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# Service and Maintenance

## 6.1 Lubrication System

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### 6.1.1 Oil Change Intervals

- The oil change intervals are dependent on the engine application and the quality of the lube oil.
- If the engine runs fewer hours during the year than stated in the table, the oil should be changed at least once a year.
- The table refers to the following conditions:
  - For diesel fuel: sulfur content max. 0.5% by weight.
  - Continuous ambient temperatures down to -10 °C (+14 °F).
- If the sulfur content is > 0.5 to 1% or the continuous ambient temperature below -10 °C (+14 °F), the intervals between oil changes should be halved.

- In the case of fuels containing more than 1% sulfur, contact your service representative.

Installed engines			Lube oil intervals in OH		Lube oil intervals in OH	
			Naturally aspirated engines		Turbocharged engines	
Lube oil quality	API classification		CC 1)	CD/CE 1)	CD/CE/CF-4	—
	CCMC classification		D4	D5 2) (SHPD) 3)	D4	D5 2) (SHPD) 3)
<b>Normal oil usage, e.g.:</b>			250	500	250	500
Road vehicles, cranes, construction machinery, ships, electrical units, pumps, rail-run vehicles						
<b>Heavy-duty oil usage, e.g.:</b>			125	250	125	250
Combine harvesters, emergency pumps, underground equipment, sweeping machines, winter operation equipment, emergency power generating units						
Vehicle engines			Lube oil intervals in km		Lube oil intervals in km	
			Naturally aspirated engines		Turbocharged engines	
Lube oil quality	API classification		CC 1)	CD/CE 1)	CD/CE/CF-4	—
	CCMC classification		D4	D5 2) (SHPD) 3)	D4	D5 2) (SHPD) 3)
Service group	Annual kilometrage km	average speed approx. km/h				
I	to 30 000	20	5 000	10 000	5 000	10 000
II	more than 30 000 to 100 000	40	10 000	20 000	10 000	20 000
III	more than 100 000	60	15 000	30 000	15 000	30 000

Change the oil with the engine off but still warm (lube oil temperature approx. 80 °C).

<sup>1)</sup> Lube oils having both a C- and an S classification (e.g. CD / SE) can be used. Oils with only a C classification (e.g. CE) generally perform very well in diesel engines and are to be preferred.

<sup>2)</sup> D5 grade oil with sulfate ash content > 1.8% by mass.

<sup>3)</sup> SHPD lube oils can be used.

These are the equivalent of D5 grade.

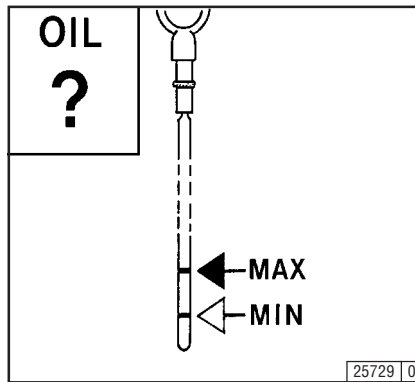
## 6.1 Lubrication System

## Service and Maintenance

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### 6.1.2 Checking Oil Level / Changing Engine Oil

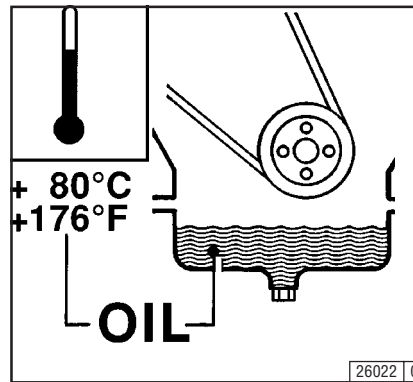
#### 6.1.2.1 Checking Oil Level



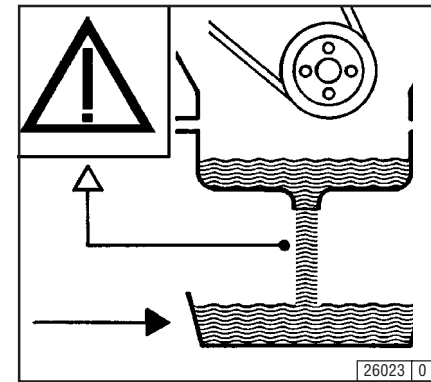
- Check the oil level with the engine switched off.
- Ensure that the engine or vehicle is in a level position.
- Remove the oil dipstick.
- Wipe the dipstick with a non-fibrous, clean cloth
- Insert it to the stop and remove again.
- Check the oil level, and if necessary, top up to the "MAX" mark. If the oil level is only just above the "MIN" mark, more oil must be added.

