Workshop manual

TAD1630G/GE/P/V, TAD1631G/GE, TID162AP, TWD1620G/GH, TWD1630G/GE/P/V, TD164KAE

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Contents

Safety Precautions

Introduction

This Workshop manual contains descriptions and instructions for the repair of the Volvo Penta products or product types. Check that you have the correct Workshop manual for your engine.

Before starting work on the engine, read these safety precautions with care as well as ”General information” and ”Service procedures”.

Important

In this book and on the product you will find the following special warning symbols.

WARNING! Possible danger of personal injury, extensive damage to property or serious mechanical malfunction if the instructions are not followed.

IMPORTANT! Used to draw your attention to something that can cause damage or malfunctions on a product or damage to property.

Note: Used to draw your attention to important information that will facilitate the work or operation in progress.

Below is a summary of the risks involved and safety precautions you should always observe or carry out when operating or servicing the engine.

Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) turned off before starting work. Set up a warning notice at the engine control point.

As a general rule all service operations must be carried out with the engine stopped. However, some work, for example certain adjustments require that the engine is running when they are carried out. Approaching an engine which is operating is a safety risk. Loose clothing or long hair can fasten in rotating parts and cause serious personal injury.

If working in proximity of an engine which is operating, careless movements or a dropped tool can result in personal injury. Take care to avoid contact with hot surfaces (exhaust pipes, Turbocharger (TC), air intake pipe, starter heater etc.) and hot liquids in lines and hoses on an engine which is running or which has just been stopped. Reinstall all protective parts removed during service operations before starting the engine.

Check that the warning or information labels on the product are always clearly visible. Replace labels which have been damaged or painted over.

Never start the engine without installing the air cleaner (ACL) filter. The rotating compressor in the Turbo can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.

Never use start spray products or similar when starting the engine. They may cause an explosion in the inlet manifold. Danger of personal injury.

Avoid opening the coolant filler cap when the engine is hot. Steam or hot coolant can spray out and the system pressure will be lost. When needed, open the filler cap slowly and release the pressure in the system. Be very careful if a cock or plug or engine coolant line must be removed when the engine is hot. It is difficult to anticipate in which direction steam or hot coolant can spray out.

Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil filler cap removed, otherwise oil could be ejected.

Stop the engine before carrying out operations on the engine cooling system.

Only start the engine in a well-ventilated area. If operating the engine in an enclosed area en- sure that there is exhaust ventilation leading out of the engine compartment or workshop area.

Always use protective glasses or goggles when carrying out work where there is a risk of splinters, grinding sparks, acid splashes or where other chemicals are used. The eyes are extremely sensitive, an injury could result in blindness!

Avoid getting oil on the skin! Repeated exposure to oil or exposure over a long period can result in the skin becoming dry. Irritation, dryness and eczema and other skin problems can then occur. Used oil is more dangerous than fresh oil from a health aspect. Use protective gloves and avoid oil soaked clothes and shop rags. Wash regularly, especially before eating. There are special skin creams which counteract drying out of the skin and make it easier to clean off dirt after work is completed.

Many chemicals used on the product (for example engine and transmission oils, glycol, gasoline and diesel oil), or chemicals used in the workshop (for example degreasing agents, paint and solvents) are dangerous to health. Read the instructions on the product packaging with care! Always follow the safety precautions for the product (for example use of protective mask, glasses, gloves etc.). Make sure that other personnel are not exposed to hazardous chemicals, for example in the air. Ensure good ventilation in the work place. Follow the instructions provided when disposing of used or leftover chemicals.

Exercise extreme care when leak detecting on the fuel system and testing the fuel injector nozzles. Use eye protection. The jet from a fuel injector nozzle is under extremely high pressure and has great penetrative energy, so the fuel can penetrate deep into the body tissue and cause serious personal injury. Danger of blood poisoning.

WARNING! The delivery pipes must under no circumstances be bent. Damaged pipes should be replaced.

All fuels and many chemical substances are flammable. Do not allow naked flame or sparks in the vicinity. Fuel, certain thinner products and hydrogen from batteries can be extremely flammable and explosive when mixed with air. Smoking is not to be permitted in the vicinity! Ensure that the work area is well ventilated and take the necessary safety precautions before starting welding or grinding work. Always ensure that there are fire extinguishers at hand when work is being carried out.

Ensure that rags soaked in oil or fuel and used fuel or oil filters are stored safely. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally dangerous waste and must be deposited at an approved site for destruction together with used lubricating oil, contaminated fuel, paint remnants, solvent, degreasing agents and waste from washing parts.

Never expose a battery to naked flame or electrical sparks. Never smoke in proximity to the batteries. The batteries give off hydrogen gas during charging which when mixed with air can form an explosive gas - oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause a single spark which is sufficient to cause an explosion with resulting damage. Do not shift the connections when attempting to start the engine (spark risk) and do not lean over any of the batteries.

Always ensure that the Plus (positive) and Minus (negative) battery cables are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to the electrical equipment. Refer to the wiring diagrams.

Always use protective goggles when charging and handling the batteries. Battery electrolyte contains sulfuric acid which is highly corrosive. Should the battery electrolyte come into contact with unprotected skin wash off immediately using plenty of water and soap. If battery acid comes in contact with the eyes, immediately flush with plenty of water and obtain medical assistance at once.

Turn the engine off and turn off the power at the main switch(es) before carrying out work on the electrical system.

Clutch adjustments must be carried out with the engine stopped.

Use the lifting eyes fitted on the engine when lifting the drive unit. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including gearbox, if fitted, and any extra equipment installed). Use an adjustable lifting beam or lifting beam specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine.

If extra equipment is installed on the engine which alters its center of gravity a special lifting device is required to obtain the correct balance for safe handling. Never carry out work on an engine suspended on a hoist.

Never work alone when removing heavy engine components, even when using lifting devices such as locking tackle lifts. When using a lifting device two people are usually required to do the work, one to take care of the lifting device and another to ensure that components are lifted clear and not damaged during the lifting operations. Always check before starting work if there is enough room to carry out removal work without risking personal injury or damage to the engine or parts.

WARNING! The components in the electrical system and in the fuel system on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

Always use the fuels recommended by Volvo Penta. Refer to the Instruction Book. Use of fuels that are of a lower quality can damage the engine. On a diesel engine poor quality fuel can cause the control rod to seize and the engine to overrev with resulting risk of damage to the engine and personal injury. Poor fuel quality can also lead to higher maintenance costs.

Observe the following rules when cleaning with high-pressure water jets: Never direct the water jet at seals, rubber hoses, electrical components or the radiator.

General information

About this Workshop manual

This Workshop manual contains descriptions and instructions for the repair of engines in standard format.

The Engine Designation and Engine Numbers can be found on the product plate (see page 10). Please always include both the engine designation and the engine number in all correspondence.

The Workshop manual is produced primarily for the use of Volvo Penta workshops and service technicians. For this reason the manual presupposes a certain basic knowledge and that the user can carry out the mechanical/electrical work described to a general standard of engineering competence.

Volvo Penta products are under a continual process of development and we therefore reserve all rights regarding changes and modifications. All the information in this manual is based on product specifications available at the time the book was published. Any essential changes or modifications of the product or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

Spare parts

Spare parts for the electrical and fuel systems are subject to various national safety requirements. Volvo Penta Original Spare Parts meet these specifications. Any type of damage which is the result of using spare parts that are not original Volvo Penta parts for the product in question will not be covered under any warranty or guarantee provided by AB Volvo Penta.

Certified engines

When performing service and repairs on an emissions certified engine that is used in an environment where exhaust emissions are governed by law, it is important to be aware of the following:

Certification means that an engine type is controlled and approved by the appropriate authority. The engine manufacturer warrants that all engines of the same type that are being made, are equivalent to the certified engine.

The following special requirements regarding service and repairs apply:

- Service and maintenance intervals recommended by Volvo Penta must be followed.
- Only Volvo Penta Original Spare Parts may be used.
- Service work on the injection pump, pump settings, and injectors must always be carried out by an authorized Volvo Penta workshop.
- The engine must not be altered or modified in any way, except for accessories and service kits approved by Volvo Penta for that engine.
- No modifications to the exhaust pipes and engine air intake pipes are allowed.
- Any seals on the engine may not be broken by unauthorized persons.

For other matters, the general instructions in the Instruction Book apply.

⚠ **IMPORTANT!** Neglected or substandard operation or service, as well as use of replacement parts other than AB Volvo Penta Original Parts will result in AB Volvo Penta being unable to assume any liability that the engine corresponds to the certificated engine variant.

AB Volvo Penta excludes any liability for all and any type of damage or costs caused by the use of replacement parts that are not Volvo Penta Original Parts for the product in question.

Repair instructions

The working methods described in the Workshop manual apply to work carried out in a workshop. The engine has been removed and is installed in an engine fixture. Unless otherwise stated reconditioning work which can be carried out with the engine in place follows the same working method.

Warning symbols used in this Workshop manual (for full explanation of the symbols refer to the section ”Safety Precautions”)

WARNING!

IMPORTANT!

Note:

are not in any way comprehensive since it is impossible to predict every circumstance under which service work or repairs may be carried out. AB Volvo Penta can only indicate the risks considered likely to occur as a result of incorrect working methods in a well equipped workshop using working methods and tools tested by AB Volvo Penta.

All operations described in the Workshop manual for which there are Volvo Penta Special Tools available assume that these tools are used when carrying out the repair. Volvo Penta Special Tools have been specifically developed to ensure as safe and rational working methods as possible. It is therefore the responsibility of anyone using other tools or other working methods than we recommend to determine that there is no risk of personal injury or mechanical damage or malfunction as a result.

In some cases special safety precautions and user instructions may be required in order to use the tools and chemicals mentioned in the Workshop manual. Always follow these precautions. There are no specific instructions given in the Workshop manual.

By following these basic recommendations and using common sense it is possible to avoid most of the risks involved in the work. A clean work place and a clean engine will eliminate many risks of personal injury and engine malfunction.

Especially when working on the fuel system, engine lubrication system, air intake system, turbocharger unit, bearing seals and seals, it is extremely important to avoid dirt or foreign objects entering the parts or systems, since this can result in reduced service life or malfunctions.

Our common responsibility

Every engine consists of many systems and components that work together. If one component deviates from the technical specifications this can have dramatic consequences on the environmental impact of the engine even if it is otherwise in good running order. It is therefore critical that the stated wear tolerances are observed, that systems which can be adjusted are correctly set up and that only Volvo Penta Original Parts are used on the engine. The stated service intervals in the Maintenance Schedule must be followed.

Some systems, such as the components in the fuel system, require special expertise and special testing equipment for service and maintenance. Some components are factory sealed for environmental and product specific reasons. Under no circumstances attempt to service or repair a sealed component unless the service technician carrying out the work is authorized to do so.

Bear in mind that most chemical products, incorrectly used, are hazardous to the environment. Volvo Penta recommends the use of bio-degradable degreasing agents for all cleaning of engine components unless otherwise stated in the Workshop manual. Pay special attention to make sure that oils and washing residue etc are handled correctly for destruction, and do not unintentionally end up in nature.

Torque

Correct torque for critical joints which must be tightened using a torque wrench are listed under ”Technical Data - torque” and stated in the method descriptions in the Workshop manual. All torque data apply to cleaned threads, bolt heads and mating surfaces. Torque data stated apply to lightly oiled or dry threads. Where grease, locking or sealing agents are required for screwed joints this is stated in both the operation description and in ”torque”. Where no torque is stated for a joint use the general torque shown in the table below. The torques stated are a guide and the joint does not have to be tightened using a torque wrench.

Dimension	Torque Nm
M5	6
M6	10
M8	25
M10	50
M12	80
M14	140

Torquing with Protractor tightening (angle tightening)

When torquing with protractor (angle tightening), the fastener is tightened to a predetermined torque and then turned a predetermined angle. Example: a 90° protractor tightening means that the joint is tightened a further 1/4 turn in one operation after the stated torque has been applied.

Lock nuts

Do not re-use lock nuts that have been removed during disassembly operations as these have reduced service life when re-used. For lock nuts with a plastic insert such as Nylock® the torque stated in the table is reduced if the Nylock® nut has the same head height as a standard hexagonal nut without plastic insert. Reduce the torque by 25% for bolt size 8 mm or larger. Where Nylock® nuts are higher, where the metallic thread is of the same height as a standard hexagonal nut, the torques given in the table apply.

Strength classes

Bolts and nuts are divided up into different classes of strength; the class is indicated by the number on the bolt head. A higher number indicates stronger material. For example, a bolt marked 10-9 indicates a higher strength than one marked 8-8. It is therefore important that bolts removed during the disassembly of a bolted joint must be reinstalled in their original position when assembling the joint. If a bolt must be replaced check in the spare parts catalogue to make sure the correct bolt is used.

Sealant

A number of sealants and locking liquids are used on the engines. The agents have varying properties and are used for different types of jointing strengths, operating temperature ranges, resistance to oil and other chemicals and for the different materials and gap sizes in the engines.

To ensure service work is correctly carried out it is important that the correct sealant and locking fluid type is used on the joint where the agents are required.

In this Volvo Penta Workshop manual the user will find that each section where these agents are applied in production states which type was used on the engine.

During service operations use the same agent or an alternative from a different manufacturer.

Make sure that mating surfaces are dry and free from oil, grease, paint and anti-corrosion agent before applying sealant or locking fluid.

Always follow the manufacturer's instructions for use regarding temperature range, curing time and any other instructions for the product.

Two different basic types of agent are used on the engine and these are:

1. RTV agent (Room temperature vulcanizing).
Used for gaskets, sealing gasket joints or coating gaskets. RTV is visible when a part has been disassembled; old RTV must be removed before resealing the joint.

The following RTV agents are mentioned in the Workshop manual: Loctite® 574, Permatex® No. 3, Permatex® No 77. Old sealant can be removed using denatured alcohol in all cases.

2. Anaerobic agents. These agents cure in an absence of air. They are used when two solid parts, for example cast components, are installed face-to-face without a gasket. They are also commonly used to secure plugs, threads in stud bolts, cocks, oil pressure switches etc. The cured material is glass-like and it is therefore colored to make it visible. Cured anaerobic agents are extremely resistant to solvents and the old agent cannot be removed. When reinstalling the part, degrease it carefully and then apply new sealant.

The following anaerobic agents are mentioned in the Workshop manual: Loctite® 572 (white), Loctite® 241 (blue).

Note: Loctite® is a registered trademark of Loctite Corporation, Permatex® is a registered trademark of the Permatex Corporation.

Safety rules for fluorocarbon rubber

Fluorocarbon rubber is a common material in seal rings for shafts, and in O-rings, for example.

When fluorocarbon rubber is subjected to high temperatures (above 300°C/572°F), **hydrofluoric acid** can be formed, which is highly corrosive. Skin contact can give severe chemical burns. Splashes in your eyes can give severe chemical burns. If you breathe in the fumes, your lungs can be permanently damaged.

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

- Always use gloves made of chloroprene rubber (gloves for handling chemicals) and protective goggles.
- Handle the removed seal in the same way as corrosive acid. All residue, including ash, can be highly corrosive. Never use compressed air to blow anything clean.
- Put the remains in a plastic jar which is sealed and provided with a warning label. Wash the gloves under running water before removing them.

The following seals are probably made from fluorocarbon rubber:

Seal rings for the crankshaft, camshaft, intermediate shafts.

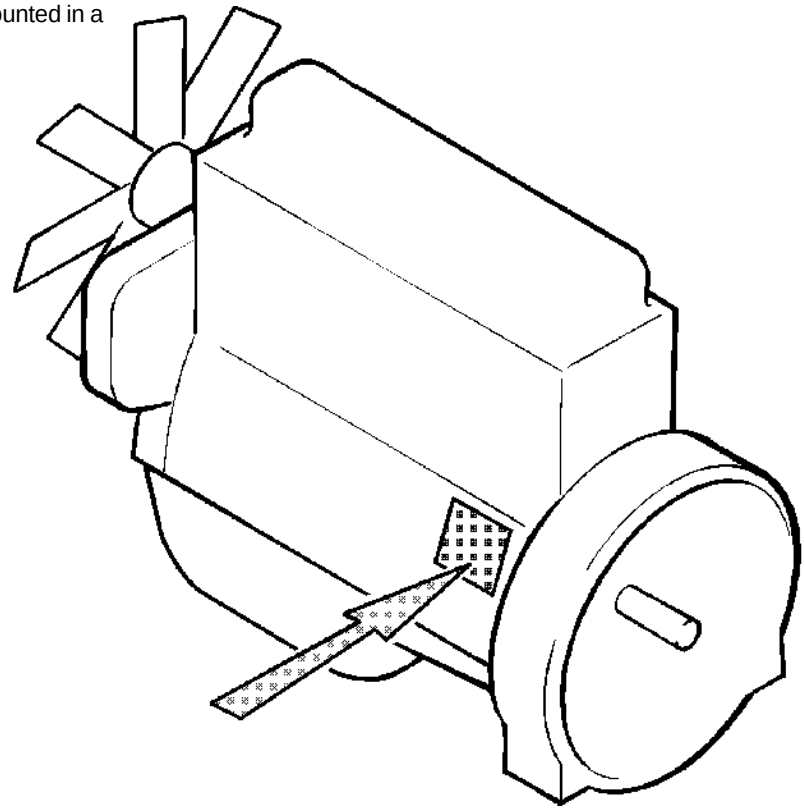
O-rings irrespective of where they are installed. O- rings for cylinder liner sealing are almost always made from fluorocarbon rubber.

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

Location of identification plates

Each engine is supplied with two identical identification plates, of which one is mounted on the cylinder block, see figure.

The other identification plate should be mounted in a suitable location adjacent to the engine.



1. Engine model
2. Spec. no.
3. Serial no.
4. Rated net power (without fan)
5. Rated net power (with fan)
6. Max. rpm
7. Prelift/Inj. timing T–Turbo charged

Key to engine model:

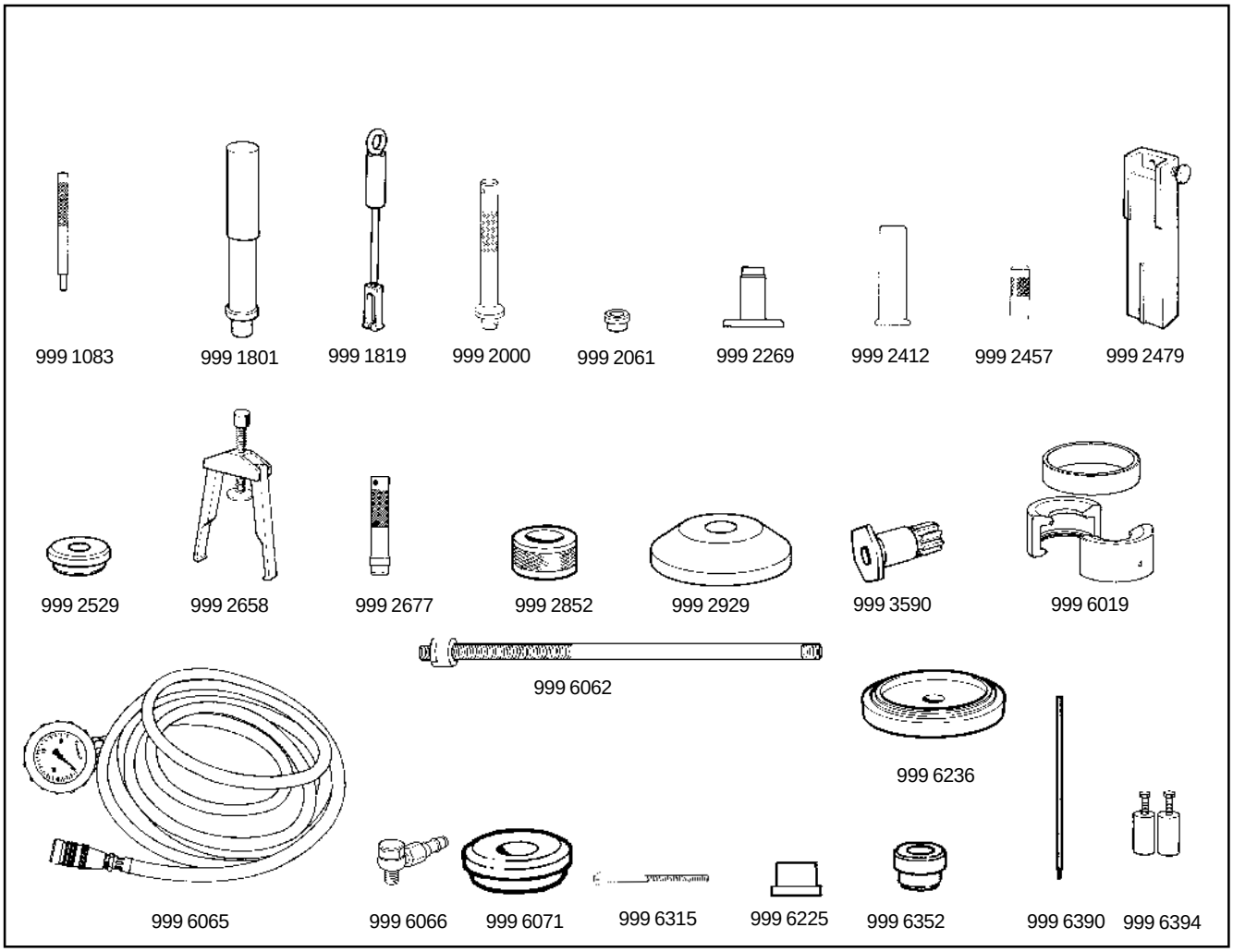
For example: TAD1630GE

T	–	Turboalimentado
A	–	Air-to-air charge air cooler
I	–	Intercooler
W	–	Water-to-air charge air cooler
D	–	Diesel engine
16	–	Displacement, liters
3	–	Generation
0	–	Version
P	–	Stationary engine (Power Pac)
G	–	Gen Set Engine
H	–	Raised engine output
V	–	Engine for stationary and mobile operation
M	–	Engine for mobile operation
E	–	Low emission engine

Special tools

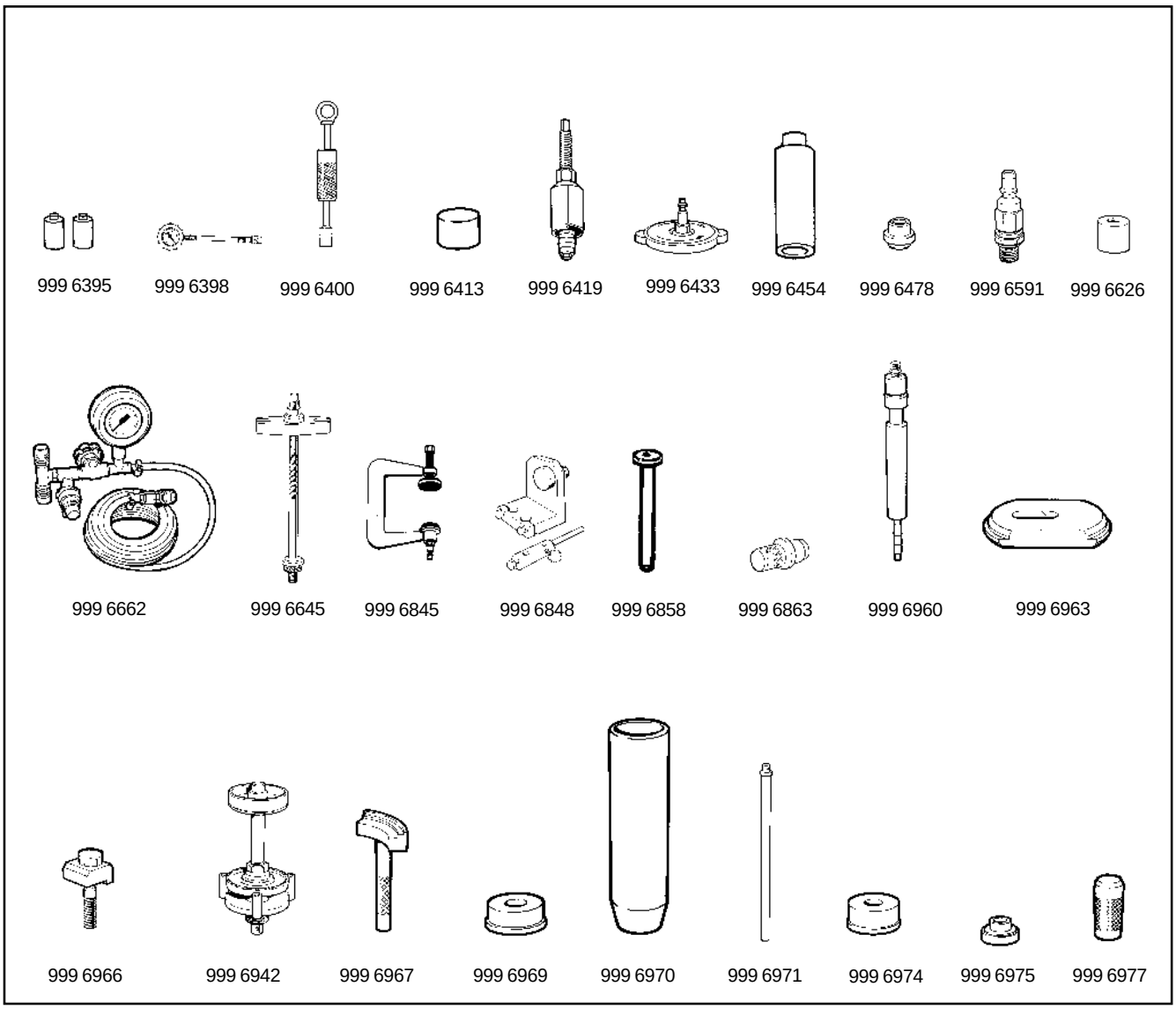
The following special tools are used when working on the engine.

The tools can be ordered from AB Volvo Penta by specifying the number shown.



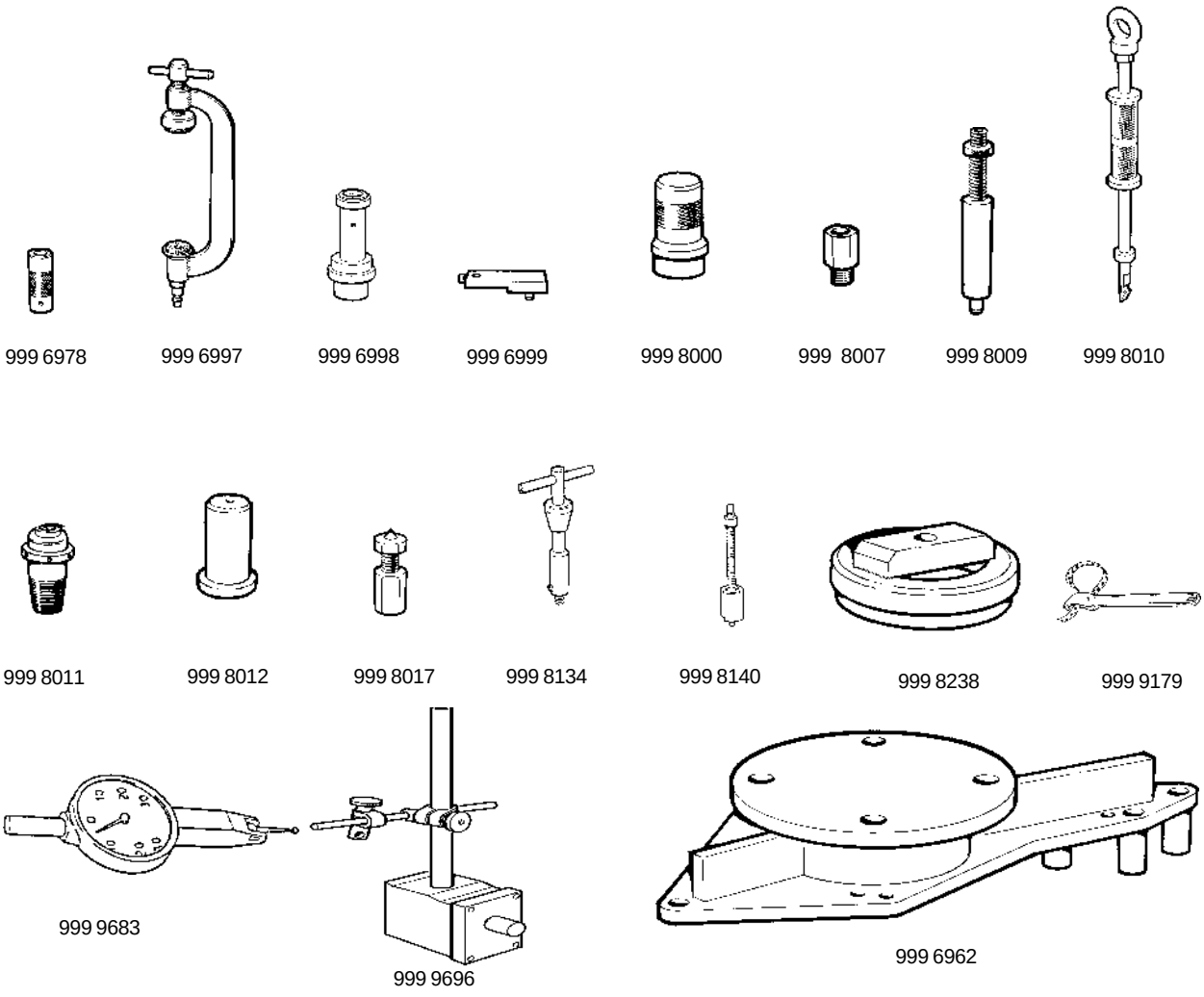
Tool	Designation/use
999 1083	Drift for valve guides
999 1801	Standard handle 18x200
999 1819	Puller
999 2000	Standard handle 25x200
999 2061	Drift for reconditioning coolant pump
999 2269	Drift for fitting flywheel
999 2412	Drift for reconditioning coolant pump
999 2457	Hollow drift for rocker arm bushings
999 2479	Holder for dial indicator
999 2529	Drift for gudgeon pin
999 2658	Puller
999 2677	Drift for reconditioning oil pump
999 2852	Press ring

Tool	Designation/use
999 2929	Drift, coolant pump seal ring
999 3590	Cranking tool for flywheel
999 6019	Support segments
999 6062	Spindle 7/8”-9 UNC
999 6065	Pressure gauge 2.5 bar.
999 6066	Nipple for feed pressure
999 6071	Drift for camshaft bearings
999 6225	Drift for rocker arm bushings
999 6315	Spindle
999 6236	Drift for cylinder liners
999 6352	Drift for rocker arm bushings
999 6390	Gauge extension
999 6394	Spacer for liner extractor



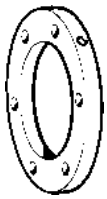
Tool	Designation/use
999 6395	Spacer for liner extractor
999 6398	Gauge 16 Bar
999 6400	Slide hammer for injectors
999 6413	Extension for oil pump drive gear
999 6419	Puller for injectors
999 6433	Adapter (cap) with nipple
999 6454	Extension for camshaft
999 6478	Drift for rocker arm bushings
999 6591	Nipple for oil pressure and boost pressure
999 6626	Hollow drift for fitting camshaft bearings
999 6662	Pressure gauge 2.5 bar
999 6645	Extractor for cylinder liners
999 6845	C-clamp
999 6484	Gauges for injection pump
999 6858	Drift for coolant pump

Tool	Designation/use
999 6863	Hollow drift for thermostat seal
999 6960	Expander
999 6963	Puller plate
999 6966	Press tool
999 6942	Milling tool
999 6967	Drift for fitting sealing ring to cylinder liner
999 6969	Drift for camshaft bearings
999 6970	Guide tool for camshaft
999 6971	Handle, camshaft bearings
999 6974	Drift for camshaft bearings
999 6975	Drift for steel ring for copper sleeve
999 6977	Drift for in valve guides, exhaust



Tool	Designation/use
999 6978	Drift for pressing in valve guides, inlet
999 6997	Tool for leakage test, cylinder head
999 6998	Drift for coolant pump
999 6999	Tool for coolant pump
999 8000	Drift for coolant pump
999 8007	Puller for injectors
999 8009	Adapter for compression test
999 8010	Puller for crankshaft seal
999 8011	Puller for seal

Tool	Designation/use
999 8012	Hollow drift
999 8017	Press tool
999 8134	Thread cutting tool for copper sleeve
999 8140	Puller for copper sleeve
999 8238	Drift for seal
999 9179	Removal tool
999 9683	Dial indicator
999 9696	Magnetic stand
999 6962	Engine fixture



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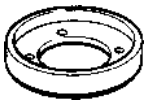

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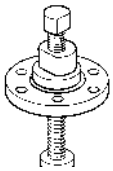

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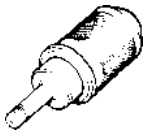

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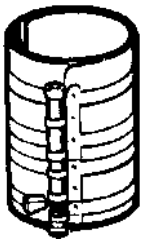

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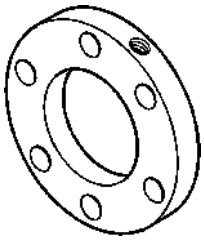

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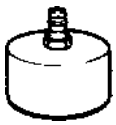

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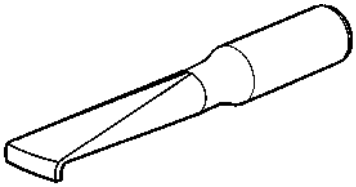


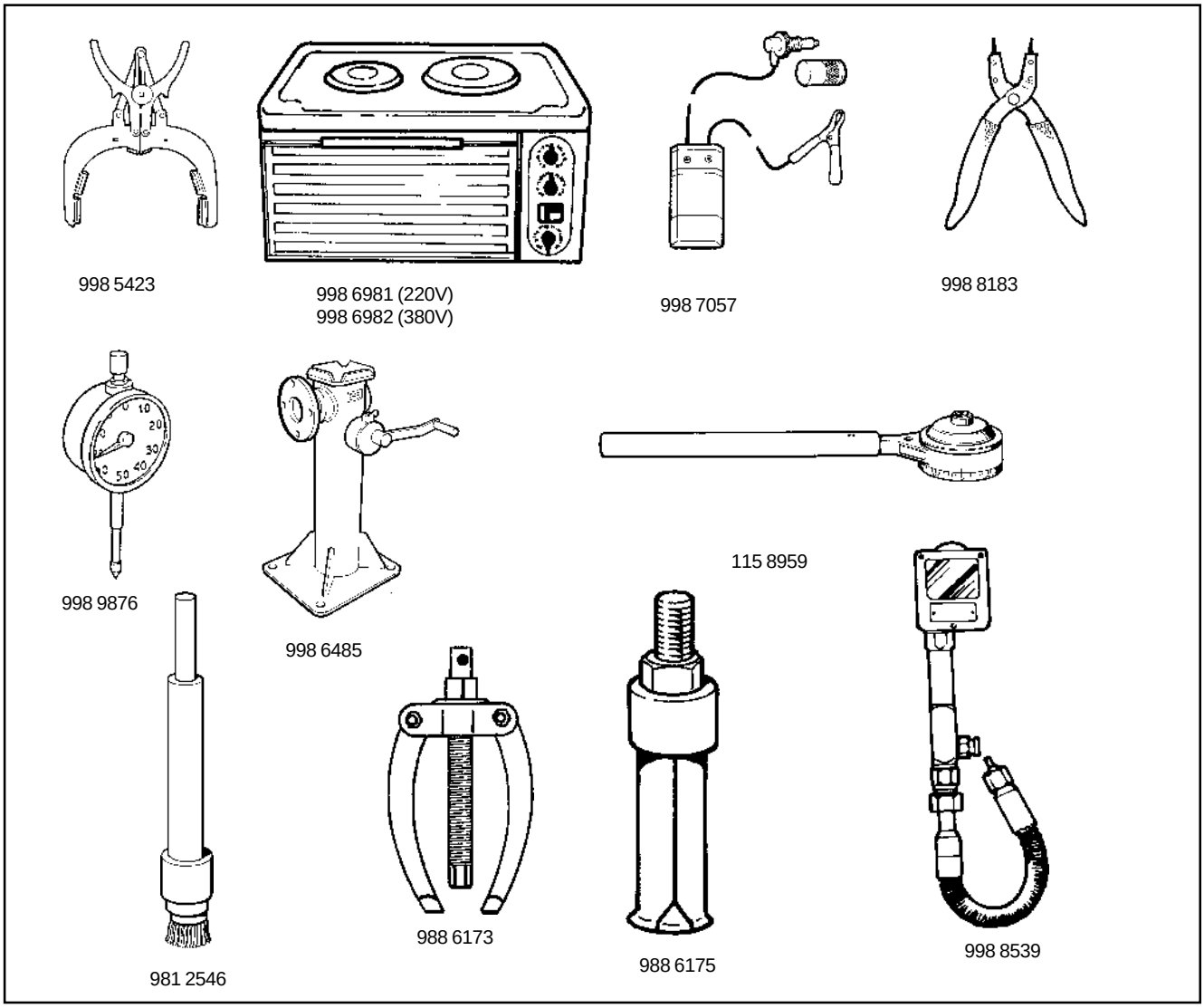
885341

Tool	Designation/use
884969	Flange kit
884983	Tool for seal and fitting wear ring
884994	Puller for polygon hub
884995	Drift for polygon hub
884997	Tool for crankshaft drive
885126	Piston ring compressor

Tool	Designation/use
885184	Flange kit
885231	Connection tool for leakage check
885232	Sealing tool for leakage check
885341	Puller

Other special equipment

The following special tools are used when working on the engine. The tool can be ordered from AB Volvo Penta by specifying the appropriate Part number.

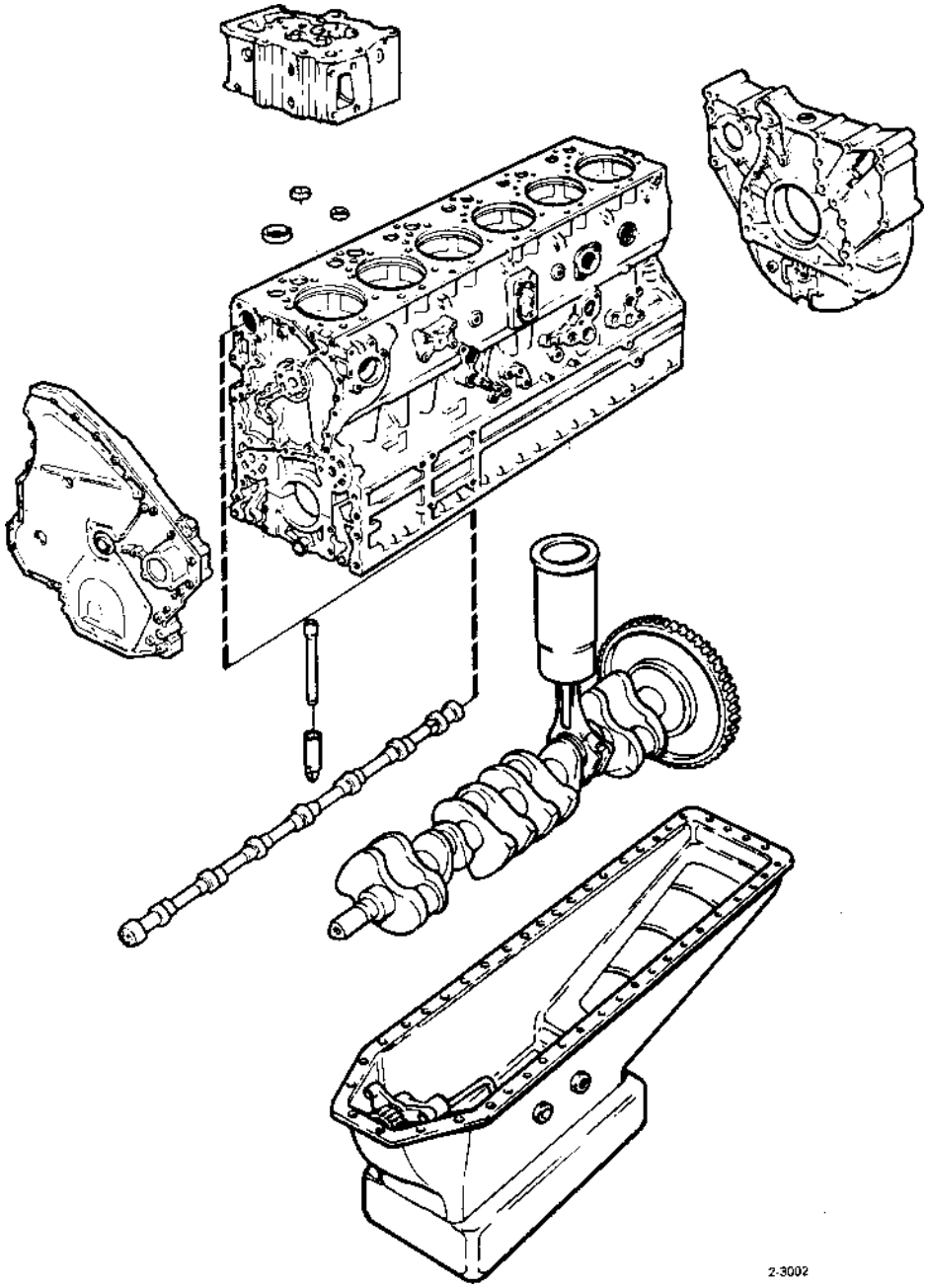


Tool	Designation/use
998 5423	Piston ring tool
998 6981	Oven 220V
998 6982	Oven 380V
998 7057	Measuring instrument
998 8183	Circlip pliers

Tool	Designation/use
998 9876	Dial indicator
998 6485	Assembly stand
115 8959	Torque amplifier (x6)
981 2546	Pin brush, copper sleeve
998 6173	Puller for rocker arm bushings
998 6175	Puller
998 8539	Compression gauge

Engine

Design and Function

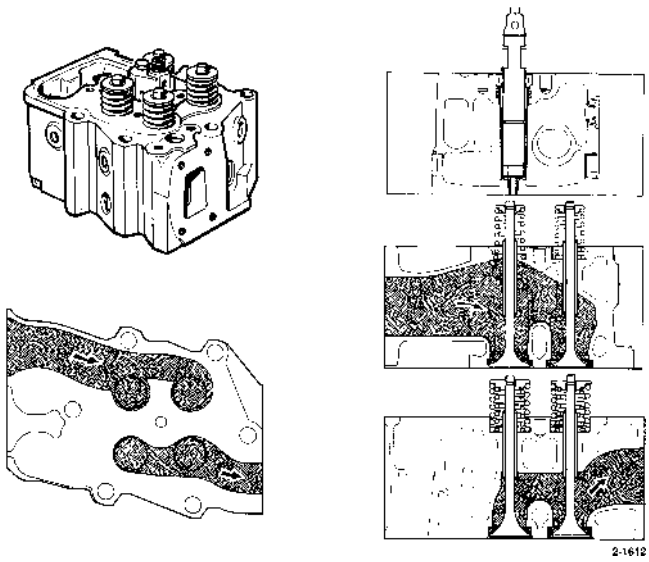


Cylinder head

The engine has individual, cast iron cylinder heads each carrying four valves. The injectors are centrally positioned in copper sleeves between the valves.

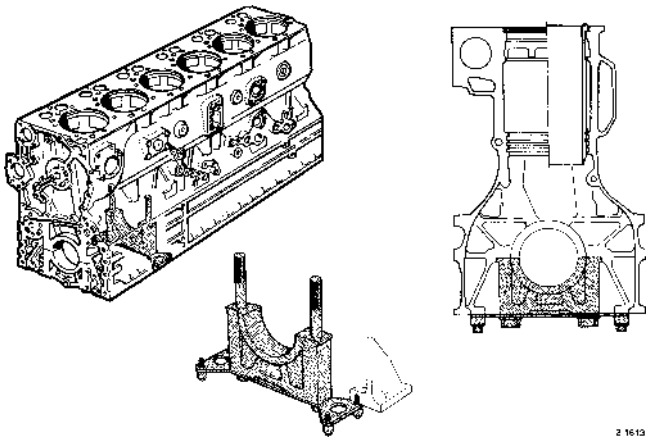
Cylinder block

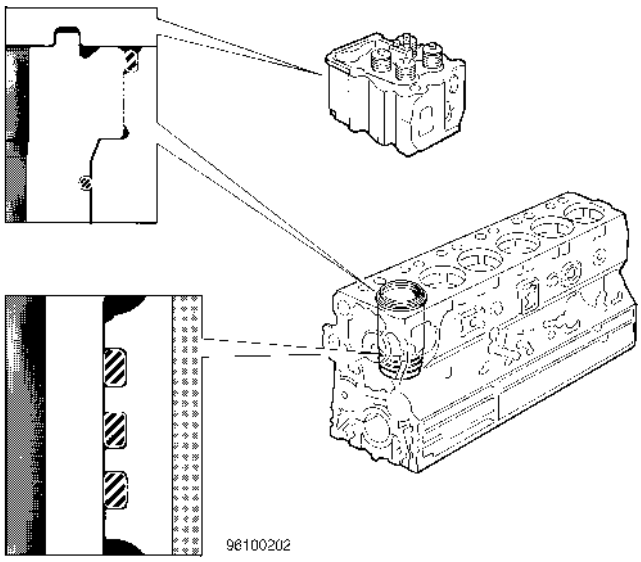
The cast iron cylinder block has bearing caps of ductile cast iron. The main bearing caps are tied to the block sides by reinforcing plates.



Seals

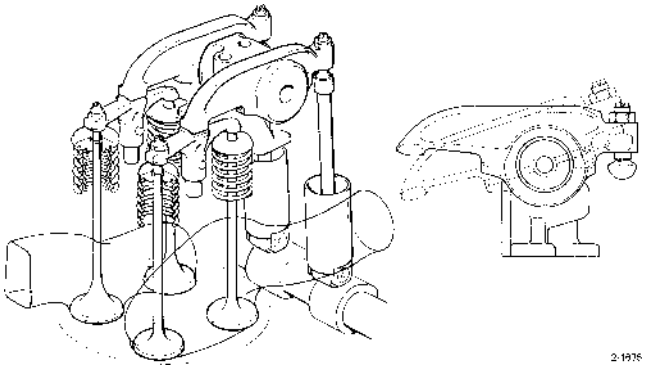
Cylinder block - Cylinder liners - Cylinder heads
A direct contact sealing method is used. The upper sealing face of the liner seals directly against the cylinder head without a gasket. The liner incorporates a flame retainer. Beneath the liner collar is a sealing ring. In addition, there is an extra sealing ring between the liner and cylinder block. The bottom seals of the liner consists of three rings.





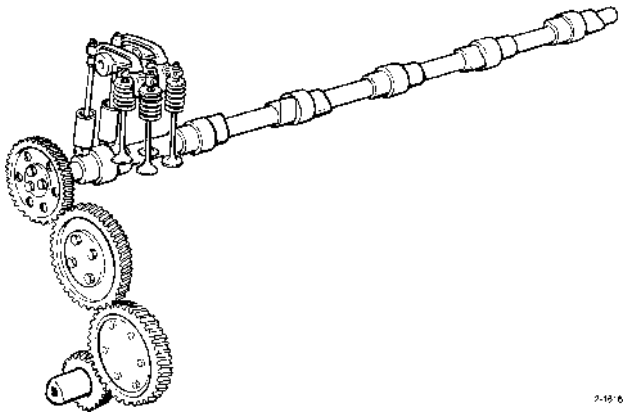
Valve mechanism

Valve mechanism is carried from the camshaft by tappets of the roller type, short push rods, rocker arms and valve calipers. In each rocker arm is an oil drilling which due to the movement lubricates the valve caliper and ball cup of the push rod.



Camshaft

The camshaft is positioned high in the cylinder block and is journalled by 7 bushings. The front bushing is of a larger dimension than the other 6. The camshaft is driven via two idler gears.

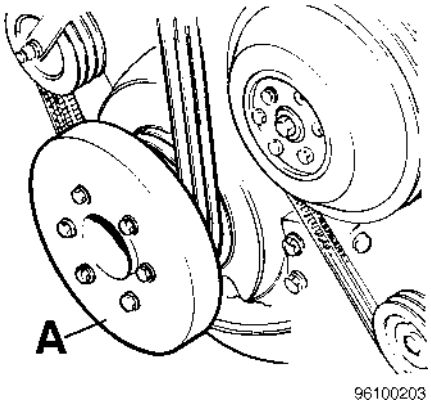


Timing gears

The timing gears are completely built-in, which means that the crankshaft hub and vibration damper are underneath the casing cover. This gives a lower level of noise. Genset engines have an additional vibration damper in front of the pulley.

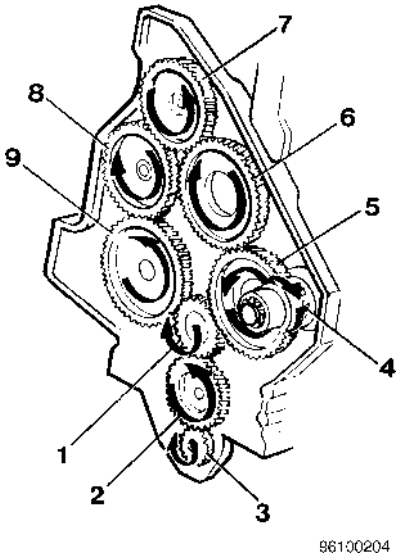
The cooling fan is belt driven. The coolant pump has a pulley to provide a drive for the alternator.

A. Additional vibration damper



96100203

1 Crankshaft drive
2 Idler, oil pump
3 Oil pump drive
4 Coolant pump drive
5 Idler, right
6 Idler, upper
7 Camshaft drive
8 Injector pump drive
9 Idler, left



96100204

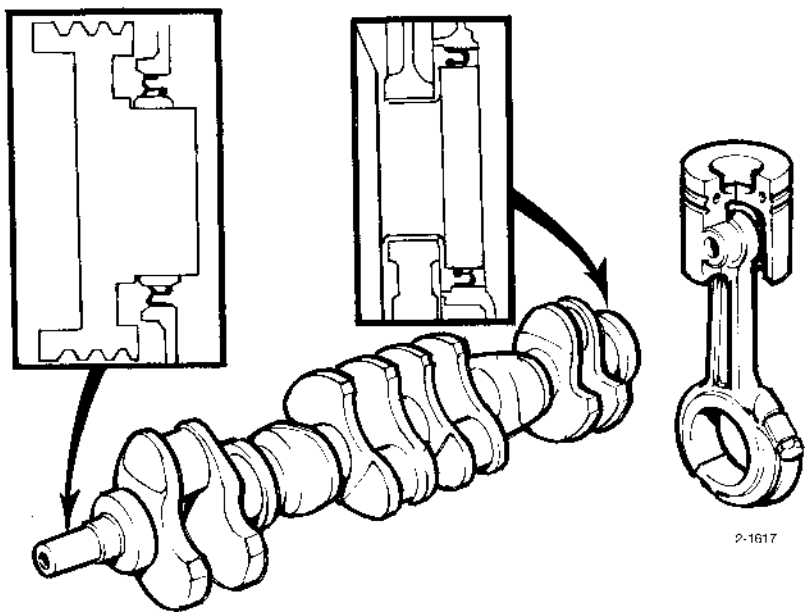
Crankshaft/pistons

The crankshaft has 7 main bearings and is nitrocarburized. The oscillation damper is screw-attached to the polygon hub.

The rear and front crankshaft seal consists of a liptype sealing ring. The front sealing ring seals against a wear ring on the pulley.

The upper end of the connecting rods is trapezoidal in shape. The bushing must be line bored after replacement.

The pistons are made of aluminum alloy, have three piston rings and an inner oil drilling for cooling purposes.



Service procedures

The engine must always be washed before repairs are started

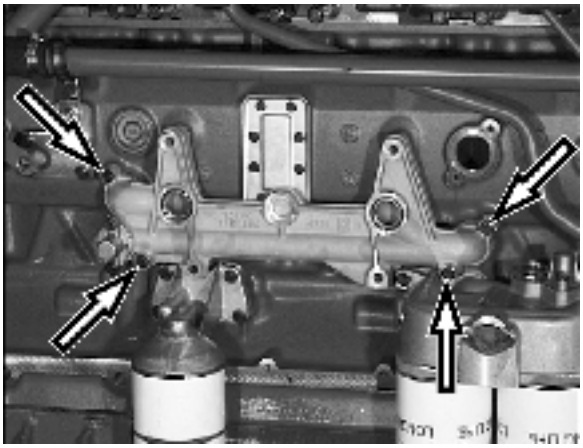
Engine fixture, attaching

Special tools: 998 6485, 999 6962

1

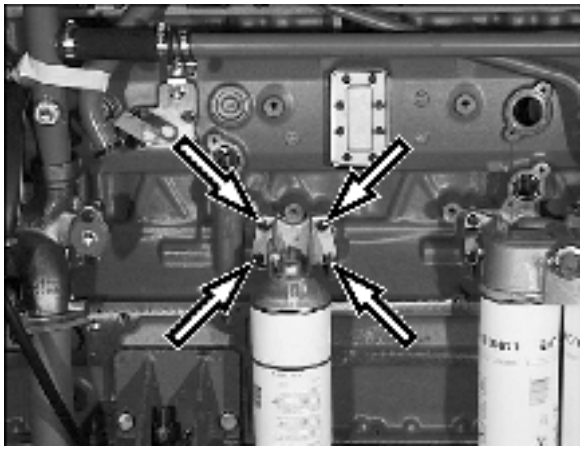
Remove the oil cooler as shown in ”oil cooler, replacing”.

2



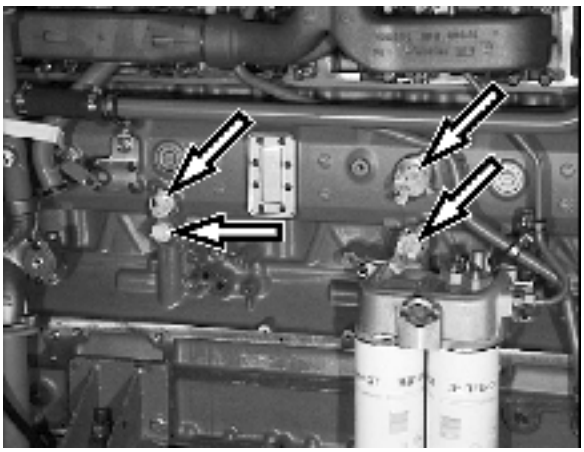
Remove the spacer plate (four screws).

3



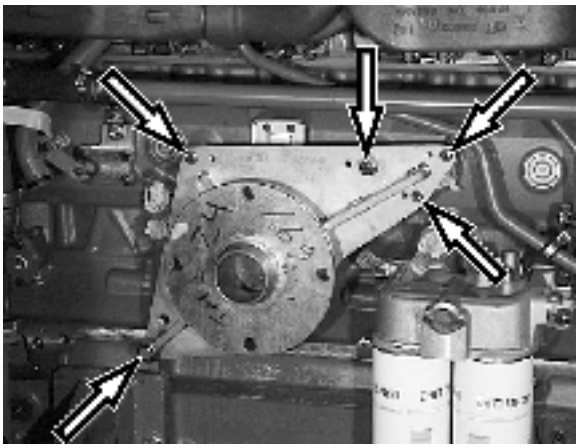
Remove the bypass filter and bracket (four screws).

4



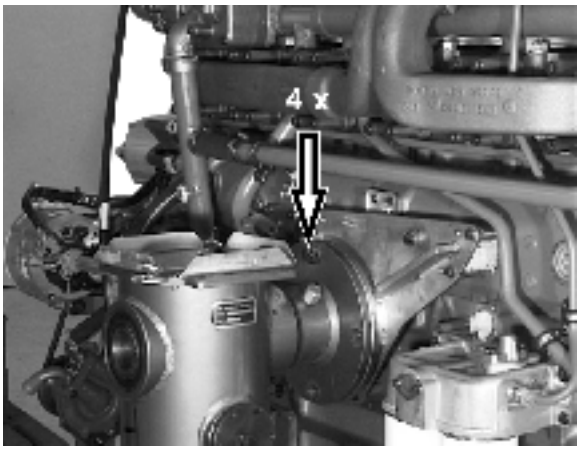
Cover the holes with rags or equivalent to prevent dirt or foreign matter from entering the engine.

5



Mount the engine fixture on the engine.

6



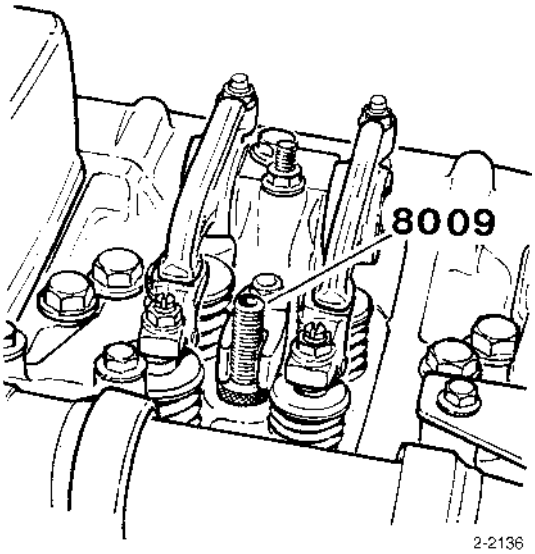
Lift the engine in place and secure it with screws and nuts in the holes on the assembly stand (four).

Compression test

(Injectors removed)

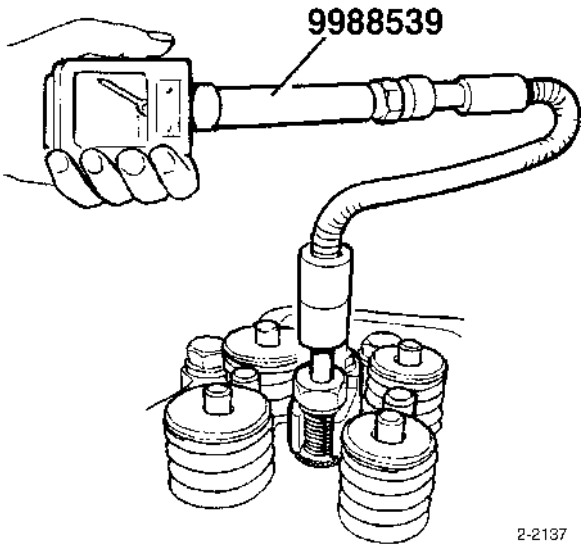
Special tools: 999 8009, 998 8539

1



Fit adapter 999 8009. Attach the adapter by means of the injector retainer and nut.

