

Workshop Manual

Group 00-08, 20-26, 32-37

I

4(0)

TAD734GE



**VOLVO
PENTA**

AB Volvo Penta
SE-405 08 Göteborg, Sweden

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**VOLVO
PENTA**

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Workshop Manual

Group 00-08, 20-26, 32-37

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4(0)

TAD734GE

Content

General Information	
00-0 General	2
Specifications	
03-2 Specifications, Engine	6
Safety and Other Instructions	
05-1 Safety Instructions	16
Special Tools	
08-1 Universal Tools	20
08-2 Special Service Tools	22
General	
20-0 Engine Information, General.....	25
Engine	
21-0 Engine Complete, General	61
21-1 Cylinder Head	112
21-4 Valve Mechanism	133
21-6 Crank Mechanism	137
Lubricating and Oil System	
22-0 Lubricating and Oil System, General	155
22-2 Oil Filter	156
Fuel System	
23-0 Fuel System, General	168
23-3 Fuel Feed Pump and Filter	170
23-7 Injectors and Delivery Pipes	181
23-8 Control System ..	193
Inlet and Exhaust System	
25-1 Inlet and Exhaust Manifolds	195
25-5 Turbocharger	201
25-6 Air Cleaner and Throttle Housing	206
Cooling System	
26-1 Radiator, Heat Exchanger	213
26-2 Coolant Pump, Thermostat	221
Alternator, Charge Regulator	
32-1 Alternator	234
Starting System	
33-1 Starter Motor	238
Cables and Fuses	
37-0 Wiring Diagram	240
Alphabetical Index	241
References to Service Bulletins	243

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 **Technical Data**.

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 in situ, 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.

About 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 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), 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!

Tätningar får aldrig brännas loss vid demontering eller eldas upp under okontrollerade former. Risk för giftiga gaser.



WARNING!

Använd alltid handskar av kloropregummi (handskar för kemikaliehantering) och skyddsglasögon. Hantera den borttagna tätningen på samma sätt som frätande syra. Alla rester, även aska, kan vara starkt frätande. Använd aldrig tryckluft vid rengöring.

Lägg gummiresterna i en plastburk som försluts och försetts med varningstext. Tvätta handskarna under rinnande vatten innan de tas av.

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.

03-2 Specifications, Engine

Technical Data

Group 20 General

Type Designation	TAD734GE
Power	Refer to the sales literature
Torque	Refer to the sales literature
No. of cylinders	6
Bore	108
Stroke, mm	130
Cylinder volume, dm ³	7,15
Weight* dry, kg	850
Weight* wet, kg	910
Firing order	1-5-3-6-2-4
Compression ratio	17:1
Low idle, rpm	900
High idle, rpm	1500/1800

**only engine, excluding cooling system*

Group 21 Engine

Engine block

Length	986 mm
Height, upper block plane-crankcase center-line	623 mm
Height lower block plane-crankcase centerline	385 mm

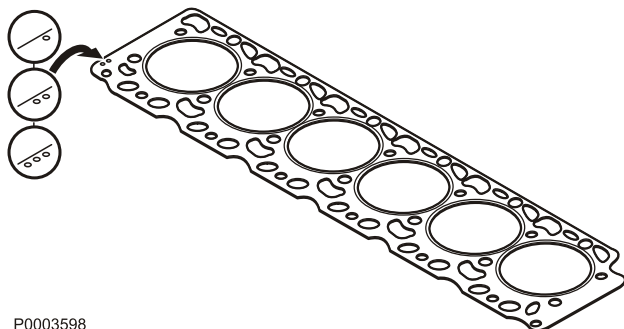
Cylinder head

Type	6 cyl.
Length	849.5 mm
Width	256 (±0,2) mm
Height	110 mm

Cylinder head bolts

No./cylinder head	26
Dimension, thread	M15x2
Length	134 mm, 170 mm respectively

Cylinder head gasket



Identification

- 1 hole
- 2 holes
- 3 holes

Piston height

- 0.28-0.53 mm
- 0.54-0.63 mm
- 0.64-0.75 mm

P0003598

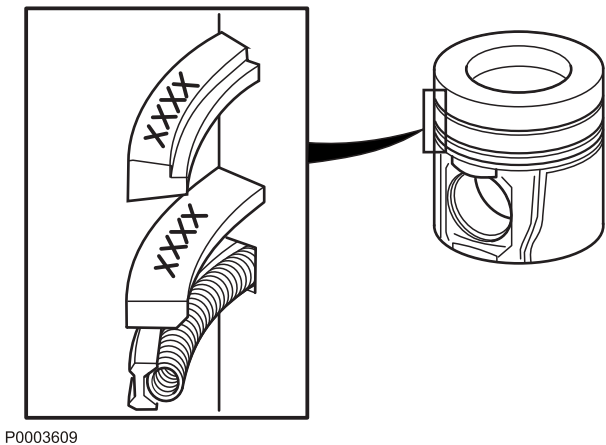
Cylinder liner

Type	Wet, replaceable
Height, total	228 mm
Sealing surface height above block plane	0.1 mm
No. of seal rings per cylinder liner	2

Piston

Type	Forged piston
No. of ring grooves	3
Piston pin diameter	45 mm

Piston rings



Compression rings

Number	2
Specification	Wear tolerance
Piston ring clearance in groove:	
<u>Upper</u>	
compression ring (trapezium profile)	—
<u>Lower</u>	
Compression ring	—
0.07 mm	0.105 mm
Piston ring gap, measured at ring opening:	
<u>Upper</u>	
compression ring	—
0.3 mm	—
<u>Lower</u>	
compression ring	0.15 mm
1.5 mm	2.0 mm
Maximum piston ring gap, measured at ring opening:	
<u>Upper</u>	
compression ring	—
35.5 mm	—
<u>Lower</u>	
compression ring	—
35.5 mm	—
Oil scraper ring	
Number	1
Width, including spring	3.95 mm
Specification	Wear tolerance

Piston ring clearance in groove:

0.03 mm**0.075 mm**

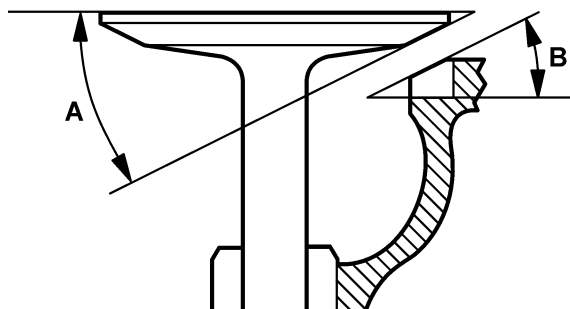
Piston ring gap, measured at ring opening:

0.25 mm**0.3 mm**

Maximum piston ring gap, measured at ring opening:

22.7 mm

—

Valve mechanism

P0003608

Valves**Valve head, diameter**

Inlet

38.2 mm

Exhaust

35.8 mm**Valve stem, diameter**

Inlet

8.0 mm

Exhaust

8.0 mm**Valve seat angle (A)**

Inlet

28,0°

Exhaust

44,8°**Seat angle in cylinder head (B)**

Inlet

30° (±0,5°)

Exhaust

45° (±1°)**Specification**

Dimension between valve head and cylinder head plane:

Inlet

1.25 mm**+0.25/-0.1 mm**

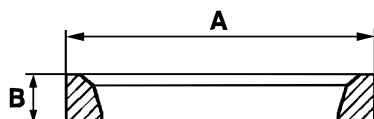
Exhaust

1.25 mm**+0.25/-0.1 mm****NOTICE!** If the valve seats are replaced, the valves must also be replaced.**Wear tolerance****Valve clearance, cold engine, setting value**

Inlet

75° (0.35 mm)

Exhaust

105° (0.45 mm)

P0003962

Valve seats**Standard****Outer diameter (A)**

Inlet

39.31 mm

Exhaust

36.81 mm**Height (B)**

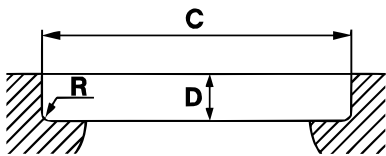
Inlet

7.5 (±0.005) mm

Exhaust

7.5 (±0.005) mm

P0003963



Valve seat bed

Standard

Diameter (C)	
Inlet	39.2 mm
Exhaust	36.7 mm
Depth (D)	
Inlet/exhaust	11.5 mm
Seat base radius (R)	
Inlet/exhaust	max 0.5 mm

Valve guides

Length

Inlet/exhaust	145.85 mm
---------------	-----------

Inner diameter

Inlet/exhaust	8 (±0.1) mm
---------------	-------------

Specification

Play, valve stem guides

Inlet	
0.02 mm	±0.01 mm
Exhaust	
0.03 mm	±0.01 mm

Wear tolerance

Rocker arms

Rocker arm springs	max 38.8 mm
--------------------	-------------

Valve springs

Inlet

Uncompressed length	64.48 mm
---------------------	----------

Exhaust

Uncompressed length	64.48 mm
---------------------	----------

Timing gear

Timing gear wheels

No. of teeth

Drive gear, crankshaft	48
Drive gear, camshaft	96
Drive gear, fuel feed pump	23
Drive gear, lubrication oil pump	51

Camshaft

Drive	gear wheel
No of bearings	7

NOTICE! Only check values, **not** for machining.

Diameter, bearing journals, standard	77.10-77.15 mm
Undersize	no

Valve lift

Inlet	6.63 (± 0.08) mm
Exhaust	7.13 (± 0.08) mm

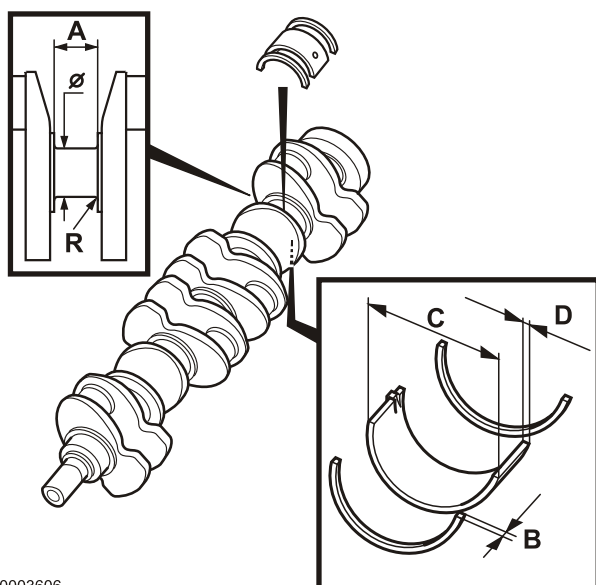
Camshaft bearings

Camshaft bearing thickness, standard	2.0 mm
Oversize	no

Reciprocating components**Crankshaft**

Length	976.50 (± 0.25) mm
Crankshaft, end float*	0.10-0.32 mm
Ovality of main and big end bearings	0.002 mm/10° max 0.05 mm/360°
Taper of main and big end bearings	Grade 0.005 mm/Parallel 0.008mm

*Dimensions refer to oiled components.



P0003606

Main bearing journal

NOTICE! Only check values, **not** for machining.

Diameter ($\varnothing$) standard	85 mm
-------------------------------------	--------------

Undersize

0.25 mm	84.75 mm
0.50 mm	84.50 mm

Width thrust bearing journal (A) standard	33.9 mm
--	----------------

Oversize

0.4 mm (thrust bearing 0.2)	34.3 mm
Fillet radius (R)	2.5 (± 0.2) mm

Thrust washers (thrust bearing)

Width (B) standard	2.9 mm
--------------------	---------------

Oversize

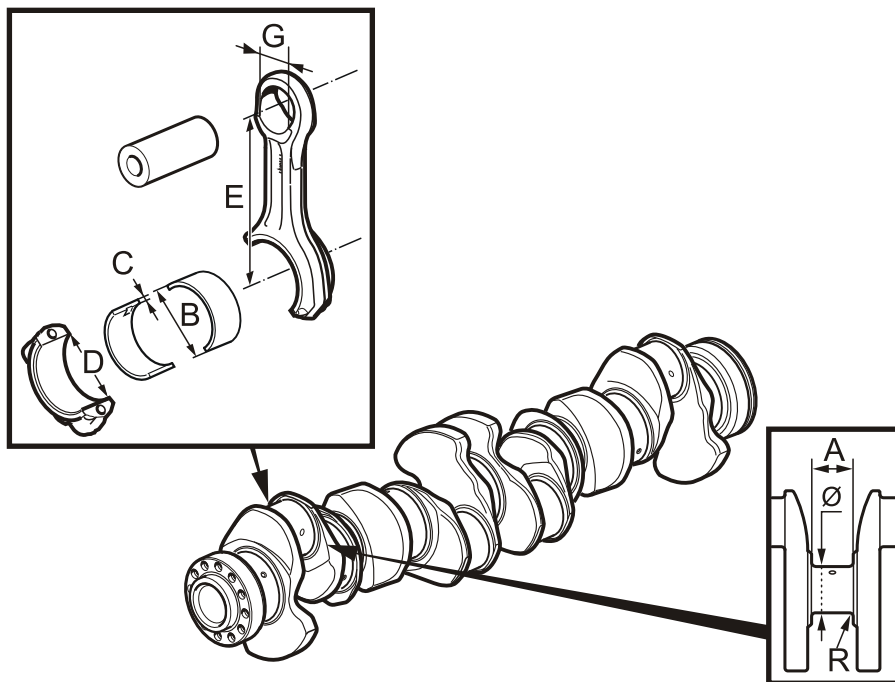
0.2 mm	3.1 mm
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Main bearing shells

Outer diameter (C)	91.0-92.5 mm
Thickness (D) standard	2.73 mm

Oversize

0.25 mm	2.85 mm
0.50 mm	2.98 mm
Radial clearance, main bearings	max 0.1 mm



P0003607

Big end bearing journal

NOTICE! Only check values, **not** for machining.

Diameter (Ø)	75 mm
Undersize	
0.25 mm	74.79-74.82 mm
0.50 mm	74.54-74.58 mm
Width (A)	37.4 (±0.04) mm
Fillet radius (R)	3.5 (±0,2) mm

Big end journal shells

Outer diameter (B)	80.5-82.0 mm
Thickness (C) standard	2.47 mm

Oversize	
0.1 mm	2.60 mm
0.2 mm	2.72 mm

Diameter, bearing shell seat (D)	80-80.02 mm
----------------------------------	-------------

Connecting rod

Length, center - center (E)	210 (±0.02) mm
Gudgeon pin bush internal diameter (G)	45 mm
End float, con rod - crankshaft*	max 0.1 mm
Crankshaft bearings, diametrical float*	max 0.04-0.10 mm
Straightness, max. deviation on 100 mm measured length	0.04 mm
Twist, max. deviation on 100 mm measured length	0.04 mm

*Dimensions refer to oiled components.

Group 22 lubrication system

Oil change volume, including change of filter

Oil pan, standard **29 liter** (7.7 US gallon)

Oil pressure, engine oil at working temperature (Min. 120° C)

At rated engine speed **420-450 kPa** (61-65 psi)

Automatic stop at pressure less than **100 kPa** (15 psi)

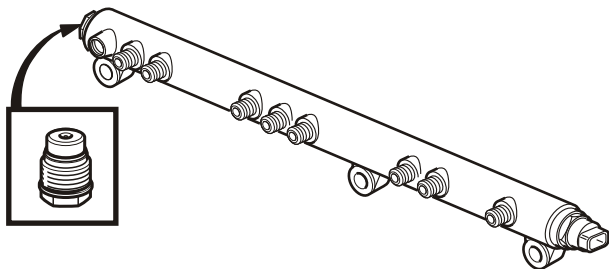
Oil filter, full-flow filter

Number **1**
(tighten 1/2–3/4 turn after it just touches)

Lubrication oil pump

Type Gear driven

Group 23 fuel system



Common Rail

Safety valve opening pressure **1850-1950 bar**

Feed pump

Supply pressure, at 1200 rpm **0.2 MPa** (29 psi)

P0003599

Group 25 inlet and exhaust system

Turbochargers

Charge pressure (1500 rpm) **250 kPa** (2.5 bar)

Charge pressure (1800 rpm) **240 kPa** (2.4 bar)

Group 26 cooling system

Coolant

Volvo Penta anti-freeze, mixed 40/60% with water. See specification below.

Water specification: To avoid the risk of cooling system clogging the coolant must be mixed with clean water according to ASTM D4985. If there is any doubt regarding the purity of the water, distilled water must be used, alternatively ready-mixed coolant.

Cooling system, type Pressurized, sealed

Pressure valve, max. opening pressure **120 kPa** (17.4 psi)

Volume (engine) **8 liter** (2.11 US gallon)

Thermostat

Quantity and type 1 pc. piston thermostat

Opening temperature **83 °C** (181 °F)

Fully open at **103 °C** (217 °F)

Tightening torque

Torque applies to oiled bolts and nuts. Degreased (washed) parts should be oiled prior to assembly.

General tightening torque values

In those cases where no tightening torques are indicated, Volvo standard torques for the respective thread dimension and bolt grade must be used.

Bolts, grade 8.8, median level

Thread	Tightening torque, assembly (Nm)
M5	6 (± 1)
M6	10 ($\pm 1,5$)
M7	17 (± 3)
M8	24 (± 4)
M10	48 (± 8)
M12	85 (± 15)
M14	140 (± 25)
M16	220 (± 35)
M18	290 (± 45)
M20	430 (± 70)
M22	580 (± 90)
M24	740 (± 120)

Bolts, grade 10.9, median level

Thread	Tightening torque, assembly (Nm)
M5	7,5 ($\pm 1,2$)
M6	12 (± 2)
M7	22 (± 3)
M8	30 (± 5)
M10	60 (± 10)
M12	105 (± 20)
M14	175 (± 30)
M16	275 (± 45)
M18	360 (± 55)
M20	540 (± 90)
M22	730 (± 120)
M24	900 (± 140)

Special torque

Group 21 Engine

Engine mount

275 Nm

Main bearing

NOTICE! Screws for main bearing caps may only be re-used three times.

Step 1

50 Nm

Step 2

angle tighten **60°**

Step 3

angle tighten **60°**

Big end bearing

NOTICE! New bolts for each installation.

Step 1

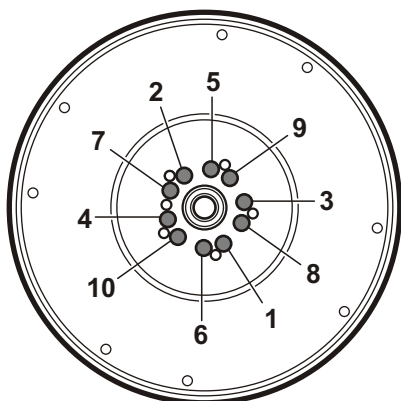
30 Nm

Step 2

angle tighten **60°**

Step 3

angle tighten **60°**



P0003164

Flywheel

Step 1

30 (±5)

Step 2

angle tighten **60°**

Step 3

angle tighten **60°**

Flywheel housing

Step 1 (M12)

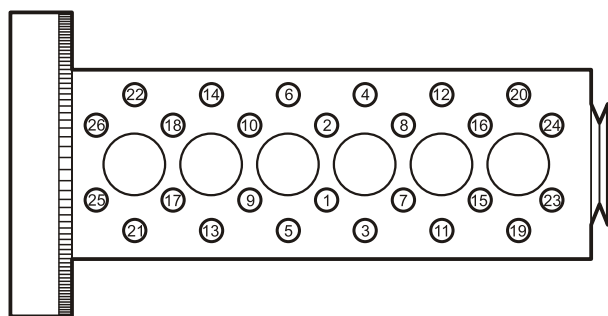
110 Nm

Step 2 (M8)

30 Nm

Step 3 (M16)

260 Nm



P0003361

Cylinder head

NOTICE! Cylinder head bolts may only be re-used five times.

Step 1

30 Nm

Step 2

angle tighten **60°**

Step 3

angle tighten **60°**

Oscillation damper

NOTICE! The screws on the vibration damper may **not** be re-used.

Step 1

30 (±5) Nm

Step 2

angle tighten **60°**

Step 3

angle tighten **60°**

Valve cover

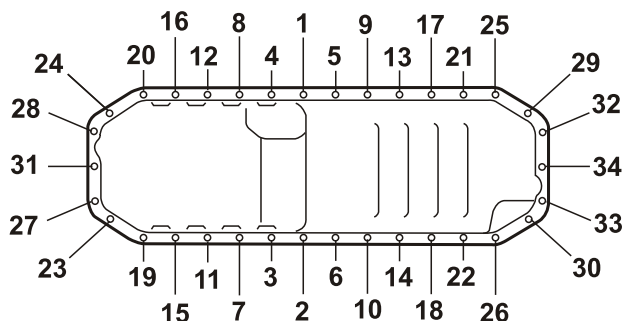
Bolt, valve cover

8.5 Nm

Rocker arm bridge

20 Nm

Valve adjustment, lock nuts

20 Nm**Group 22 lubrication system**

P0003417

Oil cooler, retaining bolts

22 (±2) Nm

Oil filter housing

60 (±10) Nm

Oil strainer

30 (±5) Nm

Oil pan

30 Nm

Oil pressure sensor

30 (±5) Nm**Oil pan**

Step 1

15 Nm

Step 2

30 (±3) Nm

Piston cooling nozzles

21 (±4) Nm**Group 23 fuel system**

Common Rail

30 Nm

Rail pressure sensor, common rail

70 Nm

Safety valve, common rail

100 Nm

Fuel delivery pipe

25 Nm

Fuel pressure sensor

30 (±5) Nm**Fuel pump**

Step 1

10 Nm

Step 2

50 Nm**Group 25 inlet and exhaust system****Exhaust manifold**

Step 1

15 Nm

Step 2

45 Nm

Inlet pipe

30 Nm

Turbocharger, exhaust manifold

30 (±5) Nm

Turbocharger, oil delivery pipe

39 (±8) Nm**Group 26 cooling system**

Thermostat housing

30 (±5) Nm

Fan hub

60 (±10) Nm

Coolant pump

30 (±5) Nm

Coolant temperature sensor

25 Nm

05-1 Safety Instructions



P0003451

Safety Information

This Service Manual contains repair instructions, descriptions and technical data for products or product designs from Volvo Penta. Ensure that you are using the correct service manual.

Read the safety information below and the service manual section **About this Workshop manual** and **About repair instructions** carefully before repair and service work is begun.



This symbol is used in the service manual and on the product, to call attention to the fact that this is safety information. Always read such information very carefully.

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



DANGER!

Indicates a hazardous situation which, if not avoided, will 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 draw your attention to something that may cause minor damage or a minor malfunction to the product or property.

NOTICE! Is used to draw your attention to important information that will facilitate the work or operation in progress.



This symbol is used on our products in certain cases and refers to important information in the instruction book. Make sure that warning and information symbols on the engine are clearly visible and legible. Replace symbols which have been damaged or painted over.

A compilation of safety precautions that must be taken and risks which must be paid attention to is presented in the following pages.



Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the off position before starting work. Post a warning notice at the main circuit breaker.



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



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



Hot oil can cause burns. Avoid skin contact with hot oil. Ensure that the lubrication system is not under pressure before any work is begun. Never start or operate the engine with the oil filler cap removed, because of the risk of oil ejection.



Be aware of hot surfaces (exhaust pipes, turbos, charge air pipes, starting heaters etc.) and hot fluids in pipes and hoses on an engine that is running or has just stopped. If work is done adjacent to a running engine, a careless movement or a dropped tool may in the worst case lead to personal injury.



Never start the engine without installing the air filter. 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 the engine is started.



Ensure that the warning symbols or information decals on the product are always clearly visible. Replace decals which have been damaged or painted over.



Only start the engine in a well-ventilated space. When running in a confined space, exhaust fumes and crankcase gases must be led away from the engine bay or workshop area.



Avoid getting oil on your skin! Protracted or repeated exposure to oil can cause skin to become dry. Irritation, dryness, eczema and other skin problems may then result. From a health standpoint, used oil is more dangerous than new. Use protective gloves and avoid oil-soaked clothes and rags. Wash regularly, especially before eating. Use suitable barrier creams to counteract drying out of the skin 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 injurious to health. Carefully read the instructions on the product packaging! Always follow a product's safety directions, e.g. use of protective mask, glasses, gloves etc. Ensure that other personnel are not exposed to substances that are injurious to health. Ensure good ventilation. Handle used and leftover chemicals in the prescribed manner.



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



Clutch adjustments must be carried out with the engine stopped.



Always use protective glasses or goggles when carrying out work where a risk of splinters, grinding sparks, splashes from acid or other chemicals is present. Your eyes are extremely sensitive; injury may cause blindness!



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



All fuels, as well as many chemicals, are flammable. Do not allow open flames or sparks in their vicinity. Gasoline, some thinners, and hydrogen gas from batteries are extremely flammable and explosive when mixed with air in the correct proportions. **No Smoking!** Ensure that 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.



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

Do not touch the connections during start attempts. Sparking hazard! Do not lean over batteries.



Never transpose the positive (+) and negative (-) battery posts when installing batteries. Such a transposition can result in serious damage to electrical equipment. Refer to the wiring diagram.

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



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



Stop the engine before working on the cooling system.

Marine engines: Close the sea cock / cooling water inlet valve before work on the cooling system is begun.



Make sure that oil, fuel-soaked rags, and used fuel and oil filters are stored in a safe manner. Rags soaked in oil can spontaneously ignite under certain circumstances. Used fuel and oil filters are environmentally hazardous waste and must be handed to an approved waste management facility for destruction, as must any used lubrication oil, contaminated fuel, paint residue, solvents, degreasers and wash residue.



Never work alone when removing heavy components, even when using lifting devices such as locking tackle lifts. When using a lifting device, two people are usually required to do the work - one to take care of the lifting device and the other to ensure that components are lifted clear and not damaged during the lifting operations.



The existing lugs on the engine should be used for lifting. Always check that the lifting equipment used is in good condition and has the load capacity to lift the engine (engine weight including gearbox or extra equipment). For safe handling and to avoid damaging components fitted to the top of the engine, the engine must be lifted with a correctly adjusted lifting boom. All chains or wires must run parallel to each other and as perpendicular to the engine as possible. If other equipment attached to the engine has altered its center of gravity, special lifting devices may be needed to obtain the correct balance for safe handling. Never perform any work on an engine that is only suspended from the lifting equipment.



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 run in areas where there are explosive materials.



Exercise extreme caution when leak-detecting on the fuel system and testing the fuel injector nozzles. Use eye protection. The jet from a fuel nozzle has very high pressure and great penetration power. Fuel can force its way deep into body tissue and cause severe injury. There is a risk of blood poisoning (septicemia).



Only use fuels and lubricating oils recommended by Volvo Penta. Refer to the Operator's Manual for the product in question. Use of fuels that are of a lower grade may damage the engine, the injection pump and the injectors. On a diesel engine, low grade fuel can cause the control rod to bind and the engine to over-rev, with the risk of engine damage and personal injury as a result. Low fuel and oil grades may result in high service, maintenance and repair costs.



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



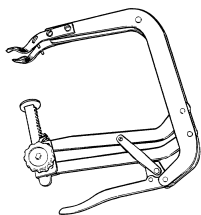
Fuel delivery pipes must not be bent or straightened under any circumstances. Cracks may occur. Damaged pipes must be replaced.

08-1 Universal Tools



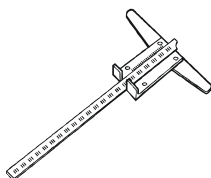
Other Special Equipment

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



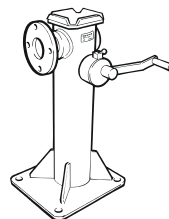
9985468 Valve spring compressor

Removal/installation of valve collets.



9985471 Sliding depth gauge

For use when checking valves.



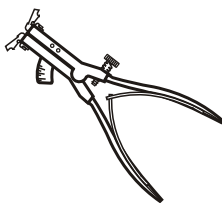
9986485 Stand

For use with e.g. 88800050 Fixture.



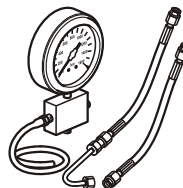
9989876 Dial indicator

E.g. checking cylinder liner wear.



88800083 Piston ring pliers

Removal/installation of piston rings.



88890080 Manometer

Checking fuel pressure.



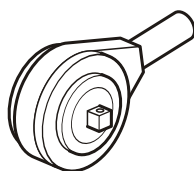
Other Equipment

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.



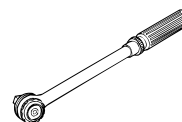
885510 Plugs

For use with e.g. fuel pressure lines.



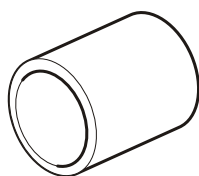
885633 Torque multiplier

For use with e.g. the crankshaft.



1159794 Torque wrench

For use with e.g. the injector pressure lines.



1678297 Spacer

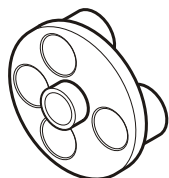
For use with 9996398 Manometer.

08-2 Special Service Tools

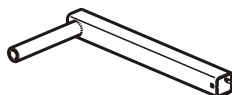


Special tools

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



885530 Rotation tool
Crankshaft cranking.



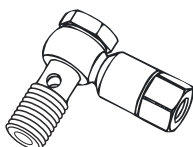
885648 Counterhold
For use with 885633 Torque multiplier.



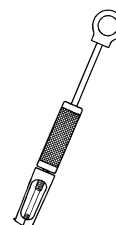
885812 Timing tool
Adjusting e.g. valve play.



885822 Magnetic pen
Replacement of e.g. camshaft.



9990124 Nipple
Banjo fitting, for use with 9996398 Manometer.



9991821 Extractor
Removal of roller cam.



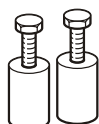
9992000 Handle
Replacement of e.g. crankshaft seal.



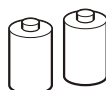
9992564 Drift
Installation of crankshaft seal.



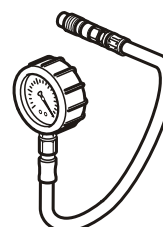
9996049 Draining hose
Cooling system, draining.



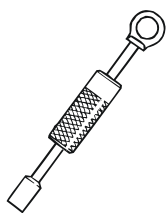
9996394 Support
Support leg for 9996645 Puller



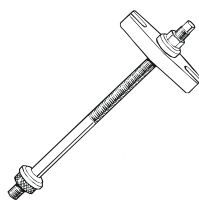
9996395 Support
Support leg for 9996645 Puller



9996398 Manometer
Adjusting e.g. lubricating oil pressure.

**9996400 Slide hammer**

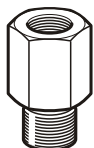
Removal of injector pressure pipe.

**9996645 Puller**

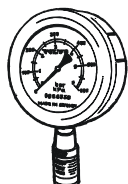
For use with cylinder liners.

**9996666 Nipple**

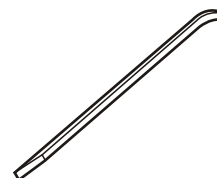
For use with, among other things, 9996398 Manometer.

**9998007 Adapter**

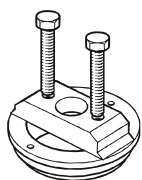
For use with 9996400 Slide hammer.

**9998339 Manometer**

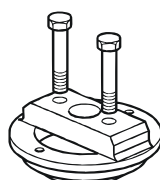
Checking charge air pressure.

**9998511 Lever**

Removal of e.g. seals.

**9998672 Press tool**

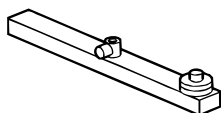
Replacement of crankshaft seal (rear).

**9998673 Press tool**

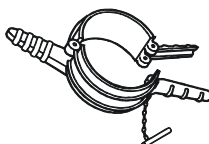
Replacement of crankshaft seal (front).

**9998675 Press tool**

Installation of cylinder liner.

**9998678 Gauge rod**

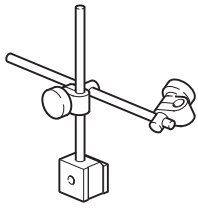
Selection of cylinder head gasket, with spacers.

**9998687 Compressor**

Installation of pistons in engine block.

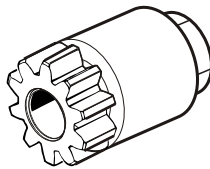
**9999179 Extractor oil filter**

Removal of filters.



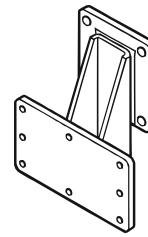
9999696 Magnetic stand

For use with 9989876 Dial indicator.



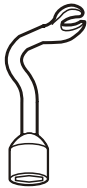
88800014 Rotation tool

E.g for valve play adjustment.



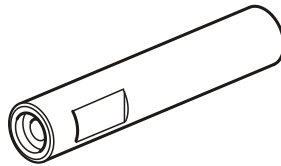
88800050 Fixture

For use with 9986485 Stand.



88800070 Wrench

Installation of injector pressure pipes.



88800151 Drift

Installation of piston rings.

20-0 Engine Information, General

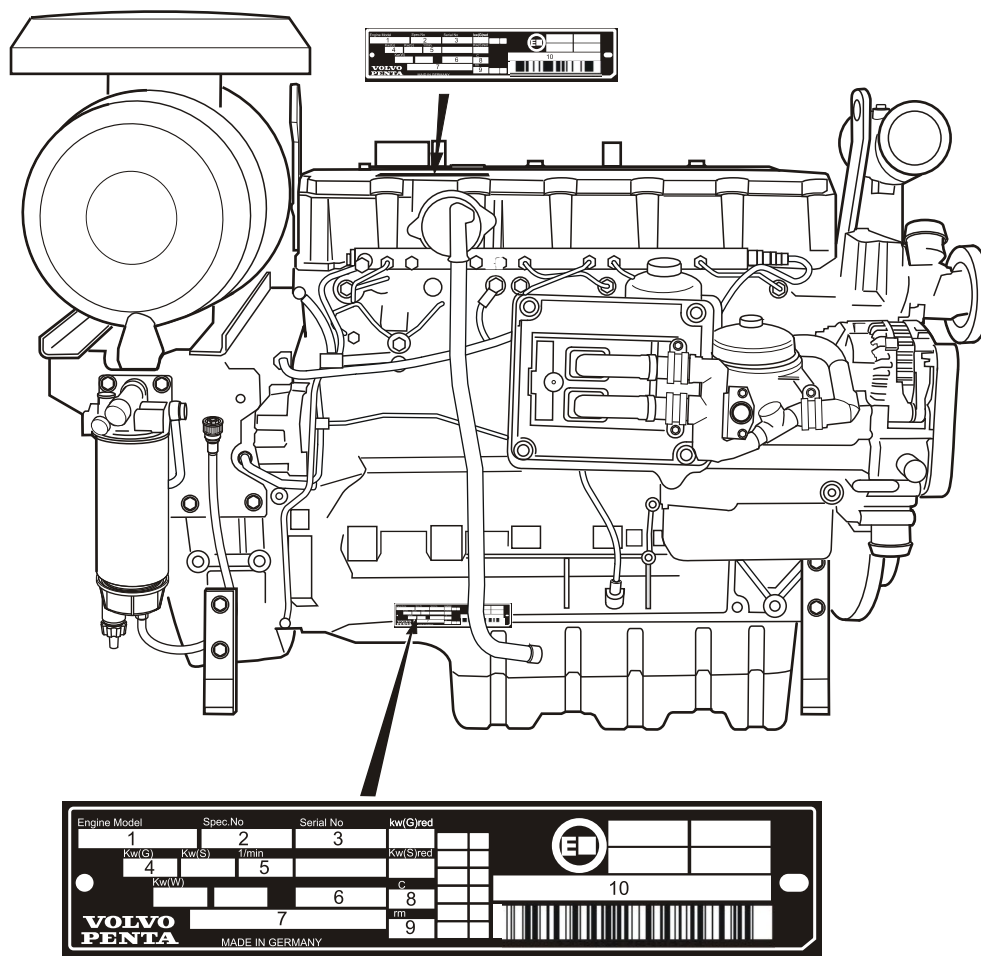
Design and Function

Engine, description

Location of engine plate (early design)

Each engine is supplied with two identification plates, of which one is mounted on the right side of the cylinder block.

The other engine plate is located upon the valve cover.



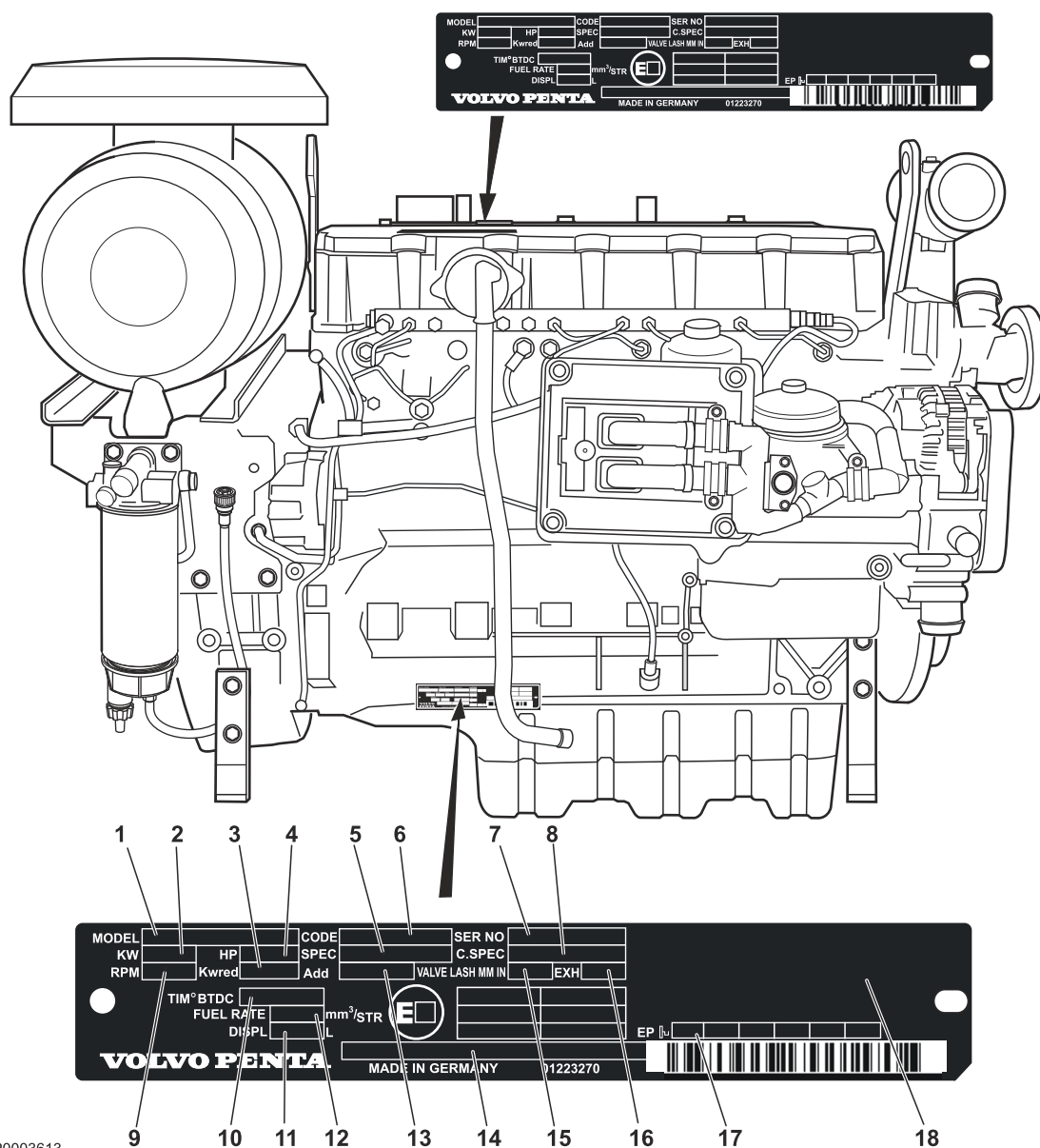
P0003290

- | | |
|------------------------------------|---|
| 1. Engine model | 6. Engine code (linked to EPA/EU Tier III approval) |
| 2. Engine specification number | 7. Rated power, standard (peak power according to Tier III) |
| 3. Engine serial number (10 digit) | 8. Air temperature in °C (°F), in accordance with ISO 3046 |
| 4. Engine stall power, without fan | 9. Altitude above mean sea level, in accordance with ISO 3046 |
| 5. Engine speed | 10. EU Tier III, approval number |

Location of engine plate (late design)

Each engine is supplied with two identification plates, of which one is mounted on the right side of the cylinder block.

The other engine plate is located upon the valve cover.

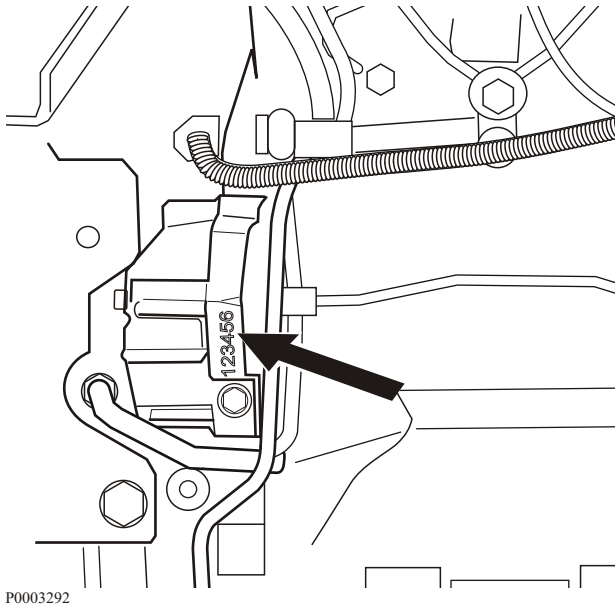


P0003613

- | | |
|------------------------------------|---|
| 1. Engine model | 10. Injection angle and camshaft type |
| 2. Engine power, without fan (kW) | 11. Cylinder volume, total |
| 3. Not used | 12. Injection volume |
| 4. Engine power, without fan (hp) | 13. Not used |
| 5. Not used | 14. Certification approval number |
| 6. Manufacturer's ID code | 15. Valve play, inlet valve (mm ³ /stroke) |
| 7. Engine serial number (10 digit) | 16. Valve play, exhaust valve (mm ³ /stroke) |
| 8. Engine specification number | 17. EP code for injection pump (cyl. 1 first) |
| 9. Engine speed | 18. Further information |

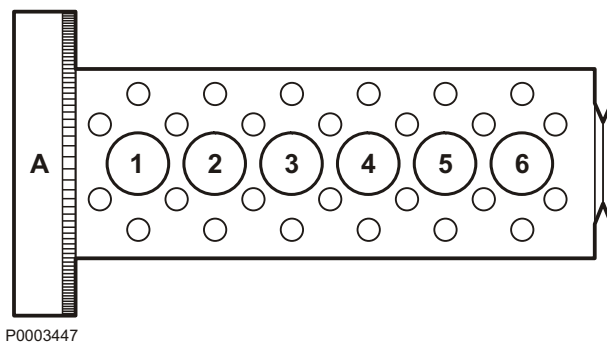
Engine serial number

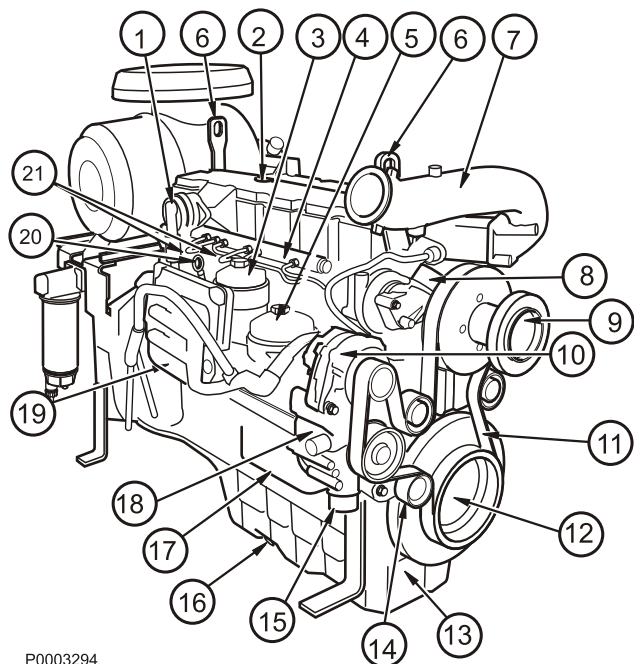
Engine serial number is stamped on the engine block and on the product plate. The serial number consists of 10 digits. Only the last eight digits are stamped on the engine block.



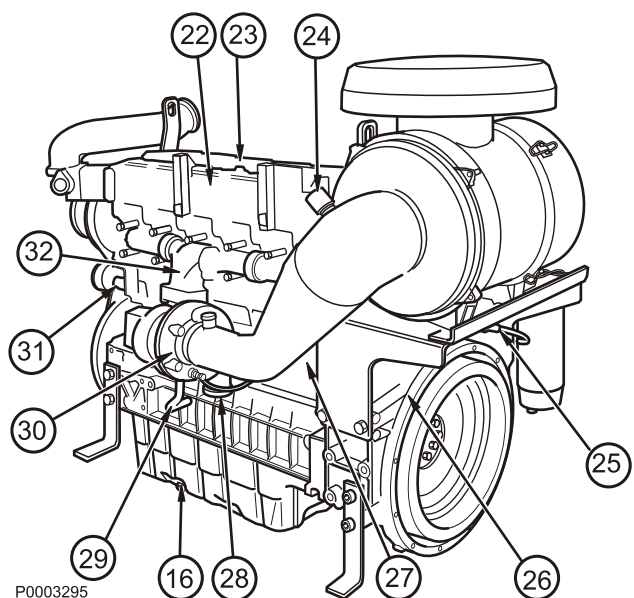
Cylinder numbering

A = flywheel



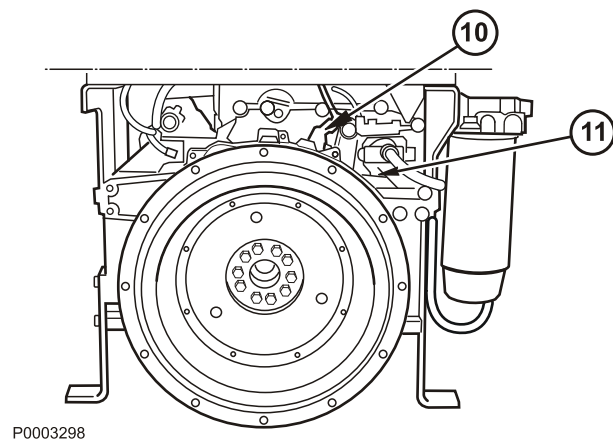
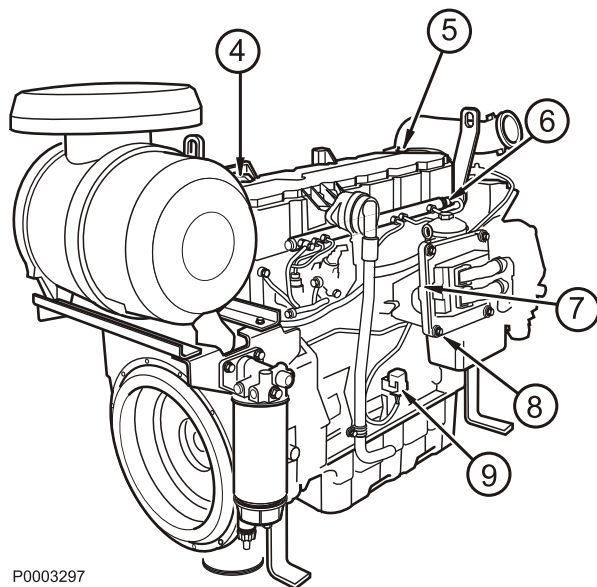
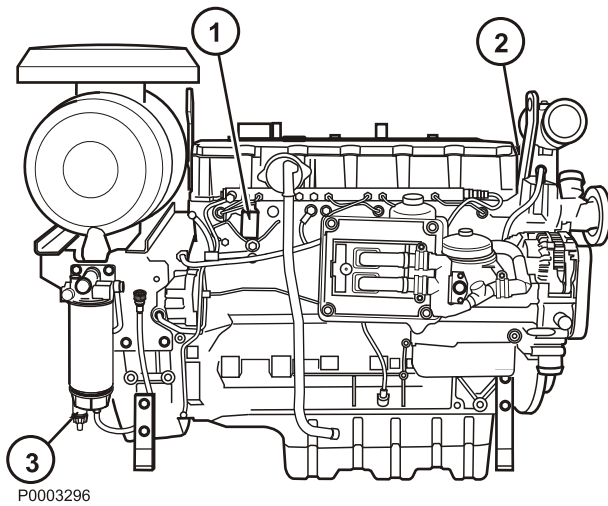
Component locations, TAD734GE

P0003294



P0003295

- 1 Crankcase ventilation, (sealed crankcase, ventilation optional)
- 2 Oil filler
- 3 Fuel filter
- 4 Common Rail unit, with safety valve and rail pressure sensor
- 5 Oil filter
- 6 Lifting eyes, (2 pcs)
- 7 Inlet, after charge-air cooler
- 8 Coolant outlet, from thermostat housing
- 9 Fan hub
- 10 Alternator
- 11 Drive belt
- 12 Drive gear, crankshaft
- 13 Oil pan
- 14 Tensioner pulley
- 15 Coolant inlet, to engine
- 16 Drain plug, oil pan
- 17 Oil cooler
- 18 Coolant pump
- 19 Outlet (option)
- 20 Oil dipstick
- 21 High pressure pumps
- 22 Inlet pipe
- 23 Valve cover
- 24 Indicator, air filter
- 25 Fuel pump
- 26 Flywheel housing
- 27 Starter motor guard
- 28 Charge air, to cooler
- 29 Oil pipe, from turbo
- 30 Turbo
- 31 Relay
- 32 Exhaust manifold



Location of sensors

NOTICE! Positions may differ depending on the engine model.

- 1 Solenoid proportional valve, high pressure pump - fuel (MPROP)
- 2 Coolant temperature
- 3 Water in fuel, (mounted on fuel pre-filter)
- 4 Charge air pressure and temperature
- 5 Pre-heating, inlet air
- 6 Fuel pressure in distributor manifold (Rail)
- 7 Fuel pressure
- 8 Oil pressure sensor
- 9 Relay
- 10 Rpm sensor, flywheel
- 11 Rpm sensor, camshaft

EMS 2

EMS 2 (Engine Management System) is an electronic system with CAN communication (Controller Area Network) for diesel engine control. The system was developed by Volvo and includes fuel control and a diagnostic function.

Summary

The system comprises, among other things, a control unit, sensors and injectors. The sensors send input signals to the control unit, which in turn controls the injectors.

The information from the sensors gives exact data about prevailing operating conditions and allows the processor in the control module to calculate the correct injection amount, injection timing and check engine health.

Input signals

The control unit receives input signals about engine operating conditions from the following components:

- coolant temperature sensor
- charge air pressure and temperature sensor
- rpm sensor, camshaft
- rpm sensor, flywheel
- coolant level sensor
- oil pressure sensor
- fuel pressure sensor
- water-in-fuel indicator
- fuel pressure in distributor manifold

Output signals

The control module uses the input signals to control the following components:

- unit injectors
- starter motor
- main relay
- pre-heating relay
- solenoid valve, EGR
- MPROP, high pressure fuel pump

Fuel control

The engine fuel requirement is analyzed up to 100 times per second. The amount of fuel injected into the engine and the injection advance are fully electronically controlled via fuel valves and the unit injectors.

This means that the engine always receives the correct volume of fuel in all operating conditions, which provides lower fuel consumption, minimal exhaust emissions etc.

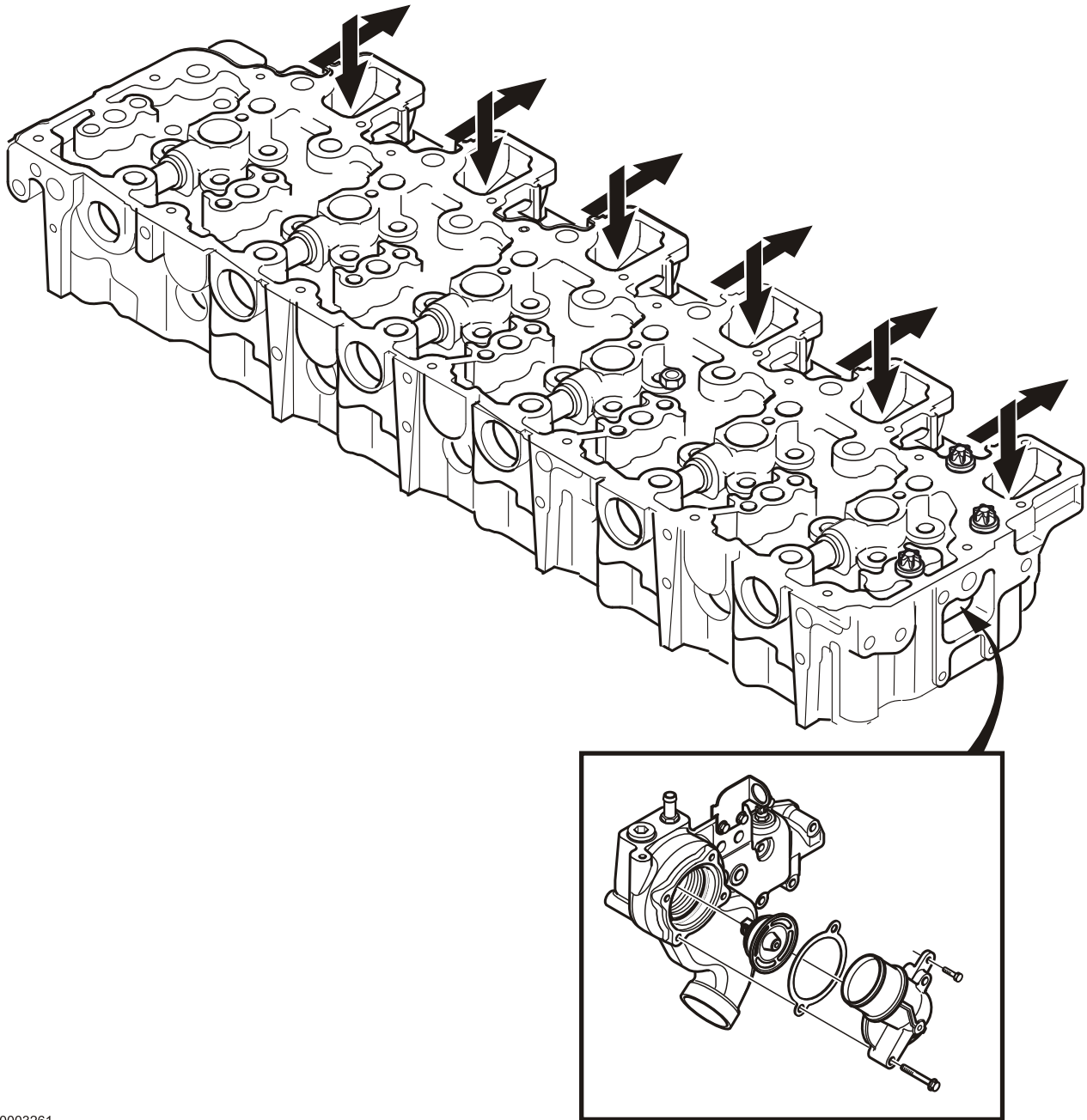
Diagnostic function

The task of the diagnostic function is to detect and locate disturbances within the EMS 2 system, to protect the engine, and to provide information about problems that have arisen.

If a malfunction is detected, it is announced by warning lamps, a flashing diagnostic lamp or in plain language on the instrument panel, depending on the equipment used. If a fault code is obtained as a flashing code or in plain language, it is used for guidance in any fault tracing. Fault codes can also be read by Volvo's VODIA tool at authorized Volvo Penta workshops.

If there is a serious malfunction, the engine will be shut down altogether, or the control unit will reduce the power delivered (depending on application). Once again, a fault code is set for guidance in any fault tracing.

Cylinder head

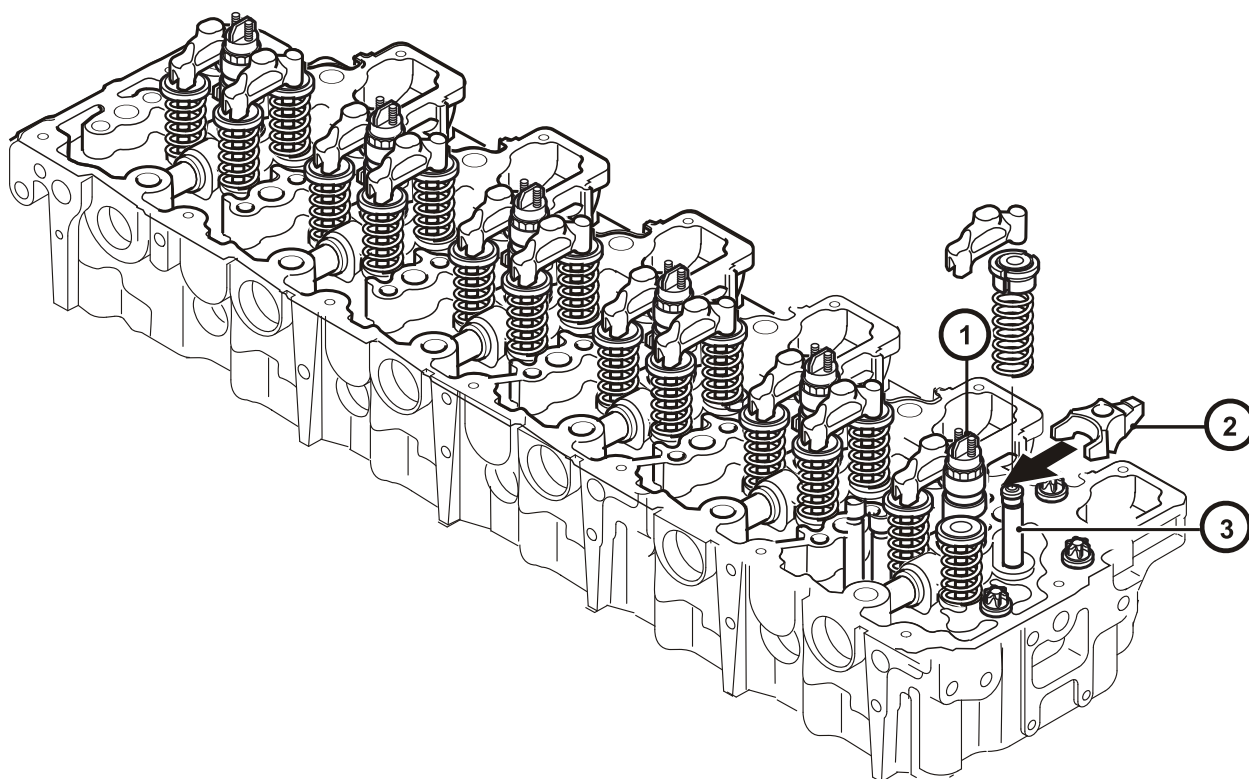


P0003261

The cylinder head is made of cast iron and is cast in one piece. The thermostat housing is mounted directly on the cylinder head.

The fuel return channel for the injectors is drilled along the length of the cylinder head and has a machined, ring-shaped chamber around each injector.

There is a drilled channel for the injector delivery pipe unions. The unions are sealed against the cylinder head with O-rings.

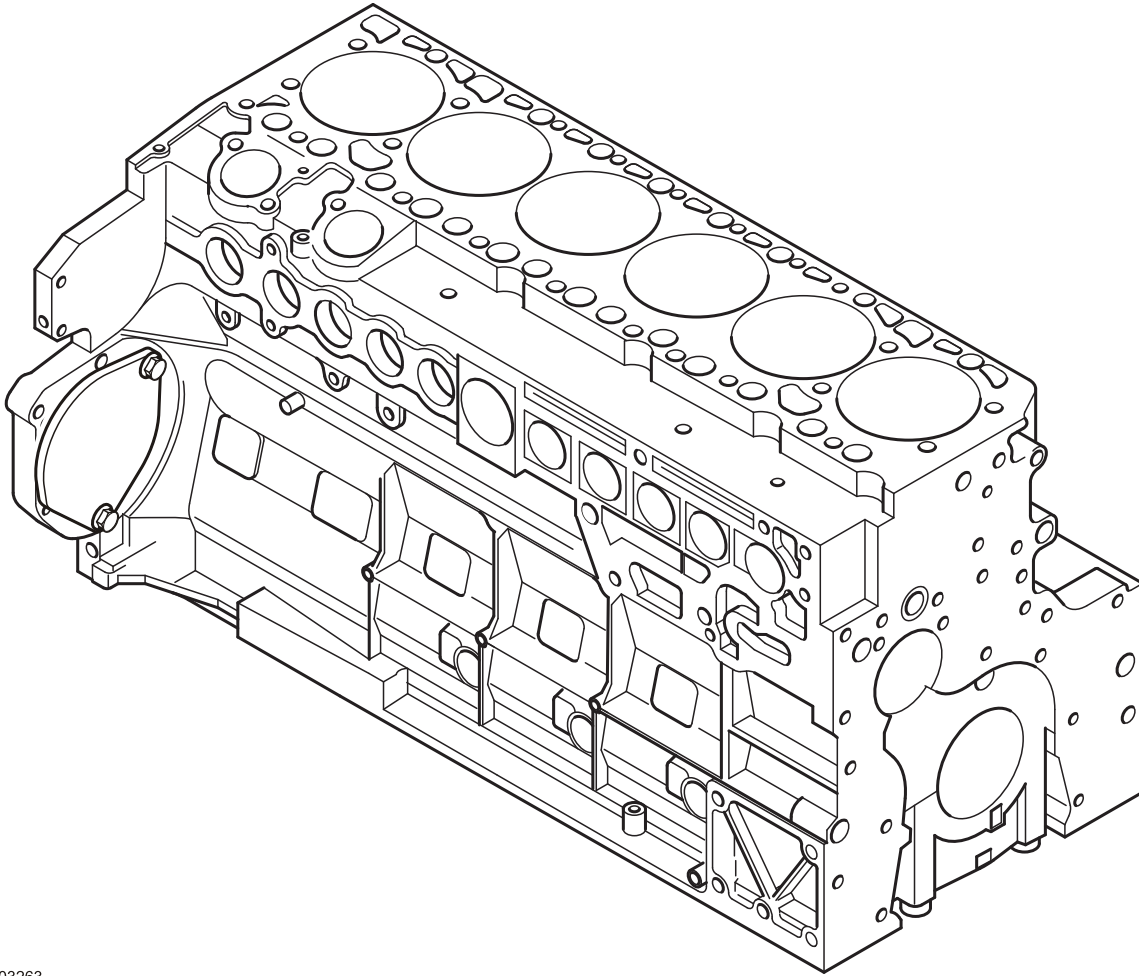


P0003262

The injector (1) is regulated by the control unit. The injectors are centrally positioned between the four valves and are held in place by yokes (2).

The valve guides (3) are made from cast iron alloy. Valve stem seals are fitted to the valve guides.

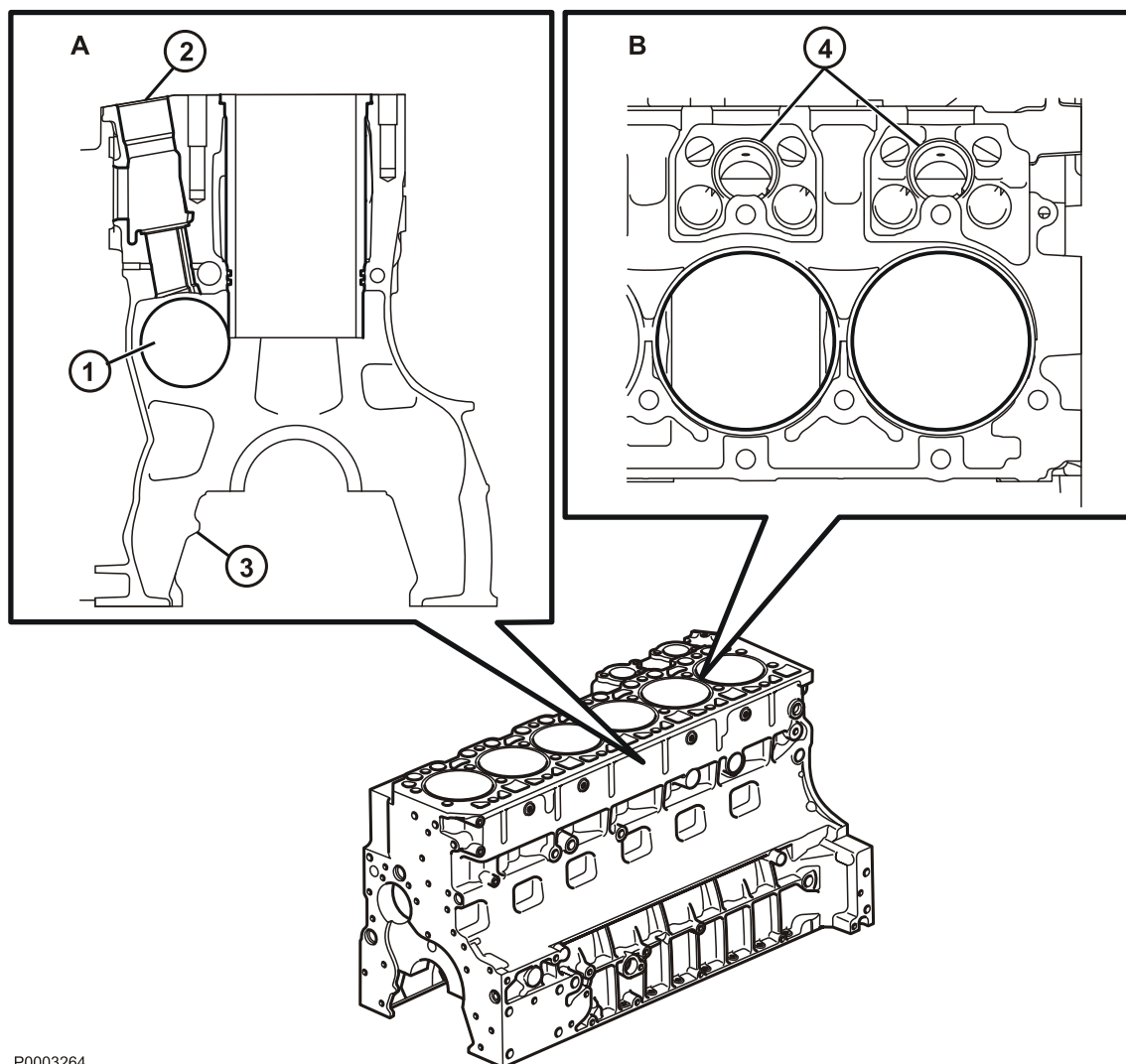
Cylinder block



P0003263

The cylinder block is made of cast iron and cast in one piece.

All oil channels are machined directly in the block. There are two longitudinal oil channels: the right side of the block, seen from the front, is the piston cooling channel and on the left side is the main oil channel. Both channels are plugged



P0003264

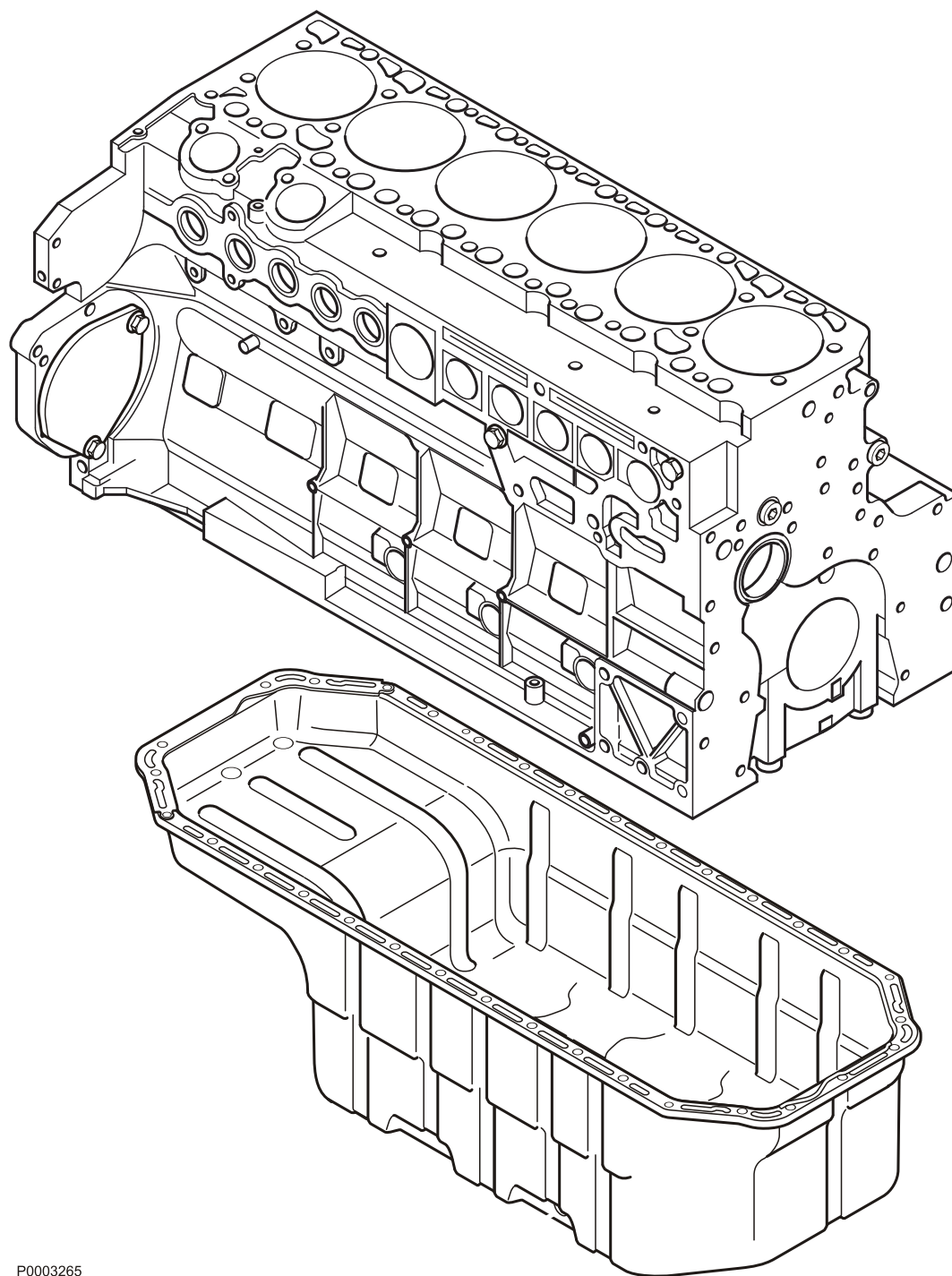
The vertical cross section (**A**) shows the position of the cylinder liner and unit pump in the block.

The camshaft (**1**) is located on the right side of the cylinder block.

All the camshaft bearings are the same size. To render faulty main bearing cap positioning impossible, there is a boss cast into the block (**3**) and an equivalent boss on the main bearing cap. The main bearing caps are furthermore marked with the numbers 1-7 from the rear of the engine. The underside of the bearing cap has an arrow showing the flywheel rotation direction.

The location of the unit pumps is shown both in the vertical cross section (**A2**) and the horizontal cross section (**B4**).

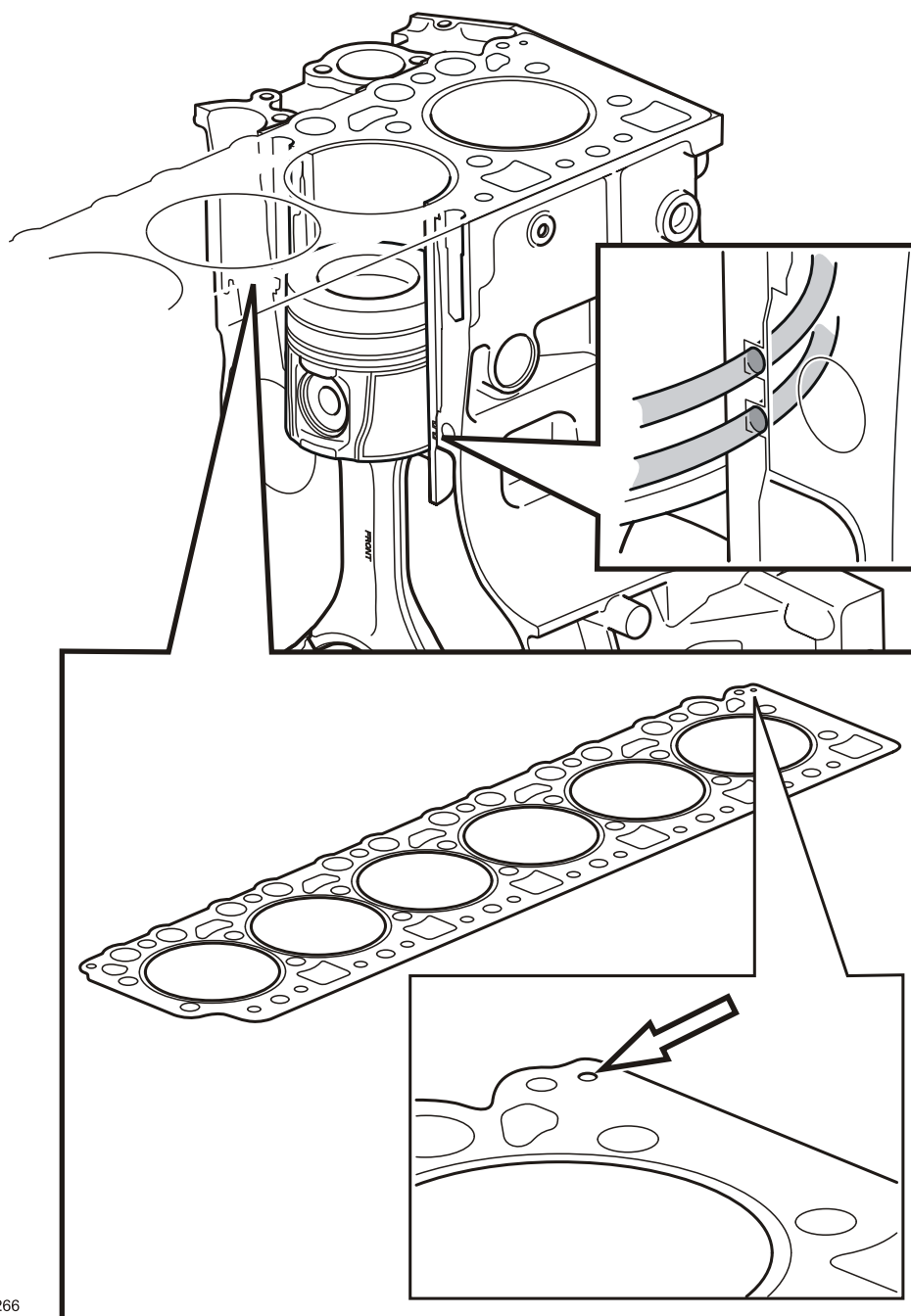
Oil pan



P0003265

The oil pan is a die-cast metal laminate with a volume of about 24 liters. Sealing is achieved with silicon. The oil pan is attached with 34 bolts.

Sealing joints

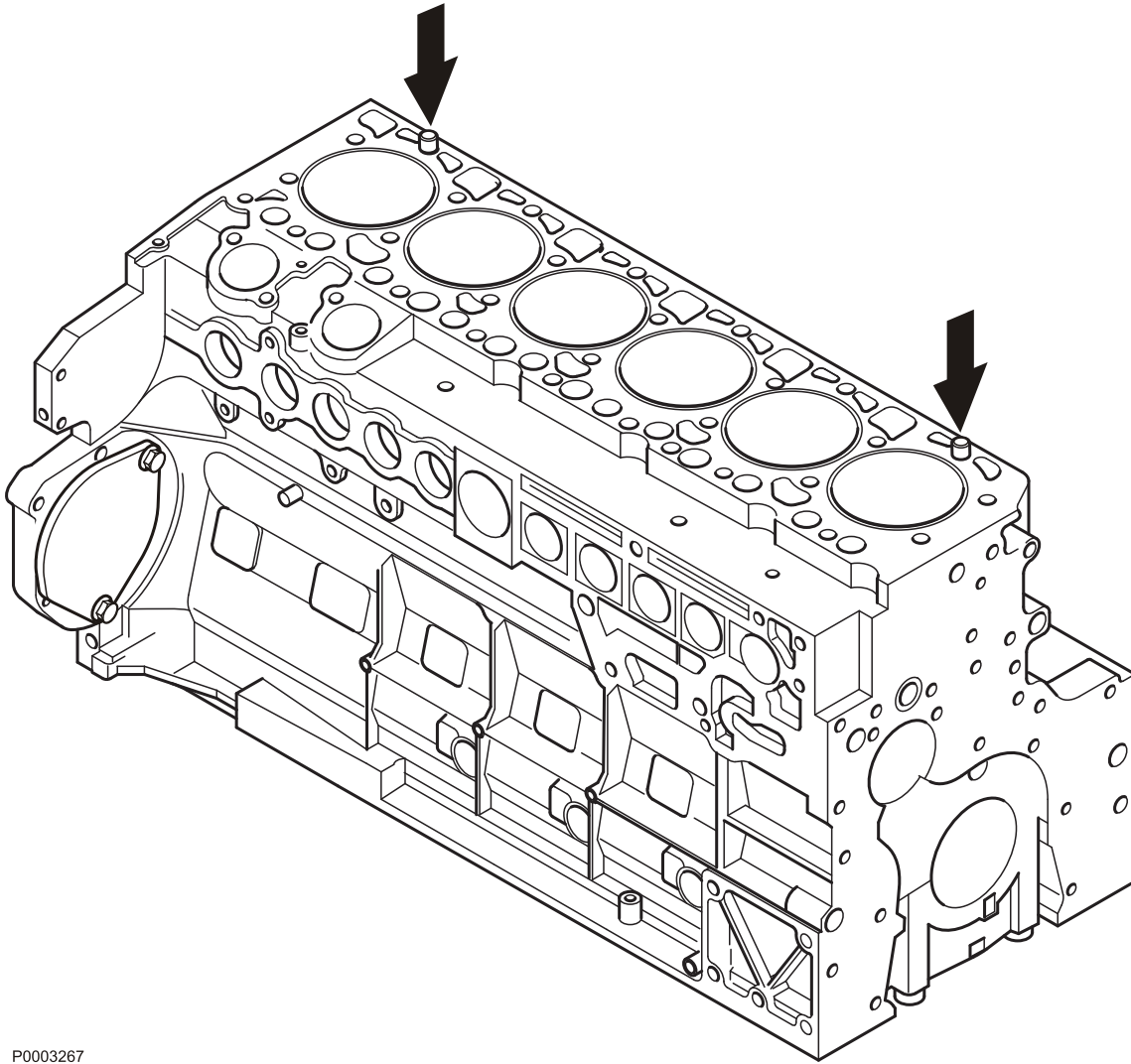


P0003266

TAD734GE has wet cylinder liners. They are sealed against the cylinder block with a direct seal at the liner collar and two rubber ring seals at the lower edge. The sealing rings are made from the same material and have the same color. The liner's sealing surface against the gasket is convex.

The gasket between the cylinder head, block and liner is made from steel and has vulcanized rubber seals for the coolant and oil channels. The thickness of the gasket is determined by one to three holes, where one hole represents the thinnest gasket. The marking holes are located next to the hole for the cylinder head oil supply.