The oil level must not drop below the "MIN" mark

#### 6.1.2.2 Changing the Engine Oil



- Allow the engine to warm up.
- Ensure that the engine or vehicle is on a level position.
  - Lube oil temperature approx. 80 °C.
- Turn the engine off.



- Place oil tray under the engine.
- Unscrew drain plug.
- Drain oil.
- Fit oil drain plug with the new gasket and tighten firmly (for torque see 9.2).
- Pour in lube oil
  - For grade / viscosity, see 4.1.
  - For quantity see 9.1.
- Check the oil level, see 6.1.2.1



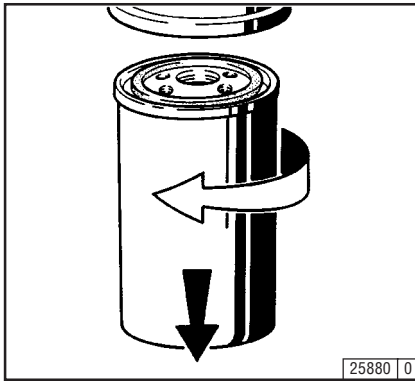
! Be careful when draining hot oil - danger of scalds!  
Do not let used oil run into the soil but catch it in a container ready for proper disposal!

# Service and Maintenance

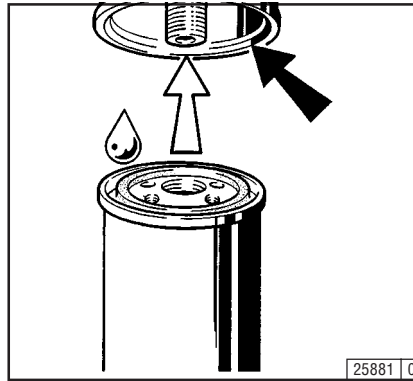
## 6.1 Lubrication System

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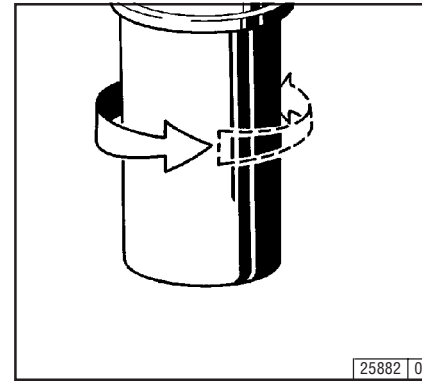
### 6.1.3 Changing Oil Filter



- Undo the filter cartridge using a commercial tool and spin off.
- Catch any dripping oil.



- Clean any dirt from the filter carrier rim.
- Lightly oil the rubber gasket of the new oil filter cartridge.
- Screw in the new cartridge finger tight against the gasket.



- Tighten the oil filter cartridge with another half-turn.
- Check oil level, see 6.1.2.
- Check oil pressure, see 3.3.1.
- Check cartridge seal for leaks.



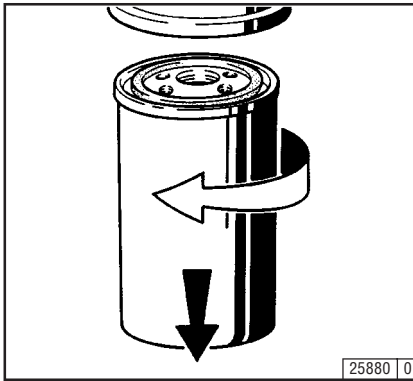
Beware of burns from hot oil.

## 6.2 Fuel System

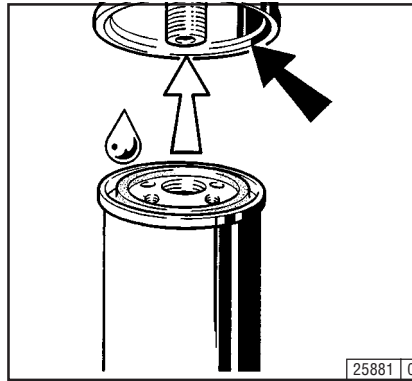
## Service and Maintenance

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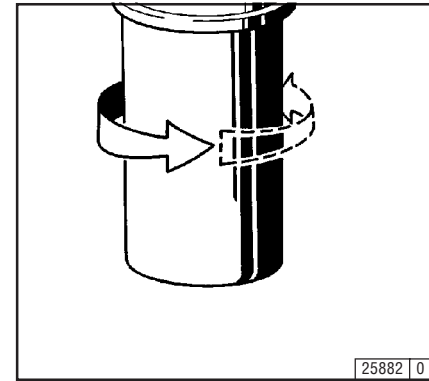
### 6.2.1 Changing Fuel Filter



- Close fuel stopcock.
- Undo fuel filter cartridge with commercial tool and spin off.
- Catch any fuel.



