

WORKSHOP MANUAL

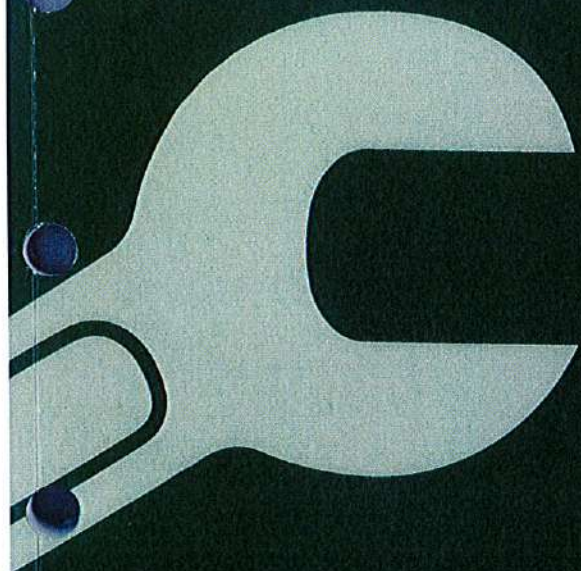
GROUP 21-26

TAD164X GE/VE/VE-B, TAD165X GE/VE/VE-B

TAD166X VE, TAD167X VE, TWD164X GE

TWD165X GE, TWD166X GE, TWD167X GE

TWD1683 GE



**VOLVO
PENTA**

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00-0 General

General information

This Service Manual contains technical data, descriptions and maintenance and repair instructions for standard model Volvo Penta products. A list of these products may be found in the section **Specifications**.

The product designation and the serial number and specification is indicated on the engine decal or type plate. This information must be included in all correspondence regarding the product.

The service manual is produced primarily for the use of Volvo Penta workshops and their qualified personnel. It is assumed that any person using the Service Manual has a fundamental knowledge of the product and is able to carry out mechanical and electrical work to trade standard.

Volvo Penta continually develops its products; we therefore reserve the right to make changes. All information in this manual is based on product data which was available up to the date on which the manual was printed. New working methods and significant changes introduced to the product after this date are communicated in the form of **Service bulletins**.

Spare Parts

Spare parts for the electrical and fuel systems are subject to various national safety standards. Volvo Penta Original Spare Parts meet these standards. No damage of any kind caused by the use of spare parts not approved by Volvo Penta will be compensated by any warranty undertaking.

About this Workshop manual

Certified engines

When carrying out service and repair on emission-certified engines, it is important to be aware of the following:

Certification means that an engine type has been inspected and approved by the relevant authority. The engine manufacturer guarantees that all engines of the same type are manufactured to correspond to the certified engine.

This places special demands on service and repair work, namely:

- Maintenance and service intervals recommended by Volvo Penta must be complied with.
- Only spare parts approved by Volvo Penta may be used.
- Service on injection pumps, pump settings and injectors must always be carried out by an authorized Volvo Penta workshop.
- The engine must not be converted or modified, except with accessories and service kits which Volvo Penta has approved for the engine.
- No changes to the exhaust pipe and engine air inlet duct installations may be made.
- No warranty seals (where present on the product) may be broken by unauthorized persons.

The general instructions in the Operator's Manual concerning operation, service and maintenance apply.

IMPORTANT!

Neglected or poorly-performed care/service and the use of spare parts not approved by Volvo Penta, will mean that AB Volvo Penta no longer guarantees that the engine conforms to the certified model.

Volvo Penta accepts no responsibility for damage or costs arising as a result of failure to follow the above mentioned standards.

Introduction

The working methods described in this manual are based on a workshop scenario where the product is mounted in a holding fixture. Maintenance work is often carried out on site, in which case – if nothing else is indicated – using the same working methods as the workshop.

Warning symbols that occur in the service manual. For significance, refer to **Safety Information**.



DANGER!



WARNING!



CAUTION!

IMPORTANT!, NOTICE!

are by no means comprehensive since not everything can be foreseen as service work is carried out in the most varied of circumstances. We call attention to risks that may occur due to incorrect handling during work in a well-equipped workshop using working methods and tools tried and tested by us.

The service manual describes work operations carried out with the aid of Volvo Penta Special Tools, where such have been developed. Volvo Penta Special Tools are designed to ensure the safest and most rational working methods possible. It is therefore the responsibility of anyone using tools or working methods other than those we recommend to ensure that no risk of personal injury or mechanical damage is present, or that malfunction can result.

In some cases, special safety regulations and user instructions may be in force for the tools and chemicals mentioned in the Service Manual. These regulations must always be followed, and no special instructions regarding this are to be found in the Service Manual.

By taking these basic precautions and using common sense it will be possible to guard against most elements of risk. A clean workplace and a clean product will eliminate many risks of personal injury and malfunction.

Above all, when working on fuel systems, hydraulic systems, lubrication systems, turbochargers, inlet systems, bearings and seals, it is of the utmost importance that dirt and foreign objects are kept away, as malfunctions or shortened service intervals may otherwise result.

Our mutual responsibility

Each product comprises a large number of interacting systems and components. A deviation from the technical specification may dramatically increase the environmental impact of an otherwise reliable system. It is therefore critical that the stated wear tolerances be adhered to, that systems which can be adjusted be correctly set up and that only Volvo Penta Original Parts are used. The intervals in the care and maintenance schedule must be followed. Some systems, e.g. fuel systems, often require special expertise and test equipment. A number of components are factory-sealed, for among other things environmental reasons. Warranty-sealed components may not be worked on without authorization to perform such work.

Remember that most chemical products, incorrectly used, are harmful to the environment. Volvo Penta recommends the use of biodegradable degreasers whenever components are cleaned, unless otherwise specified in the Service Manual. When working outdoors, take especial care to ensure that oils and wash residues etc. are correctly properly for destruction.

Tightening torques

Tightening torques for vital fasteners that must be applied using a torque wrench are indicated in the Service Manual, chapter **Tightening torques** and in the Manual's work descriptions. All torque indications apply to clean threads, bolt heads and mating faces. Indicated torque data apply to lightly-oiled or dry threads. If lubricants, locking fluids or sealants are required for fasteners, the correct type will be noted in the job description.

Torque, angle tightening

When torque/angle tightening, the fastener is tightened to a specified torque, and tightening then continues through a pre-determined angle.

Example: For 90° angle tightening, the fastener is turned a further 1/4 turn in one sequence, after the specified tightening torque has been achieved.

Lock nuts

Removed locknuts may not be re-used; they must be replaced by new ones, as locking properties are impaired or lost with re-use.

In the case of lock nuts with plastic inserts the tightening torque indicated must be reduced if the nut has the same nut height as a standard, all-metal hexagonal nut.

Reduce the torque by 25% for bolt sizes of 8 mm or larger.

In the case of lock nuts with plastic inserts with a high nut-height (where the all-metal thread is as high as a standard hexagonal nut), the indicated torque applies.

Strength classes

Nuts and bolts are subdivided into different strength classes. The classification is shown by a marking on the bolt head. Markings of a higher number indicate stronger material. For example, a bolt marked 10-9 is stronger than one marked 8-8.

For this reason, it is important that when bolts are removed they are returned to their original locations on re-assembly. When replacing bolts check the applicable **Spare parts catalogue** to ensure the correct bolt is used.

Sealing compounds etc.

To ensure service work is correctly carried out it is important that the correct type of sealants and locking fluids are used on joints where such are required.

In each service manual section concerned, the sealants used in product manufacture are indicated. The same sealants, or sealants with equivalent properties, must be used for maintenance work.

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 regarding applicable temperatures, hardening times and such.

Two basic types of compound are used:

RTV preparations (Room Temperature Vulcanizing).

Used most often together with gaskets, e.g. sealing gasket joints, or are brushed on gaskets. RTV sealants are completely visible when the part has been removed. Old RTV sealant must be removed before the component is sealed again. Use denatured alcohol.

Anaerobic agents.

These agents cure (harden) in the absence of air. These preparations are used when two solid components, e.g. two cast components, are fitted together without a gasket. Common uses are also to lock and seal plugs, stud threads, taps, oil pressure monitors etc.

Hardened anaerobic preparations are glassy and for this reason, the preparations are colored to make them visible. Hardened anaerobic preparations are highly resistant to solvents, and old compound cannot be removed. On re-assembly, it is important to carefully degrease and wipe dry components first, before applying new sealant in accordance with the instructions.

Safety regulations for fluorocarbon rubber

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

When fluorocarbon rubber is exposed to high temperatures (above 300°C/572°F), hydrofluoric acid can form. This is highly corrosive. Contact with the skin can result in severe chemical burns. Splashes in your eyes can result in chemical wounds. If you breathe in the fumes, your lungs can be permanently damaged.

WARNING!

Seals must never be cut with a torch, or be burnt afterwards in an uncontrolled manner. Risk for poisonous gases.

WARNING!

Always use chloroprene rubber gloves (gloves for chemicals handling) and 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 clean. Put the remains in a plastic container, seal it and apply a warning label. Wash the gloves under running water before removing them.

The following seals are most probably made from fluorocarbon rubber:

Seal rings for the crankshaft, camshaft, idler shafts.

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

Please note that seals which have not been exposed to high temperature can be handled normally.

Introduction

The working methods described in this manual are based on a workshop scenario where the product is mounted in a workholding fixture. Maintenance work is often carried out in situ, in which case - if nothing else is indicated - using the same working methods as the workshop.

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In some cases, special safety regulations and user instructions may be in force for the tools and chemicals mentioned in the Service Manual. These rules must always be observed, so there are no special instructions about this 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 workplace and a clean product will eliminate many risks of personal injury and malfunction.

Above all, when working on fuel systems, hydraulic systems, lubrication systems, turbochargers, inlet systems, bearings and seals, it is of the utmost importance that dirt and foreign objects are kept away, as malfunctions or shortened service intervals may otherwise result.

Repair instructions

Our Mutual Responsibility

Each product comprises a large number of interacting systems and components. A deviation from the technical specification may dramatically increase the environmental impact of an otherwise reliable system. It is therefore critical that the stated wear tolerances be adhered to, that systems which can be adjusted be correctly set up and that only Volvo Penta Original Parts are used. The intervals in the care and maintenance schedule must be followed.

Some systems, e.g. fuel systems, often require special expertise and test equipment. A number of components are factory-sealed, for among other things environmental reasons. Warranty-sealed components may not be worked on without authorization to perform such work.

Remember that most chemical products, incorrectly used, are harmful to the environment. Volvo Penta recommends the use of biodegradable degreasers whenever components are cleaned, unless otherwise specified in the Service Manual. When working outdoors, take especial care to ensure that oils and wash residues etc. are correctly properly for destruction.

Tightening torque

Tightening torques for vital fasteners that must be applied using a torque wrench are indicated in the Service Manual, chapter **Tightening torques** and in the Manual's work descriptions. All torque indications apply to clean threads, bolt heads and mating faces. Indicated torque data apply to lightly-oiled or dry threads. If lubricants, locking fluids or sealants are required for fasteners, the correct type will be indicated in the job description.

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When torque/angle tightening, the fastener is tightened to a specified torque, and tightening then continues through a pre-determined angle.

Example: For 90° angle tightening, the fastener is turned an additional 1/4 turn in one sequence, after the specified tightening torque has been achieved.

Lock nuts

Removed lock nuts may not be re-used; they must be replaced by new ones, as locking properties are impaired or lost with re-use.

In the case of lock nuts with plastic inserts, the tightening torque indicated must be reduced if the nut has the same nut height as a standard, all-metal hexagonal nut.

Reduce the torque by 25% for bolt sizes of 8 mm or larger.

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Strength Classes

Nuts and bolts are grouped into different strength classes. Their classification is shown by a marking on the bolt head. Markings of a higher number indicate stronger material. For example, a bolt marked 10-9 is stronger than one marked 8-8.

For this reason, it is important that when bolted joints are removed they are returned to their original locations on re-assembly. When replacing bolts, check the applicable **Spare parts catalog** to ensure the correct bolt is used.

Sealing compounds etc.

To ensure service work is correctly carried out, it is important that the correct type of sealants and locking fluids are used on joints where such are required.

In each service manual section concerned, the sealants used in product manufacture are indicated. The same sealants, or sealants with equivalent properties, must be used for maintenance work. A service technician should have a basic knowledge of how sealing compounds are handled, and are able to assess the condition of existing seals.

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 regarding applicable temperatures, hardening times and such.

Two basic types of compound are used:

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Hardened anaerobic preparations are vitreous and for this reason, the preparations are colored to make them visible. Hardened anaerobic preparations are highly resistant to solvents, and old compound cannot be removed. On re-assembly, it is important to carefully degrease and wipe dry components first, before applying new sealant in accordance with the instructions.

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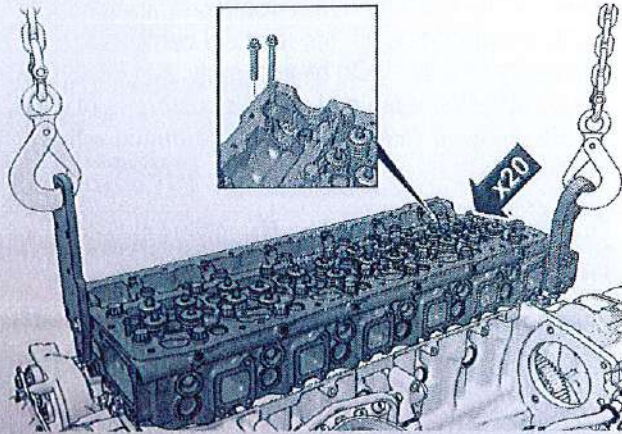
O-rings, regardless of where they are installed. O-rings for cylinder liner sealing are almost always made of fluorocarbon rubber.

Please note that seals which have not been exposed to high temperature can be handled normally.

Illustrations

Colors used in illustrations

Most illustrations include a highlighted component which is secured by a bolt or similar as part of a (light gray) engine or transmission.



P0022106

- 1 Highlighted components (blue)
- 2 Fastener (red)
- 3 Assembly (light gray)
- 4 Background (white)
- 5 Special Tools (yellow)
- 6 Seals (green)
(as of 06/2018)

Other types of symbols used in the images are divided into the following categories:

- Safety
- Important
- Cleanliness
- Position
- Movement
- Measured value
- Tools
- Chemicals
- Sealant
- Units

03-0 General Specifications

General Tightening Torques

General Tightening Torques

M6	10 Nm
M8	24 Nm
M10	48 Nm
M12	85 Nm
M14	140 Nm
M16	220 Nm

IMPORTANT!

Check screws which are to be re-installed. Damaged bolts with e.g. shear marks under the heads, must be scrapped.

03-2 Specifications, Engine

Type designation	TAD1640GE	TAD1641GE	TAD1642GE	TWD1643GE TWD1644GE TWD1645GE
Power, Prime/Stand-by	Refer to the sales literature			
Torque, Prime/Stand-by	Refer to the sales literature			
Number of cylinders	6	6	6	6
Cylinder diameter mm (inches)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke, mm (inches)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Cylinder volume, liters (inch ³)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight dry, kg (lbs)	1440 (3175)	1440 (3175)	1480 (3263)	1700 (3748)
Weight wet, kg (lbs)	1510 (3329)	1510 (3329)	1550 (3417)	1770 (3902)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	17.5:1	16.5:1	16.5:1	16.5:1
Low idle, rpm	900	900	900	900
High idle, rpm	1500/1800	1500/1800	1500/1800	1500/1800

Type designation	TWD1652GE, TWD1653GE	TWD1663GE, TWD1672GE, TWD1673GE	TAD1650GE	TAD1651GE
Power, Prime/Stand-by	Refer to the sales literature			
Torque, Prime/Stand-by	Refer to the sales literature			
Number of cylinders	6	6	6	6
Cylinder diameter mm (inches)	144 (5.67)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke, mm (inches)	165 (6.50)	165 (6.50)	165 (6.50)	165 (6.50)
Cylinder volume, liters (inch ³)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight dry, kg (lbs)	1700 (3748)	1700 (3748)	1440 (3175)	1440 (3175)
Weight wet, kg (lbs)	1770 (3902)	1770 (3902)	1510 (3329)	1510 (3329)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	16.5:1	16.5:1	16.5:1	16.5:1
Low idle, rpm	900	900	900	900
High idle, rpm	1,500	1800	1500/1800	1500/1800

Type designation	TAD1641VE	TAD1642VE, TAD1643VE	TAD1650VE
Power, Prime/Stand-by	Refer to the sales literature		
Torque, Prime/Stand-by	Refer to the sales literature		
Number of cylinders	6	6	6
Cylinder diameter mm (inches)	144 (5.67)	144 (5.67)	144 (5.67)
Stroke, mm (inches)	165 (6.50)	165 (6.50)	165 (6.50)
Cylinder volume, liters (inch ³)	16.12 (983.9)	16.12 (983.9)	16.12 (983.9)
Weight dry, kg (lbs)	1480 (3263)	1480 (3263)	1425 (3142)
Weight wet, kg (lbs)	1550 (3417)	1550 (3417)	1495 (3296)
Firing order	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
Compression ratio	17.5:1	17.5:1	18.0:1
Low idle, rpm	600	600	700
High idle, rpm	1800	1800	1800-2000

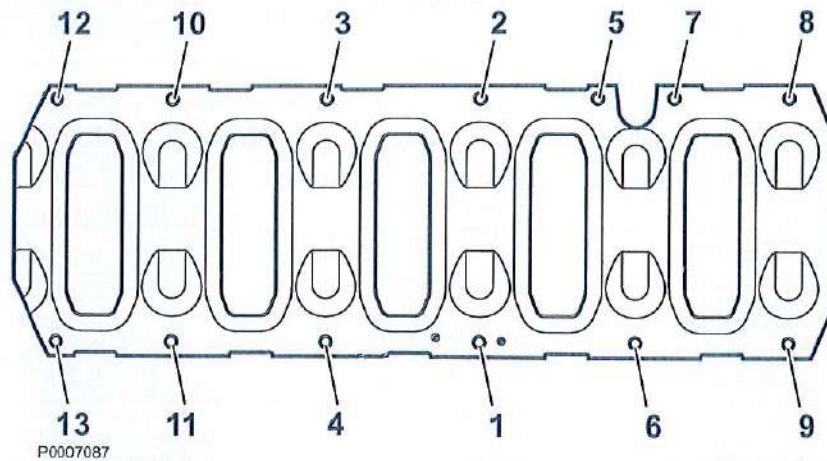
Type designation	TAD1640-43VE-B, TAD1650VE-B, TAD1651VE, TAD1660-62VE, TAD1670-72VE
Power, Prime/Stand-by	Refer to the sales literature
Torque, Prime/Stand-by	Refer to the sales literature
Number of cylinders	6
Cylinder diameter mm (inches)	144 (5.67)
Stroke, mm (inches)	165 (6.50)
Cylinder volume, liters (inch ³)	16.12 (983.9)
Weight wet, kg (lbs)	1440 (3175)
Firing order	1-5-3-6-2-4
Compression ratio	16.8:1
Low idle, rpm	700
High idle, rpm	1900

Special Tightening Torques

Group 21 - Engine

Front engine mounting, engine block	220 ± 35 Nm (162.3 ± 25.8 lbf ft)
Front engine mounting	220 ± 35 Nm (162.3 ± 25.8 lbf ft)
Rear engine mounting, flywheel housing	220 ± 35 Nm (162.3 ± 25.8 lbf ft)
Main bearing caps	
step 1	300 ± 20 Nm (221.3 ± 14.75 lbf ft)
stage 2	120° ± 5° angle tightening
Big end bearing cap	
step 1	20 ± 3 Nm (14.75 ± 2.21 lbf ft)
stage 2	60 ± 5 Nm (44.25 ± 3.69 lbf ft)
stage 3	90° ± 5° angle tightening

Stiffening Frame



NOTICE! Tighten the bolts in the order illustrated.

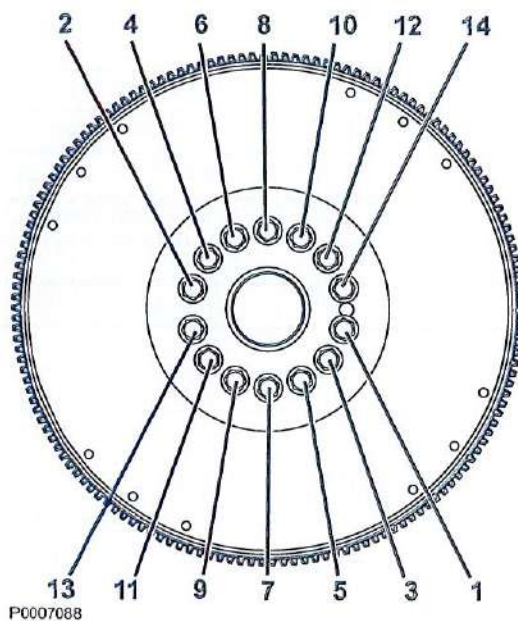
step 1

$65 \pm 5 \text{ Nm}$ ($47.9 \pm 3.69 \text{ lbf ft}$)

stage 2

$60^\circ \pm 5^\circ$ angle tightening

Flywheel

**IMPORTANT!**

Make sure the flange is clean and dry.

NOTICE! Tighten the bolts in the order illustrated.

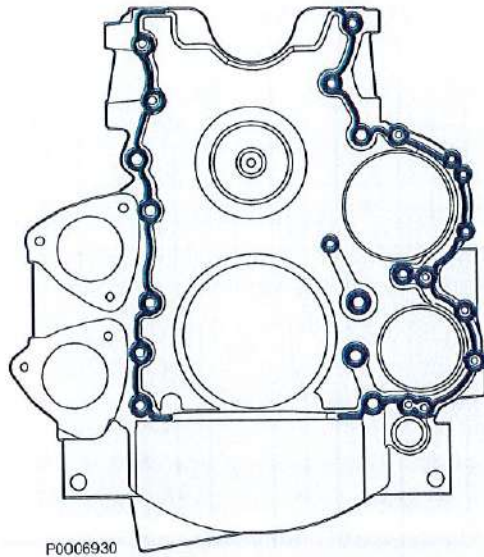
step 1

$60 \pm 5 \text{ Nm}$ ($44.25 \pm 3.69 \text{ lbf ft}$)

stage 2

$120^\circ \pm 10^\circ$ angle tightening

Flywheel Housing



P0006930

NOTICE! Apply 2 mm (0.08") silicone (part # 1161231 and 1161277) as illustrated.

stage 1: Torque all M14 screws to

160 ± 20 Nm (118.0 ± 14.75 lbf ft)

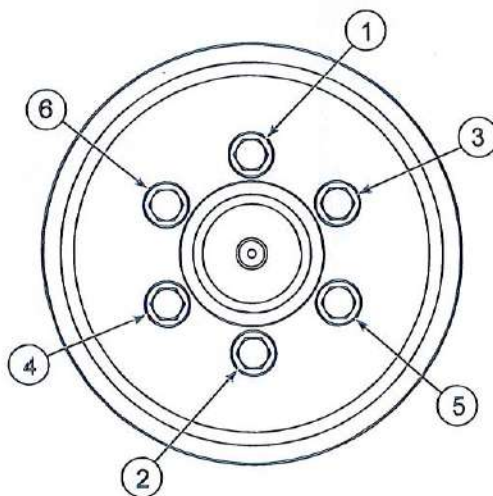
stage 2: Torque all M10 bolts to

48 ± 8 Nm (35.4 ± 5.9 lbf ft)

stage 3: Torque all M8 bolts to

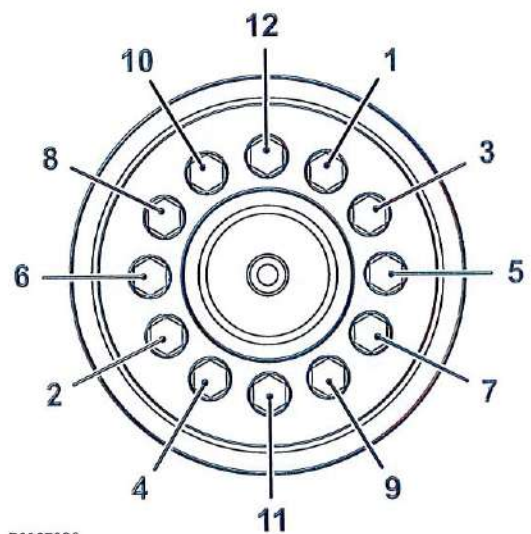
24 ± 4 Nm (17.7 ± 2.95 lbf ft)

Vibration Damper, Crankshaft



P0007089

NOTICE! Tighten the bolts in the order illustrated.



P0007090

Single vibration dampers: 90 ± 10 Nm (66.38 ± 7.38 lbf ft)

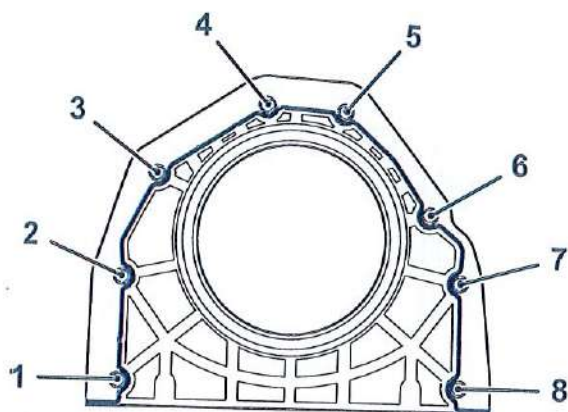
Double vibration dampers:

Stage 1: 35 Nm (25.8 lbf ft)

Stage 2: 125 Nm (92.2 lbf ft)

NOTICE! The 8.8 bolts on the oscillation damper may not be re-used.

Cover, crankshaft seal



P0007091

NOTICE! Apply 2 mm (0.08") silicone (part # 1161231 and 1161277) as illustrated.

stage 1: Tighten all bolts by hand.

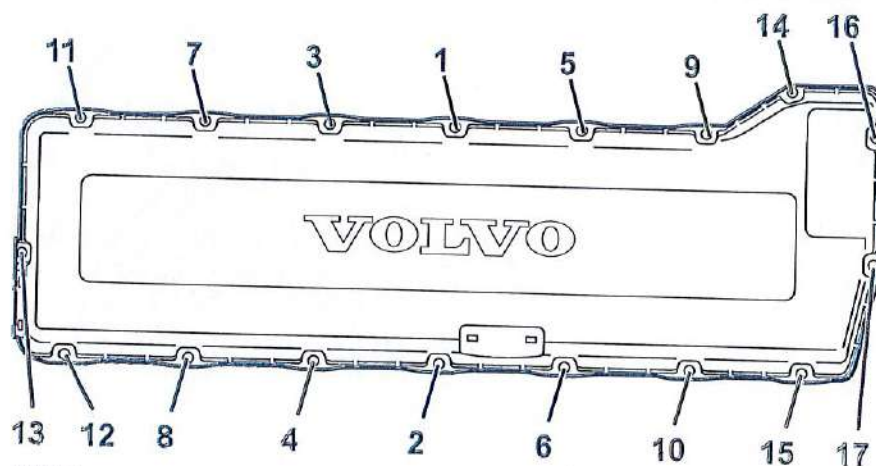
stage 2: Torque the bolts to 2 and 7

$24 \pm 4 \text{ Nm}$ ($17.7 \pm 2.95 \text{ lbf ft}$)

stage 3: Torque the remaining bolts to

$24 \pm 4 \text{ Nm}$ ($17.7 \pm 2.95 \text{ lbf ft}$)

Valve Cover

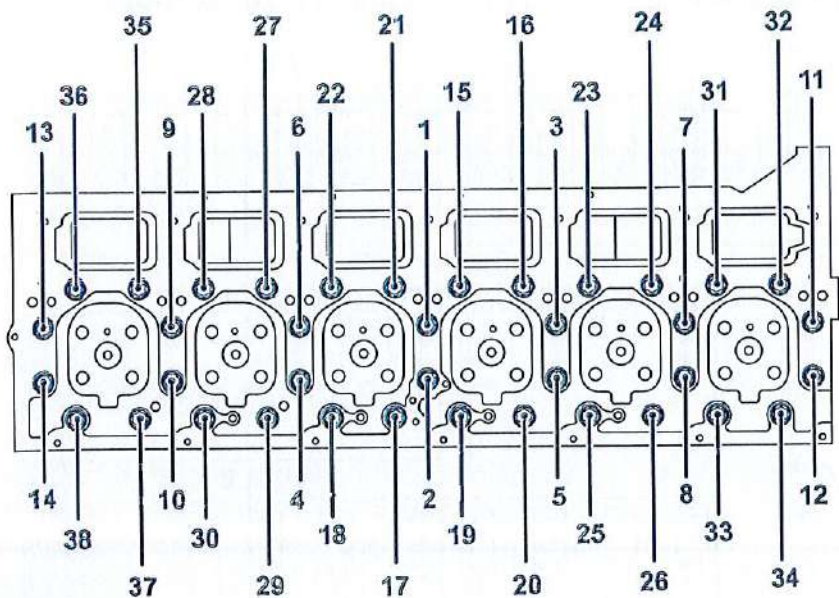


P0007092

NOTICE! Tighten the bolts in the order illustrated.

$25 \pm 3 \text{ Nm}$ ($18.44 \pm 2.21 \text{ lbf ft}$)

Cylinder head

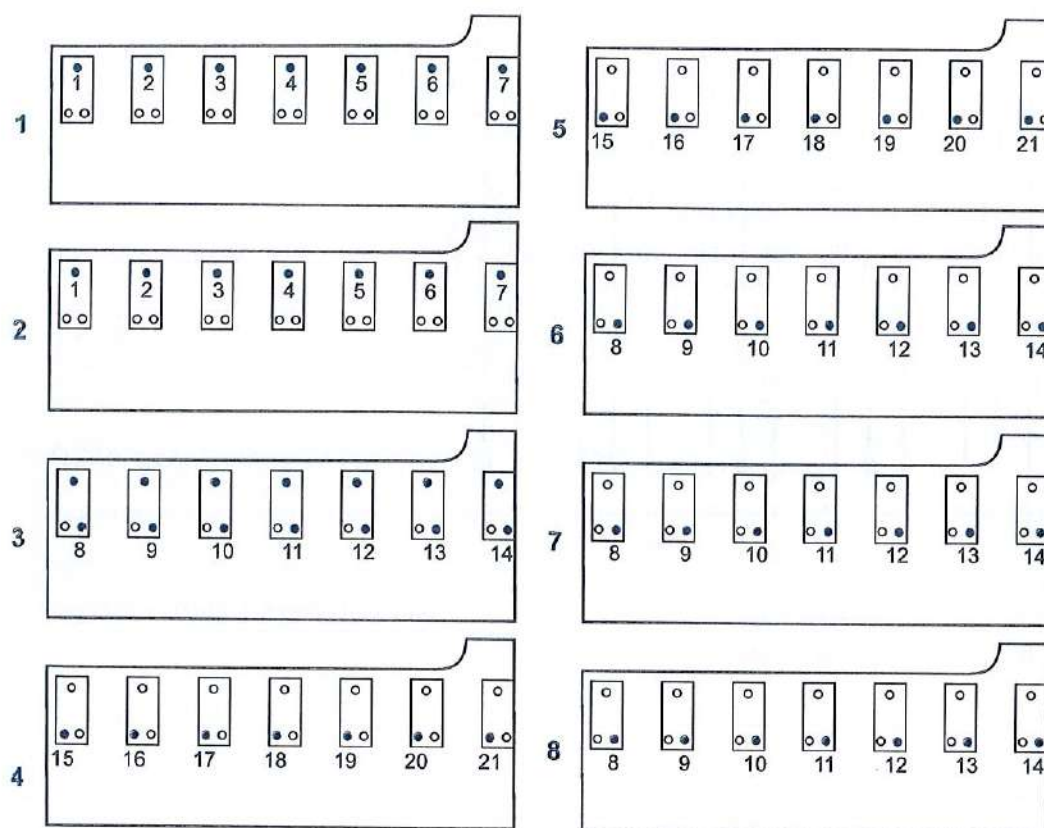


P0007093

NOTICE! Tighten the bolts in the order illustrated.

step 1	60 + 10 / – 0 Nm (44.25 + 7.38 / – 0 lbf ft)
stage 2	90° ± 5° angle tightening
stage 3	90° ± 5° angle tightening

Bearing Caps, Camshaft/Rocker Arm Shaft, thru engine no. 2016010024,



P0007094

IMPORTANT!

Tighten the screws in stages to make sure the rocker arm shaft is lowered without being bent.

step 1: Tighten bolts 1-7.

step 2: Tighten bolts 1-7.

step 3: Tighten bolts 8-14. Start with screw 11

step 4: Tighten bolts 15 through 21

step 5: Tighten bolts 15 through 21

step 6: Loosen bolts 8 through 14.

step 7: Tighten bolts 8 through 14

step 8: Tighten bolts 8 through 14

$15 \pm 3 \text{ Nm}$ ($11.06 \pm 2.21 \text{ lbf ft}$)

$90^\circ \pm 5^\circ$ angle tightening

$100 \pm 10 \text{ Nm}$ ($73.76 \pm 7.38 \text{ lbf ft}$)

$50 \pm 5 \text{ Nm}$ ($36.88 \pm 3.69 \text{ lbf ft}$)

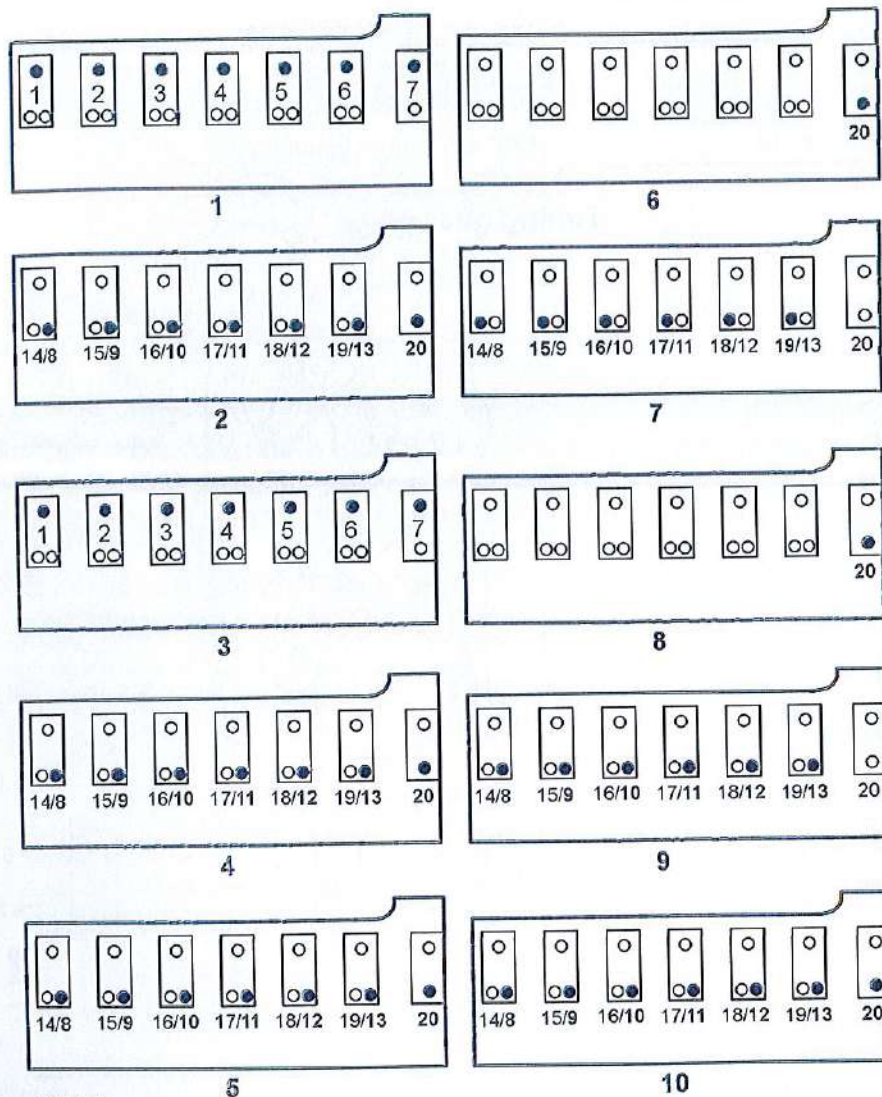
$120^\circ \pm 5^\circ$ angle tightening

—

$50 \pm 5 \text{ Nm}$ ($36.88 \pm 3.69 \text{ lbf ft}$)

$120^\circ \pm 5^\circ$ angle tightening

Bearing Caps, Camshaft/Rocker Arm Shaft, as of engine no. 2016010025



P0005233

P0005233

IMPORTANT!

Tighten the bolts in stages to ensure that the rocker arm shaft bottoms against the bearing housing without bending.

Camshaft (camshaft and bearing caps in place)

Fit a drift to no. 7 bearing bracket (to protect the guide sleeve).

step 1: Tighten bolt 1–7, tightening sequence 4, 3, 5, 2, 6, 1, 7

step 2: (with shorter extra bolts). Tighten bolts 8 through 13

step 3: Angle tighten screws 1 through 7

Remove the extra bolts (8-13). Remove the drift from no. 7's bearing seat.

Rocker arm shaft (rocker arm shaft in place).

step 4: Tighten bolts 8-13 **incrementally** in the sequence 11, 10, 12, 9, 13, 8

If the rocker arm shaft has been loosened or removed, only the bolts that hold the shaft must be tightened in accordance with the chart on re-assembly.

$40 \pm 3 \text{ Nm}$ ($29.5 \pm 2.21 \text{ lbf ft}$)

$100 \pm 10 \text{ Nm}$ ($73.76 \pm 7.38 \text{ lbf ft}$)

$90^\circ \pm 5^\circ$ angle tightening

$100 \pm 10 \text{ Nm}$ ($73.76 \pm 7.38 \text{ lbf ft}$)

step 5: Tighten bolts 14 through 19

step 6: Tighten bolt 20

step 7: Angle tighten bolts 14–19

step 8: Angle tighten bolt 20

Loosen bolts 8 through 13.

step 9: Tighten bolts 8-13

step 10: Angle tighten bolts 8 through 13

50 ± 5 Nm (36.88 ± 3.69 lbf ft)

60 ± 5 Nm (44.25 ± 3.69 lbf ft)

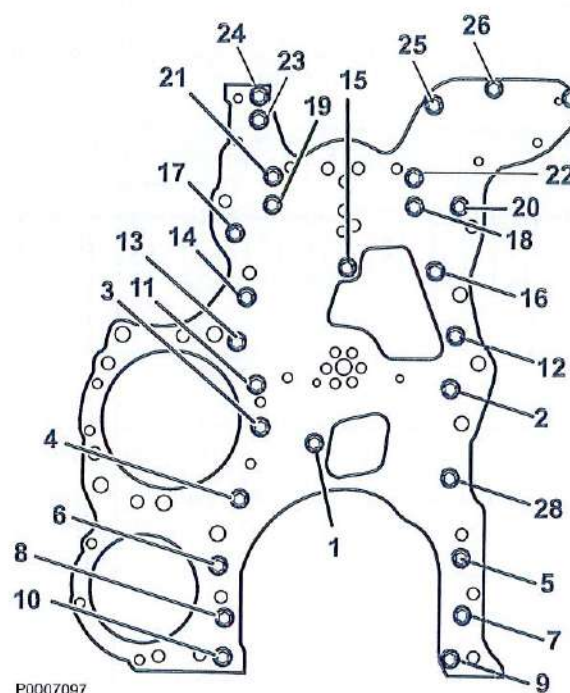
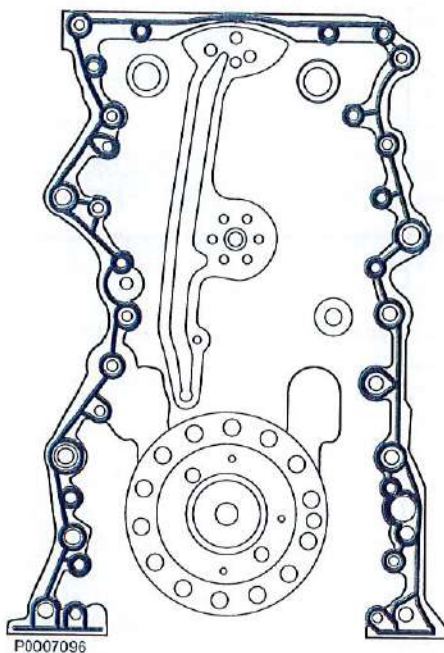
$120^\circ \pm 5^\circ$ angle tightening

$100^\circ \pm 5^\circ$ angle tightening

50 ± 5 Nm (36.88 ± 3.69 lbf ft)

$120^\circ \pm 5^\circ$ angle tightening

Timing gear plate



NOTICE! Apply 2 mm (0.08") silicone (part # 1161231 and 1161277) at the rear of the engine as illustrated.

NOTICE! Tighten the bolts in the order illustrated.

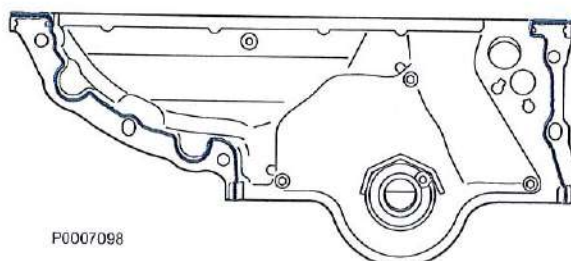
Screws 1–27,

Bolt 28,

28 ± 4 Nm (20.65 ± 2.95 lbf ft)

60 ± 8 Nm (44.25 ± 5.90 lbf ft)

Timing gear cover, top

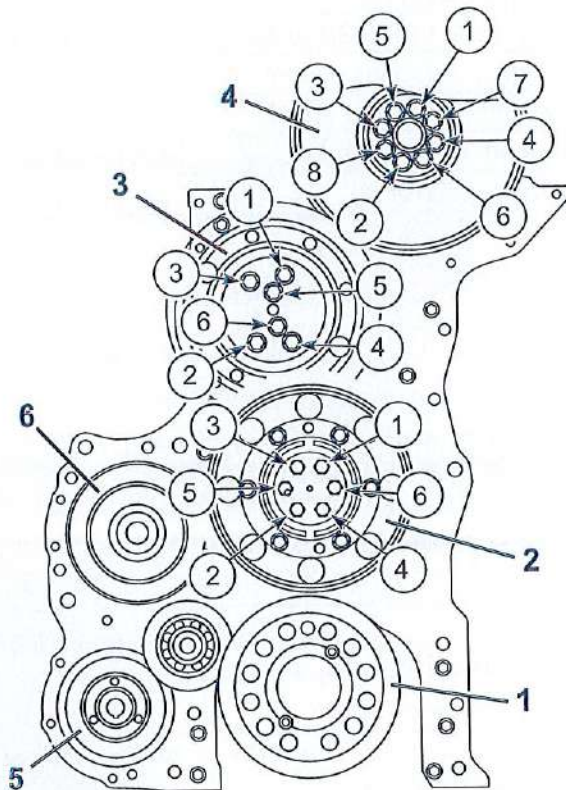


NOTICE! Apply 2 mm (0.08") silicone (part # 1161231 and 1161277) as illustrated.

Tightening torque

24 ± 4 Nm (17.7 ± 2.95 lbf ft)

Transmission



P0007099

1 Drive gear, crankshaft

step 1

 $60 \pm 5 \text{ Nm}$ ($44.25 \pm 3.69 \text{ lbf ft}$)

stage 2

 $120^\circ \pm 10^\circ$ angle tightening**2 Idler wheel, double drive, outer**

Tighten the bolts in the order illustrated.

step 1

 $45 \pm 5 \text{ Nm}$ ($33.19 \pm 3.69 \text{ lbf ft}$)

stage 2

 $90^\circ \pm 5^\circ$ angle tightening**3 Intermediate gear, adjustable**

Tighten the bolts in the order illustrated.

step 1

 $35 \pm 4 \text{ Nm}$ ($25.81 \pm 2.95 \text{ lbf ft}$)

stage 2

 $120^\circ \pm 5^\circ$ angle tightening**4 Drive gear, camshaft**

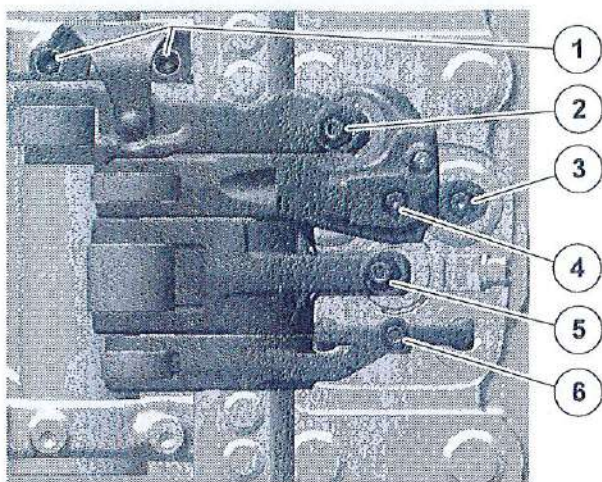
Tighten the bolts in the order illustrated.

step 1

 $45 \pm 5 \text{ Nm}$ ($33.19 \pm 3.69 \text{ lbf ft}$)

stage 2

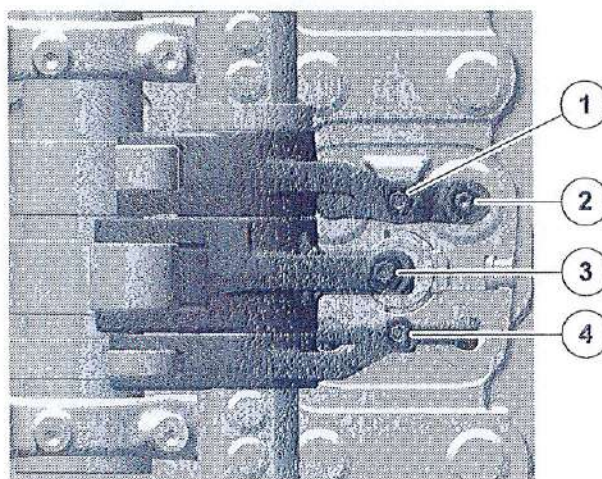
 $90^\circ \pm 5^\circ$ angle tightening**5 Drive gear, power steering and fuel feed pump** $100 \pm 10 \text{ Nm}$ ($73.76 \pm 7.38 \text{ lbf ft}$)**6 Drive gear, air compressor** $200 + 50 / - 0 \text{ Nm}$ ($147.51 + 36.88 / - 0 \text{ lbf ft}$)



P0016365

Valve mechanism, VCB / EGR

Bolt, leaf spring (1)	25 Nm (18.4 lbf. ft.)
Adjustment, VCB/EGR rocker (2)	52 Nm (38.4 lbf. ft.)
Adjustment, exhaust tappet (3)	38 Nm (28.0 lbf. ft.)
Adjustment, exhaust (4)	38 Nm (28.0 lbf. ft.)
Pre-load, injector (5)	52 Nm (38.4 lbf. ft.)
Adjustment, inlet (6)	38 Nm (28.0 lbf. ft.)



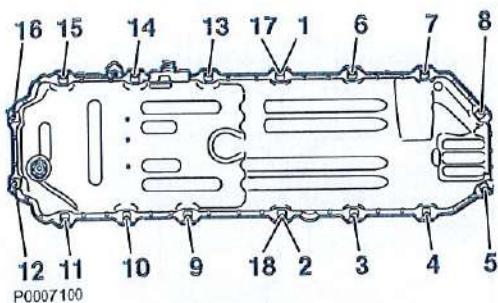
P0016366

Valve mechanism, standard

Adjustment, exhaust (1)	38 Nm (28.0 lbf. ft.)
Adjustment, exhaust tappet (2)	38 Nm (28.0 lbf. ft.)
Pre-load, injector (3)	52 Nm (38.4 lbf. ft.)
Adjustment, inlet (4)	38 Nm (28.0 lbf. ft.)

Group 22 - Lubrication System

Oil Sump



NOTICE! Tighten the bolts in sequence, as illustrated.

$24 \pm 4 \text{ Nm}$ ($17.7 \pm 2.95 \text{ lbf ft}$)

Oil pump

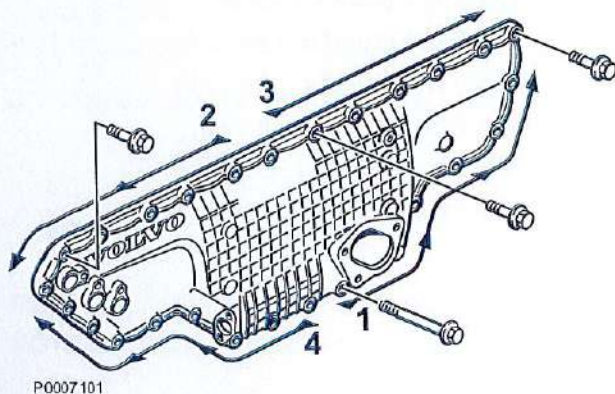
stage 1

$35 \pm 3 \text{ Nm}$ ($25.81 \pm 2.21 \text{ lbf ft}$)

stage 2 (not 17 and 18)

$90^\circ \pm 5^\circ$ angle tightening

Oil cooler, retaining bolts



NOTICE! Tighten the bolts in sequence, as illustrated.

$24 \pm 4 \text{ Nm}$ ($19.91 \pm 2.95 \text{ lbf ft}$)

Oil pressure pipe

stage 1

tighten to zero play

stage 2

pipe diameter $\varnothing 12$

$80 \pm 10 \text{ Nm}$ ($59.00 \pm 7.38 \text{ lbf ft}$)

pipe diameter $\varnothing 18$

$110 \pm 10 \text{ Nm}$ ($81.13 \pm 7.38 \text{ lbf ft}$)

pipe diameter $\varnothing 20$

$130 \pm 10 \text{ Nm}$ ($95.88 \pm 7.38 \text{ lbf ft}$)

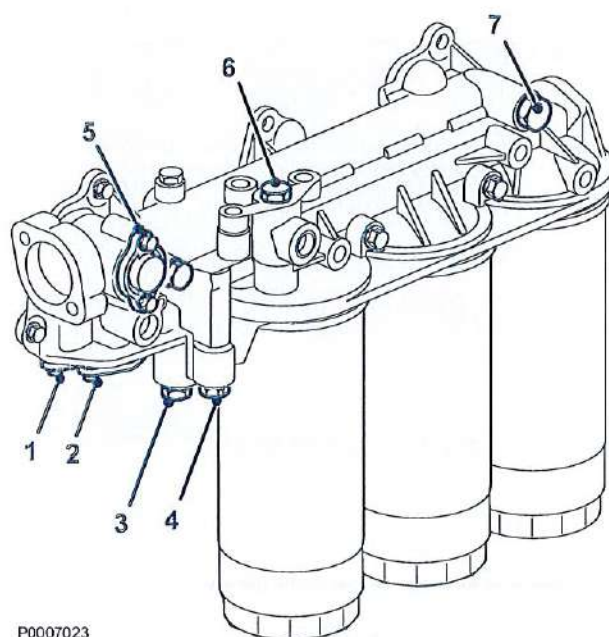
pipe diameter $\varnothing 22$

$170 \pm 10 \text{ Nm}$ ($125.39 \pm 7.38 \text{ lbf ft}$)

pipe diameter $\varnothing 28$

$200 \pm 10 \text{ Nm}$ ($147.51 \pm 7.38 \text{ lbf ft}$)

Oil Valves



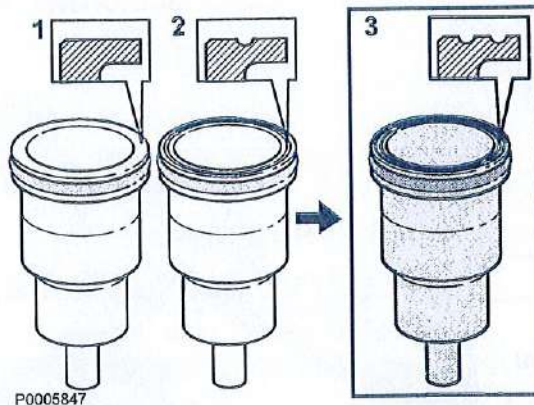
P0007023

1	Safety valve, lubricating oil pump	$10 \pm 2 \text{ Nm}$ ($7.39 \pm 1.48 \text{ lbf ft}$)
2	Reducing valve	$10 \pm 2 \text{ Nm}$ ($7.39 \pm 1.48 \text{ lbf ft}$)
3	Control valve, piston cooling	$55 \pm 5 \text{ Nm}$ ($40.57 \pm 3.69 \text{ lbf ft}$)
4	Opening valve, piston cooling	$55 \pm 5 \text{ Nm}$ ($40.57 \pm 3.69 \text{ lbf ft}$)
5	Overflow valve, oil cooler	$10 \pm 2 \text{ Nm}$ ($7.39 \pm 1.48 \text{ lbf ft}$)
6	Overflow valve, bypass filter	$12 \pm 2 \text{ Nm}$ ($8.85 \pm 1.48 \text{ lbf ft}$)
7	Overflow valve, full flow filter	$55 \pm 5 \text{ Nm}$ ($40.57 \pm 3.69 \text{ lbf ft}$)

Group 23 - Fuel System

Feed pump – steering servo pump

$25 \pm 2 \text{ Nm}$ ($18.44 \pm 1.48 \text{ lbf ft}$)



- 1 Copper sleeve, earlier model
- 2 Copper sleeve, earlier model (only ever available as factory fit, not as spare part)
- 3 Copper sleeve, new model

Fixing yoke, unit injector (new or re-used copper sleeve type 3)

IMPORTANT!

Always use a **new** steel gasket beneath the unit injector.

First tightening

stage 1

$20 \pm 5 \text{ Nm}$ ($14.75 \pm 3.69 \text{ lbf ft}$)

stage 2

$180^\circ \pm 5^\circ$ angle tightening

NOTICE! Loosen the fixing yoke bolt before doing the second tightening.

Second tightening

stage 1

$20 \pm 5 \text{ Nm}$ ($14.75 \pm 3.69 \text{ lbf ft}$)

stage 2

$90^\circ \pm 5^\circ$ angle tightening

Fixing yoke, unit injector (re-used copper sleeve, types 1 or 2)

NOTICE! The steel gasket must **never** be used under the unit injector.

stage 1

$20 \pm 5 \text{ Nm}$ ($14.75 \pm 3.69 \text{ lbf ft}$)

stage 2

$60^\circ \pm 5^\circ$ angle tightening

Locknut for adjuster screw, unit injector

stage 1

tighten until it contacts

stage 2

$45^\circ \pm 5^\circ$ angle tightening

Lock nut, valve adjusting

stage 1

tighten until it contacts

stage 2

$60^\circ \pm 5^\circ$ angle tightening

Hollow bolt M16x1.5

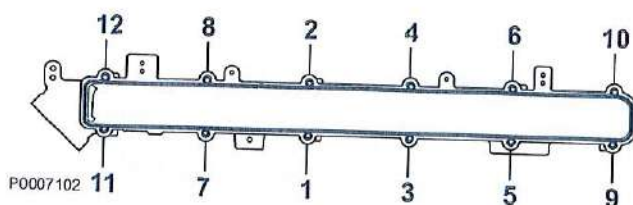
$50 \pm 8 \text{ Nm}$ ($36.88 \pm 5.90 \text{ lbf ft}$)

Hollow bolt M10x1

$25 \pm 4 \text{ Nm}$ ($18.44 \pm 2.95 \text{ lbf ft}$)

Group 25 - Inlet and Exhaust System

Intake manifold



Stage 1: Tighten the bolts 1-12 until contact

max. 10 Nm (7.38 lbf ft)

Stage 2: Tighten the bolts 1-12

24 ± 4 Nm (17.7 ± 2.95 lbf ft)

NOTICE! Apply a 2 mm (approx 0.08") bead of sealing compound 1161231-4, as illustrated.

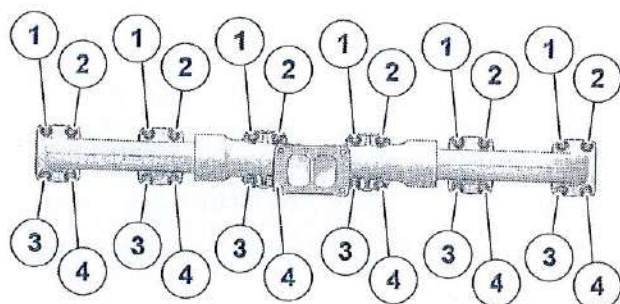
Plug, M10

20 ± 3 Nm (14.75 ± 2.21 lbf ft)

Pressure/temperature sensor, charge air

12 ± 2 Nm (8.85 ± 1.48 lbf ft)

Exhaust Manifold



P0007103

Stage 1: Tighten the bolts (1-4-2-3) until contact

max. 10 Nm (7.4 lbf ft)

Stage 2: Tighten the bolts (1-4-2-3)

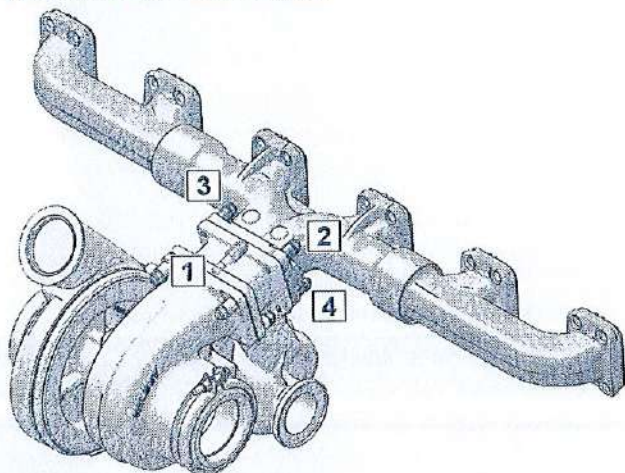
40 Nm (29.5 lbf ft)

Stage 3: Tighten the bolts (1-4-2-3)

54 Nm (39.8 lbf ft)

item

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE



P0018887

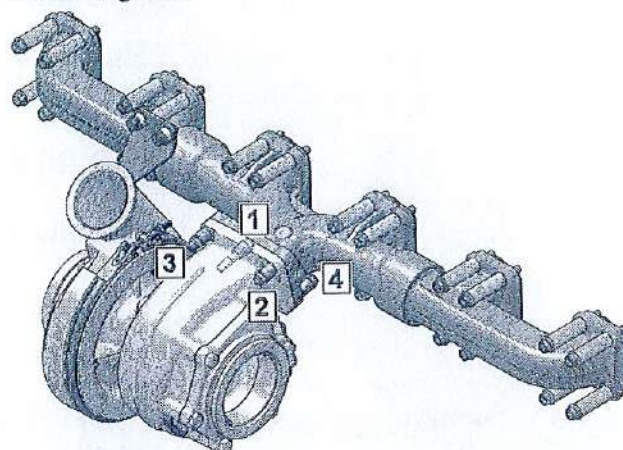
Turbocharger – exhaust manifold

Stage 1: Tighten the nuts diagonally.

Stage 2: Tighten the nuts diagonally.

Turbo

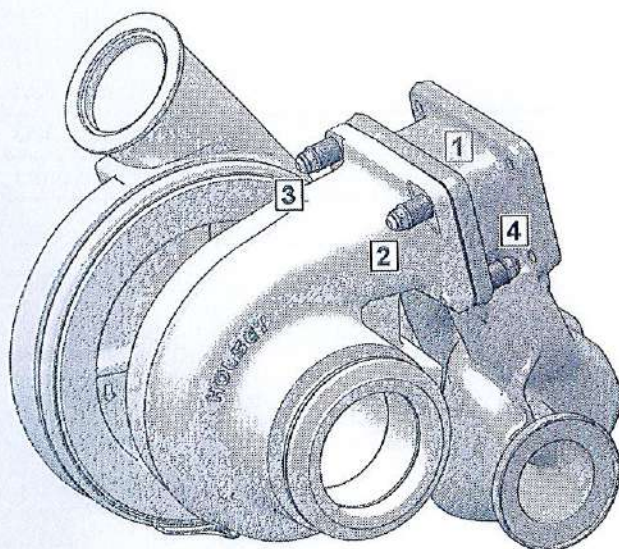
Other engines



P0018895

20 Nm (14.8 lbf ft)

55 Nm (40.6 lbf ft)



P0018906

Turbocharger – wastegate valve housing (TWD only)

Stage 1: Tighten the nuts diagonally.

Stage 2: Tighten the nuts diagonally.

20 Nm (14.8 lbf ft)

55 Nm (40.6 lbf ft)

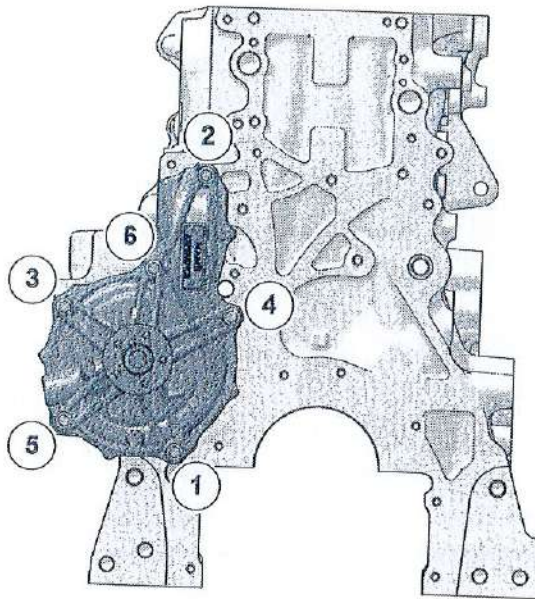
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1672GE, TWD1673GE

Dosing unit:

Tightening torque: 8 Nm (5.9 lbf. ft.)

Group 26 - Cooling System

Tightening sequence 1-6 24 Nm (17.7 lbf. f)



P0020409

7 lbf. ft.)

Engine

Technical Data

Engine body

Cylinder block

Length	1156 mm (45.512"),
Height, upper block plane - crankcase centerline	453 mm (17.835")
Height lower block plane - crankcase centerline	120 mm (4.724")
Crankcase pressure, normal value, irrespective of engine speed	max 0.5 kPa

Cylinder head

Type	6 cyl.
Length	1194 mm (47.008"),
Width	438 mm (17.244 in)
Height	135 mm (5.315 in)
Max. unevenness (bottom plane) ⁽¹⁾	0.02 mm (0.000787 in)

¹⁾ per 100 mm (3.937") measured length

Cylinder head bolts, Change

Number of bolts	38,
Dimension, thread	M18
Length	188 mm (7.402"),

Cylinder Liner

Type	Wet, replaceable
Height, total	288 mm (11.339"),
Sealing surface height above block plane	0.15–0.21 mm (0.00591–0.00827")
Quantity of seal rings per cylinder liner	3
Cylinder bore	144.00–144.02 mm (5.669–5.670 in)

Piston

Type	aluminum
Height above engine block plane	0.15–0.65 mm (0.00591–0.0256 in)
Diameter, combustion chamber	98 mm (3.858 in)
Depth, piston bowl:	
TAD1640GE, TAD1641-43VE, TAD1650VE, TAD1660-62VE, TAD1640-43VE-B, TAD1670-72VE, TAD1650VE-B, TAD1651VE	19.35 mm (0.762 in)
TAD1641-42GE, TAD1650-51GE, TWD1643GE, TWD1644GE, TWD1645GE, TWD1652GE, TWD1653GE, TWD1663GE, TWD1672-73GE	21.15 mm (0.883 in)

Number of piston ring grooves	3
Front marking	Arrow towards front
Gudgeon pin diameter	63 mm (2.480")

Piston rings

Compression Rings

Quantity	2
Piston ring clearance in groove:	
upper compression ring	—
lower compression ring	0.07 mm (0.00276"), wear tolerance 0.1 mm (0.00394")
Piston ring gap, measured at ring opening:	
upper compression ring	0.62 mm (0.0244"), wear tolerance 0.85 mm (0.0335")
lower compression ring	1.1 mm (0.0433"), wear tolerance 1.35 mm (0.0531")

Oil ring

Quantity	1
Width, including spring	4.55 mm (0.179 in) 0.04 mm (0.00157"), wear tolerance 0.1 mm (0.00394")
Piston ring clearance in groove	0.55 mm (0.0217"), wear tolerance 0.9 mm (0.0354")
Piston ring gap, measured at ring opening	

Valve mechanism

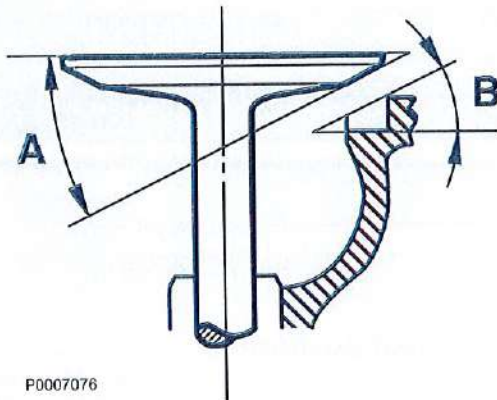
Valves

Valve head, diameter:

Inlet	49 mm (1.929")
Outlet	46 mm (1.811")

Valve stem, diameter:

Inlet	10 mm (0.394")
Outlet	10 mm (0.394")



Valve seat angle (A):

Inlet	19.5°
Outlet	44.5°

Serial no: ≤ 2016010024:	Serial no: ≥ 2016010025:
-----------------------------	-----------------------------

19.5°	24.5°
44.5°	44.5°

Seat angle in cylinder head (B):

Inlet	20°
Outlet	45°

Serial no: ≤ 2016010024:	Serial no: ≥ 2016010025:
-----------------------------	-----------------------------

20°	25°
45°	45°

Dimension between valve head and cylinder head plane:

Inlet	0.9–1.4 mm (0.0354–0.0551 in)
Wear tolerance	1.5 mm (0.0591 in)
Outlet	1.4–1.9 mm (0.0551–0.0748 in)
Wear tolerance	2.0 mm (0.0787 in)

NOTICE! When replacing valve seats, even the valves must be replaced.

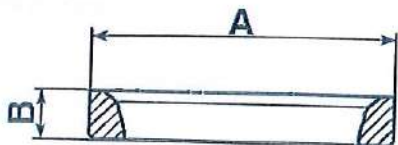
Valve clearance, cold engine, setting value:

Inlet (TWD1663GE, TWD1672-73GE)	0.4 mm (0.0157")
Inlet (other engines)	0.3 mm (0.0118 in)
Outlet	0.6 mm (0.0236")

Valve clearance, cold engine, check value:

Inlet (TWD1663GE, TWD1672-73GE)	0.35–0.45 mm (0.0138–0.0177")
Inlet (other engines)	0.25–0.35 mm (0.00984–0.0138 in)
Outlet	0.55–0.65 mm (0.0217–0.0256 in)

Valve seats



P0007077

External diameter (A)

Standard:

	SN —76468	SN 76469 —
Inlet	52.1 mm (2.051")	52.1 mm (2.051")
Outlet	49.1 mm (1.933")	49.1 mm (1.933")

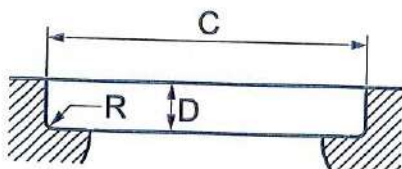
Oversize:

Inlet	52.2 mm (2.055")	52.2 mm (2.055")
Outlet	49.2 mm (1.937")	49.2 mm (1.937")

Height (B):

Inlet	7.7 mm (0.303")	6.1 mm (0.240 in)
Outlet	7.9 mm (0.311")	6.3 mm (0.248 in)

Valve seat position



P0007078

Diameter (C) standard:

	SN —76468	SN 76469 —
Inlet	52.0 mm (2.047")	52.0 mm (2.047")
Outlet	49.0 mm (1.929")	49.0 mm (1.929")

Diameter (C) oversize dimension:

Inlet	52.2 mm (2.055")	52.2 mm (2.055")
Outlet	49.2 mm (1.937")	49.2 mm (1.937")

Depth (D):

Inlet	11.7 mm (0.461")	10.2 ± 0.13 mm (0.402 in)
Outlet	11.7 mm (0.461")	10.2 ± 0.13 mm (0.402 in)

Seat base radius (R):

Inlet	max 0.8 mm (0.0315")	max 0.8 mm (0.0315 in)
Outlet	max 0.8 mm (0.0315")	max 0.8 mm (0.0315 in)

Valve guides

Length:	
Inlet	83.5 mm (3.287")
Outlet	83.5 mm (3.287")
Inner diameter:	
Inlet	10 mm (0.394")
Outlet	10 mm (0.394")
Height above cylinder head spring plane:	
Inlet	24.4 ± 1.0 mm (0.961 ± 0.0394")
Outlet	24.4 ± 1.0 mm (0.961 ± 0.0394")
Clearance, valve stem guide ⁽¹⁾ :	
Inlet	0.025–0.054 mm (0.000984–0.00213 in)
Wear tolerance	max 0.4 mm (0.0157")
Outlet	0.058–0.87 mm (0.00228–0.0343 in)
Wear tolerance	max 0.4 mm (0.0157")

1) The dimensions are calculated for the measurement method described in the workshop manual (Group 21).

Rocker arms

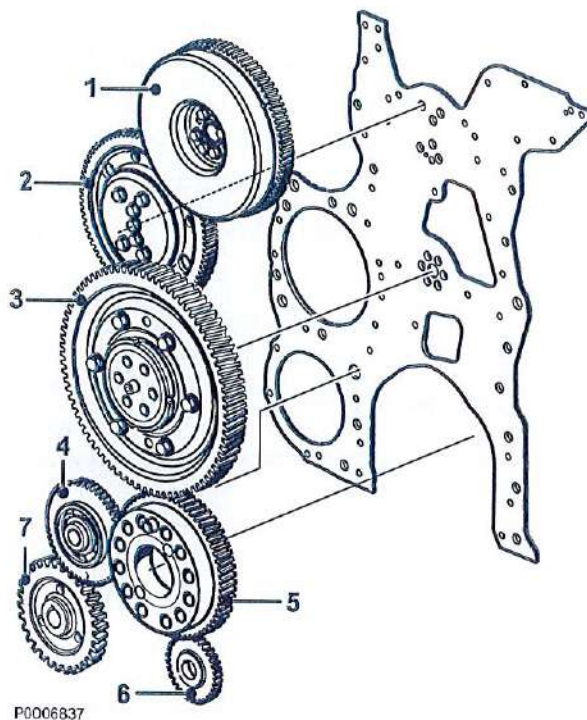
Bearing clearance	max 0.1 mm (0.00394")
Clearance rocker arm roller	max 0.1 mm (0.00394")

Valve spring

Inlet	
Uncompressed length	67.5 mm (2.657")
With load 522 N (117.35 lbf)	57.0 mm (2.244")
With load 1205 N (270.9 lbf)	43.3 mm (1.705")
Coil bound length, max.	40.3 mm (1.587")
Outlet	
Outer valve springs:	
Uncompressed length	69.3 mm (2.728")
With load 930 N (209.1 lbf)	54.0 mm (2.126")
With load 1813 N (430.1 lbf)	39.5 mm (1.555")
Coil bound length, max.	37.0 mm (1.457")
Inner valve spring:	
Uncompressed length	67.0 mm (2.638")
With load 465 N (104.5 lbf)	51.0 mm (2.008")
With load 887 N (199.4 lbf)	36.5 mm (1.437")
Coil bound length, max.	34.0 mm (1.339")

Engine Transmission

Timing gear wheels



P0006837

No. of teeth:

1	Drive gear, camshaft	84
2	Intermediate gear, adjustable	85
3	Intermediate gear, bull drive outer	84
	Intermediate gear, bull drive, inner	56
4	Intermediate gear, servo pump	29
5	Drive gear, crankshaft	63
6	Drive gear, lubrication oil pump	37
7	Drive gear, steering servo and fuel feed pump	36

Gear lash	0.05–0.17 mm (0.00197–0.00669")
Shaft journal, intermediate gear, diameter	Ø 99.97–99.99 mm (3.9358–3.9366")
Intermediate gear bush, diameter	Ø 100.036–100.05 mm (3.9384–3.9390")
Radial clearance for intermediate gear	max. 0.05 mm (0.00197")

Camshaft

Check camshaft setting, cold engine and valve clearance =0.

At a flywheel position of 6° after TDC, the inlet valve must be open 1.4 ± 0.3 mm (0.055 ± 0.012 "). During this check, the timing gear must be turned clockwise, seen from the front, to take up all gear lash.

Drive	gear wheel
No. of bearings	7
NOTICE! Only check values; not for machining.	
Diameter, bearing journals, standard	69.97–70.00 mm (2.755–2.756")
Diameter, bearing journals, undersize dimension:	
0.25 mm (0.00984")	69.72–69.78 mm (2.745–2.747")
0.50 mm (0.01968")	69.47–69.53 mm (2.735–2.737")
0.75 mm (0.02953")	69.22–69.28 mm (2.725–2.728")
Max. end float	0.35 mm (0.0138")
Max permissible ovality (with new bearings)	0.05 mm (0.00197")
Bearing, max. permissible wear on diameter	0.05 mm (0.00197")
Valve lift:	
inlet	13.7 mm (0.539")
exhaust	14.5 mm (0.571")
Permitted wear between base circle and max lift	max. 0.1 mm (0.00394")
Unit injector, stroke	18 mm (0.709")

Camshaft Bearings

Camshaft bearing thickness, standard	1.92 mm (0.0756")
Oversize dimension:	
0.25 mm (0.00984")	2.05 mm (0.0807")
0.50 mm (0.01968")	2.17 mm (0.0854")
0.75 mm (0.02953")	2.30 mm (0.0906")

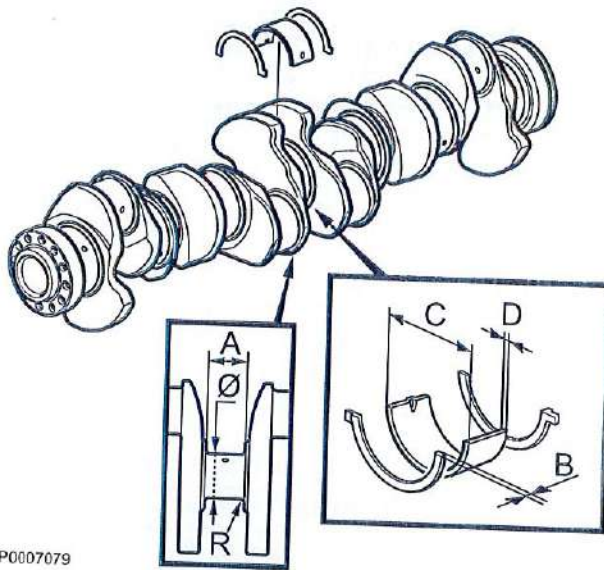
Crank Mechanism

Crankshaft

Length	1,256 mm (49.449")
Crankshaft end float ⁽¹⁾	0.10–0.40 mm (0.0039–0.0157 in)
Ovality of main and big end bearings	max. 0.01 mm (0.000394")
Taper on main and big end bearings	max. 0.02 mm (0.000787")
Runout on center bearing	0.15 mm (0.00591")

1) Dimensions refer to oiled components.

Main bearing journal



P0007079

NOTICE! Only check values; not for machining.

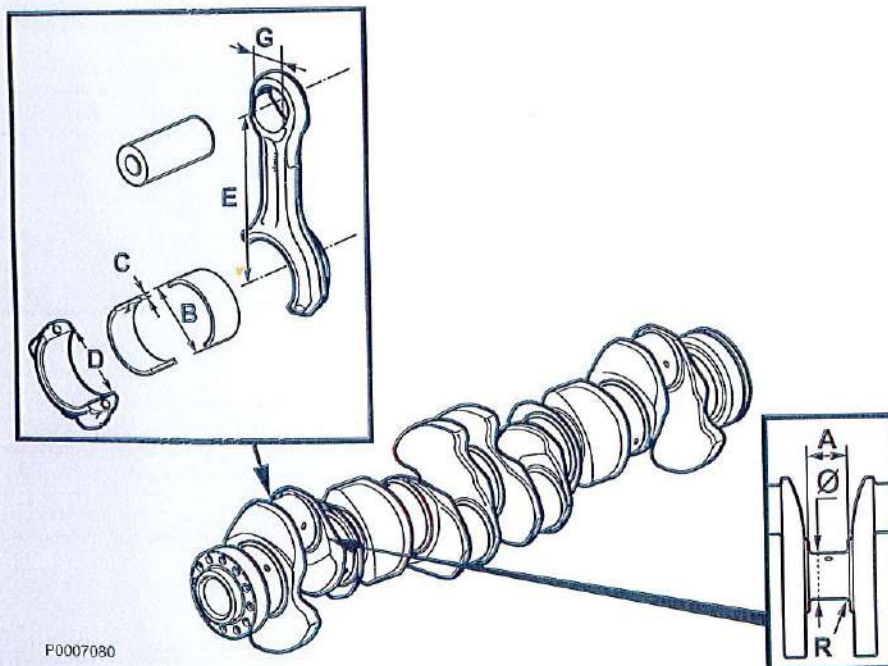
Diameter (Ø) standard	118 mm (4.646")
Undersize dimension:	
0.25 mm (0.00984")	117.75 mm (4.636")
0.50 mm (0.0197")	117.50 mm (4.626")
0.75 mm (0.030")	117.25 mm (4.616")
1.00 mm (0.0394")	117.00 mm (4.606")
1.25 mm (0.0492")	116.75 mm (4.596")
Surface finish, main bearing journal	Ra 0.25 (9.84·10 ⁻⁶ ")
Surface finish, radius	Ra 0.4 (1.575·10 ⁻⁵ ")
Width, thrust bearing journal (A) standard	49.0 mm (1.929")
Oversize dimension:	
0.2 mm (0.00787"), thrust bearing 0.1 mm (0.00394")	49.2 mm (1.937")
0.4 mm (0.01575"), thrust bearing 0.2 mm (0.00787")	49.4 mm (1.945")
0.6 mm (0.02362"), thrust bearing 0.3 mm (0.0118")	49.6 mm (1.953")
Fillet radius (R)	4.5 mm (0.177")

Thrust washers (thrust bearings)

Width (B) standard	3.18 mm (0.1252")
Oversize dimension:	
0.1 mm (0.00394")	3.28 mm (0.1291")
0.2 mm (0.00787")	3.38 mm (0.1331")
0.3 mm (0.0118")	3.48 mm (0.1370")
0.4 mm (0.016")	3.58 mm (0.1409")

Main bearing shells

Outer diameter (C)	123.12 mm (4.847")
Thickness (D) standard	2.51 mm (0.0988")
Oversize dimension:	
0.25 mm (0.00984")	2.64 mm (0.104")
0.50 mm (0.0197")	2.76 mm (0.109")
0.75 mm (0.0295")	2.89 mm (0.114 in)
1.00 mm (0.0394")	3.01 mm (0.119")
1.25 mm (0.0492")	3.14 mm (0.124")
Radial clearance, main bearings	0.07–0.14 mm (0.00276–0.00551")

Big-end bearing journal**NOTICE!** Only check values; not for machining.

Diameter (Ø)	112 mm (4.409")
Undersize dimension:	
0.25 mm (0.00984")	111.75 mm (4.400")
0.50 mm (0.0197")	111.50 mm (4.390")
0.75 mm (0.0295")	111.25 mm (4.380")
1.00 mm (0.0394")	111.00 mm (4.370")
1.25 mm (0.0492")	110.75 mm (4.360")

Surface finish, big end bearing journal	Ra 0.25 ($9.84 \cdot 10^{-6}$ "
Surface finish, radius	Ra 0.4 ($1.575 \cdot 10^{-5}$ "
Width (A)	60 mm (2.362")
Fillet radius (R)	4.5 mm (0.177")

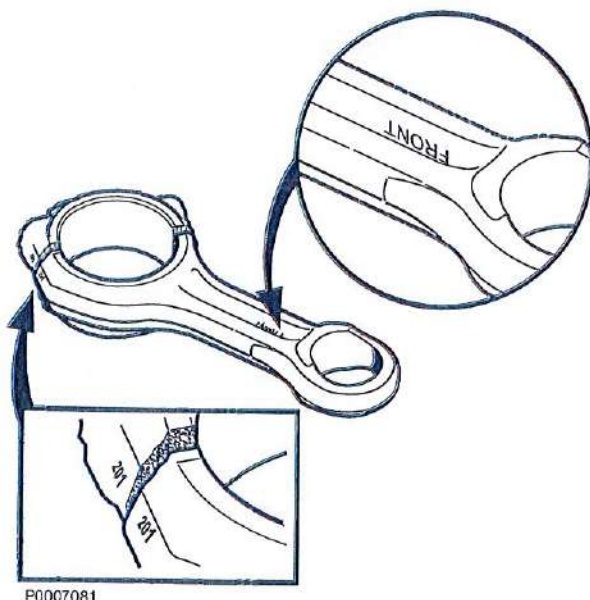
Big-end journal shells

Outer diameter (B)	116.8 mm (4.598")
Thickness (C) standard	2.35 mm (0.0925")
Over-size dimension:	
0.25 mm (0.00984")	2.48 mm (0.0976")
0.50 mm (0.0197")	2.60 mm (0.102")
0.75 mm (0.0295")	2.73 mm (0.107")
1.00 mm (0.0394")	2.85 mm (0.112")
1.25 mm (0.0492")	2.98 mm (0.117")
Diameter, bearing shell seat (D)	116.8 mm (4.598")

Connecting rod

Length, center - center (E)	280 mm (11.024")
Piston pin bush internal diameter (G)	63 mm (2.480")
End float, connecting rod - crankshaft ⁽¹⁾	max. 0.35 mm (0.01378")
Big end bearing, radial clearance ⁽¹⁾ :	max. 0.10 mm (0.00394")
Straightness, max. deviation on 100 mm (3.937") measured length	0.06 mm (0.00236")
Twist, max. deviation on 100 mm (3.937") measured length	0.15 mm (0.00591")

1) Dimensions refer to oiled components.



P0007081

Marking:

"FRONT" on the connecting rod faces forwards.

The connecting rods and caps are marked in pairs, using a three digit serial number (see illustration).

Flywheel, Installed

Runout, measured radius 150 mm (5.905")	max. 0.1 mm (0.00394")
No. of teeth on starter gear ring	153
Sensor grooves in flywheel	54

Flywheel Cover, Installed

Runout for mating face against clutch bellhousing.	max. 0.1 mm (0.00394")
Runout for alignment against clutch bellhousing.	max. 0.05 mm (0.00197")

Lubrication System**Technical Data****Oil****Oil change volume, incl. filter:**

TAD1650VE (optional for TAD1660-62VE, TAD1640-43VE-B, TAD1670-72VE)	53 liter (14.0 US gals)
Other engines	48 liter (12.7 US gals)

Oil Pressure

Operating speed (above 1,100 rpm)	300–650 kPa (43.51–94.27 psi)
Low idle	min 160 kPa (min 23.21 psi)

Oil temperature

Cold engine	Ambient temperature
Hot engine	max 125 °C (257 °F)

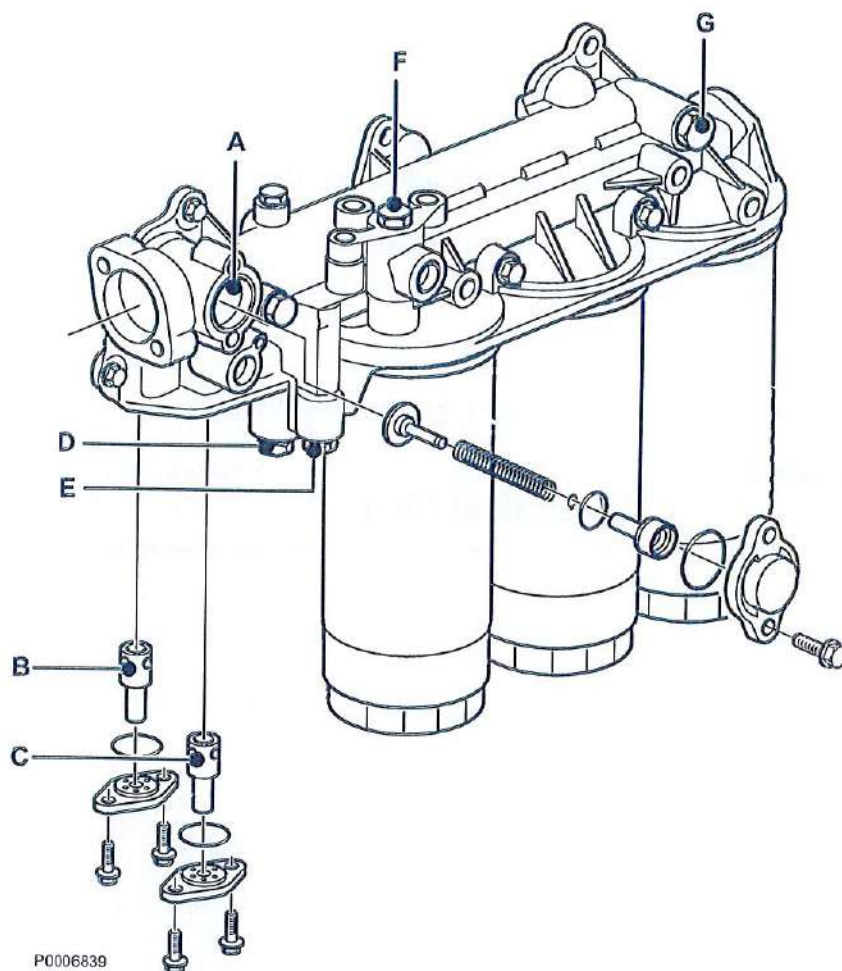
Lube oil pump

Typ	Gear driven
No. of teeth, drive wheel	37
Gear lash	0,05–0,40 mm (0.00197–0.0157 in)

Oil filter

Full flow filters	2
Turbo filter (Bypass filter)	1

Oil Valves



A:	Bypass valve, oil cooler	
	Spring, free length	69 mm (2.717 in)
	Compressed 13–15 N (2.92–3.37 lbf)	40 mm (1.575 in)
B:	Safety valve, lubricating oil pump	
	Marking	Violet
C:	Reduction valve, oil pressure	
	Marking	Blue (not remote oil filter)
D:	Control valve, piston cooling	
	Spring, free length	122 mm (4.803 in)
	Compressed 60 N (13.49 lbf)	84 mm (3.307 in)
E:	Opening valve, piston cooling	
	Spring, free length	122 mm (4.803 in)
	Compressed 95 N (21.36 lbf)	63 mm (2.480 in)
F:	Overflow valve, bypass filter	
	Spring, free length	69 mm (2.717 in)
	Compressed 13–15 N (2.92–3.37 lbf)	40 mm (1.575 in)
G:	Overflow valve, full flow filter	
	Spring, free length	69 mm (2.717 in)
	Compressed 13–15 N (2.92–3.37 lbf)	40 mm (1.575 in)

Fuel System

Technical Data

Feed pump

Feed pressure at:

600 rpm

1,200 rpm

full load

min. 100 kPa (14.5 psi)

min. 300 kPa (43.5 psi)

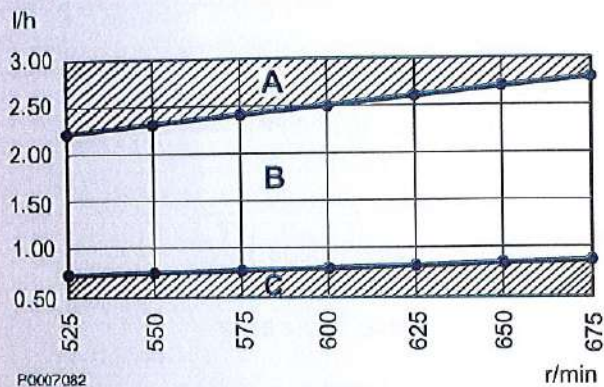
min. 300 kPa (43.5 psi)

Bypass valve

Opening pressure

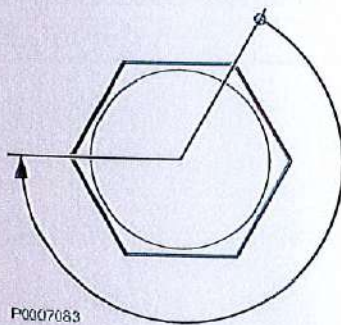
400–550 kPa (58.0–79.8 psi)

Fuel amount



At low idle and with the engine unloaded, the fuel quantity must be inside area B. The engine must be run in at least 600 h.

Unit injectors



Pre-load

Tighten the adjuster screw to zero clearance against the camshaft, then turn 4 flats.

4 flats (0.85 mm (0.0335")); see illustration.

