



Operating Instructions for MAN Industrial Diesel Engines
Bedienungsanleitung für MAN-Industriedieselmotoren

D 2866 TUE

Description,
Operating and Maintenance Instructions –
for Diesel Engine





Dear Customer,

these Operating Instructions are intended to familiarize you with your new MAN Diesel engine and how it operates.

This manual is supplemented by the publication “Fuels, Lubricants and Coolants for MAN Diesel Engines” and the “Service record”.

Note:

All three publications belong to the engine and must always be kept ready to hand near the engine in the engine room.

Please read this Manual and the “Installation Instructions” before you put the new engine into operation.

Comply in full with instructions relating to operation, prevention of accidents and environmental protection.

MAN Diesel engines are developed and manufactured in line with the latest state of the art. However, trouble-free operation and high performance can only be achieved if the specified maintenance intervals are observed and only approved fuels, lubricants and coolants are used.

It is imperative and in your own interest to entrust your MAN Local Service Centre with the removal of any disturbances and with the performance of checking, setting, and repair work.

Yours faithfully,
MAN Nutzfahrzeuge Aktiengesellschaft
Werk Nürnberg

Subject to change to keep abreast with technological progress.

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Declaration

In accordance with Article 4, paragraph 2, in conjunction with Appendix II, section B, of Directive 89/392/EEC, version 93/44/EEC

MAN Nutzfahrzeuge Aktiengesellschaft,

hereby declares that the engine described below is destined for installation in a machine as defined in the EC directive on machines.

Engine model:

Design:

For data see original declaration

Engine number:

If required this declaration is enclosed with the delivery note.

Rating / speed:

Note:

The manufacturer of the complete ready-to-use machine in which this engine is to be installed must take the further action necessary in the context of indirect safety-related engineering and provision of instructions to ensure that the ready-to-use machine complies with the requirements of the EC directive on machines.

The engine must not be put into operation until the complete machine satisfies the conditions laid down in the EC directive on machines 89/392/EEC, most recently amended by 93/44/EEC, or the latest amendment of said directive.

MAN Nutzfahrzeuge Aktiengesellschaft

Vogelweiherstraße 33

D-90441 Nürnberg



Nameplates

In all your correspondence please always quote engine model, serial number and job number (Order number).

For this reason it is advisable to read off the data from the engine type plates before putting the engine into operation and to enter them in the appropriate spaces.

The engine type plates are on the crankcase.

Model

delivered on

installed on

Engine serial number

Order number

MAN Nutzfahrzeuge Aktiengesellschaft
 Typ
 Motor-Nr. / Engine No. NI/II

MAN Nutzfahrzeuge Aktiengesellschaft
 Werk Nürnberg Germany
DIESEL ENGINE

Bauj. Year	Typ	Model	Motor-Nr.	Serial No
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Werk-Nr.	Job No	Leistung kW Rating kW	Drehz. 1/min	Speed rpm
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Temp.°C	Leistg. PS Rating BHP	Aufstellhöhe m uNN Altitude m		
<input type="text"/>	<input type="text"/>	<input type="text"/>		

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General notes

Day-to-day use of power engines and the service products (fuels, lubricants, coolants) necessary for running them presents no problems if the persons occupied with their operation, maintenance and care are given suitable training and think as they work.

This summary is a compilation of the most important regulations. These are broken down into main sections which contain the information necessary for preventing injury to persons, damage to property and pollution. In addition to these regulations those dictated by the type of engine and its site are to be observed also.

Important:

If, despite all precautions, an accident occurs, in particular through contact with caustic acids, fuel penetrating the skin, scalding from hot oil, anti-freeze being splashed in the eyes etc., **consult a doctor immediately.**

1. Regulations designed to prevent accidents with injury to persons

During commissioning, starting and operation

- Before putting the engine into operation for the first time, read the operating instructions carefully and familiarize yourself with the “critical” points. If you are unsure, ask your MAN representative.
- For reasons of safety we recommend you attach a notice to the door of the engine room prohibiting the access of unauthorized persons and that you draw the attention of the operating personal to the fact that they are responsible for the safety of persons who enter the engine room.
- The engine must be started and operated only by authorized personnel. Ensure that the engine cannot be started by unauthorized persons.
- When the engine is running, do not get too close to the rotating parts. Wear close-fitting clothing.
- Do not touch the engine with bare hands when it is warm from operation – risk of burns.
- Exhaust gases are toxic. Comply with the instructions for the installation of MAN Diesel engines which are to be operated in enclosed spaces. Ensure that there is adequate ventilation and air extraction.



- Keep vicinity of engine, ladders and stairways free of oil and grease. Accidents caused by slipping can have serious consequences.

During maintenance and care

- Always carry out maintenance work when the engine is switched off. If the engine has to be maintained while it is running, e.g. changing the elements of change-over filters, remember that there is a risk of scalding. Do not get too close to rotating parts.
- Change the oil when the engines is warm from operation.
Caution:
There is a risk of burns and scalding. Do not touch oil drain plugs or oil filters with bare hands.
- Take into account the amount of oil in the sump. Use a vessel of sufficient size to ensure that the oil will not overflow.
- Open the coolant circuit only when the engine has cooled down. If opening while the engine is still warm is unavoidable, comply with the instructions in the chapter entitled "Maintenance and Care".
- Neither tighten up nor open pipes and hoses (lube oil circuit, coolant circuit and any additional hydraulic oil circuit) during the operation. The fluids which flow out can cause injury.
- Fuel is inflammable. Do not smoke or use naked lights in its vicinity. The tank must be filled only when the engine is switched off.
- When using compressed air, e.g. for cleaning the radiator, wear goggles.
- Keep service products (anti-freeze) only in containers which can not be confused with drinks containers.
- Comply with the manufacturer's instructions when handling batteries.
Caution:
Accumulator acid is toxic and caustic. Battery gases are explosive.



2. Regulations designed to prevent damage to engine and premature wear

Do not demand more from the engine than it is able to supply in its intended application. Detailed information on this can be found in the sales literature. The injection pump must not be adjusted without prior written permission of MAN Nürnberg.

If faults occur, find the cause immediately and have it eliminated in order to prevent more serious damage.

Use only genuine MAN spare parts. MAN will accept no responsibility for damage resulting from the installation of other parts which are supposedly “just as good”.

In addition to the above, note the following points:

- Never let the engine run when dry, i.e. without lube oil or coolant.
- When starting do not use any additional starting aids (e.g. injection with starting pilot).
- Use only MAN-approved service products (fuel, engine oil, anti-freeze and anti-corrosion agent). Pay attention to cleanliness. The Diesel fuel must be free of water. See “Maintenance and care”.
- Have the engine maintained at the specified intervals.
- Do not switch off the engine immediately when it is warm, but let it run without load for about 5 minutes so that temperature equalization can take place.
- Never put cold coolant into an overheated engine. See “Maintenance and care”.
- ***Do not add so much engine oil that the oil level rises above the max. marking on the dipstick. Do not exceed the maximum permissible tilt of the engine.***
Serious damage to the engine may result if these instructions are not adhered to.
- Always ensure that the testing and monitoring equipment (for battery charge, oil pressure, coolant temperature) function satisfactorily.
- Comply with instructions for operation of the alternator. See “Maintenance and care”.

3. Regulations designed to prevent pollution

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

- Take old oil only to an old oil collection point.
- Take strict precautions to ensure that no oil or Diesel fuel gets into the drains or the ground.
The drinking water supply could be contaminated.
- Filter elements are classed as dangerous waste and must be treated as such.

Coolant

- Treat undiluted anti-corrosion agent and / or anti-freeze as dangerous waste.
- When disposing of spent coolant comply with the regulations of the relevant local authorities.

4. Notes on safety in handling used engine oil *

Prolonged or repeated contact between the skin and any kind of engine oil decreases the skin. Drying, irritation or inflammation of the skin may therefore occur. Used engine oil also contains dangerous substances which have caused skin cancer in animal experiments. If the basic rules of hygiene and health and safety at work are observed, health risks are not to the expected as a result of handling used engine oil.

Health precautions:

- Avoid prolonged or repeated skin contact with used engine oil.
- Protect your skin by means of suitable agents (creams etc.) or wear protective gloves.
- Clean skin which has been in contact with engine oil.
 - Wash thoroughly with soap and water. A nailbrush is an effective aid.
 - Certain products make it easier to clean your hands.
 - Do not use petrol, Diesel fuel, gas oil, thinners or solvents as washing agents.
- After washing apply a fatty skin cream to the skin.
- Change oil-soaked clothing and shoes.
- Do not put oily rags into your pockets.

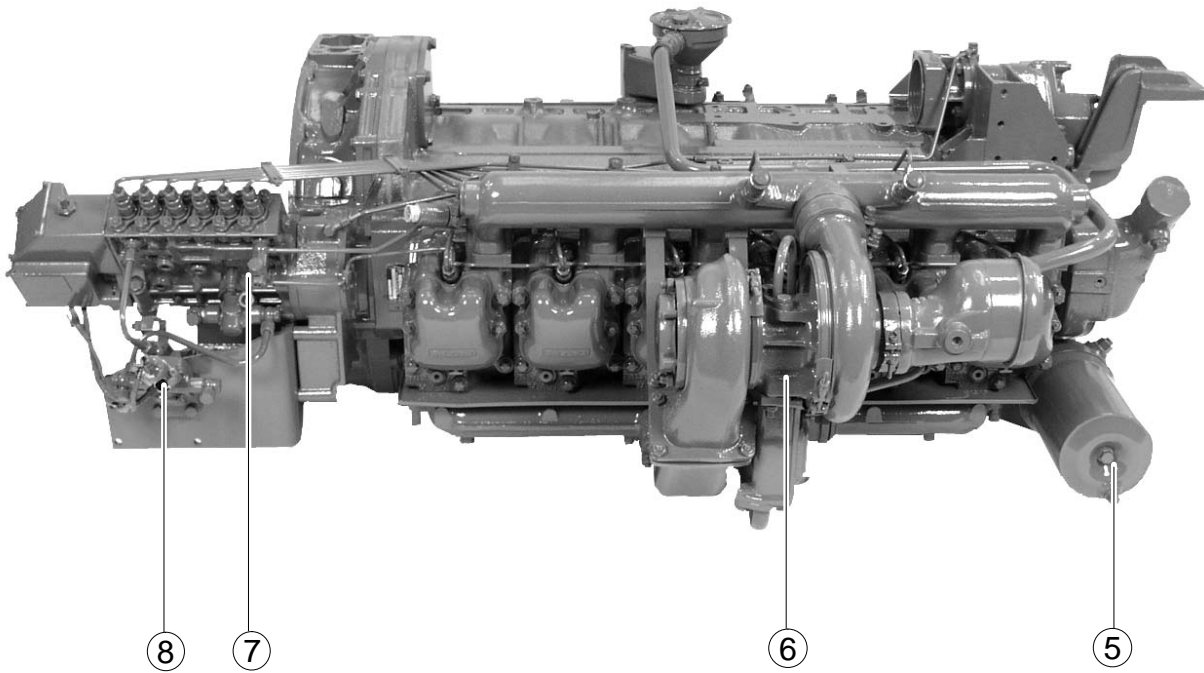
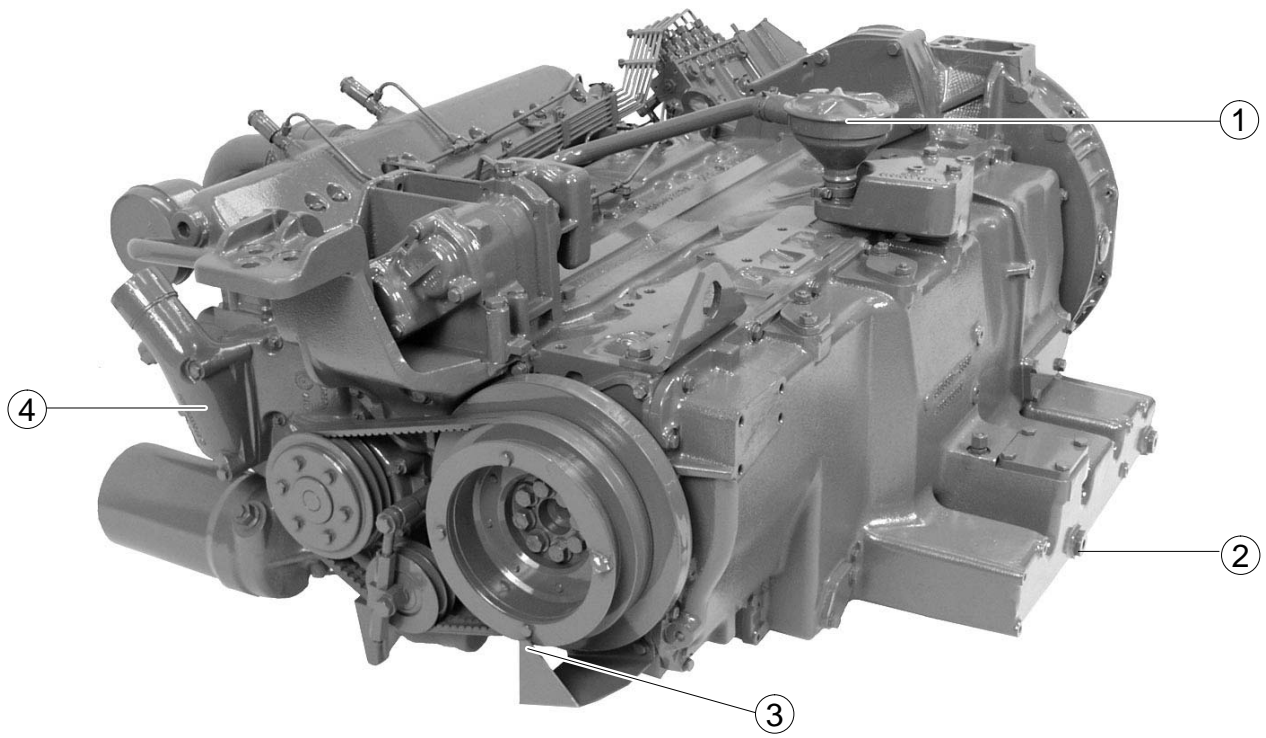
Ensure that used engine oil is disposed of properly – Engine oil can endanger the water supply –

For this reason do not let engine oil get into the ground, waterways, the drains or the sewers. Violations are punishable.

Collect and dispose of used engine oil carefully. For information on collection points please contact the seller, the supplier or the local authorities.

* Adapted from "Notes on handling used engine oil".