- Clean any dirt from the filter cartridge with a final half-turn.
- Apply light film of oil or diesel fuel to the rubber gasket of the new fuel filter cartridge.
- Screw in the new cartridge finger tight against



- the gasket.
- Tighten the fuel filter cartridge with a final half-turn.
- Open fuel stopcock.
- Check for leaks.



Keep naked flames away when working on the fuel system. Do not

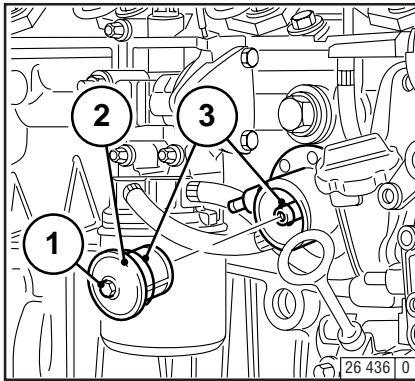
The fuel system does not need to be bled.

# Service and Maintenance

## 6.2 Fuel System

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### 6.2.2 Fuel Pump Cleaning the Strainer



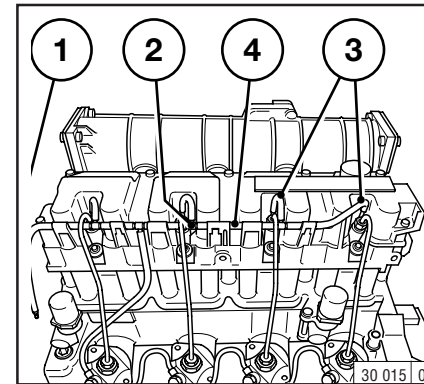
- Close the fuel shut-off valve.
- Loosen and unscrew the hexagonal nut 1.
- Remove the fuel strainer cover 2 (cover and strainer, one unit)
- Clean the fuel strainer with diesel fuel. Replace if necessary.
- Place seals 3 in position.

- Mount the fuel strainer cover 2.
- Tighten the hexagonal screw 1.
- Check for leaks.



Keep naked flames away when working on the fuel system.  
Do not smoke!

### 6.2.3 Change Fuel Leakage Line



- Close the fuel shutoff valve.
- Disconnect rubber hoses 3 from the injection valves.
- Disconnect rubber hose 1 from fuel tank.
- Disconnect rubber hoses 4, 3 and 1 from unions 2 and dispose of in an environmentally friendly manner.
- Connect new rubber hoses 4, 3 and 1 to unions 2.
- Connect rubber hoses 3 to injection valves.
- Connect rubber hose 1 to fuel tank.
- Open fuel shutoff valve.
- Check for leaks after start-up.

## 6.3 Cooling System

# Service and Maintenance

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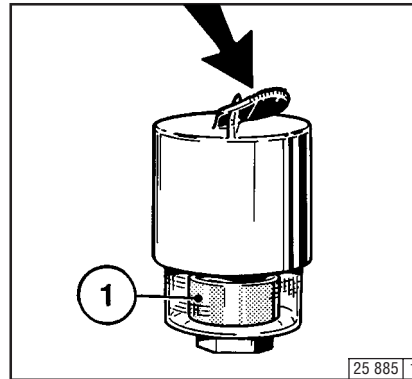
### 6.3.1 Cleaning Intervals

- The amount of contamination in the cooling system depends on the engine application.
- Spilled oil or fuel on the engine increases the risk of contamination. Be especially careful if the engine is used in dusty environments.
- Serious contamination can occur, for example:
  - on construction sites where there is a high level of air-borne dust.
  - in harvesting application where there are high concentrations of chaff and chopped straw in the vicinity of the machine.
- Because applications vary, cleaning intervals have to be determined from case to case. The cleaning intervals given in the table on the right can be used as a guide.
- Clean the engine as described in 6.8.1.