Inlet and Exhaust System

Technical Data

Turbo

**TAD1640-1642GE, TAD1641-1643VE, TAD1660-62VE,
TAD1640-43VE-B, TAD1670-72VE, TAD1650VE-B,
TAD1651VE**

Manufacturer/type

I3K/K29

End float, turbine shaft

max 0.13 mm (0.00512")

TAD1650VE, TAD1650-51GE

Manufacturer/type

Holset/HE551

End float, turbine shaft

max 0.127 mm (0.00500")

**TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652-53GE, TWD1663GE, TWD1672-73GE**

HP Turbo:

Manufacturer/type

Holset/HE551

End float, turbine shaft

max 0.127 mm (0.00500")

LP Turbo:

Manufacturer/type

Holset/HE82

End float, turbine shaft

max 0.152 mm (0.00598")

Inlet temperature indicator

Cold engine

Ambient temperature

Hot engine, coolant temperature 75–95 °C (167–203 °F)

max. 30 °C (86 °F) above ambient temperature

Pressure drop indicator

Pressure drop indicator alarms at an underpressure of

5 kPa (37.5 mm VP) (0.725 psi)

Charge pressure

1500 rpm

TAD1640GE	232 kPa (33.65 psi)
TAD1641GE	240 kPa (34.81 psi)
TAD1643VE-B	335 kPa (48.59 psi)
TWD1644GE, TWD1645GE	426 kPa (61.79 psi)

1500 / 1800 rpm

TAD1642GE	268 kPa (38.87 psi)
TWD1643GE, TWD1663GE	462 kPa (67.01 psi)
TWD1652GE, TWD1653GE	480 kPa (69.62 psi)
TAD1650GE	320 kPa (46.41 psi)
TAD1651GE	264 kPa (38.29 psi)

1800 rpm

TAD1640GE	231 kPa (33.50 psi)
TAD1641GE	252 kPa (36.55 psi)
TAD1641VE	193 kPa (27.99 psi)
TAD1642VE	225 kPa (32.63 psi)
TAD1643VE	230 kPa (33.36 psi)
TAD1650VE	200 kPa (29.01 psi)
TWD1672GE, TWD1673GE	360 kPa (52.21 psi)
TAD1643VE-B	330 kPa (47.86 psi)
TWD1644GE	400 kPa (58.02 psi)
TWD1645GE	416 kPa (60.34 psi)

1900 rpm

TAD1640VE-B, TAD1660VE	170 kPa (24.66 psi)
TAD1641VE-B, TAD1661VE	180 kPa (26.11 psi)
TAD1642VE-B, TAD1662VE, TAD1650VE-B, TAD1651VE	197 kPa (28.57 psi)
TAD1670VE, TAD1671VE	163 kPa (23.64 psi)
TAD1672VE	200 kPa (29.01 psi)

Cooling System

Technical Data

General

75 / 100 kPa
See lid labeling

Thermostat

1

Pressure valve opens at

Quantity

Opening temperature:

TAD1640-42GE, TAD1641-43VE, TAD1650VE,
TAD1650-51GE, TAD1660-62VE, TAD1640-
43VE-B, TAD1650VE-B, TAD1651VE,
TAD1670-72VE

82°C (179.6°F)

TWD1643GE (early model), TWD1663GE (early
model)

76°C (168.8°F)

TWD1643GE (late model), WD1644GE,
TWD1645GE, TWD1652GE, TWD1653GE,
TWD1663GE (late model), TWD1672-73GE

72°C (161.6°F)

Fully open:

TAD1640-42GE, TAD1641-43VE, TAD1650VE,
TAD1650-51GE, TAD1660-62VE, TAD1640-
43VE-B, TAD1650VE-B, TAD1651VE,
TAD1670-72VE

92°C (197.6°F)

TWD1643GE (early model), TWD1663GE (early
model)

86°C (186.8°F)

TWD1643GE (late model), WD1644GE,
TWD1645GE, TWD1652-53GE, TWD1663GE
(late model), TWD1672-73GE

82°C (179.6°F)

Type

Color

Contains

Mix with

Mixture proportions (Conc. coolant/water)⁽¹⁾

Coolant

There are two different types of coolant.

Volvo Penta Coolant

Green

Ethylene glycol and anti-corrosion additives

Water (according to ASTM D4985)

40/60, freezing point -28 °C (-18.4 °F)

Type

Color

Contains

Mix with

Mixing proportions (conc. coolant/water)⁽¹⁾

Volvo Penta Coolant VCS

Yellow

Ethylene glycol and anti-corrosion additives

Water (according to ASTM D4985)

40/60, freezing point -24 °C (-11.2 °F)

1. Volvo Penta recommends "Ready Mixed" coolant.

IMPORTANT!

Under no circumstances mix VCS (yellow) with Volvo Penta Coolant (green) or any other coolant. Engines filled with VCS (yellow) will have yellow decals as external distinguishing features, e.g. the coolant filler cap will be surrounded by a yellow decal.

IMPORTANT!

Industrial engines may not use coolant filters in combination with VCS (yellow); coolant filters will be omitted on new industrial engines filled with VCS (yellow).

Refill quantity

Coolant quantity (engine, radiator and hoses):

TAD1640-42GE, TAD1641-43VE, TAD1650VE,
TAD1650-51GE, TAD1660-62VE, TAD1640-
43VE-B, TAD1670-72VE, TAD1650VE-B,
TAD1651VE

TWD1643GE (early model), TWD1663GE (early
model)

TWD1643GE (late model), WD1644GE,
TWD1645GE, TWD1652-53GE, TWD1663GE
(late model), TWD1672-73GE

60 ± 2 liter (16 ± 0.5 US gallons)

95 liters (25 US gals)

65 liters (17 US gals)

03-3 Specifications, Electrical

Sensor

Charge air pressure sensor

TAD engines:

Check value

1.05–1.12 V at 100 kPa (14.50 PSI)

TWD engines:

Check value

0.81–0.91 V at 100 kPa (14.50 PSI)

Camshaft sensor

Distance to camshaft

1.1 ± 0.4 mm (0.0433 ± 0.0157 ")

Flywheel sensor

Distance to flywheel

1.1 ± 0.4 mm (0.0433 ± 0.0157 ")

Pressure drop indicator

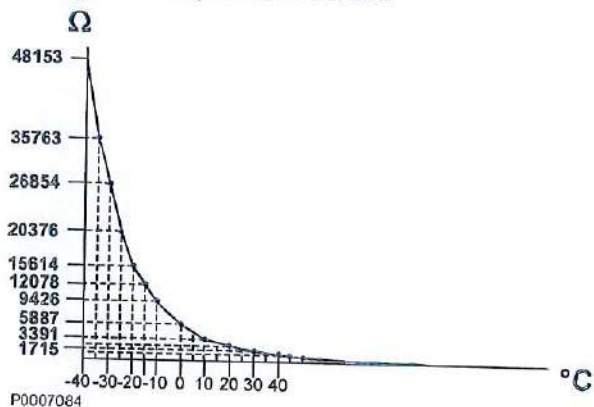
Active

$V = 0.48 \times U_{bat}$

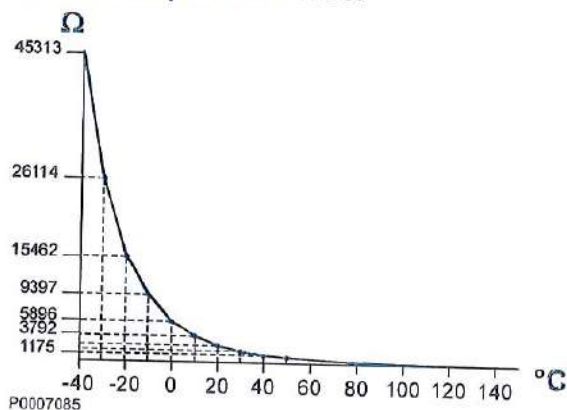
Inactive

$V = 0.12 \times U_{bat}$

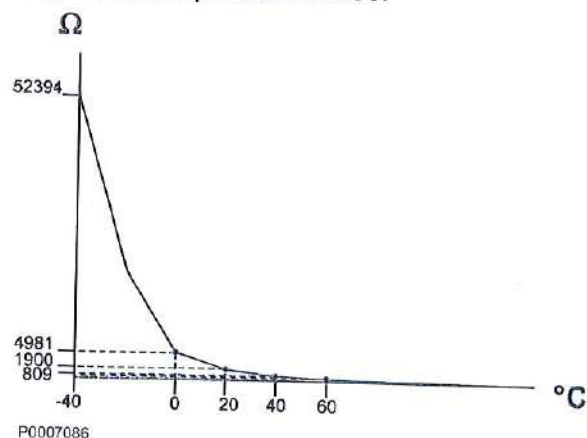
Charge air temperature sensor



Coolant temperature sensor



Engine oil temperature sensor



05-1 Safety Instructions



P0003451

Safety Information

This workshop manual contains repair instructions, descriptions and technical data for products or product drawings from Volvo Penta. Check that you have the correct workshop manual.

Read the safety information below and the section **About this Workshop manual** and **Repair instructions** carefully before beginning any work with repairs or service.



In the workshop manual and on the product, this symbol is used to call your attention to the fact that this is safety information. Always read such information very carefully.

Warning texts in the manual have the following order of priority:

▲ DANGER!

Indicates a hazardous situation, which, if not avoided, result in death or serious injury.

▲ WARNING!

Indicates a hazardous situation, which, if not avoided, could result in death or serious personal injury.

▲ CAUTION!

Indicates a hazardous situation, which, if not avoided, could result in minor or moderate personal injury.

IMPORTANT!

Is used to make you aware of something that may cause minor damage or a minor malfunction to the product or property.

NOTICE! Is used to make you aware of important information that will facilitate the work or operation in progress.



This symbol is used on certain functions to indicate the following:

This operation requires prior theoretical and/or instructor led training before attempting. Contact your local training organization for further information.



This symbol informs you that supplemental information needs to be read. And where necessary information can be found.



This symbol is used when a VODIA computer is needed, either for troubleshooting, testing or programming.

A compilation of safety precautions that must be taken and risks which you must be aware of is presented in the following pages.



Immobilize the engine by turning off the power supply with the main switch(es) and lock it (them) in the off position before starting work. Place a warning notice at the main switch.



Avoid opening the coolant filling cap when engine is hot. Steam or hot coolant may spray out and the system can lose pressure. Open filler cap slowly, and release the pressure in the cooling system if the filler cap or valve has been opened, or if a plug or coolant hose has to be removed while the engine is hot.



As a general rule, all service operations must be carried out with the motor stopped. However, some work, such as adjustments, will require the engine to be running. Approaching a running engine is a safety risk. Remember that loose clothing and long hair can fasten in rotating parts and cause serious personal injury.



Hot oil can cause burn injuries. Avoid exposing your skin to hot oil. Make sure that the lubrication system is not under pressure before any work is begun. Never start or run an engine without the oil filler cap in place. Hot oil under pressure can spray out.



Be aware of hot surfaces (exhaust pipes, turbocharger, charge air pipe, starting heaters, etc.) and hot liquids in supply lines and hoses on an engine that is running or has just stopped. A careless movement or a dropped tool may, in the worst case, result in personal injury when working in the vicinity of a running engine.



Never start the engine without the air filter in place. The rotating compressor turbine in the turbocharger can cause severe injury. Foreign objects entering the intake ducts can also cause mechanical damage. Install all protective covers before starting the engine.



Make sure that all warning and information decals on the product are always visible. Replace decals that have been damaged or painted over.



Only start the engine if the surrounding ventilation is satisfactory. When operating in a confined space, exhaust fumes and crankcase gases must be led away from the engine compartment or workshop area.



Avoid getting oil on the skin! Prolonged or repeated exposure to oil can cause skin to become dry. Irritation, dryness, eczema and other skin problems may then result. Used oil is more dangerous than fresh oil from a health aspect. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before eating. Use suitable protective creams to counteract skin dryness and to aid dirt removal.



The majority of chemicals, e.g. engine and transmission oils, glycol, gasoline, and diesel oil, together with chemicals for workshop use such as degreasing agents, paints and solvents, are health hazards. Carefully read the instructions on the product packaging! Always follow the safety directions for a product, e.g. with regard to use of protective mask, glasses, gloves, etc. Make sure that other personnel are not exposed to substances that are health hazards. Ensure good ventilation. Handle used and leftover chemicals in the prescribed manner.



Turn off the engine and disconnect the power at the main switch(es) before starting work on the electrical system.



Only make connection adjustments with the engine switched off.



Always wear protective goggles if there is a risk of splinters, sparks and splashes from acid or other chemicals. Your eyes are extremely sensitive, injury to them could result in blindness!



Never start the engine with the valve cover removed. There is a risk of personal injury.



Never use start gas or similar products as a starting aid. They may cause an explosion in the inlet manifold. Danger of personal injury.



Stop the engine before working on the cooling system.

Marine engines: Close the seacock/cooling water inlet valve before starting work on the cooling system.



All fuels, and many chemicals, are flammable. Never allow open flames or electrical sparks in the their vicinity. Gasoline, certain solvents and hydrogen from batteries are extremely flammable and explosive in the right concentration in air. **No smoking!** Ensure the work area is well ventilated and take the necessary safety precautions before welding or grinding work is begun. Always ensure that there are fire extinguishers close at hand in the work area.



Make sure that rags soaked in oil or fuel and used fuel and oil filters are stored safely. Oil-soaked rags may ignite spontaneously in certain conditions. Used fuel and oil filters are environmentally hazardous waste and must be taken to an approved waste management facility for correct handling, as must any used lubricating oil, contaminated fuel, paint residue, solvents, degreasers and wash residue.



Batteries must never be exposed to open flames or electrical sparks. Never smoke in the vicinity of the batteries. During charging they generate hydrogen gas, which is explosive when mixed with air. This gas mixture is easily ignited and highly explosive. A spark, which can be caused by incorrect battery connection, is enough to cause the battery to explode and cause serious damage.



Never work alone when dismantling heavy components, even when using lifting equipment such as lifting devices with lockable blocks. Two people are usually required when using a lifting device; one to operate the lifting device and the other to make sure the components do not collide with objects and suffer damage during the hoist.

Do not touch the connections during a starting attempt. Spark hazard! Do not lean over batteries.



Never mistake the positive (+) for the negative (-) battery pole when installing batteries. Incorrect pole connections can result in serious damage to electrical equipment. Refer to the wiring diagram.



Use the loops on the engine when lifting it. Always check that the hoisting equipment is in good condition and has the capacity to lift the engine (engine weight including gearbox and any auxiliary equipment installed). The engine must be lifted with a properly adjusted lifting boom to ensure safe handling and avoid damage to components fitted to the top of the engine. All chains or wires must run parallel to each other and be as perpendicular to the engine as possible. If the engine has equipment fitted that alters its center of gravity, special lifting devices may be required to achieve the correct balance for safe handling. Never carry out any work on an engine that is only suspended by lifting equipment.

Always wear protective goggles when charging or handling the batteries. The battery electrolyte contains sulfuric acid which is highly corrosive. Rinse immediately with plenty of water and soap if battery electrolyte comes into contact with unprotected skin. If you get battery acid in your eyes, flush at once with a generous amount of water, and get medical assistance at once.



The components in the electrical and fuel systems on Volvo Penta products are designed and manufactured to minimize the risk of fire and explosion. The engine must not be operated in areas where there are explosive materials or gases.



Take extreme care when searching for fuel system leaks and testing fuel injector nozzles. Wear safety goggles. The jet from a nozzle is under very high pressure and has great penetration power. Fuel can penetrate deep into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).



Only use fuels and lubricating oils as recommended by Volvo Penta. Refer to the operator's manual for the product concerned. Using fuels that are of a lower grade may damage the engine, the injection pump and the injectors. In the case of diesel engines, low-quality fuel may cause the control rod to stick and the engine to overrev with the risk of engine damage and personal injury as a result. Low-quality fuel and oils may lead to higher service, maintenance and repair costs.



Never use a high-pressure washer to clean the engine.

Pay attention to the following when using a high-pressure washer on components other than the actual engine: Never aim the water jet at seals, rubber hoses or electrical components.



Under no circumstances may fuel pipes be bent or straightened. Cracks may occur. Damaged pipes must be replaced.



When overhauling an engine, perform leakage and functional checks as necessary.

Requirements for work with after-treatment system (EATS)

TAD1660VE, TAD1661VE, TAD1662VE,
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1663GE, TWD1672GE, TWD1673GE



P0003451

The following information must be observed for work performed on engines equipped with an after-treatment system.

All work must be carried out in well-ventilated premises that meet health, safety and other national or international requirements.

AdBlue/Diesel Exhaust Fluid (DEF):

IMPORTANT:

- Always wait at least 2 minutes after ignition has been interrupted before beginning work.
- AdBlue/DEF and urea solutions cause corrosion damage.
Avoid removing or loosening AdBlue/DEF hoses or electrical lines unless the work requires this.
Always clean the AdBlue/DEF system before carrying out any from of work.
Use lukewarm water when cleaning.
- Always plug AdBlue/DEF and urea hoses in order to avoid dirt in the AdBlue/DEF and urea system, and any crystallization of AdBlue/DEF.
- Tools that have come into contact with AdBlue/DEF or urea solution must be cleaned.
Protective gloves must be discarded after use.
Remove contaminated clothing.

SCR catalyzer:

▲ WARNING!

- Use nitrile gloves and goggles.
- Keep in mind that SCR can contain residue of AdBlue/DEF.
- Never cut off, cut or machine an SCR. There is a risk of exposure to harmful gases.
- If the casing is damaged, a protective mask must be used.

Particulate filter:

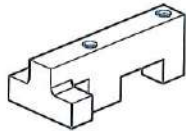
▲ WARNING!

- Always allow the components to cool to room temperature before starting work.
- Use nitrile gloves goggles and protective filter mask.
- Handle the particulate filter with care.
Never try to cut off, cut or machine a particulate filter.
There is a risk of exposure to very harmful substances.
- Always follow the instructions that apply for the transport of particulate filter.

08-2 Special Service Tools

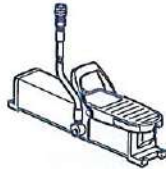


The following special tools are used when working on the engine. The tools can be ordered from AB Volvo Penta by specifying the number indicated.



885810 Fixture

For upper timing cover



9809726 Pneumatic hydraulic pump

Used with 9809729 or 9992670. Replaces 9996222



9809729 Hydraulic cylinder

Used with press tool 9990176



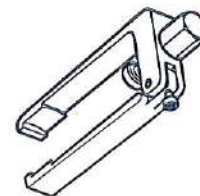
9986173 Puller

For flywheel bearings



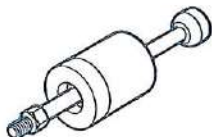
9986179 Puller

For flywheel bearings



9990006 Puller

For unit injectors

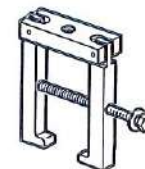


9990013 Slide hammer



9990107 Connection washer

Used for pressure testing



9990114 Puller

Used for main bearing caps

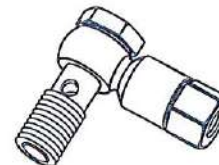


9990118 Cone

For installation of front crankshaft seal



9990123 Pressure testing kit



9990124 Nipple

**9990125 Nipple**

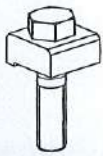
For turbo pressure manometer

**9990143 Fixture**

Up to and including engine no. 2016010024

**9990156 Adapter**

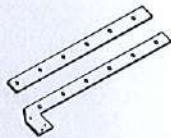
For sealing plug 9998251

**9990157 Press tool**

For cylinder liner (7 pcs. required)

**9990158 Piston ring compressor****9990160 Fixture**

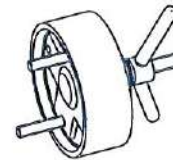
For cylinder head

**9990164 Fixture**

For pressure testing cylinder head

**9990165 Guide sleeve**

For valve spindle seal

**9990166 Mounting tool**

For rear crankshaft seal

**9990174 Drift**

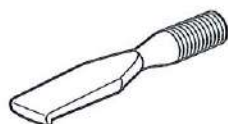
For removal/installation of valve springs, outlet

**9990176 Press tool**

For removal/installation of valve springs and valve guides

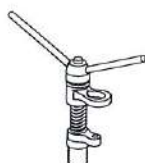
**9990185 Lifting tool**

For rocker arm bridge



9990192 Puller

For rear crankshaft seal, used with 9996400



9990210 Valve spring compressor



9991801 Standard handle

For e.g. changing flywheel bearing



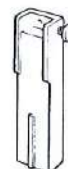
9992000 Handle

Standard handle

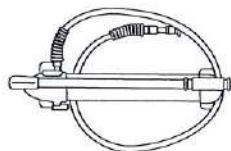


9992269 Drift

For installation of flywheel bearing



9992479 Holder for dial indicator



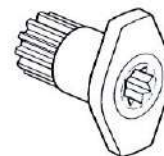
9992670 Hand pump

Used with 9809729, alternative to 9809726



9992873 Nipple

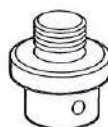
For pressure checking



9993590 Rotation tool



9996049 Draining hose



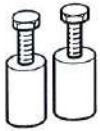
9996159 Adapter

For hydraulic cylinder 9809729

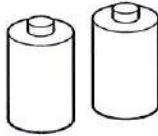


9996239 Lifting tool

For removal/installation of cylinder head and flywheel housing, (2 pcs. required)



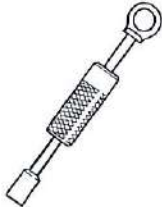
9996394 Support



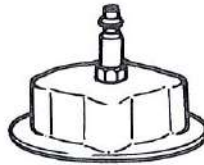
9996395 Support



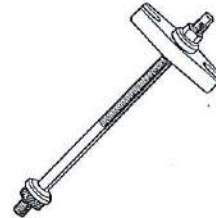
9996398 Manometer



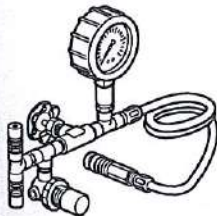
9996400 Slide hammer



**9996441 Cover, with
connecting nipple**
For cooling system leakage test



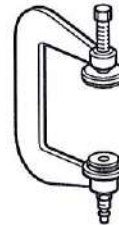
9996645 Puller



9996662 Pressure testing kit



9996666 Nipple



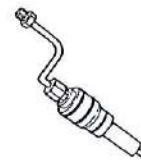
9996845 Screw clamp
For pressure testing oil cooler
(2 pcs. required)



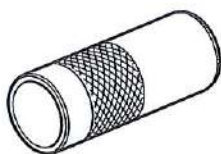
9996963 Plate
For removing/installing cylinder
liners



9998246 Drift
For removal/installation of valve
springs, inlet



9998248 Adapter
For measuring cylinder
compression (6 pcs. required)



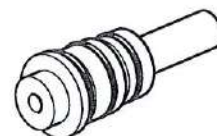
9998249 Protective sleeve

For unit injectors (6 pcs. required)



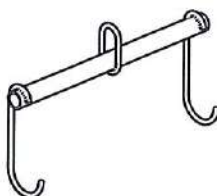
9998250 Sealing ring

For fuel duct in cylinder head (2 pcs. required)



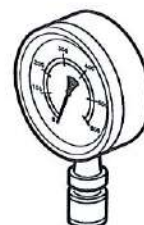
9998251 Protection plug

For cylinder head (6 pcs. required)

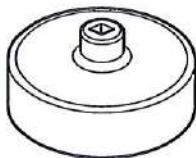


9998264 Lifting tool

For camshaft

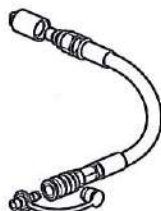


9998339 Manometer



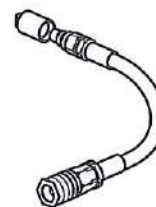
9998487 Sleeve

For removal of oil filter



9998494 Hose

For measuring fuel pressure (red), used with 9990123 and 9990124



9998502 Hose

For pressure testing cooling system (green), used with 9990123

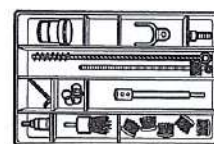


9998511 Lever



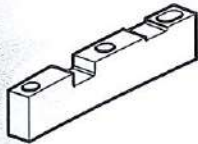
9998517 Adjustment tool

For checking/setting flywheel and camshaft sensor



9998599 Cleaning kit

Complete kit for cleaning unit injectors



9998601 Fixture
For upper timing cover



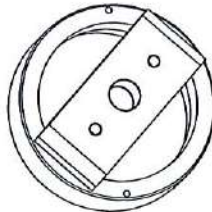
9998629 Lifting tool
Thread M10, 2 pcs. required



9999179 Extractor oil filter



88800003 Fixture
Used with 9986485 (from and including engine no. 2016010025)



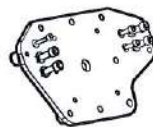
88800021 Drift
For removal of front crankshaft seal



88800064 Drift
For changing valve guides (inlet), installation



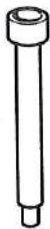
88800513 Drift
For removal of copper sleeve



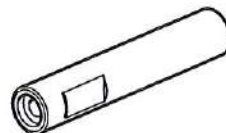
88800123 Plate
Used with 88800003 (from and including engine no. 2016010025)



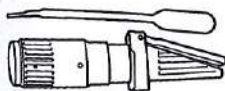
88800127 Drift
For changing valve guides (exhaust), installation



88800147 Drift
For changing valve guides, removal



88800151 Drift
For valve stem seal



88890105 Refractometer

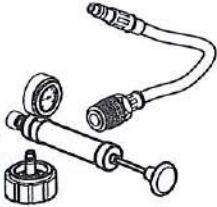
9998599 Cleaning kit

Cleaning kit for unit injector. Contains:

- **959239** Screw M10
- **9808570** Brush, white
- **9998580** Sleeve with holder and O-ring
- **276948** O-ring set
- **9808634** Brush kit, contains:
 - Storage box
 - Holder
 - Holder
 - Handle
 - **9808614** Brush, yellow 10 pcs
 - **9808617** Wire brush, narrow
 - **9808618** Wire brush, coarse

Other Equipment

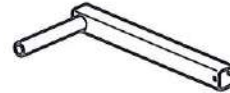
The following miscellaneous equipment is used when working on the engine. The equipment can be ordered from AB Volvo Penta by specifying the number indicated.



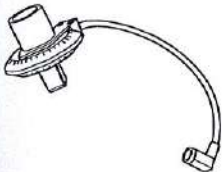
885531 Pressure testing kit
Cooling system



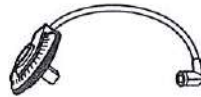
885633 Torque multiplier



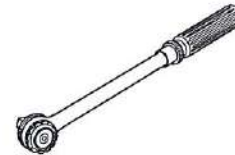
885648 Counterhold



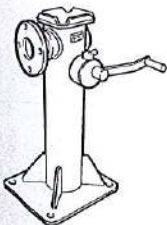
885811 Timing tool



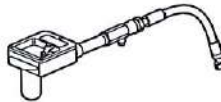
885812 Timing tool



1159794 Torque wrench
3/8", 10-100 Nm (7.4-73.8 lbf.
ft.)



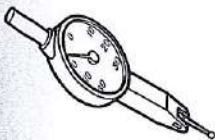
9986485 Stand



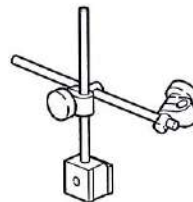
9988539 Compression meter



9989876 Dial indicator



**9999683 Dial indicator (short
probe)**



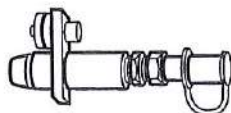
9999696 Magnetic stand



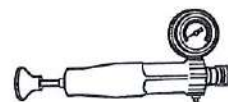
9999881 Torque wrench



88800083 Piston ring pliers



88890102 Nipple



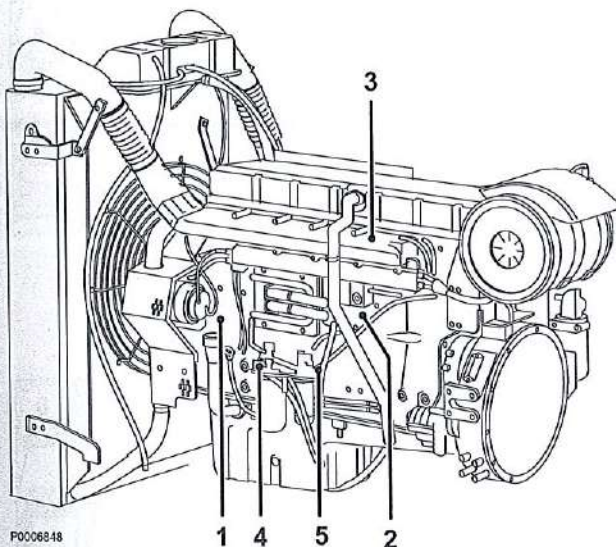
88890104 Pump

20-0 Engine Information, General

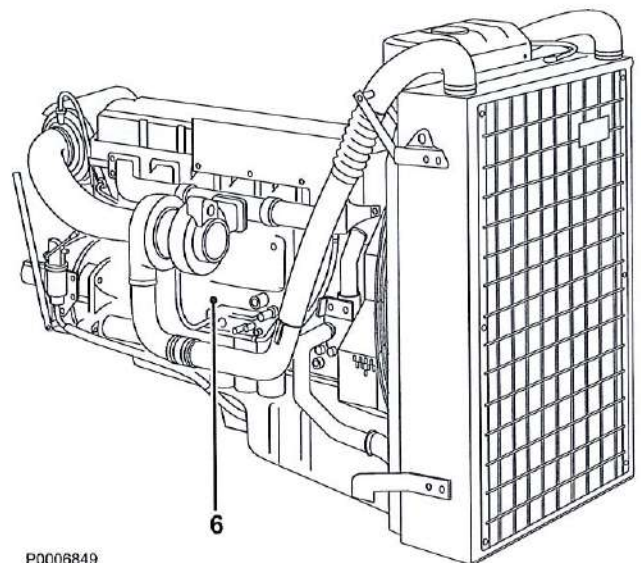
Placement of Instrument Socket(s)

TAD1640GE, TAD1640VE-B, TAD1641GE, TAD1641VE, TAD1641VE-B, TAD1642GE, TAD1642VE-B, TAD1643VE-B, TAD1650GE, TAD1650VE, TAD1650VE-B, TAD1651GE, TAD1651VE, TAD1660VE, TAD1661VE, TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

The figures below show where measuring points may be located on the engines.



- 1 Crankcase pressure
- 2 Lubricating oil pressure
- 3 Charge air pressure / temp. after charge air cooler.

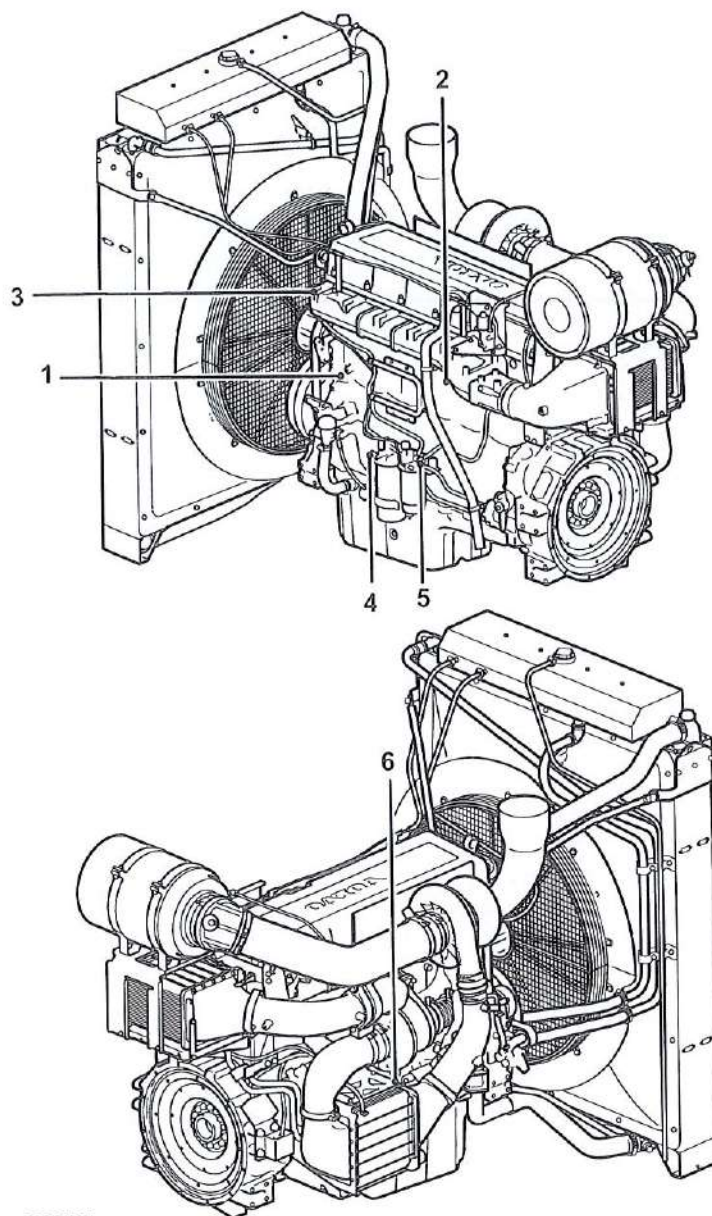


- 4 Fuel feed pressure (before filter)
- 5 Fuel feed pressure (after filter)
- 6 Piston cooling oil pressure (not apply for TAD1650/1651GE)

Placement of Instrument Socket(s)

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

The figures below show where measuring points may be located on the engines.



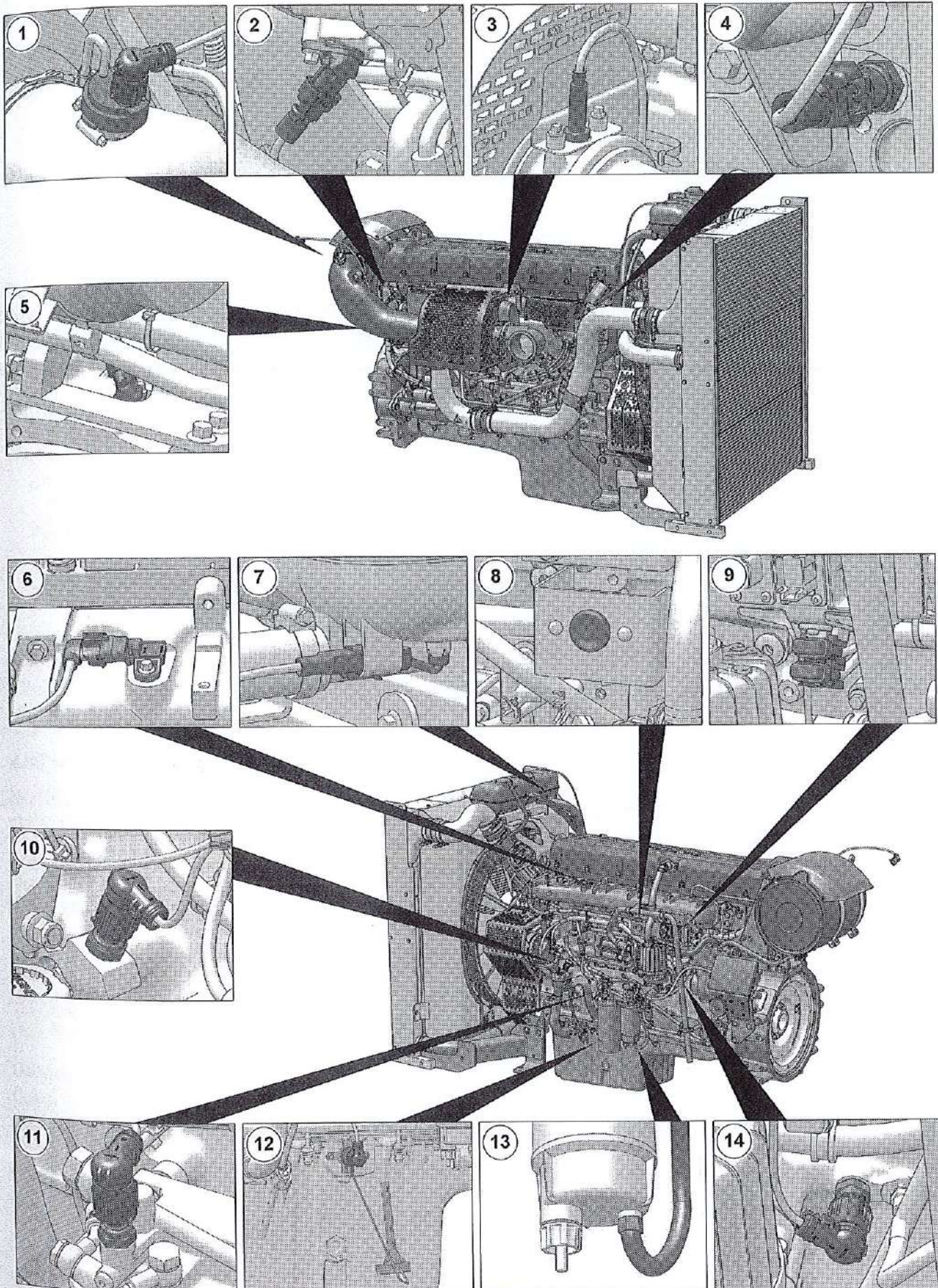
P0006850

- | | |
|--|--------------------------------------|
| 1 Crankcase pressure | 4 Fuel feed pressure (before filter) |
| 2 Lubricating oil pressure | 5 Fuel feed pressure (after filter) |
| 3 Charge air pressure / temp. after charge air cooler. | 6 Piston cooling oil pressure |

ret(s)

ints may

Location of Sensors



P0020699

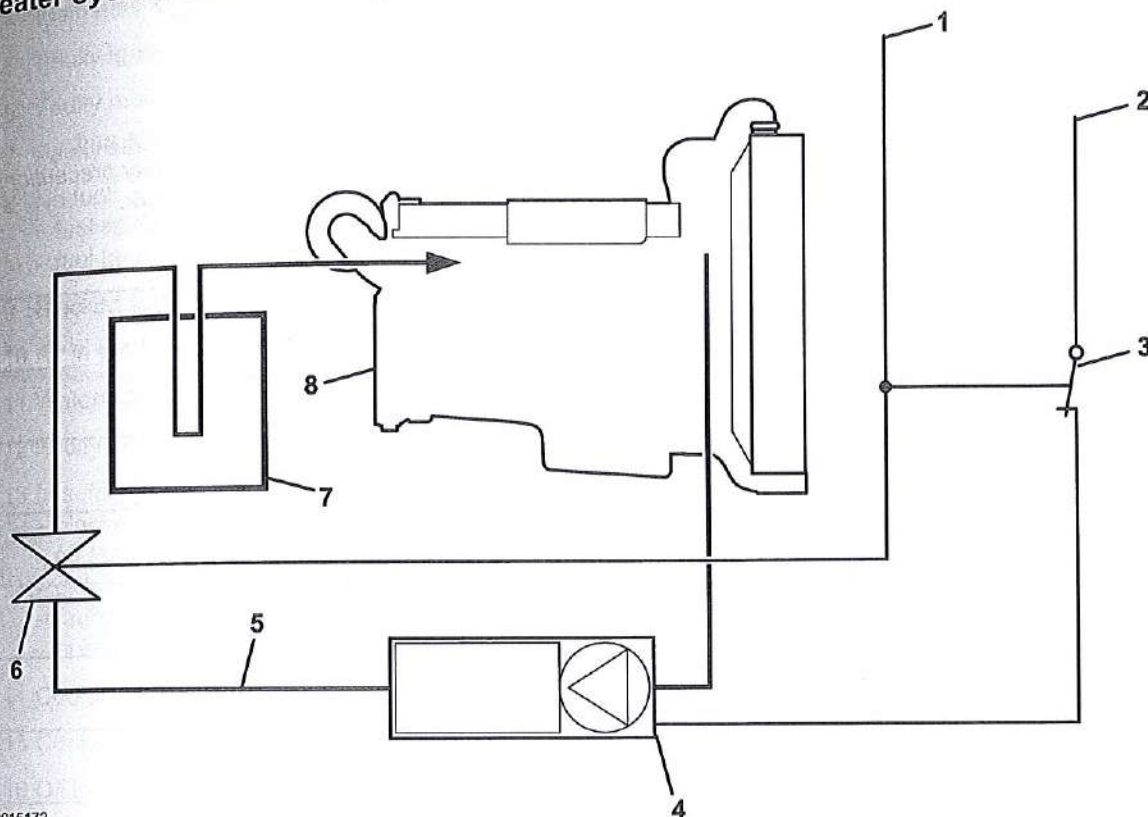
Electrical Components

- 1 Under pressure sensor, air filter (only TWD engines)
- 2 Camshaft position sensor
- 3 Pre-NOx sensor (TAD1670-72VE)
- 4 Coolant temperature sensor
- 5 Flywheel position sensor
- 6 Air inlet pressure/intake manifold temperature sensor
- 7 Coolant level sensor
- 8 AUX-stop
- 9 Fuses
- 10 Crankcase pressure sensor
- 11 Fuel pressure sensor
- 12 Oil level/temp sensor
- 13 Water in fuel switch
- 14 Oil pressure sensor

AdBlue/DEF tank heating

TWD1663GE, TWD1672GE, TWD1673GE

Schematic connection stand-by AdBlue/DEF heating system using an independent heater system Hotstart CSM 10302 for a standby heating system or similar.



P0015172

AdBlue/DEF heating for standby engines

NOTICE! The freezing point of AdBlue/DEF is: -11°C (12°F).

AdBlue/DEF must be kept liquid all the time on standby engines to allow immediate high engine load. If the AdBlue/DEF is frozen, the AdBlue/DEF injector may be damaged due to overheating. In areas where freezing may occur, a heating system for the engine cooling liquid is required.

The AdBlue/DEF should not be heated above 50 °C (122 °F) during a longer period.

Description of operation

Using the connection points for the standard engine heater system an independent heater system must be installed (see picture above).

The system requires a heater with a pump unit (4) to ensure a proper flow through the AdBlue/DEF tank and a valve (6) that will stop the circulation when the engine is shut-down to prevent the AdBlue/DEF from overheating.

NOTICE! The standard valve mounted on the AdBlue/DEF tank is used only for continuous operation.

The heater unit shall also ensure an acceptable start-up temperature for stand-by operation.

- 1 Power supply, valve (at engine running)
- 2 Power supply, heater and pump unit
- 3 Relay (open at engine running)
- 4 Heater and pump unit. Thermostatically controlled. Max temperature 50 °C (122 °F)
- 5 Hose, max 5m (16.4ft) total length
- 6 Valve, normally open (closed at engine running)
- 7 AdBlue/DEF tank 200 l
- 8 Engine

If the pressure build-up in the AdBlue/DEF dosing system is not working correct, the engine is shut down within less than 1 hour.

Troubleshooting

A number of symptoms and possible causes of engine malfunctions are described in the table below. Always contact your Volvo Penta dealer if any problems occur which you can not solve by yourself.

IMPORTANT!

Read through the safety advice for care and maintenance work in the chapter *Safety precautions for boat operation* before you start work.

Symptoms and possible causes

✱ The diagnosis button lamp flashes Please refer to <i>Diagnostic Function</i>
Engine can not be stopped 2, 5
Starter motor does not rotate 1, 2, 3, 4, 5, 6, 7, 24
Starter motor rotates slowly 1, 2
Starter motor rotates normally but engine does not start 8, 9, 10, 11,
Engine starts but stops again 8, 9, 10, 11, 13
Engine does not reach correct operating speed at full throttle 9, 10, 11, 12, 13, 21, 25, 26
Engine runs roughly 10, 11
High fuel consumption 12, 13, 15, 25
Black exhaust smoke 12, 13
Blue or white exhaust smoke 15, 22
Too low lubrication oil pressure 16
Excessive coolant temperature 17, 18, 19, 20, 28
Too low coolant temperature 20
No, or poor charge 2, 23
Too high exhaust temperature (only TWD engines) 13, 17, 18, 19, 21, 25, 27, 28, 29, 30

Reason code

- 1 Discharged batteries
- 2 Poor contact/open circuit in electrical wiring
- 3 Main switch turned off
- 4 Main fuse faulty
- 5 Faulty ignition lock
- 6 Faulty main relay
- 7 Faulty starter motor/-solenoid
- 8 No fuel:
 - fuel cocks closed
 - fuel tank empty/wrong tank connected
- 9 Blocked fuel fine-filter/pre-filter (due to contaminations, or stratification in the fuel at low temperature)
- 10 Air in the fuel system
- 11 Water/contamination in fuel
- 12 Faulty unit injectors
- 13 In sufficient air supply to the engine:
 - blocked air filter
 - air leakage between the turbo and the engine's intake manifold
 - dirty compressor part in the turbocharger
 - faulty turbo compressor
 - poor engine room ventilation
- 14 Coolant temperature too high
- 15 Coolant temperature too low
- 16 Oil level too low
- 17 Coolant level too low
- 18 Air in the coolant system
- 19 Faulty circulation pump
- 20 Defective thermostat
- 21 Blocked charge air cooler
- 22 Oil level too high
- 23 Alternator drive belt slips
- 24 Water entry into engine
- 25 High back pressure in the exhaust system
- 26 Break in "Pot+" cable to throttle
- 27 High temperature, charge air cooler
- 28 Blocked radiator
- 29 No pressure in cooling system
- 30 Check wastegate function

Functional Disturbances

For more detailed information and further fault tracing help, See Operator's Manual, group 30, "MID 128, PID 110 Engine coolant temperature". If there is a malfunction, first check the following items:

- Check that the coolant level is between the markings on the expansion tank (at approx. 20°C) [68 °F]. If the level in the expansion tank is too low, top up and start the engine. If the coolant disappears, there is internal or external leakage.
- Check that the coolant is not contaminated. If the coolant is contaminated, this signifies internal leakage (oil) or that the cooling system has a blockage (deposits). Blockage in the cooling system is caused by one or more of the following factors:
 - 1 The coolant has not been changed at the specified intervals.
 - 2 Incorrect mixture of coolant and water.
 - 3 Contaminated water has been used.

Clogging

Is often caused by high coolant temperature, internal or external blockage of the cooling system, or a combination of both. If the cooling system is blocked, it must be cleaned.

- **External dirt:** Check that the cooler and/or the charge air cooler are not clogged. If you cannot see light through at least one third, the cooler should be removed and cleaned. Check if there is any internal or external leakage in the cooling system.
- **Internal contamination:** Check that the cooler and/or the charge air cooler are not clogged.

Common Interference Causes

Suitable actions

External cleaning:

- 1 Remove guards as necessary, to access the radiator.
IMPORTANT!
Take care that the radiator lamella are not damaged.
A high pressure washer may under **no circumstances** be used!
- 2 Clean with water and a mild detergent.
Use a soft brush.
- 3 Re-install removed parts.

Internal cleaning:

- Refer to *Cooling System, Cleaning*.

Further checks

- **External and internal leakage in the cooling system:** Check if there is leakage in the system.
- **Coolant circulation:** Check that coolant circulates by letting the engine run at high speed. Also check the expansion tank to see that coolant circulates. This can be an indication of a fault in the cooling system.
- **Thermostat:** Check thermostat function. Drain enough coolant to allow the thermostat to be removed. Check the thermostat; refer to *Thermostat, Function Check*.

Charge Pressure, Troubleshooting

Charge Air Pressure, Check

Tools:

9998339 Manometer

9998493 Hose

9996666 Nipple

- 1 Connect the nipple with hose and pressure gauge to the measuring point on the inlet manifold; refer to *Engine Placement*.
- 2 Compare this pressure with the pressure that can be read with the VODIA tool; refer to "Workshop manual, EMS 2"
If the two measurements show different values, the pressure sensor is faulty and must be changed.

Pressure drop indicator, check

TAD1640-42GE, TAD1641-43VE, TAD1650-51GE, TAD1640-43VE-B, TAD1650VE, TAD1660-62VE, TAD1650VE-B, TAD1651VE, TAD1670-72VE

NOTICE! For TWD engines the pressure drop indicator is electrical and provides a signal to the engine management system.

- 1 Check that the air filter is clean and that there are no obstructions to air entry.
- 2 Remove the pressure drop indicator from the air filter housing
- 3 Check the pressure drop indicator by sucking out air until the indicator shows red. Re-set by pressing the yellow button.
- 4 When for example the air filter is blocked and pressure drop occurs, the pressure drop indicator shows this by indicating red. Change the indicator if it does not function according to the checks in the previous steps (shows red).
- 5 Install the pressure drop indicator on the air filter housing.

Exhaust system, inspection

TAD1640-42GE, TAD1641-43VE, TAD1650-51GE, TAD1640-43VE-B, TAD1650VE, TAD1660-62VE, TAD1650VE-B, TAD1651VE, TAD1670-72VE

- 1 Check that the exhaust system is a Volvo Penta original component.
- 2 Check whether the exhaust system has been modified, has bends or damage that prevent exhaust gas from flowing out.
If the exhaust system is not a Volvo Penta original, has been modified, has bends or damage, exhaust back pressure may be too high, which will entail reduced engine power.

Charge air cooler, checks

TAD1640-42GE, TAD1641-43VE, TAD1650-51GE,
TAD1640-43VE-B, TAD1650VE, TAD1660-62VE,
TAD1650VE-B, TAD1651VE, TAD1670-72VE

- 1 Check the charge air cooler for damage to the cells and connections.
If there is any damage, change the charge air cooler.
- 2 Check the charge air cooler and radiator for internal blockage.
If there is any blockage, clean in accordance with *Charge Air Cooler, External Cleaning*.

Inlet manifold, checks

- 1 Check that the inlet pipes are clean inside, and undamaged. Crushed, damaged or dirty inlet pipes can reduce the charge pressure.

Charge air pipes, checks

- 1 Inspect the charge air pipes for visible cracks and external damage.
- 2 Check that there is no oil in the charge air pipes. If the pipes are damaged or the union seal rings leak, the charge pressure will be too low and engine performance will be impaired. If the pipes are contaminated with oil on the inside, this indicates oil leakage in the turbocharger turbine shaft seal. In this case, the turbocharger must be changed as a complete unit.

IMPORTANT!

If there is oil in charge air pipes and charge air hoses, the charge air cooler and all pipes and hoses in the charge air system must be very thoroughly cleaned inside, before the engine is started.

Charge Air Cooler, External Cleaning

Remove guards as necessary, to access the cooler. Clean with water and a mild detergent. Use a soft brush. Be careful not to damage the radiator matrix. Re-install the components.

IMPORTANT!

Do not use a high pressure power washer.

Test and Adjustments

Compression Test

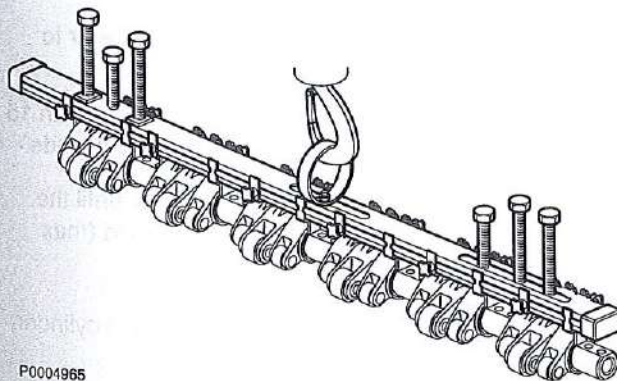
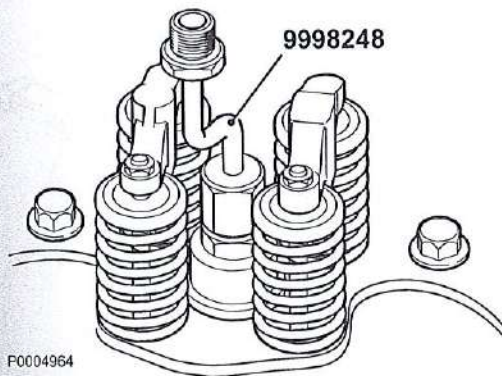
The fuel system shall be emptied and the rocker bridge removed, see *Draining, Fuel Duct in Cylinder Head*.

Tools:

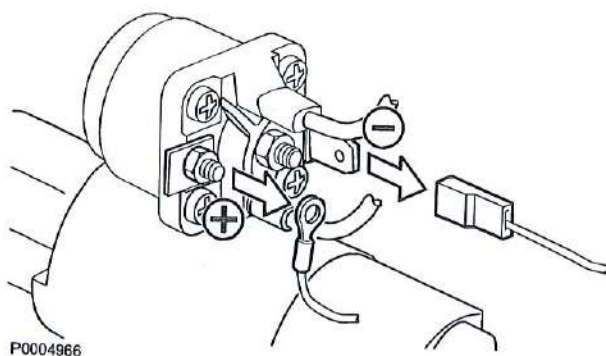
9988539 Compression meter
9990185 Lifting tool
9998248 Adapter
9998249 Protective sleeve
9998599 Cleaning kit

Removal

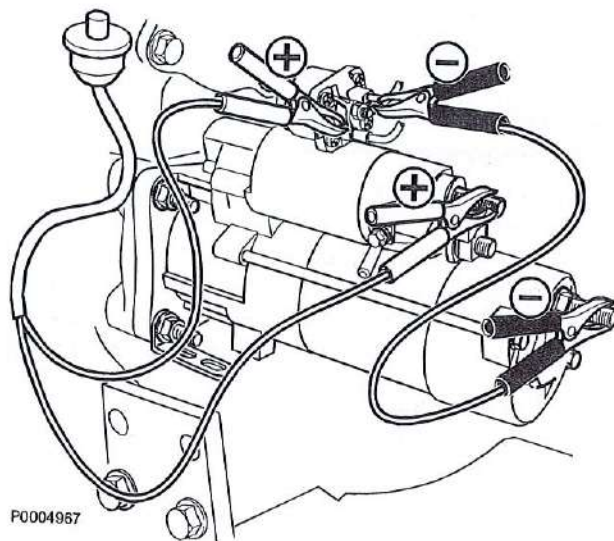
- 1 **IMPORTANT!**
Make sure that the area around the unit injectors is clean before they are removed.
Remove the unit injectors, see *Unit Injector, Replace* and mount the unit injector protection (9998249 Protective sleeve). Clean the copper sleeves as needed with 9998599 Cleaning kit.
- 2 Fit all⁽¹⁾ adapters (6 pcs), tool 9998248 Adapter, to the cylinder head and pull them on with the injector retainers.
- 3 Oil valve caliper, cam shaft ridges and the rocker bridge.
- 4 Fit the rocker bridge with 9990185 Lifting tool.
Torque the screws evenly along the rocker arm to avoid that the rocker arm bends or warps.
Make sure that guide pins fit in the camshaft support bearing. Torque the rocker bridge as specified in *Technical Data*. Use torque wrench.
- 5 Install the middle piece and the oil pipe to the rocker bridge.
- 6 Check the valve clearance, see *Valves and Unit Injectors, Adjustment*, for all valves as specified in *Technical Data*.



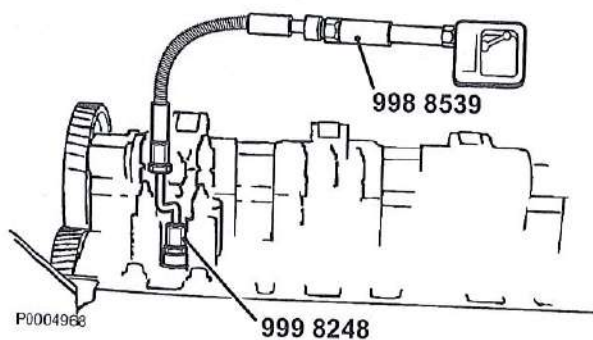
1. This in order to avoid repeating removal/refitting of rocker bridge and unit injector and performing valve adjustment six times.



- 7 Remove both control wires from the starter motor control connector (the two thin cables). Connect one of the two free connectors on the control connector to ground.



- 8 Connect the other connector to a switch, which in turn is connected to the positive (plus) connection on the starter motor.



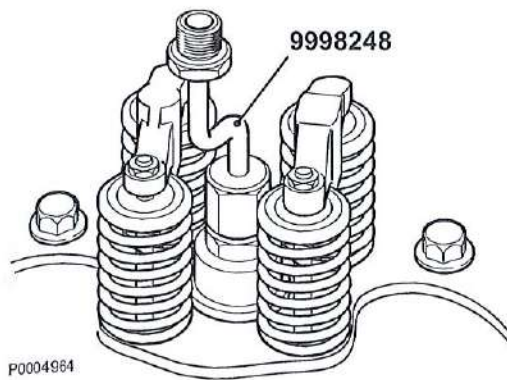
- 9 Connect tool 9988539 Compression meter to 9998248 Adapter on the first cylinder.
- 10 **NOTICE!** Do not run the engine for more than 15 seconds at a time with intervals of 60 seconds.

Run the engine with the starter motor until the compression meter needle has stopped (max compression reading).

Read the value.

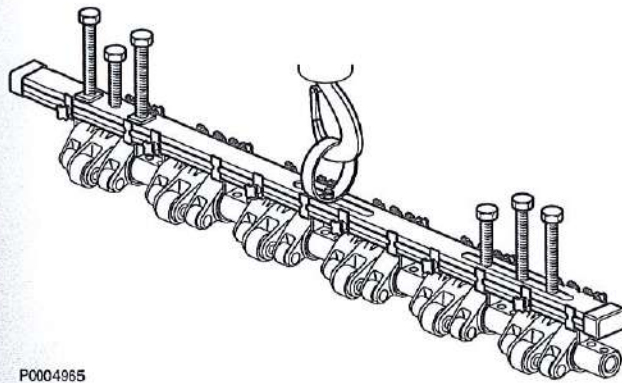
Move the compression meter to the next cylinder. Repeat the test on all cylinders.

- 11 Remove the middle piece and the oil pipe for the rocker bridge.
- 12 Remove the rocker bridge screws equally in stages so that it is not bent. Remove the bolts and carefully lift off the rocker bridge using 9990185 Lifting tool.



- 13 Remove all adapters, tool 9998248 Adapter from all cylinders.

Installation



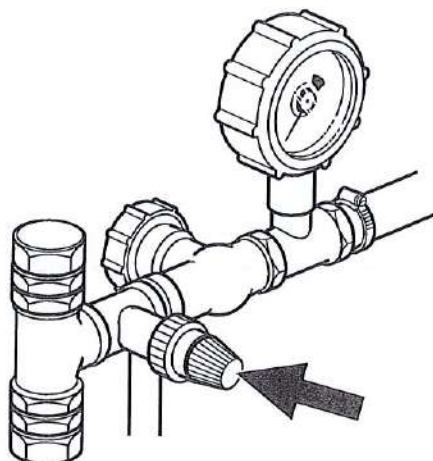
- 14 Mount the unit injectors and new o-rings, see the **Installation** section in chapter *Unit Injector, Replace*.
- 15 Fit the rocker bridge with 9990185 Lifting tool. Torque the screws evenly along the rocker arm to avoid that the rocker arm bends or warps. Make sure that guide pins fit in the camshaft support bearing. Torque the rocker bridge as specified in *Technical Data*. Use torque wrench.
- 16 Install the middle piece and the oil pipe to the rocker bridge.
- 17 Adjust valves and unit injectors, see *Valves and Unit Injectors, Adjustment*.
- 18 Check and if needed change the valve cover bearing. Install the valve cover.
- 19 Re-install the fuel lines. Use new sealings.
- 20 Vent the fuel system, see *Fuel system, bleeding*.

Cooling System, Pressure Testing

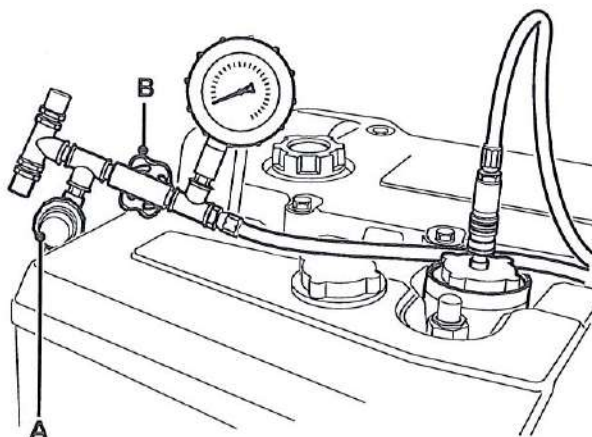
Tools:

- 9996441 Cover, with connecting nipple
- 9996662 Pressure testing kit

Check the pressure testing device 9996662 Pressure testing kit before using it. See *Cylinder Head, Pressure Testing*.



P0006858



P0006859

- 1 Check that all hoses are free from defects.
 - 2 Check that the cock on the pressure reduction valve is fully opened.
 - 3 Replace the coolant filler cap on the expansion tank with cap 9996441 Cover, with connecting nipple. Connect the pressure testing device to the nipple on the lid.
 - 4 Connect the pressure-testing device to the compressed air system and open the cock (B). Adjust the pressure reduction valve (A) so that pressure gauge shows a pressure of 70 kPa (10.2 PSI). Close cock (B).
 - 5 The pressure must not drop during **two minutes** for the cooling system to be considered free from leaks.
- NOTICE!** Repeat the pressure testing if you are uncertain whether the cooling system leaks or not.
- 6 Close the compressed air after the pressure testing. Eliminate the excess pressure in the cooling system by unscrewing the pressure reduction valve and opening the cock (B).
 - 7 Remove the testing device.
 - 8 Check coolant level in the expansion tank. Install the regular coolant filler cap.
 - 9 Start the engine and check for leaks.

Cylinder Head, Pressure Testing

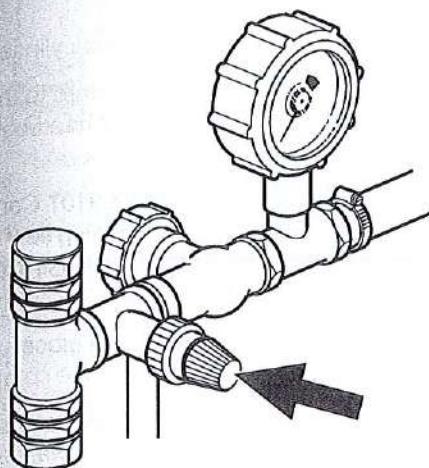
Tools:

9990123 Pressure testing kit
 9996239 Lifting tool
 9986485 Stand
 9990160 Fixture
 9990107 Connection washer
 9990164 Fixture

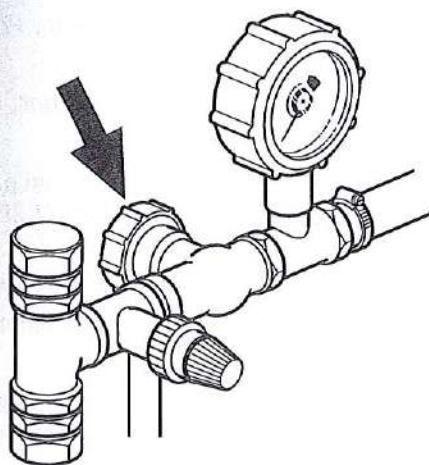
Checking the pressure test unit

Check pressure testing device 9990123 Pressure testing kit before it is taken into service:

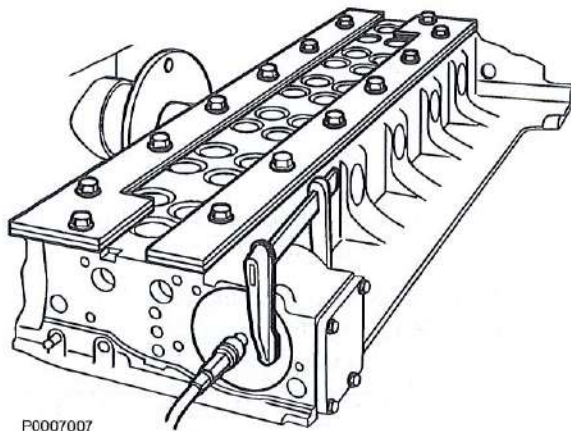
- 1 Connect the pressure testing device to the compressed air mains.
- 2 Set the pressure gauge to 100 kPa (14.5 PSI) using the reducing valve. The knob can be locked with a retainer ring moved axially.
- 3 Close the shut-off valve. The pressure on the pressure gauge must not fall for 2 minutes, for the device to be regarded as reliable.
- 4 Unscrew the knob on the reducing valve and open the tap.



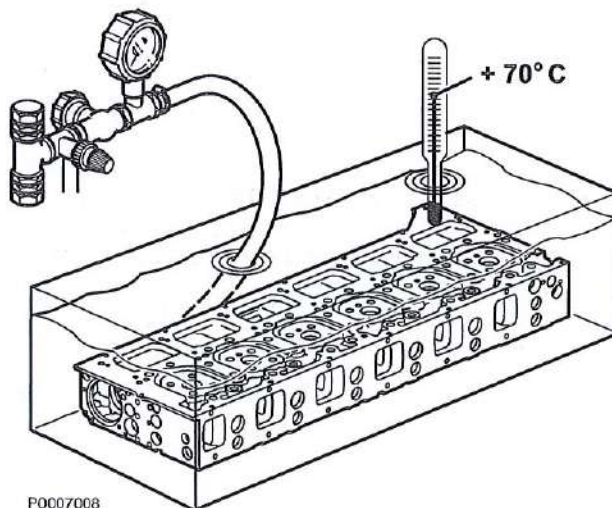
P0006858



P0007006



P0007007



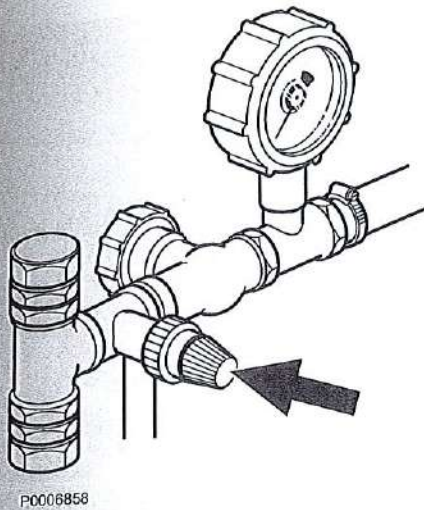
P0007008

Pressure Testing

Cylinder head removed.

For all lifts of the cylinder head use 2 lifting chains, tool 9996239 Lifting tool; refer to *Cylinder Head, Removal*.

- 1 Wash the cylinder head in a washing bath.
- 2 Fit the cylinder head to an assembly stand, tool 9986485 Stand with the aid of 9990160 Fixture and 4 bolts, M8 x 25.
- 3 Clean the mating surfaces on the cylinder head.
- 4 Fit seal plates, tool 9990164 Fixture to the cylinder head using the cylinder head bolts and M18 nuts (14 pcs. required).
- 5 Fit connection washer, tool 9990107 Connection washer onto the thermostat housing seat. Secure the washer with a G-clamp; see illustration. Leave the side cover in place.
- 6 Leave the temperature sensor in place. Plug any coolant connections for the compressor.
- 7 Connect the pressure gauge hose to connection washer, tool 9990107 Connection washer.
- 8 Remove the cylinder head including fixture from the assembly stand. Remove the fixture.
- 9 Put the cylinder head in a water bath, +70 °C (+158 °F).
- 10 Connect air to the pressure testing unit. Open the shut-off valve.
- 11 Adjust the reducing valve knob so that pressure gauge shows a pressure of 50 kPa (7.25 psi). Maintain the pressure for 1 minute.
- 12 Raise the pressure to 150 kPa (21.76 PSI). Lock the reducing valve knob with the retainer ring. Close the shut-off valve.
- 13 After 1 to 2 minutes, check whether the pressure has dropped, or if bubbles of air can be seen in the water bath.
If bubbles are visible, check seal plates and inspect the cylinder head for any cracks.
- 14 Unscrew the knob on the reducing valve to relieve the pressure in the cylinder head, and open the tap.
- 15 Take the cylinder head out of the water bath. Attach the fixture.
Secure the cylinder head in the assembly stand.



- 16 Blow the cylinder head dry. Be extra thorough with the fuel channels.

IMPORTANT!

Make sure no dirt gets into the fuel channels, as this may cause damage to the unit injectors.

- 17 Remove all the sealing washers and any plugs installed for the pressure testing.
- 18 Remove the cylinder head including fixture from the assembly stand.
Remove the fixture.

Charge Air Pipe, Leakage Check

- 1 Inspect the charge air pipes for visible cracks and external damage.
- 2 Check that there is no oil in the charge air pipes. If the pipes are damaged or the union seal rings leak, the charge pressure will be too low and engine performance will be affected. If the pipes are contaminated with oil on the inside, this indicates oil leakage in the turbocharger turbine shaft seal. In this case, the turbocharger should be changed as a unit.

NOTICE! If there is any oil in the charge air pipes and charge air hoses, the charge air cooler and all pipes and hoses in the charge air system must be cleaned very carefully before the engine is started.

Wastegate Valve, Adjustment

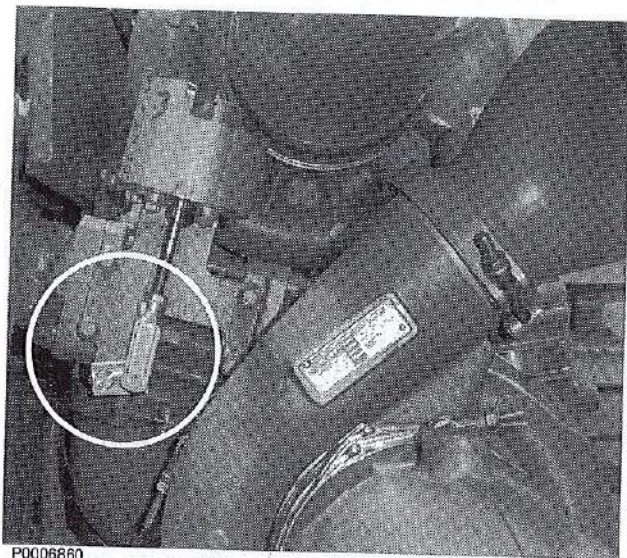
TWD1643GE (early mod.)

Localising

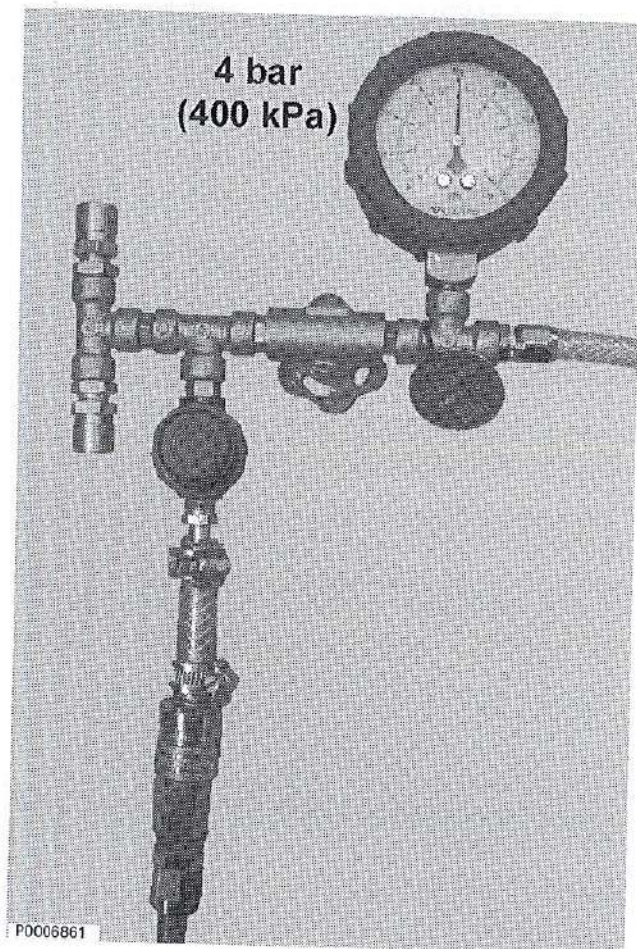
The wastegate valve link arm is on the side of the wastegate housing.

Tools:

9990123 Pressure testing kit



P0006860



P0006861

- 1 Connect manometer, tool 9990123 Pressure testing kit to the waste gate actuator and to compressed air. Adjust the tool to 4 bar (400 kPa) [58.02 PSI].



- 2 Remove the lock pin from the link arm.



- 3 Lift the link arm so that the wastegate flap closes completely.

IMPORTANT!

Hold the adjusting rod with a pair of pliers when adjusting, so that the membrane in the pressure actuator is not damaged by turning.

- 4 Adjust the rod so that the holes coincide.



P0006864

- 5 Insert the lock pin and snap the lock into place on the adjustment rod.
Tighten the lock nut.
- 6 Release the pressure from the tool and remove it.
- 7 Reconnect the pressure hose to the wastegate actuator.

Drive Belt and Alternator Belt, Inspection

Belts must be checked after operations while they are still warm. The alternator belt and the drive belt must be able to be depressed about 3–4 mm (0.12–0.16") between the pulleys.

Both the alternator belt and the drive belt have automatic belt tensioners and need not be adjusted.

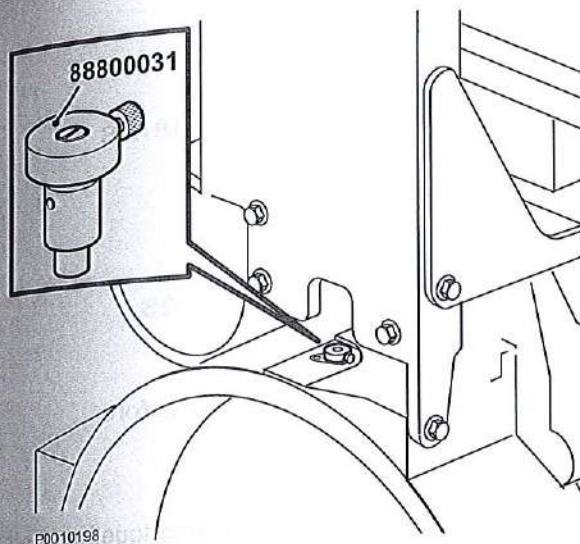
Sensors, Adjustment

Sensor removed.

Tools:

88800031 Measuring tool

- 1 If the camshaft sensor needs to be adjusted, rotate the crankshaft so that one tooth on the camshaft vibration damper is centered in front of the sensor hole.
- 2 Remove any shims beneath the sensor.
Clean the tool's contact surface on the engine.



- 3 Insert 88800031 Measuring tool without tightening the lock screw. Press in the tool firmly so that it is in contact with the cover. Press in the center part of the tool until it contacts the gearwheel and tighten the lock screw. Remove the tool and inspect the center section position in its sleeve.

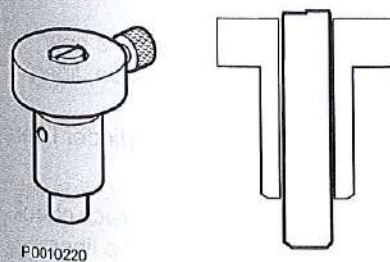
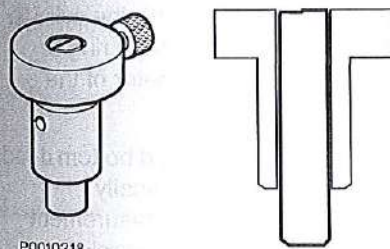
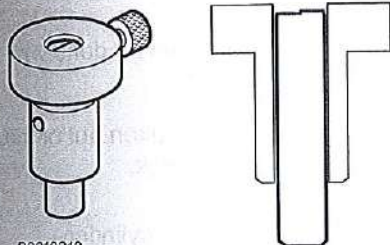
- 4 **Determine further actions according to the following:**

If the center section of the tool is entirely below the sleeve's upper edge, no shims are required.

If only the center section upper surface is above the sleeve's top edge, one shim is required.

If the two center section surfaces are above the sleeve's top edge, two shims are required.

- 5 Install the sensor with a new seal and any shims.



21-0 Engine Complete, General

Replacement of Components

Group 21 - Engine

Cylinder Liner and Pistons, Inspection

Clean the cylinder liners carefully before inspection and measurement.

IMPORTANT!

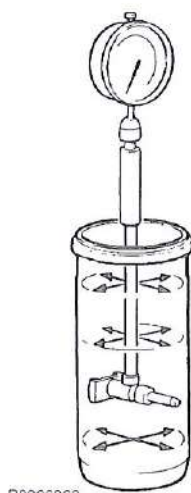
Cylinder liners and pistons are classed together. This means that cylinders and liners must not be mixed.

The piston and cylinder liner sets are only available as a single, complete unit.

Cylinder Liner

Measurement of cylinder liner wear can be done with the liner installed in the cylinder block.

NOTICE! The cylinder liners must be taken out of the engine block, to do a careful crack check.



P0006962

- 1 Measure the cylinder liners with a cylinder indicator. In order to obtain the greatest possible accuracy in the wear measurement, the cylinder liner must first be set up with a gauge ring or micrometer. Use the original diameter of the cylinder liner as the base value.
- 2 Measure the cylinder liner at top and bottom dead centers, and at several places vertically. At each measurement location, measurement must be lengthwise and crosswise in relation to the engine.
- 3 If wear is greater than 0.45–0.50 mm, a new complete lining kit must be used (piston, liner, piston rings, piston pin and seals). Oil consumption also affects when cylinder liners must be changed.
- 4 Remove the cylinder liner and do a crack check. Be specially careful when checking the liner collars. The Magnaflux method may be used for this check.

Pistons

- 5 Check for worn piston ring grooves, damaged retainer ring grooves, cracks and other damage to the pistons. If the piston has deep scratches on its skirt, the piston (liner kit) must be scrapped. The same applies if the piston has one or more cracks in the

piston pin hole or in the bottom of the combustion chamber.

Crack tests must be done using the chalk powder method.

Cylinder Liner and Pistons, Replace (all)

Tools:

9989876 Dial indicator
9990157 Press tool
9990158 Piston ring compressor
9992479 Holder for dial indicator
9993590 Rotation tool
9996394 Support
9996395 Support
9996645 Puller
9996963 Plate
9998511 Lever
88800083 Piston ring pliers

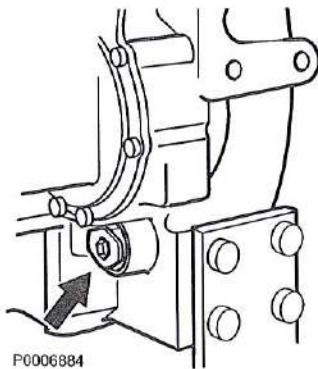
Removal

Cylinder head, oil pan, bracing frame and piston cooling nozzles removed.

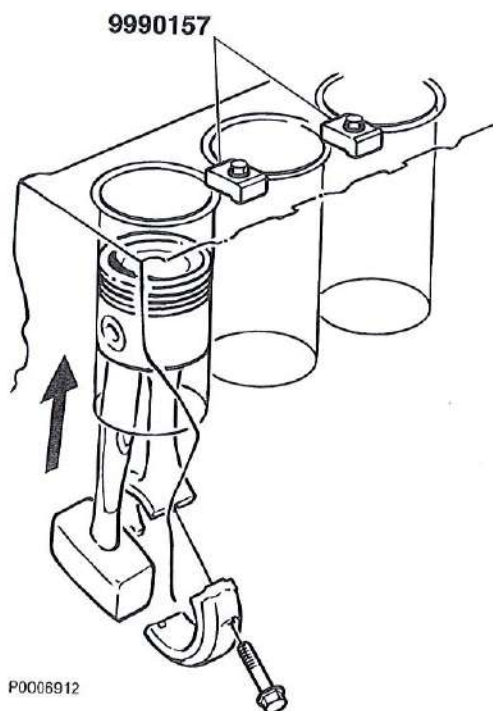
IMPORTANT!

It is important that the piston cooling nozzles be removed before the pistons are removed. Damaged nozzles may cause extensive engine damage.

- 1 Remove the protective cover in the flywheel housing and install tool 9993590 Rotation tool. Turn the crankshaft until access is gained to the bolts on the connecting rod that is to be removed.



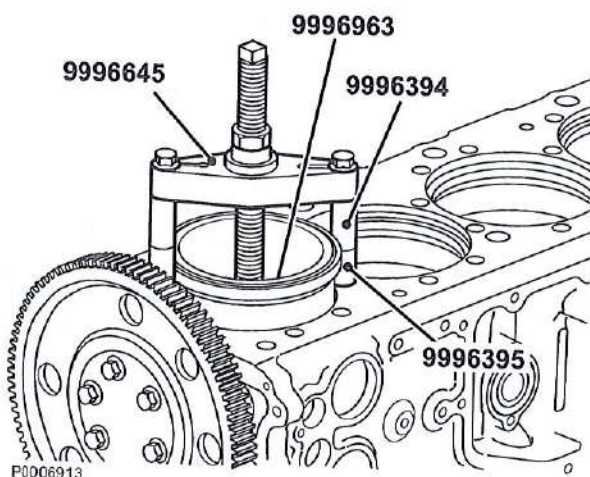
P0006884



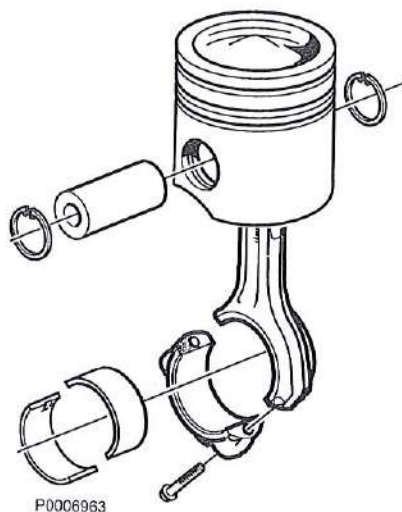
- 2 Remove the big end bearing caps and bearing cups.
- 3 Remove the piston together with the connecting rod.

IMPORTANT!

Re-install the bearing cap on the connecting rod to avoid damaging the split surface, as this is very sensitive.



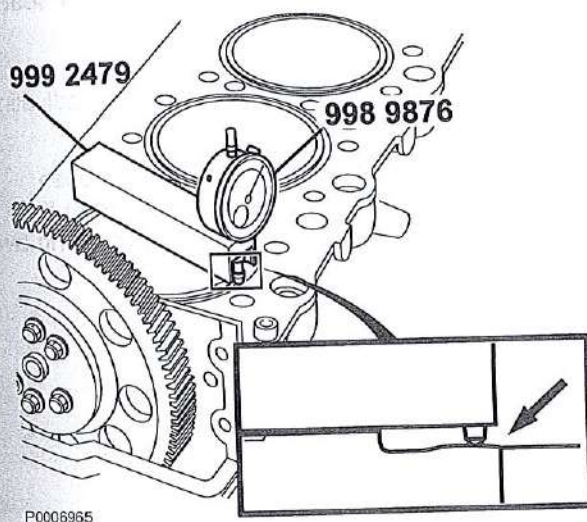
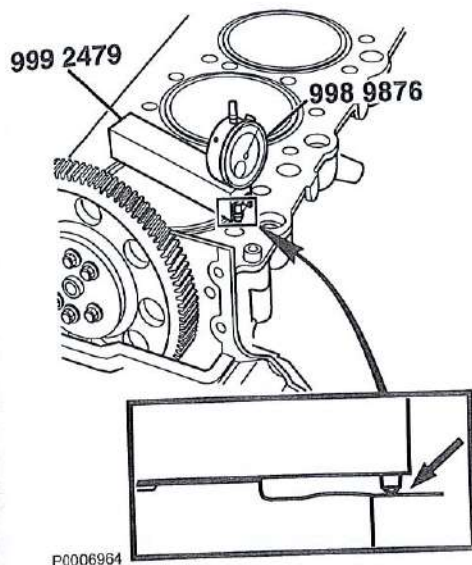
- 4 Pull the cylinder liner out of the block using tools 9996963 Plate, 9996645 Puller and 9996394 Support. If necessary, extend using tool 9996395 Support.
- 5 Remove the cylinder liner sealing rings.



- 6 Remove the retainer rings from the piston and press out the piston pin. Remove the piston from the connecting rod.
- 7 Clean the sealing surfaces in the cylinder block and the grooves for the sealing rings. Do not use scrapers or other tools that can damage the sealing surfaces.

Installation

- 8 Check the cylinder block liner seat for damage. In case of damage, the cylinder liner seat must be reconditioned.
Fit the cylinder liner, **without** sealing rings. Locate it using **two** tools 9990157 Press tool.
- 9 Fit tool 9989876 Dial indicator into tool 9992479 Holder for dial indicator.
Place the holder with dial gauge across the cylinder liner.
Zero the dial gauge with a couple of millimeters' pre-load against the cylinder block plane.

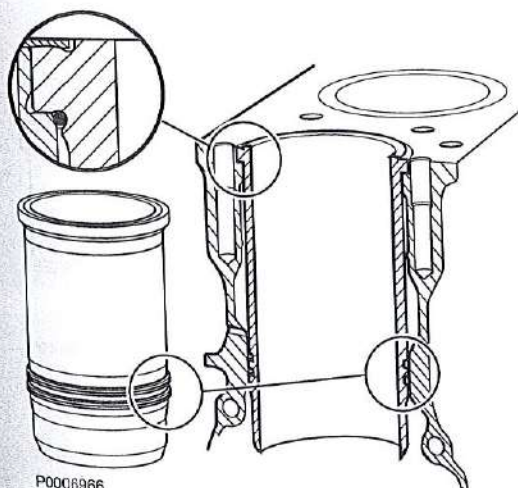


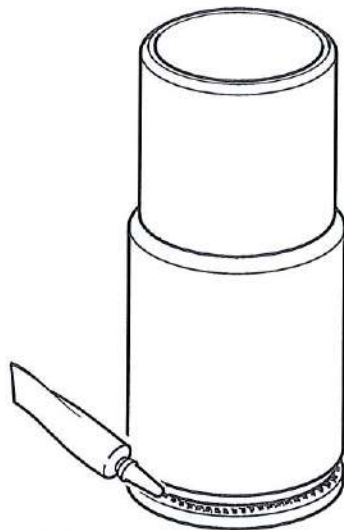
- 10 Measure the height between the cylinder liner and the cylinder block plane.
Measure the height of the liner in two places, diagonal to each other.
Calculate the average of the two measurements.
For correct liner height above block plane, see specifications. If the liner height above block plane is outside the specified tolerance, the liner collar in the cylinder block must be milled.

NOTICE! Always measure at the highest point of the sealing surface. Mark the liner position in the cylinder block with an felt-tip pen, so that it is replaced in the same position during installation. Repeat the procedure for the remaining cylinder liners.

- 11 Remove the two tools 9990157 Press tool. Pull the cylinder liner out of the block.
Place the cylinder liners in the same sequence that they were installed, together with any adjusting spacers.
- 12 Lubricate the sealing rings with the lubricant supplied with the lining kit and install them on the cylinder liners.

NOTICE! The purple seal ring must seat in the lowest groove

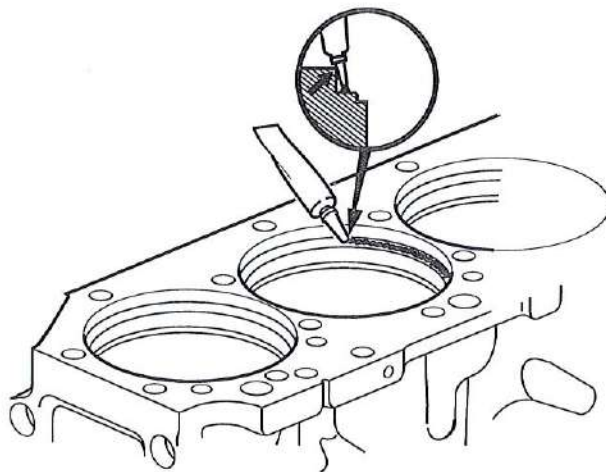




P0006917

- 13 When the cylinder liner is fitted **without** shims, an even, thick bead of about 0.8 mm (0.03") of sealing compound must be placed on the underside of the cylinder liner collar.

NOTICE! Do not put sealing compound around the entire liner. Leave a 2 mm (0.08") gap.



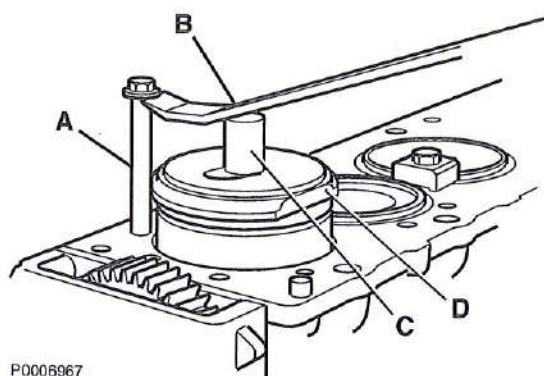
P0006918

- 14 If the liner is installed with shims, the sealant bead must be placed on the cylinder block liner seat.

IMPORTANT!

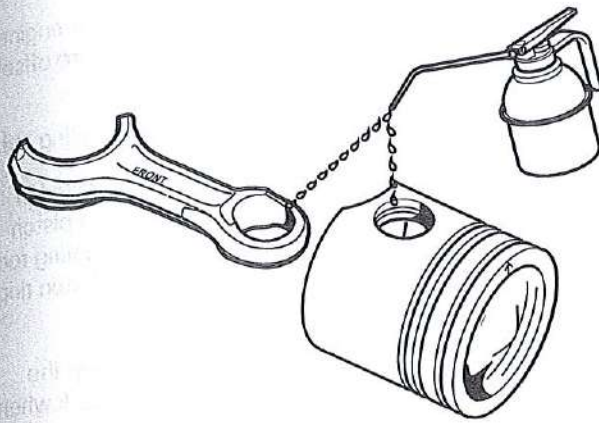
Sealant must not be used between the adjusting spacers and the cylinder liner collar.

- 15 **NOTICE!** After sealing compound has been applied, the liner must be installed **within 5 minutes** and fixed in the engine block using two tools 9990157 Press tool.



P0006967

- 16 Install one of the cylinder head bolts (A). Position tool 9996963 Plate (D) above the cylinder liner together with a suitable spacer (C) and press the cylinder liner down using tool 9998511 Lever (B).



- 17 Lubricate the piston pin, the piston bearing seat and the connecting rod bearing with engine oil.

P0006920

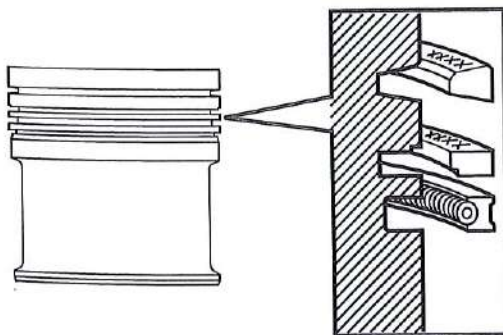


P0006921

- 18 Install the connecting rod in the piston with the mark "FRONT" on the connecting rod and the arrow on the piston facing the same direction. Press in the piston pin.