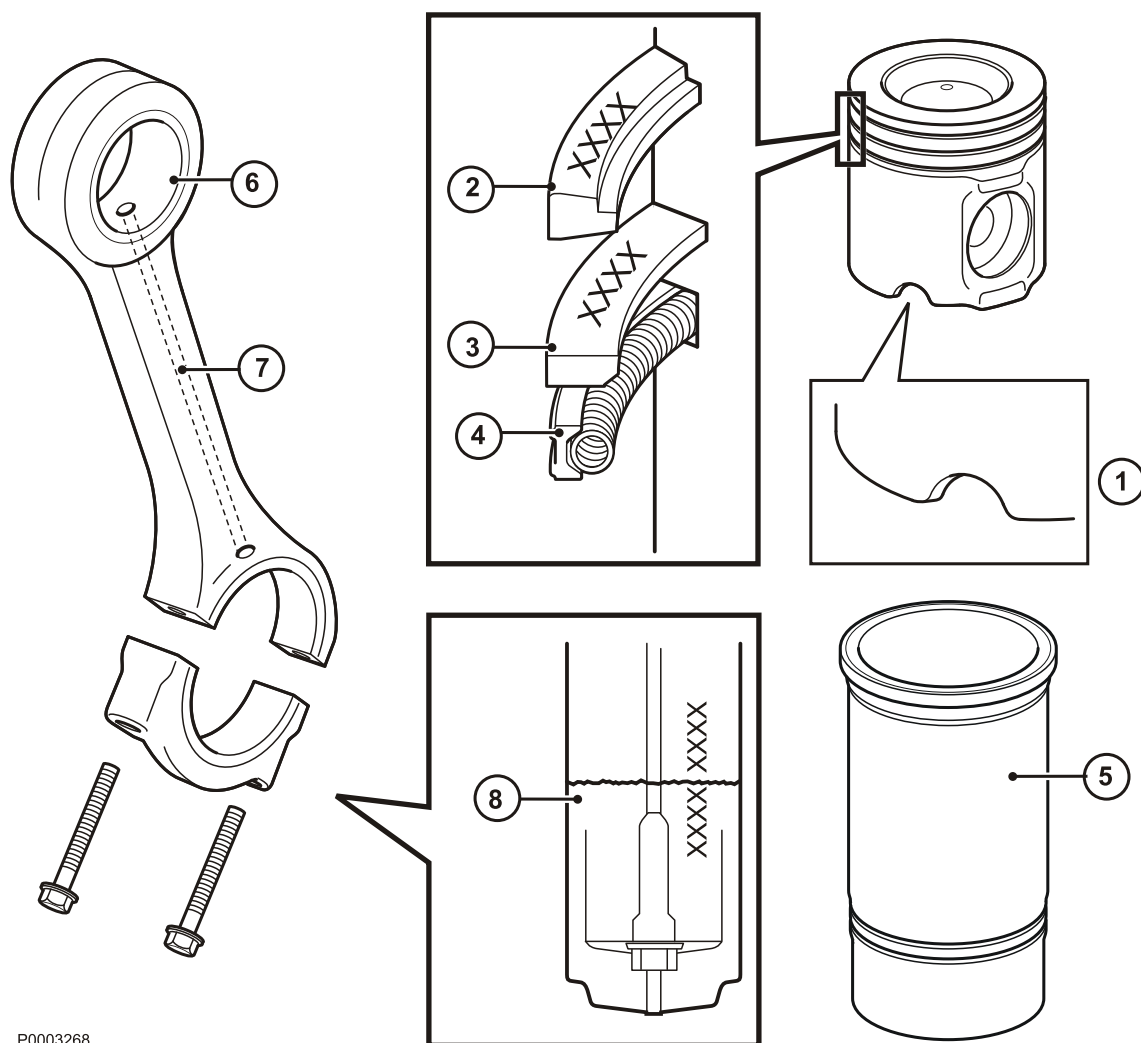
Cylinder head, alignment with the block



P0003267

To facilitate assembly and to achieve an exact positioning of the cylinder head onto the cylinder block, two cylindrical *guide pins* are fitted to the block. There are two corresponding guide holes in the cylinder head.

Piston, cylinder liner and connecting rod



P0003268

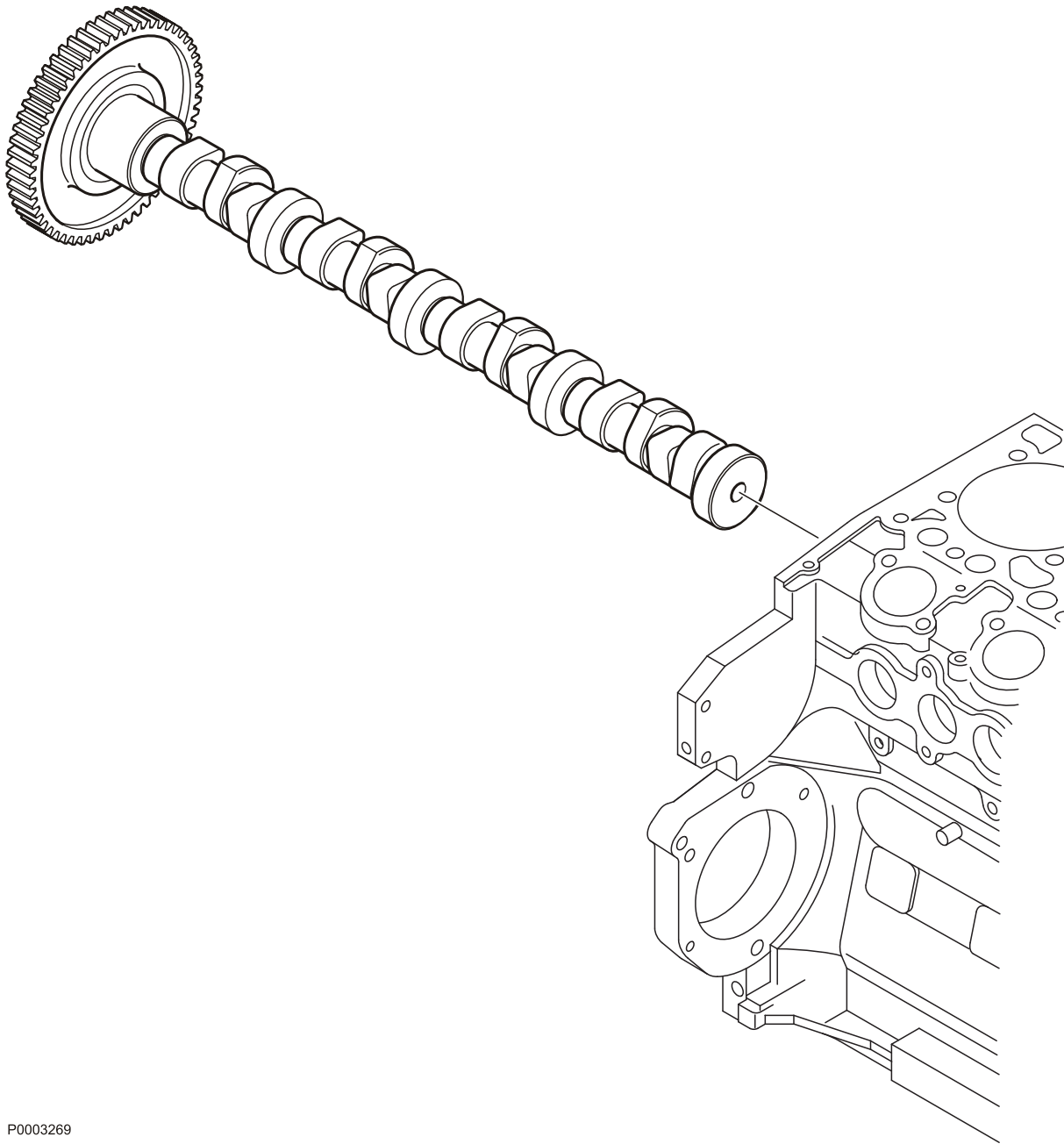
The engine has pistons cast in aluminum alloy. The lower edge of the skirt has a "recess" for piston cooling (1). The piston has two compression rings and one oil scraper.

The upper compression ring (2) is of Keystone type with a trapezoid section. The lower compression ring (3) has a rectangular section with a chamfered lower edge. The oil scraper (4) is spring loaded.

The valve guides (5) are made from cast iron alloy.

The conrod is forged and split at the lower end (big end) using a method known as fracture splitting. The upper end (little end) has a bush (6) lubricated via a drilled channel (7). Each connecting rod is marked on both parts (8).

Camshaft and valve mechanism



P0003269

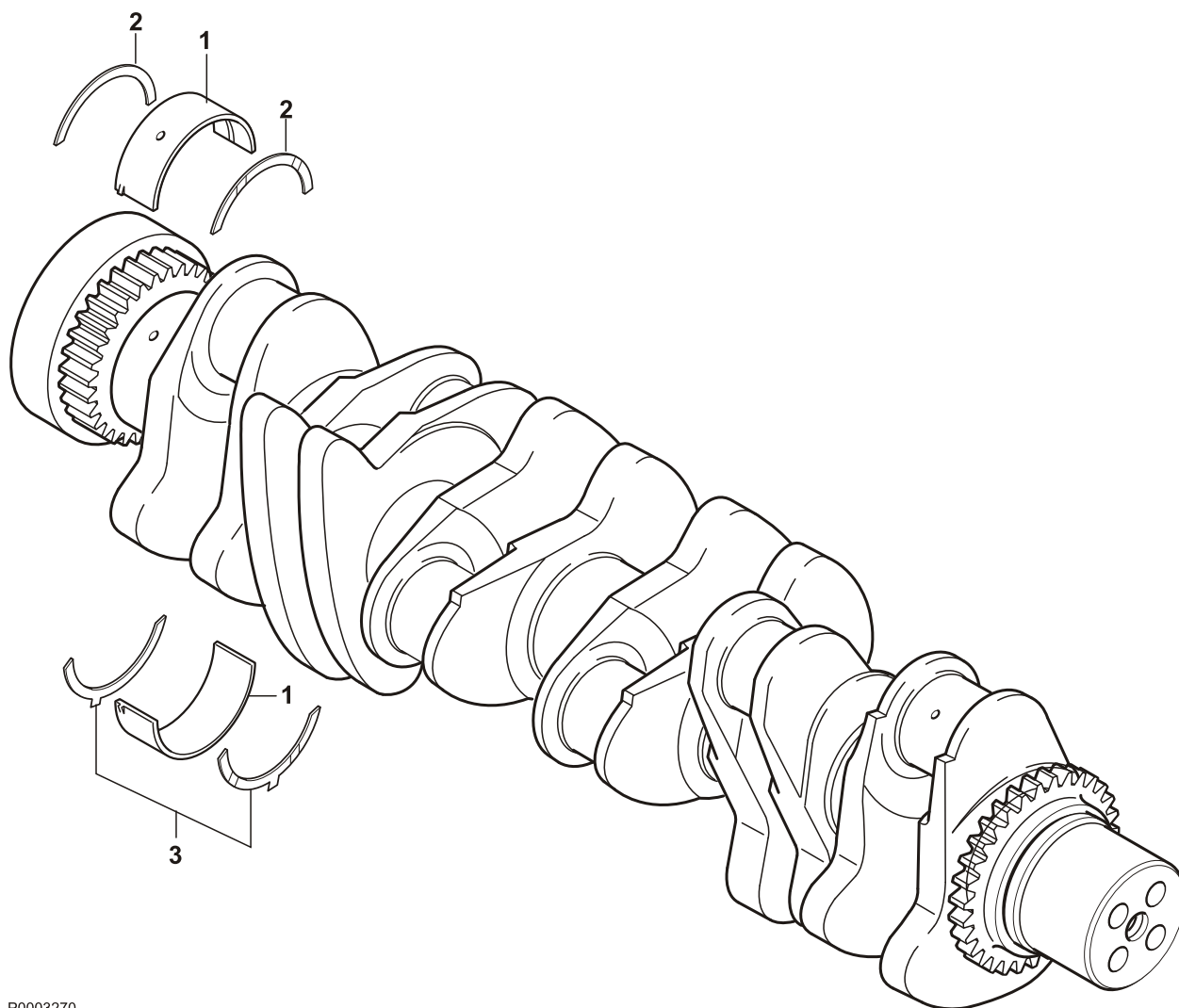
The camshaft is induction hardened and is supported in seven main bearings with interchangeable bearing shells. Between each bearing cap there are two cams: an inlet and an exhaust cam. The exception is by the two unit pumps, where there are three cams: an inlet, an exhaust and a unit pump cam. The unit pumps are staggered at 120° intervals in relation to one another.

The camshaft is driven directly by the crankshaft. The camshaft and drive gear are a single unit, since the gear is shrink-fitted in place.

The camshaft sensor lugs are located within the gear wheel. There are seven sensor lugs, of which six handle sensor signals and one acts as a zero-setting lug.

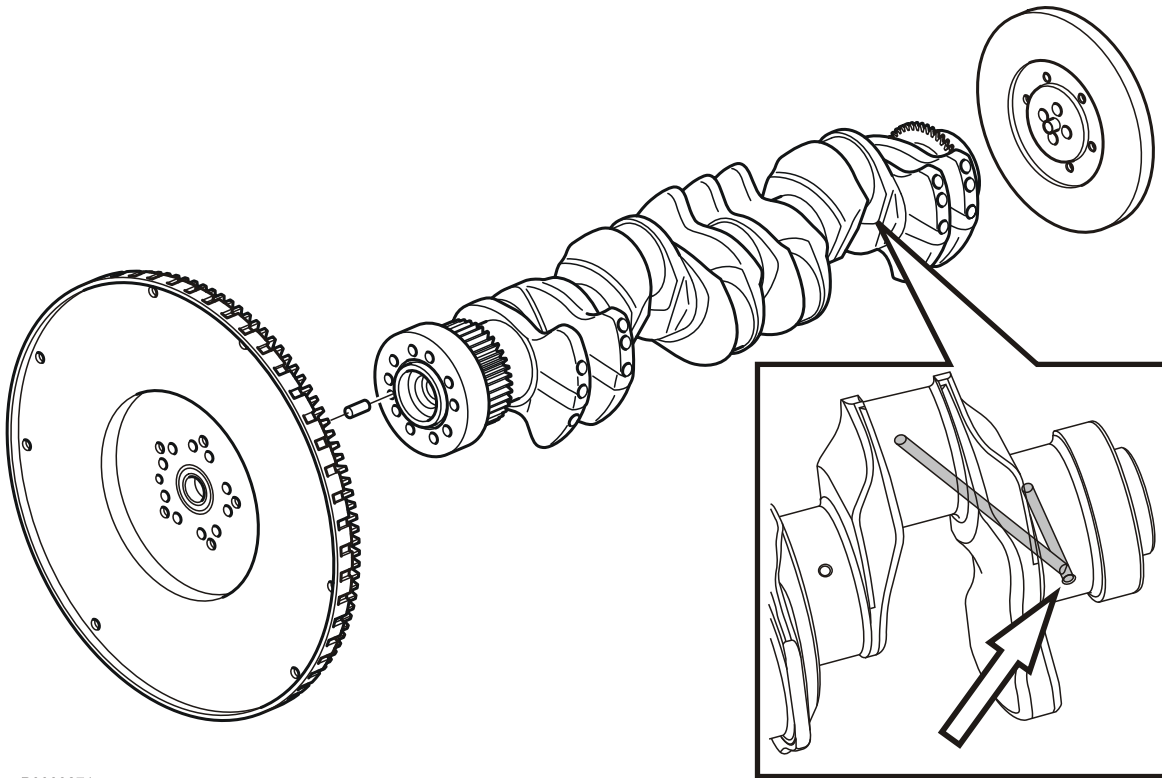
The engine valve mechanism works according to the pushrod principle. Power transfer from the camshaft to the push rods takes place via roller cams. During rotation, the roller-follower roller moves back and forth transversely on the cam. This minimizes wear. The unit pumps are also operated by roller followers.

Crankshaft, oscillation damper, flywheel



P0003270

The crankshaft is supported in seven main bearings with interchangeable bearing shells (1). The main bearing caps are furthermore marked with the numbers 1-7 from the rear of the engine. The second main bearing from the rear also houses the thrust bearing, comprising four half-moon shaped washers. The thrust bearing in the cylinder block (2) has no pins while the thrust bearings in the caps (3) have pins for easier fitting.



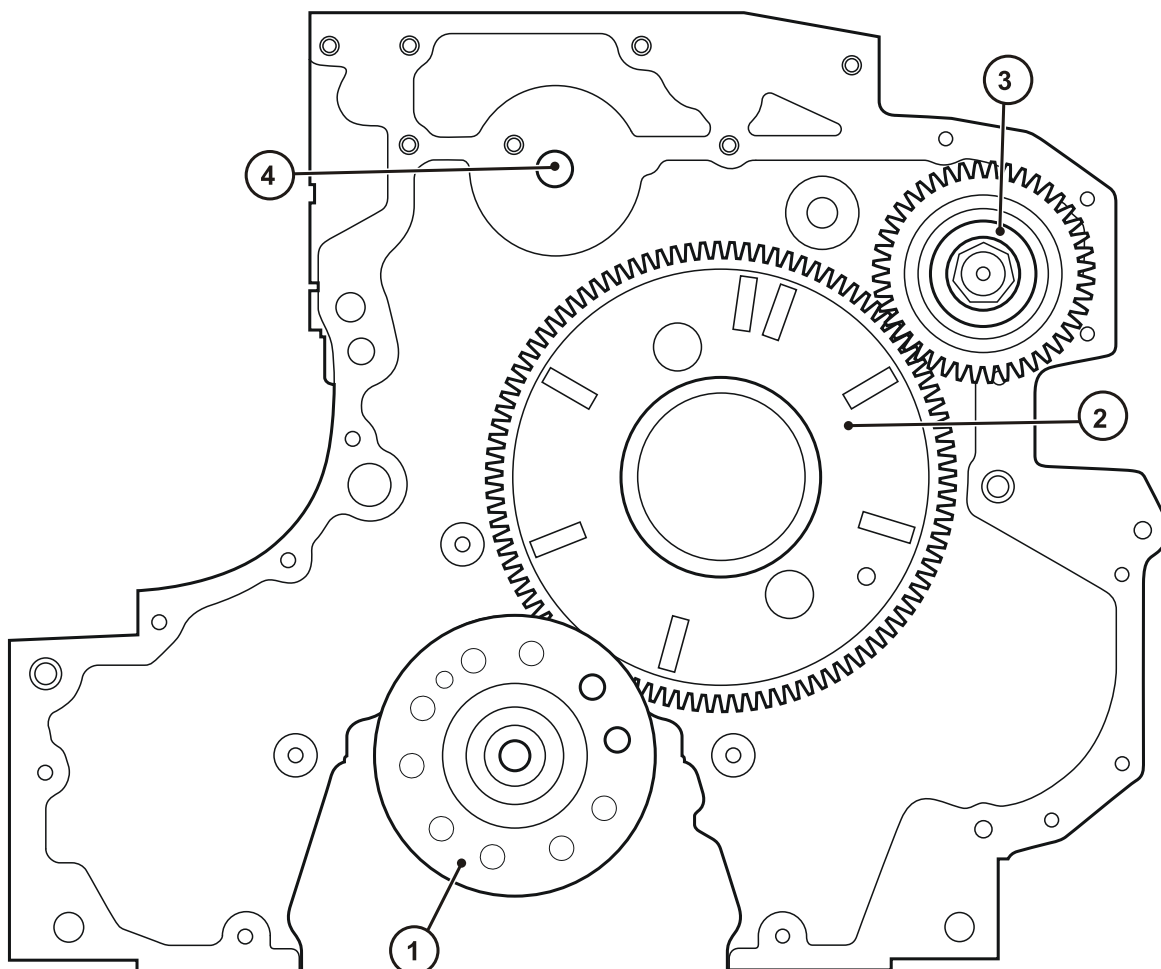
P0003271

The crankshaft and drive gear are a single unit, since the gear is shrink-fitted in place. The oil pump drive is located at the front end of the crankshaft. There is a machined surface in front of the drive gear, on which the crankshaft seal sits against the oil pump housing. The gear that drives the camshaft is located at the rear end of the crankshaft. There is a machined surface behind the drive gear, on which the crankshaft seal sits against the flywheel housing.

The crankshaft is lubricated via separate channels in the cylinder block feeding each main bearing. Each crankshaft cap has a bored channel, from which a channel is drilled to the closest big end journal.

The oscillation damper is hydraulic and is bolted directly onto the front crankshaft flange. The damper is also used as a multi-grooved belt pulley. The flywheel is bolted to the rear crankshaft flange with ten bolts. The flywheel is fixed to the crankshaft with a guide pin. The ring gear is replaceable. There are milled grooves on the periphery for the flywheel sensor.

Timing gear

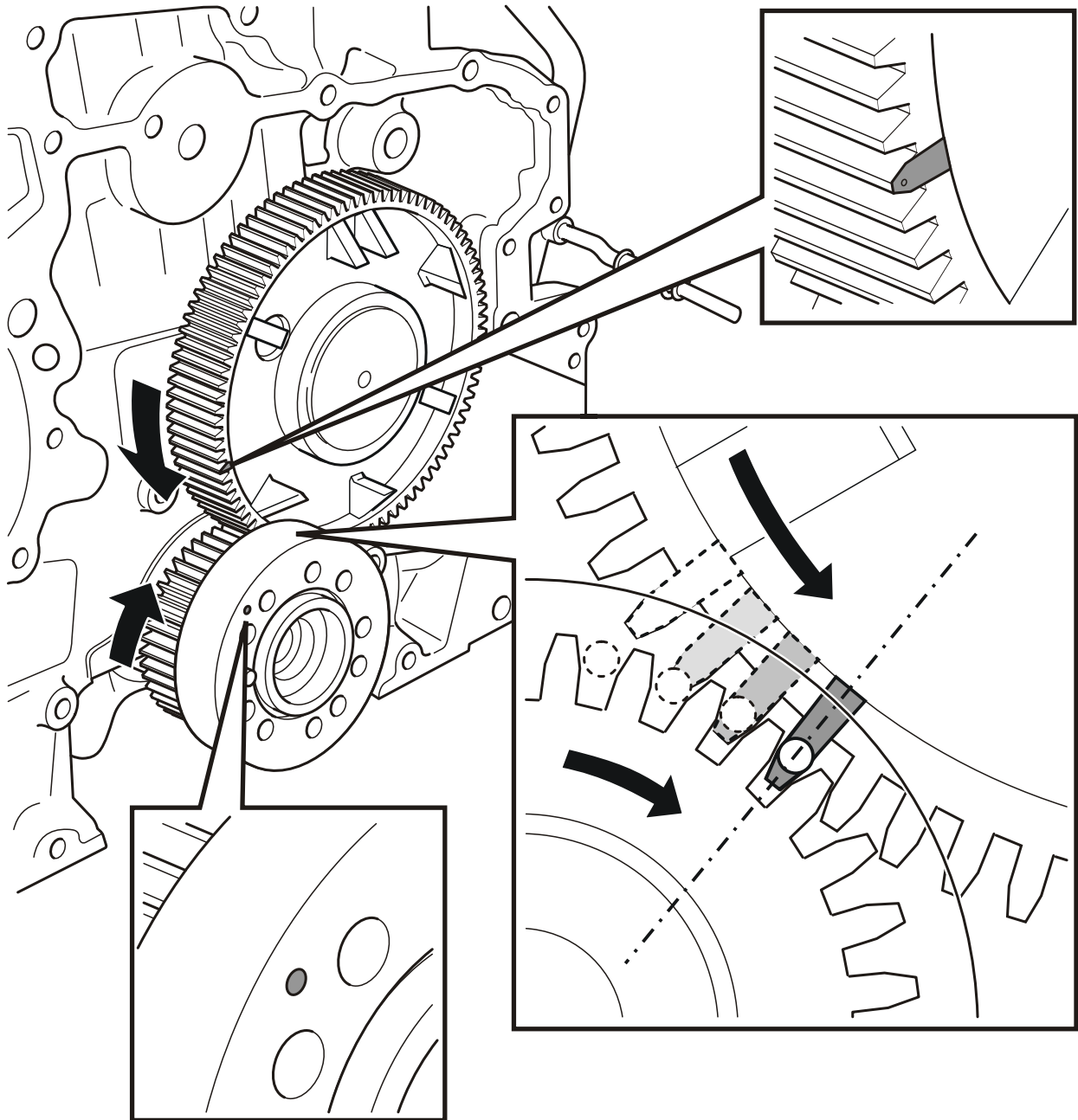


P0003272

- 1 Crankshaft gear
- 2 Camshaft gear
- 3 Fuel pump drive
- 4 Flywheel housing alignment

The engine timing gears are located between the engine block and flywheel housing at the rear of the engine. The crankshaft drives the camshaft gear and the camshaft gear drives the fuel pump gear. The crankshaft flange overlaps the camshaft gear.

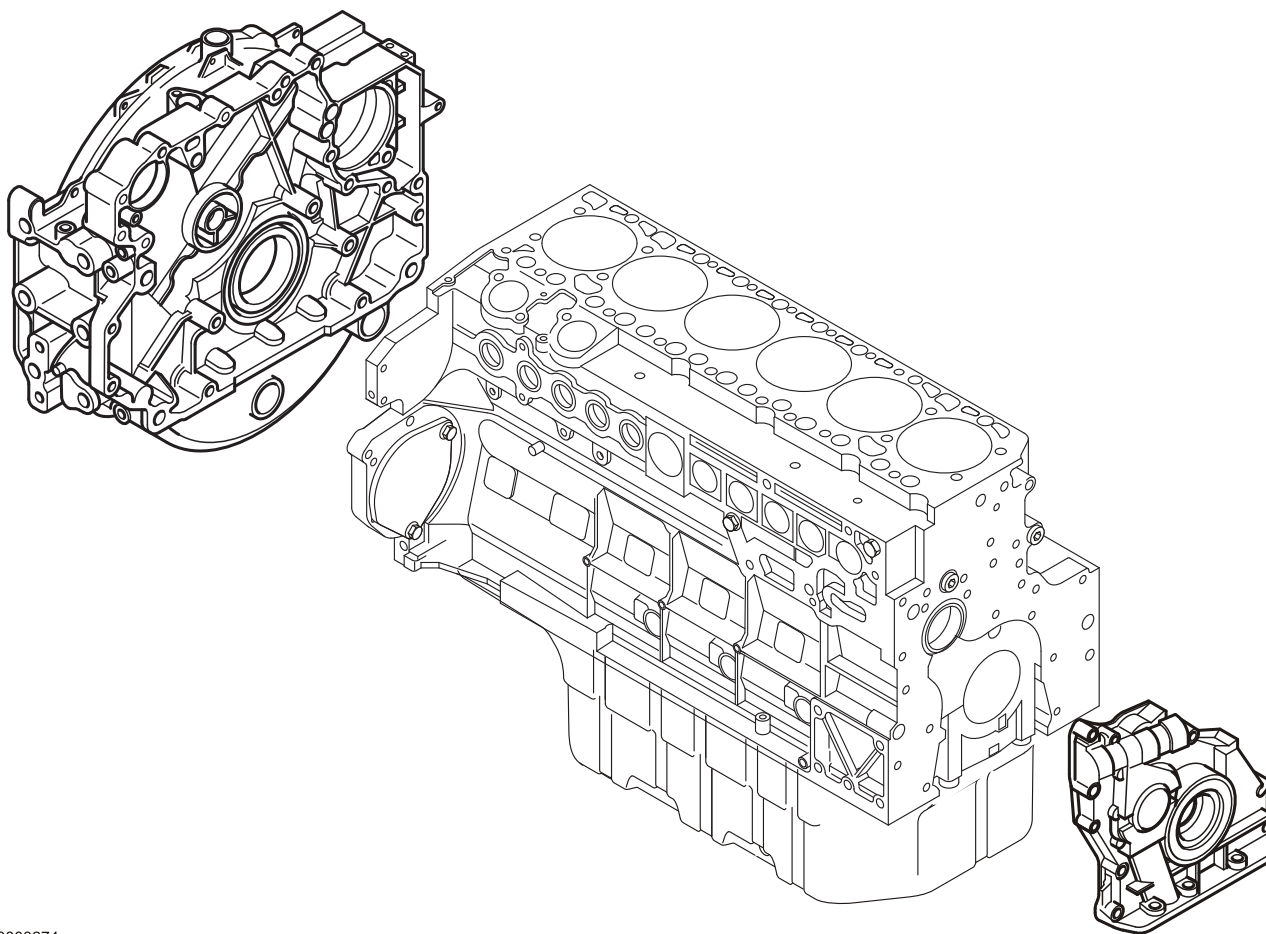
The seal between the flywheel housing and engine block is made with sealant.



P0003273

The crankshaft and camshaft are aligned by placing the punch mark on the camshaft gear in line with the marking on the crankshaft flange.

Housings

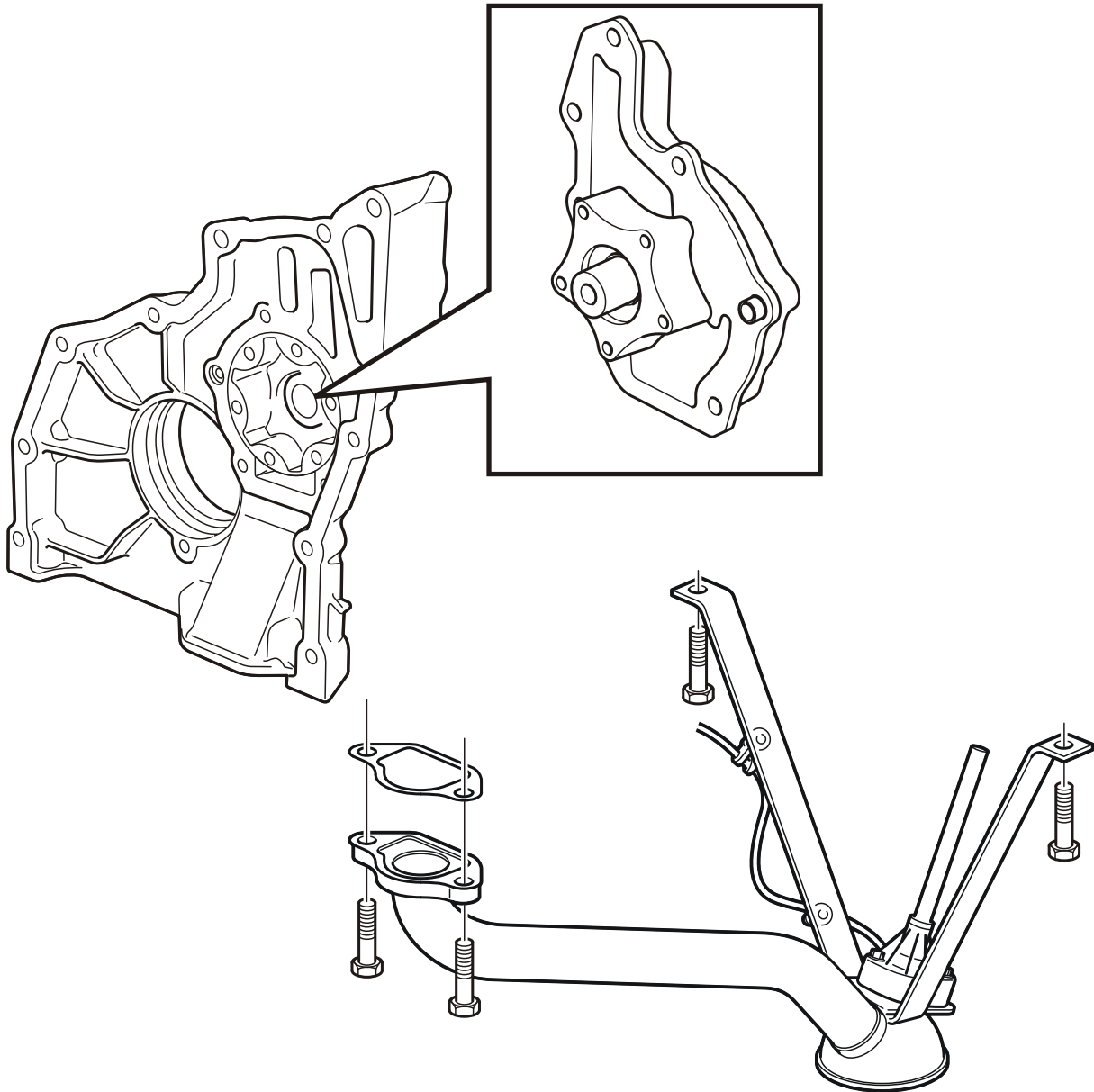


P0003274

The engine has two housings. At the front end the drive gear between the crankshaft and the oil pump is protected by a cover into which the oil pump is integrated. At the rear end, the timing gears are covered by the flywheel housing.

The crankshaft is sealed against the housings with oil seals.

Oil pump

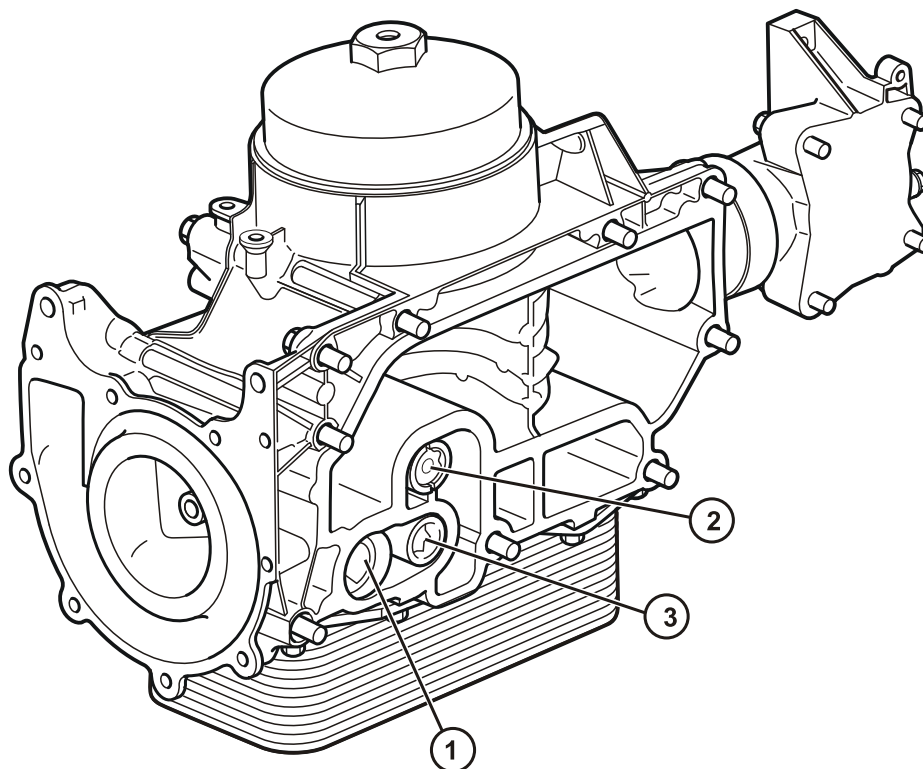


P0003275

The oil pump is a gear pump with a rotating inner ring. It is integrated into the oil pump cover at the front of the engine and is driven by a gear on the crankshaft. A safety valve is fitted in the oil pump cover directly after the oil pump.

The oil strainer supplies oil to the pump. The strainer is connected to the oil pump via a pipe and gasket.

Oil filter housing



P0003276

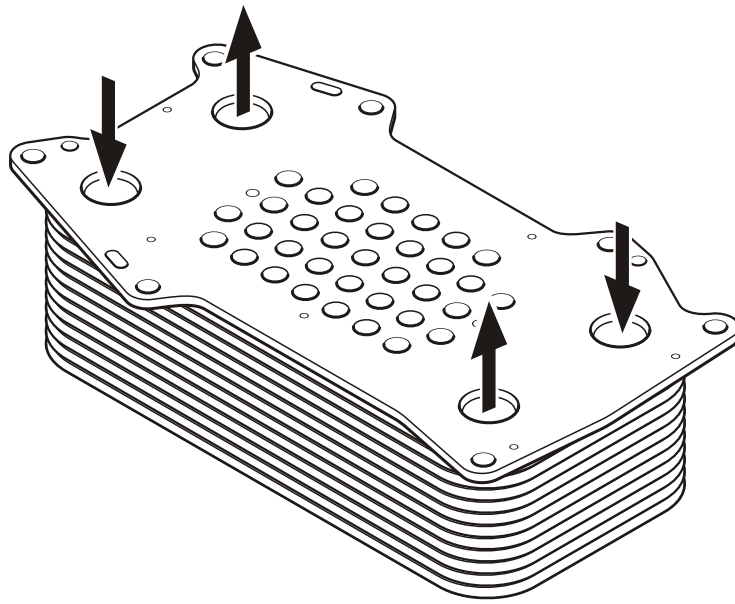
The oil pressure sensor is mounted in the oil filter housing and measures the pressure entering the engine. Oil flow to the engine is regulated by three valves located in the oil filter housing.

- 1 Oil filter check valve. The function of the valve is to prevent oil draining out from the filter housing when the engine stops.
It also provides back pressure to the oil pump.
- 2 By-pass valve, which regulates system pressure. Oil is returned to the oil pan.
- 3 Oil cooler by-pass valve. The valve has a by-pass function.

There are a further two valves in the oil filter:

- There is a by-pass valve at the very top of the filter.
- Below the filter is a valve that drains automatically when the filter is lifted.

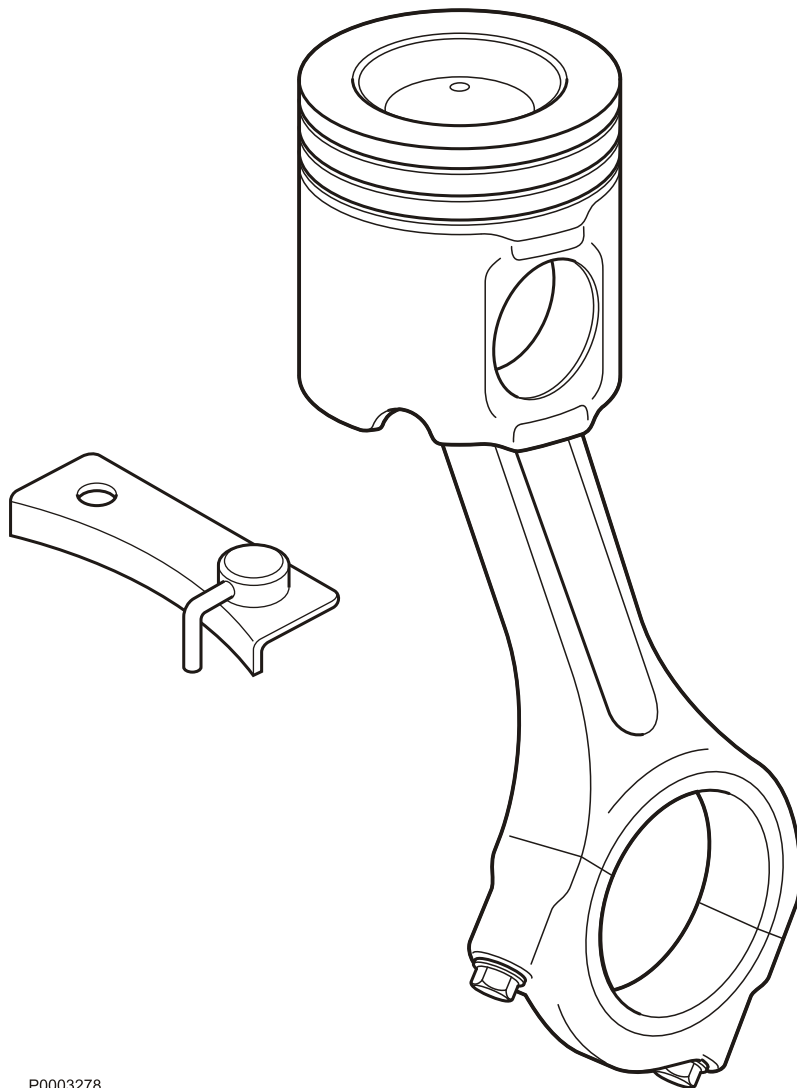
Oil cooler



P0003277

The oil cooler is mounted directly under the oil filter housing. It is a reverse-flow cooler where the oil is transported backwards and water forwards.

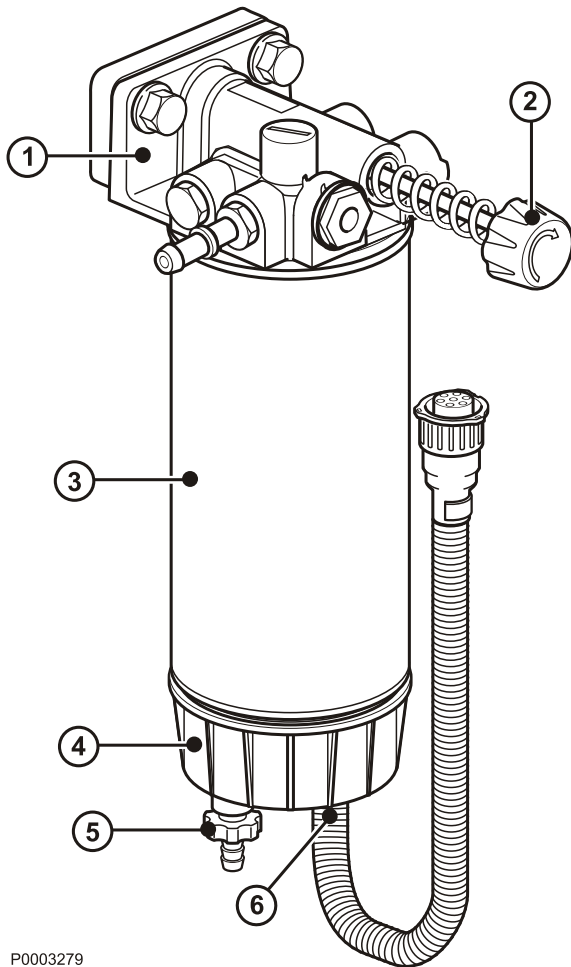
Piston cooling system



P0003278

The piston cooling nozzle is aimed so that the oil spray reaches the underside of the piston crown. The piston skirt has a recess for the piston cooling nozzle.

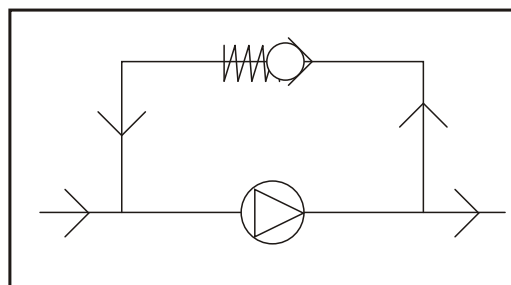
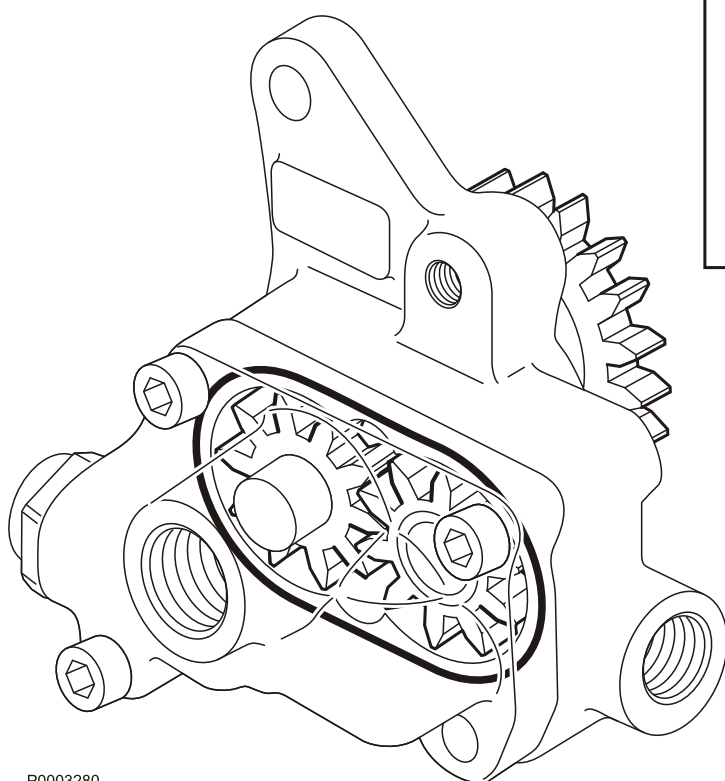
Fuel pre-filter and water separator



P0003279

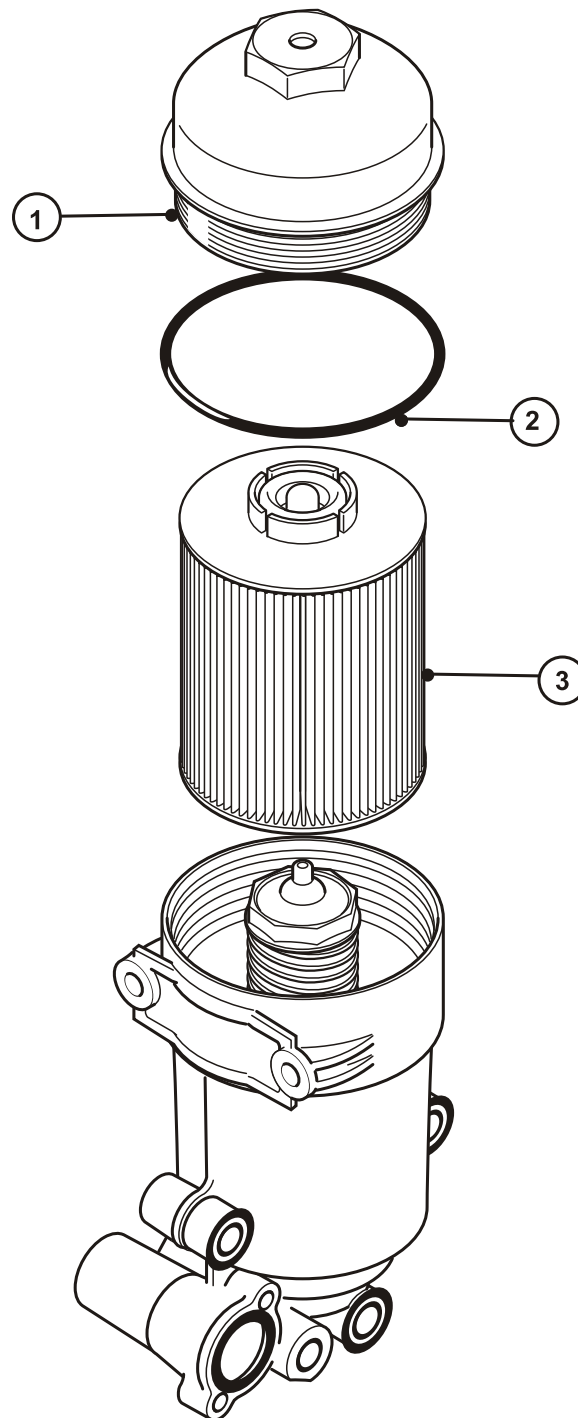
The hand pump unit (1) has a hand pump (2), which is used to purge the fuel system. The pre-filter is fitted beneath the hand pump unit (3). The water separator's lower part is fitted to the pre-filter (4), along with a drain nipple (5) and a sensor (6).

Fuel feed pump



The feed pump is a gear pump driven by the camshaft. It is located on the right side of the flywheel housing. The pump has an integrated by-pass valve to maintain the correct flow and pressure in the fuel system. The by-pass valve is not replaceable.

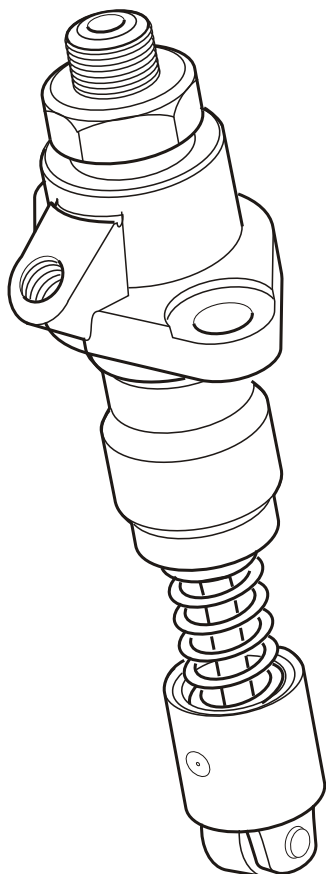
Fuel filter



P0003281

The fuel filter housing comprises a filter and two valves. At the very top of the filter there is a by-pass valve and beneath the filter there is a valve which automatically drains the housing when the filter is removed. The feed pressure sensor is fitted in the fuel filter housing.

Unit pumps



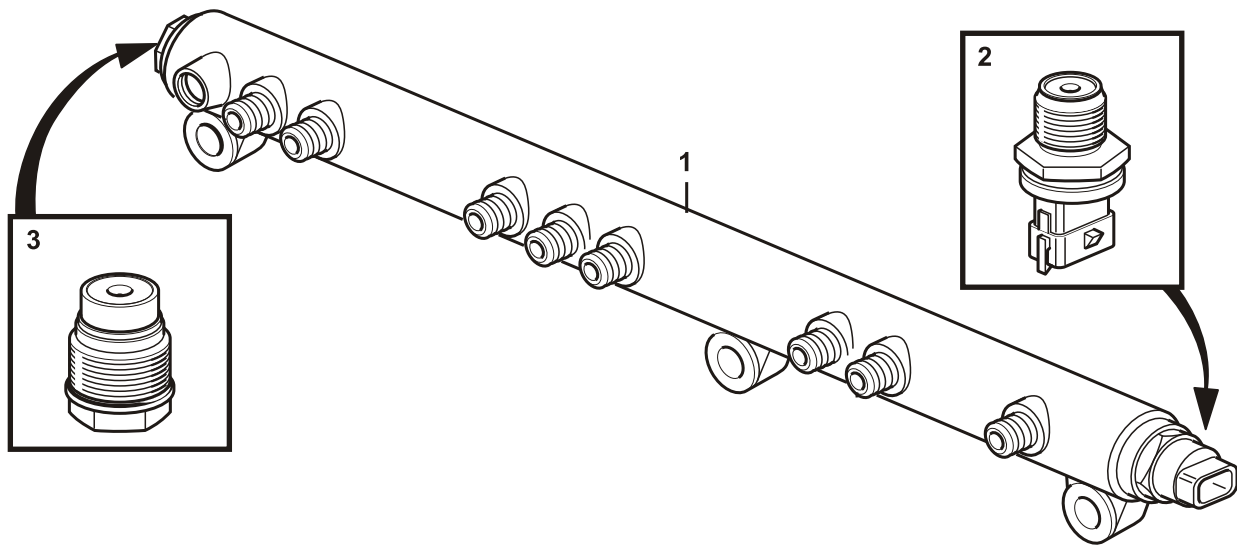
P0003287

The fuel system contains two unit pumps that are driven by roller followers activated by the camshaft. Their purpose is to pressurize the fuel system.

The high pressure and low pressure sides of the unit pumps are hydraulically separated. The unit pumps require a pressure of at least 1.7 bar in order to work.

NOTICE! *Unit pumps are very sensitive to dirt particles.*

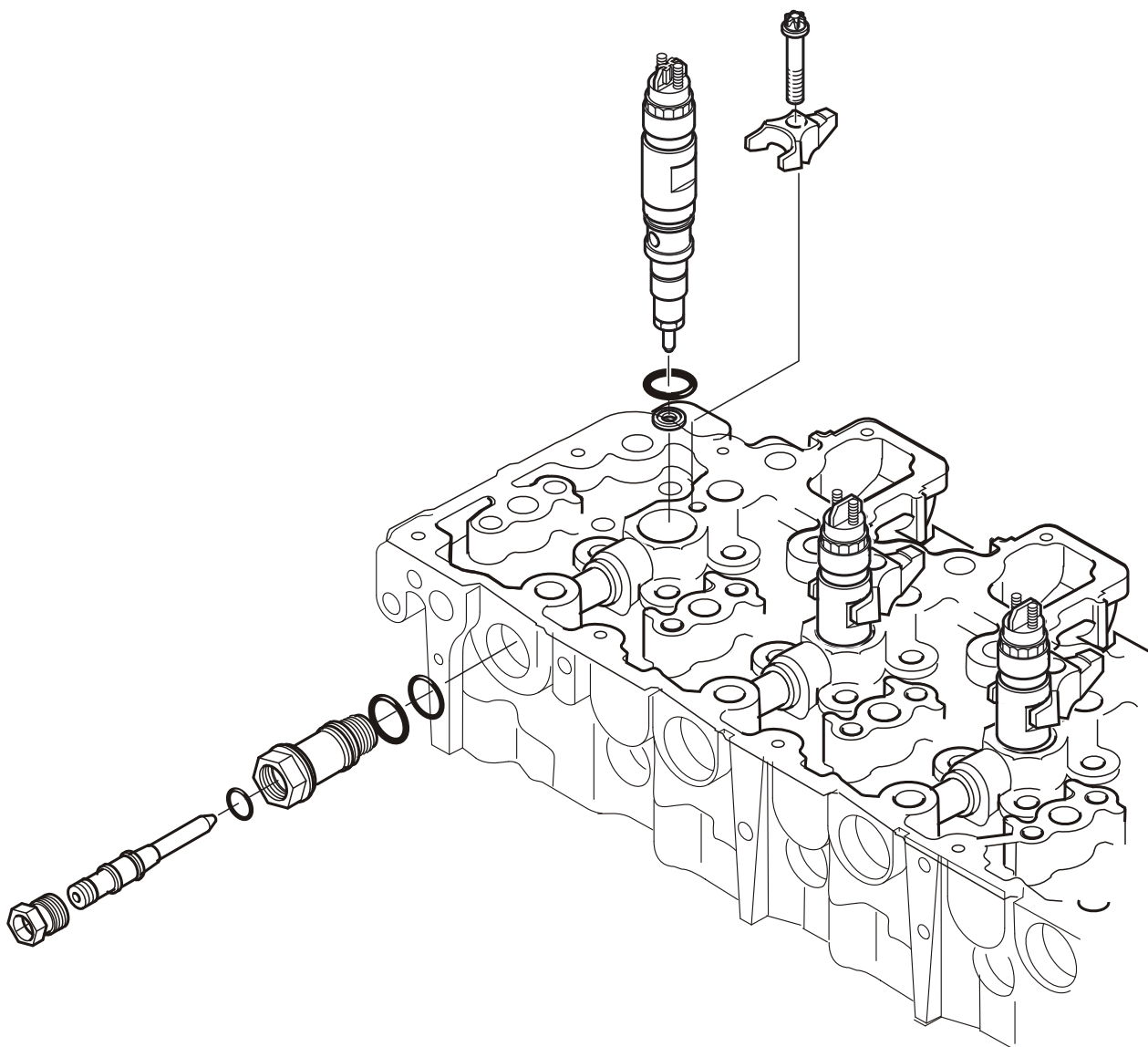
Pressure pipes and common rail



P0003283

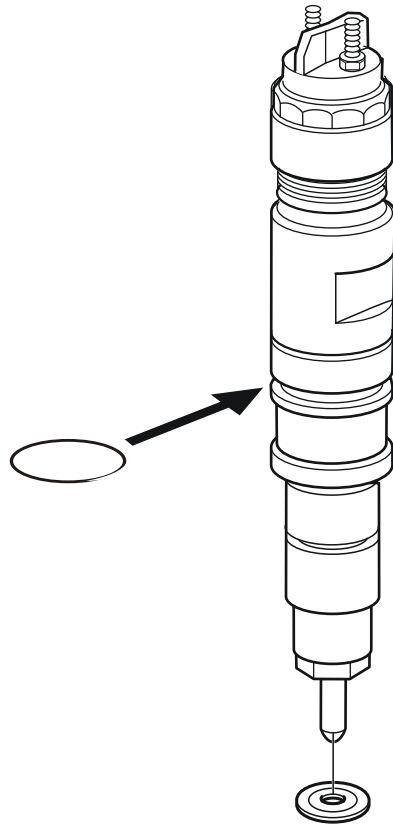
The common rail (1) has an inner volume of 35 cm³ and is used to store pressurized fuel for the injectors. The common rail has a pressure sensor (2) and a safety valve (3) that opens at a pressure of about 1850-1950 bar. The safety valve protects the high pressure side of the fuel system against excess pressure. If a safety valve opens, the pressure drops to about 650-850 bar.

Injector delivery pipe and injector



P0003284

The pressurized fuel passes through a union in the cylinder head, via the injector delivery pipe to the injector. Fuel is fed to the injector via a metallic seal between the injector delivery pipe and the injector.



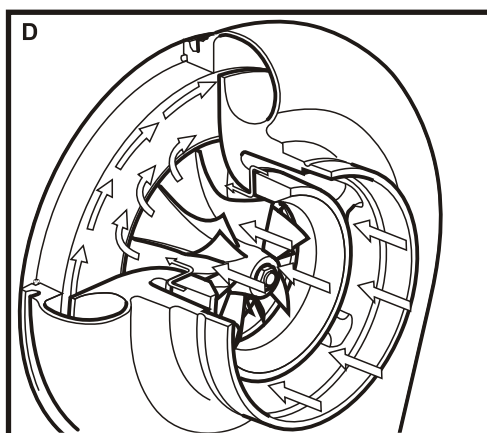
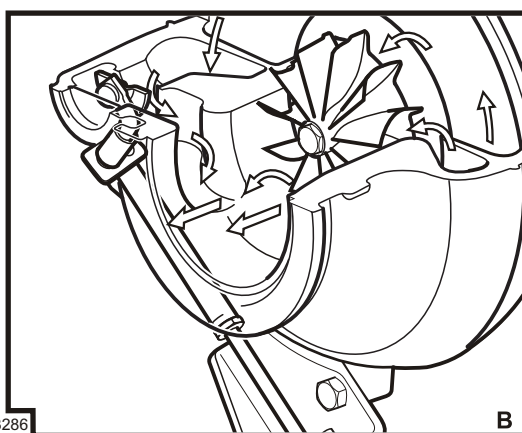
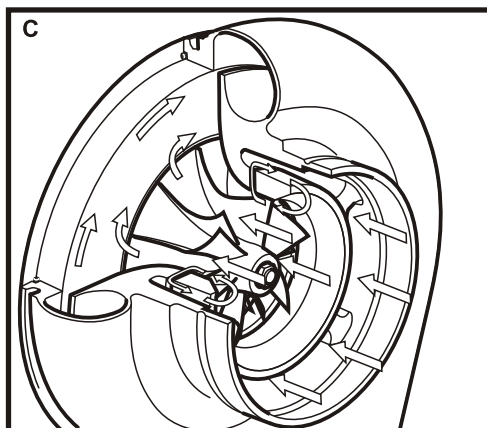
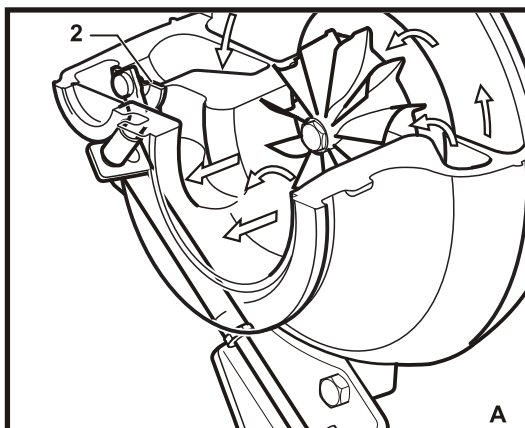
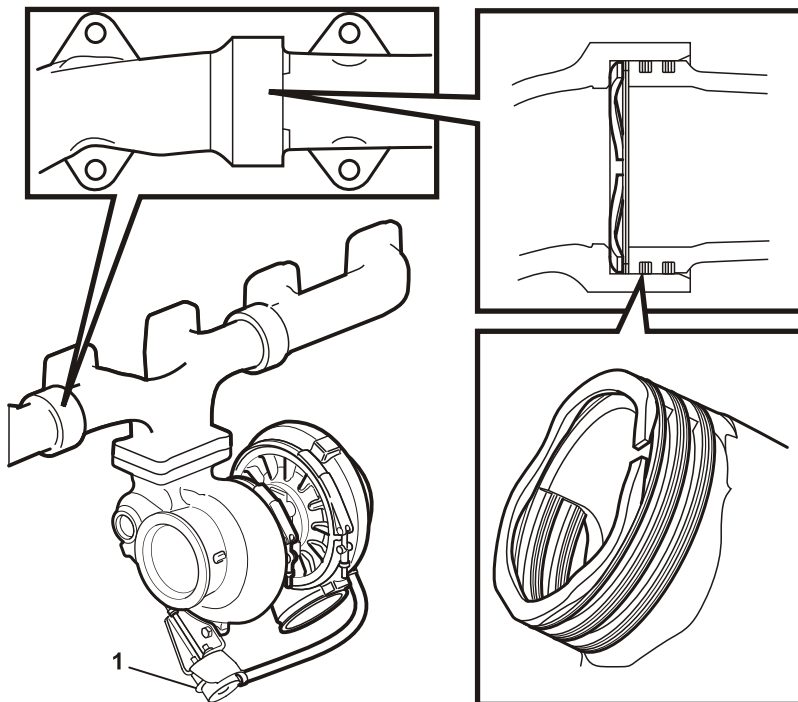
P0003285

Injector opening is controlled by electrical impulses.

The injectors are centrally positioned between the four valves and are held in place by yokes.

The injector fuel return channel is drilled longitudinally through the cylinder head. O-rings seal the injectors and the return channel.

Exhaust manifold and turbocharger

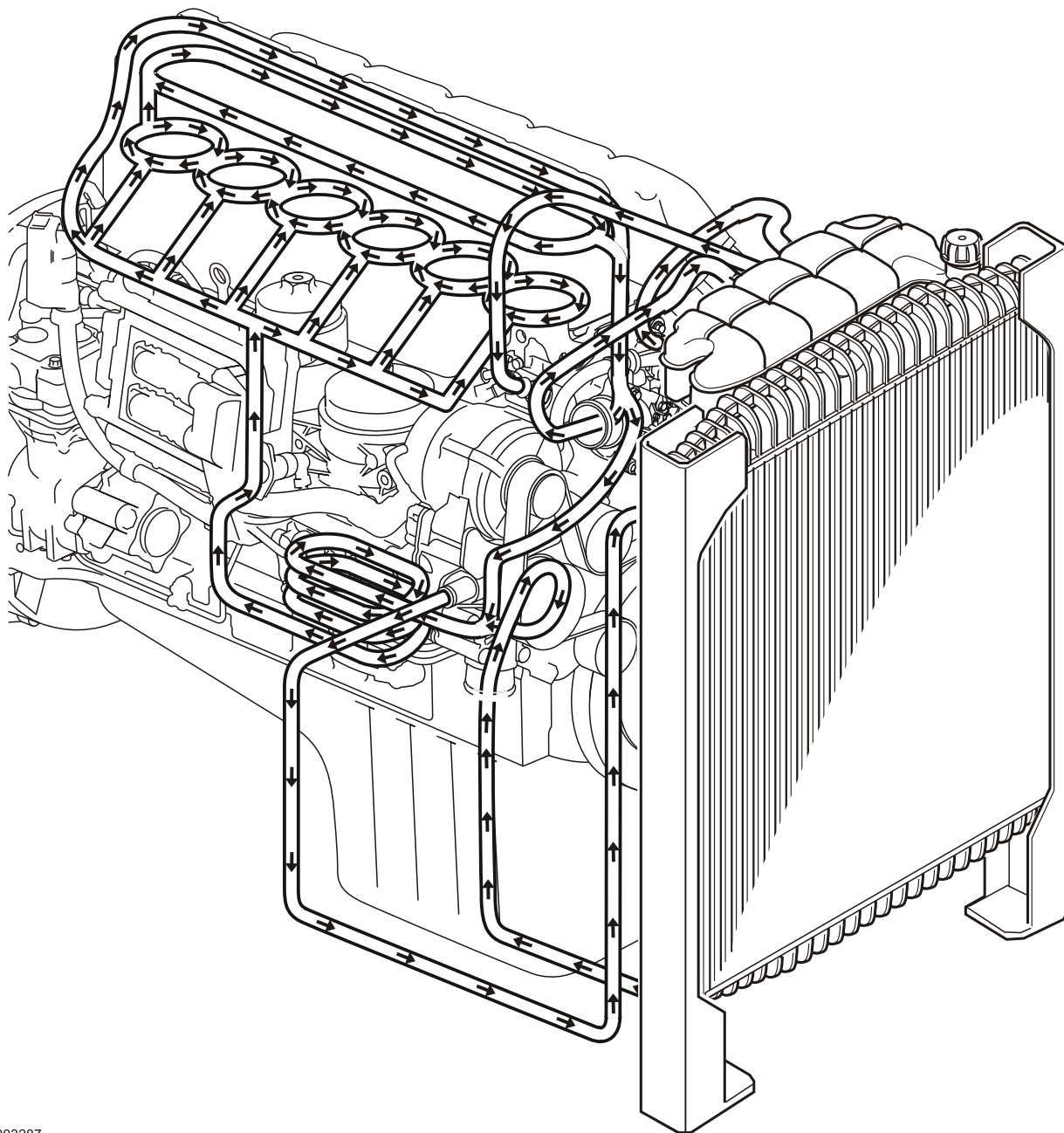


P0003286

The exhaust manifold is made in three parts in heat-resistant cast steel. The joints are sealed with sealing rings. Between the cylinder head and the manifold flanges, there are gaskets made from graphite coated sheet steel. The turbocharger has a turbine with a by-pass and is a MWE-type (Map Width Enhancement). The compressor's air inlet is divided into an inner and outer area, connected via a ring-shaped chamber. The by-pass valve on the exhaust side is designed to protect the turbo by reducing its speed at high power levels. The valve is influenced by the turbo pressure via an actuator and a lever.

- A Exhaust flow at low turbo pressure is shown here. The valve is closed and the entire exhaust flow is through the turbine rotor.
- B When the turbo pressure reaches a certain level, the valve starts to open. Some of the exhaust gases flow via the valve and by-pass the turbine thus reducing turbine revolutions.
- C When the engine is working hard at low speed, the air that the engine cannot use is recirculated via the ring-shaped chamber.
- D At high engine speed and high turbo pressure, the entire inlet area is used, which provides more air to the engine. The turbo thus has a broader working range and engine torque is improved.

Cooling System

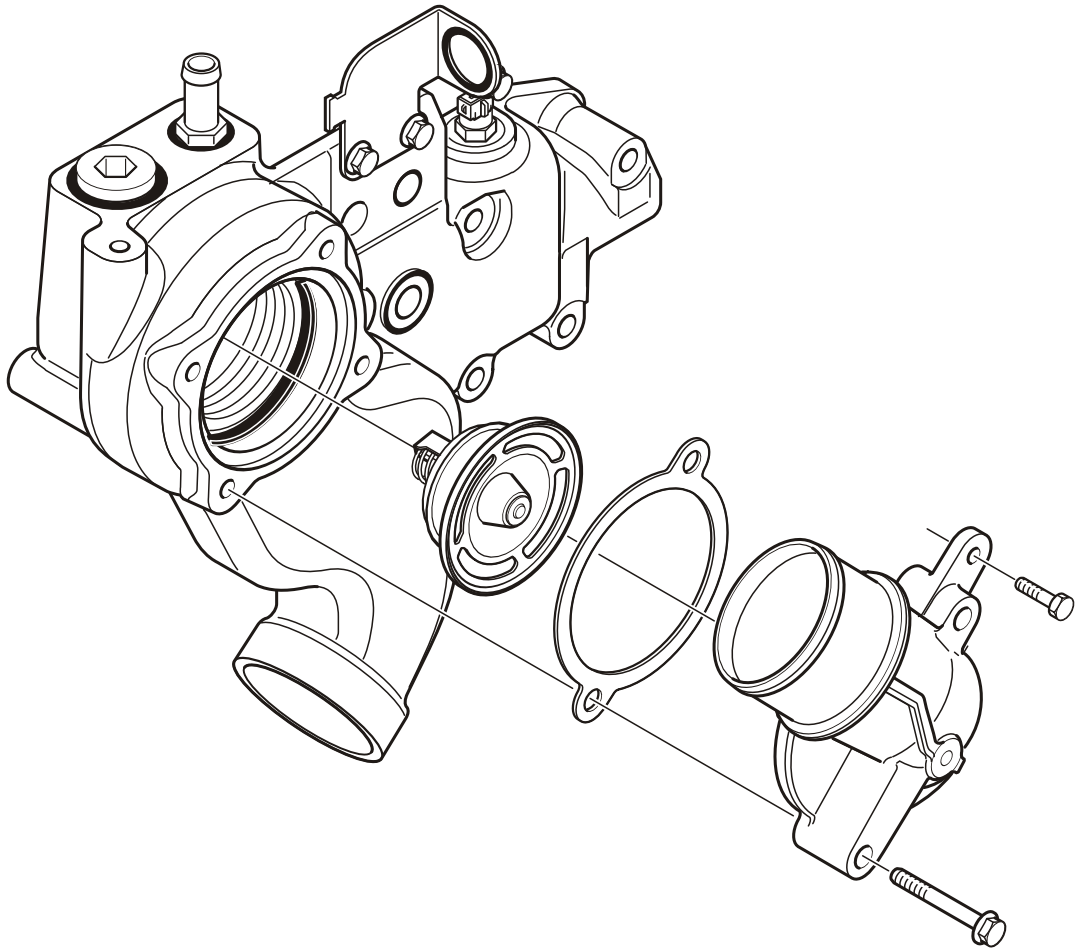


P0003287

The coolant pump pumps coolant into the cylinder block via the oil filter housing. In the oil filter housing the coolant passes both through the oil cooler and the oil cooler's cooling jacket. The cylinder liners are cooled in the cylinder block.

The cylinder block is supplied with coolant through both the return coolant from the liner jacket and via drilled channels. All coolant flows via the thermostat to the radiator or back to the coolant pump, depending on engine temperature.

Coolant pump and thermostat

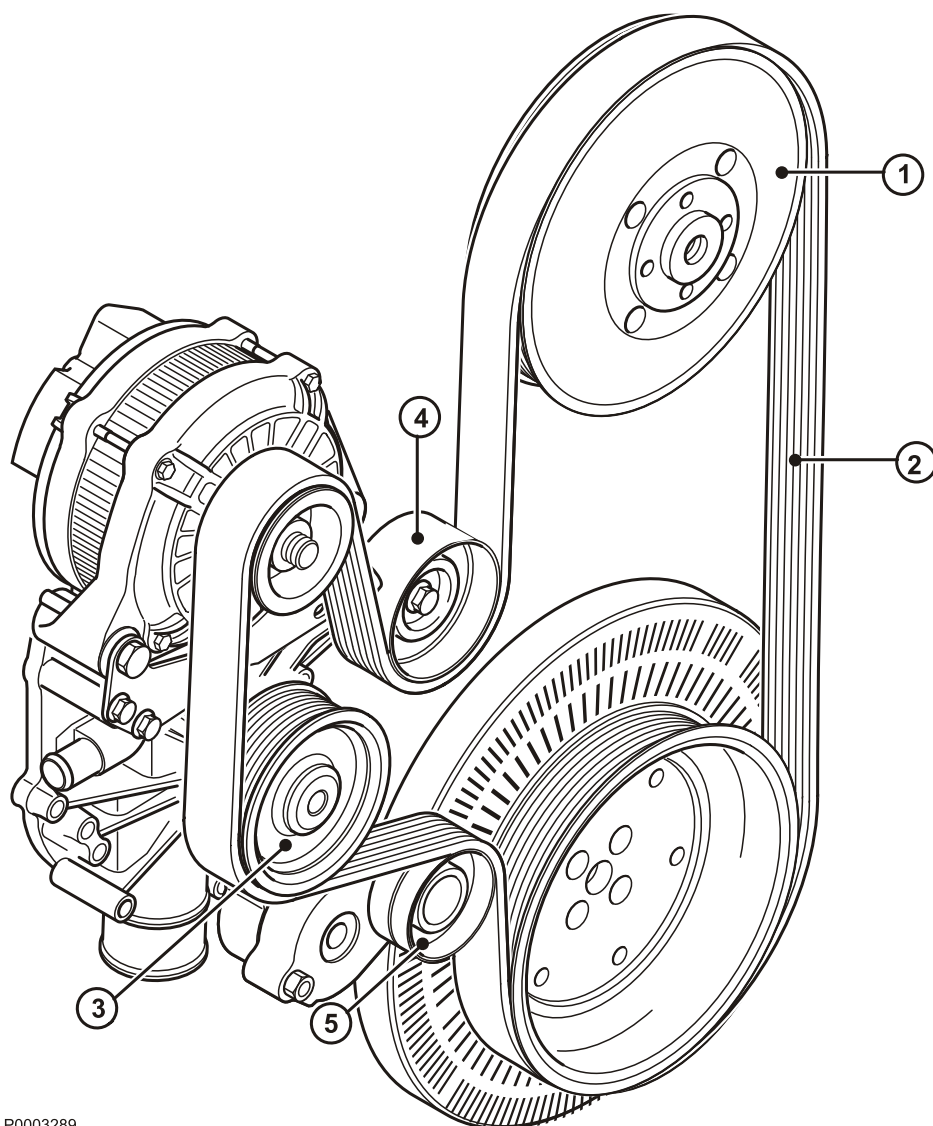


P0003288

The thermostat housing is made from cast iron and is located on the front of the cylinder head. The thermostat opens at 84°C.

The rear section of the coolant pump is machined directly in the oil filter housing and the oil cooler is mounted on the underside of oil filter housing.

Drive belt



P0003289

The fan is driven by a separate drive pulley (1). The drive belt (2) drives the fan, the alternator and the coolant pump (3) via an idler wheel (4) and a belt tensioner (5).

21-0 Engine Complete, General

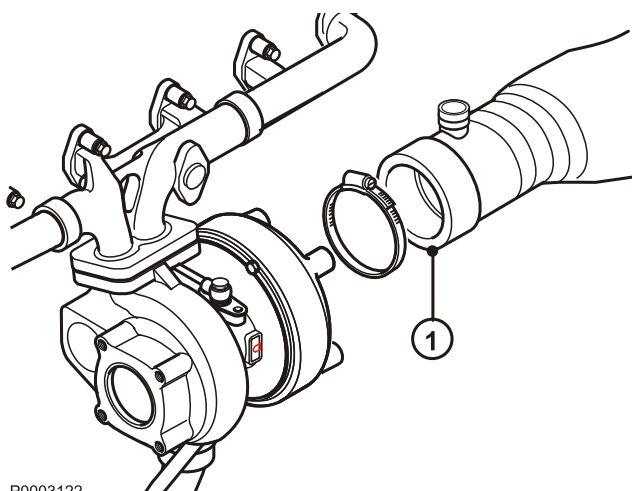
Engine

Engine Fixture, Installation

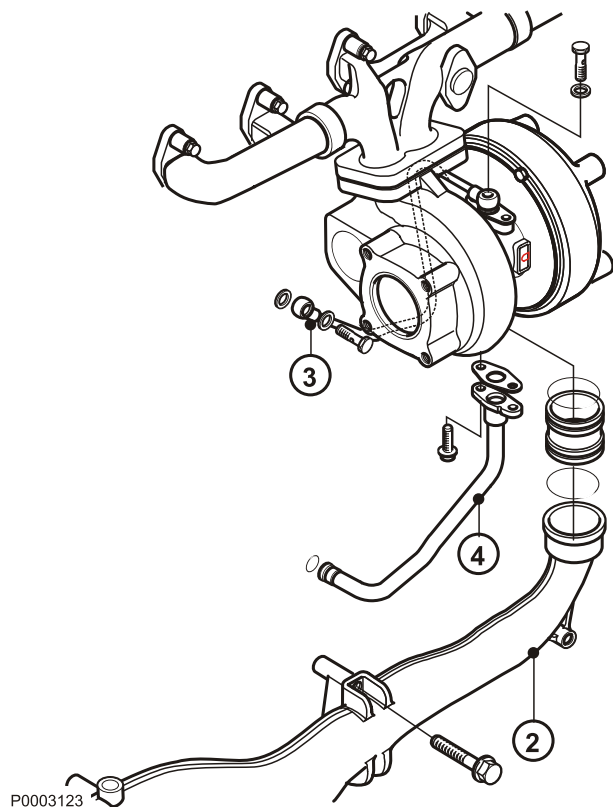
885510 Plugs
9986485 Stand
88800050 Fixture

The method consists of removal of the exhaust pipe, air cleaner and charge air pipe.

- 1 **Remove:**
 - the inlet hose (1)

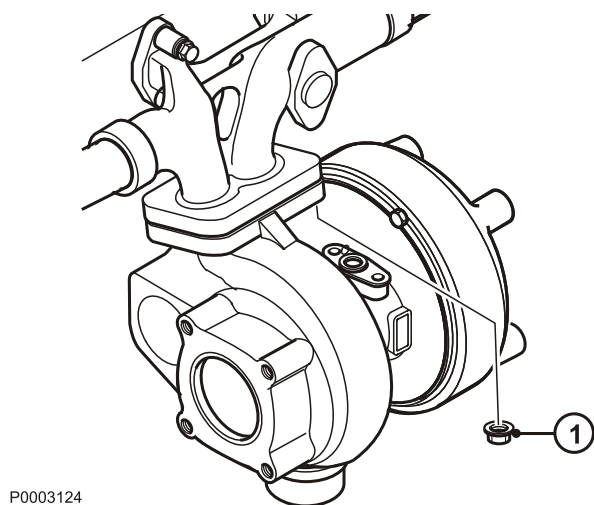


P0003122

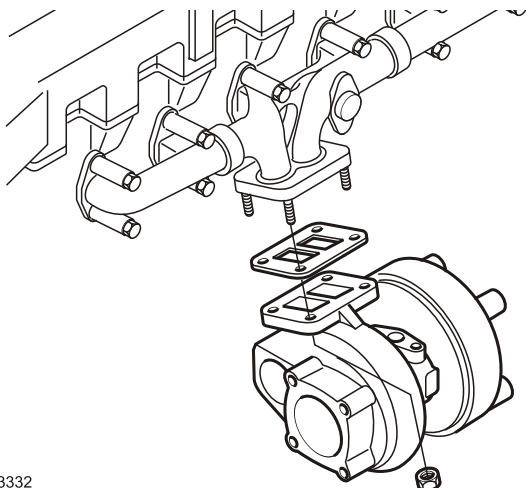


2 **Remove:**

- turbocharger pressure pipe (2), to the charge air cooler
- oil delivery pipe (3) and oil return pipe (4)

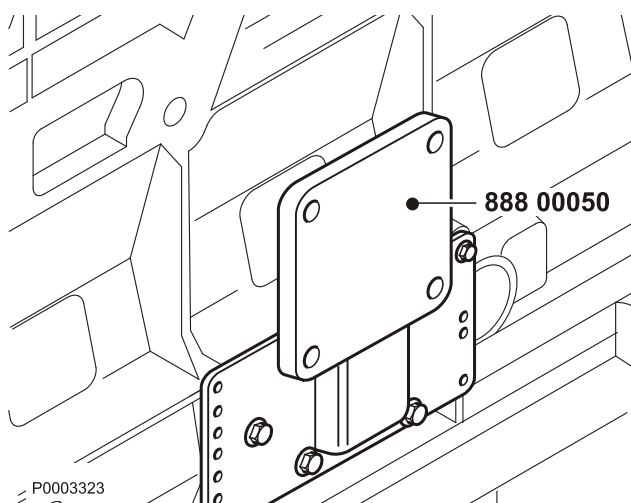


3 Remove the turbocharger nuts from the exhaust manifold.



- 4 Remove the turbocharger.

NOTICE! Fit protective plugs (885 510) to all of the turbocharger connections.



- 5 Fit engine fixture **888 00050** to the engine and torque to **25 Nm**.

NOTICE! Use the supplied screws and sleeves.

Raise the engine and offer it on to the rotatable holding fixture **998 6485**. Bolt the engine to the holding fixture.

