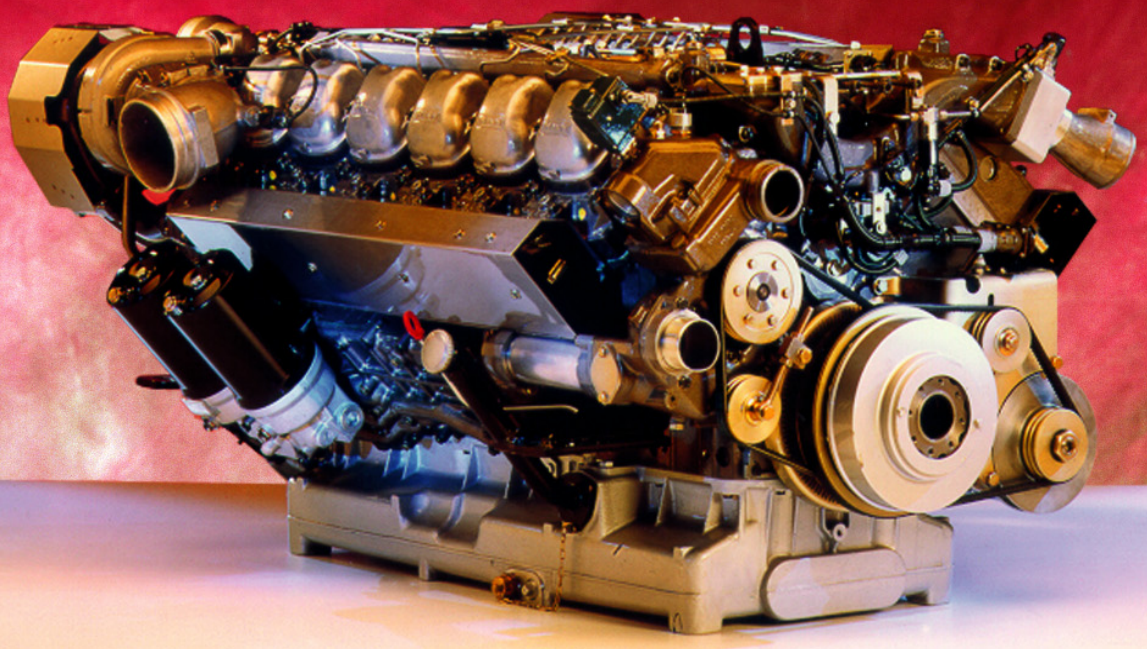
Repair manual

MAN-Industrial Diesel Engines

D 2842 LE 602
D 2842 LE 604
D 2842 LE 606
D 2842 LE 607



This Repair Manual is designed to facilitate competent repair of the engines listed herein.

The pictures and relevant descriptions show typical work that may not always be applicable to the engine in hand, which nevertheless does not mean that they are not correct.
In such cases the repair work is to be planned and carried out in a similar way.

Please note that all jobs described in this Repair Manual were carried out on an engine which was not installed.

The expert knowledge necessary for handling Diesel engines was taken for granted when this publication was compiled.

Any repair of components such as injection pump, alternator etc. ought to be left to our or the manufacturer's service department.

Yours faithfully,
MAN Nutzfahrzeuge Aktiengesellschaft
Nuremberg Works

We reserve the right to make technical modifications in the course of further development.

MTDB Technical status: 10.2004 51.99598–8038

Important instructions which concern technical safety and protection of persons are emphasised as shown below.

Danger:
This refers to working and operating procedures which must be complied with in order to rule out the risk to persons.

Caution:
This refers to working and operating procedures which must be complied with in order to prevent damage to or destruction of material.

Note:
Explanations useful for understanding the working or operating procedure to be performed.

Fitting flat seals / gaskets

Flat seals / gaskets are often inserted with sealing agents or adhesives to make fitting them easier or to achieve better sealing. Flat seals may slip in operation due to the “sewing-machine” effect, in particular if they are used between parts with different rates of linear expansion under heat (e.g. aluminium and cast iron), and leaks may then occur.

Example:
the cap of the front crankshaft seal. If a sealing agent or an adhesive is used here the flat seal will move inwards in the course of time as a result of the different expansion rates of the materials. Oil will be lost, for which the shaft seal may be thought to be responsible.

Flat seals / gaskets can be fitted properly only if the following points are observed:

- Use only genuine MAN seals/gaskets.
- The sealing faces must be undamaged and clean.
- Do not use any sealing agent or adhesive – as an aid to fitting the seals a little grease can be used if necessary so that the seal will stick to the part to be fitted.
- Tighten bolts evenly to the specified torque.

All the engines dealt with here are related by design and together form a family.

The sequence of letters and numbers which make up the model designation reveal a number of characteristic properties of the engine in question to those familiar with the basic nomenclature.

We will explain the system using model D 2842 LE 602 as an example:

D The “D” at the beginning of the model designation stands for **“Diesel”**

28 The number “28” indicates that the engine has a 1**28** mm bore

4 The “4” means 1**4**2 mm stroke

2 The “2” shows that the engine has 1**2** cylinders. If there is a 0 here instead, the engine is a 10-cylinder model

L This letter stands for the German word “Ladeluftkühlung”, meaning **“Intercooling”**

E “E” stands for the German word “Einbaumotor”, meaning **“Installation engine”**, and distin guishes these engines from MAN vehicle engines

602/4.. This is a Works internal development number.

General information

This brief overview summarises important instructions and is structured into areas of main concern in order to impart the knowledge necessary to prevent accidents involving injury to persons, damage to the engine or other property and harm to the environment. Additional notes are included in the operator's manual for the engine.

Important:
If despite all safety precautions an accident occurs as a result of contact with caustic acids, penetration of fuel into the skin, scalding with hot oil, anti-freeze splashes into the eyes etc, ***consult a doctor immediatel.***

1. Instructions for preventing accidents with injury to persons

Checks, setting jobs and repair work must be carried out by authorised skilled personnel only.

- When carrying out maintenance and repair work, ensure that the engine cannot be accidentally started from the bridge by unauthorised persons.
- The engine must be started and operated by authorised personnel only.
- When the engine is running, do not get too close to revolving components.
  Wear tight-fitting working clothes.

- Do not touch hot engine with bare hands: risk of burning yourself.

- Keep engine vicinity, ladder and steps free of oil and grease. Accidents resulting from slipping may have serious consequences.
- Work only with tools that are in good condition. Worn spanners slip: risk of injuries.
- Persons must not stand under an engine suspended from a crane hook.
  Keep lifting gear in good order.

- Open coolant circuit only after the engine has cooled down. If opening the coolant circuit while the engine is hot is unavoidable, observe the instructions in the chapter "Maintenance and care" in the Operator's Manual.
- Neither retighten nor open pressurised pipelines and hoses (lube oil circuit, coolant circuit and downstream hydraulic oil circuit if fitted): risk of injuries resulting from emerging fluids.

- When checking the injection nozzles, do not hold your hands in the fuel jet.
  Do not inhale fuel mist.

- When working on the electrical system, unplug earth cable from battery first and reconnect it last to avoid short-circuits.

- Observe the manufacturer's instructions for handling batteries.
  Caution:
  Battery acid is toxic and caustic. Battery gases are explosive.

- When carrying out welding work, observe the "Information sheets for welders".

2. Instructions for preventing damage to the engine and premature wear

- ***Prior to repairing the engine, clean it thoroughly. Ensure that dirt, sand or foreign matter will not get into the engine during repair work.***
- In the event of operational faults immediately identy the cause and rectify to prevent more serious damage.
- Always use genuine MAN parts only. Installation of "equally" good parts from other suppliers may cause severe damage for which the workshop carrying out the work is responsible.
- Never operate the engine while it is dry, i.e. without lubricant or coolant.
  Use a suitable label to mark engines not ready for operation.
- Only use operating materials (fuel, engine oil, antifreeze and anticorrosion agents) approved by MAN. Ensure that everything is kept clean. Diesel fuel must be free of water.
- ***Do not fill up with engine oil above the max. notch on the dipstick. Do not exceed the engine's maximum permissible operating inclination.***
  Non-compliance with these instructions may cause severe engine damage.
- Control and monitoring devices (charge check, oil pressure, coolant temperature) must work faultlessly.
- Observe the instructions for operating the alternator; see chapter "Maintenance and care" in the Operator's Manual.

3. Instructions for preventing environmental damage

Engine oil and filter cartridges and elements, fuel / fuel filters

- Take old oil to an old oil disposal point only.
- Ensure without fail that oil and Diesel fuel will not get into the sewerage system or the ground.
  Caution:
  Danger of contaminating potable water!
- Treat filter elements and cartridges as special waste.

Coolant

- Treat undiluted anticorrosion and / or antifreeze agents as special waste.
- The regulations of the relevant local authorities are to be observed for the disposal of spent coolants.

4. Instructions for handling used engine oil *

Prolonged or repeated contact of any kind of engine oil with the skin causes the skin to degrease, which may result in dryness, irritation or inflammation. Old engine oil also contains hazardous substances which in animal experiments have caused skin cancer. Handling old engine oil does not pose any health hazard if the basic safety and hygiene related regulations are observed.

Health and safety regulations:

- Avoid prolonged, excessive or repeated contact of old engine oil with the skin.
- Use a suitable skin protection agent or wear protective gloves.
- Clean the skin that has been in contact with engine oil.
  - Wash yourself thoroughly with soap and water. A nailbrush is an effective aid.
  - Special hand cleaning agents facilitate cleaning soiled hands.
  - Do not use petrol, Diesel fuel, gas oil, fluxes or solvents as cleaning agents.
- After washing apply moisturising handcream to your skin.
- Change oil-soaked clothes and shoes.
- Do not put any oil-soaked cloths into pockets.

Pay meticulous attention to the proper disposal of old engine oil.
– Old oil is a water hazard –

Therefore, do not pour any old oil into the ground, the drains or the sewerage system. Any violation of this rule is punishable.

Collect and dispose of old engine oil properly. For information concerning collection points, contact seller, supplier or the local authorities.

* Based on the “Information sheed for handling used engine oil”
  (Notes on how to handle old engine oil).

Faults and possible causes

We recommend

Repair work is to be considered complete only after the damage which has occurred and the possible causes have been eliminated. Ascertaining the causes of damage is frequently more difficult than eliminating the damage caused. For this reason we recommend you have the operational fault exactly described to you before removal or disassembly work is commenced. Then, track down the probable causes by asking specific questions, examining and eliminating these causes one by one with the aid of the table ***and your own experience.*** This helps to reduce repairs to those necessary and counter complaints about “premature” exchange of parts and expensive working and downtimes.

Remark:

The subsequent list is meant to be a memory aid so that no causes of damage will be overlooked in the elimination of faults. The precondition for this, however, is that you are familiar with the Repair Manual for the engine and the relevant Operator’s Manual as well as the publication “Fuels, Lubricants, Coolants for MAN Diesel Engines”.

Troubleshooting chart

1. EDC self-diagnosis or flash code output	2. Starter turns over engine only slowly or not at all	3. Starter turns, engine does not start, engine does not start / difficult to start when cold	4. Engine stalls (dies) during operation, no longer starts (starter turns), engine does not start / starts with difficulty when hot	5. Sudden, temporary engine shut-down, engine does not reach full revs	6. Engine only runs at idle speed, no throttle response	7. Engine only runs at increased idle speed, no throttle response	8. Rated engine speed distinctly reduced (even under no load)	9. Reduced output in all ranges	10. Irregular engine operation, traction loss	11. Unstable idle speed, engine hunting, misfiring, knocking in engine	12. Engine judder	13. Unusual combustion noise	14. Excessive smoke emission: White smoke / blue smoke	15. Excessive smoke emission: Black smoke	16. Engine temperature too high (coolant loss)	17. Intermediate engine speed control cannot be activated / does not switch off, engine revs too high	18. Fuel consumption too high	19. Lubricating oil pressure too low	20. Lubricating oil pressure too high	21. Lubricating oil consumption too high	22. Engine too loud / mechanical noise	**Possible causes**
x	x																					Batteries discharged, battery lead connections loose or corroded, break in power circuit
x																						Crank gear blocked
x	x																					Starter solenoid switch sticks (clicks) / defective, cable connection loose or damaged
x	x																					Starter / starter interlock relay defective (carbon brushes worked loose / worn, winding defective, short to ground)
x																	x	x	x			Engine oil viscosity unsuitable, not suitable for ambient temperature, lubricating oil quality does not correspond to specifications
						x													x			Oil level in sump too high
																	x					Oil level in sump too low, oil in sump too thin (mixed with condensate or fuel)
																	x					Engine temperature too high
																	x					Oil filter clogged
																	x	x				Oil pressure gauge faulty
																	x					Safety valve in oil circuit defective (does not close, spring fatigued or broken)
																	x				x	Bearing wear
																	x					Oil pump gears worn
																					x	Crankshaft timing gears worn, tooth flank backlash too great
								x		x								x				Engine cold
										x												Lubricating oil entering combustion chamber (piston rings worn, piston rings broken) – valve stem guide worn – overpressure in crankcase (crankcase vent clogged)
																		x				Relief valve in oil circuit faulty (does not open), oil lines / oil galleries clogged
																			x			Leaks in lubricating oil circuit, particularly at turbocharger and oil cooler
								x											x			Piston rings heavily worn, broken
								x													x	Piston pin or crankshaft bearing worn
																			x			Valve stems worn
	x							x													x	Valve clearance not correct
	x							x														Valves jam
	x	x				x		x														Compression deficient, or more than 3–4 bar pressure difference between individual cylinders
	x							x				x										Valve seats leaking
o			x									x										Increased power consumption due to faulty secondary consumers such as hydraulic pumps, fan, etc, power take-off engaged
			x			x					x	x									x	Air cleaner soiled or clogged, charge-air system leaking, air inlet / exhaust lines clogged / leaking
	x	x	x	x		x	x		x		x	x										Fuel low pressure system: fuel tank, prefilter, water trap faulty / clogged / mould / fungal attack, fuel unsuitable / heavily contaminated (paraffin added)
	x	x	x			x	x	x		x		x										Fuel low pressure system: Fuel lines leaking, broken, clogged
	x	x	x			x	x		x	x												Fuel low pressure system: AIR in the system (turn on ignition when bleeding the system)
	x	x	x			x	x	x	x	x		x										Fuel low pressure system: delivery pump, overflow valve, main filter

x = Probable
o = Possible

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	x					x		x	x	x	o	x		x								Fuel high pressure system: nozzles faulty / clogged / leaking / coked
						x		x	x	x				o								Fuel high pressure system: pressure lines – constriction, cavitation, leaking
		x				x		o	x	x	x	x		o								Fuel high pressure system: injection pump worn / incorrectly set
						o			x	o				o								Fuel high pressure system: injection pump constant-pressure control valve / return flow constrictor faulty
	x	x	x			o	x															EHAB defective, drive faulty
	o	o				o		x		o	x	x		x								Injection pump / engine synchronisation: start of delivery incorrect (basic installation), start of delivery set incorrectly
x	x	x	x			o		x	o													Injection pump controller: stiff movement – fuel volume regulator (control deviation)
x	x	x	x				o															Control rod position sensor in regulator: connection lines, break, short-circuit
	o					o					o											Control rod position sensor in regulator: set incorrectly
x	x		o																			Control rod position sensor in regulator: capacitance reserve of the wiring harness too low (e.g. water penetrated wiring harness)
						x		o	x	o		o										Injection pump: fuel volume set incorrectly / uniform delivery, lower idle speed set too low
x	o	x	x										x									Delivery actuating solenoid in controller: Connection lines, break, short-circuit, or CAN-Bus
x				x		x	x	x	o													Drive stage selection defective:Connection lines, short-circuit, break
x																						EDC rpm sensor defective, implausible with auxiliary rpm sensor, line defective
									x	o												EDC rpm sensor, polarity reversed
x																						EDC auxiliary rpm sensor defective, implausible with rpm sensor, line defective
x	x	x	x	x	o			o	o				o									EDC detects incorrect engine speed (interference signal on rpm sensor line)
x	x	x	x							o												Both rpm sensors faulty, line fault
x							x					x										EDC boost pressure sensor: faulty, incorrect, implausible with atmospheric pressure sensor, line fault
							x		x		o	x										Exhaust turbocharger leaking or faulty
																					x	Turbine and compressor rotor in turbocharger dirty (out-of-balance, irregular running)
													x									Intercooler leaking, faulty
	x										x											Flame starting system defective
x	o						x	x			o		x									EDC coolant temperature sensor: faulty, line fault
x							x	x														EDC charge-air temperature sensor: faulty, line fault
o							x						x									Radiator dirty or cooling system failure (temperatures too high)
													x									Coolant level too low, air in coolant circuit
													x									V-belt for water pump drive not tensioned correctly
																					x	Incorrect V-belt tension
													x									Water pump leaking, faulty / thermostat faulty, does not open
													x									Coolant lines leaking, clogged or twisted
												x										Coolant entering combustion chamber (cylinder head / gasket leaking)
								x														Resistor bank EDC control unit pin 51

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x		x	x	o				o													Power supply to EDC control unit interrupted or battery voltage too low / Relay K1 faulty
		x	x	o				o													Line terminal 15 to EDC control unit (pin 47) interrupted / loose contact
															x						Line defective: Pin 23 or 41
x		o	o	o																	EDC control unit faulty (internal fault)
		x				x	x	x		o	o		o	x							Incorrect EDC control unit (check MAN part number)
						x	x								o						Intermediate engine speed activated
		x																			EOL programming terminated / voltage interrupt
x																					Afterrunning not completed (e.g. shut-down via EMERGENCY STOP)
															x						EOL programming: configuration incorrect
										x											Engine bearings worn

x = Probable
o = Possible

Very different factors have an influence on the life expectancy of an engine. For this reason it is not possible to give certain predetermined numbers of operating hours for basic overhauls.

In our opinion, opening an engine or carrying out a basic overhaul is not appropriate as long as the engine achieves good compression values and the following operating values measured and recorded and have not changed significantly since commissioning:

- Charge-air pressure
- Exhaust-gas temperature
- Coolant and lube-oil temperature
- Oil pressure and oil consumption
- Formation of smoke

The following criteria have a major influence on the life expectancy of an engine:

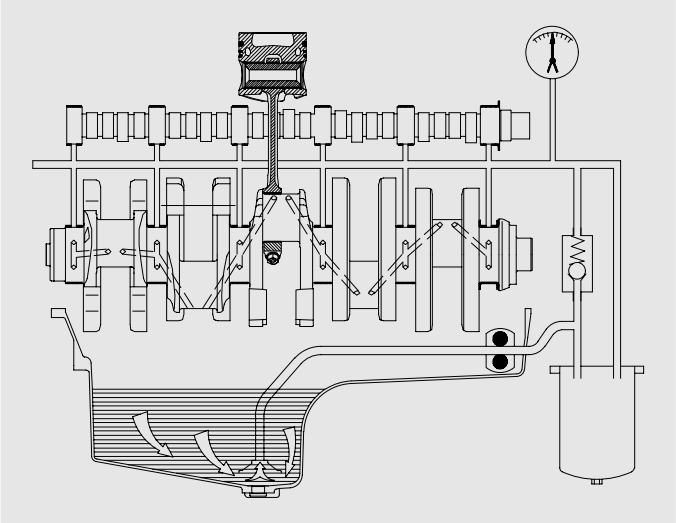
- Correct output setting according to the type of operation
- Expert installation in accordance with the installation instructions
- Inspection of the installation by authorized personnel
- Regular maintenance as per maintenance plan in the Operator's manual
- Selection and quality of lube oil, fuel and coolant as specified in the publication "Fuels, Lubricants, Coolants for MAN Diesel Engines"

Pressurisation

It is of utmost importance that after completion of repair work, ie in the dry condition, internal combustion engines be pressurised with lube oil before being recommissioned. This procedure may also be used for ascertaining damage and the cause of it.

If engines are not pressurised, the risk of premature damage to bearing surfaces is very high, because it takes a relatively long period of time until the lube oil sucked in from the oil pan via the oil pump has reached the individual bearing points.

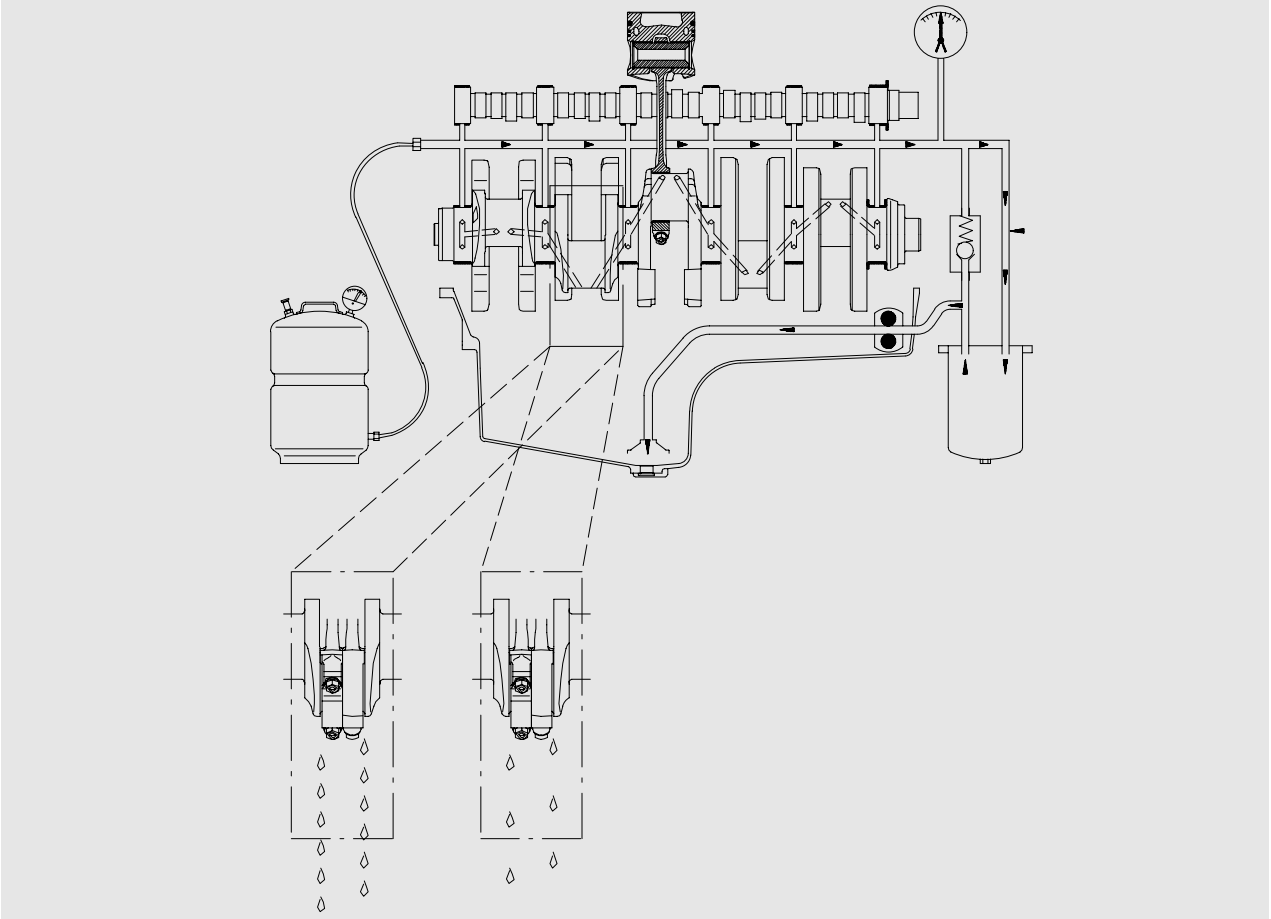
Such incipient damage need not necessarily lead to bearing failure, but may affect the functioning of bearings and shorten their service lives.



Schematic diagram of the flow of oil in non-pressurised engines.

Pressurising an engine affords the following advantages:

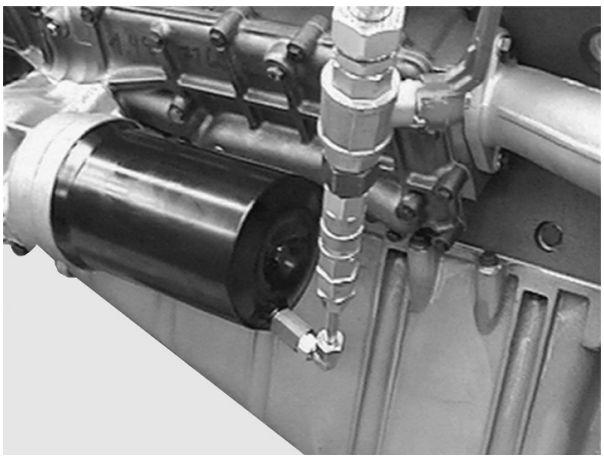
- All engine parts are lubricated before engine start; inside the bearings a lubricating film can build up as early as after the first few turns of the crankshaft, which prevents damage to the bearing races.
- Loss of oil, be it the result of excessively large bearing play or leaks from the crankcase or from crankcase bores which may not be plugged, can be recognised immediately. For this purpose mount the engine on a dolly, take off the oil pan and install a suitable oil collector under the crankcase in such a way that the bearings are visible.



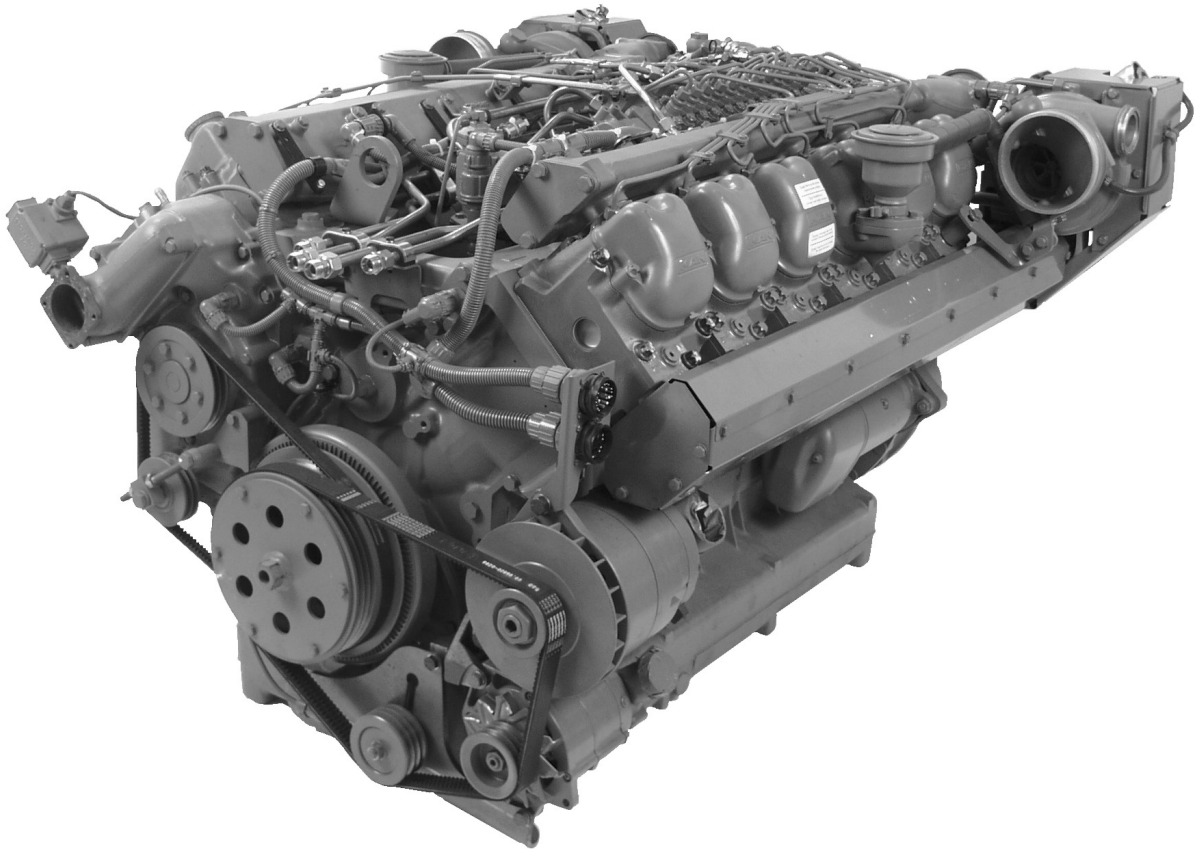
Execution of pressurisation:

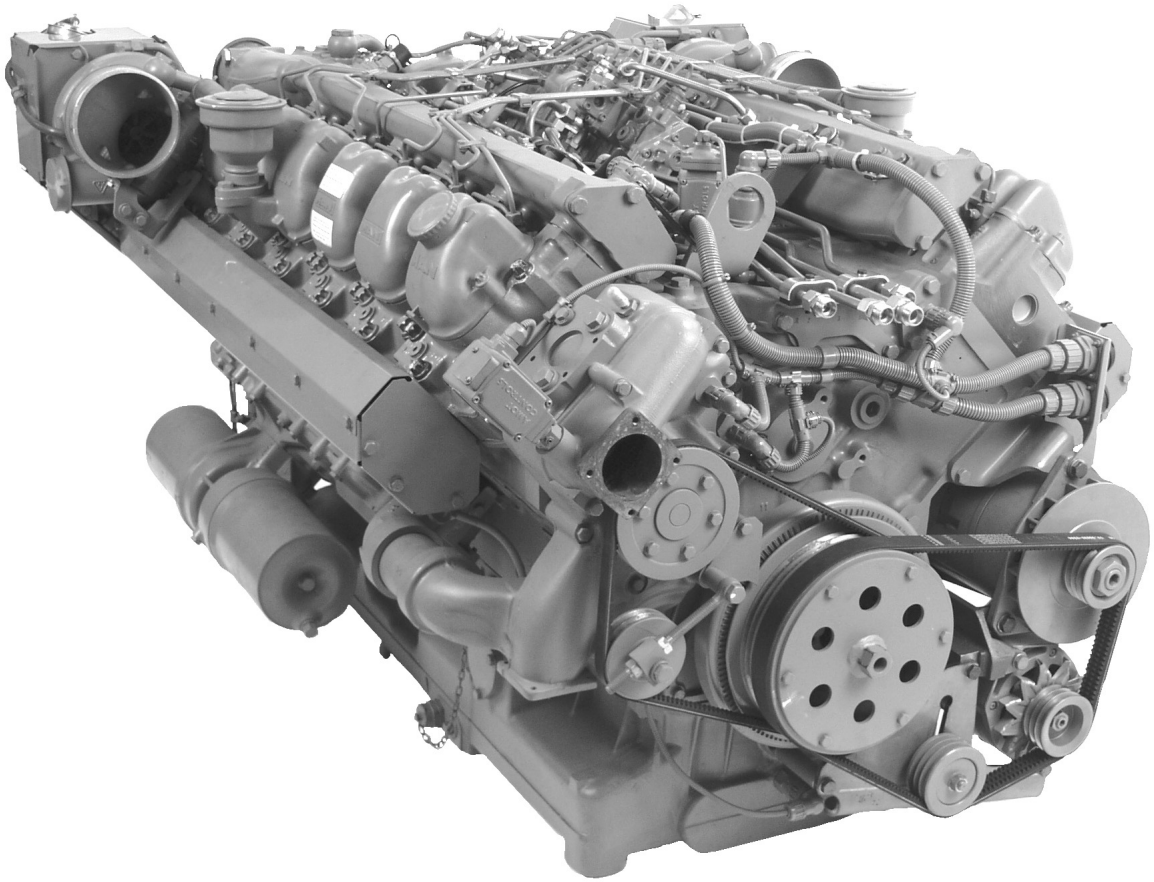
At least 30% of the overall oil quantity is pressed from the pressurisation container into the engine oil circuit. The operating pressure serves as a yardstick for the pressure to be injected. This must not be exceeded.

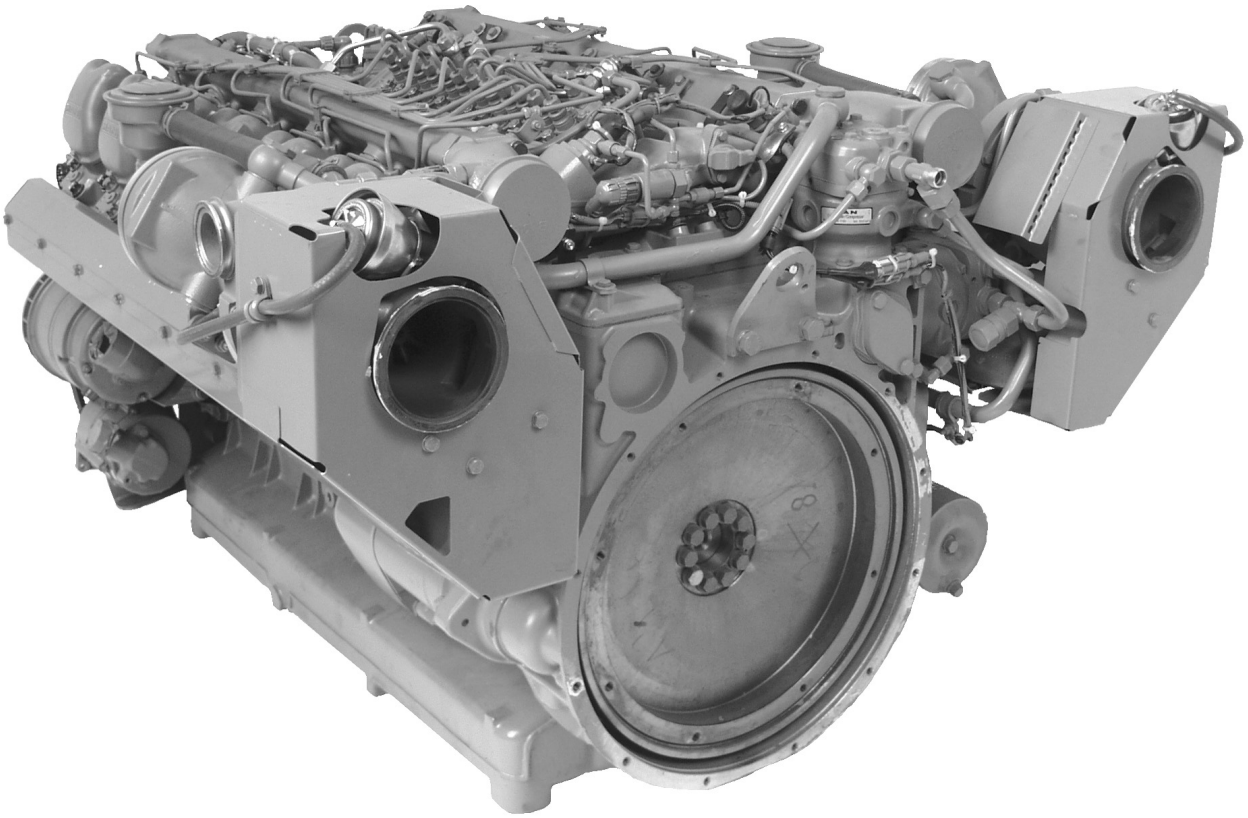
The pressurisation container is connected up to the engine's oil circuit at the oil filter head (screw plug).

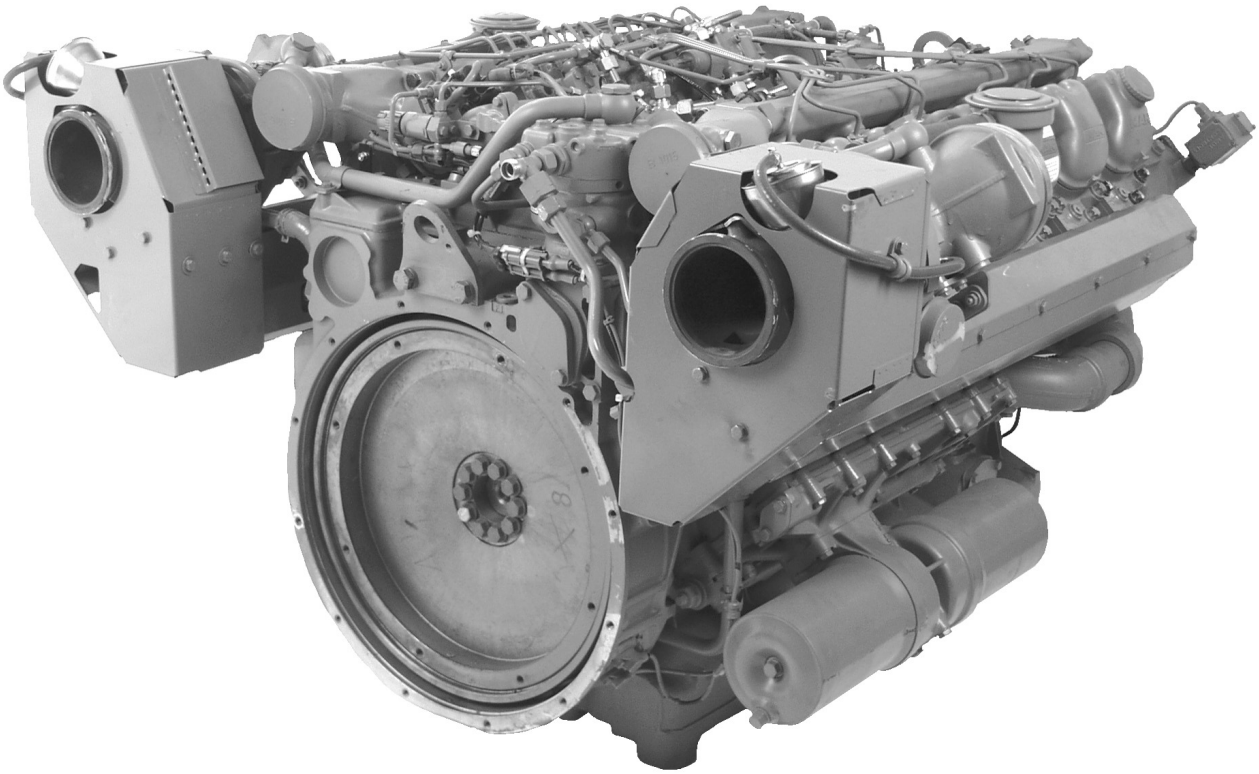


Engine views D 2842 LE 602

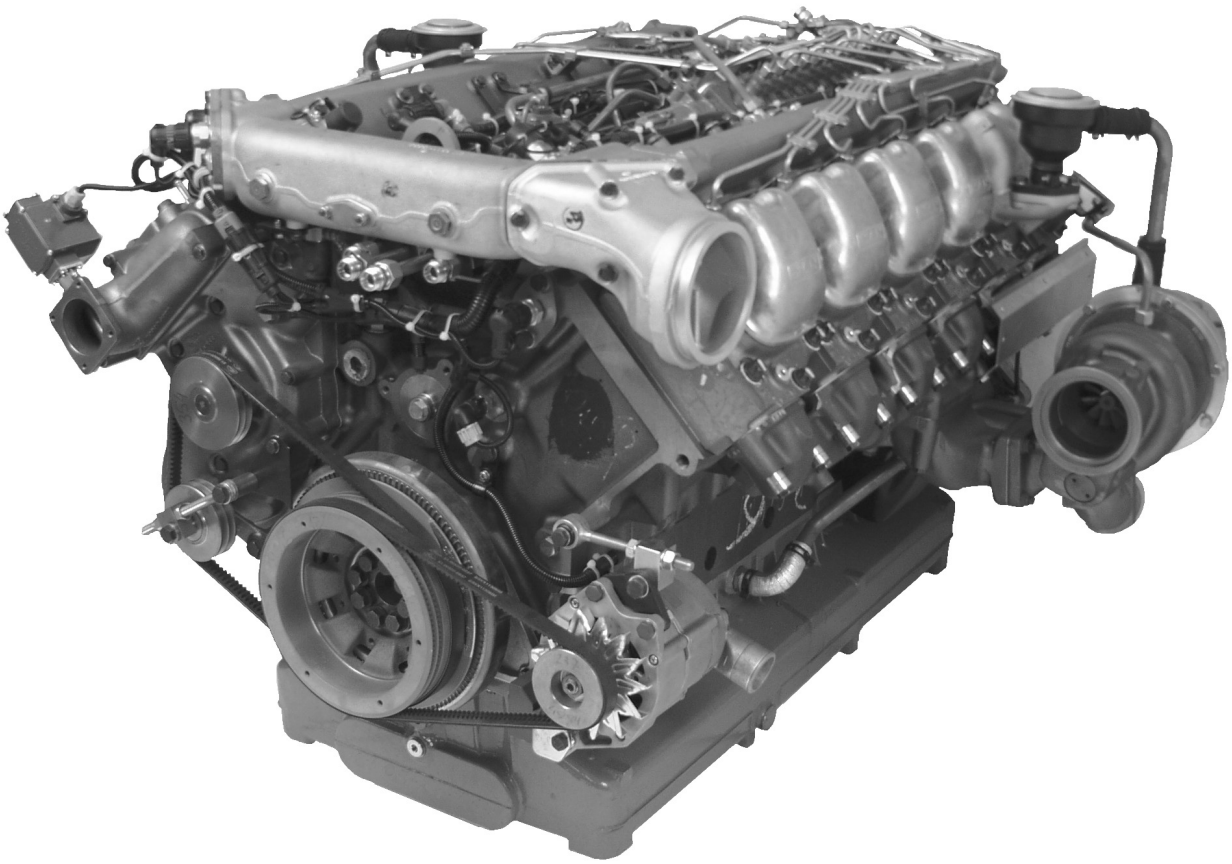


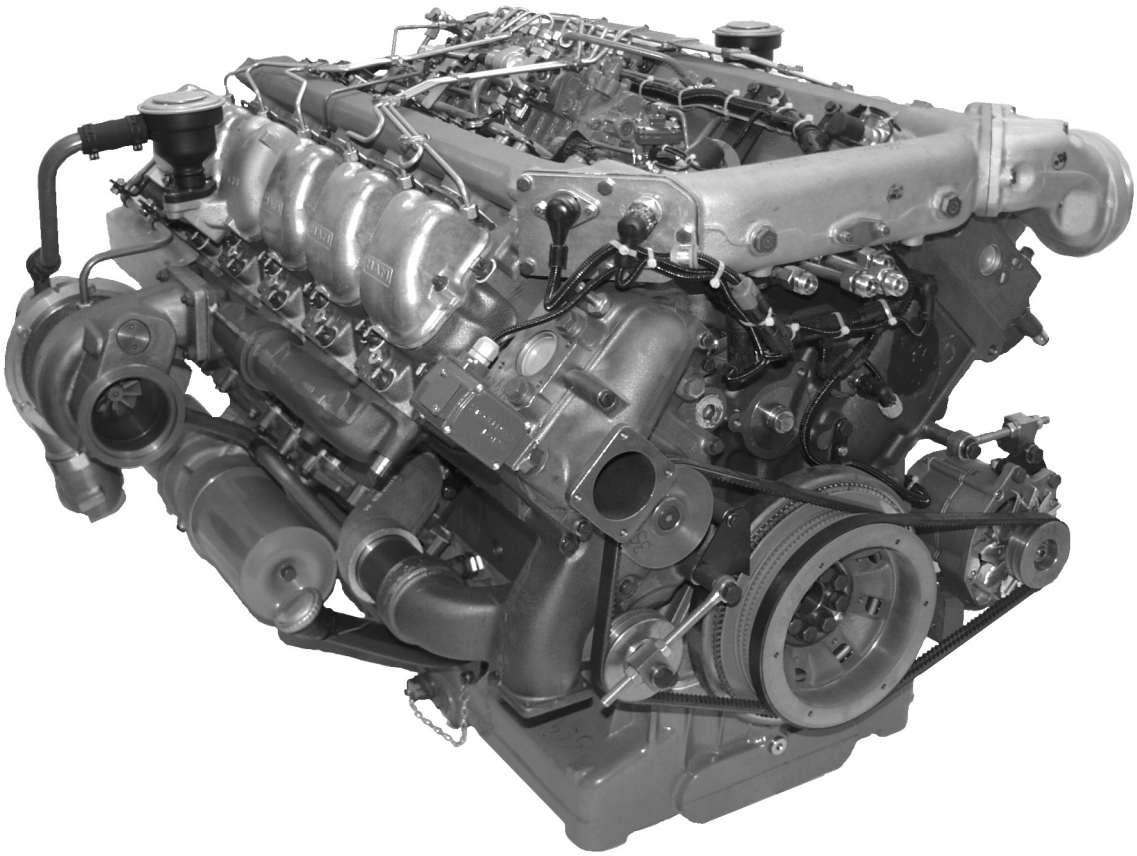


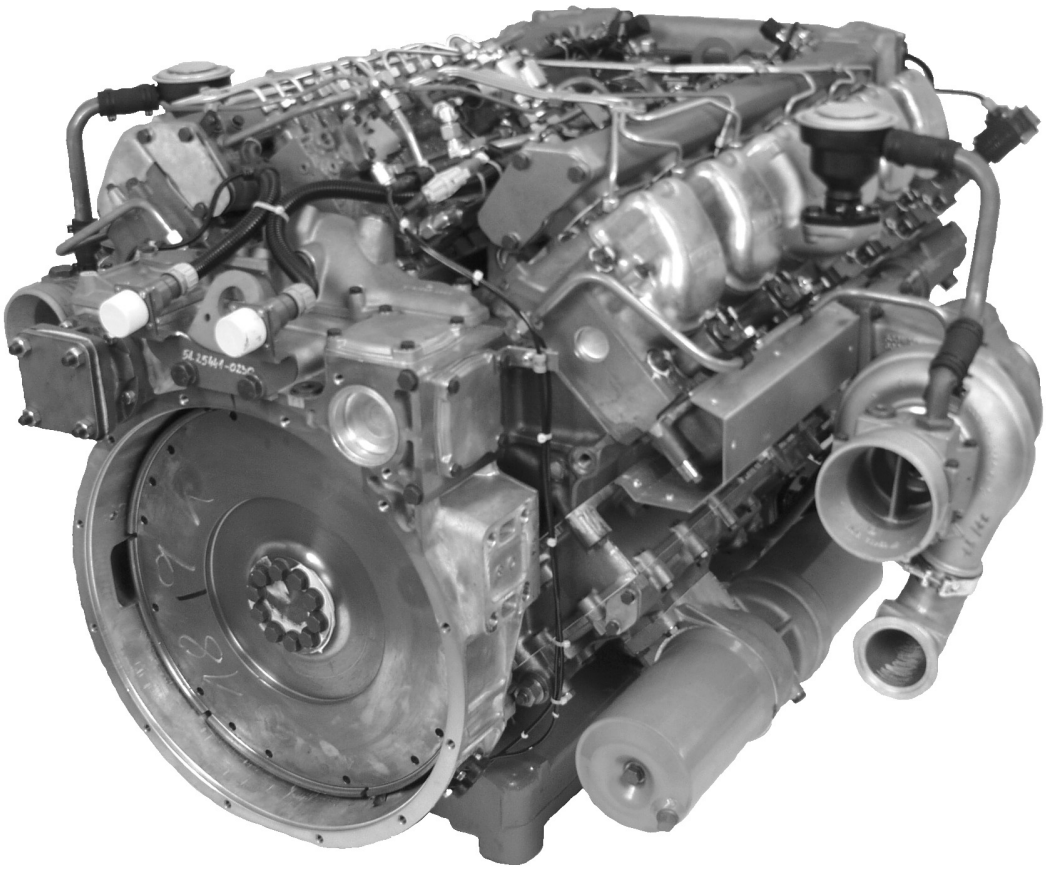




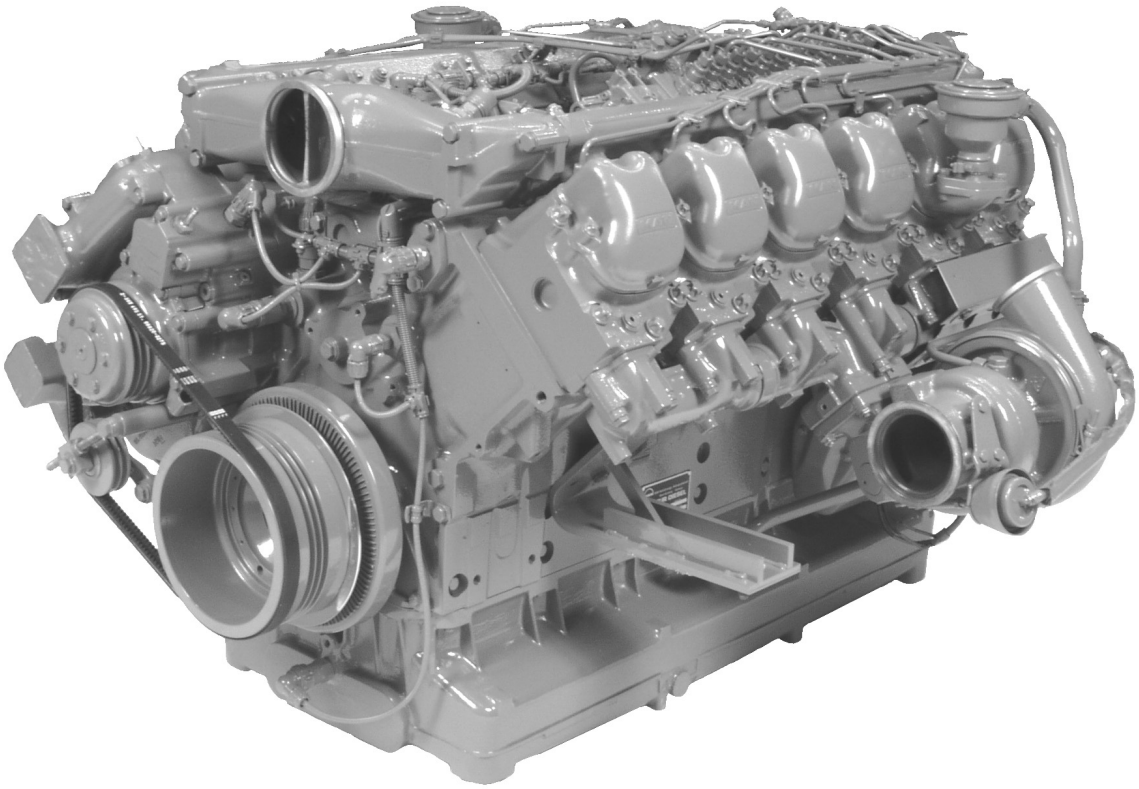
Engine views D 2842 LE 604

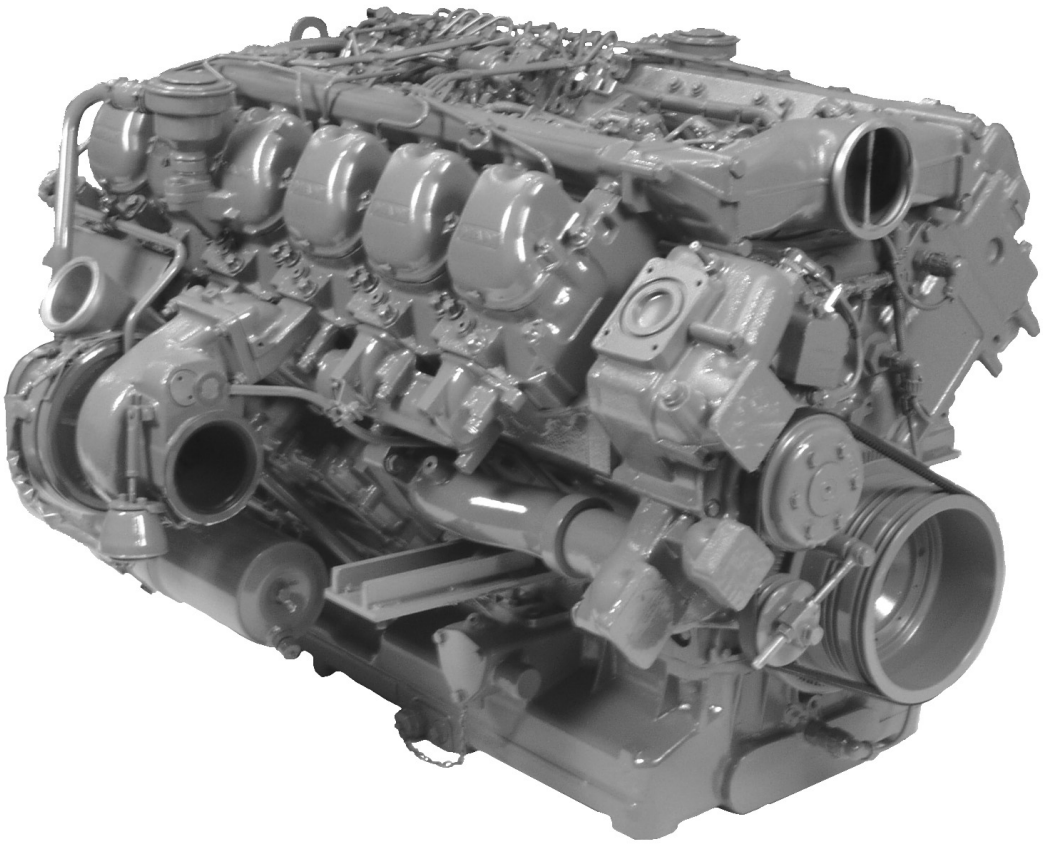


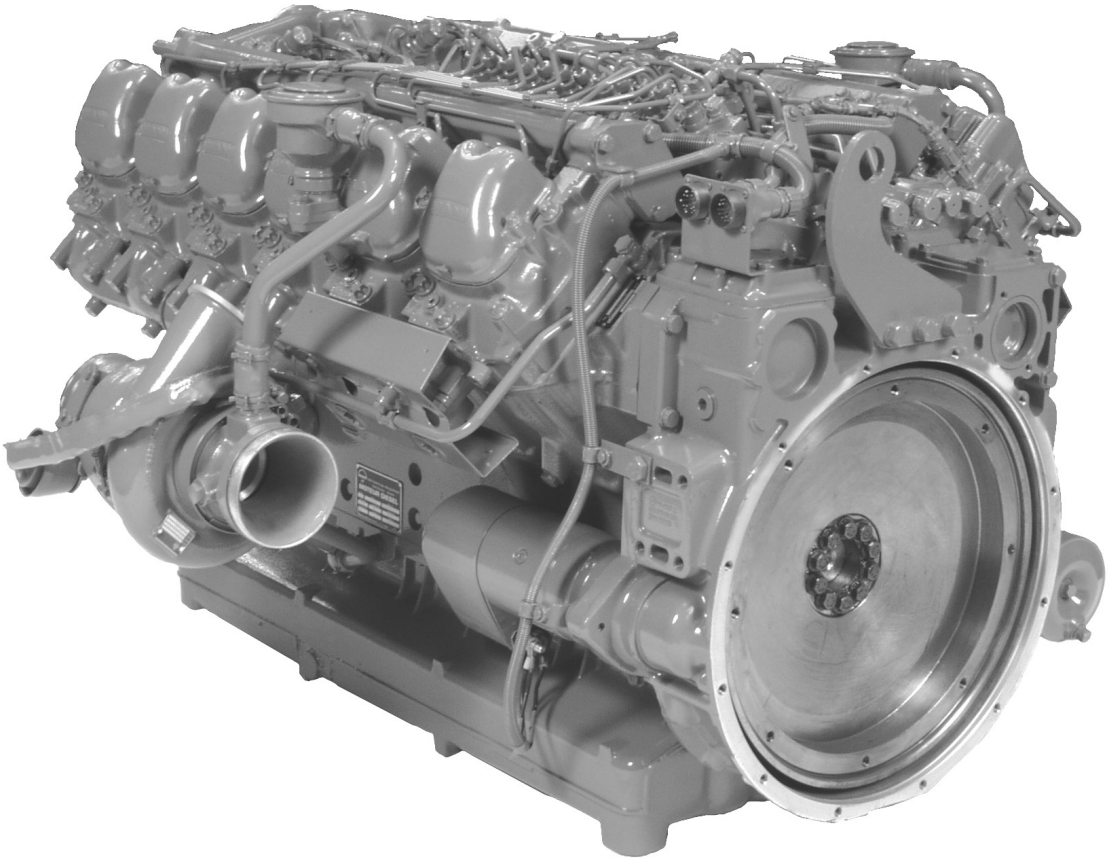


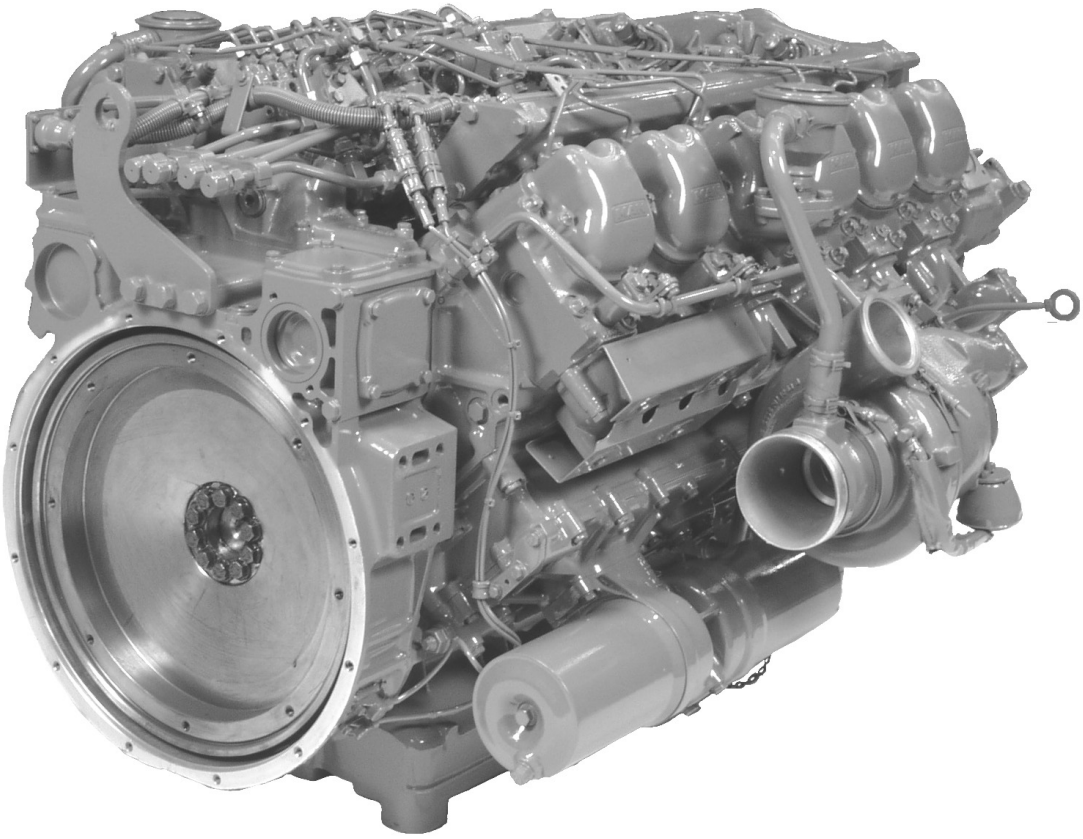


Engine views D 2842 LE 606









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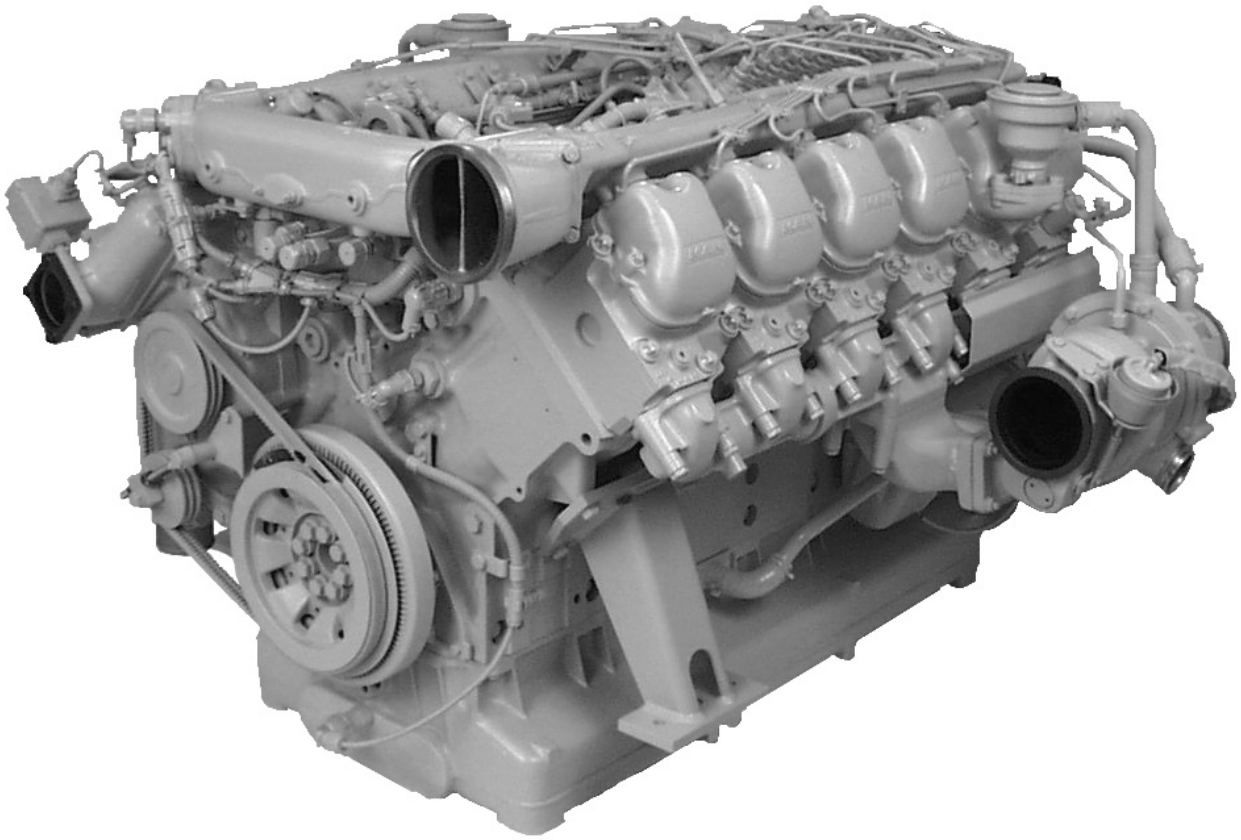
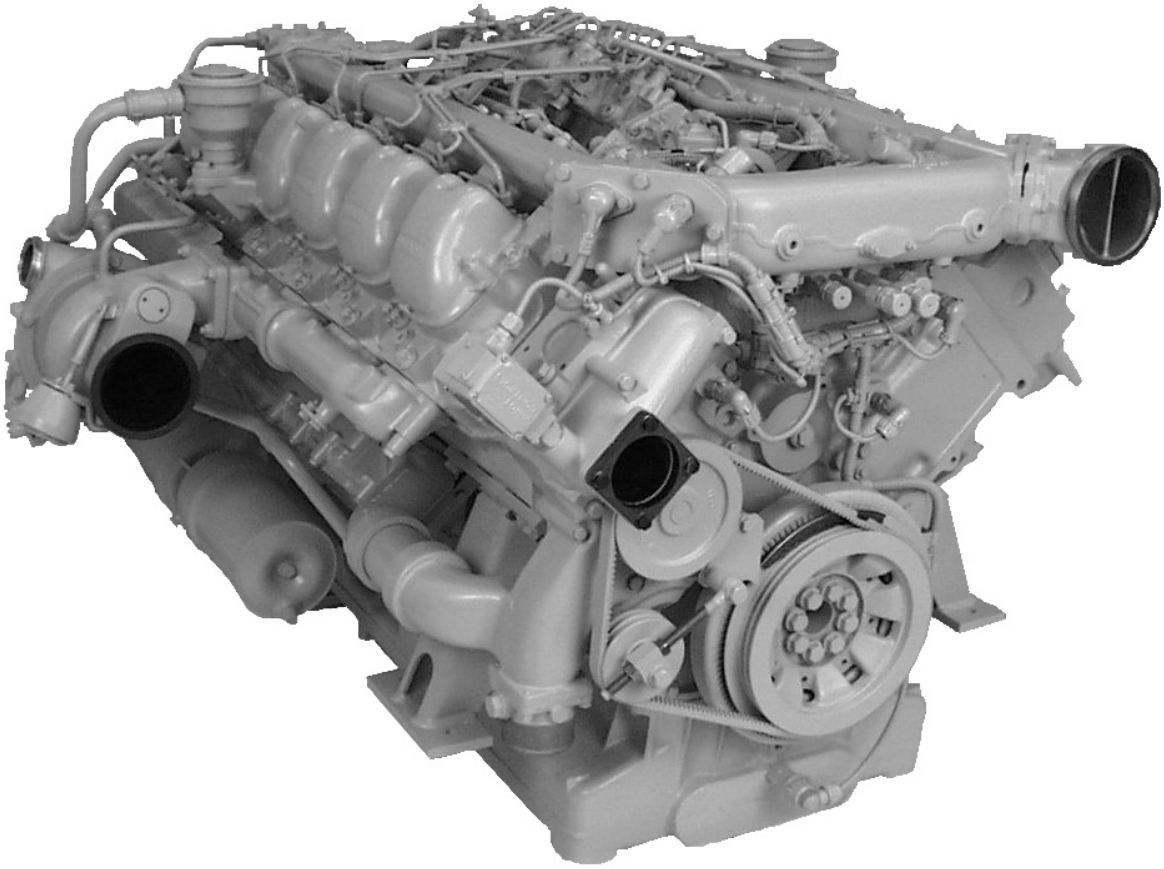
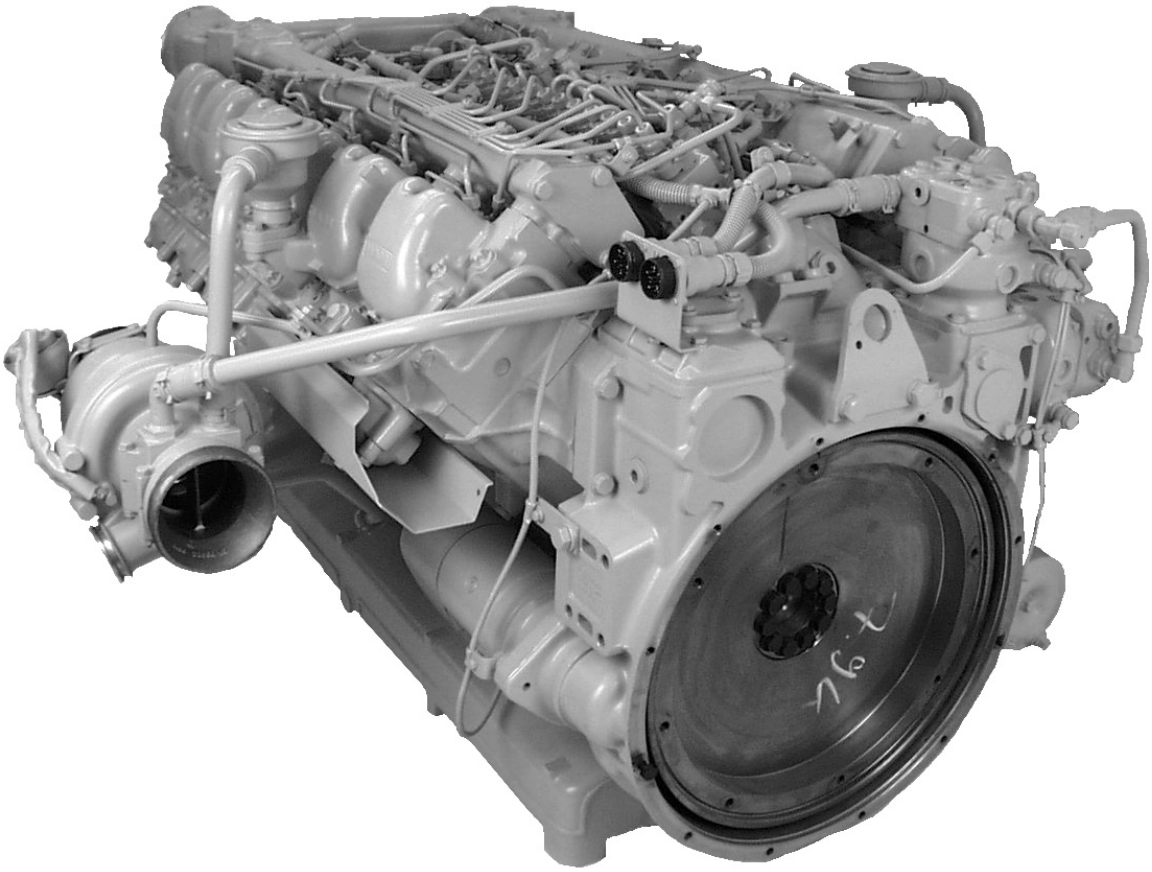
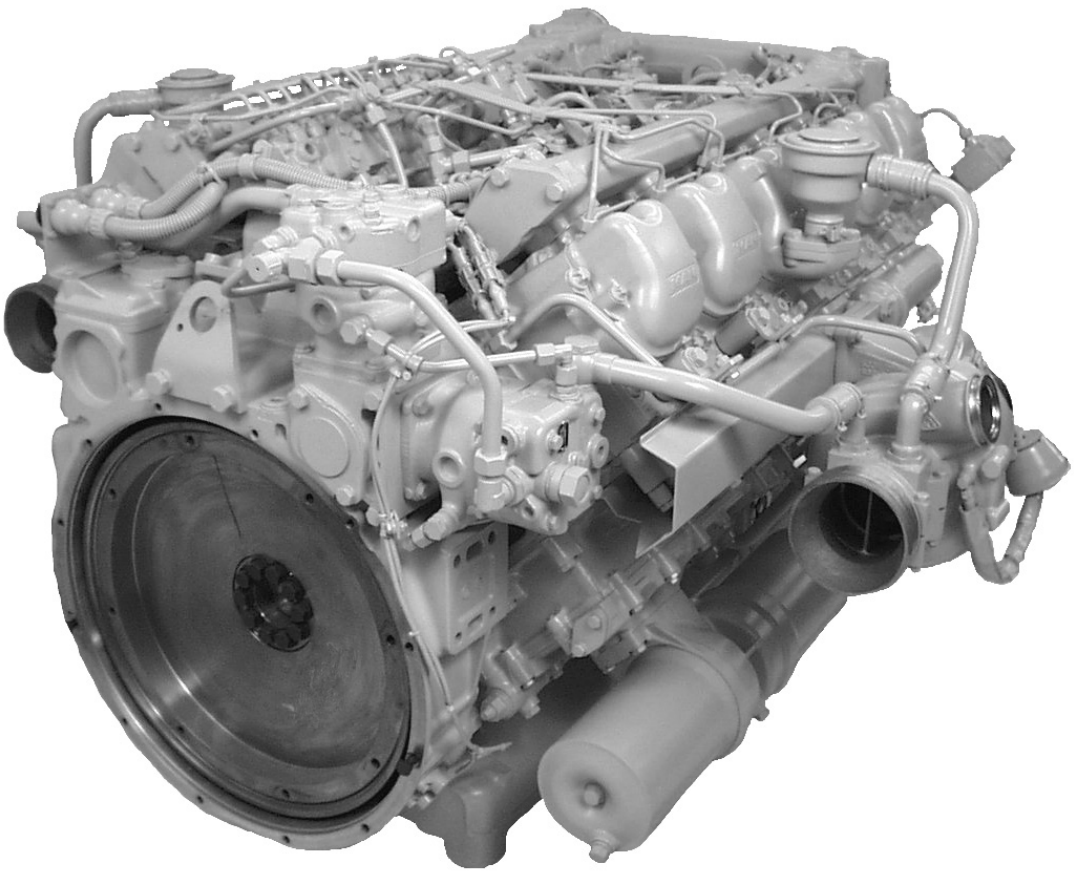
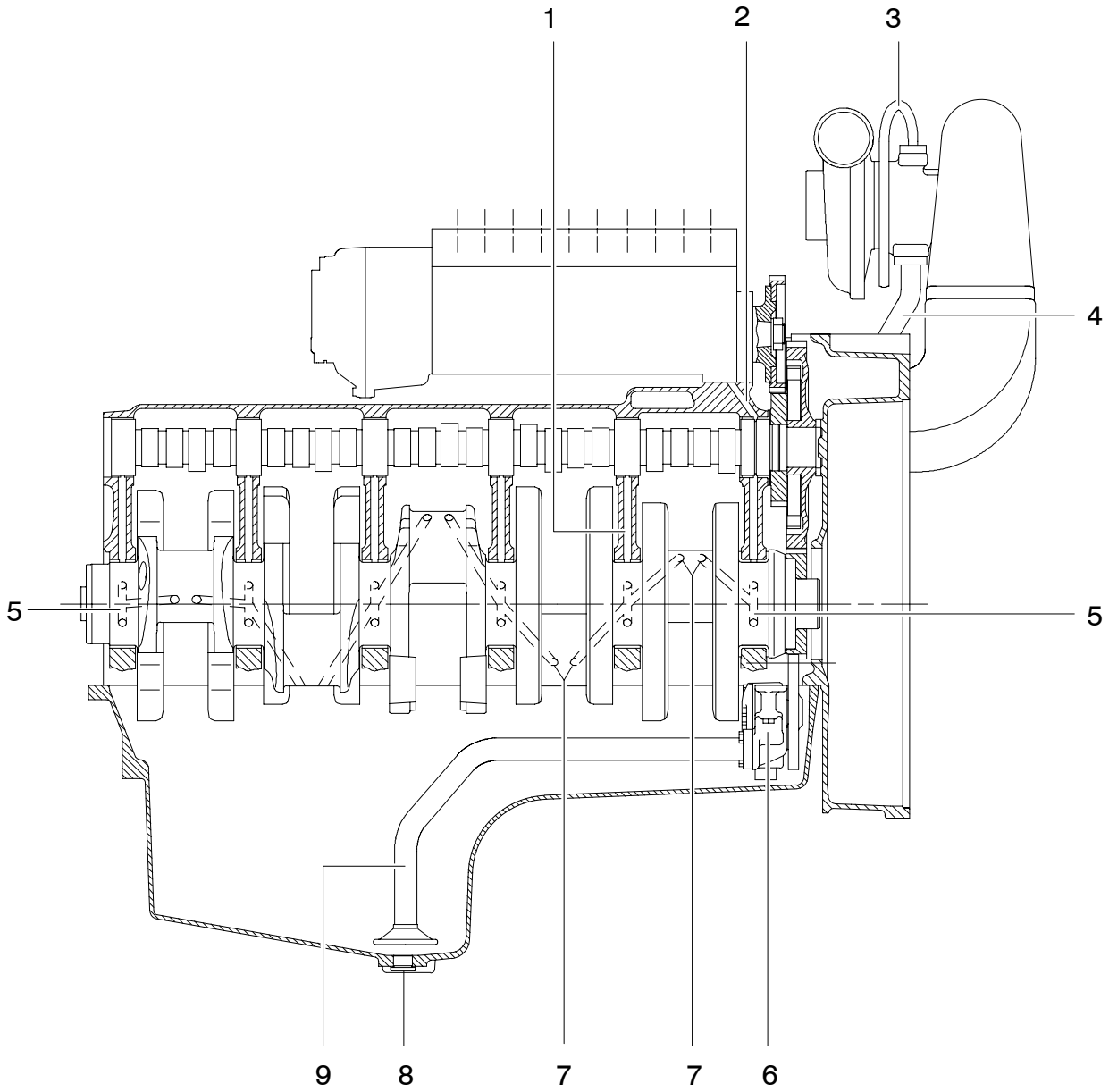