NOTICE! It should be possible to press the piston pin in without much force. If the resistance is too great, the piston may need to be heated. The connecting rod should turn freely on the piston pin.

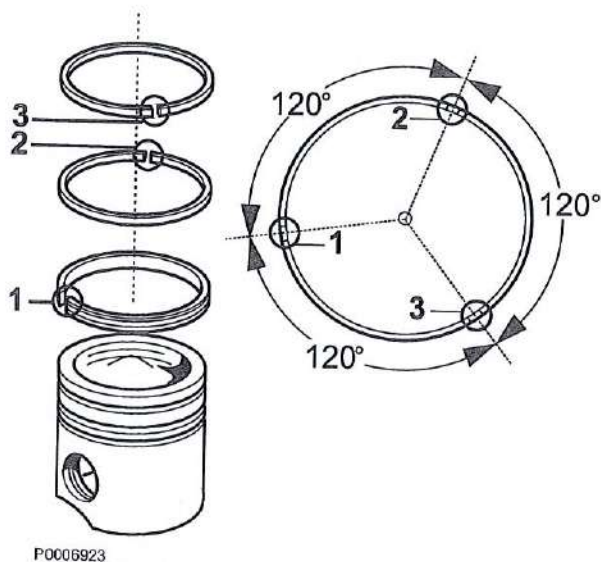
Install the retainer rings.



P0006968

- 19 Install the piston rings. Use tool 88800083 Piston ring pliers. The piston ring openings must be evenly spaced in relation to each other. The oil scraper ring opening must be diametrically opposite the opening in the spring.

NOTICE! The two upper piston rings are marked with letters or dots. The markings must face upward. The oil scraper ring is symmetrical and may face either way.



- 20 Lubricate the piston and piston rings with engine oil. Check that the piston ring openings are offset 120° in relation to each other.
- 21 Install the piston together with the connecting rod.

NOTICE! Connecting rods must be installed in their original positions. The arrow on the piston and the "FRONT" marking on the connecting rod must face forwards. Use tool 9990158 Piston ring compressor.

Temporarily remove the press tools when the piston is installed. Put the press tools back when the piston is in place.

- 22 Lubricate the bearing journal and bearing shells with engine oil. Install the bearing shells. Check that they are correctly aligned in the connecting rods and bearing caps. Install the main bearing cap according to the markings and torque as specified; refer to *Technical Data*.
- 23 Clean the piston cooling nozzle and check that it is undamaged. Install the nozzle and torque according to specifications; refer to *Technical Data*.

NOTICE! Make sure that the nozzle is directed toward the cutout in the piston.

Crankshaft, Inspection

The crankshaft is induction hardened.

Inspect the crankshaft very carefully to avoid unnecessary overhaul.

The following applies when the need for overhaul is checked:

- 1 Clean the crankshaft carefully.
Measure the bearing journals' out-of-round, wear and taper. Refer to *Technical Data* for specifications.
- 2 Check whether there is any surface damage on the bearing journals. If there is any damage on the surface layer, the shaft must be re-ground.
- 3 Place the shaft pair of V-blocks, under 1st and 7th main bearing journals. Alternatively, hold the crankshaft between the two centers.
- 4 Measure crankshaft axial displacement (throw) on the 4th main bearing.
For maximum permissible values, refer to *Technical Data*.

IMPORTANT!

Crankshaft straightening is not permitted.

- 5 Check for cracks before and after any grinding.
Magnetic powder testing is used for this test, i.e. fluorescent powder which is viewed under ultra-violet light.

Main bearing, Change

Oil pan removed

The method describes replacement of main bearings with the crankshaft in place in the engine

Tools:

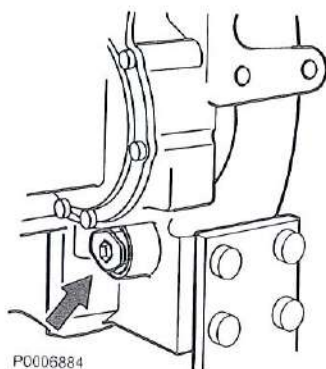
9990013 Slide hammer

9990114 Puller

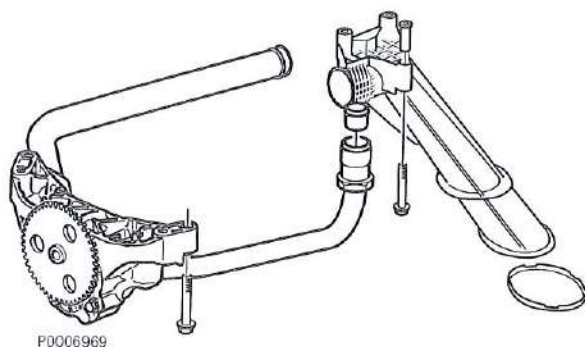
9993590 Rotation tool

Removal

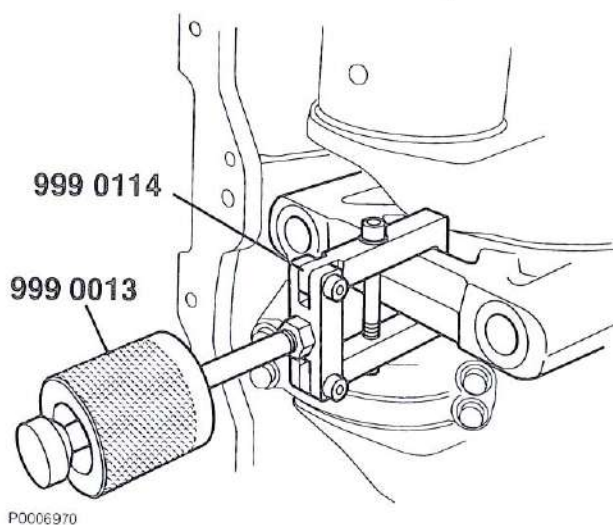
- 1 Fit tool 9993590 Rotation tool.

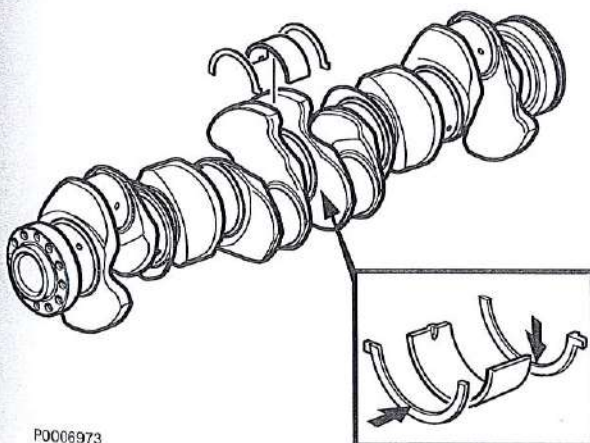
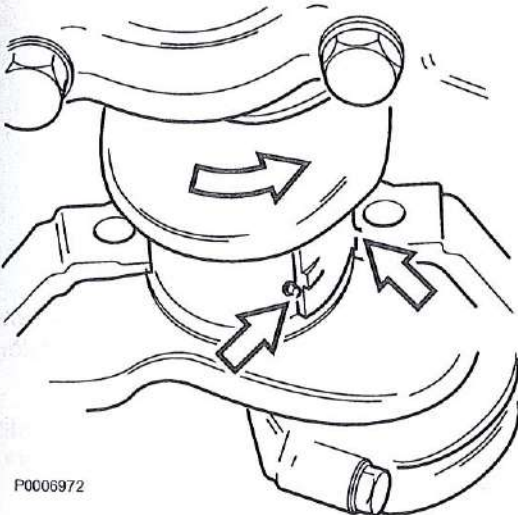
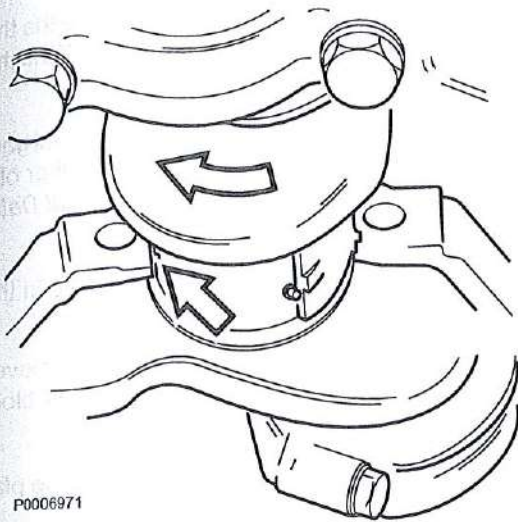


- 2 Remove the oil suction pipe and oil pump.
Remove the bracing frame.



- 3 Remove one bearing cap.





- 4 Remove the upper main bearing shell by putting a pin in the crankshaft oil hole and rolling the bearing shell out by turning the crankshaft in the direction of rotation with tool 9993590 Rotation tool.
- 5 Clean and check the bearing seat, bearing cap, shaft journal and bearing shell.
If the bearing has seized, the reason must be determined before a new bearing is installed.
- 6 Check that the correct bearing dimension is used when the bearing shells are changed.

NOTICE! If case of uncertainty, check in *Technical Data* which oversize dimensions are available.

Installation

- 7 Lubricate the shaft journal and the new bearing shells with engine oil.
- 8 Install the upper bearing shell by turning the crankshaft using tool 9993590 Rotation tool against the direction of rotation with the pin in the oil hole.

NOTICE! Check that the pressed-out bearing shell heel is correctly aligned in the bearing seat cutout.

Make sure that the upper bearing shells (those to be located in the engine block) are equipped with oil holes.

NOTICE! Remove the pin when done.

- 9 Fit the main bearing cap together with the lower bearing shell.

NOTICE! The main bearing caps are asymmetric and can only be installed in one position. Note the main bearing cap numbers showing their locations if several caps are removed simultaneously.

Torque the caps in two steps as specified; refer to *Technical Data*.

- 10 Change the other bearing shells, one a time, in the same way as the first one. Each time a changed is made, check that the crankshaft does not seize by turning it using tool 9993590 Rotation tool.

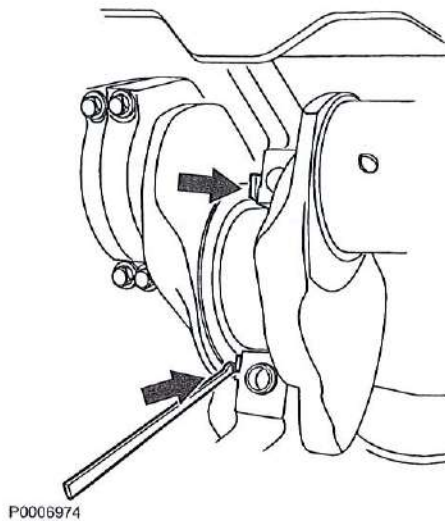
- 11 Check crankshaft end float and replace the thrust washers if the clearance is too great or if the thrust washers are damaged.

NOTICE! Measure the end float with a dial gauge. Thrust bearings are available in a number of oversize dimensions. Refer to *Technical Data* for oversize dimensions and axial play.

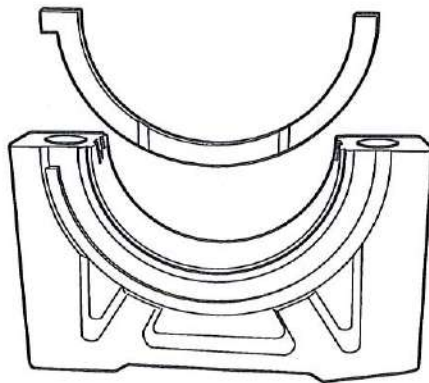
The crankshaft thrust bearing is located in the center main bearing.

- 12 Use a narrow plastic or wood stick to remove the thrust bearing washers from the cylinder block bearing seat.

NOTICE! The thrust washers can only be placed in one position.



P0006974



P0006975

- 13 Check the axial play of the crankshaft when all main bearing caps have been torqued; refer to *Technical Data* for specification.
- 14 Install the bracing frame and torque according to the tightening chart; refer to *Technical Data*.
- 15 Install the oil pump and oil suction pipe.
- 16 Remove tool 9993590 Rotation tool from the flywheel housing and install the cover.
- 17 Install the oil pan.
Add oil and change the oil filter.
Check the oil pressure.

Big end bearing, Change (all)

Oil pan, oil suction pipe and bracing frame removed.

Tools:

9993590 Rotation tool

Removal

- 1 Fit tool 9993590 Rotation tool and turn the flywheel until the bearing caps on connecting rods 1 and 6 are in a position that allows the bolts to be removed.
- 2 Mark and remove the bearing caps on connecting rods 1 and 6.

IMPORTANT!

Be careful not to damage the surfaces.

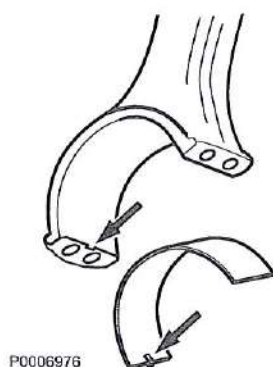
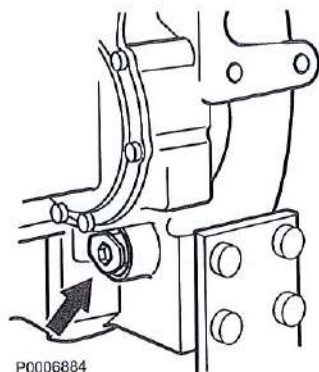
- 3 Remove the bearing shells and clean the connecting rod and cap bearing seats.

NOTICE! Make sure the bearing caps are installed on the same connecting rod.

- 4 Check the bearing journals and bearing caps.
- 5 Measure the shaft journals; if any value exceeds the maximum allowed, the crankshaft must be removed and remedied.

Installation

- 6 Fit the new the bearing shells and check that the bearing size is correct. Make sure the bearing shell guide pins is aligned with the connecting rod recess.
- 7 Lubricate the bearing shells and the big end journals. Fit the bearing caps and torque the bolts as specified; refer to *Technical Data*.
- 8 Turn the flywheel so that connecting rods 5 and 2 are in position for bolt removal and repeat steps 2-7.
- 9 Turn the flywheel so that connecting rods 3 and 4 are in position for bolt removal and repeat steps 2-7.
- 10 Check that no big end bearing binds.
- 11 Remove the turning tool from the flywheel housing and install the cover.
- 12 Install the bracing frame, oil suction pipe and oil pan.
Add oil and change the oil filter.
Check the oil pressure.

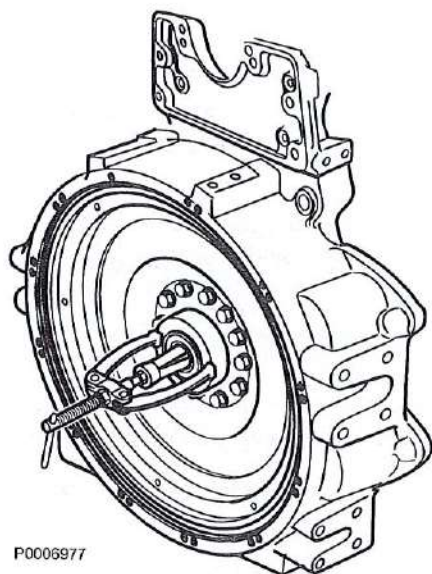


Flywheel Bearing, Change

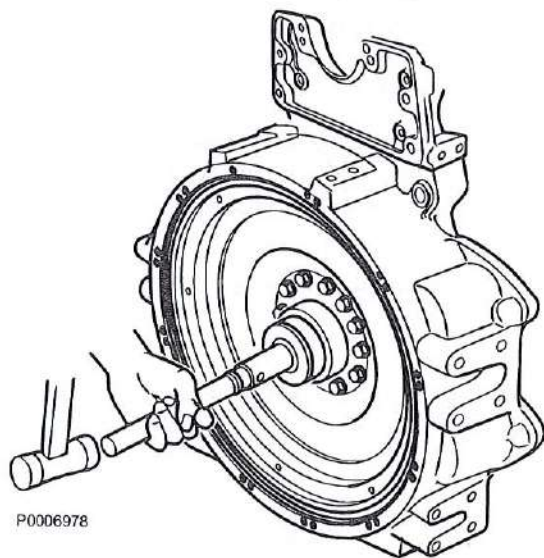
Tools:

9986173 Puller
9986179 Puller
9991801 Standard handle
9992269 Drift

- 1 Measure the bearing position on the flywheel.
- 2 Remove the old bearing using tool 9986173 Puller and 9986179 Puller.



- 3 Tap the new bearing into the measured position, using tool 9991801 Standard handle and 9992269 Drift.

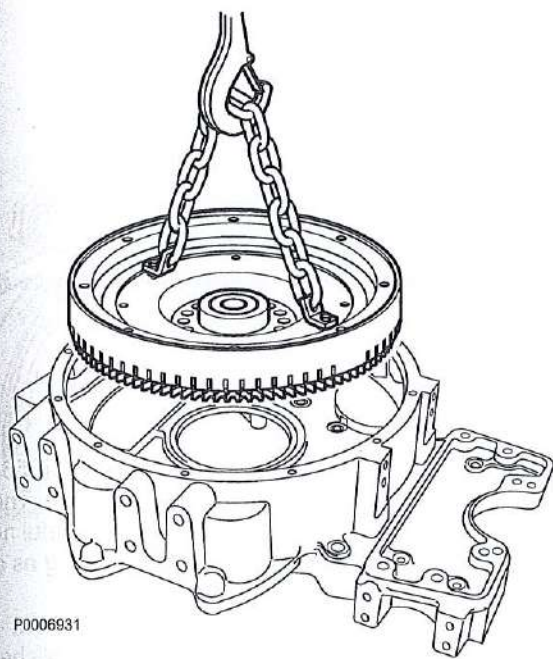


Flywheel, Change

Tools:

9993590 Rotation tool

9996239 Lifting tool



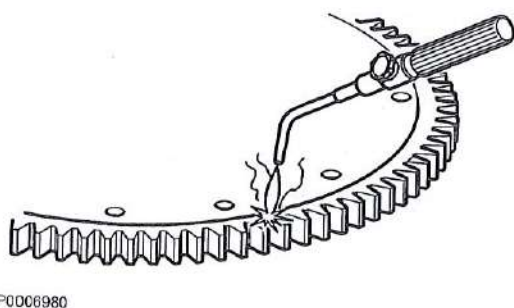
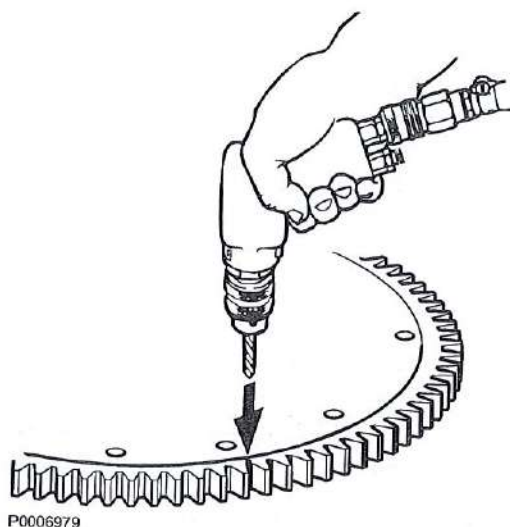
P0006931

- 1 Remove the flywheel sensor.
- 2 Fit tool 9993590 Rotation tool.
- 3 Bolt tool 9996239 Lifting tool onto the flywheel with two bolts.
Remove the flywheel retaining bolts. Use as the turning tool as a counterhold.
Lift the flywheel away.
- 4 Clean the flywheel contact surface on the crankshaft.
- 5 Clean the flywheel. Check that the tracking surfaces for the flywheel sensor are clean.
- 6 Check that the flywheel guide pin is correctly inserted into the crankshaft.
Check that there is no damage.
- 7 Lift the flywheel into position and install the retaining bolts.
- 8 Torque the retaining bolts according to the tightening chart; refer to *Technical Data*. Use tool 9993590 Rotation tool as a counterhold.
- 9 Remove the cranking tool and re-install the cover.
- 10 Check the flywheel sensor clearance; refer to *Sensors, Adjustment*.
Install the flywheel sensor.

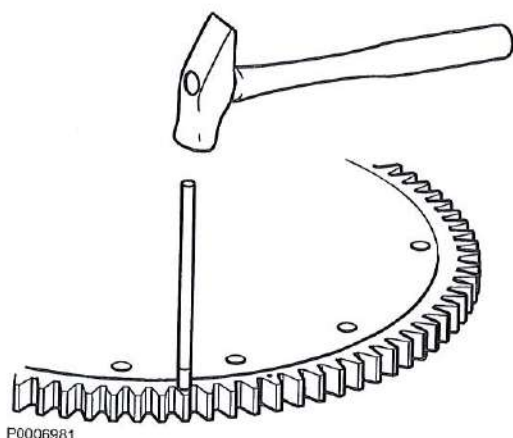
Gear Ring, Flywheel: Replace

Flywheel removed.

- 1 Drill 1–2 holes between teeth on the ring gear. Split the gear ring at the drilled hole, using a cold chisel. Lift the gear ring away from the flywheel.
- 2 Brush the flywheel contact surface clean with a steel wire brush.



- 3 Heat the new gear ring up to 180–200°C (356–392 °F) with a welding torch or in an oven. The gear ring must be evenly heated. Be careful not to heat the gear ring up far with annealing as a result. Check the heat by polishing the ring bright at several places. Stop heating when the polished surfaces become blued.



- 4 Put the heated gear ring onto the flywheel and tap it into place with a soft mandrel and hammer. Leave the gear ring to cool.

Flywheel, Indication

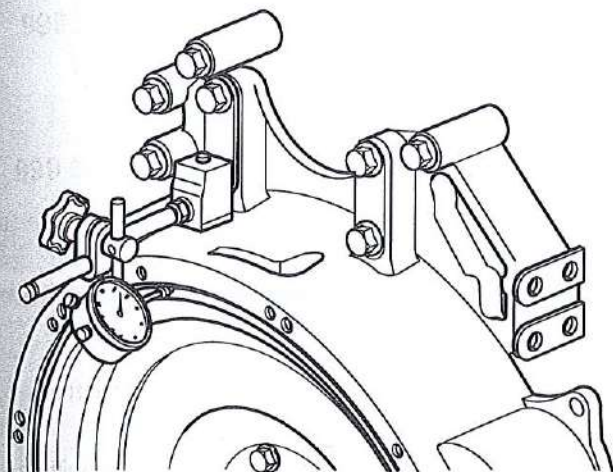
Pressure plate removed.

Tools:

9989876 Dial indicator

9993590 Rotation tool

9999696 Magnetic stand



P0006985

- 1 Install tool 9989876 Dial indicator and 9999696 Magnetic stand with the measuring tip against the flywheel.
- 2 Remove the cover from the engine flywheel housing. Fit tool 9993590 Rotation tool.
- 3 Set the dial gauge to zero. Turn the flywheel and observe the maximum value measured on the dial gauge. This must not exceed 0.20 mm (0.0079") on a measurement radius of 150 mm (5.91").
If the runout is greater, remove the flywheel and investigate whether there is any dirt or unevenness between the flywheel and the crankshaft flange.
- 4 Remove tool 9993590 Rotation tool and install the cover.

Crankshaft Seal, Change (front)

Option 1

Tools:

9990118 Cone
9992000 Handle
88800021 Drift

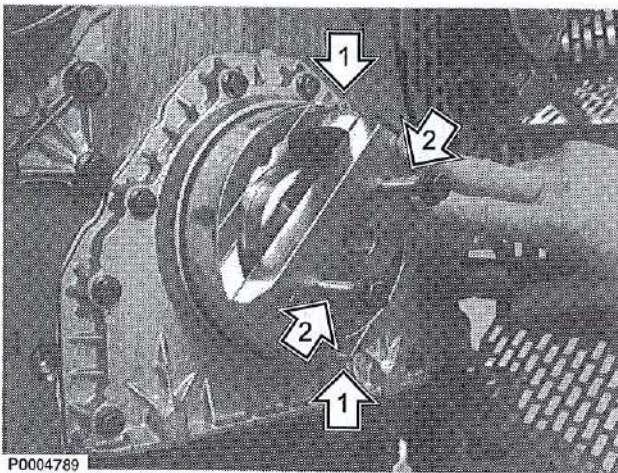
Option 2

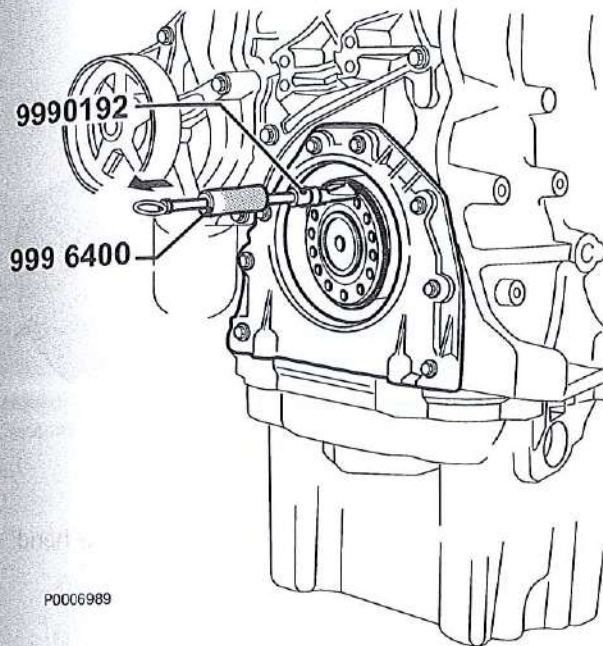
Tools:

9990118 Cone
9990192 Puller
9992000 Handle
9996400 Slide hammer
88800021 Drift

Removal, alternative 1

- 1 Remove the crankshaft pulley and oscillation damper (12 bolts).
- 2 Drill 2 holes \varnothing 3.5 mm (0.14") in the seal with the aid of the guide holes in tool 88800021 Drift. Brush grease on the drill to prevent dirt from getting into the engine.
- 3 Screw two 5 mm self-tapping screws (1) 5 mm (0.2") into the seal.
- 4 Screw in two long thread M10 x 60 bolts (2) into the tool and pull the seal out. Remove the seal and bolts from the tool.
- 5 Clean the seal area in the cover and the sealing surface on the crankshaft.





Removal, alternative 2

Tools:

9990192 Puller

9996400 Slide hammer

- 1 Hammer out the seal with tool 9990192 Puller together with 9996400 Slide hammer.

IMPORTANT!

Incline the tool to ensure that the crankshaft is not damaged.

Installation

Tools:

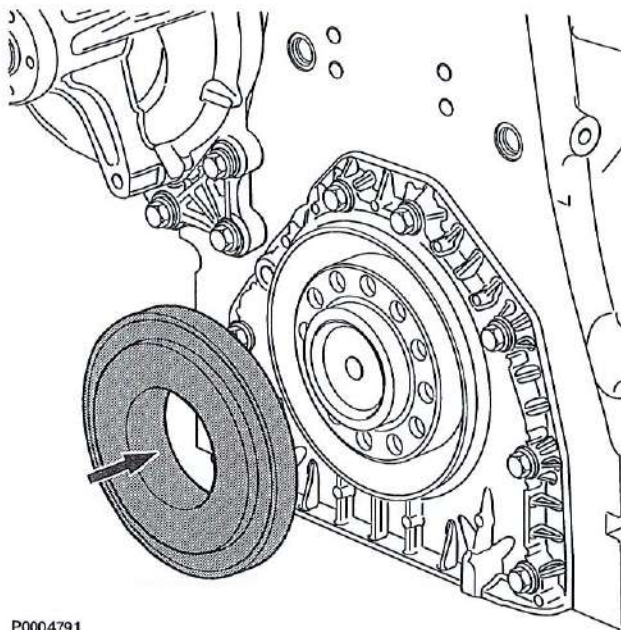
9992000 Handle

88800021 Drift

- 1 Check that the plastic ring is correctly in place in the new seal.

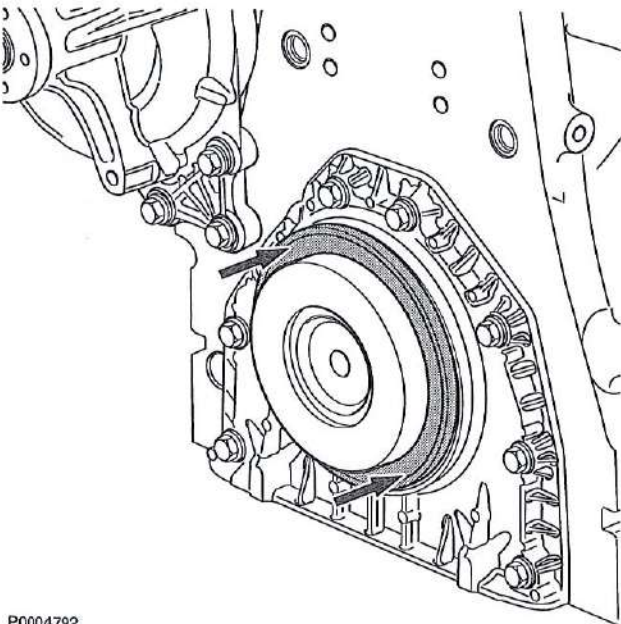
NOTICE! If the plastic ring is not in place in the new seal, the seal ring may be damaged and must not be used.

- 2 Clean the crankshaft sealing surface and cover. Check that these are damage free.



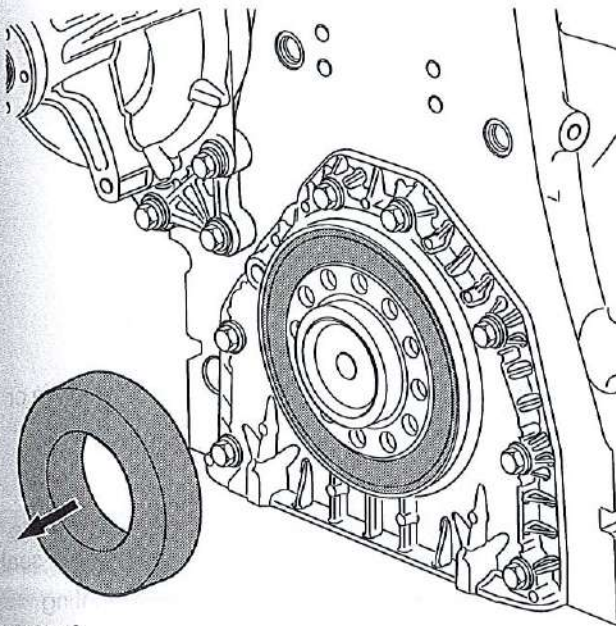
P0004791

- 3 Install the new sealing ring and plastic ring onto the crankshaft journal.



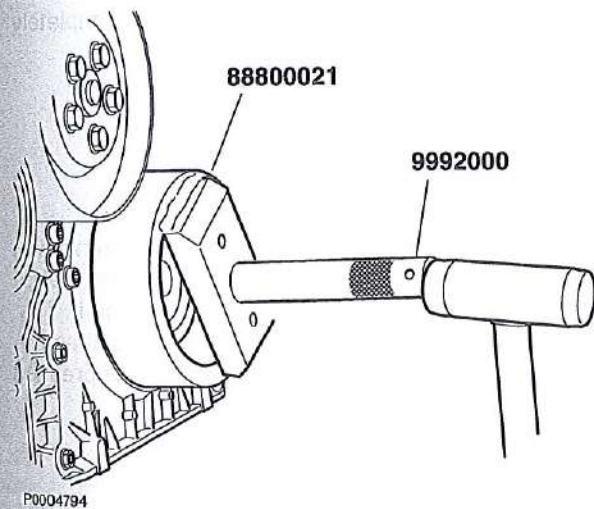
P0004792

- 4 Press home the seal toward the cover by hand.



P0004793

- 5 Remove the plastic ring.



P0004794

- 6 Carefully tap in the new seal until it bottoms against the crankshaft journal. Remove the tool.
- 7 Ensure that the crankshaft, belt pulleys and hub mating surfaces are clean and damage free.
- 8 Install the oscillation damper and pulley. Torque according to specifications; refer to *Special Tightening Torques*.

Crankshaft Seal, Change (rear)

Tools:

9990166 Mounting tool
9990192 Puller
9992000 Handle
9996400 Slide hammer

Removal

- 1 Fit tool 9996400 Slide hammer and 9990192 Puller on the old seal by pressing it in or tapping it in with a slide hammer.

IMPORTANT!

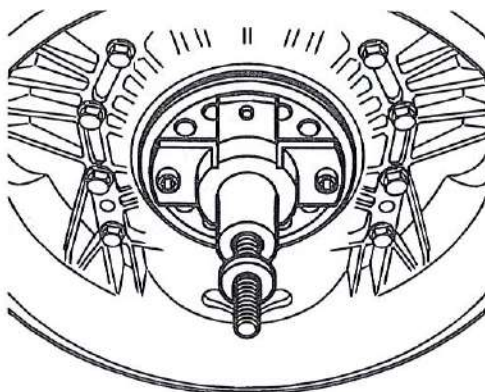
Be careful not to damage the crankshaft. Incline the tool inwards to ensure a good grip in the seal. Hammer out the seal with 9990166 Mounting tool.

- 2 Clean the seal area in the flywheel housing (the timing gear cover) and the sealing surface on the crankshaft (sealing surfaces must be completely clean and dry).

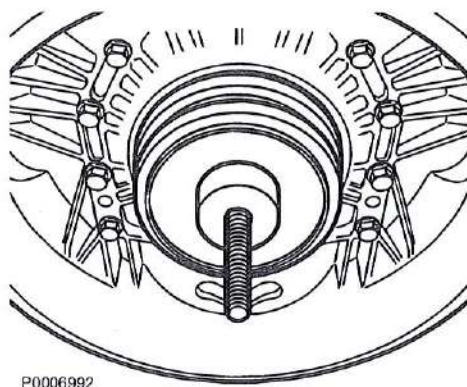


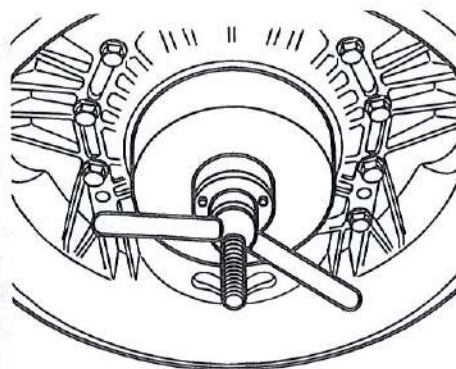
Installation

- 3 Install the tool on the crankshaft and fasten it with the bolts. Make sure that the plate on the tool is touching the crankshaft before tightening it. The washer must be placed on the center bolt as a spacer. It determines how far the seal is pressed into the cover.



- 4 Install the plastic ring that the new seal is mounted on and install the cover together with the screw handle.





P0006993

- 5 Press in the seal using the tool; when the cover bottoms against the tool, the seal will be in the correct position.

IMPORTANT!

No lubricants may be used and surfaces must be clean.

- 6 Remove 9990166 Mounting tool.

Connecting Rod, Check

Important consideration when removing/installing fracture-split connecting rods.

Installing a NEW connecting rod:

Carefully fix the connecting rod in a vise with soft jaw pads.

Undo the connecting rod bolts a few turns and carefully tap the bearing cap with a plastic faced hammer until it loosens.

The split line can be difficult to find when the connecting rod is assembled.

When the cap is separated from the connecting rod, it may occur that a chip is missing or comes loose. This does not affect the function of the connecting rod adversely.

Handle the connecting rod and bearing cap carefully. If any strike marks occur on the split line, this may affect strength after torquing.

IMPORTANT!

If the connecting rod or bearing cap are damaged, change the connecting rod.

Connecting Rod Bushing, Check up

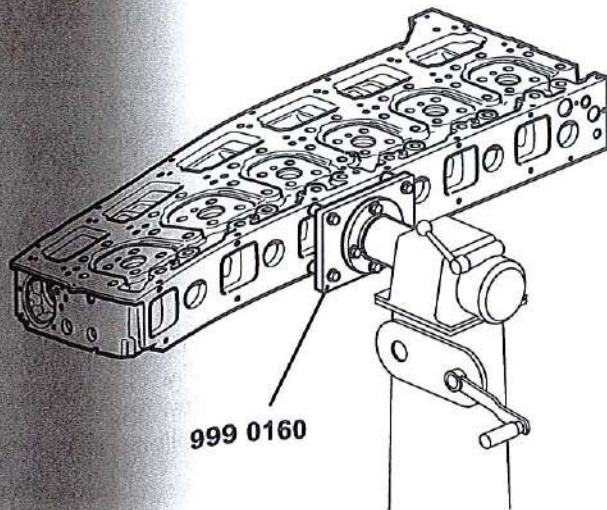
- 1 Check the connecting rods for cracking, straightness and twist before any piston pin bush replacement. Scrap the connecting rod if it is cracked, bent or twisted.
When the piston pin bush is changed, the bush must be machined (trapezoid piston pin end).
When the clearance is correct, an oiled piston pin should slowly slide through the bush under its own weight.

IMPORTANT!

Regarding max. allowed straightness and twist deviations, refer to *Technical Data*.



- 2 Use a new piston pin and measure the straightness of the connecting rod, using a fixture.
- 3 Measure connecting rod twist.



P0006996

Valves, Removal

Work is made easier if the cylinder head is fixed in an equipment stand using tool 9990160 Fixture. Use 4 pcs. bolts M8 x 25.

NOTICE! It is important that the greatest possible cleanliness is observed during work on the cylinder head. Dirt particles in the fuel ducts can cause failure or malfunction of the unit injectors.

Alternative 1

Tools:

9809726 Pneumatic hydraulic pump
9809729 Hydraulic cylinder
9990160 Fixture
9990174 Drift
9992670 Hand pump
9996159 Adapter
9998246 Drift

Note: 9992670 Hand pump is alternative to 9809726 Pneumatic hydraulic pump .

Alternative 2

Tools:

9990210 Valve spring compressor

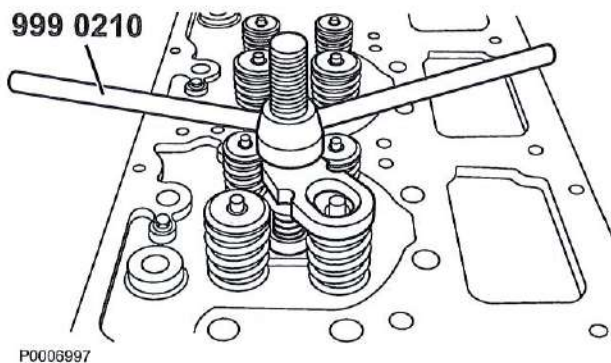
Alternative 1

- 1 Fit tool 9809729 Hydraulic cylinder into tool 9990176 Press tool.
- 2 Install tool 9996159 Adapter and tool 9998246 Drift (inlet) or tool 9990174 Drift (outlet) on the hydraulic cylinder. Place the tool in the holes for the cylinder head retaining bolts. Tighten the tool nuts.
- 3 Connect tool 9809726 Pneumatic hydraulic pump (alternatively 9992670 Hand pump).
- 4 Press the valve spring washer down and remove the collets.

NOTICE! Check that the tool does not damage the unit injector electrical connector, if the injector is left in place.

NOTICE! Put the valves and springs in a marked stand, to facilitate putting components back in the same places in the cylinder head.

- 5 Remove the remaining valves in the same way as above, using the press tool.
- 6 Remove the oil seals from the valve guides.



Alternative 2

Tools:

9990210 Valve spring compressor

- 1 Lay the cylinder head on a flat, clean surface. Make sure the cylinder head is not damaged when the valves are to be removed.
- 2 Fit tool 9990210 Valve spring compressor in the unit injector hole. Fix the tool in the bolt hole for the unit injector yoke, M10 x 30.
- 3 Place the moving part of the tool over the valve spring to be removed. Screw down the "wing nut" on the tool until the valve washer has been pressed down so far that the collets can be removed.

NOTICE! Put the valves and springs in a marked stand, to facilitate putting components back in the same places in the cylinder head.

- 4 Remove the remaining valves in the same way as above.
- 5 Remove the oil seals from the valve guides.

Valves, Installation

Alternative 1

Tools:

9809726 Pneumatic hydraulic pump
9990165 Guide sleeve
9990174 Drift
9990176 Press tool
9990210 Valve spring compressor
9992670 Hand pump
9996159 Adapter
9998246 Drift

Note: 9992670 Hand pump is alternative to 9809726 Pneumatic hydraulic pump .

Alternative 2

Tools:

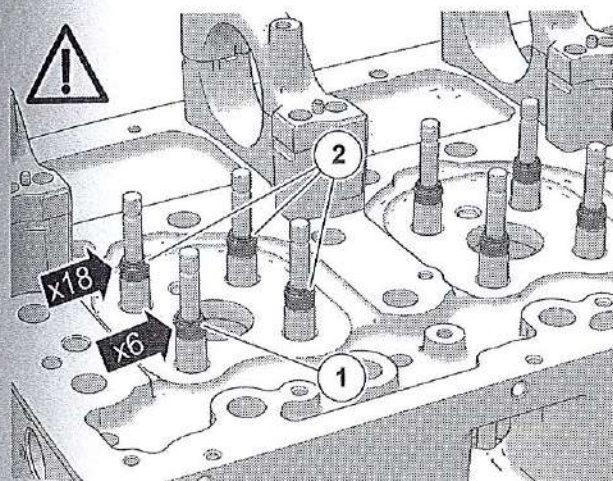
9990210 Valve spring compressor

Alternative 1

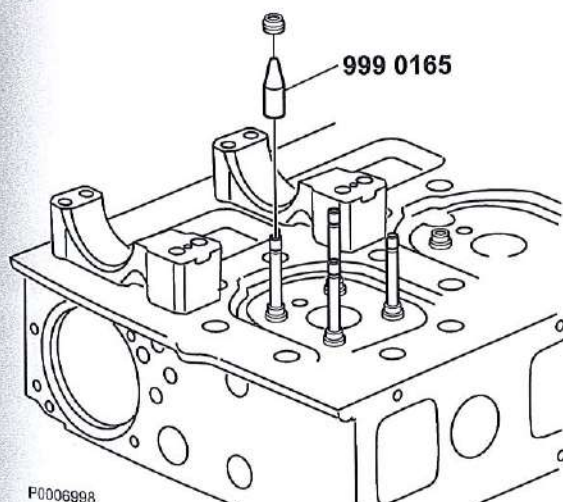
Not TAD670-672VE

IMPORTANT!

- 1 Blue valve stem sealing.
- 2 Brown valve stem sealing.



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P0006998

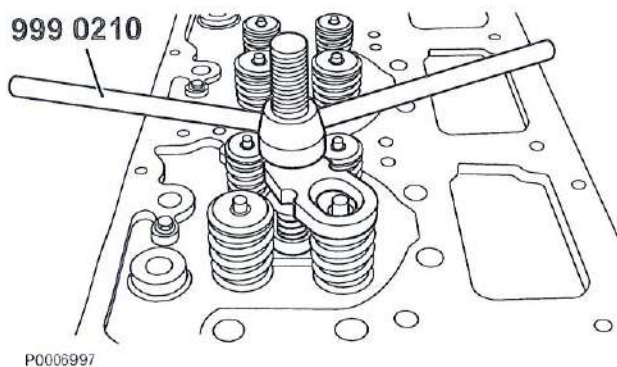
- 1 Oil the valve stems and install the valves. Oil the oil seals.
 - 2 Install tool 9990165 Guide sleeve on the valve stem and press the new oil seals down over the valve guides.
- NOTICE!** Check that the oil seals are pressed down properly.
- 3 Install the valve caliper guide pins. Install the springs and valve spring washers. Carefully press down the valve spring washer and install the collets. Use tool 9990176 Press tool together with 9809726 Pneumatic hydraulic pump , 9996159 Adapter and 9998246 Drift (inlet) or 9990174 Drift (outlet), in the same way as for Valves, Removal.

Alternative 2

Tools:

9990210 Valve spring compressor

- 1 Alternatively, tool 9990210 Valve spring compressor may be used instead of the hydraulic cylinder, in the same way as for Valves, Removal.



Valve Seat, Change

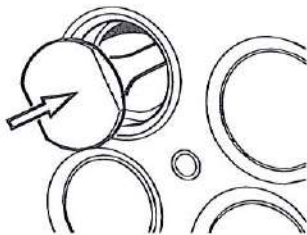
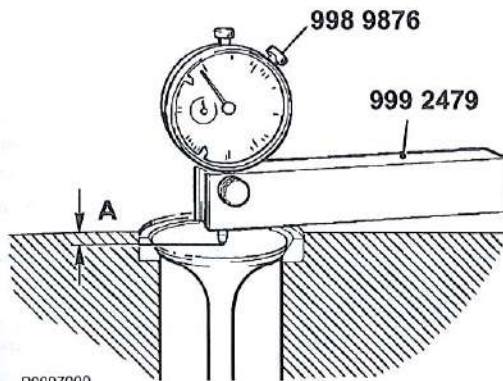
Cylinder head and valves removed.

Tools:

9989876 Dial indicator

9992479 Holder for dial indicator

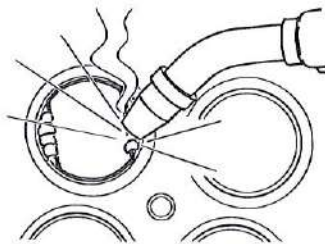
- 1 The valve seats must be changed if a satisfactory seal cannot be obtained or when the distance (A) exceeds the value stated in the specification; refer to *Technical Data*.

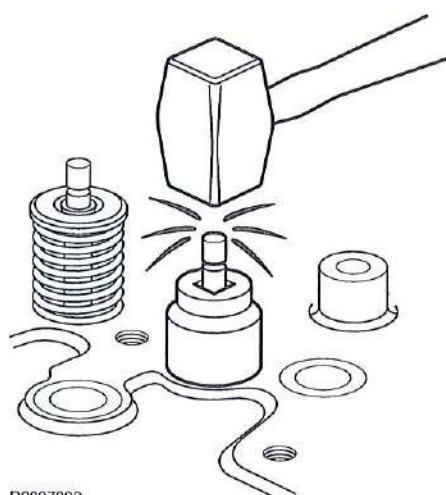


- 2 Grind the head off an old valve and weld it onto the valve seat. Use a MAG welder, or a conventional arc welder (with a stainless welding electrode).

IMPORTANT!

Carefully cover the other surfaces on the cylinder head to prevent any weld spatter from fastening.





- 3 Place a suitable socket over the valve/valve guide and carefully tap the valve seat out.

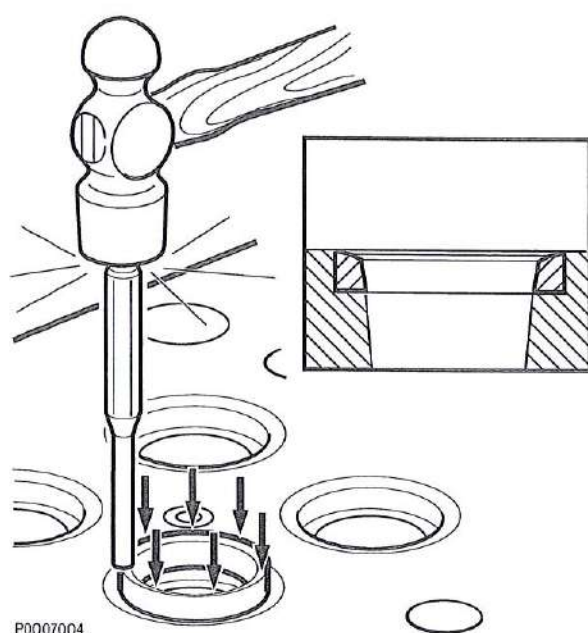
IMPORTANT!

Be careful not to damage the cylinder head.

CAUTION!

Risk of eye injury. Eye protection required.

- 4 Clean the seat bed carefully and check the cylinder head for cracks.
- 5 Measure the diameter of the valve seat bed in the cylinder head. Determine whether a standard or oversize dimension valve seat must be used. Carry out any necessary machining to the valve seat bed; refer to *Technical Data*.



- 6 Cool the seat in carbon dioxide snow between -60°C (-76°F) and -70°C (-94°F) and heat the cylinder head by flushing with hot water, or by some other method. Install the new valve seat using a drift.

NOTICE! Align the seat with the seat angle facing the tool. Check sealing against the valve.

Valve Guides, Inspection

Refer to *Valve Guides, Inspection*.

Valve Guides, Replacing

Cylinder head removed.

NOTICE! If the valve seats must also be changed, this must be done before the valve guides are removed.

CAUTION!

Risk of eye injury. Eye protection required.

Option 1

Tools:

9809726 Pneumatic hydraulic pump
9809729 Hydraulic cylinder
9990176 Press tool
9996159 Adapter
88800064 Drift
88800127 Drift
88800147 Drift

Optional tools

Tools:

9992670 Hand pump

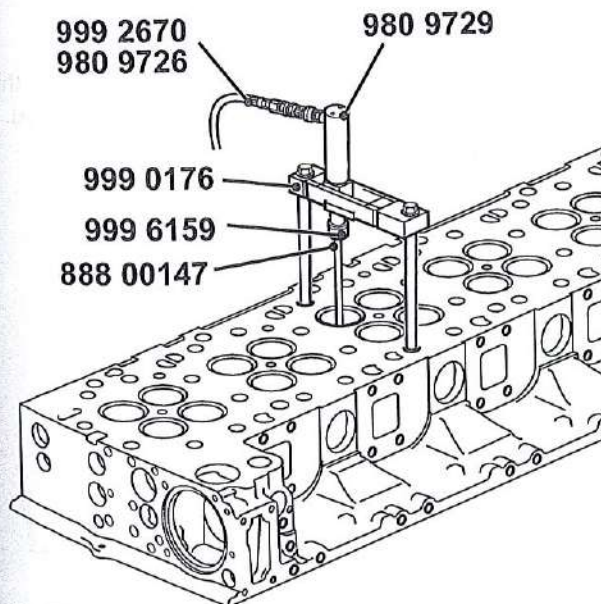
Note: 9992670 is alternative to 9809726.

Removal

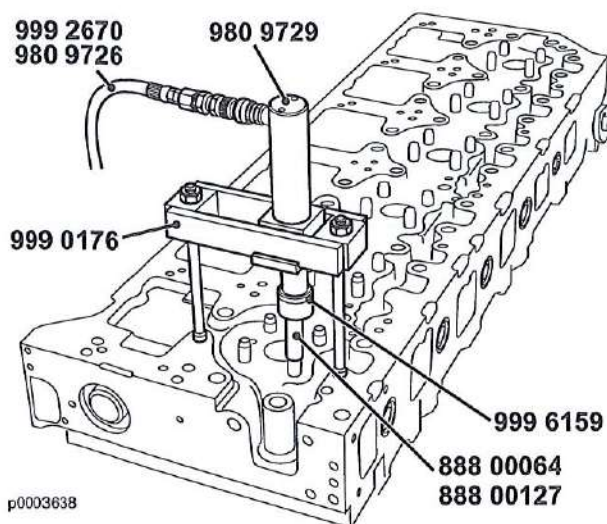
- 1 Install tool 9990176 Press tool into the cylinder head retaining bolt holes.

NOTICE! Put washers between the nuts and the cylinder head plane.

- 2 Tighten the tool nuts.
- 3 Install tool 9996159 Adapter in the hydraulic cylinder.
- 4 Fit tool 9809729 Hydraulic cylinder into tool 9990176 Press tool and press out the valve guide using tool 88800147 Drift and 9809726 Pneumatic hydraulic pump, alternatively 9992670 Hand pump.
- 5 Press the other valve guides out in the same way.



p0003637



Installation

- 6 Heat the cylinder head with hot water while cooling the valve guides with e.g. carbon dioxide snow.
Lubricate the cylinder head valve guides with engine oil.

IMPORTANT!

Wear protective goggles when pressing.

- 7 Press in the valve guide for the inlet valve using tool 88800064 Drift. Press in the exhaust valve guide using tool 88800127 Drift.
- 8 Press until the tool bottoms against the cylinder head plane.
- 9 Remove the tool from the cylinder head.

IMPORTANT!

After the valve guides have been changed, the cylinder head must be cleaned carefully to prevent dirt particles from getting into the fuel and oil ducts. Contamination may cause failure or malfunction of the unit injectors.

Option 2

Tools:

9992000 Handle
88800064 Drift
88800127 Drift
88800147 Drift

NOTICE! If the valve seats must also be changed, this must be done before the valve guides are removed.

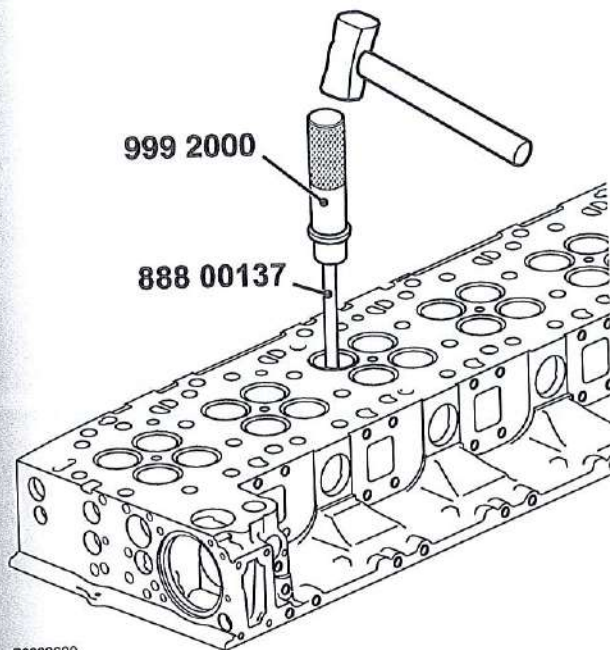
⚠ CAUTION!

Risk of eye injury. Eye protection required.

Removal

NOTICE! Take out the valve guides from beneath the cylinder head.

- 1 Tap out the valve guides with tool 88800147 Drift together with 9992000 Handle.
- 2 Tap the other valve guides out in the same way.



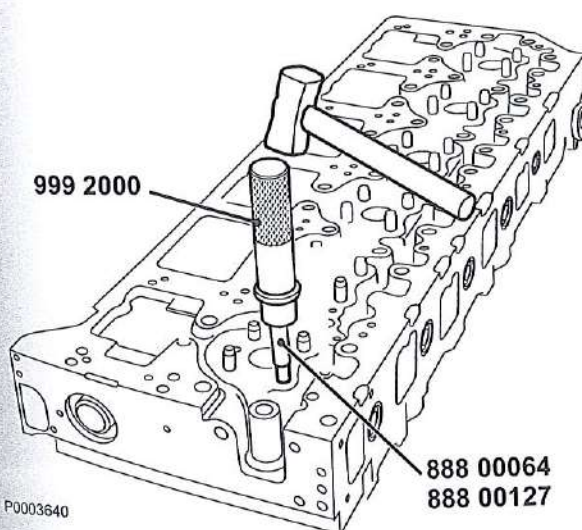
Installation

- 3 Heat the cylinder head with hot water while cooling the valve guides with e.g. carbon dioxide snow. Lubricate the cylinder head valve guides with engine oil.

CAUTION!

Risk of eye injury. Eye protection required.

- 4 Tap in the valve guide for the inlet valve using tool 88800064 Drift. Tap in the exhaust valve guide using tool 88800127 Drift.
- 5 Tap until the tool bottoms against the cylinder head plane.
- 6 Repeat the procedure for the remaining valve guides.



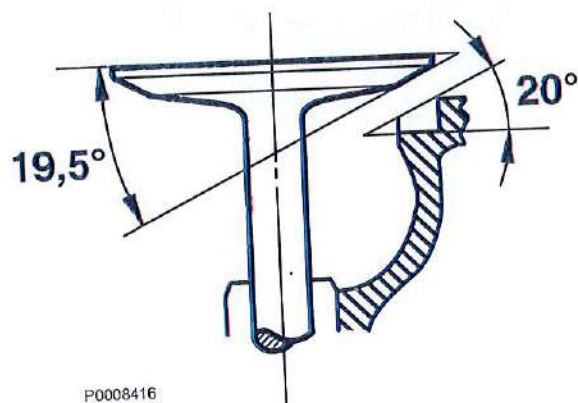
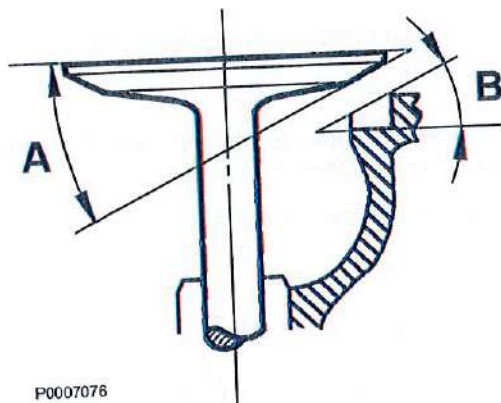
IMPORTANT!

After the valve guides have been changed, the cylinder head must be cleaned carefully to prevent dirt particles from getting into the fuel and oil ducts. Contamination may cause failure or malfunction of the unit injectors.

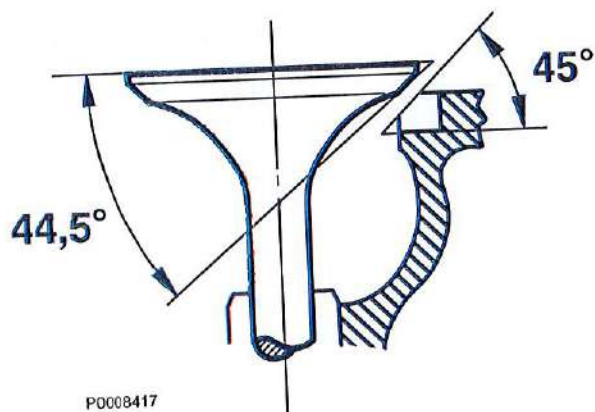
Valve Seats and Valve, Grinding

For valve sealing angles, refer to *Technical Data*.

NOTICE! Spare part valve seats are already machined, and do not need further grinding.



Inlet valve



Exhaust valve

Valve seat, grinding

- 1 Before the valve seats are ground, the valve guides must be checked and changed if wear tolerances have been exceeded.
- 2 When grinding valve seats, do not remove an unnecessary amount of material; only remove enough material to give the valve seat the correct shape and a good mating surface.
- 3 Grind new seats down so far that the dimension between the cylinder head plane and the valve disc surface, is in accordance with specifications; refer also to *Technical Data*.
- 4 Check the valve seat angle with a valve seat gauge, once the seat mating surface has been coated with a thin layer of marker dye.

NOTICE! Spare part valves are already machined, and do not need further grinding.

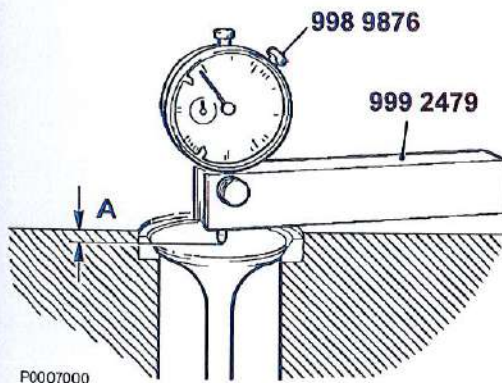
NOTICE! The sealing surface must be ground as little as possible; however, enough to grind away all damage.

Valves, grinding

- 1 Check dimension (A). If the dimension is greater than the wear tolerance as specified in *Technical Data*, the valve must be changed.

NOTICE! Always change a valve with a bent valve stem.

- 2 Check valve sealing with marker dye. If there is any leakage, grind the **valve seat** again; refer to Valve Seat, Grinding, then do a new check. Once the results of grinding are acceptable, the valve and seat may be lapped in with fine grinding paste.



P0007000

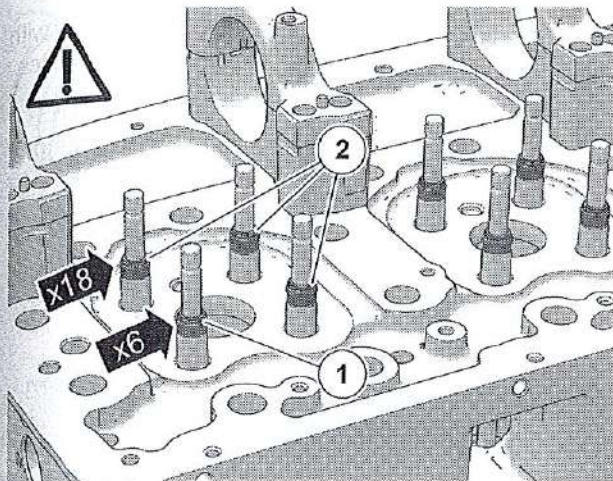
Valve Stem Sealings, Replace

Tools:

9990165 Guide sleeve
9990210 Valve spring compressor
9993590 Rotation tool

Removal

- 1 Switch off all electrical power to the engine at the main switch.
- 2 Remove the unit injectors; refer to the section in *Unit Injector, Replace*.
- 3 **NOTICE!** The piston must be at top dead center when the valves are removed. This is to prevent the valves from falling down into the cylinder. Use tool 9993590 Rotation tool.
- 4 Compress the valve springs for # 1 cylinder. Use tool 9990210 Valve spring compressor .
- 5 Remove the valve washers, valve springs and collets.
- 6 Remove the old valve stem seals.



P0021295

Installation

Not TAD1670-1672VE

IMPORTANT!

- Blue valve stem seal (1)
- Brown valve stem seal (2)

- 7 Lubricate the valve stem with engine oil. Install tool 9990165 Guide sleeve on the valve stem. Fit the new seal and slide it over the drift.
- 8 Install the valve springs, valve spring washers and collets. To ensure the collets arrive in the correct positions, carefully tap with a plastic mallet.
- 9 Transfer the valve spring compressor to cylinder # 6 and repeat the above procedure. Then crank the engine so that cylinders 3 and 4 are at TDC. Repeat the procedure. Then continue with cylinders 2 and 5.

NOTICE! The piston must be at top dead center when the valves are removed. This is to prevent the valves from falling down into the cylinder. Use tool 9993590 Rotation tool.

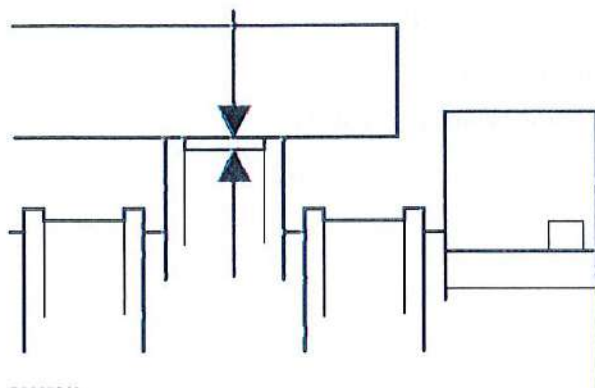
- 10 Install the unit injectors; refer to the section in *Unit Injector, Replace*.
- 11 Adjust valves and unit injectors; refer to *Valves and Unit Injectors, Adjustment*.
- 12 Purge the fuel system; refer to *Fuel system, bleeding*. Perform function and leakage checks.

Cylinder Head, Pressure Testing

Refer to *Cylinder Head, Pressure Testing*.

Sleeve for unit injector, replace

See *Sleeve for unit injector, replace*.



P0007013

Camshaft, Wear Check

Rocker bridge removed

Put a steel rule across the camshaft lobes, parallel with the camshaft axis, to check whether the cam profiles show signs of wear.

Measure the wear with a feeler gauge or wire gauge. Alternatively, a digital caliper gauge may be used.

Compare the measured values with those specified in *Technical Data*.

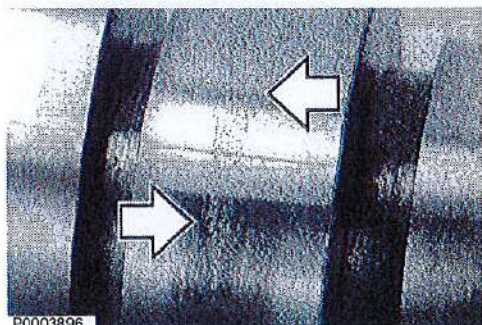
Guidelines for replacement

In normal conditions, unevenness may occur on the surface of engine camshaft lobes. This does not mean that the camshaft must be changed. These marks do not have any negative influence on either engine performance or the durability of the engine and its components.

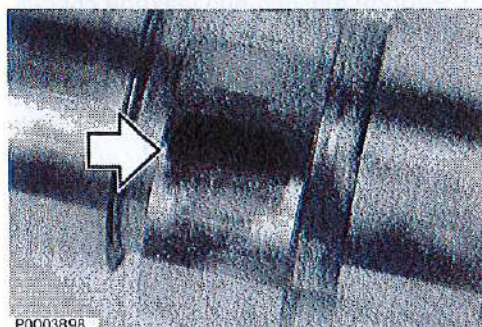
Examples of acceptable wear and **unacceptable** wear are shown below.

Acceptable wear:

The camshaft need not be changed.



P0003896

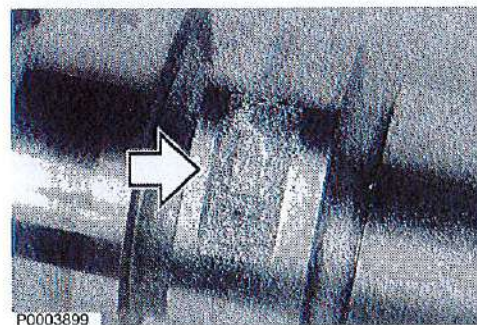


P0003898

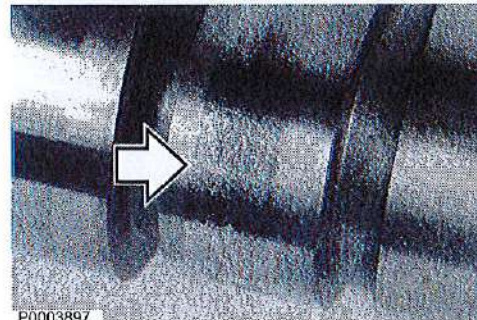
Unacceptable wear:

IMPORTANT!

The camshaft and associated rocker arms must be changed.



P0003899

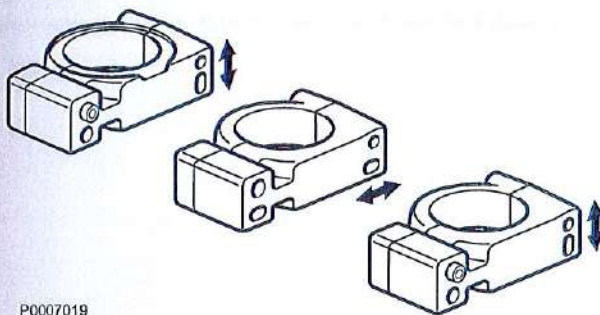
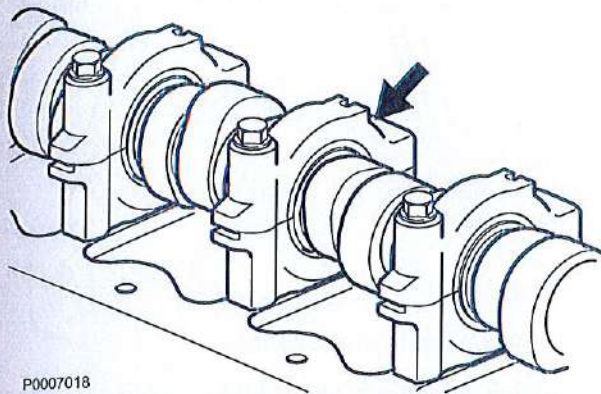


P0003897

Camshaft Bearing Housing, Replace

The factory-installed bearing housings are machined together with the cylinder head, and may therefore not be moved from one cylinder head to another.

Therefore, the first time one or more bearing housings are replaced, all bearing housings must be replaced so that the positions of the bearing housings can be aligned. Bearing housings may then be replaced individually.



The holes for the guide sleeves are oval in the replacement housings, which allows radial adjustment of the center bearing housing and axial adjustment of the front and rear bearing housings.

If replacement housings are installed, mark them with their numbers so they can be put back in the same place as before, if they need to be removed.

Timing Gear, Replace

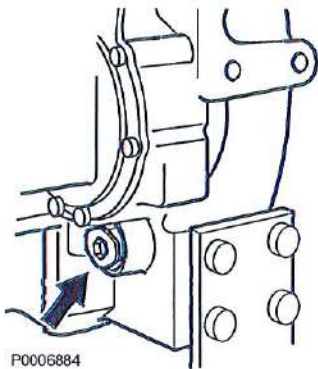
Valve cover, cable harness, upper timing gear cover, camshaft sensor, oil pan, and oil pump removed.

Tools:

885810 Fixture
9993590 Rotation tool
9996239 Lifting tool
9998601 Fixture

Removal

- 1 Remove the flywheel sensor.
- 2 Install 9993590 Rotation tool.
- 3 Turn the engine to TDC on the camshaft and check that the mark on the flywheel is at "0".



P0006884

- 4 Bolt lifting chain tool 9996239 Lifting tool onto the flywheel. Remove the flywheel.

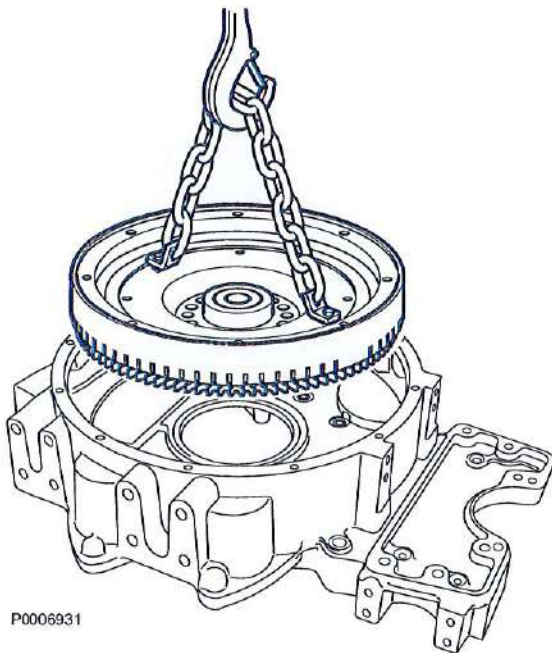
WARNING!

Pinch hazard. Keep fingers clear.

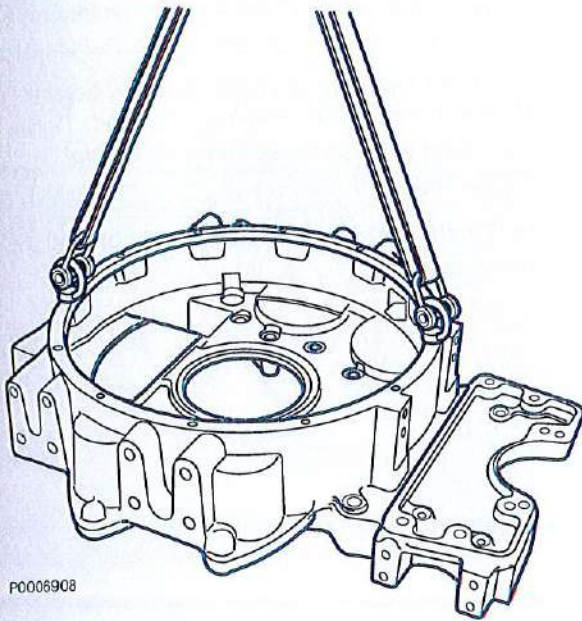
IMPORTANT!

The flywheel weighs about 40 kg (88.2 lbs).

- 5 Remove the starter motor, rear lifting eye and fuel pump together with servo pump, the cover and any rear engine mounts.

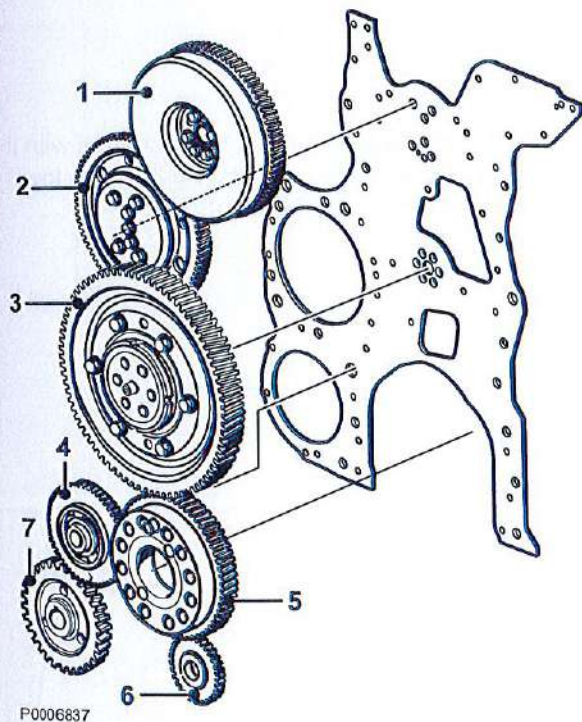


P0006931



- 6 Remove flywheel housing bolts. Remove the housing using lifting eyes and lifting strap.
- 7 Remove the lower intermediate gear (4).
- 8 Remove the camshaft gear (1).
- 9 Remove the two bolts on the crankshaft gear (5) and remove the gear using a suitable puller.

NOTICE! To protect the puller thread, place a thick washer between the threaded shaft and the crankshaft.



- 10 Remove the six Allen bolts in the bull drive hub (3) and remove it complete.
- 11 Remove the upper intermediate gear (2).

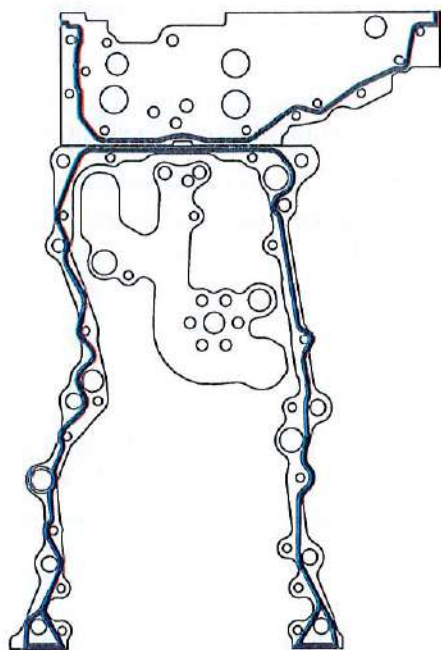
NOTICE! Save the spacer plate behind the gear and note how it is installed.

- 12 Remove the timing gear plate and clean both sides.

- 1 Camshaft gear
- 2 Upper intermediate gear
- 3 Bull drive
- 4 Lower intermediate gear
- 5 Crankshaft gear
- 6 Drive gear, lubricating oil pump
- 7 Drive gear for fuel feed pump/servo pump

Installation

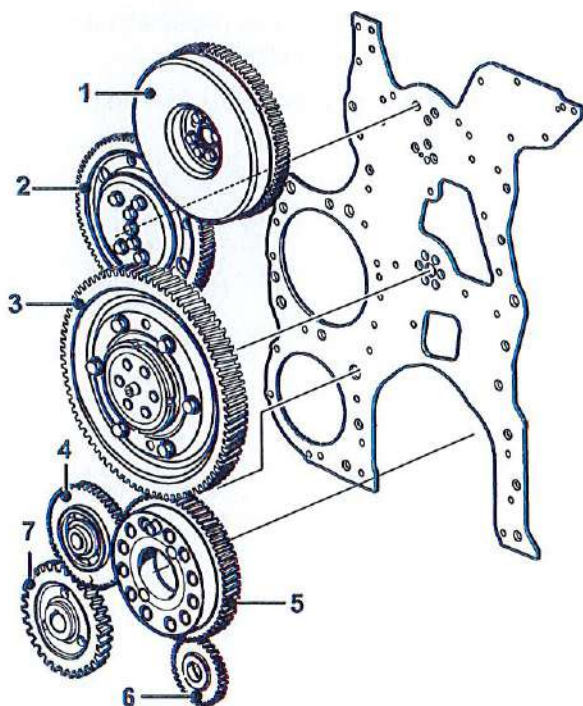
NOTICE! Lubricate the inside of the gears before installation.



P0006926

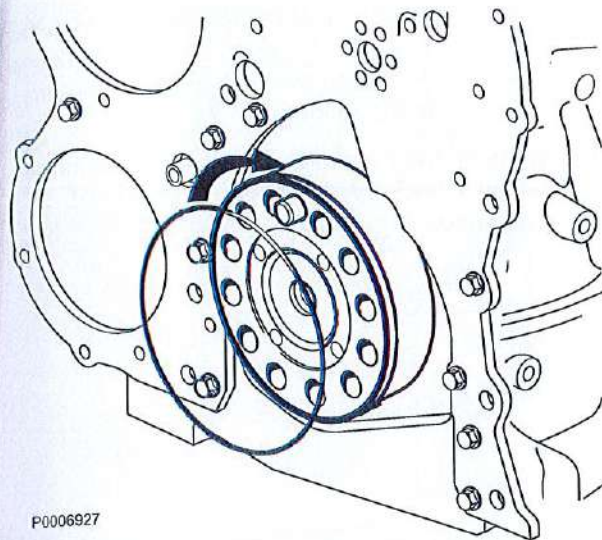
- 13 Apply a 2 mm (0.08") thick bead of sealant on the engine block and the cylinder head, as illustrated.
- 14 Install the timing gear plate. Use new bolts that are pre-treated with locking compound. Tighten according to the specifications in *Special Tightening Torques*.

NOTICE! Torque within 20 minutes of sealant being applied.



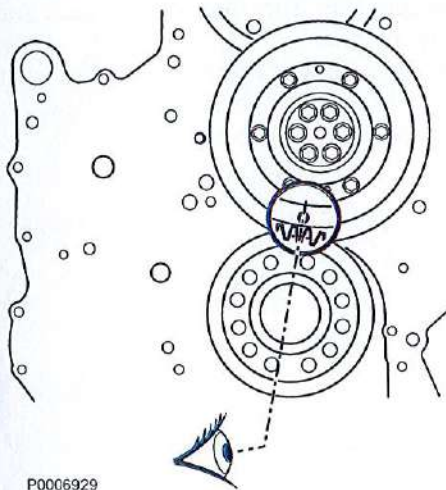
P0006837

- 15 Oil the spacer plate and install it together with the upper intermediate gear (2). Tighten with low torque, max. 10 Nm (2.25 lbf).



P0006927

- 16 Install a new O-ring on the crankshaft.
- 17 Install the camshaft gear (5) and torque the Allen bolts according to the specification in *Special Tightening Torques*.

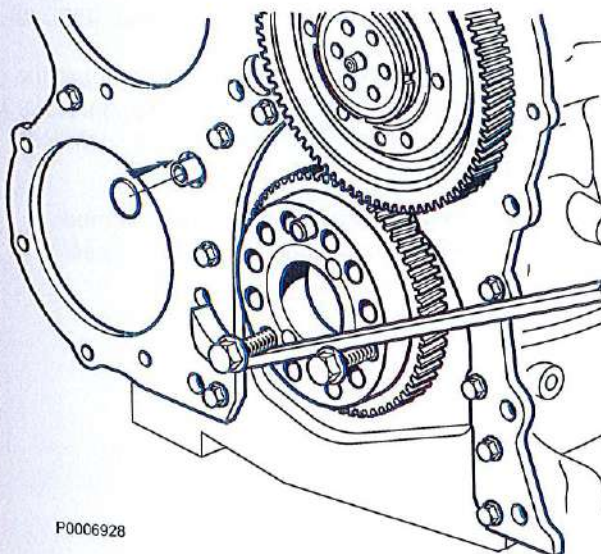


P0006929

- 18 Install the bull drive kit (3) with the hole marking between the two hole markings on the crankshaft gear.

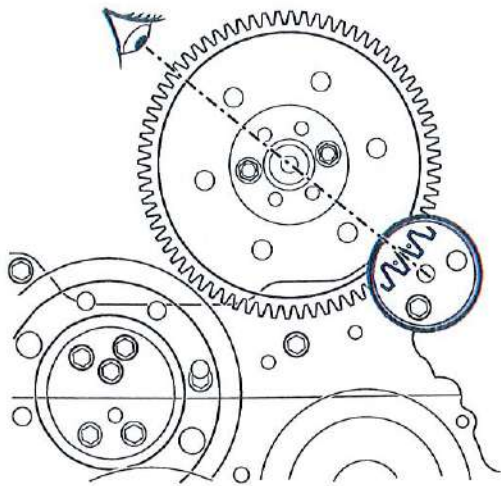
NOTICE! The bull drive inner and outer gears have different gear pitch. For the camshaft to be set correctly, the markings must correspond.

Tighten the bolts according to the specification in *Special Tightening Torques*.



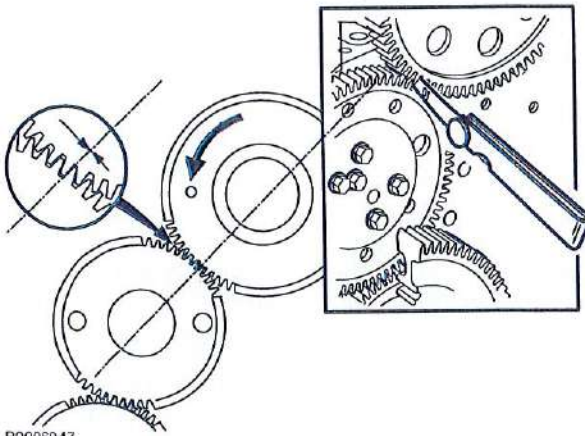
P0006928

- 19 Install the lower intermediate gear (4) with a new O-Ring.
- 20 Install the lubricating oil pump.
- 21 Screw two bolts in the crankshaft gear for crowbar grip, to allow the crankshaft to be turned when necessary.
- 22 Fit the camshaft gear (5) without the oscillation damper; use nuts as spacers.



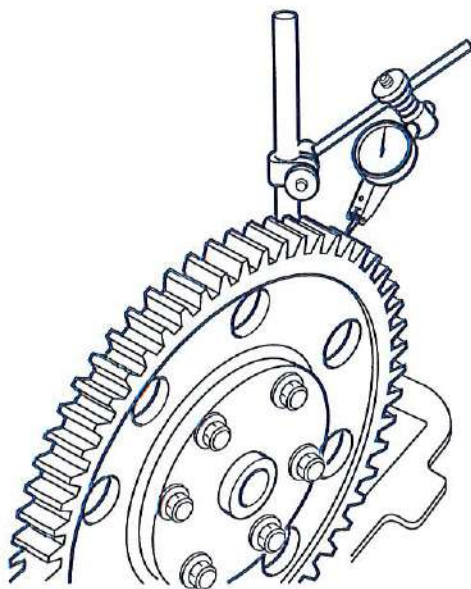
P0006944

- 23 Place the gear so that the reference hole in the timing gear plate is between the gear markings. Temporarily tighten two bolts with low torque, max. 10 Nm (2.25 lbf).
- 24 Remove the 2 lower bolts (1) in the adjustment wheel. Check that the upper bolts are not tightened.



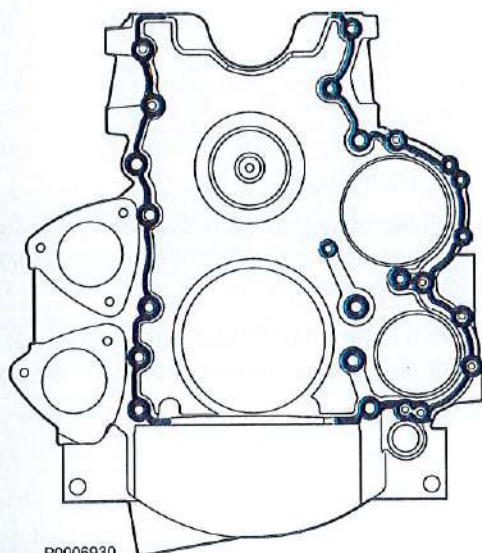
P0006947

- 25 Place a 0.1 mm (0.004") feeler gauge on the pressure side. Turn the camshaft gear against the feeler gauge. Torque the upper intermediate gear according to step 1 in *Special Tightening Torques*. Remove the feeler gauge.



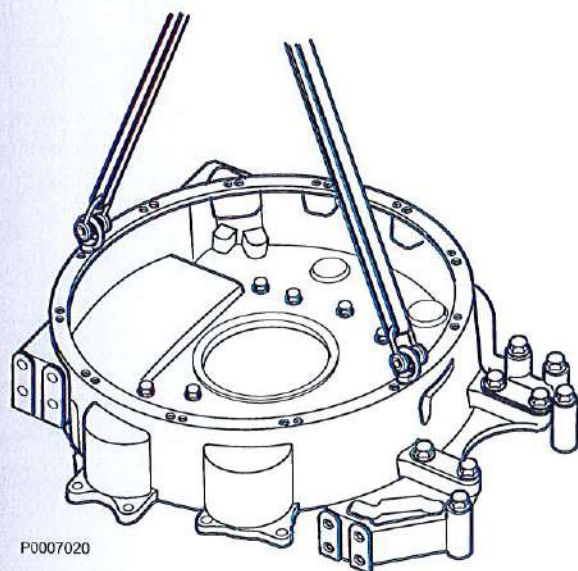
P0006948

- 26 Check the clearance as follows:
Fix the adjustment wheel.
Place a dial indicator on the camshaft gear, as illustrated.
Turn the gear back and forth and compare the result against the gear lash specification. Refer to the Engine Transmission section in *Technical Data*.
- 27 If gear lash is correct; torque the intermediate gear bolts (1) according to step 2 in *Special Tightening Torques*.



P0006930

- 28 Remove the crankshaft seal and apply new sealing compound to the flywheel housing, facing the engine block.

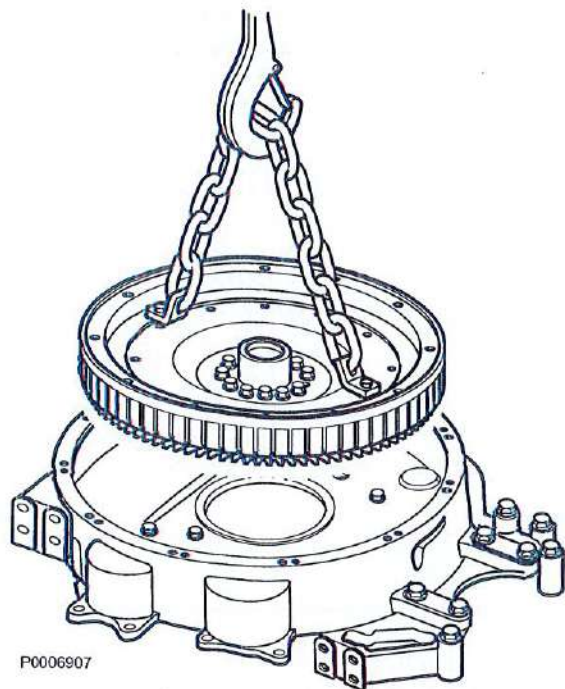


P0007020

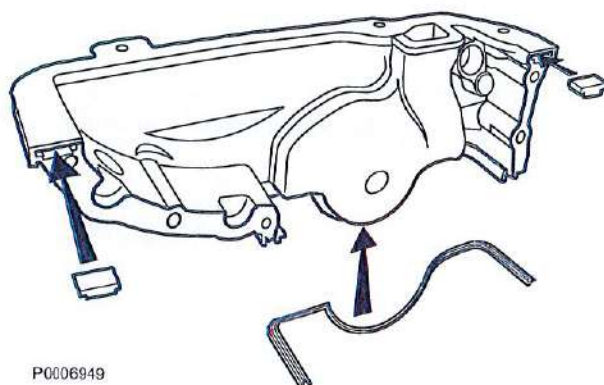
- 29 Install the flywheel housing. Check that the housing is aligned with the bottom edge of the engine block.
- 30 Install a new crankshaft seal. See "Crankshaft seal, front, replacing." *Group 21 - Engine*.

IMPORTANT!

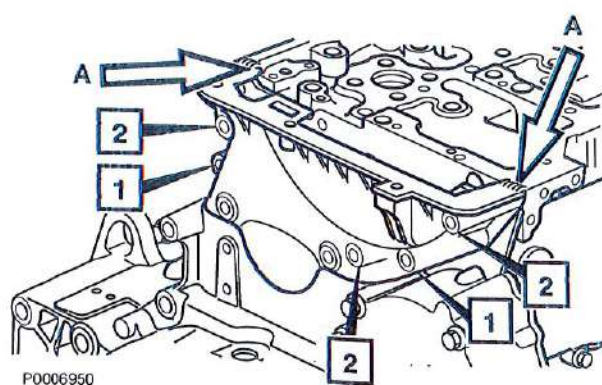
No lubrication. Must be installed completely dry.



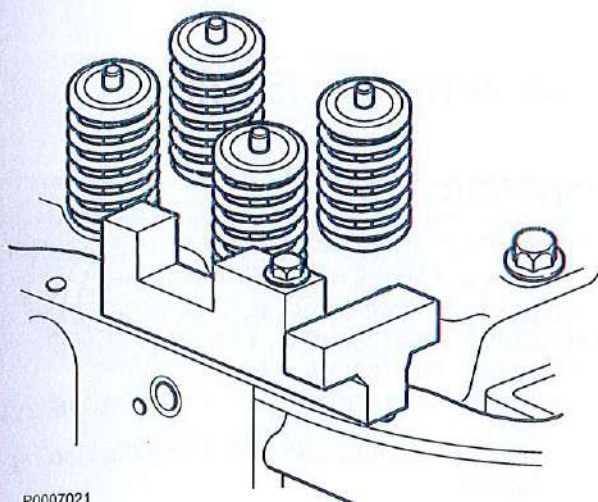
- 31 Install the flywheel and tighten according to specifications in *Special Tightening Torques*. Refer to "Flywheel, indication" Group 21 - Engine.
Install the flywheel sensor and adjust it; refer to *Sensors, Adjustment*.
- 32 Install the camshaft oscillation damper and tighten according to specifications in *Special Tightening Torques*.
- 33 Apply a 2 mm (0.08") thick bead of sealant to the upper timing gear casing contact surface, as illustrated.