Engine views D 2866 TUE



-
- 1 Crankcase breather
 - 2 Oil drain plug
 - 3 TDC mark
 - 4 Water pump
 - 5 Oil filter
 - 6 Turbocharger
 - 7 Injection pump
 - 8 Electrohydraulic shut-off device (EHAB)

Engine

The D 2866 TUE Engine is a liquide-cooled 6-cylinder four stroke Diesel engine with direct injection and supercharging.

The cylinders are in a horizontal in-line arrangement (for underfloor installation).

Crankcase

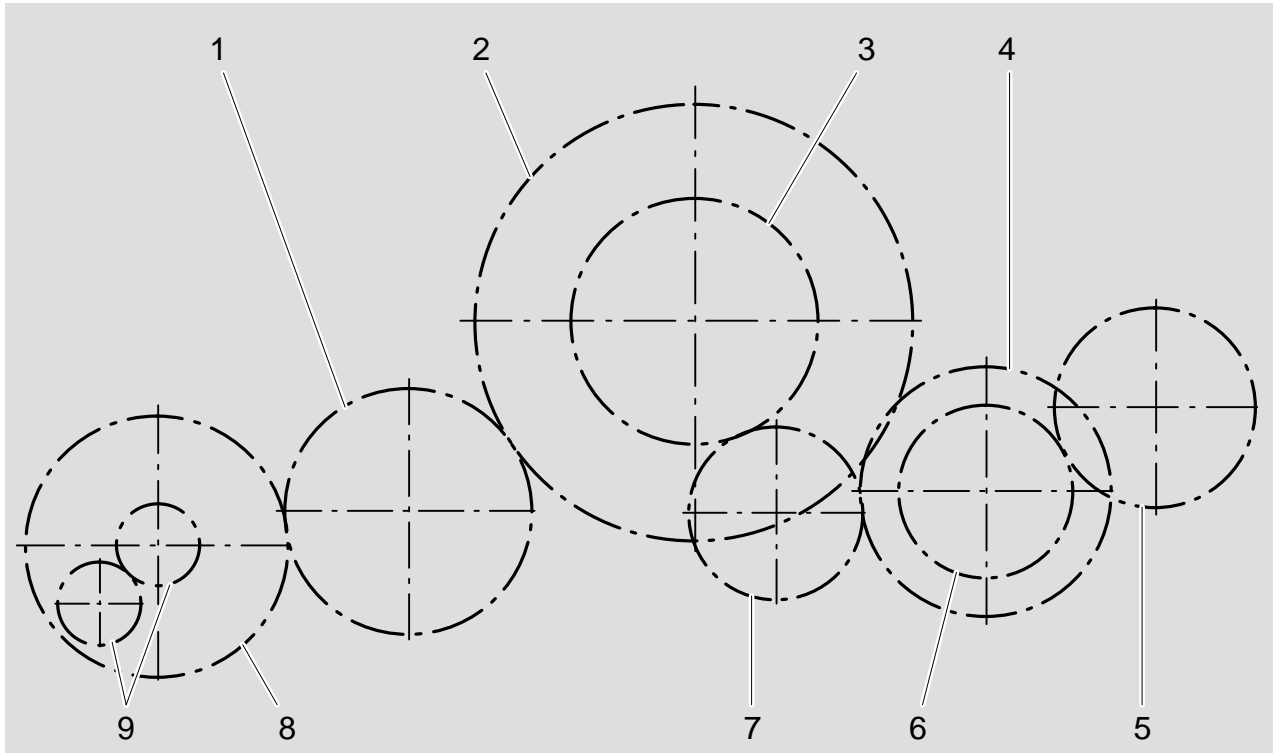
The cylinder block is a single piece of alloy cast iron. To increase it's stiffness, it is extended to a level below the crankshaft centre line. The engine has exchangeable wet cylinder liners and individual cylinderheads with shrunk-in valve seat rings and replaceable valve guides. Wherever a cylinder head has been removed the cylinder head gasket should be changed.

Crank assembly

The forged crankshaft runs in 7 bearings and has screwed-on counterweights. Radial seals with replaceable wearing rings on crankshaft and flywheel are provided to seal the crankcase penetrations.

The connecting rods are die-forged, diagonally split and can be removed through the top of the cylinders together with the pistons. The crankshaft and connecting rods run in ready-backed lead-bronze bearings.

Engine timing



- | | |
|-----------------------|-----------------------------|
| ① Crankshaft gear | ⑤ Injection pump drive gear |
| ② Camshaft drive gear | ⑥ Drive gear |
| ③ Drive gear | ⑦ Idler gear |
| ④ Idler gear | ⑧ Oil pump drive gear |
| | ⑨ Oil pump impeller gears |

The crankshaft gear and the camshaft drive gear are match-marked by the digit “1” or “●”.

Valves

The overhead valves are actuated via chilled cast iron tappets, push rods and rocker arms from the camshaft.

Engine lubrication

The engine is equipped with force-feed lubrication.

The pressure is generated by a gear pump. The drive gear is in direct mesh with the crankshaft gear at the flywheel end. A second oil pump (scavenge pump) supplies the oil from the sump area to the inlet chamber of the pressure pump.

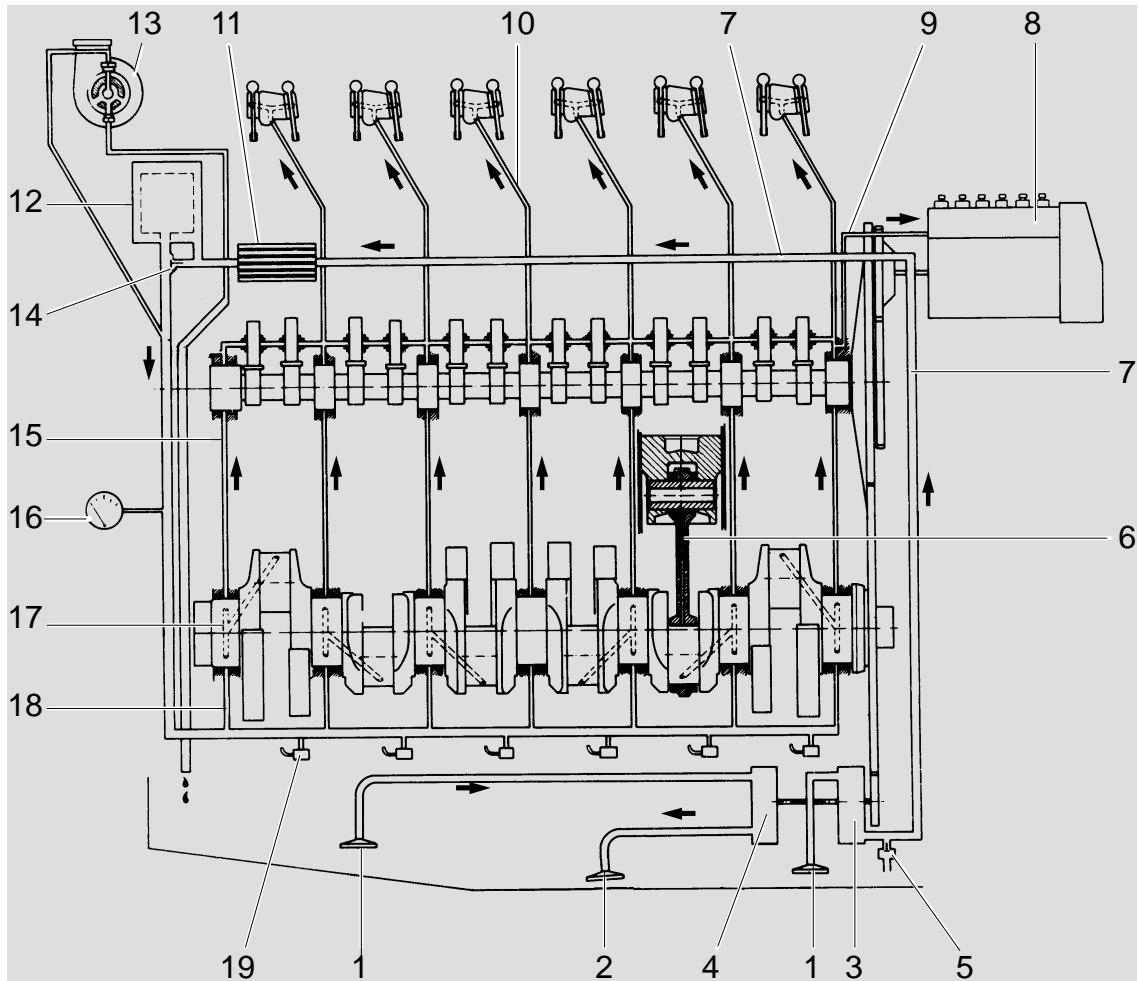
The oil pump draws the oil from the oil sump and delivers it via the oil cooler and oil filter to the main distributor gallery and there to the main bearings, big-end bearings and camshaft bearings as well as to the piston pin bushings and the rocker arms. The injection pump is likewise lubricated by the oil from the engine's lubrication system.

The cylinder walls and timing gears are splash-lubricated.

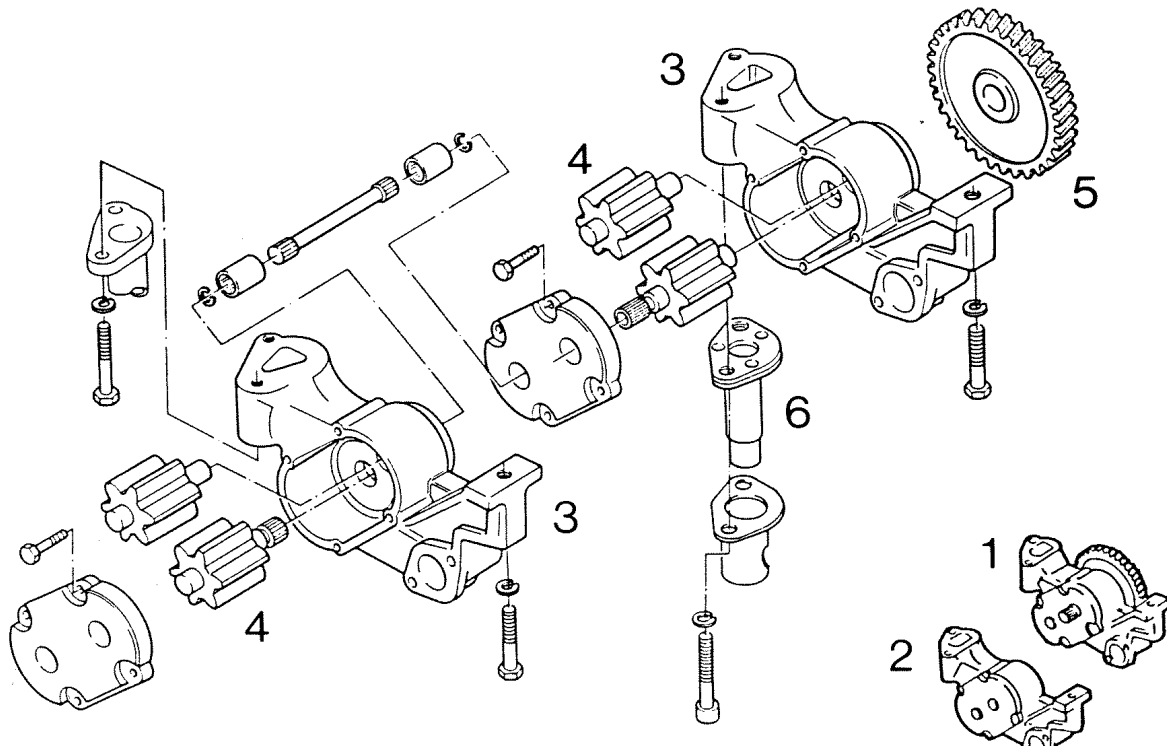
Each cylinder has an oil jet for piston cooling.

The engine is equipped with an oil pressure sensor.

Lubricating system D 2866 TUE



- | | |
|---|--|
| ① Oil pump strainer | ⑪ Oil cooler |
| ② Oil settling strainer | ⑫ Oil filter |
| ③ Oil pressure pump | ⑬ Exhaust turbocharger |
| ④ Oil scavenge pump | ⑭ Bypass valve (in oil cooler housing) |
| ⑤ Oil overpressure valve | ⑮ Oil bore for camshaft bearings |
| ⑥ Oil bore for piston lubrication | ⑯ Oil pressure monitors |
| ⑦ Oil bore to oil cooler | ⑰ Oil bore for big-end bearings |
| ⑧ Injection pump | ⑱ Oil bore for crankshaft bearings |
| ⑨ Oil bore for injection pump lubrication | ⑲ Oil jet for piston cooling and lubrication |
| ⑩ Oil bore for rocker arm lubrication | |

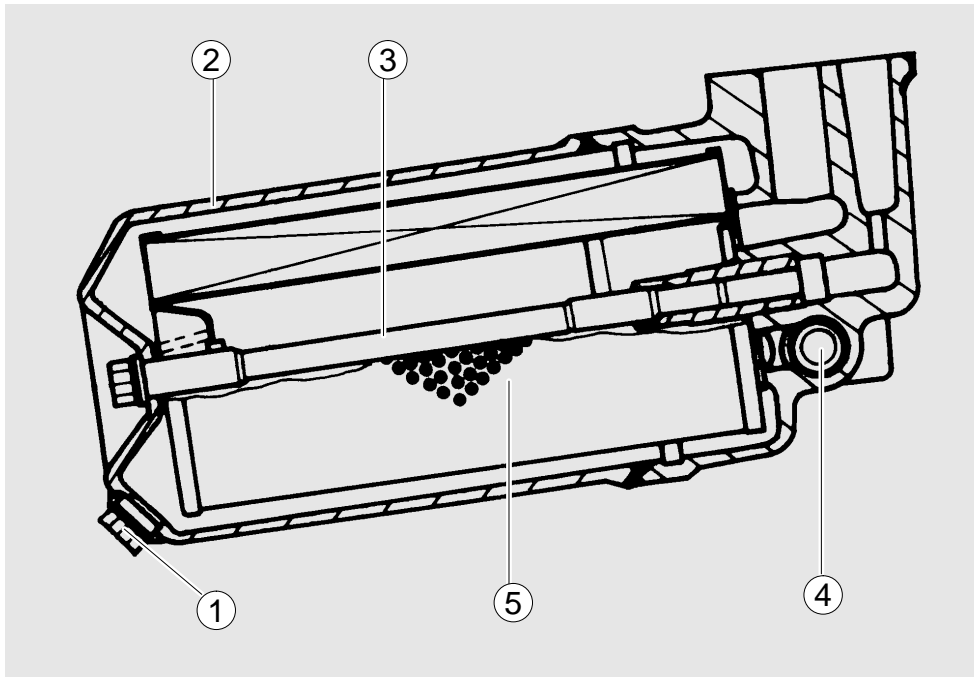


- ① Pressure pump
- ② Scavenge oil pump
- ③ Oil pump housing
- ④ Oil pump gears
- ⑤ Oil pump drive gear
- ⑥ Oil pressure relief valve

The oil filter is attached by a flange to the oil cooler housing.

