Fitting

1. Check that the oil line to the compressor is clean and also make sure that oil is being fed unobstructedly to the compressor.
2. Clean or change all damaged, rusty or dirty air or water lines before connecting them to the compressor. Always use a new gasket for the discharge line. Also, connect the oil line.
3. Tighten the compressor retaining screws firmly.
4. Fit the driver pin for the tachometer drive (applies only to D/DS14).

Inspection

After having fitted the compressor, check in accordance with the directions given under "Functional Check".

Trouble Shooting

I Compressor not maintaining sufficient pressure in the system

a. Clogged air filter.

b. Excessive coking in the cylinder head or discharge line of the compressor.

c. Leaky discharge valves.

d. Excessive wear (pistons and cylinders).

e. Inlet valves leaky or stuck.

f. Faulty pressure regulator (see "Pressure Regulator").

II Abnormal noise

a. Gearwheel loose on the crankshaft.

b. Excessive coking in the cylinder head or discharge linie of the compressor.

c. Worn bearings.

d. Excessive wear (pistons and cylinders).

III Compressor allowing too much oil to pass

a. Excessive wear (pistons and cylinders).

b. Clogged air filter.

c. Compression rings or oil scraper rings incorrectly fitted.

d. Overpressure in the engine crankcase.

IV Compressor not being relieved

a. Defective relief-piston seals.

b. Relief mechanism has seized.

c. Faulty pressure regulator (see "Pressure Regulator").

COMPRESSOR 232615 (218469)

Capacity: 0.755 m^3 at 1.730 r/min (equiwalent to 2.000 r/min on engines D/DS8 and D/DS11 and 1.730 r/min on engines D/DS14

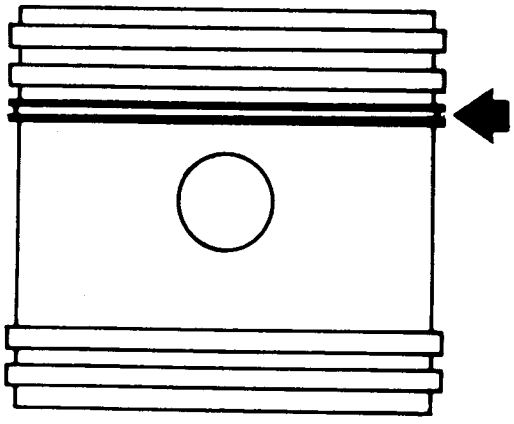
Charging time: max. 2.5 min. from 0–7.7 bar (kgf/cm^2) for a reservoir volume of 150 litres at an engine speed of 2.000 r/min

Clearance between piston and cylinder bore:	0.08–0.11 mm
Clearance between piston and piston rings (all of):	0.01–0.06 mm
Piston ring gap (rings located in cylinder bore):	
1st compression ring	0.13–0.25 mm
2nd compression ring	0.08–0.17 mm
Oil scraper ring	0.13–0.25 mm
Clearance between connecting rod and crankpin, normal	0.04–0.10 mm
Clearance between connecting rod and crankpin, max.	0.11 mm
Clearance between crankshaft and sliding bearing of rear end cover, normal	0.02–0.07 mm
Clearance between crankshaft and sliding bearing of rear end cover, max.	0.09 mm
Clearance between connecting rod and wrist pin, max.	0.04 mm

Tightening torques

Eleven long cylinder-head screws to be tightened to (2.1–2.4 kgf m)	21–24 Nm
Two short cylinder-head screws to be tightened to (0.6–0.8 kgf m)	6–8 Nm
Connecting rod bolts to be tightened to (1.4–1.7 kgf m)	14–17 Nm
Rear end cover screws to be tightened to (1.0–1.2 kgf m)	10–12 Nm
Bottom plate screws to be tightened to (0.6–0.8 kgf m)	6–8 Nm
Air filter screws to be tightened to (0.6–0.8 kgf m)	6–8 Nm

75.16710/3200 – 10.333



OIL LEAKAGE FROM COMPRESSOR TU-FLO 500

Compressor Tu-Flo500 has been modified to prevent oil leakage. The modification means that the compression ring above the piston bolt is replaced by an oil scraper piston ring. The modification has been introduced on new compressors from and including datum code MH2718 and on reconditioned compressors from and including AMN.

The new oil scraper piston ring has the same dimensions as the compression rings. Accordingly, there is nothing to prevent the fitting of oil rings on older compressors also. The ring shall be fitted in the third groove.

Part number:

Standard dimension	232352
First oversize	232353
Second oversize	232354
Third oversize	232355

OIL LEAKAGE FROM COMPRESSOR TU FLO 500

General

Oil Leakage from Compressor

In order to ensure lubrication of the compressor pistons a certain quantity of oil leaking past must be tolerated. What is normally described in daily conversation as oil leakage is none other than normal leaking past.

Manifestation of Damage

Very Dirty Engines

One disadvantage with this oil leaking past is, that the oil in some cases has a tendency to penetrate out through the air filter. The engines then become very dirty.

Probable Reasons

Compressor Load-relieved During Long Periods

Engine fouling is primarily noticeable when the compressor is load-relieved during long periods, e.g. on trucks engaged in long-distance haulage service. Besides this, leaking past increases with compressor wear. The normal "service life" of the compressor is 180.000 km (2.700 hours). After this distance it is advisable to carry out reconditioning work.

Service Solutions

Fitting of "Oil Trap"

The inconveniences suffered on account of badly fouled engines can be remedied by fitting a so-called oil trap. The design of this is shown by the drawing according to fig. 1. It is made of a square pipe material with dimension 40x20x2 mm. N.B. The reinforcement at two of the bolt holes is accomplished by using a suitable pipe and, secured by welding through the apertures for the air flow.

The fitting of the oil trap is shown by fig. 2. It may be necessary to make a new gasket of thicker gasket material (klingerit or similar) to obtain satisfactory sealing between compressor and oil trap.

Drain the Compressed Air Receiver Daily

The fitting in of the oil trap means that the engine will be kept clean. The oil which leaks past the compressor pistons (and which is necessary for the lubrication of the compressor) will be led to the wet receiver in the brake system. Therefore, it is very essential that the directions given in the Operators' Manual about daily draining of the compressed air receivers are followed assiduously. By doing so the oil will not flow out to the compressed air system and it will be possible to check the state of wear of the compressor continuously.

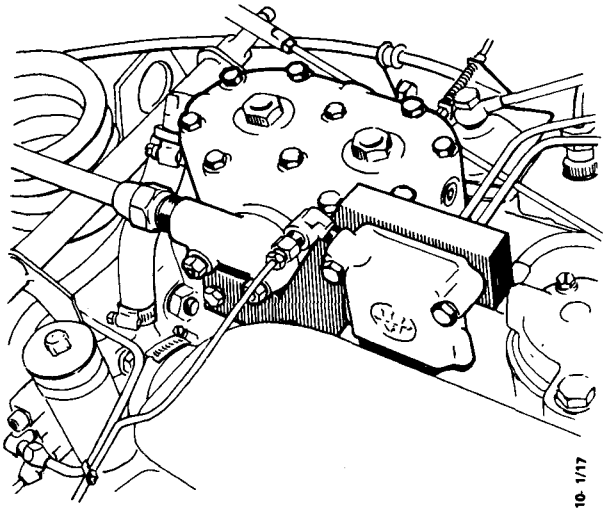
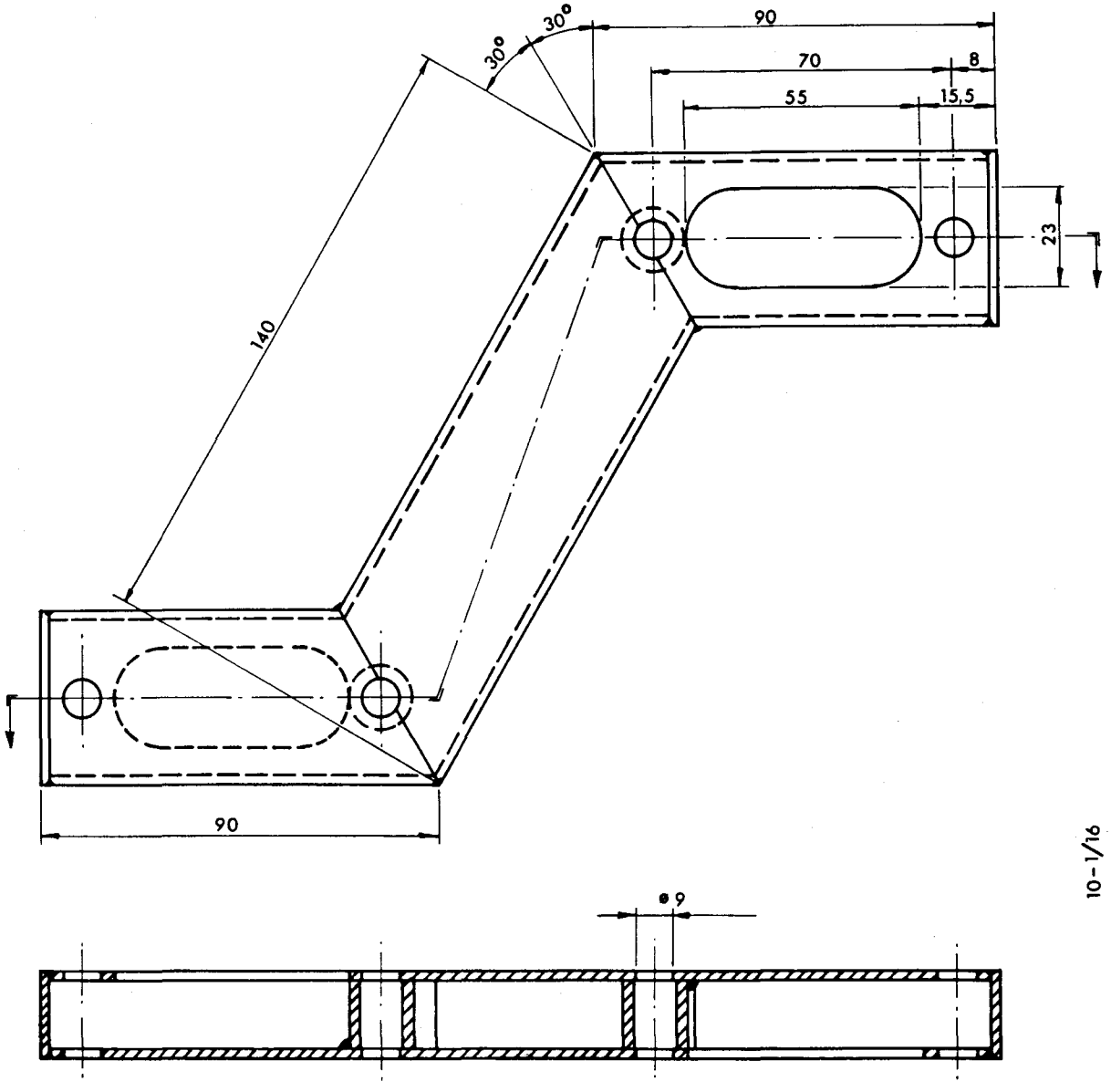


Fig. 2



10-1/16

Fig. 1

NYTT KOLVUTFÖRANDE TILL KOMPRESSOR TU–FLO 500

För att säkerställa smörjning av kompressorns kolvar måste en viss kvantitet olja tillåtas passera mellan kolv och cylinderväggg Detta medför den olägenheten att olja kan tränga ut genom kompressorns luftfilter . Speciellt förekommer detta i driftsfall där kompressorn går avlastad stor del av drifttstiden

De originalmonterade kolvarna är av aluminium. Det har emellertid visat sig att nämnda oljepassage respektive oljeutkast genom luftfiltret, utan nackdel, kan minskas genom användning av en gjutjärnskolvar.

