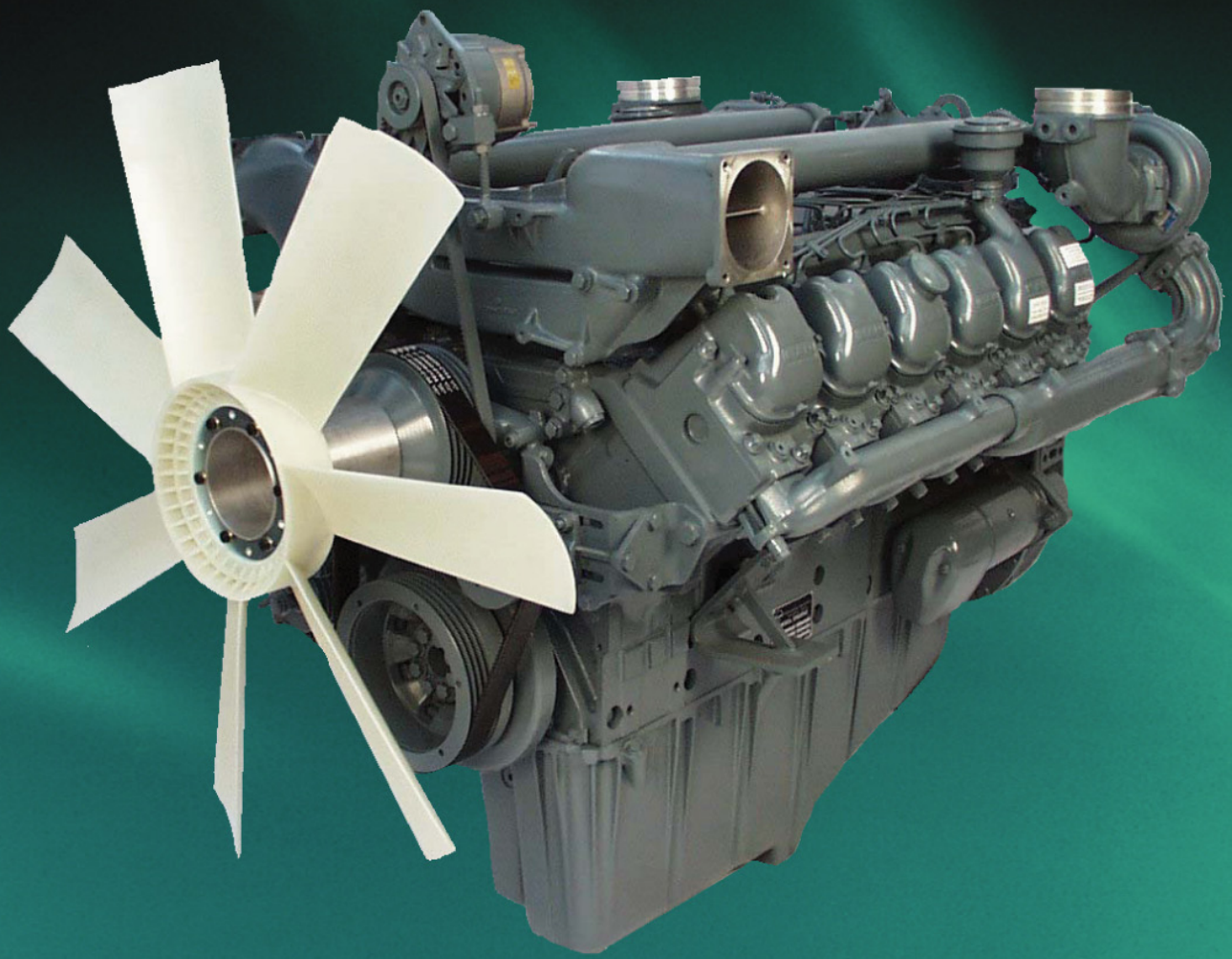
Repair manual

MAN-Industrial Diesel Engines

D 2848 LE 2..
D 2840 LE 2..
D 2842 LE 2..



This Repair Manual is designed to facilitate proper repair of the engines listed here.

The pictures and associated 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.

It is compulsory that the engine be removed before performing any of the work described in this Repair Manual.

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

Note:
Only use fuel, coolants and lubricants in accordance with MAN regulations, otherwise the manufacturer's warranty will not apply!
For basic information on the fuels see the publication "Fuels, Lubricants and Coolants for MAN Diesel Engines".
You can find the approved products on the Internet at:
–**http://www.man-mn.com**/ → **Products & Solutions** → **E-Business**–

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

Best regards
MAN Nutzfahrzeuge Aktiengesellschaft
Nuremberg Plant

Since our products are in continuous development, we reserve the right to make technical modifications.

MTDB Technical status: 07.2005 51.99493–8504

Important instructions concerning technical safety and personal protection are, as shown below, especially highlighted.

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:
Explanatory descriptions which help in understanding the relevant work or operating procedure to be carried out.

Assembly of pipes

Danger:
No pipes may be bent.
Risk of breakage!

Fitting flat seals / gaskets

Gaskets are frequently used with sealants or adhesives as an aid to assembly or to achieve a better seal. Above all when parts with different levels of thermal expansion (e.g. aluminium and cast iron) are bonded, this can mean that the gasket is shifted during operation by the so-called stitching or sewing machine effect and leaks 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.

Perfect assembly of gaskets can only be achieved if the following instructions are adhered to:

- 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.

Assembly of round sealing rings

- Use only genuine MAN round sealing rings.
- The sealing faces must be undamaged and clean.
- Always wet round sealing rings with engine oil before fitting them.

Masking of fuel and lube oil pipe connections (for classified engines only)

The unions of pressurised oil and fuel pipes are masked with a protective tape.
If this tape is removed during a repair, the unions must be masked with protective tape again afterwards.

The following pipes are affected:

- Oil supply pipe to turbochargers
- Fuel pipes between supply pump, filter and injection pump
- Injection pipes protected against leaks

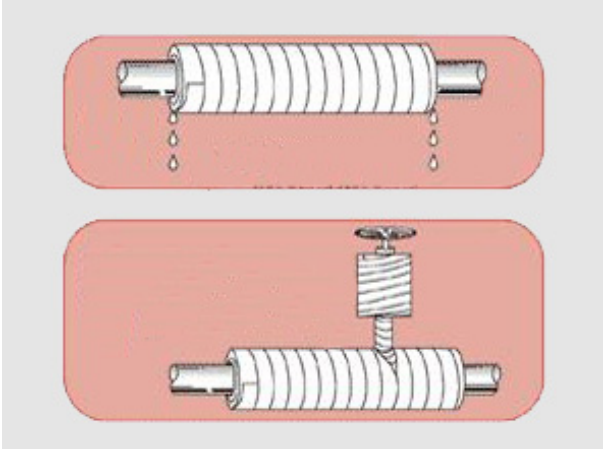


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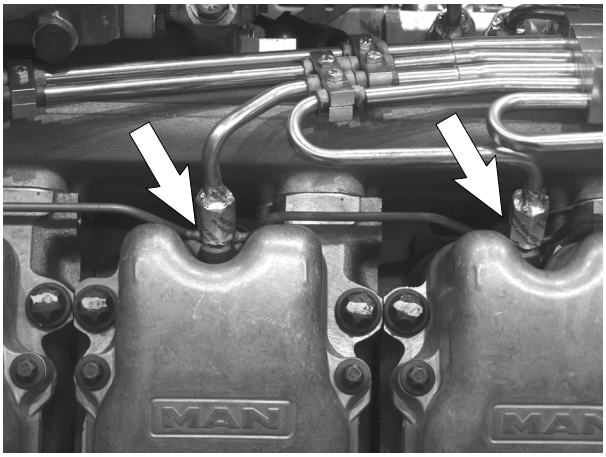
Fig. 1
A protective tape is wound around the unions. Ensure that there is 50 % overlap on every pass.



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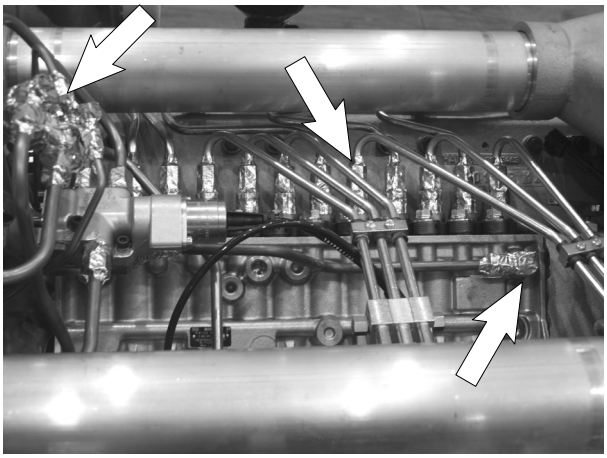
Figs. 2–4
The unions to be masked must be clean and free of oil and grease.
Do not apply the protective tape unless this is the case



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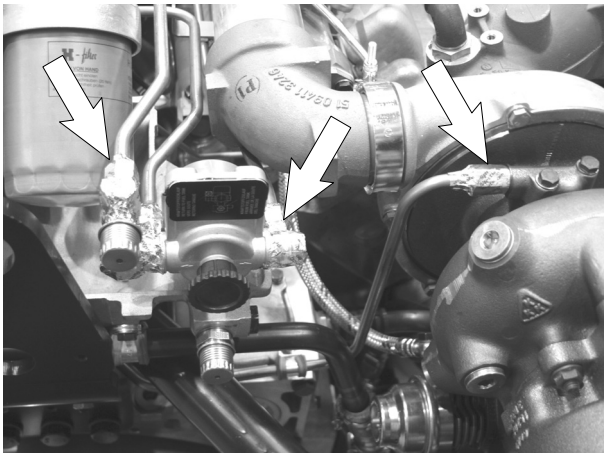

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Contents

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 201 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 12 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 distinguishes these engines from MAN vehicle engines

201/2.. — This is a Works internal development number. This engine generation was introduced early 1994 with modified turbocharger, high-pressure injection and, fitted as standard, an electronically controlled quantity regulator.

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”.

1. Starter turns over engine only slowly or not at all																					
	2. Starter turns, engine does not start, engine does not start / difficult to start when cold																				
		3. Engine stalls (dies) during operation, no longer starts (starter turns), engine does not start / starts with difficulty when hot																			
			4. Sudden, temporary engine shutdown, engine does not reach full revs																		
				5. Engine only runs at idle speed, no throttle response																	
					6. Engine only runs at increased idle speed, no throttle response																
						7. Rated engine speed distinctly reduced (even under no load)															
							8. Reduced output in all ranges														
								9. Irregular engine operation, traction loss													
									10. Unstable idle speed, engine hunting, misfiring, knocking in engine												
										11. Engine judder											
											12. Unusual combustion noise										
												13. Excessive smoke emission: White smoke / blue smoke									
													14. Excessive smoke emission: Black smoke								
														15. Engine temperature too high (coolant loss)							
															16. Intermediate speed control cannot be activated / does not switch off; engine running at an excessively high speed						
																17. Fuel consumption too high						
																	18. Lubricating oil pressure too low				
																		19. Lubricating oil pressure too high			
																			20. Lubricating oil consumption too high		
																				21. 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 defective
																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 defective (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 loose
																		x			Valve stems worn, bent
	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 intake due to defective secondary consumers such as hydraulic pumps, fan etc., power take-off engaged
			x			x				x		x							x		Air cleaner soiled or clogged, turbo air system leaking, air inlet / exhaust line clogged / leaking
	x	x	x	x		x	x		x			x									Fuel low pressure system: Fuel tank, prefilter, water trap faulty / clogged / mould / fungal attack, fuel unsuitable / contaminated (paraffin added)
	x	x	x			x	x	x		x		x									Fuel low pressure system: Fuel lines leaking, broken, clogged

x = trifft eher zu
o = trifft eventuell zu

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.	Possible causes
x	x	x			x	x		x		x											Fuel low pressure system: Air in system (turn on ignition when bleeding system)
x	x	x			x	x	x	x		x			x								Fuel low pressure system: Fuel pump, overflow valve, main filter
x					x		x	x	x	o	x		x								Fuel high pressure system: Jets defective / 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 / set incorrectly
					o			x	o				o								Fuel high pressure system: Injection pump constant-pressure control valve / return flow restrictor defective
x	x	x			o	x															EHAB defective, drive faulty
o	o				o		x		o	x	x		x								Injection pump-engine allocation: Start of delivery incorrect (basic installation), start of delivery set incorrectly
x	x	x						o													Both rpm sensors defective, line defective
					x		x			o	x										Exhaust turbocharger leaking or defective
																				x	Turbine and compressor rotor in turbocharger dirty (out-of-balance, irregular running)
											x										Intercooler leaking, defective
x										x											Flame starter defective
					x							x									Radiator dirty or failure of cooling system (temperatures too high)
												x									Coolant level too low, air in coolant circuit
												x									V-belt for water pump drive not tensioned correctly
												x								x	Incorrect V-belt tension
												x									Water pump leaking, defective / Thermostat defective, does not open
												x									Coolant lines leaking, clogged or twisted
											x										Coolant entering combustion chamber (cylinder head / gasket leaking)
									x												Engine bearings worn

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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:

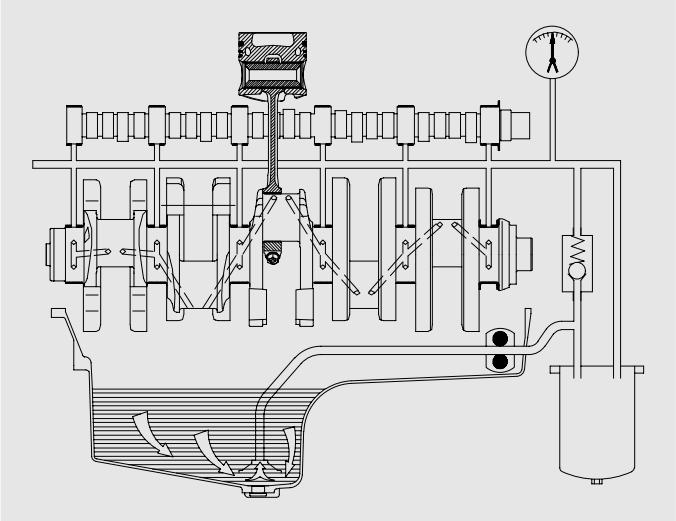
- Correct output setting according to the type of operation
- Expert installation in accordance with the installation instructions
- Inspection of the installation by authorized personnel
- Regular maintenance as per maintenance plan in the Operator's manual
- Selection and quality of lube oil, fuel 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.

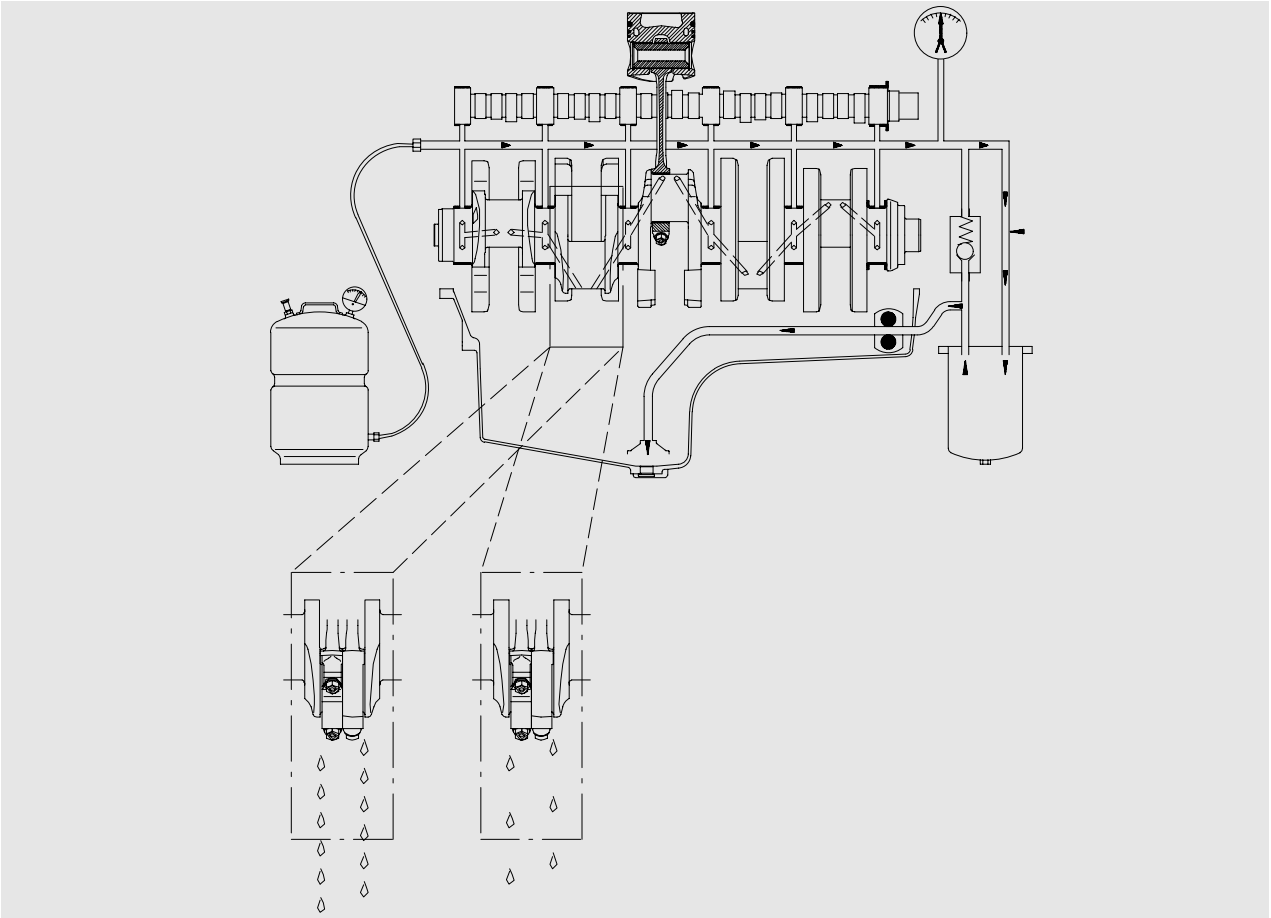
Such incipient damage need not necessarily lead to bearing failure, but may affect the functioning of bearings and shorten their service lives.



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

Pressurising an engine affords the following advantages:

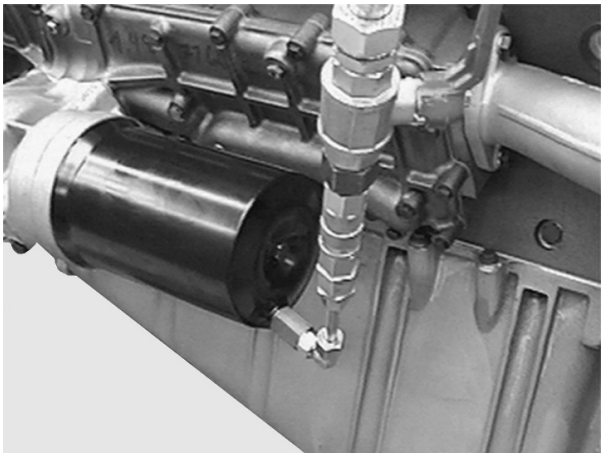
- All engine parts are lubricated before engine start; inside the bearings a lubricating film can build up as early as after the first few turns of the crankshaft, which prevents damage to the bearing races.
- Loss of oil, be it the result of excessively large bearing play or leaks from the crankcase 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.



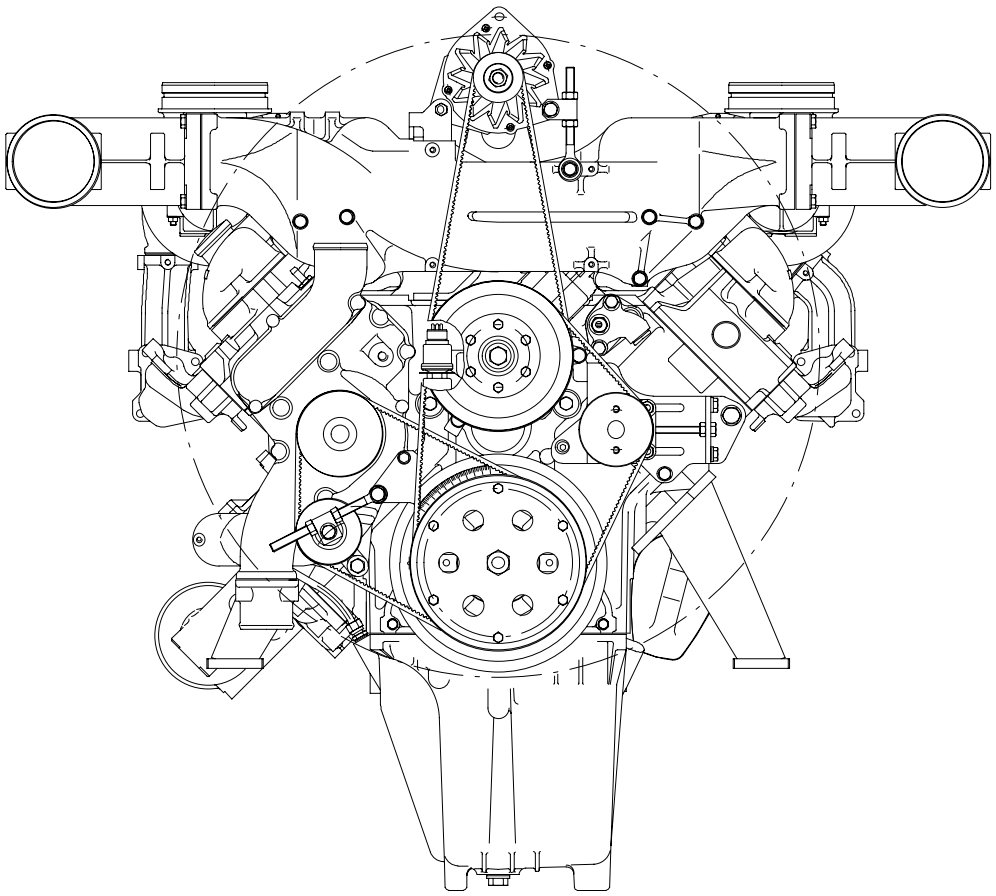
Execution of pressurisation:

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.

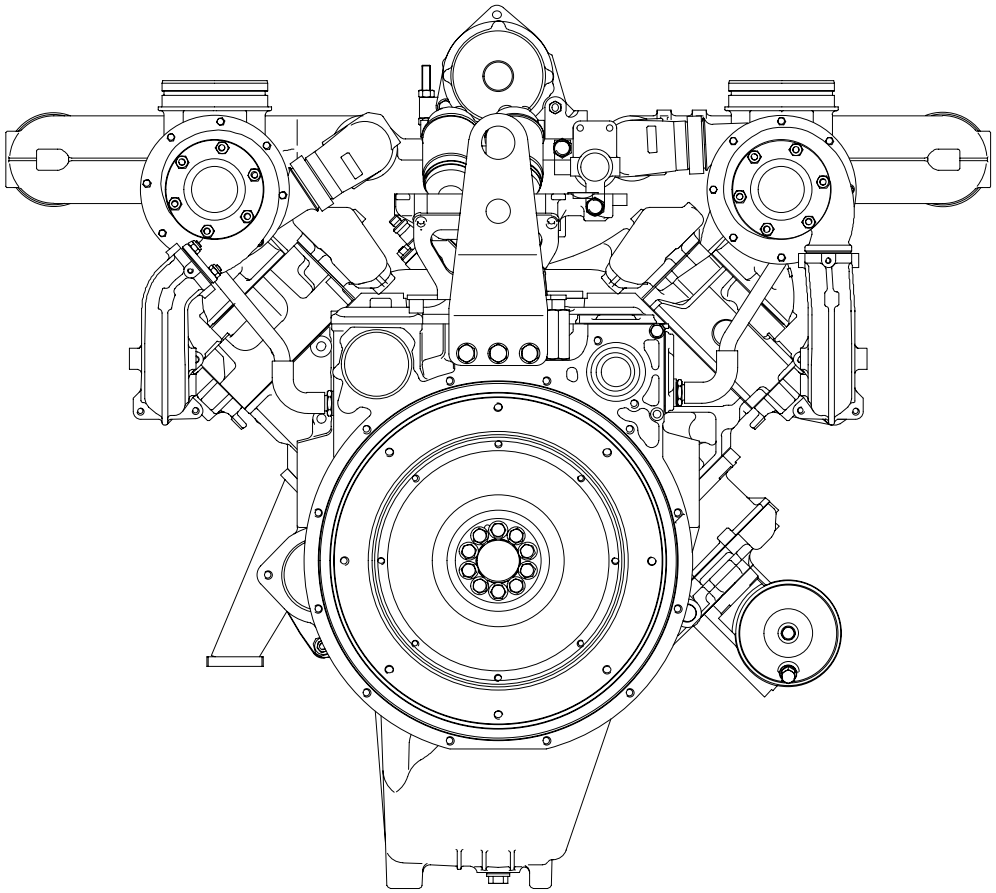
The pressurisation container is connected up to the engine's oil circuit at the oil filter head (screw plug).



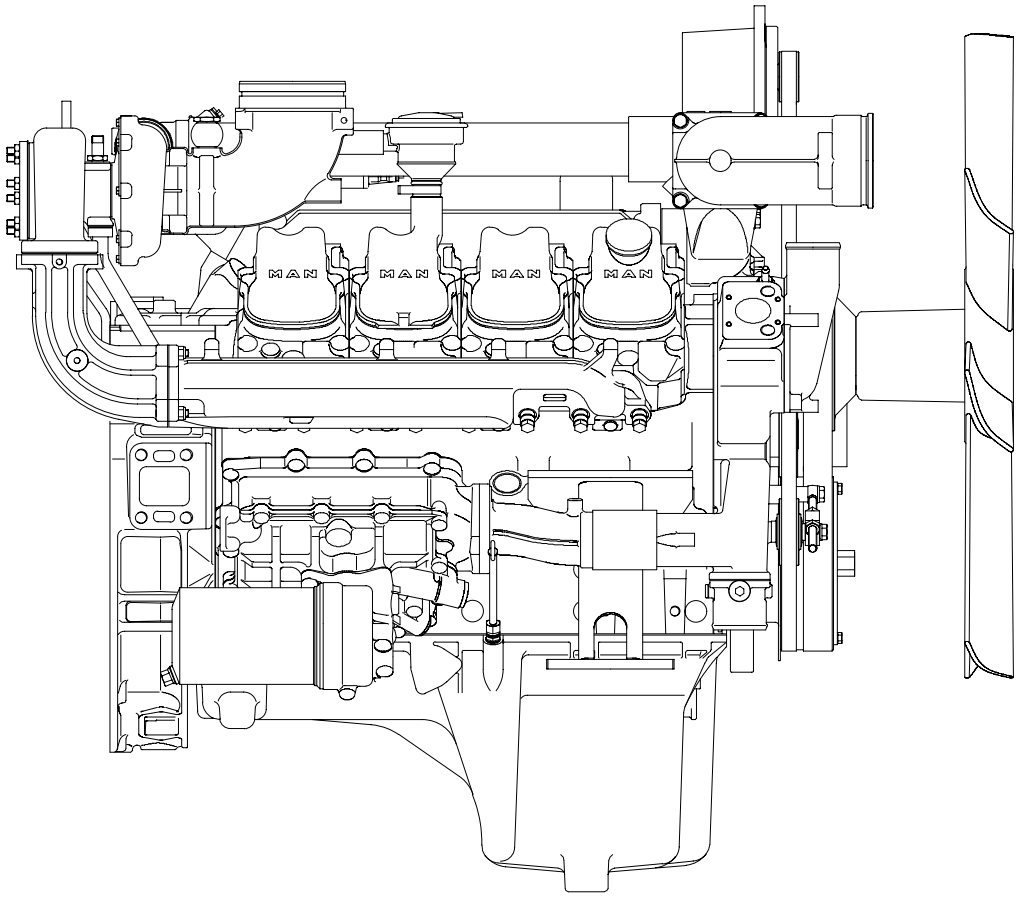
Front view of engine



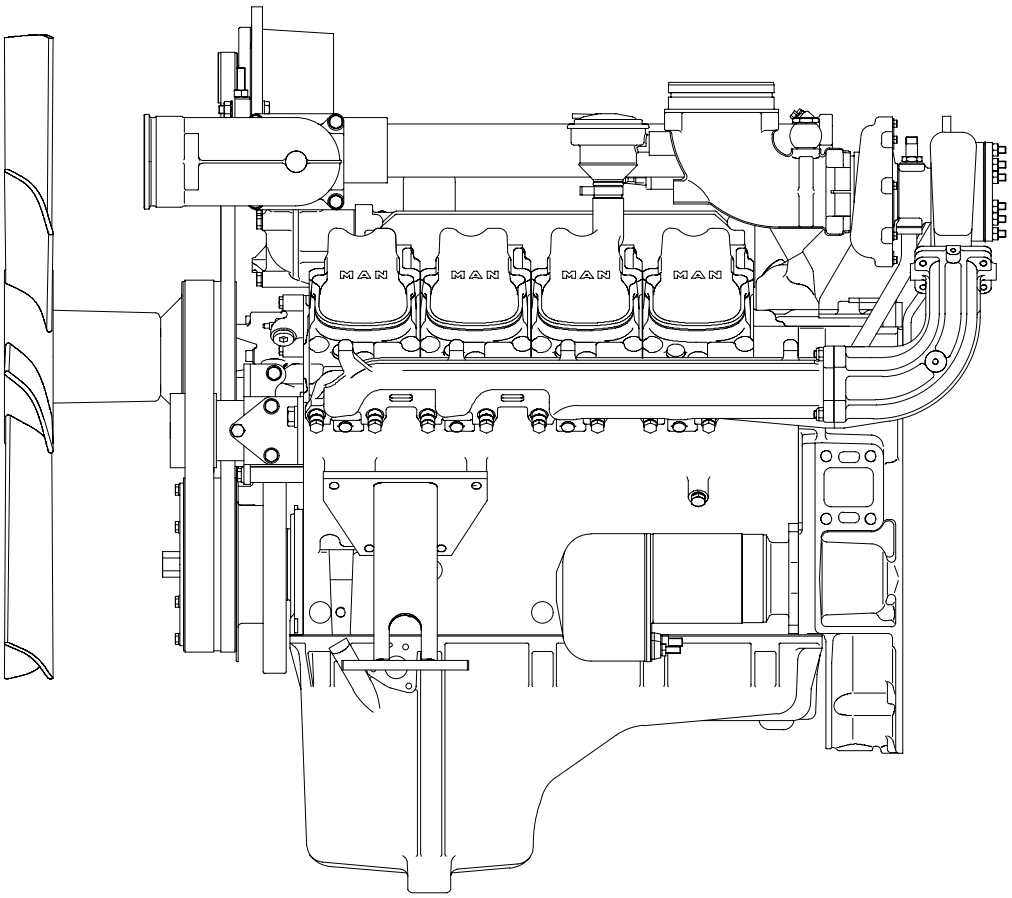
Rear view of engine



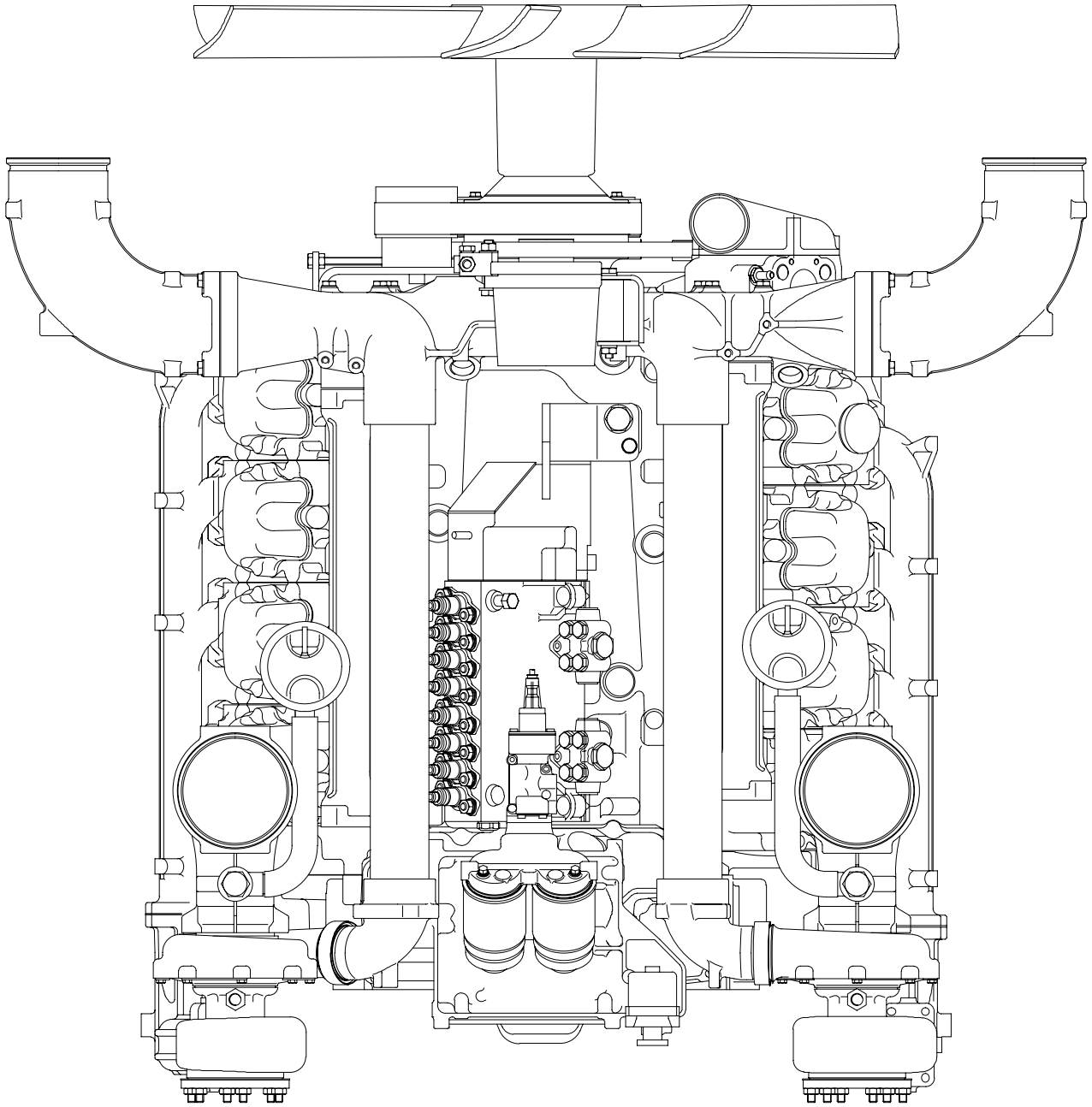
View of engine from right-hand side

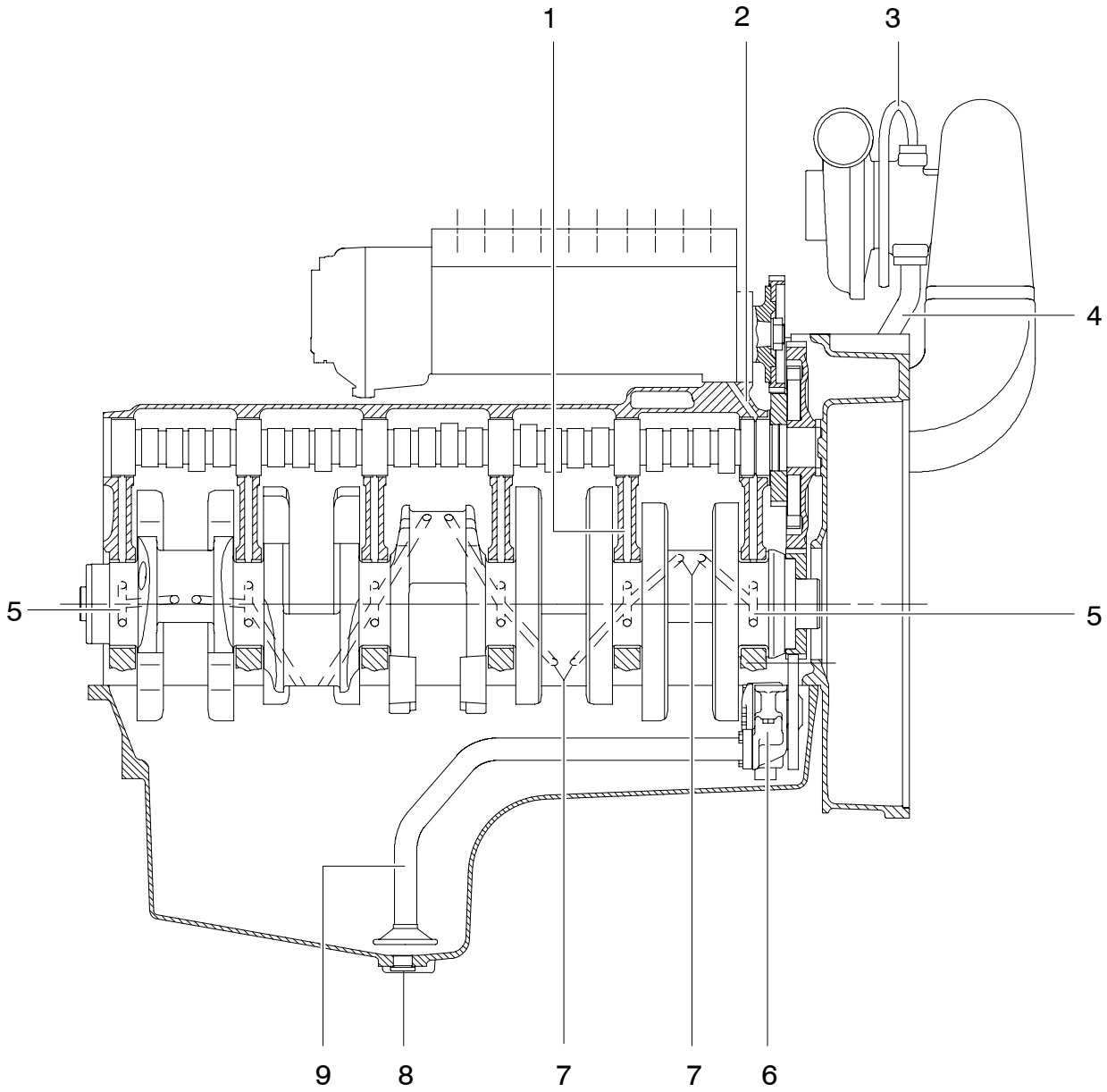


View of engine from left-hand side



View of engine from above





1 Oil line to crankshaft

2 Injection pump lubrication

3 Lube oil lines to turbochargers

4 Oil return line from turbochargers

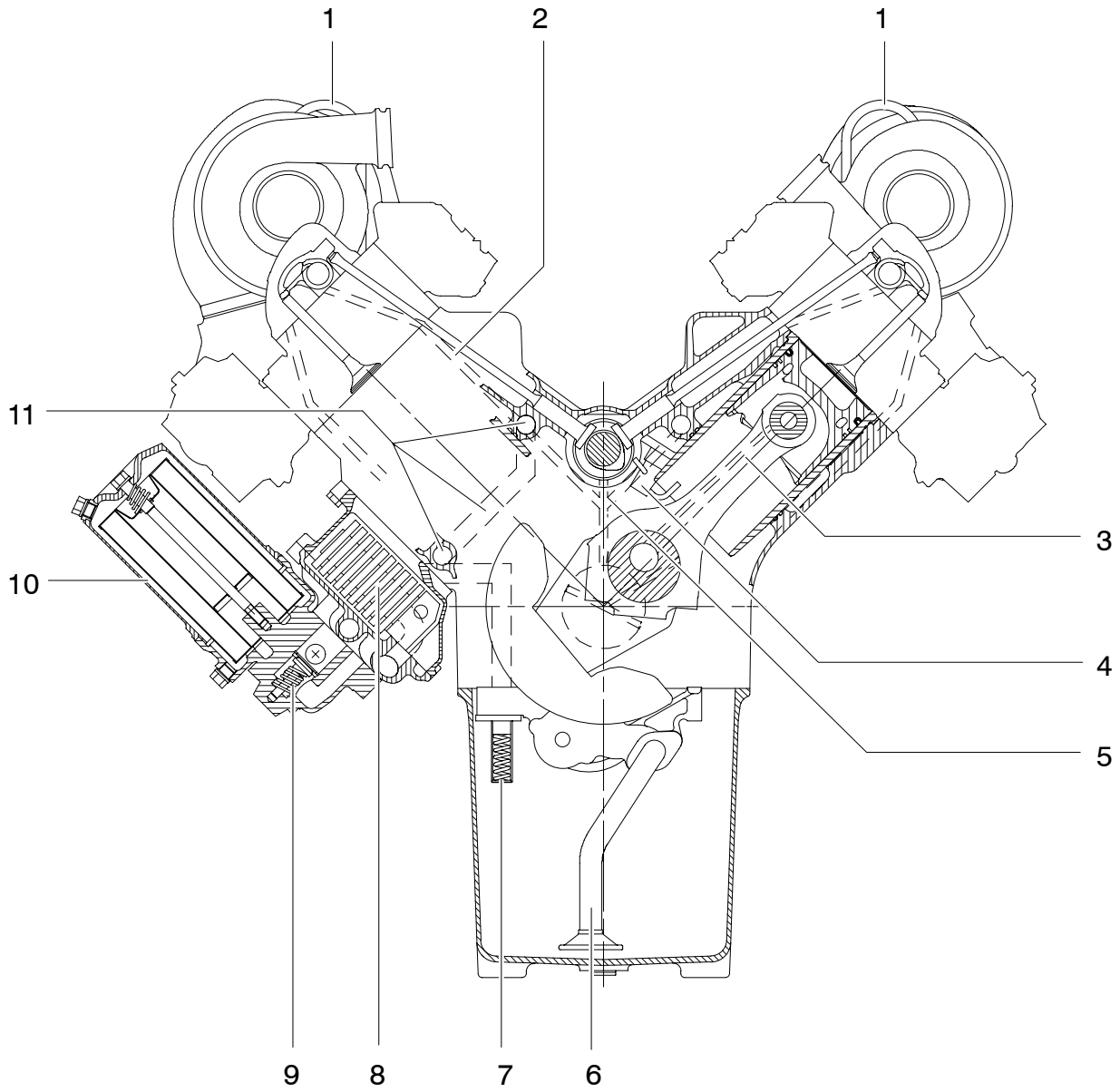
5 Bores for main bearing lubrication

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

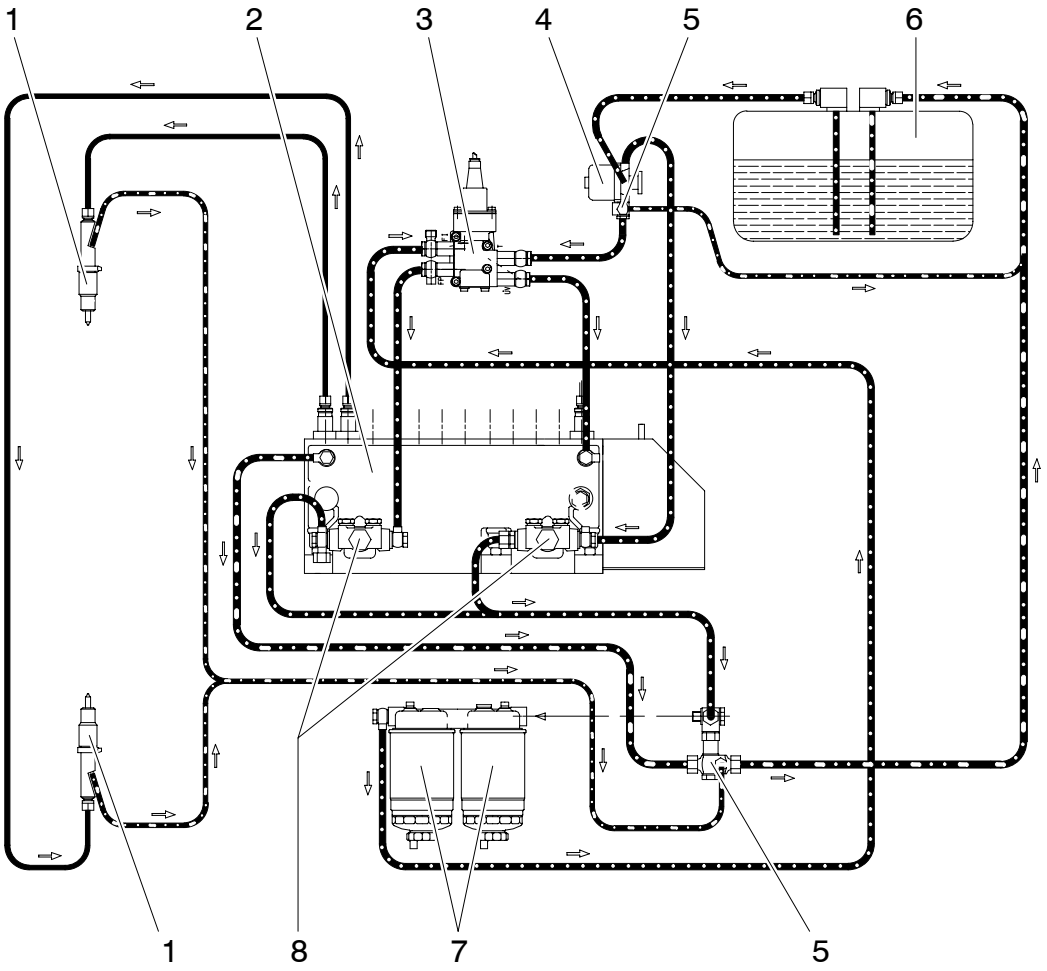
7 Oil pressure relief valve

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)

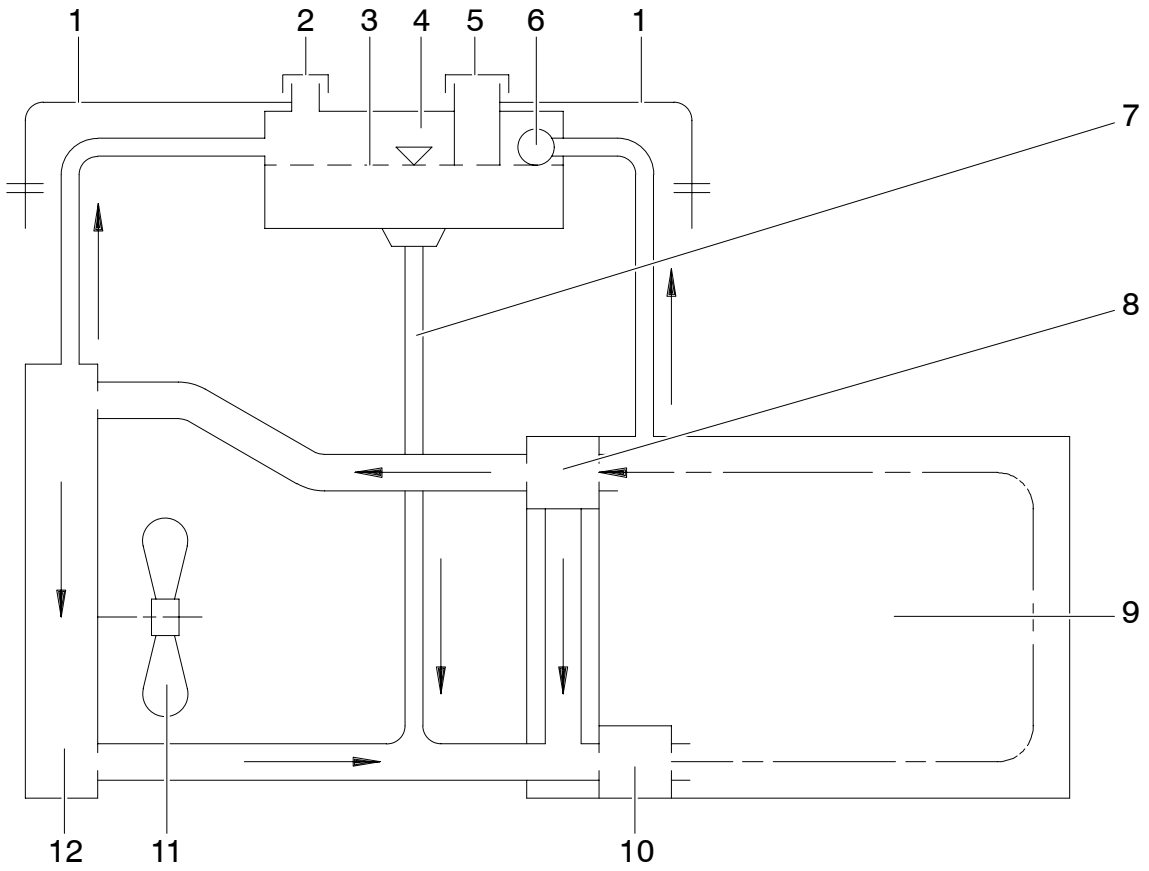
4 Hand pump with prefilter

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

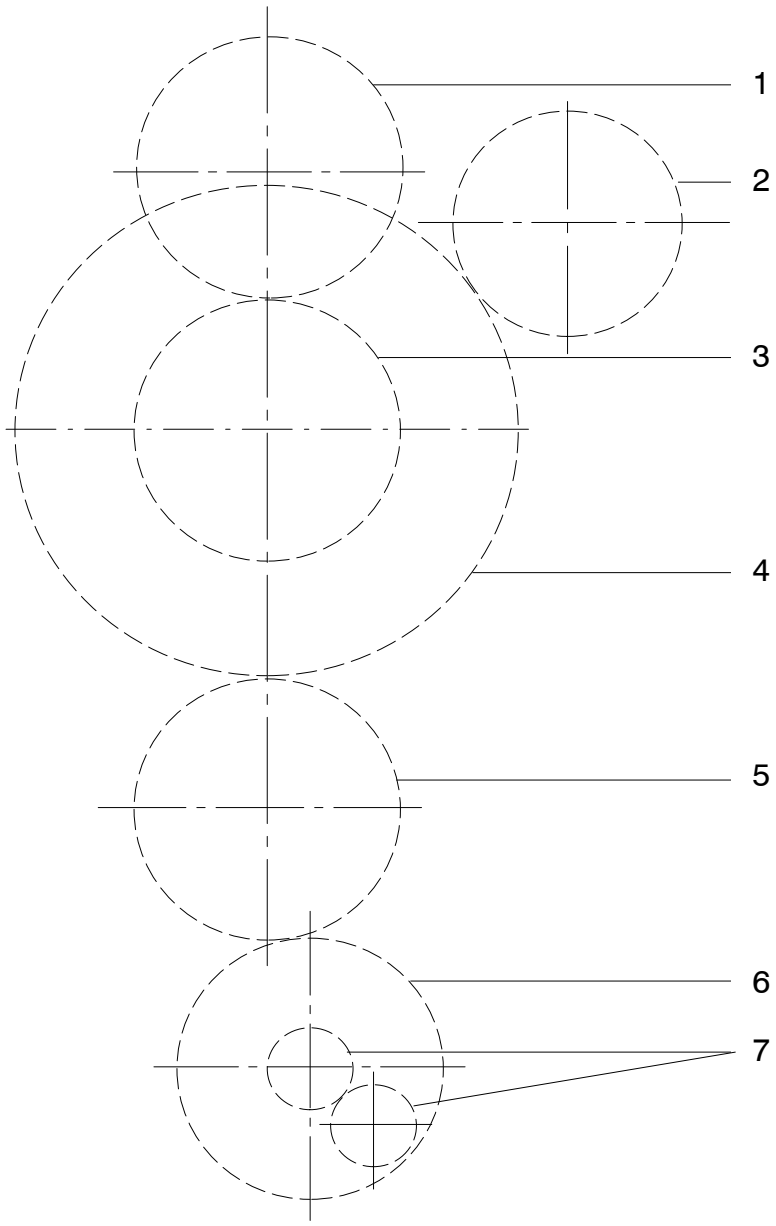
8 Thermostat

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

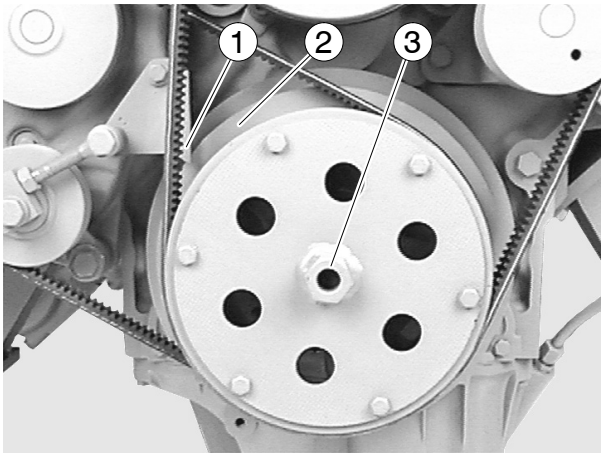
7 Oil pump impeller gears

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.



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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 (barring device).

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.

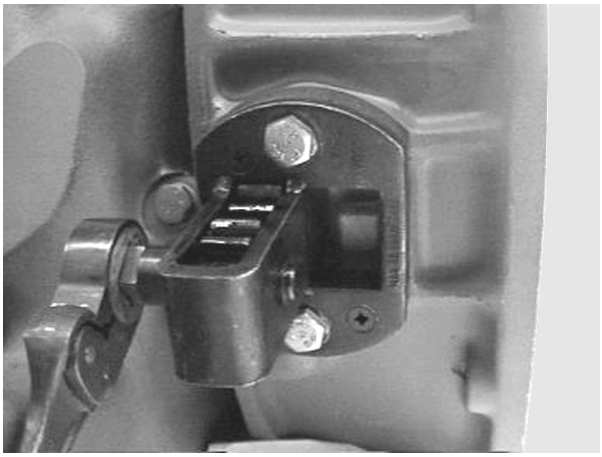

2

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.

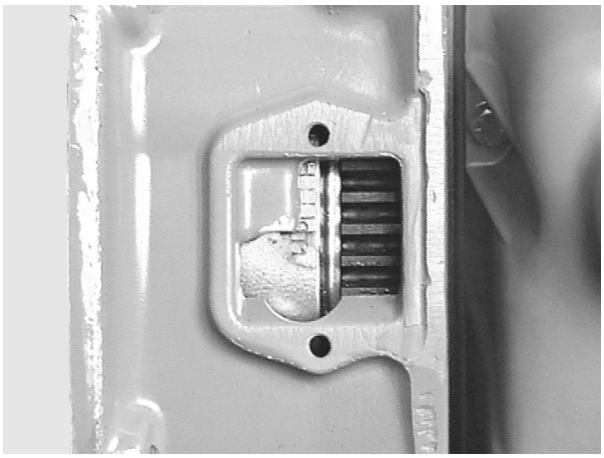

3

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.

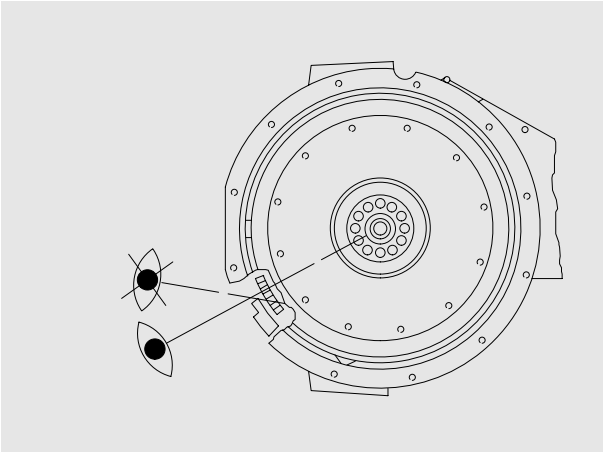
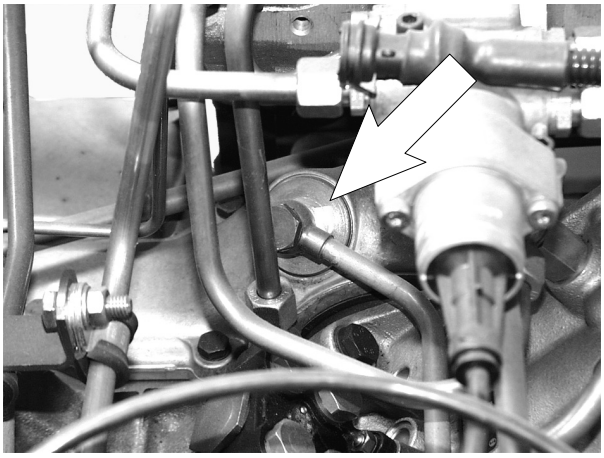

4

Fig. 5

Remove plug from inspection hole in timing case cover.



5

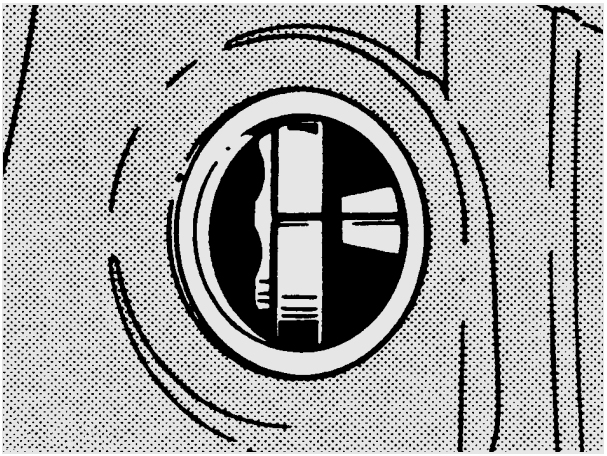
Fig. 6

Then rotate engine so that mark on pointer fitted to injection pump coincides with mark on pump hub.