- 34 Fit the rubber seals and install the upper timing gear casing.



- 35 Only install the bolts (1) and tighten by hand. (The holes are oblong so that the casing can be pressed down against the rubber seal).



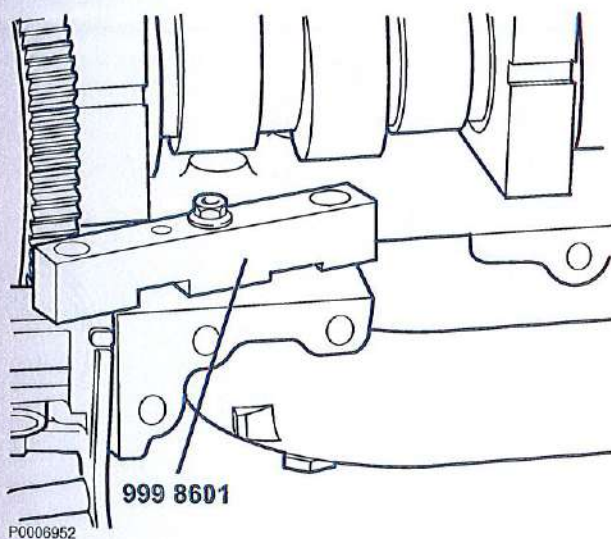
- 36 Press the casing down using tools 885810 Fixture and 9998601 Fixture so that the cylinder head and the upper timing gear casing sealing surfaces are aligned.

Install the remaining bolts (2).

Tighten according to the specifications in *Special Tightening Torques*.

NOTICE! The timing gear casing must be installed and torqued within 20 minutes of sealant application.

- 37 Install the flywheel sensor and adjust it according to *Sensors, Adjustment*.
- 38 Install the remaining removed components.

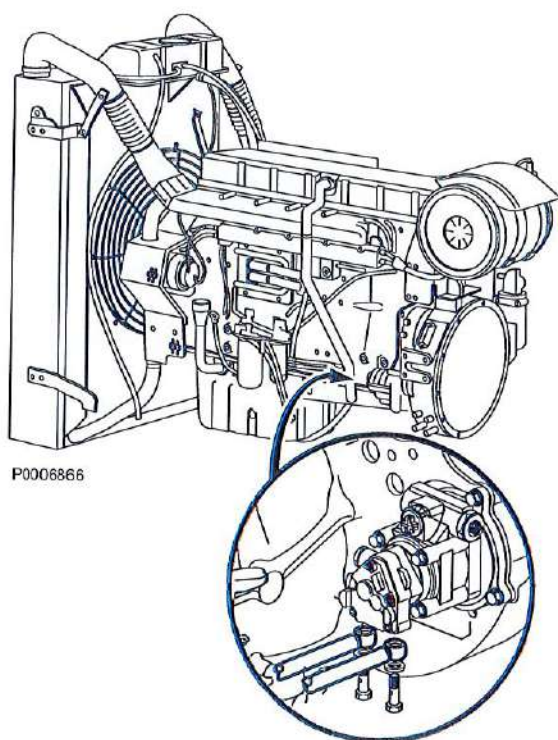
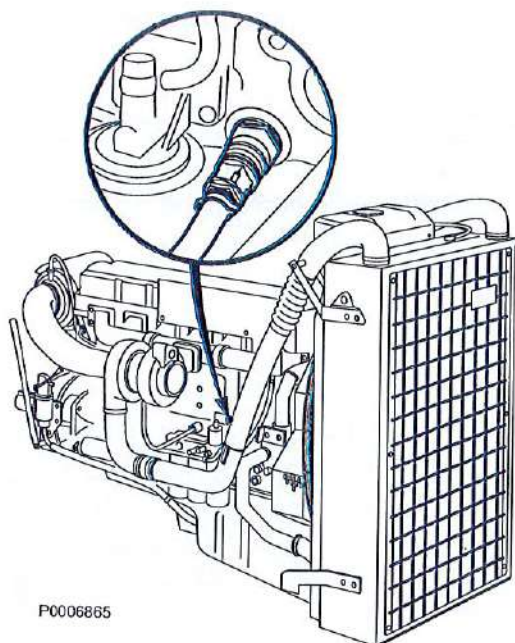


Exposing the Engine

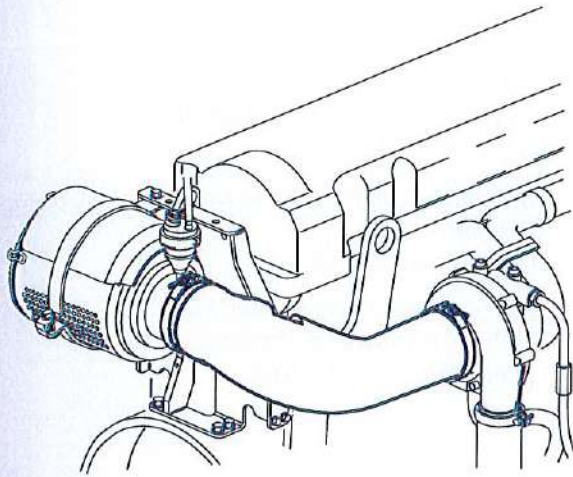
Exposing

TAD1640GE, TAD1640VE-B, TAD1641GE,
TAD1641VE, TAD1641VE-B, TAD1642GE,
TAD1642VE-B, TAD1643VE-B, TAD1650GE,
TAD1650VE, TAD1650VE-B, TAD1651GE,
TAD1651VE, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

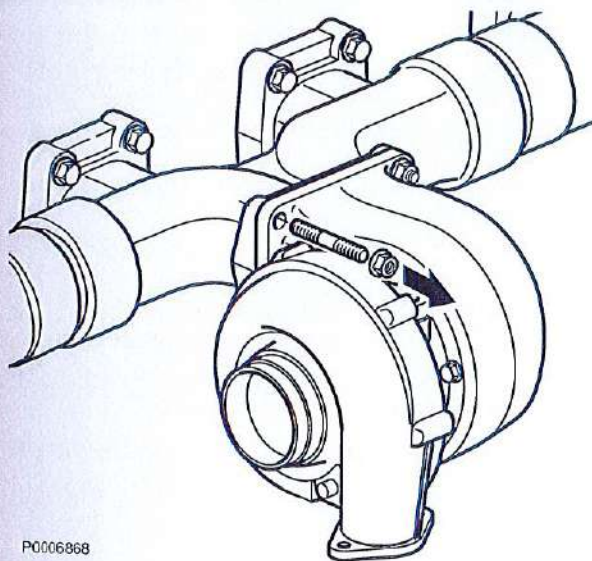
- 1 Drain the coolant; refer to *Draining the Cooling System*.
Drain the engine oil.



- 2 Remove fuel connections to the fuel pump and allow the fuel to run out into a suitable container. Also loosen the upper connection on the cooling coil and water drain.
- 3 Remove the hoses from the radiator and the expansion tank.
- 4 Remove the heat shield above the turbo, if fitted.



P0006867



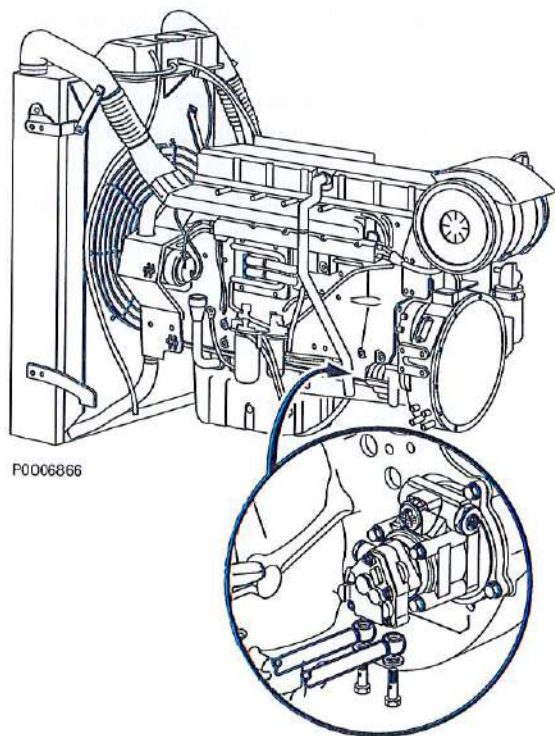
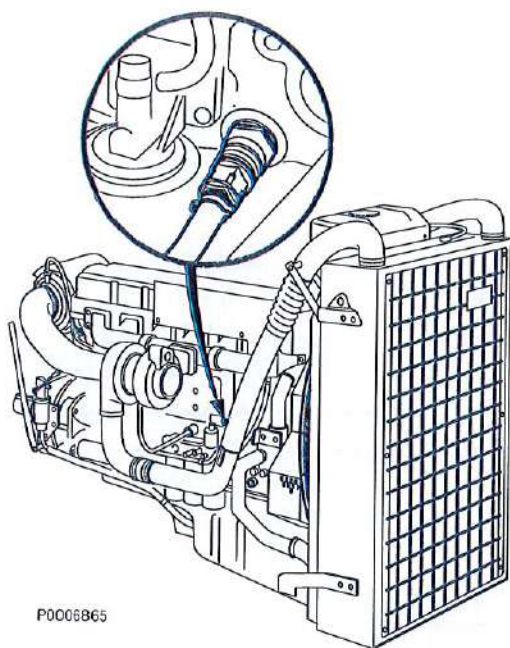
P0006868

- 5 Remove the air filter sensor.
- 6 Remove the pipe between the air filter and turbocharger. Cover all openings. Remove the air filter housing and mounting bracket.
- 7 Remove muffler and attachments, if fitted. Remove the turbo from the exhaust pipe, plus the two the oil pipes. Cover the turbo opening.
- 8 Remove the crankcase breather with its bracket and oil separator.
- 9 Remove the pipe between the inlet manifold and the charge air cooler. Cover all openings.
- 10 Remove the safety cover above the alternator, if fitted.
- 11 Remove the radiator fan safety cover/grille and remove the fan, the hub and its brackets to the cylinder head.
- 12 Remove the coolant pipe from the thermostat.
- 13 Remove the belt guard and drive belts.

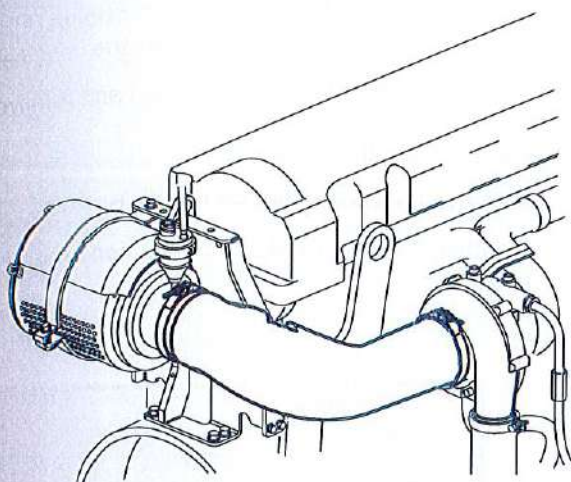
Exposing

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

- 1 Drain the coolant; refer to *Draining the Cooling System*.
Drain the engine oil.
- 2 Remove the radiator assembly.
Refer to removal for *Radiator Assembly (Complete Unit)*, *Change*.

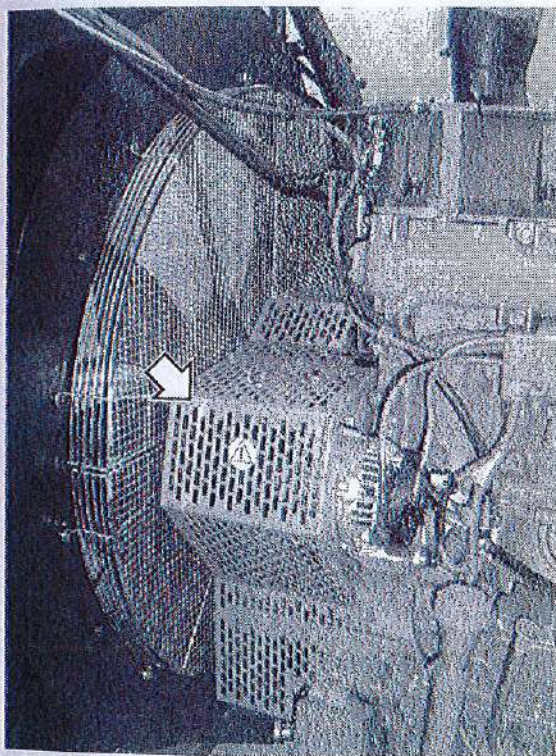


- 3 Remove fuel connections to the fuel pump and allow the fuel to run out into a suitable container. Also loosen the upper connection on the cooling coil and water drain.
- 4 Remove the heat shield above the turbo, if fitted.



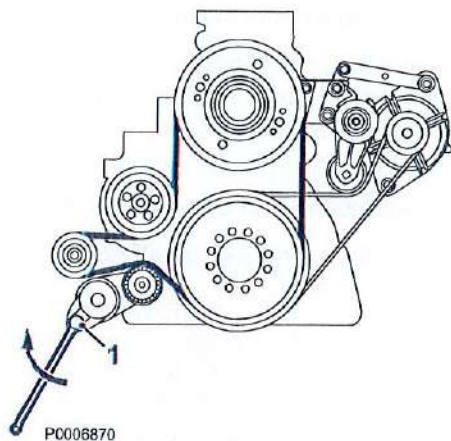
P0006867

- 5 Remove the air filter sensor.
- 6 Remove the pipe between the air filter and turbocharger. Cover all openings. Remove the air filter housing and mounting bracket.
- 7 Remove muffler and attachments, if fitted.
- 8 Remove the crankcase breather with its bracket and oil separator.

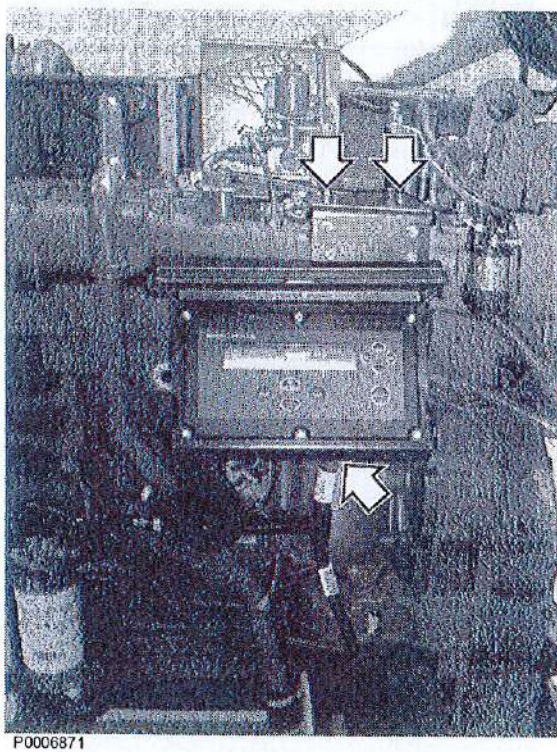


P0006869

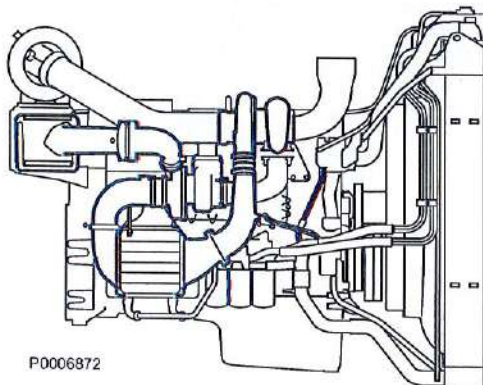
- 9 Remove both belt guards, right and left. Leave the cover on the right guard.



- 10 Fit a 1/2" socket drive to the belt tensioner (1). Lift the square wrench and unhook the drive belt.
- 11 Thread the drive belt round the fan and remove it.
Remove the alternator belt.
- 12 Remove the cooling fan and fan hub.
- 13 Remove the upper radiator attachment and bracket.



- 14 Undo the connector and remove the control panel.

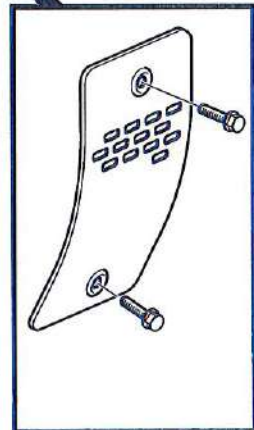
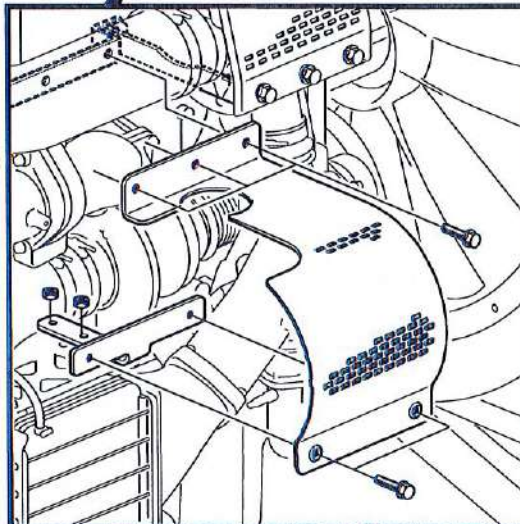
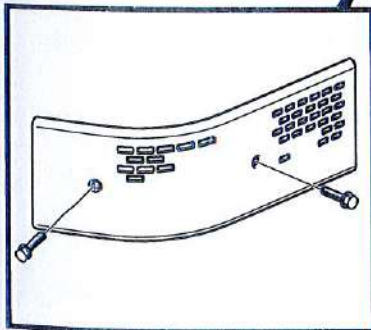
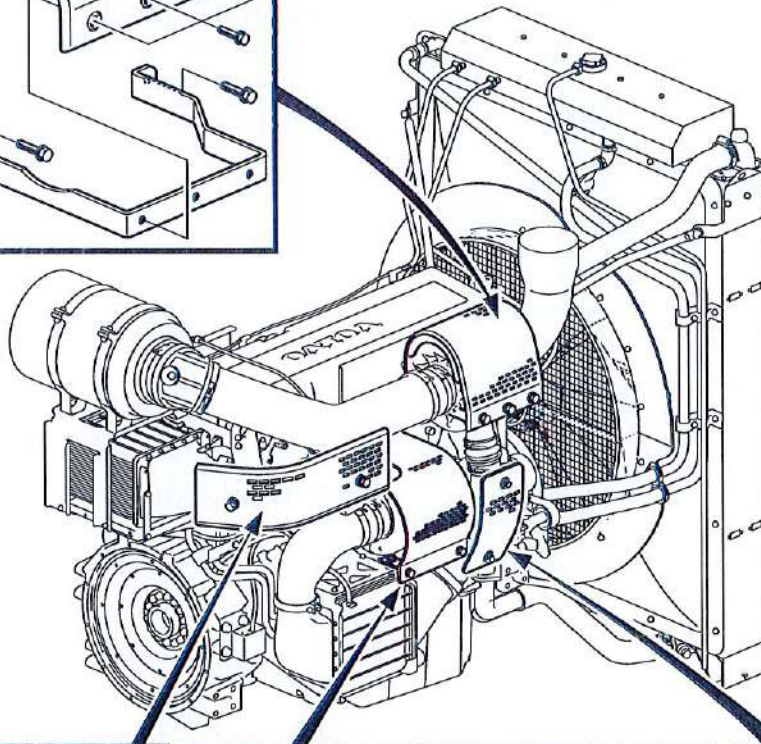
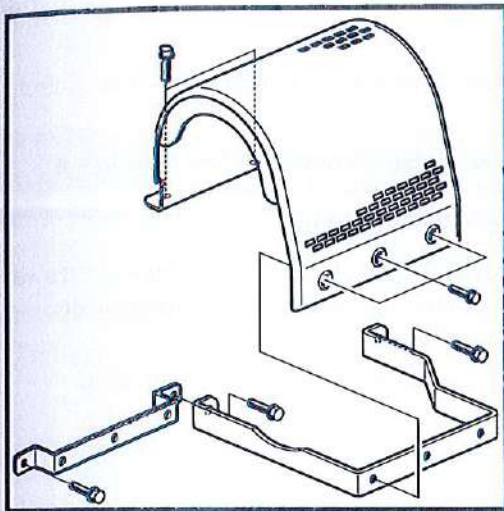


- 15 Remove both turbochargers, charge air cooler and associated pipes and hoses.
Refer to removal for *Turbo, Charge and Charge Air Cooler, Removal*.

Heat Protection

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

The heat shield is an option and may be removed for increased accessibility for certain types of repair work. Re-install the heat shield carefully after completion of work.



P0003624

Fitting the Fixture

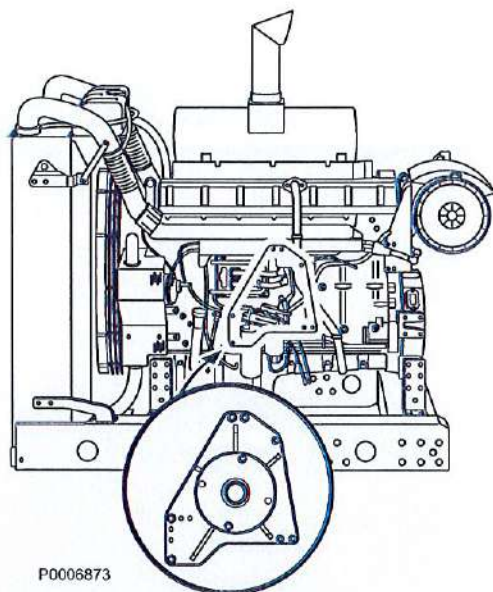
Engine Fixture, Installation

Applies to engine nos. through 2016010024

Tools:

9990143 Fixture

- 1 Remove electrical distributor above the control unit.
- 2 Remove cable harness and fuel lines to the control unit. Cover all openings. Remove the control unit.
- 3 Remove fuel and electrical connections. Lift away the fuel filter bracket together with the filter. Cover all fuel connections.
- 4 Attach tool 9990143 Fixture using 7 bolts.



Engine Fixture, Installation

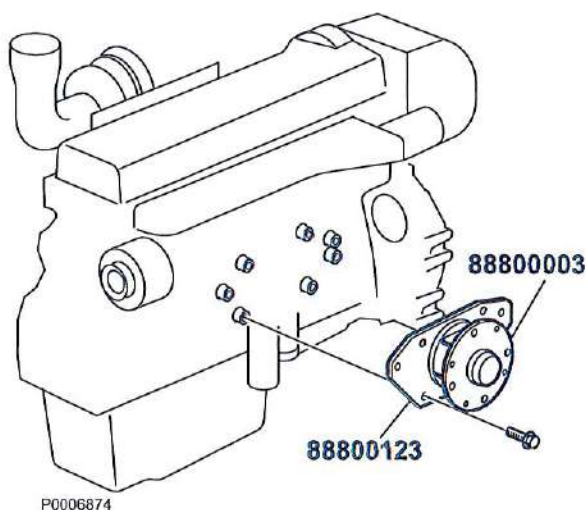
Applies from, and including, engine no. 2016010025.

Tools:

88800003 Fixture

88800123 Plate

- 1 Remove the crank case breather.
- 2 Remove the cover for the alternator cables.
- 3 Remove the electrical cover bolts.
- 4 Remove all connection cables.
- 5 Remove the valve cover.
- 6 Remove the electrical cover including cable harnesses.
- 7 Remove the electronics unit and fuel hoses.
- 8 Fit tool 88800003 Fixture and 88800123 Plate.
- 9 Hoist the engine onto the stand.



Engine Disassembly

Cylinder Head, Removal

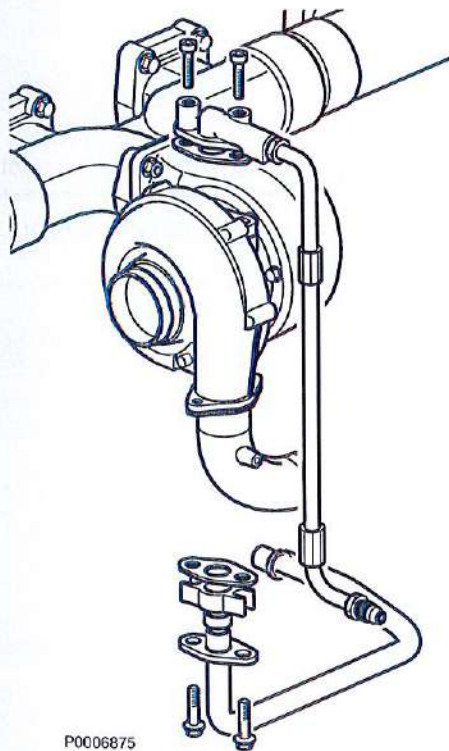
NOTICE! The illustrations in the manual conform in all essential parts, but due to differences in models cannot always be shown in greater detail.

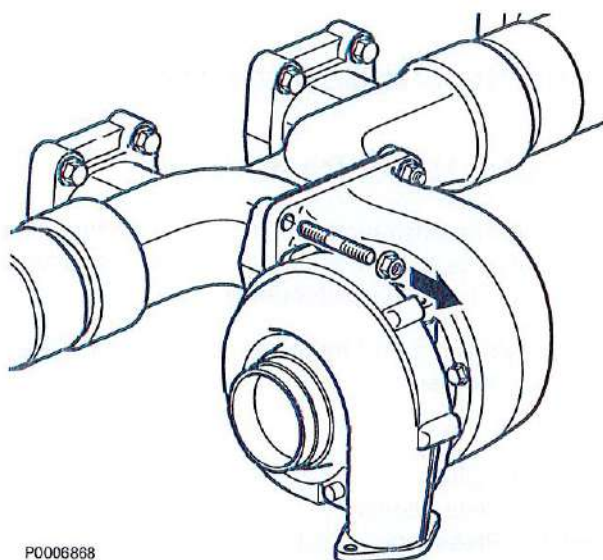
Engine exposed and installed on stand, coolant and fuel drained.

Tools:

9990006 Puller
9990013 Slide hammer
9990157 Press tool
9990160 Fixture
9990185 Lifting tool
9990192 Puller
9993590 Rotation tool
9996239 Lifting tool
9996400 Slide hammer
9998249 Protective sleeve
9998251 Protection plug
9998264 Lifting tool
9998511 Lever

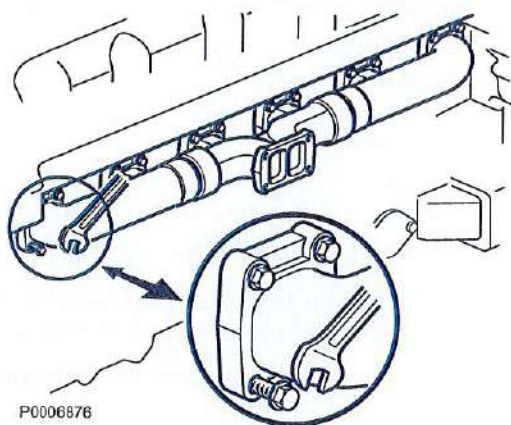
- 1 Remove the rear lifting eye/mounting bracket.
- 2 Remove the heat shields above the turbo, if this was not done when the engine was exposed.
- 3 Remove the oil pipes between the turbo and the oil filter bracket and the engine block. Cover all openings.





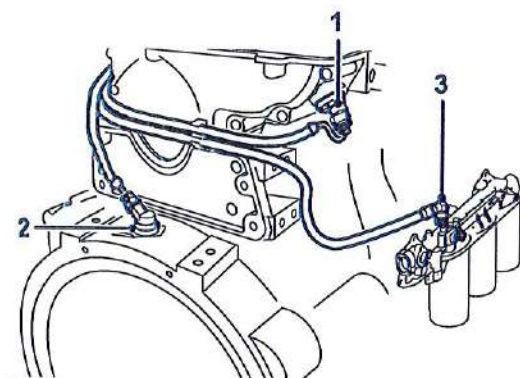
P0006888

- 4 Cover the turbo exhaust port and remove the turbo.



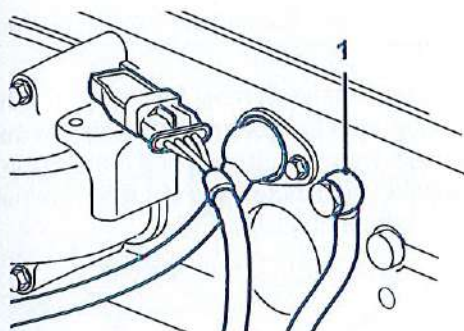
P0006876

- 5 Remove the exhaust manifold.



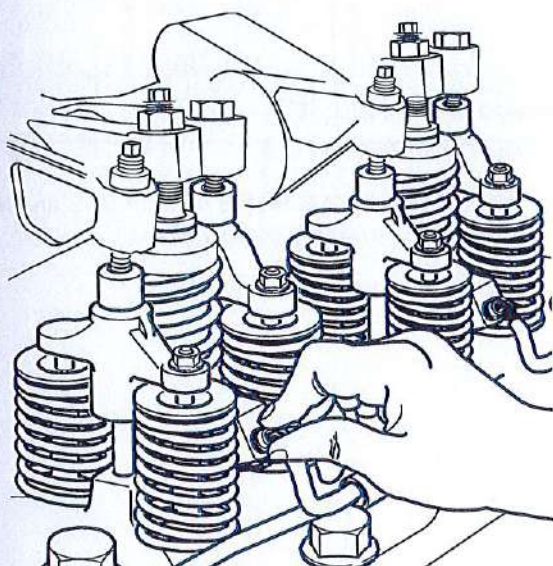
P0006877

- 6 Remove camshaft sensor (1), the flywheel sensor (2) and the sensor on the oil filter bracket (3). Remove the cable harness from sensors and starter motor.



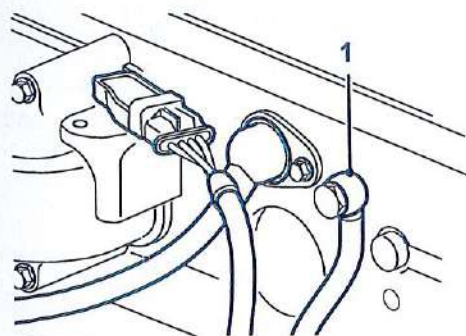
P0006878

- 7 Remove the fuel lines to the cylinder head (1) and plug the connections.
- 8 Remove the valve cover and the crankcase breather.



P0006879

- 9 Clean around the unit injectors and remove the unit injector contacts. Remove cable holders together with cable harness. Cut off cable ties and remove the cable harness from the cable holder.



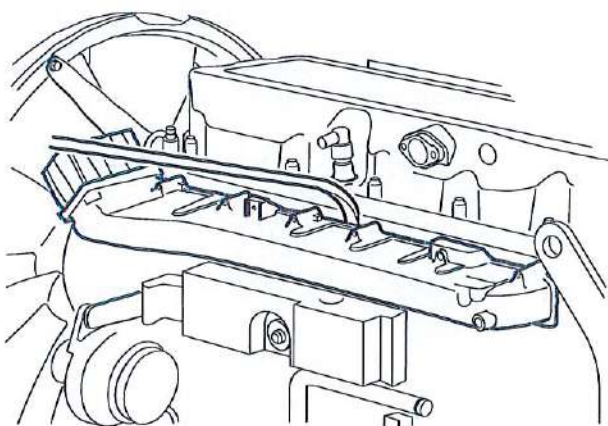
P0006878

- 10 Remove the bolt (1) from the cable bushing and carefully extract the harness from the cylinder head.

IMPORTANT!

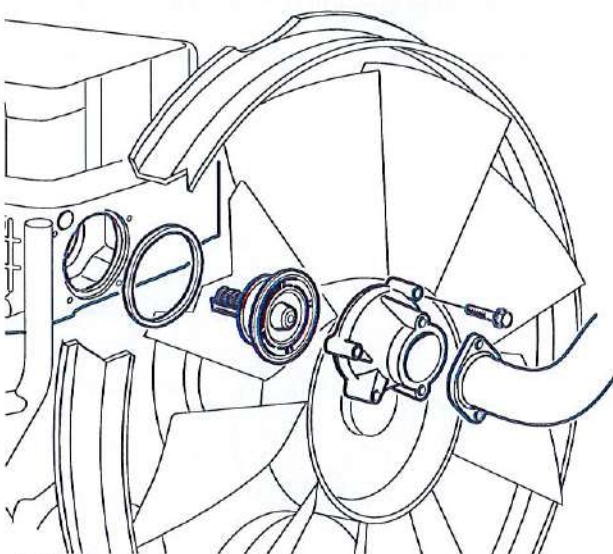
Remove the bolt, **do not split** the cable bushing.

- 11 Remove the contact to the coolant sensor, the hoses to the expansion tank and the rest of the cable harness and lift it away.
- 12 Remove the return fuel lines on the cylinder head front edge and plug the connections.



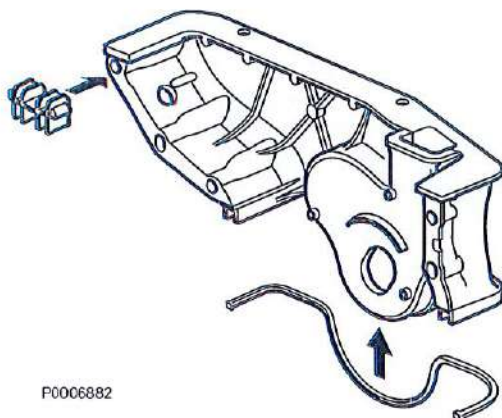
P0006880

- 13 Remove cables from any preheater on the intake manifold.
- 14 The intake manifold must be removed if the cylinder head fixture, tool 9990160 Fixture, is to be used. Remove all bolts and remove the intake manifold using tool 9998511 Lever against the reinforcement bosses.



P0006881

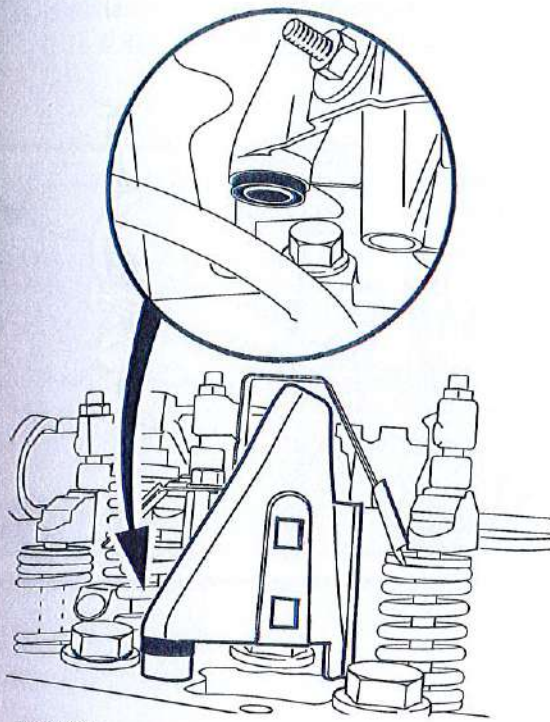
- 15 Remove the thermostat housing and thermostat, and the front lifting eye.
- 16 Remove the bolts from the coolant pipe and the hose clamp from the coolant hose.



P0006882

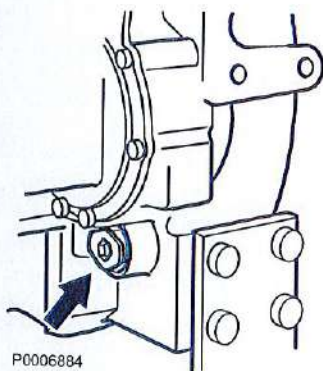
- 17 Remove the upper timing gear casing and remove the rubber seals.

- 18 Remove the center piece for lubrication of the rocker arm bridge, together with the delivery pipe.



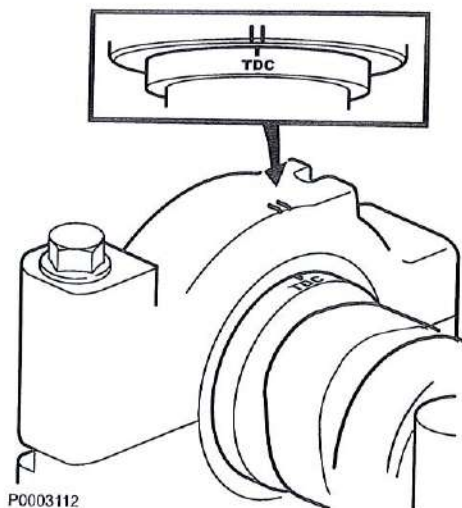
P0006883

- 19 Remove the cover in the flywheel housing and install tool 9993590 Rotation tool.

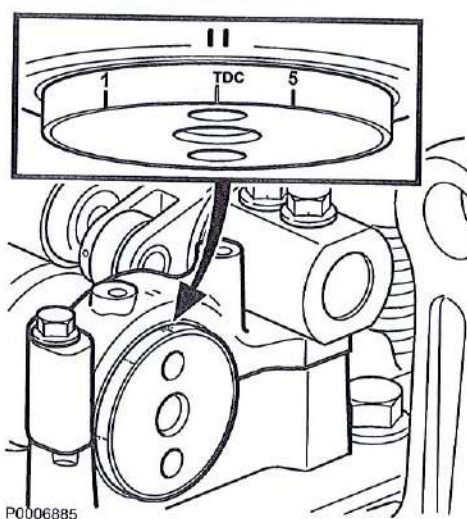


P0006884

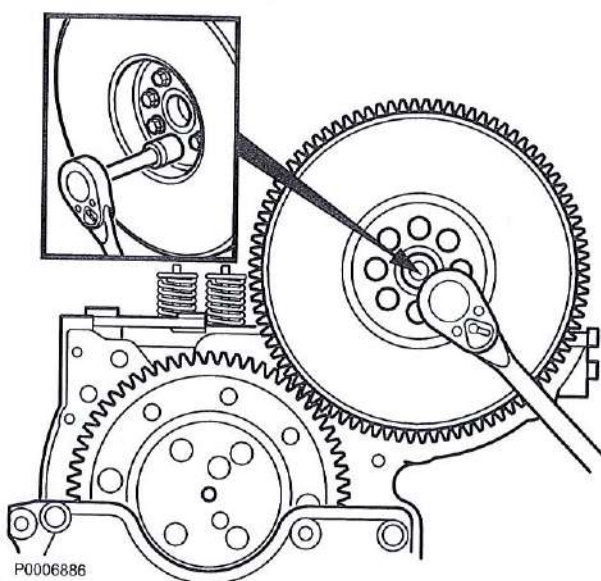
- 20 Turn the engine to TDC on the camshaft and check that the mark on the flywheel is at "0".



Early model.

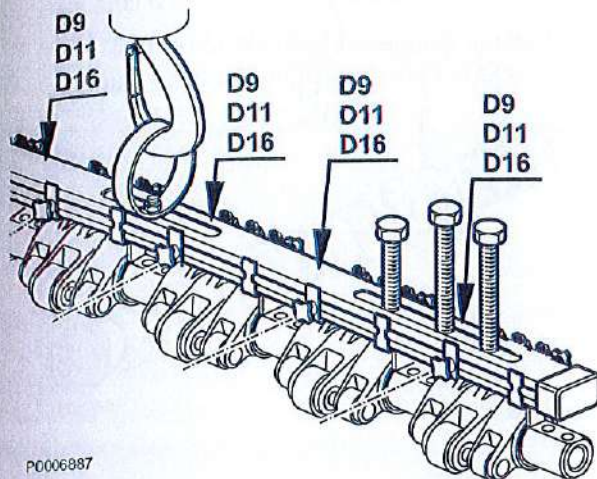


Late model.

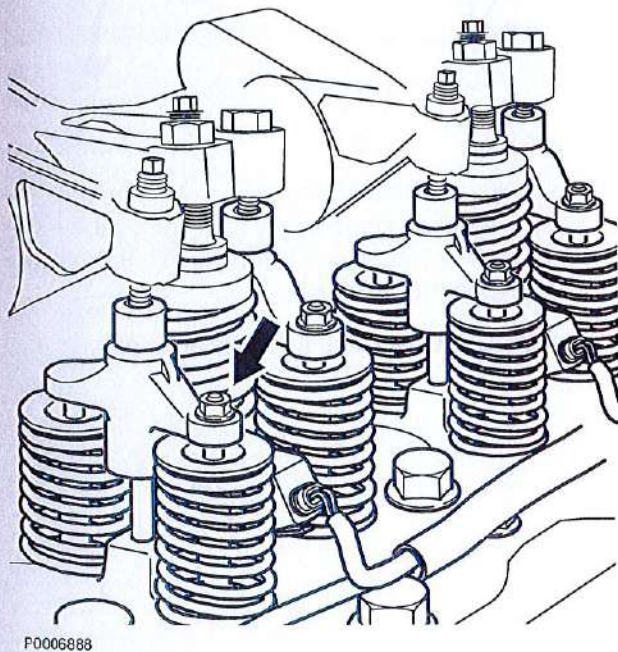


- 21 Remove the camshaft gear together with the oscillation damper.

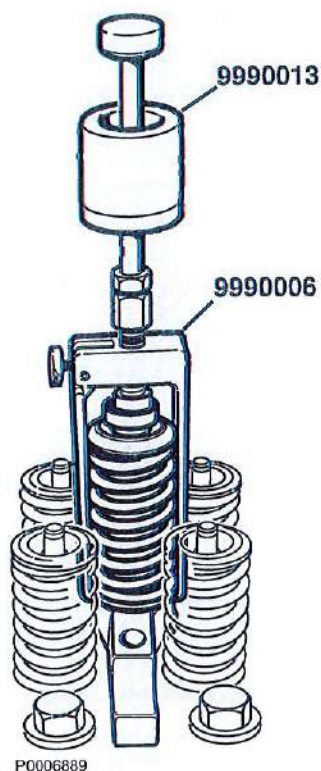
NOTICE! The oscillation damper is very sensitive to shocks.



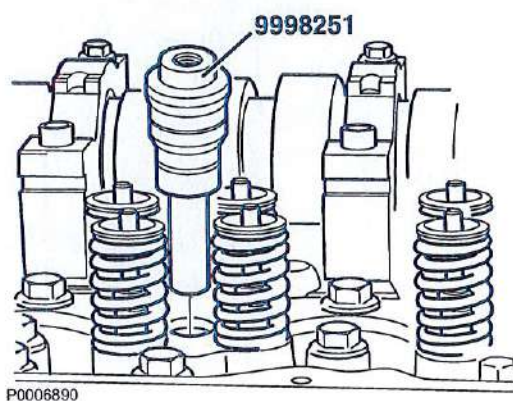
- 22 Remove the rocker arm bridge bolts alternately to avoid uneven load.
- 23 Lift away the rocker arm bridge using tool 9990185 Lifting tool.



- 24 Mark and remove the valve calipers.

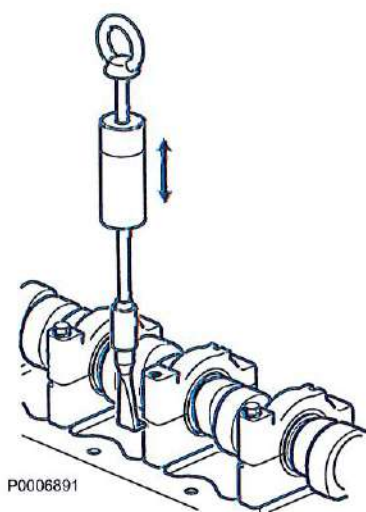


- 25 Clean around the unit injectors and remove the injector retainer bolts.
Remove the unit injectors, one at a time.
- 26 Pull out the injector with the aid of tool 9990006 Puller and 9990013 Slide hammer.

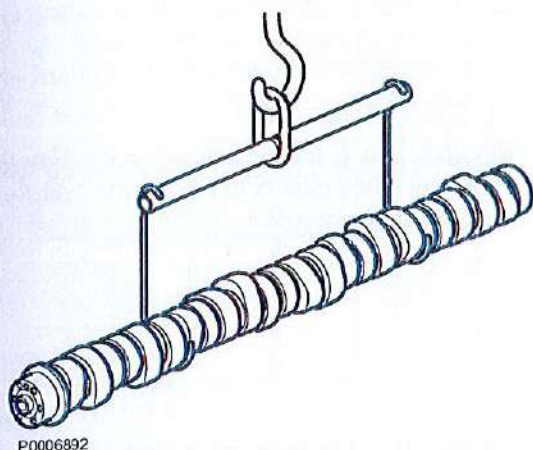


- 27 Insert tool 9998251 Protection plug into the cylinder head immediately after removal.
Mark the injectors and fit tool 9998249 Protective sleeve to the injector.

NOTICE! Check that the tools are clean.

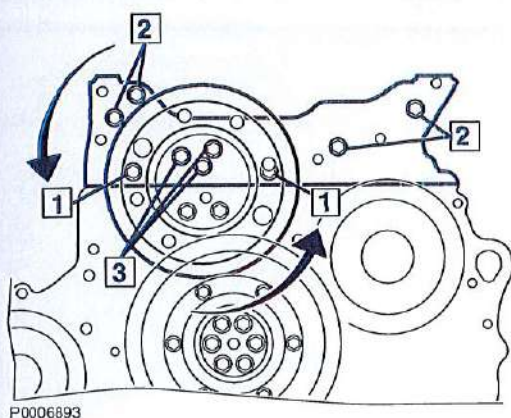


- 28 Remove the camshaft bearing cap with the aid of tool 9990192 Puller and 9996400 Slide hammer.

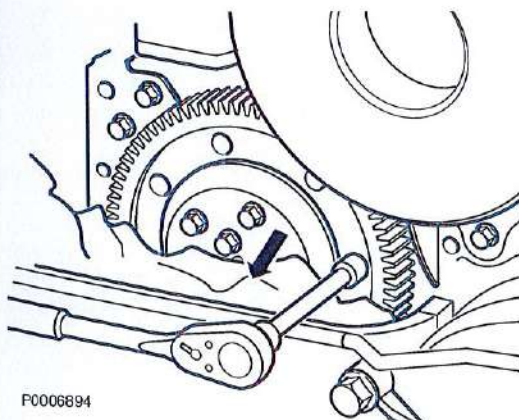


- 29 Lift the camshaft carefully using tool 9998264 Lifting tool.
- 30 Loosen the bearing brackets by tapping them carefully with a plastic faced mallet. Remove the bearing brackets with the lower bearing halves and put them in the right order together with their respective camshaft bearing caps, upper bearing halves and bolts.

NOTICE! The camshaft bearing brackets are held by guide pins marked 1 through 7.



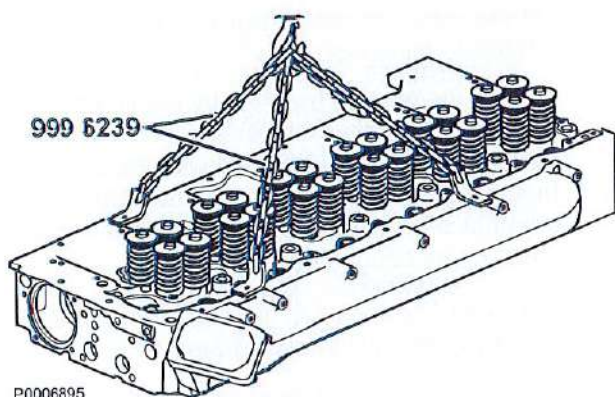
- 31 Turn the engine so that the two the bolts (1) can be accessed through the timing gear wheel.



- 32 Place a rag in front of the gear to prevent bolts from falling into the timing gear housing. Remove the two bolts (1).

NOTICE! When the engine is cranked, the rag must be removed.

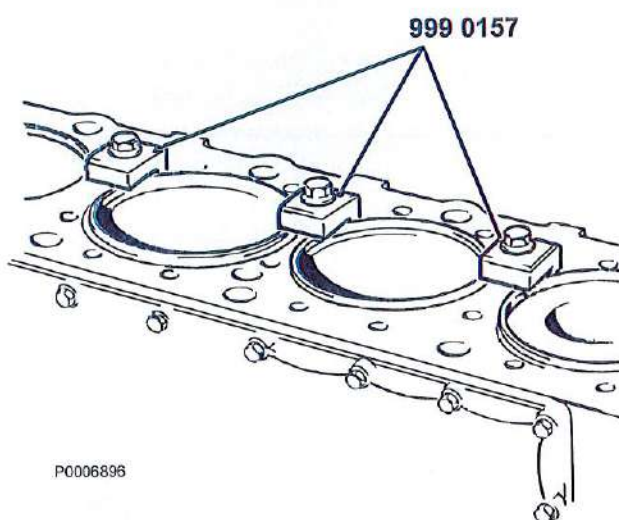
- 33 Remove the remaining bolts (2). Remove the three upper bolts (3) from the timing gear hub.



P0006895

- 34 Remove the cylinder head bolts.
Use two lifting chains, tool 9996239 Lifting tool, to carefully lift away the cylinder head.
(Alternatively, lifting eyes and lifting straps may be used).

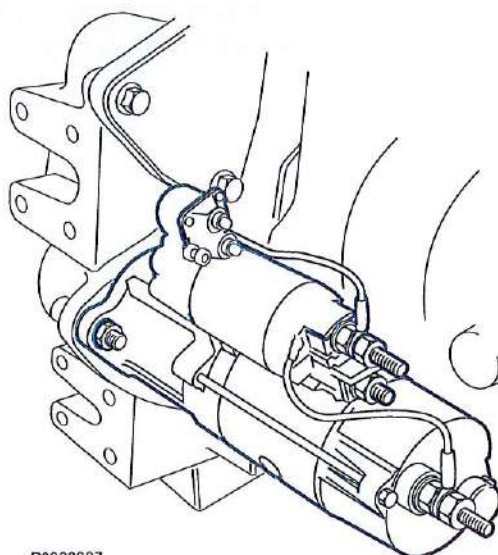
NOTICE! Place washers between the cylinder head and lifting chains to protect the cylinder head sealing surface.



P0006896

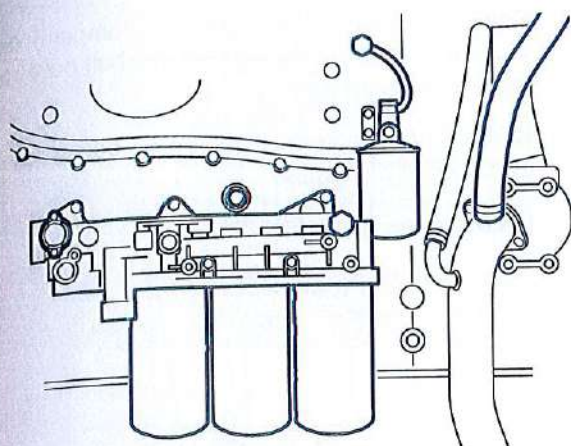
- 35 Remove the cylinder head gasket and clean the contact surface on the cylinder block thoroughly.

NOTICE! Secure all cylinder liners using tool 9990157 Press tool.



P0006897

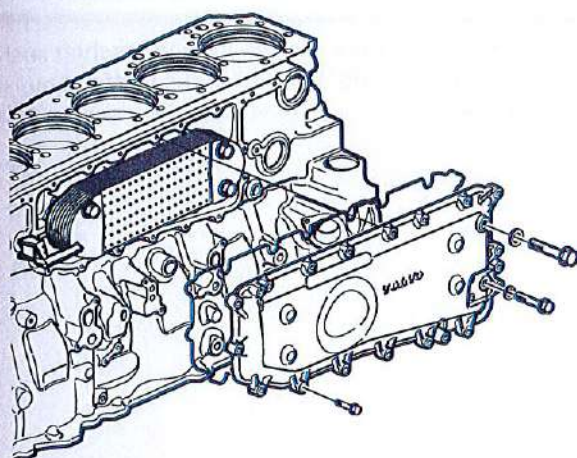
- 36 Remove the starter motor.



P0006898

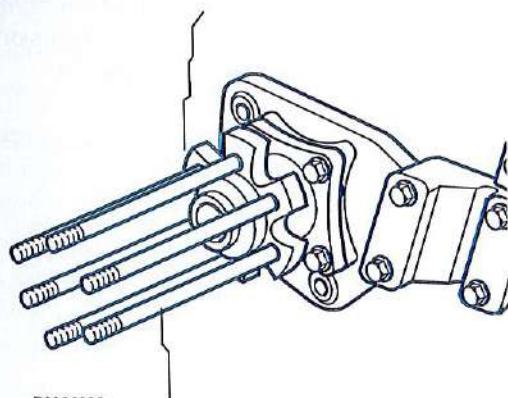
- 37 Remove the oil filters complete with bracket.
- 38 Remove the coolant filter with bracket and the connection to the oil cooler cover.

NOTICE! Industrial engines may not use coolant filters in combination with *Coolant VCS* (yellow); coolant filters will be omitted on new industrial engines filled with *Coolant VCS* (yellow).



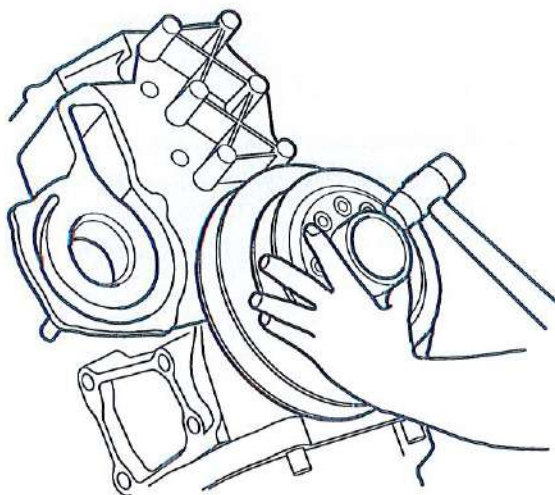
P0006899

- 39 Remove the oil cooler cover. Remove the oil cooler and seals.
- 40 Remove the two coolant pipes and the coolant pump.



P0006900

- 41 Remove the fan bearing.

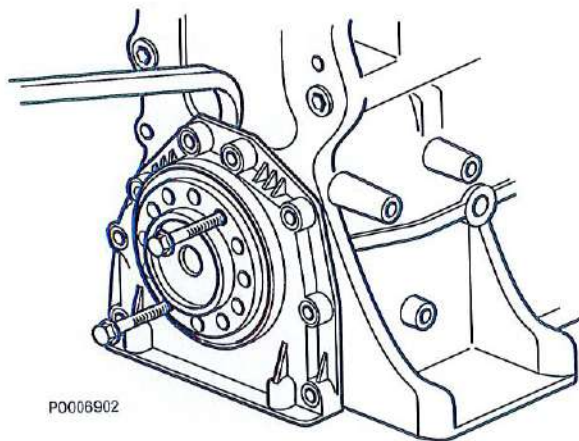


P0006901

- 42 Remove the belt pulley/oscillation damper bolts. Carefully tap and rock the hub and belt pulley to loosen them.

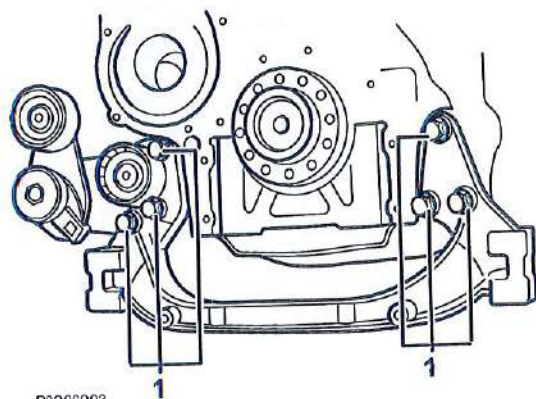
NOTICE! Do not prize between the belt pulley and oscillation damper.

Lift away the oscillation damper.



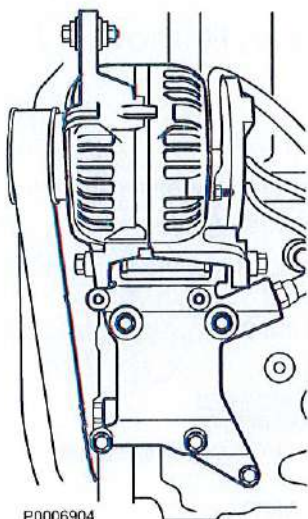
P0006902

- 43 Remove the bolts and the front crankshaft seal fan bearing using a prybar at the reinforcement illustrated.



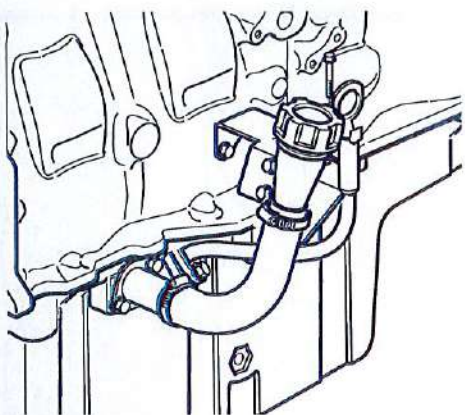
P0006903

- 44 Remove the tensioning wheel and the front engine mounts together with the belt tensioner on the right side of the engine; 6 bolts (1).



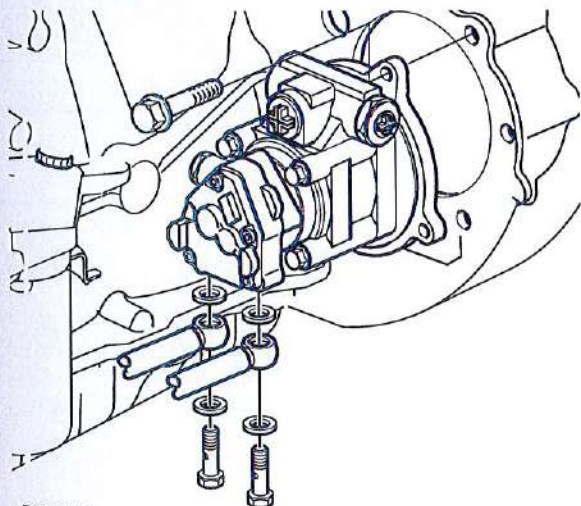
P0006904

- 45 Remove the alternator with its brackets together with the belt tensioner and the bracket for the fan bearing on the left side of the engine.



P0006905

- 46 Remove engine mounts, oil filler pipe and oil dipstick.



P0006906

- 47 Remove the fuel pump and servo pump complete.
- 48 Remove the oil level sensor contact and remove the oil pan.
- 49 Remove the oil strainer complete with pipe connections.
- 50 Remove the bracing frame.

Timing Gear, Removal

Tools:

9996239 Lifting tool

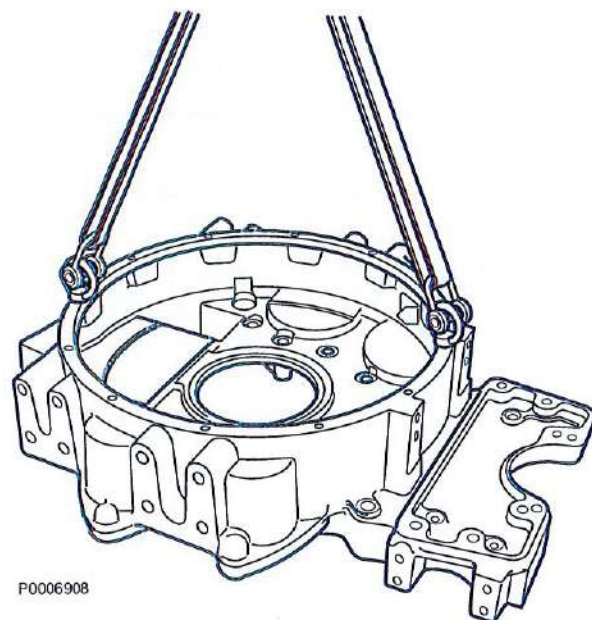
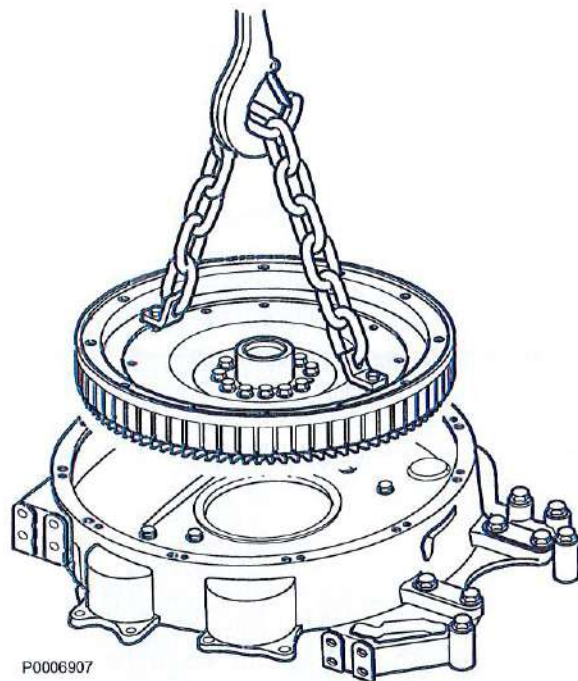
- 1 Remove the flywheel sensor, if not done previously.
- 2 Attach 9996239 Lifting tool to the flywheel with two bolts. Remove the bolts in the flywheel. Remove the flywheel.

▲ WARNING!

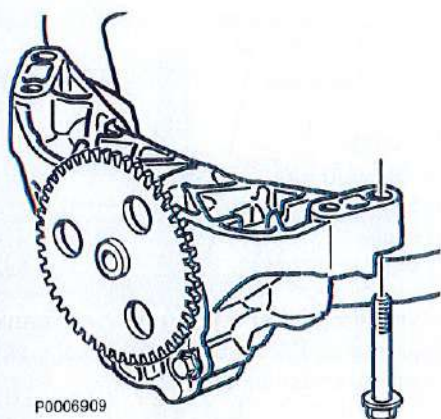
Pinch hazard. Keep fingers clear.

IMPORTANT!

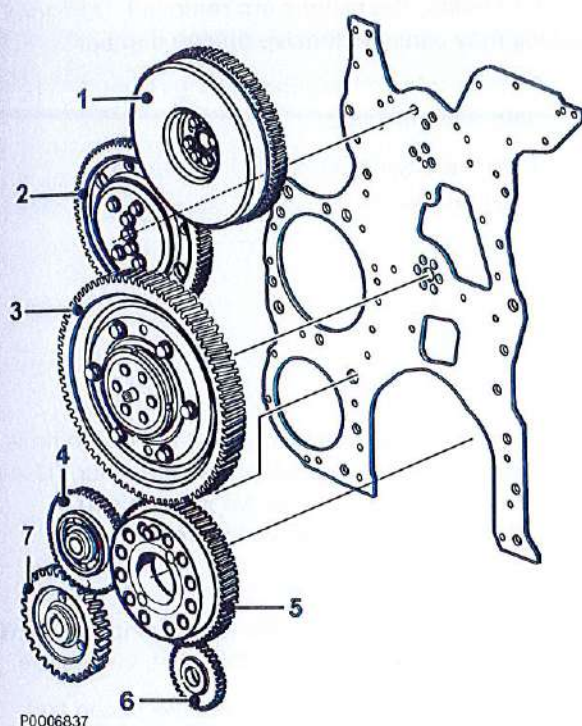
The flywheel is heavy.



- 3 Remove the bolts in the flywheel housing and remove the flywheel housing using lifting eyes and lifting straps.

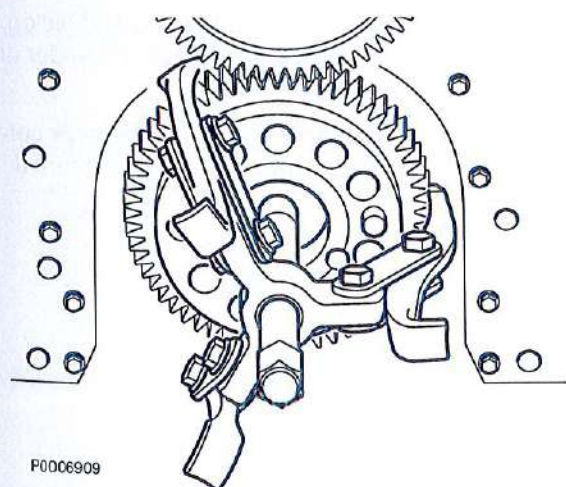


- 4 Remove the lubricating oil pump together with the drive gear.



- 5 Remove the lower intermediate gear (4).

- 1 Camshaft drive gear
- 2 upper intermediate gear
- 3 bull drive
- 4 lower intermediate gear
- 5 crankshaft gear
- 6 oil pump drive gear
- 7 fuel pump drive gear/servo pump



- 6 Remove the two bolts on the crankshaft gear (5) and remove the gear using a suitable puller.

NOTICE! To protect the puller thread, place a thick washer between the threaded shaft and the crankshaft.

- 7 Remove the six Allen bolts in the bull drive hub (3) and remove it complete.
- 8 Remove the upper intermediate gear (2).

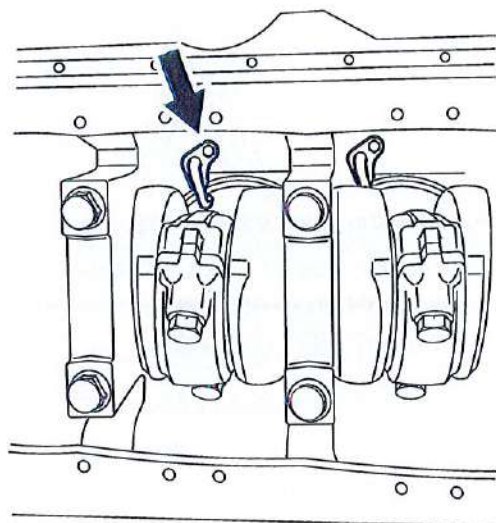
NOTICE! Save the spacer plate behind the gear and note how it is installed.

- 9 Remove the timing gear plate and clean both sides.

Pistons, Removal

Tools:

9986485 Stand
9993590 Rotation tool
9996394 Support
9996645 Puller
9996963 Plate



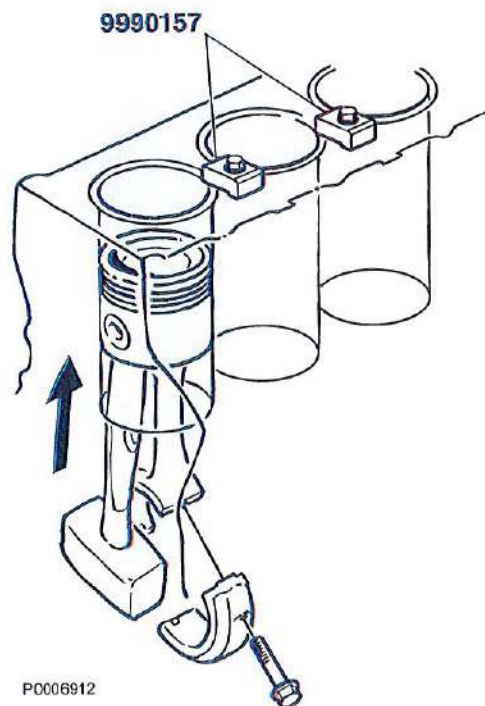
PC006911

- 1 Remove the piston cooling nozzle. Crank the engine using 9993590 Rotation tool so that all become accessible, two at a time.

IMPORTANT!

It is important that the piston cooling nozzles be removed before the pistons are removed. Damaged nozzles may cause extensive engine damage.

- 2 Remove big end bearing caps and bearing shells; note any markings.
- 3 Turn the engine 90° if it is installed in 9986485 Stand.



PC006912

- 4 Press the piston so far out that the piston rings are outside the edge of the cylinder liner. (Use a hammer handle or other wooden object). Lift the piston and connecting rod out.

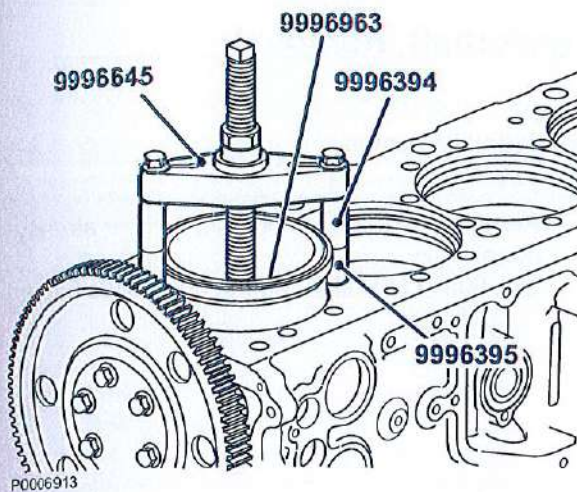
IMPORTANT!

Replace the bearing cap on the connecting rod to avoid damaging the split surface, as this is very sensitive.

- 5 Remove the retainer ring from the piston and press out the piston pin. Disassemble the connecting rod and piston.

NOTICE! Mark the connecting rod and piston, if they are to be installed in the same cylinder at assembly.

- 6 Mark the cylinder liner position in the block before it is removed to facilitate correct placement if reinstalled.



- 7 Fit 9996963 Plate and 9996394 Support to 9996645 Puller.
- 8 Move the plate down through the cylinder and place it in the correct position below the cylinder liner. Pull the cylinder liner out of the block, using the puller. If necessary, extend the support legs with 9996395.
- 9 Remove the cylinder liner sealing rings.

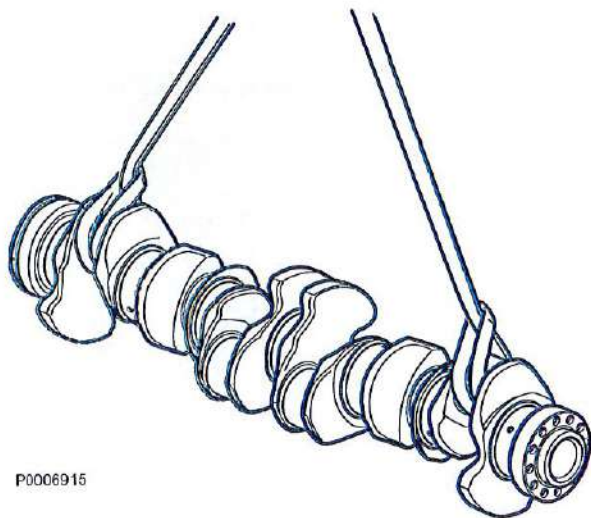
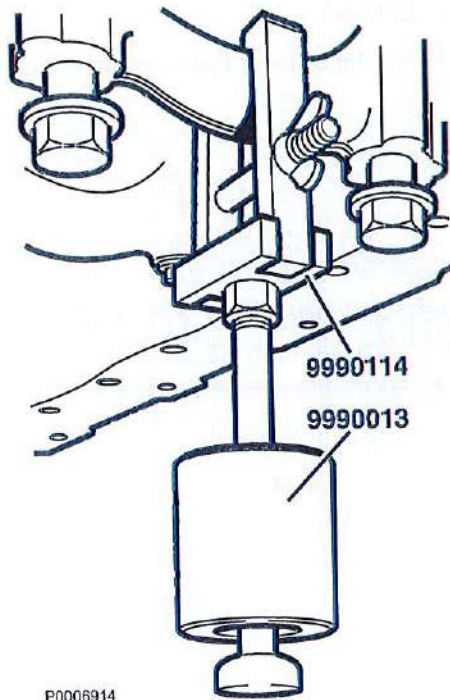
Crankshaft, Removal

Tools:

9990013 Slide hammer

9990114 Puller

- 1 Remove the main bearing caps, if not already done.
Use 9990114 Puller and 9990013 Slide hammer.



- 2 Lift the crankshaft out carefully.

NOTICE! The crankshaft weighs about 80 kg (176 lbs).

- 3 Before the engine block is washed, all plugs, bolts and remaining brackets must be removed.
- 4 Clean the contact surfaces on parts to be reinstalled.

Crankshaft, Installation

- 1 Inspect the crankshaft; refer to *Group 21 - Engine, Crankshaft, inspection*.
- 2 Check the crankshaft ducts, the bearing shell seats, the engine block and bearing caps.
- 3 Fit new main bearing shells.
- 4 Put the bearing shells in their correct places in the engine block and bearing caps. Make sure that bearing shells or caps are not damaged.

NOTICE! Make sure that the upper bearing shells to be fitted into the cylinder block have oil holes.

- 5 Lubricate bearing journals and bearing shells with engine oil and carefully lift the crankshaft into position.
- 6 Install the thrust washers for the center main bearing (thrust bearing). The thrust washers can only be placed in one position.
- 7 Install the main bearing caps with the lower bearing shells. The bearing caps are asymmetric and can only be installed in one position. The center bearing cap (by the thrust bearing) has a cutout, which must be aligned to fit over the guide pin.

NOTICE! Note the markings on the bearing caps, 1 through 7.

- 8 Oil the main bearing screws. Let surplus oil run off before installation.
Tighten according to the specifications in *Special Tightening Torques*.

NOTICE! Check that the crankshaft can be cranked.

- 9 Install the front cover at the belt pulley and install a new seal. Refer to *Group 21 - Engine, Crankshaft seal, replace (front)*.

NOTICE! No lubrication. Must be installed completely dry.

Cylinder Liner, Installation

Tools:

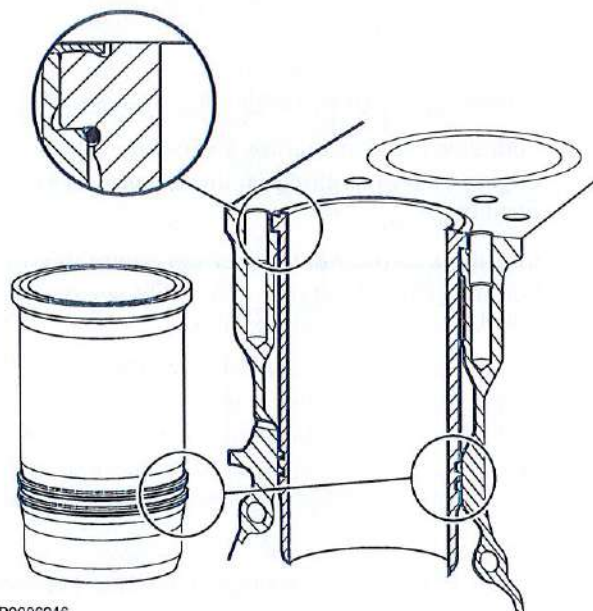
9990157 Press tool

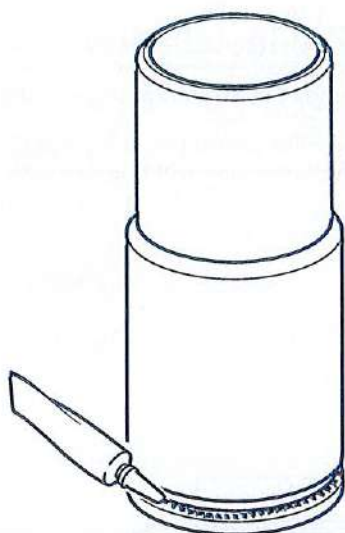
9996963 Plate

9998511 Lever

- 1 Inspect the cylinder liner and pistons; refer to *Group 21 - Engine*, Cylinder liners and pistons, inspection.
- 2 Lubricate the sealing rings with the lubricant supplied with the lining kit and install them on the cylinder liners.

NOTICE! The purple seal ring must seat in the lowest groove





P0006917

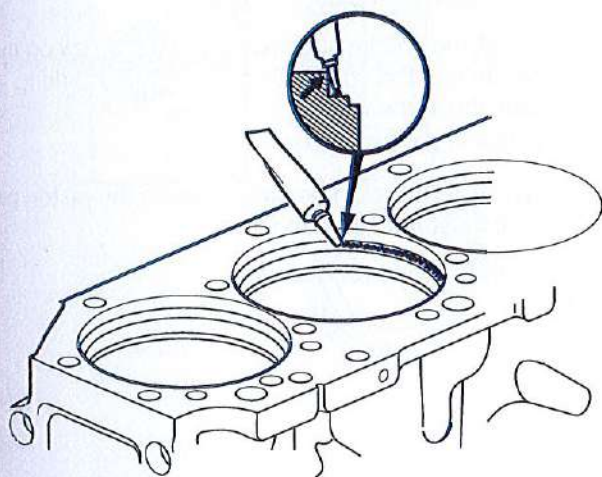
- 3 When the cylinder liner is installed without shims, an even bead 0.8 mm (0.0315") of sealing compound (part no. 1161231) must be applied to the underside of the cylinder liner collar.

NOTICE! Do not put sealing compound around the entire liner. Leave a 2 mm (0.8") gap.

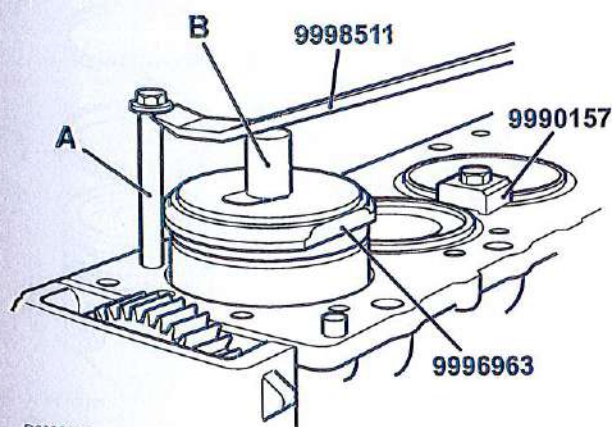
If the liner is installed with shims, the sealant bead must be placed on the cylinder block liner seat.

NOTICE! Sealing compound must not be used between the adjusting shims and the cylinder liner collar.

NOTICE! The liner must be installed within 20 minutes of sealing compound application.



P0006918

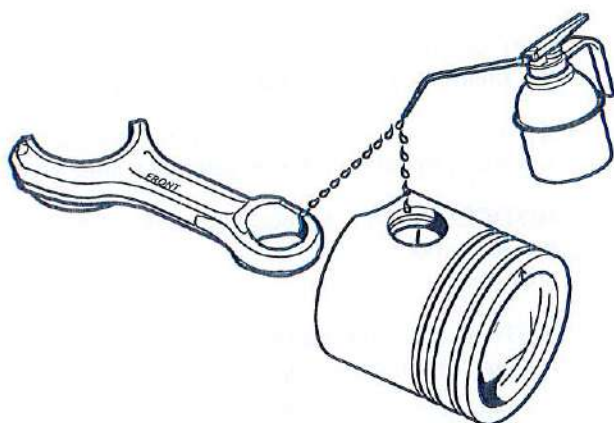


P0006919

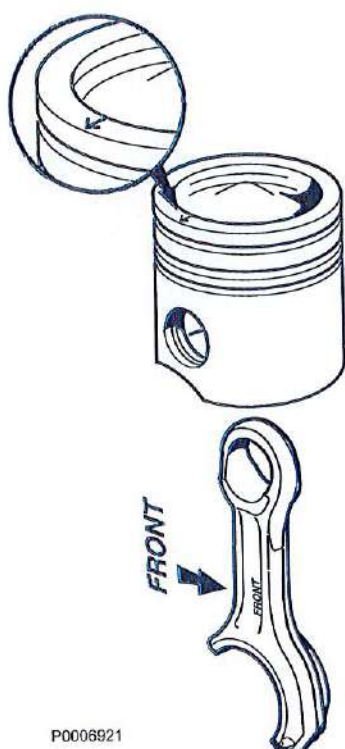
- 4 Screw one of the cylinder head bolts in place (A). Place 9996963 Plate above the cylinder liner together with a suitable spacer (B). Press the liner down using 9998511 Lever and secure it with 9990157 Press tool.

Piston, Pre-installation

- 1 Install one of the retainer rings on the new piston.
- 2 Lubricate the piston pin, the piston bearing seat and the connecting rod bearing with engine oil.



P0006920

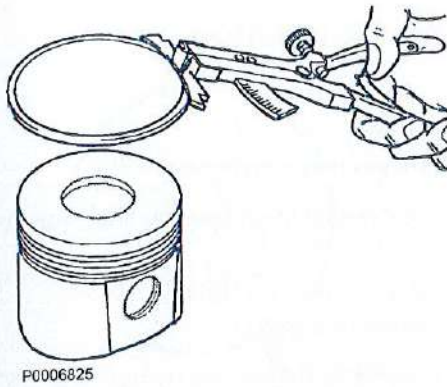


P0006921

- 3 Install the connecting rod so that the arrow on the piston and the connecting rod "Front" marking face the same way.
Press in the piston pin.

NOTICE! It should be easy to press the piston pin in; it must not be driven in.

- 4 Fit the second retainer ring.

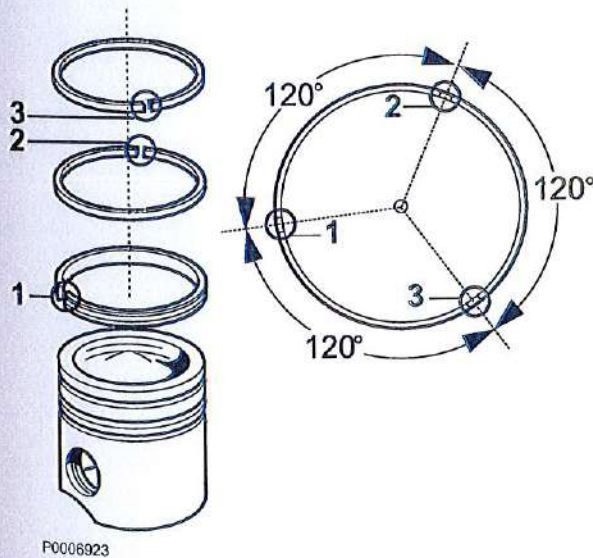
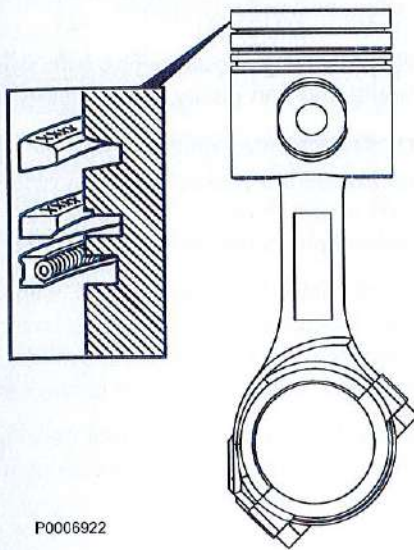


- 5 Check that the piston pin does not move stiffly in the small end, and that the piston can be moved easily.

IMPORTANT!

Always use piston ring pliers to install/remove the piston rings. The oil scraper rings are especially brittle and easily damaged.

NOTICE! The two upper piston rings are marked with letters or punch marks. The mark must face upwards.



- 6 Align the piston ring gaps staggered about 120° around the piston. However, the piston ring gaps must not end up directly over the piston pin.

NOTICE! New cylinder liner kits are supplied complete with pistons and piston rings.

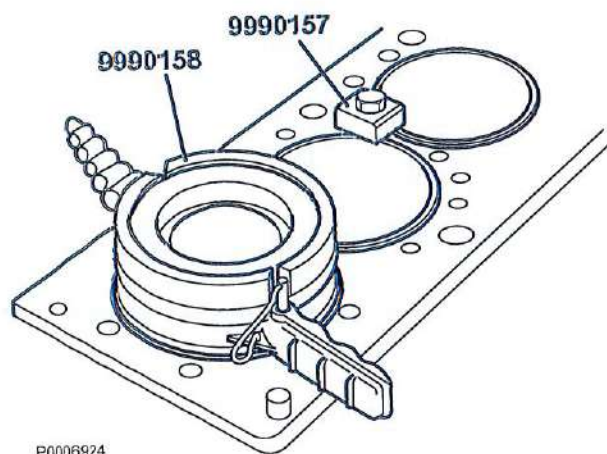
- 7 Install the bearing shells in the engine block.

Pistons, Installation

Tools:

9990157 Press tool

9990158 Piston ring compressor



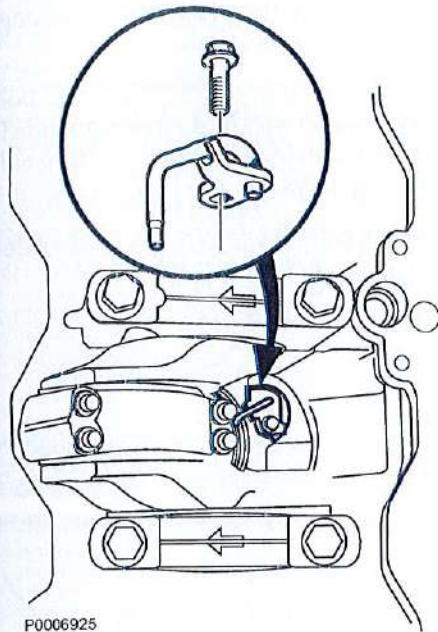
P0006924

- 1 Oil the cylinder liner, bearing shells and big end bearing journals.
- 2 Temporarily remove 9990157 Press tool when the piston is installed.
- 3 Use 9990158 Piston ring compressor and guide the piston with piston rings down into the cylinder. Ensure that the connecting rod does not damage the crankshaft bearing journal.

NOTICE! Take great care. The oil scraper rings are brittle and can easily be damaged.

NOTICE! The piston ring compressor may not be opened when the piston has been placed in the tool, the piston rings can be damaged. Press out the piston first, before opening the tool.

- 4 Re-install 9990157 Press tool. All cylinder liners must be locked with the press tool in order to prevent movement between the cylinder liner and engine block when the engine is cranked.
- 5 Install the bearing caps with their bearing halves. Torque according to the specifications in *Special Tightening Torques*.



P0006925

Piston Cooling Jet, Installation

- 1 Blow the piston cooling nozzle clean and check it is undamaged and that the O-ring is fault free.

IMPORTANT!

Faulty piston cooling will cause the pistons to seize. If piston cooling nozzle damage or deformation is suspected, the nozzle must be replaced (also applies to new nozzles).

- 2 Install the piston cooling nozzle.

IMPORTANT!

Check that the nozzle sits correctly in the hole in the cylinder block and is directed towards the recess in the piston and that the retaining plate lies flat against the block. If the piston cooling nozzle is not correctly installed, the engine will immediately break down under load.

- 3 Tighten according to the specifications in *Special Tightening Torques*.

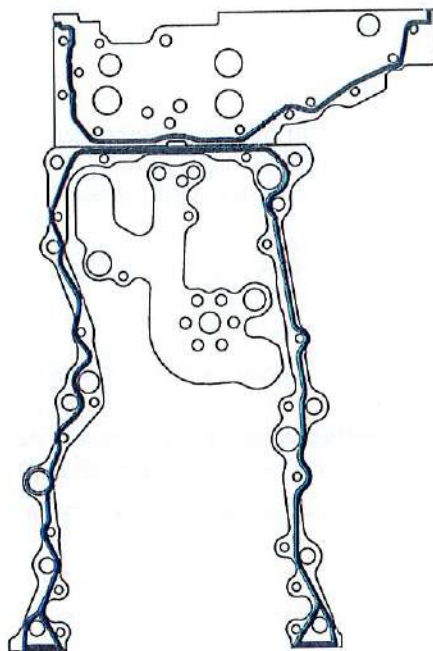
NOTICE! The piston cooling nozzle retaining screw has a friction coating and may only be used once.

- 4 Install the bracing frame and tighten according to the tightening chart in *Special Tightening Torques*.

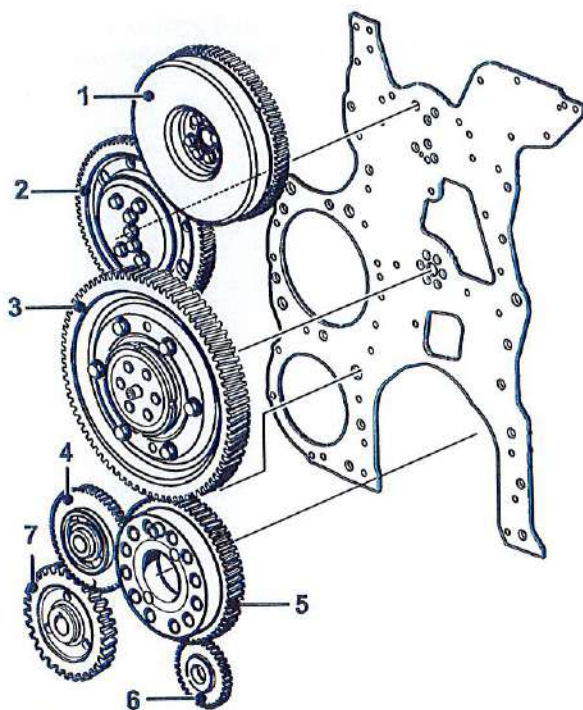
Timing Gear, Installation

- 1 Apply a 2 mm (0.08") thick bead of sealant on the engine block as illustrated.
- 2 Install the timing gear plate. Use new bolts that are pre-treated with locking compound. Tighten according to the specifications in *Special Tightening Torques*.

NOTICE! Torque within 20 minutes of sealant being applied.