Disassembly, Complete Engine

885510 Plugs
885530 Rotation tool
885633 Torque multiplier
885648 Counterhold
885822 Magnetic pen
9989876 Dial indicator
9991821 Extractor
9996049 Draining hose
9996394 Support
9996400 Slide hammer
9996645 Puller
9998007 Adapter
9998675 Press tool
88800014 Rotation tool
88800070 Wrench

Drain the engine oil. Drain the coolant (999 6049).

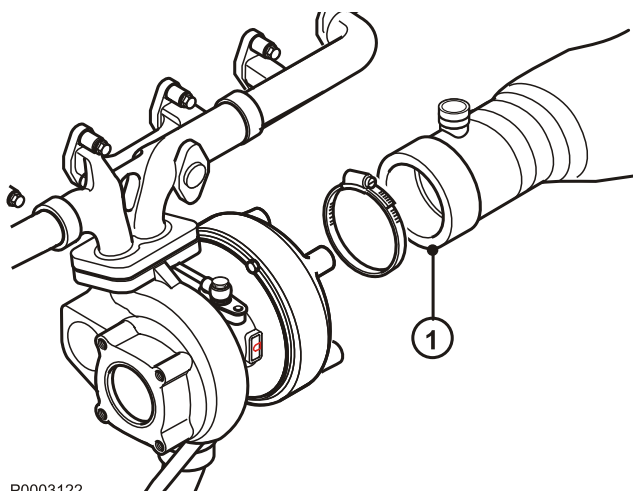
Clean the entire engine with cold degreasing agent, paying special attention to the valve cover and the cylinder head.

Blow clean with compressed air.

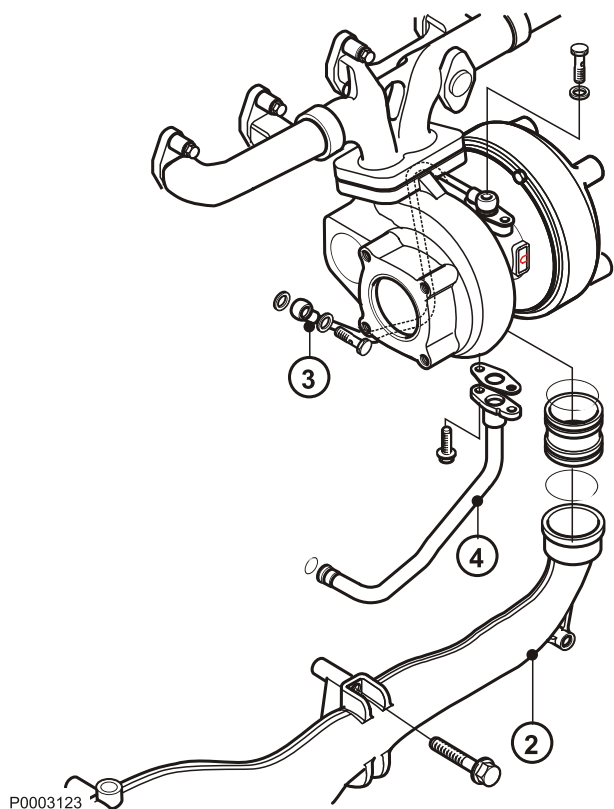
NOTICE! Make sure the cold degreaser does **not** enter sensor connectors.

Removal

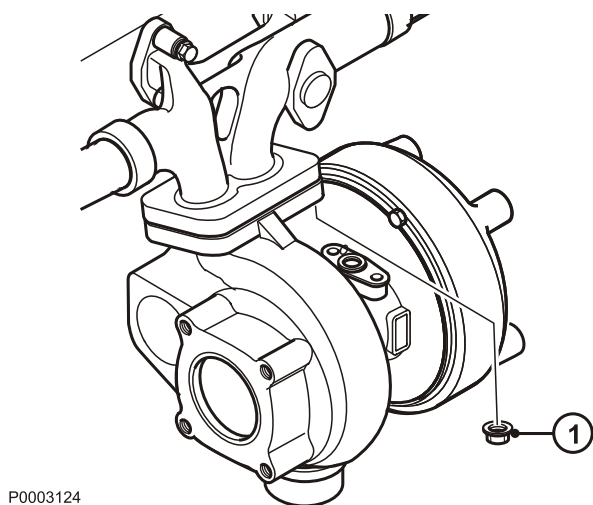
- 1 **Remove:**
 - the induction hose (1)



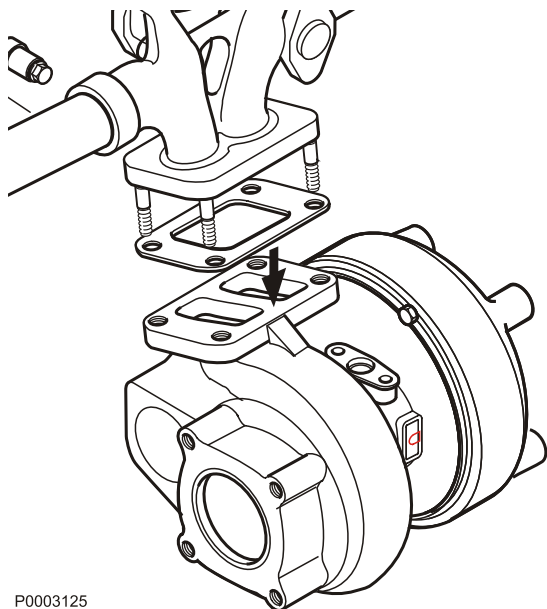
P0003122

**2 Remove:**

- turbocharger pressure pipe (2), to the charge air cooler
- oil delivery pipe (3) and oil return pipe (4)

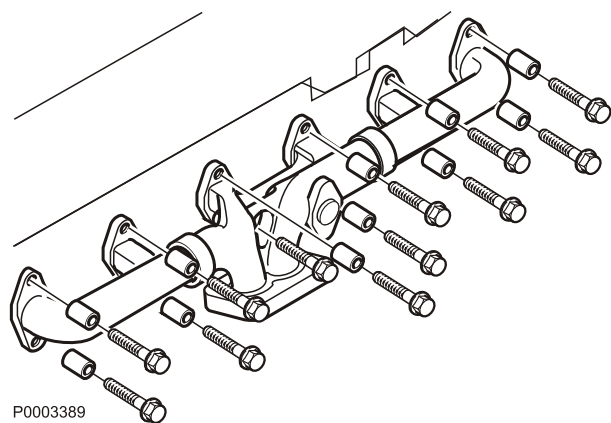
**3 Remove the nuts (1), from the exhaust manifold.**

NOTICE! Use lubricant on the turbocharger nuts.



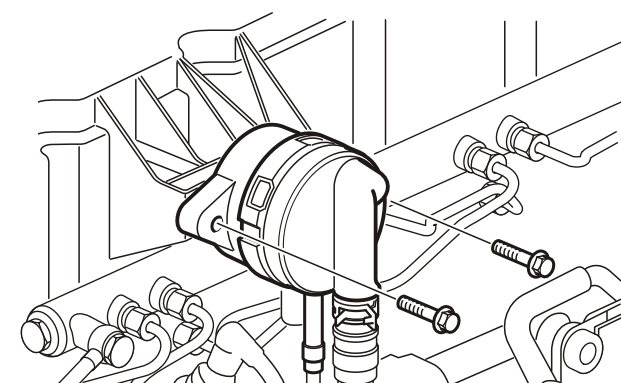
P0003125

- 4 Remove the turbocharger.



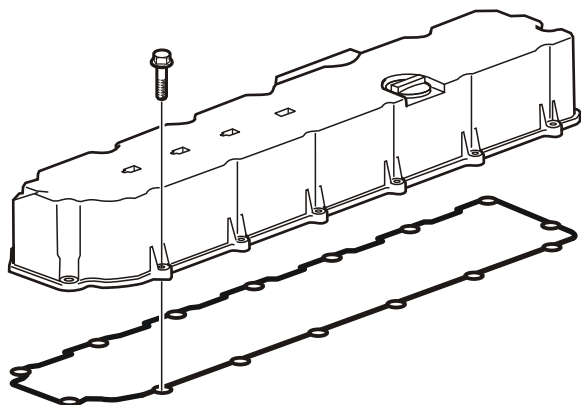
P0003389

- 5 Remove the exhaust manifold.



P0003141

- 6 Remove the oil trap.



P0003142

- 7 Remove the valve cover.

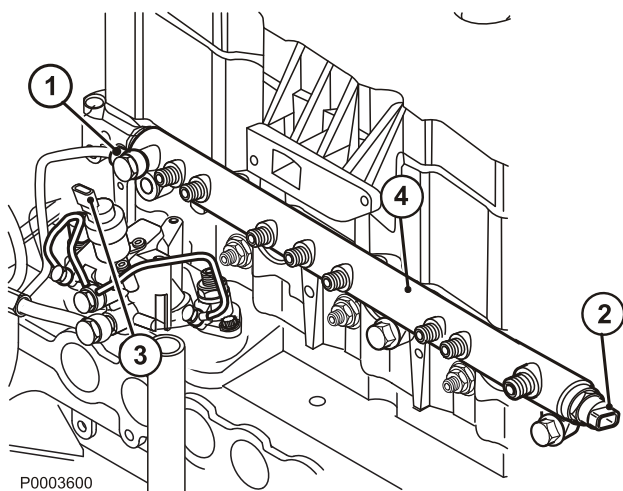
Common Rail unit, removal

- 8 Remove the fuel supply line from the Common Rail unit; use wrench **888 000 70**.

NOTICE! The pressure pipes may **not** be re-used.

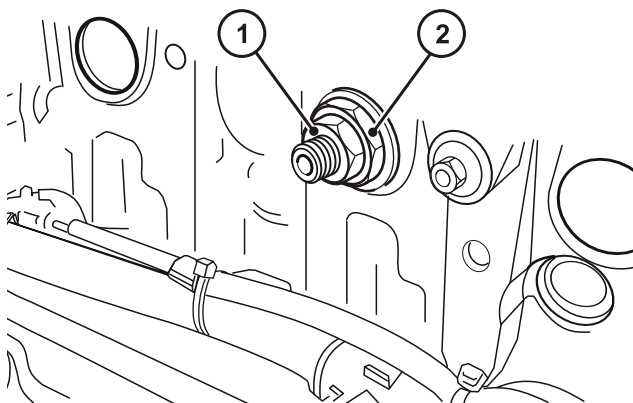
Undo the return line connection (1).
Disconnect the connector from the rail pressure sensor (2).
Disconnect the connector from "M-prop" (3).
Remove the Common Rail unit (4).

NOTICE! Plug all connections to exclude dirt (885 510).

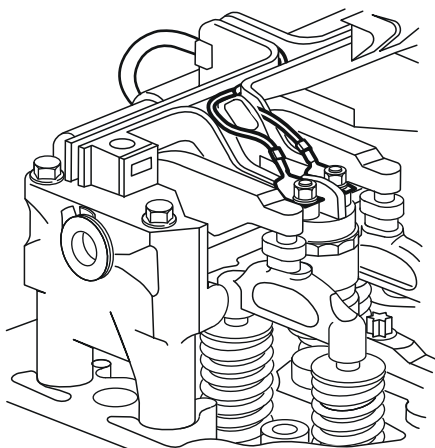


P0003600

- 9 Remove the injector pressure line nuts (1) from the unions (2).

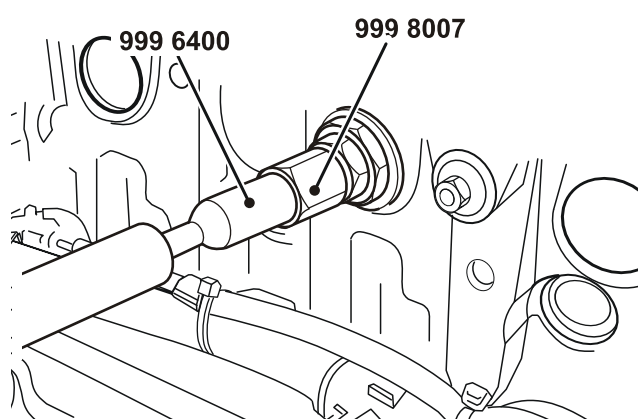


P0003433



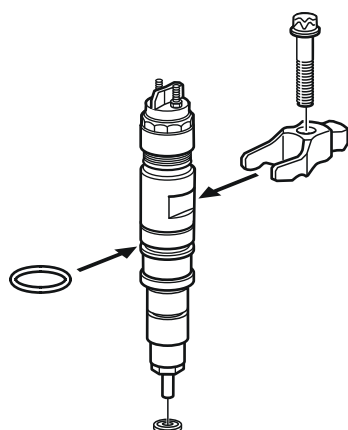
P0003149

- 10 Remove the wiring from the injectors.



P0003434

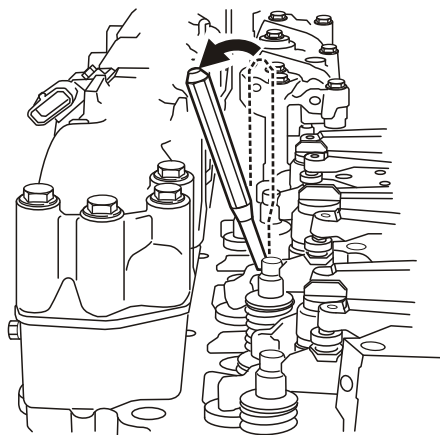
- 11 Remove the injector pressure lines by tapping out the pipes **carefully** with the aid of the puller **999 6400** and adapter **999 8007**.



P0003152

- 12 Remove the injector bolts.

NOTICE! Ensure that the cylinder head is clean.

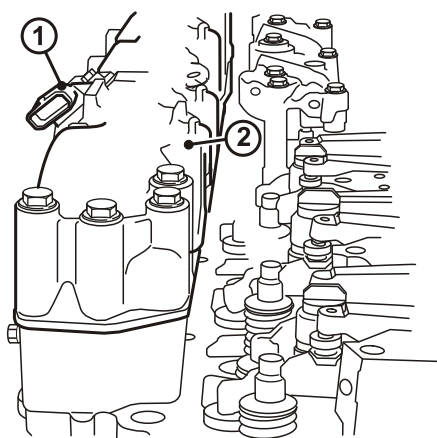


P0003153

- 13 Remove the injector by inserting a **9 mm** drift in the retaining yoke.
Move the drift towards the inlet manifold, to lever the injector out.
Plug the hole.

NOTICE! Make sure the sealing washers are also removed.

Inlet pipe, removal



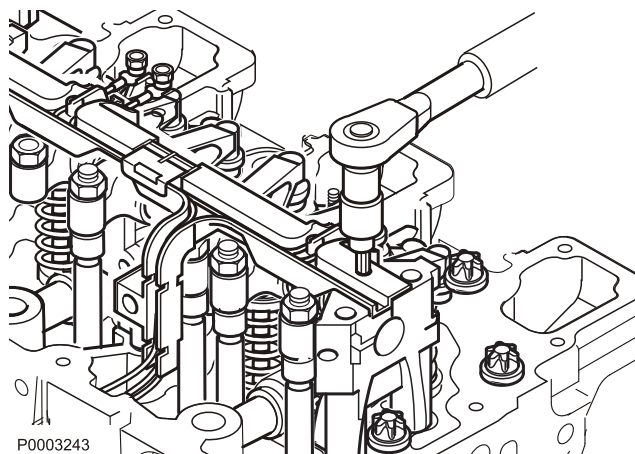
P0003338

14 Remove:

- pressure sensor cable (1) from the sensor on the inlet pipe (2)
- hose and pipe to the charge air cooler
- pre heater
- inlet pipe bolts

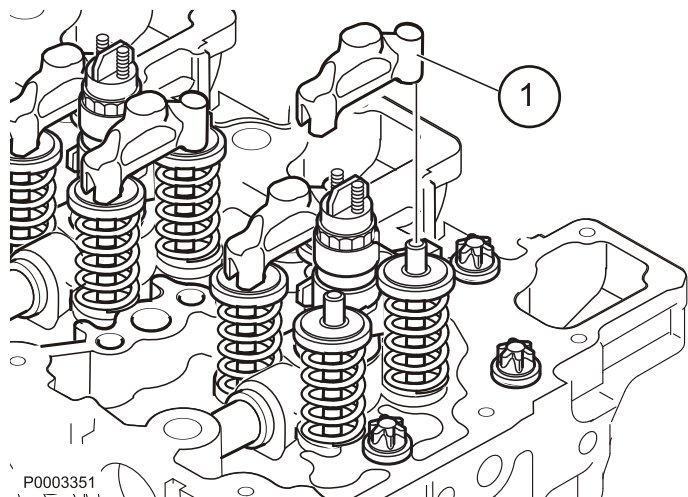
Remove the intake manifold (2).

Rocker arm bridges and rocker arms, removal

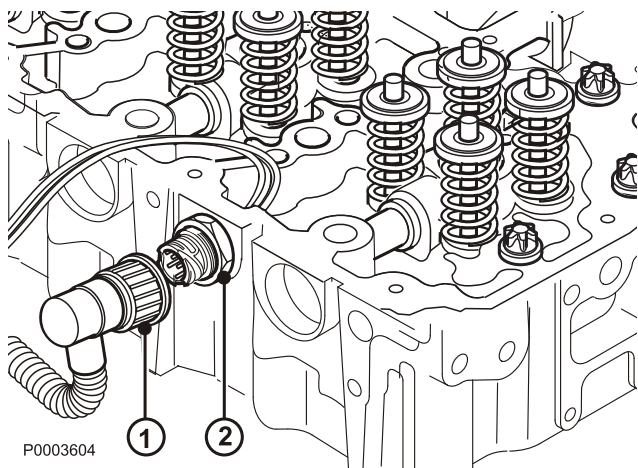


P0003243

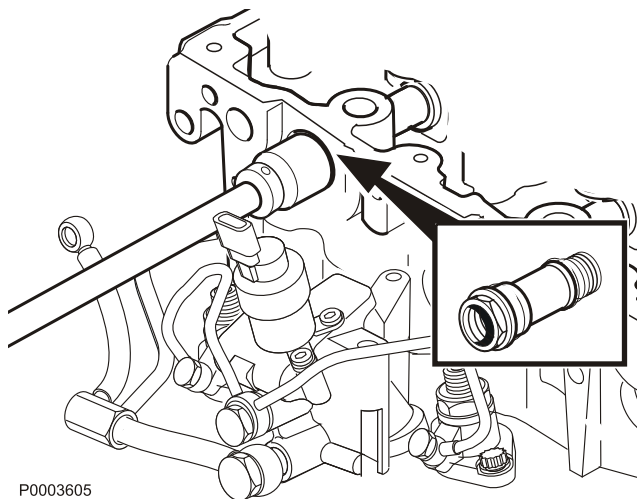
- 15 Remove the cable holders (2 pcs.) and twist them aside.
Undo the rocker arm bridge bolts alternately.
Remove the rocker arm bridge with rocker arms



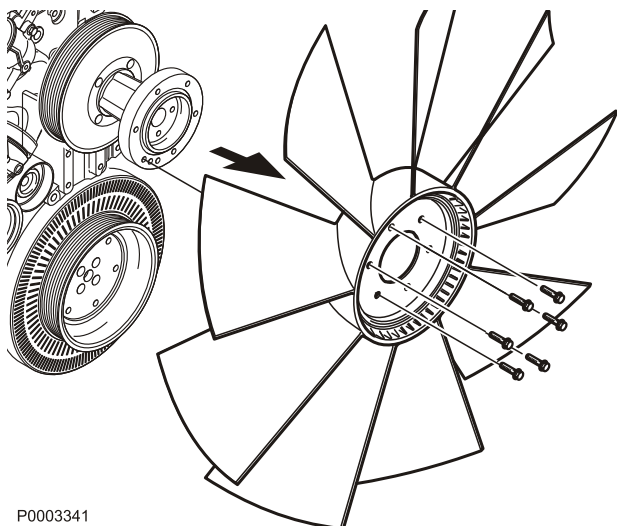
- 16 Mark the valve yokes (1).
Remove the valve yokes (1).
Remove the push rods.



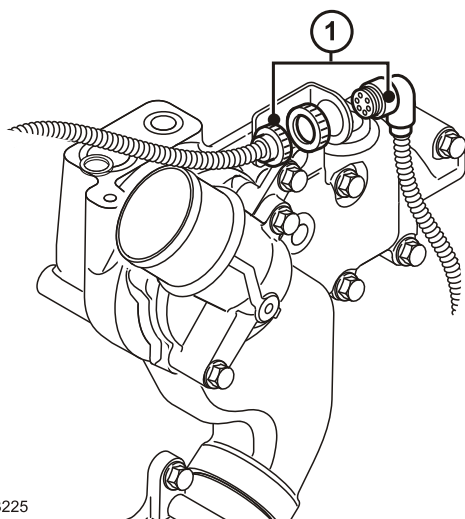
- 17 Remove the wiring connections (1) and the nuts (2) to the cable holders.
Lift away the wiring.



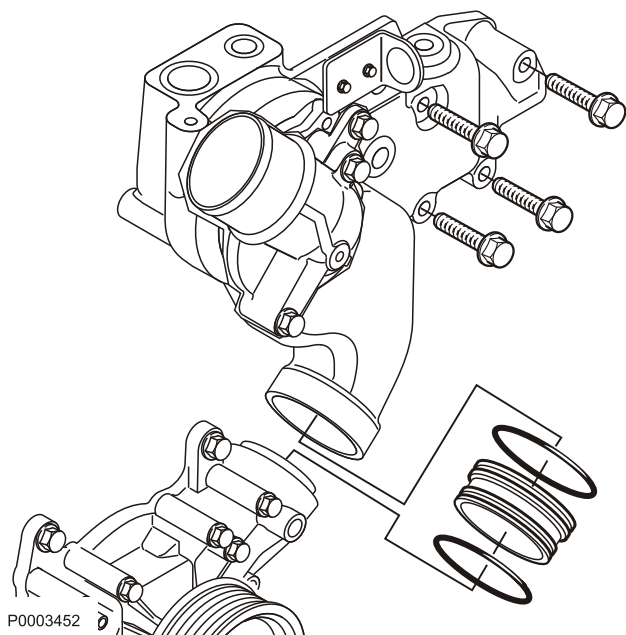
- 18 Remove the injector pressure line holders.

**19 Remove:**

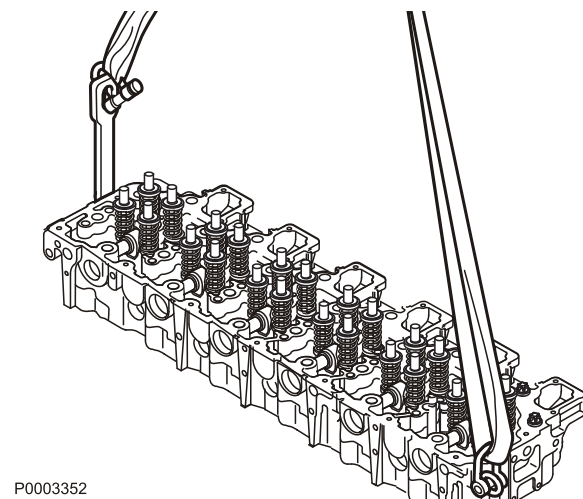
- drive belt
- fan
- fan bearing, with belt pulley
- fan bearing holder



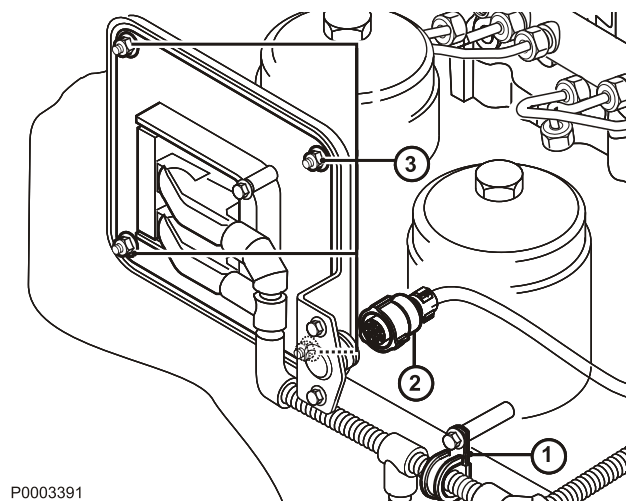
- 20** Remove the wiring (1) from the thermostat housing.



- 21 Remove the thermostat housing; pull it away from the coolant pump O-ring seals.

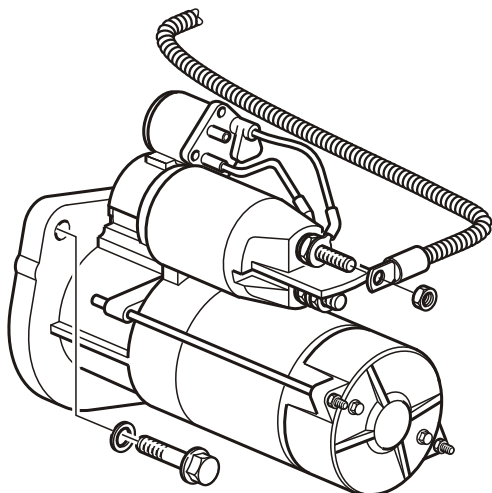


- 22 Remove the cylinder head bolts.
Attach a lifting eye to the front of the cylinder head.
Connect straps to the lifting eyes and lift the cylinder head to remove it.



- 23 Remove the electronics unit (3) and the entire cable trunk.
Undo connector (2).
Remove the clamp (1).

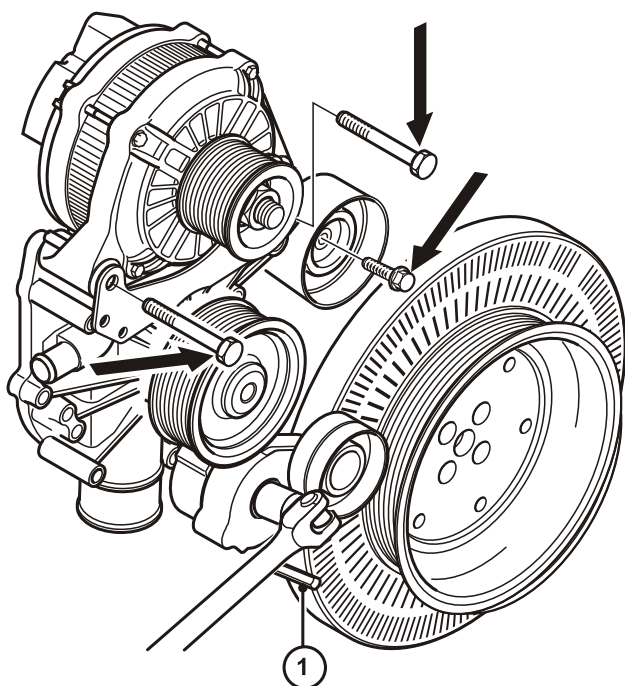
24 Remove the starter motor.



P0003140

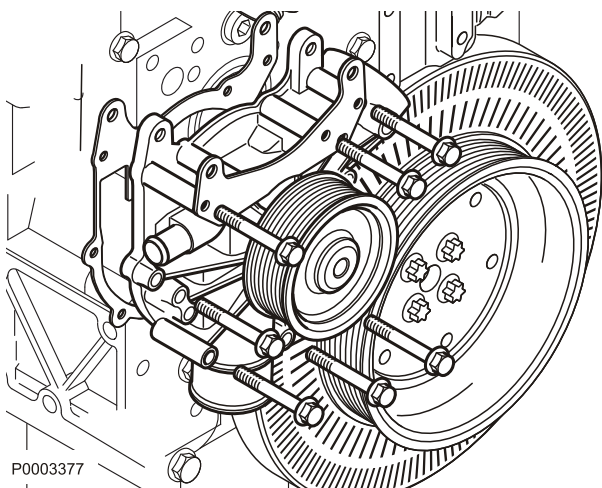
25 **Remove:**

- the alternator
- the belt tensioner, with drift (1)
- idler wheel, at the alternator

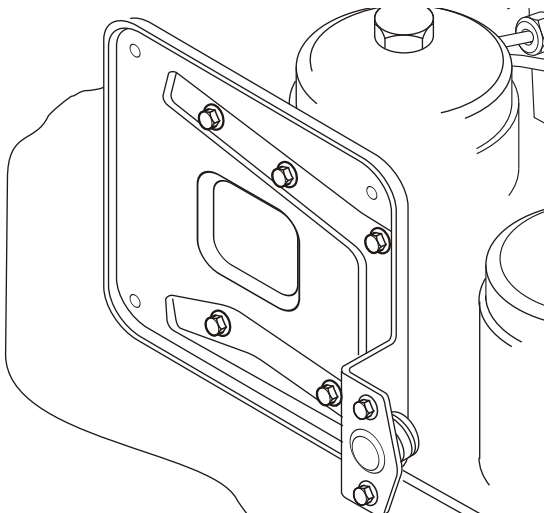


P0003603

26 Remove the coolant pump.

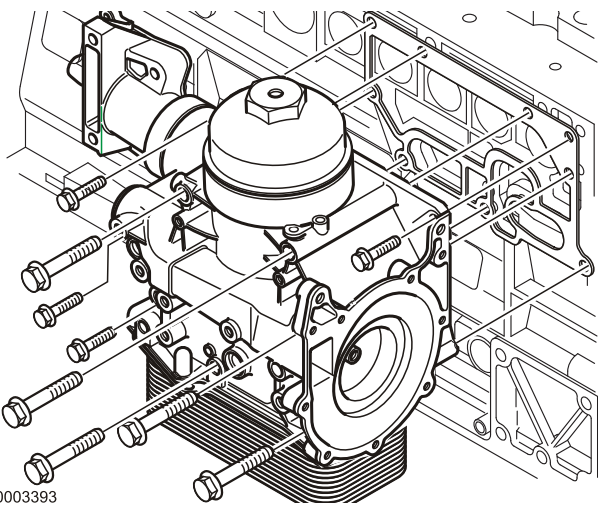


P0003377



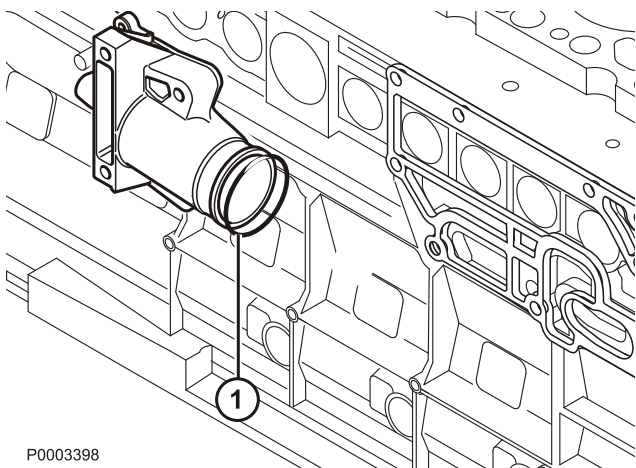
P0003392

27 Remove the electronics unit holder.



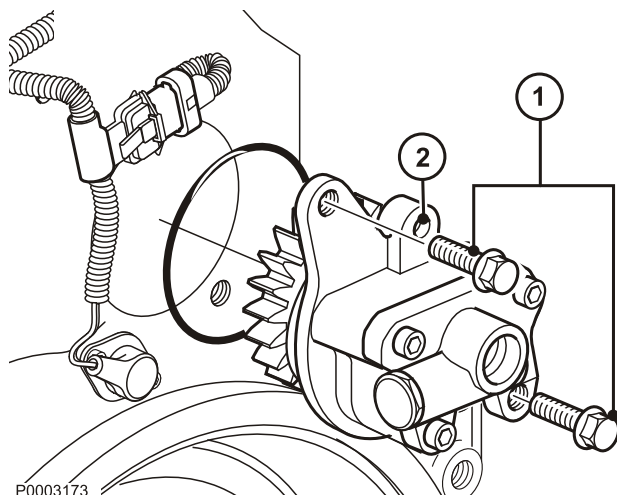
P0003393

28 Remove the oil filter housing (9 bolts).



P0003398

29 Remove the coolant neck (1).

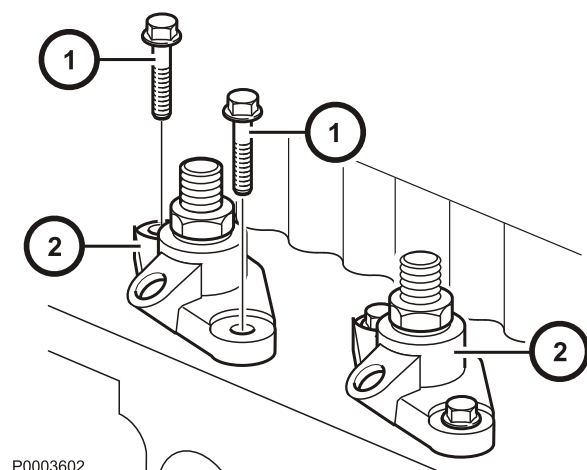


- 30 Remove the two pump attachment bolts (1) to the fuel feed pump.
Use the "lower" of the attachment bolts in hole (2) to loosen the pump from the flywheel housing.

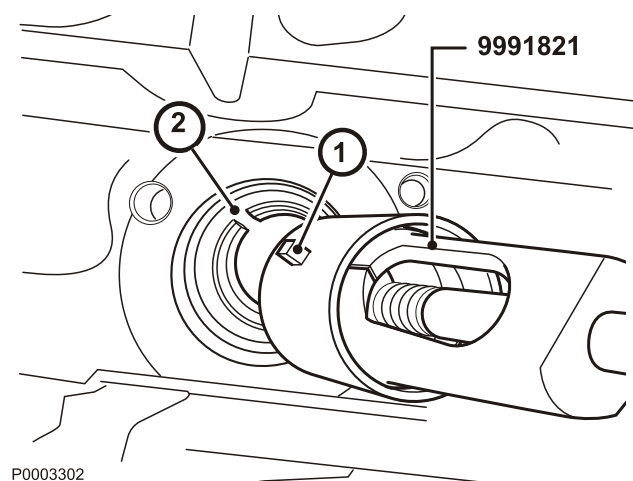
NOTICE! Turn the bolt in only one turn after the bolt has bottomed against the flywheel housing.

Pull out and remove the fuel feed pump.

MPROP and fuel pumps, removal

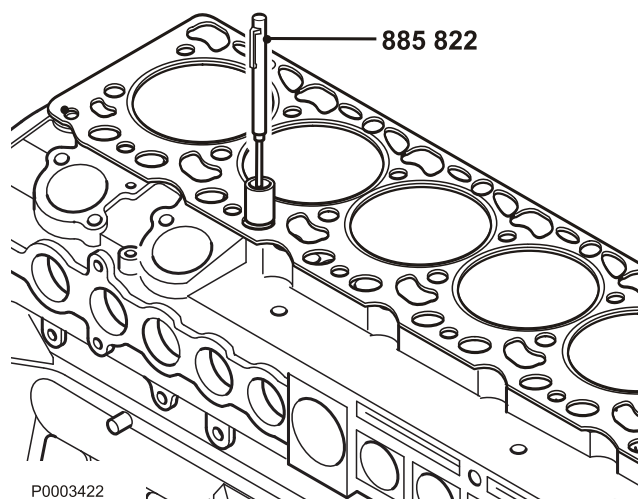


- 31 Remove fuel line between the MPROP and the fuel pumps. Remove the MPROP.
Undo the pump bolts (1) alternately and then remove the fuel pumps (2).



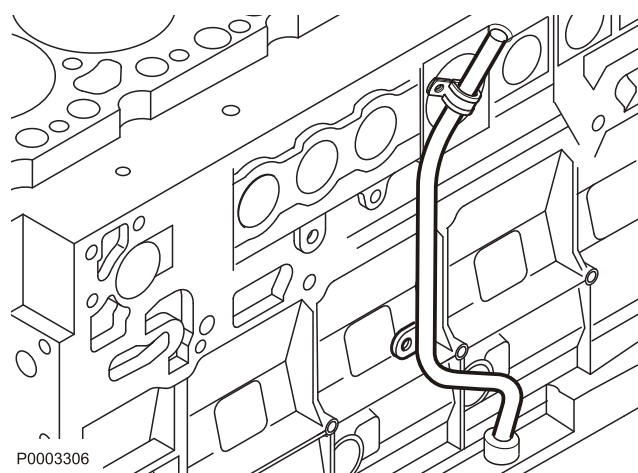
- 32 Remove the fuel pump cam rollers.
Use tool **999 1821**.

NOTICE! Pay attention to the key (1) and keyway (2).

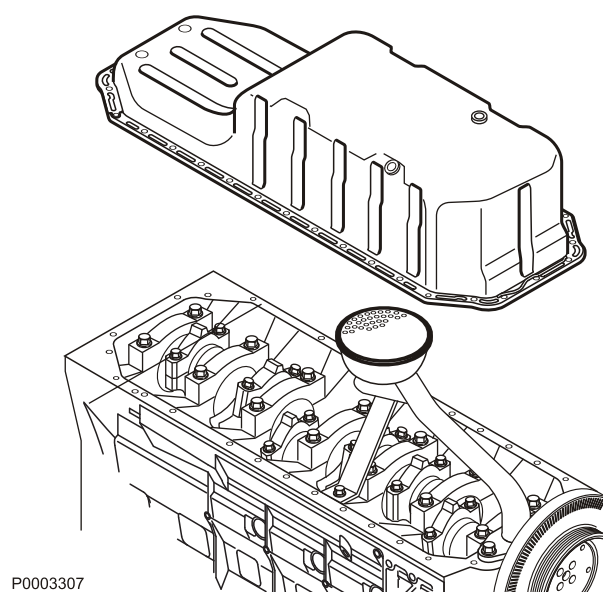


- 33 Remove all valve lifters.
Use magnetic pen **885 822**.

NOTICE! Lay out the removed valve lifters in sequence so that they are replaced in the **correct** order.



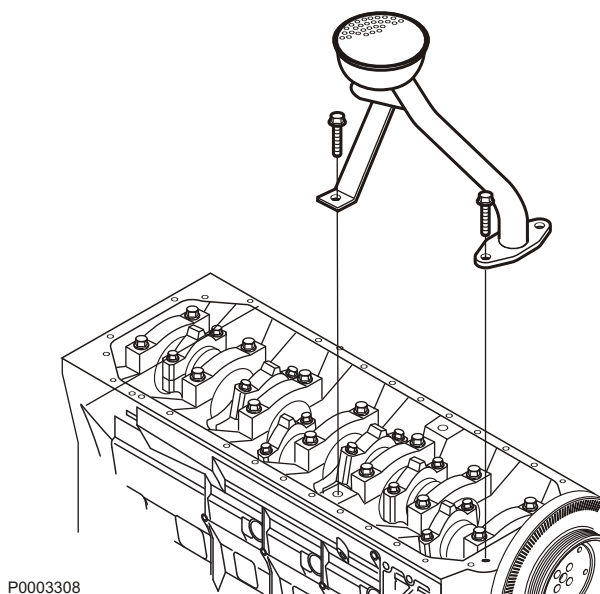
- 34 Remove the oil dipstick.



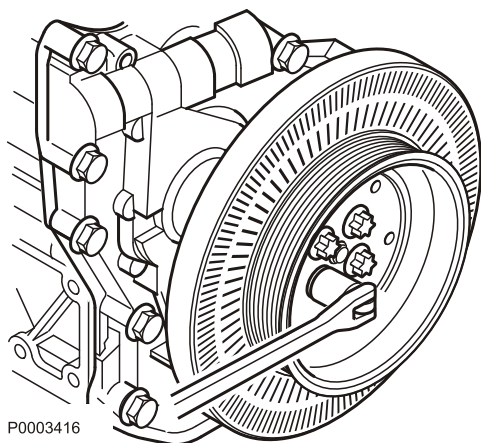
- 35 Crank the engine 180 degrees.
Remove all the oil pan bolts.
Remove the oil pan.

NOTICE! The oil pan is installed using liquid gasket and can therefore be difficult to remove. Use a gasket scraper. To remove the gasket, tap the scraper into those gaps where the bolts were previously situated.

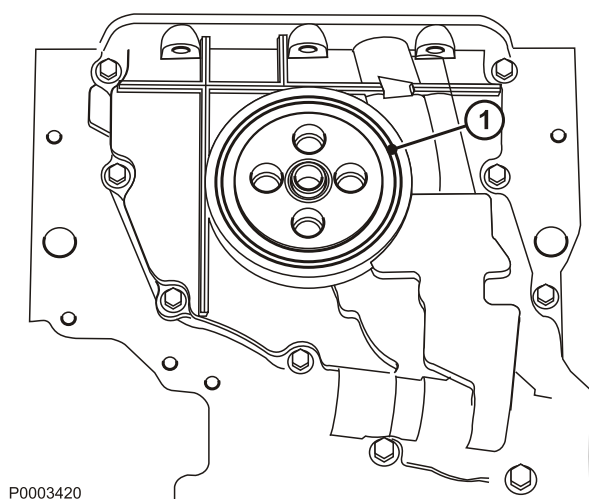
- 36 Remove the oil suction pipe.

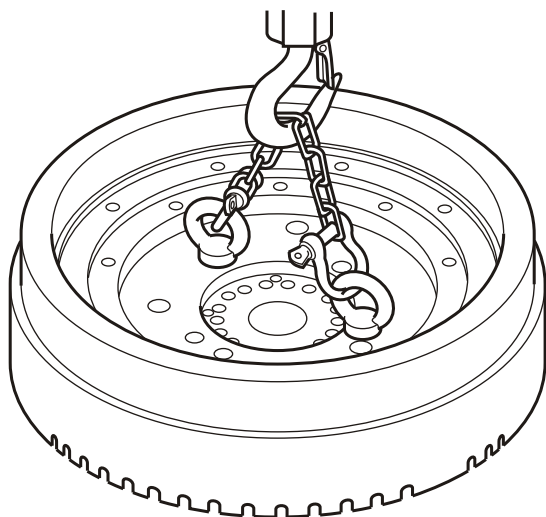


- 37 Remove the belt pulley and oscillation damper.
Use Torx tool E20 and counterhold **8880 0014**.



- 38 Remove the oil pump/front cover and the crankshaft seal (1).
Use a plastic mallet and **carefully** tap the cover loose from the guide pin and gasket glue.





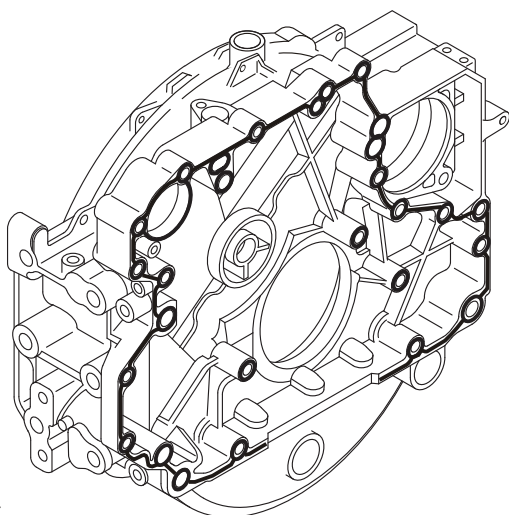
P0003311

Flywheel, removal

- 39 Remove the engine rpm sensor from the flywheel housing. Crank the engine 90°. Remove any plastic plugs used for locking the flywheel bolts, from between every alternate bolt. Remove the flywheel bolts. Use tool **8880 0014** as a counterhold.
- 40 Attach suitable lifting eyes and straps to achieve the correct balance for lifting. Lift the flywheel away.

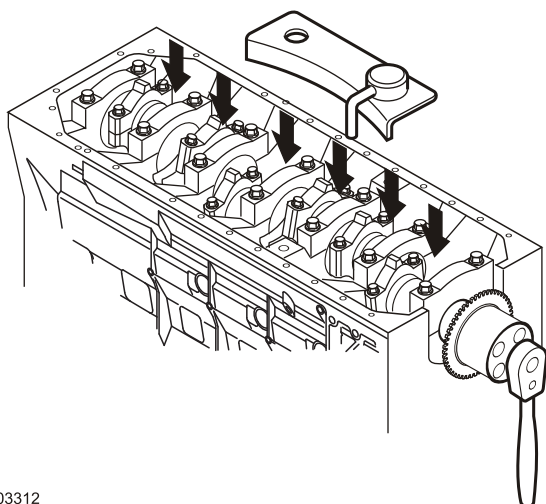
CAUTION!

Heavy object. Use lifting device when installing or removing.



P0003237

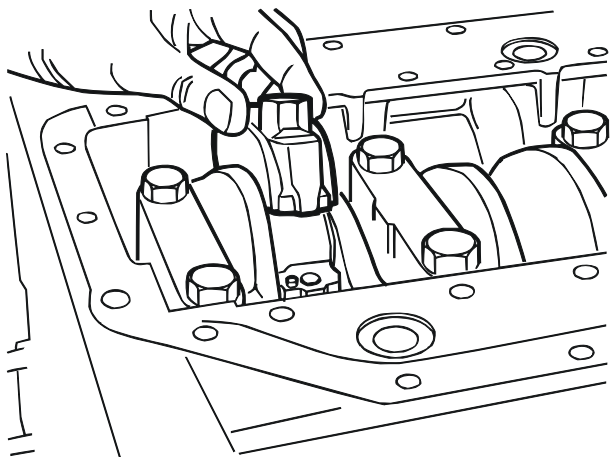
- 41 Remove the camshaft sensor from the timing gear cover. Remove timing gear casing.



P0003312

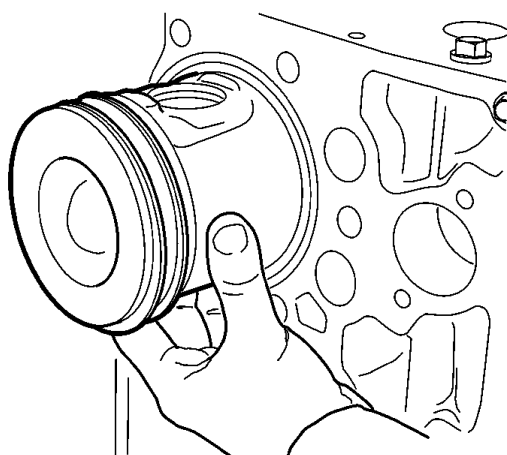
Pistons and connecting rods, removal

- 42 Remove the piston cooling nozzles. Use tool **885 530** in order to rotate the crankshaft. Lift out the nozzles with the aid of magnetic pen **885 822**.



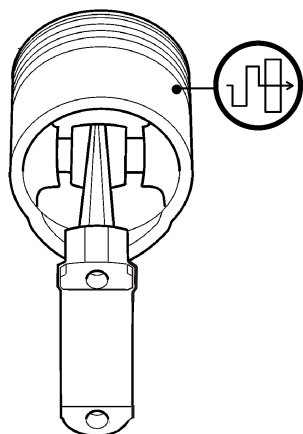
P0003414

- 43 Check and mark the connecting rod caps and undo the bolts.
Remove caps and bearing halves.
Keep the bearing halves safe.



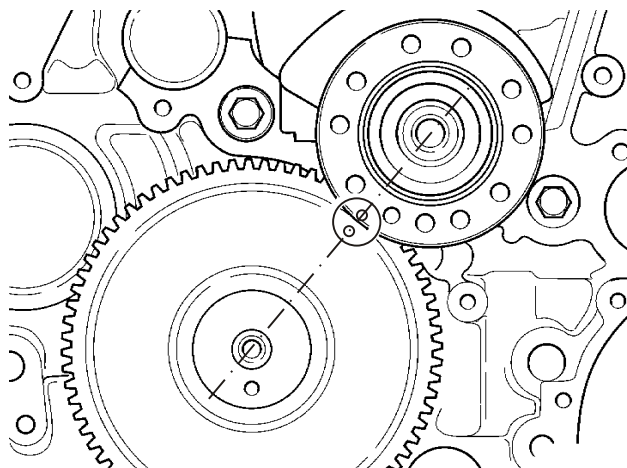
P0003423

- 44 Remove pistons, complete with connecting rod.
IMPORTANT!
Sätt tillbaka överfallet på vevstaken för att undvika skador på delningsytan - denna är mycket känslig.



P0003411

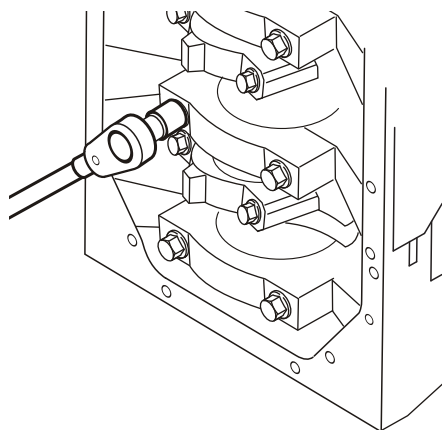
- 45 Check and note the markings on pistons and connecting rods with regard to the crankshaft symbol.



P0003403

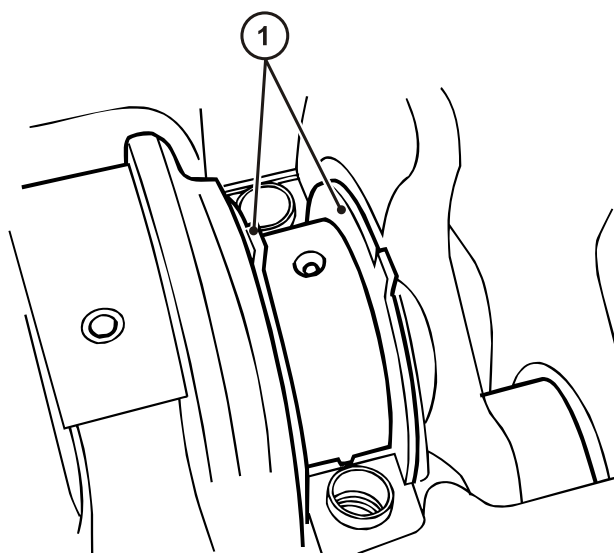
Crankshaft

- 46 Check that the camshaft and crankshaft drives are marked (otherwise mark them). Rotate the engine so that the crankshaft faces up.



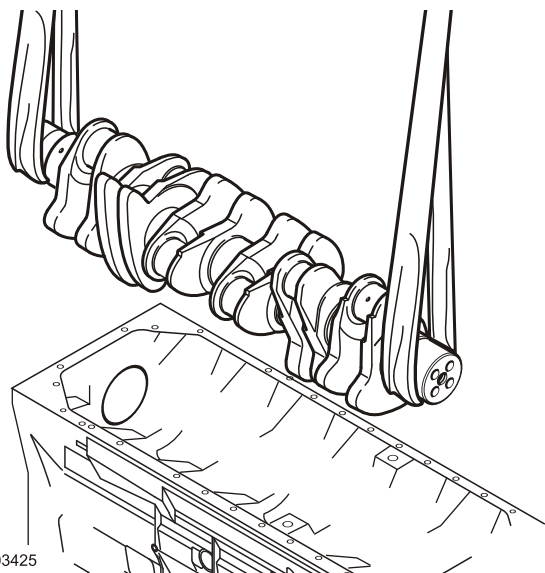
P0003429

- 47 Check that the main bearing caps are marked (otherwise mark them). Remove retaining bolts and remove caps and main bearing halves. If necessary use wrench extension **885 633** together with counterhold **885 648**.



P0003424

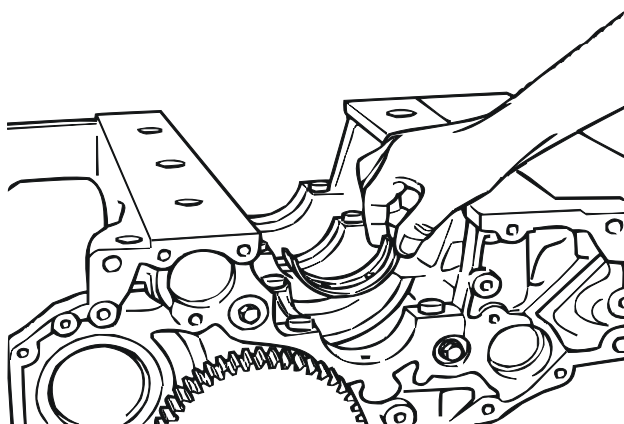
- 48 Remove thrust washers (1) at main bearing number 2.



P0003425

- 49 Lift the crankshaft out of the engine block.

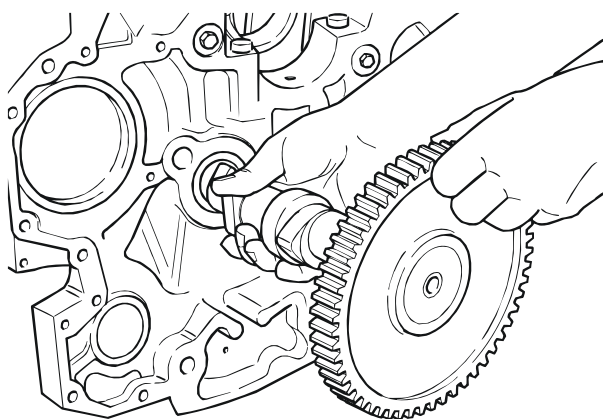
NOTICE! The crankshaft is heavy (about 75 kg). Use a soft lifting strop to lift it out.



P0003402

- 50 Remove the bearing shells and thrust bearings on main bearing number 2.

NOTICE! Mark main bearing halves if they are to be reused.



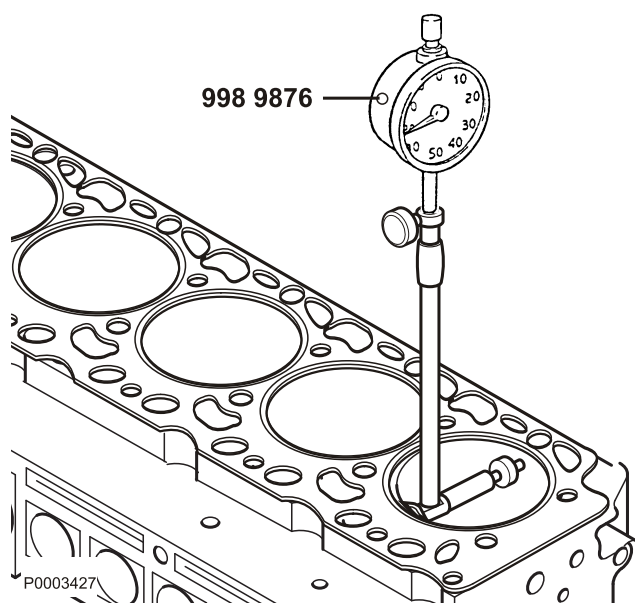
P0003401

- 51 Remove the camshaft.

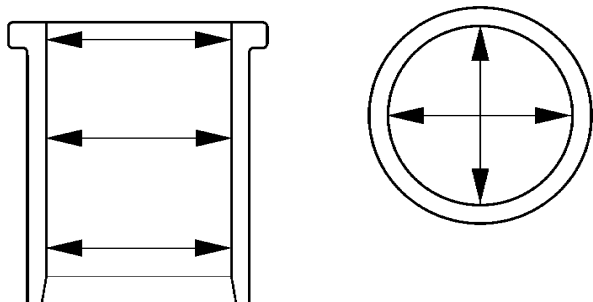
NOTICE! Remove the camshaft **carefully**, so that the bearings are not damaged.

Cylinder, measuring

- 52 Set the dial indicator to **108 mm**.
Use dial indicator **998 9876**.

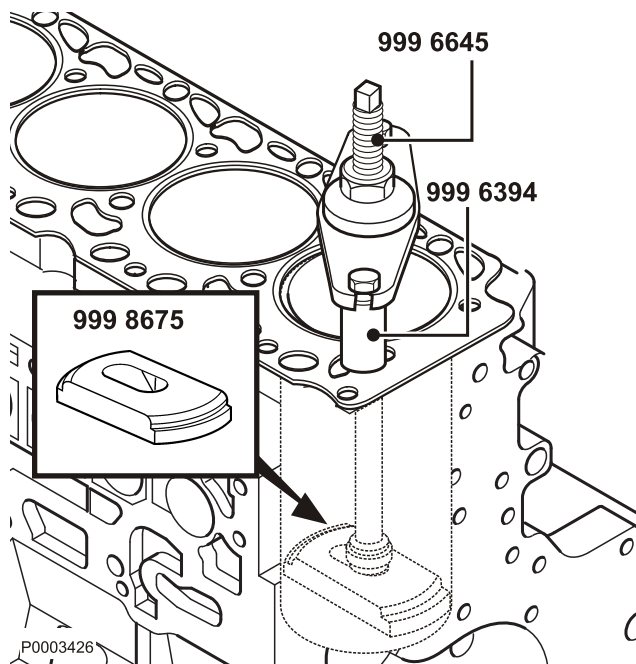


- 53 Check that the liner is free from cracks or other damage.
Measure cylinder internal diameter.
Measure at three depths (longitudinal- transverse).



P0003428

Diameter	108 +0.02 mm
Wear limit	108.1 mm



- 54 Crank the engine 90°.
Remove cylinder liner.

NOTICE! Mark the liners if they are to be re-used.

Use plate **999 8675** together with cylinder liner puller **999 6645** with support legs **999 6394** and **999 6395**.

Assembly, Complete Engine

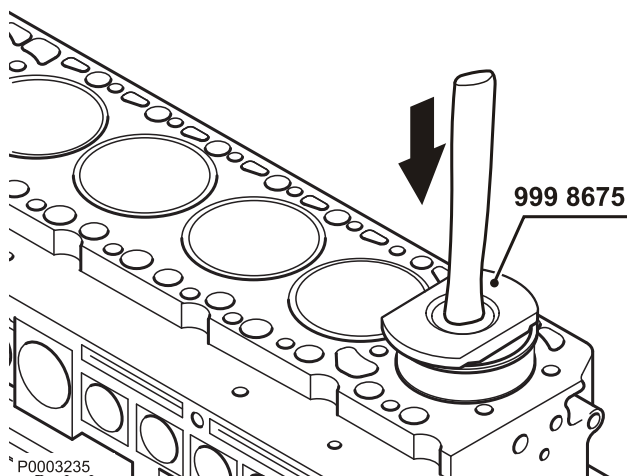
885530 Rotation tool
885633 Torque multiplier
885812 Timing tool
885822 Magnetic pen
9989876 Dial indicator
9991821 Extractor
9992000 Handle
9998511 Lever
9998672 Press tool
9998673 Press tool
9998675 Press tool
9998678 Gauge rod
9998687 Compressor
9999696 Magnetic stand
88800014 Rotation tool
88800070 Wrench
88800083 Piston ring pliers
88800129 Press tool

Installation

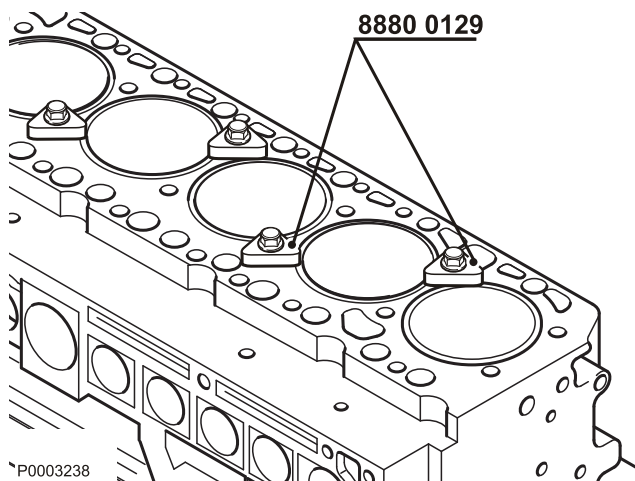
Cylinder liners, installation

- 1 Make sure the cylinder liner and the cylinder in the engine block are clean and apply a thin oil film.
Fit **new** O-rings.
- 2 Tap in the cylinder liner with the aid of tool (1)**999 8675**.

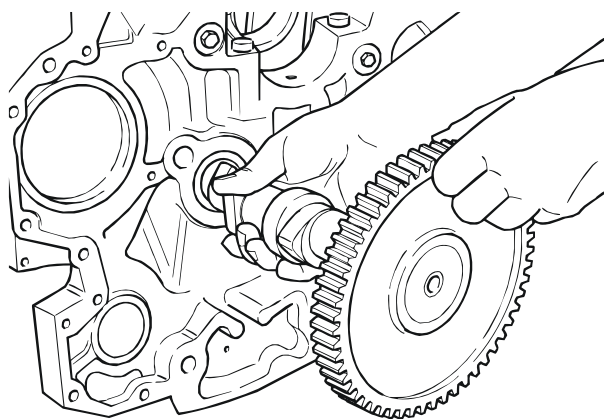
NOTICE! Measurement of cylinder liner and cylinder should be carried out before installation.



*P0003235

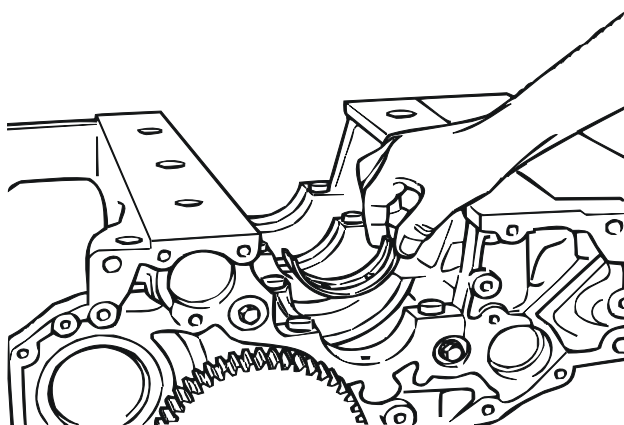


- 3 Check that the cylinder liner collar touches the seat.
Fit the cylinder liner installation tool **8880 0129** to hold the liner in place when subsequently inserting the piston.



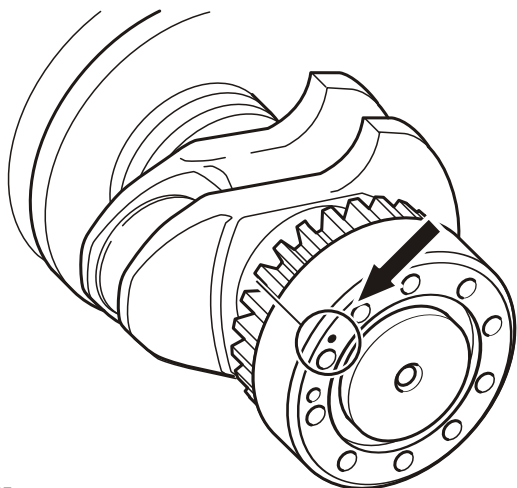
- 4 Lubricate the camshaft bearing surfaces. Insert the camshaft.

NOTICE! Fit the camshaft **carefully** so as not to damage the bearings.



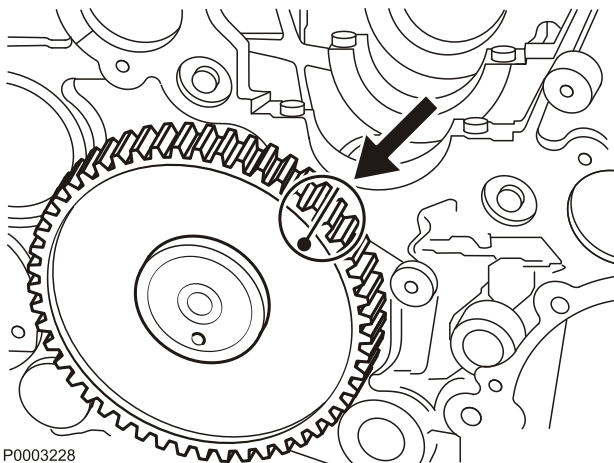
- 5 Fit the main bearing shells in the engine block and oil the bearings.

- 6 Mark the crankshaft as needed (to facilitate refitting).



P0003227

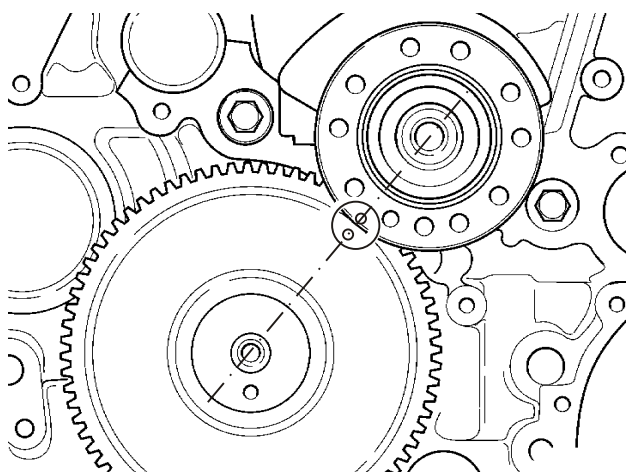
- 7 Mark the camshaft as needed and turn it to the correct position



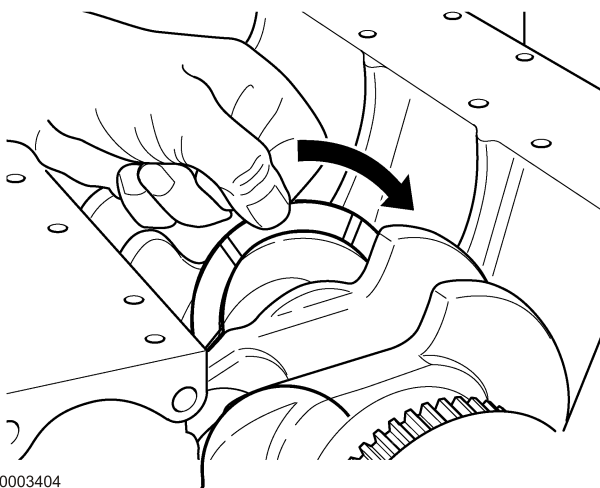
P0003228

Crankshaft, installation

- 8 Lower in the crankshaft. The marks must be aligned.
Use a ruler to check that the marks are aligned through the crankshaft and camshaft centers.



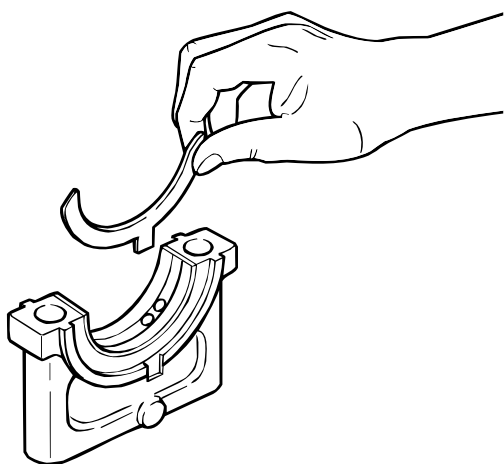
P0003403



P0003404

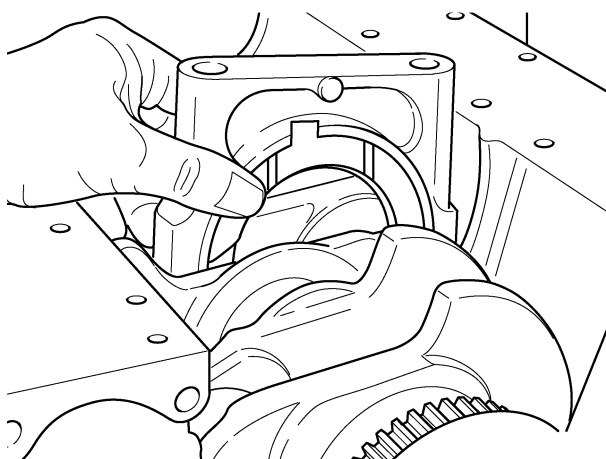
- 9 Insert the thrust bearing halves without pins.

NOTICE! The thrust washer bearing surface (with two grooves) must point towards the crankshaft.



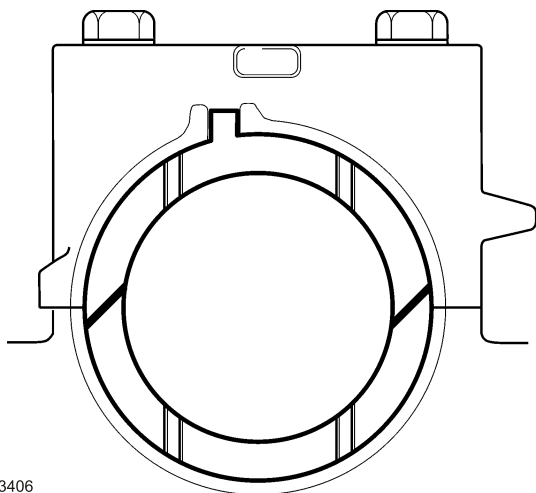
P0003229

- 10 Install the thrust washer halves and pin to the thrust washer caps (with the aid of a little grease on the pin).
The thrust washer bearing surfaces must face towards the crankshaft.



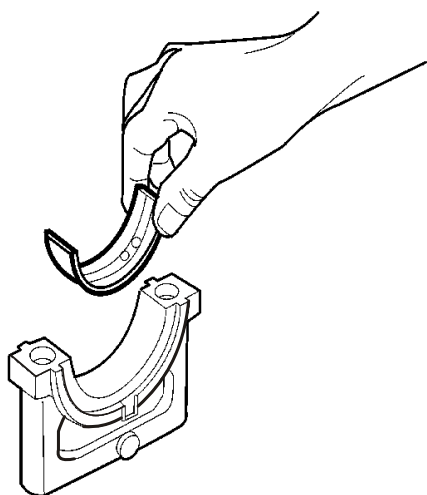
P0003405

- 11 Install the main bearing caps, according to markings.



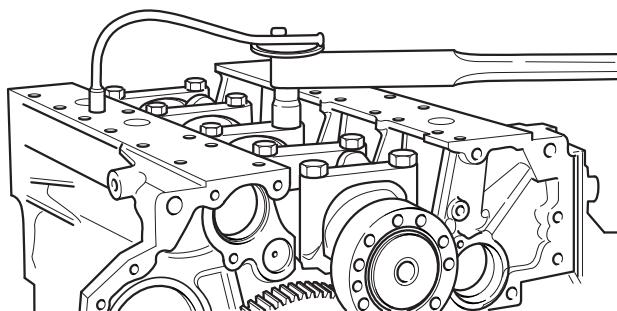
P0003406

- 12 Make sure that the thrust washers on the cap mate with the washers in the block.



P0003407

- 13 Fit the upper bearing shells into the bearing caps and lubricate them. Install the main bearing caps, according to previous markings.



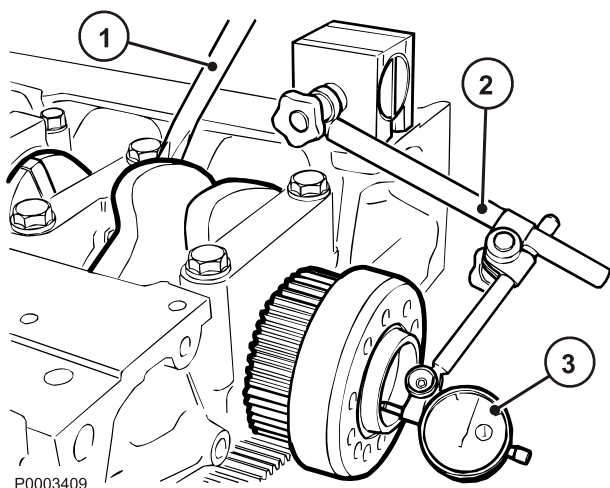
P0003442

- 14 Tighten the main bearing cap bolts in three steps:

Step 1	50 Nm
Step 2	60°
Step 3	60°

NOTICE! The bolts may be used 3 times if it can be proven how many times they have been stretched. (Mark them with a punch for each subsequent stretching.)

Check that the crankshaft can be cranked (free rotation). Use cranking tool **885 530**.



P0003409

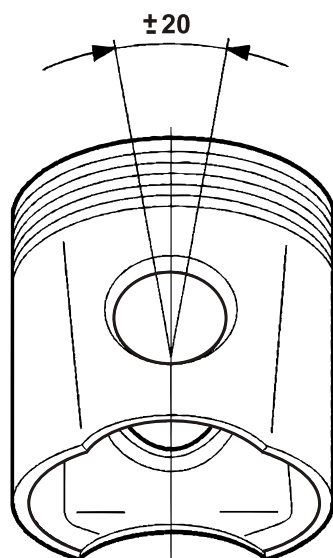
- 15 Install dial indicator **998 9876 (3)** with magnetic base **999 9696 (2)**.
Lever with pry bar **999 8511 (1)** and check the axial clearance of the crankshaft.
Permissible float: **0.1–0.3 mm**.

Piston and connecting rod, assembling

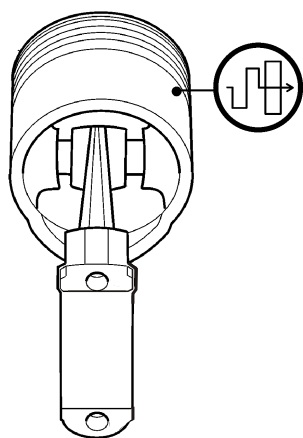
- 16 Fit one of the snap clips in the groove in the piston.

IMPORTANT!

Ringgapet på fjäderringen skall vara vänt mot kolvkronan.



P0003410



P0003411

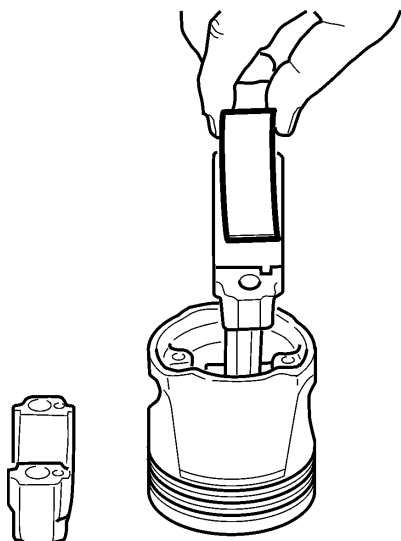
- 17 Position the connecting rod in the piston so that the crankshaft number marking arrives at the camshaft side and the flywheel symbol is facing the flywheel end of the engine.
Press in the piston pin. Check that the connecting rod can be slid sideways on the piston pin.
Install the remaining snap clips (one for each piston).

IMPORTANT!

Ringgapet på fjäderringen skall vara vänt mot kolvkronan.

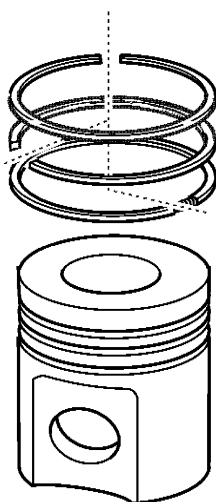
Pistons and connecting rods, installation

- 18 Fit the bearing shells on the connecting rods and oil them.



P0003412

- 19 Install the piston rings. Stagger the piston ring gaps at 120° intervals. Use piston ring pliers **8880 0083**.



P0003415

NOTICE! The piston rings must **not** be over-stretched.

Pistons, installation

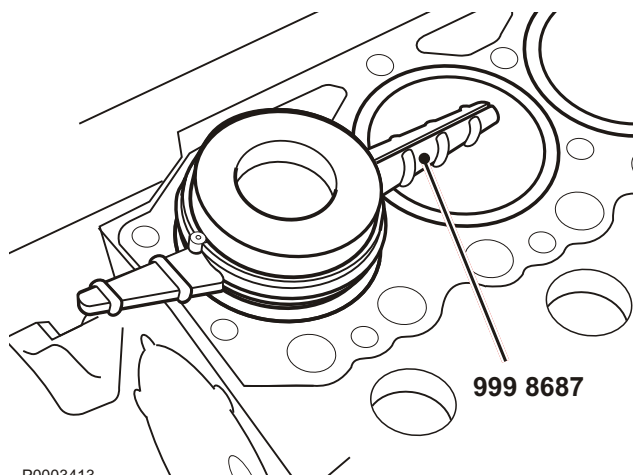
- 20 Temporarily remove the installation tool (8880 0129) holding the cylinder liner where the piston is to be installed. When the piston is in position the tool must be put back again.

NOTICE! The installation tool must be in position when the crankshaft is cranked.

Use piston ring compressor **999 8687** and fit pistons with connecting rods from the cylinder head side. The flywheel symbol should be facing the flywheel end.

Use cranking tool **885 530** to rotate the crankshaft.

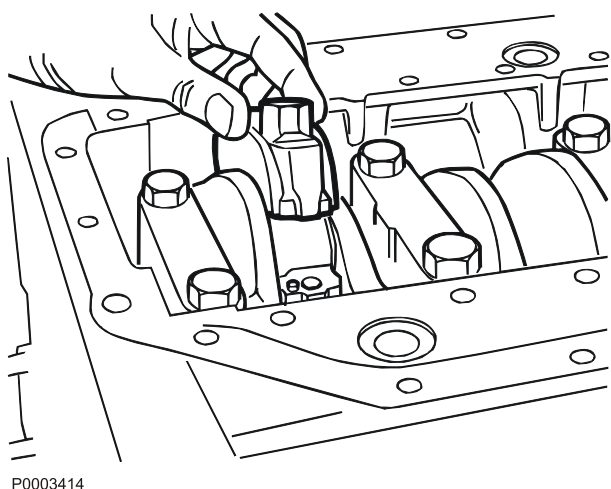
NOTICE! The connecting rod bearing surfaces are **extremely sensitive** to damage.

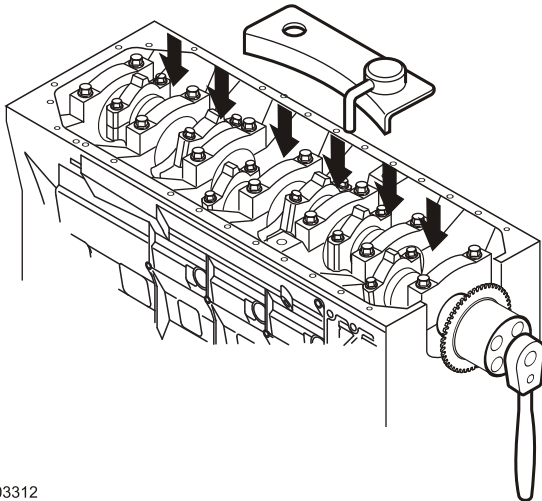


- 21 Oil big end bearing journals on the crankshaft. Press the connecting rod against the journal and position the cap according to the marking. Insert **new** bolts and tighten them in three steps:

Step 1	30 Nm
Step 2	60°
Step 3	30°

NOTICE! Check that the crankshaft turns freely.



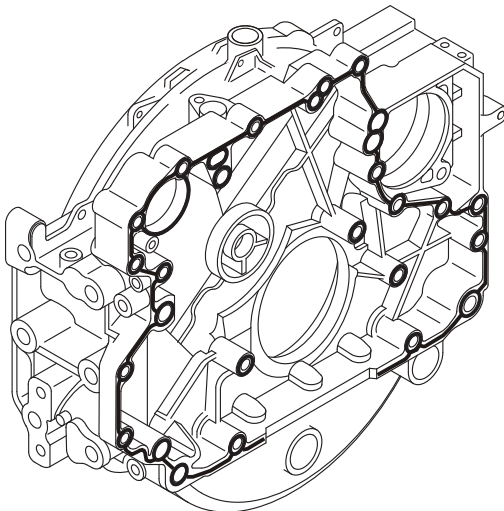


P0003312

Piston cooling nozzles

- 22 Check that the oil channels are not clogged.
Attach the piston cooling nozzles to the engine block.

Torque to: **21 (±4) Nm**



P0003237

Timing gear casing, installation

- 23 Remove the old crankshaft seal.
Remove remnants of gasket from the timing gear casing and engine block.
- 24 Spread gasket compound (1161 231 or 1161 277, 840 879 may also be used) on the timing gear cover mating surface (width 2 mm).
1161 231 = Large tube
1161 277 = Small tube
840 879 = Flange sealant

NOTICE! Excess gasket compound must not be pulled away. It must be cut off.

- 25 Replace the timing gear cover; align it with the guide pin.