Gjutjärnskolvar har därför införts som reservdel som ersättning för aluminiumkolvar som utgår ur reserdelssortimentet.

Observera

Byte till gjutjärnskolvar måste ske samtidigt i båda cylindrarna på grund av viktskillnaden mellan aluminiumkolv och gjutjärnskolv.

NEW DESIGN PISTON FOR COMPRESSOR TU–FLO 500

To ensure lubrication of the compressor$ pistons a certain amount of oil must be allowed to pass between the piston and cylinder walls. This leads to some inconvenience due to the fact that oil can be forced out through the compressor$ air filter. This particularly occurs in cases of operation where the compressor funtions in an unloaded state for a consederable part of the operating time.

The originally fitted pistons are made of aluminium. However, it has been shown that the oilpassage and oil throw-out mentioned through the air filter, without detriment, can be minimized by the use of cast iron pistons.

Therefore, cast iron pistons have been introduced as spare parts for the purpose of replacing aluminium pistons, which are now to be discontinued as spares in our range of goods.

Note

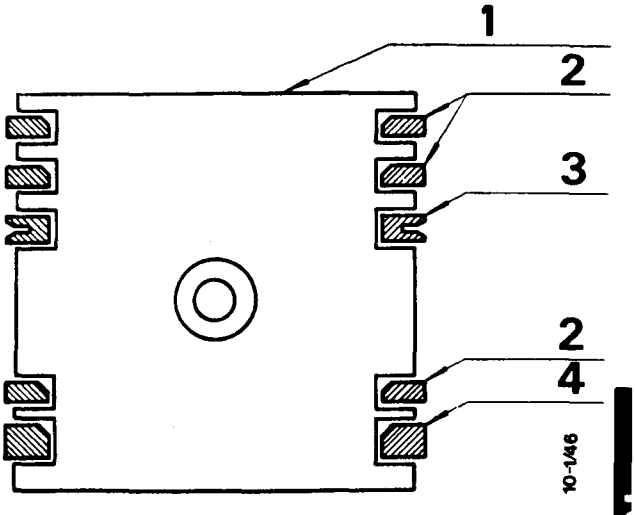
The changeover to cast iron pistons must take place simultaneously in both the cylinders on account of the difference in weight between aluminium and cast iron pistons.

Förteckning över tillkommande detaljer

List Covering Parts Added

Pos	Kolvdimension, Piston dimensions			
	Standard	0,010[1)]	0,020[1)]	0,030[1)]
1, 2, 3, 4	141966	150044	150045	150046
2	141970	145124	145126	145128
3	250442	250443	250444	267840
4	141971	145125	145127	145129

1) Oversizes in inches



3200:955

HYDRAULIC PUMP OF ROTOR TYPE
(Current production up to 1975)

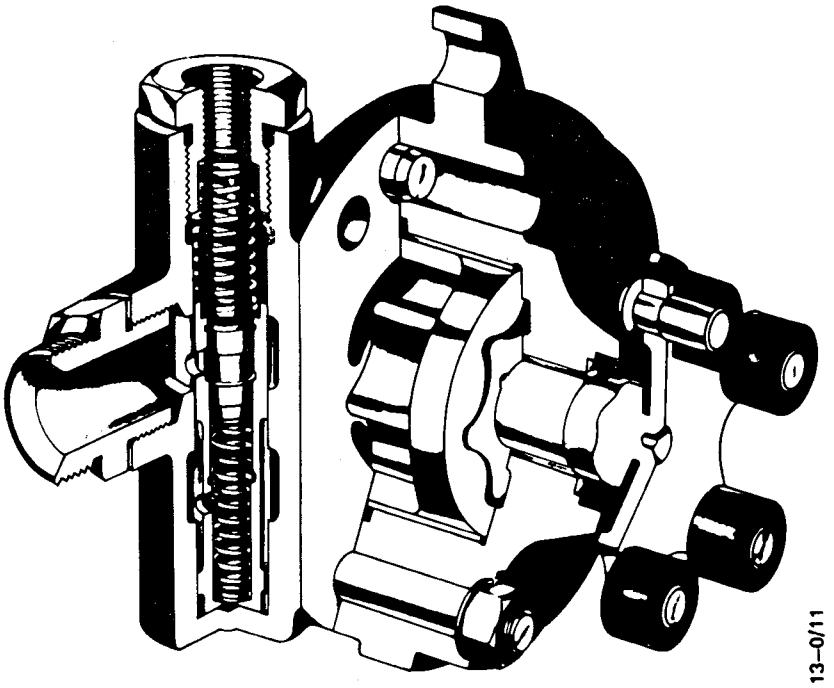


Fig. 1 Hydraulic pump

Description

The hydraulic pressure for the power steering is supplied by a pump which is driven by the engine. The reduction ratio is matched so that the delivery pressure of the pump will be sufficient even when the engine is idling. All moving parts of the hydraulic pump are lubricated by the circulating hydraulic fluid.

The moving parts consist of an inner rotor (1), an outer rotor (4) and a drive shaft (24). The outer rotor runs eccentrically in relation to the drive shaft. The inner rotor is secured to the drive shaft and has one tooth less than the number of "tooth gaps" in the outer rotor. The teeths and the gaps are formed so that the tips of the teeths of the inner rotor are continuously in contact with the outer rotor. For every revolution of the shaft, the inner rotor misses one of the gaps in the outer rotor. On the suction side of the pump, the space between the inner and outer rotors gradually increases, i.e. the pump draws fluid. On the delivery side, the space gradually decreases and the fluid between the teeths is forced out of the pump.

A flow control valve (17) and a pressure control valve (19) are incorporated into the pump, and the method of operation of these two valves is described on page 3.

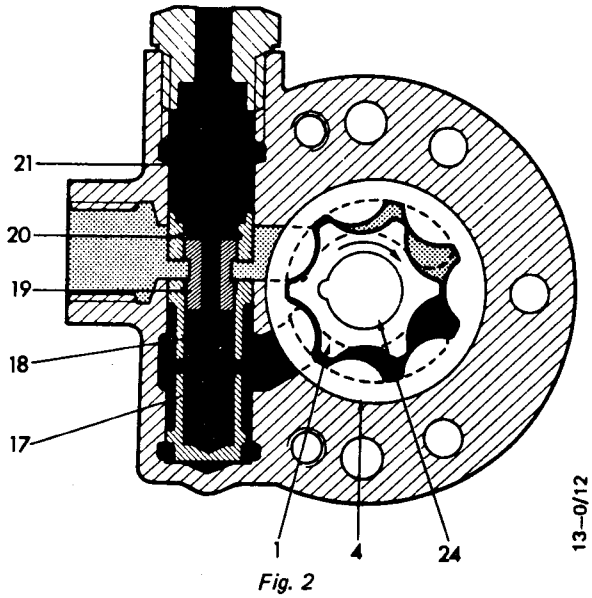


Fig. 2

1.	*Inner rotor*	*19.*	*Pressure control piston*
4.	*Outer rotor*	*20.*	*Circlip*
17.	*Flow control piston*	*21.*	*Flow control spring*
18.	*Pressure control spring*	*24.*	*Pump shaft with coupling half*