1 Oil line to crankshaft

2 Injection pump lubrication

3 Lube oil lines to turbochargers

4 Oil return line from turbochargers

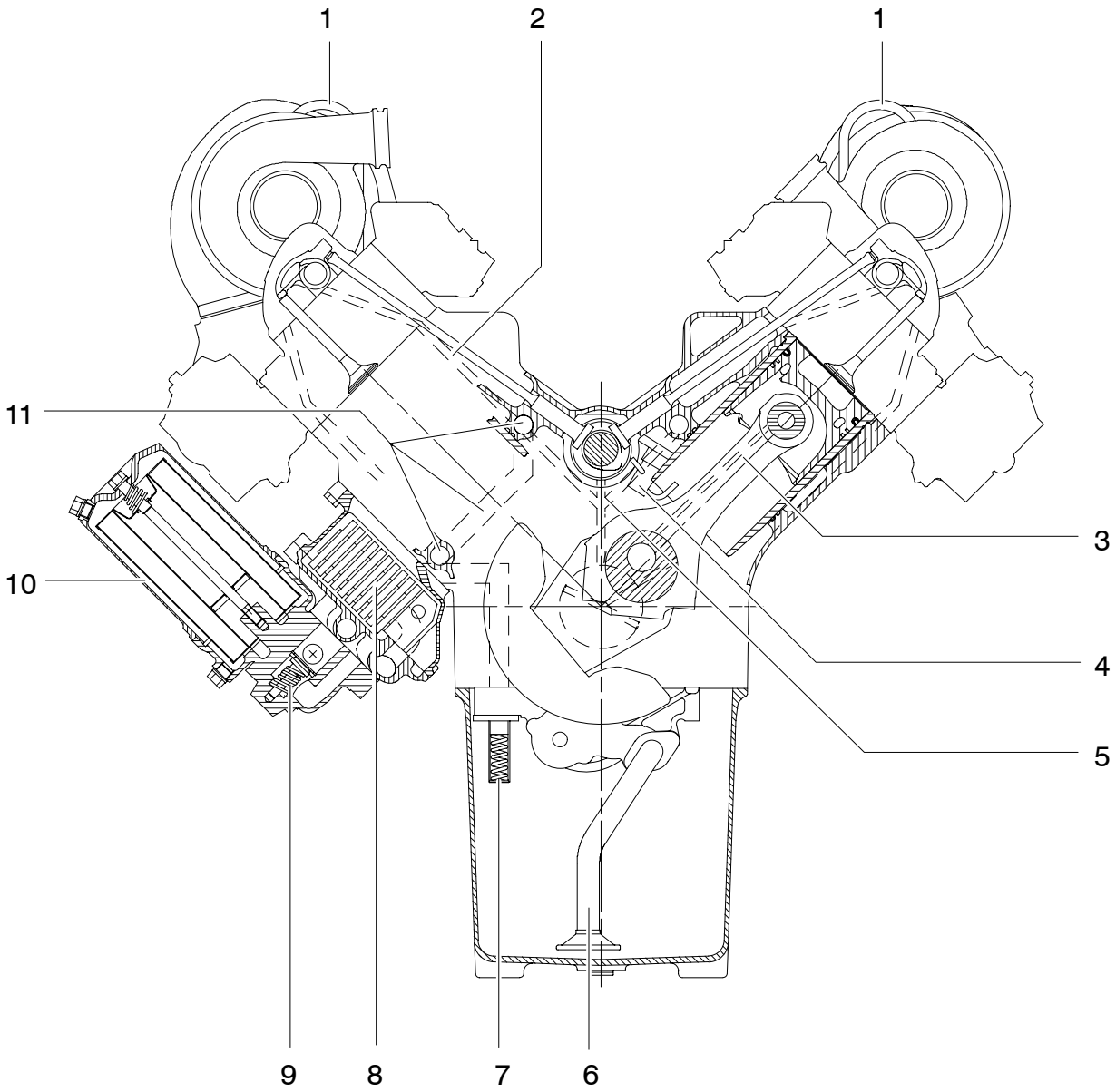
5 Bores for main bearing lubrication

6 Oil pump with oil pressure relief valves

7 Bores for connecting rod bearing lubrication

8 Oil drain plug

9 Oil suction pipe



1 Lube oil lines to turbochargers

2 Rocker arm lubrication

3 Gudgeon pin lubrication

4 Spray nozzles for piston cooling and cam lubrication

5 Camshaft bearing lubrication

6 Oil suction pipe

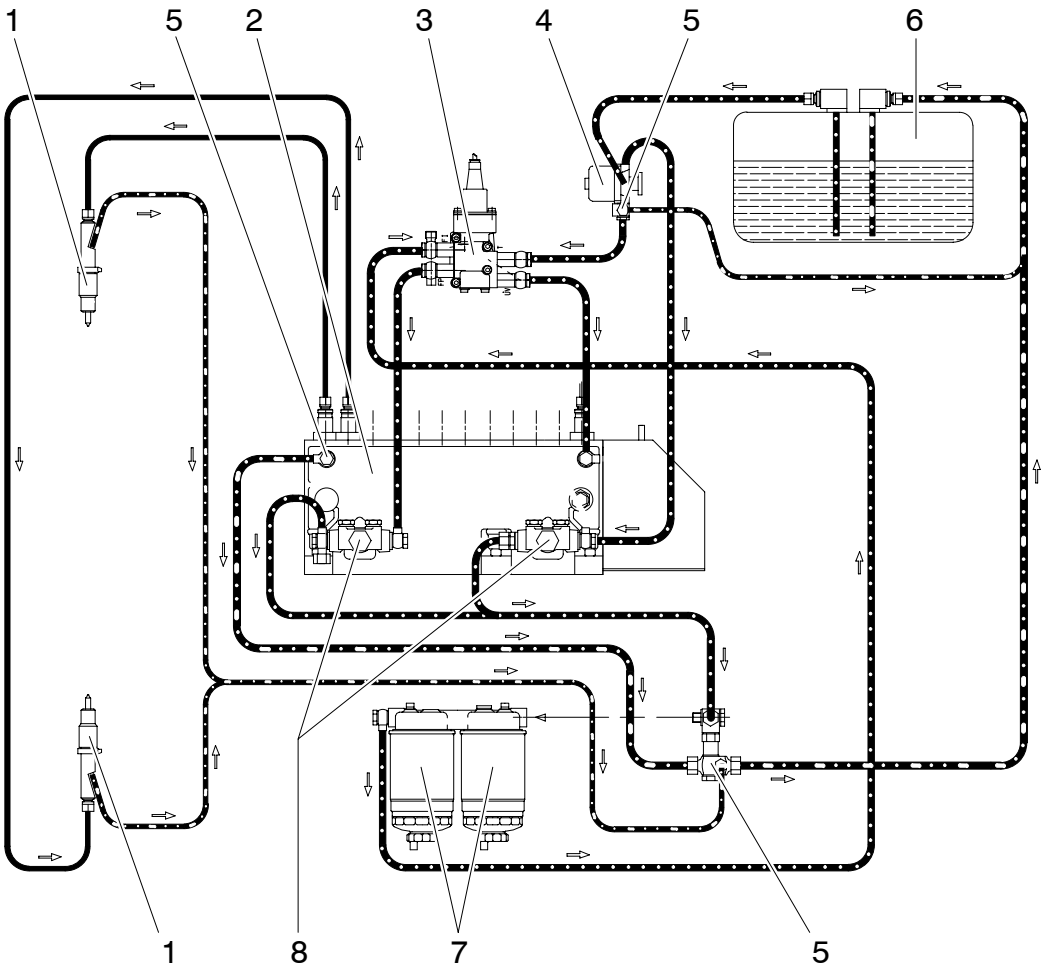
7 Oil pressure relief valve

8 Oil cooler

9 Bypass valve

10 Oil filter

11 Oil galleries



1 Fuel injector

2 Fuel injection pump

3 Electro-hydraulic shut-off (EHAB)

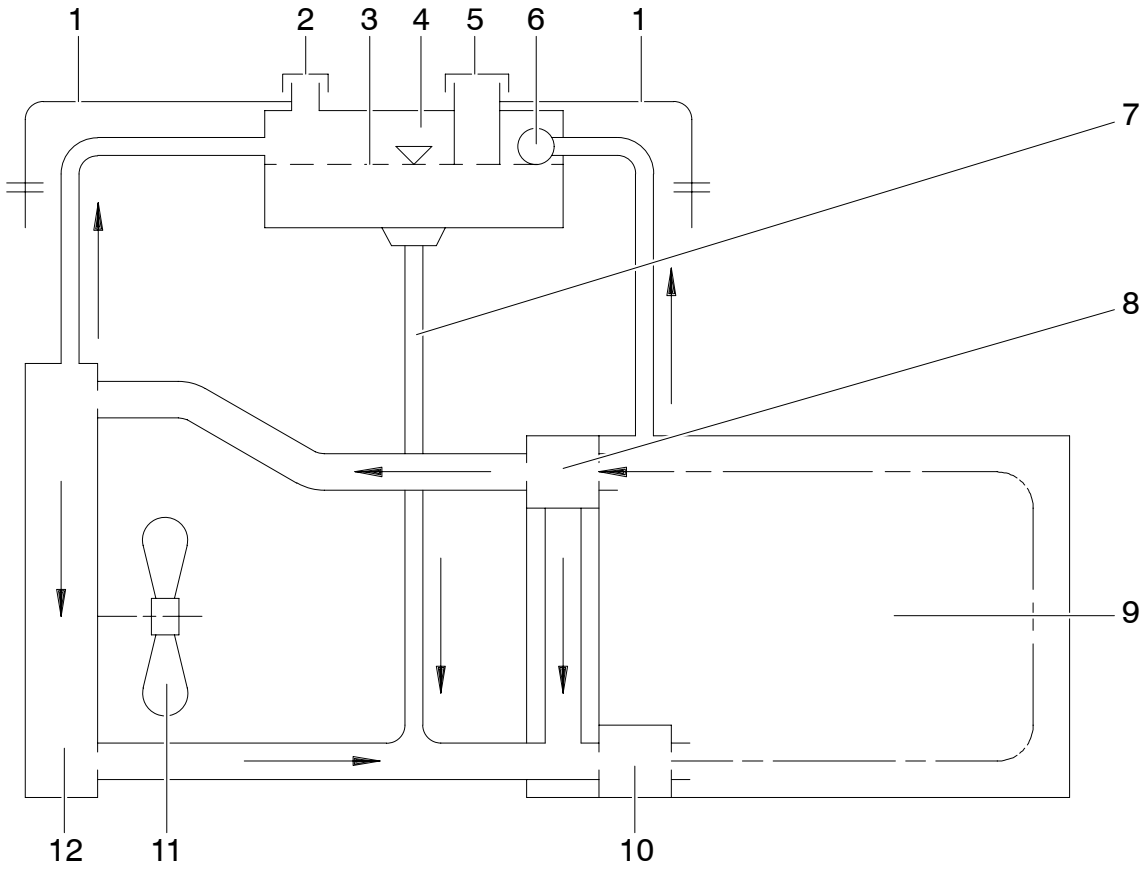
4 Hand pump with prefilter

5 Overflow valve

6 Fuel tank

7 Fuel filter

8 Fuel delivery pumps



1 Overflow and vent pipe

2 Positive pressure / negative pressure valve

3 Coolant level in surge tank

4 Surge tank

5 Coolant filler neck

6 Degassing system

7 Filler pipe

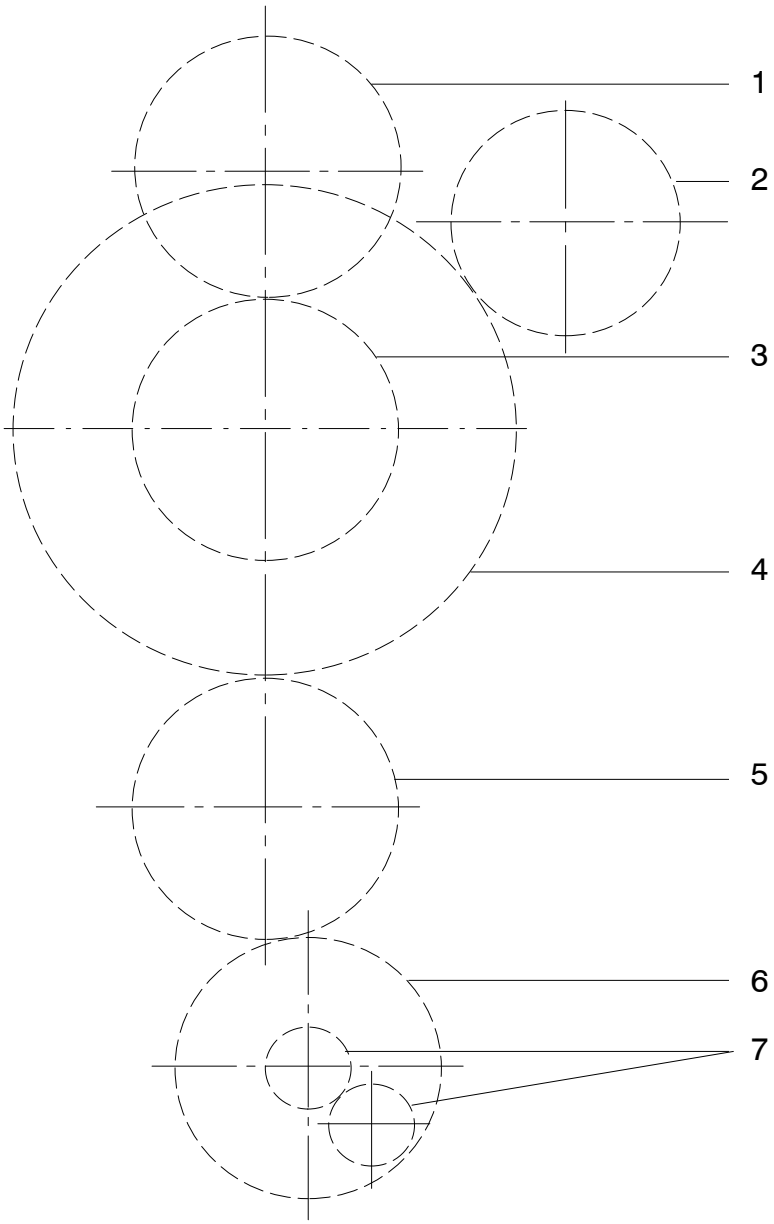
8 Thermostat

9 Engine / crankcase

10 Water pump

11 Fan

12 Radiator / intercooler



1 Injection pump drive gear

2 PTO output gear / air compressor gear

3 Idler gear

4 Camshaft drive gear

5 Crankshaft gear

6 Oil pump drive gear

7 Oil pump impeller gears

Checking start of delivery

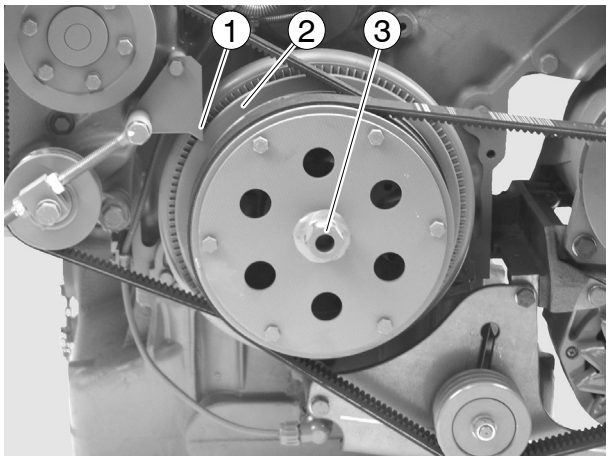
Figs. 1 and 2

For the purpose of checking the start-of-delivery setting, an “OT” (= TDC) mark and a scale from 10 ... 50° before TDC are engraved on a disc ② fitted in front of the torsional vibration damper.

The scale marks are read against a pointer ① fitted to the crankcase.

In order to enable the engine to be rotated manually during adjustments, there is a plate with a central hexagon driver ③ fitted to the front of the crankshaft pulley (D 2842 LE 602).

An engine cranking device (special tool) may be mounted also at the inspection hole of the flywheel housing. For this purpose, the speed pickup together with the plate is to be previously detached.



1

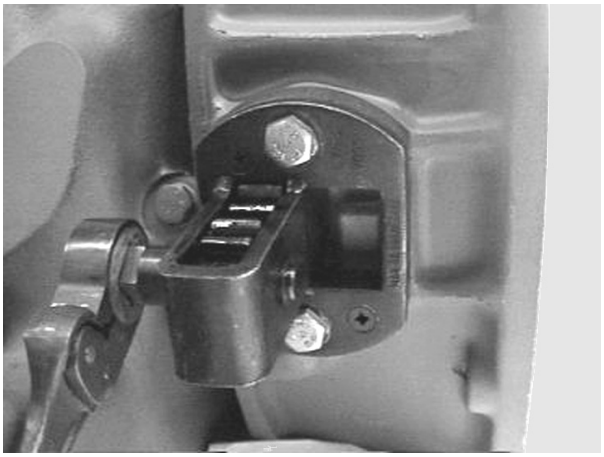

2

Fig. 3

There is another scale engraved on the flywheel which can be read through an inspection hole in the flywheel housing but access may be difficult. The scale should be used for readjusting the pointer after the vibration damper has been removed or replaced.

In other words, before the vibration damper with the scale disc is installed, the engine should be positioned at “OT” (top dead centre) by means of the scale on the flywheel.

The pointer should then be aligned such that its measuring edge exactly coincides with the “OT” mark on the scale disc.

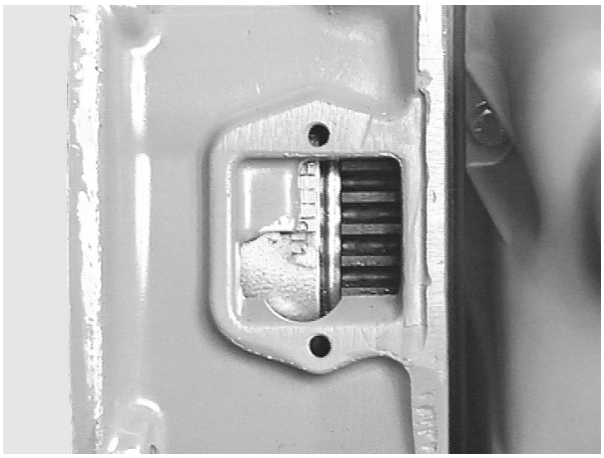

3

Fig. 4

To avoid incorrect readings, always look past the notch on the flywheel housing and straight towards the flywheel centre.

The marking on the graduated scale must be on the imaginary “notch - flywheel centre” line.

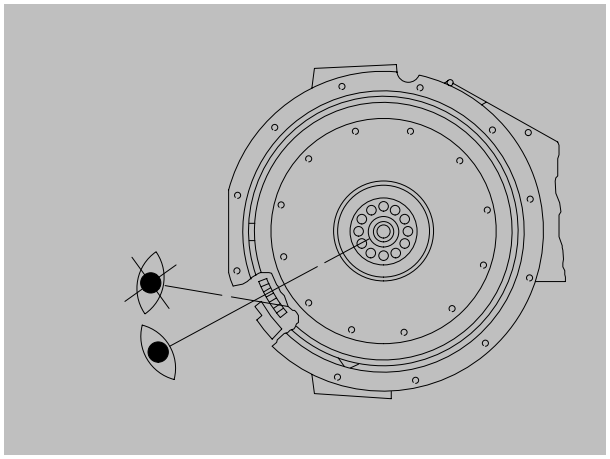
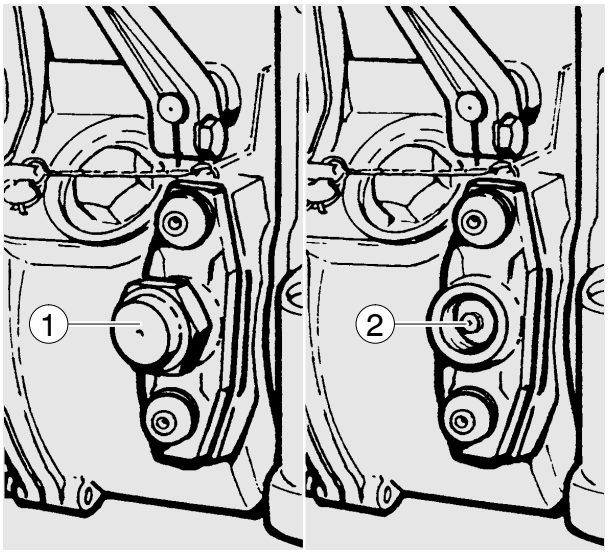

4

Fig. 5

Remove screw plug ① on governor housing.
If fitted, take out blocking pin ②.
If the pointer is exactly in the centre of the inspection hole, the pump plunger for cylinder no. 1 is at start of delivery. However, it is possible to determine exactly whether or not the pump is at start of delivery only by means of the following special tools:

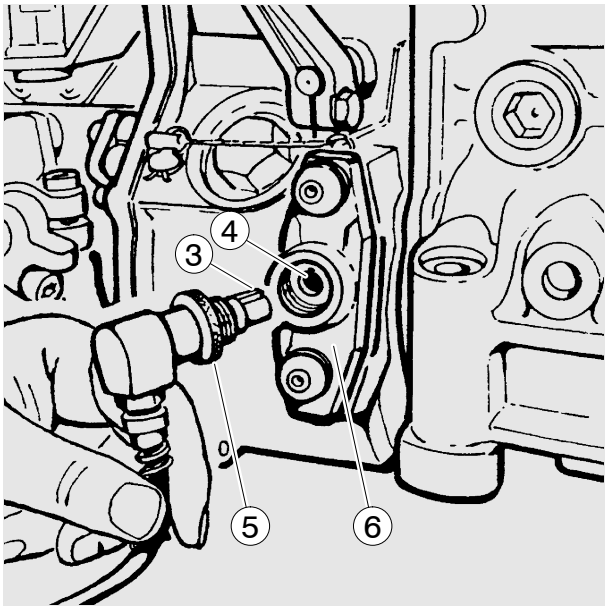


5

a. Light signal transmitter

Fig. 6

Push light signal transmitter into socket in governor housing. Ensure that the lug ③ fits in the groove ④. Tighten the knurled nut ⑤ by hand.



6

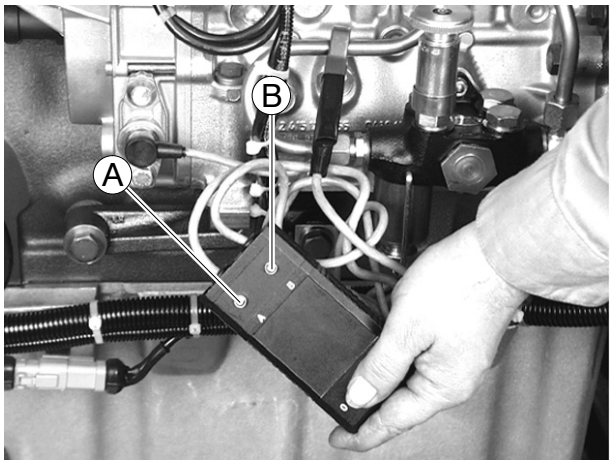
Fig. 7

Turn engine by hand so that piston in cylinder no. 1 in the compression stroke comes close to the start of delivery.
Lamp (A) comes on shortly before start of delivery is reached.

Slowly turn the engine further until lamp (B) comes on too. The injection pump is now at start of delivery.

Note:
If only lamp (B) comes on during this test, the engine has been turned past the start of delivery. In this case turn the engine back and repeat the procedure.

This figure illustrated the KDEP 1601 light signalling device.
This functions on its own battery-driven electricity supply.



7

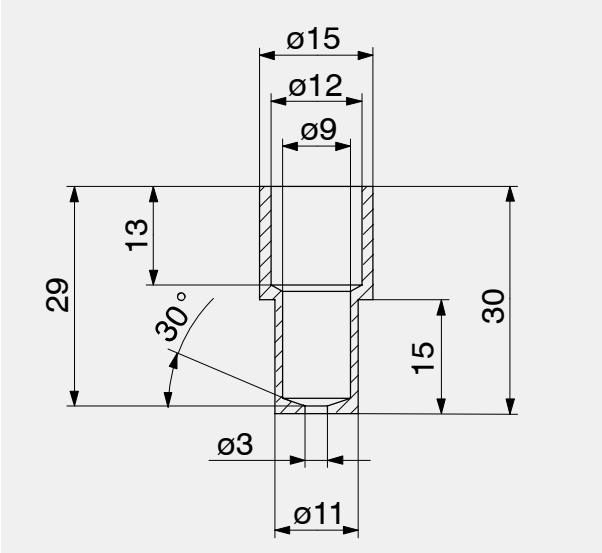
b. Sleeve

Fig. 8

If a light signal transmitter is not available, good measurement results can also be achieved with a plug-in sleeve.
The sleeve is to be made of aluminium or steel.

Set engine to start of delivery as described above. Insert the sleeve into the governor housing up to the stop.

The start of delivery is set exactly when the pointer for start of delivery is in the centre of the 3 mm bore in the sleeve.



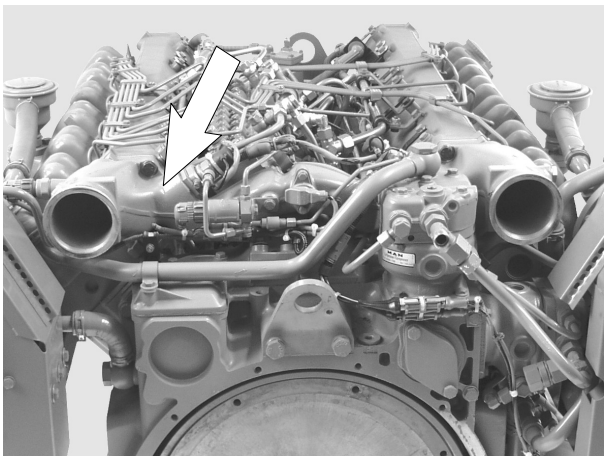
8

Adjusting start of delivery

If the check according to method a) or b) should prove that the delivery start is not correct, proceed as follows:

Fig. 9

On engine D 2842 LE 602 remove the charge−air pipe (arrow) between the two intake pipes.

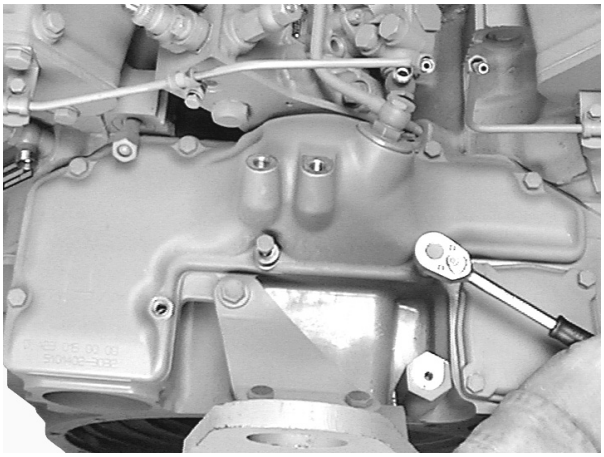


9

Fig. 10

Remove timing case cover.

Note:
Pipelines are attached to the timing case cover. To facilitate reassembly, memorise or make a drawing or photograph of the positions of holders, pipe clamps, spacer sleeves etc.



10

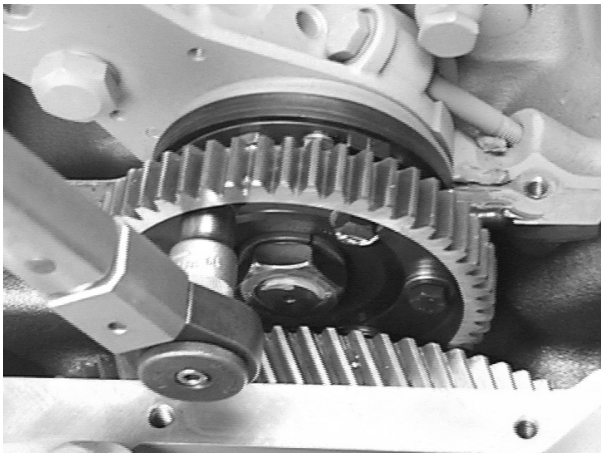
Fig.11

Turn engine to specified angle for delivery start.

Fig. 12

Loosen all bolts fastening the drive gear to the injection pump hub. For this, two complete turns of the engine are necessary.

Turn the injection pump camshaft on the drive flange to the left or right until the conditions mentioned under a) or b) apply.



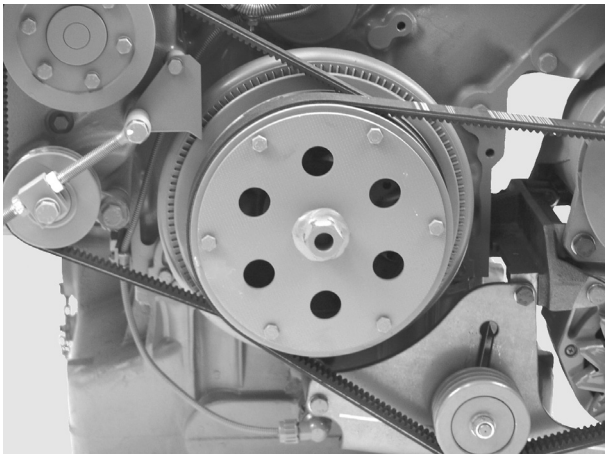
11

Note:
If the setting specified cannot be reached by turning the injection pump hub, the installation of the injection pump is to be checked.

Tighten bolts for fastening drive gear to drive flange consecutively to 5 Nm and then to 38 Nm.

Note:
Use only M8x22 mounting bolts (property class 12.9).

Check delivery start once again.
Close governor housing.

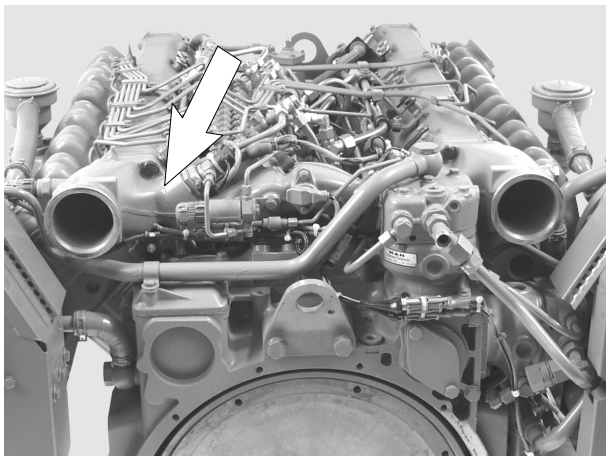


12

Removing injection pump

Note:
The subsequent reinstallation of the injection pump is rendered considerably easier if before its removal the engine has been turned to start of delivery. See page 29.

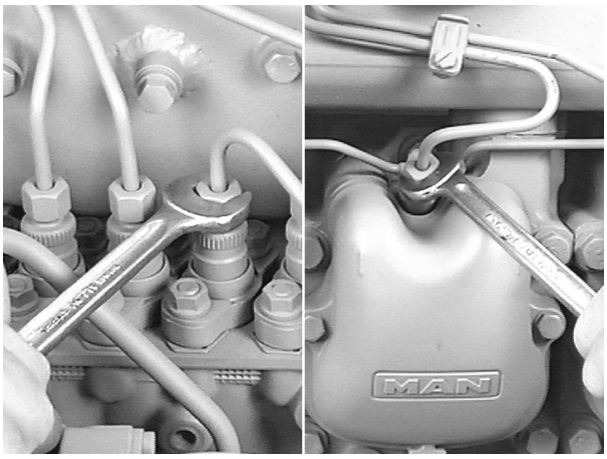
Fig. 1



1

D 2842 LE 602
Disconnect the flame glow plugs and remove the lines from the solenoid valve.
Remove charge-air pipe between the intake pipes.

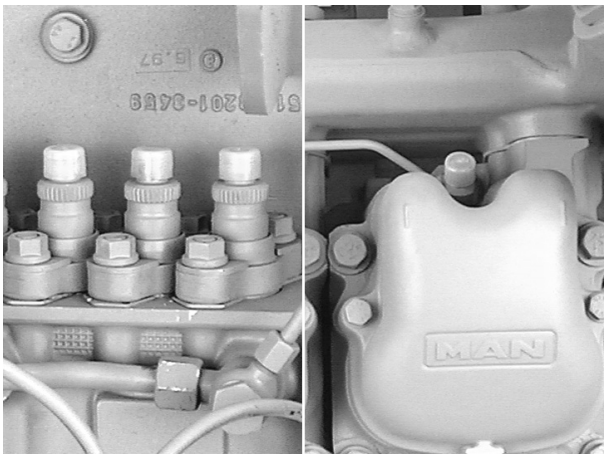
Fig. 2



2

Remove the injection lines from the injection pump and from the injection nozzles.

Fig. 3



3

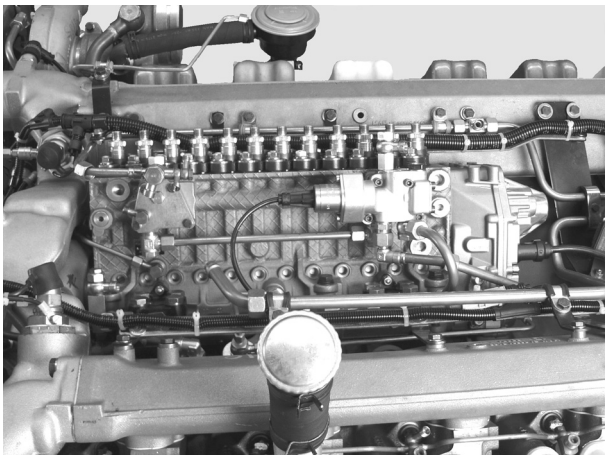
After removal of the injection lines we recommend fitting caps to the connections on the injection nozzles and injection pump.
This prevents dirt from getting into the injection system.

Caution:
Dirt in the injection system causes:
- nozzles to jam
- the injection-pump drive gear to break

Fig. 4

Remove all fuel connections from injection pump.
Remove oil return line from crankcase.

Caution:
The lines contain fuel.
Catch emerging fuel in a container.

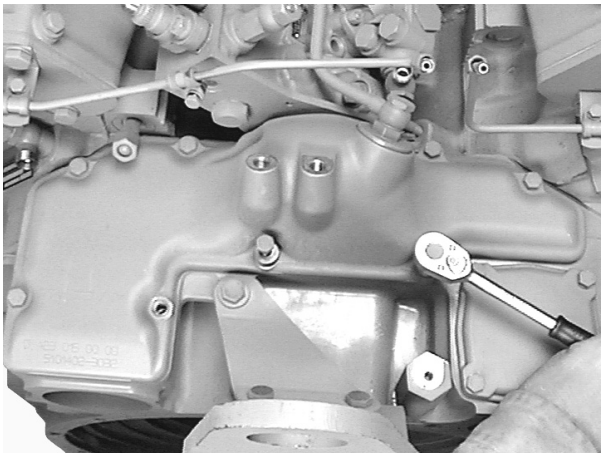


4

Fig. 5

Remove timing case cover.

Note:
Pipes are attached to the timing case cover.
To facilitate reassembly, note down the positions of the brackets, pipe clamps, spacer sleeves etc.

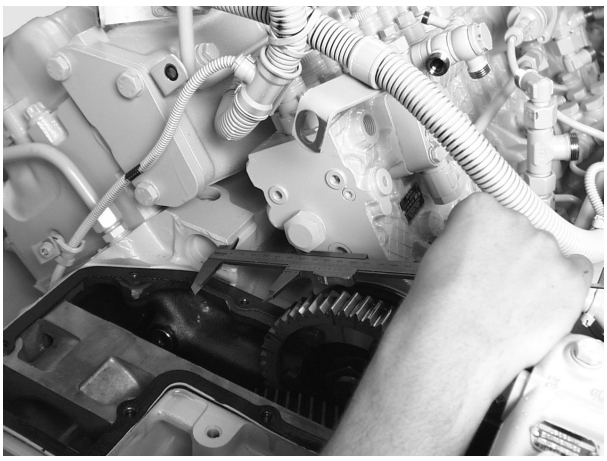


5

Fig. 6

Measure and note down distance between injection pump and crankcase.

Maintaining this distance in the assembly later on ensures that the oil supply bore of the injection pump will remain clear.



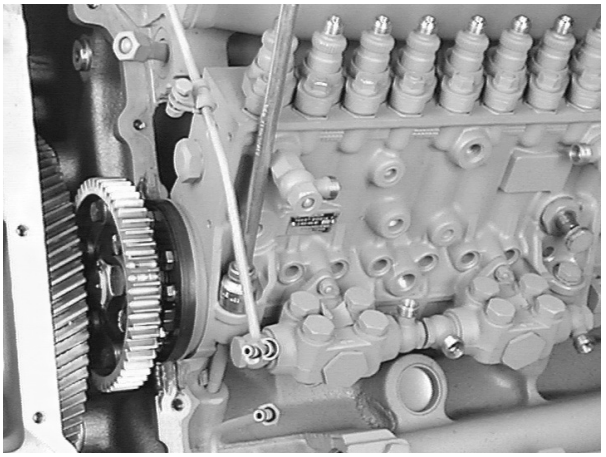
6

Fig. 7

Remove mounting bolts from injection pump.

Take off injection pump.

Note:
Ensure meticulous cleanliness when working on the injection pump.
Prevent dirt and foreign matter from penetrating into opened line connections.



7

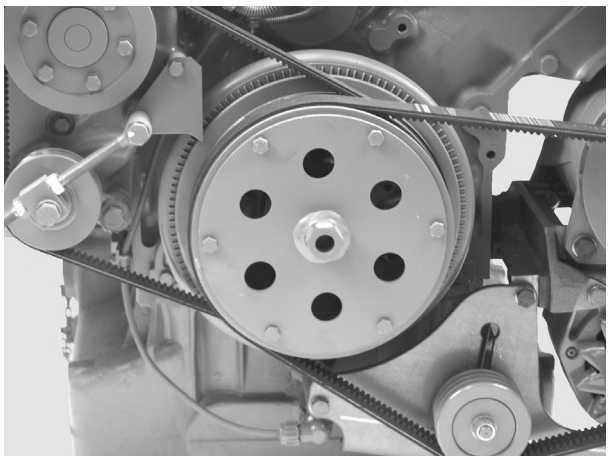
Installing injection pump

Fig. 8

Check whether engine is at start of delivery.

The start of delivery of the individual engines is indicated in the Service Data, see relevant page 139.

Note:
In the event of new pumps, remove plug from oil supply bore.



8

Fig. 9

Remove the mounting bolts from the injection pump drive gear so that it can be turned in the slots.

Hold injection pump camshaft in place while turning the gear.

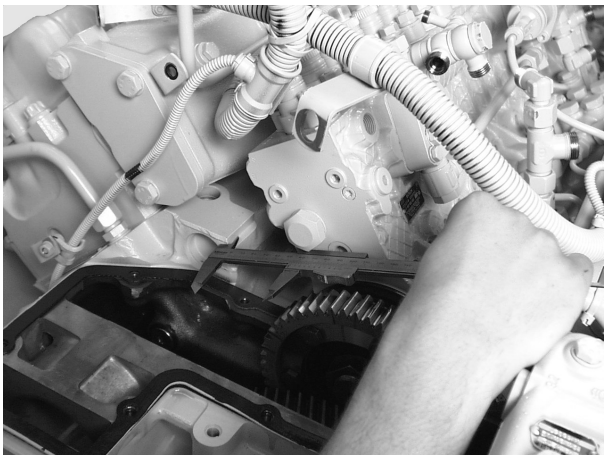
Fit new O-ring (slightly coated with oil) to injection pump flange.

9

Fig. 10

Fit injection pump in such a way that the mounting bolts can be screwed in by hand.

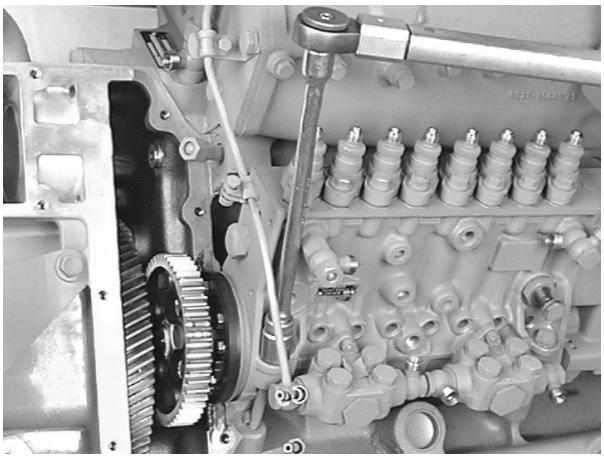
Check distance between injection pump and crankcase.



10

Fig. 11

Tighten mounting bolts to specified torque (see “Service Data”).



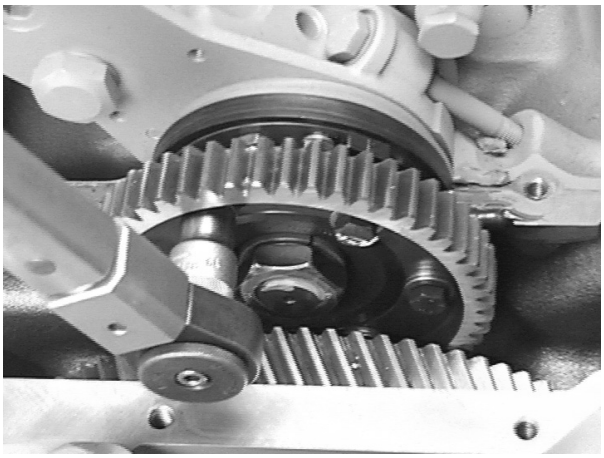
11

Fig. 12

Apply an initial torque of 5 Nm to all mounting bolts on the gear through the inspection hole. Two complete engine turns are necessary for this operation.

Note:
Use only M8x22 mounting bolts (property class 12.9).

Now tighten all mounting bolts to 38 Nm.



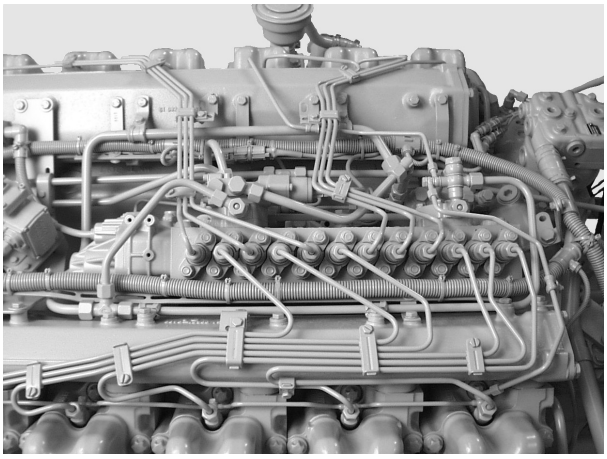
12

Fig. 13

Check delivery start, if necessary readjusting it (see page 29).

Refit in reverse sequence to the removal procedure all parts previously removed.

Observe specified tightening torques indicated in the publication “Service Data”.



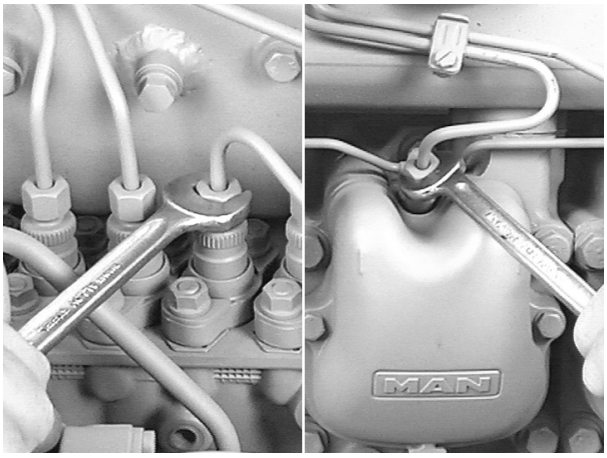
13

Removing fuel injectors

Fig. 1

Remove the injection lines from the injection nozzles and from the injection pump.

Remove the fuel return lines.

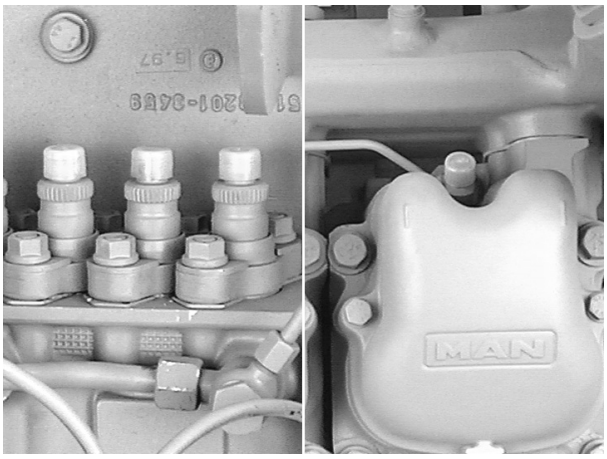


1

Fig. 2

After removal of the injection lines we recommend fitting caps to the connections on the injection nozzles and injection pump.
This prevents dirt from getting into the injection system.

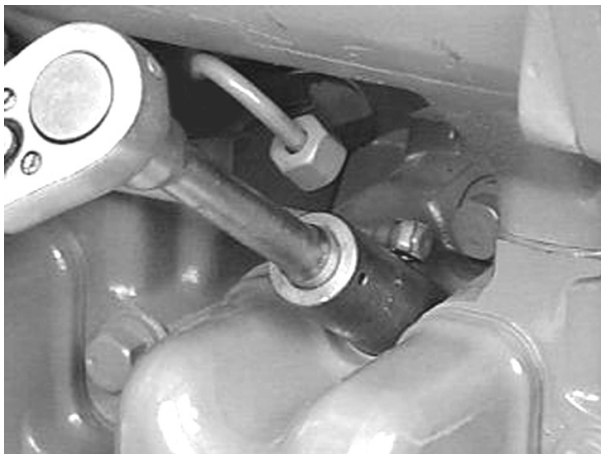
Caution:
Dirt in the injection system causes:
- nozzles to jam
- the injection-pump drive gear to break



2

Fig. 3

Remove pressure screw from fuel injector using a pin spanner.



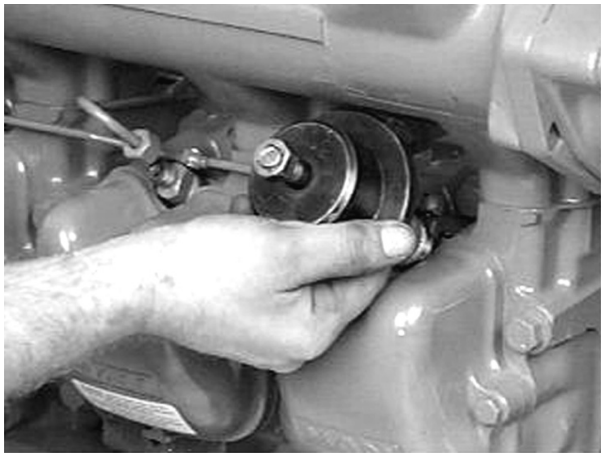
3

Fig. 5

Screw adapter on to nozzle holder.
Screw on inertia extractor and knock out nozzle holder.

Take sealing ring off the injection nozzle.

Check and repair injector, see page 39.



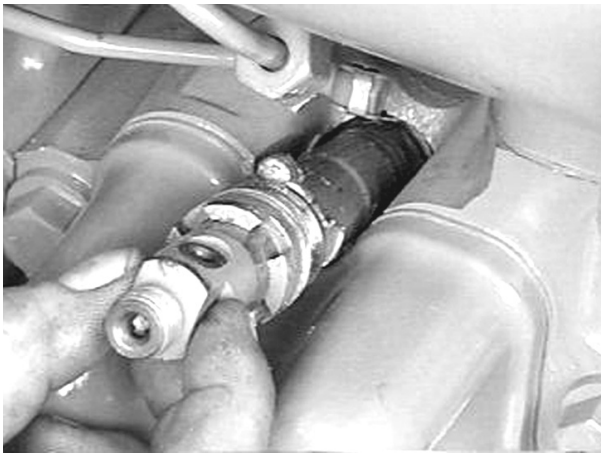
4

Installing fuel injectors

Fig. 5

Insert new sealing ring, apply “Never Seeze” to the contact points of the nozzle holder and insert nozzle holder with nozzle into cylinder head.

Screw in injector with new seal. Screw on union nut and tighten to specified torque.

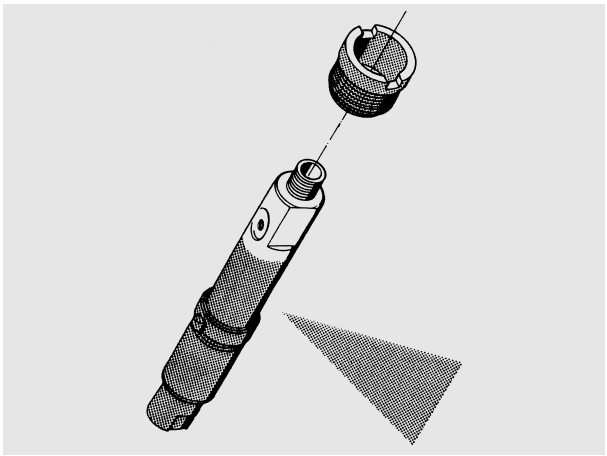


5

Fig. 6

(Example)

The lubricant, which is available as a spray, must be applied to the inside of the pressure screw, to the threaded portion of the pressure screw and to the nozzle holder (see shaded area).

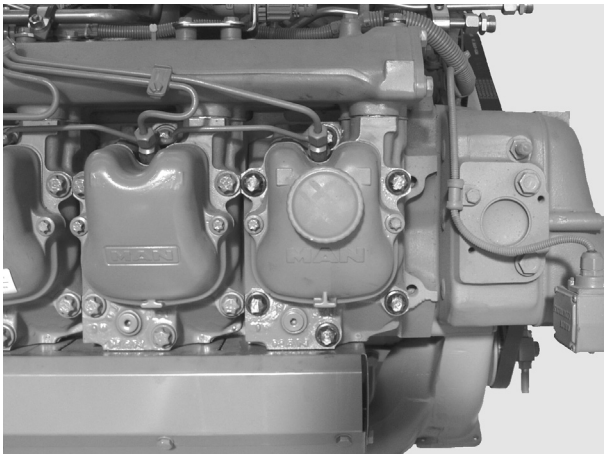


6

Fig. 7

Fit fuel return line together with new sealing rings to the nozzle holders and tighten to specified torque.

Screw the pressure lines to the nozzle holders and to the injection pump and tighten to specified torque.



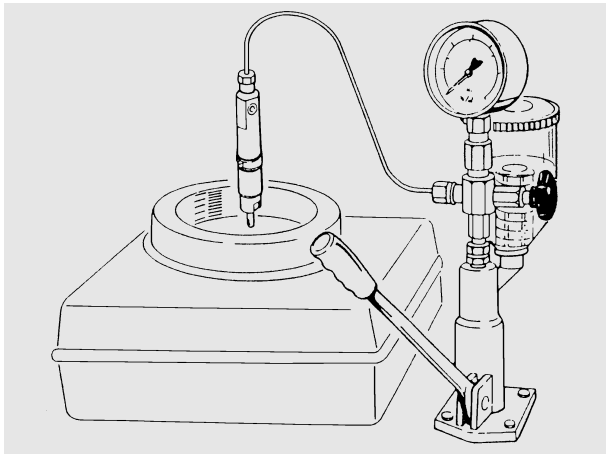
7

Checking fuel injectors

Fig. 1

The nozzle tester (manual test stand) is used to check the
- opening pressure
- tightness
- spray pattern of the injection nozzle.

Use pure testing oil or pure Diesel fuel for the test. Prior to testing, clean nozzle and check it for wear, see page 40.



1

Fig. 2

Check injector assembly.
Connect the nozzle's supply connection to the test unit's pressure line.

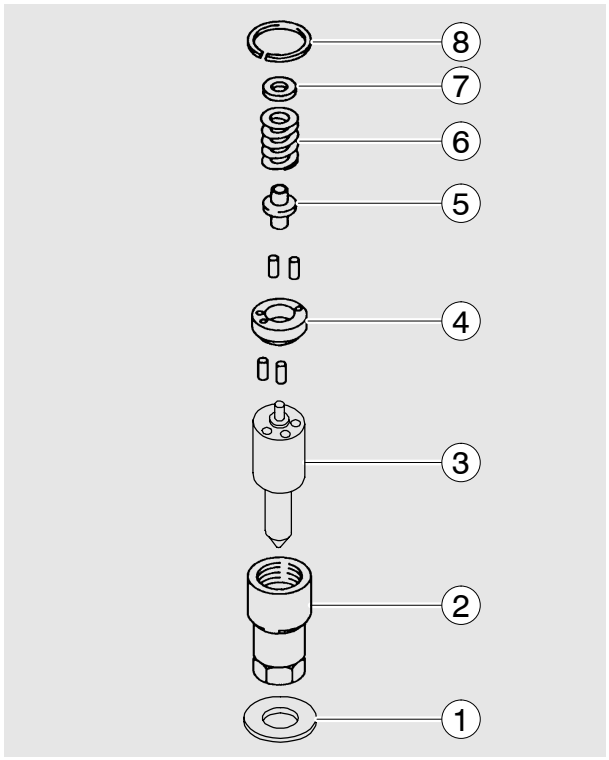
Danger:
The high opening pressure may lead to severe injuries. Do not place hands under the jet. Wear safety goggles.

1. Checking opening pressure:
Switch on the pressure gauge and slowly press lever downwards until the nozzle emits a jet with a light grating noise.
Read **opening pressure** from the pressure gauge.
In the event of a pressure deviation insert a different shim.
If the pressure is too low, insert thicker shims, if it is too high, insert thinner shims ⑦.
The initial tension of the compression spring ⑥ decreases if a high number of operating hours has been clocked up.
Consequently, the injection pressure drops slightly.
When repairing injection nozzles, always set the opening pressure to the upper limit.

Note:
Shims are available in 0.01 mm steps from
1.0 mm to 1.99 mm.

2. Checking tightness:
Actuate hand lever.
At a pressure of 20 bar below the opening pressure set not a single drop must fall from the nozzle opening within 10 sec.

3. Checking jet:
Switch off pressure gauge and carry out some swift strokes. The nozzle must emit an audible grating noise and / or a well-atomised jet.
Nozzles that satisfy these three requirements can be reused.



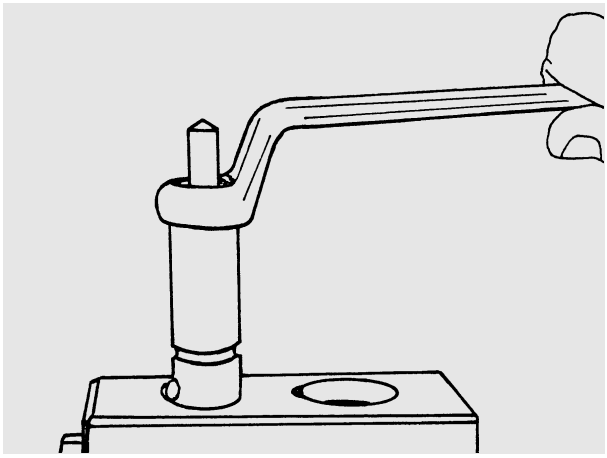
2

1 Seal
2 Nozzle tension nut
3 Injection nozzle
4 Intermediate washer
5 Pressure pin
6 Compression spring
7 Shim
8 Circlip

Disassembling fuel injectors

Fig. 3

Insert injector assembly (the inlet orifice facing downwards) into the clamping device and hold in a vice.
Remove union nut and take out nozzle body, intermediate washer, pressure pin, compression spring and shim.
Take pressure pipe neck out of holder.



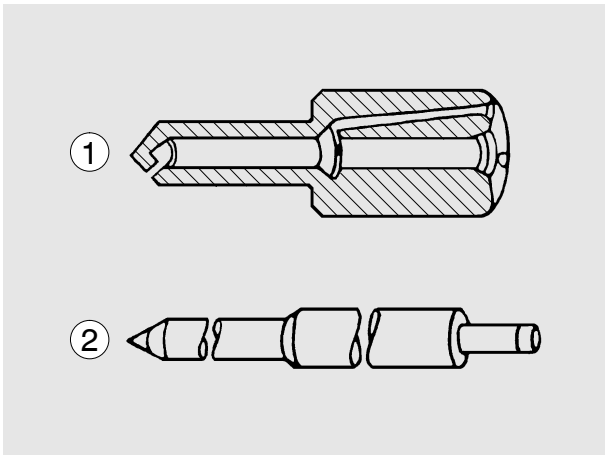
3

Repairing fuel injectors

Fig. 4

Clean interior of injection body ① with a small wooden stick and petrol or Diesel fuel.
Clean nozzle needle ② with a clean cloth.
Clean coked nozzle needle surface on lathe with a piece of wood (not too hard) dipped into oil.

Note:
To prevent corrosion, do not touch lapped faces of nozzle needle with the fingers. The needle and injection nozzle are matched to each other and must not be interchanged.



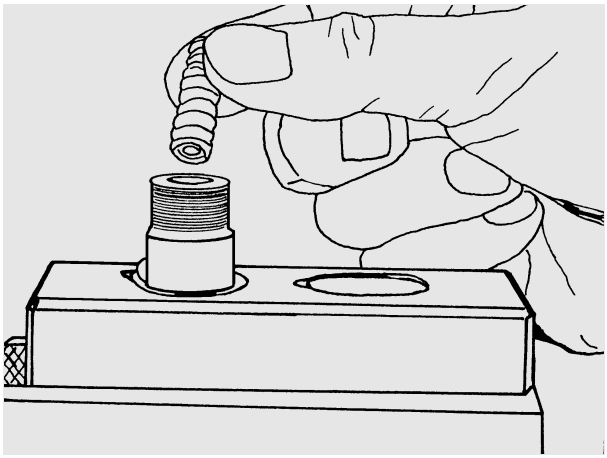
4

Check cleaned parts for wear and damage, replacing them if necessary. De-grease new parts.

Assembling fuel injectors

Fig. 5

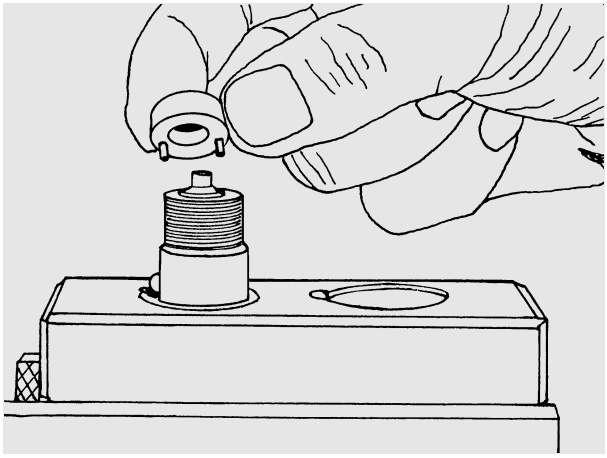
Insert pressure pipe neck into clamping device.
Insert shim and compression spring.



5

Fig. 6

Check intermediate piece for wear.
Insert pressure pin and intermediate washer.



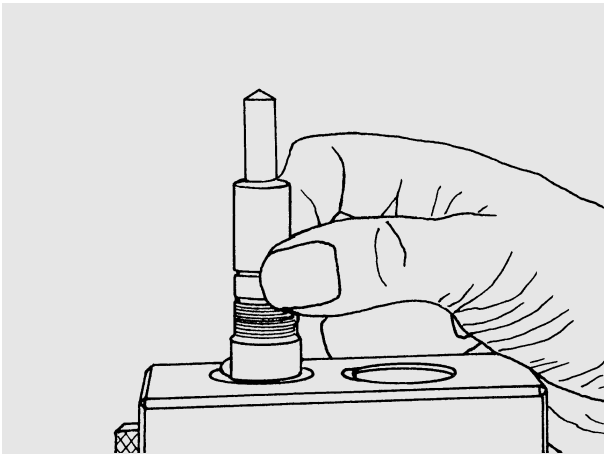
6

Fig. 7

Dip nozzle body and nozzle needle separately into filtered Diesel fuel and check their gliding quality.