Inspection and cleaning intervals Recommended OH	Engine application
2000	Ships, Electrical units in enclosed areas, pumps
1000	Vehicles on reinforced highways
500	Tractors, fork-lift trucks, mobile electrical units
250	Vehicles on construction sites and on roads with loose surfaces, construction machinery, compressors, mining equipment
125	Agricultural machinery, tractors used for harvesting purposes

#### 6.4.1 Cleaning Intervals

- The amount of dirt in the air cleaner depends on the amount of dust in the air and the size of the air cleaner used. If a high level of dust is anticipated, a cyclone-type precleaner can be fitted to the air cleaner.
- Cleaning intervals will have to be determined from case to case.
- Air cleaner servicing is needed when:
  - **Service indicator**  
the red signal 1 is fully visible when the engine is off.
  - **Service switch**  
the yellow pilot light comes on when the engine is running.
- After carrying out service work, reset the signal by pressing the button on the service indicator.



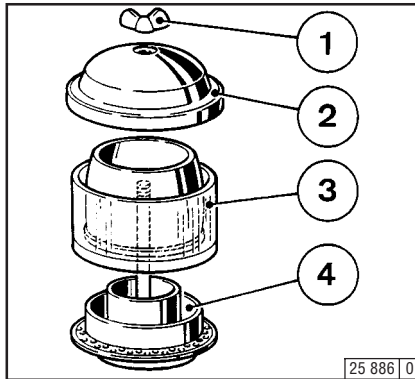


## 6.4 Combustion Air Filter

# Service and Maintenance

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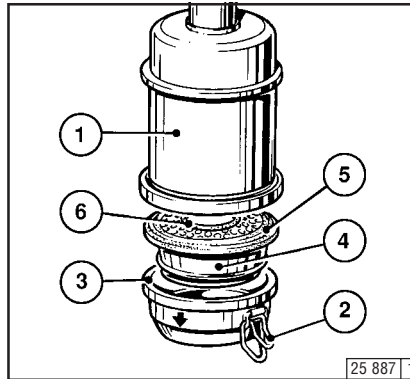
### 6.4.2 Emptying Cyclone Type Precleaner



- Undo wing nut 1 and remove cover 2.
- Remove collector bowl 3 from lower section 4 and empty. Clean leaves, straw and other foreign matter from lower section of pre-cleaner.
- Reposition collector bowl 3 onto lower section 4, fasten cover 2 in place by tightening wing nut 1.

Never fill collector bowl with oil. Replace collector bowl if damaged.

### 6.4.3 Cleaning Oil Bath Air Cleaner



- Turn engine off and wait about 10 minutes for the oil to drain from filter housing 1.
- Release snap clips 2 and remove oil cup 3 together with filter element 4. If necessary prise element out with a screwdriver, taking care not to damage the rubber gasket 5.
- Remove dirty oil and sludge. Clean oil cup.
- Clean filter element 4 in diesel fuel and allow to drip-dry.

- Clean filter housing 1 if very dirty.
- Inspect and replace rubber gasket 5 and 6 if necessary.
- Fill oil cup with engine oil up to the mark (arrow) (for viscosity, see 4.1.2).
- Refit oil cup and element to filter housing and secure with snap clips.



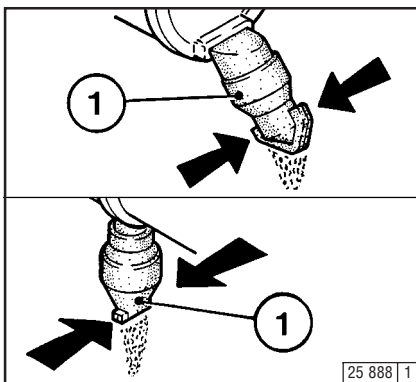
Never clean air cleaner with gasoline. Dispose of cold oil in accordance with environmental regulations!

# Service and Maintenance

## 6.4 Combustion Air Cleaner

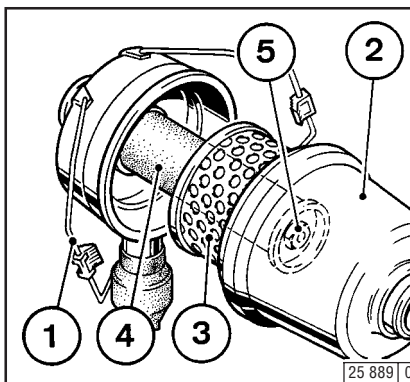
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### 6.4.4 Dry Type Air Cleaner Dust Discharge Valve



- Empty dust discharge valve 1 by pressing apart lips of discharge slot as indicated by arrows.
- Clean discharge slot from time to time.
- Remove any caked dirt by pressing together the upper section of the valve.

