp switch excessfuel solenoid
19. Excessfuel solenoid
20. Stop solenoid
21. Signal horn
22. Water temperature gauge
23. Temp sender/switch engine
24. Alarm lamp cool water
25. Oil pressure gauge
26. Alarm lamp oil pressure
27. Oil pressure sender/switch
28. Water level switch
29. Alarm lamp water level
30. Relay
31. Preheating button
31. Diode
32. Tachometer (sender)

Conductor area

	12V	24V
A.	90 mm² (0.140 in²)	70 mm² (0.109 in²)
B.	16 mm² (0.025 in²)	16 mm² (0.025 in²)
C.	25 mm² (0.04 in²)	25 mm² (0.04 in²)
D.	50 mm² (0.08 in²)	25mm² (0.04 in²)
E.	6 mm² (0.009 in²)	25 mm² (0.04 in²)

Unspecified area 15 mm² (0.023 in²)



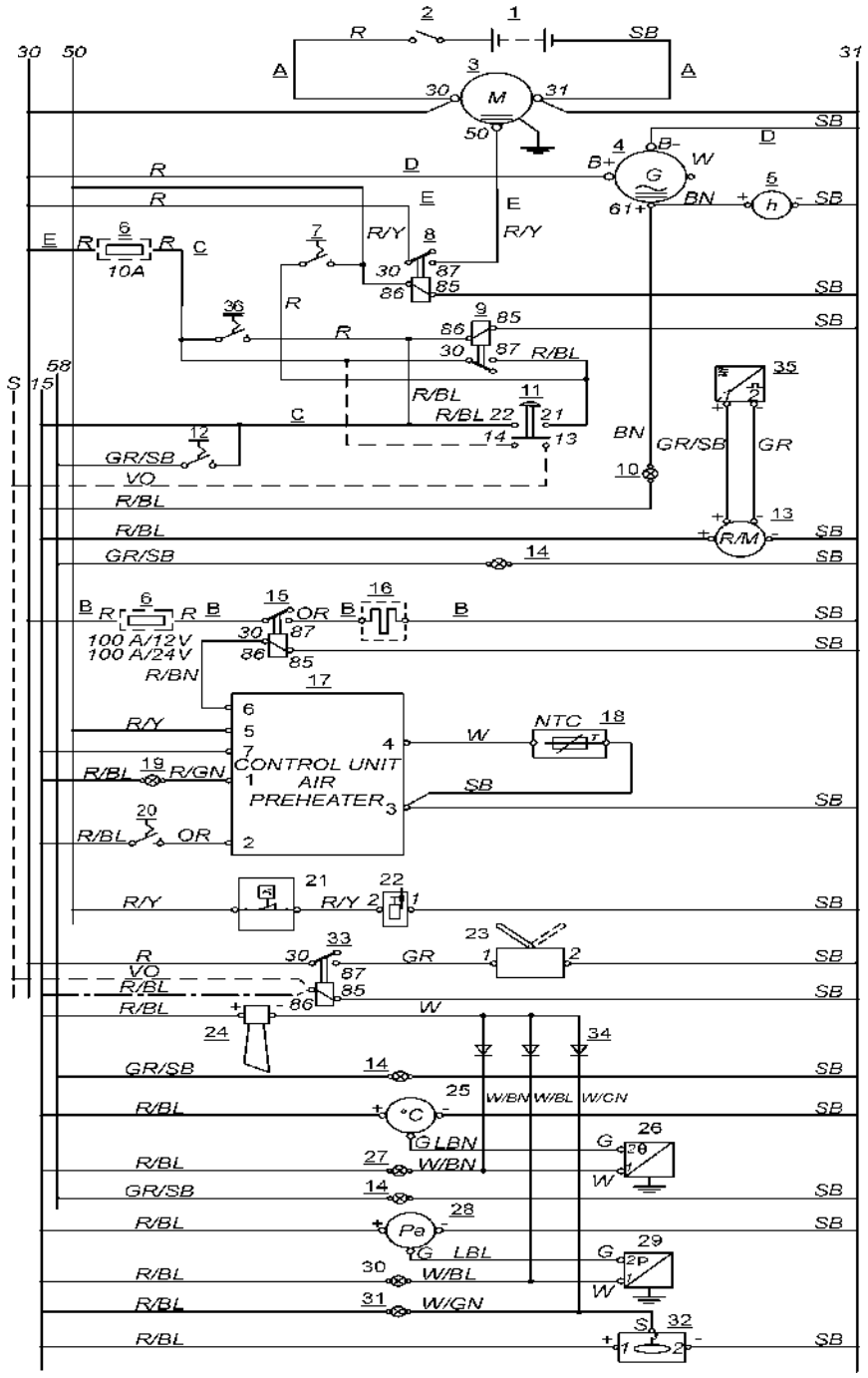
Wiring diagram (TD/TAD520, 720, 721, 722 VE stage 2 engines with start-/ stop button activation)

1. Battery
2. Main switch
3. Starter motor
4. Generator
5. Hourmeter
6. Fuse
7. Start button
8. Start relay
9. Holding current relay
10. Charging control lamp 3W
11. Stop button
12. Switch for instrument light
13. Revolution counter
14. Instrument light
15. Power relay
16. Heating flange
17. Control unit air preheater
18. Resistor NTC
19. Preheater lamp
20. Preheating button
21. Temp switch excessfuel solenoid
22. Excessfuel solenoid
23. Stop solenoid
24. Signal horn
25. Water temperature gauge
26. Temp sender/switch engine
27. Alarm lamp cool water
28. Oil pressure gauge
29. Oil pressure sender/switch
30. Alarm lamp oil pressure
31. Alarm lamp water level
32. Water level switch
33. Relay
34. Diode
35. Tachometer (sender)
36. Supply button

Conductor area

	12V	24V
A.	90 mm² (0.140 in²)	70 mm² (0.109 in²)
B.	16 mm² (0.025 in²)	16 mm² (0.025 in²)
C.	25 mm² (0.04 in²)	25 mm² (0.04 in²)
D.	50 mm² (0.08 in²)	25mm² (0.04 in²)
E.	6 mm² (0.009 in²)	25 mm² (0.04 in²)

Unspecified area 15 mm² (0.023 in²)



Index

S

T

V

W

Notes

Notes

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