Torque the bolts (three different sizes of bolts):

Stage 1: torque all M12 bolts to **110 Nm**

Stage 2: torque all M8 bolts to **30 Nm**

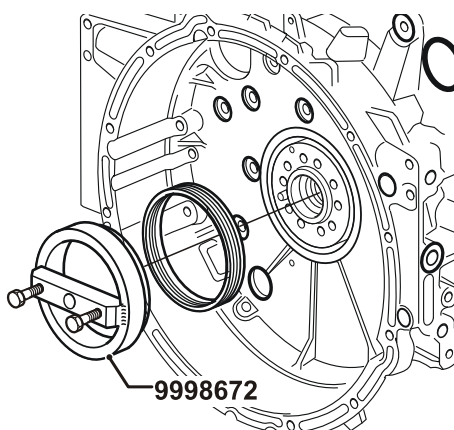
Stage 3: torque all M16 bolts to **260 Nm**

Crankshaft seal, rear, installation

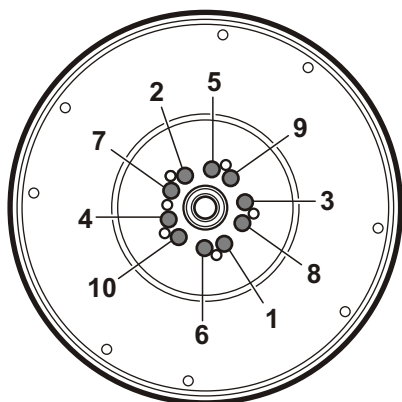
- 26 Lubricate the lip of the seal with engine oil.
Install the **new** crankshaft seal using tools **999 2000** and **999 8672**. Press home the crankshaft seal with the tool.

NOTICE! Use caution so that the crankshaft seal is **not** damaged.

Tap the seal **carefully** home until it bottoms on the cover. Pull the tool **carefully** out of the seal, by turning it.



P0003166



P0003164

Flywheel, installation

- 27 Clean the surfaces on the flywheel and crankshaft.

⚠ CAUTION!

Heavy object. Use lifting device when installing or removing.

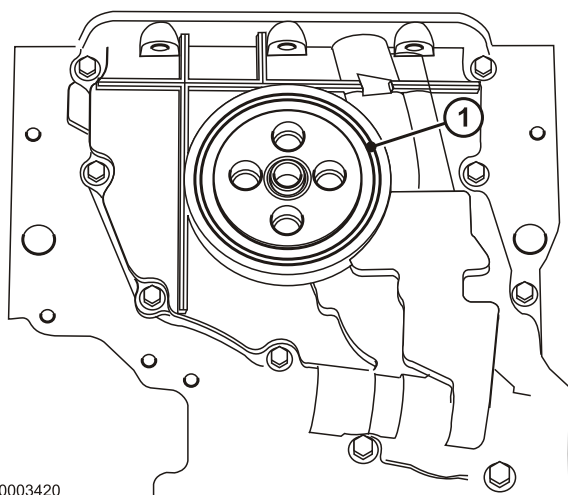
Offer the flywheel into place and align it with the guide pin. Tighten the bolts by hand. Remove the flywheel plug (for the cranking tool). Use tool **8880 0014** as a counterhold.

Tighten the bolts in the sequence illustrated:

Step 1	30 (±5) Nm
Step 2	60°
Step 3	60°

Oil pump, front cover, installation

- 28 Clean the cover and engine block from gasket residue, and remove the crankshaft seal (1) from the cover. Apply liquid gasket. Install the oil pump/front cover; align them with the guide sleeves. Tighten the bolts.



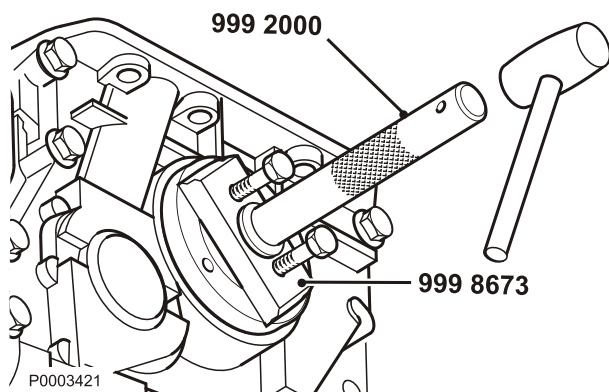
P0003420

Crankshaft seal, front, installation

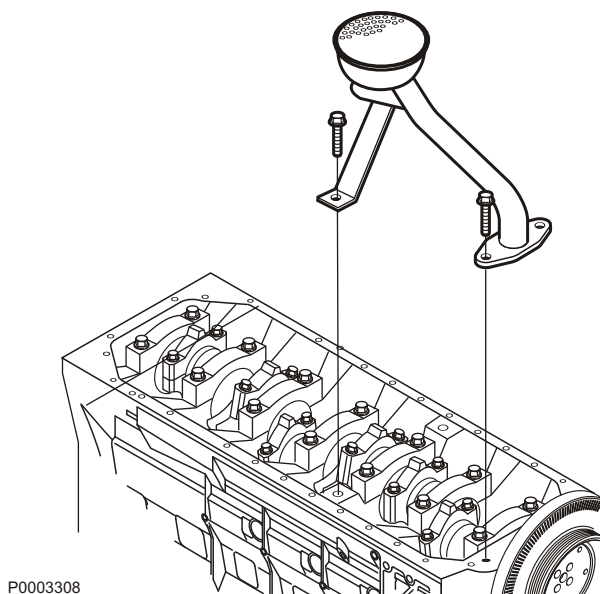
- 29 Lubricate the lip of the seal with engine oil. Install the **new** crankshaft seal using tools **999 2000** and **999 8673**. Press home the crankshaft seal with the tool.

NOTICE! Use caution so that the crankshaft seal is not damaged.

Tap the seal home **carefully** so that it sits edge-to-edge with the cover. Pull the tool **carefully** out of the seal, by turning it.



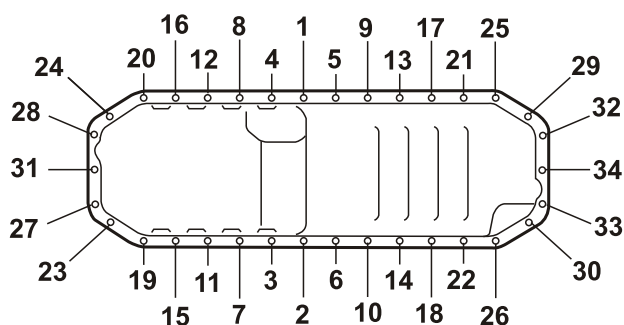
P0003421



P0003308

Oil suction pipe, installation

- 30 Fill a little oil in the oil pump. Install the oil suction pipe with **new** gaskets.

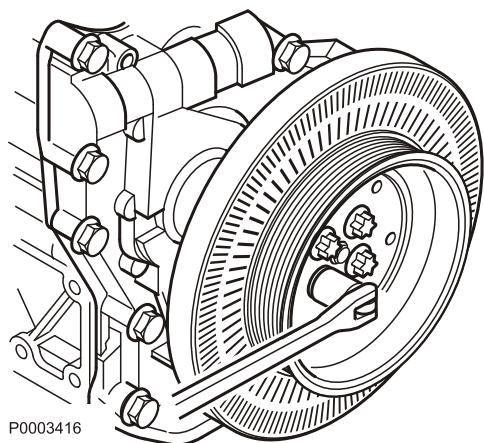


P0003417

Oil pan, installation

- 31 Clean the gasket surfaces from gasket residue. Apply liquid gasket (part # 11 61 771). Install the oil pan; tighten the bolts in the sequence illustrated.

Torque to: **30 Nm**



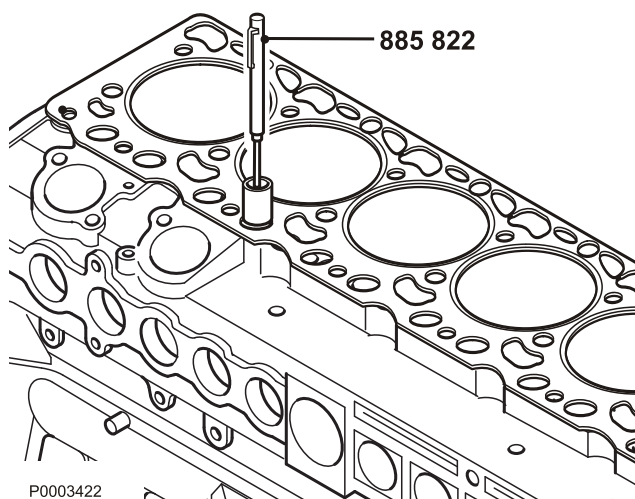
P0003416

- 32 Clean the mating surfaces. Fit the belt pulley and the oscillation damper. Use tool **8880 0014** as a counterhold.

NOTICE! The oscillation damper bolts may **not** be re-used.

Tighten in three steps:

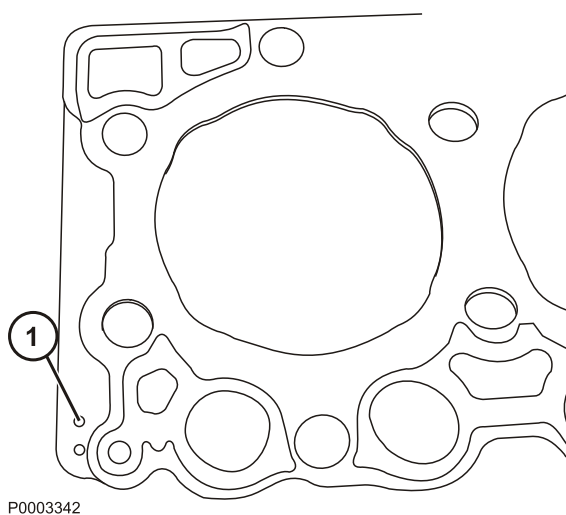
- | | |
|--------|--------------------------|
| Step 1 | 30 (±5) Nm |
| Step 2 | angle tighten 60° |
| Step 3 | angle tighten 60° |



- 33 Oil the camshaft and its bore in the engine block. Position all valve lifters (lightly oiled); use magnetic pen **885 822**.

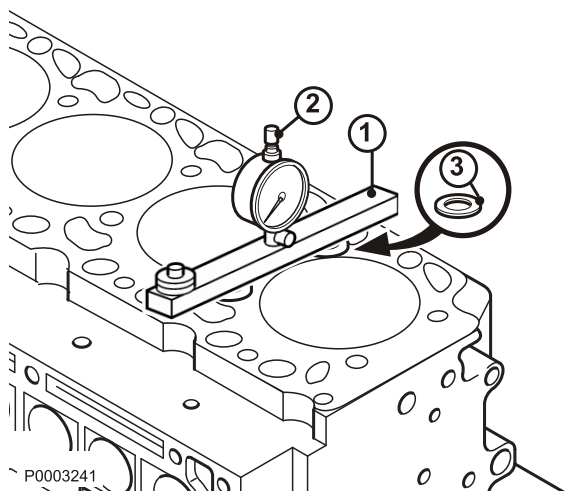
Determining gasket thickness for the cylinder head

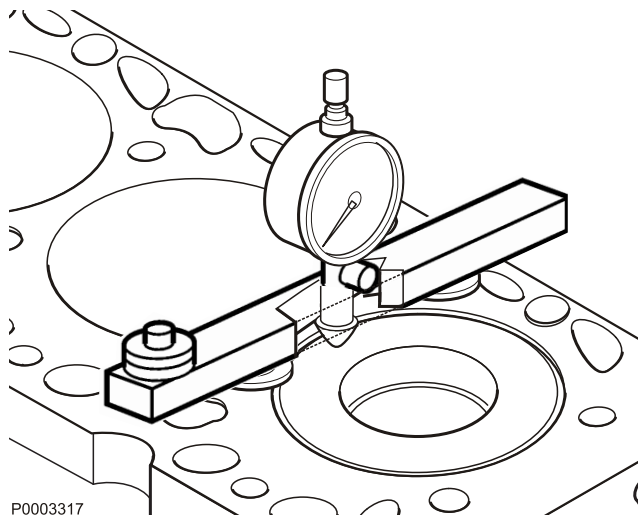
- 34 Remove the cylinder liner press tools (8880 0129).
Cylinder head gaskets are marked (1) with one, two or three holes in one corner. The gaskets must be used for different piston heights above the engine block top side.
The piston height above the engine block must be measured at two points on all pistons.



Cylinder head gasket

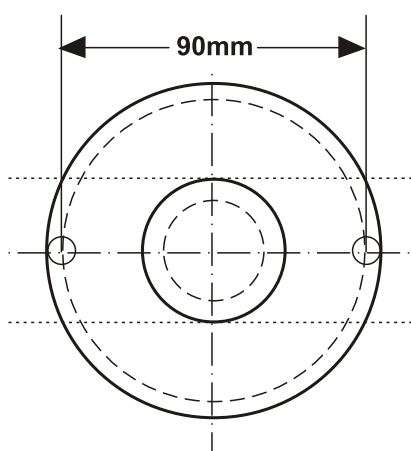
- 35 Decide on cylinder head gasket.
Place spacing washers (3) and gauge (1) **999 8678** on the engine block sealing surface and set the dial indicator (2) to "0".



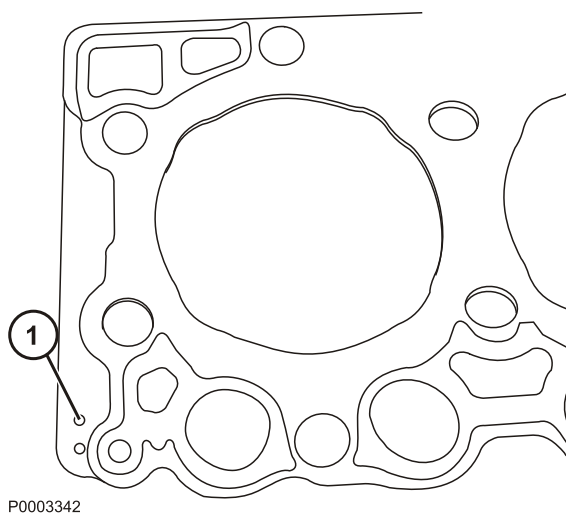


- 36 Place the dial indicator on the piston at the measurement points.
Read and note the value on the dial indicator at the pistons highest position, top dead center.

NOTICE! All pistons should be measured at top dead center in line with the piston pin.



- 37 Pay attention to the measurement points, since the piston surfaces are domed.



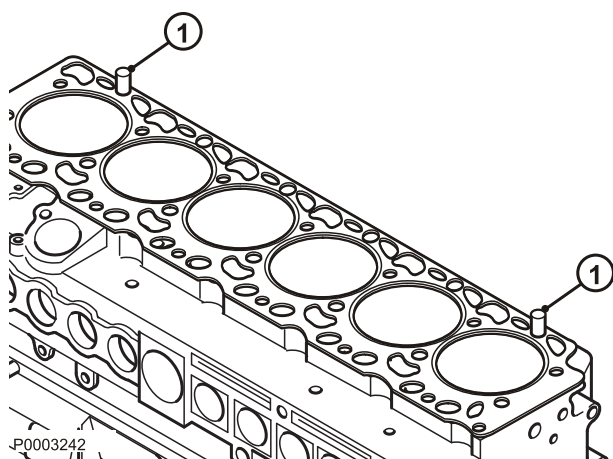
- 38 Compare the highest noted value with the table below.
Decide on the most suitable cylinder head gasket. Cylinder head gaskets are marked (1) with one, two or three holes in one corner.

Piston height:

0.28 – 0.53 mm
0.54 – 0.63 mm
0.64 – 0.75 mm

Cylinder head gasket markings:

1 hole
2 holes
3 holes



- 39 Position the cylinder head gasket with the marking toward the flywheel.

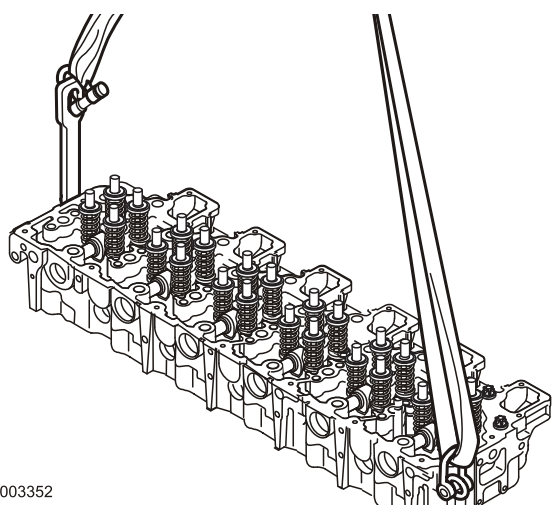
NOTICE! The sealing surfaces on the cylinder head and the engine block plane must be clean and free from oil.

Pay attention to the guide sleeves (1).

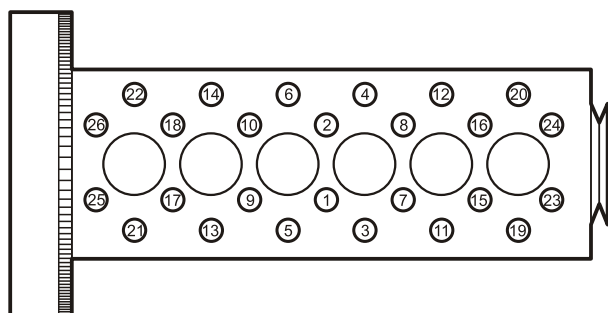
Cylinder head, installation

- 40 Lift the cylinder head into place. Pay attention to the guide sleeves.

NOTICE! The cylinder head bolts may be used up to 5 times if it can be proven how many times they have been used. (Mark them with a punch for each subsequent stretching.)



P0003352

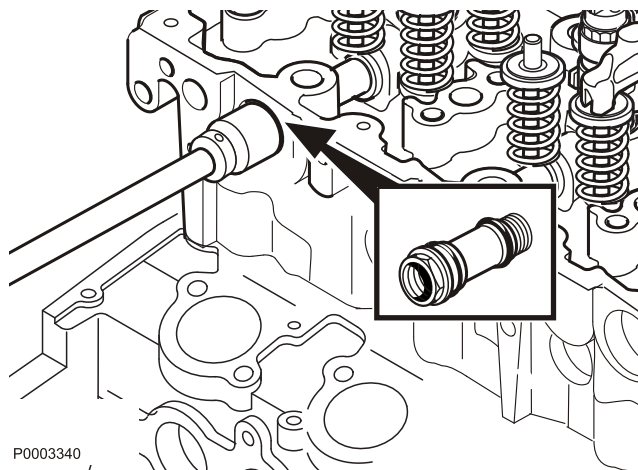


P0003361

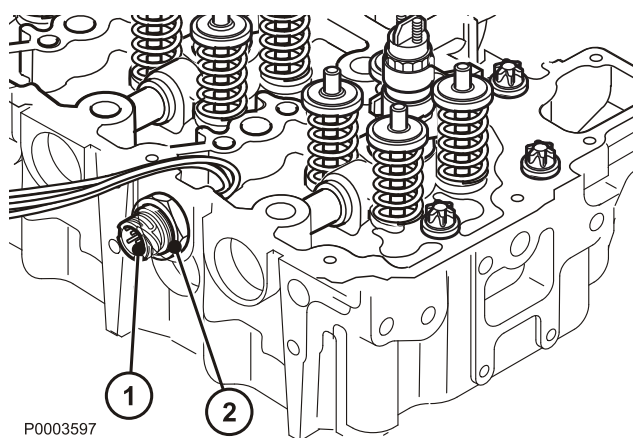
- 41 Oil the cylinder head bolts (M12) and let them drip off.
Install the cylinder head bolts.

Tighten in three steps:

Step 1	30 Nm
Step 2	80 Nm
Step 3	90°

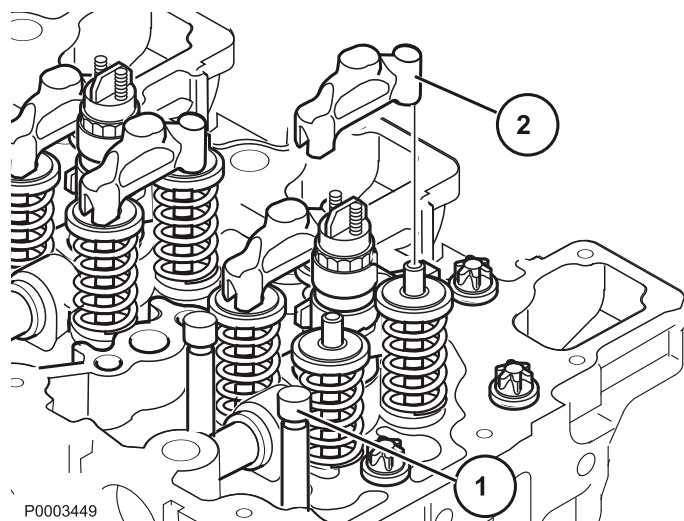


- 42 Install the injector pressure line holders.

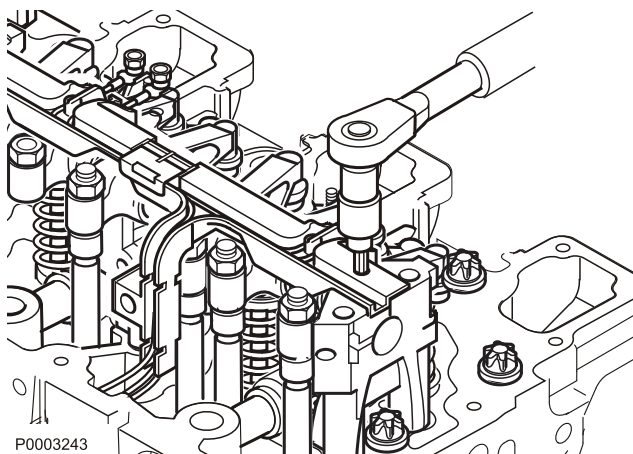


Cable connectors for injector wiring

- 43 Check the wiring seals, replace as necessary. Connect the cable connectors (1) to the cylinder head with the lock washer, and tighten the plastic nut (2). Allow the cable holder to hang free from the engine.



- 44 Fit the push rods (1). Lubricate the valve stems. Replace the valve yoke (2) in accordance with the earlier marking.



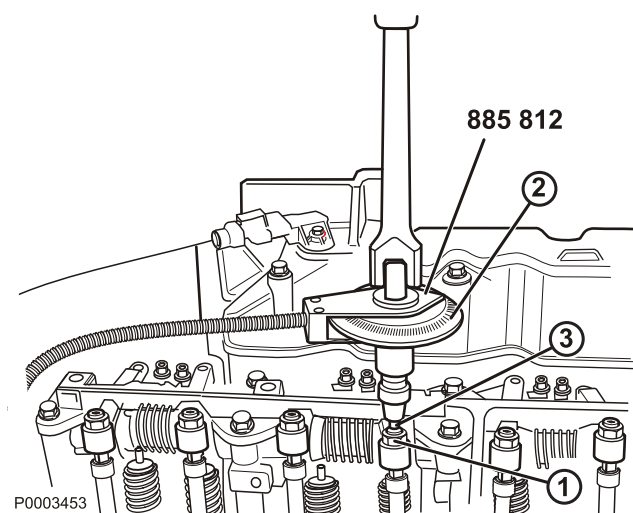
Rocker arm bridges and rocker arms, installation

- 45 Position the rocker arm bridge, align the two guide sleeves at the front and rear while at the same time ensuring that the push rods align with the rocker arms.

Tighten the rocker arm bridge bolts alternately.

Torque to: **20 Nm**

Install the cable holders (2 pcs.) on the rocker arm bridge.

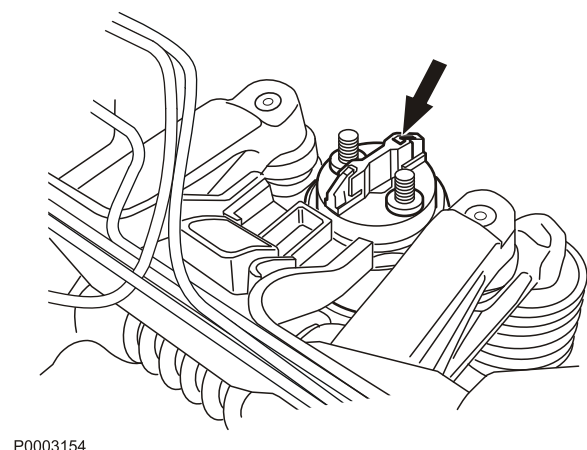


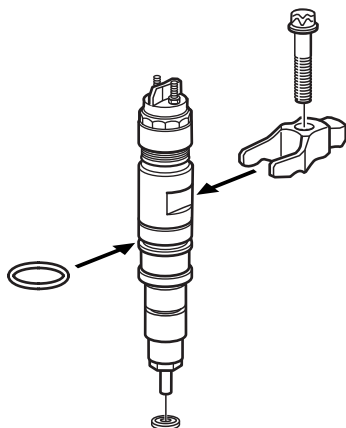
- 46 Adjust valve play according to the method "Valve play, adjustment".

Injectors, installation

- 47 Install the injectors and injector yokes.

NOTICE! Do **not** press directly on the connector screws, but on the plastic between them. Use **new** copper washers.





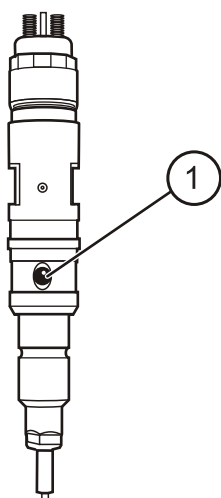
P0003155

48 **IMPORTANT!**

Innan insprutarna sätts dit måste förbränningsrester noggrant torkas bort från cylinderhuvudets lopp. Sug bort smutspartiklar.

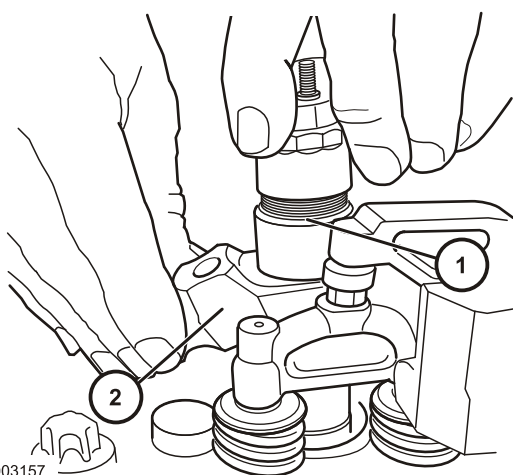
Always use a **new** O-ring and a **new** washer.

- 49 Position the injector so that the installation hole (1) is turned towards the fuel pump side. Lightly oil the O-ring.

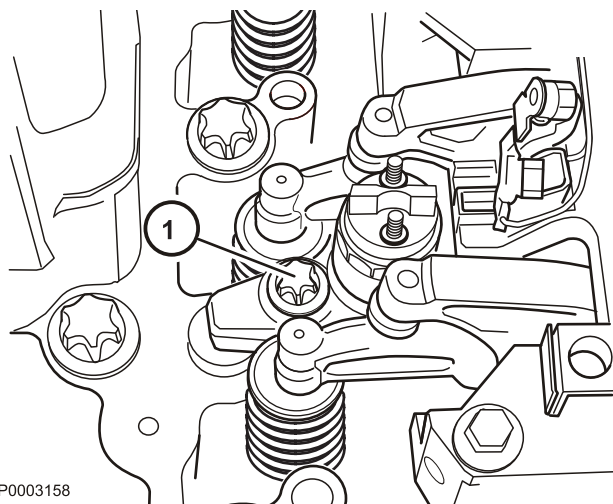


P0003156

- 50 Insert the injector (1) and yoke (2) carefully in the cylinder head.



P0003157

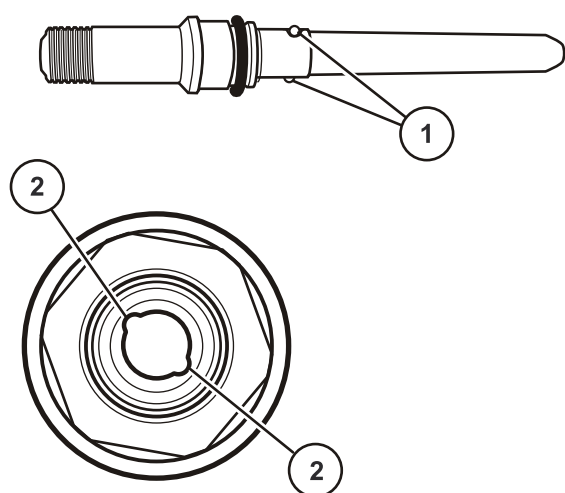


P0003158

- 51 Install bolt (1) in the injector yoke.

Torque to: **4 Nm**

Then loosen the bolt (1) somewhat.

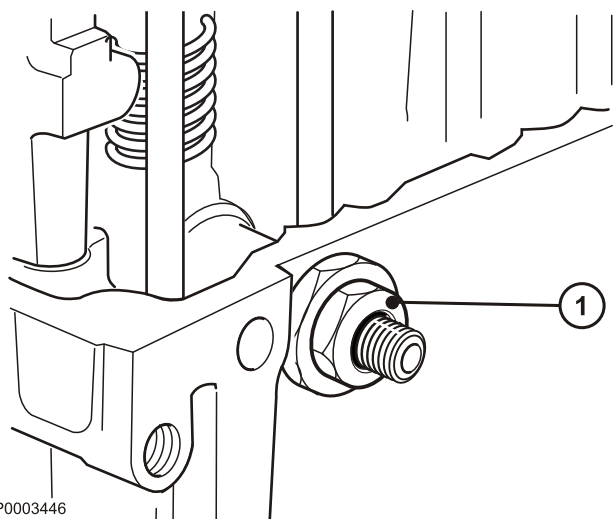


P0003159

- 52 Oil and install a **new** O-ring. Align the injector pressure line and insert it into the holder so that the balls (1) align with the grooves (2) in the holder.

IMPORTANT!

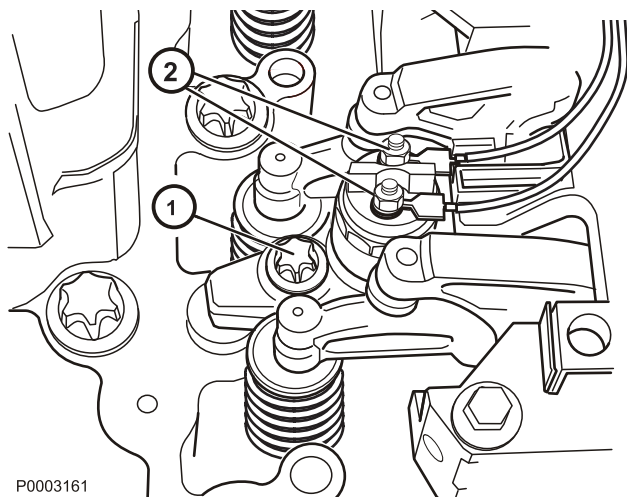
Spridartryckröret måste alltid vara nytt.



P0003446

- 53 Install the connection screw (1).

Torque to: **20 Nm**

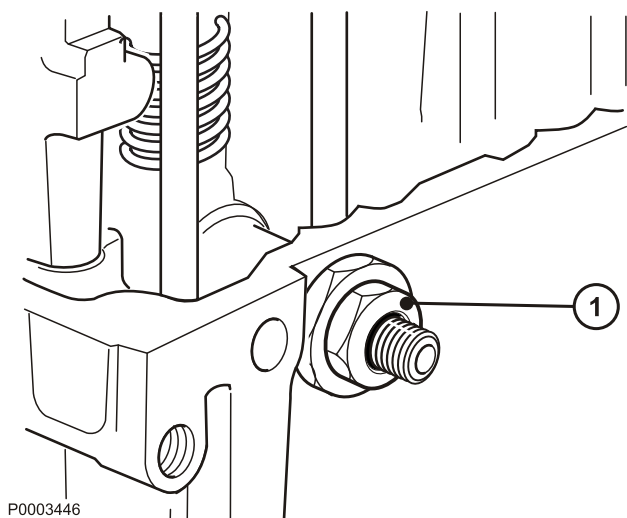


54 Tighten the screw (1).

Torque to: **23 Nm**

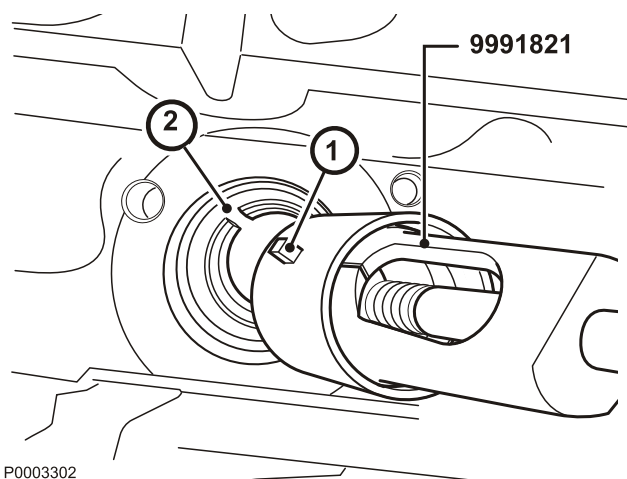
Connect the electrical wiring (2) to the injectors.

Torque to: **1.5 Nm**



55 Re-tighten the connection screw (1).

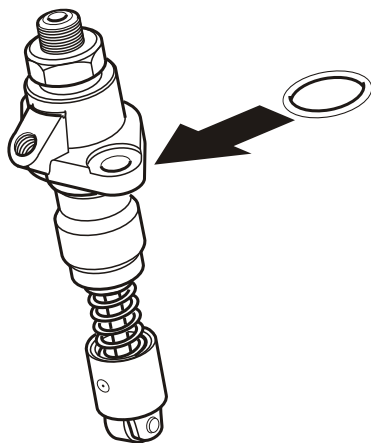
Torque to: **52 Nm**



56 Install the fuel pump roller cams. Use tool **999 1821**.

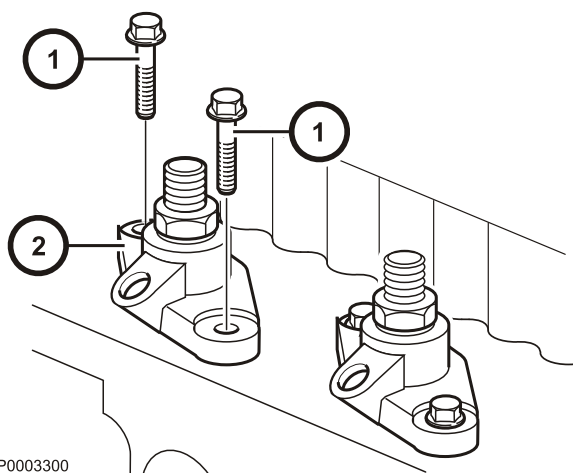
NOTICE! Align the key (1) with the keyway (2).

- 57 Install **new** O-rings on the fuel pumps.



P0003301

- 58 Install the fuel pump (2).
Screw down the bolts (1) alternately.



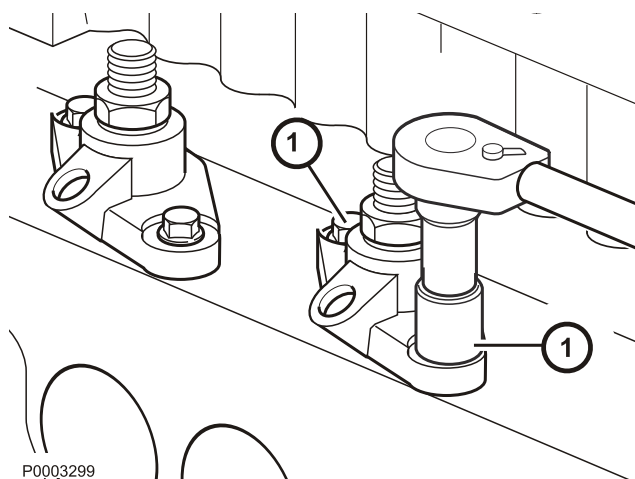
P0003300

Tighten in two steps:

Step 1	10 Nm
Step 2	50 Nm

Install the second fuel pump.

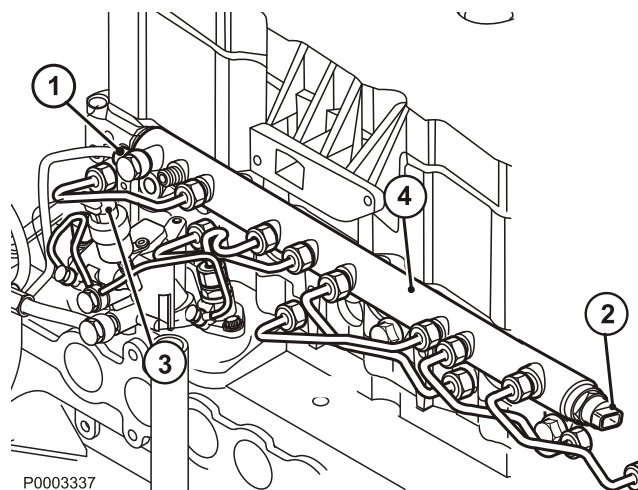
- 59 Crank the engine crankshaft so that the roller cam arrives at the lowest position.
Screw down the bolts (1) alternately.



P0003299

Tighten in two steps:

Step 1	10 Nm
Step 2	50 Nm



60 Install the Common Rail unit (4).

Torque the bolts to: **30 Nm**

Install the "M-prop" and connect the connector (3).

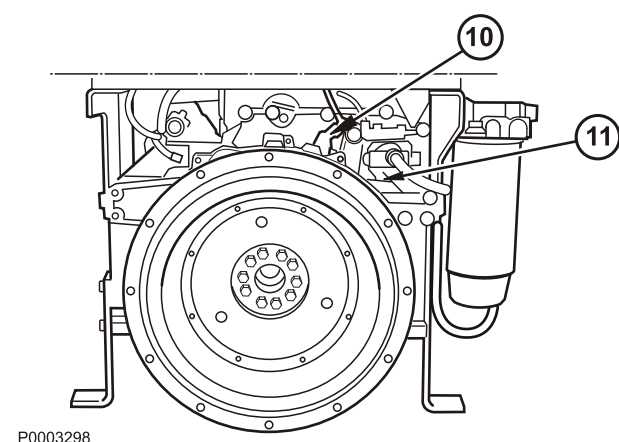
Connect the connector to the rail pressure sensor (2).

Install the return line connection (1); use **new** copper washers.

Torque to: **39 Nm**

Install **new** fuel delivery pipes (tool 888 000 70).

Torque to: **25 Nm**

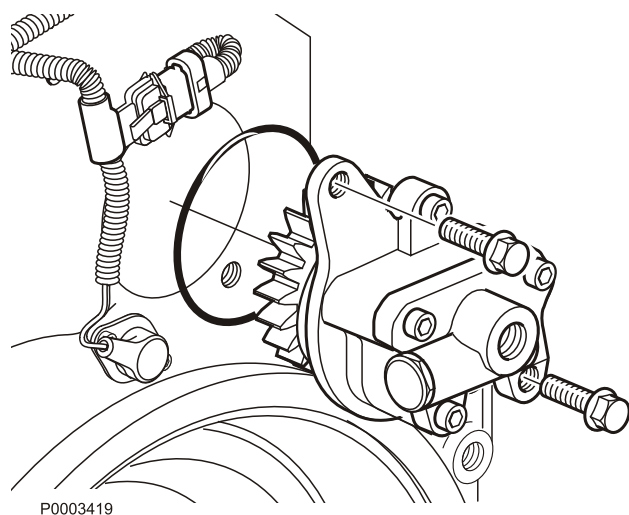


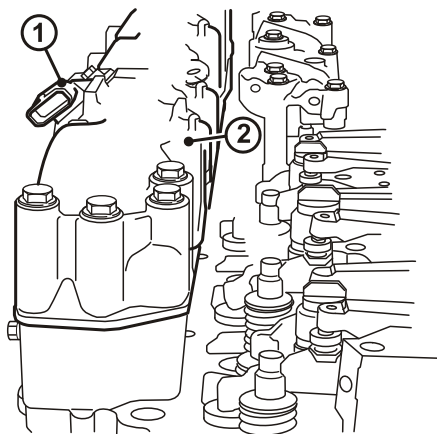
61 **Install:**

- speed sensor, camshaft (11)
- Speed sensor, flywheel (10)

Fuel feed pump, installation

62 Install the fuel pump. Use a **new** O-ring.





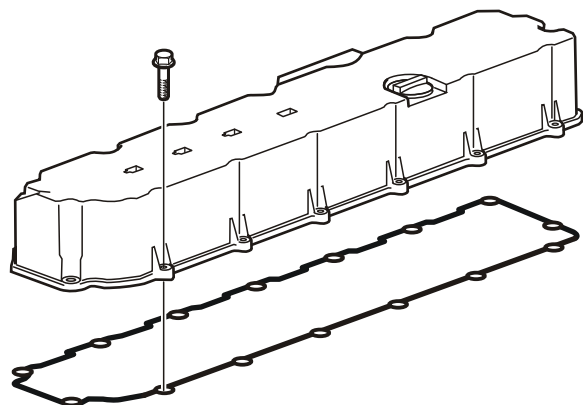
P0003338

Inlet pipe, installation

63 Install:

- Inlet pipe (2), with new gaskets
- pressure sensor cable (1)
- inlet pipe bolts

Torque the bolts to: **30 Nm**



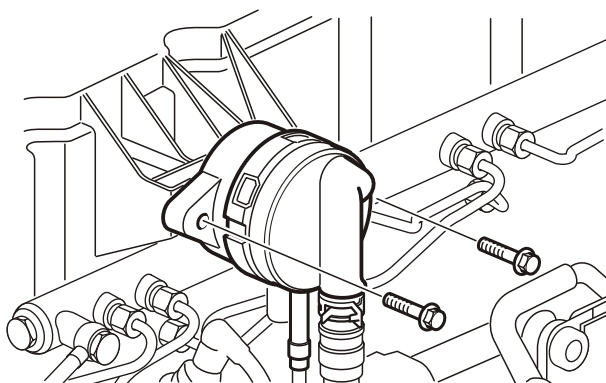
P0003142

Valve cover, installation

- 64 Check the valve cover gasket and replace as necessary.

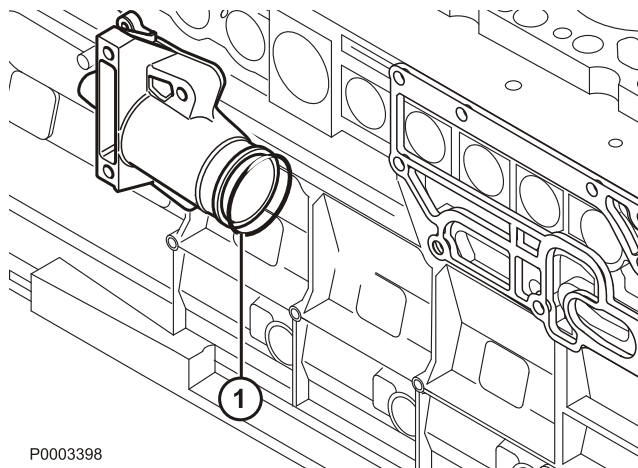
Install the valve cover:

Torque to: **8.5 Nm**

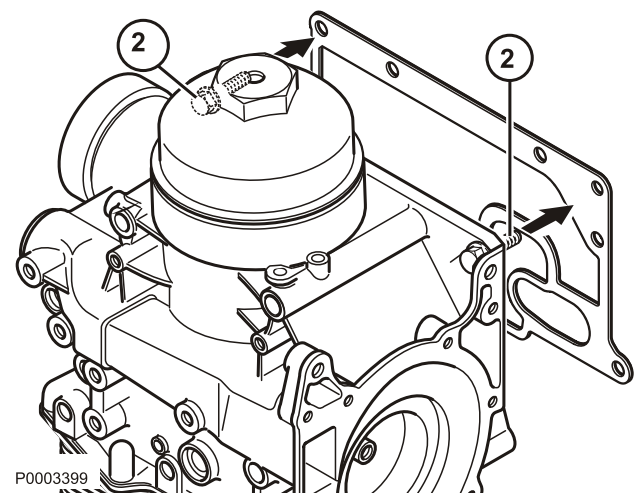


P0003141

- 65 Install the oil trap.



- 66 Install the coolant neck with a **new** seal and two **new** O-rings (1).
Re-install the oil dipstick tube and the oil dipstick.

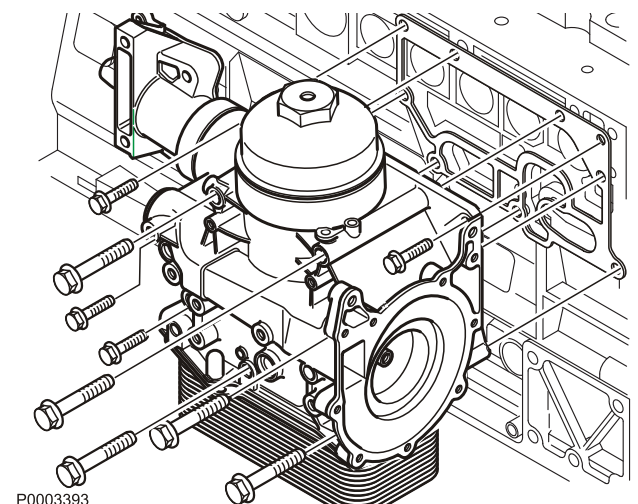


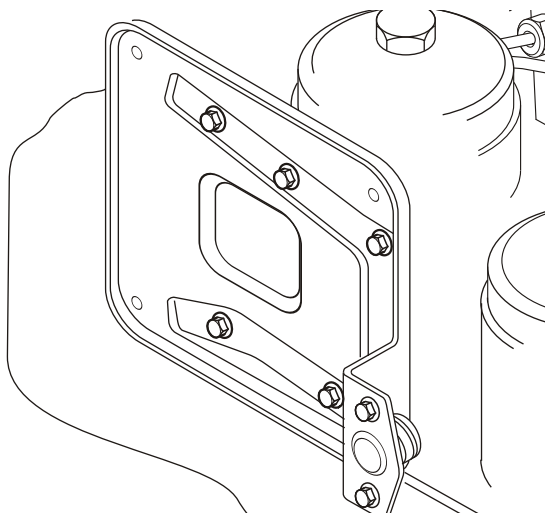
- 67 Install a **new** gasket on the oil filter housing.
Suspend the gasket by the two short bolts (in the upper corners (2) of the oil filter housing).

Oil filter housing, installation

- 68 Guide the oil filter housing and gasket onto the O-rings.
Align the two top bolts (which hold the gasket) with the engine block.

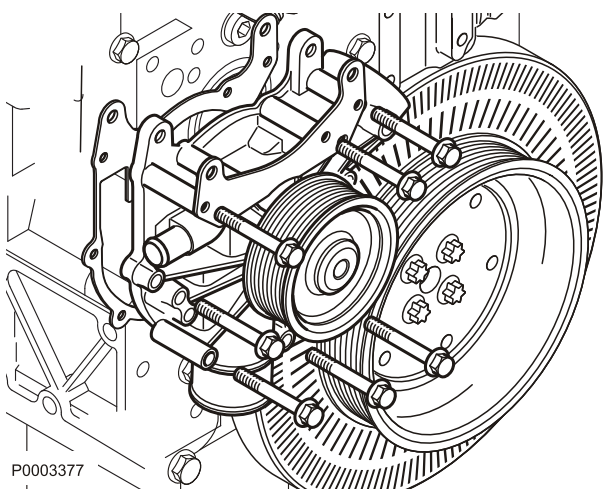
Torque to: **60 (±10) Nm**





P0003392

- 69 Install the cable holder for the electronics unit.

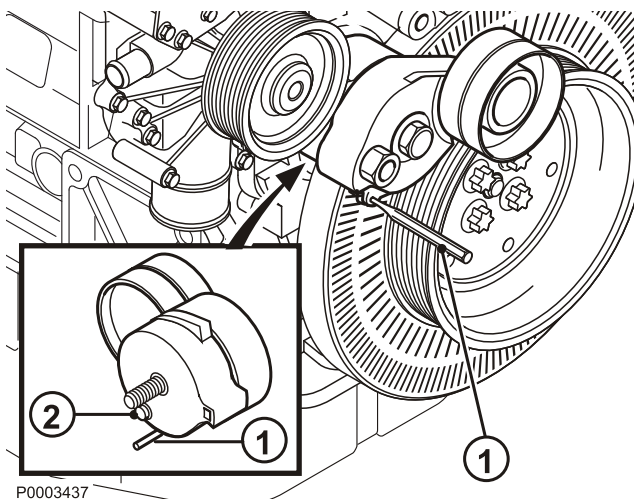


P0003377

- 70 Install the coolant pump.

Torque to: **30 (±5) Nm**

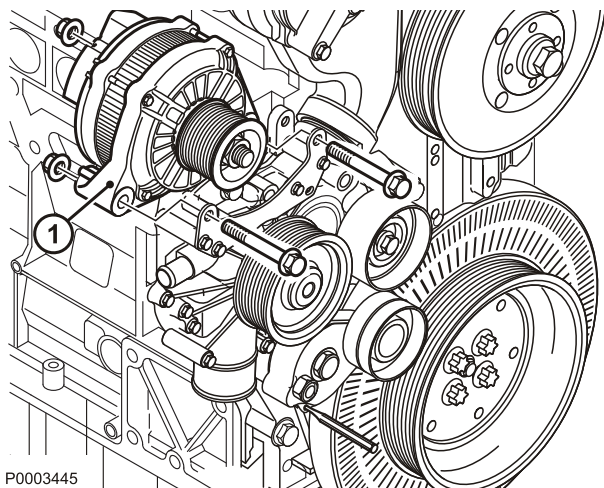
NOTICE! Use a **new** gasket and **new** O-rings.



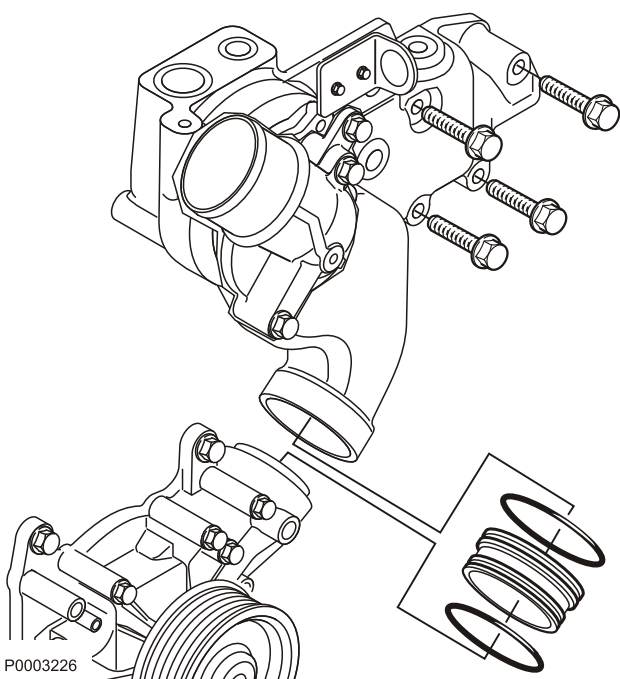
P0003437

- 71 Install the alternator idler wheel.
Install the belt tensioner with drift (1).

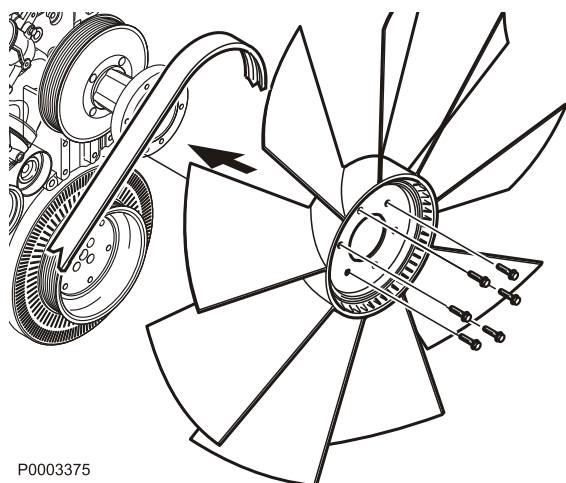
NOTICE! Align the belt tensioner guide pin (2).



72 Install the alternator (1).

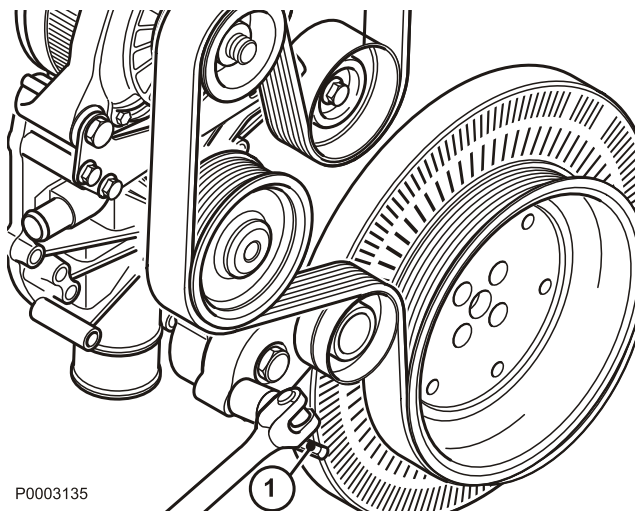


73 Install the thermostat housing with a **new** gasket; press it home against the coolant pump's **new** O-ring seals.



74 **Install:**

- fan bearing holder
- fan bearing, with belt pulley
- fan
- drive belt

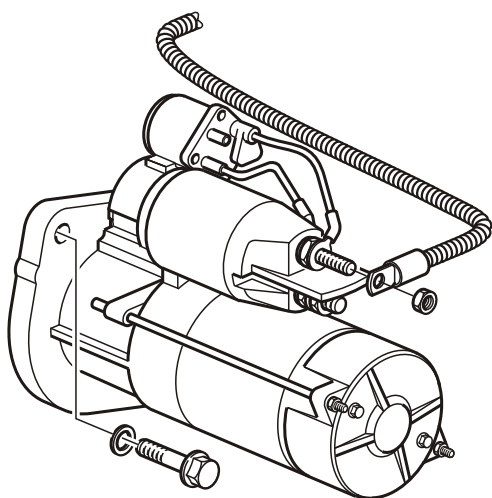


P0003135

- 75 De-tension the belt tensioner.
Remove the drift (1).
Check that the belt is correctly aligned in the belt pulley grooves.

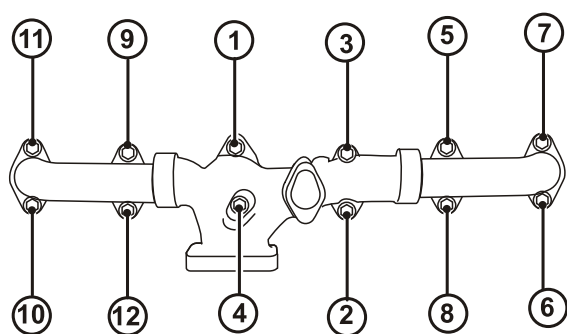
⚠ WARNING!

Pinch hazard. Keep fingers clear.



P0003140

- 76 Fit the starter motor.



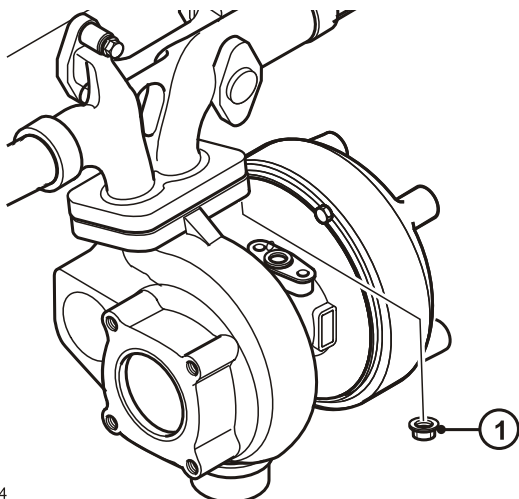
P0003388

- 77 Install the exhaust manifold with **new** gaskets and **new** bolts.

Tighten (as illustrated) in two steps:

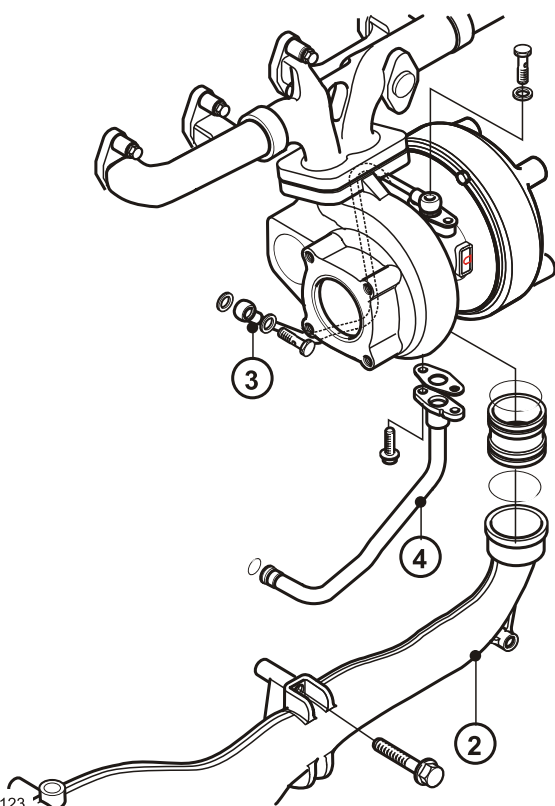
Step 1 **15 Nm**

Step 2 **45 Nm**



78 Install the turbocharger with a **new** gasket.

Torque to: **30 Nm**



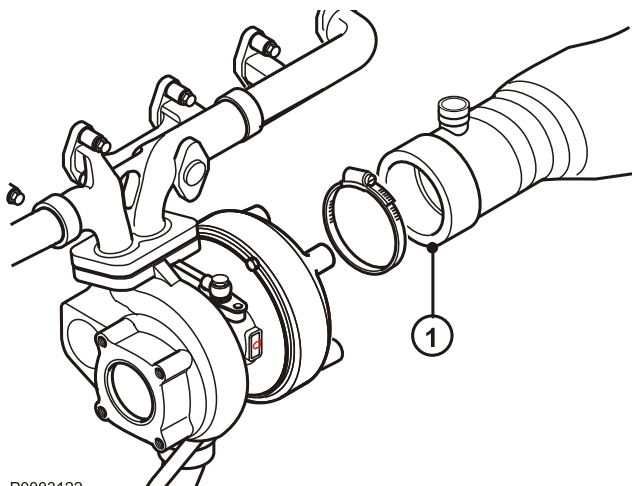
79 Install the turbocharger oil pressure pipe (3) with a **new** gasket.

Torque to: **39 Nm**

Install the turbocharger oil return pipe (4) with a **new** gasket and a **new** O-ring.

Torque to: **20 Nm**

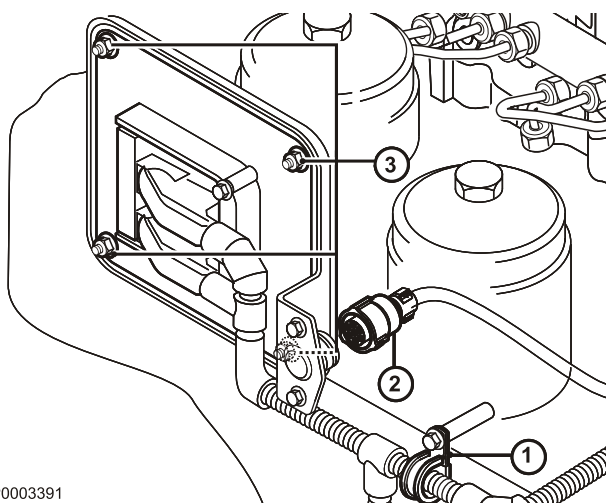
Install the turbocharger pressure pipe (2) to the charge air cooler using **new** O-rings.



P0003122

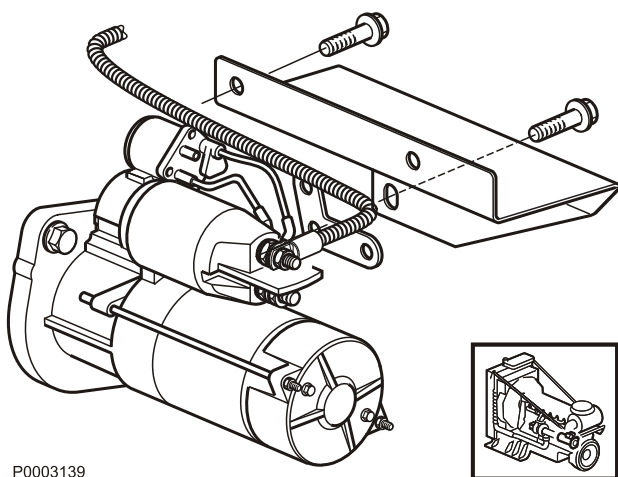
80 Install:

- the induction hose (1)



P0003391

- 81** Install the electronics unit (3) with cable trunk.
Connect the connector (2). Install the clamp (1).



P0003139

- 82** Install the heat shield for the start motor.

Install a **new** fuel filter, oil filter and air filter.
Fill with engine oil.

After installation:

- Fill with coolant, purge the system.
- Fill with fuel, purge the system.
- Connect all electrical connections.

Check that there are **no** leaks anywhere.

21-1 Cylinder Head

Cylinder Head, Change

885510 Plugs
885812 Timing tool
9989876 Dial indicator
9996049 Draining hose
9996400 Slide hammer
9998007 Adapter
9998678 Gauge rod
88800070 Wrench

Drain the coolant (Use drain hose: 999 6049).

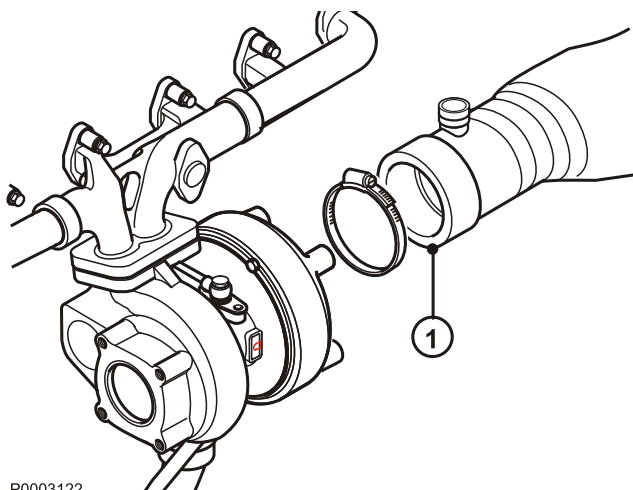
Clean the valve cover and cylinder head with cold degreaser and blow clean with compressed air.

NOTICE! Make sure the cold degreaser does not enter the rail pressure sensor connector.

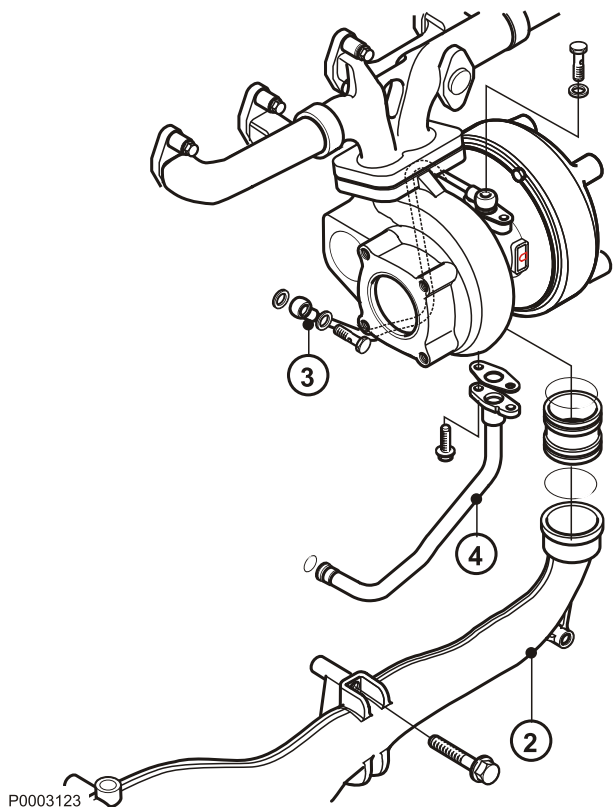
The working method requires removal of the exhaust manifold.

Removal

- 1 **Remove:**
 - air cleaner
 - inlet hose (1)

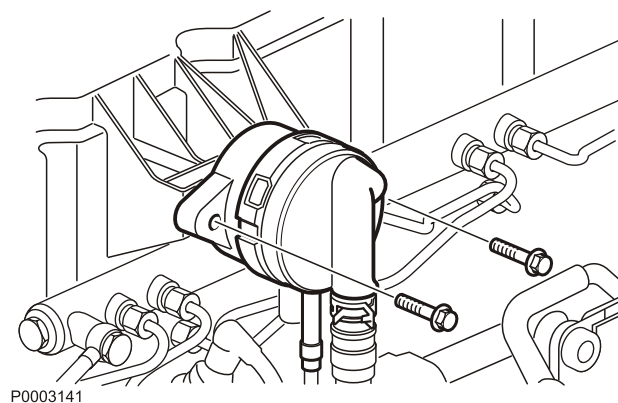


P0003122

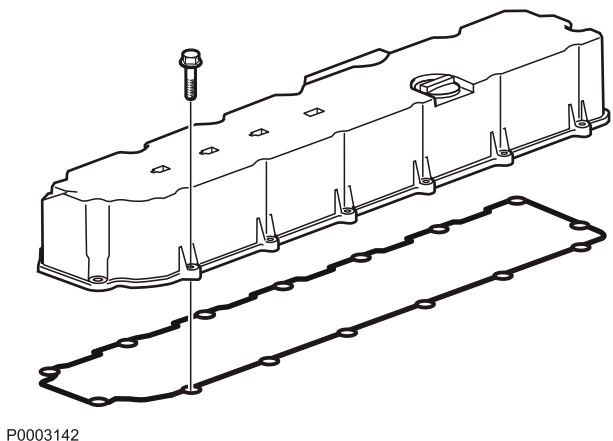


2 Remove:

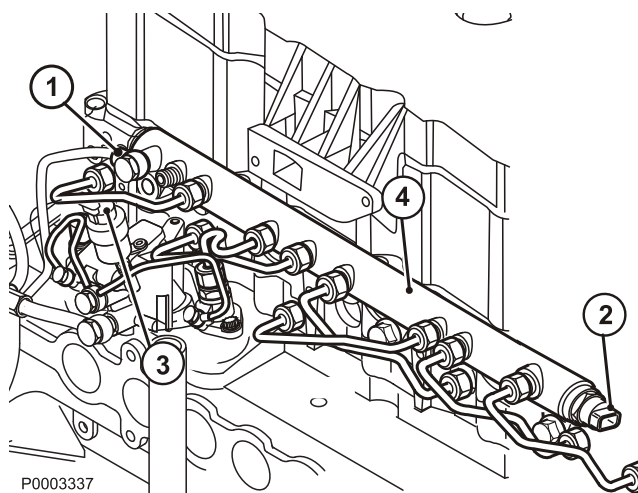
- charge air pipe (2) to the charge air cooler
- oil delivery pipe (3) and oil return pipe (4)
- exhaust manifold, complete with turbo-charger



3 Remove the oil trap.



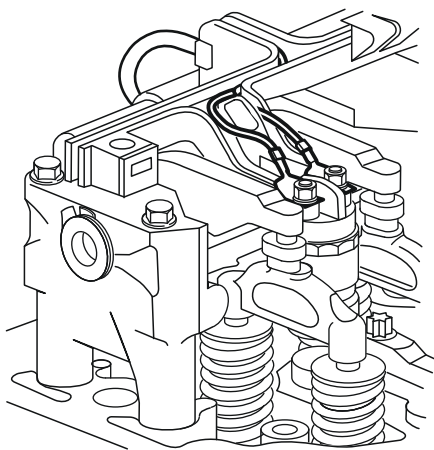
4 Remove the valve cover.



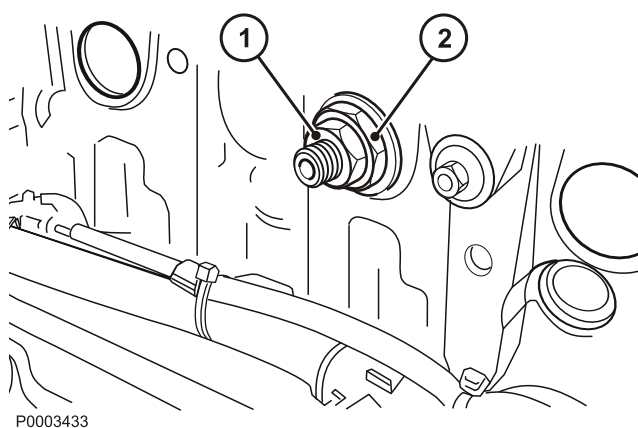
Common Rail unit, removal

- 5 Remove the fuel supply line, use wrench **888 000 70**.
Undo the return line connection (1).
Disconnect the connector from the rail pressure sensor (2).
Disconnect the connector from "M-prop" (3).
Remove the Common Rail unit (4).

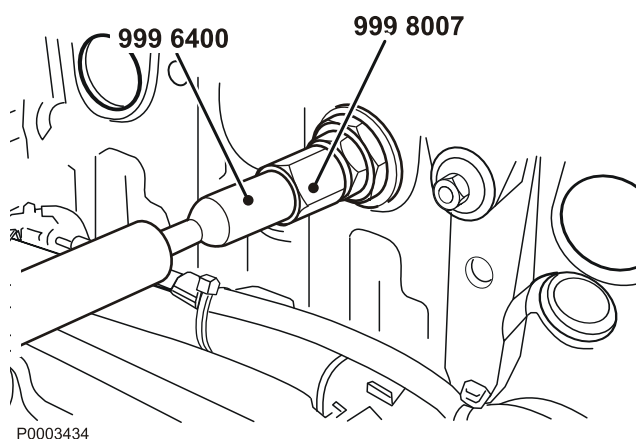
NOTICE! Plug all connections to exclude dirt (885 510).



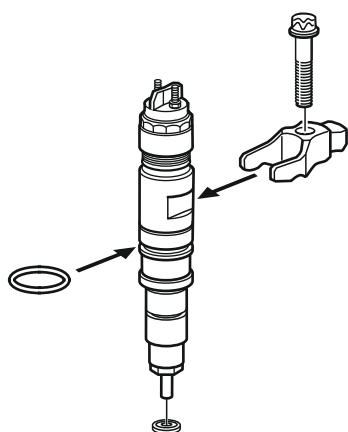
- 6 Remove the wiring from the injectors.



- 7 Remove the nuts (1) that hold the injector pressure pipes in the union (2).

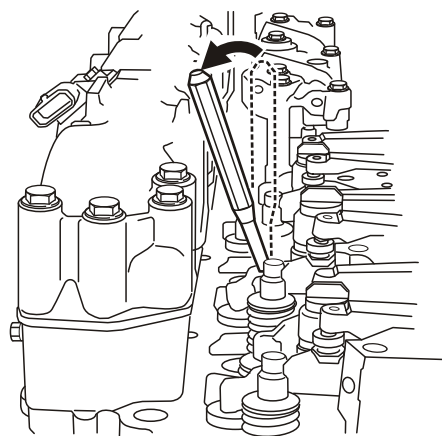


- 8 Remove the injector pressure lines by tapping out the pipes **carefully** with the aid of the puller **999 6400** and adapter **999 8007**.



- 9 Remove the injector bolts.

NOTICE! Ensure that the cylinder head is clean.



- 10 Remove the injector by inserting a **9 mm** drift in the retaining yoke. Move the drift towards the inlet manifold, to lever the injector out. Plug the hole.

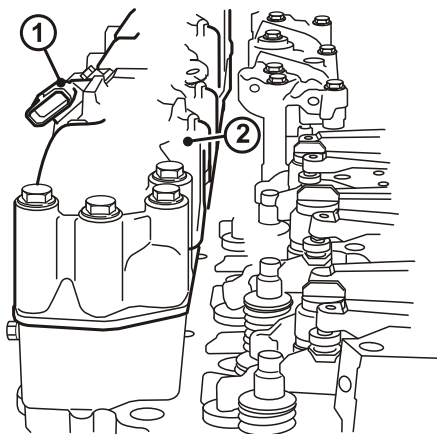
NOTICE! Make sure the sealing washers are also removed.

Inlet pipe, removal

11 Remove:

- pressure sensor cable (1) from the sensor on the inlet pipe (2)
- hose and pipe to the charge air cooler
- pre heater
- inlet pipe bolts

Remove the intake manifold (2).



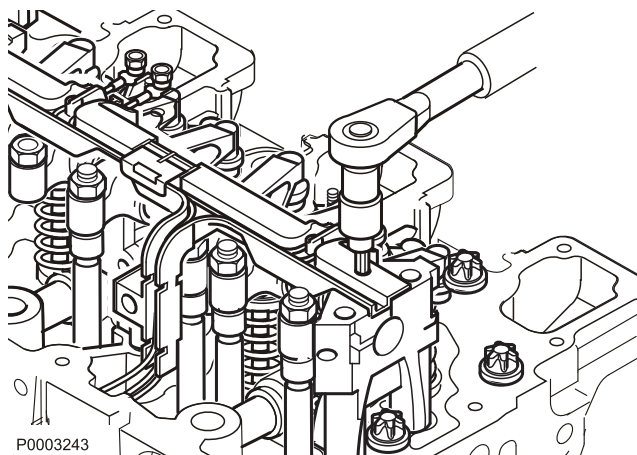
P0003338

Rocker arm bridges and rocker arms, removal

12 Remove the cable holders (2 pcs.) and twist them aside.

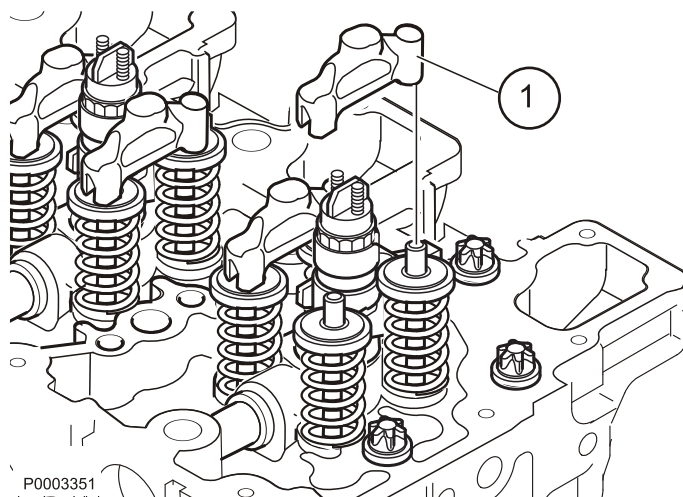
Undo the rocker arm bridge bolts alternately.

Remove the rocker arm bridge with rocker arms

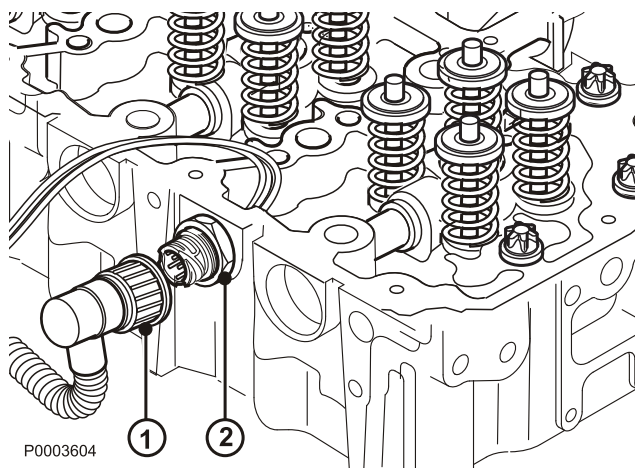


P0003243

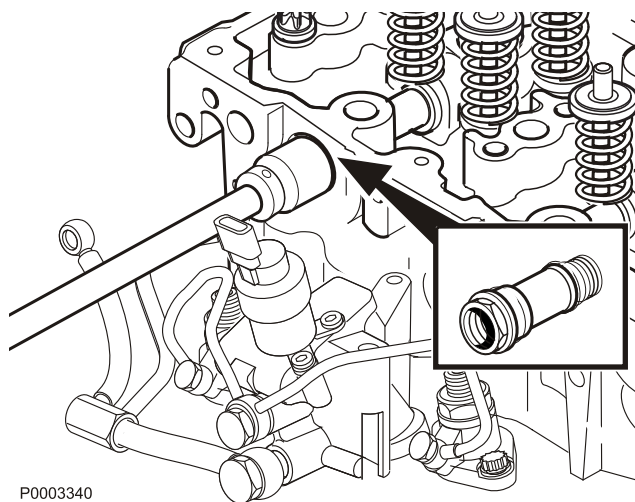
13 Mark up the valve yokes. Remove the valve yokes (1). Remove the push rods.



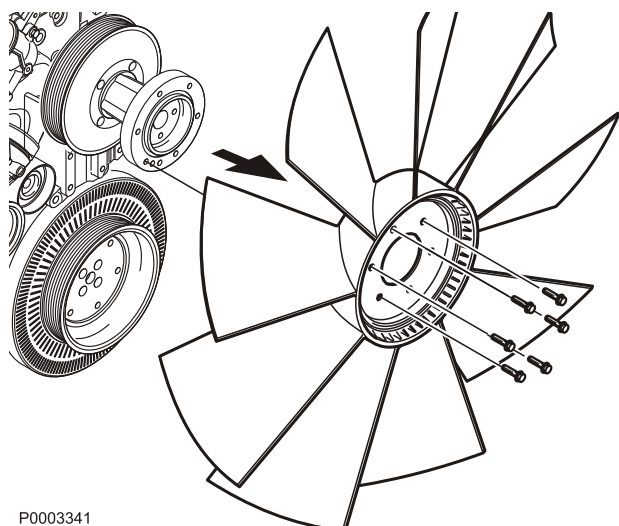
P0003351



- 14 Remove the wiring connections (1) and the nuts (2) to the cable holders. Lift away the wiring.

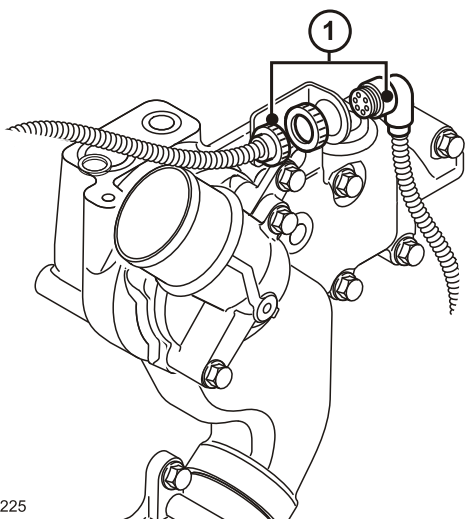


- 15 Remove the injector sleeve.



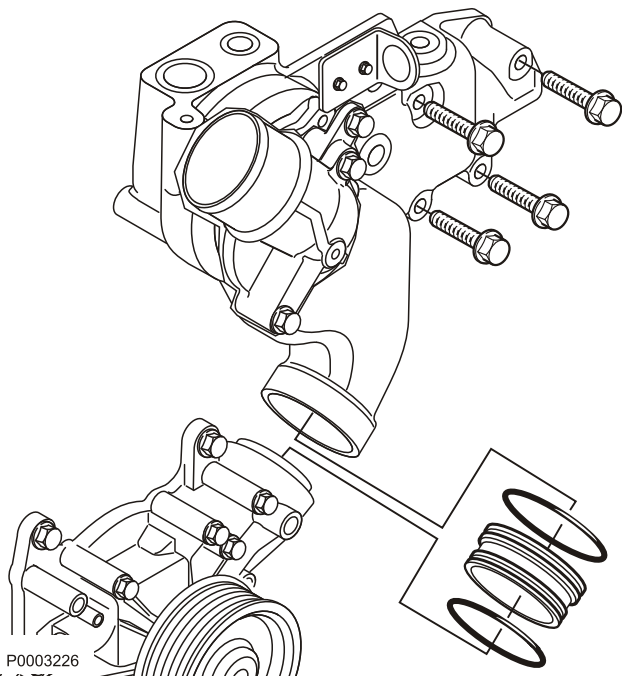
- 16 **Remove:**
- drive belt
 - fan
 - fan bearing, with belt pulley
 - fan bearing holder

- 17 Remove the wiring (1) from the thermostat housing.