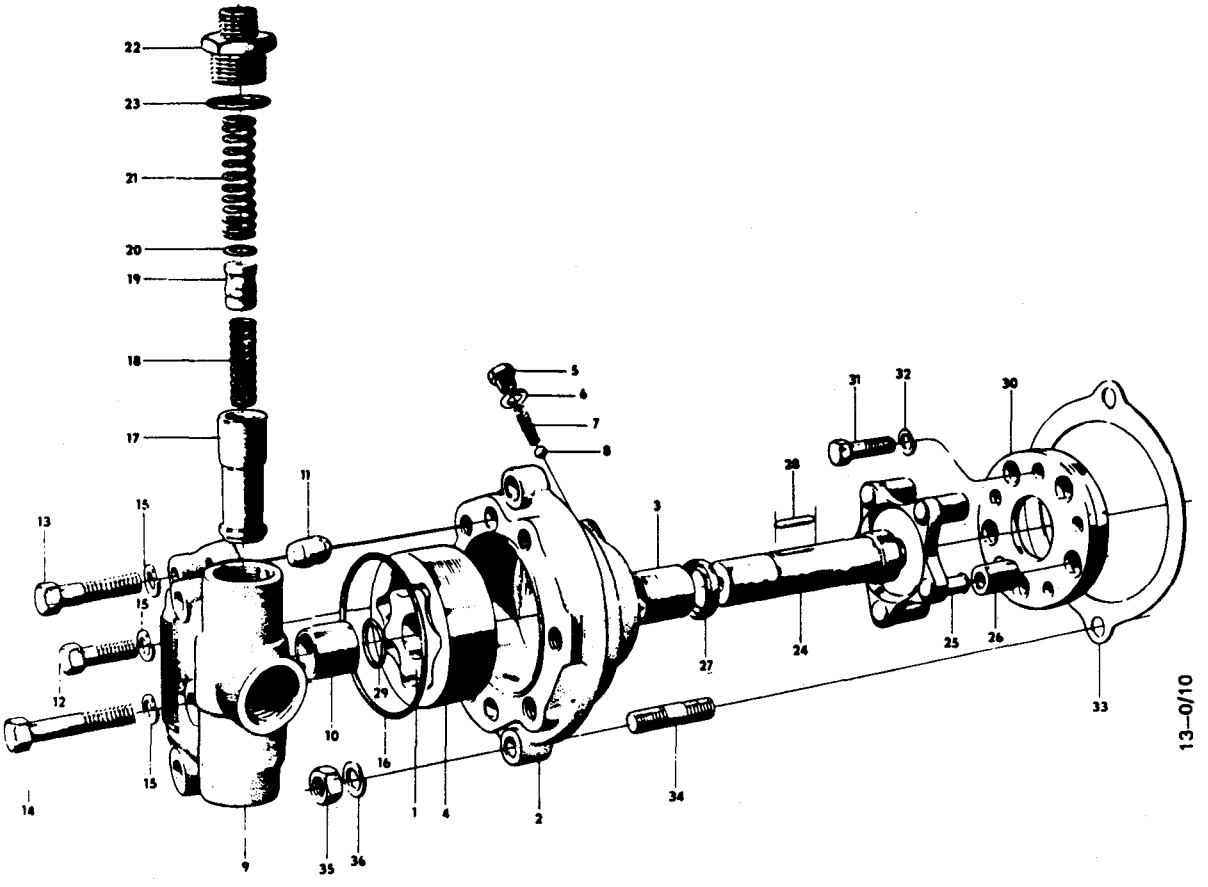


Fig. 3

1.	*Inner rotor*	19.	*Pressure control piston*
2.	*Casing with bush*	20.	*Circlip*
3.	*Bush*	21.	*Flow control spring*
4.	*Outer rotor*	22.	*Adapter*
5.	*Valve plug*	23.	*O-ring*
6.	*Sealing washer*	24.	*Pump shaft with coupling*
7.	*Spring*		*half*
8.	*Valve ball*	25.	*Coupling pin*
9.	*Cover*	26.	*Rubber bush*
10.	*Bush*	27.	*Oil seal*
11.	*Dowel*	28.	*Cylindrical key*
12.	*Bolt*	29.	*Circlip*
13.	*Bolt*	30.	*Coupling half*
14.	*Bolt*	31.	*Bolt*
15.	*Spring washer*	32.	*Spring washer*
16.	*O-ring*	33.	*Gasket*
17.	*Flow control piston*	34.	*Stud*
18.	*Pressure control spring*	35.	*Nut*
		36.	*Spring washer*

The flow control valve consists of a spring-loaded piston (17) and is designed to control the oil flow. The hydraulic fluid delivered by the pump flows through throttling holes in the piston. The throttling holes cause a pressure difference between the inside and outside of the piston. The magnitude of the pressure difference is dependent on the velocity of flow of the fluid. As the engine speed increases, the hydraulic fluid-flow will also increase, and the pressure difference will cause the flow control valve to move upwards and compress the spring (21). When the piston has lifted, a recess in the periphery of the piston places the delivery side of the pump in communication with the suction side, and some of the fluid will be re-circulated back to the pump.

The pressure control valve protects the servo system against excessive pressure which may occur when the circulation resistance increases. The valve consists of a piston (19), one end of which is subjected to the load of a spring (18) and both ends of which are subjected to the oil pressure in the system. The diameter of the piston is smaller at the spring-loaded end, and the hydraulic forces in the two directions will therefore be different. When the pressure has risen to a value at which the difference in the two forces is sufficient to compress the spring, a hole will be exposed in the outer piston, and the hydraulic fluid will be discharged to the suction side of the pump.

When the pressure control valve opens, the hydraulic fluid will be recirculated in the pump and its temperature will therefore rise quickly, thus involving the risk of the pump seizing.

The drive shaft is mounted in two bushes (3 and 10). The shaft is provided with a coupling flange with cylindrical coupling pins which fit into a corresponding coupling half or a gearwheel in the transmission. The coupling pins are fitted with rubber bushes (26).

The driven coupling half is integral with the shaft. A shear section is provided between the driven flange and the shaft, so that the shaft will shear off at this point if the drive should be overloaded, e.g. due to impurities in the hydraulic fluid.

The shaft is sealed by means of a lip seal (27). A drain passage to the suction side of the pump is provided between the seal and the bush (3), and any fluid leaking past the drive shaft bush will be drained through this passage. The passage is fitted with a spring-loaded ball valve (5–8). The pressure on the pump side of the lip seal is determined by the ball valve and this pressure prevents air from being drawn into the pump.

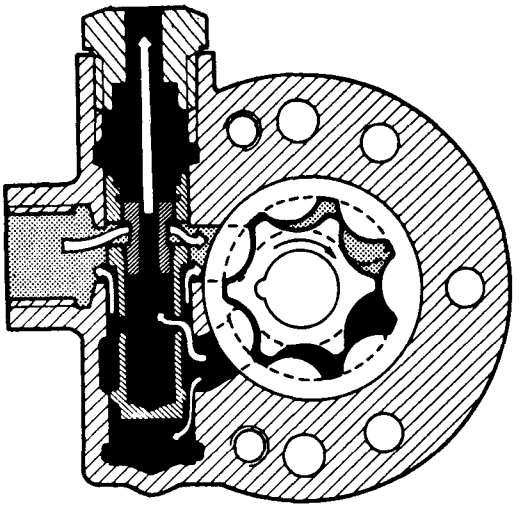


Fig. 4 Flow control valve in operation

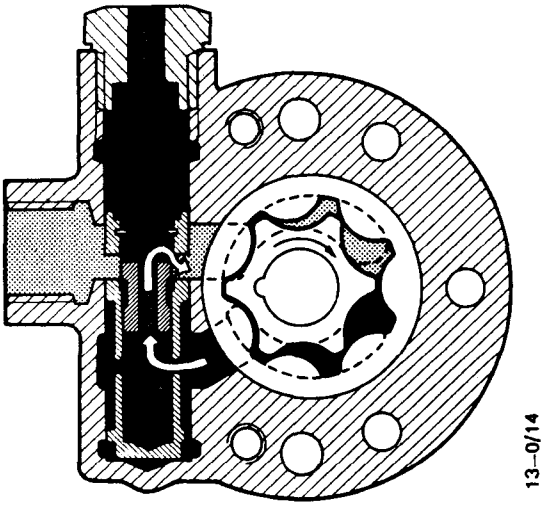


Fig. 5 Pressure control valve in operation

HYDRAULIC FLUID CONTAINER

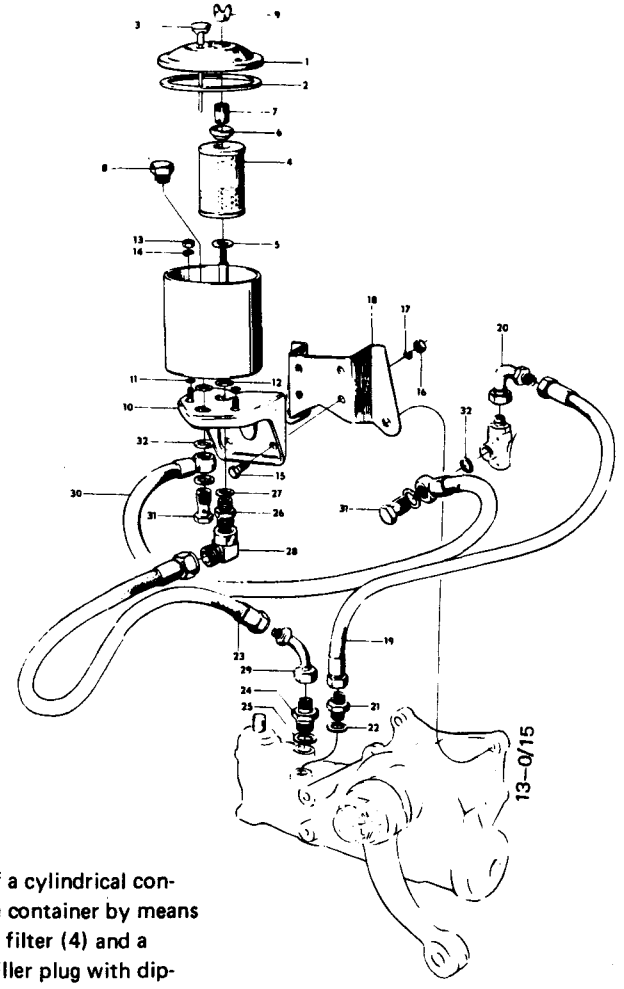


Fig. 6 Hydraulic fluid container of the LB110 (Other truck models are fitted with corresponding components)

1. *Cover*
2. *Gasket*
3. *Filler plug with dipstick*
4. *Filter*
5. *Washer*
6. *Centering ring*
7. *Sleeve*
8. *Connector*
9. *Wing nut*
10. *Bracket with screws*
11. *O-ring*
12. *O-ring*
13. *Nut*
14. *Spring washer*
15. *Bolt*
16. *Nut*
17. *Spring washer*
18. *Bracket*
19. *Pressure hose to steering unit*
20. *Elbow*
21. *Connector in steering unit*
22. *Sealing washer*
23. *Return hose from steering unit*
24. *Connector in steering unit*
25. *Sealing washer*
26. *Connector in the container*
27. *Sealing washer*
28. *Elbow*
29. *Elbow*
30. *Suction hose between container and pump*
31. *Banjo coupling screw in container and pump*
32. *Sealing washer*

Description

The hydraulic fluid container consists of a cylindrical container with a cover (1) which seals at the container by means of a gasket (2). The container contains a filter (4) and a relief device. The cover is fitted with a filler plug with dipstick.

The return hose (25) from the steering unit is connected to the container, and another hose (32) is connected to the hydraulic pump. (The figure shows the hydraulic system of an LB truck. The same applies to other models).

The return oil is delivered through the hose, through the coupling of the container and into a tube in the filter. A hole in the tube distributes the hydraulic fluid in the filter.

The relief valve consists of a spring sleeve with a slit, the sleeve being mounted over a hole in the tube below the filter. If the pressure in the return line should rise due to the filter being clogged by impurities, the spring sleeve will open and the hydraulic fluid will flow out into the container without passing the filter.