When pulled out of the nozzle body by up to a third of its length the nozzle needle must sink back to its seat under its own weight when released.

Place injection nozzle on top, ensuring that the associated pins are correctly fitted.

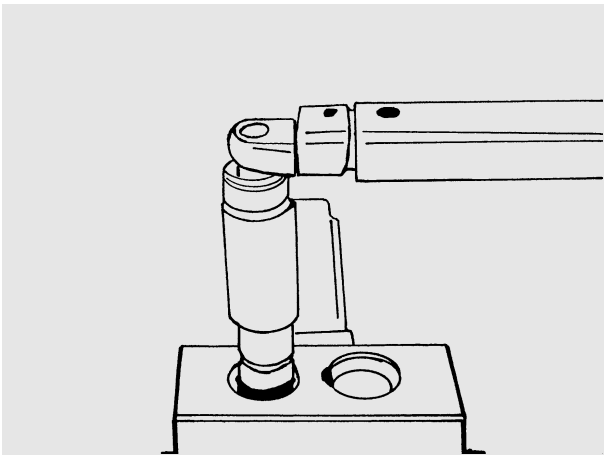


7

Fig. 8

Screw on union nut, tightening it to the specified torque (see “Service Data”).

Check injector on the manual test stand.



8

Ensure that the edge-type filter is correctly seated in the injector body.

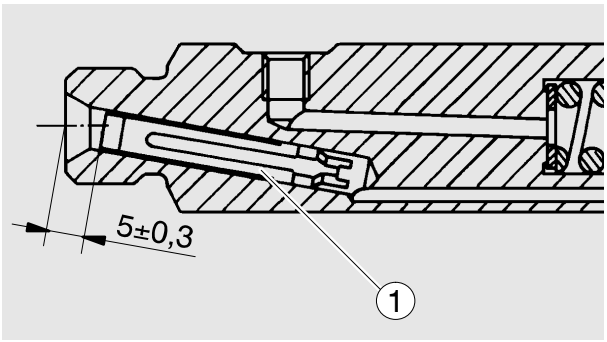
Fig. 9

A dislocated sieve bar filter ① throttles and prolongs the injection and consequently causes poor performance, high consumption and heavy smoke formation in conjunction with heavy engine vibrations.

For this reason measure the rim offset of the sieve bar filter in the nozzle inlet.

The sieve bar filter must not be pressed into the nozzle holder farther than approx 5 mm.

In the event of larger rim offsets, the nozzle holder is to be replaced.



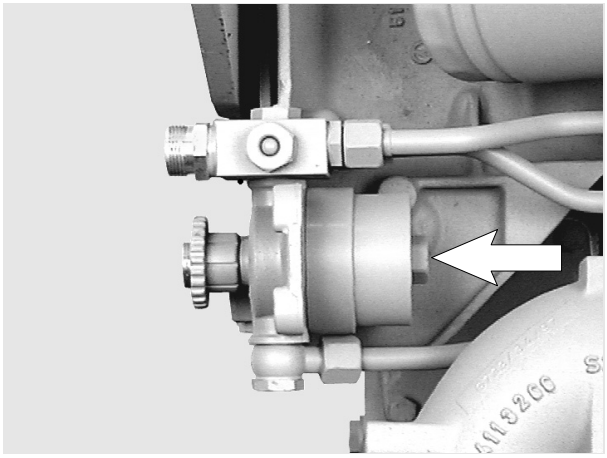
9

Cleaning fuel prefilter

Fig. 1

Disassemble fuel prefilter:

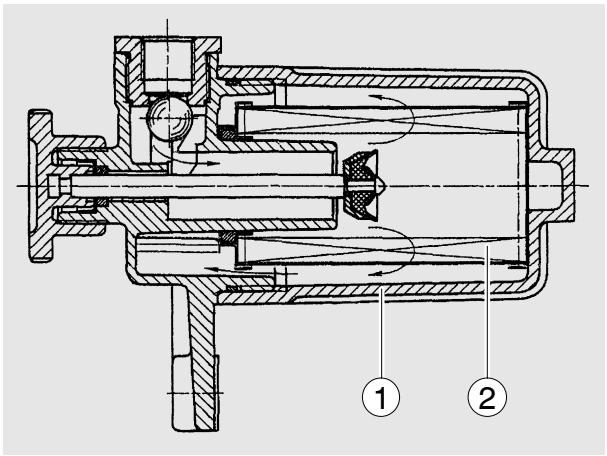
- Remove filter housing (arrow)



1

Fig. 2

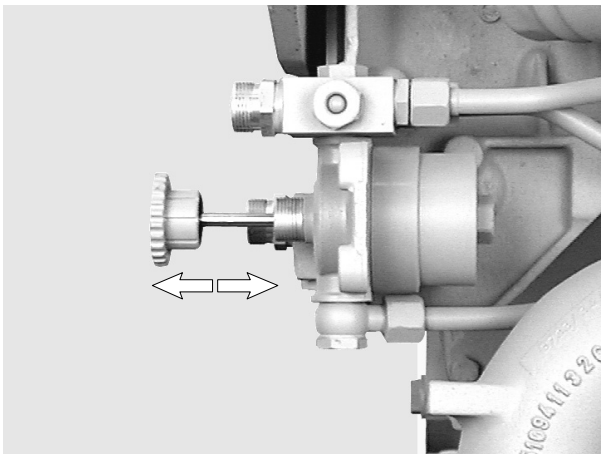
- Wash out filter housing ① and gauze filter ② in clean Diesel fuel and blow them out with compressed air
- Reassemble using new seal
- Screw on filter housing and tighten it to 10–12 Nm



2

Fig. 3

- Actuate plunger of hand priming pump until the overflow valve of the injection pump opens audibly
- Screw in and tighten plunger on hand pump
- Start engine
- Check fuel prefilter for leaks



3

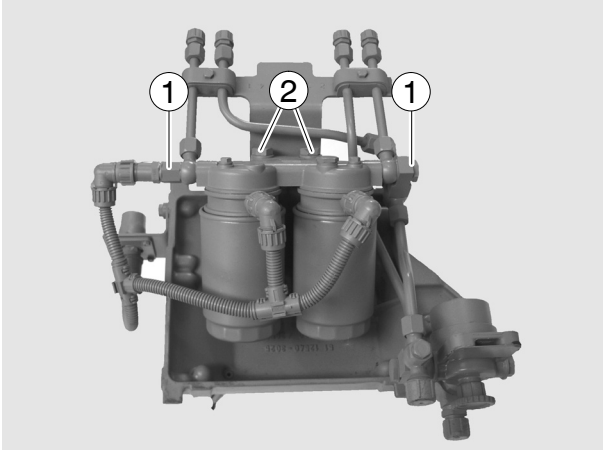
Removing and attaching fuel filter

Fig. 1

Remove the fuel lines ①.

Remove the mounting bolts ② and take off fuel filter.

Attachment is to be carried out in reverse sequence. The fuel lines are to be fitted with new sealing rings.



1

Changing fuel filter cartridge

Parallel fuel filter
Only when engine is switched off

Fig. 2

- Loosen filter cartridge by means of tape wrench, unscrew it by hand and take it off
- Moisten the seals on the new filter cartridge with fuel
- Screw on the filter cartridges and tighten them vigorously by hand
- Bleed fuel system
- Check filter for leaks

2

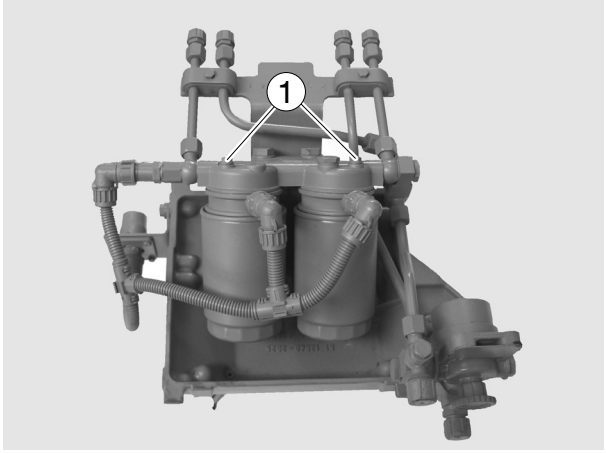
Caution:
Used fuel filters are classed as dangerous waste and must be disposed of accordingly.

Bleeding the fuel system

Note:
To bleed the fuel system switch on the “ignition” so that the EHAB will be open.

Figs. 3 and 4

- Unscrew bleed screw ① of first filter in direction of flow by one or two turns
- Actuate tappet of hand primer until fuel emerges without bubbles
- Screw in and tighten plunger on hand pump
- Close bleed screw again
- Repeat this procedure at the second bleed screw
- Check fuel system for leaks



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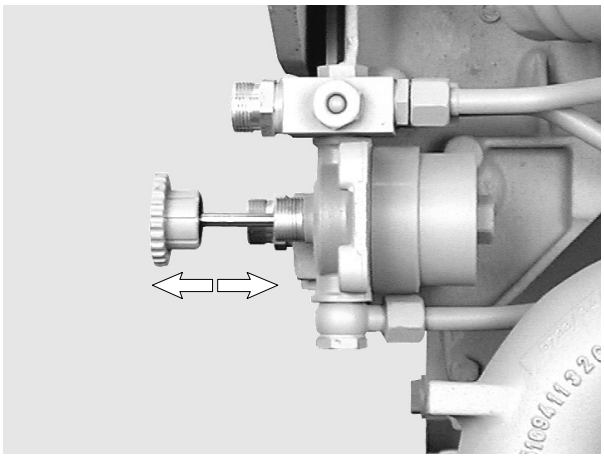

4

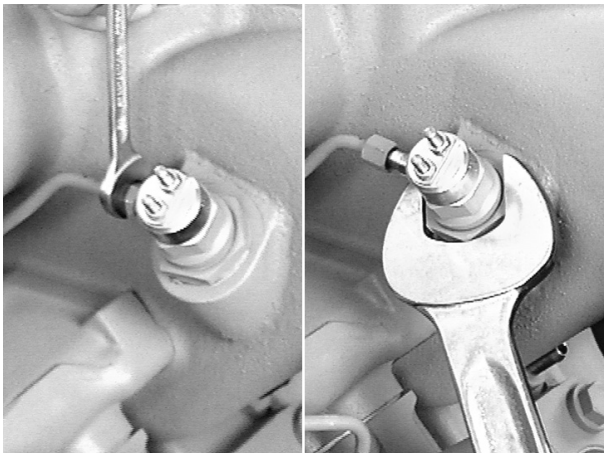
Removing sheathed-element glow plug

Fig. 1

Disconnect the electric connections from the sheathed-element glow plug.

Remove fuel line carefully.

Loosen counter nut on sheathed-element glow plug and remove glow plug.



1

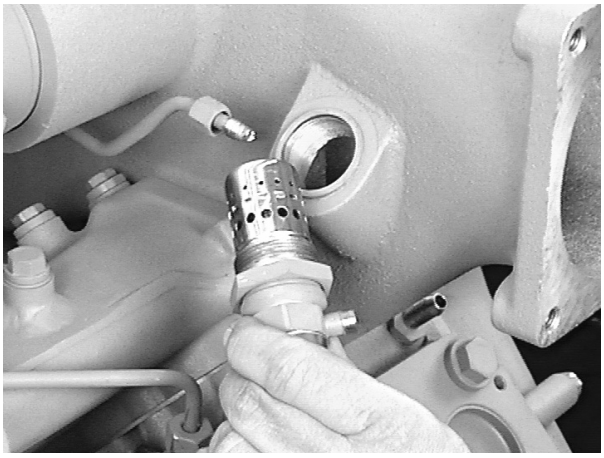
Installing sheathed-element glow plug

Fig. 2

Turn counter nut on sheathed-element glow plug upwards until it stops and apply “Curil T” sealant to threaded portion.

Screw in sheathed-element glow plug with new sealing ring until it stops at the counter nut and align it with fuel line.

Connect up fuel line and electric connection. Tighten counter nut.



2

Checking solenoid valve for leaks

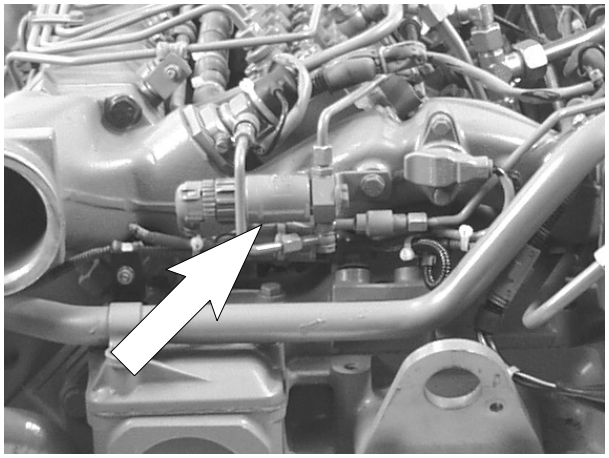
Remove fuel line from flame glow plug.
When the engine is running and hot, no fuel must emerge.

Removing solenoid valve

Fig. 3

- Remove fuel lines
- Remove electric connection from valve
- Remove the two hex bolts and take off valve

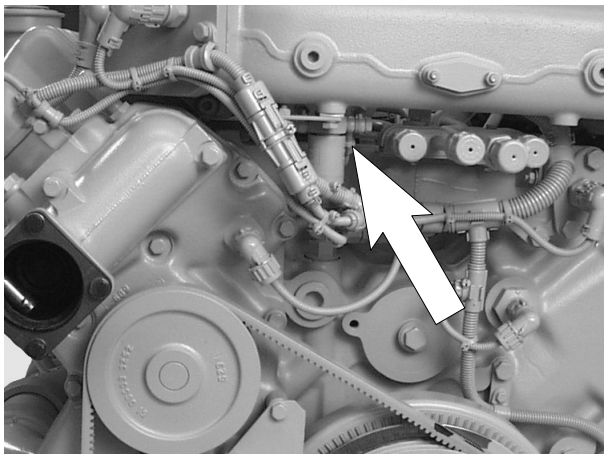
The valve cannot be repaired.
Exchange the defective valves.



3

Fitting solenoid valve

- Screw valve to holder
- Screw on electric connection
- Fit the fuel lines with new sealing rings



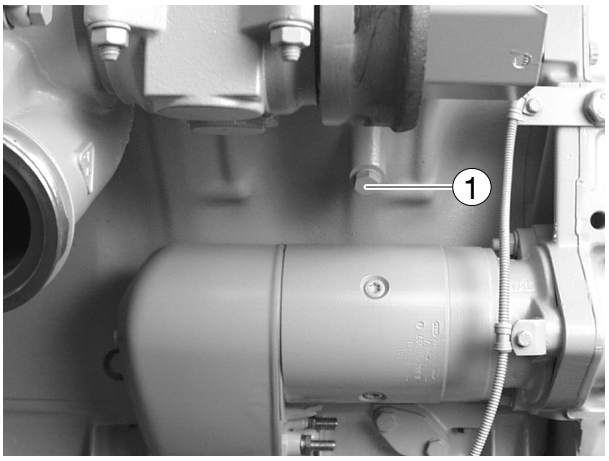
4

Draining coolant

Danger:
Draining hot coolant involves a risk of scalding.

Drain coolant as follows when cooling system has cooled down:

Caution:
Drain coolant into a suitable container and dispose of it in accordance with regulations.



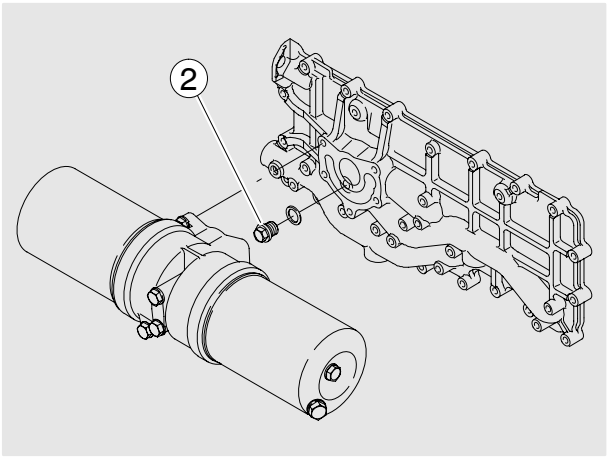
1

Figs. 1 and 2

Briefly open cap on filler neck of expansion tank for pressure compensation.
Observe the vehicle manufacturer's instructions.

Open drain plug in crankcase ① or in the oil cooler housing ②.

Catch emerging coolant in a suitable container.



2

Fill / bleed the cooling system (only when engine has cooled down)

Fill the cooling system of the engine with a mixture of drinkable tap water and anti-freeze agent on the ethylene glycole basis or anti-corrision agent.
See Publication "Fuels, Lubricants and Coolants for MAN Diesel Engines".

Coolant must be poured in according to the vehicle manufacturer's filling specifications.

Do not pour any cold coolant into an engine which is still warm.

Ensure that the ratio of water to anti-freeze is correct.

- Pour in coolant slowly until the correct coolant level is reached (max. 10 ltr./min.)
- Run the engine briefly and then check coolant level once more

Danger:
If, in **exceptional** cases, the coolant level on warm engines has to be checked or the cooling circuit opened, observe the vehicle manufacturer's safety regulations.

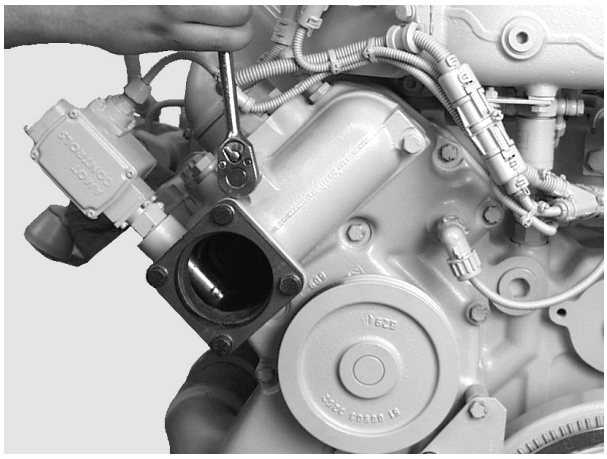
Fig. 1

- Drain coolant, see page 46

Remove the three mounting bolts from the coolant neck and take off coolant neck.

Fig. 2

Take out short-circuit inserts / thermostats.



1

Check the function of the thermostat insert as follows:

- Hang thermostat in a pot filled with water
- Heat water
- Use suitable thermometer to ascertain the opening start and compare it with the set-point value given in “Service Data”
- Measure opening stroke if necessary

Exchange defective thermostats.

2

Insert thermostat inserts (ball valve facing upwards (“TOP”) with new O-ring seal and new seal.

Caution:
Never let engine run without thermostats or short-circuit inserts.

Note:
Exchange or repair coolant pump only if it has been found to be leaky.

For design-related reasons small quantities of coolant may permeate through the mechanical seal on the coolant pump. This permeating coolant leaves a trace below the drain bore on the coolant pump. The coolant pump need not be exchanged or repaired because of this trace of permeating coolant.

For this reason before exchanging or repairing a coolant pump ascertain,

- whether the coolant circuit shows visible and recurrent loss of water; if so,
- whether the loss of water is caused by coolant emerging from the expansion tank (e.g. over-filled) or by other leaks on hoses, etc.

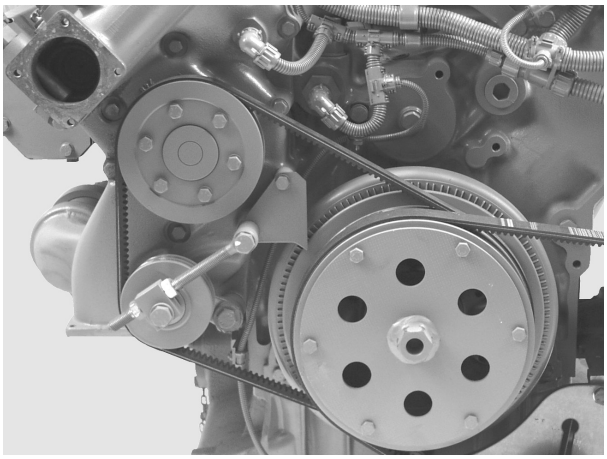
Coolant pumps must be exchanged only if water drips visibly while the engine is in operation or after the engine has been switched off.

Removing coolant pump

- Drain coolant, see page 46
- Remove the thermostats, see page 47

Fig. 1

Take V-belt off water pump, see page 131.

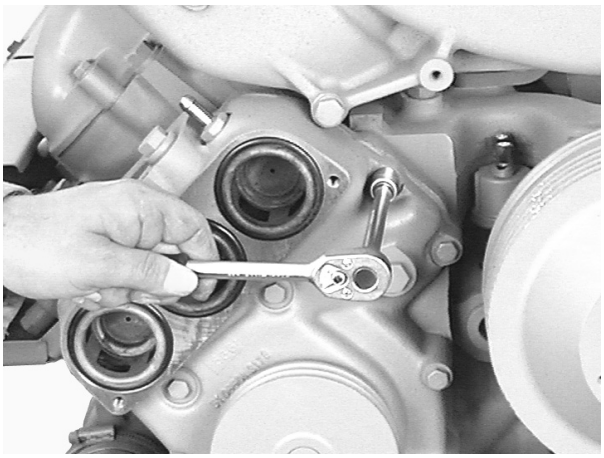


1

Fig. 2

Remove the mounting bolts from coolant pump.

Take off coolant pump and delivery start indicator.



2

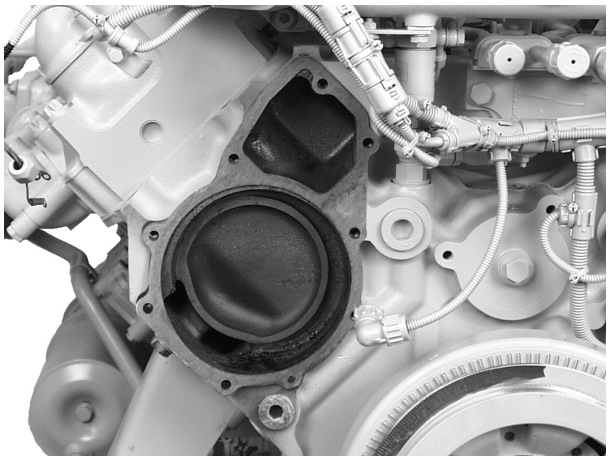
Installing coolant pump

Fig. 3

Clean the sealing faces on coolant pump and engine housing.

Fit coolant pump with new seal.

Fit the mounting bolts.



3

Fig. 4

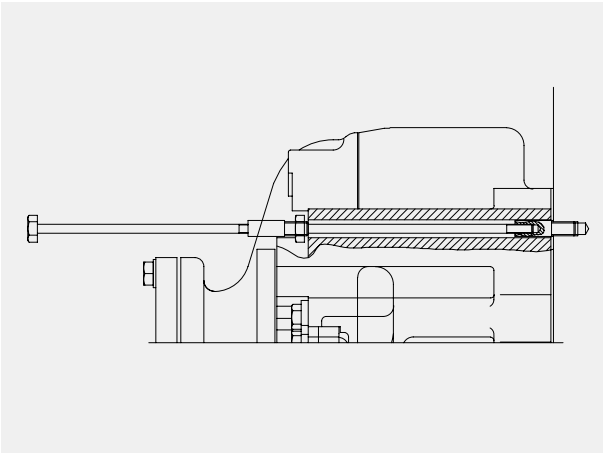
With water pumps with high-temperature and low-temperature sections

To aid in assembly pins (special tool, see page 177, no. 43) can be screwed into the crankcase (arrows, Fig. 3). The water pump can then be fixed to the protruding pins.

Fit mounting bolts.

There is a screw for removing the pins (special tool, see page 177, no. 42).
This screw has a left-handed thread and is screwed into the pin. In this way the two can be screwed out together.

Fit remaining mounting bolts.



4

Fig. 5

Turn engine to ignition TDC, see page 29.

Set delivery start indicator so that its measuring edge points exactly to the TDC point on the graduated scale.

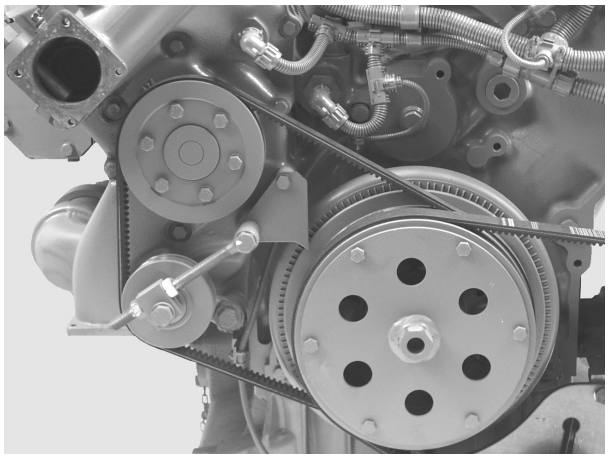
Tighten the mounting bolts to the specified torque.

Screw coolant hose pipe on to oil cooler.

Install short-circuit inserts / thermostats, see page 47.

Fit and tighten V-belts, see page 131.

Filling up with coolant, see page 46



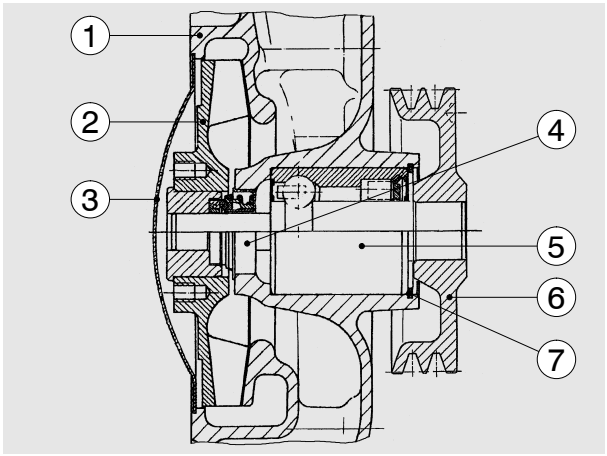
5

Coolant pump for three thermostats

Fig. 1

1 Pump housing
2 Impeller
3 Cap
4 Axial face seal
5 coolant pump bearing
6 V-belt pulley / hub
7 Circlip

Removing coolant pump, see page 48.



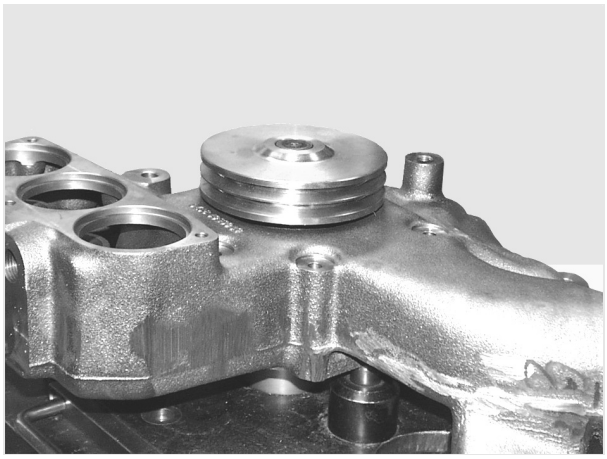
1

Disassembling coolant pump

Fig. 2

Clamp coolant pump in vice (using soft jaws).

Pull off V-belt pulley with three-arm puller.



2

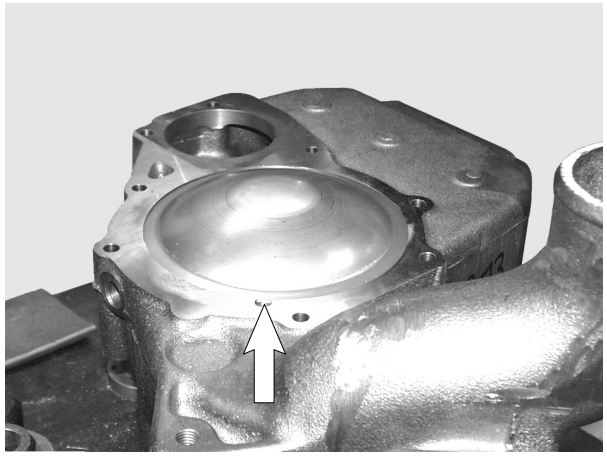
Fig. 3

Unclip the circlip from the water-pump housing.

3

Fig. 4

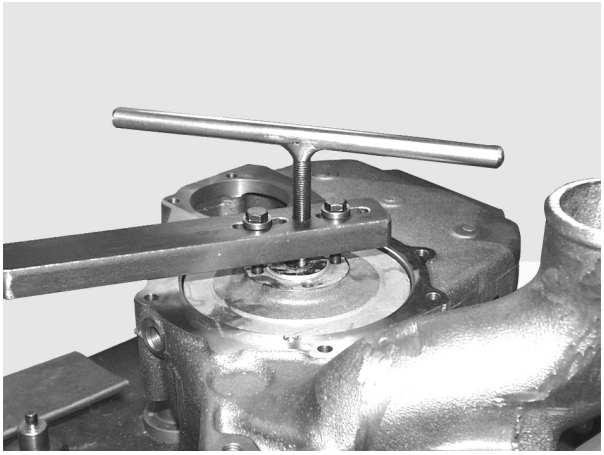
Knock out cover by driving a suitable mandrel under it (Fig. 1, item 3) at notch (arrow).



4

Fig. 5

Pull impeller off the pump bearing.
For this purpose four threaded bores M8 are provided.



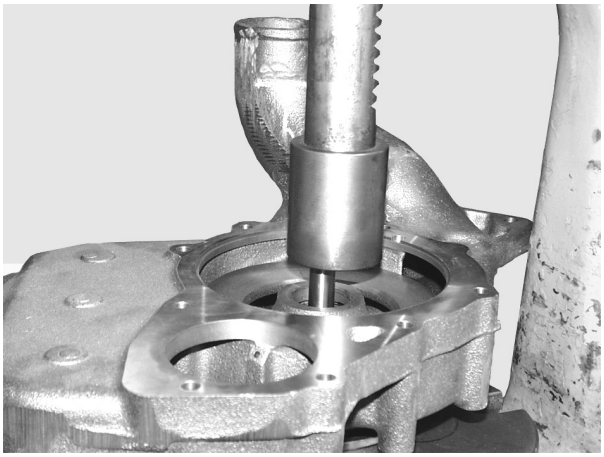
5

Fig. 6

Align coolant pump housing on a suitable and stable surface.

Use a suitable mandrel to press the coolant pump shaft together with bearing out of the housing. Shaft and bearing are encapsulated and exchanged together only.

Take off axial face seal.



6

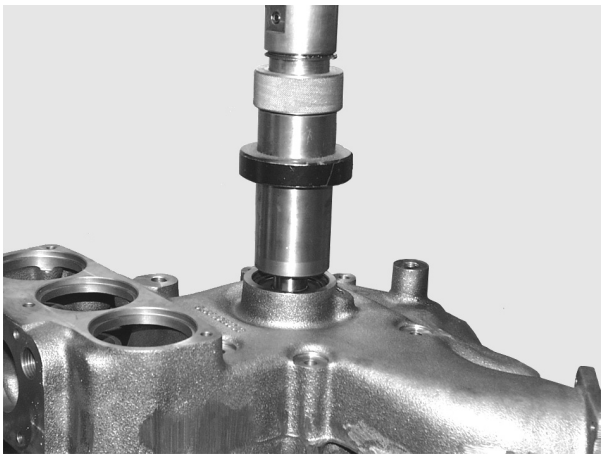
Assembling coolant pump

Fig. 7

Press in coolant pump bearing.

Use a hollow mandrel to apply pressure to the bearing outer ring but not to the bearing shaft.

Refit circlip.



7

Fig. 8

Press V-belt pulley flush on to bearing shaft.

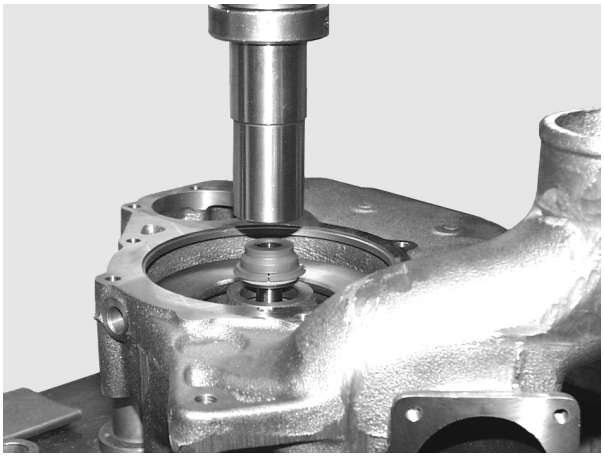
8

Fig. 9

Turn coolant pump housing over.
Press in new mechanical seal with press-fitting sleeve (special tool) until it stops.

Observe installation note for seal on page 60.

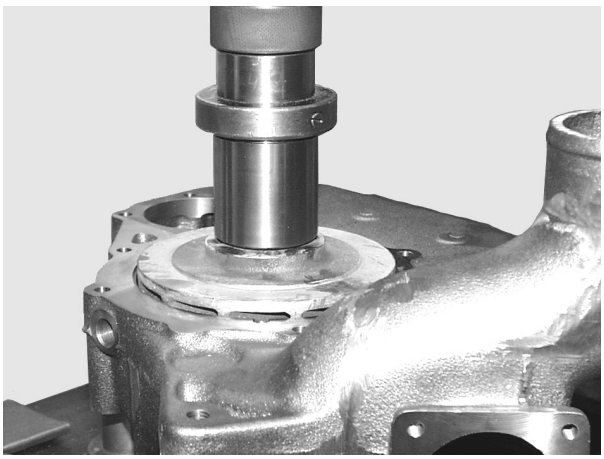
Note:
The seal can be exchanged even without removing the coolant pump shaft.



9

Fig. 10

Slowly press impeller on to bearing shaft to ensure correct gap.

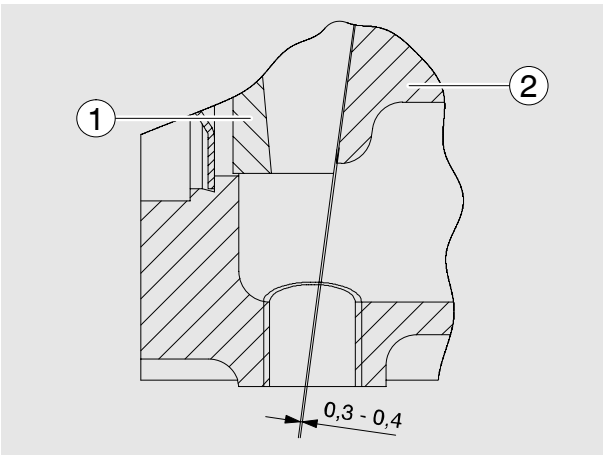


10

Fig. 11

For this purpose an inspection hole closed up with a screw plug (M16x1.5) is provided on the bottom of the water pump housing.

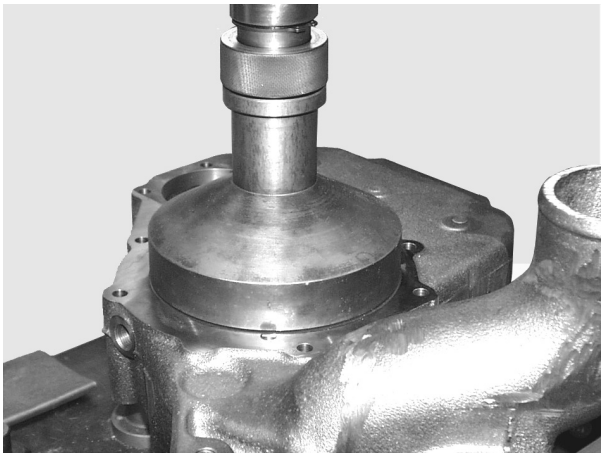
1 Impeller
2 Coolant pump housing



11

Fig. 12

Fit new pump cover and press it into housing, using a suitable pressing tool.



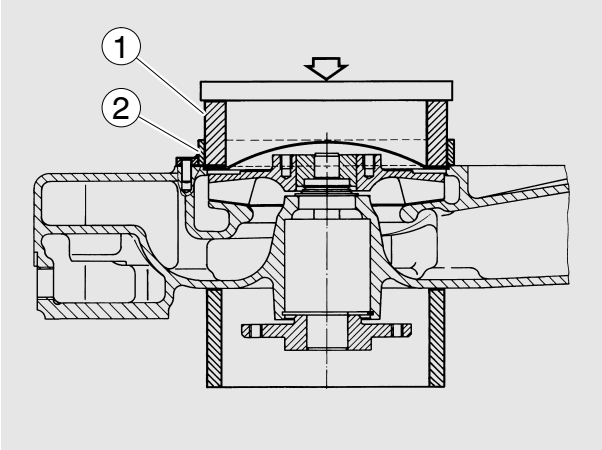
12

Fig. 13

If no suitable pressing tool is available, you may use self-made special tools (see chapter “Special tools”) and proceed as follows:

- Align guide ring ② with the two dowel pins on the pump housing
- Insert pressing ring ① into guide ring
- Place a flat steel (min. thickness: 10 mm) on the pressing ring
- Press cover into housing using a press

Attach water pump with new seal, see page 48.

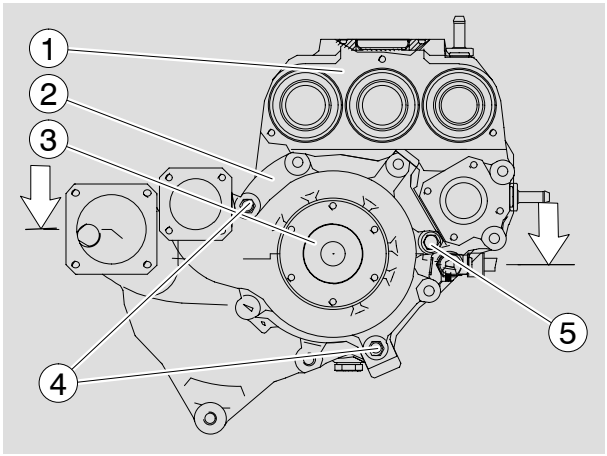


13

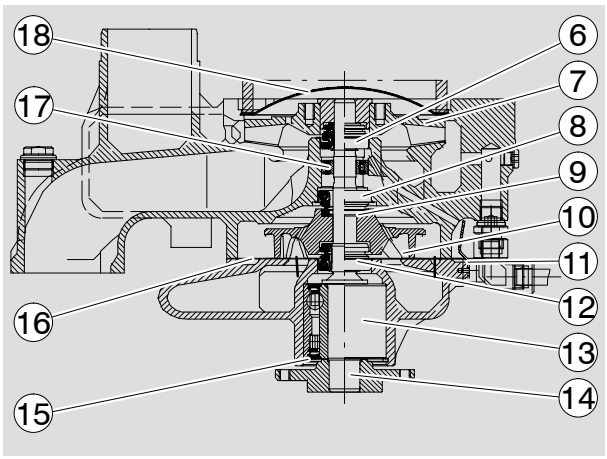
Coolant pump for three thermostats

Fig. 1 and 2

1 Pump housing HT (high-temperature part)
2 Pump housing LT (low-temperature suction part)
3 Hub
4 Bolt DIN 931–M8x155, hex nut DIN 934–M8
5 Bolt DIN 933–M8x35–8.8
6 Mechanical seal 51.06520–0085
7 Impeller for coolant pump, HT circuit
8 Mechanical seal 51.06520–0099
9 Counterring complete 51.06520–0100
10 Impeller for coolant pump, LT circuit
11 Splash shield
12 Mechanical seal 51.06520–0096
13 Coolant pump bearing
14 Drive shaft for coolant pump
15 Circlip
16 Coolant pump seal
17 Grooved ball bearing 6003
18 Cap



1



2

Disassembling water pump

Fig. 3

Removing the water pump, see page 48.

Clamp water pump in a vice, use protective jaws.

Pull off boss with three-arm puller.

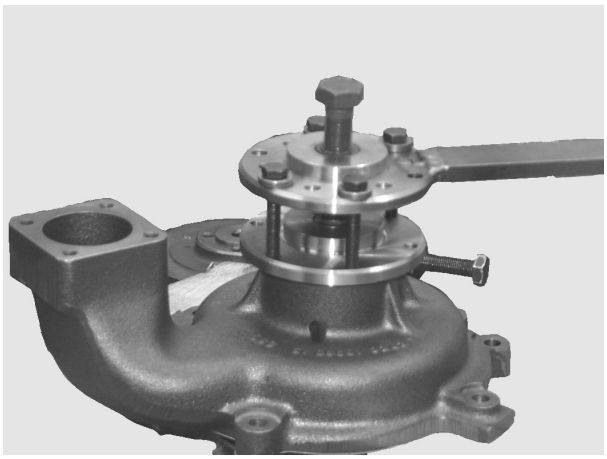

3

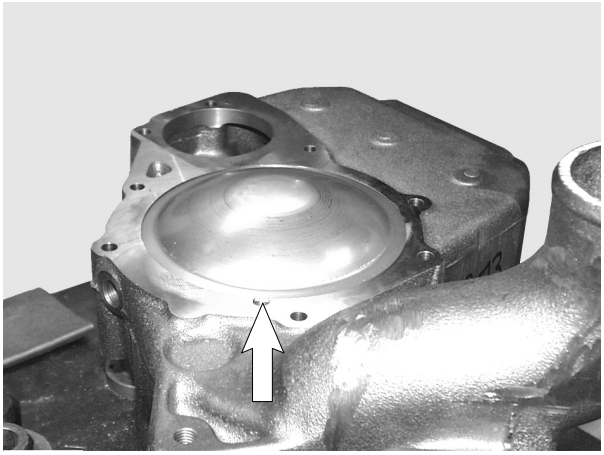
Fig. 4

Unclip the circlip from the coolant pump housing.


4

Fig. 5

Knock a suitable mandrel under the cover (Fig. 2, no. 18) at the notch (arrow) and knock out the cover (destroying it).

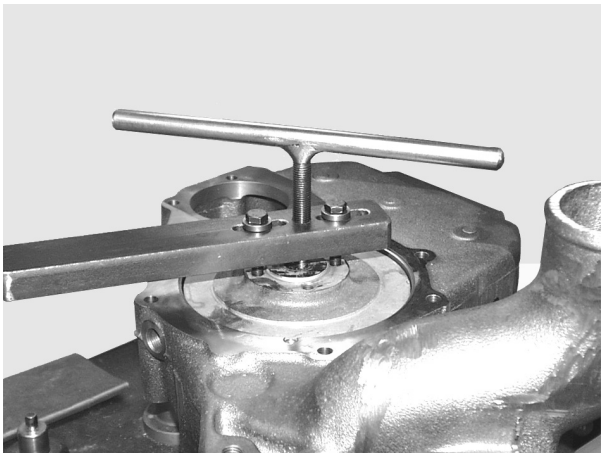


5

Fig. 6

Pull impeller off coolant pump shaft.

For this purpose four threaded bores M8 are provided.



6

Fig. 7

Note:
Remove bolt from low-temperature part (Fig. 1, item 5).

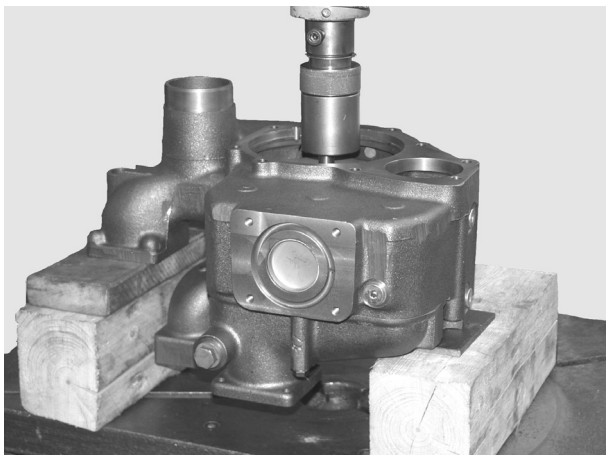
Align water pump housing on a suitable and stable surface.

Use a suitable mandrel to press the water pump shaft together with bearing out of the housing.

Take off mechanical seal.

The high-temperature part and the low–temperature suction part are now separated.

Remove axial face seals and grooved ball bearing from high–temperature part if they are still in the housing.



7

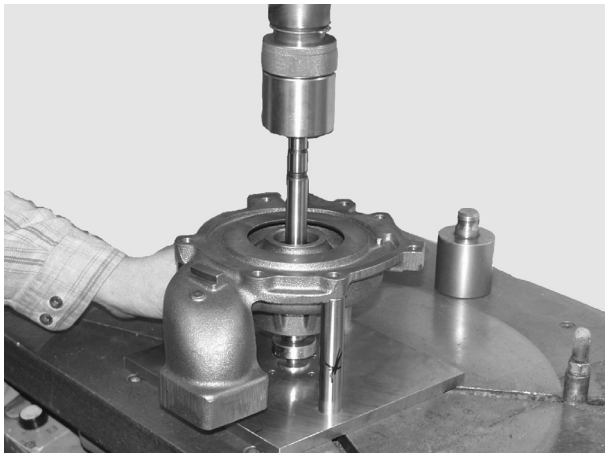
Reassembling coolant pump

Fig. 8

Press in water pump bearing.

Fit the circlip.

Note:
If you change the seals always install a new shaft and axial face seals.

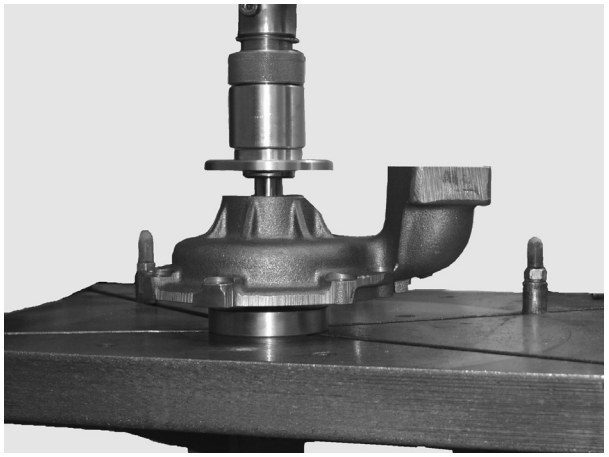


8

Fig. 9

Press boss flush on to bearing shaft.

Use suitable plates (80.99614−0027 and 80.99606−0628) to brace the bearing shaft.

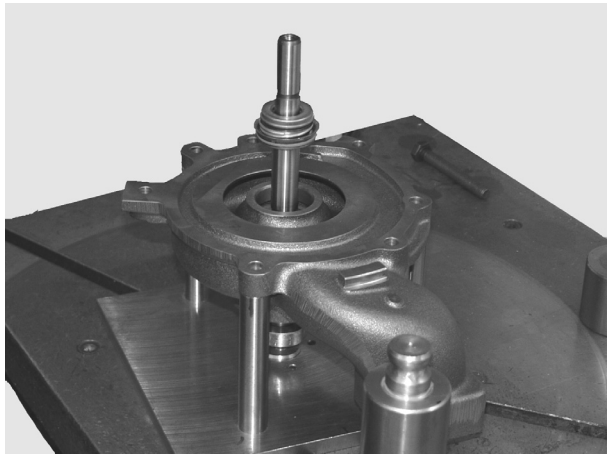


9

Fig. 10

Turn coolant pump over (for this support bearing shaft with 80.99606−0629) and press in new axial−face seal (Fig. 1, no. 12) using mandrel (80.99606−0252) until mandrel is in contact.

Observe installation note for seal on page 60.

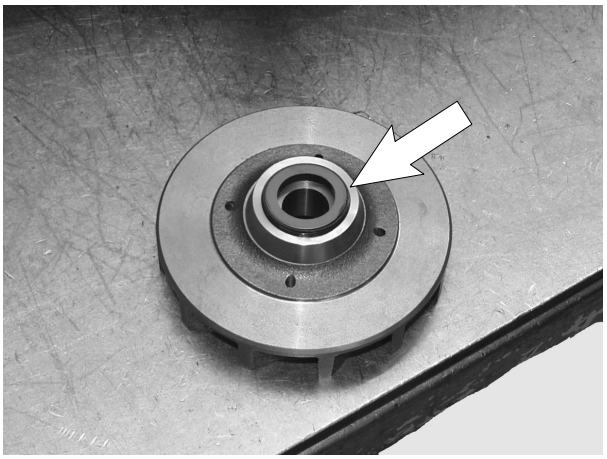


10

Fig. 11

Press in counterring (arrow) with a suitable pressing tool (may be possible by hand).

Install mechanical seal while “wet”, i.e. to install it, coat holding sleeve and water pump shaft with a mixture of either 50% water and 50% cleaning spirit or 40% to 50% antifreeze agent as per MAN 324 and water.

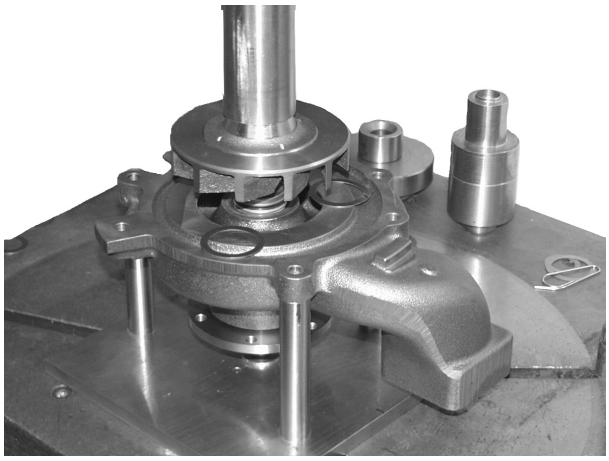


11

Fig. 12

Note:
Brace the bearing shaft.

Press impeller slowly on to bearing shaft (mandrel 80.99604−0252) to ensure that the correct gap ($0{,}5^{+0{,}4}$) is achieved.

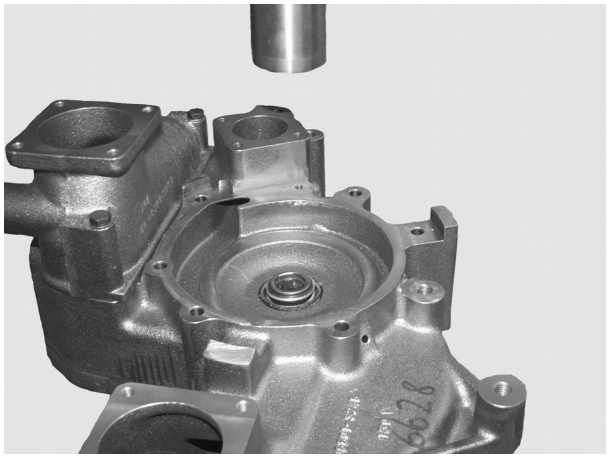


12

Fig. 13

Press axial−face seal (no. 8) into pump housing (no. 1) using pressing tool (80.99606−0252).

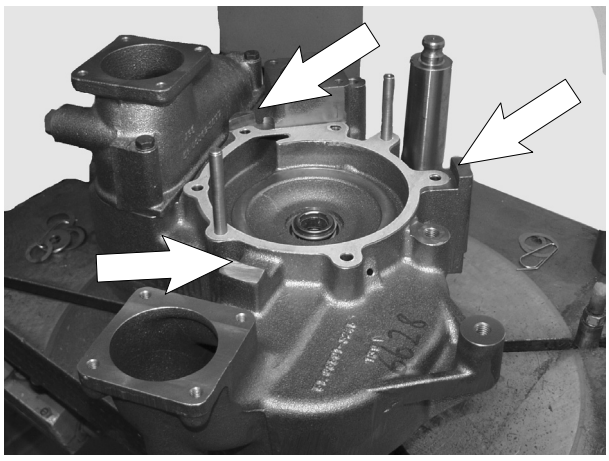
Observe installation note for seal on page 60.



13

Fig. 14

Lay coolant pump gasket on pump housing.



14

Fig. 15

Carefully fit low-temperature suction part to high-temperature pump housing.

To make assembly easier insert 2 pins in opposite sides of HT part (see Fig. 14)

Do not use force (hammer etc.) and note the 3 centring features (see arrows in Fig. 14).

Screw in bolt (Fig. 1, item 5).

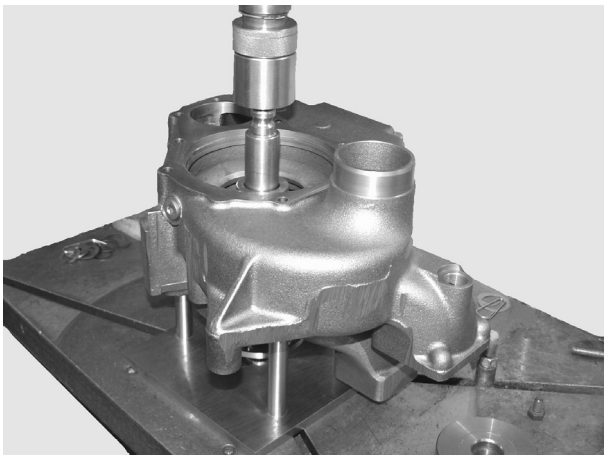
Bolt LT and HT parts together with 2 bolts and nuts on opposite sides (Fig. 1, item 4).

15

Fig. 16

Note:
For subsequent steps brace the bearing shaft.

Press grooved ball bearing 6003 into position using special die (80.99604−0254).

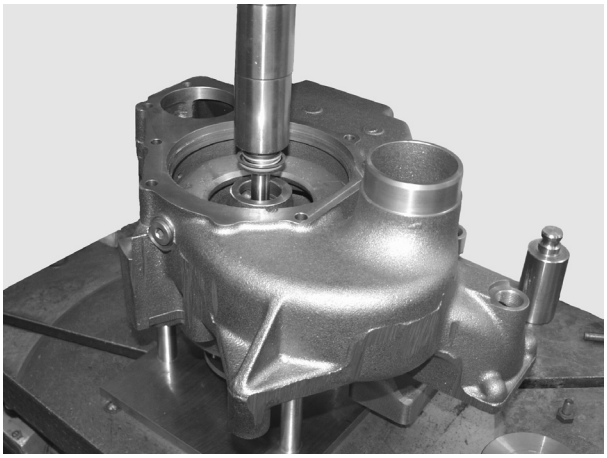


16

Fig. 17

Press axial-face seal (no. 6) into pump housing (no. 1) using pressing tool (80.99617−0191).

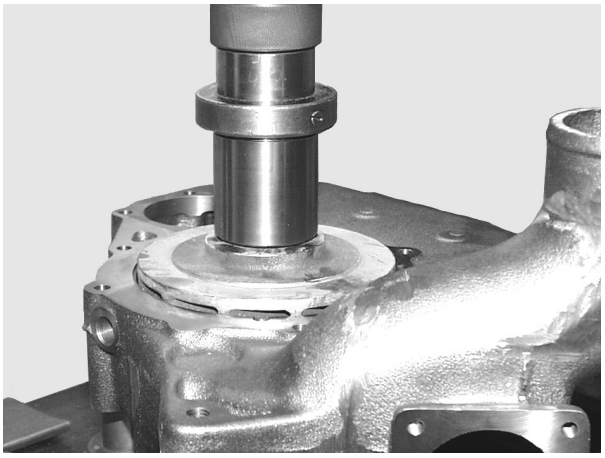
Observe installation note for seal on page 60.



17

Fig. 18

Slowly press impeller on to bearing shaft to ensure correct gap.

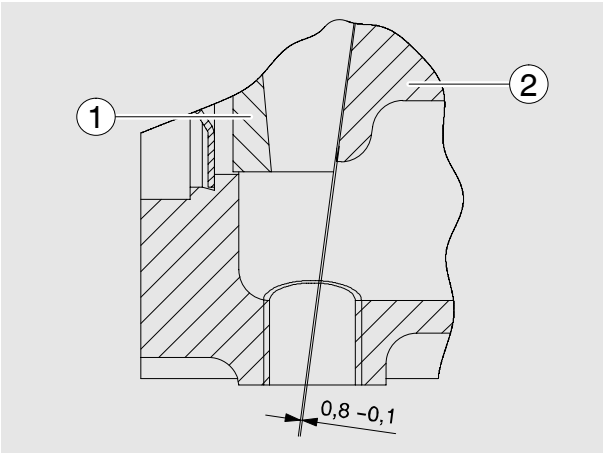


18

Fig. 19

For this purpose an inspection hole closed up with a screw plug (M16x1.5) is provided on the bottom of the water pump housing.

1 Impeller
2 Water pump housing

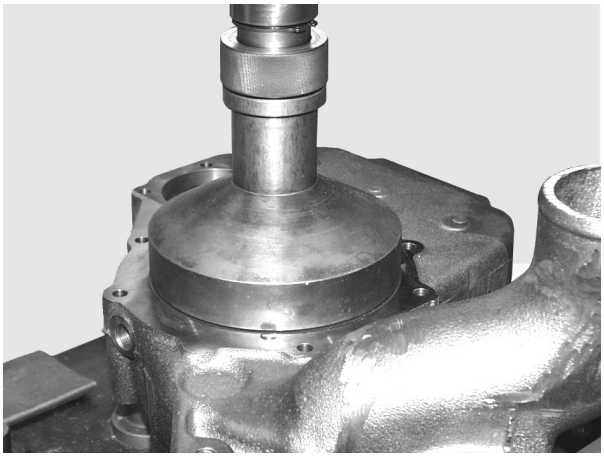


19

Fig. 20

Fit new pump cover and press it into housing, using a suitable pressing tool.

Attach water pump with new seal, see page 48.


20

Replacing coolant pump during repair work only in event of identified leakage

The design of the coolant pump mechanical cassette seal permits small amounts of coolant to pass through it.
This coolant passing through results in a trace of drained coolant below the drain bore.
This trace of drained coolant does not mean that the coolant pump has to be replaced.

For this reason, before replacing or repairing a coolant pump, ascertain

- whether the cooling circuit shows visible and recurring signs of coolant loss; if yes
- whether the coolant loss is caused by spillage from the expansion tank (e.g. too full) or by other leakages from hoses, radiator etc.

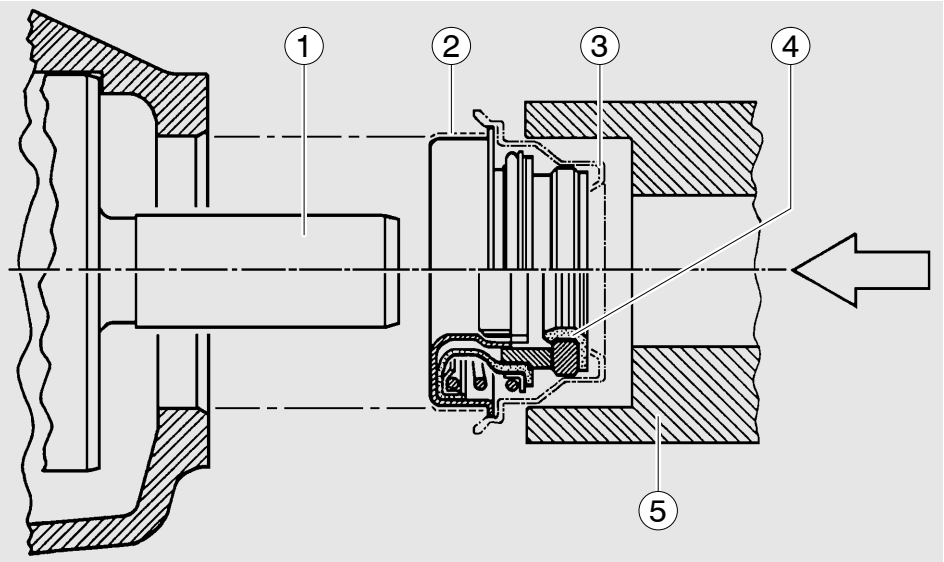
Coolant pumps may only then be replaced if dripping water can clearly be seen while the engine is running or after it has been turned off.

Installation note for mechanical seal:

Install mechanical seal while “wet”, i.e. to install it, coat holding sleeve and water pump shaft with a mixture of either 50% water and 50% cleaning spirit or 40% to 50% antifreeze agent as per MAN 324 and water.

Other antiseize agents must not be used.

Because the seal on collar ② is coated with sealing paint, no sealing paint needs to be applied if the locating bore in the coolant pump housing is in perfect condition.
If the bore shows even the slightest scoring or other minor damage, a sealing bead of Dirko-Transparent, Part No. , must be applied to collar ②.
Fit the seal with a plastic transportation cap onto shaft ① and use installation tool to press it in until the tool contacts the housing. Remove the plastic cap.



Note:
Tests have shown that most cases of damage to the coolant pump can be attributed to the use of unsuitable coolants.
Only the anticorrosion and antifreeze agents expressly approved by MAN Nutzfahrzeuge AG as per MAN norm 324 (see brochure “Fuels, Lubricants, Coolants for and MAN Diesel Engines”) guarantee faultless operation

Cleaning the outside of the radiator

Extreme dirt deposits can clog the honeycombs so that the remaining surface no longer ensures sufficient cooling. In such cases, the insects, dust etc. should be removed from the honeycomb system of the radiator block and the radiator itself then cleaned with the cleansing agent HENKEL P3-begesol. This cleansing agent is available from MAN in 10-kg cans under Part No. 09.21002-0164.

Procedure:

- Mix P3-begesol with water, ratio 1:1
- Using a spray gun, spray the mixture in as straight a jet as possible directly into the radiator fins
- Let the mixture work for 5 minutes
- Hose down the radiator with a straight jet of tap water directly from the front. In cases of stubborn dirt deposits remove the radiator and hose it down directly from behind. Do not use high-pressure cleaners (steam sprayers may be used)

Henkel P3-begesol contains no toxic or corrosive substances and, if handled properly, may be used without hesitation.

Cleaning the inside of the cooling system

Investigations have shown that in many cases the poor condition of the coolant and / or the cooling system accounts for damage to the water pump mechanical seal. The poor condition of the cooling system is normally due to use of unsuitable or no anti-freezing agents and corrosion inhibitor or defect, not early enough replaced covers for filler neck and working valves.

If twice in a short time the water pump of an engine develops leakes or the coolant is heavily contaminated (dull, brown, mechanically contaminated, grey or black signs of a leakage on the water pump casing, after the defect on the oil cooler) clean the cooling system **prior to** removing that water pump as follows:

a) Drain coolant
b) Open thermostats positively (use short-circuit inserts), so that the entire coolant circuit is flushed in the cleaning operation
c) Fill coolant circuit with a mixture of hot water (min. 50°C) and Henkel P 3 neutrasel 5265 detergent (1.5% by volume) (-5266, -5225, Kluthe Hakopur 316), refer to Publication ”Fuels, Lubricants ...”
d) Warm up engine under load. After a temperature of 60°C is reached, run engine for a further 15 minutes
e) Drain cleaning fluid
f) Repeat steps c) and d)
g) Flush cooling system. To this effect
h) Replace drain plug by drain plug with a bore of 8 mm dia
i) Fill cooling system with hot water
k) Run engine at idle for 30 minutes. At the same time continuously replenish the water leaking from the bore in drain plug by adding fresh water

Repair water pump only now. Thereafter, fill the cooling system with approved cooling fluid. See Publication “Fuels, Lubricants ...”.

Note:
Only sediments and suspended particles can be removed by this cleaning method. If corrosion and lime deposits are found, proceed according to the following section:

Removal of lime deposits in the cooling system

Procedure:

- Drain the coolant
- Fill the system with undiluted original pickling fluid (Lithsolventsäure or engine pickling fluid RB-06), see sources of supply
- Let the engine run (also in normal operation) for approx. 8 hours with this filling in the cooling circuit
- Drain the pickling fluid and thoroughly flush the system with tap water
- If necessary, refill the circuit again with fresh pickling fluid and pickle the engine for another 8 hours
- Drain the pickling fluid, fill the system with tap water, and run the engine at idle for 5 minutes to flush out all fluid; then drain the water
- Fill the system with a 1% soda solution. Drain the soda solution after running the engine at idle for 5 minutes, and flush with tap water until the discharging water is clear
- Fill cooling circuit with a mixture of potable tap water and anti-freeze with at least 40% by volume, refer to Publication “Fuels, Lubricants ...”

Note:
Older radiators may develop leaks when such deposits are removed. The surge tank should be filled only up to the bottom edge as otherwise foaming will cause the pickling fluid to spill over. Damaged tube bundles may develop leaks when dirt deposits are removed.

Filler caps and working valves of cooling system

The rubber gaskets of the filler caps and working valves (negative pressure and positive pressure valves) of the cooling system are subject to natural aging.
To preclude leakages in the cooling system and tailing pressure drop and its consequences up to severe engine damage, renew the filler caps and working valves in line with the change of coolant (every two years at the latest) see also “Filling-in of coolant” in this chapter.

Waste water treatment

Drained and spent cleaning and pickling fluid should be brought up to a pH value of 7.5 to 8.5 with the aid of caustic soda. Once the precipitation has settled to the bottom of the container the clear fluid above can be dumped into the sewer. The sludge at the bottom should be taken to a special waste dump. Anyway, it is recommended to consult the local authorities for more information about waste water rules or restrictions.

Sources of supply for pickling fluids

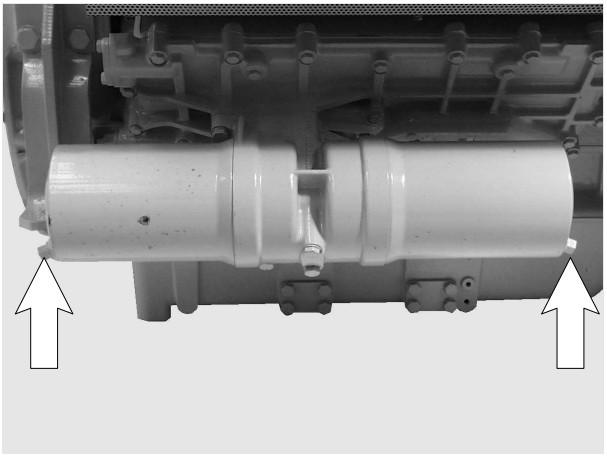
Lithsolventsäure
Keller & Bohacek
Liliencronstr. 54
D–40472 Düsseldorf
Phone: (02 11) 96 53 0

Motor pickling fluid RB–06
Reincolor-Chemie GmbH
Werkstr. 21
D–90518 Altdorf
Phone: (0 91 87) 97 03 0

Caution:
Used oil and oil filters are classed as dangerous waste and must de disposed of accordingly. Note instructions for preventing environmental damage.

Fig. 1

Open oil drain plug on oil filter can and use container to catch oil that may emerge.



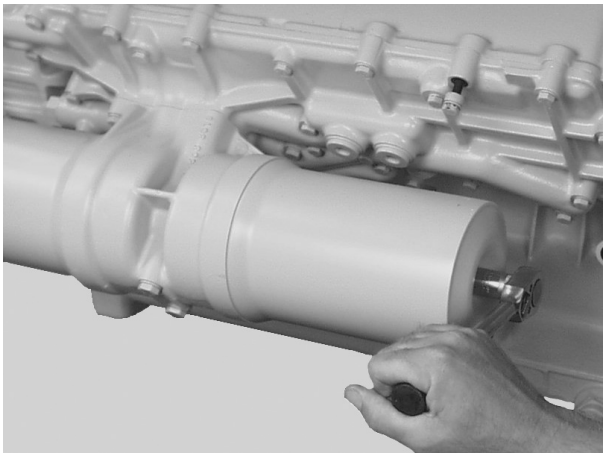
1

Danger:
Oil filter can and oil filter are filled with hot oil.
Risk of burns and scalding.

