

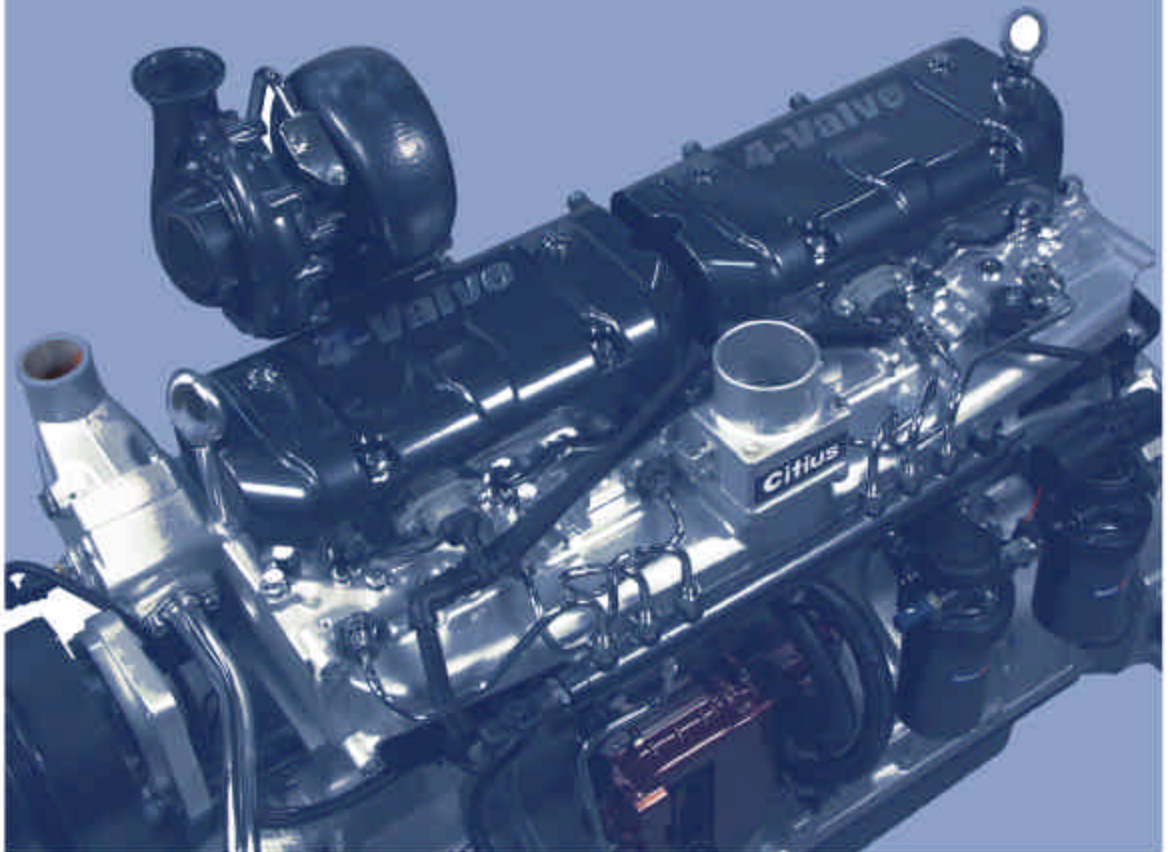
SisubDiesel

Workshop Manual

Citius Series

44, 49, 66, 74 and 84 Engines

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SisuDiesel Citius Series

44, 49, 66, 74 and 84 Engines

Workshop Manual

Version 2

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GENERAL

TO THE USER

This Workshop Manual is intended to assist with workshop operations and repair work.

Citius series engines (types 44, 49, 66, 74 and 84) are generally of the same construction, so the same repair instructions will usually apply to various engine types. The differences between the various engine types, which affect repair work, are mentioned in the technical data and repair instructions. All measurements are in millimetres and valid when the temperature of the parts is +20°C, unless otherwise stated.

Before starting any repair work, please read the safety instructions at the beginning of this book. Make sure that you have all the necessary tools, parts and accessories to hand. The special tools mentioned in the work instructions are not all essential, but they speed up and facilitate the work and contribute to successful execution of the work. An engine which has undergone repairs must be run in just like a new one.

Should the engine require work not described in this manual, please consult your local agent or the Service Department of Sisu Diesel Inc., Linnavuori, Finland. To facilitate consulting, find out the following facts about the engine before contacting us:

- engine type
- engine number
- model or equipment
- hours operated or kilometres driven.

This Workshop Manual does not cover the regular service procedure as this is explained in the Citius series Instruction Manual.

As Sisu Diesel Inc. is continuously developing the products, all rights are reserved to alter the specifications, accessories and the service and repair procedure without separate notice.

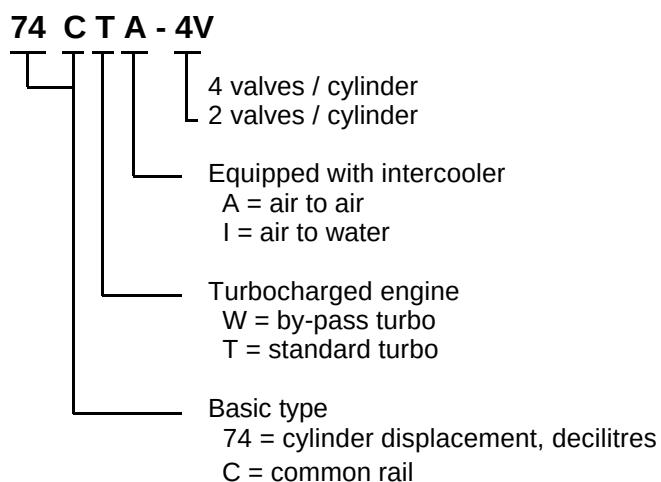
SAFETY INSTRUCTIONS

There is always the risk of injury when using or servicing the engine. Before starting the service, please ensure you have read and understood the following safety instructions and remarks!

- ⚠ Do not start any repair work that you do not fully understand.
- ⚠ Make sure that the location and surroundings in which you are carrying out the repair provide a safe environment in which to work.
- ⚠ Always ensure the location is clean and free of clutter.
- ⚠ Do not use faulty or otherwise unsuitable tools.
- ⚠ Remove all rings, chains and watches before starting work.
- ⚠ Use up-to-date protection equipment while you work. For example, eye protection, as you will be working with compressed air for cleaning, grinding, hammering or similar.
- ⚠ Use a lifting device for lifting and transporting heavy (over 20 kg) pieces. Ensure all lifting hooks and chains are in good condition. The lifting ears on the engine must not be subjected to side forces during lifting.
- ⚠ Never work under an engine that is hanging from a lifting device or raised up on a jack. Always use strong supports before starting the work.
- ⚠ Use only genuine **SisuDiesel** spare parts.
- ⚠ Start the engine only by using the starting switch in the cabin.
- ⚠ Do not start an engine if the protection covers are removed. **Note!** The fan is difficult to see when the engine is running! Ensure that loose clothing or long hair does not get caught in the rotating parts of the engine.
- ⚠ If you start the engine indoors, ensure that there is proper ventilation.
- ⚠ Never use an aerosol starting aid! (Risk of explosion.)
- ⚠ When you are operating the engine or working near it, use ear protection to avoid noise injuries.
- ⚠ Always stop the engine before starting any servicing or repair work.
- ⚠ Avoid touching the exhaust manifold, turbocharger and any other hot parts of the engine.
- ⚠ Open the radiator cap with care when the engine is hot, as the cooling system is pressurised. The cooling liquid and lubrication oil of a hot engine will cause injury if they come into contact with skin.
- ⚠ Do not open high pressure pipe connectors of the fuel system when the engine is running. Wait at least 30 sec. after the stopping of the engine. If the jet of high pressure fuel contacts your skin, fuel penetrates the skin causing severe injuries. Contact your doctor immediately!
- ⚠ Never allow a naked flame, smoking or sparks near the fuel system or batteries, especially when loading batteries, as these are explosive.
- ⚠ Always disconnect the minus (-) wire of the battery when servicing or repairing the electric system.

-  At temperatures in excess of 300°C, e.g. if the engine is burnt by a fire, the viton seals of the engine (i.e. the undermost cylinder liner O-ring) produce very highly corrosive hydrofluoric acid. Do not touch with bare hands when viton seals are subjected to abnormally high temperatures. Always use neoprene rubber or heavy-duty gloves and safety glasses when decontaminating. Wash the seals and the contaminated area with a 10% calcium hydroxide or other alkali solution. Put all removed material in sealed plastic bags and deliver them to the relevant disposal point provided by the authorities concerned. **Note!** Never destroy viton seals by burning!
-  When checking fuel injectors do not allow the jet of high-pressure fuel to come into contact with your skin. The fuel penetrates the skin causing severe injuries. Seek medical attention immediately!
-  The fuel, lubricating oil and coolant cause long-lasting irritation on contact with skin.
-  If you are carrying out welding or similar high current operations for the model, we recommend that you disconnect the EEM3 control unit main connector before starting work.
-  Avoid unnecessary idling of the engine.
-  Do not let oil and other liquids leak onto the ground when servicing the engine. Deliver used oil and oil filter always to the problem-waste collection.
-  All the engine gaskets are made of non-asbestos material.
-  Be careful when washing the engine with high-pressure washing machine equipment. Do not use high pressure to wash e.g. the electric and fuel equipment or the radiator because they can easily be damaged.

ENGINE TYPE DESIGNATIONS



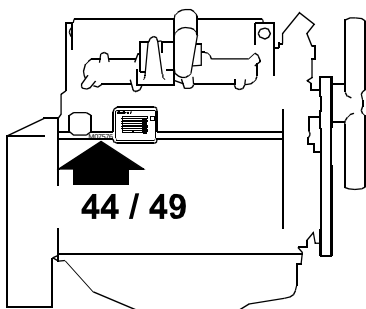
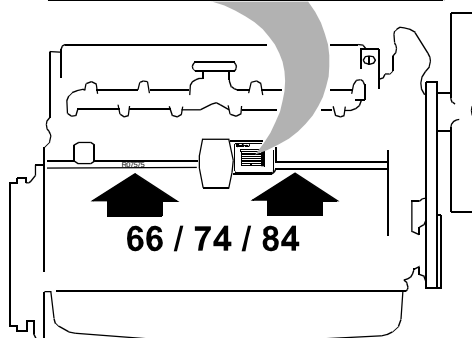
LOCATION OF THE ENGINE SERIAL NO.

The engine serial number is always stamped on the cylinder block as shown in the picture.

The serial number is also marked on the type plate.

SisuDiesel Manufacturer SISU Diesel Inc. FIN-37240 Linnavuori FINLAND	
Type	SISUDIESEL 74.234 CTA
Power	135 kW 2200 rpm
Serial nr	
Valve clearance	0.35 mm
Timing TDC	SW degrees
Low idle	650 rpm
Cust. Part nr	N 5903820
EU Family	D20AEE
EPA Family	YSIDL07.4C2A
Displacement: 7.4 l Fuel: 2-D fuel oil	
Assembled by:	

e1 7*97/68EA*97/68EA*0016*00
This engine conforms to 199 U.S. EPA
regulations large nonroad compression
ignition engines

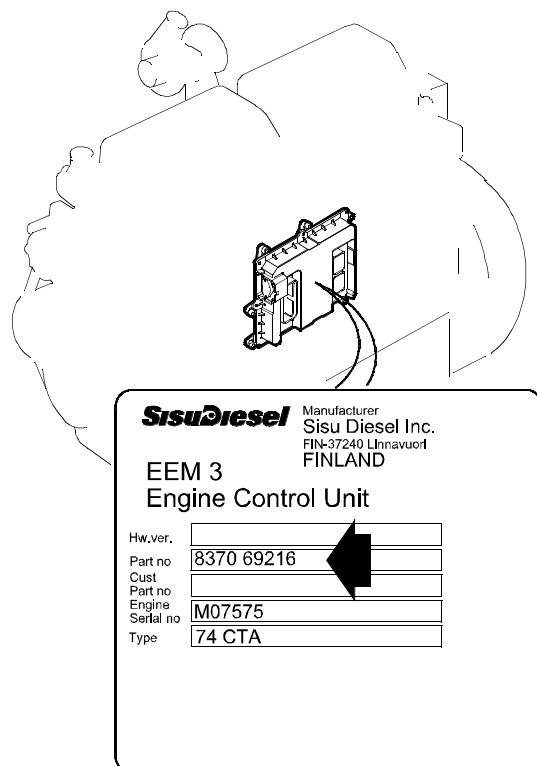


MARKING OF THE EEM 3 CONTROL UNIT

The model specification is indicated on the type plate of the EEM 3 control unit. This specification must always be stated when ordering a control unit or requesting adjusted settings.

Note! The engine meets EU97/68/EC Stage IIIA and EPA 40 CFR 89 Tier 3 emission requirements.

Do not fit any components on the engine other than those originally intended for it. The use of parts other than original SisuDiesel spare parts will invalidate the responsibility of Sisu Diesel Inc. with respect to the fulfilment of the emission requirements.



LIFTING THE ENGINE

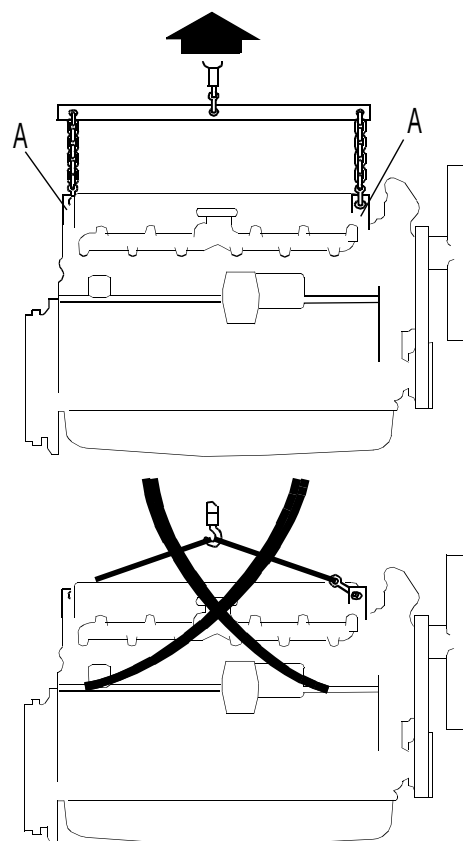
Safe lifting of the engine can be done using a lifting device with which the lifting force is applied vertically to the lifting ears.

Weight of engine

Engine type	Weight kg *)
44	345
49	345
66	515
74	525
84	650

*) Dry weight without flywheel and electrics

A = Engine lifting ears



CONSTRUCTION**Technical Data**

Engine Type	44	49	66	74	84
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Principal Dimensions and Data

Number of cylinders	4	4	6	6	6
Displacement (ltr)	4.4	4.9	6.6	7.4	8.4
Cylinder bore (mm)	108	108	108	108	111
Stroke (mm)	120	134	120	134	145
Combustion	Direct injection				
Injection advance	Automatically adjusted				
Valve clearance, intake and exhaust (mm)	0.35 (hot or cold)				
Direction of rotation from the engine front	Clockwise				

Fuel System

High-pressure pump	Bosch CP 1H or CP 3.3	
Fuel	The fuel must comply with the EN 590 standard, see page 95	
Injection order	1 - 2 - 4 - 3	1 - 5 - 3 - 6 - 2 - 4
Feed pressure at idle speed	1.0...1.2 bar with CP 3.3 high-pressure pump 0.75 bar with CP 1H high-pressure pump	
Injector	Bosch CRIN 2, electronic control 2V engines, five-hole nozzle 4V engines, eight-hole nozzle	
Injection pressure	Max. 1400 bar with CP3.3 high-pressure pump Max. 1100 bar with CP 1H high-pressure pump	
Fuel filters		
Pre-filter	Stanadyne 30 μ	
Final filter	Stanadyne 5 μ	

Lubrication System

Oil pressure in hot engine at running speed	2.5...5.0 bar				
Oil pressure at idle speed, min.	1.0 bar				
Oil capacity	see page 77				
Oil quality requirements	see page 76				

Cooling system

Number of thermostats	1	1	1/2	2	2
Opening temperature	Ø 54 mm = 79°C Ø 67 mm = 83°C				
Coolant quality requirements	see page 79				

General

The Citius engine series consists of water-cooled in-line diesel engines with four and six cylinders. The turbo-charged engines are equipped with wet, changeable cylinder liners.

All the engine types have a rigid and ribbed cylinder block. The crank mechanism is designed for supercharging. The cylinder liners are wet and supported at the middle. The cylinder head bolts are high tensile bolts.

Cylinder Block

The cylinder block is the main body of the engine, to which other engine parts are attached. Wet and replaceable cylinder liners are supported at the middle, which reduces vibrations and directs coolant circulation mainly to the upper part of the liners.

In 44-, 49-, 66- and 74-engines, the seal between the lower part of the cylinder liner and the cylinder block is achieved by three O-rings, which are fitted in grooves in the liner. In 84-engines, the O-rings are fitted in grooves in the cylinder block. The upper part is sealed by the cylinder head gasket.

The camshaft is located in the cylinder block. In 44- and 49-engines, the camshaft front bearing location is fitted with a separate bearing sleeve. The remaining bearing locations are machined directly in the cylinder block. The 66-, 74- and 84-engines have separate bearing sleeves in all camshaft bearing locations. The drilling for the camshaft rear end is covered with a plug.

There are spaces on both sides of the rear main bearing for guide bearing shims (the crankshaft thrust bearings).

Flywheel Housing

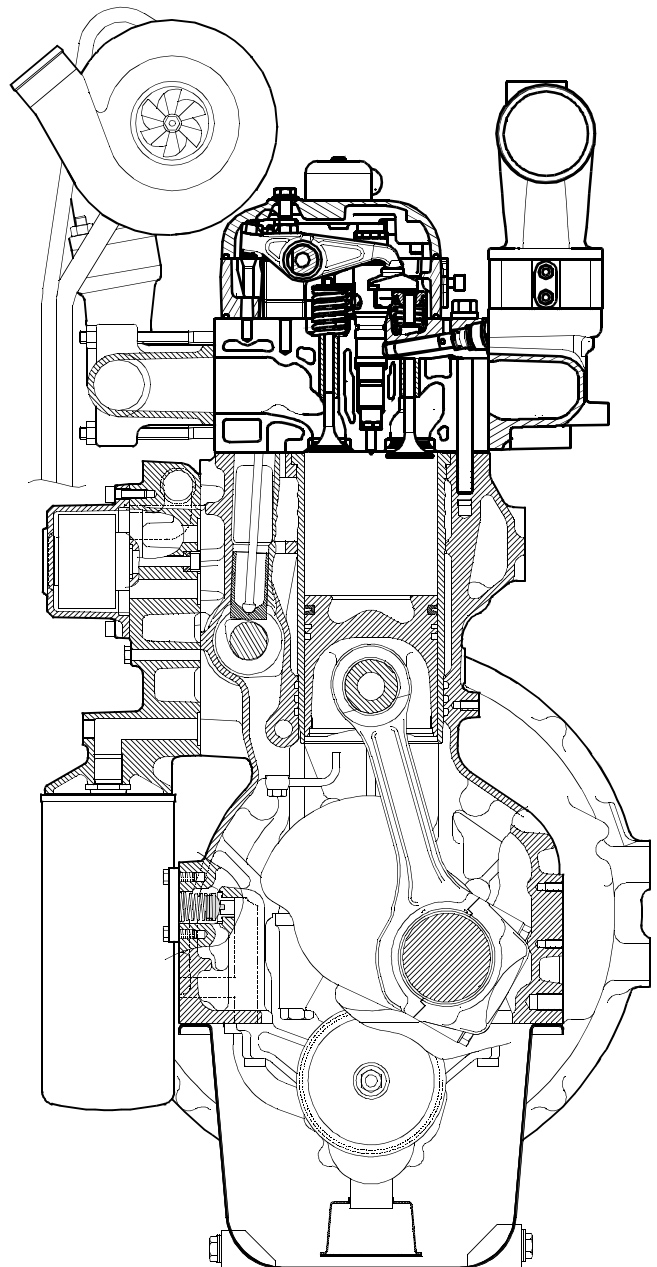
The flywheel housing is fitted at the rear end of the cylinder block. The seal for the crankshaft rear end is placed in a bore in the housing. The starter motor fixing point is fitted in the flywheel housing.

The lower face of the flywheel housing functions as a sealing surface for the oil sump gasket. This means that the lower face of the cylinder block must be level with the flywheel housing. When fitting the flywheel housing, its position is determined by tension pins.

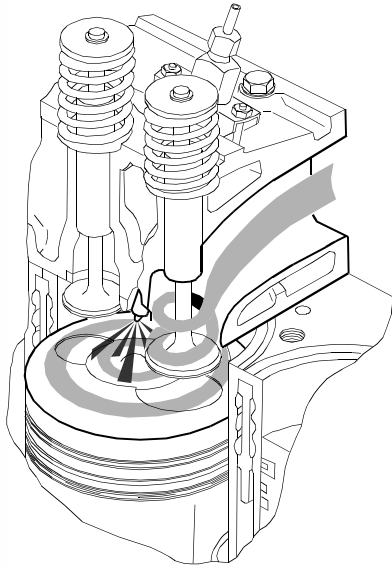
The flywheel housing is delivered according to the requirements set by the engine model and different flywheel housings can be mounted on all engine types.

Valve Mechanism

The valve mechanism is operated by the camshaft which is located in the cylinder block. The drive is transferred with the help of tappets and push rods. The camshaft gear wheel is fitted with a nut and guided with a key. Each bearing is lubricated by the force feed lubrication system through drilled oilways in the cylinder block.



Cylinder Head, 2V Engines



44- and 49-engines have one cylinder head. 66- and 74-engines have two cylinder heads, which are interchangeable with each other. Each cylinder has its own inlet and exhaust ports located on either side of the head. A cool inlet valve is fitted between hot exhaust valves to balance the thermal load.

Cylinder head bolts are high tensile bolts, which are tightened up to yield limit using the angle tightening method. Due to the large stretch, the tightening forces are kept constant during the whole lifetime and retightening is unnecessary.

The injector locations are machined directly into the cylinder head. The inlet and exhaust valve guides are identical and can be interchanged. Exhaust valves are fitted with separate valve seat rings. The engines with high output are also equipped with separate inlet valve seats.

Cylinder Head, 4V Engines

44- and 49-engines have one cylinder head and 66-, 74- and 84-engines have two cylinder heads. Every cylinder has four valves. There is a place for the injector in the middle of four valves. The injector is located vertically in the centre of the cylinder and in the middle of the combustion chamber. This ensures accurate and homogenous mixing of fuel and air and leads to clean and low emission combustion with good efficiency.

Each cylinder has its own inlet and exhaust ports located on either side of the head. Every inlet valve has its own inlet port but there is only one exhaust port for every two of the cylinder's exhaust valves. There are no water holes on the inlet side of the cylinder head. This eliminates the possibility of water entering the inlet air.

Cylinder head bolts are high tensile bolts, which are tightened up to yield limit using the angle tightening method. Due to the large stretch, the tightening forces are kept constant during the whole lifetime and retightening is unnecessary.

The injector and its side feeding pipe locations are machined directly into the cylinder head. The port for the side feeding pipe is located between the inlet ports. The inlet and exhaust valve guides are identical and can be interchanged. Exhaust valves are fitted with separate valve seat rings. The engines with high output are also equipped with separate inlet valve seats.

Crank Mechanism

The crankshaft is forged from chrome alloy special steel and is induction hardened at the bearing and sealing surfaces. This makes it possible to grind bearings four times without a new heat treatment. Gear wheels are located at the front end of the crankshaft. They are a press fit, and drive the idler wheel and oil pump. In addition, the front end of the crankshaft has splines for the hub of the V-belt pulley. The hub of 74- and 84-engines is fastened to the crankshaft with a cone joint. An oil deflector ring is fitted between the hub and gear wheel.

The crankshaft is supported on the cylinder block by main bearings, which are placed on both sides of each cylinder. There is therefore one main bearing more than there are cylinders. The crankshaft thrust washers are placed in both sides of the rearmost main bearing.

A flywheel, on which there is a press-fit starter ring gear, is fitted at the rear end of the crankshaft. The forged connecting rod has an I-cross-section. The bearing location at the bottom end of the connecting rod is fracture-split, and the bearing cup is secured by two special elongated screws.

The upper part has a wedge-shaped bearing location, in which the piston pin bearing bushing is fitted with a press fit.

The piston is made of a eutectic aluminium alloy. In the upper face of the piston there is a combustion chamber. The shape of the chamber is intended to maximise the mixture of air and fuel. The upper ring location is formed in a cast iron ring, which is cast in the piston. In addition, the piston is graphite-coated to ensure correct running-in.

The piston has three rings. The upper molybdenum-coated ring has a wedge-shaped cross-section. On some slightly supercharged engines the upper ring is right-angled. The middle ring is tapered and it fits into its groove. The oil control ring is spring-loaded and it has a two-stage, chromed scraping edge.

Some four-cylinder engines are equipped with a balancer unit. The eccentric weights, which rotate at twice the engine speed, even out the vibration forces exerted by the movement of the pistons and the crank mechanism.

Timing Gears

44-, 49-, 66- and 74-Engines

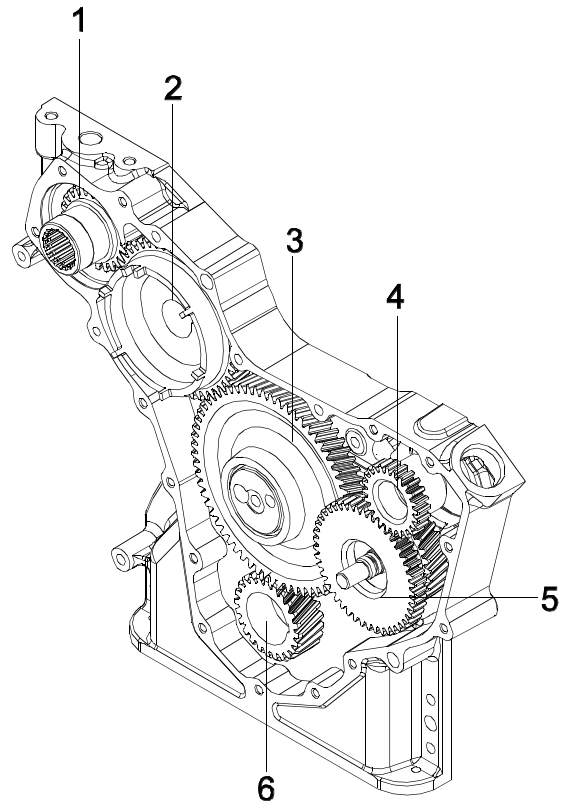
The timing gear drives the camshaft, high-pressure pump and oil pump. The timing gear train consists of hardened, helically cut gear wheels. The gear of the high-pressure pump is spur-gear and it is driven by a double idler gear. The gears are encased by the timing gear casing, which is fitted to the front of the engine.

If the engine is equipped with a hydraulic pump, it is driven via a gear or a separate drive unit.

The idler gear is supported with a bearing sleeve / ball bearing (66- and 74-engines) on the shaft on the front face of the cylinder block. Two different dimensions of gear and shaft are used.

Timing gear parts

- | | |
|----------------------|----------------------------|
| 1. P.T.O. gear | 2. Camshaft gear |
| 3. Idler gear | 4. High-pressure pump gear |
| 5. Double idler gear | 6. Crankshaft gear |



84-Engines

There are two main types of timing gear assembly: narrow and broad timing gear casing.

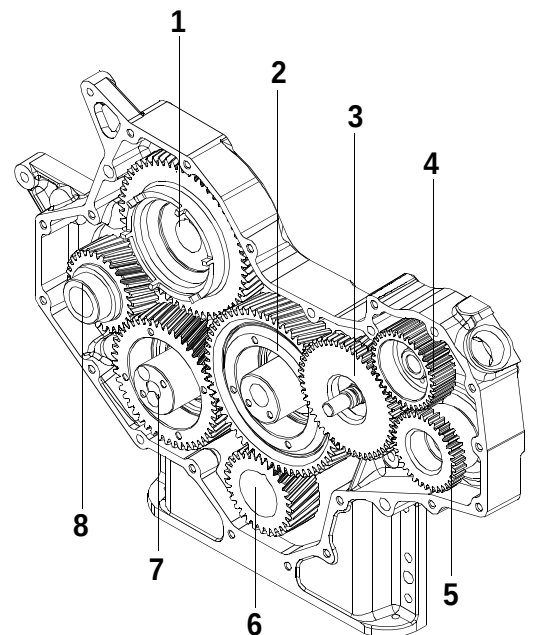
The timing gear drives the camshaft, high-pressure pump, oil pump and coolant pump. The timing gear train consists of hardened, helically cut gear wheels. The gears of the high-pressure pump and coolant pump are spur-gear and they are driven by a double idler gear. The gears are encased by the timing gear casing, which is fitted to the front of the engine.

If the engine is equipped with the broad timing gear casing, there is a separate drive unit for a hydraulic pump or a compressor. The drive unit is driven via a small idler gear.

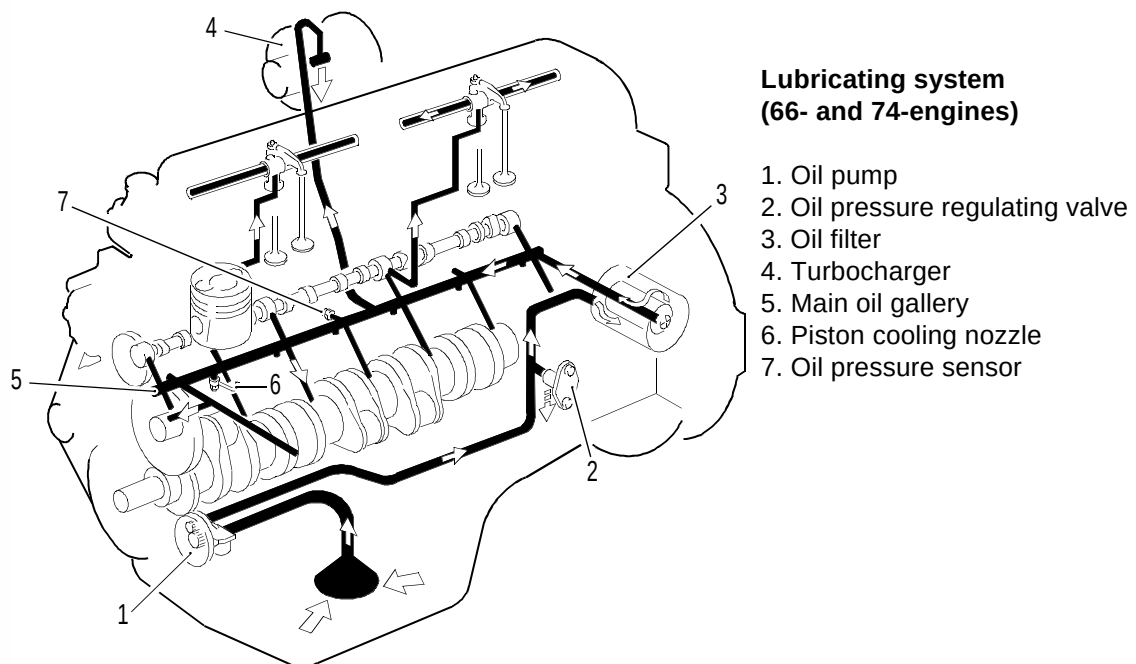
The idler gear is supported with a bevelled ball bearing on the shaft on the front face of the cylinder block.

Timing gear parts

- | | |
|----------------------------|----------------------|
| 1. Camshaft gear | 2. Idler gear |
| 3. Double idler gear | 4. Coolant pump gear |
| 5. High-pressure pump gear | 6. Crankshaft gear |
| 7. Small idler gear | 8. P.T.O. gear |



Lubricating System



The engine has a pressure lubricating system in which the oil pump (gear pump) is attached to the lower face of the cylinder block. The oil is sucked up by the pump through a suction strainer. After the pump, the oil is led through an oilway to the oil pressure regulating valve and via the oil cooler to the oil filter. After the filter, the oil is led through the main oil gallery from which oilways branch out. The oil is led through the oilways in the main bearings and through the crankshaft to the big-end bearings.

The oil is further directed from the main gallery to accessory equipment, turbocharger, balancer unit (44-, 49-engines) and, if applicable, to a compressor. In addition, the camshaft bearing points and the valve mechanism get their lubrication oil via the main oil gallery.

The undersides of the pistons of the engines with high output are always cooled by the oil spray when the oil pressure is more than 3 bar.

The oil pressure regulating valve is located under the oil filter on the left side of the engine (on the right side in 84-engines). The regulating valve keeps the oil pressure constant, independent of the engine speed. At working speed, the oil pressure is 2.5 to 5 bar depending on the temperature and the quality of the lubricating oil. At idling speed, the pressure is 1.0 bar minimum.

The oil filter is of main flow type. It has a replaceable cartridge mounted on the left side of the engine (on the right side in 84-engines). At the bottom of the oil filter cartridge there is a by-pass valve for cold start or clogging of the filter.

Some engine types are equipped with an oil cooler located between the cylinder block and the oil filter. All the oil that circulates through the filter also goes through the cooler and is cooled by the engine coolant circulating in the oil cooler.

84-engines are equipped with a plate type oil cooler, which is situated on the right side of the engine above the filter. The cooler is of main flow type.

Cooling System

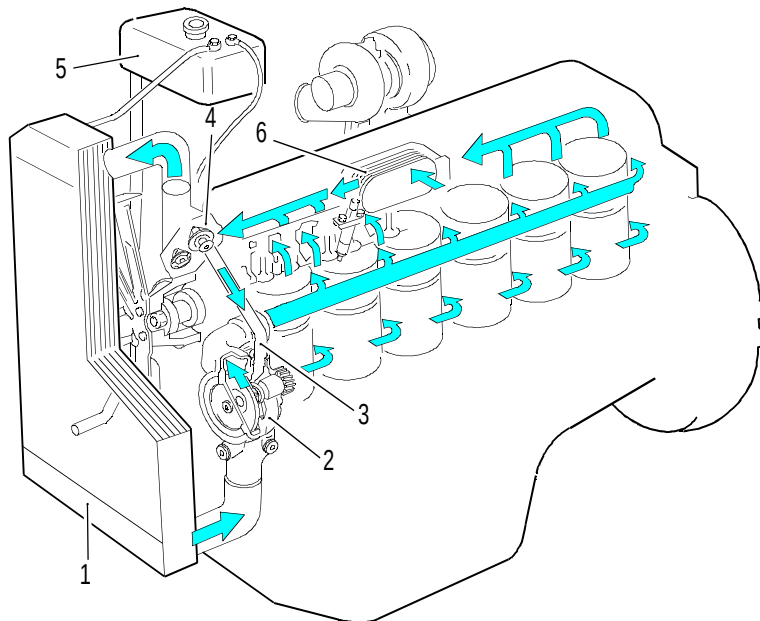
The coolant pump is attached to the front face of the cylinder block and the thermostat housing is mounted above it.

On 84-engines, the gear driven coolant pump is attached to the front face of the timing gear housing. The thermostat housing is mounted on the front end of the cylinder head.

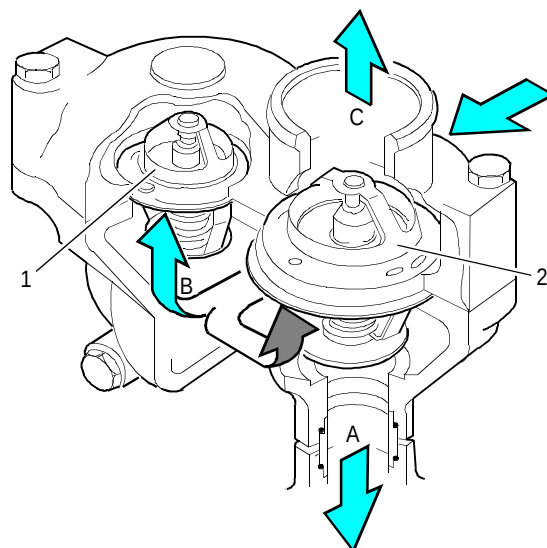
The system has an internal liquid circulation via the by-pass pipe. The circulation is regulated by the 2-way thermostat. This arrangement ensures a steady warming-up of the engine under all conditions.