Read degrees on scale engraved on disc on torsional vibration damper.

The reading should equal the specified start-of-delivery setting (see “Service Data”).

If not, correct start-of-delivery setting.



6

Adjusting start of delivery

Fig. 7

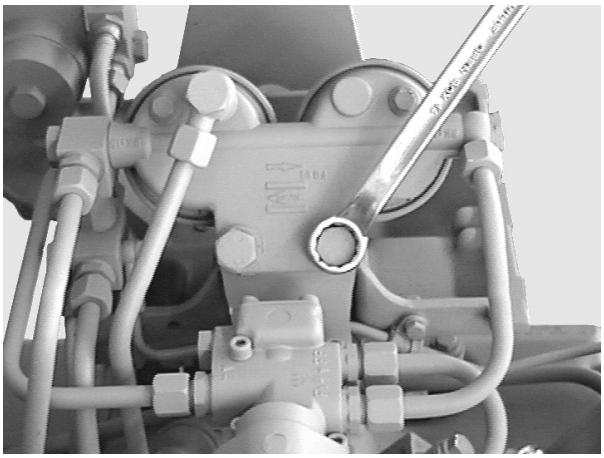
To adjust the start of delivery, the injection pump drive must be made accessible.

For this purpose the fuel filter is to be removed.

Close cut-off valve from fuel tank to engine.

Remove all fuel lines and the filter complete with EHAB.

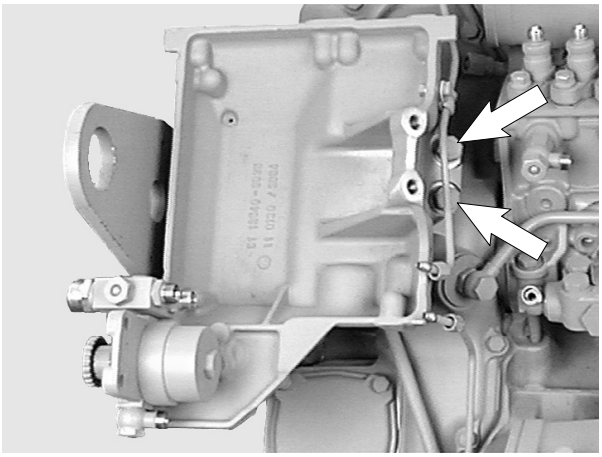
Caution:
The filter cartridges contain fuel.
When putting aside the filter, catch emerging fuel in a suitable container.



7

Fig. 8

Remove container together with fuel hand pump too.

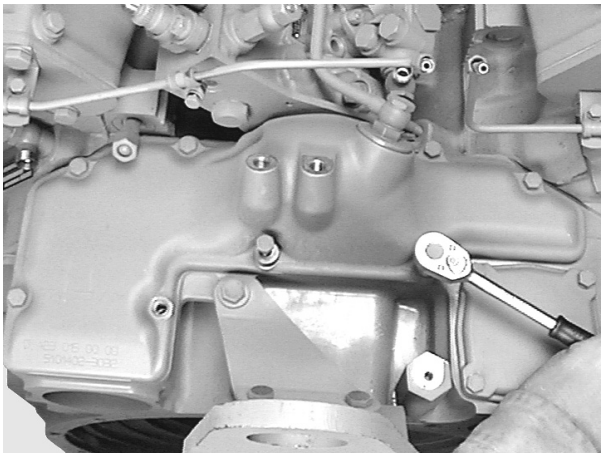


8

Fig. 9

Remove timing case cover.

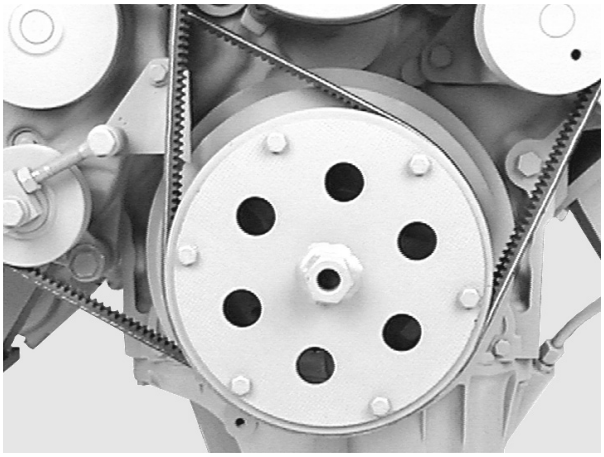
> **Note:**
> Pipes are attached to the timing case cover.
> To facilitate reassembly, note down the positions of the brackets, pipe clamps, spacer sleeves etc.



9

Fig. 10

Turn engine to specified angle for delivery start.



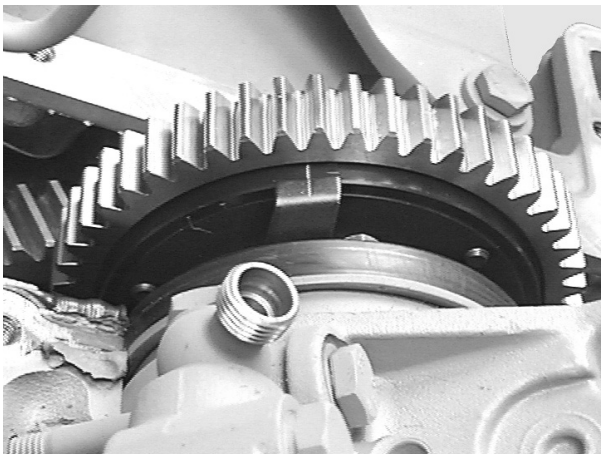
10

Fig. 11

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 at the drive flange either to the left or right until the markings are aligned with each other.

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



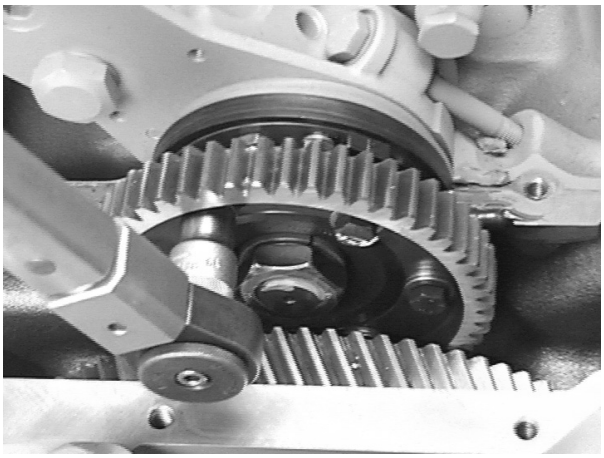
11

Fig. 12

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.
Refit all parts previously removed.



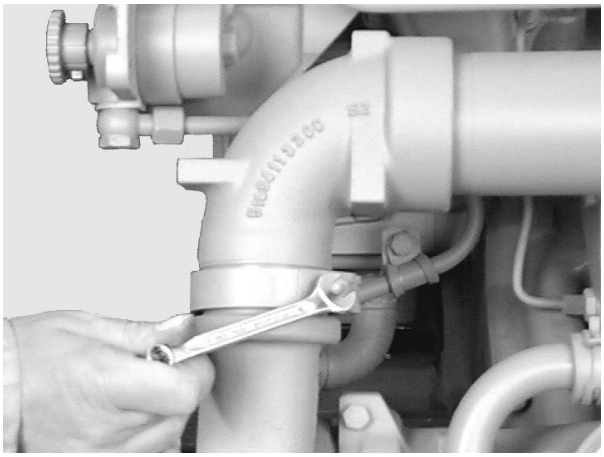
12

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 24.

Fig. 1

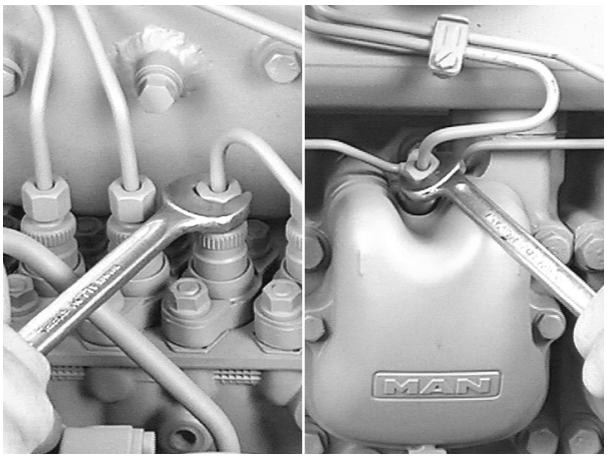
Remove the charge-air elbow and the charge-air pipes leading to the turbocharger.



1

Fig. 2

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

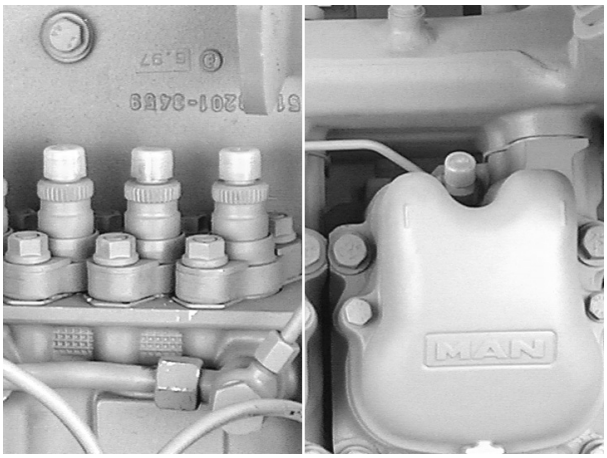


2

Fig. 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



3

Fig. 4

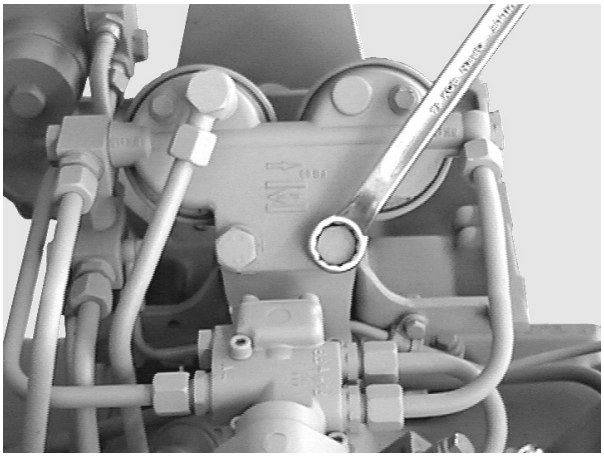
To set start of delivery, the injection pump drive must be made accessible.

For this purpose the fuel filter is to be removed.

Close cut-off valve from fuel tank to engine.

Remove all fuel lines from fuel filter and take off filter complete with EHAB.

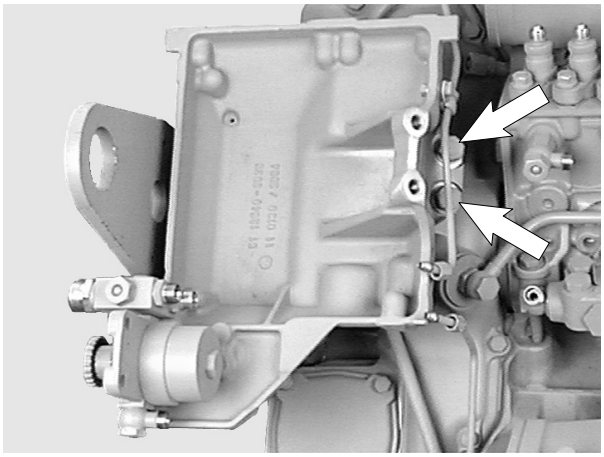
Caution:
The filter cartridges contain fuel.
When putting aside the filter, catch emerging fuel in a suitable container.



4

Fig. 5

Remove container together with fuel hand pump too.

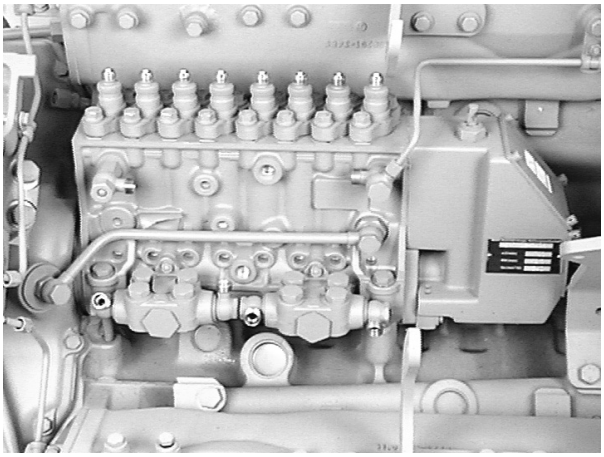


5

Fig. 6

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

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

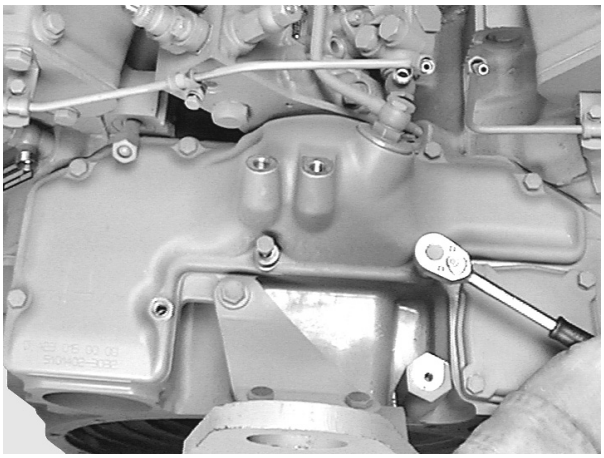


6

Fig. 7

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.

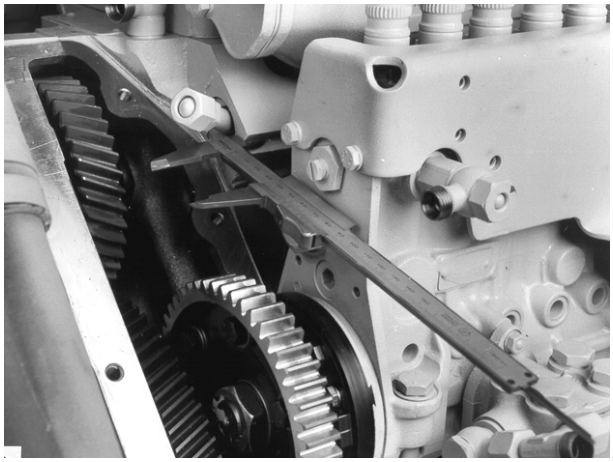


7

Fig. 8

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.



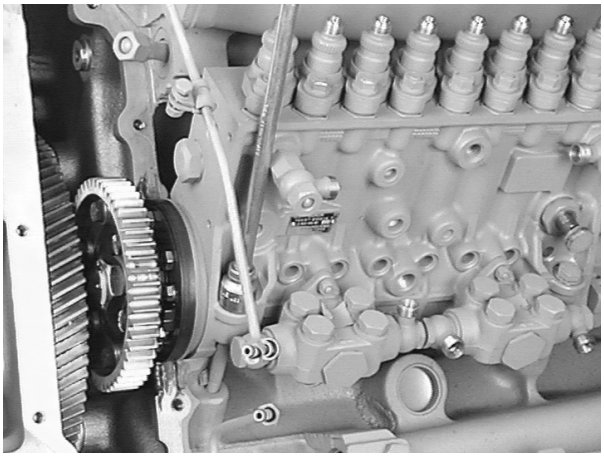
8

Fig. 9

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.



9

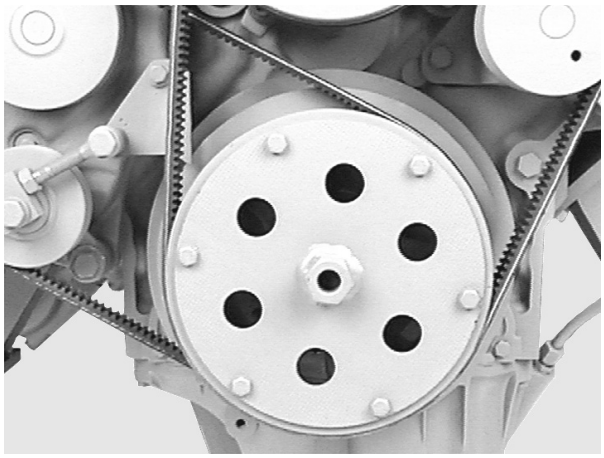
Installing injection pump

Fig. 10

Check whether engine is at start of delivery.

Start of delivery of individual engines is indicated in the publication “Service Data”, see also page 24.

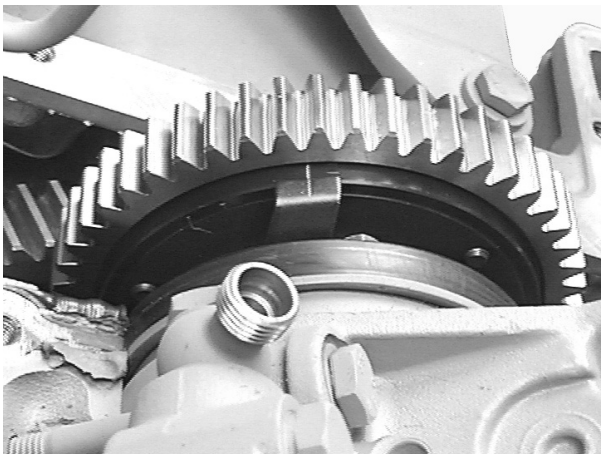
Note:
In the event of new pumps, remove plug from oil supply bore.



10

Fig. 11

Check whether the injection pump is in delivery start position.
The markings on the injection pump and on the setting pointer must be aligned with each other.



11

Fig. 12

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.

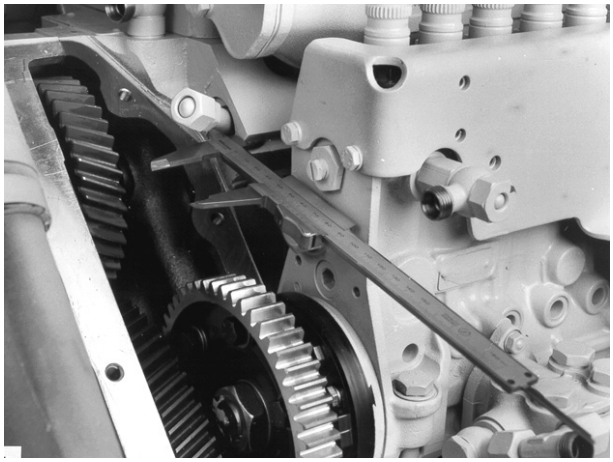
Fit new O-ring (slightly coated with oil) to injection pump flange.

12

Fig. 13

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

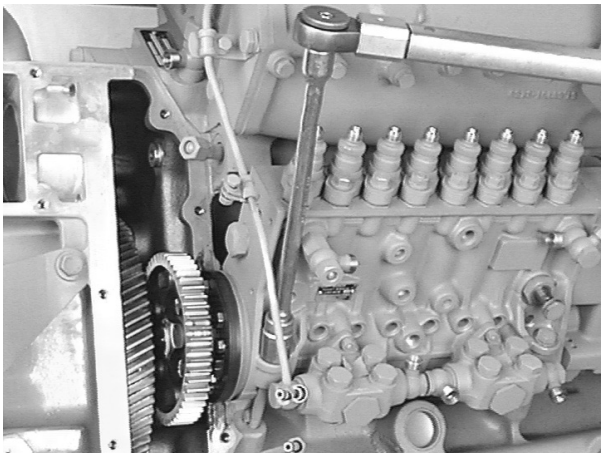
Check distance between injection pump and crankcase.



13

Fig. 14

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



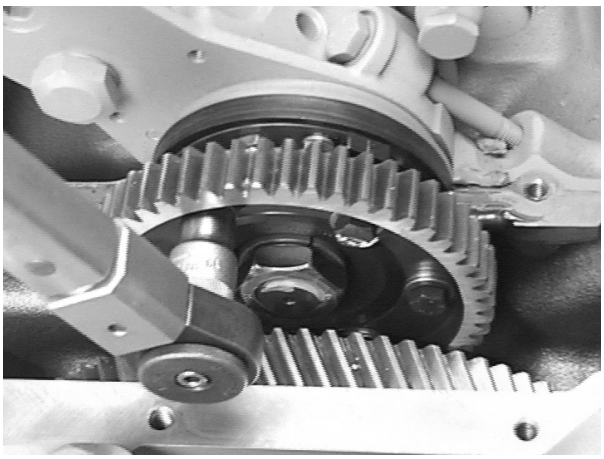
14

Fig. 15

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.



15

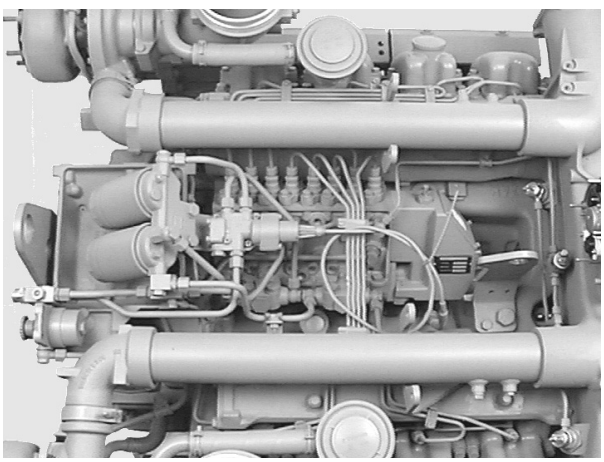
Fig. 16

Check delivery start, if necessary readjusting it (see page 24).

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

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

Caution:
Comply with instructions for masking unions on pressurised oil and fuel pipes (see page 3).

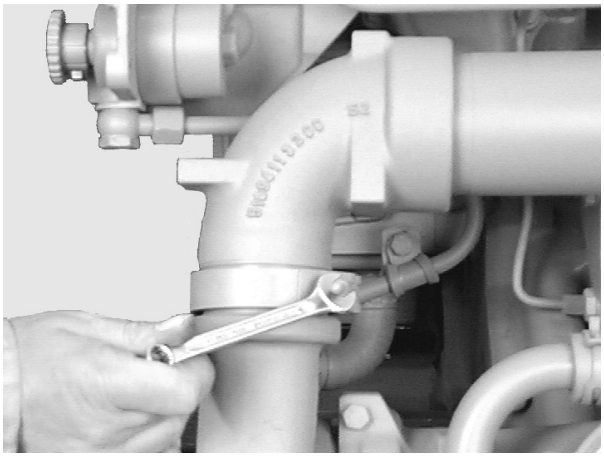


16

Removing fuel injectors

Fig. 1

To facilitate removing the injection lines, remove the charge-air elbow and the charge-air pipes leading to the turbocharger.

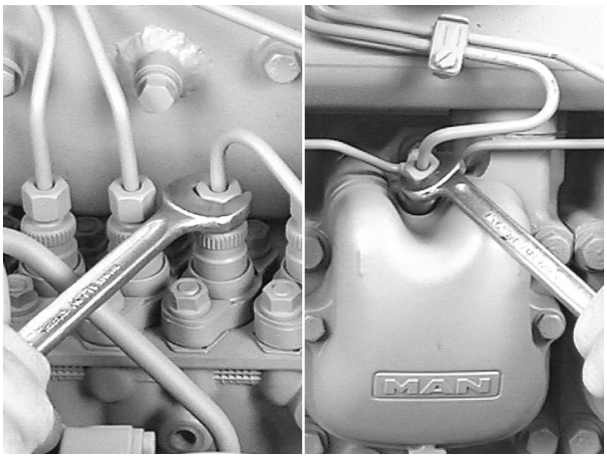


1

Fig. 2

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

Remove the fuel return lines.

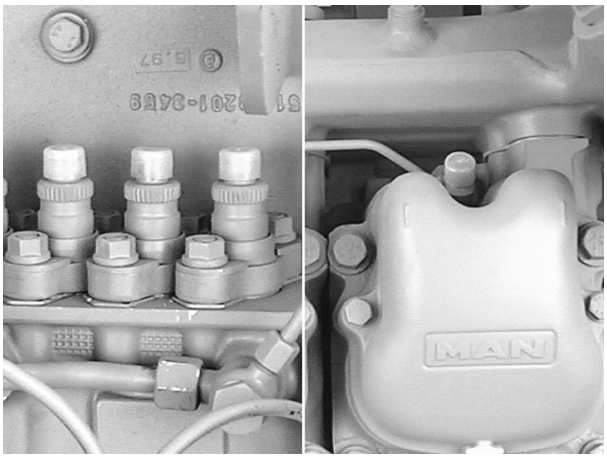


2

Fig. 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.

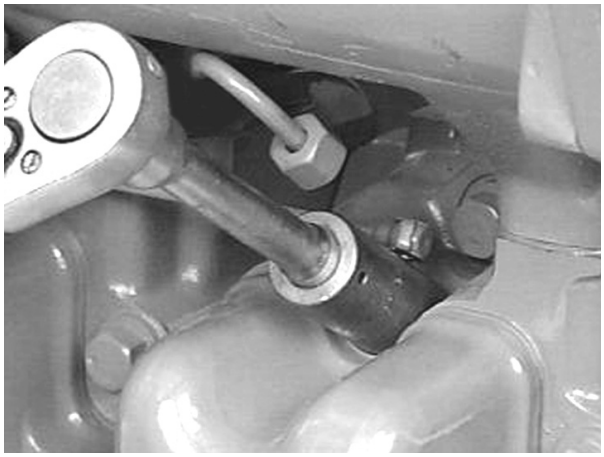
Caution:
Dirt in the injection system causes:
- nozzles to jam
- the injection-pump drive gear to break



3

Fig. 4

Remove pressure screw from fuel injector using a pin spanner.



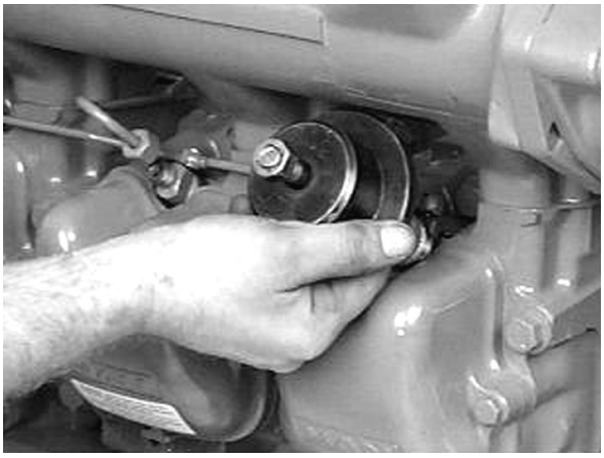
4

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 33.



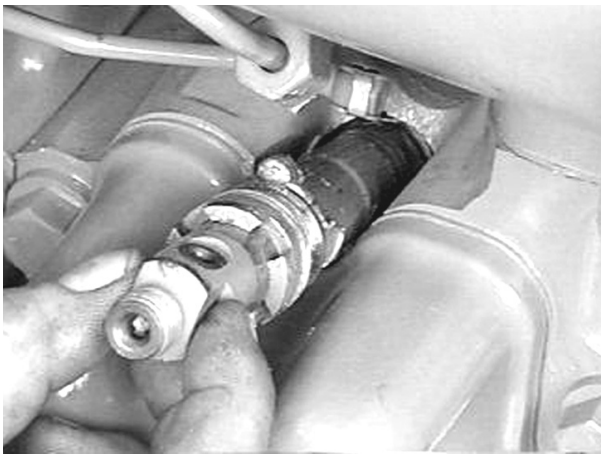
5

Installing fuel injectors

Fig. 6

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.

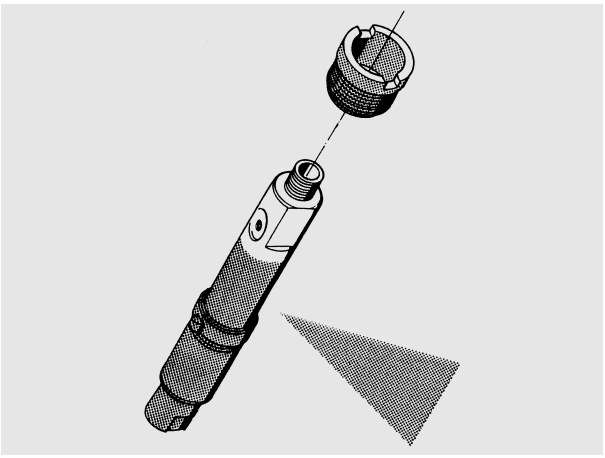


6

Fig. 7

(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).



7

Fig. 8

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.

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

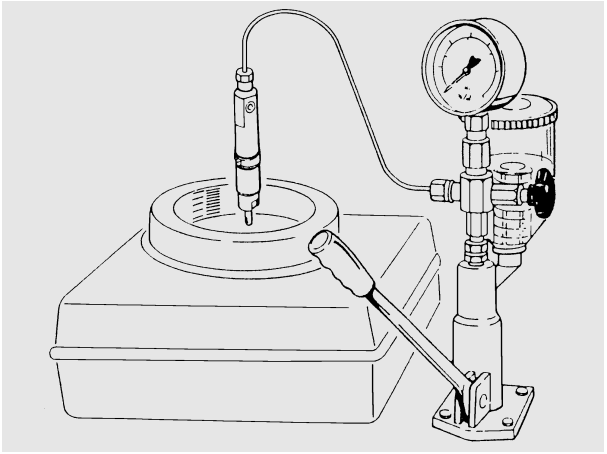
8

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 34.



1

Fig. 2

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

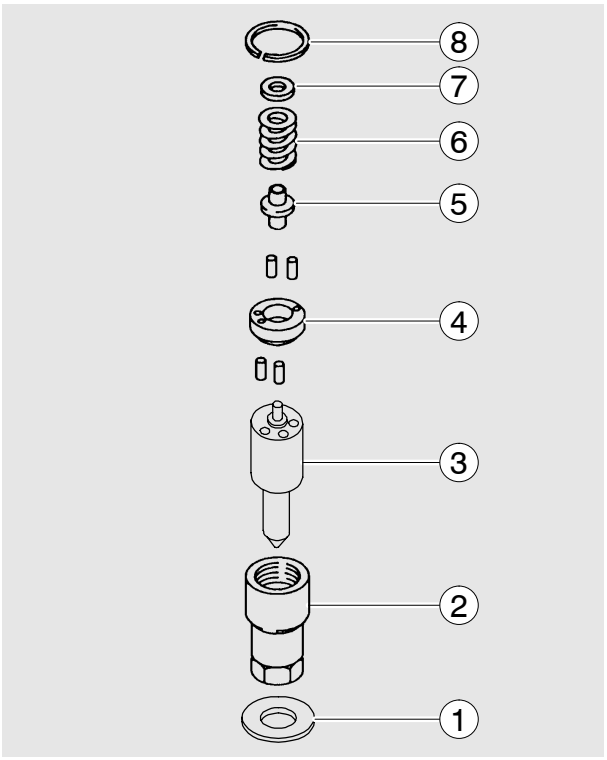
Danger:
The high opening pressure may lead to severe injuries. Do not place hands under the jet. Wear safety goggles.

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 (+ 8 bar).

Note:
Shims are available in 0.05 mm steps from 1.0 mm to 1.98 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.



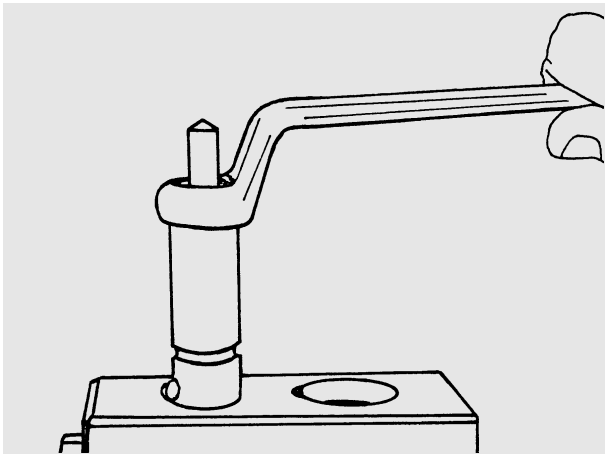
2

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.



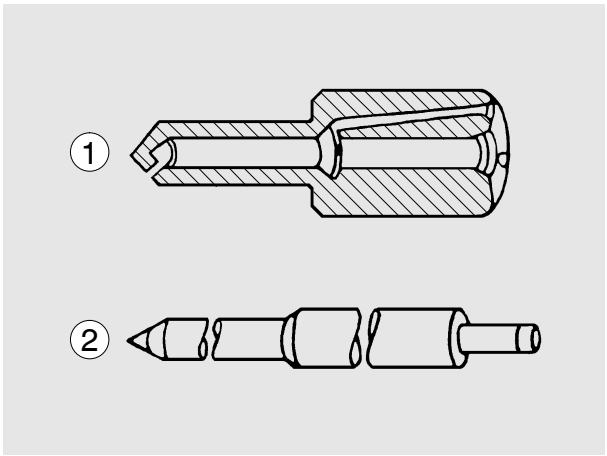
3

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.



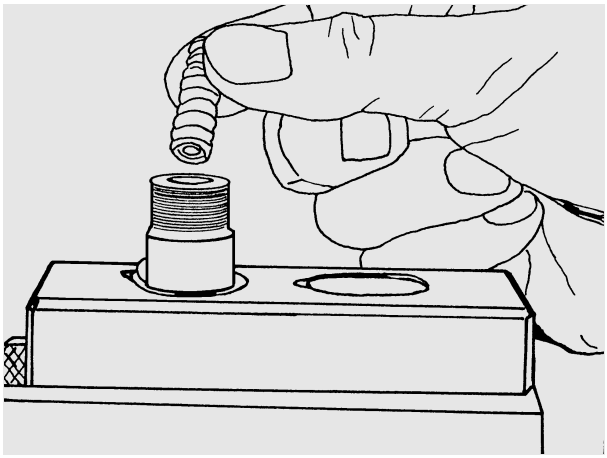
4

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

Assembling fuel injectors

Fig. 5

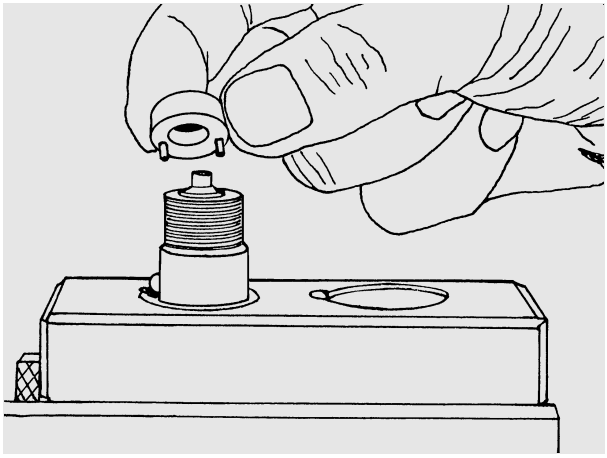
Insert pressure pipe neck into clamping device.
Insert shim and compression spring.



5

Fig. 6

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



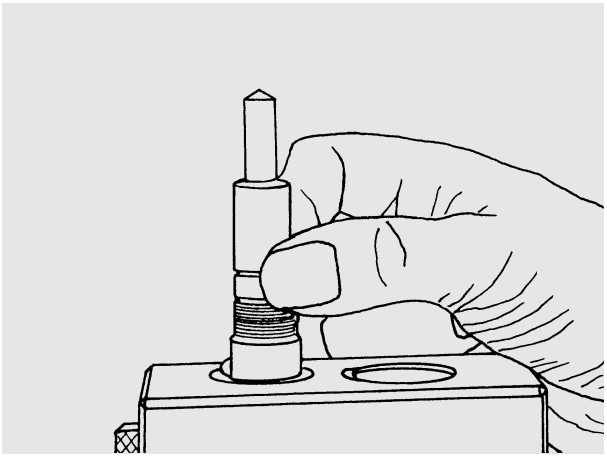
6

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.

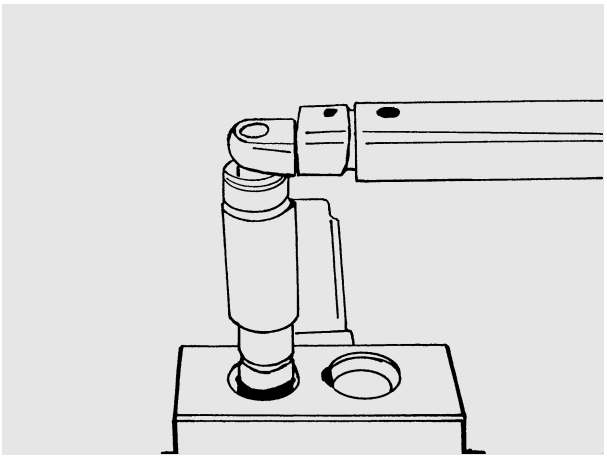


7

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.

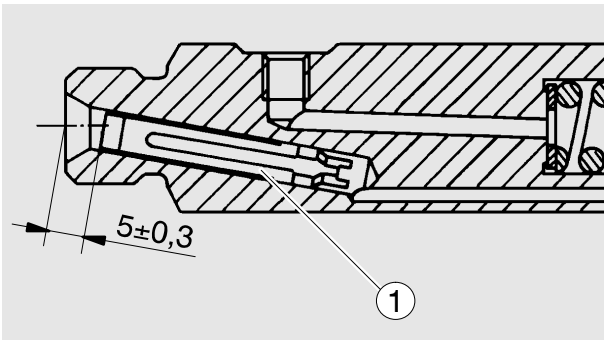
Fig. 9

A dislocated sieve bar filter 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.



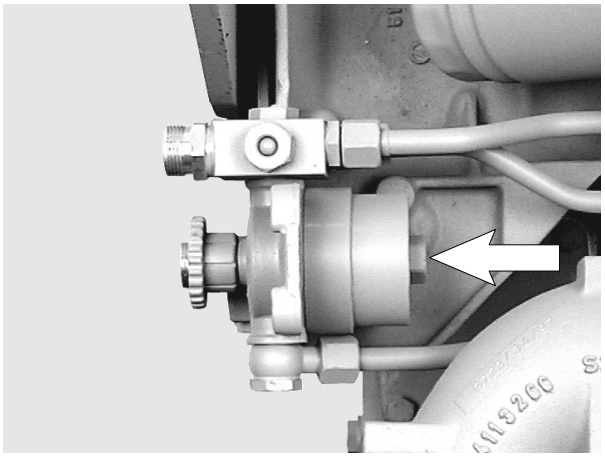
9

Cleaning fuel prefilter

Fig. 1

Disassemble fuel prefilter:

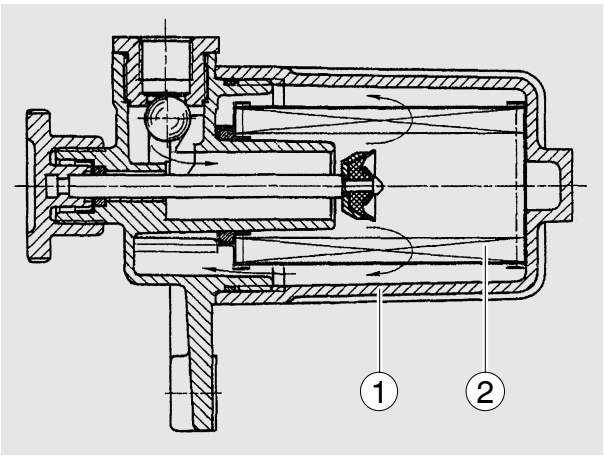
- Remove filter housing (arrow)



1

Fig. 2

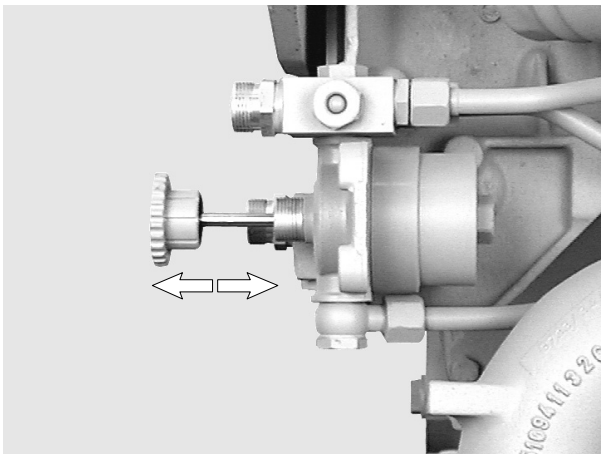
- Wash out filter housing ① and gauze filter ② in clean Diesel fuel and blow them out with compressed air
- Reassemble using new seal
- Screw on filter housing and tighten it to 10–12 Nm



2

Fig. 3

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



3

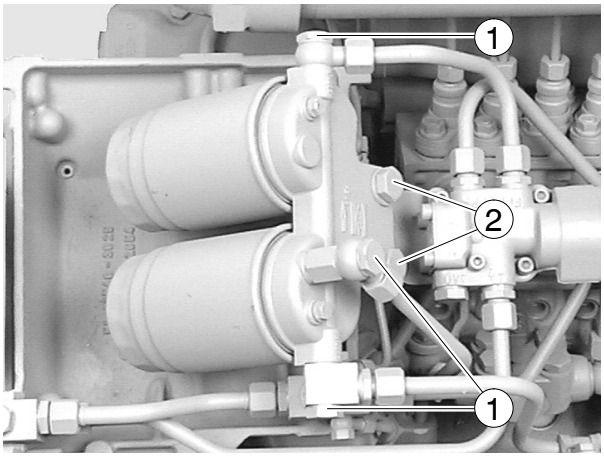
Removing and attaching fuel filter

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.

Change-over fuel filter

Fig. 3

Where the changeover-type filter is installed, the servicing procedure is for the filter side requiring to be shut off with the engine running. During continuous operation, the selector lever should be placed in a position where both filter halves are in operation.

Caution:
Do not leave selector lever in any intermediate position because this would be liable to interfere with fuel supply. If in doubt stop the engine to change the fuel filter.

The filter cartridge is then to be exchanged as described under parallel box filter (Fig. 2).

Continuous operation
(both filter halves
in operation)

Right-hand filter
cut out

Left-hand filter
cut out

3

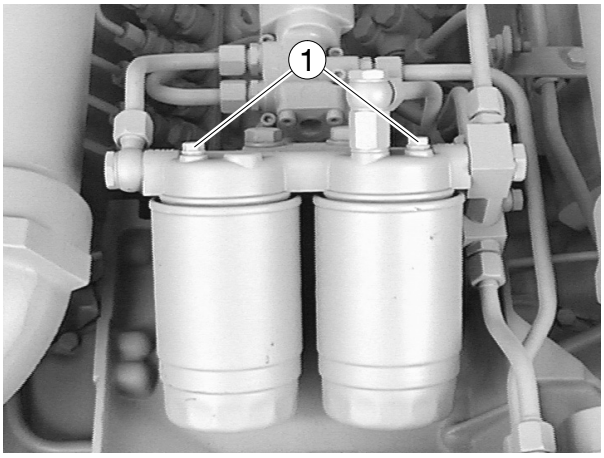
Bleeding the fuel system

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

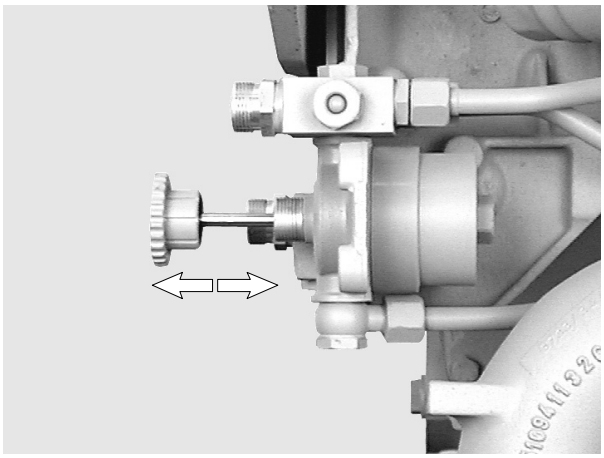
Figs. 4 and 5

An arrow on the filter head indicates the direction of fuel flow.

- 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 the tappet of the hand pump again and tighten it
- Close bleed screw again
- Repeat this procedure at the second bleed screw
- Check fuel system for leaks



4



5

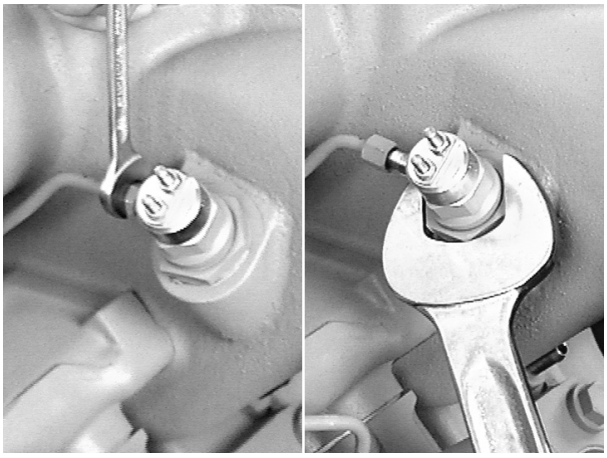
Removing sheathed-element glow plug

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

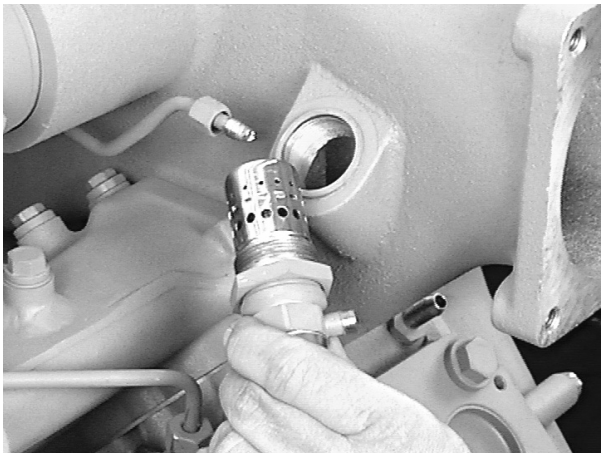
Installing sheathed-element glow plug

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

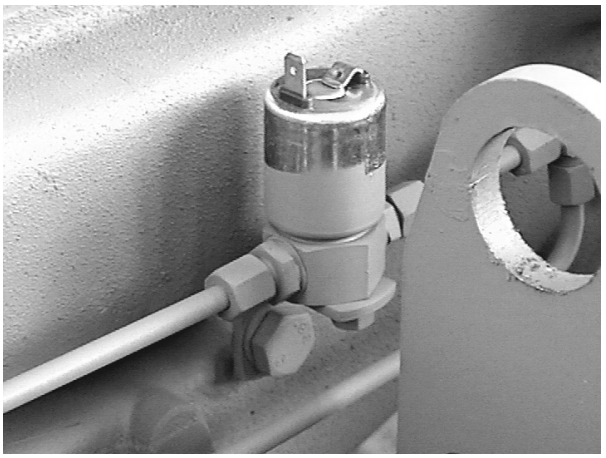
Remove fuel line from flame glow plug.
When the engine is running and hot, no fuel must emerge.

Removing solenoid valve

Fig. 3

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

The valve cannot be repaired.
Exchange the defective valves.



3

Fitting solenoid valve

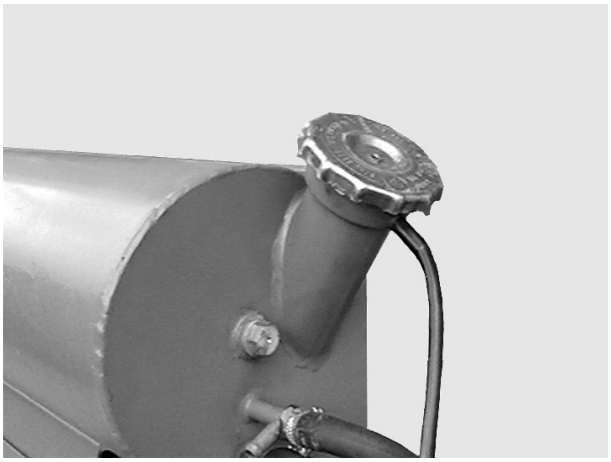
- Screw valve to holder
- Push on electric connection
- Fit the fuel lines with new sealing rings

Draining coolant

Danger:
Draining hot coolant involves a risk of scalding.

Drain coolant as follows when cooling system has cooled down:

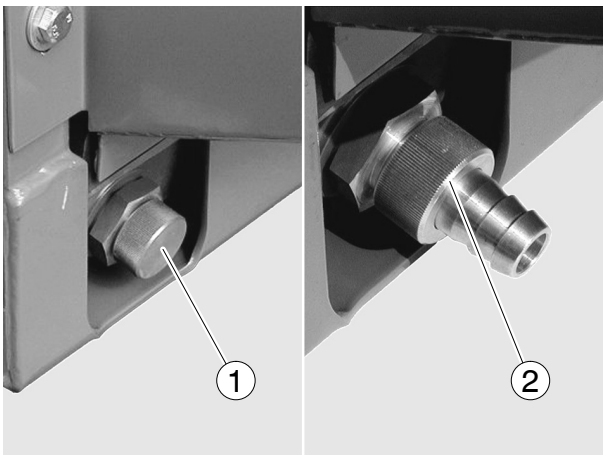
Caution:
Drain coolant into a suitable container and dispose of it in accordance with regulations.



1

Fig. 1

Open cap (large cap) on filler neck of expansion tank, let off pressure and remove cap.

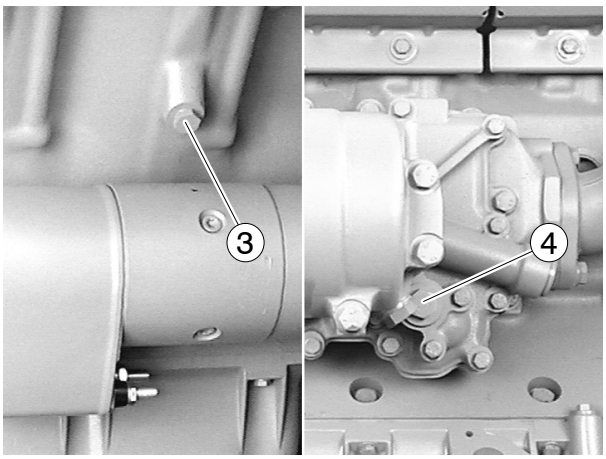


2

Fig. 2

Remove cap ① on left-hand side of lower radiator water tank.

Screw in the adapter ② supplied. A sealing cone then opens in the radiator, and the coolant can then be drained out via the adapter using a hose (internal diameter 20 mm).



3

Fig. 3

Open drain plug in crankcase ③ or in the oil cooler housing ④.

Drain coolant into a container of adequate size.

Take cover off filler neck of expansion tank at fan radiator.

Filling up with coolant

(only when engine has cooled down)

Figs. 4 and 5

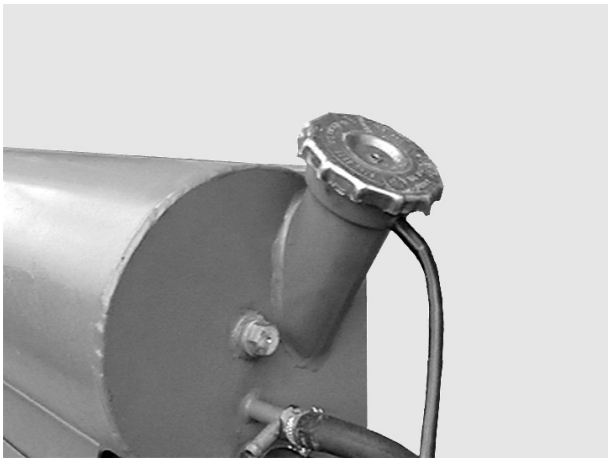
Fill the cooling system of the engine with a mixture of drinkable tap water and anti-freeze agent on ethylene glycole basis or anti-corrosion agent. See Publication “Fuels, Lubricants and Coolants for MAN Diesel Engines”.

Coolant must be added at the filler neck only.

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

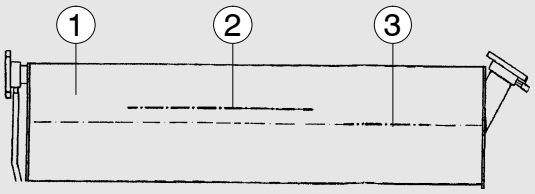
- Remove cap (large cap)
- Slowly fill up with coolant until correct coolant level is reached
- Refit end cover
- Run the engine briefly and then check coolant level once more

Danger:
If, in an **exceptional** case, the coolant level has to be checked in an engine that has reached operating temperature, first carefully turn the cap with safety valve to the first stop, let off pressure, then open carefully.



4

Total quantity ①	30 Litres
Max. level ②	20 Litres
Medium level ③	15 Litres
The numbers of litres indicated refer to the quantity in the expansion tank	



5

Fig. 6

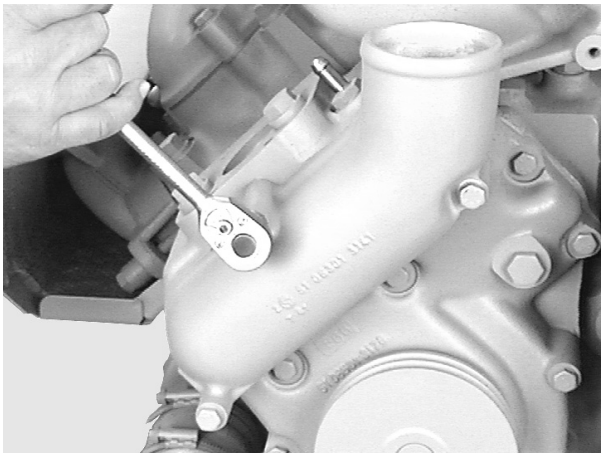
Caution:
If the cap with the working valves is opened, there is the risk that it will not close tightly again afterwards. The excess pressure required in the system will then no longer build up. Premature boiling occurs and coolant is lost. To prevent damage to the engine open this cap only in exceptional circumstances and fit a new one as soon as possible.

6

Fig. 1

- Drain coolant, see page 40

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



1

Fig. 2

Take out short-circuit inserts / thermostats.

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.

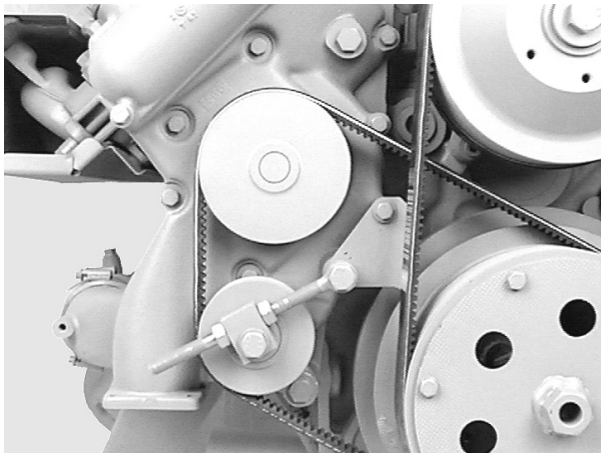
Caution:
Never let engine run without thermostats or short-circuit inserts.

Removing engine water pump

- Drain coolant, see page 40
- Remove the thermostats, see page 42

Fig. 1

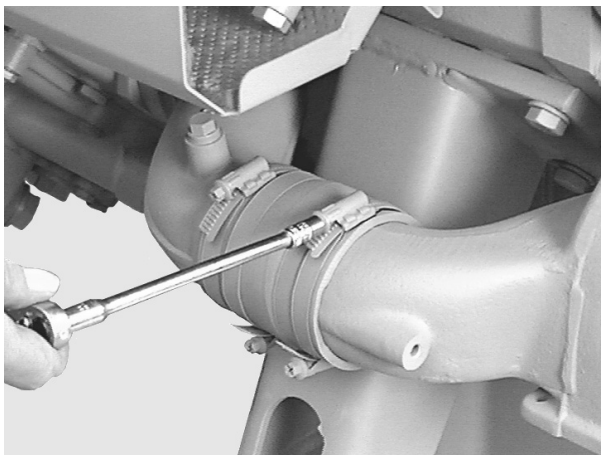
Take V-belt off water pump, see page 120.



1

Fig. 2

Remove coolant hose pipe leading to oil cooler.

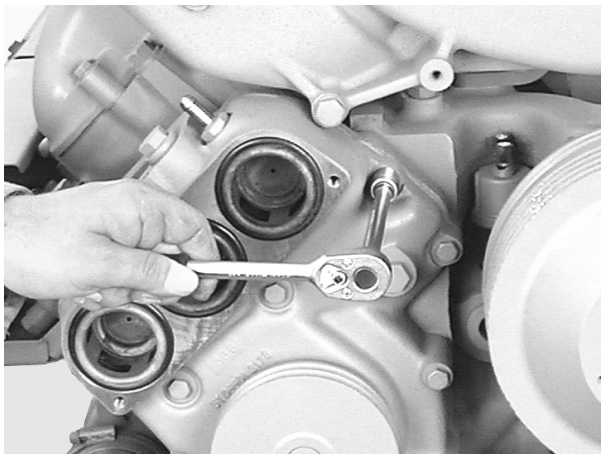


2

Fig. 3

Remove the mounting bolts from water pump.

Take off water pump and delivery start indicator.



3

Installing engine water pump

Fig. 4

Clean the sealing faces on water pump and engine housing.

Fit water pump with new seal.

Fit the mounting bolts.

4

Fig. 5

Turn engine to ignition TDC, see page 24.