Fig. 2

Remove mounting bolt of filter bowl.

Take off filter bowl and clean it internally.



2

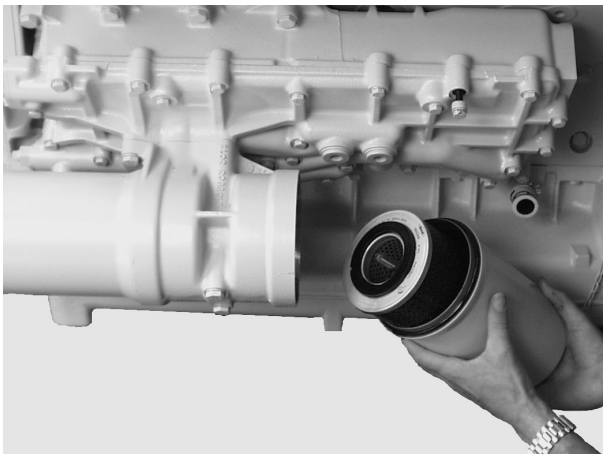
Fig. 3

Insert new filter element and fit filter bowl with new seals.

Refit oil drain plug with new seal.

Observe tightening torque for mounting bolt.

Note:
To prevent the seal from twisting hold the filter bowl firmly when tightening the tensioning screw.



3

Top up with engine oil, let engine run briefly and then check for leaks.

Check oil level.

- Drain coolant, see page 46
- Remove oil filter, see page 63

Caution:
Used oil and oil filter cartridges are dangerous waste.
Observe safety regulations to prevent damage to the environment.

Fig. 1

Remove oil filter head (5 bolts).

Take off filter head gasket.

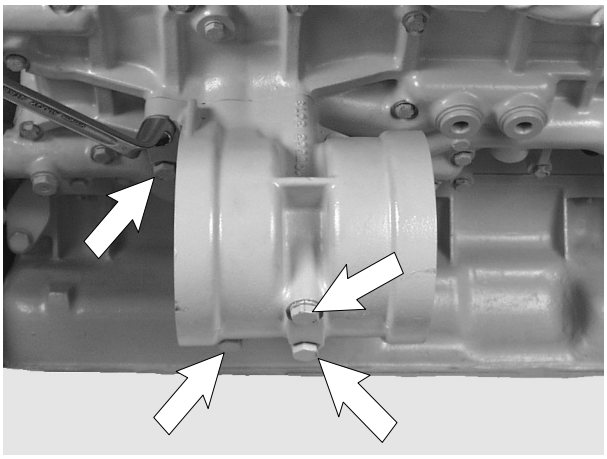

1

Fig. 2

Remove oil cooler housing cover with the oil cooler attached.

The oil cooler is secured by the 10 bolts marked. Loosen these screws only after removal of the housing cover.

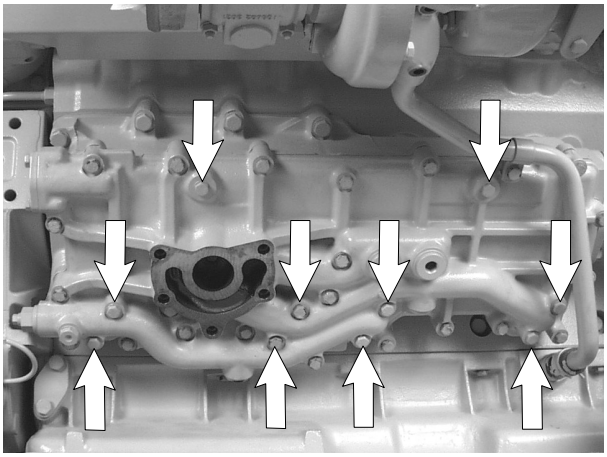

2

Fig. 3

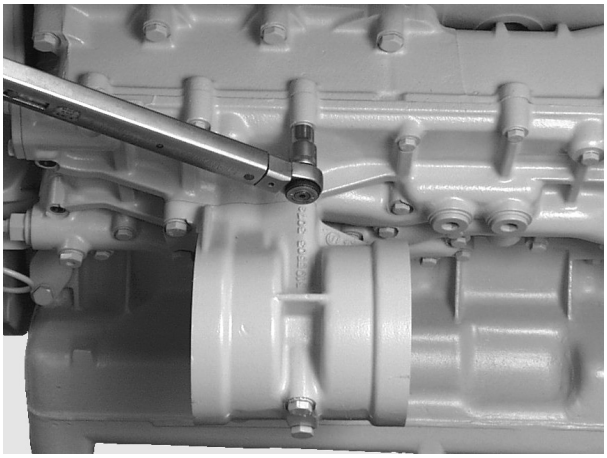
Check both oil cooler for damage and if necessary replace them. Fit oil cooler with new gaskets.


3

Fig. 4

Tighten the mounting bolts to the specified torque.

- Screw on oil cooler housing cover together with attached oil cooler
- Attach oil filter head and oil filter with new seals, see also page 63
- Top up with engine oil, let engine run briefly and then check for leaks
- Check oil level
- Filling up with coolant, see page 46


4

Drain engine oil

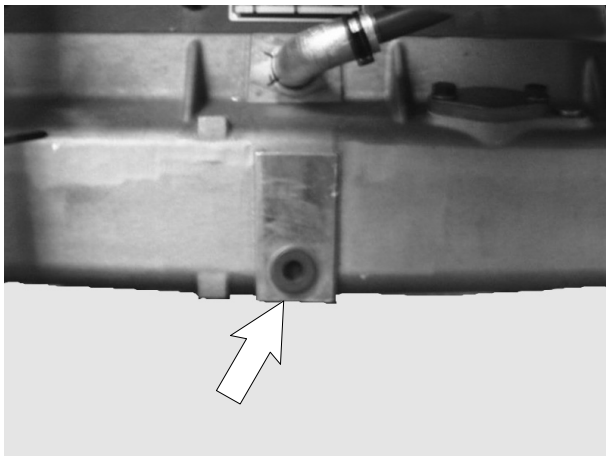
Danger:
The oil is hot – risk of scalding. Do not touch the oil drain plug with bare fingers. Oil is an environmental hazard. Handle it with care!

Figs. 1 and 2

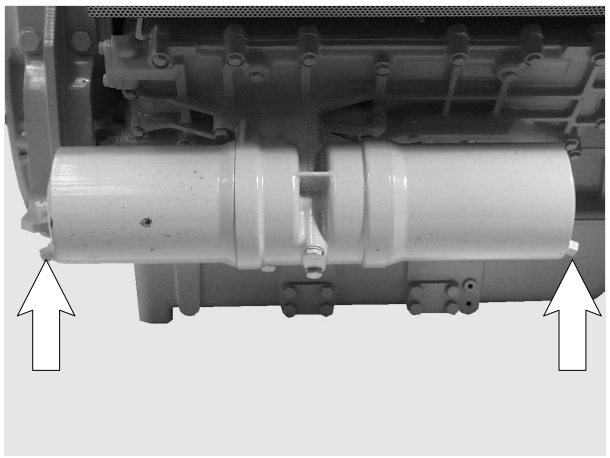
With the engine at operating temperature, remove the oil drain plugs on the oil sump and the oil filter bowl and allow the old oil to drain off completely.

Use a vessel of sufficient size to ensure that the oil does not overflow.

Caution:
Used oil is dangerous waste.
Observe safety regulations to prevent damage to the environment.



1



2

Remove oil pan

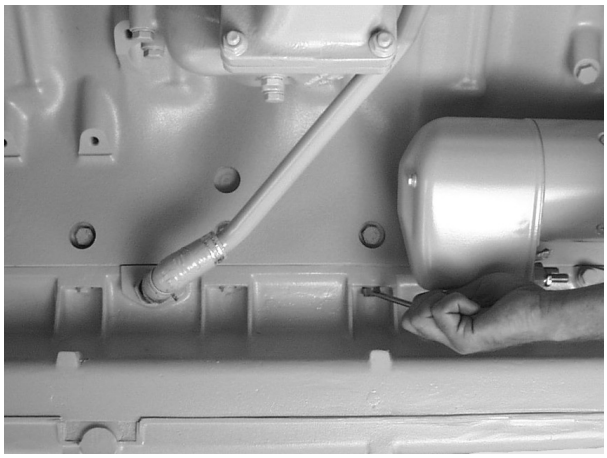
Caution:
Oil pans are awkward to handle and heavy.
They may contain residual amounts of engine oil.
Use lifting gear or work with a helper.

Fig. 3

Remove the mounting bolts from oil pan.

Take off oil pan.

Note:
There are several possible oil pans.
The picture shows a deep oil pan.



3

Removing oil pump

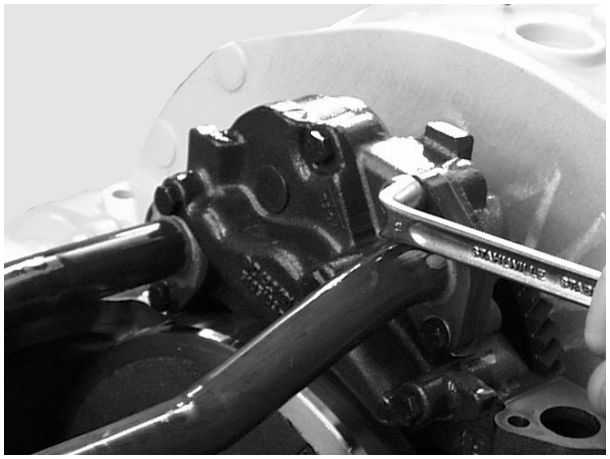
Fig. 4

Remove the mounting bolts from the bracket and from the oil pump.

Take off oil suction pipe.

Measure backlash between oil pump drive gear and crankshaft gear and compare value with the nominal value.

Replace worn gears.



4

Fig. 5

Remove the mounting bolts from the overpressure valve and from the oil pump.
Take off overpressure valve and oil pump.

The overpressure valve is encapsulated.

Opening pressures see “Service Data”.

Note:
Depending on the engine model and oil pan variant, various oil pump versions are possible.


5

Repairing oil pump

Fig. 6

Clamp oil pump in a vice (fitted with soft jaws).

Remove oil pump cover.

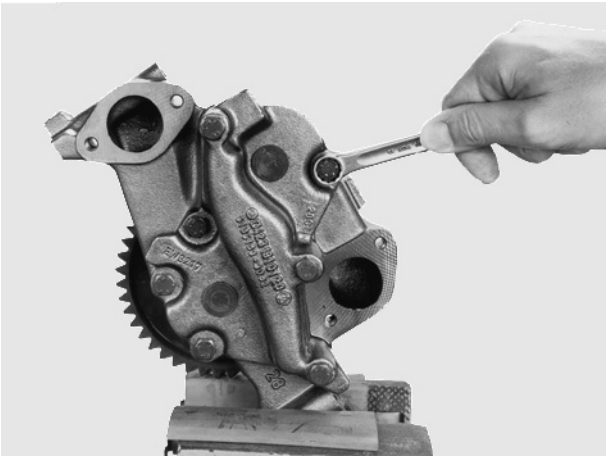

6

Fig. 7

Pull driven oil pump gears out of the housing.
Check gears and pump housing for wear (see “Service Data”).

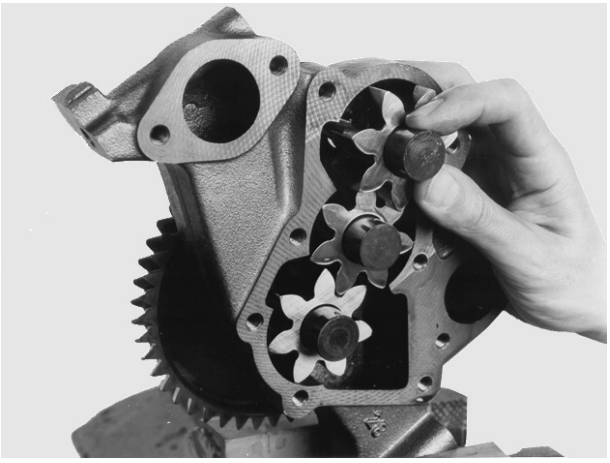

7

Fig. 8

Remove oil pump drive gear.

To do this, lay pump on suitable support and press off drive gear using a mandrel.

To install it, put drive gear on shaft, supporting facing shaft end.

Press on drive gear, taking into account the specified retrusion (see “Service Data”).

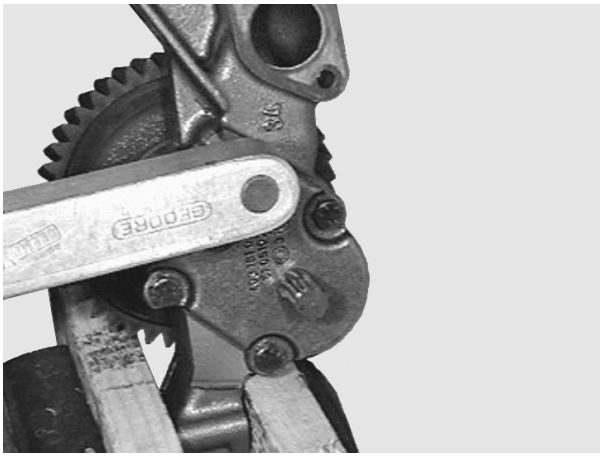

8

Fig. 9

Attach cover.

Tighten the mounting bolts to the specified torque.

Grind or exchange heavily worn covers.



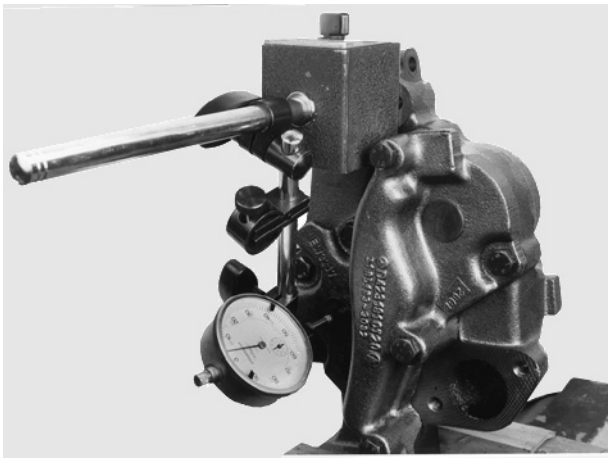
9

Checking axial play of the pump gears

Fig. 10

Position dial gauge and push shaft up to the stop in one direction and set dial gauge to “0”.

Push shaft in opposite direction and read the movement from the dial gauge.



10

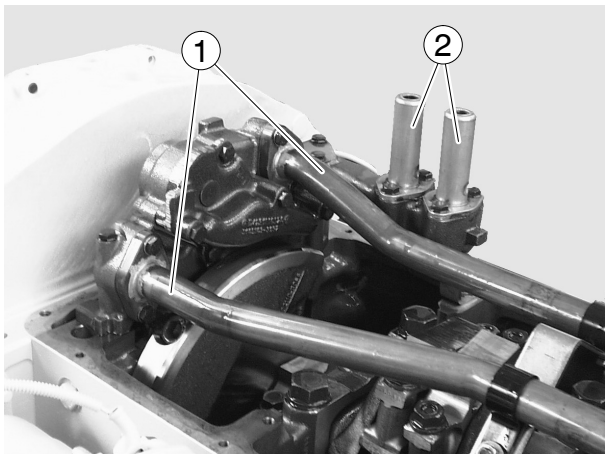
Installing oil pump

Fig. 11

Tighten the mounting bolts to the specified torque.

- Before installing, check whether the oil pump run smoothly and then fit it / them free of tension
- Fit oil suction line ① with seal in a tension-free manner
- Screw on pressure-relief valve ② without seal

Before mounting the oil pan, turn over the engine to check whether the crankgear and the oil pumps run unimpeded and smoothly.



11

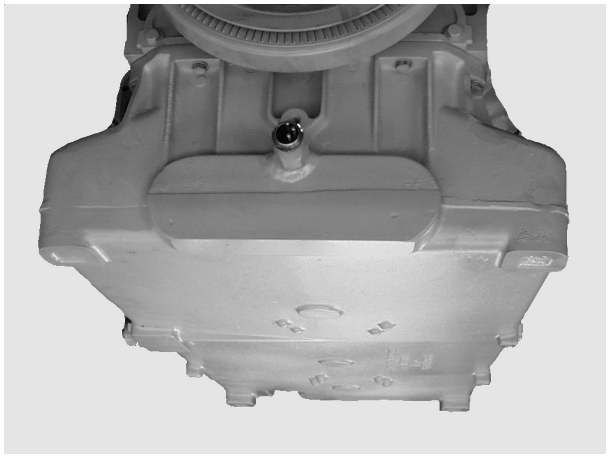
Attaching oil pan

Fig. 12

Fit a oil pan gasket.

Fit oil pan to crankcase and screw in the mounting bolts.

Tighten the mounting bolts to the specified torque.



12

Refilling with oil

Caution:
Do not add so much engine oil that the oil level rises above the max. marking on the dipstick. Overfilling will result in damage to the engine.

Figs. 13 and 15

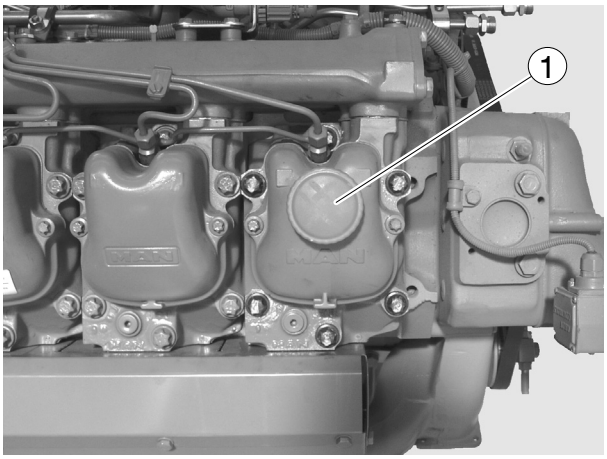
Refill with fresh engine oil at the oil filler neck ①.

After filling with oil disconnect electric connection from speed pickup. Turn engine over with starter until oil pressure warning lamp goes out / oil pressure gauge indicates pressure.
Then restore electric connection to speed pickup. Then start the engine and allow it to run at medium speed for a few minutes. Check oil pressure and tightness of system.

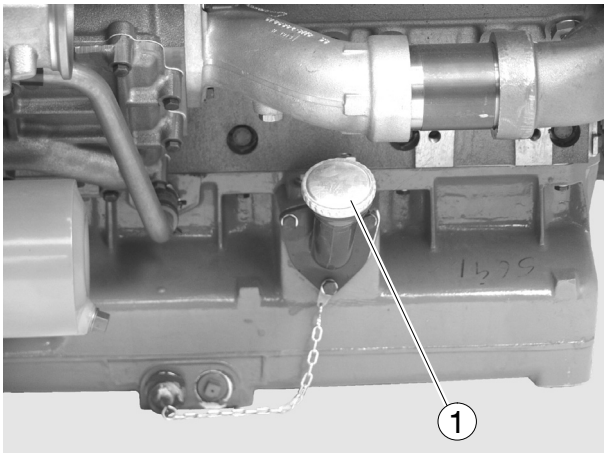
Then shut down the engine. After about 20 minutes, check the oil level.

- Pull out dipstick
- wipe it with a clean, lintfree cloth
- and push it in again up to the stop
- Pull out dipstick again

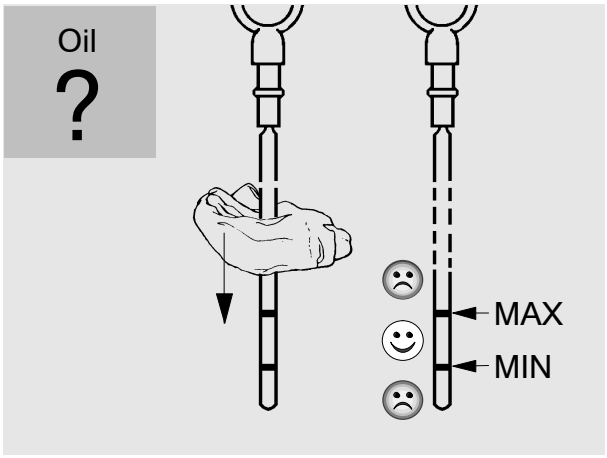
The oil level should be between the two notches in the dipstick and must never fall below the lower notch. Top up oil as necessary.



13



14



15

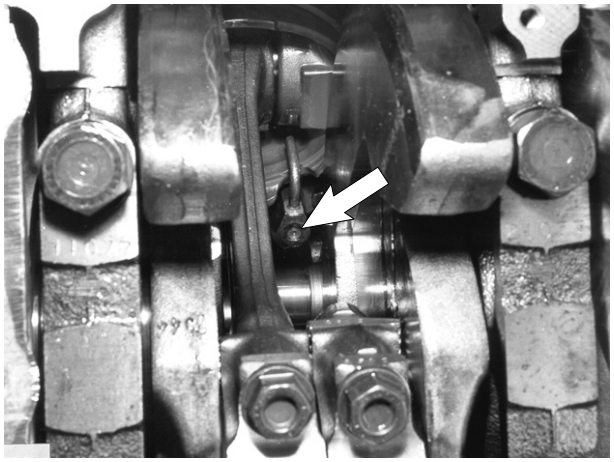
Removing oil spray nozzle

- Drain engine oil, see page 65
- Remove oil pan, see page 65

Fig. 1

Remove mounting bolts from oil spray nozzle (arrow).

Take off oil spray nozzle with valve.



1

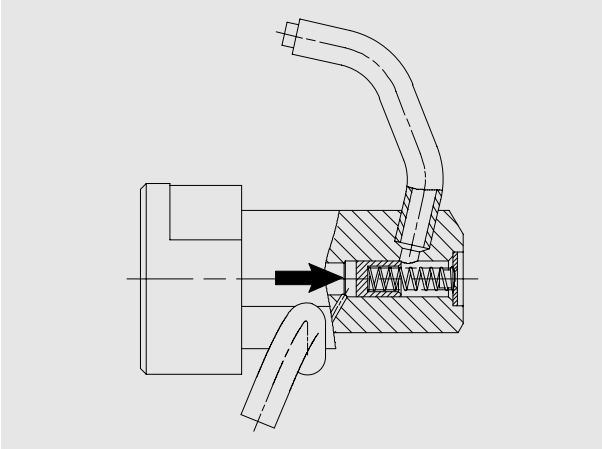
Checking oil spray nozzle valve

Fig. 2

Remove oil spray nozzle valve from oil spray nozzle body.

It must be possible to move the valve plunger up and down easily. If the plunger sticks, change the oil spray nozzle.

For opening pressures, see “Service Data”.

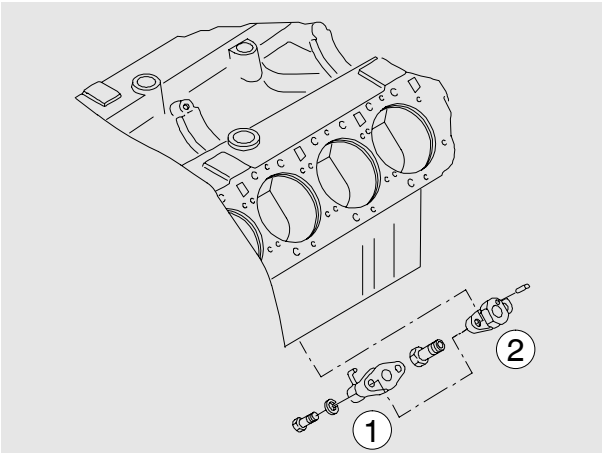


2

Installing oil spray nozzle

Fig. 3

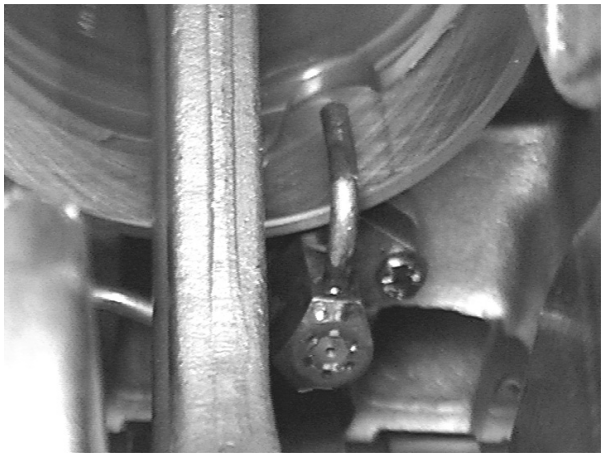
Place oil spray nozzle ① on oil spray nozzle flange ②.



3

Fig. 4

Tighten mounting bolts to specified torque.



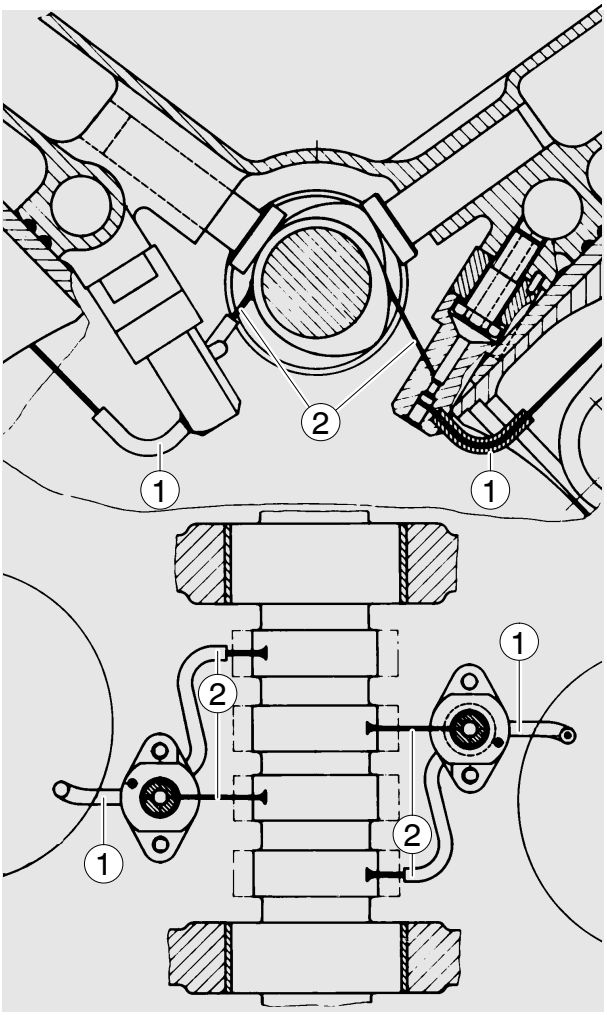
4

Fig. 5

Check direction of oil jet. The oil jet from each nozzle must reach unhampered the inlet port of the cooling duct in the piston crown ① and two cams ②.

On no account must bent oil spray nozzles be re-adjusted.

Turn the engine over. Neither the crankgear nor the pistons must collide with the oil spray nozzle.



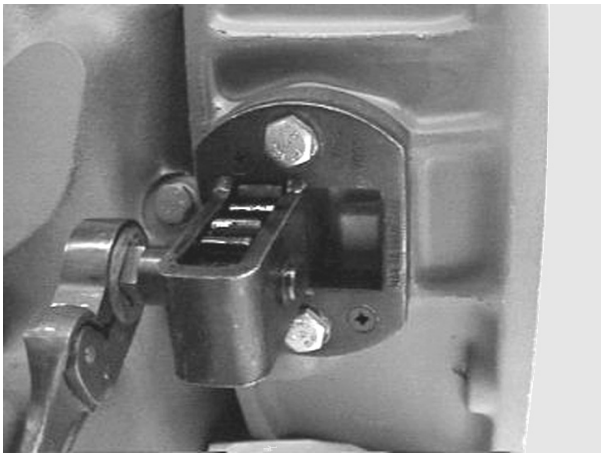
5

Removing vibration damper

- Relax and remove V-belt, see page 131
- Turn engine to ignition TDC. This ensures that in subsequent assembly work the indicating dial will be in the correct position.

Fig. 1

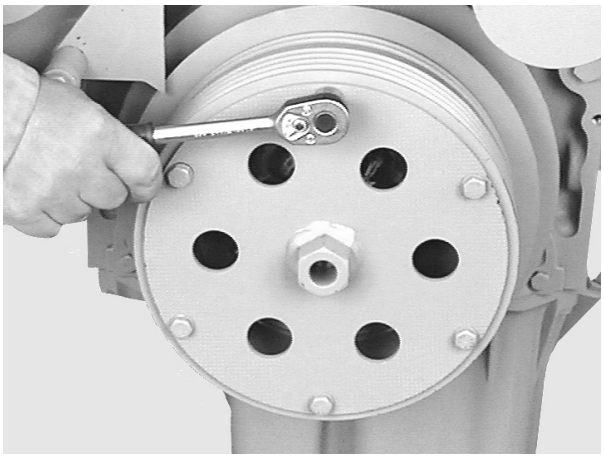
Block the crankgear.
The picture shows a special tool which is to be fitted to the inspection hole of the flywheel housing.



1

Fig. 2

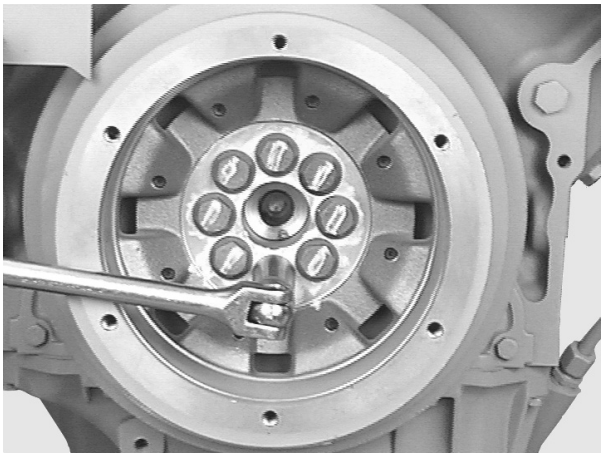
Remove cranking device.
(D 2842 LE 602)



2

Fig. 3

Loosen mounting bolts on vibration damper.



3

Fig. 4

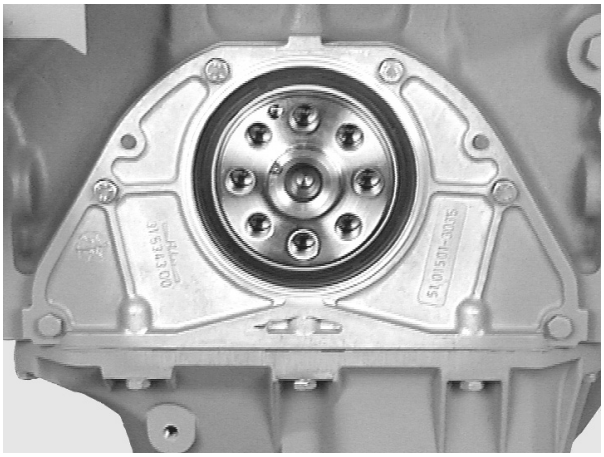
Remove two bolts facing each other and replace them by two guide pins (M16x1.5).

Remove all bolts.

Remove vibration damper.

Caution:
The vibration damper is susceptible to shocks.

Take oil splash ring off crankshaft.

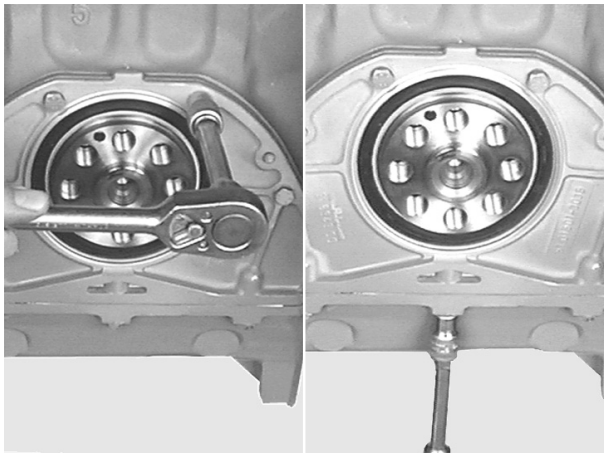


4

Changing front crankshaft seal

Fig. 5

Remove the mounting bolts from the cover.

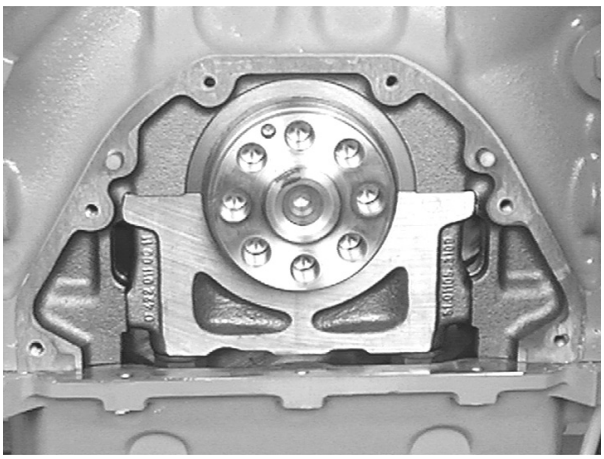


5

Fig. 6

Take off cover.

Replace front crankshaft seal only as a complete unit, i.e. race and radial shaft seal.

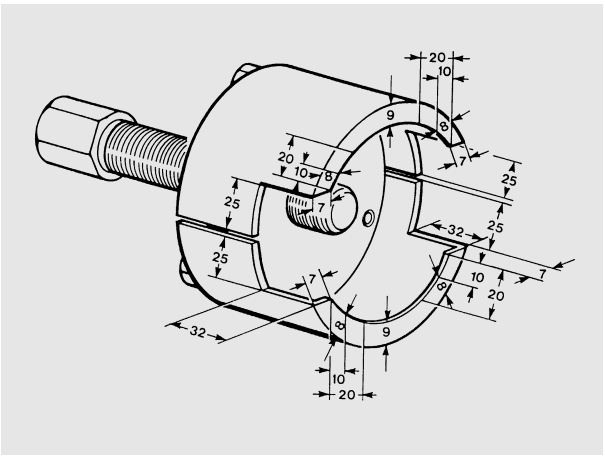


6

Replace race

Fig. 7

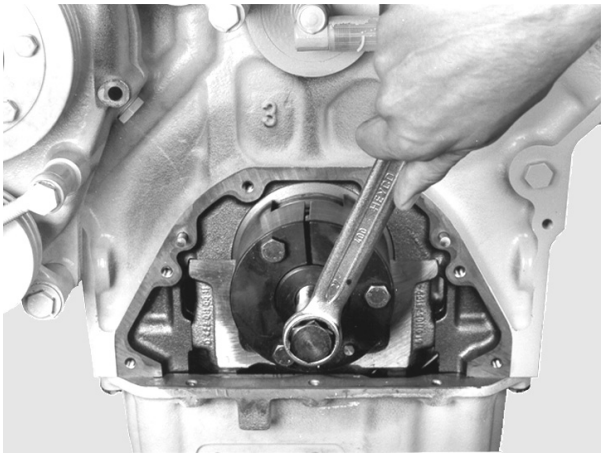
To remove the race, a puller (special tool) is necessary.



7

Fig. 8

Pull off race.



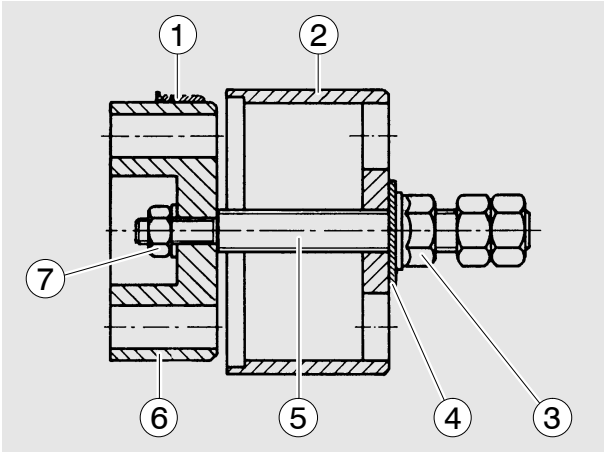
8

Fig. 9

Special tools are required for installing the race.

Clean inner side of race and crankshaft stub. Coat crankshaft stub with sealing agent “Antipor 46”.

- Push race ⑦ and pressing sleeve ⑧ onto adapter ③
- Tighten spindle ① in adapter ③ with nut ④
- Bolt adapter ③ to crankshaft



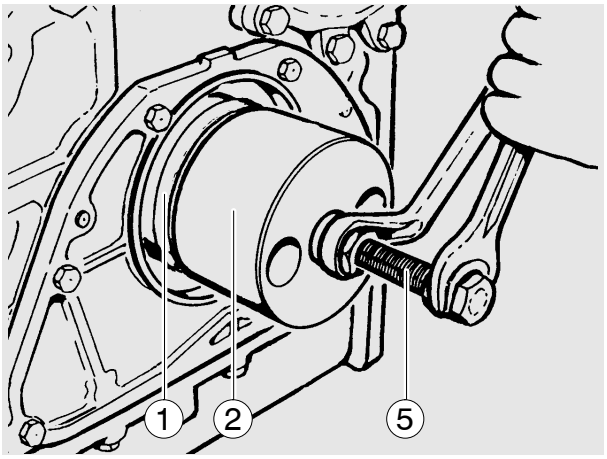
9

Fig. 10

The adapter must contact the crankshaft free of play so that the correct pressing depth for the race is ensured.

Pull in race using collar nut and pressing plate (⑨ and ⑩ in Fig. 9) until pressing sleeve ⑧ stops on the adapter.

Note:
The bearing race can be installed even while the cover remains fitted.



10

Exchanging radial shaft seal

Fig. 11

As spare parts the cover and shaft seal are delivered only as a complete assembly in order to ensure correct installation.

To ensure that the shaft seal remains suitable for installation, it must remain on the transport and assembly sleeve until installed.

Observe the remarks and assembly instructions on page 79.

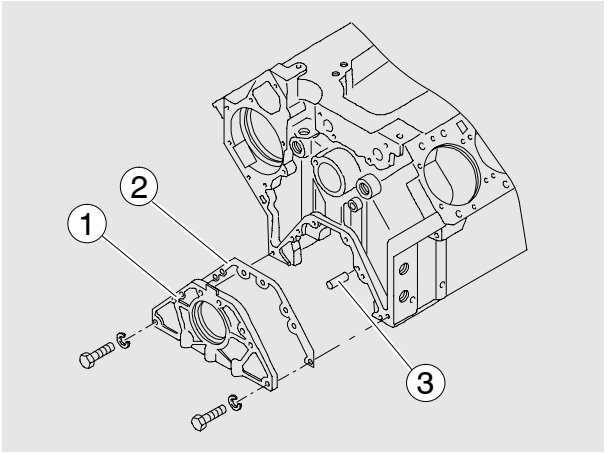

11

Fig. 12

Fit cover ① with new seal ②.

The cylinder pins ③ provide better guidance for the cover.
These will ensure that the seal is not too easily damaged when the cover is put on.

Tighten screws to specified torque.



12

Installing vibration damper

Fig. 13

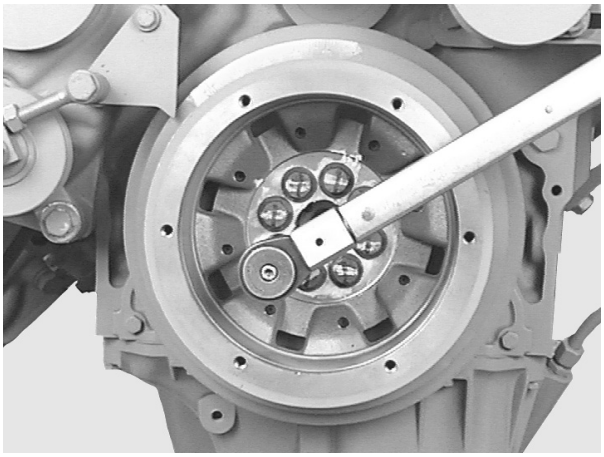
Fit oil splash ring to crankshaft.

Place vibration damper on two guide pins (M16x1.5). Ensure that the position of the graduated disc relative to the crankshaft is correct.

Tighten mounting bolts to specified torque.

Fit cranking device.

Fit and tension V-belts, see page 131.



13

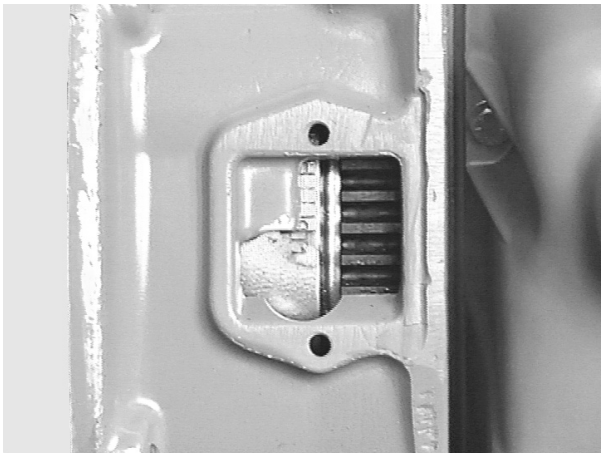
Figs. 14 and 15

During assembly the delivery start indicator on the vibration damper may have moved out of correct adjustment.

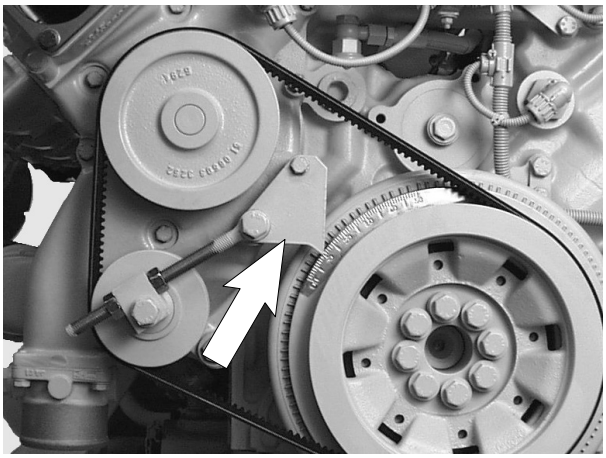
Therefore check whether the scale of degrees on the inspection hole cover of the flywheel housing (picture 14) and on the vibration damper (picture 15) indicate the same values.

If necessary readjust delivery start indicator.

Caution:
Unblock the crankshaft.



14



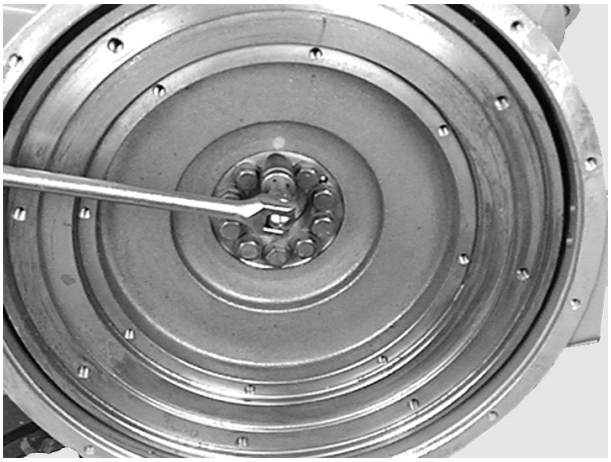
15

Removing flywheel

- Remove speed pickup, see page 137

Fig. 1

- Loosen mounting bolts, securing the engine against turning if necessary.



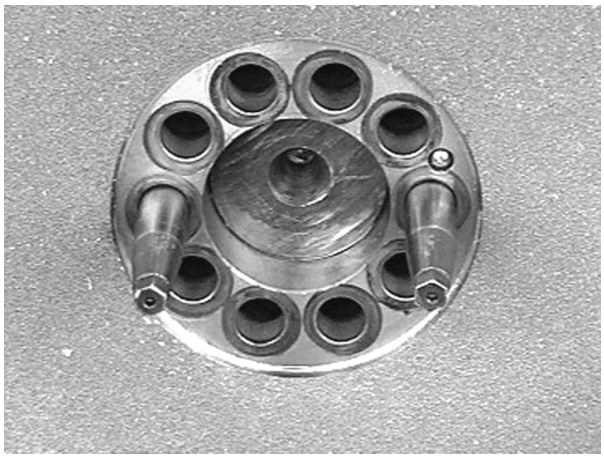
1

Fig. 2

Remove two bolts facing each other and replace them by two guide pins (special tool).

Remove all bolts.
Pull off flywheel with suitable lifting gear.

Danger:
The flywheel is heavy.
Use lifting gear.



2

Installing flywheel

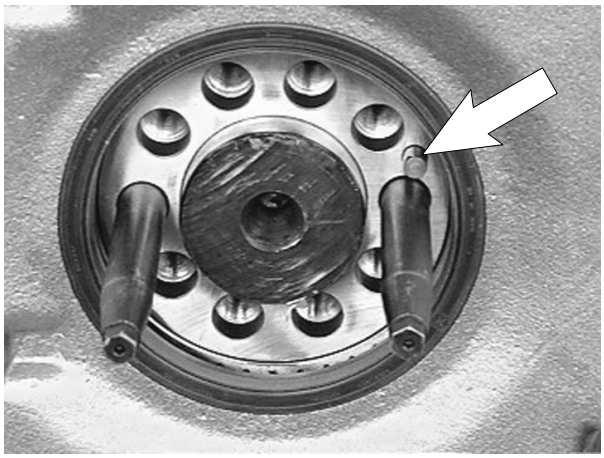
Fig. 3

Screw in guide mandrels.

Apply sealing agent “Antipor 46” to the sealing face on the inside of the flywheel.

Place guide mandrels on the flywheel, ensuring that the centering mandrel (arrow) fits correctly into the bore in the flywheel.

Push on flywheel until it stops.

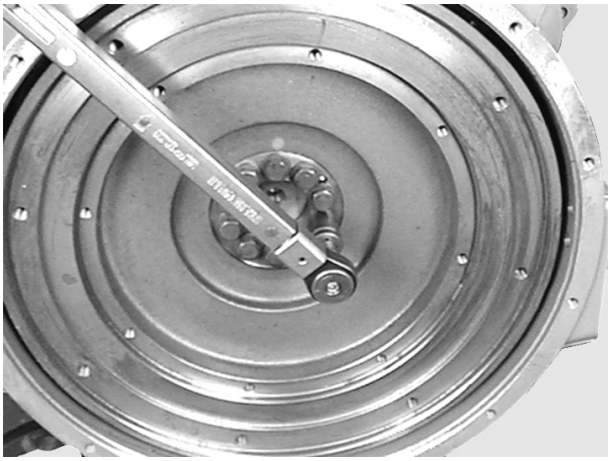


3

Fig. 4

Lightly oil new mounting bolts (elasticated bolts), screw them in and tighten alternately on opposite sides of the ring gear to specified torque.

- Install speed pickup, see page 137



4

Changing starter gear ring

Fig. 5

Remove flywheel.
Drill a hole in starter gear ring and snap it using a chisel.

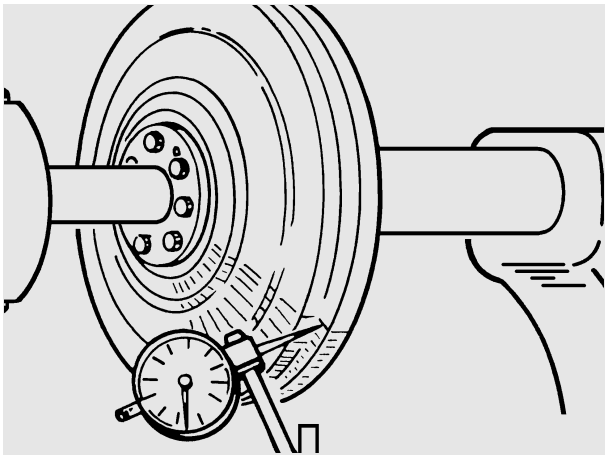
Caution:
Take care not to damage the flywheel.

5

Fig. 6

Note:
Since the maximum axial runout (lateral runout) of the starter ring gear must not be exceeded, the axial runout of the flywheel is to be measured on the contact face of the starter ring gear before the starter ring gear is shrunk on.
Exchange flywheel if the value required is exceeded.

Take up flywheel at hub.
Apply dial gauge to contact face of ring gear.
Turn flywheel by hand by several revolutions and observe the deflection shown on the dial gauge.



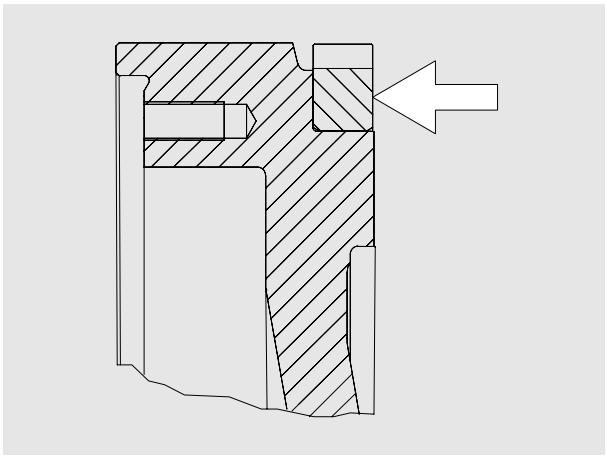
6

Fig. 7

Heat new starter gear ring up to approx. 200°C to 230°C and press on until it stops.

Danger:
The parts are hot. Risk of burns. Wear protective gloves.

Check axial runout and compare with max. permissible value.



7

Removing crankshaft seal

Fig. 1

Remove flywheel, see page 75.

Use special tool or a screwdriver to prise out seal.

1

Installing crankshaft seal

Fig. 2

When fitting a new shaft seal, you should also exchange the bearing race of the flywheel.

Insert new shaft seal into flywheel housing.

Use mandrel (special tool) to drive in sealing ring until flush.

Observe the remarks and assembly instruction on page 79.

2

Exchanging bearing race

Remove flywheel, see page 75.

Fig. 1

If the shaft seal on the flywheel end is to be exchanged, it is advisable to exchange the bearing race too.

Pull off the bearing race to be exchanged using a puller (special tool, see Page 173).

1

Fig. 2

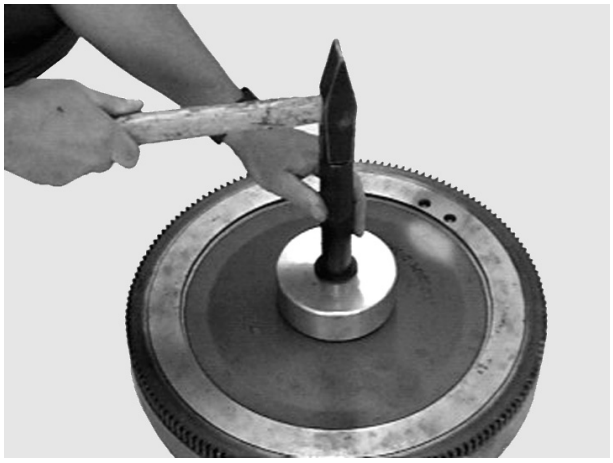
Insert the new bearing race into the pressing mandrel (special tool) so that for the subsequent assembly the internally chamfered side faces the flywheel.

Carefully heat the pressing mandrel with the bearing race.
The installation temperature for the bearing race is about 150°C.

2

Fig. 3

Press in bearing race until it stops.



3

Fig. 4

Seal the gap between the flywheel and the bearing race with “Antipor 46”.

4

General remarks on crankshaft seals

As a matter of fundamental principle only radial shaft seals made of polytetrafluor ethylene (PTFE), trade name Teflon, are used.

PTFE seals can be easily distinguished from the former elastomer seals by their considerably wider and flat sealing lip which is no longer pre-loaded by means of a tubular spring.

As a result of its relatively high initial stress the sealing lip curves inwards. For this reason PTFE seals are supplied on transport sleeves. They must not be taken off the sleeves before they are needed so as to ensure that they can still be installed. Great care should be taken when fitting lip seals. Even the slightest damage to the seal would result in leaks.

The sealing lip and the race of the flywheel must not be coated with oil or any other lubricants.

When installing a new seal always replace the race too.

Assembly instructions for crankshaft seals

- The PTFE seal must be absolutely free of oil and grease when installed. Even the slightest traces of oil on the race or the sealing ring cause leakage.
- Before installing the race remove oil, grease and anticorrosion agent from it. All cleaning agents normally used in workshops can be used for this purpose.
- A PTFE seal soiled with oil or grease is useless. Cleaning it is not permissible.
- The PTFE seal must never be stored without the transport sleeve delivered with it. Even after a storage period of only 30 minutes without the transport sleeve it looses its initial stress and becomes useless.

Note:
When carrying out work on the intake system, ensure meticulous cleanliness to prevent dirt and foreign matter from penetrating into the system.

Removing intake manifold

Fig. 1

Remove intake manifold (D 2842 LE 602 / 604 at front, D 2842 LE 607 at rear).

Remove the injection lines, see page 37.

1

Fig. 2

Remove the mounting bolts from the charge-air pipe.

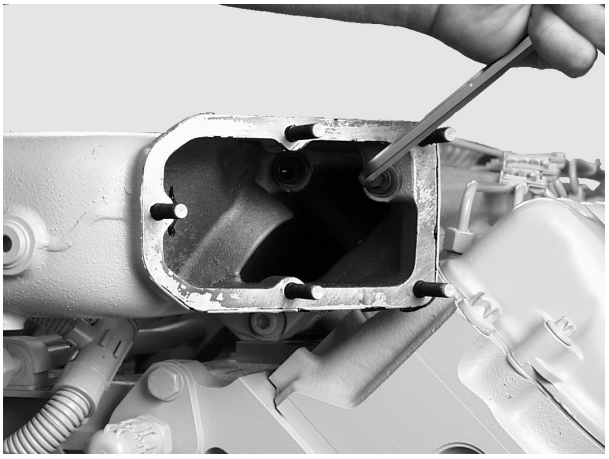
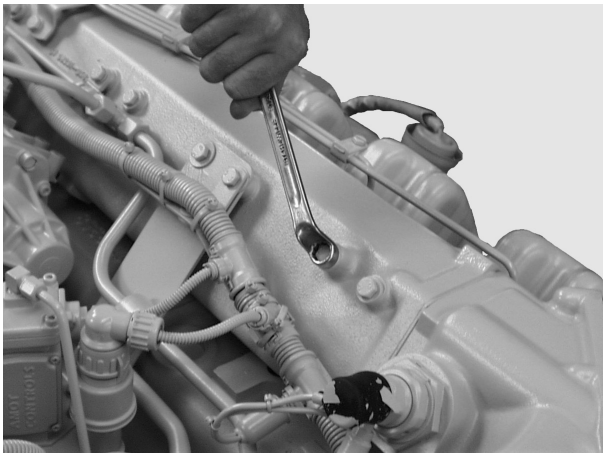

2

Fig. 3

Remove the mounting bolts from the intake pipe.

Take off intake pipe.


3

Installing intake manifold

Fig. 4

Place intake manifold with new seals in position.

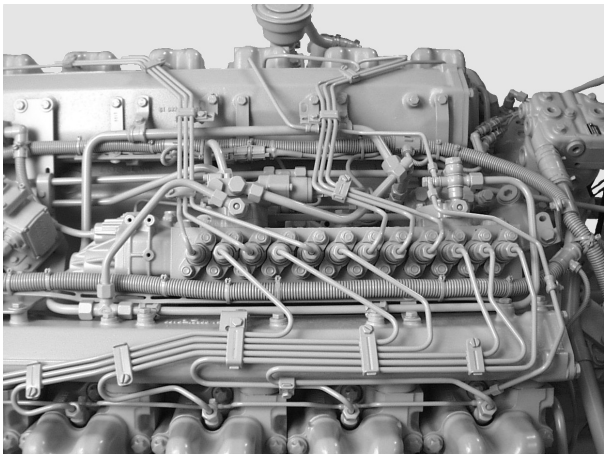
Fit the mounting bolts.

Ensure that the seals are correctly seated.

Tighten mounting bolts to the specified torque.

Attach the injection lines.

Fit the charge-air elbow and the charge-air pipes leading to the turbocharger. Exchange O-ring seals.


4

Removing exhaust manifold

- Remove turbocharger, see page 87

Fig. 1

Remove the guard plates.

Fig. 2

Note:
The exhaust-gas pipe can be removed with the exhaust manifold attached.

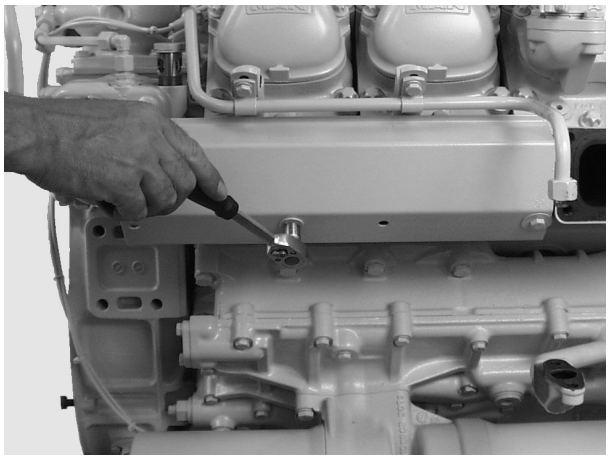
Remove the mounting bolts from the exhaust pipe.

Danger:
The exhaust pipe is heavy.

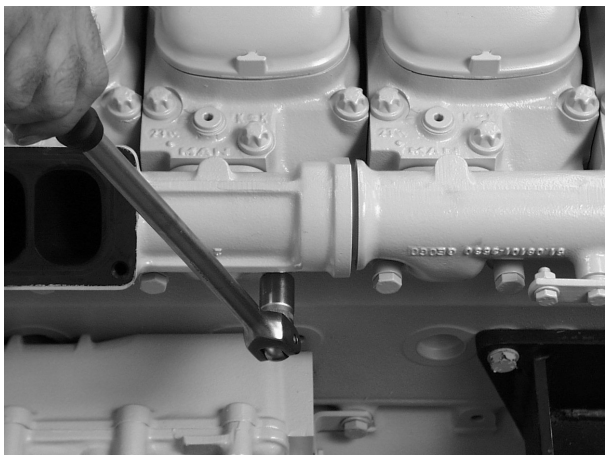
Before removing all mounting bolts, it is advisable to replace two bolts with self-made threaded guide pins.

Take off the exhaust pipe.

D 2842 LE 602
Take off exhaust-gas pipe and heat shield



1



2

Installing exhaust manifold

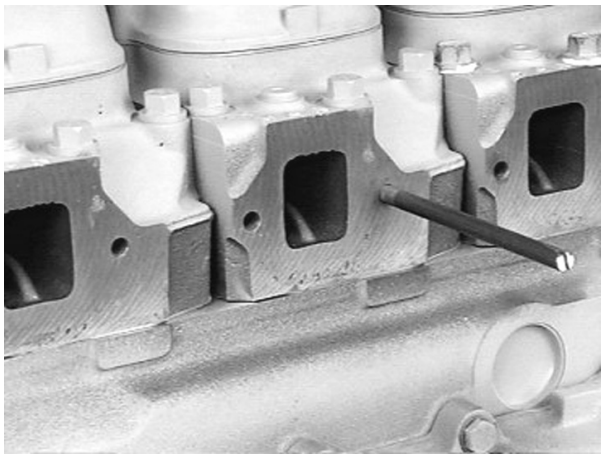
Fig. 3

Before fitting the exhaust pipe, screw in two guide pins.

Fit exhaust pipe with new seals.

D 2842 LE 602
Fit exhaust-gas pipe with heat shield and new seals (Observe correct sequence).

Ensure that the seals are correctly seated.



3

Fig. 4

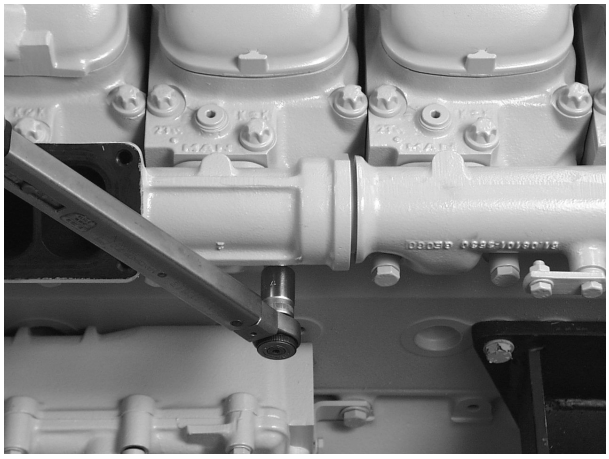
Tighten mounting bolts 51.90490–0054 M10x103–HWF, spacer bush 51.91701–0942 and heat shield.

Initial torque: 60–65 Nm

Rotation angle: 90°

Retighten by 90° after 100 h.

- Installing turbocharger



4

Before removing the turbocharger carry out the following checks

Turbochargers are frequently exchanged if the oil consumption is too high, the output too low or the intake and / or exhaust gas noises appear to be abnormal.
Subsequent inspections by the manufacturer of the supposedly defective parts frequently prove the turbochargers to be in order.
To ensure that only defective turbochargers will be exchanged in future, the following checks are to be carried out beforehand:

If the oil consumption is too high

- Check air filter for contamination
- ensure that the engine room ventilation is adequate
- check intake pipe for cross section reduction (owing e.g. to damage, contamination)

These causes lead to higher oil consumption owing to the increased vacuum on the intake side of the compressor.

- Check outside of turbocharger for oil traces

Oil consumption caused directly by turbocharger depends on the bearing wear and results in relatively early mechanical damage.

If engine performance is not satisfactory

Correct adjustment of the
- delivery start
- valve clearance
- speed adjustment (to full load stop)

In addition, the following are to be checked:
- the compression
- the air filters for contamination
- the charge-air pressure
- intake system for reduction of cross-section and for leaks
- exhaust system for damage and leaks

If you do not detect any possible cause in the above checks, check the turbocharger for:
- Carbonization in the turbine area, which impairs the movement of the wheel assembly (can be eliminated by axial movement)
- Dirt in the compressor area
- Damage caused by foreign objects
- Scraping of the turbine rotor on the housing

If a considerable amount of dirt has accumulated, clean the compressor end and check the bearing clearance.

Caution:
Do not damage the aluminium compressor wheel.

When there is unusual intake or exhaust noise

- Check the intake and exhaust system in the area of the charger group.
  Defective gaskets can lead you to think the turbocharger is defective. Replace them.
- If there are still unusual noises, check the bearing clearance.
  Turbochargers in good working order do not make any excessive noise.

Oil accumulation in charge-air lines and the intercooler

A small amount of oil collects in the charge-air system. This is supposed to happen, is caused by oil mist, and is desirable. The oil mist is required to lubricate the intake valve seats.

If more oil accumulates than usual, that is, if oil pockets develop in the lower air box of the intercooler, for example, this can lead to oil disintegration or uncontrolled raising of the engine speed when the oil is separated. In such cases, you must eliminate the cause.

Possible causes:

- The engine is overfilled with oil
  - Check whether the correct dipstick and guide pipe combination is installed
- The engine oil used is unsuitable (see publication “Fuels, Lubricants, Coolants for MAN Diesel Engines”)
- The engine is being run on impermissibly steep inclines
- The crankcase pressure is to high. This may be caused by a defective oil separator valve or piston ring wear

Compressor carbonization

This can occur when the charge-air temperature is permanently high, for example when the engine is constantly run at full load.

Carbonization lowers the charging pressure but does not negatively affect performance or acceleration. Carbonization can lead to increased exhaust clouding.

If exhaust emissions test values are no longer met:

- Remove the compressor housing, being careful not to let it get jammed
  - If it gets jammed, the compressor wheel blades may get damaged or bent, and the resultant imbalance can ruin the turbocharger
- Remove carbonization in the compressor housing with a suitable cleaning agent

Danger:
Never spray in cleaning agent while the engine is running.
- ineffective
- dangerous

- In problem cases, use oil types that are less likely to lead to compressor carbonisation (see publication “Fuels, Lubricants, Coolants for MAN Diesel Engines”)

Sufficient charge-air pressure is indispensable for full power output and clean combustion.
The check is designed to ascertain whether damage to the turbocharger and leaks in the intercooler and in the charge-air pipes have occurred.
Extreme operating conditions (full-load operation and high air temperature) and the use of unsuitable engine oils (also see publication “Fuels, Lubricants, Coolants for MAN Diesel Engines”) may cause deposits on the compressor as well as in the intercooler, which results in a reduction in charge-air pressure.

Preconditions for the measurement:

The delivery start and the valve clearance must be set as specified, and the engine must be at operating temperature.

Charge-air pressure:

A general set-point value for charge-air pressure cannot be given, as the installation conditions have a bearing on this.
The value ascertained during the commissioning of the engine and noted in the commissioning report is to be used as the set-point value.

When carrying out the measurement, observe the following:

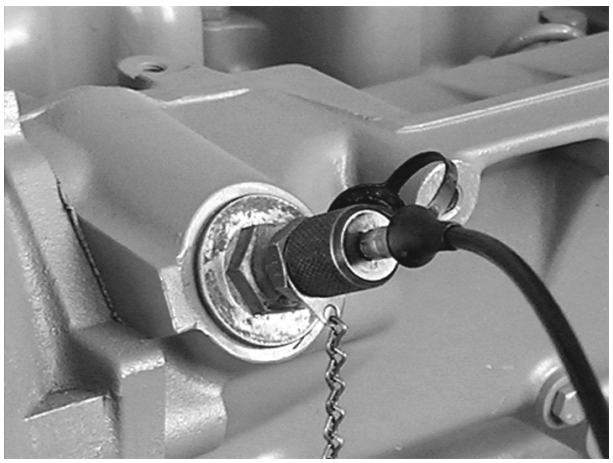
Owing to various atmospheric reference conditions during the measurements and to tolerances of the pressure gauges used, deviations of max. ± 100 hPa (± 100 mbar) are permissible.

Fig. 1

The measuring connection for checking the charge-air pressure and the charge-air temperature is located in the intake pipe at the point where the flame-starter sheathed-element glow plug is screwed in.

Remove flame-starter sheathed-element glow plug, see page 45.

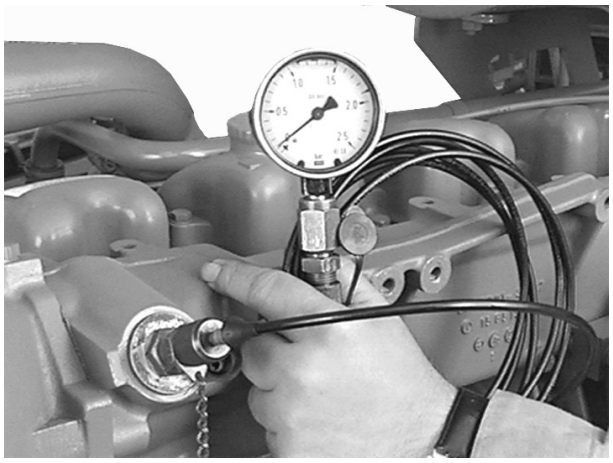
Connect up pressure gauge (if necessary using a suitable threaded pipe as adapter).



1

Fig. 2

Measure the charge-air pressure downstream of the intercooler at nominal engine speed and full load.