2



Connect compression gauge 998 8539 to 999 8009. Crank the engine with the starter motor while the stop button is depressed. Read the compression pressure at normal starter motor rpm.

Exposing engine body

TAD1630/TAD1631

1

Shut the fuel cocks. Disconnect the battery cables.

2

Drain the coolant.

3

Remove air filters and pipes for the turbo charger. Remove stays and brackets.

4

Remove the two charge air pipes.

5

Disconnect the starter heater.

TID162/TWD1620/TWD1630/TD164

1

Shut the fuel cocks. Disconnect the battery cables. Drain the coolant.

2

Disconnect electric cabling and connections with all sensors and transducers on the sensor rack. Disconnect the starter heater.

3

Remove the filters and pipes for the turbo charger. Remove stays and brackets.

4

Remove the turbo charger from the exhaust pipe and charge air cooler.

5

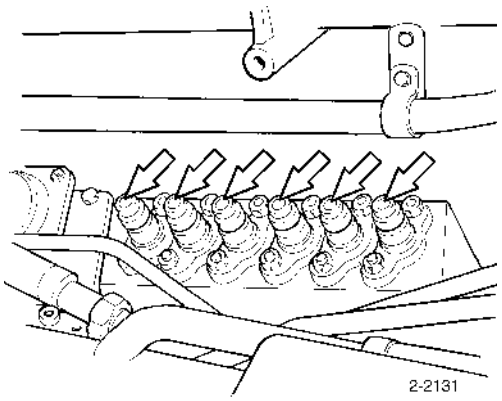
Remove the charge air cooler together with the inlet manifold.

TAD1630/TAD1631/TID162/TWD1620/ TWD1630/TD164

6

Remove the fuel delivery pipe and return fuel pipe together with the clamps and brackets from the injectors and the injection pump.

7



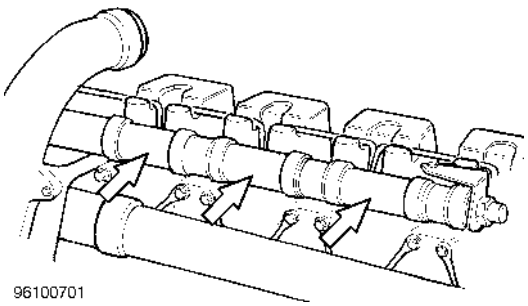
Fit protective plugs to all injectors and also to the pressure valve holders in the injection pump.

8

Remove the pipe of the smoke limiter from the inlet pipe (TAD1630P/V only).

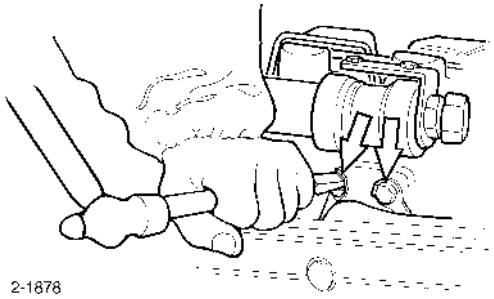
Remove the inlet manifold (TAD1630, TAD1631 only).

10



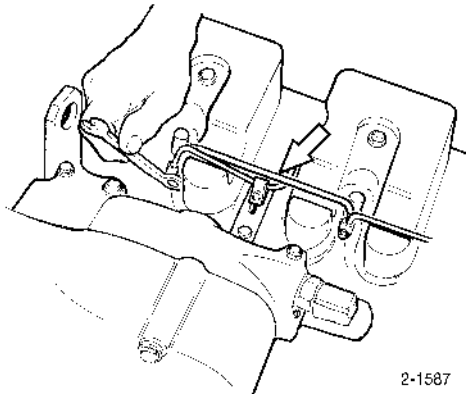
Remove all pipes for distribution of coolants, and the thermostat housing.

11



On the cylinder heads which are to be removed, bend up the locking tabs on the exhaust manifold bolts.

12



Remove the fuel return pipes together with the copper washers between the injectors.

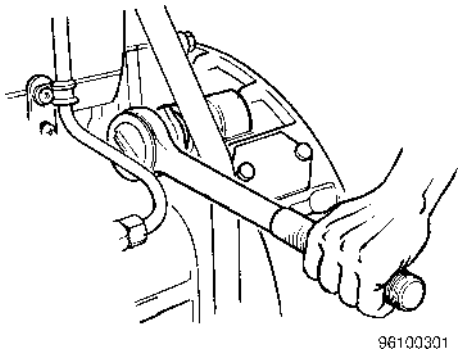
13

Remove the valve cover.

Cylinder head, removing

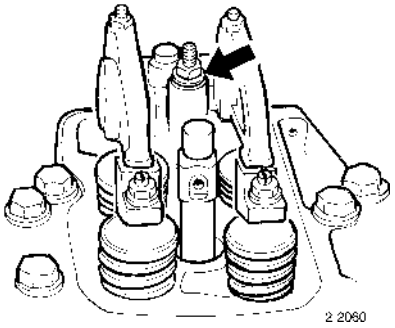
Special tools: 999 3590, 999 6400, 999 6966, 999 8007

1



Remove the plug from the flywheel casing using a 16 mm hex socket key. Fit cranking tool 999 3590 in the hole. Rotate the engine until both valve pairs, on the cylinder head to be taken out, shut. The rocker bridge should not be loaded with any of the springs.

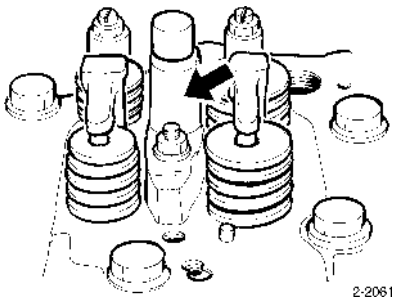
2



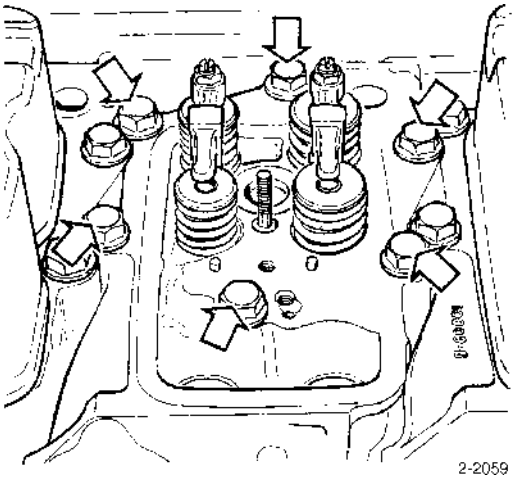
Remove the rocker arm bridge and both push rods. Lift and turn the tappets 1/4 turn until they rest on the guide stud in the cylinder head, or remove them.

Note: Put all tappets and push rods in a stand or mark them to make sure that they are returned to their original positions when reinstalled**.**

3



Remove the injectors. If an injector sticks in the copper sleeve, fit tool 999 6400 and 999 8007 to the injector and carefully knock out the injector.



4

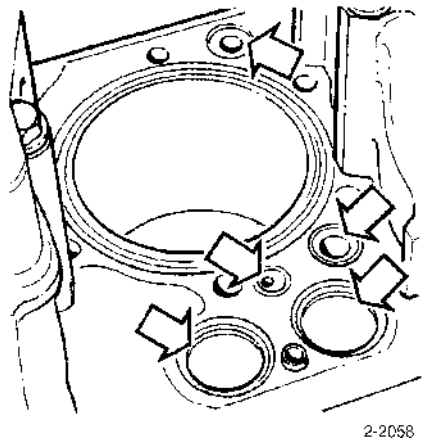
Remove the cylinder head bolts.

5

Lift off the cylinder head.

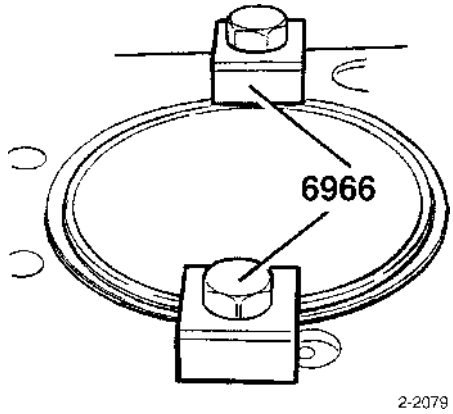
Note: Never put the cylinder head on the sealing surface as damage can result.

6



Remove all sealing rings from the cylinder block.

7



Attach 999 6966 (two) to hold the cylinder liner.

Cylinder head, disassembling

1

Remove the valves and valve springs. Use a valve spring clamp to compress the springs for removal of the valve collets.

2

Put the valves in a valve stand in the order they were fitted in the engine.

3

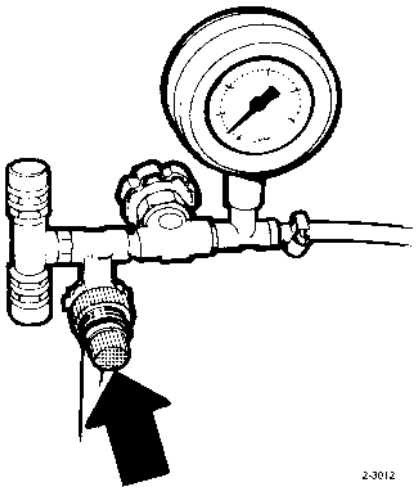
Clean all parts. Take particular care with the ducts for oil and coolant. Carry out a leakage test.

Cylinder head, pressure testing

(Cylinder head removed)

Special tools: 999 6662, 999 6997 (2 ea)

Before using the pressure testing equipment, check it for accuracy.

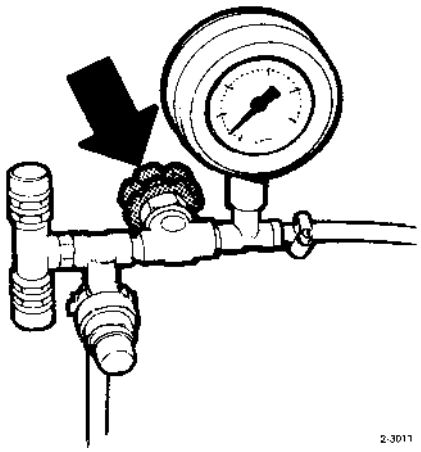


1

Connect the pressure testing equipment 999 6662 to an air supply and set the gauge to **100 kPa (14.5 psi)** by means of the reduction valve.

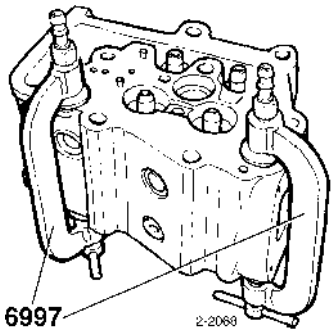
Note: The knob of the reduction valve can be locked with a circlip, which is moved in an axial direction.

2



Then close the bleed valve. The pressure gauge dial pointer must not drop during minutes, otherwise the gauge cannot be relied upon.

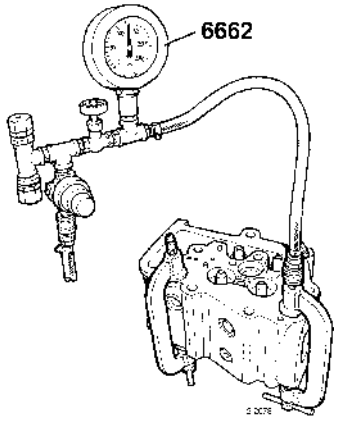
3



Fit 999 6997 (two) to the cylinder head.

Note: Tighten the wing nuts with care so as not do damage the rubber gaskets of the tool.

4



Connect the hose between 999 6662 and 999 6997.

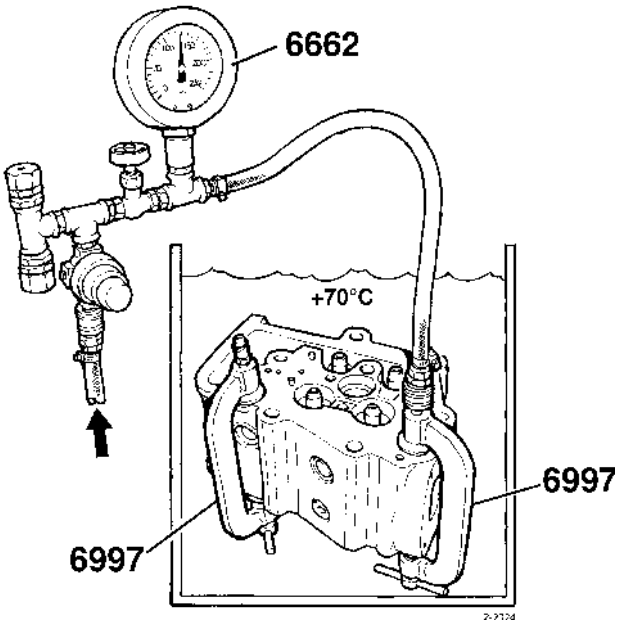
5

Check that the knob on 999 6662 is fully opened.

6

Put the cylinder head into a 70°C (158°F) water bath.

7



Connect air to 999 6662. Open the valve.

8

Pull out the locking ring on the knob of the reduction valve.

9

Screw in the knob until the pressure reading is **50 kPa**. Maintain the pressure for one minute.

10

Increase the pressure to **150 kPa**. Secure the knob of the reduction valve by pushing the locking ring down. Shut the valve on 999 6662.

11

After 2 minutes, check whether the pressure has dropped on 999 6662, or if bubbles of air can be seen in the bath.

12

Remove the air hose from 999 6662.

13

Remove 999 6997 (two) from the cylinder head.

Cylinder head, inspection

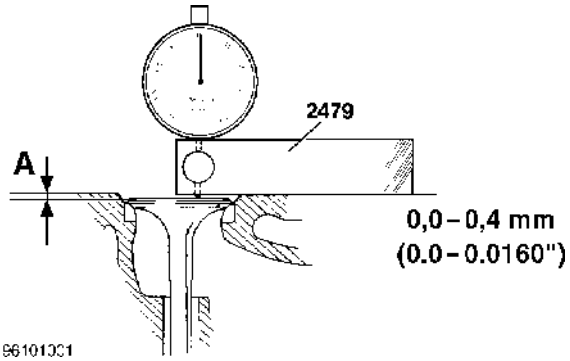
Unevenness of the cylinder head face must not exceed 0.02 mm (0.0008"). If the unevenness does exceed the maximum of 0.02 mm, or if any blow-by marks are observed, the cylinder head must be face-ground or replaced. Make sure that the stud is secure.

IMPORTANT! Replace all rubber seals.

Cylinder head, face-grinding

Special tools: 999 2479, 998 9876

When face-grinding, check surface smoothness with a dial indicator. Surface finish after grinding must be max **1.6 RA**.



The measurement (A) from the face of the valve disc to the face of the cylinder head must be **0.0–0.4 mm**. Should further machining of the cylinder head face be required, the valve seats must be milled down to maintain this measurement.

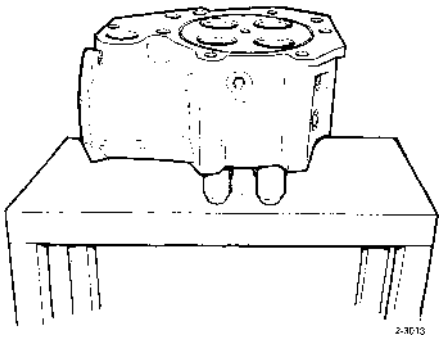
The cylinder head height after face grinding must not be less than **134.6 mm**.

Valve guides, inspection

Special tools: 998 9876, 999 9696

To determine the degree of valve guide wear, fit a new valve into the guide and then measure the amount of play with a dial indicator.

1



Put the cylinder head on a flat surface with the head resting on the valve guides.

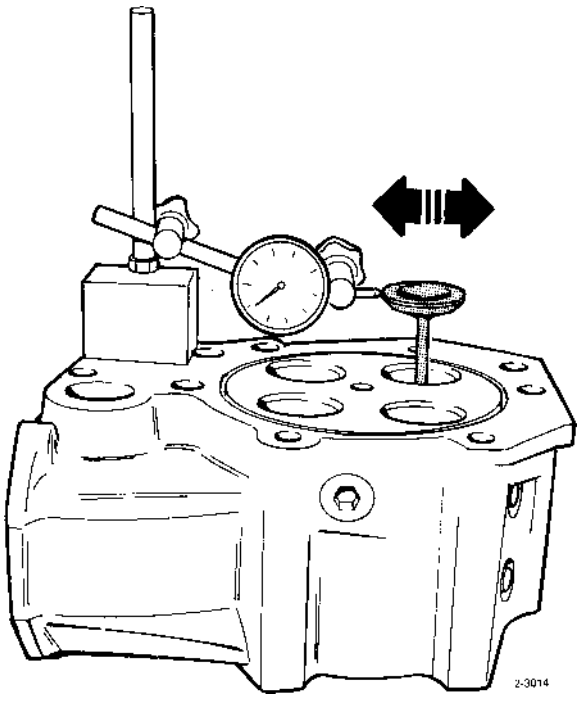
2

Fit a new valve into a valve guide pushing the valve down until the stem rests against the flat surface underneath.

3

Use a dial indicator with a magnetic stand, placing the tip of the dial indicator against the edge of the valve.

4



Move the valve sideways in the direction of the exhaust or inlet ducts. Note the reading of the dial indicator.

Wear tolerances:

Inlet valve max play 0.30 mm (0.0118")

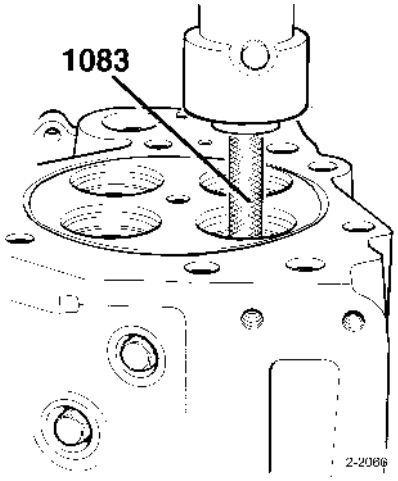
Exhaust valve max play 0.45 mm (0.0177")

If these amounts of play are exceeded, the valve guides must be replaced.

Valve guides, replacing

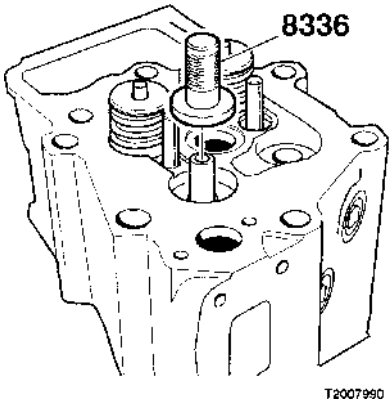
Special tools: 999 1083, 999 8336

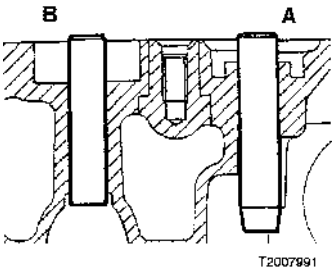
1



Press out the valve guides using tool 1083.

2





Oil the new valve guides and press the guides into the cylinder head using drift 999 8336. The tool installs the guides at the correct height above the cylinder head surface. The same tool is used for all valve guides.

Note: The guides for intake and exhaust valves should have the same short chamfer pointing up. Intake valve guides (A) should have their long chamfer pointing down.

3

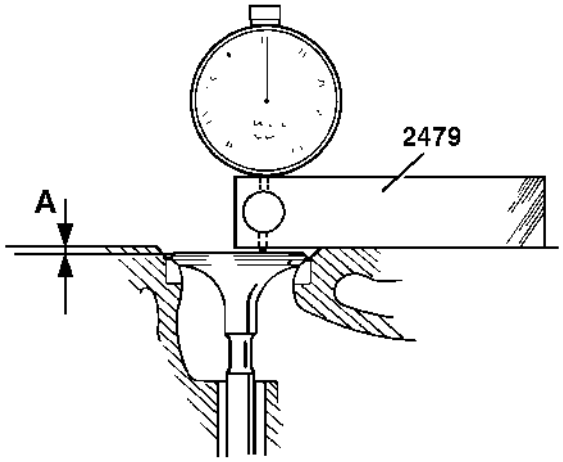
Ream valve guides if necessary.

Valve seats, replacing

Special tools: 999 2479, 998 9876

The valve seat must be replaced when measurement "A", measured with a new valve, exceeds **1.0 mm**.

This measurement applies to both the inlet and exhaust valves.



Remove the old valve seat by cutting two diametrical notches in the seat and cracking it with a chisel.

Note: Be careful not to damage the cylinder head.

Thoroughly clean the seat location and check the cylinder head for cracks.

Measure the diameter of the valve seat location. With this measurement as a basis, check whether a standard size seat or an oversize seat is required. Machine the valve seat location if necessary.

Cool the seat in carbon dioxide snow to minus **60- 70°C (140-158°F)** and heat the cylinder head by hosing it with hot water or some other suitable source of heat. Press in the seat using a drift.

Machine the seat to the correct angle and width.

Valve seats, grinding

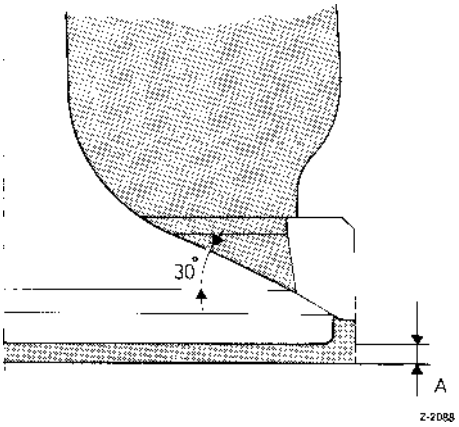
Before grinding, check the valve guides and replace them if the wear limits have been exceeded.

Grind the valve seat just enough to give correct form and angle and to ensure good contact.

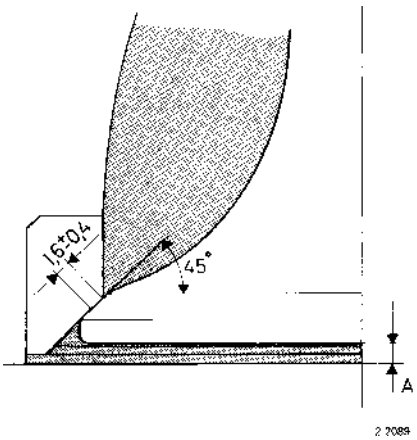
The seat should be replaced when distance ”A”, measured with a new valve, exceeds **1.0 mm (0.0394”).**

A new seat is ground until the measurement between the cylinder head face and the upper area of the valve (A) is **0.0-0.4 mm (0.0-0.0158")** for both inlet and exhaust valves.

This angle is checked with a valve seat gauge after coating the seat contact surface with a light layer of marking paint.



Intake valve



Exhaust valve

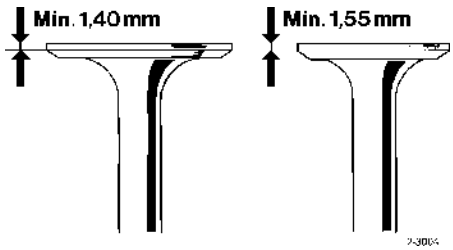
Valves, grinding

Valve sealing angles:

Inlet	**29,5°**
Exhaust	**44,5°**

The sealing surface should be ground as little as possible, just enough to remove all signs of damage.

If there is an edge of less than **1.40 mm (0.0552")**on inlet valves and **1.55 mm (0.0610")** on exhaust valves, the valve must be replaced. This also applies if the valve stem is bent.



Check for leakage using marking paint.

If leakage is found, regrind the valve seat - not the valve - and recheck for leakage.

Cylinder head, assembling

1

Oil the valve stems and fit the valves into their guides. Fit the valve springs and the spring washers. Clamp the springs with a valve spring compressor and fit the collets.

2

If the cylinder cleaning plugs have been removed, make sure that the sealing surfaces are well cleaned. Fit new gaskets.

Torque the plugs.

IMPORTANT! The plugs must be tightened manually!

Plug diameter:

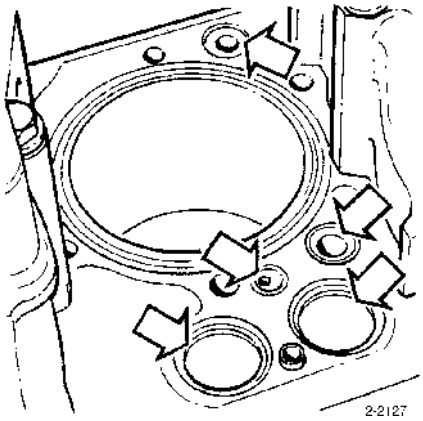
M30: 60 Nm (44.3 ft-lb).

3/4": 70 Nm (51.6 ft-lb).

Cylinder head, installation

Special tools: 999 2479, 998 9876, 115 8959

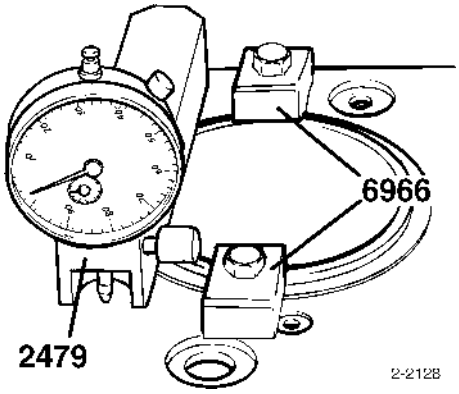
1

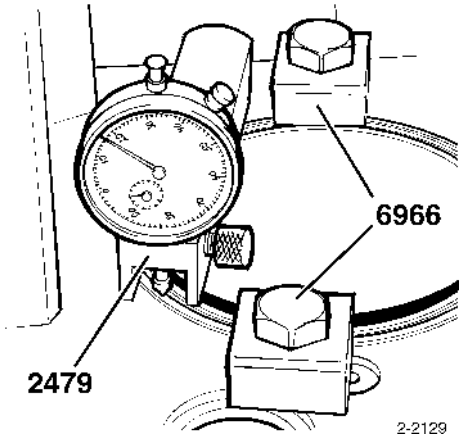


Use a brass wire brush to clean the sealing surfaces of the cylinder block.

IMPORTANT! Take care not to scratch the contact surfaces which seal against the cylinder liner.

2





Check the height of the cylinder liner above the face of the block, see ”Cylinder liner with piston, fitting”.

3

Fit new greased sealing rings to the cylinder block.

4

Fit the exhaust manifold bolts (two), locking tabs, washers and sleeves. Put the gasket onto the bolts.

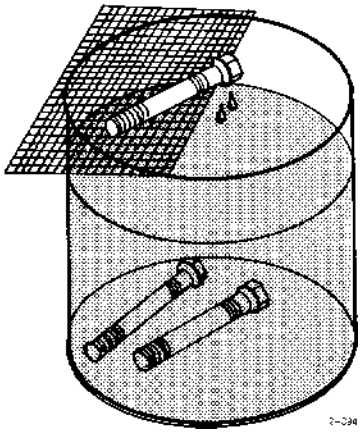
5

Lift the cylinder head carefully into position on the cylinder block. Make sure that the exhaust manifold gasket is correctly in position.

6

Screw in the exhaust manifold bolts 2-3 turns.

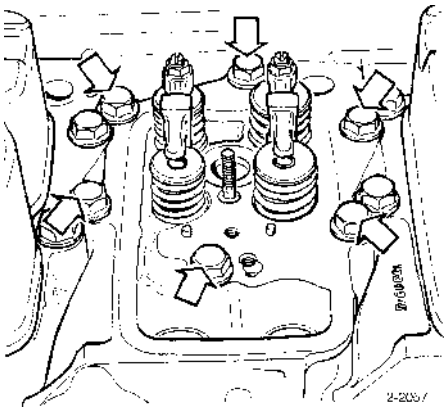
7



Dip the cylinder head bolts completely into a rustproofing agent (part No. 282036-3).

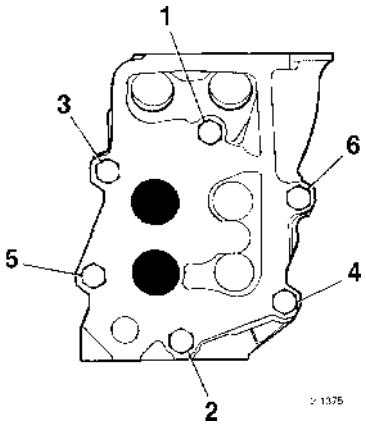
Then place the screws on a net to remove excess.

8



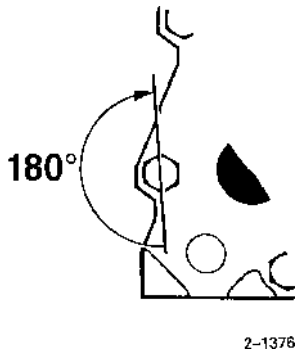
Fit the bolts to the cylinder head.

9



Tighten the head bolts in the specified order and in four stages.

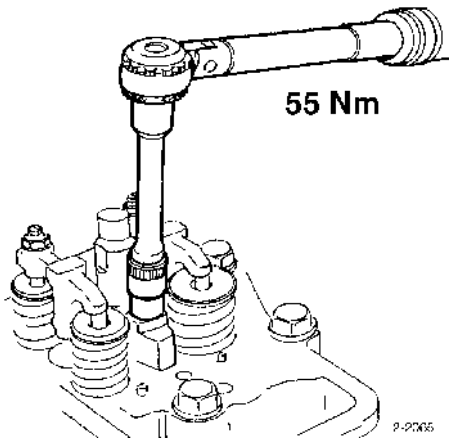
1st stage 50 Nm (36.9 ft-lb)
2nd stage 125 Nm (92.2 ft-lb)
3rd stage 200 Nm (147.5 ft-lb)



Note: Mark the socket and the cylinder head with a felt-tipped pen.

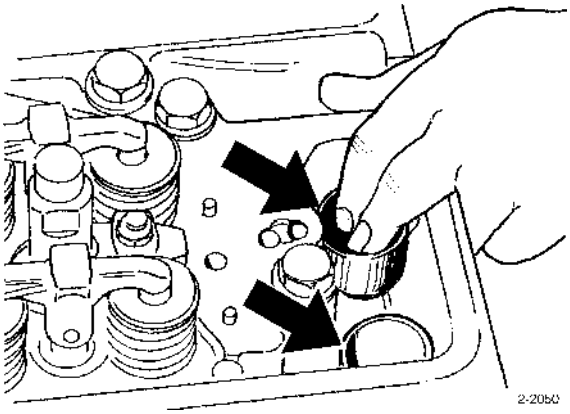
4th stage 180° (the angle tightening should be carried out using torque amplifier 115 8959).

10



Fit the injector. Torque the attaching yoke nut to **55 Nm (40.6 ft-lb).**

11



Fit the tappets, resting them against the camshaft.

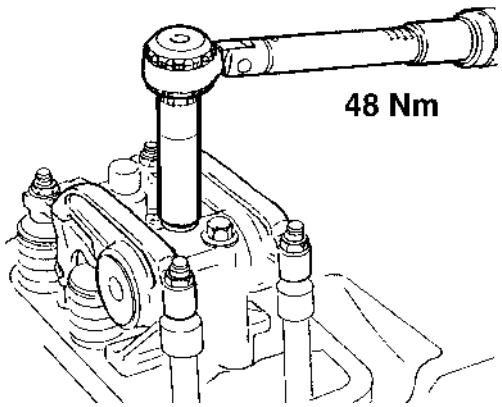
Note: The tappets must be placed in an oil bath before fitting. New tappets are packed in oil. The oil must not be removed before fitting. Observe good cleanliness when handling the tappets!

12

Fit the push rods.

Note: Make sure that the tappets and push rods are in their correct positions.

13



Fit the rocker arm mechanism, torque **48 Nm (35.4 ft-lb).**

14

Adjust the valves. See ”Valves adjusting”.

15

Fit the valve cover together with the gaskets.

16

Fit the coolant distribution pipes, and the thermostat housing.

17

Torque the exhaust manifold bolts to **48 Nm (35.4 ft-lb).**

18

Fit new O-rings to the inlet pipes of all cylinders.

(On TWD1630, the delivery pipes to the injectors have to be fitted before the inlet manifold.)

19

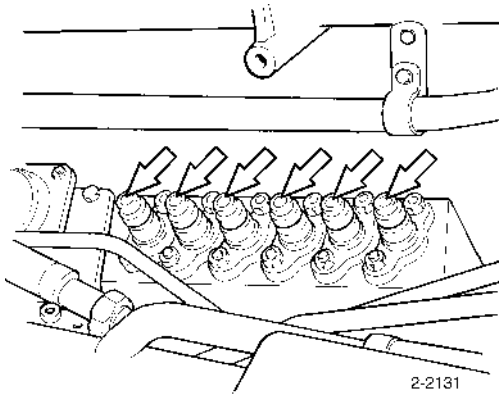
TAD1630P/V only

Connect the smoke limiter hose to the inlet pipe.

20

Connect the cables to the starter heater.

21



Remove all protective plugs from the injectors and the injection pump.

22

Fit the delivery pipes and the fuel return pipe together with washers, clamps and brackets.

23

Fit all other dismounted details (brackets filters etc.

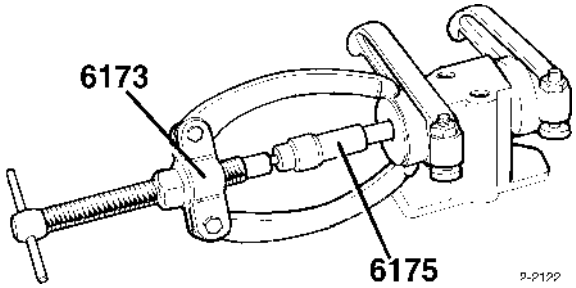
24

Fill with coolant. Bleed the fuel system.

Rocker arm mechanism, reconditioning

Special tools: 999 1801, 999 2000, 999 2457, 999 6225, 999 6352, 999 6478, 998 6173, 998 6175

1



Remove the locking plugs using tools 998 6173 and 998 6175.

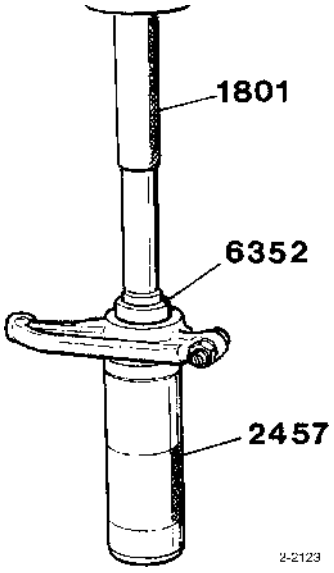
2

Clean all parts. Pay particular attention to the oil drilling in the bearing bracket as well as the rocker arm shaft and rocker arm oil holes.

3

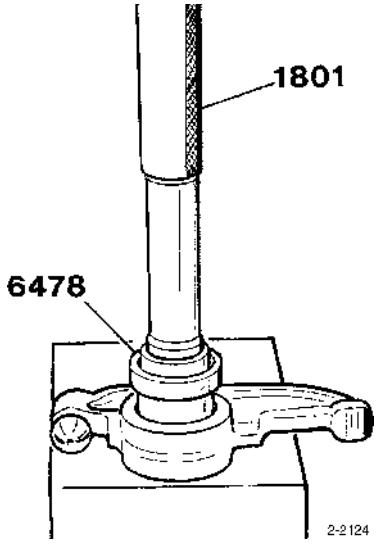
Check the wear on the rocker arm shaft and the ball screw. The threads on the ball pin and lock nut must be in good condition. The surface of the rocker arms which is in contact with the valve must not be worn or pitted.

4



Press out the rocker arm bushing using tools 999 1801, 999 2457 and 999 6352.

5



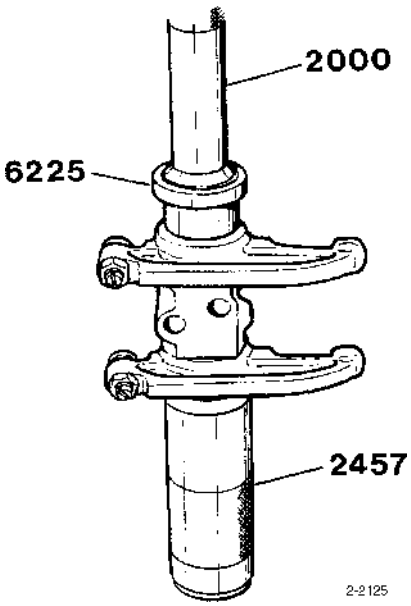
Fit the new bushing using tools 999 1801 and 999 6478 making sure that the oil holes align with the oil channels in the rocker arms. The slit in the bushing must point diagonally upwards.

Note: On completion of pressing, machine-ream the bushings.

6

Oil the rocker arm shaft and fit the rockers.

7



Fit the new locking plugs.

Valves, adjusting

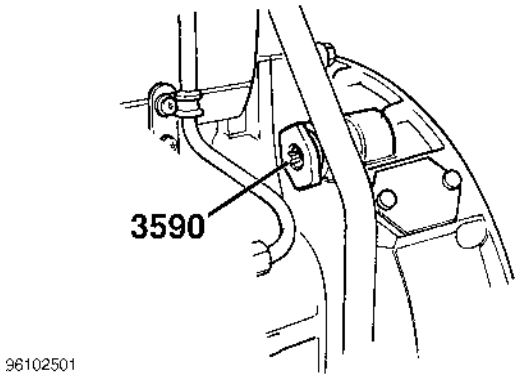
Special tools: 998,3590

Valves are adjusted with the engine cold. On no condition should the engine be running since the valves can strike against the piston and cause serious damage.

Make sure that the stop control is pulled out and the starting key is turned off.

Valve adjustments are done in accordance with the two-position method, but also each pair of valves are adjusted in two stages. The first stage is to adjust the valve caliper, the second to adjust the rocker arm play.

1



Remove the plug in the flywheel casing and attach cranking tool 998 3590.

2

Remove the delivery pipe and the fuel return pipe.

3

Remove all valve covers.

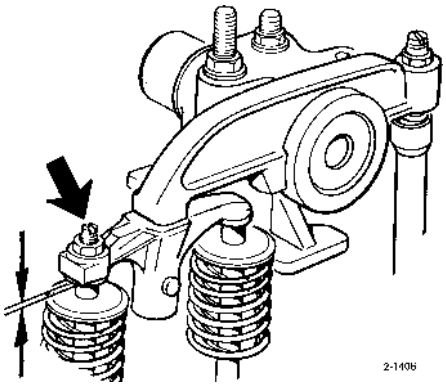
Note: After removing the valve cover, always check the torque on the studbolt to the rocker arm bridge. Correct torque **48 Nm (35.4 ft-lb)**.

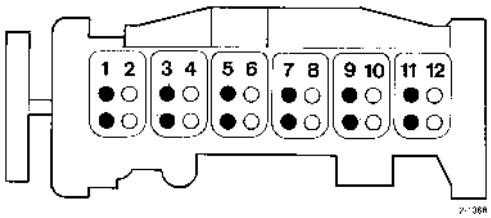
4

Crank the flywheel in the engine's direction of rotation until 1st piston is in the top dead center after the compression stroke (0° on the flywheel, both pairs of valves on 6th cylinder rocking).

Adjusting the valve caliper

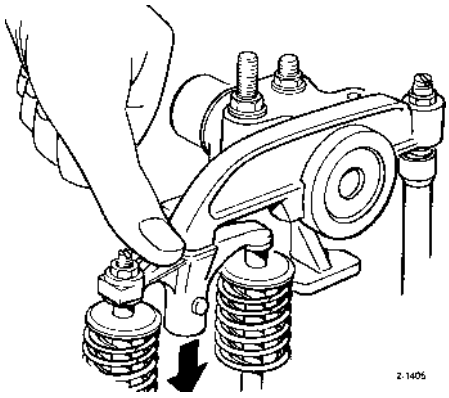
5





Slacken the lock nut and adjusting screw for the no. 1 pair of valves on 1st cylinder until there is play between the caliper and the valve stem.

6

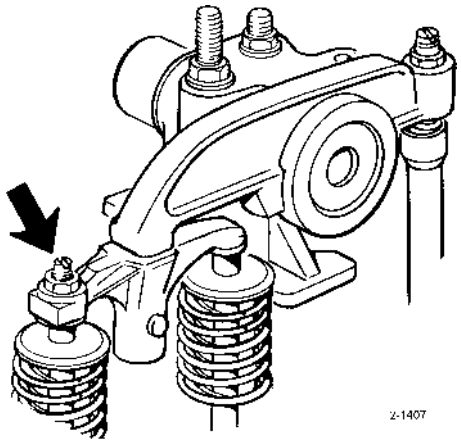


Press the valve caliper down.

7

Turn the adjusting screw until it touches the valve stem.

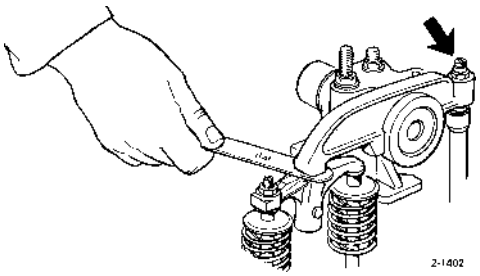
8



Turn it down a further 1/4 turn. Secure the adjusting screw with the lock nut.

Adjusting valves

9

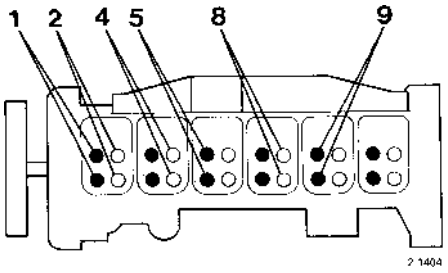


Adjust the valve clearance between the rocker arm and the valve caliper for pair of valves no. 1 of 1st cylinder.

Valve clearance:

○	**Inlet**	**0.30 mm (0.0118")**
●	**Exhaust**	**0.60 mm (0.0236")**

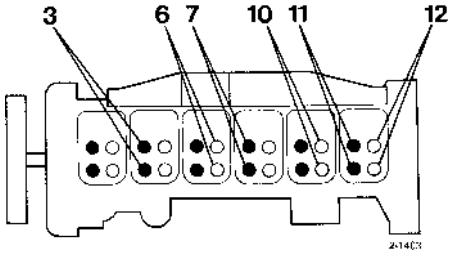
10



After adjusting the valve pair on 1st cylinder, repeat the procedures of 5, 6, 7, 8 and 9 above on valve pairs no. 2, 4, 5, 8 and 9.

11

Crank the engine with the flywheel one more full turn in its direction of rotation until 6th cylinder piston is at top dead center after the compression stroke and both valve pairs of 1st cylinder are rocking.



12

Repeat stages 5, 6, 7, 8 and 9 on valve pairs no.

13

On completion of adjustment, remove tool 998 3590 and fit the plug in the flywheel casing.

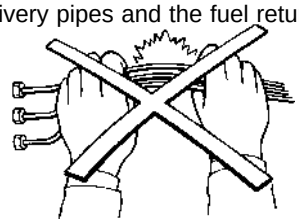
14

Fit all valve covers.

Torque: **20 Nm (14.8 ft-lb.).**

15

Fit the fuel delivery pipes and the fuel return pipes.



Note: Fuel delivery pipes must never be bent or altered. A damaged fuel delivery pipe should always be replaced with a new one.

16

Bleed the fuel system.

Copper sleeve for injectors, replacing

Special tools: 999 1801, 999 1819, 998 3590, 999 6400, 999 6960, 999 6975, 999 8007, 999 8134, 999 8140, 981 2546

1

Drain the coolant and disconnect the batteries.

2

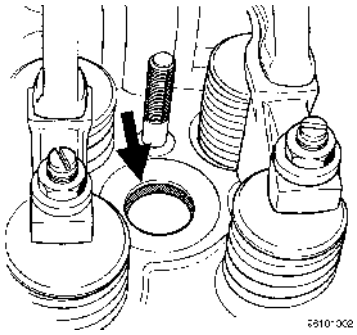
Remove the delivery pipe and the fuel return pipe.

3

Remove the appropriate valve cover on the cylinder where the copper sleeve is to be replaced.

4

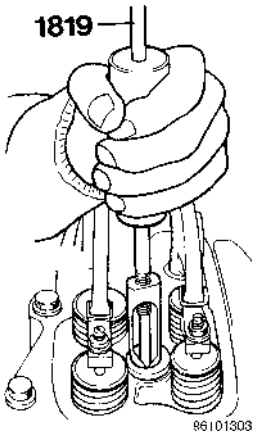
Remove the retainer and the injector, fitting a protective plug to the injector and in the delivery valve holder in the injection pump.



5

Remove the sealing ring from the steel ring.

6

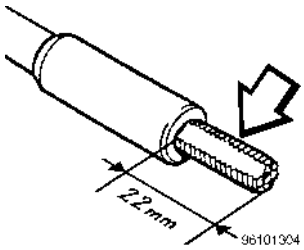


Remove the steel ring with puller 999 1819.

7

Rotate the engine until the piston in the cylinder where the replacement of the copper sleeve is to be carried out is in its lower position.

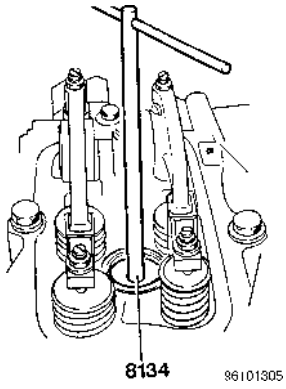
8



Grease the threaded tap on tool 999 8134.

Note: The grease ensures that swarf will not fall into the cylinder and cause damage. Set the tap so that it extends about 22 mm (0.87")

9

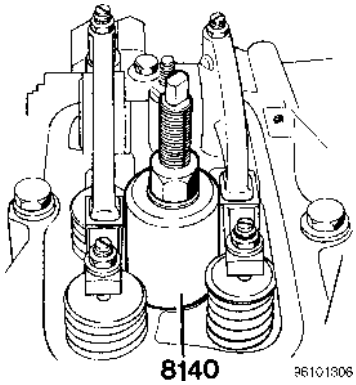


Make threads in the copper sleeve's tap with tool 999 8134.

10

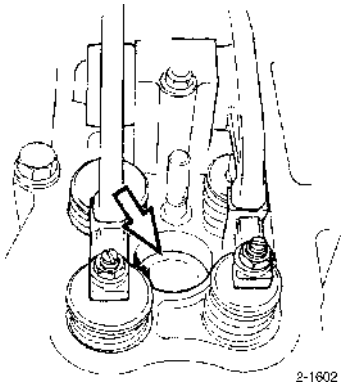
Remove the pin screw for the injector's yoke. Check that the screw on tool 999 8140 extends about 22 mm (0.87") from the tool.

11



Screw tool 999 8140 tight in the copper sleeve. Remove the copper sleeve from the cylinder head.

12

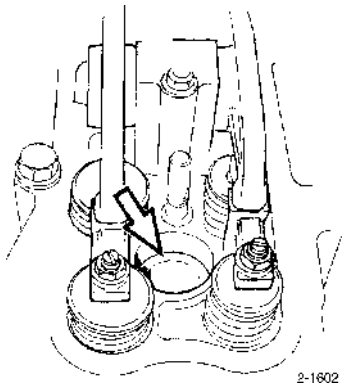


Remove the sealing ring of the copper sleeve from the cylinder head.

13

Clean the sealing surface between the cylinder head and the base of the copper sleeve. Tool 9812546 can be used for this purpose.

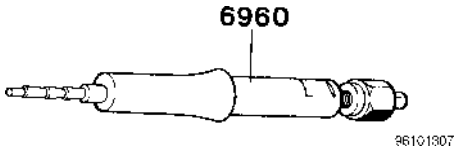
14



Fit a new sealing ring to the cylinder head.

15

Remove the reamer from tool 999 6960.

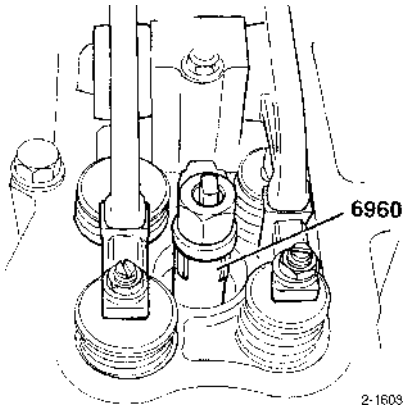


16

Fit a new copper sleeve to 999 6960. Fit the reamer.

17

Smear the inside of the copper sleeve with engine oil.



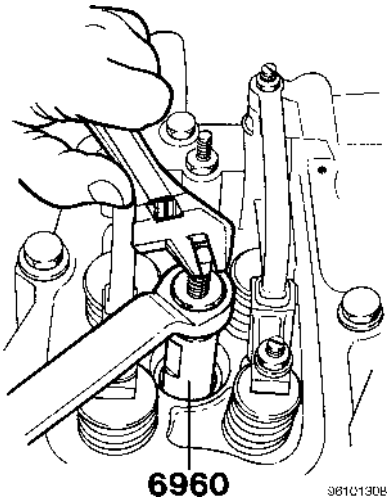
18

Fit the copper sleeve together with 999 6960 and the injector retainer to the cylinder head.

19

Screw down the retainer nut until the copper sleeve bottoms in the cylinder head.

20



Hold spindle 999 6960 and screw the nut down. The reamer will now be pressed up through the bottom section of the copper sleeve.

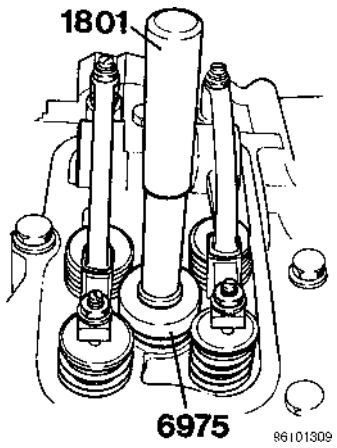
21

Screw down the nut until the reamer of the tool loosens from the copper sleeve.

22

Remove tool 999 6960.

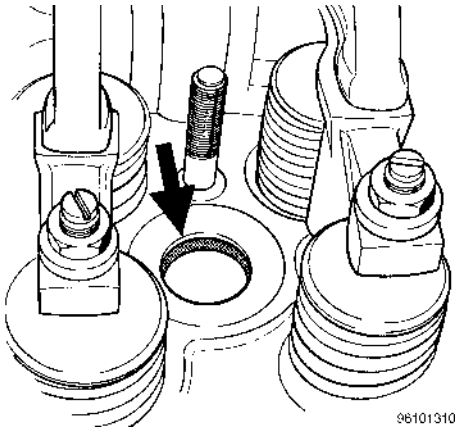
23



Put the steel ring for the copper sleeve onto drift 999 6975.

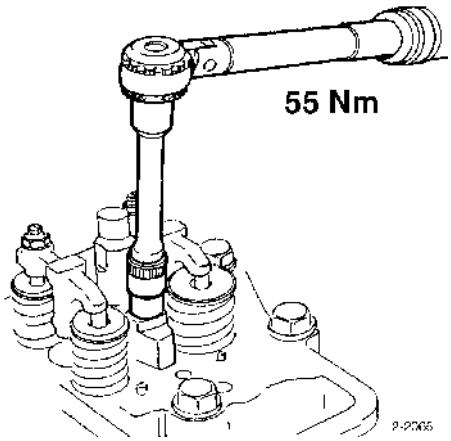
24

Tap down the steel ring carefully until the drift bottoms against the cylinder head face.



25

Insert a new sealing ring into the steel ring.



26

Fit the injector complete with retainer. Torque the injector to **55 Nm (40.6 ft-lb).**

27

Fit the valve cover.

28

Remove the protective plugs from the injector. Fit the delivery pipe and the fuel return pipe.

29

Fill with coolant.

30

Bleed the fuel system. Start the engine and check for leaks.

Cylinder liners and pistons, removing

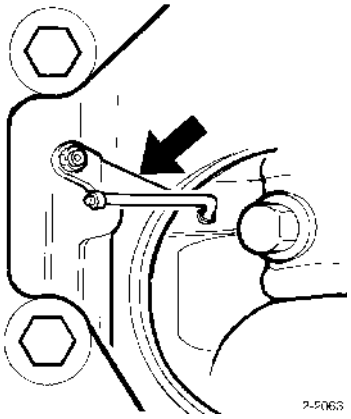
Special tools: 999 1801, 999 2529, 998 3590, 999 6394, 999 6395, 999 6645, 999 6963, 999 6966

1

Remove the pan and the cylinder head(s).

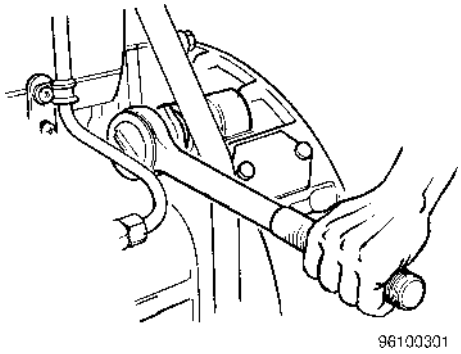
If the cylinder liner is to remain on the engine when the pistons are removed, the holders 999 6966 must be fitted so that the liner is not moved out of position. If the liner should glide up during removal of the piston then the liner should also be removed, since there is considerable risk that impurities will fall down between liner and block and cause leakage.

2



Remove the piston cooling nozzle for the cylinder in question.

3



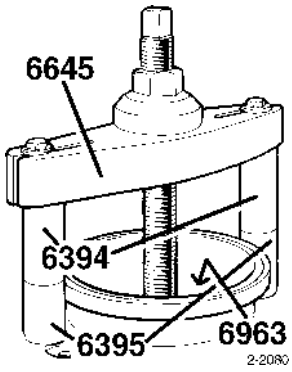
Remove the plug in the flywheel housing and fit cranking tool 3590. Turn the crankshaft so that the piston for the actual cylinder is at BDC.

4

Remove the big end cap. Tap up the connecting rod, with for example the handle of a hammer, so that the piston rings are released from the cylinder liner. Lift off the piston and connecting rod.

Note: Scrape off the soot edge on the upper part of the cylinder liner to simplify removal of the piston and connecting rod.

5

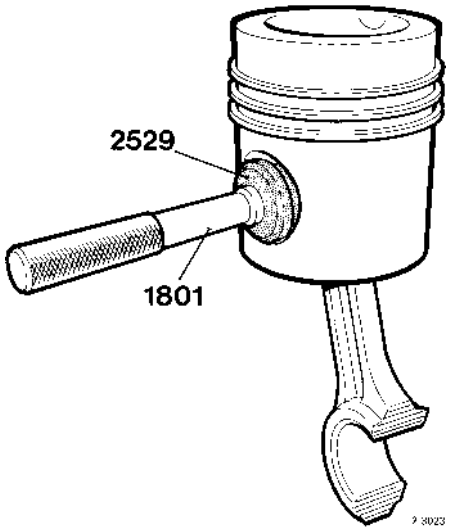


Mark the piston and liner before removing, to make sure that the same piston and liner are refitted in the same place as before.

Remove the cylinder liner with extractor 999 6645, support 999 6394 and 999 6395, and extractor plate 999 6963.

6

Remove the circlips for the gudgeon pin.



7

Tap out the gudgeon pin carefully with drift 999 and handle 999 1801.

8

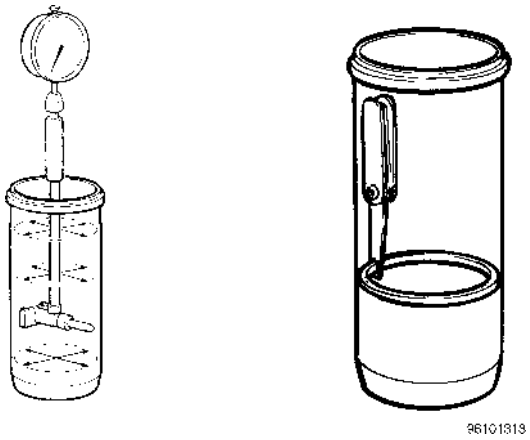
Remove the piston rings with a piston ring tool.

Cylinder liners, measurement and inspection

This check consists of measuring wear and checking for cracks.
Clean the cylinder liners thoroughly before measuring them.

Measure wear with a dial indicator.

Measuring is carried out at several positions diametrically, and also at different heights. To find out the actual amount of wear, first set the dial indicator with a gauge ring, using the cylinder liner original bore as a reference measurement.



Measure wear using a piston ring (alt.)

Liner wear is easily determined by placing a new piston ring at the upper turning position and measuring the piston ring gap. This is then compared with the piston ring gap below the lower turning point. The wear is determined by dividing the difference by 3.14.

Example:

Piston ring gap in unworn section: 0.6 mm (0.0236")

Piston ring gap at upper turning point: 1.80 mm (0.0709")

Difference: 1.80 mm–0.60 mm = 1.20 mm (0.0472")

Diameter wear: $\frac{1.20 \text{ mm}}{3.14}$ =0.38 mm (0.0150")

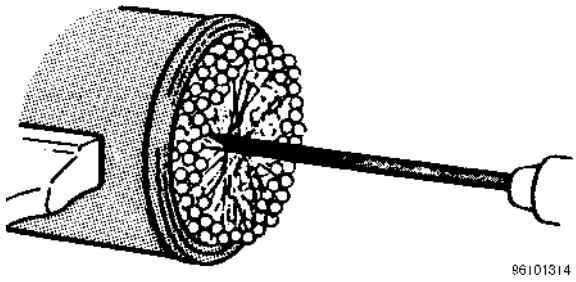
Wear tolerance:

If the wear is **0.45 - 0.50 mm (0.0177 - 0.0197")** the liner should be replaced. Like pistons, the cylinder liners are classified which means they must belong to the same class as the piston. The piston and cylinder liner sets are only available from stock as a single, complete unit.