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

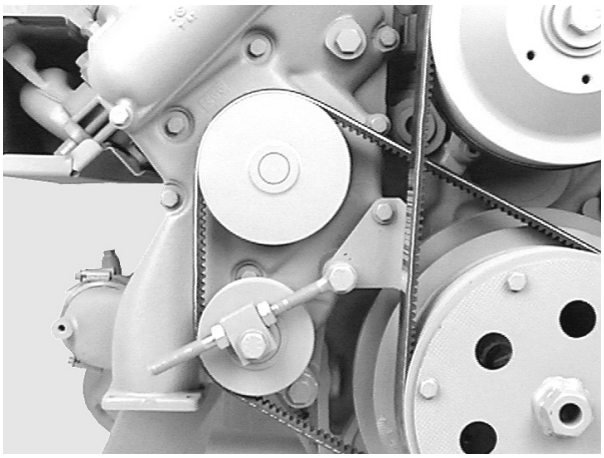
Tighten the mounting bolts to the specified torque.

Screw coolant hose pipe on to oil cooler.

Install short-circuit inserts / thermostats, see page 42.

Fit and tighten V-belts, see page 120.

Filling up with coolant, see page 41.



5

Note:
Exchange or repair water 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 water pump. This permeating coolant leaves a trace below the drain bore on the water pump.
The water pump need not be exchanged or repaired because of this trace of permeating coolant.

For this reason before exchanging or repairing a water 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. overfilled) or by other leaks on hoses, etc.

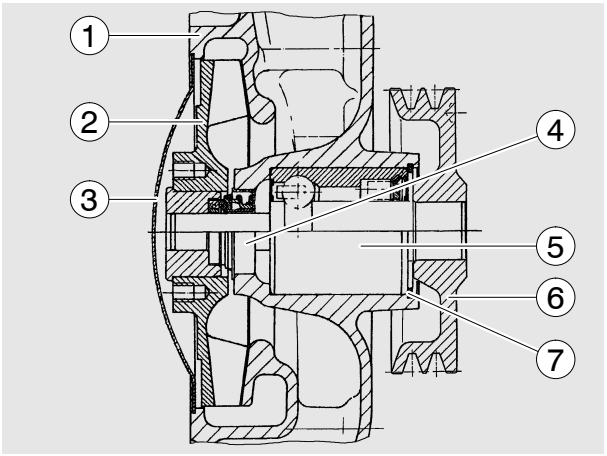
Water pumps must be exchanged only if water drips visibly while the engine is in operation or after the engine has been switched off.

Water pump for three thermostats

Fig. 1

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

Removing water pump, see page 43.



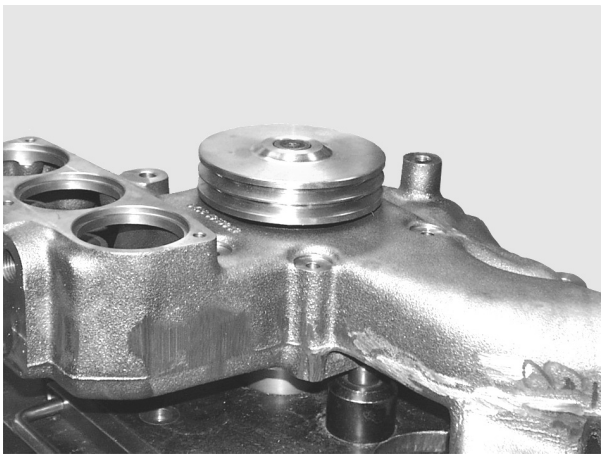
1

Disassembling water pump

Fig. 2

Clamp water pump in vice (using soft jaws).

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



2

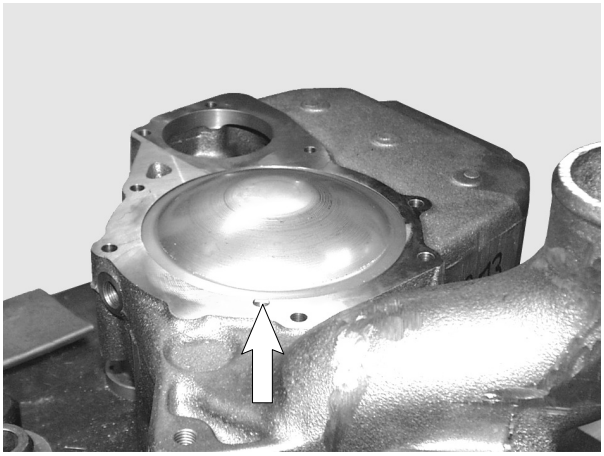
Fig. 3

Unclip the circlip from the water-pump housing.

3

Fig. 4

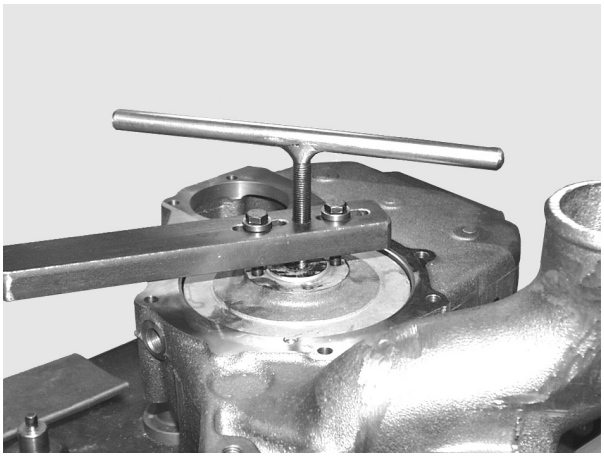
Knock out cover by driving a suitable mandrel under it (Fig. 1, item 3) at notch (arrow).



4

Fig. 5

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



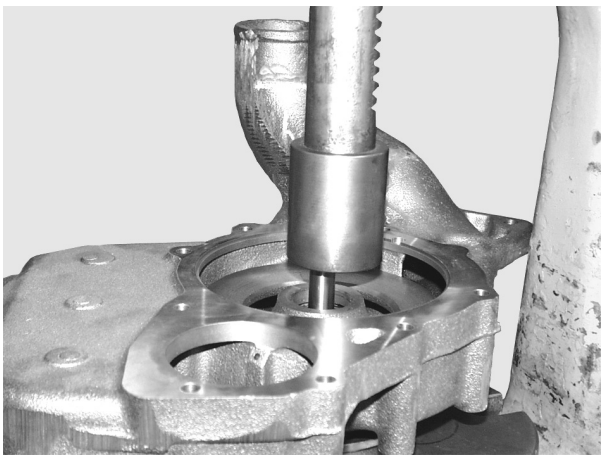
5

Fig. 6

Align 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. Shaft and bearing are encapsulated and exchanged together only.

Take off axial face seal.



6

Assembling water pump

Fig. 7

Press in water 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.

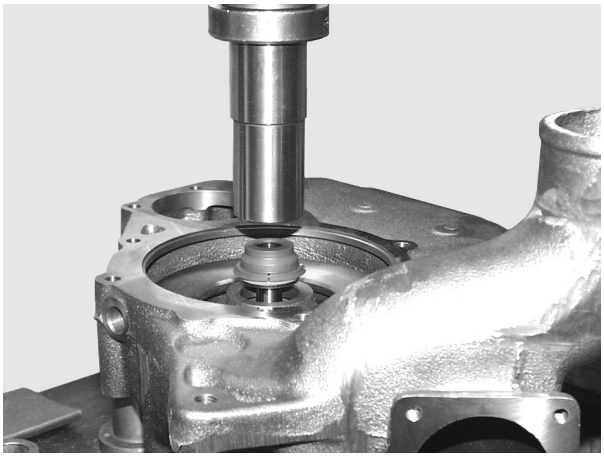
8

Fig. 9

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

Observe installation note for seal on page 51.

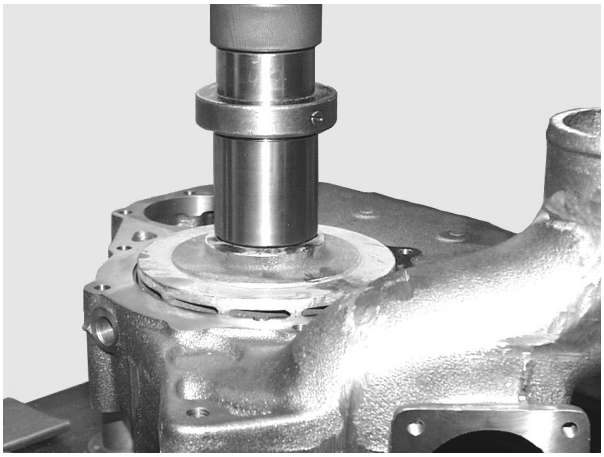
Note:
The seal can be exchanged even without removing the water pump shaft.



9

Fig. 10

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



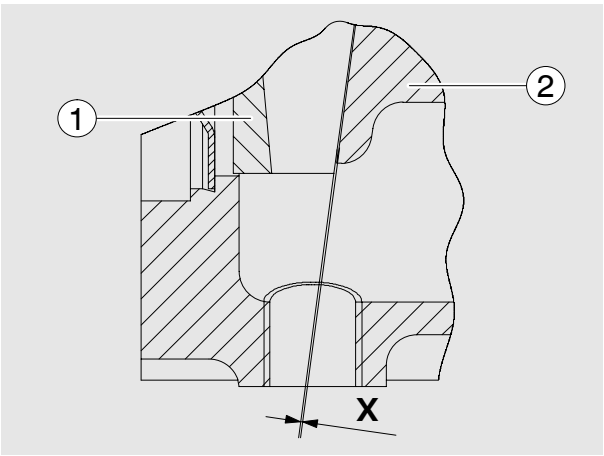
10

Fig. 11

For this purpose an inspection hole closed up with a screw plug (M16 x 1.5) is provided on the bottom of the water pump housing.

1 Impeller
2 Water pump housing

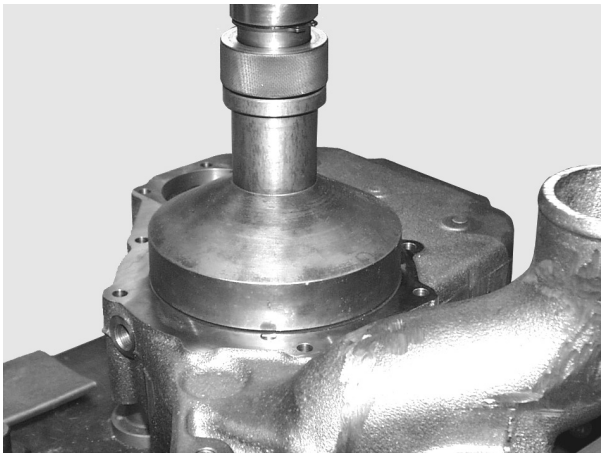
X =	D 2840 LE 2..	0,5–0,9 mm
	D 2848 / 42 LE 2..	0,7–0,8 mm



11

Fig. 12

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



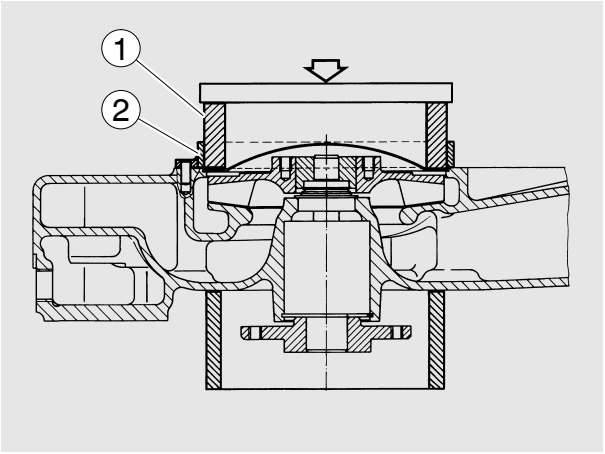
12

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 43.



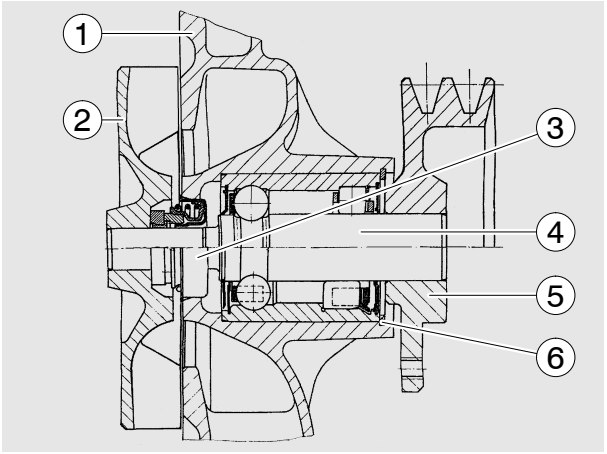
13

Water pump for two thermostats

Fig. 14

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

Removing water pump, see page 43.



14

Disassembling water pump

Fig. 15

Clamp water pump in vice (using soft jaws).

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

Unclip the circlip from the water-pump housing.

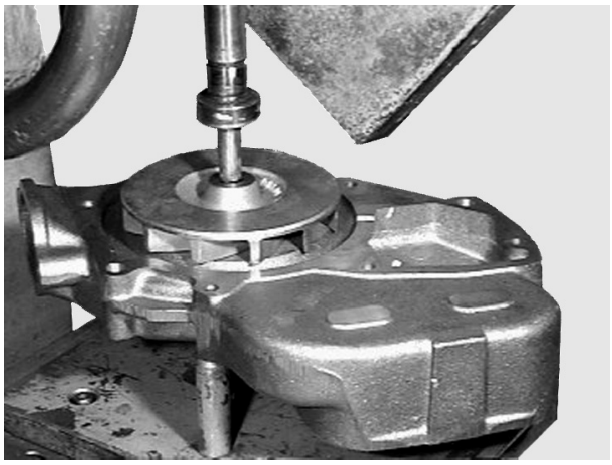
15

Fig. 16

Press impeller off the shaft, using a suitable mandrel. For this purpose align water pump housing horizontally on a stable support.

The picture shows an assembly device for this. If such a device is not available, use a support ring (special tool).

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



16

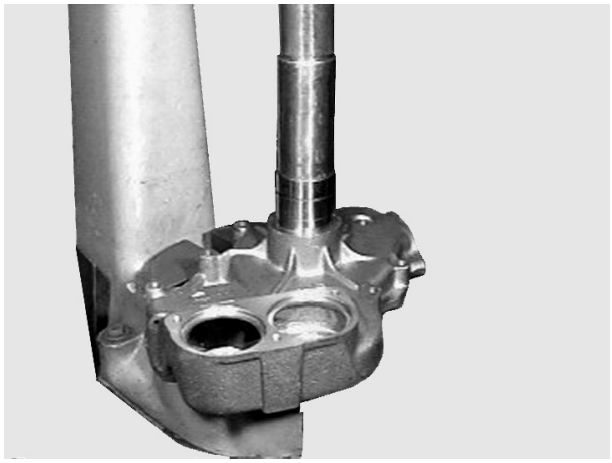
Assembling water pump

Fig. 17

Press in water pump bearing.

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

Refit circlip.



17

Fig. 18

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

Observe installation note for seal on page 51.

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

18

Fig. 19

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

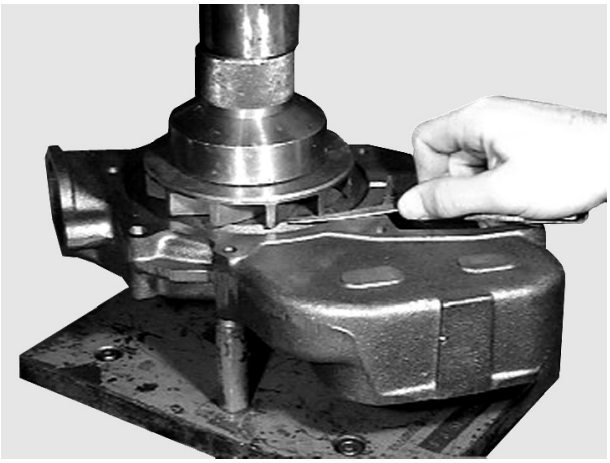
The correct gap dimension (see “Service Data”) is achieved if the outer face of the impeller is flush with the front face of the bearing shaft.

Check the gap dimension with the feeler gauge.

The impeller must be easy to turn and must not contact the water-pump housing.

Turn pump housing over and press V-belt pulley flush on to bearing shaft.

For this purpose place bearing shaft together with the flush-fitting impeller on a stable support.



19

In the event of repairs exchange water 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 water pump.
This permeating coolant leaves a trace below the drain bore on the water pump.
The water pump need not be exchanged because of this trace of permeating coolant.

For this reason before exchanging or repairing a water pump ascertain

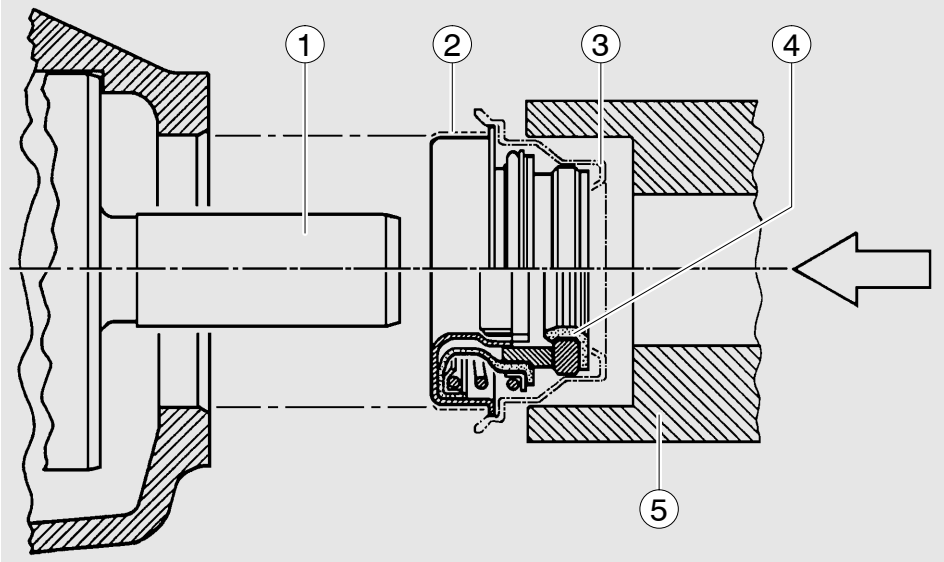
- whether the coolant circuit shows visible and recurrent loss of water; if so
- whether the loss of water is caused by coolant emerging from the expansion tank (e.g. overfilled) or by other leaks on hoses, etc.

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

Installation note for mechanical seal:

Install mechanical seal while “wet”, i.e. to install it, coat holding sleeve ④ and water pump shaft ① with a mixture of either 50% water and 50% cleaning spirit or 40% to 50% antifreeze agent as per MAN 324 and water.
Other lubricants must not be used.

Since the seal on collar ② is coated with sealing paint, no sealing agent must be applied if the location bore in the water pump housing is in faultless condition.
If the bore shows even the slightest scores or other minor damage, Dirko-Transparent, part no. 04.10394–9229 is to be applied to the collar.
Place seal with synthetic transport cap on shaft ① and use installation tool to press it in until the tool contacts the housing. Remove synthetic cap.



Note:
Examinations have shown that most cases of damage to the water pump can be attributed to 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 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 (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.

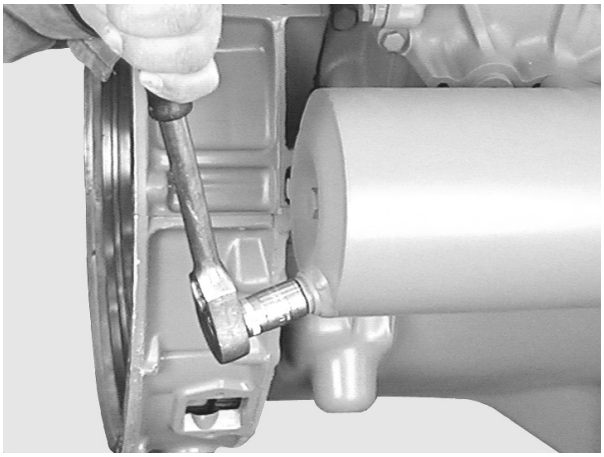
Sources of supply for pickling fluids

Motor pickling fluid RB-06
Reincolor-Chemie GmbH
Werkstr. 21
D–90518 Altdorf
Tel.: (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.



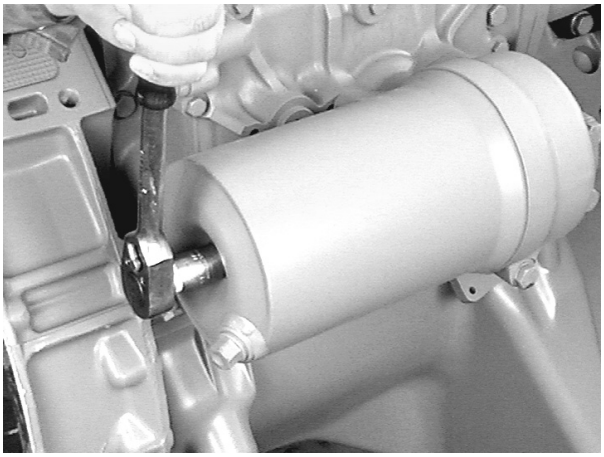
1

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

Fig. 2

Remove mounting bolt of filter bowl.

Take off filter bowl and clean it internally.



2

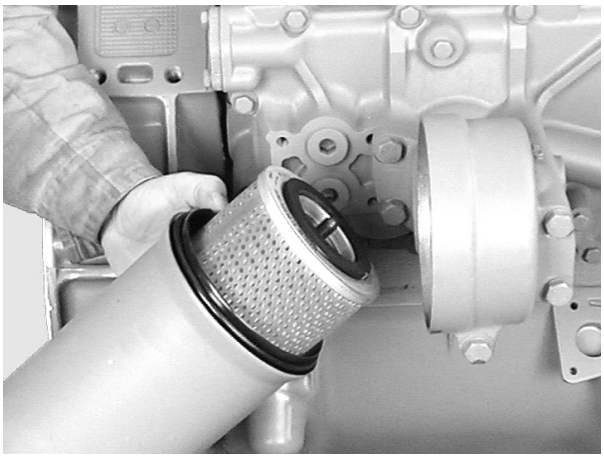
Fig. 3

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.

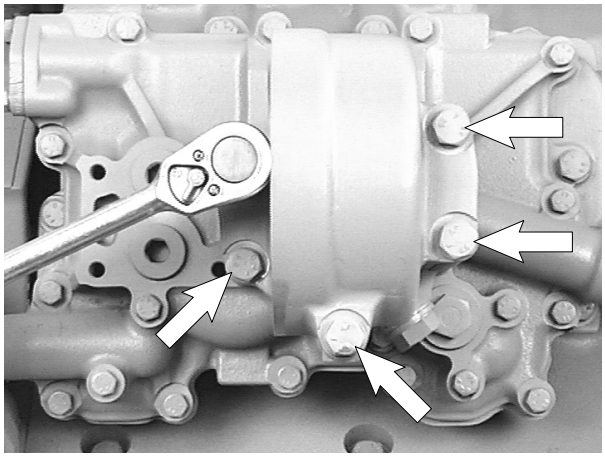
- Drain coolant, see page 40
- Remove oil filter, see page 54

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.

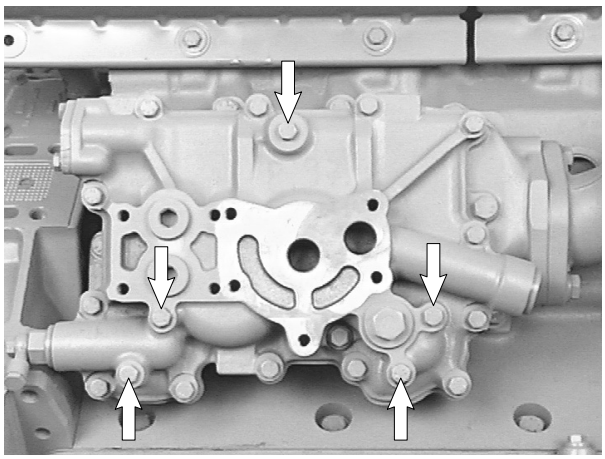


1

Fig. 2

Remove oil cooler housing cover with the oil cooler attached.

The oil cooler is secured by the 5 bolts marked. Loosen these screws only after removal of the housing cover.



2

Fig. 3

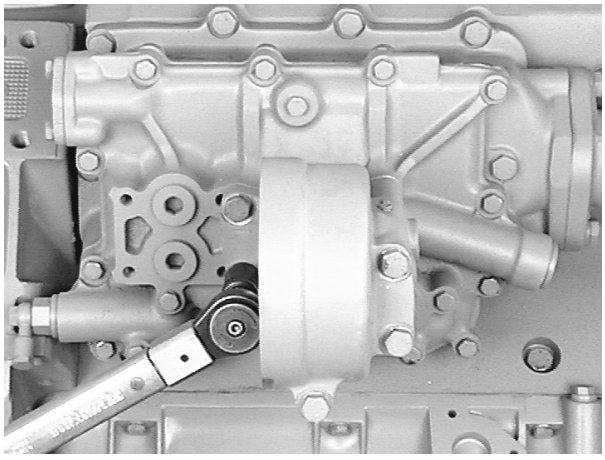
Check oil cooler for damage, changing it if necessary. Fit oil cooler with new gaskets.

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 54
- Top up with engine oil, let engine run briefly and then check for leaks
- Check oil level
- Filling up with coolant, see page 41



4

Drain engine oil

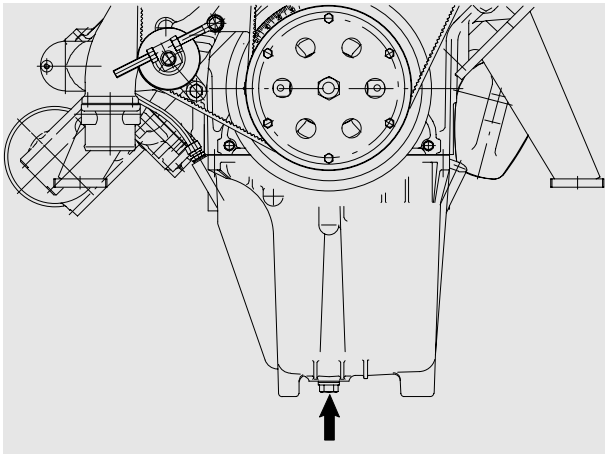
Danger:
The oil is hot – risk of scalding. Do not touch the oil drain plug with bare fingers. Oil is an environmental hazard. Handle it with care!

Figs. 1 and 2

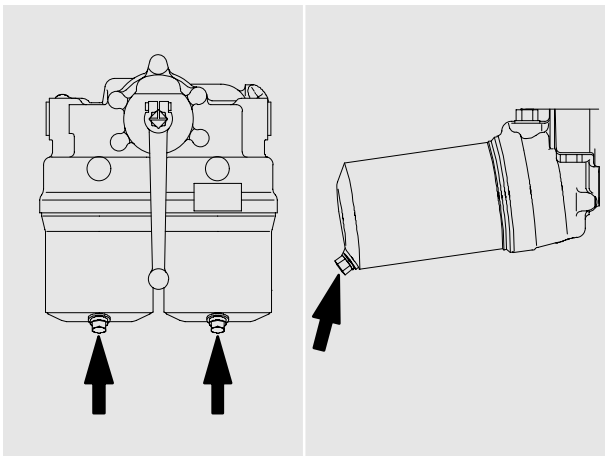
With the engine at operating temperature, remove the oil drain plugs on the oil sump and the oil filter bowl and allow the old oil to drain off completely.

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

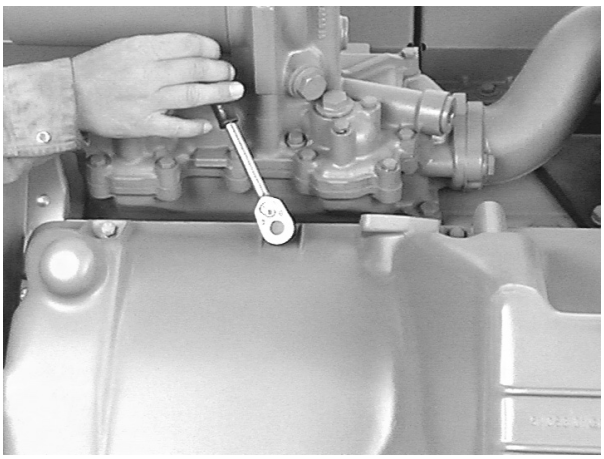
Caution:
Oil pans are awkward to handle and heavy.
They may contain residual amounts of engine oil.
Use lifting gear or work with a helper.

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

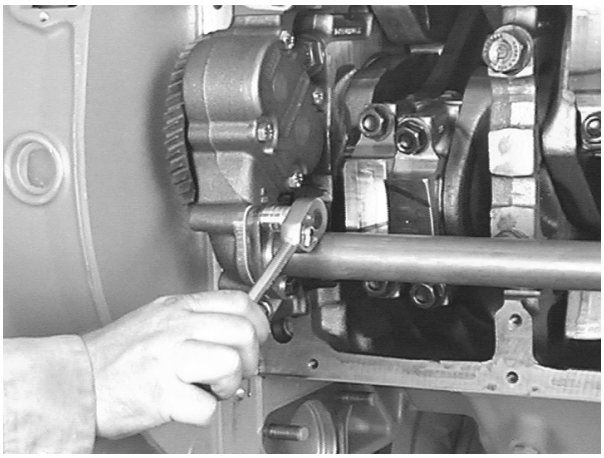
Fig. 4

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

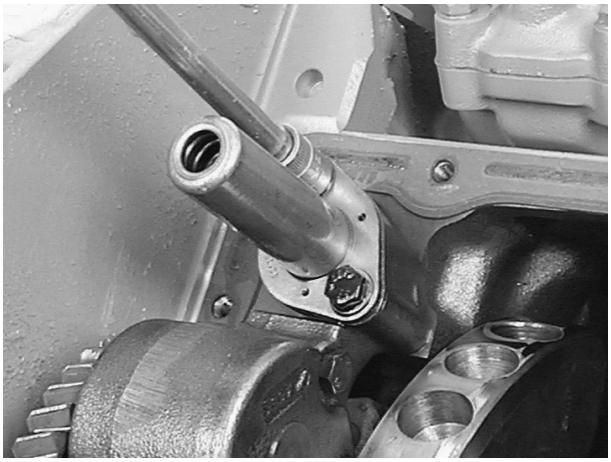
Fig. 5

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.



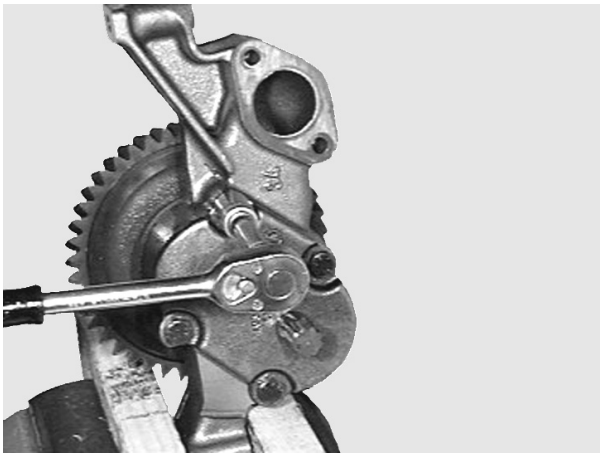
5

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”).

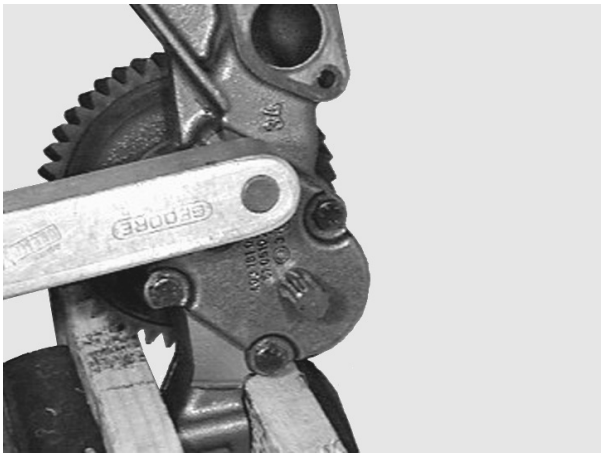
8

Fig. 9

Attach cover.

Tighten the mounting bolts to the specified torque.

Grind or exchange heavily worn covers.



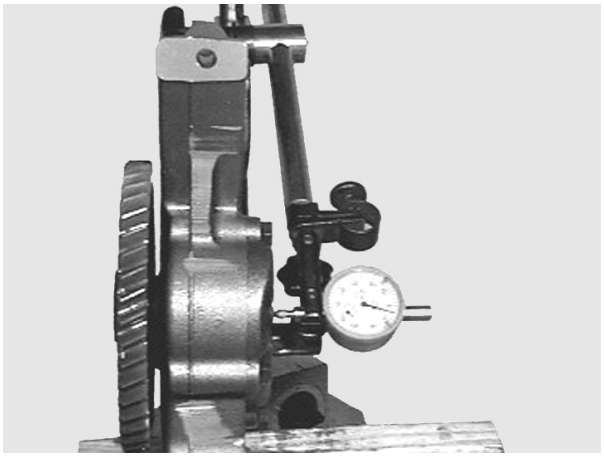
9

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

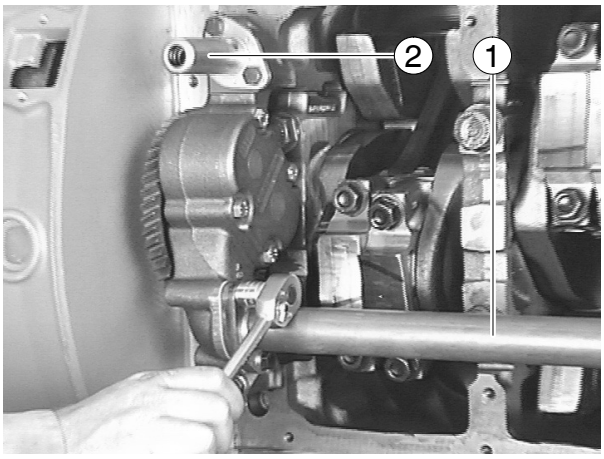
Installing oil pump

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

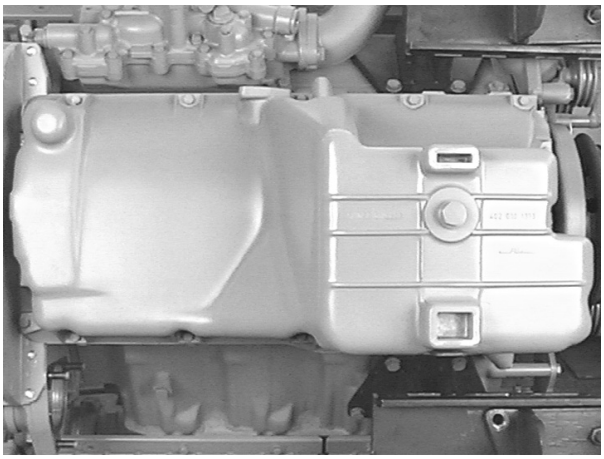
Attaching oil pan

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.



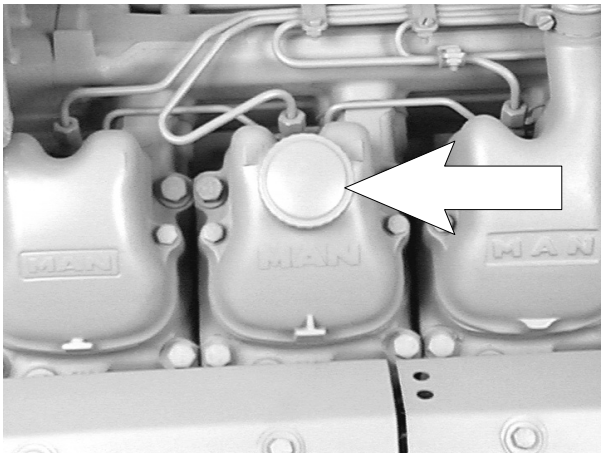
12

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 14

Refill with fresh engine oil at the oil filler neck (arrow).

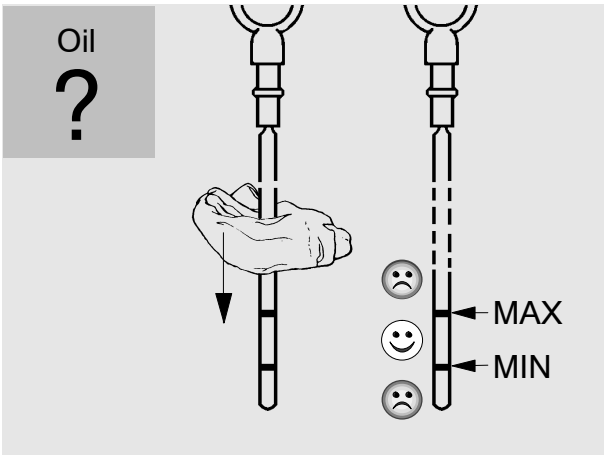


13

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



14

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.

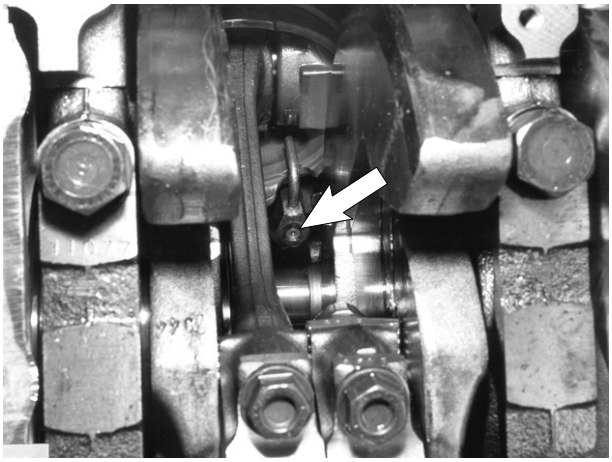
Removing oil spray nozzle

- Drain engine oil, see page 56
- Remove oil pan, see page 56

Fig. 1

Remove mounting bolts from oil spray nozzle (arrow).

Take off oil spray nozzle with valve.



1

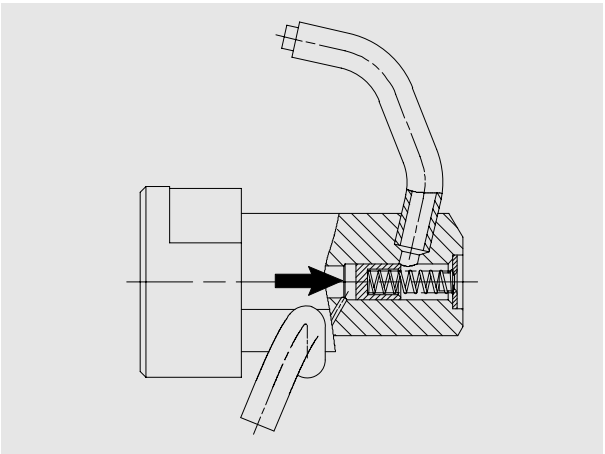
Checking oil spray nozzle valve

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”.

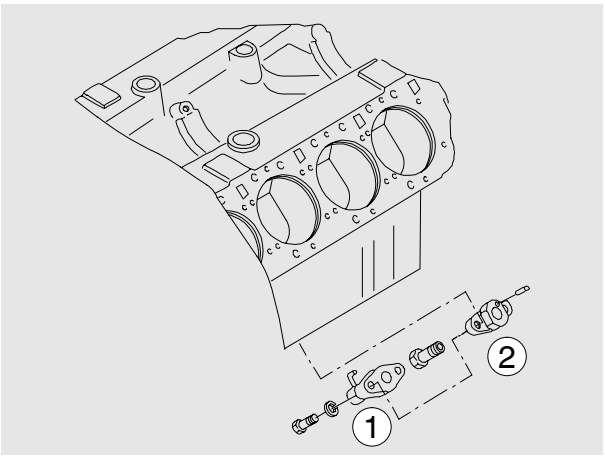


2

Installing oil spray nozzle

Fig. 3

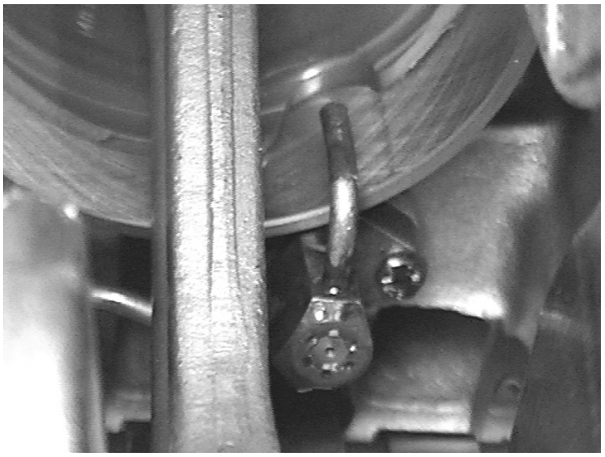
Place oil spray nozzle ① on oil spray nozzle flange ②.



3

Fig. 4

Tighten mounting bolts to specified torque.



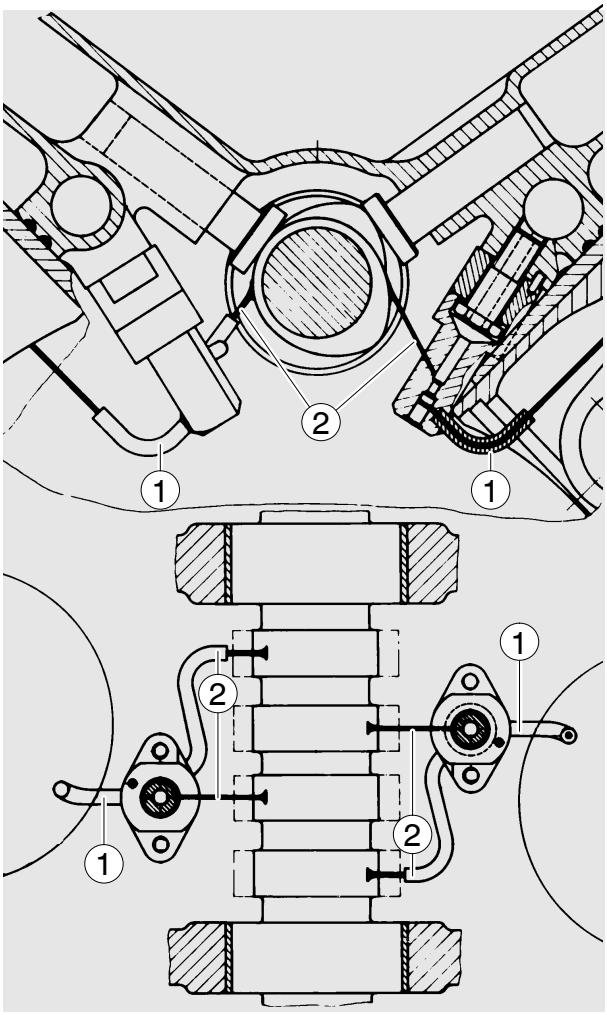
4

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 120
- 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.

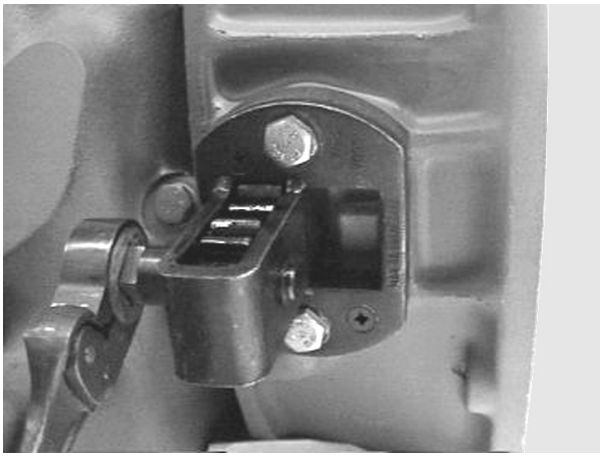

1

Fig. 2

Remove cranking device.

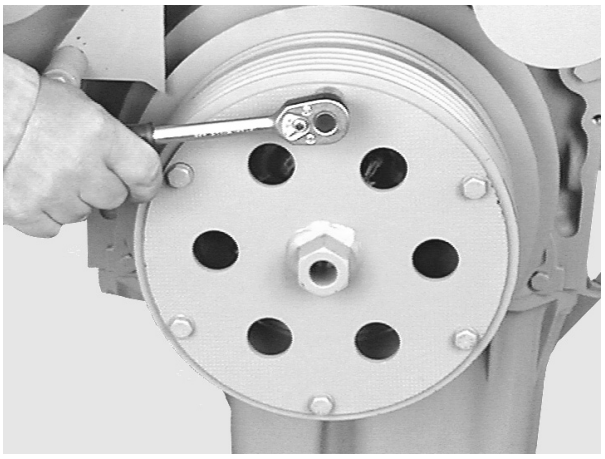

2

Fig. 3

Loosen mounting bolts on vibration damper.

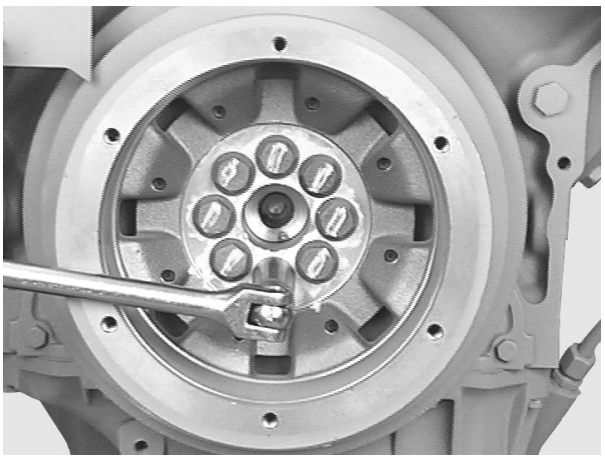

3

Fig. 4

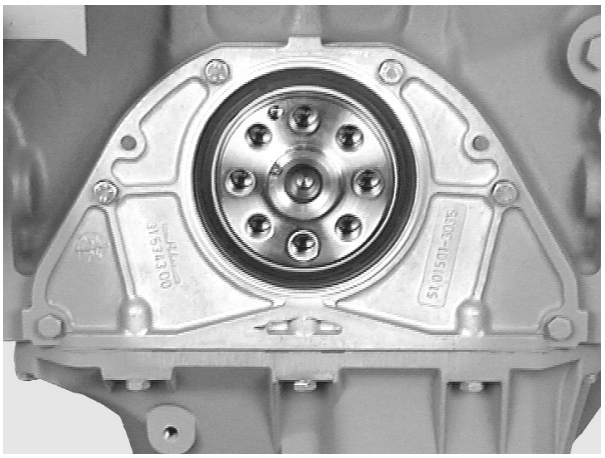
Remove two bolts facing each other and replace them by two guide pins (M16 x 1.5).

Remove all bolts.

Remove vibration damper.

Caution:
The vibration damper is susceptible to shocks.

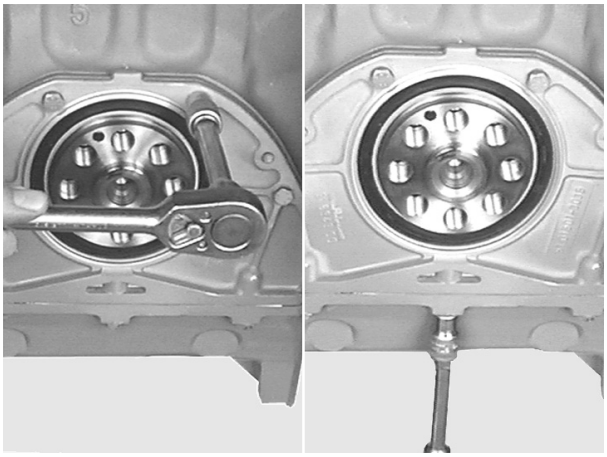
Take oil splash ring off crankshaft.


4

Changing front crankshaft seal

Fig. 5

Remove the mounting bolts from the cover.

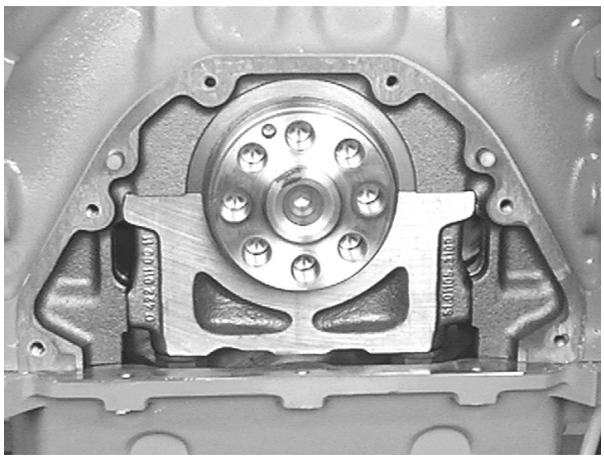


5

Fig. 6

Take off cover.

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

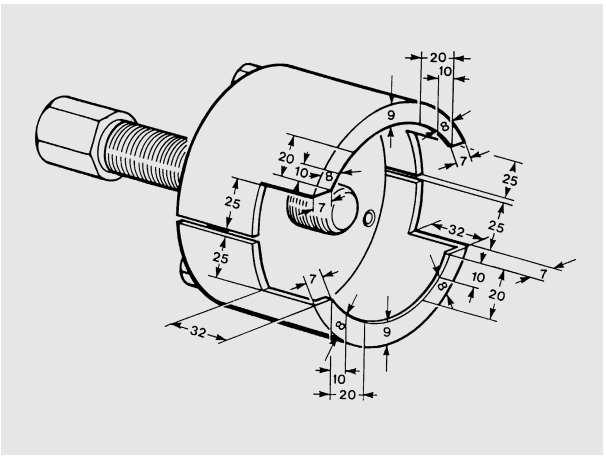


6

Replace race

Fig. 7

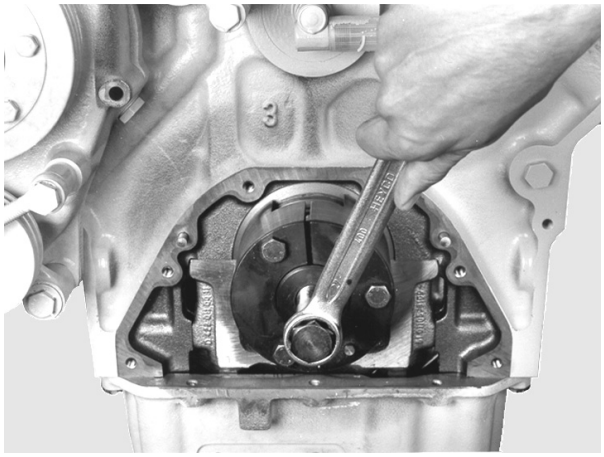
To remove the race, a puller (special tool) is necessary.



7

Fig. 8

Pull off race.



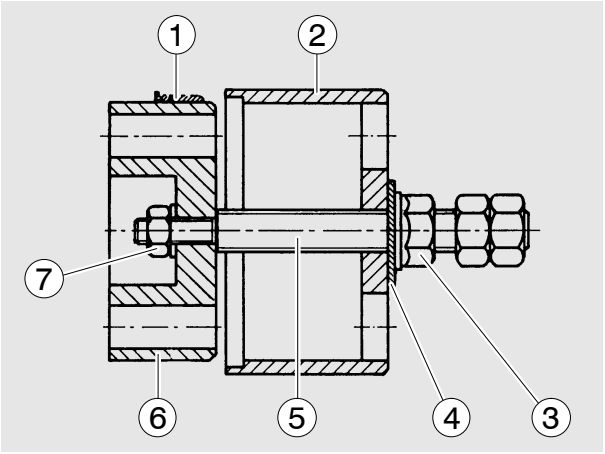
8

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 ① and pressing sleeve ② onto adapter ⑥
- Tighten spindle ⑤ in adapter ⑥ with nut ⑦
- Bolt adapter ⑥ to crankshaft



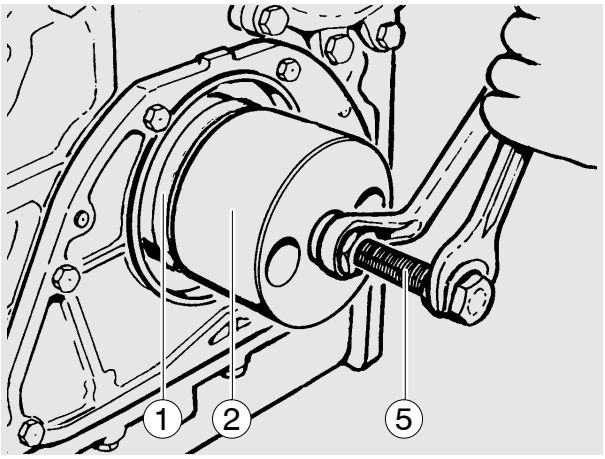
9

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 (③ and ④ 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 70.

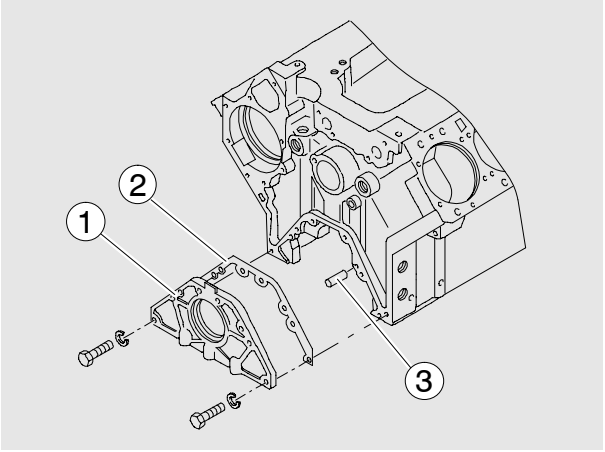

11

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

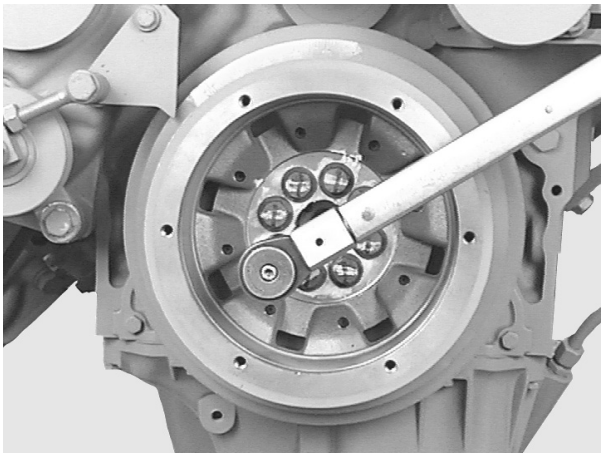
Fit oil splash ring to crankshaft.

Place vibration damper on two guide pins (M16 x 1.5). 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 120.



13

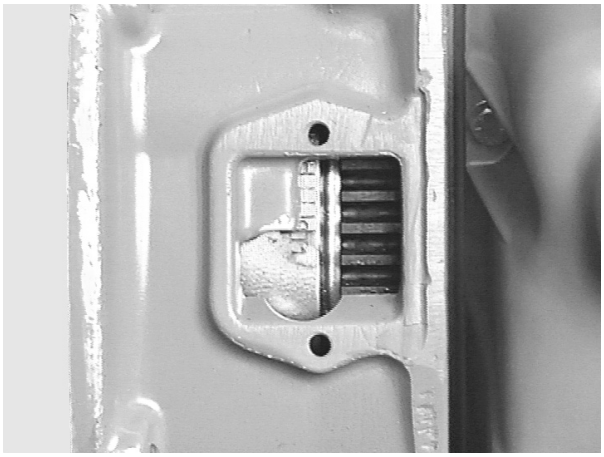
Figs. 14 and 15

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

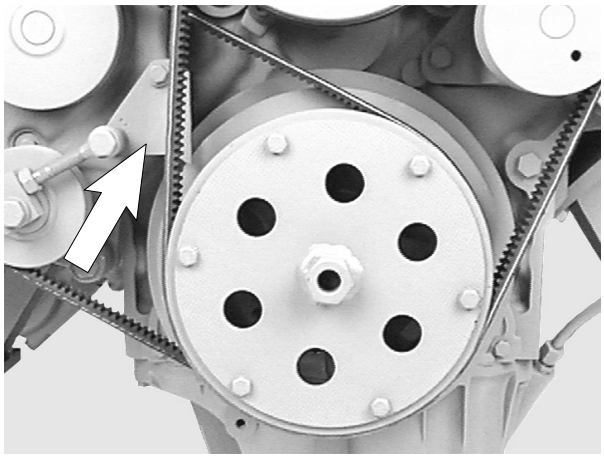
Therefore check whether the scale of degrees on the inspection hole cover of the flywheel housing (picture 14) and on the vibration damper (picture 15) indicate the same values.

If necessary readjust delivery start indicator.

Note:
Unblock the crankshaft.