Cooling system (84-engine)

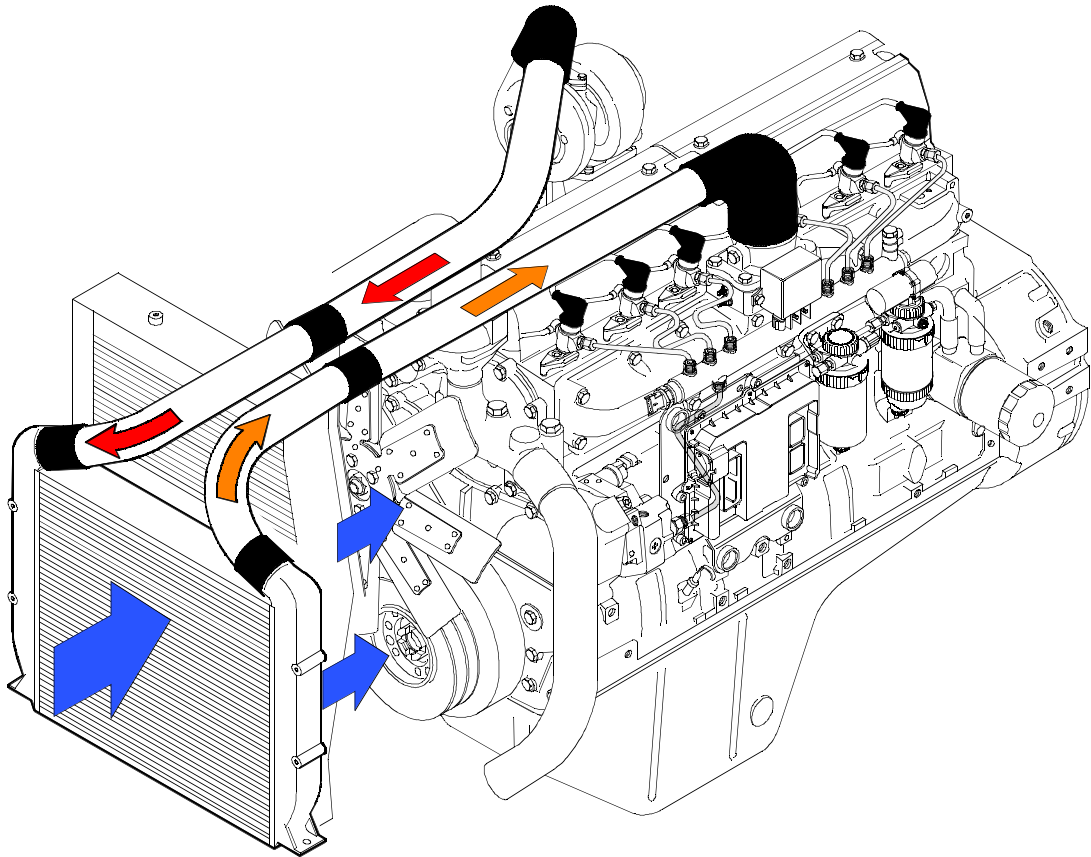
1. Radiator
2. Coolant pump
3. By-pass pipe
4. Thermostat
5. Expansion tank
6. Oil cooler



In some 66-, 74- and 84-engines there are two separate thermostats, of which one steers the by-pass of coolant liquid. The thermostats differ in type and opening temperature. When the coolant temperature is below the thermostat opening temperature, the coolant (A) circulates through the by-pass hole into the coolant pump. The smaller, single-acting thermostat (1) opens first (at 79°C), letting one part of the coolant (B) into the radiator. Following the load increase, the other thermostat (2) also opens (at 83°C). This is a double-acting type, which closes the by-pass hole when it opens and directs the coolant (C) into the radiator. These engine models do not have any separate winter-type thermostats.



Inlet and Exhaust System



The filter system for the engine inlet air comprises a cyclone type pre-cleaner, and a paper filter which acts as the main filter. The incoming air is made to rotate in the cyclone pre-cleaner. This causes most of the impurities to settle out and collect in the cyclone pre-cleaner dust collector. The paper filter comprises one or two replaceable filter elements. The paper is corrugated and surrounded by a metal support.

The impurities in the air collect at the larger filter element, which can be cleaned when necessary. The inner safety filter prevents impurities from entering the engine should the main filter element break, or be fitted incorrectly.

A mechanical or electrical service indicator can be mounted on the filter housing or on the inlet pipe to show when the filter cartridge is clogged. The inlet system also includes the hoses between the air cleaner and the turbocharger and between the turbocharger and the intake manifold.

The exhaust manifold is attached to the cylinder head with high tensile bolts without a separate gasket. Retightening of the manifold bolts is unnecessary.

The turbocharger is a turbo-compressor driven by exhaust gas. The compact design of the turbocharger is fast to react even during low revolutions. The turbocharger is lubricated and cooled by the lubrication system of the engine. The CWA-engine is equipped with a by-pass turbocharger in which excessive air pressure is adjusted by a "by-pass channel". The boost pressure is adjusted correctly by the manufacturer, and must not be changed afterwards.

The compressed air is cooled on an air-to-air basis. The air coming from the turbocharger has a temperature of about 150°C and is cooled by the cooling air of the engine. The intercooler's cell is ideally installed in front of the radiator or side-by-side with the radiator. The cooling of the compressed air stabilises the combustion, irrespective of the temperature, and minimises the thermal and mechanical load of the engine thus lowering nitric oxides (NO_x) and particles (PT). Certain engine versions can also be equipped with an air-to-water intercooler. In that case, the engine specification is CTI.

TECHNICAL DATA**Cylinder Block****44-, 49-, 66-, 74-Engines**

Holes for guide pins	13.250...13.320 mm
Main bearing housing diameter (44-, 49- and 66-engines)	91.000...91.025 mm
Main bearing housing diameter (74-engines)	96.000...96.025 mm
Main bearing housing diameter (with bearing 8361 40950), (44-, 49- and 66-engines)	92.000...92.025 mm
Cylinder liner location, diameter:	
- upper end	124.514...124.554 mm
- lower end	123.000...123.040 mm
Inside diameter of camshaft bushing no. 1 (fitted)	50.040...50.060 mm
Inside diameter of camshaft bushing nos. 2-4 (44- and 49-engines)	50.000...50.025 mm
Inside diameter of camshaft bearing bushings nos. 2-5 (fitted, 66-, 74-engines)	50.010...50.070 mm
Diameter of bearing bushing bore in block (bearing bushing no 1)	55.620...55.650 mm
Height of cylinder block	428.170...428.430 mm

84-Engines

Holes for guide pins	13.250...13.320 mm
Main bearing housing diameter	96.000...96.025 mm
Cylinder liner location, diameter:	
- upper end	125.014...125.054 mm
- lower end	121.000...121.040 mm
Inside diameter of camshaft bushing no. 1 (fitted)	50.040...50.060 mm
Inside diameter of camshaft bearing bushings nos. 2-5 (fitted)	50.010...50.070 mm
Height of cylinder block	468.850...469.150 mm

Cylinder Liners

Protrusion of cylinder liner above cylinder block top face	0.030...0.080 mm
Max. permissible height difference between liners (under same head)	0.02 mm
Height of cylinder liner flange, std.	9.03...9.05 mm
Height of cylinder liner flange, 1st oversize	9.08...9.10 mm
Height of cylinder liner flange, 2nd oversize	9.13...9.15 mm
Height of cylinder liner flange, 3rd oversize	9.23...9.25 mm
Outer diameter of cylinder liner flange	131.700...131.800 mm

44-, 49-, 66-, 74-Engines

Outer diameter of cylinder liner guide:	
- at upper end of liner	124.475...124.500 mm
- at lower end of liner	122.961...122.986 mm
Liner bore	108.010...108.032 mm

84-Engines

Outer diameter of cylinder liner guide:	
- at upper end of liner	124.975...125.000 mm
- at lower end of liner	120.966...120.991 mm
Liner bore	111.000...111.022 mm

Cylinder Head

2V Engines

Height of cylinder head	104.800...105.000 mm
Height of cylinder head after repair grinding (minimum)	104.000 mm
Length of cylinder head bolts	140 ± 0.08 mm (max. 142 mm)
Length of cylinder head studs (overall length)	186 + 1 mm (max. 188.5 mm)
Inside diameter of valve guide	9.000...9.015 mm
Outside diameter of valve guide	16.028...16.039 mm
Diameter of valve guide bore in cylinder head	16.000...16.018 mm
Position of valve guide top above cylinder head surface	21 mm
Depth of valve head face below cylinder head surface:	
- inlet valve	0.55...0.75 mm (max. 2.20 mm)
- exhaust valve	0.65...0.85 mm (max. 2.20 mm)
Angle of valve seat:	
- inlet valve	35°+20'
- exhaust valve	45°+20'
Width of valve seat:	
- inlet valve	2.9...3.7 mm
- exhaust valve	1.3...2.3 mm
Diameter of exhaust valve seat ring	44.070...44.132 mm
Diameter of exhaust valve seat rings recess	44.000...44.025 mm
Diameter of exhaust valve seat ring (overhaul part 8366 52269)	44.270...44.332 mm
Diameter of exhaust valve seal ring recess (overhaul part 8366 52269)	44.200...44.225 mm
Diameter of inlet valve seat ring	48.570...48.632 mm
Diameter of inlet valve seat ring recess	48.500...48.525 mm
Diameter of inlet valve seat ring (overhaul part 8368 55347)	48.770...48.832 mm
Diameter of inlet valve seat ring recess (overhaul part 8368 55347)	48.700...48.725 mm

4V Engines

Height of cylinder head	109.900...110.000 mm
Height of cylinder head after repair grinding (minimum)	109.500 mm
Length of cylinder head bolts	145 ± 0.08 mm (max. 147 mm)
Length of cylinder head studs (overall length)	186 + 1 mm (max. 188.5 mm)
Inside diameter of valve guide	8.000...8.015 mm
Outside diameter of valve guide	16.028...16.039 mm
Diameter of valve guide bore in cylinder head	16.000...16.018 mm
Position of valve guide top above cylinder head surface	13 mm
Depth of valve head face below cylinder head surface:	
- inlet valve	0.65...0.85 mm (max. 2.20 mm)
- exhaust valve	0.45...0.65 mm (max. 2.20 mm)
Angle of valve seat:	
- inlet valve	35°+20'
- exhaust valve	45°+20'
Width of valve seat:	
- inlet valve	2.2 mm
- exhaust valve	2.0 mm

Diameter of exhaust valve seat ring	36.060...36.122 mm
Diameter of exhaust valve seat rings recess	36.000...36.025 mm
Diameter of exhaust valve seat ring (overhaul part 8370 70187)	36.260...36.322 mm
Diameter of exhaust valve seal ring recess (overhaul part 8370 70187)	36.200...36.225 mm
Diameter of inlet valve seat ring	41.070...41.132 mm
Diameter of inlet valve seat ring recess	41.000...41.025 mm
Diameter of inlet valve seat ring (overhaul part 8370 70188)	41.270...41.332 mm
Diameter of inlet valve seat ring recess (overhaul part 8370 70188)	41.200...41.225 mm

Valves and Rockers

2V Engines

With a valve clearance of 1.0 mm:

- inlet valve opens	0°± 2° B.T.D.C
- inlet valve closes	16°± 2° A.B.D.C
- exhaust valve opens	39°± 2° B.B.D.C
- exhaust valve closes	1°± 2° A.T.D.C

Valve clearance hot and cold:

- inlet valve	0.35 mm
- exhaust valve	0.35 mm

Angle of valve face:

- inlet valve	35°-20'
- exhaust valve	45°-20'

Outside diameter of valve head:

- inlet valve	48 mm
- exhaust valve	41 mm

Max. valve movement with a valve clearance of 0.35 mm:

- inlet valve	10.9 mm
- exhaust valve	12.1 mm
Inlet valve stem diameter	8.960...8.975 mm
Exhaust valve stem diameter	8.925...8.940 mm
Inlet valve stem clearance	0.025...0.055 mm
- Reject limit	0.30 mm
Exhaust valve stem clearance	0.060...0.090 mm
- Reject limit	0.35 mm

Depth of valve head face below cylinder head surface:

- inlet valve	0.55...0.75 mm (max. 2.20mm)
- exhaust valve	0.65...0.85 mm (max. 2.20mm)

Valve spring free length 69.8 mm |

Spring pressure when spring compressed to a length of:

- 48.6 mm	327 ± 17 N
- 37.4 mm	500 ± 23 N

Rocker arm shaft diameter 22.970...22.990 mm |

Diameter of rocker arm bore 23.000...23.021 mm |

Free length of rocker arm spring 80 mm |

Spring pressure when spring compressed to a length 58 mm 70...90 N |

4V Engines

With a valve clearance of 1.0 mm:

- inlet valve opens	2°± 2° B.T.D.C
- inlet valve closes	18°± 2° A.B.D.C
- exhaust valve opens	36°± 2° B.B.D.C
- exhaust valve closes	2°± 2° A.T.D.C

Valve clearance hot and cold:	
- inlet valve.	0.35 mm
- exhaust valve.	0.35 mm
Angle of valve face:	
- inlet valve.	35°-20'
- exhaust valve.	45°-20'
Outside diameter of valve head:	
- inlet valve.	39 mm
- exhaust valve.	35 mm
Max. valve movement with a valve clearance of 0.35 mm:	
- inlet valve.	9.5 mm
- exhaust valve.	9.0 mm
Inlet valve stem diameter.	7.960...7.975 mm
Exhaust valve stem diameter.	7.925...7.940 mm
Inlet valve stem clearance.	0.025...0.055 mm
- Reject limit.	0.30 mm
Exhaust valve stem clearance.	0.060...0.090 mm
- Reject limit.	0.35 mm
Depth of valve head face below cylinder head surface:	
- inlet valve.	0.65...0.85 mm (max. 2.20mm)
- exhaust valve.	0.45...0.65 mm (max. 2.20mm)
Valve spring free length.	75.1 mm
Spring pressure when spring compressed to a length of:	
- 41.0 mm.	300 ± 10 N
- 31.0 mm.	420 ± 15 N
Rocker arm shaft diameter.	24.970...24.990 mm
Diameter of rocker arm bore.	25.000...25.021 mm
Free length of rocker arm spring.	88 mm
Spring pressure when spring compressed to a length of 66 mm.	75...95 N

Tappets and Push Rods

Outside diameter of tappet.	29.939...29.960 mm
Diameter of tappet bore in cylinder block.	30.000...30.043 mm
Max. permissible push rod deflection (when free).	0.4 mm
Overall length of push rod (44-, 49-, 66-, 74- 2V engines).	237...238.3 mm
Overall length of push rod (44-, 49-, 66-, 74- 4V engines).	245...246.3 mm
Overall length of push rod (84- 4V engines).	286...287.3 mm

Camshaft

Diameter of camshaft bearing journal no. 1.	49.875...49.900 mm
Diameter of camshaft bearing journals nos. 2-4(44-, 49-engines).	49.885...49.910 mm
Diameter of camshaft bearing journals nos. 2-4 (66-, 74- and 84-engines).	49.865...49.890 mm
Diameter of camshaft bearing journal no. 5 (66-, 74- and 84-engines).	49.885...49.910 mm
Camshaft clearance in bearing bush no. 1.	0.140...0.185 mm
Camshaft clearance in bearing bush nos. 2-4 (44- and 49-engines).	0.120...0.205 mm
Camshaft clearance in bearing bush nos. 2-4 (66-, 74- and 84-engines).	0.110...0.160 mm
Camshaft clearance in bearing bush no. 5 (66-, 74- and 84-engines).	0.100...0.185 mm
Camshaft end play.	0.7...1.2 mm
Cam height (distance between back of cam and tip of cam):	
2V engines:	
- inlet valve.	40.987...41.487 mm
- exhaust valve.	39.883...40.383 mm
4V engines:	
- inlet valve.	43.180...43.680 mm
- exhaust valve.	41.700...42.200 mm

Cam lift:

2V engines:

- inlet valve	7.38 mm
- exhaust valve	8.28 mm

4V engines:

- inlet valve	6.18 mm
- exhaust valve	7.70 mm

Width of cam, 2V engines 17.70...18.30 mm

Width of cam, 4V engines 19.70...20.30 mm

Camshaft max. permissible deflection (total indicator reading). 0.03 mm

Crankshaft

44-, 49-, 66- and 74-Engines

Crankpin diameter:

- standard	67.981...68.000 mm
- 1st undersize 0.25 mm	67.731...67.750 mm
- 2nd undersize 0.50 mm	67.481...67.500 mm
- 3rd undersize 1.00 mm	66.981...67.000 mm
- 4th undersize 1.50 mm	66.481...66.500 mm
Crankpin length	40.000...40.160 mm

Main bearing journal diameter (44-, 49- and 66-engines):

- standard	84.985...85.020 mm
- 1st undersize 0.25 mm	84.735...84.770 mm
- 2nd undersize 0.50mm	84.485...84.520 mm
- 3rd undersize 1.00 mm	83.985...84.020 mm
- 4th undersize 1.50 mm	83.485...83.520 mm

Main bearing housing diameter (in cylinder block) 91.000...91.025 mm

Main bearing journal diameter (74-engines):

- standard	89.985...90.020 mm
- 1st undersize 0.25 mm	89.735...89.770 mm
- 2nd undersize 0.50 mm	89.485...89.520 mm
- 3rd undersize 1.00 mm	88.985...89.020 mm
- 4th undersize 1.50 mm	88.485...88.520 mm

Main bearing housing diameter (in cylinder block) 96.000...96.025 mm

Main bearing shell thickness:

- standard	2.955...2.965 mm
- 1st undersize 0.25 mm	3.080...3.090 mm
- 2nd undersize 0.50 mm	3.205...3.215 mm
- 3rd undersize 1.00 mm	3.455...3.465 mm
- 4th undersize 1.50 mm	3.705...3.715 mm
- bearing 8361 40950 (see instruction 5 B).	3.705...3.715 mm

Main bearing clearance. 0.050...0.127 mm

Length of thrust bearing journal (journal nearest to flywheel):

- standard (2 standard thrust plates)	45.000...45.080 mm
- 1st oversize (one std and one 0.1 mm overthick thrust plate)	45.100...45.180 mm
- 2nd oversize (one std and one 0.2 mm overthick thrust plate)	45.200...45.280 mm
- 3rd oversize (one 0.1 mm and one 0.2 mm overthick thrust plate)	45.300...45.380 mm
- 4th oversize (two 0.2 mm overthick thrust plates)	45.400...45.480 mm

Other crankshaft journals cannot be ground longer.

Crankshaft end float 0.100...0.380 mm

Max. permissible ovality and other deformity of crankpins or journals . . . 0.03 mm

Crankshaft unbalance 1.0 Ncm max.

Balancing unit ring gear location, diameter (44- and 49-engines). 150.220...150.260 mm

Balancing unit ring gear I.D. (44- and 49-engines) 150.000...150.040 mm

Number of teeth on trigger wheel 60-2

84-Engines

Crankpin diameter:

- standard	72.981...73.000 mm
- 1st undersize 0.25 mm	72.731...72.750 mm
- 2nd undersize 0.50 mm	72.481...72.500 mm
- 3rd undersize 1.00 mm	71.981...72.000 mm
- 4th undersize 1.50 mm	71.481...71.500 mm

Crankpin length	40.000...40.160 mm
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Main bearing journal diameter:

- standard	89.985...90.020 mm
- 1st undersize 0.25 mm	89.735...89.770 mm
- 2nd undersize 0.50mm	89.485...89.520 mm
- 3rd undersize 1.00 mm	88.985...89.020 mm
- 4th undersize 1.50 mm	88.485...88.520 mm

Main bearing housing diameter (in cylinder block)	96.000...96.025 mm
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Main bearing shell thickness:

- standard	2.955...2.965 mm
- 1st undersize 0.25 mm	3.080...3.090 mm
- 2nd undersize 0.50 mm	3.205...3.215 mm
- 3rd undersize 1.00 mm	3.455...3.465 mm
- 4th undersize 1.50 mm	3.705...3.715 mm

Main bearing clearance	0.050...0.127 mm
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Length of thrust bearing journal (journal nearest to flywheel):

- standard (2 standard thrust plates)	45.000...45.080 mm
- 1st oversize (one std and one 0.1 mm overthick thrust plate)	45.100...45.180 mm
- 2nd oversize (one std and one 0.2 mm overthick thrust plate)	45.200...45.280 mm
- 3rd oversize (one 0.1 mm and one 0.2 mm overthick thrust plate)	45.300...45.380 mm
- 4th oversize (two 0.2 mm overthick thrust plates)	45.400...45.480 mm

Other crankshaft journals cannot be ground longer.

Rounded corner of crankpins and journals	R4+0.5 mm
Crankshaft end float.	0.100...0.380 mm
Max. permissible ovality and other deformity of crankpins or journals.	0.03 mm
Crankshaft unbalance	1.0 Ncm max.
Number of teeth on trigger wheel	60-2

Flywheel

Interference fit between ring gear-flywheel	0.425...0.600 mm
Before fitting the ring gear, heat up to a temperature of	150...200°C
Flywheel unbalance	1.0 Ncm max.
Max. permissible axial wobble of flywheel clutch face, measured at inner edge of clutch face on diameter 200.	0.06:Ø200

Balancing Unit**44- and 49-Engines**

Tooth backlash:

- crankshaft ring gear-balancer weight gear wheel	0.1...0.3 mm
- between the balancer weight gear wheels	0.05...0.250 mm

Balancing weights end float.	0.1...0.3 mm
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Shaft diameter at bearing surfaces	36.000...36.016 mm
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Bearing bushing inner diameter (fitted)	36.050...36.075 mm
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Diameter of holes in body for shafts, rear end.	36.058...36.083 mm
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Diameter of holes in body for shafts, front end	35.958...35.983 mm
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Shim thickness, cylinder block-balancer unit.	0.2 mm
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Timing Gears

Tooth backlash	0.05...0.25 mm
Max. permissible side wobble of gears	0.05 mm
Idle gear (slide bearing, 50.7 mm length shaft)	
- Idler gear shaft, diameter	55.151...55.170 mm
- Inner diameter of idler gear bushing (fitted)	55.200...55.230 mm
Inner diameter of idler gear hole	60.000...60.030 mm

Timing marks:

Timing marks on gears are in alignment when the 1st cylinder piston is at its top, dead centre between compression and power strokes.

On crankshaft gear 2 dots on tooth

On idler gear:

- against crankshaft gear mark 1 circle on tooth

- against camshaft gear mark 1 dot on tooth

On camshaft gear 1 dot on notch

Connecting Rod

Big-end bearing shell thickness:

- standard 1.835...1.842 mm

- 1st undersize 0.25 mm 1.960...1.967 mm

- 2nd undersize 0.50 mm 2.085...2.092 mm

- 3rd undersize 1.00 mm 2.335...2.342 mm

- 4th undersize 1.50 mm 2.585...2.592 mm

Big-end bearing clearance 0.046...0.098 mm

End float (side clearance) at big-end on crankshaft 0.200...0.410 mm

Piston pin bushing location perpendicular to longitudinal axis of connecting rod to be within 0.15:100

Piston pin bushing location and big-end bearing location to be parallel to within 0.05:100

Max. permissible weight difference between connecting rods in the same engine 20 g

Weight marking (letter) at lower end.

44-, 49-, 66- and 74-Engines

Inside diameter of piston pin bush (with bush pressed into connecting rod) 40.025...40.040 mm

Outside diameter of piston pin bush (std) 44.080...44.120 mm

Outside diameter of piston pin bush (oversize 8353 28326) 44.580...44.620 mm

Interference fit: connecting rod small end bushing-connecting rod. 0.057...0.120 mm

Connecting rod small end bore 44.000...44.025 mm

Connecting rod small end bore (oversize bush) 44.500...44.525 mm

Connecting rod big-end bore. 71.730...71.749 mm

84-Engines

Inside diameter of piston pin bush (with bush pressed into connecting rod) 44.025...44.040 mm

Outside diameter of piston pin bush (std) 48.080...48.120 mm

Outside diameter of piston pin bush (oversize 8363 38606) 48.580...48.620 mm

Interference fit: connecting rod small end bushing-connecting rod. 0.057...0.120 mm

Connecting rod small end bore 48.000...48.025 mm

Connecting rod small end bore (oversize bush) 48.500...48.525 mm

Connecting rod big-end bore. 76.730...76.749 mm

Piston, Rings and Pin

44-, 49-, 66- and 74-Engines

Piston diameter:

- 17 mm from lower edge (44-, 66- 2V and 4V engines) 107.883...107.897 mm
- 19 mm from lower edge (49-, 74- 2V and 4V engines) 107.893...107.907 mm

Pin bore in piston 40.003...40.009 mm

Piston pin diameter 39.991...40.000 mm

Width of ring grooves:

- 1st groove wedge shaped ring
- 2nd groove. 2.520...2.540 mm
- 3rd groove 4.040...4.060 mm

Side clearance of piston rings in their grooves:

- 1st ring wedge shaped ring
- 2nd ring 0.03...0.062 mm
- 3rd ring 0.05...0.082 mm
- Reject limit. 0.15 mm

Piston ring height (in direction of cylinder):

- 1st ring wedge shaped ring
- 2nd ring 2.478...2.490 mm
- 3rd ring 3.975...3.990 mm

Piston ring gap (with piston fitted in cylinder):

- 1st ring 0.40...0.55 mm
- 2nd ring 0.60...0.80 mm
- 3rd ring 0.30...0.60
- Reject limit 1st and 3rd ring 1.0 mm
- Reject limit 2nd ring 1.5 mm

Max. permissible weight difference between pistons in same engine 25 g

Piston must be heated up to 100°C before fitting gudgeon pin.

84-Engines

Piston diameter:

- 15 mm from lower edge 110.863...110.877 mm

Pin bore in piston 44.003...44.009 mm

Piston pin diameter 43.994...44.000 mm

Width of ring grooves:

- 1st groove wedge shaped ring
- 2nd groove. 2.520...2.540 mm
- 3rd groove 4.040...4.060 mm

Side clearance of piston rings in their grooves:

- 1st ring wedge shaped ring
- 2nd ring 0.03...0.062 mm
- 3rd ring 0.05...0.082 mm
- Reject limit. 0.15 mm

Piston ring height (in direction of cylinder):

- 1st ring wedge shaped ring
- 2nd ring 2.478...2.490 mm
- 3rd ring 3.975...3.990 mm

Piston ring gap (with piston fitted in cylinder):

- 1st ring (wedge shaped ring) 0.35...0.50 mm
- 2nd ring 0.60...0.80 mm
- 3rd ring 0.30...0.60
- Reject limit 1st and 3rd ring 1.0 mm
- Reject limit 2nd ring 1.3 mm

Max. permissible weight difference between pistons in same engine 25 g

Piston must be heated up to 100°C before fitting gudgeon pin.

Lubricating System

Oil pressure at normal running temperature:

- at idling speed (min.) 1.0 bar
- at running speed 2.5...5.0 bar

Oil pressure regulating valve (44-, 49-engines):

Free length of oil pressure valve spring 48.2...51.8 mm

Assembly length / load of oil pressure valve spring 28.5 mm / 89 N

Oil pressure regulating valve (66-, 74- and 84-engines):

Free length of oil pressure valve spring (identification = yellow dot). 49.3...50.8 mm

Assembly length / load of oil pressure valve spring 28.5 mm / 127 N

Oil filter by-pass valve opens at a pressure difference of 2 ± 0.5 bar

Oil Pump

44- and 49- Engines

Backlash between gears when crankshaft lies firmly against the lower side of the main bearings:

- crankshaft gear-lubricating oil pump gear. 0.05...0.25 mm

- between the pump gears 0.16...0.26 mm

Diameter of drive shaft at bearings for body and cover 17.966...17.984 mm

Diameter of shaft holes on body and cover. 18.000...18.018 mm

Diameter of gear wheel hole 18.060...18.078 mm

Fixed shaft, diameter. 18.028...18.039 mm

Protrusion of fixed shaft end below pump body face 0.5...1.0 mm

Thickness of cover gasket. 0.06...0.08 mm

Outside diameter of gear. 43.486...43.525 mm

Housing diameter 43.650...43.750 mm

Thickness of gears 24.000...24.027 mm

End play of gears 0.03...0.11 mm

Depth of housing 24.000...24.043 mm

66-, 74- and 84-Engines

Backlash between gears when crankshaft lies firmly against the lower side of the main bearings:

- crankshaft gear-lubricating oil pump gear. 0.05...0.25 mm

- between the pump gears 0.16...0.26 mm

Diameter of drive shaft at bearings for body and cover 17.966...17.984 mm

Diameter of drive shaft bearing hole on body and cover. 18.000...18.018 mm

Inner diameter of bearing for gear wheel which rotates on fixed shaft 18.000...18.018 mm

Diameter of fixed shaft at gear wheel 17.966...17.984 mm

Fixed shaft in pump body, diameter 20.035...20.048 mm

Protrusion of fixed shaft end below pump body face 0.5 mm

Thickness of cover gasket. 0.06...0.08 mm

Outer diameter of gear wheels 55.824...55.870 mm

Housing diameter 56.000...56.120 mm

Thickness of gears 32.000...32.027 mm

End play of gears 0.03...0.11 mm

Depth of housing 32.000...32.043 mm

Coolant Pump

44- and 49-Engines

Outside diameter of bearing	52 mm
Diameter of bearing housing	51.979...52.009 mm
Shaft diameter at bearing	20.002...20.015 mm
Shaft diameter at impeller	15.907...15.920 mm
Impeller hole diameter	15.876...15.894 mm
Distance between impeller blade and housing	0.2...1.0 mm
Balancing precision of fan	0.3 Ncm max.
Max. permissible eccentricity of fan	±0.3 mm

66- and 74-Engines

Outside diameter of bearing	72 mm
Diameter of bearing housing	71.961...71.991 mm
Diameter of the water seal recess in the pump body	39.981...40.019 mm
Shaft diameter at bearing	30.002...30.015 mm
Shaft diameter at impeller	15.907...15.920 mm
Impeller hole diameter	15.876...15.894 mm
Distance between impeller blade and housing	0.7 mm
Balancing precision of fan	0.3 Ncm max.

Pump Equipped with Reinforced Bearing

Outer diameter of the front bearing 95 mm:	
Bearing up diameter in water pump wheel	94.965...95.000 mm
Outer diameter of bearings position in pump frame	60.002...60.021 mm
Outer diameter of the front bearing 120 mm:	
Bearing up diameter in water pump wheel	119.965...120.000 mm
Outer diameter of bearings position in pump frame	65.002...65.021 mm
Outside diameter of rear bearing	52 mm
Diameter of bearing housing	51.979...52.009 mm
Diameter of the water seal recess in the pump body	36.450...36.489 mm
Shaft diameter at rear bearing	20.002...20.015 mm
Shaft diameter at impeller	15.907...15.920 mm

84-Engines

Outside diameter of bearing	47 mm
Diameter of bearing housing	46.967...46.992 mm
Shaft diameter at bearing	19.996...20.009 mm
Shaft diameter at impeller	15.917...15.930 mm
Impeller hole diameter	15.879...15.890 mm
Diameter of the water seal recess in the pump body	39.981...40.019 mm

Thermostat

Order no.	Type	Opening begins at	Fully open at	Max. stroke
8366 66334	ø67 mm / 83°C	83°±2°C	95°C	8.0 mm
8366 59685	ø67 mm / 86°C	86°±2°C	99°C	8.0 mm
8360 15156	ø54 mm / 79°C	79°±2°C	94°C	7.5 mm
8363 31590	ø67 mm / 83°C	83°±2°C	95°C	8.0 mm

Turbocharger

Schwitzer

	S100	S200	S300
Axial clearance max.	0.10 mm	0.10 mm	0.12 mm
Radial clearance (compressor end) max.	0.82 mm	0.88 mm	0.88 mm
Compressor wheel locknut torque	6.8 Nm	13.6 Nm	20.3 Nm
Compressor housing screws torque	13.6 Nm	13.6 Nm	13.6 Nm
Turbine housing screws torque	21.0 Nm	21.0 Nm	21.0 Nm

TIGHTENING TORQUES

Object	Nm
Cylinder head bolts and nuts	80 Nm + 90° + 90°
Cylinder head studs to cylinder block	30
Main bearing screws	200
Connecting rod screws	40 Nm + 90°
Crankshaft nut, 44/49	600
Crankshaft nut, 66/74/84	1000
Crankshaft pulley screws	30
Crankshaft pulley screws, 74/84	80
Flywheel housing screws:	
- M12	150
- M10	80
Flywheel screws	150
Flywheel screws, 84	200
Idler gear screws, 44/49/66:	
- M10	60
- M14	200
Idler gear screws (with ball bearing), 66/74/84:	
- M14	180
- M8	32
Double idler gear:	
- M12 screw	120
- M14 nut	140
Camshaft gear nut	200
Rocker arm shaft bracket screw and nuts	45
Valve cover and frame screws	25
Piston cooling valve	30
Oil pump retaining screws	50
Oil sump drain plug M18	80
Oil cooler connecting piece, 44/49/66/74	60
Coolant pump pulley screw, 44/49	80
Coolant pump pulley nut, 44/49/66/74	120
Coolant pump gear nut, 84	180
Belt tightener screw, 44/49/66/74	48
Exhaust manifold screws	50

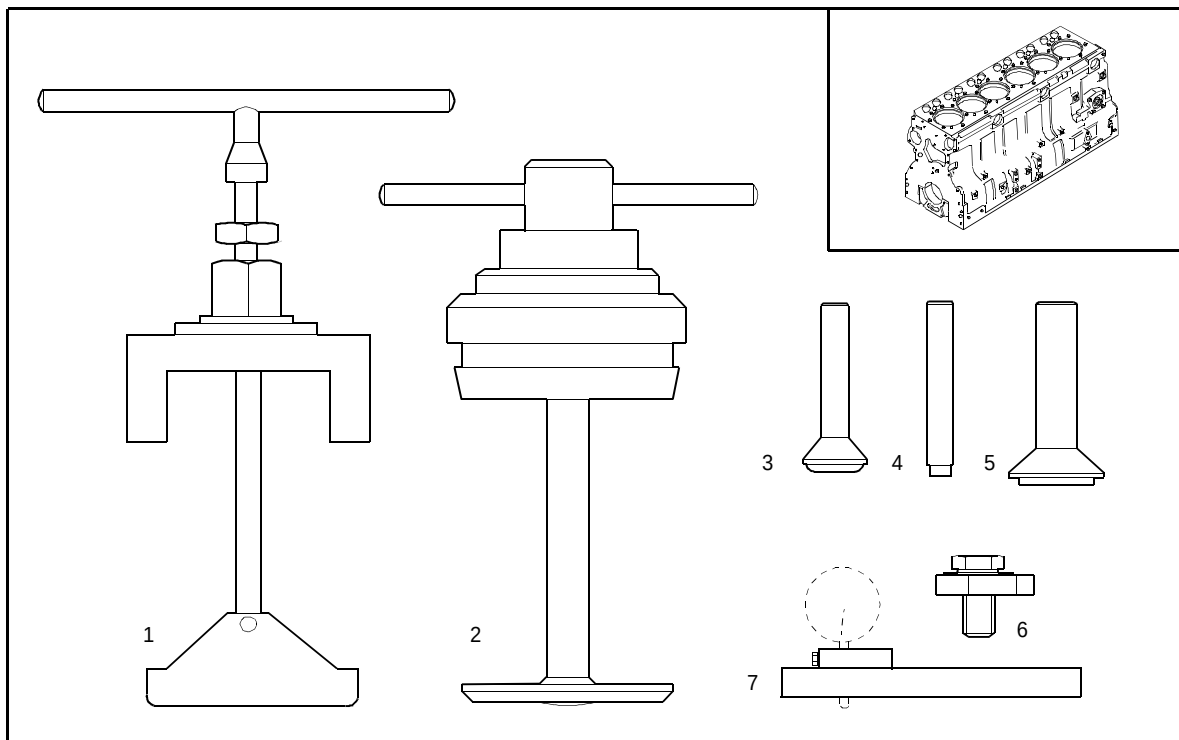
Always use the torque values listed in the following tables when specific torque values are not available.

Thread	Strength class	
	8.8	10.9
M8	25 Nm	35 Nm
M10	50 Nm	75 Nm

Use a washer with the aluminium parts.