The lubrication oil is cleaned in a full-flow filter. The element consists of a paper cartridge and a strainer element.

The strainer element has three valves for bypassing the paper filter cartridge (for opening pressure see "Technical Data"). The strainer element ensures that oil does not reach the engine unfiltered after a cold start or if the paper cartridge is clogged but partially cleans it first.



- ① Drain plug
- ② Filter bowl
- ③ Clamping bolt
- ④ Bypass valve
- ⑤ Filter cartridge

The oil filter is attached by a flange to the oil cooler housing.

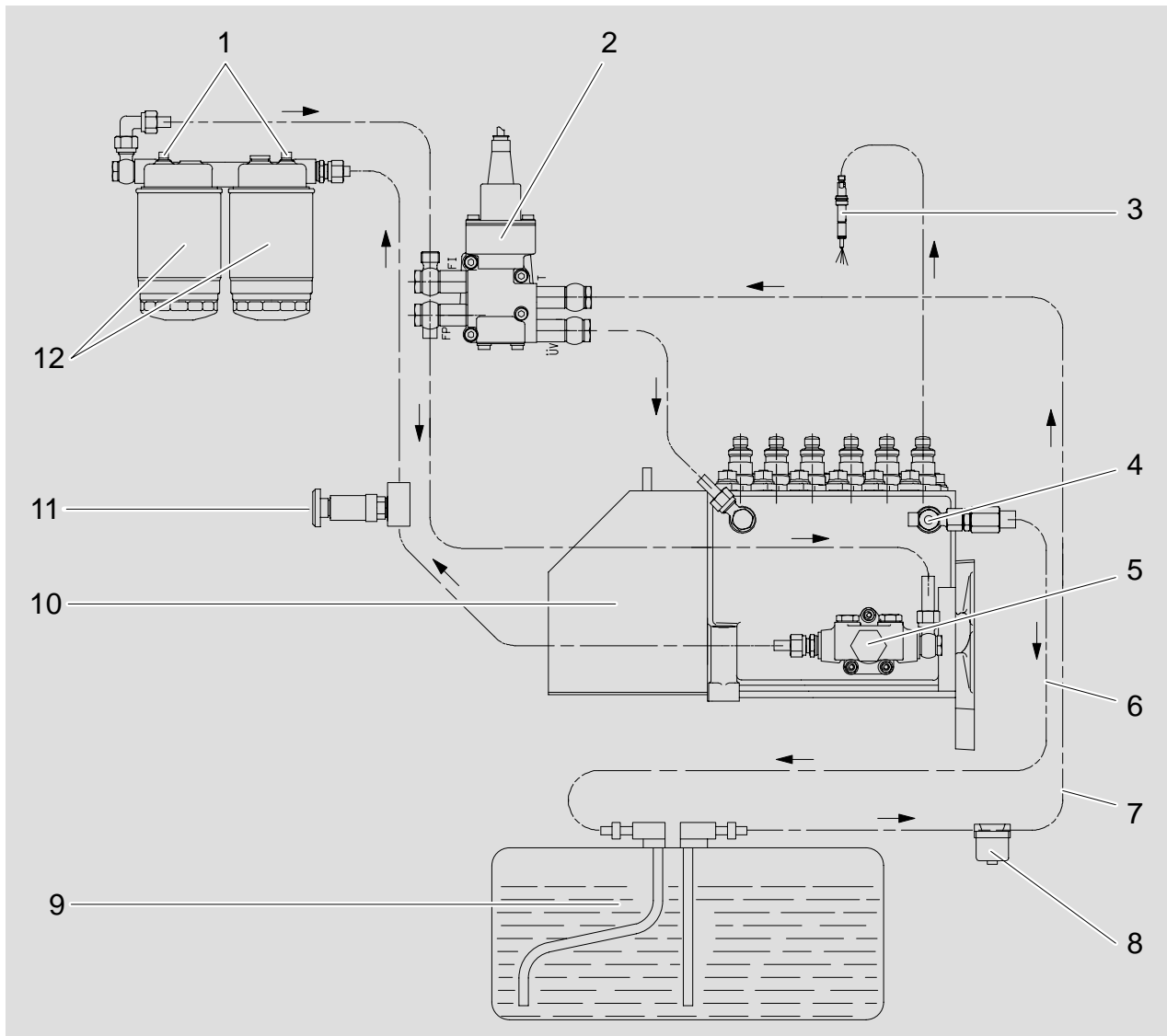
The lubrication oil is cleaned in a full-flow filter. The element consists of a paper cartridge and a strainer element.

The bypass valve in the oil filter housing safeguards the oil supply to the engine even if the filter element is clogged.

An oil cooler is fitted between the oil filter and the crankcase. This cooler is of the flat tube type with turbulence inserts and is operated by the cooling water.

Fuel system

Fuel flow when the engine is running

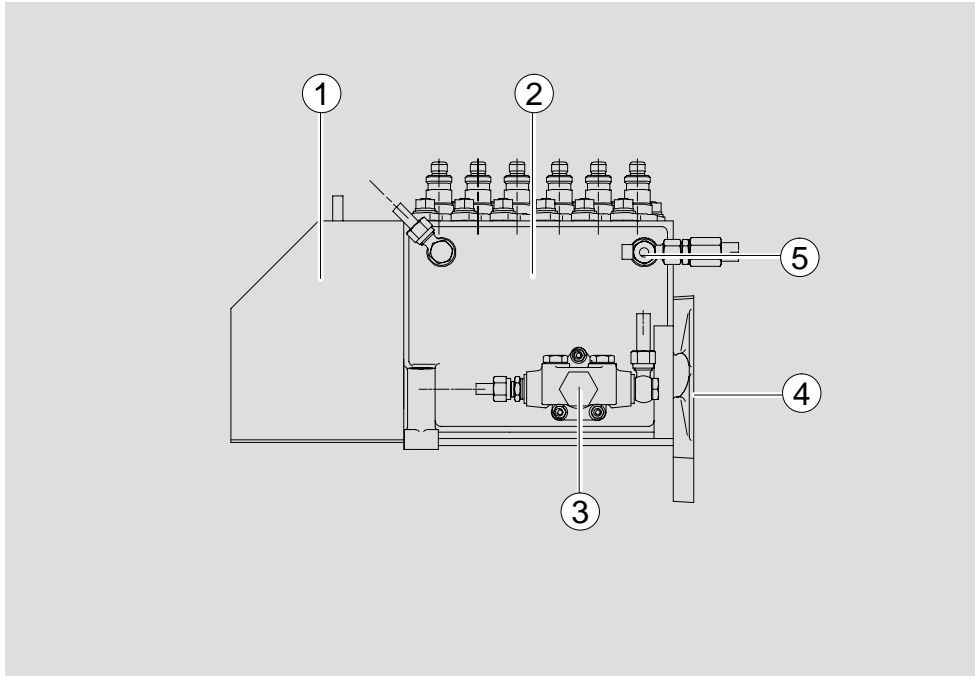


- | | |
|-----------------------------------|------------------------|
| ① Bleeder screws | ⑦ Suction line |
| ② Redundant cut-off device (EHAB) | ⑧ Pre filter |
| ③ Injection nozzles | ⑨ Fuel tank |
| ④ Overflow valve | ⑩ Injection pump |
| ⑤ Fuel lift pump | ⑪ Hand pump |
| ⑥ Return line | ⑫ Parallel fuel filter |

* When the engine is shut down by means of the electro-hydraulic cutout (emergency stop), the direction of fuel flow is switched so that fuel is returned from the suction gallery of the injection pump to the fuel tank. In this case the bypass serves to bypass the hand primer through which fuel can flow in one direction only.

Injection pump

The in-line injection pump is driven from the crankshaft via gears. It is connected to the force-feed lubricating system of the engine and consequently maintenance-free. The final control element is flanged to the injection pump housing.



- ① GAC-electronic speed governor
- ② Injection pump
- ③ Fuel lift pump
- ④ Driving hub
- ⑤ Overflow valve

Fuel lift pump

The fuel lift pump is a mechanical reciprocating pump and is attached to the injection pump. Its spring-loaded piston is driven via roller by cam on the injection pump camshaft.

Pre filter, hand pump

The strainer and the manual primer are mounted together with the fuel filter on a bracketed (not supplied). They are fitted in the intake line between the fuel tank and the fuel lift pump.

The pre filter protects the fuel lift pump and also prevents larger impurities from entering the filter.

With the help of the hand pump the injection system can be filled with fuel after repairs etc. before the engine is started. It also serves to bleed the fuel system.

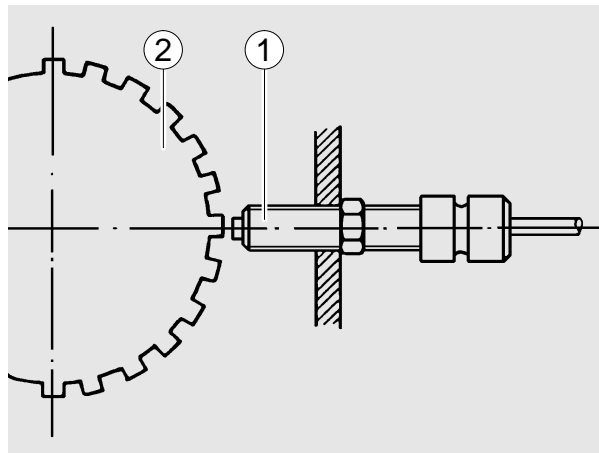
Basic design

An electronic control system consists of three components:

1. Speed pickup

In MAN engines the speed pickup ①, 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 ② 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.

Flame start system

The flame start system is an aid to start the diesel engine in cold weather.

The principle is basically one of heating the intake air by burning fuel from the vehicle's own tank in the pipe of the engine

The flame glow plug is screwed into a pocket in the air intake at the opposite end to fly-wheel. The tip of the plug warms up after approximately 1 minute of pre-glowing to about 100°C. A metering insert in the supply line to the glow plug meters the fuel to it, and the fuel evaporates under the heat of the glow plug. The fuel vapour flows out forwards the tip of the plug, there by mixing with air, which comes in through bores in the protective case of the plug. This mixture ignites at the tip of the glow plug and the resulting flame heats up the intake air. The protective case at the same time prevents the flame from going out if the air is moving at a fairly high speed.

The fuel for the flame glow plug is taken from the suction gallery of the injection pump before the overflow valve.

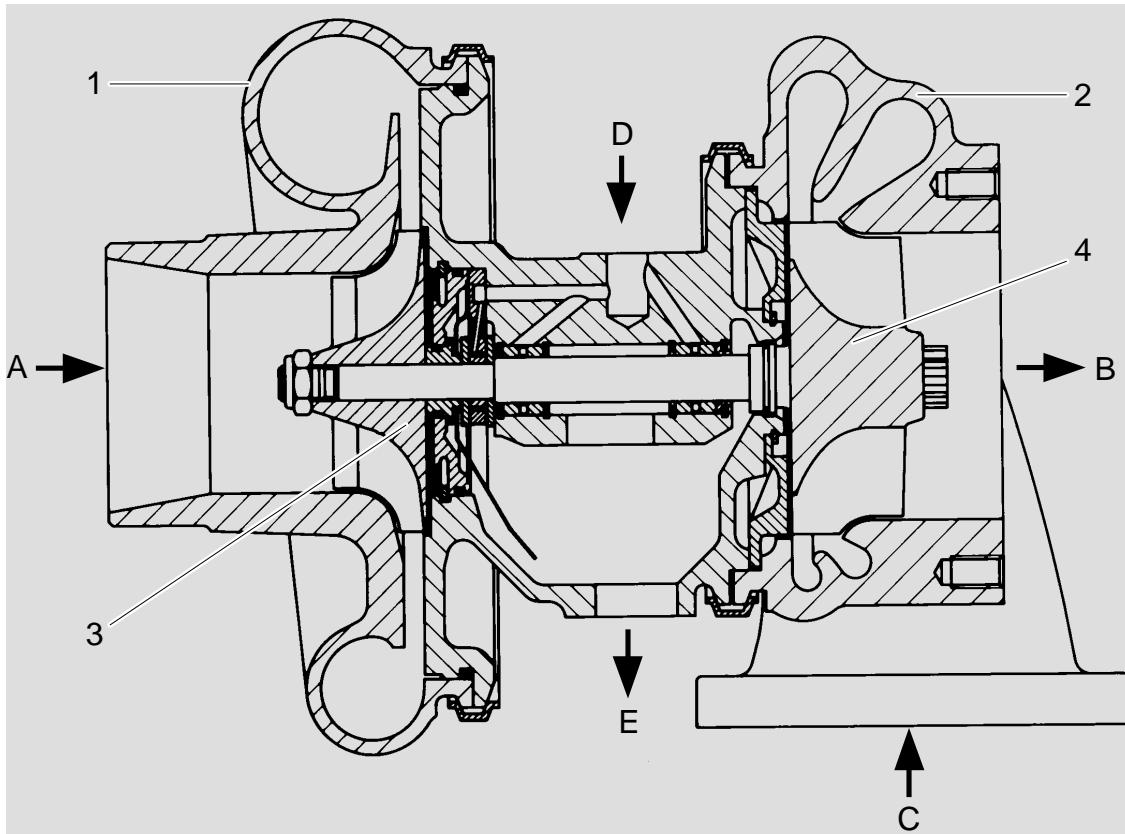
The pressure is generated by the engine's own fuel lift pump.

The supply of the fuel is controlled automatically by a solenoid valve. When this is not under voltage it blocks the fuel line. Only when the flame start switch is pressed the solenoid valve clears the line to the glow plug.

Supercharging

The exhaust gases of the engine drive the turbine wheel of the exhaust turbocharger. The compressor wheel mounted on the same shaft sucks in fresh air and directs it at overpressure to the cylinders.

The turbocharger group is air-cooled. The slide bearings are lubricated by pressurised oil from the engine lubricating system.