Cylinder liners, honing

For good lubrication and sealing it is important that the liner walls retain the original honing pattern. See figure. Honing, to restore the pattern, is therefore to be carried out when:

- the cylinder liner has scratches (ring seizure, dirt)
- the cylinder liner has bright spots (polishing)



1

Mark the piston and liner before removing to make sure that the same piston and liner are refitted in the same place as before

2

Place the cylinder liner in a vise. See figure. Honing of the cylinder liner when installed in the block is not recommended due to the risk of oil channels becoming clogged and the difficulties to feed correctly.

3

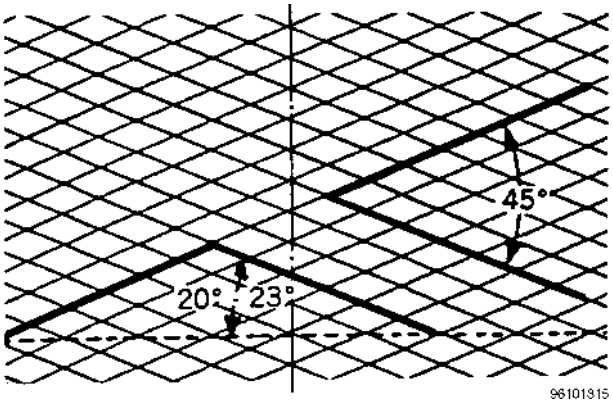
Remove the carbon edge at the top of the liner. Also clean under the liner collar and the recess in the block.

4

Use a low speed electric drill with a speed of 200- 400 rpm and a ”Flex-Hone” tool type GBD. Grade size 80.

Lubricate the cylinder liner with light engine oil before and during honing. Move the honing tool in and out of the cylinder liner at 60 strokes/min. (One inward and outward stroke per second.)

5



The cylinder liners have a honing pattern where the angles are carefully calculated to give optimal life span. See illustration.

When honing after a piston ring replacement, the original honing pattern must be followed to keep the lubrication properties.

The honing marks must be formed uniformly and cut evenly in both directions over all the cylinder surface.

Note: The correct speed must be maintained to obtain the correct pattern.

6

Clean the liner thoroughly after honing. Use warm water, a brush and detergent (never use thinners, kerosene or diesel oil). Dry the liner using paper or a cloth without nap. After drying, lubricate the liner with light engine oil.

Cylinder liner seats, reconditioning

Special tools: 999 2479, 999 9942, 999 6966, 998 9876

Note: Due to tight fitting on some engines, it may be impossible to turn the lining in the cylinder block.

Grinding with grinding paste under the liner collar can in such cases not be done. Checking of the contact pattern with marking paint cannot be done.

1

Fit the cylinder liner without sealing rings in the cylinder block and check the height of the sealing face. Make a note of the dial indicator reading.

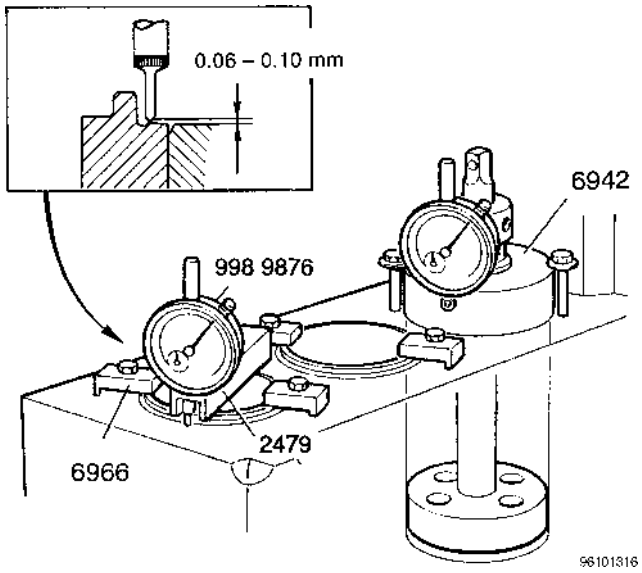
The correct height should be **0.06-0.10 mm (0.0024–0.0039")**.

Removed material is compensated by adding shims which are available in various thicknesses. The smallest possible number of shims should be used. Calculate the thickness of the shims considering the extent of the damage and the height of the sealing face above the cylinder block face.

2

Before milling the liner shelf, the surface should be roughened up with emery cloth in order not to blunt the sharpness of the cutter, particularly if the surface has been ground previously with grinding paste.

3



Prepare and fit milling tool 999 6942. Make sure that the tool collar runs free of the intermediate web of the block.

4

Fit the milling tool and yoke. The tool is bolted to the cylinder block. Place suitable flat washers under the bolt heads. Make sure that the feed bolt does not exert pressure on the tool.

5

Screw down the feed sleeve until it presses lightly against the milling tool. Use a T-handle with a 3/4" connection and a 25 mm socket to turn the milling tool. The milling tool should be turned with steady movements while turning the feed sleeve at the same time. Stop the feed and turn the mill a few turns. Check the contact surface of the liner seat and the height of the sealing face at regular intervals.

6

Engines with liners that cannot be turned:

When correct height has been achieved, stop the feeding and turn the milling tool some turns. Remove the milling tool and clean the liner shelf.

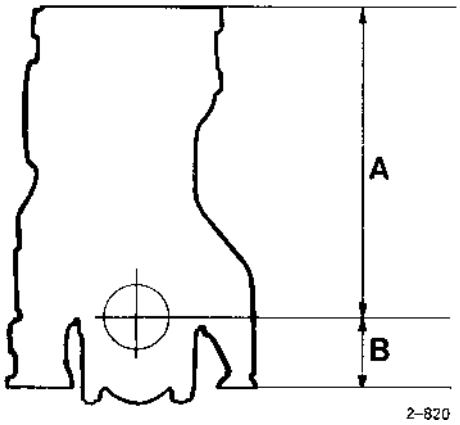
7

Engines with liners that can be turned:

When **0.02 mm (0.0008")** remains to the correct height, stop the feeding motion and turn the milling tool several times. Smear the bottom face of the liner collar with grinding paste. Fit the liner and rotate it back and forth until the paste is worn out. Remove the liner and carefully whip off the paste. Repeat this until there is good contact. Check the contact pattern with marking paint by rotating the liner back and forth and mark the liner so that it is fitted in the same position as when checking for contact. Clean all parts thoroughly.

Cylinder block, face-grinding

The cylinder block must not be ground below the minimum, specified measurements.



A = Height, upper block face - crankshaft center.

Min. 479.8 mm (18.9041")

B = Height, lower block face - crankshaft center.

Min. 119.9 mm (4.7241")

Note: After grinding the upper block face, the piston height must be measured. See, ”Cylinder liner with piston, fitting”.

Pistons, checking

Check the pistons for cracks and other damage. If the piston has deep lines around the sleeve surface it (liner unit) must be scrapped. Similarly, if the piston has one or several cracks in the gudgeon pin hole or in the bottom of the combustion chamber it shall also be scrapped. Cracks in the edge of the piston top around the combustion chamber are not serious as a rule. The crack test is carried out as per the powdered lime method.

Note: If cracks are found in the pistons the fuel injection volume should also be checked.

Pistons, fitting

Like the cylinder liners, the pistons are classified, this meaning that a certain class of piston can only be used in an equivalent class of cylinder liner. The piston and cylinder liner sets are only available from stock as a single, complete unit.

Piston rings, inspection

Check the wear surfaces and sides. Black spots on the surfaces point to poor contact, in which case the piston rings should be replaced. Piston rings should also be replaced if there is noticeable wear or the cylinders are out of round, since very often the rings do not take up the same position they had prior to removal. Oil consumption is also a matter of significant importance concerning the time at which piston rings should be replaced.

Connecting rods, inspection

Check for cracks. Check straightness and warping. Warped or twisted connecting rods should be scrapped. Check the connecting rod bushings, this is best done using a new gudgeon as a gauge. There should be no noticeable play.

Measuring is carried out in a fixture for checking connecting rods.
Straightness, max deviation 0.05 mm (0.0020") on a length of 100 mm (3.94").

Warp, max deviation 0.1 mm (0.0039") on a length of 100 mm

Connecting rod bushings, replacing

When replacing connecting rod bushings in a connecting rod of trapezoidal shape, the bushing must be line bored.

The bushing must be bored to give a fit which with the gudgeon pin oiled allows the pin to slide through slowly of its own weight **(temp. 17-20°C (63-68°F)**.

Following line boring, the connecting rods should be measured in the fixture to check that the hole in the bushing is placed correctly in the connecting rod.

Pistons, piston rings and connecting rods, assembling

Special tools: 999 1801, 999 2529, 998 3590, 885126

1

Fit one of the circlips to the piston.

2

Oil the gudgeon pin and the connecting rod bushings.

3

Heat the piston to about **100°C (212°F)**. Fit the piston and connecting rod with the arrow on the piston and the word **Front** on the connecting rod pointing in the same direction. Push the gudgeon pin in with drift 999 1801 and handle 999 1801.

Note: The gudgeon pin should enter easily, it must not be knocked in.

4

Fit the other circlip.

5

Check that the connecting rod moves smoothly in the gudgeon pin journalling.

6

Fit the piston rings to the piston using piston ring pliers. Make sure that the markings on the piston ring face upwards, and that the ring gaps are aligned. Fit the oil scraper ring first, it can be turned either way. The opening in the spring of the oil scraper ring should sit opposite the oil ring’s opening.

Cylinder liners and pistons, fitting

Special tools: 999 2000, 999 2479, 998 3590, 999 6236, 999 6394, 999 6395, 999 6645, 999 6963, 999 6966, 999 6967, 998 9876, 885126

1

Carefully clean the liner seat in the cylinder block. Any rust or deposits on the sealing surfaces must be fully removed. Use a cleaning fluid and a brass wire brush, blowing dry with compressed air.

Note: Scraping tools must not be used!

Also clean the grooves for the lower liner seals.

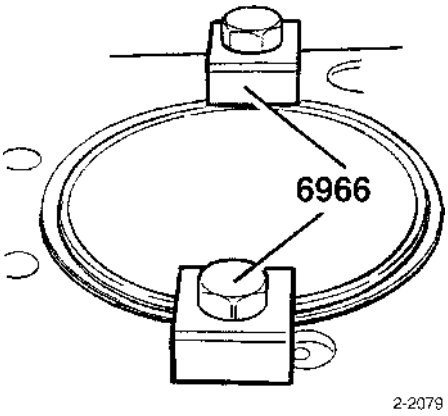
2

If the liner seat is damaged, it must be repaired. See, ”Cylinder liner seats, reconditioning”.

3

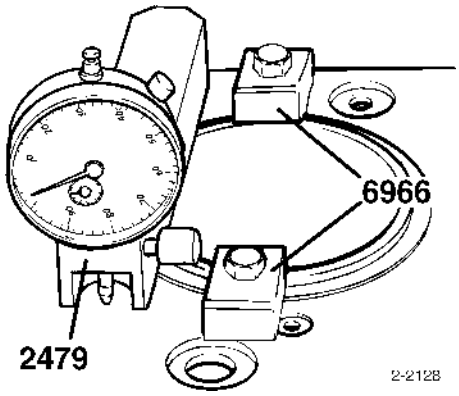
Fit the liner without sealing rings into the cylinder block.

4



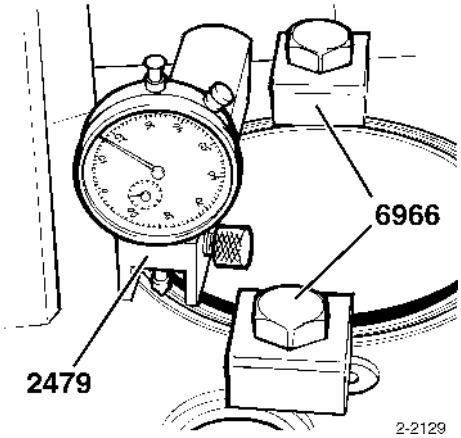
Fit clamping tool 6966 6966 (two) to hold the liner in position.

5



Fit a dial indicator to holder 999 2479 and set the dial indicator to zero against the cylinder block.

6

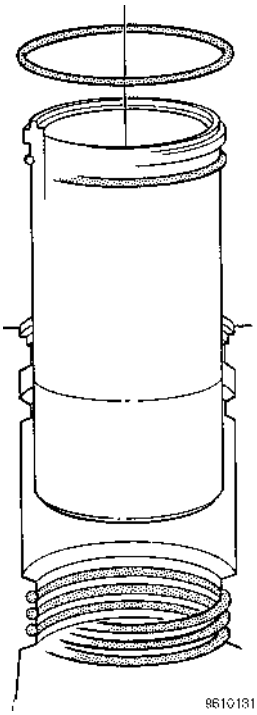


Put the tip of the dial indicator against the liner edge and make a note of the liner height. This measurement is repeated in four different places on the liner. The height of the liner above the cylinder block should be **0.06-0.10 mm (0.0024–0.0039")**.

7

Mark the position of the liner in the cylinder block using a felt tipped pen, for example, and remove the clamping tools and then the liner.

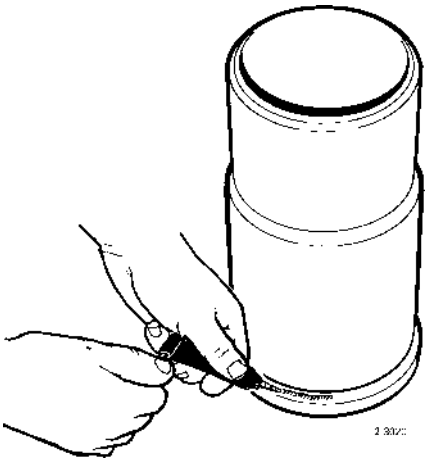
8



Fit the sealing rings into the cylinder block.

Note: Lubricate the three lower rings with the lubricant provided in the ring kit. The lower ring (1543373) is violet.

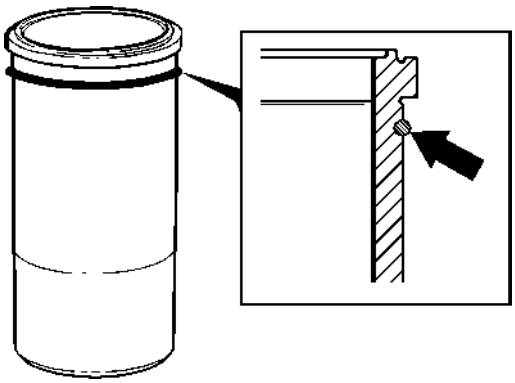
9



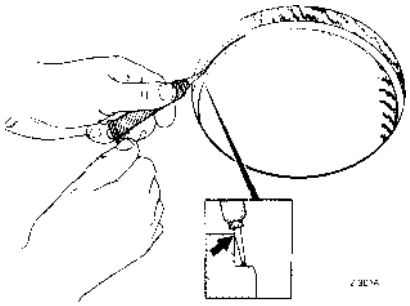
Apply an even and max **0.8 mm (0.0315")** thick bead of sealant (Part no. 1161277-7) to the cylinder liner.

Note: Too much silicone will damage the engine.

10



Fit the sealing ring under the liner collar and place the ring about 8 mm below the collar.



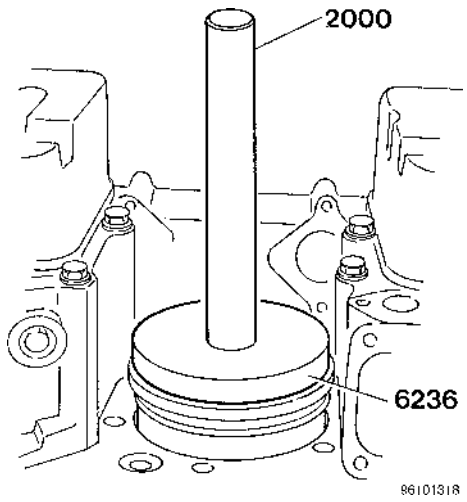
Note: In the case of shims being used for the liner, apply the bead of sealant to the liner shelf in the cylinder block.

Note: Do not apply sealant between the shims and the liner collar.

After applying the sealant, the liner must be installed within 20 minutes. The liner must be clamped down with the clamping tool. The clamping force must not be removed before the cylinder is in place and torqued.

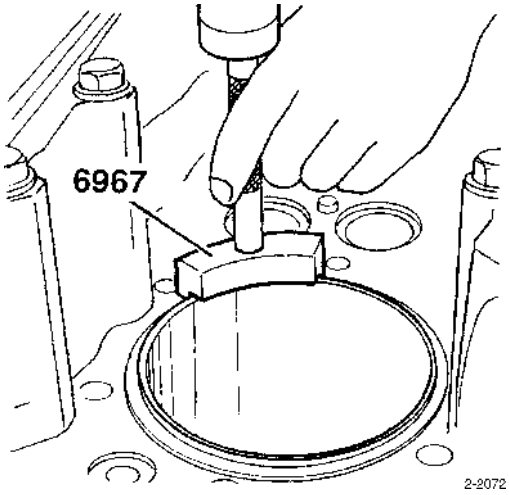
When fitting the pistons or if the engine is to be cranked, all cylinder liners must be locked down with the clamping tools to prevent movement occurring between the liner and block.

11



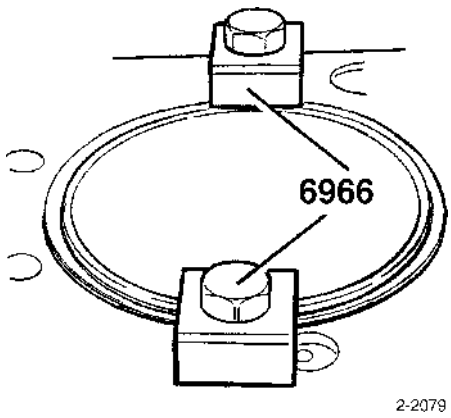
Install the liner in the cylinder block aligning to the previously made marks. Use standard handle 999 2000 and drift 999 6236. Press with care.

12



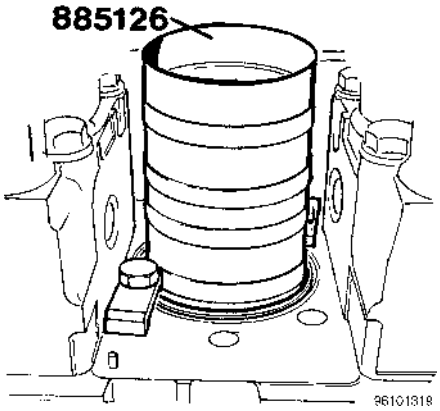
Fit the sealing ring between the block and the collar of the liner. Use drift 999 6967.

13



Fit the clamping tool.

14



Oil the piston and put it into the liner with the marking (arrow) pointing forward.

15

Check that the bearing shells are a correct fit to the connecting rod and caps. Screw down the caps according to the markings, using a torque of **250 Nm (184.5 ft-lb)**.

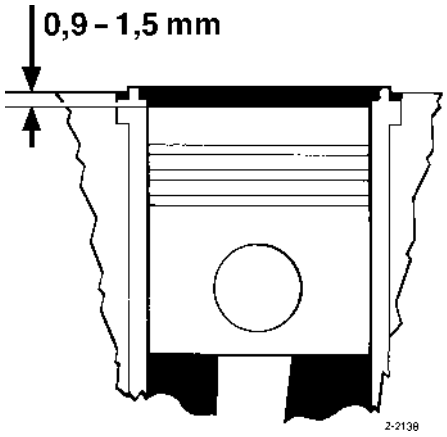
16

Fit the piston cooling nozzle. Torque the nozzle nut to **25 Nm (18.45 ft-lb).**

17

Check the piston height beneath the face of the cylinder block. Turn the engine, using tool 998 3590 until the piston is in T.D.C. (0° on the flywheel).

18



Correct piston height **0.9–1.5 mm (0.0355–0.0591")**.

19

Remove tool 3590 from the flywheel casing and fit the plug.

20

Remove the clamping tools from the cylinder liner when the cylinder head is to be refitted.

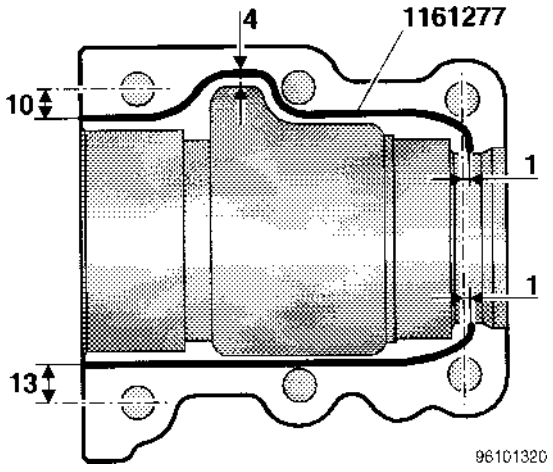
Sealant between the fuel injection pump bearing housing and the cylinder block TAD1630/TID162/ TWD1620/ TWD1630/ TD164KAE

In case the fuel injection pump bearing housing has to be removed, new guide sleeves should be installed and sealant applied prior to assembly on the engine block.

Note: The fuel injection pump bearing housing is co-machined with the engine block and therefore should not be replaced separately.

Installation

1



Apply a **2 mm (0.080")** thick string of sealant on the fuel injection pump bearing housing. Install and tighten the screws within **20 minutes**.

2

Install the bearing housing on the engine block. Tighten the screws until the bearing housing is tight against the engine block.

3

Install the transmission gear casing. Se ”Sealant, timing gear casing, replacing”.

4

Mount the screws through the timing gear casing. Tighten the screws until the bearing housing is tight against transmission gear casing. Tighten the screws alternating in three steps to the torque indicated below. Start by tightening the screws going through the bearing housing and the engine block.

Screws: Bearing housing - cylinder block

Torque: **53 ±5 Nm (39 ±4 ft-lb)**

Screws: Transmission gear casing - bearing housing

Torque: **35 ±4 Nm (26 ±3 ft-lb)**

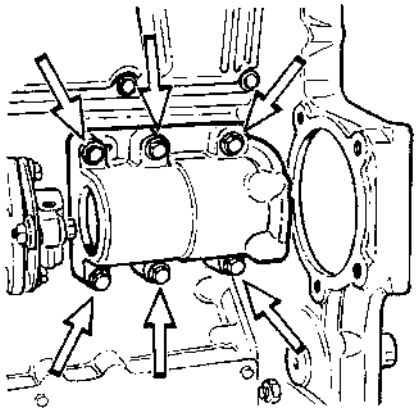
Sealant between the fuel injection pump bearing housing and the cylinder block TAD1631

Note: The fuel pump bearing housing is co-machined with the engine block and therefore should not be replaced separately.

1

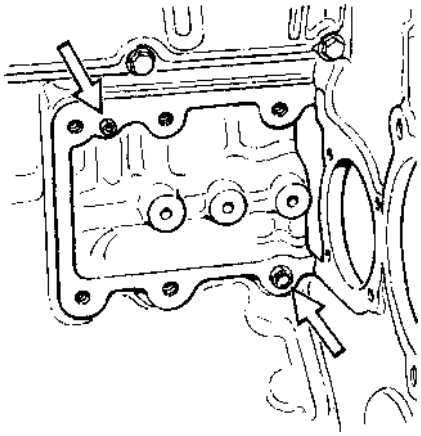
Remove pivot shaft from bearing housing.

2



Remove screws and carefully remove bearing housing from timing cover and cylinder block.

3



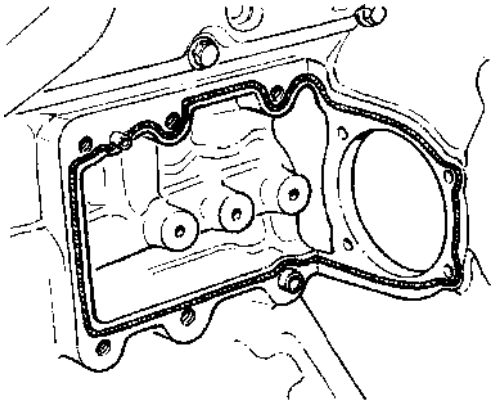
Remove locating pin and guide sleeve from cylinder block.

4

Clean bearing housing as well as cylinder block and timing cover contact surfaces.

Install a **new** locating pin and a **new** guide sleeve.

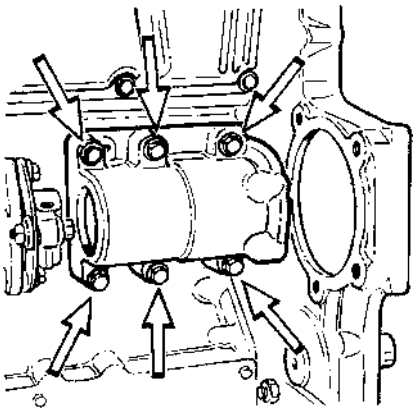
5



Apply a **2 mm (0.08")** bead of sealing compound (part No. 1161277) around the cylinder block and timing cover. See figure.

Note: Bearing housing and thrust washer screws must be installed and tightened within. **20 minutes**.

6



Install bearing housing with a new O-ring against the timing cover. Tighten screws in cylinder block.

Note: Tighten screws alternately until the bearing housing is in contact with the cylinder block.

Then torque screws alternately in three stages to **65 Nm (47.9 ft-lb)**.

7

Replace bearing housing seal ring.

8

Clean the bearing housing carefully. Lubricate bearing bushings and shaft.

9

Install pivot shaft in bearing housing. Install thrust washer and torque to **24 Nm (17.7 ft-lb)**.

Seal on output shaft from timing gear to injection pump, TAD/1630/ TID162/TWD1620/ TWD1630/ TD164KAE, replacing

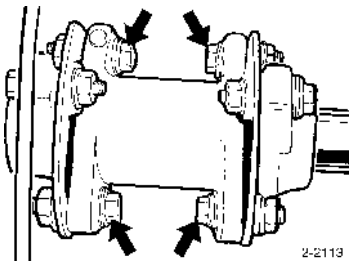
Special tools: 999 8011, 999 8012, 999 8017

1

Disconnect the batteries.

2

Remove the protection plate for the pump coupling.



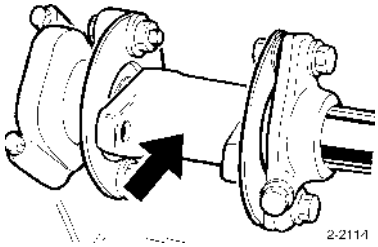
3

Remove the bolts (four) holding the pump coupling.

Note: Do not remove the bolts which hold the flange discs to the flange since this would alter the setting of the injection pump. Do not turn the injection pump or the engine.

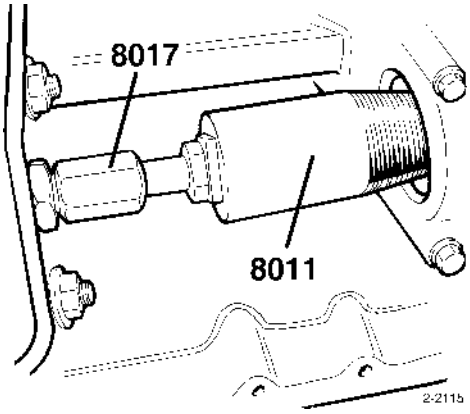
4

Remove the clamp screw holding the flange to the shaft.



5

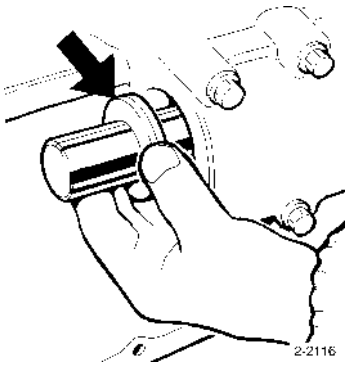
Remove the pump coupling and the flange. Clean the shaft from paint before fitting puller 999 8011 to remove the seal.



6

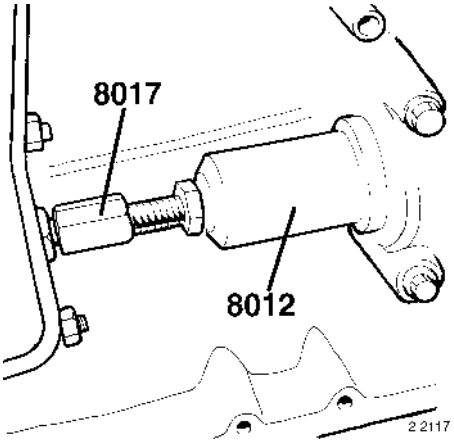
Remove the seal by screwing puller 999 8011 into the seal.

Note: Push simultaneously on puller 999 8017 so that the puller threads cut into the steel ring of the seal. Remove the seal by threading in the screw.



7

Lubricate the lips of the new seal. Oil the shaft. Fit the seal to the shaft.



8

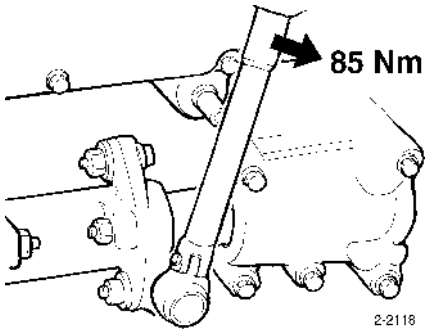
Push in the seal using tool 999 8012 and 999 8017 until tool 999 8017 bottoms against the shaft.

9

Fit the flange to the shaft.

10

Fit and tighten by hand the bolts on the pump coupling.



11

Torque the clamp screw to **85 Nm (62.7 ft-lb).** Torque the bolts on the pump coupling to **56 Nm (41.3 ft-lb)**.

12

Check the setting of the injection pump. See ”Fuel System, setting the injection angle”.

13

Fit the protection plate for the pump coupling.

14

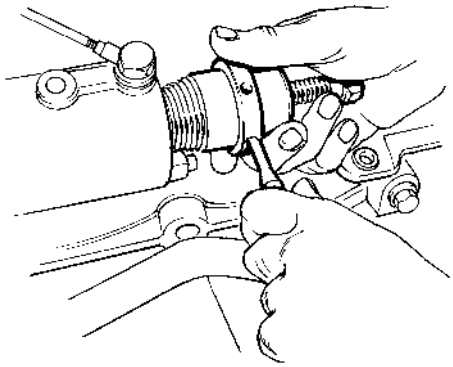
Connect the batteries.

Seal on output shaft from timing gear to injection pump TAD1631, replacing

Special tools: 999 8011, 999 8012

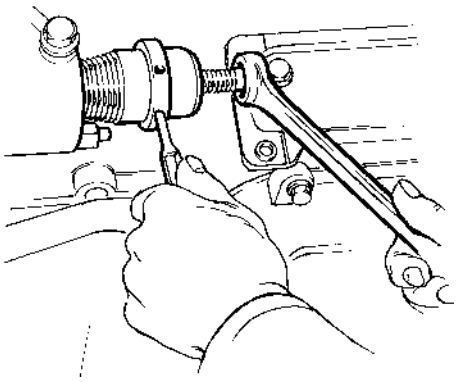
To replace the sealing ring in the bearing housing the fuel injection pump and pump coupling must be removed. See ”Removing the injection pump”.

1



Screw puller 999 8011 into the sealing using a drift. Press on the extractor at the same time so that its threads cut into the steel ring of the seal.

2



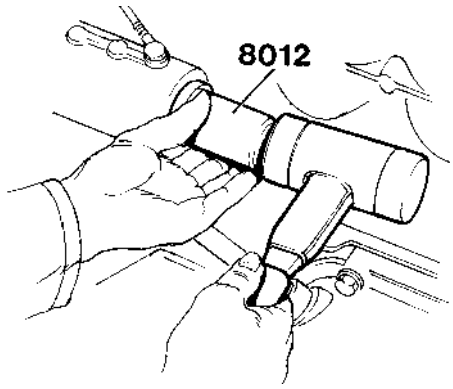
Pull out the old seal by unscrewing the extractor. Hold the outside of the extractor in place with the drift.

3

Clean the shaft and the seal seat. Lubricate the new seal and shaft.

Note: Make sure no contaminants enter the housing.

4



Locate seal ring on shaft and tap it in until the seal is level with the bearing housing. Use drift 999 8012.

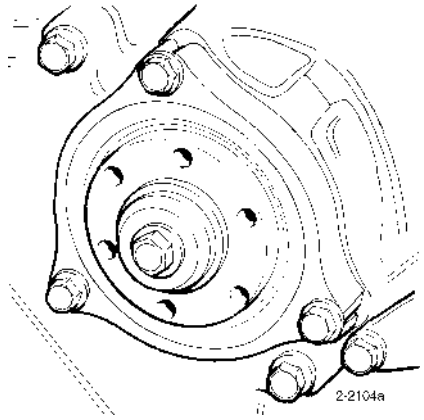
5

Install flange, pump coupling and injection pump. Check the injection angle, se ”Fitting and adjusting the injection pump”.

Front sealing ring for coolant pump, replacing

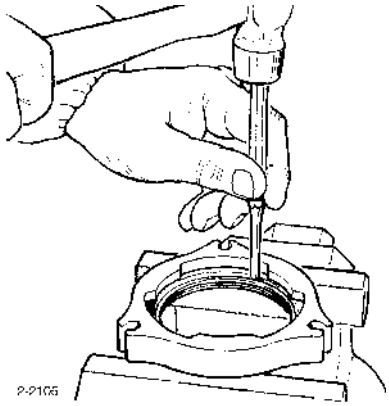
Special tools: 999 2000, 999 2929

1



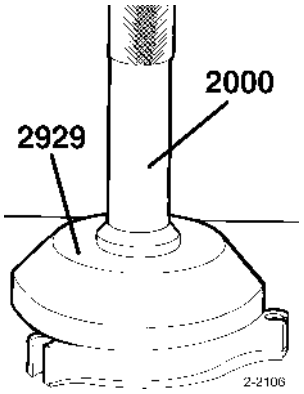
Remove the drive belt and the belt pulley and the holder from the timing cover.

2



Remove the sealing ring from the holder.

3

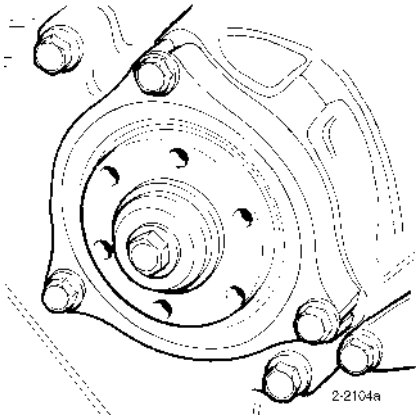


Press the new sealing ring into the holder using tools 999 2000 and 999 2929.

4

Place a bead of sealant on the mating surface of the timing gear cover.

5



Fit the holder on the timing cover.

6

Fit the belt pulley and the drive belts.

Sealant, timing gear cover, replacement

Disassembly

1

Set the electrical circuit breaker on **0** and drain off the coolant.

2

Remove the radiator and the charge air cooler (TAD- engines) along with hoses and connections.

3

Remove the electrical wires from the alternator. Remove the alternator drive belts, the alternator and the alternator bracket. Remove the driving pulley from its hub.

4

Remove the coolant pump sealing ring retainer.

5

Remove the fan belts. Remove the fan and the fan hub.

TWD1620G/GH, TID162AG, TWD1630G/GE, TAD1630/ TAD1631/G/GE:
Remove the outer torsional vibration damper and the pulley.

6

Remove the six front oil pan bolts.

7

Remove the bolts holding the timing gear cover. The through-bolts too.

8

Remove the timing gear cover. Use a screwdriver as leverage and place it at relevant spots. Tap carefully on the cover with a rubber mallet.

IMPORTANT! Make sure not to damage the oil pan gasket. Should the oil pan gasket be damaged, the pan must be removed and the gasket replaced.

Assembly

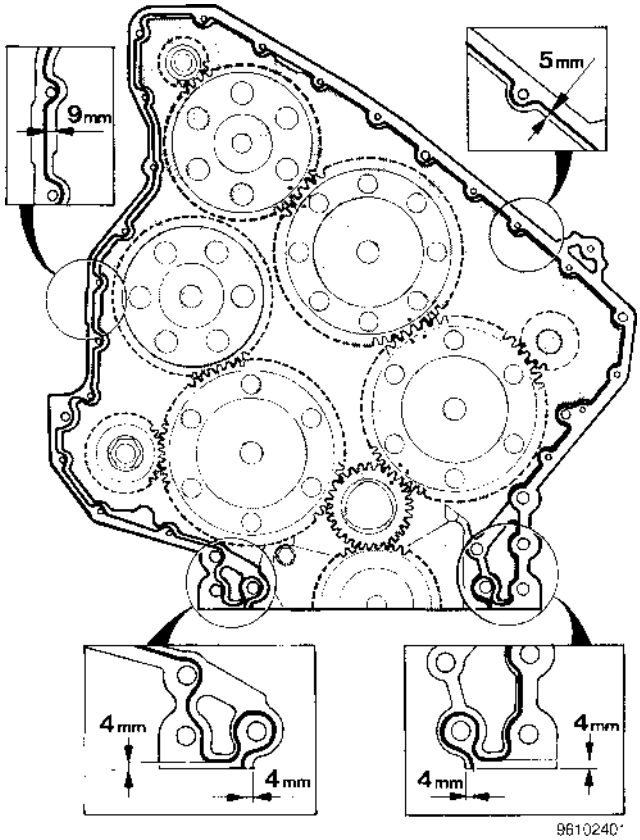
9

Remove the possible sealant residue from the timing gear cover and the timing gear housing.

10

Apply a new string of sealant the timing gear cover. See figure. Use sealant part no. 1161231-4. Install the timing gear cover within **20 minutes**.

11



Install existing cable clamps on the timing gear cover bolts. Install the alternator along with its bracket.

12

Tighten the timing gear cover bolts and the oil pan bolts. Torque:

M8	**24 Nm (17.7 ft-lb)**
M10	**48 Nm (35.4 ft-lb)**
M14	**140 Nm (103.3 ft-lb)**

Oil pan bolts: See "Workshop manual, Technical Data".

13

Install the coolant pump sealing ring retainer. See: Front sealing ring for coolant pump, replacing".

14

Fit the pulley and the outer torsional vibration damper (if any). Torque **48 Nm (44.3 ft-lb)**

Note: Check the condition of the sealing ring and the wear ring.

15

Install:

The fan hub, the fan and the fan belts. The alternator driving pulley on the coolant pump axle. The alternator bracket and the alternator drive belts. The radiator along with hoses and connections.

Connect the electrical wires to the alternator.

16

Fill up with coolant and set the electrical circuit breaker in "on" position. Check to make sure that there are no leakages.

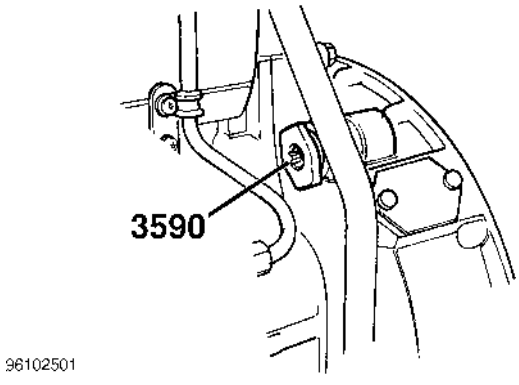
Timing gears, removing

(with the timing gear cover removed)

Special tools: 999 3590, 999 2658, 884994

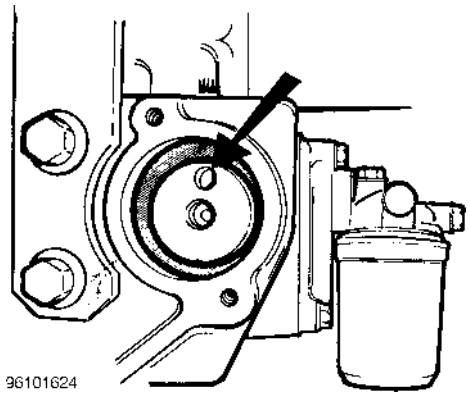
The following method should be used to avoid damaging the valve mechanism:

1



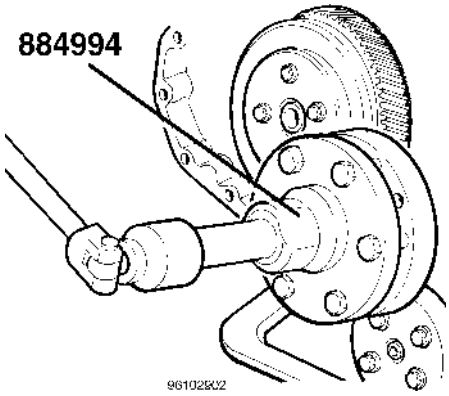
Remove the plug in the flywheel. Fit tool 999 3590. Remove the inspection cover for the camshaft on the rear of the engine. Rotate the engine until the marked hole on the camshaft's end is pointing up. See figure.

2



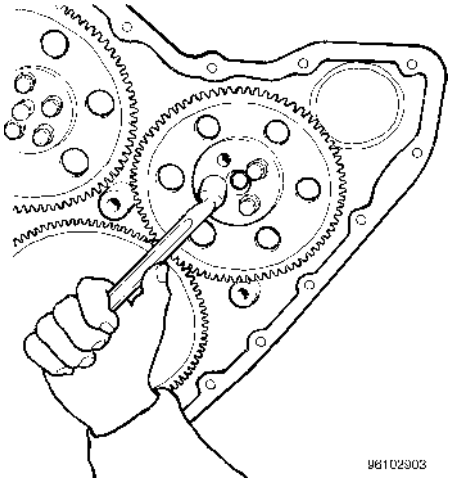
Remove the vibration damper.

3



Undo the central screw on the polygon hub. Counter with tool 999 3590. Pull off the polygon hub with tool 884994.

4



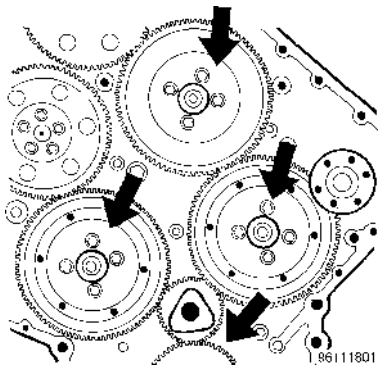
Release the tension in the camshaft drive's screws.

Note: The camshaft must be fixed. If the motor is rotated, the valves can be damaged if it is not synchronized with the camshaft. The camshaft drive should be removed last.

5

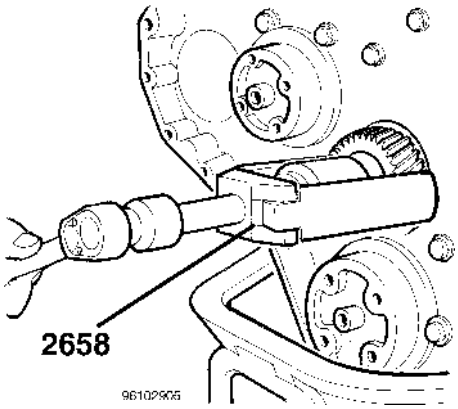
Using a felt tip pen, mark the injection pump's drive against the intermediate drive and the crankshaft drive. Thus the injection pump's adjustment will be maintained during work.

6



Remove all four intermediate gears.

7



Remove the crankshaft drive with puller 999 2658. Remove the key.

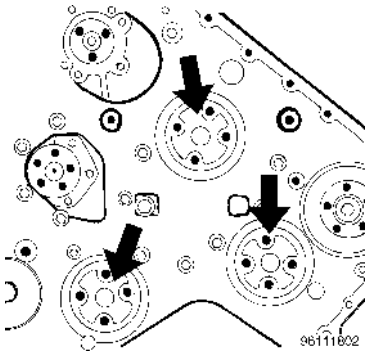
8

Remove the drives for the injection pump and the camshaft last.

Intermediate gears, replacing bearing

1

Disconnect the hub to the intermediate gears, and thrust washers.

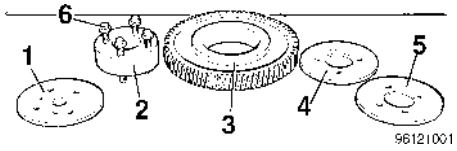


2

Dry the mating surfaces so that they are clean. Fit new thrusts washers, lubricated with engine oil. Then fit the hub and the intermediate gears.

3

Dry the mating surfaces so that they are clean and fit new outer thrust washers, lubricated with engine oil. Then fit the bearing brackets.

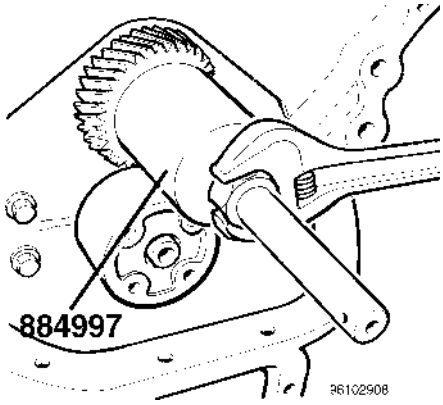


1. Inner thrust washer
2. Hub
3. Intermediate gear
4. Outer thrust washer
5. Bearing bracket
6. Screws (4 ea)

Timing gears, fitting

Special tools: 884995, 884997

1



Fit the crankshaft drive using a key. Use tool 884997. Tighten until the drive meets the base.

2

Fit all intermediate gears (4pcs). Check that the markings on the drives match. See figure. Torque the drives to **65 Nm (48 ft-lb).**The intermediate gear for the oil pump shall be torqued to **48 Nm (35.4 ft-lb).**

3

Fit the camshaft drive. Check that the marking agrees with that on the intermediate drive. Torque the drive to **60 Nm (44.3 ft-lb).**

4

Fit the injection pump drive.

Note: If the drive has not been previously marked, the injection pump must be adjusted. Torque the drive to **58 Nm (42.8 ft-lb) (TAD1631: 65 Nm (48 ft-lb), TD164KAE: 74 Nm (54.6 ft-lb).**

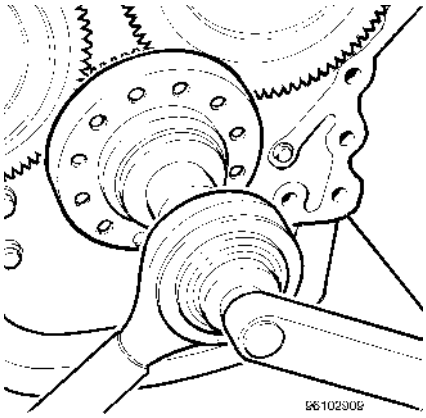
5

Grease the crankshaft journal with molybdenum disulfide. Fit the centering section of drift 884995 on the crankshaft journal.

6

Heat the polygon hub to a temperature of **100°C (212°F).** Fit the hub using drift 884995.

7



When the hub has cooled off, torque the crankshaft's central screw to **640 Nm (472.3 ft-lb).**

8

Place the vibration damper on the hub before fitting the timing gear cover.

Polygon hub, replacing

(with the timing gear cover removed)

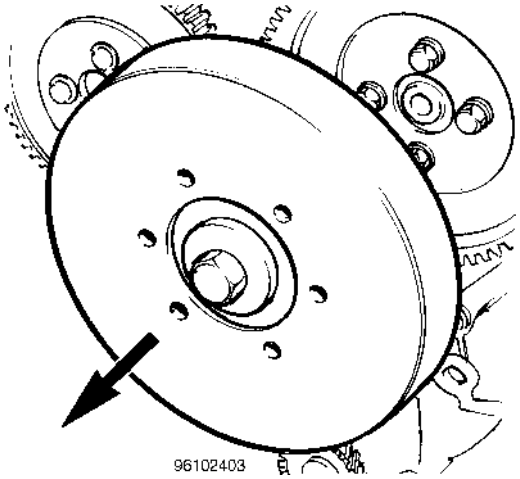
Special tools: 999 3590, 884994, 884995

Removal

1

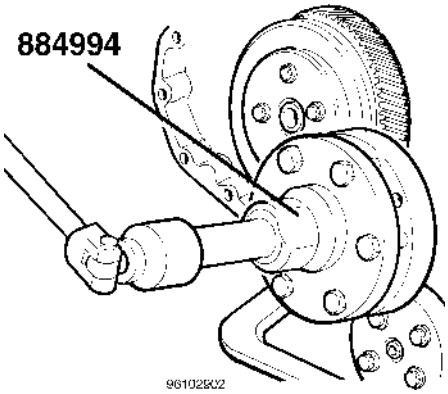
Block the flywheel.

2



Remove the vibration damper.

3



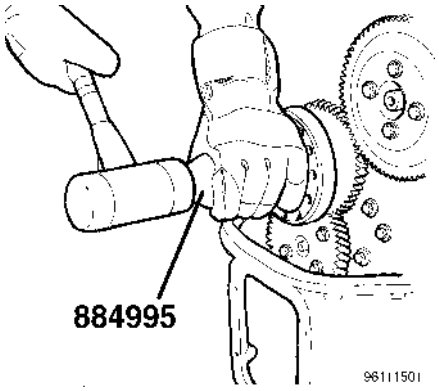
Undo the central screw on the polygon hub. Counter with tool 999 3590. Pull off the polygon hub with tool 884994.

Refitting

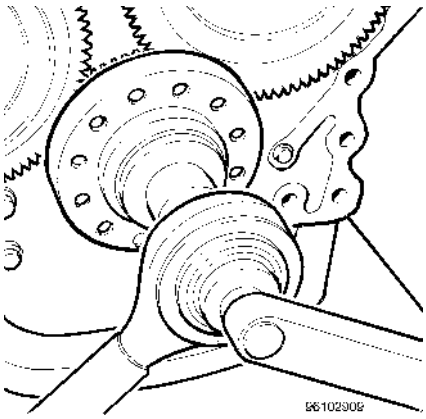
4

Check the polygon hub and its contact face on the crankshaft. Any cutting marks are to be removed with fine emery cloth.
Grease the crankshaft journal with molybdenum disulfide. Fit the centering section of drift 884995 on the crankshaft journal.

5



Heat the polygon hub to a temperature of about **100°C (212°F)**. Fit the hub using drift 884995.



6

When the hub has cooled off, torque the crankshaft's central screw to **640 Nm (472.3 ft-lb).**

7

Place the vibration damper on the polygon hub before fitting the timing gear cover.

Sealant, timing gear casing, replacing

(Timing gears, servo pump, air compressor and coolant pump removed)

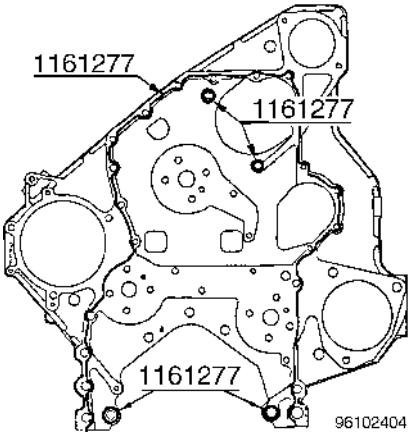
1

Remove the bolts and lift off the timing gear casing.

2

Clean the contact surface on the cylinder block and on the timing gear casing carefully.

3



Apply a new string of sealant on the timing gear casing, **2 mm (0.080")** thick. See figure. Use sealant Part no. 1161277. Install the casing within **20 minutes**.

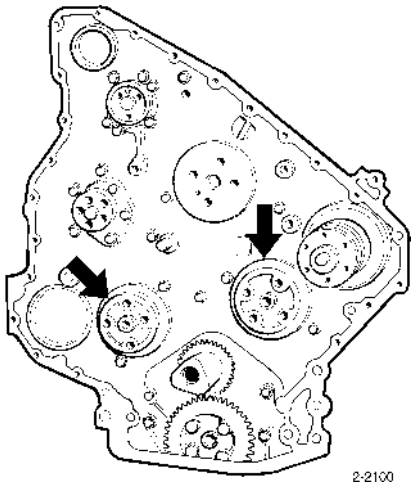
Note: The gasket (used on early engines) is replaced by sealant.

4

Lift the casing into position on the cylinder block and fit all of the bolts.

Note: Do not yet tighten the bolts.

5



Center the timing gear casing using the injection pump and the coolant pump hubs of the intermediate gears.

6

Torque the casing bolts to **35 Nm (25.8 ft-lb).**

Camshaft, checking for wear

Special tools: 999 3590, 999 6390, 999 9696, 998 9876

1

Remove the delivery and fuel return pipes. Fit protection plugs to the injectors and the injection pump.

2

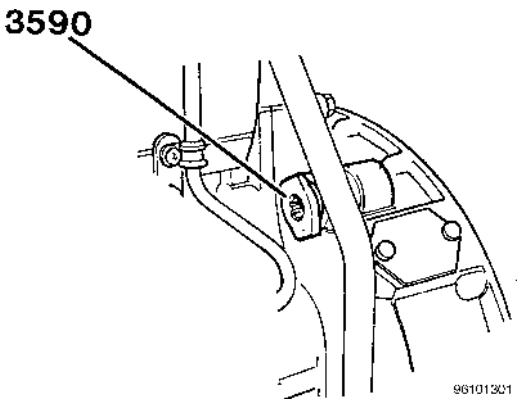
Remove all valve covers.

3

Remove all rocker arm assemblies and push rods.

Note: Mark the push rods or keep them in their proper order on a rack so that they can be put back in their original positions in the engine.

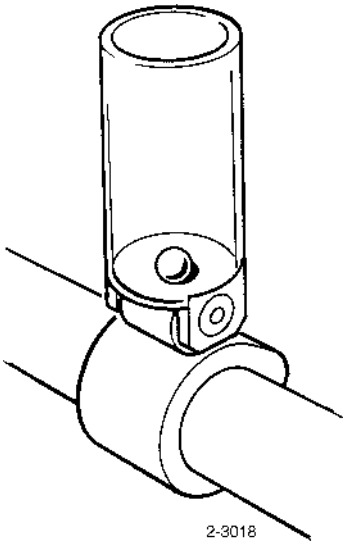
4



Remove the Plug from the flywheel casing. Fit cranking tool 999 3590.

5

Put a steel ball in the bottom of no. 1 tappet.



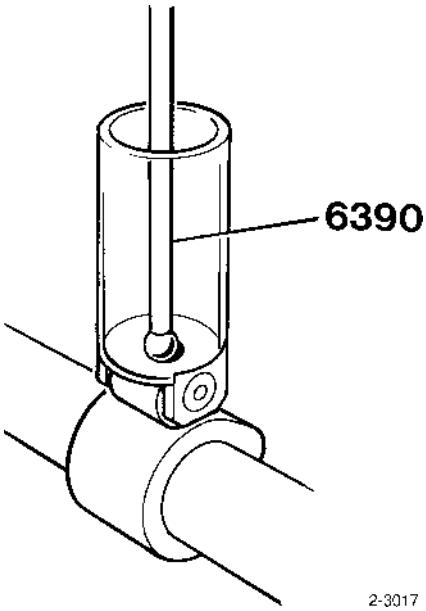
6

Fit tip 999 6390 to the dial indicator.

7

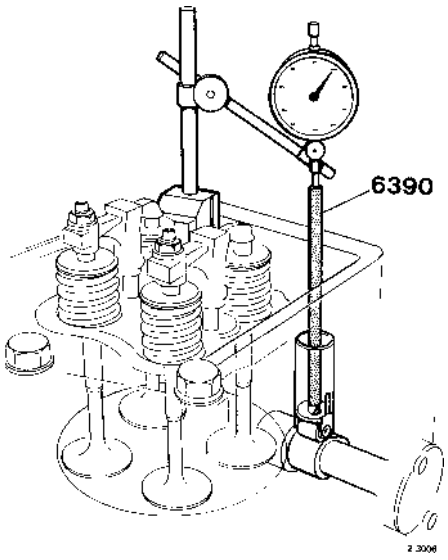
Attach the dial indicator to a magnetic stand.

8



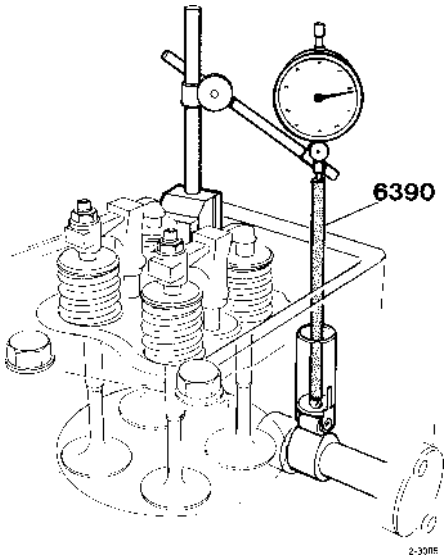
Put the magnetic stand on the front cylinder head. Start check-measuring at no. 1 valve tappet. Make sure that 999 6390 is on top of the steel ball.

9



Crank the engine until 999 6390 is at its bottom position. Make sure that the tip of the dial indicator is pre-loaded. Set the dial indicator to zero.

10



Crank the engine around until the tip of the dial indicator is in its top position. Make a note of the dial indicator reading. The lifting height must not be less than.

Min. inlet 7.80 mm (0.3073").

Min. exhaust 7.35 mm (0.2896").

11

Check the lifting height on all the other cams of the camshaft in this same manner.

12

Remove the magnetic stand, the dial indicator and the steel ball.

13

Fit the push rods in the order they were fitted previously.

14

Fit the rocker arm assemblies.

15

Adjust the valves, fit the valve covers.

16

Fit the delivery and fuel return pipes.

17

Remove tool 999 3590 from the flywheel casing, fit the plug.

