Workshop Manual

TD610G/V, TWD610G/P/V, TD630ME/VE
TWD630ME/VE, TD640VE, TWD710G/P/V,
TD730ME/VE, TAD730G/P/V, TWD730ME/VE
TWD731ME/VE, TAD740GE, TAD741GE, TWD740GE/VE

Contents

Safety information

Introduction

This Workshop Manual contains technical data, descriptions and repair instructions for the specified products or product variants from Volvo Penta. Ensure to use the correct workshop literature.

Read this safety information as well as "General information" and "Repair instructions" thoroughly before commencing any service work.

Important

The following special warning signs occur in the workshop manual and on the product.

WARNING! Warns for the risk of physical injury, severe damage to the product or other property or serious malfunctions that may occur if the instructions are not followed.

IMPORTANT! Used to call your attention to points that may cause malfunctions or damage to the product or other property.

NB! Used to call your attention to important information that can facilitate working methods or handling.

In order to give you an overview of the risks and cautions to which you must always pay attention, we have listed them below.

Cut the power using the main switch (switches) and lock it (them) in disengaged position before starting service work to make it impossible to start the engine. Display a warning sign in the driver's position.

All service work must as a rule be performed on a stationary engine. Some work, e.g. certain adjustments, require the engine to be running, however. Approaching a running engine is a safety hazard. Bear in mind that loose or hanging clothing and long hair can fasten in rotating parts, causing serious physical injury.

If work is being carried out in the vicinity of a running engine, a careless movement or a dropped tool can lead to physical injury. Pay attention to hot surfaces (exhaust pipe, turbo, charge air pipe, starting heater etc.) and hot fluids in lines and hoses on an engine that is running or has just been turned off. Refit all the protective devices that were removed for service purposes before starting the engine.

Make sure the warning and information stickers affixed to the product are in good view. Replace stickers that have been damaged or painted over.

Never start the engine without the air filter being fitted. The rotating compressor wheel in the turbocharger can cause severe personal injury. Foreign objects in the inlet line can also cause mechanical damage.

Never use start spray or similar start help. Explosions can occur in the intake manifold. Risk for personal injury.

Avoid opening the coolant filler cap when the engine is warm. Steam or hot coolant may spurt out and pressure will be lost. If it is necessary, open the filler cap slowly and release the pressure in the cooling system. Exercise extreme care if a valve, plug or coolant line must be dismantled while the engine is warm. Steam or hot coolant can flow out in an unexpected direction.

Hot oil can cause burn injuries. Avoid skin contact with warm oil. Make sure the oil system is depressurised before starting work. Never start or run the engine with the oil filler cap removed or there will be a risk of the oil being thrown out.

Stop the engine before working on the cooling system.

Start the engine in well ventilated spaces only. When running in enclosed spaces, the exhaust and crankcase gases must be led out of the engine room or workshop area.

Always use protective goggles when there is a risk of splinters, grinding sparks and splashes of acid or other chemicals. Eyes are extremely sensitive. An injury can result in blindness!

Avoid skin contact with oil! Sustained or repeated skin contact with oil can lead to loss of natural grease in the skin. This can cause skin irritation, dehydration, eczema and other problems. Used oil is more dangerous than fresh with regard to health issues. Use protective gloves and avoid oil-soaked clothing and rags. Wash regularly, especially before meals. Use special skin cream to counteract dehydration and to facilitate cleaning the skin.

Most chemicals intended for use with this product (e.g. engine oil, transmission fluid, glycol, petrol and diesel oil) and chemicals intended for workshop use (e.g. degreasing agent, paints and solvents) are hazardous to health. Reading the instructions on the package thoroughly! Always follow prescribed safety instructions (e.g. use respiratory protection, protective goggles, gloves, etc.). Ensure that other personnel is not inadvertently exposed to hazardous substances, e.g. via the air. Provide adequate ventilation. Handle used and residual chemicals as prescribed.

Take extreme care when tracing leaks in the fuel system and when testing fuel injectors. Wear protective goggles. The jet from a fuel injector has a very high pressure and high percussion power; fuel can be forced deep into body tissue and cause serious injury. Risk of blood poisoning.

WARNING! Pressure pipes must never be bent or reshaped. Damaged pipes must be changed.

All fuels, like many chemicals, are flammable. Keep naked flames and sparks well away. Petrol, certain thinners and hydrogen from batteries are highly flammable and explosive when mixed with air in certain proportions. No smoking! Ventilate well and take necessary safety precautions before starting such tasks as welding and grinding. Keep a fire extinguisher easily accessible in the workplace.

Make sure oil and fuel soaked rags and exchanged fuel or lubricant filters are kept safely. Oil drenched rags can self-ignite in certain conditions. Exchanged fuel and oil filters are hazardous chemical waste and must be left for destruction at an authorised destruction plant together with used lubricants, contaminated fuel, paint residue, solvents, degreasing agents and wash residue.

Batteries must not be exposed to naked flames and electric sparks. No smoking in the vicinity of batteries. Charging batteries generates hydrogen gas, which can form oxyhydrogen gas in combination with air. This is a highly flammable and explosive gas. One spark, which can result from incorrect connection of the battery, is sufficient to make a battery explode and cause damage. Do not touch the connections while starting (risk for sparks) and do not lean over any of the batteries.

Never reverse the polarity when fitting the batteries. Reversed polarity can cause serious damage to electrical equipment. Refer to the wiring diagram.

Always use protective goggles when charging and handling batteries. Battery electrolyte contains strong corrosive sulphuric acid. In case of splashes on the skin, wash with soap and plenty of water. If you get battery acid in your eyes, rinse immediately with plenty of water and contact a doctor.

Stop the engine and turn off the power with the main switch (switches) before working on the electrical system.

The clutch must be adjusted on a stationary engine.

Use the lifting eyes fitted on the engine when lifting the drive unit. Make sure that all lifting gear is always in good condition and has the correct lifting capacity (weight of engine with, where applicable, gearbox and accessories).
For safe handling and to avoid damaging components fitted to the top of the engine, the engine must be lifted using an adjustable lifting beam or one adapted to the engine. All chains and wires must run parallel with each other and as perpendicular as possible to the top of the engine.

If other equipment is attached to the engine that changes its centre of gravity then special lifting devices can be required to attain the correct balance and safe handling. Never perform service on an engine suspended only from a lifting device.

Never work alone when dismantling heavy components, even when using safe lifting devices such as lockable tackle. Two people are usually required even when using lifting devices, one to handle the lifting device and the other to ensure that components go free and are not damaged during the lift. Always assure yourself in advance that there is sufficient space available to dismantle the components wihtout risk for personal injury or material damage.

WARNING! Components in the electrical system and fuel system of Volvo Penta products are designed and manufactured to minimize the risk for explosion and fire. The engine must not be run in environments with explosive medium.

Use only Volvo Penta recommended fuels. Refer to the instruction manual. Use of lower grade fuel will damage the engine. Using fuel of poor quality in diesel engines can sieze the control rod and overrev the engine, causing both mechanical damage and personal injury. Poor quality fuel can also lead to higher maintenance costs.

The following must be considered when cleaning with a high-pressure water jet: Never point high-pressure water jets directly at seals, rubber hoses, electrical components or radiator. Never use the high-pressure function when washing the engine.

General information

About the Workshop Manual

This Workshop Manual contains descriptions and directions for repair of standard models of engines TD610G/V, TWD610G/P/V, TD630ME/VE, TWD630ME/VE, TD640VE, TWD710G/P/V, TD730ME/VE, TAD730G/P/V, TAD741GE, TWD730ME/VE, TWD731ME/VE, TAD740GE and TWD740GE/VE.

Engine designation and number are specified on the type plate (see page 12).

The engine designation and number must always be provided in all correspondence concerning any of our engines.

The Workshop Manual is produced primarily for qualified personnel at Volvo Penta service centres. This presupposes that the person using this manual possesses basic knowledge and can carry out the mechanical/electrical work associated with the trade.

Volvo Penta employs continuous product development and therefore reserves the right to make technical changes. All the information contained in this manual is based on product data available at the time of going to press. Any changes or revisions of consequence that are introduced in the product or service methods after this date will be issued in Service Bulletins.

Spare parts

Spare parts for the electric and fuel systems are liable to various national safety requirements. Volvo Penta Original Spare Parts fulfil these requirements. Any damage arising from the use of parts that are not Volvo Penta Original Spare Parts will not be covered by any of the warranties provided by Volvo Penta.

Certified engines

It is essential for service and repair of emission certified engines used in areas where exhaust emissions are regulated by law to be aware of the following points:

A certification involves the engine type being checked and approved by applicable authorities. The engine manufacturer guarantees that all engines of the same type correspond with the certified engine.

This puts special demands on the service and repair of your engine:

- Maintenance and service intervals recommended by Volvo Penta must be followed.
- Only Volvo Penta original spare parts may be used.
- Service of injection pumps, pump settings and injectors must always be performed at an authorised Volvo Penta workshop.
- The engine must not be modified in any way with the exception of accessories and service kits approved by Volvo Penta for use on the engine.
- Installation modifications must not be made to the engine exhaust pipe or intake air channels.
- Any sealed sections must not be broken by anyone other than authorised personnel.

Otherwise, the general directions concerning running, care and maintenance given in the instruction manual apply.

IMPORTANT! Neglected or deficient maintenance/service and the use of non-original spare parts will entail Volvo Penta renouncing any responsibility for the engine corresponding to the certified version.

Volvo Penta will not compensate for damage and/or costs arising from the above.

Repair instructions

The working methods described in this Workshop Manual apply to a workshop environment. The engine has therefore been removed and mounted in an engine stand. Reconditioning that does not require the engine to be removed from the boat can be carried out in place using the same working methods unless specified otherwise.

Warning signs that occur in this Workshop Manual (refer to "Safety information" for definitions)

WARNING!

IMPORTANT!

NB!
are by no means comprehensive because we cannot anticipate all possibilities due to the varying conditions under which the service work is carried out. Therefore, we can only point out the risks we consider may arise due to incorrect handling in a well-equipped workshop using working methods and tools that have been tried and tested at Volvo Penta.

All the processes in this Workshop Manual are carried out using Volvo Penta special tools where applicable. Special tools have been especially designed to enable safe and rational working methods. It is therefore up to the users of alternative tools or working methods that are not recommended by Volvo Penta to assure themselves that they do not risk causing physical injury, material damage or malfunctions to components.

In some cases, special safety directions and user instructions may apply to tools and chemicals mentioned in this Workshop Manual. These directions must always be complied with and this Workshop Manual does not contain any special instructions concerning them.

By taking certain elementary measures and using common sense, most risks can be avoided. A clean workplace and engine eliminates many risks for both physical injury and malfunctions.

It is of the utmost importance when working principally on the fuel system, lubricating system, intake system, turbocharger, bearing unions and sealing unions that dirt and other foreign particles do not enter as this may cause malfunctions or shorten repair service life.

Our mutual responsibility

Every engine comprises a number of interacting systems and components. If only one component deviates from its technical specification, it can dramatically increase the environmental impact of an otherwise perfect engine. It is therefore of the utmost importance that specified wear tolerances are contained, that adjustable systems are correctly set and that only Volvo Penta Original Spare Parts are used in the engine. Intervals specified in the maintenance schedule must be followed.

Certain systems, such as the braking system, may require specialist knowledge and special test equipment. Certain components have been sealed at the factory, e.g. for environmental reasons. These seals must not be broken other than by those authorised for performing service on such components.

Bear in mind that, if handled wrongly, most chemical products can harm the environment. Volvo Penta recommends the use of biodegradable de-greasing agent for all cleaning processes on engine components unless stated otherwise in the Workshop Manual. Take care to collect oil, washing residue, etc., for destruction so they do not inadvertently enter the environment.

Tightening torques

Tightening torques for vital screwed joints that must be tightened with a torque wrench can be found in "Technical data: Tightening torques" and in the work descriptions contained in this Workshop Manual. All torque specifications apply for clean threads, bolt heads and contact surfaces. Torque specifications refer to lightly oild or dry threads. Lubricant, locking compound or sealant for screwed joints is specified in the work descriptions and "Tightening torque" wherever applicable. The following general tightening torques apply where particular tightening torques are not specified. These tightenting torques are typical values that do not require use of a torque wrench.

Dimension	Tightening torque (Nm)
M5	6
M6	10
M8	25
M10	50
M12	80
M14	140

Torque-angle tightening

For torque-angle tightening, screwed joints are first tightened to the specified torque and then further tightened to a determined angle. Example: an angle tightening of 90° means that the joint is tightened a further 1/4 turn after being tightened to the specified torque.

Lock nuts

Unscrewed lock nuts must not be reused but replaced with new ones as their locking properties deteriorate or cease completely with repeated use. On lock nuts with plastic inserts, e.g. Nylock®, the tightening torques specified in the table must be reduced if the height of the Nylock® nut is the same as a standard all-metal hexagon nut. Reduce the tightening torque by 25% for bolt dimensions of 8mm or larger. Nylock® nuts with all-metal threads the same height as a standard hexagon nut can be tightened to the torques specified in the table.

Quality classes

Bolts and nuts are divided into different quality classes; the actual class is marked on the head of the bolt. A higher number in the designation indicates a stronger material. For example, a bolt marked 10-9 is stronger than one marked 8-8. It is therefore essential that bolts are refitted in their original screwed joints. Refer to the spare parts catalogue when renewing bolts to ensure the correct ones are used.

Sealant

Several different types of sealant and locking compounds are used on the engine. The properties of these agents differ and they are intended for use on various strengths of joint, temperature ranges, resistance to oil and other chemicals, different materials and various gap widths present in the engine.

It is therefore essential that the correct type of sealant or locking compound is used on screwed joints when applicable.

The relevant sections of the Workshop Manual contain information on the agents that have been used in our engine production.

The same agents or agents with equivalent properties from other manufacturers must be used in all service work.

When using sealant and locking fluid, it is essential that the surfaces are dry and free from oil, grease, paint and anti-corrosion agent.

Always follow the manufacturer's instructions concerning temperature, hardening, etc.

Two different basic types of agent are used on the engine and these can be identified as follows:

RTV (Room Temperature Vulcanizing). Often used together with gaskets, e.g. for sealing gasket joints or for use directly on the gasket surfaces. RTV agents are completely visible on dismantled components; old RTV agent must be removed before the joint is reseaied.

The following RTV agents can be specified in the Workshop Manual: Loctite® 574, Permatex® No. 3, Permatex® No 77. Old sealant must always be removed with denatured alcolhol.

Anaerobic agents. These agents harden in the absence of air. They are used when two solid components are fitted together without a gasket, e.g. castings. Normal use also includes securing and sealing plugs, stud threads, taps, oil pressure switches, etc. Hardening anaerobic agents are vitreous and therefore coloured to make them visible. Hardening anaerobic agents are extremely resistant to solvents and old agent cannot be removed. Degrease thoroughly before applying new sealant and refitting.

The following anaerobic agents can be specified in the Workshop Manual: Loctite® 572 (white), Loctite® 241 (blue).

NB! Loctite® is a registered trademark belonging to the Loctite Corporation, Permatex® is a registered trademark belonging to the Permatex Corporation.

Safety regulations concerning fluorocarbon rubber

Fluorocarbon rubber is commonly used in sealing rings for shafts and in O-rings.

Hydrofluoric acid, which is highly corrosive, forms when fluorocarbon rubber is exerted to high temperatures (above 300°C). Skin contact can result in serious burns. Contact with the eyes can result in burns. Inhaling fumes can result in injury to the respiratory system.

WARNING! Take great care when working on engines that may have been exerted to high temperatures such as those caused by siezing up or fire. Seals must never be burnt loose when dismantling or discarded in fire in uncontrolled conditions.

- Use neoprene gloves (gloves for handling chemicals) and protective goggles at all times.
- Handle the dismantled seals in the same manner as corrosive acids. All remnants, even ashes, may be very corrosive. Never use compressed air to blow clean.
- Lay the remains in a sealed plastic jar and affix with warning labels. Wash your gloves in running water before removing them.

The following seals are with near certainty made of fluorocarbon rubber:

Seals on crankshafts, camshafts, intermediate shafts.

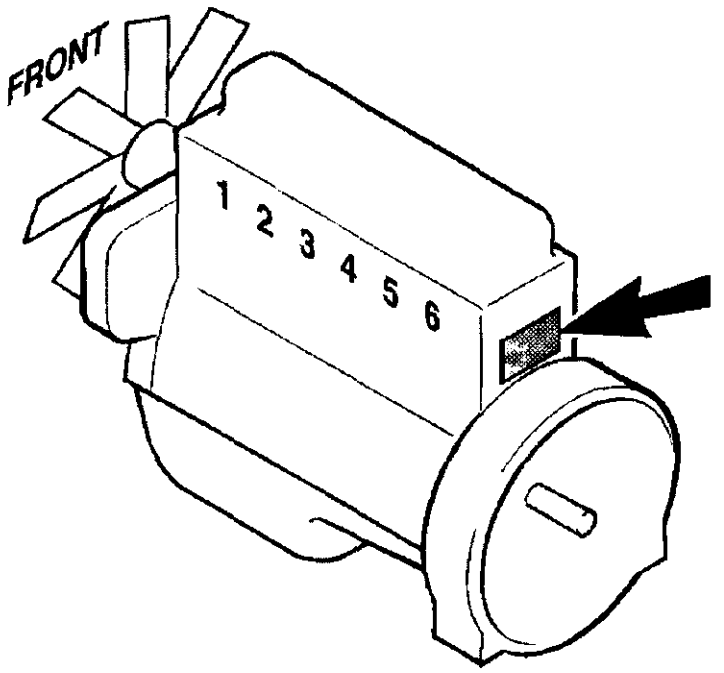
O-rings irrespective of where they are fitted. O-rings for cylinder liner seals are almost always made of fluorocarbon rubber.

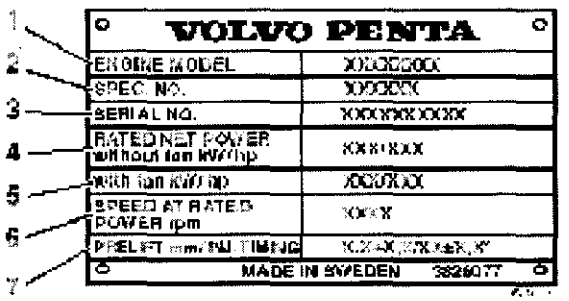
NB! Seals that have not been exerted to high temperatures can be handled normally.

Location of engine signs

The engines are supplied with two engine signs, one affixed to the cylinder block as illustrated.

The second sign is supplied separately for affixing in a suitable location in connection with the engine.





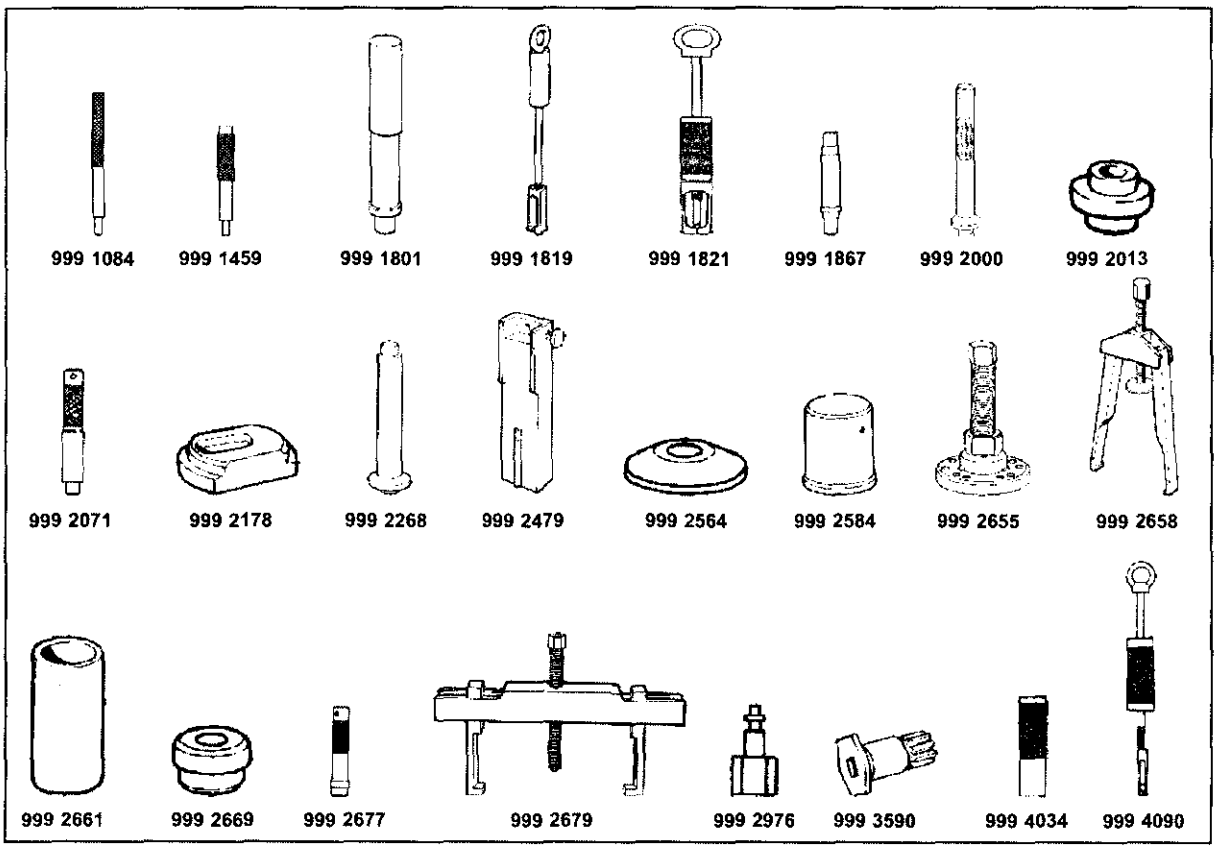
1 Engine designation
2. Product number
3. Serial number
4. Engine output, net (without fan)
5. Engine output, net (with fan)
6. Max. engine speed
7. Prelift/injection timing (BTDC)

T	–	Turbocharged
A	–	Air/air intercooler
W	–	Water/air intercooler
D	–	Diesel engine
7	–	Cylinder displacement, litres
3	–	Generation
0	–	Version
P	–	Stationary engine (Power Pac)
G	–	Gen Set Engine
V	–	Engine for stationary and mobile operation
M	–	Mobile engine
E	–	Engine with emission control

Tools

Special tools

The following special tools are required when working on the engine. These tools can be ordered from AB Volvo Penta specifying the relevant number.



999 1084-6 Drift for removing valve guides (710, 730, 731, 740)

999 1459-0 Drift for removing valve guides (610, 630, 640)

999 1801-3 Standard shank for drift

999 1819-5 Puller for flywheel bearing (610, 630, 640)

999 1821-1 Puller for flywheel support bearing(710, 730, 731, 740)

999 1867-4 Drift for changing rocker arm bushing (610, 630, 640)

999 2000-1 Standard shank for drift

999 2013-4 Drift for fitting flywheel bearing (mobile engines)

999 2071-2 Drift

999 2178-5 Plate for removing cylinder liner (710, 730, 731, 740)

999 2268-4 Drift for reconditioning coolant pump

999 2479-7 Stand for dial indicator

999 2564-6 Drift for fitting flywheel bearing (Stationary engines)

999 2584-4 Drift for reconditioning coolant pump

999 2655-2 Puller for polygon hub

999 2658-6 Puller for gear wheel on crankshaft

999 2661-0 Drift for fitting valve guide (710, 730, 731, 740)

999 2669-3 Drift for changing gudgeon pin bushing

999 2677-6 Drift for changing rocker arm bushing (710, 730, 731, 740)

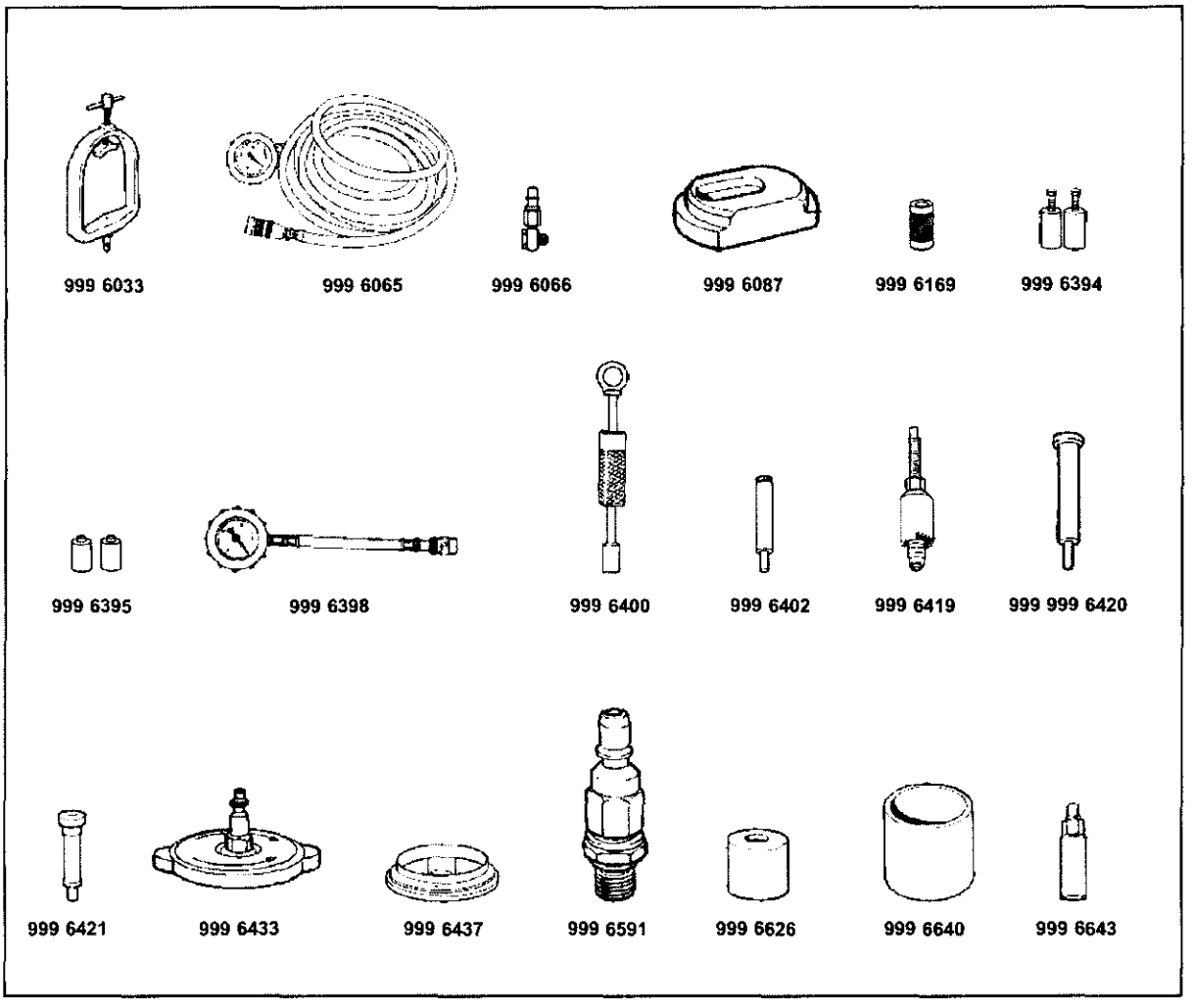
999 2679-2 Puller for timing gear wheels (710, 730, 731, 740)

999 2976-0 Nipple

999 3590-0 Rotation tool for flywheel

999 4034-8 Bushing drift for reconditioning coolant pump

999 4090-0 Puller for reconditioning coolant pump



999 6033-8 Pressure tester for oil cooler (610, 630, 640)

999 6065-0 Manometer for pressure check

999 6066-8 Nipple for pressure check

999 6087-4 Plate for removing cylinder liner (610, 630, 640)

999 6169-0 Drift for fitting valve guide (630, 730, 731, 740)

999 6394-4 Spacer for removing cylinder liner

999 6395-1 Spacer for removing cylinder liner

999 6398-5 Manometer for checking lubricant pressure

999 6400-9 Sliding hammer. Can be used with 6410 and 6657

999 6402-5 Drift for changing copper sleeve, injector

999 6419-9 Puller for changing copper sleeve, injector

999 6420-7 Drift for changing copper sleeve (710, 730, 731, 740)

999 6421-5 Drift for changing copper sleeve (610, 630, 640)

999 6433-0 Adapter (cap), used with 6662

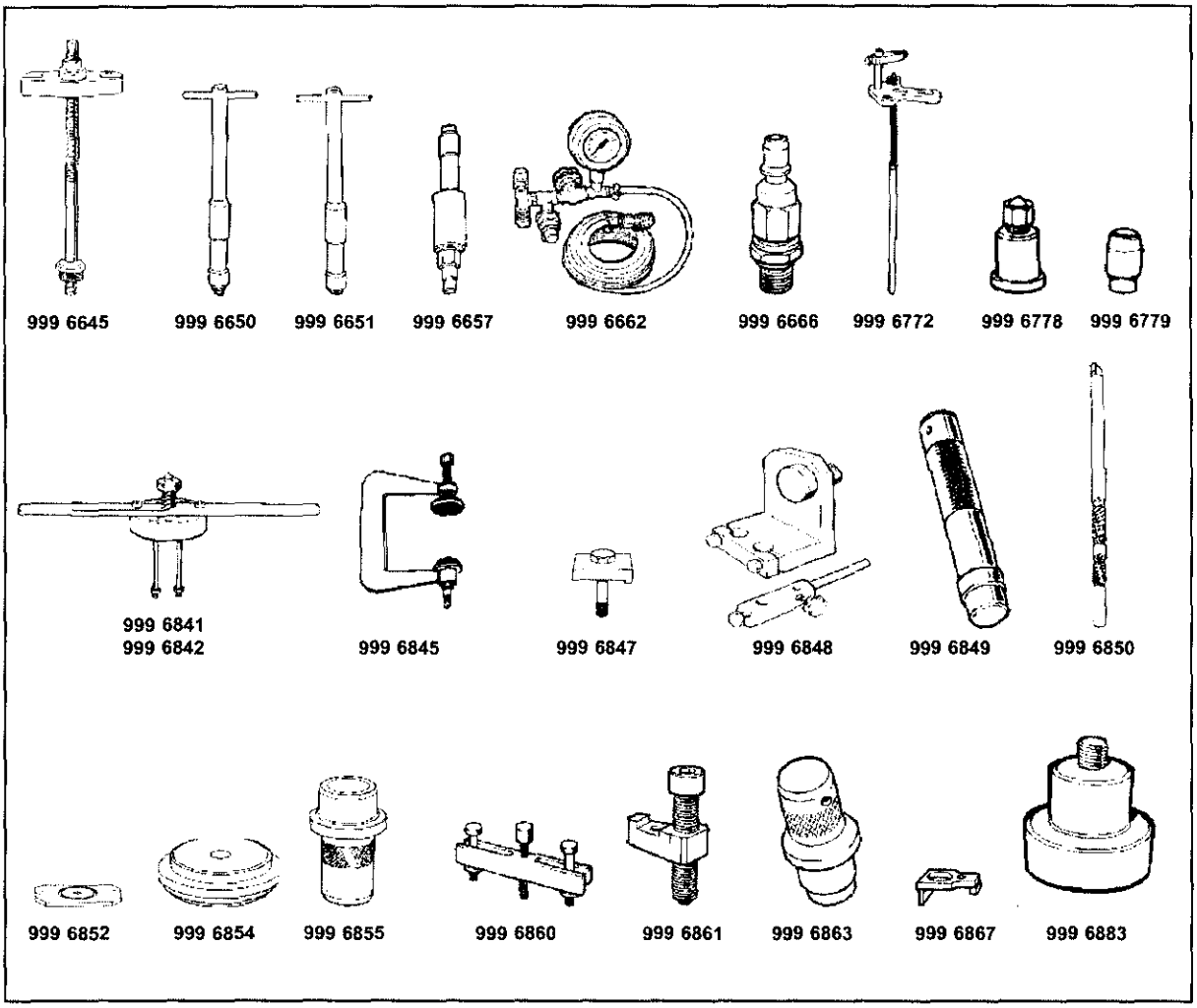
999 6437-1 Drift for changing rear crankshaft seal

999 6591-5 Nipple for checking lubricant pressure

999 6626-9 Bushing drift for overhauling coolant pump

999 6640-0 Drift, used together with puller 8011 (730, 731, 740)

999 6643-4 Puller for injector



999 6645-9 Puller for cylinder liner

999 6650-9 Cleaning tool for coopper sleeve seat

999 6651-7 Cleaning tool for coopper sleeve seat

999 6657-4 Puller for copper sleeve, injector

999 6662-4 Pressure test equipment, cooling system

999 6666-5 Nipple for checking boost pressure

999 6772-1 Measuring tool for checking camshaft wear

999 6778-8 Press tool for fitting sealing ring, pump drive output shaft (710)

999 6779-6 Puller for sealing ring, output shaft - pump drive (710)

999 6841-4 Grooving tool (610, 630, 640)

999 6842-2 Grooving tool (710, 730, 731, 740)

999 6845-5 Leak test equipment for flat oil cooler

999 6847-1 Press tool for cylinder liner

999 6848-9 Tool for setting the injection pump

999 6849-7 Drift for changing lubricant pump bushings

999 6850-5 Reamer for lubricant pump

999 6852-1 Connecting plate for leak check

999 6854-7 Press plate for cylinder liner

999 6855-4 Bushing drift for sealing ring, polygon hub

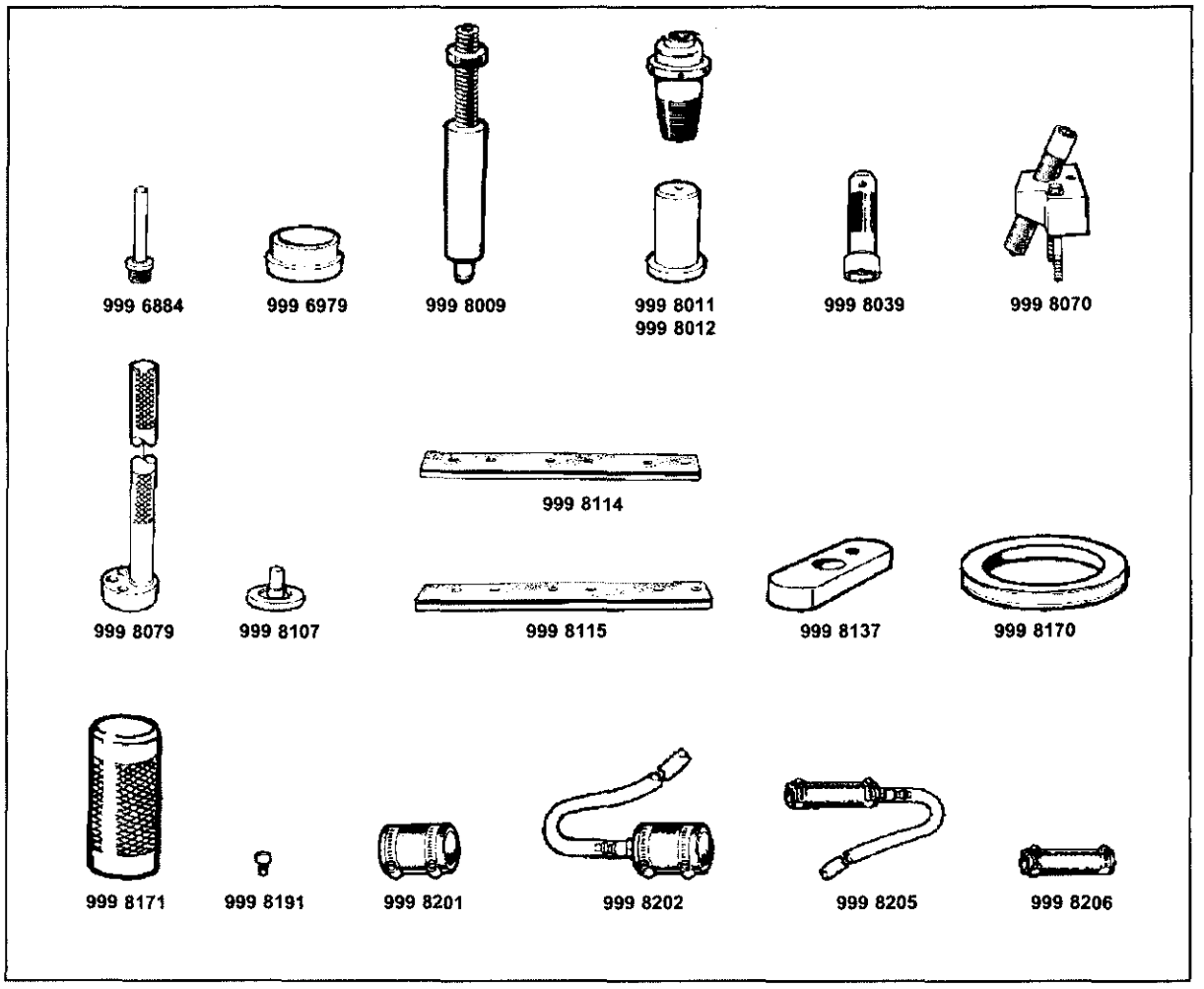
999 6860-4 Puller for lubricant pump drive

999 6861-2 Press tool for steel ring, copper sleeve (710, 730, 731, 740)

999 6863-8 Drift for changing thermostat seal sleeve

999 6867-9 Base, used together with puller 6419

999 6883-6 Adapter, for reconditioning coolant pump



999 6884-4 Drift for reconditioning coolant pump

999 6979-2 Ring for reconditioning coolant pump

999 8009-6 Adapter for compression test

999 8011-2 Puller for sealing ring, output shaft pump drive (730)

999 8012-0 Press tool for fitting sealing ring, pump drive output shaft (730, 731, 740)

999 8039-3 Drift for overhauling coolant pump

999 8070-8 Press tool for fitting copper sleeves, injectors (610, 630, 640)

999 8079-9 Lifting tool for changing camshaft

999 8107-8 Drift for overhauling coolant pump

999 8114-4 Sealing plate for cylinder head leak test (610, 630, 640)

999 8115-1 Sealing plate for cylinder head leak check (710, 730, 731, 740)

999 8137-5 Drift for overhauling coolant pump

999 8170-6 Spacer ring, used together with bushing drift 6855 for changing front crankshaft seal (630, 730, 731, 740)

999 8171-4 Drift for fitting valve guides (730, 731, 740)

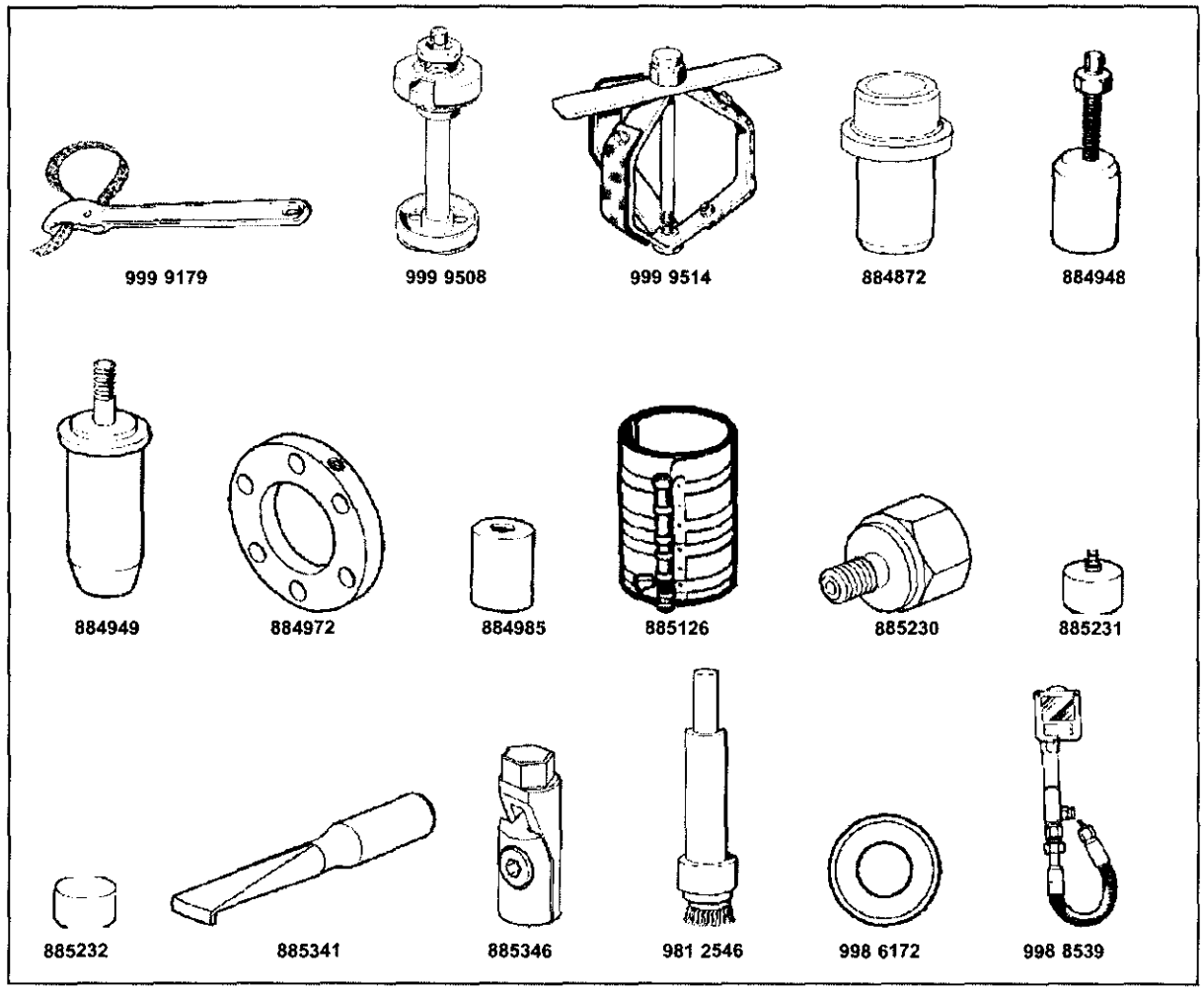
999 8191-2 Lock bolt for adjusting injection pump (TWD730ME)

999 8201-9 Sealing plug for leak test of oil cooler (710, 730, 731, 740)

999 8202-7 Hose connector for leak test of oil cooler (710, 730, 731, 740)

999 8205-0 Hose connector for leak test of oil cooler (610, 630, 640)

999 8206-8 Sealing plug for leak test of oil cooler (610, 630, 640)



999 9179-6 Tool for removing oil/fuel filter

999 9508-6 Grooving tool for cylinder liner seat (710, 730, 731, 740)

999 9514-4 Expander for rotating cylinder liner (710, 730, 731, 740)

999 9538-3 Expander for rotating cylinder liner (610, 630, 640)

999 9553-2 Grooving tool for cylinder liner seat (610, 630, 640)

884872-3 Flange kit for measuring exhaust back pressure (610, 630, 640)

884948-1 Press tool for fitting crankshaft gear

884949-9 Fitting tool for polygon hub on crankshaft

884972-1 Flange kit for measuring exhaust back pressure (710, 730, 731, 740)

884985-3 Drift for removing impeller with shaft for coolant pump

885126-3 Piston ring compression tool

885230-3 Connecting nipple for checking boost pressure

885231-1 Connection disc for leak check of intercooler (TAD engines)

885232-9 Sealing washer for leakage test of intercooler (TAD engines)

885341-8 Tool for rear crankshaft seal

885346-7 Tool for removing sealing screw

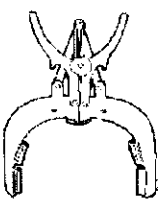
998 6172-6 Puller, air compressor gear wheel

981 2546-1 Brush for cleaning bottom of copper sleeve

998 8539-4 Compression gauge

Other special equipment

As with the special tools, the following equipment can be ordered from AB Volvo Penta using the specified part number.



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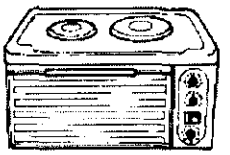

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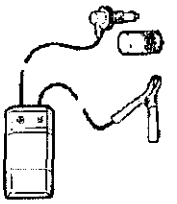

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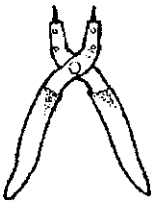

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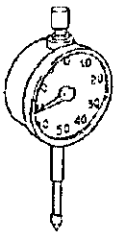
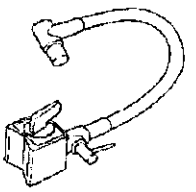


998 9876

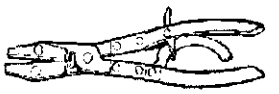
998 8460

999 9683



999 9696

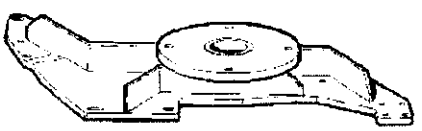
115 9795



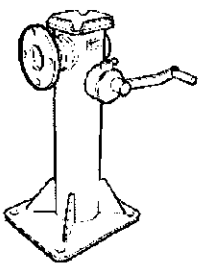
115 8957

998 5423-4 Piston ring tool
998 6981-0 Stove 220 V
998 6982-8 Stove 380 V
998 7057-8 Meter
998 8183-1 Circlip pliers

998 8460-3 Manual tachometer
998 9876-9 Dial indicator
999 9683-7 Dial indicator
999 9696-9 Magnetic stand
115 8957-0 Hose pliers
115 9795-0 Torque wrench



999 6878



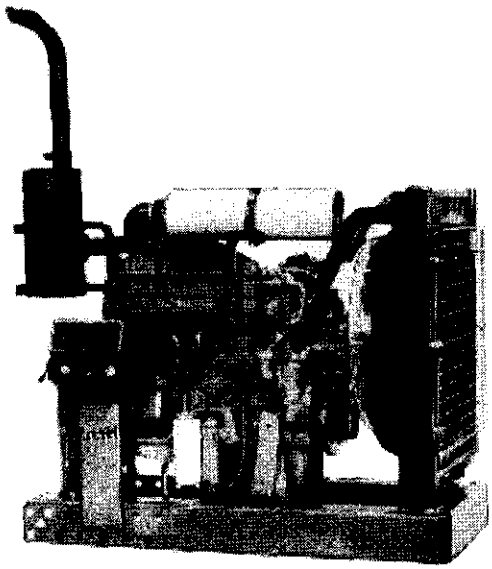
998 6485

999 6878-6 Engine fixture

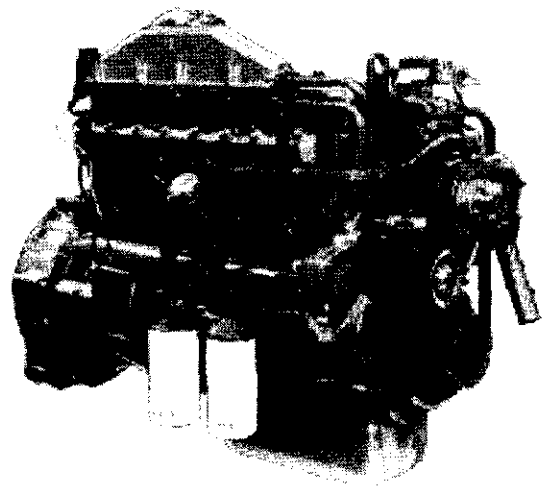
998 6485-2 Machine stand

Engine

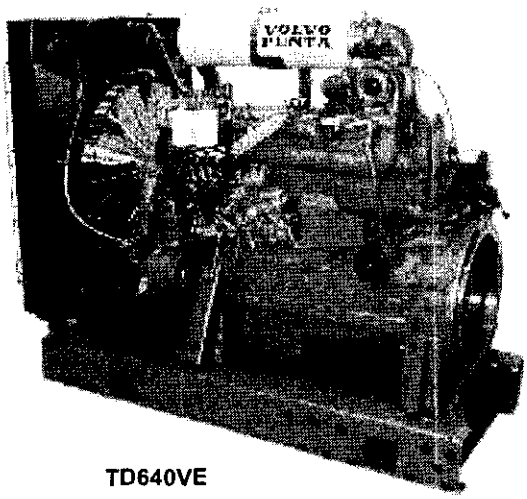
Design and function



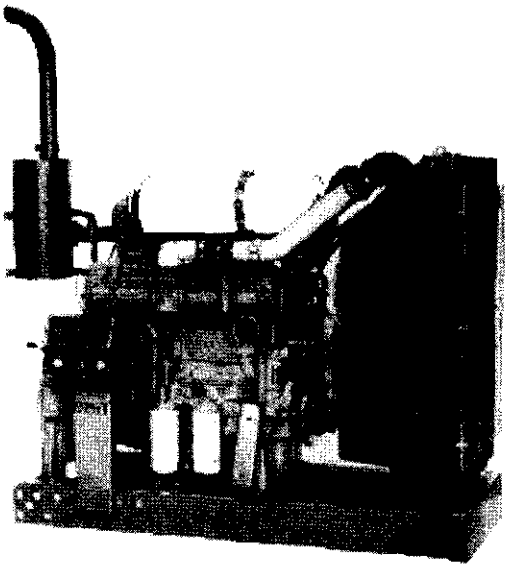
TWD610P



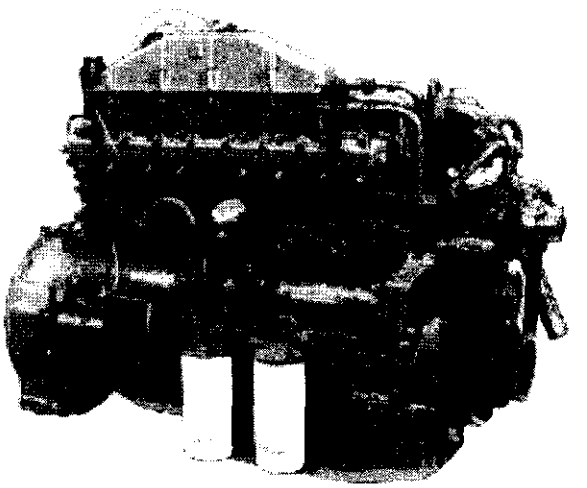
TWD630ME



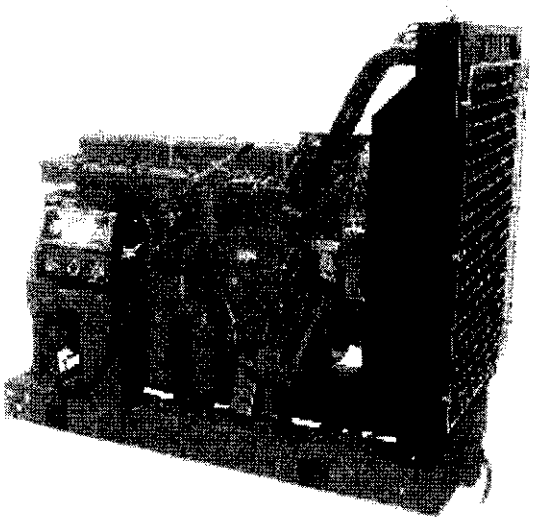
TD640VE



TAD730P



TWD730ME



TWD740GE

6 and 7 litre engines

All engine variants except TD610G/V, TD630ME/VE, TD640VE and TD730ME/VE are equipped with intercooler.

The TWD variants are equipped with water/air intercooler and the TAD variant with an air/air intercooler.

TD630ME/VE and TD730ME are equipped with injection timing adjuster.

Cylinder head

The engines are fitted with two cylinder heads, each covering three cylinders.

Each cylinder head is secured with 20 bolts evenly distributed around the cylinders.

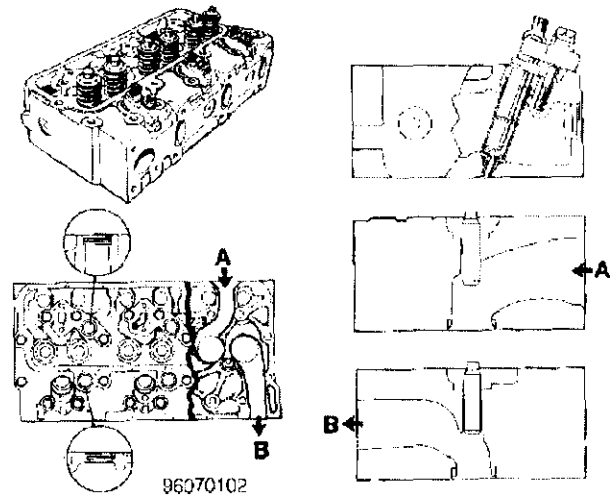
Each cylinder head has a separate intake passage (A) and exhaust passage (B).

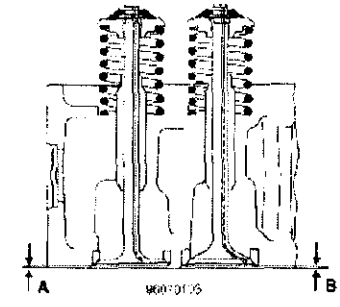
NB! In order to comply with current emission control requirements, the injector position in relation to the pistons on 630, 730, 731, 740 and 741 engines must be precisely adjusted. For this reason, the copper sleeve seat must not be machined nor must the cylinder head be refaced.

Valves

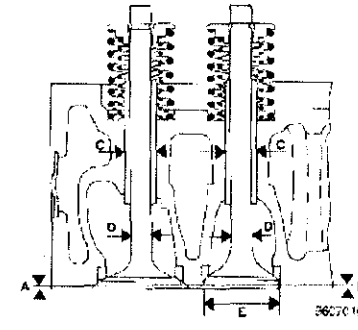
The illustrations and tables show the difference in valve locations between engines.

	A	B	C	D	E
610	0,7-1,1	0,7-1,1	-	-	-
630, 640	0,0-0,4	0,0-0,4	-	-	-
710	2,0-2,4	1,0-1,4	18	11	37
TAD730, 740, 741	0±0,2	0±0,2	18	11	37
T(W)D730, 731, 740	0-0,4	0-0,4	16	8	39

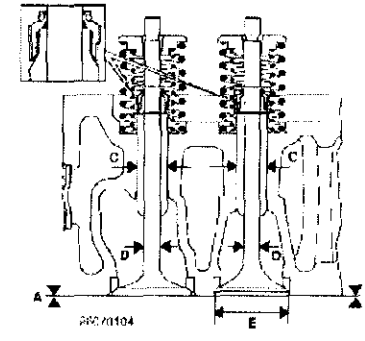




610, 630 and 640

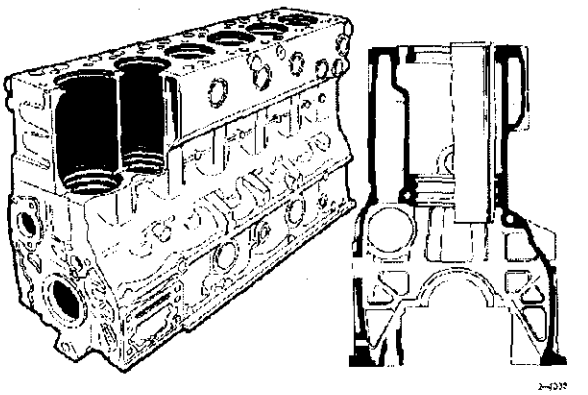


710



T(W)D730 / 731 / 740GE/VE

Cylinder block/cylinder liner



The engines are equipped with cylinder blocks with wet, exchangeable cylinder liners.

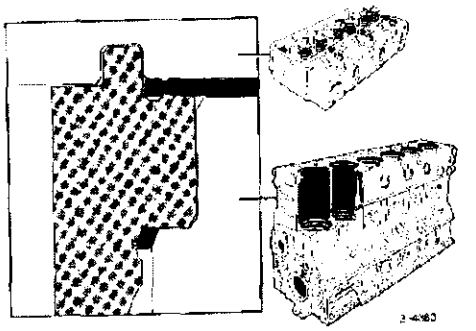
The sides of the cylinder block are dished at each cylinder and have stiffening ribs, which make the cylinder block extremely rigid.

The cylinder liners are sealed against the lower part of the cylinder block with three sealing rings.

The cylinder liners are plateau honed for lower oil consumption during the running-in period.

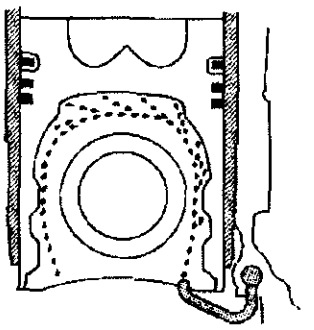
The upper cylinder block plane on the 630, 640, 730, 731, 740 and 741 engines must not be refaced since this would reduce the distance between the tops of the pistons and the vavle discs. The tips of the injectors would also come too close to the tops of the pistons and thereby affect emission levels.

Sealed joints



Seals between the cylinder block, cylinder liner and cylinder head comprise a steel gasket and grooves combined with a flame edge.

Pistons



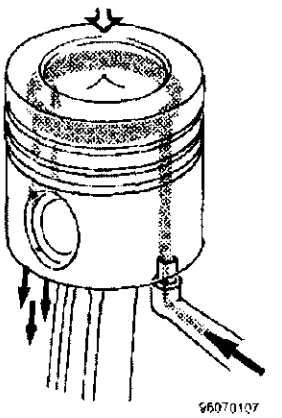
96070106

The pistons are manufactured in light alloy with two compression rings and one oil scraper ring.

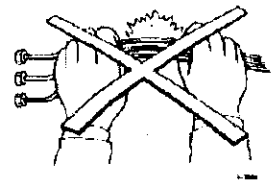
The upper compression ring is located in a special light alloy/iron retainer cast in the piston. This gives the piston ring groove a long service life despite the thermal strain.

The upper ring in 630, 640, 730, 731, 740 and 741 engines is of the "Key-stone" type to provide a better seal against the liner.

All the engines except the 610 and TD630 (piston cooling is standard in the TD630 from 139523), are equipped with piston cooling. 710-engine off- oil and. Oil is sprayed inside the upper part of the piston in the 730, 731, 740, 741 and TWD630 engines.



Fuel delivery pipe 630, 640, 730, 731, 740 and 741



The new pipes are pre-stressed (except the TD630), which means they must not be bent or reshaped in any circumstances.