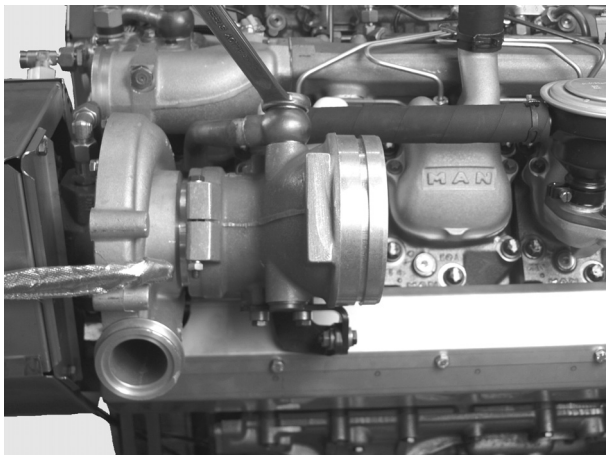


2

Removing turbocharger

Fig. 1

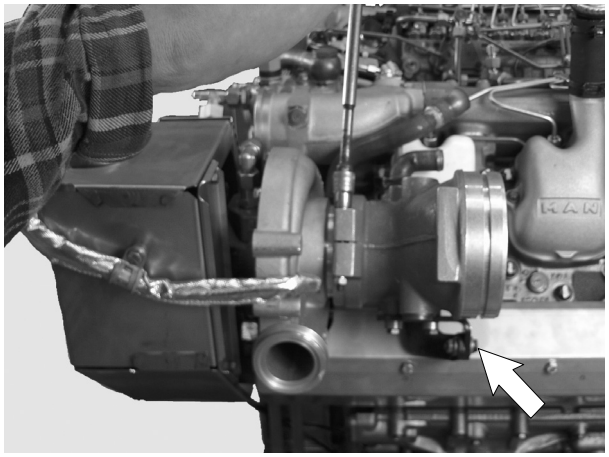
Remove the charge-air elbow and the charge-air pipes leading to the turbocharger.



1

Fig 2

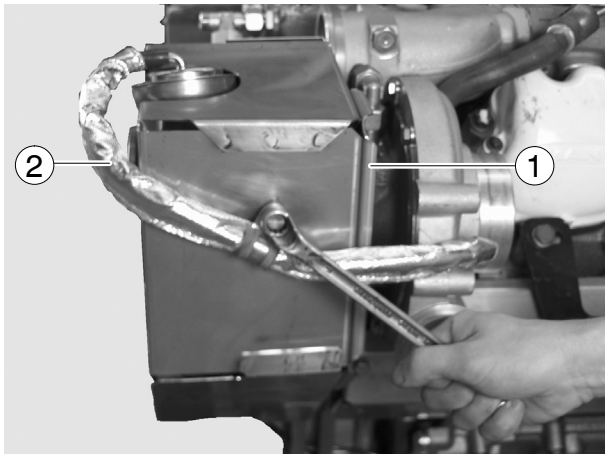
Detach intake neck.
Remove the screws (arrow) from the bracket.



2

Fig. 3

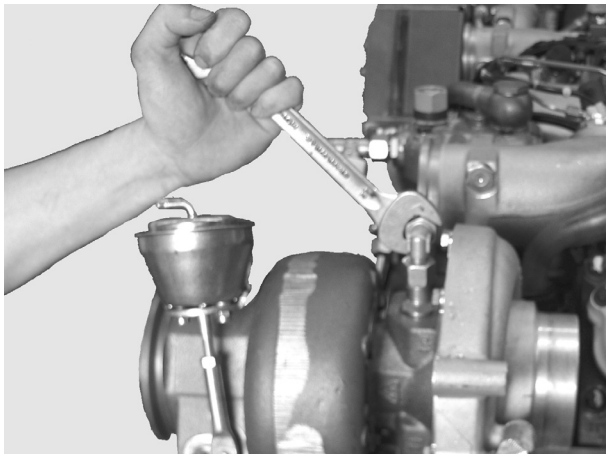
Remove the mounting bolts on the heat shield from the turbocharger.
Remove shield ①.
Remove line ② from turbocharger and compressor
Pull heat shield away towards the rear at an oblique angle.



3

Fig. 4

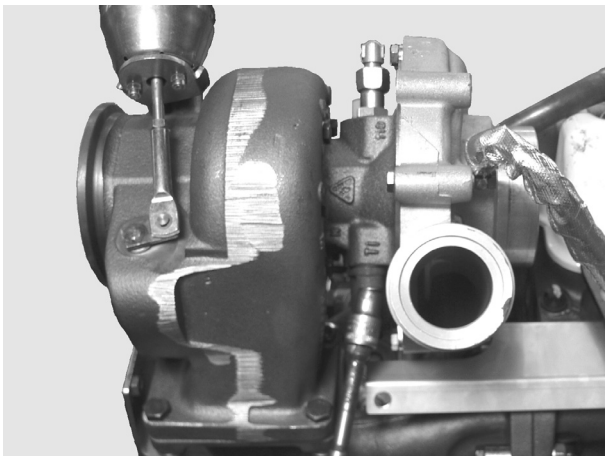
Remove oil pressure line from turbocharger



4

Fig. 5

Remove oil return line from turbocharger.



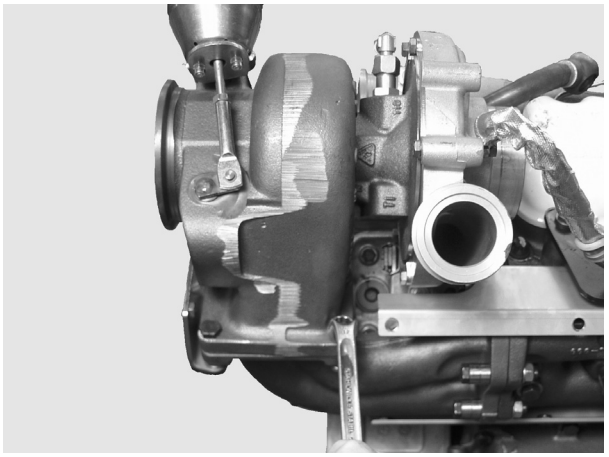
5

Fig. 6

Remove the bolts from the turbocharger.

Take off turbocharger.

Note:
Ensure meticulous cleanliness when putting the turbocharger aside to prevent dirt and foreign matter from penetrating into the interior of the turbocharger.



6

Installing turbocharger

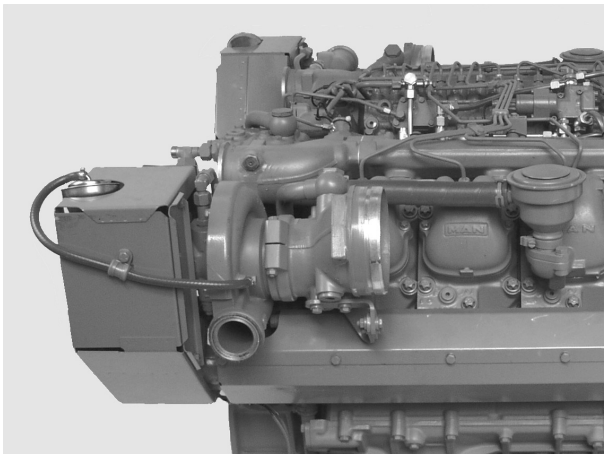
Fig. 7

The turbocharger is assembled in reverse order.

When assembling, use new seals and new self-locking nuts.

Before connecting up the oil supply line, fill bearing housing up with clean engine oil.

Check all connections for leaks and tension.

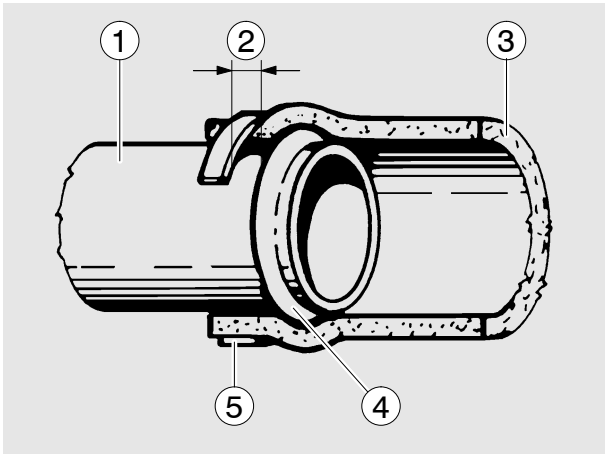


7

Fig. 8

Note:
Ensure that the clamping area of the hose is always behind the bead of the pipe.

1 Pipe
2 Hose
3 Hose clamp
4 Disatnce
5 Bead on pipe

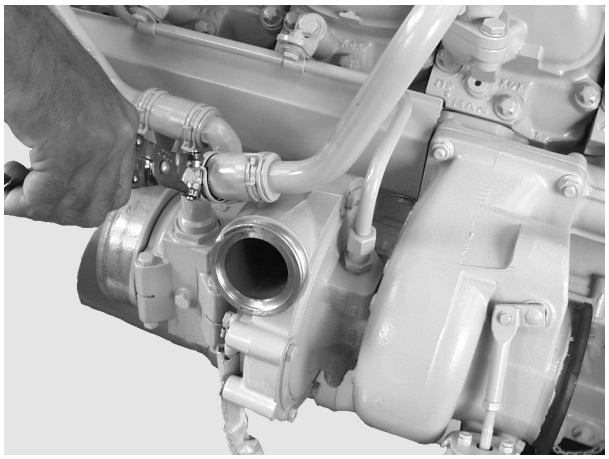


8

Removing turbocharger

Fig. 1

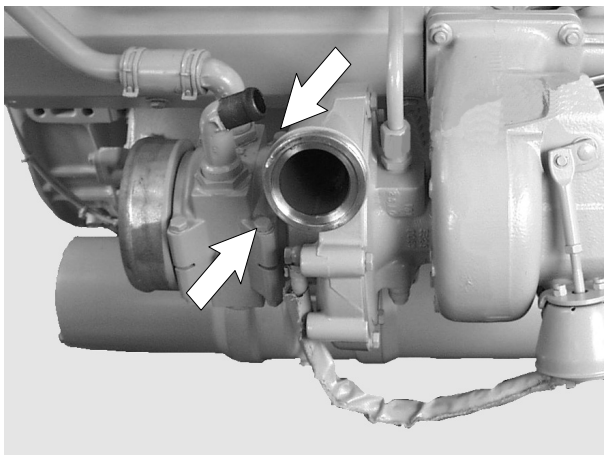
Remove the charge-air elbow and the charge-air pipes leading to the turbocharger.



1

Fig. 2

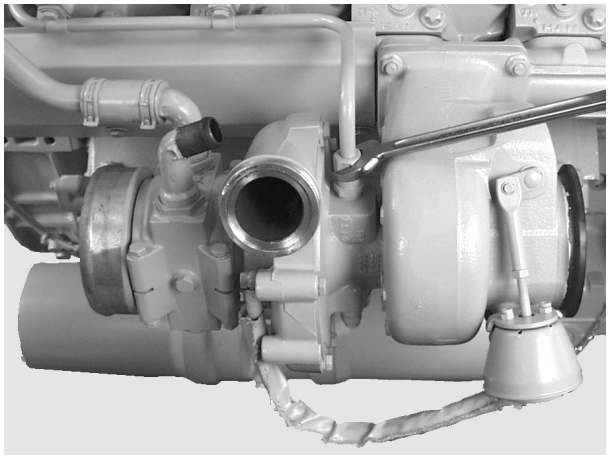
Detach intake neck.



2

Fig. 3

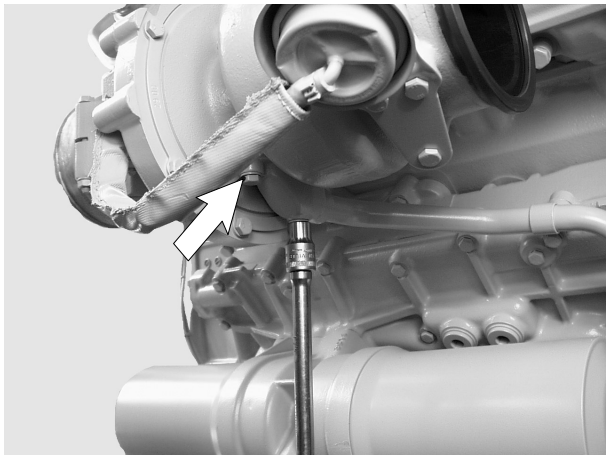
Remove oil pressure line from turbocharger.



3

Fig. 4

Remove oil return line from turbocharger.



4

Fig. 5

Remove the bolts from the turbocharger.

Take off turbocharger.

Note:
Ensure meticulous cleanliness when putting the turbocharger aside to prevent dirt and foreign matter from penetrating into the interior of the turbocharger.

5

Installing turbocharger

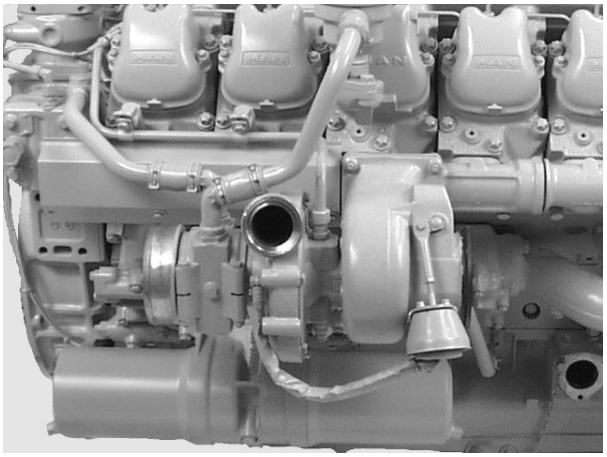
Fig. 6

The turbocharger is assembled in reverse order.

When assembling, use new seals and new self-locking nuts.

Before connecting up the oil supply line, fill bearing housing up with clean engine oil.

Check all connections for leaks and tension.

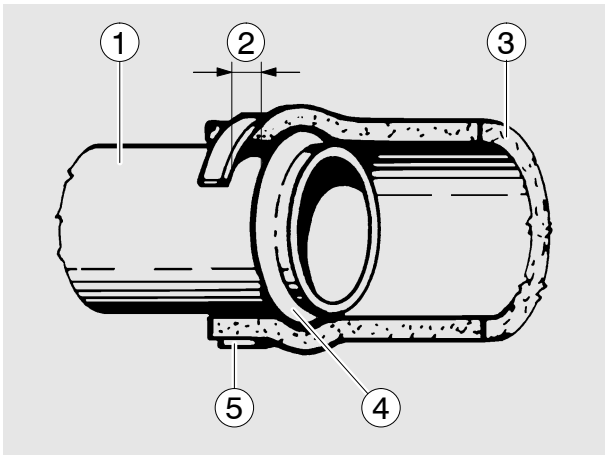


6

Fig. 7

Note:
Ensure that the clamping area of the hose is always behind the bead of the pipe.

1 Pipe
2 Hose
3 Hose clamp
4 Distance
5 Bead on pipe



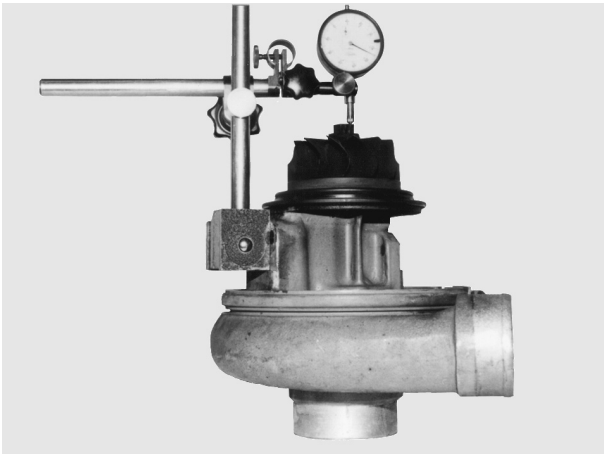
7

- Remove turbocharger, see page 87
- Mark turbine housing relative to the bearing housing
- Remove turbine housing

Axial clearance

Fig. 1

Apply dial gauge holder and dial gauge under preload to shaft end face of the turbine wheel as shown.
Press rotor shaft against dial gauge. Read and note down value. Push rotor in opposite direction. Read and note down value.
The difference between the two is the axial play.
Change turbocharger if axial clearance is exceeded.



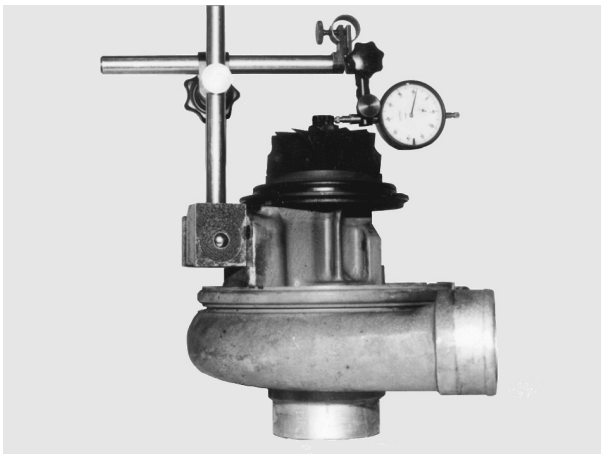
1

Radial clearance

Radial clearance is measured only on turbine end with dial gauge or feeler gauge.

Fig. 2

Dial gauge:
Apply dial gauge tip to side of hub. Push turbine wheel towards dial gauge. Read and note down value.
Push turbine wheel in opposite direction. Read and note down value. The difference between the values is the radial clearance.
Measure at several points.
If the play exceeds the permissible value, exchange turbocharger.



2

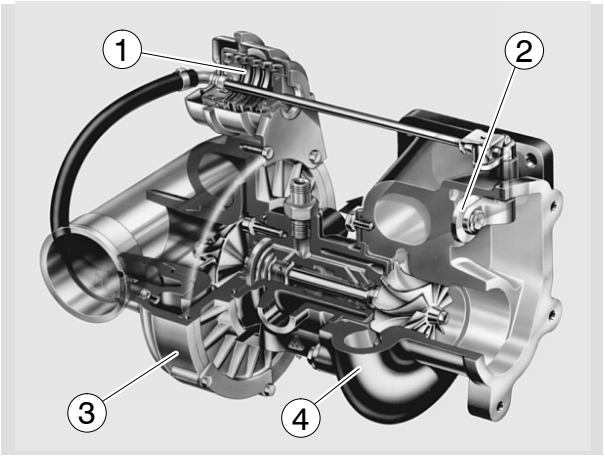
- Fit turbine housing. Ensure that the markings coincide
- Tighten turbine housing bolts to specified torque
- Installing turbocharger

Wastegate

Some engines have turbochargers which are equipped with a wastegate.
The function of the wastegate is to keep the boost pressure generated by the turbocharger within the limits of a defined tolerance band.
When a defined boost pressure is exceeded, the wastegate opens to allow some of the mass exhaust flow to bypass the turbine.
The turbine outputs less power on account of the reduced mass flow.
The compressor output decreases to the same extent and the boost pressure drops to a defined value.
This control operation is repeated each time the engine power output changes.
The wastegate is set by the manufacturer and must not be tampered with.
Apart from the regular engine inspections, no additional maintenance is required for these turbochargers.

Fig. 1

1 Control capsule
2 Valve plate
3 Compressor housing
4 Turbine housing

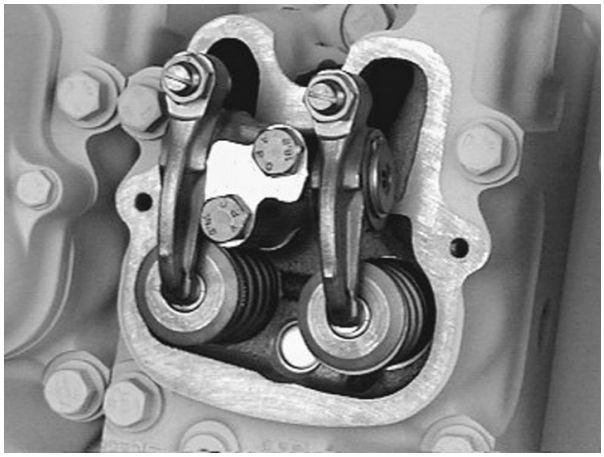


Removing the rocker arms and push rods

Fig. 1

Take off the cylinder head covers.

Caution:
Residual amounts of oil may emerge during this operation.
Used oil is dangerous waste.
Observe safety regulations to prevent damage to the environment.



1

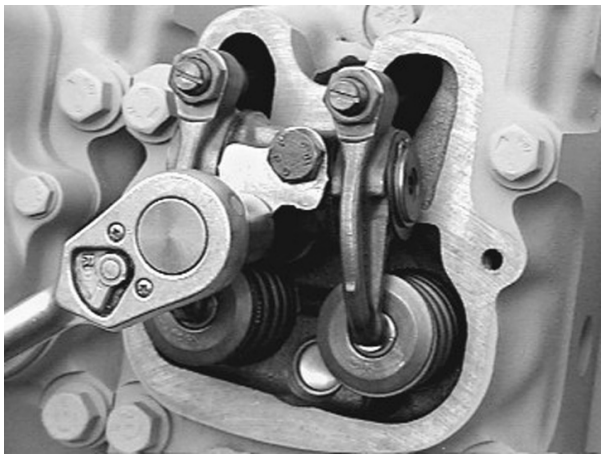
Fig. 2

Back off valve adjusting screws.

Loosen mounting bolts of rocker arm bracket.

Remove rocker arm bracket.

Disassembling and assembling rocker arms, see page 96.

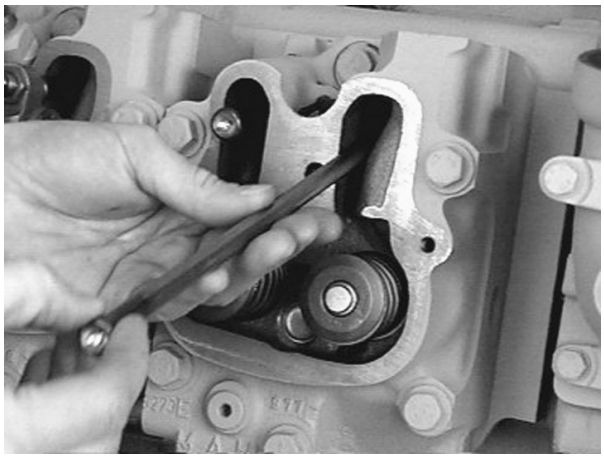


2

Removing cylinder head

- Drain coolant, see page 46
- Remove injectors, see page 37
- Removing intake manifold, see page 80
- Removing exhaust manifold, see page 81

Note:
To remove a cylinder head, it is not necessary to detach the intake and exhaust pipes.



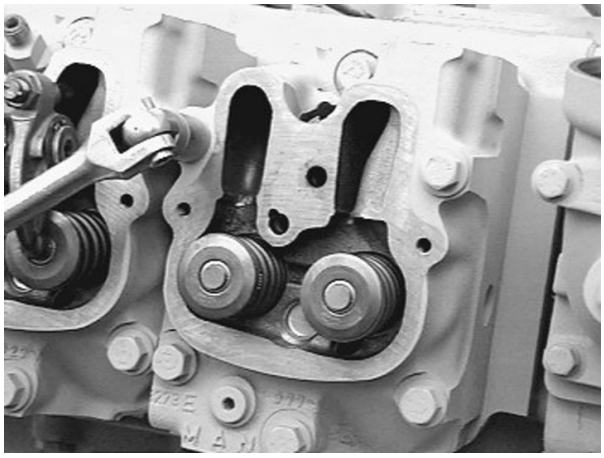
3

Fig. 3

Take out push rods.

Fig. 4

Remove cylinder head bolts in reverse order of tightening (For torque tightening diagram see “Service Data”).



4

Fig. 5

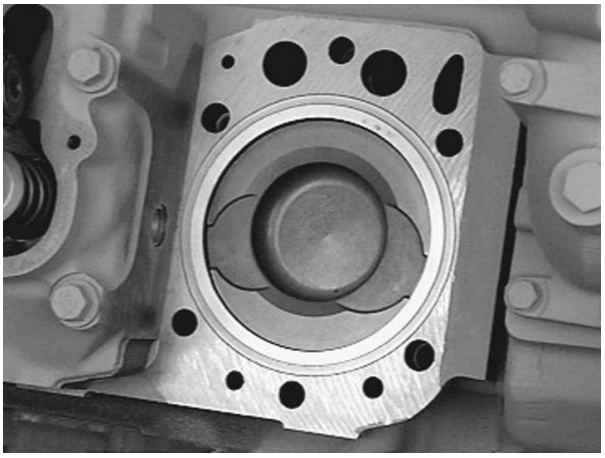
Take off cylinder head and cylinder head gasket.

Check whether cylinder head sealing face and cylinder block are plane using a straight edge.

Non-plane cylinder heads can be remilled 1 mm.

Notice specified projection of injection nozzles and valve recess.

Note:
Check cylinder heads for cracks.



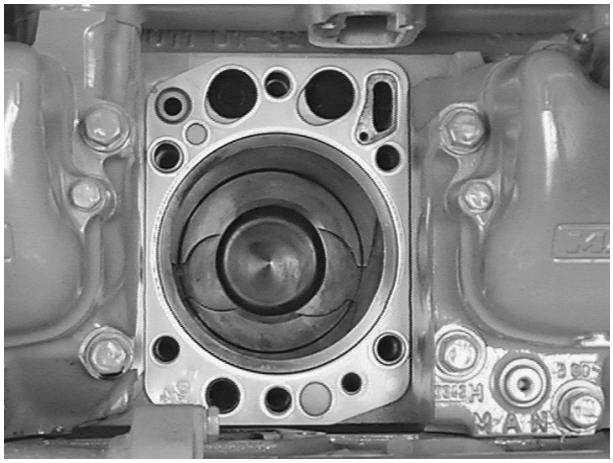
5

Installing cylinder head

Fig. 6

Before installation clean and blow out threaded bores in crankcase. Clean sealing faces on cylinder head and crankcase.

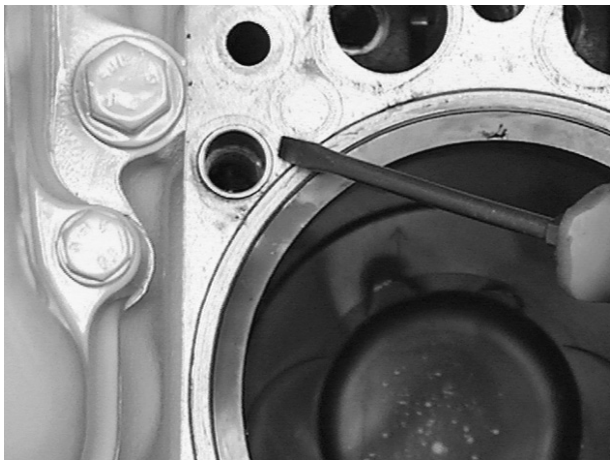
Lay new cylinder head gaskets in place in dry condition, ensuring that the holes match those in the crankcase, and place cylinder head on top.



6

Fig. 7

Each cylinder head is located with two fitting sleeves.



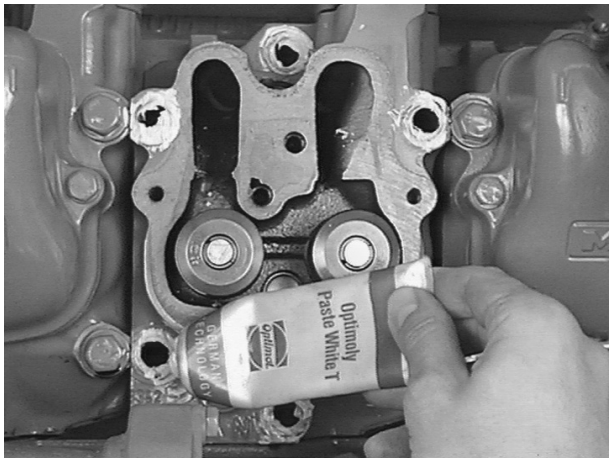
7

Fig. 8

Check whether the cylinder head bolts have the max. permissible length.

Bolts that have been removed may be used again if the max. permissible length is not exceeded.

Coat cylinder head bolts with engine oil before inserting them and apply “Optimoly WhiteT” assembly paste to the contact face of the bolt head.



8

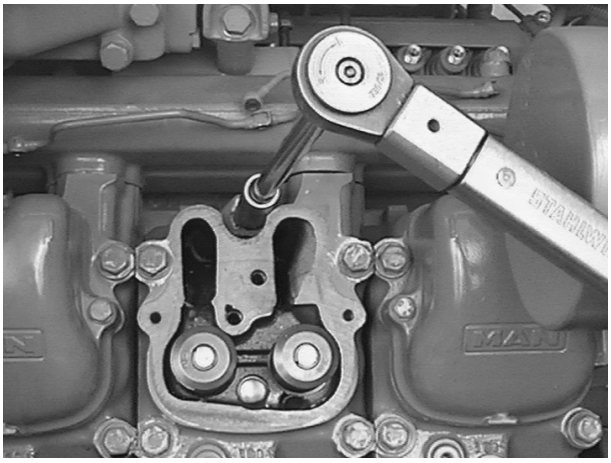
Figs. 9 and 10

Tighten bolts by angle.

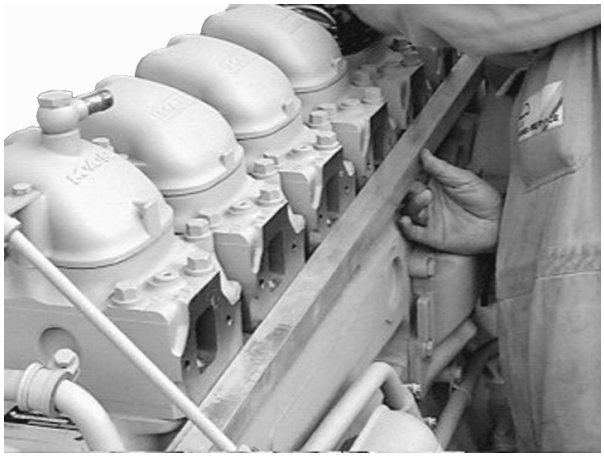
Observe tightening sequence, the specified tightening method, the instructions and notes concerning the cylinder head bolts.

Note:
To avoid any distortion between cylinder heads and exhaust manifolds, we recommend proceeding as follows:

- Place cylinder head gaskets and cylinder heads in position
- Screw in head bolts by a few turns
- Secure steel ruler (special tool) with ground face on the exhaust side; tightening torque for mounting bolts: 20 Nm.
  If a steel ruler is not available, mount exhaust manifold and tighten to 20 Nm.
- Tighten cylinder head bolts as specified
- Remove steel ruler



9



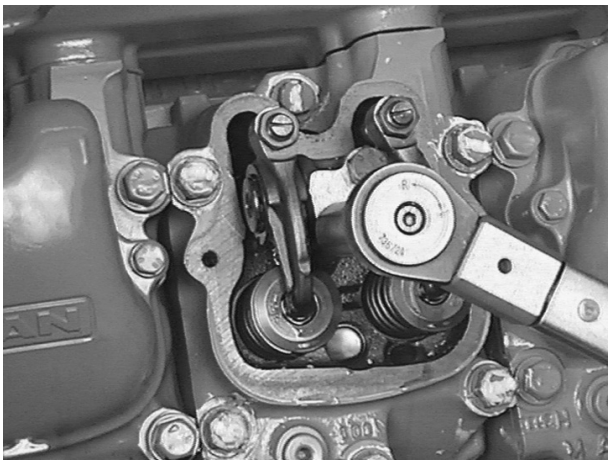
10

Installing the rocker arms and push rods

Fig. 11

Check push rods for distortion.
When inserting the push rods ensure that they fit into the seat of the valve tappet.

Put rocker arms and push rods in place.
Tighten the mounting bolts lightly and align the rocker arms to the valves.
Tighten the mounting bolts to the specified torque.



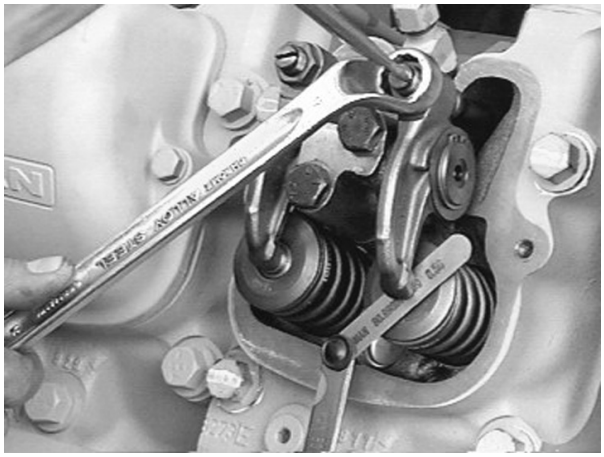
11

Fig. 12

Set valve clearance, see page 95.

Mount cylinder head cover with new seal.

- Installing exhaust manifold
- Installing intake manifold
- Fit injection nozzle
- Fill up with coolant



12

General notes

The sealing effect of the cylinder head gasket largely depends on whether the required initial tension for the cylinder head bolts is reached and maintained.

Use calibrated torque wrenches to tighten the cylinder head bolts. When the specified final torque is applied it must be maintained for at least 5 seconds. When using snap-type torque wrenches tighten bolts gradually since otherwise the torque selected will not be fully transferred to the bolts.

Observe the notes on the reusability of the cylinder head bolts, the tightening sequence and the specified tightening method.

Tightening

“Tightening” is defined as the first-time tightening of newly fitted bolts that have not been tightened after a repair, e.g. changing the cylinder head gasket. Tighten cylinder head bolts while the engine is cold, i.e. the crankcase is warm to the touch or colder.

Before inserting the cylinder head bolts, apply engine oil to the thread (not to the threaded hole) and “Optimoly White T” assembly paste to the contact faces of the bolt heads.
Do not use oil or oil additives containing MoS_2.
If the bolts are not oiled, a significant amount of the tightening torque is converted into friction and thus lost for the bolt pretensioning.

- To position cylinder heads, tighten cylinder head bolts only lightly
- Align cylinder heads by screwing on the steel ruler (special tool)
  If a steel ruler is not available, use exhaust or intake manifold
- Tighten bolts in specified order and to specified torque / tightening angle in steps

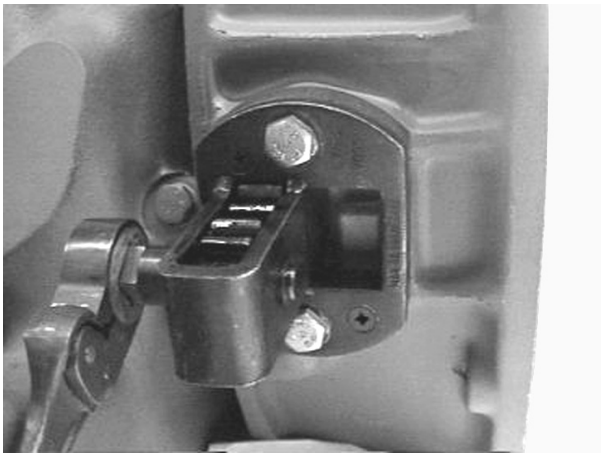
Caution:
If during initial tightening some bolts are excessively tightened, the cylinder head will be distorted. This distortion cannot be cancelled out by continuing to tighten according to the instructions.

Adjust the valves only when engine is cold (max. coolant temperature 50°C).

Fig. 1

Remove cylinder head cover.

> **Caution:**
> Residual amounts of oil may emerge during this operation.
> Used oil is dangerous waste.
> Observe safety regulations to prevent damage to the environment.



1

The speed pickup is fitted to the bottom right-hand side of the flywheel housing. Remove the mounting bolts from the retaining plate and take off plate together with the speed pickup.

Use cranking device to turn engine until the piston of the cylinder to be adjusted is at ignition TDC and the rocker arms are relieved.

The valves of the synchronous cylinder are then in cross-over.

Fig. 2

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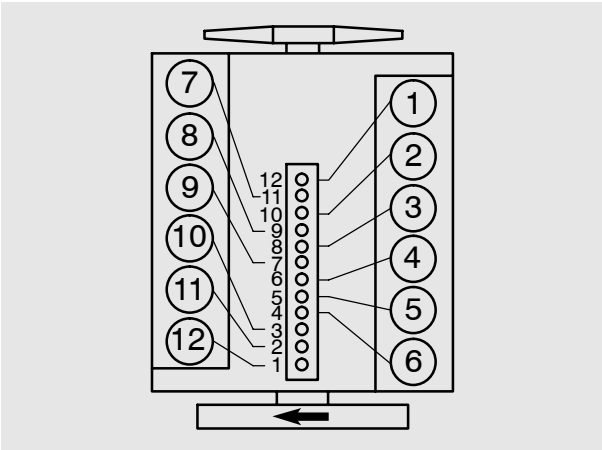


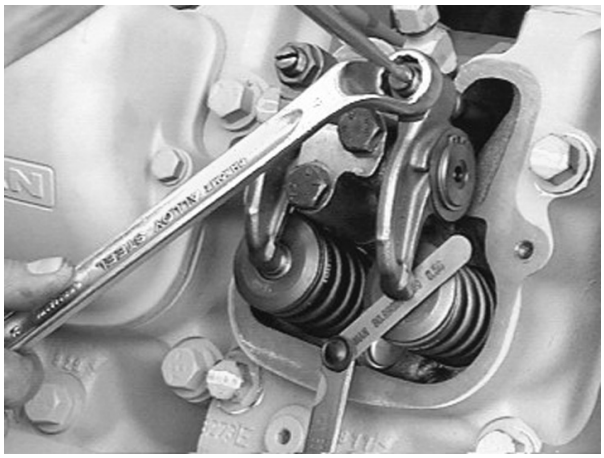
2

Set valves in the cylinder

1	12	5	8	3	10	6	7	2	11	4	9
6	7	2	11	4	9	1	12	5	8	3	10

Valves are in cross-over in cylinder

Fig. 3



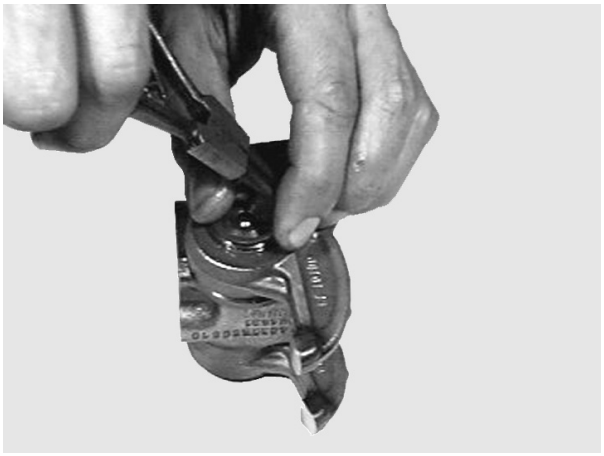
3

- Push feeler gauge between valve stem and rocker arm
- Loosen lock nut (17 mm) and turn adjusting screw with screwdriver until feeler gauge can be moved with slight resistance
- Tighten lock nut to the specified torque
- Check clearance again
- Refit cylinder head covers with new gaskets
- Tighten the bolts to the specified torque

Fig. 1

Remove rocker arms, see page 91.

Unclip circlip.



1

Fig. 2

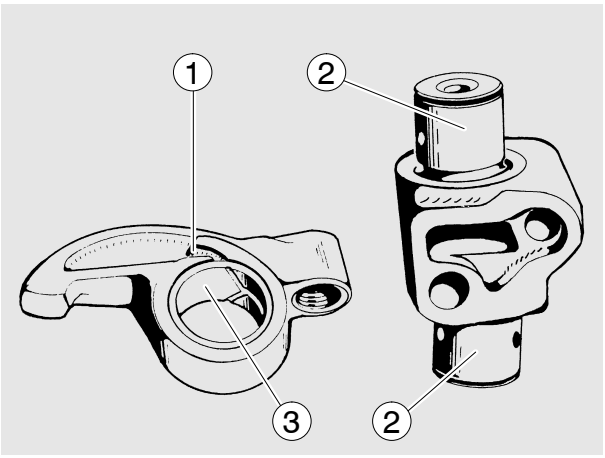
Take rocker arms off the rocker arm shaft.

Note:
If the rocker arm bearing bushes have to be exchanged, ready-to-install new or reconditioned rocker arms are to be used.

2

Fig. 3

Before fitting the rocker arms ① to the rocker arm shafts and brackets, coat sliding faces ② and ③ with Optimoly Paste White T.
This applies to both new and already used parts.



3

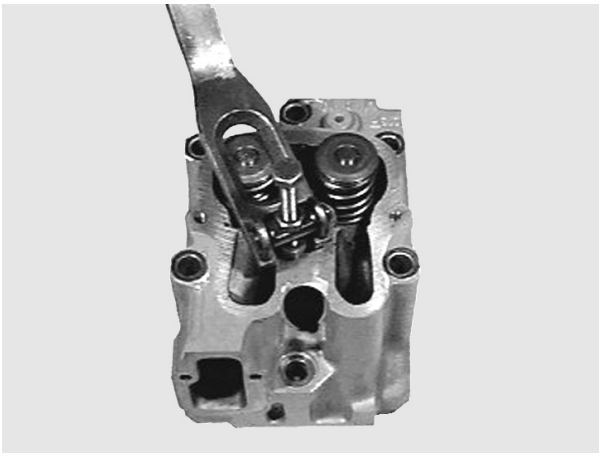
Removing valves

Remove rocker arms. Take off cylinder head, see page 91.

Fig. 1

Note:
Valve spring and valve spring retainer can also be replaced with the cylinder head installed.
For this purpose the relevant piston must be at TDC, and the valve assembly lever is required.

- Fit valve assembly lever to cylinder head
- Screw in setting screw so that the lever points slightly upwards

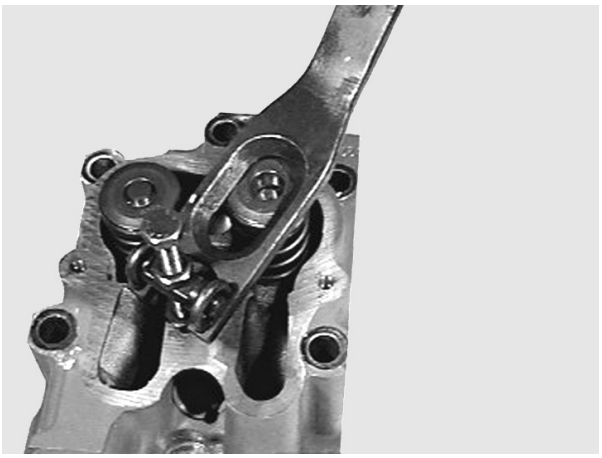


1

Fig. 2

Note:
If a valve fixture is available in the workshop, the procedure described may also be carried out on the said fixture.

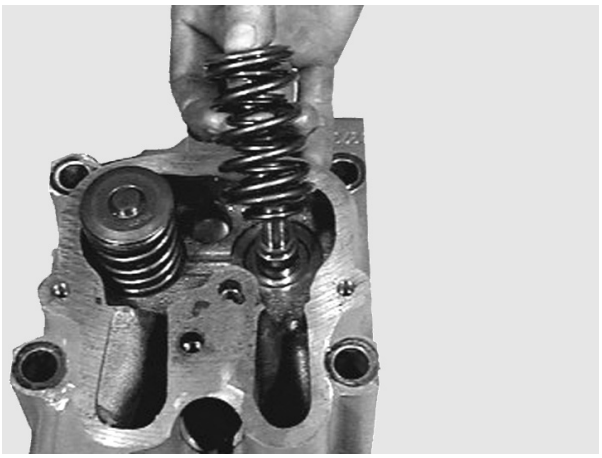
- Press spring plate and spring downwards with valve assembly lever and take out the valve cone pieces using a magnet
- Move assembly lever upwards – **Caution: spring under tension, risk of injury** – and away to one side



2

Figs. 3 and 4

- Take off the upper spring plate, the valve springs and the washer
- Turn cylinder head over. Pull out inlet and exhaust valves and put them aside, arranging or marking them in the sequence of installation
- Turn cylinder head over again and pull off valve stem seal (arrow)
- Check the valves for damage, if necessary exchanging them
- Measure the valve springs and exchange fatigued springs
- Check the valve stems and guides for scores and wear, if necessary measuring the guides with a plug gauge
- Check the valve seats for heavy indentation or signs of burn-out, if necessary grinding the valves or exchanging the seat insert
- Rework valve seat insert (see instructions of milling machine manufacturers), or if necessary exchange it



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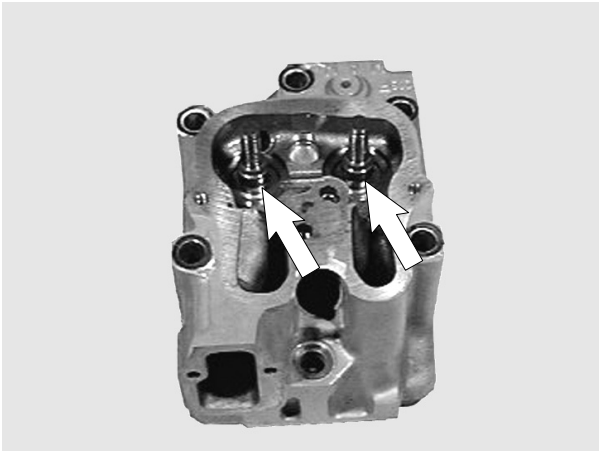


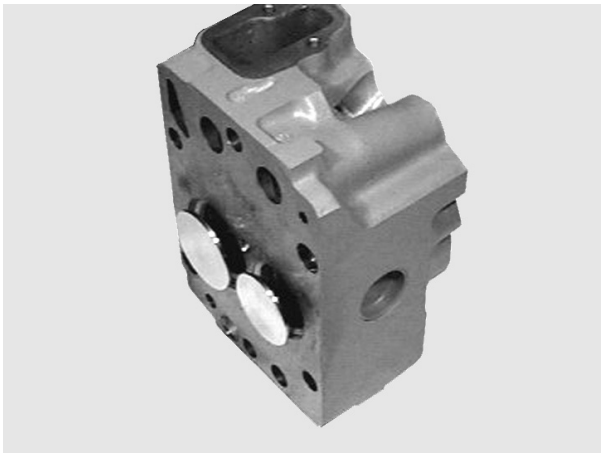
4

Installing valves

Fig. 5

Note:
Minor damage to the valve seat can be eliminated by lapping using valve lapping paste.
New valves must always be lapped until an even valve seat has been achieved.
Machine valve seat insert if necessary.

Turn cylinder head over and insert valve spring washers. Screw off valve assembly lever.

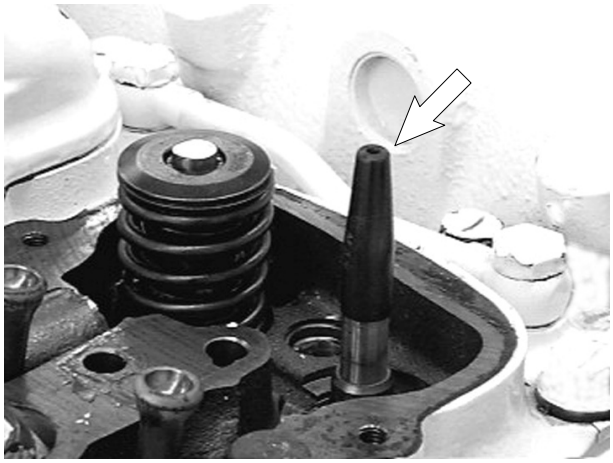


5

Fig. 6

Turn cylinder head over.

Place assembly sleeve for valve stem seals (special tool) on the respective valve.

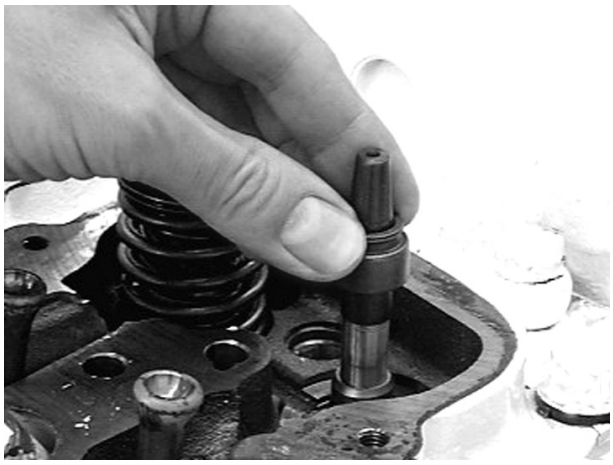


6

Fig. 7

Fit sealing ring.

Note:
Use new valve shaft seals only.

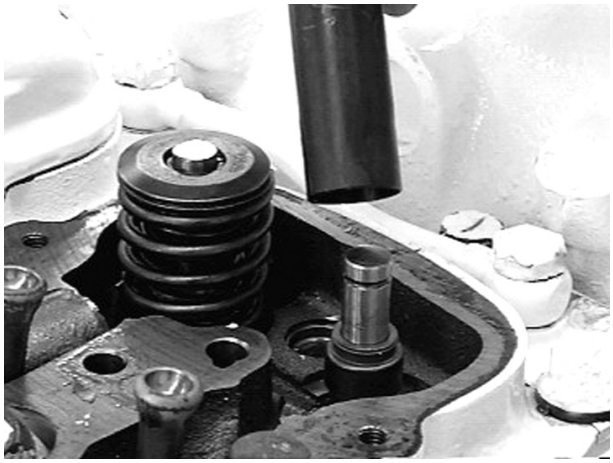


7

Fig. 8

Take off insert sleeve.

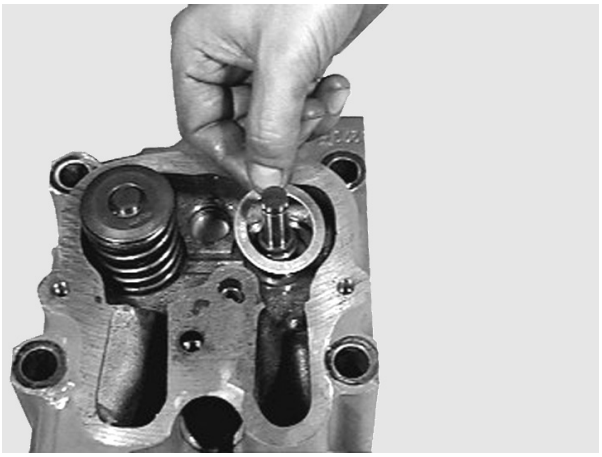
Fit press-in sleeve and press in seal.



8

Fig. 9

Screw valve assembly lever on to cylinder head.
Insert the valve spring washers.
Insert discs and valve springs.
The word “TOP” facing upwards, the tight coils facing downwards.
Replace damaged or weak springs.



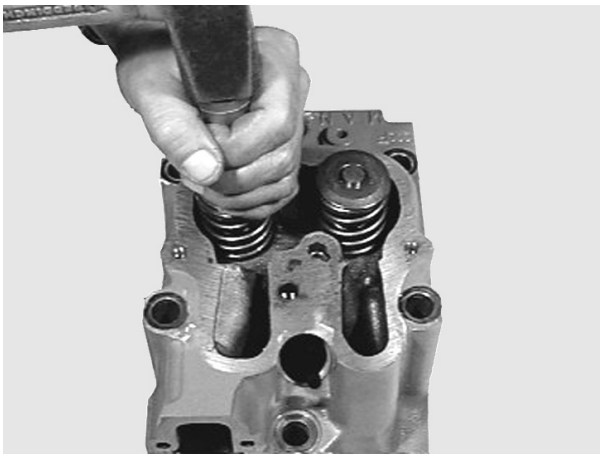
9

Fig. 10

Compress the valve springs using assembly lever and insert the valve cone pieces.

Use suitable tool to lightly knock back the valve springs to ensure that the valve cone pieces sit correctly.

Caution:
Ensure that the valve cone pieces sit correctly, since valve cone pieces which jump out may cause considerable damage.

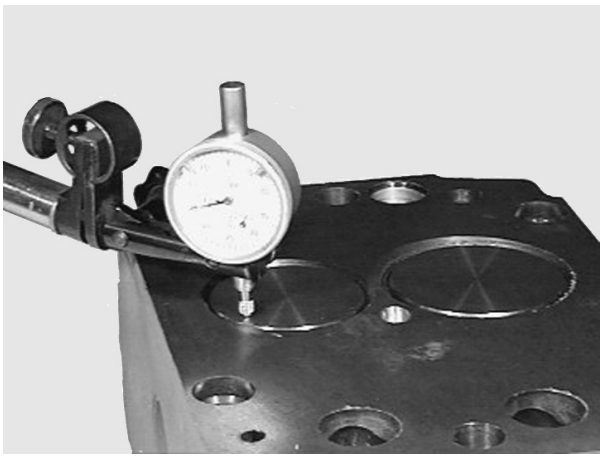


10

Measuring valve recess

Fig. 11

- Place dial gauge holder and dial gauge on cylinder head
- Apply gauge tip under preload to cylinder head
- Set dial gauge to “0”
- Slew dial gauge towards the valve disc and read off retrusion, if necessary exchanging valve and valve seat insert



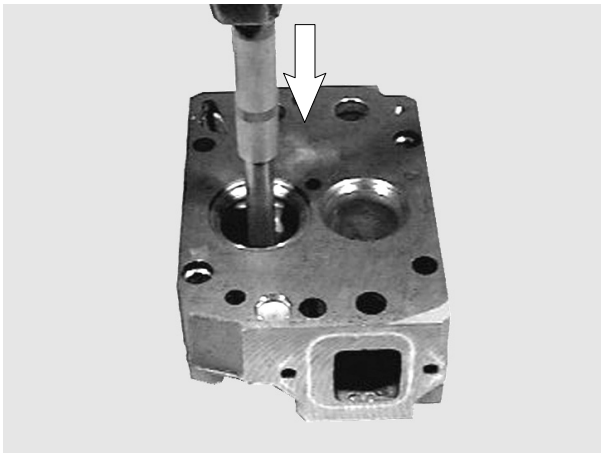
11

- Removing and installing cylinder head, see page 91
- Removing and installing valves, see page 97

Fig. 1

Press valve guide out of the combustion chamber side using pressing mandrel (special tool).

Oil new valve guide and drive / press it into the cylinder head using pressing mandrel and spacer sleeve (special tool).



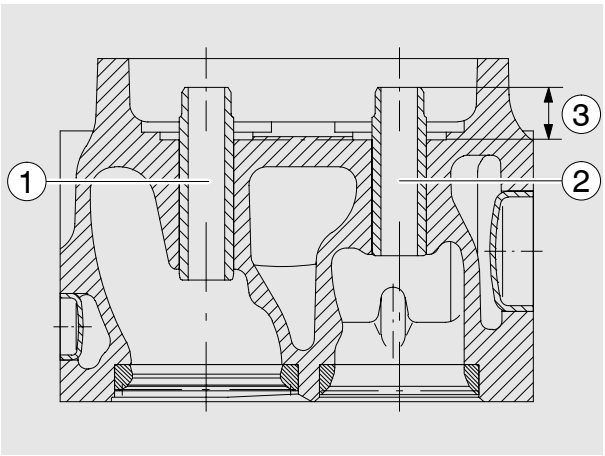
1

Fig. 2

The valve guides vary only in length.

1 Inlet
2 Exhaust
3 Press-in depth (see “Service Data”)

The correct press-in depth is obtained by using the spacer sleeve.
Afterwards ream valve guide to specified dimension.



2

Note:
When the valve guides have been changed, the valve seats too must be re-worked (see technical data and manufacturers’ instructions for valve seat lathes found in individual workshops).

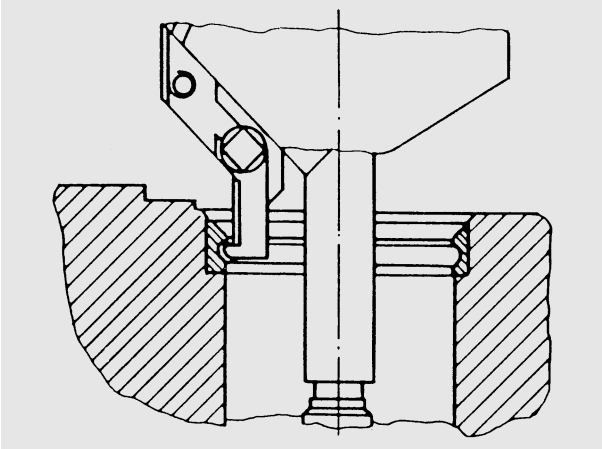
Removing valve seat insert

Note:
If the valve seat inserts have to be changed it is necessary to change the valve guides too, as otherwise exact refacing of the valve seat inserts after the replacement cannot be guaranteed. For these reasons previously mentioned the tool for removing and installing valve guides and valve seat inserts was also designed in such a way that if this tool is used valve seat inserts can be replaced only together with the valve guides, i.e. valve guides, however, can also be changed alone.

Fig. 1

Use a valve seat machining tool (valve seat lathe) to cut an approx. 3–4 mm wide groove in the valve seat insert.

Insert internal puller ① into the groove and tighten it.



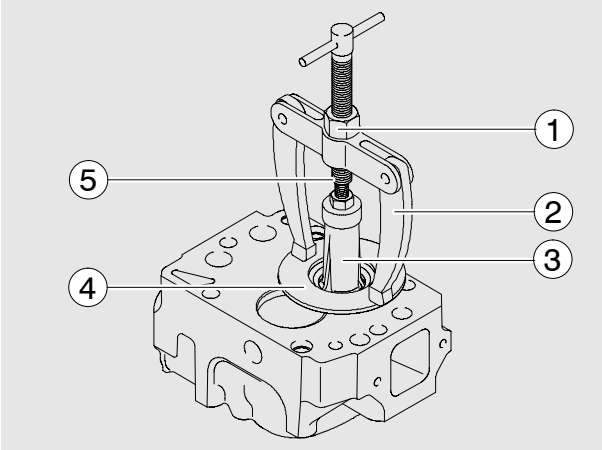
1

Fig. 2

Note:
To avoid damage to the cylinder head sealing face, lay disc ② or similar item under the arms ③ of the support.

Turn threaded spindle ④ into the internal puller ①, align the arms ③ of the support and pull out valve seat insert by turning the nut ⑤.

Clean contact face of the seat insert in the cylinder head.

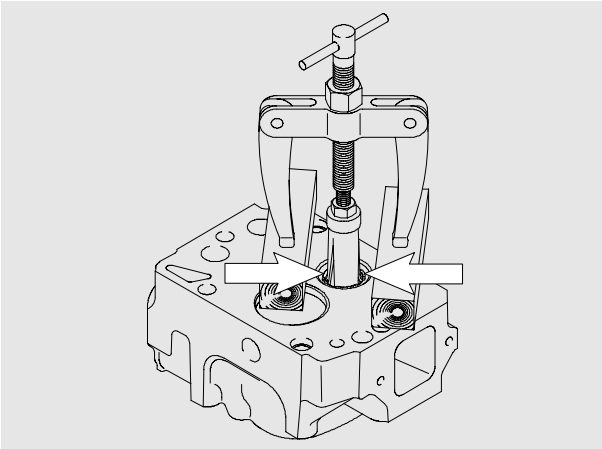


2

Fig. 3

If no valve seat machining tool is available, the following procedure may be followed:

- Apply circular weld bead on the valve seat using an arc welding set (arrows)
- then pull out valve seat insert
- Clean contact face of the seat insert in the cylinder head



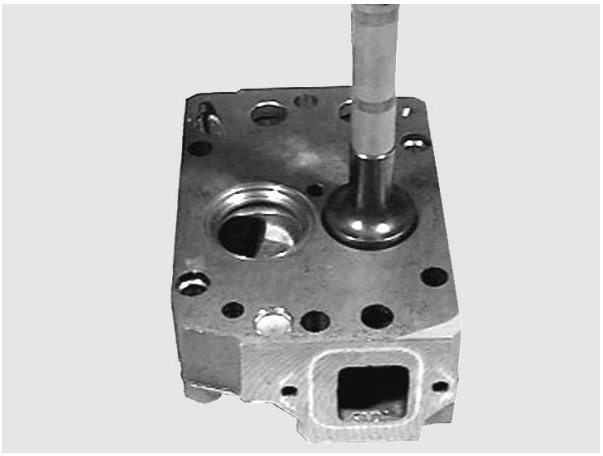
3

Installing valve seat insert

Fig. 4

Cool new valve seat insert down to approx. -200°C and insert it into the cylinder head (at an ambient temperature of approx. 20°C).
Carry out check by driving it in until the stop is reached using pressing tool.
Install valve guides.

Note:
When the valve seat inserts have been changed, the valve seats must be reworked.



4

Note:

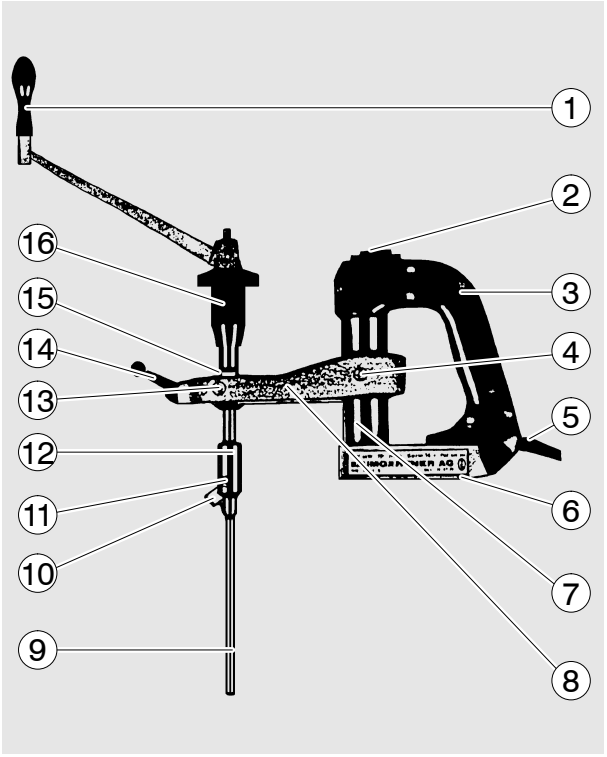
- After temperature equalization, machine valve seats
- After machining, clean cylinder head and check for leaks using leak testing device
- f the cylinder head is excessively heated (above +200°C, +390°F) the core hole covers (end covers) loose their tightness and must be exchanged
- To do this, clean core holes, blow out channels and press in new core hole covers with “LOCTITE 648” and pressing mandrel

Reworking valve seat

(with Mira precision valve seat machining device)

Fig. 1

1 Feed nut with mm scale
2 Guide ball
3 Jaccard lever
4 Lubricating nipple
5 Rotary head
6 Hex socket screw
7 Tool
8 Guide mandrel
9 Driving crank
10 Toggle switch
11 Handle
12 Lubricating nipple
13 Mains connection
14 Magnetic flange with coil
15 Guide pipe
16 Slewing arm



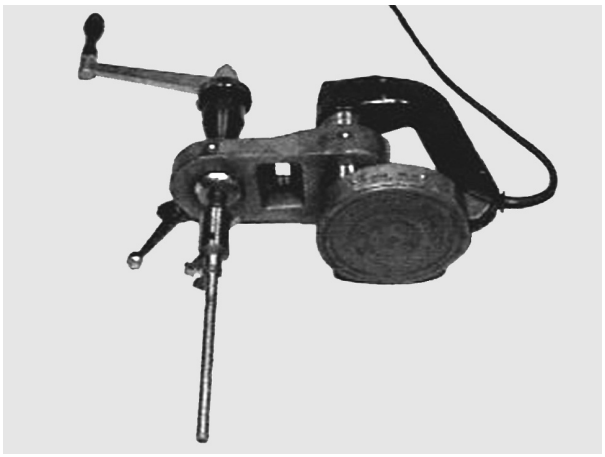
1

Fig. 2

Select suitable guide mandrel, screw it in with a spanner (12 mm) and tighten it.

Note:
For extreme precision work the guide mandrel must fit snugly.

Select and insert the tool with the corresponding seat width and the corresponding seat angle.

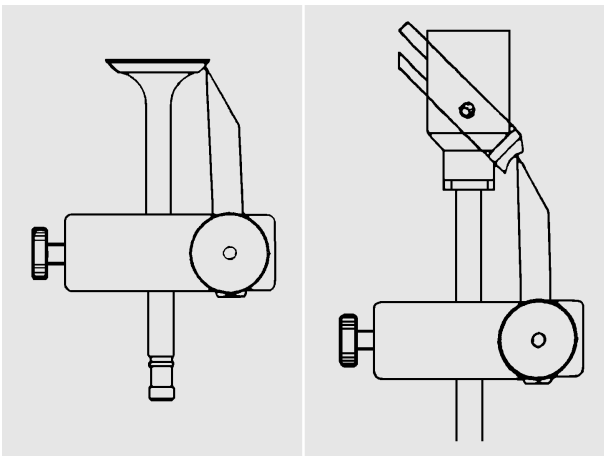


2

Fig. 3

Set the tool with a setting gauge and tighten it with the hex socket screw.

Insert unit with guide mandrel into the valve guide.



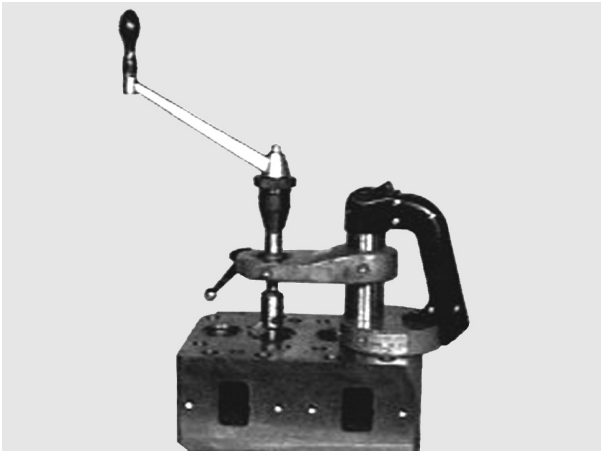
3

Fig. 4

Release Jaccard lever, place magnetic flange flush on the clamping plate and set the height so that the tool does not contact the valve seat.

Set toggle switch to position 1.

Tighten the Jaccard lever.

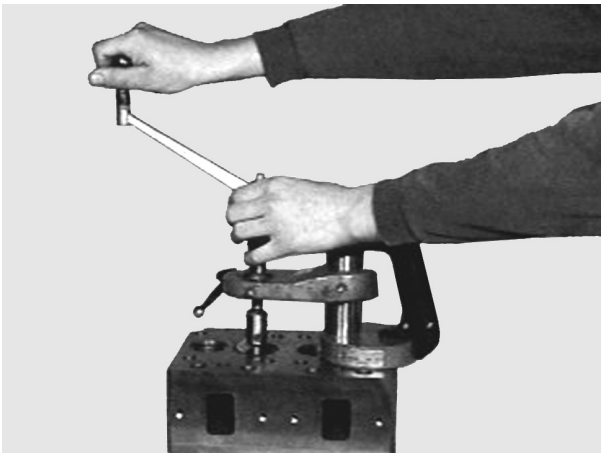


4

Fig. 5

Machine the valve seat by turning the driving crank evenly in clockwise direction and simultaneously operating the feed nut.

Caution:
During the machining process turn the driving crank vigorously and evenly but under no circumstances against the direction of turning, as otherwise the carbide cutting edge may break.



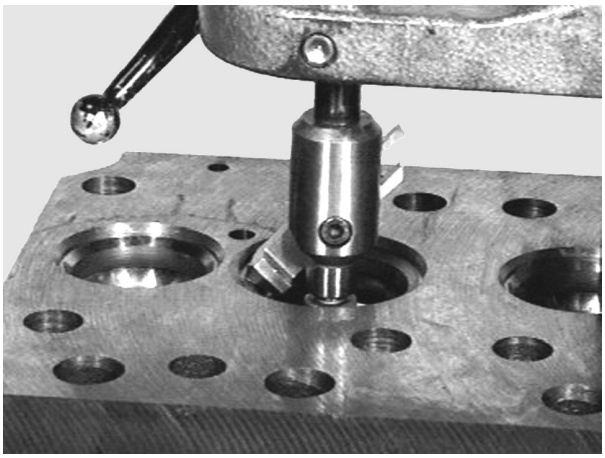
5

Fig. 6

Once the valve seat has been expertly machined, reduce the working pressure of the tool by 2-3 revolutions without feed motion.
During these revolutions turn the feed nut 2-3 revolutions back.