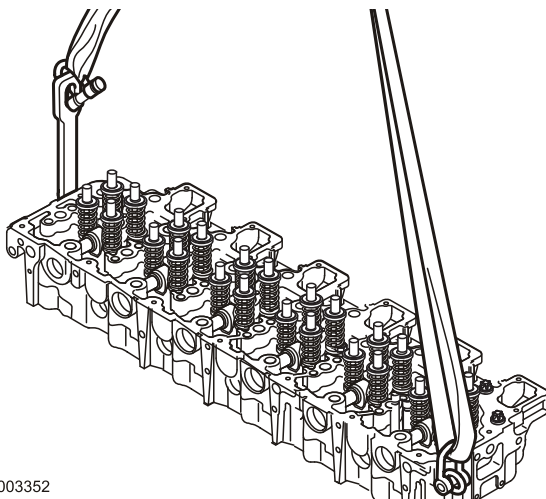
P0003225

- 18 Remove the thermostat housing; pull it away from the coolant pump O-ring seals.



P0003226

- 19 Remove the cylinder head bolts. Attach a lifting eye to the front of the cylinder head. Connect straps to the lifting eyes and lift the cylinder head to remove it.

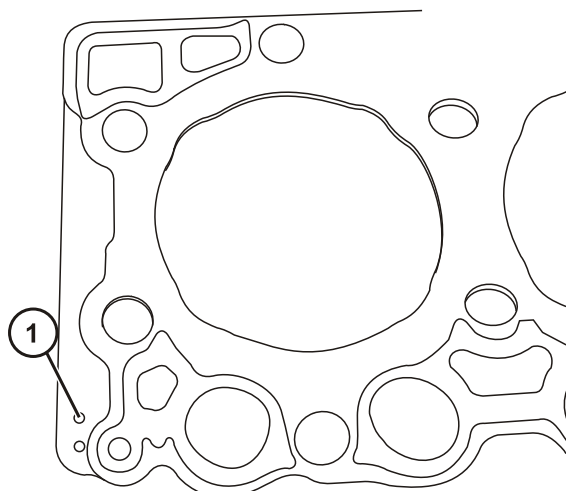


P0003352

Installation

Determining gasket thickness for the cylinder head

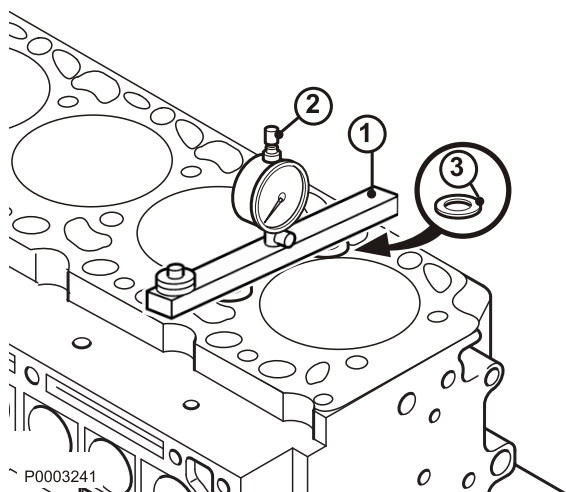
- 20 Cylinder head gaskets are marked (1) with one, two or three holes in one corner. The gaskets must be used for different piston heights above the engine block top side. The piston height above the engine block must be measured at two points on all pistons.



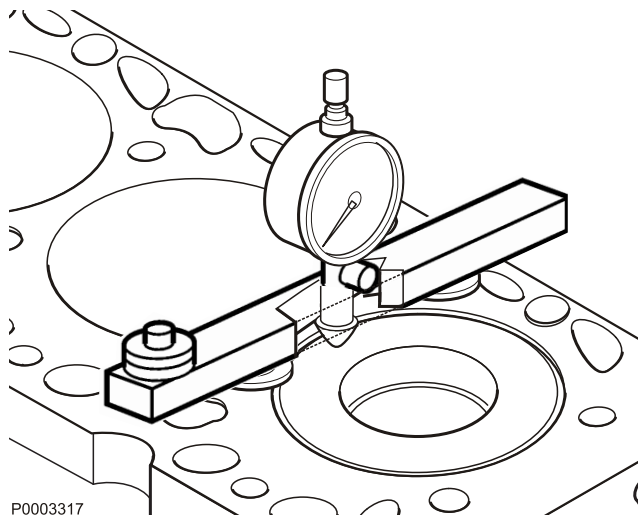
P0003342

Cylinder head gasket

- 21 Decide on cylinder head gasket. Place spacing washers (3) and gauge (1) 999 8678 on the engine block sealing surface and set the dial indicator (2) to "0".

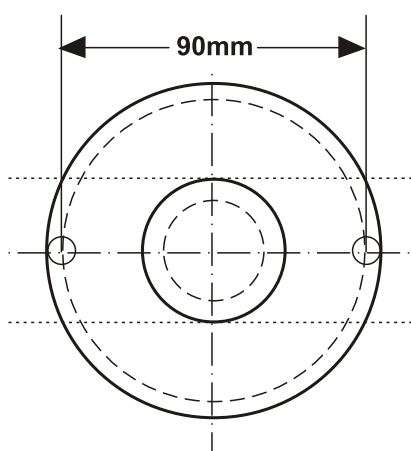


P0003241

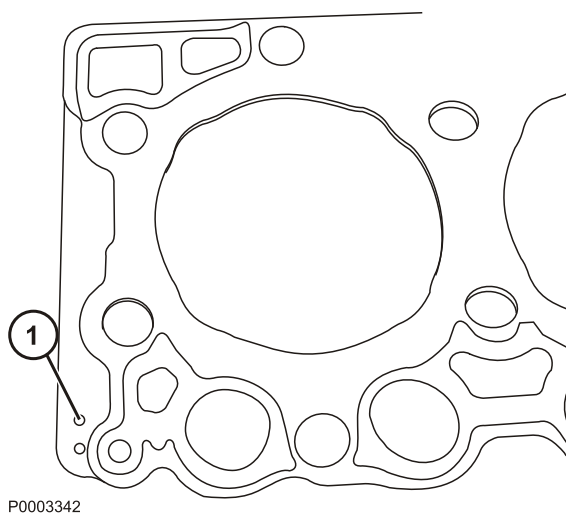


- 22 Place the dial indicator on the piston at the measurement points.
Read and note the value on the dial indicator at the pistons highest position, top dead center.

NOTICE! All pistons should be measured at top dead center in line with the piston pin.



- 23 Pay attention to the measurement points, since the piston surfaces are domed.



- 24 Compare the highest noted value with the table below. Decide on the most suitable cylinder head gasket.

Piston height:

0.28 – 0.53 mm

0.54 – 0.63 mm

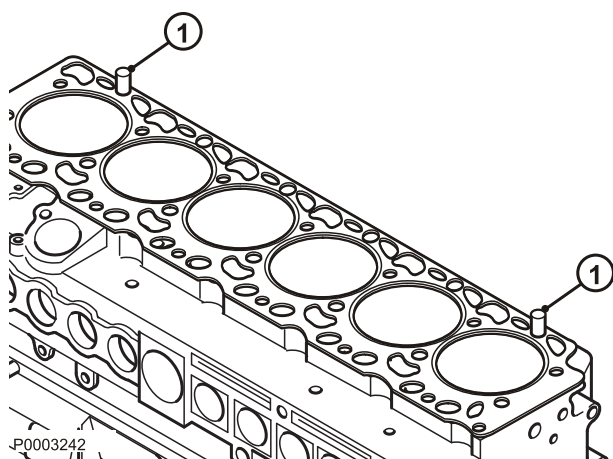
0.64 – 0.75 mm

Cylinder head gasket markings (1):

1 hole

2 holes

3 holes



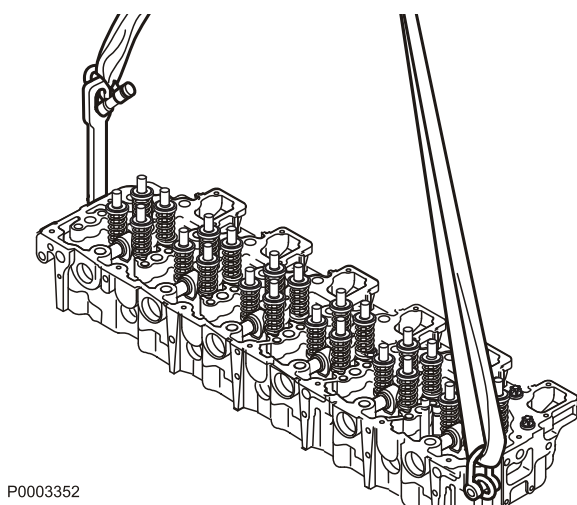
- 25 Position the cylinder head gasket with the marking toward the flywheel.

NOTICE! The sealing surfaces on the cylinder head and the engine block plane must be clean and free from oil. Pay attention to the guide sleeves (1).

Cylinder head, installation

- 26 Lift the cylinder head into place. Pay attention to the guide sleeves.

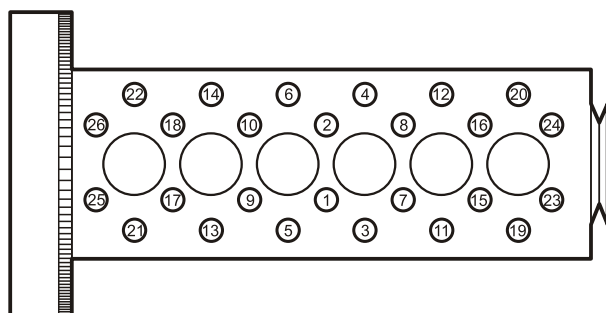
NOTICE! The cylinder head bolts may be used up to 5 times if it can be proven how many times they have been used. (Mark them with a punch for each subsequent stretching.)



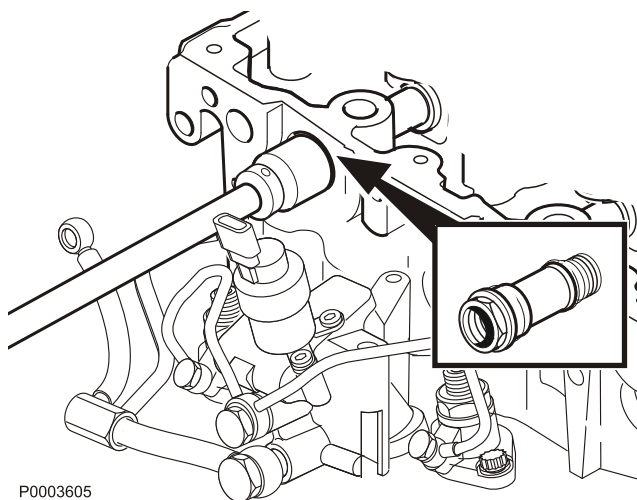
- 27 Oil the cylinder head bolts (M12) and let them drip off. Install the cylinder head bolts.

Tighten in three steps:

- | | |
|----------|---------------|
| Stage 1: | 30 Nm. |
| Stage 2: | 80 Nm. |
| Stage 3: | 90°. |



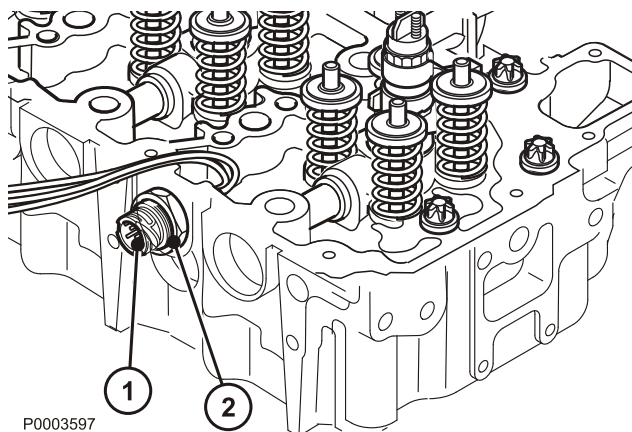
- 28 Install the injector sleeve.



P0003605

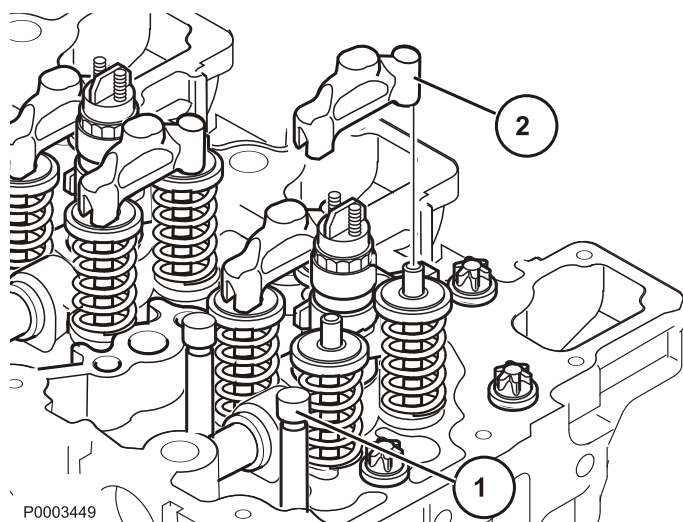
Cable connectors for injector wiring

- 29 Check the wiring seals, replace as necessary. Connect the cable connectors (1) to the cylinder head with the lock washer, and tighten the plastic nut (2). Connect the loom connector to the wiring (1). Allow the cable holder to hang free from the engine.

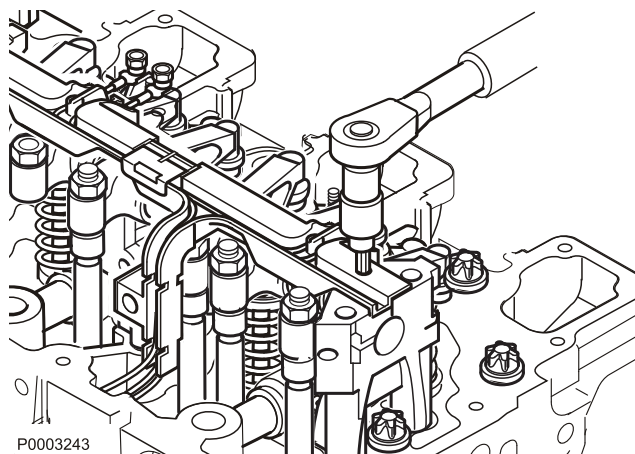


P0003597

- 30 Fit the push rods (1). Lubricate the valve stems. Replace the valve yoke (2) in accordance with the earlier marking.



P0003449



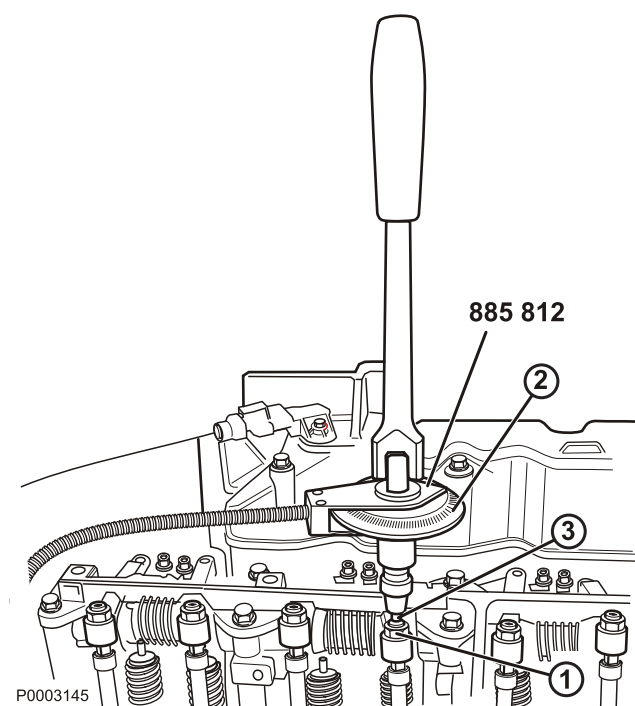
Rocker arm bridges and rocker arms, installation

- 31 Position the rocker arm bridge, align the two guide sleeves at the front and rear while at the same time ensuring that the push rods align with the rocker arms.

Tighten the rocker arm bridge bolts alternately to:

20 Nm

Install the cable holders (2 pcs.) on the rocker arm bridge.

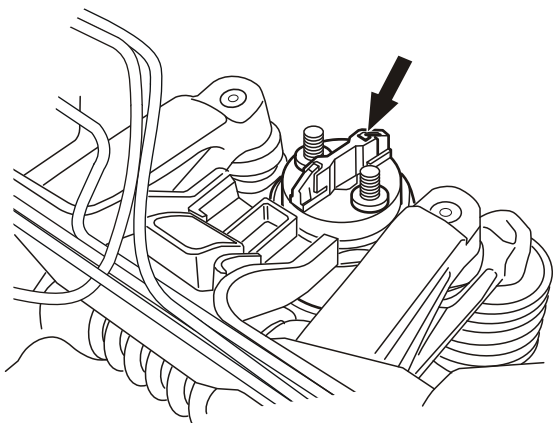


- 32 Adjust valve play according to the method "Valve play, adjustment".

Injectors, installation

- 33 Install the injectors and injector yokes.

NOTICE! Do **not** press directly on the connector screws, but on the plastic between them. Use **new** copper washers and **new** O-rings.

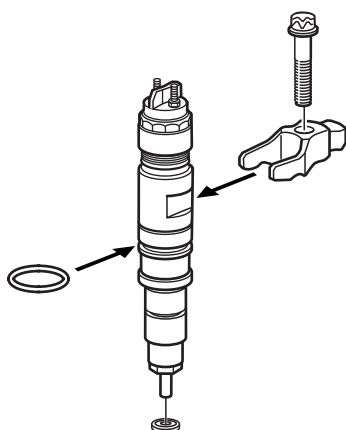


P0003154

- 34 **IMPORTANT!**

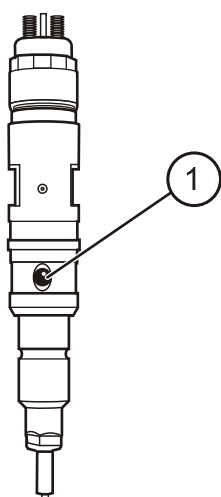
Innan insprutarna sätts dit måste förbränningsrester noggrant torkas bort från cylinderhuvudets lopp. Sug bort smutspartiklar.

Always use a **new** O-ring and a **new** washer.

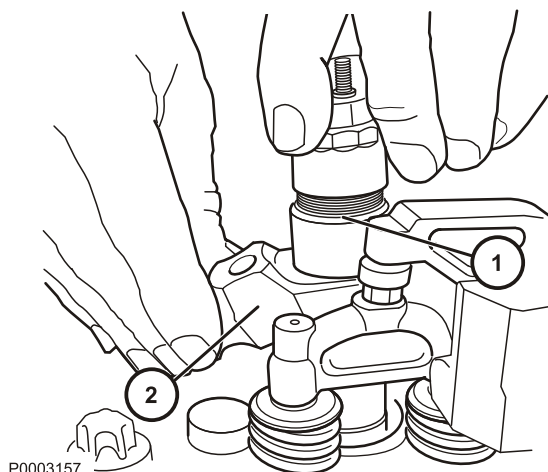


P0003155

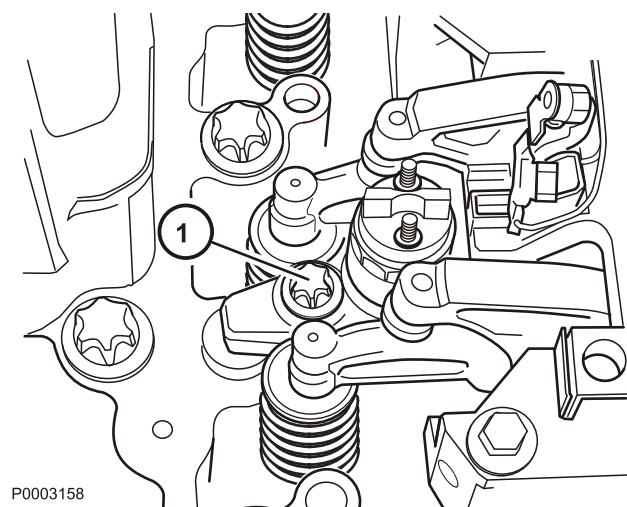
- 35 Position the injector so that the installation hole (1) is turned towards the fuel pump side. Lightly oil the O-ring.



P0003156

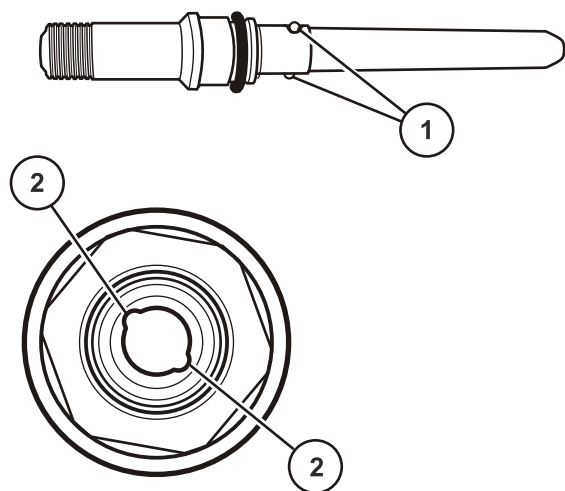


- 36 Insert the injector (1) and yoke (2) carefully in the cylinder head.

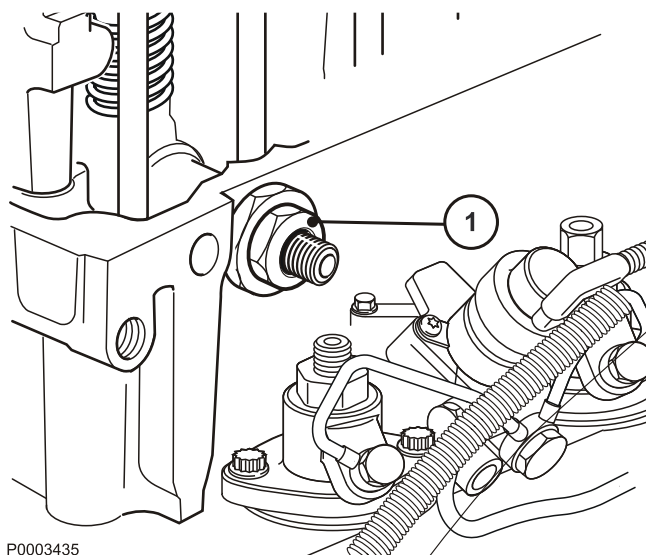


- 37 Install bolt (1) in the injector yoke.

Torque to: **4 Nm**
Then loosen the bolt (1) somewhat.



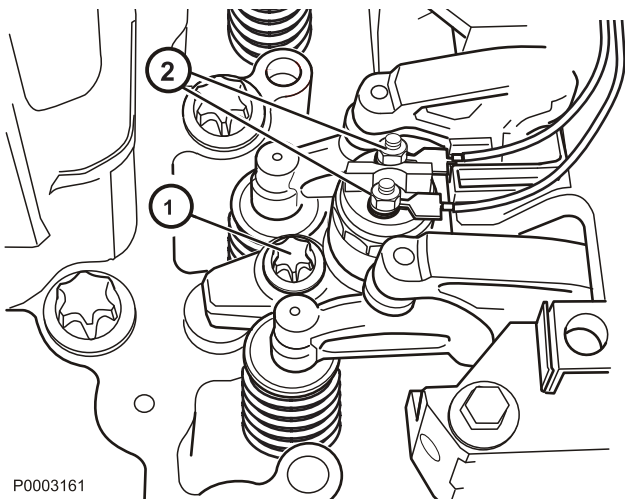
- 38 Oil and install a **new** O-ring.
Align the injector pressure line and insert it into the holder so that the balls (1) align with the grooves (2) in the holder.
IMPORTANT!
Spridartryckröret måste alltid vara nytt.



P0003435

39 Install the connection screw (1).

Torque to: **20 Nm**



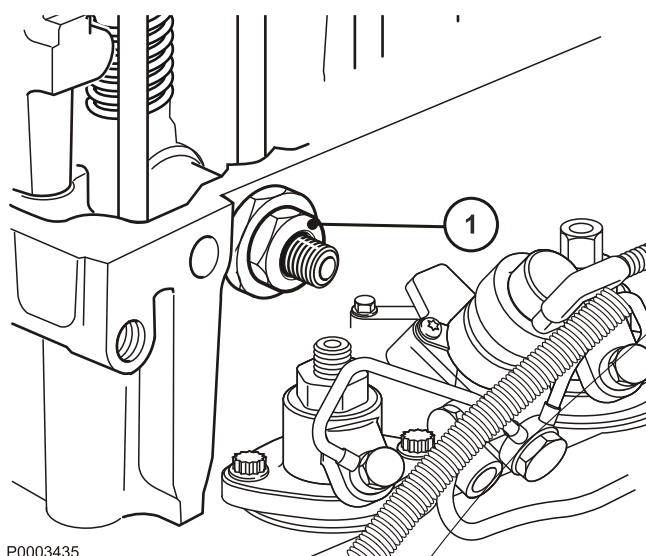
P0003161

40 Tighten the screw(1).

Torque to: **23 Nm**

Connect the electrical wiring (2) to the injectors.

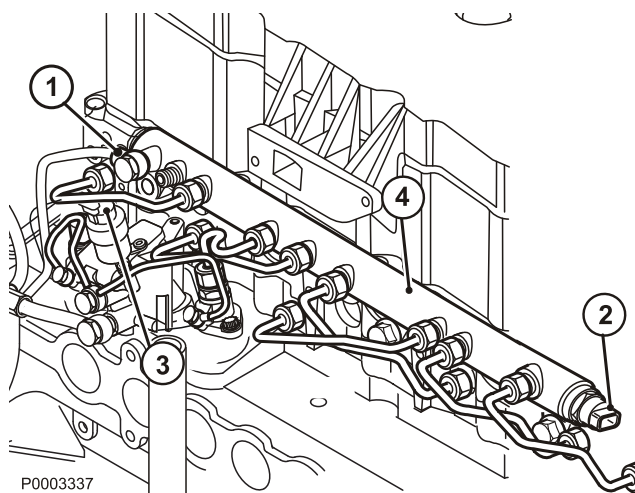
Torque to: **1.5 Nm**



P0003435

41 Re-tighten the connection screw (1).

Torque to: **52 Nm**



Common Rail unit (4), installation

42 Tighten the bolts.

Torque to: **30 Nm**

Connect the fuel hose to the rail.

Tighten the connection

to: **39 Nm**

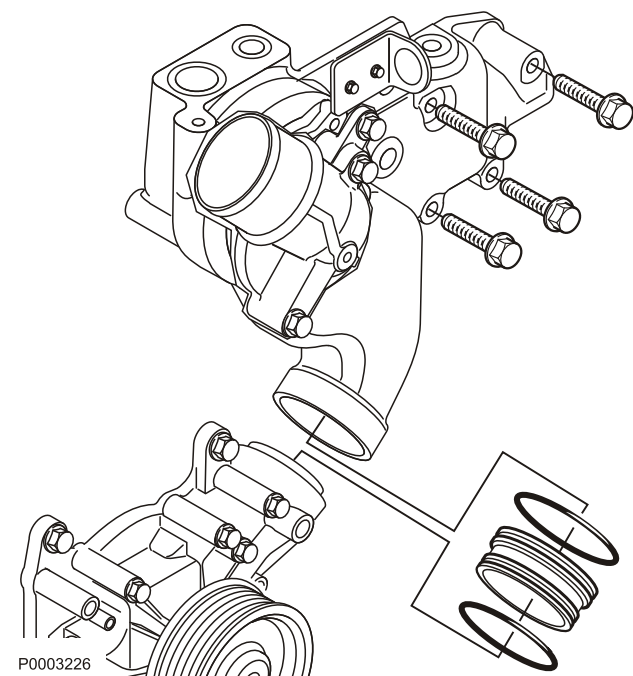
Install **new** fuel delivery pipes (tool 8880 0070).

Torque to: **25 Nm**

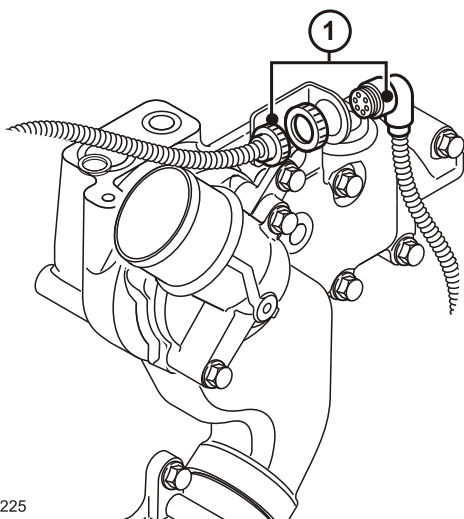
Install:

- the connector from "M-prop" (3).
- the connector to the rail pressure sensor (2).
- the return line connection (1).

43 Install the thermostat housing with **new** seals.



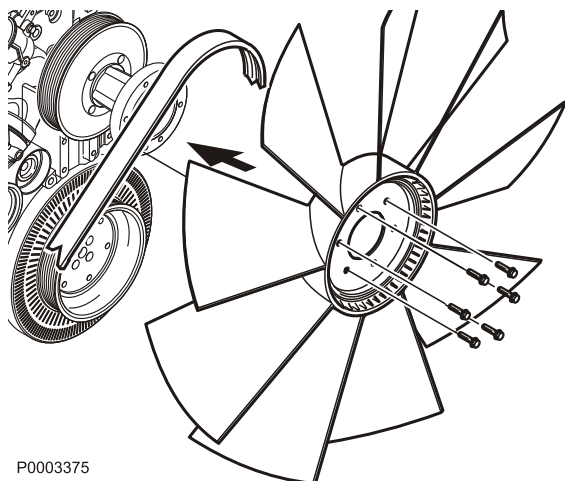
44 Connect the wiring to the thermostat housing.



P0003225

45 **Install:**

- fan bearing holder
- fan bearing, with belt pulley
- fan
- drive belt



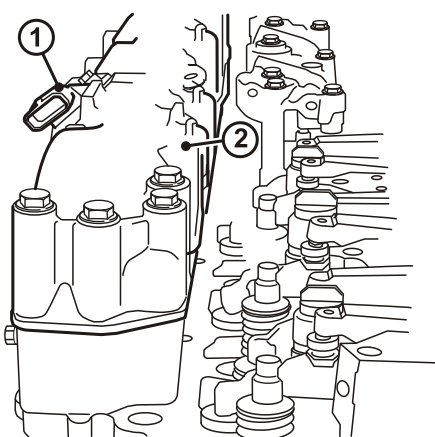
P0003375

Inlet pipe, installation

46 **Install:**

- Inlet pipe (2), with new gaskets
- pressure sensor cable (1)
- inlet pipe bolts

Torque the bolts to: **30 Nm**

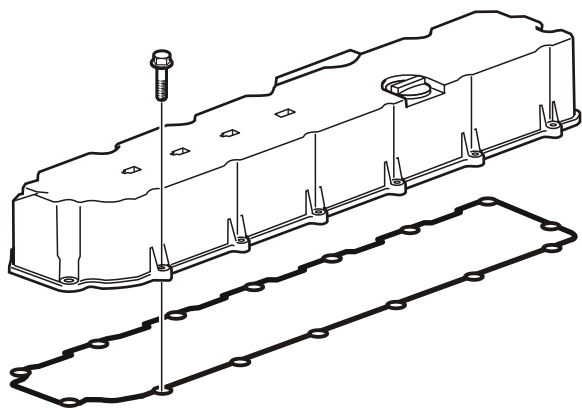


P0003338

Valve cover, installation

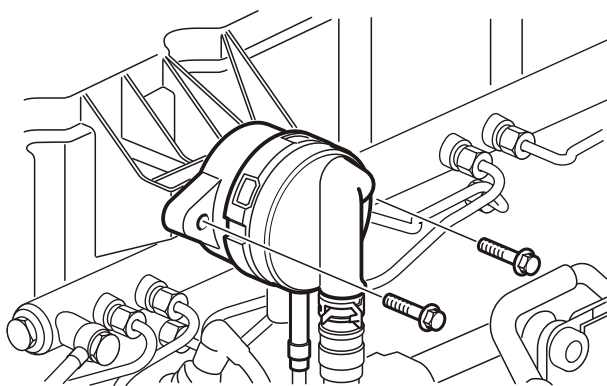
- 47 Check the valve cover gasket and replace as necessary.
Install the valve cover.

Torque to: **8.5 Nm**

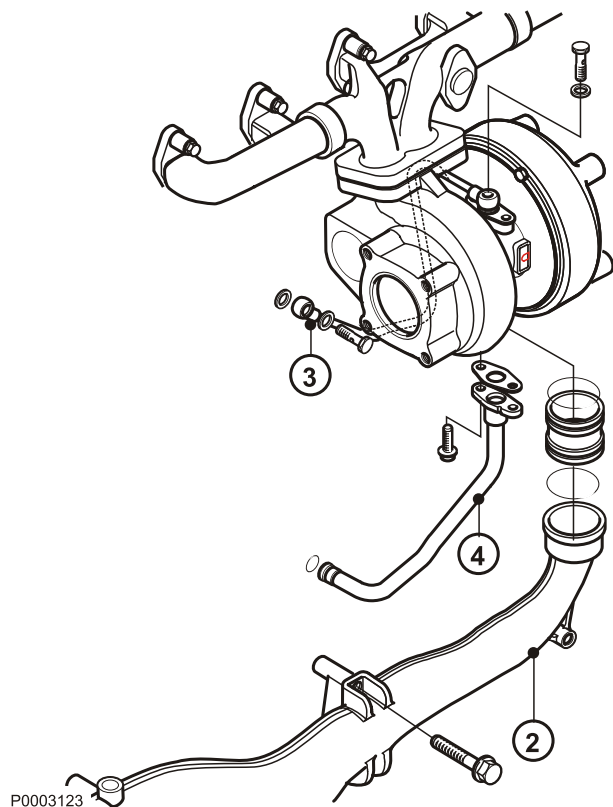


P0003142

- 48 Install the oil trap.



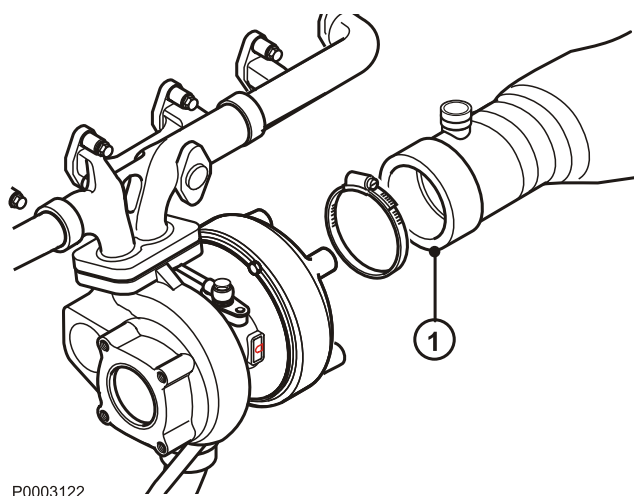
P0003141



49 Install:

- exhaust manifold, complete with turbo-charger
- oil delivery pipe (3) and oil return pipe (4)
- charge air pipe (2) to the charge air cooler

NOTICE! Use lubricant on the exhaust manifold bolts.



50 Install:

- inlet hose (1)
- air cleaner

Carry out a function test

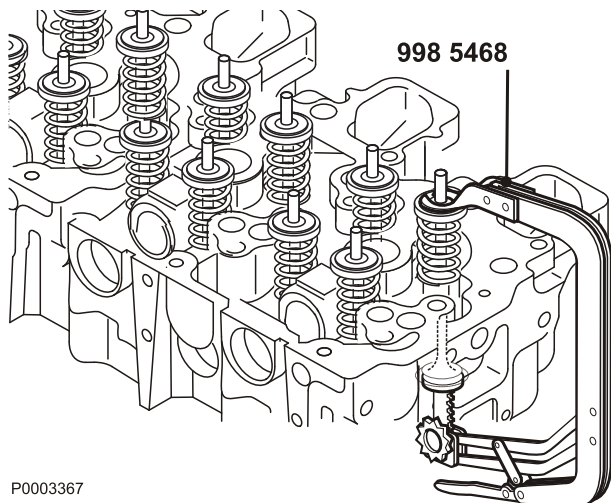
- Fill up with coolant.
- Purge the fuel system using the method, "Fuel system, purging".
- Check that there are **no** leaks anywhere.

Cylinder Head Valve, Change

9985468 Valve spring compressor
9985471 Sliding depth gauge
9989876 Dial indicator
9999696 Magnetic stand
88800151 Drift

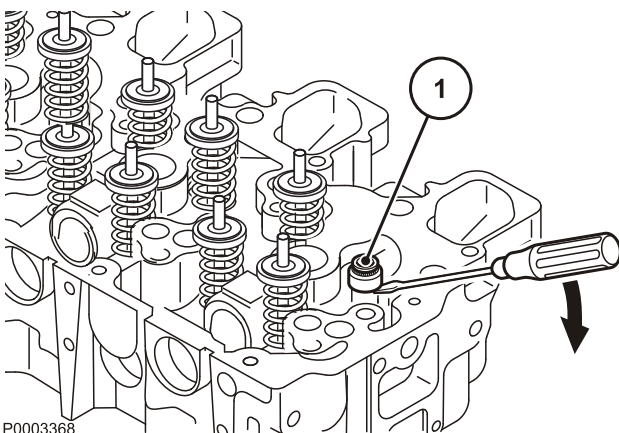
The working method requires removal of the cylinder head.

- 1 Remove the valve collets, valve washers, valve springs and valves, with the aid of valve spring compressor **998 5468**.

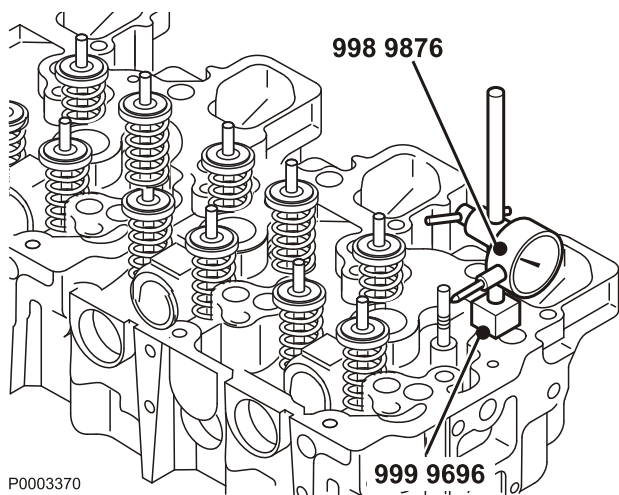


P0003367

- 2 Remove the valve spindle seals (1).



P0003368



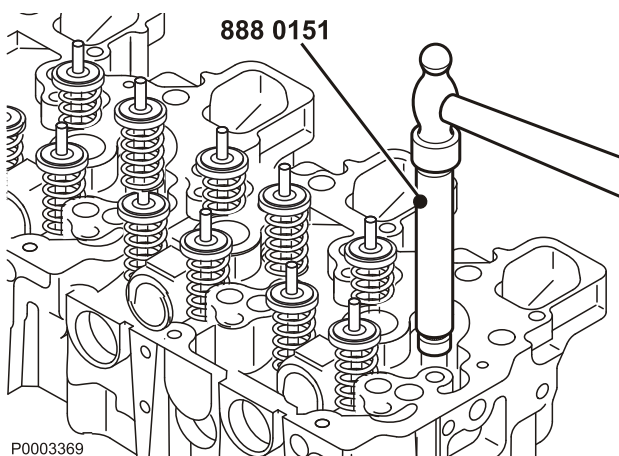
- 3 Clean the cylinder head and check for damage. Move the valve down a little so that it is not seated. Measure the clearance between valve stem and guide.

Wear limits:

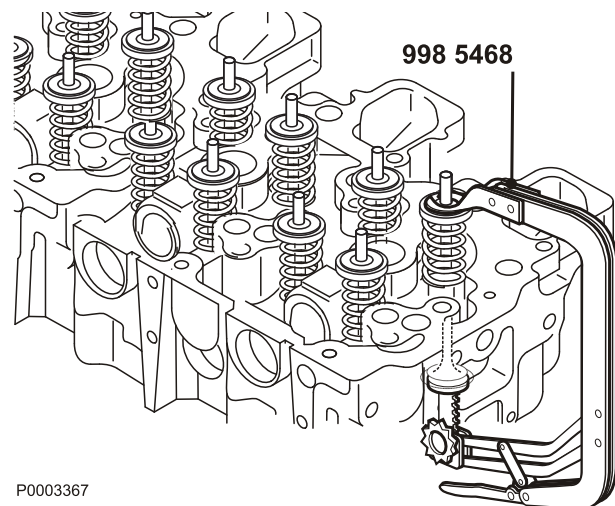
Inlet valve **0.10 mm**

Exhaust valve **0.13 mm**

NOTICE! Measure using a **new** valve.



- 4 Install a **new** valve stem seal; use drift **8880 0151**.



- 5 **Install:**
 - valve
 - valve spring
 - valve washer
 - valve collets

Use valve spring compressor **998 5468**.

21-4 Valve Mechanism

Valve Clearance Adjustment

885812 Timing tool

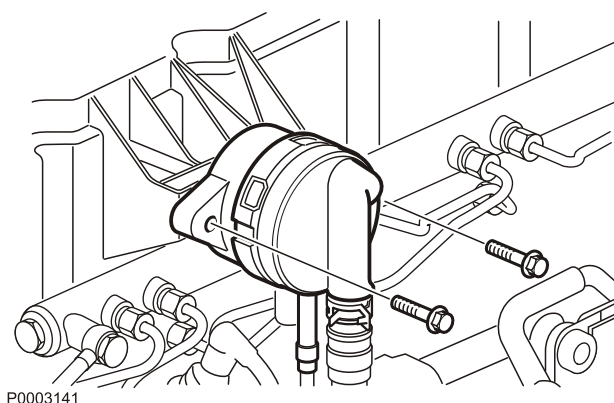
88800014 Rotation tool

NOTICE! Normal valve clearance is set when the engine is cold, or when it has been left to cool for at least a half hour. Oil temperature < 80 °C.

IMPORTANT!

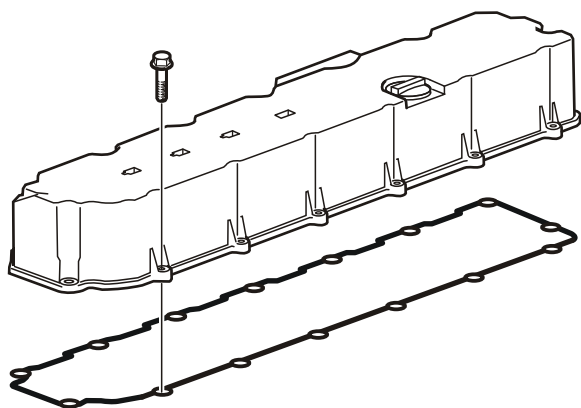
Rengör runt ventilkåpan med kallavfettningsmedel och blås rent med tryckluft. Speciellt viktigt är det att rengöra mellan inloppsrör och ventilkåpa.

- 1 Remove the oil trap.

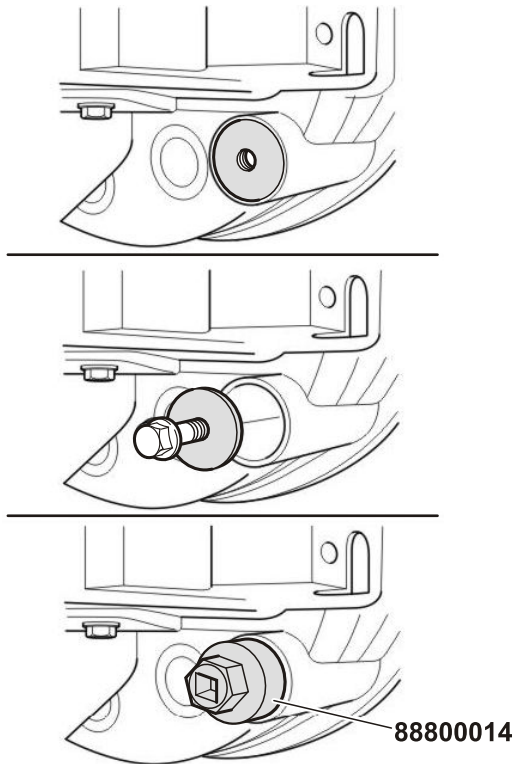


P0003141

- 2 Remove the valve cover.

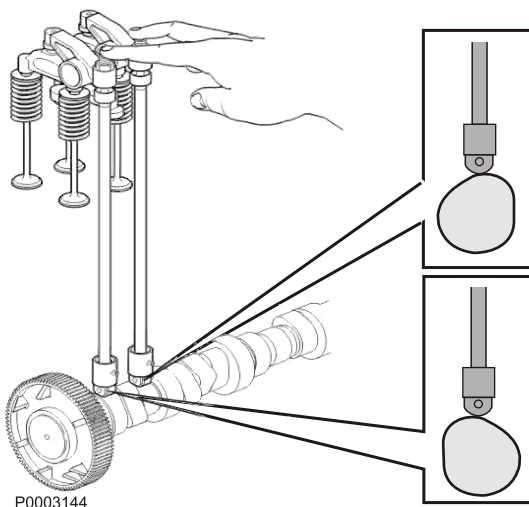


P0003142



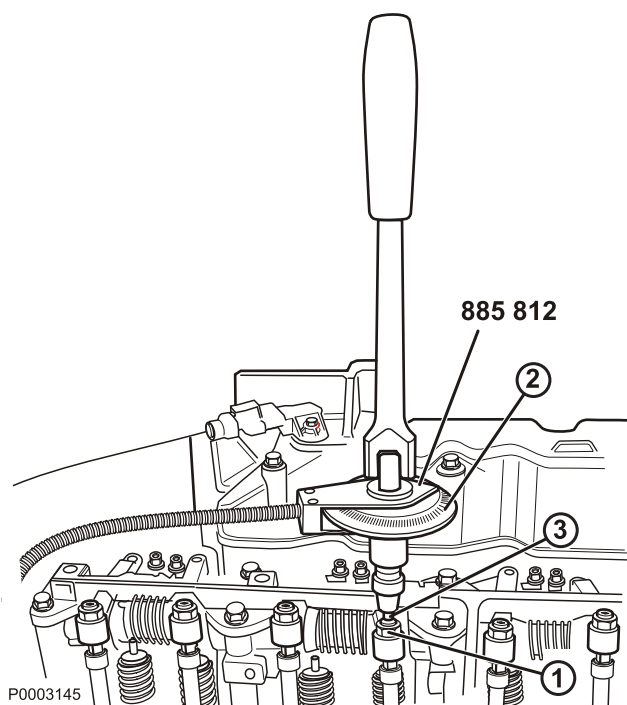
P0003143

- 3 Remove the plug at the flywheel.
Fit cranking tool **8880 0014**.



P0003144

- 4 Rotate the crankshaft so that no. 1 piston is at TDC and the exhaust and inlet valves overlap on cylinder no. 1.
None of the push rods for this cylinder should be able to be rotated in this position.



Adjust the valve play (cylinder 1 overlapping)

- 5 Adjust the valve play for each cylinder, according to the angles indicated in the table (24431). Loosen the adjuster screw locknut (1) on the rocker arm. Attach the protractor 885 812 (2), to the adjustment screw (3). Turn the adjustment screw (3) until zero clearance is obtained between the rocker arm and the valve. Zero the protractor. Turn the adjustment screw (3) clockwise **75°** for the inlet valve and **105°** counter-clockwise for the exhaust valve. Hold fast the adjustment screw (3) and tighten the locknut (1) at the same time.

Torque to: **20 Nm**

(Use a 13 mm box wrench.)

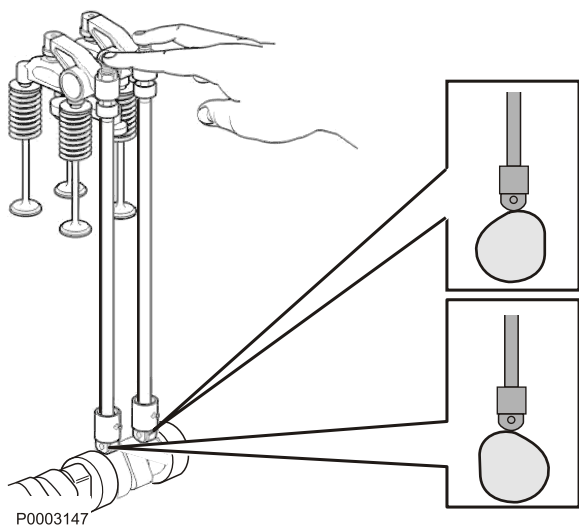
Hold fast the adjusting screw, so that it does not rotate when torqueing.

Valve clearance (cold engine), setting value:

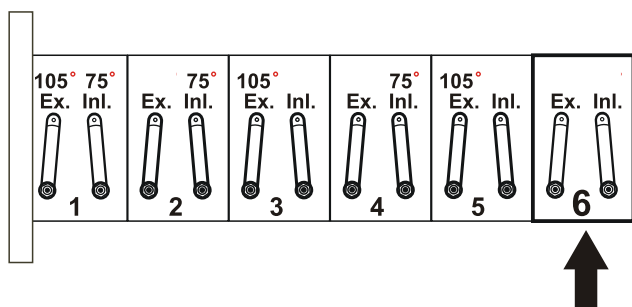
Inlet	75° (0.35 mm)
Exhaust	105° (0.45 mm)

Ex. Inl.	105° Ex. Inl.	75° Ex. Inl.	105° Ex. Inl.	75° Ex. Inl.	105° Ex. Inl.
1	2	3	4	5	6

P0003146



- 6 Crank the crankshaft 360° (one revolution), until the exhaust and inlet valves on cylinder # 6 overlap. None of the push rods for this cylinder should be able to be rotated in this position.



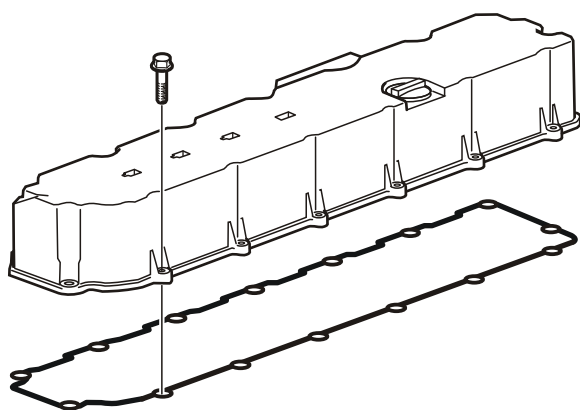
P0003148

Adjust the valve play for the other valves (cylinder 6 overlapping)

- 7 Adjust the valve play for each cylinder, according to the angles indicated in the table (24432).

Inlet	75° (0.35 mm)
Exhaust	105° (0.45 mm)

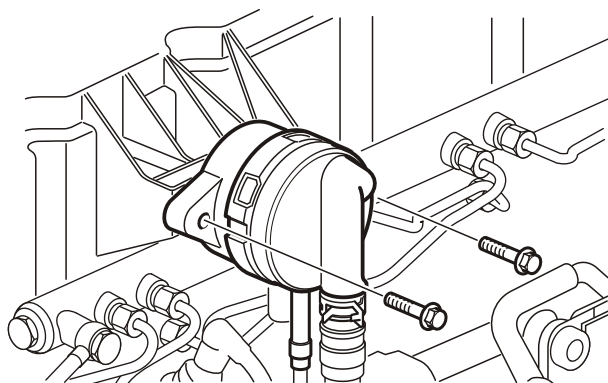
Remove the cranking tool (88800014) and replace the plug in the flywheel.



P0003142

- 8 Check the valve cover gasket and replace as necessary.
Install the valve cover.

Torque to: **8.5 Nm**



P0003141

- 9 Install the oil trap.
Check and replace the O-ring as necessary.

Perform a function check in respect of any leakages.

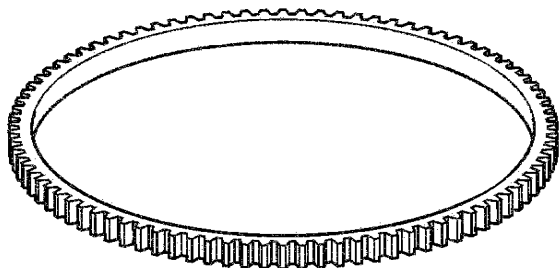
21-6 Crank Mechanism

Gear Ring, Flywheel: Replace

The working method requires removal of the flywheel.

Warm the new ring gear to 210° C

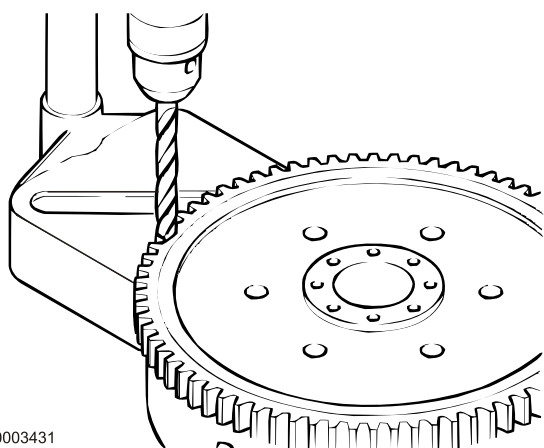
- 1 Use an oven or gas welder.
If you use an oven, start by placing the new flywheel ring gear in the oven.
If you use a gas welder, heat the flywheel ring gear just before you fit it.



P0003430

Drill a hole between two gear teeth

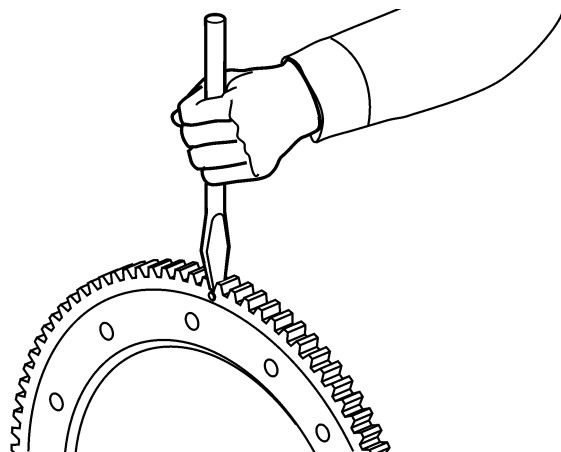
- 2 Use a 10 mm drill. Drill a 9 mm deep hole.
IMPORTANT!
Borra inte i svänghjulet, risk för obalans.



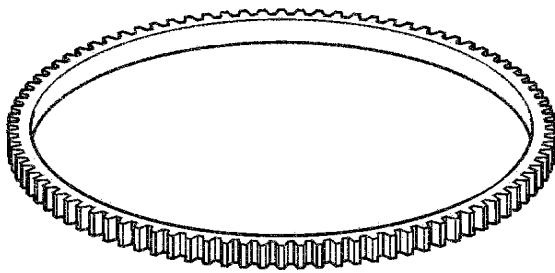
P0003431

Remove the flywheel ring gear

- 3 Hold the flywheel in a vice fitted with soft jaw pads.
Pry the flywheel ring gear loose using a screw driver. If necessary, split the ring gear at the drilled hole.
Clean the flywheel contact surfaces.



P0003432



P0003430

Fit the new ring gear

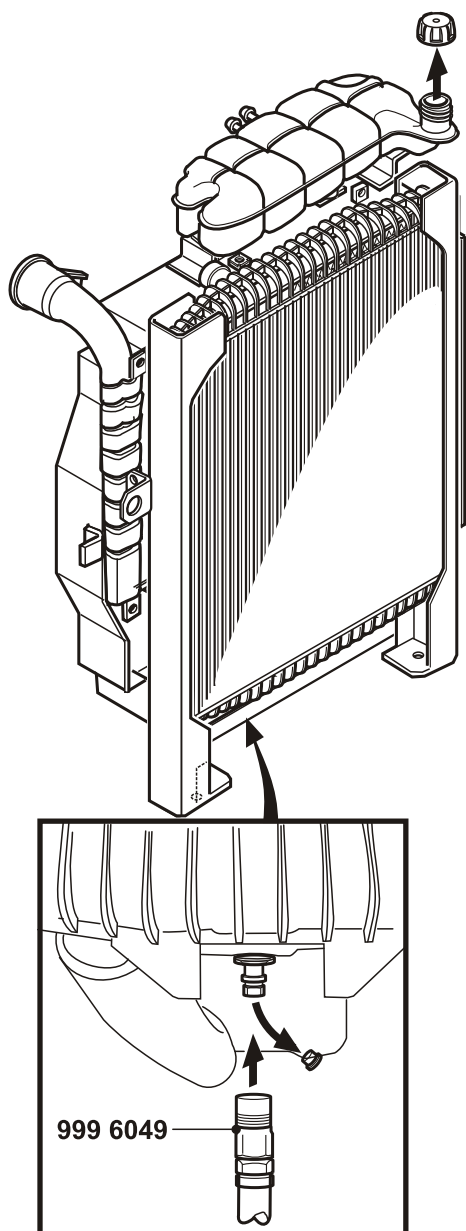
- 4 Check the temperature.
Put the flywheel ring gear in place, so that it bottoms against the flywheel flange.
If necessary, tap down the ring gear until it bottoms. Use a brass drift.
Allow the ring gear to cool.

Crankshaft seal, replace (front)

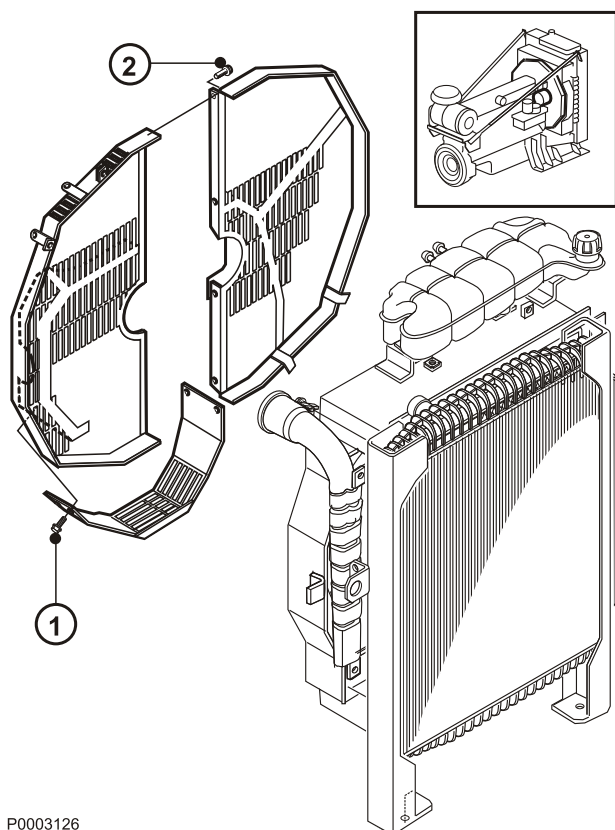
9992000 Handle
9996049 Draining hose
9998673 Press tool
88800014 Rotation tool

Removal

- 1 Remove the expansion tank cover and remove the drain nipple protective cap (beneath the radiator).
Connect drainage hose **999 6049** to the nipple.
Drain the coolant.



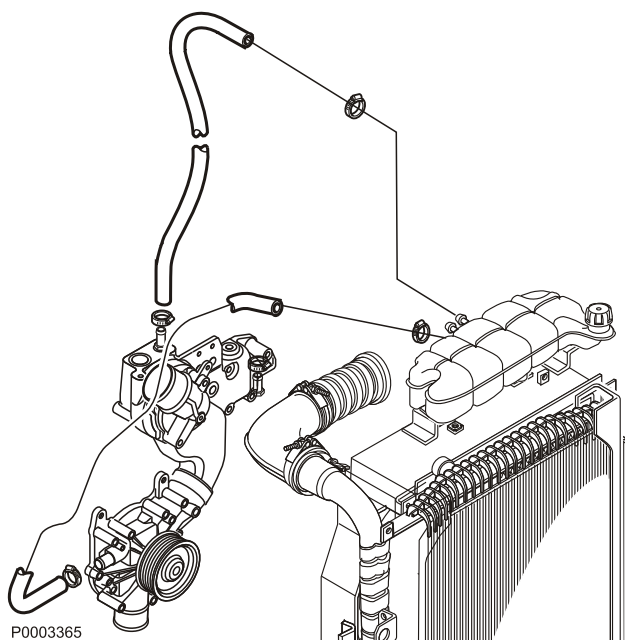
P0003127



P0003126

2 Remove the engine protection panels:

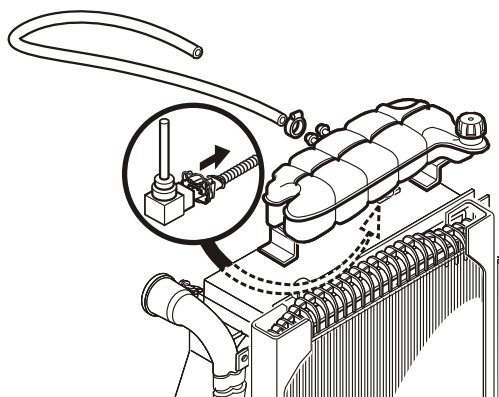
- lower protection panel (1)
- the four bolts (2) which hold together the two protection panel halves
- the two clamps for the coolant hose
- the four bolts for the protection panels, on the **right** side of the engine
- remove the **right** protection panel
- the charge air cooler hose (lower)
- **left** protection panel



P0003365

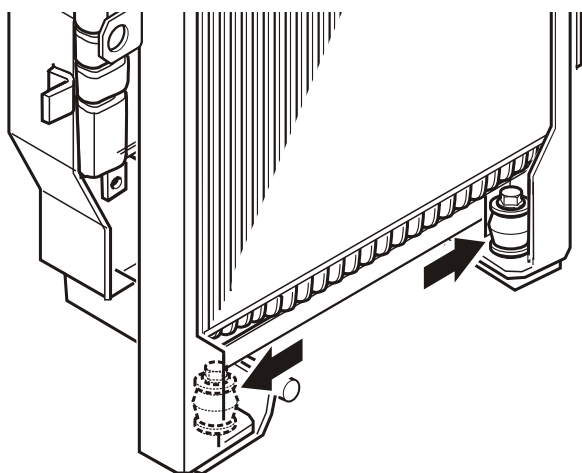
3 Remove:

- the radiator hoses from the coolant pump
- the radiator hoses from the thermostat housing



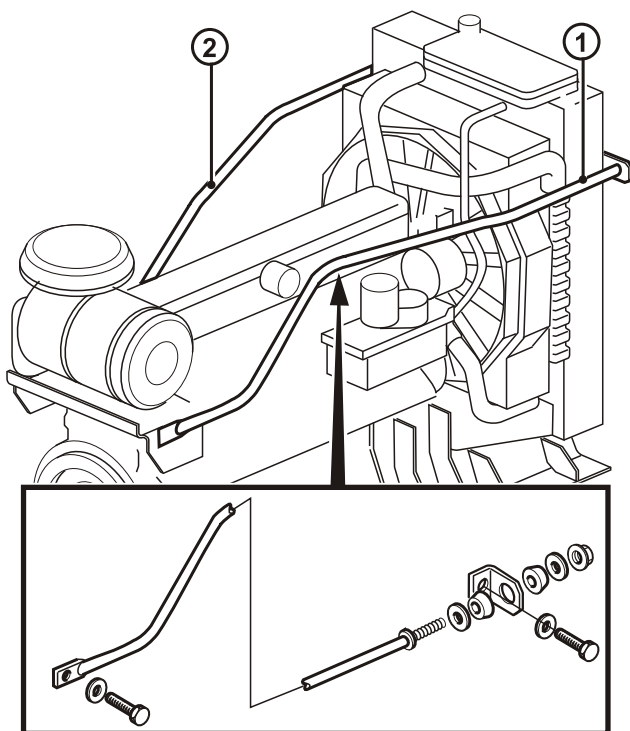
P0003371

- 4 Remove the cable to the level sensor (beneath the expansion tank).
Remove the hose to the charge air cooler (upper).



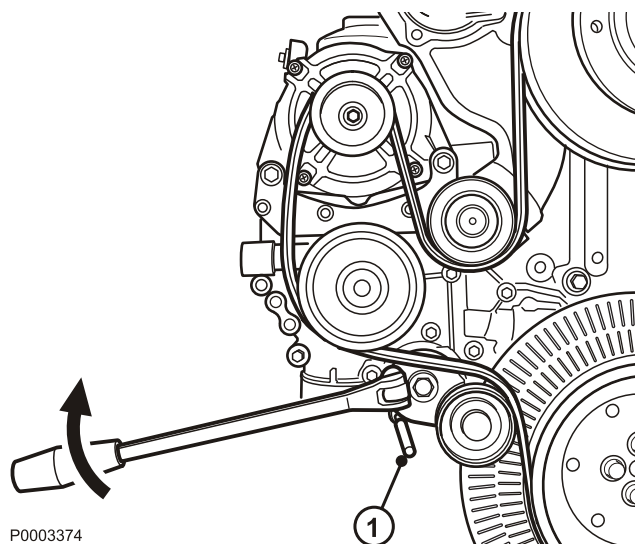
P0003364

- 5 Remove the radiator from its lower mountings (left and right).



P0003372

- 6 Remove the right radiator stay (1).
- 7 Remove the left radiator stay (2), and lift away the radiator assembly.

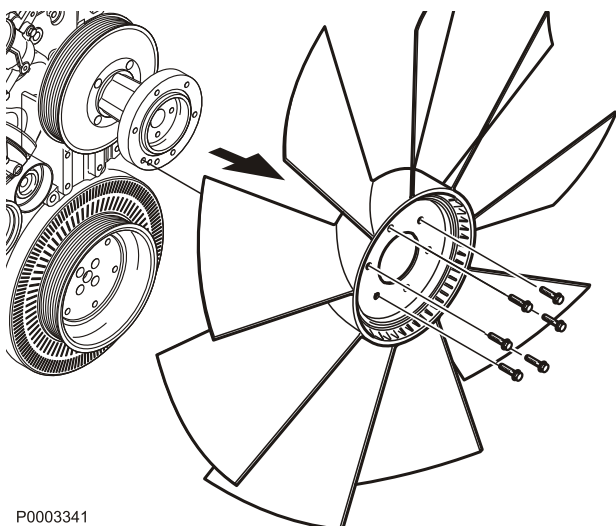


- 8 Release the belt tensioner and lock it in place with a drift (1).



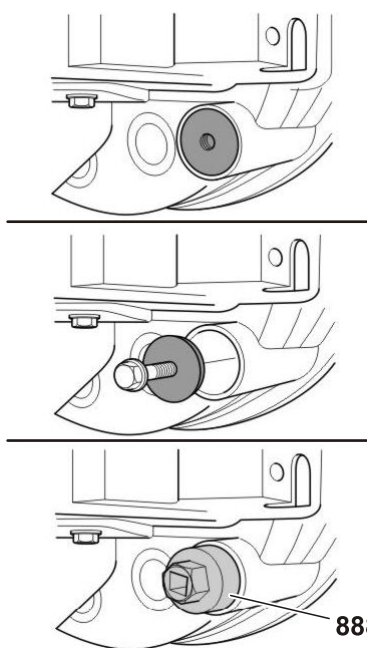
WARNING!

Pinch hazard. Keep fingers clear.



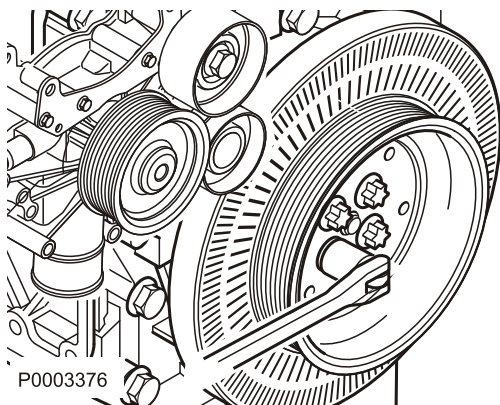
- 9 **Remove:**

- the fan
- drive belt
- the belt tensioner

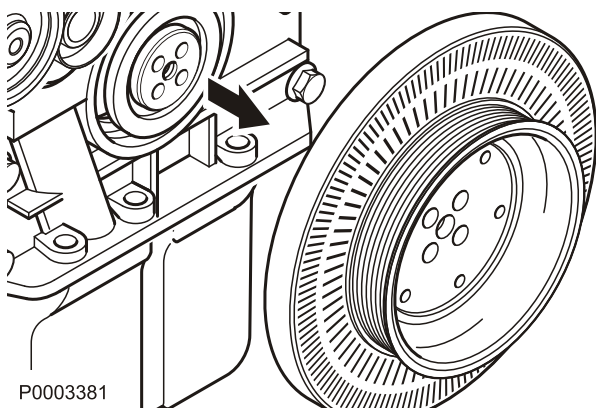


- 10 Remove the plug from the flywheel.
Fit cranking tool **8880 0014**.

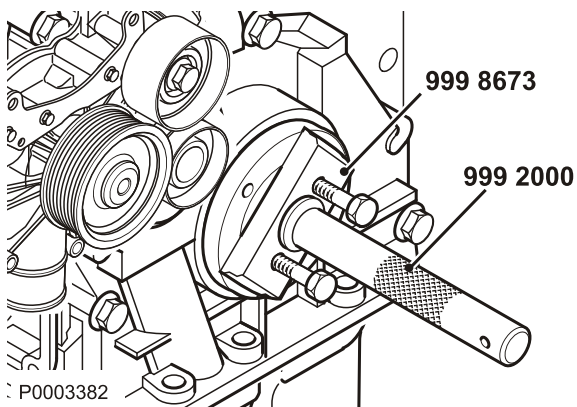
88800014



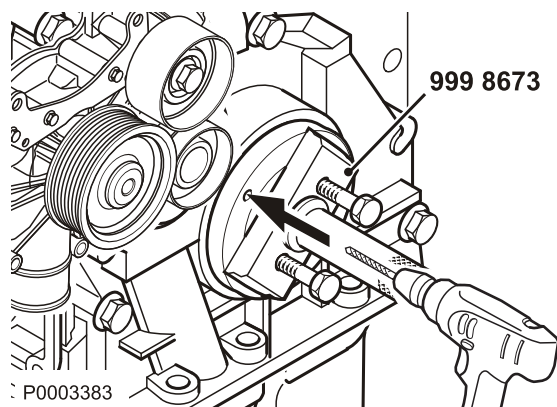
- 11 Remove the belt pulley/oscillation damper bolts. Use cranking tool **8880 0014** as a counterhold on the flywheel.



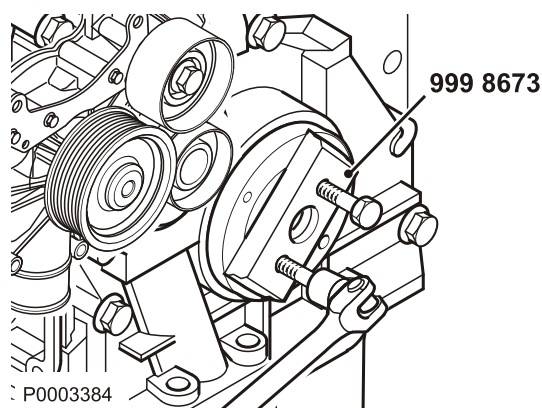
- 12 Remove the belt pulley and oscillation damper.



- 13 Attach tool **999 8673** and standard shaft **999 2000**.



- 14 Drill two (**4 mm**) holes in the seal through the guide holes in the tool (999 8673).



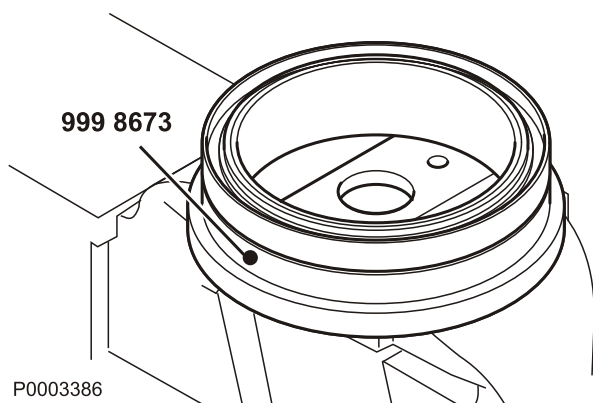
- 15 Screw two self tapping screws into the old seal, through the guide holes in the tool (999 8673). Screw two fully-threaded **M10x60** bolts in the tool's threaded holes. Pull the seal off. Remove the seal from the tool. Clean all the crankshaft sealing surfaces; ensure that they are free from oil and grease.

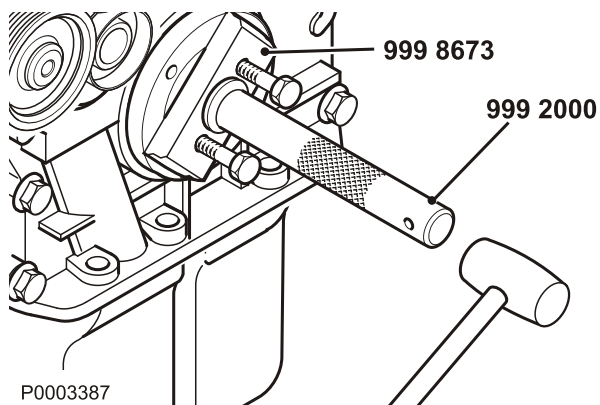
Installation

- 16 Lubricate the lip of the seal with engine oil.

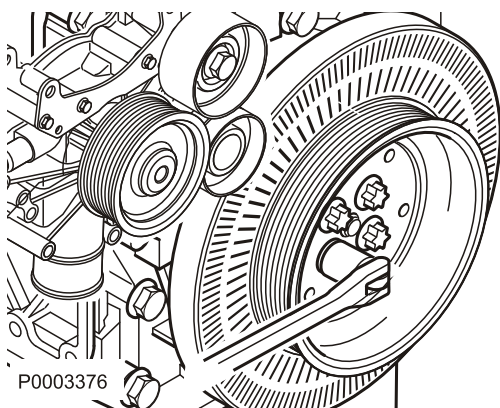
NOTICE! Use caution so that the crankshaft seal is **not** damaged.

- 17 Press a **new** crankshaft seal onto tool 999 8673.





- 18 Tap the seal home **carefully** (with tools 999 2000 and 999 8673) so that it sits edge-to-edge with the cover.
Pull the tool **carefully** out of the seal, by turning it.



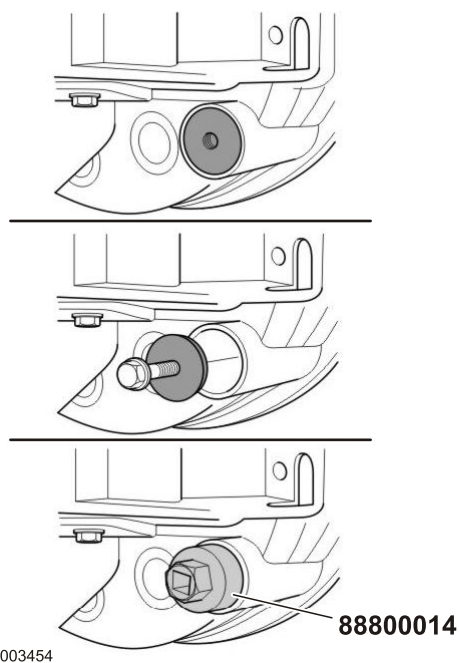
- 19 Fit the belt pulley/oscillation damper.
Use cranking tool **8880 0014** as a counterhold on the flywheel.

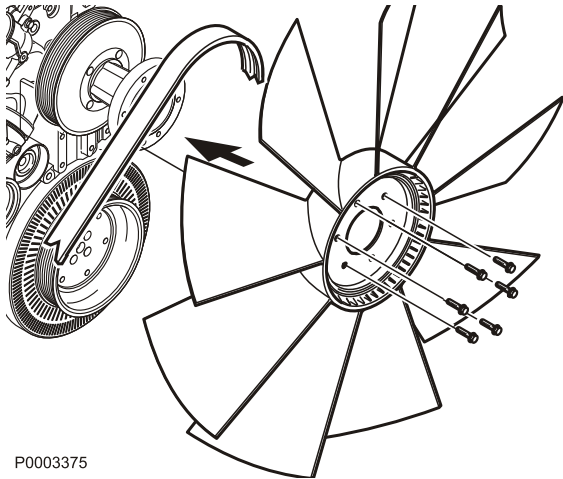
NOTICE! The screws on the oscillation damper may **not** be re-used.

Tighten in three steps:

- | | |
|--------|--------------------------|
| Step 1 | 30 (±5) Nm |
| Step 2 | angle tighten 60° |
| Step 3 | angle tighten 60° |

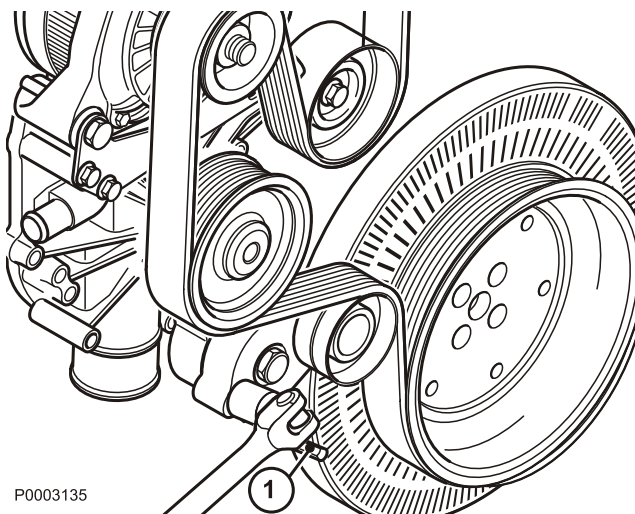
- 20 Remove the cranking tool (**8880 0014**).
Replace the plug in the flywheel.





21 **Install:**

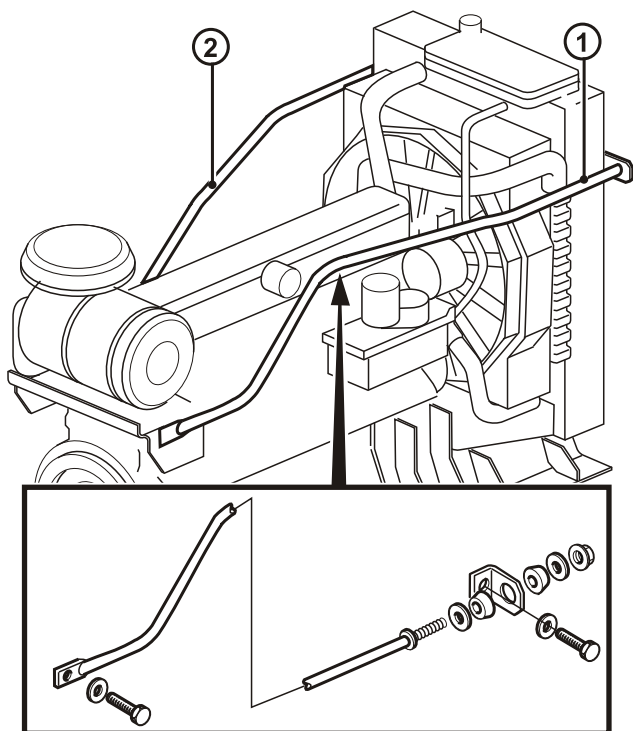
- belt tensioner
- drive belt
- fan belt



- 22 De-tension the belt tensioner.
Remove the drift (1).
Check that the belt is correctly aligned in the belt
pulley grooves.