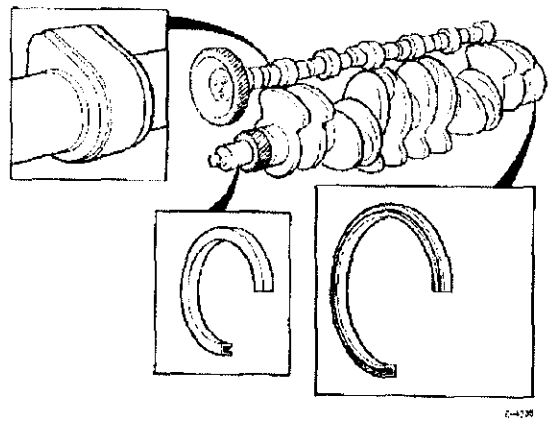
If a delivery pipe is bent or deformed, there is a risk of it breaking.

A damaged delivery pipe must be changed.

The entire pipe set must be removed when changing the injectors or injection pump.

Fuel delivery pipes for other engine versions must not be used on 630, 640, 730, 731, 740 and 741 engines.

Crankshaft/camshaft



The crankshaft, supported by 7 bearings, is drop forged and nitrocarbonized.

The front and rear crankshaft seals comprises a rubber sealing ring.

The small ends of the connecting rods are trapezoidal.

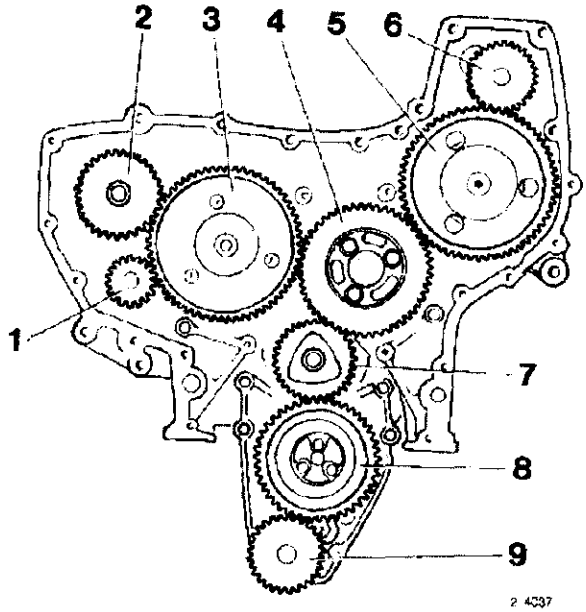
The camshaft is drop forged and induction hardened. The cams lobes are form ground.

Timing gear wheels 610, 710

The timing gear wheels can be found with three different surface treatments: case hardened, temper hardened and nitrocarbonized.

Refer to the directions concerning nitrocarbonized timing gear wheels before changing.

Timing gear wheels 630, 640, 730, 731, 740 and 741



Timing gear wheels can be found with two different types of surface treatment; case hardened and nitrocarbonized.

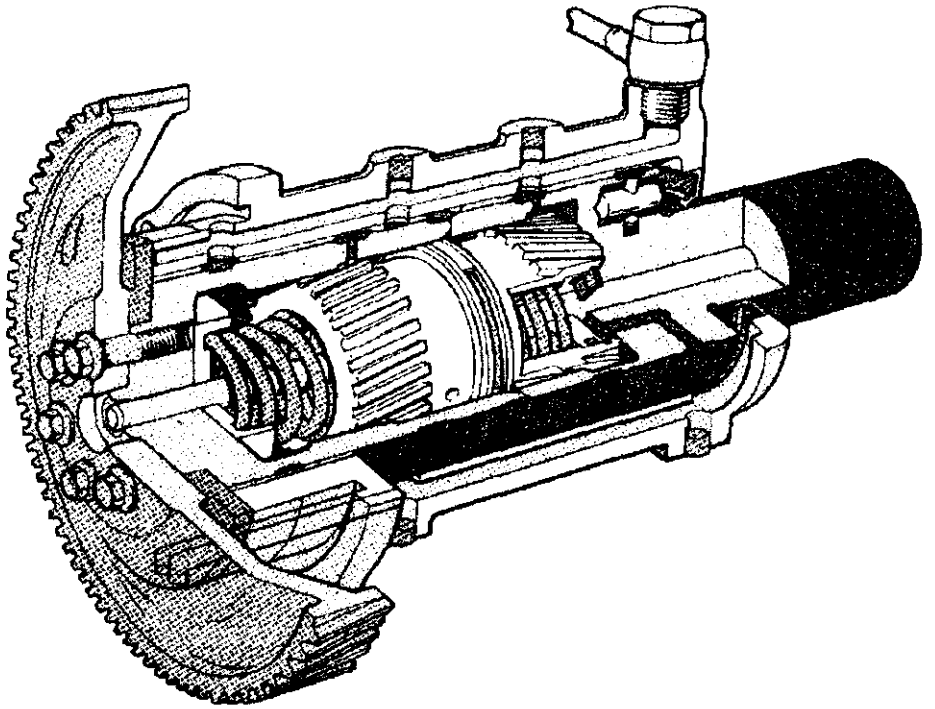
The injection pump pinion is not marked against the idler gear (TD630 does have a marking).

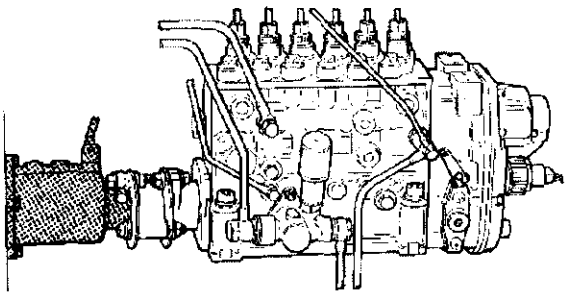
1 Servo pump gear (option)
2 Compression pinion (option)
3 Camshaft gear
4 Idler gear
5 Injection pump gear
6 Coolant pump pinion
7 Crankshaft gear
8 Idler gear
9 Lubricant pump pinion

Injection timing adjuster (TWD630ME, TWD730ME)

The injection timing adjuster is fitted on the timing gear casing and is used to provide variable injection timing depending on the engine speed.

On the front companion flange of the adjuster is the injection pump timing gear and the rear companion flange is linked to the injection pump drive shaft via a coupling.





Repair instructions

NB! Always wash the engine before starting repairs.

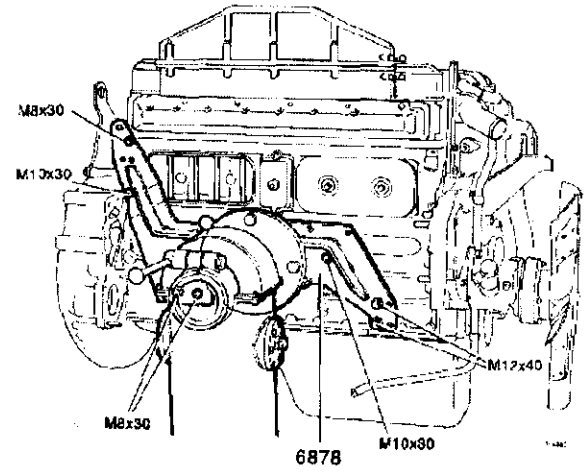
Mounting the engine fixture

Fixture 6878 is used to mount the engine on the machine stand. Screw the fixture to the right-hand side of the engine as illustrated below.

NB! It is important that the fixture is fitted to the engine according to the instructions with respect to both the number of bolts and their dimension.

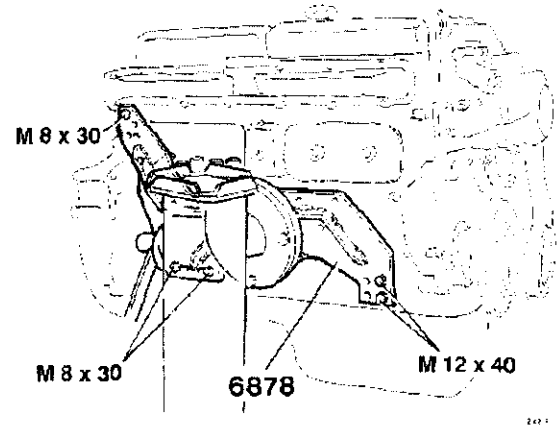
610, 630 and 610 engines

Required bolt for 610, 630, 640 engines:
- Three M8 x 30
- Two M10 x 30
- Two M12 x 40

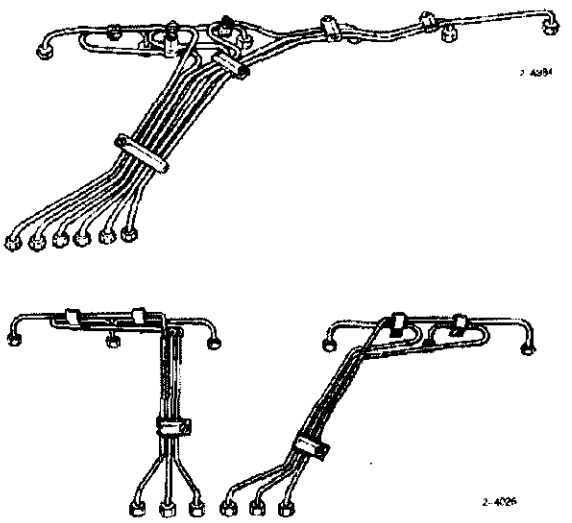


710, 730, 731, 740 and 741 engines

Required bolt for 710, 730, 731, 740 and 741 engines:
- Three M8 x 30
- Two M12 x 40



Fuel delivery pipe



630 (except TD630), 640, 730, 731, 740 and 741 engines are all fitted with pre-stressed fuel delivery pipes. The pipes must never be bent or reshaped.

If a pre-stressed pipe is bent or deformed, there is a risk of it breaking.

A damaged pipe must always be changed.

The entire pipe set must be removed when dismantling the injectors or injection pump.

Do not loosen the clamps holding the pipe set. Remove all the pipes that are clamped together instead.

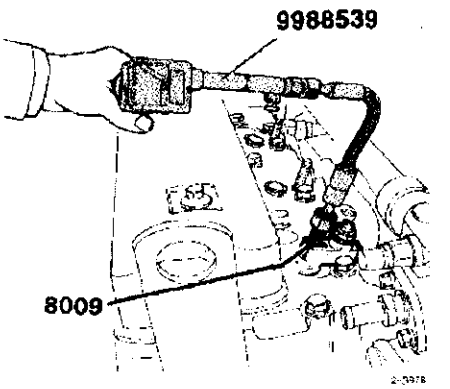
###

Compression test

NB! Removed injectors.

Special tools: 999 8009, 998 8539

1



Fit adapter *999 8009* with the injector attachment bracket and nut.

2
Connect the compression tester and perform a compression test.

Cylinder head, removing

Special tools: 999 6643, 999 6847 (2 pcs)

NB! When removing the turbocharger, the hose on the inlet side must be detached at the hose clip, not at the V-clamp.

1
Disconnect the battery earth.

2
Drain the coolant.

3
Close the fuel cock (cocks).

4
Remove air filter, fuel filter, thermostat housing and associated hoses and cables.

5
Remove the exhaust pipe and silencer where appropriate.

6
Remove the turbocharger together with the exhaust manifold.

7
Remove the intake manifold.

NB! TWD engines: Leave the intercooler in place on the intake manifold and remove them as one unit.

NB! TD, TAD engines: Leave the preheater in place on the intake manifold.

8
Dismantle the injectors. The cylinder head can be removed with the injectors in place but in this case, great care must be taken not to damage the injector jets. Remove the attachment bracket and rotate the injector with a spanner (PU-15) while pulling up the injector. If the injector is stuck, use puller 999 6643. This will prevent the copper sleeve from being pulled up.

9
Remove the valve covers. Remove the bolts securing the rocker arm bearing seats and remove the rocker arm mechanism and pushrods.

10
Remove the bolts and lift off the cylinder heads. Remove the cylinder head gaskets, rubber seals and rubber seal guides from the engine block.

NB! In cases when the crankshaft must be rotated in the engine while the cylinder head is removed, secure the cylinder liners with press tool 999 6847. One tool per cylinder liner is sufficient. Two tools must be used when measuring the height of the liner, however.

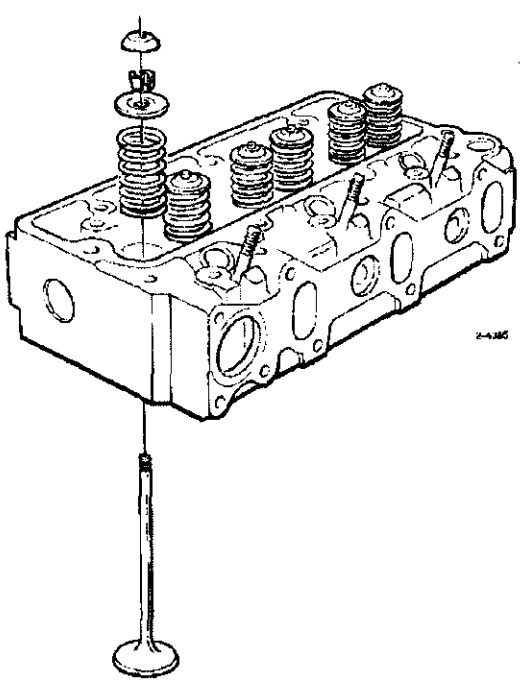
Cylinder head, dismantling/ assembling

Dismantling

1
Remove valve caps (710, 730, 731, 740 and 741), oil seals, valve collets, washers, springs and valves.

NB! Use a valve spring tool when compressing the valve springs to remove the valve collets. Place the valves in a valve stand in the order they are fitted in the engine.

2
Clean all parts, being especially thorough with the oil and coolant passages.



Assembling

1
Oil the valve stems and fit the valves. Make sure the valves are fitted in the same order as earlier.

2
Fit the valve springs and spring washers. Compress the springs with a valve spring tool and fit the valve collets.

TWD730ME/VE, 740/741/VE/GE: Fit the oil seals before putting in place the springs.

3

(610, 630, 640, 710)
Fit new oil seals.

4

(710, 730, 731, 740 and 741)
Fit the valve caps.

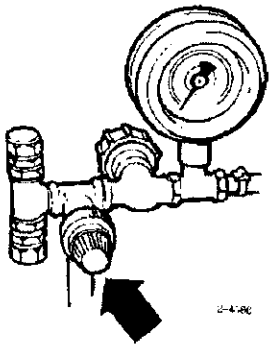
Cylinder head, leak test

NB! Cylinder head removed.

Special tools: (610, 630 and 640): 999 6662, 999 6852, 999 8114 (2 pcs) (710, 730 and 740): 999 8115 (2 pcs)

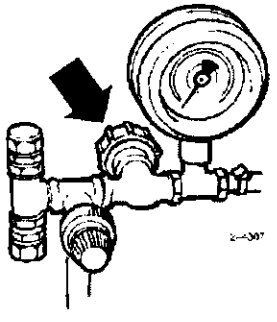
NB! The pressure test device must be checked before use.

1



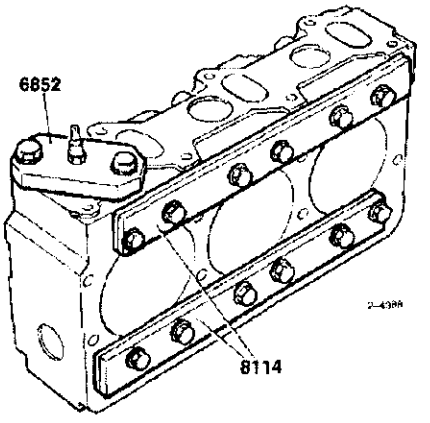
Connect the test pressure device to the compressed air supply and set the pressure gauge to **100 kPa** with the reducing valve.The knob on the reducing valve can be locked by moving a ring axially.

2



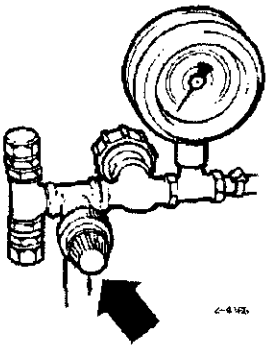
Close the valve. The pressure gauge reading must not drop for **2 minutes** if it is to be considered reliable.

3



Fit the air connection plate 999 6852 with two M10 bolts and sealing plates 999 8114 (610, 630 and 640) or 999 8115 (710, 730 and 740) with 12 M10x120 mm bolts and nut.

4

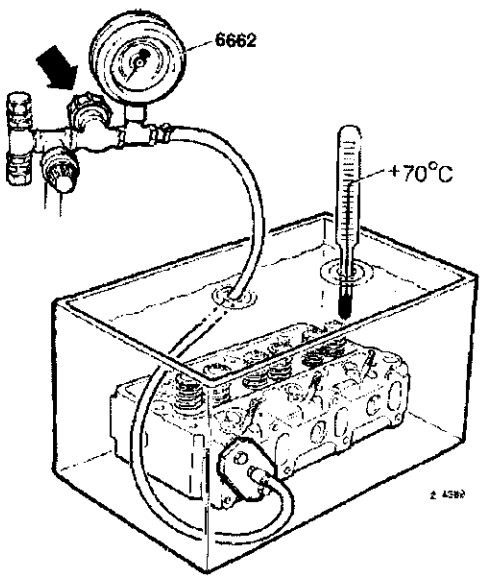


Make sure the knob on the pressure test device reduction valve is unscrewed.

5

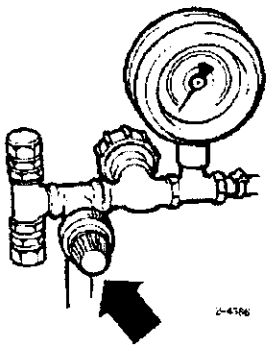
Connect the hose from the pressure test device to the air connection plate.

6



Lower the cylinder head into a **70°C** water bath and open the valve.

7

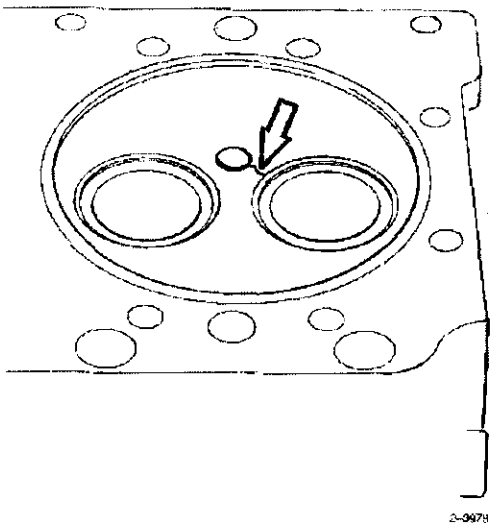


Screw in the reducing valve knob to attain a pressure of **50 kPa** on the pressure gauge. Maintain this pressure for **1 min**.

8

Increase the pressure to **150 kPa**. Lock the reducing valve with the locking ring and close the valve knob. After one or two minutes, check whether the pressure is dropping or there are air bubbles coming from the water bath.

Cylinder head, inspection



When reconditioning engines with high mileages or long driving times, occurrences of hot cracks may be evident between the valve seat and the orifice for the nozzle.

The cylinder head need not be changed or discarded due to these heat cracks unless a leak is detected during the pressure test.

Heat cracks will cease after a certain time and they have not been shown to have any significance to engine performance.

The cracks start at the injector's copper sleeve and run towards the location of the valve seat.

This type of crack can be caused by the injector attachment brackets being too tight, i.e. the incorrect tightening torque has been used.

Tests have shown that these cracks do not cause gas or coolant leaks, as they do not continue through to the bottom of the cylinder head.

Any leaks that have been found are due to impurities or damage to the copper sleeve seat. The copper sleeve seat must therefore be machined with a special tool when reconditioning, see directions for "Copper sleeve for injector, changing".

NB! The copper sleeve seat on 630, 640, 730, 731, 740 and 741 engines must not be machined.

Cylinder heads included in Volvo's exchange system may include objects with heat cracks. The cracks are always inspected during reconditioning and their presence in cylinder heads that are approved for exchange has been judged to be insignificant and the cylinder heads are guaranteed fully serviceable.

Reconditioned cylinder heads with this type of crack are therefore not to be subject to return.

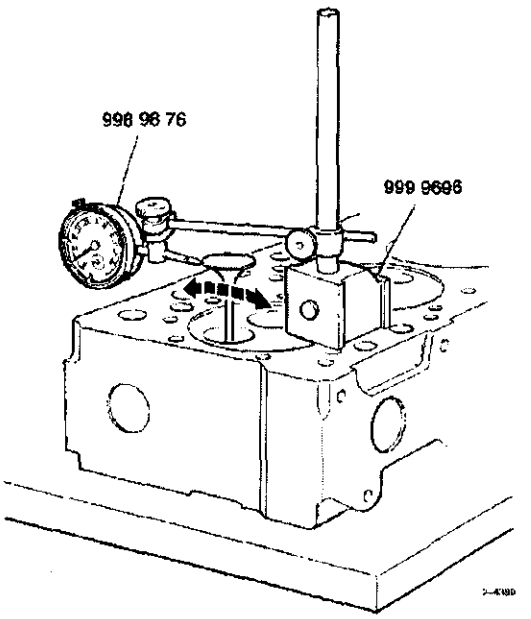
Valve guides, inspection

Special tools: 999 9696, 998 9876

1
Place the cylinder head on a flat surface and fit new valves into the guides.

The valve stems must be resting against the flat surface. If necessary, remove the injector screw studs to obtain a good contact with the surface.

2



Place a dial indicator with magnetic stand so the tip of the dial gauge is touching the edge of the valve.

Move the valve to and fro in the direction of the exhaust and intake passages. Note the value on the dial gauge.

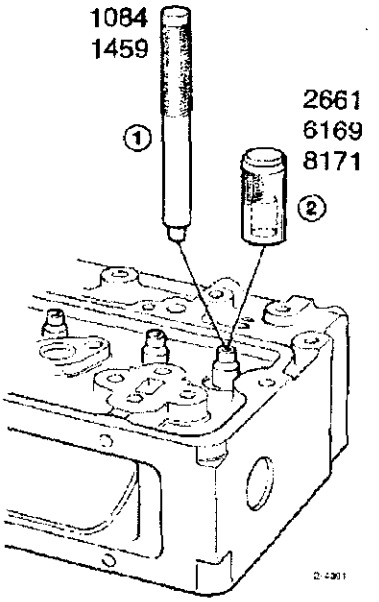
Wearing tolerance:
Inlet valve, max play 0.33 mm.
Exhaust valve, max play 0.38 mm.

The valve guides must be changed if these values are exceeded.

Valve guides, changing

Special tools: (610, 630 and 640): 999 1459, 999 6169 (710, TAD730, 740 and 741): 999 1084, 999 2661 (T(W)D730, 731 and 740): 999 1459, 999 8171

1



Press out the valve guides with a drift. See "Special tools".

2
Oil the new guides and press in them with a drift. See "Special tools".

The drift will ensure the correct height above cylinder head spring face is attained.

3
Ream the valve guides if necessary.

Cylinder head, facing, 610 and 710 engines

NB! The cylinder head on 630, 640, 730, 731, 740 and 741 engines must not be machined.

Special tools: 999 2479, 998 9876

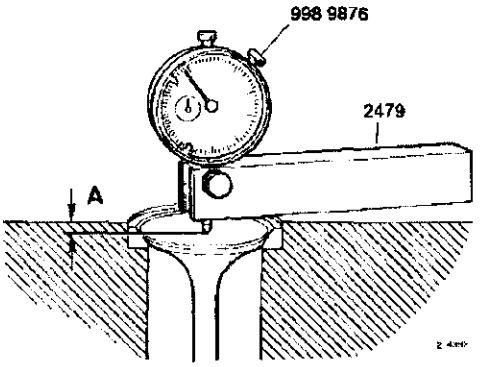
NB! Unlevelness of cylinder head must not exceed 0.03 mm.

If the unlevelness exceeds this value or if there are any blow-out ribs (all traces of the original ribs must be removed), the cylinder head must be refaced or changed.

New sealing grooves must be machined after refacing and the flame edge groove must be machined to the correct depth.

Refer to "Workshop Manual, Technical Data" concerning the minimum height of the cylinder head.

The surface finish after refacing must be **max 1.6 RA**



1

Permitted distance (A) between face of cylinder head and valve disc:

610 engines:	Inlet valve **0.7-1.1mm**
	Exhaust valve **0.7-1.1 mm**
710 engines:	Inlet valve **2.0-2.4 mm**
	Exhaust valve **1.0-1.4 mm**

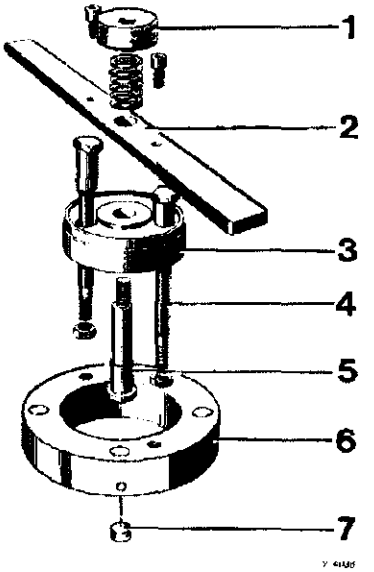
2

If further machining is required on the cylinder head then the valve seats must be reground.

Cylinder head, machining sealing grooves, 610 and 710 engines

NB! The cylinder head on 630, 640, 730, 731, 740 and 741 engines must not be machined.

Special tools: (610): 999 2479, 999 6841
(710): 999 2479, 999 6842



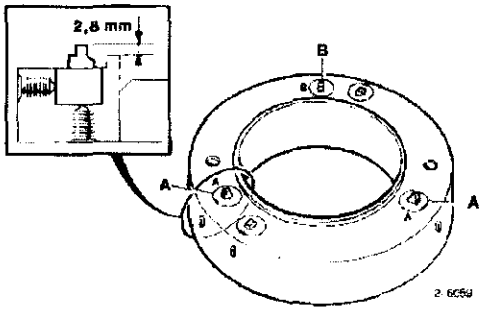
1. Nut
2. Handle
3. Guide plate
4. Retaining screw
5. Spindle
6. Cutter head
7. Cutter retainer

When machining new grooves, the cylinder head must be surfaced so that the previous grooves are removed completely.

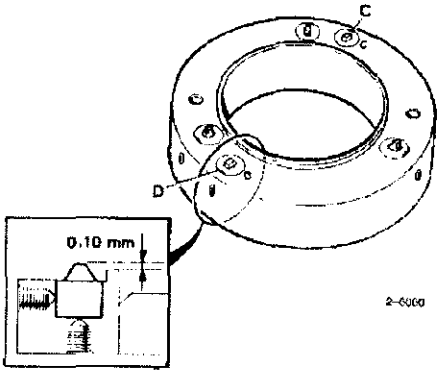
The height of the cylinder head and the distance between the face of the valve disc and the face of the cylinder head must not be less than specifications.

The grooving tool is centred on the cutter for the flame edge groove and not on the guide plate as for other grooving tools.

This is the reason for the large clearance of the guide plate retaining screws in the valve guides.



The grooving tool has five cutters.
Three of them (marked A-A-B) are for the flame edge groove and must be set to **2.8** $^{+0,1}_{-0,2}$ **mm.**



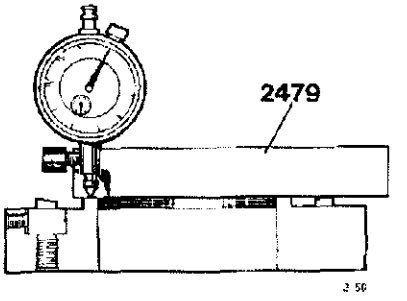
The remaining cutters (marked C-D) are for the sealing groove and must be set to **0.10 ± 0.02 mm.**

Setting cutter depth

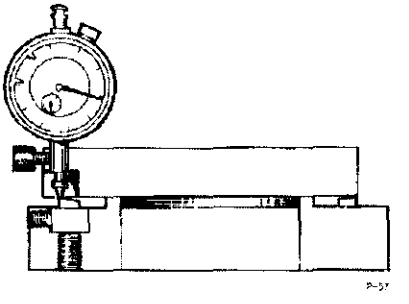
1
Fix the tool with the cutter face up.

NB! Never lay down the tool with the cutter resting on a hard surface.

2
Place a dial indicator in holder 999 2479 and place the holder over the ring-shaped shoulder of the grooving tool.

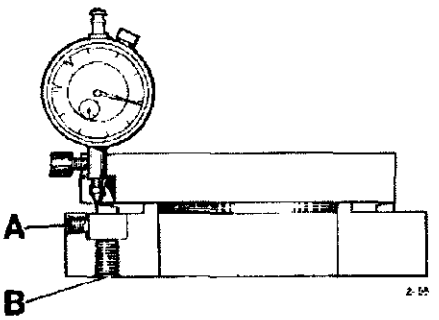


3
Zero the dial indicator against the shoulder.



4
Push the holder sideways with dial gauge so that the tip of the dial gauge is resting on the highest point of one of the cutters.

5



A. Locking screw
B. Adjusting screw

Undo the locking screw (A) with a 4 mm Allen key and the adjusting screw (B) a few turns with a 5 mm Allen key.

6
Press down the cutter retainer and tighten the locking screw until it presses against the retainer.

7
Place the tip of the dial gauge on the highest point of the cutter and screw in the adjusting screw until the correct cutter height is obtained.

8
Tighten the locking screw.

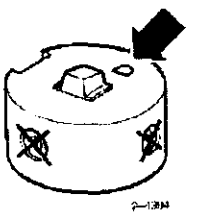
NB! Make sure the upper edge of the cutter retainer is flush with the cutter head. If this is not the case then the dial gauge has moved one revolution too many.

9
Continue to set the other cutter depths according to steps 3-8.

Changing cutter set

1
Undo the locking screw a few turns and raise the adjusting screw so that the cutter retainer can be taken out of the cutter head.

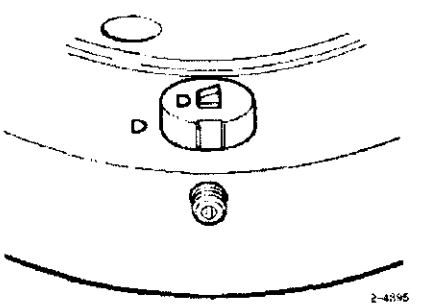
2



The cutter retainers are marked with letters (A, B, C or D) and the corresponding letter is stamped in the cutter head where the cutter retainer is to be placed.

NB! Neither of the hexagonal socket head screws in the cutter retainer must not be touched.

3



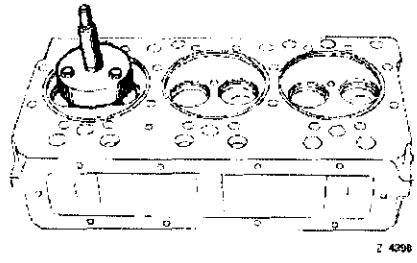
Place the cutter retainers in the cutter head according to the letter markings with the grooves facing the locking screws. Adjust as instructed.

Machining grooves

1
Place the cylinder head in a vice.

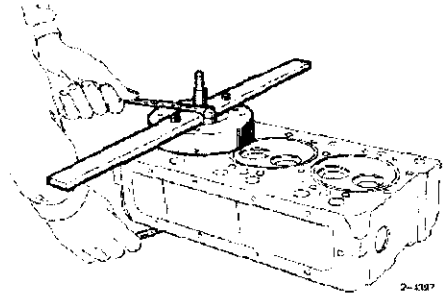
2
Make sure the cylinder head face is thoroughly clean.

3



Place the tool guide plate on the cylinder head but do not tighten the retaining screw nuts.

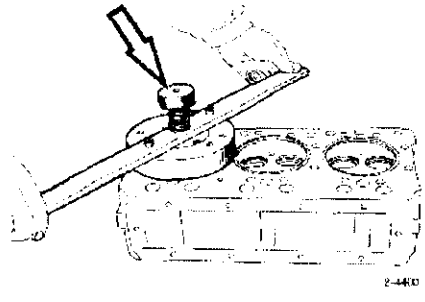
4



Carefully place the cutter head on the guide plate while twisting it so the tool centres in flame edge groove.

NB! Do not tighten the retaining screw nuts too hard as the valve guides may then be drawn into the cylinder head.

5



Fit the spring and nut. Tighten the nut loosely.

6
Turn the tool clockwise in a smooth movement without jerking. The cutter feed is automatic as the nut follows the turning motion and gradually compresses the spring.

7
Turn the tool until it stops cutting. Then remove the nut and lift off the cutter head.

8
Clean the cylinder head thoroughly. Check the groove depth by replacing the cutter head without the spring and nut and rotating it a few turns with hand pressure. If the tool does not cut any more then the grooves are the correct depth. This check must always be performed as metal chips can fasten under the cutter head shoulder. Any burrs must be left on the edges of the grooves. Removing them may damage the grooves and impair the sealing properties of the grooves.

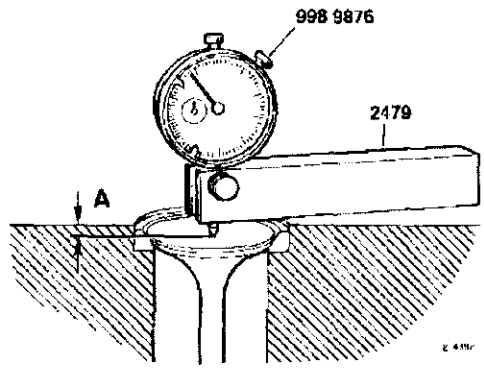
NB! The finished groove must be checked with a dial indicator when using the grooving tool for the first time after adjusting the cutters.

During this check, any burrs must be removed from the edge of the groove so that the dial gauge stand is completely flat against the cylinder head.

Valve seats, changing

Special tools: 999 2479

1



The valve seat should be changed when (A), measured using a new valve, exceeds the distance specified in "Valve seats, grinding" below or "Workshop Manual, Technical Data".

2
Remove the old seat by grinding two diametrical notches in the seat and splitting it with a cold chisel.

NB! Take care not do damage the cylinder head.

3
Clean the seat position thoroughly and check the cylinder head for cracks.

4
Measure the diameter of the valve seat position. Find out whether to use a seat of standard dimension or an oversize. Machine the valve seat position.

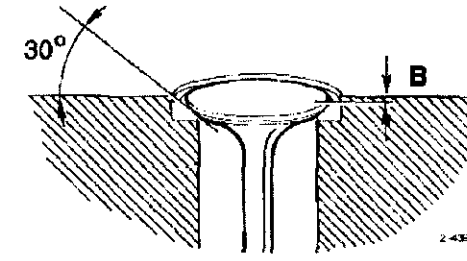
5
Cool the seat with dry ice to between **–60°C and –70°C** and heat the cylinder head with warm water or other suitable method. Press in the seat with a drift. Machine the seat to the correct angle and width.

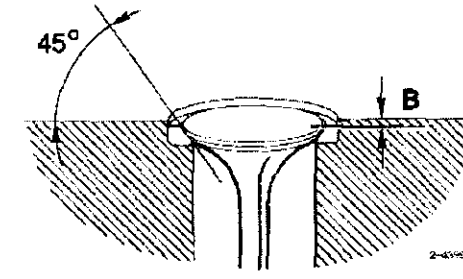
Valve seats, grinding

1
Before grinding, inspect the valve guides and change them if the wear limits have been exceeded.

Grind the seats just enough to give them the correct form and a good contact surface.

2





Grind a new valve seat so that the distance between the cylinder head face and the surface of the valve disc (B) when measured with a new valve is:

	Inlet valve (mm)	Outlet valve (mm)
610:	0.7-1.1	0.7-1.1
630, 640:	0.0-0.4	0.0-0.4
710:	2.0-2.4	1.0-1.4
T(W)D730 731, 740:	0.0-0.4	0.0-0.4
TAD730, 741:	0.0±0.2	0.0±0.2

3
Apply a thin layer of colour marker to the contact surface of the seat and then check its angle with a valve seat gauge.

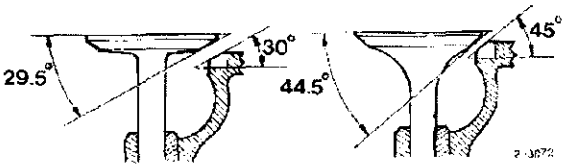
Valves, grinding

Valve sealing angles:

Inlet: 29.5°

Exhaust: 44.5°

1



The sealing surface is to be ground as little as possible but enough to remove any damage.

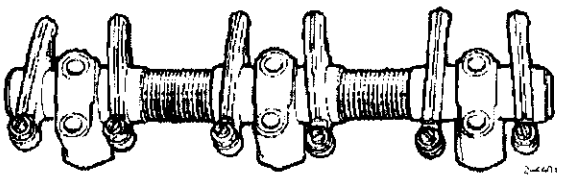
2
If edge of the valve disc is less than the specified minimum
value (see "Workshop Manual, Technical Data"), the valve must be changed. Change also any valves with bent valve stems.

3
Check the sealing tightness with a colour marker or similar. If there is a leak, grind the valve seat again, not the valve, and recheck.

Rocker mechanism, reconditioning

Special tools: (610, 630, 640): 999 1867
(710, 730, 731. 740, 741): 999 2677

1



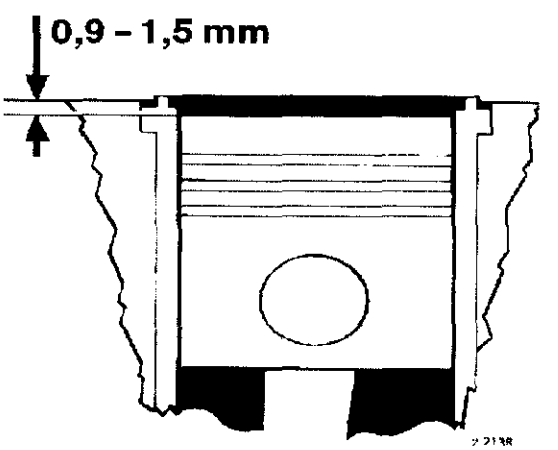
Remove the locking rings, rocker arms, bearing brackets and springs from the rocker arm shaft.

2
Clean all the parts, being especially careful with the oil passage in the bearing bracket and the oil holes in the rocker arm shaft and rocker arms.

3
Check the rocker arm shaft and ball screws for wear. The threads on the ball screw and lock nut must not be damaged. The valve contact ball on the rocker arms must not be worn or concave.

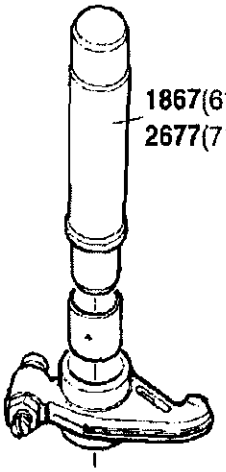
Change the rocker arm bushings if they are worn oval.

4



Press out the bushing with drift 999 1867 (610, 630, 640), 999 2677 (710, 730, 731, 740, 741).

5



1867(610, 630, 640)
2677(710, 730, 731, 740, 741)

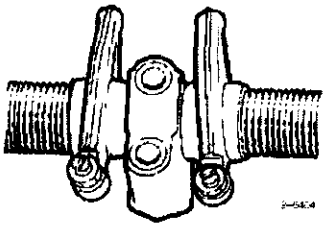
Turn over the drift* and press in a new bushing.

NB! Make sure the oil hole in the bushing is aligned with the oil passage in the rocker arm.

*999 1867 only

6
Machine ream the bushing.

7



Oil the rocker arm shaft and refit the bearing brackets, rocker arms, springs and locking rings.

NB! The rocker arms are placed in opposing pairs.

Cylinder head, fitting

NB! Torques referring to the intercooler do not apply to TD engines.

Special tools: 999 2479, 999 6847

IMPORTANT! Neither fuel nor pressure pipes may be bent or reshaped as this will cause cracks that may result in breakage.

1
Clean the contact surface on the cylinder block. Remove any rust and carbon from the bolt holes with a 9 mm drill bit (by hand). Clean the threads with a screw tap, M11x1.5. Remove all loose particles. Measure the liner height above the face of the block, see "Workshop Manual, Technical Data".

2
Oil the contact surfaces of the cylinder block and cylinder head with a thin layer of anti-corrosion fluid (part no 282036-3). Fit a new gasket and new sealing rings.

3
If the rear cylinder head has been removed, use new sealing rings when fitting the coolant distributor pipe and attachment.

4
If the front cylinder head has been removed, fit a new sealing ring in the thermostat housing.

5
Lift the cylinder head in place.

6
Check the cylinder head bolts.

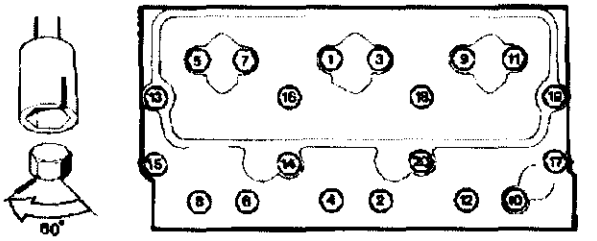
NB! The bolts are phosphatized and must not be cleaned with a wire brush. If the bottom of the bolt heads or the threads are scratched then they must be changed.

Dip the cylinder head bolts in anti-corrosion agent and place them on a net to drip dry.

7
Fit the cylinder head bolts and tighten them.

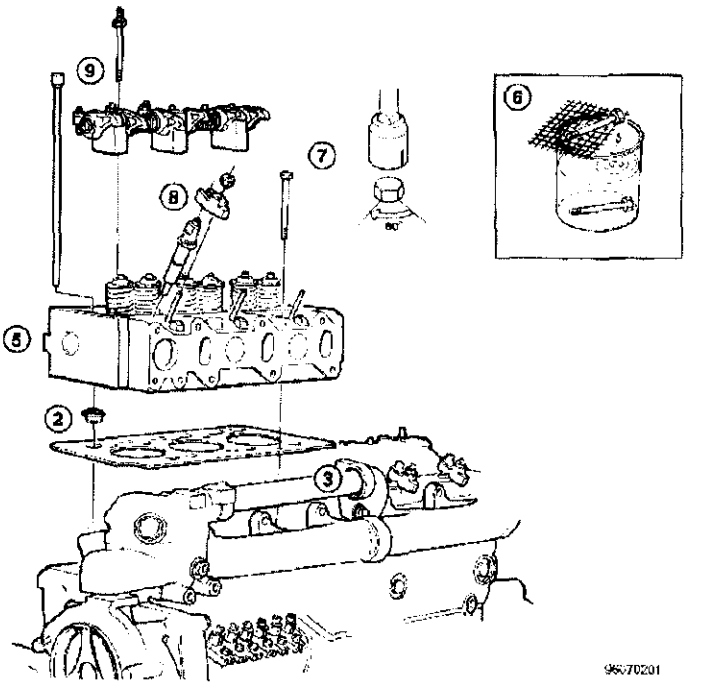
The cylinder head bolts are tightened in 4 stages:

	6 litre	7 litre
First stage	30 Nm	30 Nm
Second stage	85 Nm	90 Nm
Third stage (check)	85 Nm	90 Nm
Fourth stage (angle tightening)	60°	60°



8
Fit the injectors and torque tighten the attachment brackets to **50 ± 5 Nm**.

9
Fit the pushrods in the correct order and fit the rocker bracket. Torque tighten the bolts and adjust the valves.



10
Fit the valve cover (covers).

11
Screw on thermostat housing.

12
Fit the exhaust manifold with new gaskets. Tightening torque **48 ± 5 Nm**.

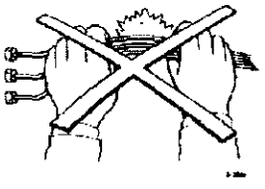
NB! Turn the gaskets with the bare metal surface towards the exhaust manifold.

13
Bolt on the turbocharger delivery and return oil pipes with new gaskets.

14
Fit the temperature sensor.

15
Fit the fuel return pipe. Use new copper washers.

16
Fit the fuel delivery pipes.



IMPORTANT! The fuel delivery pipes must never be bent or reshaped. A damaged fuel delivery pipe must be changed.
The fuel delivery pipes intended for 610 or 710 engines must not be used on 630, 640, 730, 731, 740 or 741 engines.

17
TD and TAD engines

Apply a bead of sealant approx. **2 mm** wide to the intake manifold. Fit the intake manifold complete with pre-heater and relay.

TWD engines

Fit a new gasket. Fit the intake manifold complete with intercooler, pre-heater and relay.

18
Fit the connecting pipe between the housing over the intercooler and the turbocharger.

Use new seals.

19
Detach the oil return pipe from the turbocharger.

Crank the engine using the starter motor with the injection pump in stop position until a steady flow of oil emerges from the return oil opening.

20
Refit the oil return pipe and check for leaks.

21
Check the engine oil level and top up if necessary.

Copper sleeve for injector, changing

Special tools: (610, 630, 640): 999 6421, 999 8070 (710, 730, 731, 740, 741): 999 6420, 999 6861 (all): 999 6402, 999 6419, 999 6643, 999 6650, 999 6651, 999 6657, 999 6867

IMPORTANT! Neither fuel nor pressure pipes may be bent or reshaped as this will cause cracks that may result in breakage.

NB! The copper sleeves fitted to the 630, 640, 730, 731, 740 and 741 engines in production are **approx. 1 mm shorter** than the ones supplied as spare parts.

This means that the new steel ring that is pressed in when changing copper sleeve will be **approx. 1 mm higherin** the cylinder head than the one fitted in production.

1
Clean around the injectors and pipe connections.

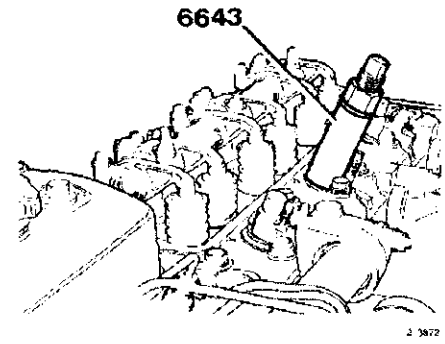
2
Remove the valve covers.

3
Remove the fuel return pipe and plug the connections.

4
Remove the fuel delivery pipes and plug the connections.

NB! Do not undo the clamps on the pipe set but remove all the pipes that are clamped together.

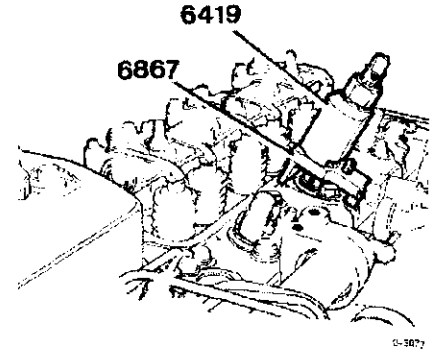
5



Remove the injector attachment bracket and dust protector.

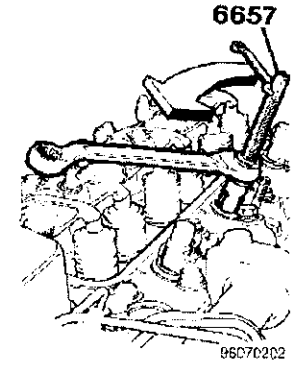
6

Rotate the injector with a 15 mm polygon wrench while pulling up the injector. Use puller 999 6643 if necessary .



7

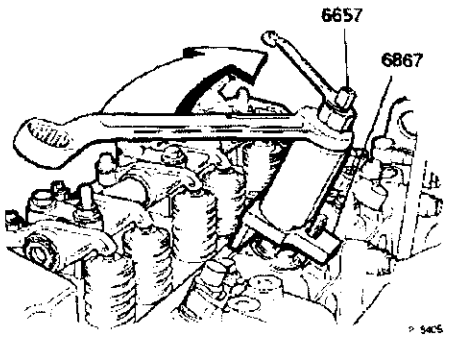
Remove the steel ring with puller 999 6419 and base 999 6867.



8

Pull out the steel ring with puller 999 6657.
First push down the puller spindle to the bottom of the copper sleeve.
Hold the puller and screw the spindle anticlockwise until the tool grips firmly to the sleeve.

9

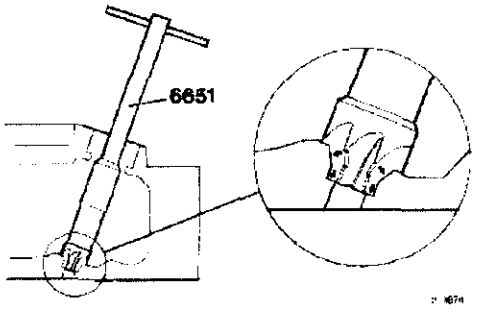


Once the tool has gripped firmly on the sleeve, fit base 999 6867 and place the puller sleeve on the spindle.
Pull out the copper sleeve by turning the nut while holding the spindle.

10

Make sure the lower sealing surface for the copper sleeve in the cylinder head is clean. If it is damaged or coated in carbon deposits, it must be cleaned.

NB! Cutting tools must not be used on 630, 640, 730, 731, 740 or 741 engines.



11

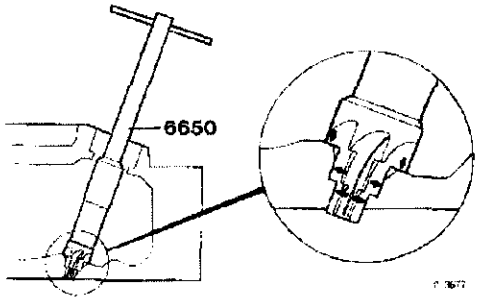
610 and 710 engines only:

Clean in two stages. First clean using cutting tool 999 6651 until it bottoms on the upper face.

NB!Clean only if it is absolutely essential, as the position of the injector in the cylinder head changes each time.

12

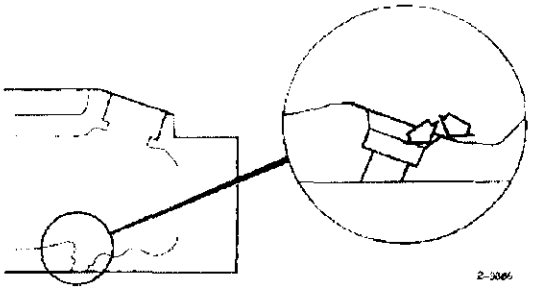
610 and 710 engines only:



Continue cleaning using cutting tool 999 6650 until it bottoms on the face below the cone.

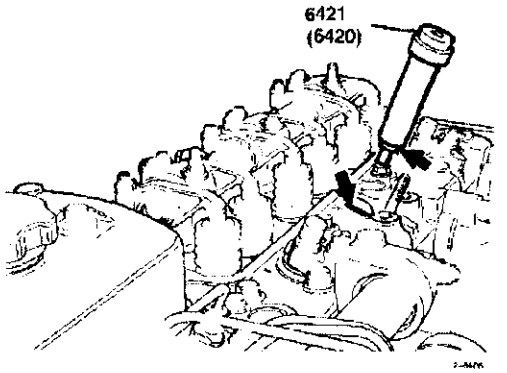
13

610 and 710 engines only:



Check the sealing surfaces. Repeat the cleaning process if necessary. Make also sure that the seat for the upper seal is clean.

14



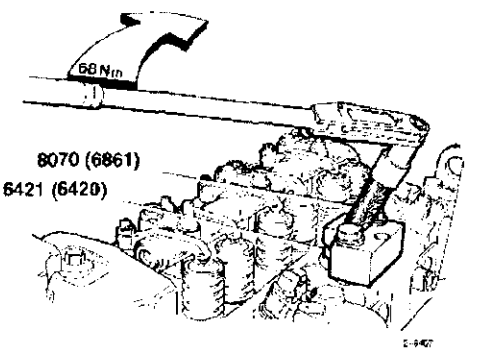
Remove the cylinder head bolts closest to the copper sleeve.

Apply petroleum jelly or soap water to the upper sealing ring and place it in the cylinder head.

Fit the lower sealing ring onto the copper sleeve.

Fit a new steel ring and copper sleeve onto drift 999 6421 (610, 630, 640) or 999 6420 (710, 730, 731, 740, 741) and lower the copper sleeve into the cylinder head.

15



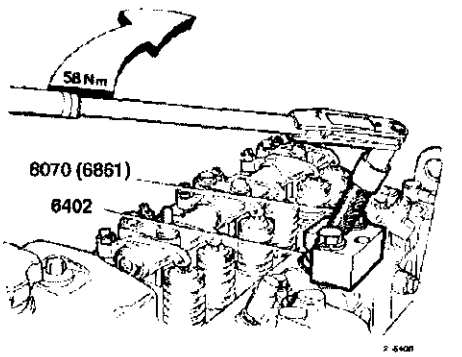
Fit press tool 999 8070 onto drift 999 6421 (610, 630, 640) or 999 6861 onto drift 999 6420 (710, 730, 731, 740, 741). Press down the steel ring and copper sleeve by depressing the press tool with **68 Nm**.

NB! Always change steel ring and copper sleeve at the same time in order to obtain the correct clearance between ring and sleeve.

16

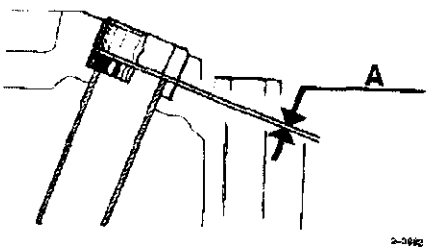
Remove the press tool and drift.

17



Fit drift 999 6402 and press tool 999 8070 (610, 630, 640) or 999 6861 (710, 730, 731, 740, 741) and press down the copper sleeve by depressing the press tool with **58 Nm**.

18



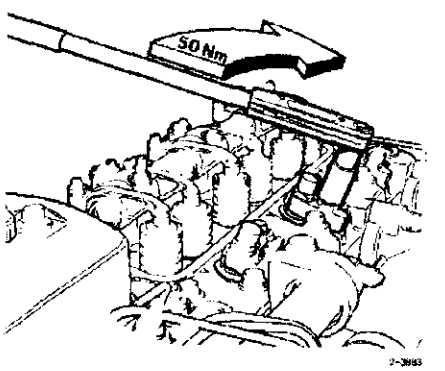
By using a new steel ring and pressing in two stages with different pressures and different drifts, the correct clearance can be obtained between the steel ring and the copper sleeve.

The clearance (A) must be **0.10–0.45 mm**.

19

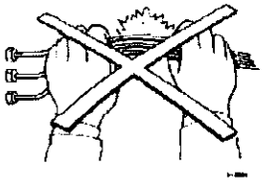
Refit the cylinder head bolts and tighten them alternately in four stages, see "Cylinder head, fitting.

20



Fit the injector, dust protector and attachment bracket. Torque tighten the attachment bracket nut to **50 ± 5 Nm**.

21



Fit the fuel delivery pipes, fuel return pipes and valve covers.

IMPORTANT! The fuel delivery pipes must never be bent or reshaped. A damaged fuel delivery pipe must be changed.

22
Perform a leak check.

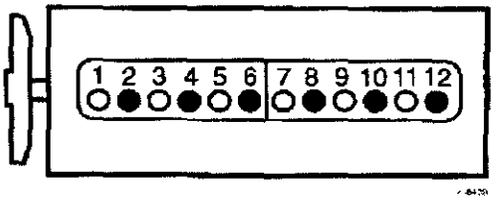
Valves, adjusting

Special tools: 999 3590

Valve location and valve clearances:

○ Inlet 0.40 mm

● Exhaust 0.55 mm

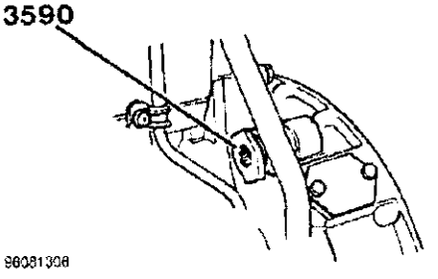


Valve adjustment must be carried out on a stationary and cold engine.

If a stop control is fitted, make sure it is pulled out and that the starter key is turned off. If the engine is equipped with an electromagnetic or pneumatic stop device, make sure the control on the injection pump is in stop position.

IMPORTANT! The valves must not be adjusted while the engine is running as the pistons may strike the valve discs.

The valves can be adjusted according to the two-position method.



1

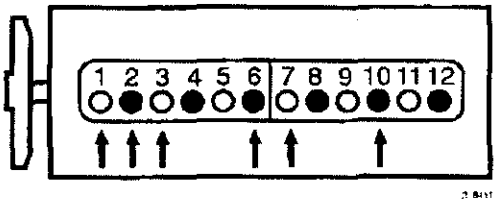
Remove the valve covers.

2

Fit rotation tool 999 3590.

3
Turn the engine in the direction of rotation until piston 1 is in TDC after the compression stroke (0° on the flywheel).

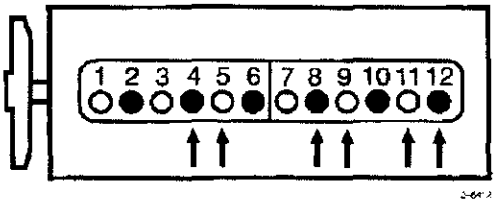
4



Adjust valves: 1, 2, 3, 6, 7, 10.

5
Turn the engine again in the direction of rotation (one turn) until piston 6 is in TDC after the compression stroke (0° on the flywheel).

6



Adjust valves: 4, 5, 8, 9, 11, 12.

7
Change valve cover gaskets if necessary and refit the valve covers.

8
Remove the rotation tool.

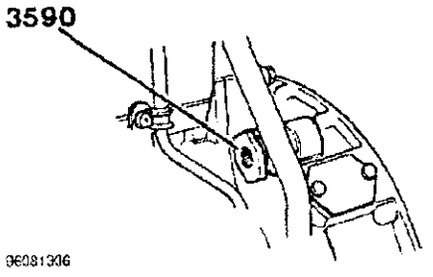
Cylinder liner with piston, removing

NB! Cylinder head and oil tray removed.

Special tools: (610, 630, 640): 999 3590, 999 6087 (710, 730, 731, 740, 741): 999 2178 999 6394 (2 pcs), 999 6395 (2 pcs), 999 6645, 999 6847 (2 pcs)

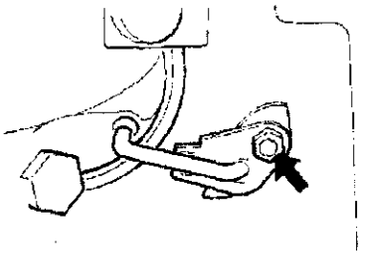
1
Fit the press tool on the cylinder liners that are not to be removed.