Press toggle switch briefly to position 2 to lift the magnetic field.

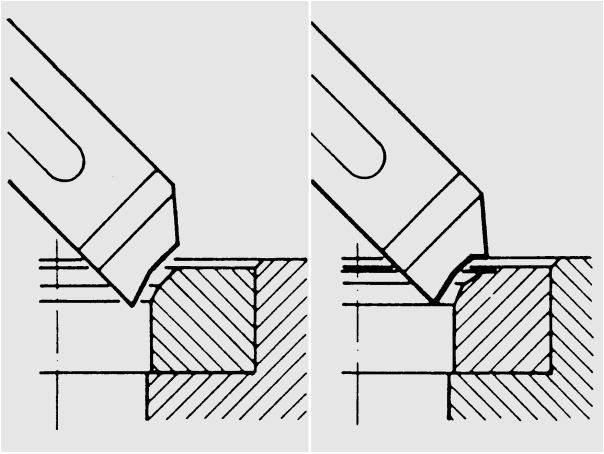
Now move the whole Mira unit out upwards and insert it into the next valve guide, repeating the centering operation.
Use the same tool settings for all intake and all exhaust valve seats (see below).



6

Fig. 7

Observe specified seat angle.



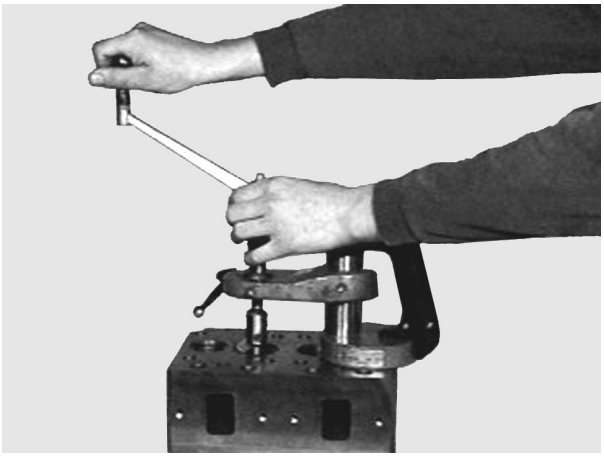
7

Fig. 8

Note:
When dressing the valve seat inserts, remove as little material as possible from the seat face.
The valve retrusion is to be used as reference value.

If the cylinder head interface is to be machined (max. 1 mm), the seat inserts must be reworked to achieve the valve retrusion.

If new valves and seat inserts are used, increase the depth of the seat bore in the cylinder head according to the amount of material removed from the cylinder head interface.

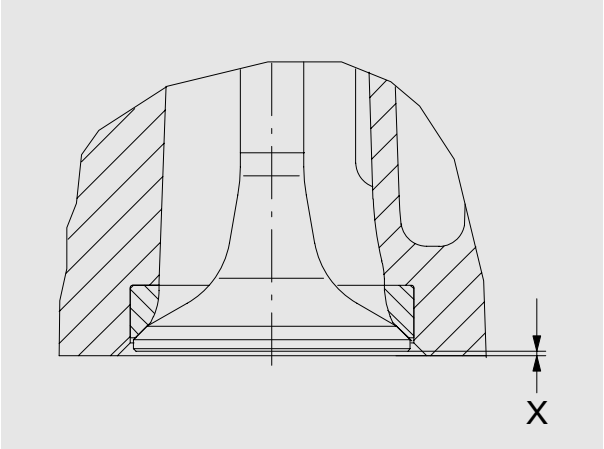


8

Fig. 9

The valve seat insert must be changed if as a result of the cylinder head interface and the valve seat insert having been machined the theoretical valve seat is too deep in the cylinder head or the seat face has become too wide.

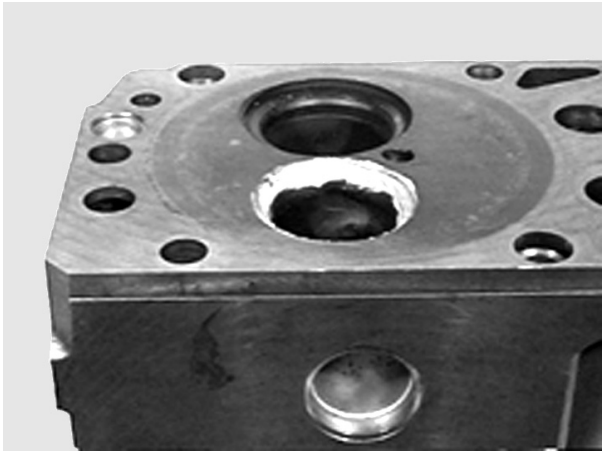
Ensure that the valve recess (X) is correct, see publication “Service Data”.



9

Fig. 1

Apply abrasive paste to tapered area on the valve seat.
Oil valve guide and insert valve.

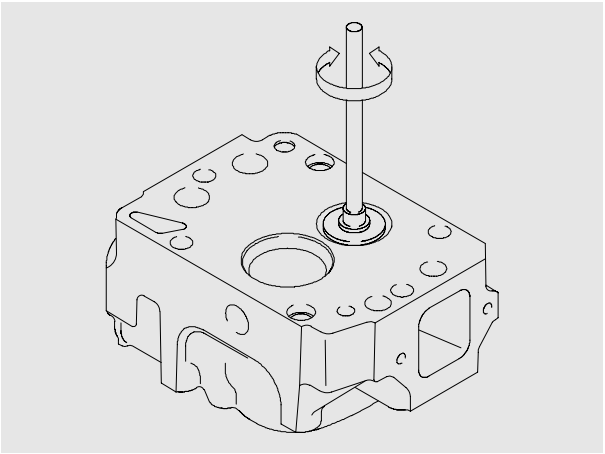


1

Fig. 2

Use valve refacer to reface valve seat by applying moderate axial pressure and describing a turning motion.

Caution:
Keep valve stem and valve guide free of abrasive paste.

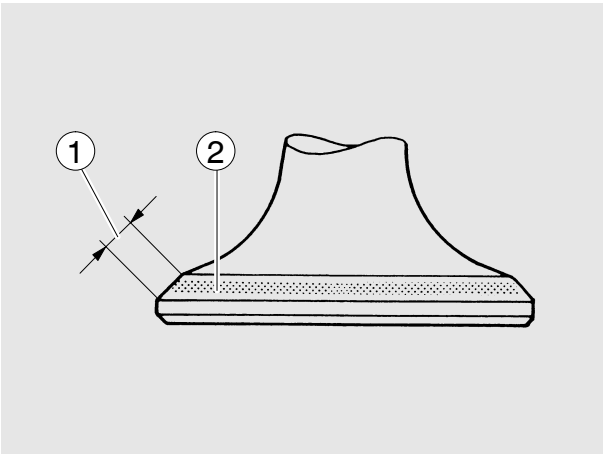


2

Fig. 3

The valve seat must have a faultless, closed grinding pattern ②.
The grinding pattern width is correct if the valve seat insert is in order.

1 Valve tapered area
2 Valve seat

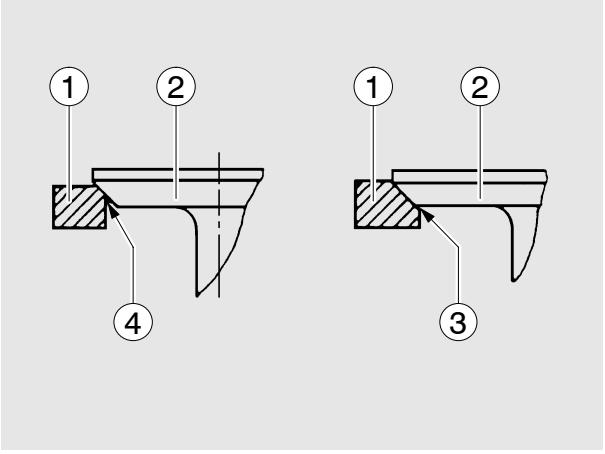


3

Fig. 4

1 Valve seat insert
2 Valve
3 Valve seat good
4 Valve seat too wide

Note:
Valve seats which are too wide tend to accumulate coking residues,
– valves become leaky –
Valve seats that are too small prevent rapid discharge of heat from the valve disc to the cylinder head,
– valves burn –

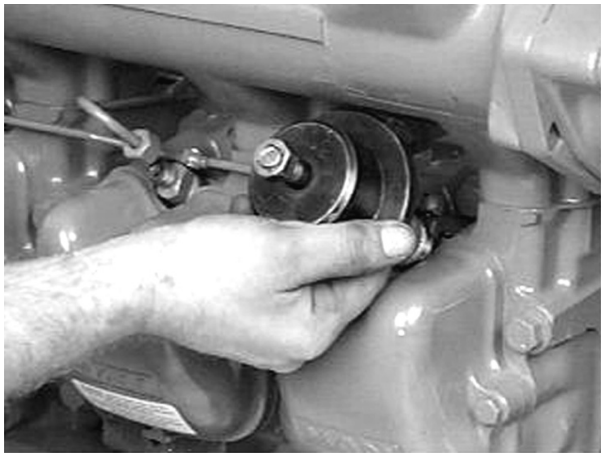


4

Fig. 1

- Check valve clearance and adjust, if necessary, see page 95
- Let engine run until coolant temperature reaches approx. 60–80°C
- Remove all fuel injectors, see page 37
- For compression guideline values, see publication “Service Data”

Start with 1st cylinder. Insert new seal, screw on test connection of compression recorder with union nut and tighten with pin spanner.



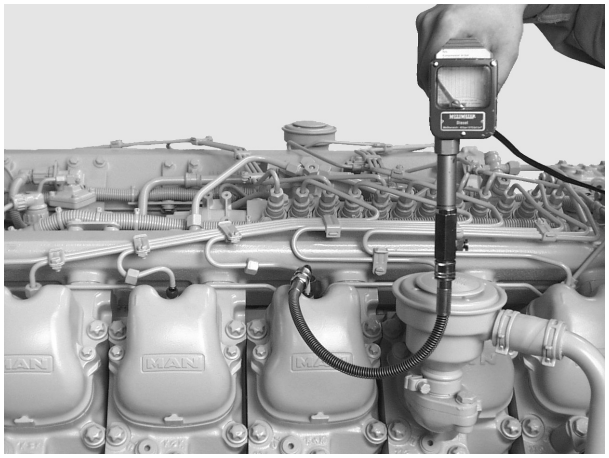
1

Fig. 2

Screw compression recorder for diesel engines on to test connection. Insert test sheet into compression recorder.

Turn engine over by means of starter until the pointer of the compression recorder is not deflected any further.

Connect up compression recorder with test connection to the next cylinder, and check all cylinders as described above.

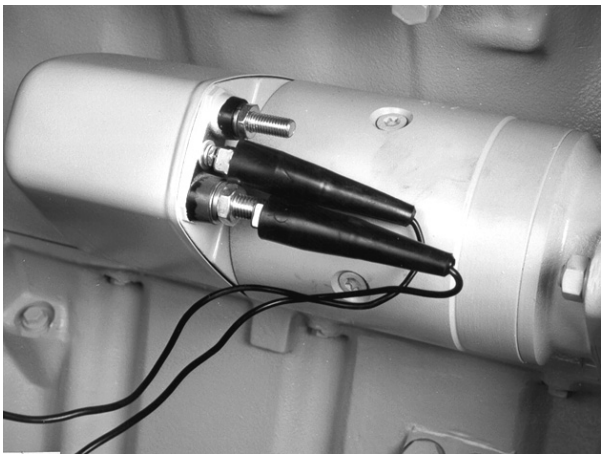


2

Fig. 3

Depending on the compression recorder design, the engine can also be started directly by the compression recorder.

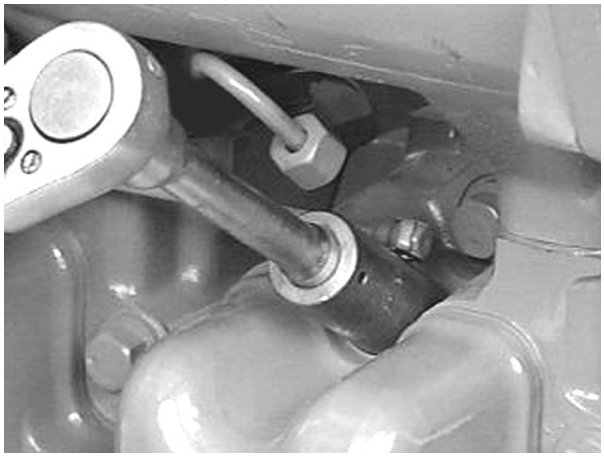
For this purpose the electrical connections on the starter electromagnetic switch (terminals 50 and 30) are to be accordingly connected up.



3

Fig. 4

Compare the values measured and remove compression recorder and test connection. Apply “Never Seeze” to contact faces on fuel injectors. Screw in fuel injectors with nozzle and new seal. Screw on union nut and tighten to specified torque. Connect up injection lines and leakage fuel return lines.



4

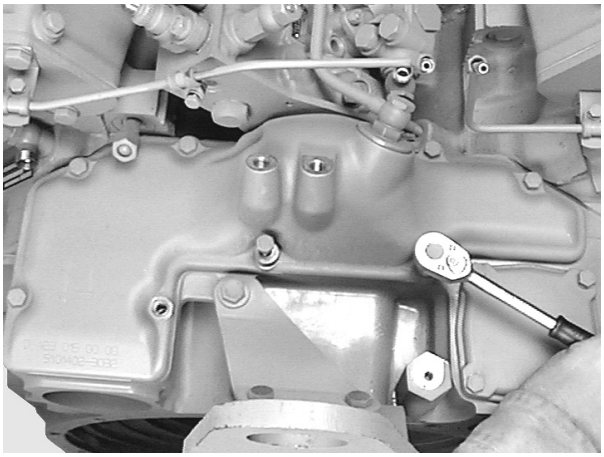
Removing timing case

- Remove starter, see page 128
- Removing flywheel, see page 75
- If necessary removing air compressor, see page 132
- If necessary, remove the charge-air pipe between the intake pipes, see Page 80

Fig. 1

Oil and coolant lines, brackets for cable harnesses etc are attached to the timing case; these items have to be removed.

Remove timing case cover.

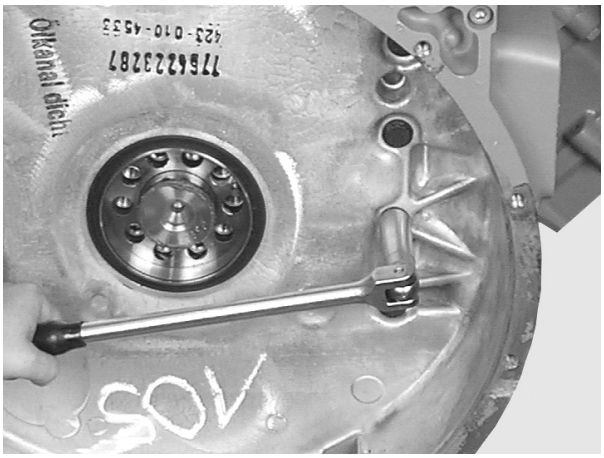


1

Fig. 2

Remove mounting bolts from timing case.

The timing case is bolted to the oil pan at the bottom.
Remove the mounting bolts from the oil pan.



2

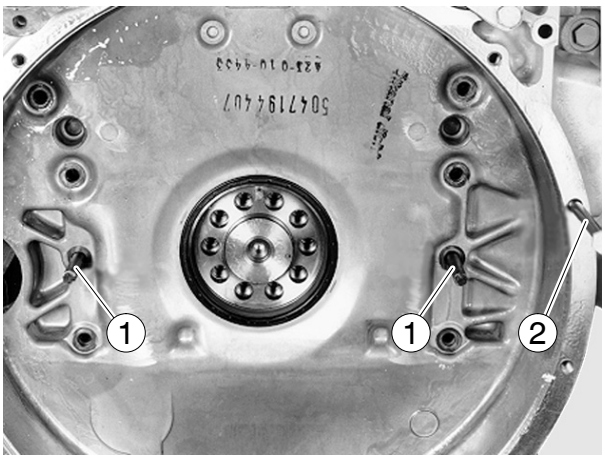
Fig. 3

Danger:
The timing case is heavy

To facilitate assembly, two facing bolts may be inserted by means of guide pins ① (M12x1.5).

Two long M10 bolts ② screwed into the dead-end holes in the flange-on face facilitate handling the timing case.

Remove timing case.



3

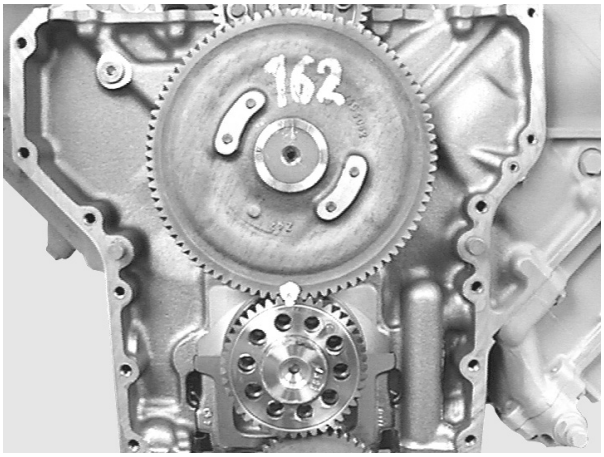
Installing timing case

Fig. 4

Clean contact face on crankcase of sealing residues. Fit a new seal, sticking it on with a small amount of grease if necessary.

Guide timing case on to the alignment pins and bolt it into place.

Ensure that the oil pan gasket is in order, if necessary exchanging it.



4

Fig. 5

Tighten bolts to specified torque.

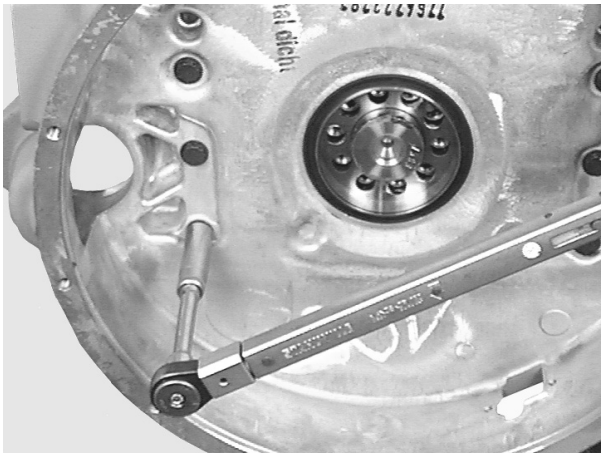
Tighten the mounting bolts of the oil pan.

Remove seal residues from sealing face of timing case cover.

Screw on timing case cover with new seal.

Fit the oil and coolant lines.

Refit all components previously removed.



5

Removing camshaft

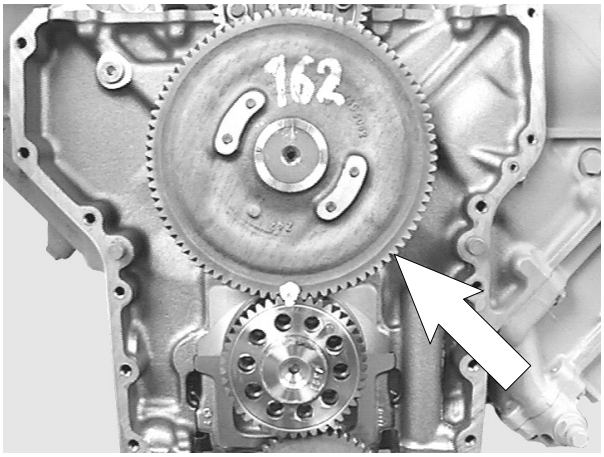
- Drain coolant, see page 46
- Remove oilpan, see page 65
- Remove starter, see page 128
- Remove flywheel and timing case, see page 75
- Remove the rocker arms and take out the push rods, see page 91

Note:
For removing the camshaft the engine must be turned by 180°. For this reason the engine must be placed on a dolly.

Fig. 1

Turn engine upside down so that the valve tappets do not obstruct removal of camshaft.

Pull out camshaft; ensure that the camshaft bearings do not get damaged.
Check camshaft for wear and damage, if necessary exchanging it.
If the camshaft or the drive gear is damaged, a new entire camshaft / gear unit must be fitted.

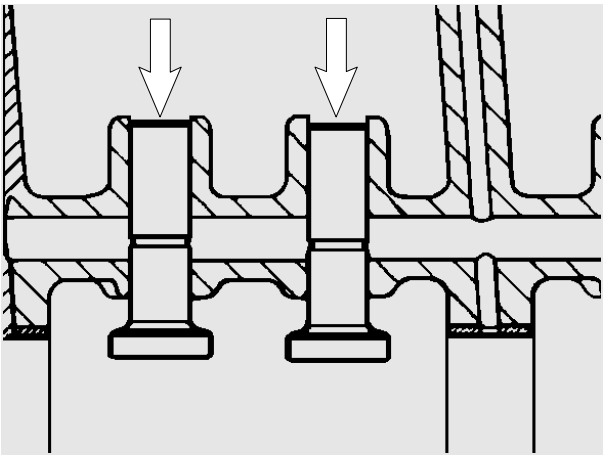


1

Fig. 2

Push push rods out of the guide using a suitable mandrel, check them for wear, if necessary exchanging them.

Push rods can be removed only if the camshaft is removed first.


2

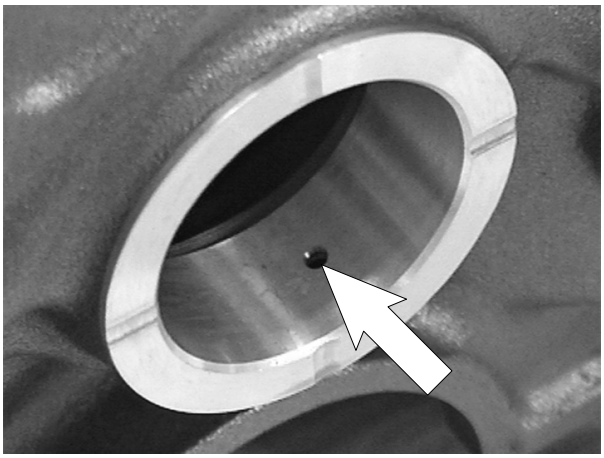
Exchanging camshaft bearings

Fig. 3

Knock out the camshaft bearing bushes using a suitable mandrel and knock in the new bushes until flush.

Ensure that the position of oil supply bore (arrow) is correct.

Note:
The axial camshaft stop is located behind the last camshaft bearing bush on the timing case side.
Owing to the helical gearing of the drive gear, the camshaft is always pulled against this stop.


3

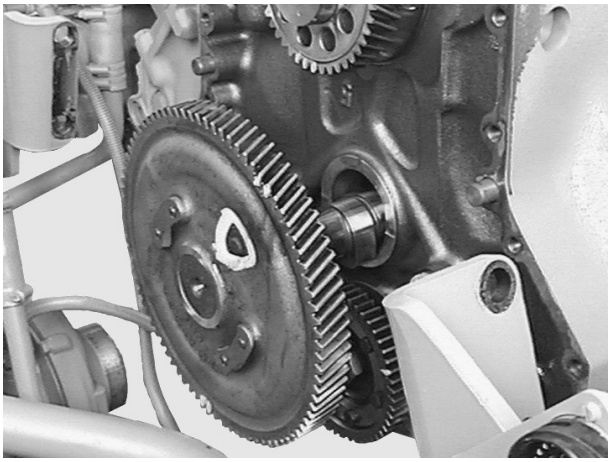
Installing camshaft

Fig. 4

Oil and insert the push rods.

Oil the camshaft bearing bushes.
Apply oil to camshaft and insert it carefully.

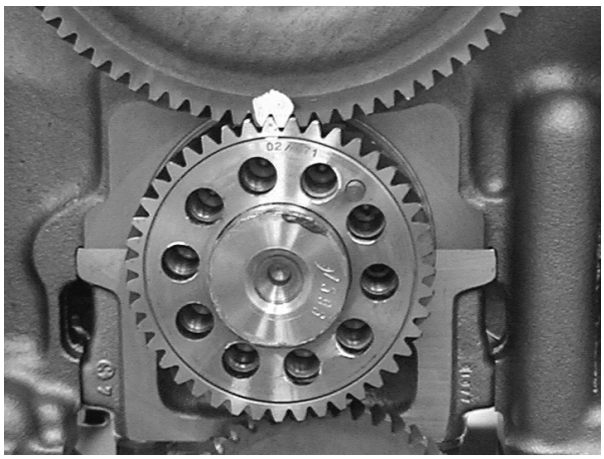
Caution:
Ensure that the bearings do not get damaged.



4

Fig. 5

Ensure that the marks on the crankshaft and the camshaft gear match.

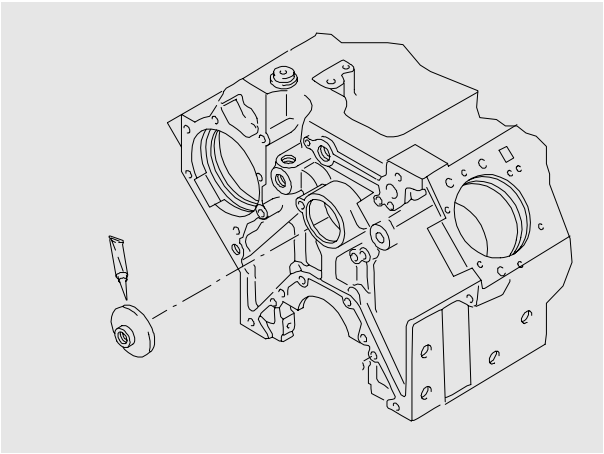


5

Fig. 6

If the camshaft cover has been removed from the crankcase, it is to be inserted as follows:

- Remove grease from bore and cover
- Apply “Hylomar” sealing agent to bore and cover including chamfer
- Carefully press in cover, taking care not to tilt it so that it jams
- Ensure that there is no oil leakage



6

Measuring camshaft axial clearance

Fig. 7

Remove screw plug or angle drive for tachometer from camshaft cover.

Apply feeler of dial gauge to end of camshaft or to driving dog for tachometer.

Set dial gauge to zero.

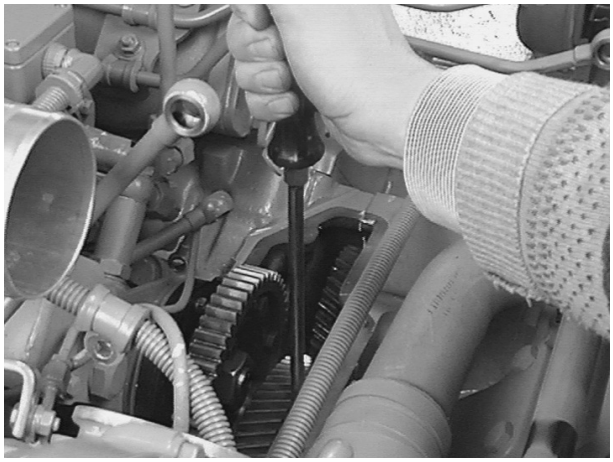
7

Fig. 8

Use suitable lever to press camshaft up to stop on timing case.

Push camshaft forwards against the dial gauge feeler until stop is reached. The dial gauge reading equals the camshaft axial play.

Refit all removed parts.
Fill up with engine oil and coolant as specified.
Check delivery start and valve clearance.

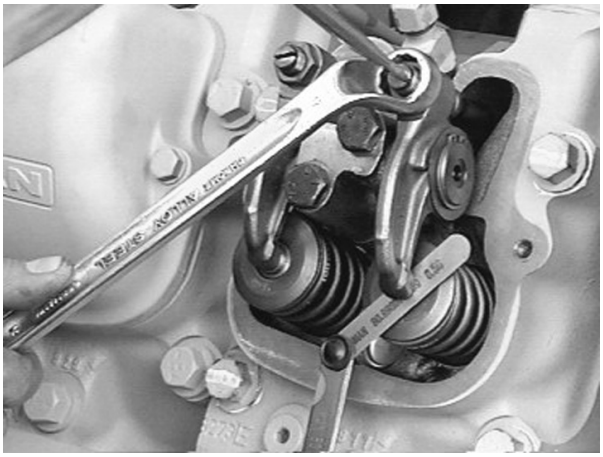


8

Note:
If the valve timing is incorrect, serious damage to the engine may result.
For this reason, if faults occur in the engine which could lead to the shrunk-fitted camshaft gear turning, check that the gear is correctly seated by checking the valve timing.
Carrying out a check after installation of the camshaft is also recommended.

Fig. 1

Remove cylinder head cover from 1st cylinder.
Set valve clearance of cylinder 1 correctly.

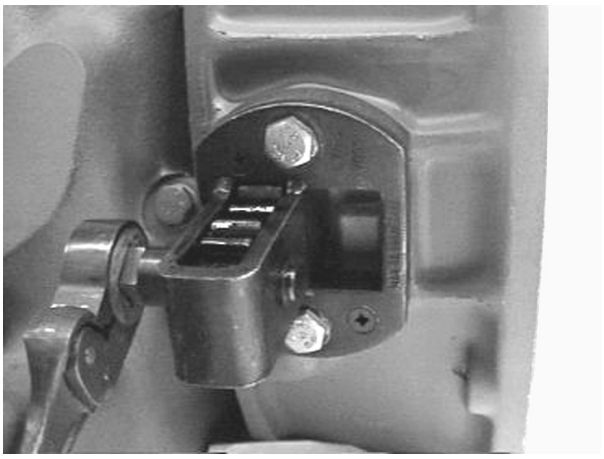


1

Fig. 2

Turn engine over with cranking device until the valves of cylinder 1 are in cross-over.

Turn engine back to approx. 50° before TDC, then forwards to 30° before TDC (observe graduation on flywheel).



2

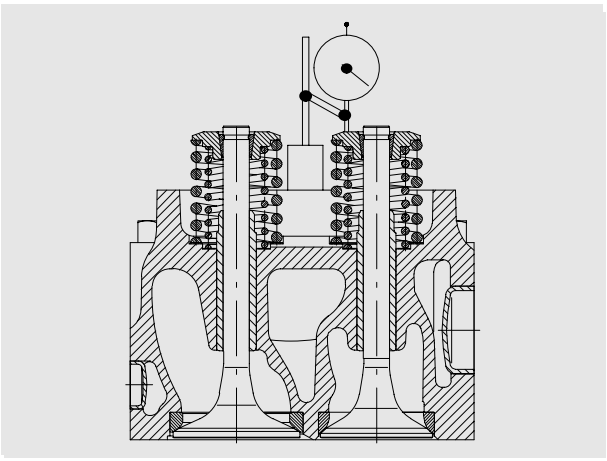
Fig. 3

Apply dial gauge with approx 2 mm preload to valve spring retainer of exhaust valve in 1st cylinder and set to “0”.

Turn engine in running direction through 180° (exhaust valve fully closed).

Read valve stroke from dial gauge.

The valve stroke must be between
4.5 and 5.4 mm.



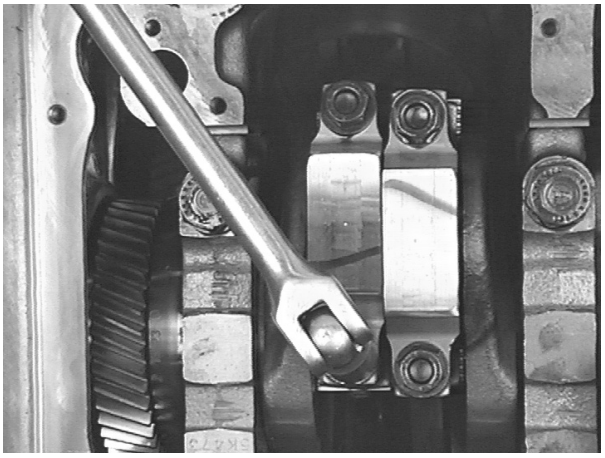
3

Removing crankshaft

- Remove oil pan and oil pump, see page 65
- Remove timing case, see page 108
- Remove front cover with crankshaft seal, see page 71

Fig. 1

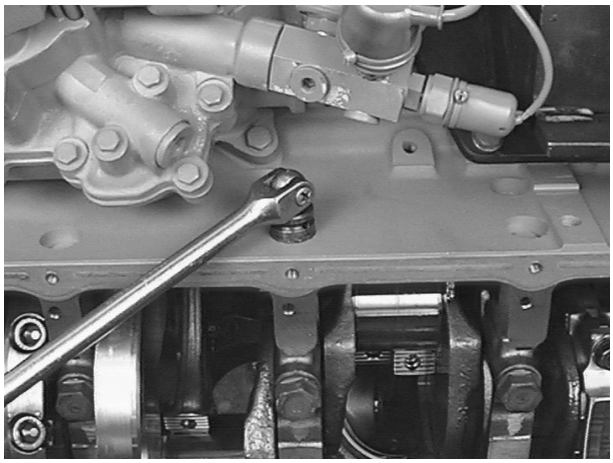
Remove the bolts from the connecting rod bearing covers and put the covers aside, arranging them in the sequence of installation.
Removing piston with connecting rod, see page 117.



1

Fig. 2

Remove horizontal bolts from crankshaft bearing caps.



2

Fig. 3

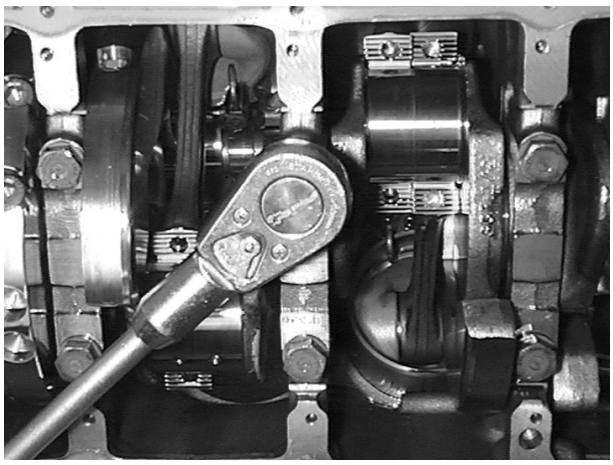
Loosen and remove mounting bolts from crankshaft bearing caps in stages from the inside out. Take off bearing caps and arrange them in order of installation.

Take the bearing shell halves out of the bearing caps and lay them aside together with their respective bearing caps.

Lift out crankshaft.

Caution:
Do not damage the rolling surfaces of the crankshaft bearing pins.

Take the bearing shells out of the crankcase and lay them aside in the sequence of installation. Clean parts and check for wear, replacing them if necessary.

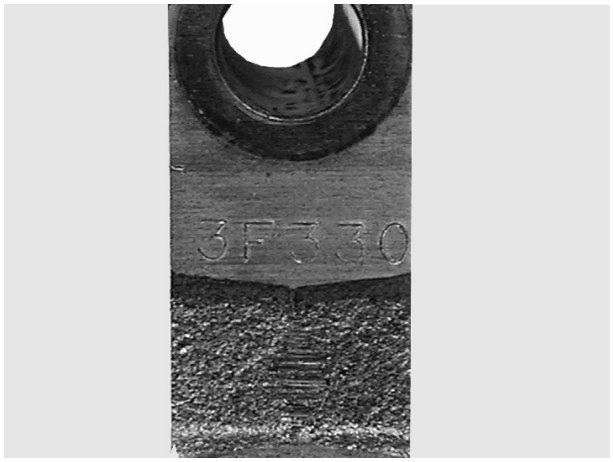


3

Fig. 4

The bearing covers are marked with regard to their sequence of installation.

Note:
Crankshaft bearing no. 1 is located at the non-flywheel end.



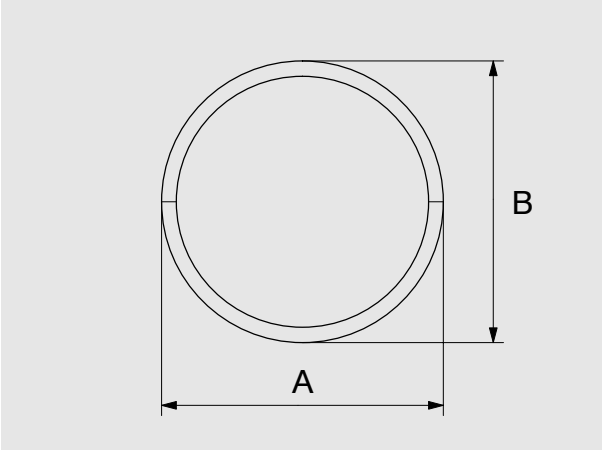
4

Checking spread of bearing shells

Fig. 5

Position bearing shells together on flat surface. Measure and note down spread dimensions “**A**” and “**B**”.

Spread dimension = A–B



5

Installing crankshaft

Fig. 6

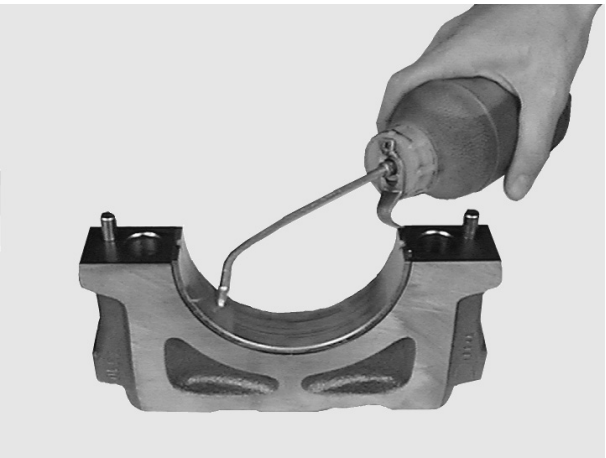
Clean oil ducts in crankcase and in crankshaft with dry compressed air.

Thoroughly clean bearing shells and bearing journals.

Install bearing shells in crankcase, observing the numbering.

Caution:
Observe relevant repair stage when using new bearing shells.

Apply oil to the running surfaces on the bearing shells and install crankcase, ensuring that the markings on the crankshaft and camshaft gears coincide.


6

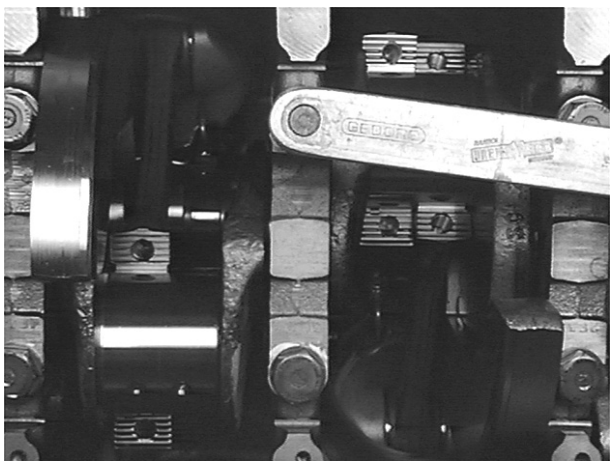
Figs. 7 and 8

Check whether the bearing cover bolts comply with the max. permissible length (see “Service Data”). Bolts previously removed may be reused if the max. permissible length is not exceeded.

Reassemble bearing caps with associated bearing shells. Insert vertical bearing cap screws and tighten to specified torque in stages from the inside out.

Tighten finally by angle.

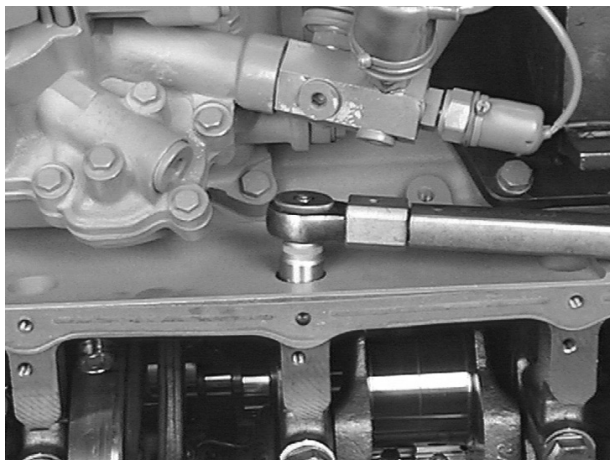
Insert horizontal crankshaft bearing cap screws and tighten to specified torque.


7

Caution:
As replacement for the lateral crankshaft bearing cap bolts now use only collar bolts 51.90020–0382 (M12x1.5x85, 12.9).
Previously used bolts of other types must be replaced by these bolts.

Check to see that crankshaft runs smoothly.

Caution:
Faulty bearing caps cannot be replaced singly.

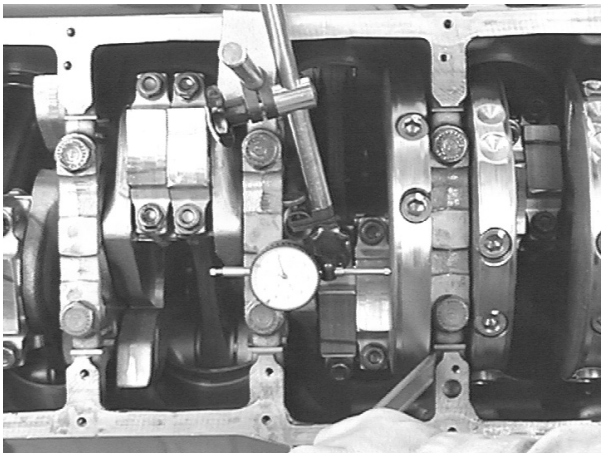

8

Checking axial clearance

Fig. 9

Note:
The axial clearance of the crankshaft depends on the crankshaft bearing at the flywheel end (thrust bearing).

- Fit dial gauge holder with dial gauge to crankcase
- Apply dial gauge tip to crankshaft
- Move crankshaft in axial direction to and fro and read off clearance on dial gauge
- If permissible axial clearance is exceeded, replace main bearing shells complete



9

Fig. 10

Measure connecting rod bearing, insert pistons with connecting rod. Coat connecting rod bearing shells with oil and pull connecting rods to bearing pin.

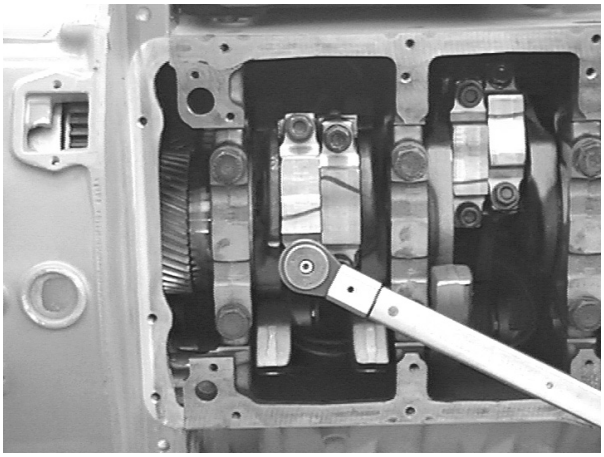
Mount connecting rod bearing caps with bearing shells (observe marking - numbers must be on the same side).

Screw in mounting bolts and tighten in stages to specified torque.

Tighten finally by angle.

(For tightening torques and reusability of bolts, see “Service Data”).

Attach oil pan and other add-on parts.



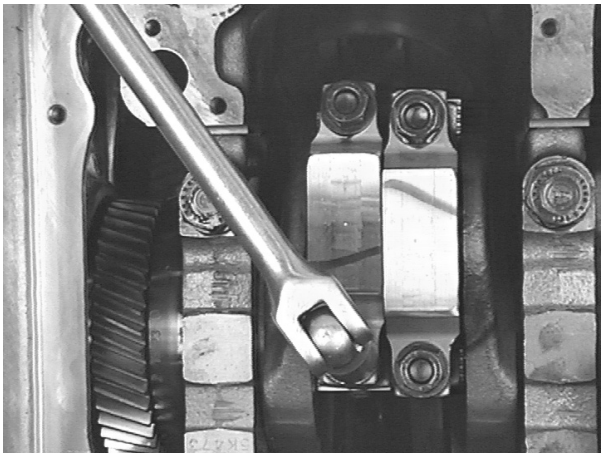
10

Removing piston with connecting rod

- Drain engine oil, see page 65
- Removing cylinder head, see page 91

Fig. 1

Remove bolts from connecting rod bearing cap.



1

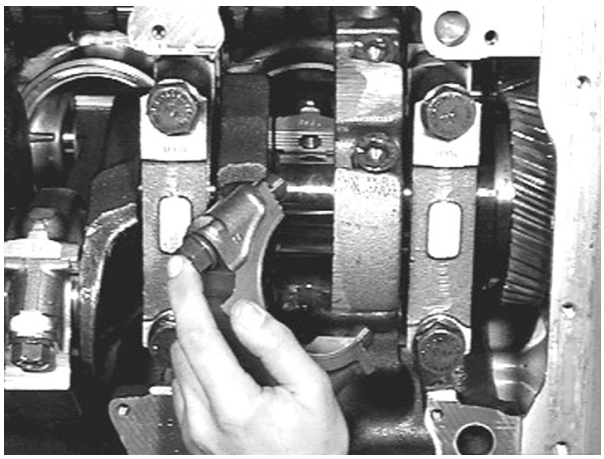
Fig. 2

Take off connecting rod bearing caps with bearing shells, expediting the procedure by means of light strokes with a synthetic hammer if necessary.

Note:
Connecting rod bearing caps are match-marked with the connecting rod big ends; arrange them in corresponding order.

Remove combustion residues (oil carbon) from top cylinder edge using a piece of hard wood.

Caution:
Do not damage cylinder liners.

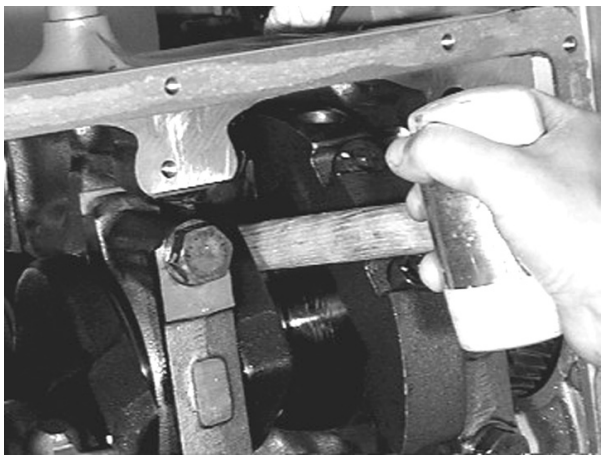


2

Fig. 3

Push out connecting rod with piston in upward direction.

Caution:
Do not damage oil spray nozzles.



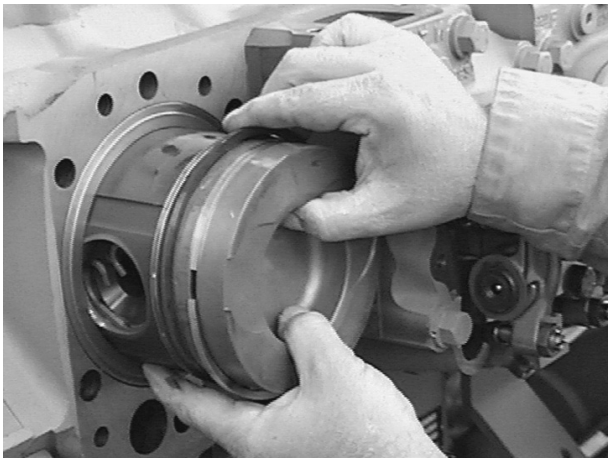
3

Fig. 4

Lay pistons with connecting rods and associated caps aside; use deposit rack if available.

Inspect pistons and piston rings visually.

Note:
For reworked crankcase sealing faces repair pistons with undersizes of 0.2, 0.4 and 0.6 mm in the compression height are available (see “Service Data”).

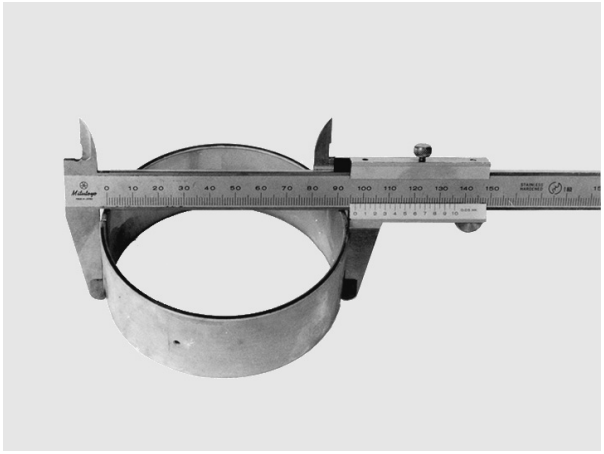


4

Installing piston with connecting rod

Note:
If the pistons must be changed, ascertain by measuring the pistons or reading the measurement on the top of the piston whether undersized pistons were installed.
If this is the case, undersized pistons must be used.

Fig. 5



5

Check bearing shells for wear and damage.
Measure the spread as for main bearing shells.
Install new bearing shells if necessary.
When repairing connecting rod bearing journals, use bearing shells of the corresponding repair stage.

Fig. 6

6

Insert bearing shells into the connecting rods or connecting rod bearing caps.

Caution:
The rod shell has a red or yellow mark on the side.

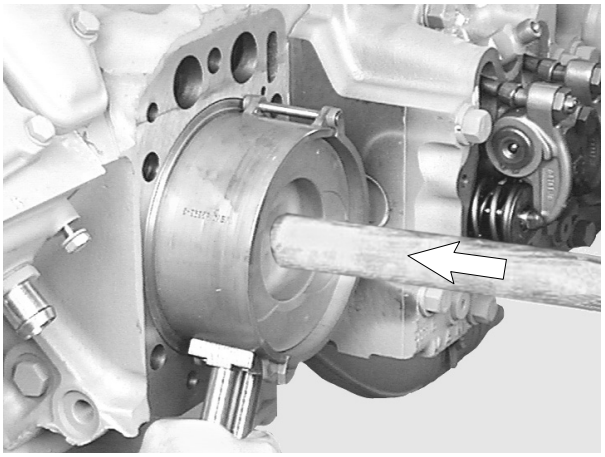
The top coat must not be damaged.
Apply a thin coat of oil to the connecting rod bearing shells.

Fig. 7

7

Apply a thin coat of oil to the cylinder liners and pistons.
Arrange piston ring gaps with an offset of approx. 120°.
Apply piston ring tightener and tighten piston rings.

Fig. 8



8

Insert the pistons so that the recess on the piston skirt points towards the oil spray nozzle.
Guide connecting rod and insert piston until connecting rod big end contacts the connecting rod bearing journal.

Caution:
Do not damage oil spray nozzles.

Fig. 9

The arrow on the top of the piston must always point towards the engine centre, i.e. towards the injection pump.

9

Fig. 10

Put connecting rod bearing caps in place.

Caution:
The numbers on the connecting rod bearing cap and connecting rod big end must be on one side.

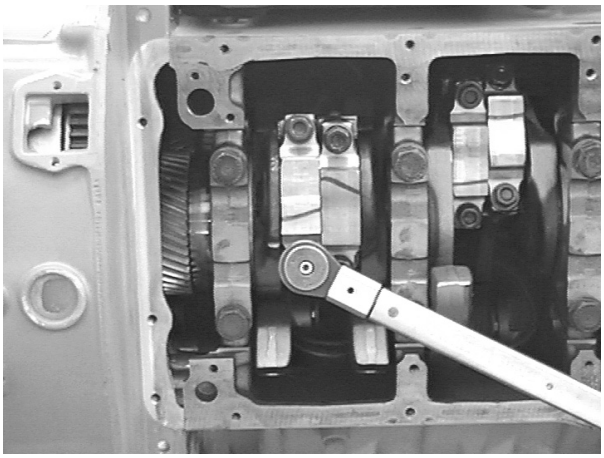
10

Fig. 11

Screw in connecting rod bearing bolts and tighten them in stages to specified value.

Tighten finally by angle.

For tightening torques and reusability of bolts, see “Service Data”.



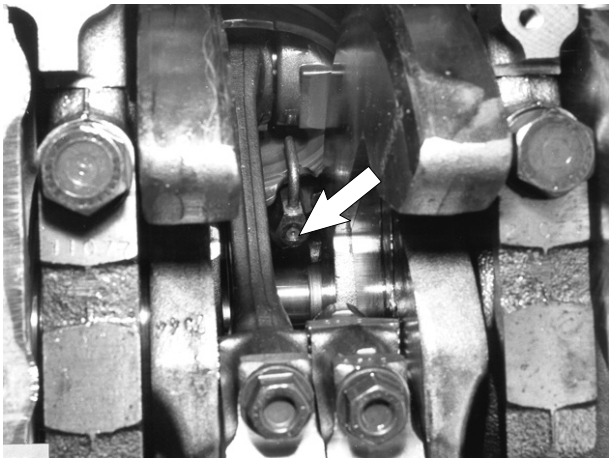
11

Fig. 12

Slowly turn engine over.

Connecting rods and oil spray nozzles (arrow) must not collide or grind against each other.

Refit in reverse sequence to the removal procedure all parts previously removed.



12

Detaching piston from and attaching to connecting rod

Fig. 1

Remove piston with connecting rod.

Clamp connecting rod in a vice using soft jaws.

Remove gudgeon pin circlip.

1

Fig. 2

Push out gudgeon pin, holding piston in place. Take off and lay it aside.

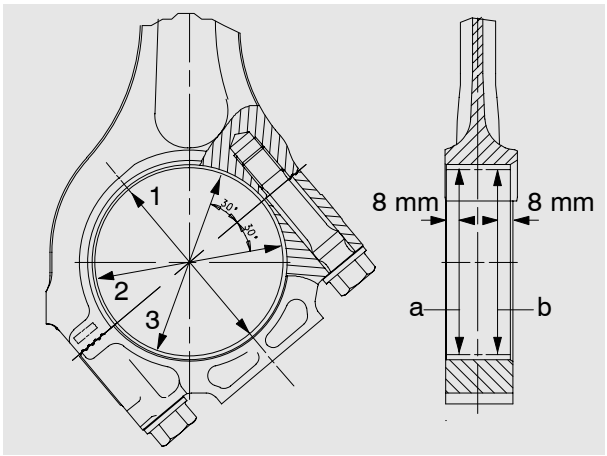
2

Measure connecting rod big end bore (basic bore)

Fig. 3

Insert new connecting rod bearing and fit cap. Tighten bolts to specified torque.

Measure bearing bores with inside micrometer in measuring directions 1, 2 and 3 as well as in planes a and b.
For max. perm. values, see “Service Data”.
Change connecting rods if deviations exceed the tolerance range.



3

Fig. 4

Small end bushes are not available.

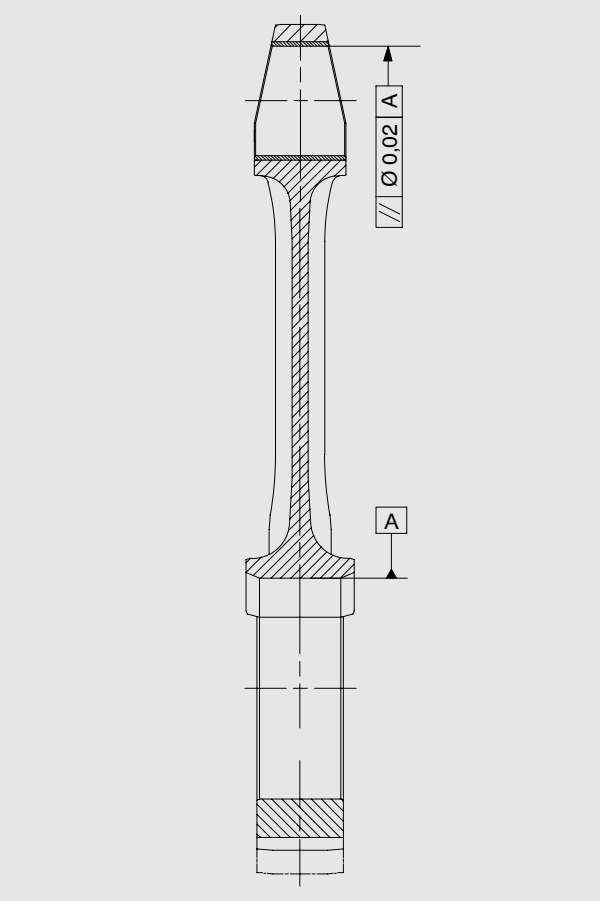
If the bushes are worn, install reconditioned connecting rod.

4

Fig. 5

Clean connecting rod and inspect for external damage; scrap any defective rods.

Check connecting rod to see whether the piston pin bore is parallel or twisted relative to the bearing shell bore. Change connecting rod if deviations exceed the tolerance range.



5

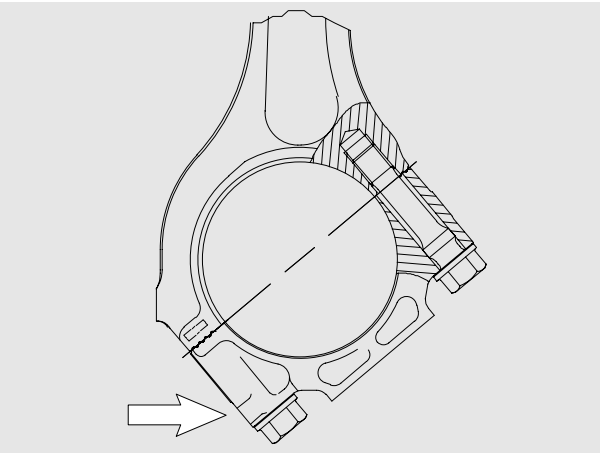
Figs. 6 and 7

Fit piston to connecting rod.

Caution:
The recess for the oil spray nozzle in the piston shaft (arrow) must be at the side of the long end.

Insert gudgeon pin. Fit circlips.
Install piston, see page 118.

6

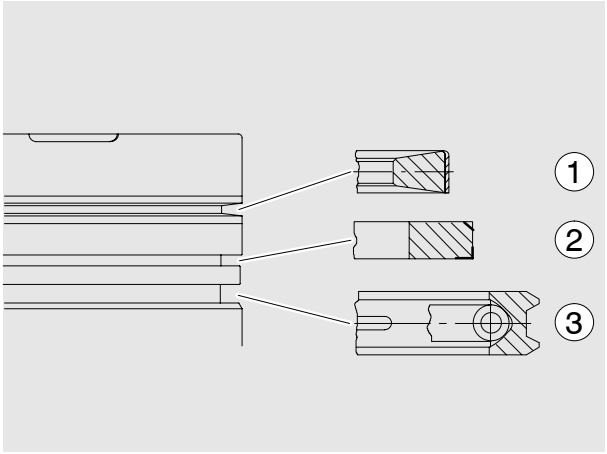


7

Piston ring arrangement

Fig. 1

1 Compression ring (double-sided keystone ring)
2 Compression ring (tapered compression ring)
3 Oil scraper ring (bevelled-edge ring)



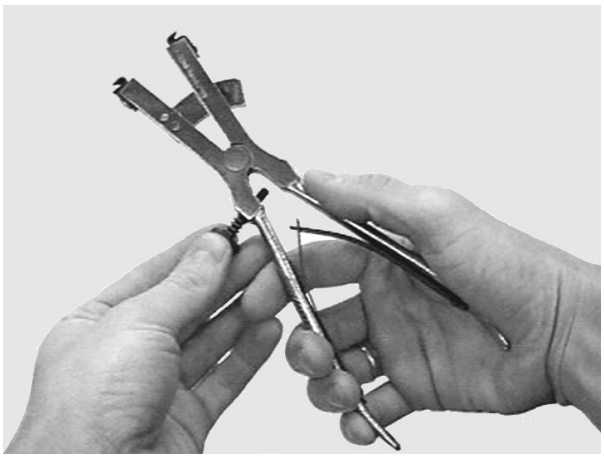
1

Removing piston rings

Fig. 2

Remove piston with connecting rod.
Clamp connecting rod in a vice using soft jaws.

Adjust piston ring pliers to piston diameter.



2

Fig. 3

Apply piston ring pliers at piston ring gap and unclip piston rings from piston ring grooves.

Note:
Owing to the hose-type spring the oil scraper ring has a higher tangential tension.

Carefully clean the piston ring grooves using a piece of wood.
Do not damage the piston ring grooves.

3

Checking ring gap

Fig. 4

Insert piston rings singly into the cylinder and ascertain the ring gap using a feeler gauge.

Replace piston rings if the ring gap is too large.

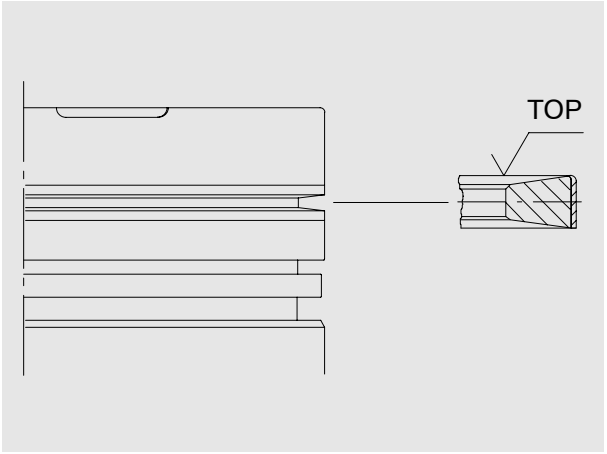
For ring gap see “Service Data”.

4

Installing piston rings

Figs. 5 and 6

Use piston ring pliers to place piston rings in the correct piston ring grooves (“TOP” mark facing upwards).



5

6

Checking piston ring axial clearance

Fig. 7

Use feeler gauge to ascertain the piston ring clearance at several points in each groove.

For this purpose the piston ring is to be fully pressed into the piston ring groove at the point to be measured.

The pistons must be replaced if the clearance ascertained is too large.

For axial clearance see “Service Data”.

7

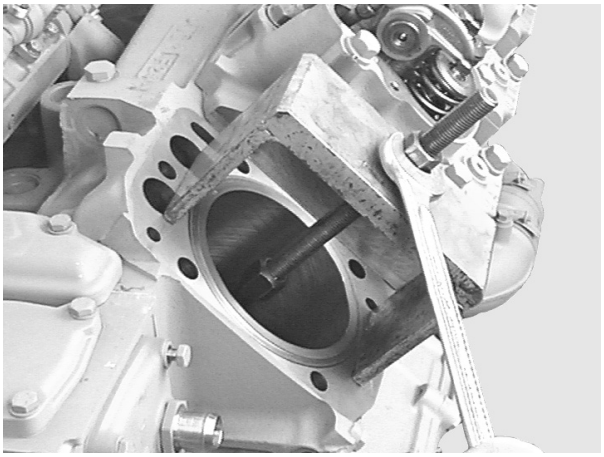
Removing cylinder liners

Note:
Observe oversizes for cylinder liner outer diameters and collar heights (see ”Engineering • Data • Setting values”).

- Remove cylinder head, see page 91
- Remove pistons, see page 117

Fig. 1

Mark cylinder liner position relative to engine so that it can be reinstalled in the same position if reused.


1

Insert cylinder liner extractor device (special tool) into cylinder liner, taking care not to damage the oil spray nozzle.

Put support on extractor spindle and tighten nut.

Fig. 2

Hold extractor spindle in place and extract cylinder liner by turning nut.

Take off extractor device and take out cylinder liner.

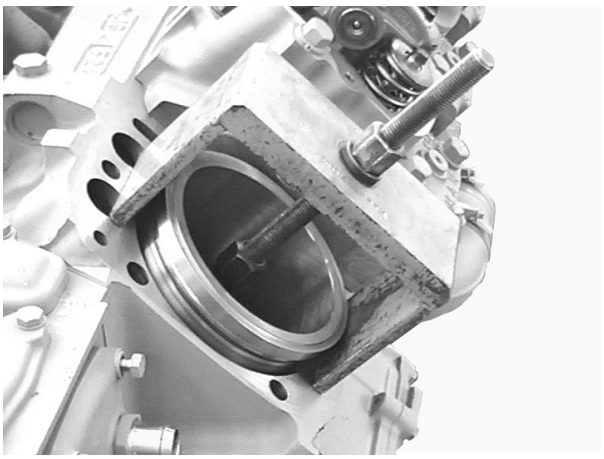

2

Fig. 3

Deposit cylinder liner upright. Take off O-rings. Number cylinder liners in order of installation.


3

Installing cylinder liners

Fig. 4

Checking cylinder liner protrusion

Clean basic bore and cylinder liner.

Insert cylinder liner without O-rings into crankcase, observing the marking (ensure that it is identical with the position prior to removal).

Measure cylinder liner protrusion at at least four different points, using gauge holder and gauge.

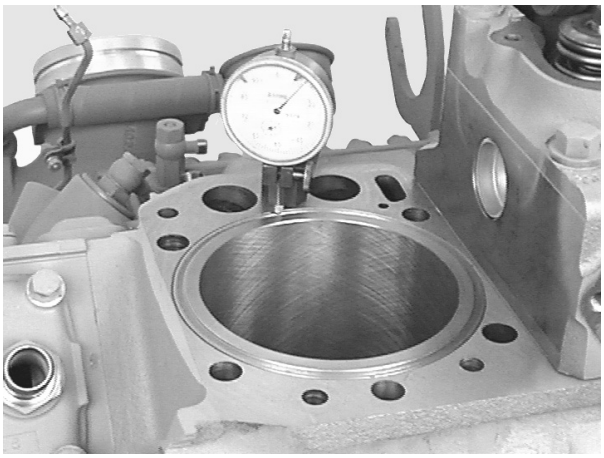
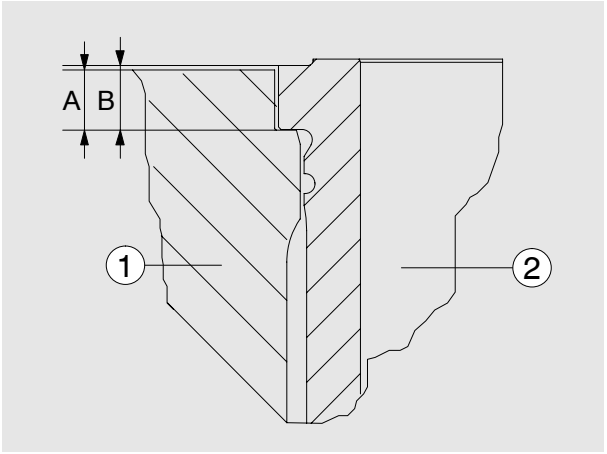

4

Fig. 5

Note:
After fitting the cylinderliners ensure that the O-rings are in the correct position by checking the liner protrusion with special tool.
Use special tool, see page 178, as follows:
Position press-on measuring plate with turned collar facing the liner using 2 fitting sleeves to centre plate.
Tighten 4 bolts (improvised: collar bolt 51.90020-0270, length shortened to 90 mm) on the press-on measuring plate in stages and crosswise to 40 Nm.
Set dial gauge combination above press-on plate to “0” under preload relative to the crankcase.
Measure cylinder liner protrusion at least at four points.



5

The cylinder liner protrusion is the difference between the collar height and the collar recess in the crankcase.

1 Crankcase
2 Cylinder liner
B–A = cylinder liner protrusion

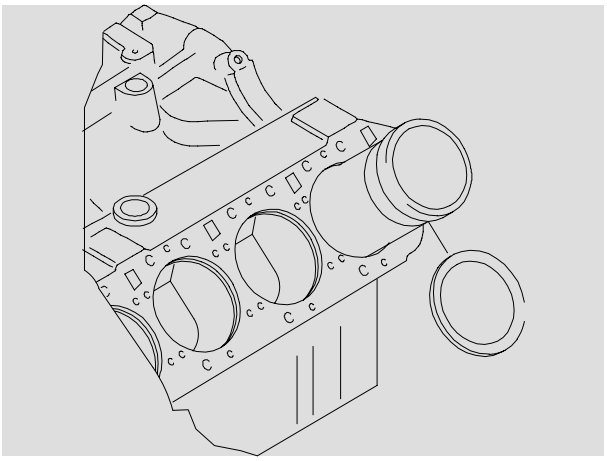

6

Fig. 6

Install shim if the protrusion is below the minimum protrusion even at only one point.
The shim is placed under the cylinder liner collar. However, it may be used only if after installation the upper tolerance limit is not exceeded.