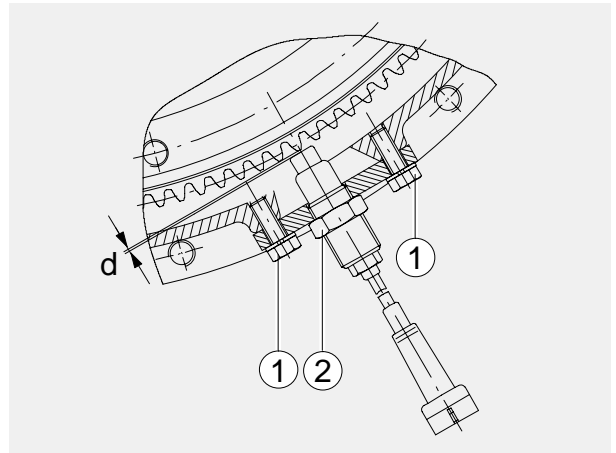
- ① Compressor housing
- ② Turbine housing
- ③ Compressor wheel
- ④ Turbine wheel

- A Air inlet
- B Gas outlet
- C Gas inlet
- D Oil supply line
- E Oil return line

Electronic speed governor (not shown)

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 ① from the retaining plate and take it off together with the speed pickup.

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



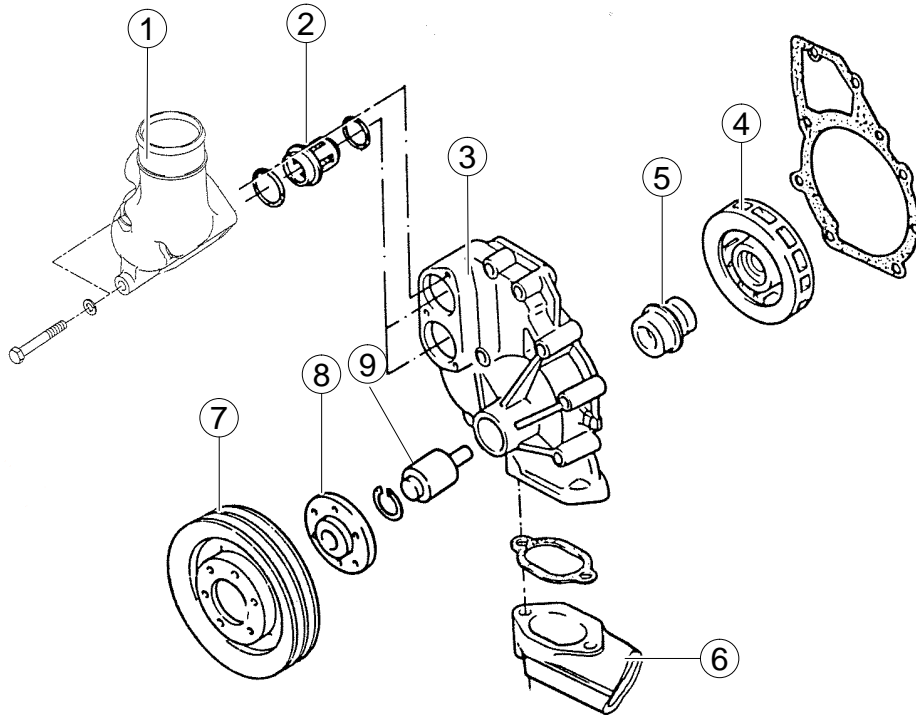
To do so, proceed as follows:

- Loosen locknut ② 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 locknut ②.

Cooling

The engine is liquid cooled

The water pump is a maintenance-free impeller pump with short-circuit inserts and is driven by V-belts from the crankshaft pulley.

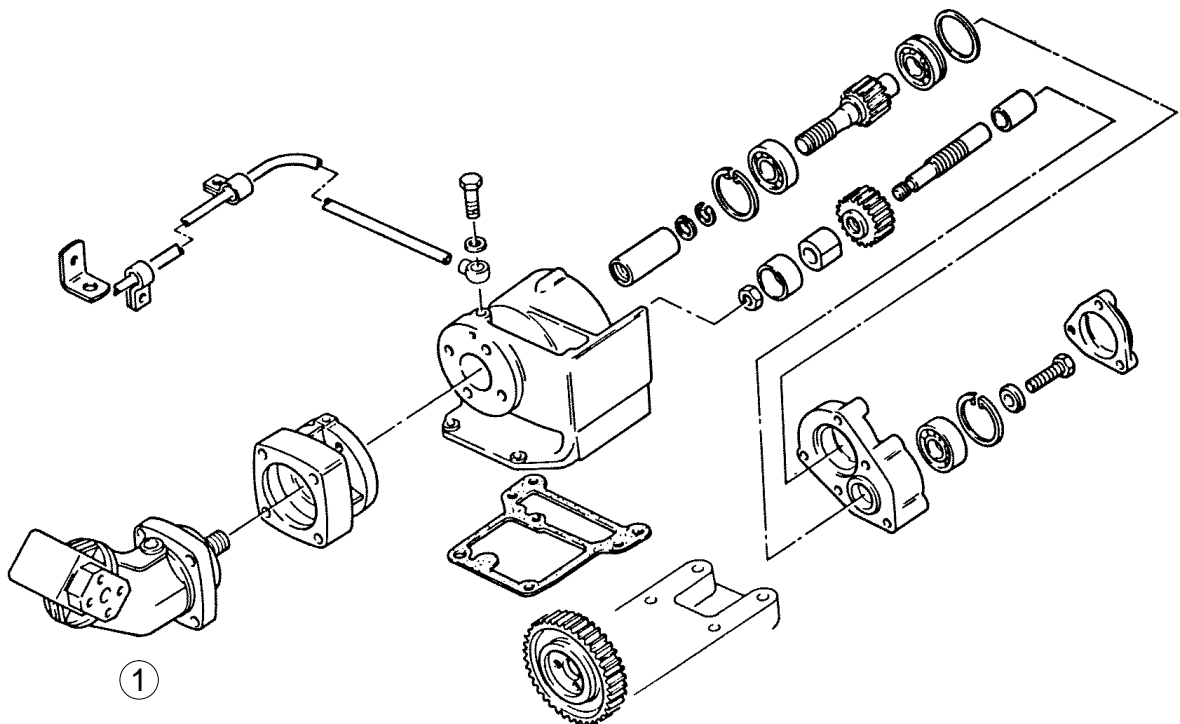


- ① Coolant outlet pipe
- ② Short-circuit insert
- ③ Waterpump housing
- ④ Impeller
- ⑤ Axial face seal
- ⑥ Coolant supply pipe
- ⑦ V-belt pulley
- ⑧ Hub
- ⑨ Water pump bearing

Hydraulik pump

The engine is equipped with an oblique piston-type hydraulic pump for remote propulsion of the hydrostatic fan.

The pump is driven from the crankshaft via gears. The pump drive unit is lubricated by the force-feed lubrication system of the engine. The pump requires no maintenance.



① Hydraulik pump

Electrical equipment

Starter motor

The electric pre-engaged-drive starting motor is flanged to the bottom of the flywheel housing on the left-hand side.

As part of every engine overhaul, the starter pinion and ring gear should be cleaned with a brush dipped in fuel and then greased again.

Warning: Always disconnect the battery earth cable before starting work on the electrical system. Connect up the earth cable last, as there is otherwise a risk of short-circuits.

Engine monitors

Fig. 1

Coolant temperature sensor (arrow)

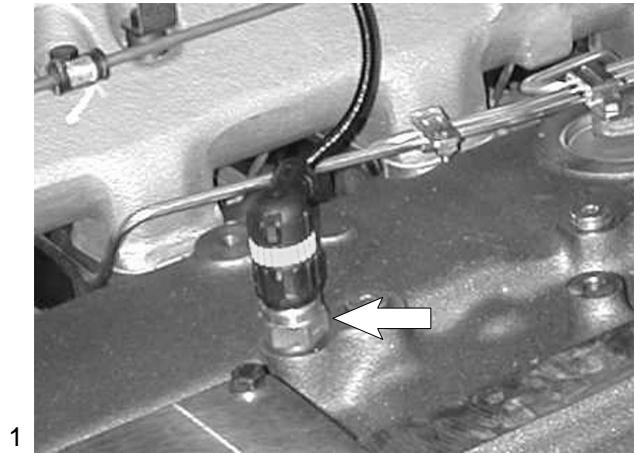
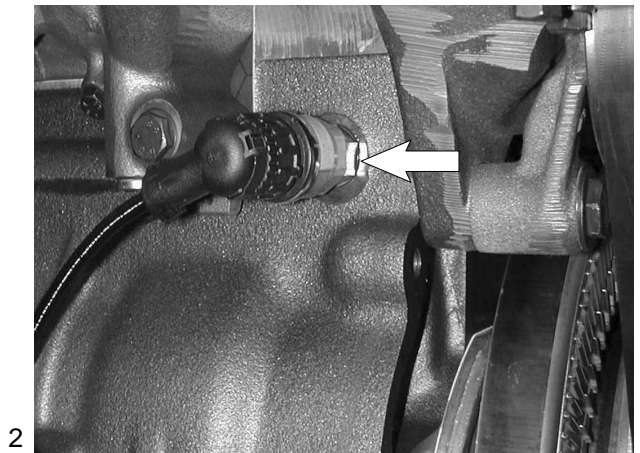


Fig. 2

Oil pressure sensor (arrow)



Lubrication system

Ensure utmost cleanliness when handling fuels, lubricants and coolants.

Note:

Use only approved fuels, lubricants etc. (see brochure "Fuels, lubricants etc."). Otherwise the manufacturer's warranty will become null and void.

Engine oil change



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!

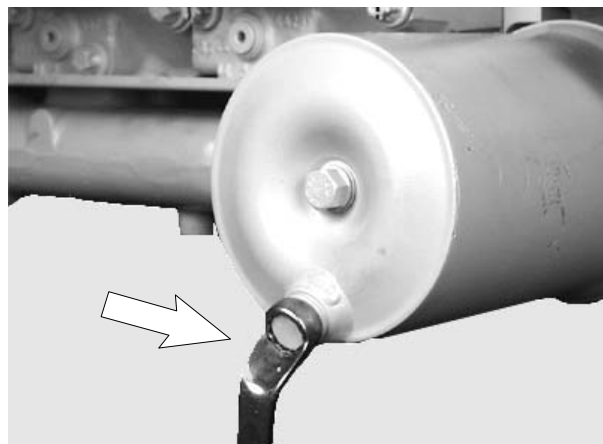
With the engine at operating temperature, remove the oil drain plugs on the oil sump and the oil filter bowl and allow the old oil to drain off completely.

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

Refit the oil drain plugs with new gaskets.

Note:

Change the oil filter elements every time the engine oil is changed.



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.

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

- Bajonet fastener ①
- Dipstick ②
- Oil filler neck ③

After filling start the engine and let it run for a few minutes at low speed.

Caution:

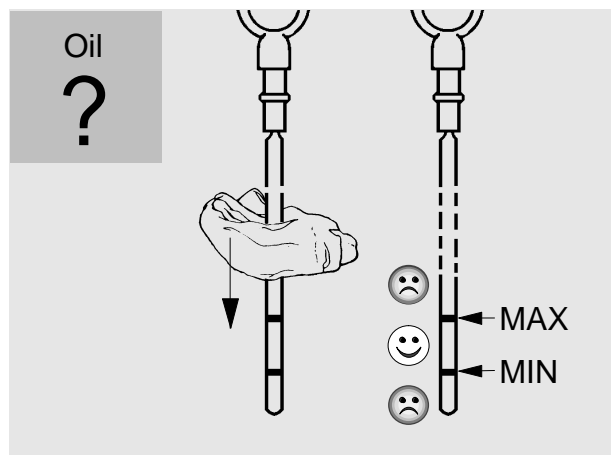
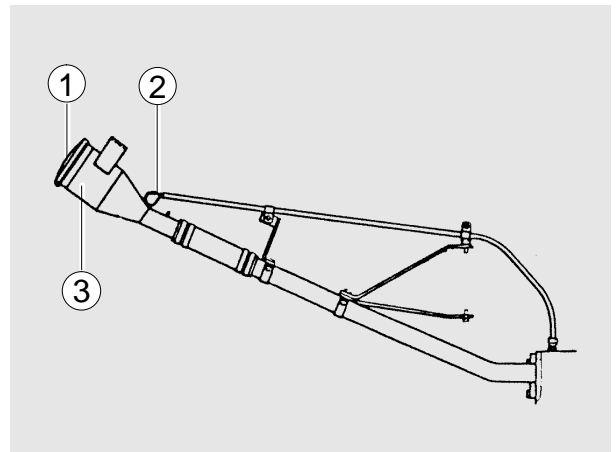
If no oil pressure builds up after approx. 10 seconds switch off the engine immediately.

Check oil pressure and check that there is no oil leakage.

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

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

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



Changing oil filter

Caution:

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

- Allow the filter content to run off along drain plug.
Hold a suitable vessel under hole

**Danger:**

The oil is hot and under pressure when the drain plug is opened.
Risk of burns and scalds.

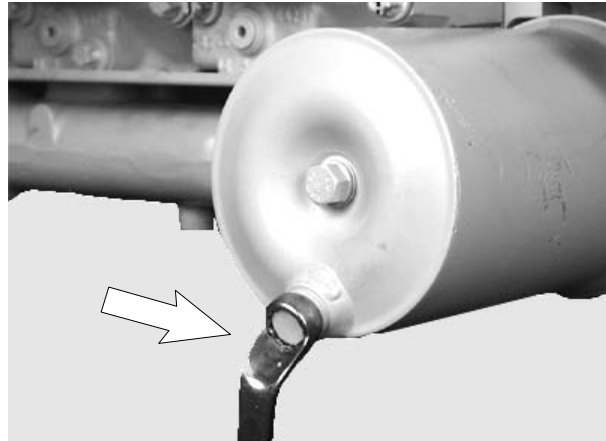
- After releasing the clamping bolts remove filter bowl
- Refit oil drain plug with new seal
- Renew filter cartridge. Thoroughly clean all other parts in cleaning fluid
- Use new gasket for reassembly of filter bowls

Note:

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

Caution:

Used oil filters are classed as dangerous waste and must be disposed of accordingly.



Fuel system

Fuel

If Diesel fuel which contains moisture is used the injection system and the cylinder liners pistons will be damaged. This can be prevented to some extent by filling the tank as soon as the engine is switched off while the fuel tank is still warm (formation of condensation is prevented). Drain moisture from storage tanks regularly. Installation of a water trap upstream of the fuel filter is also advisable. Do not use any additives to improve flow properties in winter.