2



Fit the rotation tool and turn the flywheel until the connecting rod to be removed is in position.

3

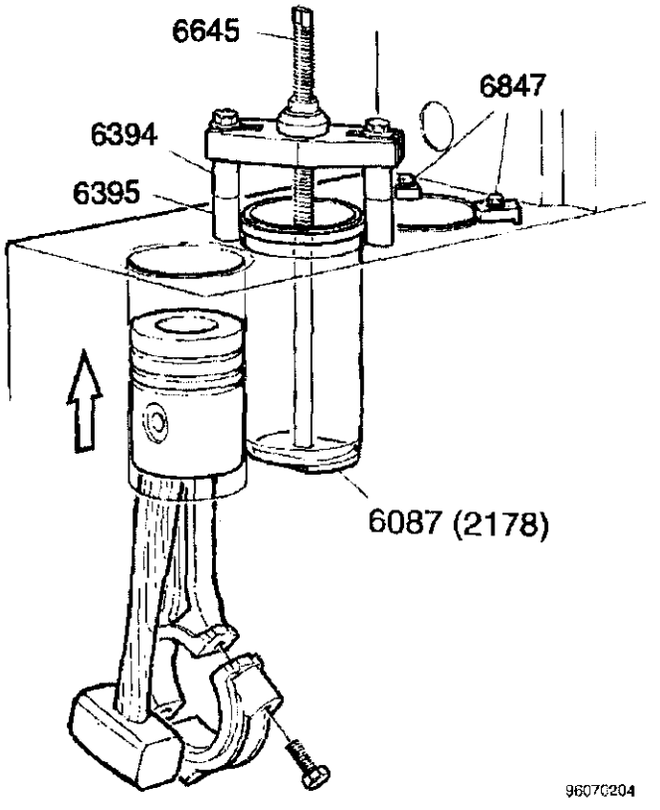


Remove the piston cooling nozzle where appropriate.

4
Remove the big end bearing caps and bearing shells.

5
Press up the piston with the handle of a hammer far enough for the piston rings to appear above the edge of the cylinder liner and lift out the piston and connecting rod.

6
Mark the position of the cylinder liner in the block with a felt-tip pen and pull out the cylinder liner.



Cylinder liner with piston and piston rings, inspection

Cylinder liners and pistons are to be cleaned thoroughly prior to inspection and measurement. The cylinder liner must be removed from the cylinder block in order to perform a thorough inspection for cracks.

The position of the cylinder liner must be marked with a felt-tip pen before removal.

NB! Cylinder liners and pistons are classified together. This means that the piston must be fitted into a cylinder liner with the same classification.

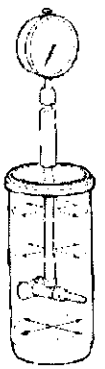
Spare pistons and cylinder liners are supplied as a complete unit only.

Cylinder liner

1

Carry out an inspection for cracks, being especially thorough when checking the liner collar. The magnaflux method of checking for cracks can be used.

2



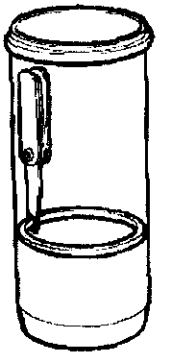
96070205

Measuring wear with a cylinder indicator:
In order to obtain a precise wear reading, the cylinder indicator must first be adjusted using a gauge ring or micrometer.

Use the original diameter of the cylinder liner as a starting value.

Measure at the top and bottom dead centres of the cylinder liner as well as at several points in between. Each measuring point must be checked longitudinally and transversely.

3



96070206

Measuring wear with a piston ring (alternative method)
The liner wear can easily be determined by placing a new piston ring at top dead centre and measuring the play of the piston ring. This is then compared with the pinston ring play under bottom dead centre. Wear is calculated by dividing the difference by 3.14.

Example:

Piston ring play with no wear ..... 0.35 mm

Piston ring play at TDC ..... 1.30 mm

Difference: 1.30 – 0.35 mm = ... 0.95 mm

Wear diameter: $\frac{0.95 \text{ mm}}{3.14}$ = 0.30 mm

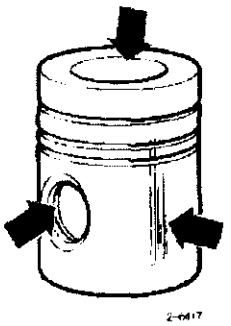
4

If the wear is greater than **0.35–0.40 mm** then the cylinder liner with piston and piston rings must be changed.

Oil consumption also has an impact on when the cylinder liners should be changed.

Pistons

5



Check the pistons for cracks and other damage. If the piston is severely scored around the skirt then the piston must be scrapped. The piston must also be scrapped if it has one or more cracks in the gudgeon pin hole or at the bottom of the combustion chamber. Cracks on the top edge of the piston are not considered to be a major defect. Crack testing must be carried out using the lime powder method.

NB! Check also the fuel injection if there are cracks in the piston.

Piston rings

6

Check wear surfaces and edges. Black spots on the surface indicates bad contact and the ring should be changed. Oil consumption also has an impact on when the piston rings should be changed

Check the piston ring play. Press down the ring below BDC using a piston. Change piston rings if the play is **1.5 mm** or more.

Piston rings should otherways be changed if there is any noticeable wear or if the cylinders are oval as the rings will normally not return to the same position as before they were removed.

Check piston ring play on new rings as well. Refer to "Workshop Manual, Technical Data" concerning measuring.

Cylinder block

Inspection

Clean the cylinder block thoroughly. Make sure all passages are free from deposits and the block is otherwise free from cracks. Minor cracks can be repaired by hot welding. If welding is carried out on the upper surface then the cylinder block must be refaced. (See "Face grinding" below).

Fit a new cylinder block if the defects are too extensive. Cylinder blocks supplied as spare parts must be thoroughly cleaned. Cylinder blocks are supplied without certain plugs fitted so that the longitudinal oil passages can be cleaned efficiently. Fit plugs and pins as shown in the figures below after cleaning.

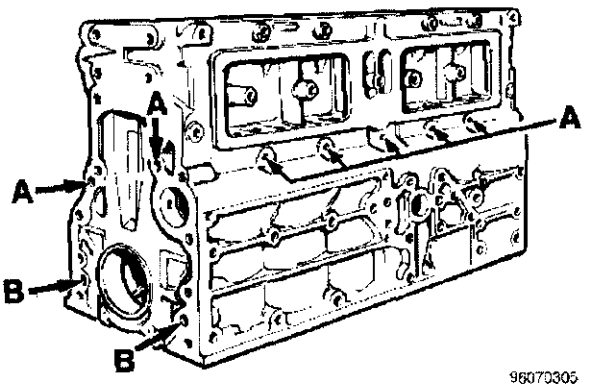
A. Plugs to be fitted.

B. Pins to be fitted.

C. Plugs not to be fitted if flat oil cooler is used.

D. Plug to be fitted if engine equipped with piston cooling.

Cylinder blocks for 610, 630 and 640 engines are shown in the figures.



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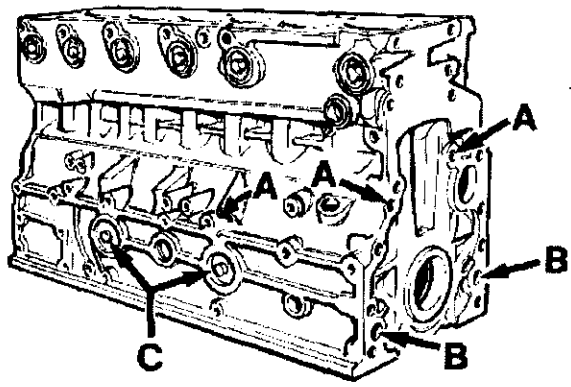

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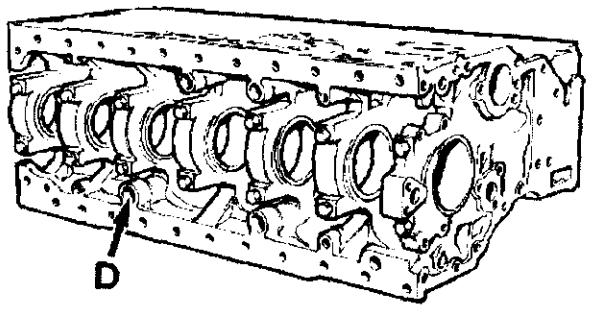
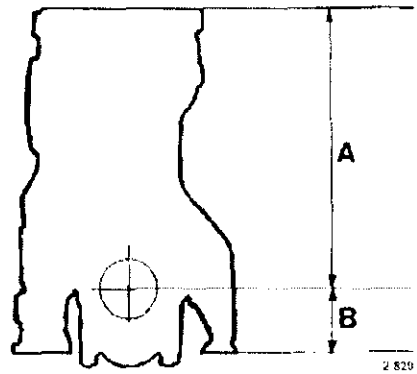


96070307

Face grinding (610, 710 only)

Keep within minimum measurements when face grinding the cylinder block. Measurements (A) and (B), see "Workshop Manual, Technical Data".

NB! After grinding the top block face, the height of the piston above the surface of the block must be measured, see "Workshop Manual, Technical Data".

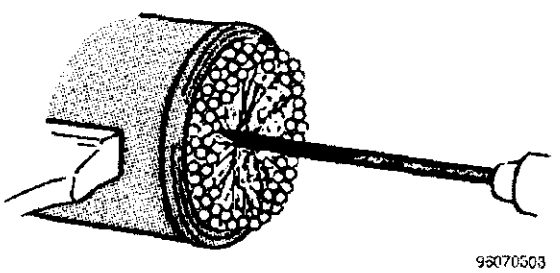


2 829

Cylinder liner, honing

To achieve good lubrication and sealing, it is important that the original honing pattern is maintained on the walls of the liner, see fig. Honing, and must be performed when:

- the cylinder liner is scored (binding ring, dirt)
- the cylinder liner has polished spots



95070503

1
Mark the piston and liner before dismantling them so that the same piston and liner can be reassembled later.

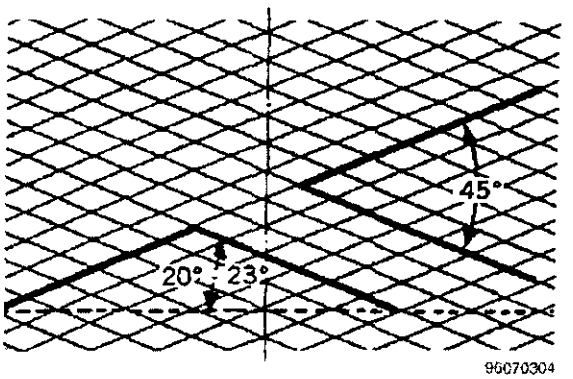
2
Place the cylinder liner in a vice, see fig. The cylinder liner should not be honed while still in the engine block as this will risk blocking the oil passages, making it difficult to obtain correct measurements.

3
Remove any carbon deposits at the top of the liner. Clean also under the liner collar and the recess in the block.

4
Use a low-speed drill at 200–400 rpm and a "Flex-Hone" tool type GBD 102 mm (610, 630 and 640 engines), or GBD 108 mm (710, 730, 740 and 741 engines). Grain size 80.

Lubricate the cylinder liner with thin engine oil before and after honing. Move the honing tool in and out of the cylinder liner at 60 strokes/min.

5



95070304

The cylinder liner has a honing pattern, the angles of which have been calculated to provide optimum service life, see fig.

This pattern must be maintained when honing after a change of piston rings on account of the lubricating properties.

The honing marks must be uniform and cut in both directions over the entire surface of the cylinder.

NB! The speed must be correct in order to attain the correct pattern.

IMPORTANT! Clean the liner thoroughly after honing. Use warm water, a brush and cleaning agent (never use thinner, paraffin or diesel). Wipe the liner with paper or a lint-free cloth. Lubricate the cylinder liner with thin engine oil after wiping it.

Cylinder liner location, reconditioning

Special tools: (610, 630, 640): 998 9876, 999 2479, 999 6847, 999 9538
(710, 730, 731, 740, 741): 999 2178, 999 6645, 999 6854, 999 9508
(610, 630, 640): 999 9553

Repair a cylinder liner location by machining the liner recess. The material removed by machining can be compensated by using shims of various thickness.

1
Clean the liner location and assess the extent of the damage.

2
Fit the cylinder liner into the cylinder block without sealing rings and secure it with two clamping tools.

3
Measure the height of the liner in four places and calculate the thickness of the shims. Try to use as few shims as possible.

The height should be **0.38–0.43 mm**.

4
Remove the cylinder liner and roughen up the surface of the liner location with emery cloth.

5
Screw cutting tool 999 9553 (610, 630, 640) or 999 9508 (710, 730, 731, 740, 741) to the cylinder block, making sure the feeder sleeve is not pressing on the cutter.

6
Once the milling tool has been screwed on, screw down the feed screw until it presses on the cutter.

Fit and zero the dial indicator.

7
Rotate the cutter steadily while turning the feeder sleeve at the same time.

NB! Use a T-handle to rotate the cutter.

8
Stop feeding and rotate the cutter for a few turns when there is **0.02 mm** left.

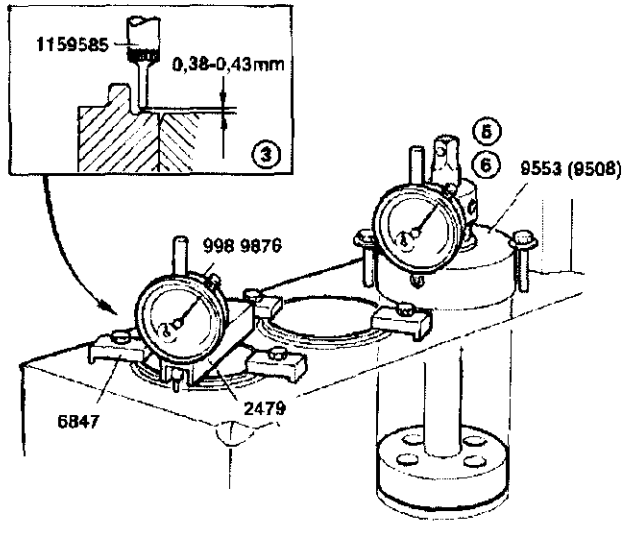
9
Remove the O-rings and apply grinding compound to the bottom of the liner flange if the damage to the liner shelf is so minor it does not require machining.

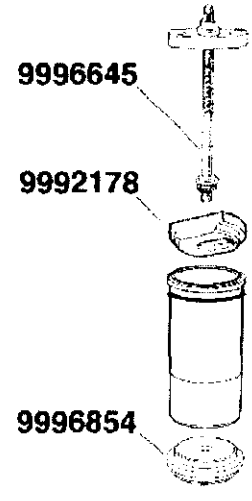
Enter the liner into the block and turn it backwards and forwards until the compound has been used up. Remove the liner and wipe off the grinding compound. Repeat the grinding until a good contact surface is obtained.

Turn the liner using expander 999 9538 (610, 630, 640) or 999 2178, 999 6645, 999 6854 (710, 730, 740, 741).

10
Check the surface contact with colour marker and mark the liner so it is reassembled in the same position as it was when the surface contact was checked.

The instructions above refer to the numbers in the illustration.





Cylinder liner, fitting

Special tools: 998 9876, 999 2000, 999 2479, 999 6847 (2 x), 999 6854

1
Remove the old sealing rings from the cylinder block, making sure the sealing surfaces are thoroughly clean. Use a cleaning agent and brass brush.

NB! Scraping tools must not be used.

2
Fit the cylinder liner without sealing rings if it has not been reconditioned and secure it with two clamping tools.

3
Measure the height of the liner in four places and calculate the thickness of the shims. Try to use as few shims as possible.

The height should be **0.38–0.43 mm**.

Mark the location of the liner on the cylinder block so that it can be refitted in the same position and remove the liner.

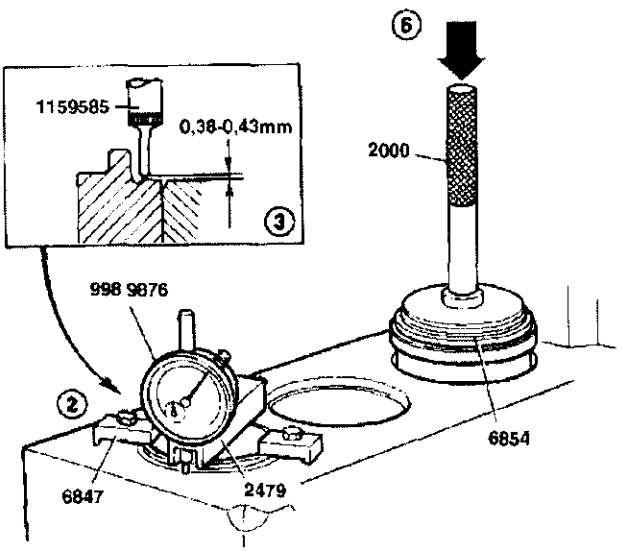
4
Lubricate the sealing rings to be fitted in the cylinder block with the lubricant supplied together with the rings.

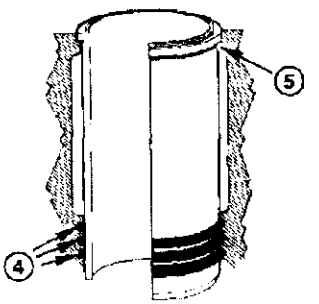
Place the rings in the grooves as described in the Volvo Parts installation instructions.

5
Place any shims on the cylinder liner. Lubricate the new sealing ring and fit it under the liner collar.

6
Carefully press down the cylinder liner. Use drift 999 6854 together with standard handle 999 2000.

7
Use press tool 999 6847 (2x) to secure the cylinder liner in position.





Gudgeon bushing, changing

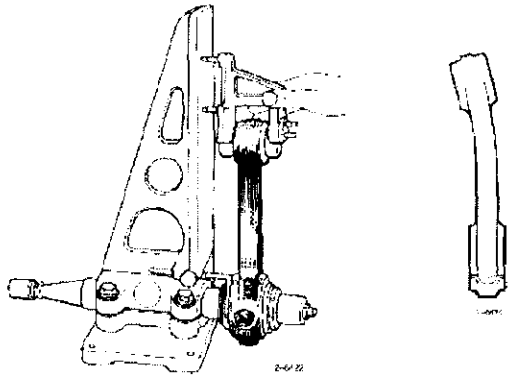
Special tools: (610, 630, 640): 999 1801, 999 2669
(710, 730, 731, 740, 741): 999 1801, 999 2497

The small ends of the connecting rods in the 710, 730, 731, 740 and 741 are trapezoidal. The bushing must be bored after changing.

Before changing the gudgeon bushing, the connecting rod must be checked for cracks, out-of-straightness and twisting.

A cracked, bent or twisted connecting rod must be scrapped.

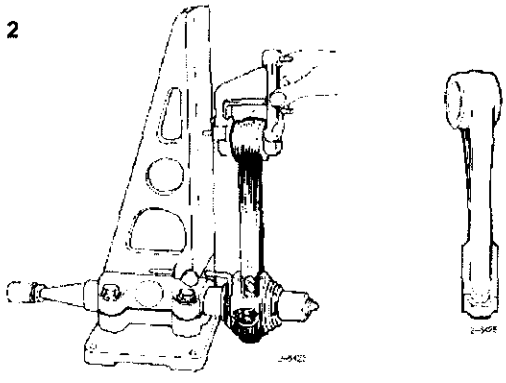
1



Use a gudgeon pin to measure the connecting rod in a fixture.

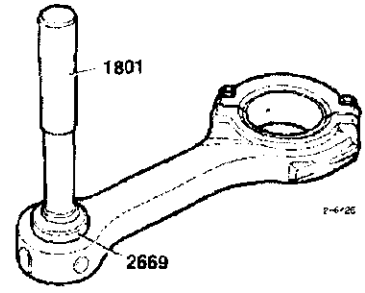
Straightness, max deviation 0.05 mm per 100 mm of measured length.

2



Torsion, max deviation 0.1 mm per 100 mm of measured length.

3

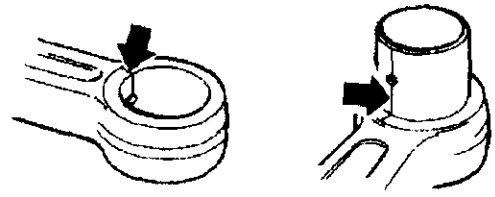


Press out the old bushing with drift and handle.

4

Heat the connecting rod to **approx. 100°C**.

5



Press in the new bushing using the same tool used for pressing it out and make sure the oil hole in the bushing is aligned with the oil passage in the connecting rod.

6

610, 630 and 640 engines
Ream the bushing.

710, 730, 731, 740 and 741 engines
Bore the bushing.

An oiled gudgeon pin should glide into the bushing of its own weight if the fit is correct.

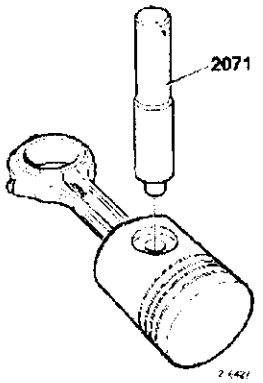
7

After reaming, the connecting rod must be measured in a fixture to make sure the hole for the bushing is located correctly in the connecting rod.

Piston, changing

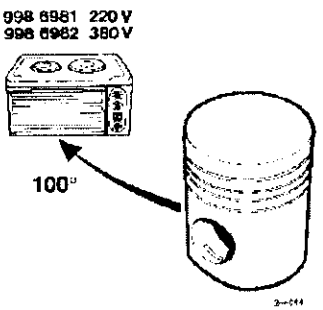
Special tool: 999 2071

1



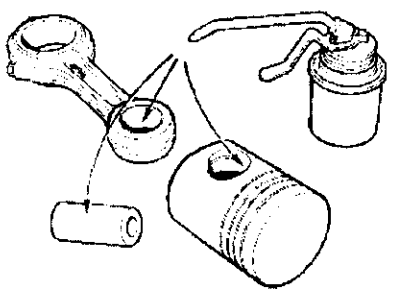
Remove the circlips and press out the gudgeon pin using drift 999 2071.

2



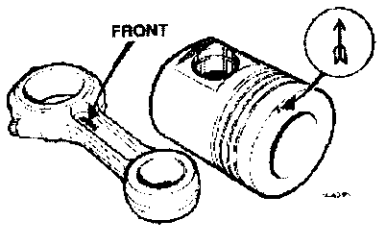
Fit one of the circlips into the piston. Heat the piston to **approx. 100°C.**

3



Lubricate piston, gudgeon pin and gudgeon bushing with engine oil.

4



Place the piston and connecting rod so that both the front markings are facing the same way.

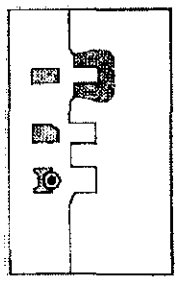
Carefully press in the gudgeon pin using drift 999 2071 and fit the other circlip.

NB! The gudgeon pin should be easy to press in, it should not be knocked in.

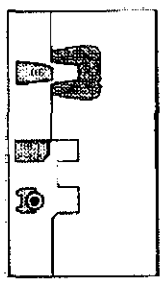
5

Make sure the piston and connecting rod can be moved easily in relation to each other and that the gudgeon pin does not stick in the gudgeon bushing.

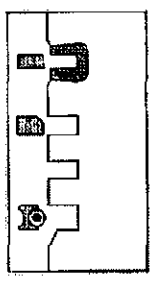
6



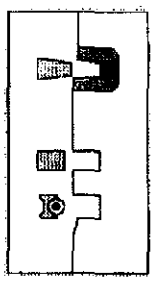
601 engines



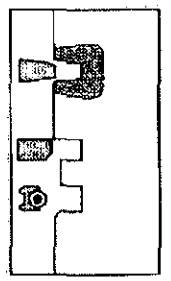
630, 640 engines



710 engines



730, 731 engines



740/741/GE/VE

Use a piston ring clamp when removing and refitting piston rings. Refer to the illustration for piston ring locations. (No third compression ring on 710 engines after engine serial no 17834).

NB! New cylinder liners are supplied with pistons and piston rings.

Pistons, fitting

Special tools: 999 3590, 999 6847, 999 9696, 998 9876, 885126

1
Lubricate piston and piston rings with engine oil.

2
Make sure the piston ring gaps are staggered around the piston.

3
Fit the piston and connecting rod with the arrow and "Front" markings facing forward. Use tool 885126 to guide the piston rings into the cylinder liner.

4
Lubricate big end bearing shells and big end bearing journal with engine oil. Fit and check the position of the bearing shells in the connecting rod and cap.

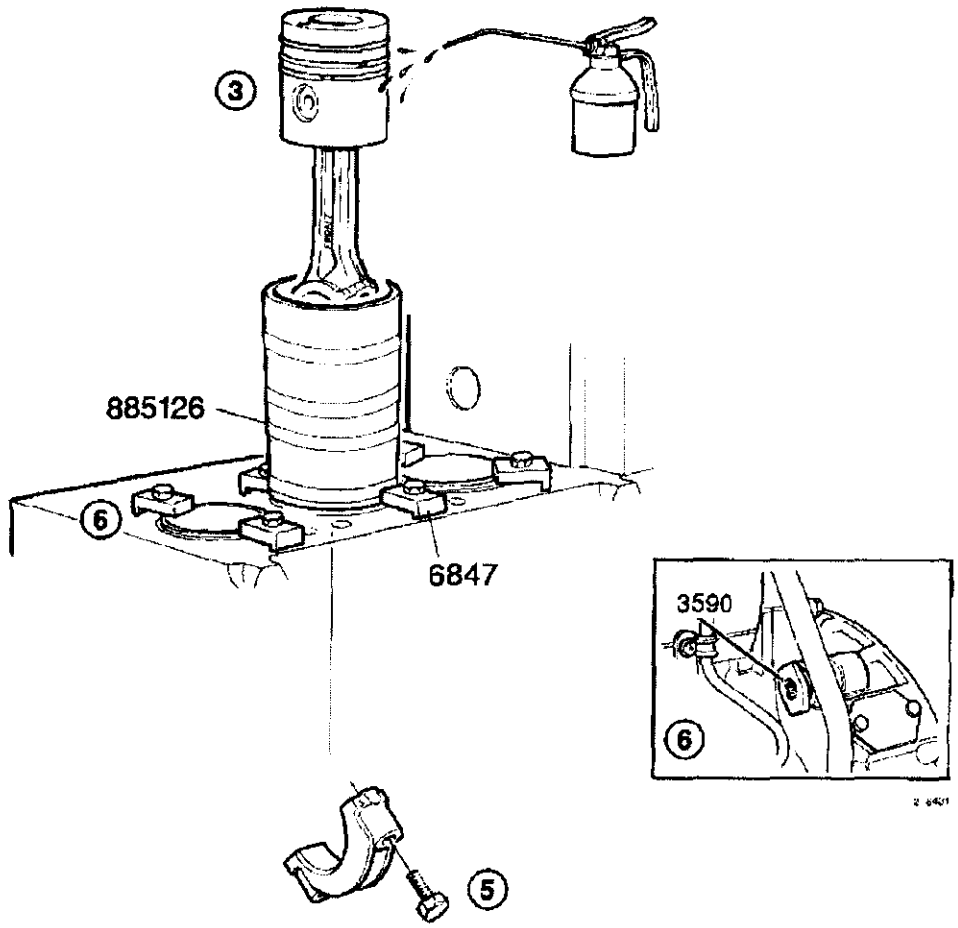
5
Fit the cap according to the marking and fit the bolts.

6
Make sure the press tool is in place and turn the flywheel until the piston reaches BDC. Tighten the bolts to standard torque.

7
Remove the rotation tool.

8
Check the height of the piston above the face of the block. See "Workshop Manual, Technical Data".

The instructions above refer to the numbers in the illustration.



Polygon hub, changing

Special tools: 999 2655, 884949

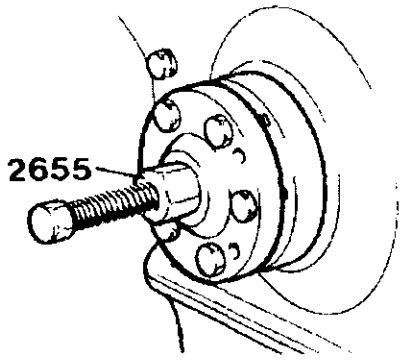
Removing

1
Remove the fan and fan belts. Remove the alternator belt, alternator and bracket.

NB! The fan must always be kept vertical.

2
Remove the polygon hub bolt and centre washer.

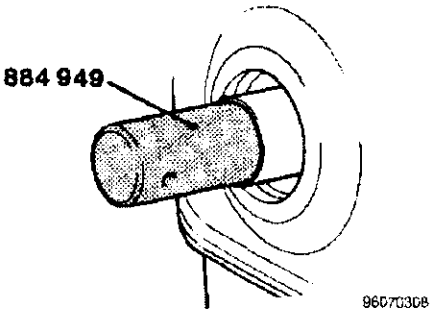
3

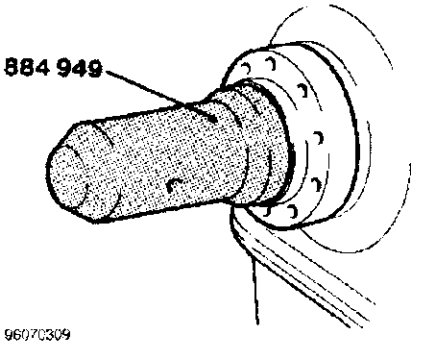


Remove the polygon hub using puller 999 2655.

Fitting

4





Check the polygon hub and its contact surface on the crankshaft. Remove any cut marks with a fine emery cloth.

Lubricate the big-end journal with molybdenum sulphide Place the centering section of drift 884949 onto the big-end journal. Heat the polygon hub to approx. **100°C**. Quickly place the hub on the journal using drift 884949. This will give a clearance of approx. **5 mm** on the surface of the pinion.

5
Position the washer and centre bolt and tighten the bolt to **200 Nm**. Allow the hub to cool down and tighten the bolt to **260 Nm**.

6
Fit the vibration damper and belt pulley if previously fitted. Torque tighten the bolts to **90 Nm**.

7
Fit the fan and alternator with belts.

Sealing ring for polygon hub, changing

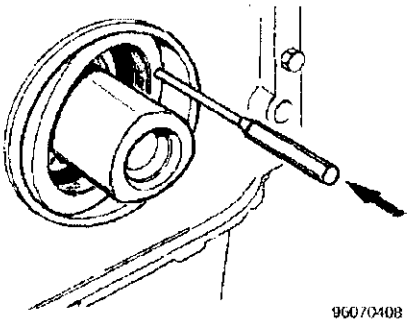
NB! Polygon hub removed.

Special tools: (630, 730, 731, 740, 741): 999 6855, 999 8170

1
630, 730, 731, 740 and 741 engines only.

Remove the acoustic shield from the timing gear cover.

2



Remove the sealing ring with a drift.

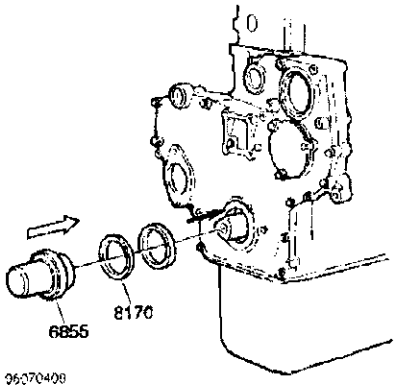
3

Clean the contact surface on the sealing ring.

4
Mobile engines

Clean the acoustic shield and the contact surface on the timing gear cover.

5



Fit a new sealing ring on drift 999 6855 and tap it all the way home.

NB! On engines with acoustic shield, fit spacer 999 8170 onto the drift before putting in place the sealing ring.

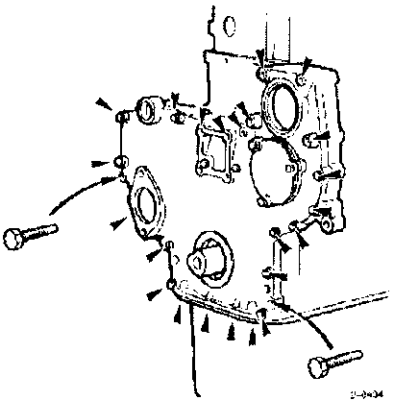
6
Mobile engines

Apply a bead of sealant (part no. 116 1231) approx. **2 mm** wide to the timing gear cover and screw on the acoustic shield.

Sealant timing gear cover, changing

NB! Polygon hub and acoustic shield (if previously fitted) removed.

1

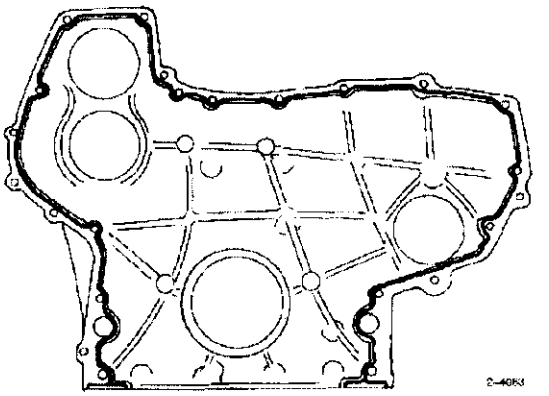


Expose the timing gear cover and remove all bolts.

NB! Use two M8x30 bolts to facilitate removing the timing gear cover. Grind off the end of the thread (approx. 10 mm) and screw the bolts into the holes. See figure.

2
Clean the timing gear casing and timing gear cover contact surfaces.

3



Apply an even bead of sealant (part no. 1161231) approx. **2 mm** wide to the timing gear cover, see figure.

NB! The timing gear cover must be fitted and screwed tight within **20 minutes**.

Timing gears, changing

NB! Timing gear cover removed.

Special tools: 999 2658, 999 2679, 999 3590, 884948

NB! Certain timing gear wheels are nitrocarbonized (marked with "N" or "NITRO"). They are easily distinguished by their grey-yellow tint. These gears must not be fitted together with earlier induction hardened gears (marked HT).

Case hardened gears (marked CH) can be used with all combinations of gears.

See also "Service Bulletin" 21–5 no 5.

WARNING! Never rotate the crankshaft or camshaft while the transmission gear is removed. Pistons and valves can collide and be damaged.

Removing

1
Remove the front valve cover.

2
Turn the flywheel until piston 1 is in TDC after the compression stroke, 0° on the flywheel.

3
Undo the camshaft gear, idler gear and injection pump pinion.

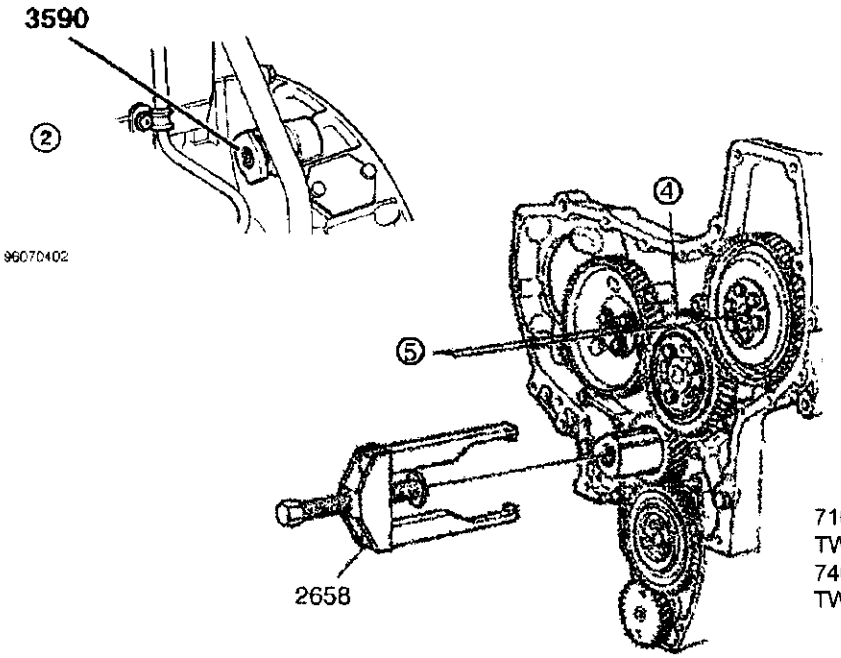
4
Remove the idler gear and thrust bearing.

5
Remove the injection pump pinion and camshaft gear. Use puller 999 2679 if necessary.

NB!! When using a puller on engines with injection timing adjuster, place a hexagonal socket plug, part no 952076-8, with the hexagonal socket against the flange to prevent the centre screw of the puller pressing against the adjuster pull rod.

6
Remove the crankshaft pinion using puller 999 2658.

The instructions above refer to the numbers in the illustration.

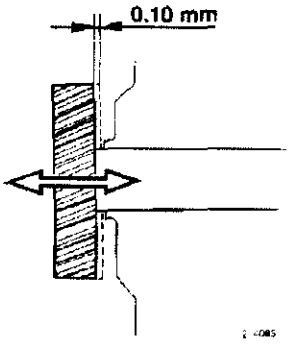


710, TD730, TWD731: 3 bolts
TWD610, TD630: 4 bolts
740, 741: 5 bolts
TWD630, 640, 730: 6 bolts

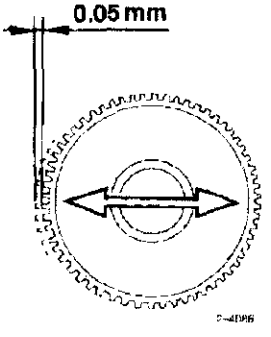
Fitting

All clearances must be checked when fitting the timing gear wheels.

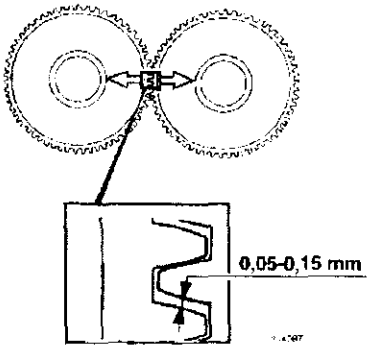
8



Axial clearance for idler gear: max 0.10 mm.



Radial clearance for idler gear: max 0.05 mm.



Flank clearance: max 0.05-0.15 mm.

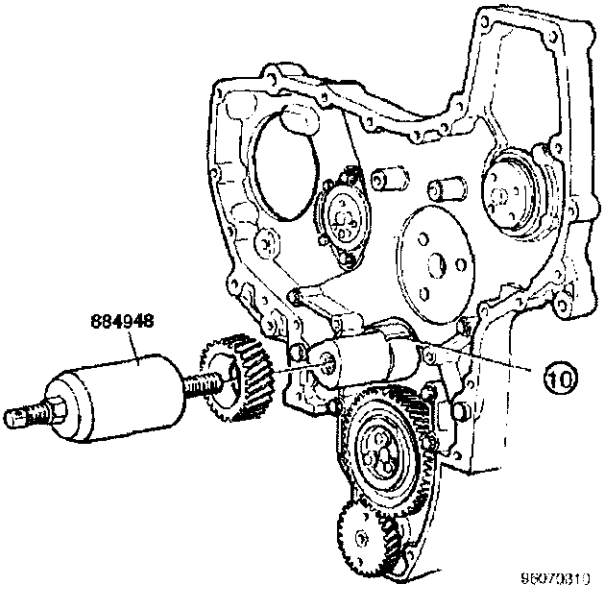
9

Make sure the keyway in the crankshaft is not damaged and that the key is seated properly in the groove.

10

Press on the crankshaft pinion with tool 884948.

NB! Make sure the teeth are meshed properly with the oil pump idler gear.



11
Fit the camshaft gear, idler gear and thrust bearing. Make sure the marks on the crankshaft gear, idler gear and camshaft gear are aligned.

12
Tighten the bolts by hand only until the gears are all the way home.

13
Fit the injection pump pinion, making sure the mark is aligned to the idler gear.

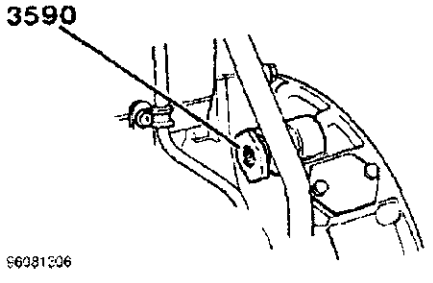
NB! The injection pump pinion is not marked on 730 and TWD630 engines.

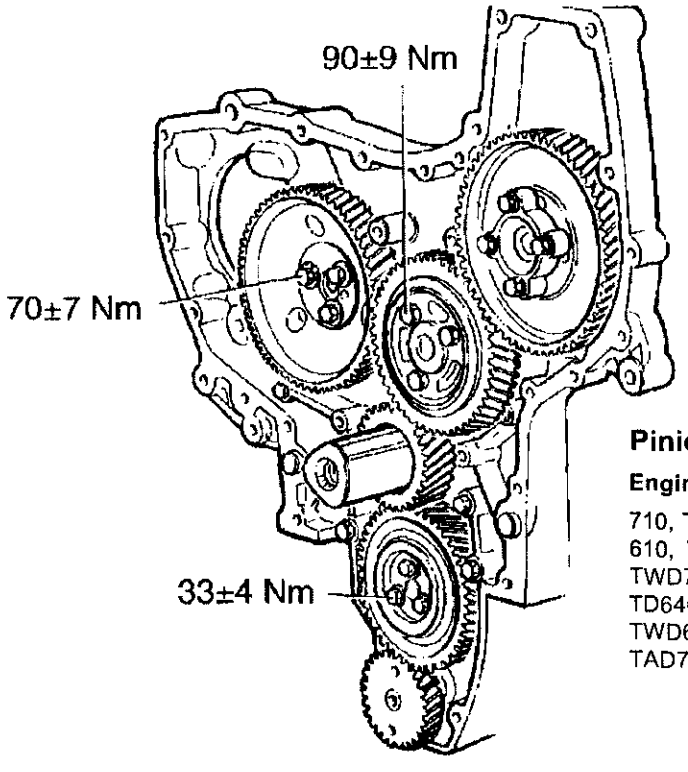
14
Torque tighten the timing gear wheels, see illustration below.

15
Set the injection pump, see "Fuel system".

16
Remove the rotation tool and close the inspection cover on the flywheel casing.

17
Refit the front valve cover.





Pinion injection pump

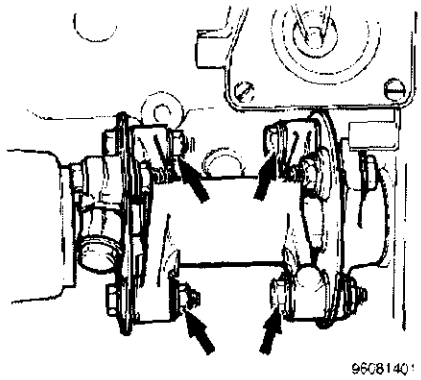
Engine	No.of bolts	Torque (Nm)
710, TD730, TWD731	3	60±6
610, TD630ME/VE	4	35±4
TWD740GE/VE	5	60±5
TD640VE	5	46±4
TWD630/730ME/VE	6	33±4
TAD730G/P/V	6	33±4

Seal ring in injection pump drive unit (mounted via pump coupling), change

Special tools: 999 3590, 999 6778, 999 6779

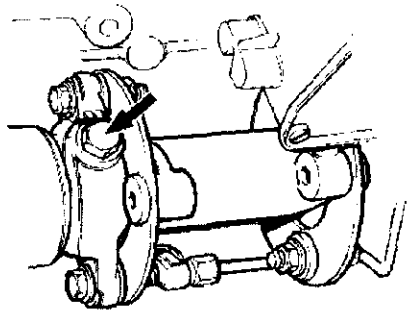
1
Remove the front valve cover.

2
Turn the flywheel in its direction of rotation using tool 999 3590 until cylinder 1 is on its compression stroke (0° on the flywheel and both valve closed in cylinder 1).



3
Remove the bolts from the pump coupling (four).

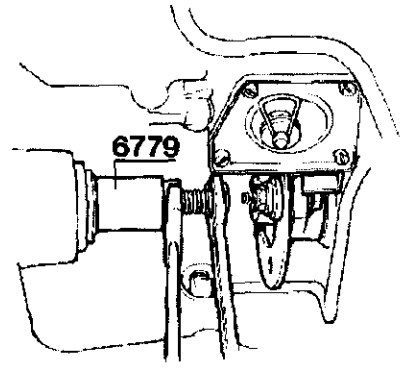
NB! Do not remove the bolts securing the flange discs to the flanges.



4
Undo the clamp bolt securing the flange to the drive shaft.

5
Remove the pump coupling and the flange.

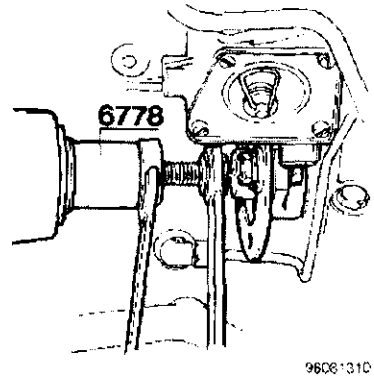
6



Pull out the old seal by screwing puller 999 6779 into the seal. Press the puller at the same time so that the threads cut into the steel ring of the seal. Pull out the seal by screwing in the puller screw.

7
Lubricate the new seal and the drive shaft with oil.

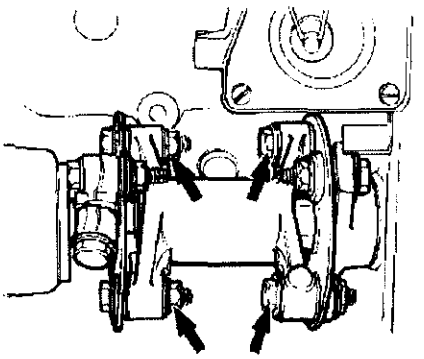
8



Press in the seal with tool 999 6778 so that it is flush with the shaft housing.

9
Fit the flange to the drive shaft.

10

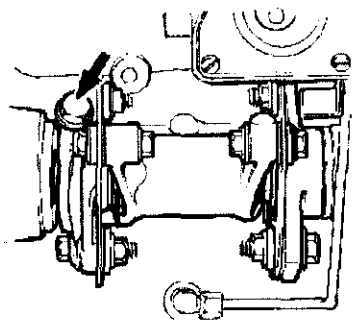


96081307

Fit the pump coupling and tighten the bolts to standard torque.

11
Check the injection pump setting.

12



96081402

Torque tighten the clamp bolt on the pump coupling to **90 ± 9 Nm**.

13
Remove the rotation tool from the flywheel casing and fit the inspection cover.

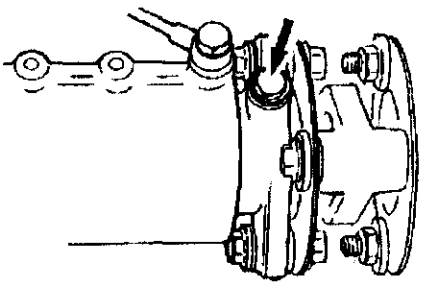
14
Fit the valve cover.

Sealing ring in injection pump drive unit, changing (730 and TWD630)

NB! Injection pump removed.

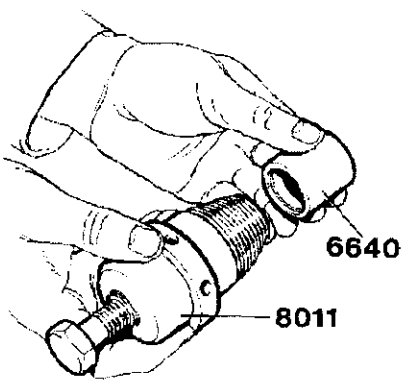
Special tools: 999 6640, 999 8011, 999 8012

1



Undo the clamp bolt securing the flange to the shaft and remove the flange.

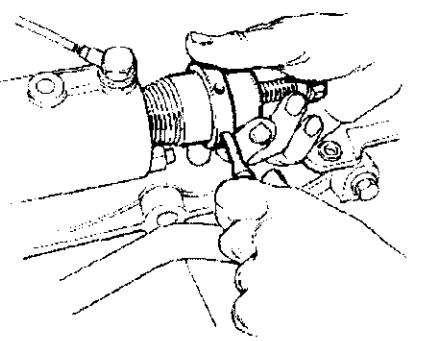
2



96081403

Fit drift 999 6640 into puller 999 8011. Turn the drift so the shallow hole is facing the puller screw.

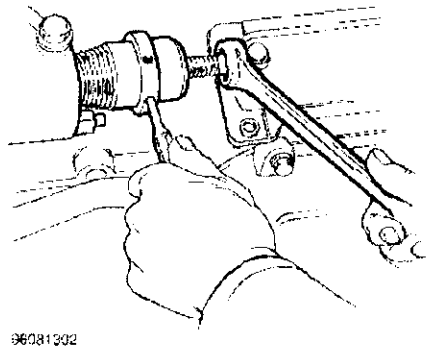
3



96081301

Screw the puller into the old seal using a drift. Press the puller at the same time so that the threads cut into the steel ring of the seal.

4



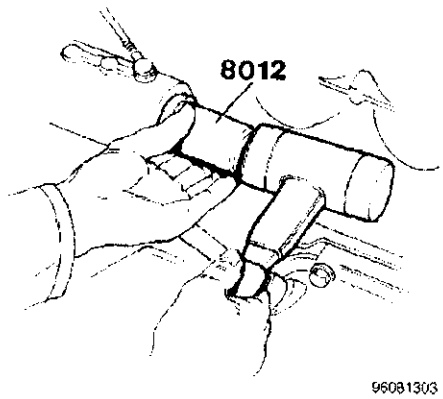
96081302

Pull out the old seal by screwing in the puller screw while restraining the puller with the drift.

5

Lubricate the new seal and the drive shaft.

6



96081303

Fit the new seal to the shaft and tap it in using drift 999 8012 until it is flush with the shaft housing.

7

Fit the flange, pump coupling and injection pump. (See "Fuel system").

8

Check the injection pump setting.

Camshaft, changing

NB! Camshaft gear removed.

Special tools: 999 3590, 999 8079

1
Remove the valve covers.

2
Remove the rocker brackets and pushrods.

NB! Mark the pushrods or place them in a stand so that they can be refitted in the same place.

3
Remove the air compressor if fitted.

4
Remove hoses, pipes and cables to expose the inspection covers for the valve tappets.

5
Remove the valve tappet inspection covers.

NB! The middle cover need not be removed.

6
Remove the valve tappets and mark them so they can be refitted in the same place.

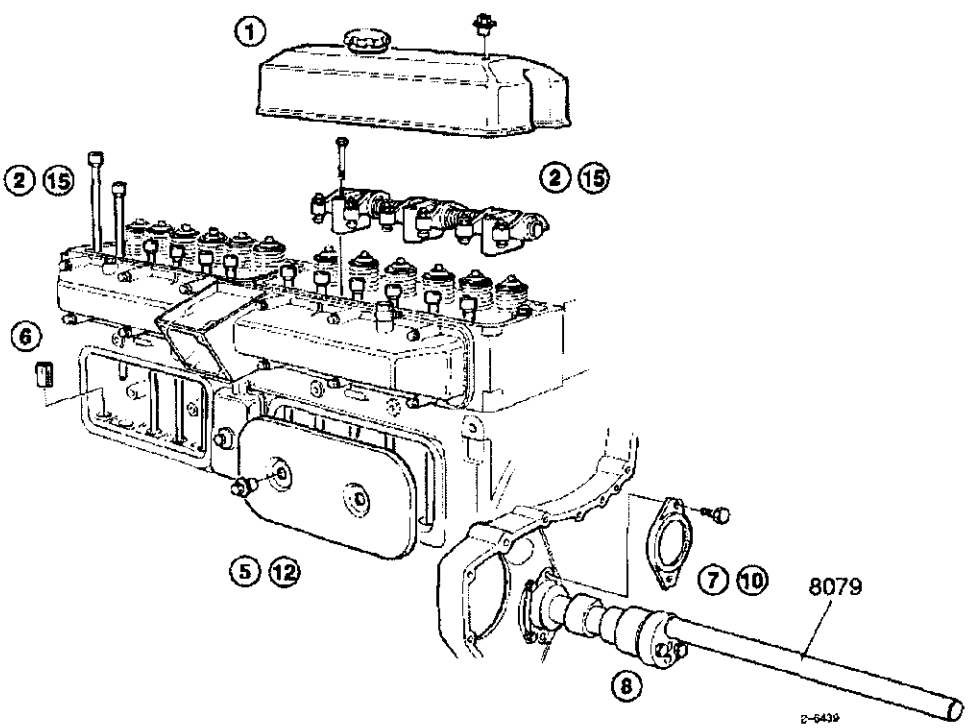
7
Remove the camshaft flange.

8
Fasten tool 999 8079 to the camshaft. Carefully pull back on the camshaft.

9
Lubricate all the bearing surfaces on the new camshaft with engine oil.

Transfer tool 999 8079 to the new camshaft and carefully lift the new camshaft in place.

The instructions above refer to the numbers in the illustration.



10
Fit the camshaft flange and torque tighten the bolts to **65 ± 7 Nm**.

11
Lubricate the valve tappets with engine oil and fit them in the same order as they were removed.

NB! Change worn or damaged valve tappets.

12
Refit the valve tappet inspection covers.
Fit new gaskets if necessary.

13
Fit the air compressor. Fit a new O-ring if necessary.

14
Fit and connect dismantled leads and pipes.

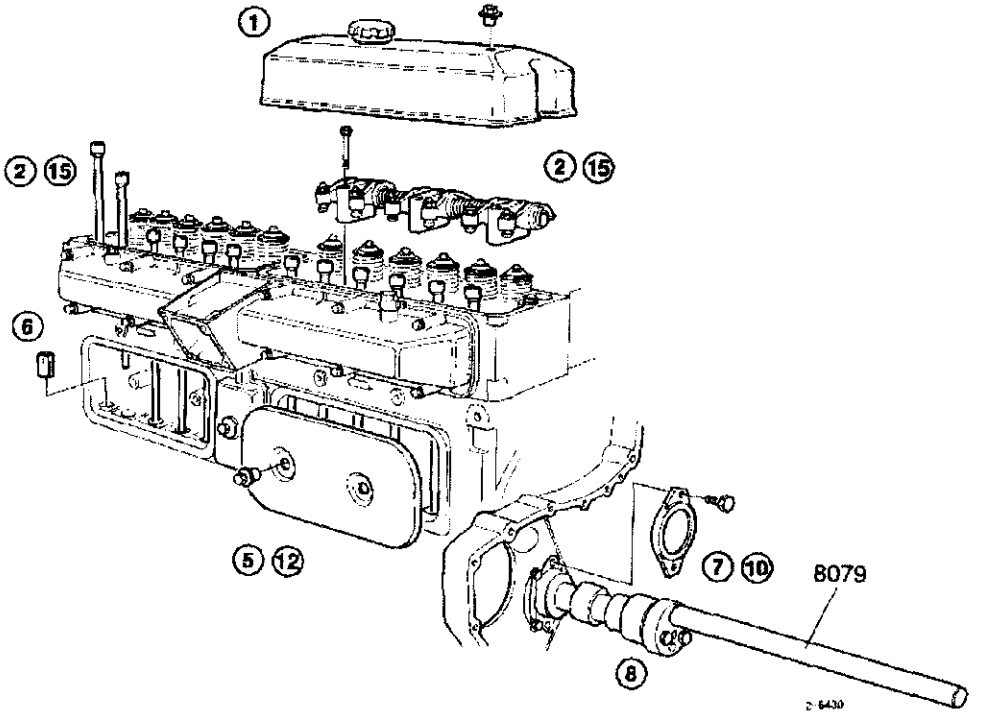
NB! Points 15 and 16 must not be carried out until the camshaft gear, idler gear and camshaft gear have been fitted as marked.

15
Fit the pushrods in the correct order, fit the rocker brackets and torque tighten the bolts.

Tightening torques: (6-lit) **50 ± 5 Nm**
(7-lit) **65 ± 7 Nm**

16
Adjust the valves and refit the valve covers.

The instructions above refer to the numbers in the illustration.



Sealant for timing gear casing, changing

NB! Coolant pump, air compressor, servo pump if fitted and timing gear wheels removed.

1
Undo the clamp bolt on the injection pump drive coupling.

Engines with injection timing adjuster
Remove the oil pipe between the engine and the adjuster.

610, TD630, 640 and 740 engines
Remove the injection pump.

2
Remove the timing gear casing bolts. Remove the casing.

3
Clean the cylinder block and timing gear casing contact surfaces.

NB! The surfaces must be dry before applying the sealant.

4
Apply an even bead of sealant (part no. 1161231) approx. **2 mm** wide to the timing gear casing, see figure.

NB! The timing gear casing must be fitted and screwed tight within **20 minutes**.

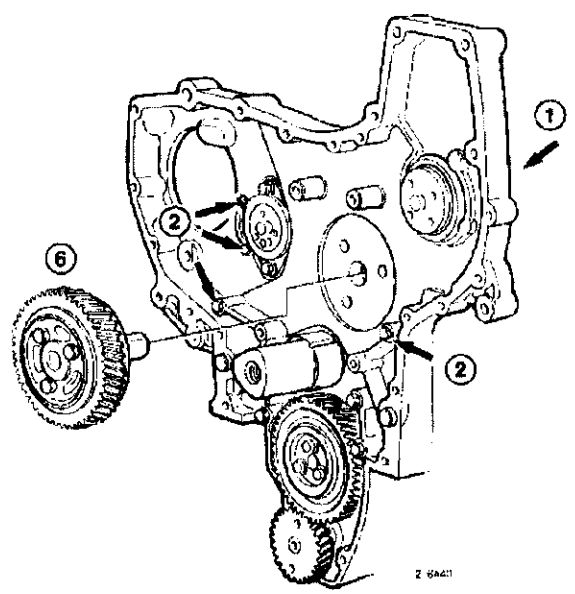
5
Lift the timing gear casing in place. Fit the timing gear casing bolts but do not tighten them.