Camshaft, replacing

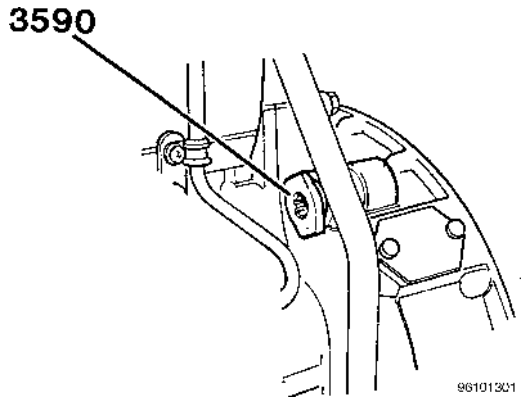
(with the timing gear cover removed)

Special tools: 999 3590, 999 6454, 999 6970

1

Remove all delivery pipes, return pipes and valve covers. Fit protection plugs to the injectors and the injection pump.

2

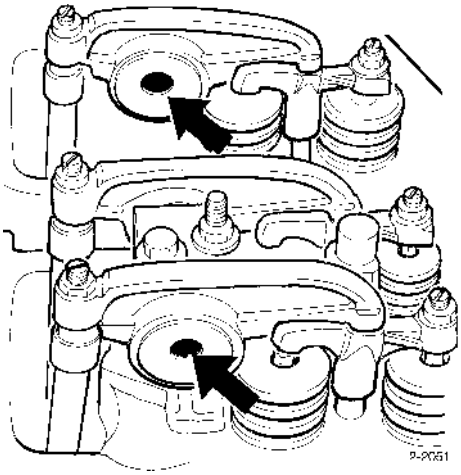


Remove the plug from the flywheel casing and fit cranking tool 999 3590. Remove the inspection cover.

3

Crank the engine until 1st piston is at its T.D.C. after the compression stroke (0° on the flywheel).

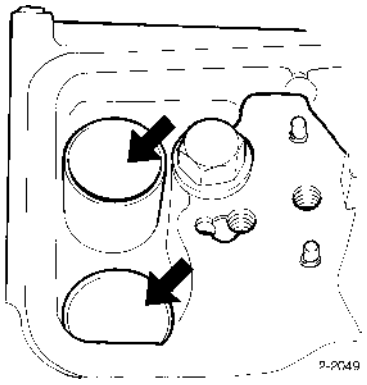
4



Remove all rocker arm assemblies and push rods. Remove the camshaft inspection covers.

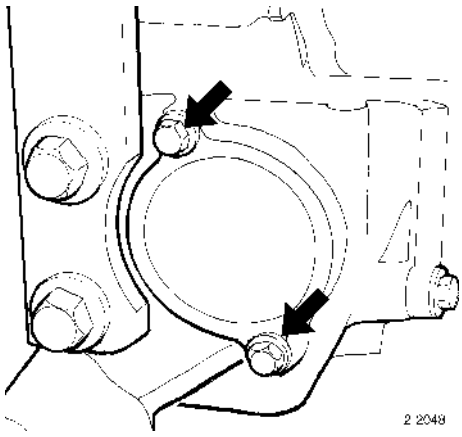
Note: Place the push rods in their proper order on a rack so that they can be put back in their original positions in the engine.

5



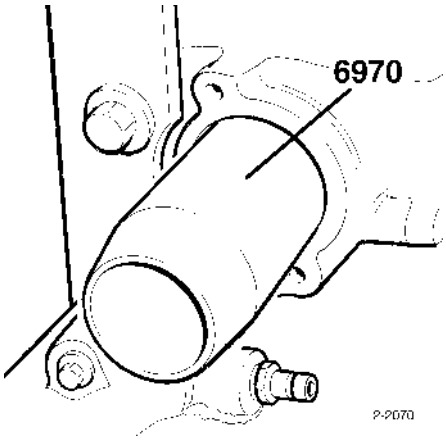
Lift up all of the tappets. Place them in order on a rack so they can be refitted in their correct positions in the engine.

6



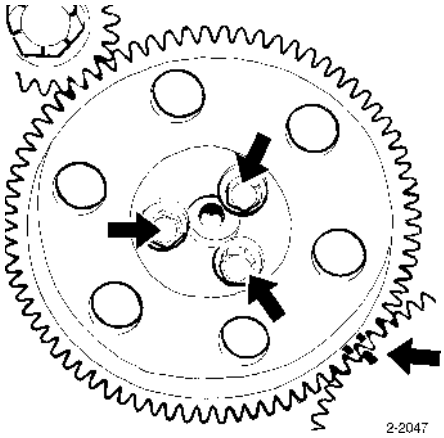
Remove the camshaft cover at the rear end of the cylinder block.

7



Push 999 6970 onto the camshaft.

8



If the pop markings on the camshaft and idler do not coincide, the gear must be marked.

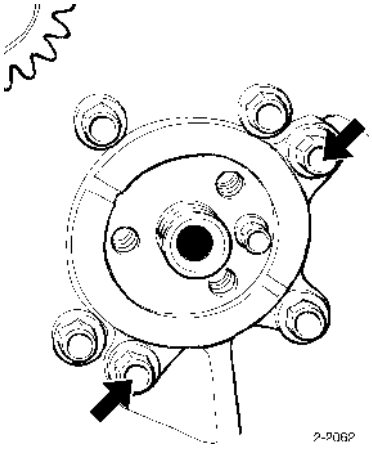
Note: These markings must be made with a felt tipped pen.

Remove the camshaft drive bolts.

9

Remove the camshaft drive.

10



Remove the bolts and the axial bearing. Pull out the camshaft.

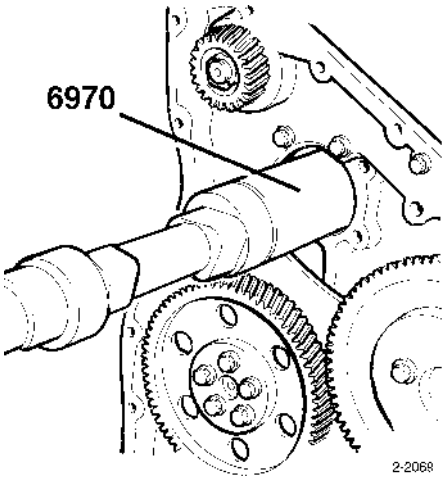
11

Clean the new camshaft and lubricate the bearing pins and the camshaft tappets with engine oil.

12

Push 999 6970 onto the camshaft.

13



Fit the camshaft, taking care not to damage the bearings.

14

Fit and tighten the camshaft axial bearing.

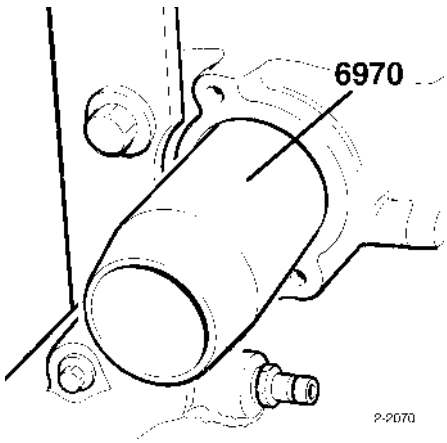
Note: The flat side of the axial bearing should be facing the cylinder block.

Torque **24 Nm (17.7 ft-lb).**

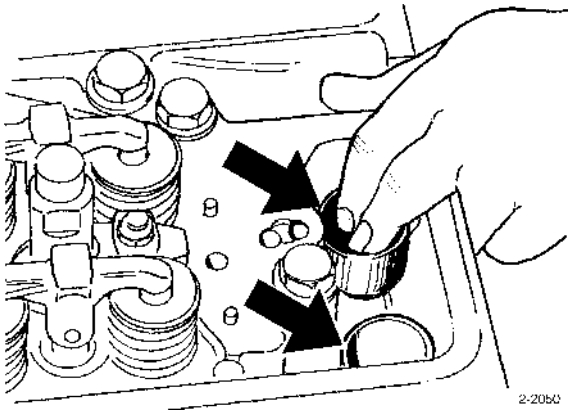
15

Fit the camshaft drive (taking note of the markings).

Torque **58 Nm (42.8 ft-lb).**



16



Remove 999 6970 from the camshaft. Fit the cover.

17

Check the tappet rollers. They should turn easily and must not have any play. The mating surfaces should be flawless. If one tappet is damaged, all should be replaced.

Note: The tappets must be placed in an oil bath for a minimum of 20 minutes before fitting. New tappets are packed in oil. The oil must not be removed before fitting.

⚠ **IMPORTANT!** Observe good cleanliness when handling the tappets!

18

Fit the push rods according to the previously made markings.

19

Fit the rocker arm assemblies. Adjust the valves.

20

Remove tool 999 3590 from the flywheel casing. Fit the plug and the inspection cover.

21

Fit the valve covers.

22

Fit the delivery and fuel return pipes.

Camshaft bearings, replacing

(Camshaft removed)

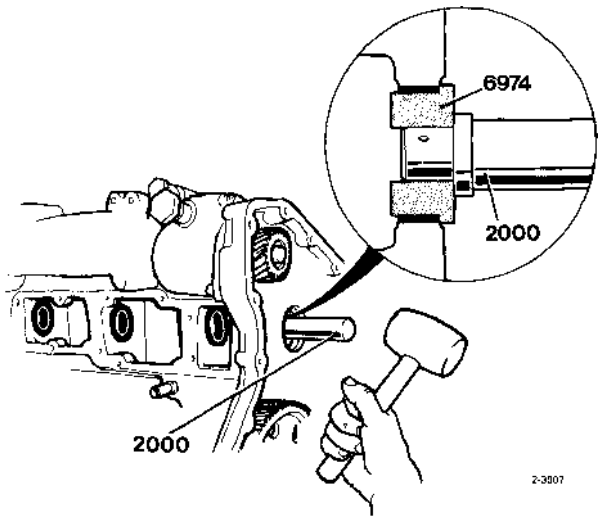
Special tools: 999 2000, 999 6062, 999 6071, 999 6626, 999 6969, 999 6971, 999 6974

Removal

1

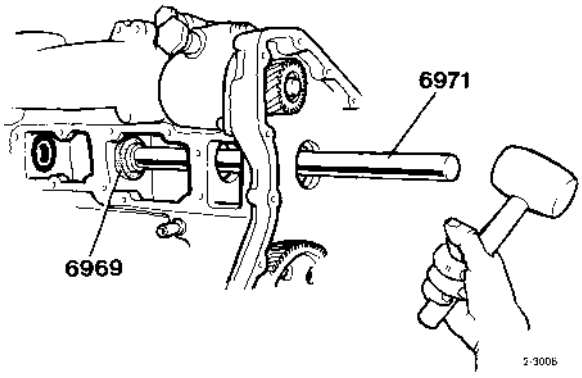
Expose and remove the camshaft inspection covers.

2



Knock out the front camshaft bearing using drift 999 2000 and handle 999 2000

3



Knock out the 2nd, 3rd and 4th bearings using drift 999 6969 and handle 999 6971. These bearings are knocked out from the front through the timing gear casing.

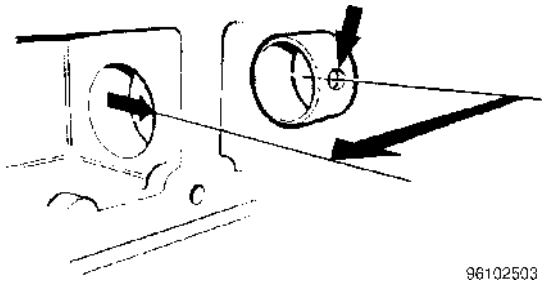
4

Knock out the 5th, 6th and 7th bearings from the back using drift 999 6971. Clean the bearing seats.

Refitting

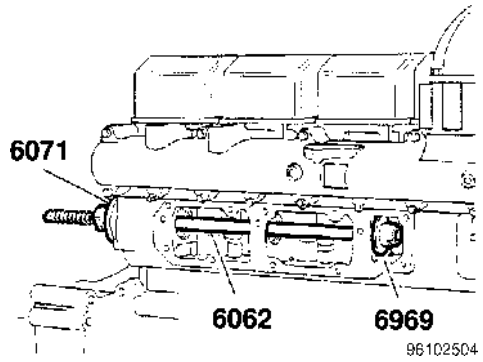
Only the front edges of the bearing seats are bevelled. For this reason, all the bearings must be fitted from the front. New camshaft bearings are ready-machined and do not need to be reamed after fitting.

5



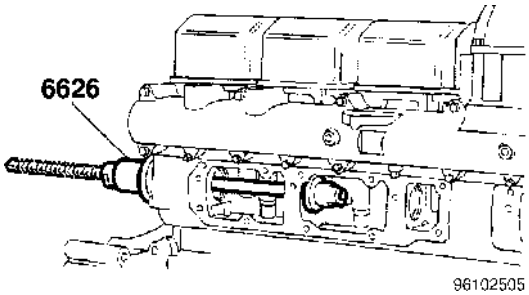
Note: When assembling, the in the bearing should line up with the bearing lube hole in the engine block. The slit should face upwards.

6



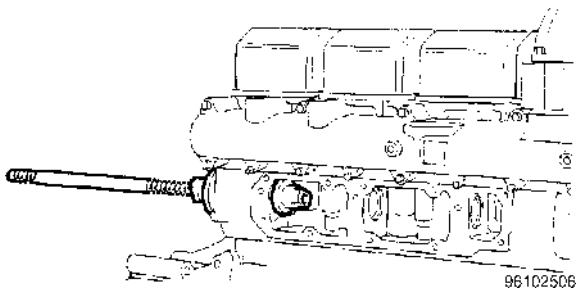
Fit the bearing on tool 999 6969and place it in bearing seat 5. Fit spindle 999 6062 and drift 999 6071 from the rear and press in the bearing.

7



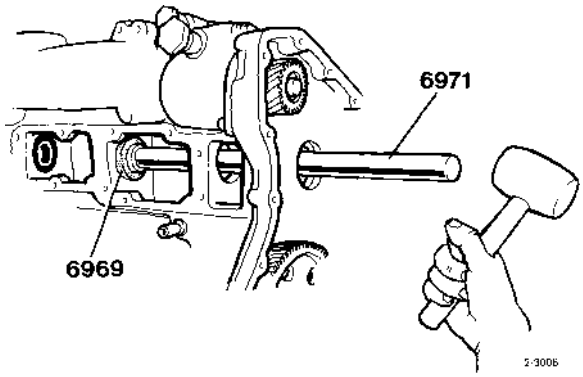
Press in bearing 6 in the same manner. Use hollow drift 999 6626 to lengthen the spindle thread.

8



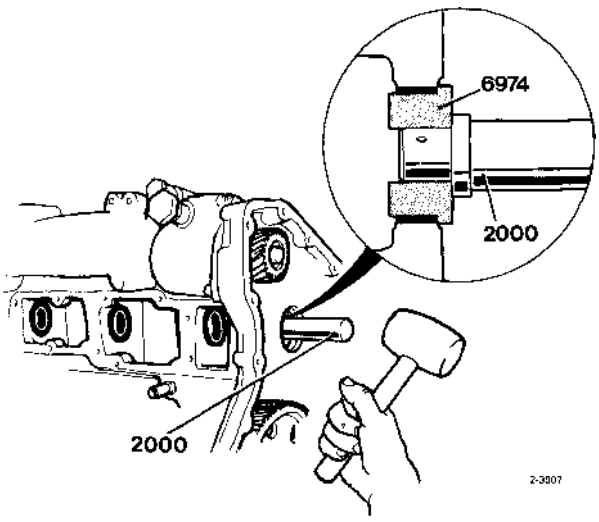
Turn the spindle and press in bearing 7.

9



Carefully tap in bearings 4, 3 and 2 in the stated order. Use drift 999 6969 and handle 999 6971.

10



Carefully tap in bearing 1. The lube channel should face forwards.

11

Fit the camshaft, camshaft drive and transmission gear cover according to directions. Place sealant on both inspection covers. Fit them within **20 minutes**. Fit the remaining components.

Main bearings, all, replacing

Special tools: 999 3590

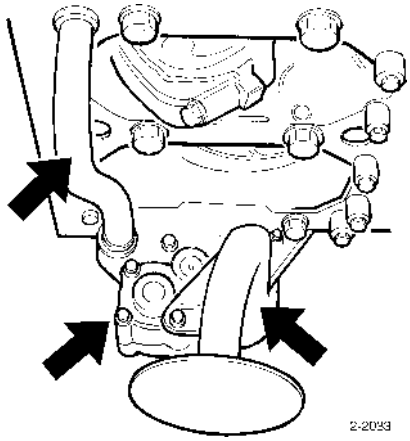
1

Remove the pan.

2

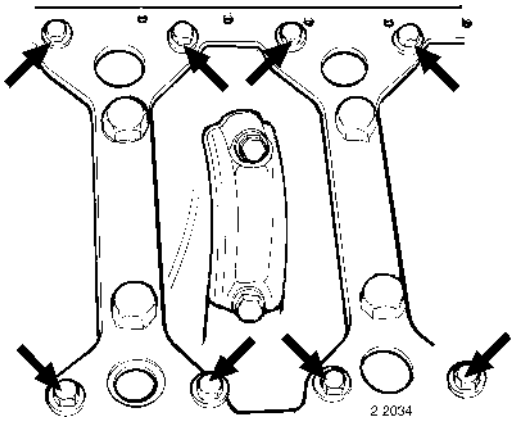
Remove the Plug from the flywheel casing. Fit tool 999 3590.

3



Remove the oil pump and the oil delivery pipe.

4



Remove all bolts and spacers holding the bearing cap reinforcing plates.

5

Remove the bearing caps, one at a time.

6

Remove the upper bearing shells by inserting a pin into the oil hole of the crankshaft.

7

Turn the crankshaft so that the pin carries the upper bearing shell with it.

8

Use a narrow piece of plastic or wood to remove the axial bearing.

9

Clean the parts and check them for wear.

10

Make sure that the correct size of bearing is being fitted.

11

Oil the shaft journals and the new bearing shells.

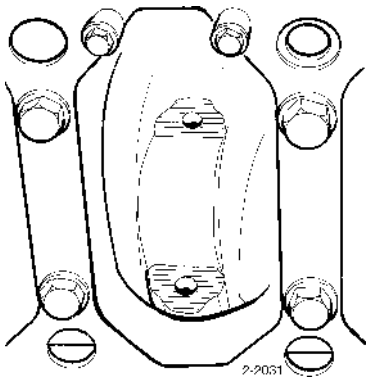
12

The upper bearing shells are slid into position by turning the crankshaft against the engine's direction of rotation.

13

Fit the bearing caps together with the reinforcing plates.

14



Torque the bearing caps to **440 Nm (324.5 ft-lb)**.

Fit the spacers and torque the reinforcing plates to **85 Nm (62.7 ft-lb).**

15

Fit the oil pump and delivery pipe.

Note: When refitting the oil pump, check the delivery pipe at its union with the block with regard to flattening of the pipe.

Push the delivery pipe in until it bottoms in the blocks, thread on the union until it stops **(≤10 Nm/7.4 ft-lb)**.

Now mark the union with a felt tipped pen and tighten it a further **60°** into the block.

16

Fit the oil pan. See ”Workshop manual, Technical Data”.

Crank bearings, wear check or replacement, all

(Pan removed)

Special tools: 999 3590

1

Remove the oil delivery pipe and oil strainer.

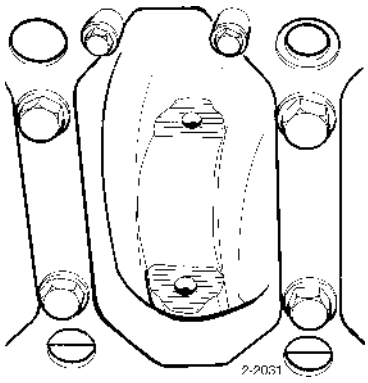
2

Remove the Plug from the flywheel casing. Fit tool 999 3590.

3

Crank the engine and remove the big-end bearing caps.

4



Clean all parts and check the bearing pins.

5

Replace any damaged or worn bearing shells.

6

Oil the bearing shells and fit them. Fit the bearing caps according to the markings and torque the bolts to **240 Nm (177.1 ft-lb)**.

7

Remove tool 999 3590 from the flywheel casing and fit the plug.

8

Fit the oil delivery pipe and the oil strainer.

Note: Before refitting the oil pump, check the delivery pipe at the pipe coupling against the block to make sure it has not been nipped. Push the delivery pipe in until it bottoms in the block. Torque the union until it stops **(≤10 Nm/7.4 ft-lb)**. Now mark the union with a felt tipped pen and tighten it a further **60°** into the block.

Crankshaft, replacing

(Engine removed)

Special tools: 999 3590

1

Remove the pan. Remove the oil pump, the oil strainer and the oil delivery pipe.

2

Remove the timing gear cover.

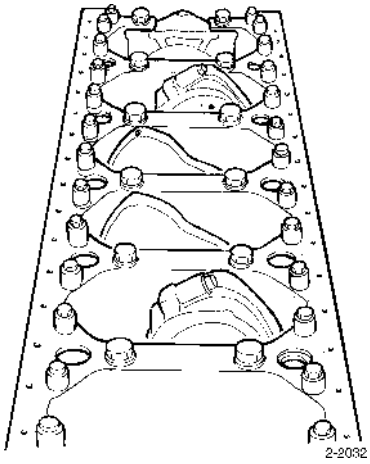
3

Remove the oscillation damper and the polygon hub.

4

Remove the flywheel and the flywheel casing.

5



Remove all bolts and spacers which hold the main bearing cap reinforcing plates.

6

Remove the main bearing bolts and the big-end bearing bolts.

7

Remove all reinforcing plates, main bearings and big-end bearing caps.

8

Lift out the crankshaft.

9

Check the oil channels of the new crankshaft and its contact surfaces with the bearing shells, cylinder block and caps.

10

Examine the bearing shells. Worn or damaged shells must be replaced.

11

Put the bearing shells in their respective positions in the engine block and caps. Make sure that the bearing shells are correctly fitted and that the caps are undamaged.

12

Smear the bearing pins with engine oil and carefully lift the crankshaft into position.

13

Fit the thrust washers for the center main bearing (axial bearing). Due to the fixing recesses, the thrust washers can only be mounted in one position.

14

Fit the main bearing caps. All of the caps incorporate a recess which must be turned to fit over the guide studs.

Note: Do not yet fit the bolts.

15

Observe the number of the main bearing caps which must be fitted in that order.

16

Fit the reinforcing plates.

17

Fit the bolts and the spacer sleeves and tighten the reinforcing plates to the engine block. Torque to **85 Nm (62.7 ft-lb).**

18

Oil and fit the main bearing bolts. Torque **440 Nm (324.5 ft-lb).**

19

Check the axial play of the crankshaft. Max play **0.19 mm (0.0075")**.

20

Fit the flywheel and the flywheel casing.

Torque:

Flywheel casing **140 Nm (103.3 ft-lb)**
Fywheel **260 Nm (191.7 ft-lb)**

21

Fit the polygon hub and the vibration damper.
Torque:

Center bolt, crankshaft **640 Nm (472.0 ft-lb)**.

22

Fit the oil pump, the oil strainer and the oil delivery pipe.

Note: Before refitting the oil pump, check the delivery pipe at the pipe coupling against the block to make sure it has not been nipped. Push the delivery pipe in until it bottoms in the block. Torque the union until it stops **(≤10 Nm/7.4 ft-lb)**. Now mark the union with a felt tipped pen and tighten it a further **60°** into the block.

23

Fit the timing cover.

24

Fit the pan. Torque the bolts in a specified order. See ”Workshop manual, Technical Data”.

25

Fit the pulley and the outer torsional vibration damper (if any). Torque **48 Nm (35.4 ft-lb).**

Crankshaft

The crankshaft is nitro-carburized.

A nitro-carburized crankshaft has a greater resistance to fatigue and wear than an induction-hardened crankshaft.

Inspection

The inspection of the crankshaft must be extremely thorough to avoid unnecessary reconditioning. To determine reconditioning requirements, the following applies:

A. Measure the bearing journals for out-of roundness, wear and taper. See ”Workshop manual, Technical Data”.

B. Assess the surface damage.

For nitro-carburized shafts, the following applies:

What on an induction-hardened crankshaft may be regarded as scoring due to dirt can in the case of a nitro-carburized shaft be the normal surface finish as on a new crankshaft. The markings show up very clearly on a shaft that has been in use because of the shiny bearing surfaces. Very small particles can loosen from the thin surface layer after the shaft has been in use for some time.

This phenomenon is easily confused with scoring caused by dirt, but close inspection will show that the marks do not go entirely round the bearing journal and have uneven edges. These slight defects do not necessarily require regrinding of the crankshaft.

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

C. Measure crankshaft alignment (throw).

The crankshaft should be placed on either a pair of V-blocks, under 1st and 7th main bearing journals, or fixed between stocks. Measurements should be made on the 4th main bearing.

The following applies with regard to the values measured:

1

Less than **0.2 mm (0.0079")** - no alignment necessary if wear and surface damage do not necessitate regrinding.

2

Align with care between **0.2-0.7 mm (0.0079-0.0276")** to avoid over-alignment.
Note: Do not align more than absolutely necessary.

3

More than **0.7 mm (0.0276")** - the shaft must be scrapped due to risk of cracking during alignment.

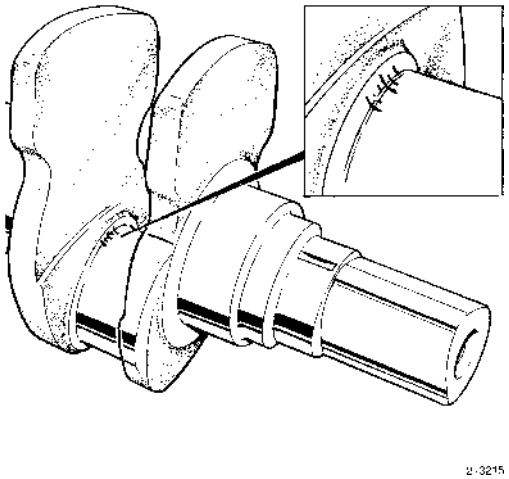
D. Check for cracks

Checking must be carried out after alignment and before and after grinding.

To check, use a magnetic powder test of type Magnaglo, i.e. fluorescent powder which can be seen under ultraviolet light.

Refer to manufacturer's instructions on the method to be adopted. When assessing the cracks, the following applies:

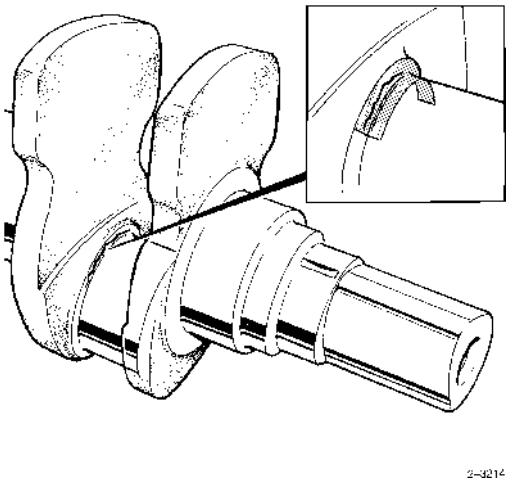
1



2-3215

The shaft must be scrapped if there are longitudinal cracks on the journals and in the fillets.

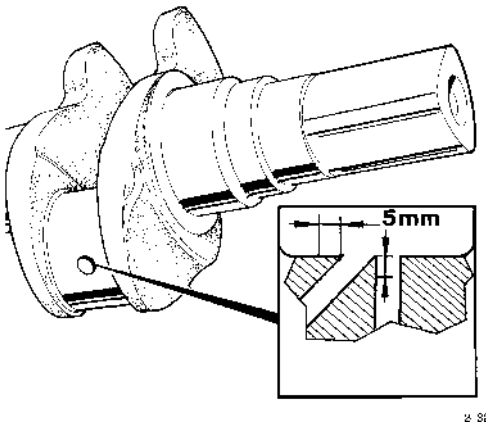
2



2-3214

The shaft must be scrapped if there are crosswise cracks within the marked zone. This applies to both crank pins and main bearing journals.

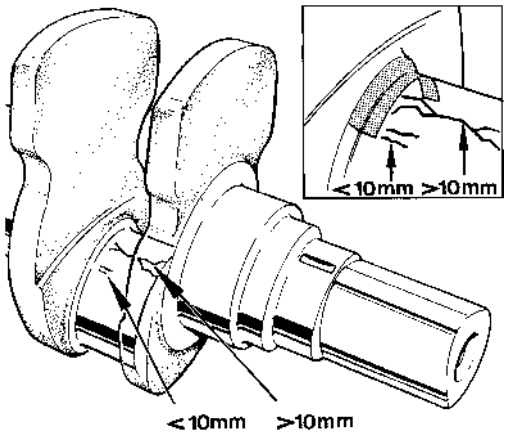
3



2-3212

The shaft must be scrapped when cracks longer than **5 mm (0.2")** are adjacent to the area around the oil holes. Cracks shorter than **5 mm (0.2")** can be removed by grinding.

4



2-3211

The shaft must be scrapped when cracks are longer than **10 mm (0.4")** outside the marked area. Isolated cracks less than **10 mm (0.4")** are acceptable.

Reconditioning

When reconditioning, keep to the following routines:

1

Alignment (only as required).

2

Check for cracks.

3

Measure the bearing pins. See ”Workshop manual, Technical Data”.

4

Grind to undersize as specified in ”Workshop manual, Technical Data”.

5

Check for cracks.

6

If you are going to re-nitro-carburize (after grinding to undersize more than **0.5 mm (0.020")**, please note: Nitro-carburizing can be performed using the gas or salt method based on the operator’s experience in carrying out the treatment.

7

Check for throw after nitro-carburizing.

8

Align if necessary (throw between **0.2–0.7 mm (0.0079–0.0276")**).

9

Carry out a magnetic powder test.

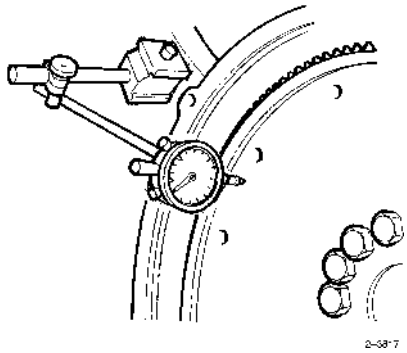
10

The crankshaft must be carefully lapped and cleaned after nitro-carburizing. The crankshaft must always be thoroughly cleaned after reconditioning. In order that all oil channels are cleaned efficiently, late production crankshafts are fitted with threaded plugs in each piston rod. These plugs should be removed during the cleaning procedure.

Flywheel, checking for warp

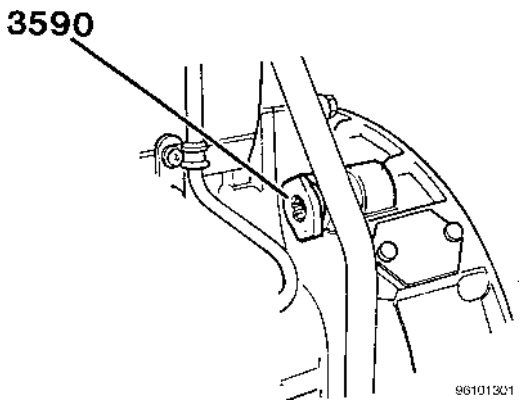
Special tools: 998 9876, 999 9696, 999 3590

1



Mount the dial indicator in a magnetic stand and set the dial indicator to zero with the probe against the flywheel.

2



Crank the flywheel with tool 999 3590, noting the max and min. values.

3

The difference must not exceed **0.15 mm (0.0060")** at a measuring radius of 150 mm (6"). In the case of excessive warp, remove the flywheel. Check for dirt or unevenness between the flywheel and the crankshaft contact face.

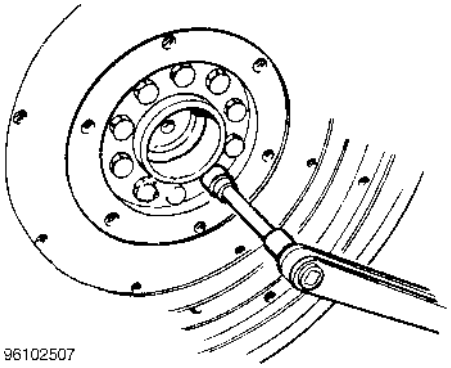
4

Remove the rotating tool.

Flywheel, replacing

(Clutch removed)

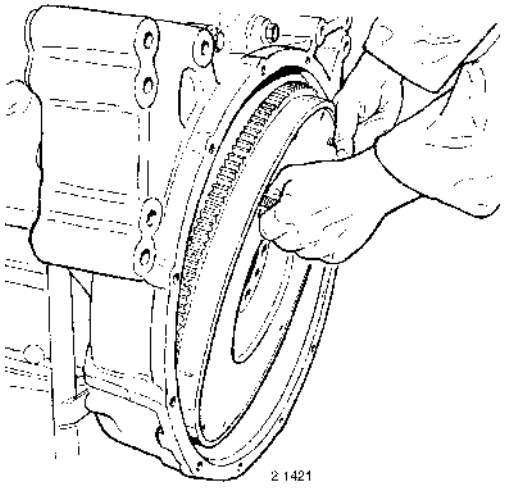
1



Remove the flywheel bolts.

2

Screw two bolts into the flywheel.



3

Using the bolts, lift off the flywheel.

4

Clean the crankshaft flange contact surface.

5

Check the guide pin, replace it if damaged.

6

Clean the flywheel contact surface which mates with the crankshaft flange. Fit a new flywheel bearing (Power Pack engines).

7

Fit the flywheel and the bolts.

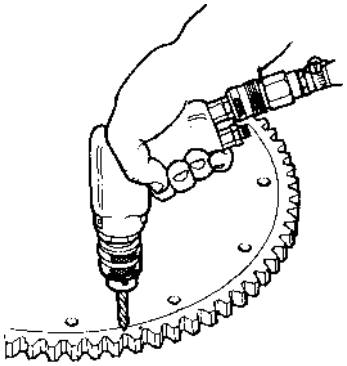
8

Torque the flywheel to **260 Nm (191.8 ft-lb).**

Ring gear, replacing

(Flywheel removed)

1

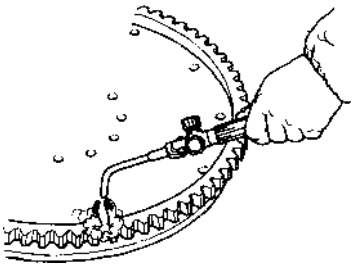


Drill one or more holes in the ring gear and crack it with a chisel. The ring gear can now be removed.

2

Use a steel brush to clean the contact surface on the flywheel.

3



Evenly heat up the ring gear all the way round using a blow torch. Take care not to overheat the ring gear since this would result in material deterioration.
To check the amount of heat, polish the ring gear to a shine at several places. At the correct temperature, these bright spots will become blue **(180-200°C/ 356-392°F)** and heating should be stopped.

4

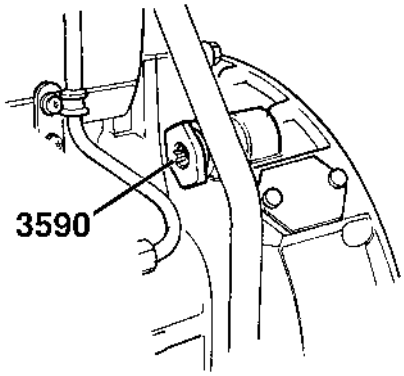
Place the heated ring gear on the flywheel. Tap it into position using a soft drift and a hammer. The ring gear should then be allowed to cool slowly in air.

Flywheel casing, checking for warp

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

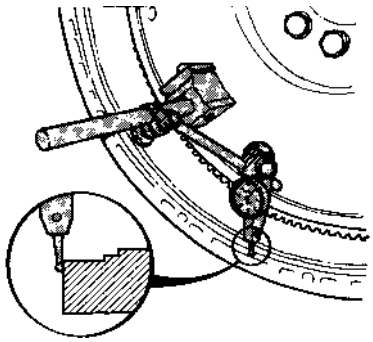
1

Clean the flywheel and flywheel casing.



2

Fit cranking tool 999 3590.



3

Fit a dial indicator to a magnetic stand.

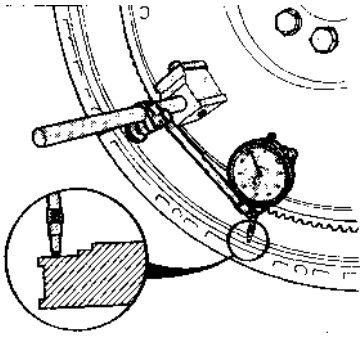
Mount the magnetic stand on the flywheel with the probe of the dial indicator against the outer edge of the flywheel casing.

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

Transfer the magnetic stand and dial indicator to the opposite side of the flywheel and carry out the same measurement procedure.

The difference between these two results must not exceed **0.20 mm (0.0079").**

4



Mount the magnetic stand on the flywheel with the probe of the dial indicator against the inner edge of the flywheel casing. Crank the flywheel, noting the max and min. values. The inner edge of the casing must be concentric with the flywheel within **0.25 mm (0.0099").**

5

Should any of the readings in points 3 and 4 be exceeded, check the contact of the flywheel casing against the cylinder block.

6

Remove the rotating tool.

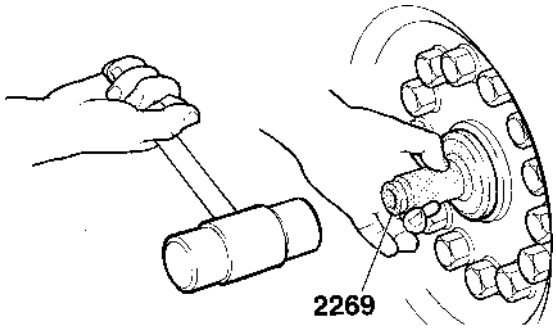
Flywheel bearing, replacing

Special tools: 999 2269

1

Due to a hard fit the flywheel must be removed to allow the flywheel bearing to be removed using a suitable drift.

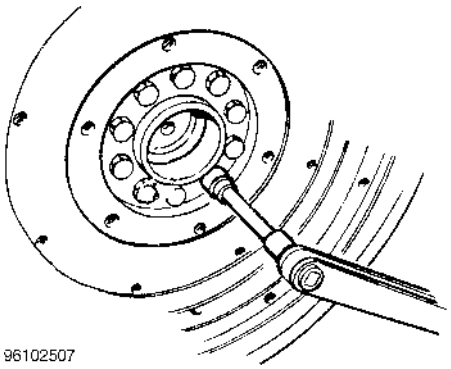
2



Fit a new flywheel bearing using drift 999 2269 and a plastic mallet.

Crankshaft seal, rear, replacing

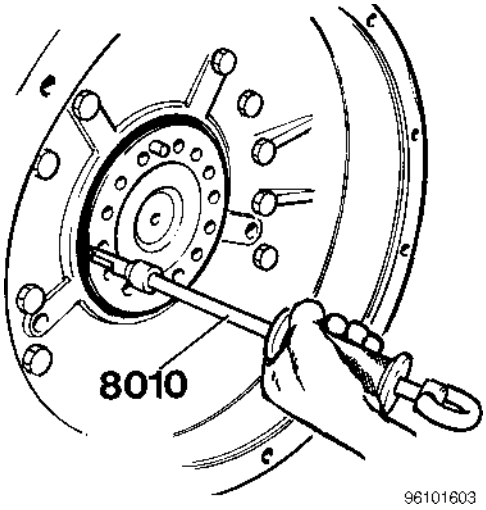
Special tools: 999 2000, 999 3590, 999 8010, 999 8238



1

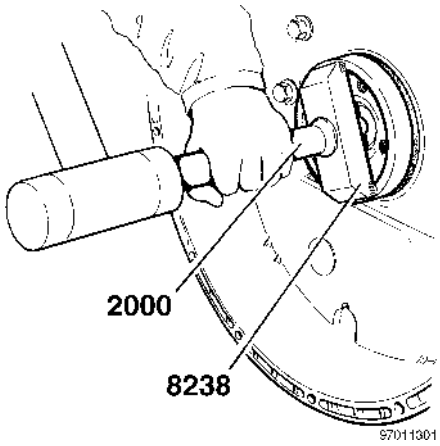
Remove the flywheel bolts.

2



Fit two bolts and lift out the flywheel.

3



Knock out the crankshaft seal using tool 999 8010.

4

Clean the seat of the sealing ring in the flywheel casing.

5

Apply sealant to the outer edge of the sealing ring and oil the inner edge of the sealing ring before fitting it with tool 999 8238 and handle 999 2000.

6

Lift the flywheel into position. Refit the bolts.

7

Block the flywheel using cranking tool 999 3590.

8

Torque the flywheel bolts to **260 Nm (191.8 ft-lb).**

Crankshaft seal, front, replacing

Special tools: 884983

A new vibration damper with a narrower hub entered production as of serial no xxxx/35550. At the same time, a spacing washer was introduced, part number 877303, installed in front of the vibration damper.

As of serial no xxx/37616, the polygon hub was changed so that this spacing washer no longer is needed. See Service Bulletin 26-01 for more information.

To reduce the risk of oil leaks, a new wear ring for the front crankshaft seal has been implemented. See Service Bulletin 24-01 for more information.

Note: Wear ring and seal ring should always be replaced at the same time

1

Remove the fan belt.

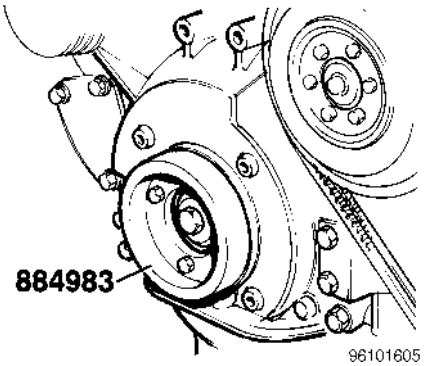
2

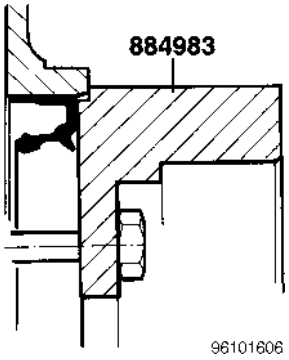
Undo the bolts (6 ea) to the outer vibration damper (if fitted) and remove the damper and the pulley.

3

Remove the sealing ring in the timing gear cover and the wear ring on the pulley.

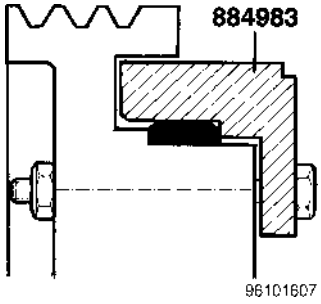
4





Oil a new sealing ring. Fit it with tool 884983 and 3 M10 x 80 mm bolts. The seal is correctly fitted, 2-3 mm (0.08-0.12") from the outer edge of the timing gear cover when the base of the fitting tool touches the timing gear cover.

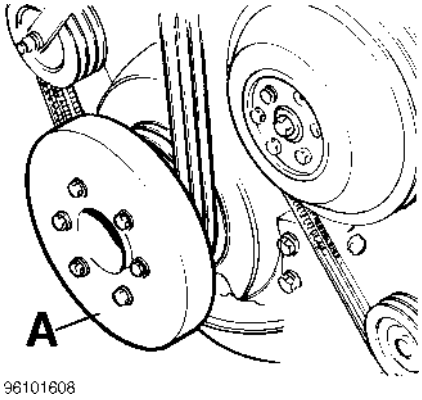
5



Oil a new wear ring for the pulley. Place the ring against the internal face of 884983.

Note: Press the wear ring on the pulley using 3 ea M10 bolts or a hydraulic press. The wear ring is correctly fitted when the tool bottoms.

6



A = Outer vibration damper (Generating set engines)

Fit the pulley and the outer vibration damper (if any). Use new O-rings on the bolts. Torque: See ”Workshop manual, Technical Data”.

7

Install the fan belts.

Sealant, flywheel casing, replacing

(Flywheel removed)

1

Remove the flywheel casing from the cylinder block.

2

Remove the old sealant from the cylinder block and on the flywheel casing.

3

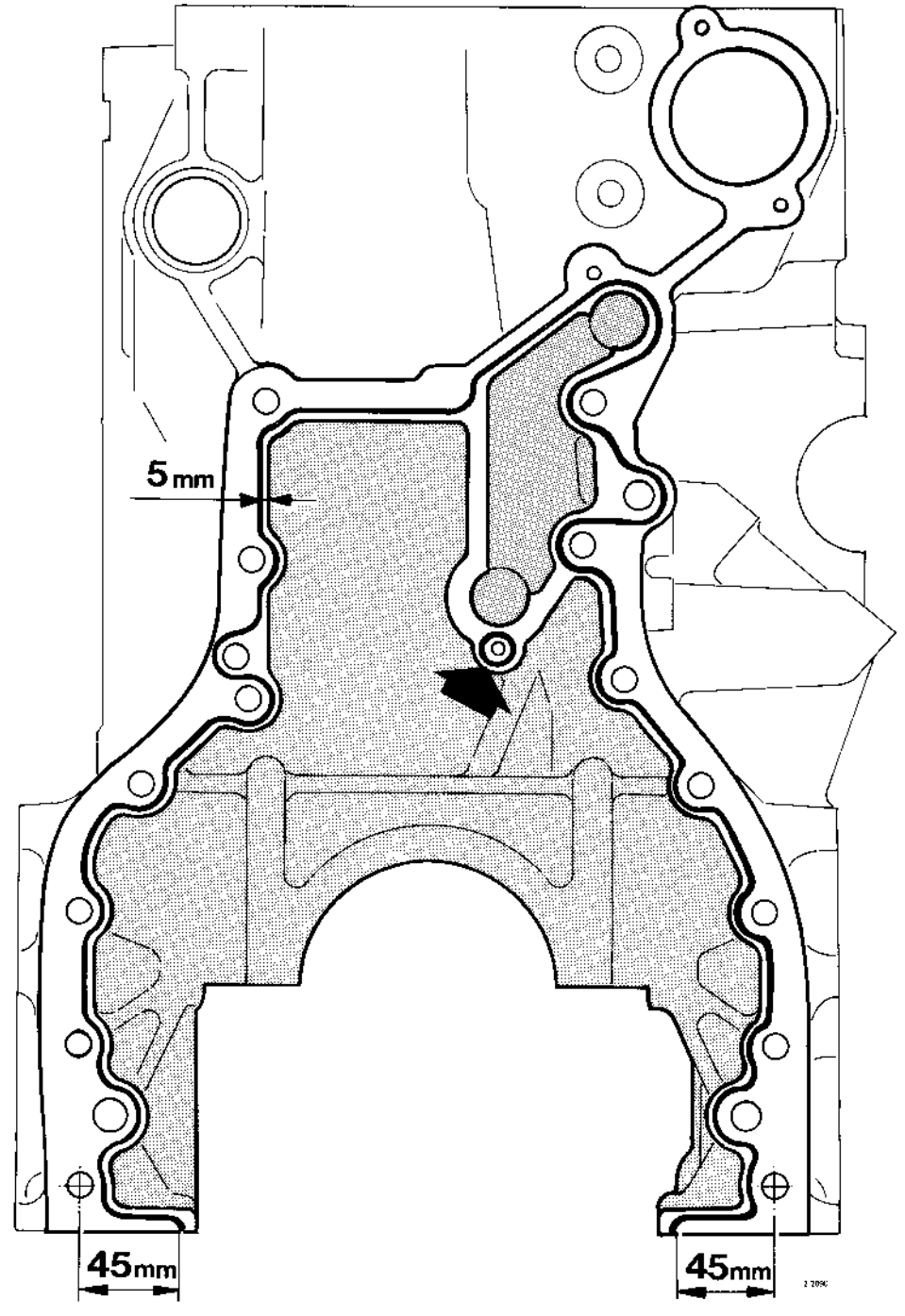
Apply an even **2 mm (0.080")** thick bead of sealant (part No. 1161277-7) to the block.

4

Fit the flywheel casing to the cylinder block.

Note: The flywheel casing must be refitted within **20 minutes** of applying the sealant. Torque **140 Nm (103.3 ft-lb).**

Application of sealant to cylinder block



Lubrication system

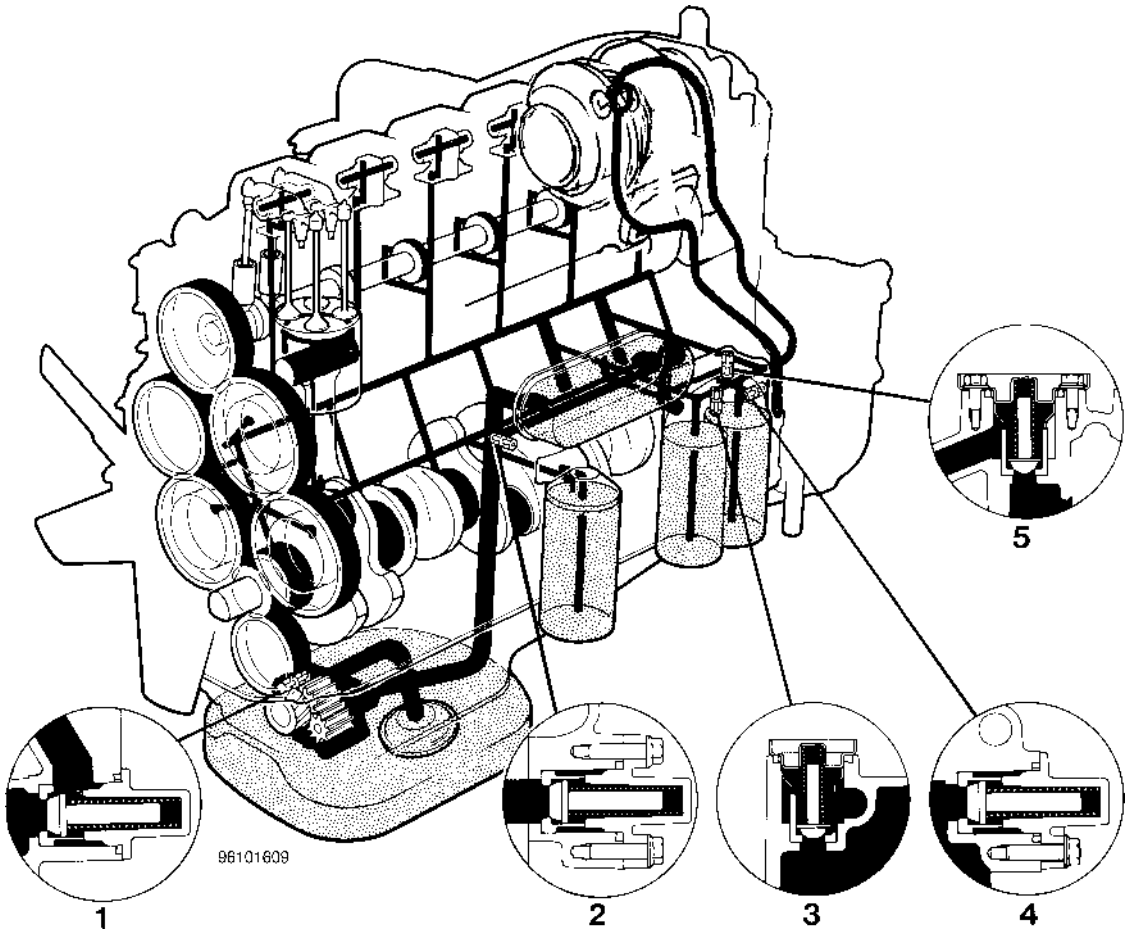
Design and Function

General

The engine is pressure lubricated by a gear wheel pump.
The system incorporates five valves:

1. Safety valve
2. Bypass valve for oil cooler
3. By-pass valve for oil filter
4. Reduction valve
5. Piston cooling valve

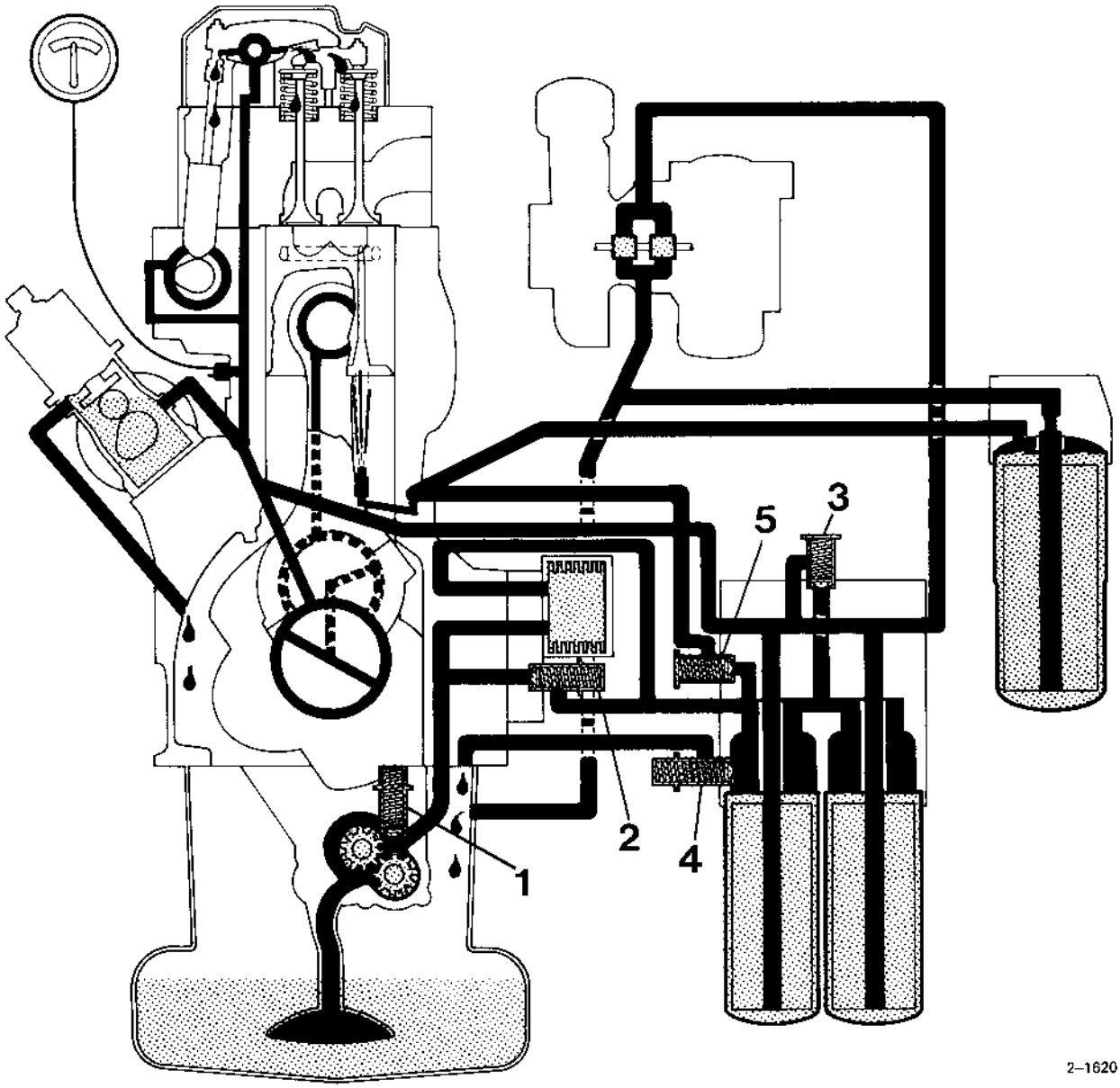
The lubricating oil is cleaned by two full-flow filters and one bypass filter. The oil cooler is mounted on the side of the engine.



(Notice. The engine outline shows a TAD-engine. The lubrication system is the same for both TAD and T(I)(W)D engines.

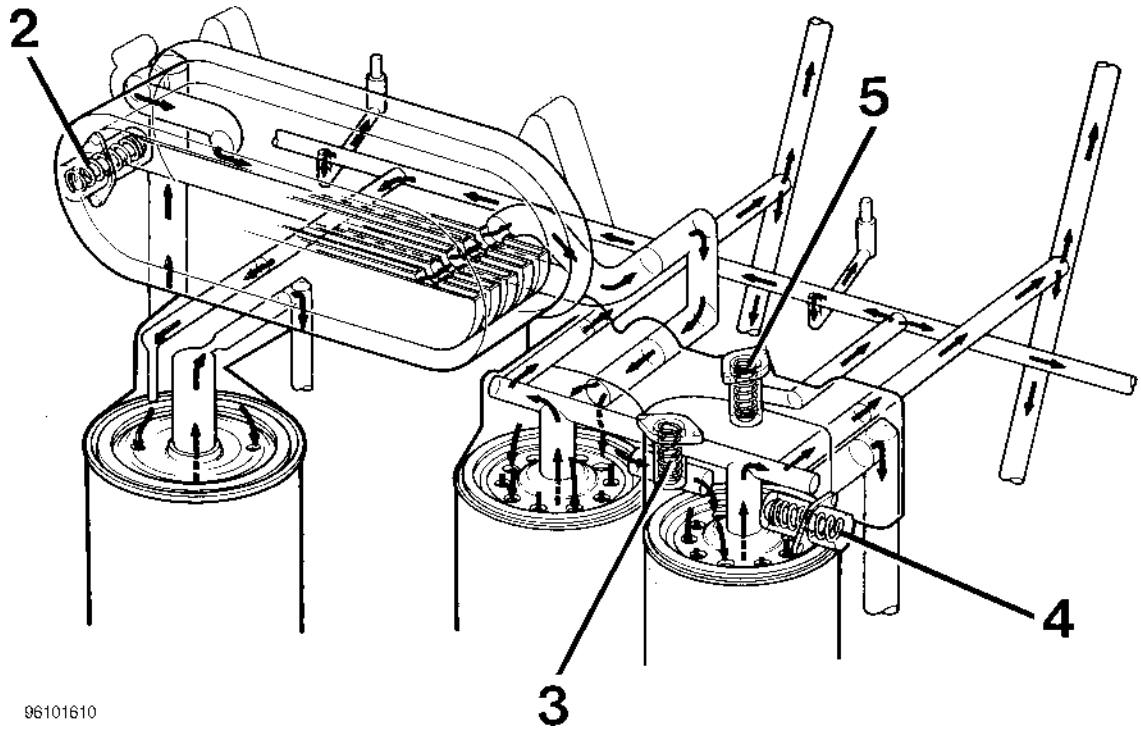
The oil pump forces the oil through the oil cooler to the two full-flow filters. From these filters the oil is led to the engine block where it is distributed through ducts and pipes to the lubricating points of the engine. On the oil pump itself is a safety valve. This opens when pressure in the system becomes too high, allowing the oil to reach the suction side of the pump via a duct in the pump housing. The reducer valve regulates the oil pressure. A bypass valve opens when the counter pressure in the oil cooler becomes too high, which occurs during cold starts, and leads the oil past the oil cooler directly out into the system.