NOTE. The oil with which the container is topped up flows directly to the pump without passing through the filter. Extreme care should therefore be taken to ensure that the oil is free from impurities, and care should be taken to ensure that no dirt will come into the system.

VANE TYPE HYDRAULIC PUMP

The pump is fitted from the front on the left-hand side of the engine. The five rubber bushes of the drive shaft fit into corresponding holes in the compressor gearwheel of the DS8 and DS11 engines and in the power take-off gearwheel of the DS14 engine.

Drive shaft 2 is mounted in a ball bearing and a needle bearing in casing 1. Rotor 3 is splined onto shaft 2. The rotor is fitted with ten vanes 4 and runs in the bore of liner 5. The rotor assembly (3, 4 and 5) is clamped between the two port plates 6 and 7 by a spring 8.

The vanes 4 are free to move in the rotor slots. They are forced outwards towards the liner by centrifugal force and by hydraulic fluid pressure.

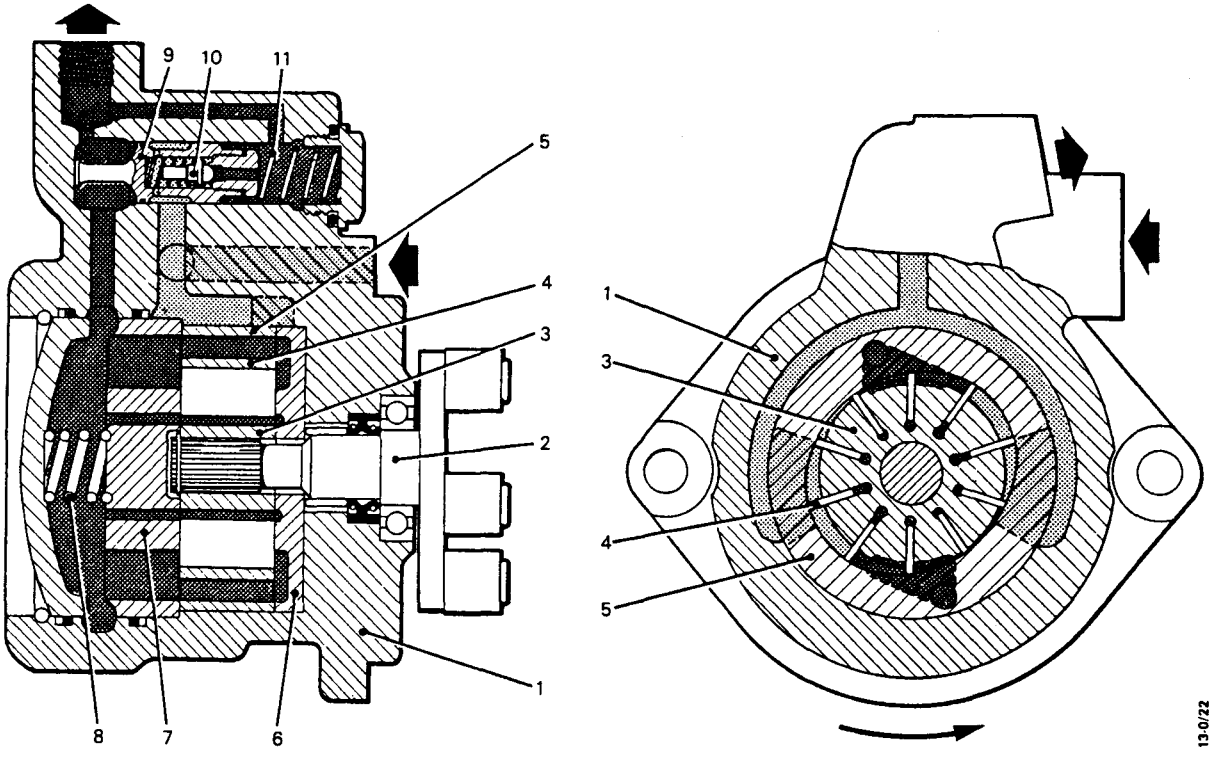
The liner is oval, and the volume between two of the vanes will thus increase and decrease twice per revolution when the rotor rotates.

The port plates have ports in communication with the liner holes. Both port plates are provided with such ports. Two of these are for the two suction sides and two for the two delivery sides.

The hydraulic pump incorporates control valve 9. This valve restricts the flow from the pump to approx. 16 dm^3/min (l/min). The pump starts to deliver this flow at a speed of about 700 r/min.

At speeds below 700 r/min, the control valve is displaced to the left by spring 11, as shown in Fig. 1. From the delivery side of the pump, the hydraulic fluid flows past the control valve, through a restriction and out into the delivery line.

A passage to the spring-loaded side of the control valve is provided downstream of the restriction. In this passage, the hydraulic fluid is at the static pressure. This pressure decreases as the flow rate and thus the flow velocity increases. As the pump delivery flow increases, the difference between the pressure on each side of the control valve 9 will also increase. When the delivery flow has attained 16 dm^3/min (l/min), the control valve will be displaced to the right, so that excess hydraulic fluid can flow back to the suction side of the pump (Fig. 2).



1. *Casing*
2. *Drive shaft*
3. *Rotor*
4. *Vane*
5. *Liner*
6. *Port plate, lower*
7. *Port plate, upper*
8. *Spring*
9. *Control valve*
10. *Safety valve*
11. *Spring*

Fig. 1 Hydraulic pump of the vane type

3200–1325

If the pump delivery flow is shut off, e.g. when the steering wheel is at either limit of its travel, the pressures at the two ends of the control valve will be equalised. Spring 11 will then displace the control valve to the left. The communication with the return passage will be closed. The pressure at both ends of the control valve will increase. When the maximum pressure has been attained, the force exerted by the hydraulic fluid will overcome the spring effort on safety valve 10, and the hydraulic fluid will flow through the return passage (see Fig. 3). The pressure on the control valve will then fall. When the pressure has fallen to the normal value, the safety valve will close and the control valve will revert to its normal position.

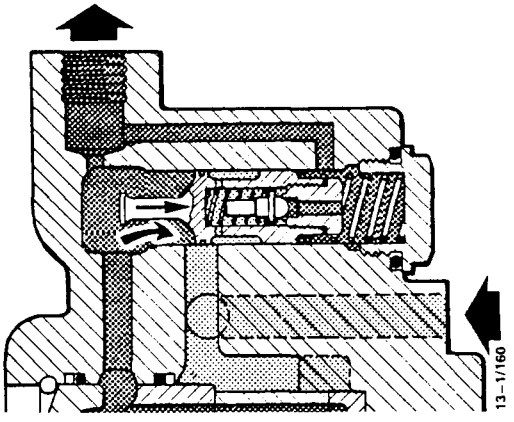


Fig. 2 Control valve in operation

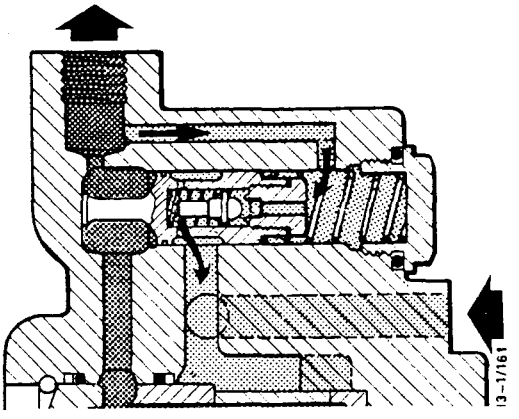
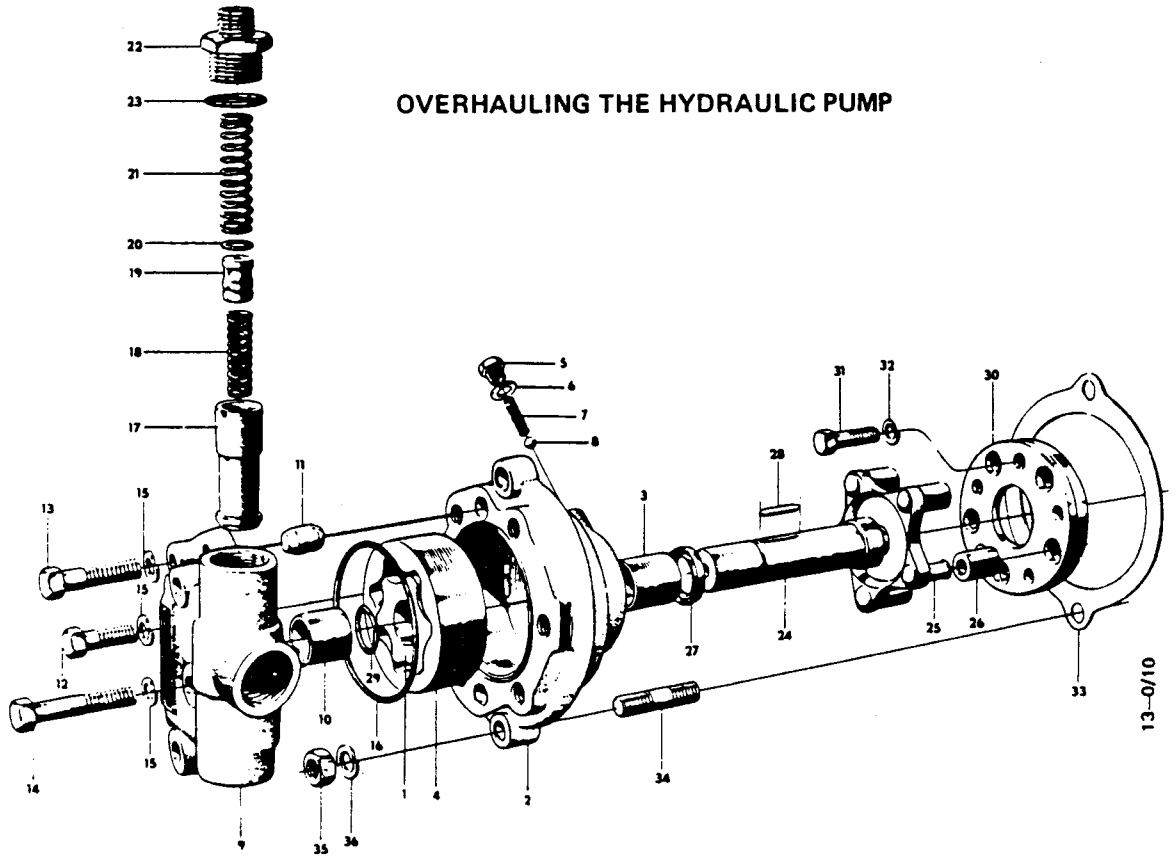


Fig. 3 Safety valve in operation

OVERHAULING THE HYDRAULIC PUMP



The following instructions comprise certain partial overhauls. More extensive repairs must be carried out at a workshop in which the necessary special equipment is available.