### Filter Cartridge



- Undo clip fasteners 1.
- Take off hood 2 and remove cartridge 3.
- Clean cartridge (replace at least once a year)
- Clean cartridge 3.  
Blow out from inside out with dry compressed air (max. 5 bar), (or in difficult cases, tap out, taking care not to damage the cartridge, or wash according to manufacturer's instructions).
- Through regular removal and replacement, the gaskets on the filter cartridge can become damaged. Check paper filter (light showing through) and gaskets for damage. Replace if necessary.

- After five cleaner services or after two years at the latest, replace safety cartridge 4 (never clean).  
To do so:
  - Undo hex. nut 5 and remove cartridge 4.
  - Install new cartridge, insert and tighten hex nut.
- Install cartridge 3, replace hood 2 and do up clip fasteners 1.

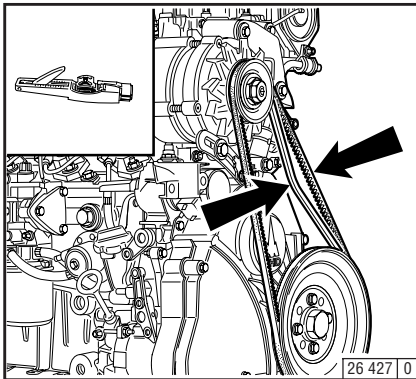


Never clean filter cartridge with gasoline or hot fluids.

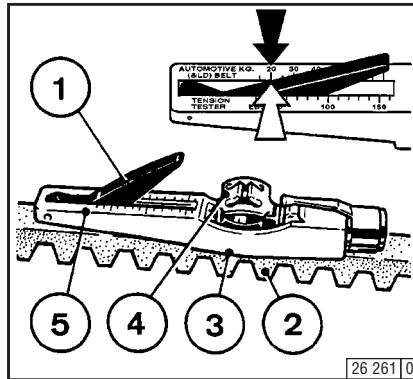
## 6.5 Belt Drives

# Service and Maintenance

### 6.5.1 Checking V-Belts



- Inspect entire V-belt for damage.
- Replace damaged V-belts.
- After installing new belts, run engine for 15 minutes, then check belt tension.
- To check the tension of the V-belt, use a tension gauge (see 9.3).
  - Place indicator arm 1 into gauge.
  - Position gauge on V-belt 2, midway between the pulleys, with flange 3 on bottom of gauge against the edge of belt.
  - Push slowly on the black pad 4 at right angles to belt 2 until the spring is heard or felt to trigger.



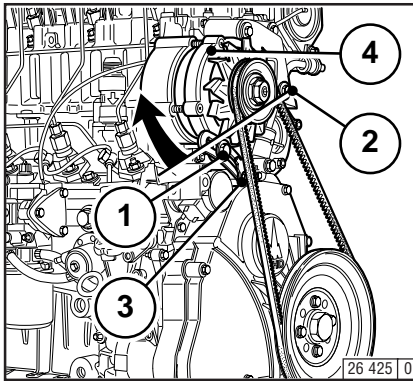
- Carefully remove the gauge without altering the position of the indicator arm 1.
- Read off the value where the black indicator arm 1 intersects scale 5 (arrow). For settings, see 9.1.
- If necessary, retension belt and measure again.



Check tension and change belts only with the engine off. Refit belt guard, if provided.

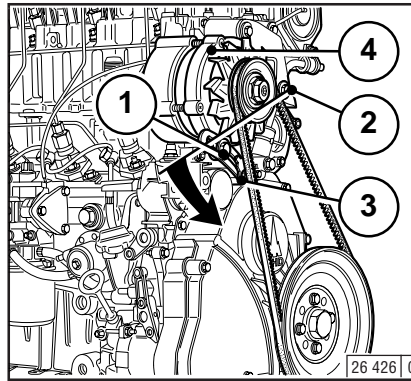
When new V-belts are fitted, check the belt tension after ca. 15 minutes running time.