P0006926

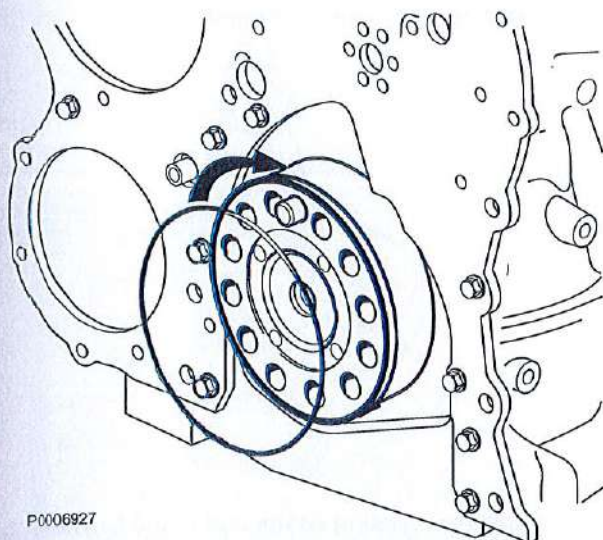


P0006837

- 1 Camshaft drive gear
- 2 upper intermediate gear
- 3 bull drive
- 4 lower intermediate gear
- 5 crankshaft gear
- 6 oil pump drive gear
- 7 fuel pump drive gear/servo pump

- 3 **NOTICE!** Lubricate the inside of the gears before installation.

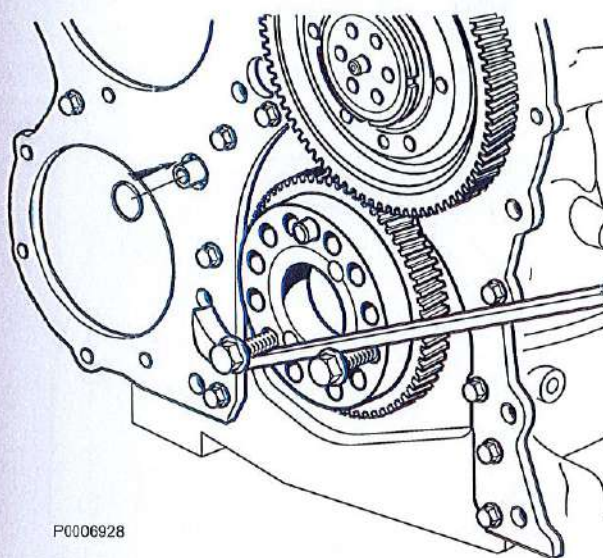
Oil the spacer plate and install it together with the upper intermediate gear (2). Tighten with low torque, max. 10 Nm (7.38 lbf ft).



P0006927

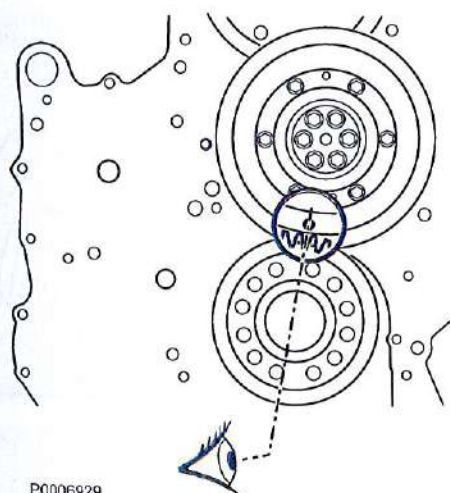
- 4 Install a new O-ring on the crankshaft.
- 5 Install the camshaft gear (5) and torque the bolts according to the specification in *Special Tightening Torques*.

NOTICE! Make sure that the mating surfaces on crankshaft and gear are clean and fault free.



P0006928

- 6 Screw two bolts in the crankshaft gear for crowbar grip, to allow the crankshaft to be turned when necessary.



P0006929

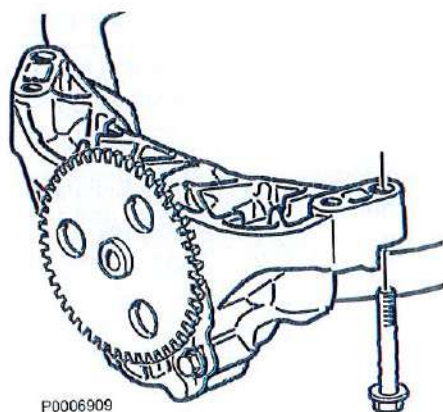
- 7 Install the bull drive kit (3) with the hole marking between the two hole markings on the crankshaft gear.

NOTICE! The bull drive inner and outer gears have different gear pitch. For the camshaft to be set correctly, the markings must correspond.

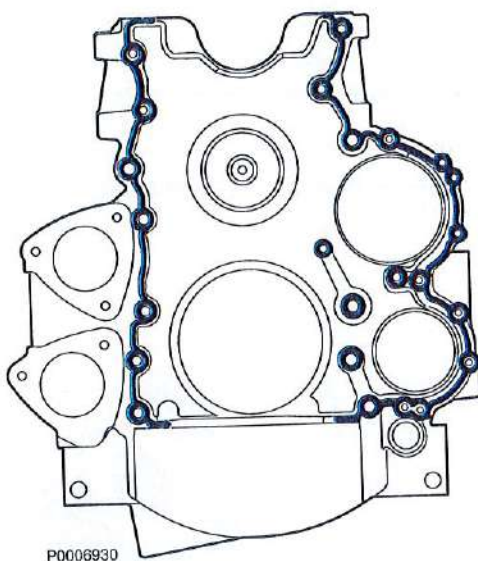
Tighten the bolts according to the specification in *Special Tightening Torques*.

- 8 Install the lower intermediate gear (4) with a new O-Ring.

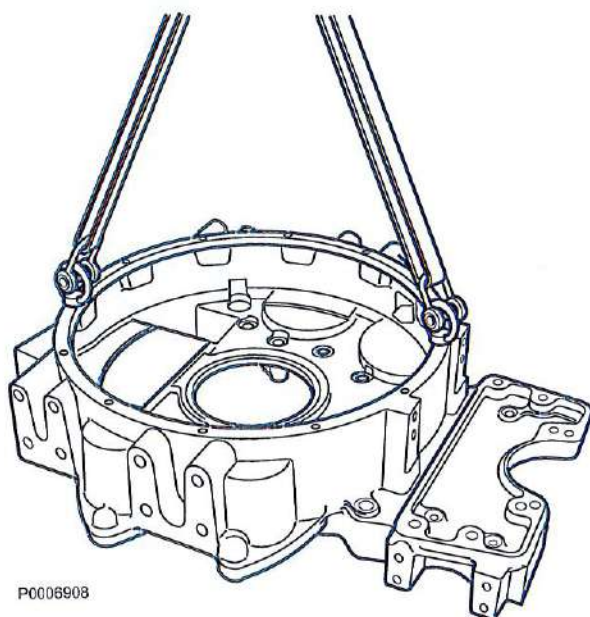
- 9 Install the lubricating oil pump.

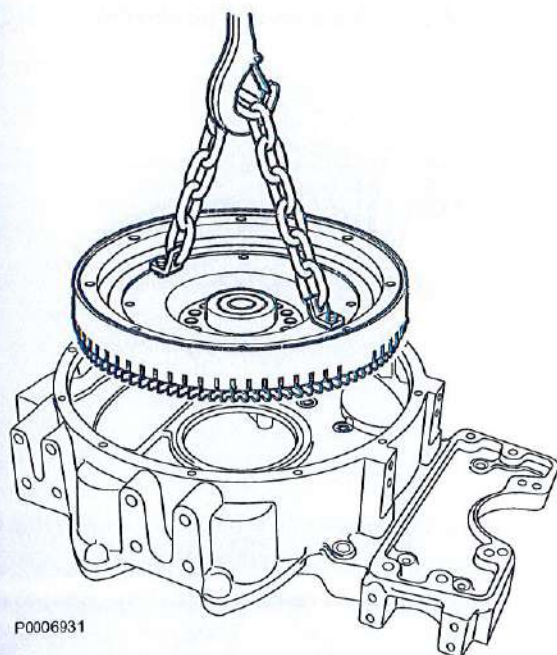


- 10 Apply new sealing compound to the flywheel casing, towards the engine block.

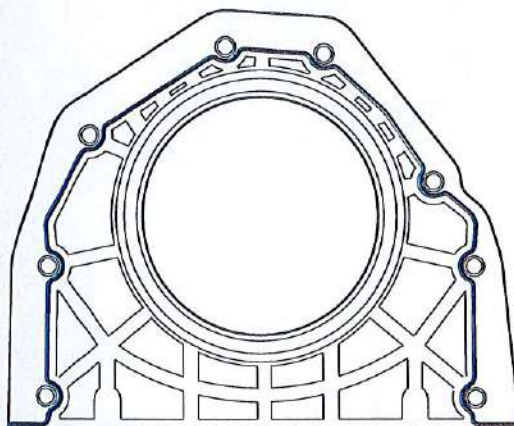


- 11 Remove the old crankshaft seal.
Install the flywheel housing. Check that the casing is aligned with the engine block plane.
Tighten according to the specifications in *Special Tightening Torques*.
Install the new crank shaft seal; refer to *Group 21 - Engine, Crankshaft seal, replace (rear)*.





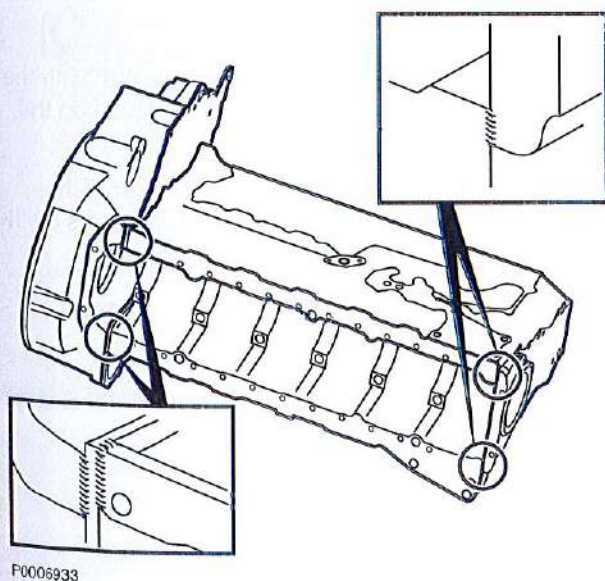
- 12 Install the flywheel and tighten according to specifications in *Special Tightening Torques*. Also refer to *Group 21 - Engine, Flywheel*, indication.



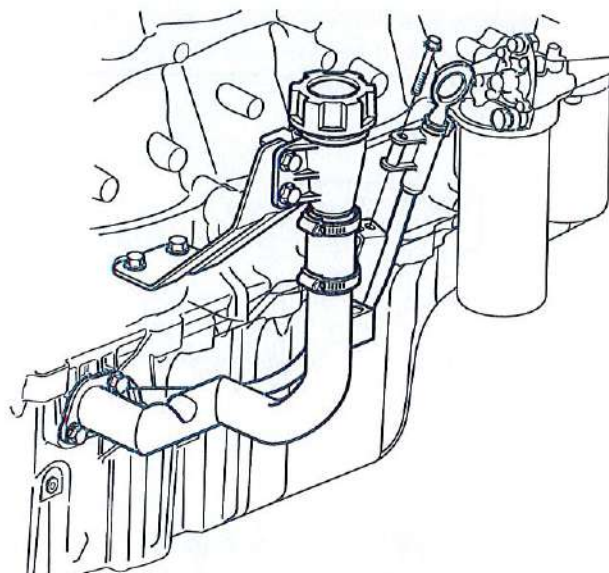
- 13 Remove the old crankshaft seal on the front the casing; refer to *Group 21 - Engine, Crankshaft seal*, replace (front).
Apply sealing compound to the front casing. Install the casing and make sure that the bottom edge of the casing is aligned with the bottom edge of the engine block.
Install a new crankshaft seal (if not already done).

NOTICE! No lubrication. The seal must be installed completely dry.

- 14 Fit the oscillation damper and the belt pulley.
15 Install the oil suction strainer and pipe.

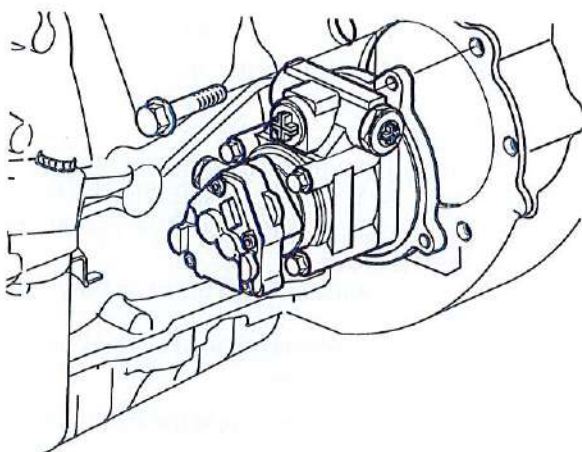


- 16 Cut away any remaining sealing compound and apply new sealant to the parting planes on the front cover, flywheel housing and engine block respectively.
17 Install the oil pan.



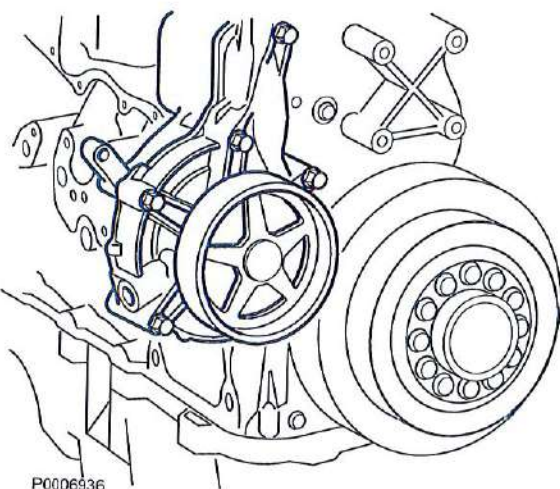
P0006934

- 18 Install the oil filler pipe and oil dipstick with new O-rings.



P0006935

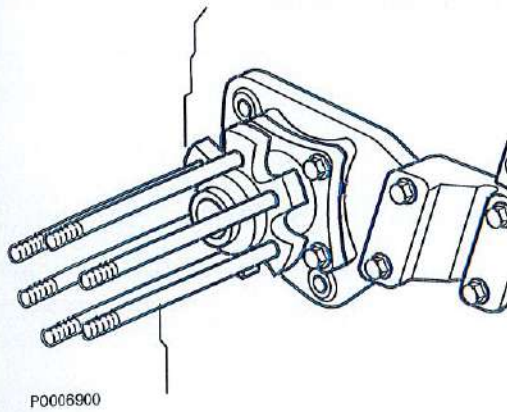
- 19 Install the fuel feed pump/servo pump.



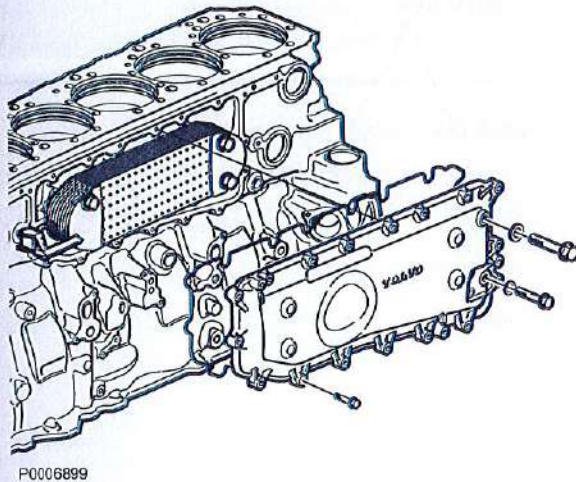
P0006936

- 20 Install the coolant pump.
- 21 Install the front engine mounts together with the belt tensioner and the tensioning wheel on the right side of the engine.
- 22 Install the alternator with brackets, the belt tensioner and the fan bearing attachments on the left side of the engine.

- 23 Install the fan bearing.



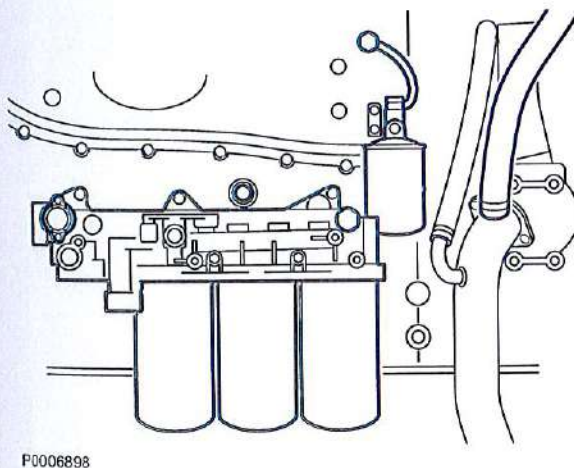
- 24 Fit new sealing rings in the block and the rubber seals on the sides of the radiator. Install the oil cooler and tighten according to the specifications in *Special Tightening Torques*. Check that the side seals are placed correctly in the block.
- 25 Install the oil cooler cover with a new o-ring and tighten according to the specifications in *Special Tightening Torques*.



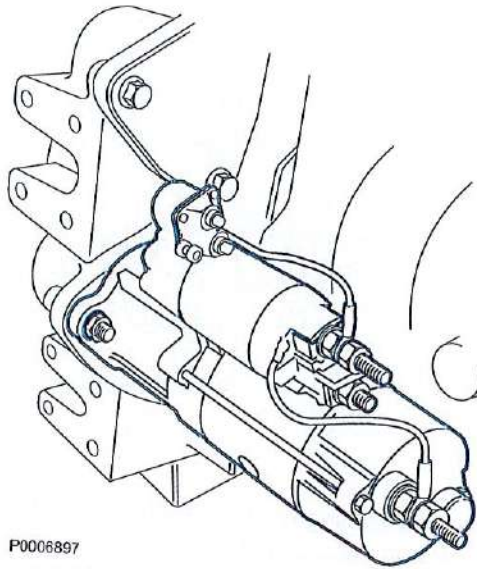
- 26 Install the coolant filter with bracket and the connection to the oil cooler cover.

NOTICE! Industrial engines may not use coolant filters in combination with *Coolant VCS* (yellow); coolant filters will be omitted on new industrial engines filled with *Coolant VCS* (yellow).

- 27 Install the oil filter bracket with a new gasket and new oil filters.

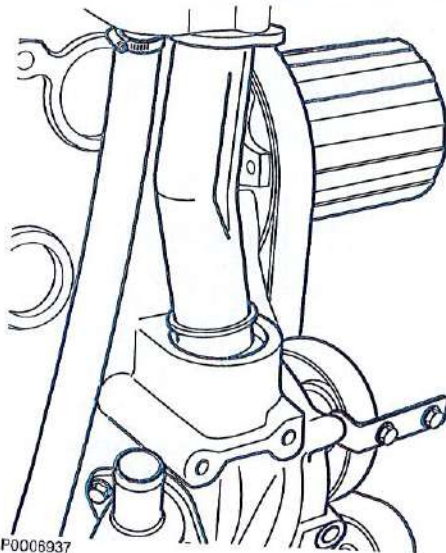


28 Fit the starter motor.



P0006897

29 Install the coolant pipes with new O-rings.



P0006937

Cylinder Head, Installation

Tools:

9990157 Press tool

- 1 Clean the cylinder head carefully both internally and externally before fitting.

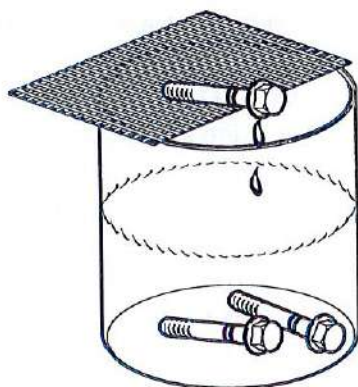
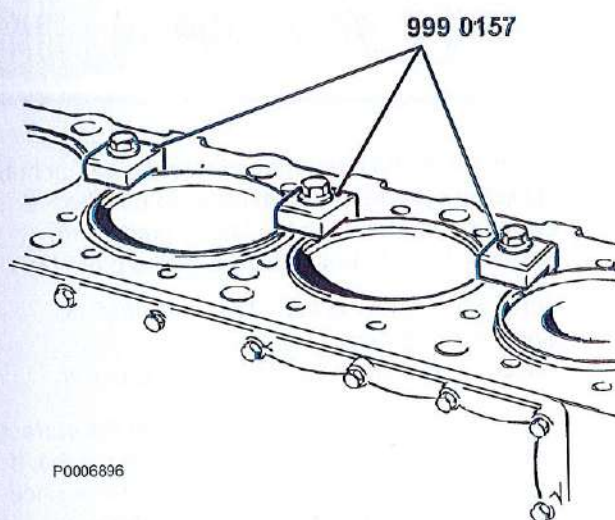
NOTICE! Dirt particles may cause the unit injectors to fail.

- 2 Clean the unit injector copper sleeves. Refer to *Group 21 - Engine*, Copper sleeve for unit injector, replacing.
Install the protection plugs immediately after cleaning.

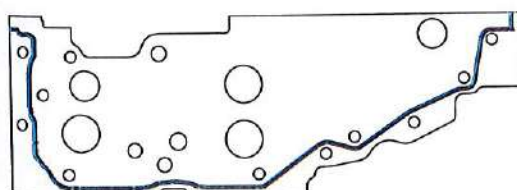
- 3 Remove 9990157 Press tool holding the cylinder liners in place.

- 4 Carefully clean the cylinder head and the engine block sealing surfaces and cut away excess sealant.

NOTICE! Do not pull away dry sealant.



- 5 Immerse the cylinder head bolts completely in a rustproofing agent.
Then place the bolts on a net to allow the excess to run off.



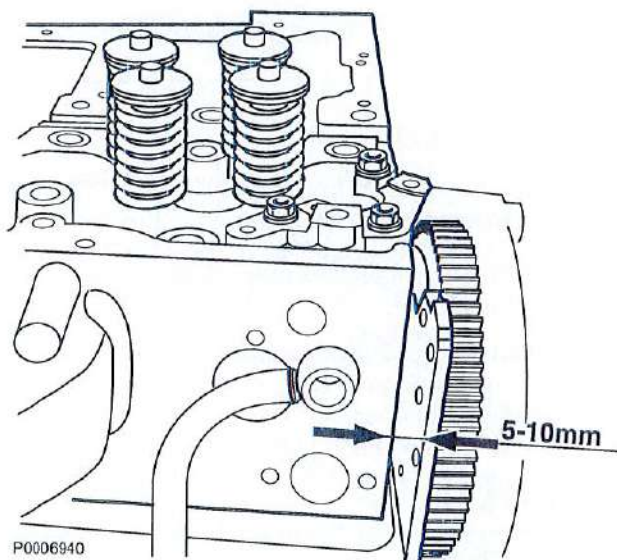
- 6 Apply a 2 mm (0.080") thick bead of sealant to the back of the cylinder head.

NOTICE! The cylinder head bolts must be torqued within 20 minutes of sealant application.

- 7 Fit a new cylinder head gasket.

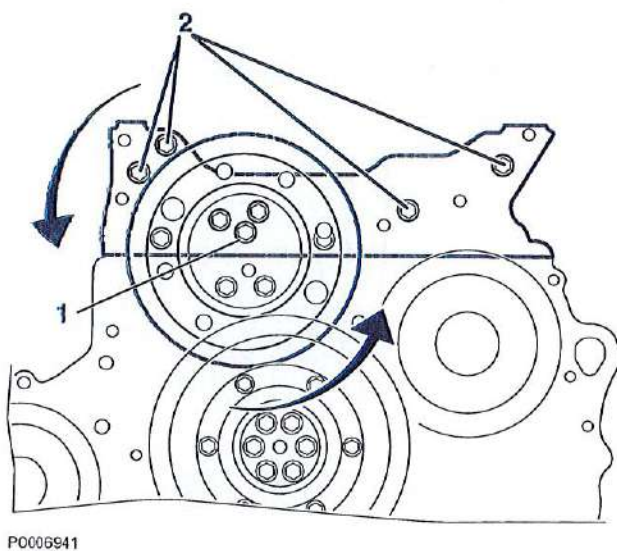
NOTICE! Convex embossments prevent damage to the rubber seals.

NOTICE! Check that the coolant pipe is in place.

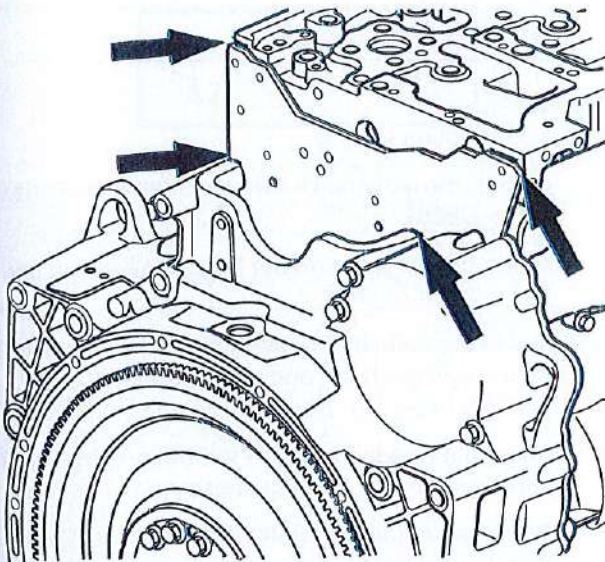


- 8 Lower the cylinder head until it rests on the cylinder head gasket. Maintain a distance to the timing gear plate of 5-10 mm (0.2-0.4"). Locating pins ensure that the cylinder head will be aligned with the engine block.
- 9 Slide the cylinder head against the transmission plate.
- 10 Place a rag in front of the gear to prevent bolts from falling into the timing gear housing.

NOTICE! The rag must be removed before the engine is cranked.



- 11 Insert a bolt into the upper intermediate gear hub (1) in the cylinder head, in order to pull the cylinder head towards the timing gear plate. Screw in five M8 bolts into the timing plate (2).
 - 12 Torque the bolts (1) and (2) as specified in *Special Tightening Torques*. Unscrew all bolts (1) and (2) about one turn.
- NOTICE!** The cylinder head is now in the correct position for fastening and must not be moved. If the cylinder head is moved, the bolts must once again be torqued and loosened as above.
- 13 Install the cylinder head bolts and tighten according to the specifications in *Special Tightening Torques*. Use a torque amplifier for angle tightening.
 - 14 Torque the four M8 bolts in the transmission plate (2) according to the specifications in *Special Tightening Torques*.
 - 15 Turn the engine so that the two M8 bolts (1) can be installed through the upper intermediate gear. Tighten according to the specifications in *Special Tightening Torques*.
 - 16 Fit the remaining two M10 bolts (3) into the upper intermediate gear, without tightening them.
 - 17 Fasten the coolant pipe in the cylinder head.



P0006942

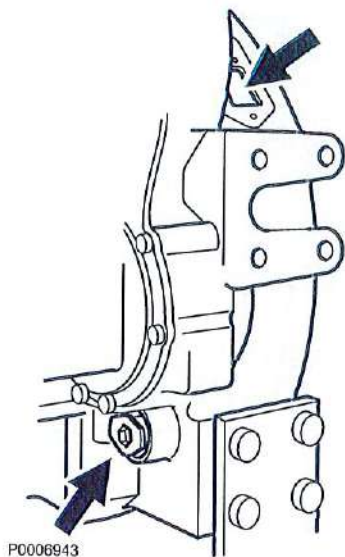
- 18 Clean sealant from the surface as illustrated.
NOTICE! Cut away the sealant.

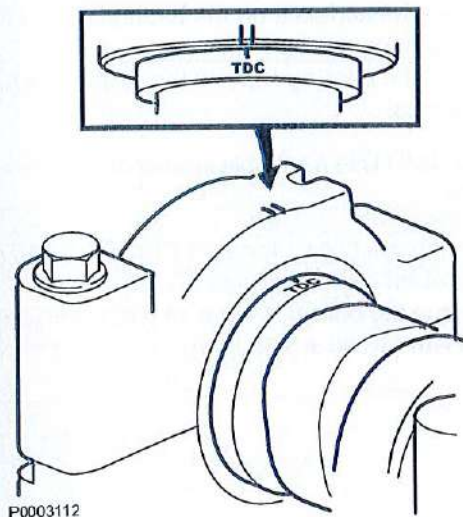
Camshaft, Installation

Tools:

9993590 Rotation tool

- 1 Inspect the camshaft for wear. Refer to *Camshaft, Wear Check*.
- 2 Clean the surfaces on the bearing brackets and the cylinder head.
- 3 Install the camshaft bearing brackets as marked on the cylinder head and make sure they abut the cylinder head, no. 7 by the transmission.
- 4 Place the bearing shells in the bearing brackets and lubricate the bearing shells with engine oil.
- 5 Turn the engine with 9993590 Rotation tool so that the flywheel is set exactly to zero, according to the marking on the flywheel housing.

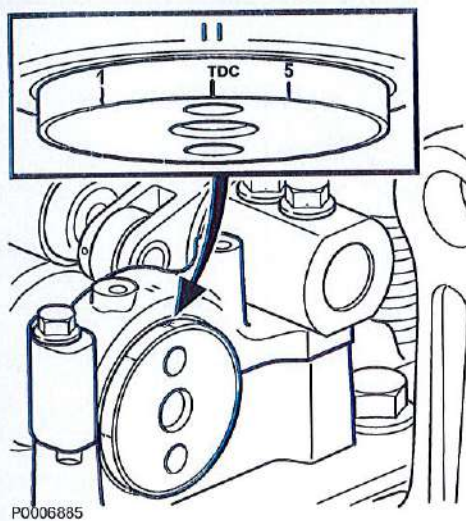




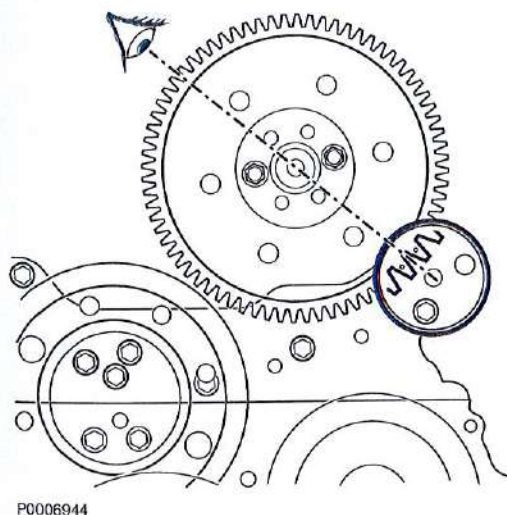
- 6 Carefully lift the camshaft in place. Make sure that the hole for the guide pin on the camshaft gear ends up straight up. The camshaft TDC marking must be centered between the markings on the no 7 bearing bracket.

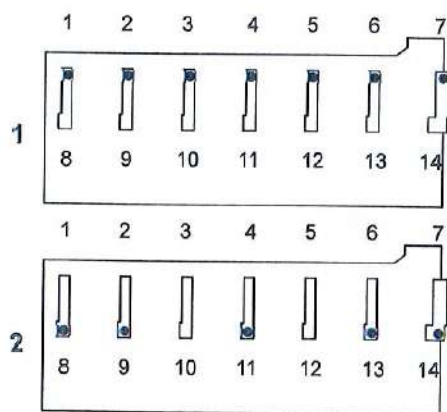


The camshaft lobes are sharp.



- 7 Fit the camshaft gear without the oscillation damper; use nuts as spacers. Place the gear so that the reference hole in the timing gear plate is between the gear markings. If necessary, remove the bolts on the upper intermediate gear. Temporarily tighten two bolts with low torque, max. 10 Nm (7.38 lbf ft).





- 8 Clean the surfaces on the bearing caps and oil the bearing shells.
Install the bearing caps on the respective bearing brackets.

NOTICE! Use a suitable spacer on the rocker arm side.

Torque the bolts 1 through 7 to $15 \pm 3 \text{ Nm}$ ($11.06 \pm 2.21 \text{ lbf ft}$).

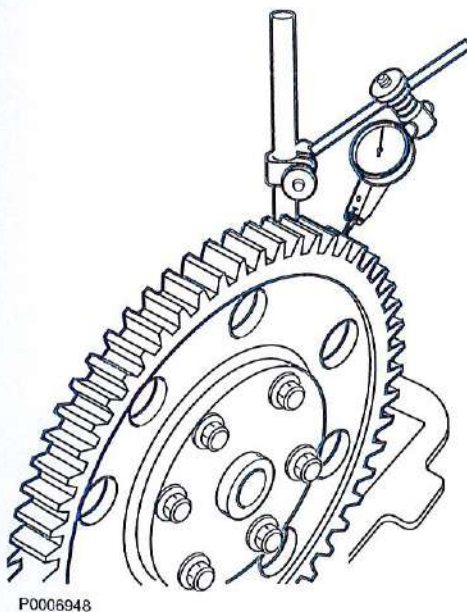
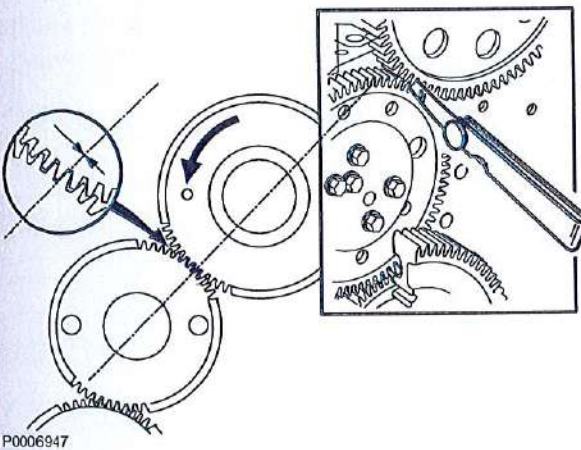
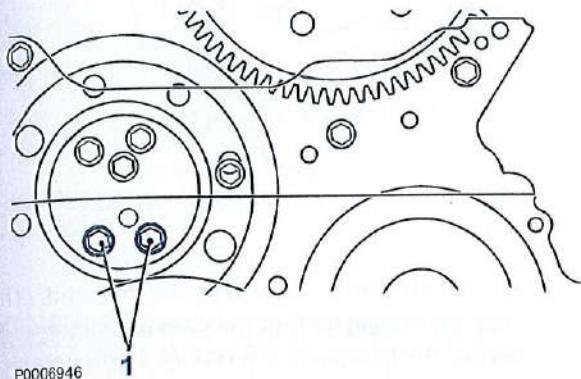
Torque the bolts 8, 11 and 14 (with spacers) to $50 \pm 5 \text{ Nm}$ ($36.88 \pm 3.69 \text{ lbf ft}$).

Flank Clearance, Adjustment

Tools:

885810 Fixture

9998601 Fixture



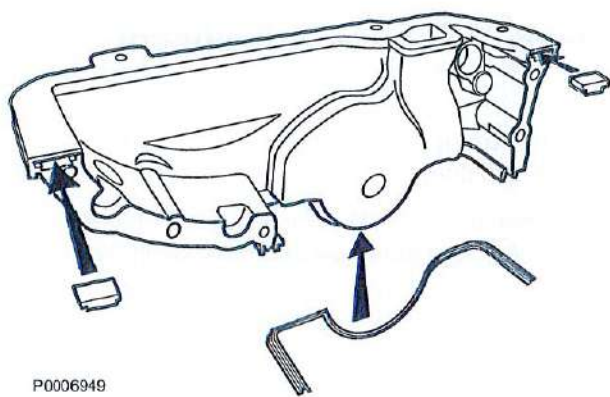
- 1 Undo the bolts (1) in the upper intermediate gear. Check that the upper bolts are not tightened.

- 2 Place a 0.1 mm (0.004") feeler gauge on the pressure side. Turn the camshaft gear against the feeler gauge. Torque the upper intermediate gear according to step 1 in *Special Tightening Torques*. Remove the feeler gauge.

- 3 Check the clearance as follows:
Fix the adjustment wheel.
Place a dial indicator on the camshaft gear, as illustrated.
Turn the gear back and forth and compare the result against the gear lash specification in *Special Tightening Torques*.

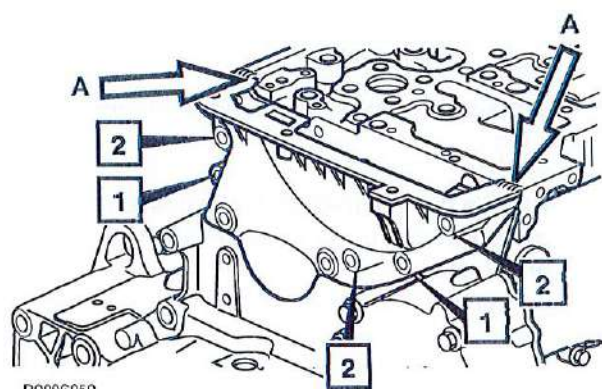
- 4 If gear lash is correct; torque the intermediate gear bolts (1) according to step 2 in *Special Tightening Torques*.

- 5 Install the oscillation damper and tighten according to specifications in *Special Tightening Torques*.



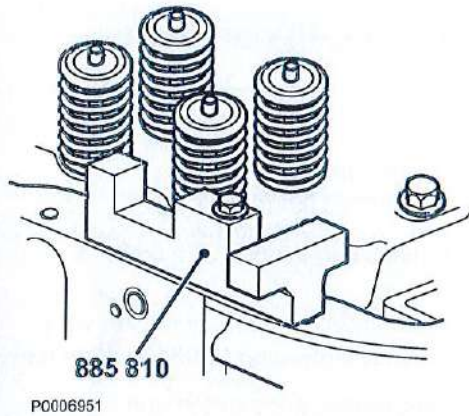
P0006949

- 6 Apply a 2 mm (0.08") thick bead of sealant to the upper timing gear casing contact surface, as illustrated.
- 7 Fit the rubber seals and install the upper timing gear casing.



P0006950

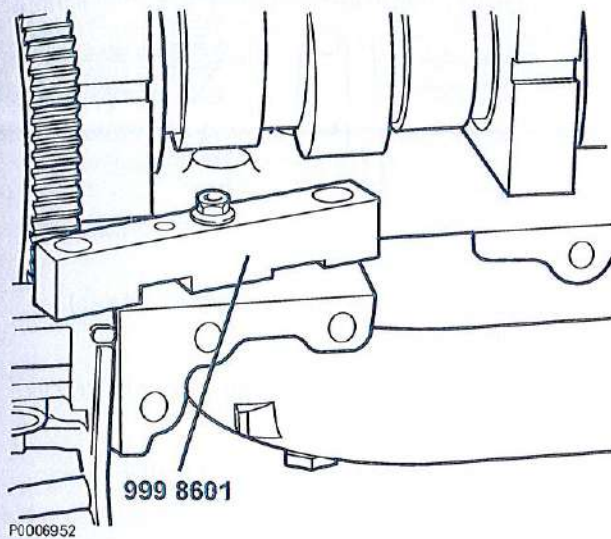
- 8 Only install the bolts (1) and tighten by hand. (The holes are oblong so that the casing can be pressed down against the rubber seal).



- 9 Press the casing down using 885810 Fixture and 9998601 Fixture so that the cylinder head and the upper timing gear casing sealing surfaces are aligned.
Install the remaining bolts (2).
Tighten according to the specifications in *Special Tightening Torques*.

NOTICE! The timing gear casing must be installed and torqued within 20 minutes of sealant application.

- 10 Install the flywheel sensor and adjust it according to *Sensors, Adjustment*.

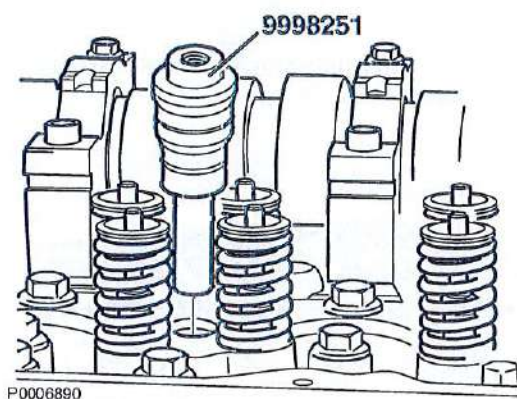


Unit injector, Installation

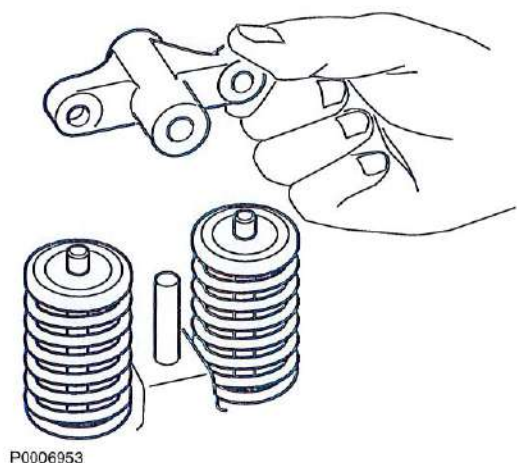
Tools:

9990156 Adapter
9996400 Slide hammer
9998251 Protection plug

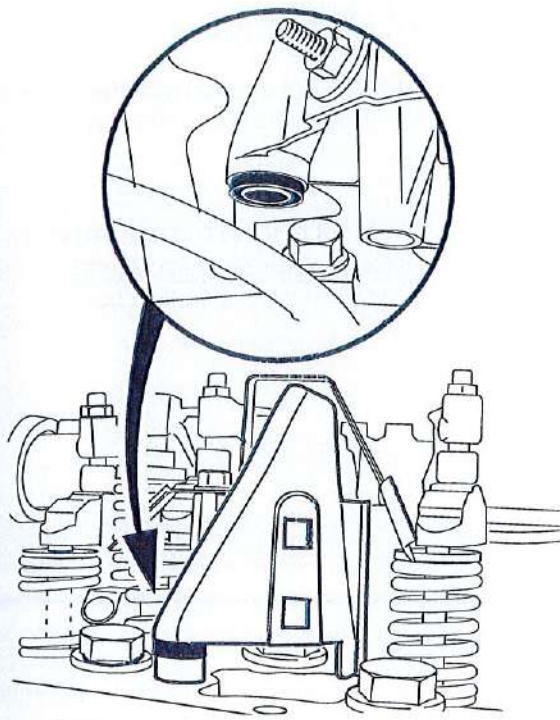
NOTICE! Install one injector at a time.



- 1 Remove 9998251 Protection plug with 9990156 Adapter and 9996400 Slide hammer.
- 2 Fit new sealing rings to the unit injectors. Lubricate the rings with diesel oil. Install the injector and fixing yoke. Center the injector so that it does not touch the valve springs. Torque according to *Special Tightening Torques*.



- 3 Reinstall the valve calipers in their original positions.
- NOTICE!** Make sure that the caliper is directly above the valve stem.
- 4 Lubricate the valve caliper and camshaft.
 - 5 Remove the temporary bolts and spacers on the camshaft cap.
 - 6 Install the rocker arm bridge using a hoist. Make sure that the guide pins fit into the rocker arm shaft. Torque the screws alternately along the rocker arm shaft according to specifications in *Special Tightening Torques*.



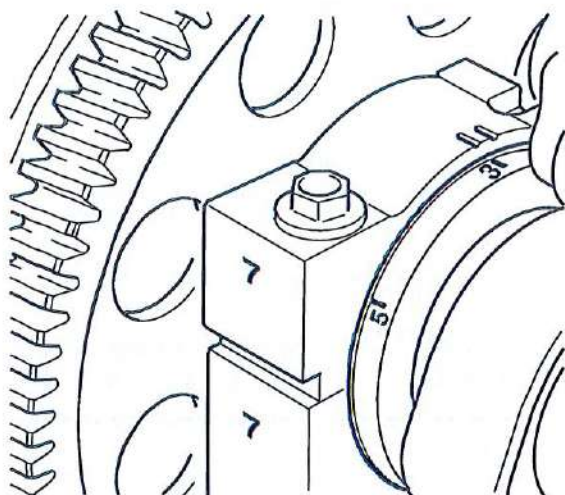
P0006883

- 7 Slide new O-rings over the lubricating oil supply pipe for the rocker arm bridge. Insert the pipe in the joining piece and install the joining piece and pipe. Check that the O-rings on the pipe and the ring under the joining piece are correctly aligned. Fit the cable holder.

Adjustment Markings

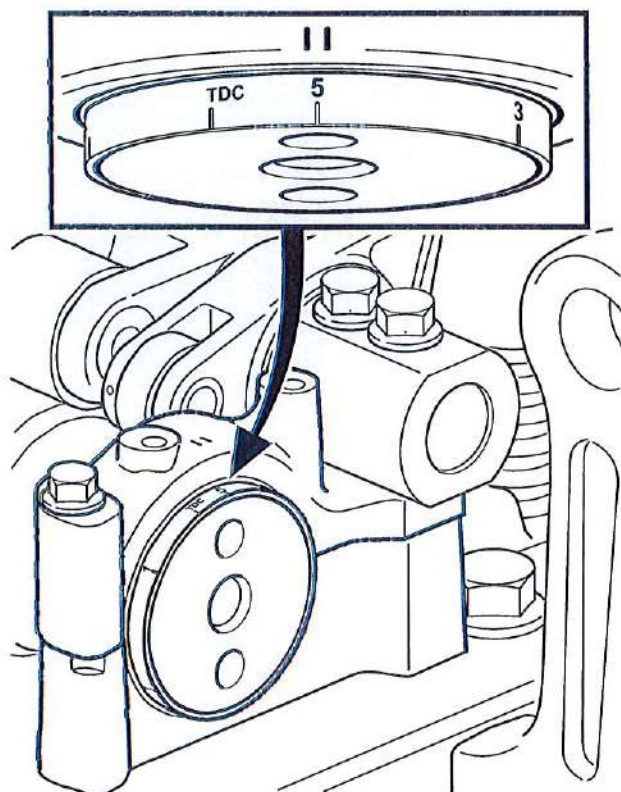
The camshaft has marks (1 through 6 for the respective cylinders) for adjusting intake and outlet valves and the unit injectors.

NOTICE! It is important that the line marked on the camshaft is centered between the two marks on the bearing cap when adjustment is carried out.

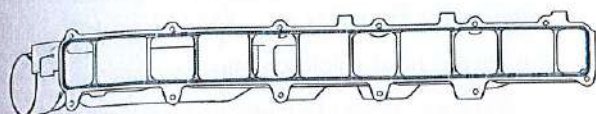


P0006954

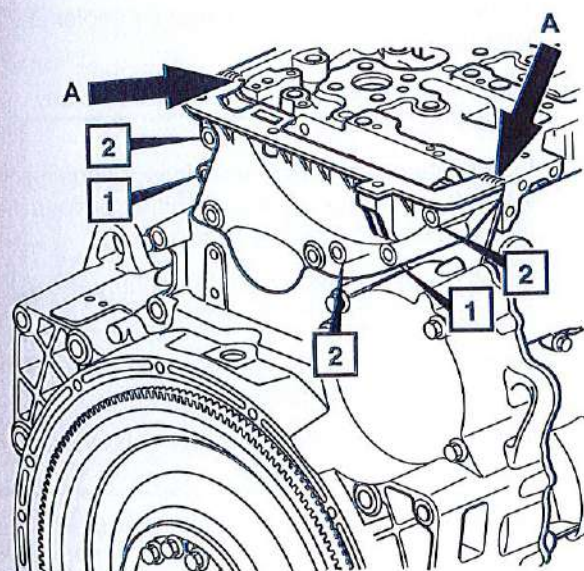
Early model.



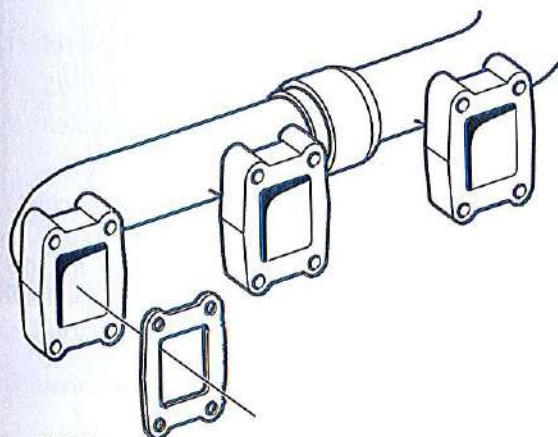
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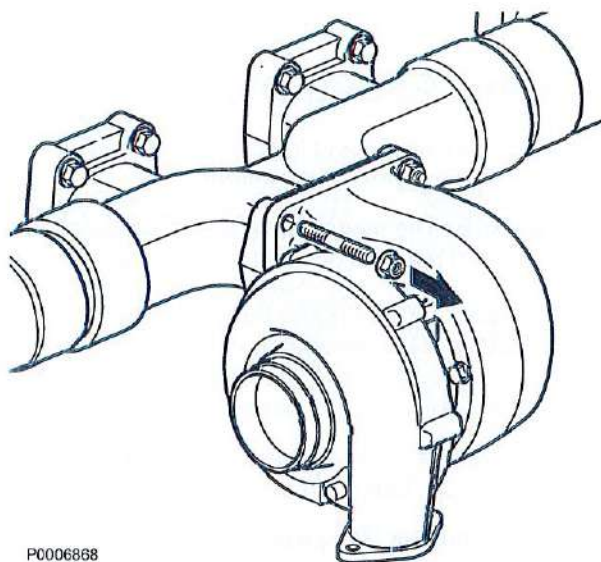
Engine Assembly

- 1 Adjusting valves and injectors; refer to *Valves and Unit Injectors, Adjustment*.
- 2 **NOTICE!** The inlet manifold must be installed within 20 minutes of sealant application.

Apply a 2 mm (0.0787") bead of sealant (1161231-4) to the inlet manifold.
Install the inlet manifold and torque according to the specifications in *Special Tightening Torques*.
- 3 Pull the cable harness to the unit injectors through the cylinder head and connect.
- 4 Install the rear lifting eye.
- 5 Install the sensors for the flywheel, camshaft and oil pressure and starter motor cables.
- 6 Connect the fuel lines to the cylinder head and torque according to *Special Tightening Torques*.
- 7 Apply a 2 mm (0.0787") bead of sealant to parting plane (A) between the timing gear casing and the cylinder head.
- 8 Install the valve cover. Tighten the bolts according to the specifications in *Special Tightening Torques*.

NOTICE! The valve cover must be installed within 20 minutes of sealant application.

- 9 Place the gaskets on the exhaust manifold. Turn the gasket so that the side with the text "Manifold side" is facing the exhaust manifold. Thread the bolts into the gaskets so that they are held in place during installation of the exhaust manifold. Install the exhaust manifold and torque according to the specifications in *Special Tightening Torques*.



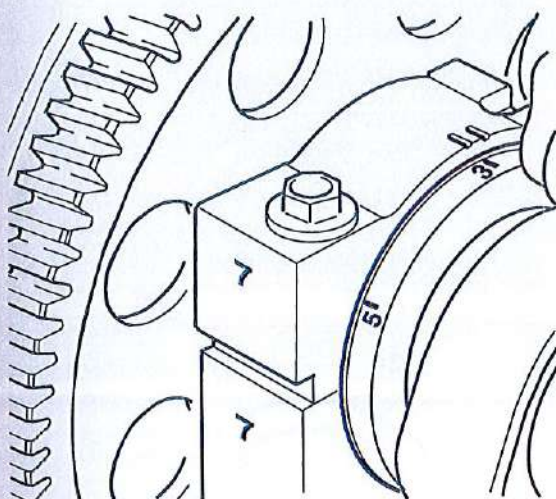
P0006868

- 10 Fit the turbocharger without tightening.
- 11 Fit the return oil pipe. Check that the old seal is removed and that the new seal ends up in correct position. Install the pressure pipe between the oil filter bracket and the turbocharger. Tighten according to the specifications in *Special Tightening Torques*.
- 12 Install the heat shield plates.
- 13 Fit the thermostat housing and torque alternately. Remove the forward lifting eye.
- 14 Fit the new coolant pipe sealing rings and torque alternately.
- 15 Remove fixture and replace the parts that were removed.
- 16 Install drive belts and fan.
- 17 Install the brackets for the radiator fan safety cover/grille. Install protection.
- 18 Install the alternator protection cover.
- 19 Install the pipe between charge air cooler and inlet pipe.
- 20 Install the crankcase breather pipe and any additional oil separator.
- 21 Insert a new cartridge in the air filter housing and install it with brackets and the pipe between the air filter housing and the turbocharger.
- 22 Install the pipe between the turbocharger and the charge air cooler.
- 23 Install the muffler with attachments. Connect the exhaust pipe to the turbocharger.
- 24 Install the heat shield above the turbocharger, if fitted.
- 25 Install the belt cover on the right side of the engine, if fitted. Install the hoses to expansion tank and radiator.
- 26 Replace oil filter. Fill with engine oil; refer to *Engine oil and oil filter, changing*.
- 27 Replace coolant filter. Fill with coolant; refer to *Coolant Level, Checking and Topping Up*.
- 28 Change the fuel filter. Bleed the fuel system; refer to *Fuel system, bleeding*.
- 29 Start the engine and let it run until it reaches normal working temperature. Let it run an additional 5–10 minutes at idle. When the idle is even, the cylinder balancing system has set the correct amount of fuel for the unit injectors.

NOTICE! Do not connect any power consuming device (e.g. power outlet) while cylinder balancing is under way.

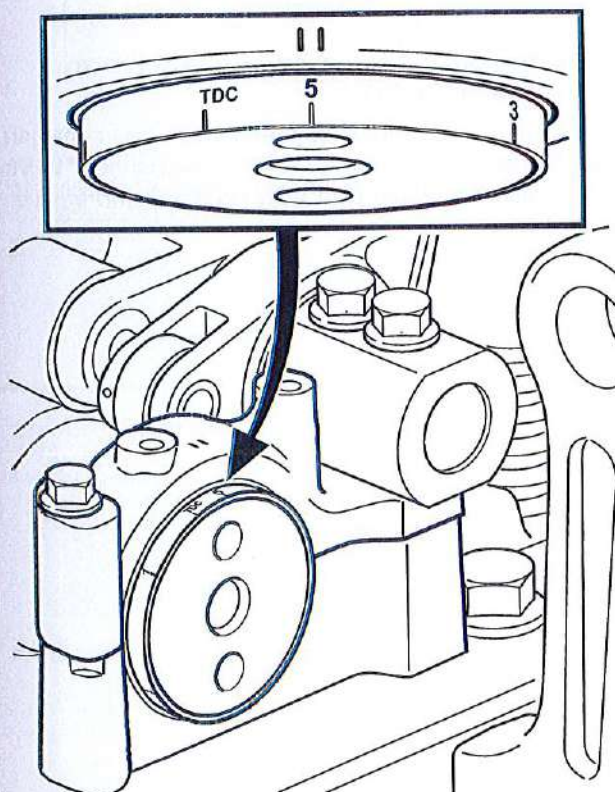
Check that no leakage is present.

21-4 Valve Mechanism



P0006954

Early model.



P0002568

Valves and Unit Injectors, Adjustment

Identifying the valve system

Depending on their specification engines are equipped with different valve mechanisms. It is extremely important that correct valve adjustment is performed according to the mechanism.

Timing marks

The camshaft has marks (1-6 for the respective cylinders) for adjusting inlet and exhaust valves and the unit injectors.

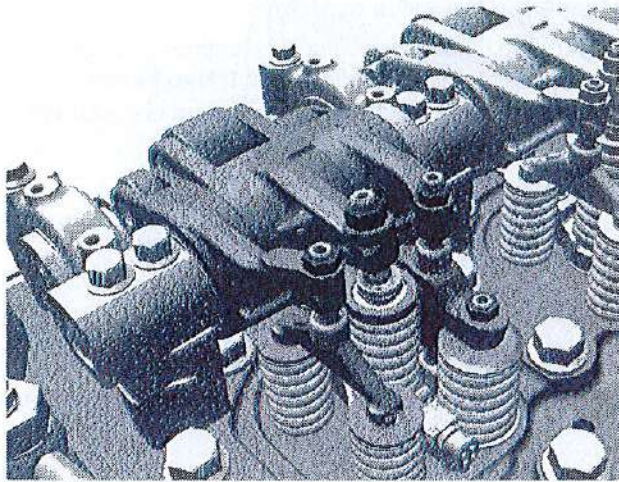
NOTICE! It is important that the line marking on the camshaft is centred between the marks on the bearing cap when adjustment is carried out.

NOTICE! There are several valve mechanism versions on the engines.

Check the version according to the below.

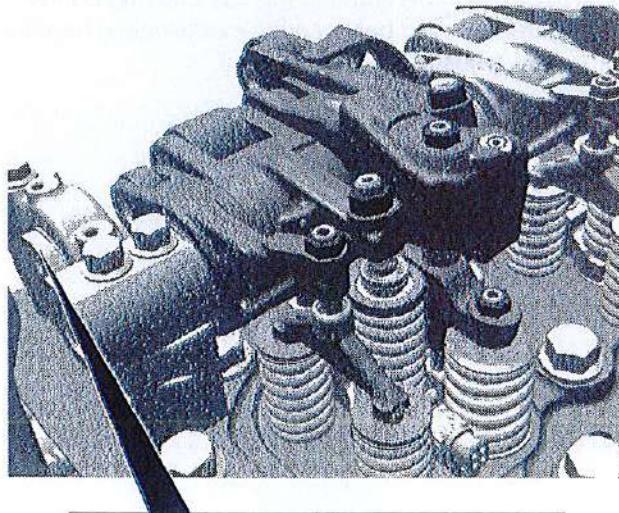
Standard valve mechanism

For adjustment of valve mechanism as illustrated, refer to *Standard valve mechanism*.



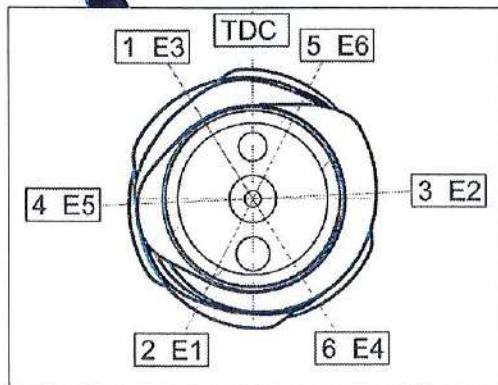
P0016503

TAD1640-42GE, TAD1641-43VE, TAD1640VE-B, TAD1641VE-B, TAD1642VE-B, TAD1660-62VE, TAD1670-72VE, TWD1643GE, TWD1644GE, TWD1645GE, TWD1652-53GE, TWD1663GE, TWD1672-73GE.



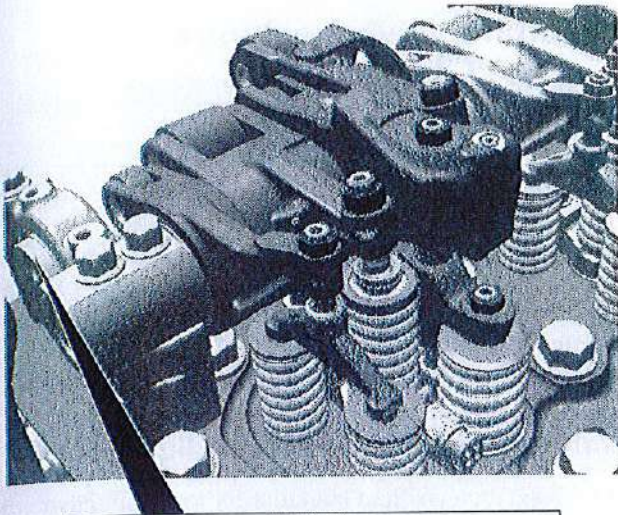
Valve mechanism equipped with VCB (Volvo Compression Brake)

For adjustment of the valve mechanism and camshaft marking as illustrated, refer to valve adjustment *Valve mechanism equipped with VCB (Volvo Compression Brake)*.



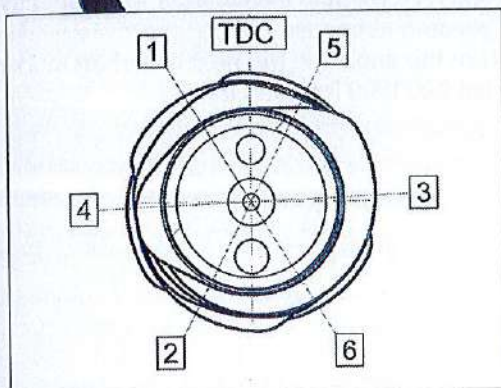
P0016504

Options for TAD1660-62VE, TAD1670-72VE, TAD1640VE-B, TAD1641VE-B, TAD1642VE-B.



Valve mechanism equipped with Internal EGR (Exhaust Gas Recirculation)

For adjustment of the valve mechanism and camshaft marking as illustrated, refer to Valve mechanism equipped with Internal EGR (Exhaust Gas Recirculation).



P0016505

TAD1650GE, TAD1650VE, TAD1651GE, TAD1650VE-B,
TAD1651VE.

Standard valve mechanism

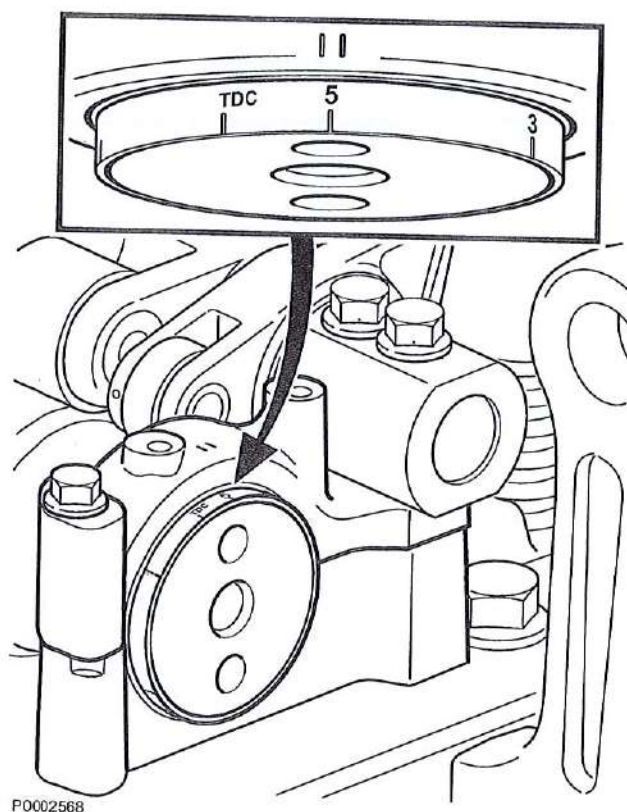
TAD1640GE, TAD1640VE-B, TAD1641GE, TAD1641VE, TAD1641VE-B, TAD1642GE, TAD1642VE-B, TAD1660VE, TAD1661VE, TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE, TWD1643GE, TWD1644GE, TWD1645GE, TWD1663GE, TWD1672GE, TWD1673GE

Tools:

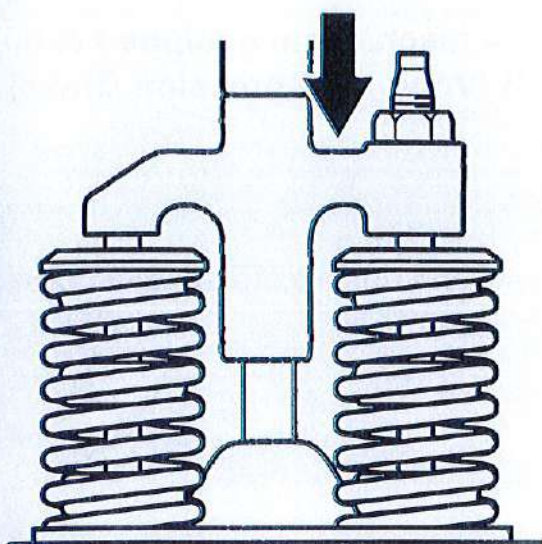
9993590 Rotation tool

Valves and Unit Injectors, Adjustment

- 1 Adjust valves and injectors for the respective cylinders at the same time.
Turn the engine to the next camshaft marking.
Use 9993590 Rotation tool.



P0002568



P0006956

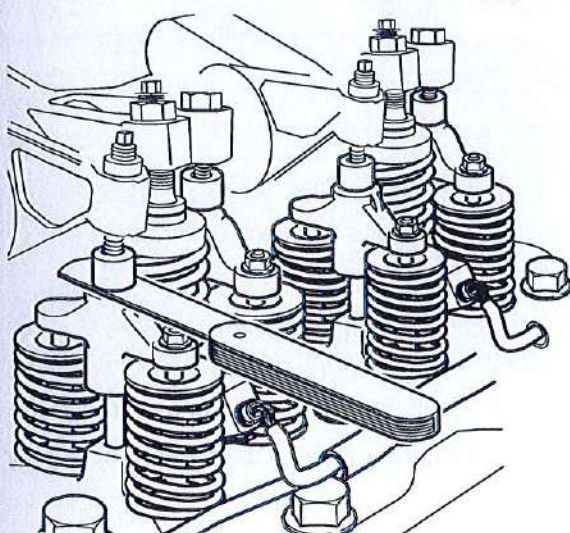
- 2 Screw out the yoke adjuster screw around 1 turn.

NOTICE! Before the adjuster screw is screwed in, the yoke must be pressed down simultaneously until it touches the valve stem. It is extremely important that the pressure is brought to bear as close to the adjuster screw as possible; see illustration.

Screw the adjuster screw down until it rests against the valve stem and then turn one additional flat (60°).

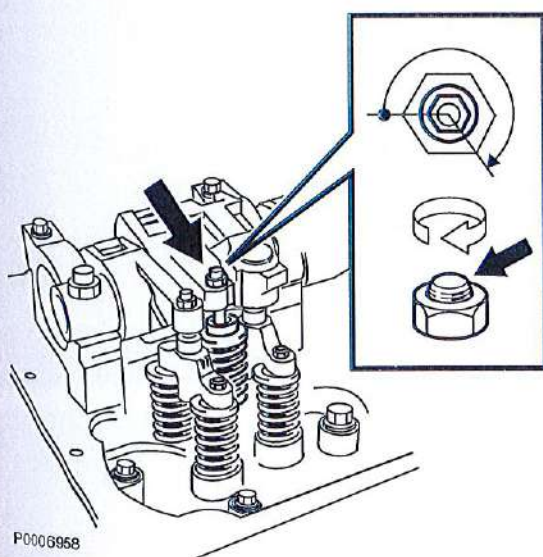
Tighten the locking nut according to the specifications in *Special Tightening Torques*.

NOTICE! Use a wrench on the yoke as a counterhold also when tightening.



P0006957

- 3 Adjust the valve clearance between the rocker arm and valve yoke as specified in the *Valve mechanism* section in the *Technical Data* chapter.
Tighten according to the specifications in *Special Tightening Torques*.
Check the valve clearance. Mark the rocker arm once the valve has been adjusted.
Adjust clearances for the inlet and exhaust valves.



P0006958

P0006958

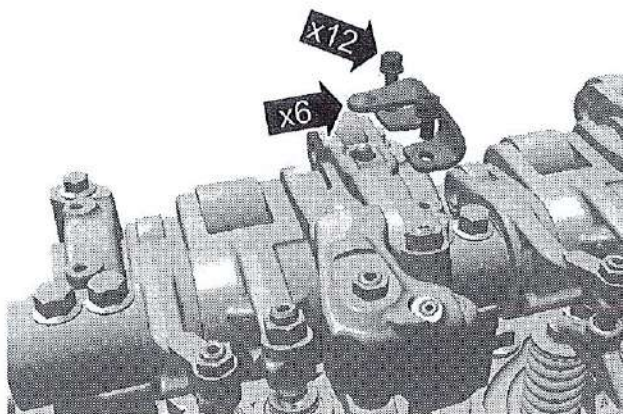
- 4 Adjust the unit injector preload by loosening the adjuster screw until a clearance is obtained on the injector.
Adjust the screw until the clearance disappears (by feel until the roller can no longer be rotated).
Tighten the adjuster screw a further 240° (4 flats).
Tighten the nut on the adjuster screw according to *Special Tightening Torques*.
- 5 Adjust the remaining valves and unit injectors as described above.
- 6 Remove 9993590 Rotation tool from the gear ring.
Install the valve cover.

Valve mechanism equipped with VCB (Volvo Compression Brake)

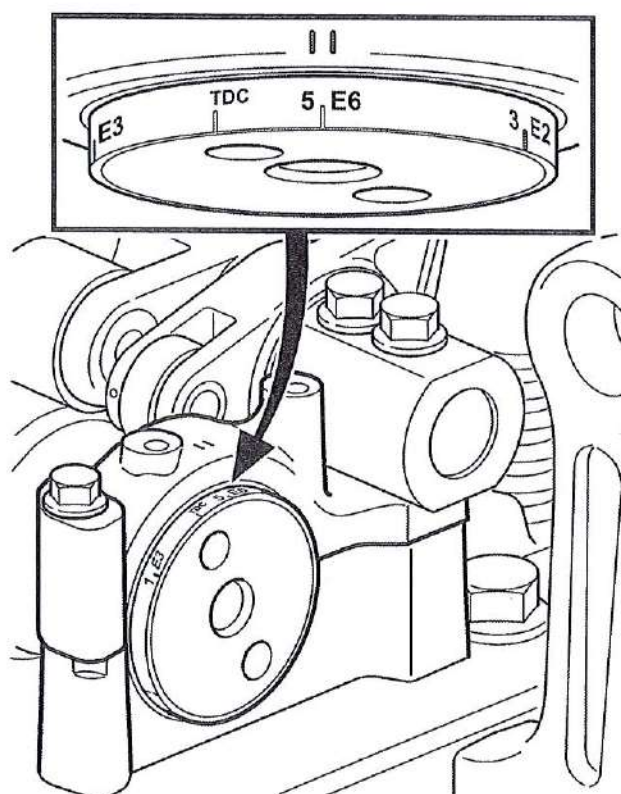
TAD1640VE-B, TAD1641VE-B, TAD1642VE-B,
TAD1643VE-B, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

Valves and Unit Injectors, Adjustment

- 1 Remove all VCB rocker arm springs.



P0016506

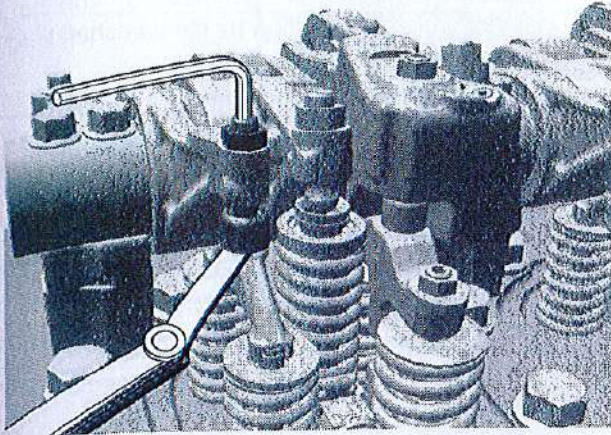


P0016507

- 2 Turn the engine to the next camshaft marking. Use 9993590 Rotation tool.

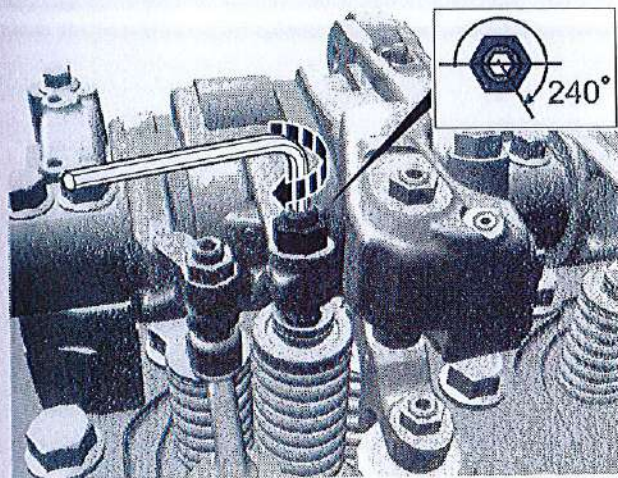
In this case camshaft position indicates adjustment of:

- 5 = Inlet and injector rocker arm, cylinder 5.
- E6 = Exhaust and VCB rocker arm, cylinder 6



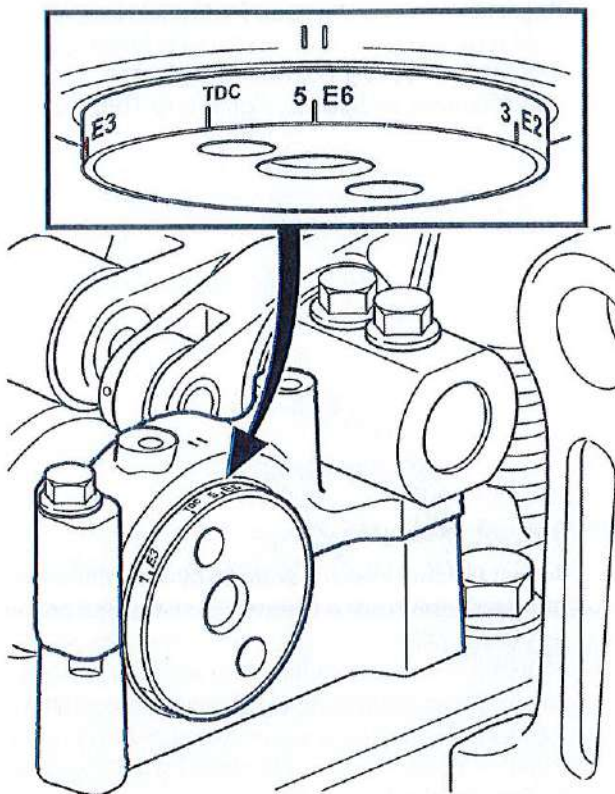
P0016508

- 3 Adjust the valve clearance for the inlet valves to 0.30 mm (0.0118") with the aid of a feeler gauge. Tighten the locking nut according to the specifications in *Special Tightening Torques*.



P0016509

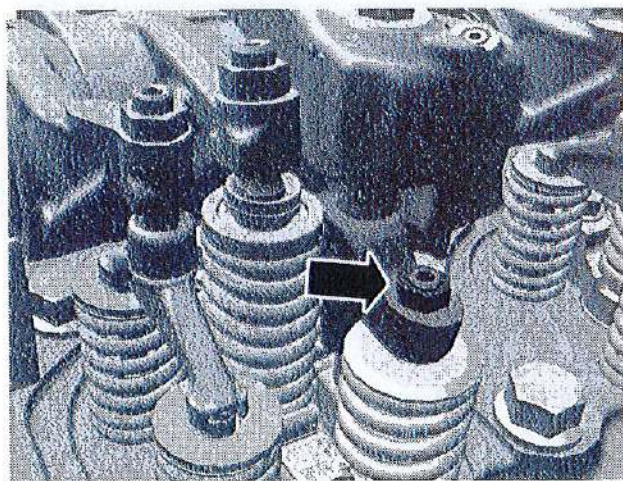
- 4 Adjust the unit injector preload by loosening the adjuster screw until a clearance is obtained on the injector. Adjust the screw until the clearance disappears (by feel until the roller can no longer be rotated). Tighten the adjuster screw a further 240° (4 flats). Tighten the nut on the adjuster screw according to *Special Tightening Torques*.



P0016507

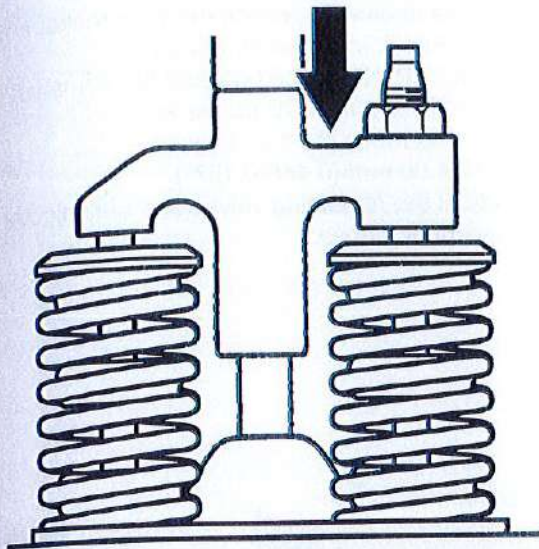
- 5 **IMPORTANT!**
Adjust the exhaust and VCB rocker arm on the cylinder which is indicated by the camshaft E marking.

Example: E6 = Exhaust and VCB rocker arm, cylinder 6



P0016510

- 6 Adjust the exhaust valve yokes by first checking that there is no clearance between the yoke and the rocker arm.
Undo the yoke locking nut while holding the yoke secure with a wrench so that the valves are not bent.



P0006956

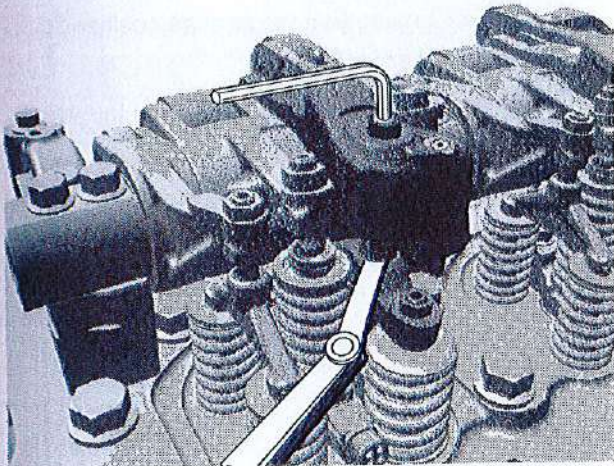
- 7 Screw out the yoke adjuster screw around 1 turn.

NOTICE! Before the adjuster screw is screwed in, the yoke must be pressed down simultaneously until it touches the valve stem. It is extremely important that the pressure is brought to bear as close to the adjuster screw as possible; see illustration.

Screw the adjuster screw down until it rests against the valve stem and then turn one additional flat (60°).

Tighten the locking nut according to the specifications in *Special Tightening Torques*.

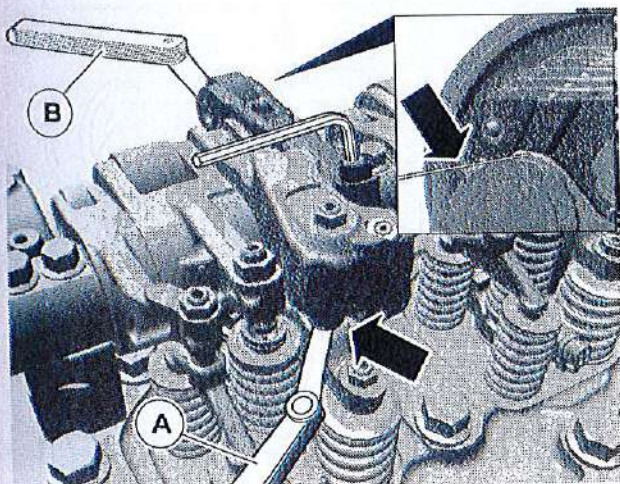
NOTICE! Use a wrench on the yoke as a counterhold also when tightening.



P0018511

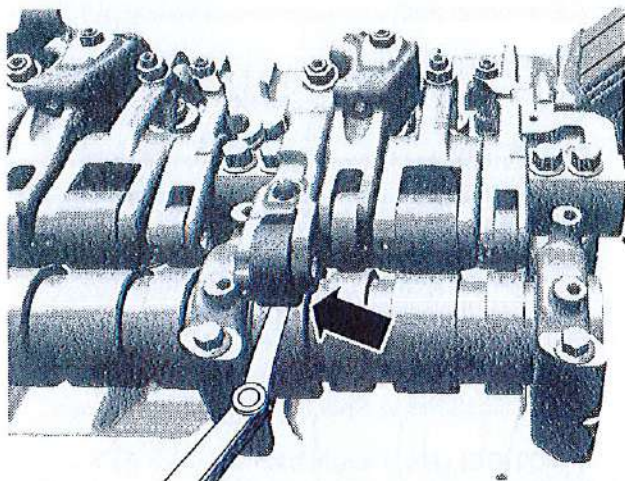
- 8 Adjust the valve clearance for the exhaust valves to 0.60 mm (0.0236") with the aid of a feeler gauge.

Tighten the locking nut according to the specifications in *Special Tightening Torques*.



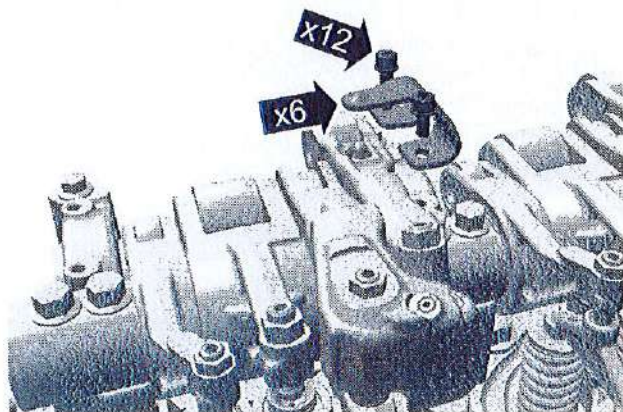
P0016512

- 9 Allow the feeler gauge (A) to remain after adjustment. Adjust the clearance between the VCB rocker arm roller and the camshaft to 3.50 mm (0.138") with the aid of feeler gauge (B). Tighten the locking nut according to the specifications in *Special Tightening Torques*.



P0016513

- 10 Where necessary, check the VCB rocker arm adjustment with a feeler gauge. Check the clearance between the camshaft and the roller on the VCB rocker arm. The clearance must be between 3.70-4.00 mm (0.146-0.157"). Adjust the remaining valves and unit injectors as described above.



P0016506

- 11 Tighten the retaining screws to the VCB rocker arm springs.

Tightening torque: 25 Nm (18.4 lbf. ft.)

NOTICE! Ensure that the springs position correctly on the pressure points.

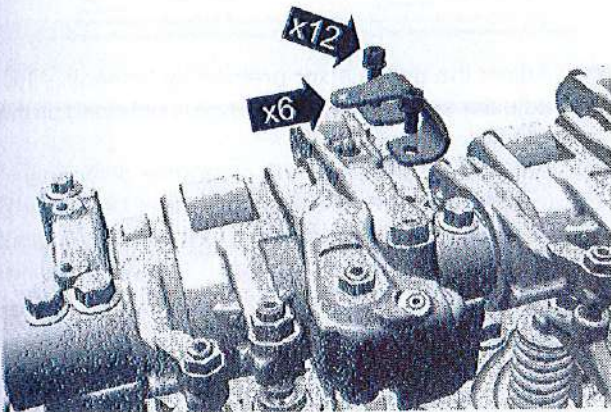
Remove 9993590 Rotation tool from the gear ring.
Install the valve cover.

Valve mechanism equipped with Internal EGR (Exhaust Gas Recirculation)

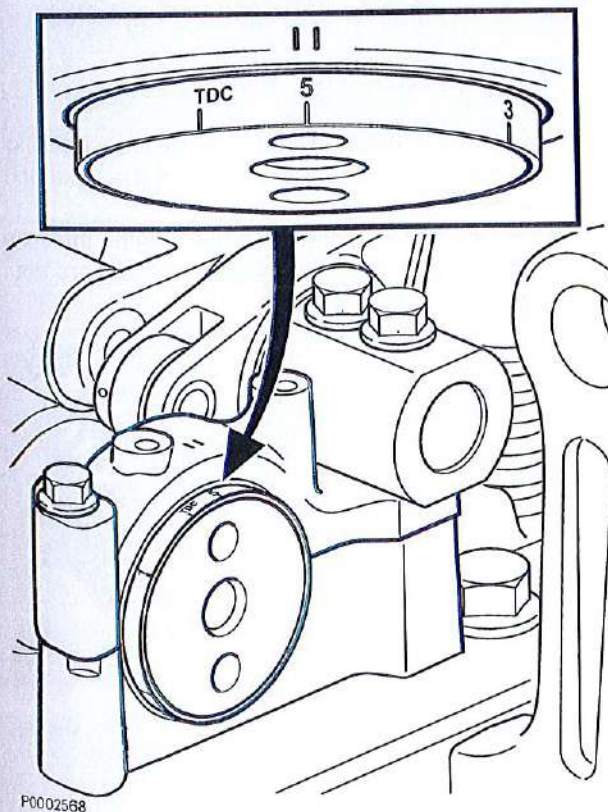
TAD1650GE, TAD1650VE, TAD1650VE-B,
TAD1651GE, TAD1651VE, TWD1652GE,
TWD1653GE

Valves and Unit Injectors, Adjustment

- 1 Adjust valves and injectors for the respective cylinders at the same time.
- 2 Remove all EGR rocker arm springs.

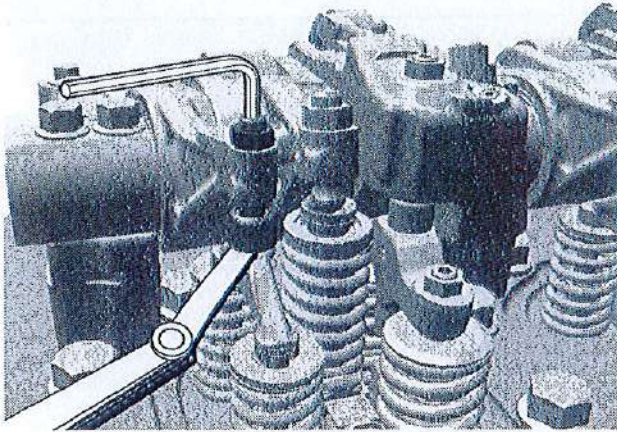


P0016506



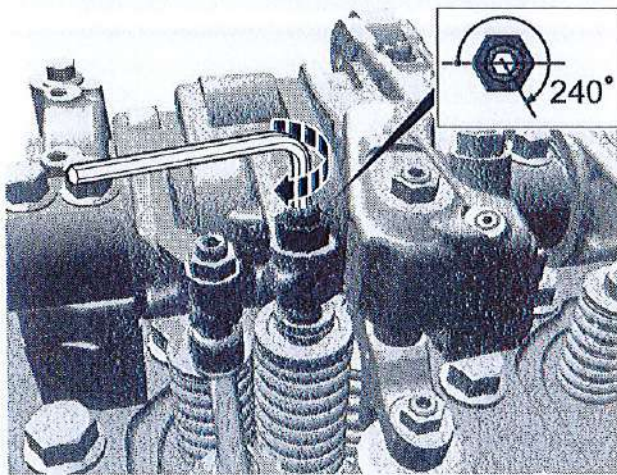
P0002568

- 3 Turn the engine to the next camshaft marking. Use 9993590 Rotation tool.



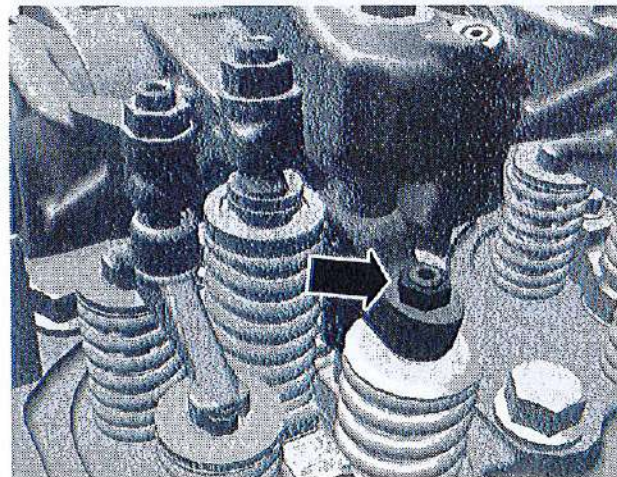
P0016508

- 4 Adjust the valve clearance for the inlet valves to 0.30 mm (0.0118") with the aid of a feeler gauge. Tighten the locking nut according to the specifications in *Special Tightening Torques*.



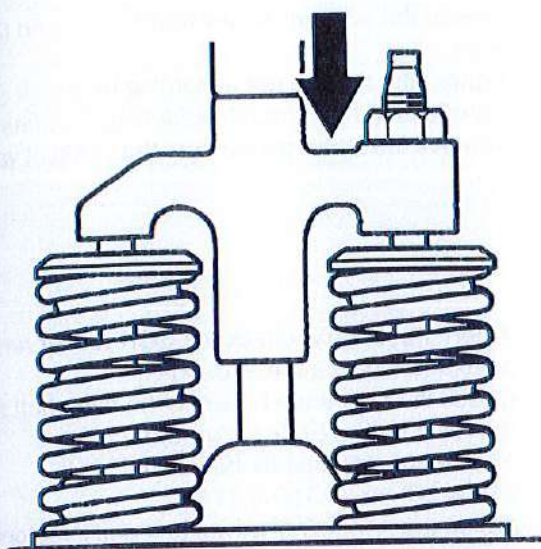
P0016509

- 5 Adjust the unit injector preload by loosening the adjuster screw until a clearance is obtained on the injector. Adjust the screw until the clearance disappears (by feel until the roller can no longer be rotated). Tighten the adjuster screw a further 240° (4 flats). Tighten the nut on the adjuster screw according to *Special Tightening Torques*.



P0016510

- 6 Adjust the exhaust valve yokes by first checking that there is no clearance between the yoke and the rocker arm. Undo the yoke locking nut while holding the yoke secure with a wrench so that the valves are not bent.



P0006956

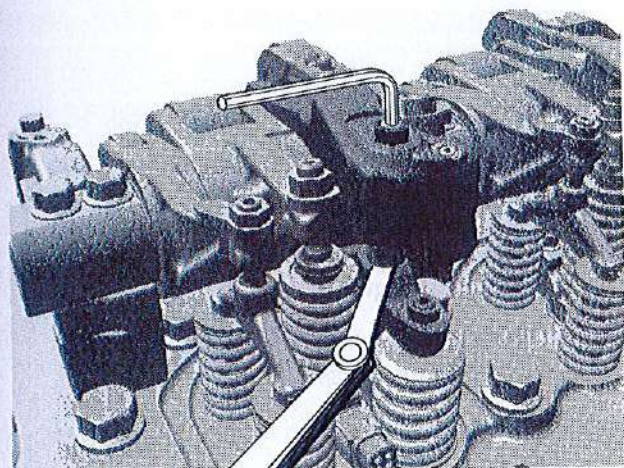
- 7 Screw out the yoke adjuster screw around 1 turn.