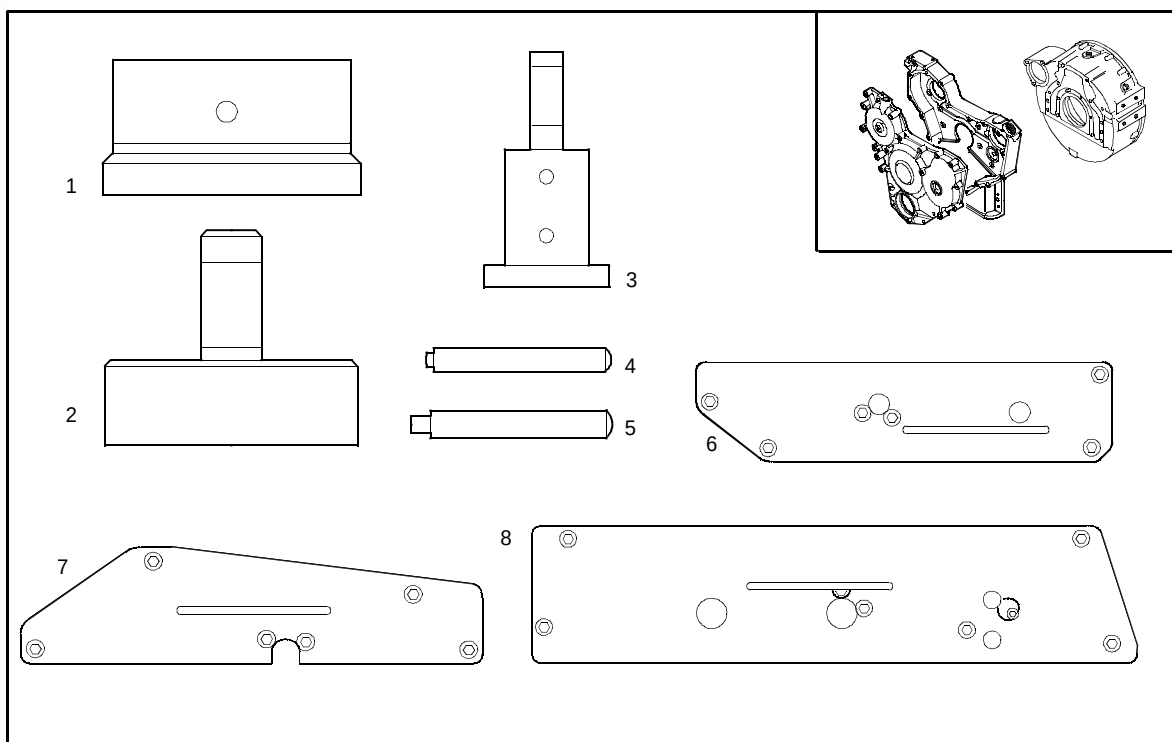
SPECIAL TOOLS

Cylinder Block



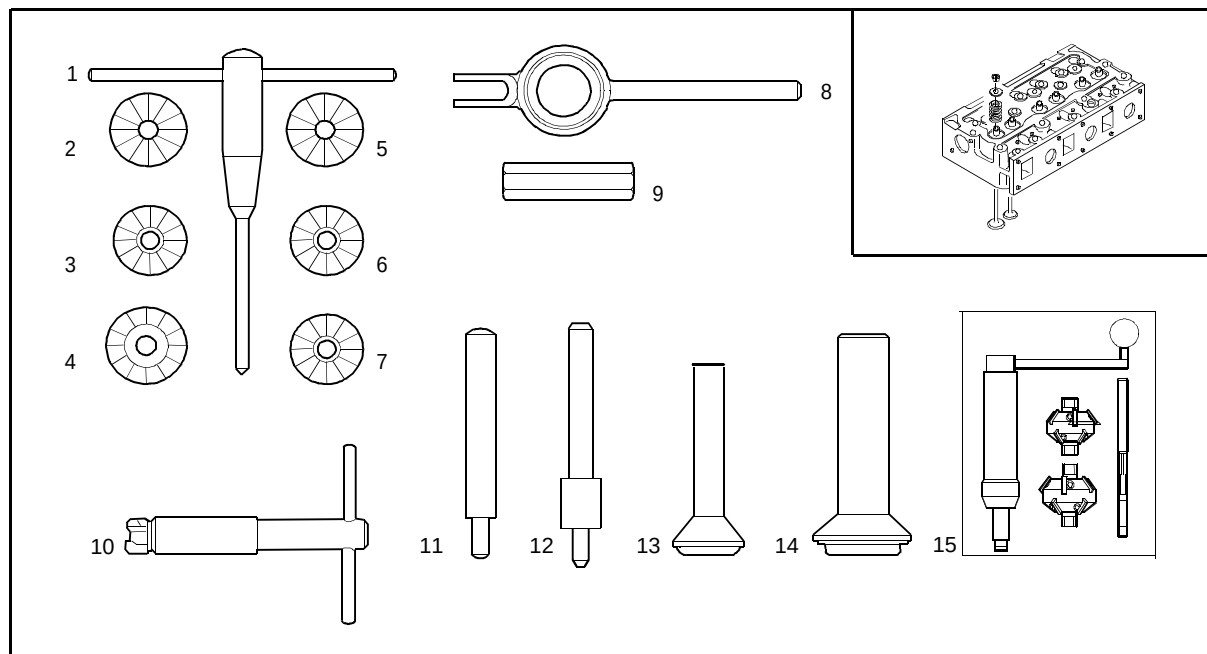
Ref.	Description	Order no.	44	49	66	74	84
1	Puller for cylinder liner	9051 73100	x	x	x	x	
		9104 51500					x
2	Milling cutter for cylinder liner seat	9101 65600	x	x	x	x	
		9104 52000					x
-	Spare cutting blade for milling cutter	9045 87600	x	x	x	x	x
3	Drift for 40 mm cup plug	9052 46620	x	x	x	x	x
4	Drift for 16 mm cup plug	9052 46650	x	x	x	x	x
5	Drift for fitting camshaft cup plug	9025 87400	x	x	x	x	x
6	Press tool for cylinder liner	9101 66300	x	x	x	x	x
7	Holder for dial gauge	9025 79200	x	x	x	x	x

Timing Gear- and Flywheel Housing



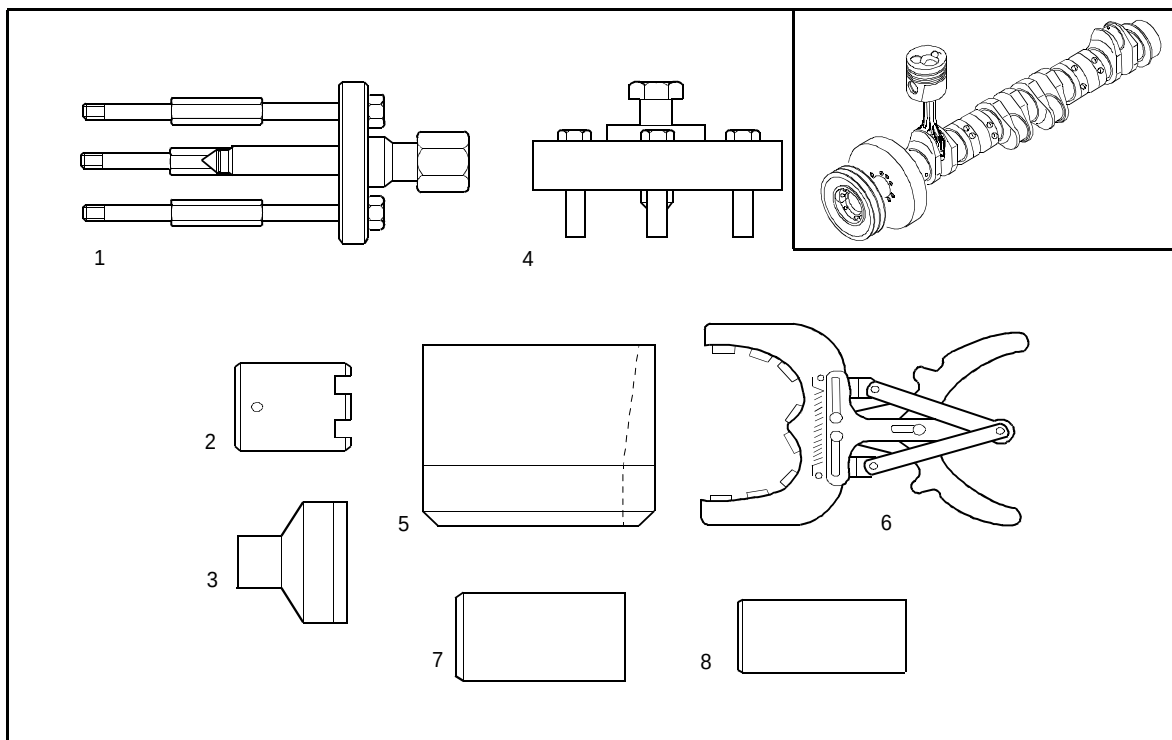
Ref	Description	Order no.	44	49	66	74	84
1	Centring tool for flywheel housing	9052 46400	x	x	x	x	
		9104 52700					x
2	Drift for fitting rear crankshaft seal	9052 46300	x	x	x	x	
		9104 52600					x
3	Drift for fitting front crankshaft seal	9030 15200	x	x	x	x	
		9103 94600					x
4	Drift for tension pins in timing gear housing	9025 98800	x	x	x	x	
5	Drift for tension pins in timing gear- and flywheel housing	9025 98700	x	x	x	x	x
6	Centring tool for idler gear, narrow timing gear housing	9201 30270				x	
7	Centring tool for idler gear, narrow timing gear housing	9201 30290					x
8	Centring tool for idler gear, broad timing gear housing	9201 30150					x

Cylinder Head and Valve Mechanism



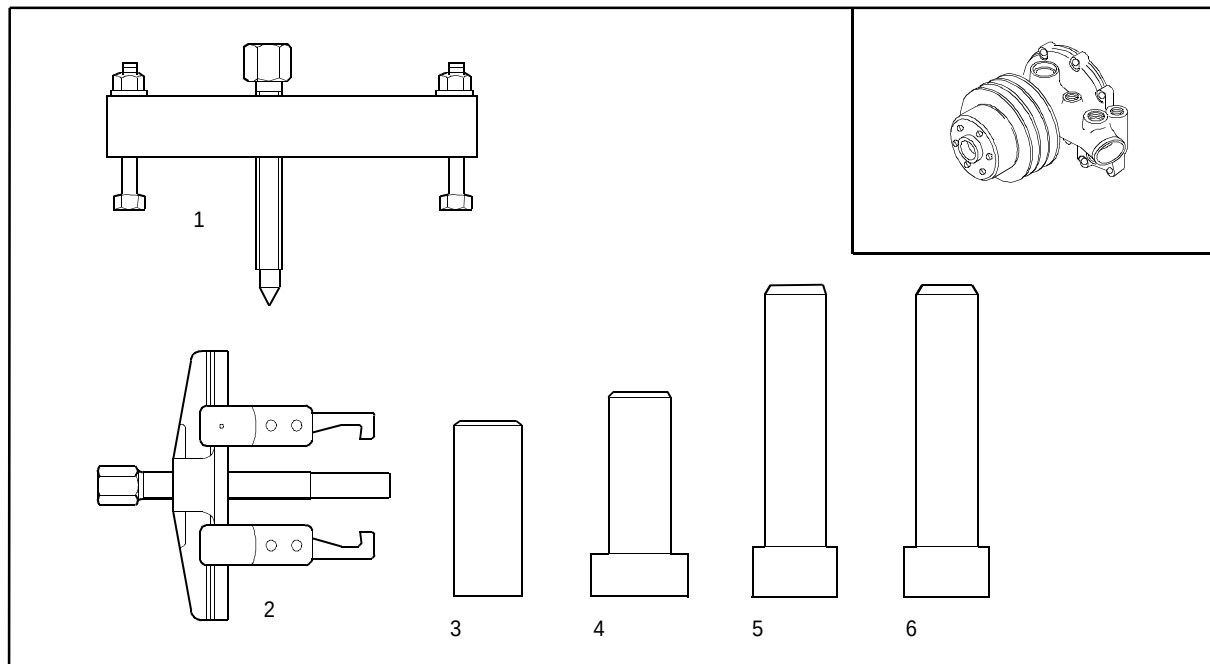
Ref.	Description	Order no.	44	49	66	74	84
1	T-handle for valve seat milling cutter	9101 66100	x	x	x	x	x
2	Milling cutter for facing exhaust valve seat	9101 71100	x	x	x	x	x
3	Milling cutter for exhaust valve seat	9101 65502	x	x	x	x	x
4	Inner milling cutter for exhaust valve seat	9101 65503	x	x	x	x	x
5	Milling cutter for facing inlet valve seat	9101 75800	x	x	x	x	x
6	Milling cutter for inlet valve seat	9101 65505	x	x	x	x	x
7	Inner milling cutter for inlet valve seat	9101 65506	x	x	x	x	x
8	Lever for compressing valve spring	9101 66200	x	x	x	x	x
9	Counter nut for lever above	9052 47200	x	x	x	x	x
10	Milling tool for injector seat, 2V engines	9120 85600	x	x	x	x	
	Milling tool for injector seat, 4V engines	9120 85400	x	x	x	x	x
11	Drift for removing valve guide, 2V engines	9101 65800	x	x	x	x	
	Drift for removing valve guide 4V engines	9120 85300	x	x	x	x	x
12	Drift for fitting valve guide, 2V engines	9101 65900	x	x	x	x	
	Drift for fitting valve guide, 4V engines	9120 85000	x	x	x	x	x
13	Drift for 36 mm cup plug	9052 46660	x	x	x	x	x
14	Drift for 45 mm cup plug	9103 94800			x	x	x
15	Milling cutter kit for valve seat, 4V engines	8370 62635	x	x	x	x	x

Crank Mechanism



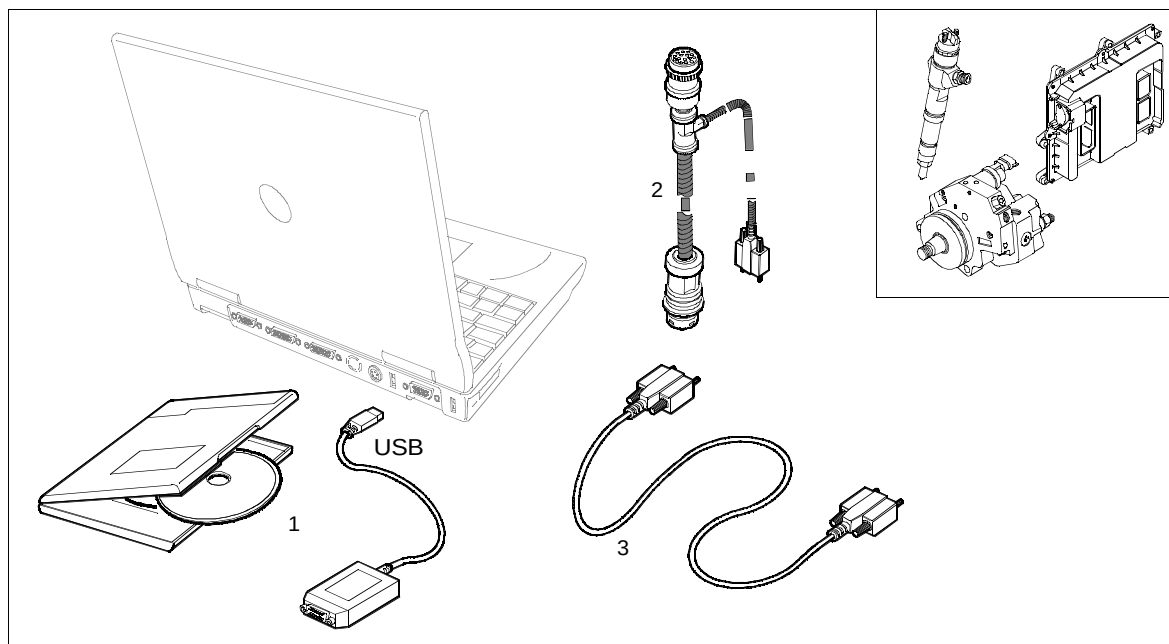
Ref.	Description	Order no.	44	49	66	74	84
1	Puller for crankshaft gears	9052 48800	x	x	x	x	
2	Spanner for crankshaft nut	9024 55800			x	x	x
3	Spanner for crankshaft nut	9101 65700	x	x	x		
4	Puller for crankshaft hub	9104 53300				x	x
5	Conical sleeve for fitting pistons	9020 01100	x	x	x	x	
		9105 18700					x
6	Piston ring pliers	9052 46900	x	x	x	x	x
7	Drift for fitting crankshaft gears	9103 94700	x	x	x	x	x
8	Drift for fitting oil deflector ring, crankshaft front end	9103 94900					x

Coolant Pump



Ref.	Description	Order no.	44	49	66	74	84
1	Puller for coolant pump impeller	9101 93200			x	x	
2	Puller for coolant pump impeller	9104 27700	x	x			
3	Drift for fitting coolant pump water seal	9051 79300	x	x	x	x	
4	Drift for fitting coolant pump bearings	9103 41300					x
5	Drift for fitting coolant pump shaft seal	9103 41000					x
6	Drift for fitting coolant pump water seal	9103 41100					x

Fuel System



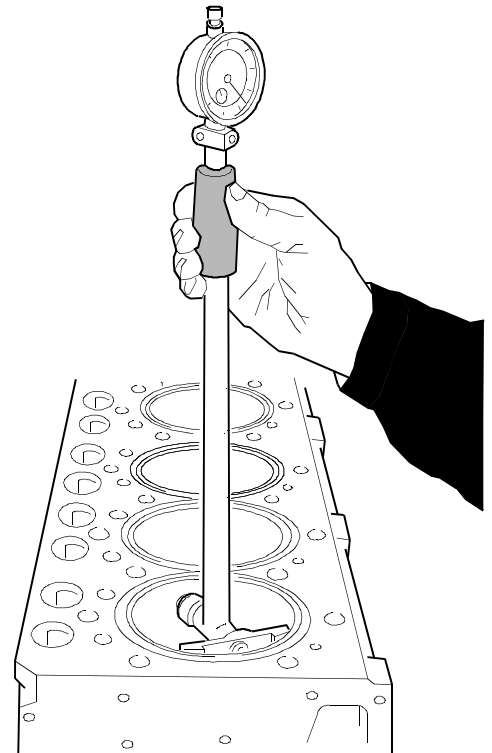
Ref.	Description	Order no.	44	49	66	74	84
1	Sisu EEM 3 service tool (incl. USB adapter)	8370 62634	x	x	x	x	x
2	Adapter for vehicle connector	8368 62480	x	x	x	x	x
3	Extension cable (L = 5 m)	8368 62483	x	x	x	x	x

WORK INSTRUCTIONS

1. CYLINDER BLOCK

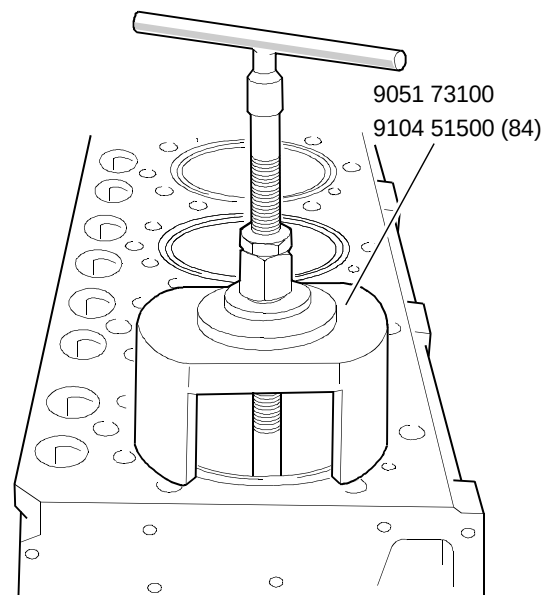
1.1. Measuring Cylinder Liner Wear

1. Using a micrometer, set the dial gauge to zero using a new cylinder liner indicating the initial dimension of the bore. See "Technical data", point "Cylinder liners".
2. Clean the inner surface of the cylinder liner thoroughly before measurement.
3. Perform the measurement crosswise at the top end, lower end and middle of the liner.
4. Check the gauge reading for maximum wear and ovalness (compare with rated).



1.2. Removing Cylinder Liner

1. If the cylinder liners are to be used again they should be marked so that they can be fitted in the same position.
2. Remove the cylinder liners using cylinder liner puller 9051 73100 or 9104 51500 (84-engines).



1.3. Checking Cylinder Block

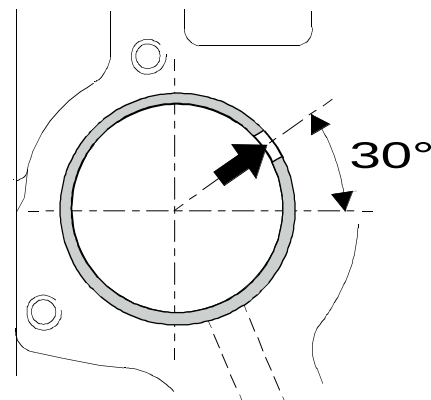
1. Clean the cylinder block and all oilways.
2. Check the cooling channels and remove the scale and sediment to ensure engine cooling.
3. Check the tightness of the cup plugs and threaded plugs in the cylinder block as well as the condition of the cylinder block and sealing faces.
4. Measure the wear of the camshaft bearing points (compare with rated).

Note! If it is necessary to machine the upper face of the cylinder block, the pistons must be shortened by the same dimension. Observe the valve disc spaces on the piston upper face.

1.4. Changing Camshaft Bushing

44- and 49-Engines

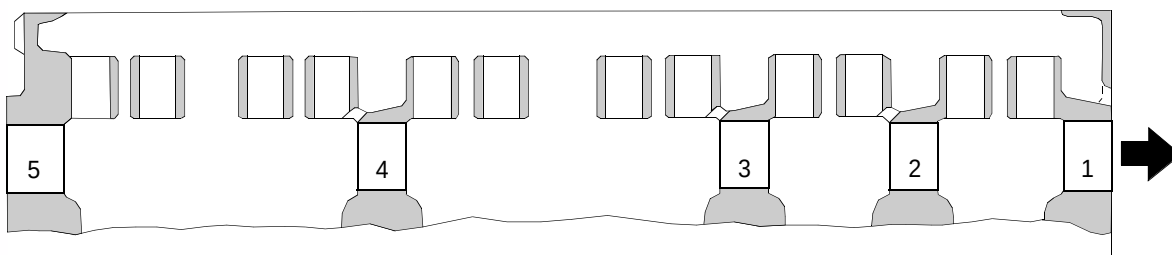
1. Extract the bushing with an internal puller, for example Sykes 854. If the camshaft rear end plug is removed, the bushing can be forced out with a long drift.
2. Clean the bushing location carefully.
3. Fit the oil hole of the bushing at a 30° angle from horizontal level as shown in the picture. It is unnecessary to ream the bushing because it has a correct inner diameter when it is fitted in place.



66-, 74-, and 84-Engines

On 66-, 74- and 84-engines, all camshaft bearing points are provided with a separate bearing bushing.

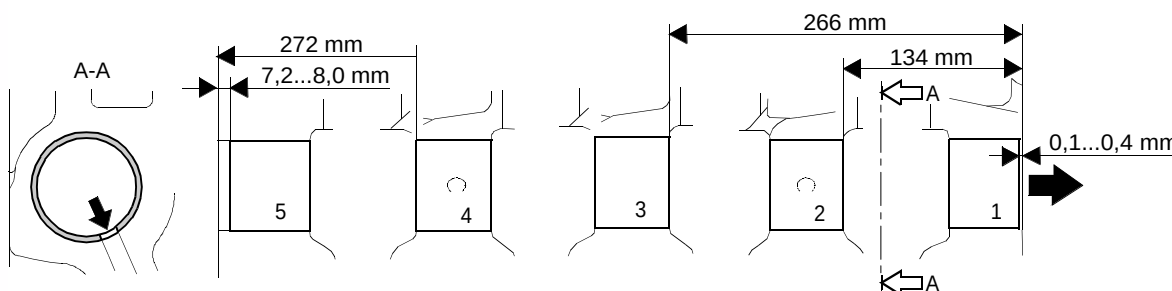
1. Remove the camshaft rear end plug and tap the bushings out with a long drift. Observe the different outer diameters when removing.
2. Clean the bushing locations carefully.



Hole diameters for the bushings. Numbering begins from the front end of the engine.

Hole Diameter

1.) 55.62...55.65 mm	2.) 55.42...55.45 mm	3.) 55.22...55.25 mm
4.) 55.42...55.45 mm	5.) 55.64...55.67 mm	



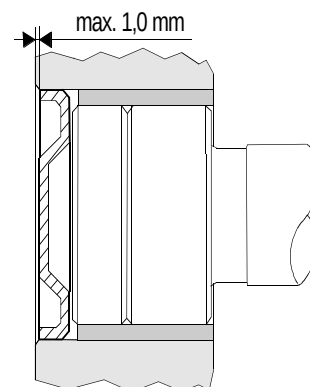
3. Press in new bushings (2 - 5). Observe the different outer diameters. Note the position of the oil hole. It is unnecessary to ream the bushing because it has a correct inner diameter when it is fitted in place.

Note! The camshaft front end bushing (1) is equipped with the oil groove on the outside. Fit the oil hole of the bushing at a 30° angle from horizontal level (see picture at the top of the page). The bushing has the correct measurements after assembly (no need for machining).

1.5. Fitting Plug at Camshaft Rear End

1. Clean the seat for the plug.
2. Apply sealing compound to the contact surface of the plug.
3. Drive in the plug with fitting drift 9025 87400.

Note! Do not drive in the plug too far because it will affect the camshaft end float



1.6. Oversize Bushings for Camshaft

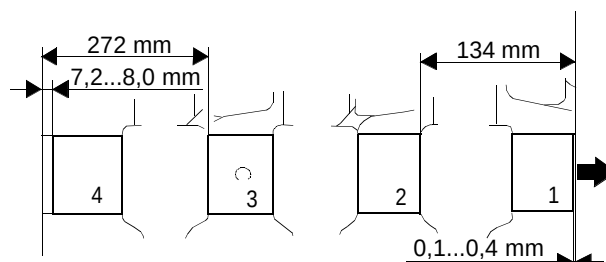
44- and 49-Engines

If the location of the camshaft bushing (front bearing) is damaged, a bushing with a **0.4 mm** oversize outer diameter can be fitted. Bushings are available even for other camshaft bearings which do not normally have bushings. Order numbers and machining dimensions for the bushing locations are shown in the figure.

Observe the position of the bushing oil holes. It is unnecessary to ream the bushings after fitting.

Order numbers of the oversize camshaft bushings and hole diameters for the bushings, 44-engines. Numbering begins from the front end of the engine.

Order no.	Hole Diameter
1. 8368 66036	56.02...56.05 mm
2. 8368 52460	55.42...55.45 mm
3. 8368 52460	55.42...55.45 mm
4. 8368 52461	55.64...55.67 mm



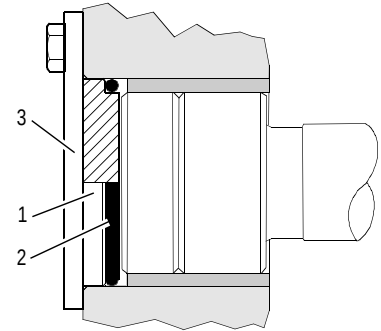
66-, 74- and 84-Engines

Order numbers of the oversize camshaft bushings and hole diameters for the bushings. Numbering begins from the front end of the engine. Installing places are the same as with the standard bushings. See the previously page.

Order no.	Hole Diameter
1. 8368 66036	56.02...56.05 mm
2. 8368 52466	55.62...55.65 mm
3. 8368 52460	55.42...55.45 mm
4. 8368 52466	55.62...55.65 mm
5. 8368 52467	55.84...55.87 mm

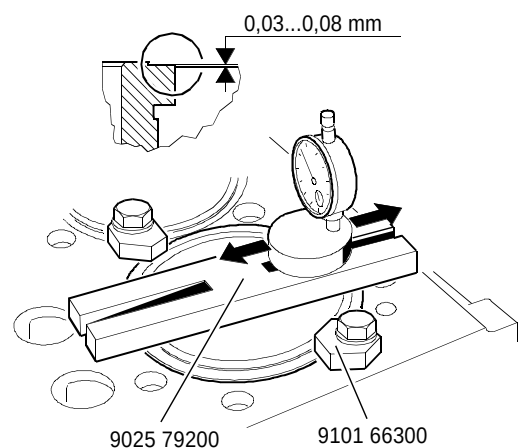
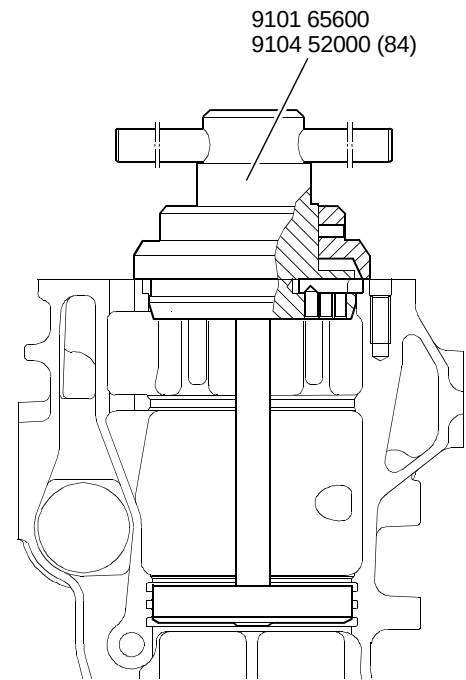
1.7. Fitting Plug at Camshaft Rear End (oversize bushings)

The camshaft rear end plug is replaced with plug 8363 24391 (1) and O-ring 6146 05125 (2) after machining. Use plate 8361 24210 (3) in those engines where the flywheel housing is not covering the blocking plug.



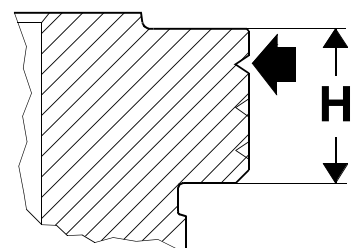
1.8. Fitting Cylinder Liner

1. Clean the cylinder liner and its recess in the cylinder block. Without O-rings, the liner should rotate easily in its recess.
2. Apply a thin layer of marking paint on the underside of the cylinder liner flange. Fit the cylinder liner without O-rings and turn it forwards and backwards. Lift out the liner and check that paint has been deposited on the whole contact surface.
3. If the recess is damaged, or the cylinder liner height (see point 5) needs to be adjusted, use milling cutter 9101 65600 or 9104 52000 (84-engines). If necessary, a light lapping can be executed after milling with the help of the cylinder liner. Apply lapping paste to the underside of the cylinder liner flange, and twist the liner with twisting tool. Lapping is not suitable for adjusting the cylinder liner height.
4. Clean the contact surfaces.
5. Fit the cylinder liners and fix each liner with two press tools 9101 66300. Measure the cylinder liner height with a dial gauge and holder 9025 79200. Zero the dial gauge against a flat surface, for example, the cylinder block face. Measure each liner in four places. The height of the liner above the cylinder block face should be **0.03...0.08 mm**. The height difference between cylinder liners under the same cylinder head must not exceed **0.02 mm**, nor must an intermediate cylinder liner lie lower than an outer one.
6. If the cylinder liner height is too low, a liner with a higher flange should be fitted.



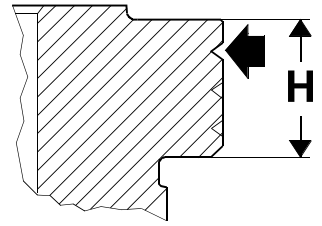
44-, 49-, 66- and 74-Engines

Order no.	H	Marking grooves pcs
8366 47420	9.03 ^{+0.02}	- (std.)
8366 47933	9.08 ^{+0.02}	1
8366 47934	9.13 ^{+0.02}	2
8366 47935	9.23 ^{+0.02}	3



84-Engines

Order no.	H	Marking grooves pcs
8368 67048	9.03 ^{+0.02}	- (std.)
8368 67050	9.08 ^{+0.02}	1
8368 67051	9.13 ^{+0.02}	2
8368 67052	9.23 ^{+0.02}	3



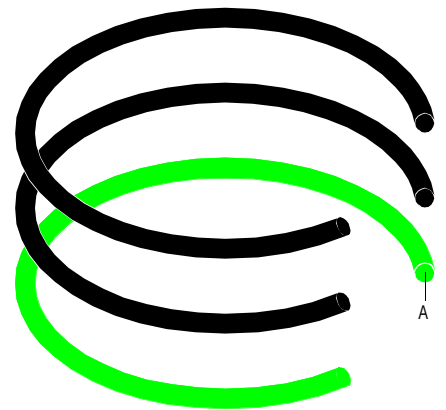
Cylinder liners with oversize flanges (higher flanges) are marked with grooves on the outer circumference as follows:

- 1st oversize, 0.05 mm = 1 marking groove
- 2nd oversize, 0.10 mm = 2 marking grooves
- 3rd oversize, 0.20 mm = 3 marking grooves

Note! Recess depth is adjusted with a cylinder liner recess cutter 9101 65600 or 9104 52000 (84-engines).

7. If the liner height of a cylinder liner is not the same all the way round, the cylinder liner flange and the cylinder block recess depth should be checked. Cylinder liners with warped flanges should be discarded.

8. Fit the O-rings into the grooves in the cylinder liner. For 84-engines, fit the O-rings into the grooves in the cylinder block. Fit the green O-ring (A) into the lowest groove. Lubricate the O-rings with a liquid soap (not with engine oil).



Note! Stretch the O-rings as little as possible when fitting them. Max. permissible stretch is 6%.

9. Press the cylinder liners into the cylinder block. It should be easy to press them fully home. Make sure that the liners do not rise up after fitting.

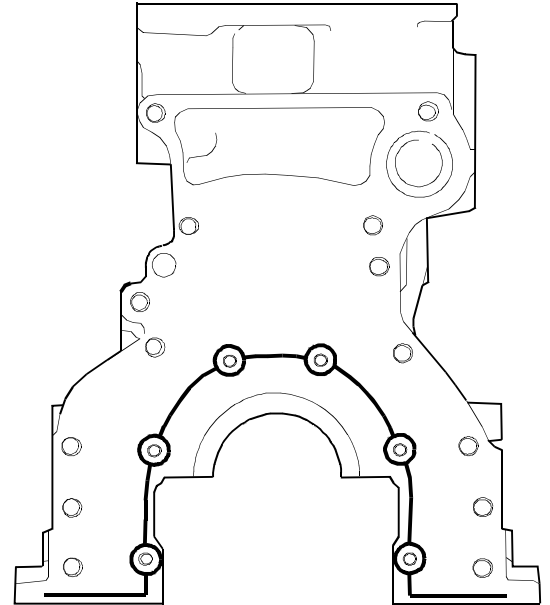


2. FLYWHEEL HOUSING

2.1. Fitting Flywheel Housing

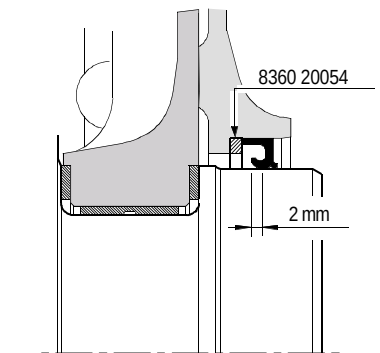
The flywheel housing is centred on the cylinder block by two tension pins. Even the flywheel housings which are delivered as spare parts have ready-made holes for the pins.

1. Clean the sealing surfaces between the cylinder block and the flywheel housing.
2. Apply silicone sealant as shown in the picture.
3. Lift the flywheel housing into place and fit all the bolts.
4. Centre the housing with centring tool 9052 46400 or 9104 52700 (84-engines). **Note!** This is important for engines with a turbine clutch. Fit the tension pins with drift 9025 98700.
5. Tighten the fixing bolts: the inner ring socket head bolts to **80 Nm** and the outer ring hexagonal bolts to **150 Nm**.



2.2. Changing Crankshaft Rear Oil Seal

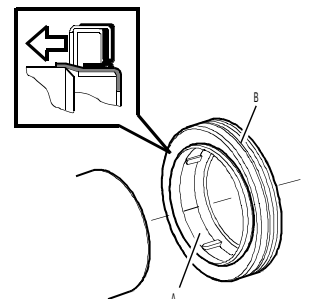
1. Lift out the engine. Remove the clutch assembly (and if applicable the turbine clutch).
2. Remove the flywheel.
3. Remove the oil seal. Do not damage the crankshaft.
4. Clean the seal location and grind off any burrs.



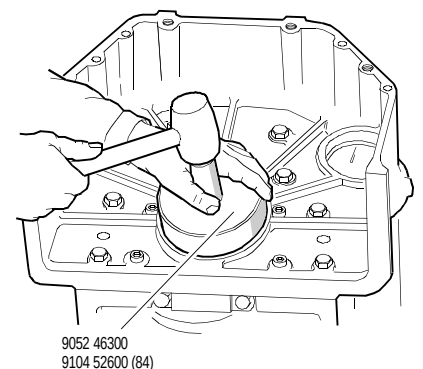
Note! If the crankshaft is worn at the sealing location, a 2 mm spacer ring, order no. 8360 20054, can be fitted in front of the crankshaft rear oil seal.

5. Fit the seal as follows:

- Do not remove the plastic sleeve before installing.
- Fit the seal dry, **not oiled**.
- Put the sleeve (A) against the crankshaft rear end so that the sleeve is on the shaft bevelling.
- Push the seal (B) over the sleeve on the shaft and further against the flywheel housing.



- Remove the sleeve and hit the seal into position with the fitting tool 9052 46300 or 9104 52600 (84-engines).



3. CYLINDER HEAD, 2V ENGINES

3.1. Removing Cylinder Head

1. Disconnect current from the main switch.
2. Clean the engine externally and drain the coolant. Disconnect the coolant hoses from the cylinder head and the thermostat housing.
3. Remove the suction hoses between the turbocharger and the air filter and between the turbocharger and the inlet manifold.
4. Disconnect the turbocharger pressure and return oil pipes.
5. Disconnect the wires from the intake air heater and injectors.
6. Remove the injector leak-off fuel pipe and the high-pressure pipes. Remove the injectors. Fit blanking-off caps on all open connections.

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 sec. after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries.

7. Remove the inlet and exhaust manifolds and the thermostat housing.

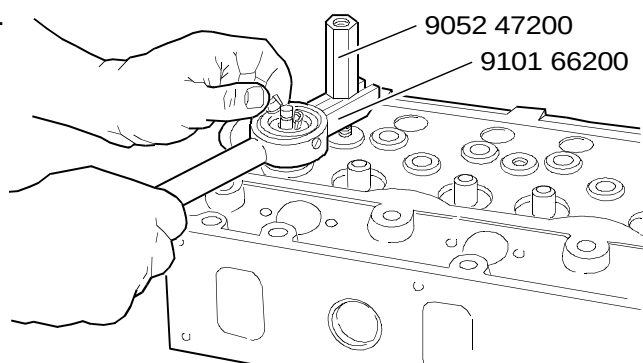
Note! It is possible to remove the cylinder head even though these parts are attached to the head.

8. Remove the valve cover.
9. Remove the rocker arm mechanism and the push rods.
10. Loosen all the cylinder head bolts first by a 1/4 turn, then loosen them fully and remove. Remove the cylinder head.

3.2. Removing Valves

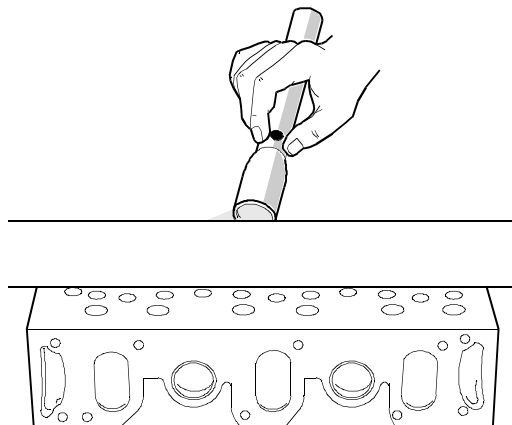
Ensure that valves which are to be re-used are marked, so that they can be re-fitted in their original locations.