#### 6.5.2 Tensioning Alternator Belts



- Slacken off bolts 1, 2 and 3.
- Adjust alternator 4 in direction of arrow by turning bolt 3 until correct belt tension is achieved.
- Retighten bolts 1, 2 and 3.

#### 6.5.3 Changing Alternator Belts



- Slacken off bolts 1, 2 and 3.
- Adjust alternator 4 in direction of arrow by turning bolt 3.
- Remove and replace belt.
- Adjust alternator 4 against the direction of the arrow by turning bolt 3, until correct belt tension is achieved.
- Retighten bolts 1, 2 and 3.



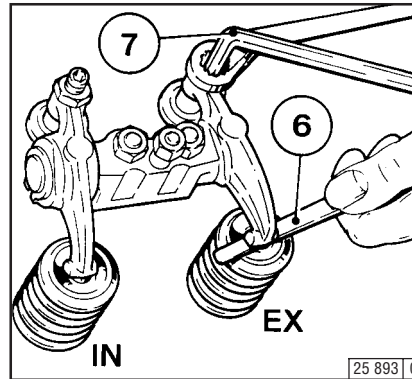
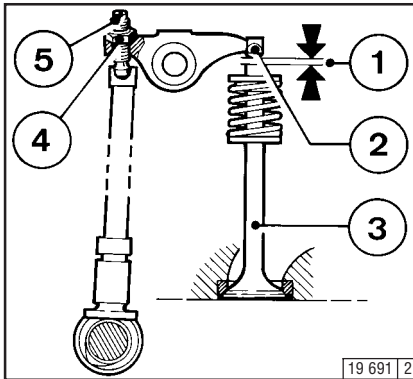
Check, tension and change belts only with the engine off. Refit belt guard, if provided.

# Service and Maintenance

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#### 6.6.1 Checking / Adjusting Valve Clearances



- Remove the cylinder head cover.
- Position crankshaft as per schematic 6.6.1.1.
- Before adjusting valve clearance, allow engine to cool down for at least 30 minutes. The oil temperature should be below 80 °C.
- Check valve clearance 1 between rocker arm / tappet contact face 2 and valve stem 3 with feeler gauge 6 (there should be only slight resistance when feeler blade is inserted).  
For permissible valve clearance, see 9.1.

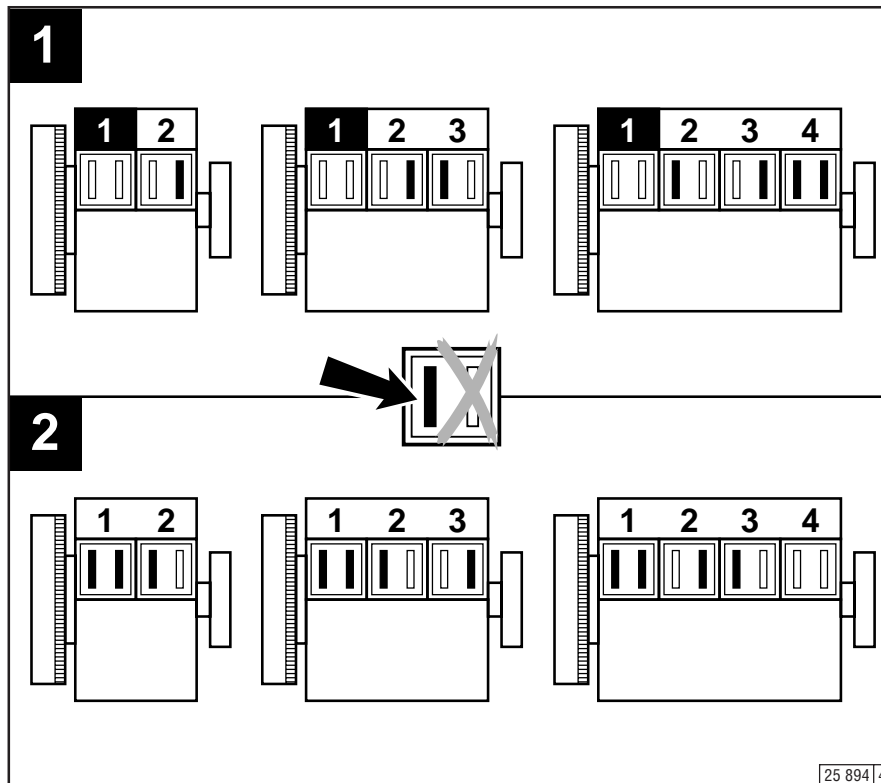
- Adjust valve clearance if necessary:
  - Release locknut 4.
  - Use allen key 7 to turn setscrew 5 so that the correct clearance is attained after locknut 4 has been tightened.
- Check and adjust valve clearance on all remaining cylinders.
- Replace cylinder head cover (use new gasket if needed).