NOTICE! Before the adjuster screw is screwed in, the yoke must be pressed down simultaneously until it touches the valve stem. It is extremely important that the pressure is brought to bear as close to the adjuster screw as possible; see illustration.

Screw the adjuster screw down until it rests against the valve stem and then turn one additional flat (60°).

Tighten the locking nut according to the specifications in *Special Tightening Torques*.

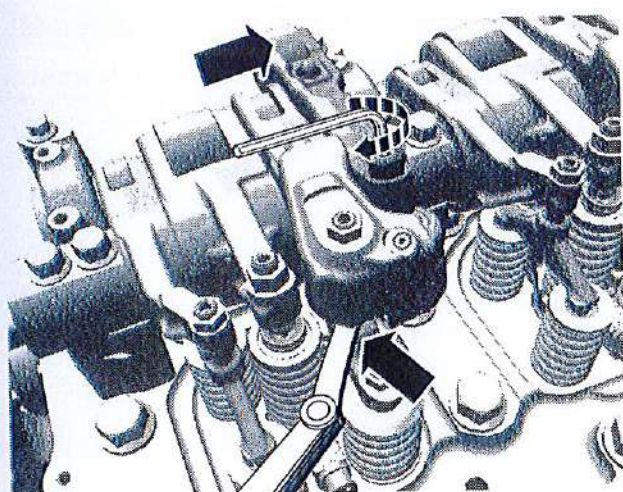
NOTICE! Use a wrench on the yoke as a counterhold also when tightening.



P0016511

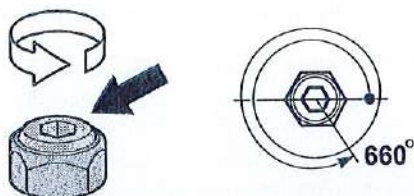
- 8 Adjust the valve clearance for the exhaust valves to 0.60 mm (0.0236") with the aid of a feeler gauge.

Tighten the locking nut according to the specifications in *Special Tightening Torques*.

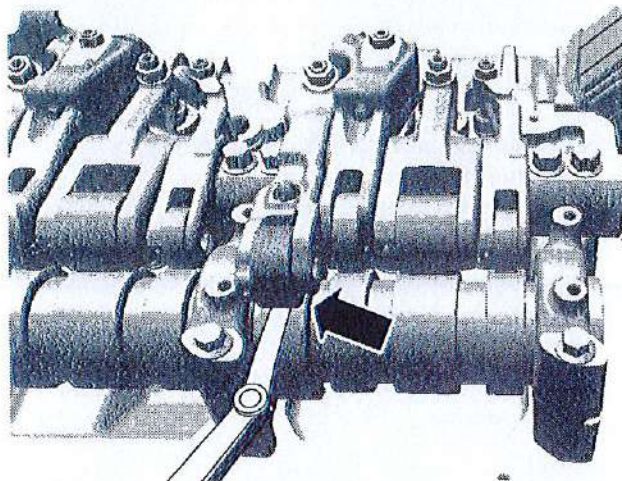


P0016514

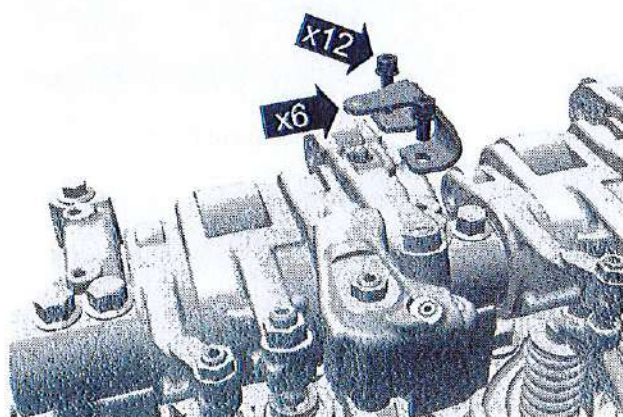
- 9 Allow the feeler gauge to remain in place after adjustment and adjust the EGR rocker arm by loosening the locking nut and adjusting the screw until zero clearance is attained (check by rotating the rocker arm roller against the camshaft).



P0004803



P0016513



P0016506

- 10 Loosen the adjuster screw 660° (1 turn and five flats).
Tighten the locking nut according to the specifications in *Special Tightening Torques*.
Remove the feeler gauge from the exhaust valve.

- 11 Where necessary, check the EGR rocker arm adjustment with a feeler gauge.
Check the clearance between the camshaft and the roller on the EGR rocker arm.
The clearance must be between 4.05-4.35 mm (0.159-0.171").
Adjust the remaining valves and unit injectors as described above.

- 12 Tighten the retaining screws to the EGR rocker arm springs.

Tightening torque: 25 Nm (18.4 lbf. ft.)

NOTICE! Ensure that the springs position correctly on the pressure points.

Remove 9993590 Rotation tool from the gear ring.
Install the valve cover.

Valve Guides, Inspection

Tools:

9989876 Dial indicator

9999696 Magnetic stand

Cylinder head removed

Refer to removal in *Cylinder Head, Change*.

- 1 Remove the valve stem seals from the valve guides.

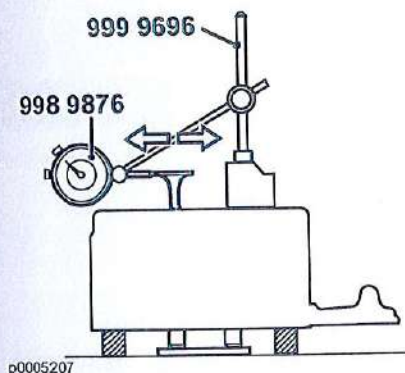
2

IMPORTANT!

The cylinder head must not be put down so its entire weight rests on the valve guides (see illustration).

Put the cylinder head on the bench with the valve discs facing upwards.

- 3 Place a new valve in the valve guide with the valve stem end in the same plane as the edge of the guide. Use a suitable counterhold under the valve stem.
- 4 Place tool 9989876 Dial indicator and tool 9999696 Magnetic stand, so that the dial indicator tip is touching the valve disc edge. Move the valve sideways, in the direction of the exhaust or inlet duct. Read off the value on the dial gauge.
- 5 Check all valve guides.
If the measurement values exceed the values noted in the specifications, the valve guide must be changed; refer to *Technical Data*.



21-6 Crank Mechanism

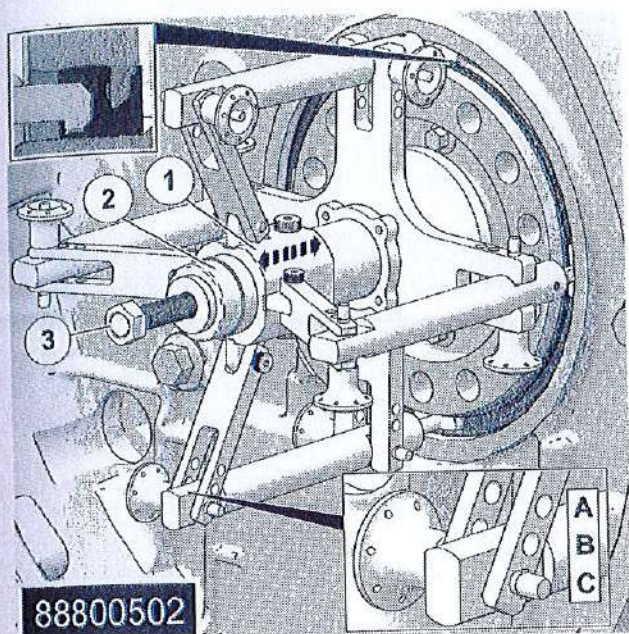
Crankshaft Seal, Change (front)

Tools:

88800501 Mounting tool
88800502 Puller

Removal

- 1 Adjust the arms 88800501 Mounting tool and attach the tool.
Setting diameter: use A. Ø 151 Front seal
 - 1 Forward: Hooks release
Backward: Hooks grip
 - 2 Tension nut
 - 3 Slowly pull out the seal.

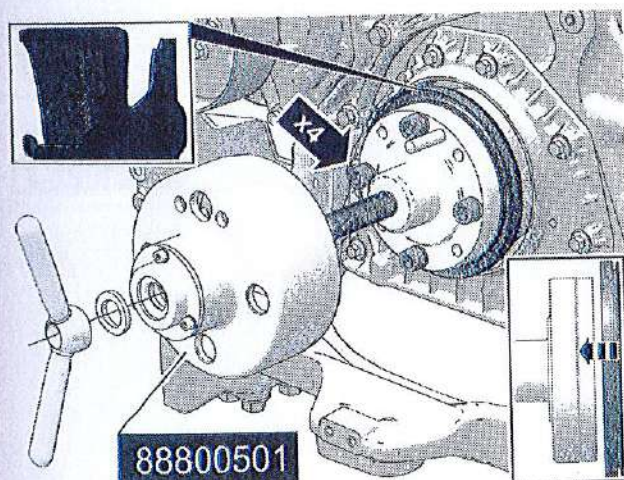


P0025163

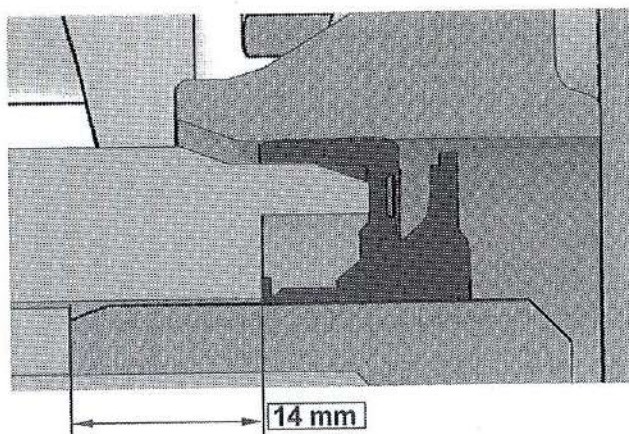
Installation

Important! The metal side of the seal ring must face inward.

- 2 Slide the seal ring onto the tool.
Screw the assembly tool with the seal onto the crankshaft.
Press the seal in until the cover touches the bottom. Hold in position for at least 3 seconds.



P0025195



P0025197

- 3 Reference dimension for a correctly installed seal.

Crankshaft Seal, Change (rear)

Tools:

88800502 Puller

88800503 Mounting tool

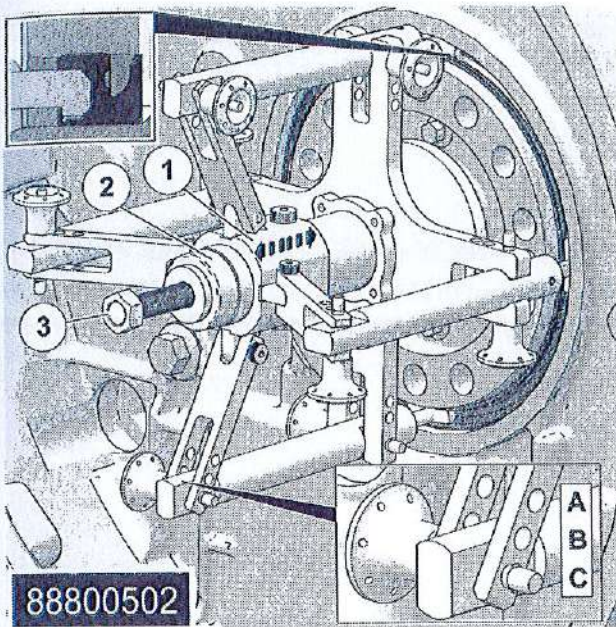
9990166 Mounting tool

Removal

- 1 Adjust the arms 88800502 Puller and attach the tool.

Setting diameter: use C. Ø 197 Rear seal

- 1 Forward: Hooks release
Backward: Hooks grip
- 2 Tension nut
- 3 Slowly pull out the seal.

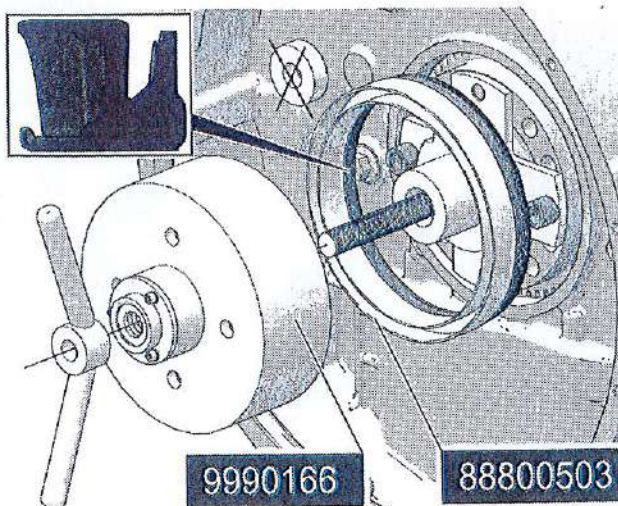


P0025163

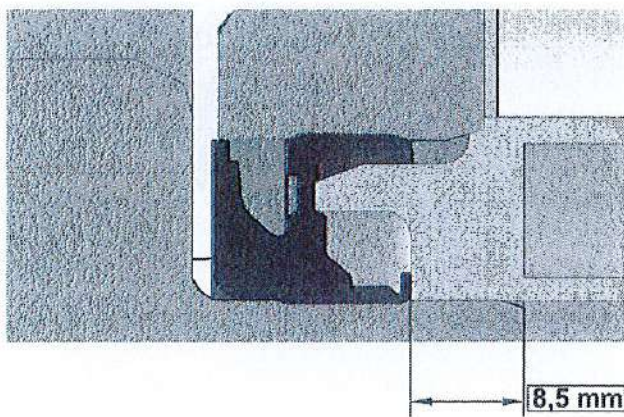
Installation

Important! The metal side of the seal ring must face inward.

- 2 Slide the seal ring onto the tool.
Screw the assembly tool with the seal onto the crankshaft.
Press the seal in until the cover touches the bottom. Hold in position for at least 3 seconds.



P0025171



P0025172

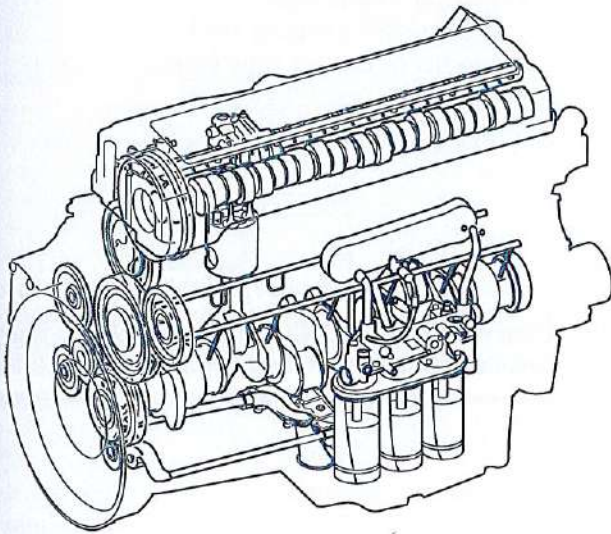
- 3 Reference dimension for a correctly installed seal.

22-0 Lubricating and Oil System, General

When you work with Chemicals, Fuel and Lubrication Oil, Change

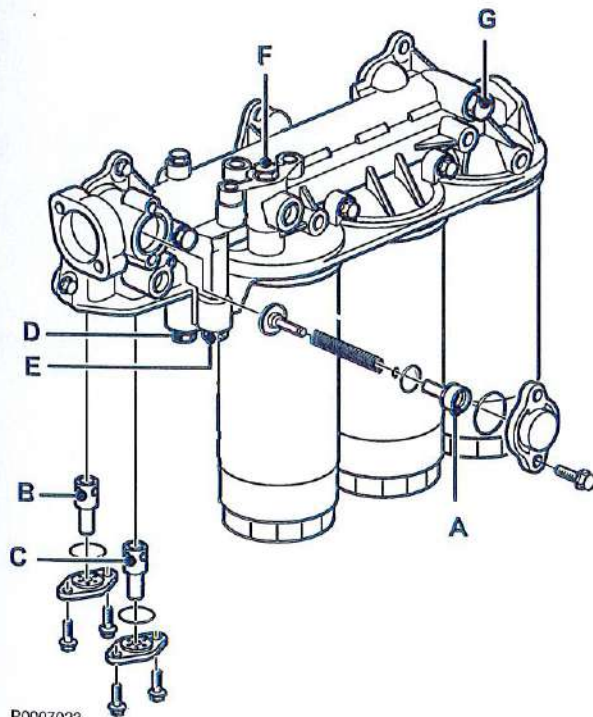
CAUTION!

Apply barrier cream to hands and always use protective gloves in work that involves the risk of contact with oil and fuel and similar. Continuous skin contact with engine oil dries the skin and can be hazardous.



P0007022

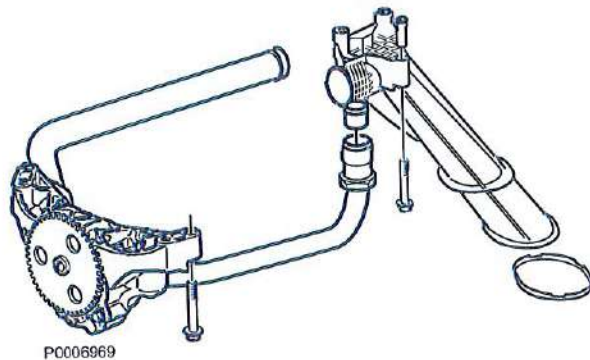
Overview Control Valve



P0007023

- A By-pass valve for oil cooler
- B Safety valve
- C Reduction valve
- D Control valve for piston cooling
- E Opening valve for piston cooling
- F Overflow valve for bypass filter
- G Overflow valve for full-flow filter

22-1 Oil pump and Line



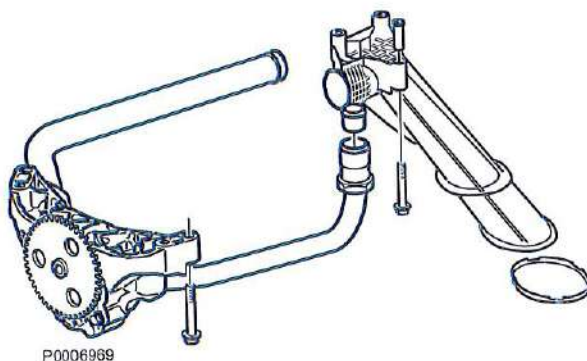
Lubrication Oil Pump, Change

- 1 Drain the engine oil.
Remove the oil filler pipe.
Remove terminal to the oil level sensor.
Remove the oil dipstick tube from the bracket.
Remove the oil pan.
- 2 Remove bolts that fasten the oil pipes to the engine.
Remove the oil pipes, the oil strainer and the bracket together.
- 3 Remove the oil pump bolts and remove the pump.
- 4 Clean the oil suction pipe and the oil delivery pipe.
Check that there is no damage.
- 5 Remove and clean the oil strainer. Check that there is no damage.
- 6 Install the new oil pump.
Make sure that the teeth fit into the camshaft gear.
Tighten the bolts according to the specification in *Special Tightening Torques*.
- 7 Assemble the oil pipes and the oil strainer on the bracket with new oil seals. The strainer must be installed so that it faces to the engine front end.
Tighten the bolts according to the specification in *Special Tightening Torques*.
- 8 Assemble the oil pipes with the oil pump.
Tighten the bolts according to the specification in *Special Tightening Torques*.
- 9 Check if the seal needs to be changed.
Install the oil pan.
- 10 Attach the oil dipstick tube to the bracket.
Install oil filler pipe and the wiring to the oil level sensor.
Top up with engine oil.
- 11 Start the engine. Check the oil pressure and check for leakage.

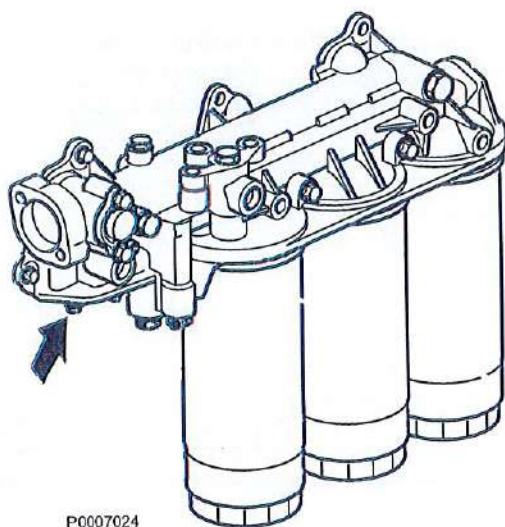
Oil Pump, Check

- 1 Remove the oil pump. Refer to *Lubrication Oil Pump, Change*.
- 2 Check the pump gear.

NOTICE! If the reason for the fault is traced to poor oil quality, clean the oil system thoroughly before new oil is filled.

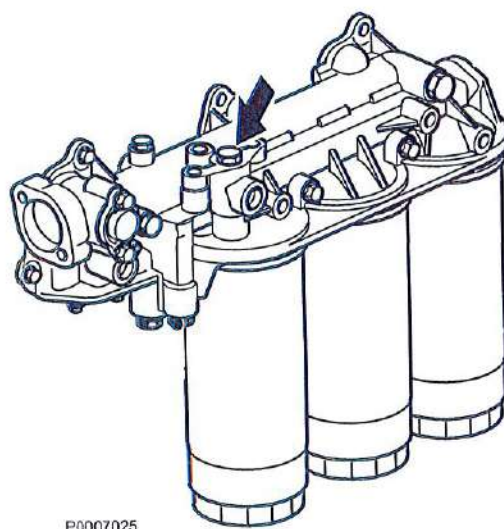


22-2 Oil filter



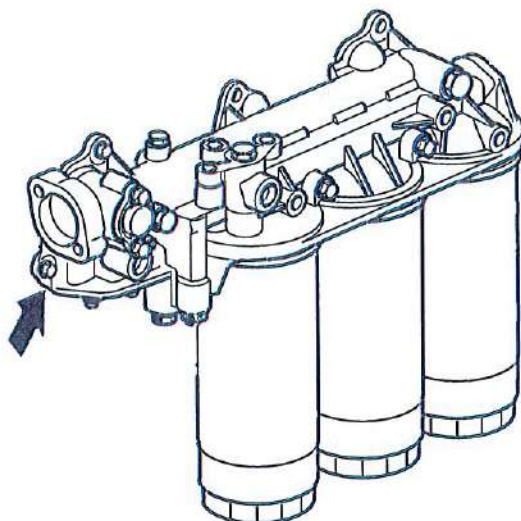
Relief Valve, Replace

- 1 Clean the area around the reducing valve.
- 2 Remove the reducing valve.
- 3 Clean the valve contact surface in the oil filter housing. Check that the old seal is not still in place.
- 4 Check that the color marking on the new valve matches the old.
- 5 Fit the new valve with a new seal ring. Check that the internal seal does not come loose when the valve is installed.
Tighten according to the specification in *Special Tightening Torques*.
- 6 Start the engine and check for leaks.



Bypass Valve, Oil Filter Bypass, Replace

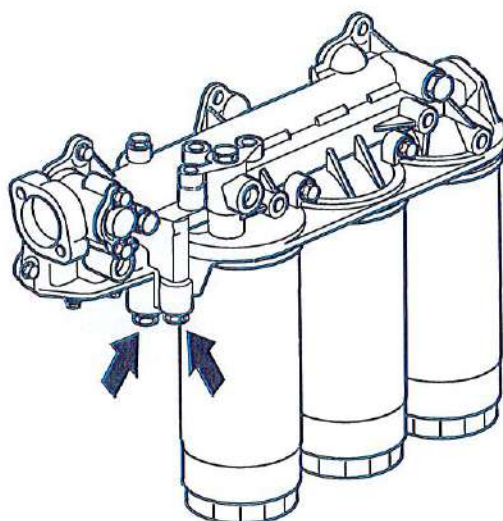
- 1 Remove the pressure pipe to the turbo.
- 2 Clean the area around the overflow valve.
- 3 Remove the overflow valve.
- 4 Clean the valve contact surface in the oil filter housing.
- 5 Fit the new the valve with a new seal ring and tighten the nut as specified in *Special Tightening Torques*.
- 6 Tighten the turbo pressure pipe.
- 7 Start the engine and check for leaks.



P0007026

Safety Valve, Oil Pressure, Replace

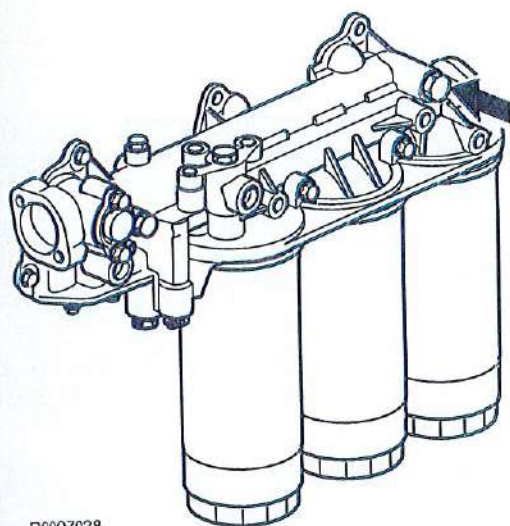
- 1 Clean the area around the valve and remove it.
- 2 Clean the valve contact surface.
- 3 Check that the color marking on the new valve matches the old.
Install the new valve and tighten according to specifications in *Special Tightening Torques*.
- 4 Start the engine and check for leaks.
Check the oil pressure; refer to *Oil Pressure Sensor, Check*.



P0007027

Piston Cooling Valves, Replace

- 1 Clean around the oil filter bracket and the piston cooling valves.
- 2 Remove the filter bracket.
- 3 Remove the two piston cooling valves: control valve and opening valve.
- 4 Clean valve seats in the oil filter bracket.
- 5 Fit new valves with new seal rings; tighten according to specification in *Special Tightening Torques*.
- 6 Re-install the oil filter bracket, with new gasket and new seal rings.
- 7 Start the engine and check for leaks.



P0007028

Bypass Valve Oil Filter, Change

- 1 Clean the area around the overflow valve.
- 2 Remove the valve and clean the valve seat in the oil filter bracket.
- 3 Fit a new valve with a new seal ring. Tighten according to the specifications in *Special Tightening Torques*.
- 4 Start the engine and check for leaks.

Oil Filter, Check

- 1 Check that the oil filters are not faulty or blocked. If the filters have external damage, oil flow through the filters may be restricted. This may cause the oil pressure to deteriorate.

Oil Pressure Sensor, Check

If you suspect that the oil pressure sensor reads incorrectly, check the oil pressure with a external **pressure sensor**.

The pressure sensor is located behind the control unit; refer to *Engine Placement*.

Tools:

9992873 Nipple

9996398 Manometer

9998493 Hose

- 1 Check the oil pressure with an external pressure gauge and compare values with the specification in *Technical Data*.
- 2 Remove the pressure sensor.
- 3 Fit tool 9998493 Hose, 9992873 Nipple and 9996398 Manometer.
- 4 Start the engine and check the oil pressure.
If the oil pressure measurement shows that the pressure is below the minimum value as specified, continue troubleshooting by checking the oil filters.
If the oil pressure measurement using an external pressure sensor shows that the pressure is within tolerance, but the regular engine pressure sensor does not, replace the pressure sensor.
- 5 Remove the hose, nipple and pressure gauge.
- 6 Install the oil pressure sensor. Connect the sensor to the wiring.

Engine oil and oil filter, changing

Tools:

9998487 Sleeve

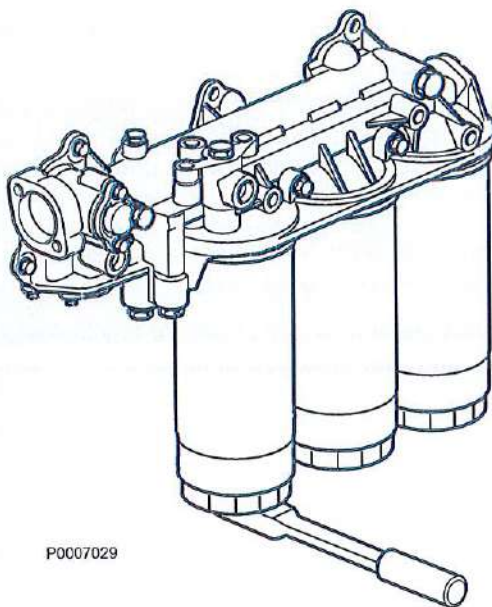
9999179 Extractor oil filter

- 1 Remove the drain plug and drain engine oil into an appropriate container immediately after running when the oil is hot and flows more easily.

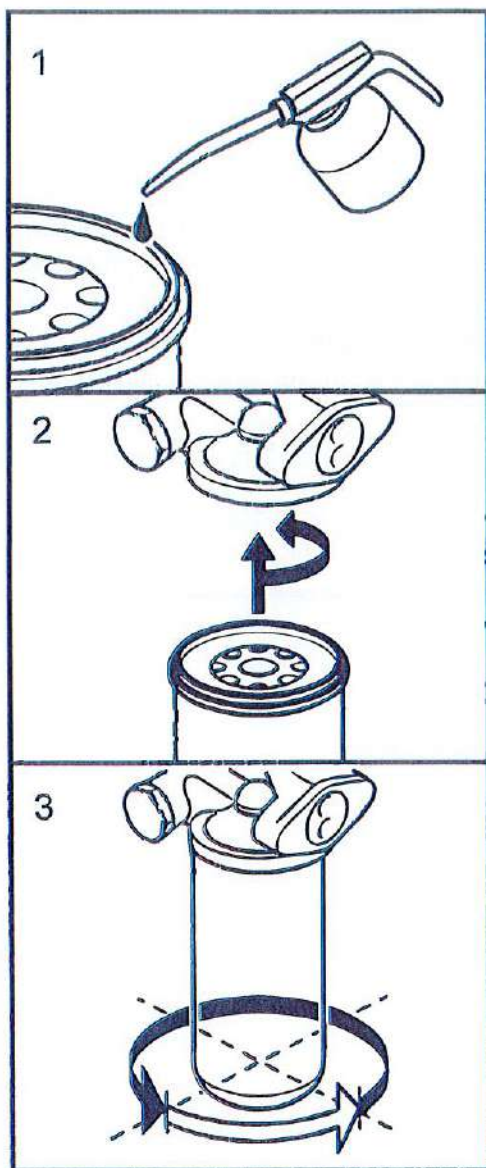
▲ WARNING!

Hot oil and hot surfaces can cause burns.

- 2 Clean around the filter bracket and remove the filters. Use 9998487 Sleeve or 9999179 Extractor oil filter.



P0007029



P0007030

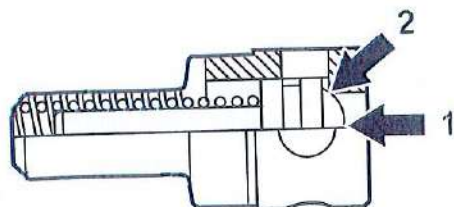
- 3 Fill the new filters with engine oil and apply some to the gaskets (1).
 - 4 Tighten the filters by hand until they touch the bracket contact surface (2). Tighten them by hand another **3/4 to one full turn (3)**.
 - 5 Re-install the drain plug. Add engine oil to correct level.
 - 6 Connect a switch to the starter motor and use it to crank the engine until the oil pressure is registered by the oil pressure gauge. This means that the oil filters are full.
- NOTICE!** Refer to *Compression Test* for connection of starter motor.
- 7 Start the engine and check for any leakage around filter bracket and filter.
 - 8 Check the oil level. Add oil as needed.

Relief Valve, Check

- 1 Check that the reducing valve has a **blue** color marking.

NOTICE! In installations with remote oil filters the reducing valve must have a **black** color marking.

- 2 Check that the valve is not damaged, which would impair its function.
Press in the valve poppet (1) with a blunt object and check that it does not seize and that it seals against the seat (2).



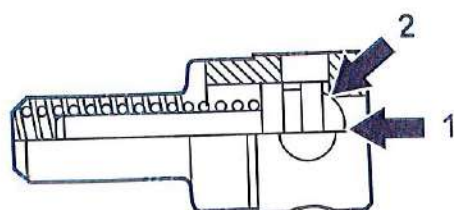
P0007031

Safety Valve, Check

- 1 Check that the safety valve has a **purple** color marking.

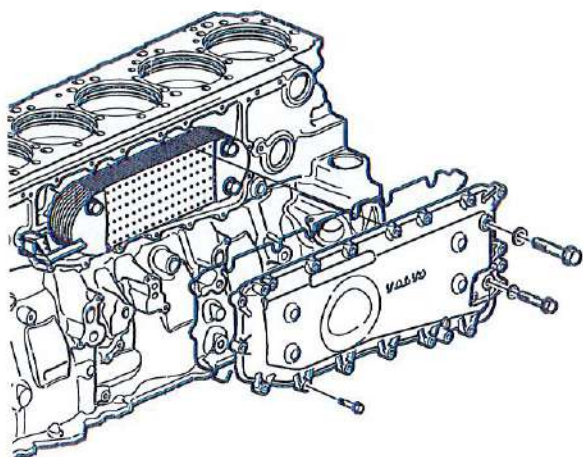
NOTICE! In installations with remote oil filters the safety valve must have a **black** color marking.

- 2 Check that the valve is not damaged, which would impair its function.
Press in the valve poppet (1) with a blunt object and check that it does not seize and that it seals against the seat (2).



P0007031

22-3 Oil cooler



P0006899

Oil Cooler, Replace

Removal

- 1 Clean around the oil cooler cover.
- 2 Drain the coolant; refer to *Draining the Cooling System*.
Remove the coolant filter with attachment⁽¹⁾.
- 3 Remove the cover bolts and lift away the cover.
- 4 Remove the oil cooler from the engine block.

Installation

- 5 Clean the cover contact surface on the engine block.
- 6 Install the oil cooler on the block with new rubber gaskets. Tighten the bolts according to the specification in *Special Tightening Torques*.
- 7 Install new gaskets in the cover.
- 8 Lift the cover into position. Check that the rubber cover gasket remains in its groove.
- 9 Install the cover bolts and torque according to specifications in *Special Tightening Torques*.
Install the coolant filter and its bracket⁽¹⁾.
- 10 Add coolant. Refer to *Coolant Level, Checking and Topping Up*.

IMPORTANT!

If the oil cooler has leaked engine oil to the cooling system, the coolant filter must be replaced and the cooling system cleaned. Refer to *Cooling System, Cleaning*.

- 11 Start the engine and check for leakage when it has reached normal temperature.
Check coolant level.

1. Only "Volvo Penta Coolant" (green).

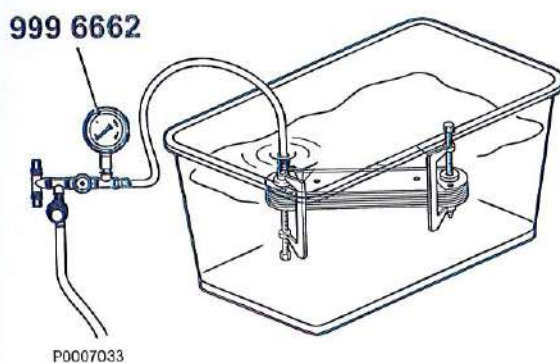
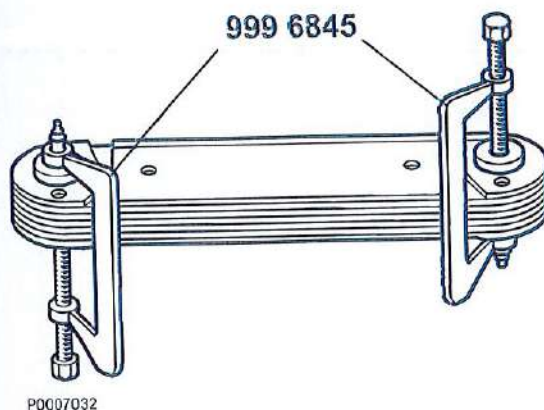
Oil Cooler, Pressure Testing

Tools:

9996662 Pressure testing kit

9996845 Screw clamp

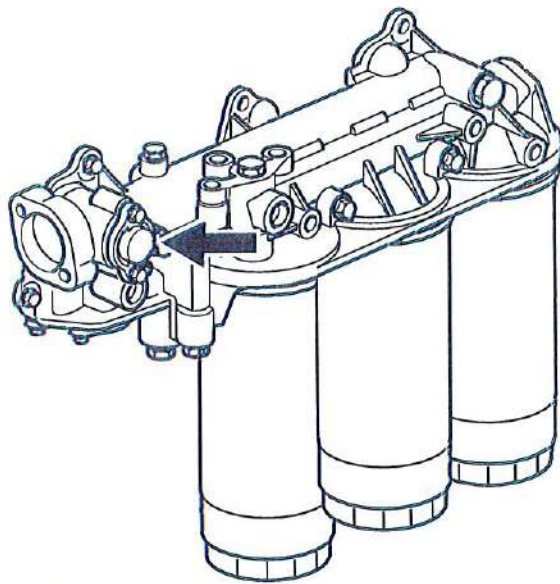
- 1 Remove the oil cooler. Refer to *Oil Cooler, Replace*.
- 2 Clean the oil cooler coolant side with water soluble degreaser.
Clean the oil side of the oil cooler with degreaser.
- 3 Check 9996662 Pressure testing kit before it is taken into service. See *Cylinder Head, Pressure Testing* in the Checking pressure testing equipment section.
- 4 Install 9996845 Screw clamp and check that they are placed correctly.



- 5 Check that the pressure reducing valve knob on 9996662 Pressure testing kit is fully opened and that the manometer shows "0".
Connect the pressure testing device to 9996845 Screw clamp.
- 6 Lower the oil cooler into a vessel containing water at room temperature.
Increase the pressure to 250 kPa (2.5 bar) [36.26 PSI] with the knob on the reducing valve.
Wait **at least one minute**.

IMPORTANT!

If an even stream of air bubbles comes from the oil cooler matrix, there is leakage and the oil cooler must be changed.



P0007034

Bypass Valve, Oil Cooler, Replace

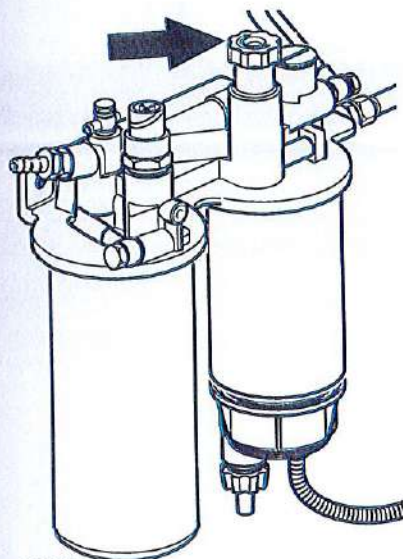
- 1 Clean the area around the overflow valve and remove it.
Clean the valve seat.
- 2 Fit the new valve with a new seal ring.
Tighten according to the specifications in *Special Tightening Torques*.
- 3 Start the engine and check for leaks.

23-0 Fuel System, General

Fuel system, bleeding

TAD1640GE, TAD1640VE-B, TAD1641GE,
TAD1641VE, TAD1641VE-B, TAD1642GE,
TAD1642VE-B, TAD1643VE-B, TAD1650GE,
TAD1650VE, TAD1650VE-B, TAD1651GE,
TAD1651VE, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

- 1 Check that there is sufficient fuel in the tank, and that any fuel taps are open.
- 2 Twist the hand pump free from the fuel filter bracket.
- 3 Vent the fuel system by pumping with the hand pump.
Air is vented to the tank via the fuel return pipe.
No venting nipples need be opened.
- 4 Start the engine and allow it to idle fast for about 10 minutes.
- 5 Perform a leakage and function check.

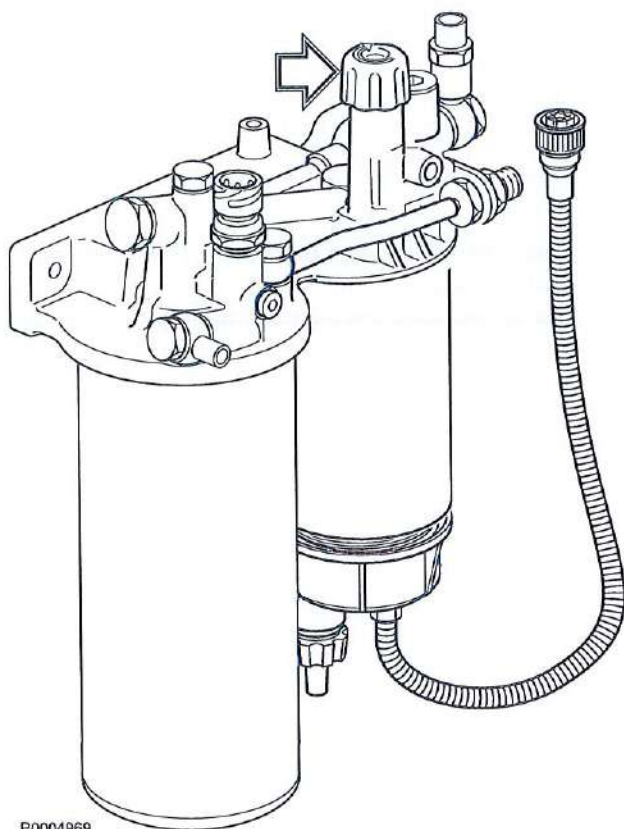


P0007042

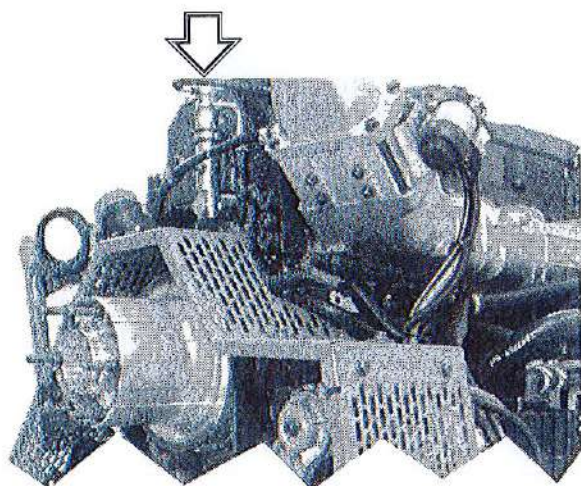
Fuel system, bleeding

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

- 1 Check that there is sufficient fuel in the tank, and that any fuel taps are open.
- 2 Twist the hand pump free from the fuel filter bracket.



P0004969



P0004970

- 3 Open the nipple on the front fuel connection. Connect a drain hose.
- 4 Purge the fuel system by pumping with the hand pump until fuel flows. Close the nipple and secure the hand pump.
- 5 Start the engine and allow it to idle fast for about 10 minutes.
- 6 Perform a leakage and function check.

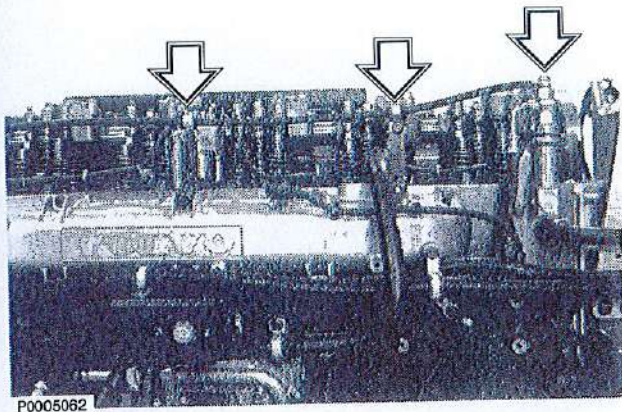
Draining, Fuel Duct in Cylinder Head

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

IMPORTANT!

Make sure that dirt does not enter the fuel channels and hoses.

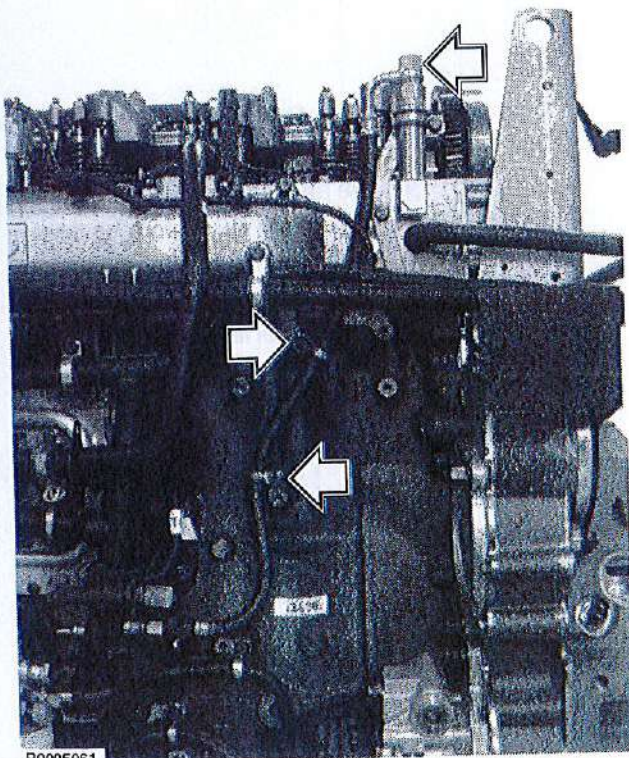
- 1 Clean around the fuel connections at the cylinder head rear end.
- 2 Remove the purging hose screw.
Remove the two clamps.



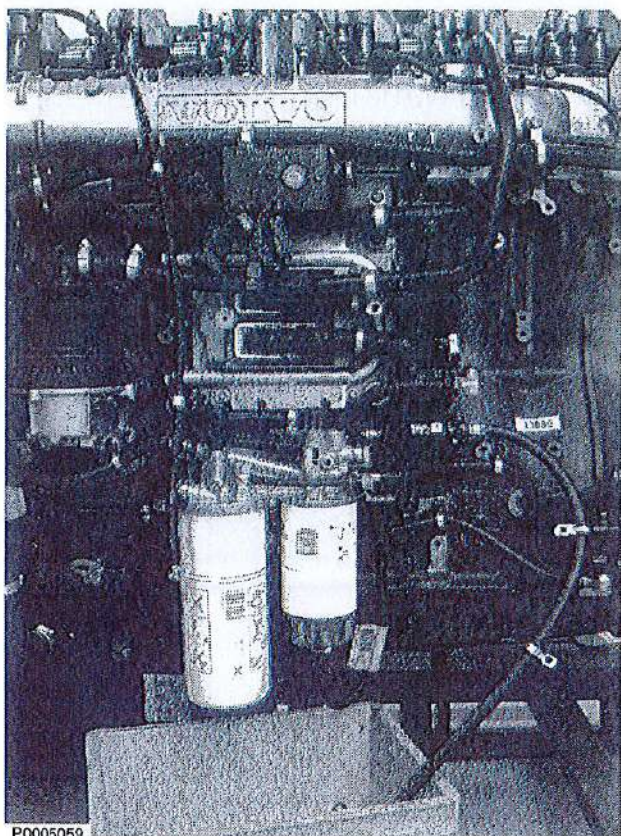
P0005062

- 3 Remove the fuel supply line on the engine topside (coming from the filter bracket).
Remove the two clamps

NOTICE! Do **not** remove the lower union at the filter bracket.

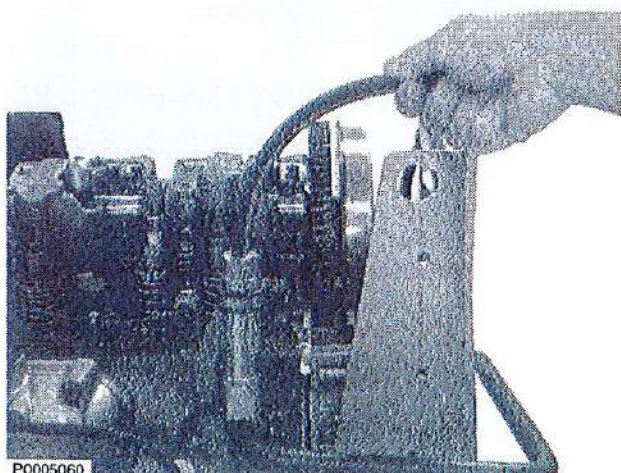


P0005061



P0005059

- 4 Allow the hoses to hang into a receptacle.



P0005060

- 5 **IMPORTANT!**
Take great care to ensure that dirt does not enter the fuel channel.
Use a suitable hose and blow the fuel through the fuel channel in the cylinder head, so that it runs out into the receptacle.
- 6 **NOTICE!** If a compression test must be carried out, do not connect the fuel lines until the test has been completed. Otherwise the cylinder head fuel channels will fill with fuel again.
- 7 When installing the fuel hoses, use new seals.

23-3 Fuel Feed Pump and Filter

Engine Fuel Filter Replacement

IMPORTANT!

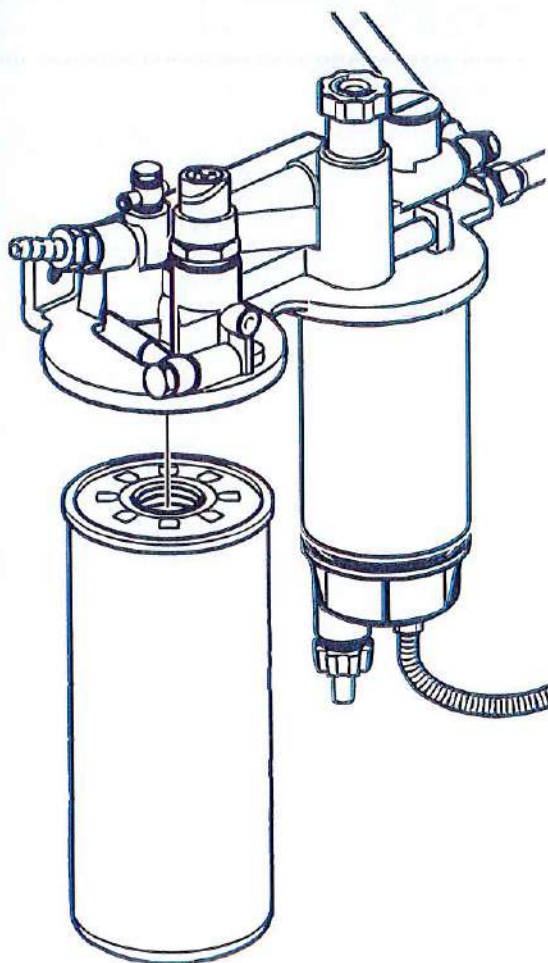
Do not fill the new filter with fuel before installation. There is a risk that contaminants will enter the system and cause operational disruptions or damage.



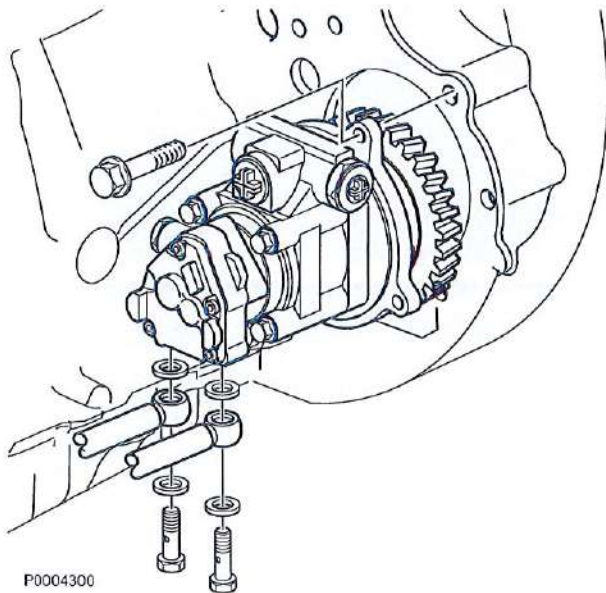
WARNING!

The fuel filter should be replaced when the engine is cold, to prevent any fire hazard from fuel being spilled onto hot surfaces.

- 1 Clean round the fuel filter.
- 2 Remove the fuel filter with the aid of a suitable filter puller.
Collect any spilled fuel in a collection vessel.
- 3 Clean around the filter housing sealing surface.
- 4 Lubricate the seal with diesel fuel and install the new fuel filter. Torque the filter according to the instructions on the filter.
- 5 Bleed the fuel system; refer to *Fuel system, bleeding*.



P0007037



Fuel Feed Pump, Change

Removal

- 1 Close any fuel cocks between the tank and feed pump, to avoid unnecessary fuel spills.
- 2 Clean thoroughly around the feed pump and its connections.
- 3 Remove fuel connections to the fuel pump and allow the fuel to flow out into a suitable container.

NOTICE! Plug the lines! Mark the suction and pressure lines.

- 4 Remove the fuel feed pump together with the servo pump.
- 5 Remove the three Torx bolts and separate the feed pump from the servo pump.
- 6 Remove the feed pump by carefully pulling it straight out.

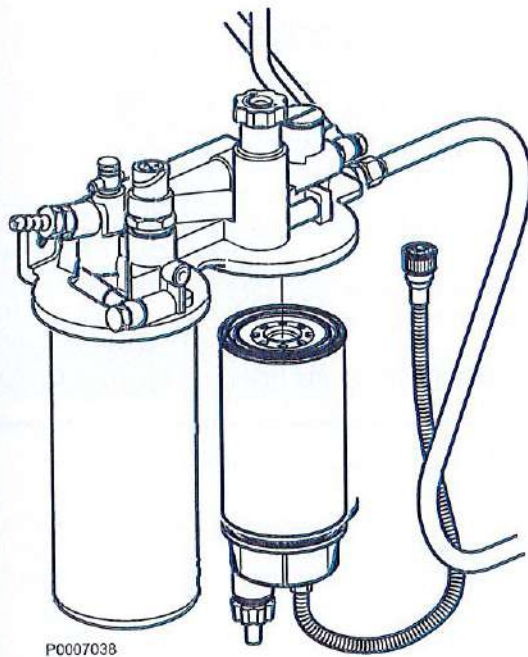
NOTICE! Ensure that the intermediate connector on the servo pump shaft does not follow it out.

Installation

- 7 Replace the O-ring on the servo pump flange. Check that the intermediate connector slots into its groove on the servo pump shaft.
- 8 Fit the feed pump and the servo pump together. Facilitate assembly by turning the pump shaft so that it slots into the groove in the intermediate connector.
Torque the bolts according to specifications:
Refer to *General Tightening Torques*.
- 9 Install the feed pump and servo pump on the engine.

NOTICE! Use a new O-ring.

- 10 Replace the sealing washers. Remove the plugs and attach the fuel lines.
- 11 Open the fuel taps and purge the fuel system:
Refer to *Fuel system, bleeding*.
- 12 Start the engine.
Perform a function and leakage check.



Fuel Pre-filter, Change

- 1 Disconnect the cable harness at the water separator sensor.
- 2 Remove the water separator filter from the filter housing. Collect any spilled fuel in a collection vessel.
- 3 Remove the lower section of the water separator from the filter.
- 4 Clean the lower section of the water separator with a soft rag. Check that the strainer and drain hole in the lower section are not clogged.
- 5 Install a new seal on the lower section and lubricate the seal with diesel fuel. Re-install the lower section of the filter.
- 6 Lubricate the seal with diesel fuel. Screw the filter onto the filter bracket by hand until the rubber seal bottoms on the mating surface. Then tighten a further half turn, no more.
- 7 Connect the cable to the water separator sensor.
- 8 Bleed the fuel system; refer to *Fuel system, bleeding*.

23-7 Injectors and Delivery Pipes

Unit Injector, Replace

Tools:

9990006 Puller
9990013 Slide hammer
9990185 Lifting tool
9998249 Protective sleeve
9998599 Cleaning kit

The tool kit 9998599 Cleaning kit includes:

- 9808570 Brush
- 9808616 Extender
- 9998580 Protective sleeve

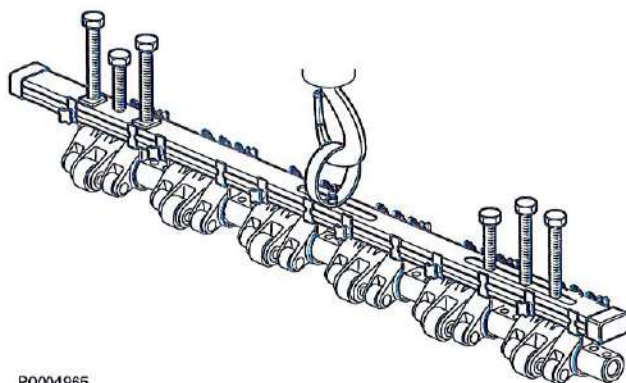
For adjusting valves and unit injectors, refer to *Valves and Unit Injectors, Adjustment*.

NOTICE! When reinstalling, use new seals.

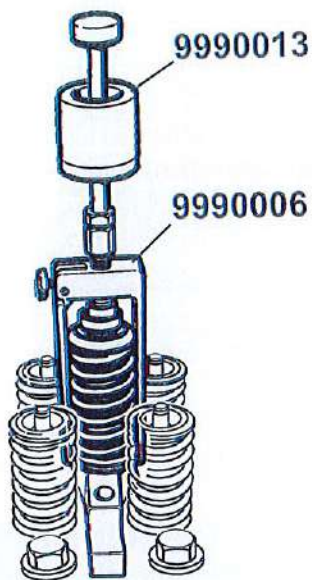
NOTICE! If a new unit injector is fitted, a new injector code must be programmed into the control unit, see "Service manual EMS 2". The injector code is stamped on the unit injector.

Removal

- 1 Remove the valve cover.
- 2 Disconnect the electric connectors on the unit injectors.
Cut the cable ties holding the cable harness and fold it to one side.
- 3 Remove the fuel supply pipe and the rocker arm bridge lubrication oil supply union.
- 4 Undo the rocker arm bridge bolts in stages, equal amounts each time, to avoid bending the rocker shaft.
Carefully lift the rocker arm bridge using 9990185 Lifting tool.
- 5 Mark and remove the valve calipers.
- 6 Empty the cylinder head fuel channels; refer to *Draining, Fuel Duct in Cylinder Head*.

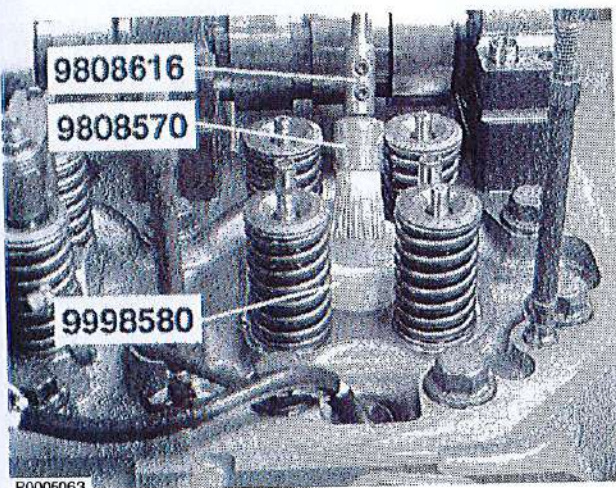


P0004965



P0001370

- 7 Remove the bolts for the unit injector fixing yoke. Place the tool 9990006 Puller on the injector. Put the puller fork in the groove in the injector and lock the arm with the screw on the side. Fasten the puller by turning the screw down against the injector ball seat. Attach tool 9990013 Slide hammer and remove the injector.
- 8 Attach tool 9998249 Protective sleeve to the removed injector.



P0005063

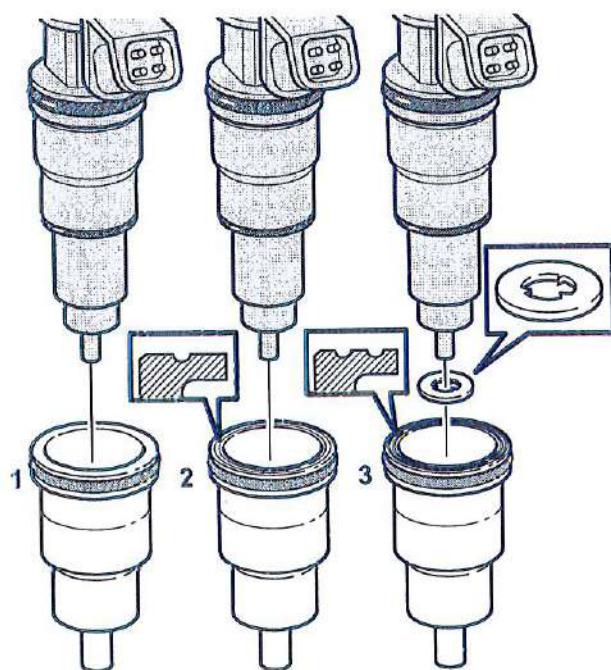
- 9 Install tool 9998580 Protective sleeve and clean thoroughly using tool 9808570 Brush and tool 9808616 Extender from the toolkit 9998599 Cleaning kit.

Installation

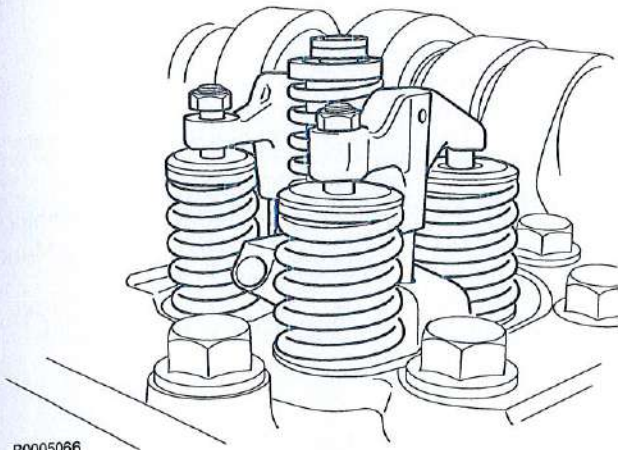
- 10 Install new O-rings on the unit injector.
Upper O-ring – large diameter
Lower ring – small diameter



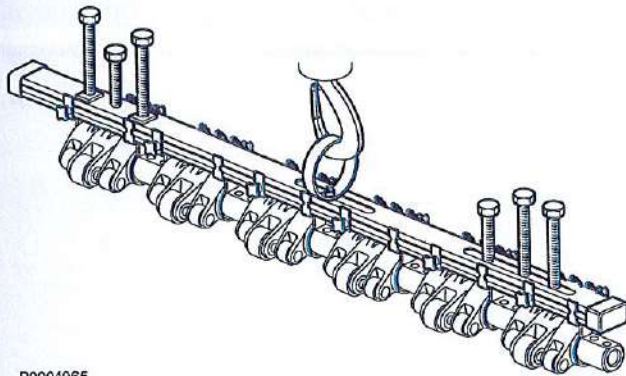
P0005064



- 11 If the copper sleeve has a smooth upper edge (1) or one groove (2) a steel gasket must **never** be used.
If the copper sleeve has two grooves (3) a steel gasket must **always** be used. **Always use a new steel gasket.**
The steel gasket is installed on the injector tip and is held in place by the gasket spines.



P0005066



P0004965

- 12 Attach the fixing yoke to the unit injector and center it between the valve springs. Torque the bolts according to specifications; refer to *Technical Data*.
- 13 Attach the connector; press it in until a clear "click" is heard. Attach new cable ties.
- 14 Install the valve caliper.
- 15 Lubricate the valve caliper and camshaft lobes with engine oil.

- 16 Lift the rocker arm bridge into place with the aid of 9990185 Lifting tool. Check that the guide pins position correctly in the bearing caps.

IMPORTANT!

Tighten alternately, to avoid bending the rocker shaft.

Torque the rocker arm bridge bolts according to specifications; refer to *Technical Data*, so that the shaft abuts the bearing caps.

- 17 Clean the cylinder head where the union is installed, and check that there is no foreign material in the cylinder head oil channel. Install new seal rings on the oil supply pipe and union. Put a thin layer of petroleum jelly on the pipe seal rings and install the pipe in the union.
- 18 Install the union and torque according to specifications; refer to *Technical Data*.
- 19 Adjust the valves and unit injectors; refer to *Valves and Unit Injectors, Adjustment*.
- 20 Connect the wiring to the unit injectors.
- 21 Install the valve cover. Replace gasket as necessary.
- 22 Purge the fuel system; refer to *Fuel system, bleeding*.

Sleeve for unit injector, replace

Unit injector removed

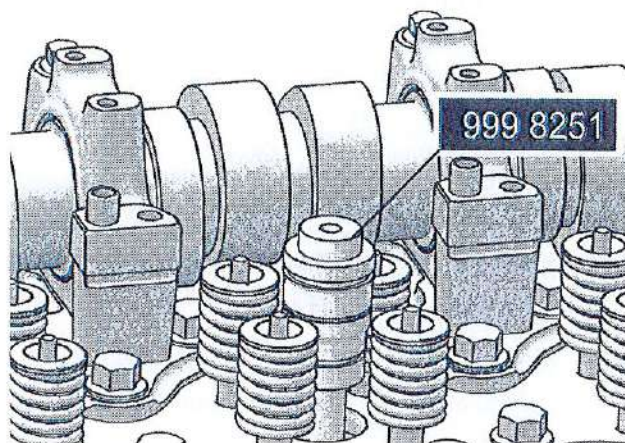
Tools:

- 9998251 Protection plug
- 9998250 Sealing ring
- 9998580 Protective sleeve
- 9998599 Cleaning kit
- 9996049 Draining hose
- 88800513 Drift
- 9986173 Puller

88800196 Drift
88800387 Puller
88800460 Sleeve

IMPORTANT! Working with the fuel system requests special cleanliness.

- 1 Drain the coolant with the aid of 9996049 Draining hose; refer to *Draining the Cooling System*. Mark and remove the valve yokes.
- 2 Remove the protective plug.

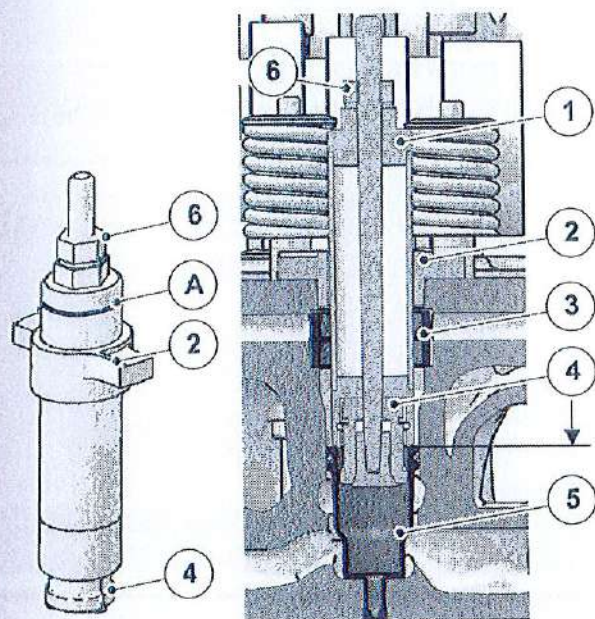


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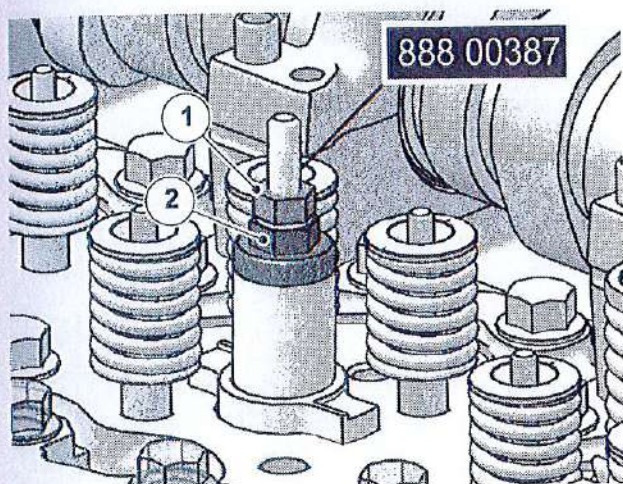


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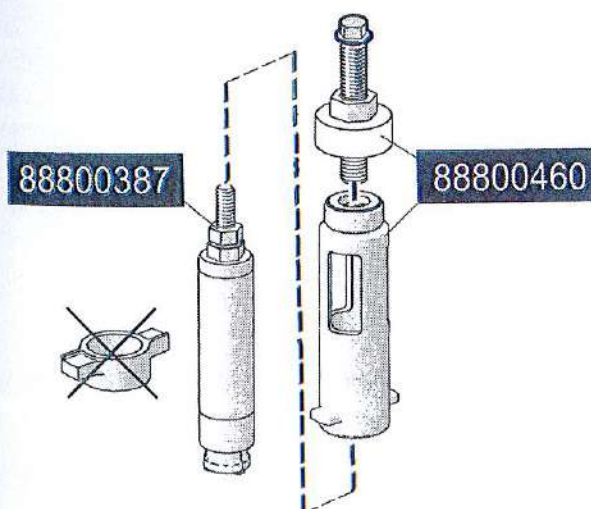
- 3 Clean carefully around the sleeve.
Install 2 seal rings to prevent dirt from entering the fuel ducts when the sleeve is removed.



P0019122



P0019123



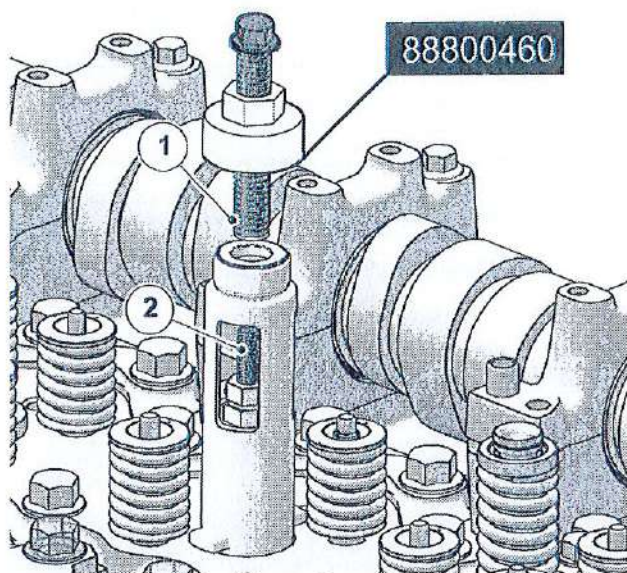
P0021199

- 4 The puller marking (A) should be visible when the support ring (2) is fitted. If the marking is not visible it may be difficult to remove the sleeve. Press the puller (1) down to the sleeve bottom; see arrow marking. Install the support ring (2).

- 9998250 Seal ring, 2 pcs (3)
- Expander (4)
- Sleeve (5)
- Nut (6)

- 5 Push the tool down to the bottom of the sleeve. Tighten the nut (1) sufficiently hard to hold the puller in place; apply moderate force and use the tool (2) as a counterhold.

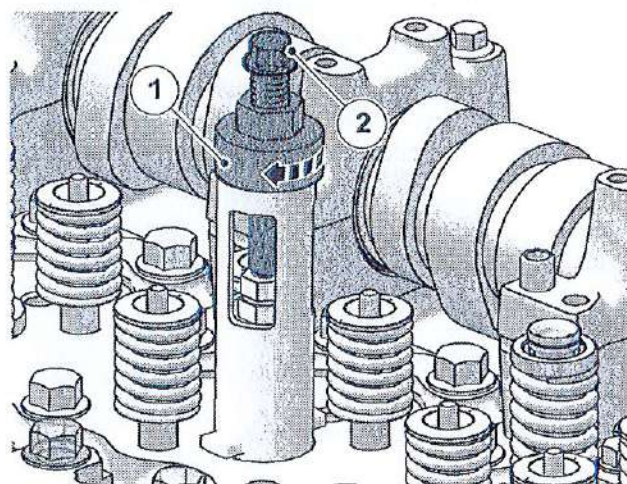
- 6 **Alternative 1**
Remove the sleeve from 88800387 Puller and fit 88800460 Sleeve.



P0021200

- 7 **NOTICE!** Tighten the bolt moderately.

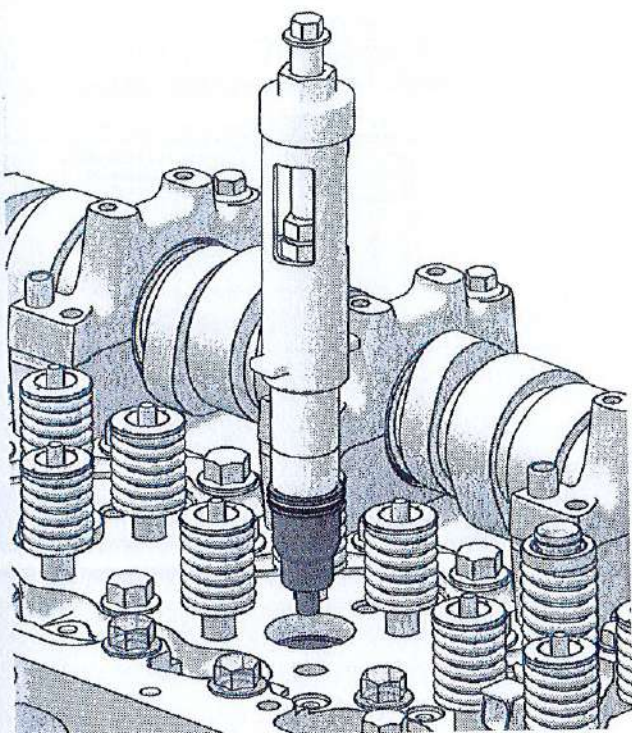
Install the sleeve with bolt (1).
Screw down to the end position towards the puller (2).



P0021202

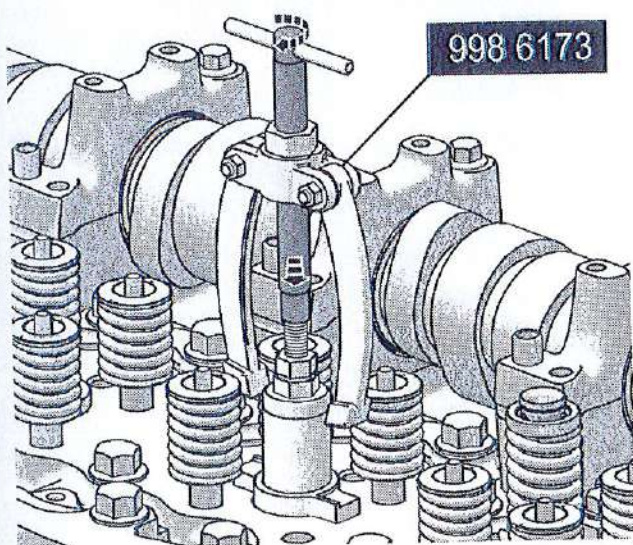
- 8 Counterhold the screw puller (2) and screw the sleeve nut (1) until the sleeve releases.

- 9 Pull up the puller and sleeve.
A misshapen sleeve can be difficult to remove. If this is the case, remove the puller and find a new grip for the expander.
Install the support ring and make a new attempt.

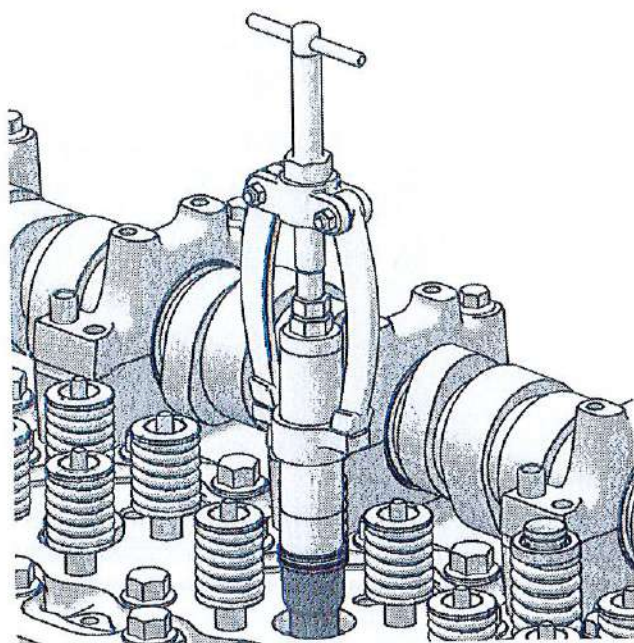


P0021201

- 10 **Alternative 2**
Install the puller.
Screw down until the puller lugs meet the support ring.

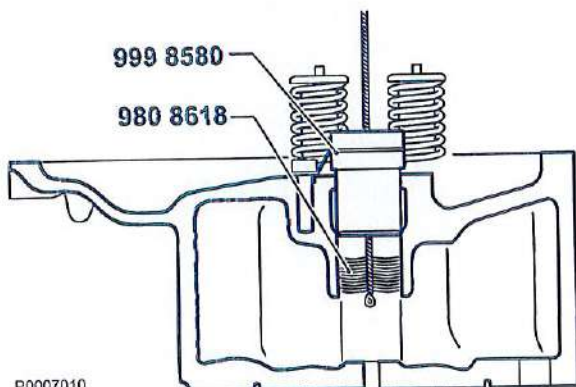


P0019124



P0019125

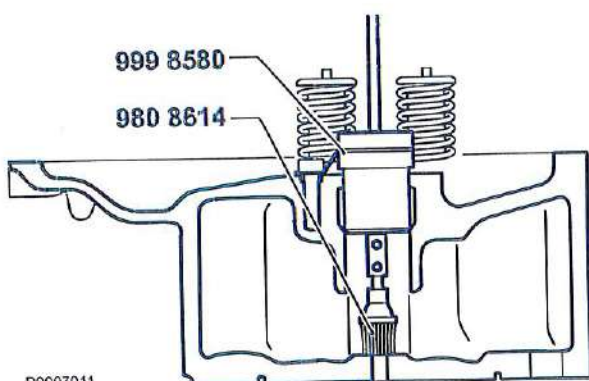
- 11 Screw until the sleeve releases and the puller and sleeve can be removed.
A misshapen sleeve can be difficult to remove. If this is the case, remove the puller and find a new grip for the expander.
Install the support ring and make a new attempt.



P0007010

P0007010

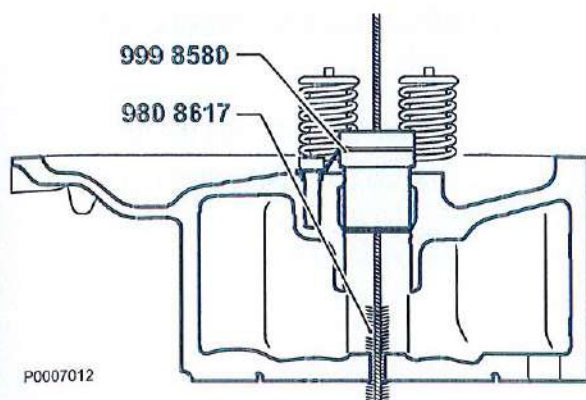
- 12 Use tool 9998599 Cleaning kit and a power drill before fitting the new sleeve.
Install tool 9998580 Protective sleeve in the injector hole and secure it with a holder.
IMPORTANT! Tool no. 9998580 Protective sleeve must be used to prevent dirt from entering the fuel duct.
- 13 Clean the cylinder head walls using 9808618.



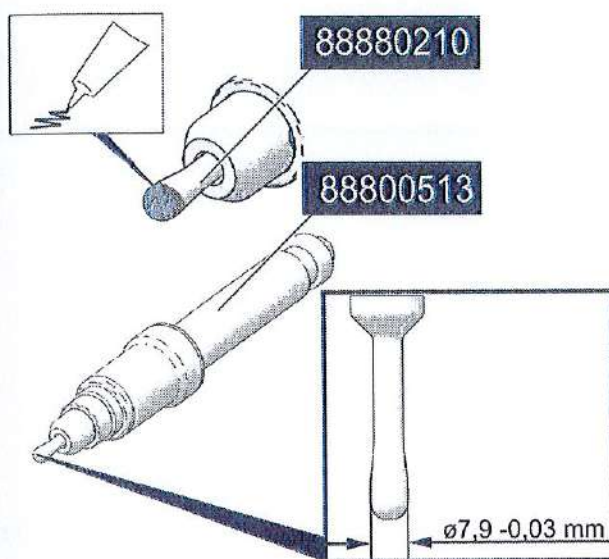
P0007011

P0007011

- 14 Clean the sleeve seat using Brush 9808614 together with the handle and holders.

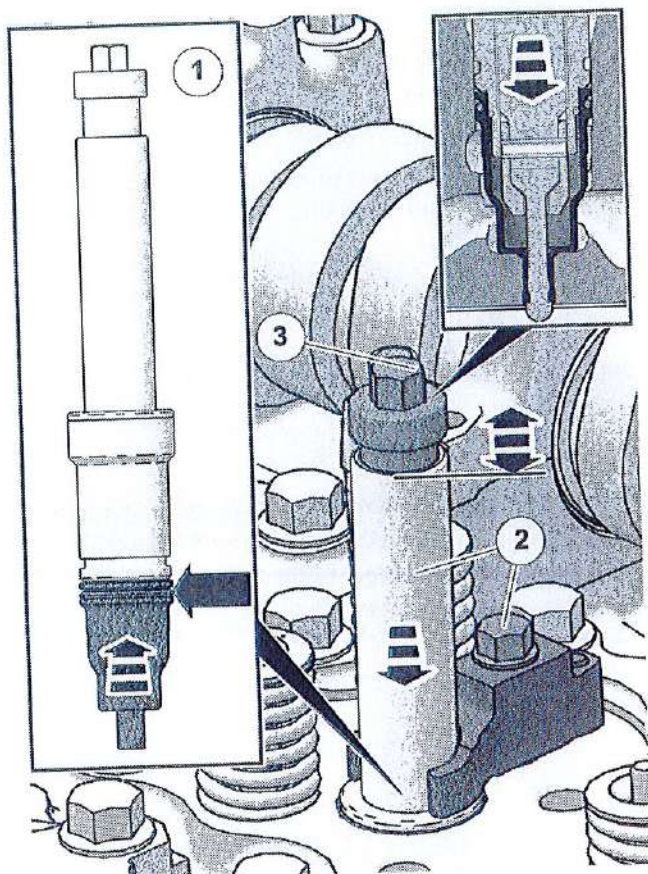


P0007012

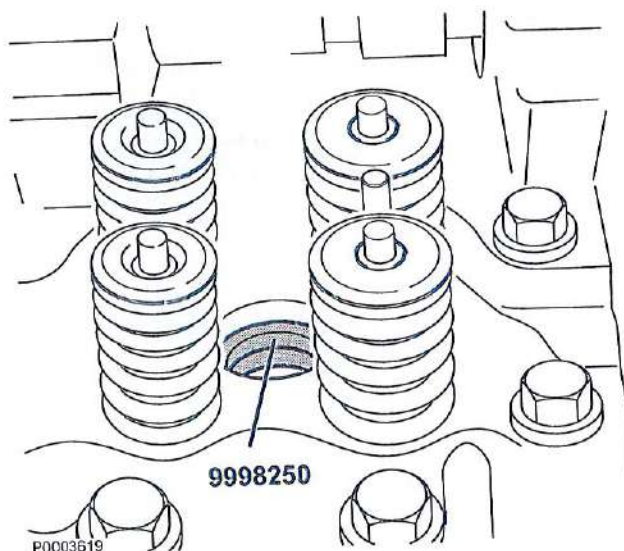


P0025230

- 15 Clean the cylinder head hole with Brush 9808617.
- 16 Remove tool 9998580 Protective sleeve. Make sure the O-ring is removed.
- 17 Check that the piston is at BDC.
IMPORTANT! This must be done so that tool no. 9808617, due to its length, does not damage the piston.
- 18 Lubricate the tap with graphite paste 85134750.



P0025231



P0003619

P0003619

- 19
 - 1 Fit the sleeve to the expander tool. Lubricate the O-rings with soapy water.
 - 2 Use the unit injector yoke to steady the tool. Tightening torque: **80 Nm (59 lbf ft)**
 - 3 Run the tap down through the tip of the sleeve.
- 20 Remove the expander tool.
- 21 Remove the seal ring, (2 pcs).
- 22 Install the unit injectors with washer; refer to *Unit Injector, Replace*.
- 23 Reinstall the valve yokes according to the markings.
- 24 Install the rocker arm bridge. Check play on valves and unit injectors.
- 25 Install the valve cover.
- 26 Fill up with coolant and check that no leakage occurs.

23-8 Control System, ECM, Data Sets

Engine Control Unit (ECU), Replace

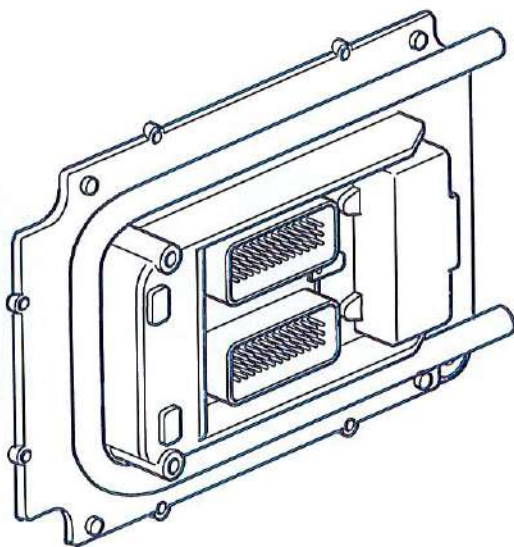
NOTICE! Before the control unit is replaced and any warranty claim made, all checks in the check list must be performed, to exclude any defect in the engine control system. If the measurements of the cable harness show defects, it is highly likely that the control unit is fault free. Refer to the "Service Manual, EMS 2".

WARNING!

Faulty individual control unit settings may result in injury to persons or damage to the engine. For information about reprogramming and reading of software, refer to "Service manual, EMS 2"

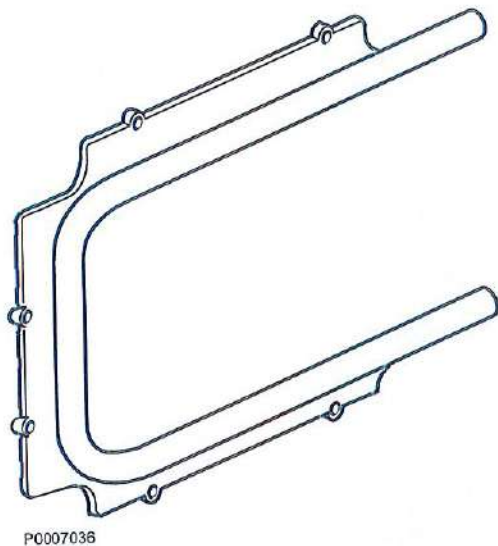
IMPORTANT!

Exchange of control units between engines, during fault tracing or repair, must never be performed under any circumstances.

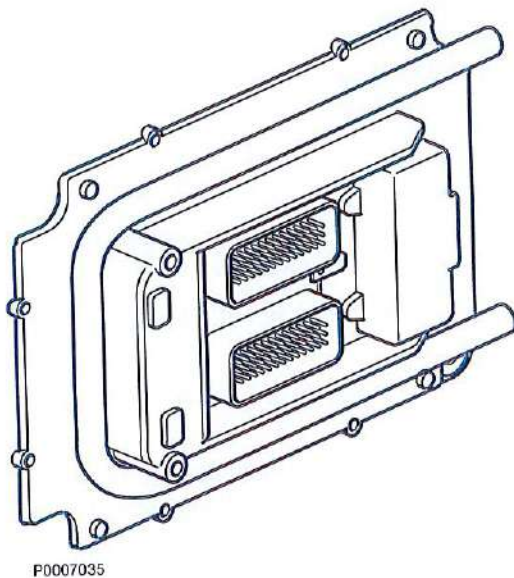


P0007035

- 1 Clean thoroughly around the control unit fuel connections.
- 2 Disconnect power from the engine by disconnecting the negative battery terminal.
- 3 Remove the lower part of the crankcase breather pipe.
- 4 Remove the upper and lower cable harness clamps.
- 5 Remove the control unit cable harness by moving the connector block retaining clips outwards.
- 6 Remove the upper and lower fuel connections to the cooling element; plug the fuel lines.
- 7 Remove the control unit retaining bolts and remove the control unit.



- 8 Transfer the cooling element to the new control unit. Make sure that the surface between the cooling element and the control unit is clean.
- 9 Install the new control unit. Torque according to specifications in *Special Tightening Torques*.
- 10 Connect the upper and lower fuel connections to the cooling element with new sealing washers.
- 11 Install the harness and clamps.
- 12 Install the crank case breather lower pipe.



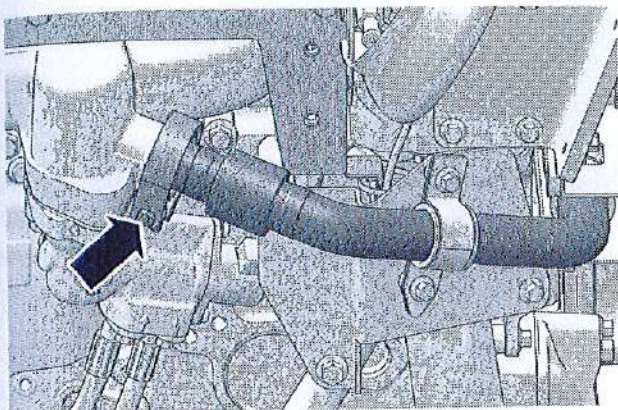
- 13 Bleed the fuel system. Refer to *Fuel system, bleeding*. Start the engine and check for error codes. Refer to the "Service Manual, EMS 2".