1. Install the counter screw 9052 47200 for the valve spring installing tool in the rocker arm cover bolt. On 33-, 66-, 74- and 84-engines there is no screw stud on the valves for the centre cylinder. A bolt of suitable length should be used instead.
2. Compress the valve springs using lever 9101 66200. Remove the valve cotters, spring guide and spring. Remove the valves.

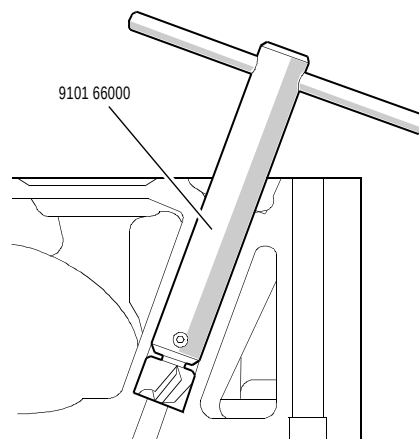


3.3. Checking Cylinder Head

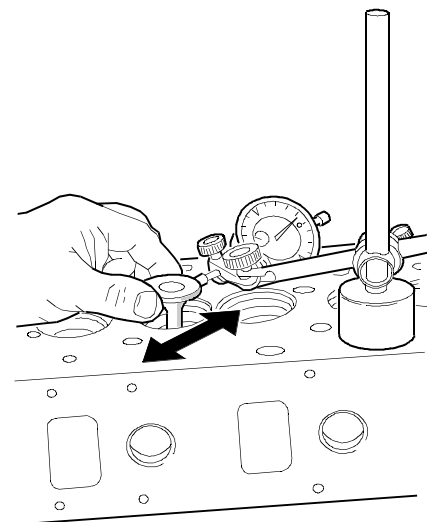
1. Remove the soot from the exhaust ports, clean the sealing surfaces and wash the cylinder head.
2. Check for cracks and other damage.
3. Check the flatness of the cylinder head against a straight edge. An uneven or warped surface should be surface ground. The height of the cylinder head, after grinding, should not be less than **104.00 mm**. The valve disc depth from the cylinder head surface should be **0.60 mm** for the exhaust valves and **0.70 mm** for the inlet valves.



4. Straighten and clean the injector location seat in the cylinder head with cutter 9101 66000.

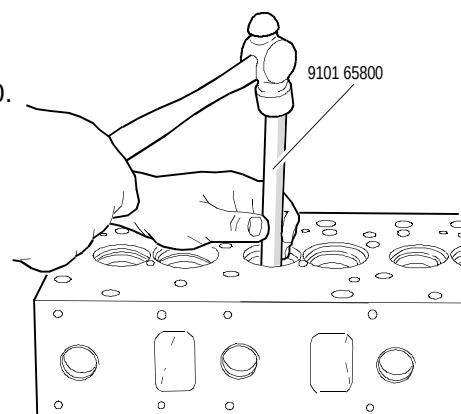


5. Measure the clearance between the valve stem and the valve guide with a dial gauge. Lift the valve so that the valve head is **15 mm** from the face of the cylinder head, and measure the clearance. It must not be greater than **0.30 mm** for the inlet valves and **0.35 mm** for the exhaust valves. In order to establish the valve guide wear, a new valve should be used when measuring.

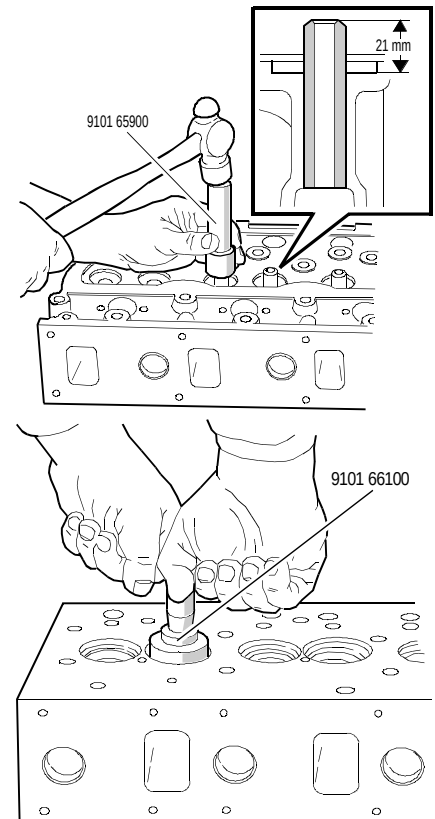


3.4. Changing Valve Guides

1. Press or knock out the old guides using drift 9101 65800. Clean the valve guide locations.



2. Lubricate the outside of the new guides and fit them using drift 9101 65900, which ensures the correct fitting height (**21 mm** over the spring face).
3. The guides are the same for the inlet and exhaust valves. Ensure that the steepest chamfer on the guide faces the valve head. Check that the valves do not bind in the guides.



3.5. Machining Valve Seat

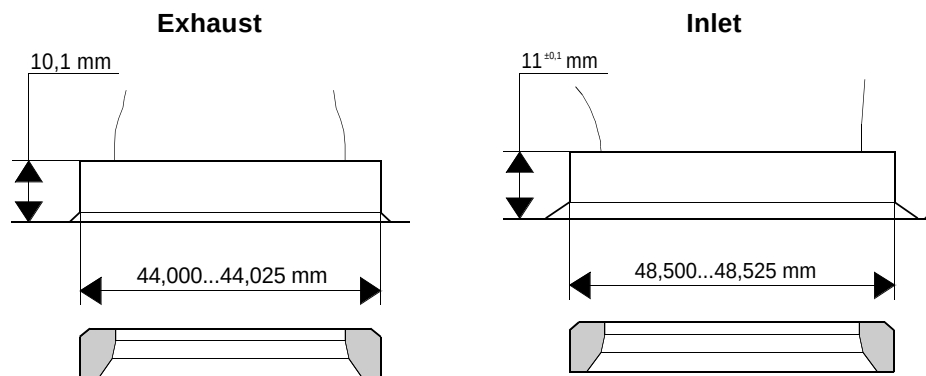
Machine the damaged valve seat with a milling cutter. If the width of the seat exceeds **2.3 mm** in the exhaust and **3.7 mm** in the intake, it should be reduced primarily at the outer edge.

The valve seat angle is $45^{\circ}+20'$ for the exhaust valve and $35^{\circ}+20'$ for the inlet valve.

3.6. Changing Valve Seat Rings

Exhaust valves are fitted with separate valve seat rings. The engines with high output are also equipped with separate inlet valve seats. If the sealing surface is damaged so badly that it cannot be repaired with machining, the seat ring should be changed.

1. Grind the valve head on a discarded valve so that it sits down in the valve seat. Fit the valve and weld it in place in the seat. Cool with water.
2. Turn the cylinder head over and knock out the valve and seat.



3. Clean the valve seat location. Cool the new seat ring in liquid nitrogen until it stops bubbling, or alternatively place it in dry ice.
4. Fit the seat with a suitable drift. Machine the seat.

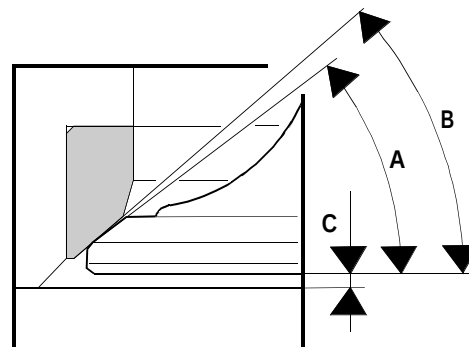
Note! Where necessary, standard size seats can be replaced by inserts with a larger outer diameter. See “**Technical data**”, point “**Cylinder head**”.

The inlet valve seat machined directly on the cylinder head can be fitted with a separate valve seat ring, order no. 8366 47936. Machine the seat insert location on the cylinder head (see picture above). Fit the insert like the seat of the exhaust valve.

3.7. Grinding Valves

In order to ensure that there is a proper seal around the valves, there is a difference in the sealing surface angles. There is therefore a very narrow sealing surface which seals effectively even after prolonged running.

	A	B	C (mm)
Inlet	35°-20'	35°+20'	0.7 ^{±0.05} (max. 2.20)
Exhaust	45°-20'	45°+20'	0.6 ^{±0.05} (max. 2.20)



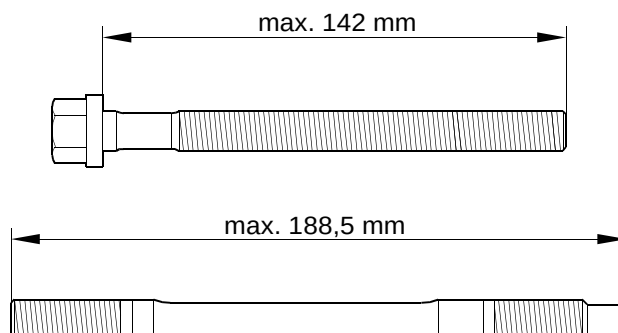
1. Grind the damaged valve disc with a valve refacer. Adjust angles to **45°-20'** for exhaust valves and **35°-20'** for inlet valves.
2. If the edge of the valve head is less than **1.5 mm** after it has been ground, or if the valve stem is bent, the valve should be discarded.
3. If necessary, grind the end of the valve stem.
4. Lap the valves with lapping paste and check the contact surface with marking paint.
5. Clean the cylinder head and valves of any remaining lapping paste.

3.8. Fitting Valves

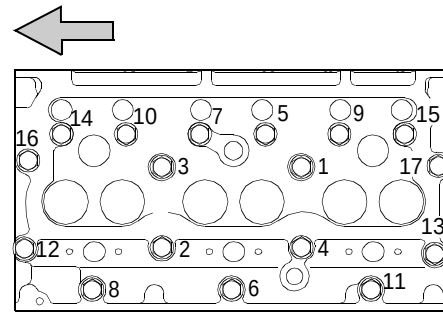
1. Check the valve springs for straightness, length and tension using a spring tester. See "**Technical data**", point "**Valves, rockers and tappets**".
2. Lubricate the valve stems and fit the valves in the correct order in the cylinder.
3. Fit the springs, spring guides and valve keepers with the aid of a lever for compressing valve springs, 9101 66200.
4. Tap the end of the valve stems lightly after fitting the valve in order to ensure that they are secure.

3.9. Fitting Cylinder Head

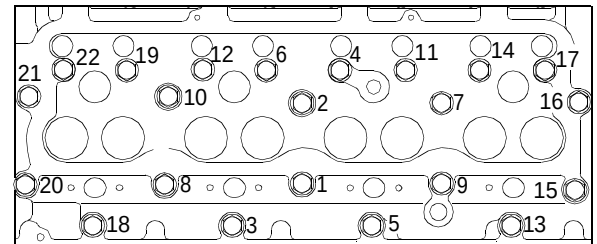
1. Measure the length of the cylinder head bolts. Compare with the dimensions shown in the figure below. Change any bolts that are too long.



2. Screw the cylinder head stud bolts into the cylinder block to a torque of **30 Nm**. Fit the valve tappets if removed.
3. Check that the sealing surfaces are clean and fit the cylinder head gasket(s) and the cylinder head(s). Ensure that on the six cylinder engines both cylinder heads are parallel by lightly fastening the exhaust manifold before tightening the cylinder head bolts (the exhaust manifold can become damaged if the heads are not parallel). Clean, lubricate and fit the bolts.
4. The pictures show the correct tightening order of the cylinder head bolts. The order is also marked on the cylinder heads.
5. Tighten the cylinder head bolts progressively as follows:
 1. First tighten to **80 Nm**
 2. Tighten by **90°**
 3. Tighten again by **90°**.
6. Adjust the valve clearances (see instruction **5.3**).

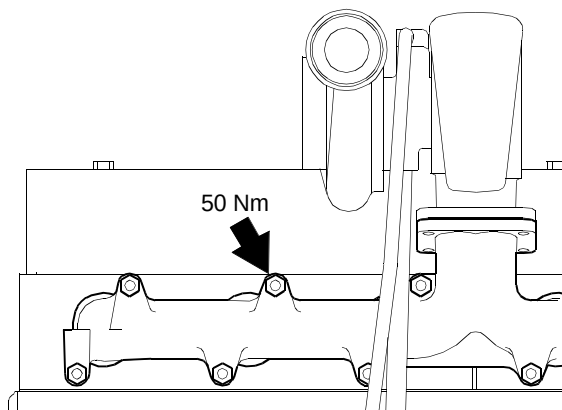


66, 74, 84



44, 49

Note! After this the cylinder head does not need retightening.



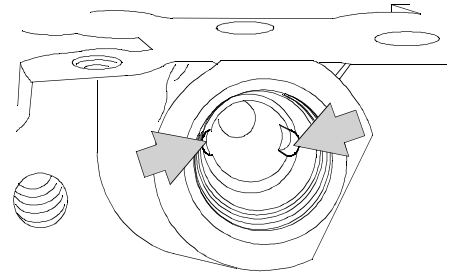
Tighten the exhaust manifold nuts to **50 Nm**. **Do not overtighten!**

4. CYLINDER HEAD, 4V ENGINES

For removing, checking or reconditioning the 4V engine cylinder head, follow the instructions for the 2V engine as shown in section 3. The following are repair instructions for 4V cylinder heads which differ from the 2V cylinder head.

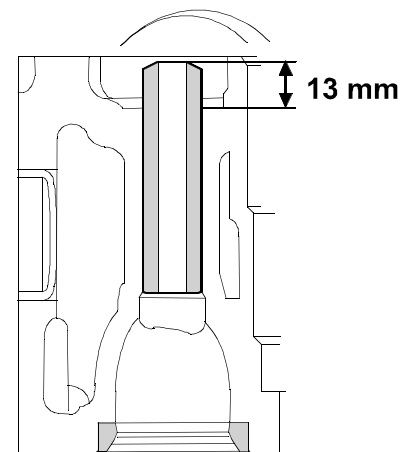
4.1. Reconditioning

1. Using a standard valve spring press, remove the valve cotters, spring guide and spring. Remove the valve. If you are re-fitting the old valves, ensure that they are re-fitted in the exact same locations.
2. The height of the cylinder head, after grinding, should not be less than **109.50 mm**. The valve disc depth from the cylinder head surface should be **0.60 mm** for the exhaust valves and **0.80 mm** for the inlet valves.

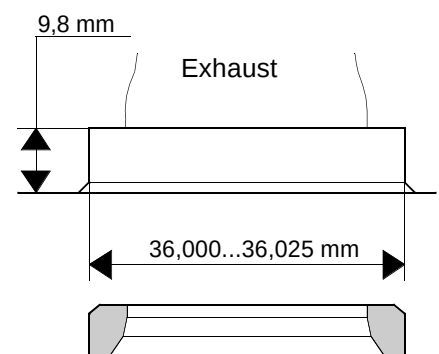


3. Straighten and clean the injector location seat in the cylinder head with cutter 9120 85400. Also check that the location for the side feed pipe is clean—especially the grooves for the guide balls.

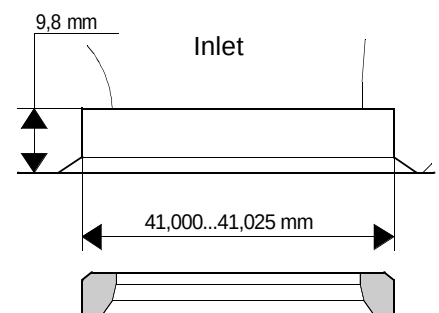
4. When needed, press or knock off the old guides using drift 9120 85300. Clean the valve guide locations. Lubricate the outside of the new guides and fit them using drift 9120 85000, which ensures the correct fitting height (**13 mm** over the spring face).



5. Machine the damaged valve seat with milling cutter kit 8370 62635. If the width of the seat exceeds **2.0 mm** in the exhaust and **2.2 mm** in the intake, it should be reduced primarily at the outer edge. The valve seat angle is **45°+20'** for the exhaust valve and **35°+20'** for the inlet valve.



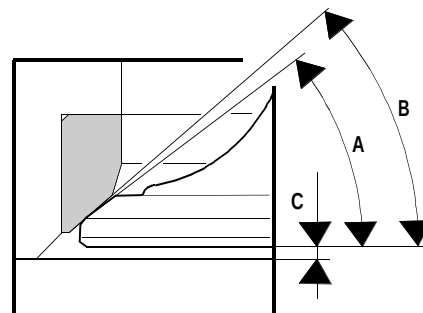
6. Exhaust and inlet valves are fitted with separate valve seat rings. If the sealing surface is damaged so badly that it cannot be repaired with machining, the seat ring should be changed. The seat ring is changed as instructed for 2V engines.



Note! Where necessary, standard size seats can be replaced by inserts with a larger outer diameter. See “**Technical data**”, point “**Cylinder head, 4V engines**”.

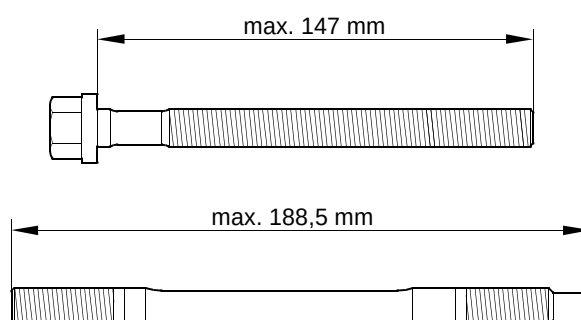
7. In order to ensure that there is a proper seal around the valves, there is a difference in the sealing surface angles. There is therefore a very narrow sealing surface which seals effectively even after prolonged running.

	A	B	C (mm)
Inlet	35°-20'	35°+20'	0.8 $\pm$ 0.05 (max. 2.20)
Exhaust	45°-20'	45°+20'	0.6 $\pm$ 0.05 (max. 2.20)

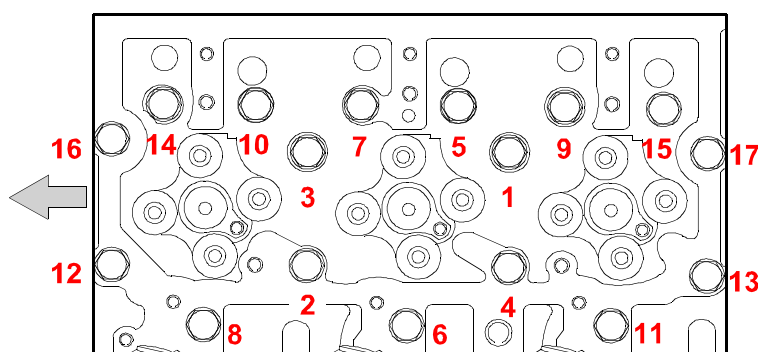


4.2. Fitting Cylinder Head

1. Measure the length of the cylinder head bolts. Compare with the dimensions shown in the figure below. Change any bolts that are too long.



2. Screw the cylinder head stud bolts into the cylinder block to a torque of **30 Nm**. Fit the valve tappets if removed.
3. Check that the sealing surfaces are clean and fit the cylinder head gasket(s) and the cylinder head(s). Ensure that on the six cylinder engines both cylinder heads are parallel by lightly fastening the exhaust manifold before tightening the cylinder head bolts (the exhaust manifold can become damaged if the heads are not parallel). Clean, lubricate and fit the bolts.



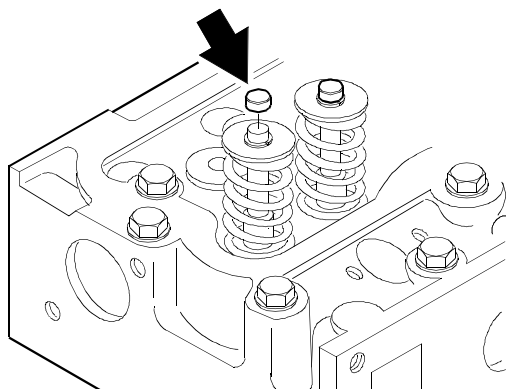
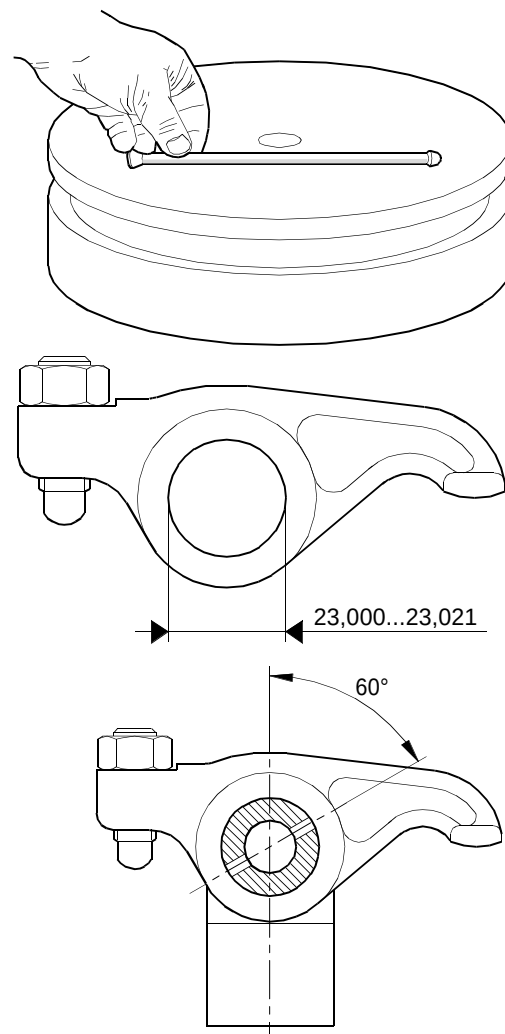
4. The picture above shows the correct tightening order of the cylinder head bolts. The order has not been marked on the cylinder heads.
5. Tighten the cylinder head bolts progressively as follows:
1. First tighten to 80 Nm
 2. Tighten by 90°
 3. Tighten again by 90°

Note! After this the cylinder head does not need retightening.

5. VALVE MECHANISM, 2V ENGINES

5.1. Reconditioning Valve Mechanism

1. Check the valve tappets, especially the contact surface against the camshaft. Worn or damaged tappets should be discarded.
2. Check the straightness of the push rods by rolling them on a surface table. Also check the spherical surfaces at the ends.
3. Dismantle and clean the rocker arm mechanism. Check the shaft for wear and check that the oilways are clean.
4. Check the diameter of the rocker arm bore, **23.000...23.021 mm**. Change the worn or damaged rocker arm. Where necessary, grind the rocker arm valve contact surface to the correct shape. Do not grind more than necessary, as the hardened layer is thin.
5. Fit the plug to the other end of the rocker arm shaft. Lubricate the shaft and fit various parts in the correct order. Note the correct position of the shaft and the bearing brackets. The split side of the bracket and the shaft oil holes must be turned to the valve side (see pictures above). Fit the other end plug.



Note! The valves can be fitted with separate caps.

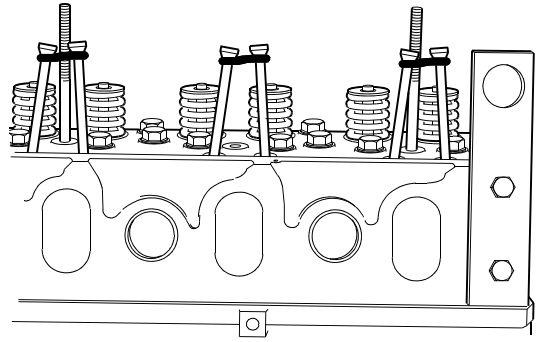
5.2. Changing Camshaft / Camshaft Gear

1. Remove the valve cover. Remove the rocker arm mechanism.
2. Remove the radiator, cooling fan, alternator and belt.
3. Remove the belt pulley, the crankshaft nut and the hub (with damper).

For 74- and 84-engines, remove the belt pulley and damper. Slacken the crankshaft nut. **Do not remove it!** Remove the hub using puller 9104 53300. Take off the puller, open the nut and remove the hub.

4. Remove the timing gear casing cover (engine front cover).

5. Lock the tappets up to eliminate the risk of their falling down when removing the camshaft and thus preventing the installation of the camshaft. Lift two adjacent push rods up, stretching them slightly towards each other. Connect the push rods in pairs, using O-rings or elastic bands to prevent them from falling through.

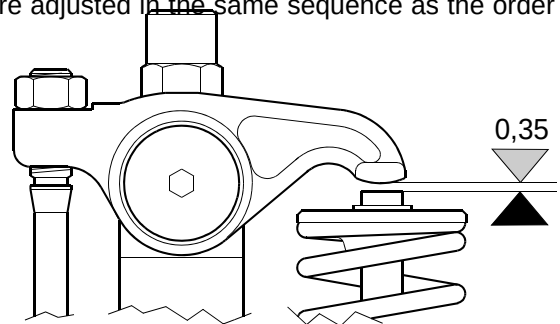


Note! Do not connect the push rods too tightly as this might cause them to bend or snap.

6. Crank the engine until the aligning marks on the idler gear and camshaft gear are facing each other. Extract the camshaft.
7. Separate the camshaft from the gear wheel.
8. Clean the parts which are to be re-fitted.
9. Fit the key in its groove and fit the gear on the camshaft. Tighten the nut to 200 Nm.
10. Lubricate bearing surfaces and lobes and insert the shaft in the cylinder block. Ensure that the aligning marks on the gears correspond.
11. Fit the timing gear casing cover, the hub, damper and crankshaft belt pulley.
12. Free the push rods and fit the rocker arm mechanism. Adjust the valves. Fit the valve cover.
13. Fit the other removed parts.

5.3. Adjusting Valves

The valve clearance, which can be adjusted on a hot or cold engine, is **0.35 mm** for both inlet and exhaust valves. The clearance is adjusted when the respective piston is at T.D.C. in the compression stroke. The valves for the different cylinders are adjusted in the same sequence as the order of injection.

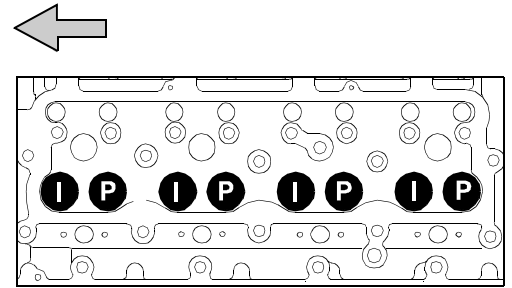


Adjusting

- Loosen the locknut on the adjusting screw.
- Check the clearance with a feeler gauge and adjust to the correct clearance by turning the adjusting screw.
- Tighten the locknut and check again that the clearance is correct.

44- and 49-Engines

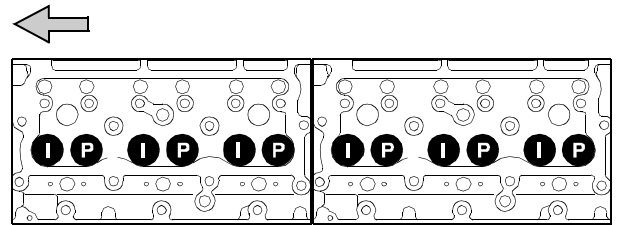
- Rotate the crankshaft in the running direction until the valves in the 4th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/2 a turn in the running direction so that the valves in the 3rd cylinder are rocking. Check the valves in the 2nd cylinder.
- Continue according to the order of injection:


44, 49

Injection order	1 - 2 - 4 - 3
Valves rock in cyl. no.	4 - 3 - 1 - 2

66-, 74- and 84-Engines

- Rotate the crankshaft in the running direction until the valves in the 6th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/3 of a turn in the running direction so that the valves in the 2nd cylinder are rocking. Check the valves in the 5th cylinder.
- Continue according to the order of injection:


66, 74, 84

Injection order	1 - 5 - 3 - 6 - 2 - 4
Valves rock in cyl. no.	6 - 2 - 4 - 1 - 5 - 3

6. VALVE MECHANISM, 4V ENGINES

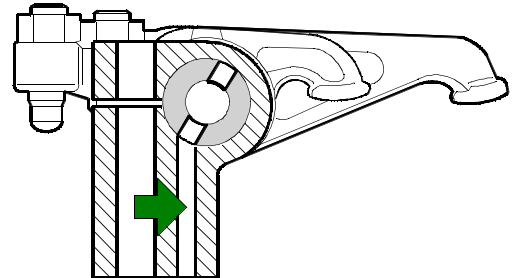
For removing, checking or reconditioning the 4V engine valve mechanism, follow the instructions for the 2V engine as shown in section 5. The following are repair instructions for 4V valve mechanisms which differ from the 2V valve mechanism.

6.1. Reconditioning Valve Mechanism

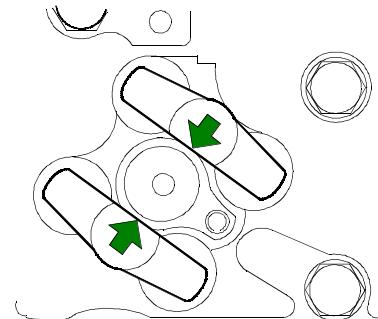
1. Notice the length difference between the push rods in different engine types. See the schedule as follows:

Engine	Total Length of Push Rod, mm	Order Number of Push Rod
44-/49-/66-/74- 2V engines	237...238.3	8366 55867
44-/49-/66-/74- 4V engines	245...246.3	8370 70119
84- 4V engines	286...287.3	8370 69014

2. Check the diameter of the rocker arm bore, **25.000...25.021 mm**. Change the worn or damaged rocker arm.

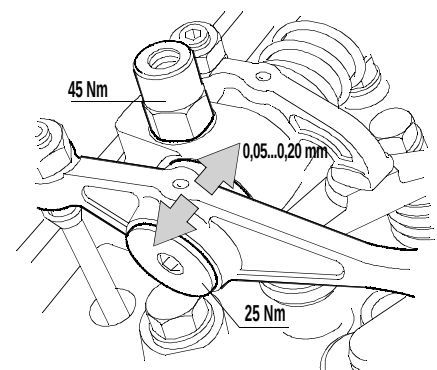


3. Fit the plug to the other end of the rocker arm shaft. Lubricate the shaft and fit various parts in the correct order. Notice the correct position of the brackets and the shaft. Fit the other end plug and tighten the plugs to 25 Nm.



4. Fit the connecting parts onto the valves in position as shown in the pictures.

5. Fix the valve mechanism and ensure the right end clearance, **0.05...0.20 mm**, for the levers at the end. Tighten the mechanism screw and nuts to a torque of **45 Nm**.

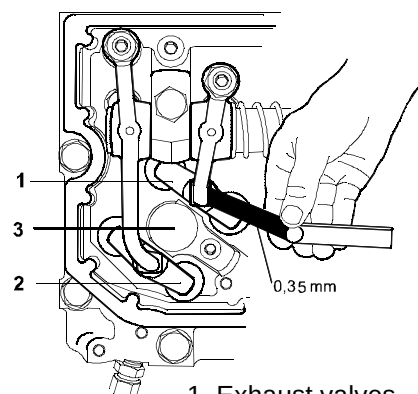


6.2. Checking and Adjusting Valve Clearances

The valve clearance, which can be adjusted on a hot or cold engine, is **0.35 mm** for both inlet and exhaust valves. The clearance is adjusted when the respective piston is at T.D.C. in the compression stroke. The valves for the different cylinders are adjusted in the same sequence as the order of injection.

Adjusting

- Loosen the locknut on the adjusting screw.
- Check the clearance with a feeler gauge and adjust to the correct clearance by turning the adjusting screw.
- Tighten the locknut and check again that the clearance is correct.



1. Exhaust valves
2. Inlet valves
3. Injector

44-/49-Engines

- Rotate the crankshaft in the running direction until the valves in the 4th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/2 a turn in the running direction so that the valves in the 3rd cylinder are rocking. Check the valves in the 2nd cylinder.
- Continue according to the order of injection:

Injection order	1 - 2 - 4 - 3
Valves rock in cyl. no.	4 - 3 - 1 - 2

66-/74-/84-Engines

- Rotate the crankshaft in the running direction until the valves in the 6th cylinder are rocking (exhaust closes, inlet opens). Check the valve clearance of the 1st cylinder.
- Rotate the crankshaft by 1/3 of a turn in the running direction so that valves in the 2nd cylinder are rocking. Check the valves in the 5th cylinder.
- Continue according to the order of injection:

Injection order	1 - 5 - 3 - 6 - 2 - 4
Valves rock in cyl. no.	6 - 2 - 4 - 1 - 5 - 3

7. CRANKSHAFT

7.1. Removing Crankshaft

1. Remove the oil sump.
2. Disconnect the balancing unit lubricating oil pipe from the cylinder block and unscrew the balancing unit fixing bolts. Remove the balancing unit and the lubricating oil pipe (only 44- and 49-engines).
3. Unscrew the lubricating oil pump pressure pipe fixing screws from the cylinder block. Remove the oil pump and the suction and pressure pipes.
4. Remove the flywheel and the flywheel housing.
5. Detach the belt pulley and the hub from the crankshaft front end. Remove timing gear housing. (see instruction **11.1.** and **12.1**).
6. Remove the connecting rod bearing caps and push the connecting rods out of the way of the crankshaft.
7. Remove the main bearing caps and lift out the crankshaft.

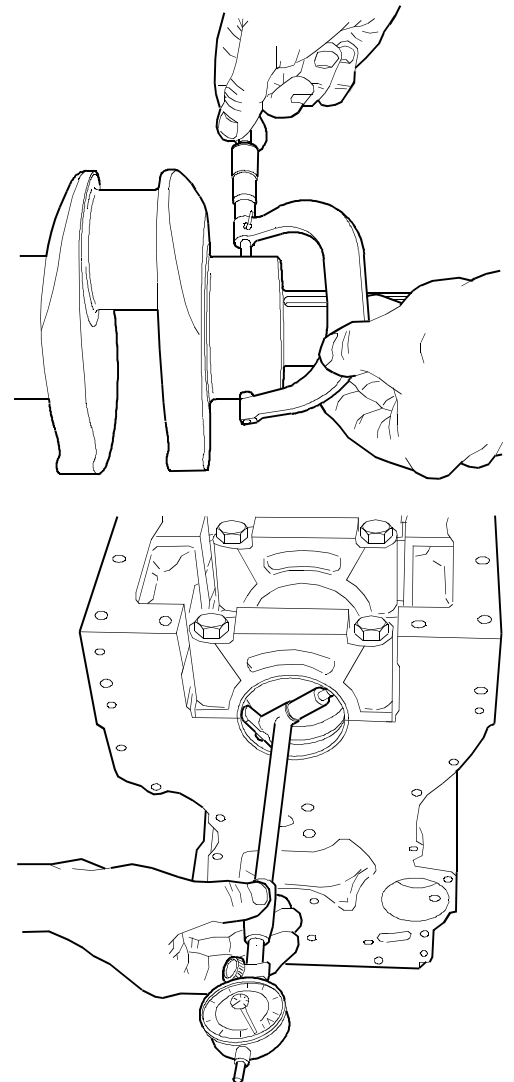
7.2. Checking Crankshaft

1. Clean the crankshaft. Do not forget the oilways.
2. Measure the journal wear in several points. Out-of-round, taper or other wear must not exceed **0.03 mm**.
3. Refit the bearing caps with new bearing shells and tighten them to the correct torque. Measure the I.D. with a dial gauge which has been zeroed to the dimensions given in point 2. With this method the indicator shows the actual bearing clearance. Measure at several points in case the worn bearing housing is not round.
4. If the bearing clearance exceeds **0.18 mm** for main bearings or **0.14 mm** for connecting rod big-end bearings with new bearing shells, the bearing journals on the crankshaft should be ground. Refer to the specifications for the relevant correct undersize and the corresponding bearings, see "**Technical data**", point "**Crankshaft**".

Note! When grinding, note that the journal edges must remain round.

Note! If necessary, the main bearing can also be fitted with outer diameter 1.0 mm oversize and inner diameter 0.5 mm undersize. Order no. is 8361 40950. The main bearing housing is machined to 92.000...92.025 mm and the crankshaft to 84.485...84.520 mm. (Special bearings not available for 74- and 84-engines.)

Note! Because of the automatic assembly, the main bearings with integrated thrust bearings have been installed in 44, 49 and 66 engines since week 614. However, spare part main bearings and thrust bearings are always delivered separately.



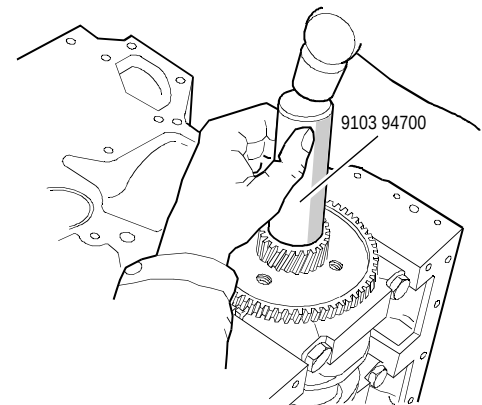
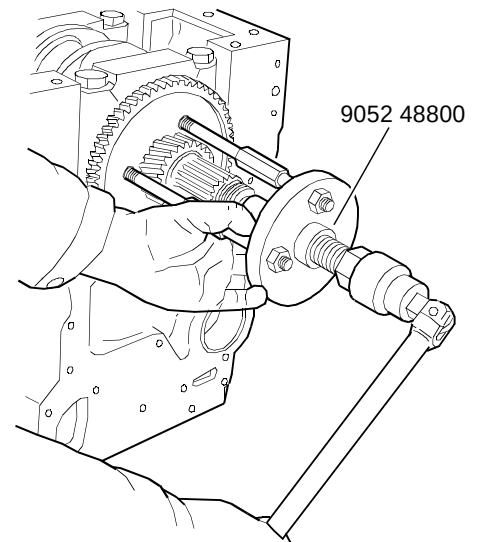
7.3. Changing Crankshaft Gears

1. Apply puller 9052 48800 to the crankshaft gears and pull off both gears.

With 84-engines, break the crankshaft gears using e.g. a grinder. Grind the gears sufficiently. Hit the gears apart with a chisel. Do not damage the crankshaft!