## 6.6 Adjustments

# Service and Maintenance

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### 6.6.1.1 Valve Clearance Adjustments Schematic



#### ● Crankshaft Position 1:

Turn crankshaft until both valves in cylinder 1 overlap (exhaust valve about to close, inlet valve about to open). Adjust clearance of valves marked in black on schematic. Mark respective rocker arm with chalk to show that adjustment has been done.

#### ● Crankshaft Position 2:

Turn crankshaft one full revolution (360°). Adjust clearance of valves **marked in black** on schematic.

25 894 4

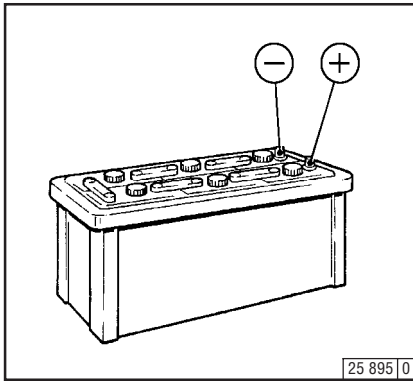
# Service and Maintenance

## 6.7 Accessories

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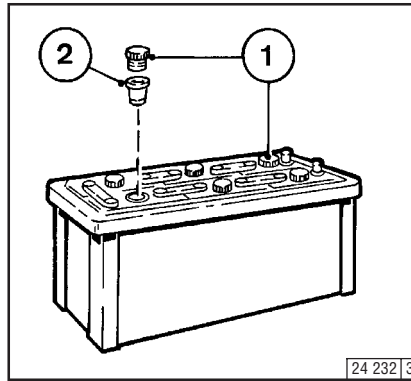
### 6.7.1 Battery

#### 6.7.1.1 Checking Battery and Cable Connectors



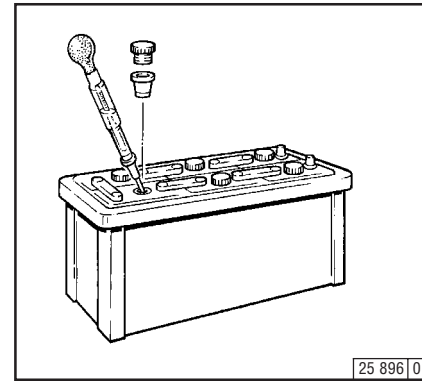
- Keep battery clean and dry.
- Undo dirty clamps.
- Clean terminal posts (+ and -) and clamps of the battery, and grease with acid-free and acid-resistant grease.
- When reassembling, ensure that clamps make good contact. Do up clamp bolts finger tight.

#### 6.7.1.2 Checking Electrolyte Level



- Remove caps 1.
- If testers 2 are used, the electrolyte should come up to their base.
- If testers are not used, the electrolyte level should be 10-15 mm above the top of the plates.
- If necessary, top up with distilled water.
- Replace caps.

#### 6.7.1.3 Checking Electrolyte Density



- Measure the electrolyte density of individual cells with a commercial hydrometer.

The hydrometer reading (see table on following page) indicates the state of charge. During measurement, the temperature of the electrolyte should preferably be 20 °C.



Electrolyte density				
in kg/l		in ° Bé (Baumégrad)*		State of Charge
Normal	Tropics	Normal	Tropics	
1.28	1.23	32	27	Fully charged
1.20	1.12	24	16	Half charged, recharge
1.12	1.08	16	11	Discharged, recharge immediately

\* Measurement of electrolyte density in ° Bé (Baumé-grad) is out of date and rarely used today.



The gases emitted by the battery are explosive! Keep sparks and naked flames away from the battery. Do not allow battery acid to come into contact with skin or clothing.