25-1 Inlet and Exhaust Manifolds

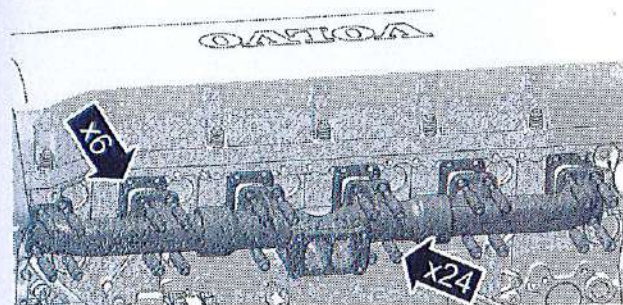
Exhaust Manifold, Change

Removal

- 1 Remove the turbocharger as per: *Turbo, Change*.
- 2 Remove the heat shield, if fitted.
- 3 **TAD1670-72VE only**
Undo e-EGR connection.



P0022360

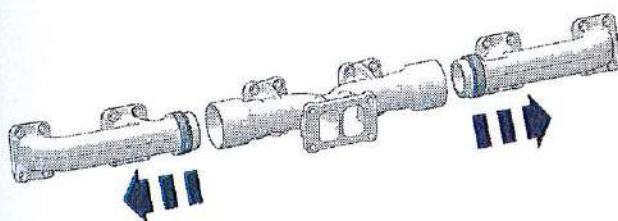


P0022355

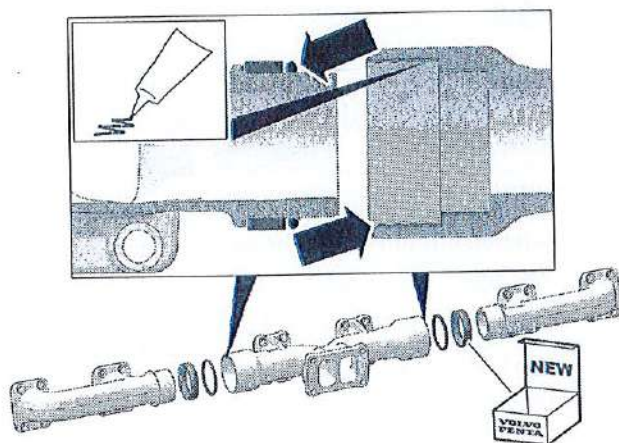
- 4 Remove the exhaust manifold.

Exhaust manifold inspection

- 5 In case of inspection:
Dismantle the exhaust manifold.
Check that the components have no cracks or damage.



P0022356



P0022357

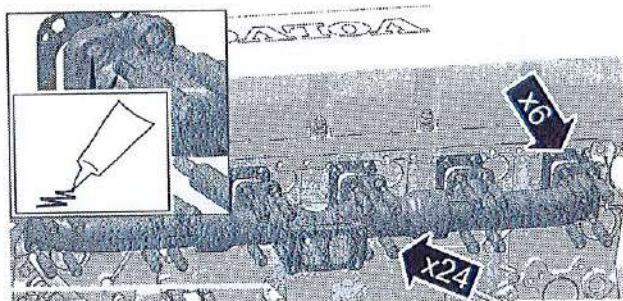
- 6 Clean the mating surfaces and install the gaskets as illustrated.

NOTICE! Apply assembly paste (part # 1161929) around the exhaust manifold insertion surfaces at the connections.

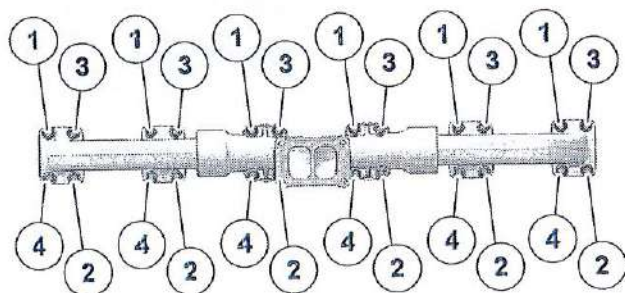
Assemble the exhaust manifold.

Installation

- 7 Apply assembly paste (part # 1161929) for fasteners.
- 8 Place the gaskets on the sealing surface. Install the exhaust manifold.



P0022358



P0022359

- 9 **Torque the exhaust manifold in the following stages:**
 - 1 Tighten the bolts (1-2-3-4) until contact.
Tightening torque: (10 Nm) 7.4 lbf. ft.
 - 2 Tighten the bolts (1-2-3-4).
Tightening torque: (40 Nm) 29.5 lbf. ft.
 - 3 Tighten the bolts (1-2-3-4).
Tightening torque: (54 Nm) 39.8 lbf. ft.
- 10 Install the heat shield, where fitted.
- 11 Install the turbocharger as per: *Turbo, Change.*
- 12 Start the engine and perform a function check.

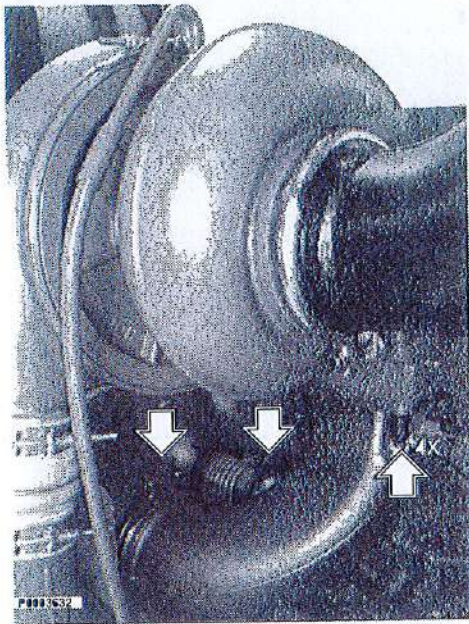
25-2 Exhaust Pipe, Silencer

Exhaust Pipe (Y-pipe), Replace

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

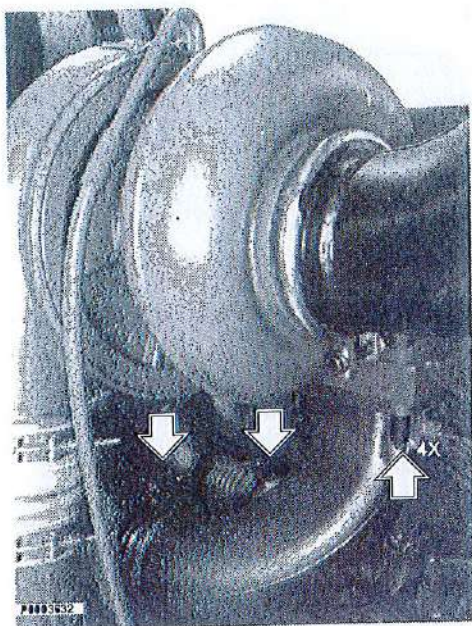
Removal

- 1 Remove the heat shield and any exhaust temperature sensor. Refer also to *Heat Protection*.
- 2 Remove the two exhaust clamps.
- 3 Remove the four nuts and the Y pipe spacers.
- 4 Remove the pipe.



Installation

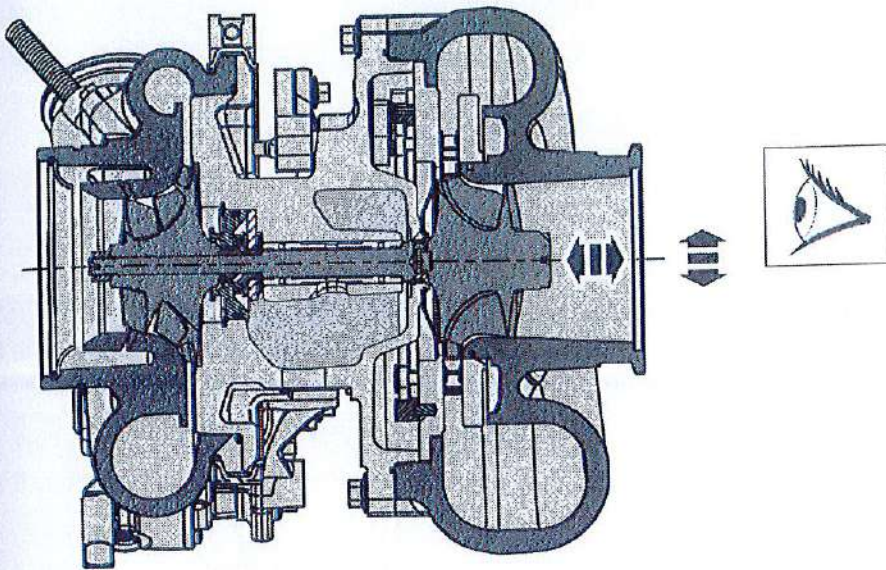
- 5 Check the seal surface condition and check that the flange joint surfaces are clean. Install a new gasket.
- 6 Install the new exhaust pipe. Torque the nuts according to specifications in *Special Tightening Torques*.



- 7 Make sure the flange joint positions correctly.
Adjust as necessary.
Tighten the clamps.
- 8 Install the heat shield.
Refer to *Heat Protection*.
- 9 Install the exhaust temperature sensor, where fitted.

25-5 Turbo and supercharger

Turbocharger, Inspection



P0026397

Check:

- That no visible external damage to the compressor wheel/turbine wheel is present.
- Press the turbine wheel/compressor wheel axially and radially while rotating the shaft. No contact between the turbine wheel or compressor wheel and their housings may occur.

Bear in mind:

- Oil accumulation in the intake system downstream of the turbocharger may indicate a worn turbocharger.
- Heavy carbon deposits on the turbine blades may indicate a worn turbocharger.

Turbo, Change

Always determine and rectify the reasons why the turbocharger has failed, before a new turbocharger is installed.

A prerequisite for the turbocharger to work satisfactorily is that the engine lubrication and intake systems are kept in good condition, i.e. that oil and oil filter changes are completed as scheduled, that the right grade of oil is used and that the air filter is maintained correctly.

Therefore the first action should be to check the engine oil and replace the oil filters if needed, and preferably to run the engine for a few minutes with the new oil before the new turbo unit is installed.

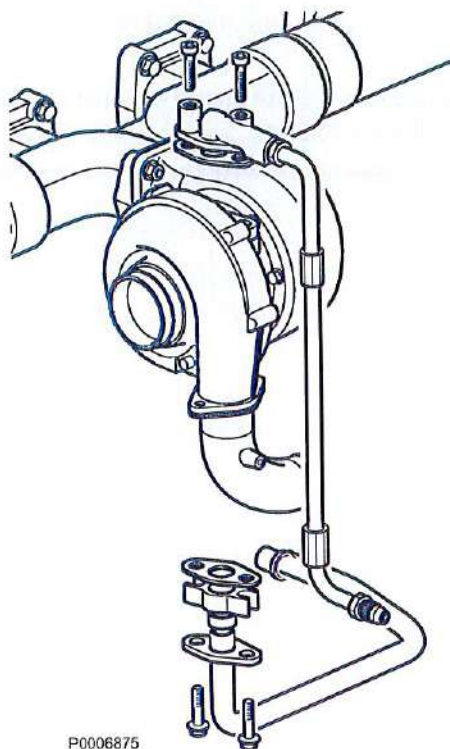
Blow any rust and soot flakes out of the exhaust manifold when the turbocharger is changed. The soot flakes could damage the turbine wheel on the new unit. It is also important to clean the intake line from the air filter. Debris from a failed turbine wheel may remain in place and cause instant breakdown of the new turbocharger.

Removal

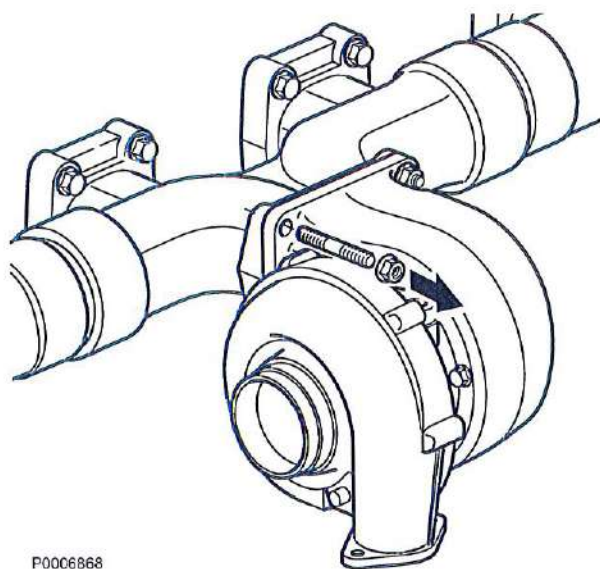
TAD1640GE, TAD1640VE-B, TAD1641GE,
TAD1641VE, TAD1641VE-B, TAD1642GE,
TAD1642VE-B, TAD1643VE-B, TAD1650GE,
TAD1650VE, TAD1650VE-B, TAD1651GE,
TAD1651VE, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

Variants with single turbo

- 1 Remove the air hose between the turbo and the air filter housing.
- 2 Remove the bolts and remove the exhaust pipe from the turbo.
- 3 Remove the oil delivery pipe and return oil pipe.



- 4 Remove the nuts and the spacer sleeves.
- 5 Remove the turbo.

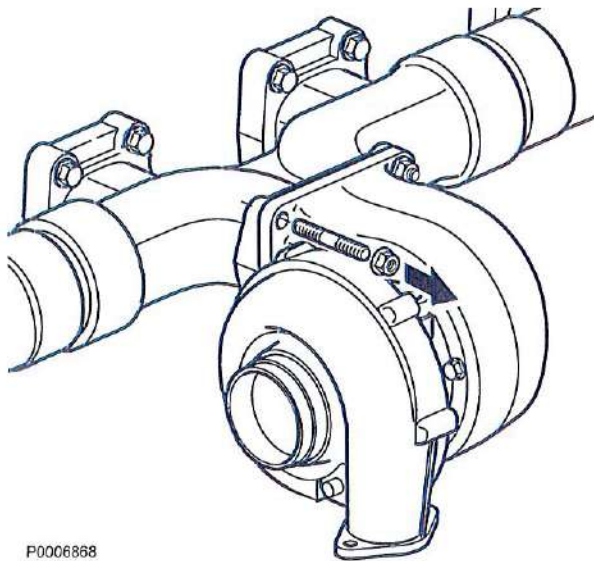


Installation

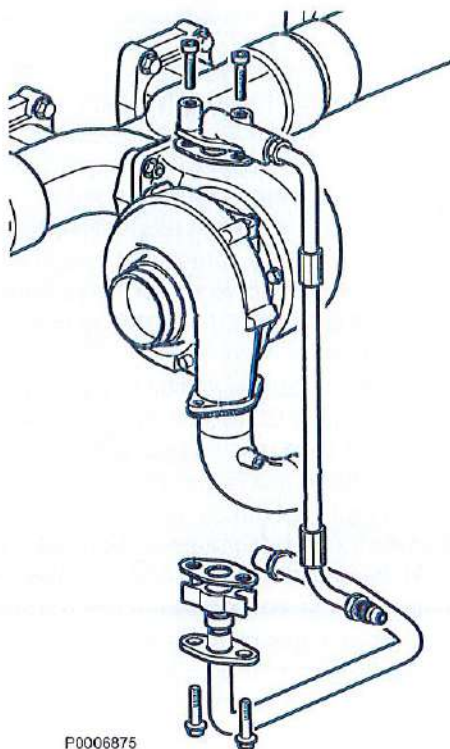
TAD1640GE, TAD1640VE-B, TAD1641GE,
TAD1641VE, TAD1641VE-B, TAD1642GE,
TAD1642VE-B, TAD1643VE-B, TAD1650GE,
TAD1650VE, TAD1650VE-B, TAD1651GE,
TAD1651VE, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

Variants with single turbo

- 1 Clean the turbo contact surface on the exhaust manifold.
- 2 Fit the return oil pipe with a new seal ring against the engine block.
- 3 Place a new gasket on the exhaust manifold and install the turbo.
Tighten the nuts according to the specification in *Special Tightening Torques*.



P0006868



- 4 Connect return oil pipe using a new gasket against the turbo.
- 5 Fill the turbo with clean engine oil through the oil delivery pipe connection.

IMPORTANT!

Make sure no dirt gets into the connection. Use a strainer when filling oil.

- 6 Fit the oil delivery pipe with a new gasket.
- 7 Fit the exhaust pipe to the turbo.
- 8 Fit the hose between air filter and turbo.
- 9 Start the engine and check for leaks.

Low-Pressure Turbo, Change

Always determine and rectify the reasons why the turbocharger has failed, before a new turbocharger is installed.

A prerequisite for the turbocharger to work satisfactorily is that the engine lubrication and intake systems are kept in good condition, i.e. that oil and oil filter changes are completed as scheduled, that the right grade of oil is used and that the air filter is maintained correctly.

Therefore the first action should be to check the engine oil and replace the oil filters if needed, and preferably to run the engine for a few minutes with the new oil before the new turbo unit is installed.

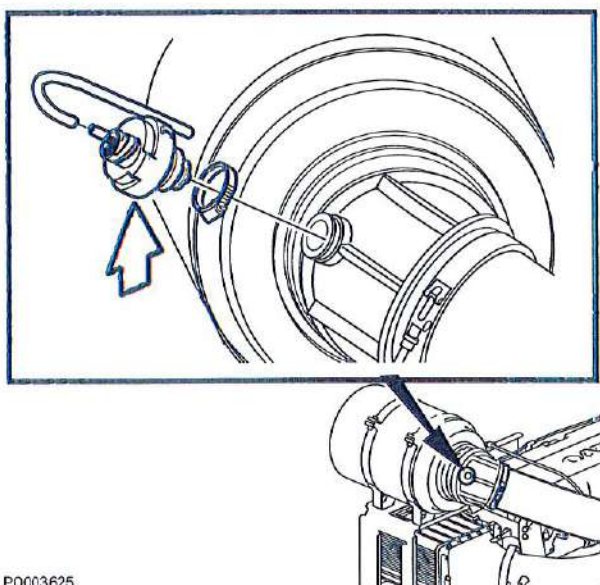
Blow any rust and soot flakes out of the exhaust manifold when the turbocharger is changed. The soot flakes could damage the turbine wheel on the new unit. It is also important to clean the intake line from the air filter. Debris from a failed turbine wheel may remain in place and cause instant breakdown of the new turbocharger.

Removal

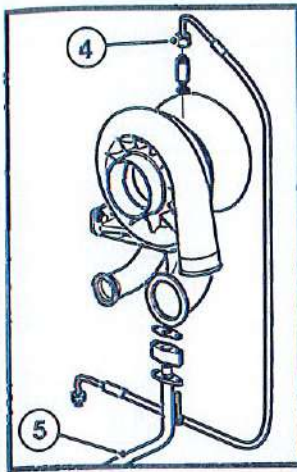
TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

Low-Pressure Turbo Variants with twin turbo

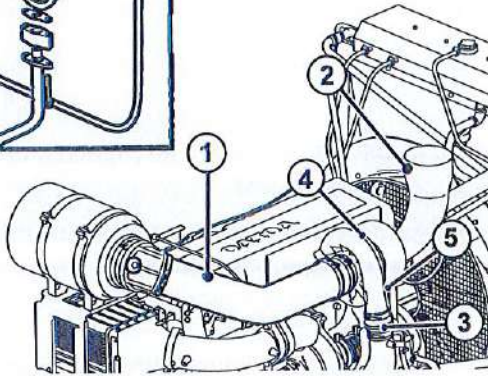
- 1 Remove the heat shield, if fitted.
Refer to *Heat Protection*.
- 2 Undo the connector for the air filter sensor.



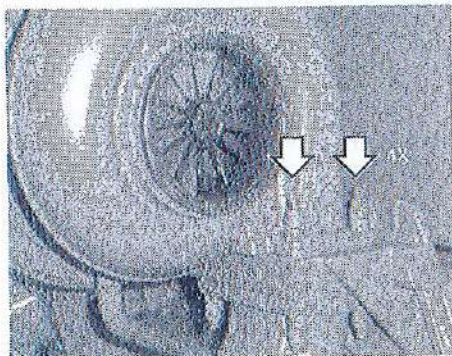
P0003625



P0003626



- 3 Remove the inlet pipe (1).
- 4 Remove the exhaust system (2).
- 5 Undo the upper clamp (3) between the turbo and the charge air cooler.
- 6 Remove the oil supply hose (4).
- 7 Remove the bolts for the oil return pipe (5) on the turbo. Allow the other end to remain in the engine block.



P0007044

- 8 Remove the four nuts and spacers to the turbo.
- 9 Lift away the turbocharger.
- 10 Transfer any oil supply pipe extension to the new turbo.

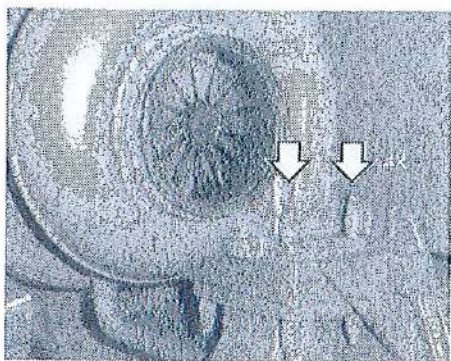
Installation

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

Low-Pressure Turbo

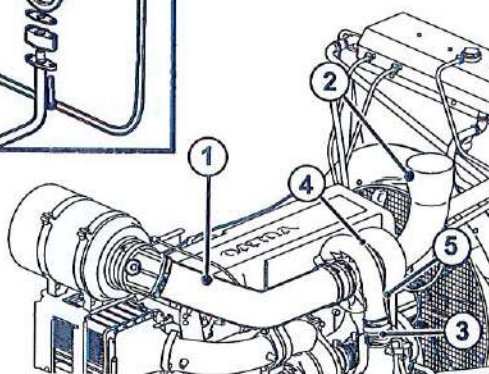
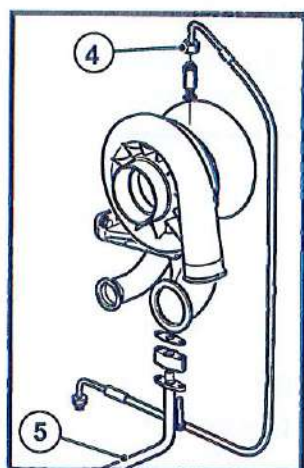
Variants with twin turbo

- 1 Install the studs if they were removed from the fixture.
- 2 Fit the gasket.
- 3 Lift the turbo into place and align it with the hose on the charge air cooler.



P0007044

- 4 Fit the spacers and nuts to the turbo.
Torque the nuts according to specifications in *Special Tightening Torques*.



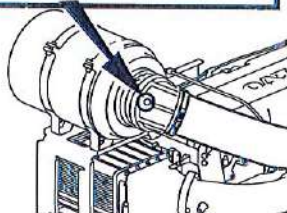
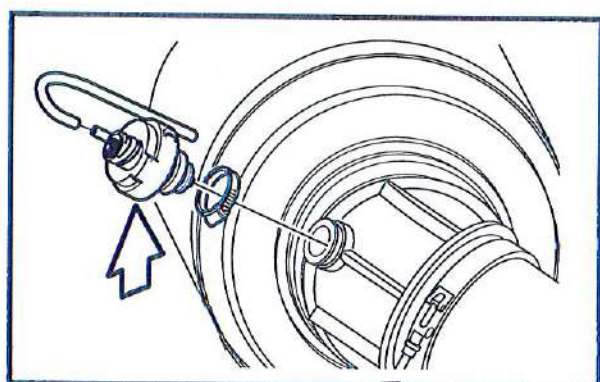
P0003626

- 5 Install the oil return pipe (5) and a new gasket.
Tighten the bolts.
- 6 Fill the turbo with clean engine oil through the oil delivery pipe connection.

IMPORTANT!

Make sure no dirt gets into the connection. Use a strainer when filling oil.

- 7 Install the oil supply hose (4).
Tighten the nut.
- 8 Tighten the hose clamp (3) on the turbo.
- 9 Check the condition of the rubber connectors.
Install the inlet pipe (1).
Tighten the hose clamps.
- 10 Install the exhaust system (2).
Tighten the clamp.



P0003625

- 11 Install the air filter sensor connector.
- 12 Install the heat shield, where fitted.
Refer to *Heat Protection*.

High-Pressure Turbo, Change

Always determine and rectify the reasons why the turbocharger has failed, before a new turbocharger is installed.

A prerequisite for the turbocharger to work satisfactorily is that the engine lubrication and intake systems are kept in good condition, i.e. that oil and oil filter changes are completed as scheduled, that the right grade of oil is used and that the air filter is maintained correctly.

Therefore the first action should be to check the engine oil and replace the oil filters if needed, and preferably to run the engine for a few minutes with the new oil before the new turbo unit is installed.

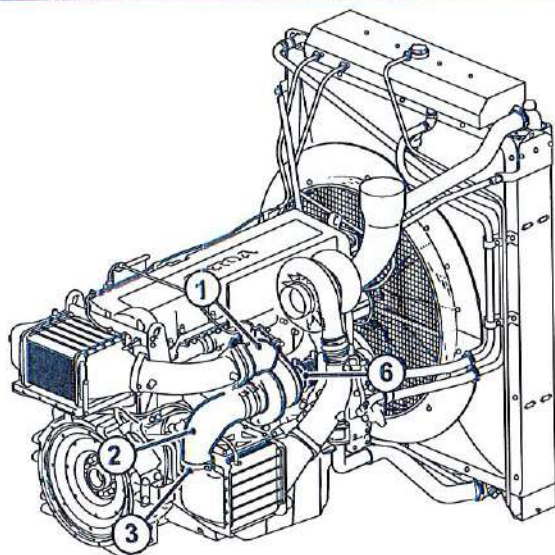
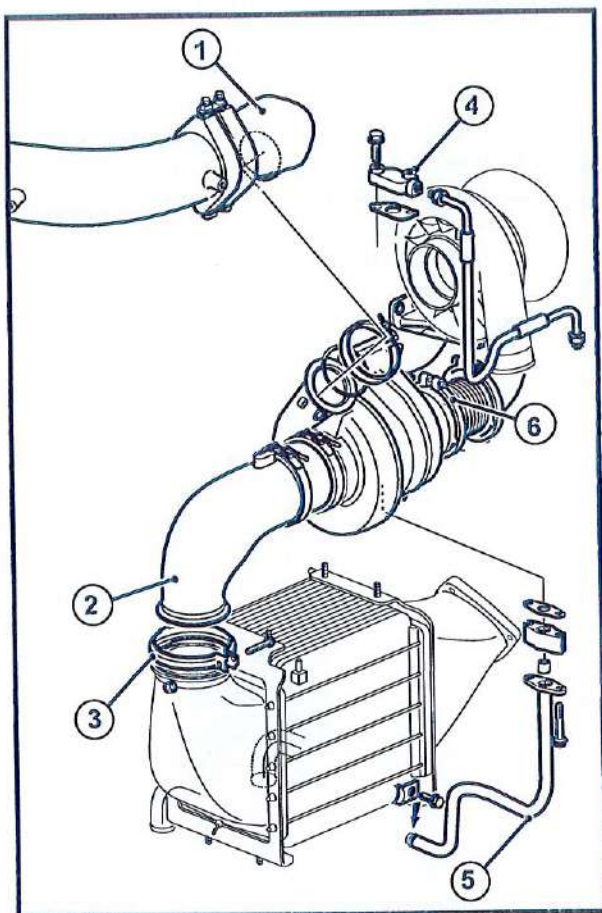
Blow any rust and soot flakes out of the exhaust manifold when the turbocharger is changed. The soot flakes could damage the turbine wheel on the new unit. It is also important to clean the intake line from the air filter. Debris from a failed turbine wheel may remain in place and cause instant breakdown of the new turbocharger.

Removal

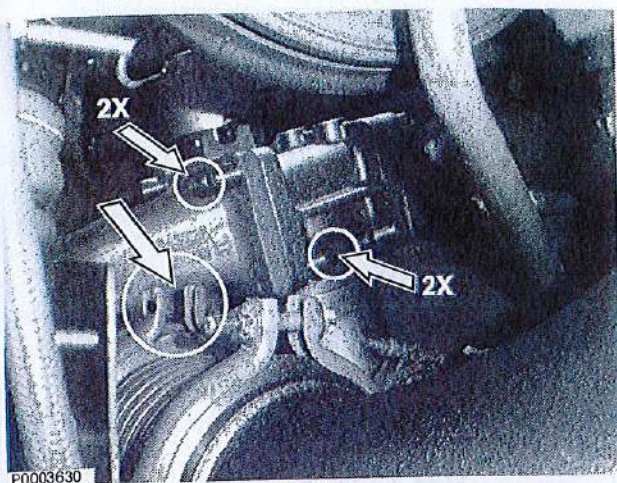
TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

High-Pressure Turbo Variants with twin turbo

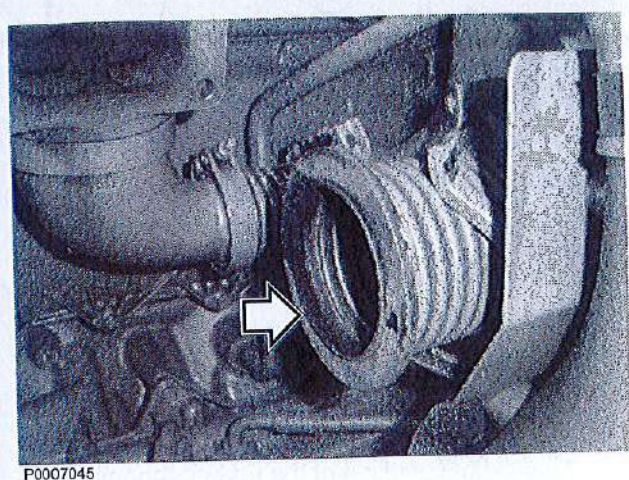
- 1 Remove the heat shield, if fitted.
Refer to *Heat Protection*.
- 2 Remove the charge air pipe (1) from the turbocharger.
- NOTICE!** Note the O-ring.
- 3 Remove the charge air pipe (2) from the turbocharger.
- 4 Cover the opening (3) on the charge air cooler.
- 5 Remove the oil supply line (4).
- 6 Remove the bolts for the oil return pipe (5) on the turbo. Allow the other end to remain in the engine block.
- 7 Undo the clamp (6) for the flex-pipe on the exhaust side.



P0003627



- 8 Remove the nuts from the turbo attachment to the wastegate valve.



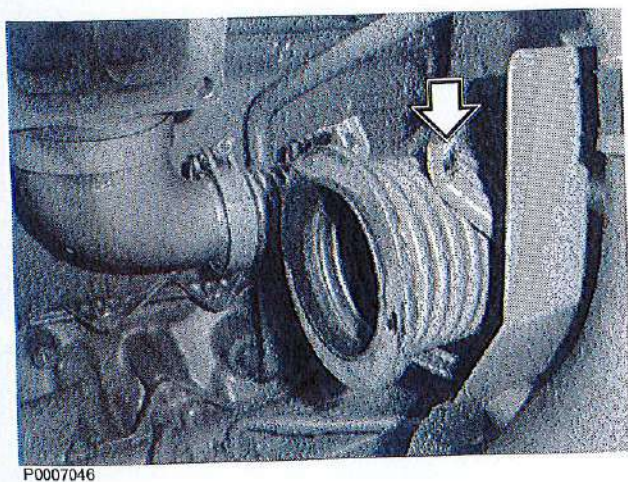
- 9 Separate the flange, so the sealing surfaces are free. Leave the clamp on the flex-pipe. Lift away the turbocharger.

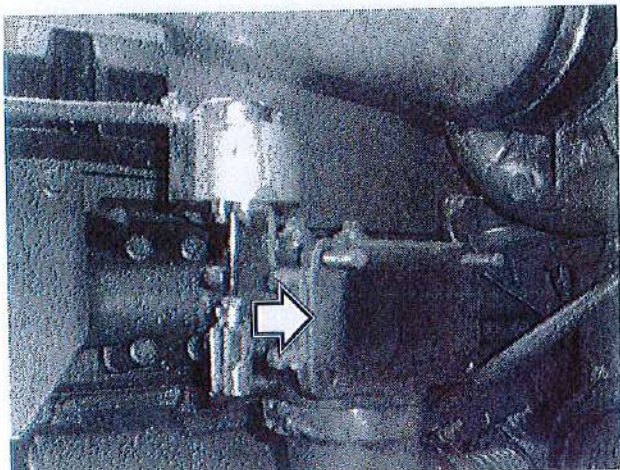
Installation

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

High-Pressure Turbo Variants with twin turbo

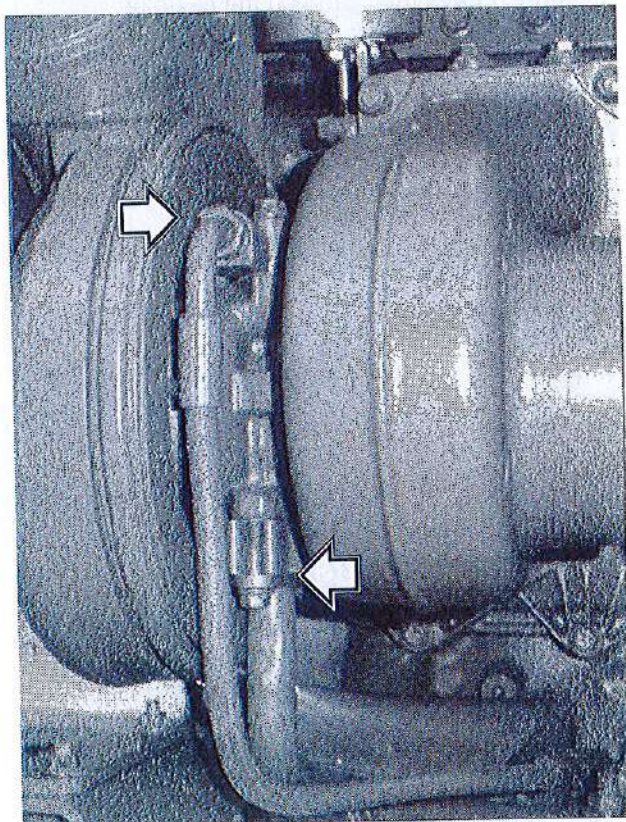
- 1 Make sure the clamp is on the flex-pipe.





P0007047

The picture shows TWD1643GE, TWD1652-53GE.



P0007048

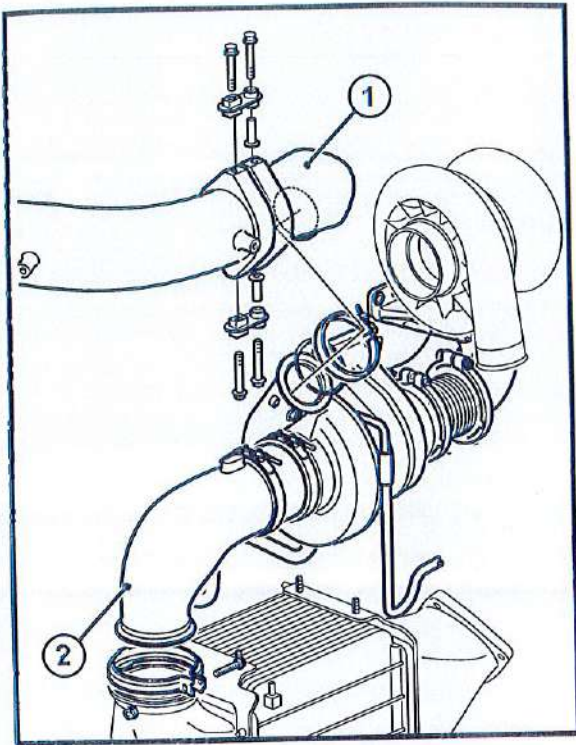
- 2 Install the high pressure turbo and a new gasket
- 3 Tighten the nuts on the turbo according to specifications in *Special Tightening Torques*.
- 4 Tighten the flex-pipe clamp.

- 5 Install the turbo oil return pipe with a new gasket. Tighten the bolts.
- 6 Fill the turbo with clean engine oil through the oil delivery pipe connection.

IMPORTANT!

Make sure no dirt gets into the connection. Use a strainer when filling oil.

- 7 Install the oil supply line to the turbo with a new gasket. Tighten the bolts.
- 8 Check the condition of the rubber connector. Check that the flange joint sealing surfaces are clean and correctly aligned.



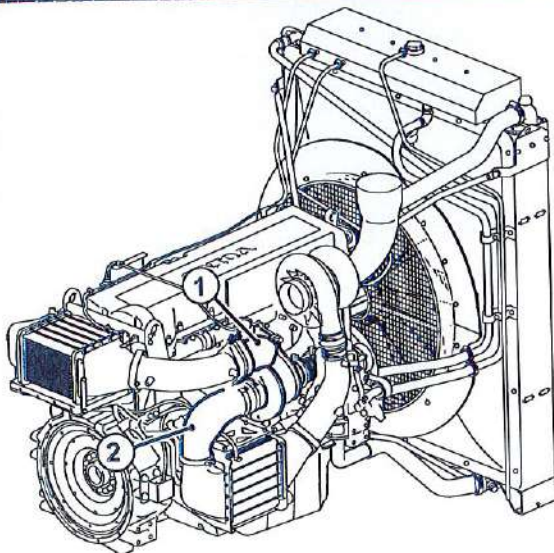
- 9 Install the charge air pipe (2) on the turbo with a new O-ring.
- 10 Fit the clamp and tighten it.
- 11 Tighten the clamp on the rubber connector.
- 12 Check the condition of the rubber connector. Fit new O-rings.

NOTICE! Make sure the O-rings fit properly in their grooves.

- 13 Install the charge air pipe (1) from the turbocharger.
- 14 Tighten the flange joint. The lower clamp must be tightened first.

NOTICE! TWD1643GE (early mod.): Adjust the wastegate valve; refer to *Wastegate Valve, Adjustment*.

- 15 Install the heat shield, where fitted. Refer to *Heat Protection*.



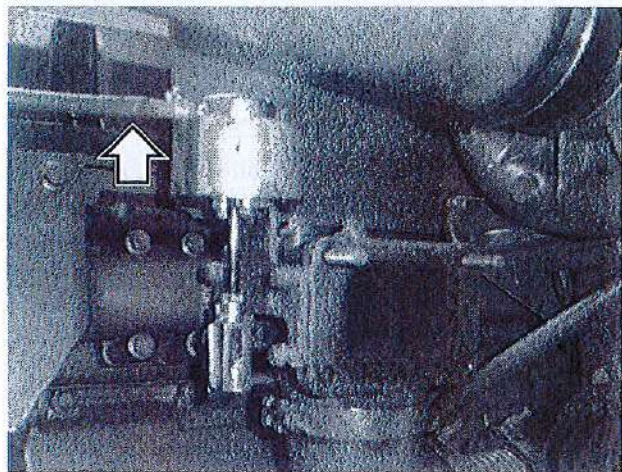
P0003631

Wastegate Valve, Replace

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

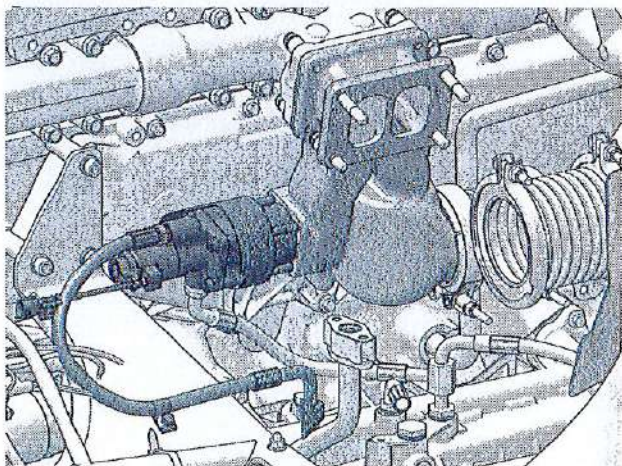
Removal

- 1 Remove the high pressure turbo in accordance with *High-Pressure Turbo, Change*.
- 2 Remove the wastegate valve connection.



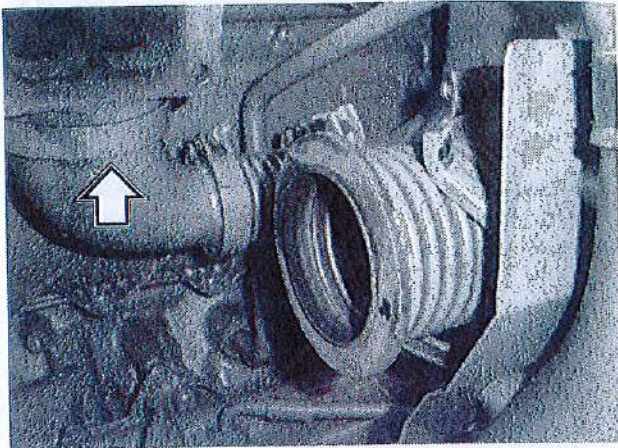
P0007049

The picture shows TWD1643GE, TWD1652-53GE.



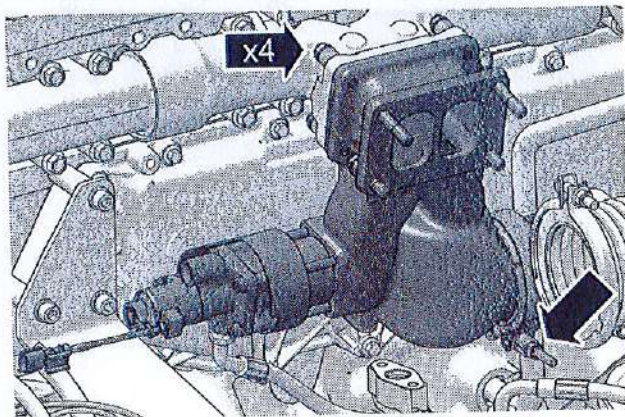
P0018880

The picture shows TWD1663GE, TWD1672-73GE.



P0007050

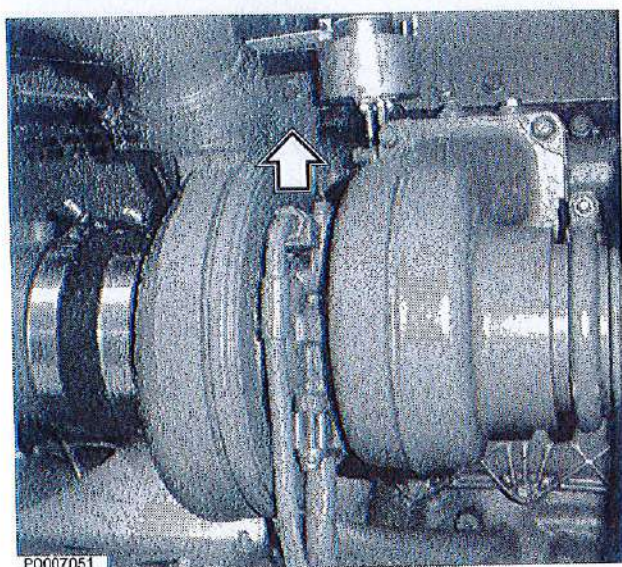
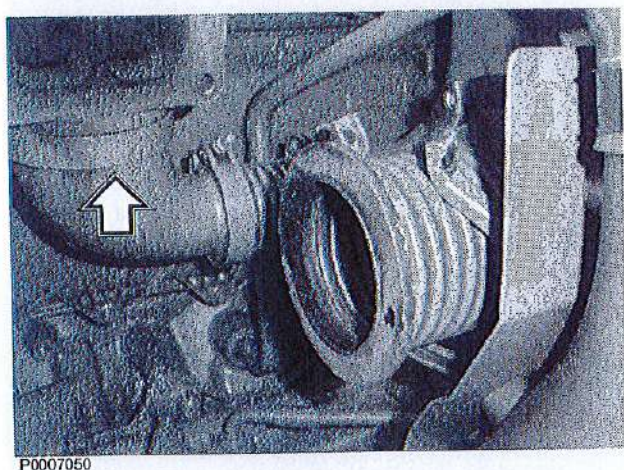
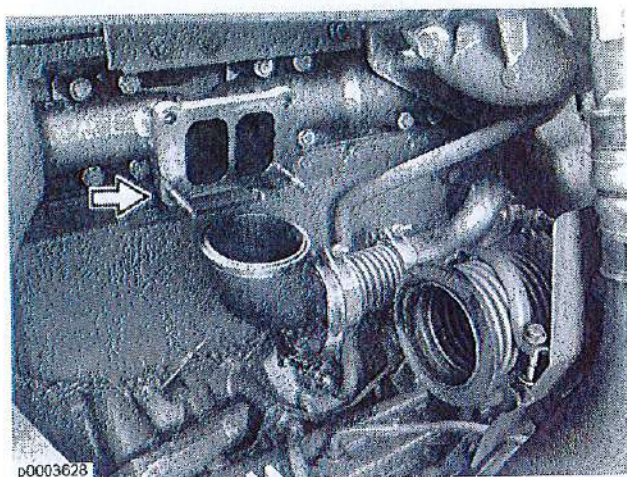
The picture shows TWD1643GE, TWD1652-53GE.



P0018881

The picture shows TWD1663GE, TWD1672-73GE.

- 3 Remove the clamp under the wastegate housing.
- 4 Remove the nuts and spacers.
- 5 Lift the wastegate valve away.



Installation

- 6 Check the condition of the rubber connector.
- 7 Install the wastegate housing and a new gasket.
- 8 Tighten the nuts.
- 9 Install the clamp under the wastegate housing and tighten until it touches.
- 10 Install the high pressure turbo in accordance with *High-Pressure Turbo, Change*.
- 11 Tighten the clamp below the wastegate housing.
- 12 Install the wastegate valve connector.

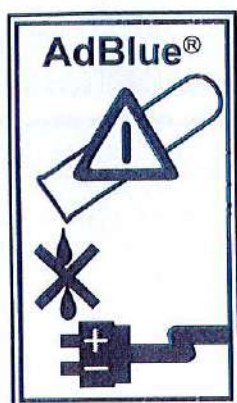
NOTICE! TWD1643GE (early mod.): Adjust the wastegate valve in accordance with *Wastegate Valve, Adjustment*.

25-8 Emission After-Treatment

Repair instructions

TAD1660VE, TAD1661VE, TAD1662VE,
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1644GE, TWD1645GE, TWD1663GE,
TWD1672GE, TWD1673GE

NOTICE! Because the illustrations in the maintenance literature are used for different engine variants, certain details may vary compared to the actual model concerned. The essential information in the illustrations is always correct, however.



P0011697



IMPORTANT!

AdBlue/DEF and urea solutions cause corrosion damage. Do not remove AdBlue/DEF hoses, urea hoses or electrical wiring during normal service or when moving a component. Tools that have come into contact with AdBlue/DEF or urea solution must be cleaned.

CAUTION!

Gloves must be changed. Take off contaminated clothes.

WARNING!

In the case of any contact with eyes or skin the affected area must be thoroughly rinsed with lukewarm water. If you inhale any fumes, make sure you breathe fresh air.

NOTICE! Always plug AdBlue/DEF and urea hoses in order to avoid dirt in the AdBlue/DEF system, and any crystallization of AdBlue/DEF.

NOTICE! Clean the AdBlue/DEF system before any type of work is done to avoid dirt.

IMPORTANT!

Fluids other than AdBlue/DEF (such as diesel) and that are not approved by Volvo, will cause a breakdown of the exhaust aftertreatment system.

AdBlue/DEF Tank, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE

Tools:

1158957 Pliers

1159794 Torque wrench

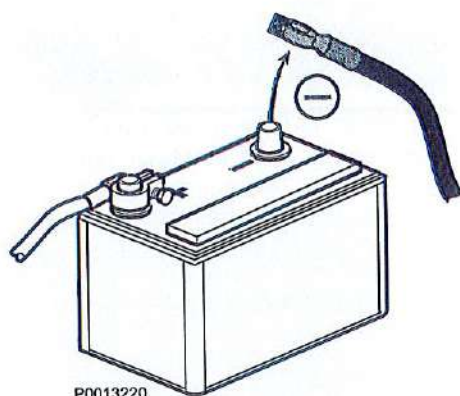
- 1 Switch off the engine.

NOTICE! Wait at least two minutes before removing the AdBlue hoses so that automatic drainage of the AdBlue system can proceed and for the AdBlue system to de-pressurize.

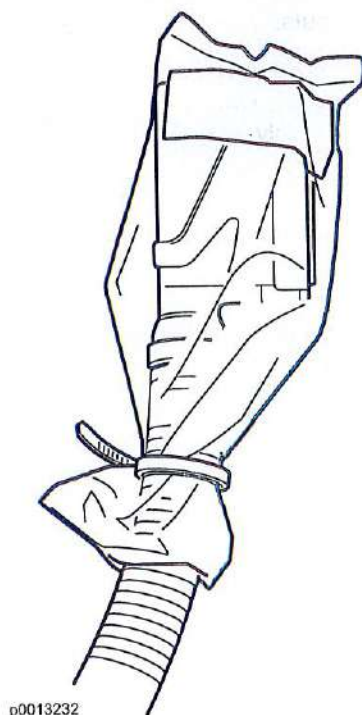
- 2 Cut power to the engine by disconnecting the negative battery terminal.
Assemble the necessary equipment and place a recovery container under the AdBlue tank.

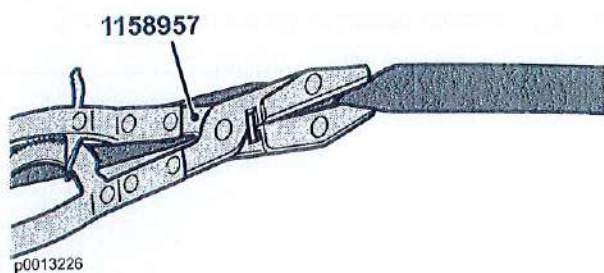
NOTICE! Use protective equipment and an approved recovery container.

- 3 Remove the AdBlue tank filler cap. Remove the drain plug. Empty the AdBlue tank.

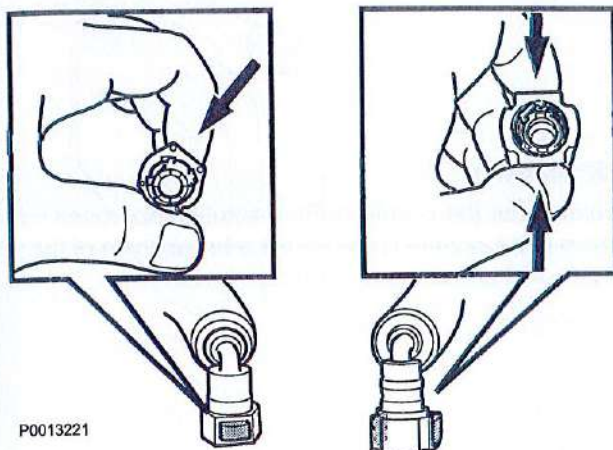


- 4 Remove the electrical connection from the tank fitting.
Protect the connector by enclosing it in a plastic bag and moving it to one side.





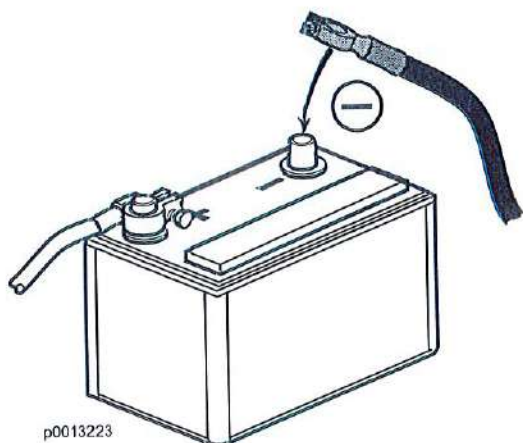
- 5 Clamp hose pinch-off pliers 1158957 on each coolant hose. Remove the coolant hoses.



- 6 Remove the AdBlue hoses by pressing in the latches.



- 7 Install the new AdBlue tank.
- 8 Install the AdBlue tank. Torque-tighten the nuts.
- 9 Install the electrical connection to the tank fitting. Install the AdBlue hoses. Check that the connection locks securely.
- 10 Install the coolant hoses. Unclamp both hose pinch-off pliers from the coolant hoses.
- 11 Install cable ties around hoses and electrical wiring.
- 12 Install the filler cap on the new AdBlue tank. Affix a new adhesive decal to the new AdBlue tank.



- 13 Connect the battery negative terminal.
- 14 Fill with clean AdBlue solution.
Start the engine and check for any leaks.

IMPORTANT!

Fluids other than clean AdBlue solution approved by Volvo (ISO 22241-1) will cause a breakdown of the exhaust aftertreatment system.

NOTICE! Top up with coolant as necessary.

- 15 **NOTICE!** Gather up equipment and surplus AdBlue solution.

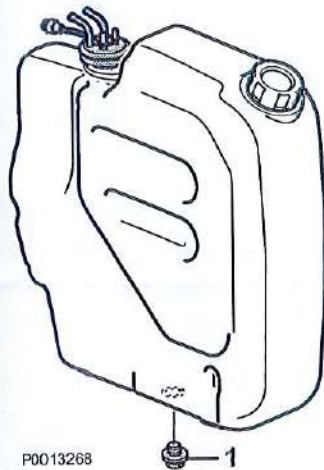
AdBlue/DEF Tank, Cleaning

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE

⚠ CAUTION!

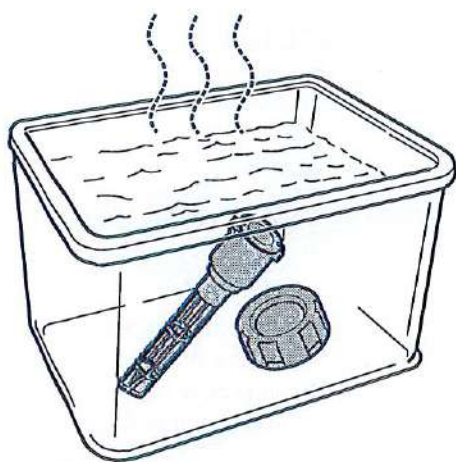
Gloves must be changed. Take off contaminated clothes.

- 1 Remove the drain plug (1) from the bottom of the tank and empty any remaining AdBlue solution and coolant into a suitable recovery container. Change the plug gasket and remount the plug (1).



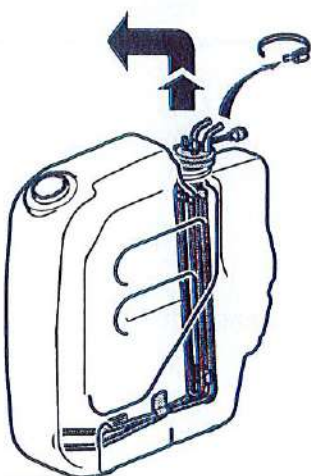
- 2 Remove the filler cap and undo the filler assembly.





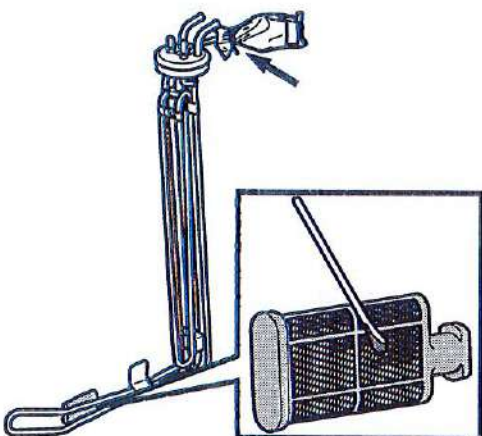
P0013267

- 3 Immerse the filler cap and filler assembly in a water bath for at least 2 minutes.



P0013235

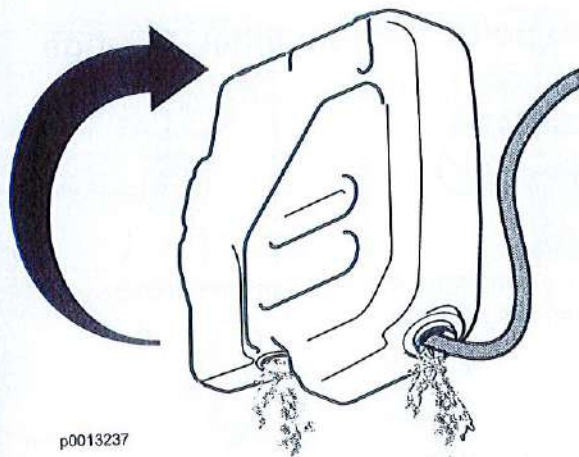
- 4 Undo and remove the tank fittings.



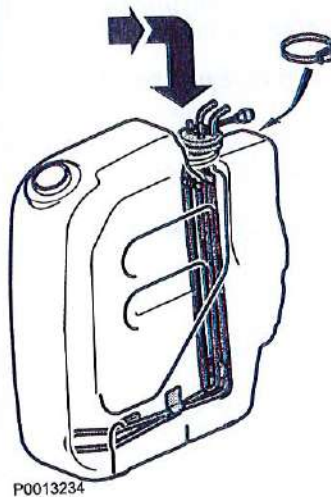
P0013236

- 5 Check the strainer on the fittings: clean as necessary.

NOTICE! Always replace a damaged strainer.



- 6 Flush the tank with hot water for at least 10 minutes.
Make sure the AdBlue tank is completely drained of water afterwards.



- 7 Reinstall the tank fittings.



- 8 Install the filler assembly.
- 9 Fill the tank with AdBlue solution; refer to *Filling AdBlue®/DEF*. Install the filler cap.

AdBlue/DEF-Pump Filter, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE



See *Requirements for work with after-treatment system (EATS)*.

Tools:

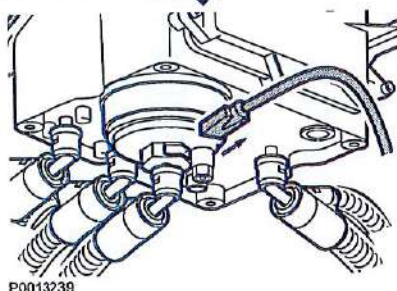
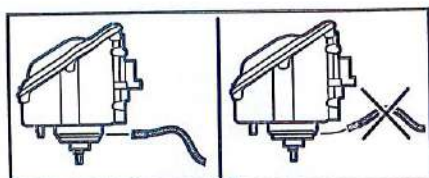
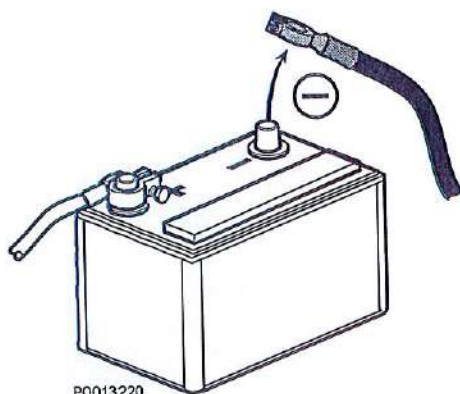
1159794 Torque wrench

- 1 Switch off the engine.

NOTICE! Wait at least two minutes before removing the urea hoses so that automatic drainage of the urea system can proceed and for the urea system to depressurize.

- 2 Cut power to the engine by disconnecting the negative battery terminal. Assemble the necessary equipment and place a recovery container under the pump unit.

NOTICE! Use protective equipment and an approved recovery container.



- 3 Remove the heater element from the filter cover and move the coil to one side.

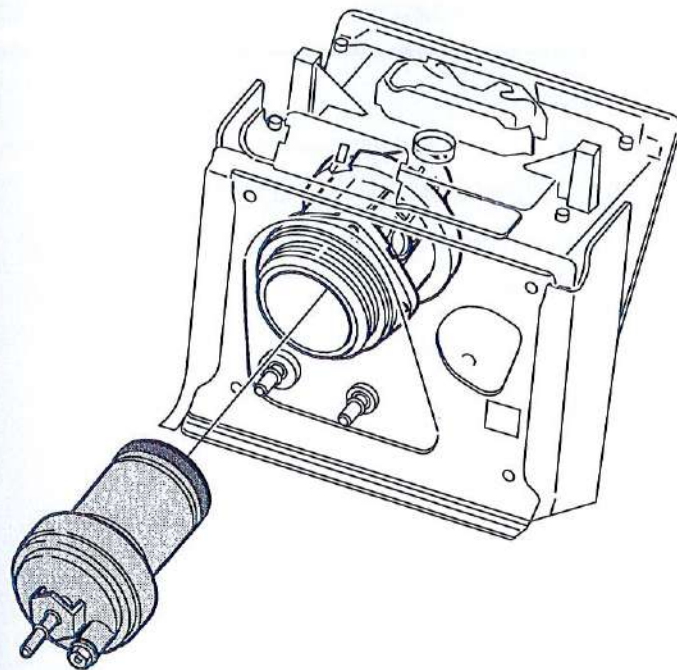
NOTICE! Pull the heater element out straight.



P0013221

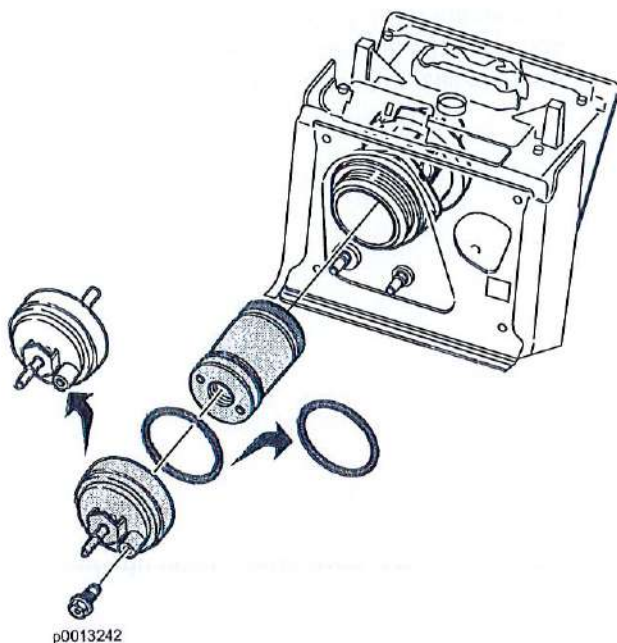


- 4 Expose the urea hoses connections to gain access to the latches. Remove the urea hose from the filter cover by pressing in the latches.

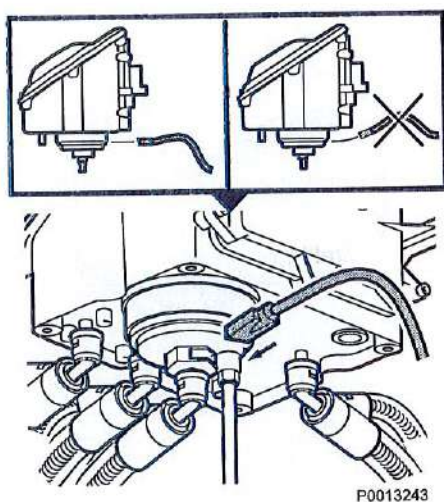


p0013241

- 5 Remove the filter cover from the pump unit. Remove the urea filter.

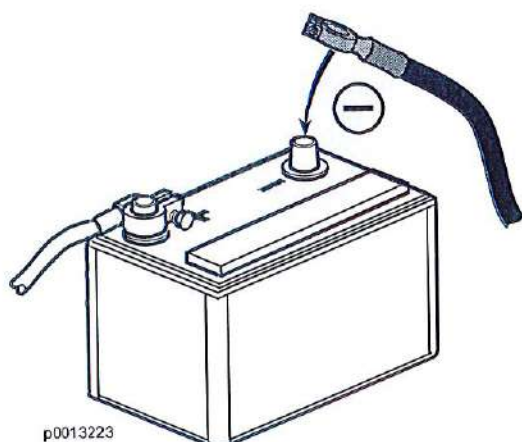


- 6 Install a new seal ring in the filter cover. Install a new AdBlue/DEF pump by first pulling the filter toward the filter cover. Then install the filter cover onto the filter housing. Tighten the filter cover to: **20 (+5) Nm**
- 7 Install the urea hose. Make sure that the connection locks securely.



- 8 Insert the heater element.

NOTICE! Make sure that the connection locks securely.



- 9 Connect the battery negative terminal.
- 10 Start the engine and check that there are no leaks.
- 11 Delete any fault codes.
- 12 **NOTICE!** Gather up equipment and surplus urea solution.

Solenoid Valve, AdBlue/DEF Tank, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1663GE, TWD1672GE, TWD1673GE

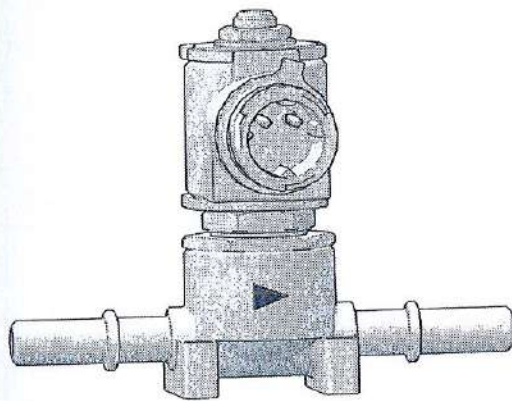
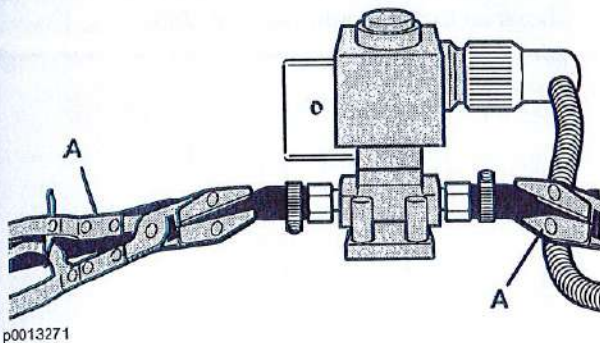


See *Requirements for work with after-treatment system (EATS)*.

Tools:

1158957 Pliers

- 1 Pinch off the coolant hoses.
Remove the hoses.



- 2 **NOTICE!** When installing the valve. Check valve installation direction. Arrow toward tank.

Pressure Sensor, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE



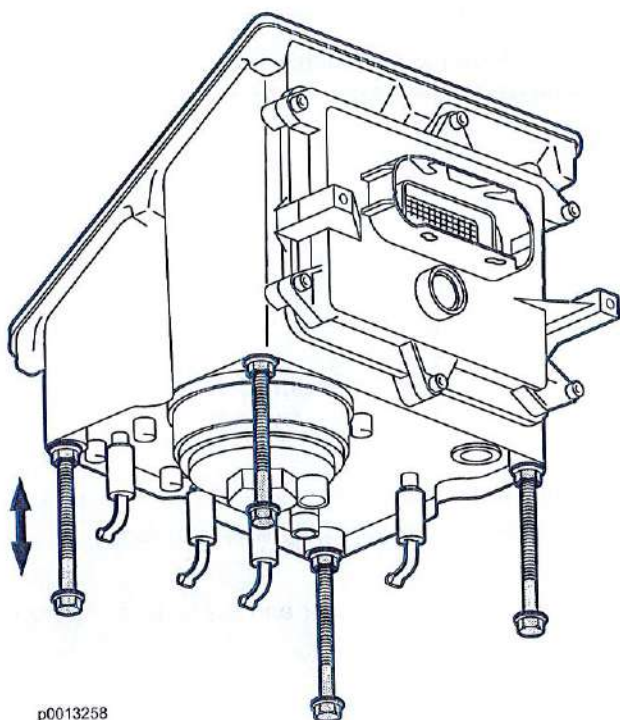
See *Requirements for work with after-treatment system (EATS)*.

Tools:

88890102 Nipple

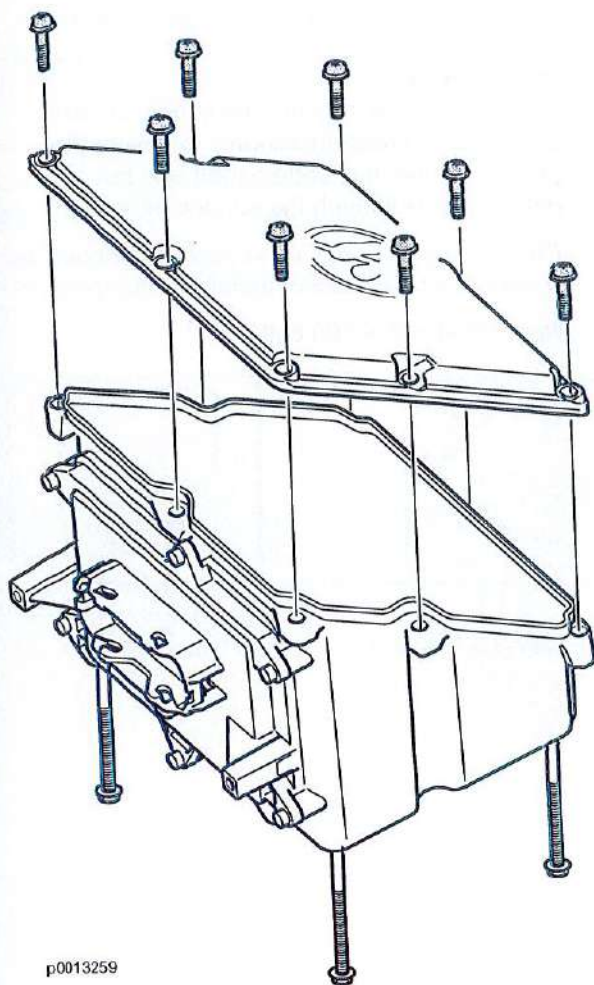
88890104 Pump

- 1 Install an M8 X 100 bolt with a non-locking nut in each of the 4 holes beneath the pump. Adjust the bolts so that the pump is held stably.

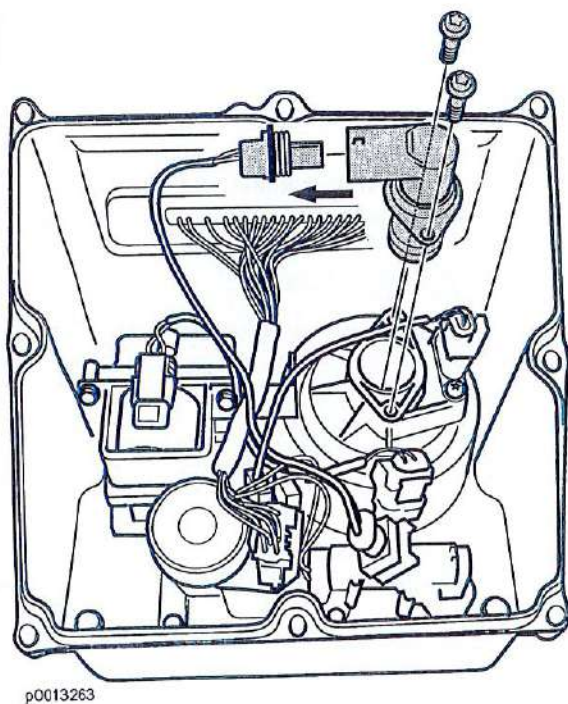


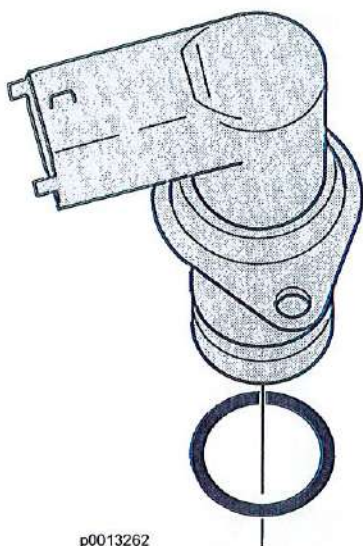
p0013258

- 2 Clean around the pump cover.
Remove the pump cover.



- 3 Remove the connector and the sensor.



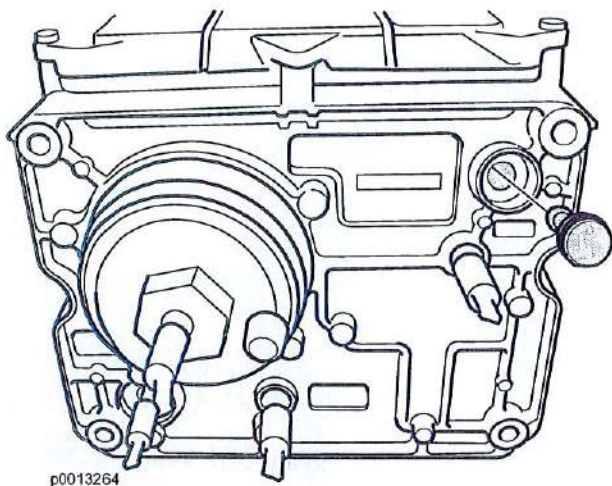


- 4 Install the new sensor. Use soapy water on the O-ring.

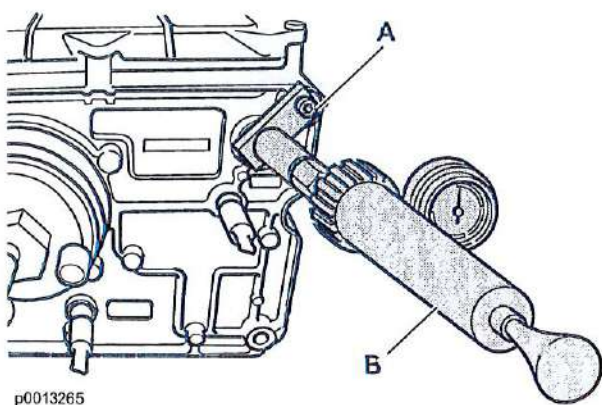
IMPORTANT!

Do not touch the sensor! The sensor is easily damaged so check thoroughly to ensure the pressure surface is undamaged and free of defects. Do not touch the surface either!

- 5 Check the cover seal; if the seal is damaged the cover must be replaced. Install the pump cover.
- 6 Remove all M8 X 100 bolts.



- 7 Remove the valve underneath the pump.



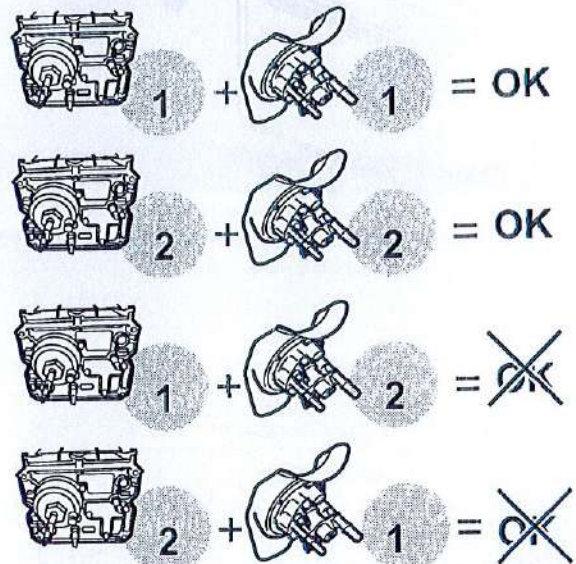
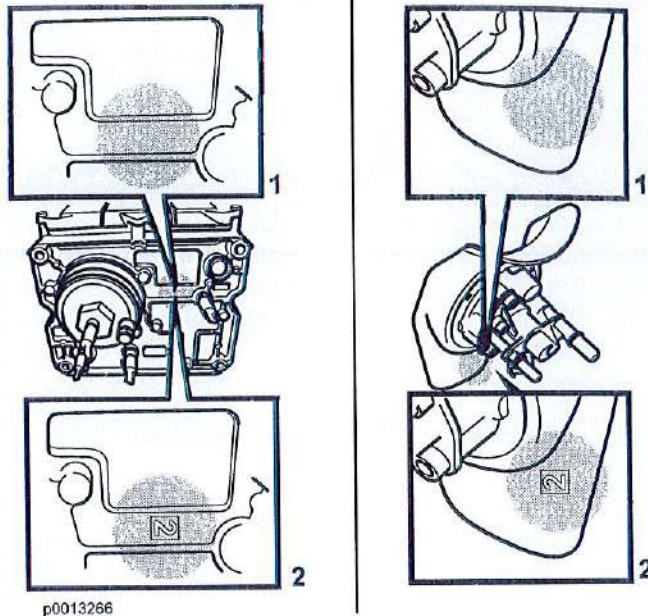
- 8 Install the pressure testing nipple **A = 88890102**. Pressure test with **B = 88890104 0.2–0.3 bar**. Spray soapy water around the cover and the valve connections that protrude from the housing and check for any leaks.
- 9 Remove the pressure test tool and install a new valve.

Pump Unit, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE



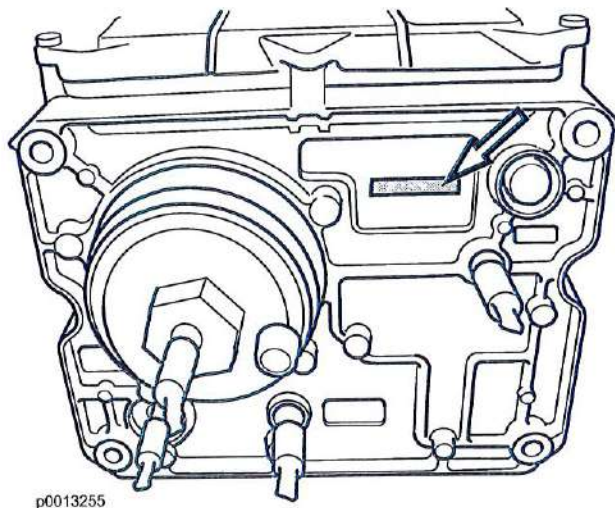
See *Requirements for work with after-treatment system (EATS)*.



IMPORTANT!

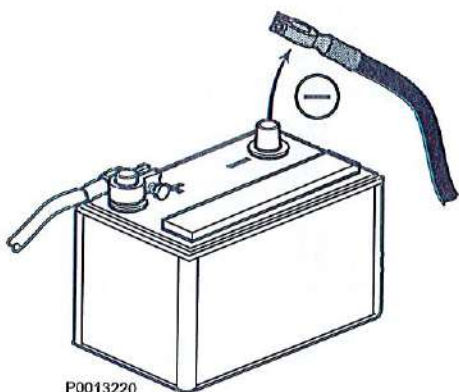
The dosing unit and pump unit are available in different versions.

Before changing, check that any component markings correspond to one another.



IMPORTANT!

Make sure that the new pump is intended for the engine concerned. Check the part number underneath the pump.



- 1 Switch off the engine.

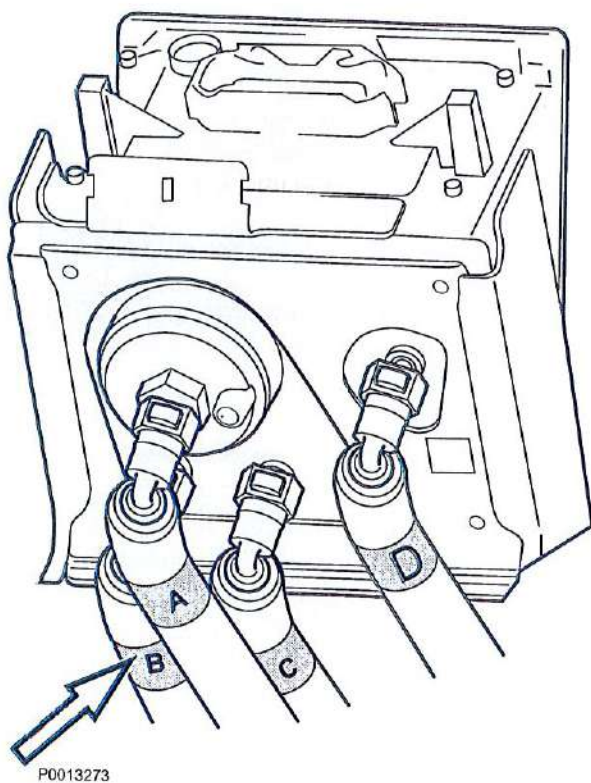
NOTICE! Wait at least two minutes before removing the AdBlue hoses so that automatic drainage of the AdBlue system can proceed and for the AdBlue system to depressurize.

- 2 Cut power to the engine by disconnecting the negative battery terminal.
Assemble the necessary equipment and place a recovery container under the pump unit.

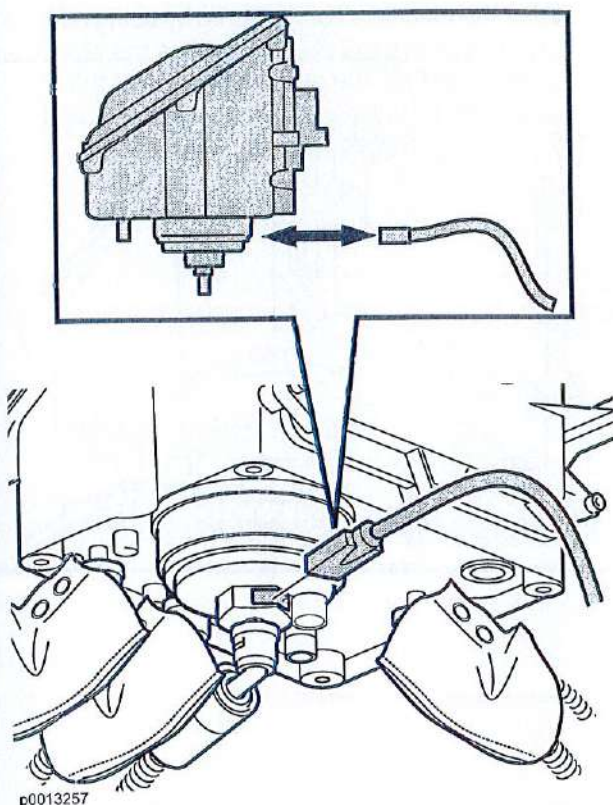
NOTICE! Use protective equipment and an approved recovery container.

- 3 Remove the cable ties from around the AdBlue hoses and wiring.

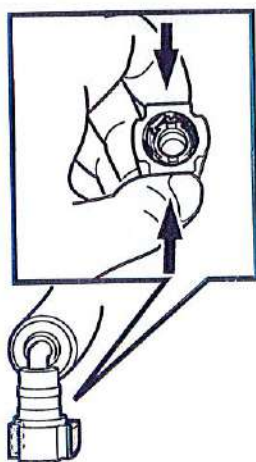
- 4 Mark the hose so that they cannot be transposed.

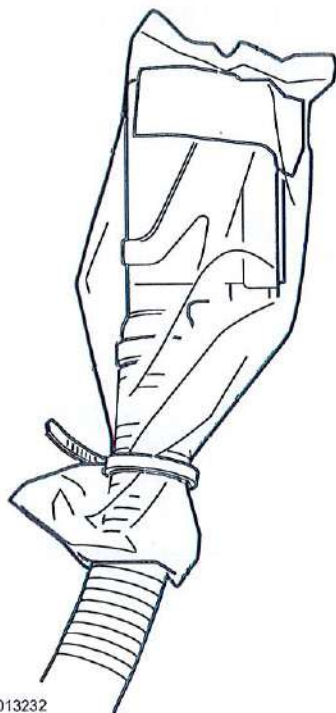


- 5 Remove the heater element from the filter.
NOTICE! Pull the heater element out straight.



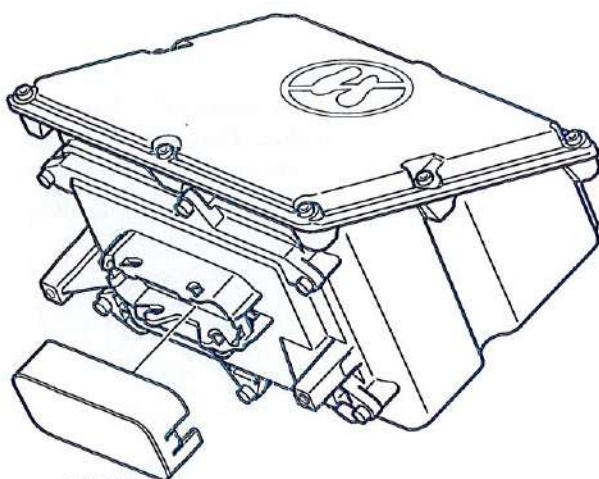
- 6 Expose the AdBlue hose connections to gain access to the lock catches. Remove the AdBlue hoses from the pump unit by pressing in the lock catches.





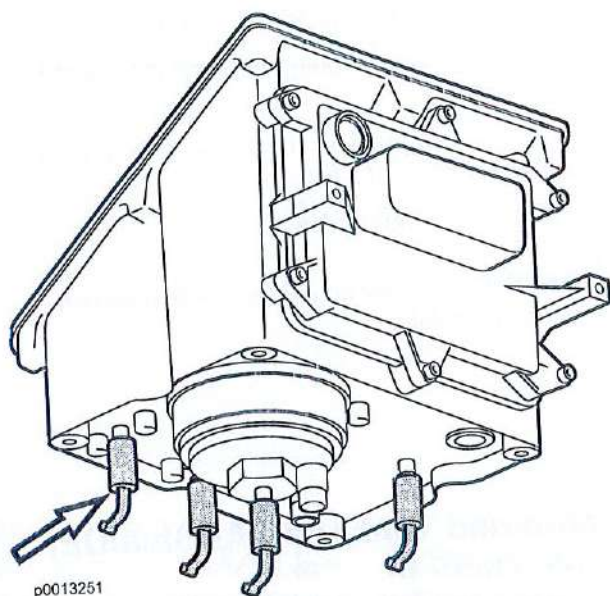
p0013232

- 7 Wipe the electrical connections dry using a rag or paper. Remove the clamp. Remove the electrical connection from the pump unit. Protect the connector by enclosing it in a plastic bag and moving it to one side.



p0013047

- 8 Place a protective cover on the pump unit connectors.
- 9 Remove the pump unit bolts. Remove the pump unit from the bracket.



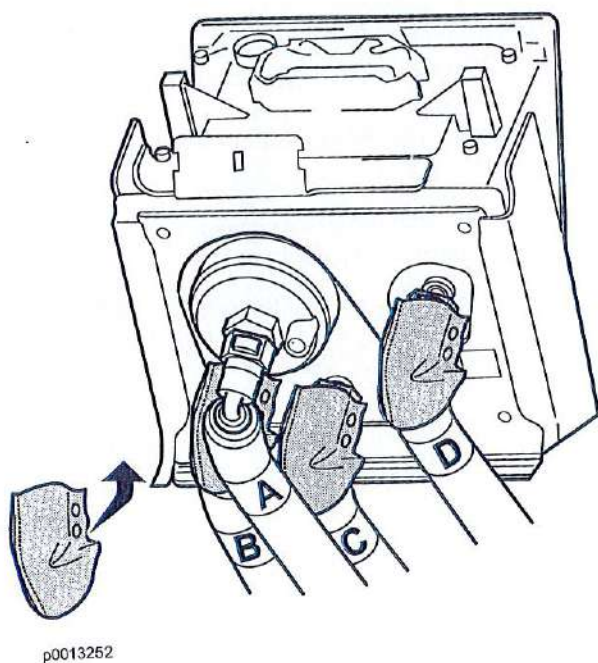
- 10 Transfer the plugs from the old pump unit to the new one.

NOTICE! It is extremely important that the inlet and outlet connections be plugged.

- 11 Install the new pump unit on the bracket; tighten the bolts.

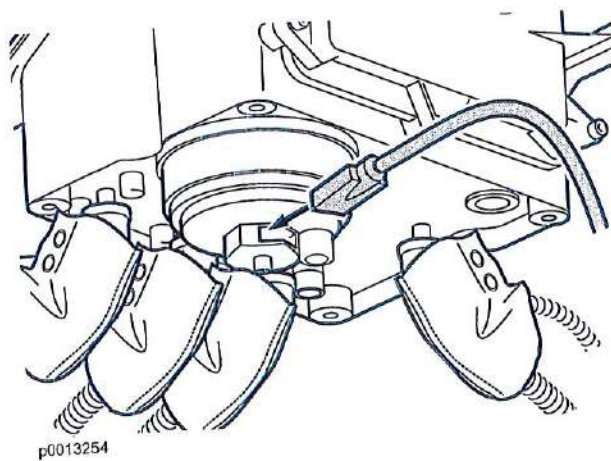
NOTICE! Allow the protective cover to remain to protect the connectors.

- 12 Remove the protective cover. Connect the electrical connectors. Install a new drive clamp.

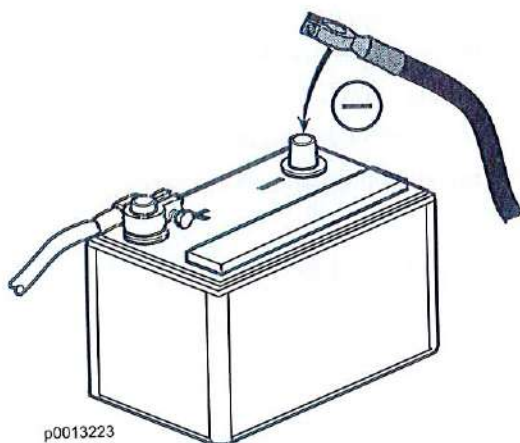


- 13 Install the AdBlue hoses on the pump unit according to the markings. Check that the connection locks securely.

- 14 Install cable ties around the AdBlue hoses and electrical wiring.



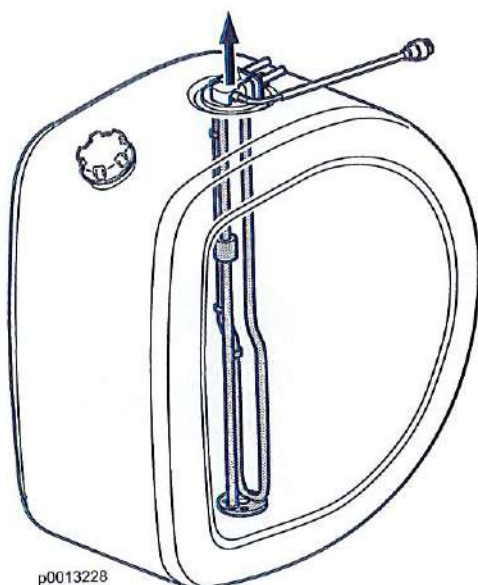
- 15 Insert the heater element into the filter cover. Make sure that the connection locks securely.