1. Safety valve
2. Bypass valve for oil cooler
3. By-pass valve for oil filter
4. Reduction valve
5. Piston cooling valve



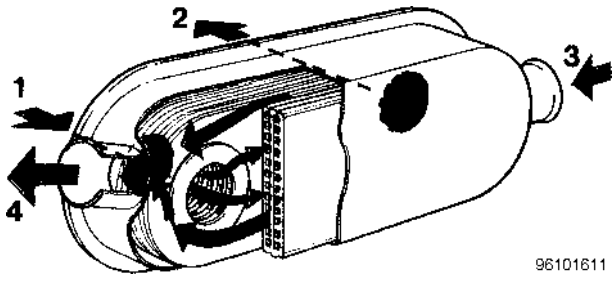
The piston cooling valve opens when engine revs have increased to slightly above idling speed. Oil flows through the piston cooling duct to the nozzles for the pistons. Here, the oil is sprayed into the annular cooling channels. The oil then passes through a duct to the bypass oil filter. This filter has a low through- flow speed and gives a high degree of filtration.

The oil cooler maintains the temperature of the lubricating oil at a relatively low level which is advantageous from the point of view of wear, and also maintains the oil's beneficial qualities.



The two full-flow filters have a bypass valve which guarantees lubrication of the engine should the filters become blocked.

Oil cooler



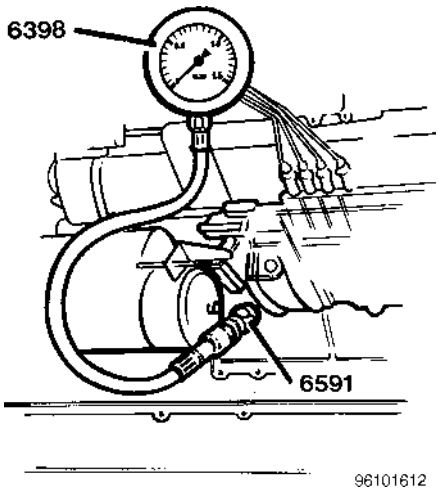
2. Bypass valve for oil cooler
3. By-pass valve for oil filter
4. Reduction valve
5. Piston cooling valve
1. Oil from the block
2. Oil from the oil cooler
3. Coolant flowing into the oil cooler
4. Coolant flowing out of the oil cooler

Service procedures

The engine must always be washed prior to starting repairs.

Lubricating oil pressure, checking

Special tools: 999 6591, 999 6398

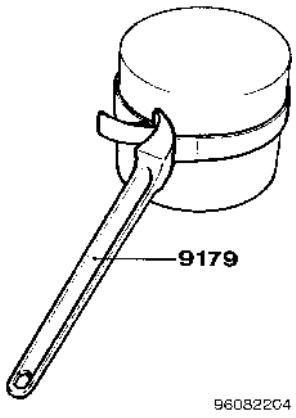


1
Lubrication oil pressure is checked by connecting the pressure gauge and hose to the connection on the oil pressure contact. With hot engine and at operating speed, the oil pressure should be **300-500 kPa (43,5-72,5 psi).** At engine idling speed, the oil pressure should be min. **150 kPa (21.75 psi).**

Oil filters, replacing

Special tools: 999 9179

1



Clean around the filter bracket and remove the 3 filters using tool 999 9179.

2

Moisten the seals of the new filters with oil and screw the filters on by hand until the seals are in contact with the filter bracket. Then tighten the filters by hand a further half turn.

Note: Install only Volvo oil filters type "Long Life." The oil filters must not be damaged. If the filter is dented, it may crack, resulting in engine breakdown.

3

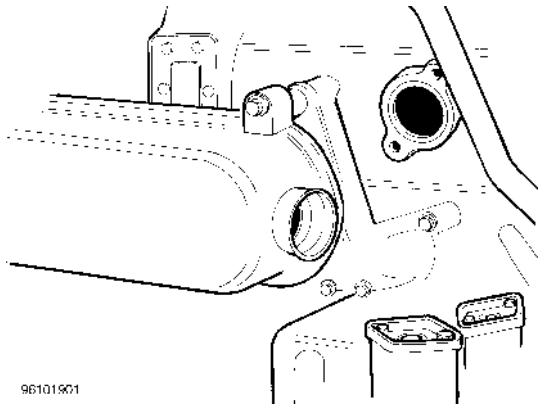
Fill the engine with oil. Crank the engine with the stop button depressed or the stop control pulled out until oil pressure is recorded by the pressure gauge.

Note: Cranking the engine with the stop control pulled out applies when replacing filters and oil cooler or other components of the lubricating oil system.

Start the engine and check for leaks around the oil filters.

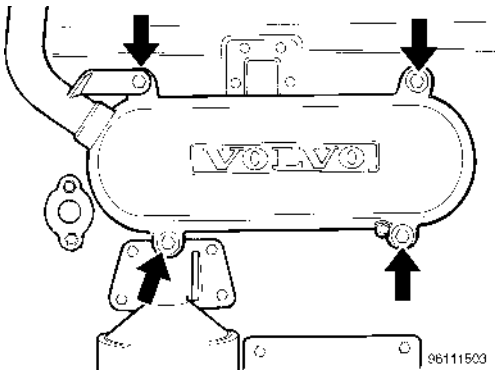
Oil cooler, replacing

1



Drain the coolant.

2

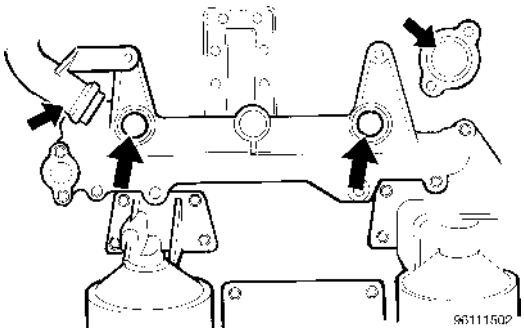


Remove the rear coolant pipe.

3

Remove the bolts (4) holding the oil cooler to the engine block and spacer plate.

4



Disconnect the oil cooler from the front coolant pipe.

5

Fit new sealing rings to the engine block and to both coolant pipes.

6

Push the new oil cooler onto the front coolant pipe.

7

Bolt the oil cooler to the spacer plate and engine block.

8

Replace the rear coolant pipe.

9

Fill with coolant.

10

Fill the engine with oil.

11

Start the engine and check for leaks.

Oil cooler, leakage test

(Oil cooler removed)

Special tools: 999 6662, 999 6845

1

Flush the coolant side of the oil cooler with water- soluble degreasing fluid. Wash the oil side of the cooler with degreasing solvent.

2

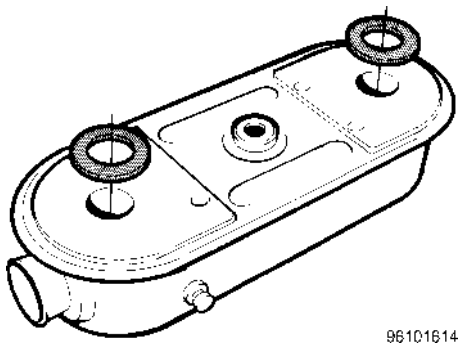
In order to discover any small leakages, the oil cooler must be the same temperature as the room. To achieve this, flush the oil cooler with water which has the same temperature as the room until the cooler reaches the required temperature. Drain off all water in the cooler.

3

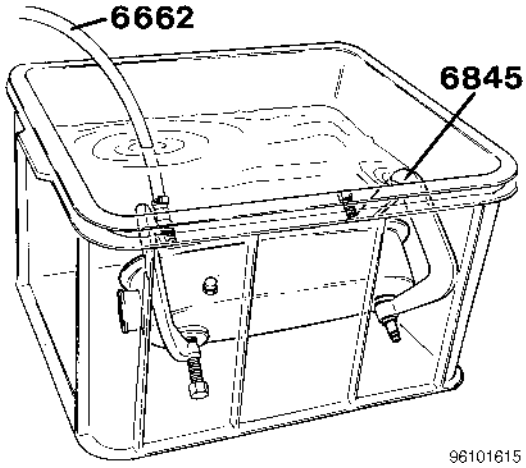
Fit leak detection tool 999 6845 and check that it seals correctly.

4

Connect leak detection equipment 999 6662 to 999 6845.



96101614



96101615

Lower the oil cooler into the bath which contains water that has the same temperature as the room. The leakage test is to be carried out at **15, 100 and 250 kPa (2.2, 14,5 and 36.3 psi).** Begin at 15 kPa and then continue with 100 and 250 kPa. The test period for test pressure each should last for at least one minute. Air bubbles emerging from the water connections indicate internal leakage in the oil cooler. Air bubbles around the oil cooler indicate external leakage.

5

Lift up the oil cooler and remove the leak detection equipment.

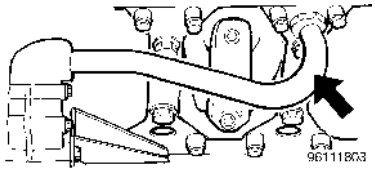
Oil pump, replacing

(Pan removed)

Special tools: 999 6413, 999 8012

Removal

1

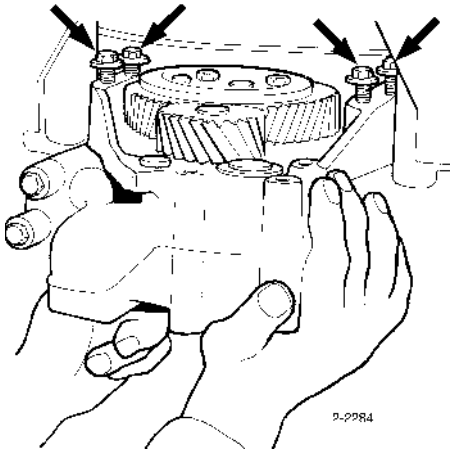


Remove the delivery oil pipe.

2

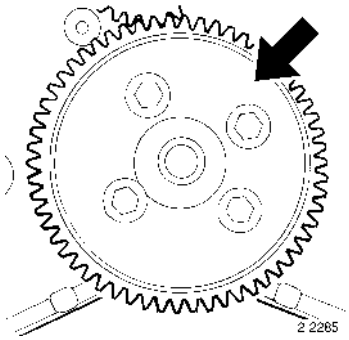
Remove the suction oil pipe.

3



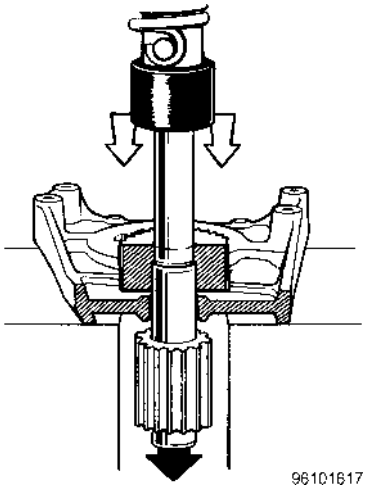
Remove the bolts for the bracket (4). Remove the pump together with the bracket.

4



Remove the idler gear from the bracket.

5



Remove the pump housing from the bracket. Push the shaft out of the drive gear.

6

Remove the pump from the bracket.

Refitting

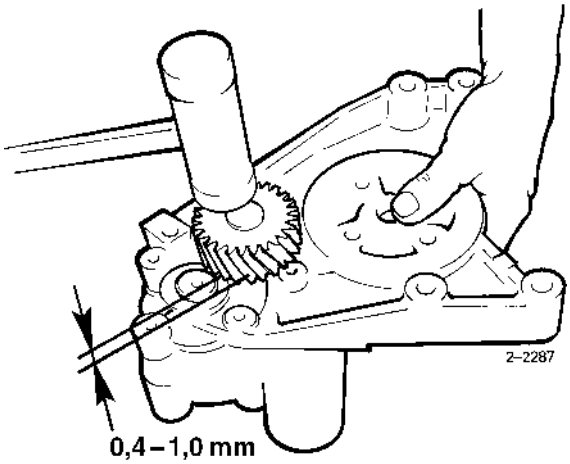
7

Fit the new pump to the bracket.

8

Heat up the pump drive gear to **180° ±20°C (356° ± 36°F).**

9



Tap the drive gear onto the pump shaft. The drive can also be pressed in using drift 999 6413 and using 999 8012 as a counterforce.

Note: The clearance between the drive gear and the bracket should be **0.4-1.0 mm (0.0157–0.0394")**.

10

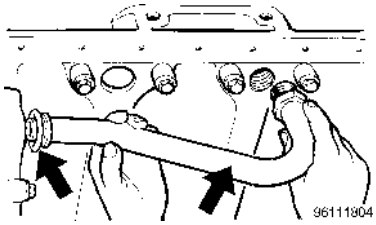
Fit the idler gear to the bracket.

Torque: **48 Nm (35.4 ft-lb)**.

11

Fit a new sealing ring to the suction pipe. Fit the suction pipe to the pump.

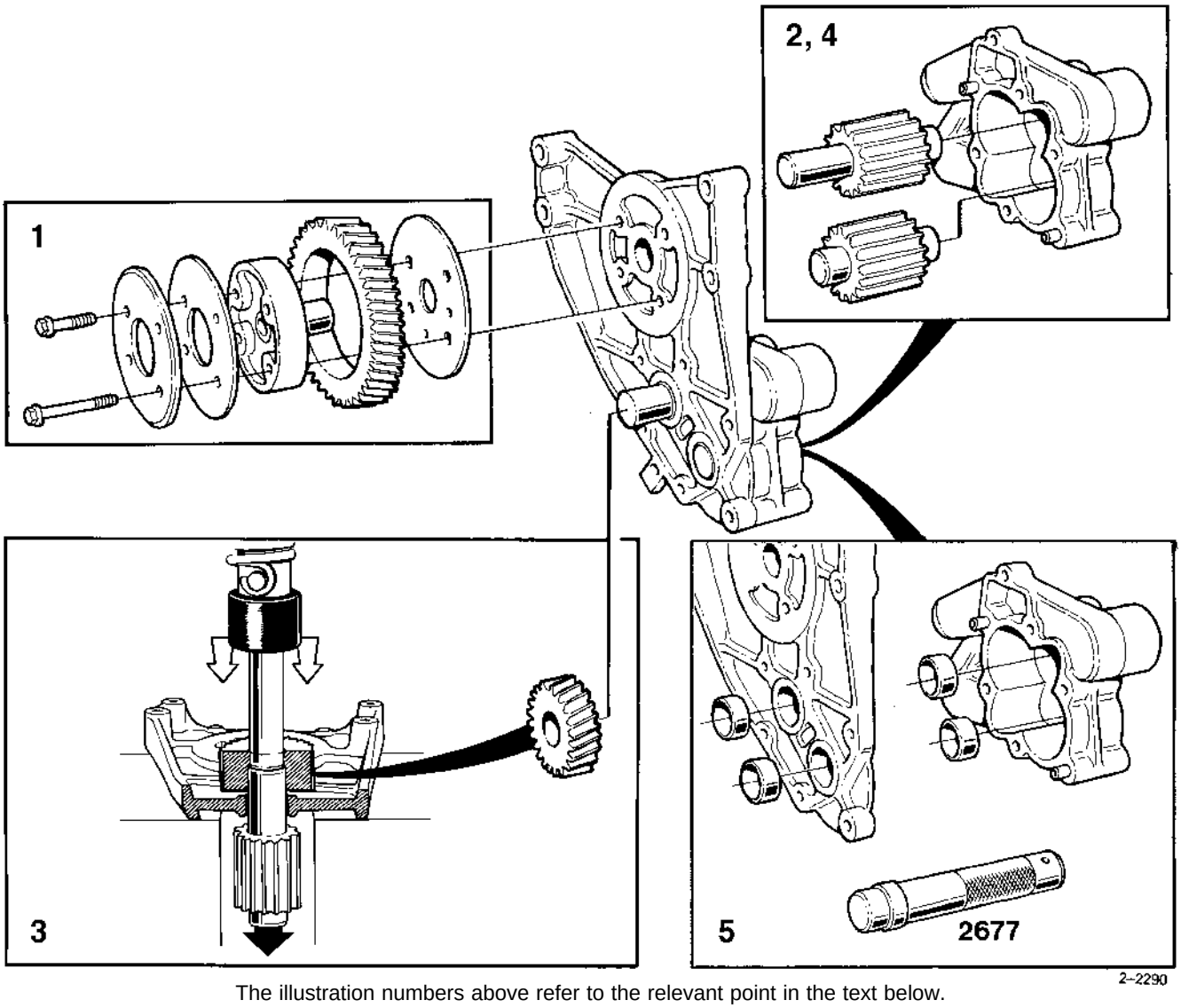
12



Fit a new sealing ring to the delivery pipe. Fit the delivery pipe.

Note: When refitting the oil pump, check the delivery pipe at its union with the block with regard to flattening of the pipe. Push the delivery pipe in until it bottoms in the block. Torque the union until it stops **(≤ 10 Nm/7.4 ft-lb)**.

Now mark the union with a felt tipped pen and tighten it a further **60°** into the block.



The illustration numbers above refer to the relevant point in the text below.

Oil pump, reconditioning

(Safety valve removed)

Special tools: 999 2677, 999 6413, 999 8012

1

Remove the flange screws, the bearing end plate, the thrust washers, hub and idler gear.

2

Remove the pump housing from the bracket.

3

Push the shaft out of the drive gear.

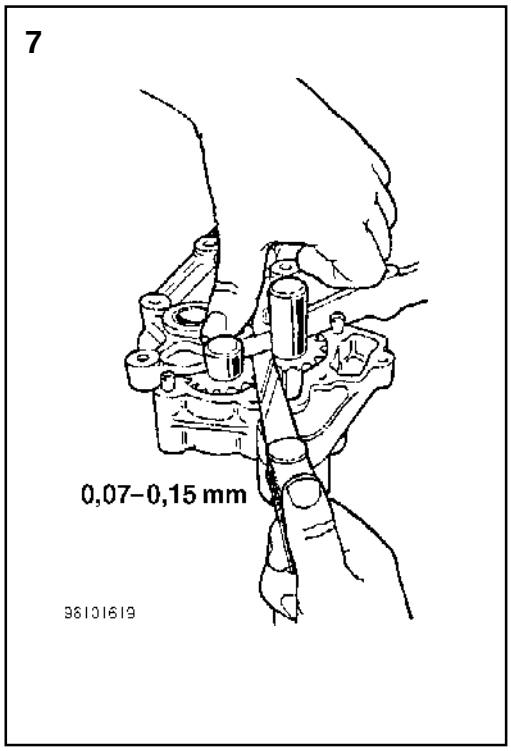
4

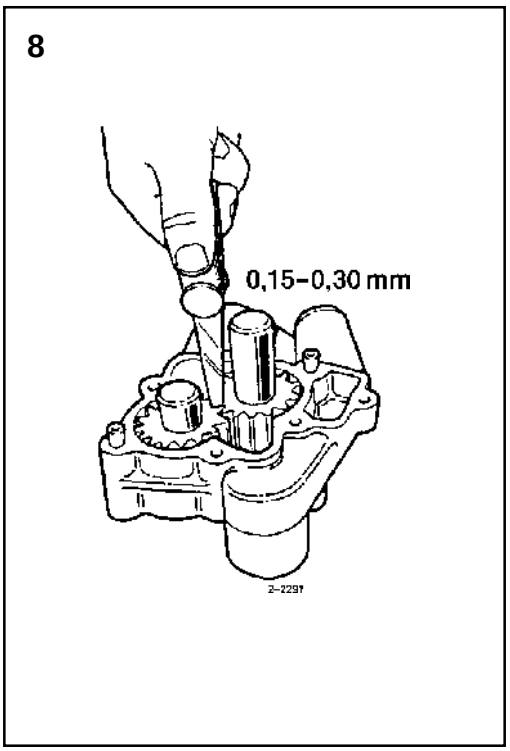
Remove the gear wheel from the pump housing.

5

Press the old bushings out of the pump housing and bracket using drift 999 2677. Press in the new bushings.

Note: The bushings are ready-machined as supplied and need not be reamed.





The illustration numbers above refer to the relevant point in the text below.

6

Check the housing for scoring and wear, and also check for leakage between the bracket and pump housing. In the case of leakage, the surfaces will be black. The bushings in the pump housing and bracket must be replaced. The gear wheels of the pump must be checked concerning wear on the flanks of the teeth, on the outer diameter and the end faces.

7

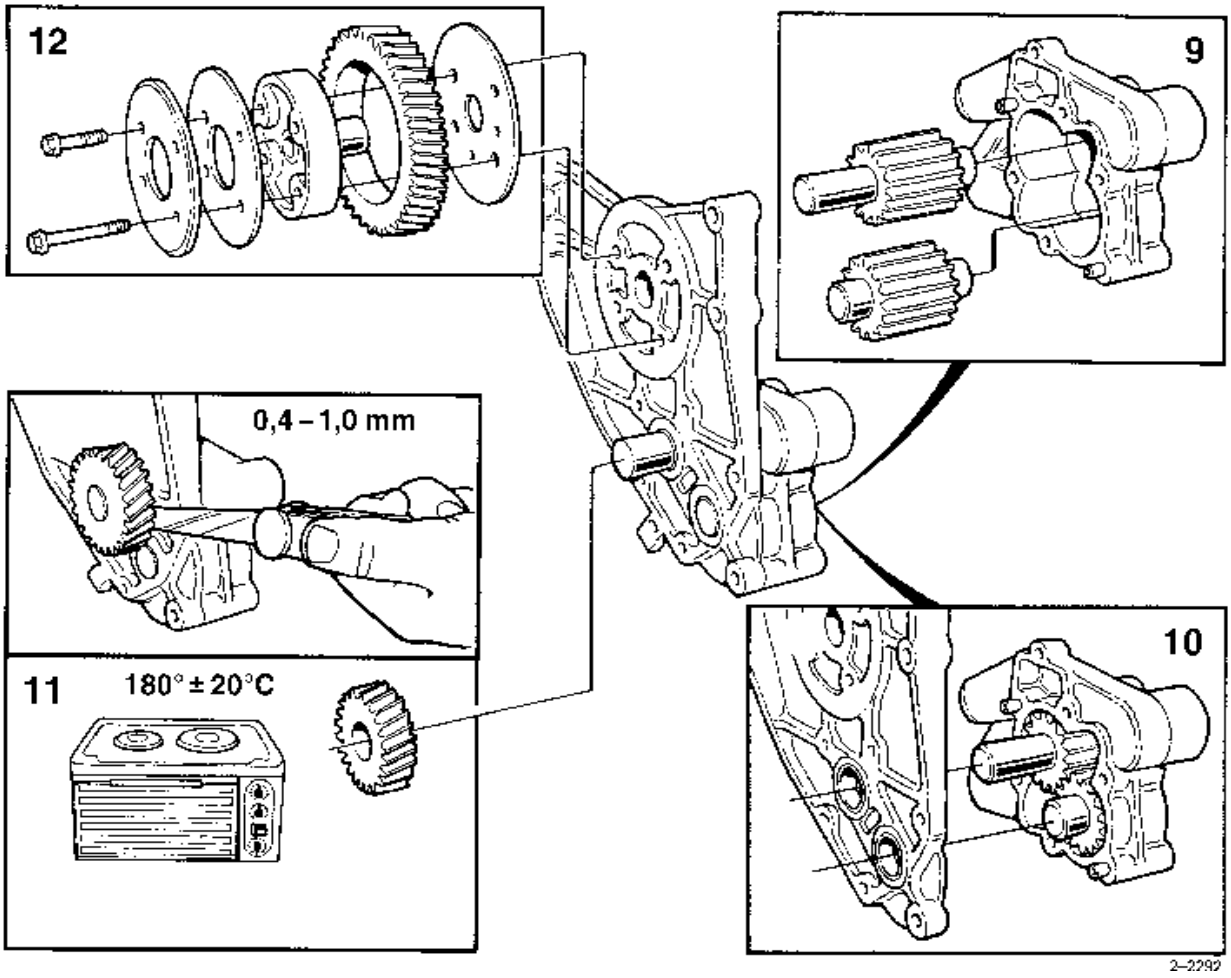
Check the axial play of the pump using a feeler gauge.

Correct play: **0.07–0.15 mm (0.0028–0.0059")**.

8

Check backlash with a feeler gauge**.**

Correct play: **0.15–0.30 mm (0.0059–0.0118")**.



The illustration numbers above refer to the relevant point in the text below.

9

Place the gear wheels in the pump housing.

10

Fit the pump housing to the bracket.

Note: Check that the gears turn easily.

11

Heat up the pump drive to **180°±20°C (356° ± 36°F).** Tap the drive gear on to the pump shaft. The drive can also be pressed in using drift 999 6413 using 999 8012 as an anvil.

Note: The clearance between the drive gear and the bracket should be 0.4-1.0 mm (0.0157-0.0394").

12

Fit the thrust washers, the hub, the idler gear and the bearing end plate. Fit the flange screws.

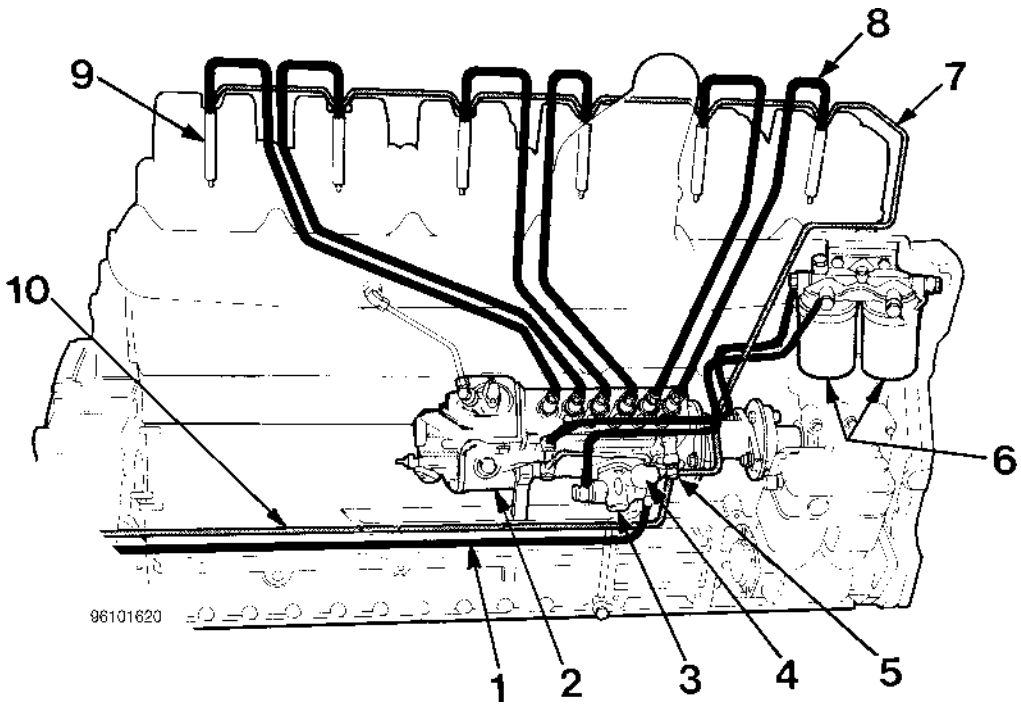
Fuel system
Design and Function

General

The injection system consists of the injection pump, fuel filters (2 ea), feed pump, injectors and pipes.

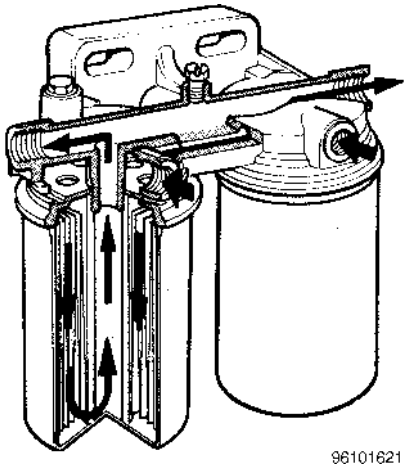
The injection pump is mounted on the ”cold” side of the engine (right-hand side of engine).

1. Suction pipe
2. Injection pump
3. Feed pump
4. Manual pump
5. Bypass valve
6. Fuel filters
7. Fuel return pipe
8. Delivery pipes
9. Injectors
10. Fuel return pipe

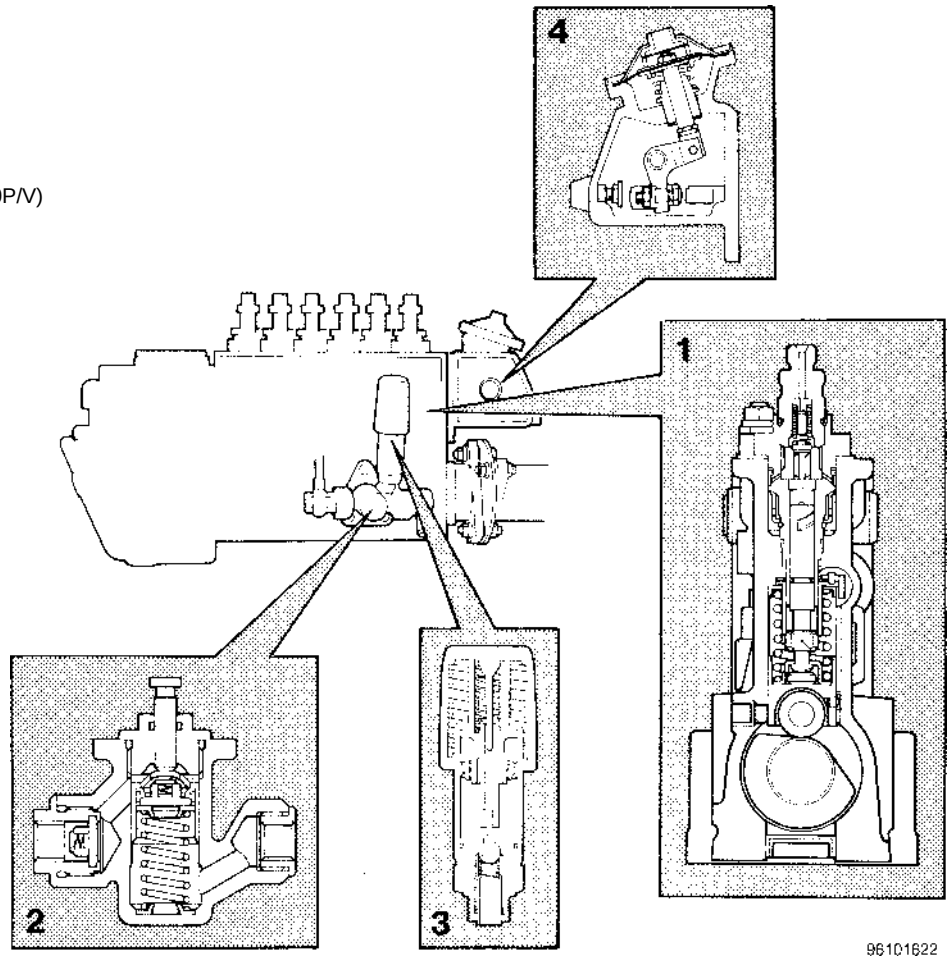


Fuel filters

The fuel system is fitted with two parallel fuel filters and a common filter housing. The fuel filters are of a disposable type and the filter cartridge is a specially wrapped paper filter.



1. Injection pump
2. Feed pump
3. Manual pump
4. Smoke limiter (TAD1630P/V)



Injection pump

The pump does not have a separate bottom plate. The pump body and flange are of integral design. The smoke limiter is mounted on top of the governor housing (TAD1630P/V only).

The pressure leveling device and bypass valve are mounted opposite each other at the front of the pump.

The injection pump carries no external markings for checking the injection angle.

To check the injection angle, the lifting height must be measured with a dial indicator.

Note: Repairs requiring work in the injection pump can alter its setting and should only be carried out by specially trained mechanics with the required tools and testing devices at their disposal.

All warranties on the engine are void if the seals are broken by unqualified mechanics.

Ensure the greatest possible cleanliness when working with the fuel system.

TWD1620G/GH, TID162AG, TWD1630G/GE

These engines have an RQ-governor. The RQ- governor is mechanical and works by means of speed sensitive governor flyweights. The governor is used when constant speed is to be obtained (1500/ 1800 rpm).

TAD1630P/V, TWD1630P/V, TID162AP and TD164KAE

The injection pump on TAD/TWD1630P/V, TID162AP and TD164KAE is equipped with an RQV governor. The RQV-governor is mechanical and works by means of speed sensitive governor flyweights. The speed is regulated throughout the entire speed range of the engine, from low idling to high idling (variable speed type).

TAD1630G/GE, TAD1631G/GE

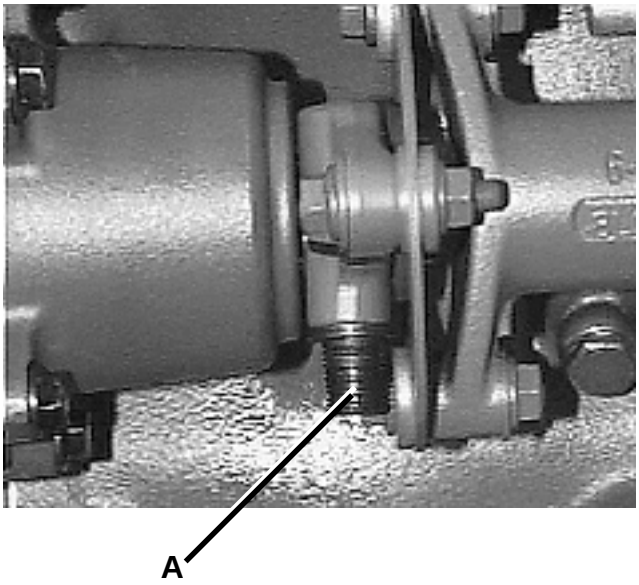
The injection pump on TAD1630G/GE, TAD1631G/ GE is fitted with an electronic speed governor. The electronic governor system is a control unit which controls the engine speed. Its task is to:

– maintain the idling speed at the set value.
– maintain the engine's operating speed at the preset value despite varying loads.

Unlike the mechanical governor, the electronic governor does not have governor weights. The speed is instead controlled by the control unit, "sensing" the difference between the set speed and the actual speed. The difference value is converted into a signal to an electromagnet (actuator) which adjusts the injection pump's control rod to increase or decrease the injection quantity.

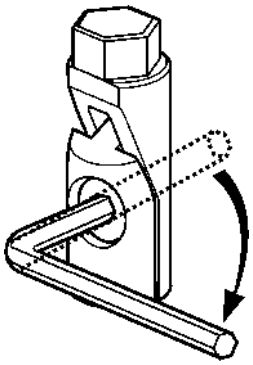
An overspeed protection must always be fitted beside the electronic governor to prevent bodily injury or material damage if the engine should go out of control.

Seal screw, removal



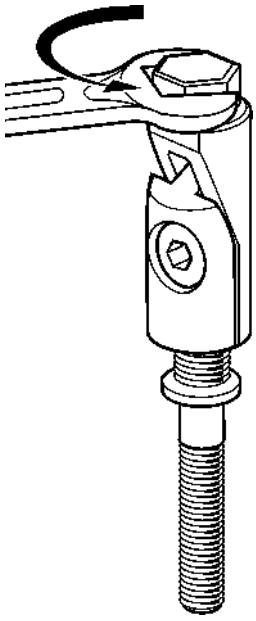
When removing seal screw (A) for the injection pump, use tool 885346 as shown below:

1



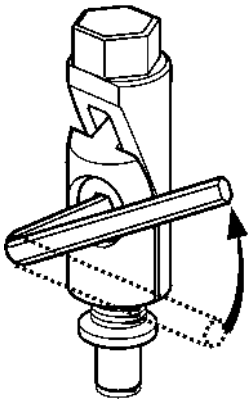
Tighten the tool's socket head cap screw with a hex socket key.

2



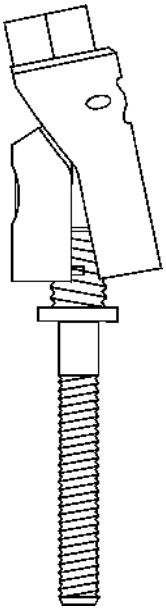
Place the tool on top of the seal screw's conical thread and turn the top of the tool counter-clockwise by hand. Use a 17 mm key to loosen the seal screw.

3



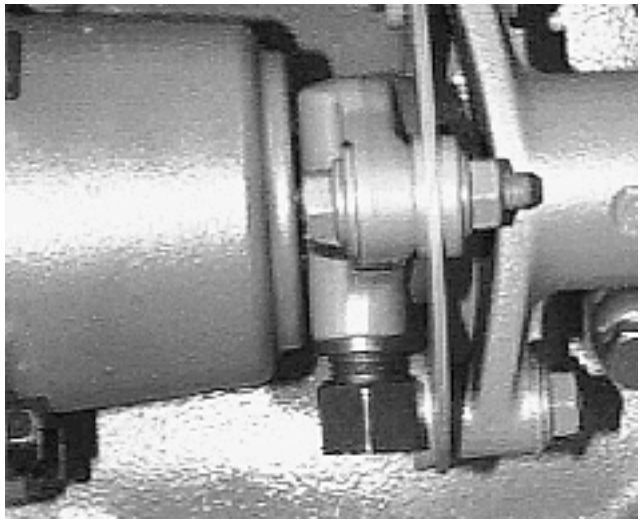
When the seal screw is loose, loosen the socket head cap screw.

4



Press hard on the top of the tool and remove it. Unscrew the seal screw by hand. The seal screw cannot be reused.

5



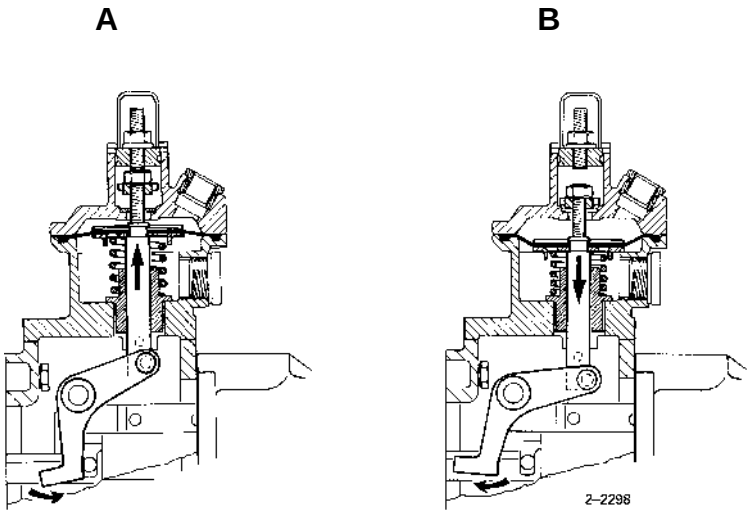
New seal screws (two different ones) have a pre-installed, pre-stressed nut on the conical thread. During assembly, you turn the nut until it releases (the screw has left-hand threads). This provides correct torque. Screws apply to engines as follows:

Screw	**Engine**
982138	TAD1630
982145	TAD1631, TD164

Smoke limiter, TAD1630P/V

The task of the smoke control device is to limit the quantity of fuel from the injection pump at low boost pressure.

The diaphragm in the smoke control device is activated via a pipe by the pressure in the inlet pipe. The diaphragm's movement operates an angle lever via a link system. The lower section of the lever acts on the control rod of the injection pump. In the case of low boost pressure, the lever acts on the control rod to lower the maximum amount of fuel available. In the case of a high boost pressure, the lever permits the control rod to allow a higher maximum quantity of fuel.



A. Low boost pressure

B. High boost pressure

Feed pump

The feed pump is mounted on the injection pump and is driven by the injection pump camshaft. The feed pump pressure in the injection pump is determined by the bypass valve which is mounted on the injection pump. The feed pump has completely replaceable valves.

Manual pump

The hand pump is mounted on top of the feed pump. The hand pump has a built-in valve and does not need to be opened or closed when used.

Service procedures

The engine must always be washed prior to starting repairs.

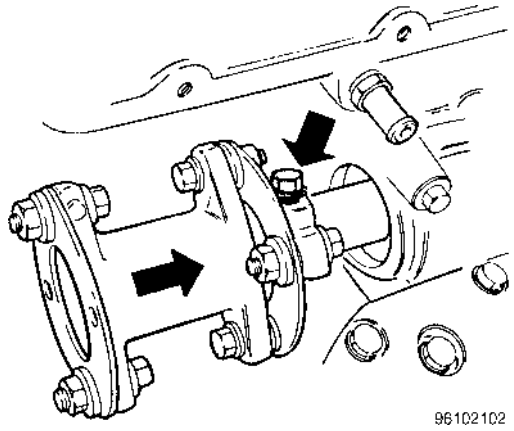
Injection pump, removal

1

Carefully clean the injection pump, pipes and the engine near the pump. Remove the protection plate for the pump coupling.

2

Undo the pressure pipe, fuel and lubrication pipes at the pump and the control connections. Fit protective caps.



3

Undo the clamping screws on the pump coupling. Remove the screws between the pump coupling and the carrier to the pump. Press the pump coupling forwards onto the drive axle.

4

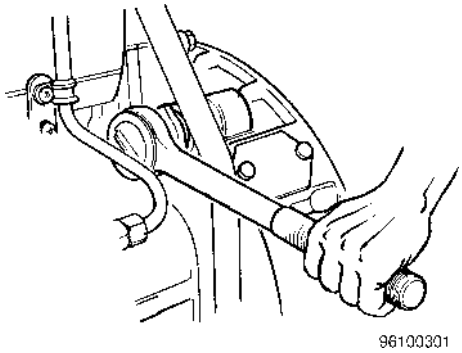
Unscrew the pump's securing screws and lift the pump out. Ensure that the steel laminates do not get damaged.

Fitting and adjusting the injection pump

Special tools: 999 3590, 998 9876, 999 6648

Note: Check that there is about 0.2-0.3 liters (0.2-0.3 quarts) of engine oil in the pump and regulator before the injection pump is fitted. Refilling takes place in the regulator housing.

1

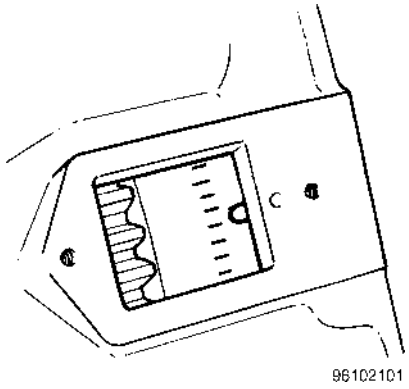


Remove the plug in the flywheel cover (16 mm hex socket key) and fit rotating tool 999 3590. Remove the inspection cover on the flywheel cover. Remove the inspection cover on the camshaft at the cylinder block's rear end.

2

Rotate the engine with a ratchet handle to the compression stroke for No. 1's cylinder (0° marking on the flywheel). The camshaft's marking hole should be pointing up.

3



Turn back the flywheel **in the opposite direction to the engine's direction of rotation** about 90° from the starting point. Then turn it forward **in the direction of rotation** until the correct number of degrees for the pump setting is immediately behind the needle on the flywheel housing. See "Workshop manual, Technical Data".

Note: Set the degree marking within the upper half of the tolerance area which is stated in the specifications.

The setting must be accurately carried out, and do not crank the flywheel back against the direction of rotation to finely adjust the setting. If the flywheel has been cranked too far, the setting procedure must be carried out again.

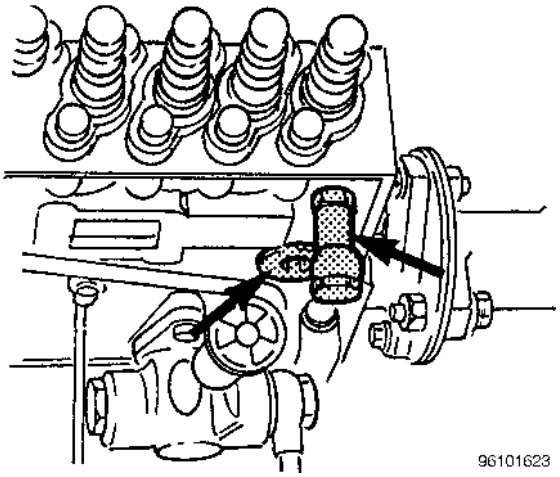
4

Screw the injection pump securely to the engine.

5

Screw the carrier securely to the pump coupling (do not tighten the clamping screws).

6

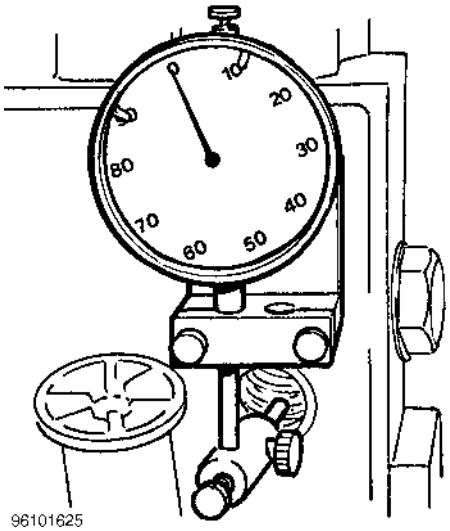


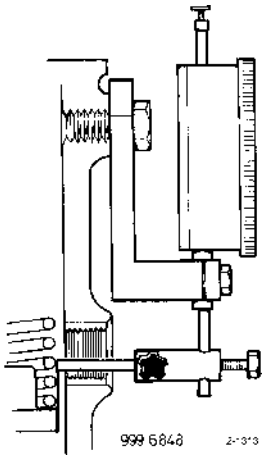
Remove the overflow valve and hex socket plug from the pump so that No. 1's lifter is visible.

7

Rotate the pump coupling until the lifter is at the base position.

8



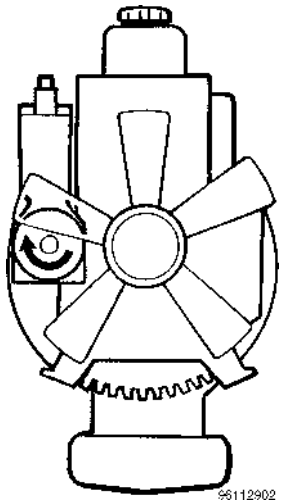


Fit tool 999 6848 and dial indicator 998 9876. Adjust the measurement tip so that it rests on the lifter.

9

Set the dial indicator to zero.

10

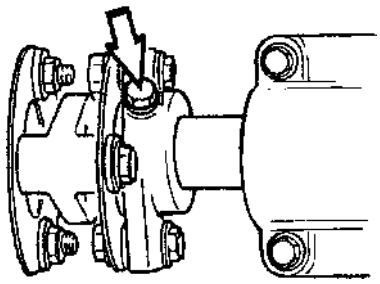


Rotate the pump coupling **in the engine's rotational direction**. Check that the dial test indicator is still at zero when rotation commences.

11

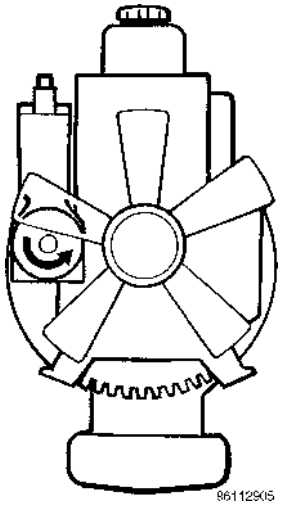
Continue to rotate until the lifter has moved up until the value of the lift from basic circle is shown on the dial indicator. See ”Workshop manual, Technical Data” for each engine type. Further rotate the pump coupling until the dial test indicator shows about **1-2 mm (0.04-0,08”)** more than the figure specified. See ”Workshop manual, Technical Data”.

12



Tighten the clamping screw sufficiently tight so that the pump coupling can be turned with powerful resistance. This must be done to eliminate gear-tooth flank play in the timing gears.

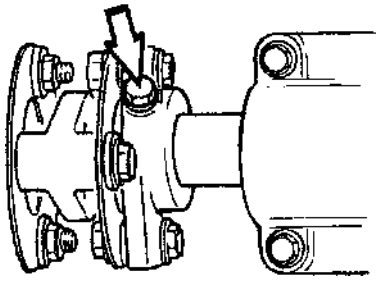
13



Rotate the pump coupling back **against the engine’s rotational direction** until the test indicator shows the value for the lift from basic circle. See ”Workshop manual, Technical Data”.

Note: If the pump coupling is turned too far, it is necessary to start over from item 10.

14



Torque the clamping screws to **85 Nm (62.7 ft-lb)**.

15

Check that the correct adjustment has been maintained by again rotate the engine **backwards 90°, and forwards to correct setting angle**. The dial test indicator should show the correct value for lift from basic circle. See ”Workshop manual, Technical Data”.

16

Remove the dial indicator and fixture.

17

Fit the hex socket plug and a new copper washer.

18

Screw in the overflow valve securely.

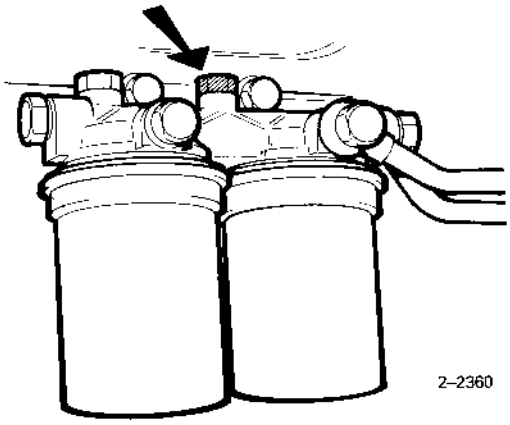
19

Screw in the fuel and lubricating oil pipes together with new washers. Connect the controls.

20

Remove the rotating tool. Fit the plug and inspection covers.

21



Bleed the fuel system and test run the engine. See ”Fuel system, bleeding”.

Injection pump, setting with instrument 998 7057

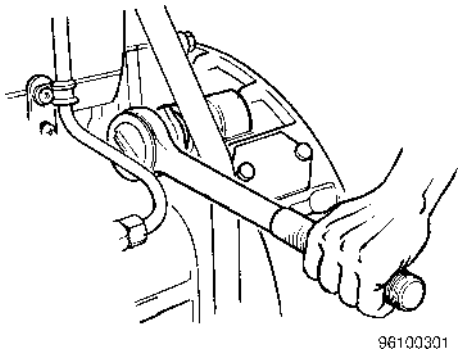
(Injection angle)

Special tools: 999 3590, 998 7057

1

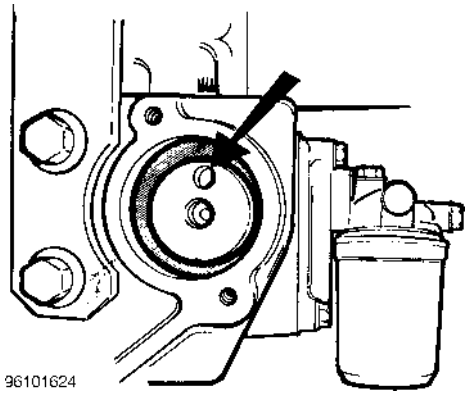
Remove the inspection cover on the camshaft at the back of the cylinder block.

2



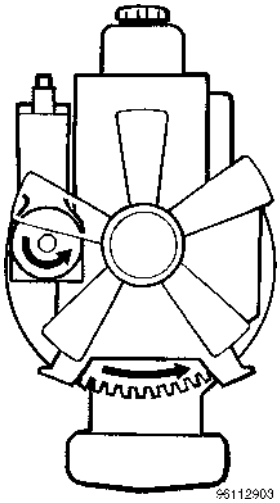
Remove the plug in the flywheel cover (16 mm hex socket key) and fit rotating tool 999 3590 together with a ratchet. Remove the inspection cover on the flywheel cover.

3



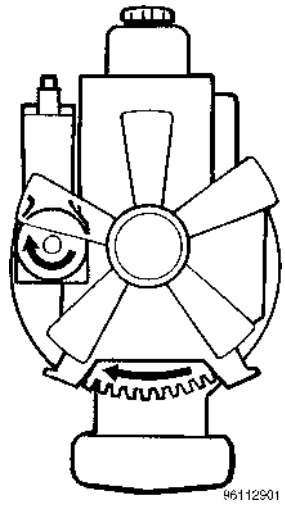
Crank the flywheel **in the direction of rotation** until 1st cylinder is on compression, 0° on the flywheel and the camshaft’s marking hole pointing upwards.

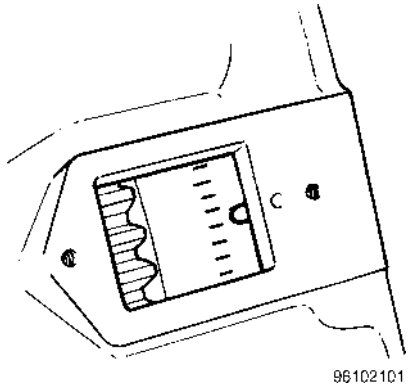
4



Crank the flywheel back **against the engine direction of rotation** about 1/4 turn.

5



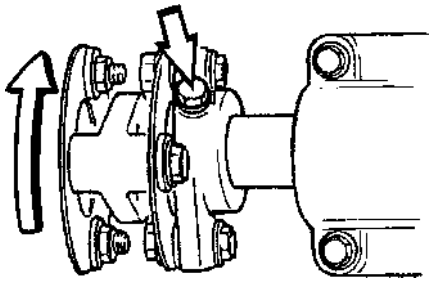


Crank the flywheel **in the direction of rotation** until the correct degree marking immediately behind the needle on the flywheel housing. See "Workshop manual, Technical Data

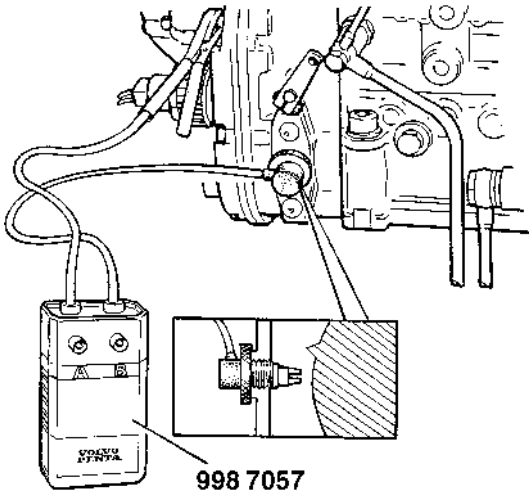
Note: Set the degree marking within the upper half of the tolerance area which is stated in the specifications.

The setting must be accurately carried out, and do not crank the flywheel back against the direction of rotation to finely adjust the setting. If the flywheel has been cranked too far, the setting procedure must be carried out again.

6

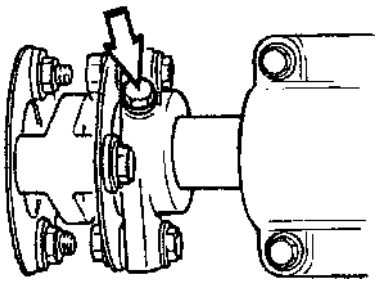


Slacken the pump coupling clamping bolt and turn the pump coupling about 1/4 turn **in the pump direction of rotation.**



7

Remove the plug in the governor housing and fit the measuring instrument sensor. Ground the measuring instrument ground cable to a suitable place on the injection pump.



8

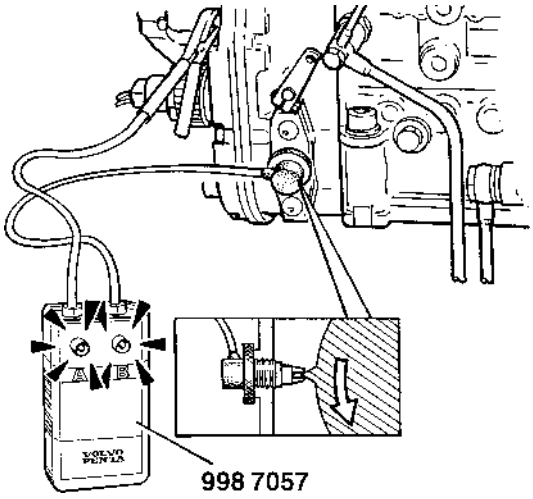
Tighten down the pump coupling clamping bolt so much that the coupling, with considerable resistance, can be turned against the direction of rotation.

Note: The pump coupling should always be turned **against the direction of rotation** when setting the injection angle. This in order to eliminate any play between the timing gears as much as possible.

If the pump coupling clamping bolt is not tightened down sufficiently when the pump coupling is turned against the direction of rotation, there will be insufficient preloading and the setting will not be exact.

Care must be taken not to damage the pump coupling.

9

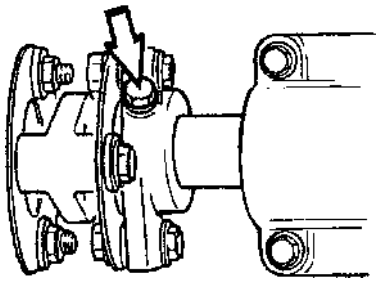


Carefully turn the pump coupling **against the direction of rotation** until both light emitting diodes on the instrument light up. The injection pump is now in position for the injection cycle to commence on No.1 cylinder.