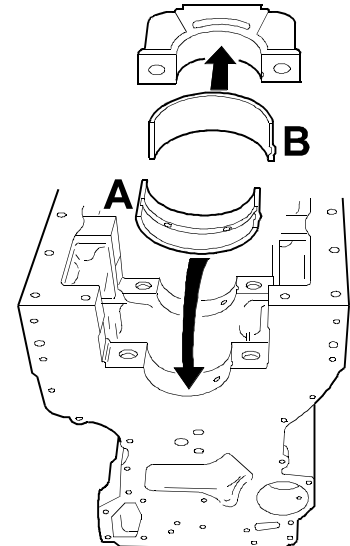
2. Clean the seat on the crankshaft, for example, with a wire brush.

3. Heat the new gears to **220...250°C**. Tap them onto the shaft with drift 9103 94700. Note the position of the key and ensure that the aligning marks on the front gear are visible. Leave it to cool.

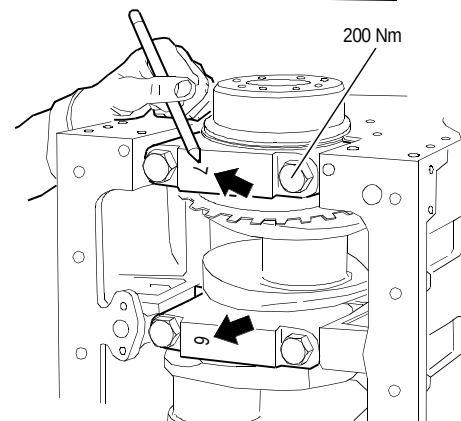


7.4. Fitting Crankshaft

1. Clean the oilways, bearing shells and bearing locations. Check that the crankshaft is clean.
2. Assemble the bearing with oilholes/groove (A) to the cylinder block and the bearing with no hole (B) to the bearing cap. Ensure that the bearing shell clamping claws fit into their notches and that the shells to be fitted in the cylinder block have a hole coinciding with the oil port.
3. Lubricate the bearing surfaces and fit the crankshaft. Fit the crankshaft thrust bearings with the lubricating grooves facing the crankshaft.

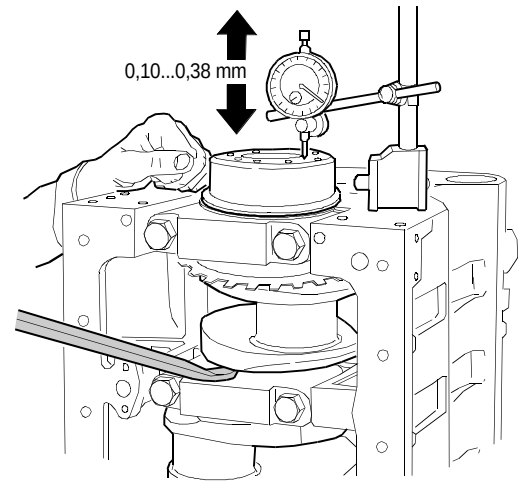


4. Fit the main bearing caps according to their numbering (bearing lock in the block and in the cap are on the same side); the rear thrust bearings are provided with guide lugs. Lubricate the bolts and tighten them to **200 Nm**.



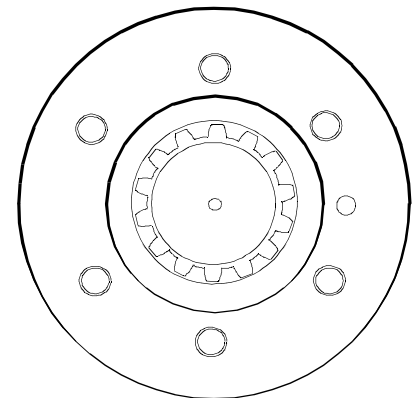
5. Check that the crankshaft can rotate without binding. Check the end float using a dial gauge. The correct end float is **0.10...0.38 mm**. If the end float is too large, oversize thrust bearings should be fitted.

Note! Bearing shells should never be reamed or machined in any other way, nor should the sides of the bearing caps be filed.



7.5. Crankshaft Hub Piece

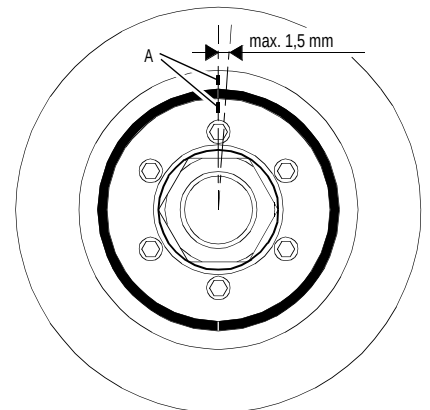
Check hub piece functionality, especially the sealing surface. If the sealing surface is worn out, see the instruction 11.3. point 9. In Citius series Common Rail engines, the crankshaft pulley does not have any timing or installation marks. There is no specific position for the crankshaft hub piece.



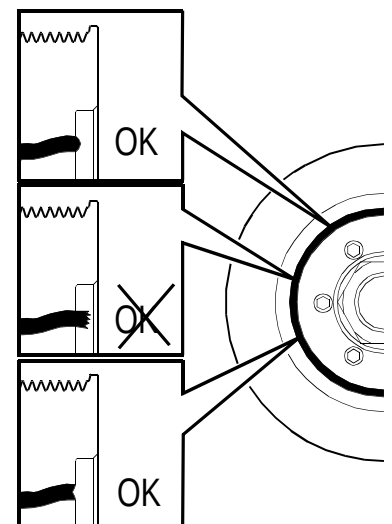
7.6. Checking Element of the Rubber Damper

44-, 49- and 66-Engines

1. Check the alignment marks (A) on both sides of the rubber element. If the difference is more than **1.5 mm**, change the damper for a new one.



2. Also check the condition of the rubber element. If rubber pieces have been loosened from the element, rubber has been pressed to a depth of more than **3.5 mm** or the outer circumference is slack or it moves in the direction of the shaft, change the damper.

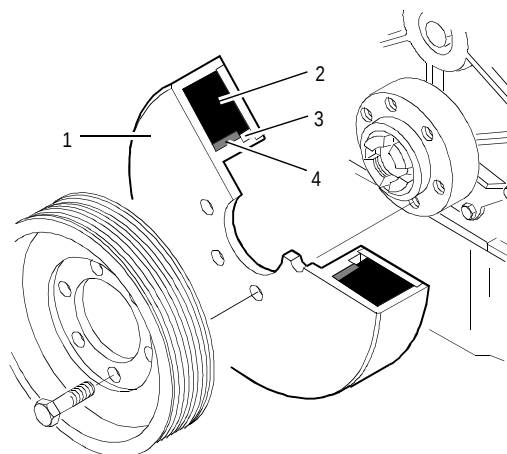


7.7. Viscose Type Vibration Damper

66-, 74- and 84-Engines

In 74- and 84-engines and some 66-engine versions, there is a vibration damper of "viscose type". Inside the damper there is a housing filled with stiff silicone oil, in which the damping substance has very small tolerances.

1. Housing
2. Damper mass
3. Liquid cavity
4. Bushing



Note! Even a small dent makes the vibration damper inoperative. Do not remove it by turning forcibly and be careful not to damage it when it is loose. If you detect a dent on the outer surface, do not re-install the damper in the engine.

Note! If you are making the installation mark on the vibration damper, use an electric pen, do not tap it.

8. CONNECTING RODS AND PISTONS

8.1. Removing Pistons Together with Connecting Rods

1. Remove the oil sump and the oil inlet and pressure pipes.
2. Remove the cylinder head.
3. Scrape off any soot in the cylinder liner. If the turning edge is clearly marked, smooth it down carefully with a scraper.
4. Remove the big-end bearing caps and bearing shells. Place the shells in order if they are to be re-used.
5. Push up the piston and connecting rod with the shaft of a hammer or similar wooden tool.
6. Remove the piston pin snap rings. Push out the pin.

Note! If the piston pin does not move under thumb pressure, the piston should be heated to **100°C**.

8.2. Changing Connecting Rod Bearings

Piston Pin Bushing

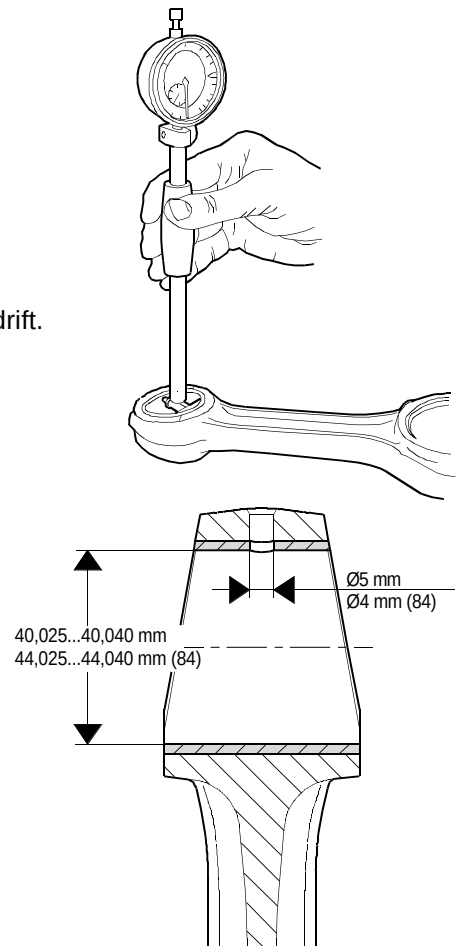
1. Clean the connecting rod and bearing shells.
2. Measure the I.D. of the piston pin bushing using a cylinder gauge.
3. If the piston pin bushing is worn, it should be driven out using a suitable drift.
4. Press the new bush in its place. Ensure that the oil hole in the bush coincides with the respective hole in the connecting rod. After fitting drill oil hole (84-engines), ream the bush to obtain its correct diameter.

Note! The connecting rod can, if needed, be fitted with a 0.5 mm oversize bushing. See “**Technical data**”, point “**Connecting rod**”.

Big-End Bearing

1. Fit the bearing shells together and tighten the screws.
2. Measure the I.D. using a cylinder gauge which has been zeroed to the diameter of the respective bearing journal. If the clearance exceeds **0.14 mm** with new bearing shells, the big-end journals require grinding. Refer to the specifications for the correct undersize and the corresponding bearing.

Note! Ensure that the radii at the end of the bearing journals are not altered when grinding.



8.3. Checking Connecting Rod

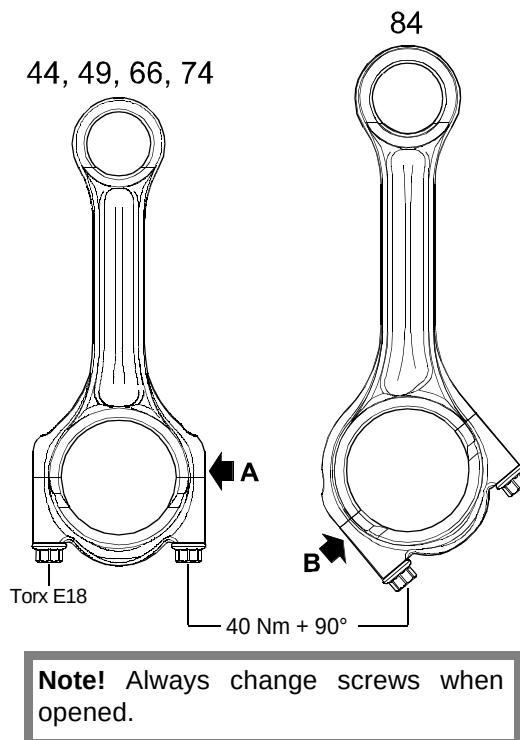
The connecting rod is checked in a special fixture, intended for the purpose (e.g. Carl Larsson). See "Technical data", point "Connecting rod".

The connecting rods are divided into weight classes with intervals of **20 g**. The weight class (a letter) is stamped on the side face of the connecting rod. All the connecting rods in one engine should be of the same weight class, that is to say the greatest permissible weight difference is **20 g**.

The letters show the weight classes as follows:

44-, 49-, 66- and 74-Engines

Letter (A)	Order no.	Weight
F	8366 66430	1935 - 1954 g
V	8366 66431	1955 - 1974 g
X	8366 66432	1975 - 1994 g
Y	8366 66433	1995 - 2014 g
W	8366 66434	2015 - 2034 g
Z	8366 66435	2035 - 2054 g
G	8366 66436	2055 - 2074 g



84-Engines

Letter (B)	Order no.	Weight
E	8368 64101	2230 - 2249 g
F	8368 64102	2250 - 2269 g
G	8368 64103	2270 - 2289 g
H	8368 64104	2290 - 2309 g
I	8368 64105	2310 - 2329 g
J	8368 64106	2330 - 2349 g
K	8368 64107	2350 - 2369 g

The order numbers of the connecting rod kits as spare parts are as follows:

Engine type	Number of cyl.	Order no.
44. 49	4	8367 40859
66, 74	6	8368 40928
84	6	8363 40948

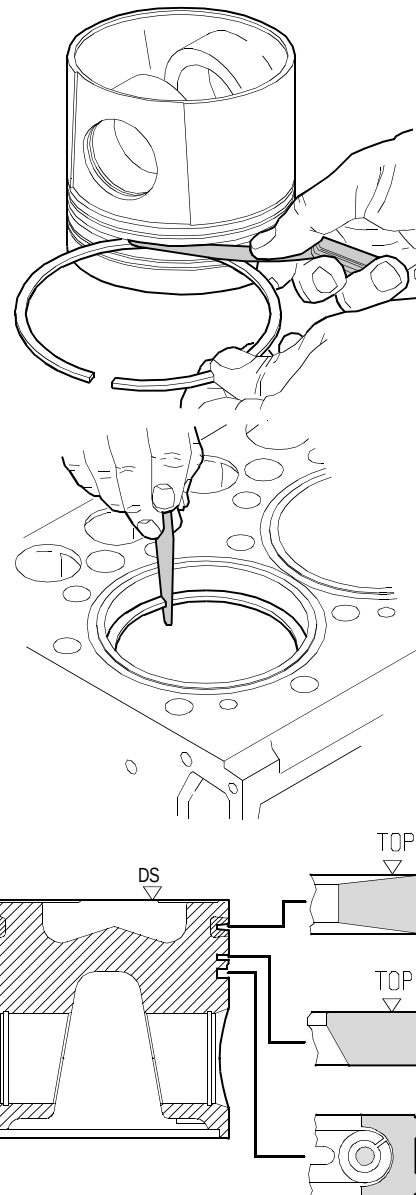
8.4. Changing Piston Rings

1. Remove the piston rings with piston ring pliers 9052 46900. Do not open the rings more than is necessary. If the rings are to be used again ensure that they are fitted in the same groove.

2. Clean the piston ring grooves and measure the piston ring clearance, which must not exceed **0.15 mm**. Determine whether too large a clearance is due to worn rings or a worn groove. Change worn parts.

3. Measure the piston ring gap by pushing one piston ring at a time into the cylinder bore. The piston ring gap must not exceed **1 mm** on the 1st and 3rd piston rings and **1.5 mm** (84-engines: **1.3 mm**) on the 2nd piston ring.

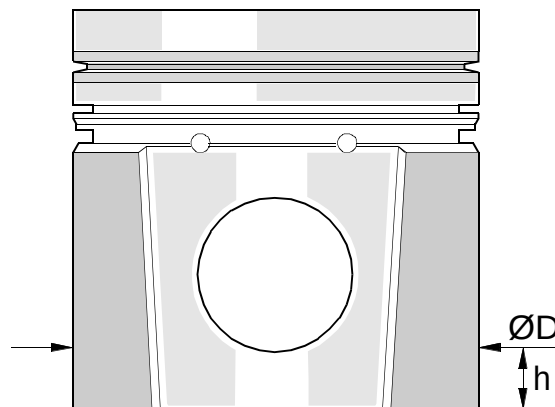
4. Fit the piston rings on the piston using the piston ring pliers. Ensure that the rings are fitted in the correct groove and that "TOP", or the manufacturer's designation, faces upwards.



8.5. Checking Pistons

Check the condition of the pistons and piston pins. Pay special attention to any cracks on the edge of the combustion chamber and on the upper edge of the piston pin hole. Measure the diameter of the piston at the point shown in the figure below. Replace the piston if needed.

Engine	D (mm)	H (mm)
44, 66	107.883...107.897	17.0
49, 74	107.893...107.907	19.0
84	110.863...110.877	15.0



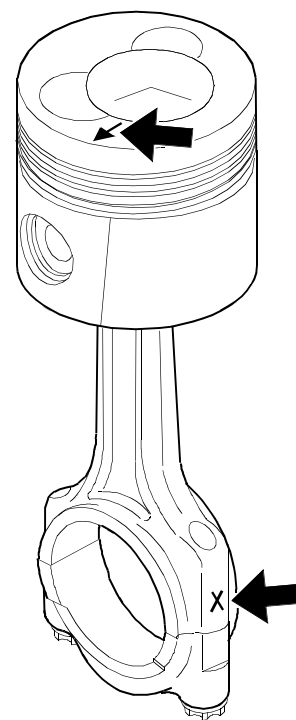
8.6. Fitting Piston Pin

1. Place the connecting rod inside the piston and push the piston pin into place.

In 2V engines, the combustion chamber and the weight class letter should be on the same side (the fuel equipment side). The arrow on the piston points towards the front end of the engine.

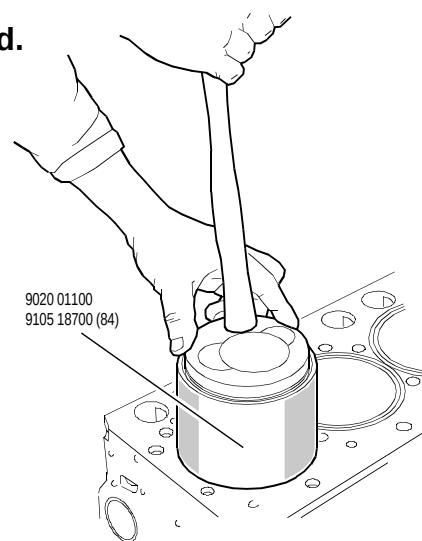
Note! In 84-engines, the weight class letter should be on the side of the camshaft.

2. Fit the piston pin circlips. Ensure the circlips are pressed correctly into the grooves. The circlip ends must point upwards.



8.7. Fitting Piston Together with Connecting Rod.

1. Check that the bearing locations are clean and place the bearing shells in the connecting rod and bearing cap. Note the position of the bearing shells.
2. Lubricate piston, rings and cylinder bore. Ensure that the piston ring gaps are spread around the piston.
3. Use a piston ring strap or preferably fitting tool 9020 01100 or 9105 18700 (84-engines). Fit the piston with the connecting rod so that the direction of the arrow on the piston shows forward.
4. Lubricate the big-end bearing journal and bearing shells, and push the piston down. Fit the bearing cap so that the notches for the guide lugs are in the same side. Tighten the connecting rod screws to **40 Nm + 90°**.
5. Check that the connecting rod has sufficient end float on the big-end bearing journal.



9. COUNTERBALANCE (44- and 49-Engines)

9.1. Removing and Disassembling Counterbalance Unit

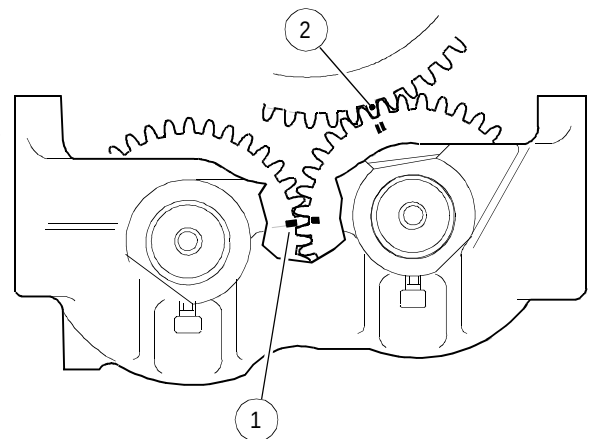
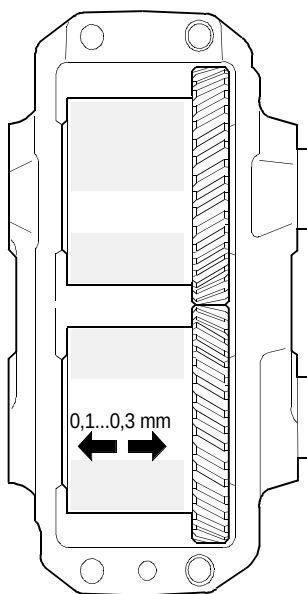
1. Remove the oil sump.
2. Disconnect the lubricating oil pipe of the counterbalance unit.
3. Remove the counterbalance unit. Take care of any shims.
4. Loosen the locking screws and press out the shafts in the direction of the locking screws. Remove the counterweights and thrust washers.
5. Clean all parts.

9.2. Reconditioning Counterbalance Unit

Check the shafts, gear wheels and bushings for wear and damage.

1. If one of the gear wheels is damaged, change both counterweights as a complete unit. The gear wheels are not available separately as a spare part.
2. If necessary, remove the old bearing bushings with a suitable drift. Before removing them, mark the position of the bushing oil groove on the counterweight. Press in new bushings in the correct position. After fitting, the bushings should be reamed to a correct dimension, see Specifications.

3. Place the weights in the body, observing the notch markings. The gear wheel with two notch marks run against the crankshaft and should therefore be placed highest. Insert the shafts, remembering the thrust bearings. Apply thread lock fluid (e.g. Loctite 270) to the locking screws, and lock the shafts.

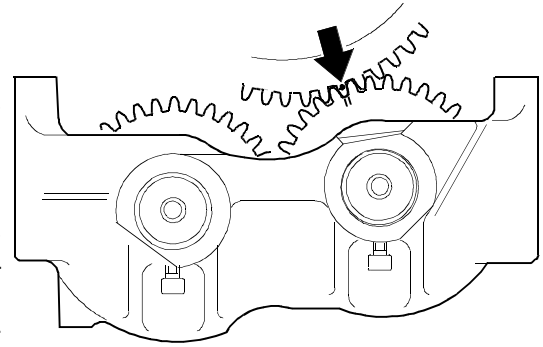


1. Synchronisation marking (notch)
2. Marking against crankshaft (punch / notch mark)

4. Check that the tooth backlash is **0.05...0.25 mm** and that the end float is **0.1...0.3 mm**.

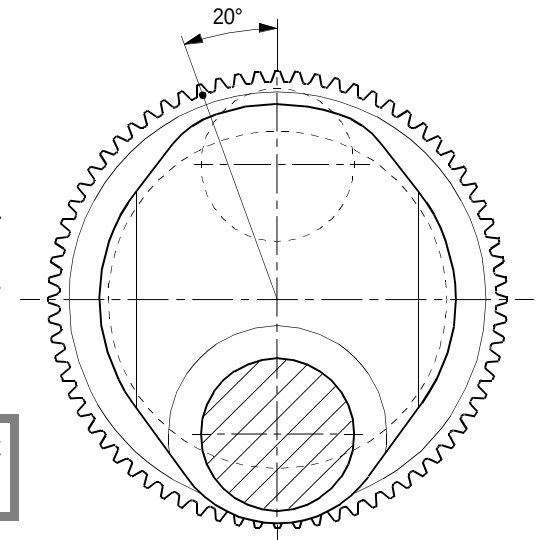
9.3. Fitting Counterbalance Unit

1. Fit the tension pins to the cylinder block.
2. Turn the crankshaft and weights so that the markings correspond, and lift the unit into place.
3. Tighten the screws to **60 Nm**. Check that the tooth backlash between the crankshaft and counterweight is **0.1...0.3 mm**. The backlash can be increased by placing 0.2 mm-thick shims (order no. 8361 19920) between the cylinder block and balancer unit body. One shim (0.2 mm) changes tooth backlash by about 0.07 mm.
4. Fit the lubricating oil pipe using new seals.
5. Fit the oil sump.



9.4. Changing Crankshaft Gear Rim

1. Mark the position of the gear rim on the shaft.
2. Heat the gear rim with a welding torch and drive it off using a suitable drift.
3. Heat the new gear rim to max. **250°C**. Fit the gear rim with the chamfer facing the crankshaft flange, and with the teeth according to markings or according to the figure above. Tap the gear rim down and leave it to cool.



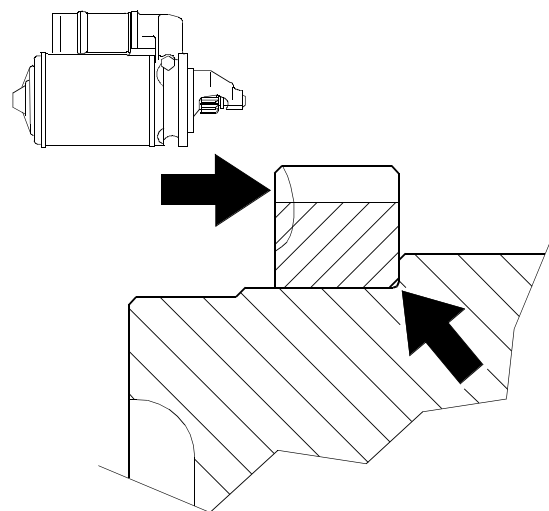
Note! The picture shows a rear view of the crankshaft and no. 2 cylinder big-end bearing journal.

10. FLYWHEEL

10.1. Changing Starter Ring Gear on Flywheel

If the ring gear is worn, replace it with a new one. The ring gear cannot be turned around because its teeth are chamfered and hardened on the starter motor side.

1. Remove the old starter ring by tapping it at various points with a drift. Clean the flywheel contact face with a steel-wire brush.
2. Warm the ring gear to a temperature of **150...200°C**. Fit the ring gear with the inner diameter chamfering turned against the flywheel and the teeth chamfering against the starter motor.
3. Allow the ring gear to cool freely without using any coolant.

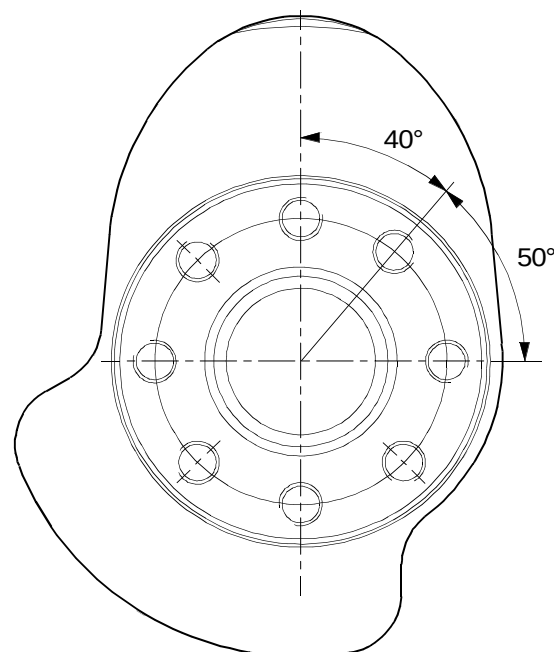


10.2. Fitting Flywheel

1. Clean the contact surfaces on the crankshaft rear flange and on the flywheel.
2. Fasten the flywheel to the crankshaft rear end. Suitable studs (2 pcs) can be used as guide pins, and screwed into the flywheel fixing bolt holes.

Note! In 84-engines, the flywheel fixing bolt holes are unsymmetrical.

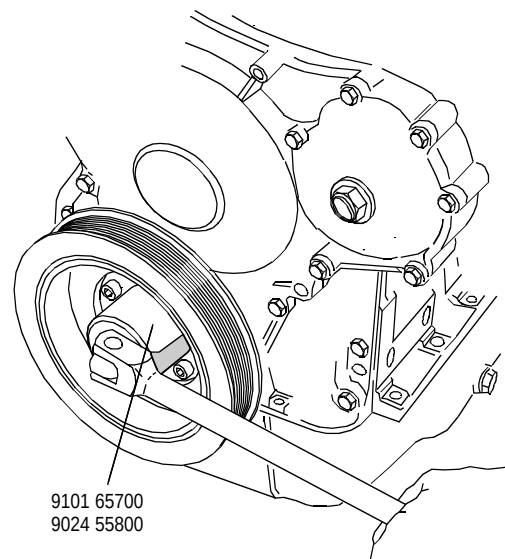
3. Tighten the flywheel retaining screws evenly to a torque of **150 Nm (200 Nm, 84-engines)**.



11. TIMING GEAR ASSEMBLY, 44-, 49-, 66- ENGINES**11.1. Removing Timing Gear Casing**

Since the bottom face of the timing gear casing forms a part of the mating face of the oil sump gasket, the casing cannot be removed without first removing the oil sump.

1. Drain the engine oil and remove the oil sump.
2. Remove the radiator, fan, alternator, belt tensioning and belt (if not previously removed). If the engine is equipped with an air compressor or air conditioner, it must be removed.
3. Loosen the crankshaft nut (special tool 9101 65700 for 44- and 49-engines or tool 9024 55800 for 66-engines). Remove the hub (with belt pulley and viscose damper).
4. Remove the drive unit and hydraulic pump (if installed).
5. Open the double idler gear nut and remove the timing gear casing cover and the oil deflector ring at the front end of the crankshaft.
6. Remove the high-pressure pump. See instruction **16.5.1**.



Note! If the timing gear casing does not need changing, the high-pressure pump can remain in place. In this case, disconnect all leads and pipes from the pump.

7. Remove the double idler gear.

Note! If the timing gear casing does not need changing, the double idler gear shaft can remain in place.

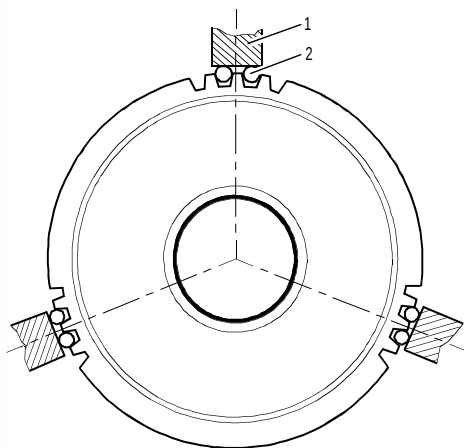
8. Unscrew the idler gear bolts (17 and 22 mm). Remove the flange, gear wheel and bearing journal.
9. Extract the camshaft.

Note! If the cylinder head and valve mechanism have not been removed, the tappets must be prevented from falling down, see instruction **5.2**.

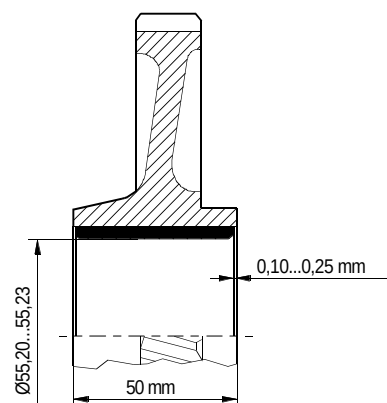
10. Remove the timing gear casing. Ensure that none of the sealing surfaces are damaged.
11. Remove the crankshaft front sealing ring from the front casing and clean all the parts that have been removed.

11.2. Reconditioning Idler Gear

If the idler gear bushing has been changed, press in a new bushing so that its rear edge is **0.1...0.25 mm** inside the gear wheel rear edge.



1. Chuck of lathe
2. Roller 5 mm

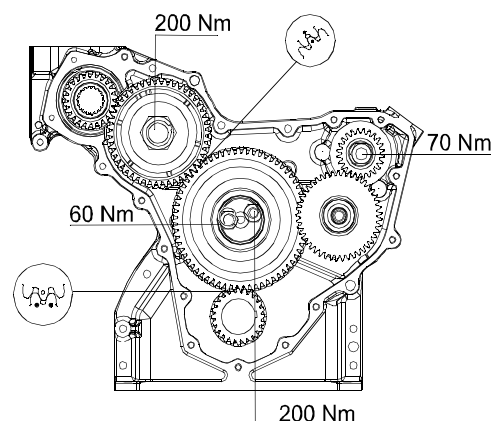


Machine the idler gear bushing inner diameter to a correct dimension after fitting. Centre the idler gear according to the figure above so that the tooth backlash is kept the same.

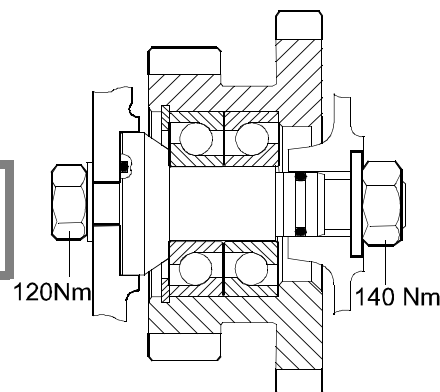
11.3. Fitting Timing Gear Casing

The position of the timing gear casing and cover is determined by two tension pins. Centring should therefore not be undertaken in connection with fitting. However, the tooth backlash between the different gears should be checked. Casing and covers that are delivered as spare parts also have holes for the tension pins already machined.

1. Apply sealant to a sealing surface and fit the casing against the cylinder block. Drive in the tension pins with drift 9025 98700. Tighten nuts and bolts.
2. Lubricate the camshaft bearings and insert the shaft into the cylinder block. Release the push rods and tappets if they have been suspended.
3. Fit the idler gear with a shaft stud and ensure that the markings are in the correct position. Fit the washer and tighten the bolts to the correct torque.
4. Fit the double idler gear bearings as shown in the picture. Fit the double idler gear using a new O-ring. Tighten the shaft fastening screw to 120 Nm.

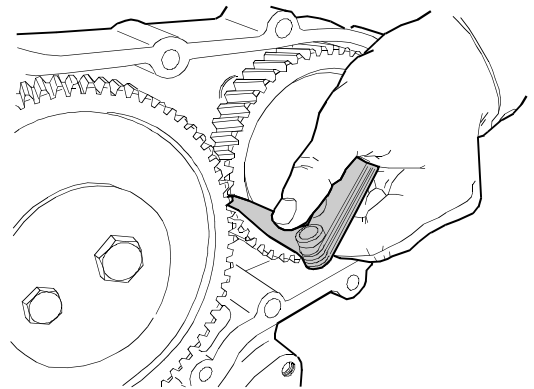


Note! Fit the double idler gear shaft before fitting the high-pressure pump. Otherwise the shaft screw is impossible to tighten.

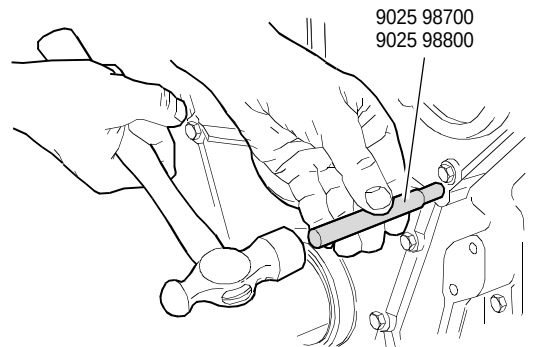


5. Fit the high-pressure pump and gear wheel.
6. Tighten the camshaft and high-pressure pump gear nuts to the correct torque.

7. Check the tooth backlash, which should be **0.05...0.25 mm**.

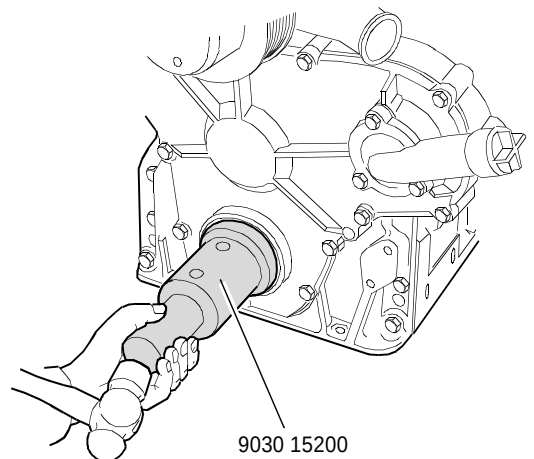


8. Fit the oil deflector ring on the crankshaft and fit the timing gear casing cover using a sealant. Drive in the tension pins with drifts 9025 98700 and 9025 98800 respectively (the tubular pin round the screw stud). Tighten nuts and bolts.



9. Fit the protective plate into the seal location and fit the crankshaft front seal with special tool 9030 15200.

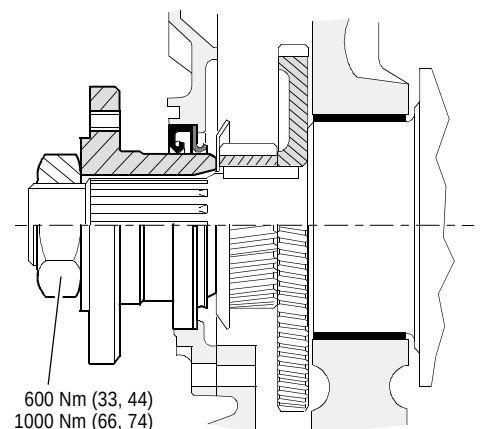
Note! If the hub piece is worn out at the sealing surface, a 3 mm spacer ring, order number 8353 28899, can be fitted in front of the crankshaft rear oil seal.



10. Lubricate both the seal and sealing surfaces and fit the crankshaft hub (with belt pulley).

11. Lubricate the crankshaft nut threads. Tighten the nut to **600 Nm** on 44- and 49-engines and **1000 Nm** on 66-engines.