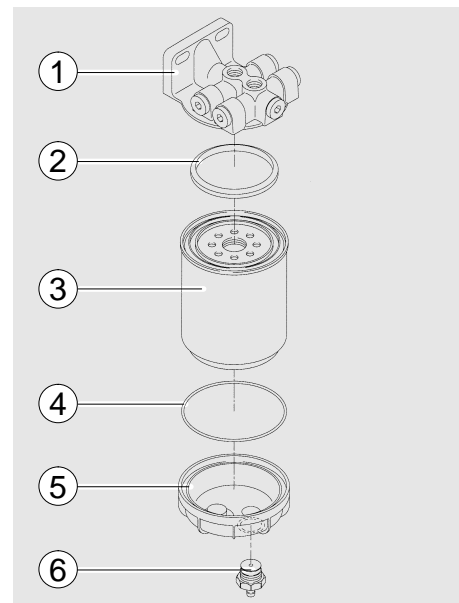
Injection pump

No alterations must be made to the injection pump. If the lead seal is damaged the warranty on the engine will become null and void. We urgently recommend that you have faults in the injection pump rectified only in an authorised specialist workshop.

Cleaning fuel pre-filter

Strip the fuel pre-filter:

- open drain valve ⑥
- remove the sight glass ⑤ and gasket ④ from filter cartridge ③
- remove filter cartridge ③ and gasket from the filter head ①
- wash out Filter head ①, sight glass ⑤ and drain valve ⑥ in clean Diesel fuel and blow them out with compressed air
- Reassemble using new seal
- Screw on new filter cartridge and tighten it by hand
- Actuate plunger of hand priming pump until the overflow valve of the injection pump opens audibly
- Start engine
- Check fuel pre-filter for leaks



Fuel filter

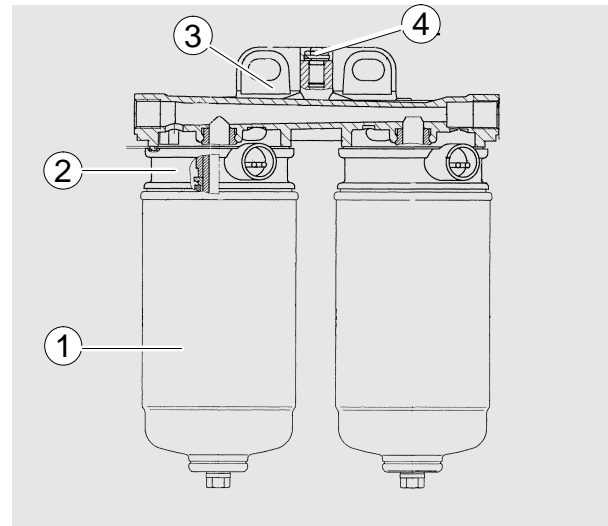
Changing fuel filter

Only when engine is switched off

- Loosen filter cartridge ① 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

Caution:

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



- ① Filter cartridge
- ② Fuel preheater
- ③ Filter head
- ④ Bleed screw

Bleeding fuel system

Note:

When bleeding the fuel system switch on the electromagnetic shut-off valve (EHAB) without fail (ignition on), as otherwise fuel cannot reach the injection pump suction gallery / suction chamber.

- Open bleed screws ④ at fuel filter.
- Actuate hand priming pump until bubble-free fuel emerges.
- Close bleed screws ④.
- Check system for leaks.

Checking start of delivery

Fig. 1

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 ① fitted in front of the torsional vibration damper.

The scale marks are read against a pointer ② fitted to the crankcase.

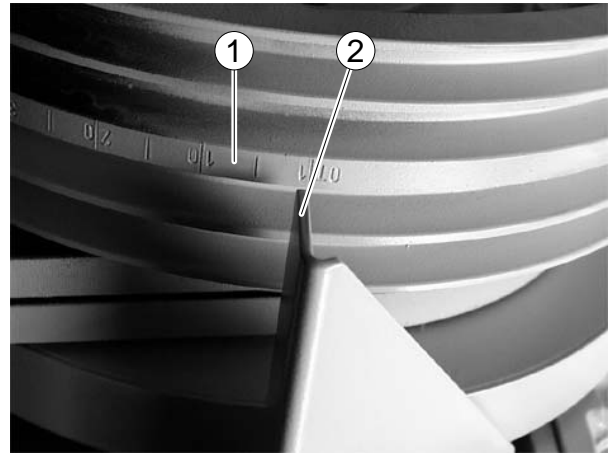


Fig. 2

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

1



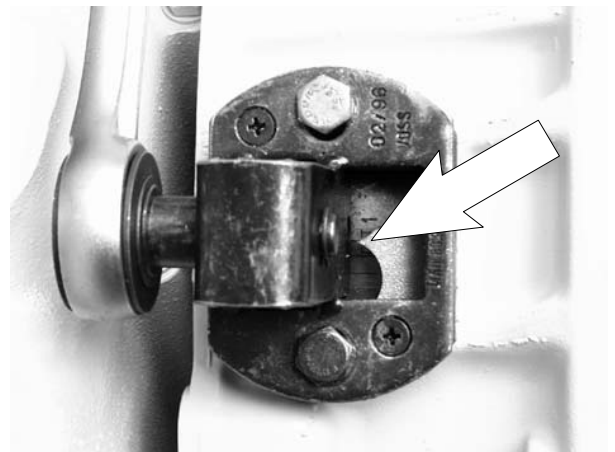
2

Fig. 3

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

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

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

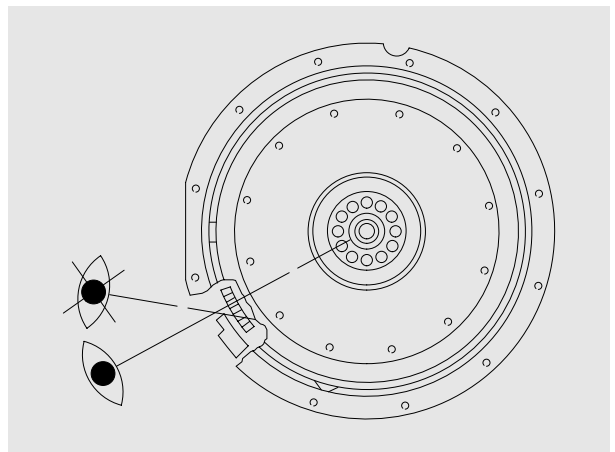


3

Fig. 4

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

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



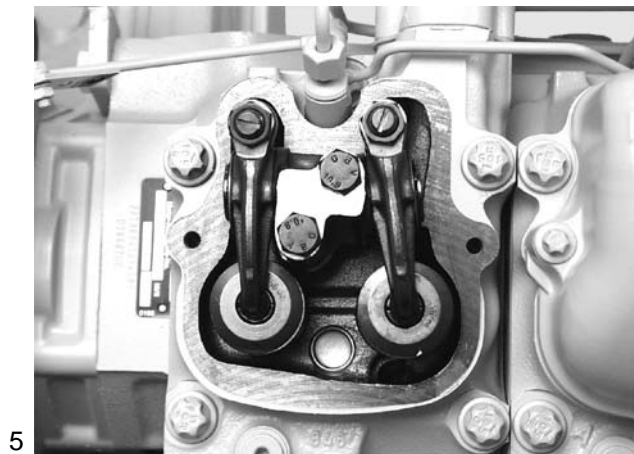
4

Adjusting start of delivery

Set piston of cylinder 1 (water pump end) to top dead centre (TDC). When the engine is in this position the valves of cylinder 6 are in crossover.

The measuring edges of the pointer at the front and in the inspection hole in the flywheel housing coincide respectively with the "OT" marks on the scale disc at the front and on the flywheel.

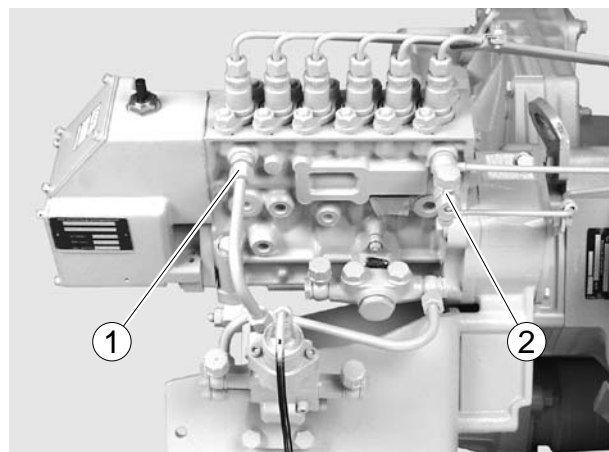
Turn engine back past the degree mark to eliminate backlash, turn it forwards in direction of rotation to the degree mark of the specified value for start of delivery (see "Technical Data").



5

Fig. 6

Close up injecton pump return line ② with a screw plug and connect hose of high-pressure pump to injection pump supply line ①.



6

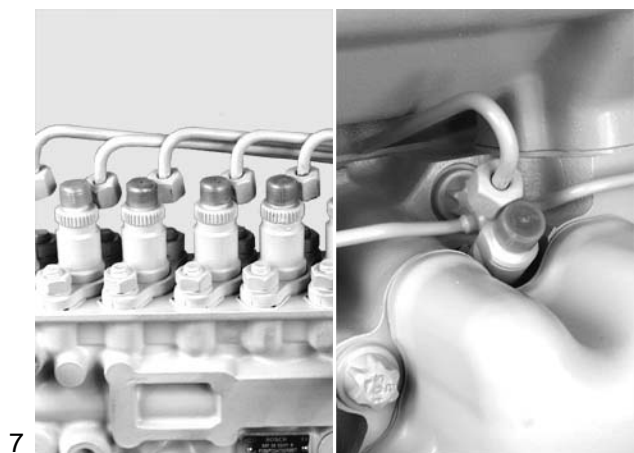
Fig 7

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

Important:

Dirt in the injection system causes:

- nozzles to jam
- the injection-pump drive gear to break



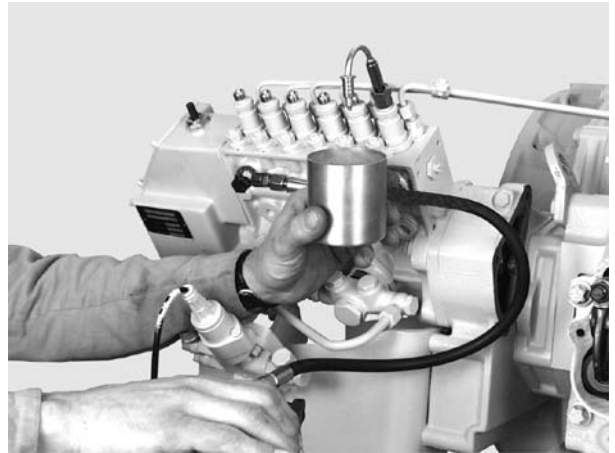
7

Fig. 8

Fit a bent pipe in place of the injection line to cylinder 1.

Set regulating lever to full load.

Build up pressure with the high-pressure pump. The fuel must flow out of the bent pipe. Now turn the engine in the direction of rotation until the flow of fuel decreases to a drip. At this position it must be possible to read off the specified value for the start of delivery (see "Technical Data") at the measuring edge on the flywheel housing and at the measuring edge of the pointer on the scale disc. If this is not the case correct the start of delivery setting.



8

Adjusting start of delivery

Figs. 9 and 10

To correct the start of delivery turn the injection pump drive gear to injection pump hub.

Remove bolts and take off cover ①. Turn engine back by 360° and loosen the two bottom bolts ④. Turn engine by a further 360° and loosen the two upper bolts ④. Then turn engine back to the start of delivery mark (eliminate backlash clearance as described under “checking start of delivery” above).

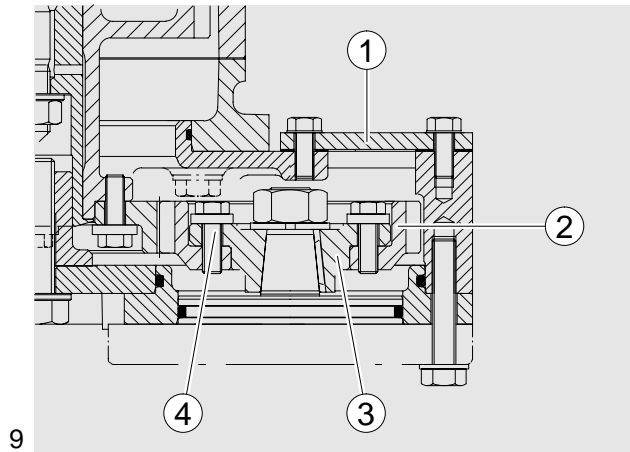
Build up pressure with the high-pressure pump. Move intermediate gear ② slowly with a screwdriver until the jet of fuel emerging from the bent pipe decreases to a drip. In this position carefully retighten the injection pump drive mounting bolts ④.

Check start of delivery again.

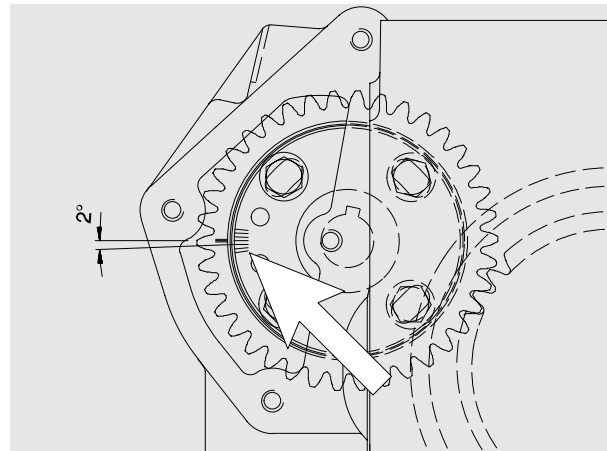
Now tighten all mounting bolts to 30 Nm.

Note:

If the start of delivery cannot be set by moving the injection pump drive, check that the injection pump is installed correctly.



9



10

Removing fuel injectors

Fig. 1

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

Remove the fuel return lines.