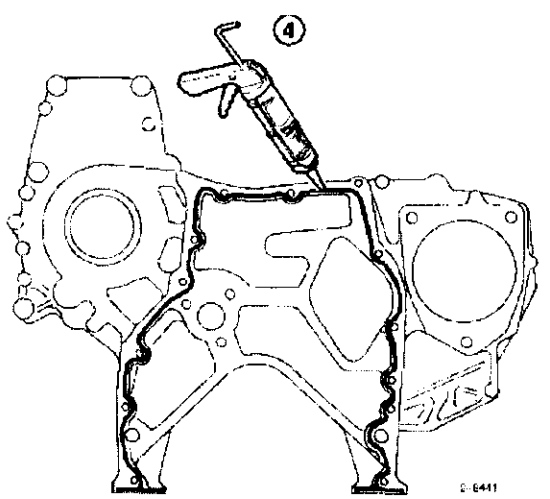
6
Fit the idler gear and tighten the bolts to centre the timing gear casing.

7
Torque tighten the timing gear casing bolts to **33 ± 4 Nm**.

8
Remove the idler gear.

The instructions above refer to the numbers in the illustration.





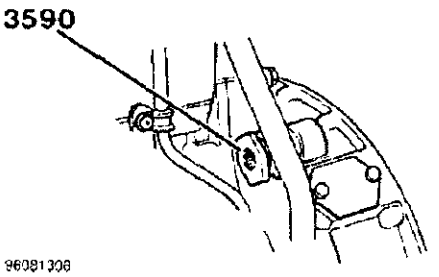
Camshaft wear check

NB! Cylinder head fitted.

Special tools: 999 3590, 999 6772, 998 9876

1
Remove the valve covers.

2

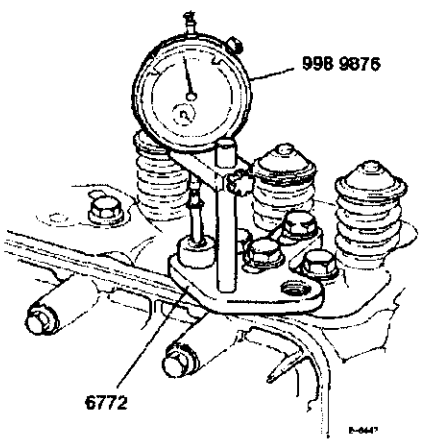


Fit rotation tool 999 3590

3
Turn the flywheel until the rocker arms on cylinder 1 move.

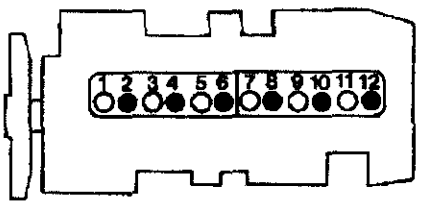
4
Remove the rocker bridges and all the pushrods. Mark the pushrods or place them in a stand so that they can be refitted in the same place.

5

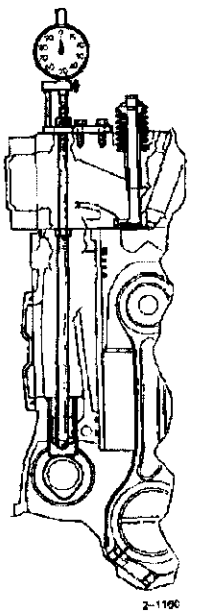


Screw tool 999 6772 onto the cylinder head at the exhaust valve for cylinder 1. (Use two M10x20 mm bolts). Fit a dial indicator in the tool.

○ **Inlet**
● **Exhaust**



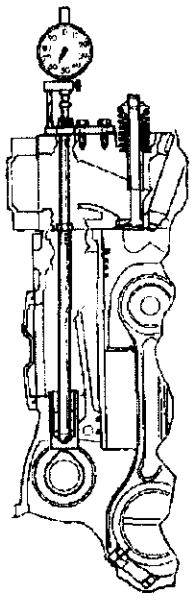
6



Adjust the length of the tool's pushrod with pre-tension against the exhaust valve tappet.

Turn the flywheel until the pushrod on tool 999 6772 reaches its bottom position. Make sure the pushrod is pretensioned and zero the dial.

7



Turn the flywheel until the pushrod on tool 999 6772 reaches its top position. Read the value on the dial indicator.

8
Transfer the pushrod from tool 999 6772 to the exhaust valve tappet and repeat the process.

None of the readings must be below the specified value.
See "Workshop Manual, Technical Data".

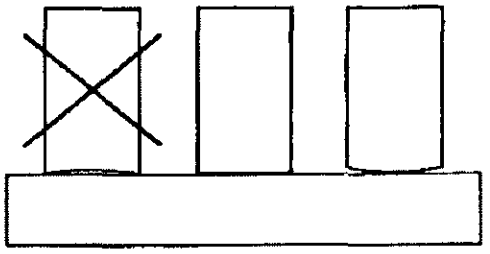
9
Move the tool and measure the lifting height for the remaining cylinders.

10
Fit the pushrods in their marked positions, fit the rocker brackets and torque tighten the bolts.
Tightening torques: (6-lit) **50 ± 5 Nm**
(7-lit) **65 ± 7 Nm**

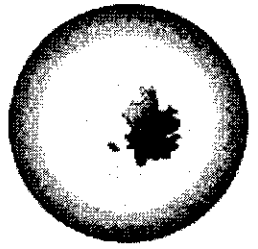
11
Adjust the valves, fit the valve covers and remove the rotation tool.

Camshaft and valve tappets, inspection

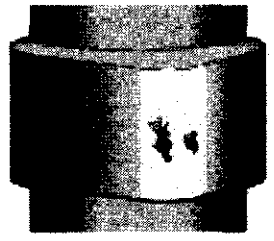
Use a steel ruler to check that the valve tappet contact surfaces for the camshaft are spherical (convex). They can also be completely flat but never concave, see fig. If there is a slight, visible opening between the steel ruler and the centre of the lifting surface, the valve tappet must be changed.



Checking the valve tappets



A



B

A slight, insignificant, pitting of valve tappet (A) and camshaft (B).

NB! If the lifting surface of the valve tappet is worn, the valve tappet must be discarded. A "ditch" indicates that the valve tappet has not rotated. A dark edge on the valve tappet indicates that the surface is not worn.

The condition of the valve tappets determines whether the camshaft should be checked for wear.

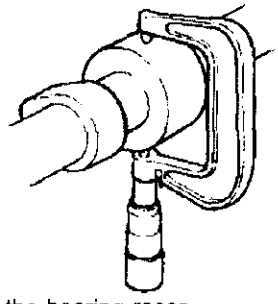
Inspect the valve tappets for pitting. Pitting can have many causes. The damage is due to small particles of metal coming loose from the hardened surface. Valve tappets and camshaft with slight pitting (see fig.) can be refitted. It has been established that this kind of damage seldom becomes aggravated.

Check bearing races and cam curves on the camshaft for wear. For example, the cams can be worn at an angle axially. Minor cases can be adjusted by grinding the cams. Change the camshaft if there is any further damage or wear. All the valve tappets must also be changed when changing the camshaft.

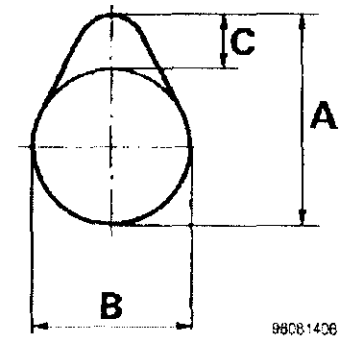
Camshaft, measuring

Measure the camshaft bearing races with a micrometer. Max. permitted wear and ovality: **0.07 mm**. Check the straightness of the camshaft with an indicator device. Max radial runout in relation to end bearings: **0.04 mm**. Lift height (cam height) is measured with a vernier caliper.

Measuring the camshaft and camshaft bearings is described in
"Workshop Manual, Technical Data".



Measuring the bearing races



Measuring camshaft lift C (cam height)

C = A – B

Camshaft bearings, changing

The camshaft bearings are pressed in place and must be bored in line after fitting. This means that the camshaft bearings can only be changed in conjunction with a complete reconditioning of the engine.

It is especially important that the oil holes are aligned with the corresponding passages in the engine block when pressing in the bearings. The front camshaft bearing must have the groove pointing forward, see illustration.

Crankshaft

The crankshaft is nitrocarbonized.

En nitrocarbonized shaft has a higher resistance to fatigue and wear than an induction hardened shaft.

Inspection

The crankshaft must be thoroughly inspected to avoid unnecessary reconditioning. The following applies when determining the need for reconditioning:

A. Check out-of-round, wear and taper on the bearing journals. See "Workshop Manual, Technical Data".

B. Assess surface damage.

The following applies to nitrocarbonized shafts:

What is assessed as being a dirt score on an induction hardened crankshaft can be the normal surface finish on a new nitrocarbonized crankshaft. This is especially apparent on a used shaft due to the bright bearing surface. After a long period of service, small particles may come loose from the thin surface layer.

This phenomenon can easily be mistaken for dirt scores but differs in that they do not continue around the bearing journal and have uneven edges. These minor defects need not entail regrinding of the crankshaft.

As a rule, it is sufficient to polish the bearing journal and fit a new bearing shell.

C. Measure crankshaft run-out.

Place the crankshaft on a couple of V-blocks under the 1st and 7th main bearing journals or suspend it between centres. Measure on the 4th main bearing journal.

The following applies to the recorded value:

1
Below **0.2 mm** – no straightening unless wear or surface damage demand regrinding.

2
Between **0.2–0.7 mm** – straighten with care to avoid excessive straightening.

NB! Do not straighten more than absolutely necessary.

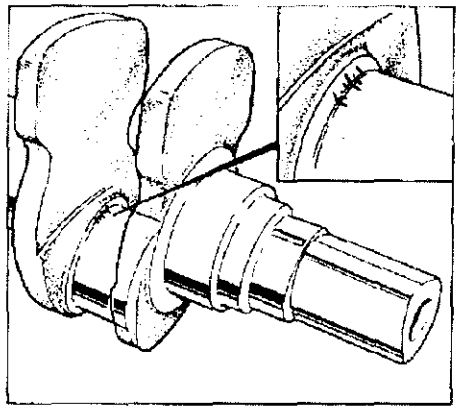
3
Over **0.7 mm** – the shaft must be discarded as there is a risk of it fracturing when straightened.

D. Checking for cracks.
Check after straightening and before and after grinding.

Use magnetic power testing of type Magnaglo, i.e. fluorescent powder observed in UV light, to check for cracks.

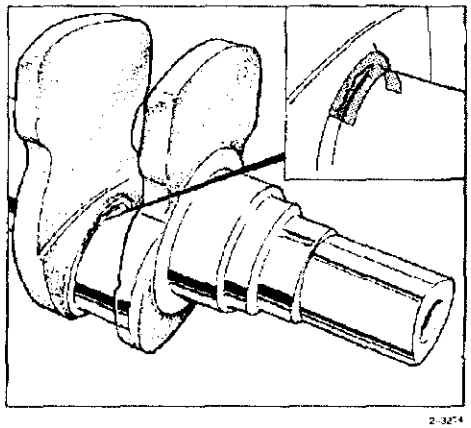
Follow the equipment manufacturer's instructions. The following applies when assessing cracks:

1



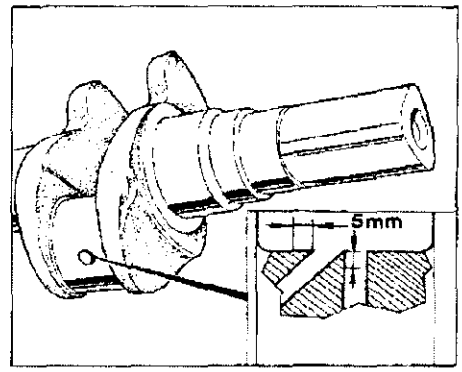
The shaft must be discarded if there are longitudinal cracks on journals and fillets .

2



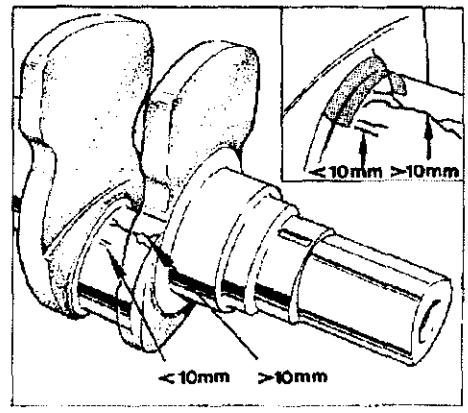
The shaft must be discarded if there are longitudinal cracks within the marked area. This applies to both the crank pin and the main bearing journal.

3



The shaft must be discarded if there are cracks longer than **5 mm** in conjunction with lubrication holes. Cracks shorter than **5 mm** can be removed by grinding.

4



The shaft must be discarded if there are cracks longer than **10 mm** outside the marked area. Individual cracks smaller than **10 mm** are acceptable.

Reconditioning

The following procedure applies to reconditioning:

1
Straightening (only if required).

2
Checking for cracks.

3
Measure the bearing journals, see "Workshop Manual, Technical Data".

4
Grind to undersize specifications in "Workshop Manual, Technical Data".

5
Checking for cracks.

6
Re-nitrocarbonizing after grinding to undersize more than **0.50 mm**. Nitrocarbonizing can be carried out using gas or salt depending on the experience of the person performing the process.

7
Check run-out after nitrocarbonizing.

8
Straighten as necesary (run-out between **0.2–0.7 mm**).

9
Carry out magnetic particle testing.

10
Patch and clean the crankshaft thoroughly after nitrocarbonizing. The crankshaft must always be cleaned thoroughly after reconditioning.

In order to clean all the oil passages efficiently, later versions of crankshaft have screw plugs in each crankshaft throw. Remove the plugs when cleaning.

Big end bearings, change all

NB! Lubricating oil pump removed.

Special tool: 999 3590

1
Fit rotation tool 999 3590 and rotate the flywheel until the caps on connecting rods 1 and 6 are in position for removing the bolts.

2
Remove the caps on connecting rods 1 and 6. Remove the bearing shells and clean the bearing location on the connecting rod and cap.

NB! Do not get the caps mixed up.

3
Inspect bearing journals and bearing shells. If any of the bearings have seized, the cause must be determined before new bearing shells are fitted.

4
Measure the bearing journals. Max. permitted ovality: **0.08 mm**.

Max. permitted taper: **0.05 mm**. If any of the values exceed the maximum permitted, the crankshaft must be removed and corrected.

NB! Check the specifications to see whether the shaft is standard size or undersize if there is any doubt.

5
Fit new bearing shells, making sure the correct bearing dimension is used. Make sure the guide lug on the bearing shell is positioned correctly in the recess on the connecting rod and that the oil hole in the connecting rod and bearing shell are aligned.

6
Oil the bearing shells and big end bearing journals. Fit the caps in their marked positions and torque tighten the bolts to **190 ±10 Nm**..

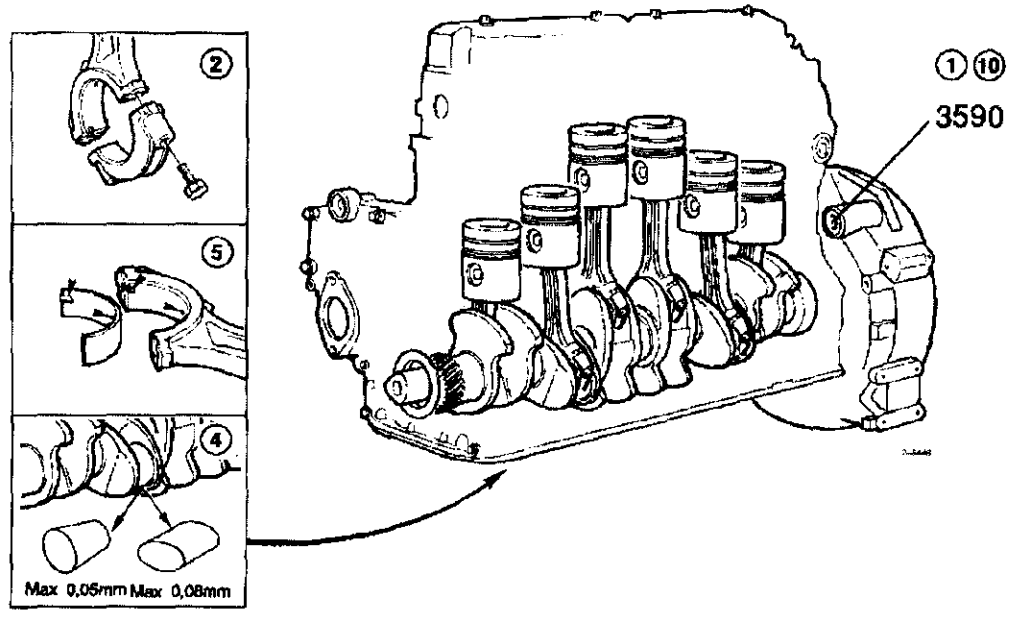
7
Turn the flywheel until connecting rods 5 and 2 are in position and repeat steps 2-6.

8
Turn the flywheel until connecting rods 3 and 4 are in position and repeat steps 2-6.

9
Make sure non of the big end bearings are binding.

10
Remove the rotation tool.

The instructions above refer to the numbers in the illustration.

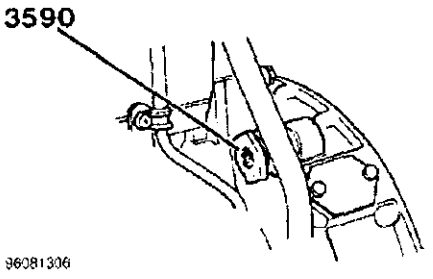


Main bearings, change all

NB! Oil tray removed

Special tool: 999 3590

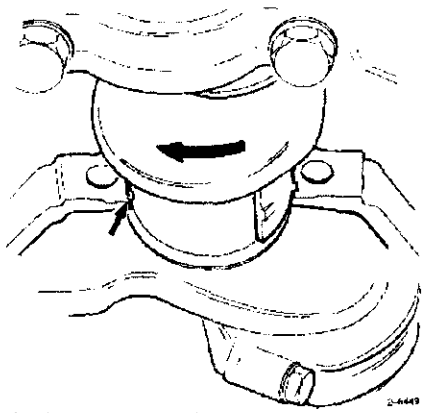
1
Fit rotation tool 999 3590



2
Remove the lubricating oil pipes from the cylinder block and oil pump.

3
Unscrew the bolts for the front main bearing cap. Remove the lubricating oil pump together with the main bearing cap.

4



Dismantle the upper bearing shell by placing a pin in the crankshaft oil hole and rotating the crankshaft to roll out the bearing shell.

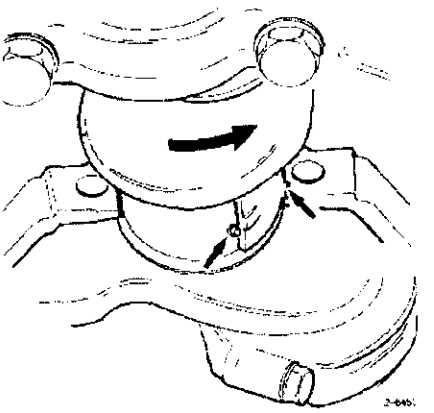
5
Clean and inspect the bearing location, cap, shaft journal and bearing shells. If the bearing has seized, the cause must be determined before new bearing shells are fitted.

6
Make sure to use the correct bearing dimension when changing.

NB! If in doubt, refer to the specifications to see which oversize is fitted.

7
Oil the shaft journal and the new bearing shells.

8



Fit the upper bearing shell by rotating the crankshaft against the direction of rotation with a pin in the oil hole.

Make sure the pressed lug on the bearing shell is correctly seated in the recess of the bearing location.

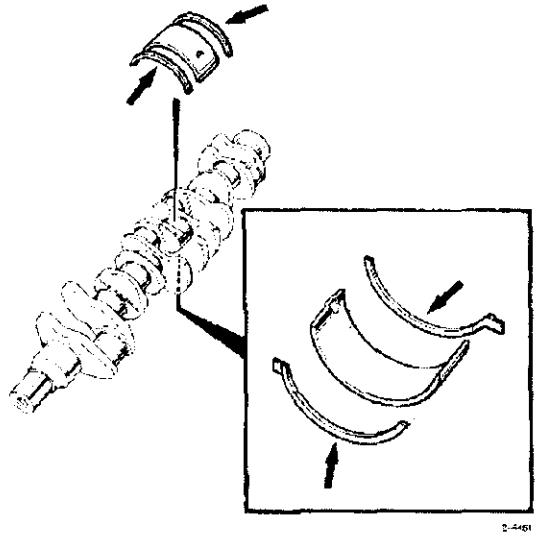
9
Fit the bearing cap with a new bearing shell and torque tighten to **150 ±10 Nm**.

10
Change the remaining main bearings one at a time in the same manner as the first. Make sure the shaft does not bind after changing each main bearing by turning it with the rotation tool.

11
Check the end float of the crankshaft and change thrust bearing washers if it is too large or if the washers are damaged.

End float should be **0.07–0.27 mm, max 0.40 mm**
Check with a dial indicator.

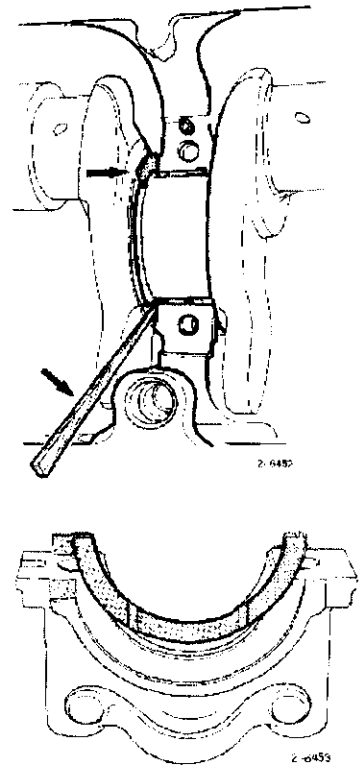
12



The crankshaft thrust bearing is located in the middle main bearing.

Thrust bearing washers are available in a number of oversizes, see "Workshop Manual, Technical Data".

13



Use a narrow plastic or wooden pin to remove the thrust bearing washers from the bearing locations in the cylinder block.

The thrust bearing washers are located in machined grooves in the main bearing cap.

14
Recheck the end float of the crankshaft once all the main bearing caps have been torque tightened.

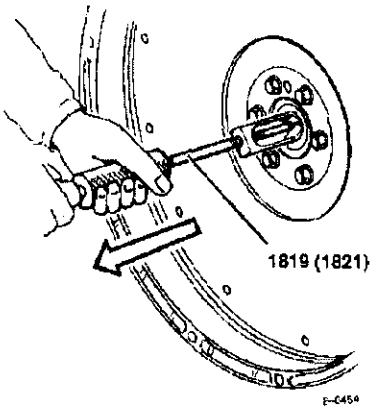
15
Fit the lubricating oil pipes.

16
Remove the rotation tool.

Flywheel bearing, changing

Special tools: (Mobile) 999 1801, 999 1819, 999 2013 (Stationary) 999 1801, 999 1821, 999 2564

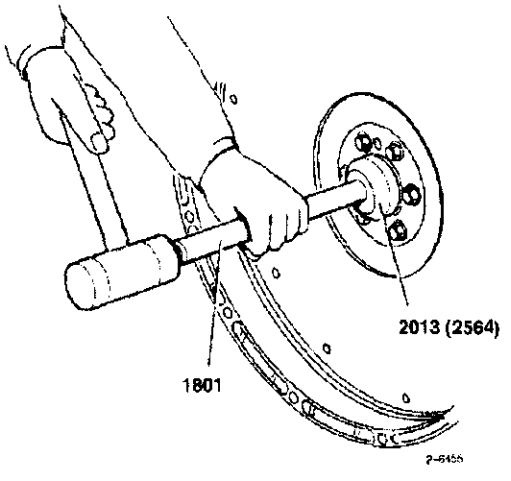
1



Remove the flywheel bearing using tool 999 1819 (mobile) or 999 1821 (stationary).

2
Clean the flywheel and inspect for damage.

3

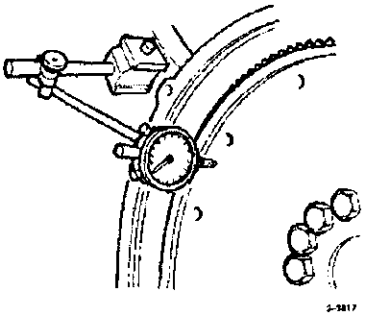


Fit a new flywheel bearing using drift 999 2013 (mobile) or 999 2564 (stationary) and handle 999 1801.

Flywheel, checking trueness

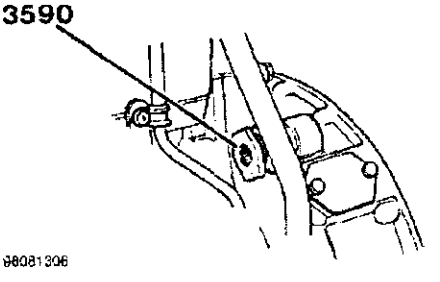
Special tools: 998 9876, 999 9696, 999 3590

1



Mount a dial indicator in a magnetic stand and zero the dial indicator with its measuring tip against the flywheel, **150 mm** from its centre.

2



Rotate the flywheel with tool 999 3590 and read off the max and min values.

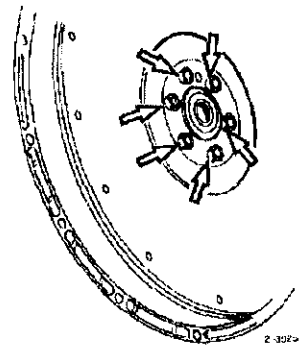
3
The difference must not exceed **0.15 mm** with a measuring radius of 150 mm.

If the out-of-true is greater, remove the flywheel and see whether there is any dirt or unevenness between the flywheel and the crankshaft contact surface.

4
Remove the rotation tool.

Flywheel, changing

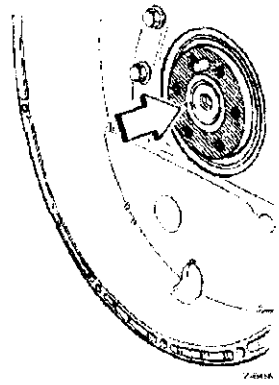
1



Remove the bolts and lift off the flywheel.

2
Inspect the flywheel bearing. Change a defective bearing.

3



Clean the crankshaft flange contact surface to the flywheel.

4
Clean the flywheel contact surface to the crankshaft flange.

5
Make sure the flywheel guide pin in the crankshaft is in place and not damaged.

6
Lift in place the flywheel and fit the bolts.

7
Lock the flywheel.

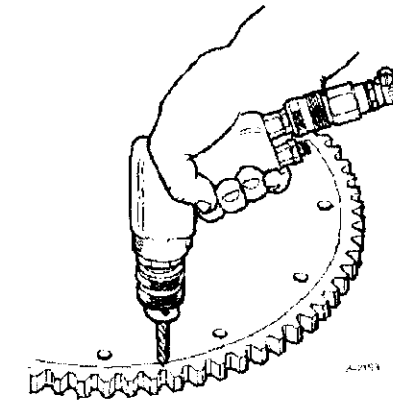
8
Torque tighten the flywheel bolts to **190 ±10 Nm**.

9
Remove the stop tool if fitted.

Ring gear, changing

NB! Flywheel removed.

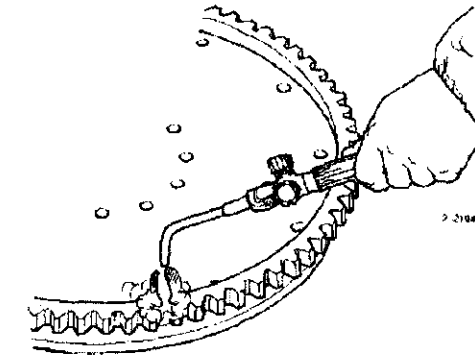
1



Drill 1 or 2 holes in a tooth gap on the ring gear. Split the ring gear at the drilled holes with a cold chisel and lift away the ring gear.

2
Brush clean the flywheel contact surface to the ring gear with a wire brush.

3

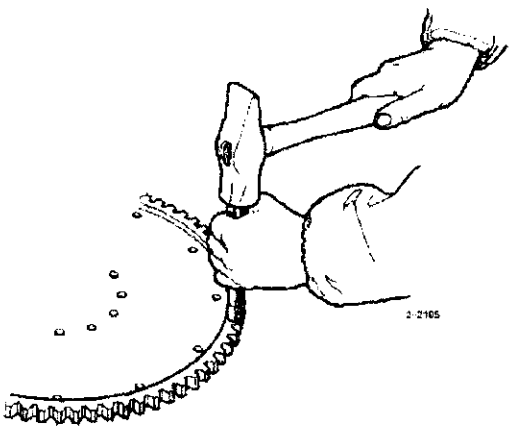


Heat the new ring gear with a gas flame or place it in an oven.

The ring gear must be heated evenly. Take care not to heat the ring gear too much as this will result in it losing its tempering.

Check the heating by polishing the ring gear bright at several places. Cease heating when the polished areas are blued **(180–200°C)**.

4



Place the heated ring gear onto the flywheel and tap it home using a soft drift or hammer.

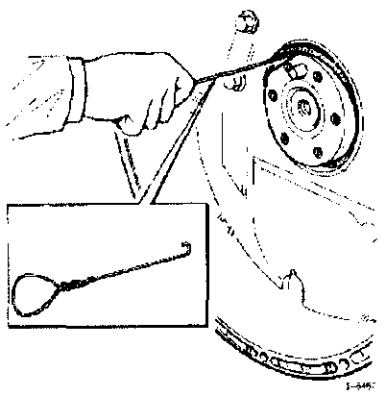
5
Allow the ring gear to air cool.

Rear crankshaft seal, changing

NB! Flywheel removed.

Special tools: 885341, 999 6400, 999 2000, 999 6437

1

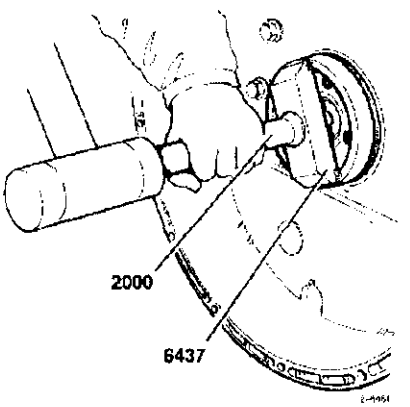


Grip the edge of the sealing ring with tool 885341 and pull it out using a sliding hammer 999 6400.

NB!Take care not to damage the crankshaft.

2
Clean the sealing surface in the flywheel casing and on the crankshaft. Lubricate the new sealing ring with engine oil.

3



Carefully tap in the sealing ring with drift 999 6437 and shank 999 2000.

NB! If there are any grooves worn into the crankshaft, note that the sealing ring must not be placed in any of them.

Flywheel casing, changing sealant

NB! Flywheel removed.

1
Remove the rear bolts in the oil pan (4 bolts).

2
Remove flywheel casing bolts.

3
Carefully tap off the flywheel casing from the cylinder block using a plastic hammer.

4
Clean the flywheel casing and cylinder block contact surfaces.

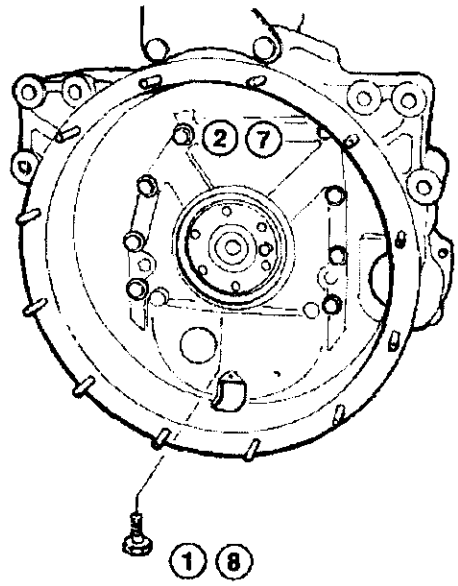
5
Apply an even bead of sealant (part no. 1161231) **2 mm** wide to the flywheel casing contact surface.

6
The flywheel casing must be fitted **within 20 minutes** of applying the sealant.

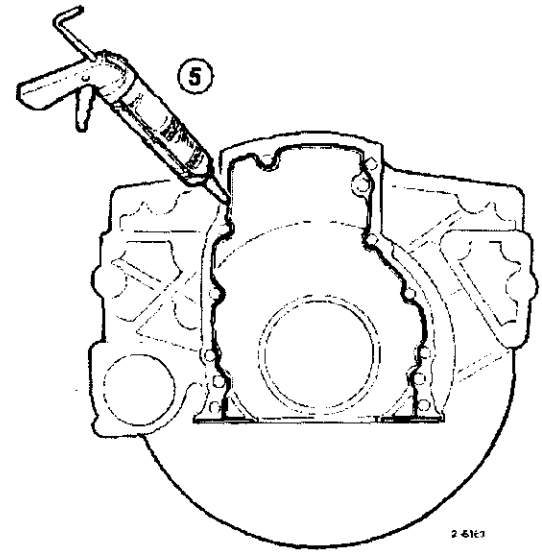
7
Torque tighten the casing bolts to **140 ± 14 Nm**.

8
Fit the oil pan bolts (4x) and torque tighten them to **16 ± 2 Nm**.

The instructions above refer to the numbers in the illustration.



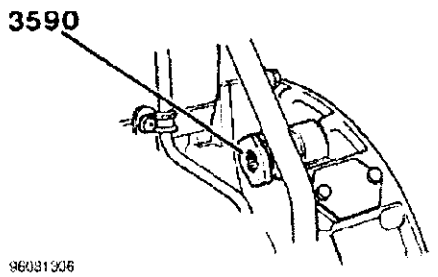
9608140B



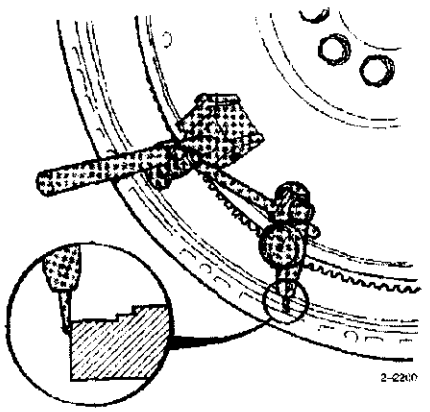
Flywheel casing, checking trueness

Special tools: 998 9876, 999 9683, 999 9696, 999 3590

1
Clean the flywheel and flywheel casing.



2
Fit rotation tool 999 3590



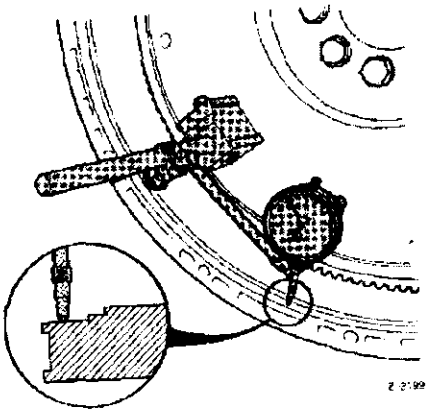
3
Fit a dial indicator in a magnetic stand.

Place the magnetic stand on the flywheel and move the tip of the dial indicator against the outside edge of the flywheel casing.

Rotate the flywheel and calculate the difference between the max and min values.

Transfer the magnetic stand and dial indicator to the other side of the flywheel and repeat the measurement.

The difference between these two measurements



must not be greater than **0.15 mm**.

4

Place the magnetic stand on the flywheel and move the tip of the dial indicator against the inside edge of the flywheel casing.

Rotate the flywheel and make a note of the max and min values.

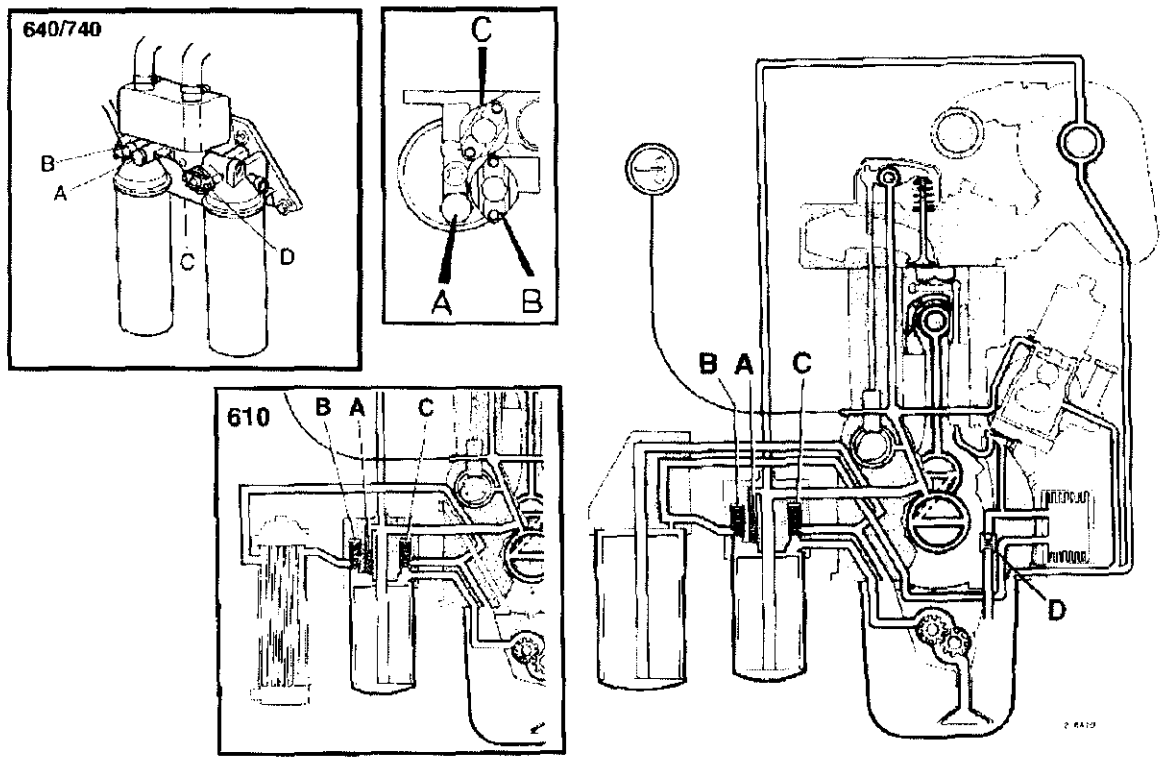
The inside edge of the flywheel casing must be centred within **0.25 mm** to the flywheel.

5
If any of the values measured in steps 3 and 4 are exceeded then the flywheel casing contact surface to the cylinder block must be inspected

6
Remove the rotation tool.

Lubricating system

Design and function



Oil valves

A
Overflow valve for oil filter

The overflow valve opens for safety reasons if the filter should become blocked.

B
Oil cooling vavle (610, TD630)
(the oil cooler is an option on TD630)

At an engine speed of approx. 1000 rpm, the oil cooling valve will open and allow oil to reach the oil cooler. The oil is subsequently returned to the oil sump.

Piston cooling valve (TWD630, 640, 710, 730, 731, 740 and 741)

The piston cooling valve opens when there is oil pressure and the engine speed is slightly above idling.

The oil passes through a drilled passage to the piston cooling passage in the engine block.

Six jets are connected to the piston cooling passage, on for each piston, which spray oil into the base of the pistons(TWD 630, T(W)D730/731) or into the piston oil passages (640, 710, TAD730 and 740).

C
Reducing valve

The reducing valve opens for excess oil pressure and passes the excess oil to the sump.

D
Shunt valve, oil cooler (TAD730)

The valve opens and passes excess oil that is not required for piston cooling back to the sump.

TWD630ME engines

The lubricating system on TWD630ME engines differs from the other 610/630 engines in the following ways:

- Larger lubricating oil pump (same as 710, 730, 740)
- Flat oil cooler (same as 710, 730, 740)

Repair instructions

NB! Always wash the engine before starting repairs.

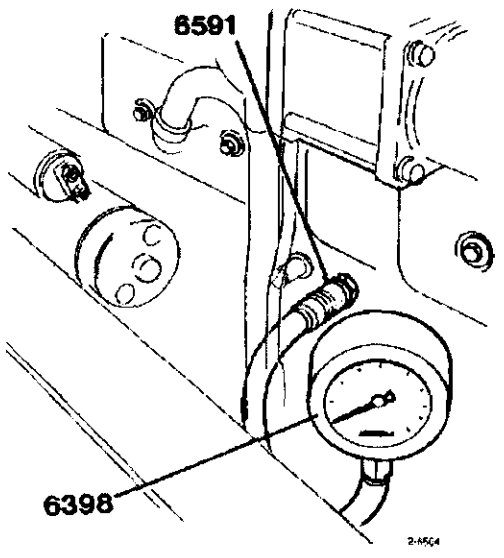
Lubricant pressure, checking

Special tools: 999 6398, 999 6591

1
Remove the oil pressure sensor from the rear right-hand side of the cylinder block.

NB! Clean the threads in the cylinder block with a screw tap (1/8"–27 NPSF). Grease the tap to collect any cuttings.

2



Fit nipple 999 6591 and connect connect pressure gauge 999 6398 to the nipple.

3
Check the oil pressure at idling speed and operating speed once the engine has reached operating temperature. See "Workshop Manual, Technical Data" concerning correct values.

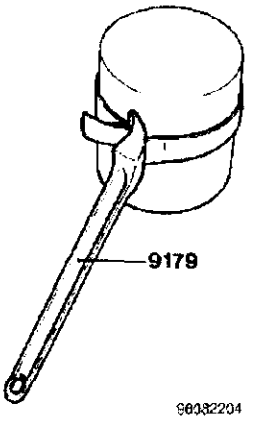
4
Remove the measuring equipment and fit the oil pressure sensor.

Oil filter, changing

Special tool: 999 9179

1
Place a receptacle underneath the filter.

2



Clean the filter attachment and remove the filter using tool 999 9179.

3
Moisten the seals on the new filter with oil and screw in the filter by hand until the seals are in contact with the filter attachment. Then tighten the filter by hand another half a turn.

4
Fill with engine oil and rotate the engine with the starter motor until oil pressure is indicated on the pressure gauge.

5
Start the engine and check for oil leaks around the filter.

Oil filter housing, changing

TD640VE, TWD740GE/VE

1
Detach the water hoses (2x) to the oil cooler.

2
Undo the two retaining bolts for the oil cooler and lift away the oil cooler.

3
Undo the oil filters.

4
Undo the nipple for the oil hose and move it to one side.

5
Undo the retaining bolts for the oil filter housing and remove the oil filter housing from the engine.

NB! The left-hand retaining bolt need not be removed completely as the oil filter housing is slid in place when refitting.

6
Fit a new oil filter housing with new gaskets and tighten all retaining bolts.

7
Fasten the oil hose to the oil filter housing.

8
Fit the oil cooler and and tighten the retaining bolts.

NB! Leave the retaining bolts in the oil cooler when putting it in place.

9
Fit the water hoses

10
Fit the oil filters.

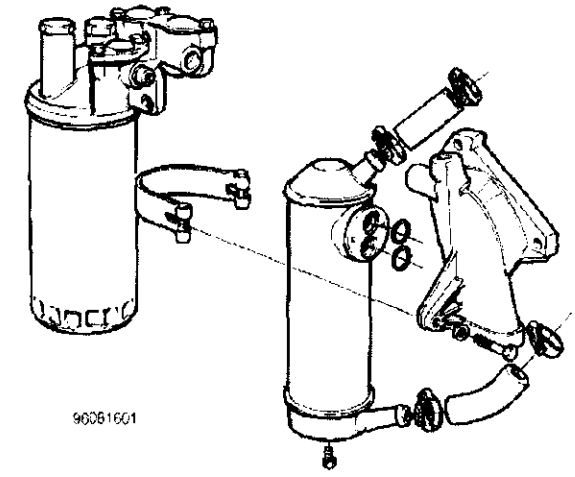
NB! Change engine oil after fitting new filters.

11
Perform a leak and functional check.

Oil cooler, changing

Oil cooler of tubular type

1
Drain the engine coolant.



2
Remove the oil cooler bottom plug and drain the coolant.

3
Remove the lower coolant hose from the oil cooler and the upper coolant hose from the pipe.

4
Undo the clamp and lift away the oil cooler.

5
Clean the surfaces on the oil cooler attachment for the sealing ring.

6
Fit the upper coolant hose to the new oil cooler.

7
Fit new sealing rings and lift in place the oil cooler while fitting the lower coolant hose.

8
Fit the clamp and tighten the two nuts the same amount.

9
Connect the upper coolant hose to the pipe.
Tighten all hose clips.

10
Fill with coolant and engine oil

11
Rotate the engine with the starter motor until oil pressure is indicated on the pressure gauge.

12
Inspect for leaks.

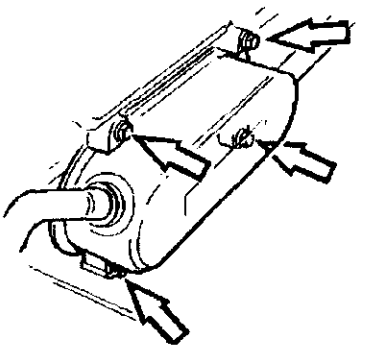
Flat oil cooler

1
Drain the coolant.

2
Remove the attachment securing the rear coolant pipe to the cylinder block.

3
Pull the coolant pipe out of the cylinder block and the oil cooler.

4



Unscrew the oil cooler retaining bolts.

5
Pull the oil cooler away from the front coolant pipe and remove the cooler from the coolant block.

6
Clean the sealing surfaces and fit new sealing rings on the cylinder block.

7
Fit new sealing rings on the coolant pipes.

NB!Apply petroleum jelly or soap water to the sealing surfaces.

8
Press up the oil cooler onto the front coolant pipe and bolt the oil cooler to the cylinder block.

9
Fit the rear coolant pipe.

NB! Slide the coolant pipe into the oil cooler first and then into the cylinder block.

10
Refit the attachment for the rear coolant pipe to the cylinder block.

11
Fill with coolant and lubricant.

12
Rotate the engine with the starter motor until oil pressure is indicated on the pressure gauge.

13
Start the engine and check for leaks around the oil cooler and its connections.

TD640VE and TWD740GE/VE

1
Drain the coolant.

2
Undo the two water hoses to the oil cooler.

3
Unscrew the oil cooler retaining bolts.

4
Fit a new oil cooler with a new gasket. Tighten the retaining bolts to standard torque.

5
Fit the two water hoses to the oil cooler.

6
Fill with coolant and lubricant.

7
Start the engine and check for leaks around the oil cooler and its connections.

Integrity check of oil cooler

NB! Oil cooler removed

Oil cooler of tubular type

Special tools: 999 6033, 999 6662, 999 8205, 999 8206

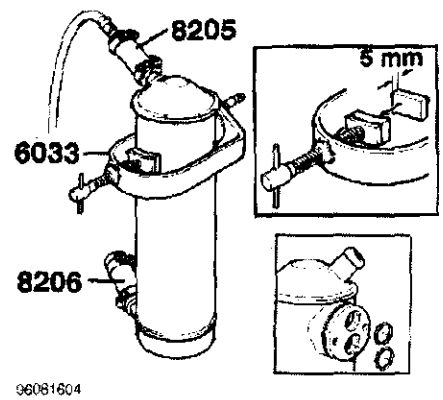
1
Flush the coolant side of the oil cooler with water-soluble degreasing agent. Flush the oil side with degreasing agent.

2
In order to detect minor leaks, the oil cooler must be at room temperature.

Flush the oil cooler with water at room temperature until it has attained room temperature. Drain all the water.

3
Fit O-rings to the flange between the cooler and the oil system.

4

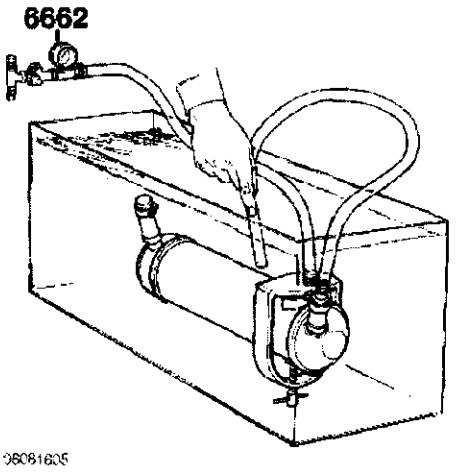


Connect leak test equipment 999 6033 and make sure it seals properly against the O-rings.

Fit seal 999 8206 to one of the coolant connections and hose connection 999 8205 (or 999 8200) to the other one.

Make sure the seals are functioning properly.

5



96061605

Connect leak test equipment 999 6662 to 999 6033. Lower the oil cooler into a bath of water at room temperature. Place the measuring hose approx. **20 mm** below the surface of the water.

NB! Water must not be allowed to enter the measuring hose.

The leak test must be performed at three different pressures:
15, 100 and 250 kPa.
The test duration at each pressure level should be **at least one minute**.

Air bubbles appearing from the measuring hose indicate that there is an internal leak in the oil cooler.

Air bubbles around the oil cooler indicate and external leak.

Extractor fans and ventilation systems in the garage must not be started or stopped during the test, nor should sudden changes in air pressure be allowed. This is because pressure changes in the garage can be misinterpreted as a leak.

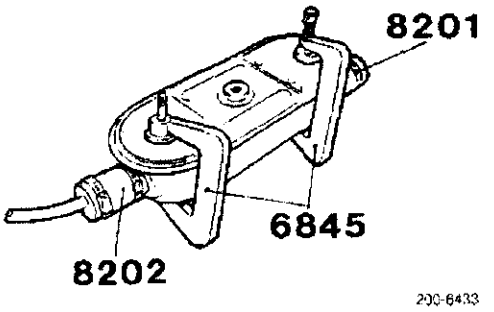
Flat oil cooler

Special tools: 999 6662, 999 6845, 999 8201, 999 8202

1
Clean the coolant side of the oil cooler with water-soluble degreasing agent.
Clean the oil side of the oil cooler with degreasing agent.

2
In order to detect minor leaks, the oil cooler must be at room temperature.
Flush the oil cooler with water at room temperature until it has attained room temperature. Drain the water.

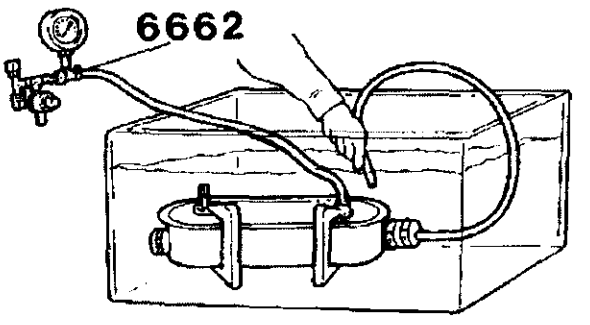
3



200-6433

Fit leak test equipment 999 6845 and make sure it is sealing properly.
Fit seal 999 8201 to one of the coolant connections and hose connection 999 8202 to the other one. Make sure the seals are functioning properly.

4



200-6434

Connect leak test equipment 999 6662 to 999 6845. Lower the oil cooler into a bath containing water at room temperature. Place the measuring hose approx. **20 mm** under the surface of the water.

NB! Water must not be allowed to enter the measuring hose.

The leak test must be performed at three different pressures:
15, 100 and. 250 kPa.
The test duration at each pressure level should be **at least one minute**.

If air bubbles appear from the measuring hose, there is an internal leak in the measuring hose.

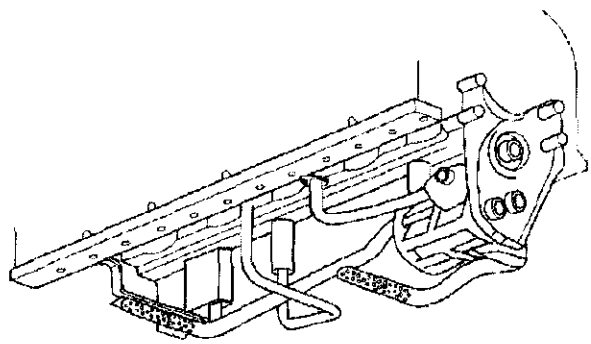
Air bubbles around the oil cooler indicate and external leak.

Extractor fans and ventilation systems in the garage must not be started or stopped during the test, nor should sudden changes in air pressure be allowed. This is because pressure changes in the garage can be misinterpreted as a leak.

5
Remove the oil cooler from the bath and disconnect the leak test equipment.

Oil delivery pipe on inclined oil sump

Engines with inclined lubricating oil sump have a different number and routing of the oil delivery pipes (see illustration).

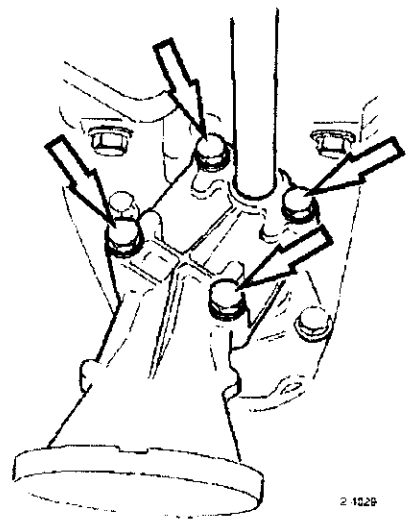


Lubricant pump, changing

NB! Lubricant oil tray removed.

Removing

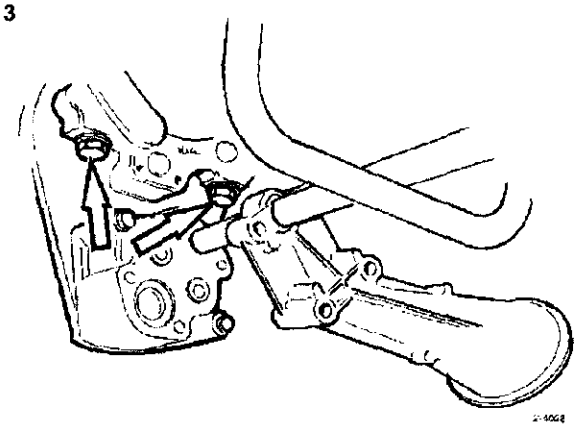
1



Unscrew the bolts securing the oil inlet pipe and the oil suction pipe.

2
Remove the oil suction pipe attachment from the oil pump.

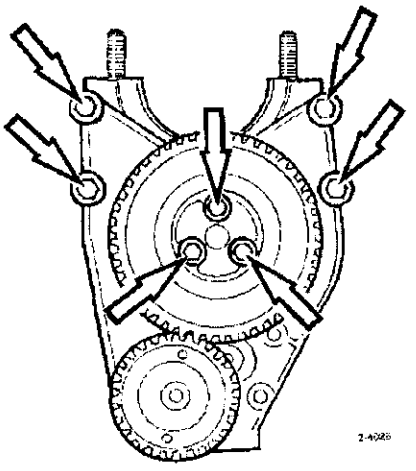
3



Remove the bolts on the front main bearing cap and lift off the pump together with the cap.

4
Remove the bearing shell from the cap.

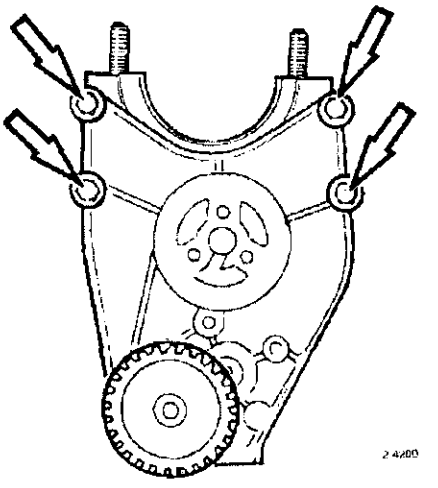
5



Remove the idler gear and main bearing cap from the oil pump attachment.

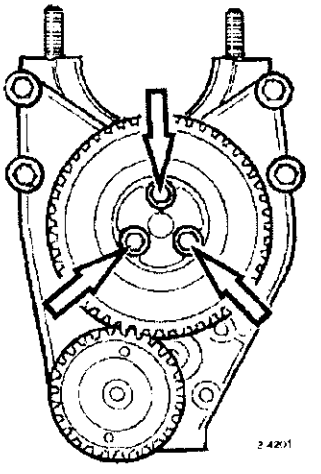
Fitting

6



Screw the main bearing cap to the oil pump attachment. Torque tighten the bolts to **65 ±7 Nm** and lock the securing lugs.

7

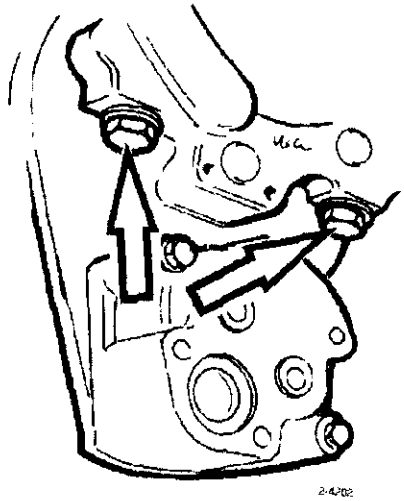


Fit the idler gear and torque tighten the bolts to **33 ± 4 Nm**.

8

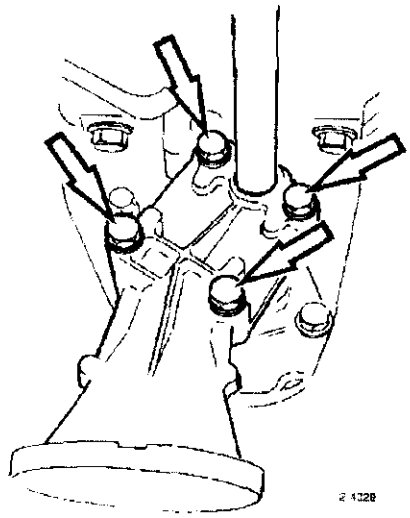
Apply oil to the main bearing shell and fit it into the cap.

9



Position the oil pump, fit the main bearing cap bolts and torque tighten them to **150 ± 10 Nm**.

10

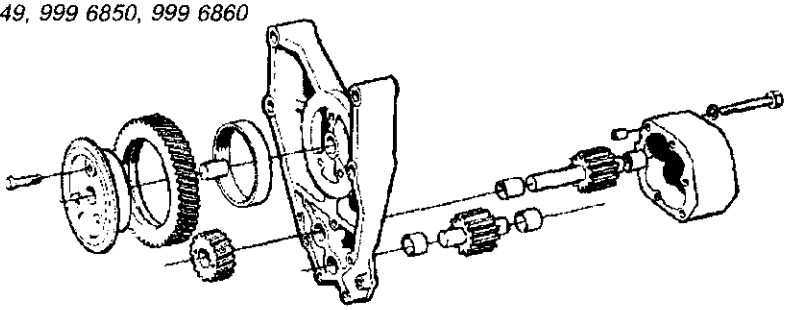


Fit new O-rings and bolt on the oil suction pipe attachment to the oil pump.