The hydraulic system includes components manufactured with very high precision and fitted with very small clearances. Extreme cleanliness is absolutely essential.

Measuring the hydraulic fluid pressure with the hydraulic pump fitted on the engine

- Connect a pressure gauge between the hydraulic pump and the steering unit.
- Check the oil level in the hydraulic fluid tank.
- Turn the wheels to the "straight ahead" position.
- Start the engine and vent the hydraulic system.
- Run the engine at idling speed. Turn the steering wheel alternately to each lock. The hydraulic fluid pressure at each lock will be aprox. 60 bar (kg/cm^2), when the engine runs at idling speed. If the pressure is appreciably lower, this indicates either that the pump is worn, in which case it should be replaced by an overhauled pump, or that the fault lies in the control valve. (See "Replacement of control valve").
- Remove the pressure gauge and vent the hydraulic system.

Fig. 7

1. Inner rotor
2. Casing with bush
3. Bush
4. Outer rotor
5. Valve plug
6. Sealing washer
7. Spring
8. Valve ball
9. Cover
10. Bush
11. Dowel
12. Bolt
13. Bolt
14. Bolt
15. Spring washer
16. O-ring
17. Flow control piston
18. Pressure control spring
19. Pressure control piston
20. Circlip
21. Flow control spring
22. Adapter
23. O-ring
24. Pump shaft with coupling half
25. Coupling pin
26. Rubber bush
27. Oil seal
28. Cylindrical key
29. Circlip
30. Coupling half
31. Bolt
32. Spring washer
33. Gasket
34. Stud
35. Nut
36. Spring washer

3200-1059

Replacement of the O-ring between the pump casing and cover

- Remove the bolts retaining the cover (9) on the pump casing (2). Tap carefully with a lead mallet to remove the cover.
- Replace the O-ring (16), checking that the groove for the ring in the pump casing and the contact surface on the cover are intact. Ensure that the new O-ring fits correctly in the groove.
- Refit the cover.

Replacement of the lip seal (27) for the drive shaft

- Remove the cover (9).
- Remove the O-ring (16), circlip (29), the rotor assembly (1, 4) and the cylindrical key (28).
- Withdraw the drive shaft (24).
- Remove the lip seal by means of an extractor.
- Carefully press a new lip seal into position. The outside of the seal should be flush with the surface of the pump casing.
- Fit the drive shaft, cylindrical key, rotor assembly and circlip (29).
- The O-ring (16) should always be replaced.
- Refit the cover.

Replacement of the control valve

- Remove the adapter (22) on the delivery side.
- Remove the spring (21) and the flow control piston.
- Inspect the cylinder bore in the pump cover. No scratches or signs of wear are permissible. Check that the flow control piston moves freely without binding in any position.
- Inspect the spring (21) by comparing it with a new spring.
- Replace the O-ring (23) under the adapter.
- Tighten the adapter.

Replacement of filter cartridge

Remove the wing nut on the hydraulic fluid container (9) and remove the cover. Remove the sleeve (7), the centering ring (6) and the filter cartridge. If the washer (5) is lifted with the cartridge, replace it before fitting the new filter cartridge. Fit the centering ring (6) and the sleeve (7). Check the gasket (2), replace it if necessary and refit the cover.

Change the hydraulic fluid and the filter insert regularly every year.

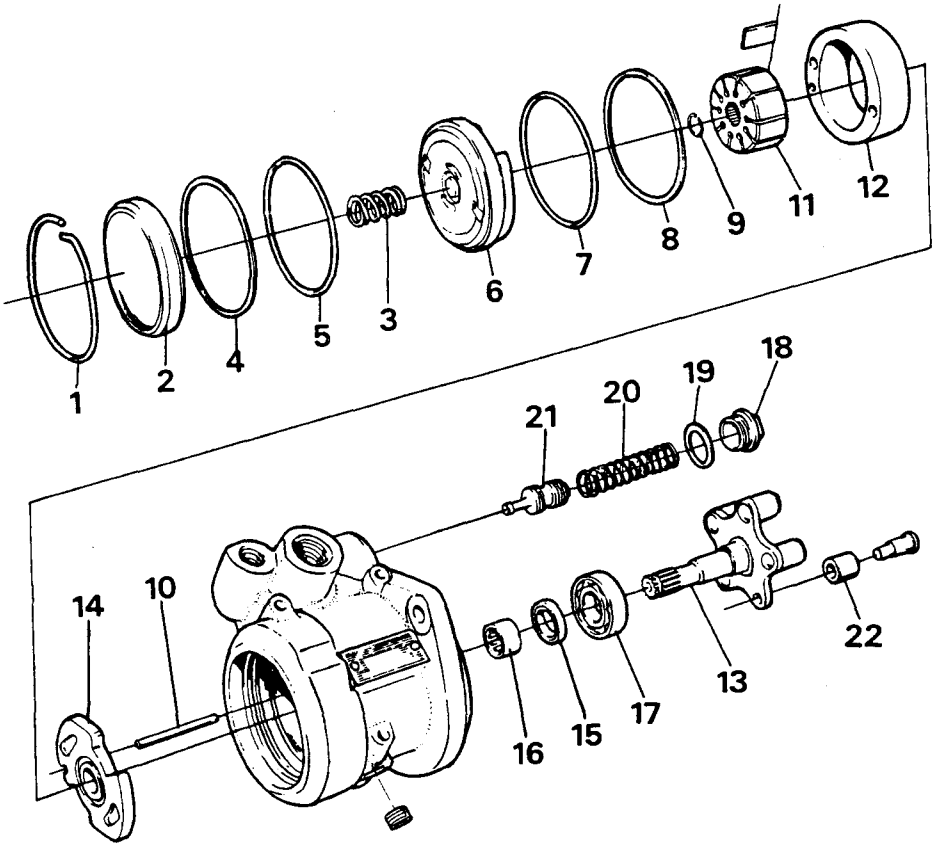
HYDRAULIC FLUID CONTAINER

Checking the hydraulic fluid level

The hydraulic fluid level should not fall below the lower mark on the dipstick when the engine is running. Top up with oil of the same grade and make as that already in the steering unit. Ensure that the fluid which is topped up is free from impurities, since it will be delivered directly to the system without being filtered.

In the event of loss of hydraulic fluid, the reason must always be ascertained and the fault must be corrected before the system is filled with new hydraulic fluid.

HYDRAULIC PUMP



1. *Spring clip*
2. *Cover*
3. *Compression spring*
4. *Backing ring*
5. *O-ring*
6. *Port plate, upper*
7. *O-ring (same as 5)*
8. *Backing ring (not same as 4)*
9. *Spring clip*
10. *Dowel*
11. *Rotor with vanes*
12. *Liner*
13. *Drive shaft*
14. *Port plate, lower*
15. *Seal*
16. *Needle bearing*
17. *Ball bearing*
18. *Plut*
19. *Gasket*
20. *Compression spring*
21. *Control valve*
22. *Rubber bush*

Fig. 1 Components of the hydraulic pump

AR

3200–1325

ismantling

lean the pump and dismantle it in the sequence of item umbers shown in Fig. 1.

.B. The following special instructions are applicable to ırtain item numbers (parts):

em 1.	Press down cover 2 slightly in a vice and remove spring clip 1 by means of a screwdriver.
em 6.	Remove the upper port plate by means of slip joint pliers.
ems 11-12.	Mark the top of the rotor and the liner with a felt pen before removing them.
tem 15.	Remove the seal by means of a screwdriver.
tem 16.	Drive out the needle bearing by means of 98443.

nspection and replacement of components

leplace the following parts:
acking rings 4 and 8 **(N.B. the backing rings are not the same)**
)-rings 5 and 7 (these are identical)
lubber bushes 22.
leedle bearing 16.
all bearing 17.
eal 15.

heck the other components. They must be replaced if hey show signs of damage or visible wear.

Reassembling

Lubricate the components with hydraulic fluid. Assemble the hydraulic pump in the reverse order to that in which it was dismantled.

N.B. The following special instructions are applicable to certain item numbers (parts):

Items 17-16-15.	Fit needle bearing 16 by means of 98443. then seal 15 by means of 98443 and 98444, and finally ball bearing 17 by means of 98443 and 98444.
Item 14.	Fit drive shaft 13 and dowel 10 before fitting lower port plate 14.
Item 12.	Note the marking at the top.
Item 11.	Note the marking at the top. Fit the ten vanes, with the rounded edges outwards, towards the liner.
Item 8.	The diameter of backing ring 8 is somewhat smaller than that of backing ring 4.
Item 6.	Fit the uppper port plate by means of slip joint pliers. Check that the recess for dowel 10 is in the correct position.

Possible types of defects

1. Oil leakage at the cover or drive end. Remedy by replacing the seals.
2. The pump draws air. Check and replace the seals in the hydraulic line between the pump and tank. If the defect is in the pump, change the seals.
3. The pump delivery pressure is low. The pressure control valve opens too early. Replace or dismantle the control piston and clean it thoroughly.
4. Seizure at the rotor end. The pump has been overloaded by the steering wheel being held at one limit of its travel. Seizure will also occur if the rotor has been fitted the wrong way around.

BATTERIES

Capacity

The capacity of a battery is indicated in ampere-hours. Thus it is possible to speak about the capacity at different discharging periods, e.g. 20 hours capacity. If a battery can indicate 4.25 A for 20 hours, its capacity is 85 ampere-hours. The capacity of a battery is affected by ambient temperature. In cold weather the battery has very much less capacity than in warm weather. When the capacity of a battery is indicated this applies at +20°C. Ampere-Hours is abbreviated to Ah.