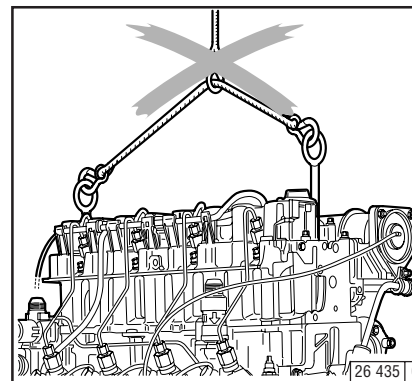
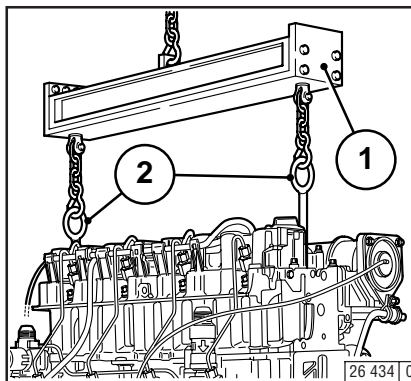
Wear protective goggles. Do not rest tools on the battery.

#### 6.7.2 Three-Phase Alternator

Notes on the three-phase system:

- Never disconnect the cables between battery, alternator and regulator while the engine is running.
- If, however, it is necessary to start and operate the engine without the battery, disconnect the regulator from the alternator before starting.
- Be sure not to confuse the battery terminals.
- Replace defective bulb of the charge pilot lamp immediately.
- When washing the engine, cover up the alternator and regulator.
- The habit of touching a lead against the frame to check whether it is live must under no circumstances be used with three-phase electrical systems.
- In case of electric welding, connect the ground terminal on the welder directly to the piece being welded.

#### 6.7.3 Lifting Tackle



- Always use proper lifting tackle 1 when transporting the engine.
- After transportation and before commissioning of the engine:  
Remove attachment eyes 2.



Use only the correct lifting tackle.

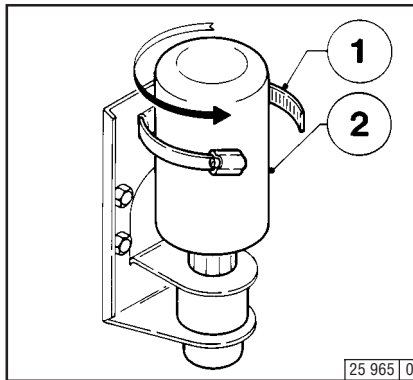
## 6.7 Accessories

## Service and Maintenance

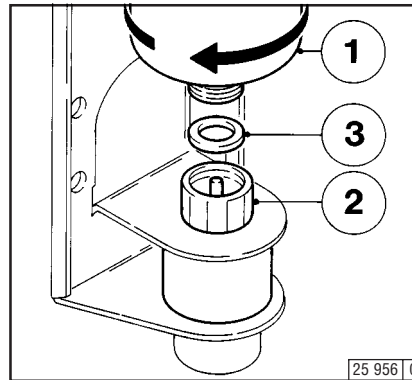
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### 6.7.4 Ether Starting System

#### 6.7.4.1 Changing the Fluid Container



- Before removing the container, clean the container support and the top of the solenoid valve.
- Loosen the bracket 1.
- Unscrew the fluid container 2.
- Empty or replace the depressurized fluid container.



- Place the container 1 on the solenoid valve 2 and tighten by hand.
- When mounting, ensure that gasket 3 is seated correctly.
- Pull in the brackets.
- Check for leaks.



Before commissioning, leave the fluid container of the ether starting system in position for 15 minutes. Check for leaks. The starting fluid is inflammable. Ensure that the container is not damaged. Prevent foreign substances from entering the container. The fluid container must not be stored at temperatures above 50 °C.

### 6.8.1 Engine Cleaning

#### Preparation

- Switch off the engine.
- Remove engine covers and cooling air hood. Replace them after cleaning and before the test run.
- Cover electrical / electronic components / connections (eg. generator, starter, governor, solenoid).

#### Using compressed air

- Blow air through the engine, taking particular care not to damage the cooler and cooling fins (begin to blow through air from the exhaust side).  
Remove the dirt which has blown into the interior space.

#### Using cold-cleaning compound

- Spray the engine with the commercial cold-cleaning compound and allow to react for approx. 10 mins.
- Spray clean the engine with a strong water jet, repeat if necessary.
- Allow the engine to run up so that the remaining water evaporates.

#### Using high pressure device

- Clean the engine with a steam jet (max. spray pressure of 60 bar, max. steam temperature of 90°C).
- Allow the engine to run up so that the remaining water evaporates.



Clean the engine only when the engine is switched off.