Lubricant pump, reconditioning

NB! Lubricant pump removed.

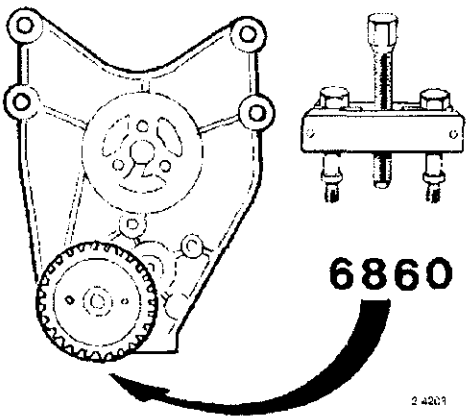
Special tools: 999 6849, 999 6850, 999 6860



1
Remove the main bearing cap from the oil pump bracket.

2
Remove the idler gear.

3



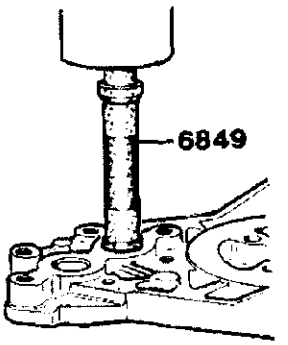
Remove the pump pinion from the shaft using puller 999 6860.

4
Mark the position of the pump housing in relation to the bracket. Remove the bolts and pump housing from the bracket

5
Remove the pump gears from the housing.

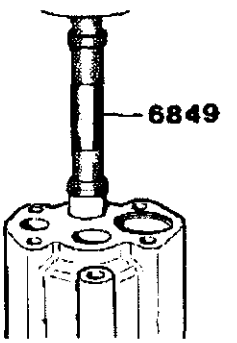
6
Check the housing for scores and wear and also for leaks between the attachment and the pump housing. The contact surfaces will be black if leaks have occurred. Check the pump gears for leaks on the flanks, casing surfaces and end planes.

7



Press out the bushings from the bracket and pump housing using tool 999 6849.

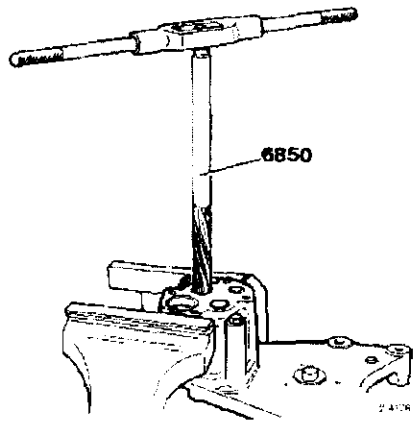
8



Press in the new bushing into the pump housing and bracket using tool 999 6849.

9
Screw the pump housing to the bracket taking in to account the marking made earlier to provide a guiding surface when reaming the bushings.

10



Ream the bushings in the pump housing and bracket using tool 999 6850.

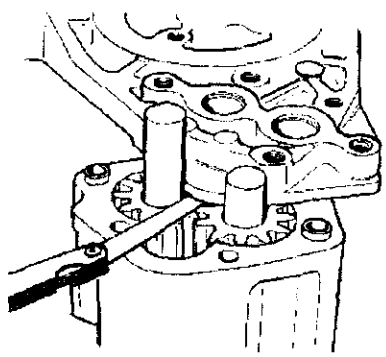
11
Unscrew the bolts and remove the pump housing from the bracket.

12
Carefully clean the pump housing and bracket to remove any iron filings.

13
Lubricate the new pump gears and bushes with engine oil and place the gears in the housing.

NB! Make sure the shortest shaft journal on the impeller gear is turned towards the oil pump bracket.

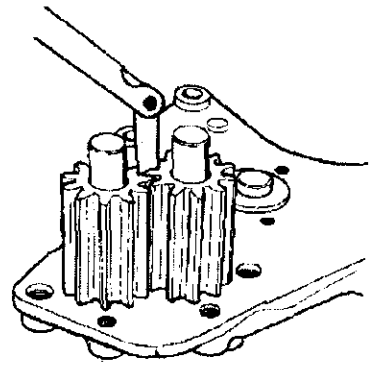
14



Check the end float of the pump gears with a feeler gauge.

Correct play: **0.07–0.15 mm**.

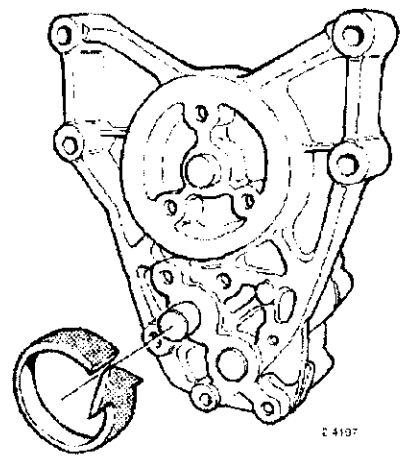
15



Check the pump gear flank clearance with a feeler gauge.

Correct flank clearance: **0.15–0.30 mm**.

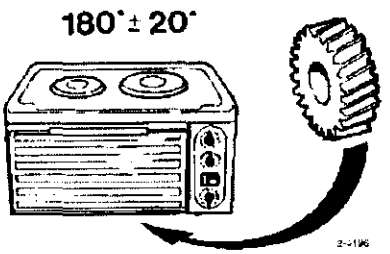
16

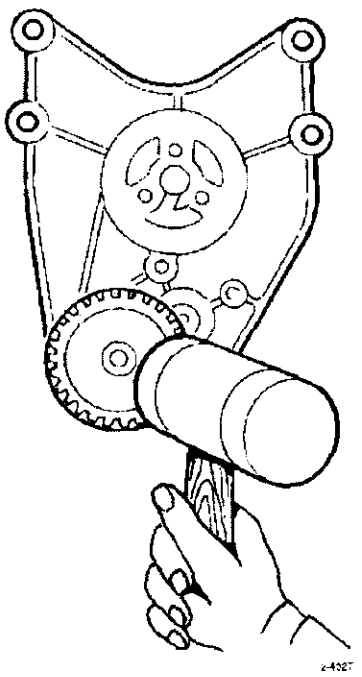


After checking the end float and flank clearance, move the pump gears to the bracket. Then fit and tighten the pump housing to the bracket according to the markings made earlier. Make sure the pump gears are rotating and that they mesh easily and do not jam by turning the pump shaft **one whole revolution**.

17
The drive gear should also be changed when reconditioning a pump of earlier design where the pump shaft and drive gear have keys and keyways.

18

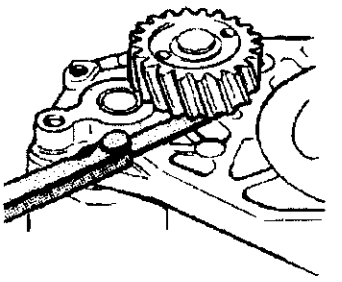




Heat the oil pump drive gear to **180 ± 20°C** and knock the gear up the shaft using a plastic hammer.

NB! Originally, there was a thrust washer between the drive gear and the bracket on pumps of earlier design. Do not refit this washer when reconditioning the pump.

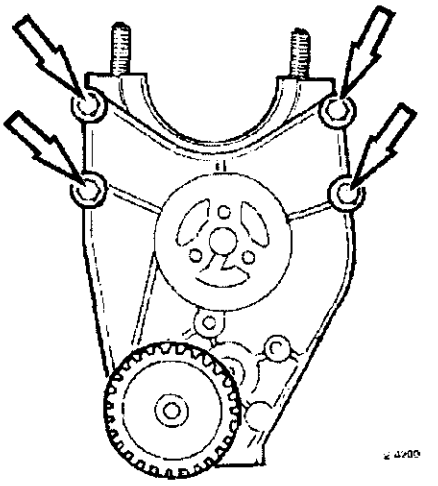
19



Check the play between the pump gear and the bracket with a feeler gauge.

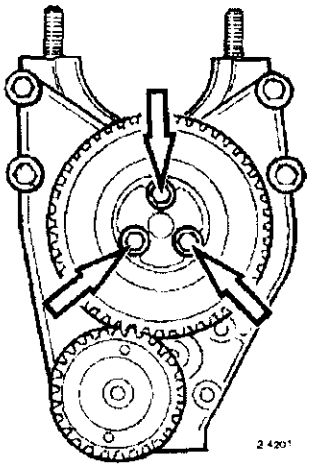
Correct play: **1.0 – 1.5 mm**.

20



Screw the oil pump bracket on the main bearing cap. Fit and torque tighten the bolts to **65 ±7 Nm**.

21



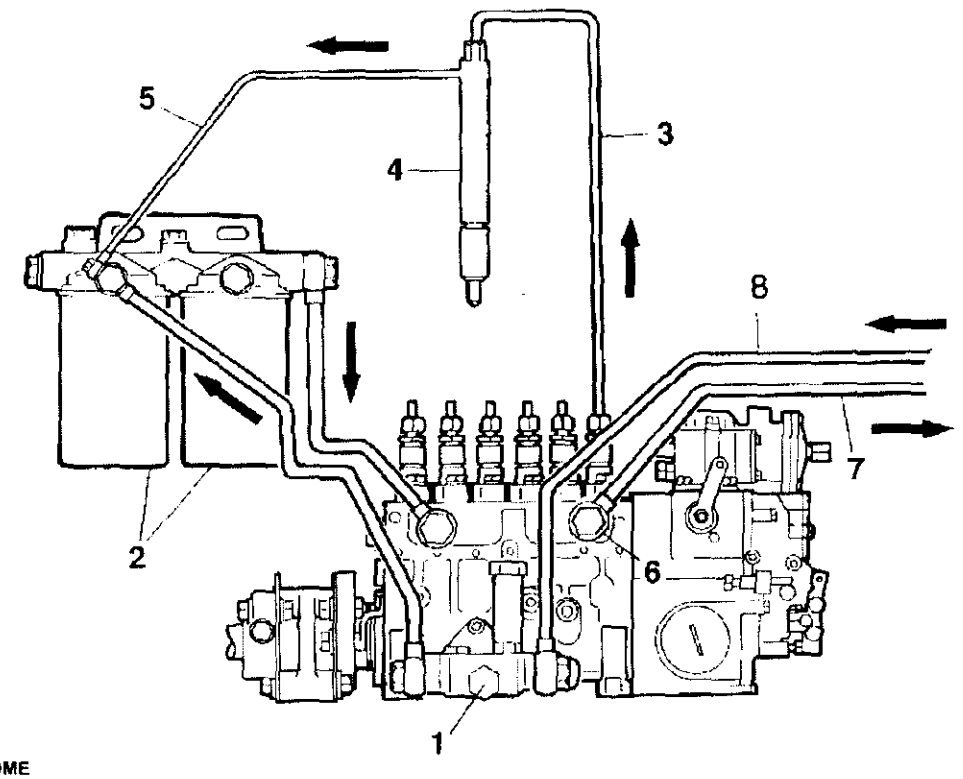
Put the idler gear in place and torque tighten the bolts to **33 ± 4 Nm**.

Fuel system

Design and function

General information

The fuel system contains the following main components: fuel tank with level sensor, feed pump, two fuel filters, injection pump, injectors and pipes.

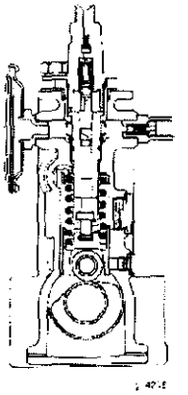


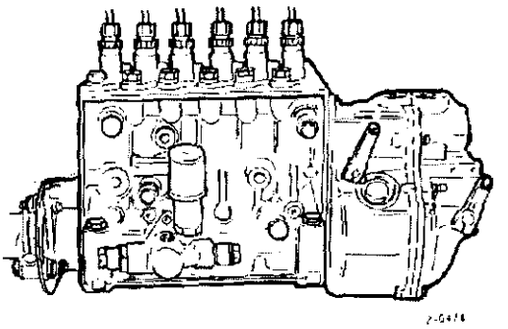
TWD730ME

1. Feed pump
2. Fuel filter
3. Fuel delivery pipe
4. Injectors
5. Fuel leak-off pipe
6. Overflow valve
7. Return pipe
8. Fuel inlet pipe

Injection pump

The pump is situated on the left-hand side of the engine and is driven from the engine timing gear via a pump coupling. (On 610, TD630 and 640, it is flange mounted on the timing gear casing). The pump is lubricated through a connection to the engine lubricating system.





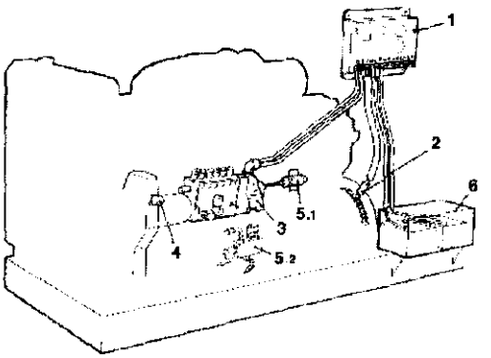
Governor

The injection pump is equipped with a centrifugal governor.

The governor operates with speed-dependent centrifugal weights. The speed is regulated over the entire engine speed range, from low to high idling (variable speed type).

Certain engines are equipped with an electronic speed regulator. An electronic regulating system is a control unit that checks the speed of the engine. Its task is to:

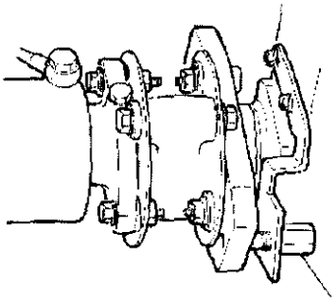
- maintain the idling speed at the set value.
- maintain the engine speed at the preset value irrespective of varying loads.



Electronic regulating system
1. Control unit
2. Engine speed sensor
3. Control device
4. Speed sensor, overrevving protection
5. Stop solenoid/fuel cut-off valve
6. Batteries

Injection timing adjuster

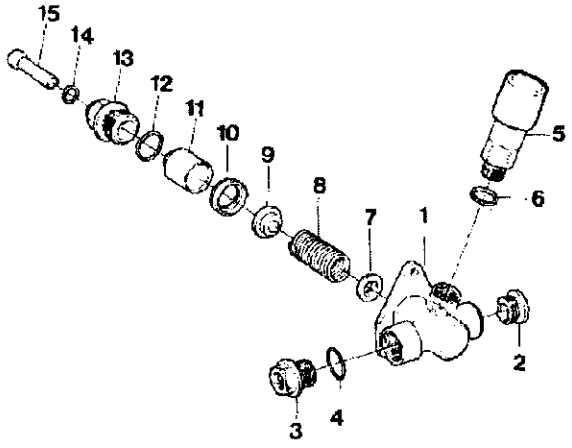
The TWD630ME and TWD730ME are equipped with an injection timing adjuster, the funciton of which is provide variable injection timing as a function of engine speed. See "Design and function, injection timing adjuster".



Feed pump

The feed pump is situated on the injection pump and is driven by the injection pump camshaft.

The feed pump pressure is determined by the overflow valve in the fuel system.



1. Housing
2. Union
3. Union
4. O-ring
5. Hand pump
6. Gasket
7. Spring disc
8. Spring
9. Valve
10. Spacer
11. Pump piston
12. O-ring
13. Union
14. O-ring
15. Push rod

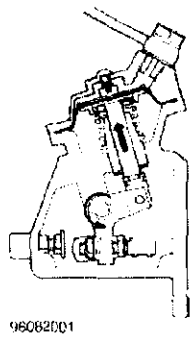
Smoke limiter (certain engine)

The location and type of smoke limiter depends on the type and make of pump but all are used to limit the amount of fuel being supplied by the injection pump when the turbocharger is delivering a low boost pressure.

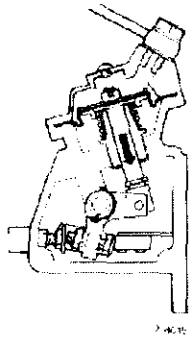
The smoke limiter diaphragm is acted on by the pressure in the intake manifold via a pipe. The movement of the diaphragm is transferred to a linkage system that affects the movement of the injection pump control rod.

In conjuction with low boost pressure, the control rod travel is shortened by the smoke limiter. This forces the injection pump to reduce the maximum amount of fuel supplied.

In conjuction with high boost pressure, the smoke limiter will allow the control rod to be displaced to a position that supplies a higher maximum fuel quantity.



Low boost pressure



High boost pressure

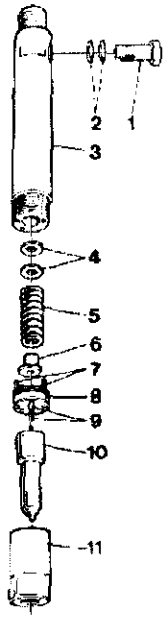
Nozzle

The injectors have the following function:

To atomize the fuel for reliable ignition and combustion.

Together with the air swirl, to distribute the jets of fuel in the combustion chamber to provide optimum mixture of fuel and air.

The injector opening pressure is determined by the tension of the feed spring.

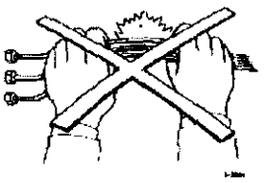


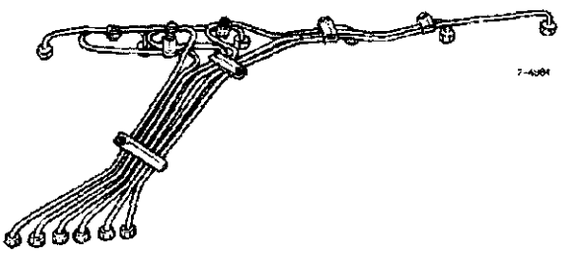
1. Banjo screw
2. Gaskets
3. Nozzle holder
4. Adjusting washers
5. Spring
6. Pressure pin
7. Guide pin
8. Guide
9. Guide pin
10. Nozzle
11. Cap nut

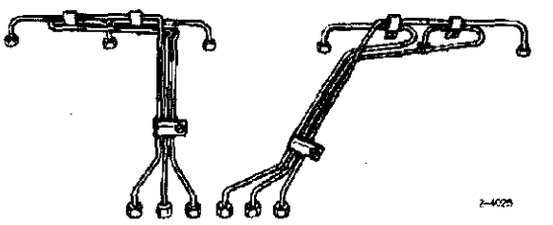
Fuel delivery pipe

Certain engines are equipped with prestressed fuel delivery pipes The fuel delivery pipes must never be bent or reshaped. If a prestressed pipe is bent or reshaped, cracks may arise that could lead to a break. A damaged pipe must always be replaced with a new one.

The entire pipe set must be removed as one unit when dismantling the injectors or injection pump. Do not remove the pipe clamps. Remove the pipes in sets of three. If the whole set of pipes are clamped together, remove all the pipes as one unit.





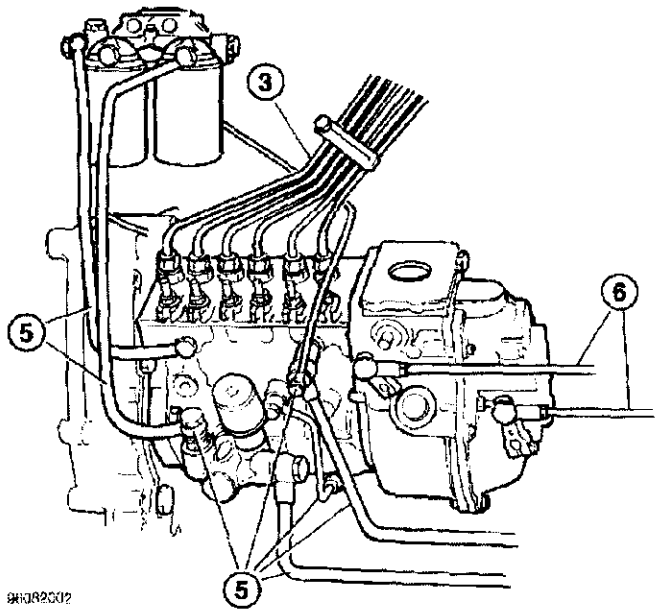


Repair instructions

NB! Always wash the engine before starting repairs.

Injection pump (flange mounted) – removal

Special tool: 999 3590



The following text refers to the numbers in the illustration.

NB! All the fuel and oil pipes and their connections must always be plugged when disconnecting the pump.

1
Clean the injection pump, pipes and engine adjacent to the pump.

2
Remove the valve cover on cylinder 1.

3
Remove the fuel delivery pipes.

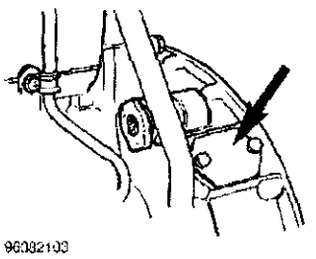
NB! The pipes are clamped together. Do not remove the clamps, remove all the pipes as one unit.

4
Remove the pipe from the smoke limiter (if fitted).

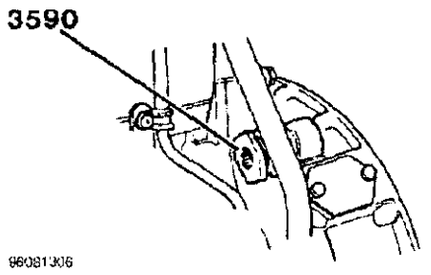
5
Detach the oil and fuel pipes from the injection pipes.
TWD740GE/VE: Detach also the vacuum hose from the injection pipe.

6
Detach the throttle control and stop linkage.

7

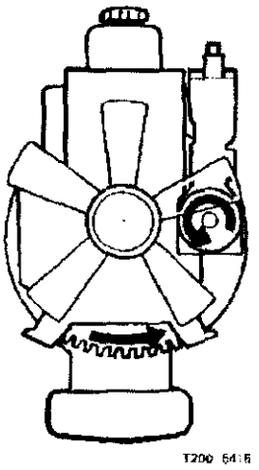


Remove the inspection cover from the flywheel casing.



8

Rotate the flywheel until cylinder 1 is in its compression position (0° on the flywheel and both valves for cylinder 1 closed).



9

Rotate the flywheel against the direction of rotation approximately 1/4 turn.

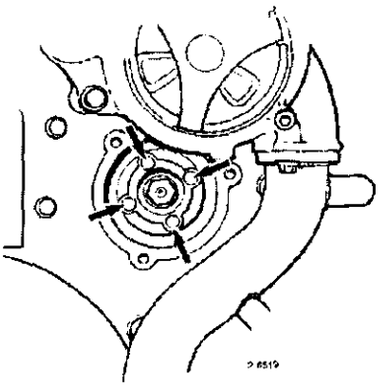
10

Rotate the flywheel in the direction of rotation of the engine until the markings for the correct setting angle, see "Workshop Manual, Technical Data", coincides with the indicator on the flywheel casing.

NB! This setting should be performed to ensure that the pump drive gear is in the correct position when fitting the pump.

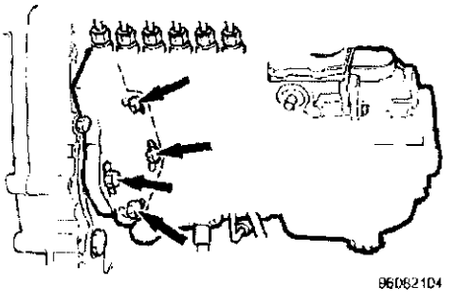
Do not turn the flywheel while the pump drive gear is removed.

11



Remove the cover in front of the pump drive gear and unscrew the drive gear bolts and flange.

12



Remove the retaining bolts and carefully lift away the injection pump.

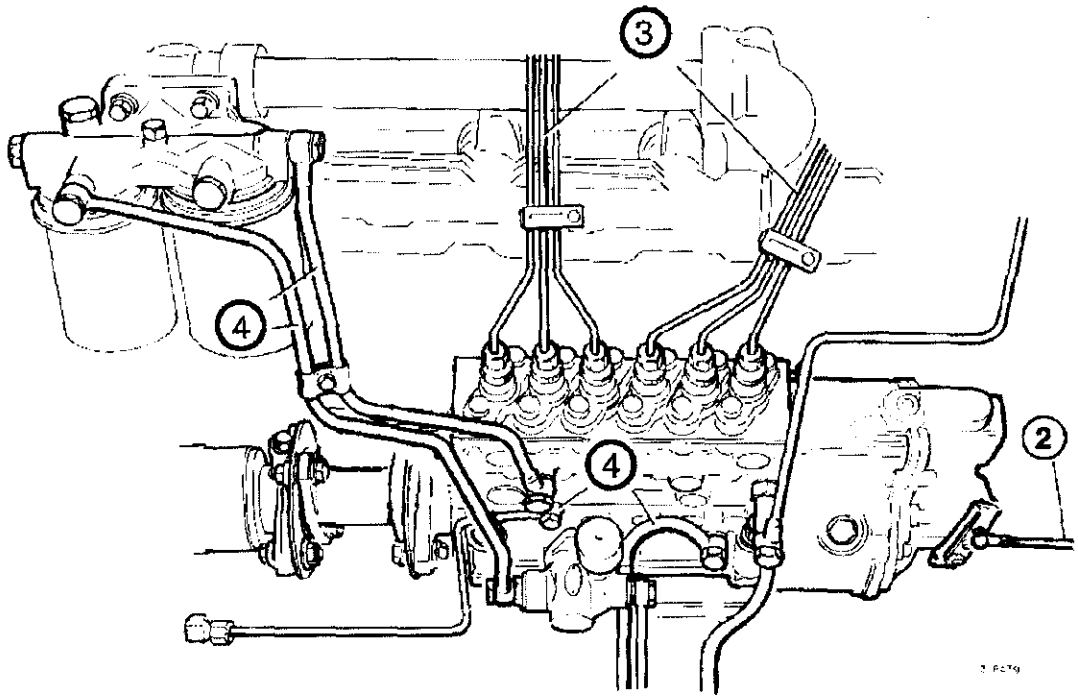
TWD740GE/VE: Remove the retaining bolts, separate the bracket and carefully lift away the injection pump

13

Fit the valve cover, use a new gasket if necessary.

Injection pump (mounted via pump coupling) - removal

Special tools: 999 3590



The following text refers to the numbers in the illustration.

NB! All the fuel and oil pipes and their connections must be plugged when disconnecting the pump.

1
Clean the injection pump, pipes and engine adjacent to the pump.

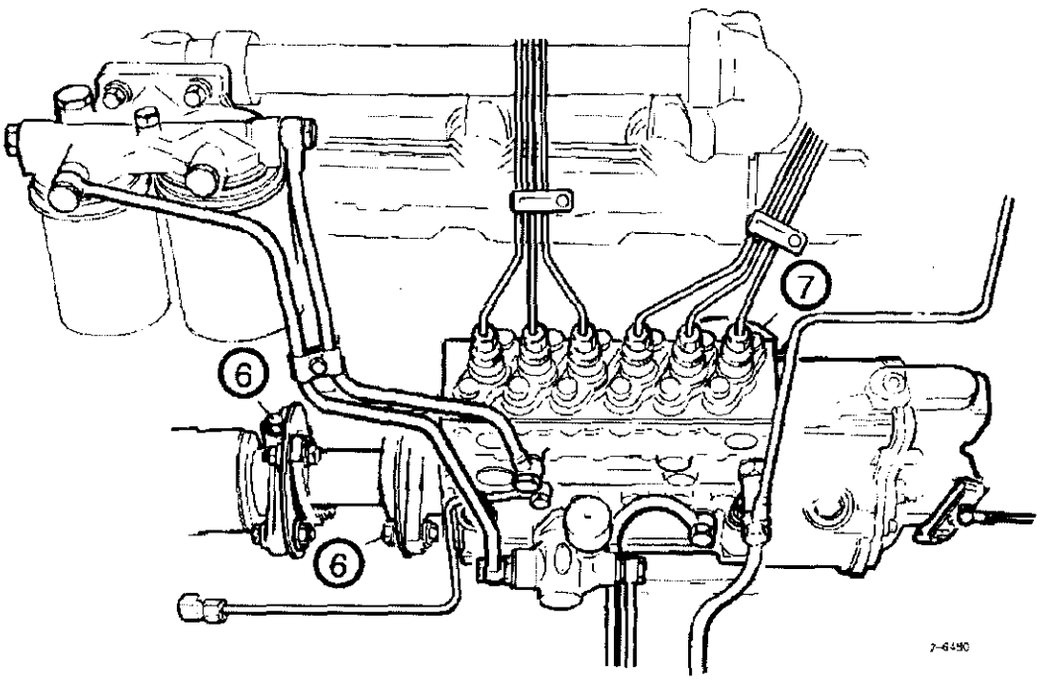
2
Detach the throttle control and stop linkage.

3
Remove the fuel delivery pipes and plug the connections.

NB! The fuel delivery pipes are clamped together in threes. Do not remove the clamps, remove all the pipes as one unit.

4
Remove all the fuel and oil pipes from the injection pump.

5
Remove the pipe from the smoke limiter (if fitted).



The following text refers to the numbers in the illustration.

6
Undo the pump coupling retaining bolt and remove the bolts between the pump coupling and the injection pump mounting flange.

7
Remove the pressure compensator from the injection pump (if fitted).

8
Remove the injection pump mounting bolts and carefully lift away the pump.

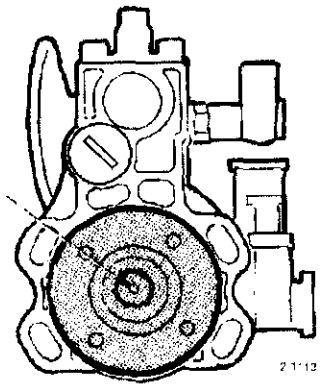
Injection pump (flange mounted) – installation

Special tools: 999 3590, 999 6848, 998 9876

NB! Do not remove the protective plugs from the injection pump before the pipes are connected. Check that the pump and governor are filled with oil to the correct level.

Use new copper washers.

1

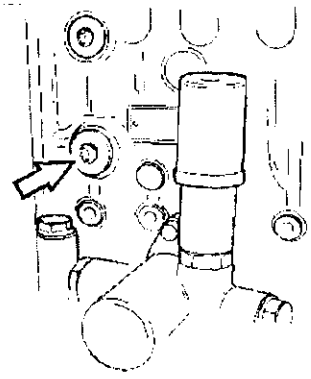


Adjust the injection pump camshaft so that the dotted line on the end of the camshaft is pointing towards the top of the oval hole in the upper, inner flange anchorage on the end of the pump.

2
Fit a new sealing ring on the injection pump guide flange for the timing gear casing.

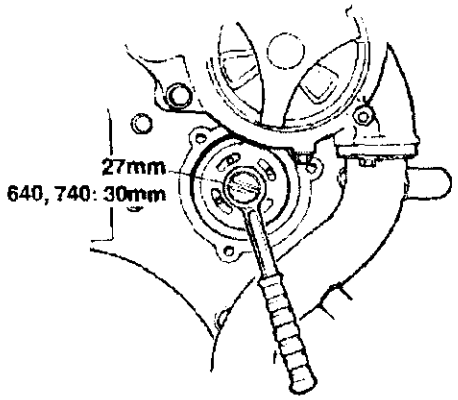
3
Fit the injection pump and screw it tight. Position the pump with the screw studs in the centre of the oval holes in the pump mounting flange.

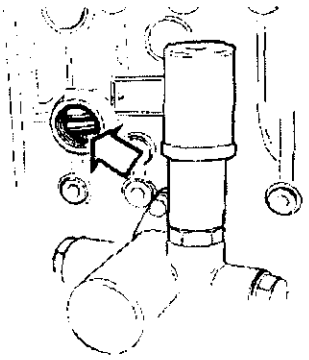
4



Remove the hexagon socket plug together with the washer to expose lifter 1 on the injection pump.

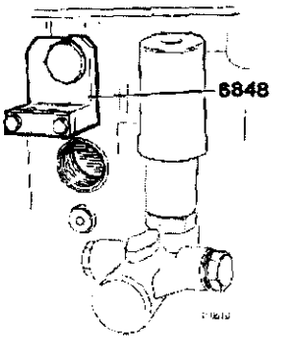
5





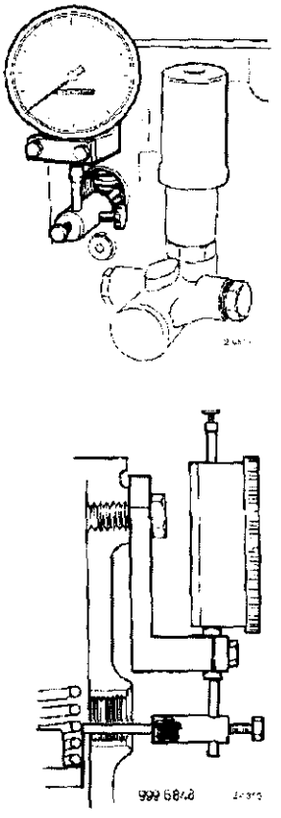
Using a socket and extension, turn the pump camshaft until lifter 1 is in its bottom position.

6



Fit fixture 999 6848 to the injection pump.

7

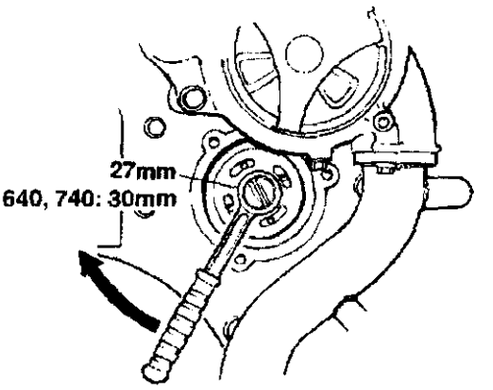


Place a dial indicator in the fixture and fit the measuring tip onto the dial indicator. Adjust the measuring tip so it rests against the lifter.

8

Zero the dial indicator.

9

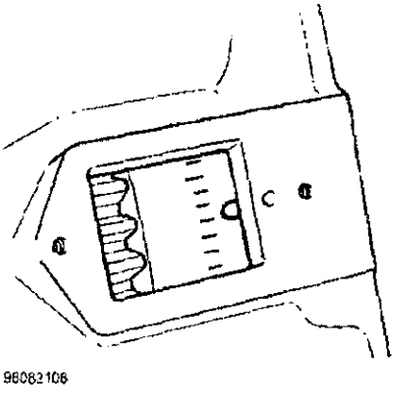


Turn the pump camshaft in the direction of pump rotation. Make sure the dial indicator is still zeroed when starting to turn.

10

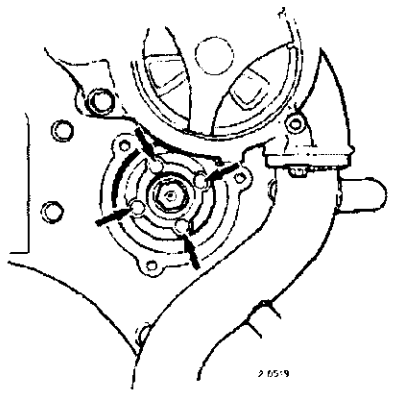
Continue turning the pump camshaft in the direction of pump rotation until the lifting height from the base circle (as specified) is displayed on the dial.

11

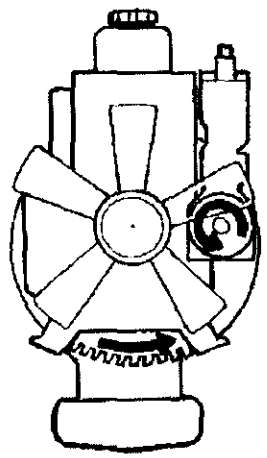


Check that the flywheel has not been moved from its set position and that the markings for the correct setting angle, see "Workshop Manual, Technical Data", coincide with the indicator on the flywheel casing.

12

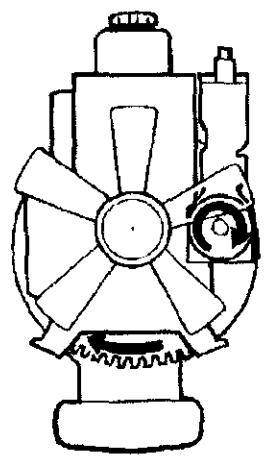


Fit the pump drive flange and torque tighten the bolts to **60 ± 6 Nm**.



T200 5415

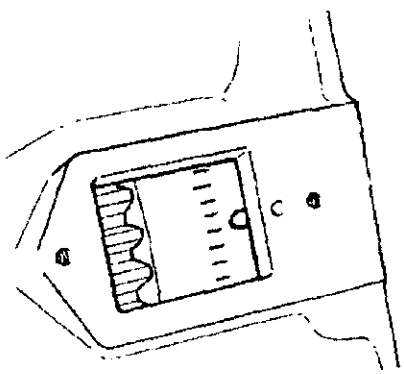
Against rotation direction



T200 5418

In rotation direction

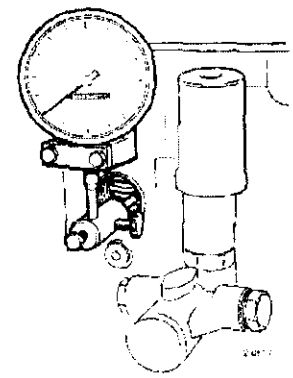
13



98082106

Check the setting by first rotating the flywheel against the direction of rotation of the engine approx. 1/4 of a revolution and then in the direction of engine rotation until the markings for the correct setting angle, see "Workshop Manual, Technical Data", coincide with the indicator.

14



Make sure the dial indicator shows the correct height above the base circle, see "Workshop Manual, Technical Data".

15

If readjusment is necessary, the injection pump can be turned towards the timing gear casing to the extent of the oval holes in the mounting flange.

NB! After undoing the retaining bolts, the injection pump should first be turned in the direction of rotation of the pump camshaft and then against the direction of rotation until the correct value is obtained on the dial indicator. The retaining nuts should then be tightened and a new check carried out.

16

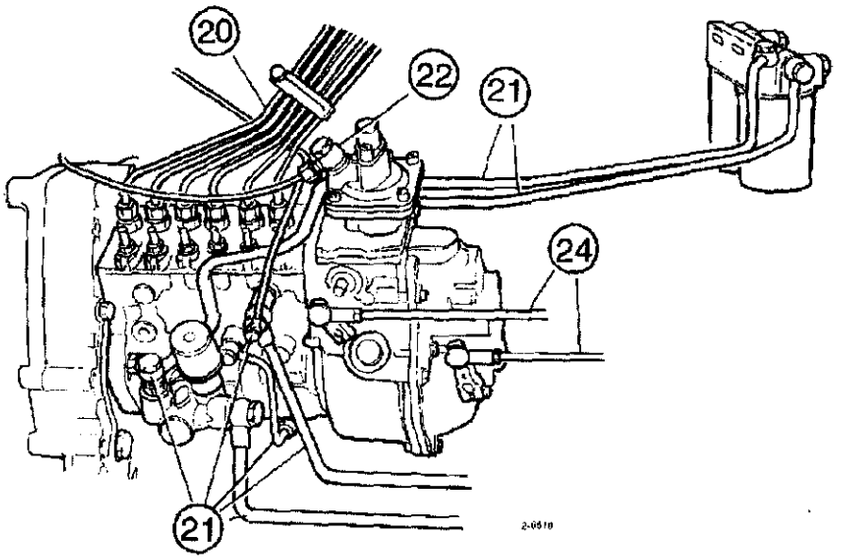
Remove the setting tool, fit new sealing washers and refit the plugs in the injection pump.

17

Remove the rotation tool from the flywheel casing.

18

Refit the inspection cover on the flywheel casing.



The following text refers to the numbers in the illustration.

19
Fit the cover in front of the pump drive gear.

20
Fit the fuel delivery pipes.

21
Fit all the fuel and oil pipes.
TWD740GE/VE: Fit also the vacuum hose to the injection pipe.

22
Fit the pipe to the smoke limiter (if fitted).

23
Fit the pressure compensator (if fitted).

24
Fit the throttle control and stop linkage.

25
Bleed the fuel system.

26
Start the engine and inspect for leaks.

Injection pump (mounted via pump coupling) – installation

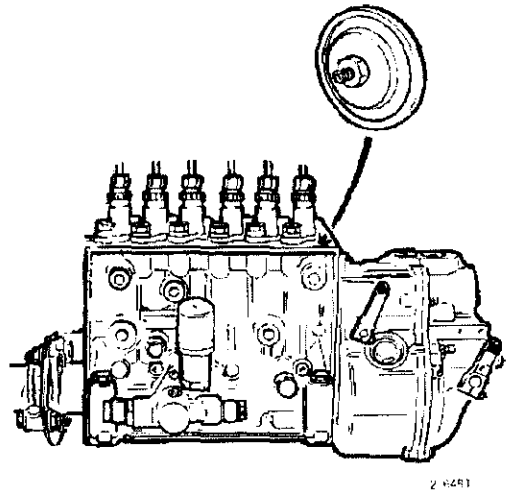
Special tools: 999 3590, 999 6848, 998 9876, 999 8590, (TWD730ME): 999 8191

NB! Do not remove the protective plugs from the injection pump before the pipes are connected. Check that the pump and governor are filled with oil to the correct level.

Use new copper washers.

1
Make sure the pump coupling is in good condition and clean it. There must not be any traces of oil or other contaminants.

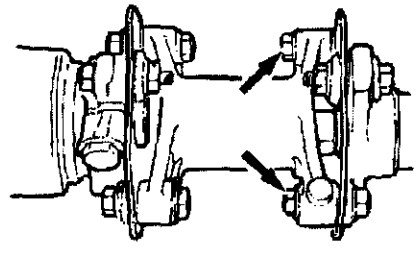
2



Fit the pressure compensator (certain engines) to the injection pump.

3
Put the injection pump in place and fit and tighten the bolts.

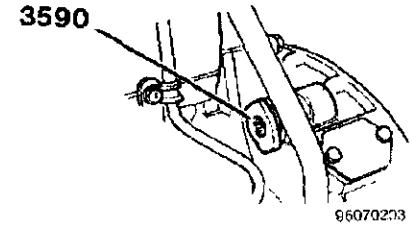
4



Assemble the pump coupling and the injection pump mounting flange and tighten the nuts to standard torque.

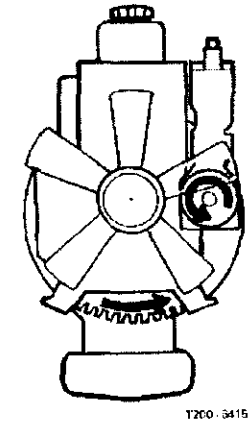
5
Remove the valve cover on cylinder 1.

6



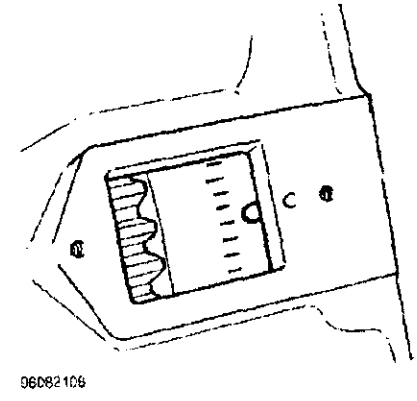
Remove the inspection cover from the flywheel casing. Fit rotation tool 999 3590 and turn the flywheel until cylinder 1 is in its compression position (0° on the flywheel and both valves for cylinder 1 closed).

7



Rotate the flywheel against the direction of rotation approximately 1/4 turn.

8

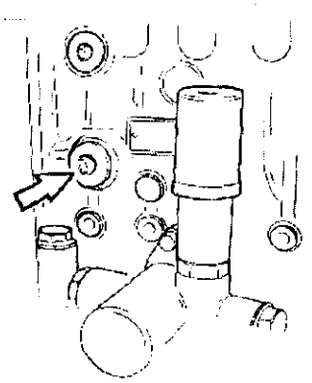


Rotate the flywheel in the direction of rotation of the engine until the number of degrees coincides with the markings on the flywheel. See "Workshop Manual, Technical Data".

9
NB! This adjustment must be carried out thoroughly and the flywheel must never be turned against the direction of rotation for fine adjustment. If the flywheel has been turned too far, the adjustment process must be restarted.

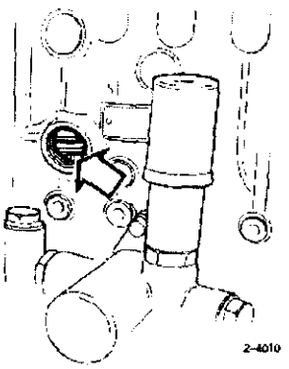
TWD630ME/VE, TWD710G/P/V, TAD730G/P/V

10



Remove the hexagon socket plug and washer to expose lifter 1 on the injection pump.

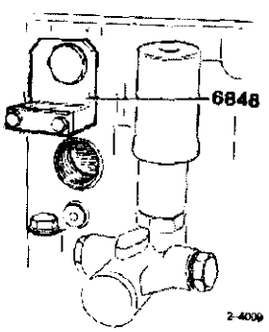
11



Turn the pump coupling with a pair of adjustable pliers until the lifter is in its bottom position.

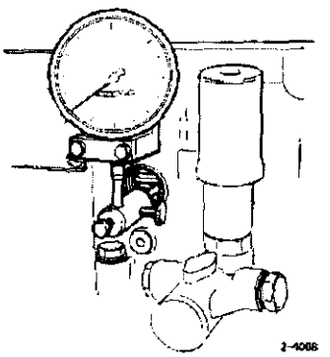
NB!Take care not to damage the pump coupling.

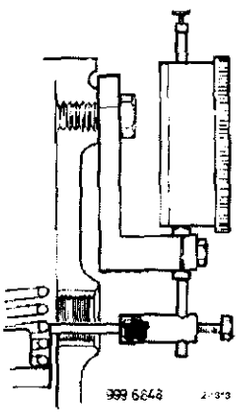
12



Fit fixture 999 6848 to the injection pump.

13



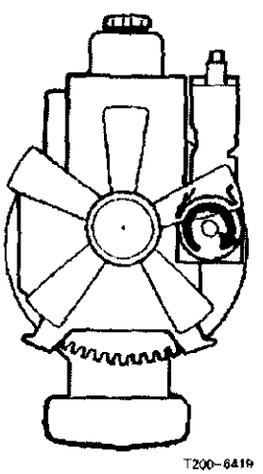


Place a dial indicator in the fixture and fit the measuring tip onto the dial indicator. Adjust the measuring tip so it rests against the lifter.

14

Zero the dial indicator.

15



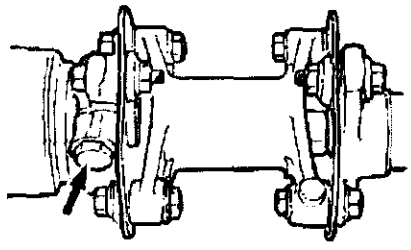
Turn the pump coupling with a pair of adjustable pliers in the direction of rotation of the pump.

Make sure the dial indicator is still zeroed when starting to turn.

16
Continue turning the pump coupling in the direction of pump rotation until the correct lifting height from the base circle (as specified) is displayed on the dial.

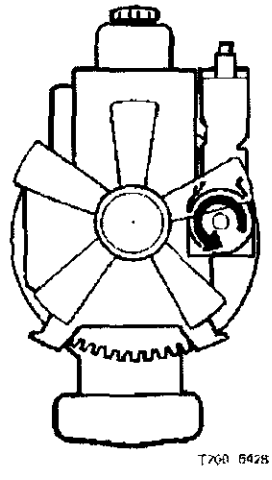
Now turn the pump coupling until the dial indicator shows approx. 1-2 mm more than the specified lift from the base circle.

17



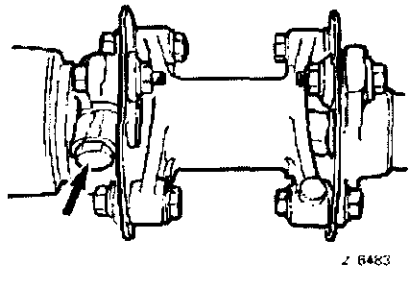
Tighten the clamp bolt hard enough so that the pump coupling can be turned with substantial resistance. This must be done to eliminate as much as possible the flank clearance in the timing gear wheels and injection timing adjuster (if fitted).

18



Turn the pump coupling against the direction of pump rotation until the specified lift from the base circle is displayed on the dial.

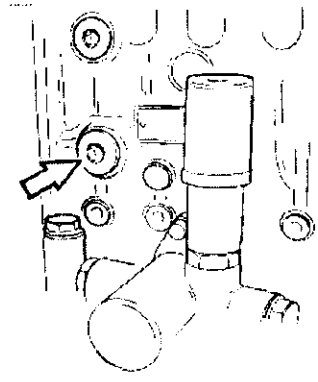
19



Now torque tighten the clamp bolt to **90 ± 9 Nm**.

20
Check the setting by turning the flywheel 1/4 of a revolution against the direction of engine rotation as described in point 7. Then turn the flywheel in the direction of engine rotation until the correct lift from the base circle is displayed on the dial. Note the angle of the flywheel and make sure it agrees with the specified angle.

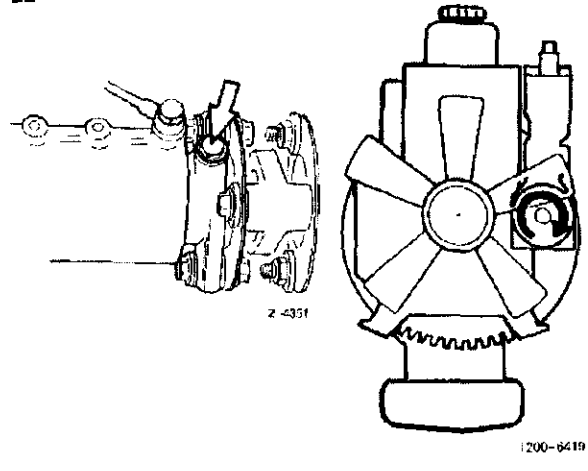
21



Remove the adjustment tool and refit the hexagon socket plug using a new copper washer.

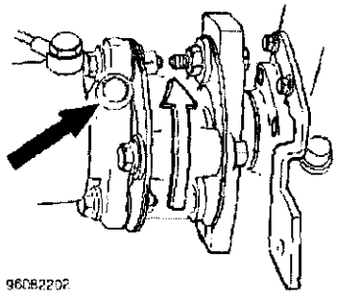
TWD730ME

22



Undo the pump coupling clamp bolt and turn the pump coupling approx. 1/4 turn in the direction of pump rotation.

23



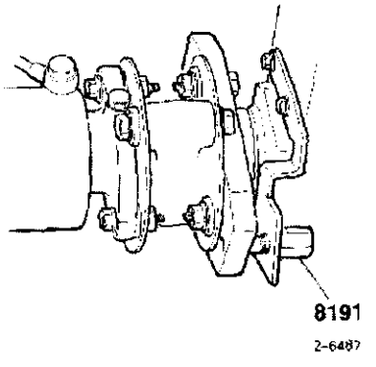
Tighten the pump coupling clamp bolt just enough so that the coupling can be turned against the direction of rotation with considerable force.

NB! The pump coupling must always be turned against the direction of rotation when setting the injection angle. This must be done to eliminate as much as possible the play between the timing gear wheels and in the injection timing adjuster.

If the pump coupling clamp bolt is not tightened hard enough when turning the pump coupling against the direction of rotation, it will not be pretensioned sufficiently and the setting will be incorrect.

Take care not to damage the pump coupling.

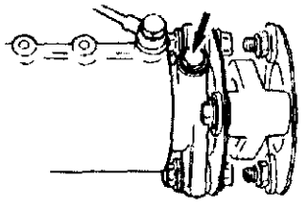
24



Turn the pump coupling against the direction of rotation until locking bolt 8191 can easily be screwed into the injection pump mounting flange.

NB!If the pump coupling has been turned too far, the setting process must be restarted.

25

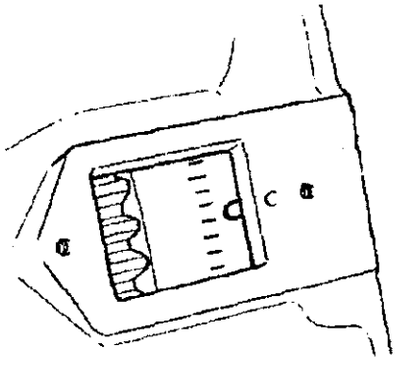


Torque tighten the clamp bolt to **90 ± 9 Nm.**

26

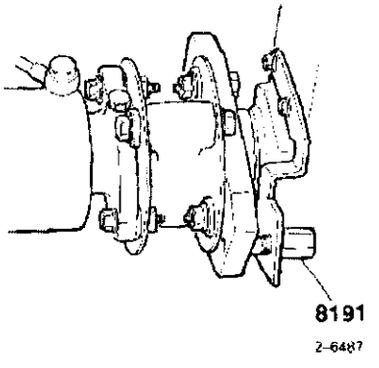
Remove locking bolt 8191 from the injection pump.

27



Check the setting by first rotating the flywheel against the direction of rotation of the engine approx. 1/4 of a revolution and then in the direction of engine rotation until the correct number of degrees coincides with the marking on the flywheel.

NB! Set the number of degrees to within the upper limit of the tolerance range. If the flywheel is turned too far, it must be turned back against the direction of rotation approx. 1/4 of a revolution.



28

Make sure locking bolt 999 8191 can easily be screwed into the injection pump mounting flange. If this is not the case, the setting must be repeated from the beginning.

29

Remove the locking bolt from the injection pump.

Common to all engines

30
Remove the rotation tool from the flywheel casing and fit the inspection cover.

31
Fit the valve covers, using a new gasket if necessary.

32
Fit the fuel delivery pipes. The fuel delivery pipe must never be bent or reshaped. A damaged fuel delivery pipe must always be replaced with a new one.

33
Fit the fuel and oil pipes.

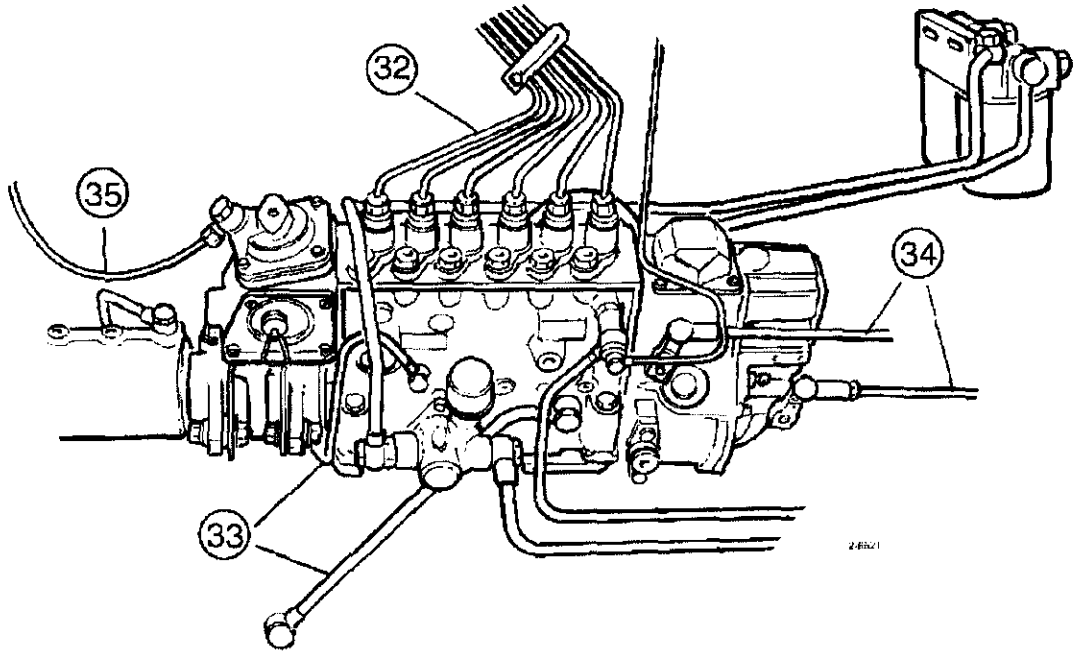
34
Fit the throttle control and stop linkage.

35
Fit the pipe to the smoke limiter (where applicable).

36
Bleed the system.

37
Start the engine and check for leaks.

The instructions above refer to the numbers in the illustration.



Injection pump, setting with measuring instrument 998 7057

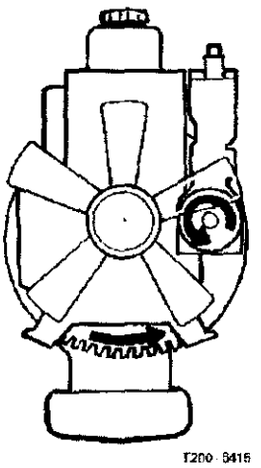
Setting injection timing

Special tools: 998 7057

1
Remove the front valve cover.

2
Turn the flywheel in the direction of engine rotation until cylinder 1 is in its compression position, 0° on the flywheel and both valves for cylinder 1 closed.

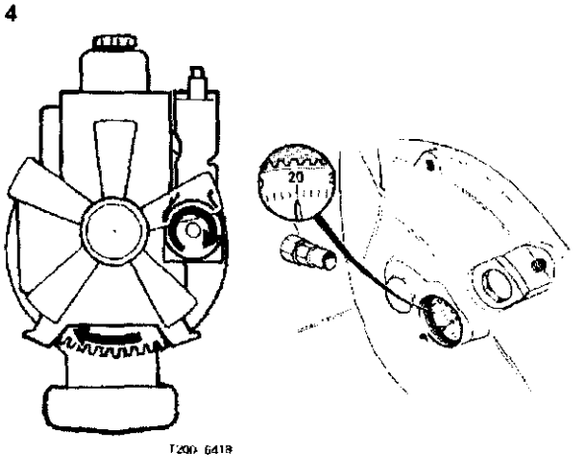
3



T200 6416

Rotate the flywheel against the direction of engine rotation approx. 1/4 turn.