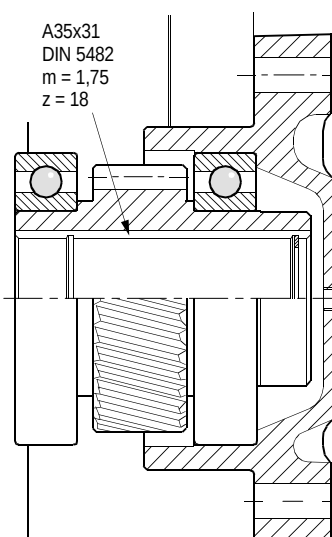
12. Fit the other removed parts.



11.4. Power Take-off

The engines use a transmission that can be equipped with a PTO run from the camshaft gear. The PTO can run e.g. a hydraulic pump.

Note! Use molybdenite-sulphide (MoS₂) ball bearing grease (NLGI 2) for the grooves of the hydraulic pump shaft and the coupling sleeve.



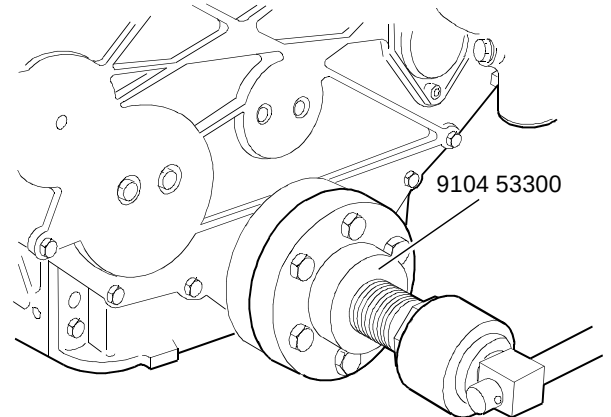
12. TIMING GEAR ASSEMBLY, 74- AND 84-ENGINES

This timing gear is equipped with the idler gear, which is fitted with a ball bearing.

12.1. Removing Timing Gear Casing

Since the bottom face of the timing gear casing forms a part of the mating face of the oil sump gasket, the casing cannot be removed without first removing the oil sump.

1. Drain the engine oil and remove the oil sump.
2. Remove the radiator, fan, alternator, belt tensioning and belt (if not previously removed). If the engine is equipped with an air compressor, it must be removed.
3. Remove the crankshaft belt pulley and the vibration damper.
4. Loosen the crankshaft nut about two turns (special tool 9024 55800). Fit extractor 9104 53300 and extract the crankshaft hub. Take off the extractor, open the nut and remove the hub.



Note! Do not remove the nut completely at first. The hub can be thrown dangerously when the nut is loosened.

5. In 84-engines, remove the cooling pump and observe the retaining screws on the high-pressure pump side. Remove the timing gear casing cover.
6. Remove the high-pressure pump. See instruction **16.5.1**.

Note! If the timing gear casing does not need changing, the high-pressure pump can remain in place. In this case, disconnect all leads and pipes from the pump.

7. Unscrew the idler gear screw and remove the idler gear. Also remove the double idler gear and small idler gear (broad timing gear casing).
8. Extract the camshaft.

Note! If the cylinder head and valve mechanism have not been removed, the tappets must be prevented from falling down, see instruction **5.2**.

9. Remove the timing gear casing. Ensure that none of the sealing surfaces are damaged.
10. Remove the crankshaft front seal ring from the front casing cover and clean all the parts removed.

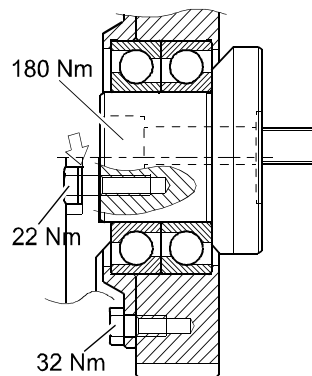
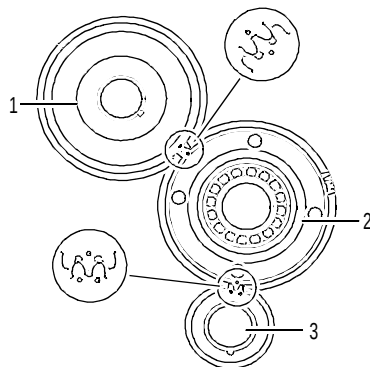
12.2. Fitting Timing Gear Casing

The position of the narrow timing gear casing and cover is determined by two tension pins. Centring should therefore not be undertaken in connection with fitting. However, the backlash between the different gears should be checked. Casing and covers that are delivered as spare parts also have holes for the tension pins already machined.

Note! The front cover of the broad timing gear has been centred with the idler gear shafts. The separate guide pins are not used.

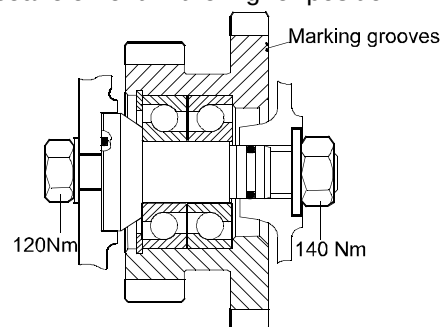
1. Screw thread piece M14/M8 into the cylinder block of the 84-engine. Apply sealant to a sealing surface and fit the casing against the cylinder block. Drive in the tension pins with drift 9025 98700. Tighten the screws and nuts.
2. Lubricate the camshaft bearings and insert the shaft into the cylinder block. Release the push rods and tappets if they have been suspended.

1. Camshaft gear
2. Idler gear
3. Crankshaft gear



3. Assemble the idler gears as shown in the picture. Fix the big idler gear in position. Note the position of the timing marks. Screw the fastening screw with seal element in the higher position.
4. Fit the double idler gear bearings as shown in the picture. Fit them using new O-rings. Tighten the shaft fastening screw to **120 Nm**.

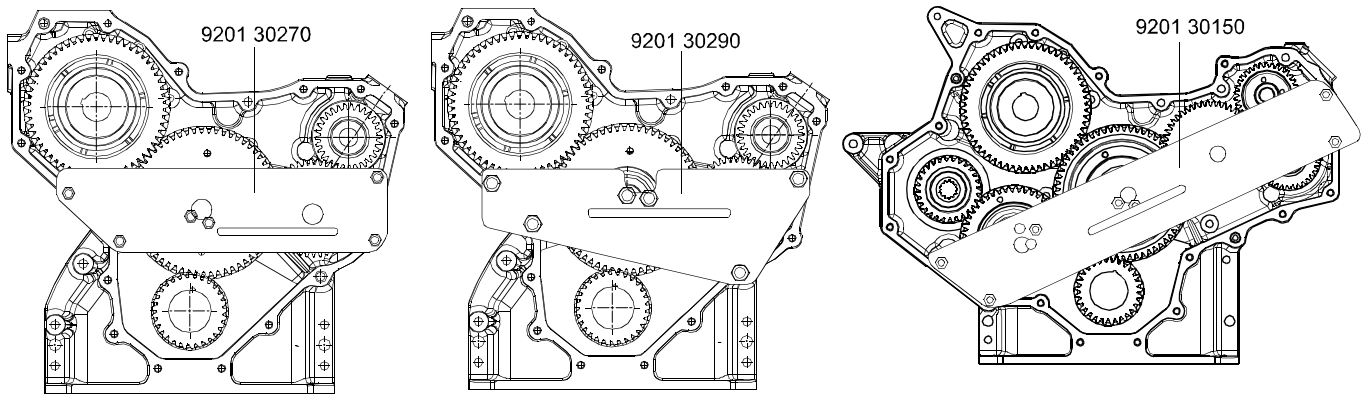
In the 74- and 84-engines, the double idler gear differs from the high-pressure pump gear in the number of teeth. The gear is recognizable with the amount of the marking grooves on the face as follows.



Engine	Marking grooves	Double idler gear	High-pressure pump gear
74	1	8370 70086 / z = 45	8370 70087 / z = 30
84	2	8370 70072 / z = 51	8370 70073 / z = 34

Note! Fit the double idler gear shaft before fitting the high-pressure pump. Otherwise the shaft screw is impossible to tighten.

5. Fit the high-pressure pump and gear wheel.

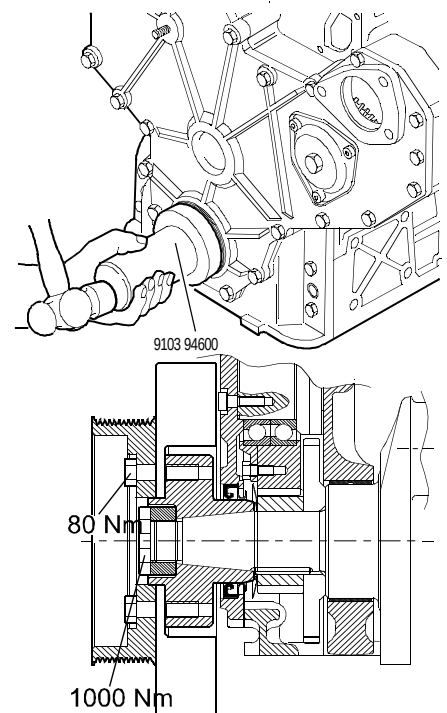


Centring tool	Engine	Timing gear casing
9201 30270	74	8370 70062 narrow 8370 70157 narrow/drive unit
9201 30290	84	8370 70064 narrow
9201 30150	84	8370 70107 broad/PTO for hydraulic pump 8370 70109 broad/PTO for compressor

6. Tighten the guide bolts in the centring tool frame and position the unit on the idler gears as shown in the picture (guide bolts in the idler gear shaft holes and housing holes). Tighten the idler gear bolts through the centring tool holes. Tighten the idler gear bolt (M14) to 180 Nm and small idler gear bolts (M8) to 45 Nm. Remove the centring tool.
7. Tighten the camshaft and high-pressure pump gear nuts to the correct torque.
8. Check the tooth clearance, which should be **0.05...0.25 mm**.
9. Fit the drive unit shaft onto the front cover (engines with a drive unit). Fit the cover and knock the tension pins into place (narrow timing gear casing). Note the seal rings for the screws of idler gear shaft. Fit the rear bearing of the drive unit and the cover.

Note! If the oil throwing ring is removed from the crankshaft, fit it with the drift 9103 94900 before fitting the cover.

10. Tighten the double idler gear nut to 140 Nm.
11. Fit the protecting plate in position at the bottom of the seal and fit the front seal of the crankshaft with special tool 9103 94600.
12. Lubricate both the seal and the sealing surface and fit the crankshaft hub. Lubricate the crankshaft nut threads slightly and tighten the nut to **1000 Nm**.
13. Fit the other removed parts.

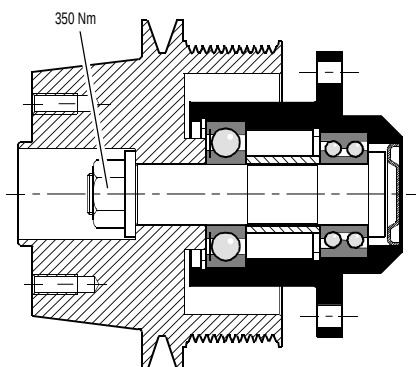


12.3. Fan Drive Device

1. Assemble the drive device as shown in the picture. Fit the shaft, inner bearing and the lock ring. Fill the bearing housing partially with heat-resistant ball bearing grease (NLGI 2). Fit the spacer sleeve, the outer bearing and the lock ring. Note the position of the outer bearing during assembly.

Note! Press the shaft into place so that the ball bearings do not transmit the pressure.

2. Tap the blocking plug (if removed) into place with fitting drift 9025 87400.
3. Fit the belt pulley, washer and nut. Tighten the nut to **350 Nm**.



13. LUBRICATION SYSTEM

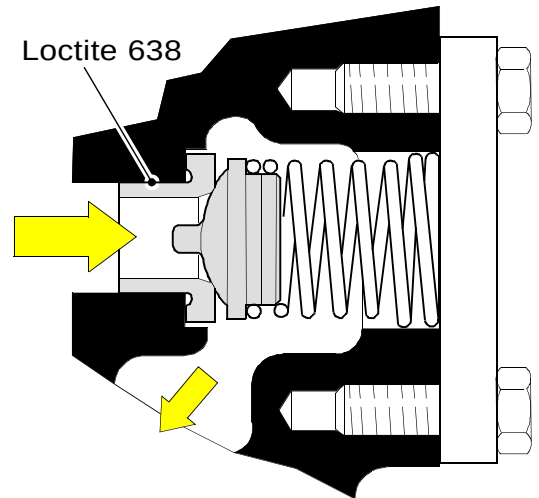
13.1. Oil Pressure Regulating Valve

If the pressure of the engine lubricating oil is insufficient or varies, the oil level then the regulating valve should be checked.

1. Remove the cover and the spring with the valve plate.
2. Clean the parts and check that the sealing surfaces are undamaged. Damaged parts should be changed. Scrape off any remains of the gasket.

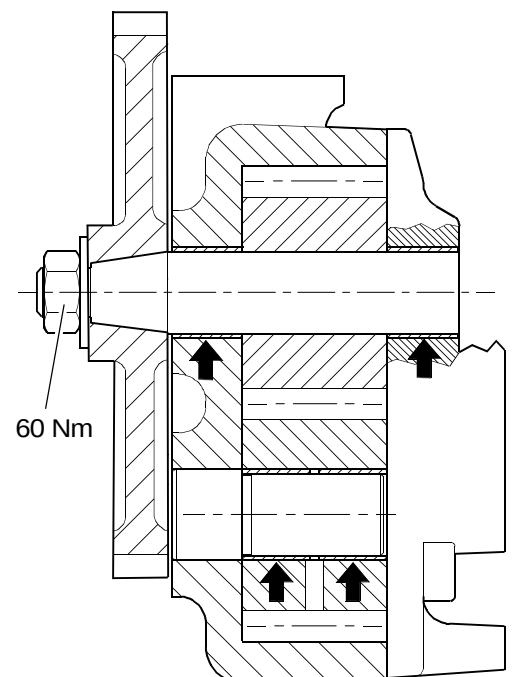
Note! There are two types of spring.

3. Apply locking fluid (e.g. Loctite 638) onto the outside of the valve seat. Tap the new valve seat into the cylinder block using a suitable drift. Place the spring with valve plate into the cylinder block and fit the cover with a new gasket.



13.2. Removing and Dismantling Lubricating Oil Pump

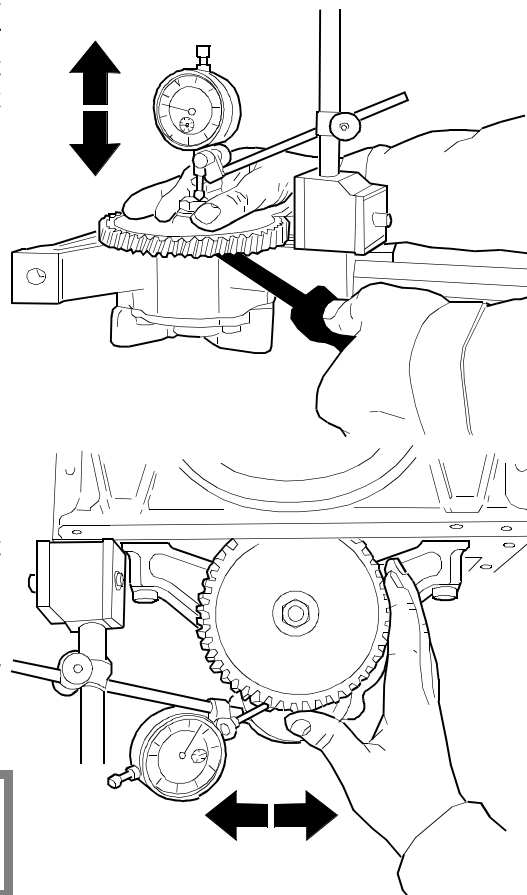
1. Drain the engine oil and remove the oil sump.
2. Remove the oil pump suction and pressure pipe.
3. Remove the oil pump together with any shims between the pump and the cylinder block.
4. Remove the pump cover and the gasket. Remove the gear on the dead axle.
5. Clamp the pump gear across the teeth in a vice fitted with soft jaws, and loosen the drive gear nut. Knock the gear wheel off by hitting the end of the shaft with a soft hammer. Pull out the drive shaft gear wheel.
6. Clean the parts and check for wear and other damage. See "**Technical data**", point "**Oil pump**". Change damaged parts and all seals.
7. On the 66-, 74- and 84-engines, the bearing points are provided with separate bearing bushings. If you change the bushings, machine them to a size of **18.000...18.018 mm** after fitting.



13.3. Assembling and Fitting Lubricating Oil Pump

1. Fit the gear wheels to the pump body. Fit the cover using a new gasket. Partly tighten the screws. Rotate the pump shaft and tap the side of the cover gently until it reaches the position in which the shaft rotates most freely. Tighten the screws and check that the shaft still rotates freely.
2. Fit the drive gear onto the shaft. Apply locking fluid (e.g. Loctite 242) onto the nut threads and tighten the nut to **60 Nm**. Remember the washer under the nut.
3. Fasten the oil pump in a vice and check the end float between gear and pump housing. The clearance, which should be **0.03...0.11 mm**, is adjusted by the number of gaskets between the cover and the body.
4. Fit the pump and check the tooth backlash against the crankshaft gear. The clearance, which should be **0.05...0.25 mm**, is adjusted with shims between the pump body and the cylinder block (shim 0.2 mm, order no. 8360 07871). One shim increases/decreases the backlash by about 0.07 mm.

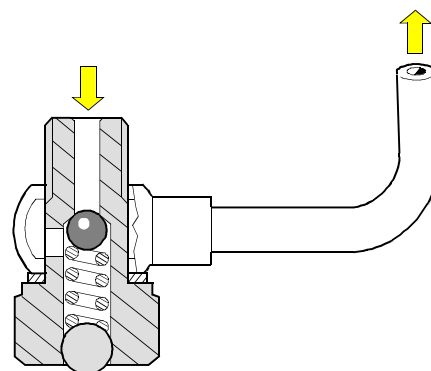
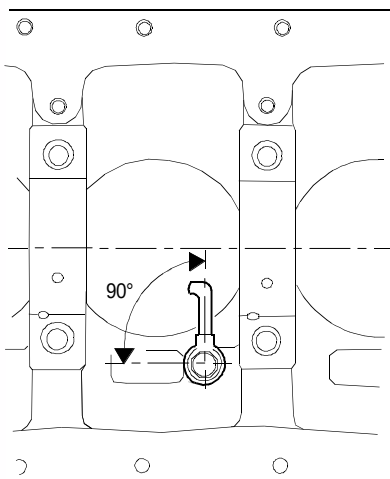
Note! When measuring the tooth backlash, the engine should be the correct way up as the crankshaft bearing clearance affects the tooth backlash.



5. Connect the suction and pressure pipes together with new seals.
6. Fit the oil sump and fill in the lubrication oil.

13.4. Piston Cooling Nozzles

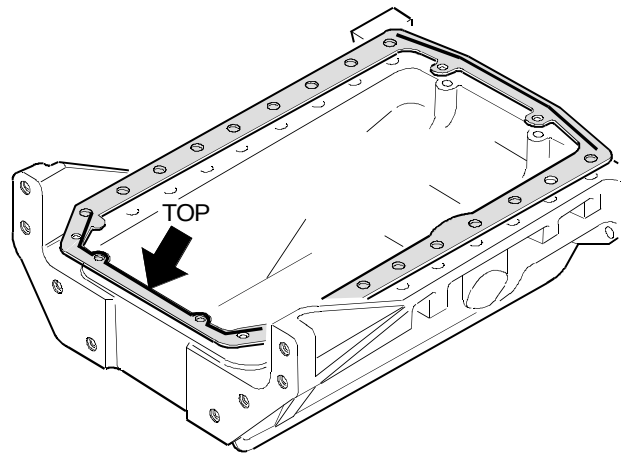
The engines with high output are fitted with piston cooling nozzles. The cooling nozzles can be removed after the oil sump is removed. The nozzles have a ball valve with an opening pressure of **3±0.25 bar**.



1. Change the valve if necessary. Detach the valve from the engine and remove the nozzle pipe. Fit a new valve.
2. Fit the nozzle pipe at a **90°** angle to the centre line of the crankshaft as shown in the picture above. Tighten the valve to **30 Nm**. Ensure that the pipe does not touch the pistons or connecting rods when the engine is running.

13.5. Fitting Oil Sump Gasket

Fit the oil sump gasket with the silicone stripes against the cylinder block (self-carrying and casted oil sumps).

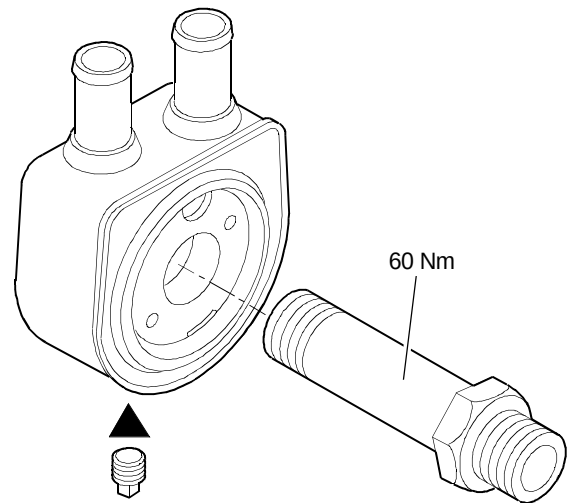


13.6. Lubricating Oil Cooler

44-, 49-, 66- and 74-Engines

Some engines are fitted with an oil cooler, which is positioned in between the oil filter and the cylinder block.

1. The engine coolant should be drained before removing the lubricating oil cooler.
2. Fit new sealing rings. Fit the cooler with the draining plug turned downwards. Connect the coolant pipes in the correct way.
3. Apply the locking fluid (e.g. Loctite 242) to the nipple (the thread that attaches to the cylinder block) and tighten it to a torque of **60 Nm**.

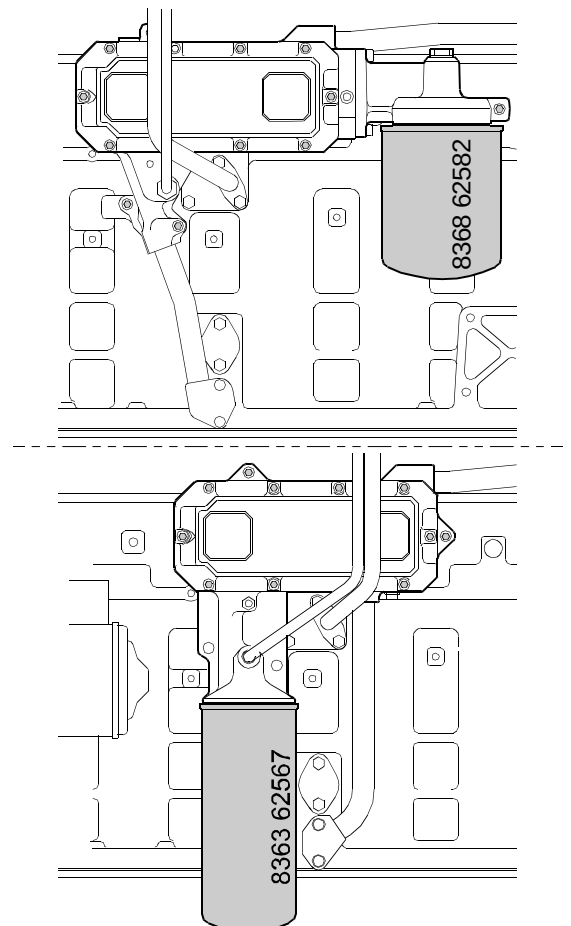


84-engines

There are two different oil coolers, the difference being the position of the oil filter, see picture below.

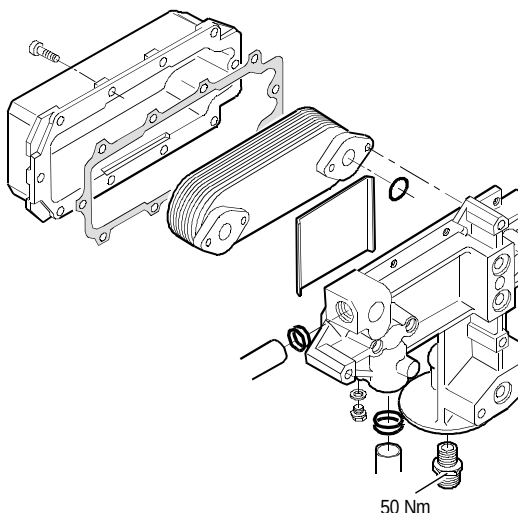
To remove

1. Open the coolant drain plug under the oil cooler and drain the coolant into a suitable container. Remove the pipe going into the thermostat housing.
2. Remove the turbo oil pipes and the oil pressure pipe from the cylinder block. Remove the oil filter. Drain the oil into a container.
3. Remove the oil cooler from the engine. Open the cooler housing and remove the guide plate. Unscrew the cell screws and remove the cell from the body. Clean all the parts.



Fitting the Oil Cooler

1. Assemble the oil cooler using new gaskets. Fit the cell to the body. The oil side can be pressure tested before the housing is fitted. Test pressure is **5 bar**.
2. Push the guide plate between the cell and the body and fit the housing. If necessary, the water side can now be pressure tested. Test pressure is **5 bar**.
3. Attach the oil cooler to the engine and assemble the oil and coolant pipes. Replace the oil filter.
4. Fill the coolant system. Start the engine and check for leakages.

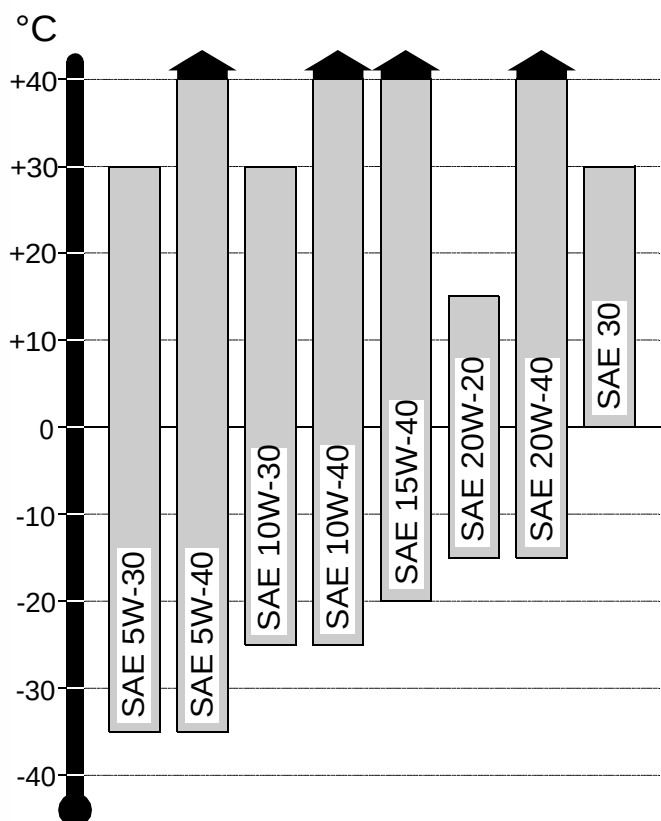


13.7. Lubricating Oil Quality Requirements

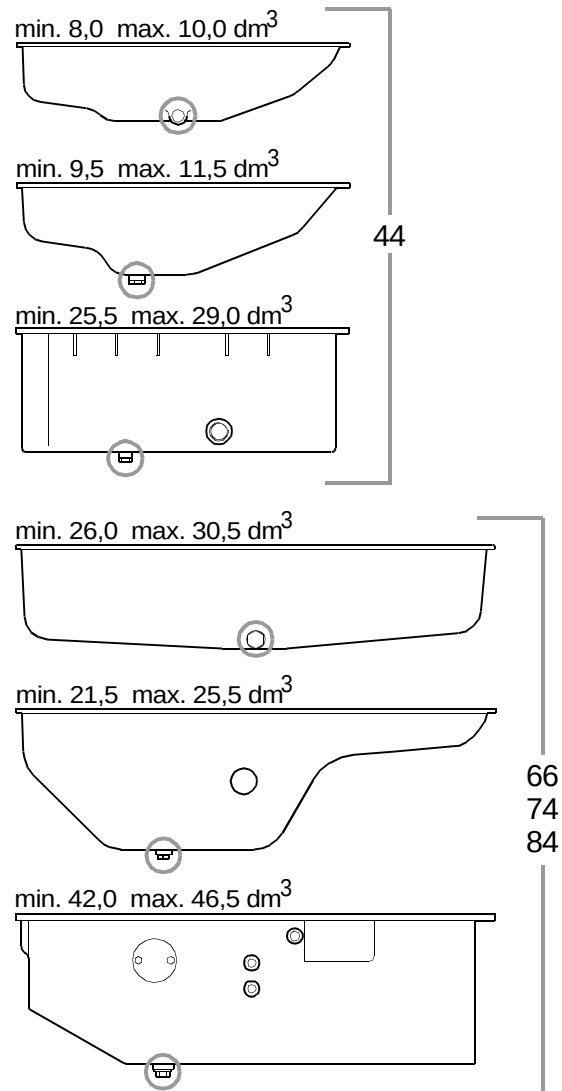
Use lubricating oils of the following quality grades.

API grade	ACEA grade
CI-4	E7

Select the viscosity grade from table below depending on the temperature outside.



13.8. Oil Capacities



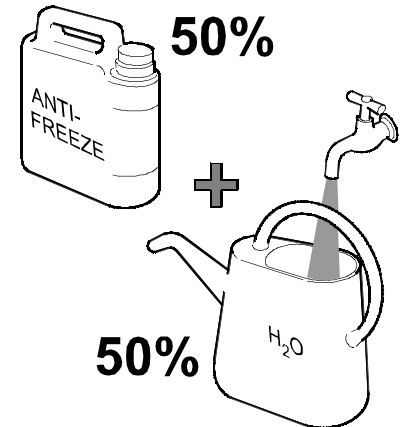
14. COOLING SYSTEM

14.1. Quality Requirements of Coolant

The coolant used must meet the requirements of standard ASTM D 3306 or BS 6580:1992.

- The cooling mixture must consist 40...60% of ethylene/propylene-glycol based antifreeze and water. The ideal proportions are 50% antifreeze liquid to 50% water.
- The water used must be mechanically clean and not too acidic (e.g. swamp water) or too hard (calcareous well water).
- The proportion (the frost proof quality) of the coolant should be checked periodically. Change the coolant every two years.

Note! Water alone should never be used as a coolant!



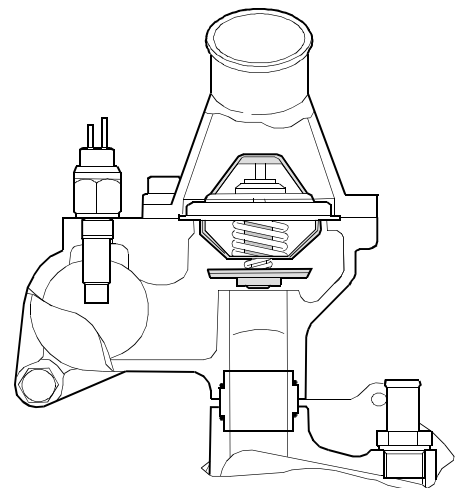
14.2. Thermostat

Check the function of the thermostat as follows:

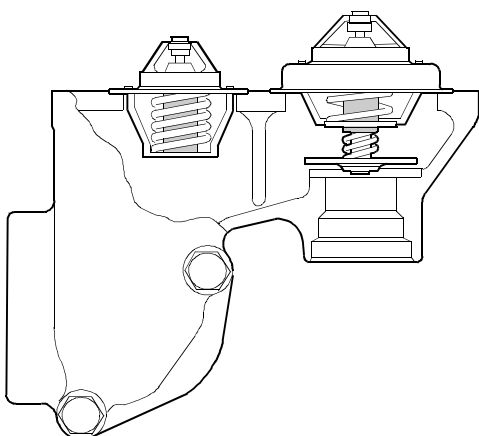
- Lower the thermostat into a vessel of boiling water so that it does not touch the sides or bottom.
- Opening must begin after less than 20 seconds.
- The thermostat must be fully open in less than 50 seconds. See "**Technical data**" point "**Thermostat**".

44-, 49- and 66-engines

It is a 2-way thermostat. Its opening temperature is 83°C.



66- and 74-Engines



Some 66- and 74-engines have two separate thermostats. These are different from the type used as single thermostats and the two are not interchangeable. For these engines there are no separate winter thermostats.

84-Engines

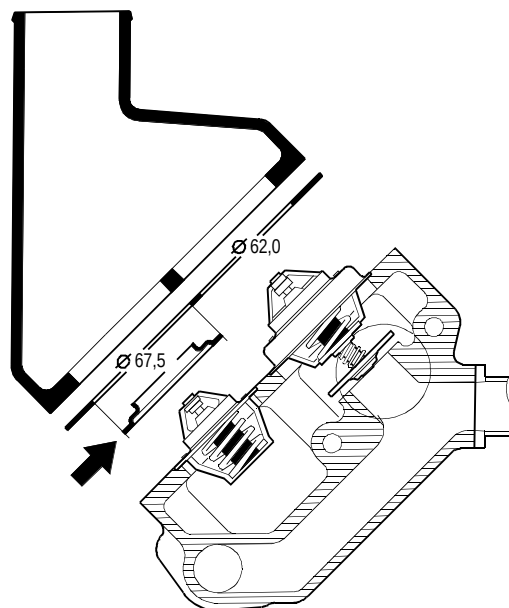
84-engines have two separate thermostats. The smaller, single-acting thermostat opens at 79°C and the other, double-acting type, at 83°C. In 84-engines there are no separate winter thermostats.

To remove

1. Drain the cooling system so that the coolant level is below the thermostats and disconnect the top hose from the water outlet cover.
2. Remove the outlet cover and the thermostats. Clean the sealing surfaces.

To replace

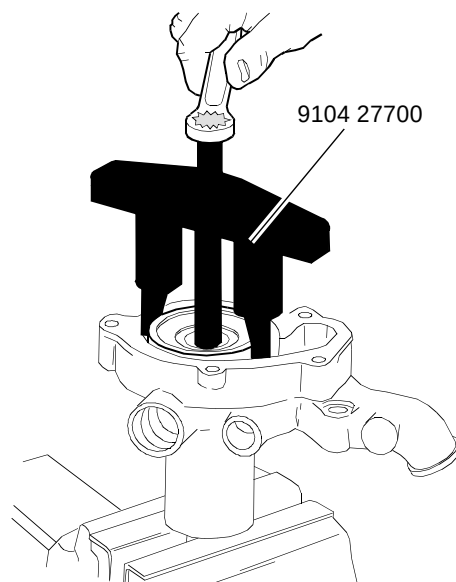
1. Place the thermostats in position in the housing. Fit a new gasket and the outlet cover. M8 studs (2 pcs) can be used as guides. Observe the plate (if mounted) that comes on top of the smaller thermostat. Fit the gasket so that the bigger hole is on the same side as the plate.
2. Connect the top hose and fill the cooling system.



14.3. Reconditioning Coolant Pump

44-, 49-, 66- and 74-Engines

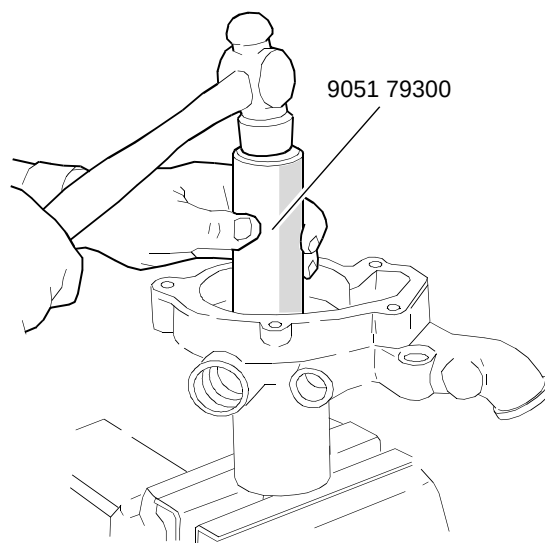
1. Drain the coolant. Remove the thermostat housing, fan and v-belt.
2. Remove the coolant pump. Detach the pump rear plate and clean the sealing surfaces.
3. Unscrew the belt pulley fixing nut/screw and remove the belt pulley
4. Remove the impeller on the shaft with puller 9104 27700 (33- and 44-engines) or 9101 93200 (66- and 74-engines).
5. Remove the circlip from the pump body. Press the shaft together with the bearings pointing in the direction of the fan. Use a hydraulic press, for example. Support the pump body so that the bearings have enough space to release.
6. Tap out the water seal and shaft seal using a drift. Clean the parts and inspect their condition. Replace faulty or worn parts with new ones.



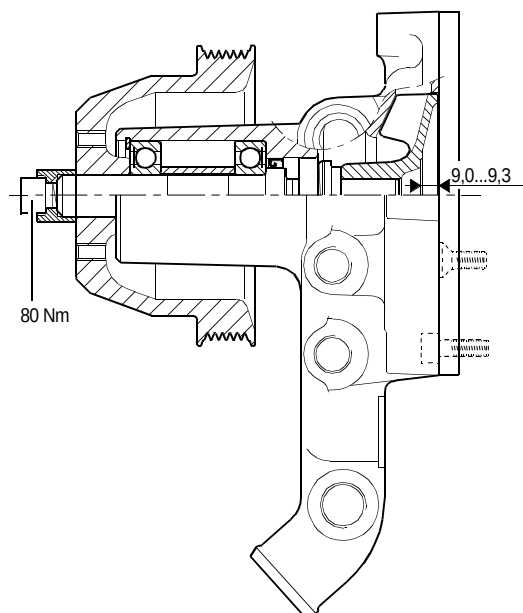
Note! If the pump bearings have to be changed, use a reconditioning kit. This kit also contains all the seals (see Parts Catalogue).