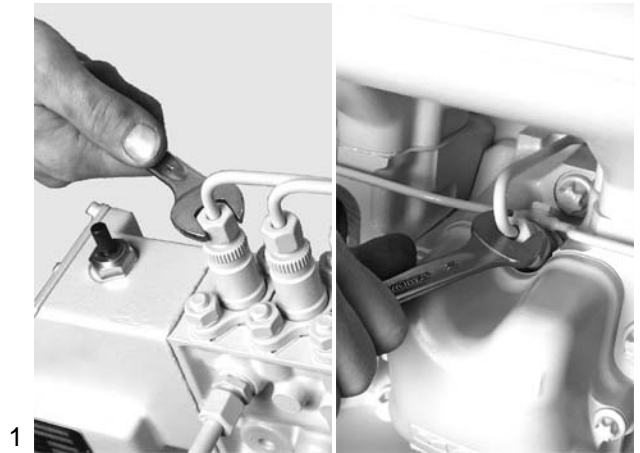


Fig. 2

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

Attention:

Dirt in the injection system causes:

- nozzles to jam
- the injection-pump drive gear to break

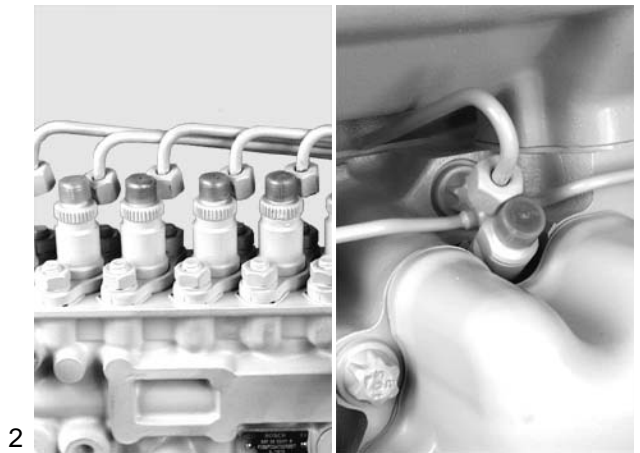


Fig. 3

Remove pressure screw from fuel injector using a pin spanner.

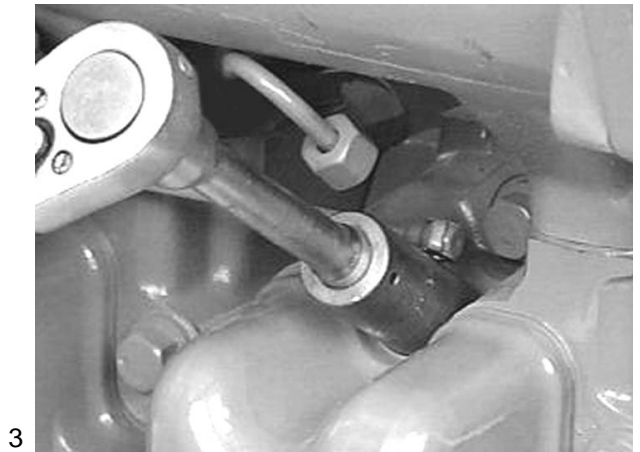
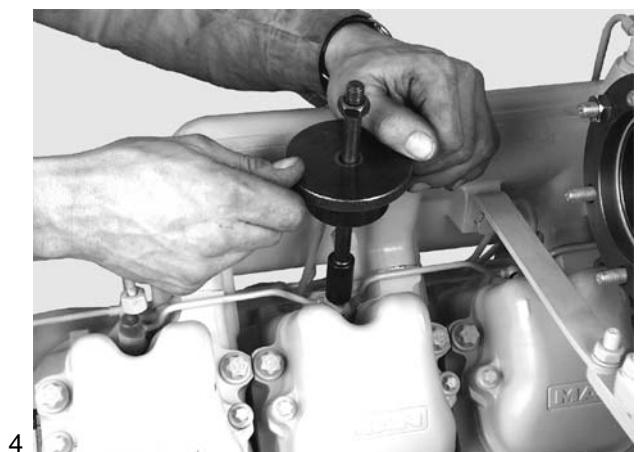


Fig. 4

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

Take sealing ring off the injection nozzle.

Check and repair injector.



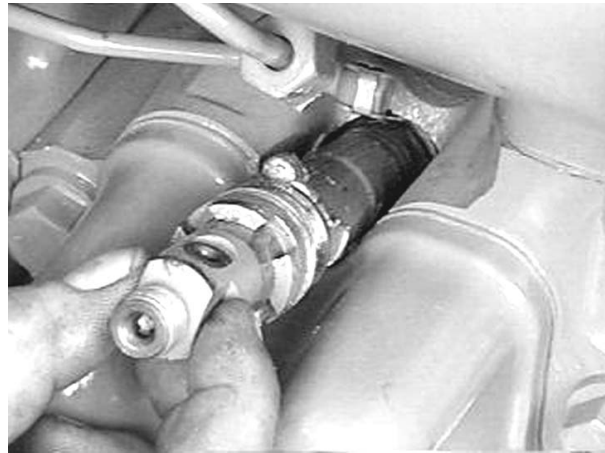
Installing fuel injectors

Fig. 5 and 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.

5



6

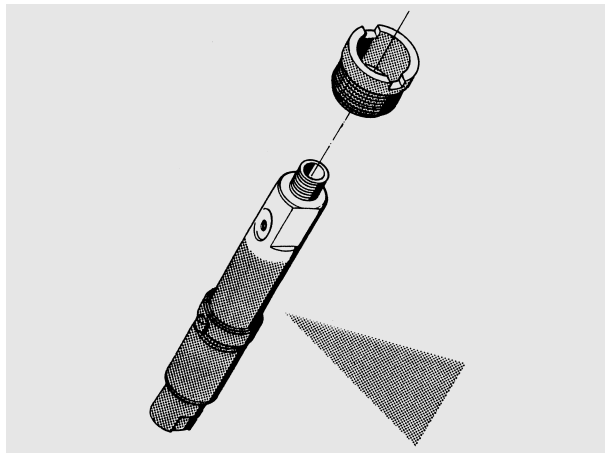


Fig. 3

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

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

7



Checking fuel injectors

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.

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:

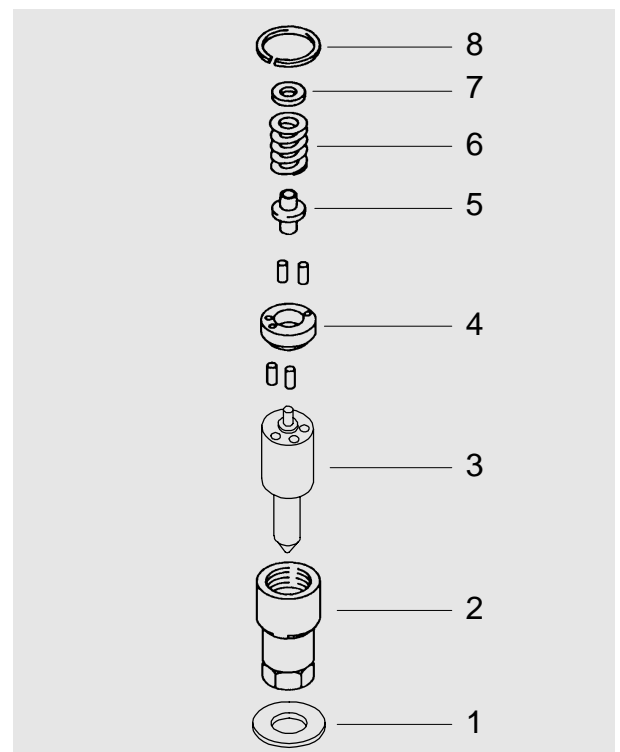
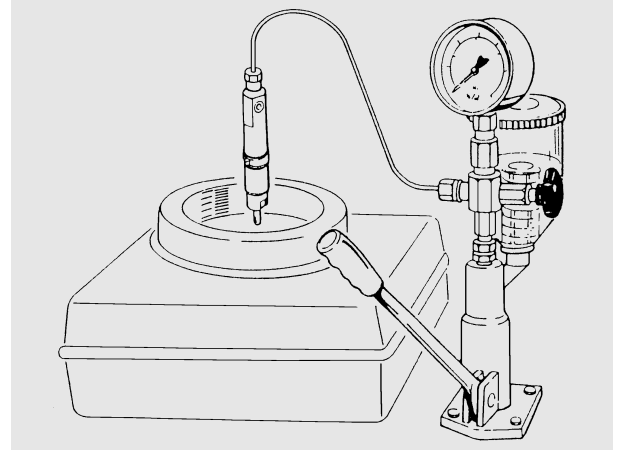
Actuate hand lever.

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.



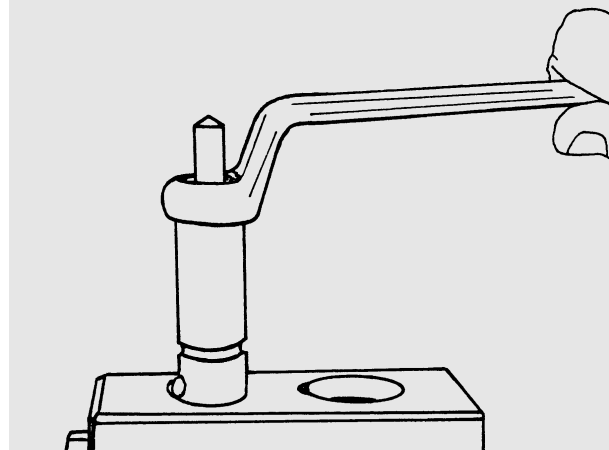
- ① Seal
- ② Nozzle tension nut
- ③ Injection nozzle
- ④ Intermediate washer
- ⑤ Pressure pin
- ⑥ Compression spring
- ⑦ Shim
- ⑧ Circlip

Disassembling fuel injectors

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.

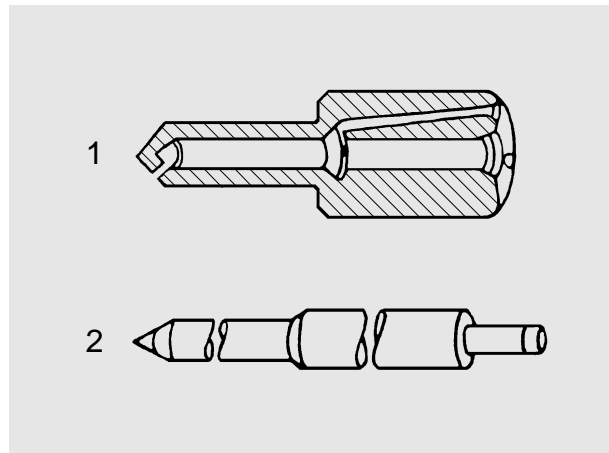
Take pressure pipe neck out of holder.



Repairing fuel injectors

Clean interior of injection body ① with a small wooden stick and petrol or Diesel fuel.

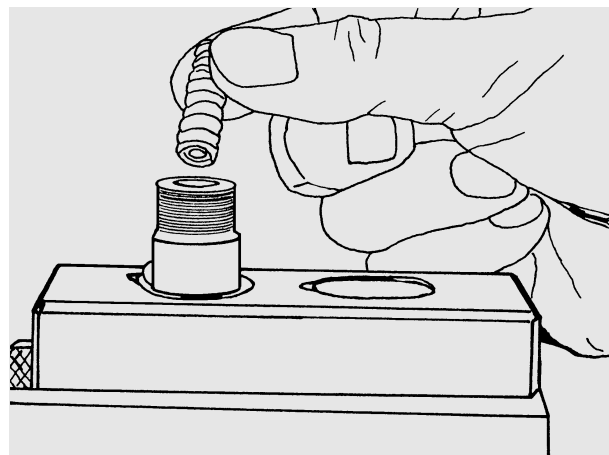
Clean nozzle needle ② with a clean cloth. Clean coked nozzle needle surface on lathe with a piece of wood (not too hard) dipped into oil.



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.

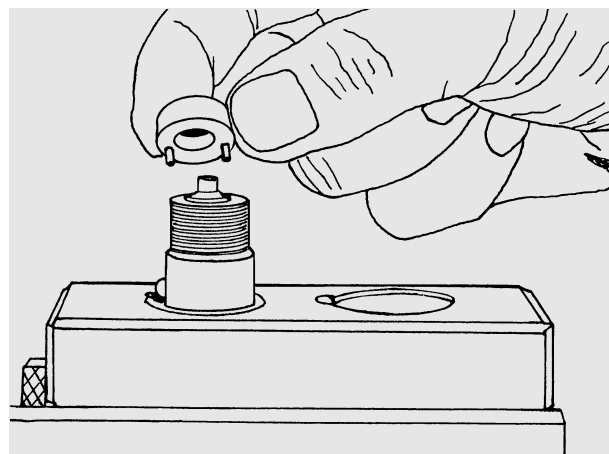
Check cleaned parts for wear and damage, replacing them if necessary. Degrease new parts.



Assembling fuel injectors

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

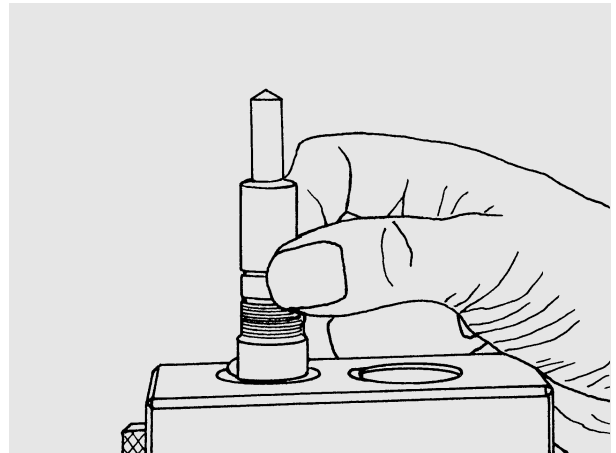
Check intermediate piece for wear. Insert pressure pin and intermediate washer.



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

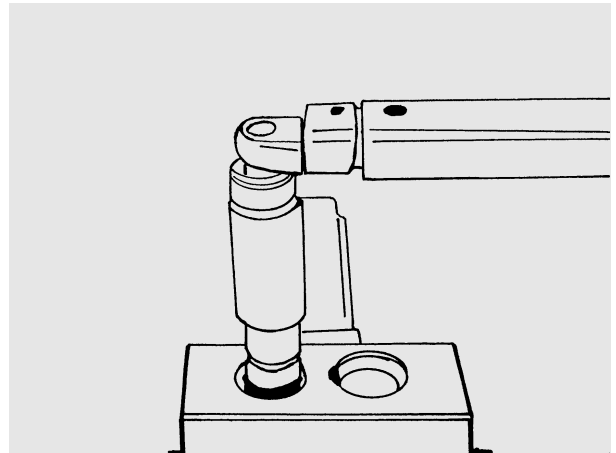
When pulled out of the nozzle body by up to a third of its length the nozzle needle must sink back to its seat under its own weight when released.