4

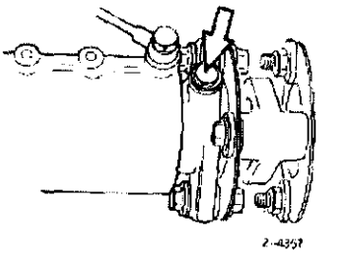


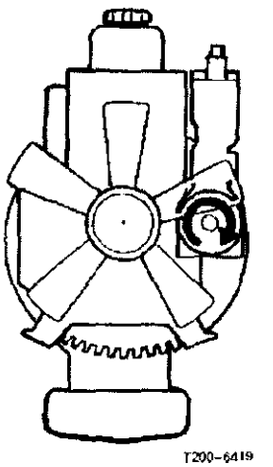
T200 6418

Rotate the flywheel in the direction of rotation of the engine until the correct number of degrees on the flywheel coincides with the indicator needle. See "Workshop Manual, Technical Data".

NB! Set the number of degrees within the upper half of the tolerance range given in the specification. Adjust the setting precisely and do not turn the flywheel against direction of rotation to make any fine adjustments. If the flywheel has been turned too far, the setting process must be restarted.

5

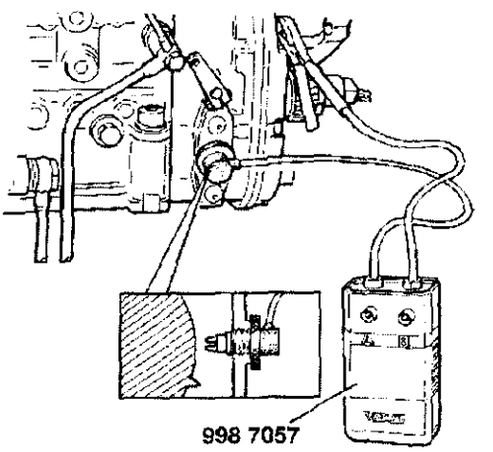




T200-6419

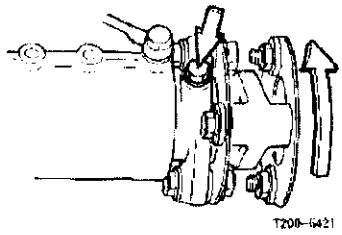
Undo the pump coupling clamp bolt and turn the pump coupling approx. 1/4 turn in the direction of pump rotation.

6

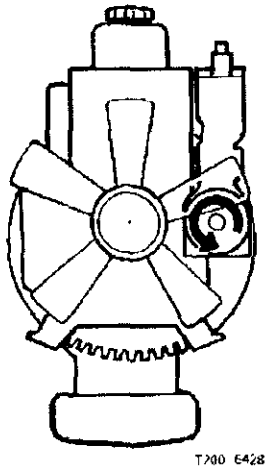


Remove the plug in the governor housing and fit the measuring tool sensor. Connect the measuring instrument earth cable to a suitable location on the injection pump.

7



T200-6421



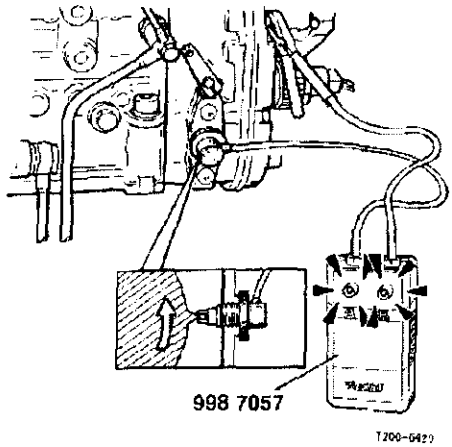
T200 6428

Tighten the pump coupling clamp bolt enough for the coupling to be turned against the direction of rotation with considerable resistance.

NB! The pump coupling must always be turned against the direction of rotation when setting the injection angle. This must be done to eliminate as much as possible the play between the timing gear wheels and in the injection timing adjuster (if fitted).

If the pump coupling clamp bolt is not tightened hard enough when turning the pump coupling against the direction of rotation, it will not be pretensioned correctly and the setting will not be exact. Take care not to damage the pump coupling.

8



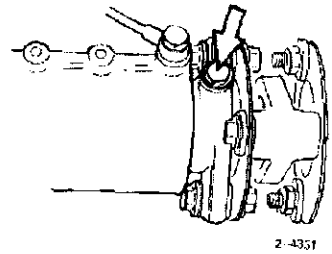
T200-6429

Carefully turn the pump coupling against the direction of rotation until both LEDs light up on the measuring instrument. The injection pump is now in position for start of injection in cylinder 1.

NB! The measuring instrument is extremely sensitive so that an exact setting is possible.

Make sure the pump coupling is not turned too far, only just enough to turn on the LEDs. If the pump coupling has been turned too far, the setting must be redone.

9



2-4351

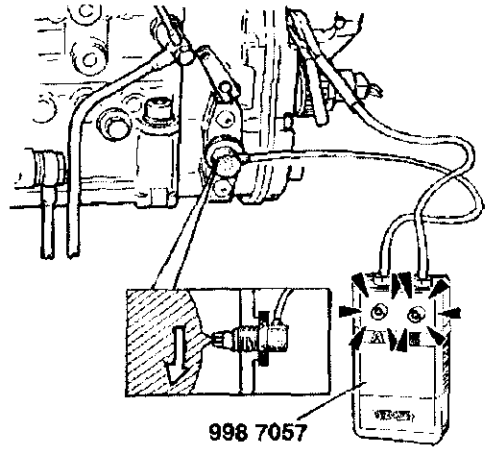
Torque tighten the pump coupling clamp screw to **90 ± 9 Nm**.

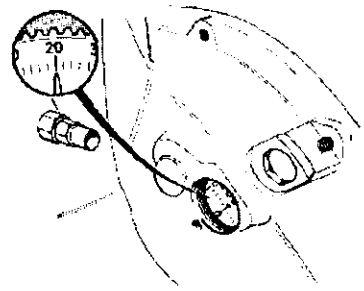
Checking

10

Rotate the flywheel against the direction of engine rotation approx. 1/4 turn.

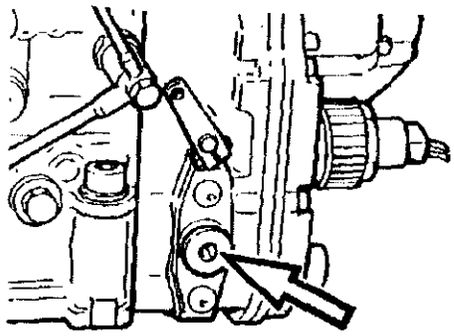
11





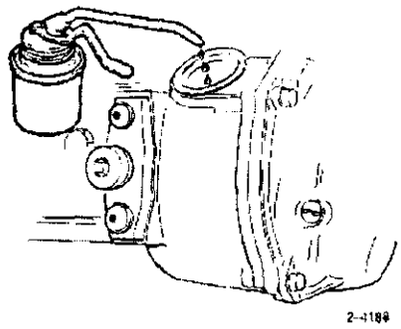
Rotate the flywheel in the direction of rotation of the engine until both LEDs light up on the measuring instrument. Read off the number of degrees on the flywheel and check that the setting is within the upper half of the tolerance range given in the specifations, see "Workshop Manual, Technical Data".

12



Remove the measuring instrument sensor and refit the plug in the governor housing.

13



Top up with the same amount of engine oil that escaped when the plug for the measuring instrument sensor was removed.

14
Refit the inspection cover on the flywheel casing.

15
Refit the front valve cover, use a new gasket if necessary.

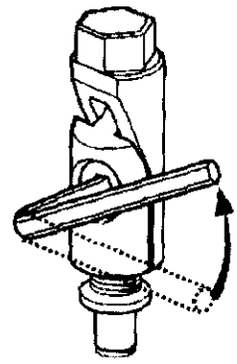
Injection pump, sealing screw

Certified engines: TD730VE, TWD630VE, TWD731VE and TWD740VE

Special tool: 885346

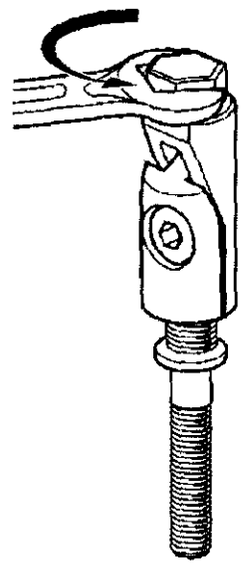
Tool 885346 must be used as follows when removing the sealing screw for the injection pump:

1



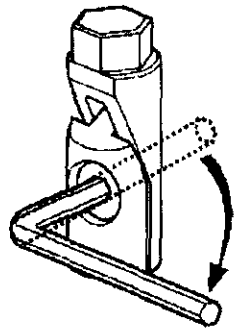
Tighten the hex socket screw on the tool with an Allen key.

2

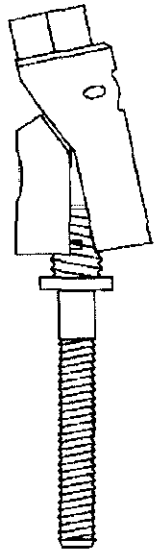


Place the tool on top of the sealing screw tapered thread and screw the tool anticlockwise by hand until it stops. Use a 17 mm spanner to undo the sealing screw.

3



Undo the hex socket screw once the sealing screw is undone.



4

Press the top of the tool hard and remove it. Unscrew the sealing screw by hand.

NB! The sealing screw can not be reused.

5

New sealing screws have a pretightened nut fitted to the tapered thread. Unscrew the nut until it comes loose when fitting (the screw has a left-hand thread). The correct tightening torque has then been attained.

Screw 982137 for TD730VE, TWD731VE and TWD740VE
Screw 982138 for TWD630VE

Injectors, changing

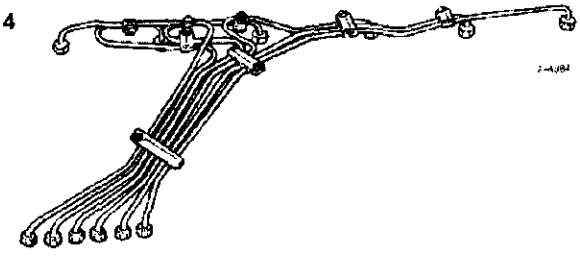
Special tools: 999 6643

1
Clean around the injector and pipe connections.

2
710, 730 and 740 engines
Remove the exhaust temperature sensor from the exhaust manifold.

3
Remove the fuel leak-off pipe between the injectors and plug the connections.

4



Remove the fuel delivery pipes and plug the connections.

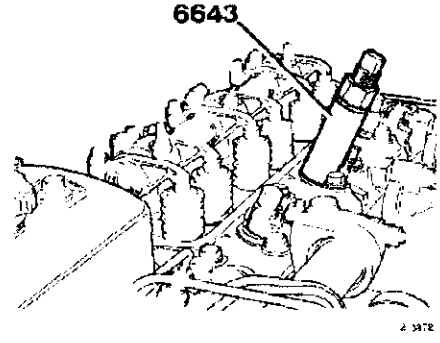
NB! The fuel delivery pipes are clamped together. Do not remove the clamps, remove all the pipes as one unit. The fuel delivery pipes must never be bent or reshaped.

A damaged fuel delivery pipe must always be replaced with a new one.

5
Remove the nuts from the injector attachment brackets and remove the brackets.

6
Remove the rubber seals from the injectors.

7

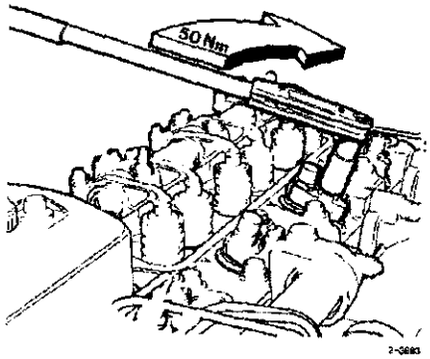


Turn the injectors with a polygon spanner (RSp-15) while pulling upward. Use puller 999 6643 if necessary.

8
Clean the surfaces of the copper sleeves that are in contact with the injectors. See "Copper sleeve for injectors, cleaning".

9
Fit the new injectors.

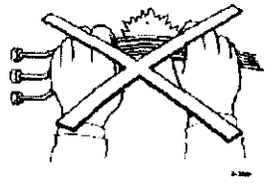
10



Fit new rubber seals around the injectors.
Fit the attachment brackets and torque tighten the nuts.
50 ± 5 Nm.

11
Fit the leak-off pipe with new copper washers.

12



Fit the fuel delivery pipes.

NB! Fuel delivery pipes must never be bent or reshaped. A damaged fuel delivery pipe must always be replaced with a new one.

13
710, 730 and 740 engines
Fit the exhaust temperature sensor.

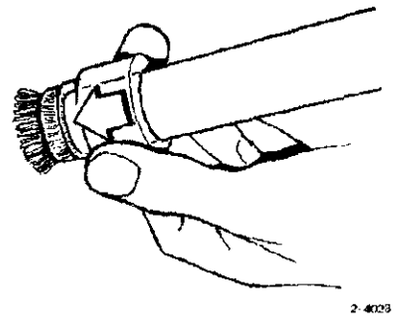
14
Start the engine and check for leaks.

Copper sleeve for injectors, cleaning

Use the special brush, part no 981 2546, for cleaning the bottom of the copper sleeves.

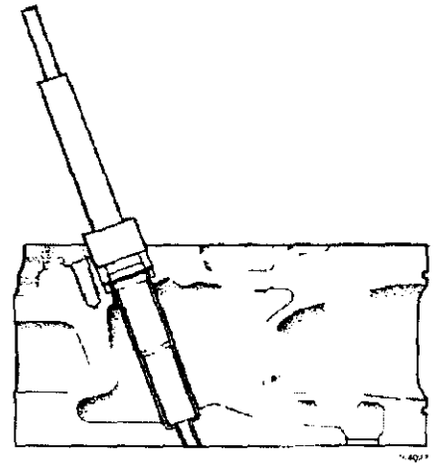
The brush can be ordered from AB Volvo Penta.

1



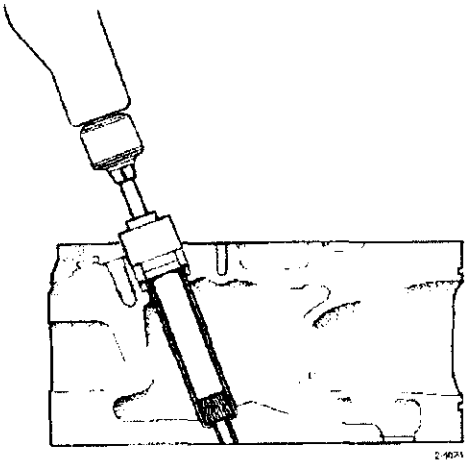
The cleaning brush is supplied complete with mounting sleeve. Press down the sleeve over the head of the brush before fitting it into a drill.

2



Place the mounting sleeve over the copper sleeve.

3



Press the brush down into the sleeve. Attach a drill and clean the sleeve.

4
Use compressed air to blow away any residue after cleaning.

Injectors, reconditioning

1
Clean the injector externally.

2
Dismantle the injector. Pull the nozzle out of the sleeve and place the components in injector cleaning fluid. If several injectors are being cleaned at the same time, make sure associated needles and sleeves do not get mixed up. To prevent this from happening, the injectors should be placed in order in a stand or in different compartments.

3
Clean the components in an ultrasonic cleaner. Blow dry with compressed air.

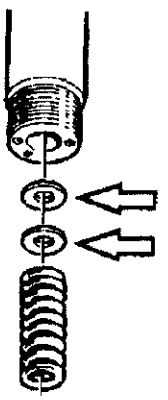
4
Check the nozzles thoroughly.

Use a magnifying glass or microscope to inspect the nozzle. The nozzle sleeve must also be inspected with a microscope. If the seat is damaged, the nozzle must be changed together with the sleeve or, if the damage is slight, polished in a polishing or grinding machine for injectors.

5
Check also other components.

6
Dip the injector components in pure diesel or calbrating oil.

7



Assemble the injector and check that the thickness of the adjusting washers for opening pressure is the same as the ones that were originally fitted.

Check the opening pressure and jet pattern in a nozzle tester, see next page.

Recommendations for adjusting opening pressure, setting pressure and changing injectors

Injection takes place at very high pressure so that the fuel is atomized as efficiently as possible. As the injectors age, the opening pressure will drop below the value specified for new injectors.

This drop in pressure is normal and does not have any appreciable effect on injector operation or engine performance. Adjusting the injectors may be detrimental to the service life of the nozzle.

Some general recommendations regarding injector checks to prevent unnecessary replacement and adjustment of injectors are given below.

Injectors do not require checking unless there are clear indications that they are not operating normally, when there is a considerable increase in exhaust smoke for example.

The opening/setting pressure and tightness are the most essential items during this test.

The jet pattern is more difficult to assess and does not provide a reliable indication as to condition of the nozzle.

Our service literature specifies the setting pressure as well as the opening pressure, these values apply to new injectors or injectors with new compression springs.

Since the setting pressure for a new spring is somewhat higher than the opening pressure, a certain margin for compression spring settling is available. When a new compression spring has settled, the opening pressure will drop by about **5 percent**.

The opening pressure will drop even more with time but the injectors will still operate satisfactorily.

Studies have shown that the drop in pressure levels off at approx. **15 percent** below the opening pressure of a used spring. However, this pressure drop is within the specified operating range.

Leak test

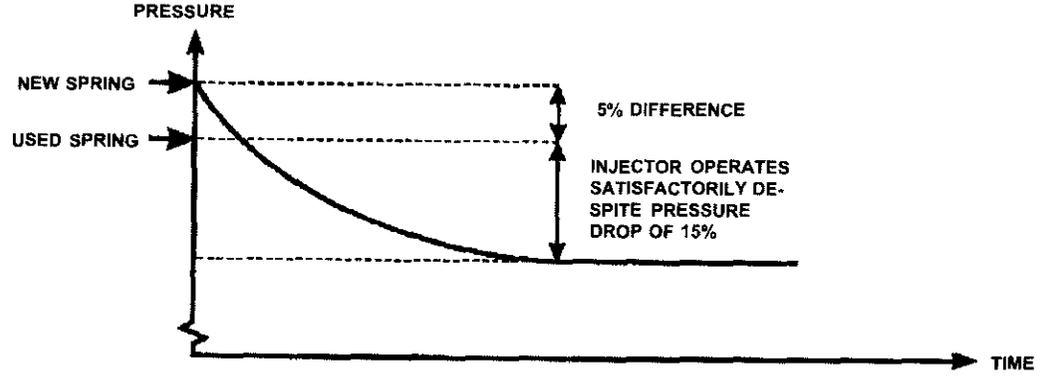
A leak test is used to check whether there are any leaks from the nozzle. If there is a leak, it will be between the tip of the injector needle and the tapered sealing surface of the nozzle sleeve.

Wipe the tip of the nozzle so it is dry. With a pressure gauge connected, pump up a pressure of **2 MPa** (20 kp/cm2) below the injector opening pressure. Maintain this pressure for **10 seconds.** Fuel must not drip from the nozzle tip but it may be moist.

Jet pattern

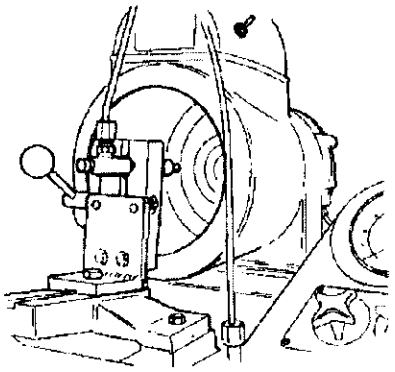
The nozzle condition is difficult to establish with the jet pattern.

On many occasions, the nozzle may be functioning satisfactorily in the engine although the jet pattern is in doubt.



Opening pressure, adjusting

1

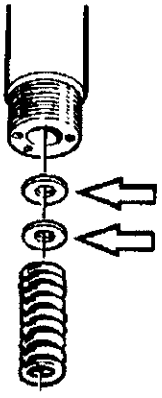


Connect the injector to a nozzle tester.

2
Press down the tester arm slowly until the injector opens and allows fuel to pass.

3
Read off the opening pressure on the test equipment pressure gauge.

4



If the pressure does not correspond to the pressure given in "Specifications", the setting must be changed. This is done by adding adjusting washers.

NB! A maximum of two washers may be used. If sufficient pressure cannot be attained with two of the thickest washers, the spring must be changed.

Opening pressure/setting pressure

See engine "Specifications" regarding opening pressure and setting pressure (new spring).

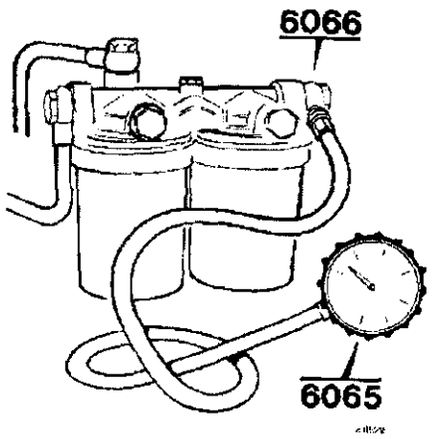
Jet pattern

At a pump frequency of 4–6 strokes/sec., the jet pattern should be uniform and the fuel atomized. After completing the test, plug the pipe connections and cover the injector tips.

Fuel feed pressure, checking

Special tools: 999 6065, 999 6066

1



Connect nipple 999 6066 and pressure gauge 999 6065 to the fuel filter outlet side. The pressure is measured once it has passed the filter insert. Carry out this check by first increasing engine speed and then lowering it so that the pressure can be read at low idling speed.

The feed pressure must not be below **100 kPa**.

Feed pump, changing

1
Clean around the feed pump.

2
Close the fuel cocks.

3
Disconnect both fuel pipes.

4
Remove the feed pump from the injection pump.

5
Clean and fit a new gasket on the injection pump.

6
Fit the feed pump and screw it tight.

7
If lubricant has been forced out of the injection pump, the same amount of engine oil must be refilled.

8
Connect the fuel pipes.

9
Bleed the fuel system.

10
Start the engine and check for leaks.

Feed pump, reconditioning

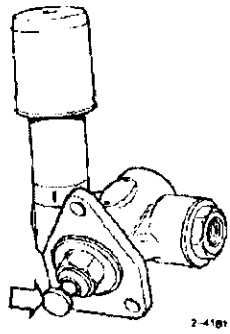
NB! Pump removed.

All engines except TWD730ME

1
Clean the pump externally.

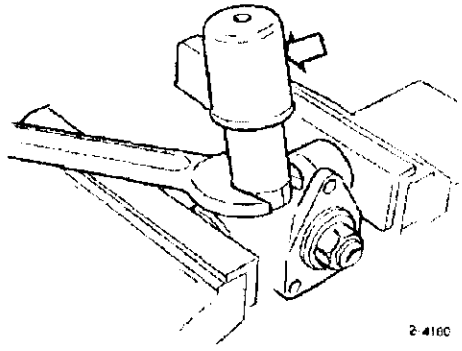
Dismantling

2



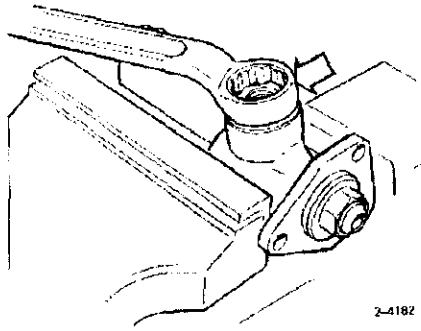
Remove the pushrod.

3



Remove the hand pump.

4



Remove the union.

5
Remove the valve body and piston.

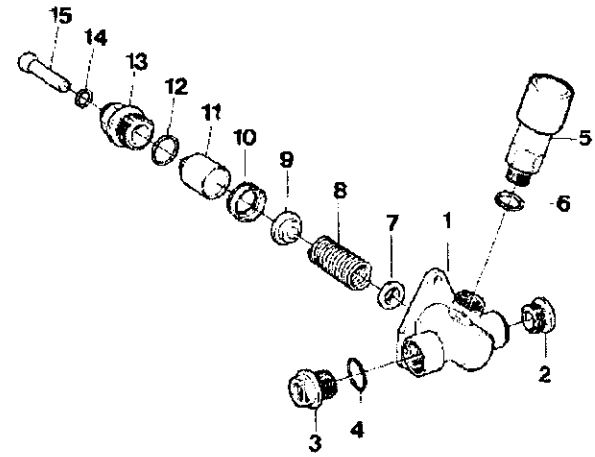
6
Remove the valve, discs (2x) and spring.

Inspection

Inspect all the components, replacing any that are damaged or worn.

Assembling

Observe thorough cleanliness and rinse the components in pure diesel before assembly.



1. Housing
2. Union
3. Union
4. O-ring
5. Hand pump
6. Gasket
7. Spring disc
8. Spring
9. Valve
10. Spacer
11. Pump piston
12. O-ring
13. Union
14. O-ring
15. Push rod

7
Place the spacer (10) into the pump piston (11).

8
Fit the valve (9), spring disc (7) and spring (8) onto the pump piston (11).

Fit the pump piston (11) into the pump housing.

9
Fit the O-ring (12) to the union (13) for the valve.

10
Fit union (13) to the pump housing.

11
Fit union (3) and O-ring (4) to the pump housing.

12
Fit hand pump (5) and gasket (6).

13
Fit O-ring (14) on pushrod (15).

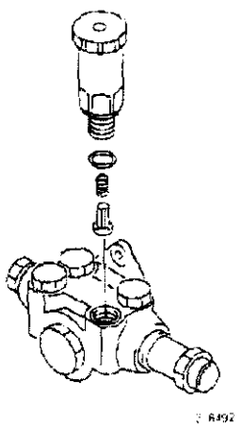
NB! Plug both the connections if the pump is not to be refitted directly.

TWD730ME

1
Clean the pump externally.

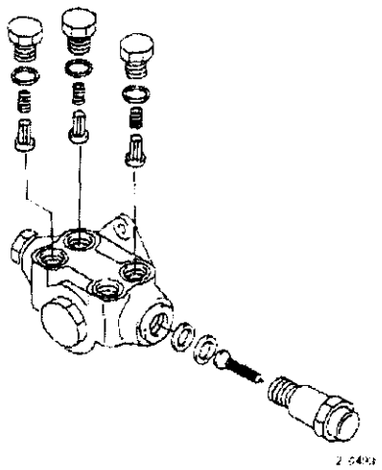
Dismantling

2



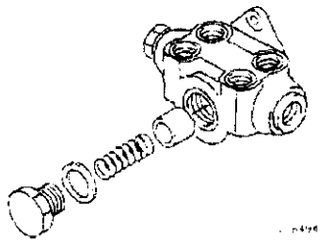
Remove the hand pump, washer, spring and valve.

3



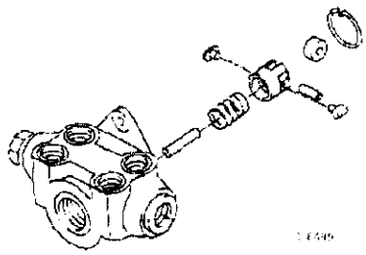
Remove the unions and from them the springs and valves. Remove the strainer from the inlet union.

4



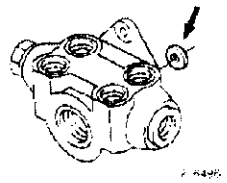
Remove the plug, spring and pump piston.

5



Remove the locking ring and then the roller carrier, spring and pushrod.

6



Remove the sealing ring.

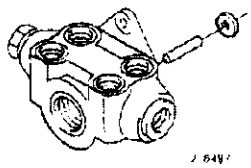
Inspection

7
Inspect all the components, replacing any that are damaged or worn. Washers and seals must be replaced with new ones.

Assembling

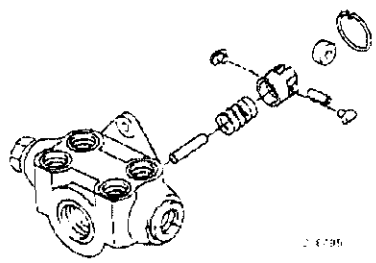
8
Observe thorough cleanliness and rinse the components in pure diesel before assembly.

9



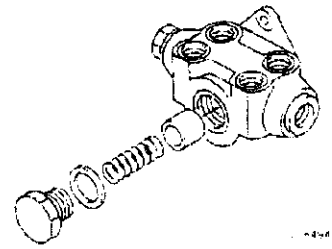
Apply oil to the seals and pushrod. Fit the pushrod into the pump housing and fit the seal. Tap the seal carefully in position with a sleeve or similar tool.

10



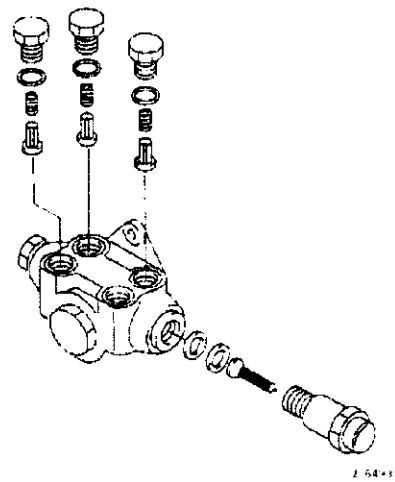
Lubricate with oil and assemble the roller carrier, rollers, plunger and guide pin. Place the spring and roller carrier in the pump housing and fit the locking ring.

11



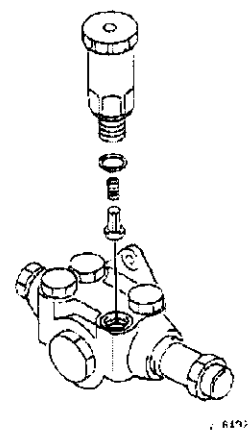
Dip the pump piston in pure diesel and refit it in the pump housing. Fit the spring and a new copper washer and screw in the plug.

12



Fit the valves and springs. Fit the plugs with new copper washers. Fit the strainer and union with new copper washers.

13



Fit the valve and spring and screw on the hand pump with a new copper washer.

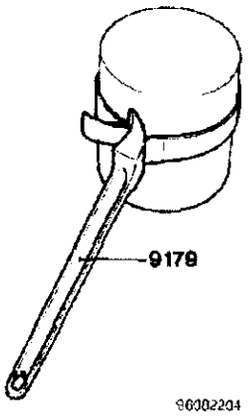
NB! Plug the connections if the pump is not to be refitted directly.

Fuel filter, changing

Special tools: 999 9179

1
Clean the filter bracket thoroughly.

2



Remove the fuel filter using tool 999 9179.

3
Moisten the seals on the new filters with oil and screw in them by hand until the seals are in contact with the filter attachment. Then tighten the filter another half a turn.

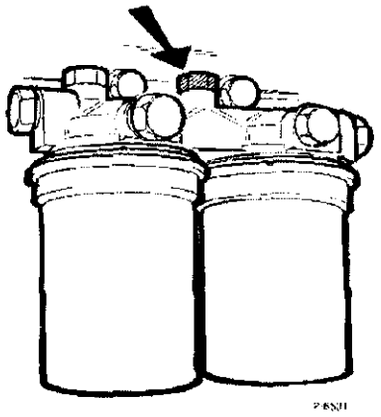
4
Bleed the fuel system.

5
Start the engine and check for leaks around the filters.

Bleeding fuel system

Engines equipped with fuel cut-off valve, live during operation, see "Fuel cut-off valve for stopping the engine".

1



Open the bleeder nipple on the fuel filter holder.

2
Pump fuel using the feed pump hand pump until the fuel is free from air bubbles. Tighten the bleed screw while fuel is running out. Keep pumping to attain a good feed pressure. Normally, no further bleeding is required.

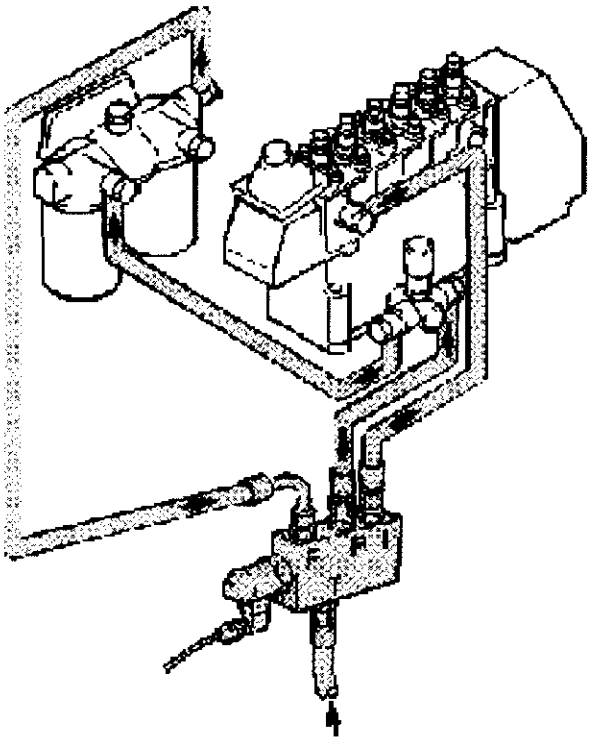
3
If it should be necessary to bleed injection pump, undo the union for the overflow valve. Continue pumping with the hand pump until fuel emerges without air bubbles here as well and retighten the union while fuel is still running out.

NB! Do not bleed via the pressure compensator.

Fuel cut-off valve for stopping the engine

Version 1

Fuel cut-off valve connected to voltage for stop



0 volt

The illustration shows the flow of fuel during operation

Fuel cut-off valve for stopping the engine. The valve changes the direction of flow in the fuel system during the stopping process.

A. Solenoid valve

B. Valve body

Connections in valve body, marking:

T. Inlet from fuel tank

P. Outlet to feed pump

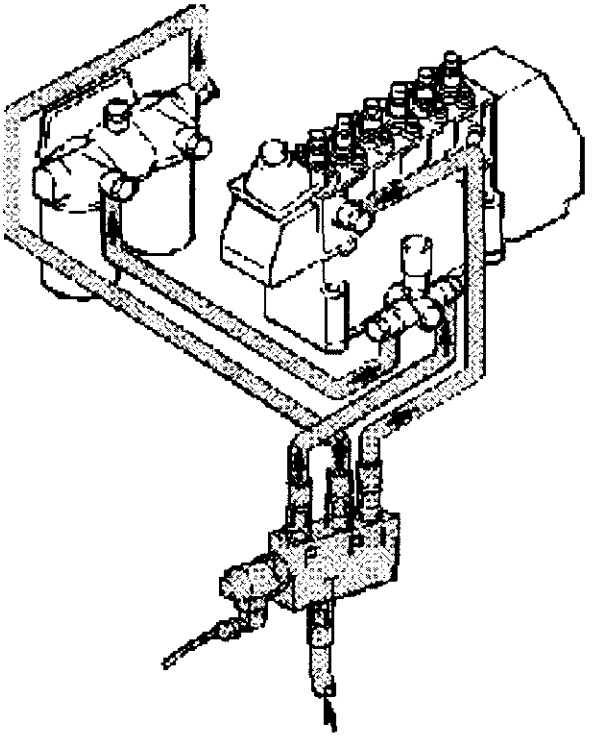
F. Inlet from fuel filter

I. Outlet to injection pump

Tightening torque for hose connections: **22 Nm**

Version 2

Fuel cut-off valve connected to voltage for operation



24 volt

The illustration shows the flow of fuel during operation

Fuel cut-off valve for stopping the engine. The valve changes the direction of flow in the fuel system during the stopping process.

A. Solenoid valve

B. Valve body

Connections in valve body, marking:

T. Inlet from fuel tank

F. Outlet to feed pump

P. Inlet from fuel filter

I. Outlet to injection pump

Tightening torque for hose connections: **22 Nm**

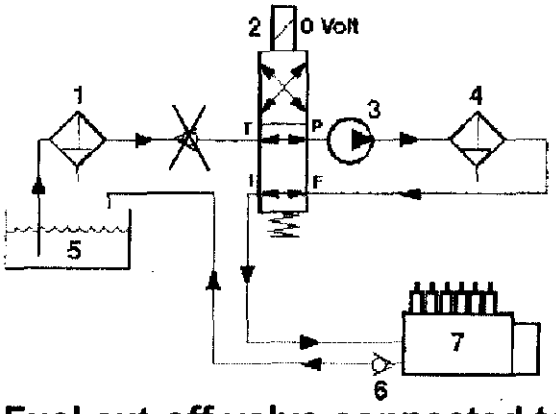
When the engine is stationary, the valve is in stop position. It is not connected to voltage. With the valve in this position, the engine will not start.

Fuel cut-off valve connected to voltage for stop

Function

During operation

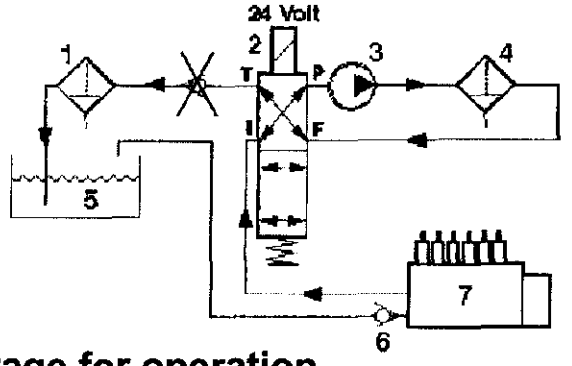
The valve is not connected and the fuel follows the normal direction of flow. The fuel pump (3) draws fuel from the tank (5) via the preliminary filter (1), after which the fuel is forced through the fine filter (4) and on to the injection pump (7).



During the stopping process

When the key switch is moved to stop position ("S"), the solenoid valve (2) will be activated. The valve then switches the direction of the fuel flow to and from the feed pump, whereby a vacuum of 0.3 - 0.4 bar is built up in the injection pump fuel chamber. This prevents the filling of the pump element and the engine will stop (the pump element requires positive pressure for filling).

The overflow valve (6) prevents the flow of fuel to the injection pump via the return line.

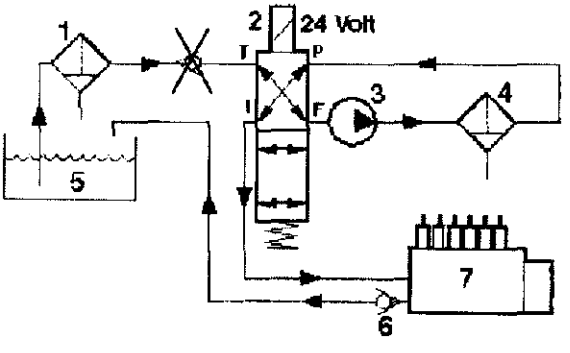


Fuel cut-off valve connected to voltage for operation

Function

During operation

The valve is connected and the fuel follows the normal direction of flow. The fuel pump (3) draws fuel from the tank (5) via the preliminary filter (1), after which the fuel is forced through the fine filter (4) and on to the injection pump (7).

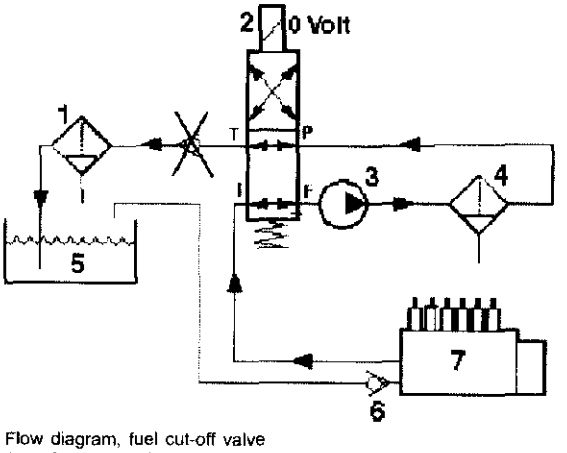


Flow diagram, fuel cut-off valve
Engine running (solenoid valve activated)

During the stopping process

When the key switch is move to 0-position or the stop button is pressed, the solenoid valve (2) will release. The valve then switches the direction of the fuel flow to and from the feed pump, whereby a vacuum of 0.3 - 0.4 bar is built up in the injection pump fuel chamber. This prevents the filling of the pump element and the engine will stop (the pump element requires positive pressure for filling).

The overflow valve (6) prevents the flow of fuel to the injection pump via the return line.



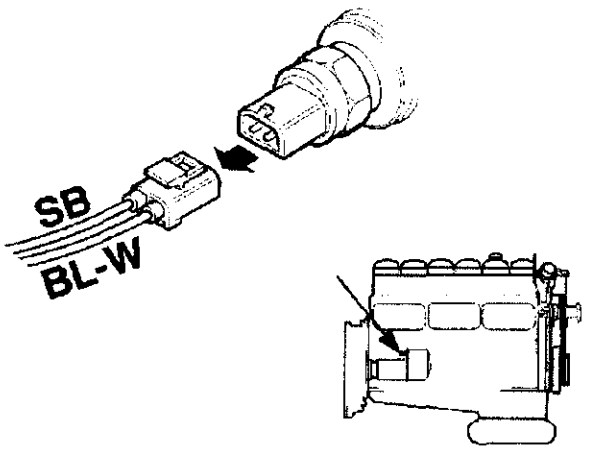
Flow diagram, fuel cut-off valve
Stop function activated (solenoid valve not activated)

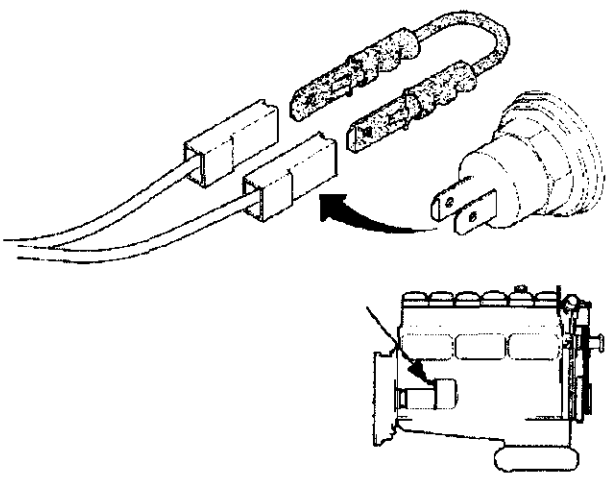
Bleeding the fuel system

Fuel cut-off valve connected to voltage for stop

The fuel system is bled in the same way as on an engine without cut-off valve, see "Bleeding the fuel system".

Fuel cut-off valve connected to voltage for operation





If an oil pressure switch is present "Nc = Normally closed" then the connector must be unplugged.

If a coolant level alarm is present then the level must be checked. The level alarm will stop the engine if the level is too low.

Press the start button briefly. If a coolant level alarm is present, the interlock button must be pressed for about **4 seconds**.

Turn on the ignition (position 1).

Bleed the fuel system, see "Bleeding fuel system".

Press the stop button.

Refit the connector on the oil pressure switch.

If an oil pressure switch "No = Normally open" is present, the connector must be short-circuited with a jumper lead.

If a coolant level alarm is present then the level must be checked. The level alarm will stop the engine if the level is too low.

Press the start button briefly. If a coolant level alarm is present, the interlock button must be pressed for about **4 seconds**.

Turn on the ignition (position 1).

Bleed the fuel system, see "Bleeding fuel system".

Press the stop button.

Remove the jumper lead and refit the connector on the oil pressure switch.

Troubleshooting

Symptom: Engine difficult to start

Cause	Action
Dirt in the fuel cut-off valve.	Dismantle and clean the valve plunger from dirt.
Dirt in the tank.	Make sure the tank is clean. Clean if necessary.
Preliminary filter and/or engine fuel filter blocked by impurities or water.	Check or change the filter element.
The valve is crooked on its bracket. There must be spacers between the bracket and valve.	Undo the retaining bolts for the valve and check the stop function If the stop function is in working order, inspect the bracket and ensure the spacers are in place.
Leak in system.	Check all hoses, pipes and connections for leaks, also the ones running via the preliminary filter to the suction side of the tank. Make sure the sealing surface on the hose taper has not bottomed, as this can result in leaks. Tightening torque **22 Nm**. The hose coupling should not be screwed in all the way.
Non-return valve fitted in inlet lines to engine. Certain preliminary filters may have non-return valves.	Remove the non-return valve.
Live for stop. There is a residual voltage when starting. The electromagnet can manage to keep the solenoid active even at extremely low voltages.	Make sure there is no residual voltage across the valve solenoid when starting. Do this by unplugging the valve connector.
Live for operation. The starter motor or other current consumer draws current from the battery at the same time as the solenoid. In this case, the solenoid may receive too low a voltage. Break in cable or bad contact in valve connector.	Use a voltmeter to test the valve connector, pins 1 and 2, while activating the stop using the key switch on the instrument panel. The max voltage variation is 10-15 V for 12 V and 20-30 V for 24 V.
The pressure drop on the suction side is so high that the feed pump is not able to draw up fuel. This can be due to excessive lifting height, long and narrow inlet lines or dirt.	Measure the pressure drop before the fuel cut-off valve. Max vacuum **0,4 bar.**
Air in fuel system. On certain installations, air pockets can remain long after the engine has been taken into service.	Bleed at the injection pump.
Overflow valve not delivering correct operating pressure.	Check the engine fuel pressure. Change overflow valve if necessary.

If the points described above are OK, check the injection pump in a pump test bench.

Symptom: Engine stops slowly or not at all.

Cause	Action
Dirt in the fuel cut-off valve.	Dismantle and clean the valve plunger from dirt.
Dirt in the tank.	Make sure the tank is clean. Clean if necessary.
Preliminary filter and/or engine fuel filter blocked by impurities or water.	Check or change the filter element.
The valve is crooked on its bracket. There must be spacers between the bracket and valve.	Undo the retaining bolts for the valve and check the stop function. If the stop function is in working order, inspect the bracket and ensure the spacers are in place.
Leak in system.	Check all hoses, pipes and connections for leaks, also the ones running via the preliminary filter to the suction side of the tank. Make sure the sealing surface on the hose taper has not bottomed, as this can result in leaks. Tightening torque **22 Nm**. The hose coupling should not be screwed in all the way.
Non-return valve fitted in inlet lines to engine. Certain preliminary filters may have non-return valves.	Remove the non-return valve.
Live for stop. A large consumer is drawing current from the battery while the solenoid is being activated, in which case, the solenoid may not receive sufficient voltage. Break in cable or bad contact in valve connector.	Use a voltmeter to test the valve connector, pins 1 and 2, while activating the stop using the key switch on the instrument panel. The max voltage variation is 10-15 V for 12 V and 20-30 V for 24 V.
Live for operation. There is a residual voltage when operating stop. The electromagnet can manage to keep the solenoid active even at extremely low voltages.	Make sure there is no residual voltage across the valve solenoid when starting. Do this by unplugging the valve connector.
Overflow valve on injection pump leaking.	If leaking, change overflow valve.
The accelerator arm is set to >1000 rpm, which provides a slower stop process.	Check settings.

Intake and exhaust systems

Design and function

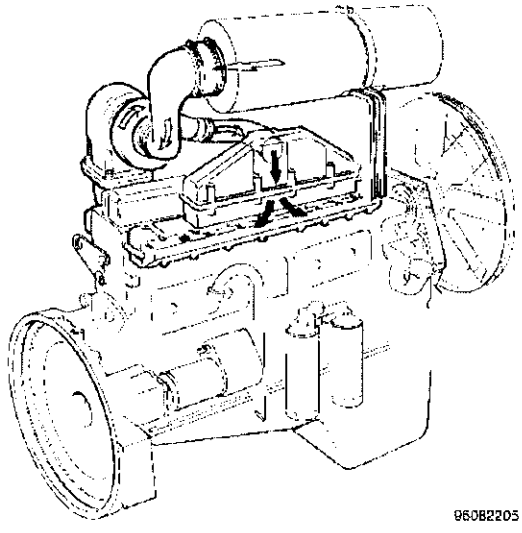
Intercooler

The intercooler is used to lower the temperature of the intake air before it is forced into the engine cylinders.

off- engine, turbocharger in, oil temperature. If the air is cooled after the turbocharger, its volume is decreased and more air (oxygen) can be forced into the cylinders. This form of cooler is called an intercooler. More fuel can be injected into the engine with an intercooler, which will increase engine power. The intercooler lowers the temperature of the intake air by about 100°C and increases engine power by about 10 %. The engine torque is also increased while fuel consumption is improved. A turbocharged diesel engine with intercooler is the most efficient of all combustion engines.

TWD engines

The intercooler is a water/air type and mounted on top of the engine. The intercooler is coupled to the engine cooling system.



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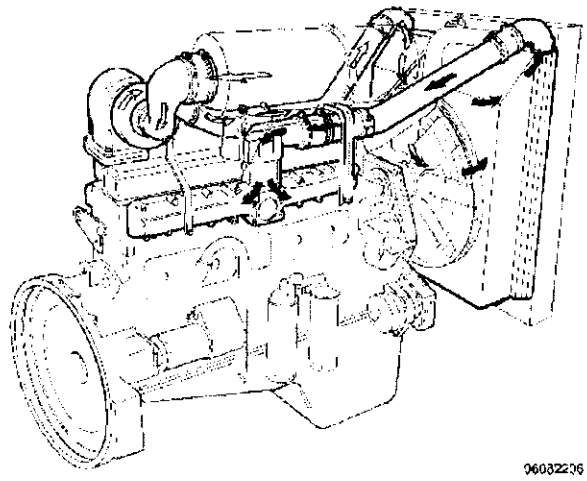
TAD engines

The intercooler is an air/air type and mounted behind the radiator.



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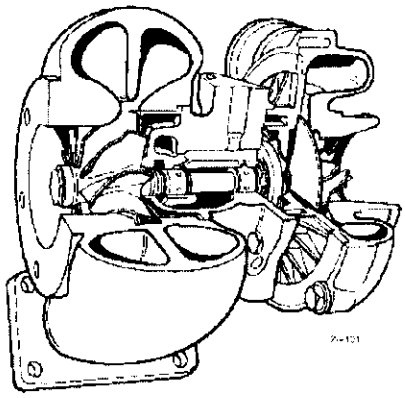
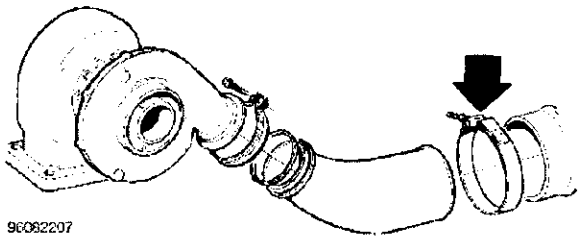
Turbocharger

The turbocharger is driven by exhaust gases that pass the turbine housing on their way to the exhaust system. The passage of exhaust gases rotates the turbine rotor inside the turbine housing. On the same shaft as the turbine rotor is the compressor impeller. The compressor impeller is located in a housing in the passage between the engine air cleaner and the intake manifold.

When the compressor impeller rotates, air is drawn in through the air cleaner. The air is compressed and forced into the cylinder.

NB! When removing the turbocharger, do not undo the "V" holder between the compressor and the pipe. Undo the hose clamp instead.





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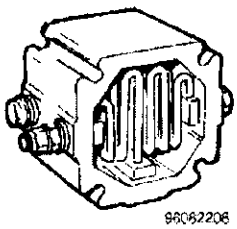
Starting heater

The starting heater is used to heat the air in the intake manifold when starting the engine. The heat air makes it easier to start the engine and reduces smoke emissions during cold starts.

The starting system has manual pre-heating. On certain engine variants, the time the starting heater is engaged is controlled by a variable temperature-dependent timer relay.

The timer relay affects the time for pre-heating and after-heating operation as a function of the engine temperature.



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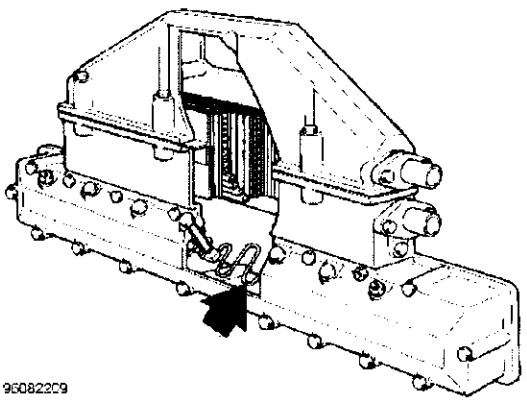
TD and TAD engines



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TWD engines

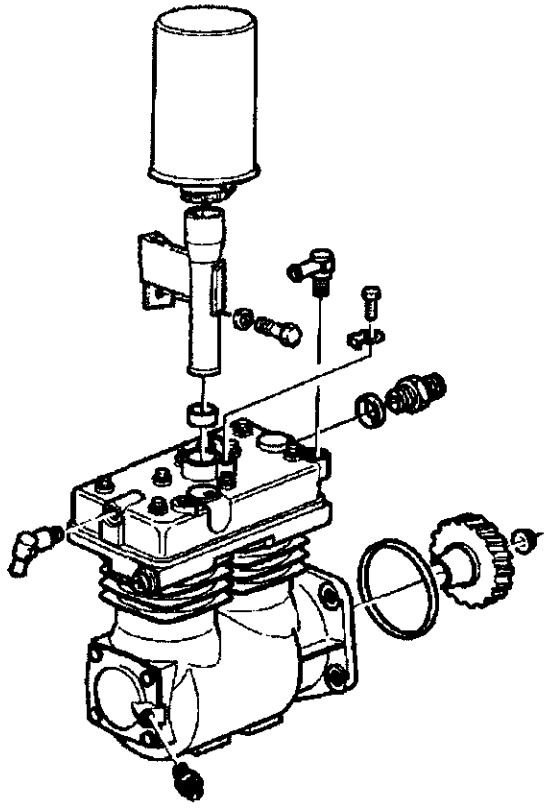
Air compressor

Penta engines can be equipped with two-cylinder air compressors that are driven directly via the engine transmission. The compressor delivers compressed air that is used principally for the braking system.

The compressor is lubricated via the engine lubrication system. The gudgeon pin bushing and piston are splash lubricated.

Intake air is cleaned from dust and dirt by the compressor's own air filter.

The warm compressed air from the compressor passes through a pipe coil for cooling. This is done to protect component parts.



Repair instructions

NB!Always was the engine before carrying out any repairs.

Turbocharger, changing

Removing

1
Detach the exhaust pipe from the turbocharger.

TWD740GE/VE: Remove the protective plate over the turbocharger. Then remove the exhaust pipe and the pipe between the turbocharger and the air filter.

2
Remove the bolts from the turbocharger oil inlet and oil return pipes.

3
Remove the nuts and lift away the turbocharger from the exhaust manifold.

TWD740GE/VE: Remove the nuts and the bracket from the protective plate. Lift away the turbocharger.

4
Clean the contact surfaces on the exhaust manifold, oil inlet pipe and oil return pipe.

Fitting

1
Make sure there are no defective turbocharger components, gasket remains or carbon deposits in the exhaust manifold, air hose or charge air pipe.

2
Fit a new gasket, put in place the turbocharger, fit and tighten the bolts to standard torque.

TWD740GE/VE: The bracket for the protective plate can be mounted together with the turbocharger.

3
Fit the turbocharger oil inlet pipe with a new gasket.

4
Fit the turbocharger exhaust pipe, fit new washers, tighten and lock the nuts.

TWD740GE/VE: Fit also the pipe between the turbocharger and the air filter.

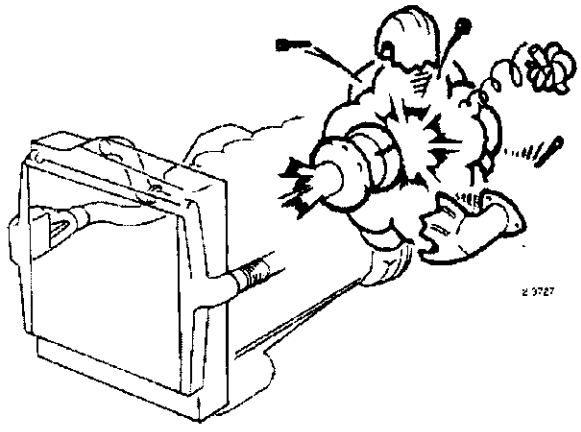
5
Rotate the engine using the starter motor until oil runs out of the turbocharger oil return hole.

6
Fit the turbocharger oil return pipe with a new gasket.

TWD740GE/VE: Fit also the protective plate over the turbocharger.

7
Check for leaks, check the engine oil level and top up as necessary.

Directions for turbocharger faults on engines with intercooler



It is imperative that the intercooler is checked after a turbo breakdown on a charge air cooled engine.

If a major oil leak is suspected or if a foreign object, e.g. part of a broken compressor impeller, has been forced into the intercooler, the following directions must be observed:

1
Check the charge air hoses leading to the intercooler. If there are traces of oil at the intercooler, it must be removed and cleaned internally with a low-aromatic cleaner like paraffin.

The intercooler must be wiped and blown clean after treating it with the cleaners mentioned above. The charge air pipe and charge air hoses must also be cleaned.

If the charge air hoses are fouled with oil, they must be changed as oil is detrimental to the state of the rubber.

2
If the turbocharger fault has caused a break in the compressor impeller, the intercooler must be leak tested to make sure it has not been damaged by parts of the compressor impeller.

Check also the filter, as particles from the compressor impeller can fasten in it.make sure.

Turbocharger, changing/fitting on engine

NB! Always localize the cause of the fault before changing a turbocharger. Rectify any faults before fitting a new turbocharger. When changing/fitting a turbocharger, it is extremely important to follow the directions supplied with the compressor.

1
In order for a turbocharger to function satisfactorily, the engine oil and induction systems must be in good condition. That is to say, the engine oil is changed at the recommended intervals, the correct type of oil is used, and the oil and air filters are changed at suitable intervals. The first action to take is therefore to check the engine oil and, if necessary, change the oil filter before the new turbocharger is installed. The engine should preferably be running for a few minutes before fitting the new turbocharger.

2
Before starting a new turbocharger, use an oil can to pump oil into the turbocharger bearing system to initiate lubrication when starting. Before starting the engine, rotate it using the starter motor until oil runs out of the turbocharger oil return hole.

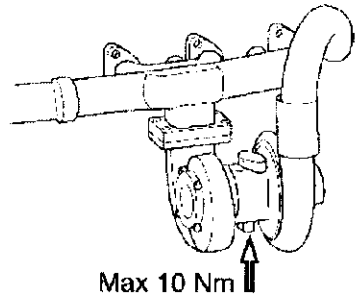
3
Great care is required when changing the turbocharger so that traces of rust or carbon deposits do not enter into the exhaust manifold. These deposits can damage the turbine on the new unit. It is also important to clean the intake passage from the air cleaner, as the remains of a cracked compressor impeller, for example, could cause the new turbocharger to break down immediately.