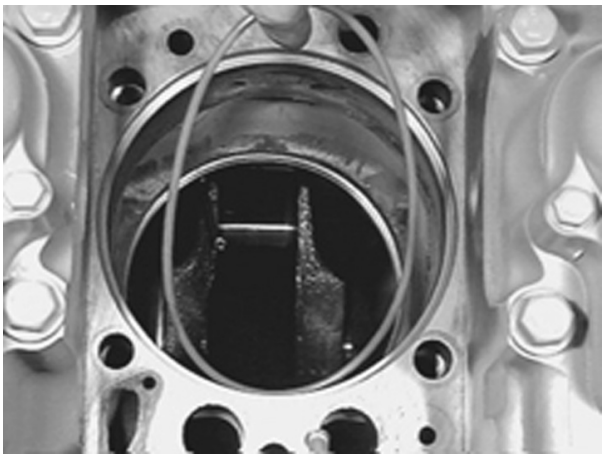

7

Fig. 7

Oil new O-rings for the lower seal (144x4) and insert them in crankcase.


8

Fig. 8

Insert new O-rings for the upper seal (138x2) into the grooves on the cylinder liner.

Do not overstretch the O-rings.

Fig. 9

Apply thin coat of engine oil to cylinder liner in the area of the upper and lower O-ring.
Apply thin coat of engine oil to lower O-rings in the crankcase.

Insert cylinder liners into crankcase and push them down by hand.
Place clean metal plate on liner and exert uniform downward pressure until the liner is seated in the crankcase recess.

If a perceptible resistance can be felt in this operation, the O-rings are no longer in their proper place.
Reposition O-rings and insert cylinder liner again.

9

Note:
No grease or sealing agents of any kind must be used for installing cylinder liners and O-rings.

Measuring piston protrusion

Fig. 1

Remove cylinder heads, see page 91.
Move piston to be measured to TDC.

Apply dial gauge in holder to crankcase sealing face.
Set dial gauge to “0”.

1

Fig. 2

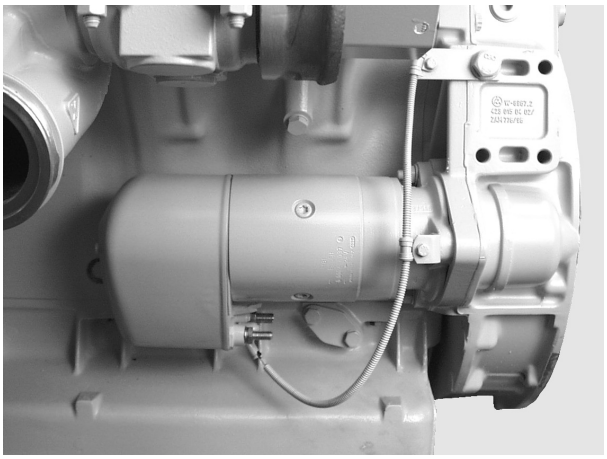
Carefully slew dial gauge holder round, lifting the dial gauge tip as you do so.

Lower dial gauge tip on to piston crown and read off piston protrusion.

2

Fig. 1

Disconnect minus cable from battery or switch off battery main switch if fitted.
Disconnect cable from terminal 31 (minus terminal, thick cable), terminal 30 (plus terminal, thick cable) and terminal 50 from starter.

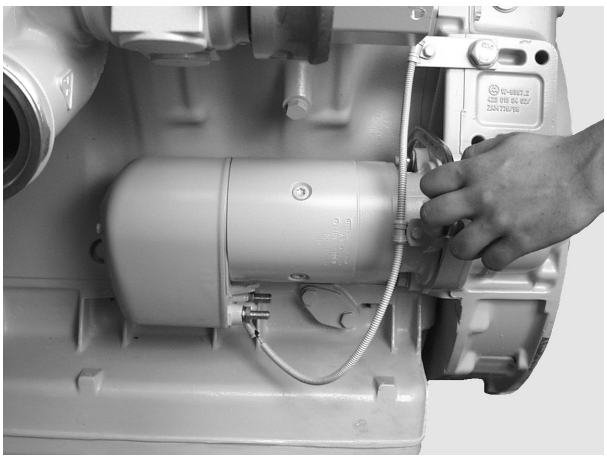


1

Fig. 2

Remove mounting nuts.

Note:
A curved wrench is advantageous for the inner bolts (see Fig.).



2

Take off starter.

Check starter pinion for wear and that it can move freely. If necessary, clean piston using a brush dipped in fuel and regrease it.

Check flywheel gear ring for wear and damage.

Turn over engine by hand once, paying particular attention to the positions at which the engine finally stops; i.e. when the engine is switched off it always stops in certain positions.

The starter pinion engages in these positions when the engine is started.

For changing starter gear ring, see page 76.

The starter is installed in reverse sequence to the removal procedure. Ensure that the cables are correctly connected up and the bolts tightened to specified torque.

Connect up battery or switch on battery main switch.
After installation check starter to see that it works properly.

Removing alternator

- Relax V-belt and take it off the alternator pulley, see page 131
- Disconnect earth cable from battery

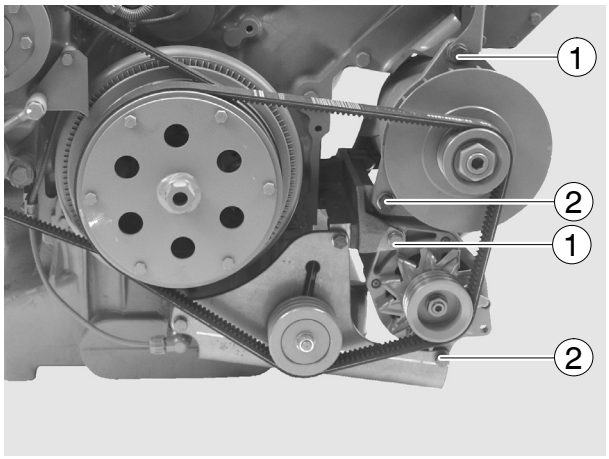
Disconnect terminals B+, B– (55 A alternator only), D+ and W from alternator.

Alternators (55 A and 140 A) – at bottom left (D 2842 LE 602)

Fig. 1

Remove mounting bolt ① from bracket

Remove mounting bolt ② from bracket and take off the alternators, one after the other



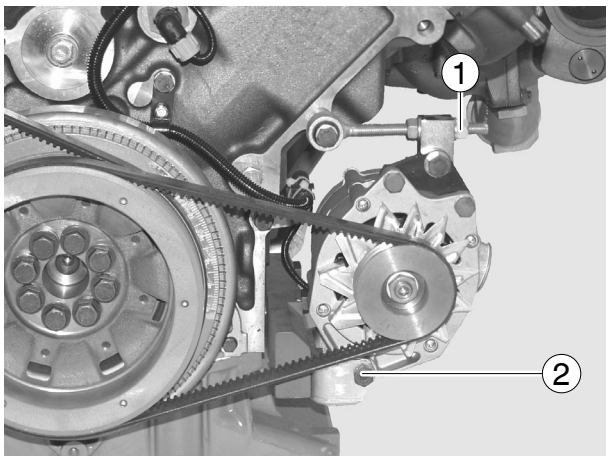
1

Alternator – at bottom left

Fig. 2

Remove lock nut ①.

Remove mounting bolt ② from bracket and take off alternator.



2

Attaching alternator

The alternator is attached in reverse sequence to the removal procedure; ensure that the cable terminals do not get mixed up.
Check and if necessary correct alignment of the V-belt pulleys with each other.
Tighten the mounting bolts to the specified torque.
Tension the V-belt.

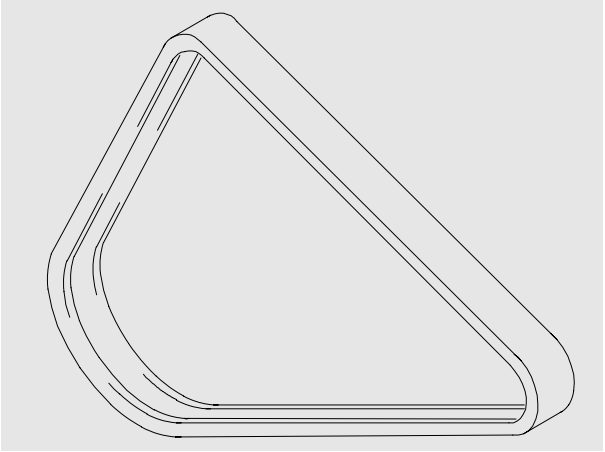
After attaching the alternator check to see whether it functions faultlessly.

V-belts

Checking condition

- Check V-belts for cracks, oil, overheating and wear
- Change demaged V-belts

If, in the case of a multiple belt drive, wear or differing tensions are found, always replace the complete set of belts.

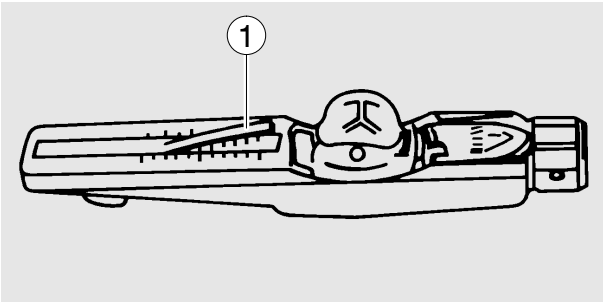


Checking tension

Use V-belt tension tester to check V-belt tension.

- Lower indicator arm ① into the scale
- Apply tester to belt at a point midway between two pulleys so that edge of contact surface ② is flush with the V-belt
- Slowly depress pad ③ until the spring can be heard to disengage. This will cause the indicator to move upwards

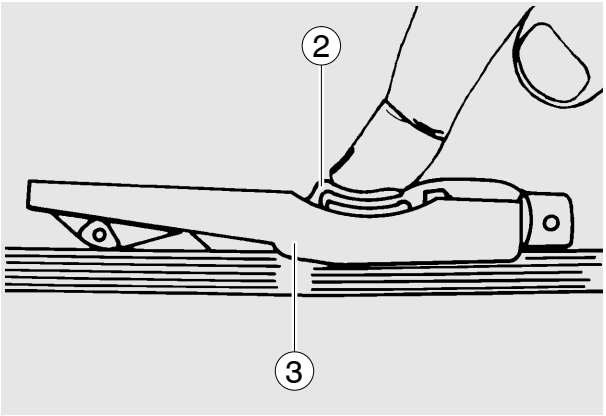
If pressure is maintained after the spring has disengaged a false reading will be obtained!



Reading of tension

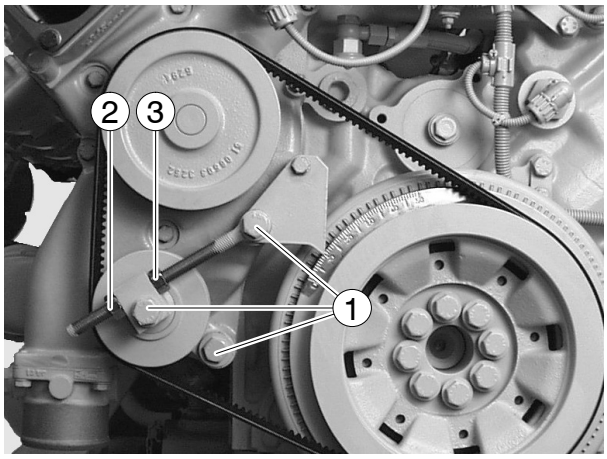
- Read of the tensioning force of the belt at the point where the top surface of the indicator arm ① intersects with the scale
- Before taking readings make ensure that the indicator arm remains in its position

If the value measured deviates from the setting value specified, the V-belt tension must be corrected.



Drive belt width	Tensioning forces according to the kg graduation on the teste		
	New installation		When servicing after long running time
	Installation	After 10 min. running time	
2/3VX	90–100	70–80	60
3/3VX	135–150	105–120	90

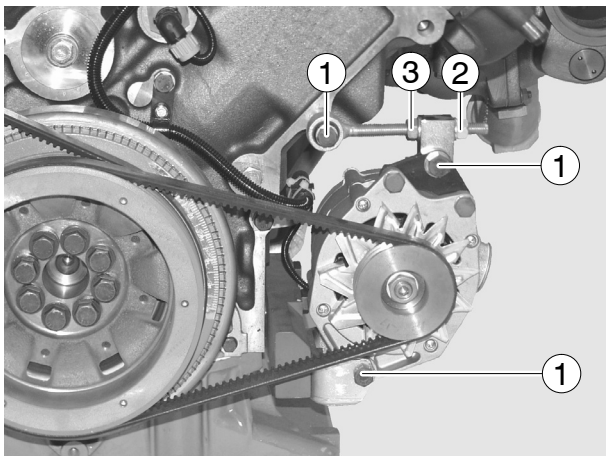
Tensioning and changing V-belt



Crankshaft – water pump – tension pulley

- Remove fixing bolts ①
- Remove lock-nut ②
- Adjust nut ③ until V-belts have correct tensions
- Retighten lock-nut and fixing bolts

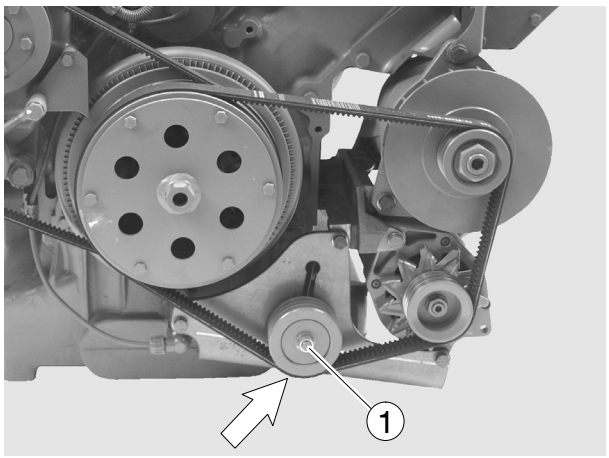
To change the V-belt, turn back the setting nut and swivel the tension pulley inwards.



Alternator – bottom left

- Remove fixing bolts ①
- Remove lock-nut ②
- Adjust nut ③ until V-belts have correct tensions
- Retighten lock-nut and fixing bolts

To change the V-belt, turn back the setting nut and swivel the alternator inwards.



Alternators (55 A and 140 A) – bottom left

- Loosen tightening nut on the tensioning roll
- Turn mounting block (arrow) clock-wise until V-belt has correct tension
- Retighten mounting nut ① on tensioning pulley

To change V-belt, loosen mounting nut ① and turn setting screw (arrow).

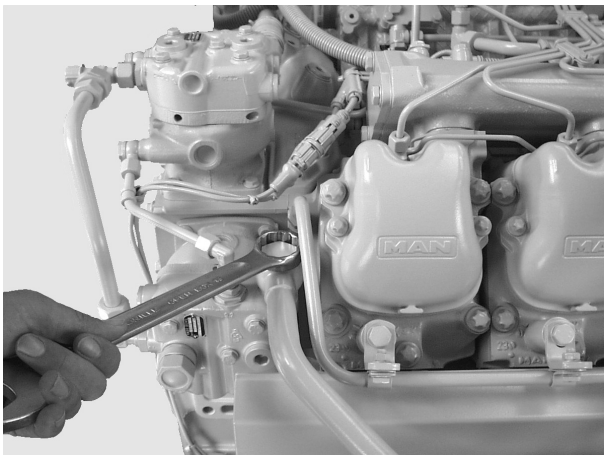
Disassembling the air compressor

Fig. 1 and 2

> **Note:**
> The disassembly described below was carried out on a 1–cylinder air compressor with water cooling. The differences when disassembling a 2–cylinder air compressor are indicated.

Remove the oil-pressure, intake-air and compressed-air lines.

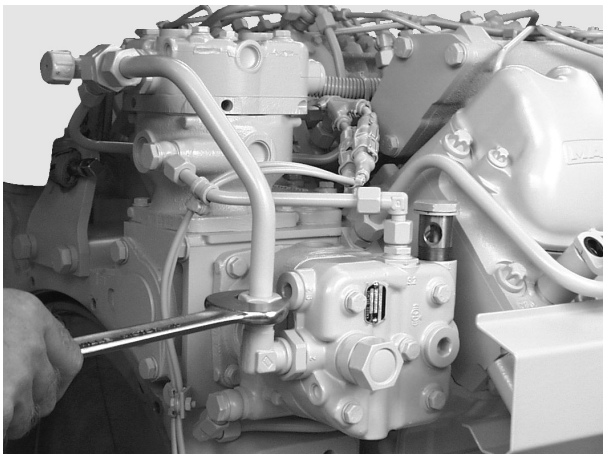
Remove the coolant lines.



1

D 2842 LE 602
When removing the horizontal air compressor the turbocharger must be removed, see page 85.

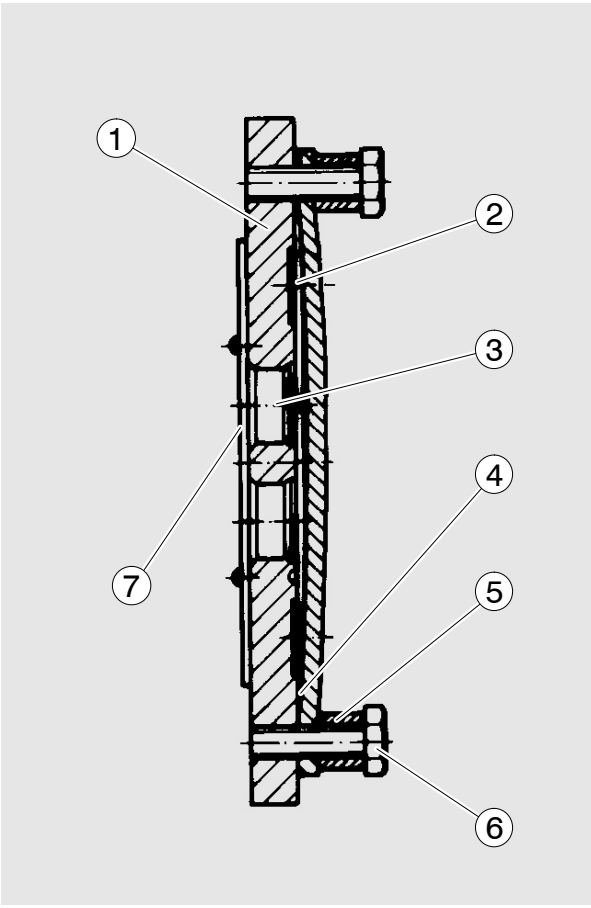
Remove the mounting bolts (4 bolts each) and take off air compressor.



2

Fig. 3

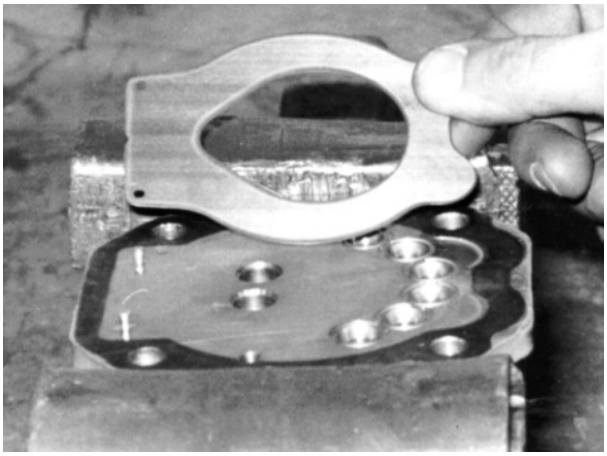
Remove the valve plate ① and clamp it into a vice fitted with soft jaws.
Unscrew the fixing bolts ⑥ of the exhaust valve ②.
Remove the bushings ⑤, exhaust valve catch ③, washer ④ and exhaust valve (plate).
Turn the valve plate, and remove the intake valve (plate) ⑦.
Auslassventil prüfen, ggf. erneuern.
Check the exhaust valve, and replace it if necessary. The valve must not be scored or worn. Replace the complete valve unit if it is damaged.



3

Fig. 4

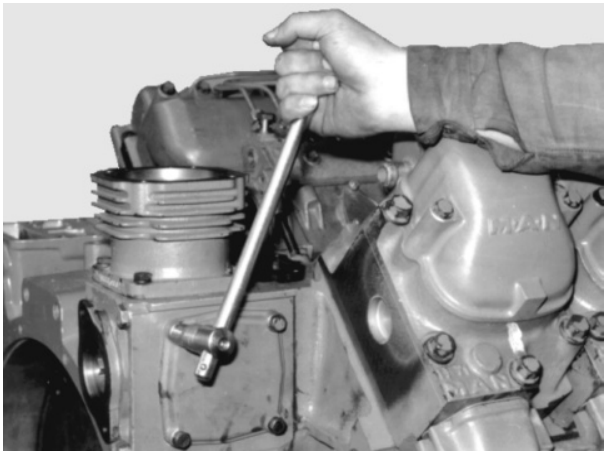
Turn the valve plate, check the intake valve (plate), and replace it if necessary.
The plate must not be worn or cracked.



4

Fig. 5

Remove the side cover on the air compressor crankcase and the timing case cover.

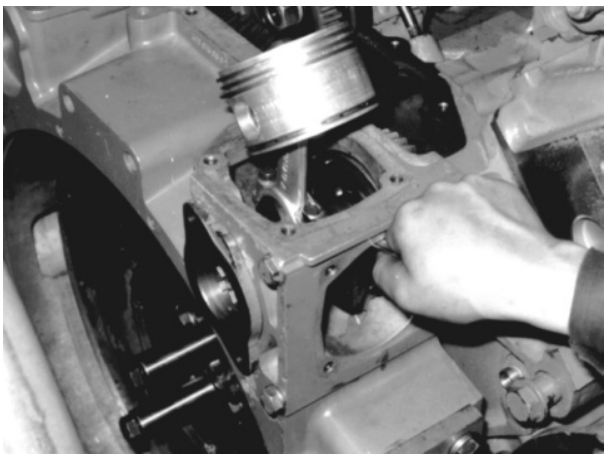


5

Fig. 6

Unscrew the bolts of the cylinder liner, and remove the liner carefully, ensuring that the piston rings do not get damaged.
Unscrew the con rod bearing cover bolts.
Remove the piston and con rod.

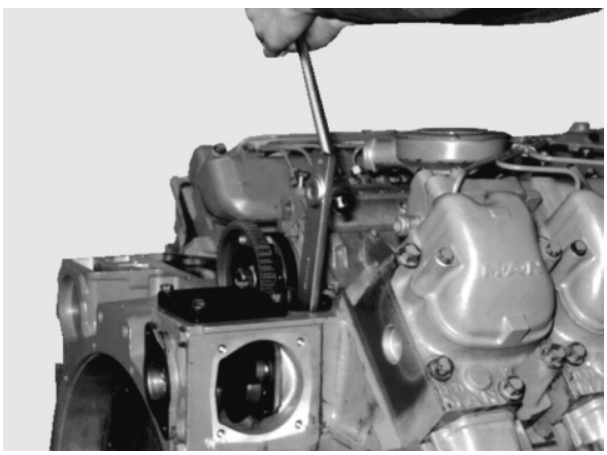
Note:
Some types of 2–cylinder air compressors have con rods whose bearing centring –clamping sleeve in the lubrication bore– is offset to the side by approximately 0.5 mm.
These con rods have bearings with an off-centre bore.
Be sure to use matching con rods and bearings.



6

Fig. 7

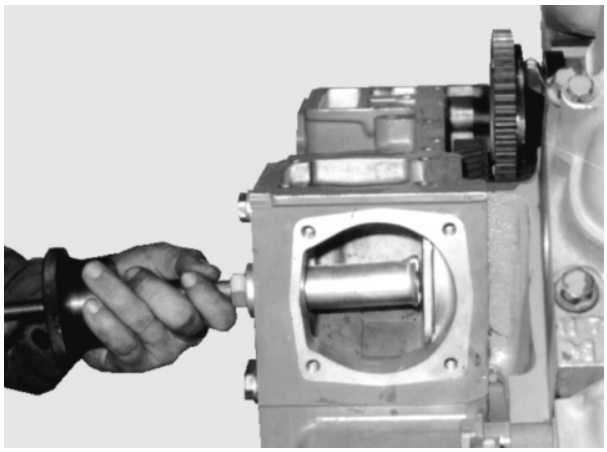
Install the counterholder, and use a special socket spanner to unscrew and remove the drive gear.



7

Fig. 8

Use an assembly iron to push out the air compressor crankshaft, with the counterweights facing up, and remove the rear bearing flange.
Remove the inner ball bearing.

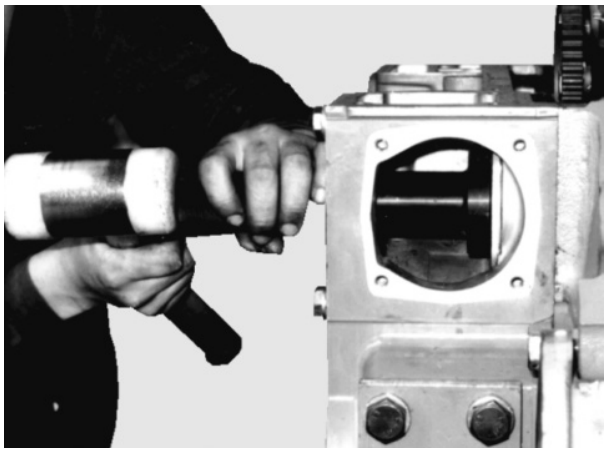


8

Assembling the air compressor

Fig. 9

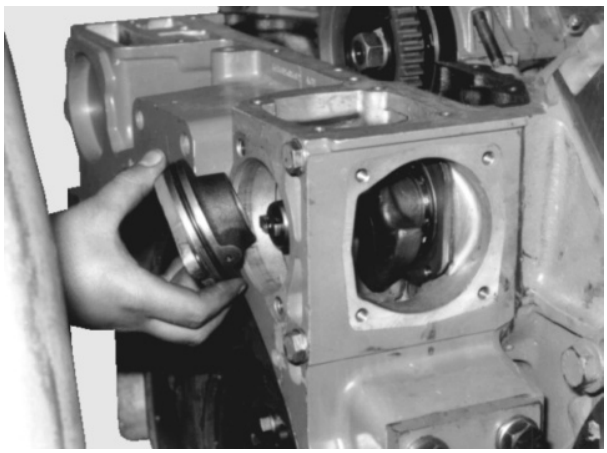
Drive in the rear ball bearing with a pin and hammer. Install the crankshaft.



9

Fig. 10

Install the rear bearing flange with a new O-ring using 2 uniformly tightened bolts.
Make sure that the oil bores in the bearing flange and in the case align.
Remove the bolts.



10

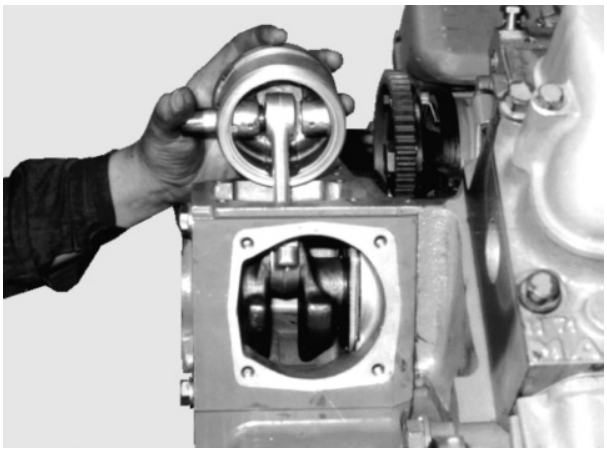
Fig. 11

Install the counterholder.
Install the drive gear, and use a special socket spanner to tighten the fixing bolts to the specified torque.
Remove the counterholder.

11

Fig. 12

Before installing the con rod, coat the bearing shells with a thin layer of Optimol White T paste.
Position the con rod and its bearing cap on the crankshaft.
Tigten the mounting bolts to the specified torque.
Install the piston with the piston pin.
Install the piston pin locks.

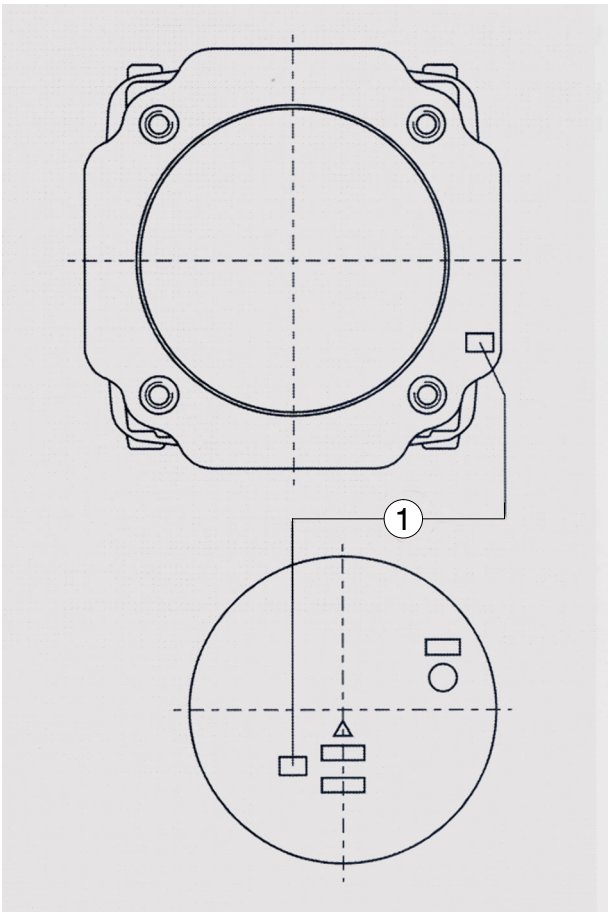


12

Fig. 13

Pistons are available in the paired sizes B, C and D, with a difference of 0.01 mm between each.
The pistons and cylinders are marked as illustrated in the drawing.
Only use parts with the same pairing.

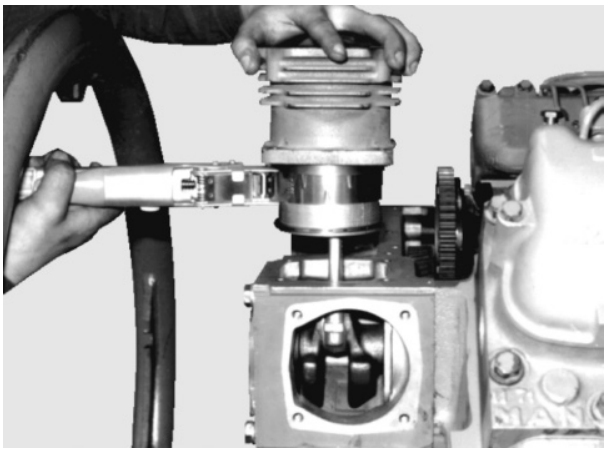
① The paired sizes are engraved.



13

Fig. 14

Install a cylinder liner with a new gasket, and tighten the bolts diagonally in pairs.
Install the side cover and timing case cover with a new gasket.

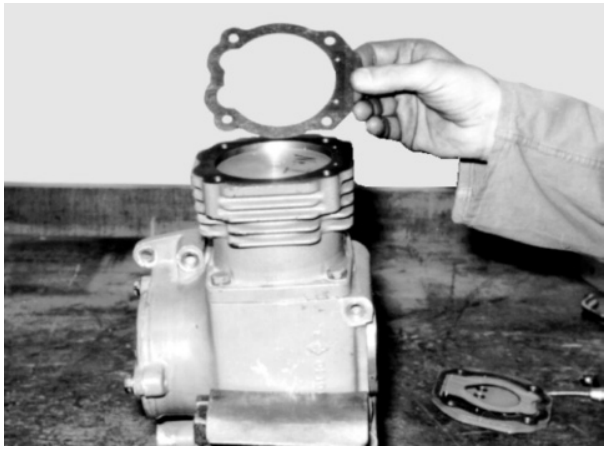


14

Fig. 15

Install a new gasket between the cylinder and the valve plate.

Note:
Note the label OBEN / TOP on the valve plate and the different gaskets for water- and air-cooled valve plates.

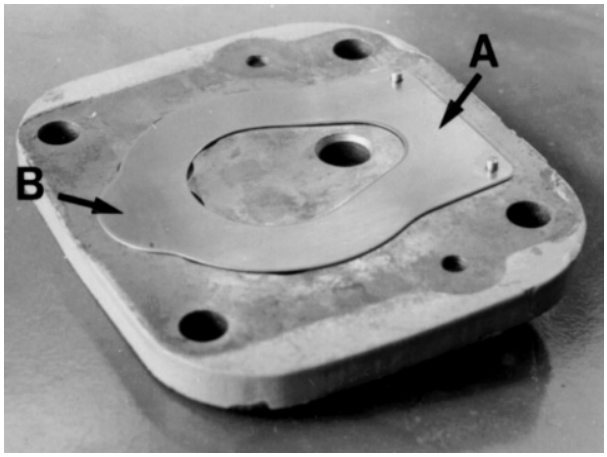


15

Fig. 16

Install the intake valve (plate) in the valve plate, taking the centring pins into account.

Note:
The plate is domed. Check the position of the plate as follows:
Hold the plate at point A on the valve plate, and tap with your finger on point B. If there is a noise, the plate is installed the wrong way round. Turn the plate and install it correctly.

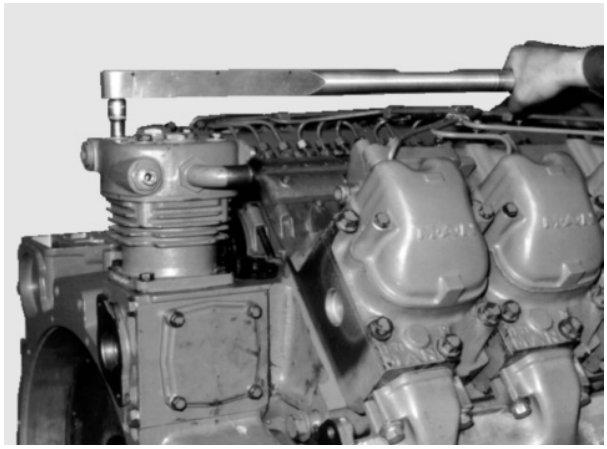


16

Install the valve plate, taking the centring pins and plate.

Fig. 17

Install the cylinder head with a new gasket (taking the pins into account), and tighten the bolts to the specified value.
Run the engine until it is warm, unscrew the bolts seperately, and then tighten them to the specified value.
Attach the coolant lines and the suction and delivery lines.

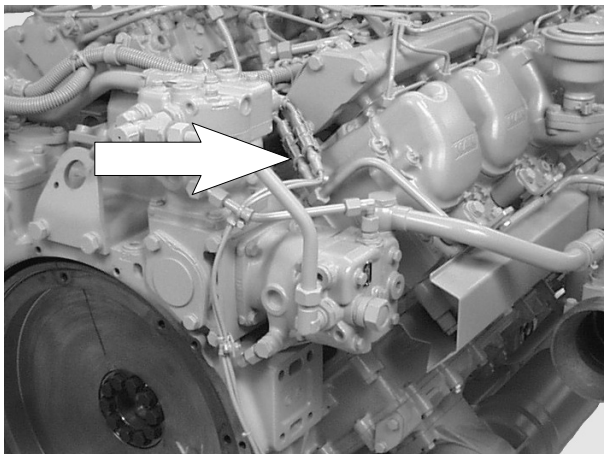


17

Fig. 1

The speed pickup and the auxiliary speed pickup are fitted to the flywheel housing, at bottom right.

For removal, disconnect cable from plug connection (arrow).

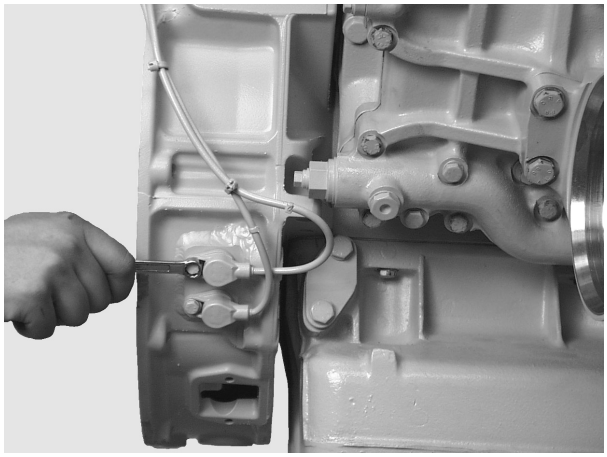


1

Fig. 2

Remove mounting bolt and take off transmitter.

The unit is installed in reverse sequence to removal procedure.



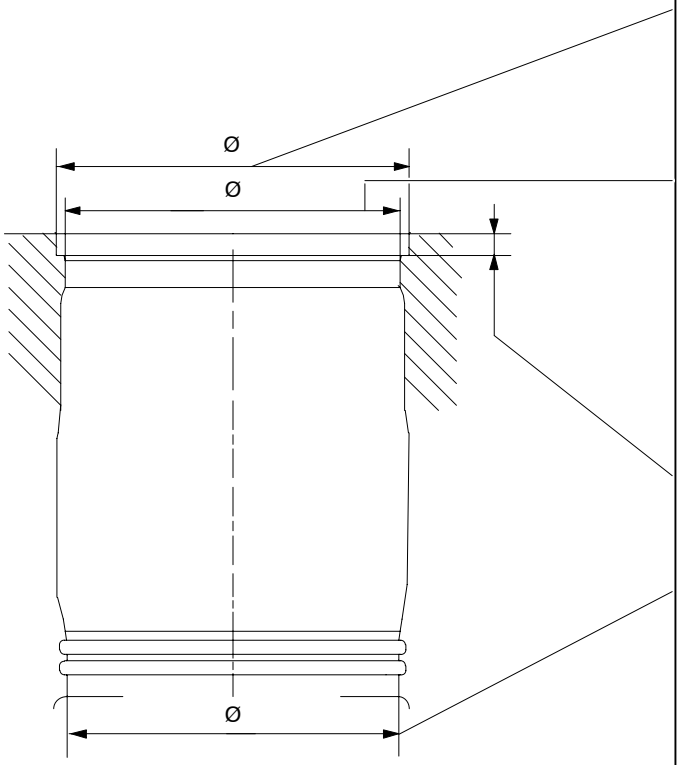
2

Service Data

Engine

Design	V 90°
Cycle	4-stroke Diesel with turbocharger and intercooler
Number of cylinders	12
Compression ratio	16,5 : 1
Bore	128 mm
Stroke	142 mm
Engine capacity	21 930 cm^3
Direction of rotation viewed on flywheel	anti clockwise
Firing order	1–12–5–8–3–10–6–7–2–11–4–9
Firing interval	120°
Power based on DIN ISO 3046	
D 2842 LE 602	588 kW at 2100 rpm
D 2842 LE 604	480 kW at 1550 rpm
D 2842 LE 607	500 kW at 2100 rpm
Lubrication	Pressure circulation
forced feed lubrication by gear oil pump	
Filling capacities	
Oil capacity in oil sump	min. 35 ltr.
	max. 50 ltr.
Oil change quantity (with filter)	53 ltr.
Cooling	Fluid cooling
by impeller pump	
Coolant temperature	90–95°C

Crankcase



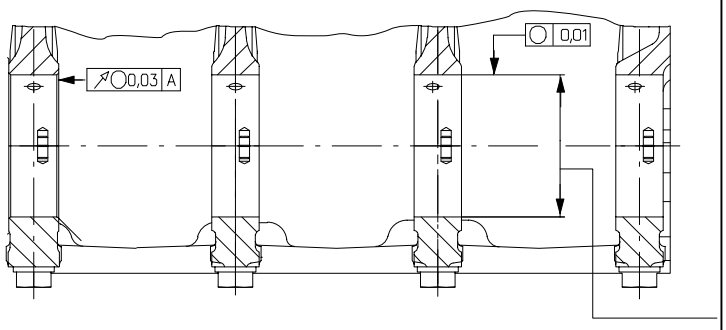
standard size: 153,90–154,00 mm
for cylinder liners with larger outside diameter:
0,5 and 1,0 mm: 154,40–154,50 mm

standard size: 145,80–145,84 mm
for cylinder liners with larger outside diameter:
0,5 mm: 146,30–146,34 mm
1,0 mm: 146,80–146,84 mm
Wear limit:
0,12 mm across maximum basic dimension.

9,97–**9,99 mm**

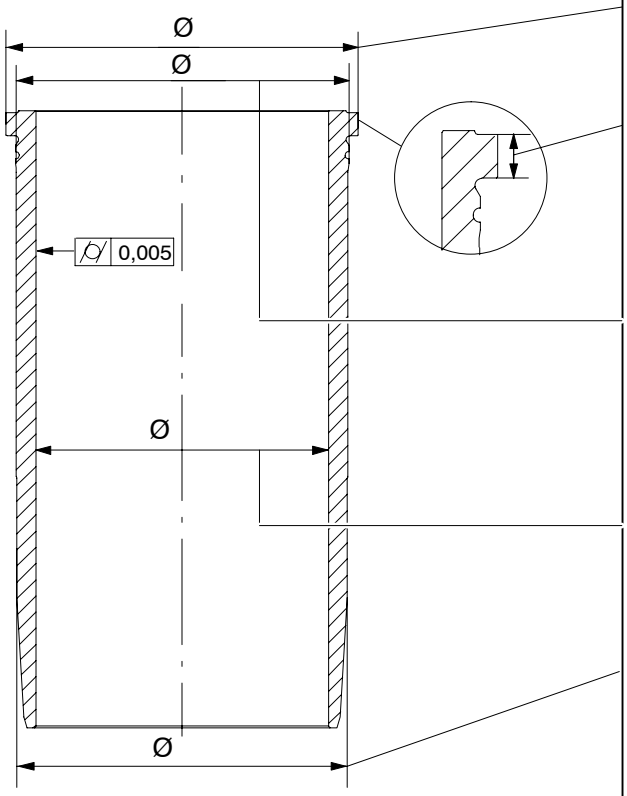
standard size: 144,50–144,54 mm
for cylinder liners with larger outside diameter:
0,5 mm: 145,00–145,04 mm
1,0 mm: 145,50–145,54 mm
Wear limit:
0,08 mm across maximum basic dimension.

Crankshaft–bearing supports and crankshaft–bearing caps



111,0–111,022 mm

Cylinder liner



standard size: 153,757–153,694 mm
with larger outside diameter
0,5 and 1,0 mm: 154,194–154,257 mm

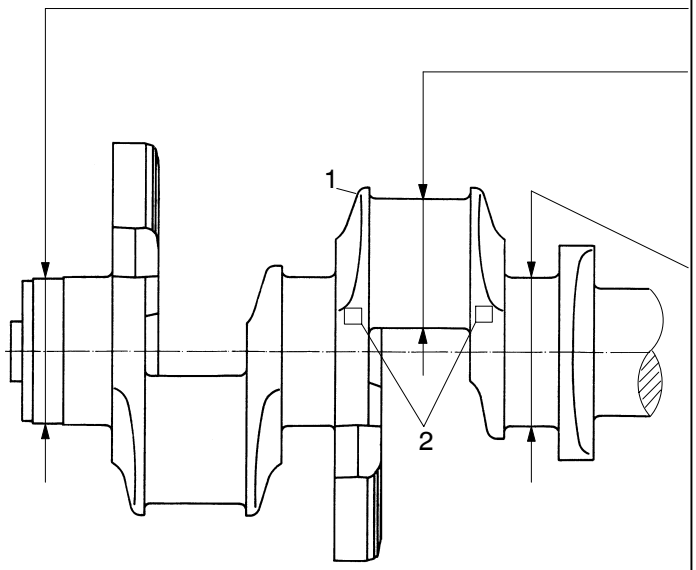
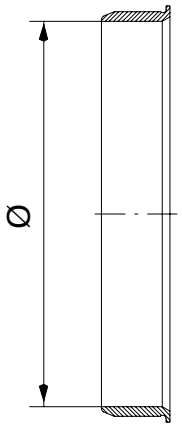
standard size: 10,03–10,05 mm
with more flange height:
0,2 mm: 10,23–10,25 mm

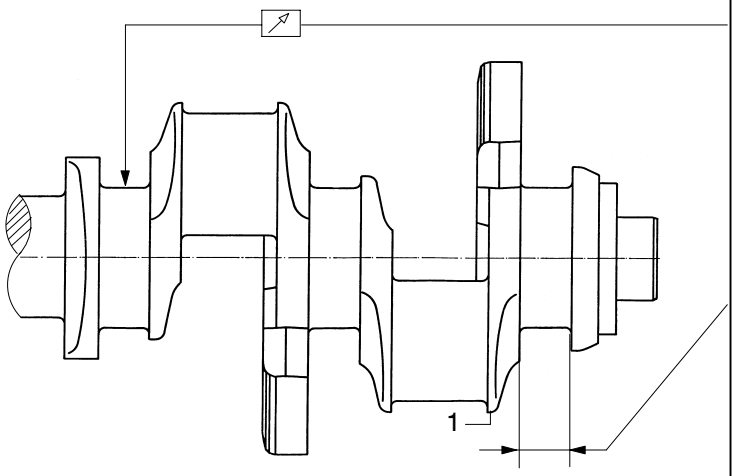
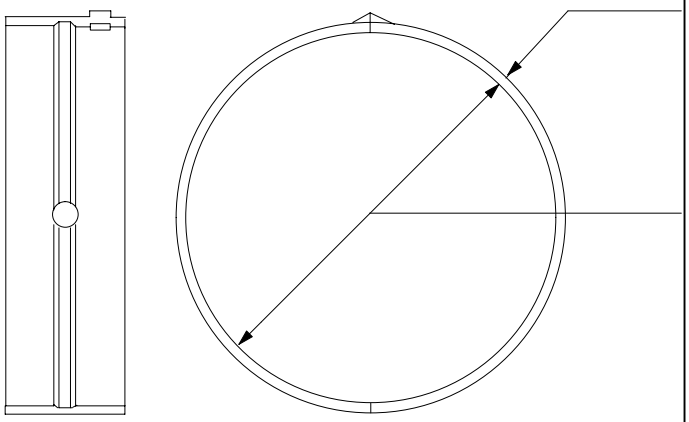
Liner protrusion above upper deck of crankcase: 0,04–0,08 mm

standard size: 145,761–145,786 mm
with larger outside diameter
0,5 mm: 146,261–146,286 mm
1,0 mm: 146,761–146,786 mm

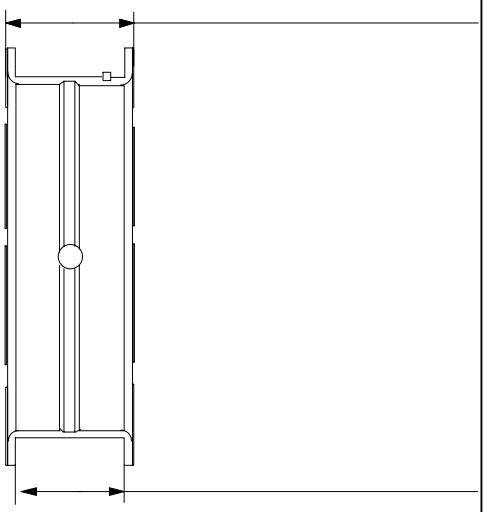
127,990–128,010 mm
Max. wear limit:0.15 mm below base dimension

standard size: 144,432–144,457 mm
with larger outside diameter
0,5 mm: 144,932–144,957 mm
1,0 mm: 145,432–145,457 mm

Service Data	Dimensions Limit values
Crankshaft	
Crankshaft, front (opposite side to flywheel) 	99,985–100,020 mm (Ø 100 j7) standard size: 89,98–90,00 mm Undersize –0,25: 89,73–89,75 mm Undersize –0,50: 89,48–89,50 mm Undersize –0,75: 89,23–89,25 mm Undersize –1,00: 88,98–89,00 mm standard size: 103,98–104,00 mm Undersize –0,25: 103,73–103,75 mm Undersize –0,50: 103,48–103,50 mm Undersize –0,75: 103,23–103,25 mm Undersize –1,00: 102,98–103,00 mm 1 = Colour marking for size identification of crank pin diameter 2 = Colour marking for size identification of main bearing journal diameter Undersize –0,25: red Undersize –0,50: white Undersize –0,75: yellow Undersize –1,00: lilac max. axial clearance of crankshaft: 0,190–0,322 mm
Bearing race for crankshaft, front 	Inner diameter: 99,907–99,942 mm (Ø 100 S7)

Service Data	Dimensions Limit values
Crankshaft rear end (adjacent to flywheel) 	Max. permissible runout with crankshaft taken up in end bearings: at bearing 4: 0,08 mm standard size: 38,000–38,062 mm (Ø 38 H9) Undersize -0,25 and -0,50: 38,500–38,562 mm (Ø 38,50 H9) Undersize -0,75 and -1,00: 39,000–39,062 mm (Ø 39 H9) 1 = Colour marking for size identification of thrust bearing journal length Undersize –0,25: red Undersize –0,50: white Undersize –0,75: yellow Undersize –1,00: lilac
Main bearing 	**Data for wall thickness and bearing inner diameter also apply to the alignment bearing** standard size: 3,455 – 3,467 mm Undersize –0,25: 3,580–3,592 mm Undersize –0,50: 3,705–3,717 mm Undersize –0,75: 3,830–3,842 mm Undersize –1,00: 3,955–3,967 mm Bearing bore in installed condition: standard size: 104,066–04,112 mm Undersize –0,25: 103,816–03,862 mm Undersize –0,50: 103,566–103,612 mm Undersize –0,75: 103,316–103,362 mm Undersize –1,00: 103,066–103,112 mm Spread:0,3 – 1,2 mm Marking: top / bottom standard size: 0958 / 0079 undersize –0,25: 0962 / 0081 undersize –0,50: 0964 / 0082 undersize –0,75: 0966 / 0083 undersize –1,00: 0968 / 0084

Thrust bearing



standard size: 37,74–37,81 mm
Undersize –0,25: 38,24–38,31 mm
Undersize –0,50: 38,24–38,31 mm
Undersize –0,75: 38,74–38,81 mm
Undersize –1,00: 38,74–38,81 mm

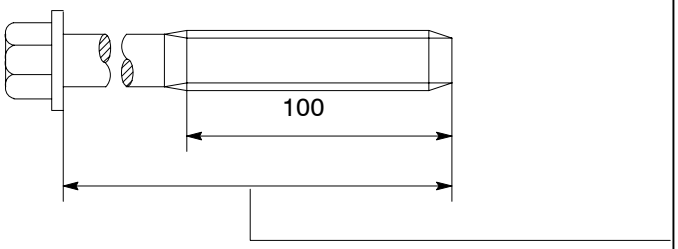
Spread: 0,1–0,5 mm

Marking:top / bottom
standard size: 0164 / 0192
undersize –0,25: 0168 / 0194
undersize –0,50: 0170 / 0195
undersize –0,75: 0172 / 0196
undersize –1,00: 0174 / 0197

31,01–31,04 mm

Data for wall thickness and bearing bore see “main bearing”

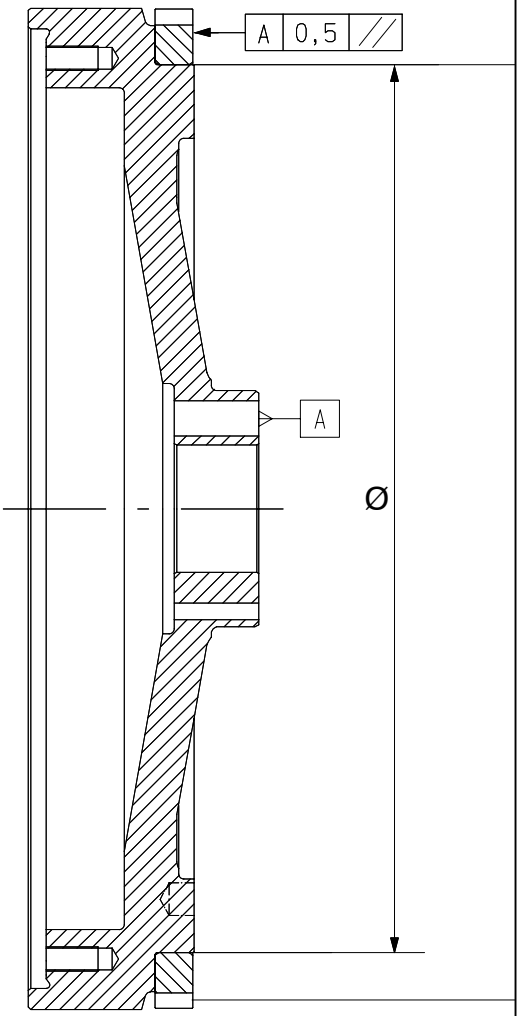
Mounting bolts for crankshaft bearing caps



Length: With each tightening, the bolts are deliberately stressed beyond the stretch limit and each tightening thus extends their length permanently. When the max. length has been reached, the bolt may no longer be used.

new: 152,5–153 mm
max. 154,5 mm

Flywheel and starter motor gear ring



Ø Flywheel:
432,490–432,645 mm (Ø 432 u9)

Starter gear ring, inside diameter :
432,000–432,155 mm (Ø 432 H9)

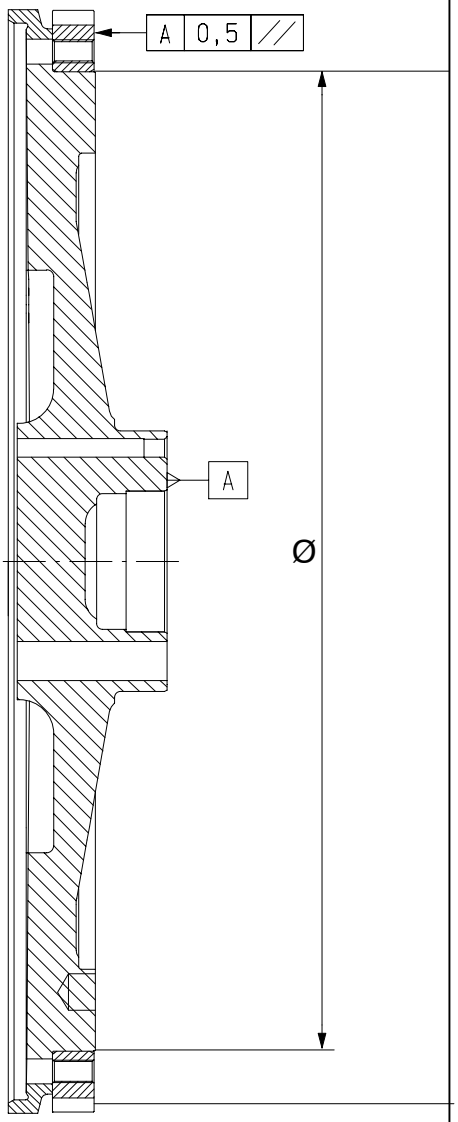
Interference: 0,335–0,645 mm
Installation temperature: 200–230°C

m = 52,3 kg (with starter gear)
J = 1,975 kgm^2

Number of teeth: Z = 160, Module 3
Matching gear: Starter pinion (Z= 9)

Backlash between: 0,6–0,9 mm

Flywheel for elastomer propshaft coupling



Ø Flywheel:
432,490–432,645 mm (Ø 432 H9)

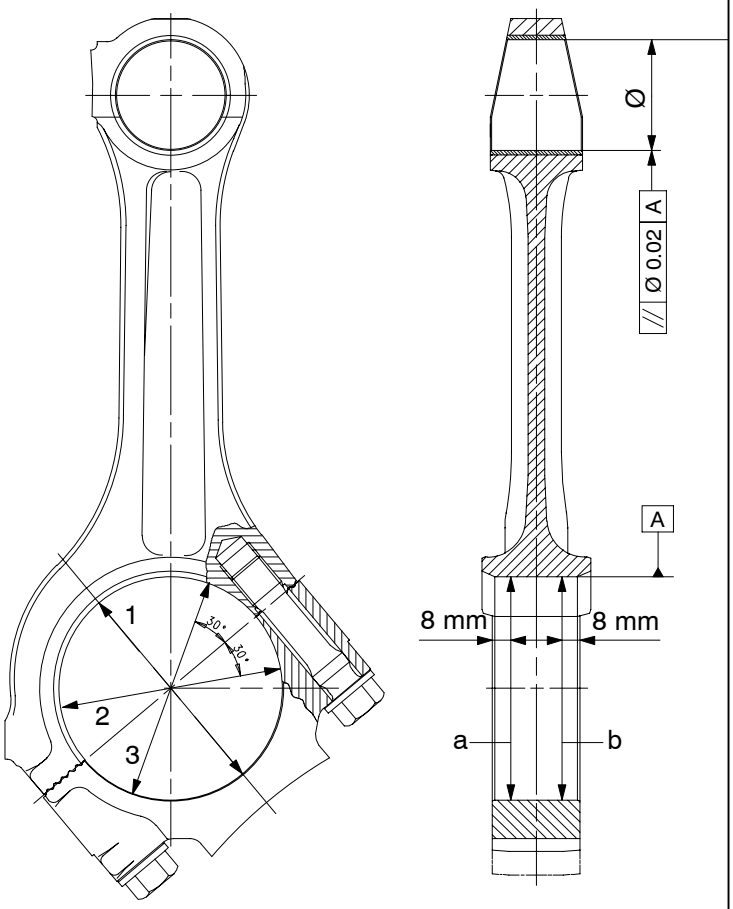
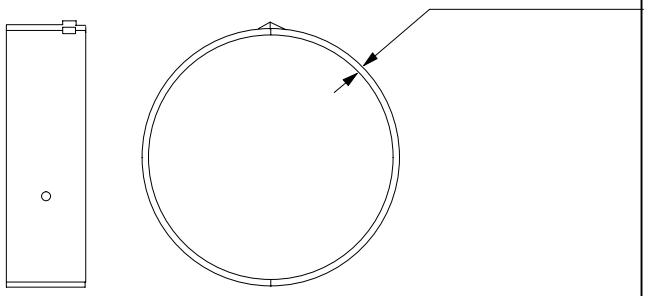
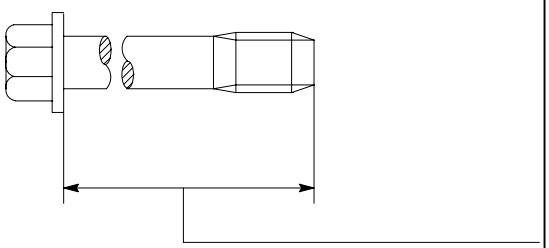
Starter gear ring, inside diameter:
432,000–432,155 mm (Ø 432 H9)

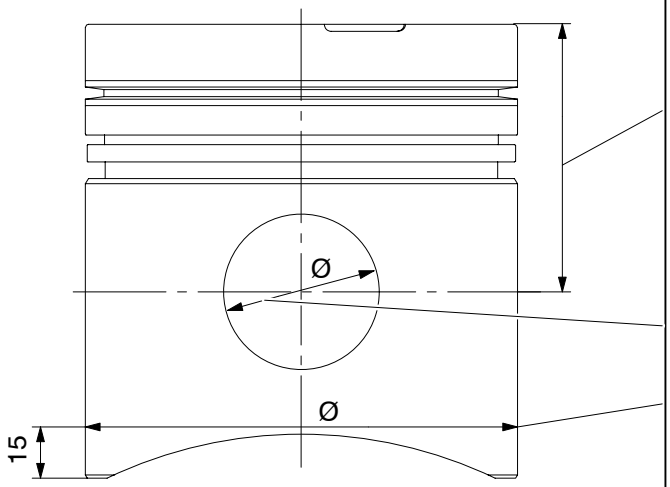
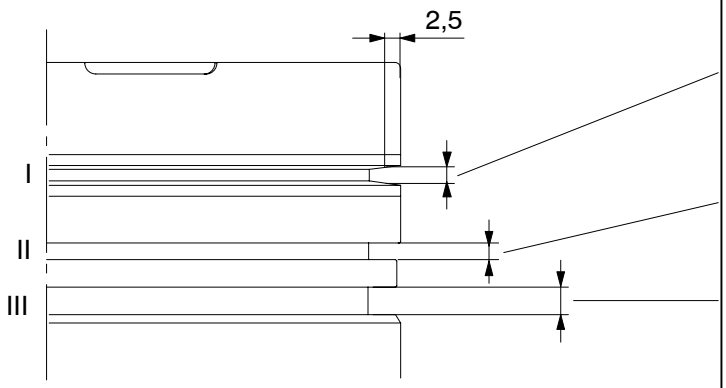
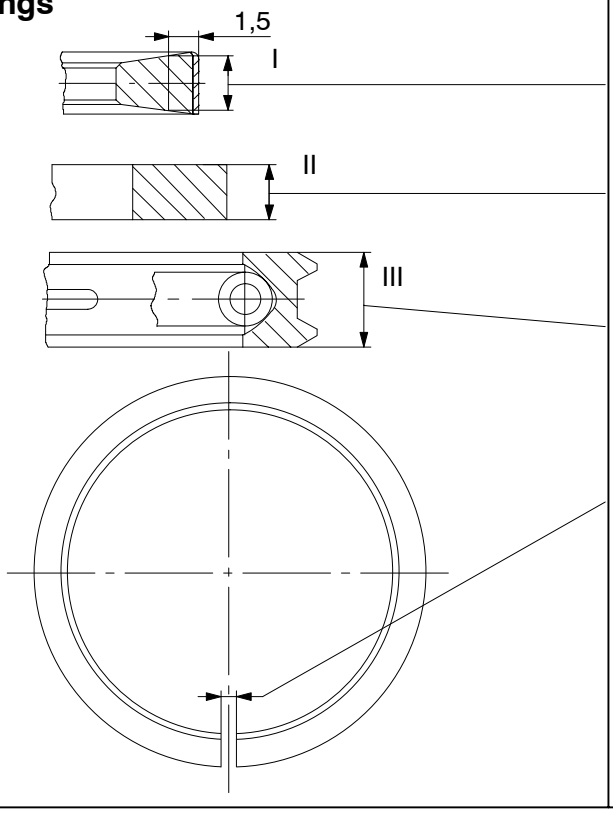
Interference: 0,335–0,645 mm
Installation temperature: 200–230°C

m = 38,5 kg (with starter gear)
J = 1,17 kgm^2

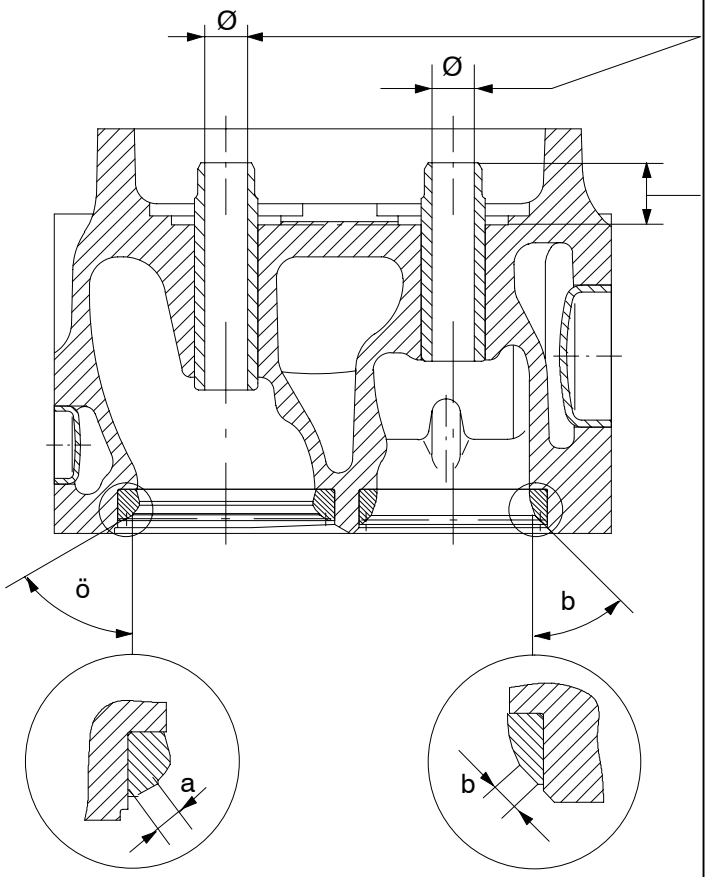
Number of teeth:Z = 160, Module 3
Matching gear: Starter pinion number of teeth: (Z= 9)

Backlash between: 0,6–0,9 mm

Service Data	Dimensions Limit values
Conrods 	46,055–46,065 mm **Wear limit: 46,09 mm** Bearing bore in directions 1,2 and 3 and in planes a and b: 90,064–90,106 mm Pre-conditions: new big-end bearing in place, conrod assembled
Conrod bearings 	Standard size: 2,463–2,473 mm Undersize -0,25: 2,588–2,598 mm Undersize -0,50: 2,713–2,723 mm Undersize -0,75: 2,838–2,848 mm Undersize -1,00: 2,963–2,973 mm Spread: 0,6–1,5 mm If signs of wear are present (scores,antiwaer coating damaged), change both bearing shells Important: Observe installation position (rod shell has red or yellow colour markings on the side)
Conrod bolts 	Length: With each tightening, the bolts are deliberately stressed beyond the stretch limit and each tightening thus extends their length permanently. When the max. length has been reached, the bolt may no longer be used. 68,2–68,5 mm, **max. 69,5 mm**

Service Data	Dimensions Limit values
Pistons 	Compression height: 81,25–81,30 mm Piston protrusion above crankcase top: 0,013–0,331 mm 46,008–46,016 mm Piston bolt diameter: 45,994–46,000 mm 127,840–127,870 mm Max. difference in weight per engine piston set: 100g
Piston ring grooves 	3,695–3,725 mm 3,040–3,060 mm 4,020–4,040 mm
Piston rings 	1st ring – keystone ring Height: 3,296–3,330 mm 2 nd ring – Minute ring: Height: 2,978–2,990 mm Axial clearance: 0,050–0,082 mm 3rd ring – bevelled ring Height: 3,975–3,990 mm Axial clearance: 0,030–0,065 mm Ring gap: 1.st ring: 0,50–0,70 mm **Wear limit: 1,00 mm** 2rd ring: 0,45–0,70 mm **Wear limit: 1,00 mm** 3rd ring: 0,25–0,50 mm **Wear limit: 0,80 mm*** * Measured in new liner.