⚠ WARNING!

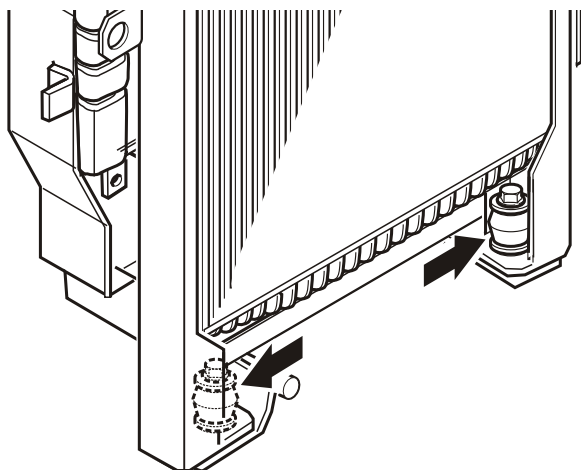
Pinch hazard.Keep fingers clear.



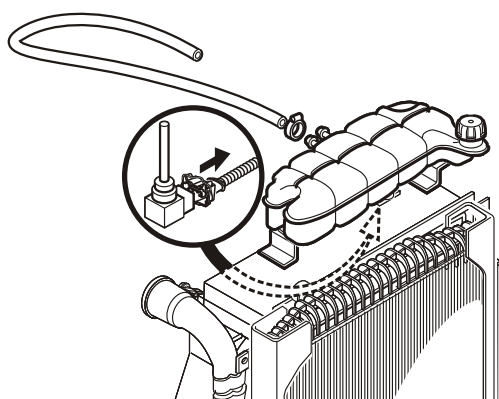
P0003372

23 Install:

- radiator assembly
- right radiator stay (1)
- left radiator stay (2)

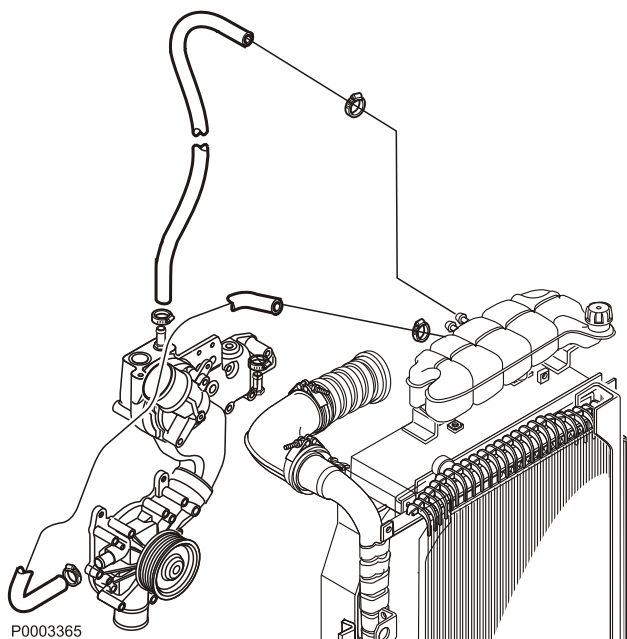


P0003364

24 Attach the radiator to its lower mountings (left and right).

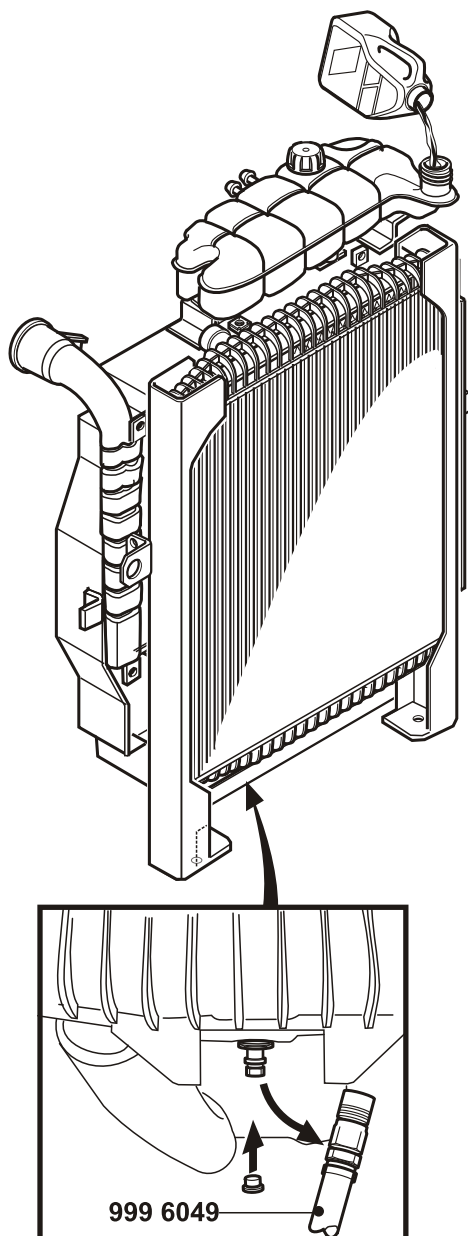
P0003371

25 Attach the cable to the level sensor (beneath the expansion tank).



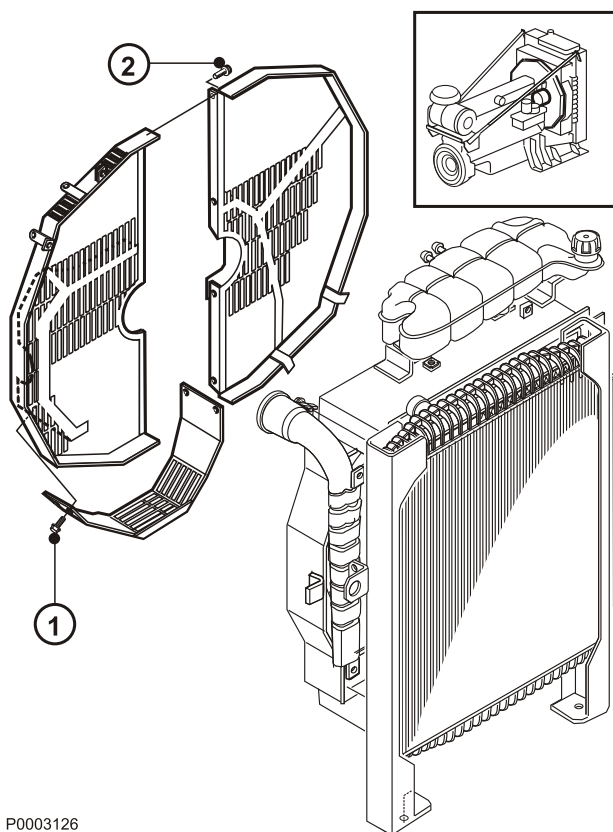
26 **Install:**

- the charge air cooler hose (upper)
- the radiator hoses to the thermostat housing
- the radiator hoses to the coolant pump



- 27 Remove the drainage hose **999 6049**, from beneath the radiator.
Fill with required volume of coolant.
Perform a function check in respect of any leakages.
Check especially carefully that the drain nipple underneath the radiator is not leaking.

P0003133



P0003126

- 28 Replace the protection panels and clamp the coolant hoses (2 pcs.) in place. Attach the charge air cooler hose (lower).

Crankshaft Sealing, Change (rear)

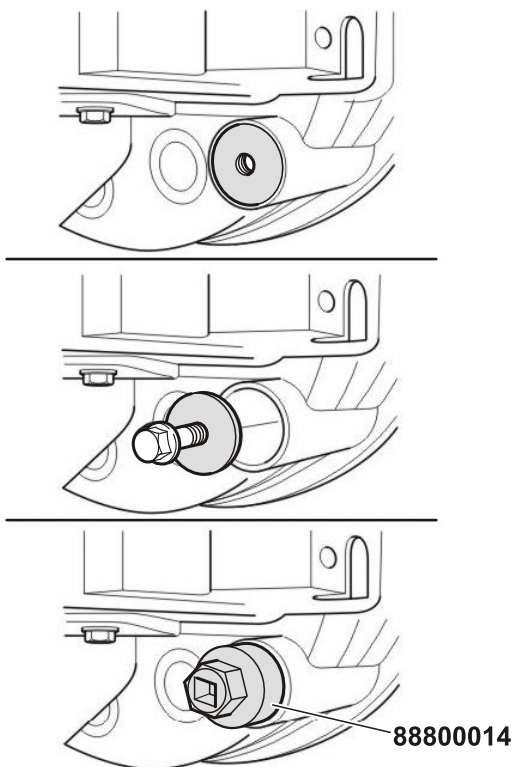
9992000 Handle

9998672 Press tool

88800014 Rotation tool

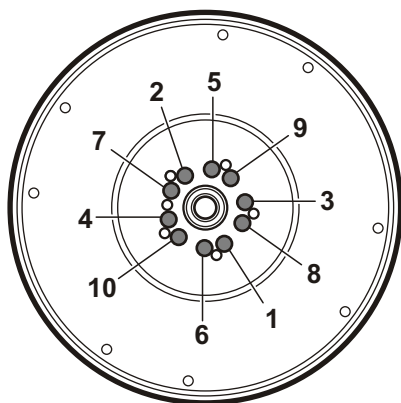
Removal

- 1 Remove the plug from the flywheel.
Fit cranking tool **88800014**.
Fit a socket to the cranking tool and use it as a stop.

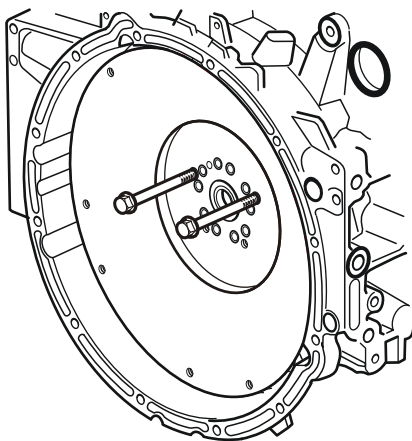


P0003143

- 2 Remove the flywheel bolts.

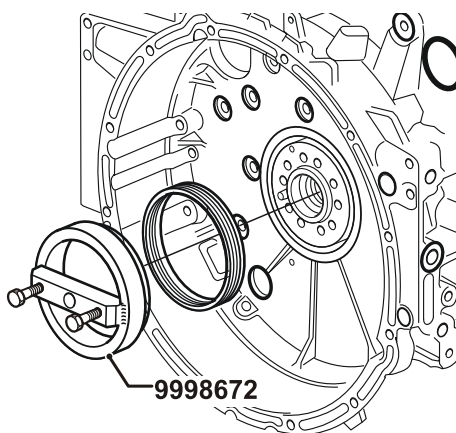


P0003164



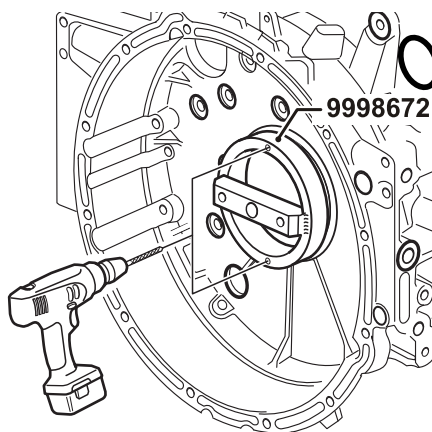
P0003165

- 3 Fit two bolts in the flywheels outer threaded holes (use M10 x 120).
Screw in the bolts until the flywheel releases from the guides.
Lift the flywheel away.



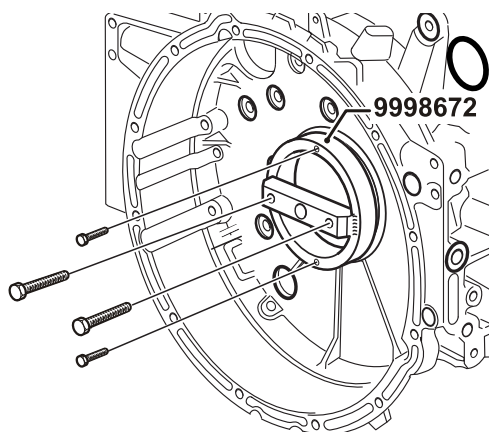
P0003166

- 4 Clean the crankshaft seal's mating surface.
Fit tool **999 8672** to the old seal by twisting.



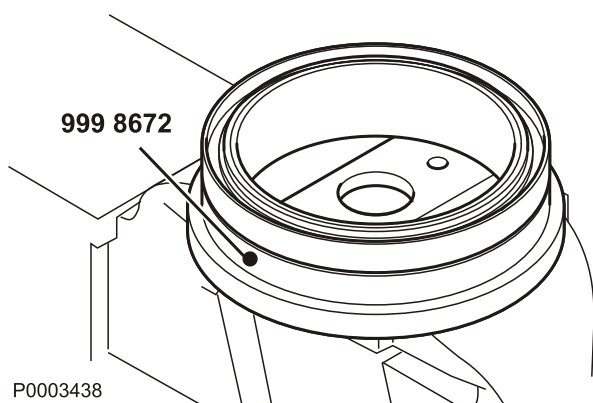
P0003167

- 5 Drill two four millimeter holes in the seal through the guide holes in the tool (999 8672).



P0003168

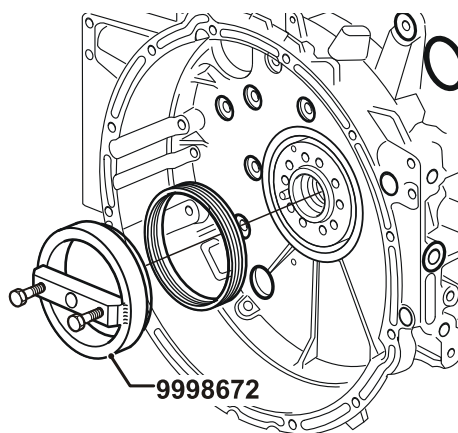
- 6 Screw two self tapping screws into the old seal, through the guide holes in the tool. Fit two M10x60 fully-threaded screws in the tool's (999 8672) threaded holes. Pull the seal off. Remove the seal from the tool. Clean the crankshaft seal's sealing surfaces on the crankshaft and the crankshaft housing. Make sure all surfaces are free from oil and grease.



P0003438

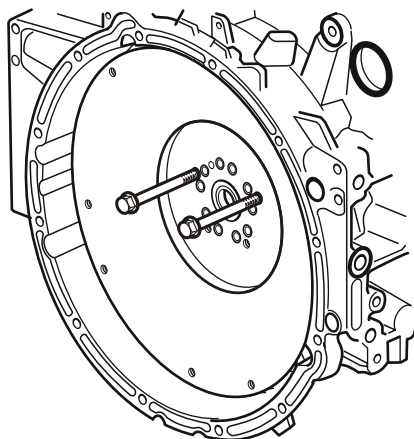
- 7 Lubricate the lip of the seal with engine oil. Install the **new** crankshaft seal using tools **999 2000** and **999 8672**. Press home the crankshaft seal with the tool (999 8672).

NOTICE! Use caution so that the crankshaft seal is **not** damaged.



P0003166

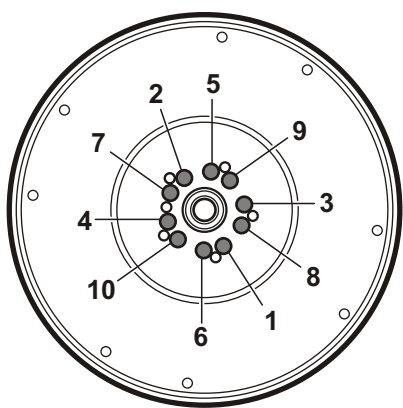
- 8 Tap the seal **carefully** home until it bottoms on the cover. Pull the tool (999 8672) **carefully** out of the seal, by turning it.



P0003165

- 9 Fit two bolts in the flywheels outer threaded holes (use M10 x 120).
Fit the flywheel by lifting at the bolts.

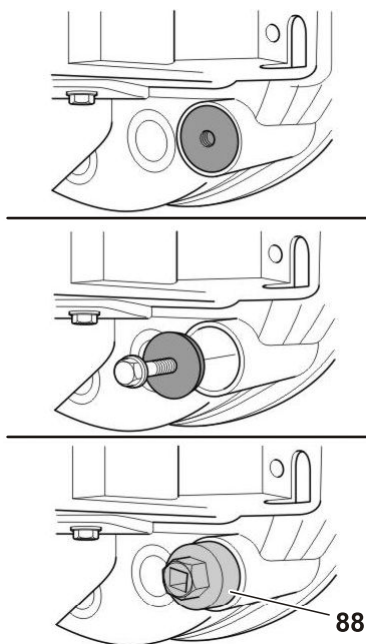
NOTICE! Make sure the bolts do not protrude through the back of the flywheel.



P0003164

- 10 Install the flywheel bolts by hand.
Then torque the bolts in two steps (sequence as illustrated).

Step 1	30 ±5 Nm
Step 2	60° + 60°



P0003454

- 11 Remove the cranking tool and replace the plug in the flywheel housing.

22-0 Lubricating and Oil System, General

Engine Oil Pressure, Check

1678297 Spacer
9990124 Nipple
9996398 Manometer
9996666 Nipple

- 1 Measure the lubricating oil pressure on the engine's "*fuel pump side*" as illustrated, using a pressure gauge, nipple and spacer.

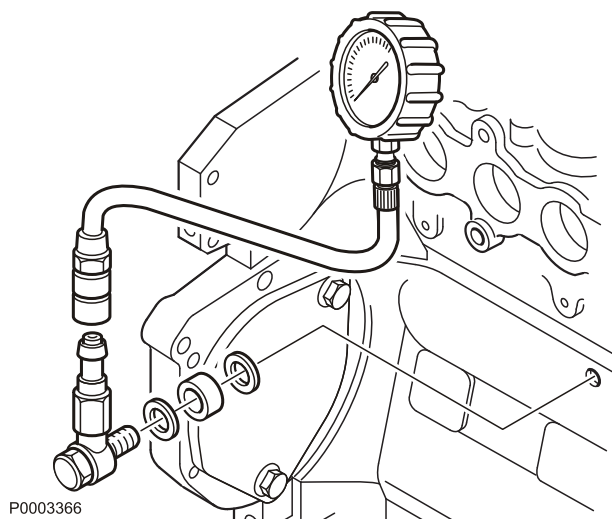
Min. oil pressure in hot conditions and at idle:

TAD734GE: **80 kPa (0.8 bar)**

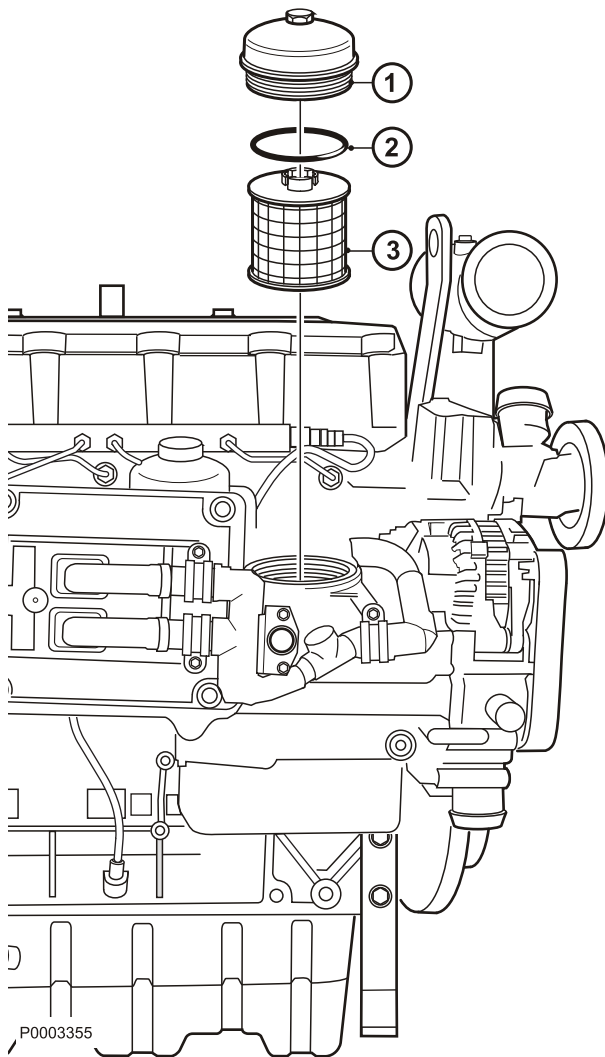
- 2 Check the oil pressure at engine oil operating temperature (120° C).

At rated engine speed: **420-450 kPa**

Automatic stop, with
pressure less than: **100 kPa**



22-2 Oil filter



Oil filter, Change

Removal

- 1 Clean around the oil filter.
- 2 Carefully remove the oil filter cover (1) and filter.
- 3 Remove the O-ring (2) and filter (3).
- 4 Let the oil drip off into a collection vessel.

Installation

- 5 Install a new filter (3) and a new O-ring (2).
- 6 Install the filter cover (1) and filter.

Torque to: **25 Nm**

- 7 Fill with required volume of oil, see "*Technical data*".

Carry out a function test

- Start the engine.
- Check that there is no oil leakage from the oil filter or drain nipple.
- Turn off the engine.
- Check the oil level after a few minutes.
- Top up with oil as necessary.

Oil Filter Housing, Change

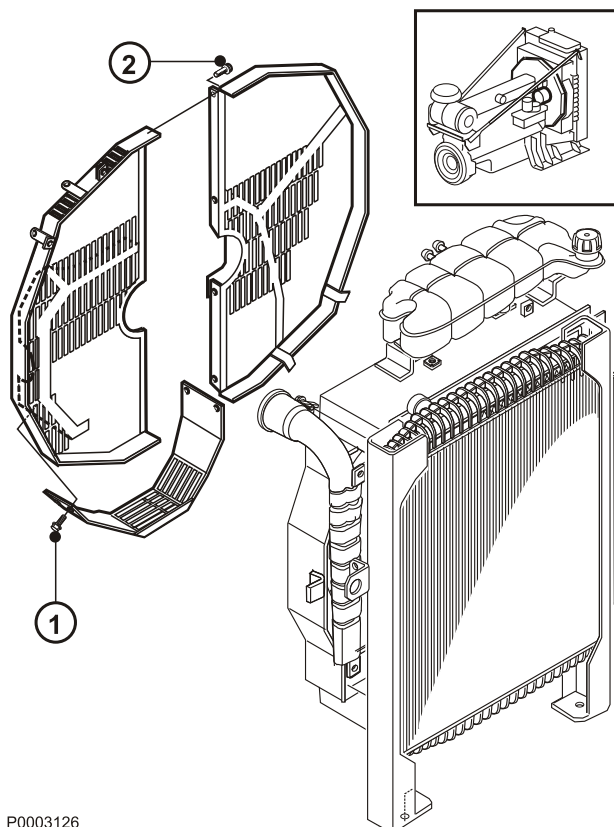
885510 Plugs

9996049 Draining hose

Removal

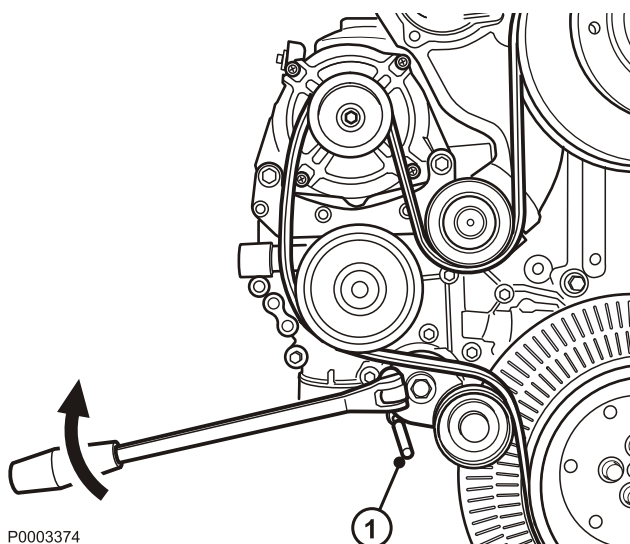
1 Remove the engine protection panels:

- lower protection panel (1)
- the four bolts (2) which hold together the two protection panel halves
- the two clamps for the coolant hose
- the four bolts for the protection panels, on the **right** side of the engine
- remove the **right** protection panel

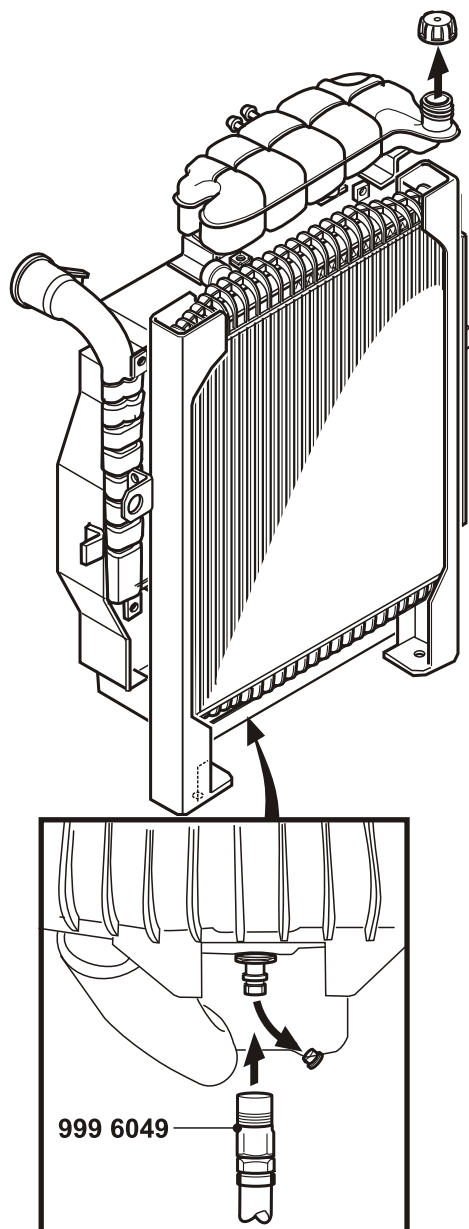


P0003126

- #### 2 Release the belt tensioner and lock it in place with a drift (1). Remove the engine drive belt from the belt pulley and hang it to one side.

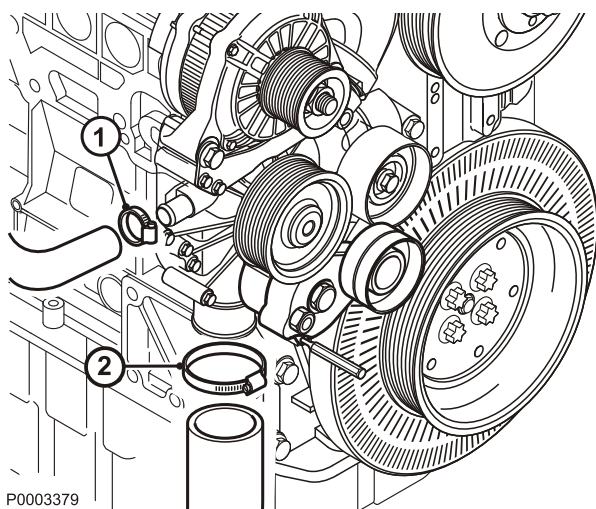


P0003374



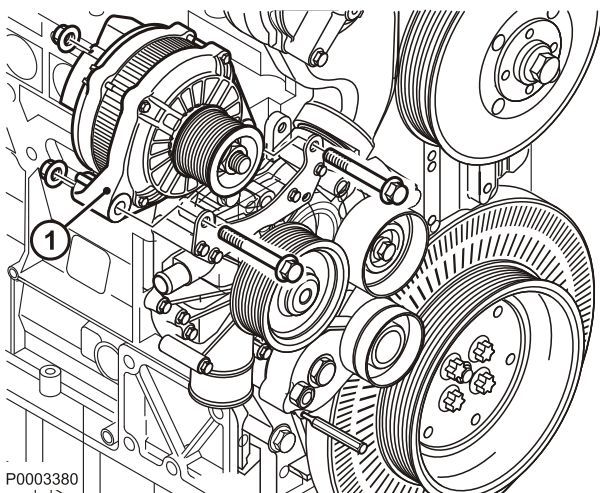
P0003127

- 3 Remove the cover to the expansion tank and drain the coolant by removing the protective cap from the drain nipple and by connecting drainage hose **999 6049**, to the nipple.

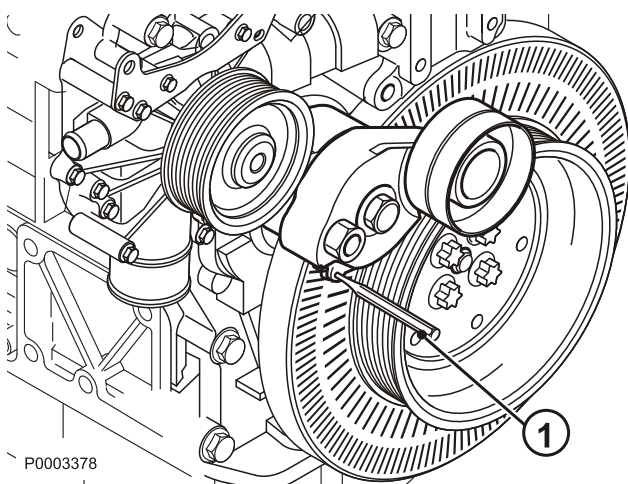


P0003379

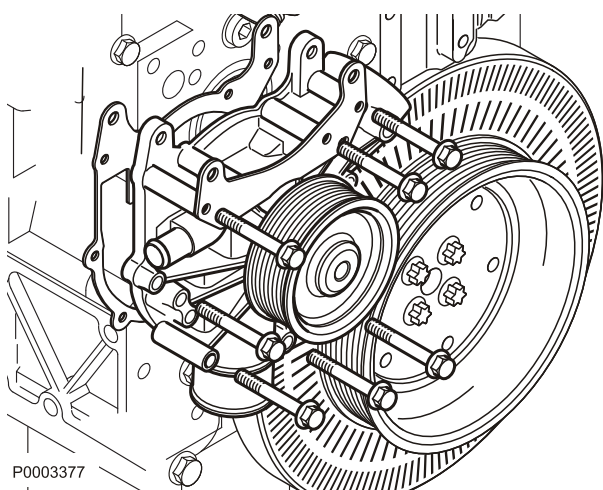
- 4 Remove the two radiator hose clamps (**1, 2**) from the coolant pump and bend them away to one side.



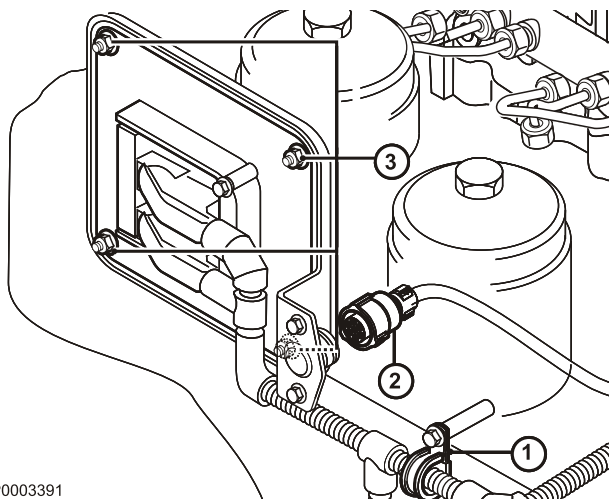
- 5 Remove the alternator cable and connector.
Remove the alternator (1).



- 6 Remove the belt tensioner, with drift (1).
Remove the alternator idler wheel.

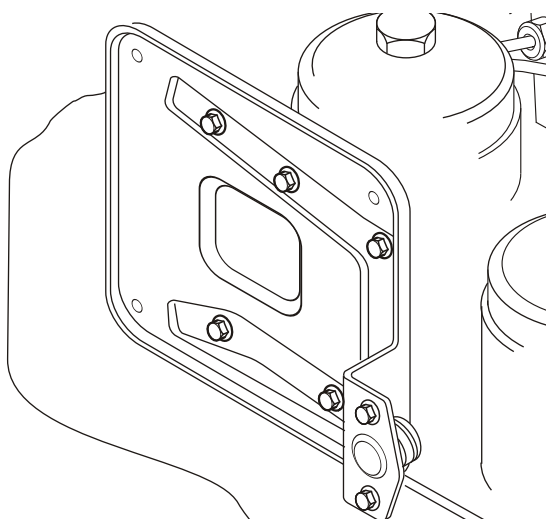


- 7 Remove the coolant pump.
Turn the pump **carefully** clockwise a little to
remove it from the thermostat housing.
Tap **carefully** with a rubber hammer, if neces-
sary.



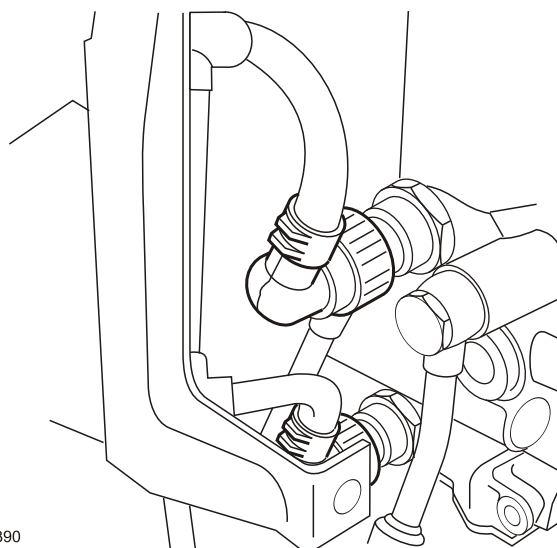
P0003391

- 8 Remove the electronics cable trunk clamp (1). Disconnect the connector from the stop button (2). Remove the electronics unit nuts and bolts (3).



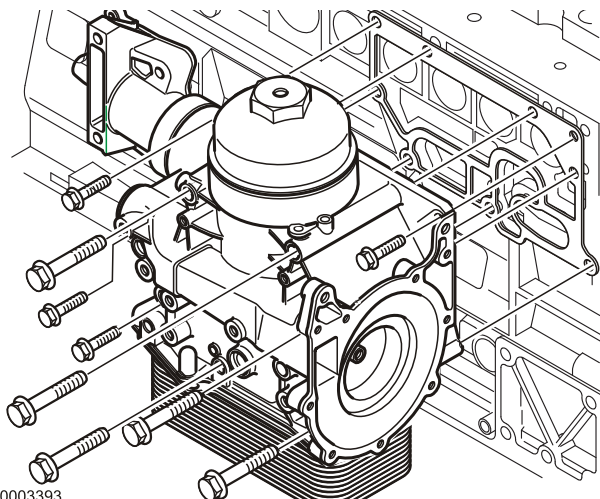
P0003392

- 9 Lift up the electronics unit cable trunk and lay it across the engine. Remove the electronics unit holder.



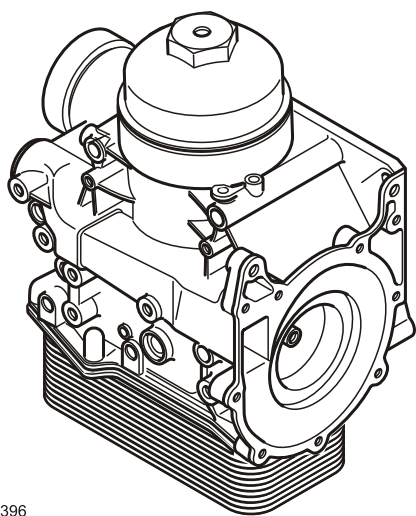
P0003390

- 10 Disconnect the electrical connections from the fuel pressure sensor and the oil pressure sensor. Remove the fuel lines (3 pcs). Plug connections to exclude dirt (885 510)



P0003393

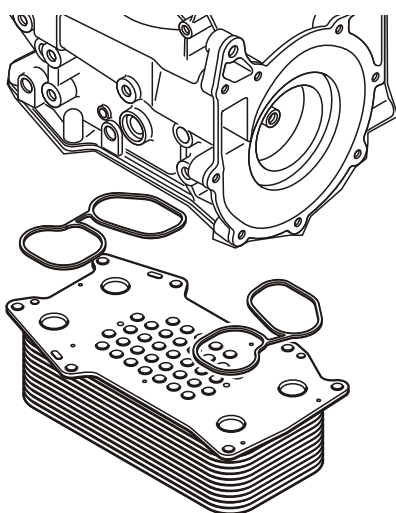
- 11 Remove the oil filter housing (9 screws). Pull the oil filter housing forward slightly and lift it away.



P0003396

- 12 Remove the oil cooler from the oil filter housing.

NOTICE! When replacing the complete oil filter housing, some components may need to be transferred to the new housing.

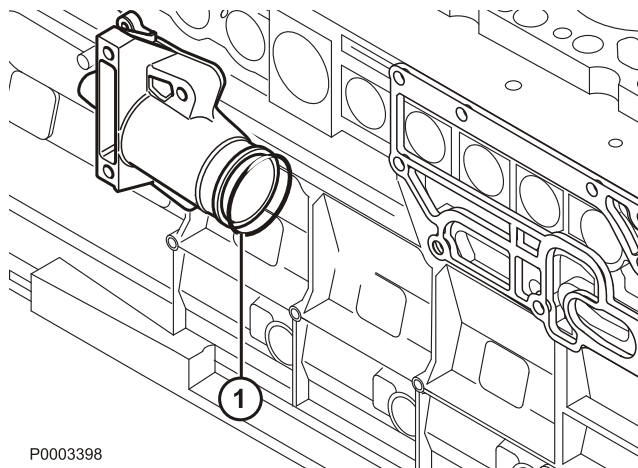


P0003397

Installation

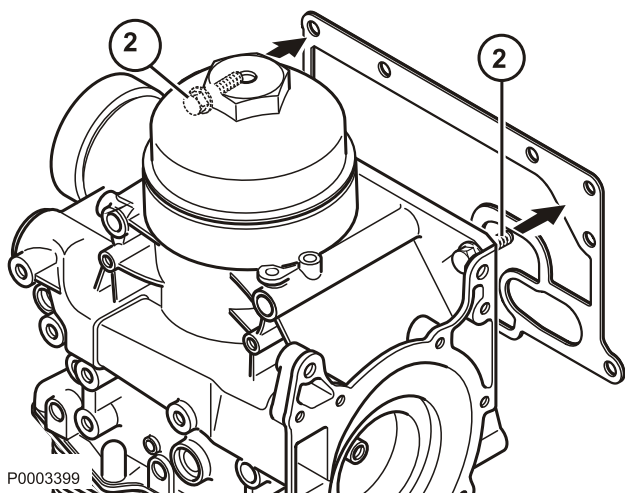
- 13 Replace the oil cooler in the oil filter housing using **new** seals.

Torque to: **30 Nm**



P0003398

- 14 Install two **new** O-rings (1) on the coolant neck.



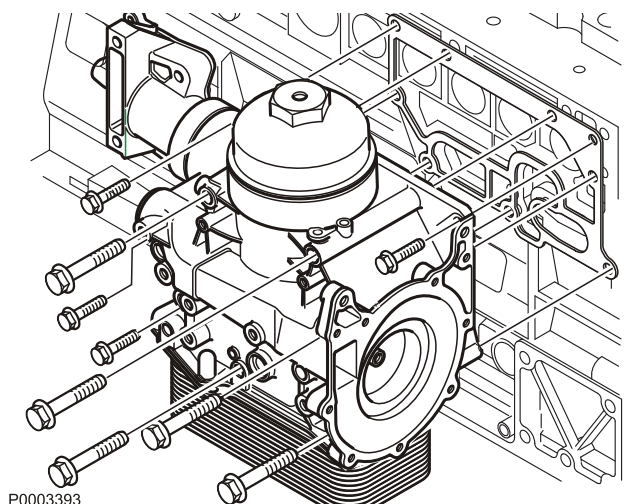
P0003399

- 15 Install a **new** gasket on the oil filter housing. Suspend the gasket by the two short screws (in the upper corners (2) of the oil filter housing).

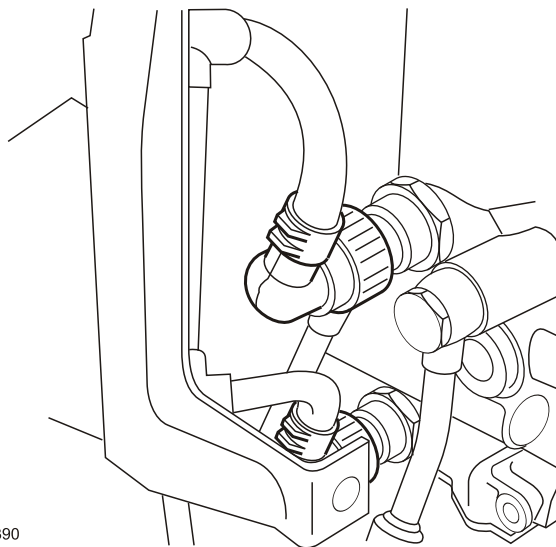
Oil filter housing, installation

- 16 Guide the oil filter housing and gasket onto the O-rings. First align the two top screws (which hold the gasket) with the engine block.

Torque to: **30 Nm**

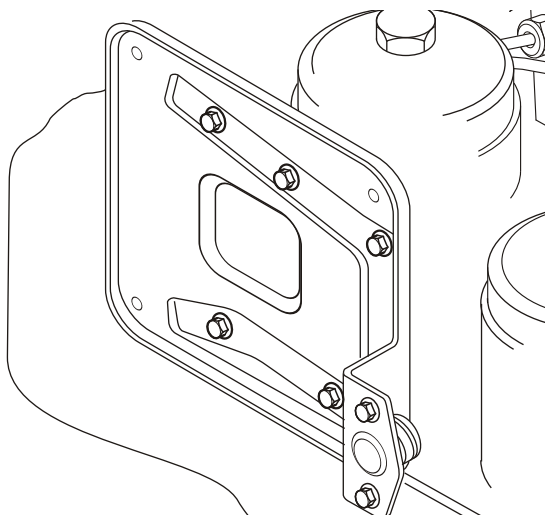


P0003393



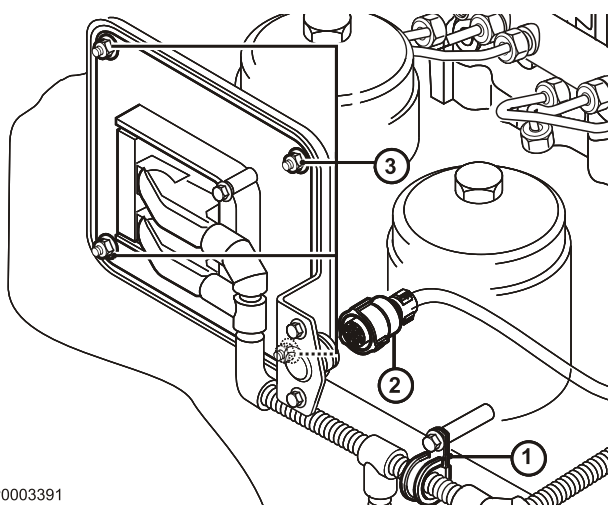
P0003390

- 17 Connect the fuel lines (3 pcs.) and connect the electrical connections to the fuel pressure sensor and the oil pressure sensor.



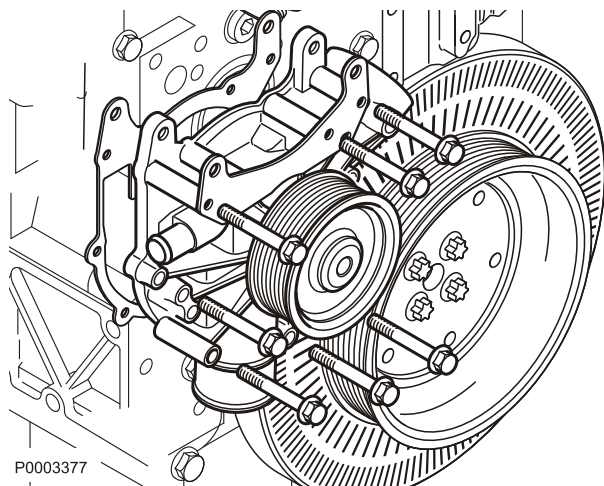
P0003392

- 18 Install the cable holder for the electronics unit. Replace the cable trunk and the electronics unit in the holder.



P0003391

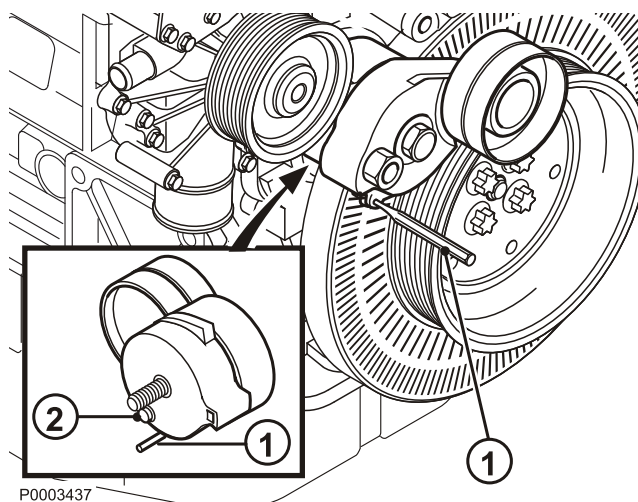
- 19 Install the electronics unit nuts and bolts (3). Connect the connector to the stop button (2). Install the electronics cable trunk clamp (1).



- 20 Install the coolant pump; first guide in the coolant pump "neck" and O-rings.

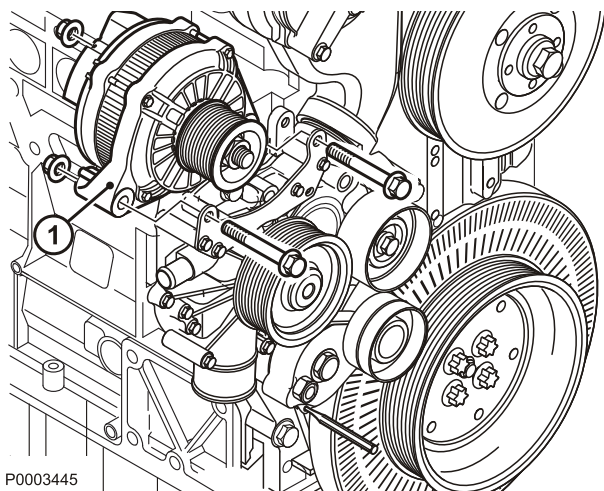
Torque to: **30 ±5 Nm**

NOTICE! Use a **new** gasket and **new** O-rings.

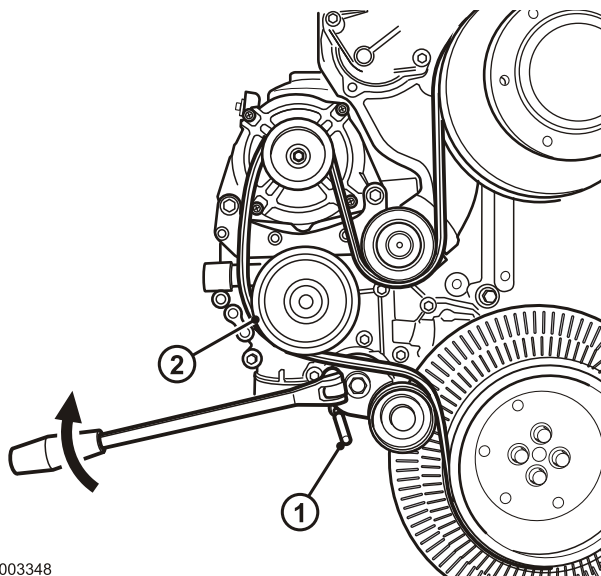


- 21 Install the alternator idler wheel.
Install the belt tensioner, with drift (1).

NOTICE! Align the belt tensioner guide pin (2).



- 22 Install the alternator (1), together with the cable and connector.

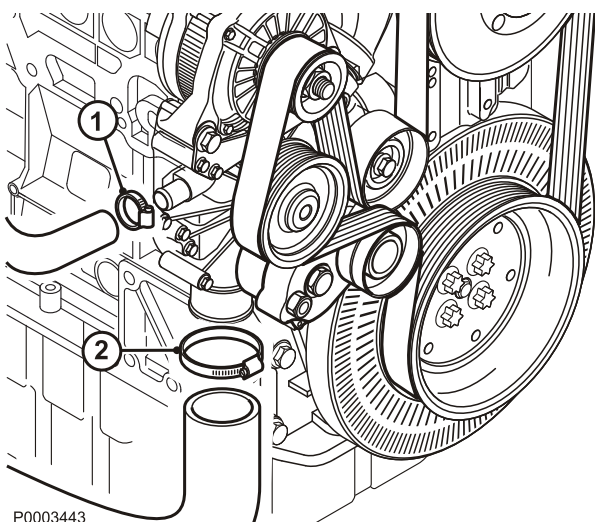


P0003348

- 23 Relieve the belt tensioner and fit the belt. Remove the drift (1). Check that the belt (2) is correctly aligned in the belt pulley grooves.

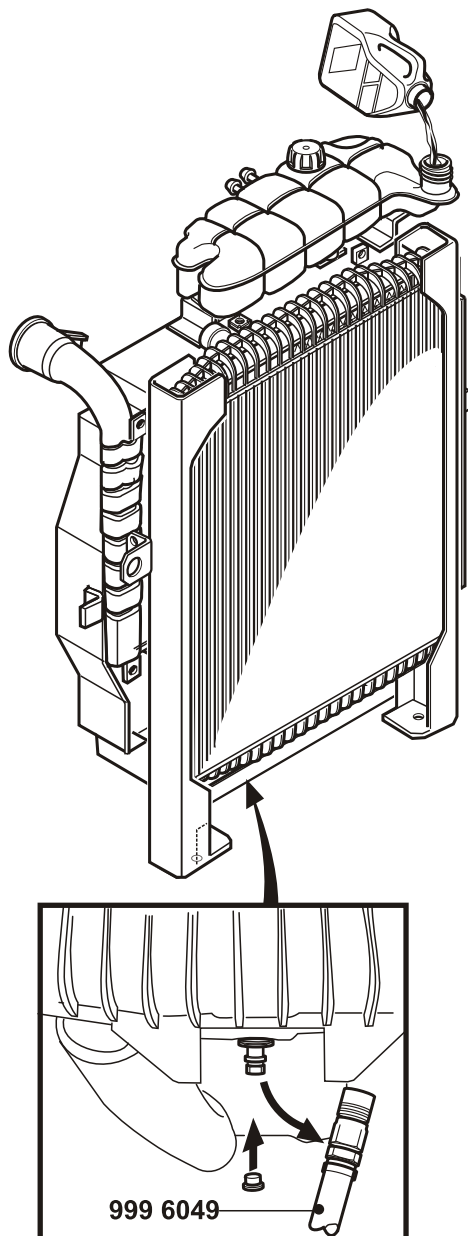
⚠ WARNING!

Pinch hazard. Keep fingers clear.



P0003443

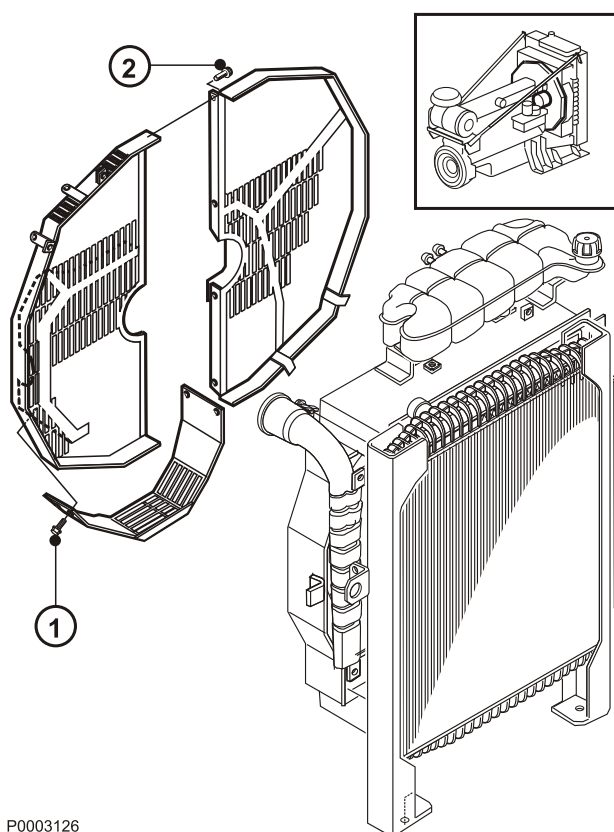
- 24 Connect the radiator hoses to the coolant pump. Tighten the hose clamps (1, 2).



- 25 Remove the drainage hose **999 6049**, from beneath the radiator.
Fill with required volume of coolant.

- 26 Perform a function check in respect of any leakages.
Check especially carefully that the drain nipple underneath the radiator is not leaking.

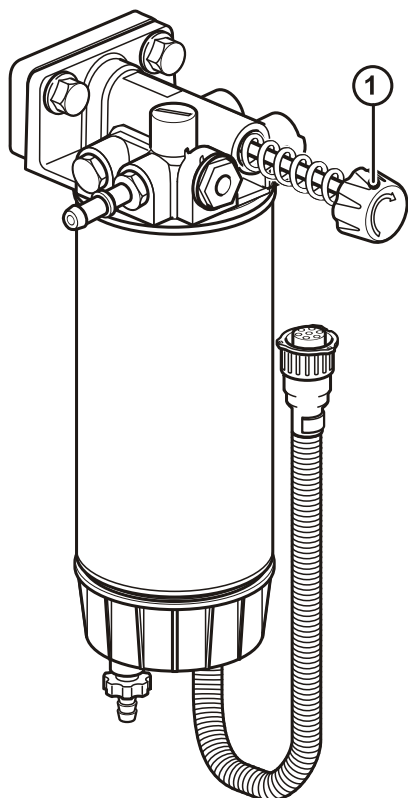
P0003133



- 27 Replace the protection panels and clamp the coolant hoses (2 pcs.) in place.

P0003126

23-0 Fuel Sytem, General



P0003304

Fuel system, bleeding

- 1 Open the hand pump (1), by pressing it in and turning it counter-clockwise.
- 2 Purge the fuel system by pumping at least 250 strokes on the hand pump.
Pump rapidly, to maintain pressure in the pump.

NOTICE! Purging is **not** complete while resistance is felt in the pump.

- 3 Close the hand pump (1) by pressing it in and turning it clockwise.
- 4 Start the engine and let it idle for at least 5 minutes, before speed is increased.

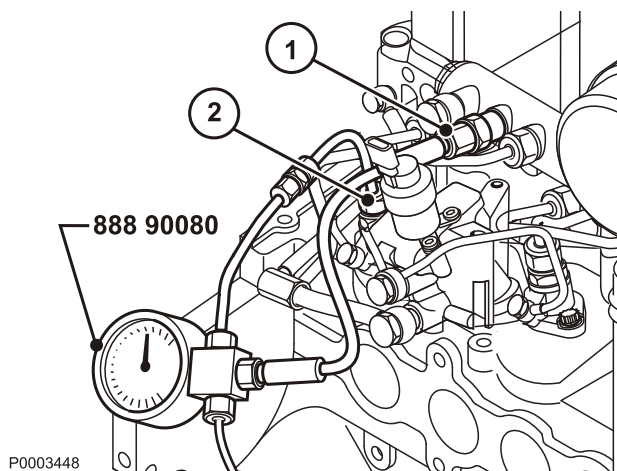
Fuel Pressure, Check

88800070 Wrench

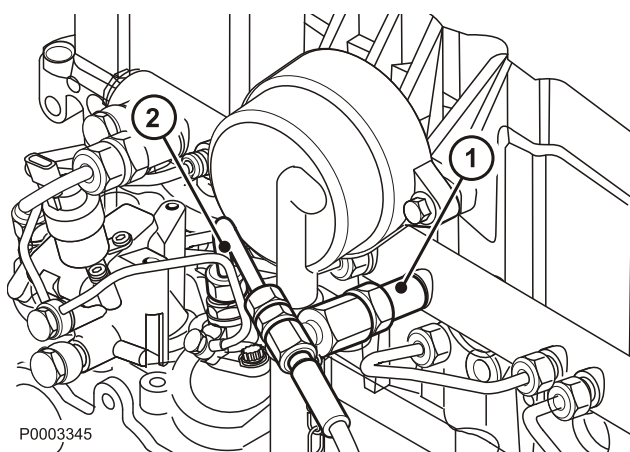
88890080 Manometer

From the high pressure pump *Common Rail*.

- 1 Clean all fuel lines, pumps and the rail.
Remove the pipes between the pumps and the rail (2 pcs).
Use wrench **8880 0070**.
Connect pressure gauge **8889 0080** with two hoses (1, 2) between one of the pumps and the rail (unions will be required for the rail and the pipe from the fuel pump).



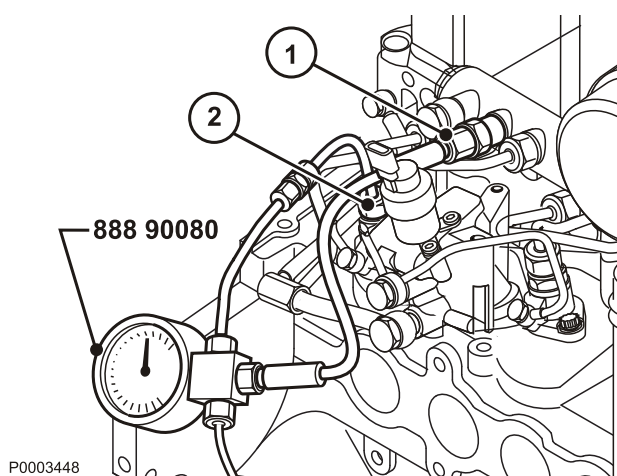
- 2 Plug the open connection (1) on the rail with the pressure gauge plug (an adapter will be required for the plug).
Attach a "spill pipe" (2) to the pump that is not being tested.
Connect a hose and lead it to a vessel. Crank the engine using the start motor and purge the pressure measuring equipment.



- 3 Crank the engine with the start motor, or start the engine, and read off the pressure.
- 4 Move the pressure testing equipment to the other high pressure pump and repeat the same test on this pump.
Compare the results to determine if either of the pumps are defective.
- 5 Install **new** fuel pressure lines, between the pumps and the rail.

Torque to: **25Nm**

Use wrench **8880 0070**.



23-3 Fuel Feed Pump and Filter

Fuel Pump, Change

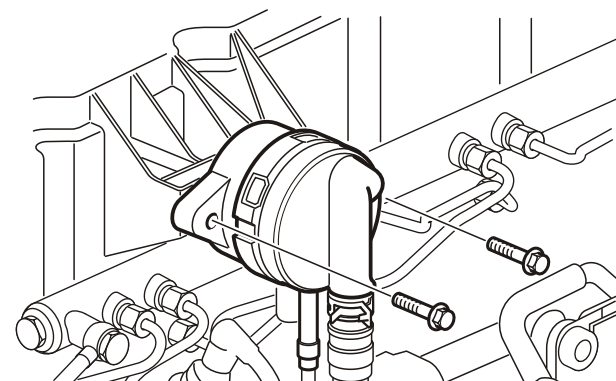
885510 Plugs
9991821 Puller
9998681 Cranking tool
88800070 Wrench

Clean the rail, safety valve, pressure pipes, rail pressure sensor and fuel pumps with cold degreaser and blow clean with compressed air.

NOTICE! Make sure the cold degreaser does not enter the rail pressure sensor connector.

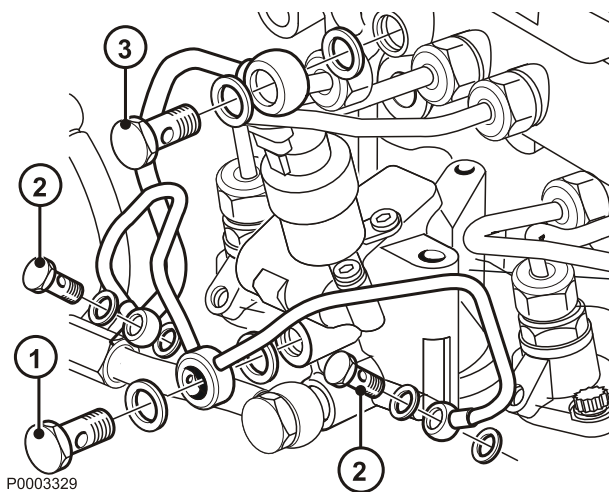
Removal

- 1 Remove the oil trap.

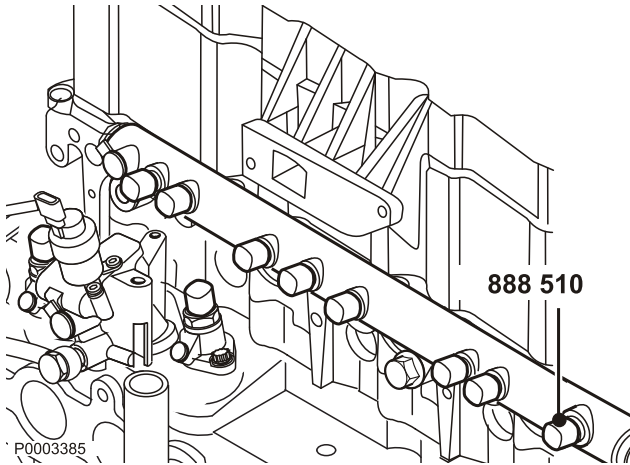


P0003141

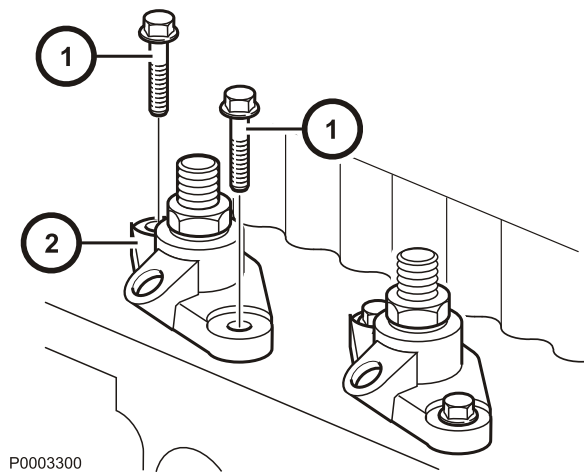
- 2 Remove the fuel pump connections (4 pcs). Remove the fuel supply line, use wrench **8880 0070**.



P0003329

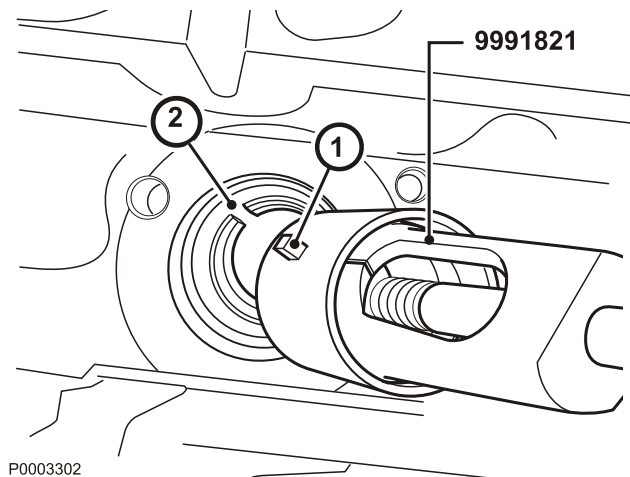


- 3 Plug all connections to exclude dirt (plugs 885 510).



- 4 Undo bolts (1) alternately and remove the fuel pump (2).

NOTICE! Turn the crankshaft (tool 999 8681) until fuel flows from the pump that is not to be removed. The fuel pump that is to be removed is not under load.

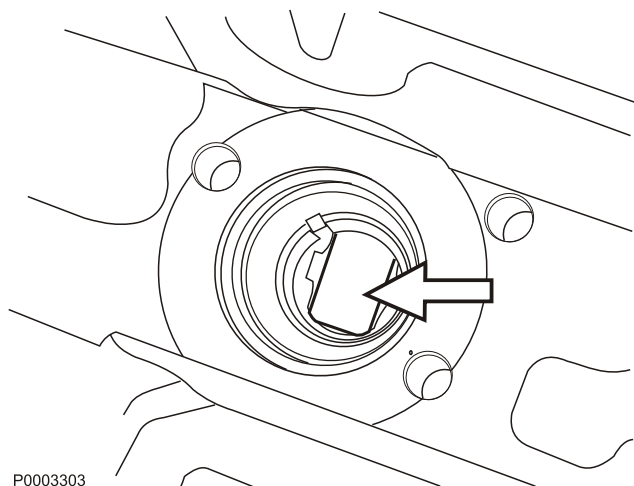


- 5 Remove the fuel pump cam followers. Use tool 999 1821.

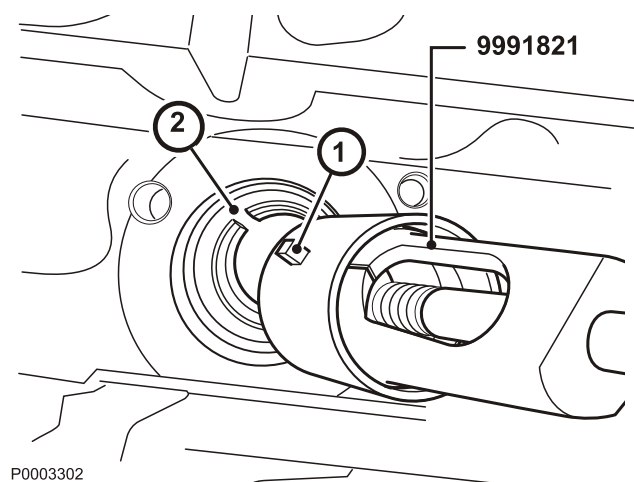
NOTICE! Pay attention to the key (1) and keyway (2).

Installation

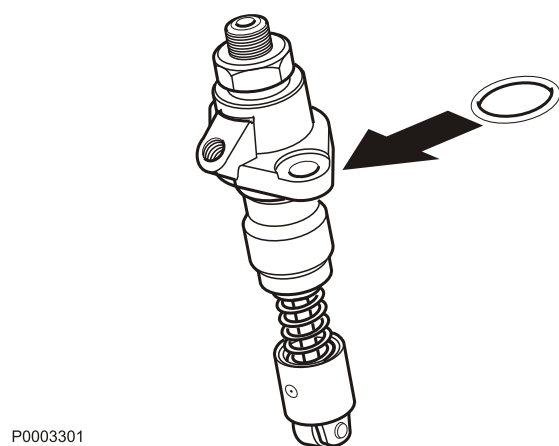
- 6 Check that there is no damage to the lobe/cam.

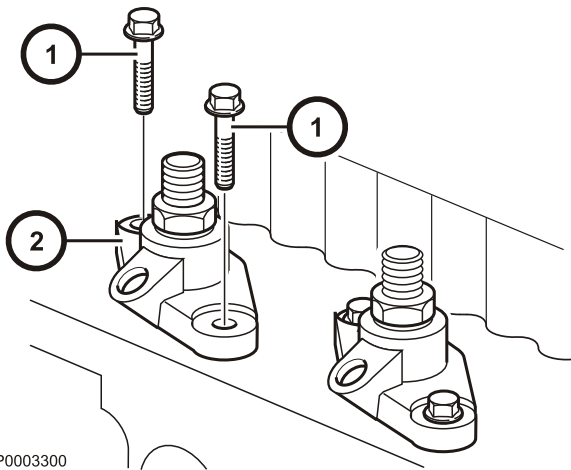


- 7 Install the cam follower. Use tool **9991821**.
NOTICE! Align the key (1) with the keyway (2).



- 8 Install **new** O-rings on the fuel pump.



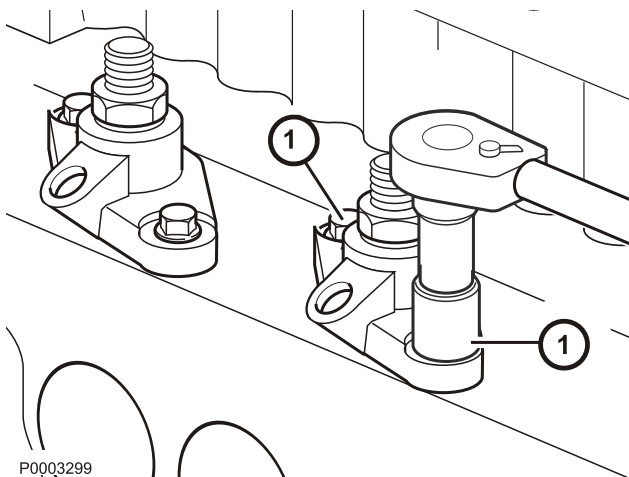


P0003300

- 9 Install the fuel pump (2).
Screw down the bolts (1) alternately.

Tighten in two steps:

Step 1: **10 Nm**
Step 2: **50 Nm**



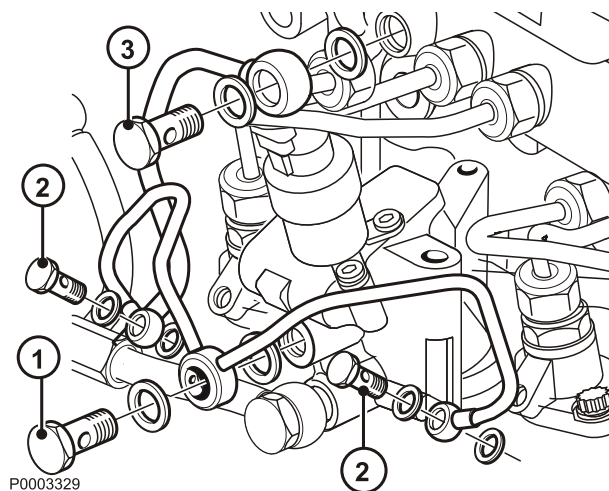
P0003299

If the other pump has been removed:

- 10 Crank the engine crankshaft so that the cam follower arrives at the lowest position.
Screw down the bolts (1) alternately.

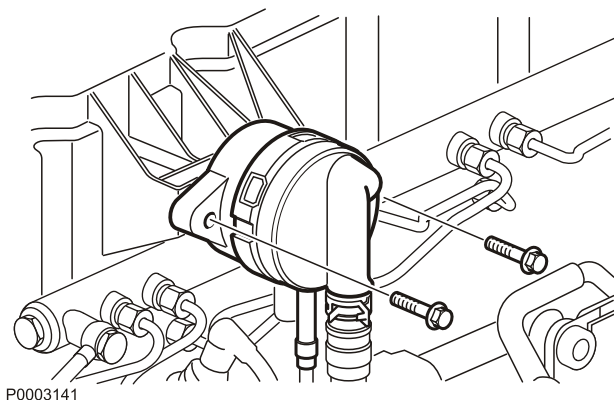
Tighten in two steps:

Step 1: **10 Nm**
Step 2: **50 Nm**



P0003329

- 11 Install **new** copper washers to the banjo fittings (1).
Torque to: **34 Nm**
- 12 Install **new** copper washers to the banjo fitting (2).
Torque to: **26 Nm**
- 13 Install **new** fuel delivery pipes (tool 888 000 70).
Torque to: **25 Nm**
- 14 Install the fuel return line with **new** copper washers (3).
Torque to: **39 Nm**



15 Install the oil trap.

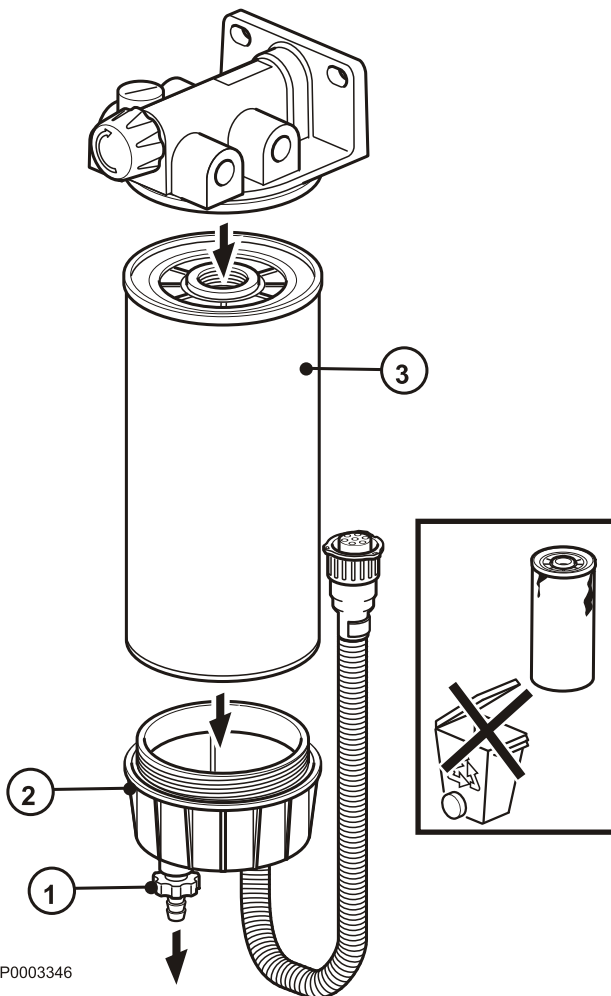
Purge the fuel system according to the method "*Fuel system, purging*".
Perform a function check in respect of any leakages.

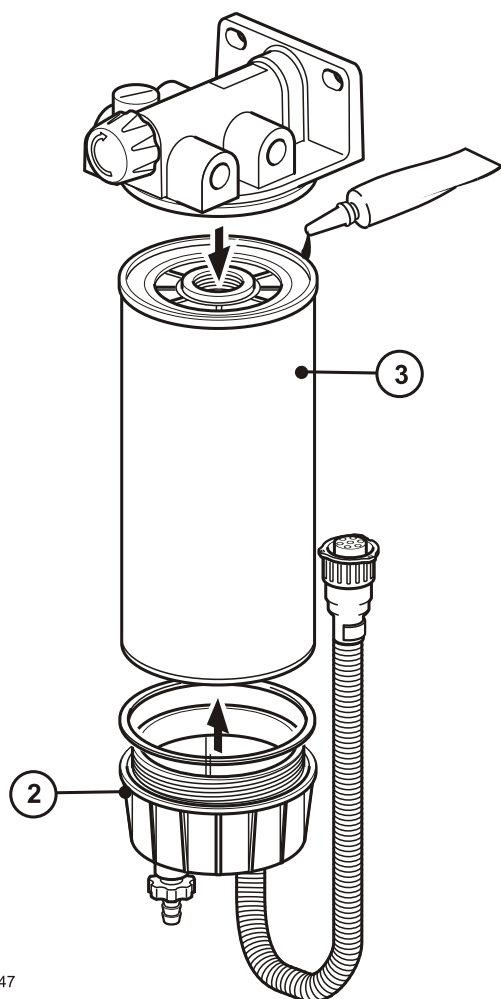
Fuel Pre-filter, Change

9999179 Extractor oil filter

Removal

- 1 Clean around the pre-filter and the water separator.
Open the drain nipple in the base of the water separator (1).
- 2 Tighten the drain nipple (1).
Remove the lower part of the water separator (2).
Remove the pre-filter (3); use tool **999 9179**.
- 3 Clean the mating surfaces.





P0003347

Installation

- 4 Grease the gasket surfaces.
Fit the **new** pre-filter (3).
Tighten according to the instructions on the filter.
- 5 Install the lower part of the water separator (2).

NOTICE! Use a **new** seal ring.

Perform a function check in respect of any leakages.

Engine Fuel Filter Replacement

Removal

- 1 Clean around the fuel filter.
- 2 **NOTE!** The filter is self-draining (when the fuel tank is located under the engine); wait a couple of seconds before removing the filter cover and filter.

If the fuel tank has a "higher" location:

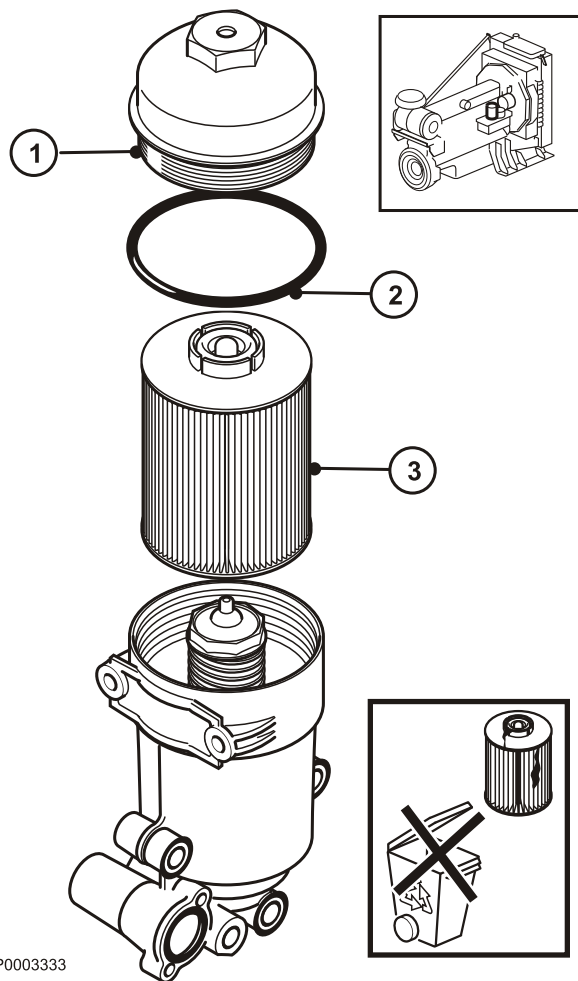
- 3 Close the cock on the return line to the tank. Place a suitable vessel underneath the filter. Disconnect the quick connector on the return line.
- 4 Remove the filter cover (1).
- 5 Remove the O-ring (2) and filter (3).

Installation

- 6 Install a new filter (3) and a new O-ring (2).
- 7 Install the filter cover (1) and filter.

If the fuel tank has a "higher" location:

- 8 Reconnect the quick connector on the return line. Open the cock on the return line and remove the collection vessel.
- 9 Purge the fuel system according to the method, *"Fuel system, purging"*.
- 10 Warm up the engine and perform a function check in respect of any leakages.