Note: The measuring instrument is very sensitive, which ensures that the setting will be exact.

Make sure that the pump coupling is not turned too far, but **precisely** to the point where both the light emitting diodes light up. If the pump coupling is turned to far, the setting procedure must be carried out again.

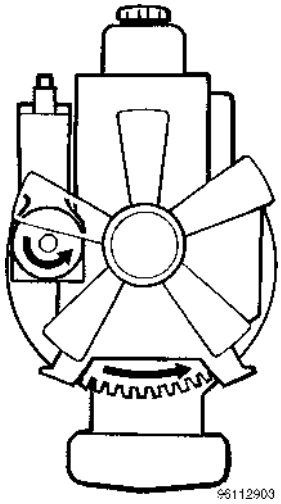
10



Torque the pump coupling clamping bolt according to the specifications in the ”Workshop manual, Technical Data”.

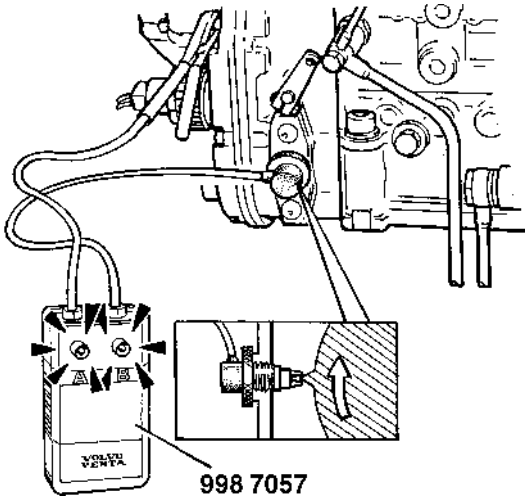
Checking

11



Crank the flywheel back **against the engine direction of rotation** about 1/4 turn.

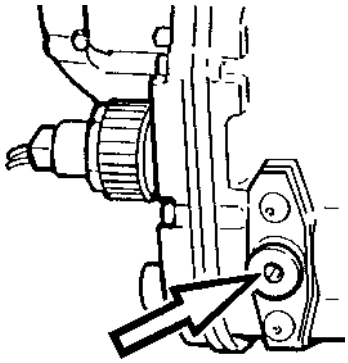
12



Crank the flywheel **in the direction of rotation** until both the light emitting diodes on the instrument light up.
Read off the degree marking on the flywheel and check that the setting lies within the upper area of the specifications given. See ”Workshop manual, Technical Data

13

Remove the measuring instrument sensor and refit the plug in the governor housing.



14

Remove the rotating tool. Replace the plug and the inspection cover on the flywheel casing

15

Fit the inspection cover to the camshaft.

Pump coupling shaft, removing

Checking and replacing the laminates on the pump coupling

Check that the laminates on the pump coupling for the injection pump are not cracked or warped.

Start the engine and let it idle (at about 500 rpm). Check visually that the plates are not warped.

If the laminates have broken or are warped they must both be replaced.

Max axial play on the pump's drive shaft, from transmission to the pump coupling should not exceed **0.1 mm (0.0039").**

Note: Laminate plates should only be fitted when dry. All screws shall be torque tightened.

Clamping screw: 85 Nm (62.7 ft-lb)

Other screws (8 ea): 56 Nm (41.3 ft-lb)

Injectors

The injectors are placed vertically in the middle of the cylinder through the valve cover.

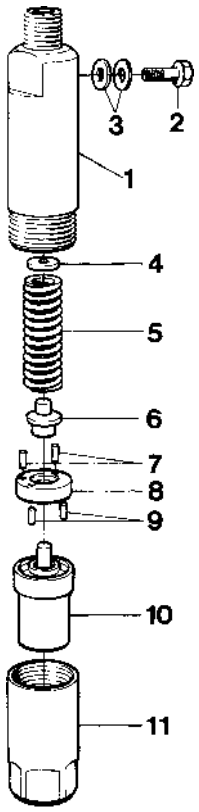
The injectors' task is to:

– Diffuse the fuel to ensure firing and combustion.

– Together with the air turbulence, distribute the spray of fuel in the combustion chamber so that a mixture of air and fuel is provided.

The tension of the compressed springs determines the injectors' opening pressure.

1. Diffuser holder
2. Hollow screw
3. Gasket
4. Adjusting washer
5. Spring
6. Pressure pin
7. Guide pin
8. Guide
9. Guide pin
10. Diffuser
11. Diffuser nut



96102105

Injectors, replacing

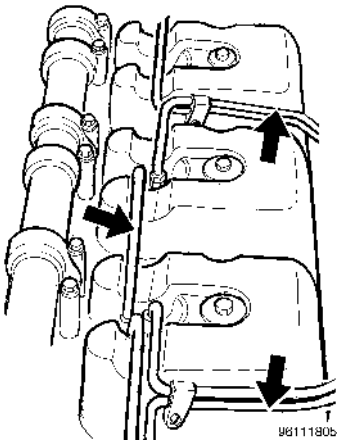
(All)

Special tools: 981 2546, 999 6400, 999 8007

1

Clean up around all fuel return and delivery pipes as well as around the pressure valve retainers on the injection pump.

2



Remove all delivery pipes together with clamps and brackets. Remove all fuel return pipes.

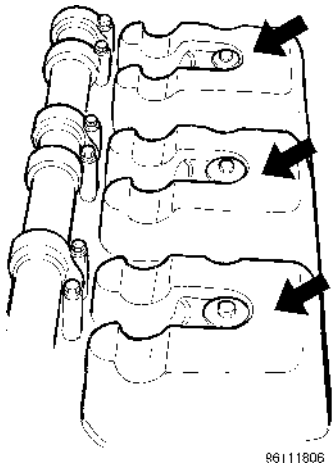
3

Fit protective caps to all injectors and to the pressure valve on the injection pump.

4

Remove return pipe and the brackets between the injectors and the injection pump.

5



Clean around all injectors and remove all valve covers.

6

Remove the injector retainers. Remove all injectors.

Note: If it is difficult to remove the injectors, tap gently on them using tools 999 6400 and 999 8007.

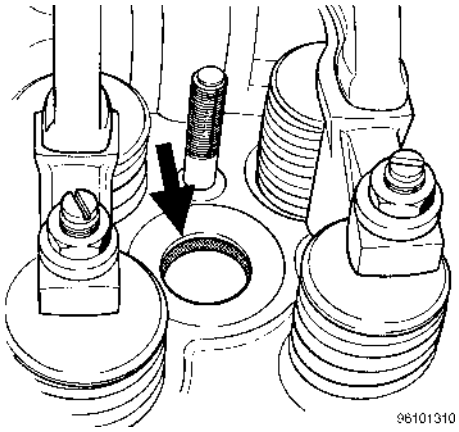
7

Remove the sealing rings from the steel rings.

Note: Clean the copper sleeve's seal using tool 981 2546. Use the mounting sleeve to press the brush into the copper sleeve and fit a drilling machine to the brush.

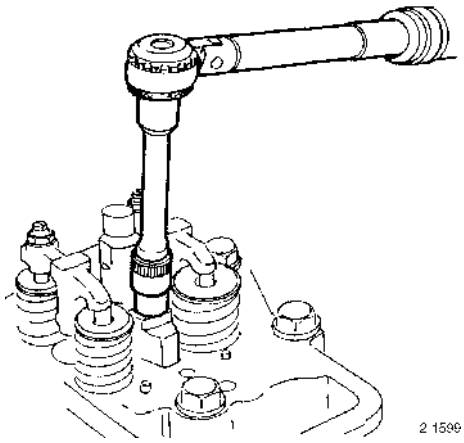
8

Fit new sealing rings.



9

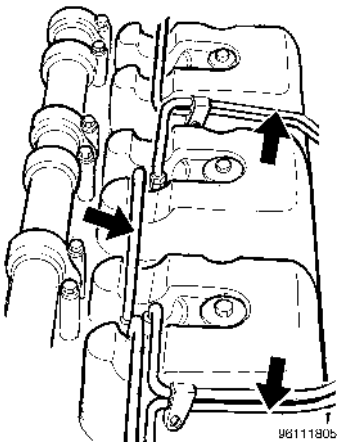
Torque the retainers to **50 Nm (36.9 ft-lb).**



10

Refit all valve covers complete with gaskets.

11



Refit the fuel tank return pipe together with the brackets between the injector and the injection pump.

12

Remove all protective caps from the injectors and pressure valves.

13

Fit the delivery pipes together with clamps and brackets.

14

Fit the fuel return pipes using new copper washers. Bleed the fuel system and start the engine.

15

Check all connections for leakage.

Injectors, reconditioning

1

Clean the outside of the injector.

2

Dismantle the injector. Pull the injector needle out of the diffuser and place the items in gasoline. If several diffusers are cleaned at the same time, make sure that the prematched needles and diffuser sleeves are not mixed up with others. To avoid this, the diffusers should be placed in order on an diffuser rack or in different compartments.

3

Wash all the parts in a sonic cleaner. Blow them dry with compressed air.

4

Check the injector thoroughly. This should be done with a illuminated magnifying glass or injector microscope. The diffuser sleeve can also be examined under the microscope. If the seat is dented, the diffuser needle must be replaced together with the sleeve or, in cases of less damage, it may be lapped in a lapping or diffuser grinding machine.

5

Check the other parts.

6

Dip the diffuser parts in clean diesel or calibration oil.

7

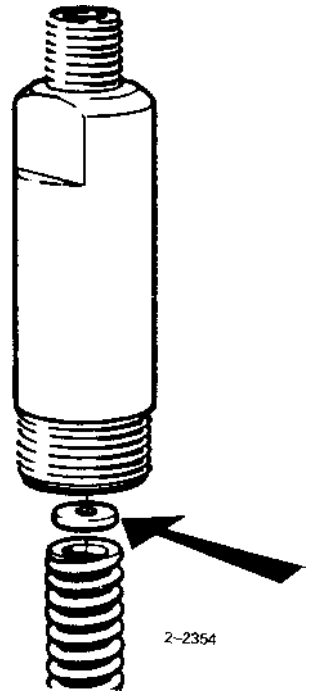
Reinstall, adjust opening pressure and check spray pattern

Opening pressure, adjusting

Two different pressures apply:

One for a run-in injector (see Technical Data, ”Opening pressure”), and one which applies to a new or reconditioned injector fitted with a new thrust spring (”Adjusting pressure”). The latter is higher since a certain margin must be allowed for the normal settling of the thrust spring.

Connect a pressure gauge and slowly press down the lever on the injection tester until the injector opens and releases fuel. Read off the opening pressure at that instant.



If this does not agree with the pressure stipulated by the ”Specifications” the setting must be altered. This is done by means of fitting adjusting washers.

Adjusting washer for opening pressure!

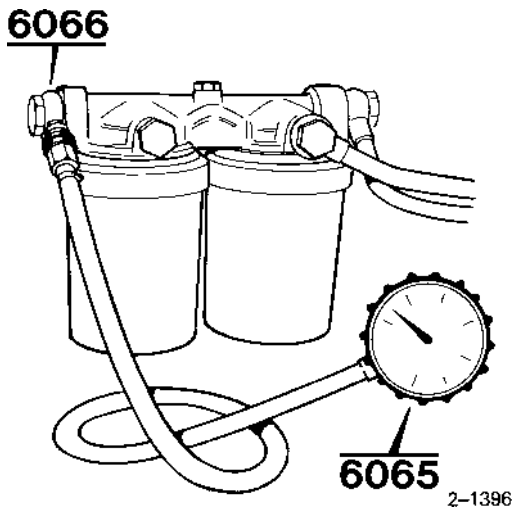
Spray pattern

At a pump speed of **4-6 strokes per second**, the spray pattern should be uniform and the fuel finely atomized.

On completion of the test, plug the pipe connections and protect the diffuser tips with caps.

Fuel feed pressure, checking

Special tools: 999 6065, 999 6066



The banjo nipple 999 6066 and pressure gauge 999 6065 are connected to the outlet on the discharge side of the fuel filter.

Pressure is measured after the fuel has passed through the filter insert. To do this check, first increase engine speed and then lower it to enable the pressure to read-off at low idle. The feed pressure must not drop below **100 kPa (14.5 psi).**

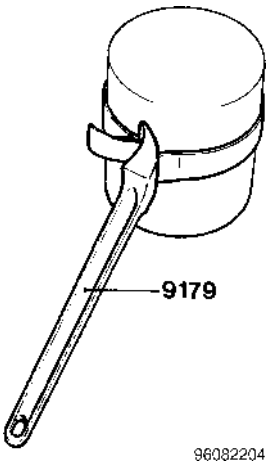
Fuel filters, replacing

Special tools: 999 9179

1

Carefully clean around the filter bracket.

2



Remove the filters with tool 999 9179.

3

Moisten the seals of the new filters with oil and then screw on the filters by hand until the seals are in contact with the bracket. Now tighten by hand a **half turn further**. Check that the new filter has not been damaged. If the filter is dented, it may crack.

4

Bleed the fuel system.

5

Start the engine and check for leaks around the filters.

Feed pump, replacing

1

Clean around the feed pump.

2

Remove the fuel pipes from the pump.

3

Remove the feed pump from the injection pump.

4

Clean and fit new gasket on the injection pump. Fit the feed pump.

Note: If lubricating oil has run out of the injection pump, an equal quantity should be replaced afterwards through the regulator's level plug, at the rear of the regulator.

5

Fit the fuel pipes.

6

Bleed the fuel system.

7

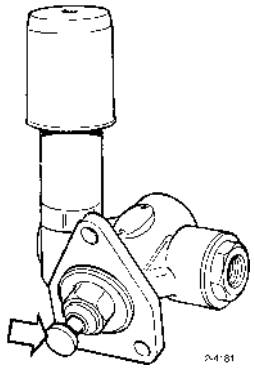
Start the engine and check for leaks.

Feed pump, reconditioning

(Pump removed)

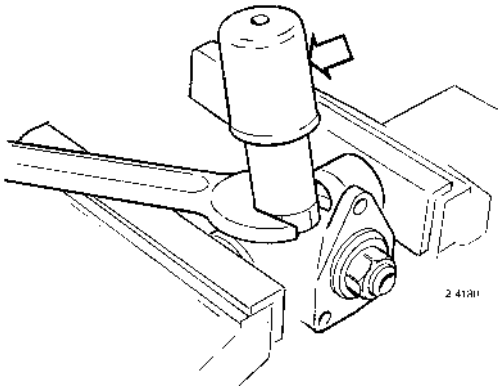
Disassembly

1



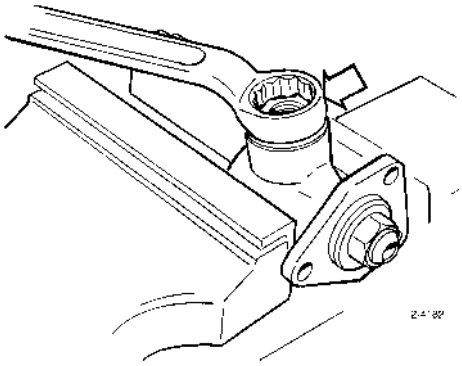
Remove the push rod.

2



Remove the hand primer pump.

3



Remove the union.

4

Remove the valve housing and the plunger.

5

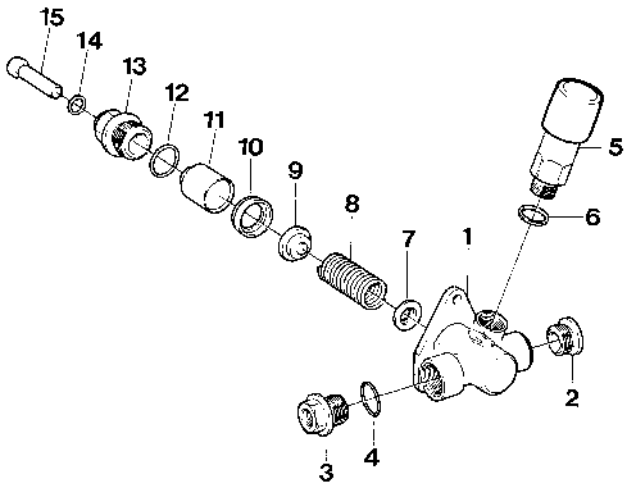
Remove the valve, spring, cups (2 ea) and the spring.

Inspection

Inspect all other parts and replace those that are damaged or worn.

Assembly

Observe the greatest of cleanliness and rinse the parts in clean diesel fuel before fitting together. If the pump is not to be installed immediately, fit protection plugs to the connections.



1. Housing
2. Union
3. Union
4. O-Ring
5. Manual pump
6. Gasket
7. Cup spring
8. Spring
9. Valve
10. Spacer ring
11. Pump plunger
12. O-Ring
13. Union
14. O-Ring
15. Push rod

6

Fit the spacer ring (10 into the pump plunger (11).

7

Fit the valve (9), the cup spring (7) and the spring (8) to the pump plunger (11). Insert the pump plunger (11) into the pump housing.

8

Fit the O-ring (4) to the union (3) for the valve.

9

Fit the union (3) and the O-ring (4) to the feed pump housing.

10

Fit the hand primer pump (5) and the seal (6).

11

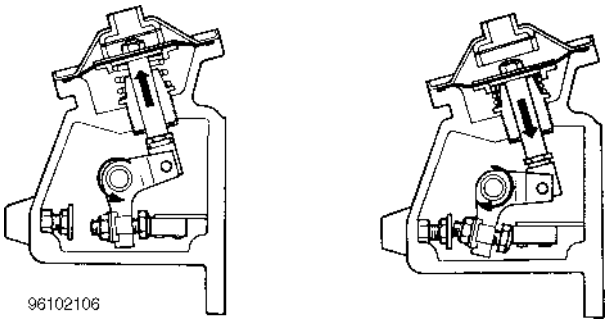
Fit the push rod (15).

Note: If the pump is not going to be refitted immediately, fit protective plugs to both connections.

Smoke limiter

The task of the smoke control device is to limit the quantity of fuel from the injection pump at low boost pressure.

The diaphragm in the smoke control device is activated via a pipe by the pressure in the inlet pipe. The diaphragm's movement operates an angle lever via a link system.



The angle lever's lower section operates the injection pump's control rod.

Low boost pressure High boost pressure

At low boost pressure the angle lever is operated by the control rod so that a low maximum quantity is maintained.

At high boost pressure the angle lever adopts a position where the control rod can provide the high maximum quantity.

Note: The seals may only be broken by authorized staff.

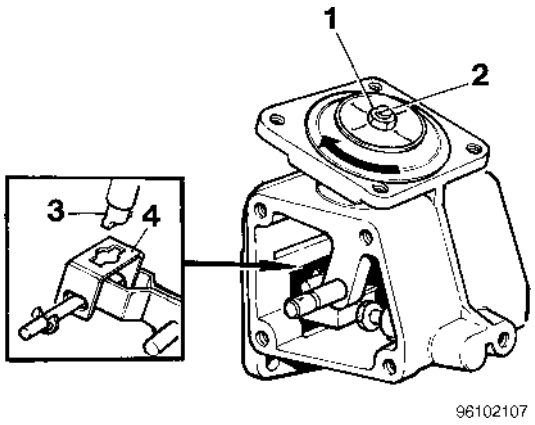
Replacing the diaphragm

(Can be carried out with the pump fitted to the engine)

Note: The seals may only be broken by authorized staff.

1

Remove the pipe between the smoke control device and the inlet pipe.



2

Remove the seals on the smoke control device and remove the upper cover and outer end cover.

3

Rotate the diaphragm **90°** and lift it out.

4

Unscrew the nut (1), remove the diaphragm and screw in a new one.

5

Fit the diaphragm in the smoke control device.

Note: The groove (2) in the axle should be across the pump's length direction before rotation. Check after fitting that the diaphragm's axle (3) is correctly secured in the yoke.

6

Fit the cover and pipe. Seal the screws.

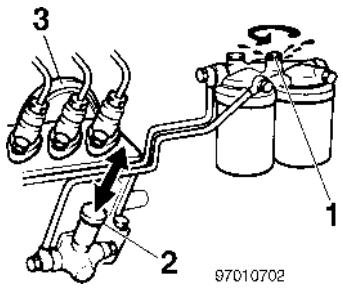
Fuel system, bleeding

The fuel system must be vented after the fuel filters or the injection pump have been replaced

1

Make sure that the engine is in operating mode.

2



Open the bleed nipple (1) on the fuel filter. Press the primer pump (2), until fuel free from bubbles of air starts to flow out. Continue to pump 15-20 strokes. Check that there is no fuel leakage.

Note: In cases where the engine is equipped with fuel shut-off valve, it is often necessary to bleed on the injection pump as well. This is done by opening the pressure equalizer (3) (27 mm U-key). Pump manually until fuel free from air bubbles flows out.

Intake and exhaust systems

Design and Function

Charge air cooler

The TAD1630 and TAD1631 are equipped with an air to air charge air cooler. The purpose of the cooler is to lower the temperature of the intake air before it is blown into the engine cylinders.

TWD1620, TID162, TWD1630 and TD164KAE is equipped with a charge air cooler of the water to air type.

The charge air cooler (intercooler) lowers the air temperature by about 100°C (TWD) and 150°C (TAD) respectively and increases engine output. Engine torque is also higher and fuel consumption is lower.

On the TAD1630 and TAD1631 the charge air is cooled when it is passing the charge air cooler which is placed behind the engine's cooler. The air is pressed from the turbocharger through the charge air cooler and into the inlet manifold (air to air cooling).

On the TWD1630 the charge air is cooled by the water cooled charge air cooler placed on top of and on the right hand side of the engine (water to air cooling).

Turbocharger

The turbo unit is of type:

TAD1630, TAD1631 – Schwitzer S4T

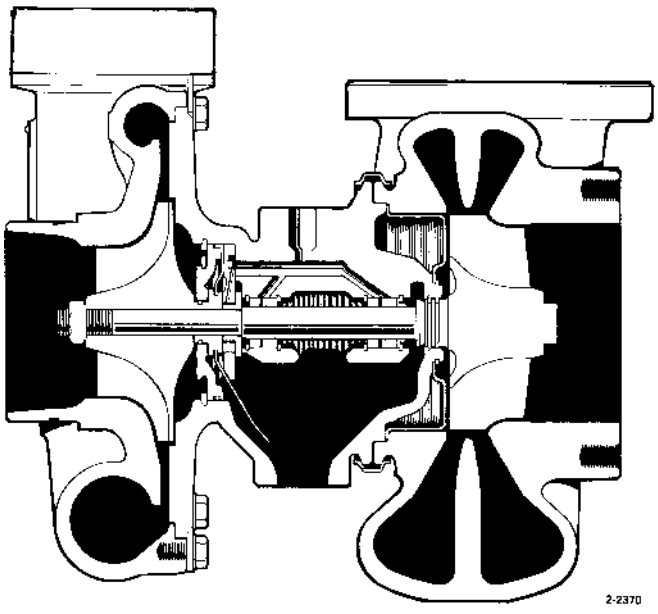
TWD1620, TID162 – Holset HSB0870/B36

TWD1630 – Holset H3B

TD164KAE – Garret TV75

The turbocharger is powered by the exhaust gases which pass through the turbine housing to reach the exhaust system. The passage of the exhaust gases causes the turbine wheel to spin. On the same shaft as the turbine wheel is a compressor wheel. The compressor wheel spins in a compressor housing which is connected between the air filter and the engine's inlet manifold.

As the compressor wheel rotates, air is sucked in from the air cleaner. The air is compressed by the compressor wheel and is forced into the engine cylinders.



Air filter

The disposable air filter is of the dry type with a paper filter element. There is a pressure drop indicator which shows a red indicator when the filter is clogged and needs replacing.

Starter heater

The pre-heating and post-heating times are a factor of engine temperature.

The purpose of the starter heater is to warm up the air in the intake manifold when the engine is started. The heated air makes for easier starting and also reduces the generation of exhaust smoke during cold starts.

Exhaust manifold

The exhaust manifold is exposed to significant heat stresses and fluctuations and is therefore manufactured of a heat-resistant material. The exhaust manifold is cooled by air.

Service procedures

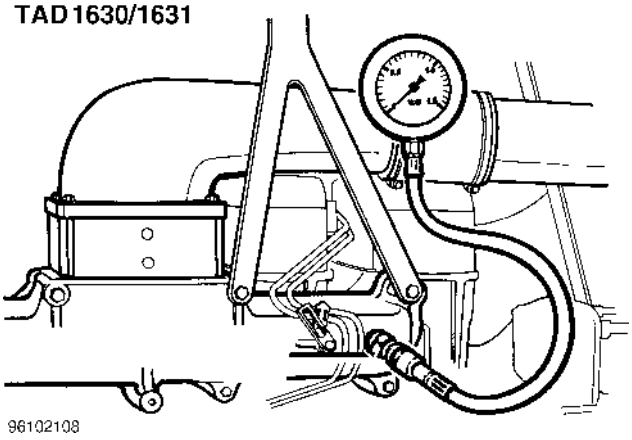
The engine must always be washed prior to starting repairs.

Boost pressure, checking

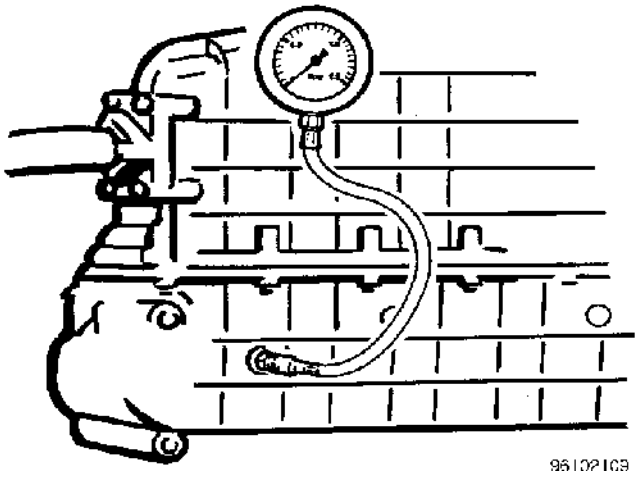
Special tools: 999 6065, 999 6591

1

TAD 1630/1631



TWD1620/TID162/TWD1630/TD164



Fit the connecting nipple 999 6591 and gauge 999 6065 to the engine's inlet manifold.

2

Measurement should occur continuously with a full load and full acceleration, while the rpm slowly exceeds the speed limits for the different engine types shown in "Workshop Manual, Technical Data".

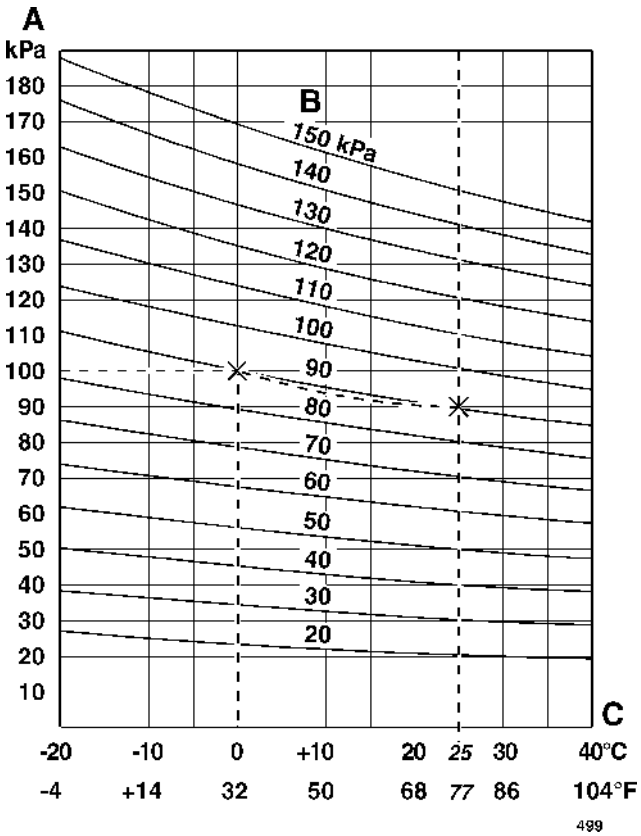
The charging pressure should not fall below these levels.

Note: For this test to give a true picture of the situation, it is essential that the full load condition is maintained a sufficiently long period of time for the pressure to stabilize. It should also be noted that boost pressure varies with the temperature of the intake air (ambient air).

If boost pressure is measured at any other temperature than **+25°C (+77°F)**, the boost pressure reading must be adjusted by means of the diagram below.

Example:

A pressure of 100 kPa measured at 0°C is equivalent of 90 kPa at +25°C.



Boost pressure at different temperatures

A. Measured boost pressure

B. Correction curves

C. Temperature of intake air

Rectifying low boost pressure

1. Tightness of seals, inlet and exhaust manifolds.

It is essential that the hose between the turbocharger and the inlet manifold is not cracked or is inadequately clamped.

In addition to a loss in boost pressure, leakage can also cause a high exhaust gas temperature which will result in excessive stresses on the exhaust pipe, turbo, valves and piston rings.

An exhaust system operating with too large a counter pressure reduces boost pressure, gives a lower engine output and increases exhaust temperature with a related risk of burnt valves and turbo failure.

When an exhaust system has been rebuilt the back pressure must always be checked in accordance with the instructions given. See next page **"Checking exhaust back pressure"**

The following demands must be met when converting an exhaust system:

A. The diameter of the connecting pipe must be 1/2-1" larger than the pipe to which it is to be connected.

B. The transition between the existing pipe, to which connection is being made, and the connecting pipe must not be abrupt. It should be tapered, the taper being about 180 mm long.

C. The pipe elbows should have as large a radius as possible. "Pleating" should be avoided.

2. Air filter

Check that the air filters are not blocked and that the correct filters are being used. The indicator on the air filter inlet pipe must not show red. Replace the filters when necessary.

3. Accelerator linkage

Check that the accelerator linkage provides full travel of the injection pump arm.

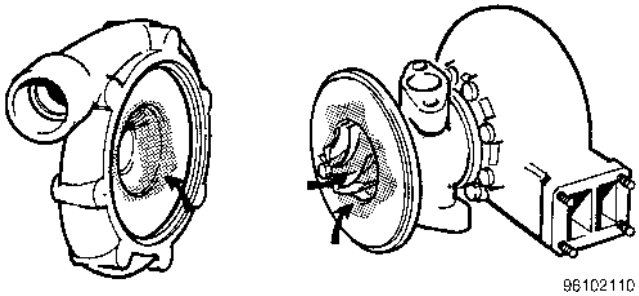
4. Turbocharger

Check if the rotor shaft is sluggish or if the turbine wheel and compressor wheel chafe against their housings. Turn the wheel at first with a slight pressure, and when with a slight axial pull. If the wheel is sluggish, the turbocharger must be immediately replaced or reconditioned. Check the wheel for damage.

In the event of daily operation in dusty or oily air, regular cleaning of the compressor housing and compressor wheel is recommended. Fouled compressor parts can result in low boost pressure.

The compressor parts can be cleaned with the unit fitted as follows:

Remove the compressor housing. Clean the compressor housing, compressor wheel and the end head in kerosene or the like. Fit the compressor housing and measure the boost pressure again.



96102110

5. Injection pump

Check the following:

Governing, injection angle, calibration, fast idle, smoke eliminator diaphragm and triggering point, curve plate setting and sealing.

6. Feed pressure

Check that fuel leakage does not occur and that the pump provides the correct feed pressure.

7. Delivery pipes

Check that the pipes are of the correct dimension and that the holes are not damaged.

8. Injectors

Check the markings, opening pressure, spray pattern and that the holes are not faulty or blocked.

9. Engine condition

Check the compression pressure and the valve clearance of the engine.

If the boost pressure remains unsatisfactory once all these points have been checked and approved, the turbocharger should be reconditioned or replaced.

Checking exhaust back pressure

Special tools: 884969 (flange kit) TWD1620/-1630, TID162
885184 (flange kit) TAD1630/-1631

1
Remove the exhaust pipe from the turbocharger's exhaust outlet. Remove the studs.

2

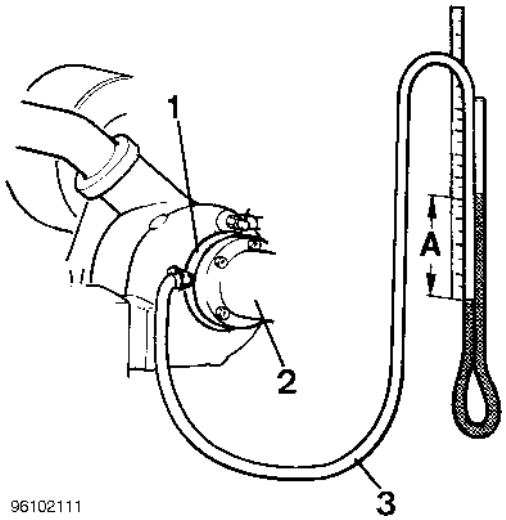
Clean the sealing surfaces. Fit the longer studs included in the flange kit.

3

Fit the measuring flange to the turbine housing with gaskets on both sides. Fit the exhaust pipe.

4

Connect a transparent plastic hose (or a low pressure manometer) to the nipple of the measurement flange. The difference between the water columns (A) gives the back pressure in WC (inches of water).



1. Flange for measuring
2. Exhaust tube
3. Transparent plastic hose, part filled with water

5
Run the engine **fully loaded and fully accelerated** for a few minutes and check the back pressure.

Max back pressure in the exhaust system is 1.0 kPa (1000 mm WC = 0.145 psi).

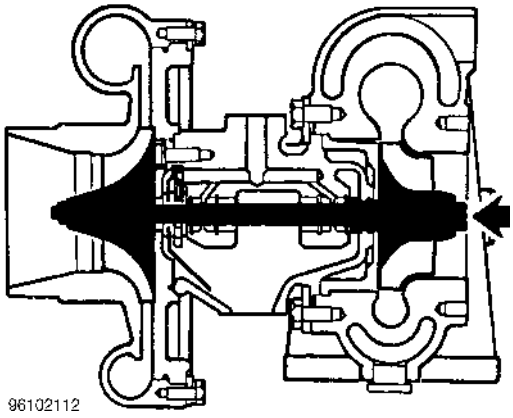
An exhaust system with exhaust pressure that is too high reduces the efficiency of the engine while increasing exhaust smoke and engine temperature, which in turn can cause burnt valves and turbo breakdown.

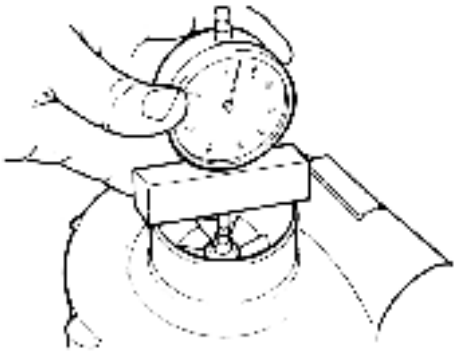
Turbocharger, checking bearing clearance

Schwitzer S4T/Holset H3B/Holset HSB870/B36

Checking axial and radial clearance is normally done only in conjunction with reconditioning when it is required to ascertain the degree of wear in the unit.

Measuring axial clearance





Place a dial indicator with an **8 mm (5/16")** shank in the holder as shown. Secure the dial indicator.

Place the holder on the compressor housing. Make sure that the measuring point rests against the center of the shaft.

Press down the holder against the compressor intake and at the same time press the turbine rotor up and down by hand. Read the dial indicator.

Axial clearance:

Max 0.20 mm (0.008") .

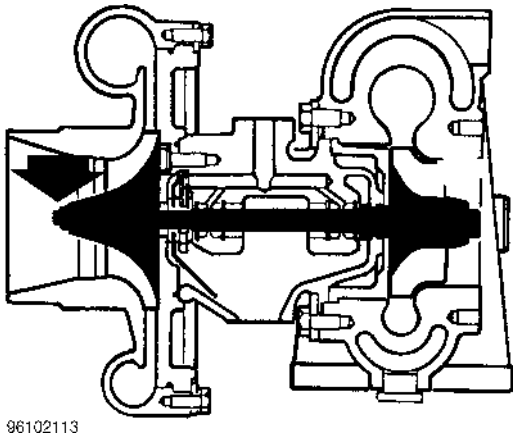
For TD164KAE **max. 0.12 mm (0.005")**.

For TWD1620 and TID162 **max. 0.18 mm (0.007").**

Measuring radial clearance

Place a rocking arm dial indicator with its measuring point on the compressor wheel hub.

Press down the wheel at the same time as the rotor on the opposite end of the shaft is pushed upwards. Set the indicator to zero.



Pull the wheel upwards at the same time as the rotor at the opposite end of the shaft is pushed downwards.

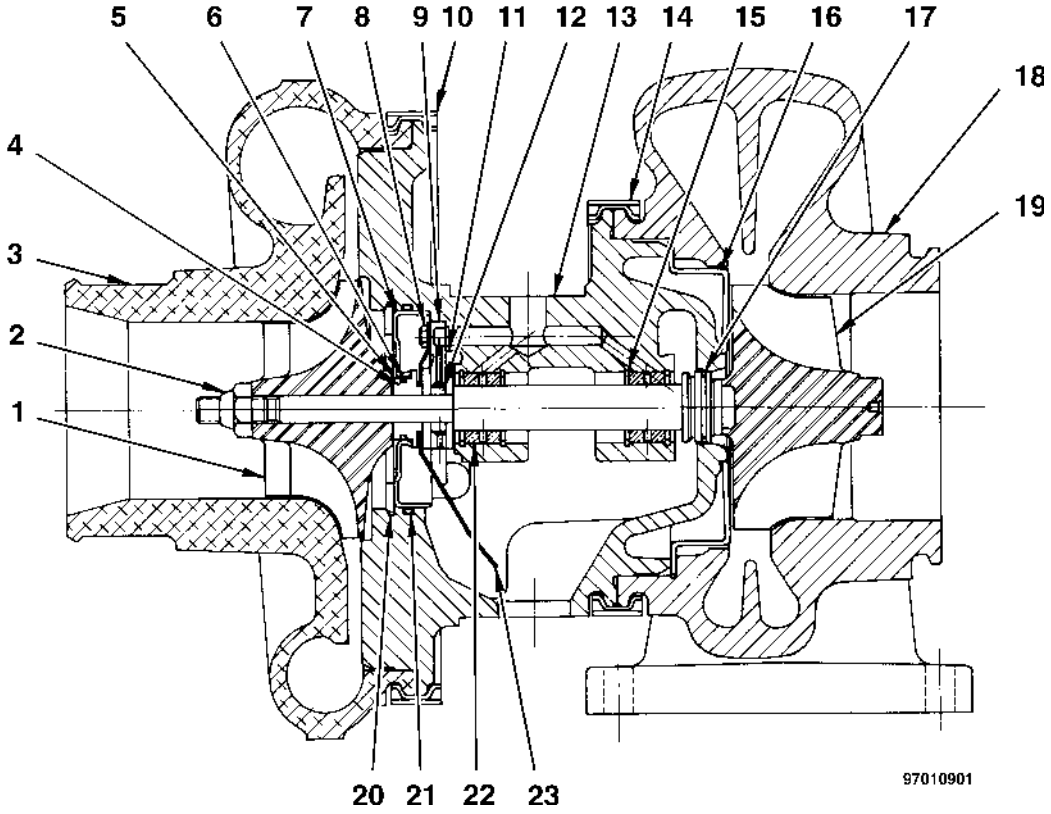
Radial clearance:

Max. (compressor side) **0.72 mm (0.028")**.
For TD164KAE **max. 0.18 mm (0.007")**.
For TWD1620 and TID162 **max. 0.15 mm (0.006")**.

IMPORTANT! Radial play shall be measured when the turbine shaft is offset in parallel.

Turbocharger, reconditioning

Schwitzer S4T (TAD1630, TAD1631)



1. Compressor Wheel
2. Lock nut
3. Compressor Cover
4. Piston ring holder
5. Shim (optional)
6. Piston ring
7. Cover
8. Screws
9. Thrust bearing
10. V-clamp
11. Thrust washers
12. Spacer sleeve
13. Bearing housing (complete)
14. V-clamp
15. Circlips
16. Heat Shield
17. Piston ring
18. Turbine housing
19. Shaft and wheel (complete)
20. Snap ring
21. O-Ring
22. Bearings
23. Oil deflector

Disassembly

1

Mark the relative positions of the compressor cover (3) and turbine housing (19) to the bearing housing (13).

2

Fix the turbine housing in the vise using soft jaws. The turbocharger shaft should be vertical.

3

Remove the V-clamp (10) securing the compressor cover.

4

Remove the compressor cover (3).

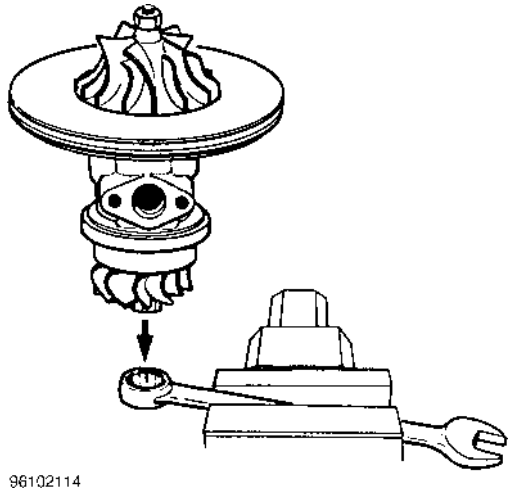
5

Remove the V-clamp securing the turbine housing.

6

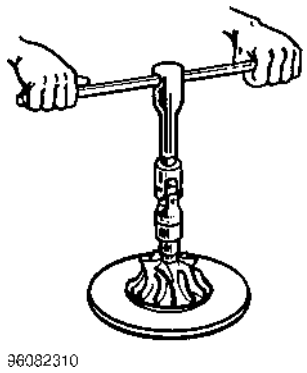
Lift the central bearing housing out of the turbine housing.

7



Clamp a suitable 12 point socket wrench in the vise with the socket axis vertical.

8



Place the 12 point hub of the turbine wheel into the socket. Release the compressor wheel locknut (2).

Note: Use a T-handle wrench together with a universal joint to avoid side-loading the turbine wheel shaft.

9

Remove the compressor nut and slide the compressor wheel from the turbine shaft. Some models have shims (5) fitted between compressor wheel and piston ring holder (4). The position and thickness of any shims should be noted.

Note: If the compressor wheel is sticking it may be heated with a hot air pistol to a max of **130°C (266°F)**.

10

Gently remove the turbine shaft and wheel by tap- ping with a small soft faced mallet on the compressor end of the shaft. **Be careful not to bend or damage the shaft.**

11

Place the bearing housing (13) on the turbine backplate (16) (if fitted) on the bench and remove the insert retaining snap ring (20).

12

Carefully bend up the cover (7) using two screwdrivers.

Note: Thread a piece of plastic tubing over the screwdrivers to avoid damaging the bearing housing.

13

Dismantle the insert assembly by pushing the piston ring holder (4) out of the insert.

14

Remove the 2 screws retaining the oil deflector (23). This will allow the oil deflector, thrust bearing (9), thrust washers (11) and spacer sleeve (12) to be removed from the bearing housing.

15

Using suitable circlip pliers, remove the outer circlips from both ends of the bearing housing, remove the journal bear- ings and inner circlips.

Cleaning of Parts

1 Aluminum parts

Soak in a non-caustic solvent until all deposits have been softened. Clean surfaces with bristle brush and soft scraper. Steam may be used providing bearing surfaces are protect- ed.

2 Cast iron parts

Soak in non-caustic solvent.

Alternatively blast. Be careful with internal profile surfaces.

3 Shaft and wheel assembly

Soak in solvent to remove oily residue. Mask entire shaft section and totally clean wheel and hub using steam. Avoid concentrating on piston ring seal groove.

Inspection of parts

1 Bearing Housing

Inspect bearing bore visually for sign of damage or wear.

Check turbine end seal bore for damage.

2 Compressor Wheel (1)

Visually inspect for evidence of bent, burred, nicked or eroded blades, and for evidence of scuffing on the back face. Very minor damage is acceptable. Reject and replace if damage appears sufficient to affect wheel balance. Do not attempt to straighten any bent blades.

3 Shaft and wheel assembly

Check journal diameter for wear. Minimum diameter is **15.99 mm (0.6300")** or **17.43 mm (0.6867")** (actual size depends on model).

Check seal groove width max **1.58 mm (0.0623")**.

Measure eccentricity between large and small shaft diameter, max **0.008 mm. T.I.R.(0.0003").**

Check balance to **0.36 gm mm (0.0005 oz. inch)** in both planes. Replace if outside limits.

4 Compressor cover (3)

Visually inspect for evidence of contour damage. Replace if damage is excessive.

5 Turbine housing (18)

Visually inspect for damage and excess temperature damage such as cracking, pitting, warping, erosion. Reject and replace if damage is excessive.

6 Turbine heat shield (16)

Replace if cracked or warped.

7 Piston ring holder (4)

Check piston ring groove width max **1.58 mm (0.0623")** and for signs of taper or damage to groove. Reject if worn.

8 Thrust washer (11)

Replace if thrust surfaces are worn. In most cases these may be reused by reversing the position so that the non worn side is in contact with the thrust bearing.

9 Spacer sleeve

This part should show no sign of surface damage or wear.

Assembly

1

Use only the parts complying with the dimensions outlined in the inspection instructions above plus an ”Overhaul Kit”.

2

All parts must be washed in clean solvent and dried with compressed air.

3

Fit the inner snap rings to the bearing housing bushing. Add a few drops of oil to the bushing and fit the journal bearings and outer snap rings.

4

Fit a new piston ring to the groove in the shaft and wheel assembly.

5

Fit turbine backplate (16) over the shaft section so that it rests on the back of the turbine wheel.

6

Fit the shaft and wheel etc. into the bearing housing after lubricating both shaft and piston ring. Take care not to damage the piston ring when inserting the sealing bore.

7

Place this assembly in the turbine housing with the shaft vertical.

8

Fit the thrust washer (11) and spacer (12) onto the shaft.

9

Fit the thrust bearing (9) into the bearing housing (13) and lubricate the bearing surfaces.

10

Fit the second thrust washer and oil deflector. Fit the two retaining screws and torque to **5.0-5.7 Nm (45-50 in-lb)**.

11

Fit a new O- ring (21) to the groove in the bearing housing.

12

Fit a new piston ring (6) into the piston ring holder (4).

13

Assemble the piston ring holder assembly into the insert taking care not to damage the piston ring.

14

Lubricate the O- ring (21) and mount the insert into the bearing housing and retain with the snap ring. Ensure that the bevelled edge is turned upward.

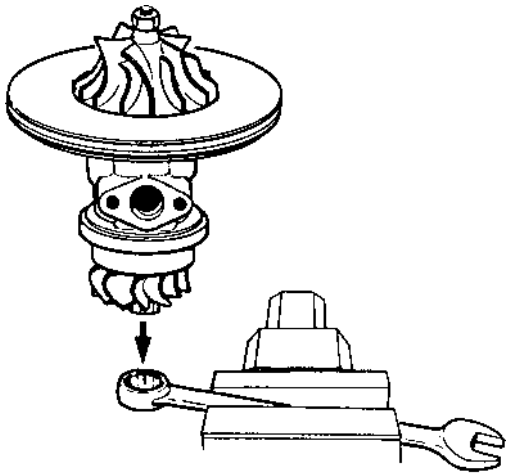
15

Fit the compressor wheel (1) and lock nut (2). On models that have shims (5) under the compressor wheel, ensure that all shims are refitted (if a new compressor wheel or compressor cover are to be used, adjust the shims as required to achieve a minimum clearance between compressor wheel and cover of **0.23 mm (0.09")**.

16

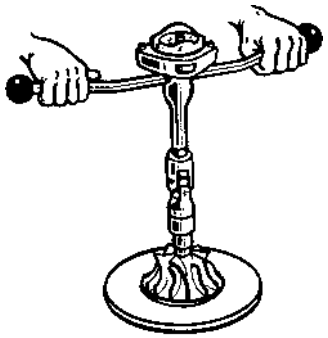
Clamp the appropriate 12 point socket wrench in the vise with the socket axis vertical.

17



Place the 12 points hub of the turbine wheel into the socket.

18



Torque the compressor lock nut with a T-handle torque wrench to **13.6 Nm (10 ft-lb)** and then rotate to an additional **90°-95°** and apply 2 drops of Loctite 601 to the threads.

Note: Use a T-handle torque wrench together with a universal joint to avoid side-loading the turbine wheel shaft.

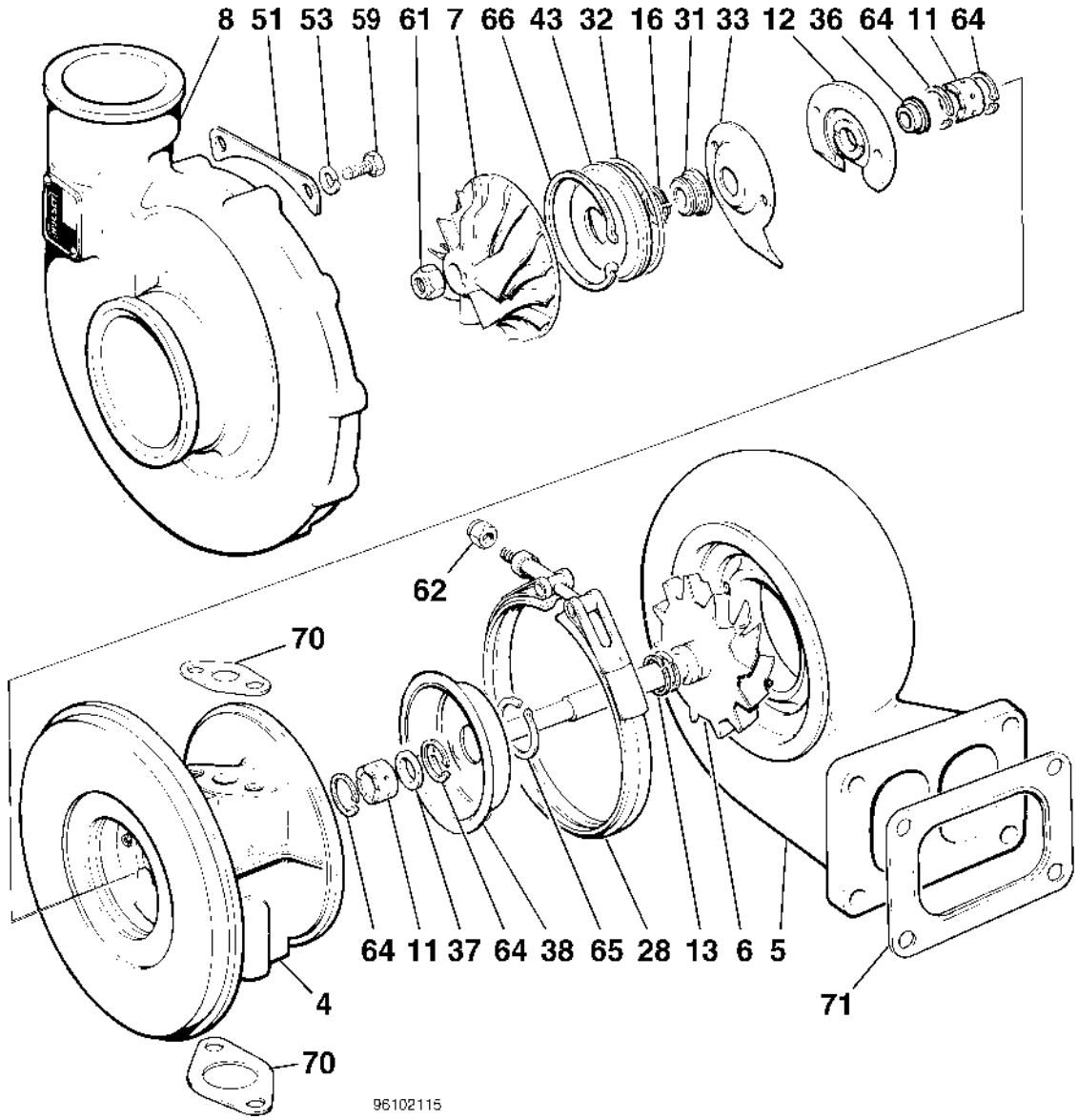
19

Fit the bearing assembly into the compressor cover (3), align with the marks, fit the V-clamp (10) and torque the locknut to **11 Nm (8 ft-lb).**

20

Fit the bearing assembly into the turbine housing, align with the marks, fit the V-clamp and torque the locknut to **11 Nm (8 ft-lb).**

Holset H3B/HSB 0870/B36, TWD1620, TID162, TWD1630



4. Bearing Housing
5. Turbine housing
6. Shaft and Wheel
7. Compressor Wheel
8. Compressor Cover
11. Bearing bushing
12. Thrust bearing
13. Piston ring
16. Piston ring
28. V-Band Clamp
31. Oil Slinger
32. O-Ring
33. Oil Deflector
36. Thrust flange
37. Oil Control Ring
38. Heat Shield
43. Insert
51. Clamp
53. Washer
59. Screw
61. Compressor Wheel Locknut
62. Clamp Locknut
64. Snap ring
65. Snap ring
66. Snap ring
70. Gasket-Oil Connection
71. Gasket-Inlet

Disassembly

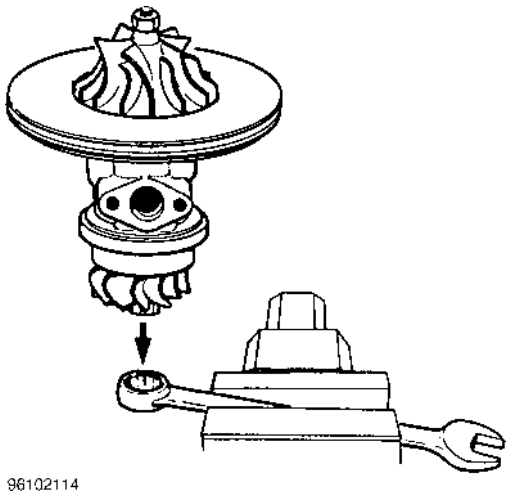
1

Clamp the turbine inlet flange and mark the relative positions of the turbine housing, bearing housing, and compressor cover.

2

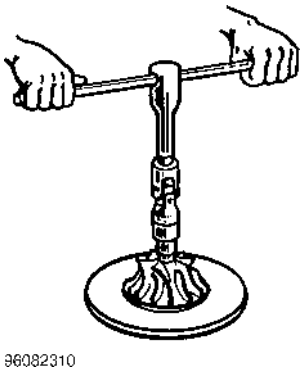
Remove screws and clamp plates and the compressor cover. Release the v-band clamp lock nut (62) and move the clamp onto the bearing housing. Remove the bearing housing from the turbine housing (5). Remove the clamp.

3



96102114

Clamp a suitable 12 point socket wrench in the vise with the socket axis vertical. Place the hub of the turbine wheel into the socket. Release the compressor wheel locknut (61).



96082310

Note: Use a T-handle wrench together with a universal joint to avoid side-loading the turbine wheel shaft.

4

Remove the compressor nut and pull the compressor wheel (7) from the turbine's shaft. If the compressor wheel is sticking it may be heated with a hot air pistol to max **130°C (266°F)**.

5

Using circlip pliers, remove the large circlip (66).

⚠ **WARNING!** Extreme caution is required during removal.

6

Slide out the insert (43). Remove the O-ring (32) and the oil slinger (31).

7

Carefully withdraw the shaft and remove the piston ring (16). Remove the oil deflector (33).

8

Remove the thrust bearing (12) and the thrust flange (36). Using circlip pliers, remove the outer circlip (64) from the compressor end. Carefully remove the bearing bushing (11) and inner circlip (64).

9

Invert the bearing housing and remove the circlip (65) and the heat shield (38). Using circlip pliers, remove the outer circlip (66). Remove the oil control ring (37), bearing (11) and inner circlip (64).

Assembly

Having cleaned and inspected all items and obtained replacement parts, where necessary, assembly can begin.

10

Fit a new piston ring to the shaft and wheel. Fit the inner circlip (64), bearing (11), oil control ring (37) and outer circlip (64). Fit the heat shield (38).

11

Invert the bearing housing and fit the inner circlip

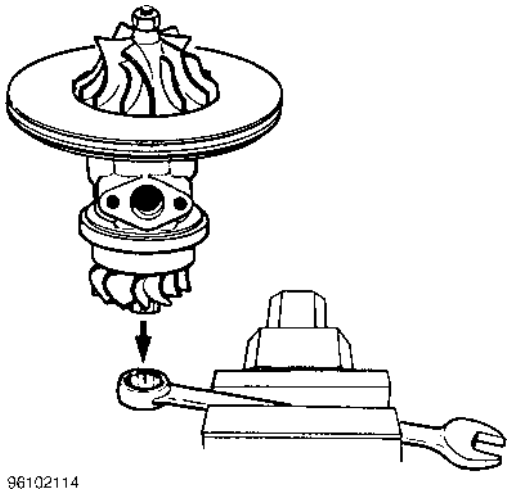
12

Gently slide the shaft and wheel into the bearing housing. Apply moderate pressure and a slight rotation to allow the piston ring to centralize and enter the chamfered bore of the bearing housing.

⚠ **WARNING!** Do not use force.

13

Clamp a suitable 12 point socket wrench in the vise with the socket axis vertical. Place the bearing housing in the socket.



96102114

14

Fit the thrust bearing (12) and thrust flange (36). Fit the oil deflector (33) with the angled edge facing down. Fit a new piston ring (16) to the oil slinger (31) and fit the oil slinger into the bearing housing. Fit the O-ring (32).

15

Fit the insert assembly into the bearing housing. Apply moderate pressure to correctly seat the insert (43).

Note: It may be necessary to use a small, soft mallet.

16

Using circlip pliers, fit the large circlip (66). Place the bevelled side facing up.

⚠ **WARNING!** Extreme caution is required during fitting.