14



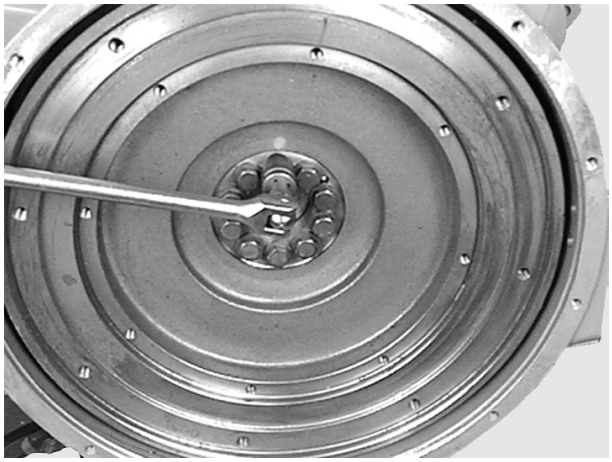
15

Removing flywheel

- Remove speed pickup, see page 127

Fig. 1

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



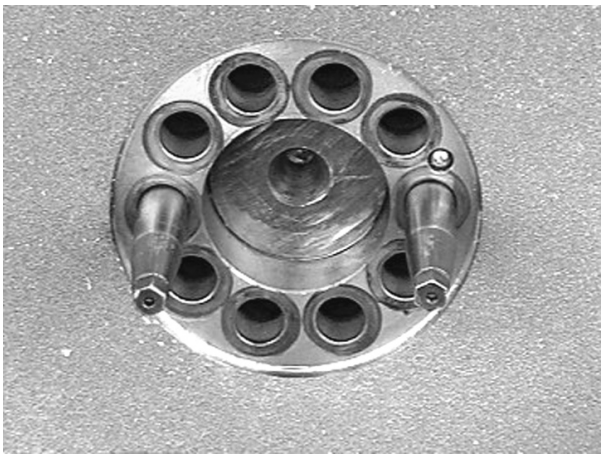
1

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

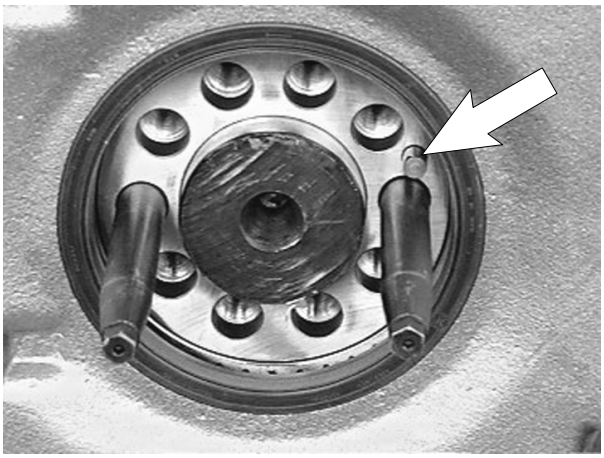
Fig. 3

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.

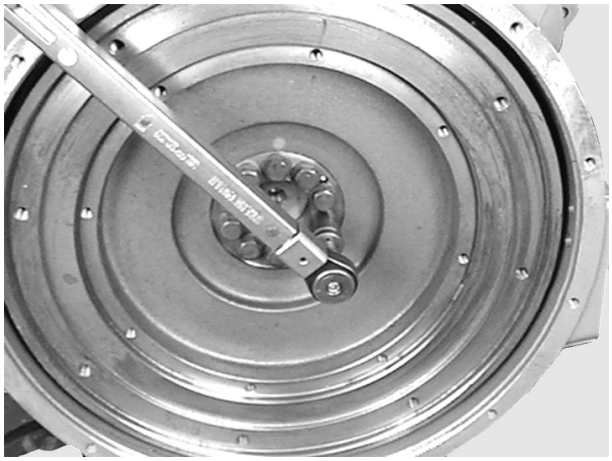


3

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 127



4

Changing starter gear ring

Fig. 5

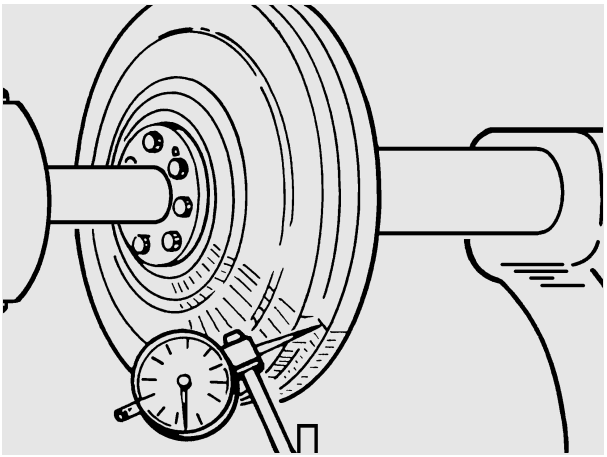
Remove flywheel.
Drill a hole in starter gear ring and snap it using a chisel.

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.



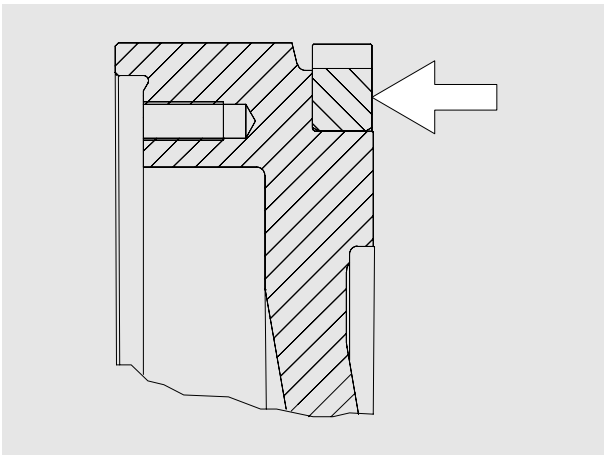
6

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.

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.



7

Check axial runout and compare with max. permissible value.

Removing crankshaft seal

Fig. 1

Remove flywheel, see page 66.

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 70.

2

Exchanging bearing race

Remove flywheel, see page 66.

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).

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.

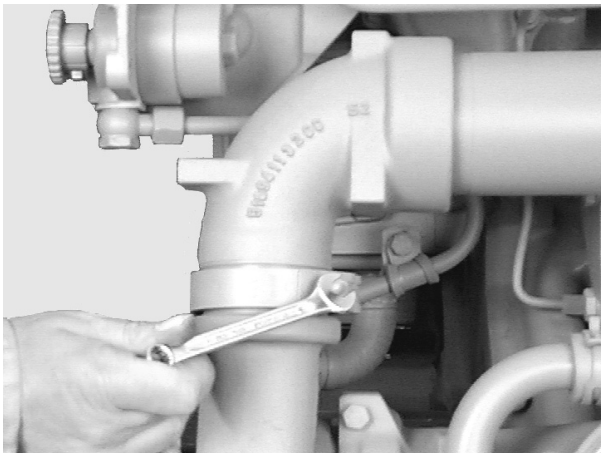
Note:
When carrying out work on the intake system, ensure meticulous cleanliness to prevent dirt and foreign matter from penetrating into the system.

Removing intake manifold

Fig. 1

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

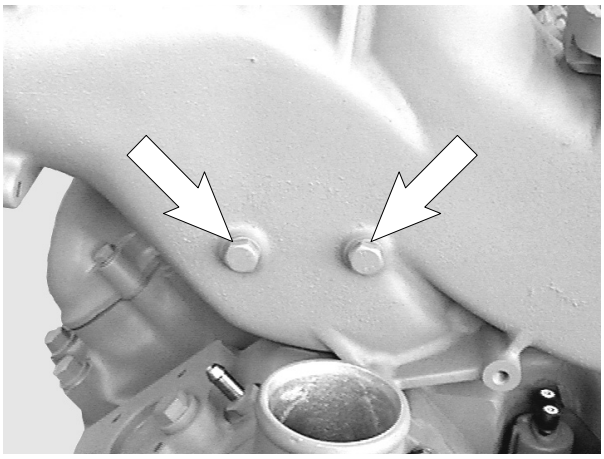
Remove the injection lines, see page 31.



1

Fig. 2

Remove the mounting bolts from the front end of the charge-air pipe.

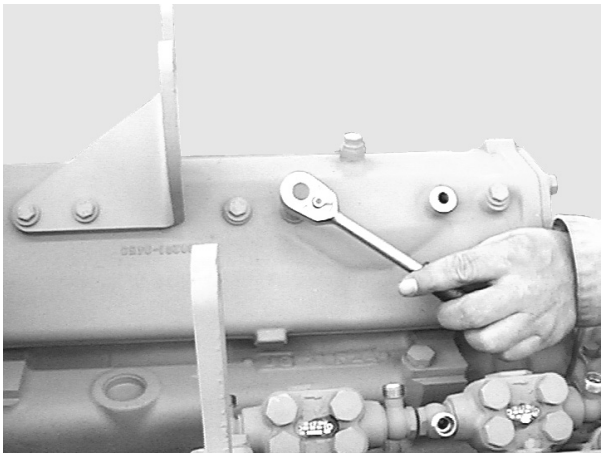


2

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.

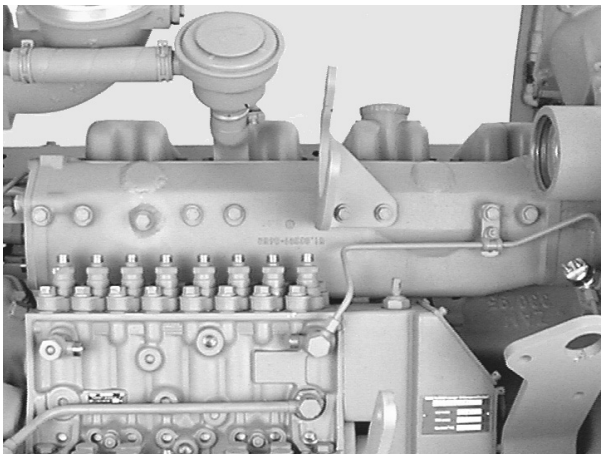
Fit the mounting bolts.

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.



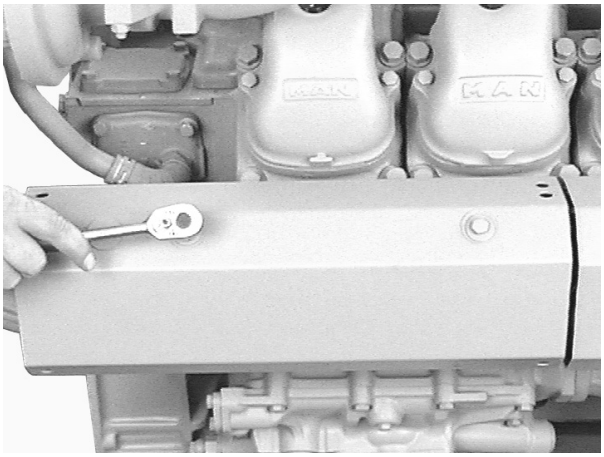
4

Removing exhaust manifold

- Remove turbocharger, see page 76

Fig. 1

Remove the guard plates.



1

Fig. 2

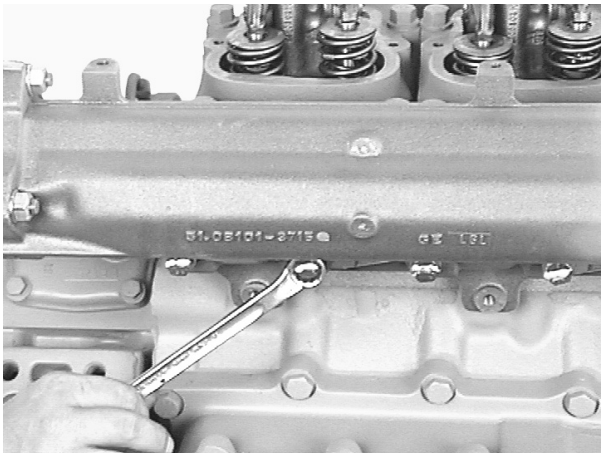
Note:
The exhaust-gas pipe can be removed with the exhaust manifold attached.

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.


2

Installing exhaust manifold

Fig. 3

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

Fit exhaust pipe with new seals.
Ensure that the seals are correctly seated.

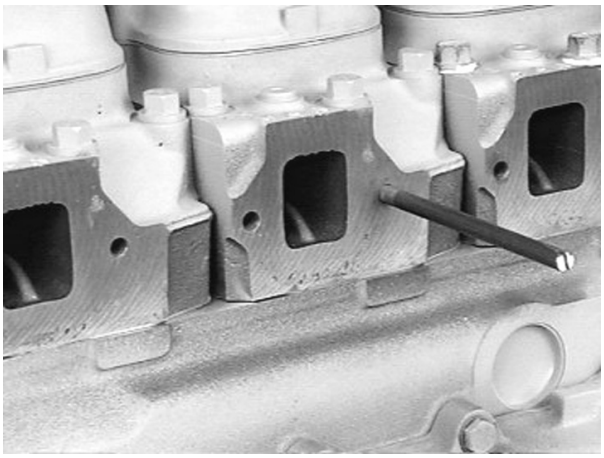

3

Fig. 4

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

- 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:

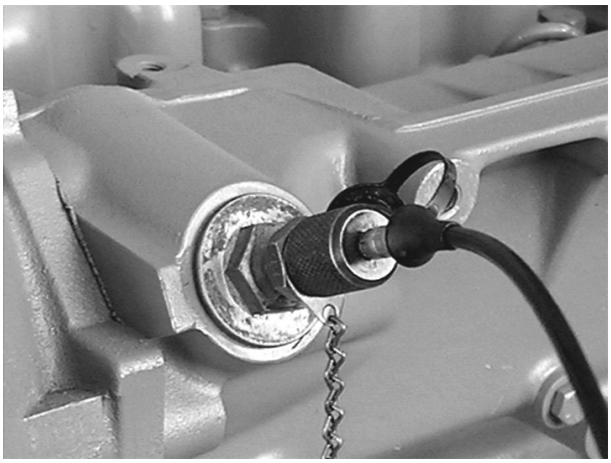
Owing to various atmospheric reference conditions during the measurements and to tolerances of the pressure gauges used, deviations of max. ± 100 hPa (± 100 mbar) are permissible.

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 39.

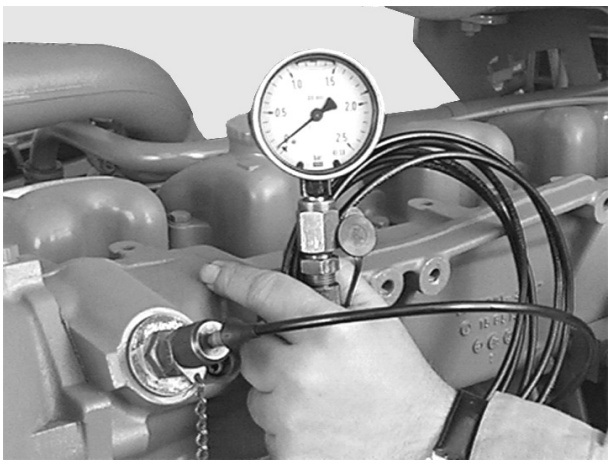
Connect up pressure gauge (if necessary using a suitable threaded pipe as adapter).



1

Fig. 2

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

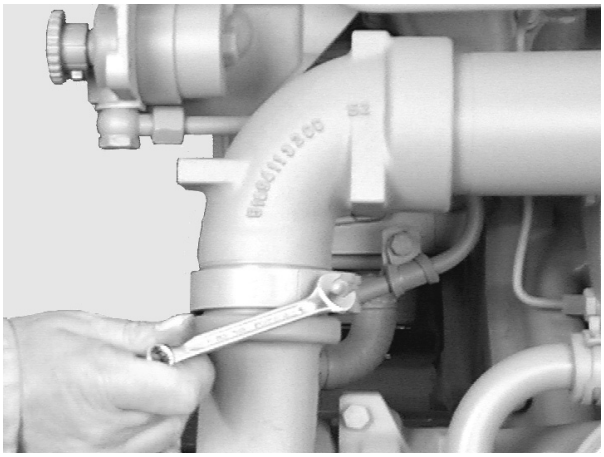


2

Removing turbocharger

Fig. 1

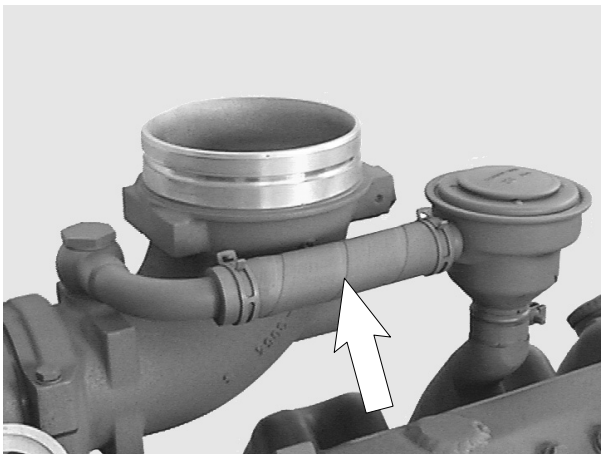
Remove the charge-air elbow and the charge-air pipes leading to the turbocharger.



1

Fig. 2

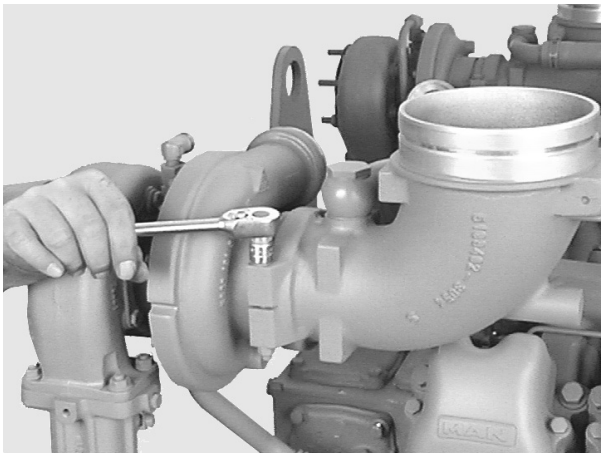
Remove pipe leading to crankcase breather (arrow).



2

Fig. 3

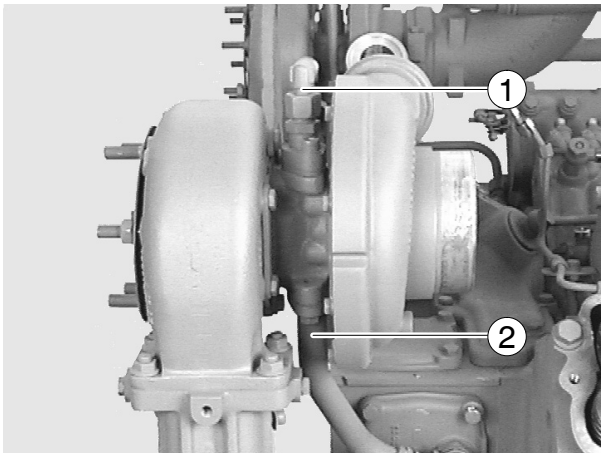
Detach intake neck.



3

Fig. 4

Remove oil pressure line ① and oil return line ② from turbocharger.



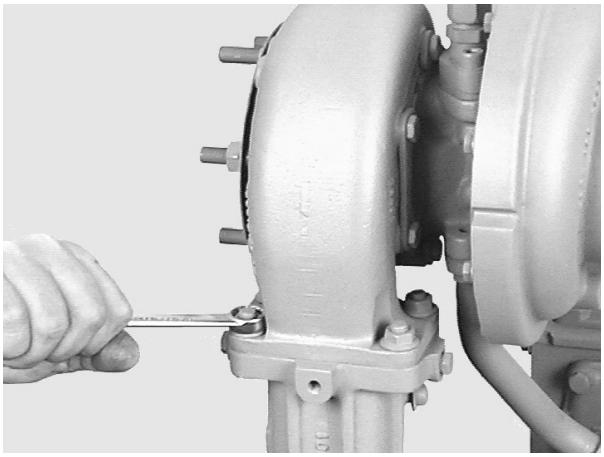
4

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

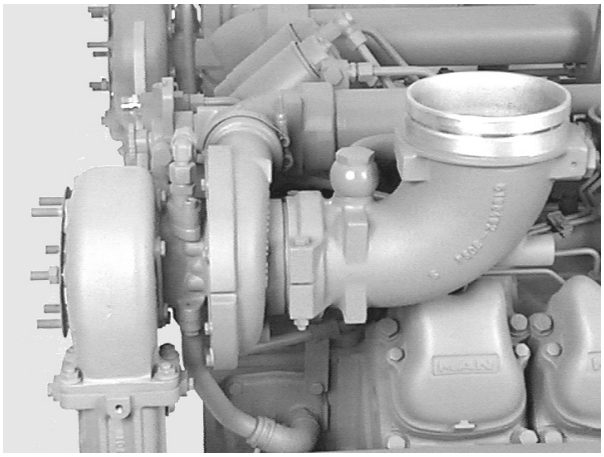
Fig. 6

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.

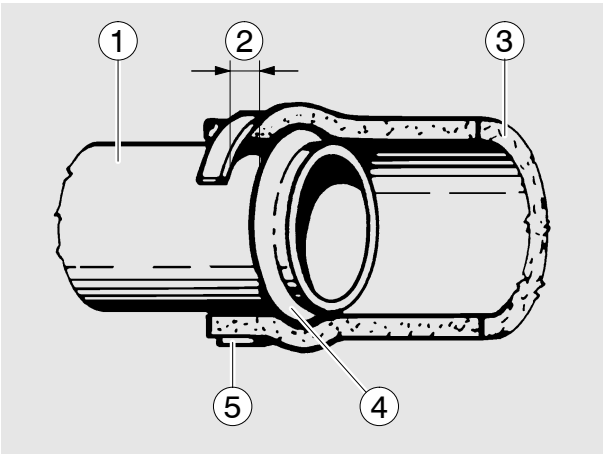


6

Caution:
Comply with instructions for masking unions on pressurised oil and fuel pipes (see page 3).

Fig. 7

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



7

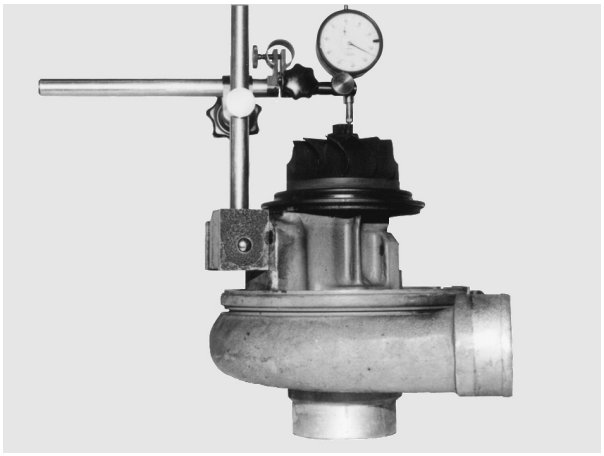
1 Pipe
2 Distance
3 Hose
4 Bead on pipe
5 Hose clamp

- Remove turbocharger, see page 76
- 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.



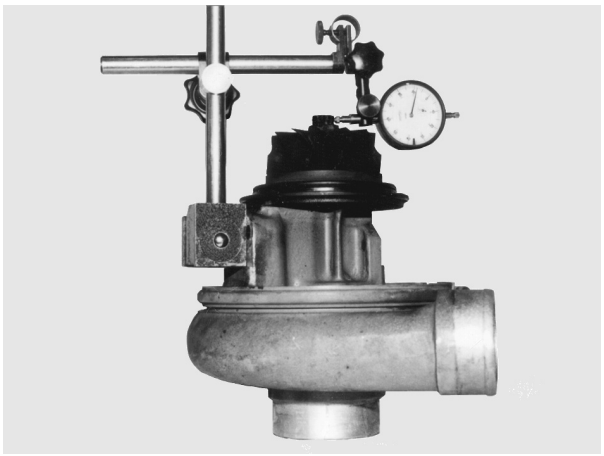
1

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

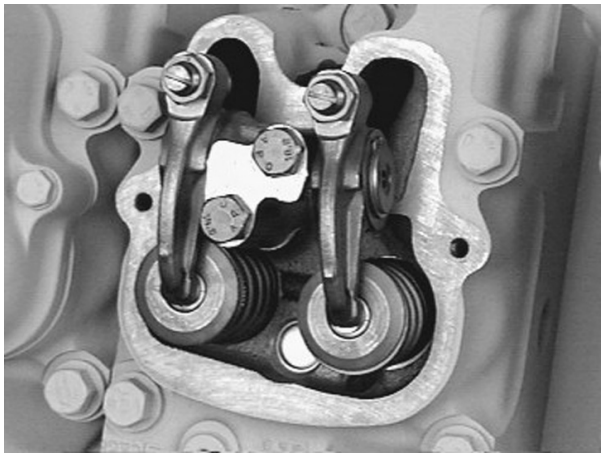
- Fit turbine housing. Ensure that the markings coincide
- Tighten turbine housing bolts to specified torque
- Installing turbocharger

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

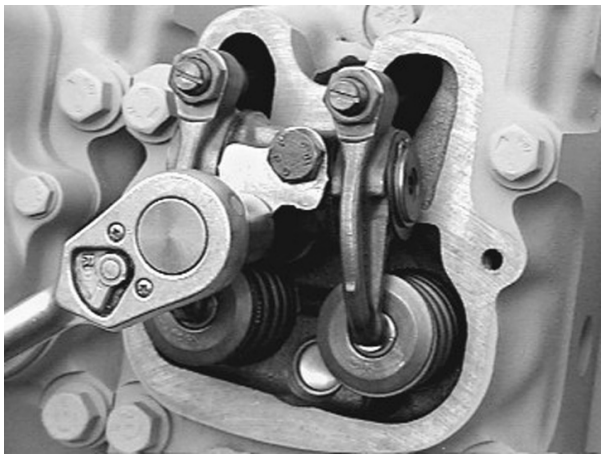
Fig. 2

Back off valve adjusting screws.

Loosen mounting bolts of rocker arm bracket.

Remove rocker arm bracket.

Disassembling and assembling rocker arms, see page 85.

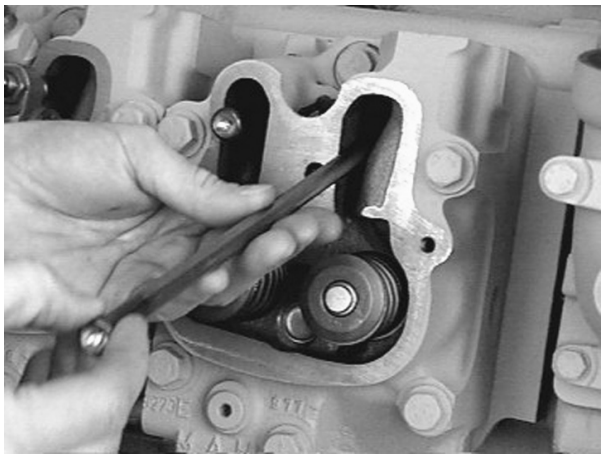


2

Removing cylinder head

- Drain coolant, see page 40
- Remove injectors, see page 31
- Removing intake manifold, see page 71
- Removing exhaust manifold, see page 72

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



3

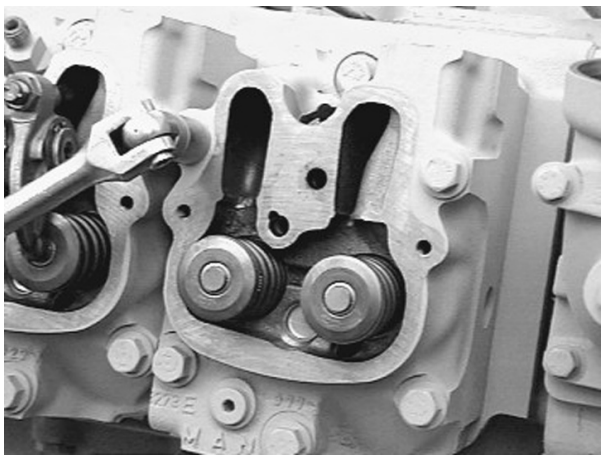
Fig. 3

Take out push rods.

Fig. 4

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

Note:
When removing a cylinder head:
Remove the mounting bolts from the intake and exhaust pipes for the respective cylinder head. Remove all bolts from intake and exhaust pipes. This will reduce the tension on the cylinder head, and the head can be taken off more easily.



4

Fig. 5

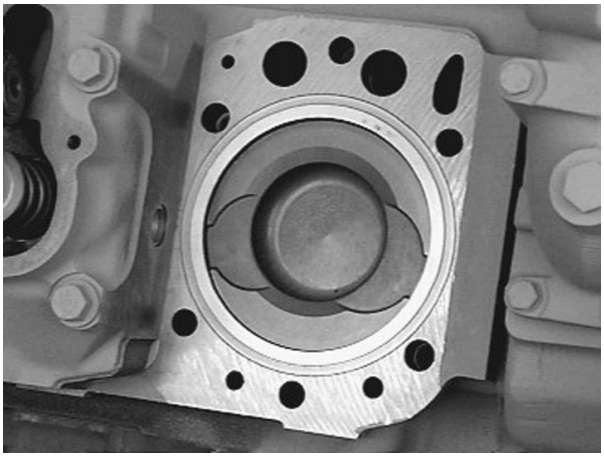
Take off cylinder head and cylinder head gasket.

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 (see “Service Data”).

Note:
Check cylinder heads for cracks.



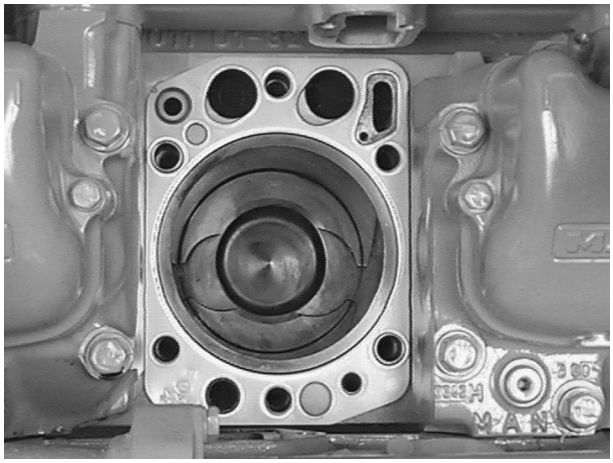
5

Installing cylinder head

Fig. 6

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

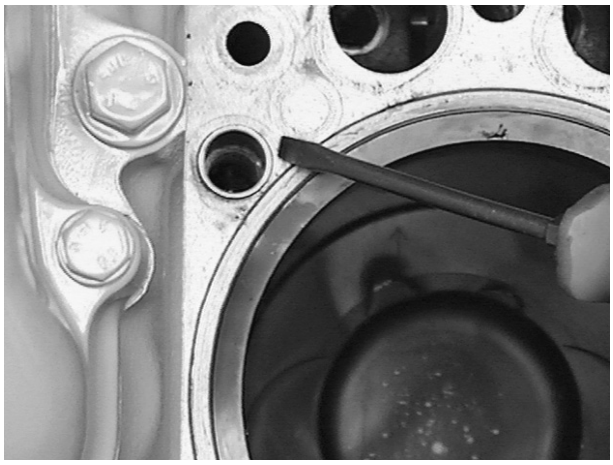
Lay new cylinder head gaskets in place in dry condition, ensuring that the holes match those in the crankcase, and place cylinder head on top.



6

Fig. 7

Each cylinder head is located with two fitting sleeves.



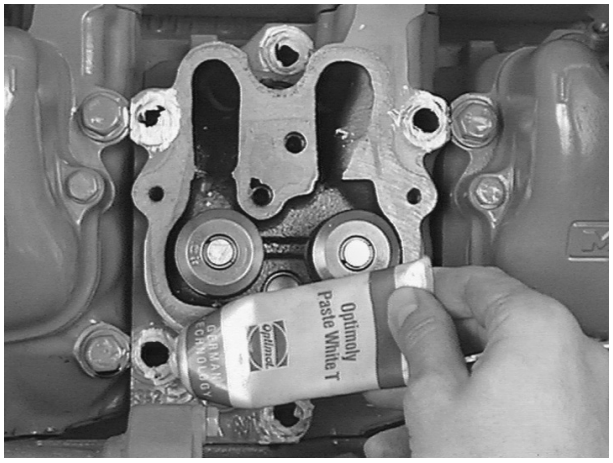
7

Fig. 8

Check whether the cylinder head bolts have the max. permissible length (see “Service Data”).

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

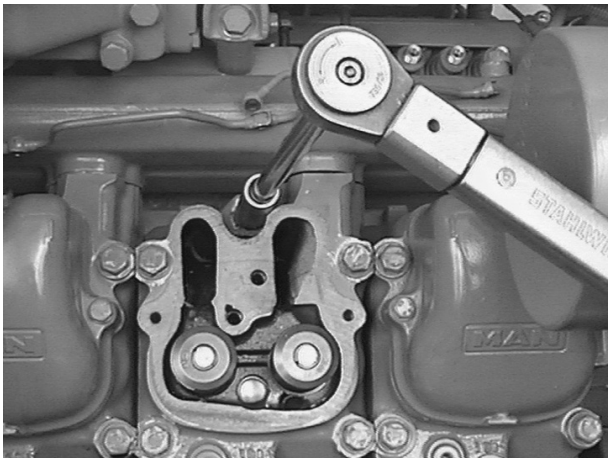
Figs. 9 and 10

Tighten bolts by angle.

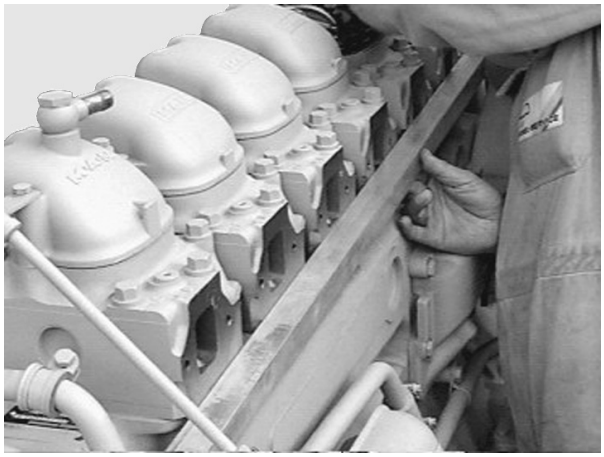
Observe order of tightening and specified tightening method, and see instructions and notes on the cylinder head bolts in the publication “Service Data”.

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



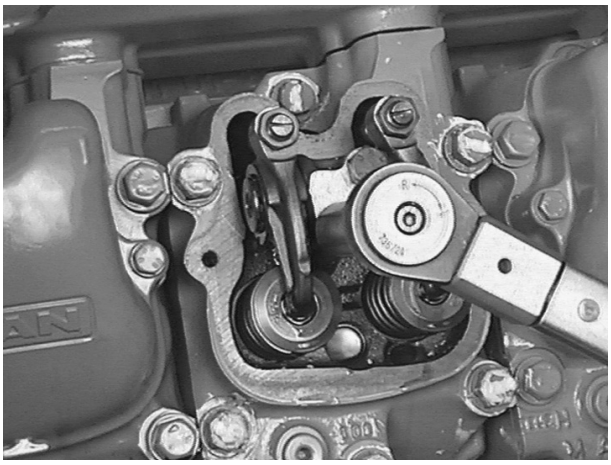
10

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.



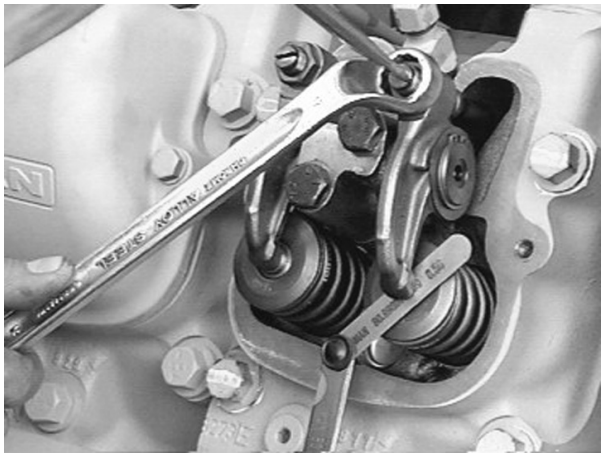
11

Fig. 12

Set valve clearance, see page 83.

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 notes on usability of cylinder head bolts, order of tightening and specified tightening method in publication “Service Data”.

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.

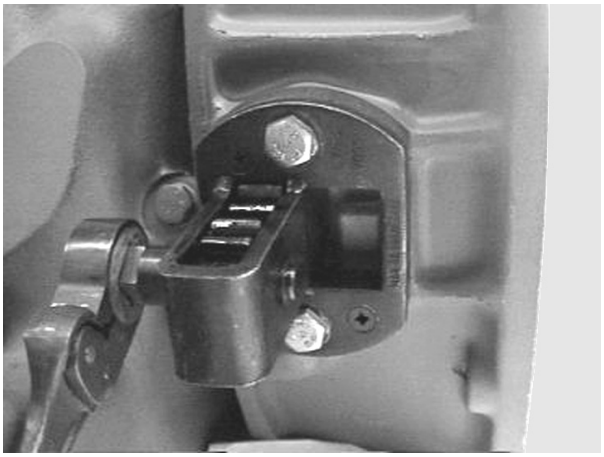
Caution:
If during initial tightening some bolts are excessively tightened, the cylinder head will be distorted. This distortion cannot be cancelled out by continuing to tighten according to the instructions.

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.

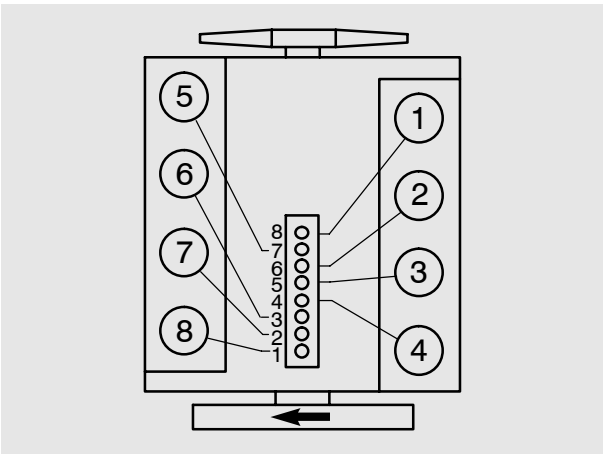
The valves of the synchronous cylinder are then in cross-over.

Fig. 2

D 2848 LE 2..
Set valves in the cylinder

1	5	7	2	6	3	4	8
6	3	4	8	1	5	7	2

Valves are in cross-over in cylinder



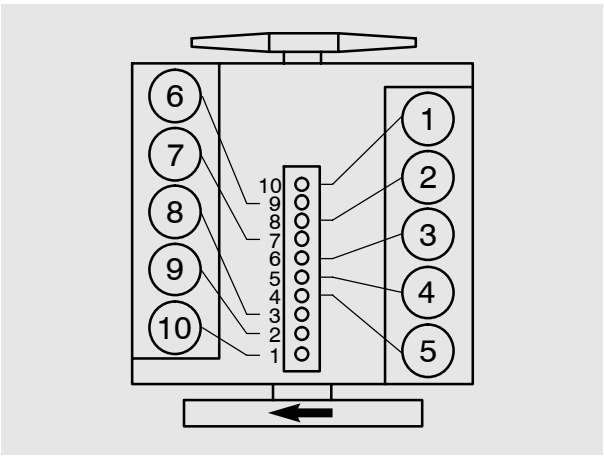
2

Fig. 3

D 2840 LE 2..
Set valves in the cylinder

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

Valves are in cross-over in cylinder



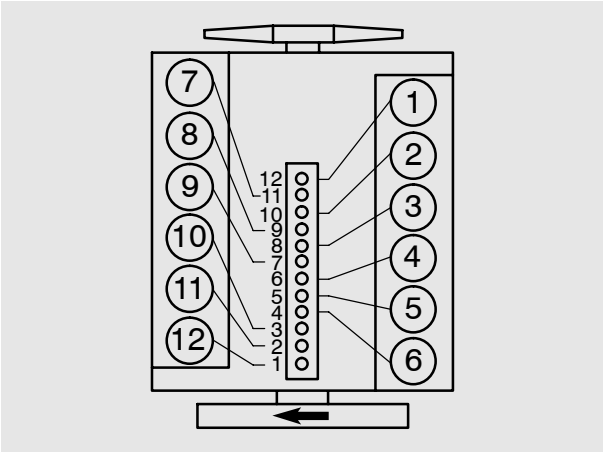
3

Fig. 4

D 2842 LE 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

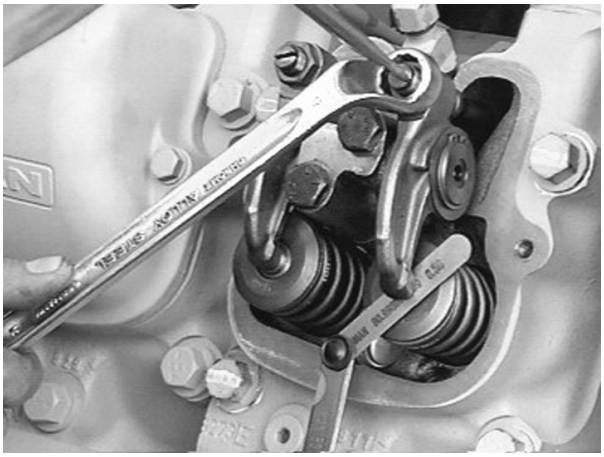
Valves are in cross-over in cylinder



4

Fig. 5

- 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

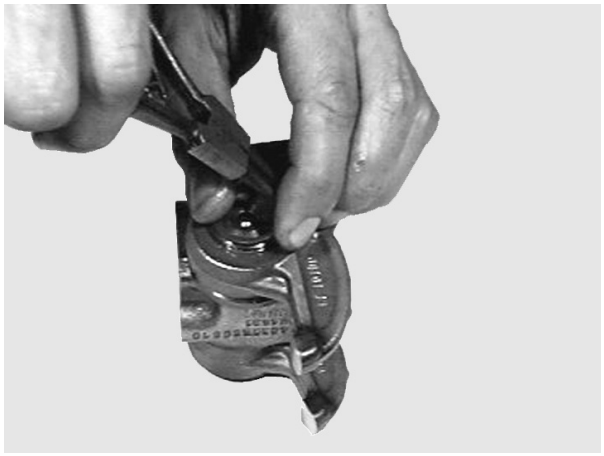


5

Fig. 1

Remove rocker arms, see page 79.

Unclip circlip.



1

Fig. 2

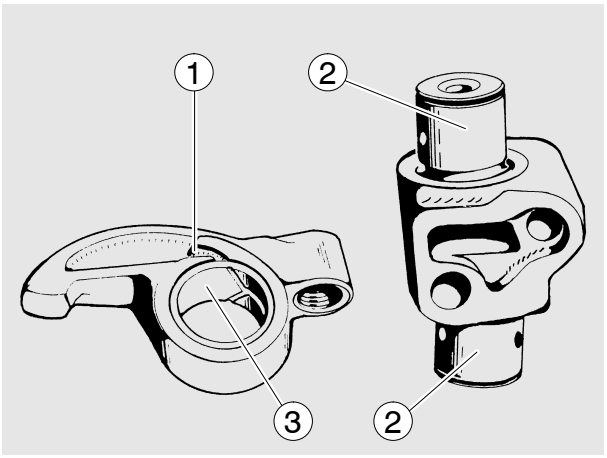
Take rocker arms off the rocker arm shaft.

Note:
If the rocker arm bearing bushes have to be exchanged, ready-to-install new or re-conditioned 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.



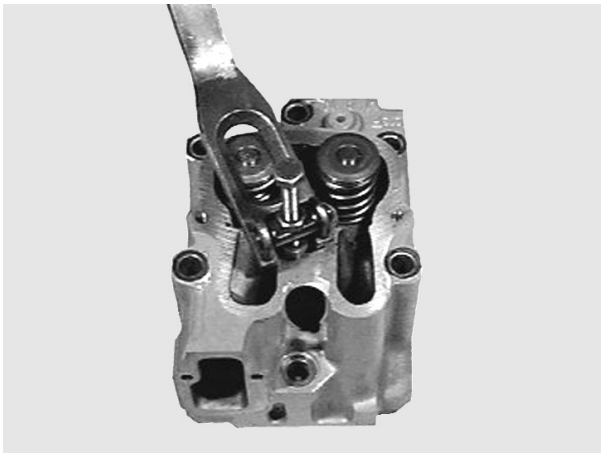
3

Removing valves

Remove rocker arms. Take off cylinder head, see page 79.

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.

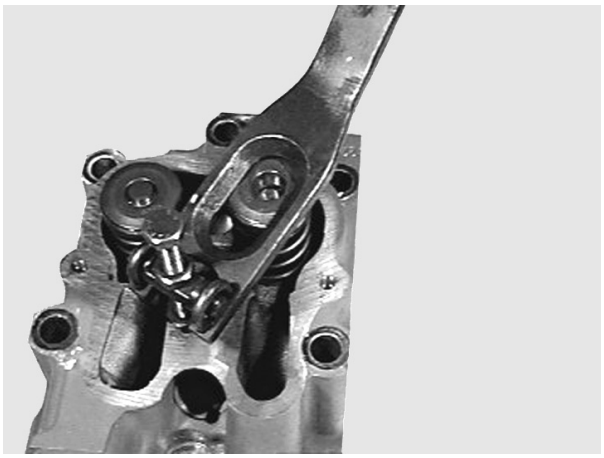


1

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

Fig. 2

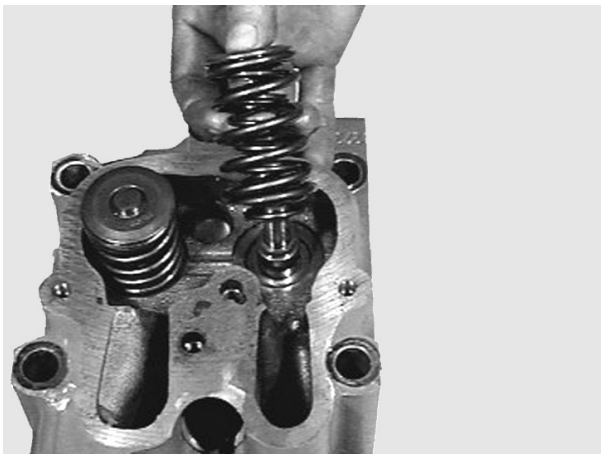
Note:
If a valve fixture is available in the workshop, the procedure described may also be carried out on the said fixture.



2

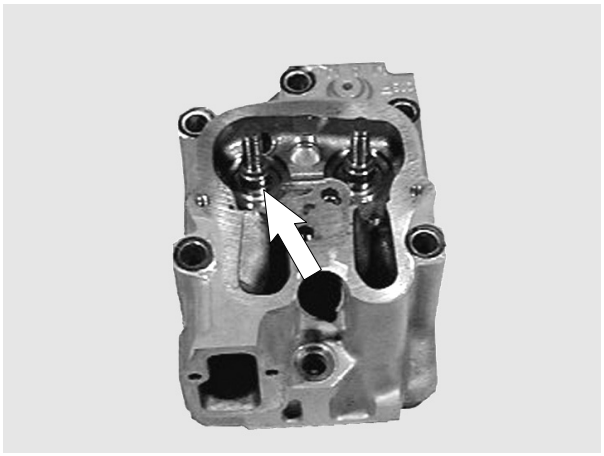
- Press spring plate and spring downwards with valve assembly lever and take out the valve cone pieces using a magnet
- Move assembly lever upwards – **Caution: spring under tension, risk of injury** – and away to one side

Figs. 3 and 4



3

- 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



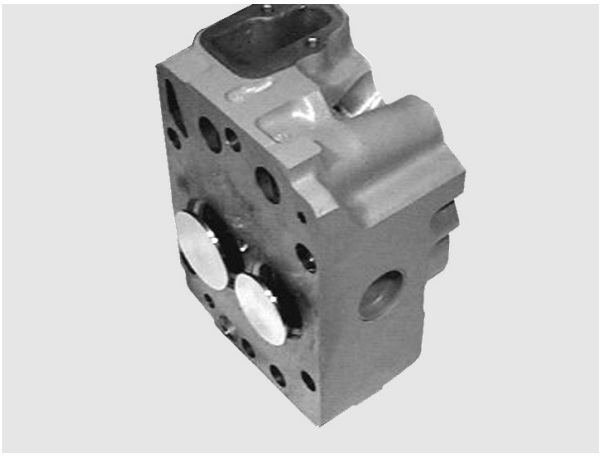
4

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.

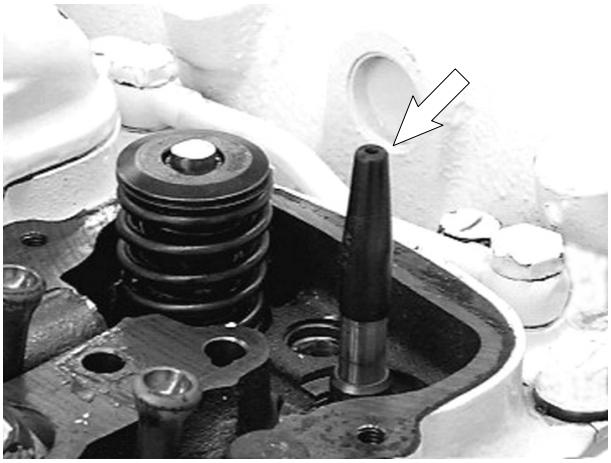


5

Fig. 6

Turn cylinder head over.

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

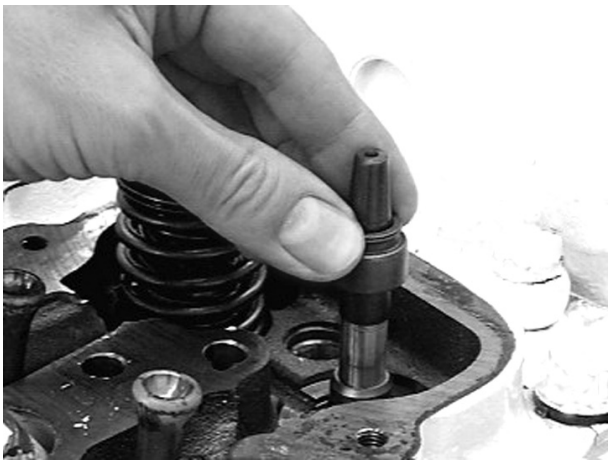


6

Fig. 7

Fit sealing ring.

Note:
Use new valve shaft seals only.

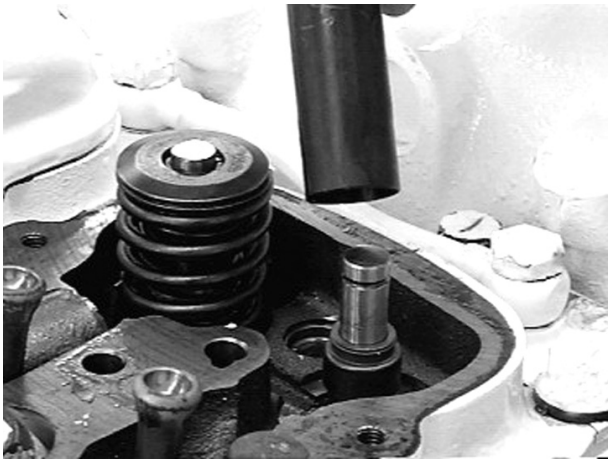


7

Fig. 8

Take off insert sleeve.

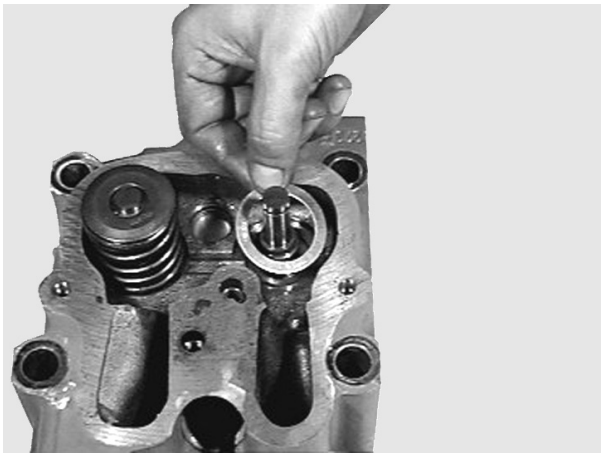
Fit press-in sleeve and press in seal.



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.



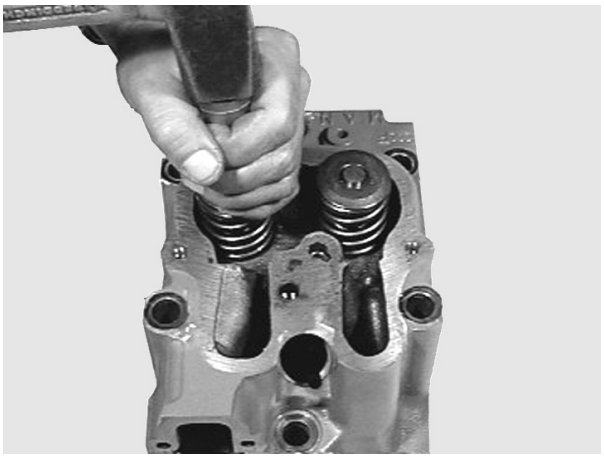
9

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.

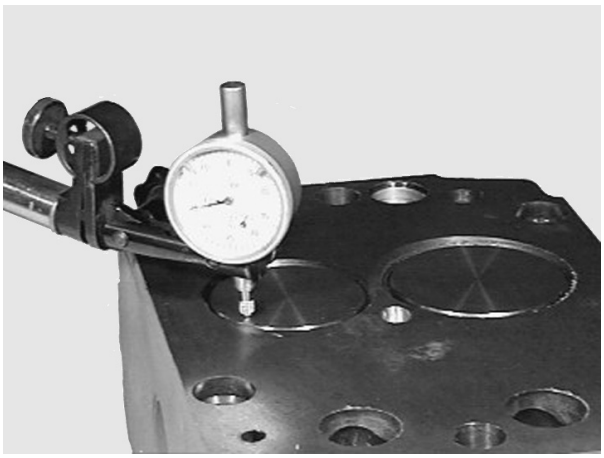


10

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



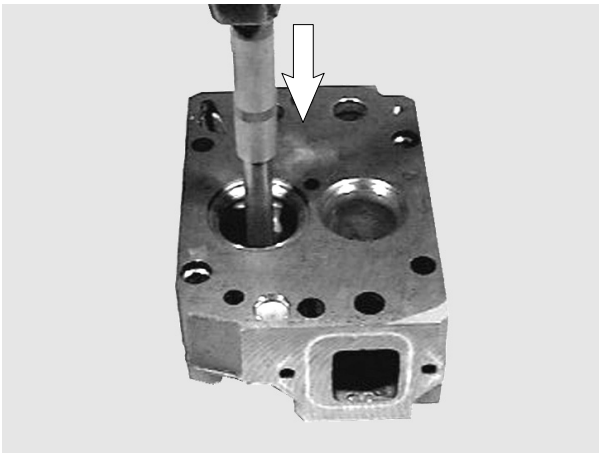
11

- Removing and installing cylinder head, see page 79
- Removing and installing valves, see page 86

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).



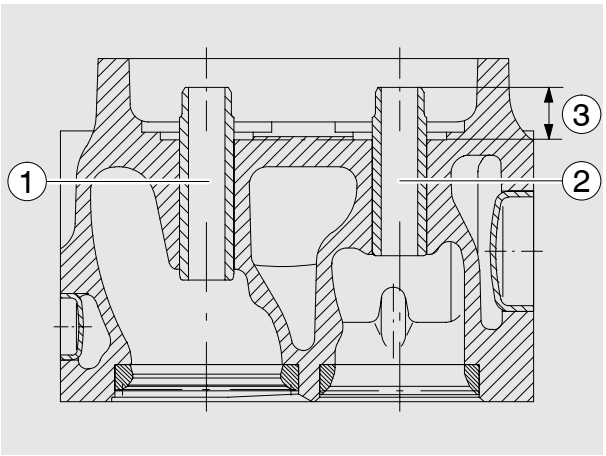
1

Fig. 2

The valve guides vary only in length.

1 Inlet = long guide
2 Exhaust = short guide
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).

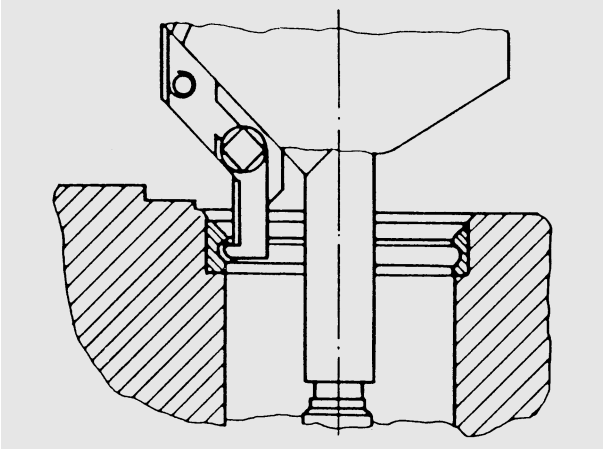
Removing valve seat insert

Note:
f 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.



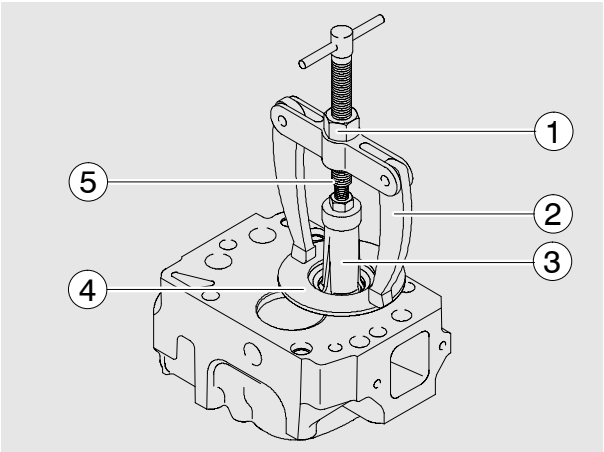
1

Fig. 2

Note:
To avoid damage to the cylinder head sealing face, lay disc ④ or similar item under the arms ② of the support.