The difference in capacity of a battery at +20°C and at −18°C

100% capacity at +20°C gives approx. 50% capacity at −18°C
70% capacity at +20°C gives approx. 35% capacity at −18°C
40% capacity at +20°C gives approx. 25% capacity at −18°C

The relation between the battery acid density at +20°C and the rest potential per battery cell and degrees of charging

Density at +20°C	Rest Potential	Degree of Charging
1.28	2.12V	approx. 100%
1.26	2.10V	approx. 85%
1.24	2.08V	approx. 70%
1.22	2.06V	approx. 55%
1.20	2.04V	approx. 40%
1.18	2.02V	approx. 25%
1.16	2.00V	approx. 10%

State of Charge

The state of charge in a battery is usually checked by measuring the density of the battery acid (specific gravity) for each cell with an acidimeter or by measuring the rest potential of a cell with a voltameter. There is a certain connection between the density and the rest potential that can be expressed in the following thumb rule: Density +0.84 = rest potential of cell. A fully charged battery has a cell potential of 2.12 V and the density of the acid at +20°C is then 1.28. The density of the battery acid, which all depends on the sulphuric acid concentration, varies with the temperature. The lower the temperature is the higher the density and the reverse. In order to decide the state of charge by voltage saturation a voltameter is required with which it is possible to read the volts in hundreths.

Density variation with the temperature of a fully charged battery

Electrolytic Temperature °C	Acid Density in Fully Charged Battery	Electrolytic Temperature °C	Acid Density in Fully Charged Battery
+35	1.269	0	1.294
+30	1.273	− 5	1.298
+25	1.276	−10	1.301
+20	1.280	−15	1.305
+15	1.284	−20	1.308
+10	1.287	−25	1.312
+ 5	1.289	−30	1.315

Storage of Batteries

1. Store the batteries whenever possible in a cool and dry room. The batteries should also be protected against dust. Dust fastens quite easily on the tar residue, thus giving it a subdued and dull appearance.

2. Do not pile the batteries on top of each other. The battery case and terminal pillars can be damaged.

3. **Wet batteries (with battery acid)** require regular checking during the storage period. Check the state of charge every fourth week. If the acid density of the battery is below 1.25 the battery should be charged. **Dry charged batteries (without battery acid)** require no maintenance during the storage period. These retain their max. state of charge for practically an unlimited period, provided dampness does not penetrate into the cells. Make sure the battery plugs are securely tightened down.

Installation and Maintenance of Batteries

Installation

When the old battery is removed attention should be paid to where the positive (+) cable terminal was connected, so that the new battery is fitted in the same way. See the marking on the cable terminal-terminal pillar. **If the cables are connected up wrongly this will cause considerable damage to the electrical system.**

73.10678:3200 404

Remarks. The negative (−) cable terminal shall be removed first and put on last in order to avoid damages to the battery and electrical system, through unintentional "earthing" with tool. Never place a tool on the battery!

1. Clean the battery holder and cable terminals so that these are free from dirt and corrosion.

2. Before the installation of a new battery, check the battery acid density. It shall be 1.25 or higher.

3. Install the new battery and tighten the screws to the battery holder in such a way that the holder does not become askew or the battery case damaged. Make quite sure that the battery is fastened properly in the holder.

4. Tighten up the cable termnals. Make sure that the cables will not present an obstacle to the removal of the battery plugs etc. Lubricate the terminal pillars and cable terminals with vaseline or grease.

Battery acid freezing point at different charging degrees of a battery

Charging Degree	Freezing Point
100%	approx. −70
40%	approx. −30
10%	approx. −10

5. Should the voltage and specific gravity be uneven in the different cells the battery ought to be examined by a specialist. If the variation between the cells is 0.05V (five graduations on the acidimeter) or more, it is time to replace the battery.

6. Do not overtax the battery. If for instance the engine will not start immediately, let the battery recover sufficiently for a few seconds before a fresh start is attempted. This saves the strength of the battery.

7. The battery can either be put on a quick charge or a slow charge for a longer period. If the battery has not been used for some time or is in poor condition, it is advisable to put it on a slow charge.

8. Warming up the battery to room temperature is only a temporary resort. It is only appropriate to do this when it is so cold outside that starting up difficulties will arise.

9. Never under any circumstances place a tool on the battery, as it is very easy for a short-circuit to occur, in consequence of which the battery can be ruined.

Maintenance

1. Keep the battery dry and clean. Dirt and oil reduce the battery effect and can cause serious damages.

2. Terminal pillars and cable terminals shall be kept free from oxides and occasionally lubricated with vaseline or grease. Poor contact between terminal pillar and cable terminal will cause a potential drop in voltage, which can lead to the engine failing to start.

3. The battery acid level should be checked regularly twice a month during the Summer, once a month during the Winter. Fill up with distilled water so the water will come approx. 10–15 mm over the cell pack.

   Warning. Sulphuric acid or so-called improvement electrolyte must not be filled.

4. The state of charge should be regularly checked with an acidimeter. If the specific gravity is below 1.20 the battery must be charged up. In a battery which is well discharged or run-down the acid density will be very low, which may result in the battery freezing and breaking up already after only a few minus degrees.

The Activation of Dry Charged Batteries

Warning

The battery acid contains sulphuric acid, which is very dangerous to get on the skin, the clothes or in the eyes. Therefore, avoid toughing or getting too near battery acid. It is also advisable to wear protective glasses, rubber gloves and a protective apron when working in the near vicinity of battery acid. If, however, battery acid does get splashed on the skin, the best method of getting rid of it is, to wash it away with clean water. If, on the other hand battery acid gets splashed in the eyes, wash immediately with plenty of clean water. Thereafter get into touch, as quickly as possible, with a doctor.

Filling with Acid

Both the battery and the acid shall have room temperature, when acid is being filled.

1. Remove the plugs and fill the battery to approx. 10 mm over the cell pack with accumulator acid (pure sulphuric acid) with specific gravity 1.28.
2. Let the battery stand for two hours in room temperature.
3. If the acid level has dropped somewhat make certain that it is again approx. 10 mm over the cell pack.

Checking

The cell voltage and the specific gravity of the acid must be checked in all cells 2 hours after filling up. The specific gravity should then be at least 1.26 and the cell voltage 2.10V. After checking, the plugs are screwed on. Any sulphuric acid that has been spilled must be washed off with water, after which the battery is wiped clean and is ready for use.

In emergency cases a battery can be put in service 15–20 minutes after filling with acid. However, it is essential that adjustment of the acid level and the checking of the specific gravity and rest potential is carried out in accordance with the above. The battery should be checked afresh after a few hours driving when acid level adjustment may be necessary.

Possible Additional Charging

In the following cases additional charging must take place before the battery is used.

1. If the specific gravity of the battery acid in any cell is below 1.26 or if the voltage in any cell has not reached a minimum of 2.10V.
2. If acid with a lower temperature than +15°C is filled.
3. If the battery is not to be used immediately after filling.
4. If the ambient temperature is below 0°C and the truck is only to be driven short distances with repeated starts, it is advisable to charge the battery for approx. 1/2–1 hour with 5 or 10 amperes or put it on a quick charge for 5 minutes. Alternatively, the battery can be allowed to stand with acid filled in it during the night so as to get a lengthened period of activity.

Additional charging is suitably carried out with the amperage recommended in the battery manufacturer's price lists until the battery is fully charged, i.e. each cell has reached a specific gravity of 1.28 and charging voltage of approx. 2.65V.
After the battery has been put in service it is maintained just like an ordinary wet charged battery.

Charging of Batteries

Since an explosive mixture of hydrogen and oxygen is formed when the batteries are being charged, a certain number of protective precautions should be taken. The charging room shall have good ventilation. Smoking shall be forbidden and no apparatus that can cause sparking must be found in the room.

When charging, the cell voltage quickly rises to approx. 2.15V and thereafter slowly to about 2.3–2.4V as soon as development of gas begins. Towards the end of the charging period, the voltage rises more rapidly and reaches the values of 2.5–2.7V, which it does not exceed even if charging continues. The charging period for different batteries is very variable depending on design, size and charging amperage.

Slow Charging

Slow charging is carried out with relatively low amperage for a long period stretching over a day or more. The maximum permissible amperage for each type battery is usually indicated in the battery manufacturer's price lists. Standard value: 8–9% of the battery's capacity. The charging of batteries, which have been in a stated of discharge or run-down for a longer period, (sulphated) must be undertaken with particularly low amperage, in general only 1/4–1/2 of the amperage just mentioned, whereby the charging period will be correspondingly longer.

Quick Charging

Quick charging is a method that over a short period and high amperage, charges up the battery. This method of charging can be undertaken on batteries that are in good condition, even though they have been in a state of discharge. Quick charging should be followed by a few minutes equalizing charge at low amperage. Batteries with sulphated cell plates, like batteries where the rest potential is below 2.02V shall not be put on a quick charge. It is good advice not to put batteries on a quick charge that are more than two years old.

73.10678/3200-404

BATTERIER

Bakgrund

Det förekommer ibland anmärkning på att batterierna ej ger fullgott driftresultat i chassier som stått lagrade någon tid alternativt i kombination med längre skeppningar.

Aktuell information

Batterier skall alltid hållas så väl laddade som möjligt.

Ett batteri har dock alltid en viss självurladdning varför batterier som lagras måste underhållsladdas kontinuerligt eller laddas med vissa mellanrum. Underhållsladdning skall ske med ca 0,05 A.

Vid längt gången urladdning bildas relativt snabbt olösliga kristaller av blysulfat på de negativa plattorna. Batteriets kapacitet sjunker härvid kraftigt.

Låt därför aldrig ett djupt urladdat batteri stå någon längre tid.

Har sulfateringen gått för långt är batteriet förstört.

Vid laddning av ett sulfaterat batteri bör laddningsströmmen vara ca 2–4 A. Snabbladdning bör undvikas.

Det bör observeras att självurladdningen är kraftigt temperaturberoende. Ett **nytt fulladdat** batteri kan i princip förvaras upp till ett år vid −20°C utan att skadas av självurladdning medan urladdningen vid +20°C redan efter 3 månader nått en klart kritisk gräns. Det är alltså viktigt att skydda batterier under lagring för onödigt höga temperaturer.

Att iakttaga

Vid mottagning och lagring av chassier måste ovanstående beaktas, dvs batteriernas laddningstillstånd måste övervakas.

Syravikt vid temp +20°C

Fulladdat batteri	1,28
Halvladdat batteri	1,21
Urladdat batteri	1,12

Syravikten bör ej tillåtas sjunka under 1,21 innan batteriet laddas om. Normalt bör laddning ske minst varannan månad (4–6 A i ca 12 timmar).

Glöm inte att kontrollera syranivån! Observera också att syravikten inte kan mätas omedelbart efter påfyllning av destillerat vatten.