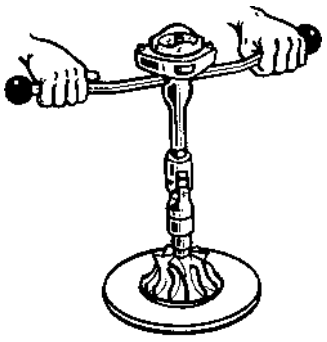
17

Fit the compressor wheel (7). Fit the compressor wheel locknut (61) and tighten down. Torque **40.7 Nm (30.0 ft-lb)**.

Note: Use a T-handle torque wrench together with a universal joint to avoid side-loading the turbine wheel shaft.

18

Referring to the marks made previously, fit the bearing housing using the V-band clamp (28).



96082306

19

Check the axial and radial clearance. See section ”Checking bearing clearance”.

20

Referring to the marks made previously, fit the compressor cover to the bearing housing using the screws and washers. Finally check that the shaft and wheels rotate freely.

Measures in case of turbo failure on TAD- engines

In case of turbo failure on TAD-engines, it is essential to check the charge air cooler. Should a large leakage of oil be suspected, or foreign objects, such as bits from the broken compressor wheel, have been forced into the charge air cooler, the following measures must be taken:

1

Check the charge air hoses to the charge air cooler. If there is any trace of oil on the charge air cooler, the hoses must be removed and cleaned internally in a suitable solvent (white spirit or equivalent). The charge air cooler must also be cleaned. If the black charge air cooler hose is contaminated with oil, it must be replaced since oil has a detrimental effect on the rubber.

2

If failure of the turbo resulted in a fracture on the compressor wheel, the charge air cooler must be pressure tested to check whether or not it has been damaged by bits from the compressor wheel.

Replacing/reinstalling turbocharger on engine

Note: When replacing a turbocharger always determine the cause of failure. Repair any damage before the new turbo unit is fitted.

When replacing/reinstalling a turbocharger, it is very important that the instructions provided with the compressor are carefully studied.

1

For a turbo unit to operate satisfactorily, one condition is that the engine oil system and intake system are kept in good working order, i.e. that the oil is replaced at the recommended times, that the correct type of oil is used and that the oil cleaner and air cleaner are also changed as directed.

The initial measure is therefore to check the engine oil and the oil cleaner and, if so required, to replace the cleaner before the new turbo unit is fitted. Preferably, the engine should be run a few minutes before the new turbo unit is fitted.

Note: As an extra precaution to prevent contaminated oil from reaching the turbocharger, a strainer can be mounted temporarily in the compressor inlet connection. The engine must then be run for at least half an hour. Note that the strainer must then be removed since otherwise, should the lubricating system not be properly serviced, there is a risk that oil will not reach the turbocharger due to the blockage of the strainer.

2

Before starting the new turbo, use an oil can to spray oil into the turbo bearing system to provide correct lubrication from the start.

3

When replacing a turbo, care must be taken so that flakes of rust or deposits do not drop into the exhaust manifold. These flakes could damage the turbine of the new unit.

It is also import to clean the intake line from the air cleaner since any bits lying there from, for example, a fractured compressor wheel, would cause an immediate breakdown of the new turbo.

Note: the rubber hose (return line) from the turbo to the engine must be oil-resistant.

4

Always check that the injection equipment is in good condition and that all of the seated components are fitted with authorized, unbroken seals.

5

Check that the oil is circulating properly after starting the engine by loosening the return pipe union on the block.

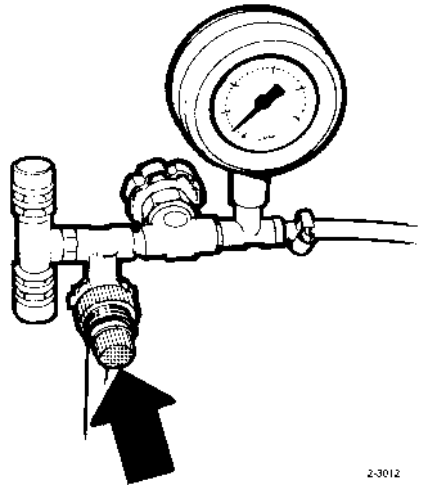
To avoid damage to the turbocharger, the engine can be cranked round with the starter motor, and the stop control pulled out, until oil pressure is built up.

Charge air cooler, checking for leakage, TAD-engines

Special tools: 999 6662, 885231, 885232

Check the pressure tester before use.

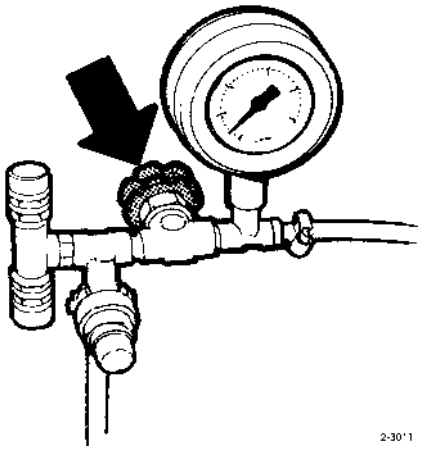
1



Connect the pressure tester to the workshop air supply and set the pressure gauge to **100 kPa (14.5 psi)** with the reduction valve.

Note: To lock the reduction valve knob, move the lock ring axially.

2

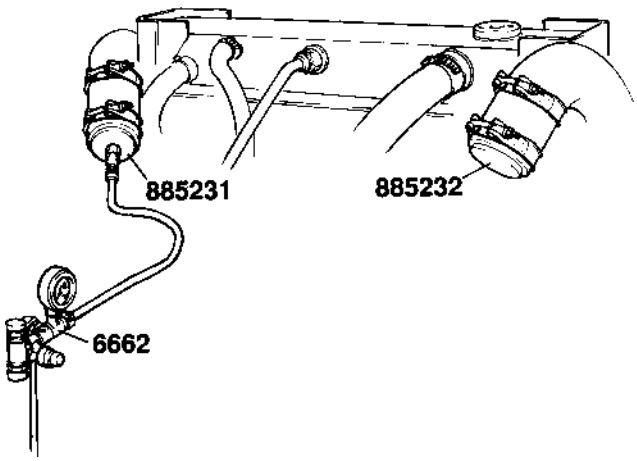


Shut off the valve. The pressure gauge dial pointer must not drop during **2 minutes**, otherwise the gauge cannot be relied upon.

3

Disconnect the charge air hoses from the charge air cooler.

4



Fit connection tool 885231 and sealing tool 884232 together with new hoses (if needed) on the charge air cooler. Unscrew the pressure tester reduction valve.
Connect the pressure tester to the charge air cooler.

5

Open the shut-off valve knob and set the gauge to a pressure of **70 kPa (10.2 psi)** with the reduction valve.

6

Close the shut-off valve. During **one minute** pressure may not drop more than **20 kPa (2.9 psi)** otherwise the charge air cooler cannot be approved.

7

In the event of leakage, repeat the check several times. Also check the pressure tester hoses and connections.

8

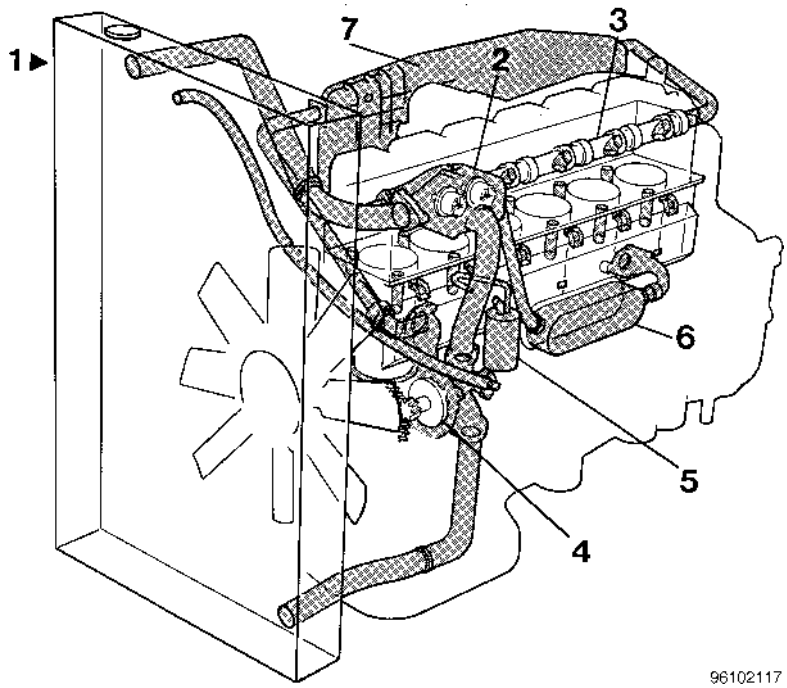
Remove the testing equipment.

9

Connect the charge air hoses.

Cooling system

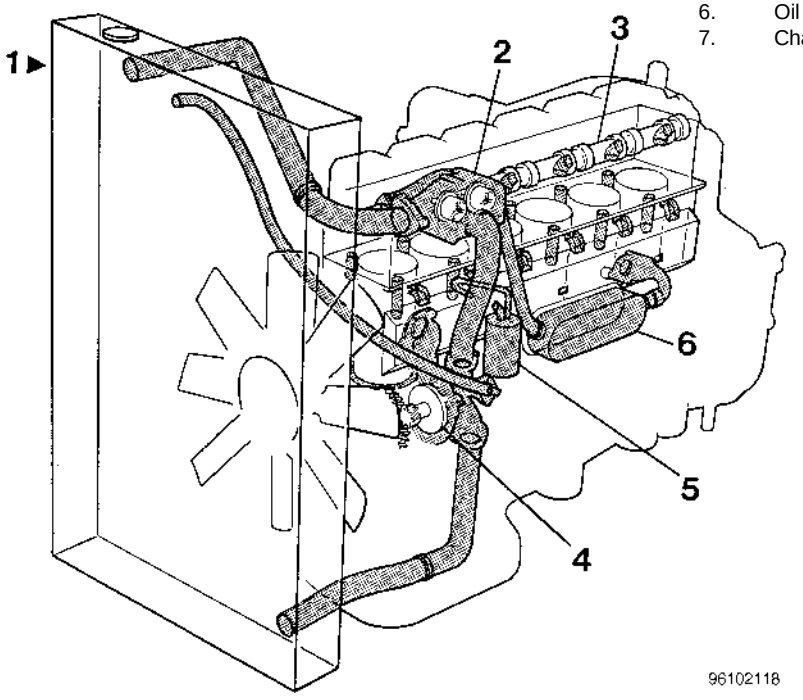
Design and Function



96102117

(These illustrations are only examples of the design and function in the cooling systems for various engines)

1. Radiator
2. Thermostats
3. Distributor pipe for coolant
4. Coolant pump
5. Coolant filter
6. Oil cooler
7. Charge air cooler

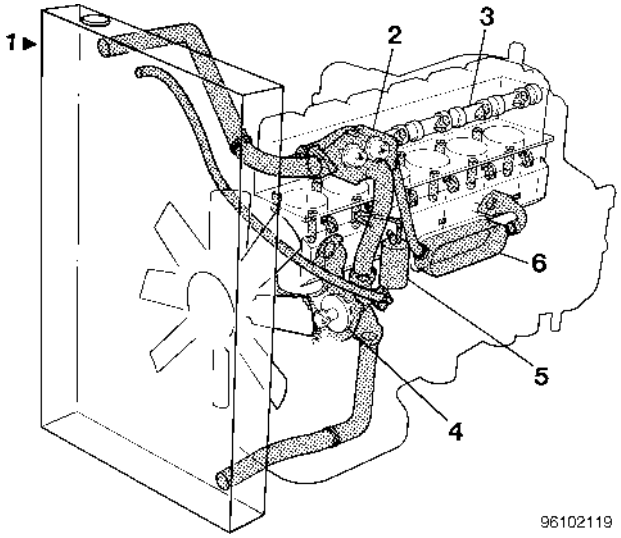


96102118

Cooling system

The coolant is circulated by an gear-driven pump (4) and is led in the cylinder block and from there through channels and openings to the cylinder heads, liner jackets and oil cooler (6).

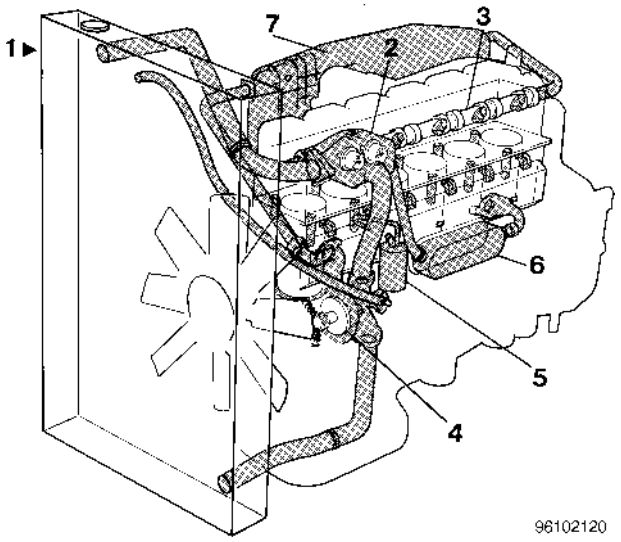
On TWD, TID and TD (7), the return flow of fluid from the cylinder blocks and from the charge air cooler is led via an outer pipe (3) from the cylinder head to the thermostat housing (2), which contains two thermostats.



96102119

(These illustrations are only examples of the design and function in the cooling systems for various engines)

1. Radiator
2. Thermostats
3. Distributor pipe for coolant
4. Coolant pump
5. Coolant filter
6. Oil cooler
7. Charge air cooler



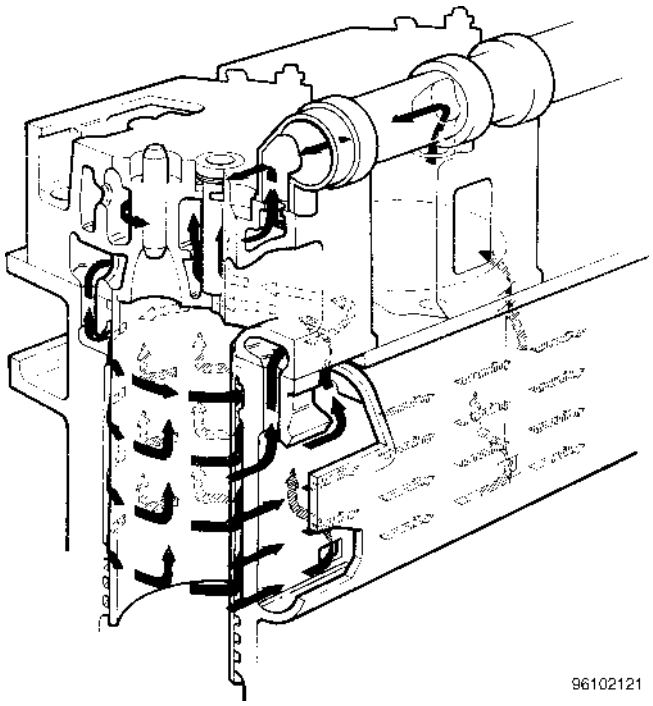
96102120

Depending of the temperature of the coolant, the fluid is led either back to the pump, or via an upper radiator hose, into the radiator.

Around the liners, the cooling jackets of the cylinder block are divided into an upper and lower plane. The purpose of this is to concentrate the flow of coolant to the hottest part of the liner. Through a small gap between the liner and the split shelf, coolant is led upwards and returns through the cylinder head.

The coolant space of the cylinder heads is also divided into two horizontal planes. This means that coolant entering the head from the block first circulates in the lower section around the valve seats and injector tips where cooling is vital. The coolant then flows up into the upper section through openings around the copper sleeve, circulates around the valve guides and then leaves via a return pipe which runs above the cylinder heads.

The left-hand illustration below shows the function of the thermostat with a cold engine. The picture on the right shows


96102121

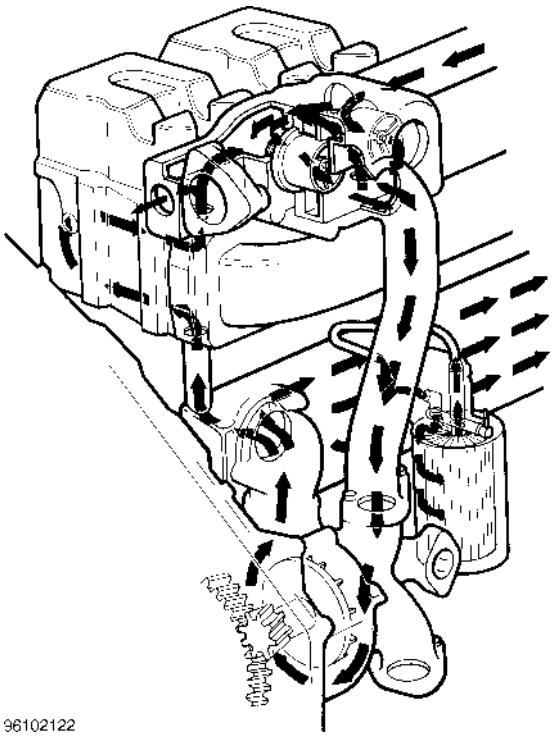
the situation with the engine warm. Both thermostats have the same opening temperature and they work in parallel.

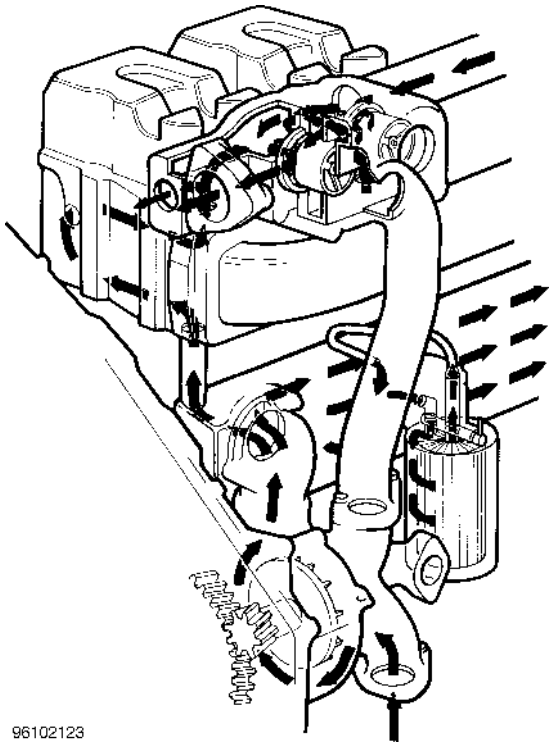
Between the distribution gallery of the engine and the return pipe of the thermostat housing is a coolant filter.

The filter consists of a filter insert made of pleated paper and containing a dosage of corrosion-inhibiting additive. When a new filter is fitted, the anti- corrosion additive is quickly leached out by the passing fluid.

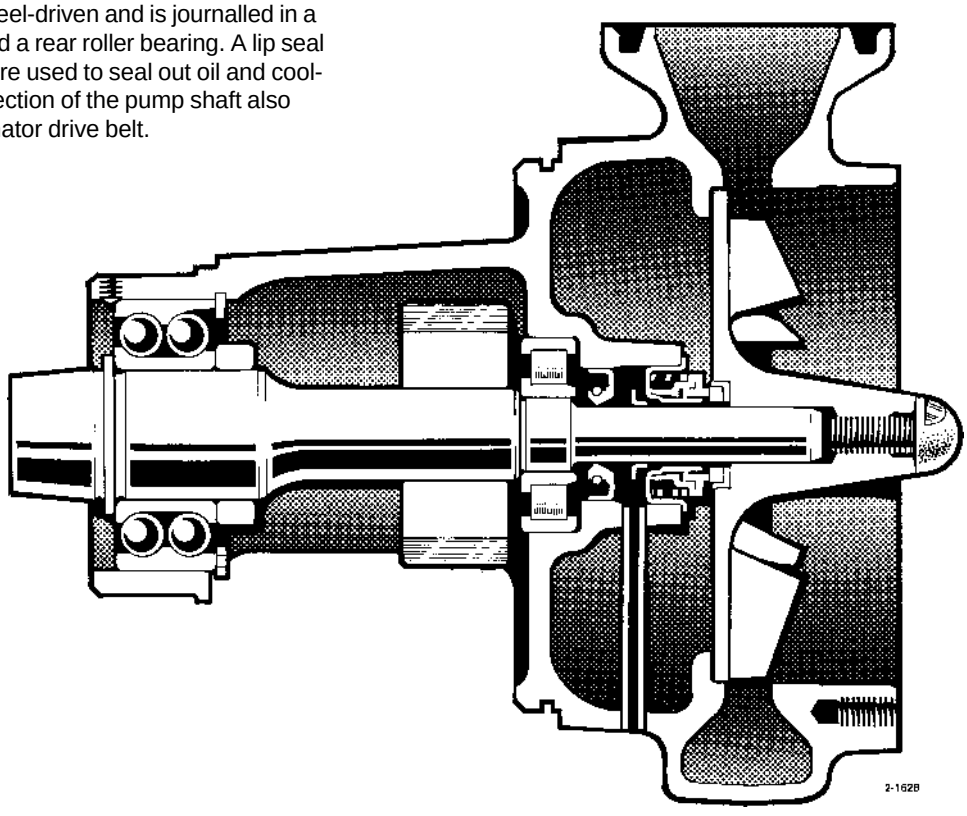
Maximum through-flow is 12 liter/min.

(Pictures show the TAD-version)

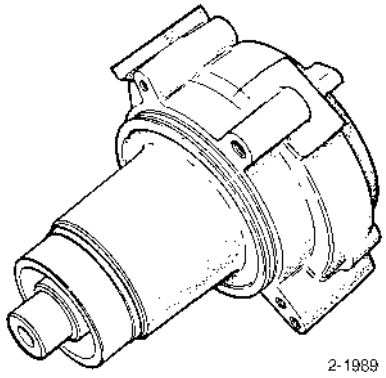




The coolant pump is gearwheel-driven and is journalled in a front two-row ball bearing and a rear roller bearing. A lip seal and a carbon-ceramic seal are used to seal out oil and coolant respectively. The front section of the pump shaft also acts as a pulley for the alternator drive belt.



Service procedures



Coolant pump, replacing

Special tools: 999 2000, 999 2929, 999 6860

Removal

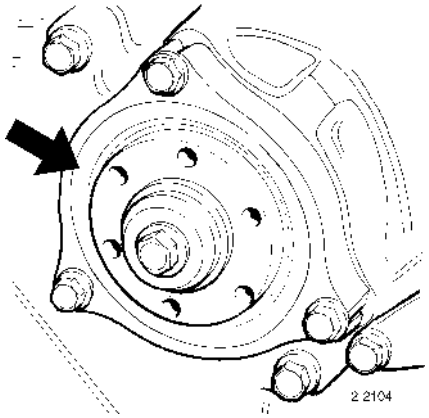
1

Switch off the main circuit breaker/disconnect batteries.

2

Drain the coolant.

3

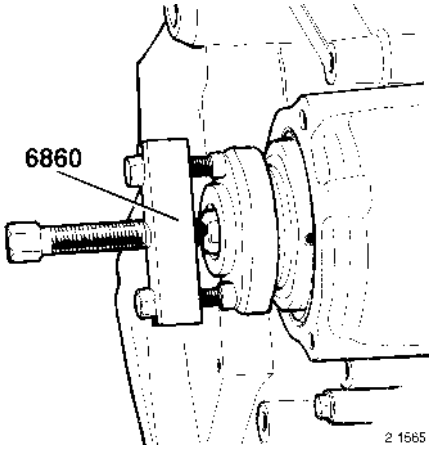


Slacken the generator's belt tension. Dismantle the belt tension device and allow the generator to hang in the bracket.

4

Remove the belt pulley. Remove the holder for the coolant pump's sealing ring.

5

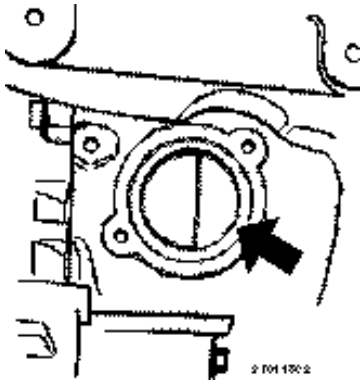


Remove the central screw. Remove the flange for the belt pulley with puller 999 6860.

6

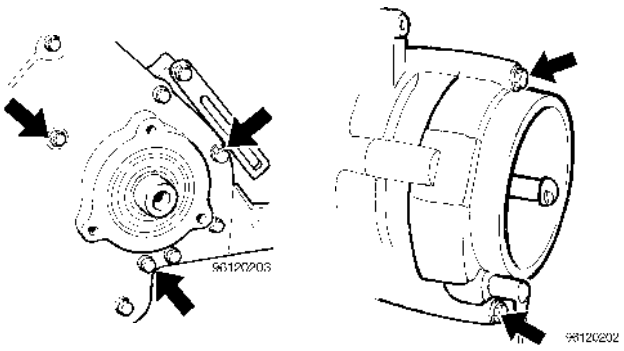
Disconnect the coolant connection at the thermostat housing.

7



Disconnect the connection at the engine block.

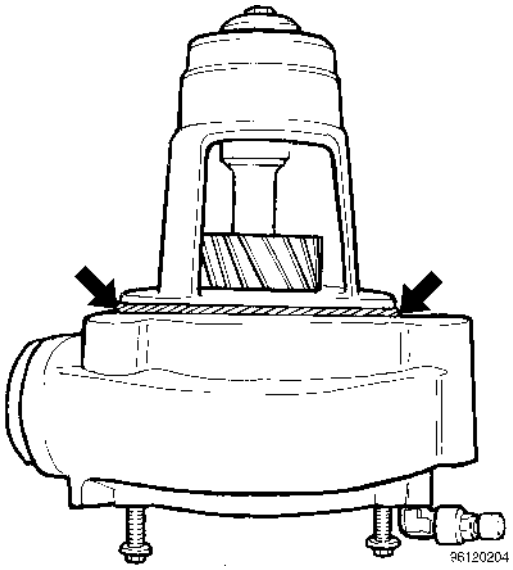
8



Remove the coolant pump's end cover. Remove the coolant pump from the timing gear casing (3 screws at the front, 2 at the rear).

Fitting the coolant pump

1

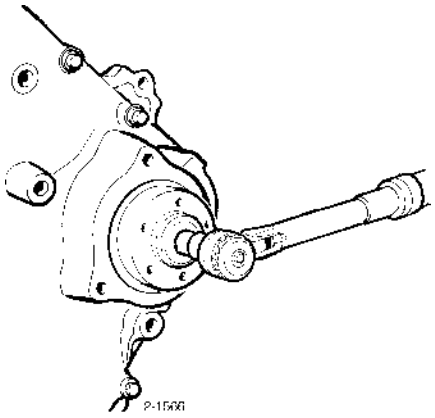


Place a new O-ring in the groove on the coolant pump. Screw the pump tightly to the timing gear casing.

2

Place an O-ring in the groove in the coolant pump's end cover. Fit the cover. Connect the pipe to the engine block and thermostat housing. Use new sealing rings.

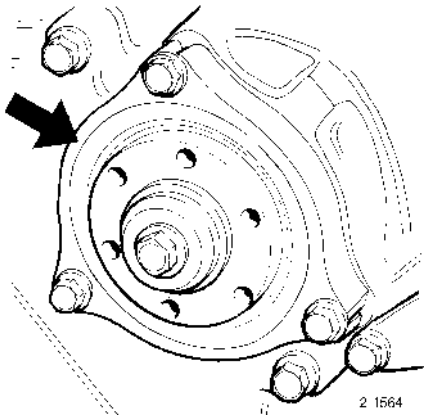
3



Fit the flange for the belt pulley. Use a torque wrench for the central screw.

Torque **60 Nm (44.3 ft-lb)**

4



Replace the sealing ring in the sealing ring holder, using tool 999 2000 and 999 2929. Scrape the mating surfaces clean. Apply a bead of sealant and fit the holder for the sealing ring.

5

Screw the belt pulley tight. Fit the drive belt/belts for the generator.

6

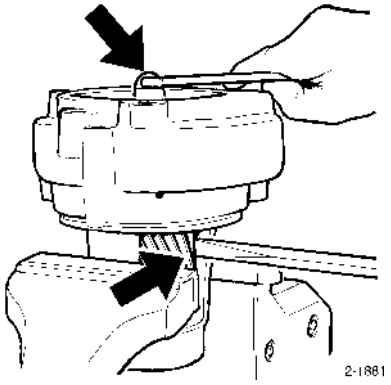
Fill with coolant. Start the engine and check for leaks.

Coolant pump, reconditioning

Special tools: 999 1801, 999 2061, 999 2412, 999 2852, 999 6019, 999 6858, 999 6998, 999 6999 999 8000, 998 9876

1

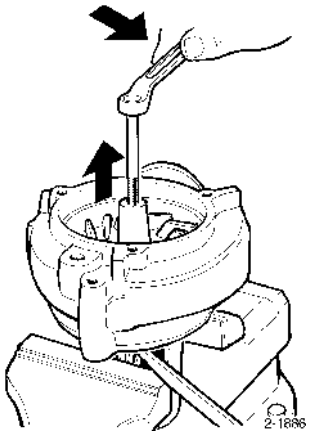
Put the coolant pump in a vise with the impeller facing upwards.



2

Remove the screw in the center of the impeller.

Note: Use a screwdriver to counter the coolant pump drive.

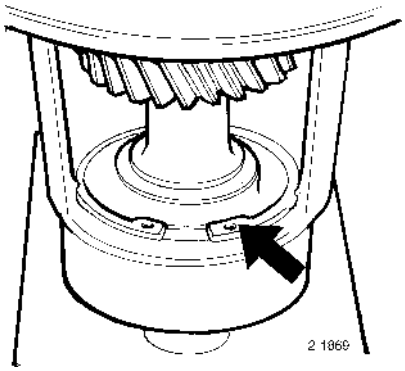


3

Pull the impeller off of the pump shaft using a bolt size **M10 x 70**.

Note: Use a screwdriver to counter the coolant pump drive.

4

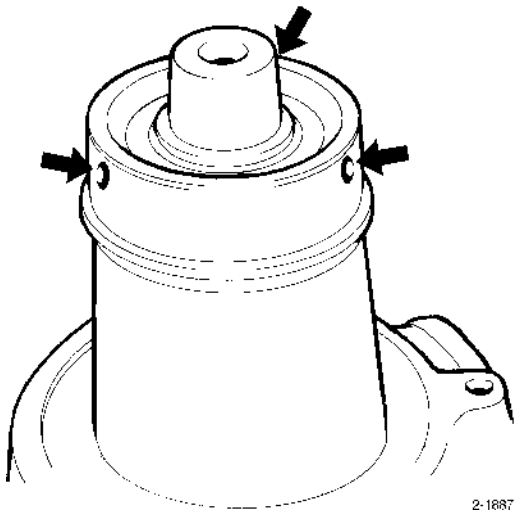


Turn the pump about-face in the vise. Remove the circlip holding the bearing and shaft in the pump housing.

5

Remove the pump from the vise.

6

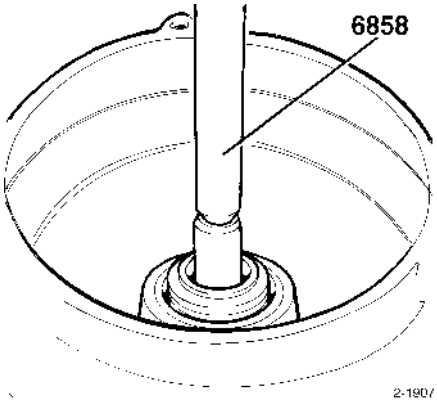


Remove the set screws (3) holding the ball bearing in the pump housing.

7

Put the pump in a hydraulic press with the drive side of the pump (gear wheel side) facing down.

8

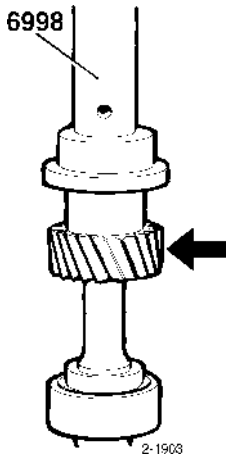


Press out the pump shaft together with the ball bearing, the roller bearing race and the gear wheel. Use drift 999 6858.

9

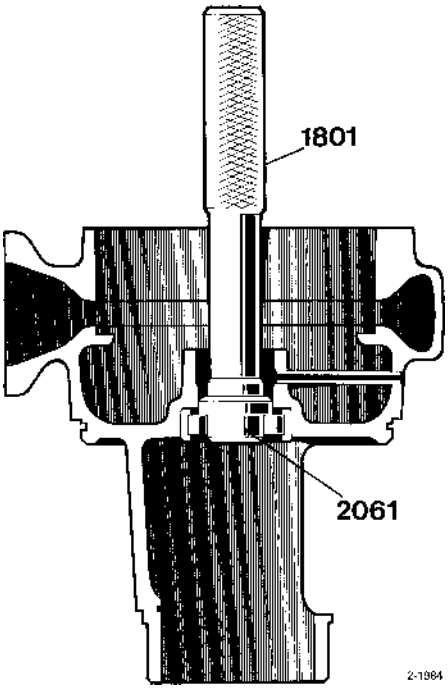
Turn the pump around in the press to bring the drive side facing up.

10



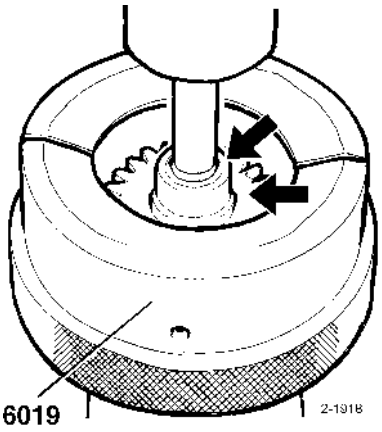
Press out the seals (2) and the deflector ring with drift 999 1801 inserted through the roller bearing.

11



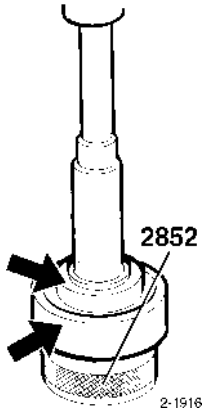
Turn the pump over to put the drive side facing down. Press the ball bearing out of the pump housing using tools 999 1801 and 999 2061. Remove the pump housing from the press.

12



Press the gear wheel and the inner ring of the roller bearing off the pump shaft.

13



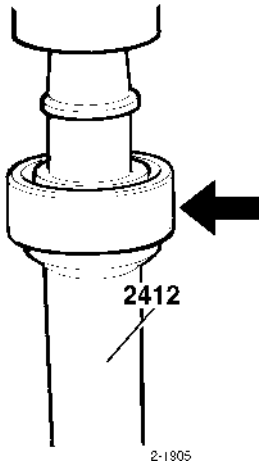
Press the ball bearing and stop ring off the pump shaft.

Inspection

Seals, deflector ring and ceramic ring must always be replaced with new ones. In addition the bearings must be replaced. Check the fit of the bearings in the pump housing and on the shaft. The bearing races must not rotate in the pump housing or on the shaft. If the impeller is damaged it must be replaced.

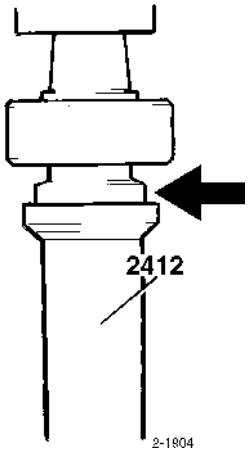
Assembly

14



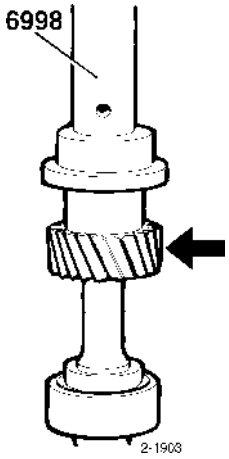
Put the ball bearing on tool 999 2412 in the press. Oil the pump shaft. Press the pump shaft into the bearing. Press until the shaft edge bottoms against the bearing.

15



Heat the stop ring to **+160°C (+320°F).** Press the ring onto the pump shaft until it stops against the inner race of the bearing.

16

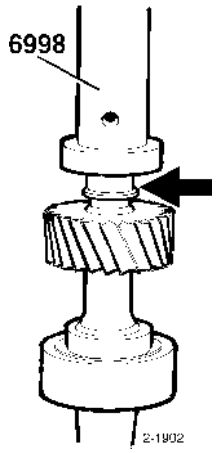


Heat the gear wheel to **+160°C (+320°F).** Press the gear wheel onto the pump shaft using tool 999 6998. Press until it bottoms.

Note: 999 6998 is used on four different occasions during the assembling of the pump; tool 999 6998 gives the right dimensions.

Note: The fitting of the roller bearing is done in two steps. First press the inner race onto the pump shaft. Then press the outer race into the pump housing.

17

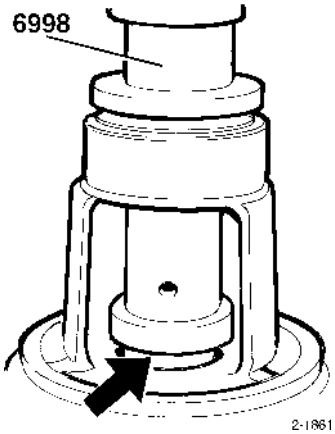


Oil the pump shaft and press the inner race of the roller bearing into position. Press until its stops.

18

Put the pump housing in the press. Oil the seat of the roller bearing in the pump housing.

19

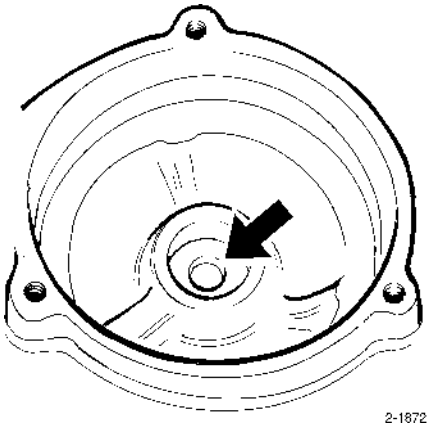


Oil the outer race of the roller bearing. Put the bearing with the text facing upwards into the pump housing. Press the bearing into position using tool 999 6998. Press until its stops.

20

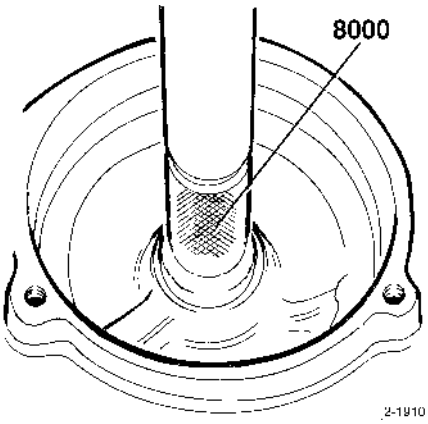
Turn the coolant pump over to bring the drive side facing down in the press.

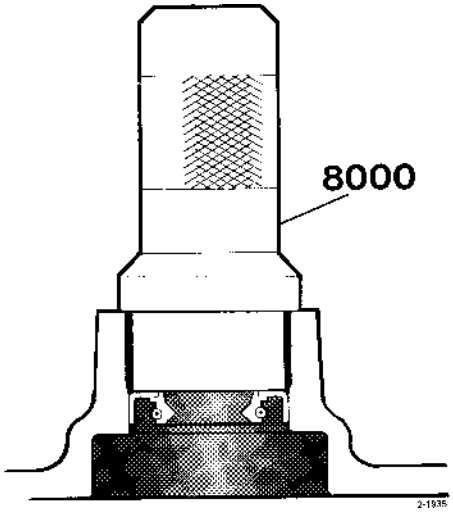
21



Grease the edge of the seal. Put the seal into the pump with the metal edge facing upwards.

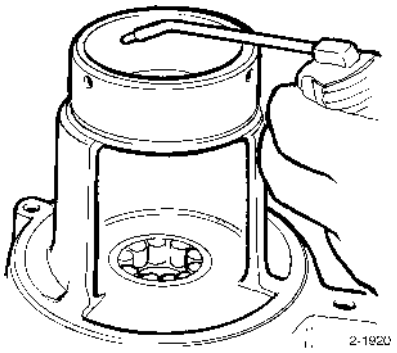
22





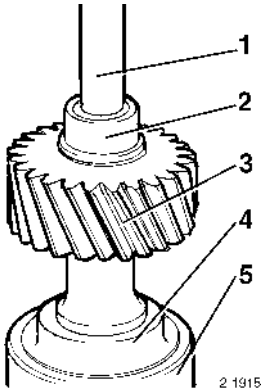
Press in the seal with tool 999 8000. Press until the tool bottoms against the edge of the pump housing.

23



Turn the pump over to bring the drive side facing upward. Oil the seat of the ball bearing in the pump housing.

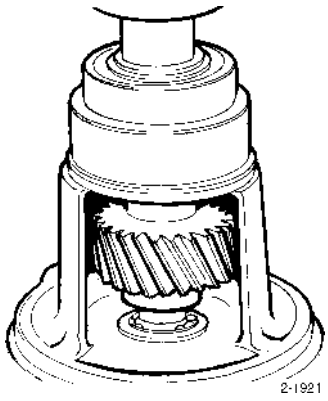
24

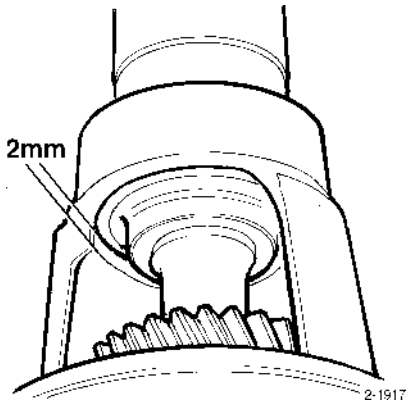


1. Pump shaft
2. Bearing race, roller bearing
3. Gear wheel
4. Stop ring
5. Ball bearing

Fit the pump shaft complete with ball bearing, stop ring, gear wheel and roller bearing race into the pump housing.

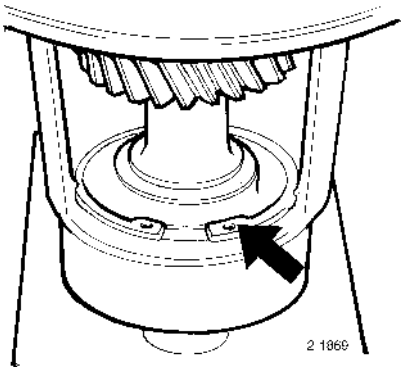
25





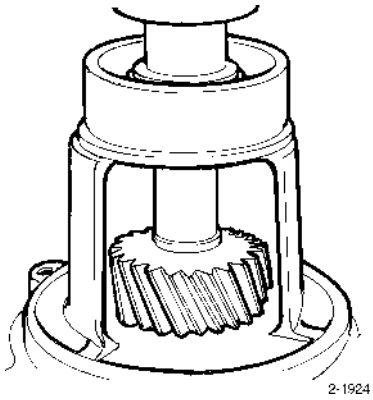
Press in the pump shaft until the ball bearing is about **2 mm (0.080")** from the circlip groove in the pump housing.

26

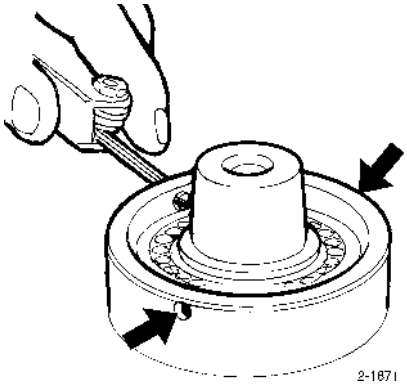


Fit the circlip into the pump housing.

27



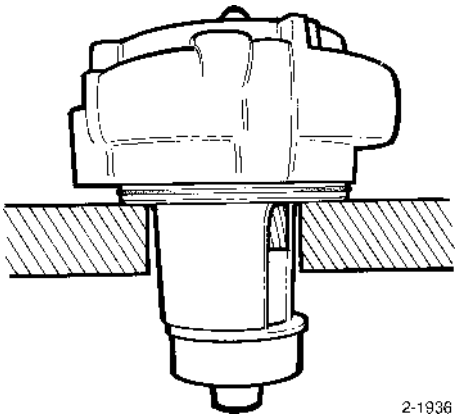
Continue to press in the shaft carefully until the outer race of the ball bearing stops against the circlip in the pump housing.



28

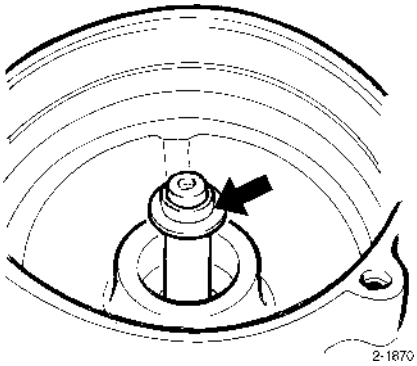
Replace the ball bearing set screws.

Note: Secure the screws with locking fluid (Part No. 1161053-0).



29

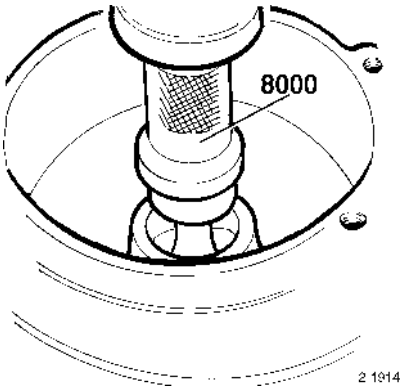
Turn the pump over in the hydraulic press to bring the drive side facing down. Position the pump in the press so that the pump shaft is free and the walls of the pump shaft



take up the pressing force.

30

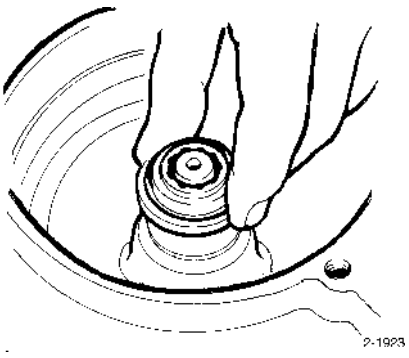
Mount the deflector ring onto the pump shaft with the edge facing down.



31

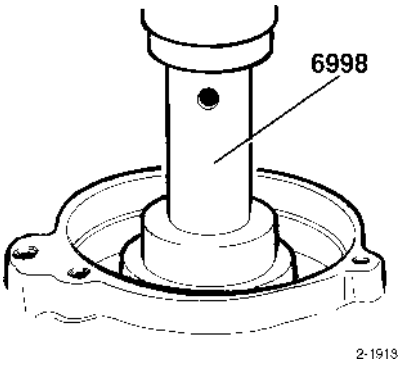
Press on the deflector ring until tool 999 8000 bottoms against the edge of the pump housing.

32



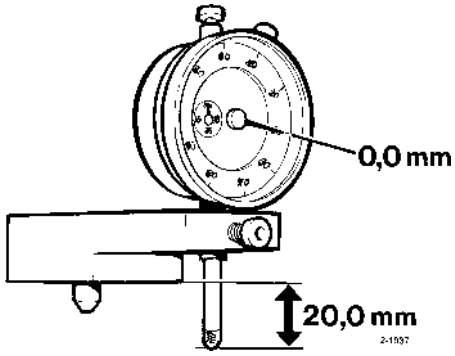
Fit the seal into the pump housing.

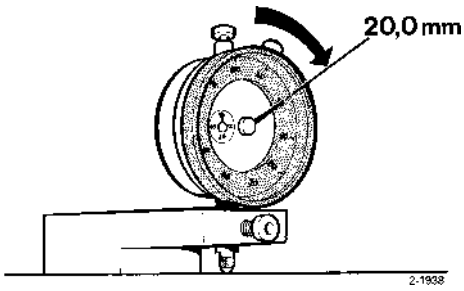
33



Press in the seal with tool 999 6998.

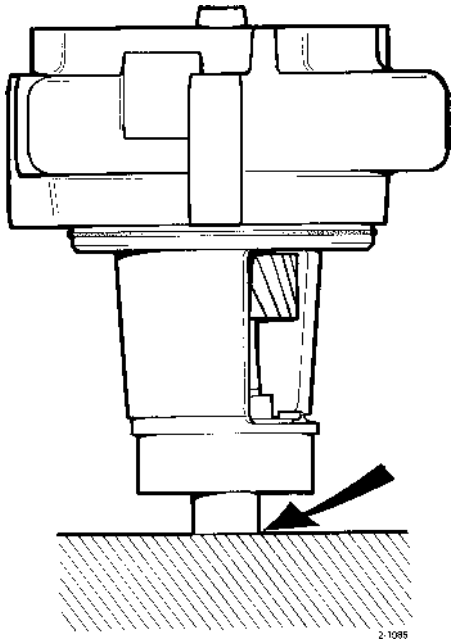
34





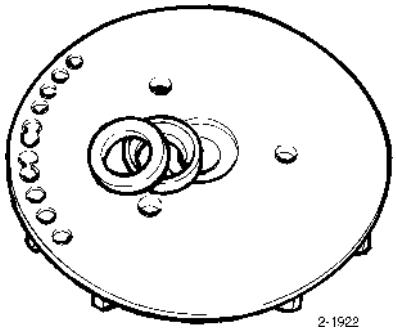
Mount dial indicator 998 9876 on tool 999 6999. Set the dial indicator so that it shows **20.0mm (0.8")** against a flat surface.

35



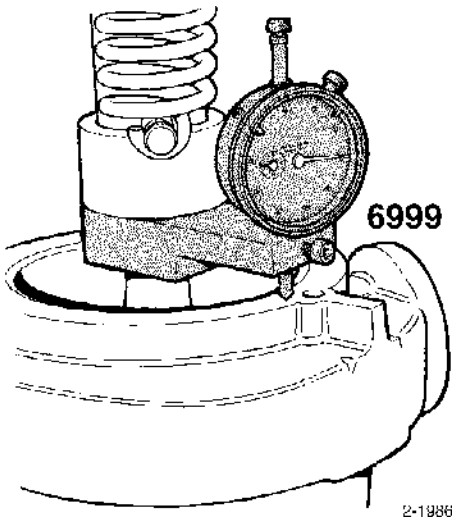
Position the pump in the press so that the pump stands on its shaft with the drive side facing down.

36



Dip the rubber ring in soapy water. Place the rubber and ceramic rings in the center of the impeller. Put the impeller onto the pump shaft.

37

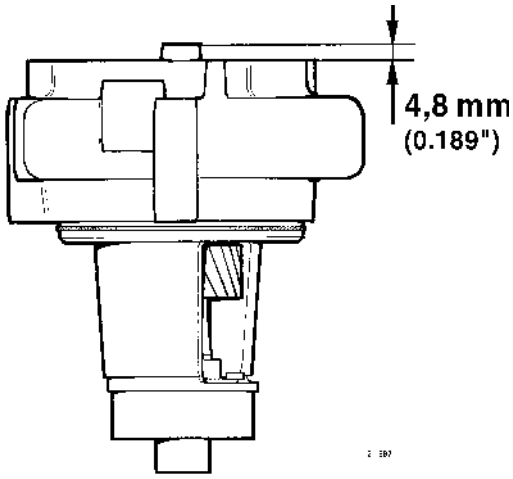


Place 999 6999 on the impeller so that the dial indicator probe is on the edge of the pump housing.

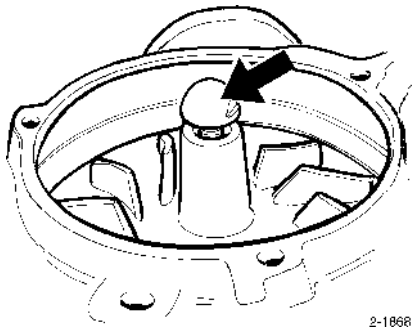
38

Apply pressure to the impeller on the pump shaft until the dial indicator shows **15.2 mm (0.5988").**

39



Remove 999 6998 from the pump. Check that the center of the impeller is **4.8 mm (0.1890")** above the edge of the pump housing.

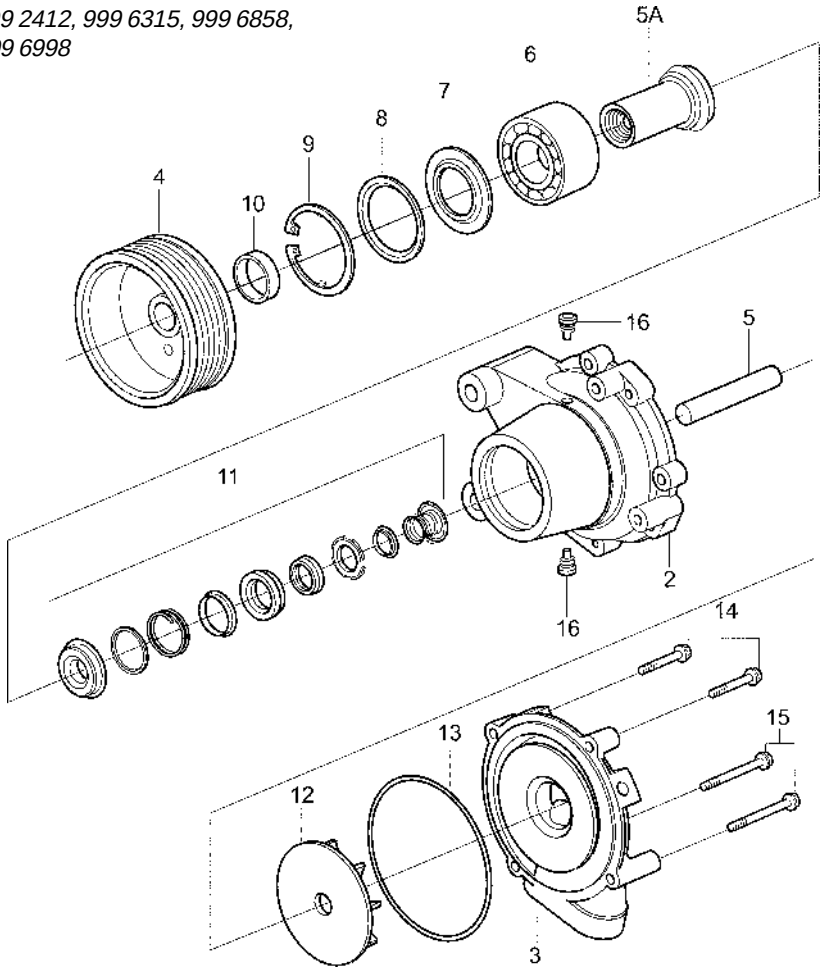


40

Fit the screw in the center of the impeller.

Extra coolant pump, reconditioning (TD164KAE)

Special tools: *999 2412, 999 6315, 999 6858, 999 6998*



Note: All numbers in parenthesis refer to the illustration above the text.

1

Note: Mark the position of the gable (3) on the coolant pump housing (2) prior to removal.

Remove the gable (3) and remove O-Ring (13).

2

Press out the impeller (12) and the shaft (5), use punch 999 6858.

3

Remove the belt pulley (4) with a suitable puller. Remove spacer ring (10).

4

Remove the bearing snap ring (9), spacer ring (8) and protective shield (7).

5

Remove seal ring (11).

6

Press out bearing (6) and bearing shaft (5A) with punch 999 6858.

7

Check that the drain plug (16) holes are not obstructed (should be 7 mm (0.275") dia.

8

Clean and check parts regarding wear and other damage,

9

Apply grease to the bearing shaft (5A) and press on the new bearing (6) with punch 999 2412.

10

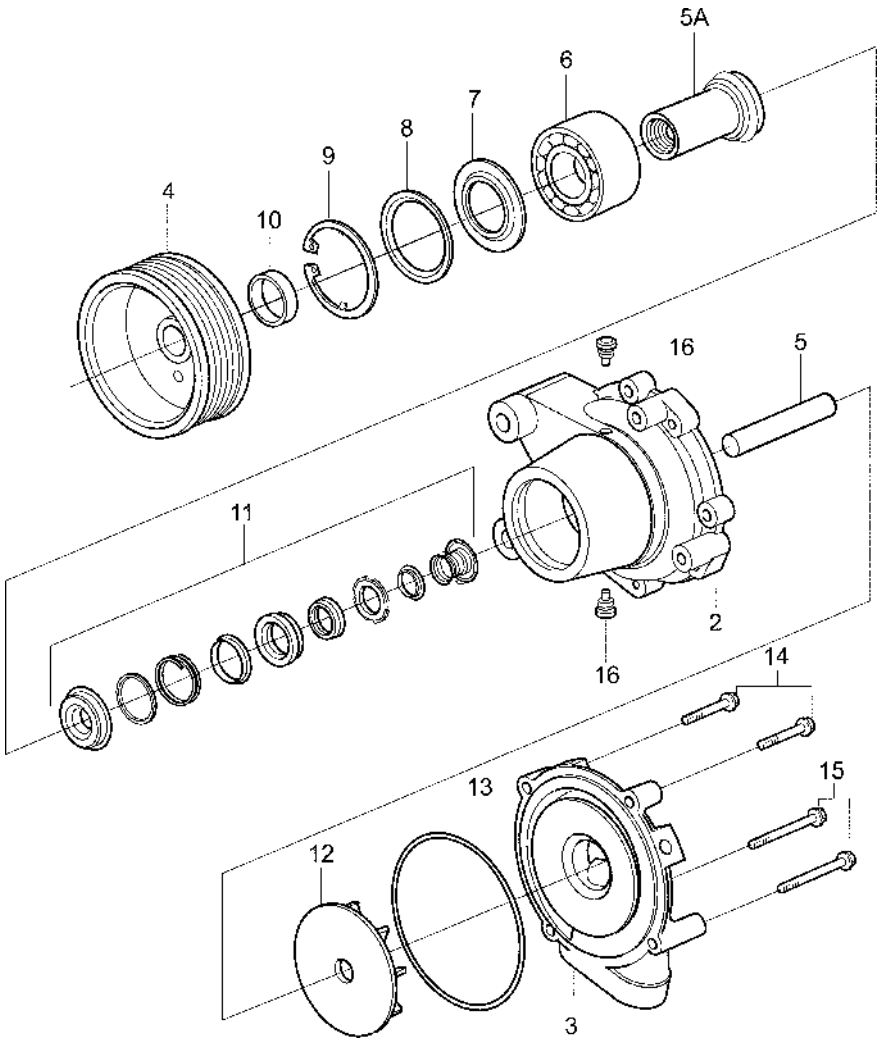
Apply grease to the bearing seat in the coolant pump housing

(2). Press on the new bearing (6) and the bearing shaft (5A) with punch 999 2412.