Turn threaded spindle ⑤ into the internal puller ③, align the arms ② of the support and pull out valve seat insert by turning the nut ①.

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

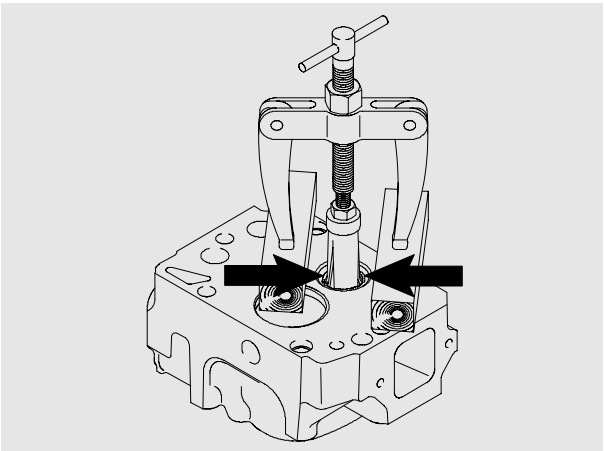


2

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

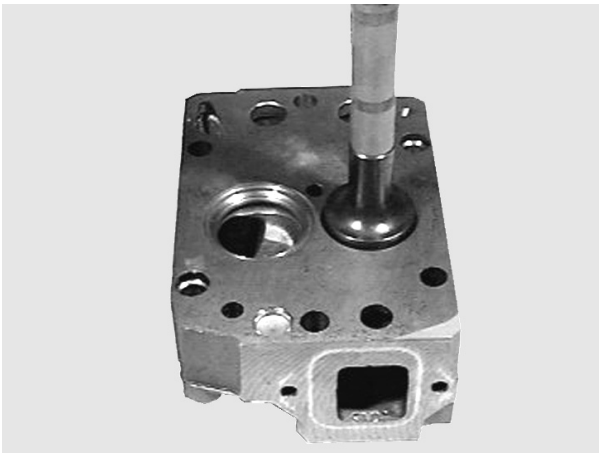


3

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.



4

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

Note:

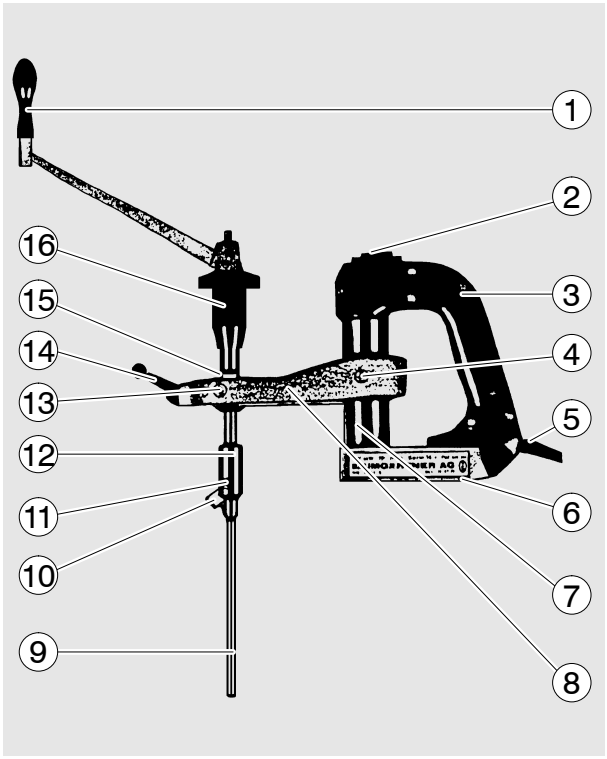
- After temperature equalization, machine valve seats
- After machining, clean cylinder head and check for leaks using leak testing device
- If the cylinder head is excessively heated (above +200°C, +390°F) the core hole covers (end covers) loose their tightness and must be exchanged
- To do this, clean 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 Driving crank
2 Toggle switch
3 Handle
4 Lubricating nipple
5 Mains connection
6 Magnetic flange with coil
7 Guide pipe
8 Slewing arm
9 Guide mandrel
10 Tool
11 Hex socket screw
12 Rotary head
13 Lubricating nipple
14 Jaccard lever
15 Guide ball
16 Feed nut with mm scale



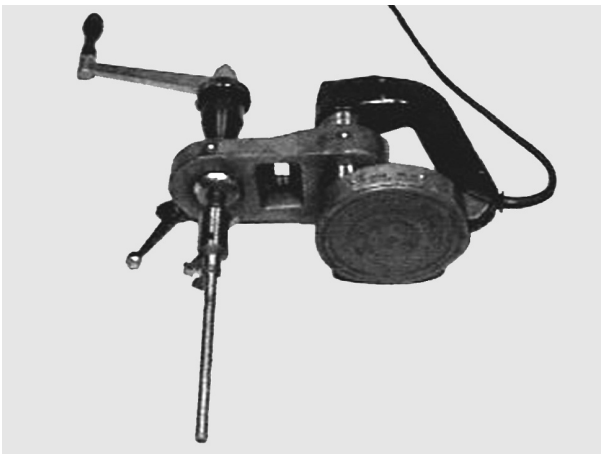
1

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.

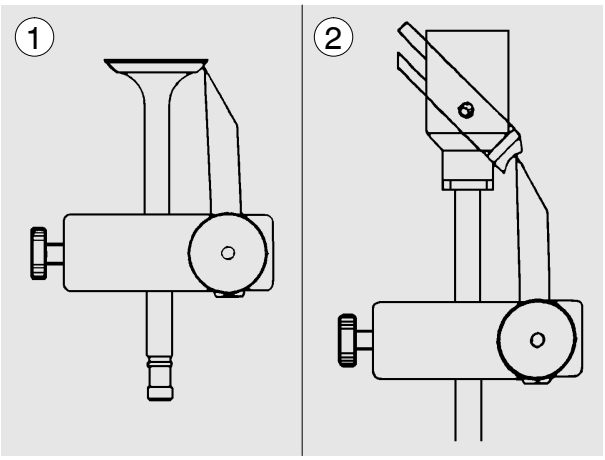


2

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.



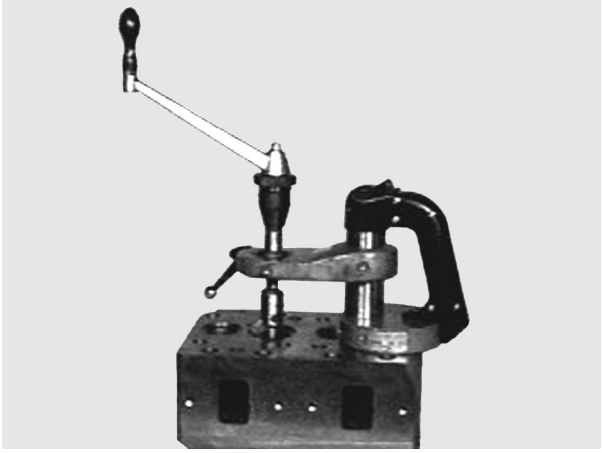
3

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.

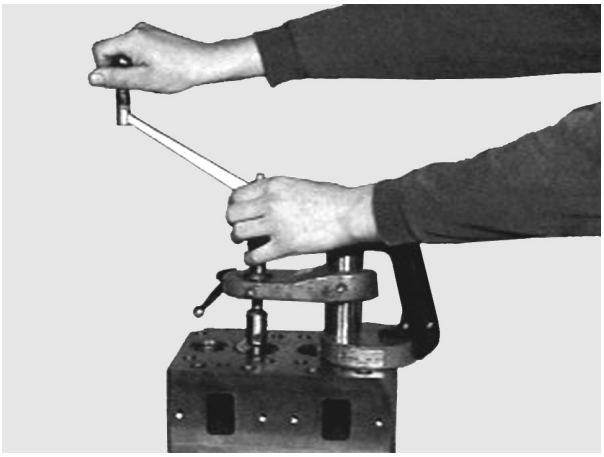


4

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.



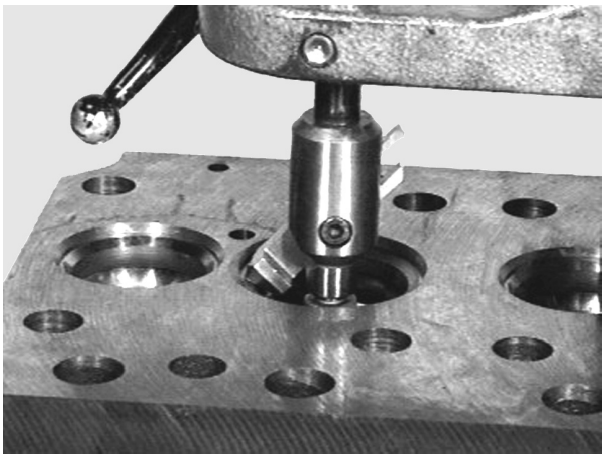
5

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.

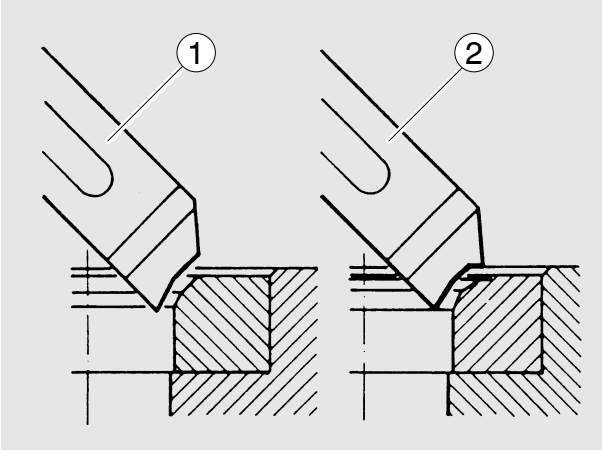
Now move the whole Mira unit out upwards and insert it into the next valve guide, repeating the centering operation.
Use the same tool settings for all intake and all exhaust valve seats (see below).



6

Fig. 7

Observe specified seat angle.



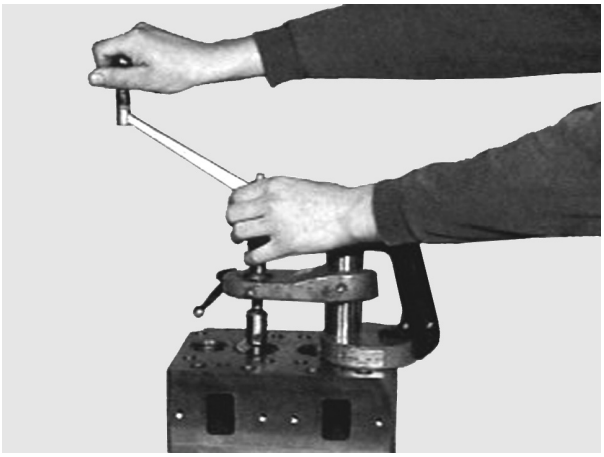
7

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.

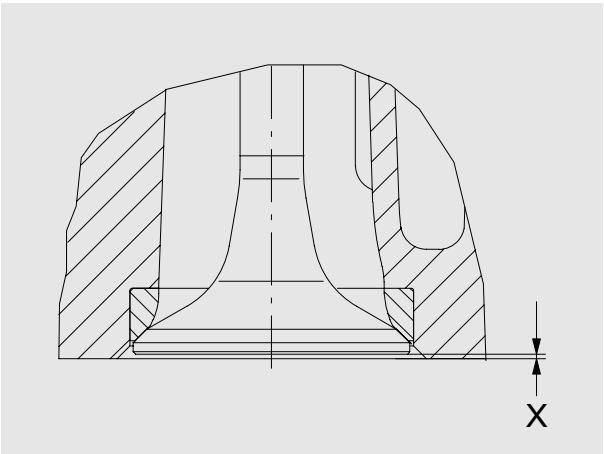


8

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.

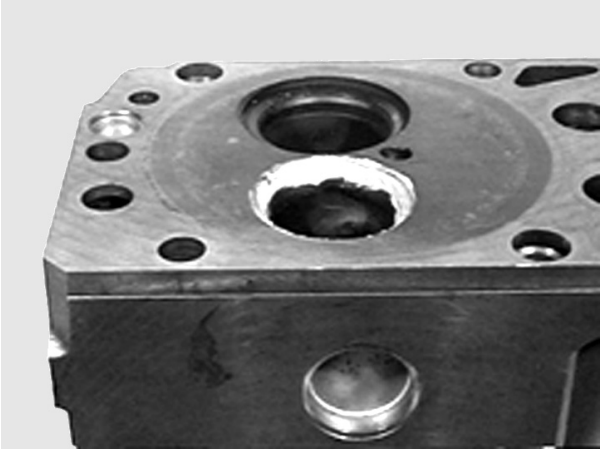
Ensure that the valve recess (X) is correct, see “Service Data”.



9

Fig. 1

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

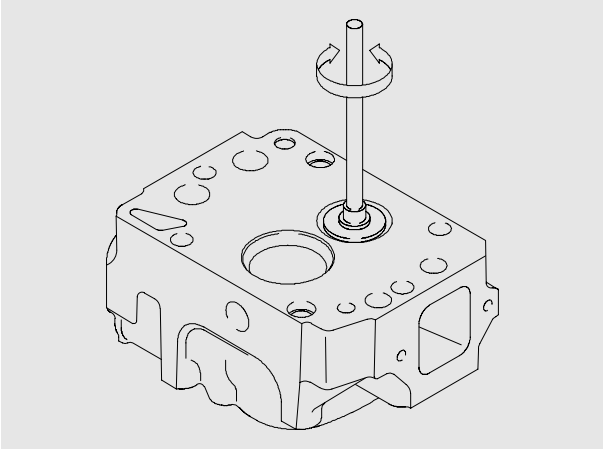


1

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.

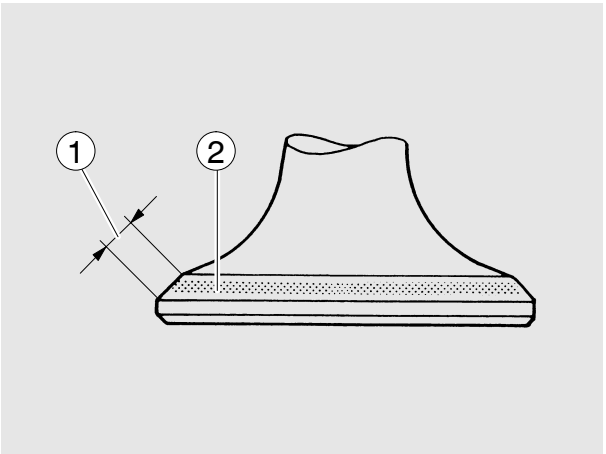


2

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

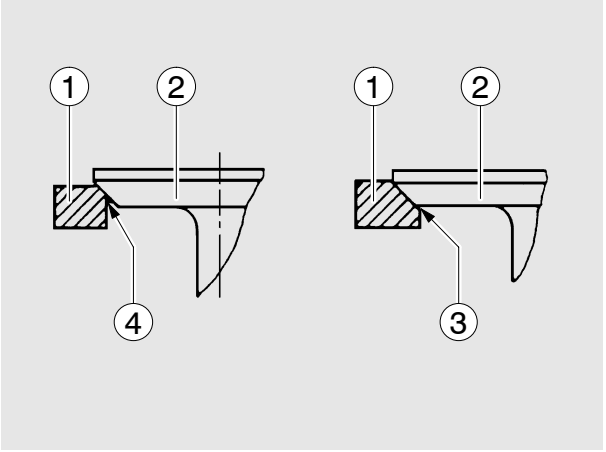


3

Fig. 4

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

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 –

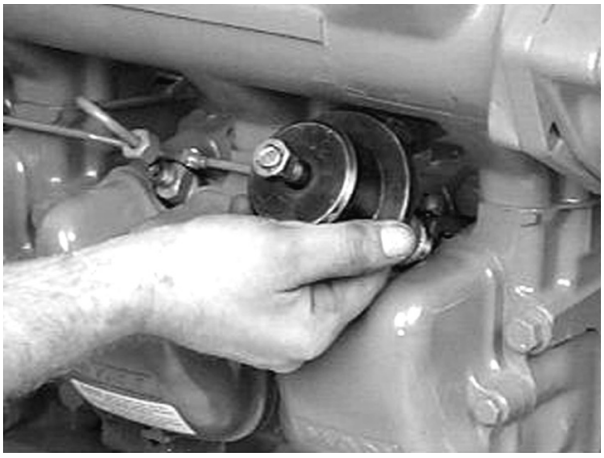


4

Fig. 1

- Check valve clearance and adjust, if necessary, see page 83
- Let engine run until coolant temperature reaches approx. 60–80°C
- Remove all fuel injectors, see page 31
- 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.



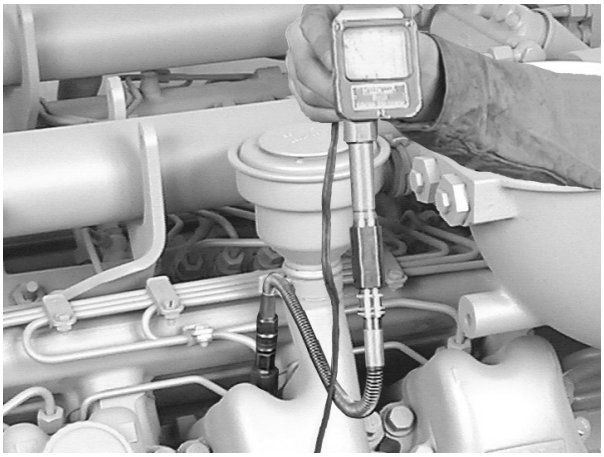
1

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.

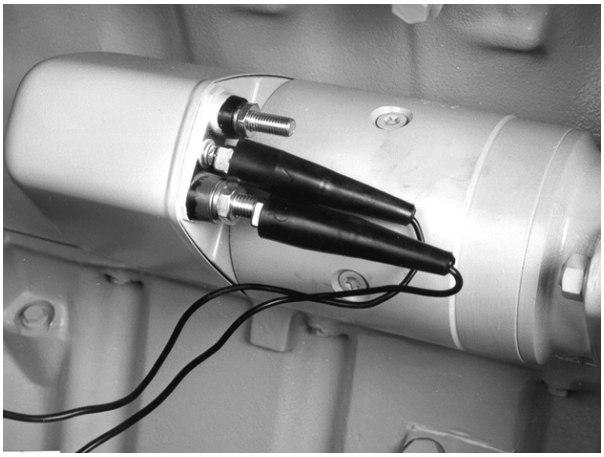


2

Fig. 3

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

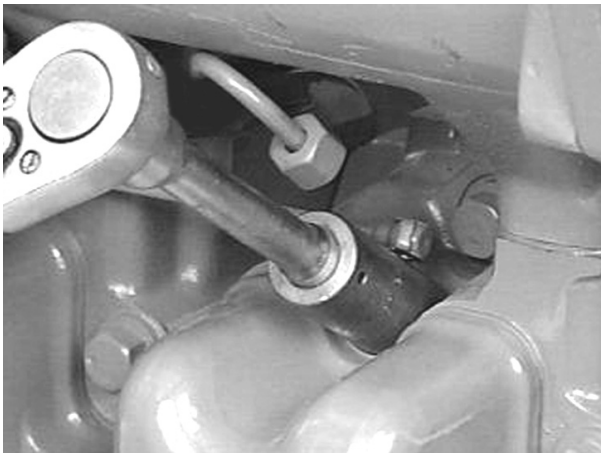
For this purpose the electrical connections on the starter electromagnetic switch (terminals 50 and 30) are to be accordingly connected up.



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 (see “Service Data”).
Connect up injection lines and leakage fuel return lines.



4

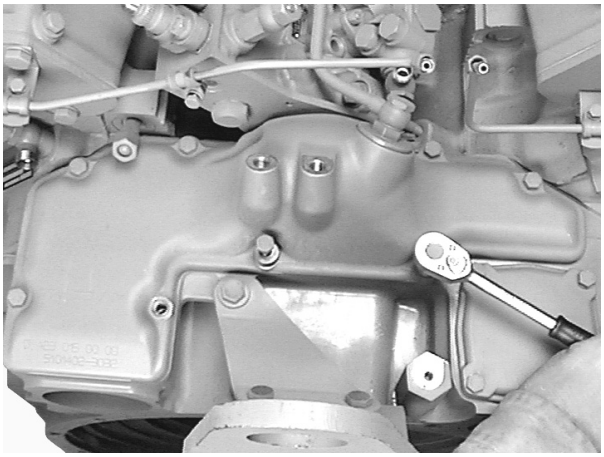
Removing timing case

- Remove starter, see page 117
- Removing flywheel, see page 66
- Remove fuel filter, see page 37
- If necessary removing air compressor, see page 121

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.

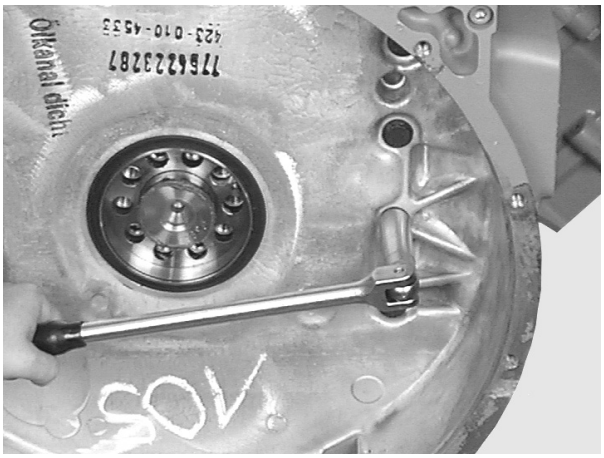


1

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

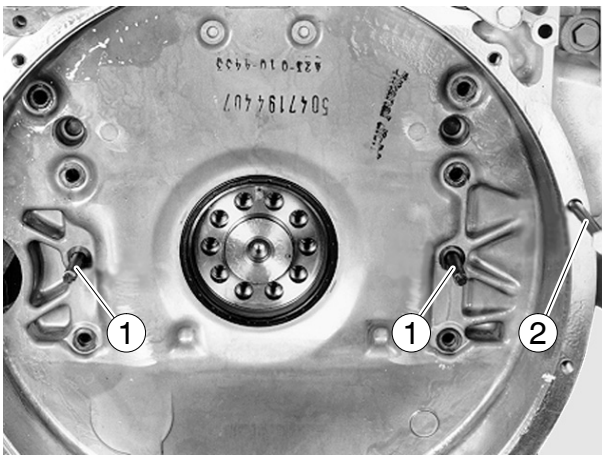
Fig. 3

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

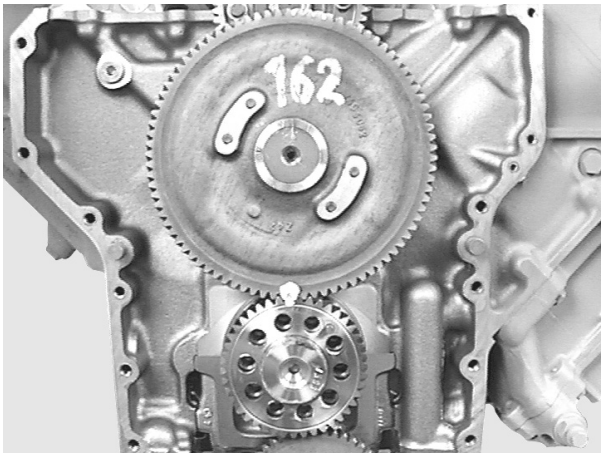
Installing timing case

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.



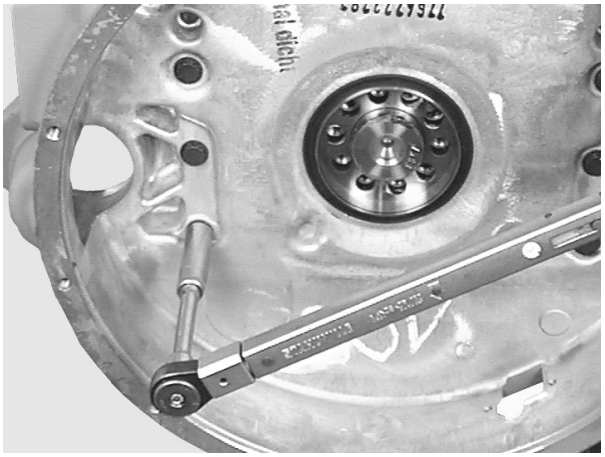
4

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

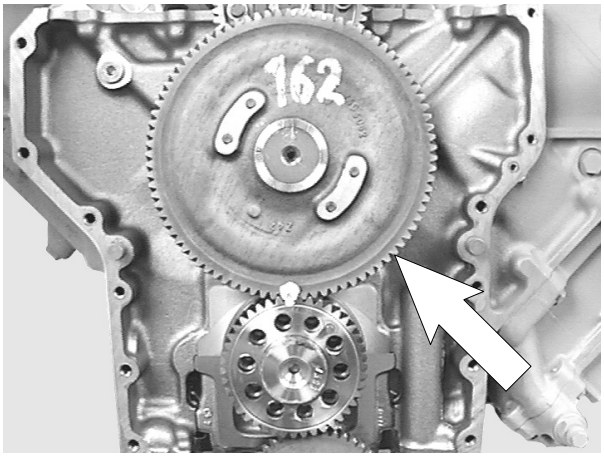
- Drain coolant, see page 40
- Remove oilpan, see page 56
- Remove starter, see page 117
- Remove flywheel and timing case, see page 66
- Remove the rocker arms and take out the push rods, see page 79

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.

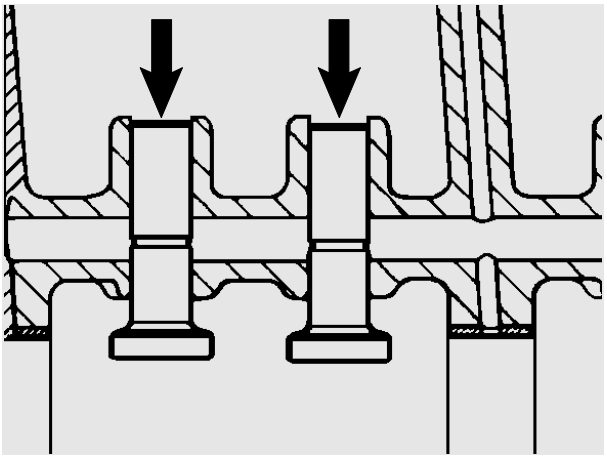


1

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

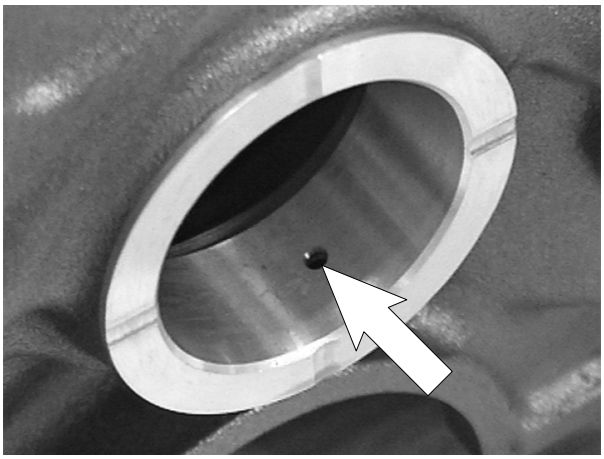
Exchanging camshaft bearings

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

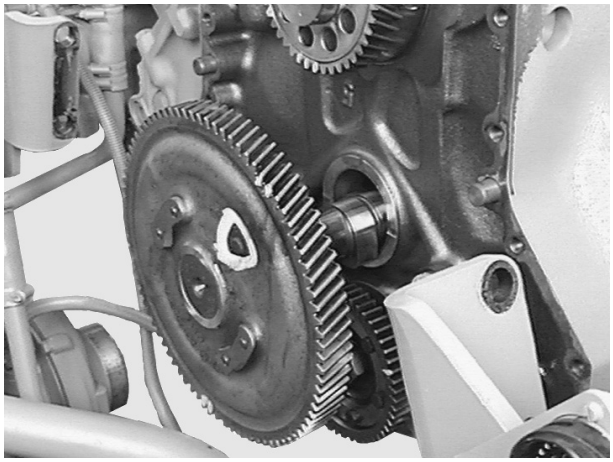
Installing camshaft

Fig. 4

Oil and insert the push rods.

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

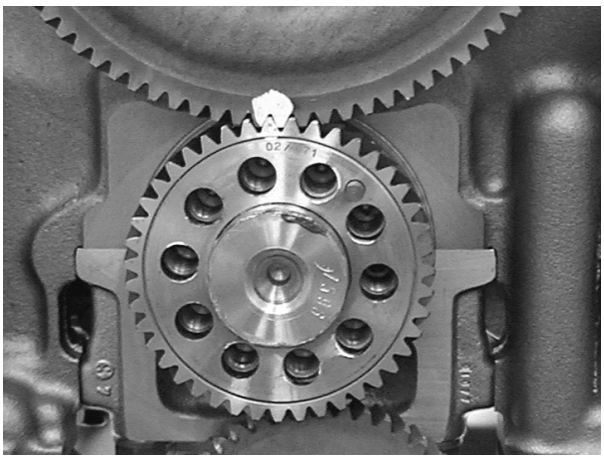
Caution:
Ensure that the bearings do not get damaged.



4

Fig. 5

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

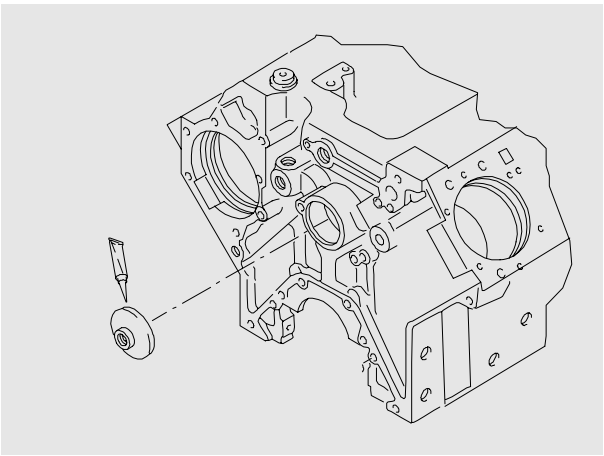


5

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.

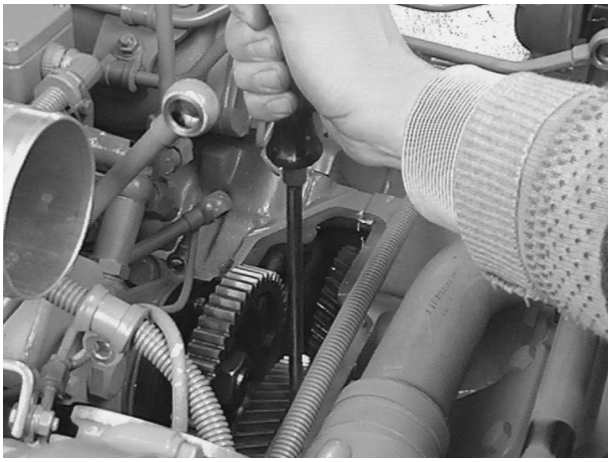
7

Fig. 8

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

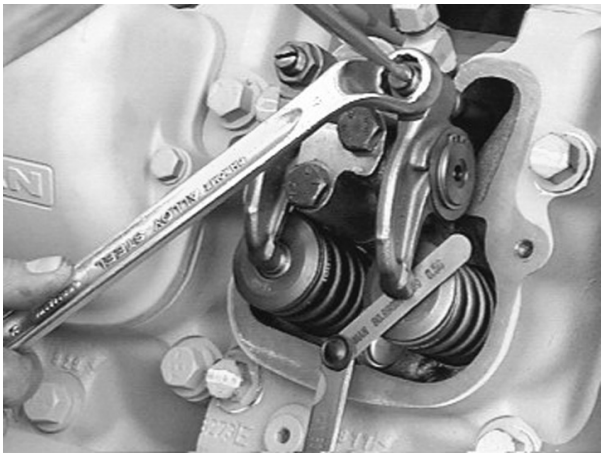
Push camshaft forwards against the dial gauge feeler until stop is reached. The dial gauge reading equals the camshaft axial play.

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



8

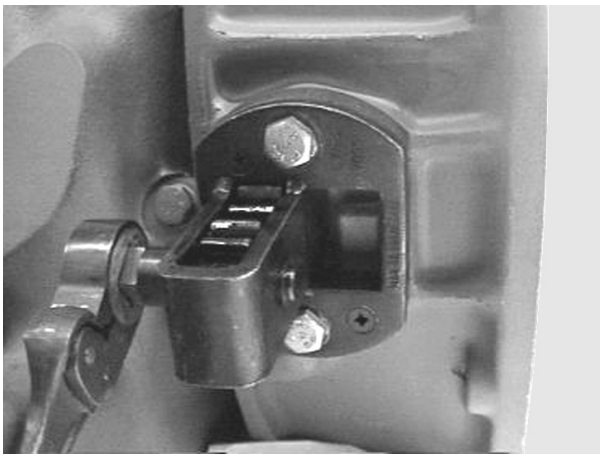
Note:
If the valve timing is incorrect, serious damage to the engine may result.
For this reason, if faults occur in the engine which could lead to the shrunk-fitted camshaft gear turning, check that the gear is correctly seated by checking the valve timing.
Carrying out a check after installation of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



1

Fig. 1

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

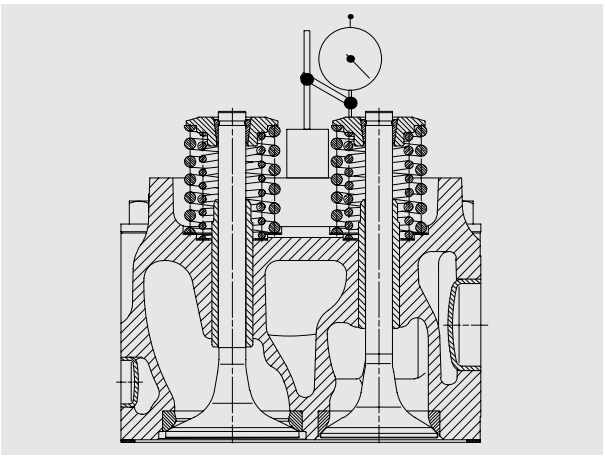


2

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).



3

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.

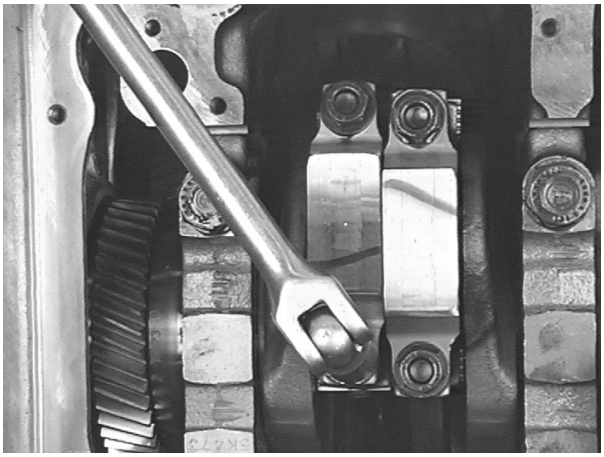
The valve stroke must be between
4.5 and 5.4 mm.

Removing crankshaft

- Remove oil pan and oil pump, see page 56
- Remove timing case, see page 97
- Remove front cover with crankshaft seal, see page 62

Fig. 1

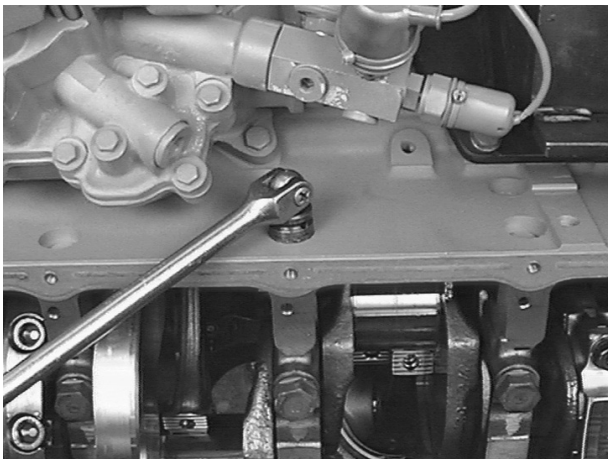
Remove the bolts from the connecting rod bearing covers and put the covers aside, arranging them in the sequence of installation.
Removing piston with connecting rod, see page 106.



1

Fig. 2

Remove horizontal bolts from crankshaft bearing caps.



2

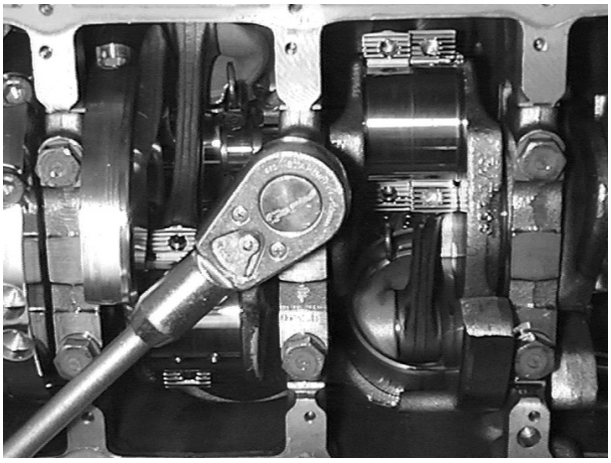
Fig. 3

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.



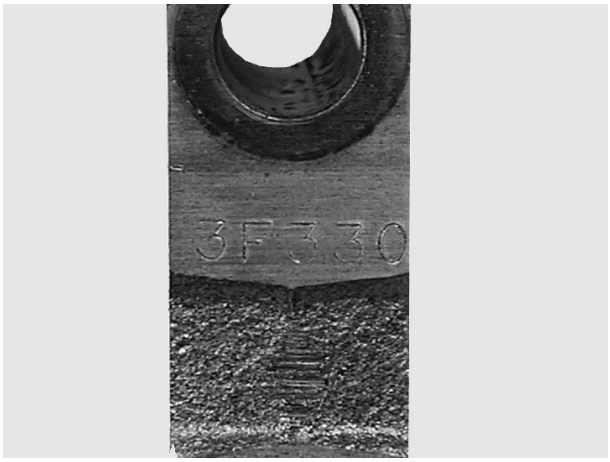
3

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.

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.



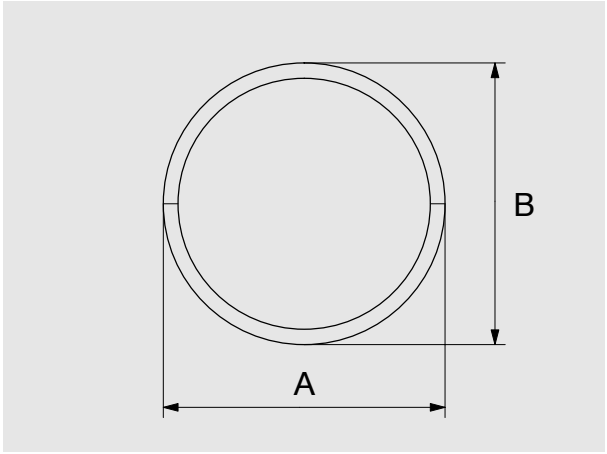
4

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

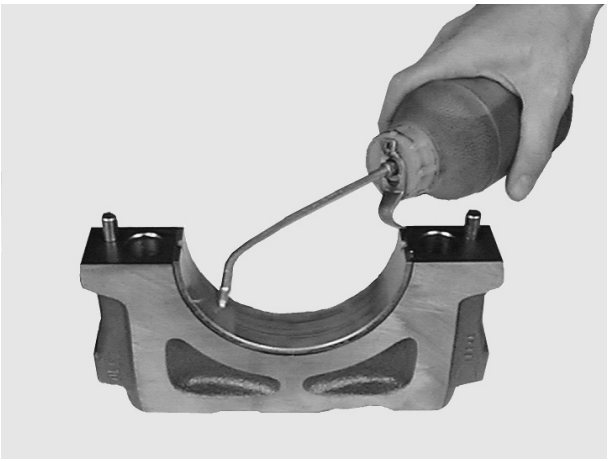
Fig. 6

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.


6

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

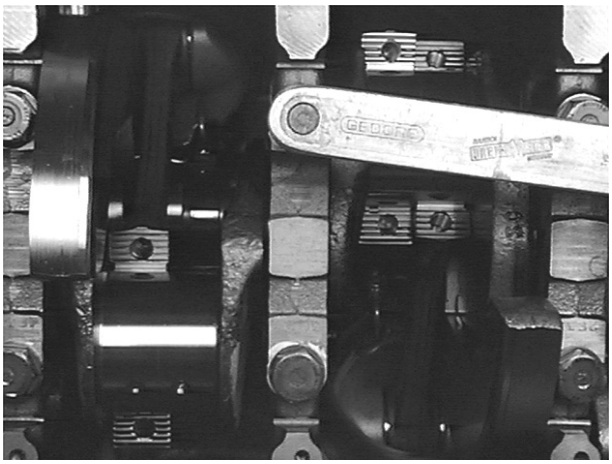
Figs. 7 and 8

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 (see “Service Data”).

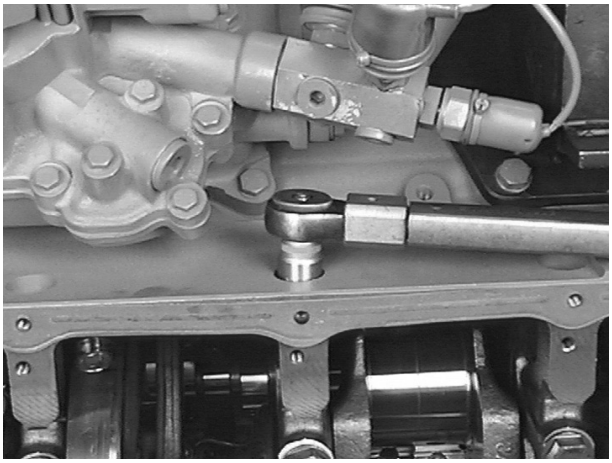
Tighten finally by angle.

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.


8

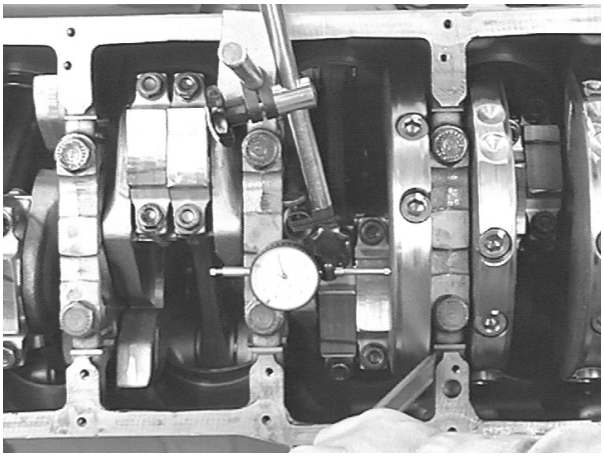
Caution:
Faulty bearing caps cannot be replaced singly.

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.

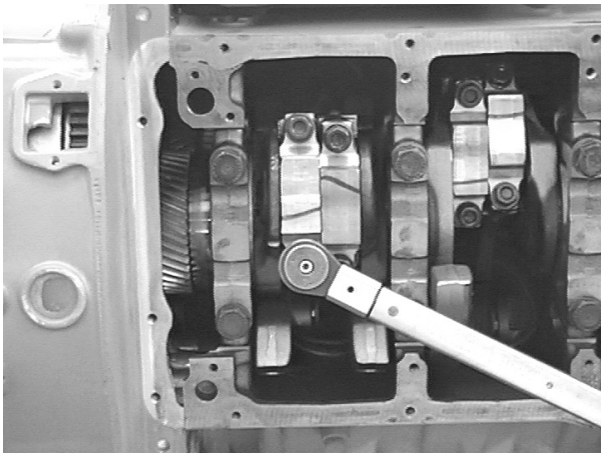
Mount connecting rod bearing caps with bearing shells (observe marking - numbers must be on the same side).

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.



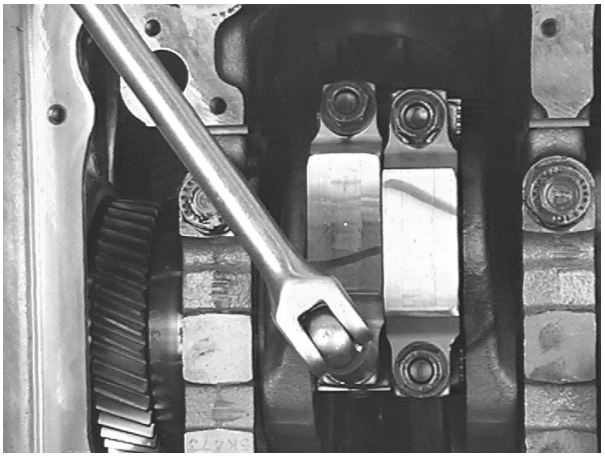
10

Removing piston with connecting rod

- Drain engine oil, see page 56
- Removing cylinder head, see page 79

Fig. 1

Remove bolts from connecting rod bearing cap.



1

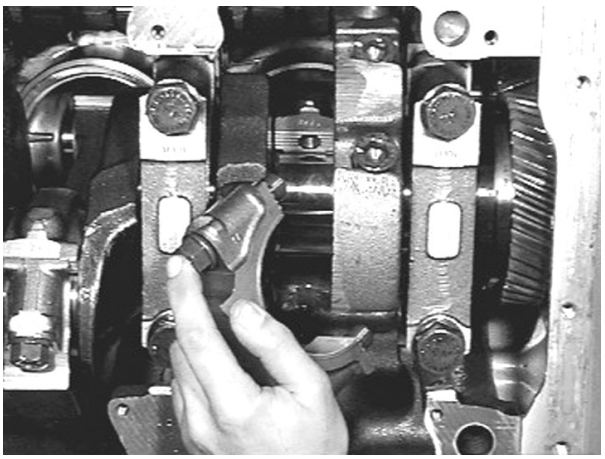
Fig. 2

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.

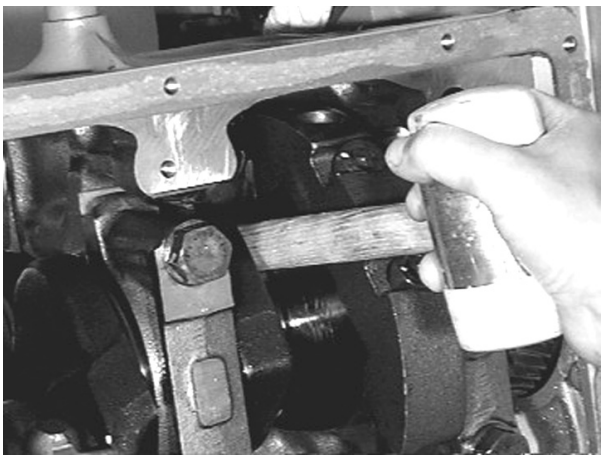


2

Fig. 3

Push out connecting rod with piston in upward direction.

Caution:
Do not damage oil spray nozzles.

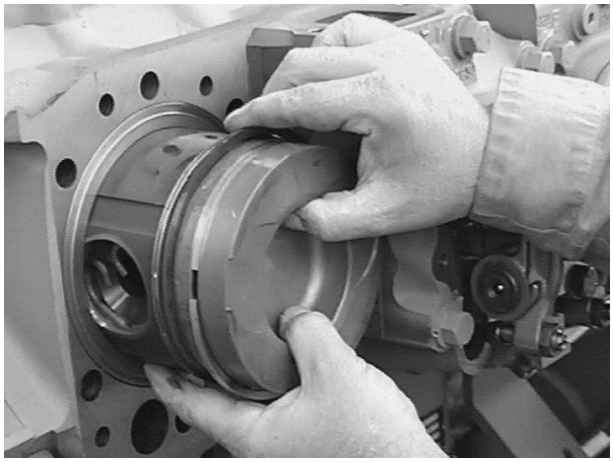


3

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”).

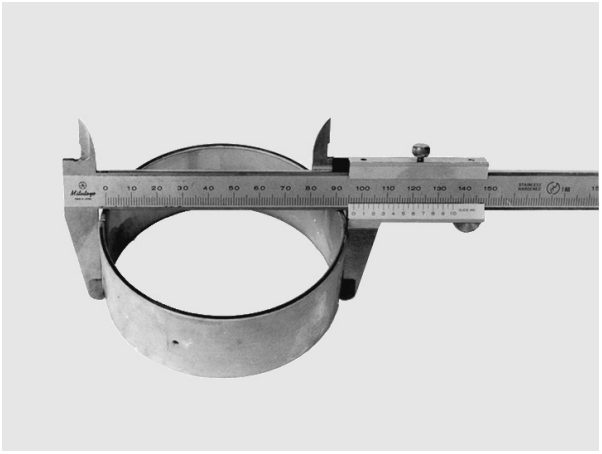


4

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.

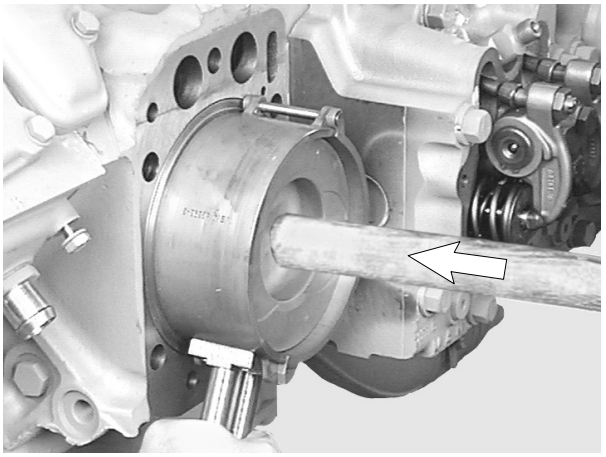
The top coat must not be damaged.
Apply a thin coat of oil to the connecting rod bearing shells.

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.

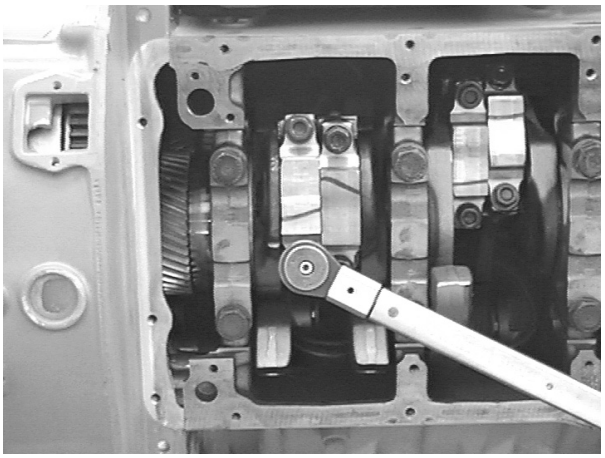
10

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”.)



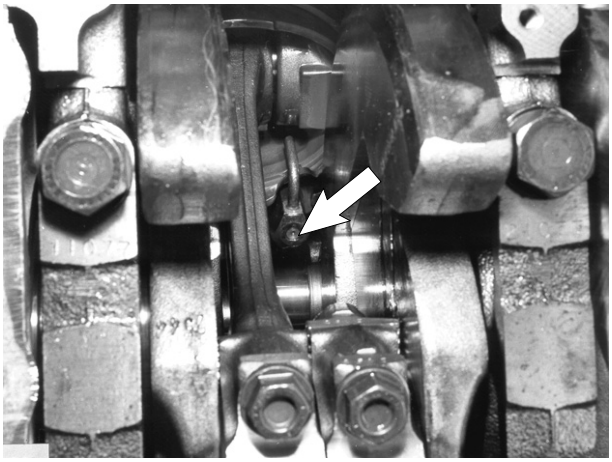
11

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.

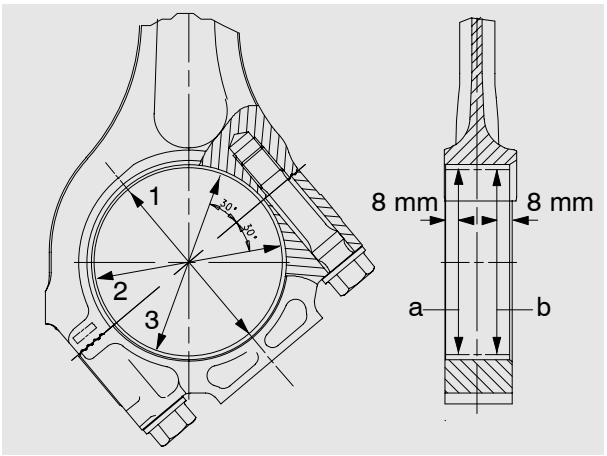
2

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.

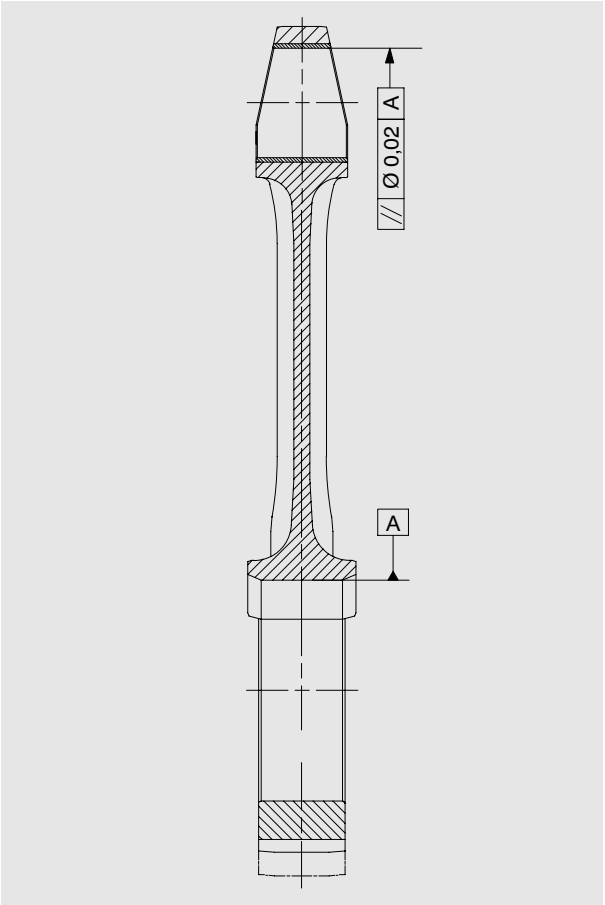
If the bushes are worn, install reconditioned connecting rod.

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

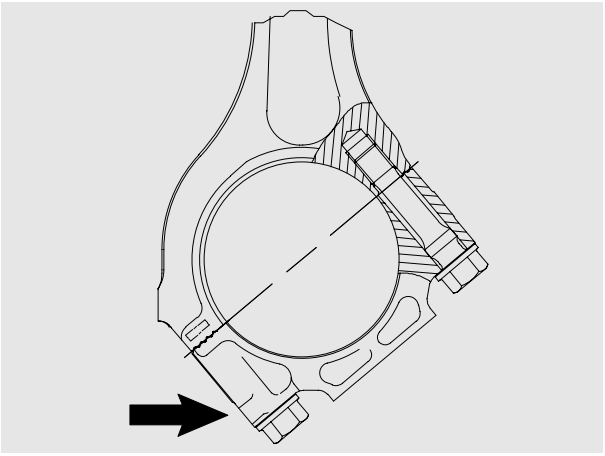
Figs. 6 and 7

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 107.

6

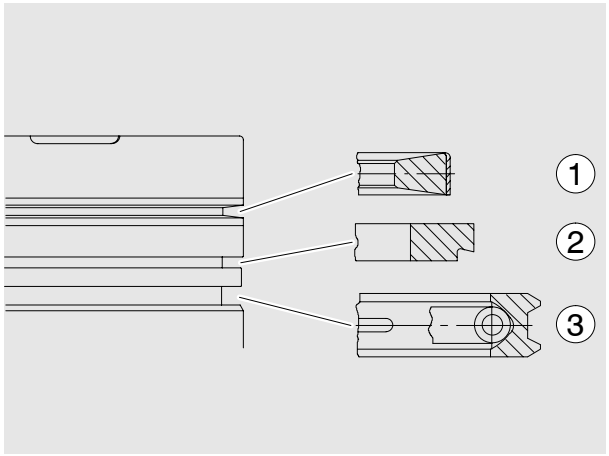


7

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)



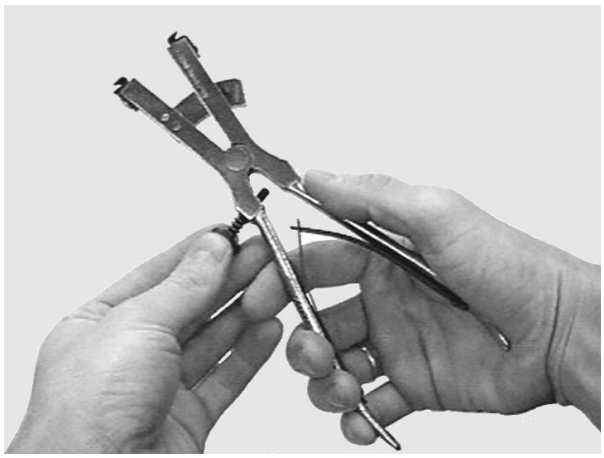
1

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.