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



Screw on union nut, tightening it to the specified torque (see "Engineering • Data • Setting values").

Check injector on the manual test stand.



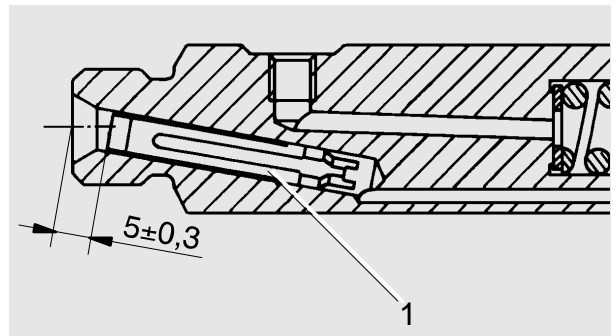
Ensure that the edge-type filter is correctly seated in the injector body.

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.

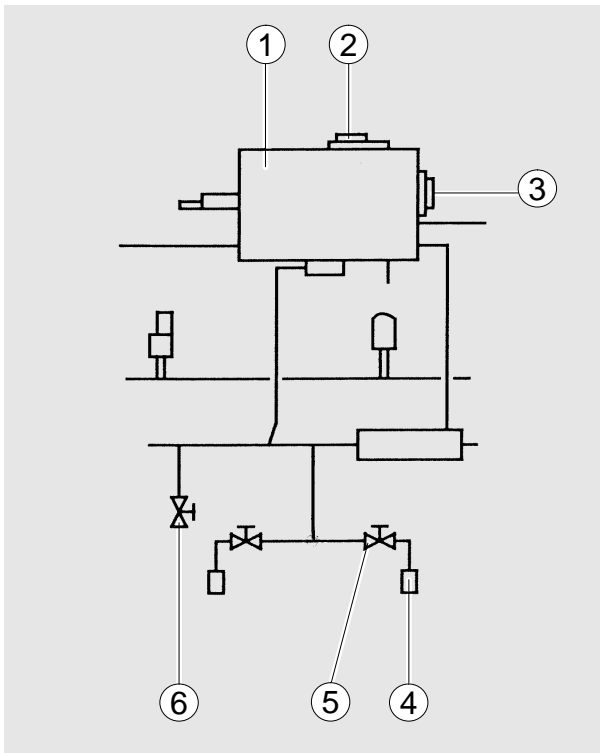
The sieve bar filter must not be pressed into the nozzle holder farther than approx 5 mm.

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



Cooling system

Schematic diagram of cooling system



- ① Surge tank
- ② Positive pressure valve
- ③ Coolant level
- ④ UIC-filler neck
- ⑤ Shut-off valve
- ⑥ Shut-off valve

Draining coolant

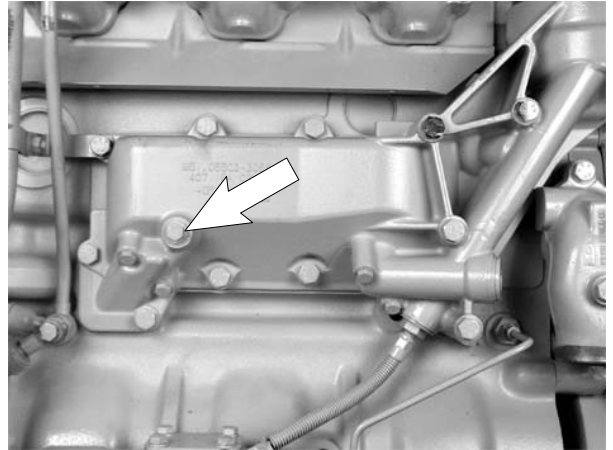


Danger:

Draining hot coolant involves a risk of scalding.

Caution:

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



Drain coolant as follows when cooling system has cooled down:

- Open drain plug in the oil cooler housing (arrow).
- Catch emerging coolant in a suitable container.
- Refit screw plug
- Fill / bleed the cooling system

Filling up with coolant (only when engine has cooled down)

Fill the cooling system of the engine with a mixture of drinkable tap water and anti-freeze agent on ethylene glycole basis or anti-corrosion agent.

See Publication “Fuels, Lubricants and Coolants for MAN Diesel engines”.

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

- Slowly fill up with coolant until correct coolant level is reached
- Make sure that all air can escape from the cooling system
- 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.

Checking / setting Valve clearance

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

Fig. 1

Remove cylinder head cover.

Attention:

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

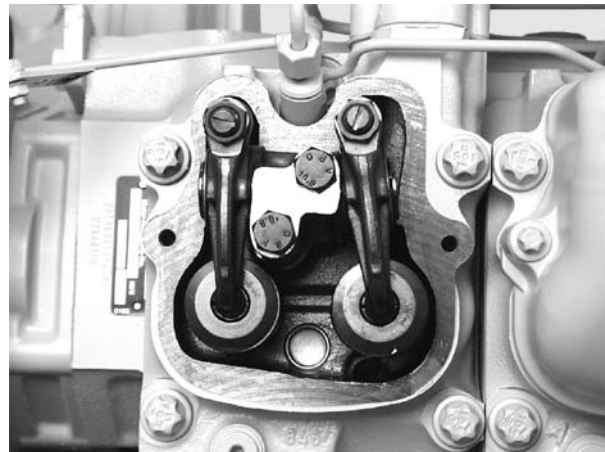


Fig. 2

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. 3

Set valves in the cylinder

1	5	3	6	2	4
6	2	4	1	5	3

Valves are in cross-over in cylinder

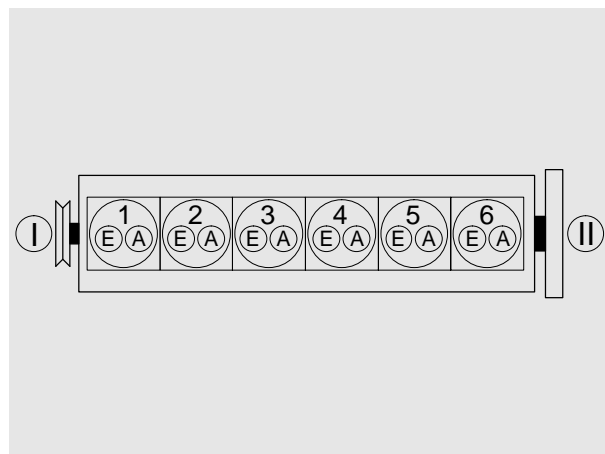
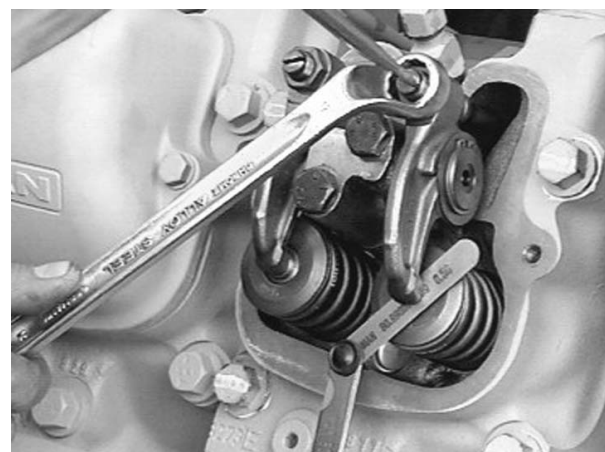


Fig. 4

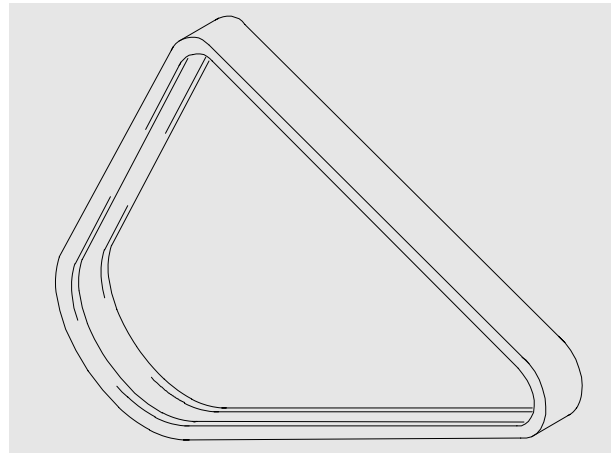
- Push feeler gauge between valve stem and rocker arm
- Loosen lock nut and turn adjusting screw with screwdriver until feeler gauge can be moved with slight resistance
- Tighten lock nut to the specified torque
- Check clearance again
- Refit cylinder head covers with new gaskets.
- Tighten the bolts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



Checking condition

Fig. 1

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



Checking tension

Fig. 2

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

- Lower indicator arm ① into the scale

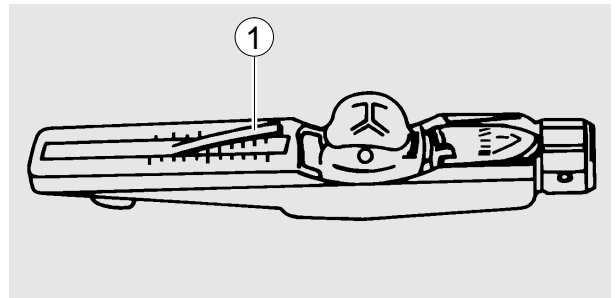
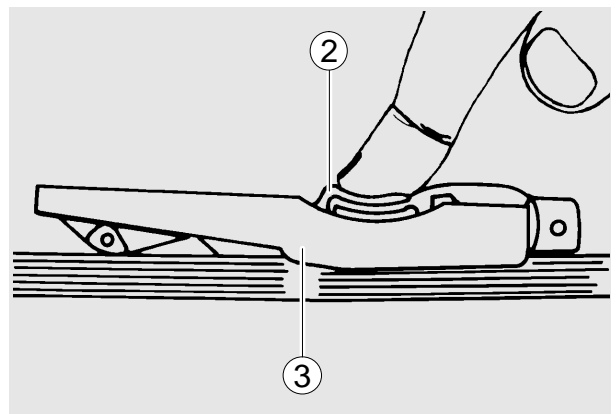


Fig. 3

- 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!



Reading of tension

- 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.

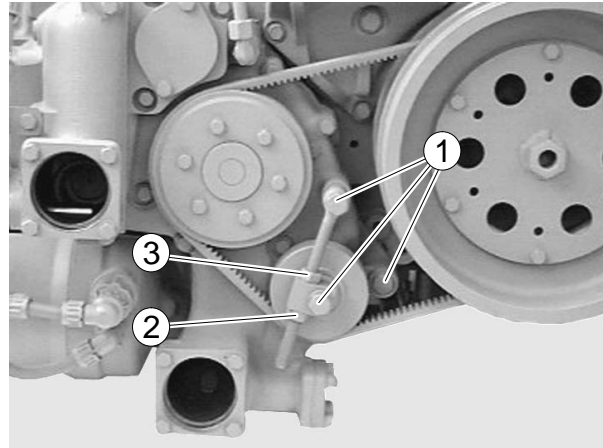
Drive belt width	Tensioning forces according to the kg graduation on the tester		
	New installation		When servicing after long running time
	Installation	After 10 min. running time	
9,5	50	45	40
12,5	55	50	45
20	75	70	60
22	75	70	60

Tensioning and changing V-belt

Crankshaft – water pump – tension pulley

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

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



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,
- function of final controlling element / control rod (rack not in full load position)

In addition, the following are to be checked:

- the compression,
- the air filters for contamination,
- the charge-air pressure,
- the pressure in the inlet chamber of the injection pump,
- the exhaust back pressure.

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.

Important:

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 Industrial and Marine Diesel Engines”).
- The engine is being run on impermissibly steep inclines.
- The crankcase pressure is too 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.



Caution:

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”)

Axial clearance

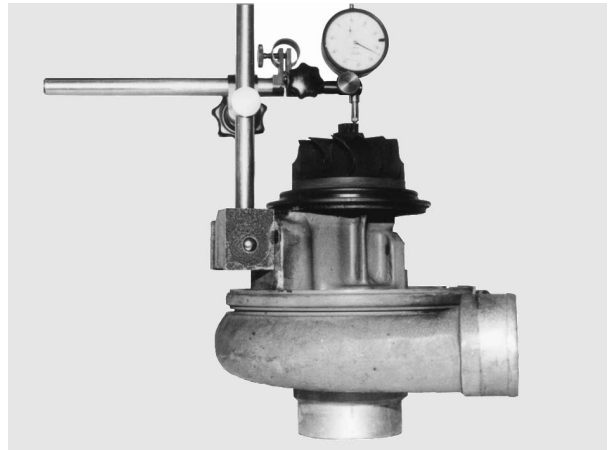
Fig. 1

Remove turbocharger. Mark turbine housing relative to the bearing housing and remove turbine housing.

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.



Radial clearance

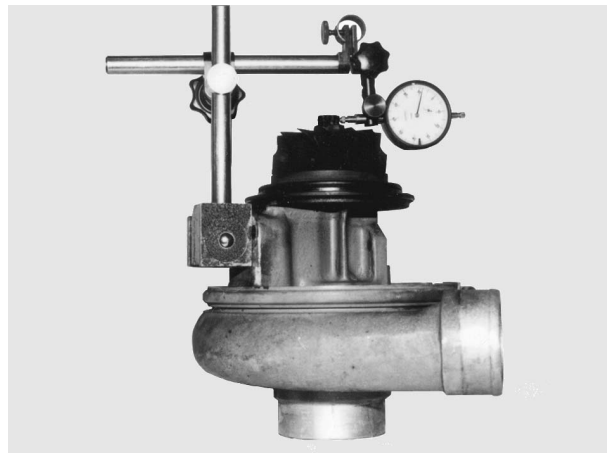
Fig. 2

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

Place turbine housing in position, observe markings and screw on turbine housing.



	KKK	axial (mm)	radial (mm)
D 2866 TUE	4 LGZ	0,20	0,65

First commissioning

At the time of initial commissioning of a new or overhauled engine make sure to have observed the “Technical Information for the installation of MAN Diesel engines”.

It is recommended that new or overhauled engines should not be operated at a load higher than about 75% maximum load during the first few hours of operation. Initial run-in should be at varying speeds. After this initial run-in, the engine should be brought up to full output gradually.

Note:

Use only approved fuels, lubricants etc. (see brochure “Fuels, lubricants etc.”).
Otherwise the manufacturer’s warranty will become null and void.