4
Always make sure the injection system is in good condition and that all the controlled components have approved and unbroken seals.

5
Make sure the oil is circulating correctly after starting the engine by undoing the oil return pipe union on the turbocharger.

Low mounted turbocharger

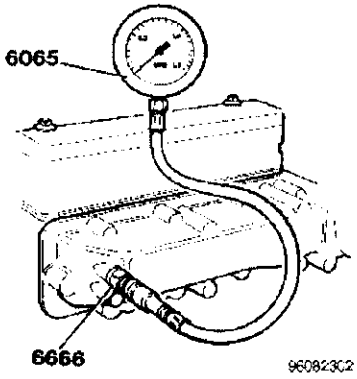
Certain mobile engines are fitted with a low mounted turbocharger. It is important when fitting them to remember that the lock nut (see illustration) must be tightened with **max 10 Nm**.



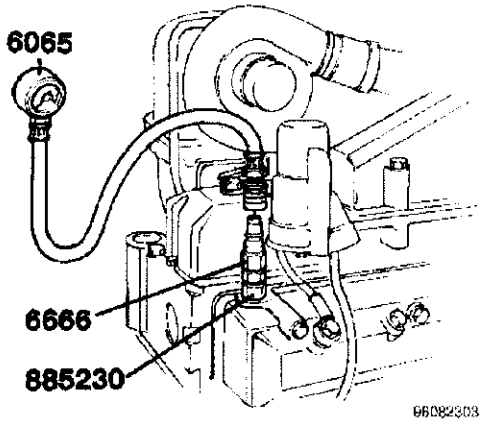
Boost pressure, checking

Special tools: 999 6065, 999 6666, (TWD) 885230

1



TD/TAD
TAD



Couple a connecting union and pressure gauge to the intake manifold.

Mobile engines: The pressure gauge should have a hose long enough to be able to view the pressure gauge from the driver's seat.

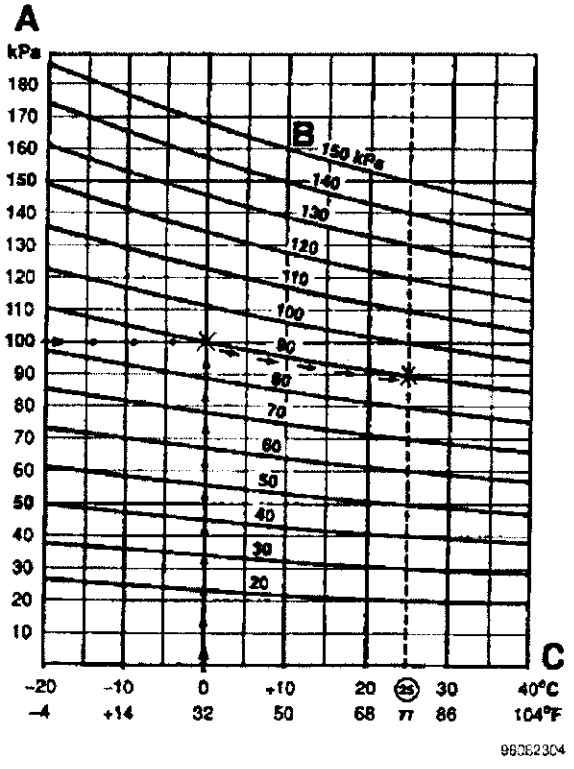
2

Measurement is carried out with the engine fully laden and with the throttle fully open. The engine speed should slowly pass the speeds given in the specifications for boost pressure.

NB! For this test to give the correct picture of reality, it is essential that full load is maintained long enough for the pressure to stabilize. It should also be noted that boost pressure varies with the temperature of the intake air (ambient temperature).

If boost pressure is not measured at a temperature of **+25°C**, the boost pressure reading must be adjusted according to the diagram below.

Example:
A pressure of 100 kPa registered at 0°C is the equivalent of 92 kPa at +25°C.



Boost pressure at different temperatures

A Boost pressure
B Correction curves
C Intake air temperature

If the boost pressure is low

1. Leaks from seals, intake manifold and exhaust pipe.

It is essential that the hose between the turbocharger and the intake manifold is not cracked or insufficiently tight.

Besides low boost pressure, a leak can also result in high exhaust gas temperature, which will severely strain the exhaust pipe, turbocharger, valves and piston rings.

An exhaust system working with excessive back pressure will lower the boost pressure, deliver a lower engine power and increase the exhaust gas temperature with consequent risk of burnt valves and turbocharger malfuncitons.

The back pressure must always be checked according to specified instructions after altering the exhaust system. See next page "Checking exhaust back pressure".

The following conditions must always be fulfilled when altering the exhaust system:

a) The diameter of the connector pipe must be 1/2-1" greater than the pipe to which it is being connected.

b) The transition between the exisiting pipe, to which the connection is being made, and the connector pipe must not be sudden. It should be tapered with a taper length of approx. 180 mm.

c) Pipe bends should be made with as large a radius as possible. Creases should be avoided.

2. Air filter

Check that air filters are not blocked and that the correct type of filter is being used. The indicator on the air filter intake pipe must not be red. Change filters if necessary.

3. Accelerator control

Make sure the accelerator control gives a full stroke of the injection pump arm.

4. Turbocharger

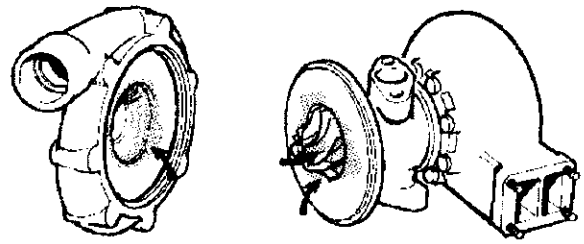
Make sure the rotor shaft is not binding and that the turbine rotor and compressor impeller are not scraping against their respective housings. Turn the rotor/impeller with a slight pressure at first and subsequently with a slight axial drag. If the rotor/impeller does not rotate freely, the turbocharger must immediately be changed or reconditioned. Inspect the rotor/impeller for damage.

Regular cleaning of the compressor housing and compressor impeller is recommeded for engines that are exerted to dusty or oily air on a daily basis. Fouled compressor components can lead to low boost pressure.

Compressor components can be cleaned with the unit fitted as follows:

Remove the compressor housing. Clean the compressor housing, compressor impeller and end section in paraffin or similar. Fit the compressor housing and measure the boost pressure.

5. Injection pump



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Check the following:

Governor, injection timing, calibration, high idling speed, smoke limiter diaphragm and break point, curve plate alignment and seals.

If the boost pressure is still too low after making the checks described above, it may be due to the compressor section being fouled. Clean the compressor housing, compressor impeller and wall in paraffin or similar.

6. Feed pressure

Make sure there are no fuel leaks and that the pump is delivering the correct feed pressure.

7. Delivery pipes

Make sure the pipes are the correct dimension and that the holes are not damaged.

8. Injectors

Check markings, opening pressure, injection pattern and make sure the holes are not damaged or blocked.

9. Engine condition

Check compression and valve clearance.

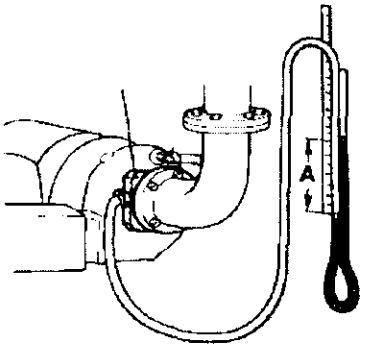
If the boost pressure is still unsatisfactory after these points have been checked and approved, the turbocharger should be reconditioned or changed.

Checking the exhaust back pressure

Special tools: (610, 630, 640): 884872
(710, 730, 731, 740): 884972

1
Detach the exhaust pipe from the turbocharger exhaust outlet. Remove the screw studs.

2
Clean the contact surfaces. Fit the long screw studs included in the flange kit.



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3

Fit the measuring flange onto the turbine housing with gaskets on both sides. Fit the exhaust pipe.

4
Attach a transparent plastic hose, partly filled with water, to the measuring flange or alternatively to a low-pressure gauge.

The difference between the height of the water columns (A) indicates the back pressure in the exhaust system in mm water column.

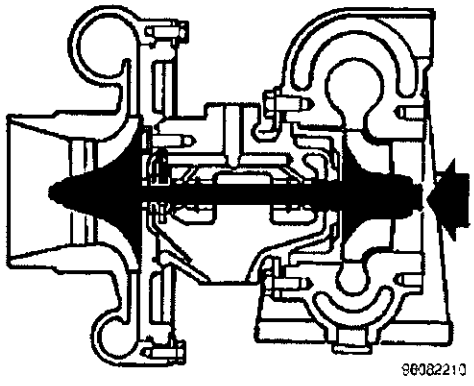
5
Run the engine at **full load and full throttle** for a few minutes and make sure the back pressure does not exceed the specified value. For maximum back pressure, see "Workshop Manual, Technical Data".

An exhaust system with excessively high back pressure reduces the boost pressure, lowers engine output, increases the smoke in the exhaust gases and increases the exhaust temperature, which in turn can lead to burnt valves and turbocharger malfunctions.

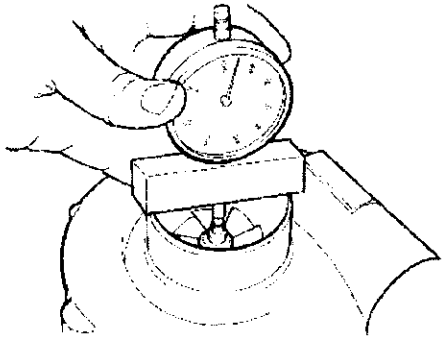
Turbocharger, checking bearing play

Axial and radial play is normally checked in conjunction with reconditioning when it is necessary to check turbocharger wear.

Measuring axial play



Place a dial indicator with an **8 mm** shaft in the holder as illustrated. Secure the dial indicator.

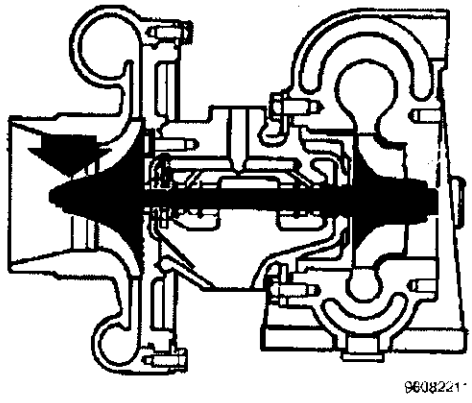


Place the holder on the compressor housing. Make sure the measuring point is resting on the centre of the shaft.

Press down the holder against the compressor inlet while pressing the turbine rotor up and down by hand. Read the dial indicator.

Axial play:
Schwitzer S2A, S2B: max 0.14 mm
Holset H1E, H2A: 0.10–0.16 mm

Measuring radial play



Place a rocker indicator with its measuring tip on the nose of the compressor.

Press down the rotor on which the indicator arm is resting while pressing up the rotor on the opposite side of the shaft. Zero the rocker indicator.

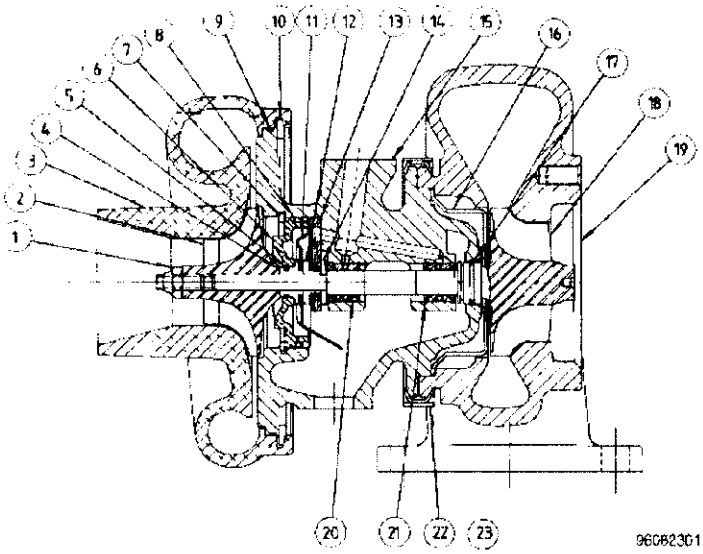
Pull up the rotor on which the indicator arm is resting while pressing down on the rotor on the opposite side of the shaft.

Measure the radial play. Turn the rotor **90°** and repeat the measuring process.

Radial play:
Schwitzer S2A: max. 0.82 mm (compressor side).
Schwitzer S2B: max. 0.95 mm (compressor side).
Holset H1E, H2A: 0.30–0.46 mm (compressor side).

Turbocharger, reconditioning

Schwitzer S2A, S2B



1. Lock nut
2. Compressor impeller
3. Compressor housing
4. Piston ring holder
5. Piston ring
6. Cover
7. Locking ring
8. O-ring
9. O-ring (option)
10. Locking ring
11. Oil deflector
12. Thrust ring
13. Thrust bearing
14. Axial washer
15. Bearing housing
16. Heat shield
17. Piston ring
18. Turbine rotor and shaft
19. Turbine housing
20. Bearing bushing
21. Locking ring
22. V-clamp
23. Lock nut

Dismantling

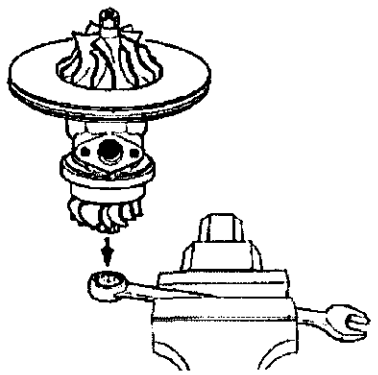
1
Mark the relative positions of the compressor housing (3) and and the turbine housing (19) to the bearing housing (15).

2
Place the turbine housing in a vice using soft jaws. The turbine shaft must be vertical.

3
Remove the large locking ring (10) securing the compressor housing and lift off the compressor housing.

4
Remove the V-clamp (22) securing the turbine housing

5



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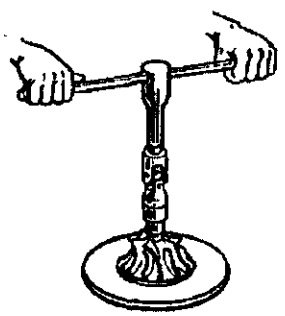
Lift out the bearing housing from the turbine housing. Place a suitable 12-sided ring spanner in a vice as illustrated.

6



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Place the turbine rotor's 12-sided hub into the spanner. Undo the compressor impeller lock nut (1).

NB! Later models of S2B have a nut with left-handed thread (4 C 94 stamped on the plate).

NB! Use a **T-handle** with universal joint and a socket so that the turbine shaft is not put under lateral strain.

7
Remove the compressor impeller nut (1) and pull off the compressor impeller (2) from the turbine shaft.

8
Carefully remove the shaft and turbine rotor (18) by tapping with a small, soft hammer on the compressor side of the shaft. Take care not to bend or damage the shaft.

9
Remove the locking ring (7) from the compressor side of the bearing housing.

10
Carefully prise up the cover (6) using two screwdrivers.

NB! Fit a plastic hose over the ends of the screwdrivers so that the bearing housing is not damaged.

11
Press out the piston ring holder (4) from the cover (6).

12
Remove the oil deflector (11), thrust bearing (13), thrust washer (14) and thrust ring (12) from the bearing housing.

13
Use a suitable pair of locking ring pliers, remove the outer locking rings from both sides of the bearing housing, remove the bearing bushings and the inner locking rings.

Cleaning the components

1
Aluminium components
Soak in a non-corrosive solvent until all the deposits have dissolved. Clean the surfaces with a bristle brush and soft scraper. A pressure steamer can be used provided the bearing surfaces are protected.

2
Cast iron components
Soak in a non-corrosive solvent. Use blasting as an alternative but take care with internal profiles.

3
Shaft and wheel unit
Soak in a solvent to remove oil residue. Mask the entire shaft section and blow clean the shaft and hub with steam. Avoid spraying too hard on the piston ring sealing grooves.

Inspection of components

1
Bearing housing
Inspect the bearing race visually for damage and wear. Check the turbine and sealing tube for damage.

2
Compressor impeller (2)
Make a visual inspection for signs of bending, jagged, nicked or eroded veins, and wear on the rear face. Very slight damage is acceptable. Discard and replace if the damage affects the balance of the impeller. Do not try to straighten bent veins.

3
Shaft and wheel unit
Inspect the bearing surface visually for wear.

The minimum diameter is **8.99 mm**.

Check the width of the sealing groove. Max **1.58 mm**.

Measure the excentricity between the large and small shaft diameters. Max **0.0076 mm**.

Max imbalance in both planes **0.36 mm**.

Change the unit if the tolerances are exceeded.

4
Inspect **the compressor housing (3) visually**. Discard and replace if the damage is extensive.

5
Piston ring holder (4)
Check the width of the piston ring groove, max **1.58 mm**, and for signs of chamfering or damage to the groove. Discard if worn.

6
Turbine heat shield
Change if cracked or worn.

7
Thrust ring (14)
Change if the surface is worn. In most cases, it can be reused by changing its position so that the side that is not worn is in contact with the thrust bearing.

8
Thrust flange (12)
No signs of surface damage or wear on the pressure surface.

9
Turbine housing (19)
Make a visual inspection for damage to the contour and signs of excess temperature damage such as cracks, pitting, warping, erosion. Discard and replace if the damage is extensive.

Assembling

Make sure all the components have been cleaned thoroughly and dried with compressed air before assembling. It is essential that no foreign bodies enter the turbocharger during assembly. **Lubricate all the components with clean engine oil when assembling.**

Use only components with dimensions complying with the inspection directions plus a "Reconditioning Kit".

1
Fit the inner locking rings (21) for the bearing bushings. Fit the bearing bushings and the outer locking rings.

2
Fit a new piston ring (17) into the groove in the turbine rotor shaft. Fit the heat shield over the turbine rotor shaft so it rests against the turbine rotor.

3
Fit the shaft and rotor, etc., into the bearing housing. Take care not to damage the piston ring while inserting it in the sealing tube.

4
Place the bearing housing in the turbine housing with the shaft vertical. Place the thrust washer (14) on the shaft. Fit the thrust bearing (13) in the bearing housing.

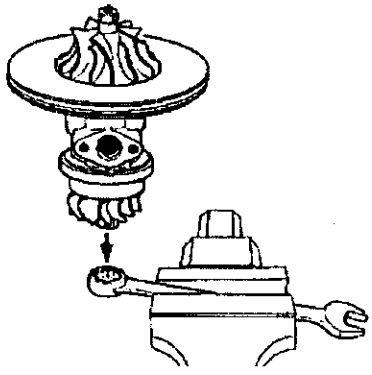
5
Fit the thrust ring (12) and the oil deflector (11). Fit a new O-ring (8) into the groove in the cover (6). Fit a new piston ring (5) into the piston ring holder.

6
Fit the piston ring holder into the cover, taking care not to damage the piston ring.

7
Lubricate the O-ring and fit the cover in the bearing housing and secure it with the locking ring (7), making sure the bevelled surface is face up.

8
Fit the compressor impeller and the lock nut.

9



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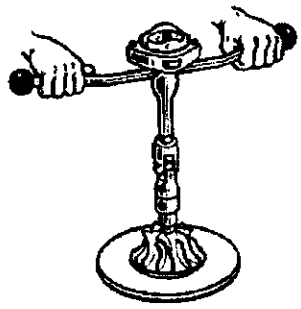
Place a suitable 12-sided ring spanner in a vice as illustrated. Place the turbine rotor hub into the spanner.

10



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Torque tighten the compressor impeller nut to **10.2 Nm** and apply two drops of Loctite to the threads.

NB! Use a torque wrench with T-handle and universal joint to avoid loading the turbine impeller axle unevenly.

11
Check radial and axial play of the wheel unit.

12
Fit the O-ring in its groove in the bearing housing end plate. Fit the bearing housing into the compressor housing (3) according to the markings. Secure the compressor housing using the large locking ring (with the bevelled side towards the turbine side).

13
Fit the bearing housing into the turbine housing (19) according to the markings, fit the V-clamp (22) and torque tighten the lock nut to **7 Nm**.

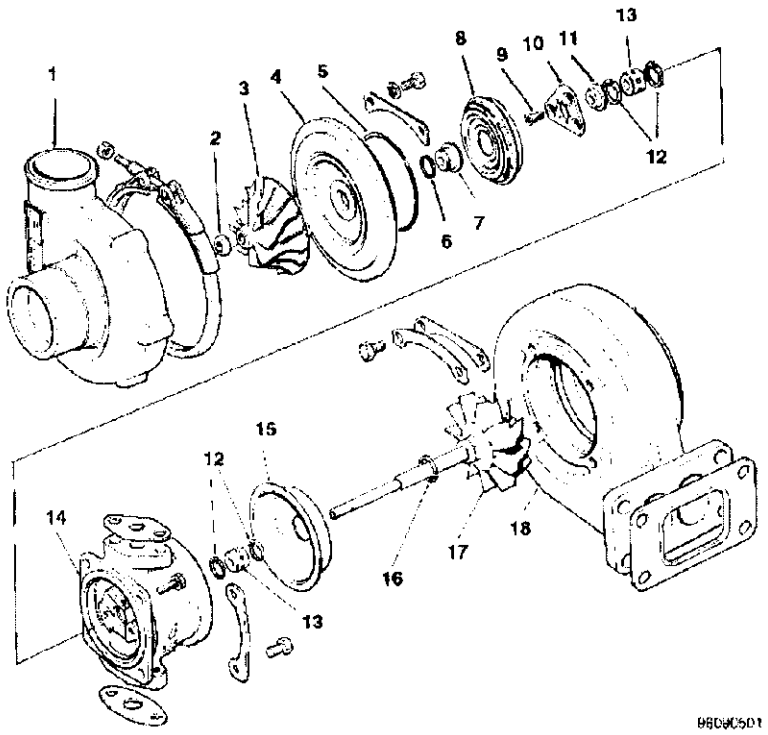
14
Check the clearance of the rotor by rotating the shaft while pressing the turbine rotor inward. Then press in the compressor impeller and carry out the same check.

15
Spray oil into the bearing housing. Cover all the openings with protective covers if the unit is not to be refitted immediately.

For fitting the turbocharger onto the engine, see "Turbocharger, changing".

Holset H1E, H2A

1. Compressor housing
2. Nut
3. Compressor impeller
4. End plate
5. Sealing ring
6. Piston ring seal
7. Piston ring holder
8. Oil guide plate
9. Bolt
10. Thrust bearing
11. Thrust ring
12. Locking ring
13. Bearing
14. Bearing housing
15. Heat shield
16. Piston ring seal
17. Turbine rotor and shaft
18. Turbine housing



Dismantling

1
Place the unit's exhaust flange in a vice.

2
Mark the relative positions between the turbine housing (18), bearing housing (14), end plate (4) and and the compressor housing (1).

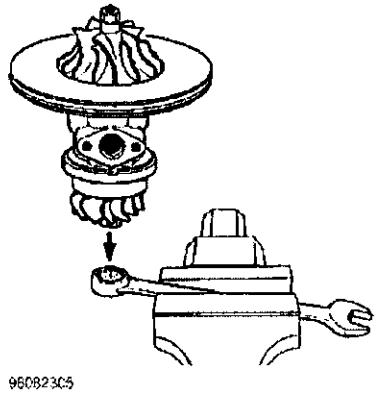
3
Undo the V-clamp (end plate-compressor housing) and transfer it to the bearing housing.

4
Remove the compressor housing. If necessary, knock with a soft hammer to separate the parts.

NB! Be extremely careful when removing the housings so that the compressor impeller and turbine rotor are not damaged. These components cannot be repaired and must be changed if damaged.

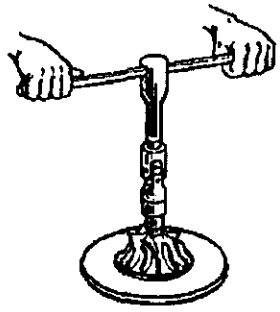
5
Remove the bolts securing the bearing housing to the turbine housing and lift out the bearing housing. Remove the strap.

6



Place a suitable 12-sided ring spanner in a vice as illustrated.

7



30082310

Place the turbine rotor hub into the spanner. Undo the compressor impeller lock nut (2).

NB! The nut has a left-hand thread.

Use a T-handle with universal joint and a socket so that the turbine shaft is not loaded unevenly. Remove the compressor impeller.

8
Remove the end plate (4) and press out the piston ring holder (7) with piston ring seal. Remove the piston ring. Lift out the oil guide plate (8).

9
Remove the thrust bearing (10) and thrust ring (11).

NB! The thrust bearing is secured with three bolts with Torx groove (12-sided socket head) Use a Torx key, size TX20 (3.86 mm).

10
Remove the bearing housing from the shaft. Remove the heat shield (15).

11
Remove locking rings and bearing bushings from the bearing housing. Remove the piston ring from the turbine rotor shaft.

Cleaning the components

1. Aluminium components
Soak in a non-corrosive solvent until all the deposits have softened. Clean the surfaces with a bristle brush and soft scraper. Steam can be used provided the bearing surfaces are protected.

2. Cast iron components
Soak in a non-corrosive solvent. Use blasting as an alternative with protected internal profiles.

3. Shaft and wheel unit
Soak in a solvent to remove all oil residue. Mask the entire shaft section and blow clean the wheel and hub with steam. Avoid spraying too hard on the piston ring sealing grooves.

Inspection of components

1. Bearing housing
Inspect the bearing race visually for damage and wear. Check the turbine end plate sealing tube for damage.

2. Compressor impeller (3)
Make a visual inspection for bending, damage, jagged or eroded veins, and wear on the rear face. Very slight damage is acceptable. Discard and replace if the damage is sufficient to affect the balance of the wheel. Do not try to straighten bent veins.

3
Inspect **the end plate (4) visually**. Discard and replace if the damage is extensive.

4. Turbine housing (18)
Make a visual inspection for damage to the contour and excess temperature damage such as cracks, pitting, erosion. Discard and replace if the damage is extensive.

5. Piston ring holder (7)
Check the piston ring groove for chamfering or damage to the groove. Discard if worn.

6. Thrust ring (11)
Change if the surface is worn.

7
Inspect all other components systematically after cleaning thoroughly. Always change bushings and associated locking rings, piston ring seals, compressor impeller nut, sealing rings, bolts and locking washer when reconditioning.

For more information on reconditioning, see the manufacturer's directions.

Assembling

Make sure all the components have been cleaned thoroughly before assembling. It is essential that no foreign bodies enter the turbocharger during assembly.

NB! Lubricate all the components with engine oil when assembling.

1
Fit the inner locking rings for the bearing bushings. Put the bushings in place and fit the outer locking rings.

NB! Fit the locking rings with the bevelled edges towards the bearing bushing.

2
Place the bearing housing so that the turbine side (without screw holes) is face up. Place the heat shield (15) on the bearing housing.

3
Place the piston ring in its groove on the turbine impeller shaft. Centre the ring and carefully guide the shaft down through the heat shield and bearing housing bushings.

4
Grip the turbine rotor shaft to prevent it falling on the floor and carefully secure the turbine impeller hub in a vice with soft jaws. Pay attention to the turbine rotor veins.

5
Place the thrust ring (11) on the rotor shaft with the flange surface face down. Fit the thrust bearing (10). Tightening torque **4.5 Nm.** Fit the oil guide plate (8).

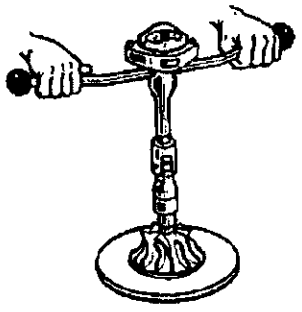
NB!The three retaining bolts for the thrust bearing have Torx grooves (internal 12-sided socket head).

Use a Torx key, size TX20 (3.86 mm).

6
Fit the piston ring on the piston ring holder (7) and fit the ring holder into the end plate(4). Place the sealing ring (5) in the end plate groove.

7
Place the end plate on the bearing housing and tighten according to the markings. Tightening torque **9 Nm.**

8



Place a suitable 12-sided ring spanner in a vice. Put in the compressor impeller. Torque tighten the nut to **14 Nm.**

NB! The nut has a left-hand thread.

Use a T-handle with universal joint and a socket so that the rotor shaft is not loaded unevenly.

9
Check radial and axial play of the rotor as directed.

10
Place the turbine housing exhaust flange in a vice.

11
Place the V-clamp on the bearing housing.

12
Fit the bearing housing onto the turbine housing according to the markings made earlier. Lubricate the threads of the retaining bolts with heat-resistant lubricating paste/graphite grease (e.g. Never Seez). Fit lock washers and clamp washers and torque tighten the bolts to **14 Nm**. Secure the bolts.

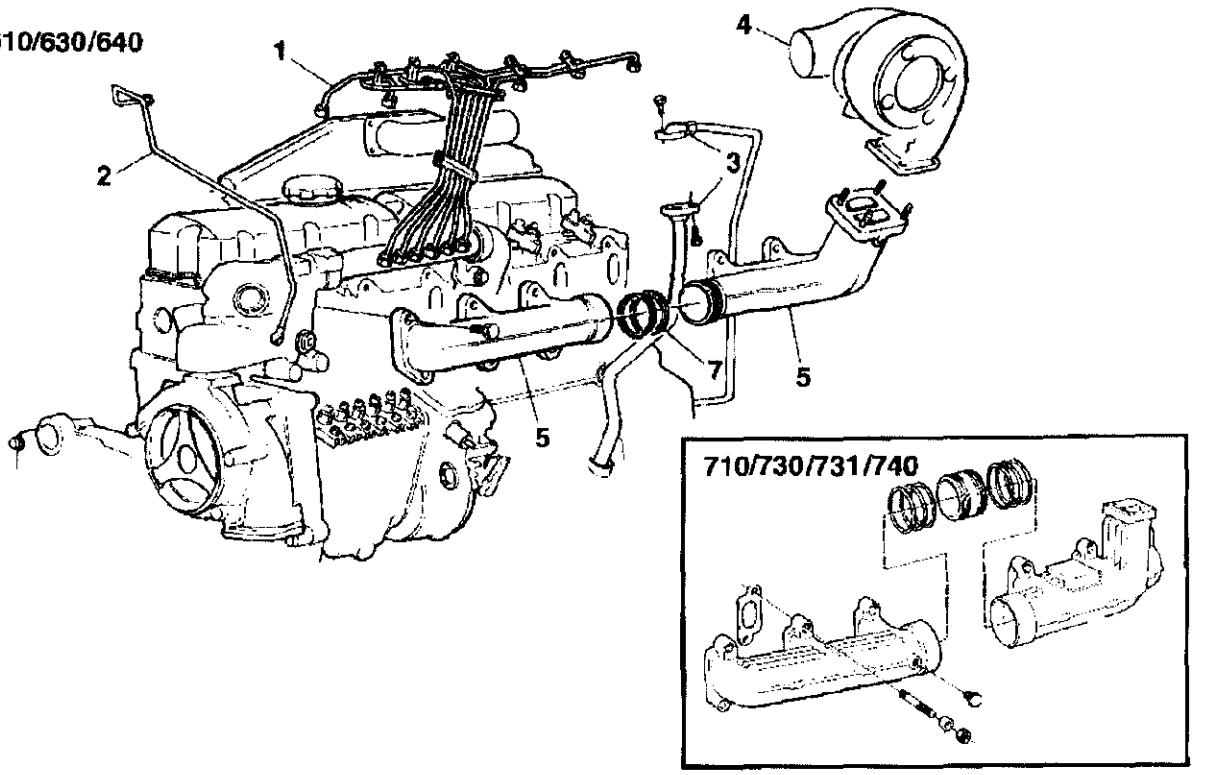
13
Fit the compressor housing according to the markings made earlier. Fit the strap and torque tighten the nut to **14.5 Nm. (8.5 Nm** on later models with silver plated nut.)

14
Check the clearance of the wheel by rotating the shaft while pressing the turbine rotor inward. Then press in the compressor impeller and carry out the same check.

15
Spray oil into the bearing housing. Cover all the openings with protective covers if the unit is not to be refitted immediately.

For fitting the turbocharger onto the engine, see "Turbocharger, changing".

Gaskets for exhaust manifold, changing



The following text refers to the numbers in the illustration.

Removing

1
Remove the fuel delivery pipes and plug the connections.

NB! The fuel delivery pipes are clamped together. Do not remove the clamps. The pipes must be removed as one unit.

2
Remove the fuel leak-off pipe from the overflow valve. Separate the pipe at the connection to the 1st or 6th injector and remove the pipe.

3
Detach the fuel delivery pipe and oil return pipe from the turbocharger.

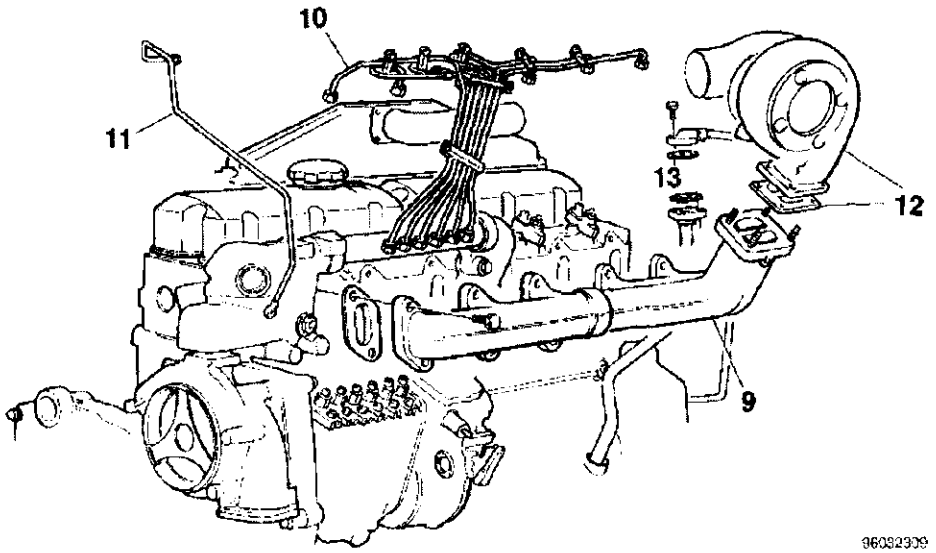
4
Remove the turbocharger from the exhaust manifold.

5
Remove the bolts and sleeves from exhaust manifold. Lift off the manifold.

6
Remove the gaskets and clean all the contact surfaces on the exhaust manifold and cylinder head.

7
Dismantle the exhaust manifold, clean the connector piece and fit new sealing rings if necessary.

8
Assemble the exhaust manifold, blow away any carbon deposits with compressed air.



The following text refers to the numbers in the illustration.

Fitting

9
Fit the exhaust manifold with new gaskets and screw it tight.
Tightening torque **48 ± 5 Nm**.

NB! Make sure the graphite side of the gasket is facing the cylinder head and that the metal surface is against the exhaust manifold.

10
Fit the fuel delivery pipes.

NB! The fuel delivery pipes must never be bent or reshaped. A damaged fuel delivery pipe must be changed.

11
Fit the fuel leak-off pipe with new copper washers.

12
Fit a new gasket on the exhaust manifold and put in place the turbocharger.

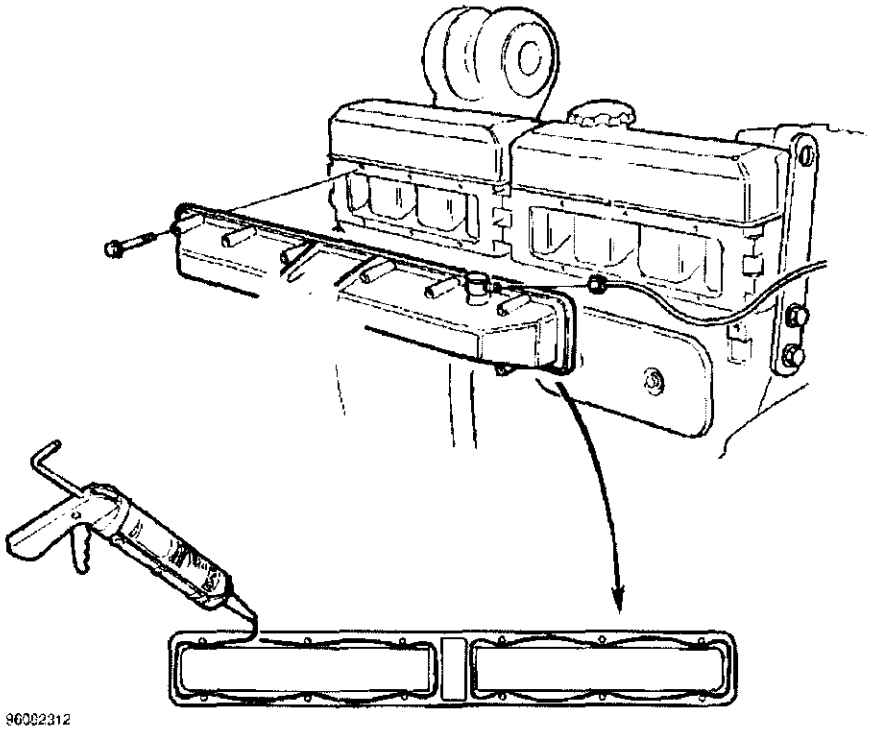
13
Fit the turbocharger oil inlet and oil return pipes with new gaskets.

14
Detach the turbocharger oil return pipe and turn over the engine using the starter motor until oil emerges from the turbocharger return oil port.

15
Fit the turbocharger return oil pipe and tighten it.

16
Check for leaks. Check the engine oil level and top up as necessary.

Intake manifold sealant/gasket, changing



The figure illustrates a TD/TAD engine

1
Expose the intake manifold.

NB! To facilitate removal of the intake manifold, it may be necessary on certain variants to remove the compressor cooling circuit.

TWD740GE/VE: Undo the heater element retaining bolts on the intake manifold and remove the element before exposing the intake manifold. Undo the union for the boost pressure gauge, sensor cable and retaining bolts for the horn.

2
Remove the bolts. Remove the intake manifold.

TWD engines (not TWD740GE/VE): Remove the intake manifold together with the intercooler.

3
Clean the contact surfaces on the intake manifold and cylinder head.

4
All TD and TAD engines plus TWD740GE/VE:
Apply a bead of sealant (part no. 1161277) about **2 mm** wide to the intake manifold.

NB! Fit the intake manifold within **30 minutes** so the sealant does not have time to harden.

TWD engines
Fit a new gasket.

5
Fit the intake manifold and screw it tight.

6
Connect the hose to the smoke limiter where applicable.

7
Screw on all the components that have been loosened or removed while exposing the intake manifold.

TWD740GE/VE: The heater element (with new gaskets) and its relay are to be mounted together.

Intercooler, changing

1
Drain the engine coolant.

2
Undo the hose clips around the intercooler.

3
Undo water pipe clamp and move the pipe to one side.

4
Undo the intercooler retaining bolts and lift away the intercooler together with the charge air pipe.

5
Place the intercooler in a vice and remove the upper and lower charge air pipes. Fit the charge air pipes with new gaskets onto the new intercooler.

6
Fit the intercooler complete with charge air pipe onto the engine. Tighten the retaining bolts to standard torque.

7
Connect all water and charge air pipes and tighten all hose clips.

8
Fill the system with coolant.

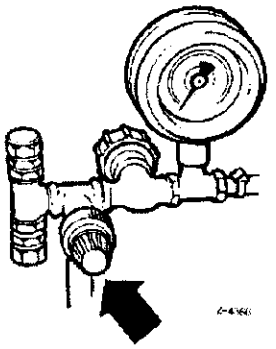
9
Perform a leak test.

Intercooler, leakage test

Special tool: 999 999 6662, 885231, 885232

Check the pressure tester before use.

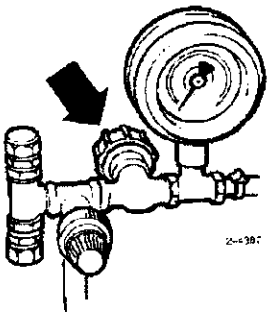
1



Connect the pressure tester to the compressed air supply and set the pressure gauge to **100 kPa** with the reducing valve.

NB! The reducing valve knob is locked by moving the locking ring axially.

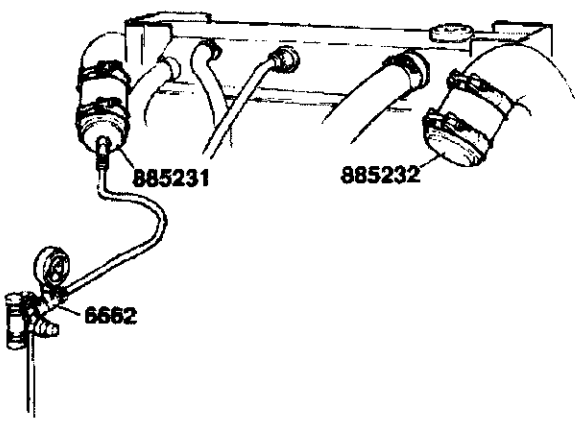
2



Close the valve. The pressure must not drop for 2 minutes if it the pressure tester is to be considered reliable.

3
Detach the charge air hoses from the intercooler.

4



Fit connection tool 885231 and sealing tool 885232 with new sealing rings to the intercooler. Unscrew the pressure tester reducing valve. Connect the pressure tester to the intercooler.

5
Open the cut-off valve knob and set the tester to **70 kPa** with the reducing valve.

6
Close the cut-off valve. During **one minute**, the pressure must not drop more than **20 kPa** for the intercooler to be approved.

7
Repeat the check several times if there is a leak. Check also the pressure tester hoses and connections.

8
Remove the pressure tester, connections and sealing washer.

9
Connect the charge air holders.

Air compressor, changing

Special tool: 999 2976

Other special equipment: 998 6172, 115 9795, 115 8957

1
Discharge the compressed air system using nipple 999 2976.

2
Detach the cooling coil from the compressor.

3
Check that the cooling coil is not blocked by carbon deposits. If necessary: decarbonize the entire cooling coil.

4
Pinch the compressor coolant hoses with hose pliers 115 8957. Undo the hose clips, pull off the coolant hoses from the compressor and put them to one side.

5
Undo the compressor air inlet pipe. Change filter.

6
Unscrew the oil pipe from the compressor.

7
Undo the compressor retaining bolts and remove the compressor and O-ring. Drain oil and water from the compressor.

8
Place the compressor gear wheel in a vice with soft jaws. Unscrew the retaining nut and pull the gear wheel loose from the compressor using puller 998 6172.

9
Unscrew the connections for the coolant hoses, oil hose and union for the outlet pipe.

10
Clean all components to be used with the new compressor. Inspect the gear wheel for wear damage.

IMPORTANT! Clean the crankshaft end of the new compressor (external cone) and the internal cone in the gear wheel from oil using paper wipes and degreasing agent. Wipe the surfaces dry with dry paper.

11
Fit the gear wheel onto the crankshaft of the new compressor and place the gear wheel in a vice with soft jaws.

Oil the nut flange against the gear wheel and torque tighten it to **200-250 Nm**.

12
Fit the unions for the coolant hoses and oil pipe on the new compressor.

13
Fit new gaskets using thread sealing fluid on threaded connections.

14
Fit the union for the outlet pipe.

15
Clean the contact surfaces on the engine and the compressor. Fit a new O-ring. Fit the compressor and tighten the retaining bolts.

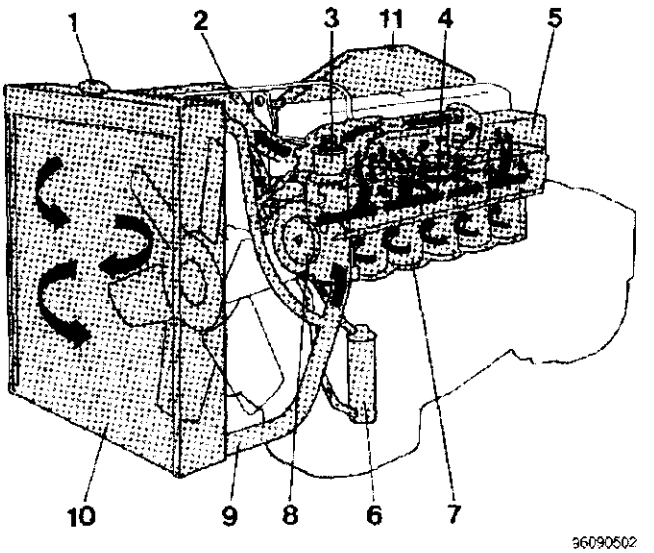
16
Fit the cooling coil upper bolt and the coolant hoses.

17
Check the oil hose for cracks. Change hose if necessary. Fit the oil hose to the compressor.

18
Fasten the cooling coil with cap nuts to the compressor and tighten them.

Cooling system

Design and function



1. Filler cap
2. Line from thermostat housing
3. Piston thermostat
4. Distribution passage
5. Cylinder head
6. Oil cooler (7-litre engine). (Tube type on 6-litre engine)
7. Cylinder liner
8. Coolant pump
9. Line to pump suction side
10. Radiator
11. Intercooler (water/air, TWD engine)

Coolant is pumped through the system by a gear driven pump and passes via the distribution gallery to the cylinder block.

The coolant is led from the gallery via holes to the cylinder liners and the two cylinder heads.

Coolant is returned directly to the thermostat housing from the front cylinder head. Coolant is returned to the thermostat housing via a separate pipe from the rear cylinder head.

On TWD engines, the intercooler is connected to the cooling system. Coolant is led through a pipe from the coolant pump. The outlet pipe from the intercooler is connected to the oil cooler.

The oil cooler is flat-type and mounted horizontally to the left-hand side of the engine.

Certain engines have a tube type of oil cooler mounted vertically on the right-hand side of the engine.

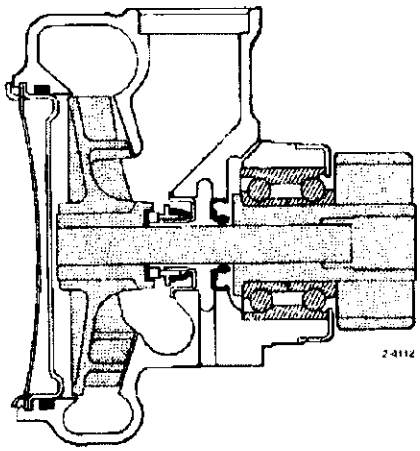
Coolant from the oil cooler is returned to the thermostat housing via a pipe connected to the thermostat housing cover. A pressure valve in the expansion tank cap governs the pressure in the cooling system.

Coolant pump

The coolant pump is moutned on the timing gear casing and is driven via a gear wheel from the engine timing gear wheels.

The pump has three seals, two coolant seals and one oil seal.

The pump shaft is supported by a double row ball bearing.



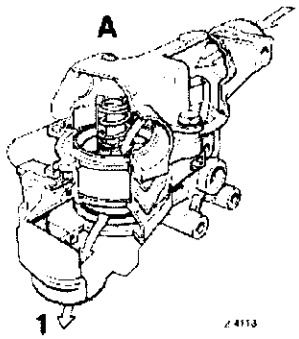
Thermostat housing, thermostat

The thermostat housing is made in die-cast aluminium and is mounted on the front cylinder head.

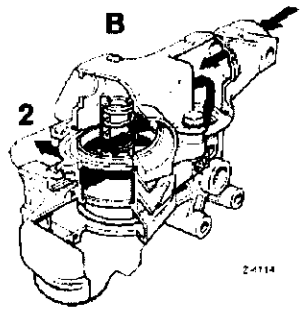
The engines are equipped with a piston thermostat.

At low engine temperatures, the thermostat closes and coolant passes through a bypass line back to the coolant pump.

As the engine temperature rises, the thermostat will gradually open the passage to the radiator while it closes the bypass line.



A. Thermostat closed
1. To coolant pump

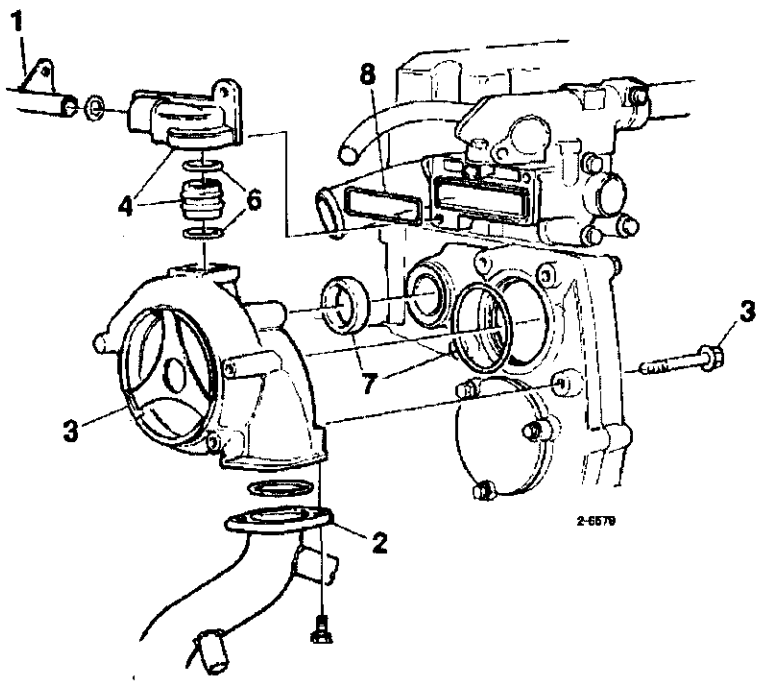


B. Thermostat open
2. To radiator

Repair instructions

NB!Always wash the engine before carrying out any repairs.

Coolant pump, changing



The following text refers to the numbers in the illustration.

1
Disconnect the pipe (if fitted) from the thermostat housing front cover and remove the cover retaining bolts.

2
Detach the pipe from the coolant pump.

3
Remove the retaining bolts and lift out the coolant pump.

4
Remove thermostat housing cover from coolant pump and remove the pipe between the cover and the pump.

5
Clean all the sealing surfaces.

6
Fit new sealing rings on the pipe between the thermostat housing cover and the coolant pump. Fit the pipe and thermostat housing cover on the coolant pump.

7
Fit new sealing rings for the coolant pump seal to the timing gear casing and cylinder head.

8
Fit a new sealing ring on the thermostat housing cover, lift in place the coolant pump, fit and tighten the bolts.

9
Fit the thermostat housing cover.

10
Fit the pipe (where applicable) onto the thermostat housing front cover and fit the pipe on the coolant pump. Use new sealing rings.

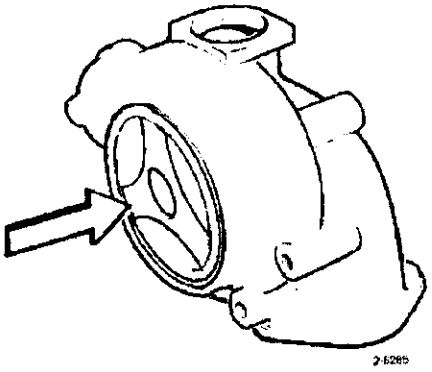
11
Fill with coolant and check for any leaks.

Coolant pump, reconditioning

Special tools: 999 2071, 999 2268, 999 2584, 999 4034, 999 4090, 999 6626, 999 6883, 999 6884, 999 6979, 999 8039, 999 8107, 999 8137, 884985

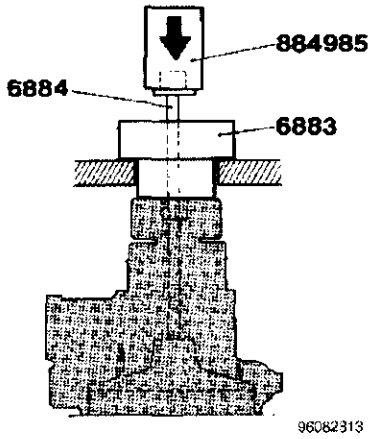
Dismantling

1



Remove the securing plate, cover and O-ring.

2



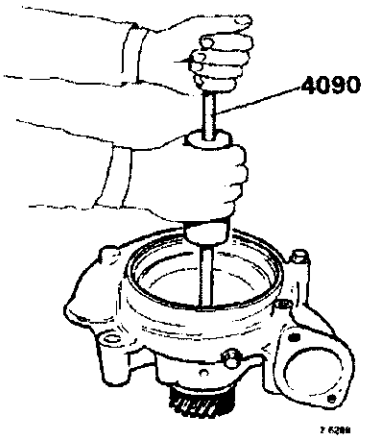
Screw tool 999 6883 onto the driveshaft.

Fit drift 999 6884 onto drift 884985. Insert the thin drift (999 6884) through tool 999 6883.

Place the coolant pump in a hydraulic press with a support under tool 999 6883.

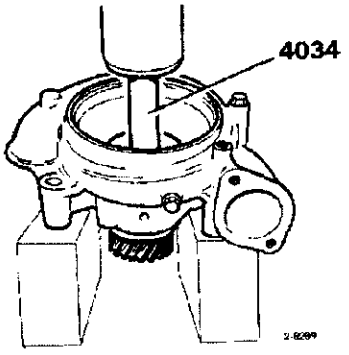
Press the impeller with shaft.

3



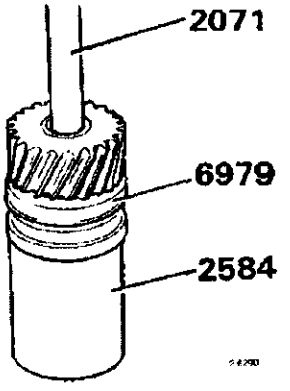
Remove the sealing ring with puller 999 4090.

4



Press out the shaft journal with bearing and gear wheel with tool 999 4034.

5



Press off the gear wheel from the shaft journal.

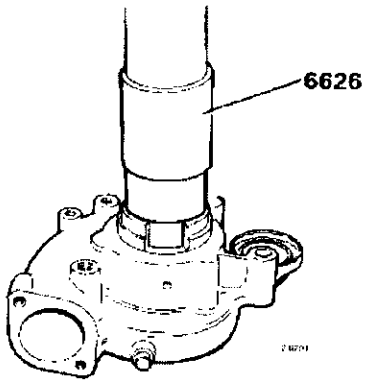
Inspection

Replace all the old components with the new ones included in the repair kit. Make sure the pump housing is not damaged before refitting it.

Assembling

NB! All the press fit surfaces should be lubricated with a mixture of equal parts of molybdenum sulphide and engine oil when assembling the coolant pump.

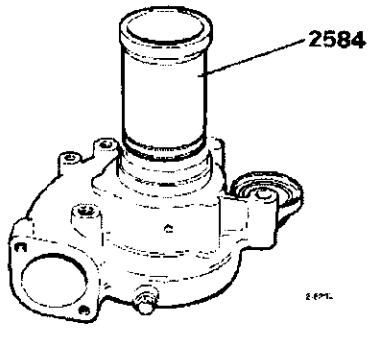
6



Press the shaft journal and bearing into the pump housing with bushing drift 999 6626.

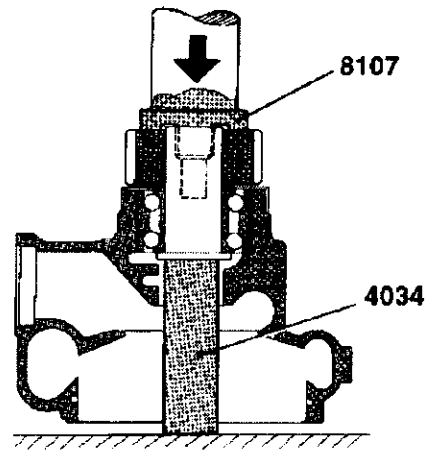
NB! Press on the outer edge of the bearing. Use assembly compound.

7



Press on the locking ring with bushing drift 999 2584.

8



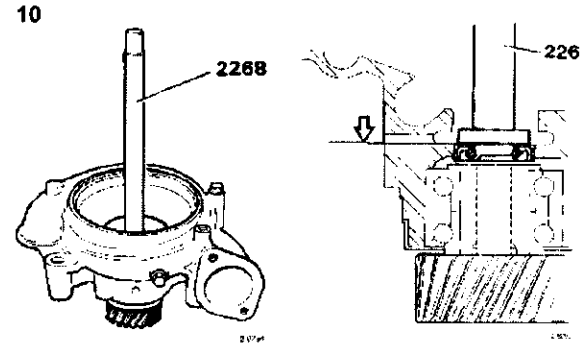
Place the coolant pump in a hydraulic press with drift 999 4034 as support under the shaft journal. Press on the gear wheel until is comes in contact with the bearing.

NB! Use assembly compound.

9

Make sure the shaft journal and gear wheel rotate freely. Noise from the bearing and axial play is not accepted.

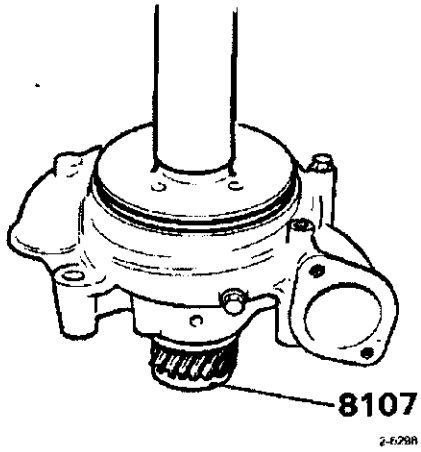
10



Place the engine oil sealing ring in the pump housing.

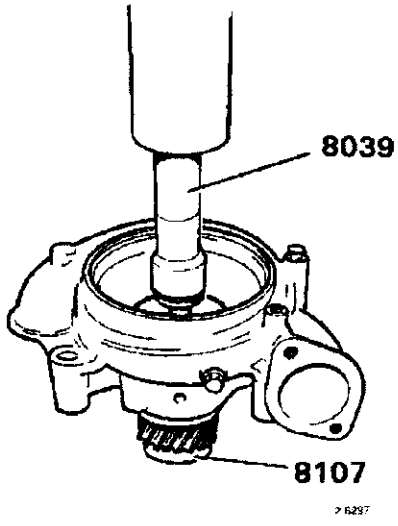
NB! Make sure sealing ring lips are face down. Press carefully on the sealing ring until it is flush with the edge of the pump housing, see figure.