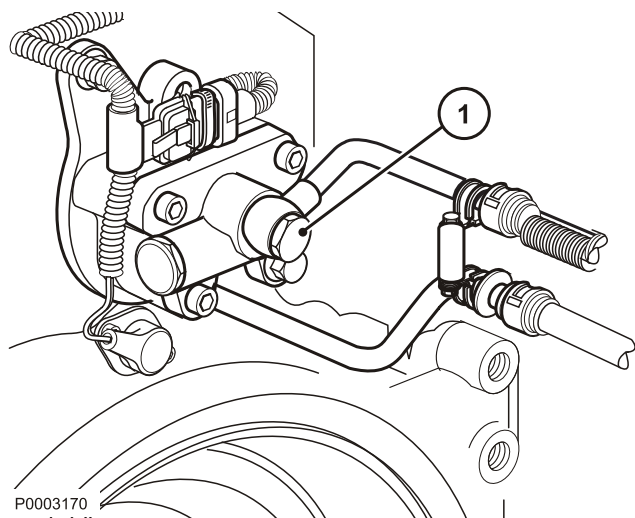


P0003333

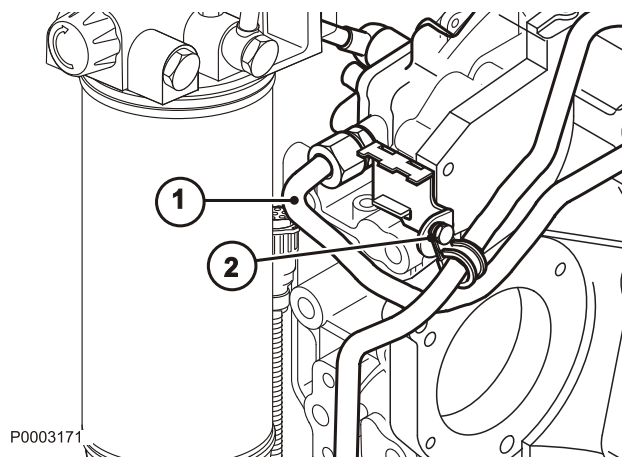
Fuel Feed Pump, Check

Removal

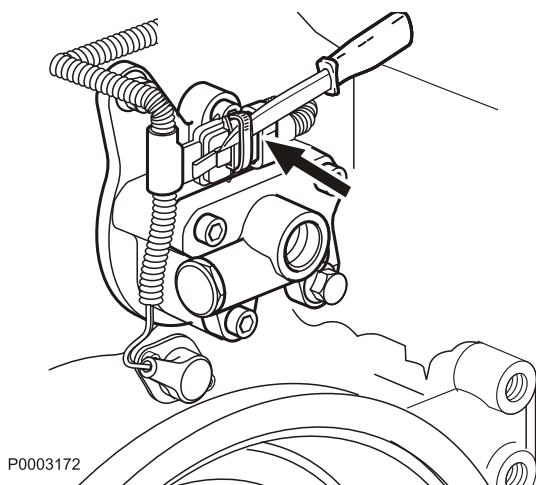
- 1 Clean the fuel feed pump with cold degreaser and blow clean with compressed air.
Remove the fuel pipes (1) between the fuel feed pump and the fuel pre-filter.

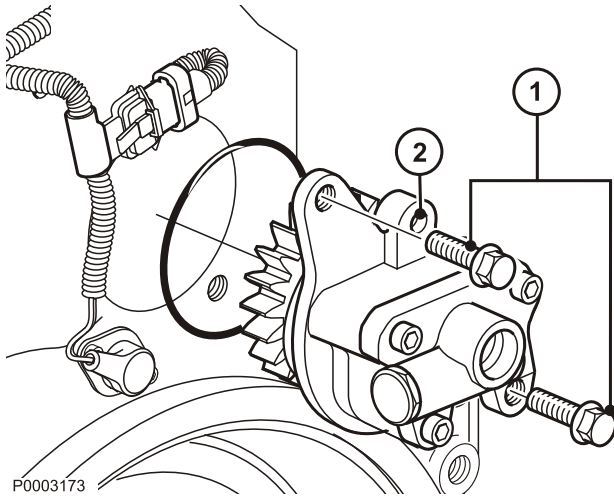


- 2 Remove pipe clamp (2) from the fuel feed pump.
Remove the fuel pipe (1) from the fuel feed pump by pulling the pipe out a little from the pump.



- 3 Remove the wiring from the fuel feed pump.



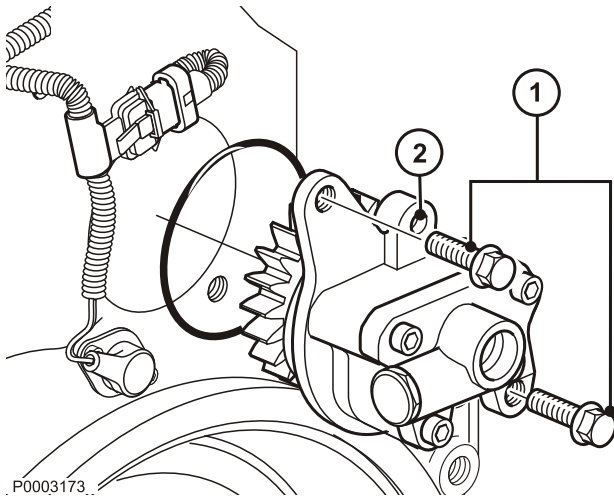


- 4 Remove the two pump attachment bolts (1). Use the "lower" of the attachment bolts in hole (2) to loosen the pump from the flywheel housing.

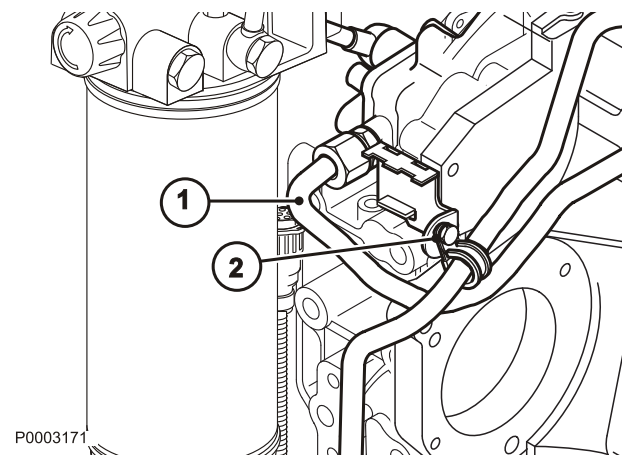
NOTICE! Turn the bolt in only one turn after the bolt has bottomed against the flywheel housing.

Pull out and remove the fuel feed pump.

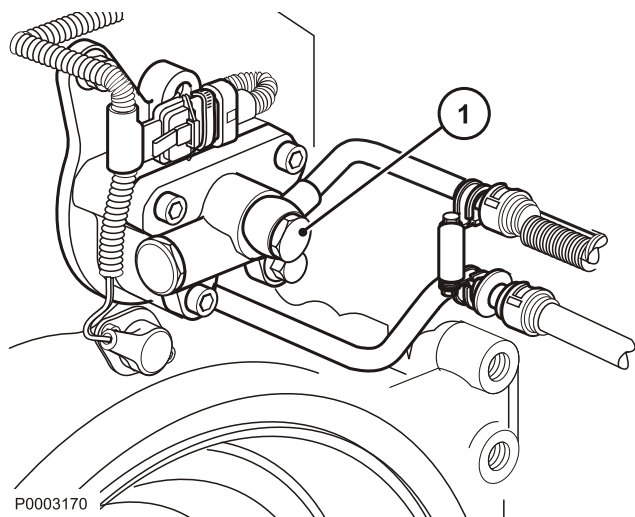
Installation



- 5 Install a **new** O-ring on the fuel feed pump. Install the fuel feed pump and tighten the three bolts (1).



- 6 **Install:**
- fuel pipe (1), to the pump.
 - the clamp (2), for the oil pipe.



- 7 Install the fuel pipes (1) between the fuel feed pump and the fuel pre-filter.
Connect the wiring to the fuel feed pump.

Purge the fuel system according to the alternative method.
Perform a function check in respect of any leakages.

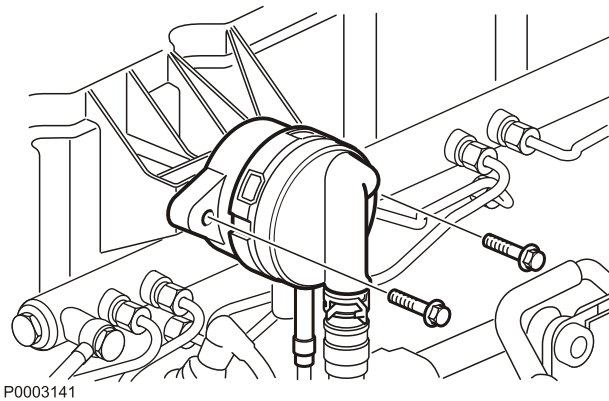
23-7 Injectors and Delivery Pipes

Injector, Change

885510 Plugs
9996400 Slide hammer
9998007 Adapter
88800070 Wrench

Removal

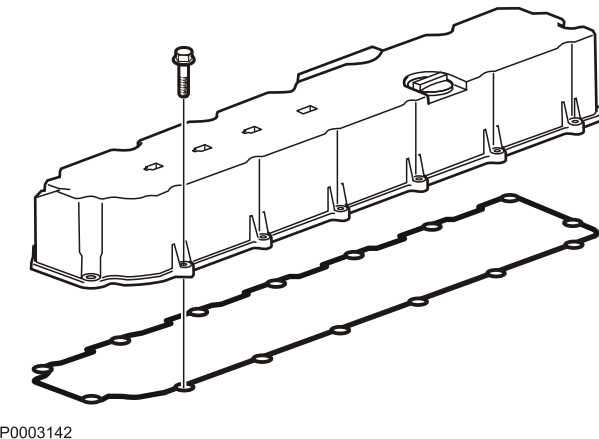
- 1 Disconnect battery power.
Remove the oil trap.

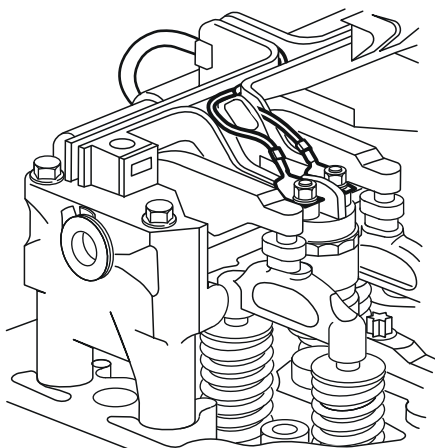


- 2 Remove the valve cover.

Drain away return fuel:

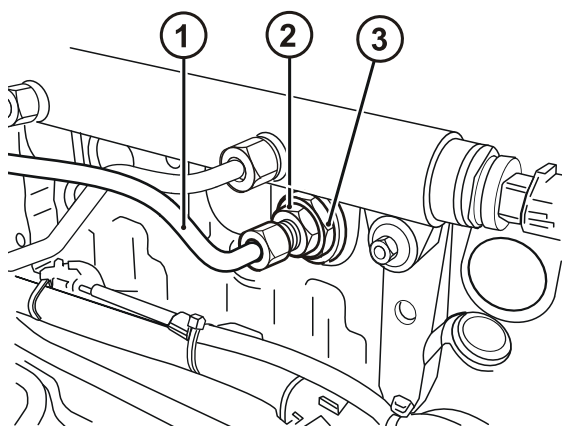
- Remove the banjo bolt from the return line on the cylinder head.
- Collect any residual fuel.





P0003149

- 3 Disconnect the wiring from the injectors.

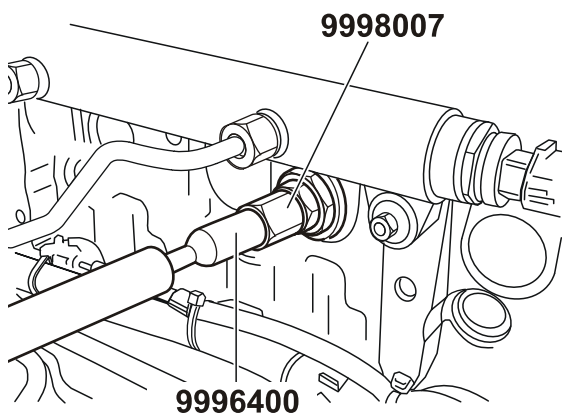


P0003150

- 4 Remove the pressure pipes (1).

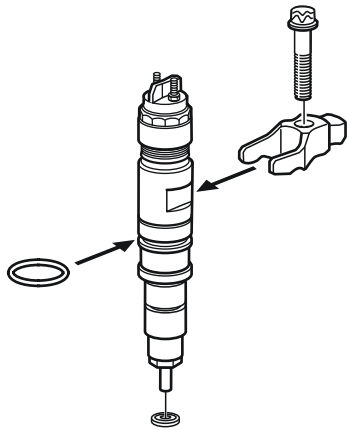
NOTICE! The pressure pipes may **not** be re-used.

Remove the injector pressure line nuts (2) from the unions (3).



P0003151

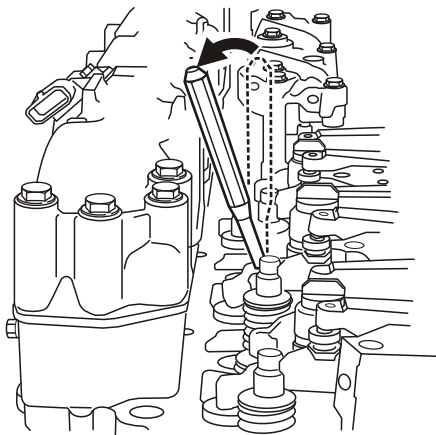
- 5 Remove the injector pressure lines by tapping out the pipes **carefully** with the aid of the puller **999 6400** and adapter **999 8007**.



P0003152

- 6 Remove the injector bolts.

NOTICE! Ensure that the cylinder head is clean.



P0003153

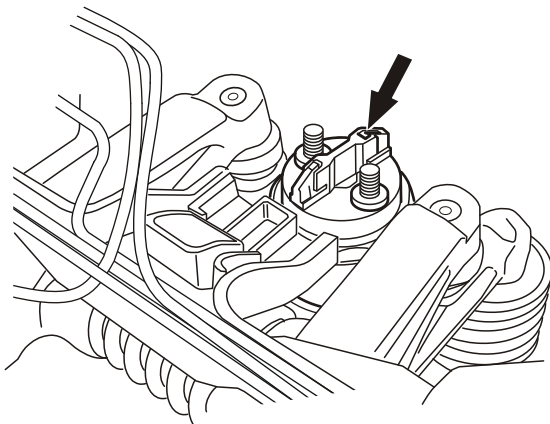
- 7 Remove the injector by inserting an 8-9 mm drift in the yoke. Move the drift towards the inlet manifold, to lever the injector out. Plug the hole (Plug: 885 510).

NOTICE! Make sure the sealing washers are also removed.

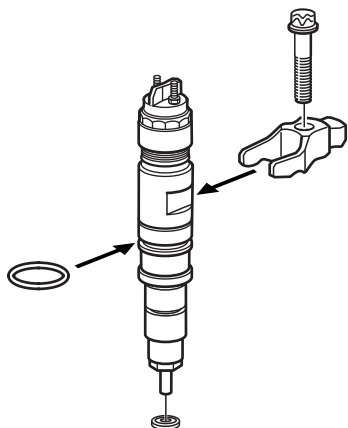
Installation

- 8 Install the new injectors together with yokes.

NOTICE! Do **not** press directly on the connector screws, but on the plastic between them. Use **new** copper washers.



P0003154

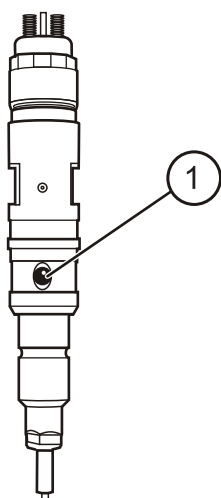


P0003155

9 IMPORTANT!

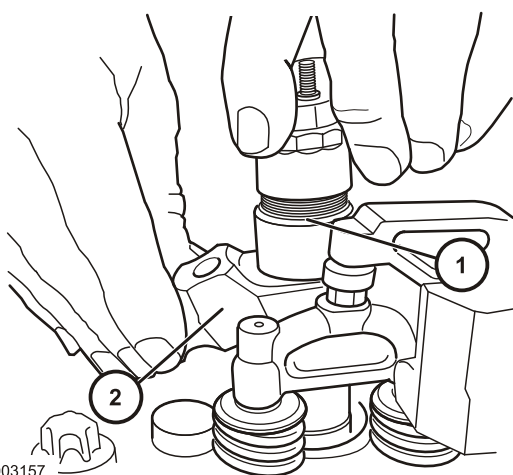
Innan insprutarna sätts dit måste förbränningsrester noggrant torkas bort från cylinderhuvudets lopp. Sug bort smutspartiklar.
Always use a **new** O-ring and a **new** washer.

- 10 Position the injector so that the installation hole (1) is turned towards the "fuel pump side". Lightly oil the O-ring.

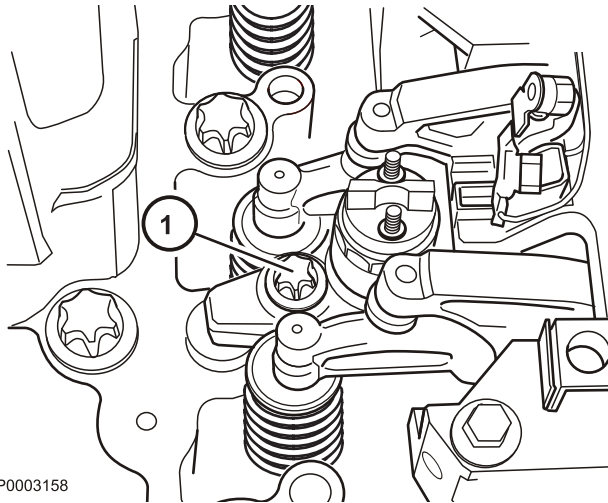


P0003156

- 11 Insert the injector (1) and yoke (2) carefully in the cylinder head.



P0003157

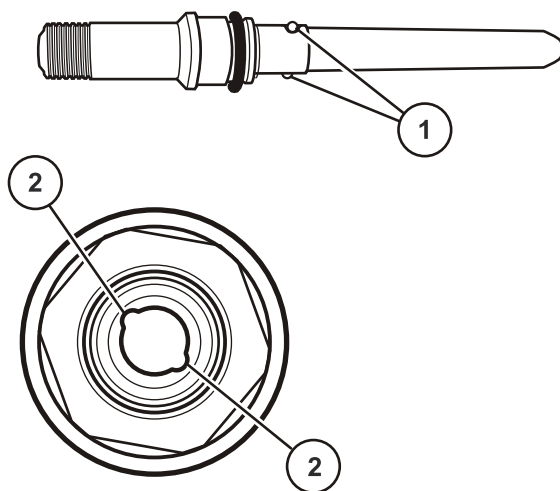


P0003158

- 12 Install bolt (1) in the injector yoke.

Torque to: **4 Nm**

Then loosen the bolt (1) somewhat.

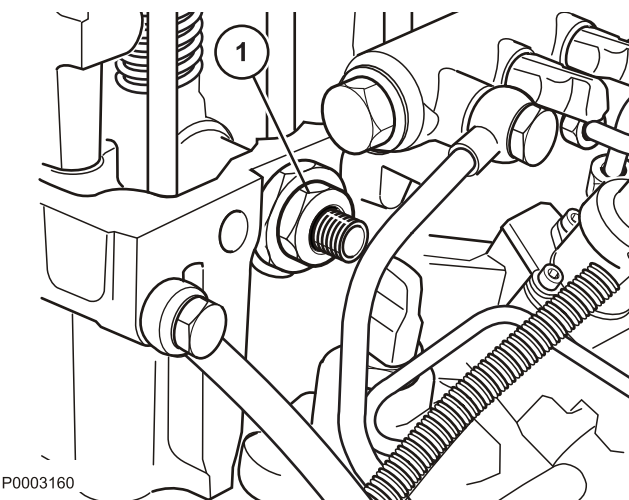


P0003159

- 13 Oil and install a **new** O-ring. Align the injector pressure line and insert it into the holder so that the balls (1) align with the grooves (2) in the holder.

IMPORTANT!

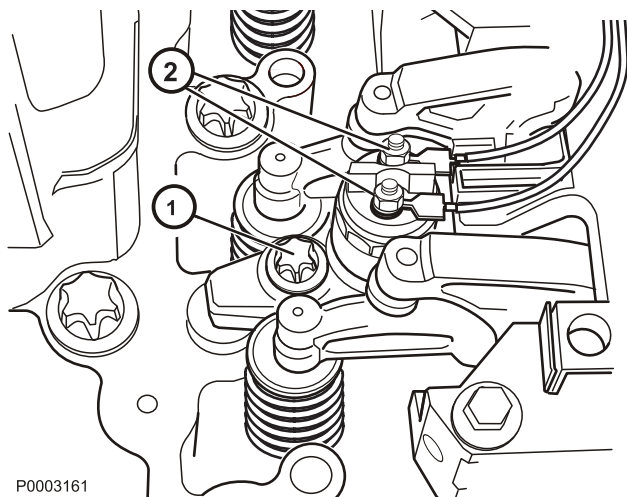
Spridartryckröret måste alltid vara nytt.



P0003160

- 14 Pre-install the connection screw (1).

Torque to: **20 Nm**

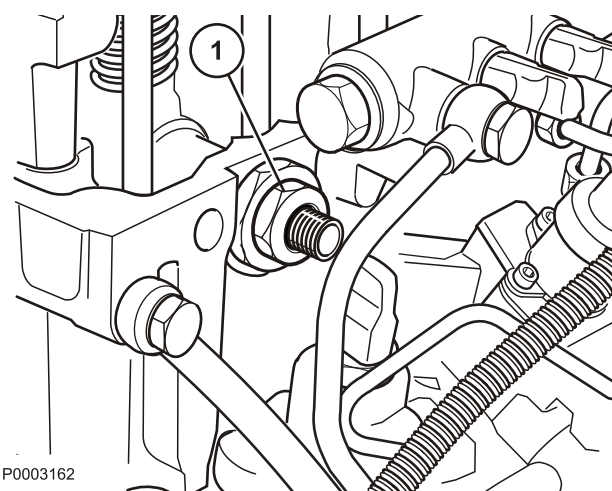


- 15 Tighten the screw (1).

Torque to: **23 Nm**

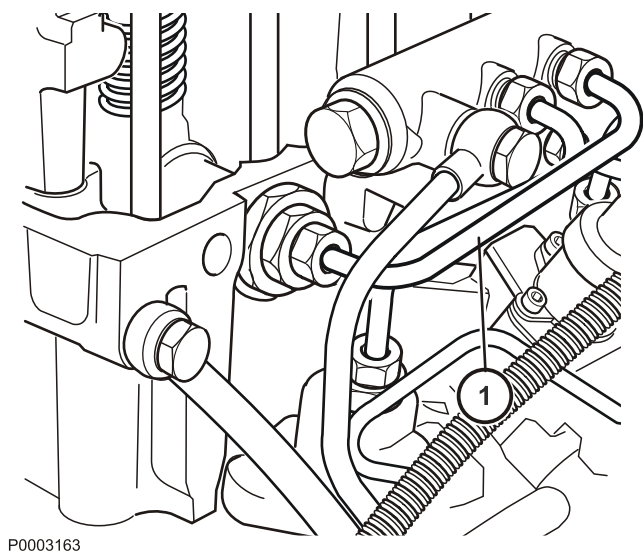
Connect the electrical wiring (2) to the injectors.

Torque to: **1.5 Nm**



- 16 Re-tighten the connection screw (1).

Torque to: **52 Nm**

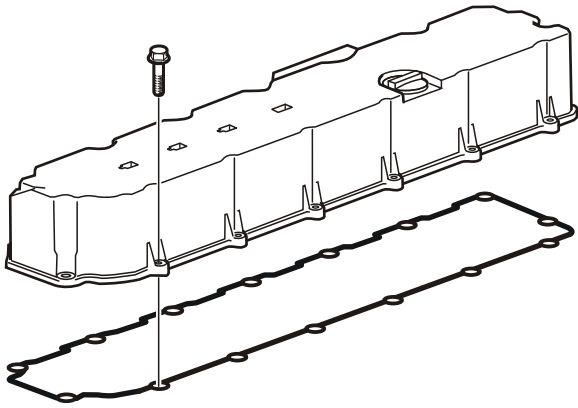


- 17 Install **new** delivery pipes (1). Use wrench **8880 0070**.

Torque to: **25 Nm**

IMPORTANT!

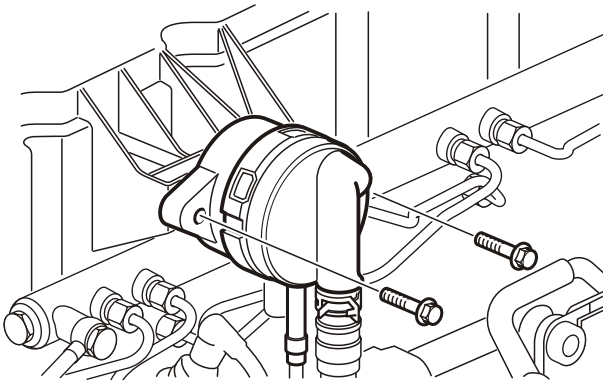
Tryckrör måste alltid bytas till nytt efter borttagning.



P0003142

- 18 Check the valve cover gasket and replace as necessary.
Install the banjo bolt from the return line on the cylinder head.
Install the valve cover.

Torque to: **8.5 Nm**



P0003141

- 19 Install the oil trap. Check and replace the O-ring as necessary.

Reconnect battery power.
Purge the fuel system using the method, "*Fuel system, purging*".

Common Rail, byte

885510 Plugs

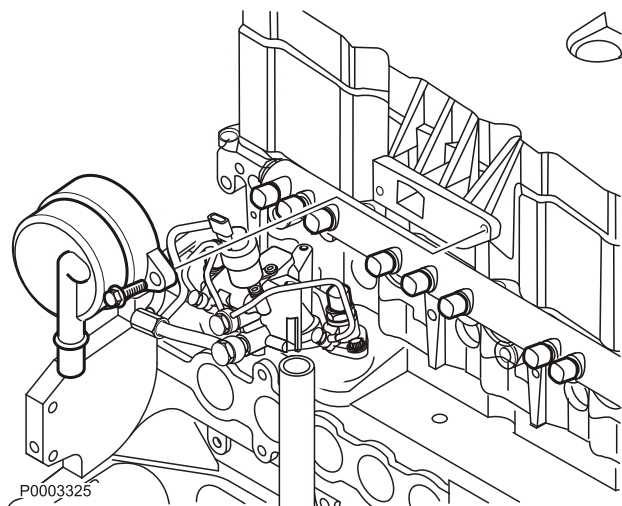
88800070 Wrench

Clean the rail, safety valve, pressure pipes, rail pressure sensor and fuel pumps with cold degreaser and blow clean with compressed air.

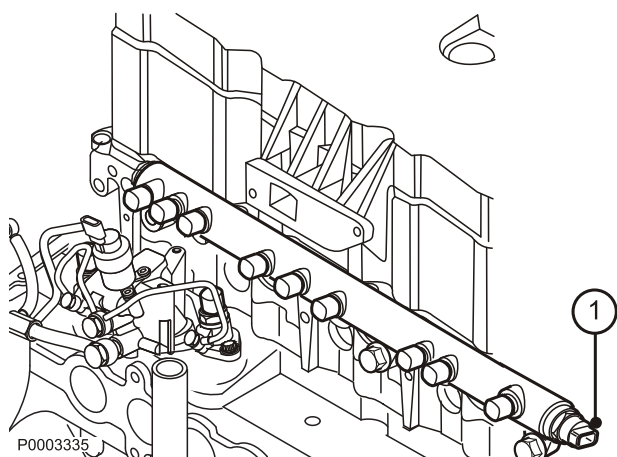
NOTICE! Make sure the cold degreaser does not enter the rail pressure sensor connector.

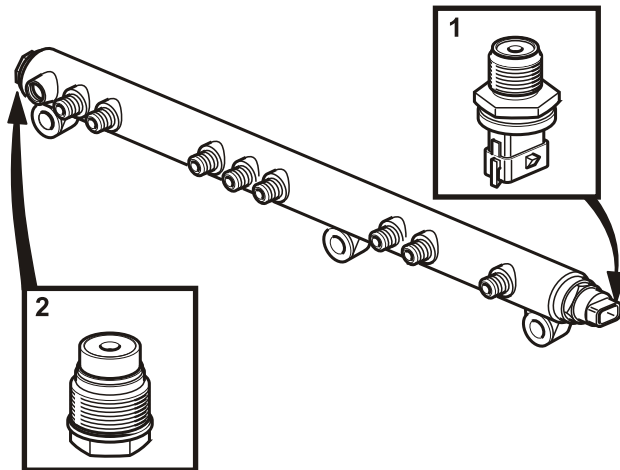
Removal

- 1 Remove the oil trap.
Remove the fuel delivery pipe. Plug (plugs 885 510) the connections against dirt entry.
Undo the fuel hose connections.



- 2 Remove the hose tie.
Disconnect the connector from the rail pressure sensor (1).
Remove the bolts and the Common Rail unit.





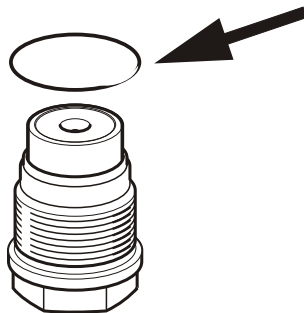
P0003315

Common Rail, dismantling

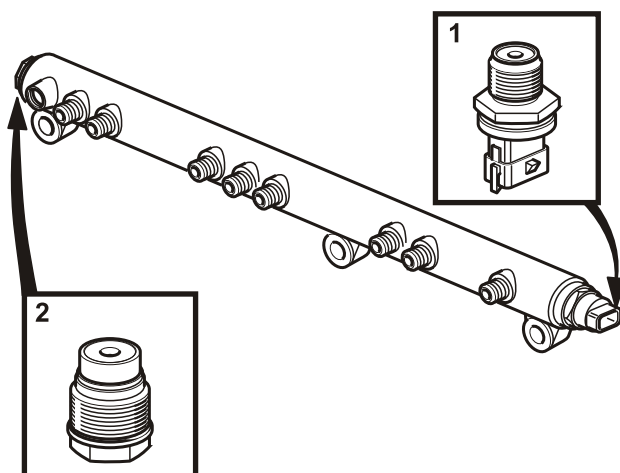
- 3 Remove the safety valve (2) and rail pressure sensor (1), from the Common Rail unit.
- 4 Check the safety valve (2) and rail pressure sensor (1), for any damage.

Common Rail, assembly

- 5 Install a **new** O-ring on the safety valve.



P0003316



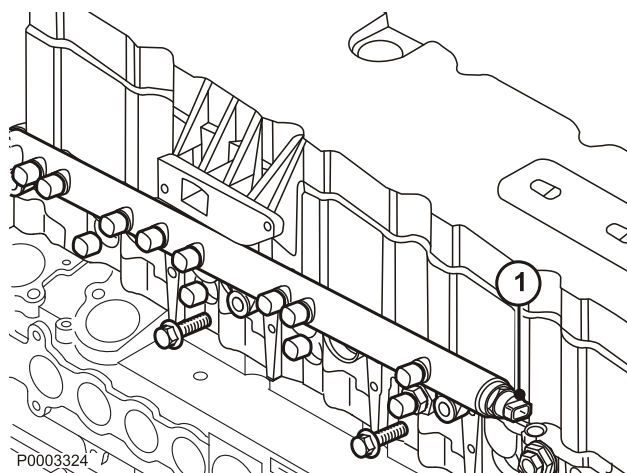
P0003315

- 6 Install the safety valve (2).

Torque to: **100 Nm**

Install the rail pressure sensor (1).

Torque to: **70 Nm**

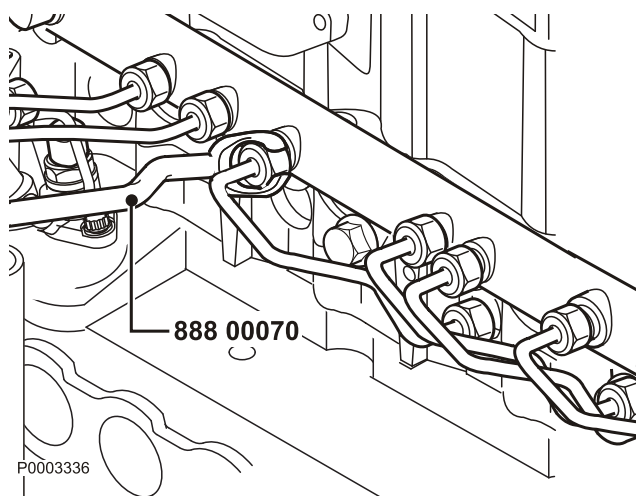


Installation

- 7 Install the Common Rail unit.

Torque the bolts to: **30 Nm**

Connect the connector (1) to the rail pressure sensor and install the hose tie.

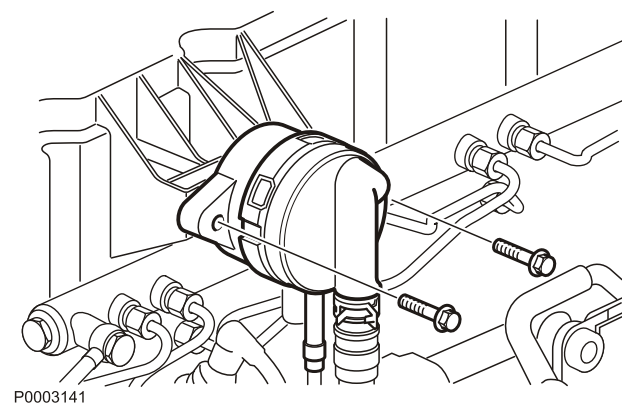


- 8 Connect the fuel hose to the rail.

Tighten the connection to: **39 Nm**

- 9 Install **new** fuel delivery pipes (tool 8880 0070).

Torque to: **25 Nm**



- 10 Install the oil trap.

Purge the fuel system according to the method, "*Fuel system, purging*".
Perform a function check in respect of any leakages.

Fuel Injection Pipe, Change

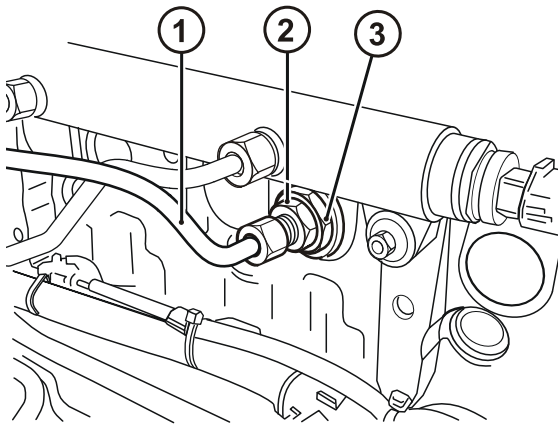
1159794 Torque wrench
 9996400 Slide hammer
 9998007 Adapter
 88800070 Wrench

Removal

- 1 Disconnect battery power.
 Remove the pressure pipes (1).

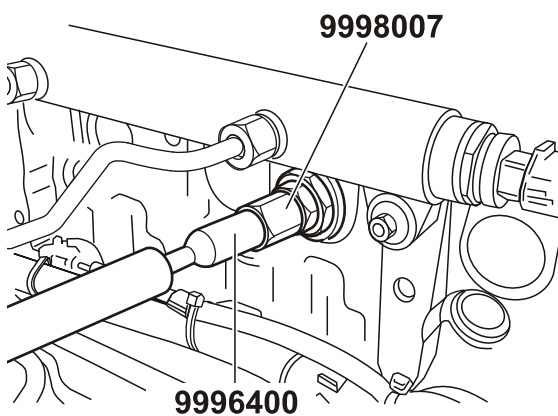
NOTICE! The pressure pipes may **not** be re-used.

Remove the nuts (2) that hold the injector pressure pipes in the union (3).



P0003150

- 2 Remove the injector pressure lines by tapping out the pipes **carefully** with the aid of the puller **999 6400** and adapter **999 8007**.



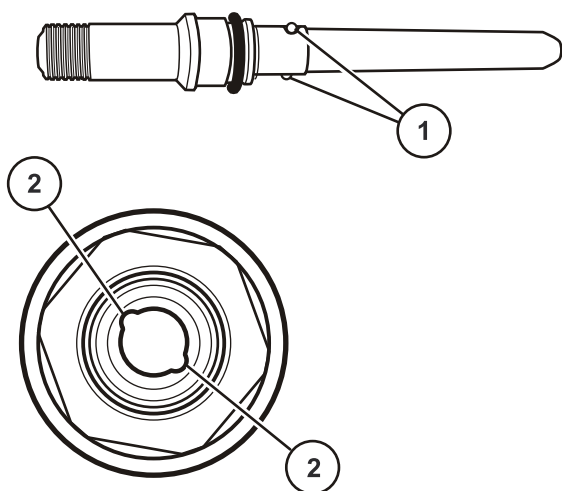
P0003151

Installation

- 3 Align the injector pressure line and insert it into the holder so that the balls (1) align with the grooves (2) in the holder.

IMPORTANT!

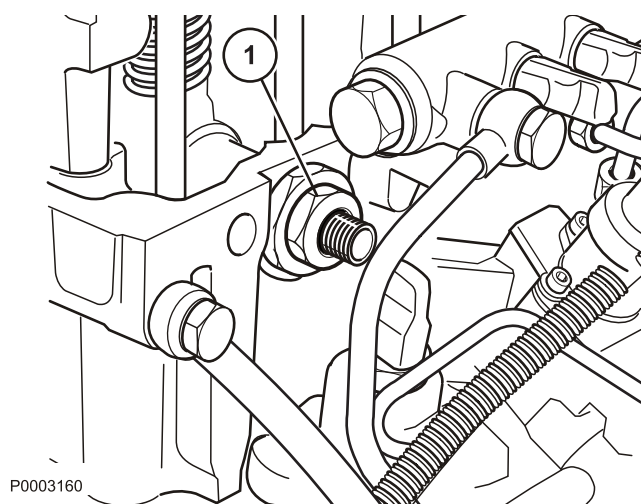
Spridartryckröret måste alltid vara nytt.



P0003159

- 4 Re-tighten the connection screw (1).

Torque to: **20 Nm**



P0003160

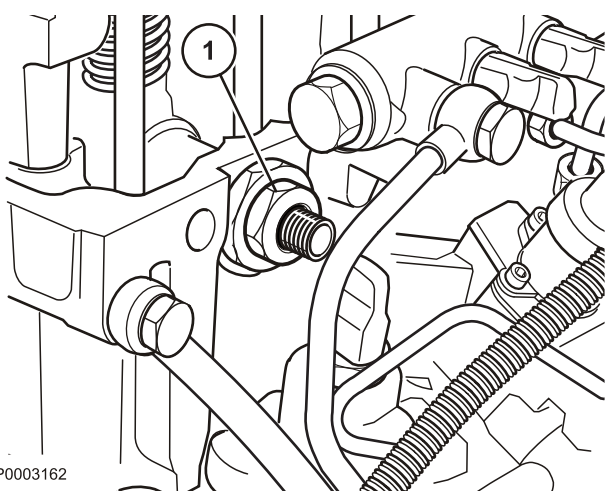
- 5 Re-tighten the connection screw (1). Use tool **115 9794**.

Torque to: **52 Nm**

- 6 Install **new** delivery pipes (1). Use wrench **8880 0070**.

Torque to: **25 Nm**

IMPORTANT!Tryckrör måste alltid bytas till nytt efter borttagning.



P0003162

Purge the fuel system according to: "*Fuel system, purging*".

Connect battery power.

Perform a function check in respect of any leakages.

23-8 Control System, ECM, Data Sets

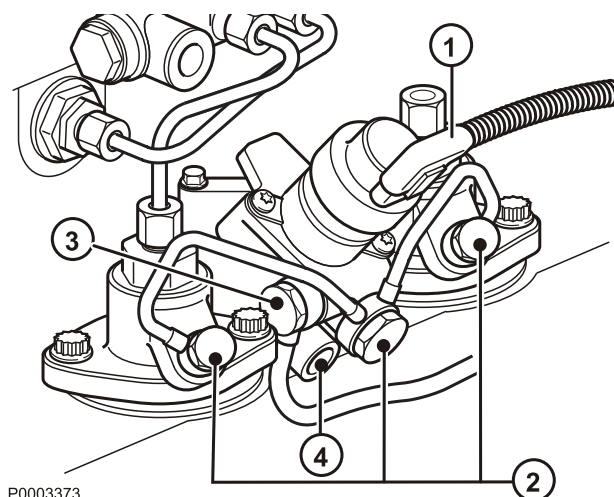
Control Valve, Change

885510 Plugs

Clean the control valve and fuel connections with cold degreaser and blow clean with compressed air.

1 Remove:

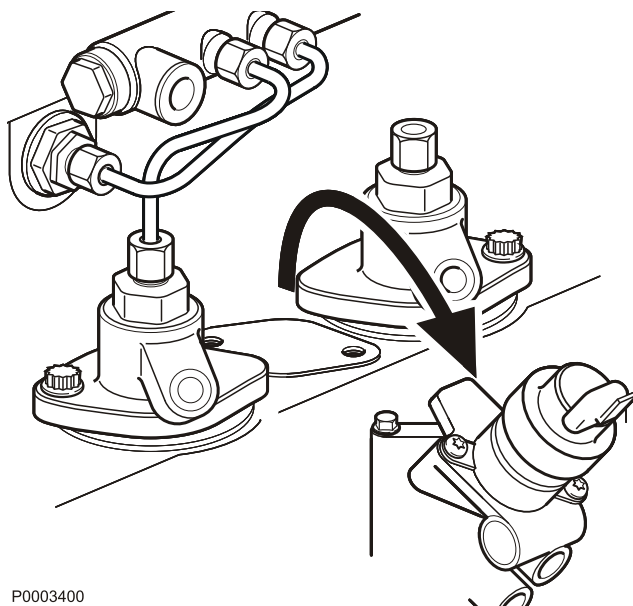
- the cable from the control valves "M-prop" (1) (cut the cable tie)
- feed line (2)
- the feed line from the fuel filter (3)
- return line (4)
- the control valve's two bolts

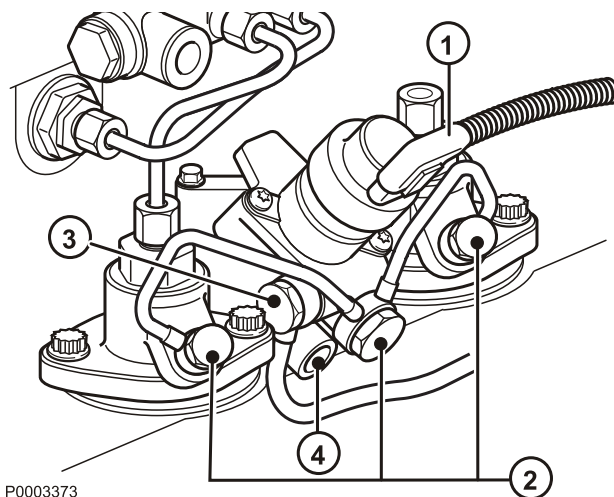


Remove the control valve

- 2 Check the control valve for damage.

NOTICE! Plug all connections to exclude dirt (885 510).





3 **Install:**

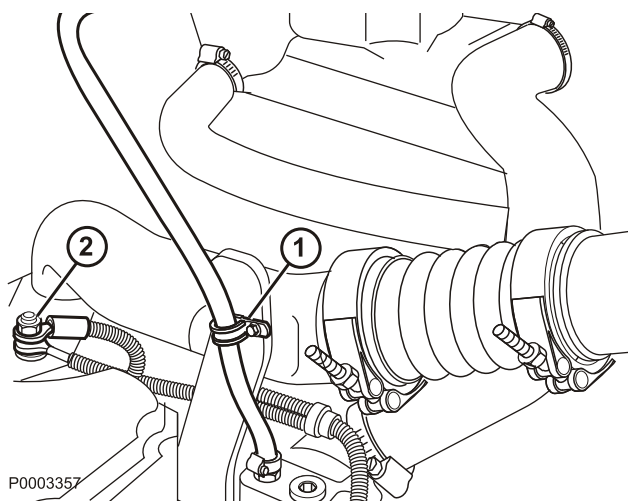
- the control valve
- return line (4)
- the feed line from the fuel filter (3)
- feed line (2)
- the cable to the control valve's "MPROP" (1) (use a new cable tie)

25-1 Inlet and Exhaust Manifolds

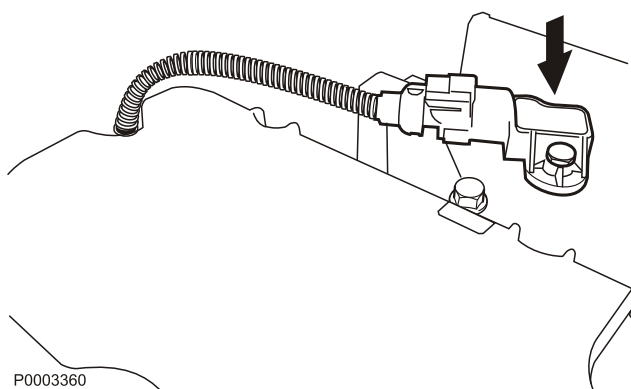
Inlet Manifold, Change

Disconnect power to the engine.

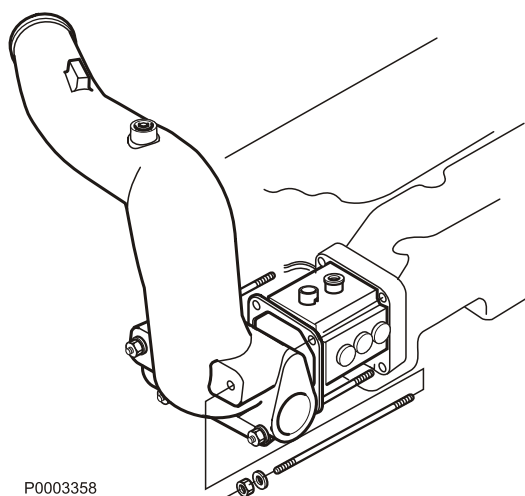
- 1 Undo the clamp (1).
- 2 Disconnect the wiring (2) to the pre-heater.

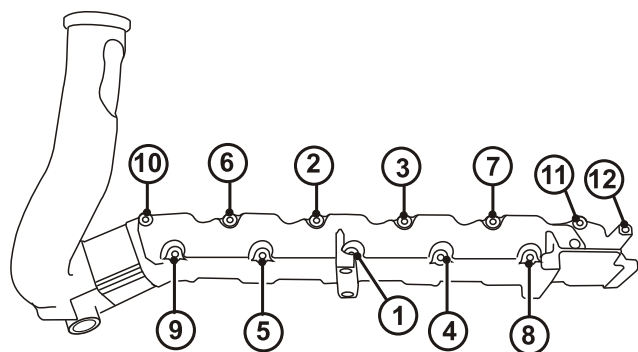


- 3 Remove the sensor "air pressure induction manifold".

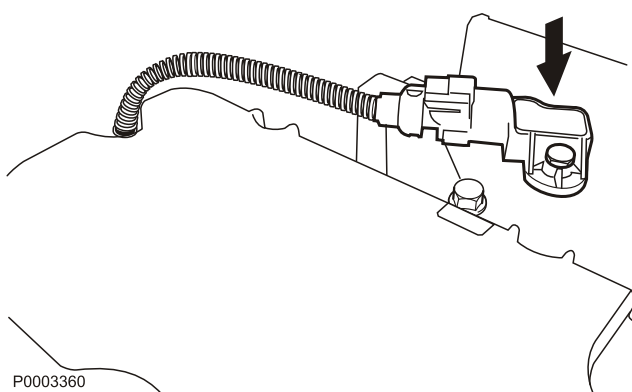


- 4 Remove the induction manifold, complete with pre-heater.
- 5 Remove the pre-heater from the induction manifold.

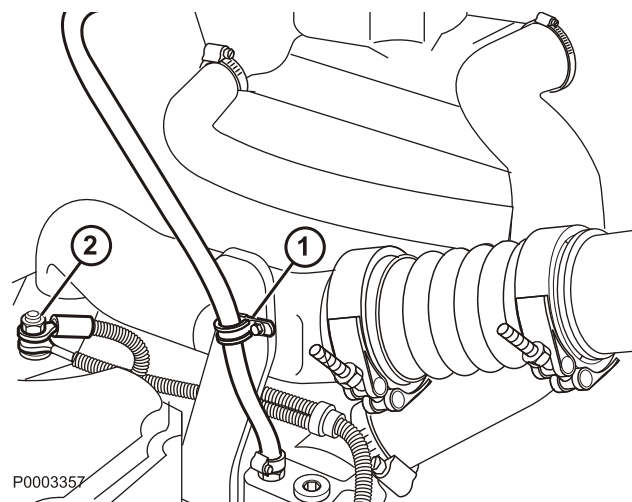




P0003359



P0003360



P0003357

Installation

- 6 Assemble the induction manifold with pre-heater.
- 7 Install the induction manifold with pre-heater using **new** gaskets.
- 8 Torque the bolts to **30 Nm**. (Tightening sequence as illustrated).

- 9 Install the sensor "air pressure induction manifold"

- 10 Connect the wiring (2) to the pre-heater.
- 11 Check and where necessary replace the O-ring, and then install the clamp (1).

Reconnect battery voltage to the engine.

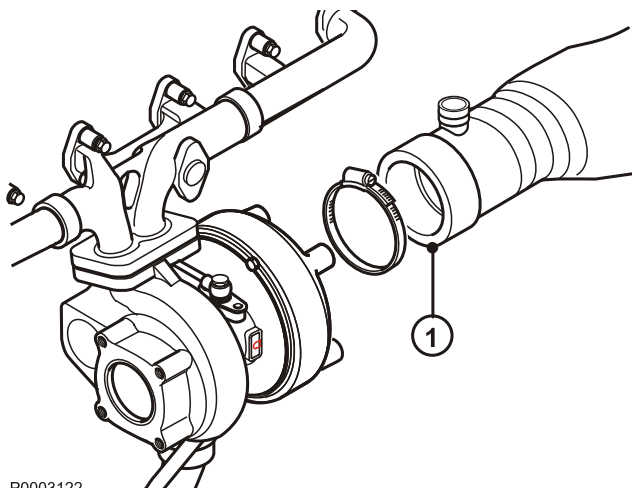
Exhaust Manifold, Change

The working method requires removal of the exhaust system.

Removal

1 Remove:

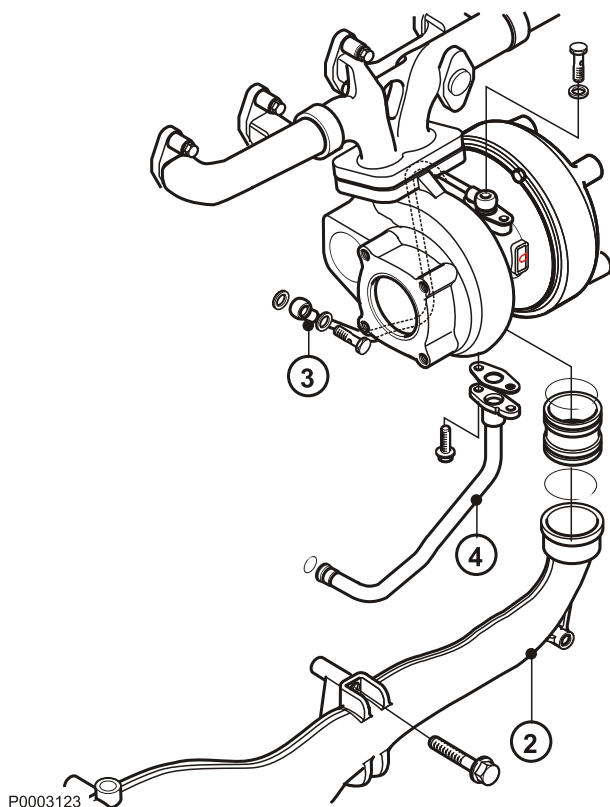
- the inlet hose (1)



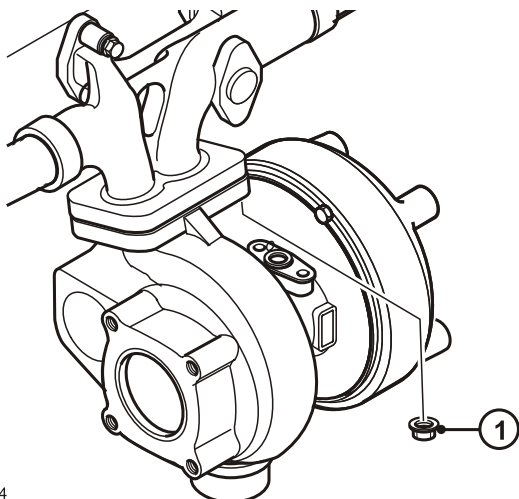
P0003122

2 Remove:

- turbocharger pressure pipe (2), to the charge air cooler
- oil delivery pipe (3) and oil return pipe (4)

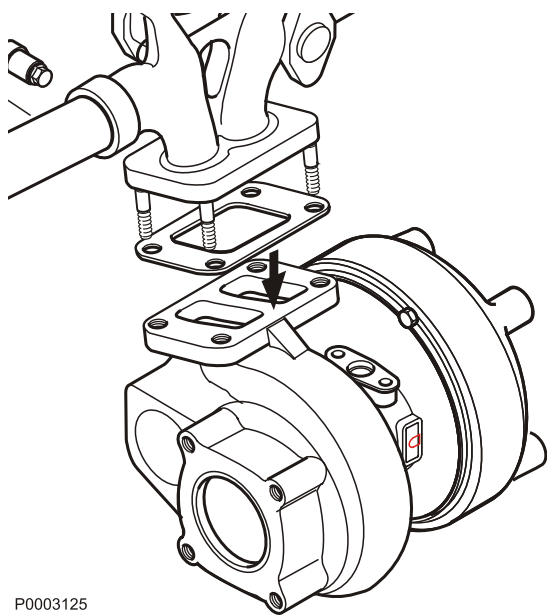


P0003123



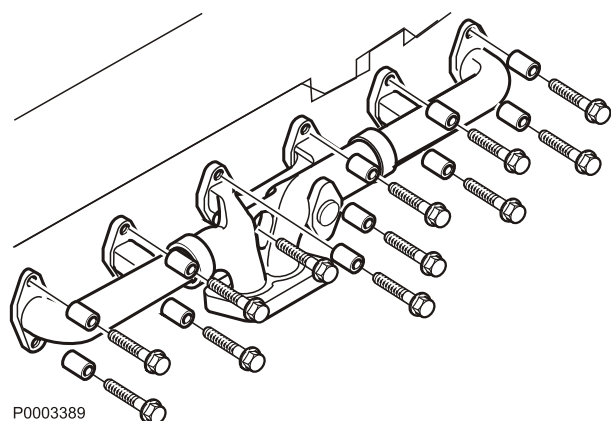
P0003124

- 3 Remove the turbo charger nuts (1) from the exhaust manifold.



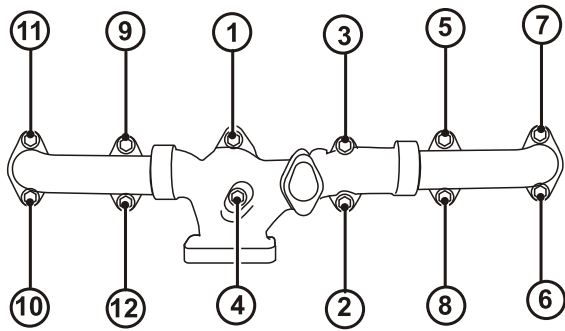
P0003125

- 4 Remove the turbocharger.



P0003389

- 5 Remove the exhaust manifold and gaskets. Clean the mating surfaces.



P0003388

Installation:

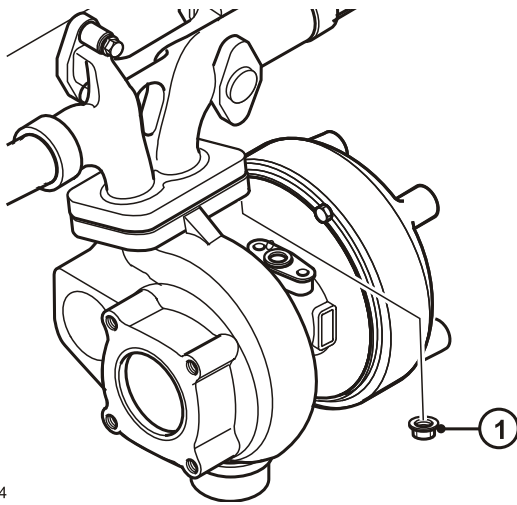
- 6 Install the exhaust manifold with **new** gaskets and **new** bolts.

NOTICE! Use high temperature paste (1161035) on the studs.

Tighten (sequence as illustrated) in two steps:

Torque to: **15 Nm**

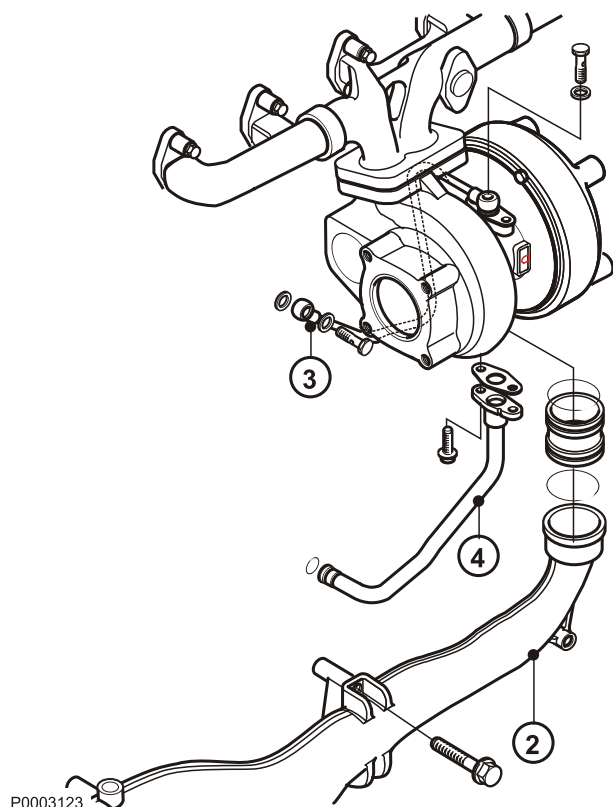
Torque to: **45 Nm**



P0003124

- 7 Install the turbocharger with a **new** gasket.

Torque to: **30 Nm**



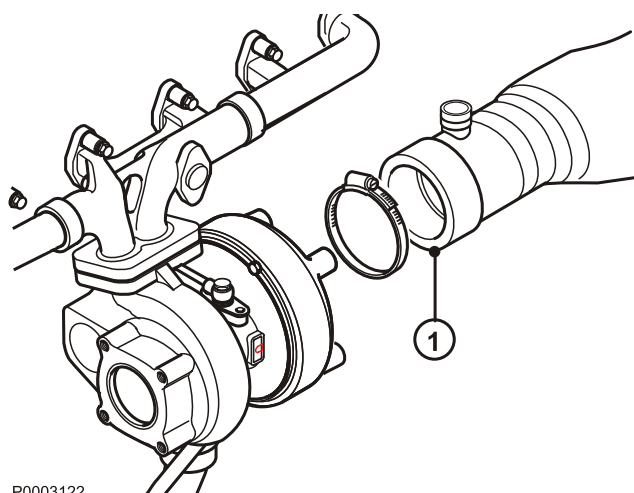
- 8 Install the turbocharger oil pressure pipe (3) with **new** gaskets.

Torque to: **39 Nm**

Install the turbocharger oil return pipe (4) with a **new** gasket and a **new** O-ring.

Torque to: **20 Nm**

Install the turbocharger pressure pipe (2) to the charge air cooler using **new** O-rings.



- 9 **Install:**
- the inlet hose (1)

Connect the exhaust system.
Perform a function check in respect of any oil leakages.
If necessary, check turbo pressure according to separate routine.

25-5 Turbocharger

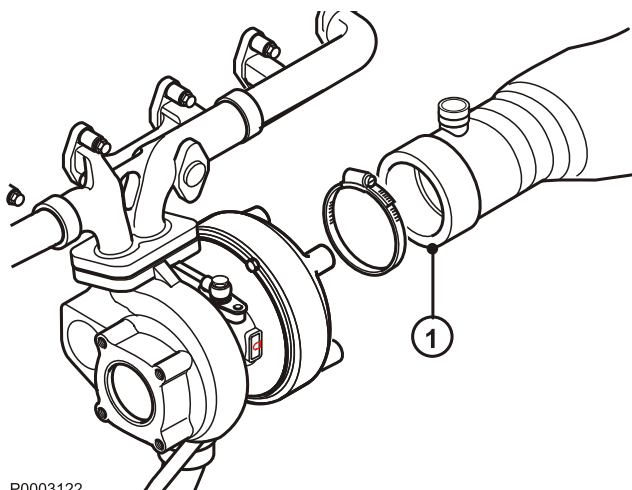
Turbo, Change

The working method requires removal of the exhaust manifold.

Removal

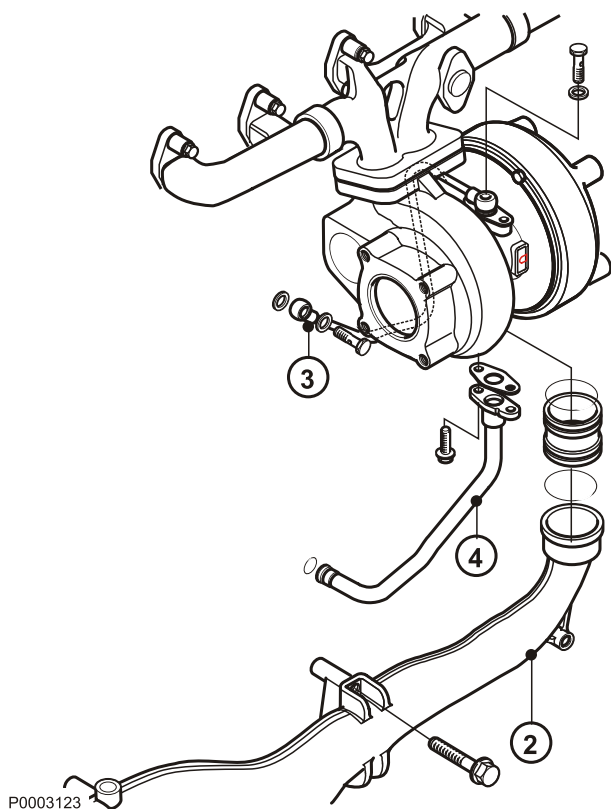
1 Remove:

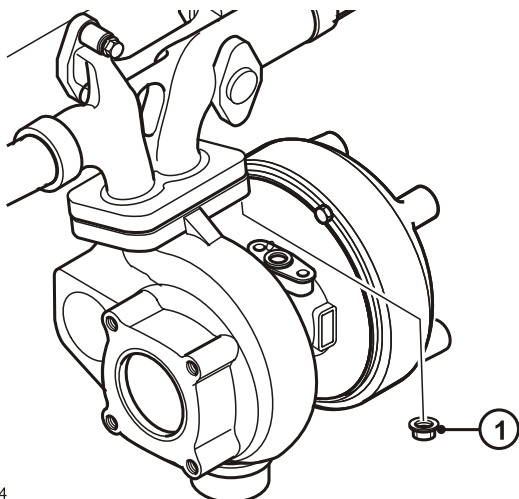
- the inlet hose (1)



2 Remove:

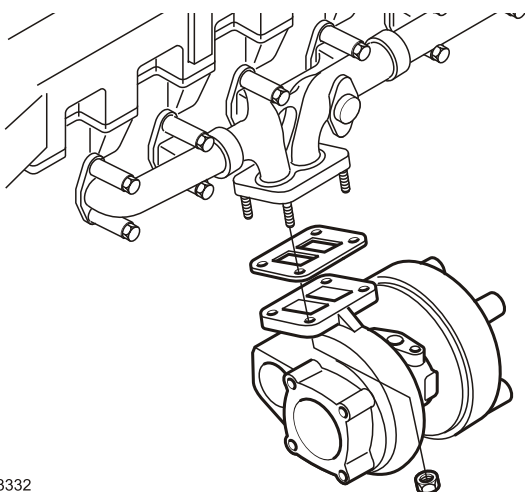
- turbocharger pressure pipe (2), to the charge air cooler
- oil delivery pipe (3) and oil return pipe (4)





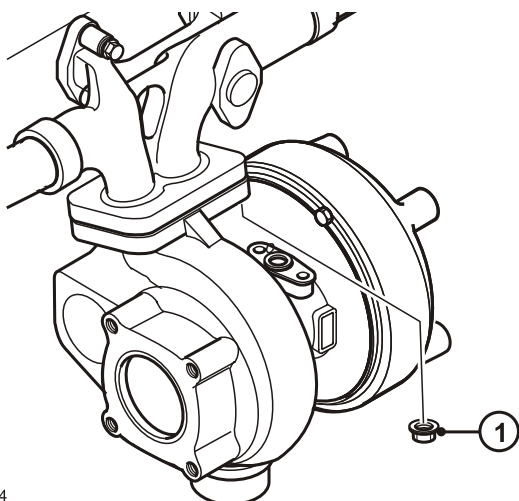
P0003124

- 3 Remove the turbocharger nuts from the exhaust manifold.



P0003332

- 4 Remove the turbocharger.

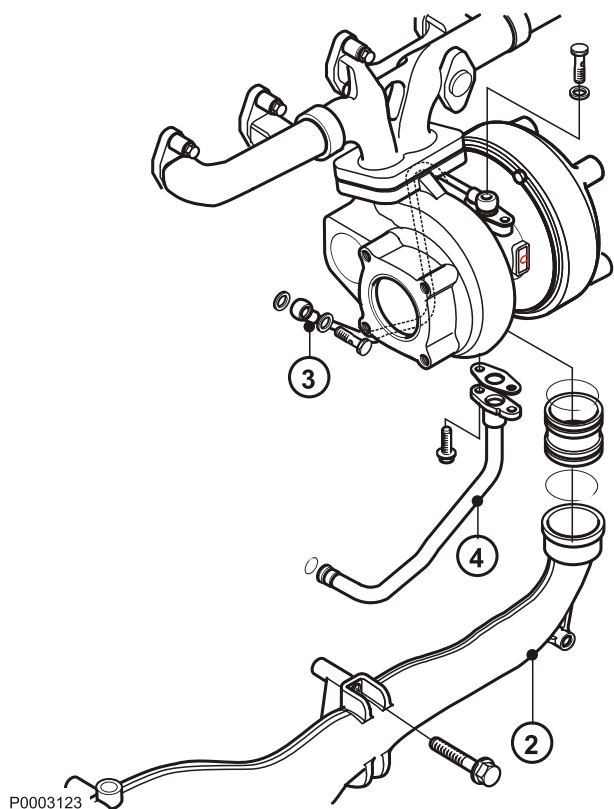


P0003124

Installation

- 5 Install the turbocharger with a **new** gasket.

Torque to: **30 Nm**



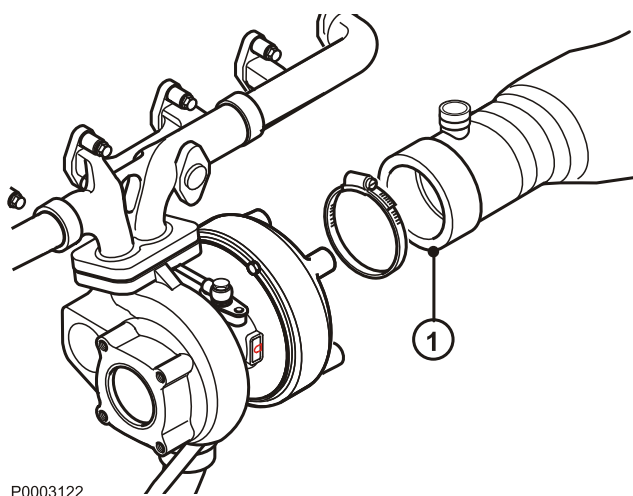
- 6 Install the turbocharger oil pressure pipe (3) with a **new** gasket.

Torque to: **39 Nm**

Install the turbocharger oil return pipe (4) with a **new** gasket and a **new** O-ring.

Torque to: **20 Nm**

Install the turbocharger pressure pipe (2) to the charge air cooler using **new** O-rings.



- 7 Install the inlet hose (1).

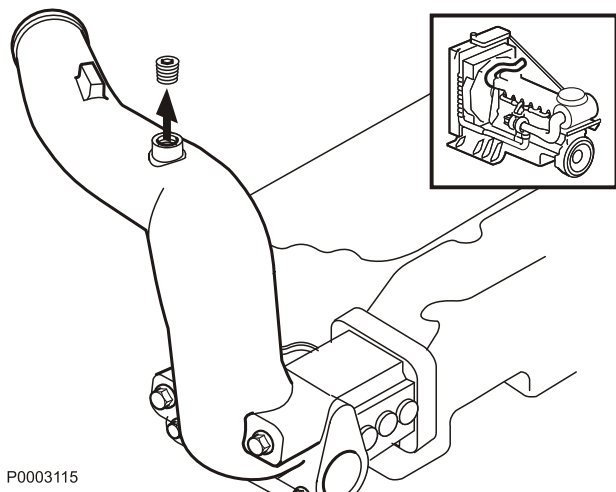
Perform a function check in respect of any oil leakages. If necessary, check turbo pressure according to separate routine.

Charge Air Pressure, Check

9996666 Nipple
9998339 Manometer

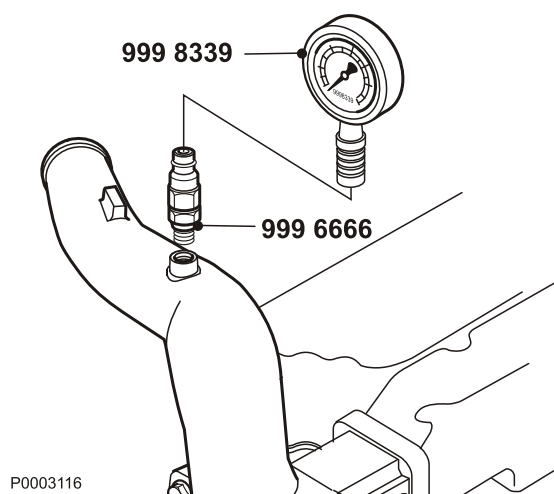
Checks

- 1 Remove the plug from the charge air pipe.
Fit nipple **999 6666**.



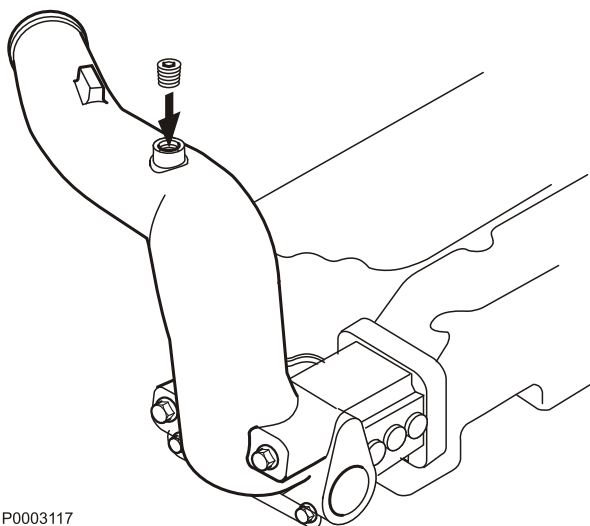
- 2 Connect manometer **999 8339** to nipple (999 6666).

Charge pressure (1500 rpm)	250 kPa (2.5 bar)
Charge pressure (1800 rpm)	240 kPa (2.4 bar)



Installation

- 3 Remove tools (999 8339, 999 6666).
Refit the plug on the charge air pipe.



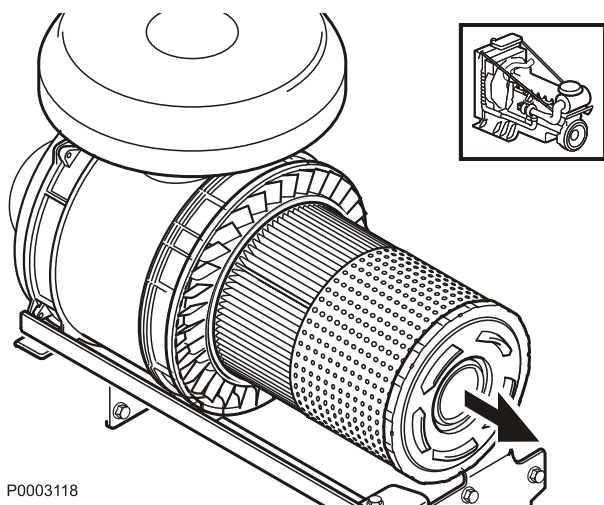
P0003117

25-6 Air Cleaner, Throttle Housing

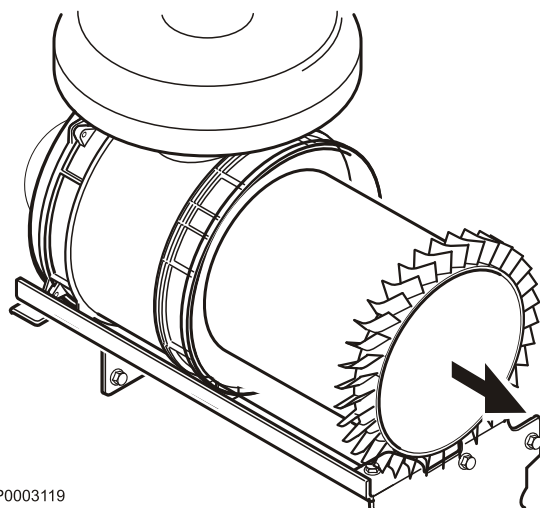
Air Filter, Change

Removal

- 1 Remove the filter housing cover/end panel.
Remove the air filter.
Clean inside the housing.



P0003118

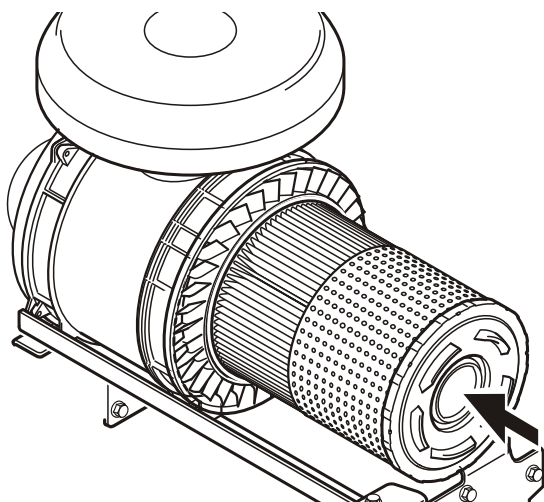


P0003119

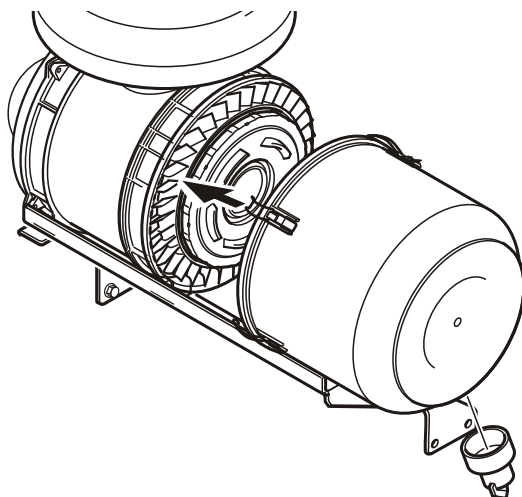
- 2 Where necessary, remove the air filter housing inner part and clean.

Installation

- 3 Replace the air filter housing inner part.
Install a **new** air filter.



- 4 Install the filter housing cover/end panel.

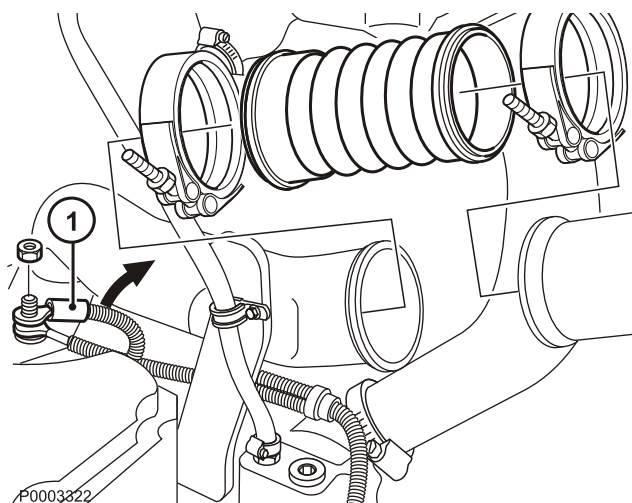


Pre-heating, Change

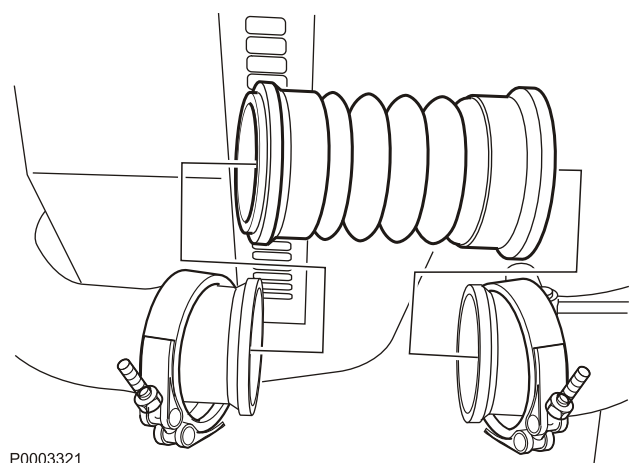
Disconnect power to the engine.

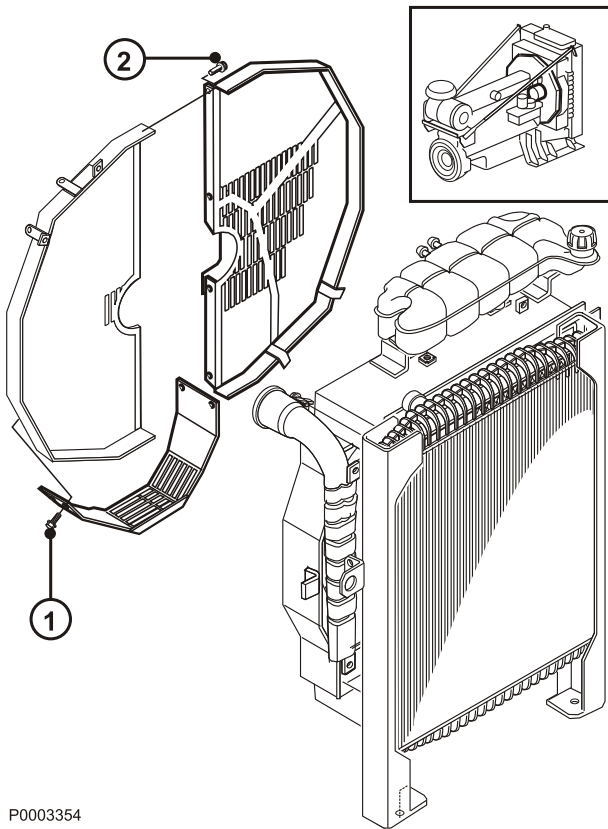
Removal

- 1 Remove the "upper" hose from the charge air pipe.
- 2 Remove the wiring (1) from the pre-heater.



- 3 Remove the "lower" hose from the charge air cooler.