Filling with fuel

Caution:

Fill the tank only when the engine is switched off. Pay attention to cleanliness.
Do not spill fuel.
Use only approved fuels (see “Fuels, Lubricants etc.”)

Filling-in of coolant

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”.

- Pour in coolant slowly via expansion tank, see page 50
- For coolant filling quantity, see “Technical data”

Filling with engine 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.

The engines are as a rule supplied without oil.
Pour oil into engine via filler neck, see page 36.
For the quantity required see “Technical Data”.

Commissioning

Before daily starting the engine, check fuel level, coolant level and engine oil level and replenish, if necessary.

Note:

Use only approved fuels, lubricants etc. (see brochure “Fuels, lubricants etc.”). Otherwise the manufacturer’s warranty will become null and void.

Checking oil level

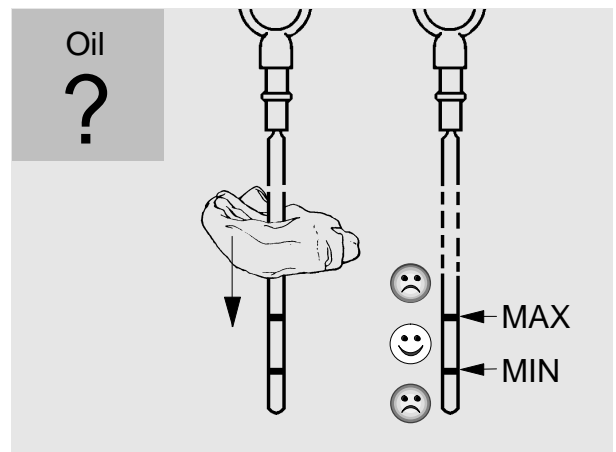
Check the oil level when the engine is horizontal, but only if at least 20 minutes have passed since the machine was switched off.

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

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

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.



Ensure utmost cleanliness when handling fuels, lubricants and coolants.

Starting

**Danger:**

Before starting make sure that no-one is in the engine's danger area.

Caution:

When starting do not use any additional starting aids (eg injection with starting pilot).

- Ensure that no load is on the engine before starting it, eg switch off load, disengage clutch, put gearbox into neutral etc..

With engines without starting aid or at temperatures above 5-10°C or when engine without flame starter is already hot:

- Insert starter key in starting lock
- Press starter button until engine starts

With engines with starting aid (flame starter), at temperatures around 0°C and below:

- Insert starter key in starting lock
- Switch on flame starter; signal lamp "Preheating" is on
- Signal lamp "Preheating" is flashing; press starter button until engine starts

Caution:

- When engine starts, release starter button immediately
- If engine does not start, actuate starter for about 10 seconds, wait for 30 seconds and then attempt to start engine again and so on

With engine with automatic starting (eg standby power units) it is indispensable that none of the moving parts be accessible. Warning signs "Unit starts automatically" are to be attached to the engine. Regulation on this which may apply locally are to be satisfied.

When engine is running, lube oil pressure must build up at the oil pressure gauge. If not switch off engine immediately.

Avoid running the cold engine for any length of time since in any internal combustion engine this is liable to cause increased wear due to corrosion. Prolonged idling is harmful to the environment.

Operation monitoring system

Caution:

Do not overload the engine. Do not exceed the maximum permissible engine tilt. If faults occur, find their cause immediately and have them eliminated in order to prevent more serious damage!

During operation the oil pressure in the engine lubrication system must be monitored. If the monitoring devices register a drop in the lube oil pressure, switch off the engine immediately.

Shutting down

Do not switch off engine immediately operation at high loads, but let it idle for about 5 minutes to achieve a temperature equalisation.

Then switch off the engine via the shut-off device provided (shut-off solenoid, electric speed governor etc.).

**Danger:**

Ensure that the engine can not be started by unauthorized persons.

Note:

All screws and bolts not listed in the following table must be tightened according to the guiding values of MAN works standard M 3059.

Apply a light film of oil to all screws and bolts before they are fitted!

Plugs

DIN 908

M 14 x 1,5, M 16 x 1,5	80 Nm
M 18 x 1,5, M 22 x 1,5	100 Nm
M 24 x 1,5, M 26 x 1,5	120 Nm
M 30 x 1,5	150 Nm

DIN 7604

AM 10 x 1, M 12 x 1,5	50 Nm
AM 14 x 1,5	80 Nm

Crankcase, crankshaft assembly

Timing case to crankcase M10, 12.9	75 Nm
Thrust washer to timing case M8, 12.9	40 Nm
Crankshaft bearing caps to crankcase M18 x 2	
initial torque	300 – 330 Nm
rotation angle	90 – 100°
Counterweight to crankshaft M16 x 1,5	
initial torque	140 – 160 Nm
rotation angle	90 – 100°
Vibration damper hub to crankshaft M16 x 1,5, 10.9	260 Nm
Flywheel to crankshaft M16 x 1,5	
initial torque	100 – 110 Nm
1st rotation angle	90 – 100°
2nd rotation angle	90 – 100°
Connecting rod bearing caps M14 x 1,5	
initial torque	100 – 110 Nm
rotation angle	90 – 100°

Cylinder head

Tightening / retightening of cylinder head bolts, see page 61.

Rocker arm bracket to cylinder head	65 Nm
Locknut on valve adjusting screw	50 Nm

Tightening torque guide values



Timing devices

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

Lubrication system

Oil pump to crankcase M8, 8.8	22 Nm
Oil pump cover M8, 8.8	22 Nm
Oil cooler to oil filter head M8, 8.8	22 Nm
Filter bowl to oil filter head M12, 12.9	50 Nm
Plug (oil drain plug) in oil pan M26 x 1,5	80 Nm
Oil jet flange to crankcase M14 x 1,5	70 Nm

Exhaust / Intake manifolds

Exhaust manifold to cylinder head M10	
initial torque	60 – 65 Nm
rotation angle	90 – 100°
Intake pipe to cylinder head M8, 8.8	22 Nm

Fuel system

Injector to cylinder head M28 x 1,5	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 M12 x 1,5	80 Nm
--	-------

Transmitter

Oil pressure transmitter	25 Nm
Temperature transmitter	20 Nm

Tightening torque guide values



Tightening torque values according to Works Standard M 3059

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

Thread size x pitch	Grade / Tightening torque 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

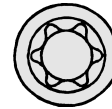
General notes

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 mounted with cylinder head bolts which are tightened by the angle-of-rotation method. On new engines the cylinder head bolts are tightened up for the first time at the factory after the engine has been broken in. The sticker "**First retightening of cylinder head bolts ...**" is then attached to one of the cylinder head covers.

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 revolution).

The two outer screws (intake and exhaust sides) must not be retightened.

Note:

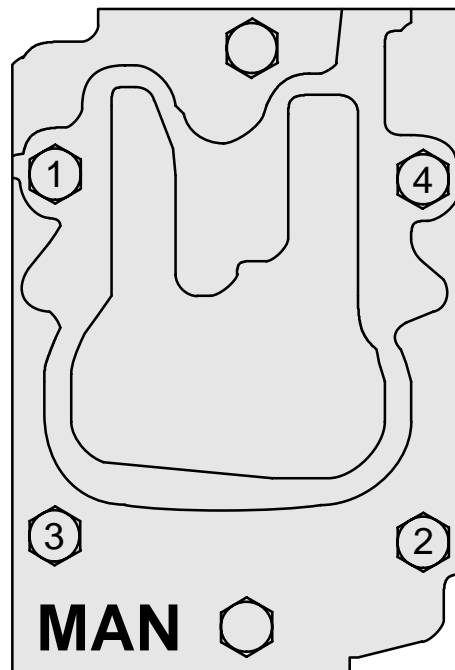
The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further 90° (1/4 revolution) from their actual position.

Remove the sticker "**First retightening of cylinder head bolts ...**" and attach the sticker "**Second retightening of cylinder head bolts ...**" to show that the cylinder head bolts have been retightened for the second time.

Erster Nachzug der Zylinderkopfschrauben erledigt

First retightening of cylinder-head-bolts completed

Spare part No. 51.97801-0211



Tightening diagram "1"

Zweiter Nachzug der Zylinderkopfschrauben erledigt

Second retightening of cylinder-head-bolts completed

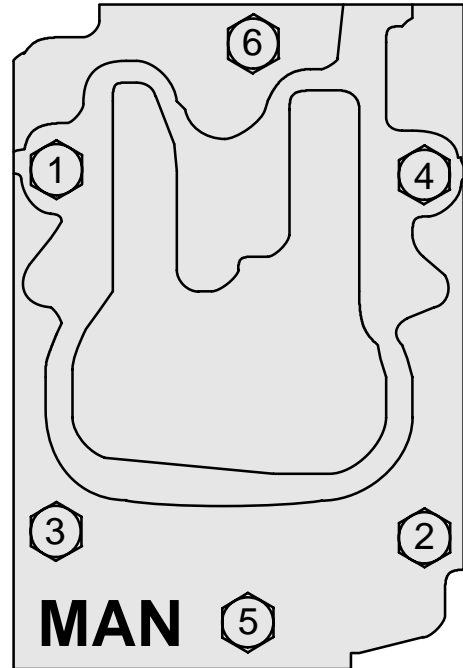
Spare part No. 51.97801-0212

Tightening cylinder head bolts after a repair (engine cold)

Before inserting the cylinder head bolts oil them with engine oil on the thread (not to the bore) and coat the contact face of the bolt head with "Optimoly White T" assembly paste. Do not use any oils or oil additives that contain MoS₂. The bolts must be tightened by the angle-of-rotation method as shown in Tightening diagram "2".

- 1st pretightening step = to 10 Nm
- 2nd pretightening step = to 80 Nm
- 3rd pretightening step = to 150 Nm
- 4th pretightening step = turn by 90°
- Final tightening = turn by 90°

Adjust valve clearance.



Tightening diagram "2"

Retightening cylinder head bolts after repairs (engine cold or warm)

After the first 10 to 20 hours of operation after a repair turn the cylinder head bolts by a further 90° (1/4 revolution) in the order shown in Tightening diagram "2".

The cylinder head bolts to be retightened must not be loosened first, but simply tightened by a further 90° (1/4 revolution) from their actual position.

Attach the sticker "**First retightening of cylinder head bolts ...**" (Remove any other stickers which may already be attached).

After the first 400 hours of operation after a repair tighten cylinder head bolts 1 to 4 in the order shown in Tightening diagram "1" again by a further 90° (1/4 revolution).

The two outside screws (intake and exhaust side) must not be retightened.

Attach the sticker "**Second retightening of cylinder head bolts ...**".

Note:

When a cylinder head has been removed the cylinder head gasket must always be changed.

Re-using old cylinder head bolts

Checking

Before re-using old cylinder head bolts check them as follows:

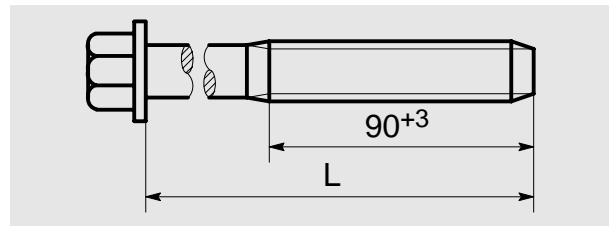
Length

During tightening the bolts are intentionally stressed beyond the yield point and therefore subjected to some permanent elongation each time they are tightened.

Surface

The surface of the bolts must be in satisfactory condition, i.e. the phosphate coating must be intact and there must be no rust.

Rusted or damaged bolts or bolts elongated beyond the maximum permissible length must immediately be made unusable – e.g. by destroying the threads with a hammer – and scrapped.



L = Shank length

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

Technical data



Model	D 2866 TE
Design	in-line vertical with turbocharging
Cycle	4-stroke Diesel
Combustion system	Direct injection
Number of cylinders	6
Bore	128 mm
Stroke	155 mm
Swept volume	11 967 cm ³
Compression ratio	15,5 : 1
Rating	see engine nameplate
Firing order	1–5–3–6–2–4
Valve clearance (cold engine)	
Intake	0.50 mm
Exhaust	0.50 mm
Valve timing	
Intake opens	23° before TDC
Intake closes	37° after BDC
Exhaust opens	60° before BDC
Exhaust closes	30° after TDC
Fuel system	
Injection	In-line pump, with flange fastening
Governor	Electronic speed governor (GAC)
Start of delivery	26° ± 1° KW before TDC
Injectors	four-hole nozzles
Opening pressure of injector	
New nozzle holder:	220 + 8 bar
Used nozzle holder:	205 + 8 bar



Technical data

Engine lubrication	Force feed
Oil capacity in oil sump (litres)	min. max. 24 l 30 l
Oil change quantity (with filter)	33 l
Oil pressure during operation (depending on oil temperature, oil viscosity class and engine rpm)	must be monitored by oil pressure monitors / gauges
Oil filter	Full-flow filter with paper filter elements
Engine cooling system	Liquid cooling
Operating temperature	80–90°C, temporarily 95°C allowed
Electrical equipment	
Starter	24 V; 5,4 kW



A series of horizontal dotted lines for writing notes.



Maintenance chart

Observe safety instructions!

Maintenance chart	Maintenance intervals in operating hours					
	1	2	3	4	5	6
Check oil and coolant level	•					
Change engine oil		•	•			
Change the oil filter elements		•	•			
Check V-belt tension.		•	•			
Check and adjust the valves clearance		•		•		
Check that removable unions (bolts, hose clips, pipe fittings) are firmly in position and, if necessary, retighten		•				
Service the air cleaner (earlier if severe operating conditions demand it)			•			
Change fuel filter					•	
Change coolant						•
Renew filler cap and working valve of cooling system						•

1 – Daily

2 – After the first 10 to 20 hours of operation (with new or overhauled engine)

3 – Every 200 hours of operation

4 – Every 400 hours of operation

5 – Every 1000 hours of operation

6 – Every 2 years

After every 3000 hours' operation

Check exhaust turbocharger (radial and axial play)

Oil change

Engine oil change intervals in hours of operation, depending on the oil grade used.

Engine	Engine oils according to MAN Works Standard*			
	270	271	M 3275	M 3277
D 2866 TUE	400 h	400 h	400 h	400 h

*) See Publication "Fuels, Lubricants and Coolants for MAN Diesel engines".

Note:

- Use only approved engine oils
- Where Diesel fuels with a sulphur content greater than 1% are used, the oil change intervals are to be halved
- Irrespective of the periods stated, the engine oil should be changed at least once every year
- Change the oil filter elements every time the engine oil is changed

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