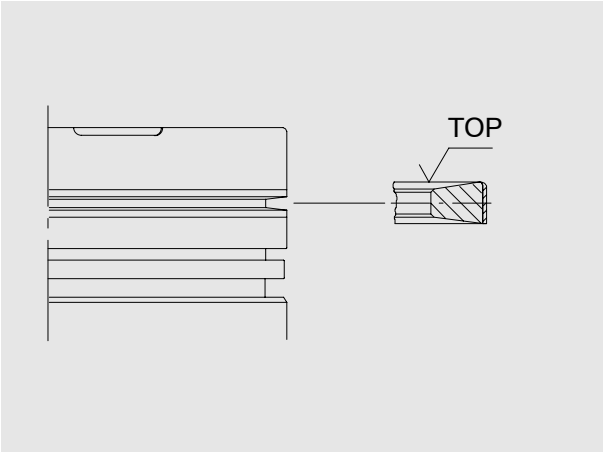
For ring gap see “Service Data”.

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 “Service Data ”).

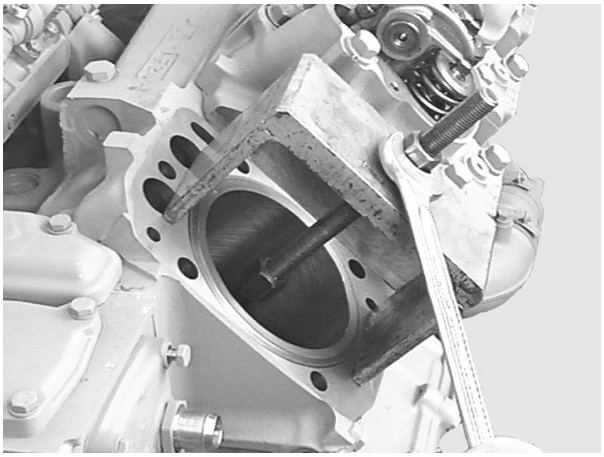
- Remove cylinder head, see page 79
- Remove pistons, see page 106

Fig. 1

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

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.

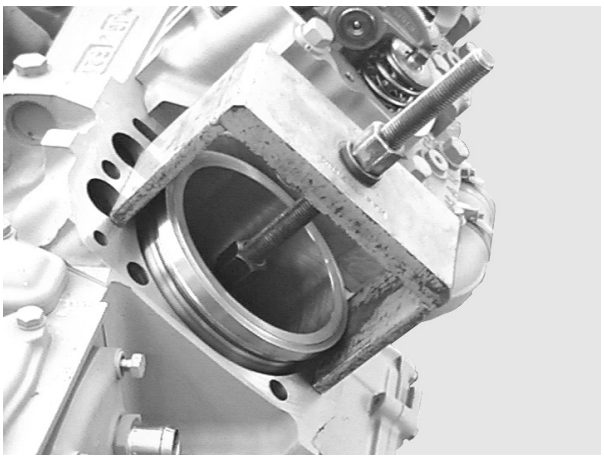


1

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

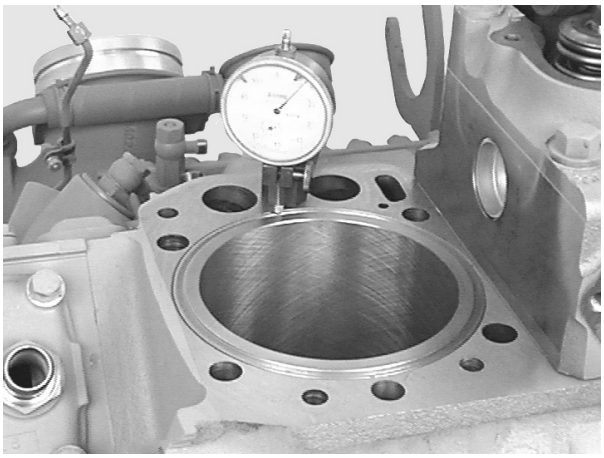
Fig. 4

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.



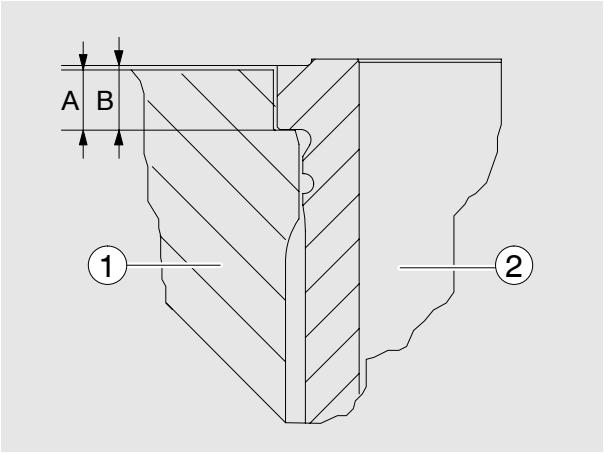
4

Fig. 5

Note:
After fitting the cylinder liners 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.

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



5

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.

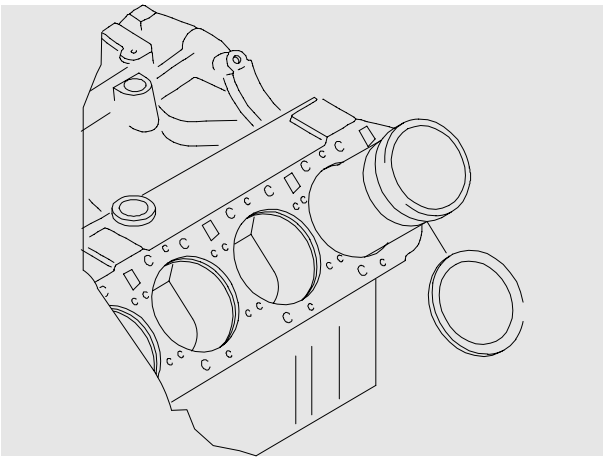

6

Fig. 7

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

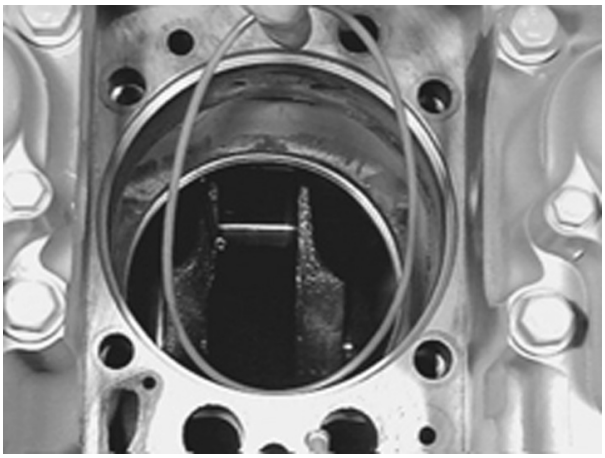

7

Fig. 8

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

Do not overstretch the O-rings.


8

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.

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

9

Measuring piston protrusion

Fig. 1

Remove cylinder heads.
Move piston to be measured to TDC.

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

1

Fig. 2

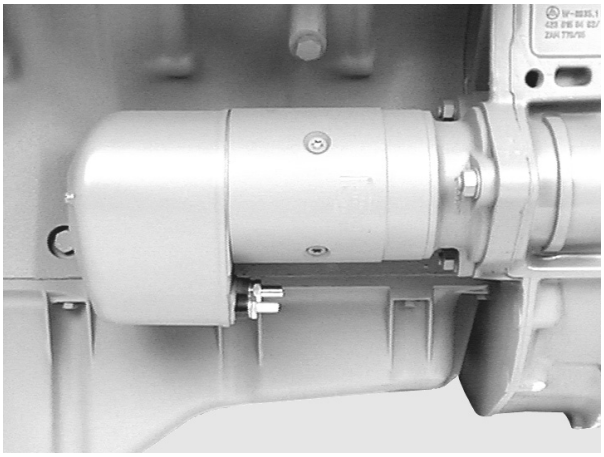
Carefully slew dial gauge holder round, lifting the dial gauge tip as you do so.

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.

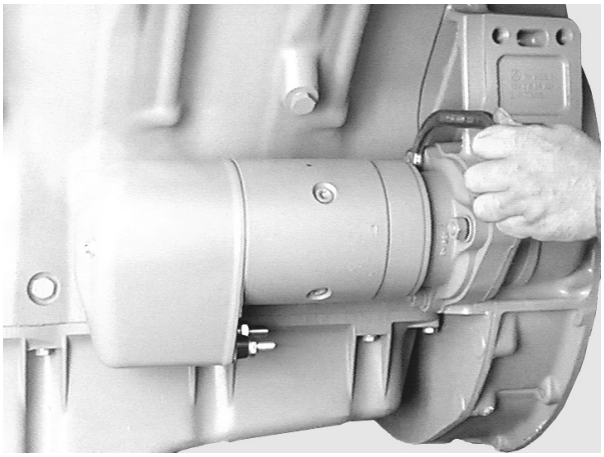


1

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 67.

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.

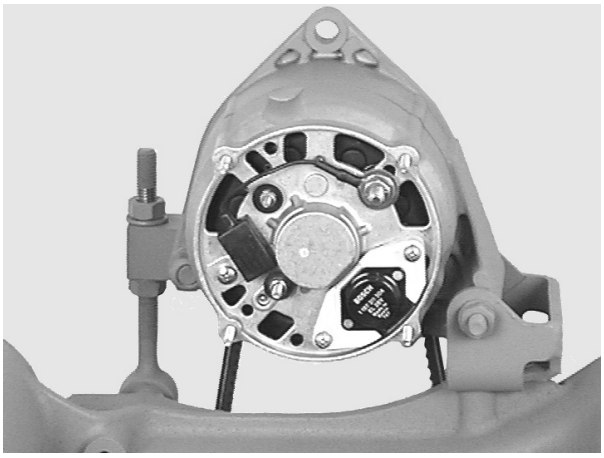
Connect up battery or switch on battery main switch.
After installation check starter to see that it works properly.

Removing alternator

- Relax V-belt and take it off the alternator pulley, see page 120
- Disconnect earth cable from battery

Fig. 1

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



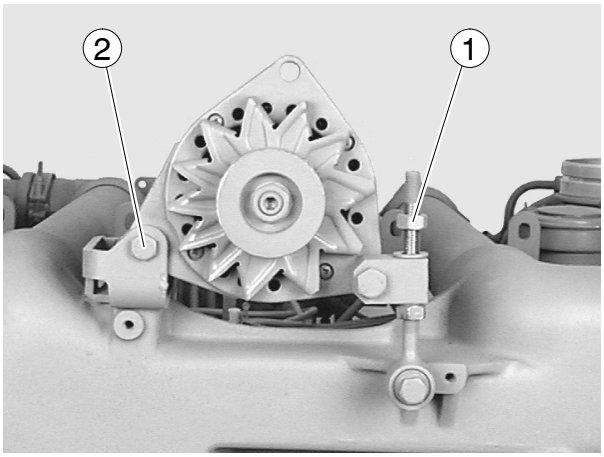
1

Alternator – top-mounted

Fig. 2

Remove lock nut ①.

Remove mounting bolt ② from bracket and take off alternator.



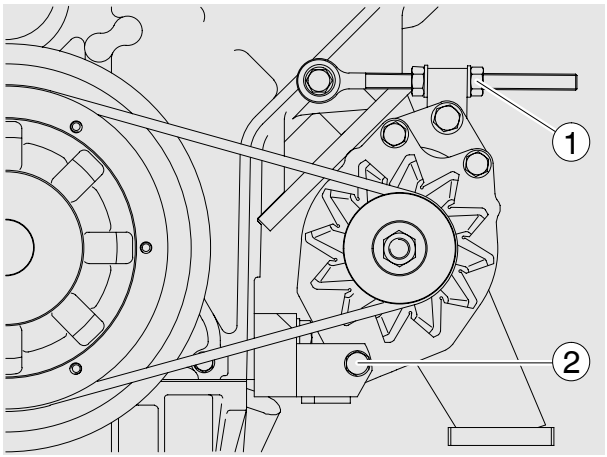
2

Alternator – mounted on bottom right-hand side

Fig. 3

Remove lock nut ①.

Remove mounting bolt ② from bracket and take off alternator.



3

Attaching alternator

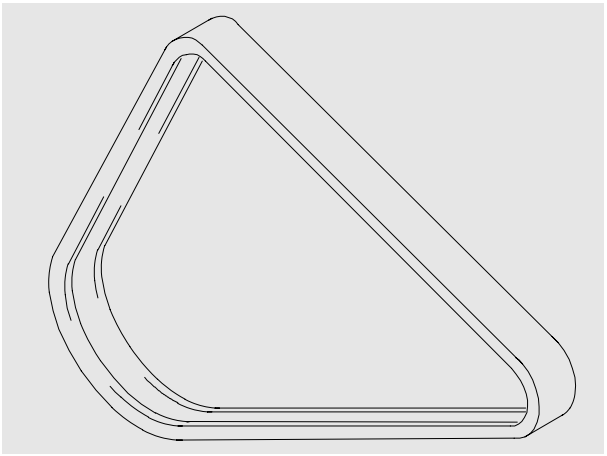
The alternator is attached in reverse sequence to the removal procedure; ensure that the cable terminals do not get mixed up.
Check and if necessary correct alignment of the V-belt pulleys with each other.
Tighten the mounting bolts to the specified torque.
Tension the V-belt.

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

Checking condition

Fig. 1

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



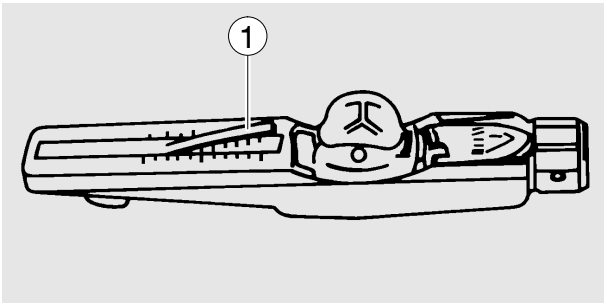
1

Checking tension

Fig. 2

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

- Lower indicator arm ① into the scale

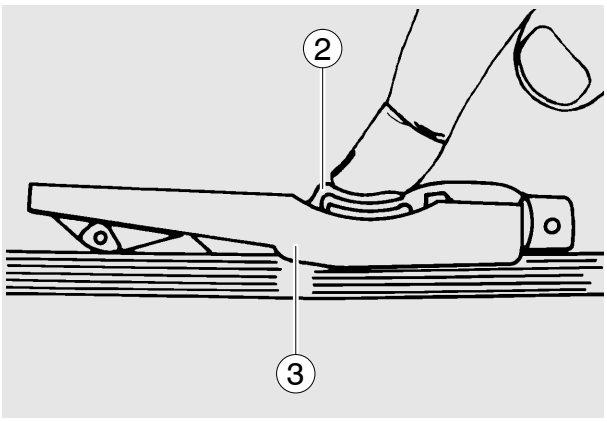


2

Fig. 3

- 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!



3

Reading of tension

Fig. 4

- Read of the tensioning force of the belt at the point where the top surface of the indicator arm 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 tester		
	New installation		When servicing after long running time
	Installation	After 10 min. running time	
2/3VX	90–100	70–80	60
4/3VX	180–200	140–160	120

4

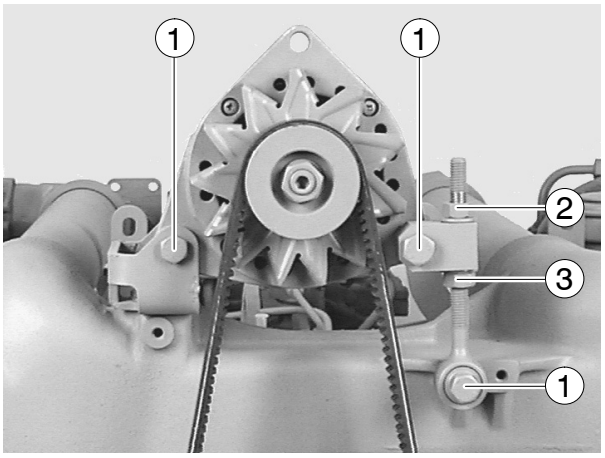
Tensioning / exchanging V-belt

Alternator – top-mounted

Fig. 5

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

To replace the V-belts loosen lock-nut and swing alternator inwards.



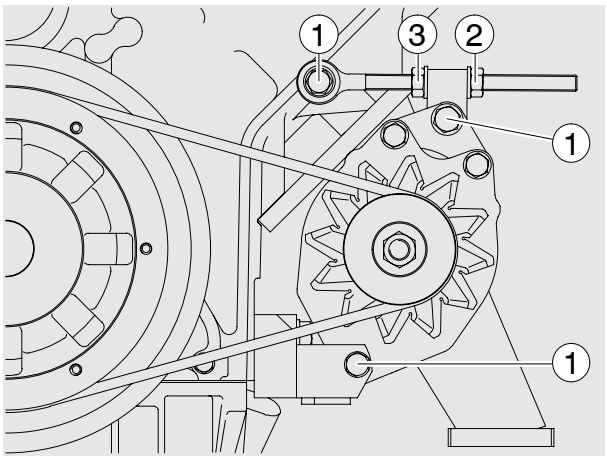
5

Alternator – mounted on bottom right-hand side

Fig. 6

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

To replace the V-belts loosen lock-nut and swing alternator inwards.



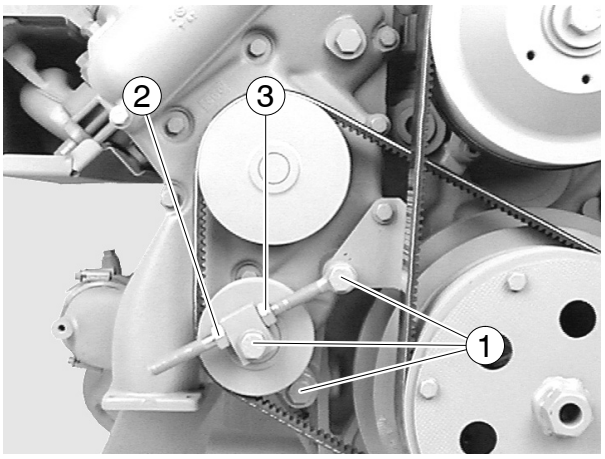
6

Crankshaft – water pump – tension pulley

Fig. 7

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

To replace the V-belts loosen lock-nut and swing alternator inwards.



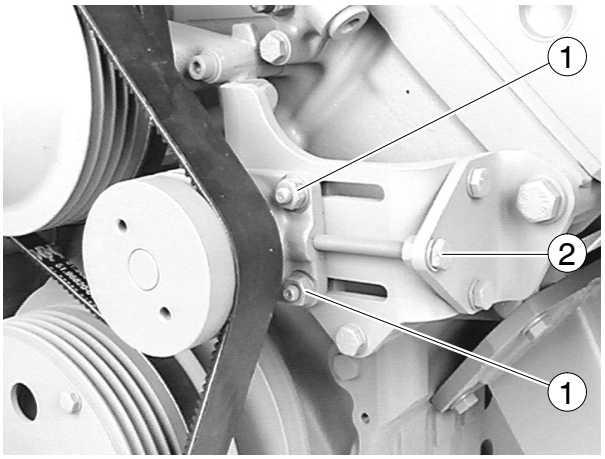
7

Crankshaft – tension pulley – fan

Fig. 8

- Remove mounting nut ①
- Turn setting screw ② in clockwise direction until the tension of the V-belts is correct
- Retighten mounting nut

To change the V-belts turn the setting screw anti-clockwise.



8

Removing air compressor

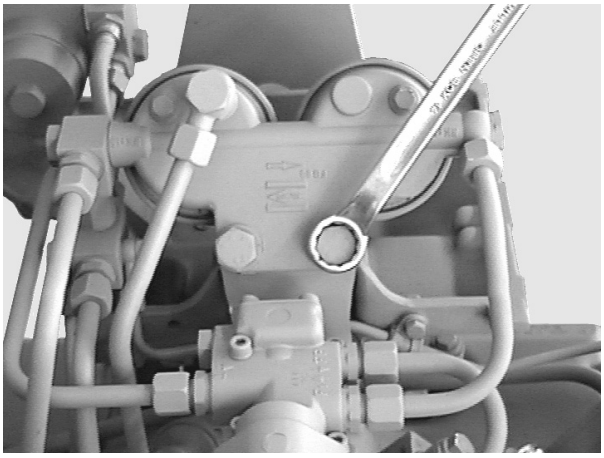
Fig. 1

Remove fuel filter.

Close cut-off valve from fuel tank to engine.

Remove all fuel lines from fuel filter and take off fuel filter complete with EHAB.

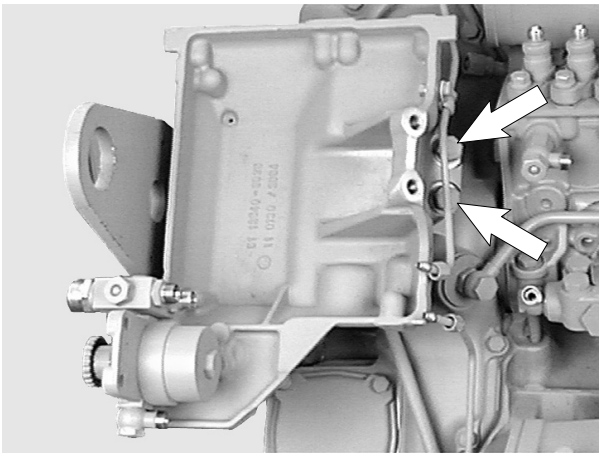
Caution:
The filter cartridges contain fuel.
When putting aside the filter, catch emerging fuel in a suitable container.



1

Fig. 2

Remove container together with fuel hand pump too.



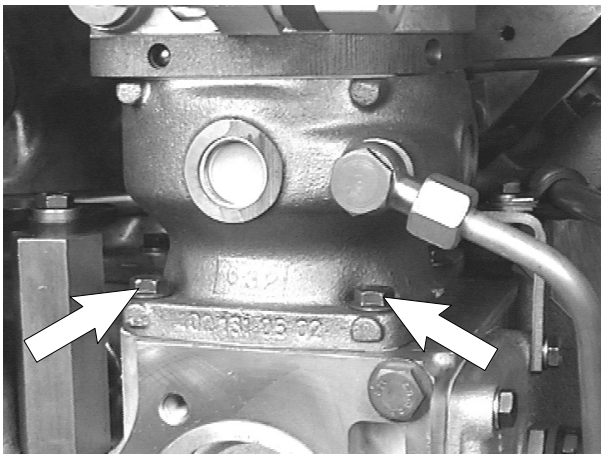
2

Fig. 3

Remove oil pressure line, air intake line and compressed-air line.

Remove the coolant lines.

Remove the four mounting bolts and take off air compressor.



3

Attaching air compressor

Fig. 4

Thoroughly clean the sealing faces on air compressor and timing case.

Screw in the mounting bolts and tighten them to specified torque.

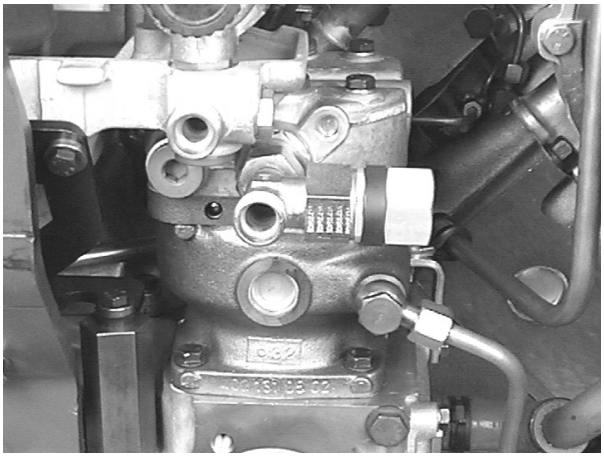
Refit the coolant lines.

Refit oil pressure line, air intake line and compressed-air line.

Top up with coolant and check engine oil level.

Refit all parts previously removed.

Check all lines previously removed to see whether they leak.



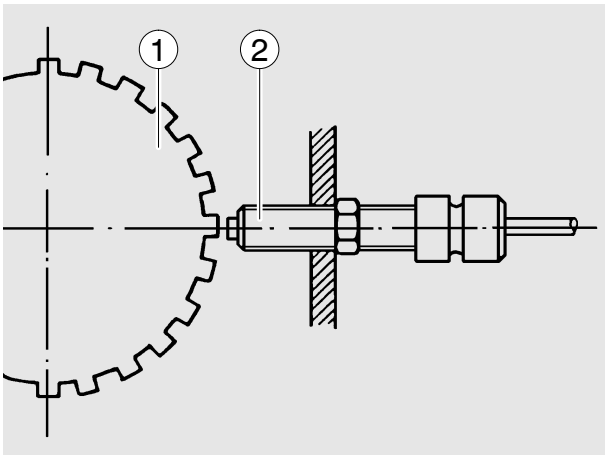
4

Basic design

An electronic control system consists of three components:

1. Speed pickup

   In MAN engines the speed pickup ②, which works according to the induction principle, is located on the flywheel housing. It consists of a permanent magnet surrounded by a coil.
   Depending on whether a tooth of the starter gear ring ① is before the magnet or not, the magnetic field changes and induces in the coil an alternating voltage which is proportional to the engine speed and serves as input signal for the control unit.



2. Electronic control unit

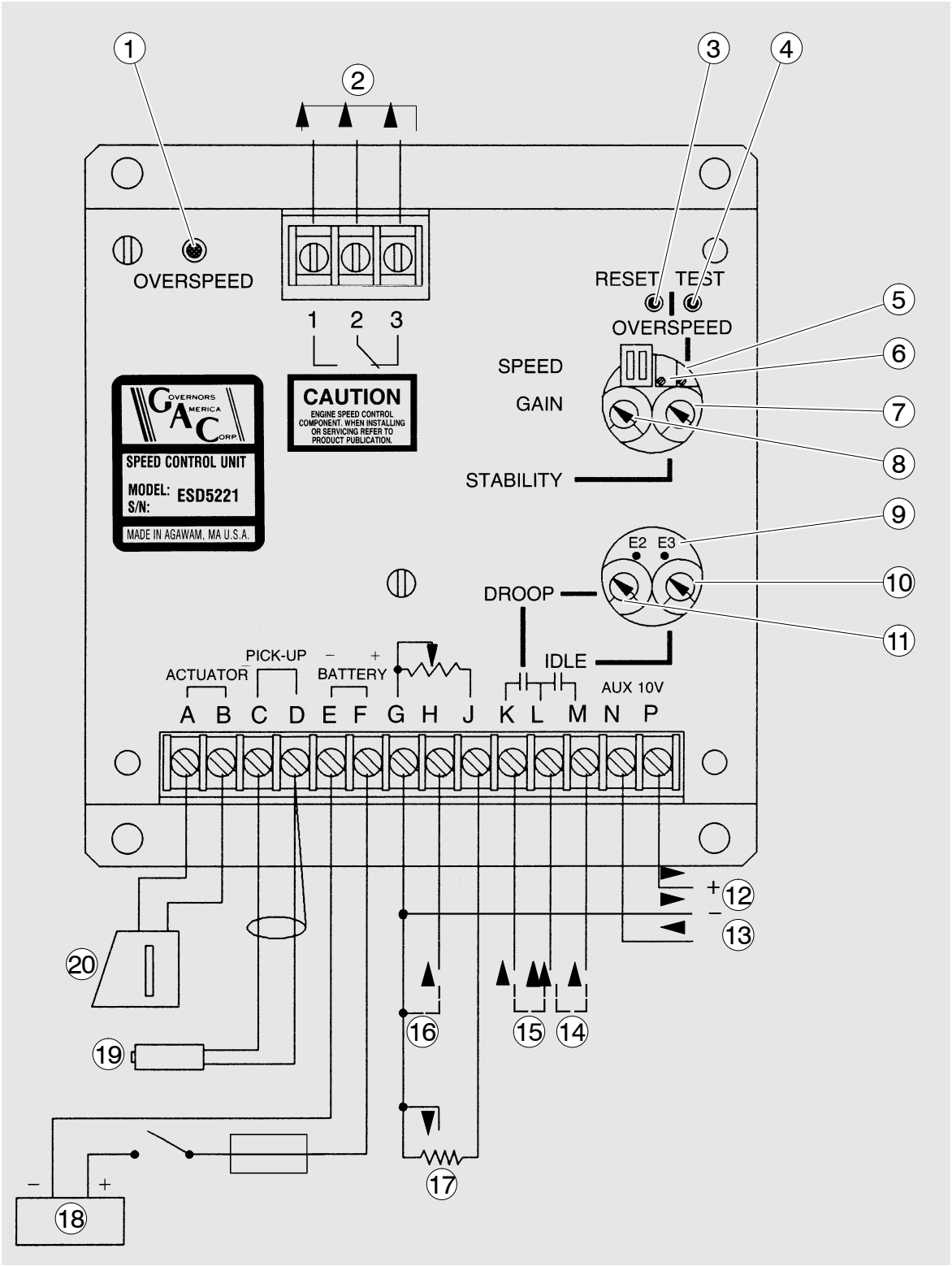
   The electronic control unit receives the signal (actual value) generated by the pickup and compares it with a preset value (nominal value).
   If the actual and the nominal values are identical, the electronic control unit will generate an output signal with which the final control element will be triggered.

3. Final control element

   In GAC governors, for example, the final control element is a spring-loaded linear solenoid.
   This solenoid is connected to the control rod of the injection pump and changes its position according to the signal from the control unit. As a result, the injection quantity and, consequently, engine speed are controlled.

Electric control unit

The GAC ESD 5221 electronic speed governor is used as an example here to give a general overview of the possibilities provided by this control system and to show what characteristic data can be set or altered. When installing and commissioning, please heed without fail the Operator's Manual for the respective control unit model.



1 LED display for electronic overspeed control

2 Output contacts “Overspeed” LED display for overspeed

3 Overspeed reset button: initial position of the relay contacts after overspeed signal has been sent. Resetting can also be effected by briefly interrupting the battery power supply

4 Overspeed test button, lowers the switching point by approx. 12 %

5 25-step potentiometer: setting of overspeed. Let engine idle, press test button and simultaneously turn it left until engine stops and the display comes on

6 25-step potentiometer: setting of rated speed

7 Setting of stability

8 Setting of sensitivity

9 Additional assistance for stability improvement. In the event of very slow pendulum motion, set 10 - 20 mF condensator from E3 to E2

10 This makes it possible to set the lower idling speed limit if “L” and “M” are connected

11 Setting the P degree if “L” and “K” are connected

12 Stabilised voltage 10 V for triggering additional modules

13 Input for signals from synchroniser, load divider, smoke limiter etc.

14 Connect “G” and “H” only if a high P degree (10 %) is required

15 Operation at low idling speed if L and M are connected

16 P degree if “K” and “L” are connected

17 Speed precision setting (only required for remote control)

18 Battery

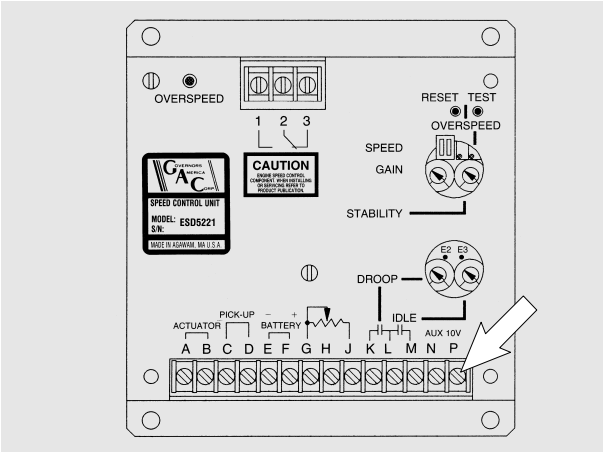
19 Pulse generator

20 Final control element

Caution:
Except in emergency cases, the engine must **never** be switched off by interrupting the cables for the final controlling elements, but only by interrupting the battery supply.

Fig. 1

The control unit is equipped with a terminal strip for the connections of the output and input signals.



1

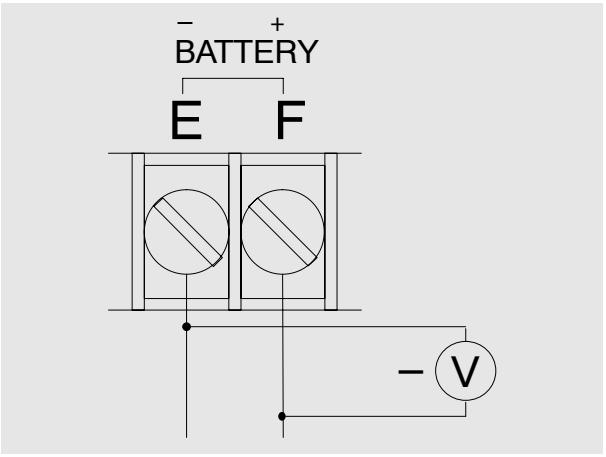
Checking procedure: Engine does not start.

Fig. 2

Check battery voltage on control unit during starting procedure.

Min. value: 17 V direct voltage

Otherwise exchange battery or reduce voltage drop in the supply line.



2

Figs. 3 and 4

Check speed pickup signal on control unit during starting procedure.

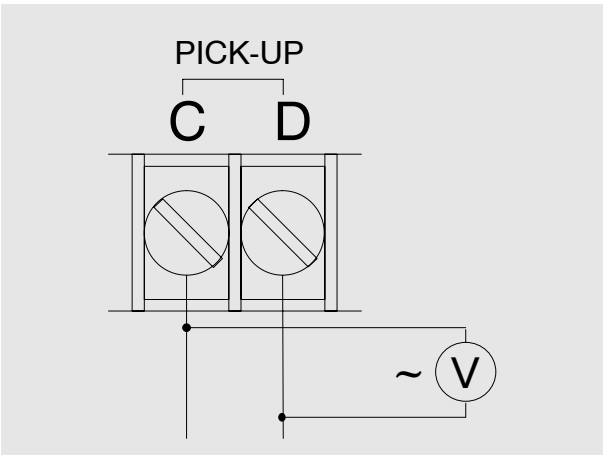
Min. value: 0.8 V alternating current

Otherwise check distance “d” of speed pickup, if necessary correcting it, see page 127.

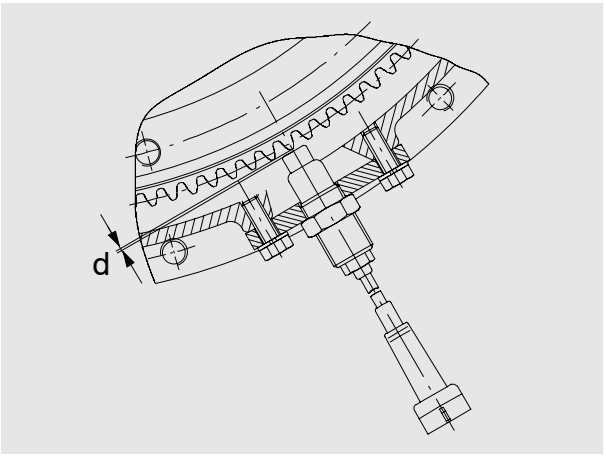
If distance “d” is correct, but the voltage still too low, disconnect cable from terminals “C” and “D” on the control unit and measure the resistance between both cables.

Correct value: 150 - 200 Ω

If value deviates, exchange speed pickup.



3



4

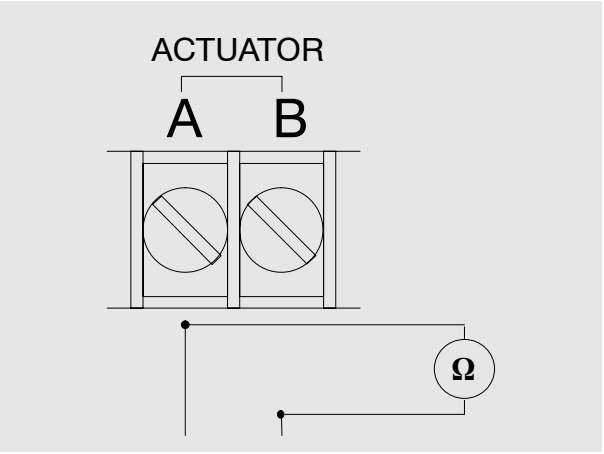
Fig. 5

Check final controlling element.

Remove both final controlling element cables from control unit and measure resistance.

Correct value: 4,6 - 5 Ω

If value deviates, check cabling and plug. If cabling and plug are in order, exchange final controlling element.

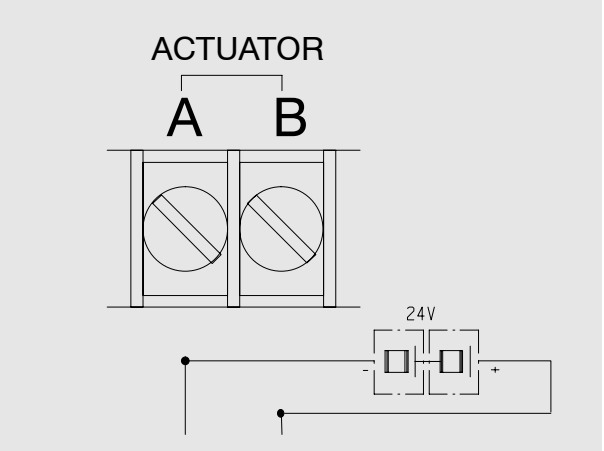


5

Fig. 6

If resistance as per Fig. 5 is in order, connect both cables to battery voltage. The final controlling element must then switch to max. position.

If it does not, the transmission linkage to the injection pump control rod or the control rod itself is blocked.
If linkage is in order, exchange final controlling element.



6

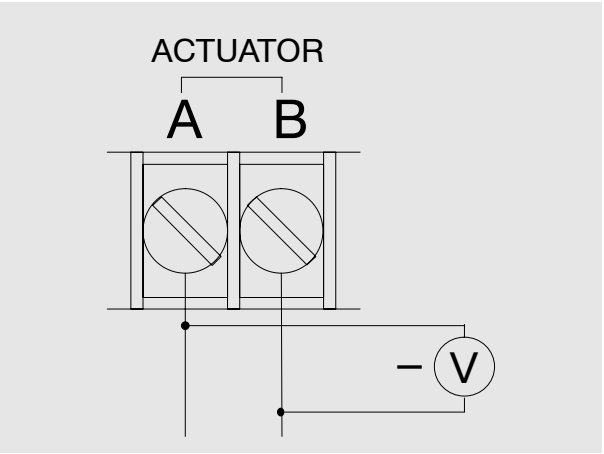
Fig. 7

If final controlling element is in order, but still fails to move during the starting procedure, the output voltage at the final controlling element terminals of the control unit are to be checked during the starting procedure.

Min. value: 17 V direct voltage

If no voltage is present, the control unit is defective.

Caution:
Before installing a new control unit, always check the cabling and the final controlling element circuit for short circuits.

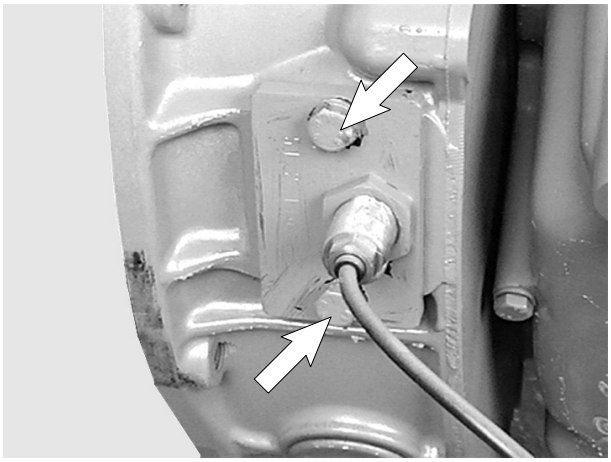


7

Fig. 1

The speed pickup is fitted to the bottom right-hand side of the flywheel housing.

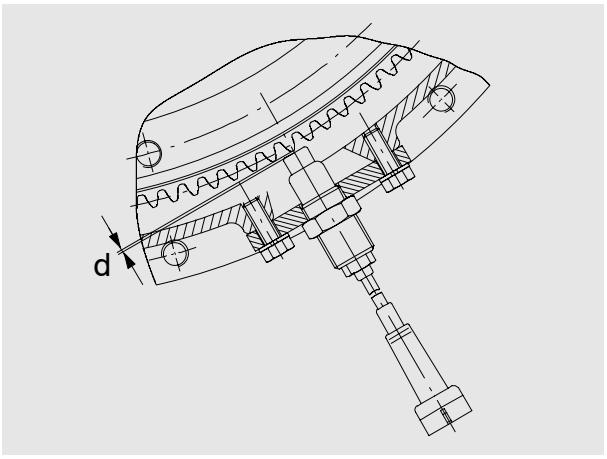
To remove it, disconnect cable from terminal, remove the mounting bolts from the retaining plate and take it off together with the speed pickup.



1

Fig. 2

After the installation, distance “d” between the speed pickup and the gear ring of the flywheel must be checked and, if necessary, readjusted.

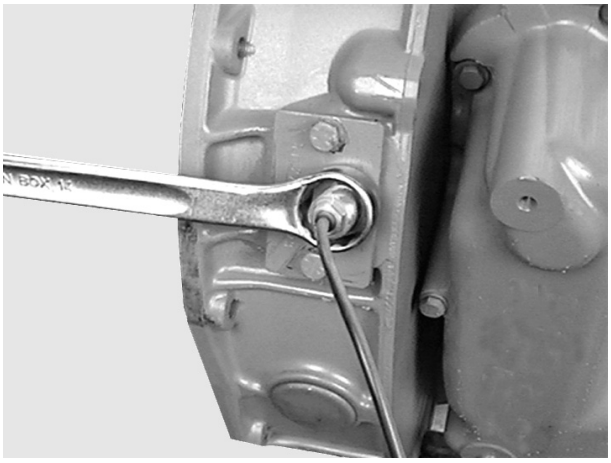


2

Fig. 3

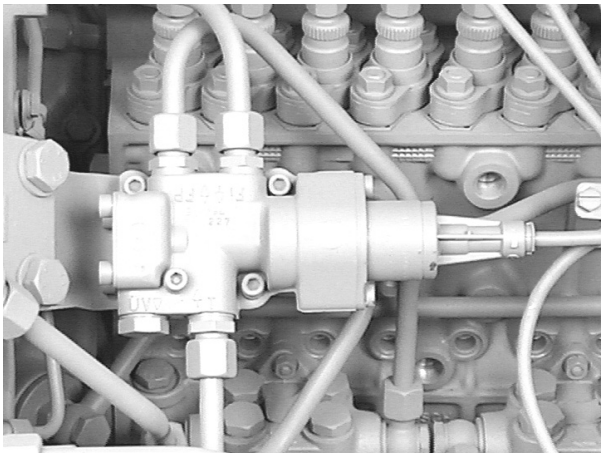
To do so, proceed as follows:

- Loosen counter nut and unscrews speed pickup
- Turn gear ring so that one tooth is in centre position relative to the thread bore
- Screw in speed pickup until it stops
- Turn it back by one revolution and fit counter nut

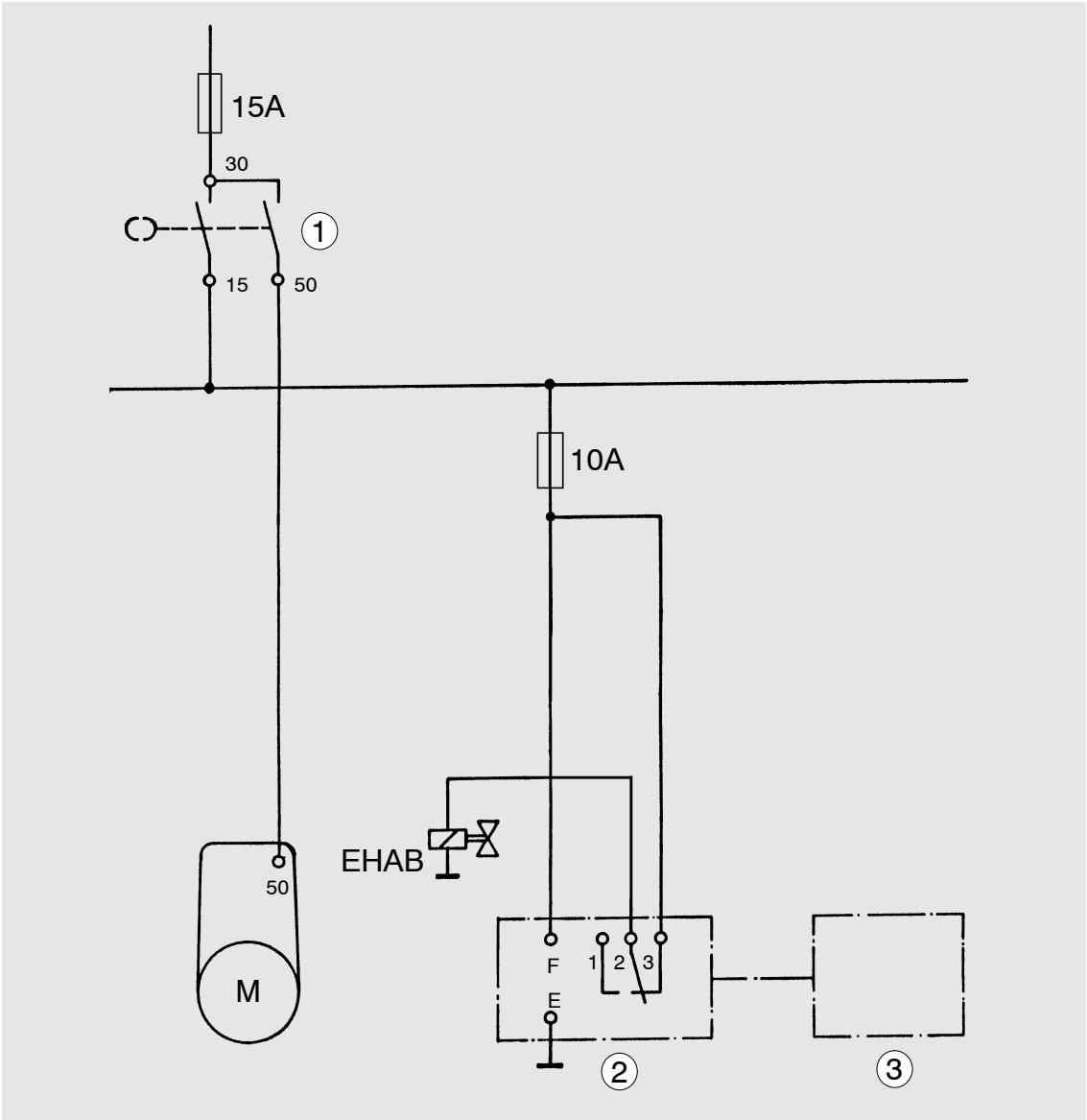


3

If an electronic speed governor is used, an overspeed protection independent of the governor must be provided.
For this purpose an electromagnetic shut-off valve (EHAB) is installed in the fuel supply line to the injection pump. If the governor fails, this valve will shut off the fuel supply, thus preventing the engine from revving up in an uncontrolled manner.



Proposal for the circuitry of an electromagnetic shut-off valve



1 Starter lock

2 GAC control unit

3 GAC actuator

Monitoring the coolant level

All engines are equipped with either one or two coolant level probes for monitoring the coolant level in the coolant expansion tank. This probe is of the capacitative type. The sensor and the evaluating electronics form a unit.

If the coolant falls below the level monitored a minus potential is sent to the signal output “S”. With this a check lamp or a relay can be triggered.

Checking the coolant level probe

The probe features an integrated checking function. As soon as voltage is applied to the probe the signal appears for approx. 2 seconds to signalise that the probe is ready for operation.

If this signal does not appear, the probe must be checked.

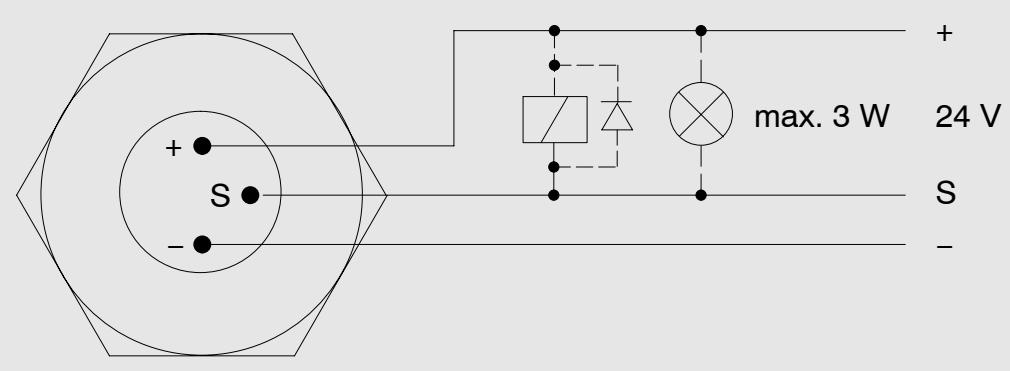
It is not possible to carry out a functional check by measuring the resistance (ohmmeter) because of the internal transistors.

The check can be carried out with a water tank and a small test bulb (< 3 watt).

Dip the probe into the water and apply a supply voltage of 24 V to the plus and minus leads. The output “S” is to be connected to the plus lead via the test lamp. The test lamp does not come on.

If the probe is taken out of the water, the test lamp must come on after approx. 7 seconds.

If the lamp does not come on the probe is defective and must be changed.