7. Drive the new shaft seal into the housing using a suitable drift. Put the bearings and the intermediate sleeve onto the shaft. Grease the bearings with heat-resistant ball bearing grease (NLGI 2). Fit the shaft and the bearings in such a way that the ball bearings do not transmit the pressure. Fit the circlip on the bearing.

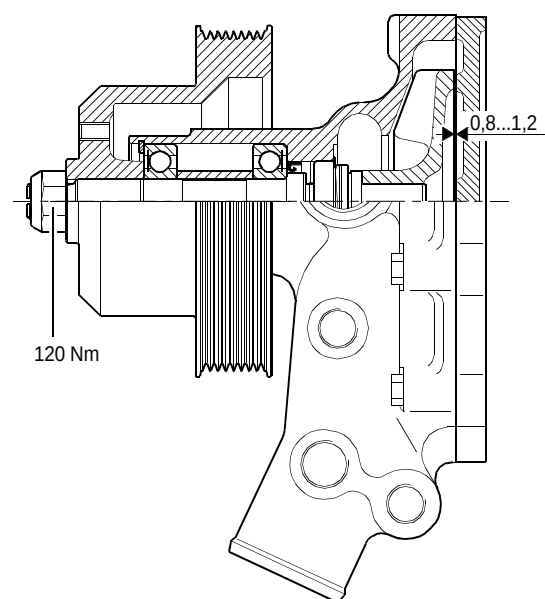
8. Fit the water seal with drift 9051 79300. Use as a "lubricating liquid" coolant between the shaft and the seal.



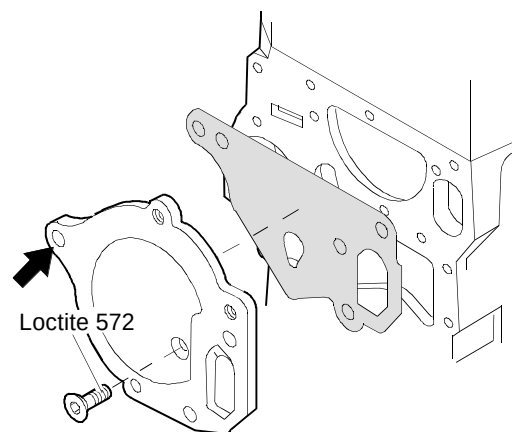
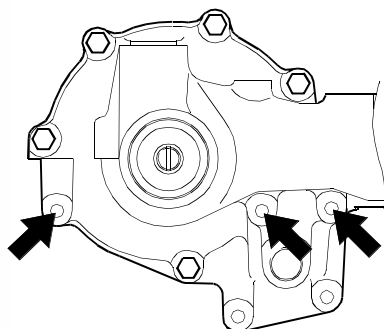
9. Press the impeller into position while, at the same time, supporting the shaft at the other end. The mounting depth of the impeller is **9.0...9.3 mm** in 33- and 44-engines (see picture above). Make sure that the shaft can rotate freely. Fit the belt pulley and tighten its attaching screw to a torque of **80 Nm**. Note in particular the left-hand thread of the belt pulley attaching screw.



The mounting depth of the impeller is **0.8...1.2 mm** in 66- and 74-engines (see picture above). Make sure that the shaft can rotate freely. Fit the belt pulley and tighten its attaching nut to a torque of **120 Nm**



10. Fit the rear plate to the cylinder block using a new seal. Use guide pin (Ø8 mm) in the hole shown with an arrow in the picture above. Apply sealing compound to the thread of the screw

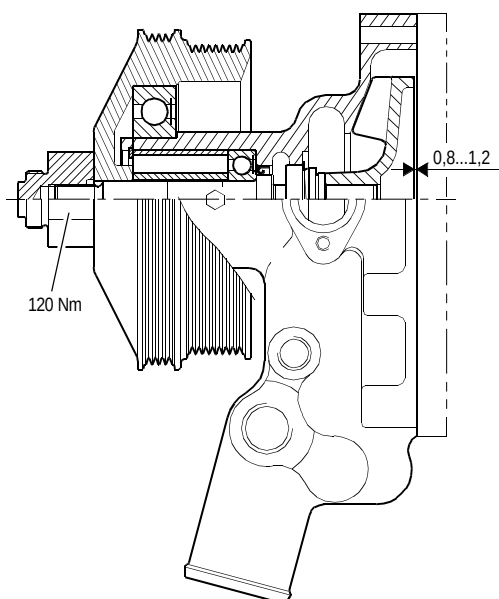


On 66- and 74-engines, fit the rear plate to the pump using a new seal. Use guide pins (Ø8.5 mm) in the holes shown with arrows in the picture above. Tighten the fitting screws (5 pcs / 10.9) to the torque of **35 Nm**.

14.4. Coolant Pumps with Heavy Duty Bearings

66- and 74-Engines

Some versions of 66- and 74-engines have heavy duty bearings in the coolant pump. The reconditioning of this pump is done according to instruction **14.3.**. Note in particular the position of the front bearing during assembly.



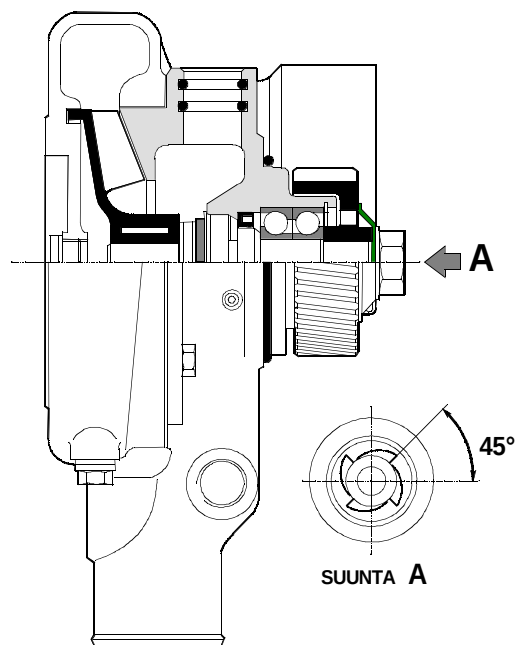
14.5. Reconditioning the Coolant Pump

84-Engines

1. Drain the coolant. Disconnect the hose from the inlet connection of the coolant pump. Loosen the coolant pipes from the coolant pump.
2. From the rear, release the three screws that connect the coolant pump to the cover of the timing case. Remove the coolant pump.
3. Unscrew the gear fixing nut and remove the gear. Remove the pump housing from the pump body.
4. Remove the circlip from the pump body. Press the shaft together with the bearings pointing in the direction of the gear.
5. Tap out the water seal and shaft seal using a drift. Remove the O-ring seals, clean the parts and inspect their condition. Replace faulty or worn parts with new ones.

Note! If the pump bearings have to be changed, use a pump repair kit. This kit also contains all the seals (see Parts Catalogue)

6. Tap the new shaft seal into the body using a drift 9103 41000. Grease the bearings with heat resistant ball bearing grease (NLGI 2). Press in the bearings and fit the circlip.
7. Fit the shaft in such a way that the ball bearings do not transmit the pressure
8. Knock the water seal into position with tool 9103 41100. Press the impeller into position (near the shaft shoulder), supporting the shaft from the other end. Make sure that the shaft can rotate freely.
9. Fit the oil collecting ring to the shaft in the position as shown in the picture. Fit the gear on the shaft and tighten the nut to **180 Nm**.
10. Fit the pump housing using a new gasket.
11. Fit the pump using a new O-ring.



Note! If both the coolant pump and high-pressure pump are removed, fit the coolant pump first (one fitting screw cannot be fitted while high-pressure pump is in position).

15. INLET AND EXHAUST SYSTEM

An engine that is fitted with a turbocharger is a lot more sensitive to disturbances and impurities in the inlet and exhaust systems than a naturally aspirated engine. Therefore, special attention should be paid to the whole inlet and exhaust system.

15.1. Checking the Air Cleaner

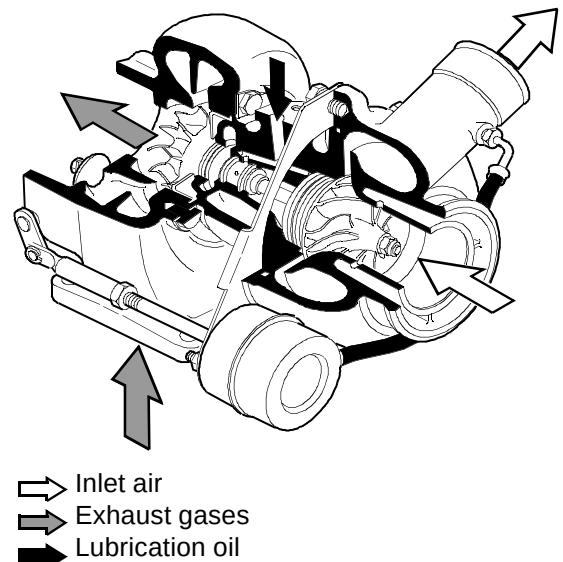
The engine performance and length of service life depend to a great extent on the state of the air cleaner. A defective air cleaner allows impurities to pass through, which in time damage the turbocharger and the engine. A blocked air cleaner reduces the engine output and also causes oil leakage through the sealing ring on the turbocharger shaft.

Note! The safety filter inside the main filter should not be removed unnecessarily for checking or cleaning. The safety filter must not be cleaned, but should be changed when necessary.

15.2. Checking the Inlet and Exhaust Pipes

Important! Leaks in the inlet or exhaust system drastically reduce the effect of the turbocharger. Because of the pressure, even small leaks in the manifold or the turbine inlet contact flange quickly increase in size. For this reason, all leaks must be dealt with immediately.

1. Inspect the pipes and sealing surfaces between the air cleaner and the turbocharger, as well as between the turbocharger and the intake manifold. If the intake manifold is dusty inside, there is a leak in either the air cleaner or the inlet pipes. Fix the leak.
2. Clean the intake manifold sealing surface. Check that the sealing surface is flat using a straight ruler. If the surface is not flat or has scratches on it, machine or renew the intake manifold. On 66-, 74- and 84-engines, ensure that the cylinder heads are parallel.
3. Fit a new gasket and fasten the intake manifold. Tighten the manifold fixing screws to a torque of **30 Nm**. Fasten the air pipes carefully.
4. Check that the exhaust manifold is airtight. Tighten the nuts to **50 Nm** and inspect for any damage (cracks, deformation, corrosion etc.). Also check the connection between the turbocharger and the exhaust manifold.
5. Remove the manifold if necessary. Clean the sealing surfaces and remove any carbon deposits. Check that the sealing surfaces are flat. If the fastening flanges are twisted or there are scratches on the sealing surfaces, machine the flanges or renew the exhaust manifold.
6. Ensure that no loose objects or impurities have entered the exhaust pipe or the silencer. Any such loose objects or impurities can increase the back pressure for the exhaust gases from the turbine wheel.

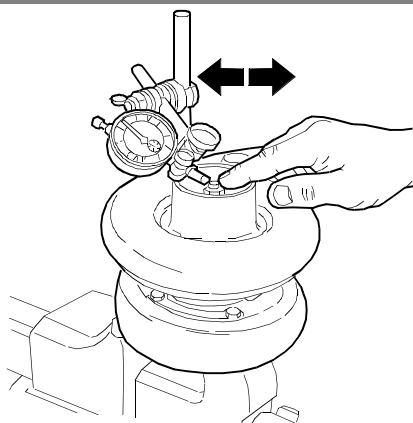


15.3. Checking the Turbocharger

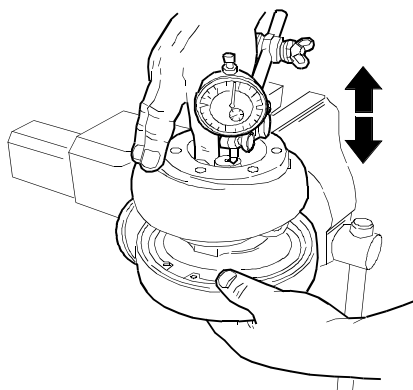
If a fault is suspected in the turbocharger, it can be located in the following way:

1. Visually inspect the turbine and compressor wheels. The vanes must not show any signs of damage, deformation or wear caused by foreign objects.
2. Investigate any oil leaks through the sealing rings on the shaft in the turbine and compressor housing.

Note! At low idling speed there is always a certain amount of oil leakage on the compressor side. However, this should not cause too much concern unless the oil consumption is too great.



3. Check the turbine shaft running clearance. Place the stylus of a dial gauge against the shaft and move the shaft sideways. Refer to the clearance given in the specifications. See "**Technical data**" point "**Turbocharger**".



4. Check the shaft end float. Place the stylus of the dial gauge against the end of the shaft and move the shaft axially. Refer to the clearance given in the specifications. See "**Technical data**" point "**Turbocharger**".

If any defects or wear are detected, the turbocharger should be reconditioned.

If the engine does not work correctly and the turbocharger is not defective or too worn, the fault could be traced to one of the following items:

- Blocked air filter.
- Leakage in the inlet or exhaust systems. Leaking flange seal.
- Defective high-pressure pump or EEM 3 control unit.
- Defective or wrongly adjusted injectors.
- Low fuel pressure (e.g. blocked fuel filter).
- Low compression, wrong valve clearance.

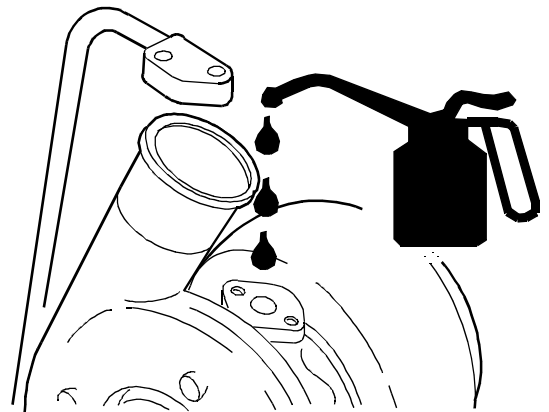
15.4. Fitting the Turbocharger

Locate the cause of the defects on the turbocharger. Remedy the fault before fitting the new turbocharger.

In order for the turbocharger to work satisfactorily, it is important that the engine oil is in good condition. Likewise, the oil should be to the correct quality specification. The air filter and oil filter should be serviced according to the Instruction Manual specification.

The adjusting of the EEM3 control system affects definitely to the function of the turbocharger. The adjusting have to be made according to the manufacturer's instructions.

1. Check the tightness of the intake and exhaust manifolds, and that they are securely fastened. Ensure that there are no loose carbon or rust particles, or other foreign objects in the manifolds.
2. Connect the turbocharger to the exhaust manifold and tighten down using a new gasket.
3. Connect the inlet pipe and the exhaust pipe to the turbo.
4. Pour about 0.1 litres of pure engine oil into the bearing housing before attaching the pressure oil pipe. This is very important in order to ensure that the turbocharger is lubricated when starting.
5. Connect the pressure and return oil pipes. Use a new seal. Check that there is no tension in the pipes when tightening.
6. Start the engine and check that there are no leaks.

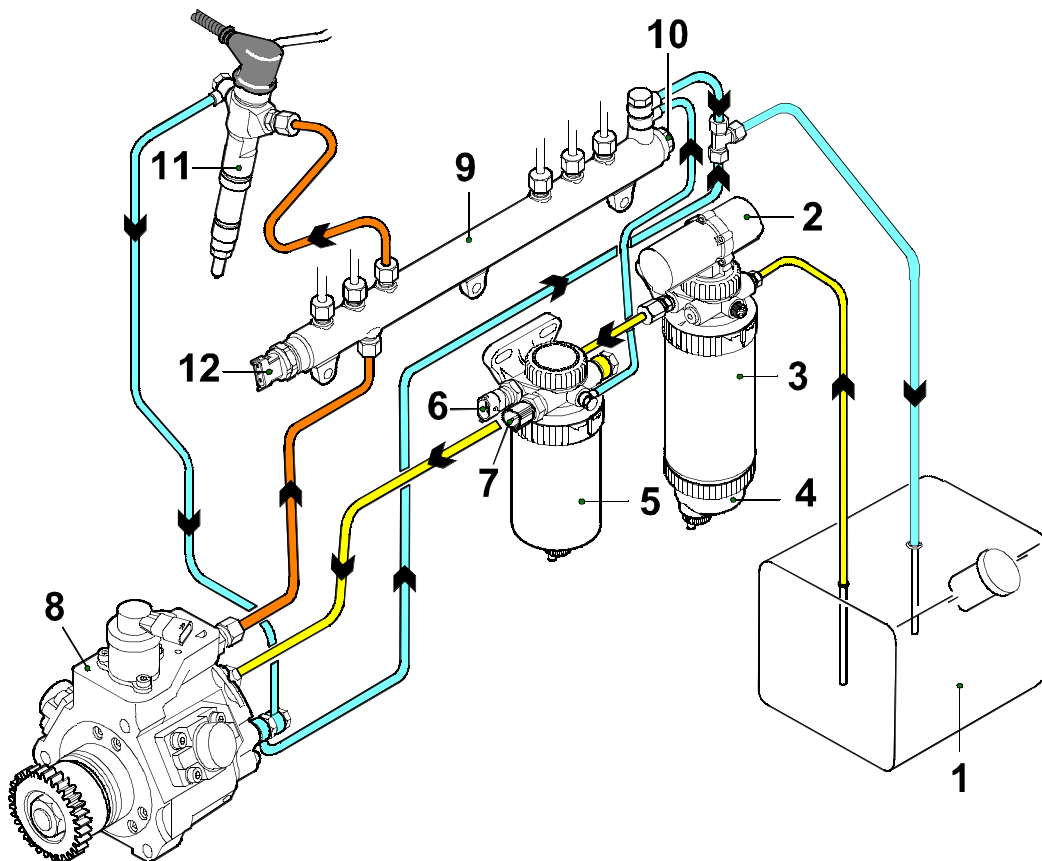


16. FUEL SYSTEM

Citius series engines fulfil the emission requirements set by the authorities (EU97/68/EC Stage III A and EPA 40 CFR 89 Tier 3). The manufacturer guarantees that all engines of this type are equivalent to the engine that is officially approved. Please note that the service schedule should be followed carefully, especially when performing periodical maintenance. Any adjustment and repair work to the injection system or the engine control unit should only be carried out by a representative authorised by Sisu Diesel Inc. When performing any service or repair work, only use original SisuDiesel spare parts. Inadequate or delayed service and the use of parts other than original SisuDiesel spare parts will invalidate the responsibility of Sisu Diesel Inc. with respect to the fulfilment of the emission requirements.

Note! This manual only provides general instructions for servicing and repair work relating to the fuel system. Therefore, there are no instructions on changing the high-pressure pump, injectors and rail, which should only be performed by someone with special training and the necessary special tools and gauges. All servicing and repair work relating to the fuel system requires particular care and cleanliness!

Citius series engines are fitted with a common rail system that is controlled by the EEM3 electronic control unit.



Parts of the Fuel System

- | | |
|-----------------------|-------------------------|
| 1. Fuel tank | 7. Feed pressure sensor |
| 2. Feed pump | 8. High-pressure pump |
| 3. Pre-filter | 9. Rail |
| 4. Water separator | 10. Overflow valve |
| 5. Fuel filter | 11. Injector |
| 6. Temperature sensor | 12. Pressure sensor |

The electric feed pump draws fuel from the tank through the pre-filter, then the main fuel filter to the high-pressure pump. From the high-pressure pump, fuel is pumped up into the rail. This highly pressurised fuel is stored in a high-pressure pipe, where it is controlled and injected through electronic injectors that are controlled by EEM3. The injection is optimised in terms of emissions, efficiency and operation noise and takes place in four steps (maximum). Excess fuel returns from the injectors and the pressure-regulating valves of the high-pressure pump and rail and is fed back into the fuel tank. The overflow pipe from the filter helps with the automatic bleeding of the system.

16.1. Technical Data

High-Pressure Pump

Type CP1H (44-, 49- and 66-engines)	3 cylinder /radial plungers
- max. injection pressure	1100 bar
- gear ratio	4 : 3
Type CP 3.3 (74- and 84-engines)	3-cylinder/radial plungers
- max. injection pressure	1400 bar
- gear ratio	3 : 2
Injection order:	
- 44- and 49-engines	1-2-4-3
- 66-, 74- and 84-engines	1-5-3-6-2-4

Injectors

Type	CRIN2-2V/CRIN2-4V
- nozzle 2V engines	5-hole
- nozzle 4V engines	8-hole

Fuel System

Fuel	The fuel must comply with the EN 590 standard.
Max. continuous fuel inlet temperature	70° C
Fuel filters:	
- pre-filter	Stanadyne 30 µ, element no. 8368 67591
- main filter	Stanadyne 5 µ, element no. 8368 67595
Feed pump	Electric type, with pre-filter
Supply voltage	12 V
Current drain	max. 6 A
Feed pressure at idle speed	
- when CP1H high-pressure pump	0.75 bar
- when CP 3.3 high-pressure pump	1.0...1.2 bar

Tightening torques

Object	Nm
Injector retaining screw (2V engines)	40 Nm
Injector retaining screw (4V engines)	See instruction 16.4.4.
Injector wire nuts (M4)	1.5
High-pressure pump gear nut CP1H (M14)	70
High-pressure pump gear nut CP3.3 (M18)	105
High-pressure pump retaining screws	30
High-pressure fuel pipes to high-pressure pump and rail	30
Low pressure fuel pipes to high-pressure pump	25
High-pressure fuel pipes to injector (2V engines)	25

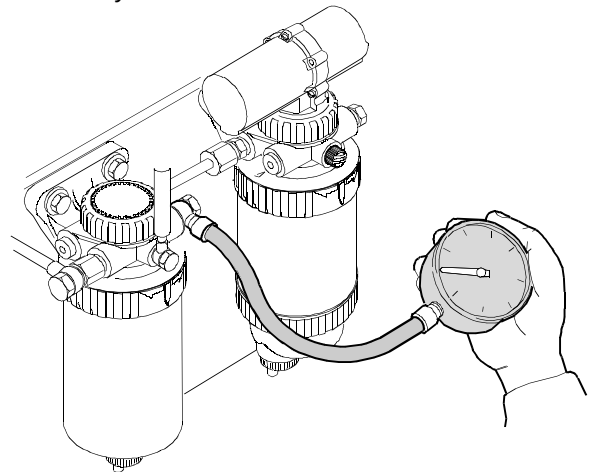
16.2. Bleeding Fuel System

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 sec. after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries. Contact immediately to medical service.

Citius series engines have an automatic fuel-bleeding system. Separate bleeding is not required for changing the fuel filters or in the event of insufficient fuel. It is sufficient to switch on the current and let the electric feed pump work for about 30 seconds before you start. Crank the engine for about 10 seconds. If the engine does not start, continue pumping and cranking alternately until it starts.

16.3. Measuring Fuel Feed Pressure

1. Clean the pre-filter, the fuel filter and the related fuel pipes from the outside.
2. Disconnect the pressure switch from the fuel filter and connect the gauge instead (the thread is M14x1.5).
3. Run the engine at low idling speed for a while and compare the gauge reading with the prescribed value (0.75 bar with CP1H high-pressure pump and 1.0...1.2 bar with CP 3.3 high-pressure pump).



If the pressure is below the prescribed value, this may be caused by:

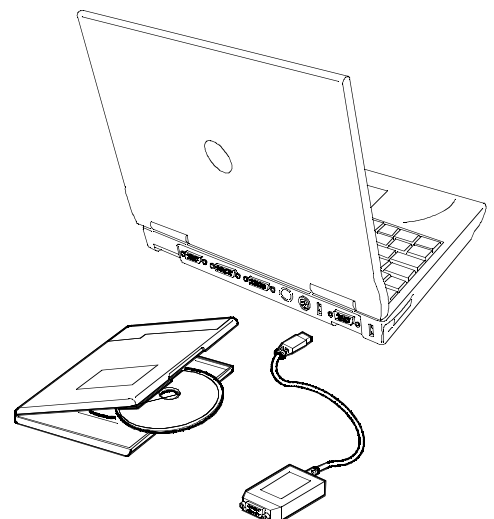
- Clogged fuel filters.
- Malfunction of the feed pump.
- Suction piping clogged or leaking air.
- Empty fuel tank or unsuitable fuel (e.g. summer fuel in the winter).

16.4. Inspecting Injectors

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 sec. after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries. Contact immediately to medical service.

The function of the injectors can be tested using the Sisu EEM3 service tool (so-called "Run-up test"). For more detail, please see the service tool manual.

Note! The nozzle on the injector cannot be changed. Instead a spare injector is available.



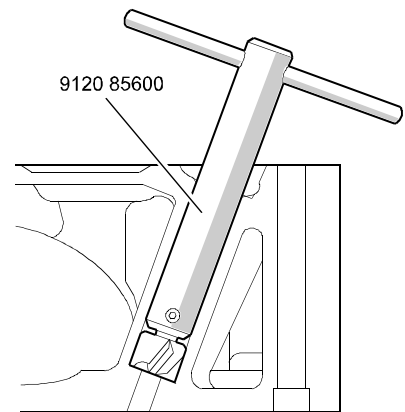
16.4.1. Remove Injectors, 2V Engine

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 sec. after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries. Contact immediately to medical service.

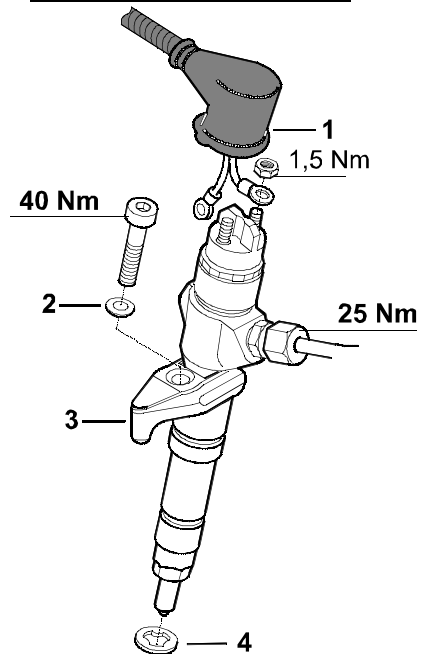
1. Clean the injectors, their pipes and surroundings.
2. Detach the injector and leak-off pipes and wires.
3. Undo the fastening screw holding the injector in place and remove the injector. Plug plastic covers into all the connection points of the injector.
4. Also remove the injector sealing ring from the cylinder head if not removed with the injector.

16.4.2. Fitting Injectors, 2V Engine

1. Clean the injector sealing surface in the cylinder head. If necessary, use a reamer 9120 85600.



2. Ensure the injector seat on the cylinder head is clean. Replace the old seal ring with a new one.
3. Install the injector on the cylinder head. Then tighten the fastening screws to a torque of **40 Nm**.
4. Attach the injector and leak-off pipes and wires.



Injector

1. Injector wiring
2. Ball washer
3. Fastener
4. Seal ring

16.4.3. Remove Injectors, 4V Engine

1. Clean high-pressure pipes and surroundings.
2. Remove the valve cover.
3. Detach the high-pressure pipe and injector wires.

Note! Prevent fuel circulation to the engine via the overflow pipe located in the cylinder head (if the fuel tank is above the engine).

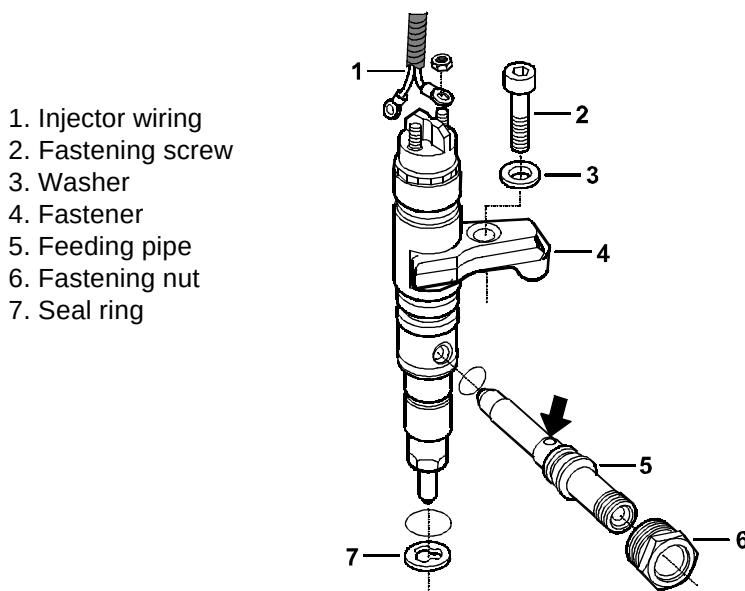
4. Loosen the fastening screw holding the injector in place and the fastening nut holding the feeding pipe in place. Unscrew and remove them. Plug plastic covers into all the connection points.

Note! The injector and feeding pipe are calibrated to couple. Do not mix them up.

5. Also remove the injector seal ring from the cylinder head if it has not been removed with the injector. Blow the injector and feeding pipe locations dry.

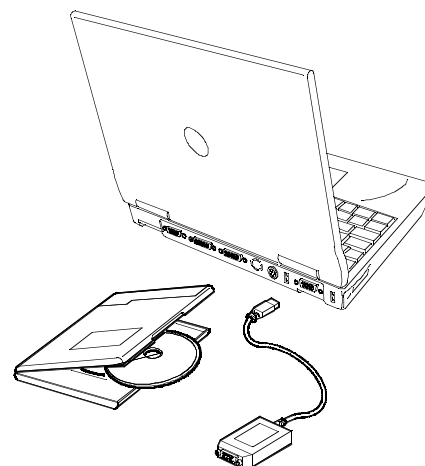
16.4.4. Fitting Injectors, 4V Engine

1. Ensure the injector seat on the cylinder head is clean. Replace the old seal ring and the O-rings with new ones.
2. Install the injector and feeding pipe on the cylinder head. Pay attention to the position of the feeding pipe. Adjust the feeding pipe's control balls (shown with an arrow on the picture) so that they line up with the grooves in the cylinder head.
3. Tighten the fastening screw and nut progressively as follows:
 1. Pre-tighten the fastening screw (2) to **15 Nm**
 2. Undo the fastening screw
 3. Pre-tighten the fastening nut (6) to **15 Nm**
 4. Tighten the fastening screw to **40 Nm**
 5. Tighten the fastening nut to **50 Nm**
5. Install the high-pressure pipe (tightening torque **30 Nm**) and injector wires (nuts M4, torque **1.5 Nm**). Replace the valve cover seals and attach the cover (torque for the screws **25 Nm**).



16.5. High-Pressure Pump

The Citius series uses two different types of pump: CP1H in 44-, 49- and 66-engines and CP 3.3 in 74- and 84-engines. The function of the high-pressure pump can be tested using the Sisu EEM3 service tool (so-called "High-pressure test"). For more detail, please see the service tool manual.



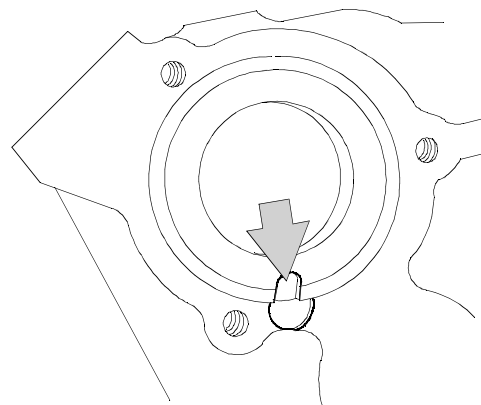
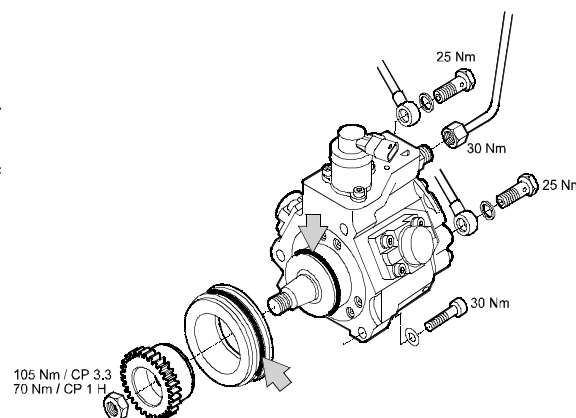
16.5.1. Remove the High-Pressure Pump

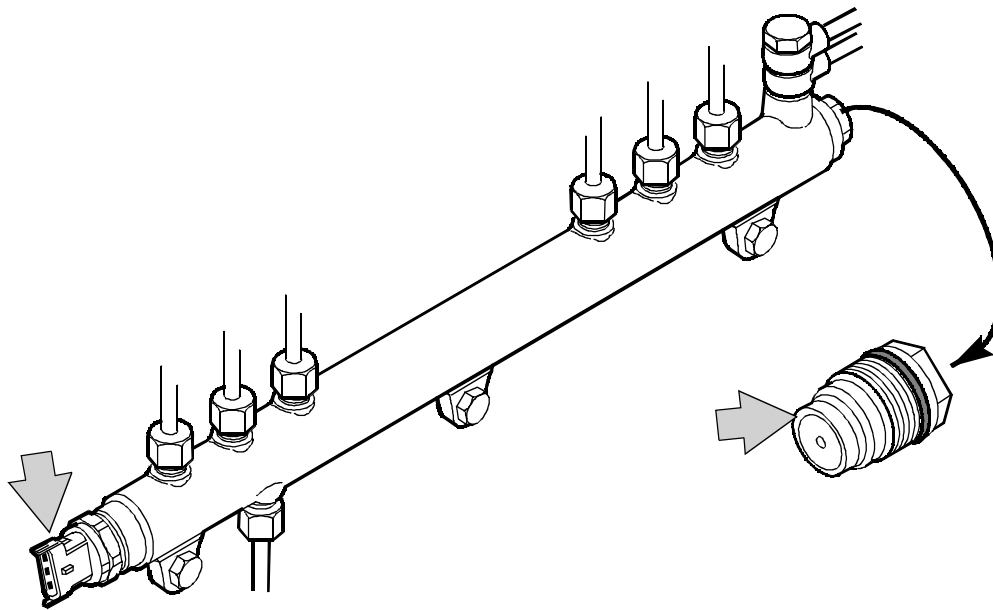
Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 seconds after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries. Contact immediately to medical service.

1. Disconnect the electric main switch. Clean the high-pressure pump and surroundings. Detach the wire connector.
2. Disconnect the fuel delivery pipes and insert protective plugs in the connections.
3. Unscrew the retaining screws and remove the high-pressure pump. Notice the guide ring used in the high-pressure pump of 44-, 49- and 66-engines. Remove the gear with the appropriate tool. Take the high-pressure pump to the Bosch Diesel agent or the service department of Sisu Diesel Oy to be reconditioned.

16.5.2. Fitting the High-Pressure Pump

1. Attach the new O-ring to the sealing groove of the high-pressure pump. If the front cover of the gear housing has not been removed, fix the gear to the shaft of the pump. Please note that the guide ring of the CP1H high-pressure pump has to be fixed to the pump flange before the gear is fixed.
2. Tighten the nut of the gear to **70 Nm** in a CP1H pump and to **105 Nm** in a CP 3.3 pump.
3. Lubricate the O-ring, place the high-pressure pump in position in the gear housing and tighten the fixing screws to 30 Nm. There are no specific instructions on the alignment of the high-pressure pump gear and the double gear.
4. Turn the borehole in the CP1H pump guide ring so that it lines up with a similar borehole the gear housing.
5. Fix the fuel feeding pipes. Tighten the connectors of the low-pressure pipes to a torque of **25 Nm** and the connectors of the high-pressure pipes to **30 Nm**. Then attach the wiring connector.



16.6. Rail

Note! Do not open high-pressure pipe connectors on the fuel system when the engine is running. Wait at least 30 seconds after the engine has stopped. If the jet of high-pressure fuel comes into contact with your skin, the fuel will penetrate the skin causing severe injuries. Contact immediately to medical service.

The Rail is attached to the intake manifold. Turn the main switch to OFF position before handling the rail. Clean the rail and its surroundings carefully. Prevent fuel from leaking to the ground. Insert plugs where fuel connectors have been removed.

The pressure sensor and shut-off valve will be delivered as spare parts for the rail. These parts can be changed while the rail is in position. Alternatively, the complete rail can be replaced.

Shut-Off Valve (DBV, Order Number 8370 69409)

Clean the sealing surface and the thread of the rail. Check the condition of the end sealing surface of the shut-off valve. Radial scratch is not permissible. Lightly lubricate the valve thread, sealing surface and O-ring. Tighten the valve in place to a torque of **100 Nm**.

Pressure Sensor (RDS, Order Number 8370 69410)

Disconnect the electrical connector before loosening the sensor. Clean the sealing surface and thread of the rail. Check the condition of the end sealing surface of the pressure sensor. Radial scratch is not permissible. Lightly lubricate the sensor thread and sealing surface. Tighten the sensor in place to a torque of **70 Nm**. Connect the electrical connector.

High Pressure Pipes

It is recommended that high-pressure pipes are replaced every time they are removed. The torque for the high-pressure pipe connector is **30 Nm**.

16.7. Fuel Quality Requirements

	Requirement	Test method
Density, +15°C	0.82...0.84 kg/dm ³	EN ISO 3675:1998, EN ISO 12185
Viscosity, +40°C	2.0...4.5 mm ² /s	EN ISO 3104
Sulphur content	max. 350 mg/kg	EN ISO 14596:1998
Cetane number	min. 51	EN ISO 5165:1998
Water content	max. 200 mg/kg	prEN ISO 12937:1996
Lubricity/HFRR	max. 460 µm	ISO 12156-1

The fuel must comply with the EN 590 standard.