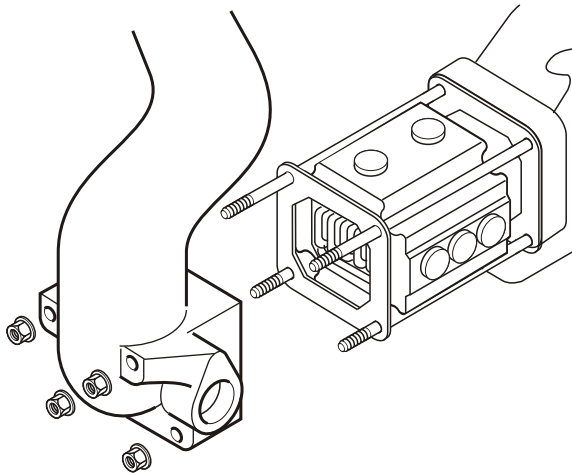




P0003354

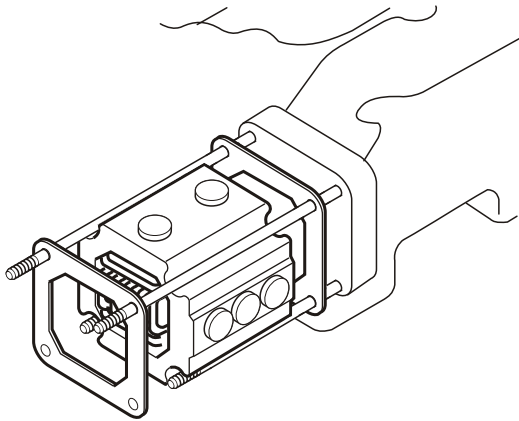
4 Remove:

- lower protection panel (1)
- the four bolts (2) which hold together the two protection panel halves
- **left** protection panel



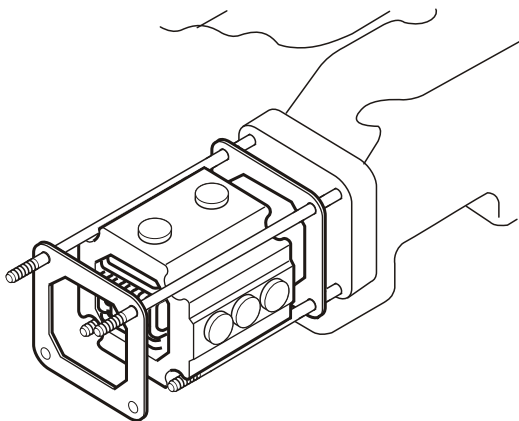
P0003319

5 Remove the charge air pipe from the pre-heater.



P0003318

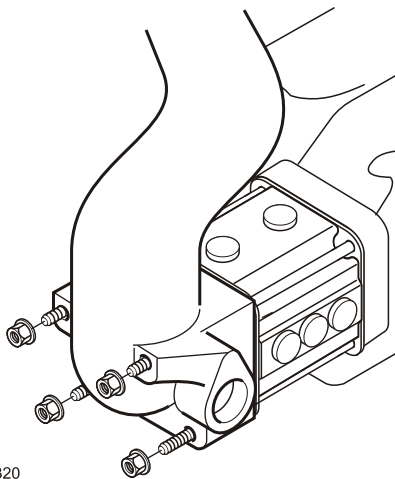
- 6 Remove the pre-heater.



P0003318

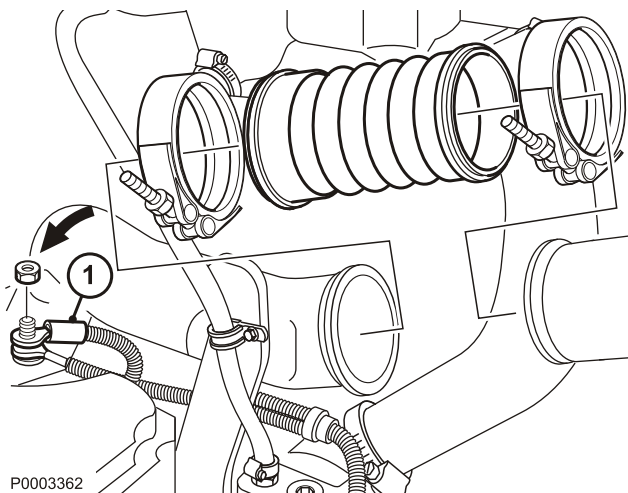
Installation

- 7 Install the pre-heater with **new** gaskets.

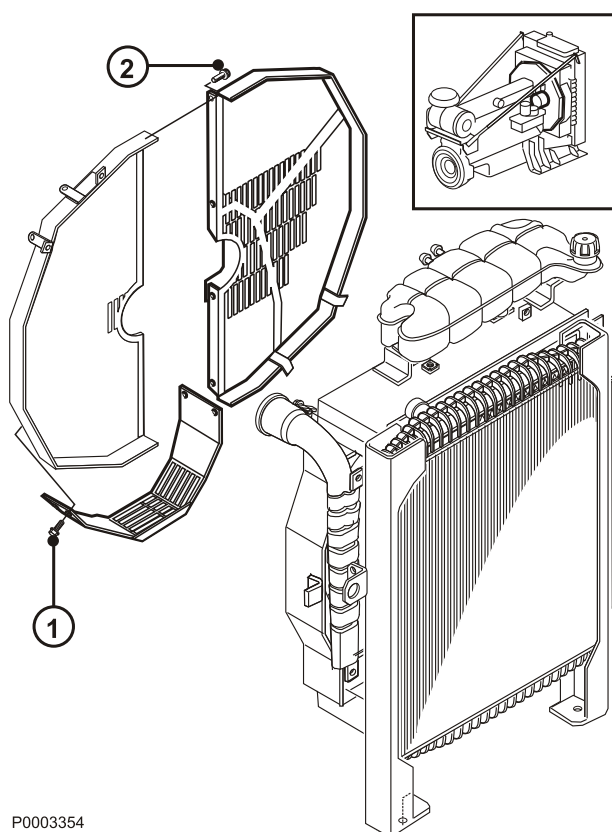


P0003320

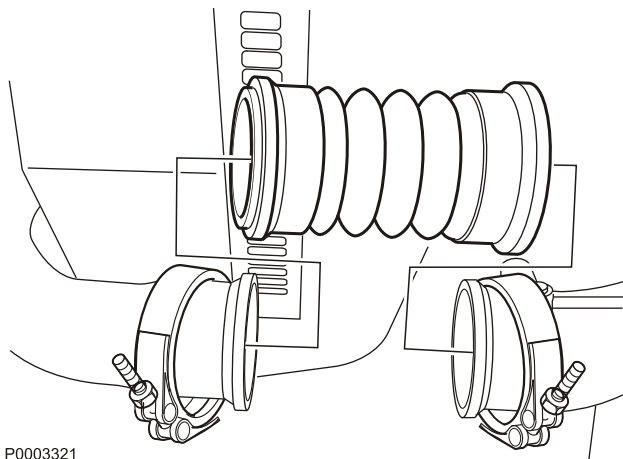
- 8 Install the charge air pipe to the pre-heater (four nuts).



- 9 Connect the cables (1), to the pre-heater.
- 10 Check and where necessary replace O-rings; then install the "upper" hose to the charge air pipe.



- 11 Install the protection panels (left and lower).



- 12 Install the hose to the charge air cooler, with new O-rings.

Reconnect battery voltage to the engine.
Carry out a function test.

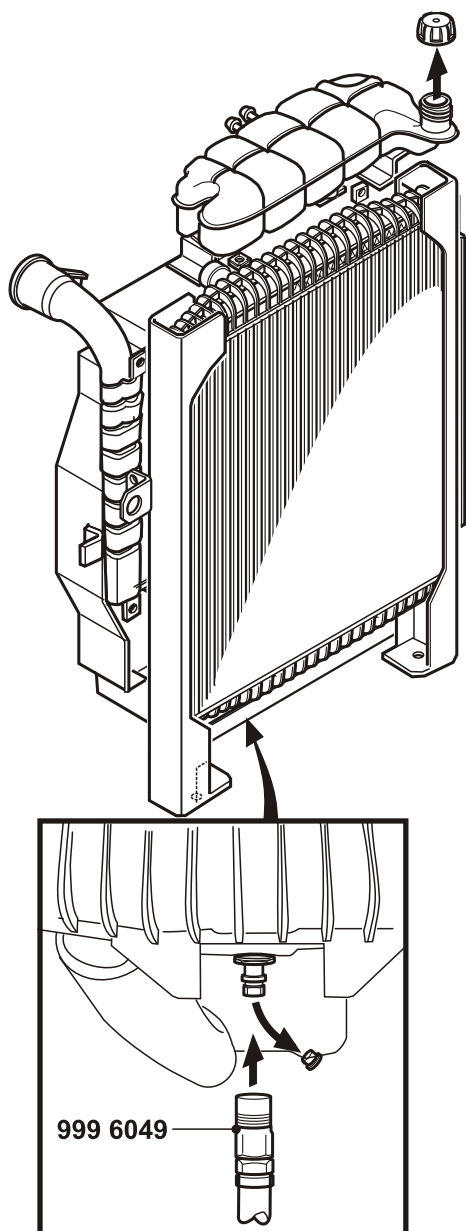
26-1 Radiator, Heat Exchanger

Radiator Assembly (Complete Unit), Change

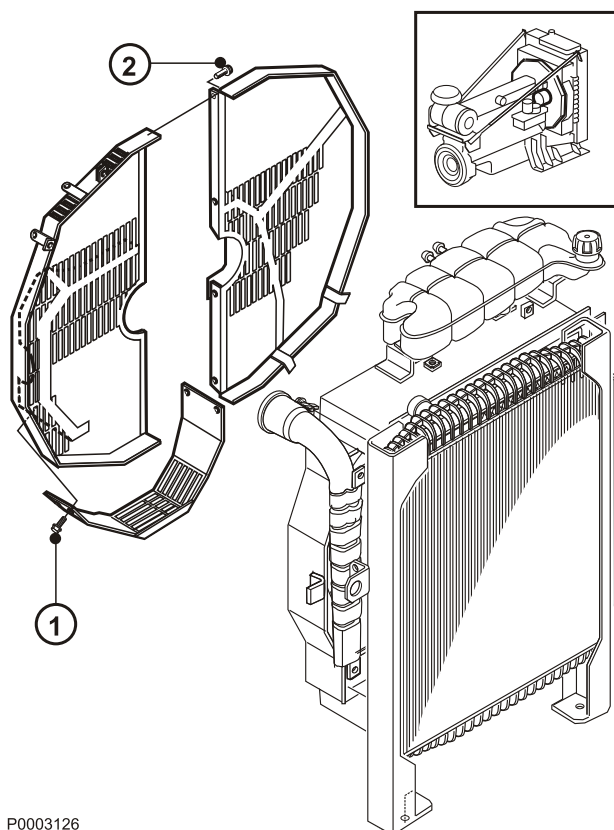
9996049 Draining hose

Removal

- 1 Remove the expansion tank cover and remove the drain nipple protective cap (beneath the radiator). Connect drainage hose **999 6049** to the nipple. Drain the coolant.



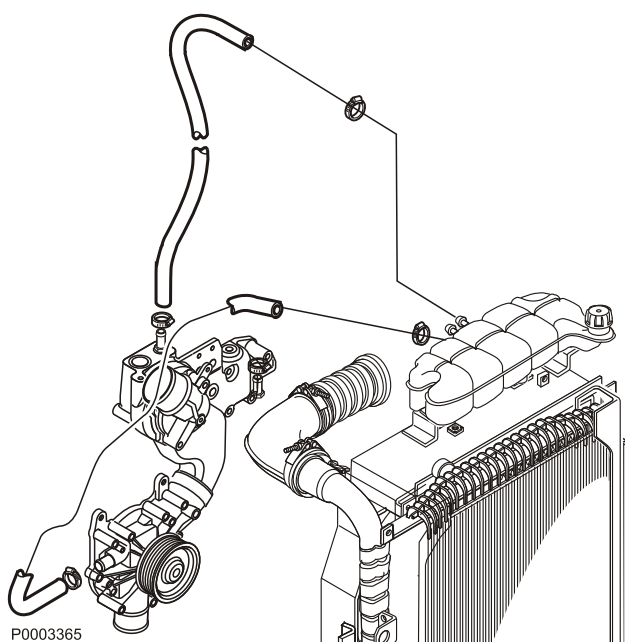
P0003127



P0003126

2 Remove the engine protection panels:

- lower protection panel (1)
- the four bolts (2) which hold together the two protection panel halves
- the two clamps for the coolant hose
- the four bolts for the protection panels, on the **right** side of the engine
- **right** protection panel
- the charge air cooler hose (lower)
- **left** protection panel

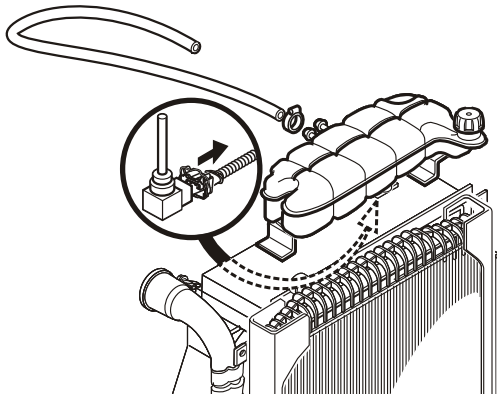


P0003365

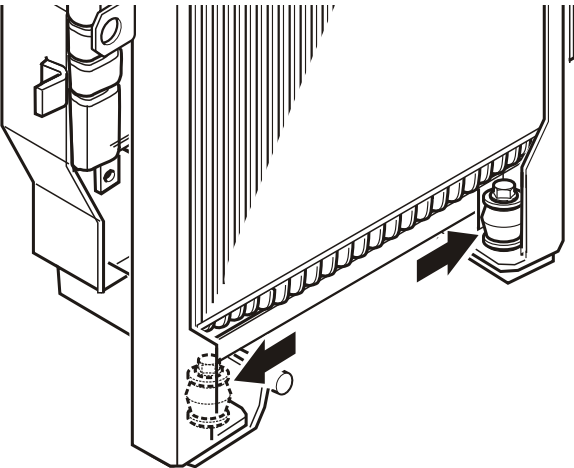
- ## 3
- Remove the radiator hoses from the coolant pump.
Remove the radiator hoses from the thermostat housing.
Remove the hose to the charge air cooler (upper).

- 4 Disconnect the wiring from the level sensor connector (under the expansion tank).

P0003371

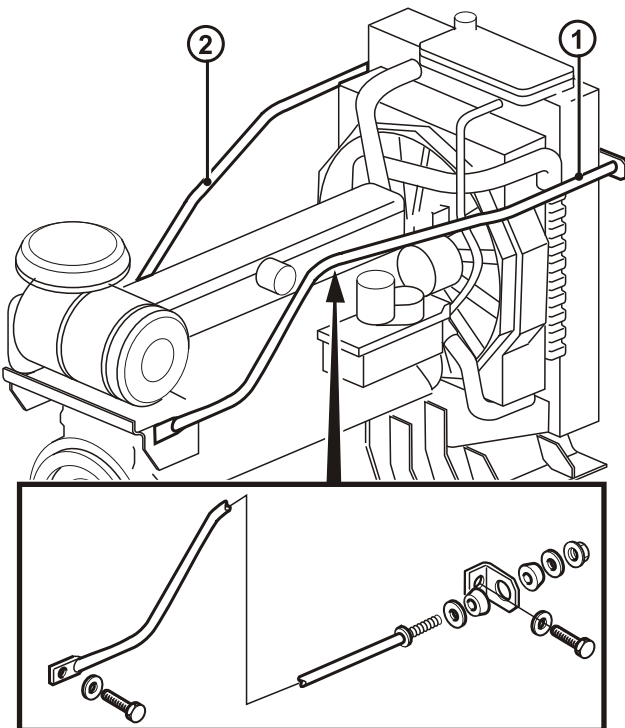


- 5 Remove the radiator from its lower mountings (left and right).



P0003364

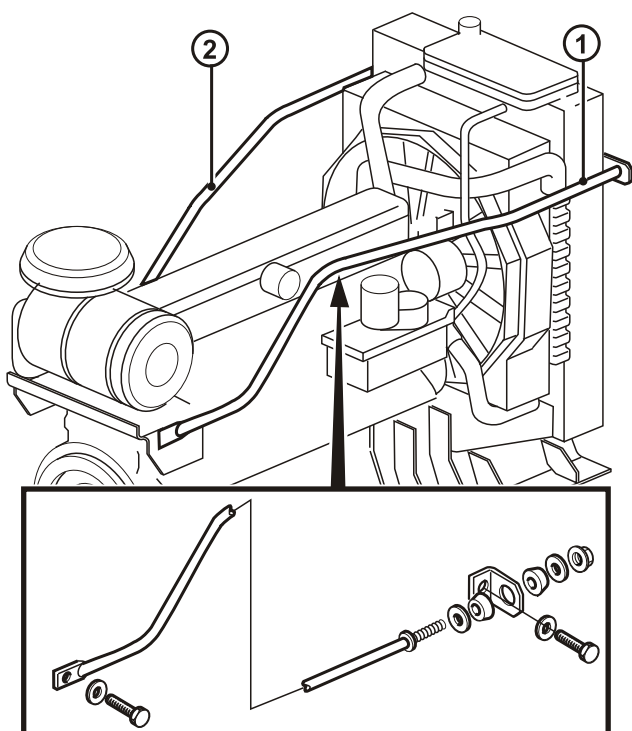
- 6 Remove the right radiator stay (1).
- 7 Remove the left radiator stay (2), and lift away the radiator assembly.



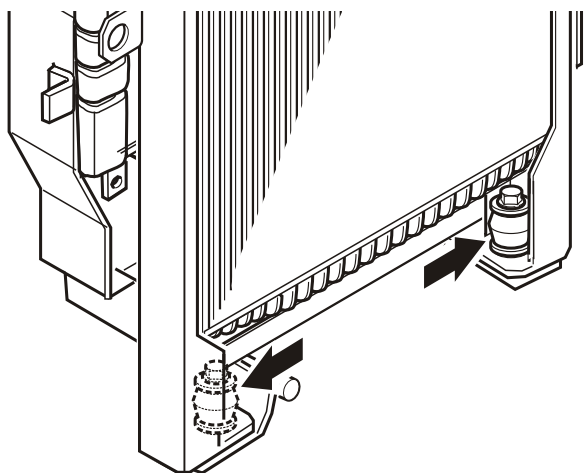
P0003372

Installation

- 8 Install the radiator assembly, and the left radiator stay (2).
- 9 Install the right radiator stay (1).

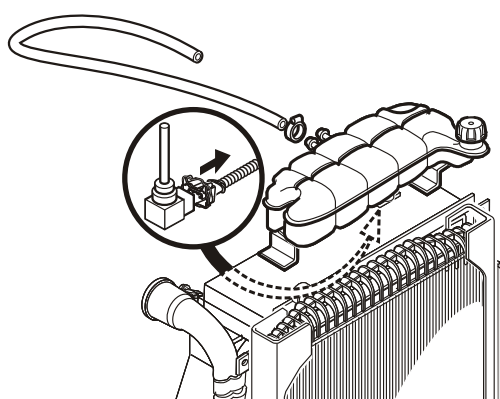


P0003372



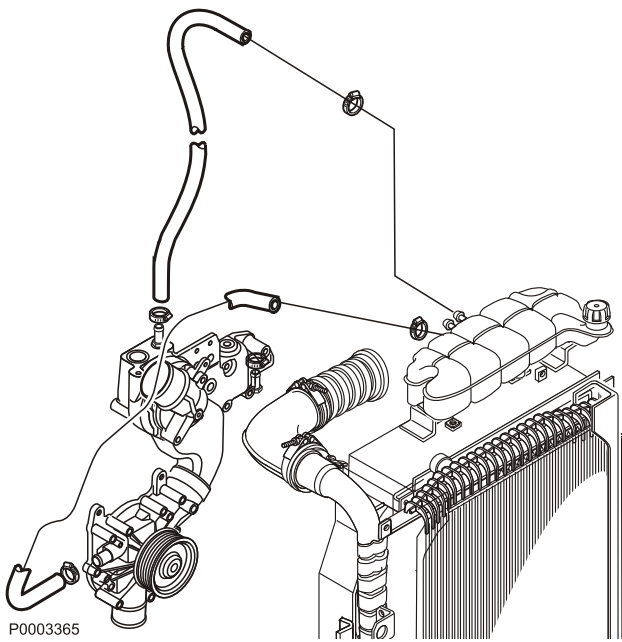
P0003364

- 10 Attach the radiator to its lower mountings (left and right).



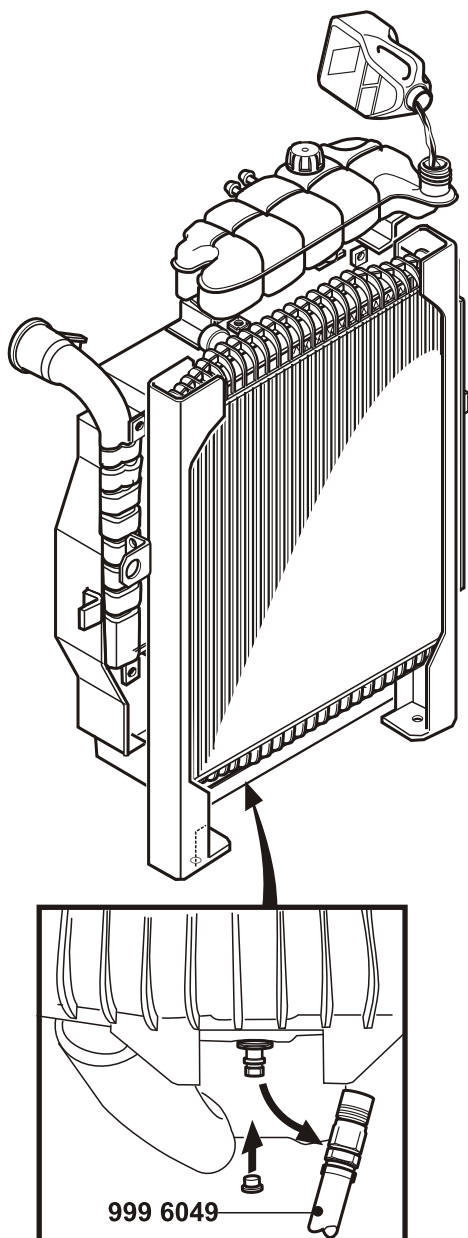
P0003371

- 11 Attach the cable to the level sensor (under the expansion tank)

**12 Install:**

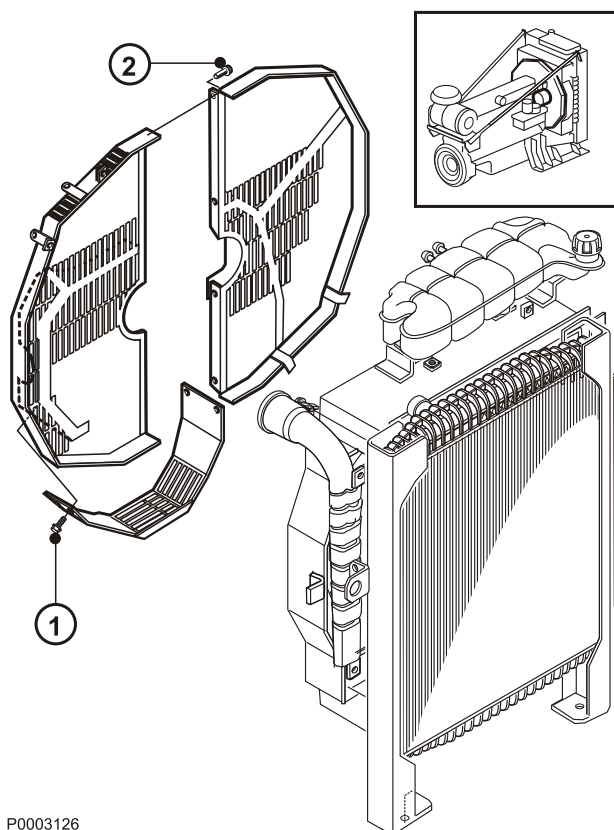
- the charge air cooler hose (upper)
- the radiator hoses to the thermostat housing
- the radiator hoses to the coolant pump

- 13 Remove the drainage hose 999 6049, from beneath the radiator.
Fill with required volume of coolant.



P0003133

Perform a function check in respect of any leakages.
Check especially carefully that the drain nipple under-
neath the radiator is not leaking.



- 14 Replace the protection panels and clamp the coolant hoses (2 pcs.) in place. Attach the charge air cooler hose (lower).

P0003126

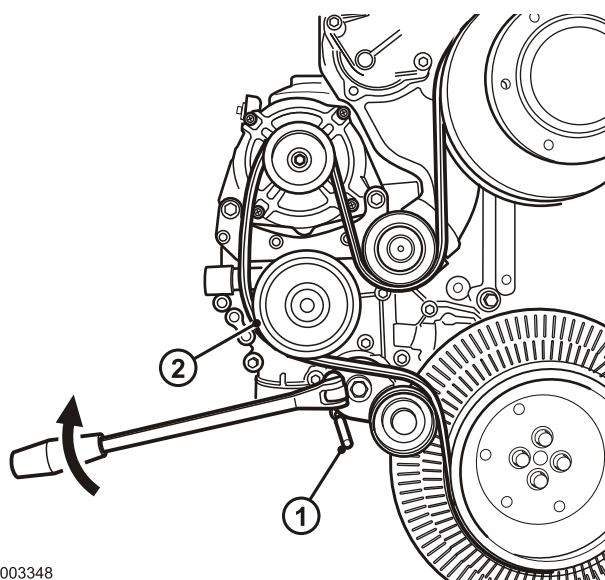
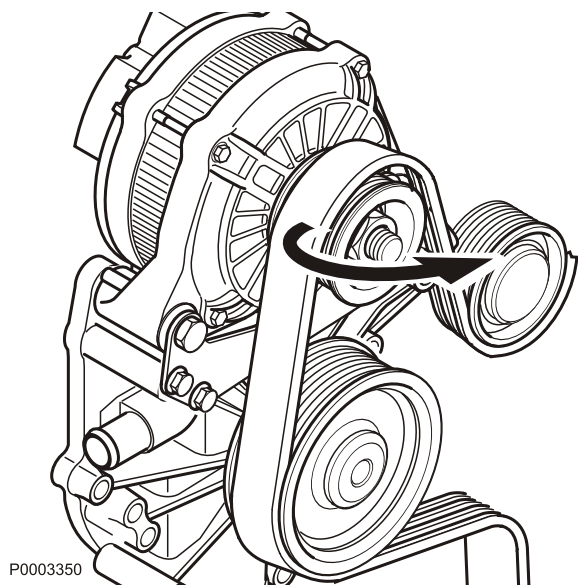
Drive Belt, Change

IMPORTANT!

Always change a belt which is oily, worn or damaged. Belts which operate in pairs must be changed together.

Drive belt, inspection/changing

Inspection should be carried out after operation, when the belt is hot. It should be possible to depress the drive belt about 3-4 mm between the pulleys. The drive belt has an automatic belt tensioner and therefore does **not** need to be adjusted.



- 1 Release the belt tensioner and lock it in place with a drift (1).
- 2 Remove the belt from the coolant pump (2) first. Install the new belt. Remove the belt tensioner and the drift (1). Check that the belts are correctly aligned in their grooves and are correctly tensioned.

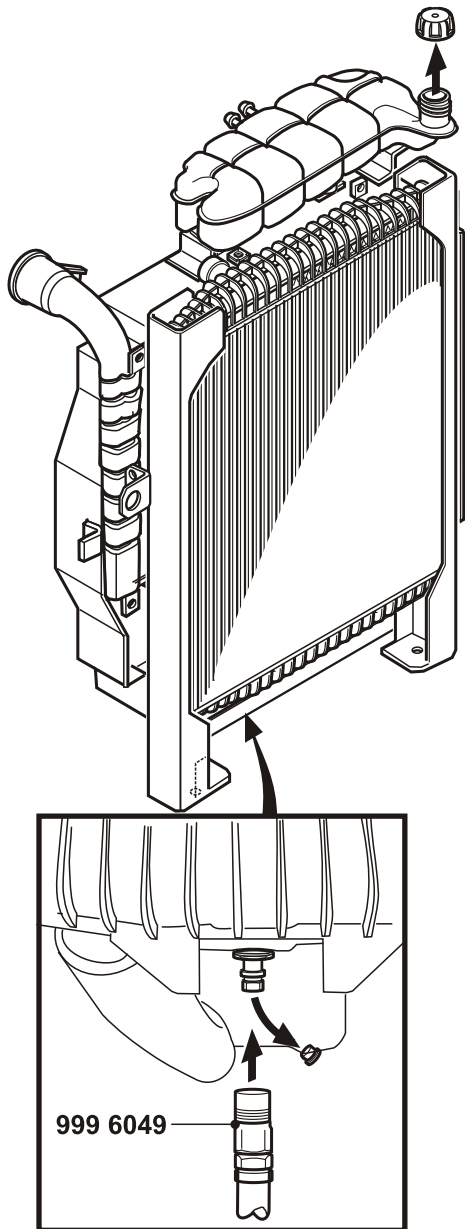
26-2 Coolant Pump, Thermostat

Coolant pump, change

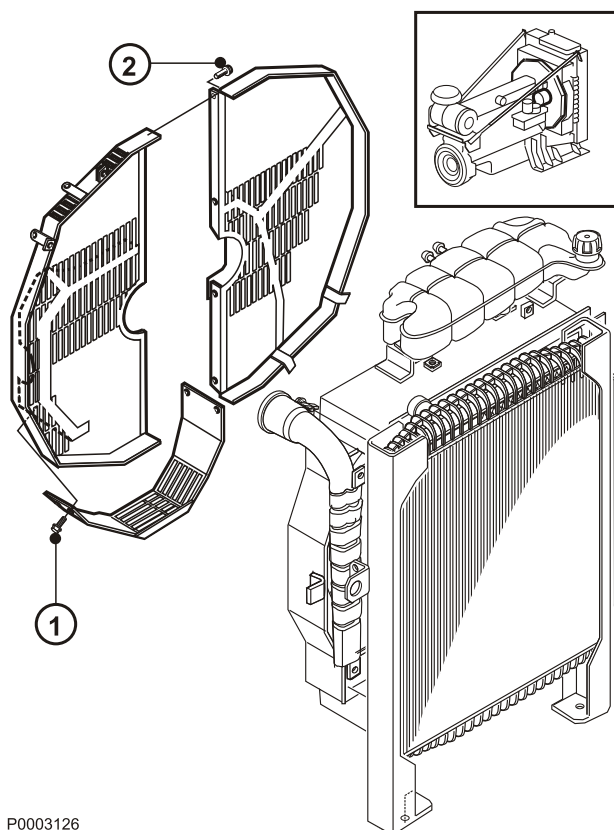
9996049 Draining hose

Removal

- 1 Remove the expansion tank cover and remove the drain nipple protective cap (beneath the radiator). Connect drainage hose **999 6049** to the nipple. Drain the coolant.



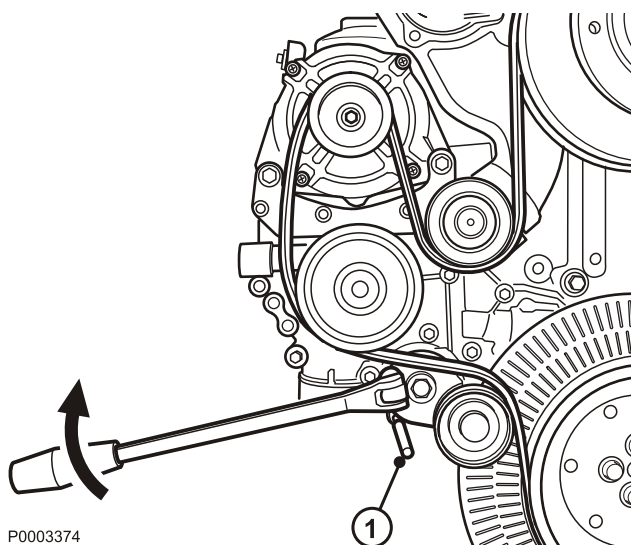
P0003127



P0003126

2 Remove the engine protection panels:

- lower protection panel (1)
- the four bolts (2) which hold together the two protection panel halves
- the two clamps for the coolant hose
- the four bolts for the protection panels, on the **right** side of the engine
- **right** protection panel



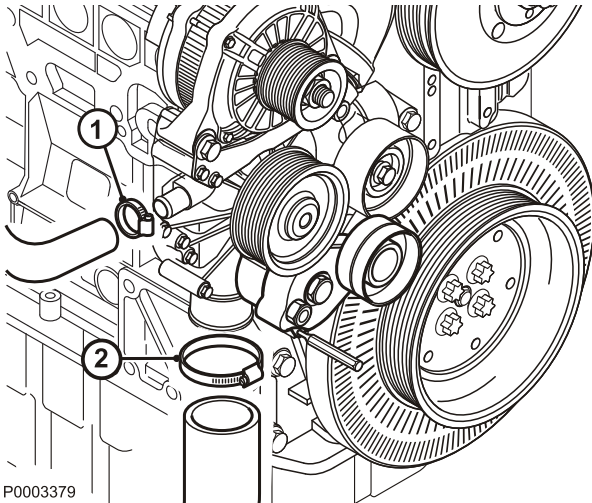
P0003374

3 Release the belt tensioner and lock it in place with a drift (1).

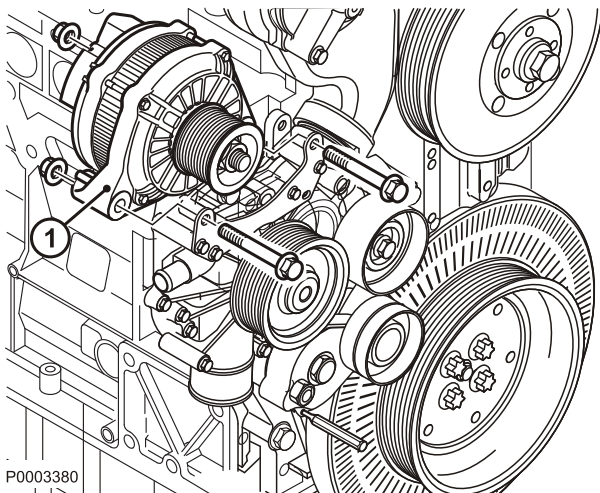
WARNING!

Pinch hazard. Keep fingers clear.

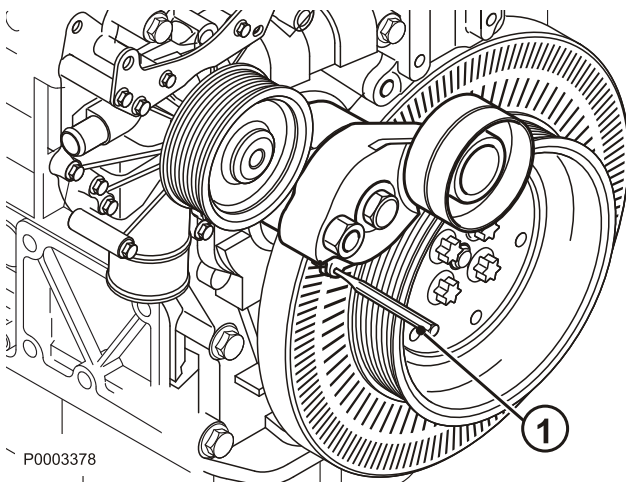
Remove the engine drive belt from the belt pulley and hang it to one side.



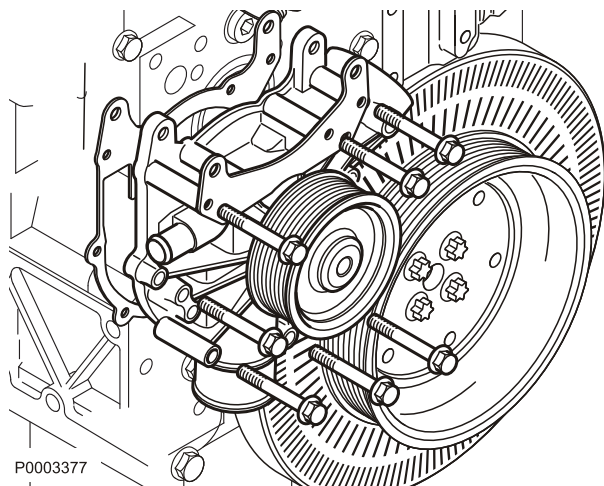
- 4 Remove the two radiator hose clamps (1, 2) from the coolant pump and bend the hoses away to one side.



- 5 Remove the alternator cable and connector. Remove the alternator (1).



- 6 Remove the belt tensioner, with drift (1). Remove the idler wheel (at the alternator).

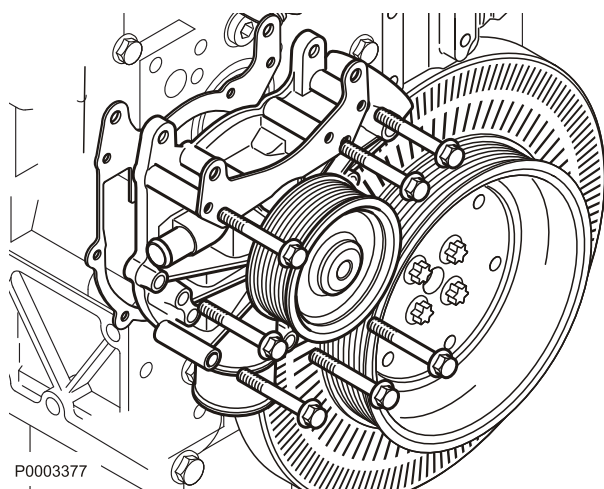


- 7 Remove the coolant pump. Turn the pump **carefully** clockwise a little to remove it from the thermostat housing. Tap **carefully** with a rubber hammer, if necessary. Clean the contact surfaces and remove any old sealant. Transfer any necessary components from the old pump.

Installation

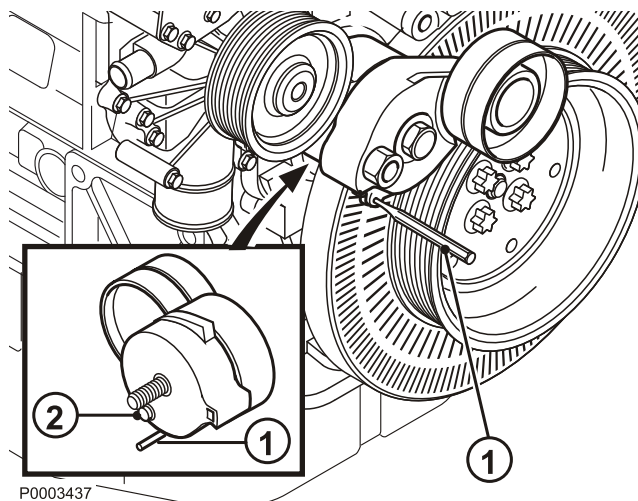
- 8 Install the coolant pump; first guide in the coolant pump "neck" and O-rings. Use a **new** gasket and **new** O-rings.

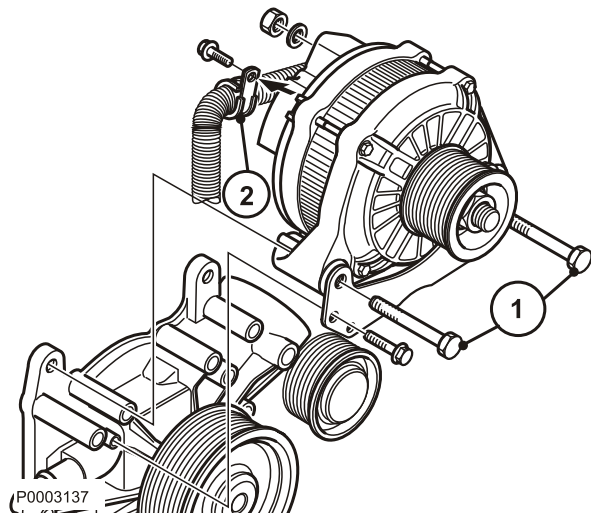
Torque to: **30 ±5 Nm**



- 9 Install the alternator idler wheel. Install the belt tensioner, with drift (1).

NOTICE! Align the belt tensioner guide pin (2).

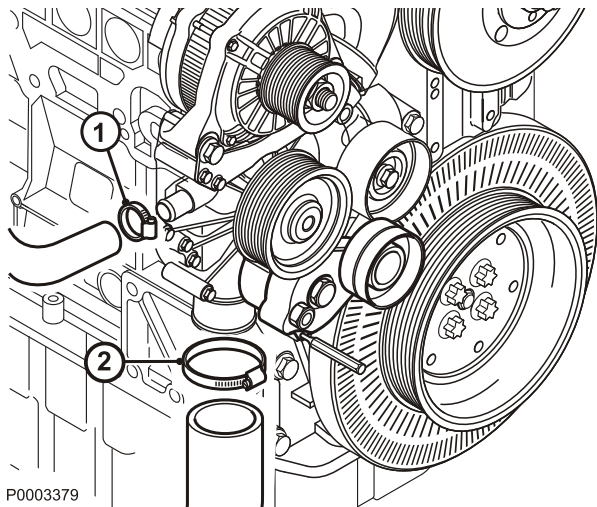




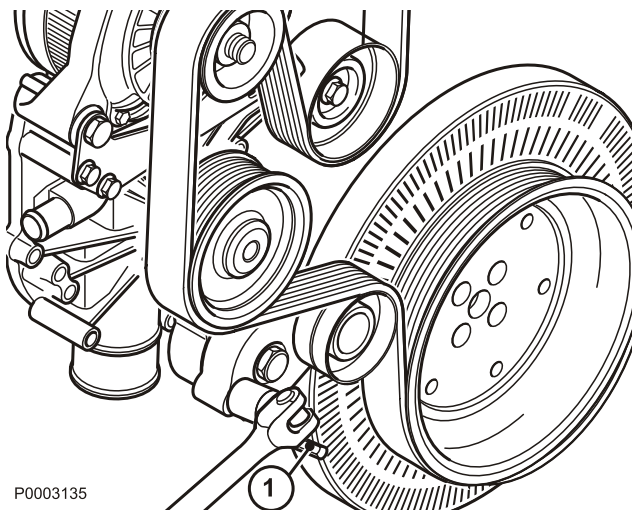
- 10 Install the alternator and tighten the bolts (1).

Torque to: **30 ±5 Nm**

Connect the alternators cable connectors, and re-install the wiring clamp (2).



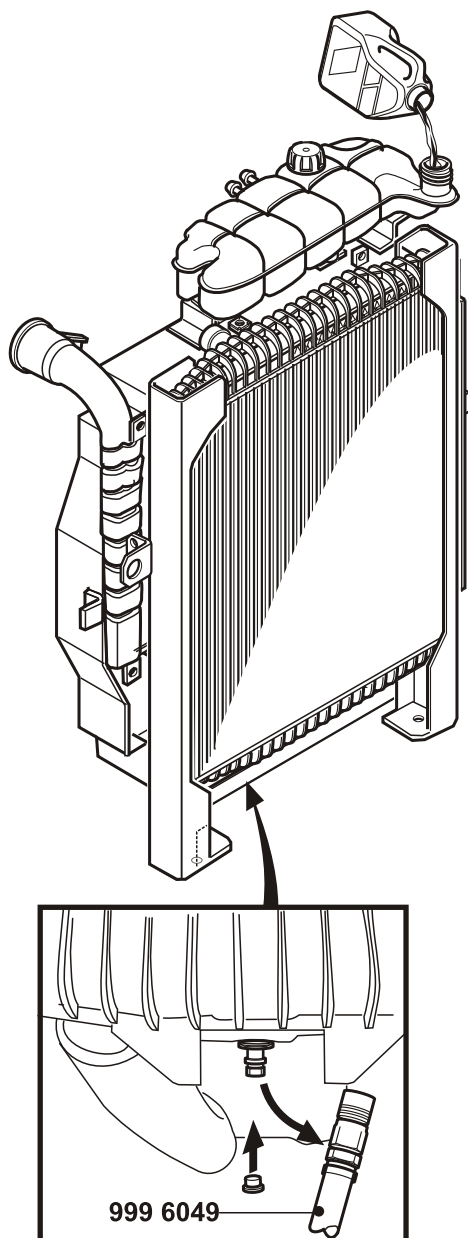
- 11 Connect the radiator hoses to the coolant pump. Tighten the hose clamps (1, 2).



- 12 Relieve the belt tensioner and fit the belt. Remove the drift (1). Check that the belt is correctly aligned in the belt pulley grooves.

⚠ WARNING!

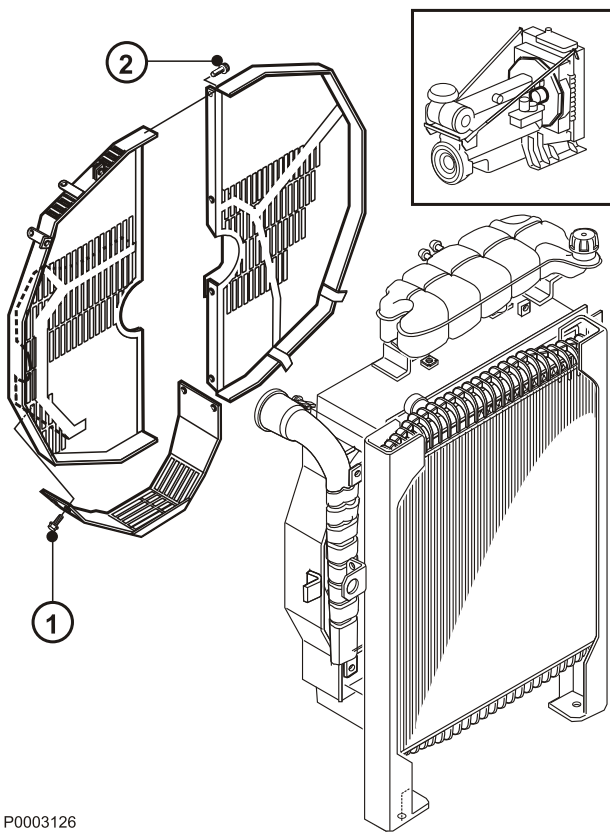
Pinch hazard. Keep fingers clear.



- 13 Remove the drainage hose **999 6049**, from beneath the radiator.
Fill with required volume of coolant.

- 14 Perform a function check in respect of any leakages.
Check especially carefully that the drain nipple underneath the radiator is not leaking.

P0003133



- 15 Replace the protection panels and clamp the coolant hoses (2 pcs.) in place.

P0003126

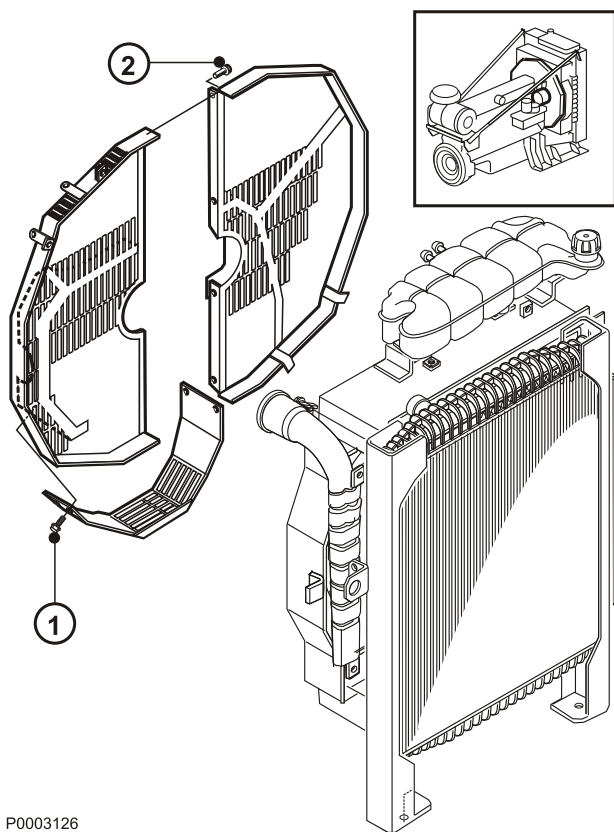
Thermostat, Change

9992564 Drift
9996049 Draining hose
9998511 Lever

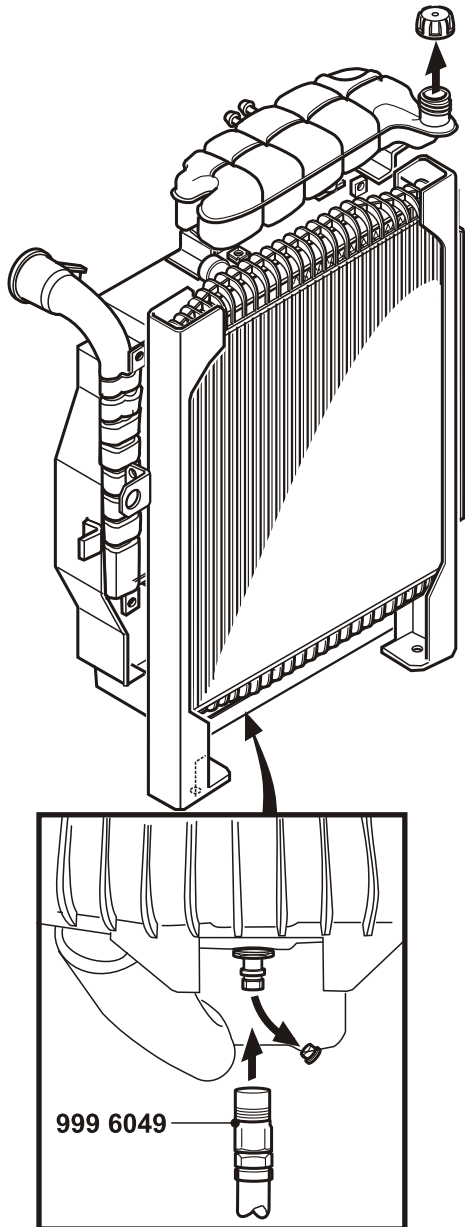
Removal

1 Remove the engine protection panels:

- lower protection panel (1)
- the four bolts (2) that hold together the two protection panel halves
- the two clamps that hold the coolant hose
- the four bolts for the protection panels, on the **right** side of the engine
- remove the **right** protection panel

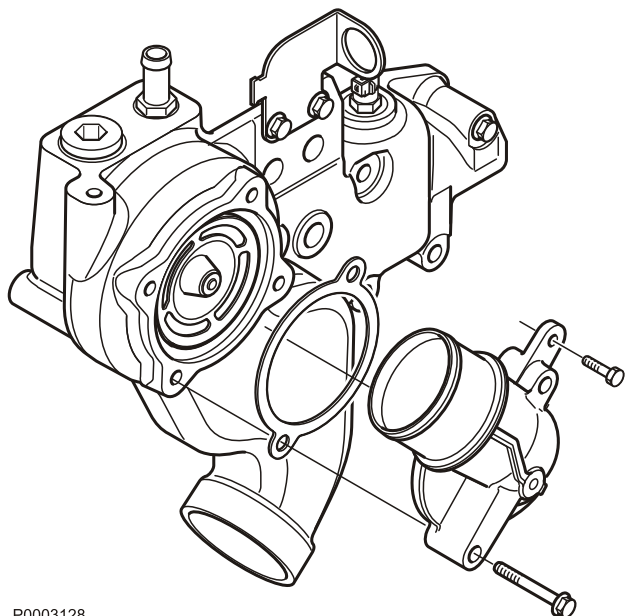


P0003126



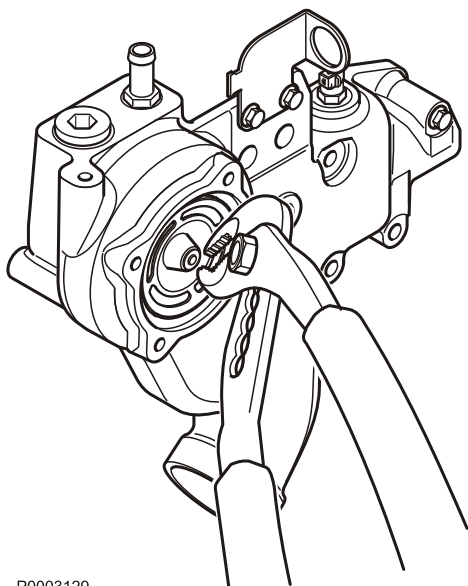
- 2 Loosen the cover to the expansion tank and drain the coolant by removing the protective cap from the drain nipple and by connecting drainage hose **999 6049** to the nipple.

P0003127



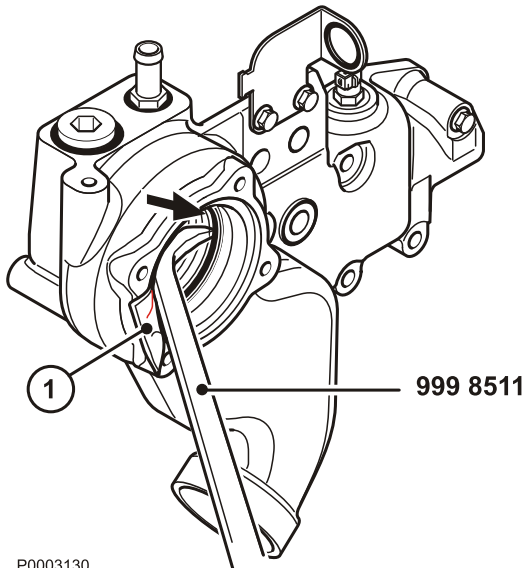
P0003128

- 3 Remove thermostat housing cover (2 bolts).



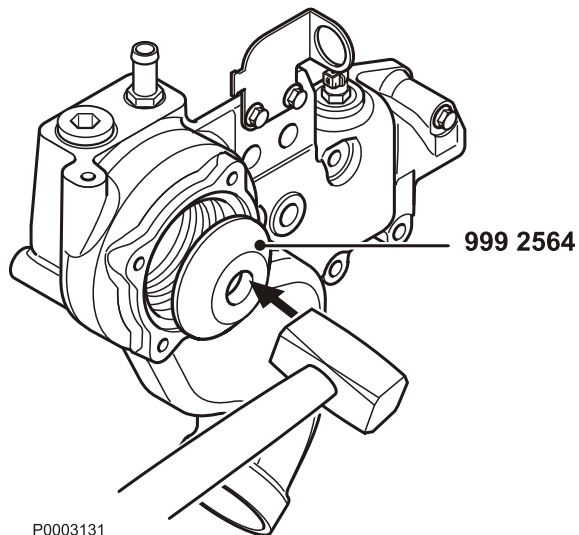
P0003129

- 4 Remove the thermostat using suitable pliers.



- 5 Check the rubber seal in the thermostat housing.
- 6 Where necessary replace the rubber seals. Remove the seal with the aid of pry bar **999 8511**.

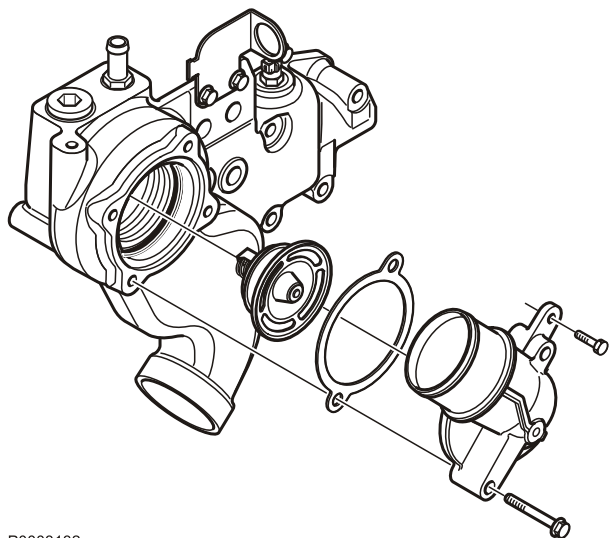
NOTICE! Use a suitable sandwich piece (1) to protect the thermostat housing, which is easily damaged.



Installation

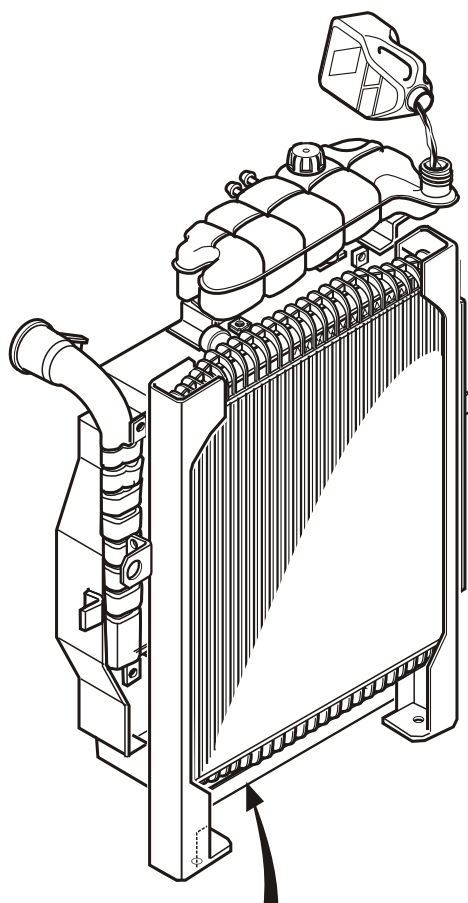
- 7 Clean the seal ring contact surfaces in the thermostat housing (scrape clean). Install the seal ring with the aid of drift **999 2564** and a small mallet.

NOTICE! Make sure that the seal ring is positioned **correctly** (bottoms all the way round).

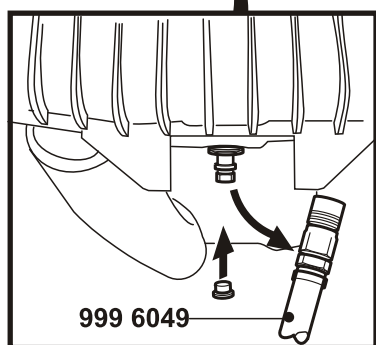


P0003132

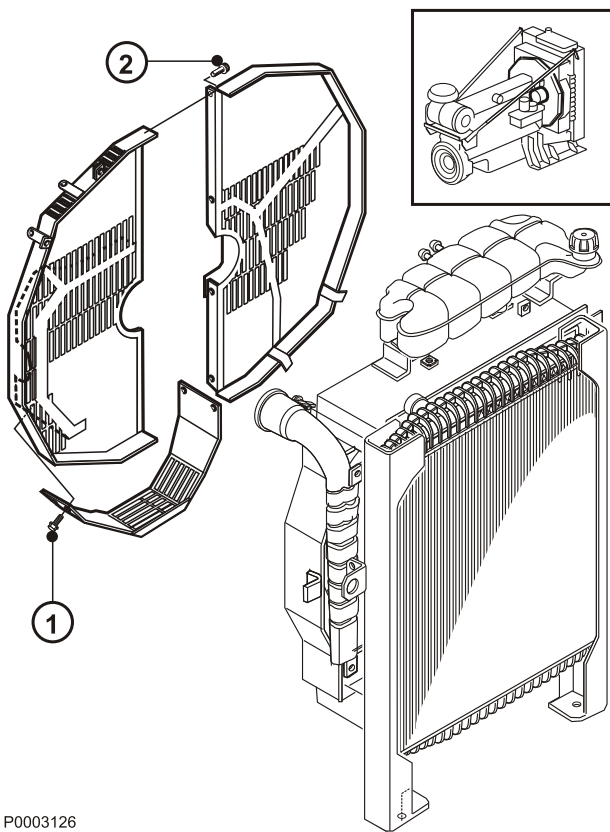
- 8 Install a **new** thermostat.
- 9 Install the thermostat housing cover with a **new** gasket.



- 10 Remove the drainage hose **999 6049** from beneath the radiator.
Fill with the required quantity of coolant.
Perform a function check in respect of any leakages.
Check especially carefully that the drain nipple underneath the radiator is not leaking.



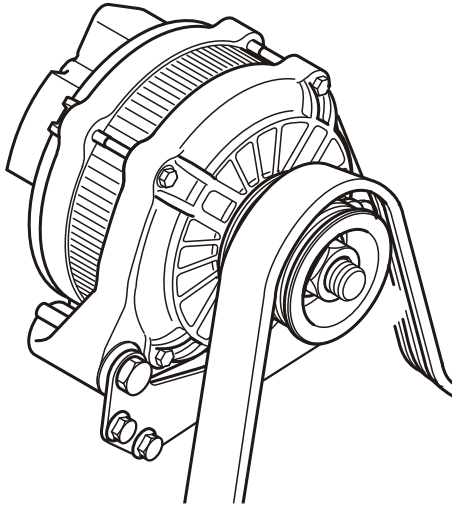
P0003133



- 11 Replace the protection panels and clamp the two coolant hose clamps in place.

P0003126

32-1 Alternator



P0003134

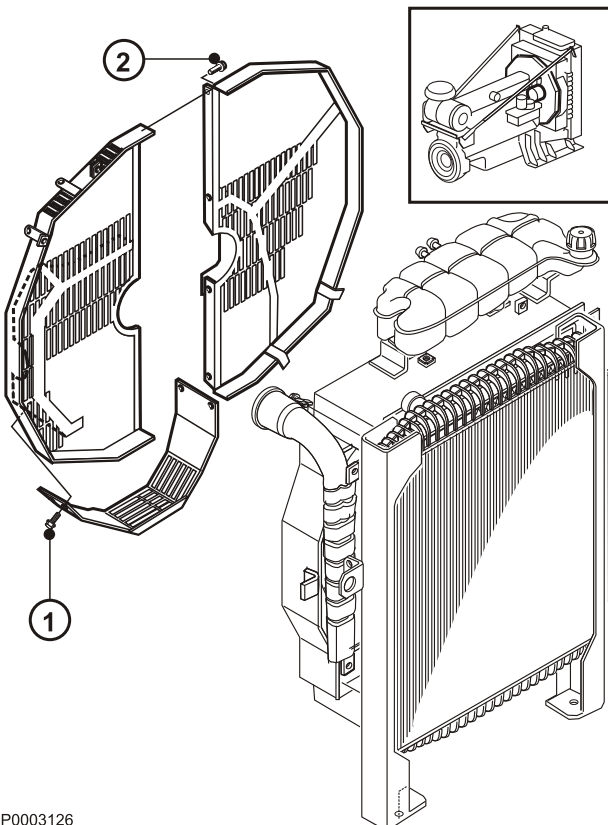
Alternator, Change

Alternator, general

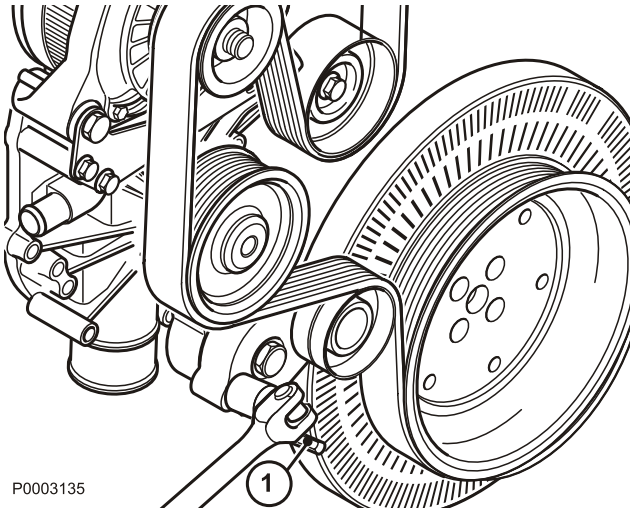
The alternator is belt driven and mounted at the front right of the engine.

Removal

- 1 Disconnect power to the engine.
- 2 **Remove the engine protection panels:**
 - lower protection panel (1)
 - the four bolts which hold together the two protection panel halves (2)
 - the two clamps that hold the coolant hose
 - the four bolts for the protection panels, on the **right** side of the engine
 - remove the **right** protection panel



P0003126

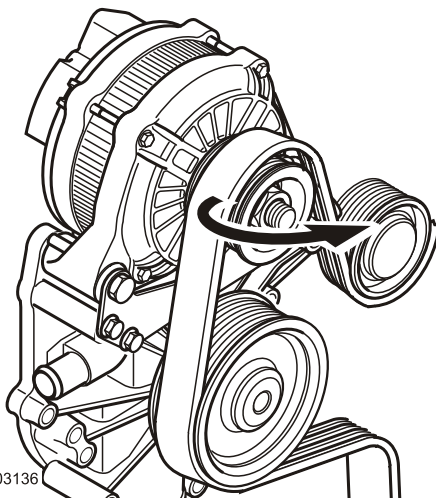


P0003135

- 3 Release the belt tensioner and lock it in place with a drift (1).

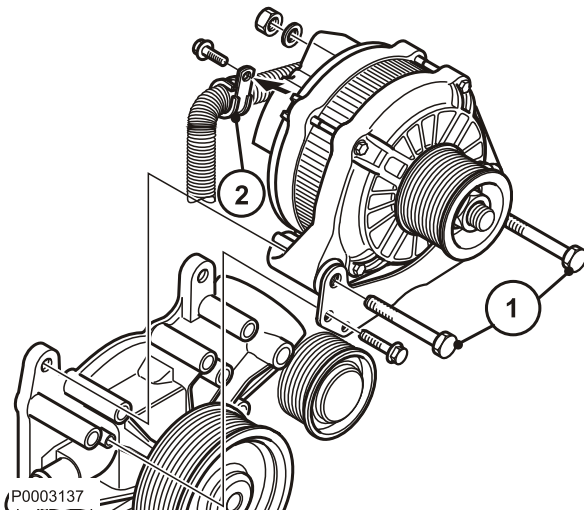
⚠ WARNING!

Pinch hazard. Keep fingers clear.



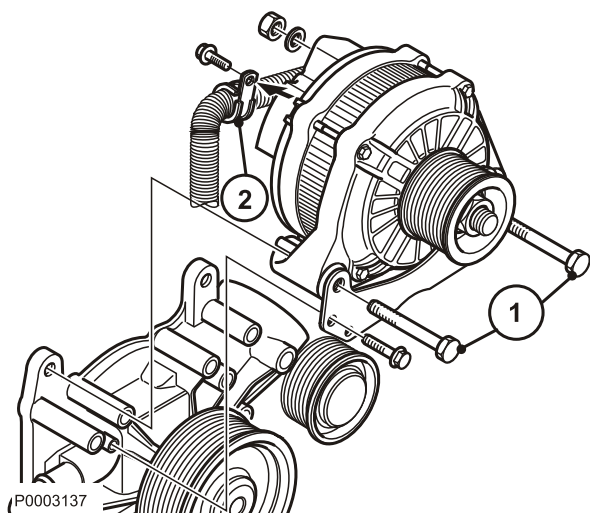
P0003136

- 4 Remove the engine drive belt from the belt pulley and hang it to one side.



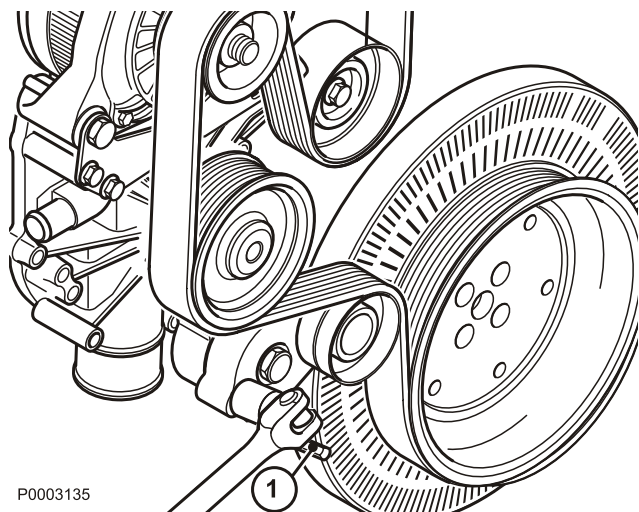
P0003137

- 5 Undo the alternator cable connections.
- 6 Remove the two retaining screws (1) and the cable clamp (2) from the alternator. Lift the alternator away.



Installation

- 7 Install the alternator and tighten the bolts (1) to **30 ±5 Nm**.
- 8 Connect the alternator cable connectors, and re-install the wiring clamp (2).



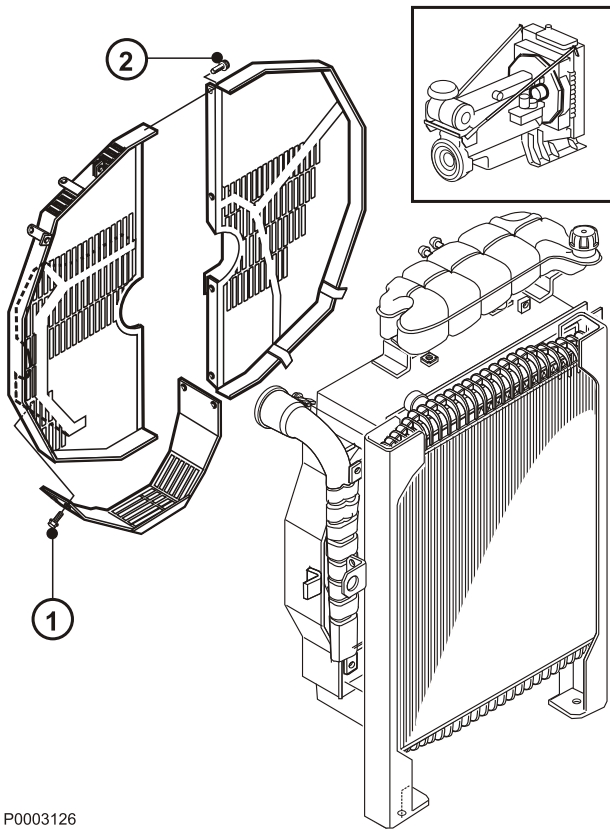
- 9 Relieve the belt tensioner and the drift (1). Install the drive belt.

NOTICE! If necessary, replace the drive belt and check the belt tensioner and idler wheel.



WARNING!

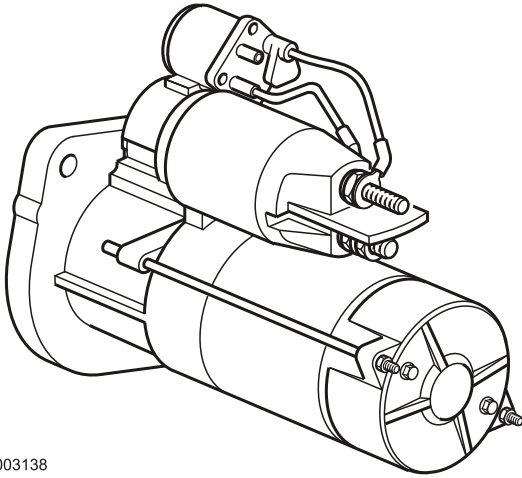
Pinch hazard. Keep fingers clear.



P0003126

- 10 Replace the protection panels and clamp the coolant hoses (2 pcs.) in place.
- 11 Reconnect battery voltage to the engine.

33-1 Starter Motor



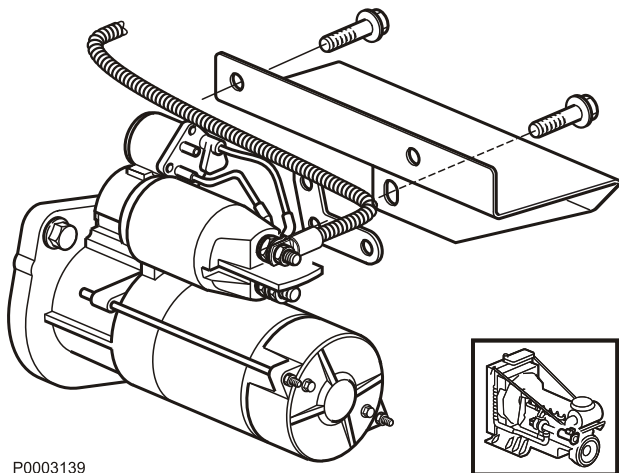
P0003138

Starter Motor, Change

Starter motor, general

The starter motor is mounted in the flywheel housing on the left side of the engine block.

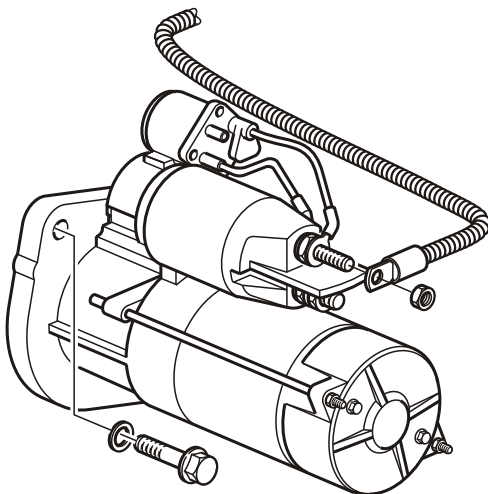
The starter motor relay is "live connected" which means that the relay is directly connected to battery voltage.



P0003139

Removal

- 1 Disconnect power to the engine.
- 2 Remove the heat shield.
Undo the starter motor cable connections.

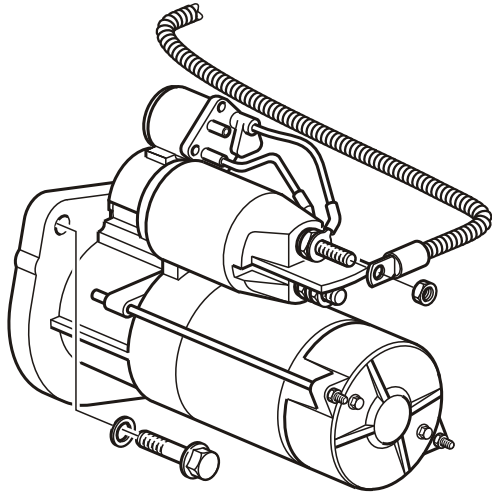


P0003140

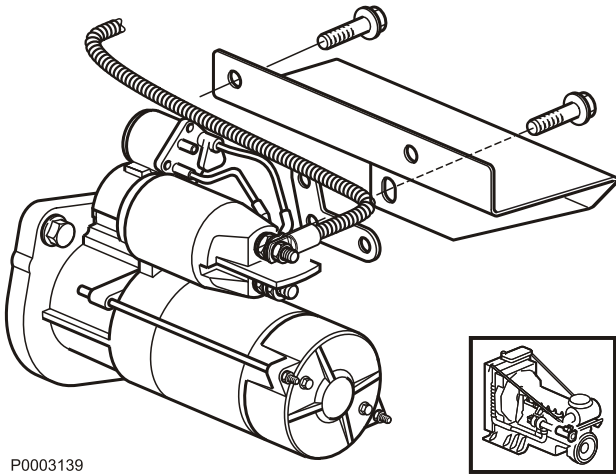
- 3 Remove the starter motor.

Installation

- 4 Fit the starter motor.
- 5 Install the starter motor cable connections.



P0003140



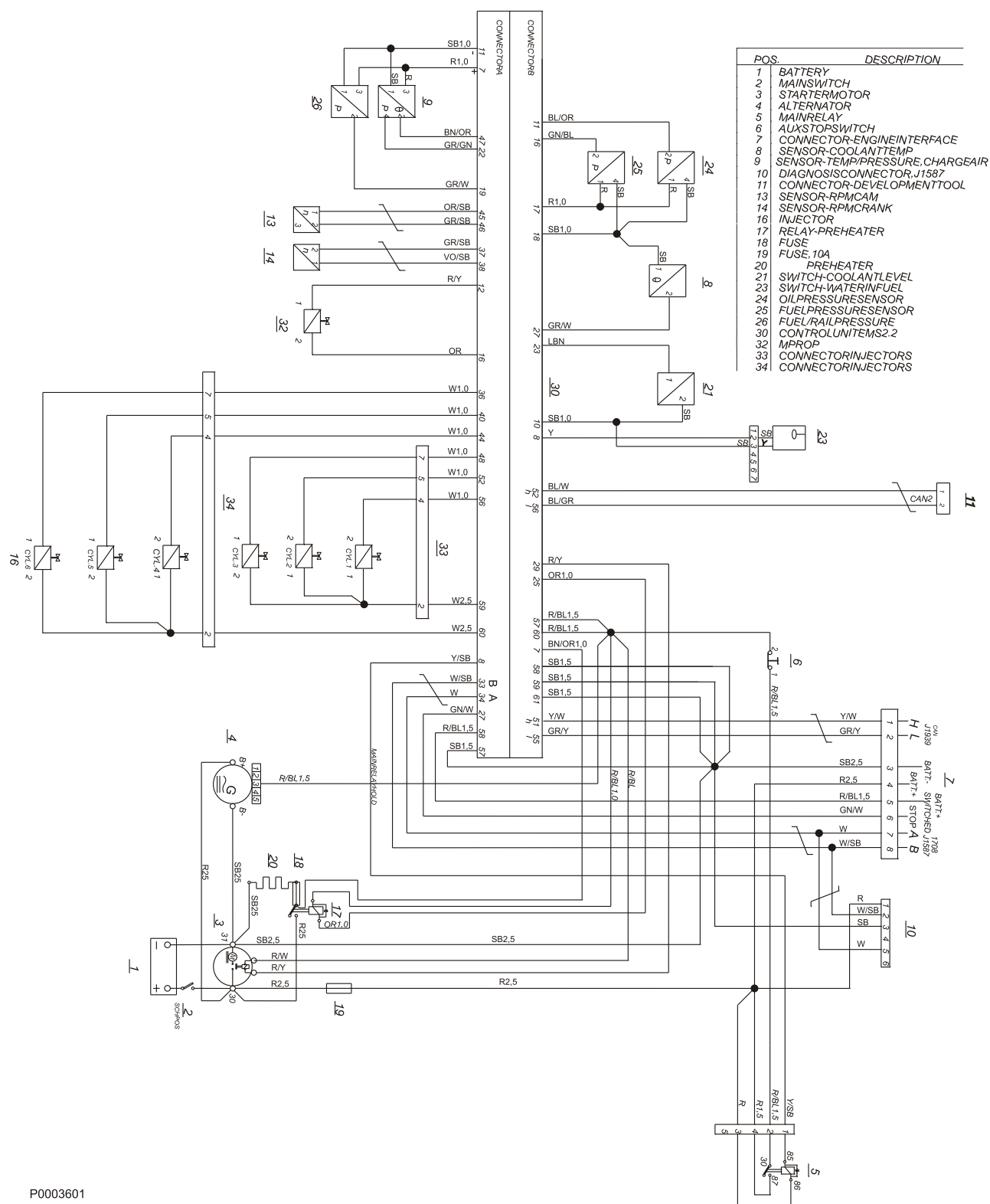
P0003139

- 6 Install the heat shield.
- 7 Reconnect battery voltage to the engine.

37-0 Wiring Diagrams

Wiring Diagram

Engine wire harness, EMS 2



P0003601

Alphabetical index

About repair instructions	3	Starter Motor, Change.....	238
About this Workshop manual.....	2	Thermostat, Change	228
Air Cleaner, Throttle Housing.....	206	Turbo, Change.....	201
Air Filter, Change.....	206	Turbocharger.....	201
Alternator, Change.....	234	Universal Tools	20
Assembly, Complete Engine.....	84	Valve Clearance Adjustment	133
Charge Air Pressure, Check	204	Valve Mechanism.....	133
Common Rail, byte.....	188	Wiring Diagram	240
Control System, ECM, Data Sets.....	193	Wiring Diagrams.....	240
Control Valve, Change.....	193		
Coolant pump, change.....	221		
Coolant Pump, Thermostat.....	221		
Crank Mechanism.....	137		
Crankshaft seal, replace (front).....	139		
Crankshaft Sealing, Change (rear).....	151		
Cylinder Head.....	112		
Cylinder Head Valve, Change.....	131		
Cylinder Head, Change.....	112		
Design and Function	25		
Disassembly, Complete Engine.....	64		
Drive Belt, Change.....	220		
Engine Complete, General	61		
Engine Fixture, Installation.....	61		
Engine Fuel Filter Replacement.....	177		
Engine Information, General.....	25		
Engine Oil Pressure, Check.....	155		
Engine, description.....	25		
Exhaust Manifold, Change.....	197		
Fuel Feed Pump and Filter	170		
Fuel Feed Pump, Check.....	178		
Fuel Injection Pipe, Change.....	191		
Fuel Pre-filter, Change.....	175		
Fuel Pressure, Check.....	169		
Fuel Pump, Change.....	170		
Fuel system, bleeding.....	168		
Fuel Sytem, General.....	168		
Gear Ring, Fywheel: Replace	137		
General.....	2, 0		
Injector, Change	181		
Injectors and Delivery Pipes.....	181		
Inlet and Exhaust Manifolds.....	195		
Inlet Manifold, Change.....	195		
Lubricating and Oil System, General	155		
Oil Filter Housing, Change	157		
Oil filter, Change.....	156		
Other Equipment.....	21		
Other Special Equipment.....	20		
Pre-heating, Change	208		
Radiatir Assembly (Complete Unit), Change	213		
Radiator, Heat Exchanger.....	213		
Safety Instructions	16		
Special Service Tools.....	22		
Specifications, Engine	6		
Starter Motor.....	238		



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References to Service Bulletins

Group No.	Date	Subject
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Date	Subject
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Subject

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A series of horizontal dotted lines spanning the width of the page, providing a guide for handwriting practice.

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