- 16 Connect the battery negative terminal.
- 17 Program the new pump unit with the aid of VODIA.
- 18 Start the engine and check that there are no leaks. Carry out a function test.
- 19 Delete any fault codes.
- 20 **NOTICE!** Gather up equipment and surplus AdBlue solution.

Combined Tank Unit, AdBlue/DEF Tank, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE



- 1 Remove the tank fitting by turning it 1/4 turn counter clockwise. Lift the tank fitting out carefully.
Empty the remaining AdBlue solution and coolant.
- NOTICE!** Use protective equipment and an approved recovery container.
- 2 Install a new seal ring in the tank fitting. Install the new tank fitting in the AdBlue tank by twisting it 1/4 turn clockwise.
- 3 **NOTICE!** Gather up protective equipment and surplus AdBlue solution.

Temperature Sensor, Change

TAD1660VE, TAD1661VE, TAD1662VE,
TWD1663GE



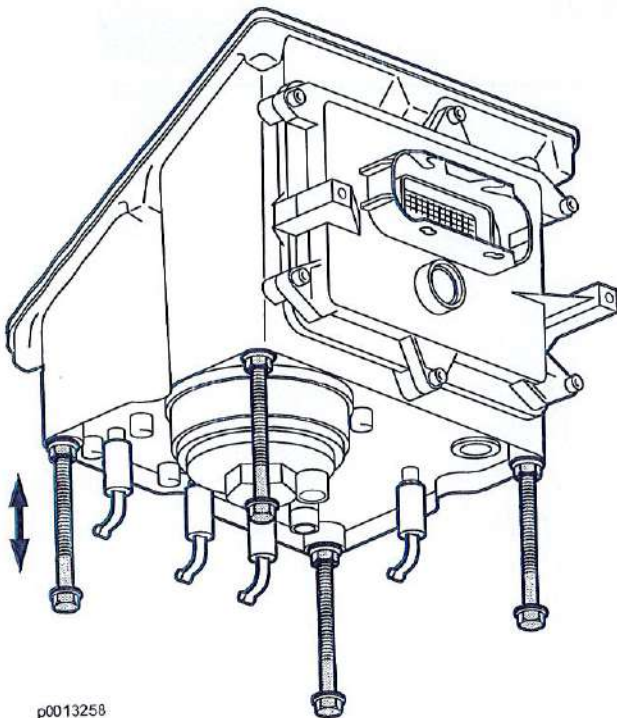
See *Requirements for work with after-treatment system (EATS)*.

Tools:

88890102 Nipple

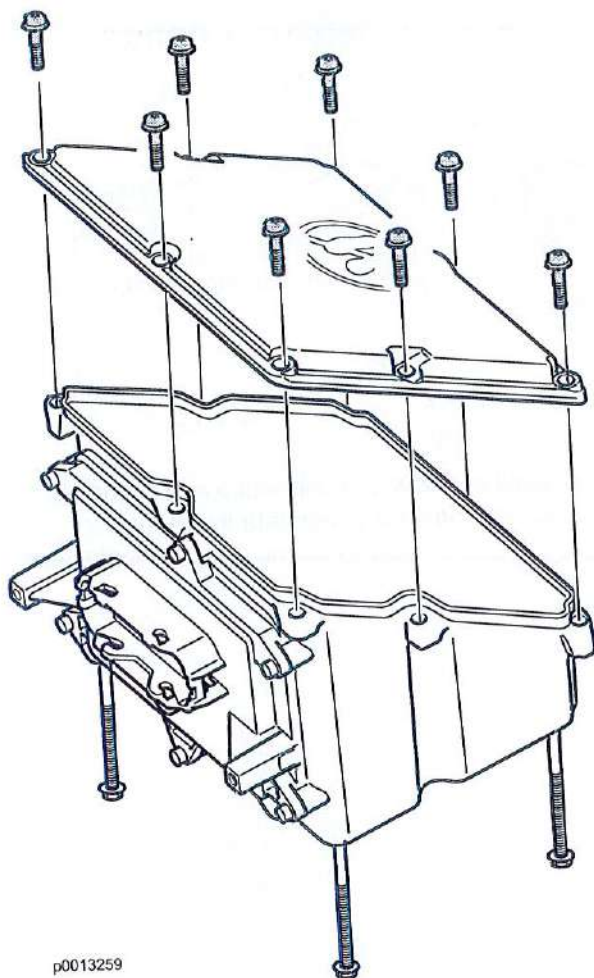
88890104 Pump

- 1 Install an M8 X 100 bolt with a non-locking nut in each of the 4 holes beneath the pump. Adjust the bolts so that the pump is held stably.



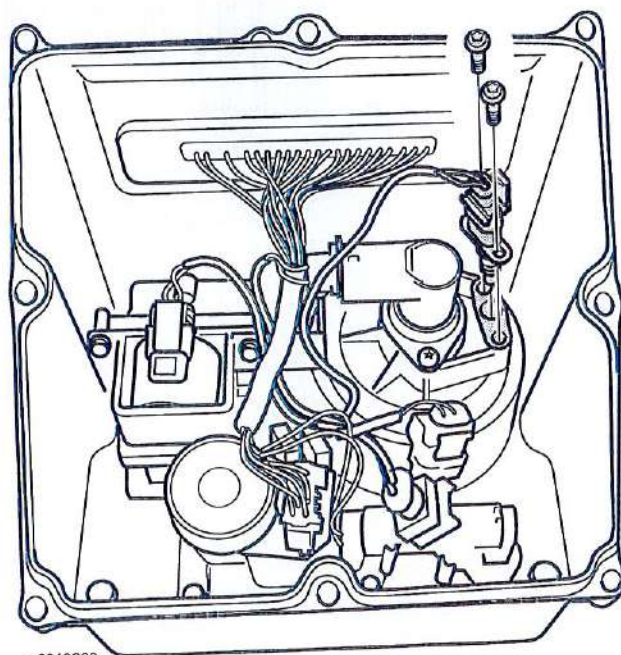
p0013258

- 2 Clean around the pump cover. Remove the pump cover.

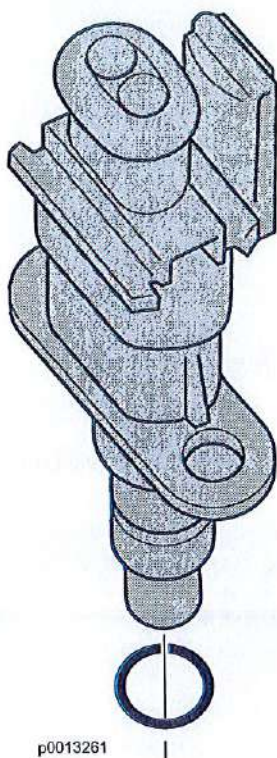


p0013259

- 3 Remove the connector and the sensor.



p0013260

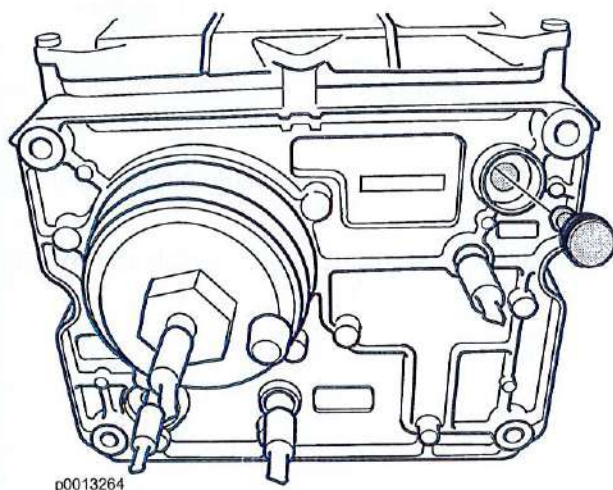


- 4 Install the new sensor. Use soapy water on the O-ring.

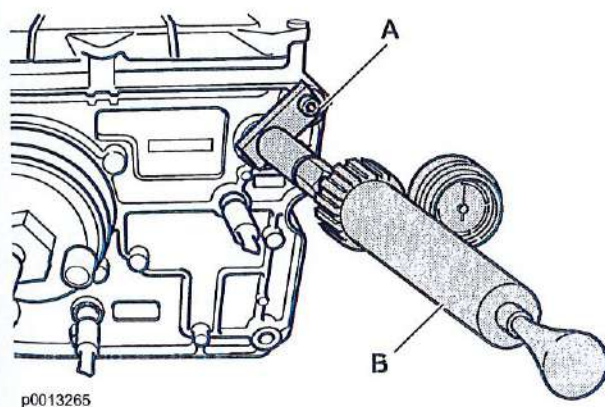
IMPORTANT!

Do not touch the sensor! The sensor is easily damaged so check thoroughly to ensure the pressure surface is undamaged and free of defects. Do not touch the surface either!

- 5 Check the cover seal; if the seal is damaged the cover must be changed.
- 6 Remove all M8 X 100 bolts.



- 7 Remove the valve underneath the pump.



- 8 Install the pressure testing nipple **A** = 88890102. Pressure test with **B** = 88890104 **0.2–0.3 bar**. Check for any leaks by spraying soapy water around the cover and valve connections that protrude from the housing.
- 9 Remove the pressure test tool and install a new valve.

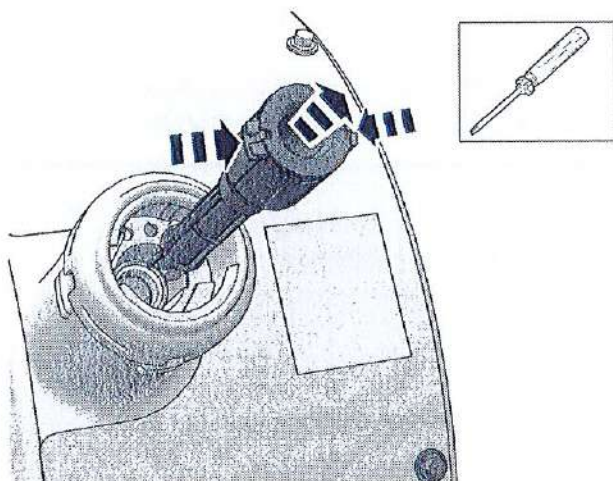
Checking for diesel or oil in the AdBlue/DEF solution

TAD1660VE, TAD1661VE, TAD1662VE,
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1663GE, TWD1672GE, TWD1673GE

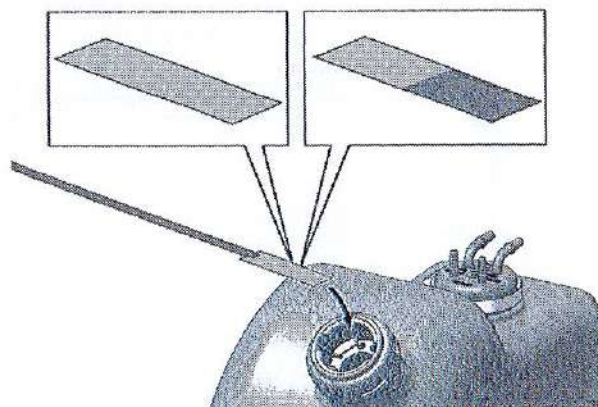


See *Requirements for work with after-treatment system (EATS)*.

- 1 Remove the inset in the tank inlet for better visibility and access to the liquid



P0019380



P0020548

- 2 Dip half the indicator paper in the AdBlue solution in the tank.
- 3 Attach the indicator paper to a suitable rod so that it can reach the surface.

Evaluation

- If there is diesel or oil in the liquid, that part of the paper that is dipped will become dark-blue in color.
- A so small a portion of diesel as 0.5% can be detected
- The largest part of the diesel will remain on the surface in the AdBlue/DEF solution, but traces of diesel can be found in the entire tank.
- The system is very sensitive to an incorrect AdBlue/DEF solution.

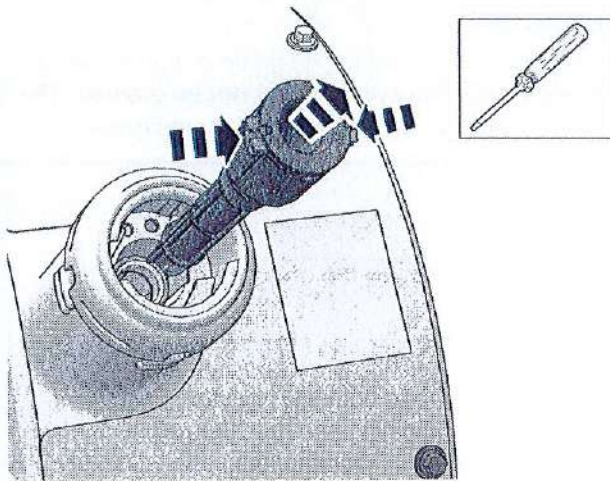
Checking urea concentration in the fluid

TAD1660VE, TAD1661VE, TAD1662VE,
TAD1670VE, TAD1671VE, TAD1672VE,
TWD1663GE, TWD1672GE, TWD1673GE

Tools:

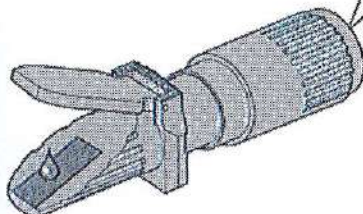
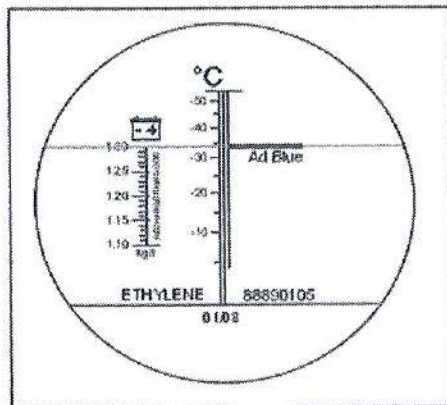
88890105 Refractometer

NOTICE! Rinse the test equipment carefully with distilled water before use.



P0019380

- 1 Remove the insertion in the tank inlet for better visibility and access to the fluid.
- 2 Draw in a small amount of the liquid from the surface using the pipette. Use a clean hose as extension to the pipette if tank level is low.



P0020549

- 3 Apply a drop on the viewer of the instrument (88890105 Refractometer).

Evaluation

- The level must be exactly on the line for correct concentration.
- The system is very sensitive for incorrect urea solution.
- If no level is shown in the instrument it may indicate chemical residue, such as pure water or diesel.

26-0 Cooling System, General

Draining the Cooling System

NOTICE! The installation implementation for TAD1650VE may vary. The pictures do not always correspond.

▲ WARNING!

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

IMPORTANT!

On engines which are to be laid up or put in storage, the engine cooling system must **not** be drained. The coolant contains corrosion-inhibiting additives.

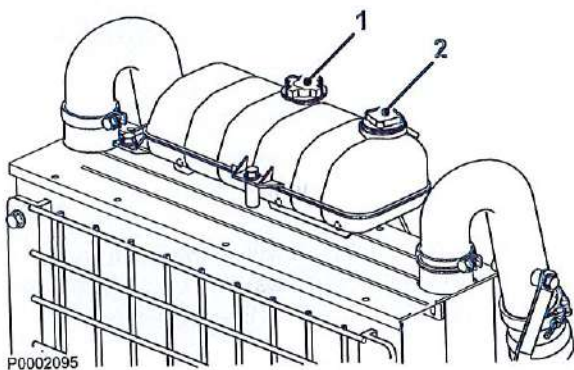
Tools:

9996049 Draining hose

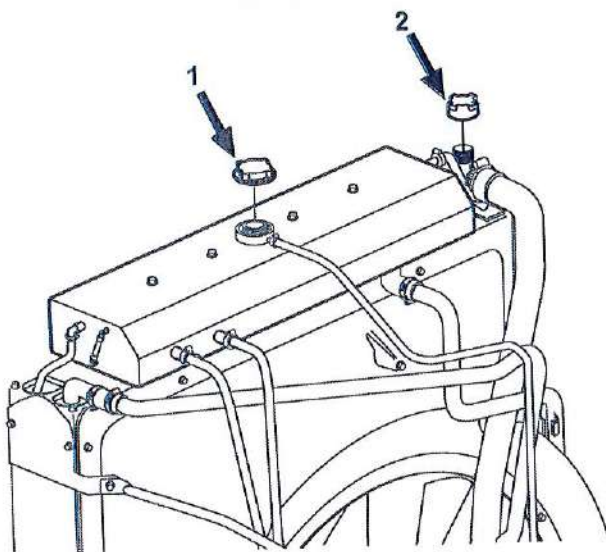
NOTICE! Do not open the pressure cap (2).

- 1 Remove the filler cap (1).

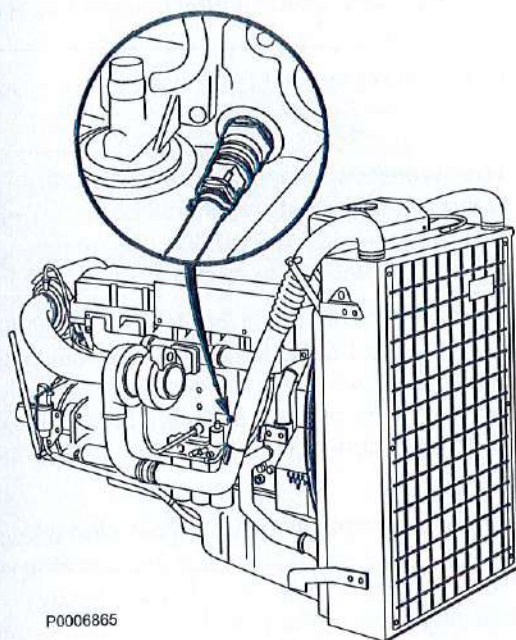
NOTICE! Open both the pressure cap on the expansion tank (1) and the filler cap on the radiator (2) on TWD engines.



TAD engines



TWD engines



P0006865

- 2 Open all drain points. Drain the coolant from the radiator and engine block, using tool 9996049 Draining hose. The drain nipples are situated under the radiator on the right side of the engine block.
- 3 Check that all coolant drains out. Deposits may be found inside the drain tap/plug that need to be cleaned away. There is otherwise a risk that coolant could remain and cause freeze bursting. Check whether the installation has any further taps or plugs at the lowest points of the cooling water lines.
- 4 Shut any taps and check that the spring-loaded covers on the nipples close completely. Install the rubber plugs.

Cooling System, Cleaning

NOTICE! The installation implementation for TAD1650VE may vary. The pictures do not always correspond.

WARNING!

All coolant is hazardous and harmful to the environment. Do not consume. Coolant is flammable.

Cooling performance is reduced by deposits in the radiator and cooling galleries. The cooling system should be cleaned out when the coolant is changed.

IMPORTANT!

Cleaning must not be done if there is any risk of the cooling system freezing, since the cleaning solution does not have antifreeze properties.

IMPORTANT!

It is extremely important that the correct concentration and volume of coolant is added to the system. Mix in a separate clean vessel before filling the cooling system. Make sure that the liquids mix.

- 1 Drain the cooling system. Refer to *Draining the Cooling System*.
- 2 Put a hose into the expansion tank filling hole and flush with clean water, according to specifications in *Technical Data*, until the water draining out is completely clear.
- 3 Should there still be some contamination left after flushing for a long time, cleaning may be done with coolant. Otherwise, continue as in stage 8 below.
- 4 Fill the cooling system with 15-20% mixture of concentrated coolant. Use only Volvo Penta

- recommended concentrated coolant mixed with clean water.
- 5 Drain the coolant after 1–2 days of operation. Remove the filler cap and the lower radiator hose if necessary to increase emptying speed. To prevent suspended material from settling back in the system, emptying should be done rapidly, within 10 minutes, without the engine having been at a standstill for a long time.
 - 6 Flush the system immediately and thoroughly with clean hot water to prevent dirt from settling on the inner surfaces. Flush until the water running out is completely clean. Make sure that any heater controls are set to full heating during emptying.
 - 7 Should contamination still remain after a long period of flushing, a clean-out may be done using Volvo Penta radiator cleaner, followed by treatment with Volvo Penta neutralizer. Carefully follow the instructions on the package. Otherwise, continue as in stage 8 below.
 - 8 When the cooling system is completely free from contamination, close the drain taps and plugs.
 - 9 Refill with new, Volvo Penta-recommended cooling fluid. Refer to *Technical Data* and *Coolant Level, Checking and Topping Up*.

Coolant Level, Checking and Topping Up

NOTICE! The installation implementation for TAD1650VE may vary. The pictures do not always correspond.

WARNING!

Do not open the coolant filler cap when the engine is hot, except in emergencies, as this could cause serious personal injury. Steam or hot fluid could spray out.

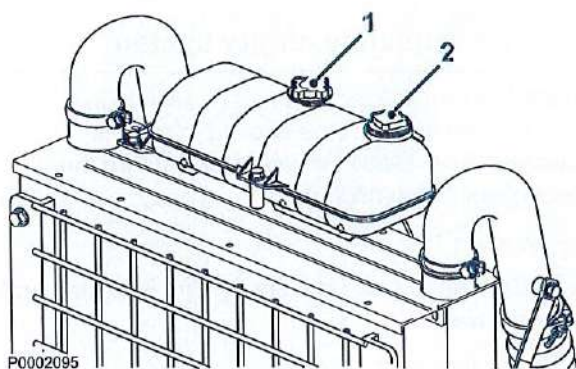
IMPORTANT!

Coolant filling must be performed with the engine stopped. Fill slowly, to allow air to flow out.

Coolant Level, Checking and Topping Up

IMPORTANT!

Only use coolant recommended by Volvo Penta.



TAD engines

- 1 **NOTICE!** Open only the filler cap (1). Do not open the pressure cap (2).

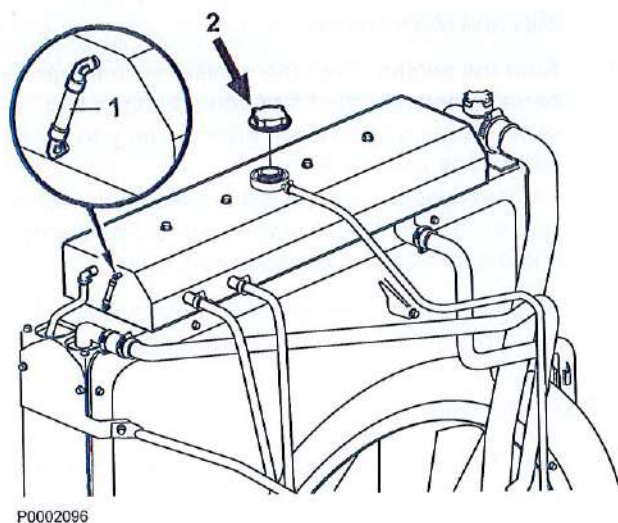
NOTICE! TWD:

The cap (2) is both filler cap and pressure cap.

- 2 Check that the coolant level is above the MIN mark on the expansion tank.
- 3 Top up with coolant as required, so that the level is between the MIN and MAX marks.

TWD:

Fill the expansion tank to the MAX mark on the sight glass.



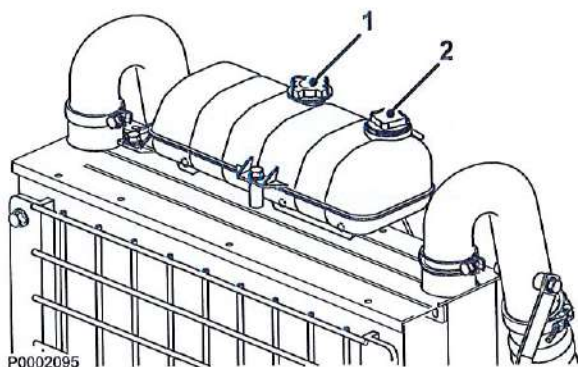
TWD engines

Filling a completely empty system

NOTICE! Mix the correct amount of coolant in advance, to ensure that the cooling system is completely filled. Refer to *Technical Data* for the correct coolant volume.

IMPORTANT!

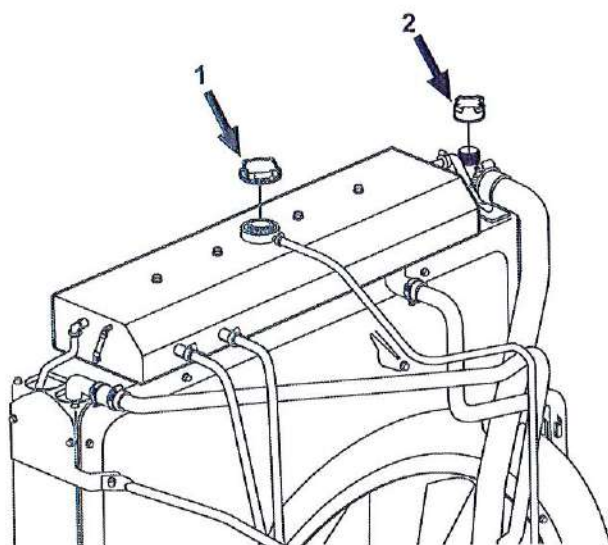
Do not start the engine until the system is vented and completely filled.



TAD engines

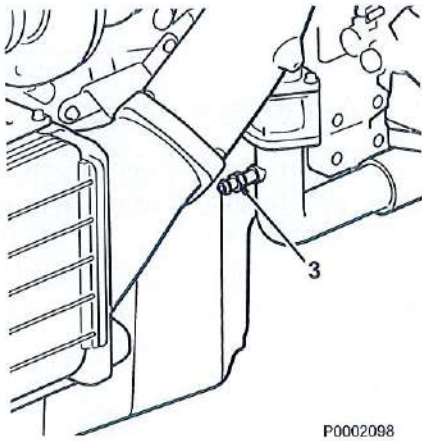
- 1 Check that all drain points are closed.
- 2 Open the filler cap (1). Do not open the pressure cap (2).
- 3 Fill with coolant, so that the level is between the MIN and MAX marks.
- 4 Start the engine when the cooling system has been completely filled and vented. Open any venting taps a short while after starting, to allow trapped air to escape.
If a heating unit is connected to the engine cooling system, the heat control valve should be opened and the installation vented during filling.
- 5 Stop the engine after about an hour and check the coolant level. Top up as necessary.

TWD engines



TWD engines

- 1 Open the caps to both the expansion tank (1) and radiator (2).
- 2 Fill coolant into the expansion tank until it is completely full.



P0002098

- 3 Fill the radiator. Vent via the venting nipple (3).
- 4 Top up until the system is completely full. Refer to *Technical Data* for the correct coolant volume.

IMPORTANT!

Do not start the engine until the system is vented and completely filled.

Cooling System, Pressure Testing

See *Cooling System, Pressure Testing*.

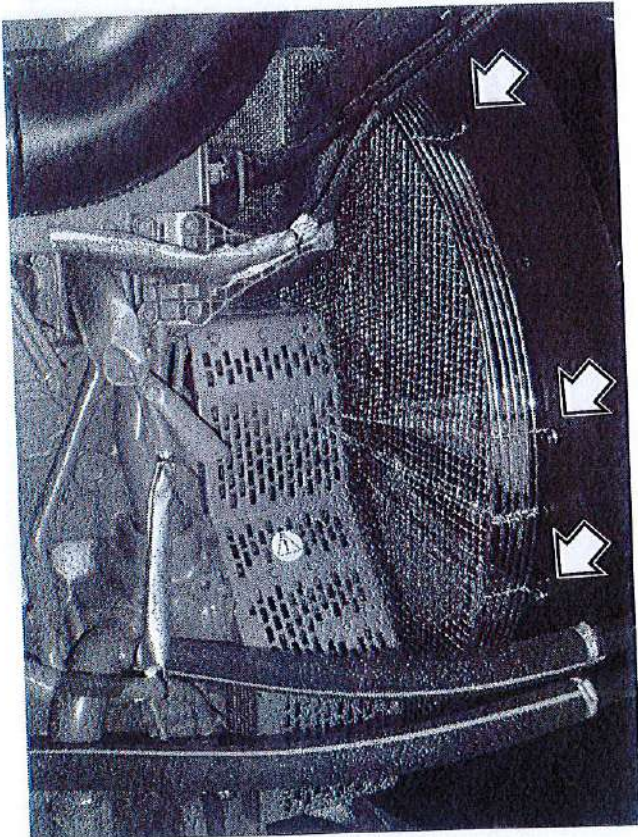
26-1 Radiator, Heat Exchanger

Radiator Assembly, Change

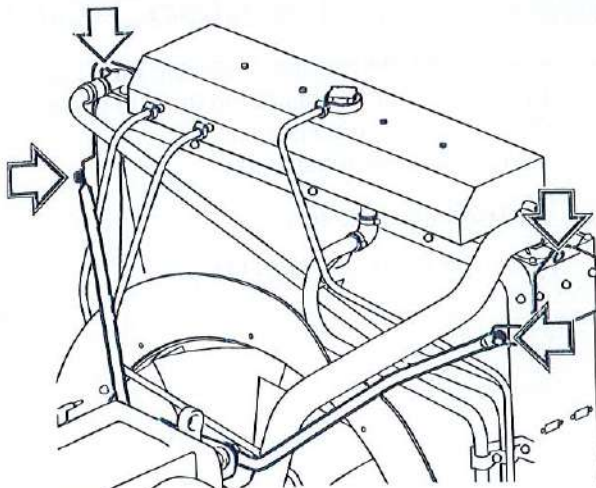
TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

Removal

- 1 Drain the coolant; refer to "Cooling system, draining"
- 2 Remove the coolant pipes.
- 3 Remove the cable ties. Disconnect the level sensor connector.
- 4 Remove the protective grille from the fan.
- 5 Attach a lifting strap to the lifting eyes.



P0007057

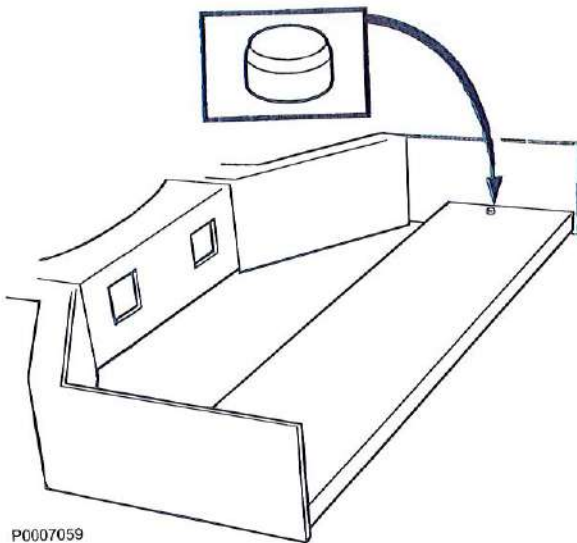


P0007058

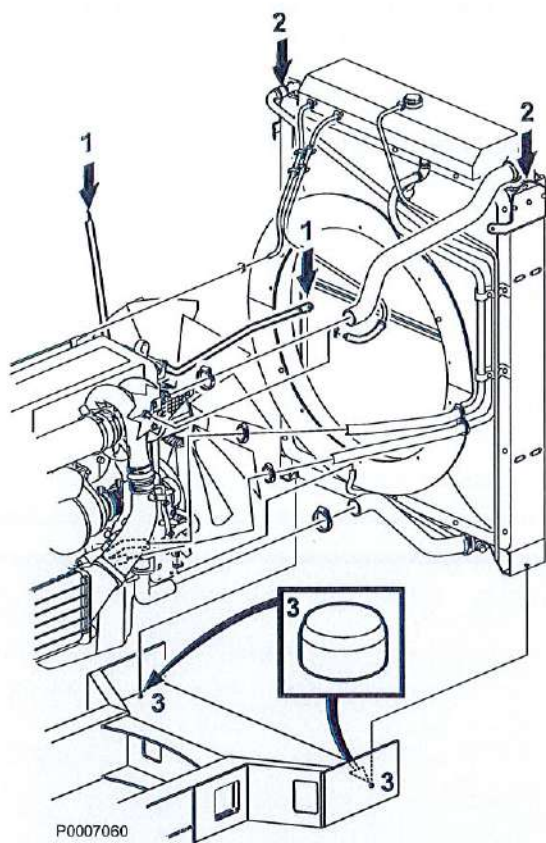
- 6 Remove the fixing stay bolts.
- 7 **NOTICE!** Start by only lifting high enough to release the guide pins.

Lift away the radiator assembly.

NOTICE! Mind the fan.



P0007059

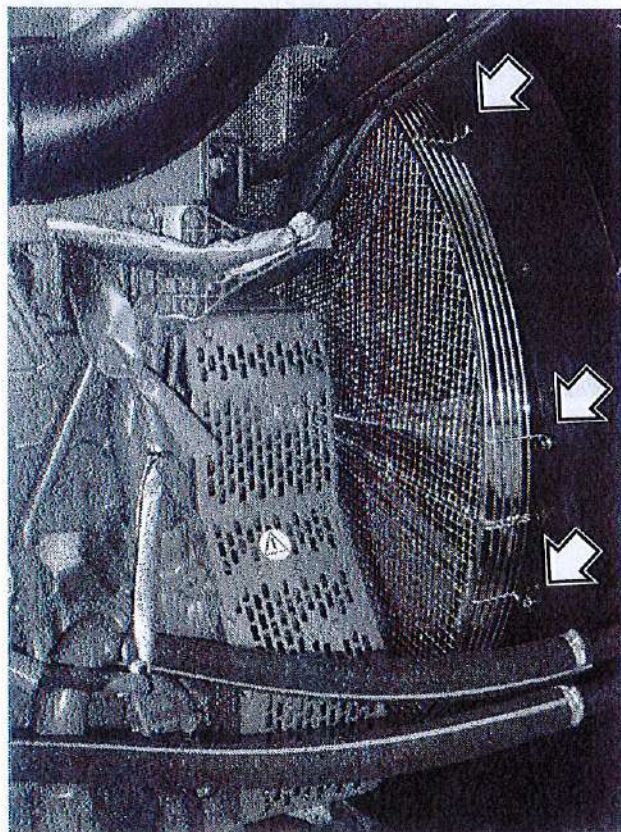


Installation

- 8 Carefully lift the radiator assembly with a strap through the lifting eyes (2) so that the guide pins (3) are in the correct position. Lower the radiator assembly.

NOTICE! Mind the fan.

- 9 Install the fixing stay bolts (1).



- 10 Install the protective grille for the fan
- 11 Install the coolant hoses.
- 12 Fit a new cable tie so that the hoses do not chafe.
- 13 Install the level sensor connector.
- 14 Add coolant. Vent the cooling system. Refer to *Coolant Level, Checking and Topping Up*, section Refill of empty system.

26-2 Coolant Pump, Thermostat

Coolant Pump, Change

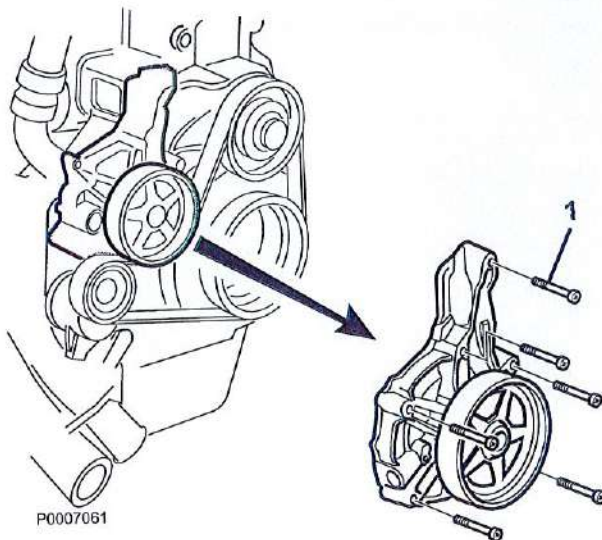
Removal



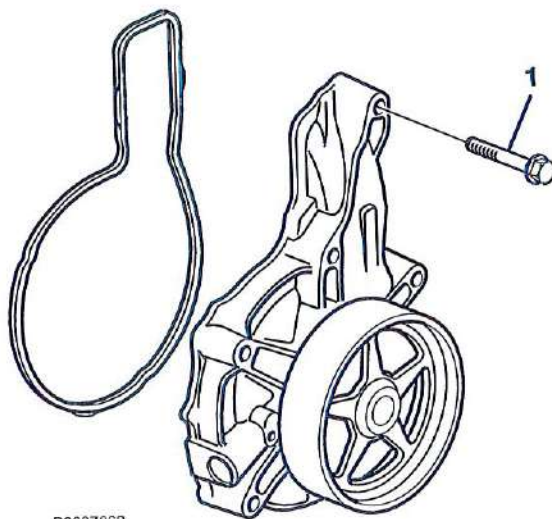
CAUTION!

Disconnect power or use some other means to prevent the engine from starting during the work.

- 1 Drain the coolant into a suitable container. Refer to *Draining the Cooling System*.
- 2 Remove the drive belt shield that is installed above the coolant pump.
- 3 Remove the coolant pump drive belt by placing a pulling handle in the belt tensioner and easing the belt tension.
Remove the drive belt from the coolant pump.
- 4 Remove the coolant pump and its seal.
Press the belt tensioner down so it is easier to access the lower bolt in the coolant pump. Allow the bolt (1) to remain in the housing.



P0007061



P0007062

Installation

- 5 Install the coolant pump with a new seal. Use petroleum jelly to hold the seal in place during installation.
The screw (1) must remain in place in the housing during installation. Tighten the bolts according to the specification in *Special Tightening Torques*.
- 6 Install the coolant pump drive belt.
- 7 Install the engine drive belt guard.
- 8 Refill with coolant; refer to *Coolant Level, Checking and Topping Up*, section Refill of empty system.
- 9 Start the engine and let it run until it reaches normal operating temperature.
Check that no leakage occurs. Top up with coolant as necessary.

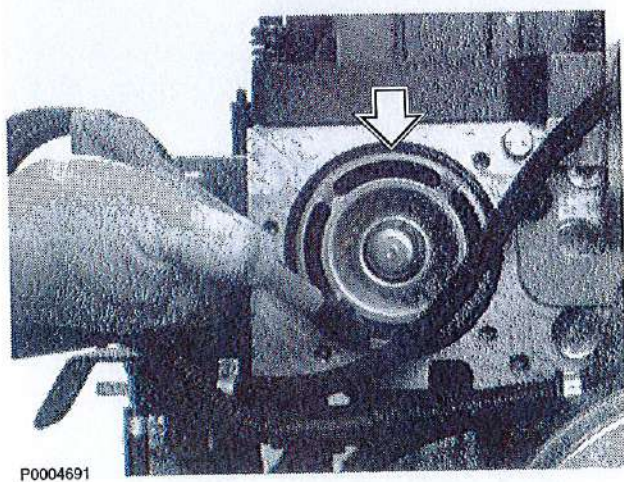
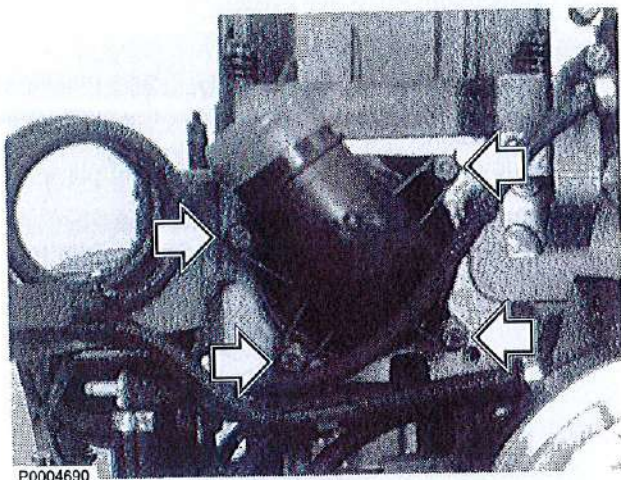
Thermostat, Change

Tools:

9996049 Draining hose

Removal

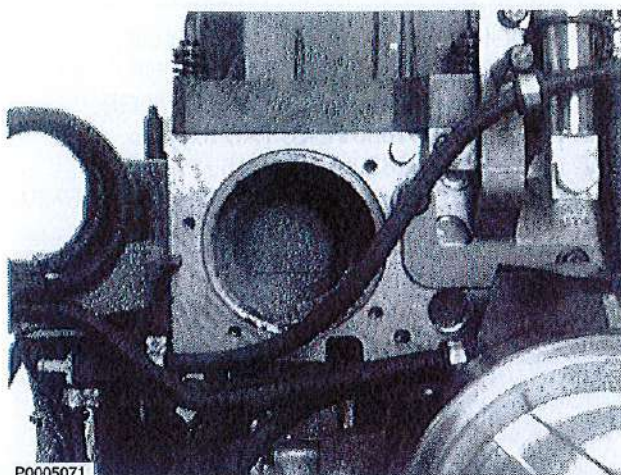
- 1 Drain the cooling system; refer to *Draining the Cooling System*.
Drain off coolant sufficient for its level to drop below the thermostat housing.
- 2 Remove the upper belt guard; refer to *Belt Guard*.
- 3 Remove the thermostat housing cover.



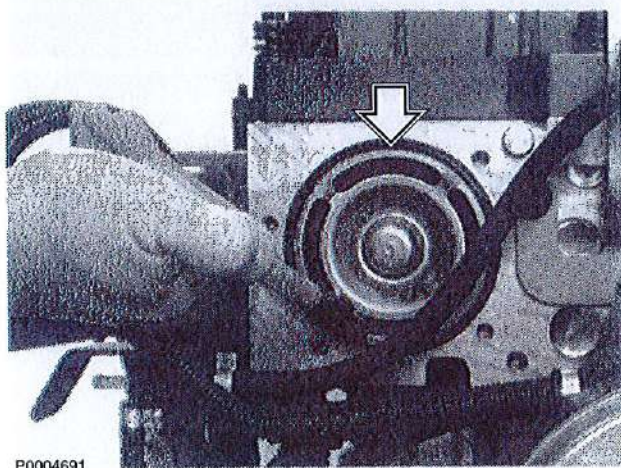
- 4 Remove the thermostat.

Installation

- 5 Clean and inspect the mating surfaces for both the thermostat and the thermostat housing cover.



- 6 Install the new thermostat and a new gasket.

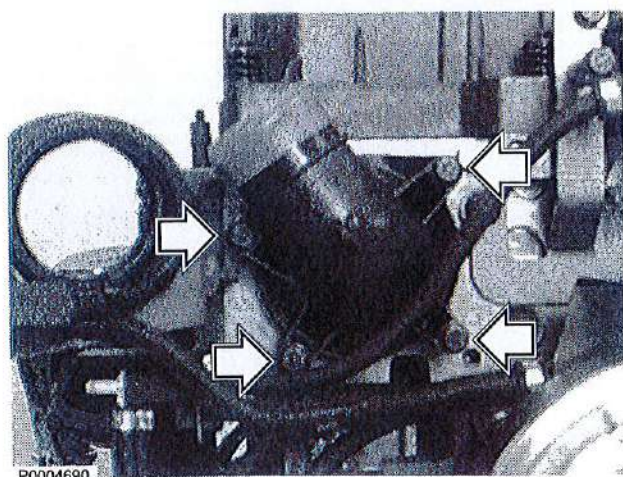


- 7 Install the thermostat housing cover and the bolts.
- 8 Install the upper belt guard: Refer to *Belt Guard*.

IMPORTANT!

Ensure that engine wiring is not pinched.

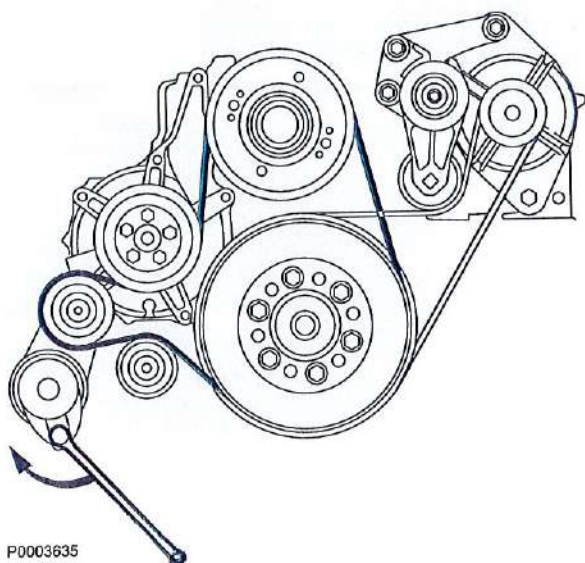
- 9 Refill with new coolant; refer to *Coolant Level, Checking and Topping Up*.
- 10 Start the engine and check for leaks. Pressurize the cooling system; refer to *Cooling System, Pressure Testing*.



Drive belt, change

TAD1640GE, TAD1640VE-B, TAD1641GE, TAD1641VE, TAD1641VE-B, TAD1642GE, TAD1642VE-B, TAD1643VE-B, TAD1650GE, TAD1650VE, TAD1650VE-B, TAD1651GE, TAD1651VE, TAD1660VE, TAD1661VE, TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

- 1 Switch off at the main switch(es) and check that the engine is not connected to voltage.
- 2 Remove the fan guard and fan ring round the cooling fan.
- 3 Remove the belt covers.
- 4 Fit a 1/2" socket drive to the belt tensioner (1). Lift the socket drive and remove the drive belt.
- 5 Thread the drive belt round the fan and remove it.
- 6 Check that the pulleys are clean and undamaged.
- 7 Thread the new drive belt over the fan.
- 8 Lift the socket drive and install the new drive belt.
- 9 Install the belt guard.
- 10 Install the fan guard and fan ring round the cooling fan.
- 11 Start the engine and perform a function check.

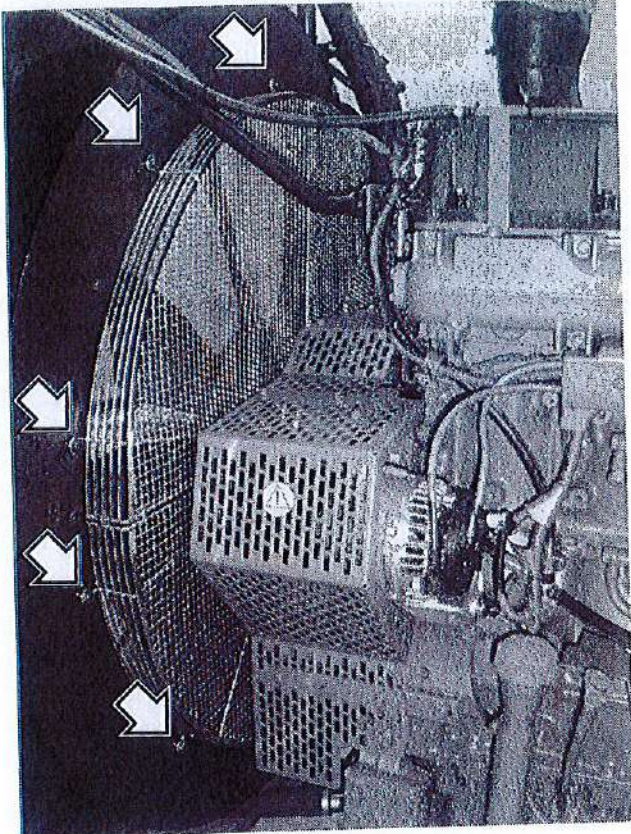


P0003635

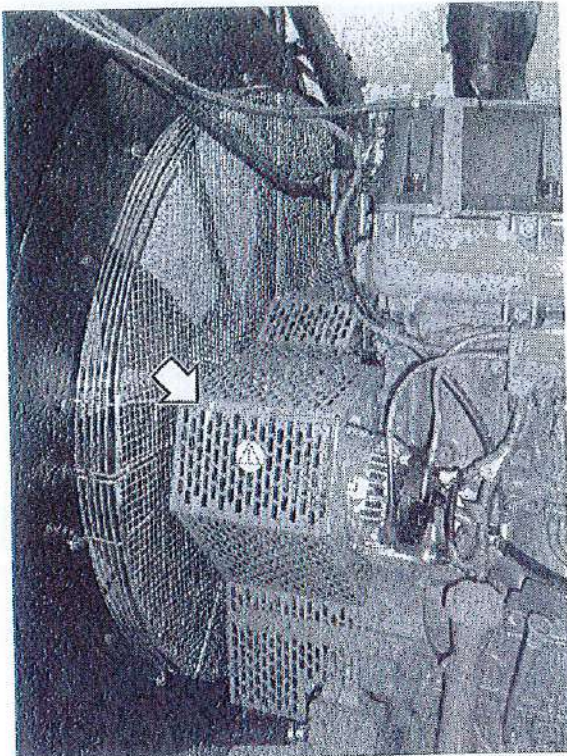
Drive belt, change

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

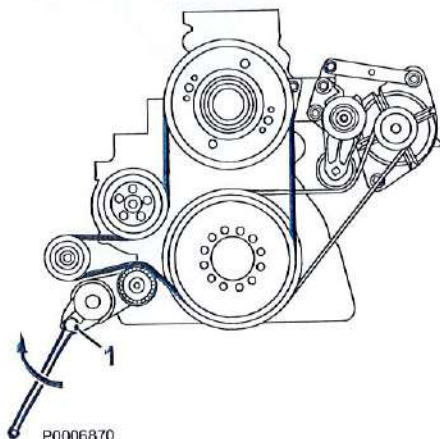
- 1 Switch off at the main switch(es) and check that the engine is not connected to voltage.
- 2 Remove both protective grilles, the upper and the lower, behind the cooling fan.



P0007073



P0006869



P0006870

- 3 Remove both belt guards, right and left. Leave the cover on the right guard.
- 4 Fit a 1/2" socket drive to the belt tensioner (1). Lift the square wrench and unhook the drive belt.
- 5 Thread the drive belt round the fan and remove it.
- 6 Check that the pulleys and idler and tensioner rollers are clean and undamaged, especially regarding bearings and condition.
- 7 Thread the new drive belt over the fan.
- 8 Lift the socket drive and install the new drive belt. Check that the belt is correctly aligned on all the pulleys.
- 9 Fit the belt guards and fan cage.
- 10 Start the engine and perform a function check.

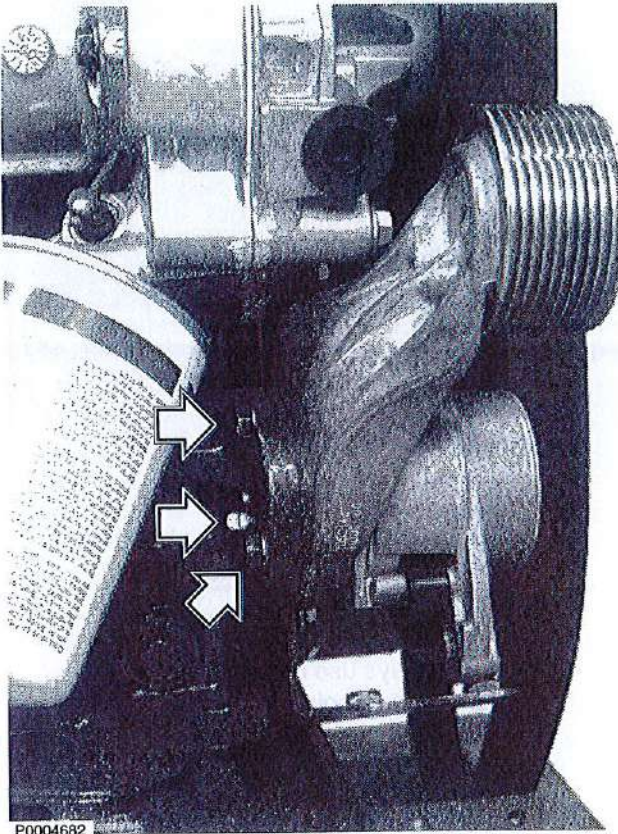
Belt Tensioner, Change

Right belt guard removed; refer to *Belt Guard*.

Drive belt removed; refer to *Drive belts*.

Removal

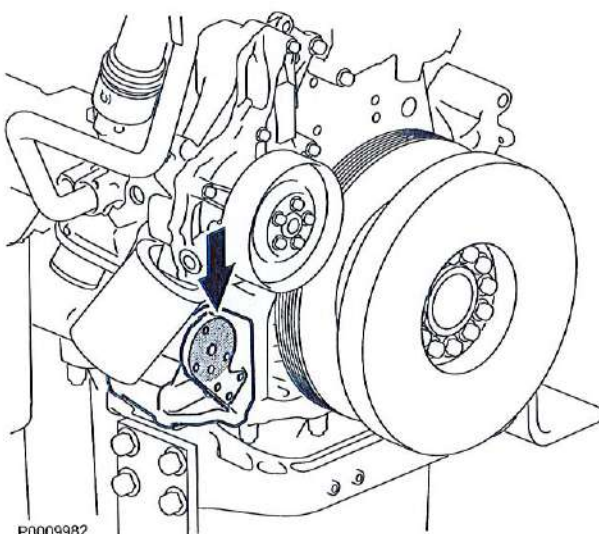
- 1 Undo the three bolts that retain the belt tensioner and return wheel. Remove the unit.
- 2 Unbolt the return wheel or tensioner, or replace the complete unit.



P0004682

Installation

- 3 Install the tensioner complete with attachment. Align the guide pin on the attachment to the installation hole and tighten the bolts. Check the condition of the drive belts.
- 4 Re-install the belts; refer to *Drive belts*.

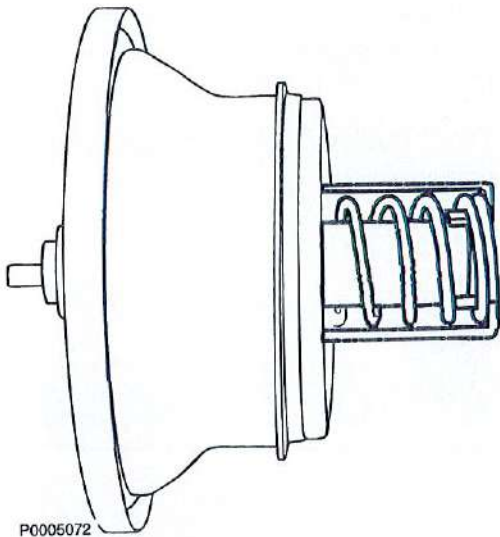


P0009982

Thermostat, Function Check

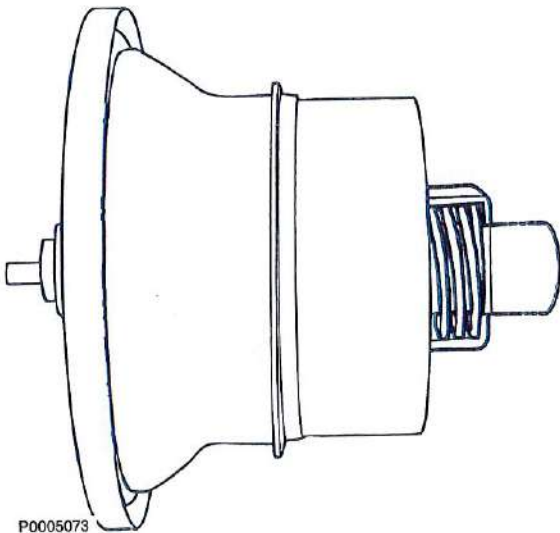
Remove the thermostat, see *Thermostat, Change*.

- 1 Place the thermostat in a big pot with water and heat it to the opening temperature as specified in *Technical Data*.



P0005072

Closed thermostat.



P0005073

Open thermostat.

- 2 If the thermostat does not open at specified temperature, it should be replaced.
- 3 Install the thermostat, see *Thermostat, Change*.

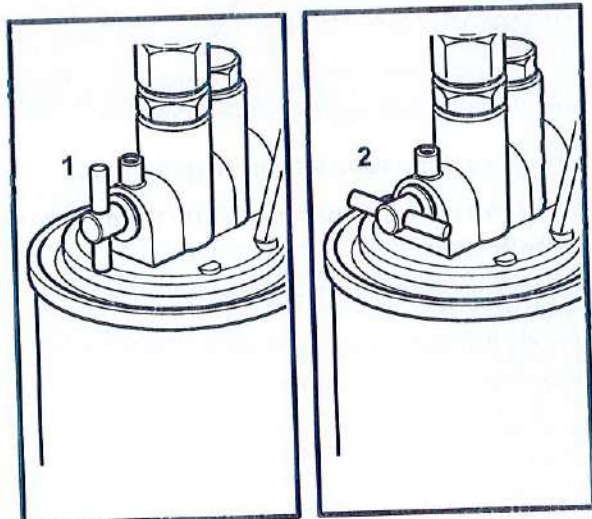
NOTICE! Always use a new seal, even if the thermostat is not replaced.

Coolant Filter, Change

IMPORTANT!

The coolant filter must be changed at the prescribed intervals. Failure to follow these intervals may result in significantly reduced engine life. When working on an engine where more than five liters (5.3 quarts) of new coolant are being added, a new coolant filter must always be installed.

- 1 Shut the filter housing tap.
- 2 Clean around the filter and remove it using filter pliers.
- 3 Lubricate the filter gasket with petroleum jelly, or soapy water, and fit the new filter. Screw the filter down until the gasket just touches the sealing surface. Then turn a further $\frac{1}{2}$ turn.
- 4 Open the tap on the filter housing.
- 5 Start the engine and check for leaks.



P0007065

- 1 Tap open
- 2 Tap closed

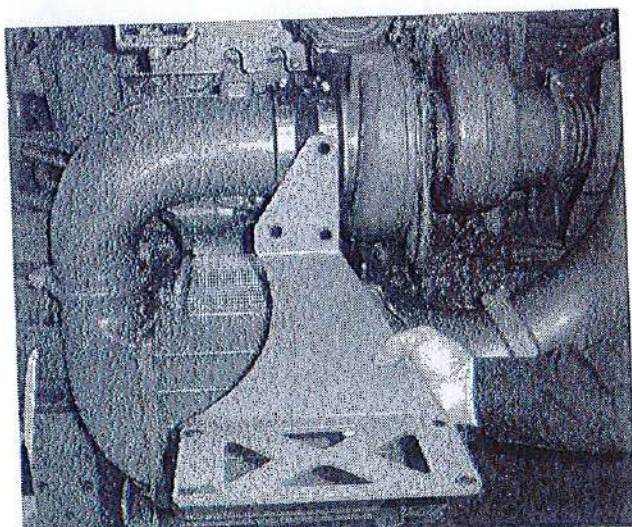
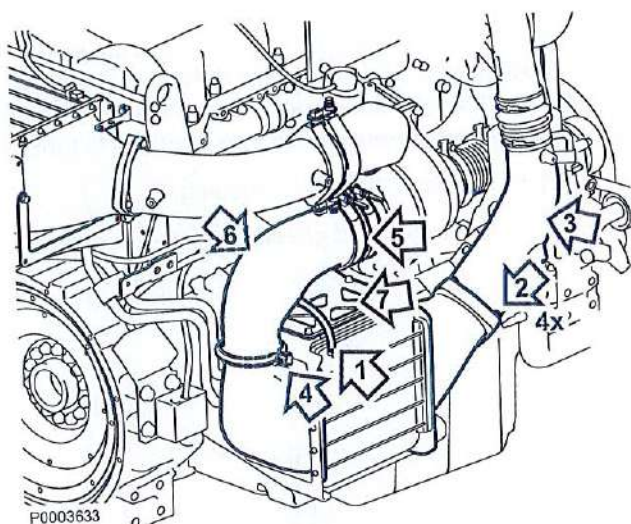
26-5 Charge Air Cooler with Connections

Lower Charge Air Cooler, Replace

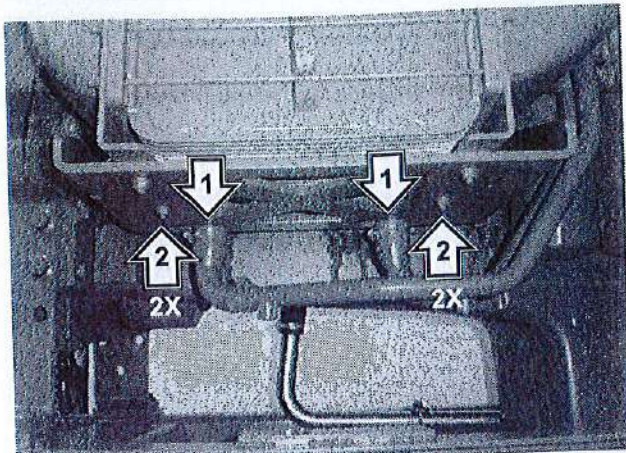
TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

Removal

- 1 Remove the heat shield, if fitted.
- 2 Drain the cooling water.
- 3 Remove the venting hose (1).
- 4 Remove the screws for the flange joint (2).
- 5 Remove the connection pipe (3) to the charge air cooler
- 6 Undo the clamp (4) to the charge air cooler.
- 7 Undo the clamp (5) to the turbocharger.
- 8 Remove the connection pipe (6) from the turbocharger.
- 9 Remove the upper attachment (7).



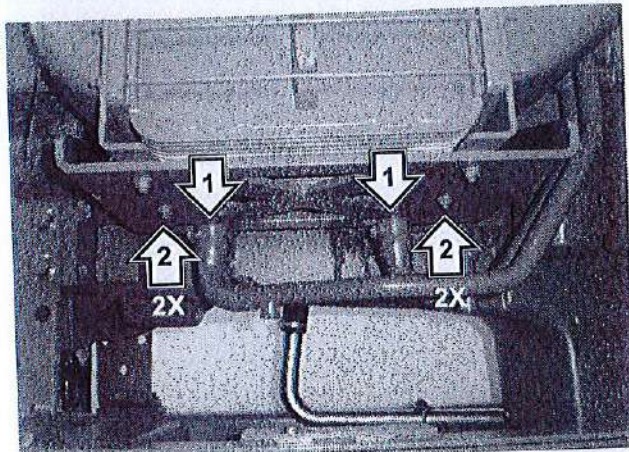
The upper attachment (7) removed.



P0007067

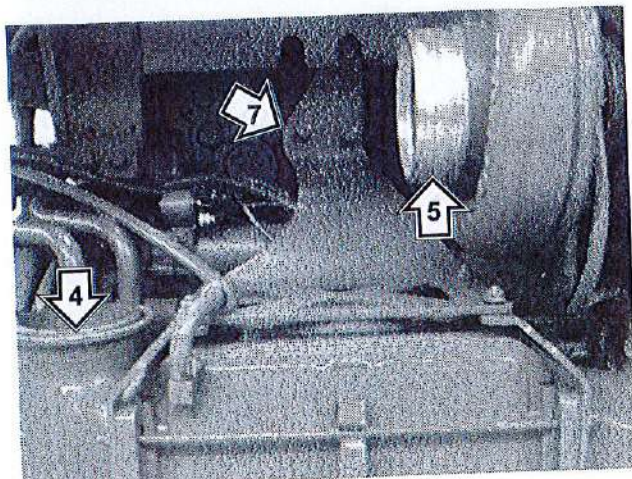
- 10 Remove the nuts (2) under the charge air cooler bracket.
- 11 Undo the hoses under the charge air cooler (1).
- 12 Lift away the charge air cooler.

Installation



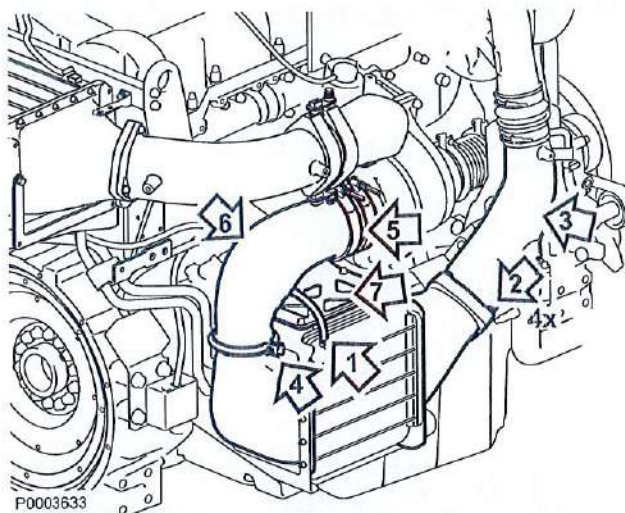
P0007067

- 13 Install the charge air cooler and align the hoses underneath (1).
- 14 Tighten the hose clamps.
- 15 Install the nuts (2) under the bracket.

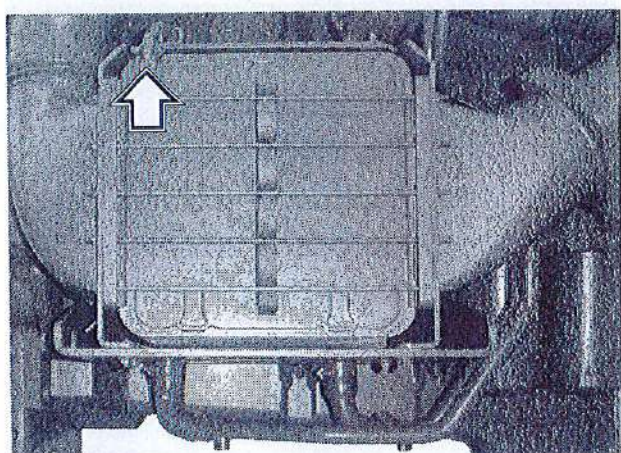


P0007069

- 16 Install the upper attachment (7).
- 17 Clean and check that the mating surfaces are unmarked (4, 5).
- 18 Install a new O-ring on the charge air cooler flange joint (4).



- 19 Remove the connection pipe (6) from the turbocharger.
- 20 Tighten the clamps (4, 5).
- 21 Fit a new O-ring on the connection pipe (3) to the charge air cooler.
Install the pipe.
- 22 Tighten the flange joint (2) and clamp.



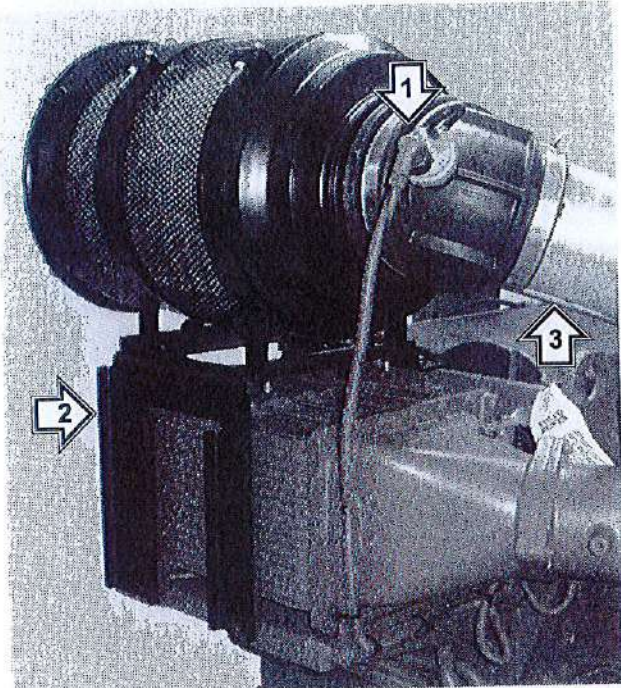
- 23 Install the venting hose.
- 24 Install the heat shield.
- 25 Add coolant.
Vent the cooling system.
Refer to *Coolant Level, Checking and Topping Up*, section Refill of empty system.
- 26 Check seals.

Upper Charge Air Cooler, Replace

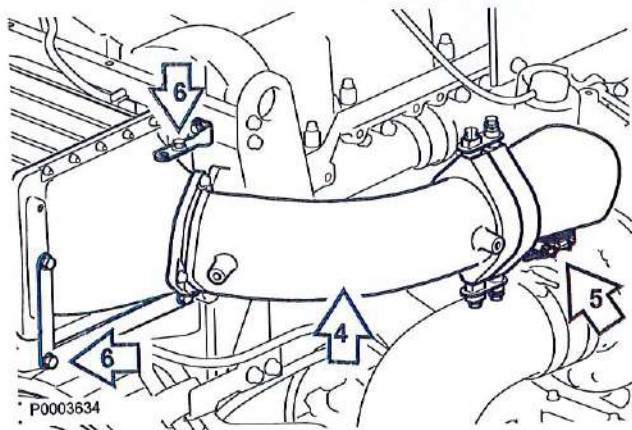
TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

Removal

- 1 Remove the heat shield, if fitted.
- 2 Drain the cooling water.
- 3 Undo the connector (1) for the air filter sensor.
- 4 Remove the air filter housing and attachment bracket (2) including inlet pipe (3) to the turbocharger.

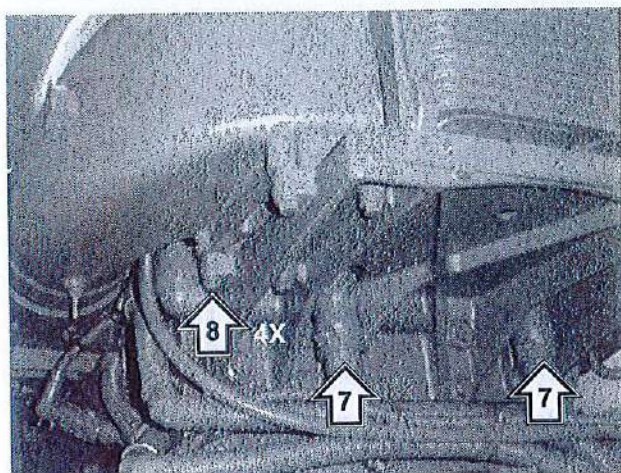


P0007070



P0003534

- 5 Remove the intake manifold (4) for the charge air cooler.
Alternatively, remove the clamp by the turbocharger if the pipe is difficult to remove.
- 6 Remove the bolts to the charge air cooler side bracket (6) and upper attachment.



P0007071

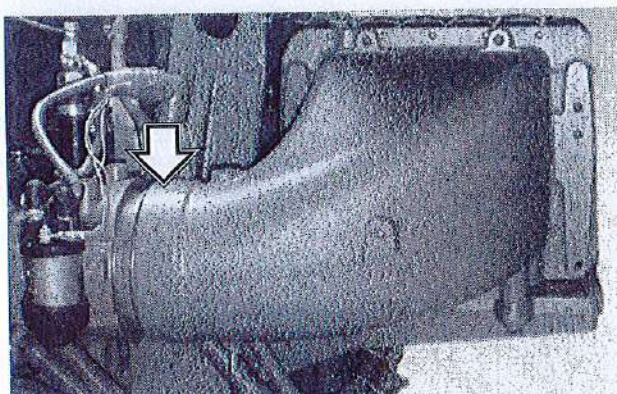
- 7 Remove the hoses (7) under the charge air cooler.
Remove the venting hose on the charge air cooler upper side.
- 8 Remove the bolts (8) below the charge air cooler.
- 9 Lift up and pull the charge air cooler backwards.
Remove the charge air cooler.

IMPORTANT!

The charge air cooler may not be taken apart.
Leakage risk.

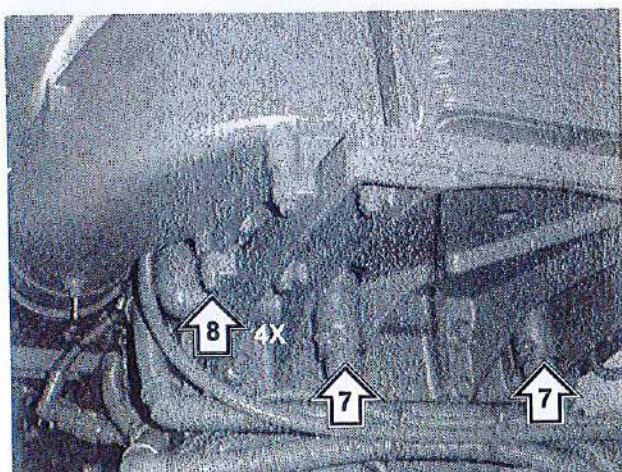
Installation

- 10 Check the condition of the rubber connector.
Install a new O-ring to the inlet pipe sealing surface.

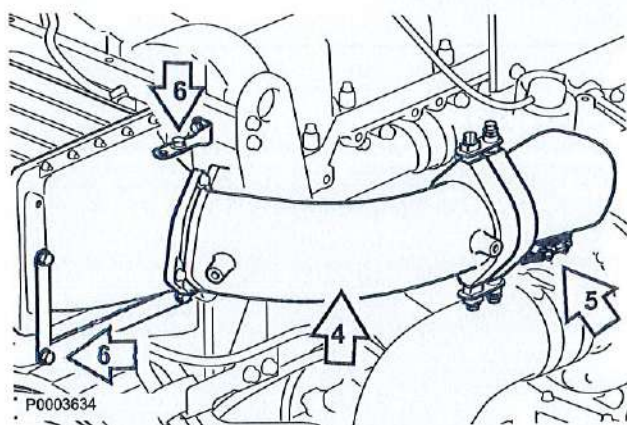


P0007072

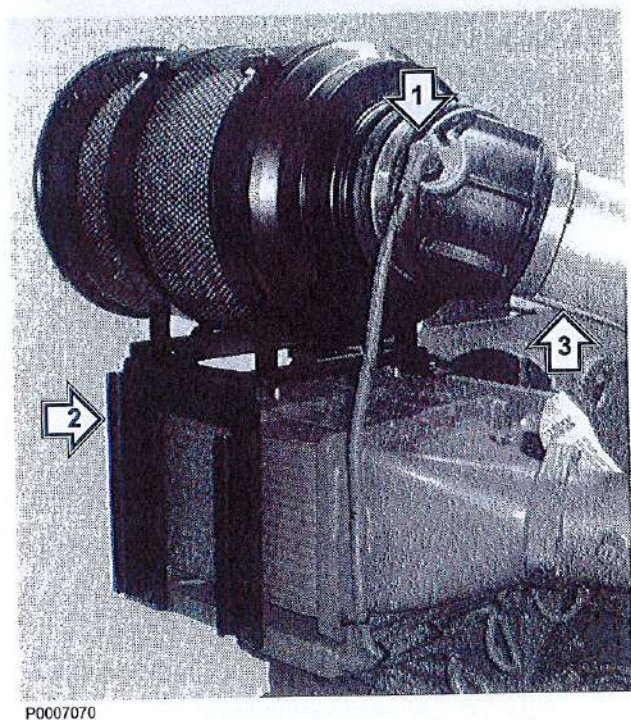
- 11 Install the charge air cooler.
Install the bolts (8) underneath.
- 12 Install the hoses (7) under the charge air cooler.
Tighten the clamps.
- 13 Install the venting hose on the charge air cooler upper side.



P0007071



- 14 Install the bolts to the charge air cooler side bracket (6) and upper attachment.
- 15 Check the condition of the rubber connector. Fit a new O-ring on the inlet pipe (4) to the charge air cooler.
- 16 Install the inlet pipe and tighten the flange joint.



- 17 Install the air filter housing and attachment bracket (2) including inlet pipe (3) to the turbocharger. Tighten the clamp on the turbocharger.
- 18 Install the air filter sensor connector (1).
- 19 Install the heat shield, where fitted.
- 20 Add coolant. Vent the cooling system. Refer to *Coolant Level, Checking and Topping Up*, Refill of empty system.
- 21 Check seals.

32-1 Alternator

Alternator Belt, Replace

TAD1640GE, TAD1640VE-B, TAD1641GE,
TAD1641VE, TAD1641VE-B, TAD1642GE,
TAD1642VE-B, TAD1643VE-B, TAD1650GE,
TAD1650VE, TAD1650VE-B, TAD1651GE,
TAD1651VE, TAD1660VE, TAD1661VE,
TAD1662VE, TAD1670VE, TAD1671VE, TAD1672VE

Left belt guard removed: Refer to *Belt Guard*.

Coolant pump belt removed: Refer to *Drive belts*.

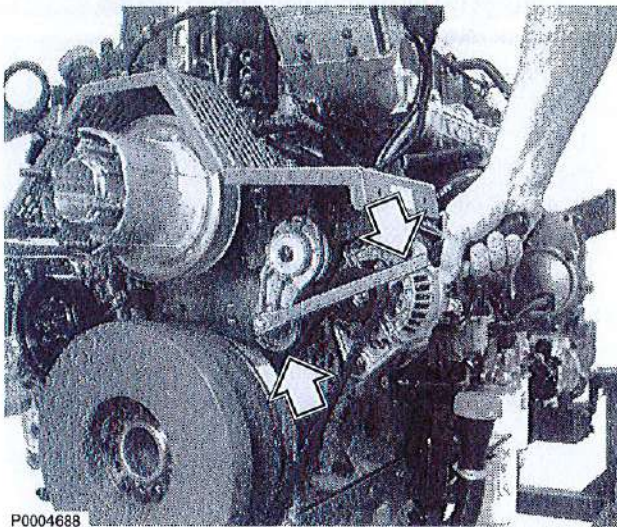
Removal

- 1 Depress the lever.

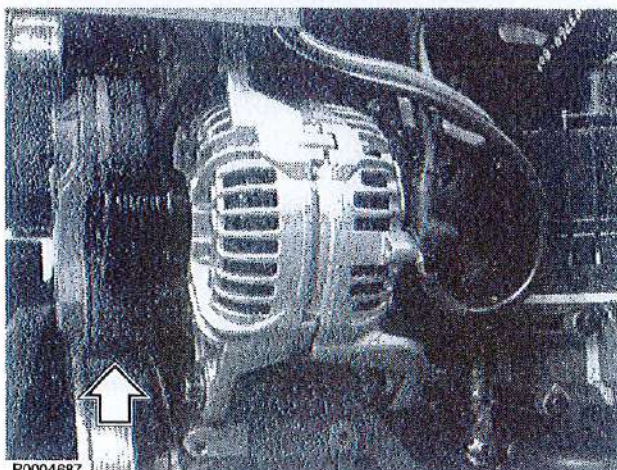
CAUTION!

Pinch hazard. Keep fingers clear.

Wind off the belt.



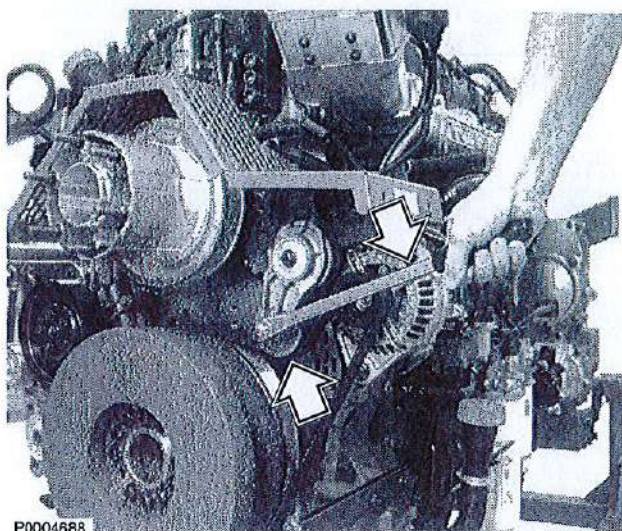
P0004688



P0004687

Installation

- 1 Check the belt tensioner pulleys.



- 2 Depress the lever.

CAUTION!

Pinch hazard. Keep fingers clear.

Wind on the belt.

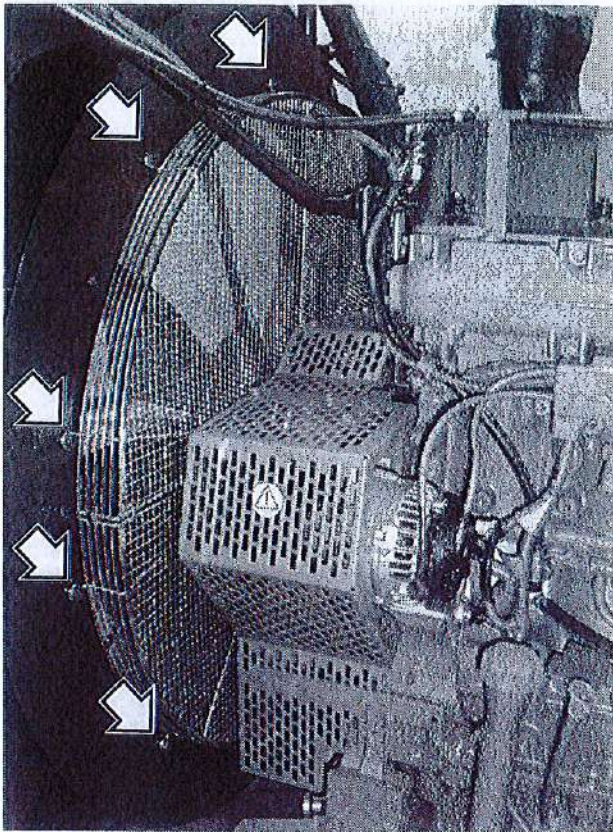
Alternator Belt, Replace

TWD1643GE, TWD1644GE, TWD1645GE,
TWD1652GE, TWD1653GE, TWD1663GE,
TWD1672GE, TWD1673GE

IMPORTANT!

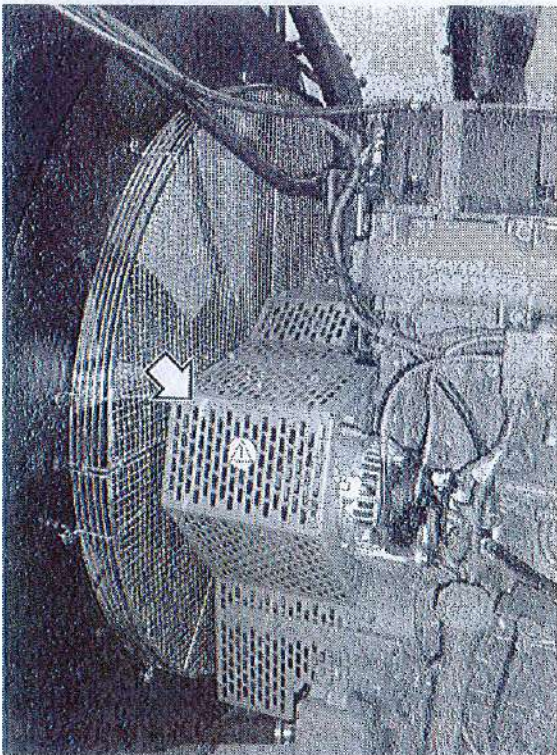
Always replace a drive belt that appears worn or is cracked.

- 1 Switch off at the main switch(es) and check that the engine is not connected to voltage.

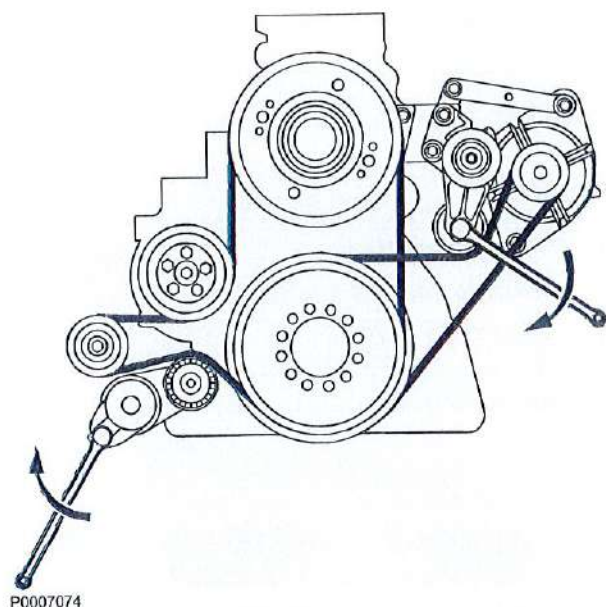


P0007073

- 2 Remove the fan cage and belt guards.
Refer to *Heat Protection*, exposure section.

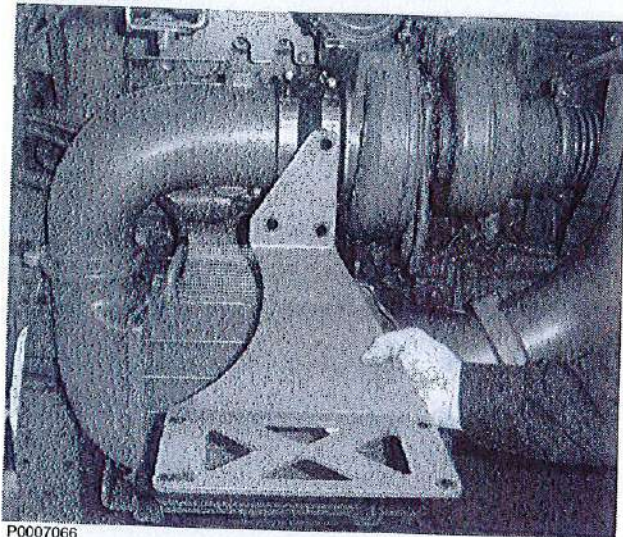


P0006869



- 3 Fit a 1/2" socket drive to the belt tensioner (1). Lift the socket drive and hook the water pump drive belt off.
- 4 Fit a 1/2" socket drive to the left belt tensioner (2). Press the socket drive down and remove the alternator belt.
- 5 Check that the pulleys and idler and tensioner rollers are clean and undamaged, especially regarding bearings and condition.
- 6 Press the socket drive to the belt tensioner (2) down and install the new alternator drive belt.
- 7 Lift the socket drive in the belt tensioner (1) and install the water pump drive belt.
- 8 Install the belt guard.
- 9 Fit the fan cage.
- 10 Start the engine and perform a function check.

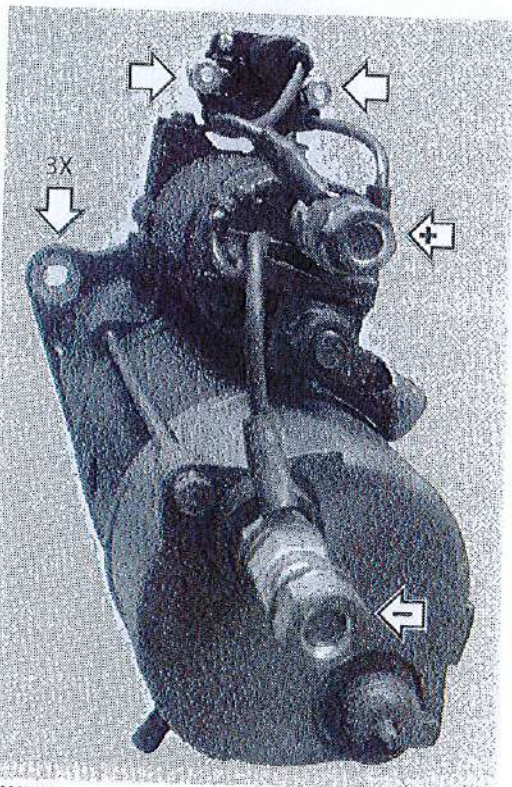
33-1 Starter Motor



Starter Motor, Change

Removal

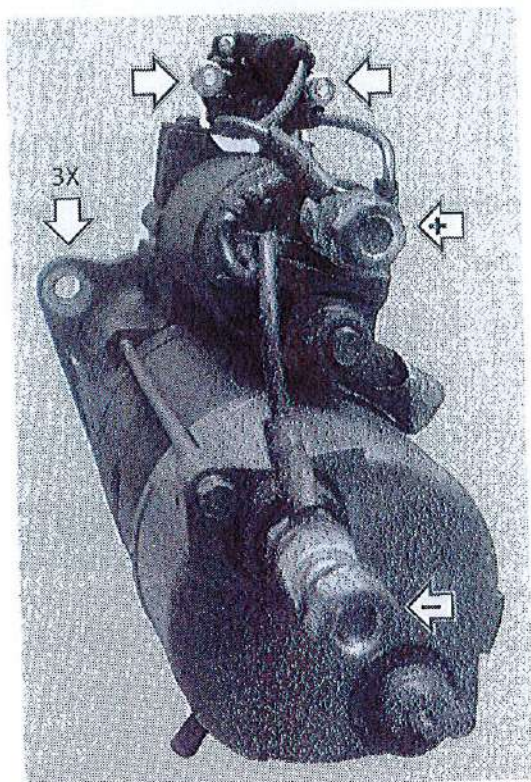
- 1 Disconnect system voltage from the engine.
- 2 Remove the heat shield, if fitted.
- 3 **Only TWD**
Remove the support plate from the lower charge air cooler.



- 4 Undo the nuts.
Remove the starter motor harness.
- 5 Undo the nuts.
Remove the starter motor.

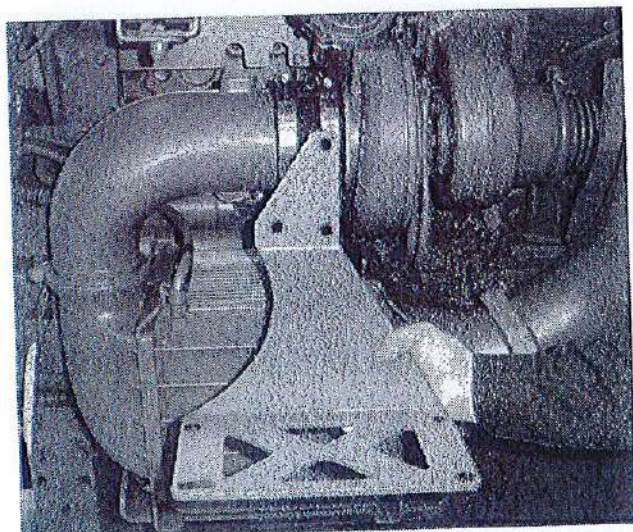
Installation

- 6 Fit the new ring starter motor.
Tighten the nuts.



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- 7 Install the harness.
Tighten the nuts.



P0007066

- 8 **Only TWD**
Install the support plate for the lower charge air cooler.
- 9 Install the heat shield, where fitted.
- 10 Check functions.



A series of horizontal dotted lines spanning the width of the page, providing a guide for handwriting practice.

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