Cylinder head

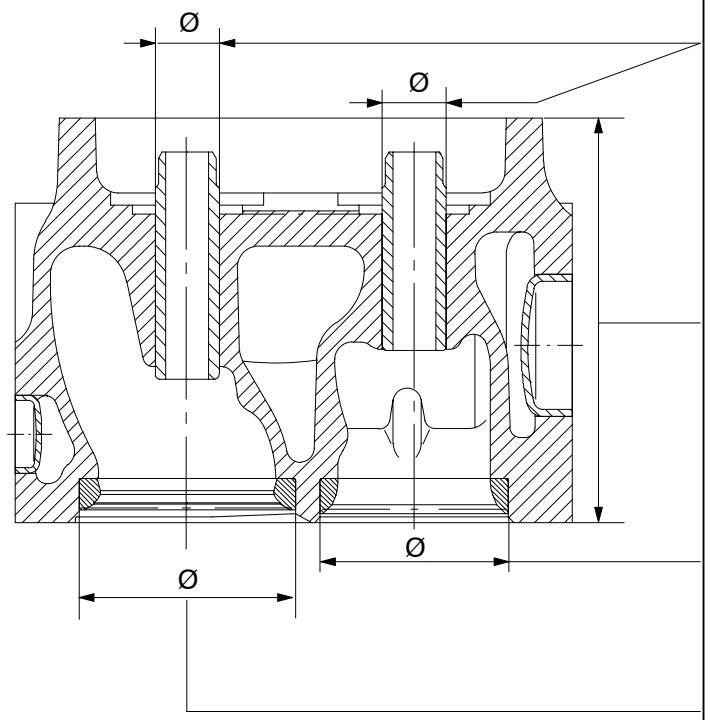


12,000–12,018 mm
Wear limit: half the height of the valve guide: **12,05 mm**

17,1–17,5 mm

Intake valve $\varphi = 60°$
Exhaust valve $\beta = 45°$

a = 3,3–3,8 mm
b = 3,3–3,8 mm



Valve guide bore in cylinder head: 18,000–18,018 mm

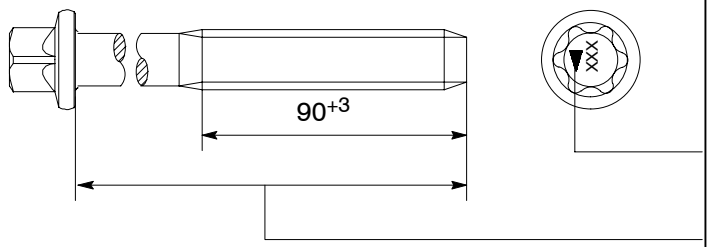
Valve guide outside diameter: 18,028–18,046 mm

standard: 113,9 –114 mm
minimum: **112,9 mm**
(observe specified dimensions for valve recess and injector projection)

Valve seat insert bore in cylinder head: 53,00–53,03 mm
Valve seat insert outside diameter: 53,10–53,11 mm

Valve seat insert bore in cylinder head: 61,00–61,03 mm
Valve seat insert outside diameter: 61,10–61,11 mm

Cylinder-head bolts

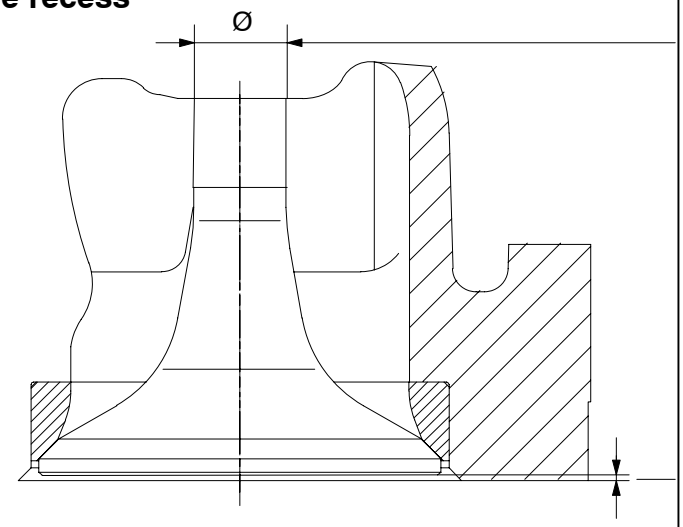


Length: With each tightening, the bolts are deliberately stressed beyond the stretch limit and each tightening thus extends their length permanently. When the max. length has been reached, the bolt may no longer be used.

Angle of rotation symbol

51.90490–0022:
new: 167,5–168 mm, **max. 170 mm**
51.90490–0023:
new:143,5–144 mm, **max. 146 mm**
51.90490–0024:
new:108,5–109 mm, **max. 111 mm**

Valve recess



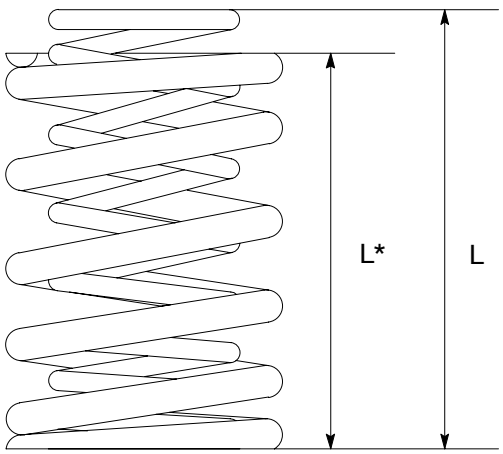
Intake valve: 11,968–11,982 mm
Exhaust valve: 11,943–11,957 mm

Max. wear limit: 0.1 mm below base dimension

Do not reuse valves with damaged chromium layer!

Valve recess for intake and exhaust valve:
0,7–1,3 mm

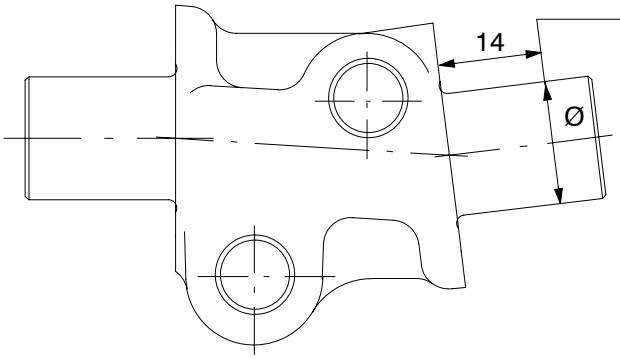
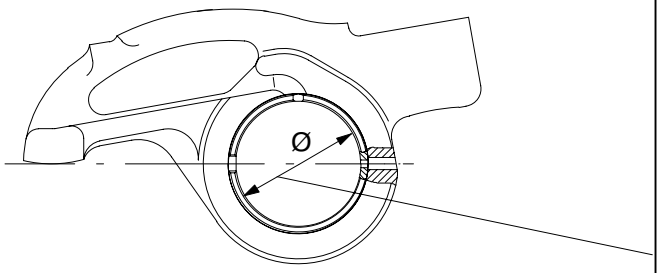
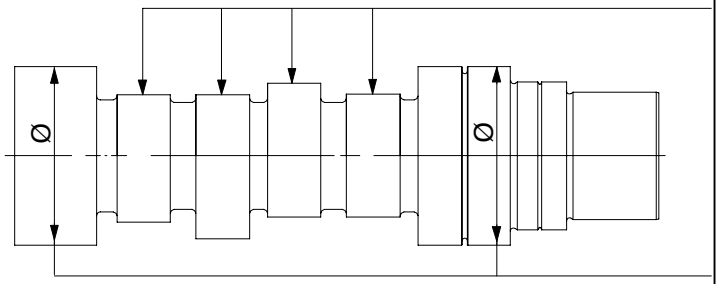
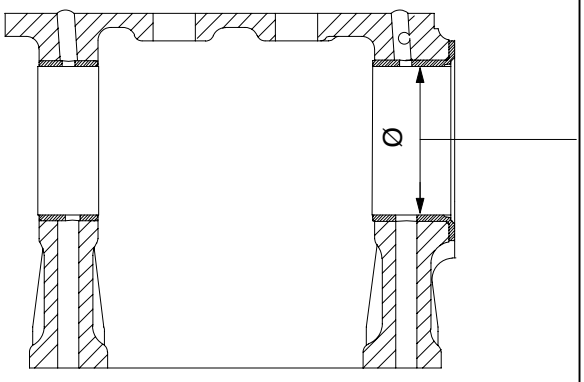
Valve springs

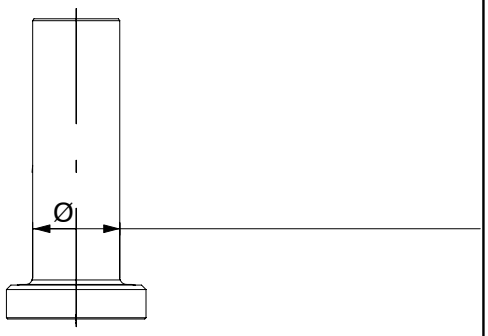
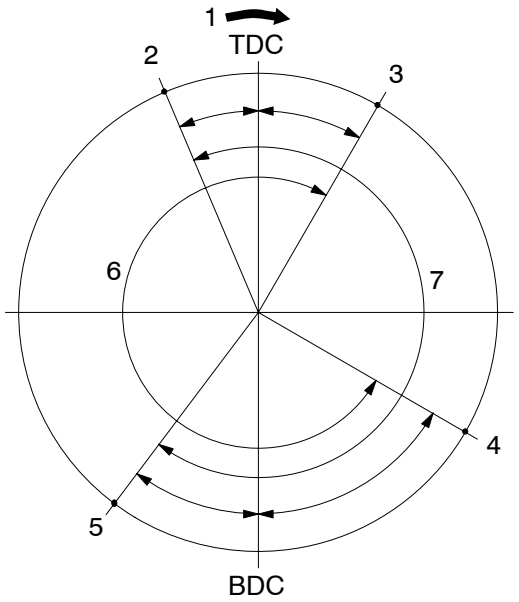


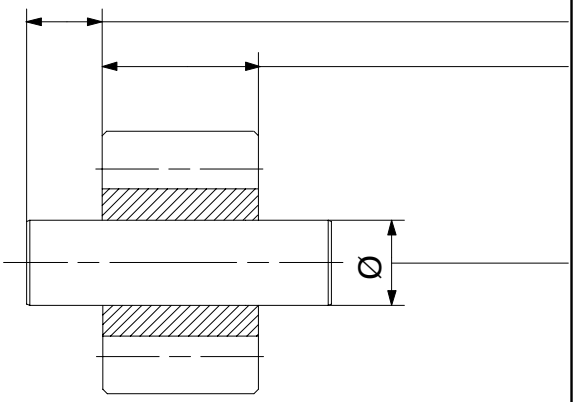
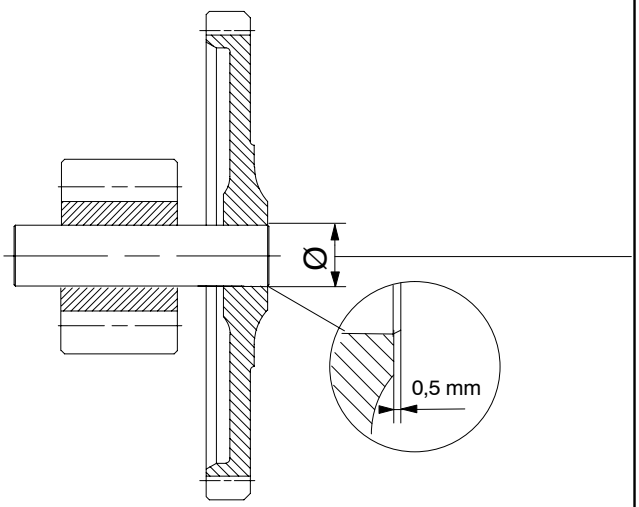
Inner spring:
Free length (L), approx. 65,5 mm
Spring force at L = 46,3 mm: 131–155 N
Spring force at L = 32,3 mm: 260–300 N

Outer spring:
Free length (L), approx. 59 mm
Spring force at L* = 46,8 mm: 330–360 N
Spring force at L* = 32,8 mm: 710–770 N

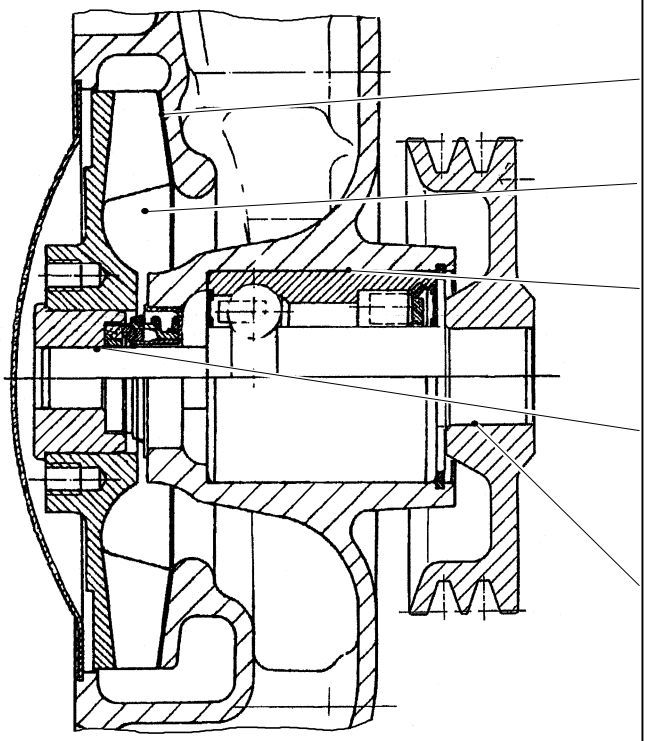
The lowest spring force is at the same time the wear limit value.

Service Data	Dimensions Limit values
Valve gear	
Rocker arm bearing pedestal 	24,967–24,980 mm
Rocker arms 	Rocker arm radial clearance: 0,025–0,054 mm **Wear limit: 0,08 mm** 25,005–25,021 mm
Camshaft 	Replace if there are traces of wear Camshaft axial clearance: 0,20–0,90 mm **Wear limit: 1,5 mm** 69,910–69,940 mm Backlash: Crankshaft wheel and camshaft wheel: 0,128–0,252 mm
Camshaft bearing 	70,000–70,030 mm **Max. camshaft radial play at collar bearing: 0,18 mm**

Service Data	Dimensions Limit values
Valve tappet 	Bore in crankcase: 20,000–20,021 mm 19,944–19,965 mm
Valve clearance	Valve clearance (cold engine) Intake valve: 0,5 mm Outlet valve: 0,6 mm
Valve timing 	1 = engine direction of turn 2 = intake valve opens 24° before TDC 3 = exhaust valve closes 27° after TDC 4 = exhaust valve opens 63° before BDC 5 = intake valve closes 36° after BDC 6 = Exhaust open for 270° 7 = Inlet open for 240° The degrees specified refer to the crankshaft angle
Compression pressures	
good	above 28 bar
permitted	25–28 bar
repair required	**below 24 bar**
Pressure difference (between the individual cylinders)	**max. 4 bar**

Service Data	Dimensions Limit values
Engine lubrication	
Valve opening pressures	
Bypass valve for oil filter	2–4 bar
Overpressure valve on the oil pump	9–10 bar
Pressure valve of the oil injection nozzles	
Opening pressure	1,6–1,9 bar
Pressure at max. opening	1,3–1,6 bar
Oil pump **Oil pump wheel** 	14,5–14,7 mm 33,911–33,950 mm Housing depth: 34,000–34,039 mm Axial clearance: 0,050–**0,128 mm** Shaft: 21,930–21,940 mm Matching bore in housing: 22,000–22,021 mm
Drive wheel with oil pump wheel 	Shaft: 21,930–21,940 mm Bore in drive gear: 21,870–21,885 mm Press on force: 12000 N Backlash: Drive wheel and crankshaft wheel: 0,099–0,451 mm
Oil pump capacity at oil pump speed (with SAE 20W/20 oil, at 90°C and p = 6 bar) oil pump speed = engine speed x 0,977	
at n = 635 rpm	63 l/min
at n = 635 rpm	160 l/min

Engine coolant pump



gap: 0,7–0,8 mm

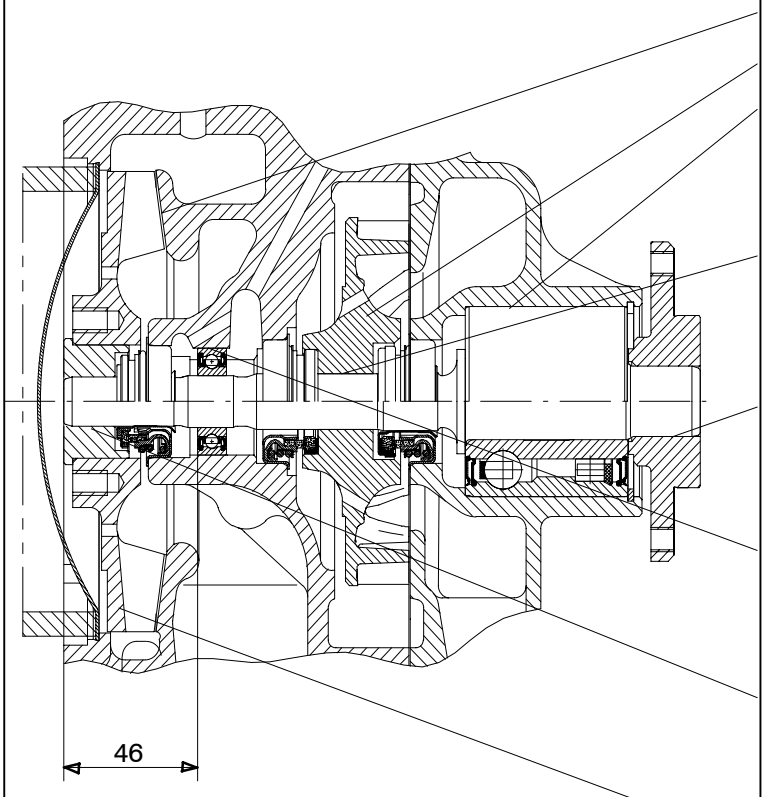
Ø impeller: 149,5–150 mm

Bearing seat in housing:
54,940–54,970 mm
Ø of bearing: 54,981–54,994 mm
Interference: 0,021–0,064 mm

Bore for bearing shaft in impeller:
15,992–16,010 mm
Ø of bearing shaft: 16,043–16,056 mm
Interference: 0,033–0,064 mm

Bore in hub / belt pulley:
25,007–25,020 mm
Ø of bearing shaft: 25,048–25,061 mm
Interference: 0,028–0,054 mm

Repairing coolant pump with high-temperature and low-temperature parts



gap: 0,7–0,8 mm

Ø impeller: 120 mm

Bearing seat in housing:
Ø 61,976–61,995 mm
Ø of bearing: 61,987–62,000 mm
Interference: 0,008–0,024 mm

Bore for bearing shaft in impeller NT:
17,992–18,010 mm
Ø bearing shaft: 18,045–18,056 mm
Interference: 0,035–0,064 mm

Bore in hub / belt pulley:
23,007–23,020 mm
Ø bearing shaft: 23,048–23,061 mm
Interference: 0,028–0,054 mm

Bearing seat in housing HT:
35,994–35,010 mm
Ø of bearing: 34,989–35,000 mm
Interference: 0,006–0,021 mm

Bore for bearing shaft in impeller HT:
15,992–16,010 mm
Ø bearing shaft: 16,045–16,056 mm
interference: 0,035–0,064 mm

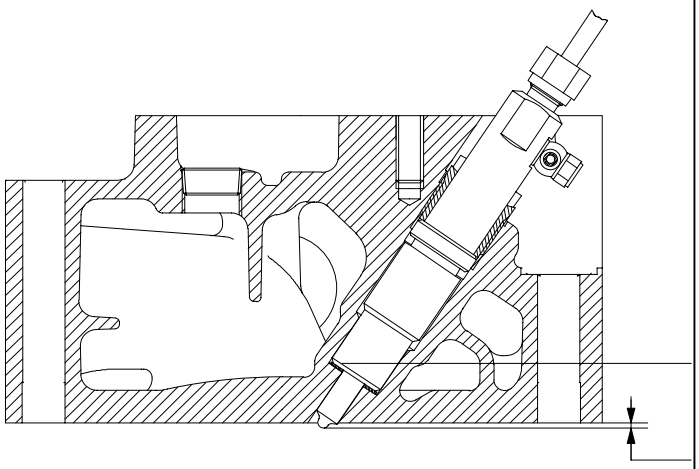
Ø impeller: 149,5–150 mm

Service Data	Dimensions Limit values
Turbocharger	
Make	Borg Warner Turbo Systems
D 2842 LE 604	left: K 31–3772XXCKB20.20DCAYD right: K 31–3772XXCKB20.20DCAYD
D 2842 LE 607	left: K 31–3767OLAKB20.20DCAYD right: K 31–3767OLAKB20.20DCAYD

Fuel system
Injection nozzles

Manufacturer	Bosch
Type of injector D 2842 LE 602 D 2842 LE 604 / 607	DLLA 148 P 984
Number of holes	6
Opening pressure of injector	
New nozzle holder:	335+8 bar
Used nozzle holder:	320+8 bar

Projection above cylinder head contact surfaces



Adjust nozzle protrusion by using Cu sealing rings of different thickness.
These sealing rings are available in thicknesses of
0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm

2,42–3,25 mm

Injectors: KDEL 82 P 12

Injection pump

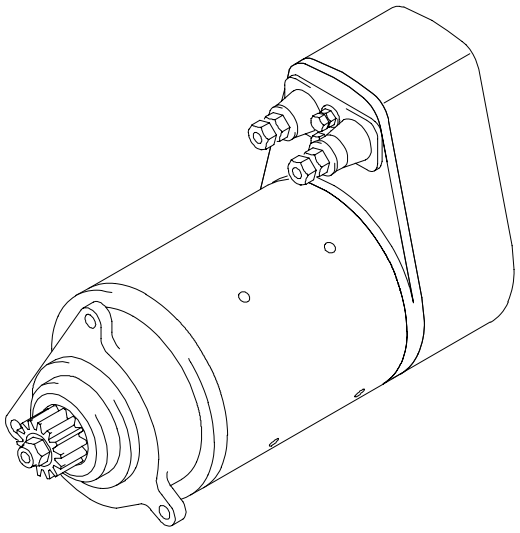
In-line injection pump

Governor
Electronic Diesel Control (EDC)

Start of delivery

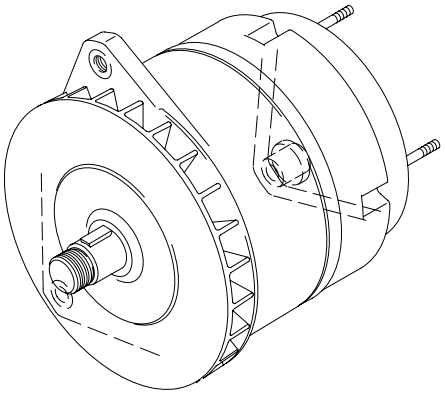
Model	crank angle before TDC
D 2842 LE 602	8° ± 1°
D 2842 LE 604	10° ± 1°
D 2842 LE 607	8° ± 1°

Starter motor



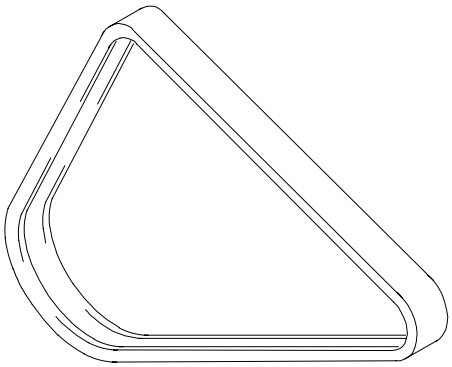
Manufacturer:	Bosch
Type:	KB
Operating method:	splined shaft
Starter motor pinion:	
Number of teeth:	Z = 9
Module:	3
Nominal power:	6,6 kW
Nominal voltage:	24 V

Alternator



Manufacturer	Bosch
Type	N1
Design	2 pole, insulated
Operation	Threephase current
Voltage	28V
Max. current:	55A
Manufacturer	Bosch
Type	T1
Design	2 pole, insulated
Operation	Threephase current
Voltage	28V
Max. current:	140A

V-belts



Change damaged V-belts (cracks, wear, oil)

Measuring tension withtension tester

Drive belt width	Tensioning forces according to the kg graduation on the tester		
	New installation		When servicing after long running time
	Installa-tion	After 10 min. run-ning time	
2/3VX	90–100	70–80	60
3/3VX	135–150	105–120	90

Note:
All screw connections whose purpose is not stated in the following table are to be tightened in accordance with the guide values in our company standard M 3059 (see page 161). Fit the bolts slightly oiled!

Screw plugs

DIN 908
- M14x1.5, M16x1.5 . . . . . 80 Nm
- M18x1.5, M22x1.5 . . . . . 100 Nm
- M24x1.5, M26x1.5 . . . . . 120 Nm
- AM14x1.5 . . . . . 150 Nm

DIN 7604
- AM10x1, M12x1.5 . . . . . 50 Nm
- AM14x1.5 . . . . . 80 Nm

Crankcase, crankshaft drive

Engine mounting to crankcase M14, 12.9 . . . . . 225 Nm
Gear case to crankcase M10, 12.9 . . . . . 75 Nm
Thrust washer to timing case M8, 12.9 . . . . . 40 Nm
Inspection port cover to gear case M8, 8.8 . . . . . 10 Nm
Crankshaft bearing cover to crankcase M18x2
- Initial torque . . . . . 300–330 Nm
- Angle tightening . . . . . 90–100°

Crankshaft main bearing caps (side)
- Hex bolt M 12 x 1,5 x 85, 10.9 (06.01494–4316)
- initial torque . . . . . 80 Nm
- rotation angle . . . . . 90°
- Hex collar bolt M 12 x 1,5 x 85, 12.9 (51.90020–0382)
- initial torque . . . . . 80 Nm
- rotation angle . . . . . 180°

Counterweight to crankshaft M16x1,5
- Initial torque . . . . . 140–160 Nm
- rotation angle . . . . . 90–100°

Vibration damper to crankshaft M16x1.5, 10.9 . . . . . 260 Nm
Flywheel to crankshaft M16x1,5
- Initial torque . . . . . 100–110 Nm
- rotation angle . . . . . 90–100°
- Angle tightening / final tightening . . . . . 90–100°

Conrod bearing cover M14x1.5
- Initial torque . . . . . 100–110 Nm
- rotation angle . . . . . 90–100°

Cylinder head

Tightening / retightening the cylinder–head bolts, see page 162.
Rocker arm bearing pedestal to cylinder head . . . . . 65 Nm
Locknut on valve setting screw . . . . . 50 Nm

Timing devices

Adjusting segment to camshaft gear M10	90 Nm
Adjusting segment to intermediate gear M10	90 Nm

Lubrication

Oil cooler to oil filter head M8, 8.8	22 Nm
Cover oil pump M8, 8.8	22 Nm
Oil cooler to oil filter head M8, 8.8	22 Nm
Oil cooler to oil filter head M8, 12.9	50 Nm
Oil pan to crankcase	22 Nm
Oil drain plug to oil pan M26x1.5	80 Nm
Oil injection nozzle Gear case to crankcase M10, 5	70 Nm

Exhaust / intake manifold

Exhaust manifold to cylinder head M10	
Initial torque	60–65 Nm
rotation angle	90–100°
Oil cooler to oil filter head M8, 8.8	22 Nm

Fuel system

Injector to cylinder head M28x1,5	120–125 Nm
Nozzle tension nut	45 Nm
Fuel filter M12, 8.8	80 Nm
Pressure pipe to injector	15–25 Nm
Pressure pipe to injection pump	15–25 Nm

Starter / alternator

Starter to timing case M10, 5	80 Nm
V–belt pulley on alternator	40–50 Nm

Transmitter

Oil pressure transmitter	80 Nm
Temperature transmitter	20 Nm

Installation tightening torques according to company standard M 3059

Bolts / nuts with external or internal hexagon, head without collar or flange

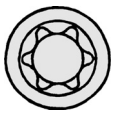
Thread size x pitch	Property classes / tightening torques in Nm		
	for **8.8** / **8**	for **10.9** / **10**	for **12.9** / **12**
M4	2,5	4,0	4,5
M5	5,0	7,5	9,0
M6	9,0	13,0	15,0
M7	14,0	20,0	25,0
M8	22,0	30,0	35,0
M8x1	23,0	35,0	40,0
M10	45,0	65,0	75,0
M10x1.25	45,0	65,0	75,0
M10x1	50,0	70,0	85,0
M12	75,0	105,0	125,0
M12x1.5	75,0	110,0	130,0
M12x1.25	80,0	115,0	135,0
M14	115,0	170,0	200,0
M14x1.5	125,0	185,0	215,0
M16	180,0	260,0	310,0
M16x1.5	190,0	280,0	330,0
M18	260,0	370,0	430,0
M18x2	270,0	290,0	450,0
M18x1.5	290,0	410,0	480,0
M20	360,0	520,0	600,0
M20x2	380,0	540,0	630,0
M20x1.5	400,0	570,0	670,0
M22	490,0	700,0	820,0
M22x2	510,0	730,0	860,0
M22x1.5	540,0	770,0	900,0
M24	620,0	890,0	1040,0
M24x2	680,0	960,0	1130,0
M24x1.5	740,0	1030,0	1220,0

Cylinder-head bolts
General notes

The engine can be equipped with the following cylinder-head bolts:

- Rotation angle cylinder-head bolts with hexagon head, WAF 19

- Rotation angle cylinder-head bolts with Torx head Torx WAF E18



Bolts to be fitted on repair:

Hexagon bolts can be replaced by Torx bolts if all the bolts of an engine are replaced.

Mixed use of hexagon and Torx bolts is not permitted!

Tightening the cylinder-head bolts on a new engine (Engine cold or warm)

The cylinder heads are fitted with cylinder-head bolts for rotation angle tightening. On new engines, the cylinder-head bolts are retightened at the factory after running in and marked by the sticker **"First retightening of cylinder-head bolts ..."** on a cylinder head cover.

After the first 400 hours of operation, following a repair, tighten the cylinder-head bolts 1 to 4 in the order specified in the tightening schedule **"1"** by 90° (1/4 turn).

The two outer bolts (intake and exhaust side) must not be retightened.

Note:
The cylinder-head bolts to be retightened must not be loosened; they are to be tightened further from their current position by 90° (1/4 turn).

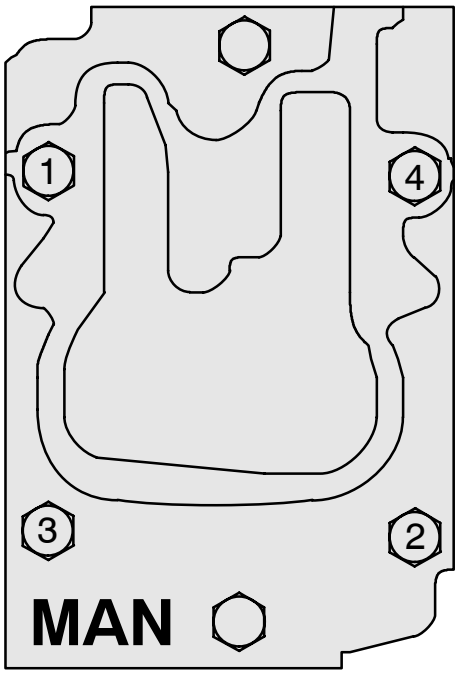
Remove the sticker **"First retightening of the cylinder-head bolts ..."** and attach the sticker **"Second retightening of the cylinder-head bolts ..."** to verify the second retightening.

Zweiter Nachzug der Zylinderkopfschrauben erledigt

Second retightening of cylinder-head-bolts completed

Spare part no. 51.97801–0211

Intake side / injection nozzle



Exhaust side

Tightening schedule **"1"**

Zweiter Nachzug der Zylinderkopfschrauben erledigt

Second retightening of cylinder-head-bolts completed

Spare part no. 51.97801–0212

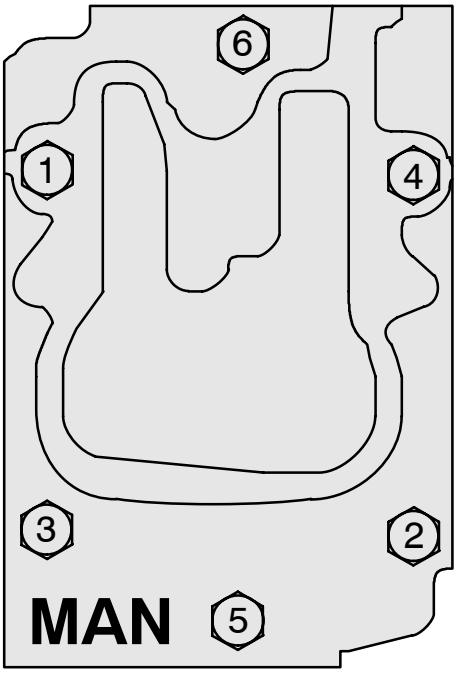
Retightening the cylinder-head bolts following a repair
(engine cold)

Before inserting the cylinder-head bolts, apply engine oil to the thread (not the threaded hole) and coat the seating surface of the bolt head with installation paste “Optimoly White T”. Do not use oils or oil additives containing MoS_2. The bolts are to be tightened using the rotation angle method according to tightening schedule **“2”** as follows.

- 1rd pretightening = to 10 Nm
- 2rd pretightening = to 80 Nm
- 3rd pretightening = to 150 Nm
- 4th pretightening = 90°
- Final tightening = 90°

Set the valve clearance.

Intake side / injection nozzle



Exhaust side

Tightening schedule **“2”**

Retightening the cylinder-head bolts following a repair
(Engine cold or warm)

After the first 10 to 20 hours of operation, following a repair, tighten the cylinder-head bolts in the order specified in the tightening schedule **“1”** by 90° (2/4 turn).
The cylinder-head bolts to be retightened must not be loosened; they are to be tightened further from their current position by 90° (1/4 turn).
Attach the sticker **“First retightening of cylinder-head bolts ...”** (remove sticker that might already be attached).
After the first 400 hours of operation, following a repair, tighten cylinder-head bolts 1 to 4 in the order specified in the tightening schedule **“1”** by another 90° (1/4 turn).
The two outer bolts (intake and exhaust side) must not be retightened.
Attach sticker **“Second retightening of cylinder-head bolts ...”**.

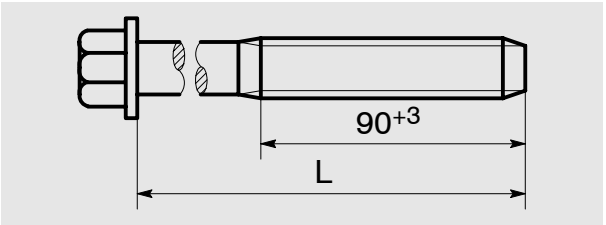
Note:
When the head has been removed, the cylinder head gasket must always be replaced.

Reuse of used cylinder-head bolts

Check
Before used cylinder-head bolts are reused, they must be checked as follows:

Length
With each tightening, the bolts are deliberately stressed beyond the stretch limit and each tightening thus extends their length permanently.

Surface
The bolts must have a perfect surface, i.e. closed phosphatisation and no rust stains.
Rusted or damaged bolts or bolts stretched beyond the maximum length are to be made unusable immediately – e.g. by hammering the thread – and to be scrapped.

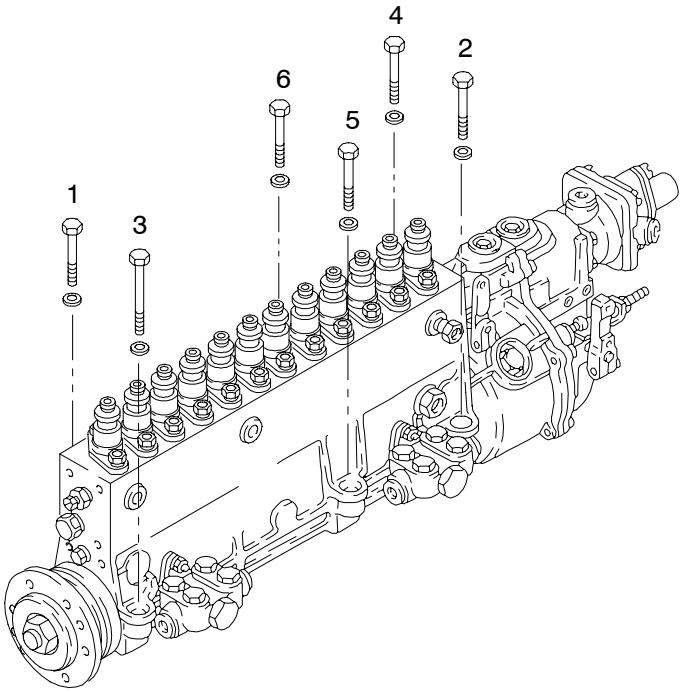


L = shaft length

Shaft lengths “L” in the case of new bolts	Largest permitted dimension
109 mm	111 mm
144 mm	146 mm
168 mm	170 mm

Tightening torque values, injection pumps

D 2842 L..

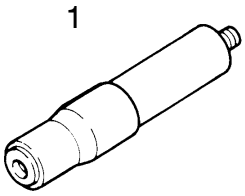


Order of tightening: 1–2–3–4–5–6
in the steps:

1. initial torque: 10 Nm
2. initial torque: 50–55 Nm
3. final torque 90°

Bracket tightening method effective only if bolts of the strength class 8.8 (no more) are used..

Special tools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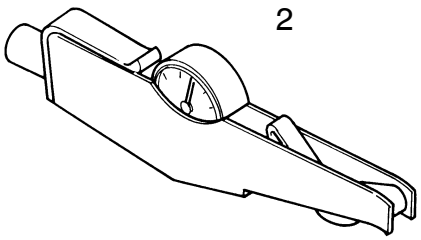
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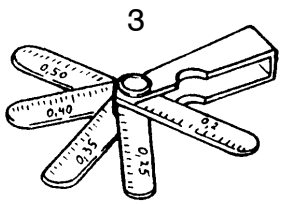
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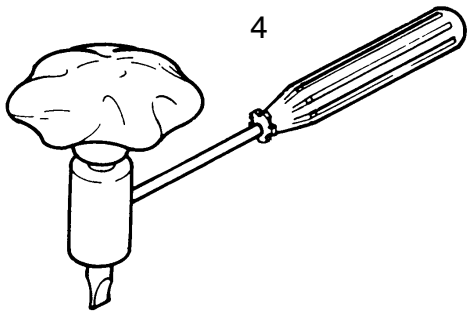
0,50
0,40
0,35
0,3
0,25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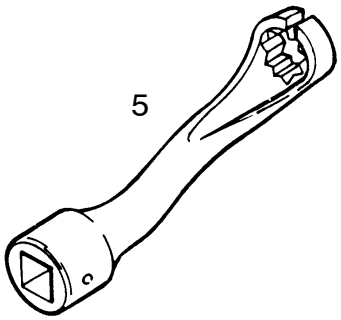
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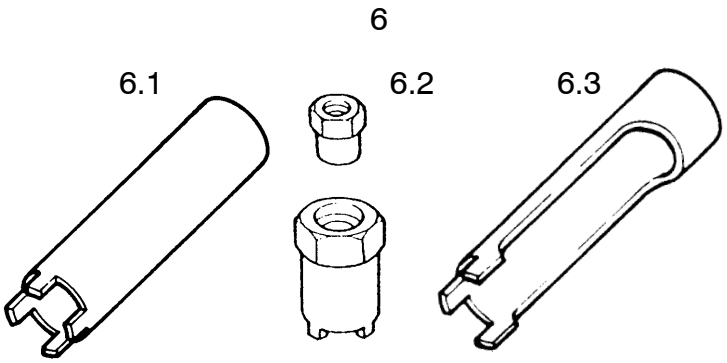
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6.1
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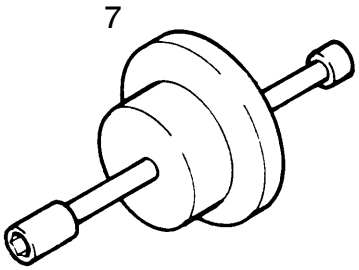
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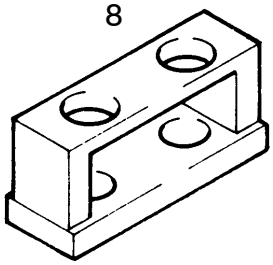
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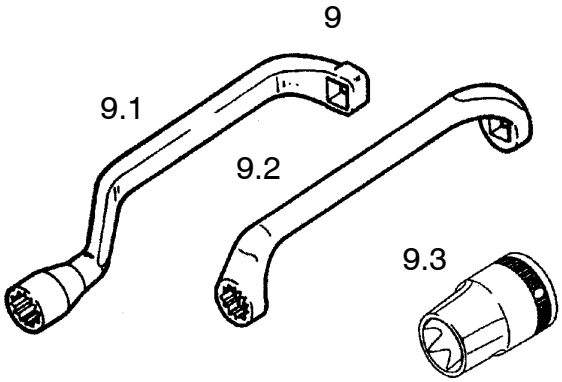
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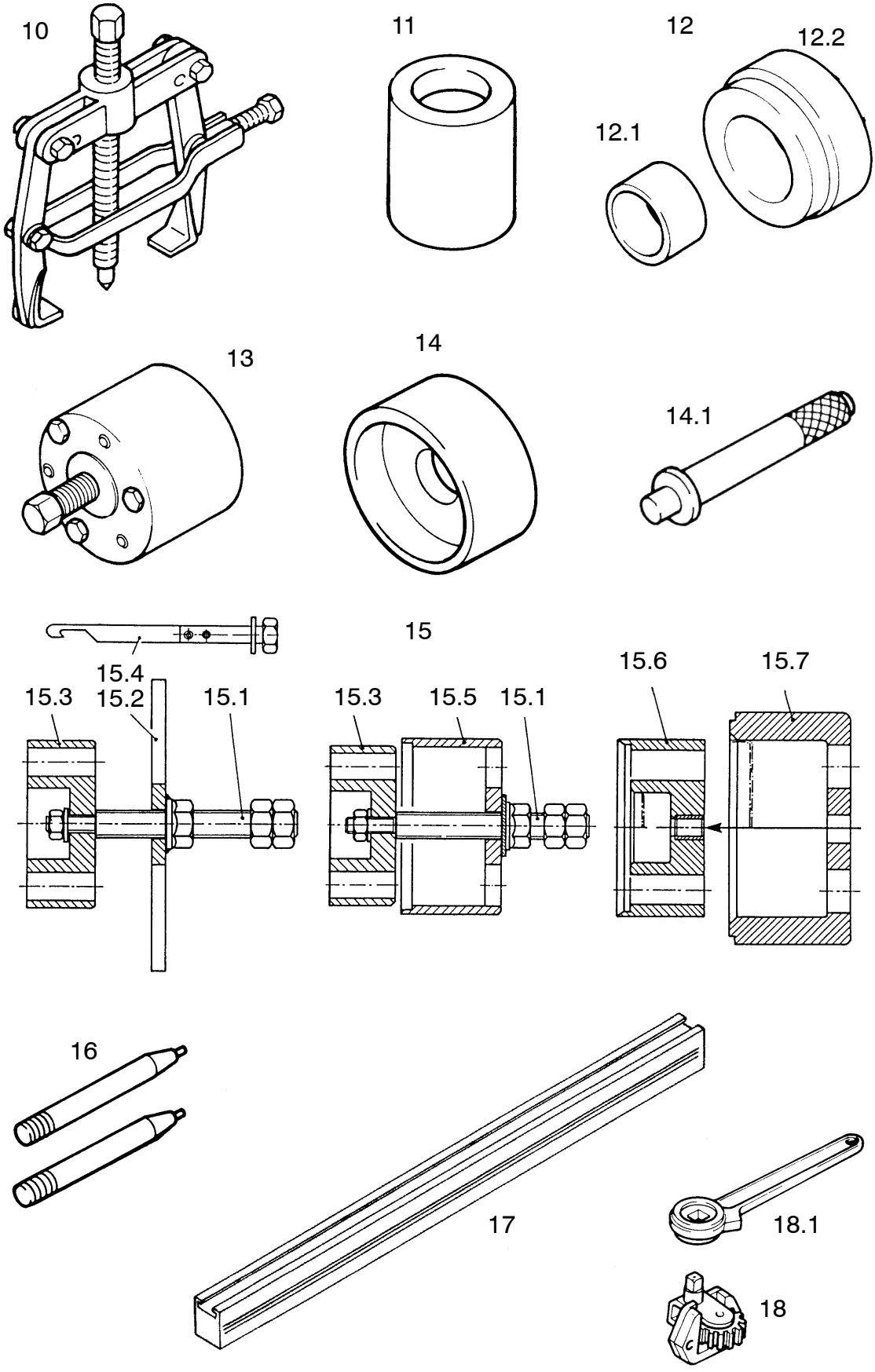
9.1
9.2
9.3

Fig. no.	Designation	Item code
1	Test connection for compression recorder	80.99607–0002
2	V-belt tension indicator	81.66814–6001
3	Valve gauge	80.99607–0076
4	Valve setting key	80.99603–6007
5	Spanner for nuts on injection lines (17 mm)	80.99603–0025
6	Socket spanner set for fuel injector	
6.1	4-groove	80.99603–0049
6.2	4-groove with fixing screw	80.99603–0121
6.3	open, 3-groove	80.99603–0038
7	Inertia puller for fuel injector	80.99602–0011
8	Clamping device for fuel injectors	80.99606–0008
9	Special spanner for cylinder-head bolts	
9.1	Special spanner for cylinder-head bolts	80.99603–0069
9.2	Special spanner for cylinder-head bolts	80.99603–0095
9.2	Special spanner for cylinder-head bolts (Torx)	80.99603–0255
9.3	Drive socket for cylinder-head bolts (Torx)	08.06143–0215


10
11
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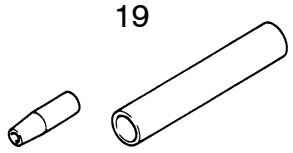
15.4
15.3
15.2
15.1
15.3
15.5
15.1
15.6
15.7
16
17
18.1
18

Fig. no.	Designation	Item code
10	Stripping device for v-belt pulley of the water pump	80.99601–0037
11	Press-in mandrel for cassette sealing in conjunction with handle 14.1	80.99617–0091
12	Drift for sealing ring in the gear case	
	consisting of:	
12.1	Guide bush	80.99604–0068
12.2	Press plate in conjunction with handle 14.1	80.99604–0069
13	Extractor for front crankshaft bearing race	80.99601–0076
14	Drift for bearing race on flywheel in conjunction with handle 14.1	80.99617–0017
14.1	Detachable handle for all press-in plates	80.99617–0129
15	Special tool for front crankshaft gasket	80.99606–6011
	Components:	
15.1	Spindle	80.99606–0229
15.2	Extractor device	80.99606–0298
15.3	Adapter	80.99606–0264
15.4	Extractor hook	80.99606–6013
15.5	Press-in sleeve	80.99606–0300
15.6	Adapter	80.99606–0302
15.7	Application sleeve	80.99606–0301
16	Guide mandrel for flywheel	80.99617–0020
17	Straightedge	80.99605–0175
18	Engine barring gear	80.99626–0004
18.1	Standard ratchet for 18	80.99627–0001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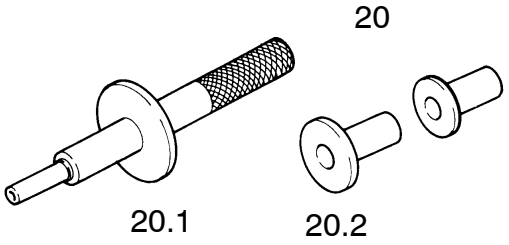
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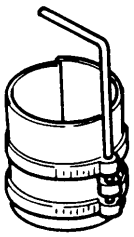
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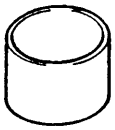
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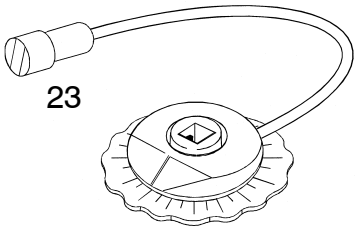
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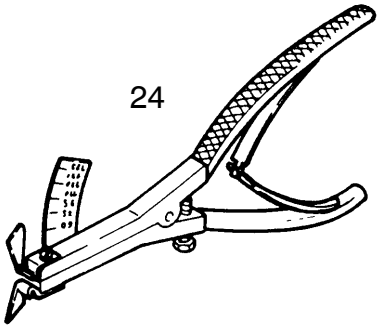
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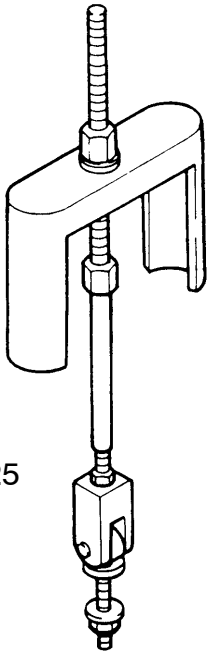
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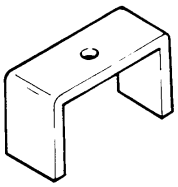
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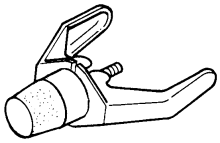
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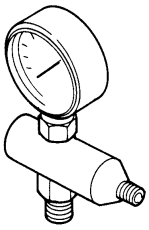


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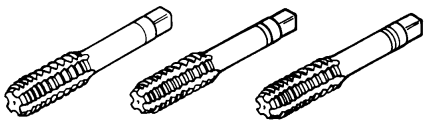
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27.2

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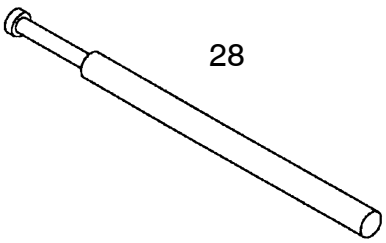
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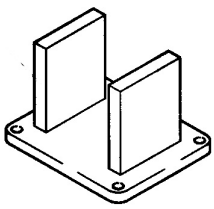
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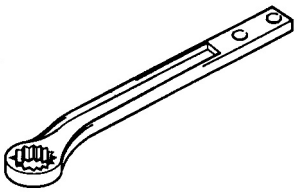
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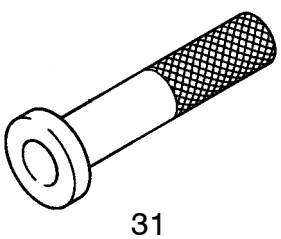
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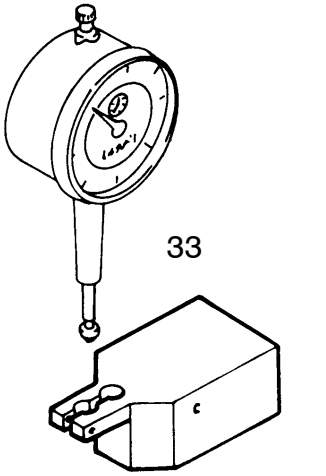
Fig. no.	Designation	Item code
19	Sleeves for valve-stem sealing	
19.1	Guide sleeve for valve shaft sealing ring	80.99616–0004
19.2	Press-in sleeve for valve shaft sealing ring	80.99604–0005
20	Pressing tool for valve guide	
20.1	Press mandrel for valve guide	80.99617–0013
20.2	Press rings in conjunction with 20.1	80.99616–0003
21	Piston ring scuff band	80.99613–0035
22	Piston ring tensioning sleeve	83.09144-0187
23	Angle of rotation measuring device	80.99607–0134
24	Piston ring pliers	83.09144–6090
25	Cylinder liner extractor	80.99602–0019
25.1	Support for 25	80.99623–0003
25.2	Extractor plate	83.09143–0195
26	Cooling system tester	80.99607–0061
27	Thread cutter	
27.1	Thread drill set, M15x2, for cylinder head bolt threads	80.40001–0001
27.2	Die ring in addition	80.43001–0001
28	Control rod (alignment tool for belt drive)	80.99607–0096
29	Blocking device	80.99606–0007
30	Ring spanner	80.99603–0021
31	Press pin	80.99617–0015
32	Extractor for ring on the flywheel (no fig.)	80.99601–6017



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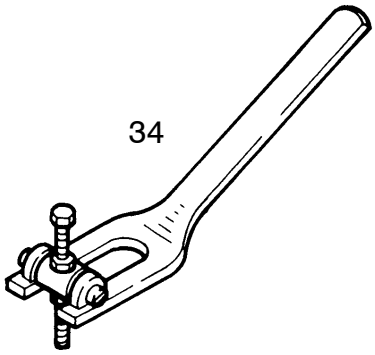

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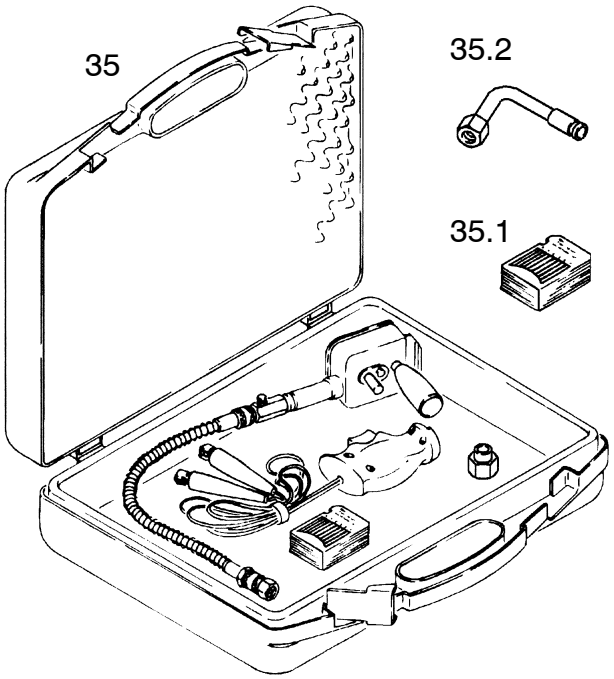

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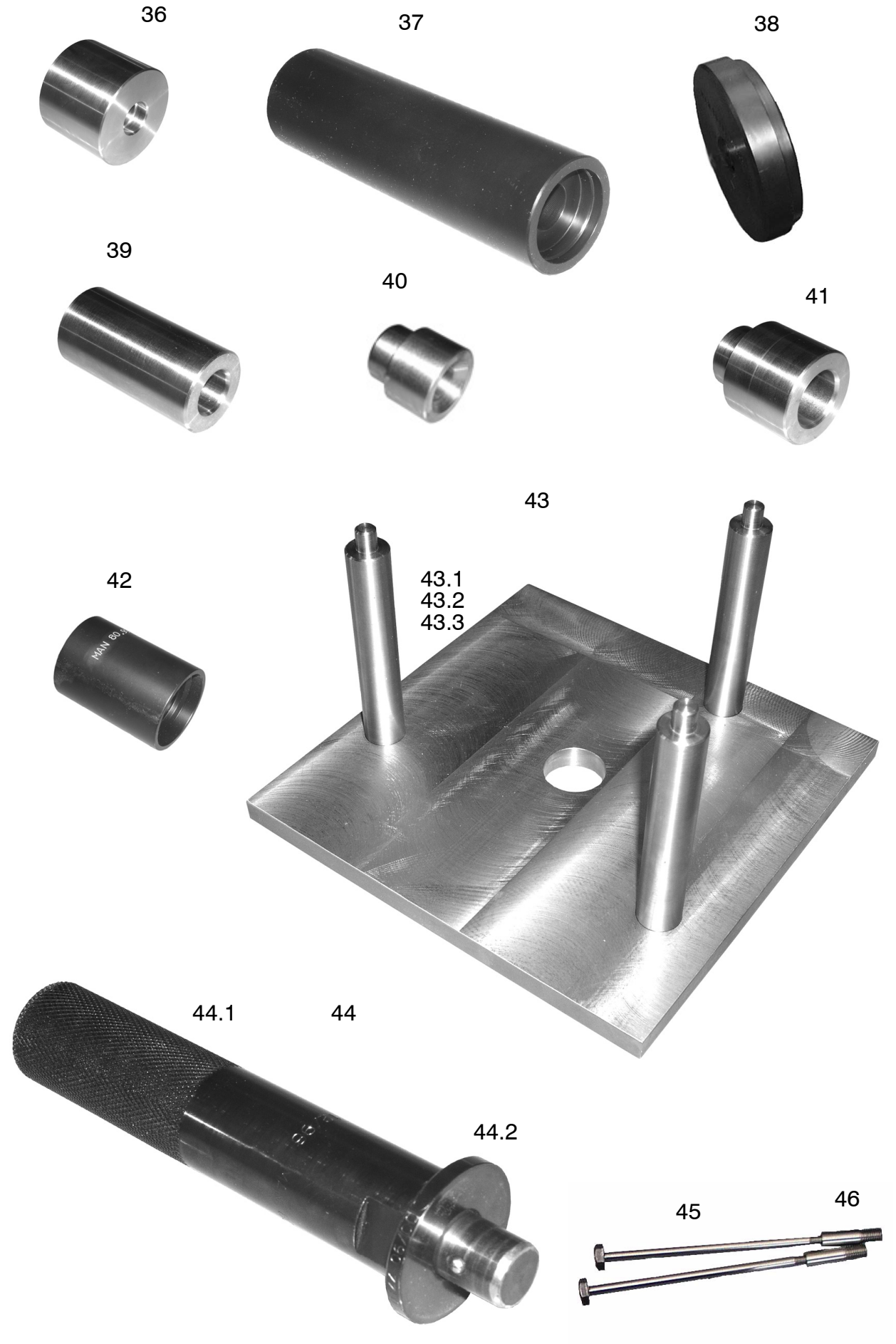
35.2

35.1

Fig. no.	Designation	Item code
33	Dial gauge bracket	90.99605–0172
34	Valve fitting lever	80.99606–0031
35	Compression recorder 10–40 bar	80.99605–0164
35.1	Tachograph disc 100 pcs	80.99605–0165
35.2	Angle adapter	81.98110–0099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43.1
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44.2
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Special tools for high- and low-temperature coolant pump

Fig. no.	Designation	Item code
36	Pressing plate / pressing in the coolant pump bearing, coolant pump shaft and V-belt pulley	80.99604−0251
37	Pressing mandrel / pressing the axial face seal into the pump housing	80.99604−0252
38	Base plate for various pressing jobs	80.99614−0027
39	Pressing mandrel / pressing the deep-groove ball bearing into the HT pump housing	80.99604−0254
40	Clamp / assembly device for pump housing	80.99606−0628
41	Clamp / assembly device for pump housing	80.99606−0629
42	Pressing mandrel / pressing in the axial face seal 51.06520−0085	80.99617−0191
43	Assembly device for pump housing	80.99606−6128
	consisting of:	
43.1	Plate	80.99606−0631
43.2	Location pin / assembly device for pump housing	80.99606−0632
43.3	Mouting bolts	06.02192−0308
44	Detachable handle for all press-in plates and clamps	80.99617−6006
	consisting of:	
44.1	Handle	80.99617−0187
44.2	Disc	80.99617−0144
45	M5 bolt with left−handed thread for installing coolant pump	80.99606−0642
46	Centring pin for installation of coolant pump	80.99606−0643
47	Bush for pressing in end cover (no fig.)	80.99604−0263

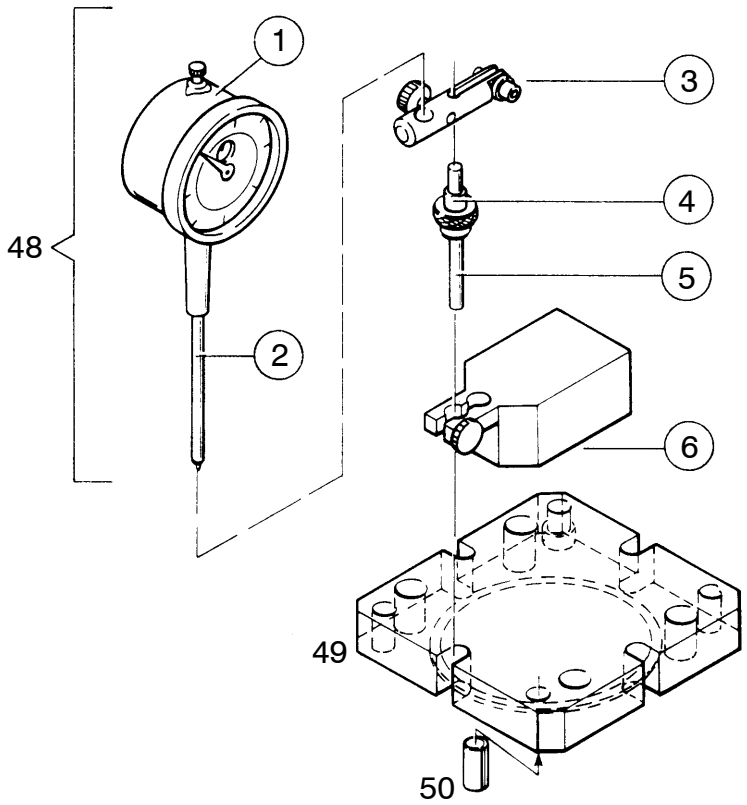
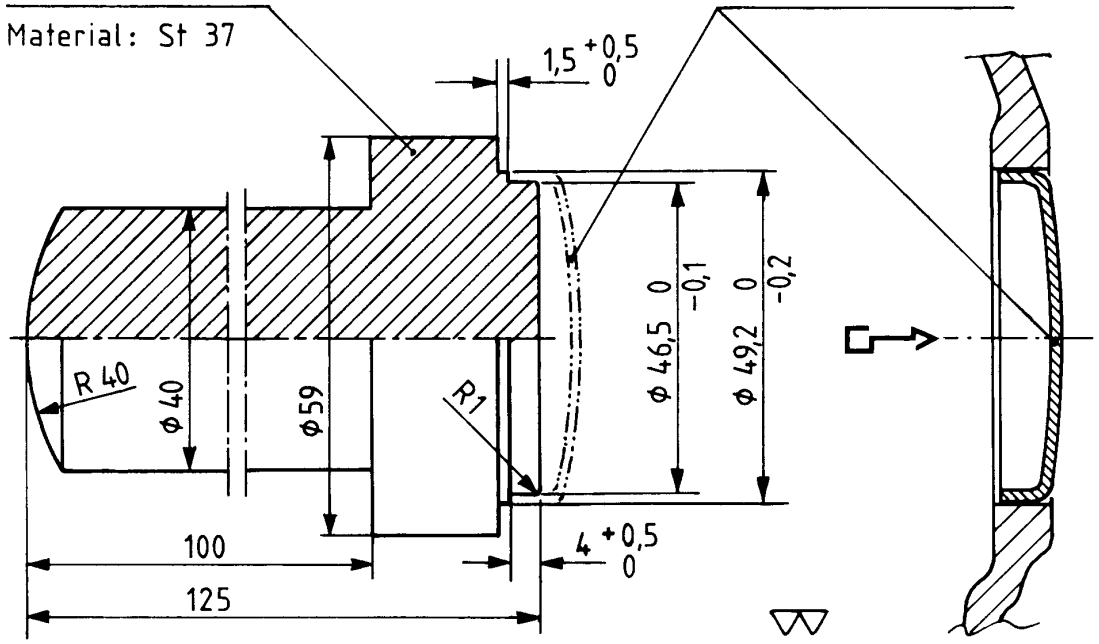
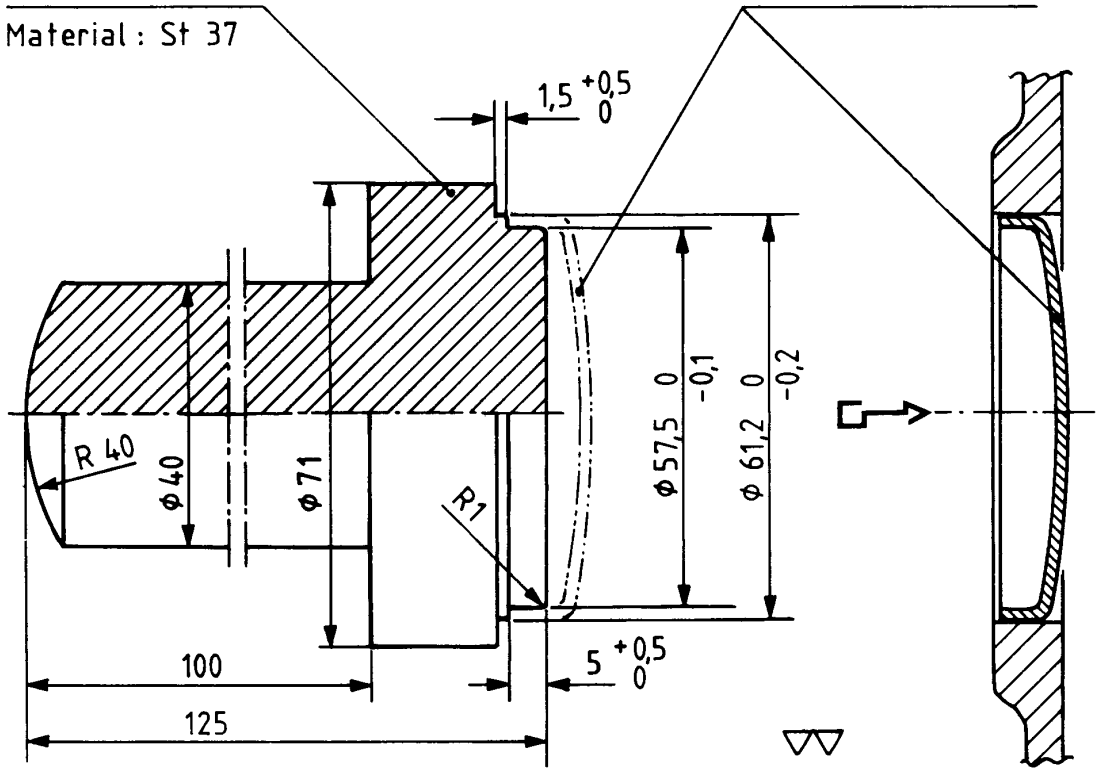


Fig. no.	Designation	Item code
48	Measuring combination, consisting of:	
	(1) Dial gauge	08.71000–1205
	(2) Tracing pin for dial gauge	80.99605–0197
	(3) Dial gauge bracket	80.99605–0179
	(4) Seating pin	80.99605–0180
	(5) Dial gauge bracket	80.99605–6006
	(6) Dial gauge bracket	80.99605–0172
49	Press-on measuring plate	80.99605–0195
50	Adjusting sleeves	51.91701–0247

Pressing mandel for cap, dia Ø 50,1 mm



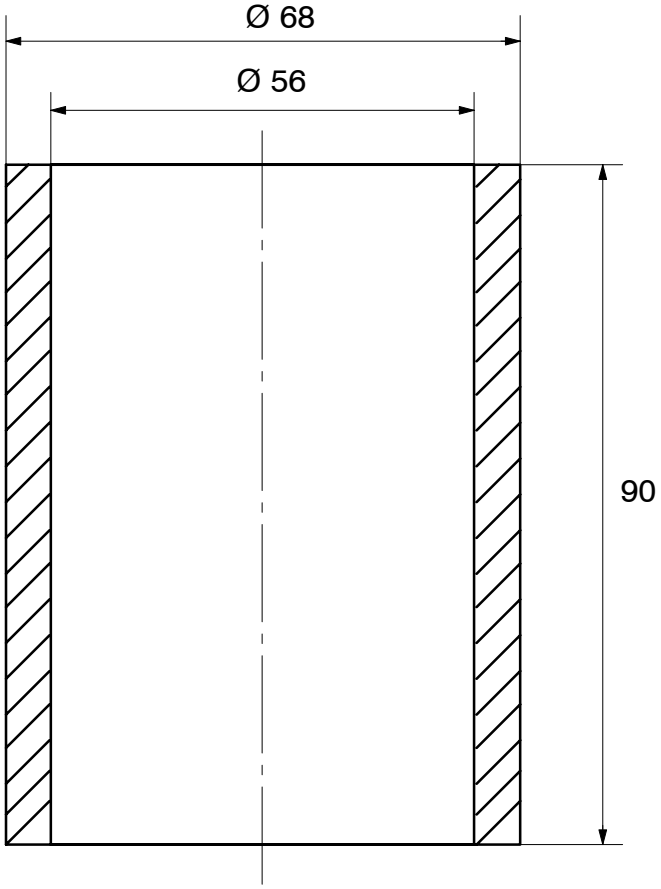
Pressing mandel for cap, dia Ø 62,1 mm



Special tools for water pump repair for local manufacture

(Material: steel as available)

Support ring for pressing out the water pump bearing



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A member of the MAN Group

Printed in Germany 51.99598-8038