Service Data

Engine D 2848 LE 201 / 202 / 203 / 211 / 212 / 213

Design	V 90°
Mode of operation	4–stroke diesel with turbocharger / inter-cooler and charge–air regulation (waste gate)
Number of cylinders	8
Compression ratio	15,5:1
Bore	128 mm
Stroke	142 mm
Engine capacity	14 620 cm^3
Direction of rotation viewed on flywheel	anti clockwise
Firing order	1–5–7–2–6–3–4–8
Power based on DIN ISO 3046	
D 2848 LE 201	363 kW at 1500 rpm 409 kW at 1800 rpm
D 2848 LE 202	320 kW at 1500 rpm 468 kW at 1800 rpm
D 2848 LE 203	414 kW at 1500 rpm 449 kW at 1800 rpm
D 2848 LE 211	446 kW at 1500 rpm 506 kW at 1800 rpm
D 2848 LE 212	446 kW at 1500 rpm 506 kW at 1800 rpm
D 2848 LE 213	495 kW at 1500 rpm 528 kW at 1800 rpm
Rated speed	see model plate
Lubrication	forced–feed lubrication
forced feed lubrication by gear oil pump	
Filling capacities	
Oil capacity in oil sump flat	min. 20 ltr. max. 24 ltr.
Oil capacity in the oil pan deep	min. 12 ltr. max. 18 ltr.
Oil change quantity (with filter) flat	27 ltr.
Oil change capacity (with filter) deep	21 ltr.
Cooling	liquid cooled
by	impeller pump
Coolant temperature	
D 2848 LE 201 / 202 / 211 / 212	
normal	90°C
Short time	max. 95°C
D 2848 LE 203 / 213	
normal	100°C
Short time	max. 105°C

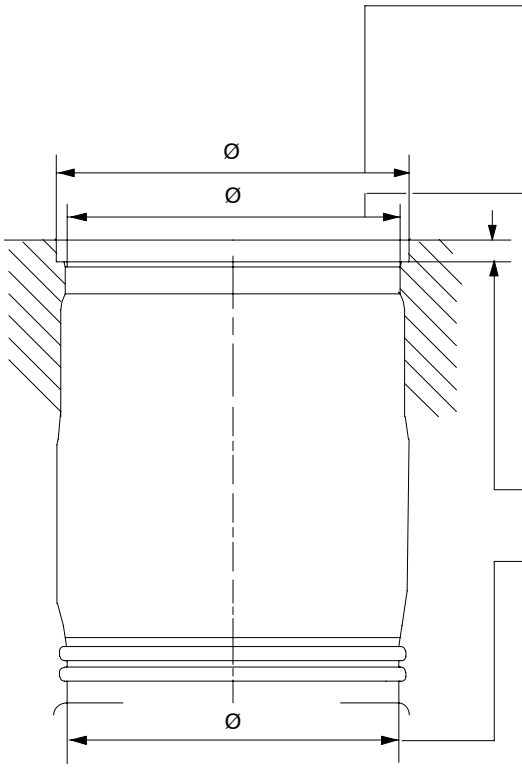
Engine D 2840 LE 201 / 202 / 203 / 211 / 212 / 213

Design	V 90°	
Mode of operation	4–stroke diesel with turbocharger / intercooler and charge–air regulation (waste gate)	
Number of cylinders	10	
Compression ratio	15,5:1	
Bore	128 mm	
Stroke	142 mm	
Engine capacity	18 270 cm^3	
Direction of rotation viewed on flywheel	anti clockwise	
Firing order	1–6–5–10–2–7–3–8–4–9	
Power based on DIN ISO 3046		
D 2840 LE 201	414 kW at 1500 rpm	
	449 kW at 1800 rpm	
D 2840 LE 202	363 kW at 1500 rpm	
	409 kW at 1800 rpm	
D 2840 LE 203	320 kW at 1500 rpm	
	368 kW at 1800 rpm	
D 2840 LE 211	443 kW at 1500 rpm	
	515 kW at 1800 rpm	
D 2840 LE 212	357 kW at 1500 rpm	
	449 kW at 1800 rpm	
D 2840 LE 213	532 kW at 1500 rpm	
	620 kW at 1800 rpm	
Rated speed	see model plate	
Lubrication	forced–feed lubrication	
by	gear oil pump	
Filling capacities		
Oil capacity in oil sump flat	min.	26 ltr.
	max.	30 ltr.
Oil capacity in the oil pan deep	min.	24 ltr.
	max.	30 ltr.
Oil capacity in the oil pan deep (enlarged)	min.	30 ltr.
	max.	70 ltr.
Oil change quantity (with filter) flat	33 ltr.	
Oil change capacity (with filter) deep	33 ltr.	
Oil change capacity (with filter) deep (enlarged)	73 ltr.	
Cooling	liquid cooled	
by	impeller pump	
Coolant temperature		
D 2840 LE 201 / 202 / 211 / 212		
normal	90°C	
Short time	max. 95°C	
D 2840 LE 203 / 213		
normal	100°C	
Short time	max. 105°C	

Engine D 2842 LE 201 / 202 / 203 / 211 / 212 / 213

Design	V 90°
Mode of operation	4–stroke diesel with turbocharger / inter-cooler and charge–air regulation (waste gate)
Number of cylinders	12
Compression ratio	15,5:1
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
Power based on DIN ISO 3046	
D 2842 LE 201	446 kW at 1500 rpm
	534 kW at 1800 rpm
D 2842 LE 202	446 kW at 1500 rpm
	534 kW at 1800 rpm
D 2842 LE 203	575 kW at 1500 rpm
	653 kW at 1800 rpm
D 2842 LE 211	638 kW at 1500 rpm
	748 kW at 1800 rpm
D 2842 LE 212	539 kW at 1500 rpm
	649 kW at 1800 rpm
D 2842 LE 213	688 kW at 1500 rpm
	798 kW at 1800 rpm
Rated speed	see model plate
Lubrication	forced–feed lubrication
by	gear oil pump
Filling capacities	
Oil capacity in oil sump semi–flat	min. 22 ltr.
	max. 30 ltr.
Oil capacity in the oil pan deep	min. 24 ltr.
	max. 32 ltr.
Oil capacity in the oil pan deep	min 40 ltr.
(Agricultural power generator)	max. 90 ltr.
Oil capacity in the oil pan deep	min. 60 ltr.
(On–board marine power generator)	max. 70 ltr.
Oil change quantity (with filter) semi–flat	33 ltr.
Oil change capacity (with filter) deep	35 ltr.
Oil change capacity (with filter) deep (Agricultural power generator)	93 ltr.
Oil change capacity (with filter) deep (On–board marine power generator)	73 ltr.
Cooling	liquid cooled
by	impeller pump
Coolant temperature	
D 2842 LE 201 / 202 / 211 / 212	
normal	90°C
Short time	max. 95°C
D 2842 LE 203 / 213	
normal	100°C
Short time	max. 105°C

Crankcase



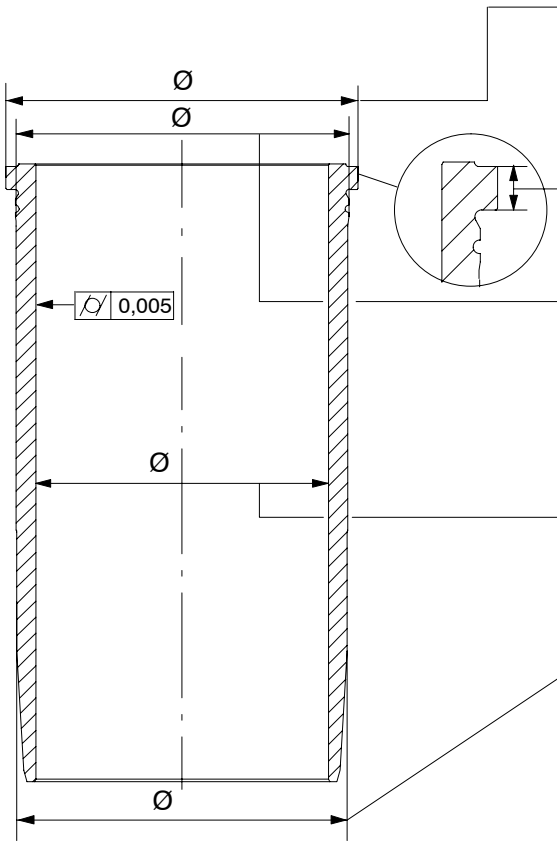
Standard size:
153,90–154,00 mm (Ø 153,9 H9)
for cylinder liners with 0,5 and 1,0 mm larger outside diameter:
154,40–154,50 mm (Ø 154,4 H9)

Standard size:
145,80–145,84 mm (Ø 145,8 H7)
for cylinder liners with 0,5 mm larger outside diameter:
146,30–146,34 mm (Ø 146,3 H7)
for cylinder liners with 1,0 mm larger outside diameter:
146,80–146,84 mm (Ø 146,8 H7)

9,97–9,99 mm

Standard size:
144,50–144,54 mm (Ø 144,5 H7)
for cylinder liners with 0,5 mm larger outside diameter:
145,00–145,04 mm (Ø 145 H7)
for cylinder liners with 1,0 mm larger outside diameter:
145,50–145,54 mm (Ø 145,5 H7)

Cylinder liner



Standard size:
153,761–153,786 mm (Ø 153,8 f8)
with 0,5 and 1,0 mm larger outside diameter:
154,194–154,257 mm (Ø 154,3 f8)

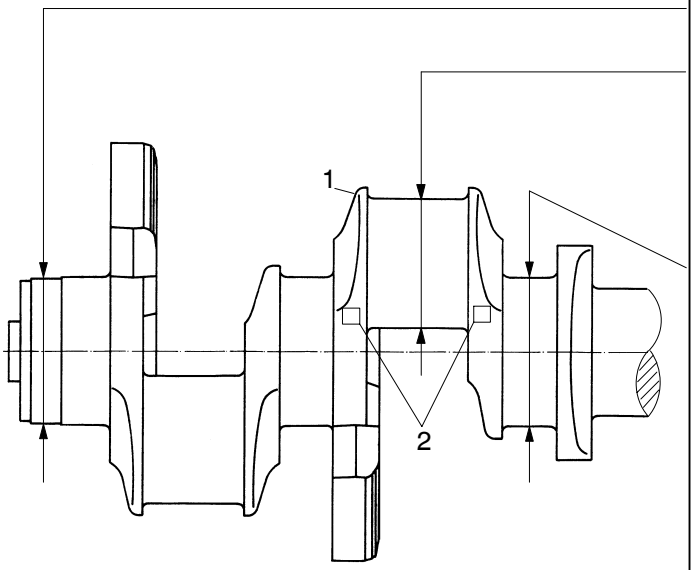
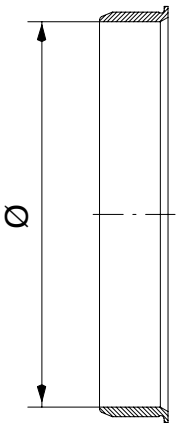
Standard size: 10,03–10,05 mm
with 0,2 mm more flange height:
10,23–10,25 mm

Standard size:
145,761–145,786 mm (Ø 145,8 g6)
with 0,5 mm larger outside diameter:
146,261–146,286 mm (Ø 146,3 g6)
with 1,0 mm larger outside diameter:
146,761–146,786 mm (Ø 146,8 g6)

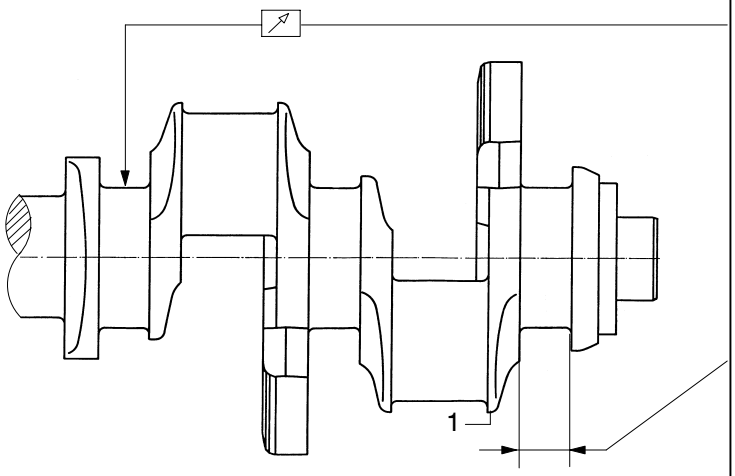
127,990–128,010
Max. wear limit:
0.15 mm below base dimension

Standard size:
144,432–144,457 mm (Ø 144,5 f6)
with 0,5 mm larger outside diameter:
144,932–144,957 mm (Ø 145,0 f6)
with 1,0 mm larger outside diameter:
145,432–145,457 mm (Ø 145,5 f6)

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

Service Data	Dimensions Limit values
Crankshaft	
Crankshaft front end (opposite end 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 Permissible axial clearance of crankshaft: 0,190–0,322 mm
Bearing race for crankshaft, front end 	Inner diameter: 99,907–99,942 mm (Ø 100 S7)

Crankshaft rear end (adjacent to flywheel)



Max. permissible runout with crankshaft taken up in end bearings:

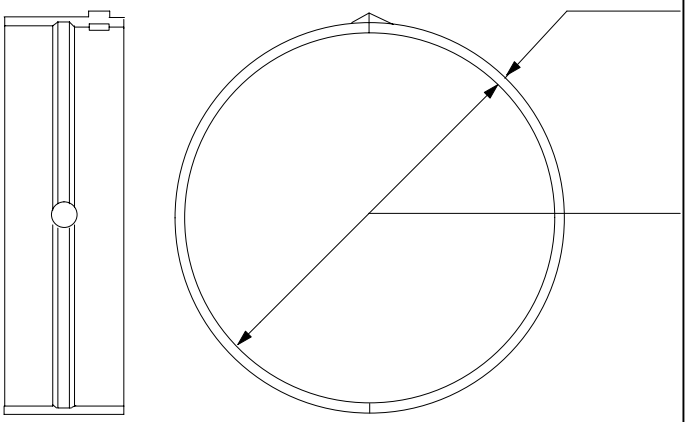
D 2848 LE 2..	
at bearing 3	0,06 mm
D 2840 LE 2..	
at bearing 3 and bearing 4	0,06 mm
D 2842 LE 2..	
at bearing 4	0,08 mm

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

Internal bearing Ø when fitted:

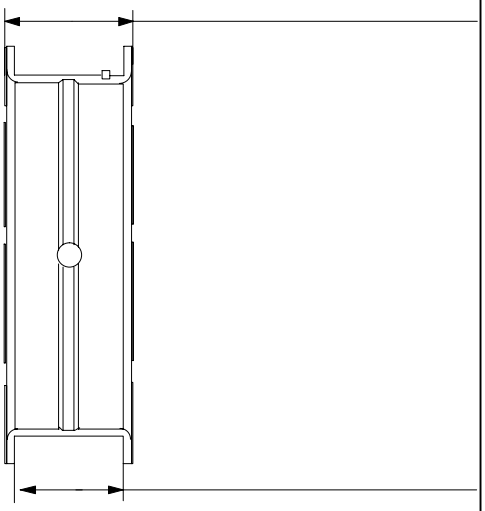
standard size:	104.066–104.112 mm
undersize –0.25:	103.816–103.862 mm
undersize –0.50:	103.566–103.612 mm
undersize –0.75:	103.316–103.362 mm
undersize –1.00:	103,066–103,112 mm

Spread: 0,3–1,2 mm

Marking: top / bottom

standard size:	0958 / 0959 mm
Undersize –0.25:	0962 / 0963 mm
Undersize –0.50:	0964 / 0965 mm
Undersize –0.75:	0966 / 0967 mm
Undersize –1.00:	0968 / 0969

Alignment 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

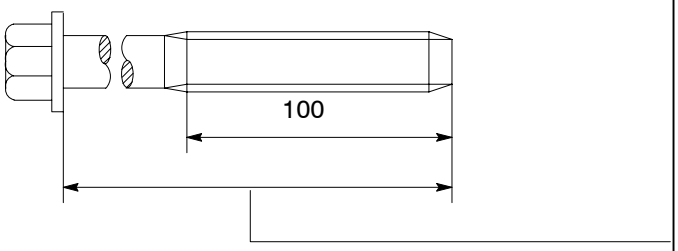
Spread: 0,1–0,5 mm

Marking: top / bottom
standard size: 0164 / 0165 mm
undersize –0.25: 0168 / 0169 mm
undersize –0.50: 0170 / 0171 mm
undersize –0.75: 0172 / 0173 mm
undersize –1.00: 0174 / 0175

31,01–31,04 mm

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

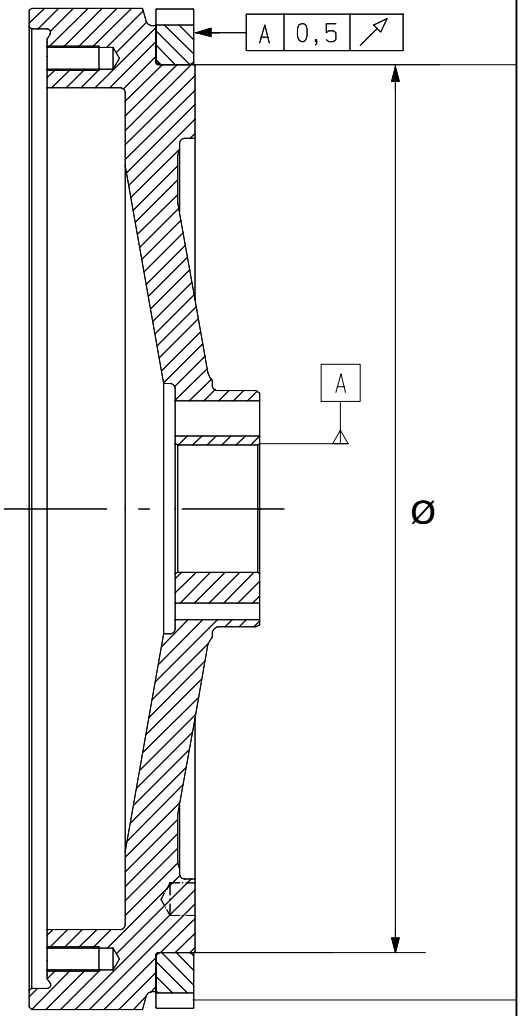
Mounting bolts for crankshaft bearing caps



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 gear ring



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

Internal gear ring Ø:
432,000–432,155 mm (Ø 432 H9)

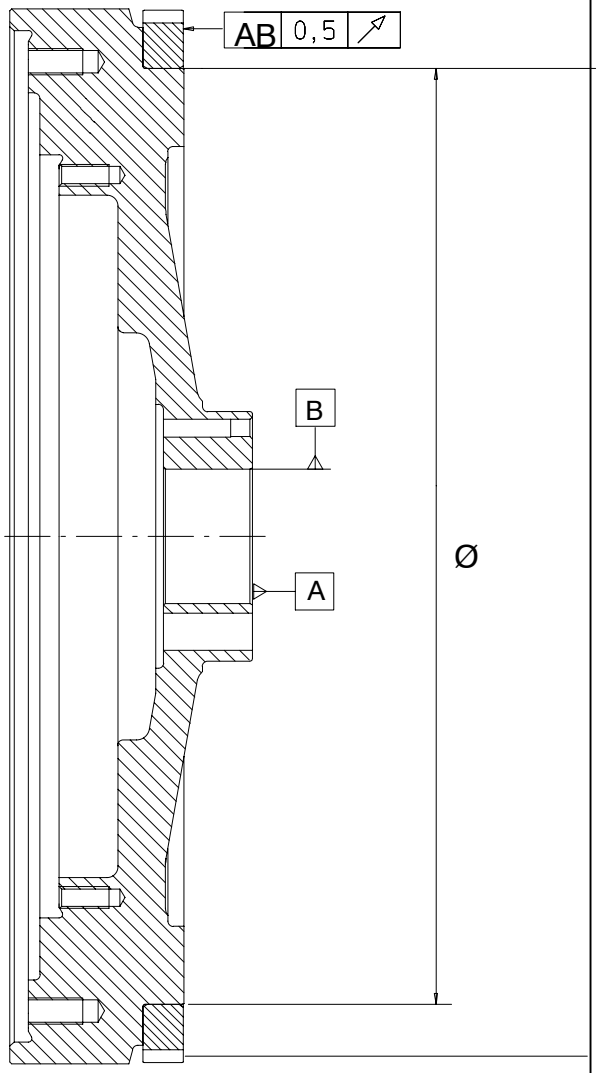
Interference: 0,335–0,645 mm
Installation temperature: 200–230°C

m = 65,1 kg (with gear ring)
J = 1,975 kgm^2

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

Backlash: 0,6–0,9 mm

Flywheel and starter gear ring



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

Internal gear ring Ø:
432,000–432,155 mm (Ø 432 H9)

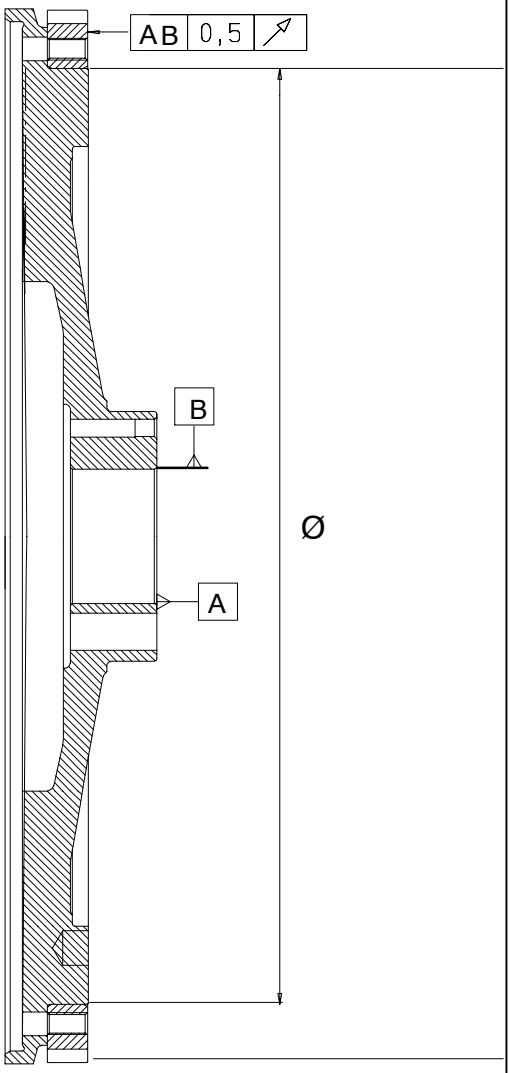
Interference: 0,335–0,645 mm
Installation temperature: 200–230°C

m = 60,554 kg (with gear ring)
J = 2,392 kgm^2

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

Backlash: 0,6–0,9 mm

Flywheel and starter gear ring



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

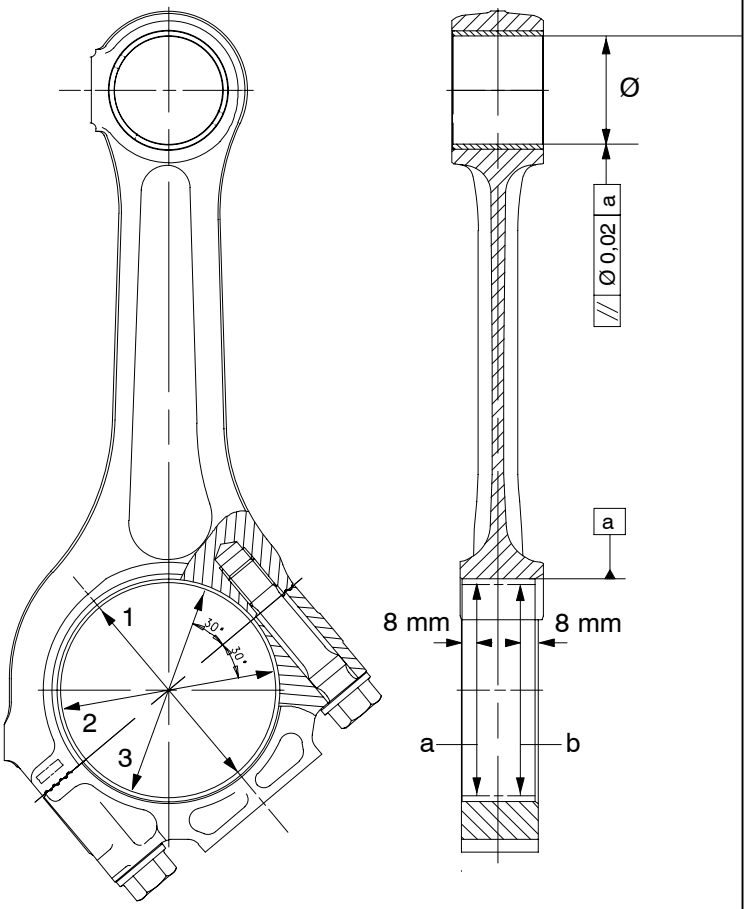
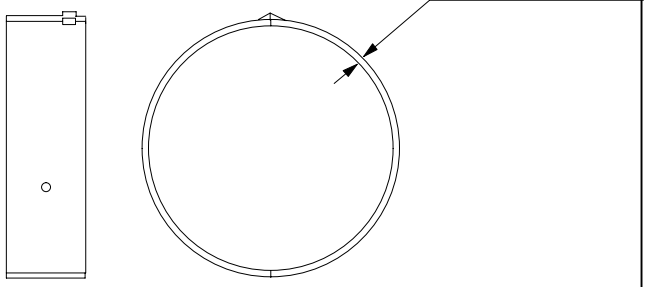
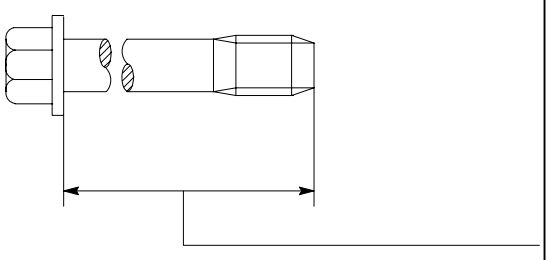
Internal gear ring Ø:
432,000–432,155 mm (Ø 432 H9)

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

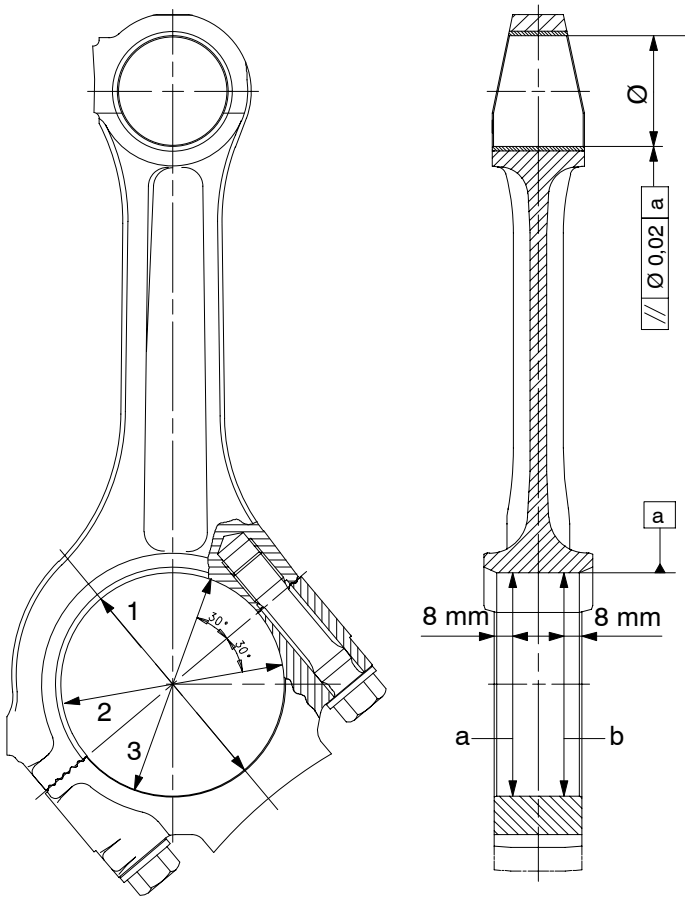
m = 32,640 kg (with gear ring)
J = 1,10 kgm^2

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

Backlash: 0,6–0,9 mm

Service Data	Dimensions Limit values
Conrod 	up to engine No... 8628 999 .... 46,055–46,065 mm Bearing bore in measuring directions 1, 2 and 3 and in measuring planes a and b: 90,064–90,106 mm Pre–condition: New conrod bearing in place, conrod assembled
Conrod bearing 	up to engine No... 8628 999 ... 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)
Connecting rod bolt 	up to engine No... 8628 999 ... 51. 90020-0139 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: 67,2–67,5 mm, max. 69 mm

Conrod



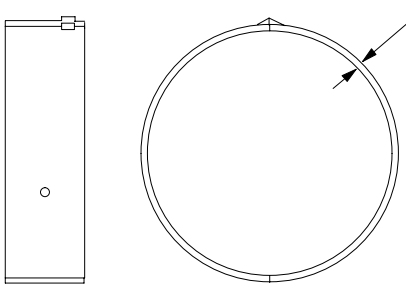
from engine No... 8629 001 ....

46,055–46,065 mm

Bearing bore in measuring directions 1, 2 and 3 and in measuring planes a and b: 90,064–90,106 mm

Pre–condition:
New conrod bearing in place, conrod assembled

Conrod bearing



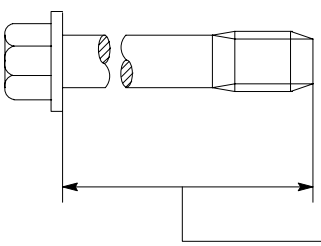
from engine No... 8629 001 ....

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)

Connecting rod bolt



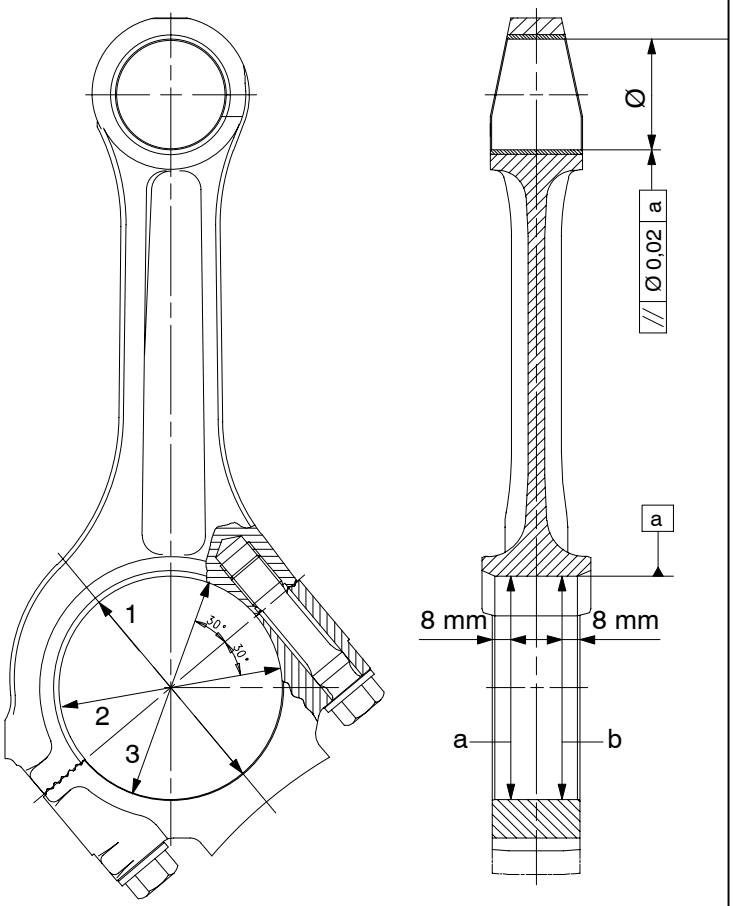
from engine No... 8629 001 ....

51. 90020-0338

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: 68,2–68,5 mm, max. 69,5 mm

Conrod D 2848 / 40 / 42 LE 211 / 212 / 213

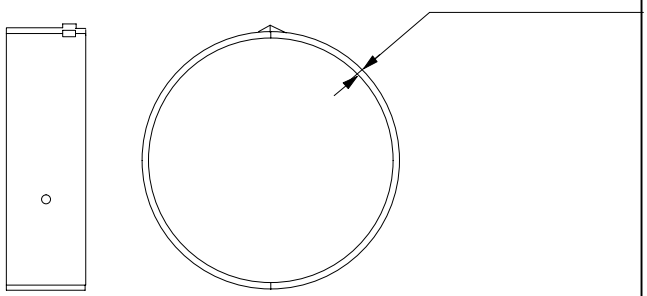


46,055–46,065 mm

Bearing bore in measuring directions 1, 2 and 3 and in measuring planes a and b: 90,075–90,120 mm

Edge condition:
New conrod bearing in place, conrod assembled

Conrod bearings

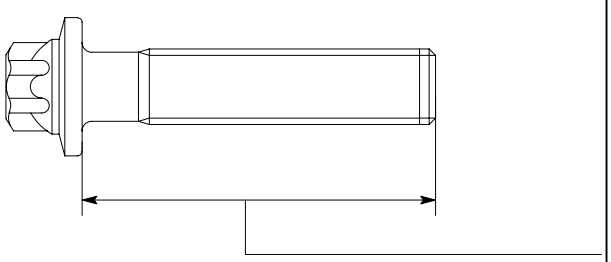


Standard size: 2.463–2.473 mm
Undersize –0.25: 2.588–2.598 mm
Undersize –0.50: 2.713–2.723 mm
Undersize –0.75: 2.838–2.848 mm
Undersize –1.00: 2,963–2,973 mm

Spread: 0,6–1,5 mm

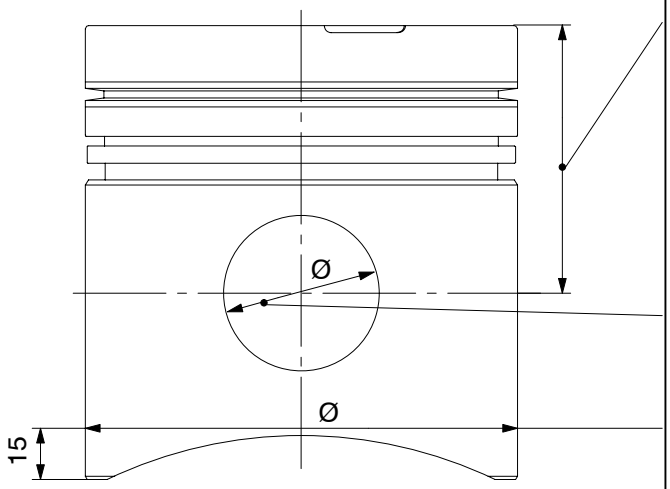
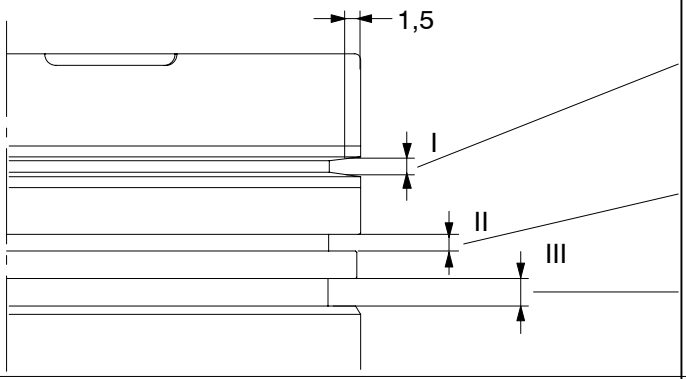
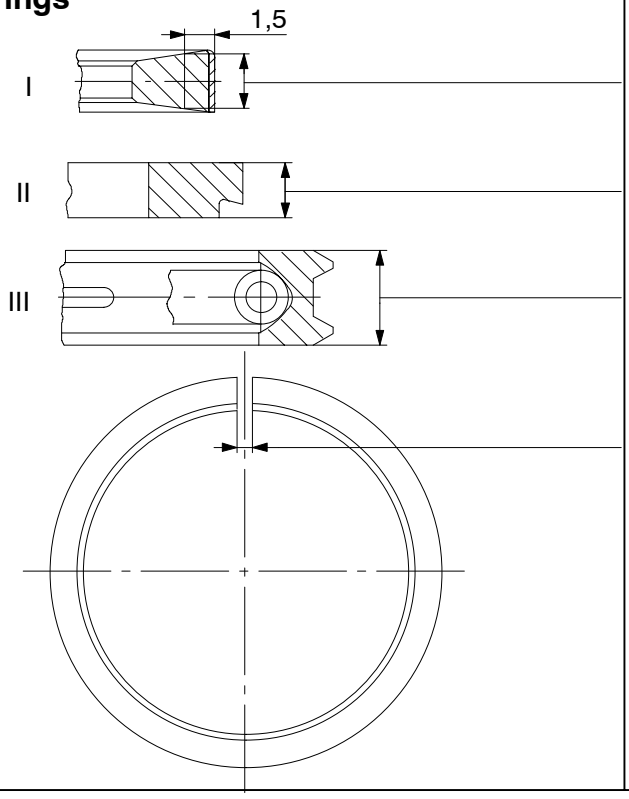
If signs of wear are present (scores,antiwaer coating damaged), change both bearing shells
Important: Observe installation position (rod shell has red colour markings on the side)

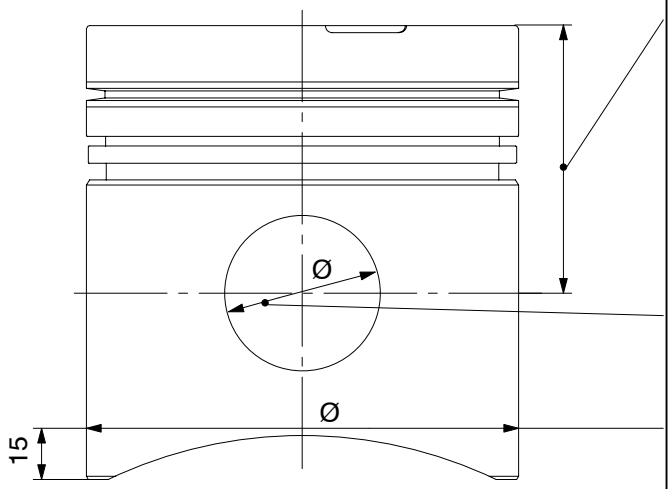
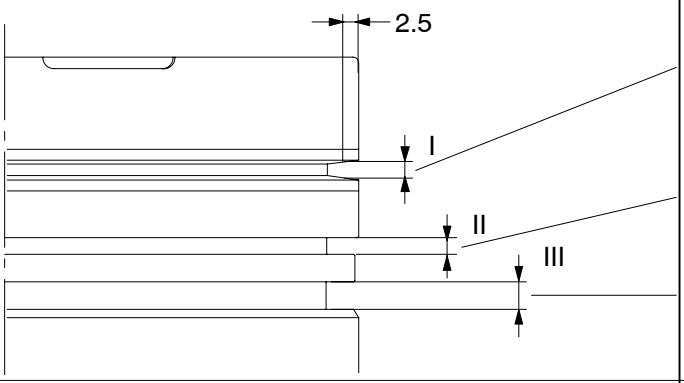
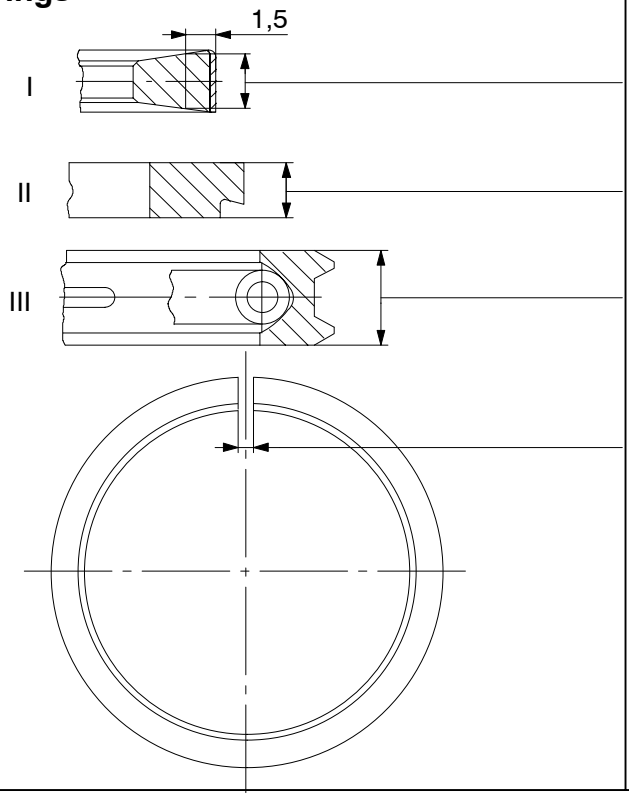
Connecting rod bolt

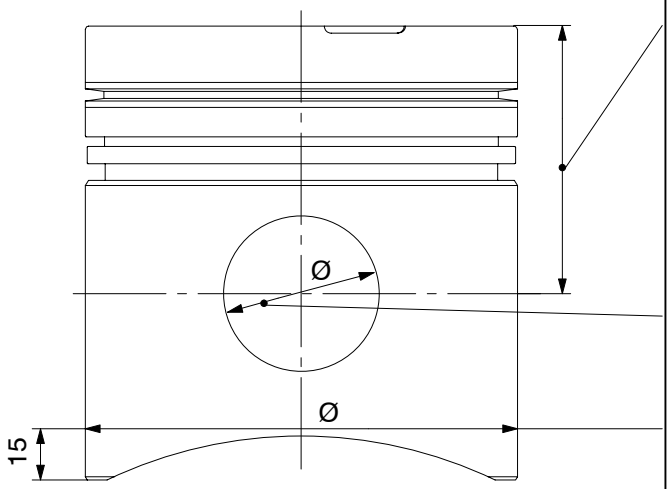
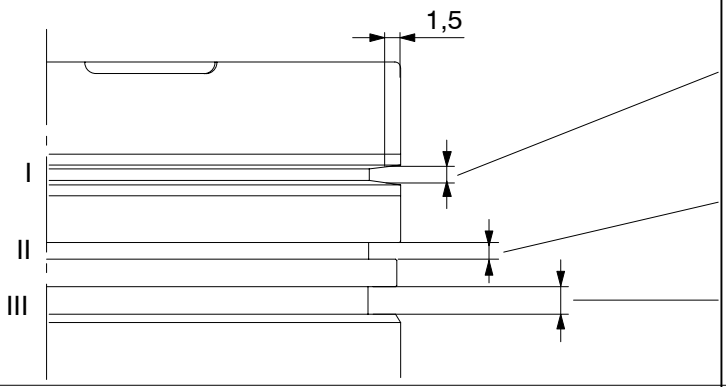
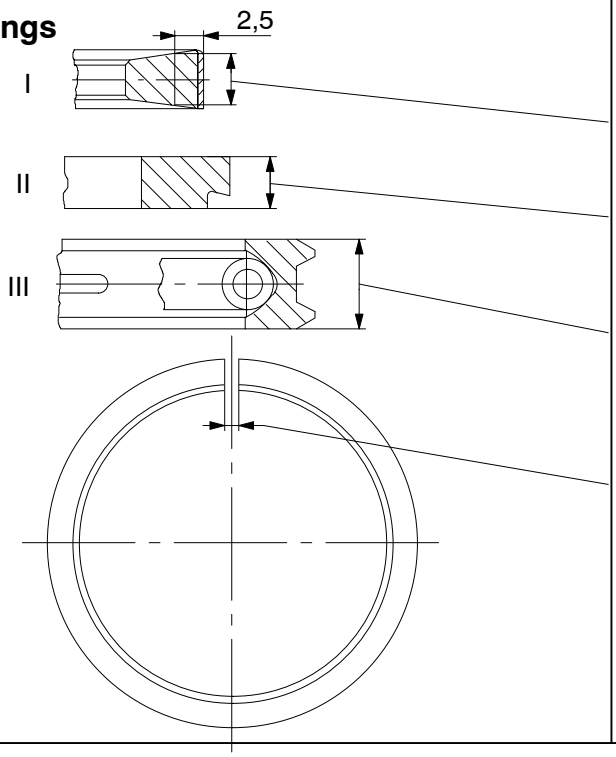


Length With each tightening, the bolts are deliberately stressed beyond the stretch limit and each tightening thus extends their length permanently. When the max. length has been reached, the bolt may no longer be used.

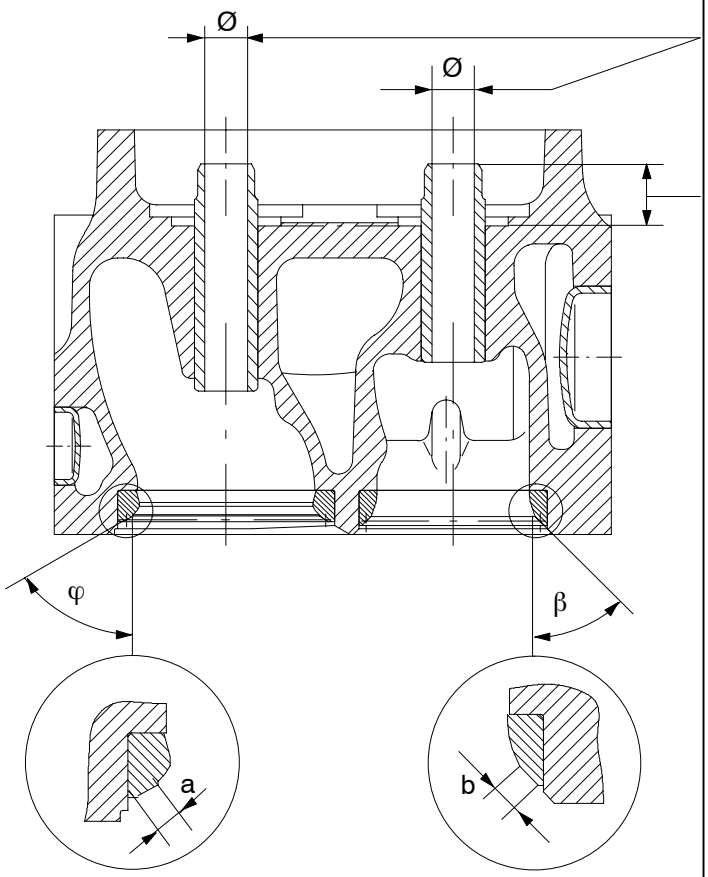
Torx bolt M14x1,5:
65,5–66,0 mm, **max. 66,5 mm**

Service Data	Dimensions Limit values
Piston 	D 2848 LE 2.. up to engine No. ...8628 999.... Compression height: 81,250–81,300 mm with undersize 0,2 mm: 81,050–81,100 mm 0,4 mm: 80,850–80,900 mm 0,6 mm: 80,650–80,700 mm Piston protrusion above crankcase top: 0,01–0,38 mm 46,005–46,013 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 	D 2848 LE 2.. up to engine No. ...8628 999... 3,195–3,225 mm 3,040–3,060 mm 5,020–5,040 mm
Piston rings 	D 2848 LE 2.. up to engine No. ...8628 999... 1st ring – keystone ring Height: 3,075–3,095 mm 2 nd ring – Minute ring: Height: 2,978–2,990 mm 3rd ring – bevelled ring Height: 4,978–4,990 mm Ring gap: 1.st ring: 0,40–0,55 mm 2nd Ring: 0,45–0,70 mm 3rd Ring: 0,25–0,40 mm

Service Data	Dimensions Limit values
Piston 	D 2840 / 42 LE 2.. up to engine No. ...8358 999.... Compression height: 81,250–81,300 mm with undersize 0,2 mm: 81,050–81,100 mm 0,4 mm: 80,850–80,900 mm 0,6 mm: 80,650–80,700 mm Piston protrusion above crankcase top: 0,01–0,38 mm 46,005–46,013 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 	D 2840 / 42 LE 2.. up to engine No. ...8358999.... 2,935–2,965 mm 3,040–3,060 mm 5,020–5,040 mm
Piston rings 	D 2840 / 42 LE 2.. up to engine No. ...8358 999.... 1st ring – keystone ring Height: 3,075–3,095 mm 2 nd ring – Minute ring: Height: 2,978–2,990 mm 3rd ring – bevelled ring Height: 4,978–4,990 mm Ring gap: 1.st ring: 0,40–0,55 mm 2nd Ring: 0,45–0,70 mm 3rd Ring: 0,25–0,40 mm

Service Data	Dimensions Limit values
Piston 	D 2848 LE 2.. from engine No. ...8629001.... D 2840 / 42 LE 2.. from engine No. ...8359 001.... Compression height: 81,250–81,300 mm with undersize 0,2 mm: 81,050–81,100 mm 0,4 mm: 80,850–80,900 mm 0,6 mm: 80,650–80,700 mm Piston protrusion above crankcase top: 0,01–0,38 mm 46,005–46,013 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 	D 2848 LE 2.. from engine No. ...8629 001.... D 2840 / 42 LE 2.. from engine No. ...8359 001.... 3,695–3,725 mm 3,040–3,060 mm 4,020–4,040 mm
Piston rings 	D 2848 LE 2.. from engine No. ...8629 001.... D 2840 / 42 LE 2.. from engine No. ...8359 001.... 1st ring – keystone ring Height: 3,296–3,330 mm 2 nd ring – Minute ring: Height: 2,978–2,990 mm 3rd ring – bevelled ring Height: 4,978–4,990 mm Ring gap: 1.st ring: 0,50–0,70 mm 2nd Ring: 0,45–0,70 mm 3rd Ring: 0,25–0,40 mm

Cylinder head

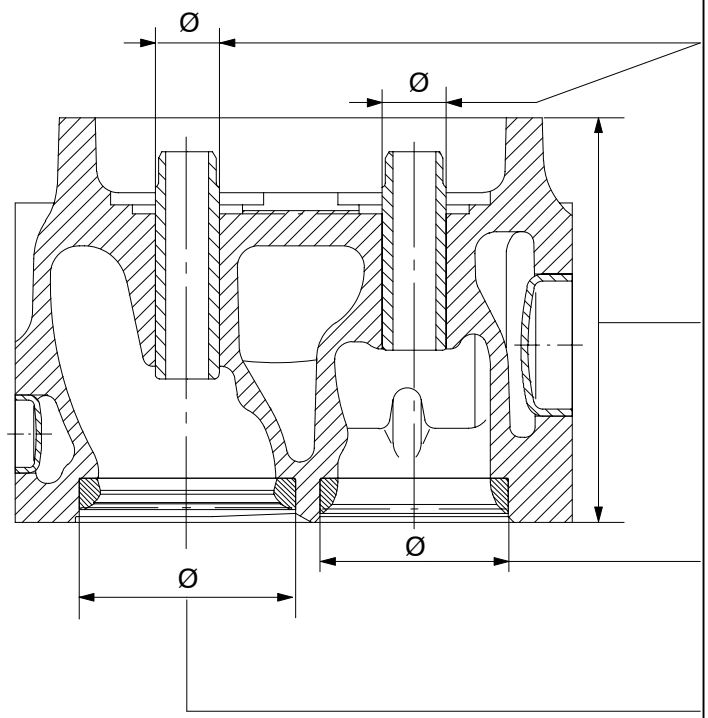


12,000–12,018 mm (Ø 12 H7)

17,1–17,5 mm

Intake valve φ = 60°
Exhaust valve β = 45°

a = 3,3–3,8 mm
b = 3,3–3,8 mm



Valve guide bore in cylinder head:
18,000–18,018 mm (Ø 18 H7)
Valve guide outside diameter:

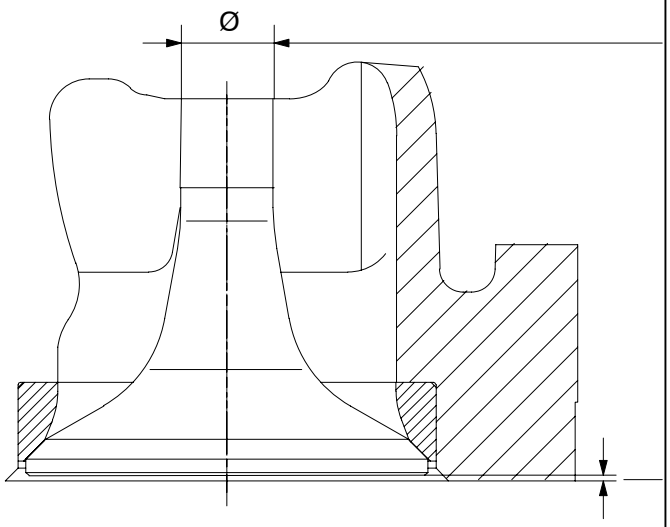
18,028–18,046 mm (Ø 18 s7)

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

Valve seat insert bore in cylinder head:
53,00–53,03 mm (Ø 53 H7)
Valve guide outside diameter:
53,10–53,11 mm

Valve seat insert bore in cylinder head:
61,00–61,03 mm (Ø 61 H7)
Valve guide outside diameter:
61,10–61,11 mm

Valves

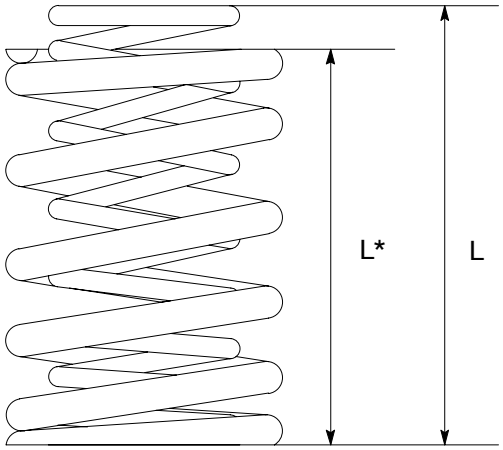


Intake valve:11,969–11,980 mm
Exhaust valve: 11,944–11,955 mm

Max. wear limit: max. 0,1 mm

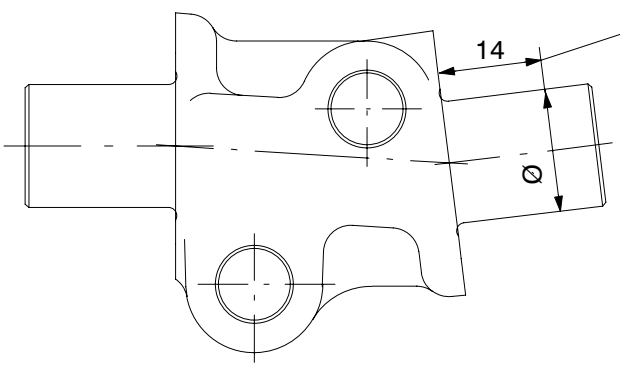
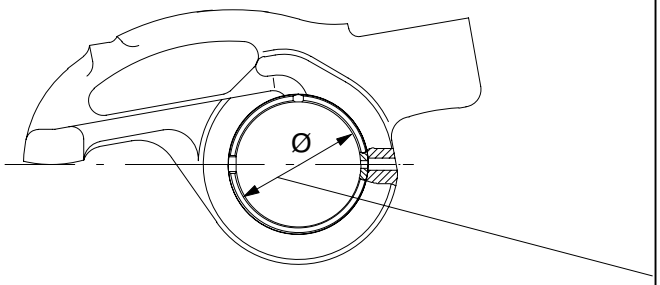
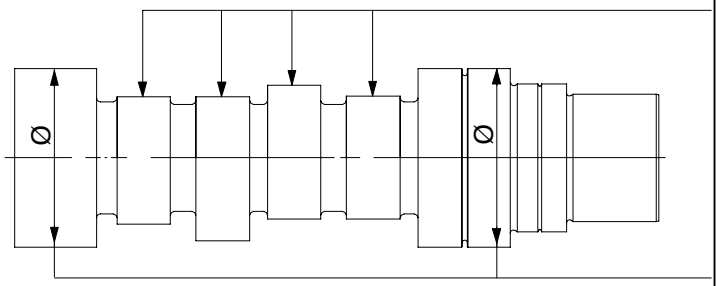
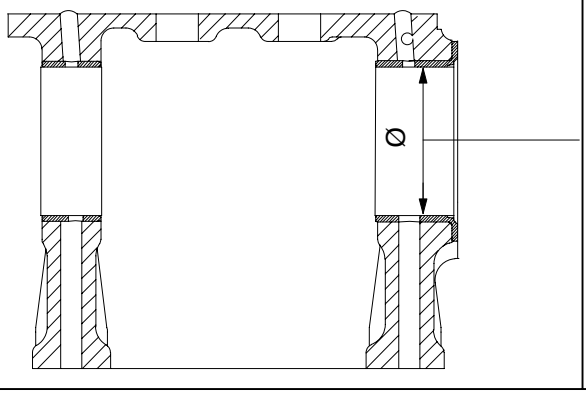
Valve recess for intake and exhaust valve:
0,7–1,3 mm

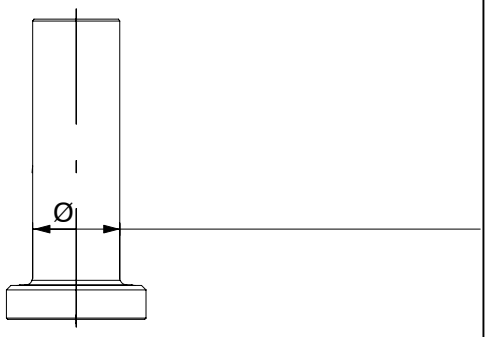
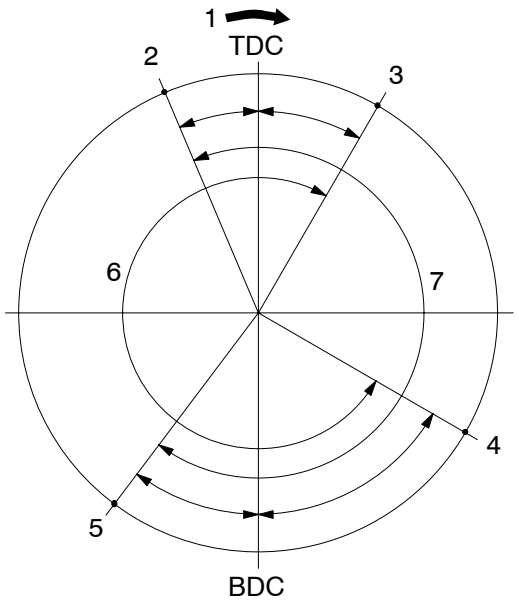
Valve springs

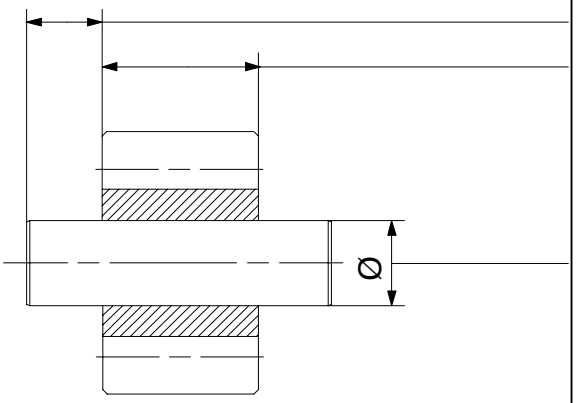
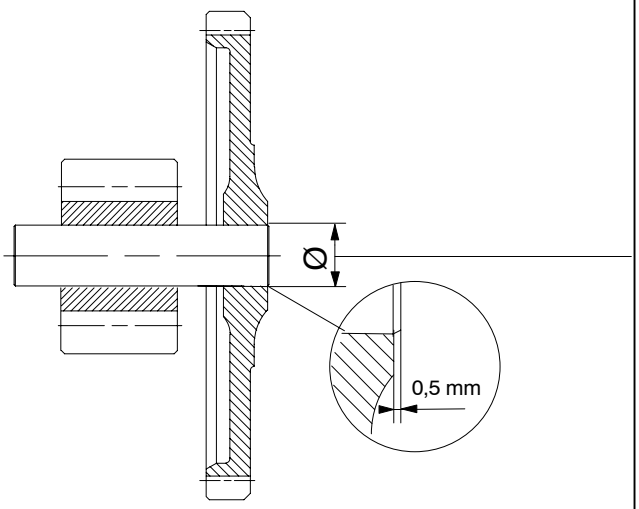


Inner spring:
Free length (L), approx. 65,5 mm
Spring force at L46,3 mm: 128–152 N
Spring force at L = 32,3 mm: 255–294 N

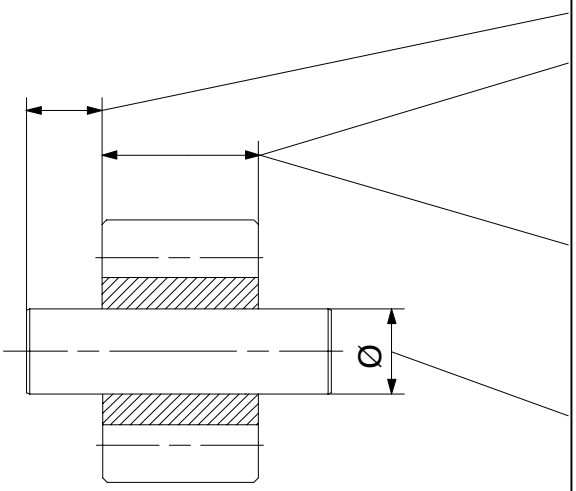
Outer spring:
Free length (L), approx. 59 mm
Spring force at L* = 46,8 mm: 324–353 N
Spring force at L* = 32,8 mm: 696–755 N

Service Data	Dimensions Limit values
Valve gear	
Rocker arm bearing pedestal 	24,967–24,980 mm (Ø 25 f6)
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 (Ø 70 e7) Backlash: Crankshaft wheel and camshaft wheel: D 2848: 0,128 mm–0,252 mm D 2840 / 42: 0,118 mm–0,242 mm
Camshaft bearing 	70,000–70,030 mm (Ø 70 H7) 70,070–70,090 mm for bush 5 (V8), 6 (V10) or 7 (V12) = bush at timing case end

Service Data	Dimensions Limit values
Valve tappets 	Bore in crankcase: 20,000–20,021 mm (Ø 20 H7) 19,944–19,965 mm
Valve clearance	Valve clearance (cold engine) Intake valve: 0,5 mm Exhaust 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
Single horizontal, 2–fold horizontal	2,8–3,6 bar
2–fold vertical, 2–fold vertical reversible	2,2–2,8 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 **Two-gears oil pump for D 2848 / 40 LE 2..** **Oil pump wheel**	
	11,5–11,7 mm 42,911–42,950 mm (Ø 43 e8) Housing depth: 43,000–43,039 mm (Ø 43 H8) Axial clearance: 0,050–0,128 mm Shaft: 21,930–21,940 mm Matching bore in housing: 22,000–22,021 mm (Ø 22 H7)
Drive wheel with oil pump wheel	
	Shaft: 21,930–21,940 mm Bore in drive gear: 21,870–21,885 mm Pressing 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 Öl, at 90°C and p = 6 bar) Oil pump speed = Engine speed x 0,977	
at n = 635 rpm	42 l/min
at n = 1465 rpm	105 l/min
at n = 1759 rpm	127 l/min

Three-wheel oil pump for D 2842 LE 2..
Oil pump wheel



14,5–14,7 mm

28,927–28,960 mm (Ø 28 e8)

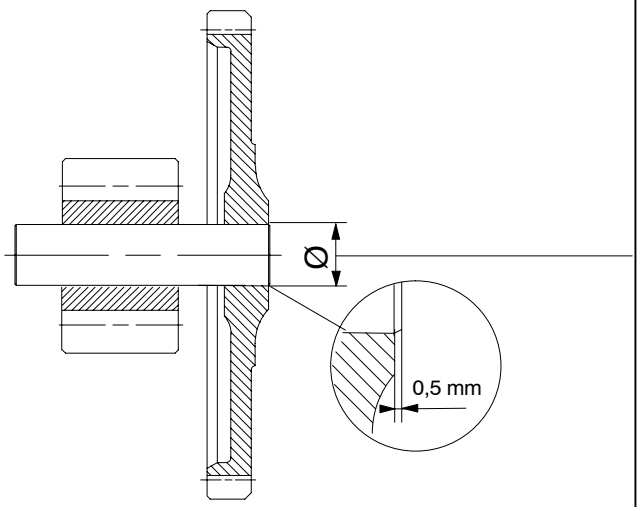
Housing depth:
28,000–28,033 mm (Ø 28 H8)
Axial clearance: 0,040–0,106 mm
or

33,911–33,950 mm (Ø 34 e8)

Housing depth:
34,000–34,039 mm (Ø 34 H8)
Axial clearance:0,050–0,128 mm

Shaft: 21,930–21,940 mm
Matching bore in housing:
22,000–22,021 mm (Ø 22 H7)

Drive wheel with oil pump wheel



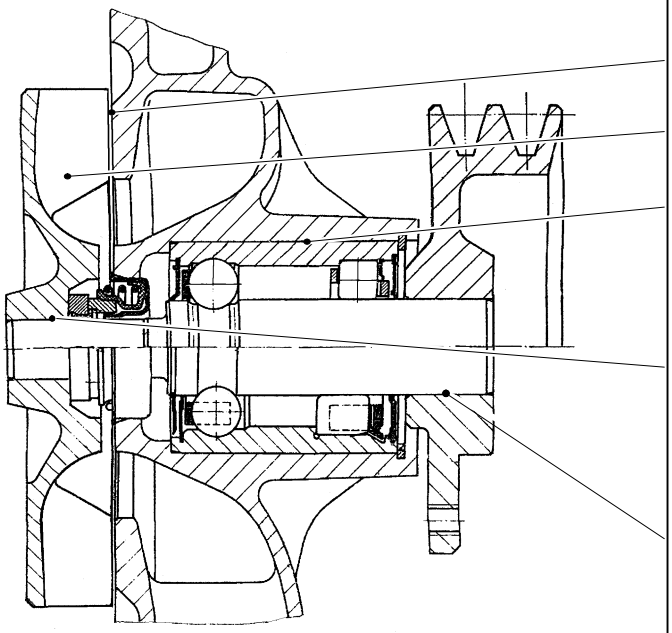
Shaft: 21,930–21,940 mm
Bore in drive gear:
21,870–21,885 mm
Pressing force: 12000 N

Backlash:
Drive wheel and crankshaft wheel:
0,099–0,451 mm

Oil pump capacity at oil pump speed
(with SAE 20W/20 Öl, at 90°C and p = 6 bar)
Oil pump speed = Engine speed x 0,977

Gear wheel width 28 mm	
at n = 635 rpm	49 l/min
at n = 1465 rpm	128 l/min
at n = 1759 rpm	159 l/min
Gear wheel width 34 mm	
at n = 635 rpm	60 l/min
at n = 1465 rpm	154 l/min
at n = 1759 rpm	194 l/min

Cooling system
Engine coolant pump



D 2840 LE 2..