BATTERIES

Background

Occasionally complaints are made that the batteries fail to give satisfactory operating results in chassis which have been standing stored for some time, alternatively in combination with longer transit journeys.

Current Information

It is always necessary to keep batteries well charged. However, a battery always discharges slightly and because of this batteries which have to be stored for any length of time must be trickle charged continuously or be charged at certain intervals. Trickle charging should be done at approx. 0.05 A.

When discharging for long periods insoluble crystals of lead sulphate form comparatively quickly on the negative (−) plates. As a result the capacity of the battery will decrease rapidly.

Therefore, never allow a badly run-down battery to stand for any length of time. If sulphating has gone too far the battery is ruined.

When charging a sulphated battery, the charging current should be about 2–4 A. Quick charging should be avoided.

It should be observed that self-discharge depends a lot on the temperature prevailing at the time. A new fully charged battery can in principle be kept up to one year at −20°C without being damaged by self-discharge, while discharging at +20°C already after 3 months has reached an obviously critical limit. Consequently, it is of vital importance to protect batteries during storage from unnecessarily high temperatures.

Attention

When receiving and storing chassis the above points must be observed, i.e. the charging state of the batteries must be paid attention to.

Acid Gravity at Temperature +20°C

Fully charged battery	1.28
Semi-charged battery	1.21
Run-down battery	1.12

The gravity of the acid should not be allowed to fall below 1.21 before the battery is recharged. Normally the battery should be charged every other month (4–6 A in about 12 hours).

Do not forget to check the acid level. Remember, too, that the gravity of the acid cannot be measured immediately after filling up with distilled water.

3200 1137

BATTERIEN

Anlaß

Mitunter wird bemängelt, daß Batterien in Fahrzeugen, die längere Zeit im Lager gestanden haben, alternativ in Kombination mit langen Verschiffungen, kein einwandfreies Betriebsresultat geben.

Aktuelle Information

Batterien müssen immer so gut wie möglich geladen gehalten sein.

Eine Batterie hat doch immer eine gewisse Selbstentladung, weshalb Batterien, die gelagert werden, in gewissen Abständen geladen werden müssen. Es kann auch Dauerladung mit ca. 0,05 A geschehen.

Bei weit fortgeschrittener Entladung bilden sich verhältnismäßig schnell unlösliche Kristalle aus Bleisulfat auf den negativen Platten, wobei die Kapazität der Batterie stark sinkt.

Eine tief entladene Batterie darf man deshalb nicht längere Zeit stehen lassen.

Ist die Sulfatierung zu weit gegangen, ist die Batterie zerstört.

Beim Aufladen einer sulfatierten Batterie soll der Ladestrom ca. 2–4 A sein. Schnelles Aufladen soll man vermeiden.

Es ist zu beachten, daß Selbstentladung stark von der Temperatur abhängig ist. Eine **neue voll aufgeladene** Batterie kann im Prinzip bis zu einem Jahr bei $-20^{o}C$ gelagert werden, ohne dabei durch Selbstentladung beschädigt zu werden, während Entladung bei $+20^{o}C$ schon nach 3 Monaten eine eindeutig kritische Grenze erreicht hat. Es ist also wichtig, die Batterien während der Lagerung vor unnötig hohen Temperaturen zu schützen.

Zu beachten

Bei Empfang und Lagerung von Fahrgestellen muß obiges beachtet werden, d.h. der Ladezustand der Batterien muß überwacht werden.

Säuregewicht bei Temp. $+20^{o}C$

Voll aufgeladene Batterie	1,28
Halb aufgeladene Batterie	1,21
Entladene Batterie	1,12

Man soll das Säuregewicht nicht unter 1,21 sinken lassen, bevor die Batterie neu aufgeladen wird. Normalerweise soll die Batterie mindestens jeden zweiten Monat aufgeladen werden (4–6 A in ca. 12 Stunden).

Nicht vergessen, das Säureniveau zu kontrollieren. Außerdem beachten, daß das Säuregewicht nicht gleich nach dem Nachfüllen von destilliertem Wasser gemessen werden kann.

BATERÍAS

Antecedentes

A veces hay quejas de que las baterías nò dan buen resultado en chasis que han estado almacenados algún tiempo alternativamente en combinación con largos transportes marítimos.

Información actual

Las baterías habrán de mantenerse siempre lo mejor cargadas posible.

Sin embargo, como una batería tiene siempre cierta autodescarga, las baterías que se almacenan tienen que ser cargadas continuamente con carga de conservación o cargadas regularmente. La carga de conservación se efectúa con unos 0,05 A.

En caso de una descarga prolongada se forman relativamente rápido cristales insolubles de sulfato de plomo en las placas negativas. La capacidad de la batería disminuye entonces notablemente.

Por lo tanto, nunca se debe dejar mucho tiempo una batería descargada a fondo.

Si la sulfatación ha sido grande la batería está estropeada.

Al cargar una batería sulfatada la corriente de carga debe ser aproximadamente de 2 a 4 A. Se debe evitar una carga rápida.

Ha de observarse que la autodescarga depende considerablemente de la temperatura. Una batería **nueva cargada a fondo** puede conservarse hasta un año a $-20^{o}C$ sin que sea dañada por la autodescarga, mientras que a $+20^{o}C$ la descarga alcanzó ya un evidente límite crítico después de 3 meses. Por lo tanto, es muy importante proteger las baterías, durante el almacenamiento, contra temperaturas innecesariamente altas.

Observar

Al recibir y almacenar chasis habrá que observar lo citado arriba, es decir, habrá que vigilar el estado de carga de las baterías.

Densidad a temperatura $+20^{o}C$

Batería cargada a fondo	1,28
Batería medio cargada	1,21
Batería descargada	1,12

No se debe dejar que la densidad baje de 1,21 antes de recargar la batería. Normalmente la carga debe efectuarse por lo menos cada dos meses (4 a 6 A durante unas 12 horas).

No olvidar controlar el nivel del ácido! Observar también que la densidad no puede medirse inmediatamente después de haber echado el agua destilada.

19 MISCELLANEOUS

a General data, standards etc.

List of contents

3200 845

CONVERSION FACTORS

After we introduced the SI-system certain problems have arisen concerning unit conversions. Therefore, we have drawn up a conversion table which deals with certain unit of measurements from the SI-system, metrical-system and inch-system.

Length

m	in (tum)	ft (fot)	yd (yard)	mile
1	39,370 1	3,280 84	1,093 61	$0{,}621\,371 \times 10^{-3}$
$25{,}4 \times 10^{-3}$	1	$83{,}333\,3 \times 10^{-3}$	$27{,}777\,8 \times 10^{-3}$	$15{,}782\,8 \times 10^{-6}$
0,304 8	12	1	0,333 333	$0{,}189\,394 \times 10^{-3}$
0,914 4	36	3	1	$0{,}568\,182 \times 10^{-3}$
$1{,}609\,344 \times 10^{3}$	$63{,}36 \times 10^{3}$	$5{,}28 \times 10^{3}$	$1{,}76 \times 10^{3}$	1

Area

m^2	in^2	ft^2
1	$1{,}550\,00 \times 10^{3}$	10,763 9
$0{,}645\,16 \times 10^{-3}$	1	$6{,}944\,44 \times 10^{-3}$
$92{,}903\,0 \times 10^{-3}$	144	1

Volume

m^3	in^3	ft^3	yd^3	gallon (UK)	gallon (US)
1	$61{,}023\,7 \times 10^{3}$	35,314 7	1,307 95	219,969	264,172
$16{,}387\,1 \times 10^{-6}$	1	$0{,}578\,704 \times 10^{-3}$	$21{,}433\,5 \times 10^{-6}$	$3{,}604\,65 \times 10^{-3}$	$4{,}329\,00 \times 10^{-3}$
$28{,}316\,8 \times 10^{-3}$	$1{,}728 \times 10^{3}$	1	$37{,}037\,0 \times 10^{-3}$	6,228 84	7,480 52
0,764 555	$46{,}656 \times 10^{3}$	27	1	168,178	201,974
$4{,}546\,09 \times 10^{-3}$	277,420	0,160 544	$5{,}946\,06 \times 10^{-3}$	1	1,200 95
$3{,}785\,41 \times 10^{-3}$	231	0,133 681	$4{,}951\,13 \times 10^{-3}$	0,832 675	1

Mass

kg	lb (pound)	slug	oz (ounce)	ton (UK)	sh tn (short ton) (US)
1	2,204 62	$68{,}521\,8 \times 10^{-3}$	35,274 0	$0{,}984\,207 \times 10^{-3}$	$1{,}102\,31 \times 10^{-3}$
0,453 592 37	1	$31{,}081\,0 \times 10^{-3}$	16	$0{,}446\,429 \times 10^{-3}$	$0{,}5 \times 10^{-3}$
14,593 9	32,174 0	1	514,785	$14{,}363\,4 \times 10^{-3}$	$16{,}086\,9 \times 10^{-3}$
$28{,}349\,5 \times 10^{-3}$	$62{,}5 \times 10^{-3}$	$1{,}942\,56 \times 10^{-3}$	1	$27{,}901\,8 \times 10^{-6}$	$31{,}25 \times 10^{-6}$
$1{,}016\,05 \times 10^{3}$	$2{,}24 \times 10^{3}$	69,621 3	$35{,}84 \times 10^{3}$	1	1,12
907,185	2×10^{3}	62,161 9	32×10^{3}	0,892 857	1

3200-245

SE, SF, SG, SH

Force

N	kp (kilopond)	lbf (pound-force)
1	0,101 972	0,224 809
9,806 65	1	2,204 62
4,448 22	0,453 592	1

Moment of Force

Nm	kpm	lbf x in	lbf x ft
1	0,101 972	8,850 75	0,737 562
9,806 65	1	86,796 2	7,233 01
0,112 985	$11{,}521\ 2 \times 10^{-3}$	1	$83{,}333\ 3 \times 10^{-3}$
1,355 82	0,138 255	12	1