11

Install protective shield (7), spacer ring (8) and snap ring (9).

Note: Turn the spacer ring chamfer and lock ring shoulders towards the bearing.



12

Install spacer ring (10) on the bearing shaft (5A).

13

Press the belt pulley (4) in place with punch 999 2412. Place a support under the bearing shaft (5A), such as a pipe with 27 mm (1.063") I.D. and 34 mm (1.338") O.D..

14

Note: Seal ring (11) is delivered complete, not as shown in the illustration.

Press a new seal ring (11) in the coolant pump housing (2) with punch 999,6998.

15

Place a wide metal plate between the shaft (5) and the press tool so the shaft is level with edges of the coolant pump housing.
Apply bearing grease and press the shaft (5) into the bearing shaft (5A).

16

Screw 999 6315 into the bearing journal (5A) where the belt pulley (4) is located, until it bottoms.
Place a washer between the impeller and the press tool so the shaft (5) may protrude through the washer.
The washer should be 2 mm (0.080") thick, with an I.D. that is greater than the shaft (5) diameter.
Press the impeller (12) on the shaft (5).

Note: Let the coolant pump rest on the nut on 9996315 during the entire press operation.

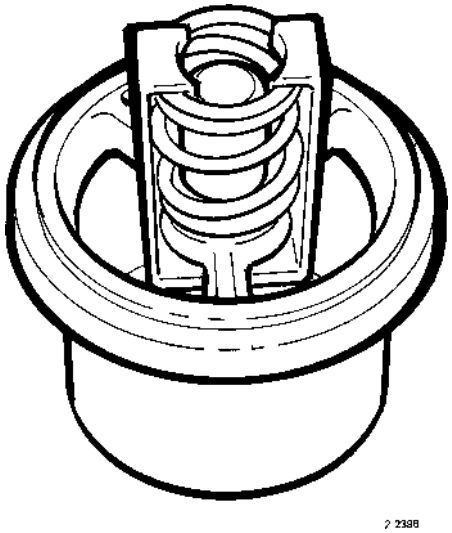
17

Install the gable (3) with a new O-Ring (13).

Sleeve thermostats, replacing

Special tools: 999 6863

1



Drain the coolant.

2

Remove the pipe between the thermostat housing and the upper radiator hose. Push the pipe to one side.

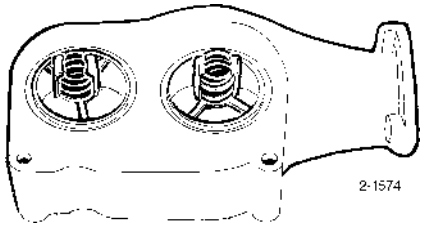
3

Remove the pipe between the coolant pump and the thermostat housing.

4

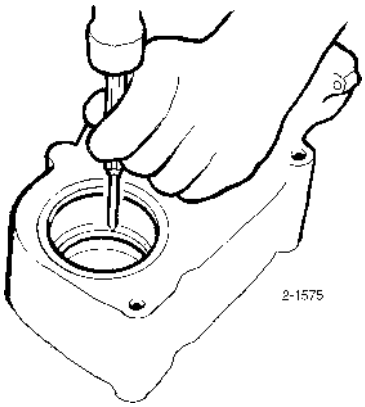
Remove the thermostat housing.

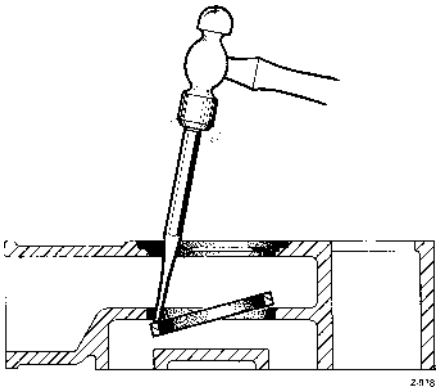
5



Remove the thermostats and the O-rings.

6





Remove the old sealing rings by tapping them down with a suitable drift.

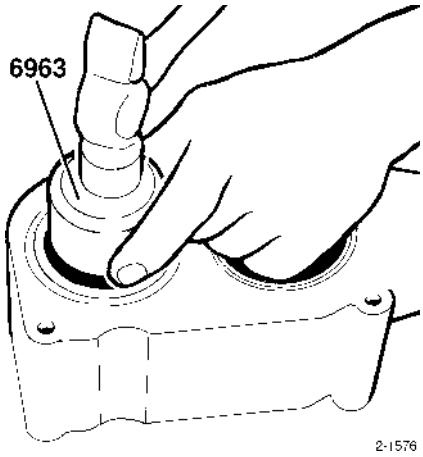
Note: Do this carefully so as not to damage the sealing ring contact surfaces in the housing.

7

Fit the new sealing ring to drift 999 6863

Note: Fit the sealing ring with the wide metal edge facing upward.

8



Tap the sealing ring in with the drift until the drift bottoms against the thermostat housing.

9

Fit the thermostats and O-rings.

10

Fit the thermostat housing.

11

Fit the pipe between the coolant pump and thermostat housing with seals.

12

Fit the pipes between the thermostat housing and the upper radiator hose.

13

Fill with coolant.

14

Perform a leakage test.

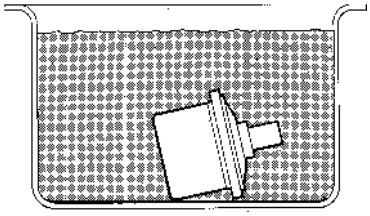
Sleeve thermostats, checking

A function check of the old thermostat must be carried out before fitting a new one. Thermostats are removed according to the instructions shown under “Sleeve thermostats, replacing”.

1

Check that the thermostat has closed fully. This can be done by holding it up against the light. There must be no visible gap. If the thermostat does not close properly, replace it.

2



Heat water in a receptacle to:

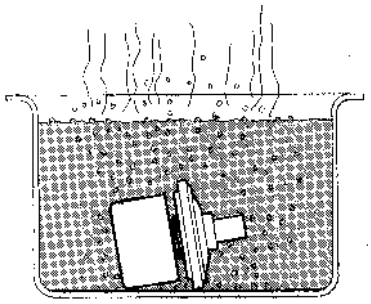
TAD1630G, TAD1631G, TD164KAE	**75°C (167°F)**
Others	**70°C (158°F)**

Immerse the thermostat in the receptacle as illustrated.

3

Check after **at least 30 seconds** that the thermostat is still closed.

4



Now heat the water to boiling point **(100°C (212°F).** Check after **at least 30 seconds** at boiling point that the thermostat has opened at least **9.5 mm (0.374")**.

If the thermostat does not open, replace it.

Coolant manifold seals, replacing

Special tools: 999 6662

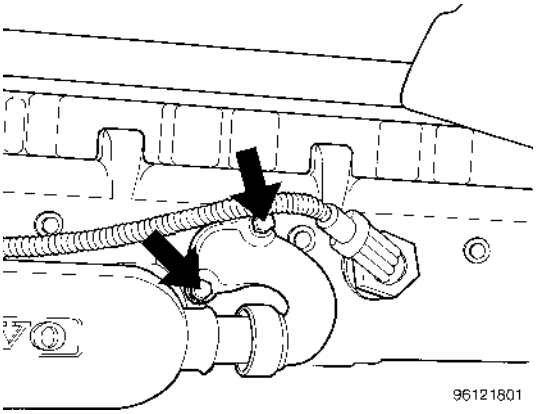
Removal

1

Switch off at main circuit breaker/disconnect batteries.

2

Drain the coolant.



3

Disconnect the rear coolant pipe from the oil cooler

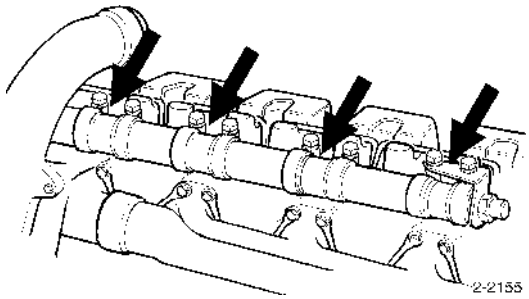
4

Remove screws (4) that hold the oil cooler to the center plate on the engine block.

5

Disconnect the oil cooler from the front coolant pipe.

6

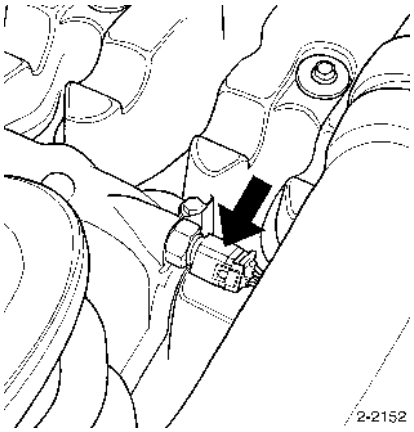


Disconnect all pipe connections.

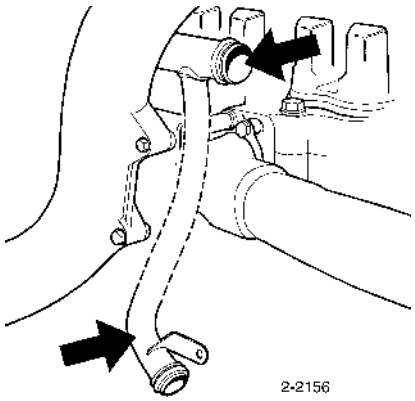
7

Remove connections and pipes as one unit.

8

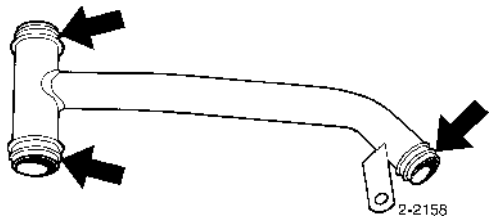


Disconnect electrical cables and engine temperature sensor.



9

Disconnect the coolant pipe from the thermostat housing.

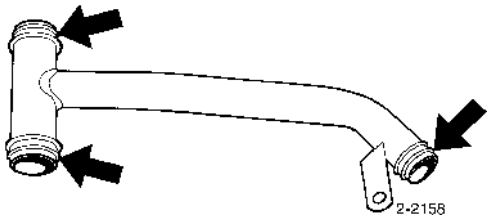


10

Remove the sealing rings (3) from the coolant pipe.

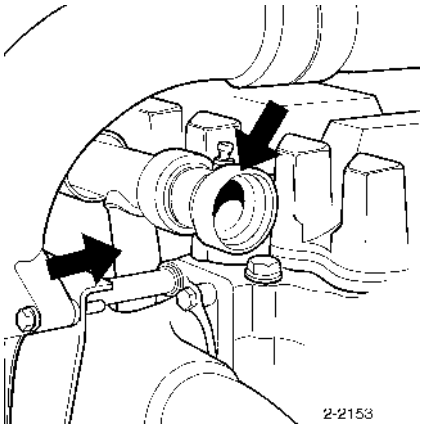
Refitting

11



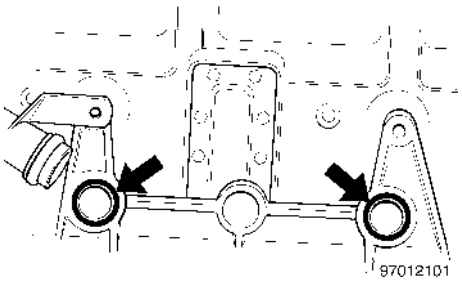
Fit new sealing rings (4) to the coolant pipe.

12



Fit the coolant pipe together with its connection

13



Remove the old sealing rings from the center plate of the oil cooler. Fit new sealing rings.

14

Push the oil cooler onto the front coolant pipe.

15

Bolt the oil cooler to the center plate and the cylinder block.

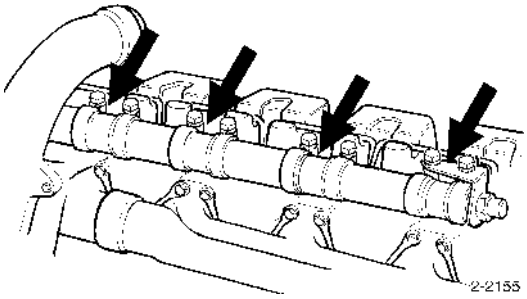
16

Fit the rear coolant pipe to the oil cooler together with the new sealing rings.

17

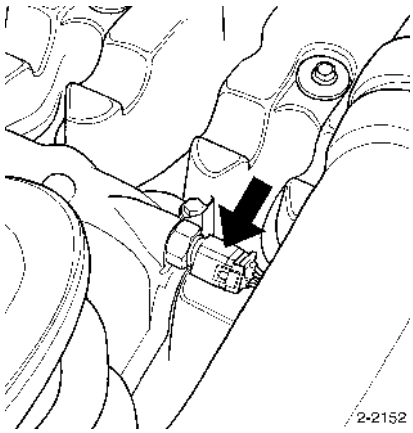
Fit the new seals to the coolant manifold.

18



Fit the manifold as one unit.

19



Restore the engine temperature sensor and the electrical connections.

20

Fill with coolant.

21

Replace the oil lost when the oil cooler was removed.

22

Test the cooling system for leakage.

23

Start the engine and check for oil leaks.

Coolant

The coolant should be a mixture of anti-freeze additive and water or, where there is no risk of freezing, anti-corrosion additive and water, see below.

The coolant should be replaced and the system flushed clean once a year. At the same time check all hoses and connections and fix any leakage. Replace all loose, swollen or otherwise damaged hoses.

Anti-freeze

The anti-freeze prevents corrosion in the cooling system and also freezing during the winter. We recommend using 50% Volvo Penta anti-freeze* (ethylene glycol, bluegreen) and 50% pure water (as neutral as possible). **This coolant mixture gives protection against freezing down to about –40°C (–40°F) and should be used year-round.**

For lower temperatures a greater quantity of anti- freeze is required according to the table below.

Notice: To get full protection against corrosion, always use at least 40% anti- freeze. This means that topping-up, whenever necessary, should be done with the corresponding anti-freeze mixture.

Note: Volvo Penta anti-freeze must not be mixed with any other kind of anti-freeze.

Part No. 1141646-8: 5 liters (1.3 US gals).
Part No. 1141647-6: 210 liters (55.5 US gals).

Mixing table, antifreeze/water

Portion as a percentage of antifreeze of total coolant volume for freeze protection down to about:		
–28°C (–18°F)	–40°C (–40°F)	–56°C (–69°F)
40 %	50 %	60 %

At the most, the freezing point can be lowered to -56°C (-69°F) (60% anti-freeze). **Increasing the mixture of anti-freeze past this point reduces the protection from freezing.**

Mix the anti-freeze with water in a separate container prior to filling the cooling system.

⚠ **WARNING!** Anti-freeze is harmful to health (poisonous if consumed).

Anti-corrosion additives

The easiest way to prevent corrosion is to use a suitable mixture of genuine Volvo Penta anti-freeze (glycol) all year round (at least 40%).

When there is never any danger of freezing, and if a water/glycol mixture is not used year-round, use water with Volvo Penta anti-corrosion additives (**Part No. 1141526-2**). Anti-corrosion additive is available in quantities of 1/2 liter. Mixing ratio 1:30.

Clean the cooling system thoroughly before filling. Run the engine warm immediately after filling to get the best possible effect from the additive.

To maintain the protection against corrosion, the coolant should thereafter be supplemented with further 1/2 liter anti-corrosion additive **every 400th hour of operation.**

Note: Other types of anti-corrosion additive, glycol or anti-freeze must absolutely not be mixed with this anti-corrosion additive. The anti-corrosion additive does not prevent the formation of ice and should only by used where the temperature is always above 0°C (32°F).

⚠ **WARNING!** Anti-corrosive agents are harmful to health (poisonous if consumed). See warnings regarding filling coolant, next page!

Checking coolant level

The level should be about 4-5 cm (2") below the filler cap's sealing edge. There must be an air space to allow for expansion of the coolant.

⚠ **WARNING!** Do **NOT** open the pressure cap (bleed cock) when the engine is hot. Steam or hot coolant can spray out and the system pressure will be lost.

An insufficient quantity of coolant can lead to poor circulation, which increases the risk of overheating, resulting in damage to the engine.

Note: Daily check of the coolant level or topping up through the fill opening is allowed only when the engine is stopped and cold.

Draining the coolant

Before draining the coolant, stop the engine, unscrew the filler cap.

Check carefully to make sure that all the water is drained.

Draining points:

– Radiator
– Engine block, right side
– Coolant pump
– Oil cooler, engine
– Charge air cooler (TWD1630)

Coolant, filling

To ensure excellent cooling of the engine, it is vital to check that the correct coolant volume is added when coolant is being replaced. Coolant levels that are too low can cause the engine to be damaged due to overheating (piston seizure).

Since the coolant volume varies between various engine types and installations, we recommend that a sufficient volume of coolant (fresh water with glycol, or anti-corrosion additives) is mixed in a container before filling. This process assures that the correct volume of coolant is added to the engine and that no air-pockets remain in the system.

See current Instruction Book/Workshop manual regarding coolant volumes and filling/venting the cooling system.

Note that if there is a heating plant, water heater or equivalent connected to the engine cooling system, a commensurately larger volume of coolant is required. There may also be additional vent cocks.

Filling must not be done so fast that air is locked in the system. The air must be able to pass out through the filler opening.

Filling should be carried out with the engine stopped. The engine must not be started until the system has been vented and completely filled.

If a heater system is connected to the engine's cooling system, the heat control valve should be fully opened and the heater system vented during filling.

Flush clean the cooling system before filling with coolant. Check all hoses and connections and fix any leaks. Close the drain cocks.

Fill with coolant to the correct level, see "Checking coolant level". Check that the cooling system is properly vented by carefully opening the venting cock after the engine has been started and has reached operating temperature. Any remaining air must be removed. The engine must not be started until the system has been vented and completely filled.

⚠ **WARNING!** Do **NOT** open the pressure cap (bleed cock) when the engine is hot. Steam or hot coolant can spray out and the system pressure will be lost. The pressure loss means that circulation in the system can be impaired, leading to overheating and engine damage. Hot fluids and hot surfaces can cause burns.

Topping-up should be carried out with the same mixture as is already used in the cooling system.

On engines with a separate expansion tank (optional equipment), the filling of large volumes is done directly through the filler opening on the radiator, until the system is vented and completely filled. Close the venting cock, screw on the filler cap and finally fill the separate expansion tank to between the MIN and MAX marks.

Coolant temperature too high

Too high coolant temperature can be caused by:

– Low coolant level, air in the system
– Reduced air flow through the radiator, dirty radiator
– Poor drive belt tension
– Blocked cooling system
– Faulty thermostat
– Faulty temperature gauge
– Faulty setting of injection pump with regard to the pre-injection angle

Coolant temperature too low

Too low coolant temperature can be caused by:

– Faulty thermostat
– Faulty temperature gauge

Temperature gauge, checking

Remove the temperature sensor. Connect the cables to the temperature gauge and immerse the sensor in hot water. Compare the temperature gauge reading with that of a thermometer.

1

Remove the level switch

⚠ **WARNING!** Remove the level switch very carefully when the engine is hot. Steam or hot coolant can spray out.

2

Place a plug M10 x 1 in the hole in the expansion tank.

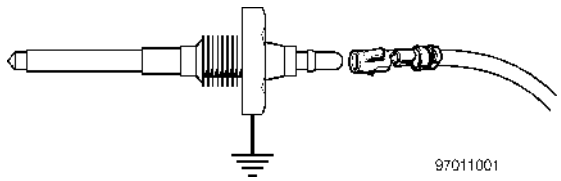
3

Clean the tip of the switch if it is oxide coated. Connect the wire to the switch, (the switch must not be connected to engine body, ground).

4

Start the engine.

5



Connect a wire between the engine body and the level switch.

6

Alarm and/or automatic stop should be triggered after **4 seconds**.

Coolant leakage

Loss of coolant can occur in two ways:

– Loss of coolant during running

– Loss of coolant after stopping a hot engine

Coolant loss during running can be due to leaks in the cooling system or air or combustion gases being pressed into the cooling system causing the coolant to be forced through the pressure valve. The fault can be in the compressed air compressor, it fitted, or leakage at the cylinder head gaskets.

Loss of coolant after stopping a hot engine is generally due to a faulty pressure valve (filler cap).

Checking radiator and charge air cooler

Should higher than normal coolant temperatures be observed, the passage of air through the charge air cooler and radiator (TAD1630/ TAD1631) must always be checked.

Check that the external cooling sections of the radiator and the charge air cooler are not blocked by insects or other impurities that can restrict the air flow. If obstructions are found use a mild grease- dissolving detergent and water. **Never use water at high pressure or compressed air.**

Straighten out any bent cells in the cell system. Flush the radiator from the front. In cases of more serious blockage the radiator must be removed entirely and then cleaned with a mild detergent. Also check that the fan cover has not come loose or is leaking in any other way.

Also check that the fan cover and, if fitted, the sealing strip fitted between the fan cover and the charge air cooler has not come loose or is leaking in any other way.

Drive belts, adjusting

Replace belts which have become oily, worn or damaged in any way.

Note: Belts that work in pairs should always be replaced at the same time.

Tension the alternator belts after loosening the alternator. Correct tension is obtained when the belts can be depressed about **10 mm (0.400")** midway between the pulleys.

The engine is equipped with an automatic belt tensioner for the fan belts.

Cooling system, cleaning

The cooling system (including the charge air cooler on TWD1630) should be cleaned when replacing the coolant.

It is generally sufficient to flush through with clean water. If the cooling system has large rust and mud deposits we recommend the following cleaning method:

1

Empty and flush the system clean. Use Volvo radiator cleaning kit, part no 1141658, or dissolve 1 kg (2.2 lbs) of oxalic acid* in 5 liter (5.3 qt) hot water and pour the mixture into the cooling system. Top up with clean water.

* Not marketed by Volvo Penta, can be purchased from chemical stores.
Chemical formula for oxalic acid: $C_2H_2O_4$.
Chemical formula for sodium hydrogen carbonate: $NaHCO_3$.

⚠ **WARNING!** Protect hands and face. Oxalic acid is poisonous and hazardous to the skin.

2

Run the engine until it reaches normal operating temperature **and then for about another 2 hours.**

Note: Any heater controls must be set to “hot”.

3

Drain the system and flush out immediately and thoroughly with clean water. For this purpose the thermostat housing (thermostat), upper and lower radiator hoses, drain cocks and plugs should be removed to give the best possible draining speed. Do not forget the engine heater or heater element, if fitted. Continue flushing until the water coming out is clean. It is essential to remove all oxalic acid, otherwise the remains can increase the risk of further corrosion.

4

Dissolve 200 grams (7 oz.) of bicarbonate* (sodium hydrogen carbonate) in 5 liters (5.3 qt) of water an pour into the cooling system. Top up with clean water.

Note: Never use soda (sodium carbonate Na_2CO_3) as incorrect handling can result in severe corrosion damage.

5

Run the engine at normal operating temperature for **about 10-15 minutes**. This must be done thoroughly in order to neutralize the oxalic acid.

6

Flush the system thoroughly clean according to point 3. Increased flushing effect can be obtained by mixing water with air, **in which case flushing must, without exception, be carried out from bottom to top (radiator), or from the drain cock in question on the cylinder block**.

Note: Remove the filler cap from the expansion tank/radiator. In the case of separate expansion tank, this should also be flushed from the bottom and up with the filler cap removed for efficient cleaning. Flush the heater, if fitted, with the hoses removed to be sure that remaining deposits are removed.

7

If there is still rust and slime the cooling system, repeat the steps under points 1–6.

When cleaning, check that all hoses are free from defects. Replace if necessary.

8

Fill the system with a coolant recommended by Volvo Penta. See section “Coolant”. Check to make sure that there are no leaks.

Cooling system, pressure-testing

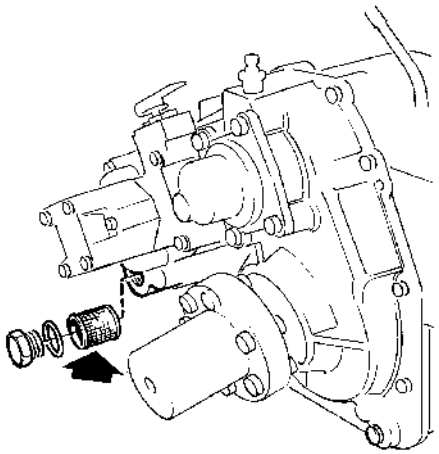
Special tools: 999 6662, 998 9860 with compressed air and 999 6433. Or use standard pressure testing gear.

Checking pressure-testing device 999 6662

Before using the pressure-testing equipment it must be checked as follows**:**

A

Check that the knob on the relief valve (A) is fully opened and connect the test device to the compressed air system. Open cock (B) and adjust the relief valve until a pressure of **100 kPa (14.5 psi.)** is indicated on the gauge.



Note: The relief valve’s knob can be locked by moving the locking ring axially.

Note: Always follow applicable safety regulations.

B

Close cock (B). The pressure must not drop during two minutes if the test device is to be considered reliable.

Pressure testing

1

Remove the coolant filler cap and instead fit cap 999 6433 on the radiator. Plug the connection to an extra plastic expansion tank, if fitted, during the pressure- testing.

2

Ensure that the knob on the relief valve (A) is fully opened and connect the hose from the pressure-testing device to the cap 999 6433.

3

Seal the drain line from the filler pipe.

4

Connect the pressure-testing device 999 6662 to the compressed air system and open the cock (B).

5

Tighten the lock ring for the knob on the relief valve. Increase the pressure by tightening the knob until the pressure gauge reads **70 kPa (10.15 psi).**Lock the knob by pressing in the lock ring and close the cock (B).

6

Check during one minute that the pressure does not drop. If there is difficulty in locating the leak, drain the coolant, re-pressurize the system and apply soapy water to hose connections, drain cocks etc., until the leak is found.

Notice: Make sure that the pressure never exceeds **70 kPa (10.15 psi**. Check that the pressure does not rise. Increased pressure can, among other things, damage the coolant pump seal.

Note: Always follow applicable safety regulations.

7

Remove the testing device.

Pressure valve, checking

The pressure valve is located in the filler cap. For this test the same pressure-testing device is used as for testing for leakage in the cooling system. See previous section.

1

Drain part of the coolant and connect the pressure- testing device with a nipple to any plugged hole in the cooling system.

2

Extend the draining hose from the filler pipe with a hose which opens out into a vessel containing water.

3

Apply the pressure, see “The cooling system “Pressure testing”, in the previous section, and read the pressure gauge when the valve opens (water will bubble in the vessel with the drain line/filler cap).

For correct opening pressure, see “Workshop manual, Technical Data).

Electrical system

The engines are equipped with a 2-pole electrical system with an alternator. System voltage is 24 volts.

Important

For engines with alternators the following is applicable:

⚠ **IMPORTANT!** Never break the circuit between alternator and battery when the engine is running. The main switch must therefore not be switched off until the engine has stopped.

1

Cables shall not be disconnected while the engine is running since this can also damage the voltage regulator.

2

Batteries, battery cables and cable terminals shall be checked regularly. The battery poles shall be well- cleaned and the cable shoes always tightened and well greased so that no interruption occurs. All cables shall be well tightened, and there shall be no loose connections.

Note: Do not interchange the battery's plus and minus poles when fitting the batteries. Refer to the wiring diagrams. Check drive belt tension regularly.

3

When starting with auxiliary batteries, see **"**Starting with auxiliary battery".

4

When repairing the alternator, both battery cabled shall be removed first. The same applies for quick-charging of batteries.

Note: Follow applicable safety instructions when charging batteries.

Arc welding

When arc welding on the engine or on installed components, always prepare as follows:

Remove the 2 battery cables and then remove all the alternator cables from the alternator.

Attach the welding clamp to the component to be welded and as close to the welding spot as possible. Never attach the welding clamp to the engine or in a way that the current will have to pass through a bearing.

⚠ **IMPORTANT!** After the welding is finished: Install the alternator cables before installing the battery cables.

Starting with auxiliary battery

⚠ **WARNING!** The batteries (especially auxiliary batteries) contain an oxyhydrogen gas mixture which is very explosive. A spark generated by connecting the jumper cables incorrectly is sufficient to explode a battery and cause personal injury and damage.

If the batteries are frozen they must be thawed out first before attempting to start them with an auxiliary battery.

1

Check that the auxiliary batteries are connected (in series or parallel) so that the rated voltage corresponds with the engines system voltage.

2

First connect the red jumper cable (+) to the auxiliary battery's plus terminal and then to the dead battery.

3

Then connect the black cable (-) to the auxiliary battery. And lastly to a point some way off from the dead batteries, e.g. at the main switch, minus cable or connection of minus cable to the start engine.

6

Start the engine.

Note: Do not interfere with connections when attempting to start (spark risk) and do not lean over batteries.

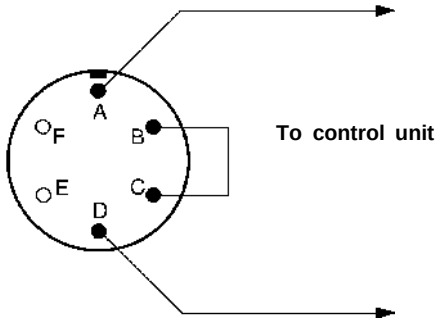
7

Remove cables in exactly the reverse order to which the were connected.

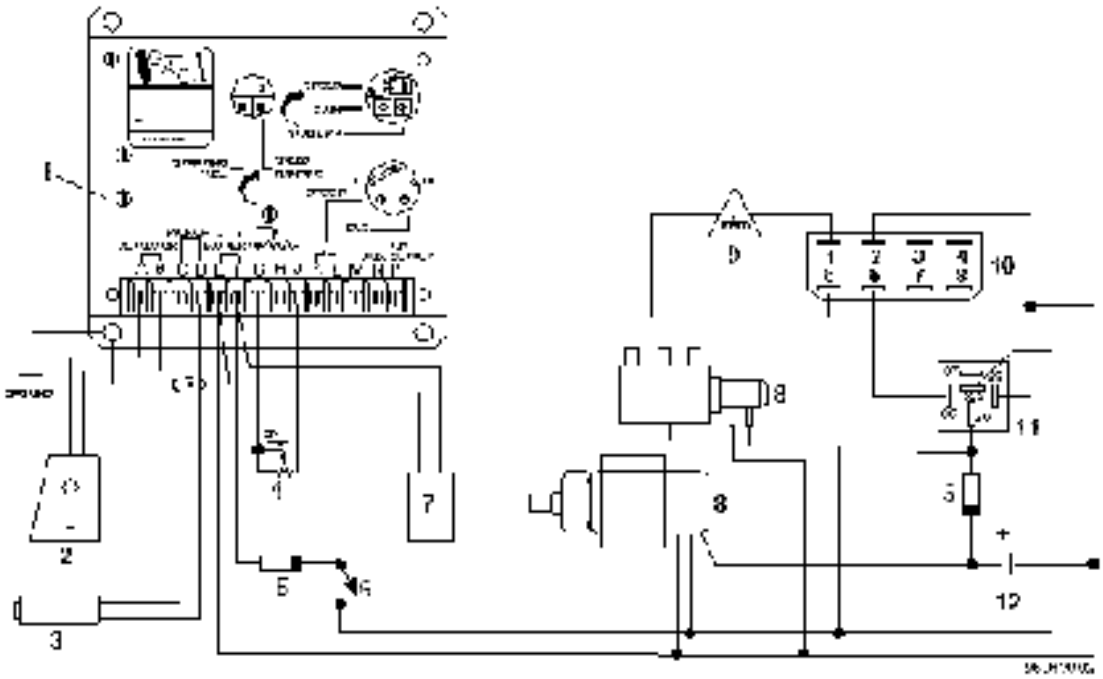
Note: The regular cables to the standard batteries must never be disconnected.

Electronic speed governor

Wiring



Connecting the actuator for 24V system voltage



The stop solenoid/fuel shut off valve (8) connected live during operation (optional). Stop the engine with switch (6).

Notice: Later versions of stop solenoids have built-in transient protection. Therefore, only a separate transient protection (7) for the Control Unit is required.

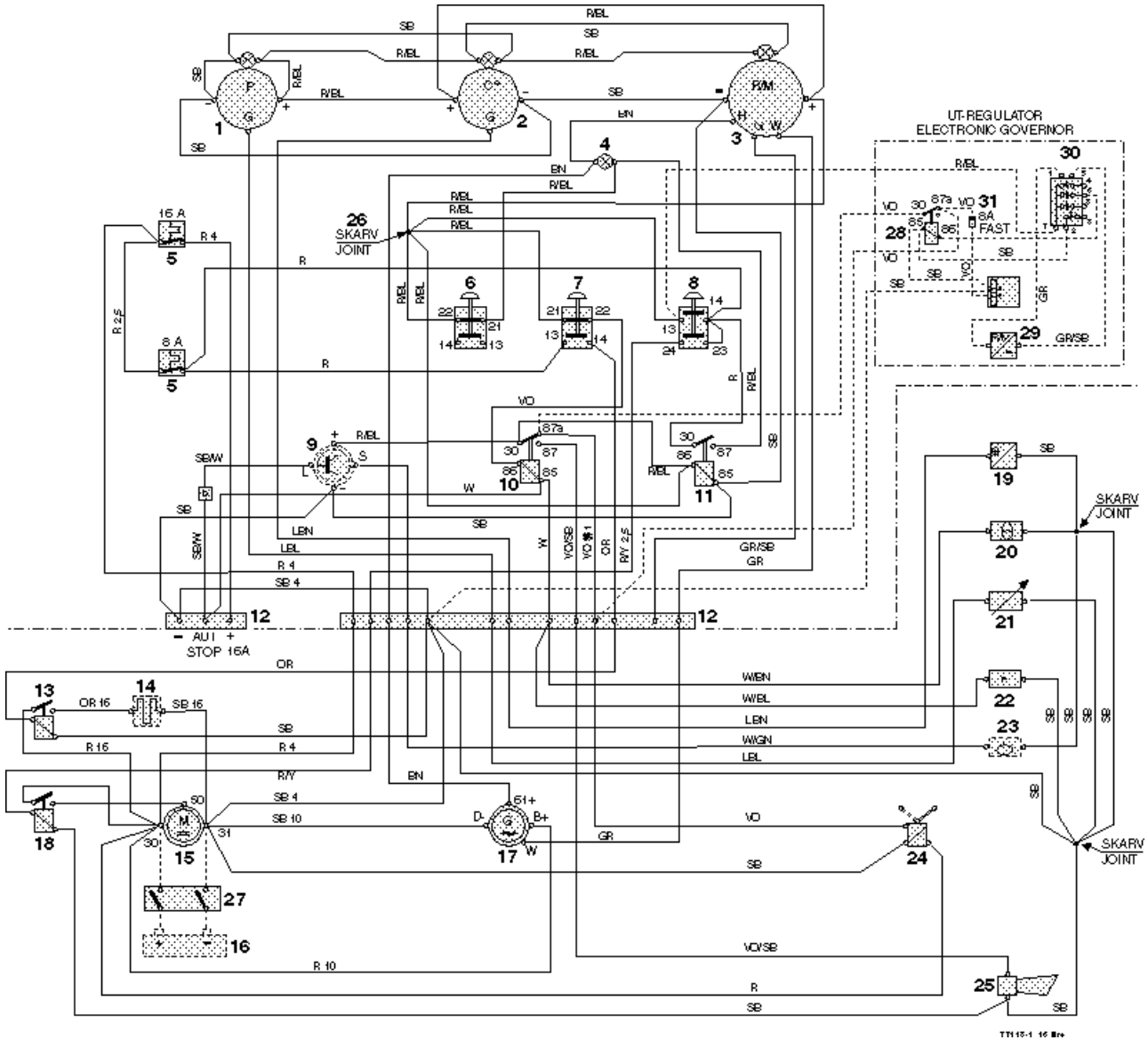
1. Control Unit
2. Actuator
3. Pickup
4. Multi-turn potentiometer*
5. Fuse (fast) 8A
6. Main switch
7. Transient protection
8. Stop solenoid/Fuel shut off valve
9. Engine speed pickup for overspeed protection
10. Engine speed switch (rpm switch)
11. Relay
12. Battery

* Not from Volvo Penta

Wiring diagrams

1.

Instrument panel and engine (except TWD1620 and TID162) **(equipped with stop solenoid).**



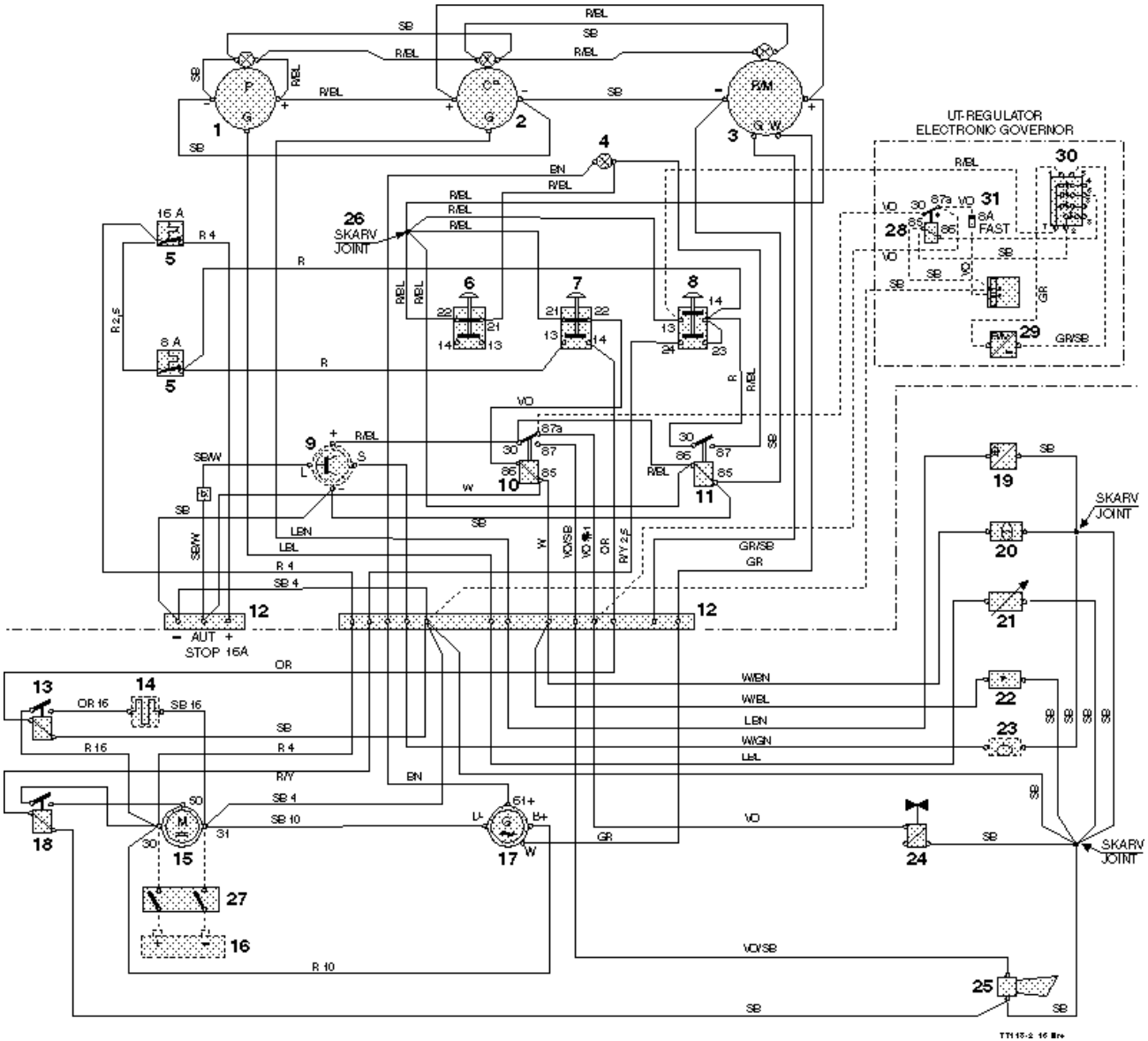
Position key for diagram 1 and 2

1. Oil pressure gauge
2. Coolant temperature gauge
3. Rev. counter with built-in hour counter
4. Warning lamp, charging
5. Semi-automatic fuses (manual resetting)
6. Stop button
7. Interlock
8. Start button
9. Relay for coolant level switch (option)
10. Relay for coolant temp. switch, oil pressure switch
11. Holding current relay (operating current and instrument)
12. Terminal block (extra receptacles, fused receptacle for automatic stop, shutdown in case of fault).
13. Relay for starter heater
14. Starter heater
15. Starter motor
16. Battery
17. Alternator
18. Start relay
19. Coolant temp sensor
20. Coolant temp. switch (normally open)
21. Oil pressure sensor
22. Oil pressure switch (normally open)
23. Coolant level switch (option)
24. Stop solenoid (diagram 1)/Fuel shut-off valve (diagram 2), (energized during operation)
25. Horn
26. Union
27. Main switch
28. Relay
29. Rpm sensor for overspeed protection
30. Engine overspeed switch
31. Fuse, 8A

*1 Disconnect during installation of GAC regulator.

2.

Instrument panel and engine (except TWD1620 and TID162) **(equipped with fuel shut-off valve).**



Cable areas in mm² (see color code in wiring diagram). 1.5 mm² applies when no other area is shown²

Color code

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

Battery cable areas are related to battery positioning.

Distance, starter motor – batteries:

max 2 m (6.5 ft.), area = 70 mm²
max 4 m (6.5 ft.), area = 120 mm²

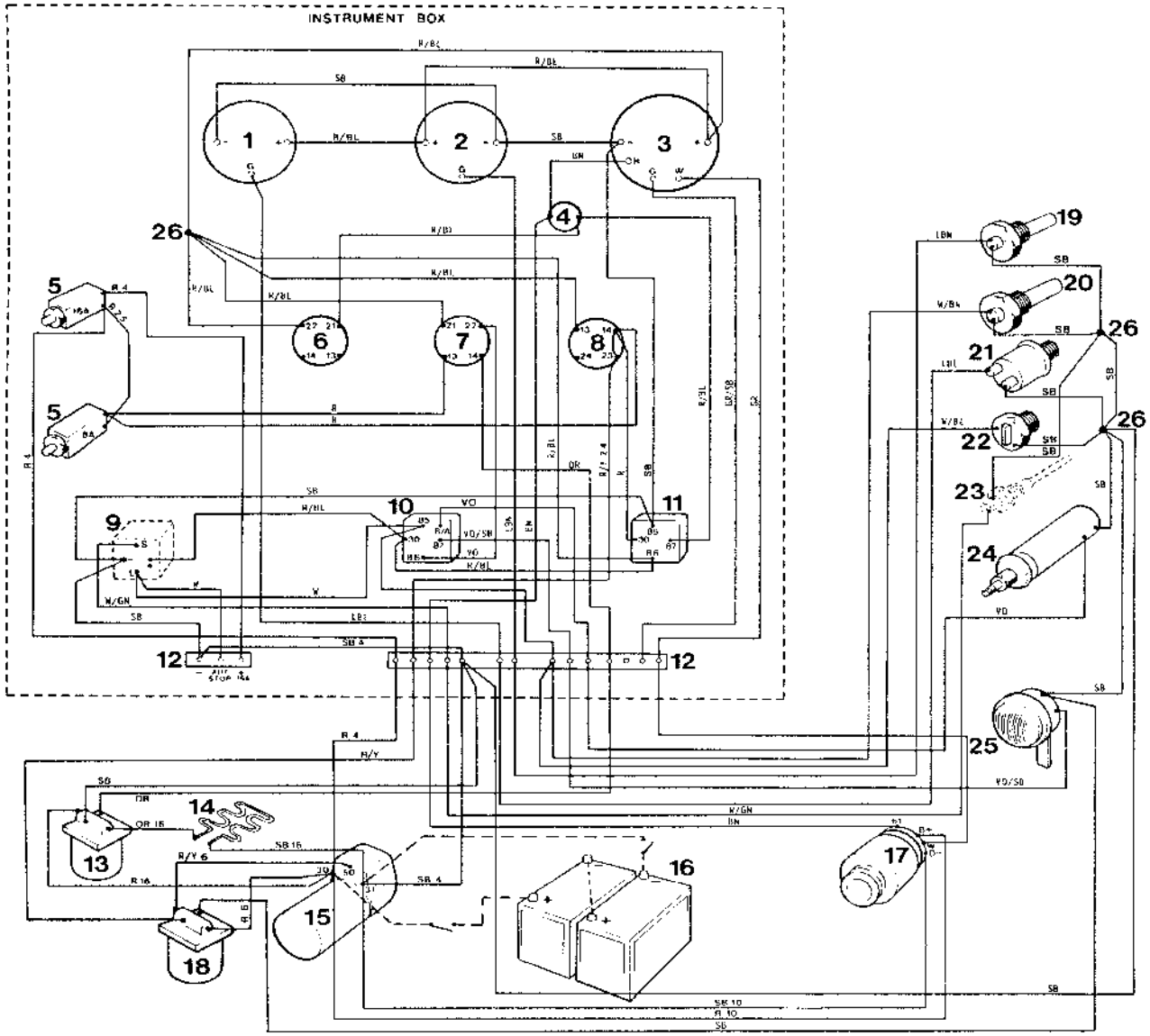
Relationship mm²/AWG*

*American Wiring Gauge

mm²	1,0	1,5	2,5	10	16

2.

Instrument panel and engine
for TWD1620 and TID162.



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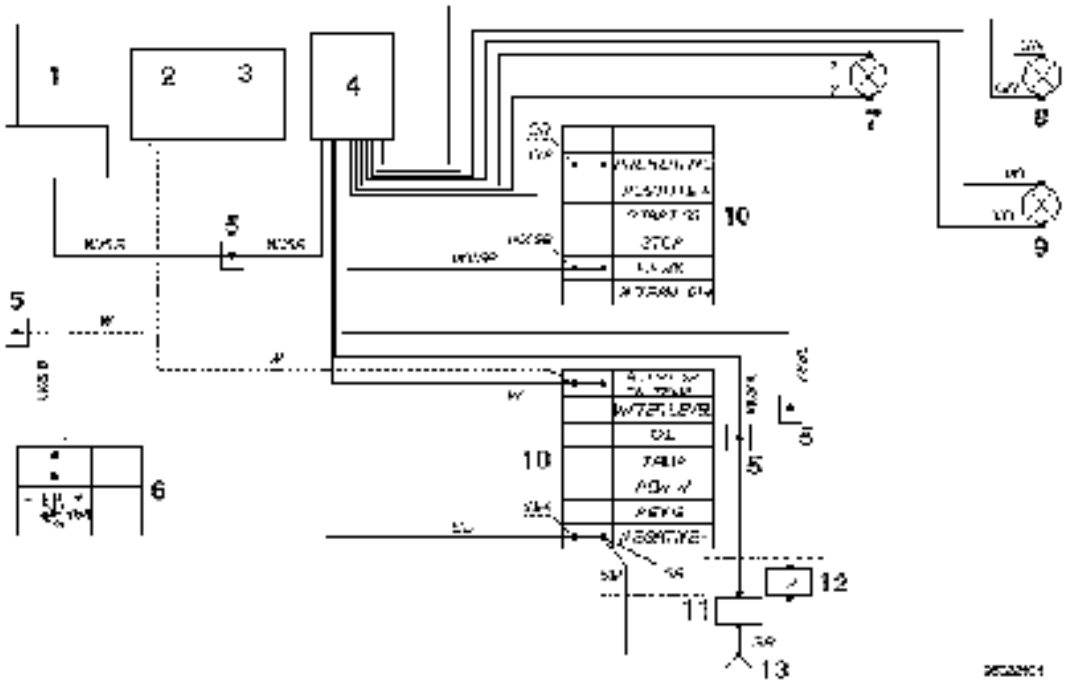
Relationship mm²/AWG*

*American Wiring Gauge

mm²	1,0	1,5	2,5	10	16
AWG	16 (17)	15 (16)	13	7	5

AWG	16 (17)	15 (16)	13	7	5	

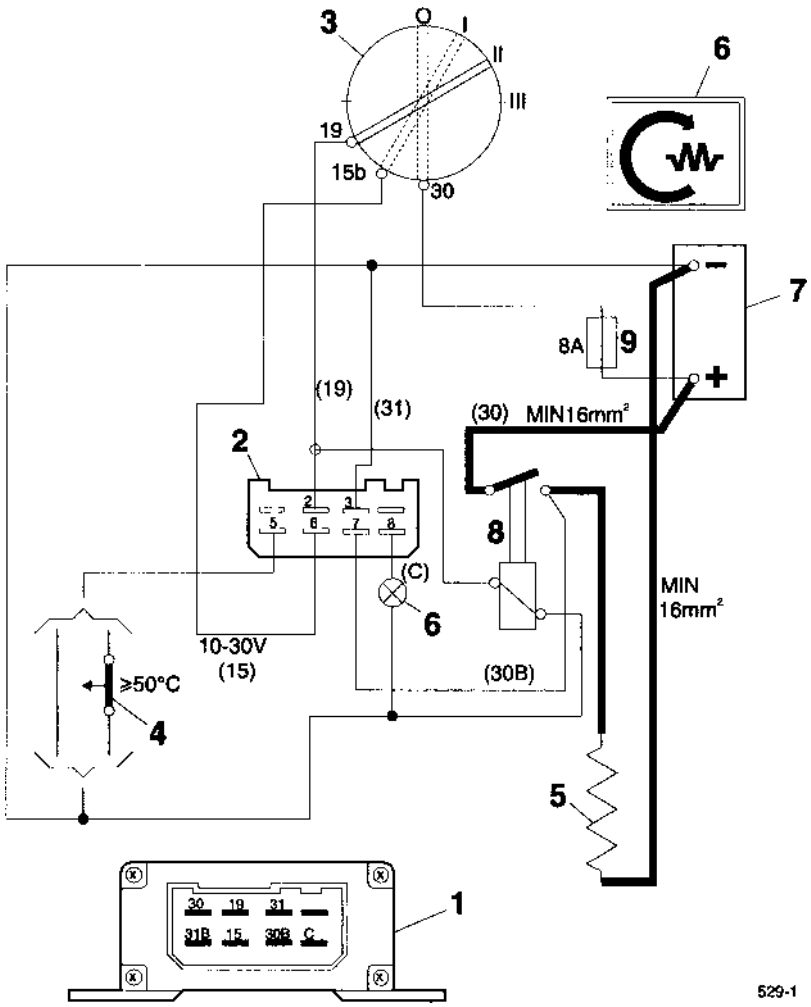
3.



Connection of alarm separator (option) to instrument panel.

1. Relay for coolant level switch (option)
2. Relay for coolant temp. switch, oil pressure switch
3. Holding current relay (operating current and instrument)
4. Alarm separator
5. Connection
6. Terminal block (extra receptacle fused for 16A. Receptacle for automatic stop, shutdown in case of fault).
7. Warning lamp, high coolant temp. (option)
8. Warning lamp, low coolant level (option)
9. Warning lamp, low oil pressure (option)
10. Terminal block for engine cables
11. Coolant temp. switch (normally open)
12. Oil pressure switch (normally open)
13. Union

Dotted line represents existing cable



4.

Connection of time relay kit (accessory) for connection of starter heater.

1. Time relay
2. Contact piece, 8-pole.
3. Ignition switch
4. Temperature switch (option)
5. Starter heater
6. Indicator lamp (starter heater connected)
7. Battery
8. High output relay for starter heater
9. Fuse, 8A)

Troubleshooting

1. Engine does not start

Starter motor does not turn engine

CAUSE	REMEDY
• Discharged batteries	Charge/replace the batteries (or connect auxiliary batteries as described in section “Starting with auxiliary battery”).
• Main switches off	Turn on the main switches.
• One of the semi-automatic fuses in the junction box has tripped (position 5 in the engine wiring diagram)	Reset the fuse by pressing the button.
• Poor contact/breaks in connections and electrical cables	Rectify any open-circuits/loose connections. Check for oxidation on the contacts. Clean them and spray with damp-inhibitor spray. See “Wiring diagrams”.
• Faulty ignition switch/start button	Replace ignition switch/start button
• Faulty start relay	Replace start relay
• Faulty starter motor/solenoid	Check starter motor/solenoid.
• Water in compression chamber	Do not make any more attempts to start if you suspect water in compression chamber. Check the engine.

Starter motor turns slowly

CAUSE	REMEDY
• Discharged batteries	Charge/replace the batteries (or connect auxiliary batteries as described in section “Starting with auxiliary battery”).
• Poor contact/breaks in connections and electrical cables	Rectify any open-circuits/loose connections. Check for oxidation on the contacts. Clean them and spray with damp-inhibitor spray. See “Wiring diagrams”.

Starter motor turns over as usual but engine does not start

CAUSE	REMEDY
• Air in fuel system	Bleed the fuel system, see “Fuel system, bleeding”.
• No fuel	
– fuel cocks closed	Open the fuel cocks
– fuel tank empty	Fill with fuel
– fuel filters clogged (due to contaminants/kerosene precipitation in the fuel as a result of low outside temperature)	Fit new fuel filters (pre-filters and/or fine filters). Bleed the system. See “Fuel system, bleeding”.
• Stop solenoid/fuel shut off valve connected/ seizing	Check that stop solenoid/fuel shut off valve is in operating position
• Insufficient preheating	
– incorrect starting procedure	Try start again as shown in the Instruction Book
– starter heater is not engaged	Check that none of the semi-automatic fuses has tripped (position 5 in engine wiring diagram). Reset the fuse by pressing the button.
	Check the electrical cables, the interlock button and the relay for the starter heater. Insufficient air flow to engine.
• Blocked combustion air intake	Check air intake for blockage**.**

2. Engine starts but stops again or runs unevenly

CAUSE	REMEDY
• Air in fuel system	Bleed the fuel system. See “Fuel system, bleeding”.
• No fuel	
– fuel cocks closed	Open the fuel cocks.
– fuel tank empty	Fill with fuel.
– fuel filters clogged (due to contaminants/kerosene precipitation in the fuel as a result of low outside temperature)	Fit new fuel filters (pre-filters and/or fine filters). Bleed the system. See “Fuel system, bleeding”.
• Stop solenoid/fuel shut off valve connected/ seizing ing position	Check that the stop solenoid/fuel shut off valve is in operat-
• Insufficient preheating	
– incorrect starting procedure	Try start again as shown in the Instruction Book
– starter heater is not engaged	Check that none of the semi-automatic fuses has tripped (position 5 in engine wiring diagram). Reset the fuse by pressing the button.
	Check the electrical cables, the interlock button and the relay for the starter heater. Insufficient air flow to engine

• Insufficient air flow to engine	
– air filter blocked	Fit new air filter or clean the air filter. Check ventilation to engine room.
• Faulty injectors	Check/replace injector(s).

3. Coolant temperature too high

CAUSE	REMEDY
• Coolant level in engine too low (air in system)	Fill the engine with coolant and vent the system See “Coolant, filling”.
• Faulty thermostat	Install a new thermostat
• Clogged radiator and/or charge air cooler (TAD)	Clean See “Cleaning cooling system”.
• Faulty circulation pump	Overhaul/replace the circulation pump.
• Faulty temperature gauge/sensor	Check/replace temperature gauge/sensor
• Faulty setting of injection angle	Check/adjust the injection angle.

4. Coolant temperature too low

CAUSE	REMEDY
• Faulty thermostat	Install a new thermostat

5. Engine does not reach correct speed at wide open throttle

CAUSE	REMEDY
• Engine overloaded	If possible reduce the load
• Insufficient fuel flow	
– fuel filters clogged (due to contaminants/kerosene precipitation in the fuel as a result of low outside temperature)	Fit new fuel filters (pre-filters and/or fine filters). Bleed the system. See “Fuel system, bleeding”.
• Water in fuel	Clean fuel tank. Drain water from pre-filter, if any.
• Insufficient air flow to engine	
– faulty injector(s)	Fit new air filter/clean air filter
– air leak between turbo and engine’s inlet manifold	Check the rubber hose between turbo and the connecting pipe, plus other connections. Tighten the hose clips.
– faulty turbo charger	Clean the compressor assembly. Overhaul the turbo compressor if needed.
– poor engine room ventilation	Check that the ventilation ducts to the engine room are not blocked.
• Accelerator incorrectly adjusted	Adjust the accelerator.
• Excessive back pressure in exhaust system	Check that the exhaust pipe is not restricted in any way.

• Faulty setting of injection pump	Adjust pump setting.
• Faulty smoke limiter	
– smoke limiter seizing	Overhaul smoke limiter.
– pressure pipe between inlet manifold and smoke limiter leaking	Fit new pressure line
– faulty diaphragm in smoke limiter	Replace diaphragm in smoke limiter.
– faulty setting	Adjust smoke limiter setting.
• Stop lever position	Check that the stop lever is in full operating position.

6. Engine runs on

CAUSE	REMEDY
• One of the semi-automatic fuses in the junction box has tripped (position 5 in the engine wiring diagram)	Reset the fuse by pressing the button.
• Poor contact/breaks in connections and electrical cables	Rectify any open-circuits/loose connections. Check for oxidation on the contacts. Clean them and spray with damp-inhibitor spray. See “Wiring diagrams”.
• Faulty stop button	Replace stop button.
• Faulty stop solenoid/fuel shut off valve	Check, replace Stop solenoid/Fuel shut off valve.

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