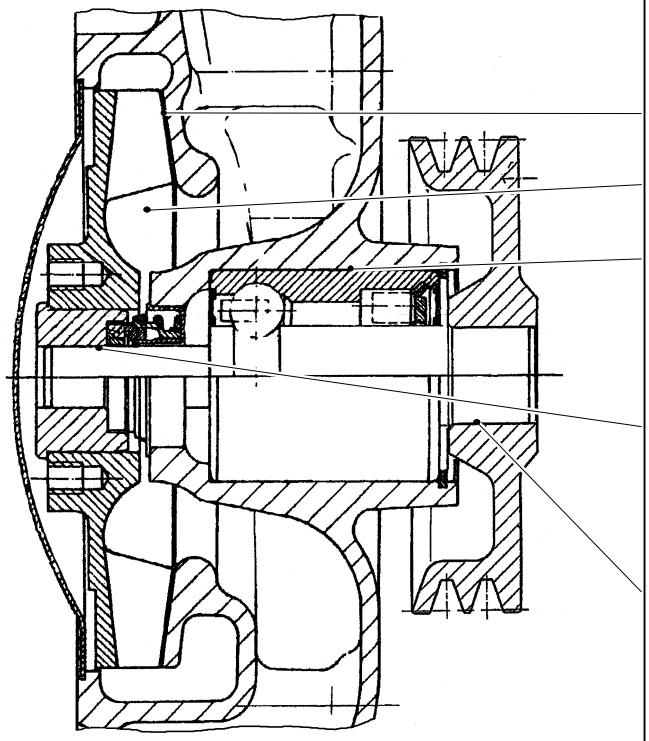
gap: 0,5–0,9 mm

Ø impeller: 135–136 mm

Bearing seat in housing:
54,940–54,970 mm (Ø 55 R7)
Ø of bearing: 54,981–54,994 mm
Interference: 0,011–0,054 mm

Bore for bearing shaft in impeller:
16,000–16,018 mm (Ø 16 H7)
Ø of bearing shaft: 16,043–16,056 mm
Interference: 0,027–0,058 mm

Bore in hub / belt pulley:
25,007–25,020 mm (Ø 25 G6)
Ø of bearing shaft: 25,048–25,061 mm
Interference: 0,028 – 0,054 mm



D 2848 / 42 LE 2..

gap: 0,7–0,8 mm

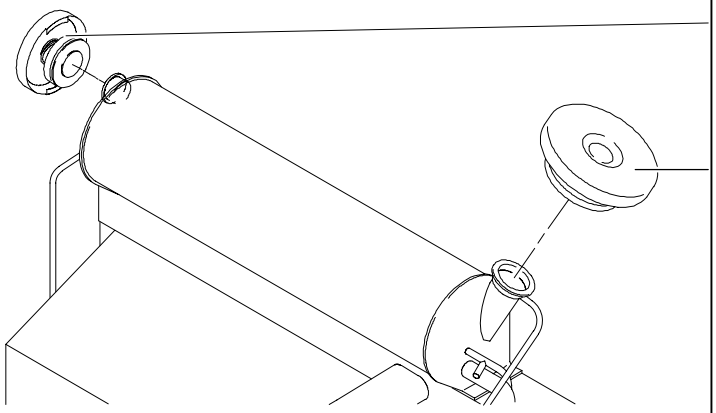
Ø impeller: 149,5–150,0 mm

Bearing seat in housing:
54,940–54,970 mm (Ø 55 R7)
Ø of bearing: 54,981–54,994 mm
Interference: 0,011–0,054 mm

Bore for bearing shaft in impeller:
15,992–16,010 mm (Ø 16 J7)
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 25 G6)
Ø of bearing shaft: 25,048–25,061 mm
Interference: 0,028 – 0,054 mm

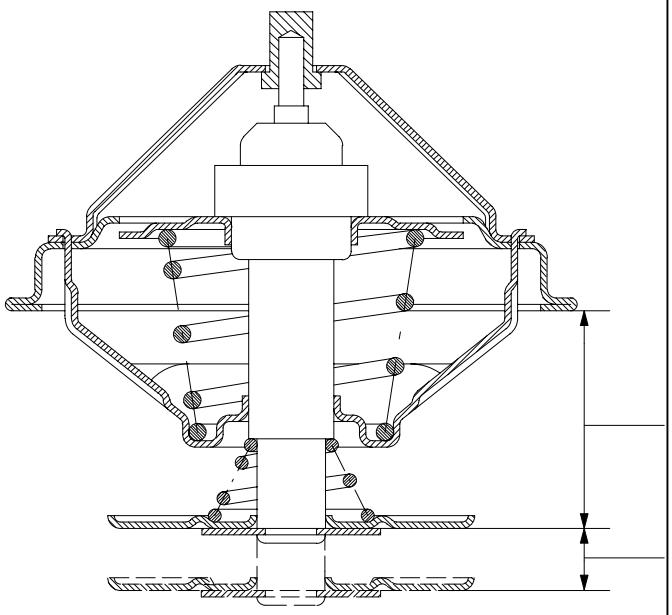
Valve cover on expansion tank



Valve cover with working valve (small cover) opens at
0,6 bar–0,7 bar overpressure,
0,02 bar–0,08 bar underpressure

Valve cover with safety valve (for filler, big cover) opens at
0,85 bar–1,2 bar overpressure

Thermostat



Opening begins at: 79°C (±2°)
Fully open: 94°C

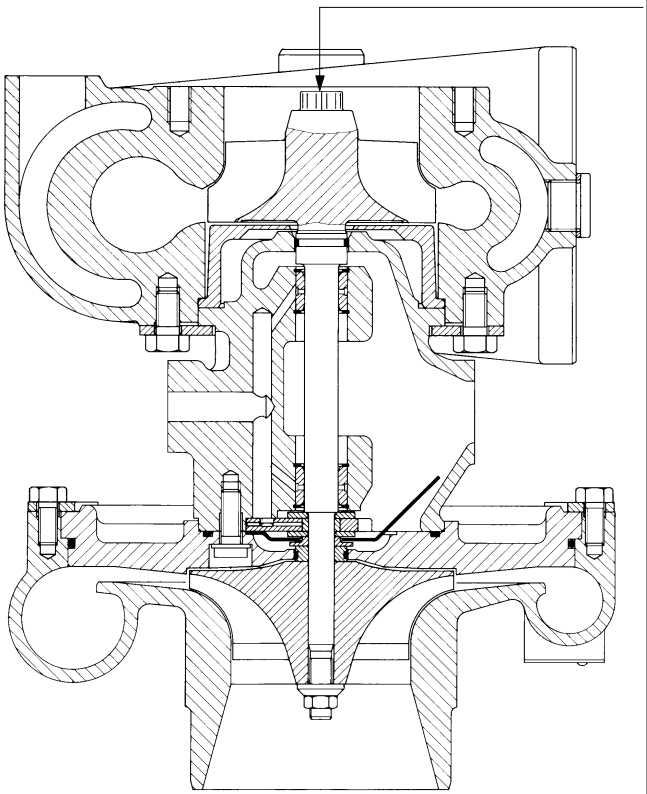
24,5–25,8 mm

Lift at least 8 mm at 94°C

Turbocharger

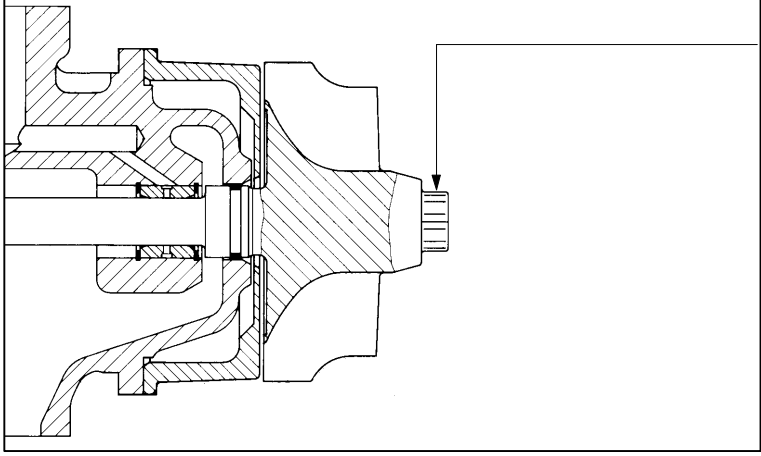
Manufacturer	KKK
D 2848 LE 201 / 202 / 203	K27–3267 MLCKA 21.22
D 2848 LE 211 / 212 / 213 – 1500 rpm	K27–3369 QXAK 19.22
D 2848 LE 211 / 212 / 213 – 1800 rpm	K27–3369 QXAK 19.22
D 2840 LE 201 / 202 – 1500 rpm	K28–3464 MOA 25.22
D 2840 LE 201 / 202 – 1800 rpm	K28–3470 MOA 25.22
D 2840 LE 203	K28–3467 OXAKB 25.22
D 2840 LE 211 / 212 / 213 – 1500 rpm	K28–3767 OOAKB 25.22
D 2840 LE 211 / 212 / 213 – 1800 rpm	K31–3967 QXAKB 27.20
D 2842 LE 201 / 202	K361–4064 MNA 21.22
D 2842 LE 203 – 1500 rpm	K31–3967 QXAKB 24.20
D 2842 LE 203 – 1800 rpm	K31–3967 QXAKB 27.20
D 2842 LE 211 / 212 / 213 – 1500 rpm	K31–3967 QXAKB 27.20
D 2842 LE 211 / 212 / 213 – 1800 rpm	K31–3971 QXAKB 32.20

Axial clearance

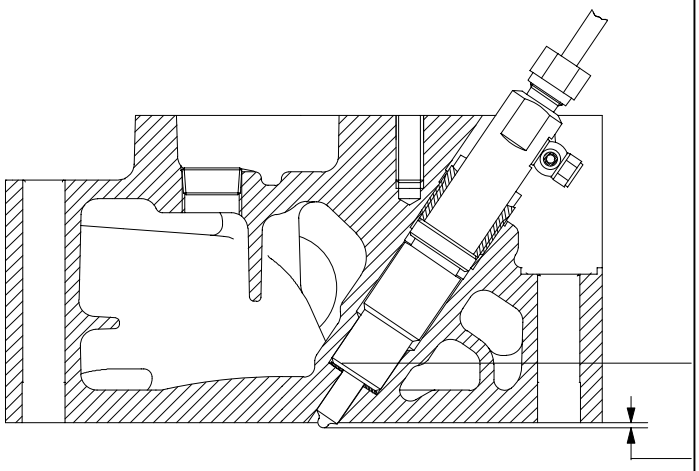


K27 / K28 max. 0,16 mm
K361 max. 0,156 mm

Radial clearance



K27 / K28 max. 0,43 mm
K361 max. 0,63 mm

Service Data	Dimensions Limit values
Fuel system **Injection nozzles**	
D 2848 LE 201 / **202** / **203**	
Manufacturer	Bosch
Type of injector	DLLA 144 P 581
Number of holes	6
Opening pressure of injector	
New nozzle holder:	295 + 8 bar
Used nozzle holder:	280 + 8 bar
Nozzle holder	KDEL 82 P 7
D 2840 / **42 LE 201** / **202** / **203**	
Manufacturer	Bosch
Type of injector	DLLA 144 P 184
Number of holes	4
Opening pressure of injector	
New nozzle holder:	295 + 8 bar
Used nozzle holder:	280 + 8 bar
Nozzle holder	KDEL 82 P 7
or	
Manufacturer	Bosch
Type of injector	DLLA 144 P 581
Number of holes	6
Opening pressure of injector	
New nozzle holder:	295 + 8 bar
Used nozzle holder:	280 + 8 bar
Nozzle holder	KDEL 82 P 7
D 2848 / **40** / **42 LE 212** / **212** / **213**	
Manufacturer	Bosch
Type of injector	DLLA 146 PV 3 188 517
Number of holes	
Opening pressure of injector	
New nozzle holder:	295 + 8 bar
Used nozzle holder:	280 + 8 bar
Nozzle holder	KDEL 82 P 12
Projection above cylinder head contact surfaces	
	Adjust nozzle protrusion by using Cu sealing rings of different thickness. These sealing rings are available in thicknesses 0,5 / 1,0 / 1,5 / 2,0 / 2,5 / 3,0 mm 2,42–3,25 mm

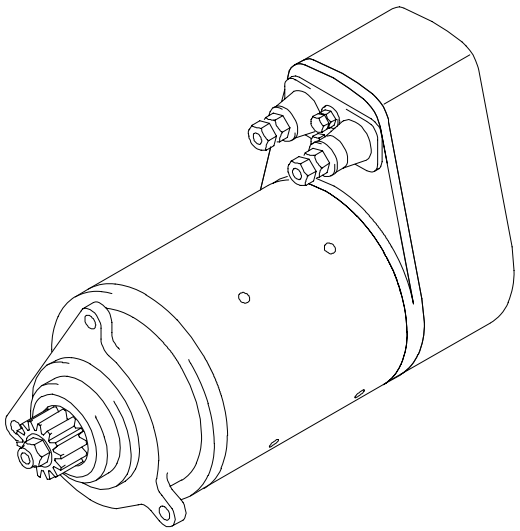
Injection pumps and governors

D 2848 LE 201 / 202 / 203		
In−line injection pump:	GAC governor	PE 8 P120 A500 LS7891
Governor:	GAC governor	ACB 275 H
D 2848 LE 211 / 212 / 213		
In−line injection pump:	GAC governor	PE 8 P120 A500 LV
Governor:	GAC governor	ACE 275 HD
D 2840 LE 201 / 202 / 203		
In−line injection pump:	RQ-Governor HZM-Governor GAC-Governor	PE 10 P120 A520 LS7876 PE 10 P120 A520 LS7876 PE 10 P120 A520 LS7881
Governor:	RQ-Governor HZM-Governor GAC-Governor	RQ 750 PA 1158 RQ 950 PAV B420 032 968 ACB 275 H
D 2840 LE 211 / 212 / 213		
In−line injection pump:	GAC governor	PE 10 P120 A500 LS8535
Governor:	GAC governor	ACE 275 HD
D 2842 LE 201 / 202 / 203		
In−line injection pump:	RQ-Governor HZM-Governor GAC-Governor	PE 12 P120 A520 LS7877 PE 12 P120 A520 LV B401 890 820 PE 12 P120 A520 LS7882
Governor:	RQ-Governor HZM-Governor GAC-Governor	RQ 750 PA 1158 RQ 950 PAV B420 032 968 ACB 275 H
D 2842 LE 211 / 212 / 213		
In−line injection pump:	GAC governor	PE 12 P120 A500 LS8533
Governor:	GAC governor	ACE 275 HD

Start of delivery

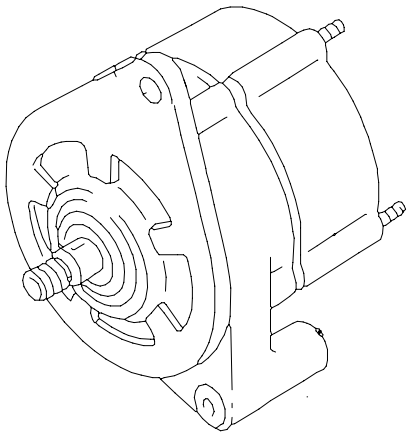
Model	Start of delivery ± 1° crank angle before TDC (Speed constant = without injection timing mechanism)	
	with optimised consumption	with optimised NOX
D 2848 LE 201		
1500 rpm, constant	14°	10°
1800 rpm, constant	14°	12°
D 2848 LE 202		
1500 rpm, constant	14°	7°
1800 rpm, constant	14°	10°
D 2848 LE 203		
1500 rpm, constant	12°	12°
1800 rpm, constant	14°	14°
D 2840 LE 201 / 202		
1500 rpm, constant	16°	12°
1800 rpm, constant	18°	14°
D 2840 LE 203		
1500 rpm, constant	15°	12°
1800 rpm, constant	16°	11°
D 2842 LE 201		
1500 rpm, constant	15°	7°
1800 rpm, constant	17°	12°
D 2842 LE 202		
1500 rpm, constant	15°	5°
1800 rpm, constant	17°	11°
D 2842 LE 203		
1500 rpm, constant	15°	10°
1800 rpm, constant	17°	15°
D 2848 LE 211 / 212 / 213		
1500 rpm, constant	12°	
1800 rpm, constant	12° / 12° / 14°	
D 2840 LE 211 / 212 / 213		
1500 rpm, constant	12°	
1800 rpm, constant	14°	
D 2842 LE 211 / 212 / 213		
1500 rpm, constant	12°	
1800 rpm, constant	16°	

Starter motor



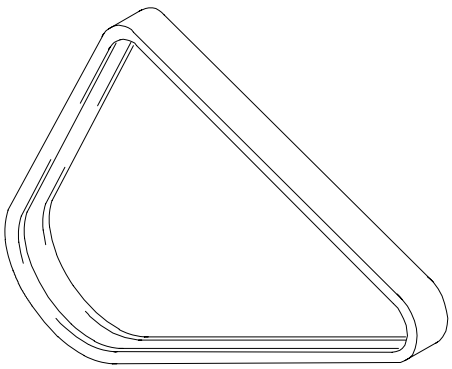
Manufacturer:	Bosch
Type:	KB
Operating method:	splined shaft
Starter motor pinion:	
Number of teeth:	Z = 9
Module:	3
Nominal power:	6,6 kW
Nominal voltage:	24 V

Alternator



Manufacturer:	Bosch
Type:	K1
Design:	1–pole, insulated
Operation:	Threephase current
Voltage:	28V
Max. current:	35A
Manufacturer:	Bosch
Type:	N1
Design:	2–pole, insulated
Operation:	Threephase current
Voltage:	28V
Max. current:	55A
Manufacturer:	Bosch
Type:	NCB2
Design:	2–pole, insulated
Operation:	Threephase current
Voltage:	28V
Max. current:	80A

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	80–90	60
4/3VX	180–200	160–180	120

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 163). 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
- M30x1,5 . . . . . 150 Nm

DIN 7604
- AM 10x1, M12x1,5 . . . . . 50 Nm
- AM 14x1,5 . . . . . 80 Nm

Crankcase, crankshaft drive

Gear case to crankcase M10, 12.9 . . . . . 75 Nm
Gear case to crankcase M12 x 1,5, 12.9 . . . . . 100 Nm
Inspection port cover to gear case M8, 12.9 . . . . . 40 Nm
Crankshaft bearing cover to crankcase M18x2
- Initial torque . . . . . 300–330 Nm
- Angle tightening . . . . . 90–100°

Crankshaft main bearing caps, side
- Hex bolt M12x1,5x85,10.9 (06.01494–4316)
  - Initial torque 80Nm
  - Angle tightening . . . . . 90–100°
- Hex collar bolt M12x1,5x85,12.9 (51.90020–0382)
  - Initial torque 80Nm
  - Angle tightening . . . . . 180–190°

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

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

Conrod bearing cover M14x1,5
- Initial torque . . . . . 100–110 Nm
- Angle tightening . . . . . 90–100°

Cylinder head

Tightening / retightening the cylinder-head bolts, see page 164
Rocker arm bracket to cylinder head . . . . . 65 Nm
Locknut on valve adjusting 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 drain plug to oil pan M26x1,5	80 Nm
Oil injection nozzle: flange to crankcase M14x1,5	70 Nm

Exhaust / Intake manifolds

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

Fuel system

Injector to cylinder head M28x1,5	120–125 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 M12x1,5	80 Nm
V-belt pulley on alternator (K1, N1)	40–50 Nm
V-belt pulley on alternator (NCB2)	75–85 Nm

Transmitter

Oil pressure transmitter	80 Nm
Temperature sensor	20 Nm

Installation tightening torques according to company standard M 3059

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

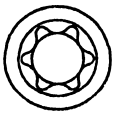
Thread size x pitch	Property classes / tightening torques in Nm		
	for **8.8** / **8**	for **10.9** / **10**	for **12.9** / **12**
M 4	2,5	4,0	4,5
M 5	5,0	7,5	9,0
M 6	9,0	13,0	15,0
M 7	14,0	20,0	25,0
M 8	22,0	30,0	35,0
M 8 x 1	23,0	35,0	40,0
M 10	45,0	65,0	75,0
M 10 x 1,25	45,0	65,0	75,0
M 10 x 1	50,0	70,0	85,0
M 12	75,0	105,0	125,0
M 12 x 1,5	75,0	110,0	130,0
M 12 x 1,25	80,0	115,0	135,0
M 14	115,0	170,0	200,0
M 14 x 1,5	125,0	185,0	215,0
M 16	180,0	260,0	310,0
M 16 x 1,5	190,0	280,0	330,0
M 18	260,0	370,0	430,0
M 18 x 2	270,0	290,0	450,0
M 18 x 1,5	290,0	410,0	480,0
M 20	360,0	520,0	600,0
M 20 x 2	380,0	540,0	630,0
M 20 x 1,5	400,0	570,0	670,0
M 22	490,0	700,0	820,0
M 22 x 2	510,0	730,0	860,0
M 22 x 1,5	540,0	770,0	900,0
M 24	620,0	890,0	1040,0
M 24 x 2	680,0	960,0	1130,0
M 24 x 1,5	740,0	1030,0	1220,0

Cylinder-head bolts
General notes

The engine may have either of the following two types of cylinder head bolt:

- Cylinder head bolts with hex head tightened by the angle−of−rotation method, socket size 19

- Cylinder head bolts with Torx head tightened by the angle−of−rotation method, Torx wrench size E18



Bolts to be used in event of repairs:

Bolts with hex head may be replaced by bolts with Torx head if all the bolts on the engine are to be changed.

Do not use bolts with hex head and bolts with Torx head on the same engine.

Retightening cylinder head bolts on new engines

(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:
After the first 400 hours of operation retighten cylinder head bolts 1 to 4 in the order shown in Tightening diagram 1” by a further 90° (1/4 turn).

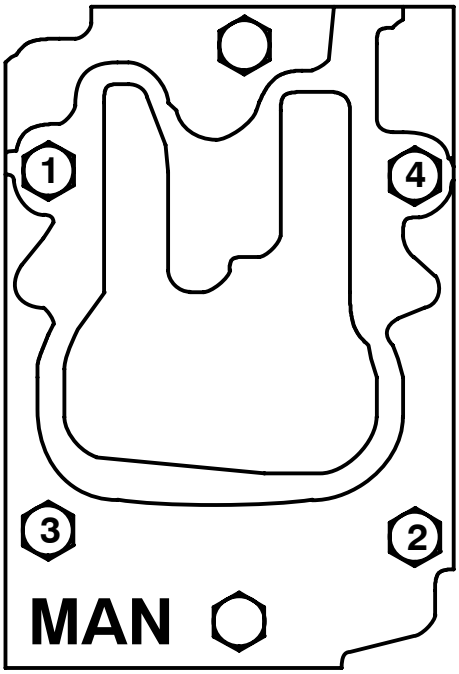
Remove the sticker **“First retightening of the cylinder-head bolts ...”** and attach the sticker **“Second retightening of the cylinder-head bolts ...”** to verify the second retightening.

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

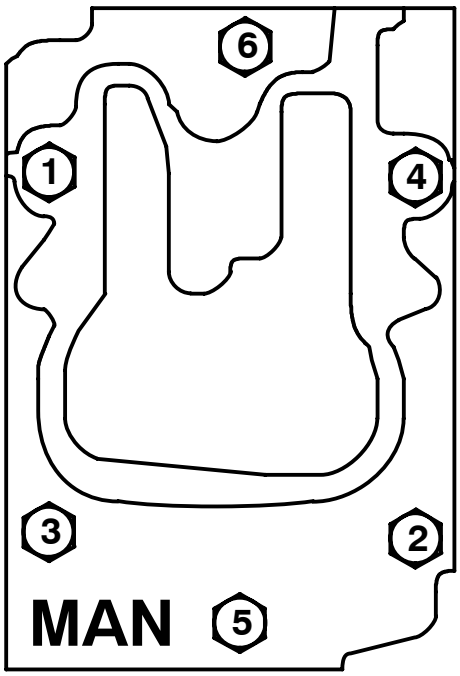
Retightening the cylinder-head bolts following a repair
(engine cold)

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 after a repair turn the cylinder head bolts by 90° (1/4 turn) in the order shown in tightening diagram **“2”**.
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

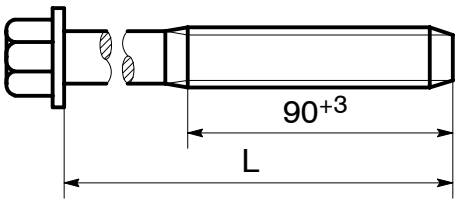
Before used cylinder-head bolts are reused, they must be checked as follows:

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.

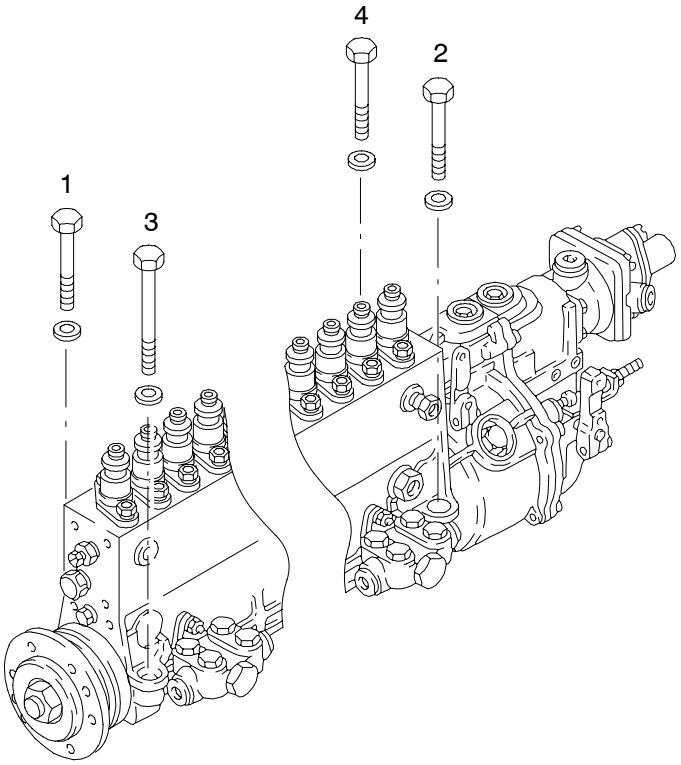


L = shaft length

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 2848 L.., D 2840 L..

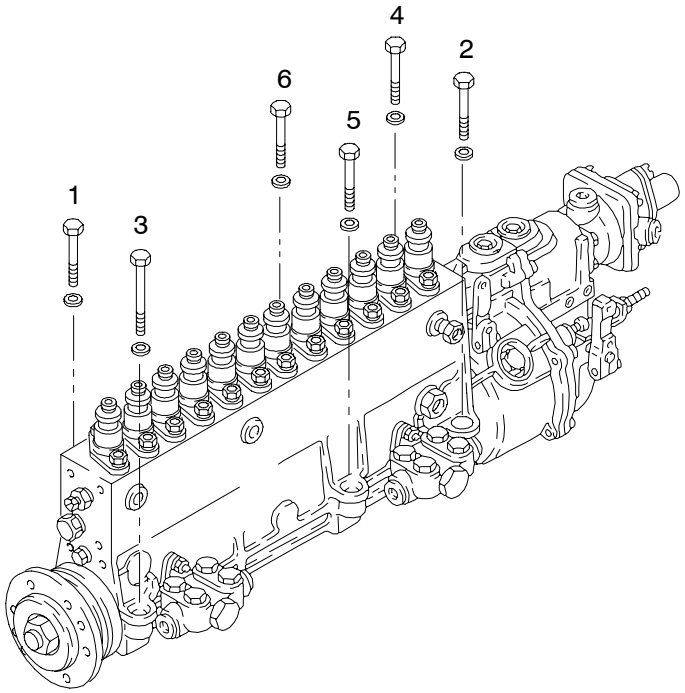


Order of tightening: 1–2–3–4
in the steps:

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.

D 2842 L..



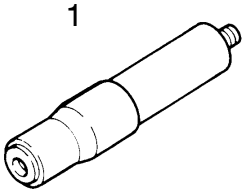
Order of tightening: 1–2–3–4 –5–6
in the steps:

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

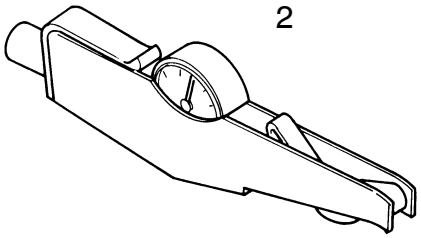
Bracket tightening method effective only if bolts of the **strength class 8.8** (no more) are used.

Special tools

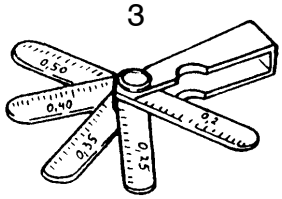
1



2



3



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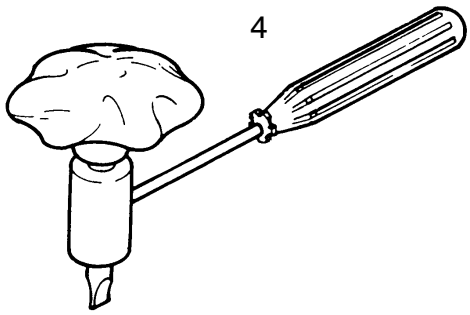

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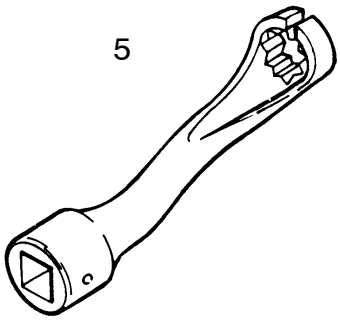

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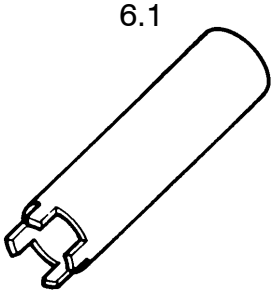

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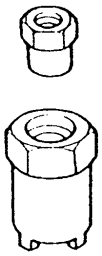

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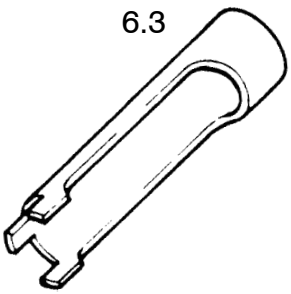

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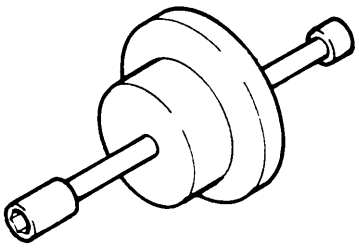

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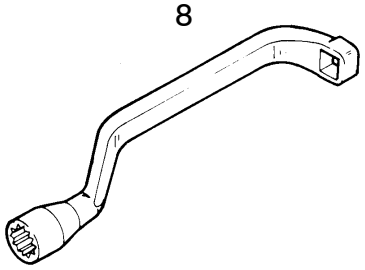

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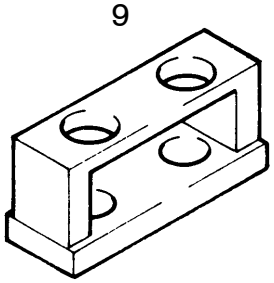
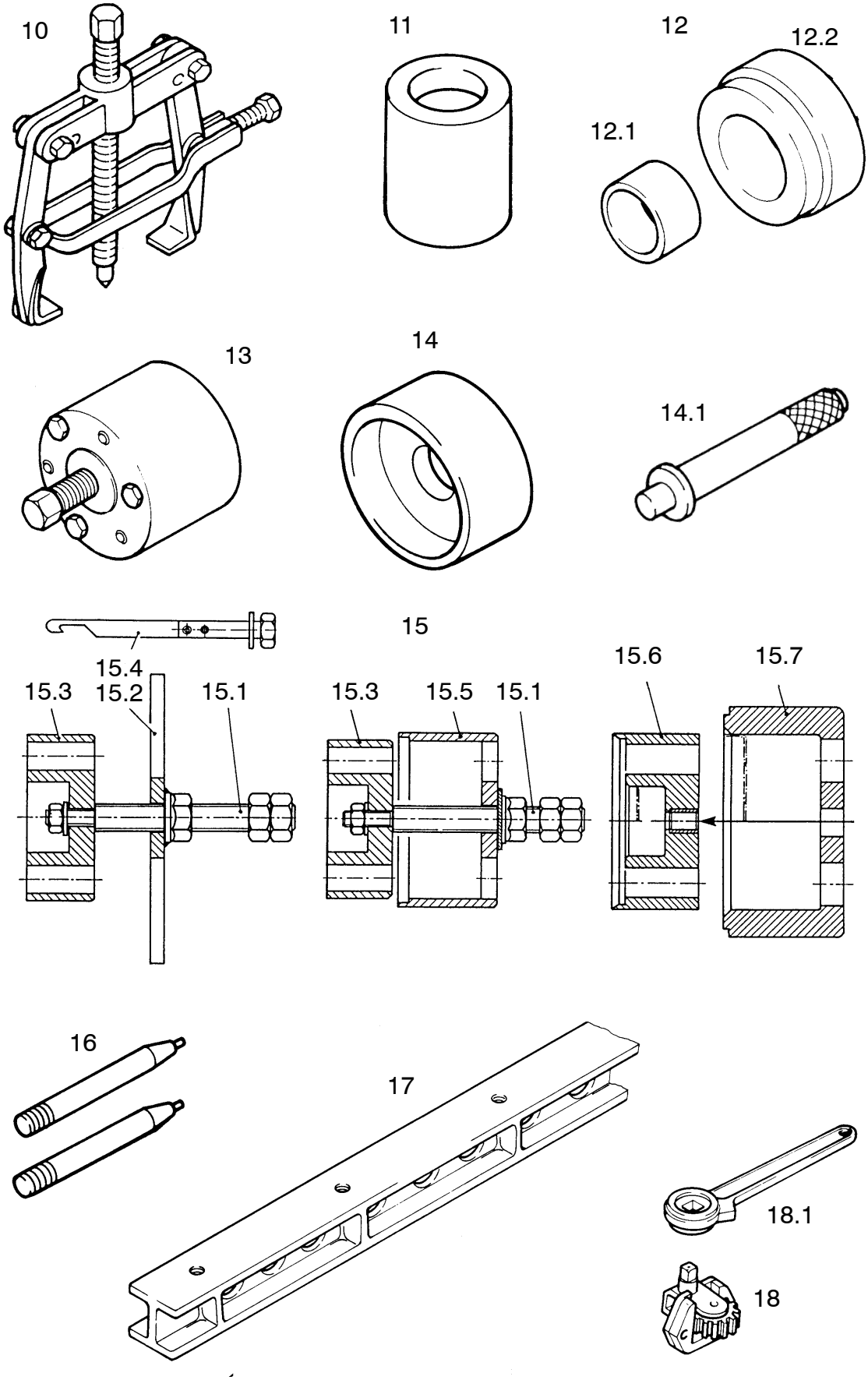


Fig. no.	Designation	Item number
1	Test connection for compression recorder	80.99607−0002
2	V-belt tension indicator	80.99605−0267
3	Valve gauge	80.99607−0076
4	Valve setting spanner	83.09195−0002
5	Spanner for nuts on injection lines (17 mm)	80.99603−0025
6	Socket spanner set for fuel injector	
6.1	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	Special wrench for cylinder head bolt under fuel injector	80.99603−0095
9	Clamping device for fuel injectors	80.99606−0008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18.1
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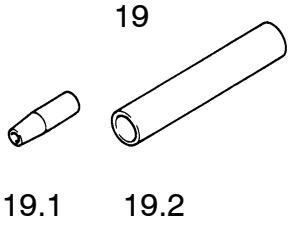
Fig. no.	Designation	Item number
10	Puller for water pump pulley	80.99601–0037
11	Pressing mandrel for cassette seal in conjunction with handle 14.1	80.99617–0091
12	Driving mandrel for seal in timing case	
	consisting of:	
12.1	Guide sleeve	80.99604–0068
12.2	Pressing plate in conjunction with handle 14.1	80.99604–0069
13	Puller for front crankshaft bearing race	80.99601–0076
14	Pressing tool for bearing race on flywheel in conjunction with handle 14.1	80.99617–0017
14.1	Handle	80.99617–0129
15	Special tools for front crankshaft seal	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	Pressing sleeve	80.99606–0300
15.6	Adapter	80.99606–0302
15.7	Fitting sleeve	80.99606–0301
16	Guide mandrels for flywheel	80.99617–0020
17	Steel ruler	80.99607–0044
18	Engine turning device	80.99626–0004
18.1	Standard ratchet for 18	80.99627–0001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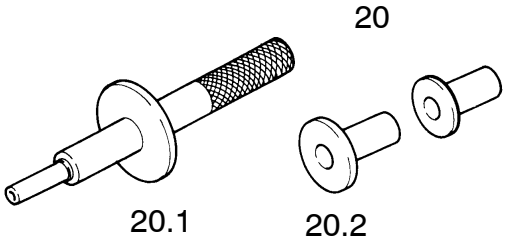
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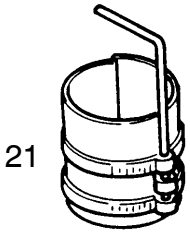
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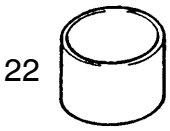
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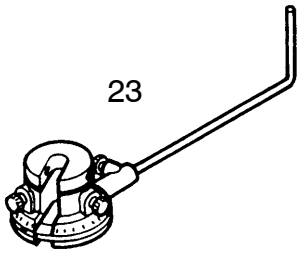
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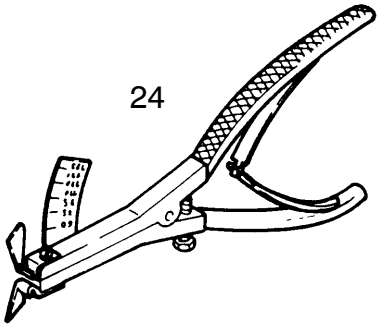
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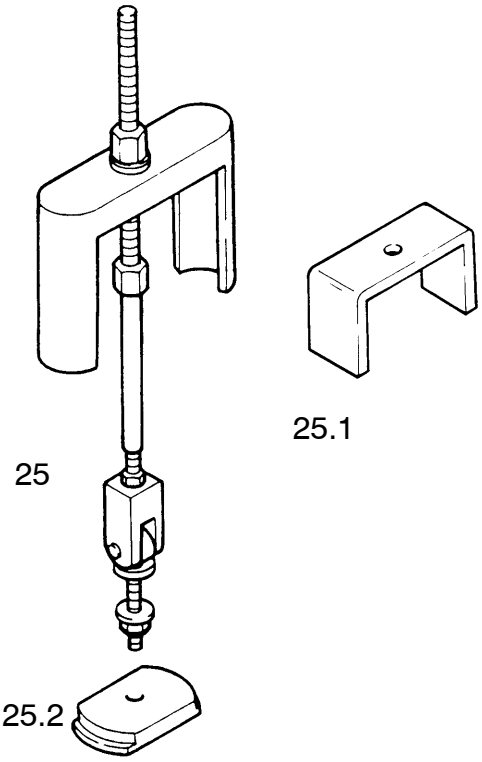
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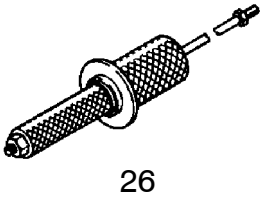
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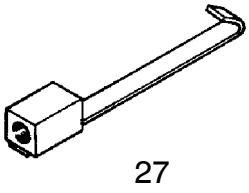
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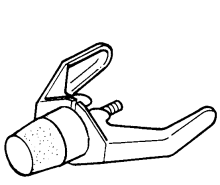
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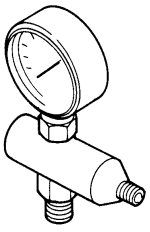

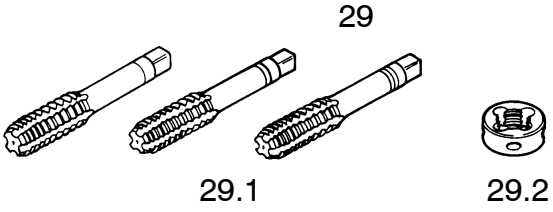
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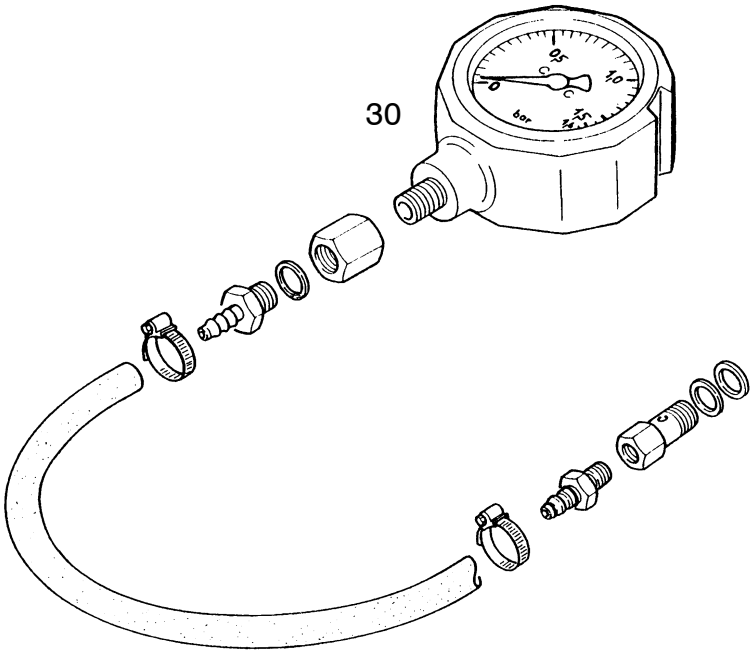
Fig. no.	Designation	Item number
19	Sleeves for valve stem seal	
19.1	Insert sleeve for valve stem seal	80.99616–0004
19.2	Pressing sleeve for valve stem seal	80.99604–0005
20	Pressing tool for valve guide	
20.1	Pressing mandrel for valve guide	80.99617–0013
20.2	Pressing rings in conjunction with 20.1	80.99616–0003
21	Piston ring tightener	80.99613–0035
22	Piston ring tightening sleeve	83.09144-0187
23	Tightening angle gauge	80.99605–0010
24	Piston ring pliers	83.09144–6090
25	Cylinder liner extractor device	80.99602–0019
25.1	Support for 25	80.99623–0003
25.2	Extractor plate	83.09143–0195
26	Extractor	80.99602–0016
27	Puller hook for rear crankshaft seal, in conjunction with 26	80.99602–0175
28	Cooling system test unit	80.99607–0061
29	Thread-cutting tool	
29.1	Thread drill set, M15 x 2, for cylinder head bolt threads	80.40001–0001
29.2	Associated die ring	80.43001–0001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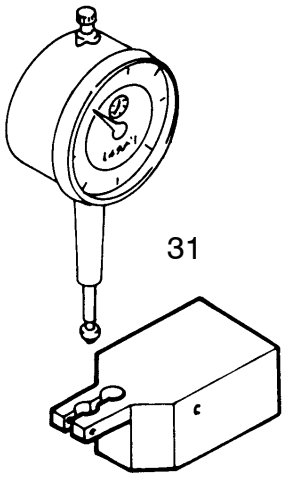
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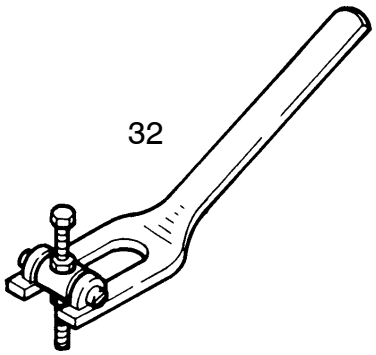

32

Fig. no.	Designation	Item number
30	Pressure gauge + accessories for charge-air pressure measurement	80.99605–0160
31	Dial gauge holder for measuring valve retrusion and piston protrusion	90.99605–0172
32	Valve assembly lever	80.99606–0031

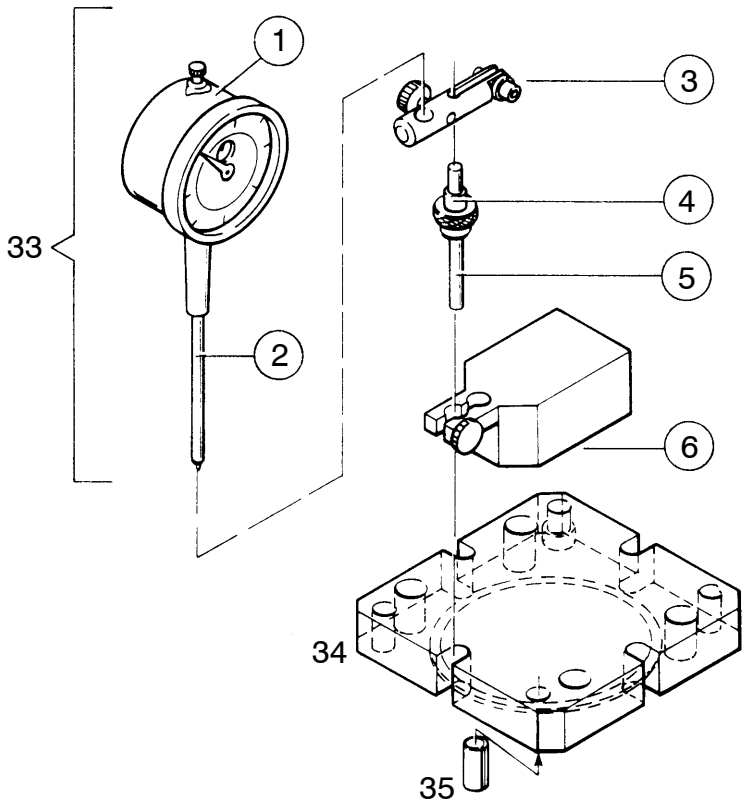
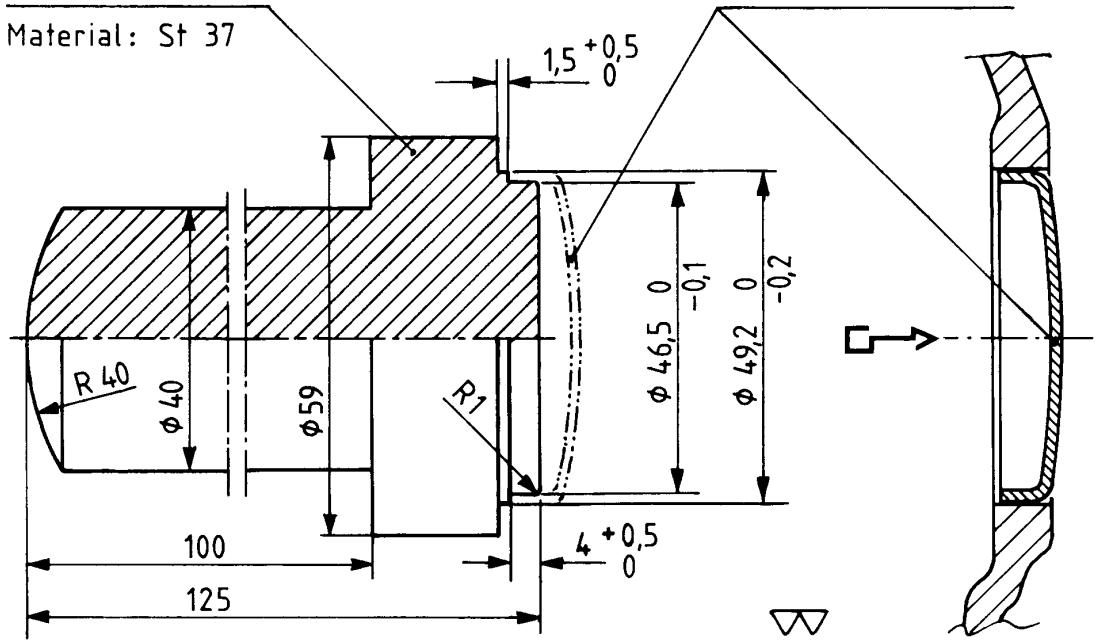
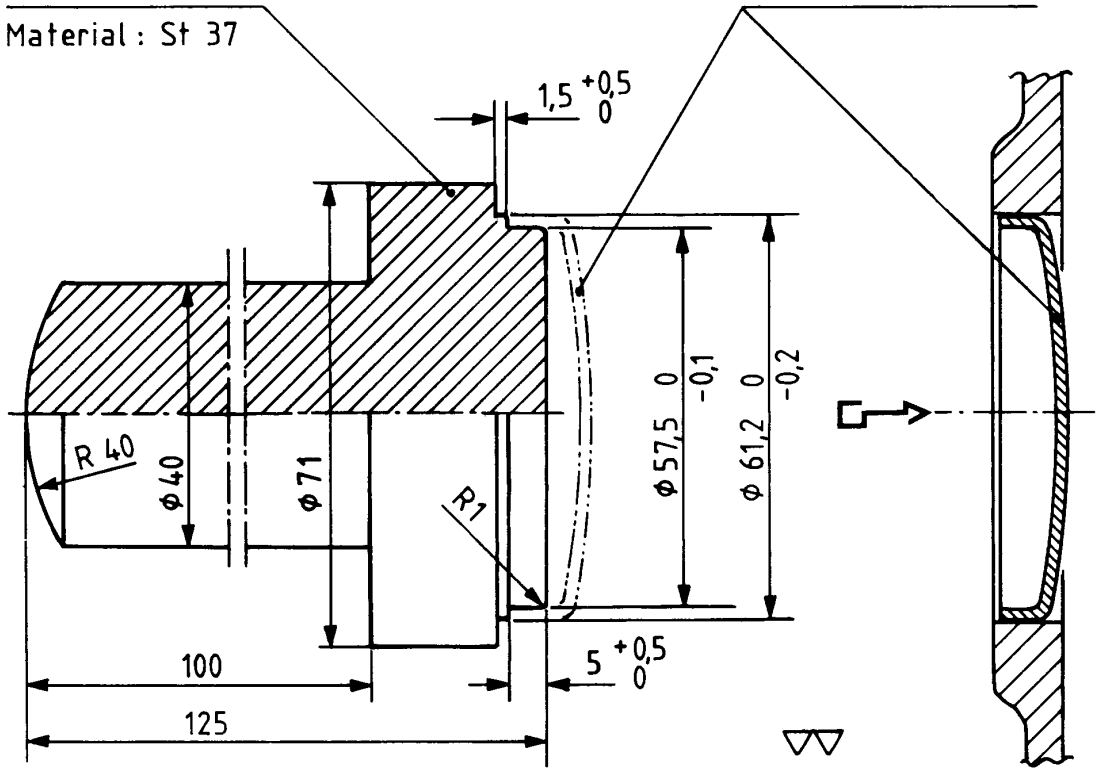


Fig. no.	Designation	Item number
33	Measuring combination, consisting of:	
	(1) Dial gauge	08.71000–1205
	(2) Tracer pin for dial gauge	80.99605–0197
	(3) Dial gauge holder	80.99605–0179
	(4) Contact pin	80.99605–0180
	(5) Dial gauge holder	80.99605–6006
	(6) Dial gauge holder	80.99605–0172
34	Press-on measuring plate	80.99605–0195
35	Fitting sleeves	51.91701–0247
36	Extractor for ring on the flywheel (no fig.)	80.99601–6017

Pressing mandrel for cap, dia. 50.1 mm



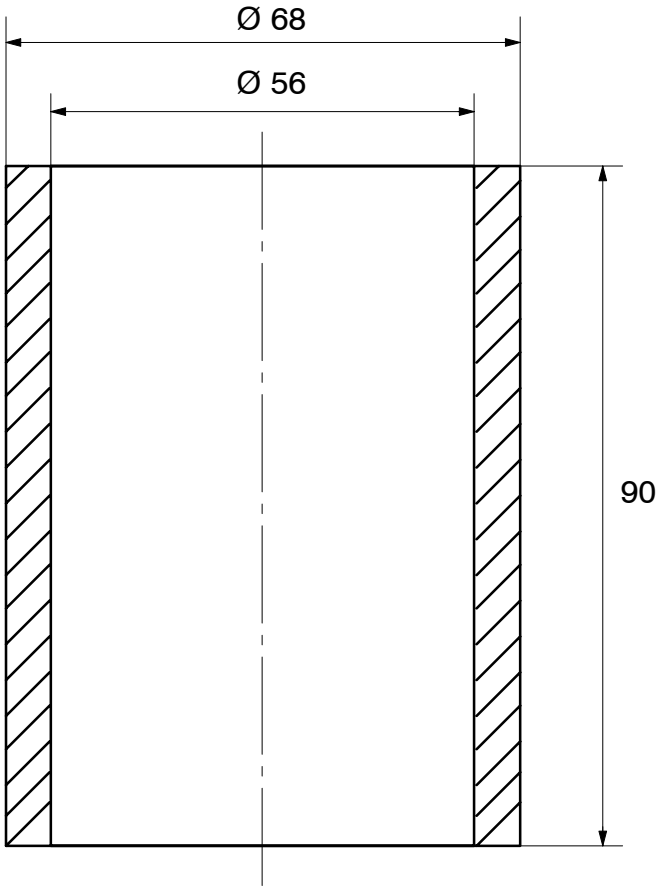
Pressing mandrel for cap, dia. 62.1 mm



Special tools for water pump repair for local manufacture

(Material: steel as available)

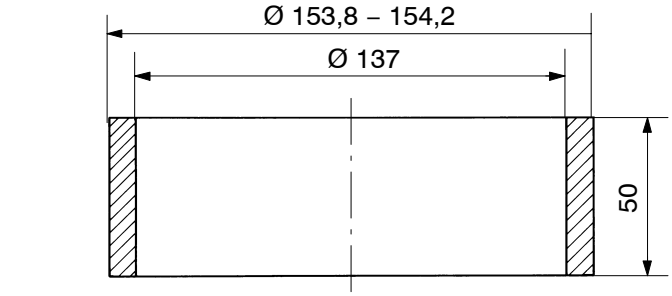
Support ring for pressing out the water pump bearing

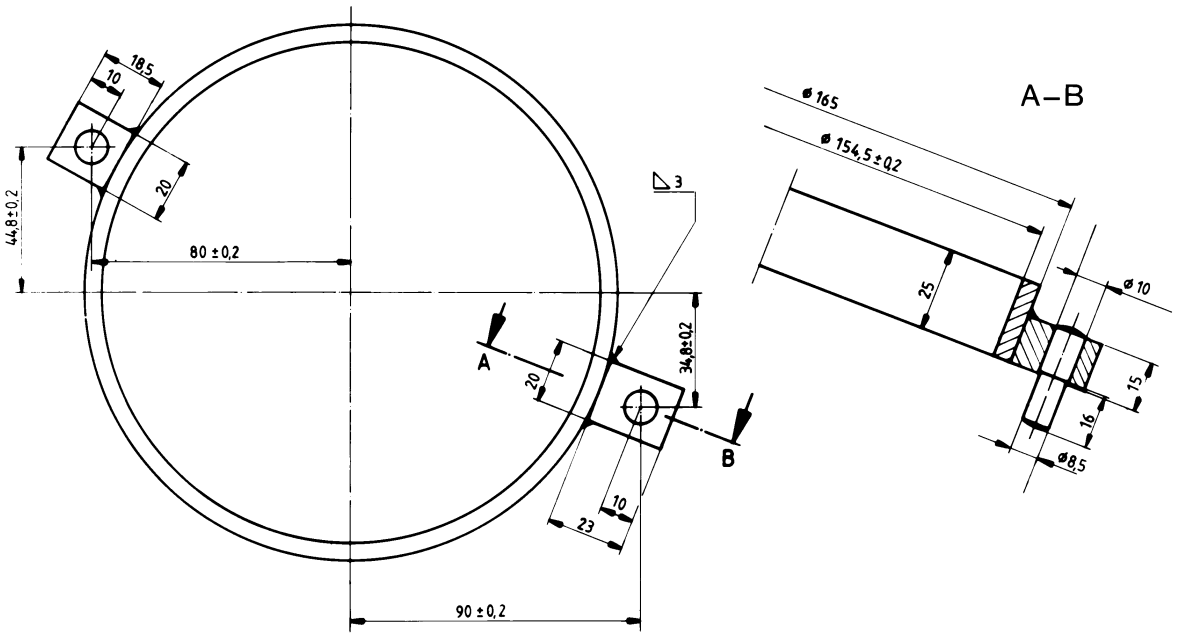


Special tools for water pump repair for local manufacture

(Material: steel as available)

Pressing ring for water pump cover





Support ring for pressing in the water pump cover

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