11



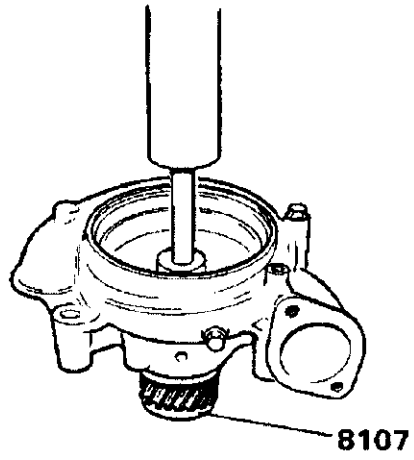
Press on the impeller shaft.
Use 999 8107 as a support under the gear wheel.
Press the shaft all the way home.

12



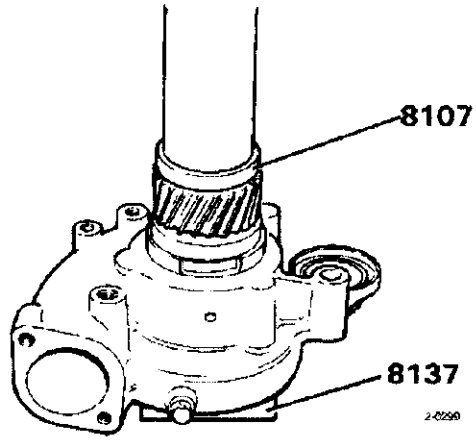
Use tool 999 8039 to press down the sealing ring until it bottoms in the pump housing. Place 999 8107 as a support under the gear wheel.

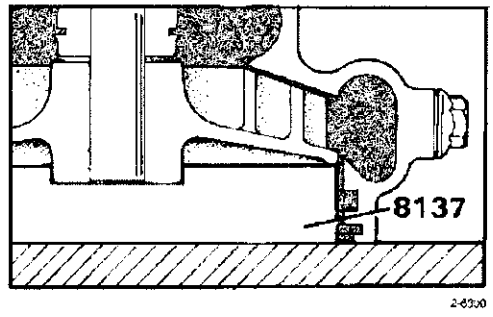
13



Press on the impeller approx. **15 mm** onto the shaft.
Place 999 8107 as a support under the gear wheel.

14



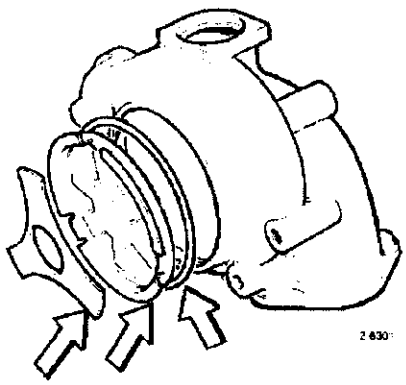


Turn the pump with the impeller face down and place it so that the impeller is resting on tool 999 8137.

Use tool 999 8107 to carefully press on the pump so it bottoms against the press bench.

NB! Tool 999 8137 is adapted so that the correct clearance is attained between the impeller and the pump housing.

15

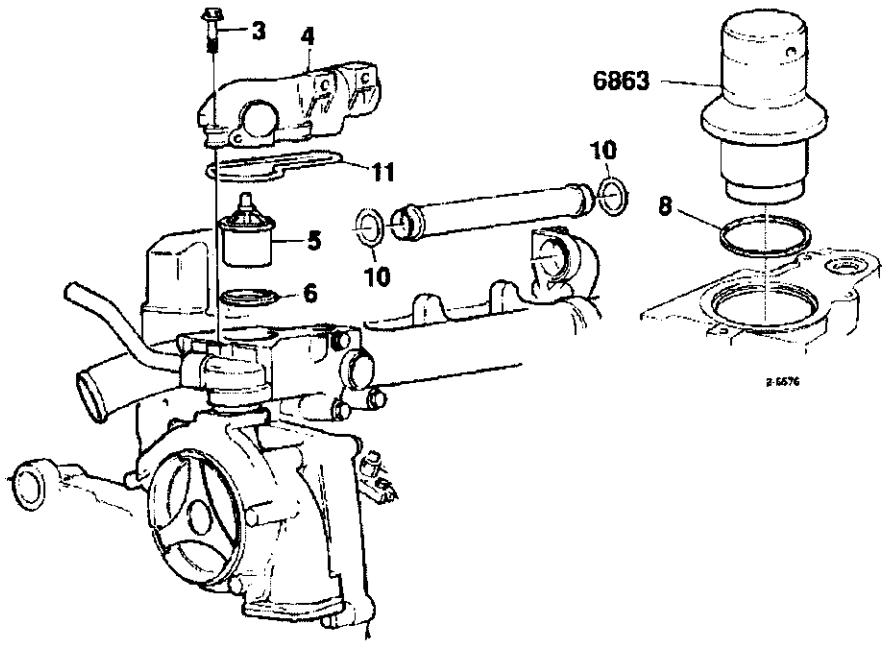


Fit a new O-ring. Refit the cover and locking plate (bent inwards).

NB!Lubricate the O-ring with soap before assembling.

Piston thermostat, changing

Special tool: 999 6863



The following text refers to the numbers in the illustration.

1
Remove the fuel filter attachment from the thermostat housing cover.

NB! Do not undo the fuel pipes.

Remove the clamp and the pipe from the oil cooler, if fitted. Remove the sealing ring.

2
Remove the intermediate fuel leak-off pipe where necessary.

3
Remove the bolts on the thermostat housing cover.

4
Lift up the thermostat housing cover approx. **20 mm** and then turn it carefully until it comes loose from the coolant distribution pipe.

5
Remove the piston thermostat.

6
Remove the thermostat housing sealing ring by tapping with a drift until it tips over and can be pulled out.

7
Clean the thermostat housing and cover.

8
Fit a new sealing ring onto drift 999 6863 and carefully tap down the ring until the drift bottoms against the housing.

NB! Fit the sealing ring with its sealing lip face down.

9
Fit a new thermostat.

10
Fit new sealing rings on the coolant distribution pipe.

NB! Apply soap solution to the sealing ring.

11
Fit a new sealing ring in the thermostat housing cover.

12
Press the thermostat housing cover onto the coolant distribution pipe and fasten the thermostat cover to the thermostat housing.

13
Fit a new sealing ring onto the oil cooler pipe (certain engines). Fit the pipe and fasten the clamp.

NB! Apply soap solution to the sealing ring.

14
Fit the oil leak-off pipe if it has been removed. Fit the fuel leak-off pipe on the thermostat housing cover.

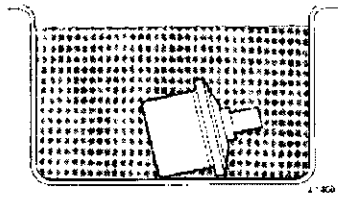
NB! The attachment holes are oval to allow adjustment of the bracket and avoid strain on the fuel pipes.

Thermostat, functional check

En functional check must be carried out before the new thermostat is fitted.

1
Make sure the thermostat is completely closed. Hold up the thermostat to the light and make sure there is no gap visible in the opening. If the thermostat does not close properly it must be changed.

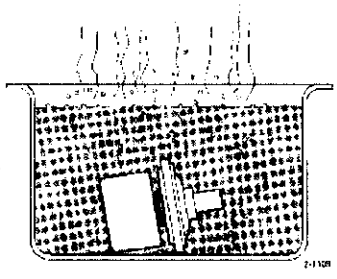
2



Heat some water in a receptacle to **+70°C** and immerse the thermostat in the water as illustrated.

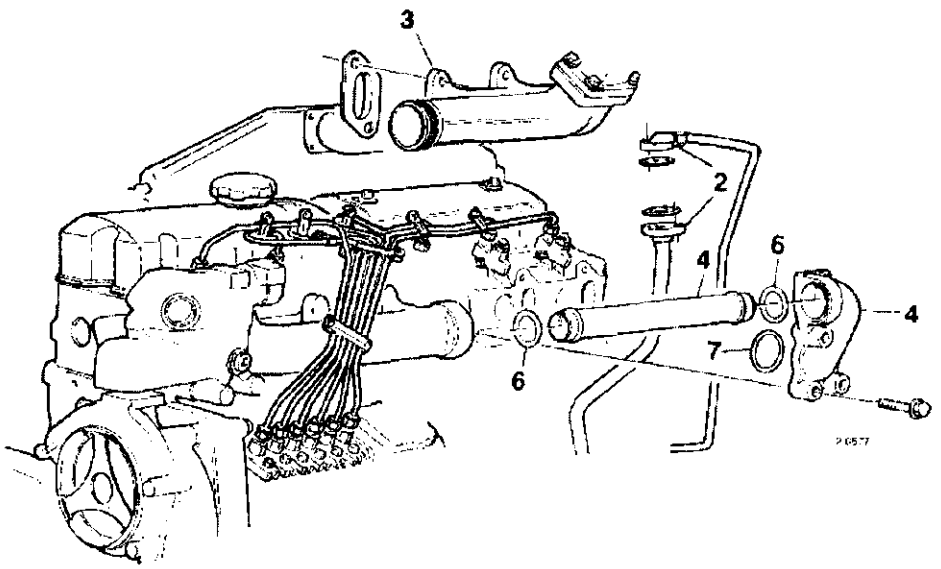
3
Check that the thermostat is still closed after at least **30 seconds**.

4



Now heat the water to boiling point (100°C). Check after at least **30 seconds** at boiling point that the thermostat has opened at least **7 mm**. If the thermostat does not open, it must be changed.

Coolant distribution pipe attachment seals, changing



610, 630 and 640 engine

1
Unscrew the oil inlet pipe from the turbocharger.

2
Detach the oil return pipe from the turbocharger.

3
Remove the bolts on the rear of the exhaust manifold and lift off the manifold together with the turbocharger.

4
Remove the bracket for the coolant distribution pipe.

5
Clean the bracket, pipe, thermostat housing cover, cylinder head and exhaust manifold contact surfaces.

6
Fit new sealing rings on the coolant distribution pipe and press up the bracket onto the pipe.

NB! Apply soap solution to the sealing rings.

7
Fit a new sealing ring on the bracket.

8
Press the coolant distribution pipe into the thermostat housing cover and bracket, fit the bracket.

9
Fit the exhaust manifold with new gaskets and screw it tight. Tightening torque **48 ± 5 Nm**.

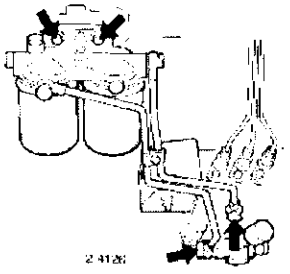
NB! Make sure the graphite side of the gasket is facing the cylinder head and that the metal surface is against the exhaust manifold.

10
Fit the turbocharger oil inlet and oil return pipes with new gaskets.

710, 730, 731 and 740 engines

WARNING! The fuel delivery pipe must not be bent or reshaped as this may cause cracks or breakage.

1



Undo the fule pipes from the injection pump and remove the fuel filters with brackets. Plug the connections on the injection pump.

2

Detach the air pipe and exhaust pipe from the turbocharger.

NB!Protect the turbocharger from dirt and foreign particles.

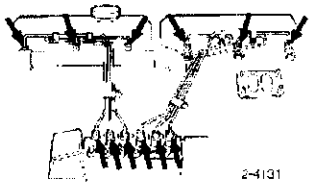
3

Remove the oil inlet pipe and detach the oil return pipe from the turbocharger.

4

Remove the nuts and lift off the tubocharger.

5



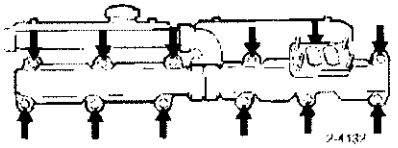
Remove the turbocharger oil return pipe from the cylinder block.

6

Remove the fuel delivery pipes and plug the connections.

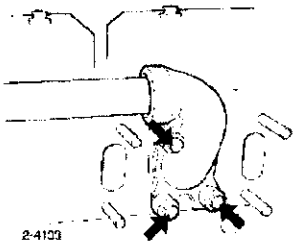
NB! The fuel deliver pipes are clamped together in threes or all six together. Do not undo the clamps, the pipes must be removed as one unit.

7



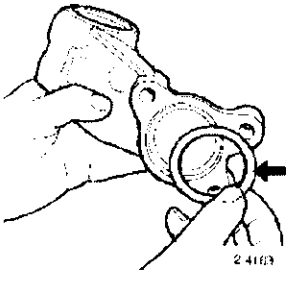
Remove the nuts and sleeves from exhaust manifold. Lift off the manifold.

8



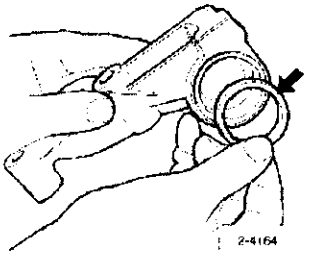
Remove the coolant distribution pipe union from the rear cylinder head and remove the pipe.

9



Clean the coolant distribution pipe union and fit it with a new sealing ring.

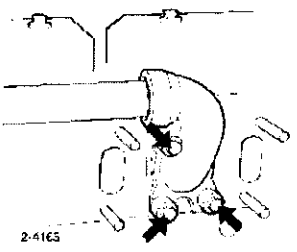
10



Fit a new sealing ring in the thermostat housing and the coolant distribution pipe union.

11
Apply soap solution to the sealing rings and press the pipe into the thermostat housing.

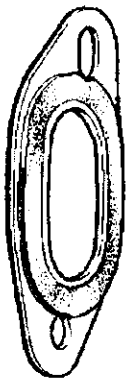
12



Fit the union to the pipe and fasten the union on the cylinder head.

13
Clean the contact surfaces on the exhaust manifold and cylinder head.

14

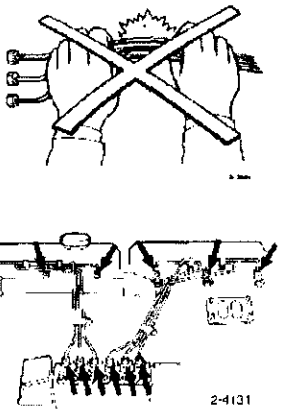


Fit new gaskets on the cylinder heads.

NB! Make sure the graphite side of the gasket is facing the cylinder head and that the metal surface is against the exhaust manifold.

15
Lift up the exhaust manifold into position and fit the sleeves and nuts. Fit the manifold.

16



Fit the fuel delivery pipes.

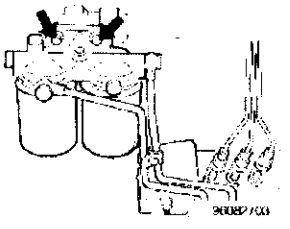
IMPORTANT! The fuel delivery pipes must never be bent or reshaped. A damaged fuel delivery pipe must be changed.

17
Fit the turbocharger oil return pipe to the cylinder block.

18
Fit a new gasket on the exhaust manifold, lift up and put in place the turbocharger. Fit the turbocharger oil inlet and oil return pipes with new gaskets.

19
Fit the air pipe and exhaust pipe.
The tightening torque for the exhaust pipe is **48 ± 5 Nm**.

20



Fit the fuel filters together with the bracket and connect the pipes to the injection pump.

NB! Do not tighten the fuel filter bolts until the pipes have been connect.

The attachment holes are oval to allow adjustment of the bracket and avoid strain on the fuel pipes.

21
Bleed the fuel system.

Thermostat controlled fan, functional check

Special tool: 998 8460

Fan breakdowns can occasionally be caused by the wrong amount of silicone fluid or worn parts in the control unit.

Before performing the functional check, make sure the radiator is not clogged and that the coolant temperature sensor is in working order.

If the thermostat in the cooling system does not work, it can interfere in the operation of the fan.

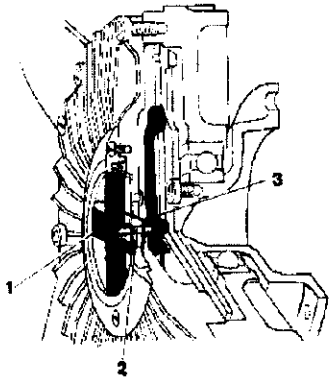
NB! Blocking the front of the radiator can make the thermostat controlled fan run continuously.

A fan malfunction can be assumed in the following cases:

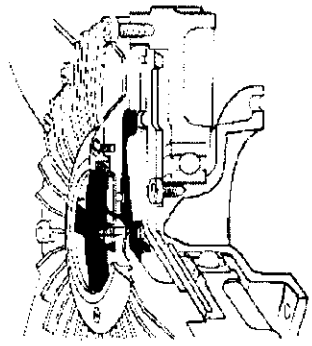
- The fan does not engage, i.e. the fan runs at low speed despite high engine load. This will result in high engine temperature.
- The fan does not disengage despite low engine load.

Control unit

A.
Fan runs at reduced speed: The bimetal spring (1) presses against the control pin (2), which is brought against the valve arm (3).



B.
The fan is fully engaged: The bimetal spring is bent outward due to increased temperature of the ambient air.



Speed check, fan disengaged

1
Run the engine at idling speed for **5 minutes**. The air temperature in front of the fan must not exceed **+ 30°C**.

The silicone fluid that entered the drive chamber when the engine was turned off is now pumped back to the storage chamber.

2
Increase engine speed to 43.3 rps (2600 rpm). The fan speed should now be 8.7-21.7 rps (520-1300 rpm).

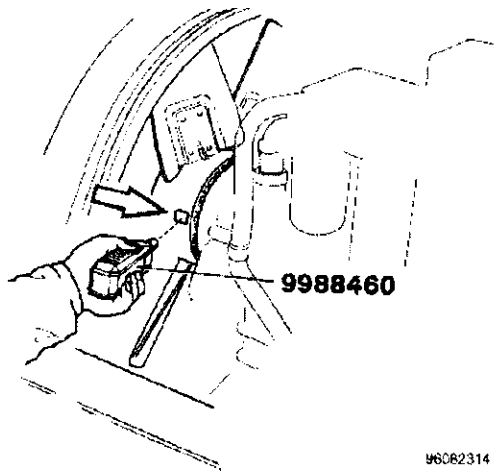
If the fan speed is not to specifications, the fan should be changed.

NB! The fan must not be filled with silicone fluid if the speed is too low.

Speed check, fan engaged

1
The engine temperature should be high enough for the fan to be fully engaged.

2
Increase the engine speed to 43.3 rps (2600 rpm). The fan speed should exceed 36.8 rps (2200 rpm). If the fan speed is lower, the fan should be changed.



Speed check of thermostat controlled radiator fan

WARNING! Keep hands and measuring equipment at a safe distance from the fan blades during the speed check.

Incorrect engagement temperature

If high coolant temperature is suspected while driving despite the fan engagement speed being correct and despite the fan engagement not being heard when the coolant temperature increases, then the fan engagement temperature is probably incorrect.

The fan engagement temperature cannot be adjusted or checked in the vehicle as special tools are required.

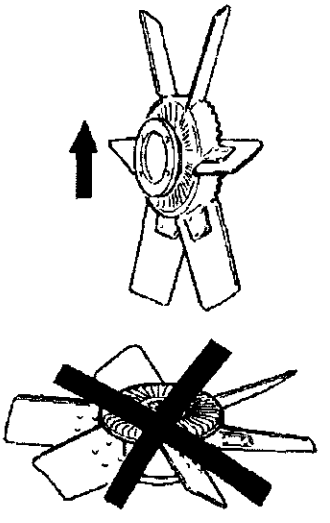
If the engagement and disengagement temperarures are thought to be incorrect, the fan must be changed.

Thermostat controlled radiator fan, changing

A thermostat controlled radiator fan contains a precise amount of silicone fluid to operate reliably.

Such a fan must therefore always be placed vertically when removed from the vehicle.

If it is placed horizontally, the silicone fluid may leak out and the fan will lose its properties.



When changing the fan, check the new one for leaks. If a leak is suspected, special tools will be required to check the engagement temperature, speed, etc.

Coolant

The coolant should consist of a mixture of anti-corrosive additives and water or, if there is risk of freezing, anti-freeze and water, see below.

The coolant should be changed and the system flushed clean once a year. Check all the hoses and connections for leaks and rectify them at the same time. Change all loose, swollen or in any other way damaged hoses.

Anti-freeze

Anti-freeze prevents corrosion in the cooling system and freezing during the winter. We recommend **Volvo Penta anti-freeze*** (ethylene glycol, lime green), which contains the correct mixture of anti-corrosion agent. In order to reach full protection against corrosion, always use at least 40% anti-freeze. This means that a corresponding mixture of anti-freeze should be used when topping up.

NB!! Volvo Penta anti-freeze must not be mixed with other makes of anit-freeze.

*) Part. no 1141646-8, 5 litres.
Part. no 1141647-6, 210 litres.

Mixing ratios, anti-freeze/water

Parts anti-freeze in % of total coolant volume for frost protection down to approx.		
-28°C	-40°C	-56°C
40 %	48 %	60 %

The freezing point can be lowered to max –56°C (60% anti-freeze). If the amount of anti-freeze is increased further, the anti-freeze protection will deteriorate.

Mix the anti-freeze and water in a separate container before filling the coolant system.

NB! Anti-freeze is a health hazard (toxic).

Anti-corrosion additives

The easiest way to prevent corrosion is to use a suitable mixture of original Volvo Penta anti-freeze (glycol) all year round (at least 40 %). The mixture should be changed each autumn.

In cases where anti-freeze is not used, anti-corrosion agent must be added to the coolant. Use **Volvo anti-corrosion agent** (part no 1129709), which is available in containers of 1/2 litre, 3 containers (1.5 litres) as necessary.

Clean the cooling system thoroughly before filling. Run the engine warm directly after filling to obtain the best possible effect of the additive.

To maintain the anti-corrosive properties, another 1/2 litres anti-corrsosion agent should be added **every 400 engine hours**.

NB! Other types of anti-corrosion agent, glycol or anti-freeze **must never** be mixed with this anti-corrosion additive. Anti-corrosion agent **does not** prevent the formation of ice and should only be used when the temperature is always above 0°C.

Checking the coolant level

On engines with separate expansion tank (accessory), the level with a cold engine should be slightly above the centre of the tank (never below the MIN mark). On other engines, the level should be about 40–50 mm below the sealing edge of the filler cap. There must be room for the coolant to expand.

WARNING! Open the filler cap very carefully. Steam or hot fluid may spurt out.

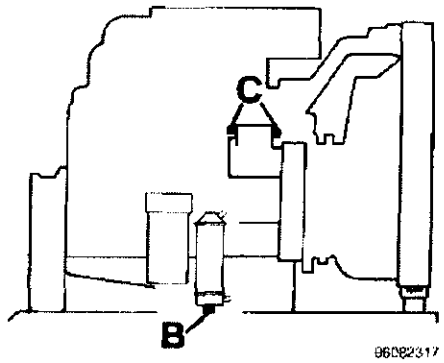
Insufficient coolant can lead to poor circulation, which will increase the risk of overheating and engien damage.

Draining coolant

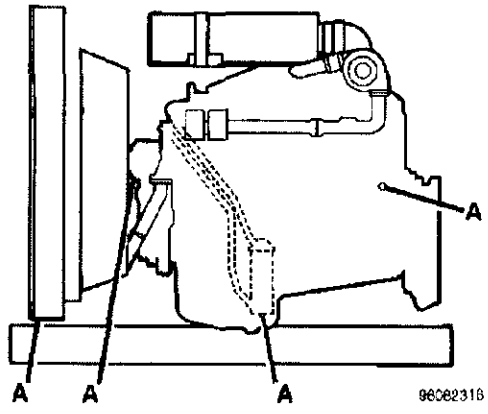
Before draining the coolant, stop the engine and unscrew the filler cap.

The drain cocks and plugs are shown in the illustration. Unscrew the coolant filter if fitted.

Make sure all the coolant runs out.



A = Drain cock/plug for coolant



B = Drain plug, 610 engine

C = Drain plug on compressor (extra equipment)

Filling coolant

Do not fill so fast that air is trapped in the system. Air must be allowed to escape through the filler hole.

Filling should be carried out with the engine stationary. The engine must not be started before the system has been ventilated and is completely full. If a heating system is connected to the engine cooling system, the heater control vavle should be fully open and the heating system ventilated while filling.

Flush the system clean before filling coolant. Check all hoses and connections and rectify any leaks. Close all drain cocks.

Refill with coolant to the correct level (see "Checking the coolant level"). Make sure the cooling system is correctly ventilated by **carefully opening the bleed cock** when the engine is started and reached working temperature. Any air pockets must be removed.

WARNING! Open the filler cap (ventilation cock) carefully when the engine is warm. Steam or hot coolant may spurt out.

Use the same mixture that is already in the cooling system when topping up.

On engines with separate expansion tank of plastic (extra equipment), large volumes can be filled directly through the filler opening on the radiator/engine expansion tank until the system is completely ventilated and full. Close the bleed cock, screw on the filler cap and finally fill the separate expansion tank to a level between MIN and MAX.

Coolant temperature too high

A high coolant temperature can be caused by:

- Low coolant level, air in system
- Reduced air flow through radiator, fouled radiator
- Poorly tensioned drive belt
- Blocked cooling system
- Faulty thermostat
- Faulty temperature sensor
- Incorrect setting of injection pump for injection timing.

Coolant temperature too low

A low coolant temperature can be caused by:

- Faulty thermostat
- Faulty temperature sensor

Check the temperature sensor

Remove the temperature probe. Connect the cables to the temperature gauge and lower the probe into warm water. Compare the temperature with the thermometer.

Coolant leaks

Coolant can leak in two ways:

- Leak while driving
- Leak after stopping a warm engine

Leaks while driving can be due to leaks in the cooling system or air/combustion gases entering into the cooling system and forcing out the coolant through the pressure valve.

Loss of coolant after stopping a warm engine is usually caused by a defective pressure valve (filler cap).

Checking the radiator

If the coolant temperature is higher than normal, the flow through the radiator should always be checked.

Make sure the external sections of the radiator are not blocked by insects or other objects that may limit the flow of air. If necessary, wash with a weak degreasing agent and water.

Straighten bent cells in the cooling system. Flush the radiator from the front. If severely fouled, the radiator must be removed completely and then cleaned with a weak cleaning agent.

Make also sure the fan casing has not come loose or is leaking in any other way.

Adjusting drive belts

Change belts that are fouled with oil, worn or damaged in any other way.

NB! Belts working in pairs should always be changed simultaneously.

Stretch the generator belts after loosening the alternator. The belts are correctly tensioned when they can be depressed approx. **10 mm** midway between the belt pulleys.

The engine has an automatic belt tensioner for the fan belts.

Cleaning the cooling system

The cooling system should be cleaned each time the coolant is changed.

It will usually suffice to flush the system with water but if there is severe rusting or sludge in the system, the following method of cleaning is recommended instead:

1
Drain and flush the system. Dissolve 1 kg (2.2 lbs) oxalic acid* in 5 litres (5.3 US qts) warm water and pour it into the cooling system. Fill with pure water.

WARNING! Protect hands and face. Oxalic acid is toxic and can cause skin damage.

2
Warm up the engine to normal working temperature **and then an additional 2 hours**.

NB! Any heater controls must be in position "hot".

3
Drain the system and **flush directly and thoroughly with pure water.** In this case, the thermostat housing (thermostat), upper and lower radiator hoses, drain cocks and plugs must be removed for fastest possible draining. Do not forget the engine heater or heater element if fitted. Continue to flush until the water running out is clean. All the oxalic acid must be removed or the remains will increase the risk of additional corrosion,

4
Dissolve 200 grams (70 ozs.) bicarbonate* (sodium hydrocarbonate) in 5 litres (5.3 US qts) warm water and pour it into the cooling system. Fill with pure water.

NB! Never use soda (sodium carbonate Na_2Co_3) as incorrect handling can cause severe corrosion damage.

5
Run the engine at normal working temperature for about **10-15 minutes**. This must be done thoroughly to neutralize the oxalic acid.

*)Not marketed by Volvo Penta. Available in chemical shops. The chemical formula for oxalic acid is: $C_2H_2O_4$.
The chemical formula for sodium hydrocarbonate is: Na HCO_3.

6
Flush clean the system thoroughly as described in point 3. The affect can be improved by mixing water with air, whereby the flushing, **without exception, must carried out from the bottom to the top of the cylinder block.**

NB! Remove the filler cap from the expansion tank/ radiator. If there is a separate expansion tank, it should also be flushed from the bottom and up with the filling cap removed for efficient cleaning. Flush the heater, if fitted, with the hoses removed so that all the residue is safely removed.

7
If any residue is remaining in the cooling system, repeat steps 1–6.

Make sure all the hoses are free from faults while cleaning. Change if necessary.

8
Fill the system with coolant recommended by Volvo Penta. See "Coolant".

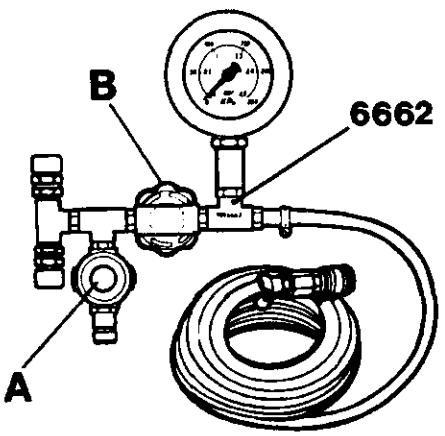
Pressure testing the cooling system

Special tools: 999 6662, together with compressed air and 999 6433. A pressure tester of standard type can also be used.

Checking pressure testing equipment 999 6662

Before using the equipment, it must be checked as follows:

A. Make sure the cock on the reducing valve (A) is unscrewed and connect the tester to the compressed air supply. Open cock (B) and set the reducing valve until a pressure of **100 kPa** (1 kp/cm² = 4.5 psi) is displayed on the pressure gauge.



NB! The reducing valve knob is locked by moving the locking ring axially.

NB! Always observe current safety regulations.

B. Close the cock (B). The pressure must not drop for 2 minutes if the pressure tester is to be considered reliable.

Pressure test

1
Remove the filler cap and fit cover 999 6433 on the radiator instead. Plug the connection to the separate plastic expansion tank, if fitted, during the pressure test.

2
Make sure the knob on the reducing valve (A) is unscrewed and connect the hose from the testing device to the cover 999 6433.

3
Seal the drain line from the filler pipe.

4
Connect test device 999 6662 to the compressed air supply and open cock (B).

5
Pull out the locking ring on the reduction valve knob. Increase the pressure by screwing in the knob until the pressure gauge shows **70 kPa** (0.7 kp/cm² = 10 psi). Lock the knob by pressing in the locking ring and close cock (B).

6
Check for one minute that the pressure does not drop. If it is difficult to localize the leak, drain off the coolant, put the system under pressure again and apply soap solution to the hose connections, drain cocks, etc., until the leak is detected.

NB! Make sure the pressure does not exceed **70 kPa** (0.7 kp/cm² = 10 psi). A higher pressure can damage the coolant seals, for example.

NB! Always observe current safety regulations.

7
Remove the test device.

Checking the pressure valve

The pressure valve is in the filler cap. It can be tested using the same testing device as was used for test pressurizing the cooling system. See previous section.

1
Drain off some of the coolant and connect the test device with a nipple to a plugged hole in the cooling system.

2
Extend the drain hose from the filler pipe with a hose to a receptacle containing water.

3
Apply pressure, see "Pressure testing the cooling system" in the previous section, and read off the pressure gauge when the valve opens (water bubbles in the receptacle with the drain line/filler cap).

See "Workshop Manual, Technical Data" for valve opening pressure.

4
Remove the test device. Put back the plug and fill the engien with coolant.

Electrical system

The engine is equipped with a bi-polar electrical system with alternator. System voltage is 24 volt.

IMPORTANT

The following applies to engines with alternator:

1. **Never break the circuit between the alternator and battery while the engine is running. The main switch must therefore not be turned off before the engine has stopped.** Cables must not be disconnected while the engine is running as this may also damage the voltage regulator.
2. Batteries, battery cables and cable terminals must be checked regularly. Battery terminals must be clean and cable shoes must be securely tightened and well greased to prevent breaks in the power supply. All cables must be well tightened with no loose connections.

NB! Take care not to switch the positive and negative battery terminals when connecting the batteries. Refer to the wiring diagram. Check drive belt tension regularly.

3. When starting using auxiliary batteries, see **"Start using auxiliary battery"**.
4. Both battery cables must be disconnected before carrying out any repairs on the alternator. The same applies when rapid-charging the batteries.

NB! Observe current safety regulations when charging batteries.

5. Never use a screwdriver or similar tool to check a connection.

Arc welding

The following preparation must always be carried out whenever arc welding is performed on the engine or installed components:

Remove the 2 battery connections and then all the alternator leads from the alternator. Always connect the weld clamp to the component being welded and as close to the welding point as possible. Never attach the welding clamp to the engine or in any way that would entail welding current passing through a bearing. After completed welding: Fit the alternator leads **before** connecting the battery cables.

Start using auxiliary battery

WARNING! Batteries (especially auxiliary batteries) contain a mixture of hydrogen gas that is extremely explosive. One spark, which can result from incorrect connection of the cables, is sufficient to make a battery explode and cause personal injury and mechanical damage.

If the batteries have frozen, they must be thawed out before trying to start with an auxiliary battery.

1. Make sure the auxiliary batteries are connected (in series or parallel) so that the rated voltage corresponds with the system voltage of the engine.
2. Connect one end of the red cable to the positive terminal of the auxiliary battery (marked P or + in red) Make sure all the cable shoes are well tightened to avoid sparks.
3. Connect the other end of the red cable to the positive terminal of the battery where the positive cable to the engine is connected.
4. Connect the end of the black cable to the negative terminal of the auxiliary battery (marked N or – in blue).
5. Connect the other end of the black cable to a point a distance away from the flat batteries, e.g. by the main switch, or the negative cable or the negative cable connection on the engine.
6. Start the engine.

NB! Do not touch the connections while starting (risk for sparks) and do not lean over any of the batteries.

7. Remove the cables in the exact reverse order to connecting.

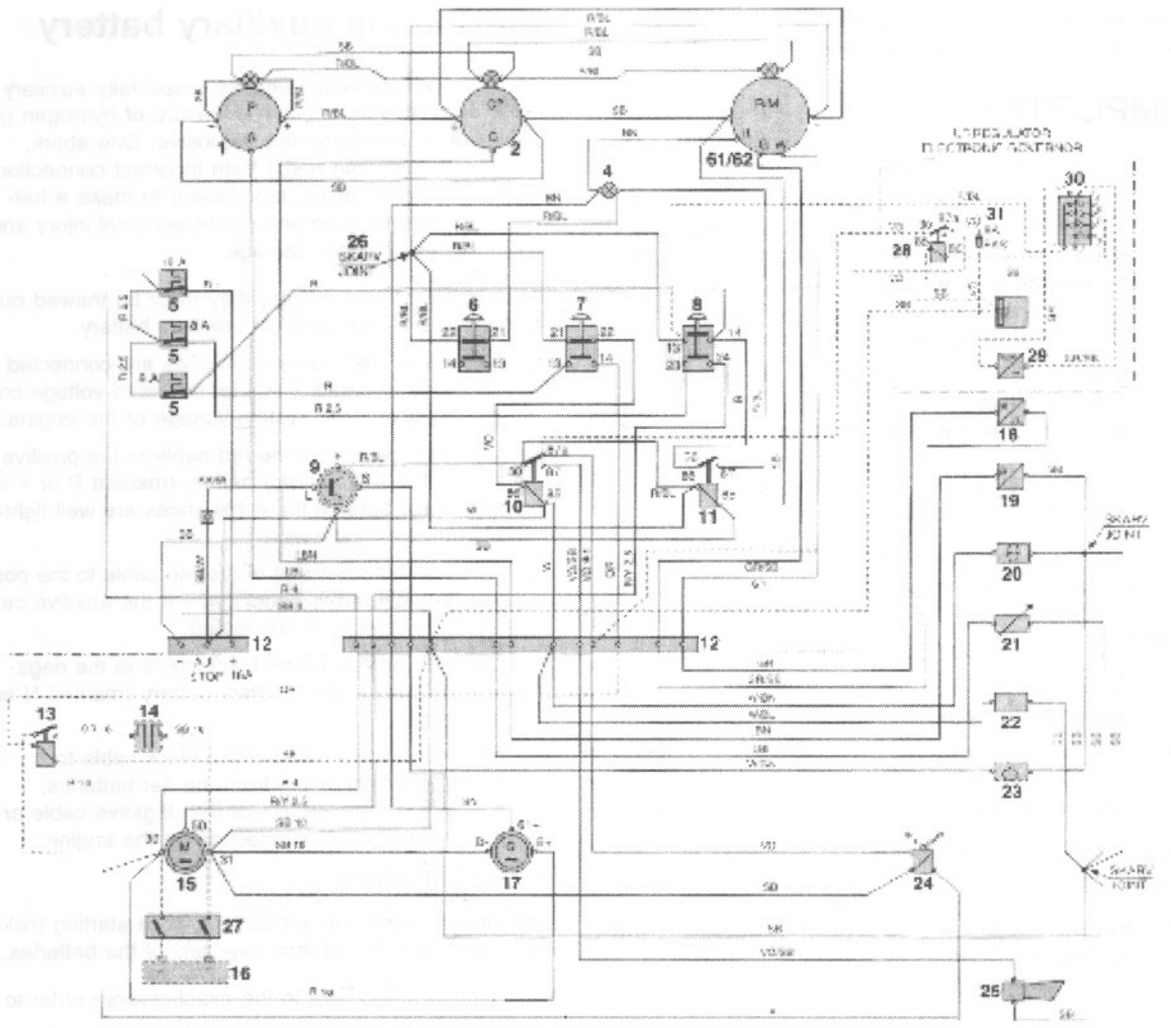
NB! The ordinary cables to the standard batteries must never be disconnected.

EDC system

TWD740VE is equipped with EDC (Electronic Diesel Control). A system that electronically governs the engine injection pump. More information on EDC can be found in "Workshop Manual, Fuel system EDC, TWD740VE, TWD1231VE".

Wiringdiagram

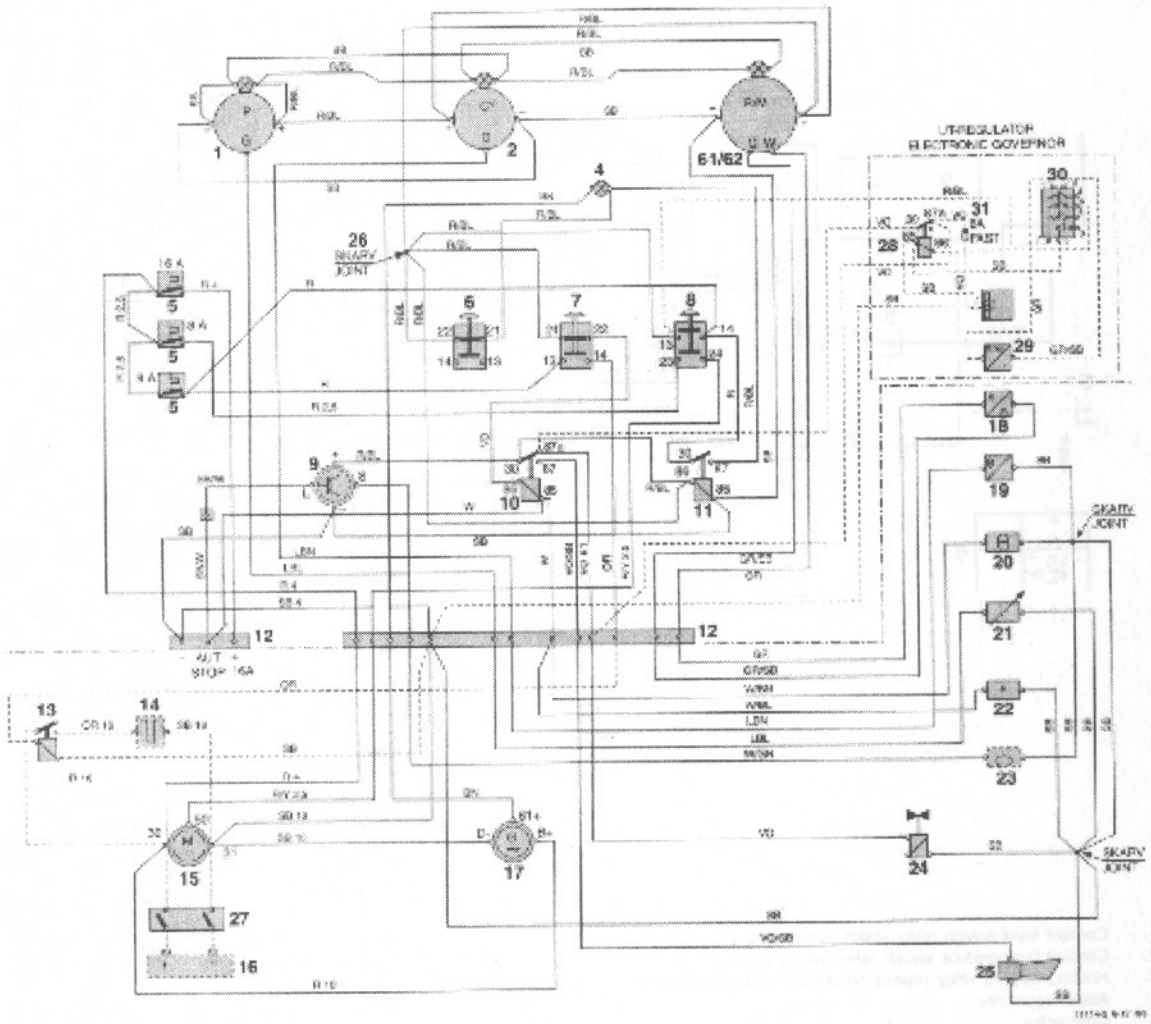
1. Instrument panel and engine (equipped with stop solenoid)



1. Oil pressure gauge
2. Coolant temperature gauge
3. Tachometer with integrated hour counter
4. Warning light, charging
5. Semi-automatic fuses (manual reset)
6. Stop button
7. Interlock button
8. Start button
9. Coolant level switch relay (extra equipment)
10. Coolant temperature switch relay, oil pressure switch
11. Holding current relay (operating current and instrument)
12. Terminal block (extra power socket, fused for 16 A, socket for automatic stop, making for fault.)
13. Relay for starting heater
14. Starting heater
15. Starter motor
16. Batteries
17. Alternator
18. Engine speed sensor
19. Engine coolant temperature sensor
20. Coolant temperature switch (normal open)
21. Oil pressure sensor
22. Oil pressure switch
23. Coolant level switch (extra equipment)
24. Stop solenoid (Basic circuit diagram 1)/Fuel cut-off valve (basic circuit diagram 2) (live during operation)
25. Horn
26. Joint
27. Main switch
28. Relay
29. Engine speed sensor, overrevving protection
30. Overrevving protection
31. Fuse, 8 A

* Disengaged when installing GAC regulator

2. Instrument panel and engine (equipped with fuel cut-off valve)



Cable areas in mm² (specified after the colour code in the wiring diagram). If an area is not specified, 1.5 mm² will apply.

Colour:	BL	=	Blue	LBN	=	Light brown
	OR	=	Orange	SB	=	Black
	LBL	=	Light blue	GN	=	Green
	VO	=	Violet	W	=	White
	BN	=	Brown	GR	=	Grey
	R	=	Red	Y	=	Yellow

The area of the battery cables depends on the location of the battery.

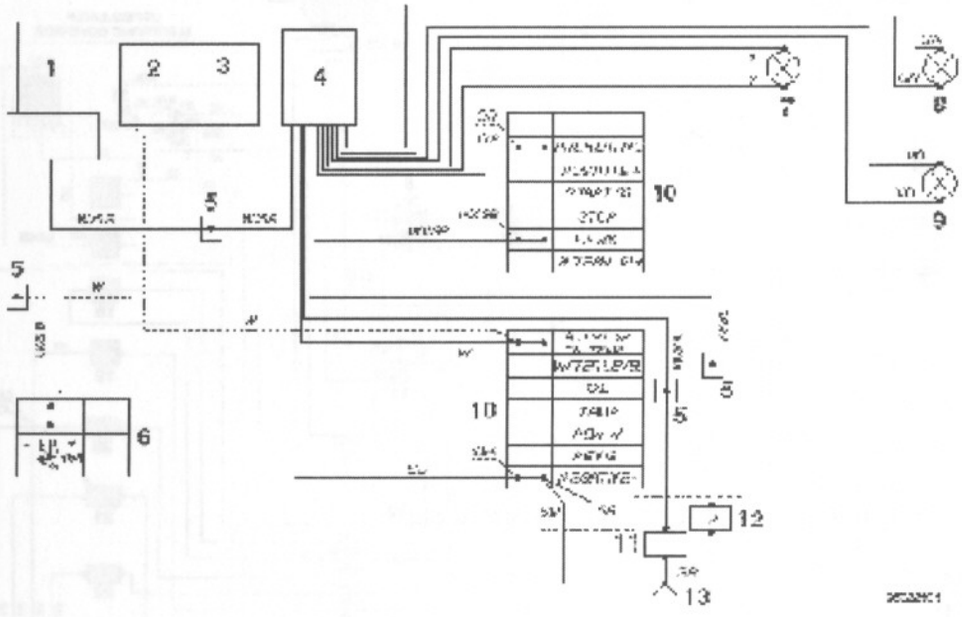
Distance starter motor - batteries: max. 2 m, area = 70 mm²

max. 4 m, area = 120 mm²

Relationship mm²/AWG (American Wiring Gauge)

mm²	1.0	1.5	2.5	10	16
AWG	16 (17)	15 (16)	13	7	5

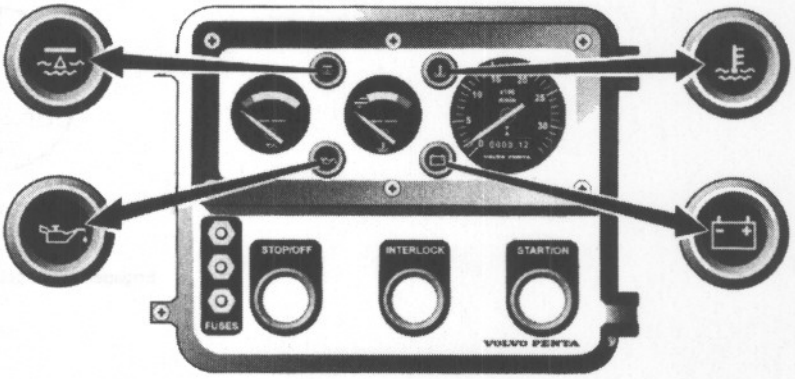
3. Connection of alarm separator (extra equipment) to instrument panel.

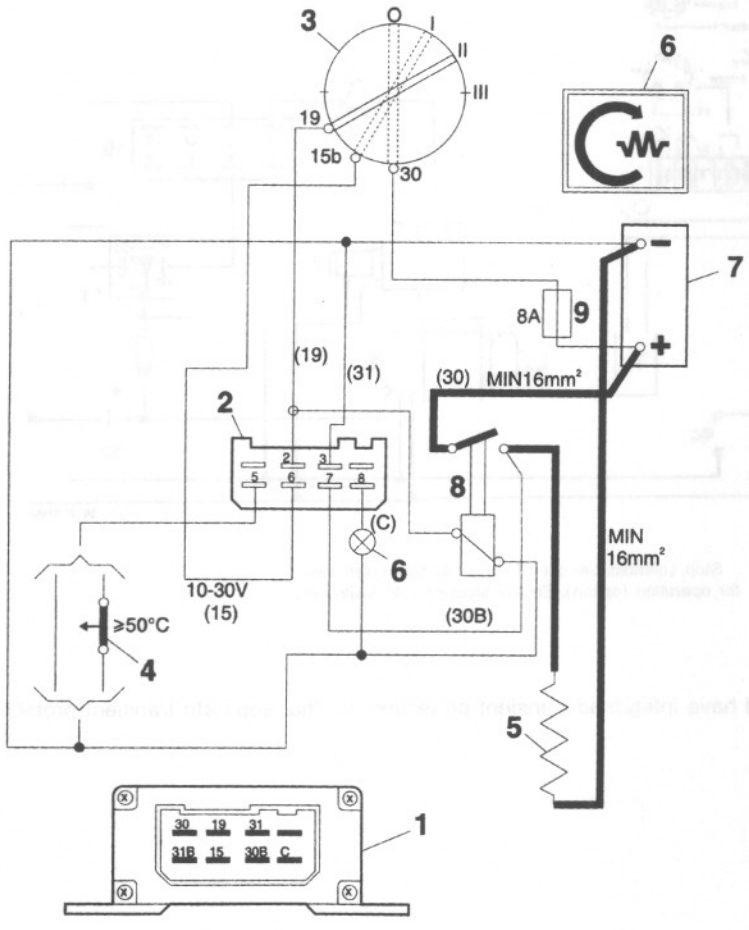


1. Coolant level switch relay (extra equipment)
2. Coolant temperature switch relay, oil pressure switch
3. Holding current relay (operating current and instrument)
4. Alarm separator
5. Connector
6. Terminal block (extra power socket, fused for 16 A. Socket for automatic stop, making for fault).
7. Warning light, high coolant temperature (extra equipment)
8. Warning light, low coolant level (extra equipment.)
9. Warning light, low lubricant pressure (extra equipment.)
10. Terminal block for engine cables
11. Coolant temperature switch (normal open)
12. Oil pressure switch (normal open)
13. Joint

Dashed line is existing cable

4. Connection of time relay (extra equipment.) for connecting time relay kit

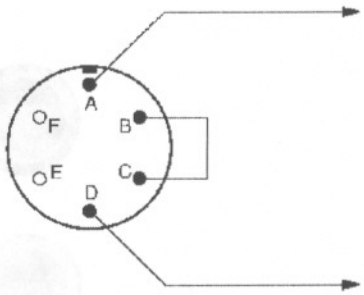




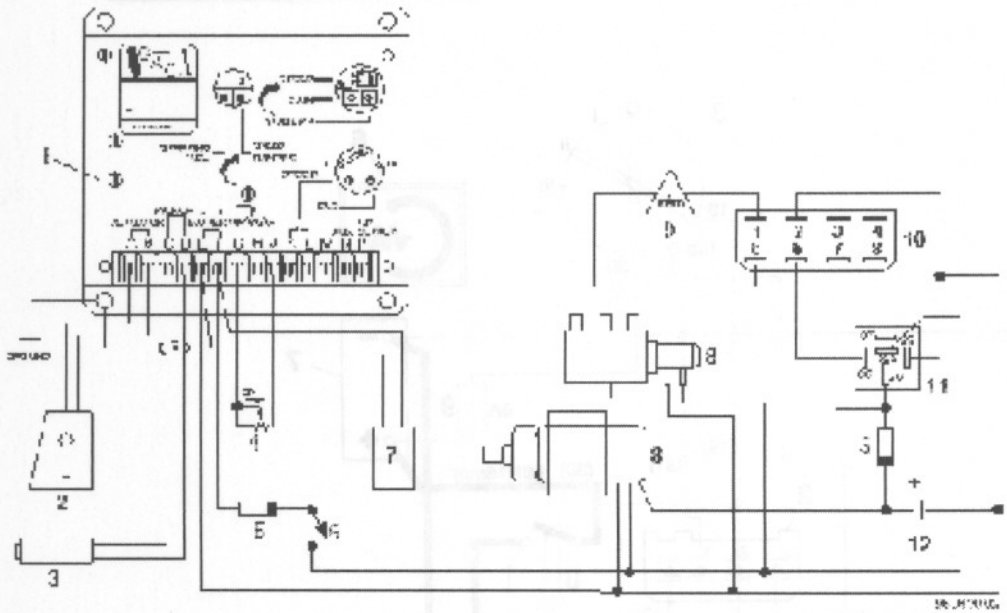
1. Time relay
2. Connector, 8-pin.
3. Key switch
4. Temperature switch (extra equipment)
5. Starting heater
6. Indicator lamp
7. Battery
8. High power relay for starting heater
9. Fuse (8 A)

Electronic speed regulator

Engagement



Engagement actuator for 24 V system



Stop solenoid/fuel cut-off valve (8) connected live for operation (option). Engine stopped with switch (6).

NB! Later versions of stop solenoid have integrated transient protection, so that separate transient protection (7) is only required for the control unit.

1. Control unit
2. Actuator
3. Engine speed sensor (pickup)
4. Multi-turn potentiometer*
5. Fuse (quick-acting) 8 A
6. Main switch
7. Transient protection
8. Stop solenoid/fuel cut-off valve
9. Engine speed sensor for overrevving protection
10. Overrevving protection (speed switch)
11. Relay

* Not from Volvo Penta

Troubleshooting

1. Engine will not start

Starter motor not turning round engine

CAUSE	ACTION
• Discharged batteries	Charge batteries/change batteries (or connect auxiliary batteries as directed in "Start using auxiliary battery").
• Main switch turned off	Turn on main switch.
• One of the semi-automatic fuses in the terminal box triggered (pos. 6 on engine wiring diagram)	Reset fuse by pressing button on fuse.
• Bad contact/break in connections and electric leads	Rectify any breaks/loose connections. Check that connections have not oxidized. Clean when necessary and spray connections with moisture repelling spray. See "Wiring diagram".
• Faulty starting switch/start button	Change starting switch/start button.
• Faulty starter relay	Change starter relay.
• Faulty starter motor/solenoid (actuator solenoid)	Check starter motor/solenoid.
• Water in compression chamber	Do not attempt further starting if water is suspected. Check engine.

Starter motor rotates slowly

CAUSE	ACTION
• Discharged batteries	Charge batteries/change batteries (or connect auxiliary batteries as directed in "Start using auxiliary battery").
• Bad contact/break in connections and electric leads	Rectify any breaks/loose connections. Make sure that connections have not oxidized. Clean when necessary and spray connections with moisture repelling spray. See "Wiring diagram".

Starter motor cranking normally but engine will not start

CAUSE	ACTION
• Air in fuel system	Bleed fuel system, see "Fuel system, bleeding".
• Lack of fuel	
– fuel cocks closed	Open fuel cocks.
– fuel tank empty	Refuel.
– blocked fuel filter (due to impurities/or due to paraffin precipitation in fuel at low outside temperature)	Fit new fuel filter (pre-filter and/or fine filter). Bleed system, see "Fuel system, bleeding".
• Stop solenoid wrongly connected/sticking	Make sure stop solenoid is in active position.
• Insufficient pre-heating	
– incorrect starting procedure	Try starting again as described in instruction manual.
– starting heater not engaged	Make sure none of the semi-automatic fuses have triggered (pos. 6 on engine wiring diagram). Reset fuse by pressing button on fuse.
	Check electric wiring and interlock button, starter relay and high-power relay. Change starting heater if necessary.
• Blocked air intake	Check air intake to engine compartment .

2. Engine starts then stops again/runs unevenly

CAUSE	ACTION
• Air in fuel system	Bleed fuel system, see "Fuel system, bleeding".
• Lack of fuel	
– fuel cocks closed	Open fuel cocks.
– fuel tank empty	Refuel .
– blocked fuel filter (due to impurities/or due to paraffin precipitation in fuel at low outside temperature)	Fit new fuel filter (pre-filter and/or fine filter). Bleed system, see "Fuel system, bleeding".
• Stop solenoid/fuel cut-off valve engaged/ sticking	Make sure that stop solenoid/fuel cut-off valve in operating position.
• Insufficient pre-heating	
– incorrect starting procedure	Try starting again as described in instruction manual.
– starting heater not engaged	Make sure none of the semi-automatic fuses have triggered (pos. 6 on engine wiring diagram). Reset fuse by pressing button on fuse.
	Check electric wiring and interlock button, starter relay and high-power relay. Change starting heater if necessary

• Insufficient air supply to engine	
– blocked air filter	Fit new air filter/clean air filter, check ventilation to engine compartment.
• Faulty injector	Check/change injector.

3. Coolant temperature too high

CAUSE	ACTION
• Coolant level in engine too low (air in system)	Top up coolant in engine and bleed system, see "Filling with coolant".
• Faulty thermostat	Fit new thermostat.
• Blocked radiator and/or intercooler (TAD)	Clean, see "Cleaning cooling system".
• Faulty circulation pump	Recondition/change circulation pump.
• Faulty temperature gauge/temperature sensor	Check/change temperature gauge/temperature sensor.
• Faulty injection timing	Check/adjust injection timing.

4. Coolant temperature too low

CAUSE	ACTION
• Faulty thermostat	Fit new thermostat.

5. Engine does not attain correct operating speed at wide open throttle

CAUSE	ACTION
• Engine overloaded	Reduce load if possible.
• Insufficient fuel supply	
– blocked fuel filter (due to impurities/or due to paraffin precipitation in fuel at low outside temperature)	Fit new fuel filter (pre-filter and/or fine filter). Bleed system, see "Fuel system, bleeding".
• Water in fuel	Clean fuel tank. Drain water from pre-filter.
• Insufficient air supply to engine	
– blocked air filter	Fit new air filter/clean air filter.
– air leak between turbo and engine intake manifold	Check rubber hose between turbo and connect intake manifold, and other connections. Tighten hose clips.
– faulty turbocharger	Clean compressor. Recondition as necessary turbocharger.
– poor engine compartment ventilation	Make sure ventilation passages to engine compart ment are not blocked.
• Accelerator control adjusted wrongly	Adjust accelerator control.
• High back pressure in exhaust system	Make sure there are no restrictions in exhaust line.

• Incorrect adjustment of injector pump	Adjust injector pump.
• Faulty smoke limiter	
– smoke limiter sticking	Recondition smoke limiter.
– pressure line between intake manifold and smoke limiter leaking	Fit new pressure line.
– faulty diaphragm in smoke limiter	Change diaphragm in smoke limiter.
– incorrect setting	Adjust smoke limiter setting.
Stop control position	Make sure stop control is in full operating position.

6. Engine does not stop

CAUSE	ACTION
• One of the semi-automatic fuses in the terminal box triggered (pos. 6 on engine wiring diagram)	Reset fuse by pressing button on fuse.
• Bad contact/break in connections and leads	Rectify any breaks/loose connections. Make sure that connections have not oxidized. Clean when necessary and spray connections with moisture repelling spray. See "Wiring diagram".
• Faulty stop button	Change stop button.
• Faulty stop solenoid/fuel cut-off valve	Check, change stop solenoid/fuel cut-off valve.

Notes

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