The engine output depends on the fuel quality.

Factors such as the temperature, density and viscosity of the fuel affect the actual output of the engine. Our outputs are based on fuel with a density of 0.84 kg/dm³ and a specific heat rate of 42.7 MJ/kg at a fuel temperature of +15°C.

The percentage correction caused by the change in fuel quality is shown in the following illustrations.

FIG. A. Dependence of engine output on fuel temperature. The reference temp is +35°C (correction 0%). The fuel temperature is not only affected by ambient conditions, it also varies according to the fuel system of the model (tank size, location, return flow etc.).

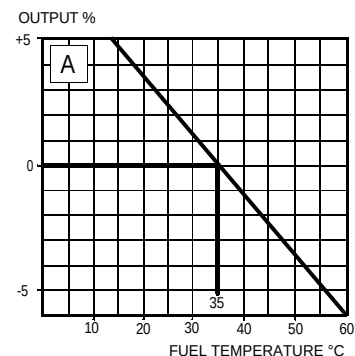


FIG. B. Dependence of engine output on fuel density. The normal value is 0.84 kg/dm³ at +15°C.

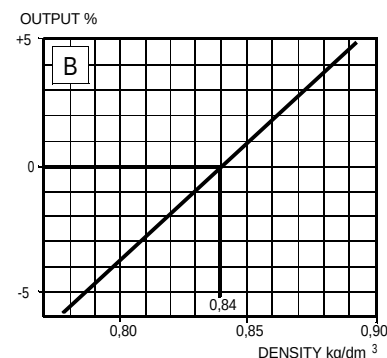
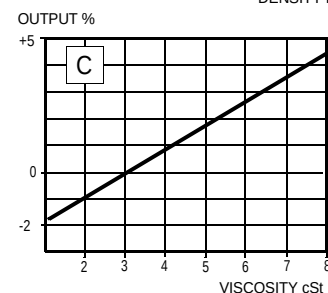


FIG. C. Dependence of engine output on fuel viscosity. The normal value is 3 cSt at +20°C.



Please note, fig. B and C are only relevant if the fuel quality is changed.

In fig. A, all the quality dependencies are caused by a change in temperature. The fuel density and viscosity can be seen in the declaration produced by the manufacturer.

The output correction is calculated as follows: The correction percentages from figures A, B and C are added together. The given rated power is then corrected on the basis of the resulting percentage.

Alternative Fuels

Using diesel fuel according to European norm EN 590, all SisuDiesel engines have full warranty for the specified warranty period and the engines will work well with good reliability and long life time.

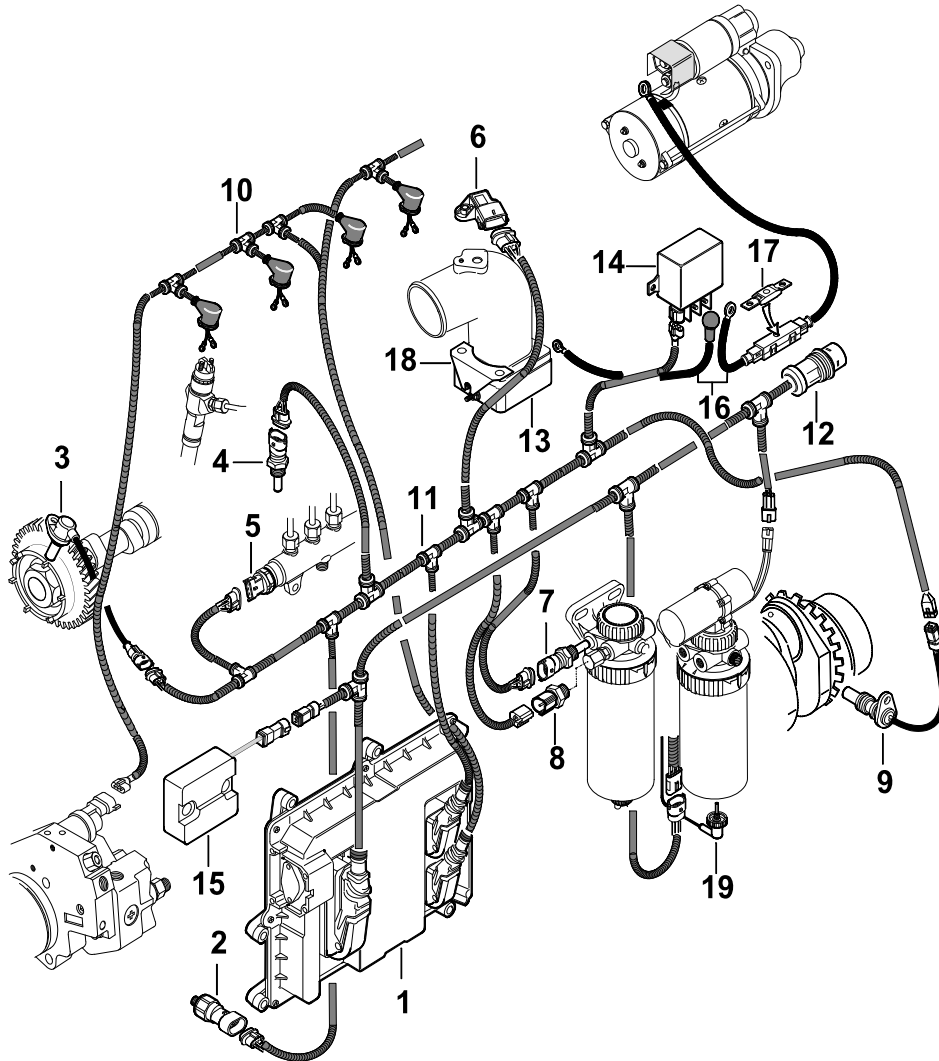
The only possible alternative fuel to use is RME (Rapeseed Methyl Ester) Biodiesel according to European norm EN 14214 or US norm ASTM D6751.

Engines with Common Rail fuel injection system only max. 20 % dilution of Biodiesel (B20) is allowed.

17. EEM3 ENGINE CONTROL SYSTEM

Citius series engines fulfil the emission requirements set by the authorities (EU97/68/EC Stage III A and EPA 40 CFR 89 Tier 3). The manufacturer guarantees that all engines of this type are equivalent to the engine that is officially approved. Please note that the service schedule should be followed carefully, especially when performing periodical maintenance. Any adjustment and repair work to the injection system or the engine control unit should only be carried out by a representative authorised by Sisu Diesel Inc. When performing any service or repair work, only use original SisuDiesel spare parts. Inadequate or delayed service and the use of parts other than original SisuDiesel spare parts will invalidate the responsibility of Sisu Diesel Inc. with respect to the fulfilment of the emission requirements.

17.1. Construction of the EEM3



Parts of the Engine Control System

- | | |
|----------------------------------|-------------------------------|
| 1. Electronic control unit (ECU) | 11. Sensor wiring |
| 2. Oil pressure sensor | 12. Vehicle connector wiring |
| 3. Speed sensor (camshaft) | 13. Inlet air heater |
| 4. Coolant temperature sensor | 14. Inlet air heater solenoid |
| 5. Rail pressure sensor | 15. ID module |
| 6. Boost pressure sensor | 16. Heater wiring |
| 7. Fuel temperature sensor | 17. Fuse |
| 8. Fuel pressure sensor | 18. Ground plate |
| 9. Speed sensor (crankshaft) | 19. Water detector (fuel) |
| 10. Injector wiring | |

17.2. EEM3 Engine Control System, Description

The basic function of electronic control of the engine is continuous adjustment and measuring of the load, quantity of fuel and rotating speed. Other additional functions include cold start automatics and engine protecting automatics. The central unit of the electronic control system continuously receives signals from sensors that measure different functions in the engine, such as rotating speed, oil pressure, boost pressure, fuel and coolant temperature. The control unit receives the relevant information about the engine load requirement from the transmission or cabin through the CAN-bus. The identifier and operation information are received from the ID module. The EEM3 unit also makes it possible to have wide diagnostics through code numbers or a diagnostic light.

17.3. Service Tool of the EEM3 System

The EEM3 engine control system can only be operated using this service tool with additional parts.

In combination with a laptop, this service tool can be used to modify the EEM3 system, for example to adjust the running speed and running hours (values can only be increased) and calibrate the throttle. It is also easy to follow up the fault diagnostics, update software, perform a function test of the injectors and high pressure pump and other service related tasks, like reading the running and shutdown memory. The engine identification and operation memory from the ID module can also be read by the Sisu EEM3 service tool.

It is possible to carry out repair work, such as changing an electronic control unit (ECU), using the Sisu EEM3 service tool.

Furthermore, the service tool can be used to cancel the stopping requests made, irrespective of the engine, for example power cuts or insufficient voltage (such as earthing problems, power needed when the engine is running: ~8 A and voltage >7 V) in the machine and the stopping requests initiated by the gear box.

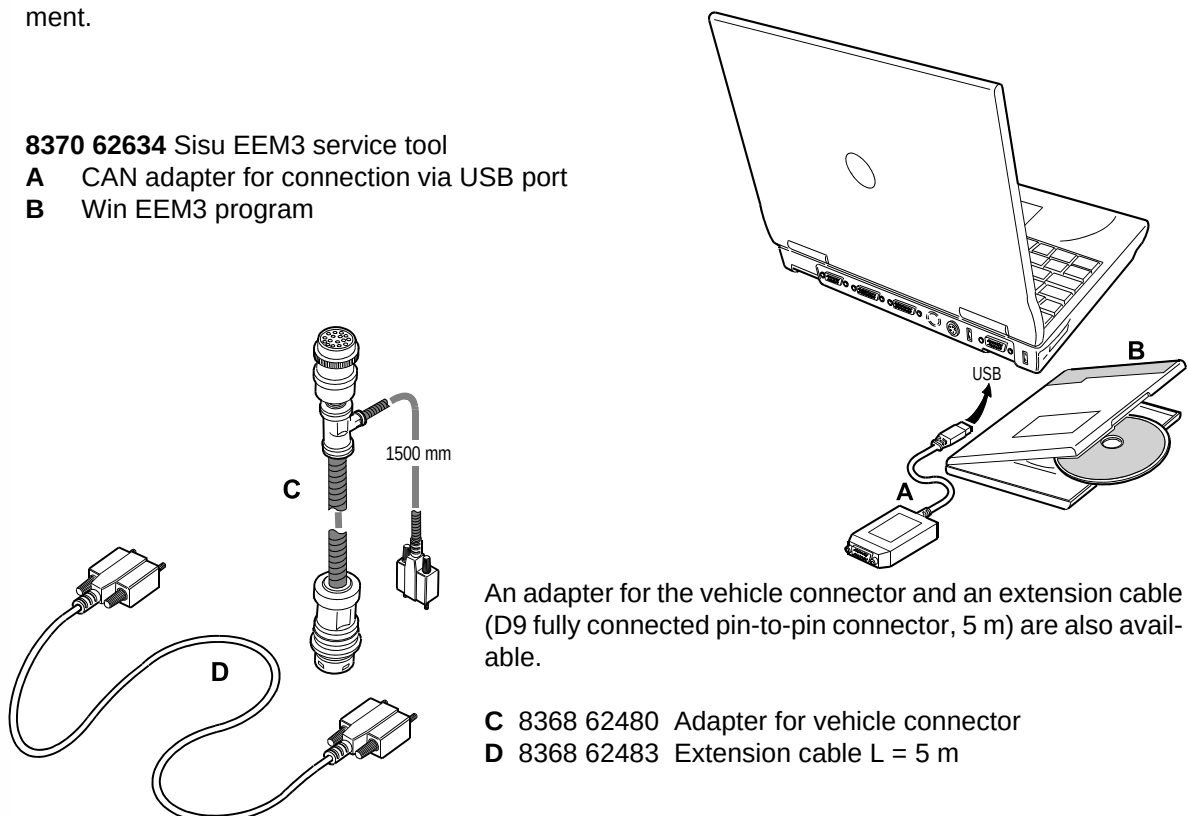
The service tool has a licence number. Every time an engine is connected to the service tool for adjustment or any other reason, this licence number is found in the EEM3 system.

The service tool and the additional parts are sold and supplied by Sisu Diesel Inc. Service Department.

8370 62634 Sisu EEM3 service tool

A CAN adapter for connection via USB port

B Win EEM3 program



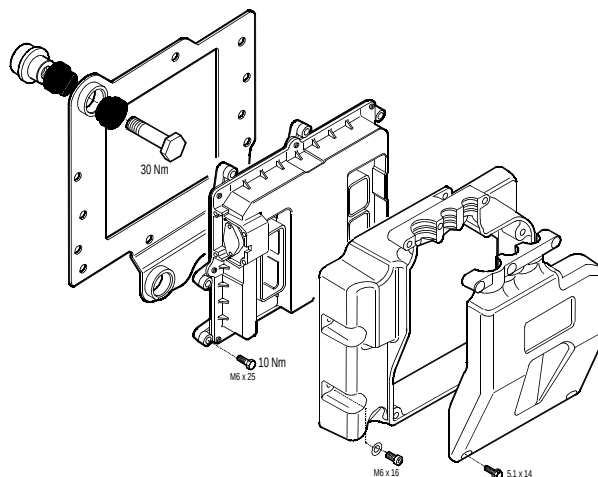
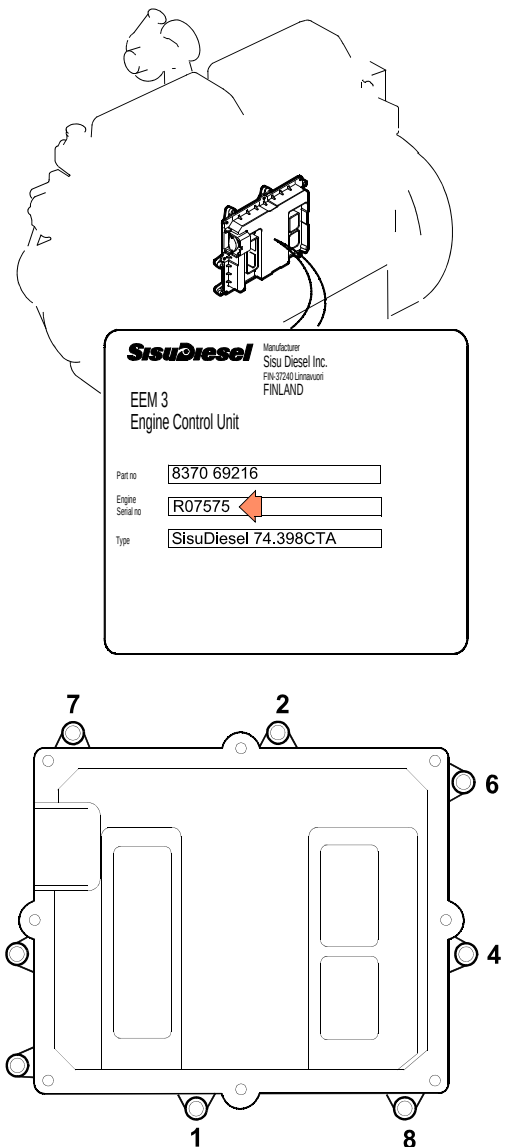
17.4. Changing the Control Unit (ECU)

Note! The control unit (ECU) formatted with SisuDiesel software, will be delivered under order number 8370 69216. This control unit is a useful spare part for all Citius series CR engines. The required software version is loaded with the SisuTronic EEM3 service tool.

Alternatively, ECU can be delivered with the specified software version already loaded. In that case, the engine serial number or F.I.E. number (Fuel Injection Equipment) must be provided. The F.I.E. number is indicated in the spare part catalogue with the spare part number of the ECU.

The control unit (ECU) is fixed to the bracket on the left side of the engine. The specification of the model and the engine serial number are indicated on the type plate of the EEM3 control unit.

1. Turn the main switch to the OFF position or disconnect the battery connectors.
2. Remove the outer plastic cover and disconnect the multipole connectors. Do not touch to the poles of the connectors. Remove the inner plastic cover.
3. Remove the control unit from the bracket. Check that the bracket's rubber damper works. Change this if necessary. Torque for the fixing screws is **30 Nm**.
4. Attach the new control unit. Tighten the screws to **10 Nm** in the order shown in the picture. Note the earth wire under the fastening screw no 8.
5. Attach the inner plastic cover, connect the multipole connectors and attach the outer plastic cover. Turn the main switch to the ON position.
6. Load the control unit (ECU) program using the SisuTronic EEM3 service tool and open the memory data file of the ID module. See the instructions for the SisuTronic EEM3 service tool. Please note that the SisuTronic EEM3 service tool can be connected using the adapter 8368 62480 if the wiring harness for the vehicle connector has been installed in the engine.

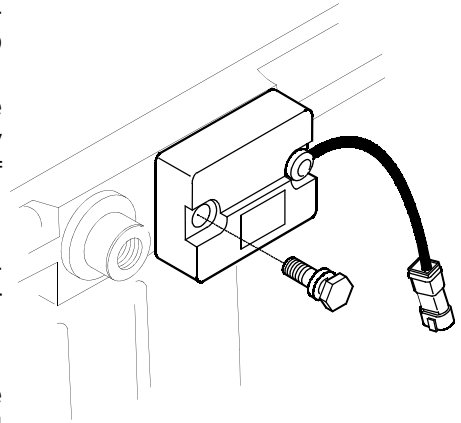


17.5. Changing the ID Module

Note! The ID module is specified for every engine. The engine serial number is therefore required when ordering the ID module.

In the event of ID module malfunction, only limited engine power is available. This power limitation can be bypassed by using the SisuTronic EEM3 service tool for a maximum of 200 hours. See service tool instruction.

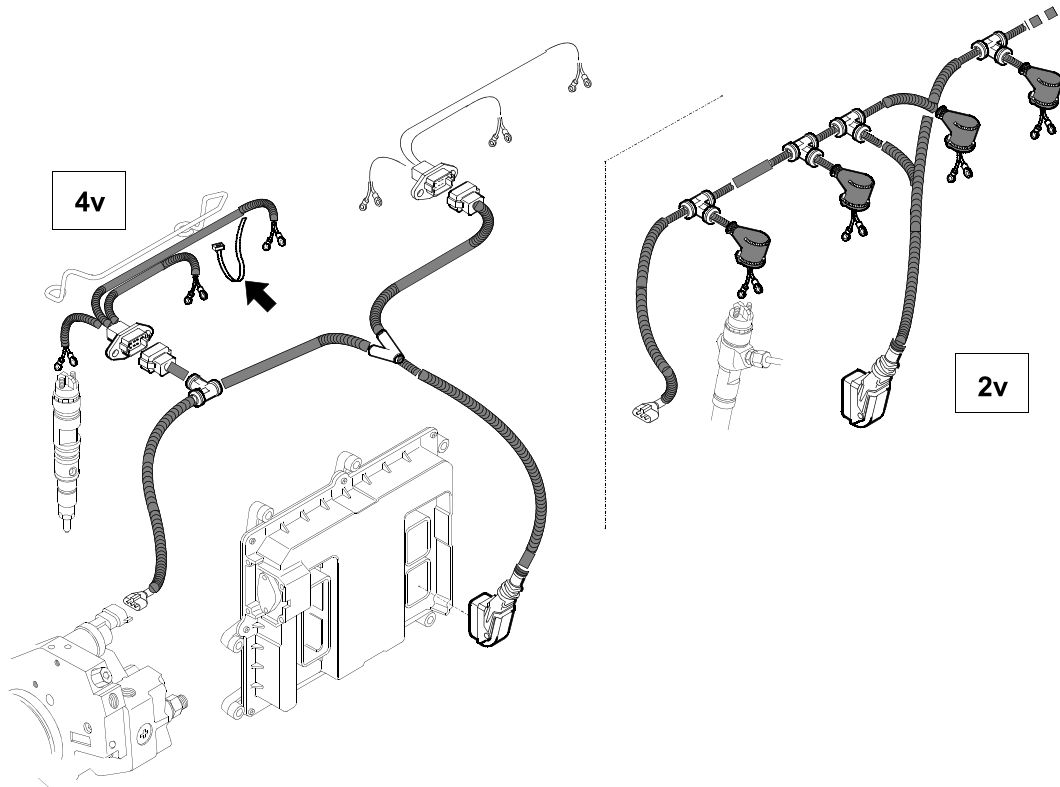
The ID module is attached to the top-left corner of the cylinder block by two M8 breakaway capscrews. With 6-cylinder engines, the ID module is located behind the ECU bracket.



1. Turn the main switch to the OFF position or disconnect the battery connectors. Disconnect the ID module electrical connector.
2. With 6-cylinder engines, loosen the ECU bracket and turn it aside.
3. Tap the screws in the direction for unscrewing, for example with a chisel, and unscrew the screws. Loosen the ID module.
4. Clean the mounting face of the ID module and fit it using new breakaway capscrews. Tighten the screws until the bolt head comes loose.
5. Connect the electrical connector and turn the main switch to ON position.

17.6. Wiring Sets

Note! The wiring sets will be delivered in full; the connectors are not marketable as a separate spare part.



Injector Wiring Sets

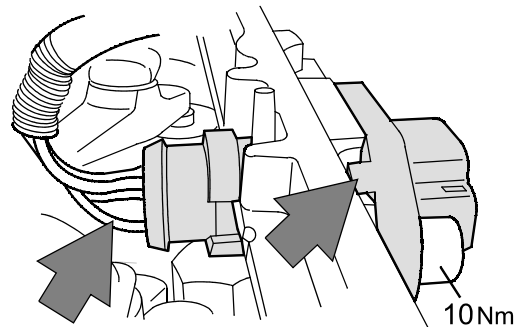
Connect the wires to the injector with a torque of **1.5 Nm**. Do not over-tighten as the injector can be damaged very easily. The wires can be connected to the injector in any order.

Injector Wiring Sets - 4V Engines

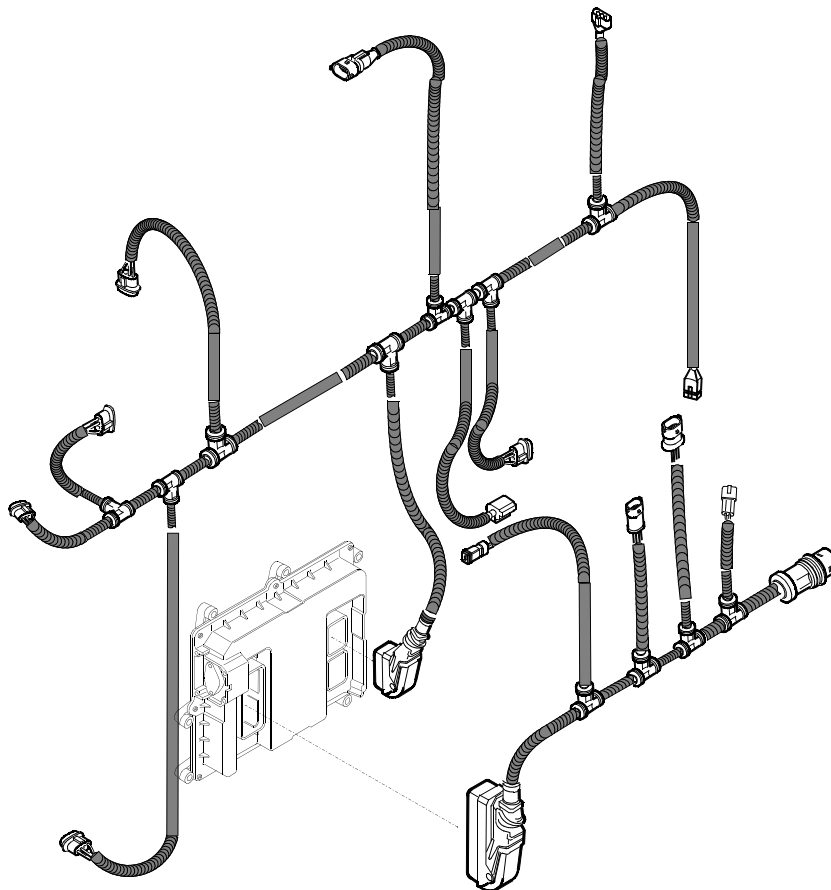
Thread the inner injector wiring set through the hole in the valve housing connector. Note the position of the connector guide point.

Attach the wiring set to the bracket so that the wires will go straight from the connector. Side thrust will cause oil to leak from the connector.

Use oil resistant bands (order number 6517 55320) to bind the wiring sets.

**Sensor Wiring Set / Wiring Set for Vehicle Connector**

Note! Not all engine versions have a wiring set for the vehicle connector.



Attach the wiring sets to the brackets with bands. Avoid too sharp turns or damage the wiring sets on sharp parts.

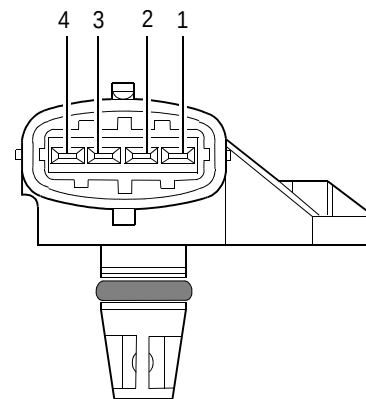
Note! EEM3 engine control system fault codes and their instructions, circuit diagrams etc. are shown in the "EEM3 Troubleshoot Information" list, which comes with the EEM3 service tool.

17.7. Sensors of the Engine Control System

Boost Pressure/Air Temperature Sensor

1. Ground
2. Temperature signal
3. +5 V
4. Pressure signal

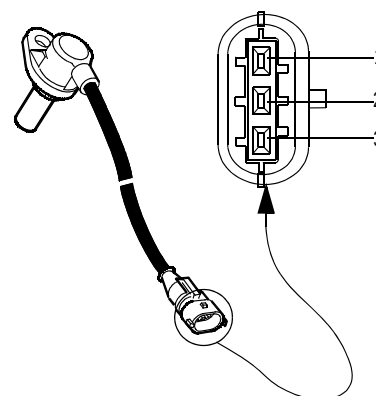
Location: Boost pipe
Screw M5/3.3 Nm



Speed Sensor (camshaft)

1. Ground
2. Rpm signal
3. Not in use

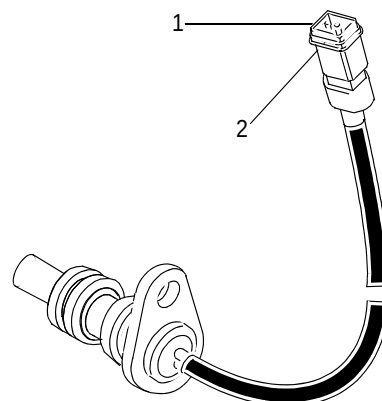
Location: In timing gear housing
Screw M6/8 Nm
O-ring, order no. 6146 01524



Speed Sensor (crankshaft)

1. Ground
2. Rpm signal

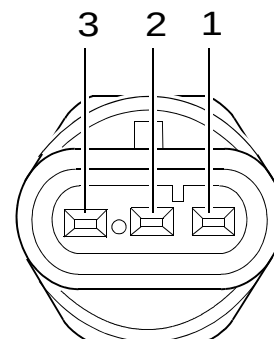
Location: Cylinder block, left side
Screw M8/25 Nm
O-ring, order no. 6146 01524



Oil pressure sensor

1. Ground
2. Pressure signal
3. +5 V

Location: Cylinder block, right side
Thread M10x1/25 Nm
Seal ring, order no. 6155 71014



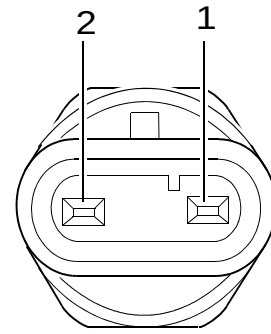
Coolant and fuel temperature sensor

1. Temperature signal/fuel signal
2. +5 V

Location: Cylinder head/coolant sensor and in fuel filter/
fuel sensor

Thread M12x1.5/25 Nm

Seal ring, order no. 6158 81418



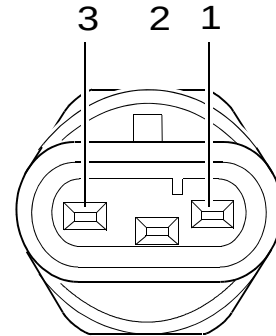
Fuel transfer pressure sensor

1. Ground
2. Pressure signal
3. +5 V

Location: Main filter

Thread M14x1.5/25 Nm

Seal ring, order no. 6158 81420



18. ELECTRICAL SYSTEM**18.1. Alternators****Iskra AAK 3370 14 V 65 A 2-pole (SisuDiesel no. 8366 66738)**

Nominal voltage	12 V
Output (test voltage 13 V)	
2000 r/min	38 A
4000 r/min	61 A
6000 r/min	65 A
Charge begins	1150 r/min
Max. allowed speed	12 000 r/min
Min. slip ring diameter	27 mm
Min. brush length	5 mm
Rotor resistance	2.70...2.97 ohm
Stator resistance	0.160...0.180 ohm
Tightening torques:	
1. Shaft nut	60...70 Nm
Joint B- (M6)	4.2...6.0 Nm
Joint W (M5)	2.7...3.8 Nm

Iskra AAK 5363 14 V 95 A (SisuDiesel no. 8366 66720)

Nominal voltage	12 V
Output (test voltage 13 V)	
2000 r/min	50 A
4000 r/min	84 A
6000 r/min	94 A
Charge begins	1100 r/min
Max. allowed speed	15 000 r/min
Min. slip ring diameter	15.3 mm
Min. brush length	5 mm
Rotor resistance	2.70...2.97 ohm
Stator resistance	0.033...0.036 ohm
Tightening torques:	
1. Shaft nut	50...70 Nm
2. Joint B+ (M6)	4.2...6.0 Nm
3. Joint D+ (M5)	2.7...3.8 Nm
4. Joint W (M 5)	2.7...3.8 Nm

Iskra AAK 5364 14 V 120 A (SisuDiesel no. 8366 66721)

Nominal voltage	12 V
Output (test voltage 13 V)	
2000 r/min.	45 A
4000 r/min	100 A
6000 r/min	115 A
Charge begins	1400 r/min
Max. allowed speed	15 000 r/min
Min. slip ring diameter	15.3 mm
Min. brush length	5 mm
Rotor resistance	2.70...2.97 ohm

Tightening torques:

1. Shaft nut	60...70 Nm
2. Joint B- (M6)	4.2...6.0 Nm
3. Joint D+ (M5)	2.7...3.8 Nm
4. Joint W (M5)	2.7...3.8 Nm

Iskra AAN 5173 14 V 150 A (SisuDiesel no. 8366 67315)

Nominal voltage	12 V
Output (test voltage 13 V)	
2000 r/min.	90 A
4000 r/min	147 A
6000 r/min	155 A
Charge begins	1200 r/min
Max. allowed speed	15 000 r/min
Min. slip ring diameter	15.3 mm
Min. brush length	5 mm
Rotor resistance	2.70...2.97 ohm

Tightening torques:

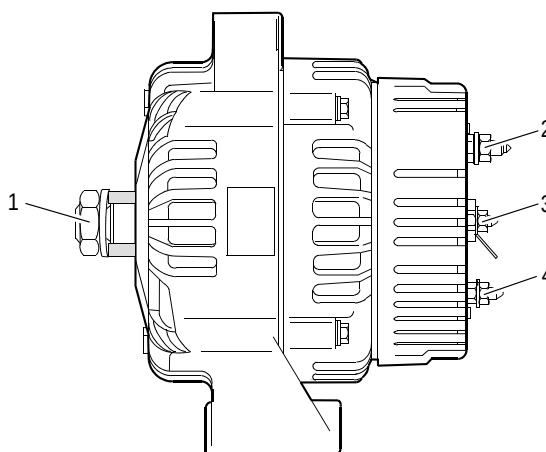
1. Shaft nut	75...85 Nm
2. Joint B- (M8)	9.0...13.0 Nm
3. Joint D+ (M5)	2.7...3.8 Nm
4. Joint W (M5)	2.7...3.8 Nm

Iskra AAK 5365 28 V 60 A 2-pole (SisuDiesel no. 8366 66722)

Nominal voltage	24 V
Output (test voltage 13 V)	
2000 r/min.	24 A
4000 r/min	54 A
6000 r/min	60 A
Charge begins	1400 r/min
Max. allowed speed	15 000 r/min
Min. slip ring diameter	15.3 mm
Min. brush length	5 mm
Rotor resistance	7.90...8.69 ohm

Tightening torques:

1. Shaft nut	60...70 Nm
2. Joint B- (M6)	4.2...6.0 Nm
3. Joint D+ (M5)	2.7...3.8 Nm
4. Joint W (M5)	2.7...3.8 Nm
Joint B- (M5)	2.7...3.8 Nm



Bosch N1 28 V 0/100 A (SisuDiesel no. 8366 59786)

Nominal voltage	24 V
Output (test voltage 26 V)	
2000 r/min.	44 A
3500 r/min	82 A
7000 r/min	100 A
Min. slip ring diameter	26.8 mm
Brush length when new	14 mm
Min. brush length	7 mm
Rotor resistance	7.5...8.3 ohm
Stator resistance	0.021...0.024 ohm
Regulating voltage	28 V
Tightening torques:	
Shaft nut	35...45 Nm
Assembling screws	4.1...5.5 Nm
Regulator screws	2.7...3.8 Nm
Joint B- (M6)	4.8...6.8 Nm
Joint D+ (M4)	1.6...2.3 Nm
Joint W (M5)	2.7...3.8 Nm
Joint B+ (M8)	7.5...8.0 Nm

18.2. Starters**Iskra AZE4540 12 V 3.0 kW z10 (SisuDiesel no. 8366 67365)**

Values, unloaded		
Running speed		4000 r/min
Amperage		120 A
Values with armature locked		
Running speed		0 r/min
Amperage		1300 A
Torque		47 Nm
Brush length (new)		15 mm
Min. brush length		9 mm
Brush spring tension		17.5..25 N
Tightening torques:		
Studs (M6)		4.8...6.8 Nm
Screws on solenoid (M5)		3.5...4.1 Nm
Screws on solenoid (M4)		3.2 Nm
Pole shoes (M10)		30...44 Nm
Brush holder (M5)		3.5...4.1 Nm
Lever pin on engagement lever		9.8...14 Nm
Contact screws on solenoid switch (M8)		7...8 Nm
Contact screws on solenoid switch (M10)		12...18 Nm

Iskra AZJ3332 12 V 3.0 kW z10 2-pole (SisuDiesel no. 8366 64029)

Values, unloaded		
Running speed		8000 r/min
Amperage		90 A
Values with armature locked		
Running speed		0 r/min
Amperage		1374 A
Torque		51 Nm
Brush length (new)		23 mm
Min. brush length		13 mm
Brush spring tension		30...35 N
Tightening torques:		
Studs (M6)		5.7...5.9 Nm
Screws on solenoid (M5)		3.15...3.25 Nm
Screws on solenoid (M6)		5...7 Nm
Pole shoes (M10)		30...44 Nm
Brush holder (M5)		3.15...3.25 Nm
Lever pin on engagement lever		10...14 Nm
Contact screws on solenoid switch (M8)		7.5...9.5 Nm
Contact screws on solenoid switch (M10)		11...15 Nm

Iskra AZF4513 12 V 4.2 kW z11 (SisuDiesel no. 8368 66817)

Values, unloaded	
Running speed	4000 r/min
Amperage	150 A
Values with armature locked	
Running speed	0 r/min
Amperage	1475 A
Torque	60 Nm
Brush length (new)	19 mm
Min. brush length	8 mm
Brush spring tension	25...37 N

Tightening torques:	
Studs (M6)	4.8...6.8 Nm
Screws on solenoid (M5)	3.5...4.1 Nm
Screws on solenoid (M4)	3.2 Nm
Pole shoes (M10)	30...44 Nm
Brush holder (M5)	3.5...4.1 Nm
Lever pin on engagement lever	9.8...14 Nm
Contact screws on solenoid switch (M8)	7...8 Nm
Contact screws on solenoid switch (M10)	12...18 Nm

Iskra AZJ3186 24 V 4.0 kW z=10 (SisuDiesel no. 8366 64354)

Values, unloaded	
Running speed	10 000 r/min
Amperage	80 A
Values with armature locked	
Running speed	0 r/min
Amperage	1200 A
Torque	70 Nm
Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	30...35 N

Tightening torques:	
Studs (M6)	5.7...5.9 Nm
Screws on solenoid (M5)	3.15...3.25 Nm
Screws on solenoid (M6)	5...7 Nm
Pole shoes (M10)	30...44 Nm
Brush holder (M5)	3.15...3.25 Nm
Lever pin on engagement lever	10...14 Nm
Contact screws on solenoid switch (M8)	7.5...9.5 Nm
Contact screws on solenoid switch (M10)	11...15 Nm

Iskra AZJ3256 24 V 4 kW z11 2-pole (SisuDiesel no. 8366 64355)

Values, unloaded

Running speed	10 000 r/min
Amperage	80 A

Values with armature locked

Running speed	0 r/min
Amperage	1200 A
Torque	70 Nm

Brush length (new)	23 mm
Min. brush length	13 mm
Brush spring tension	30...35 N

Tightening torques:

Studs (M6)	5.8 Nm
Screws on solenoid (M5)	3.2 Nm
Screws on solenoid (M6)	6.0 Nm
Pole shoes (M10)	37 Nm
Brush holder	3.2 Nm
Lever pin on engagement lever	12 Nm
Contact screws on solenoid switch (M8)	8.5 Nm
Contact screws on solenoid switch (M10)	13 N