Pressure, Stress

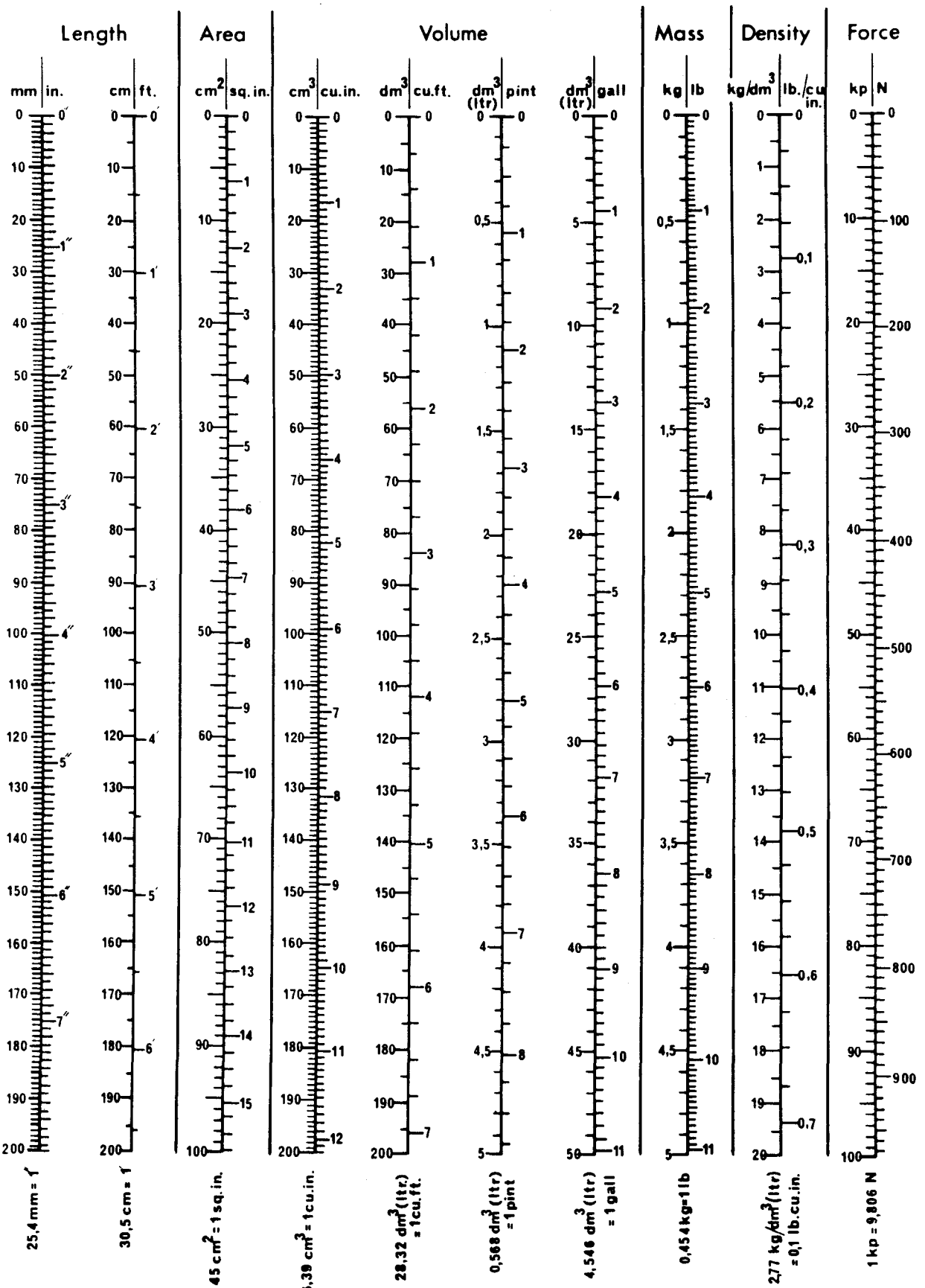
N/m^2	bar	kp/cm^2 at	kp/mm^2	lbf/in^2
1	10×10^{-6}	$10{,}197\ 2 \times 10^{-6}$	$0{,}101\ 972 \times 10^{-6}$	$0{,}145\ 038 \times 10^{-3}$
100×10^{3}	1	1,019 72	$10{,}197\ 2 \times 10^{-3}$	14,503 8
$98{,}066\ 5 \times 10^{3}$	0,980 665	1	10×10^{-3}	14,223 3
$9{,}806\ 65 \times 10^{6}$	98,066 5	100	1	$1{,}422\ 33 \times 10^{3}$
$6{,}894\ 76 \times 10^{3}$	$68{,}947\ 6 \times 10^{-3}$	$70{,}307\ 0 \times 10^{-3}$	$0{,}703\ 070 \times 10^{-3}$	1

Energy, Work

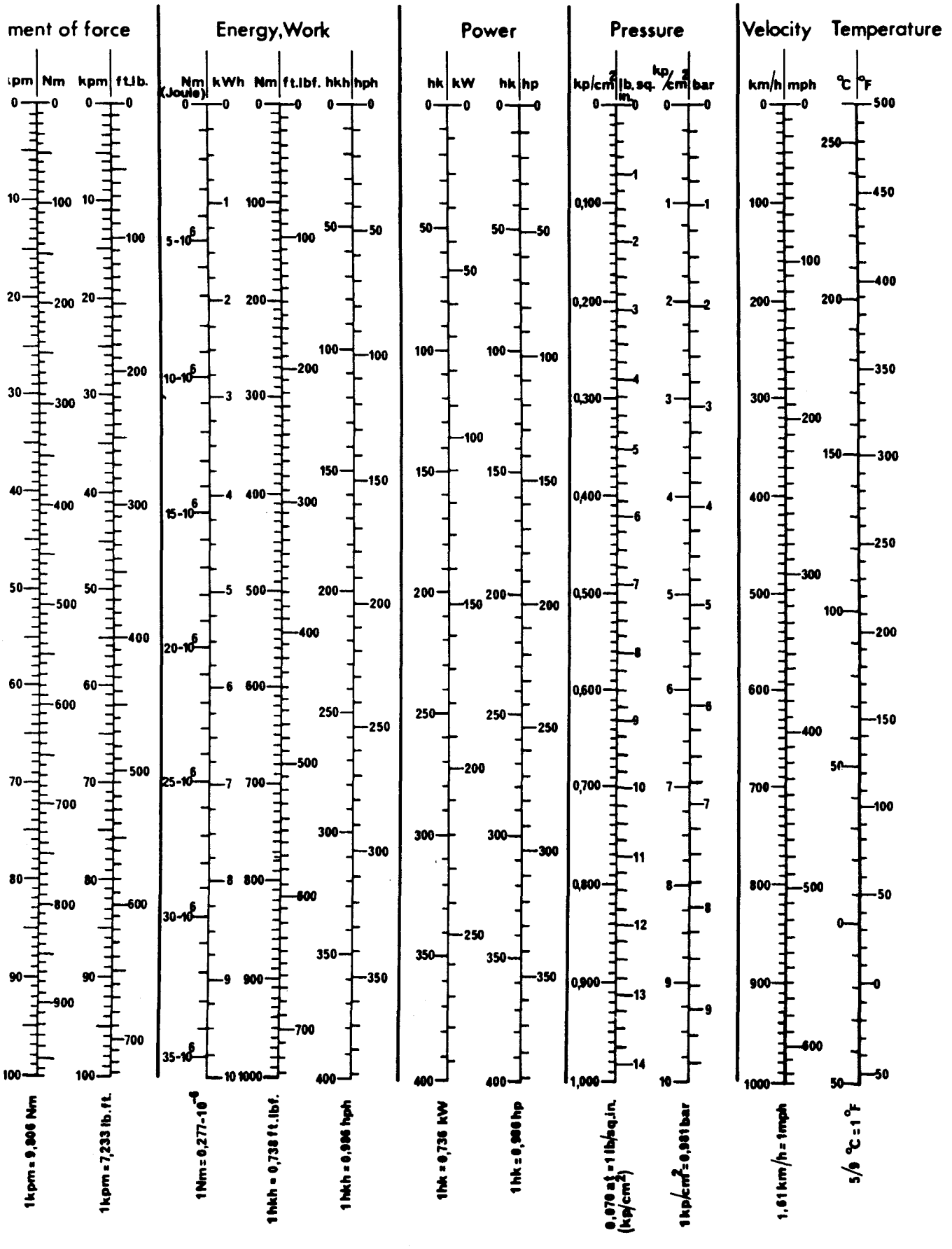
J Nm, Ws	kWh	kpm	hkh (metr. hph)	ft x lbf (foot pound-force)
1	$0{,}277\ 778 \times 10^{-6}$	0,101 972	$0{,}377\ 673 \times 10^{-6}$	0,737 562
$3{,}6 \times 10^{6}$	1	$0{,}367\ 098 \times 10^{6}$	1,359 62	$2{,}655\ 22 \times 10^{6}$
9,806 65	$2{,}724\ 07 \times 10^{-6}$	1	$3{,}703\ 70 \times 10^{-6}$	7,233 01
$2{,}647\ 795\ 5 \times 10^{6}$	0,735 499	$0{,}27 \times 10^{6}$	1	$1{,}952\ 91 \times 10^{6}$
1,355 82	$0{,}376\ 616 \times 10^{-6}$	0,138 255	$0{,}512\ 055 \times 10^{-6}$	1

Power

W Nm/s, J/s	kpm/s	kcal/s	kcal/h	hk (metr. hp)	hp (UK, US)	ft x lbf/s
1	0,101 972	$0{,}238\ 846 \times 10^{-3}$	0,859 845	$1{,}359\ 62 \times 10^{-3}$	$1{,}341\ 02 \times 10^{-3}$	0,737 562
9,806 65	1	$2{,}342\ 28 \times 10^{-3}$	8,432 20	$13{,}333\ 3 \times 10^{-3}$	$13{,}150\ 9 \times 10^{-3}$	7,233 01
$4{,}186\ 8 \times 10^{3}$	426,935	1	$3{,}6 \times 10^{3}$	5,692 46	5,614 59	$3{,}088\ 03 \times 10^{3}$
1,163	0,118 593	$0{,}277\ 778 \times 10^{-3}$	1	$1{,}581\ 24 \times 10^{-3}$	$1{,}559\ 61 \times 10^{-3}$	0,857 785
735,499	75	0,175 671	632,415	1	0,986 320	542,476
745,700	76,040 2	0,178 107	641,186	1,013 87	1	550
1,355 82	0,138 255	$0{,}323\ 832 \times 10^{-3}$	1,165 79	$1{,}843\ 40 \times 10^{-3}$	$1{,}818\ 18 \times 10^{-3}$	1


Length
mm | in.
cm | ft.
Area
cm² | sq.in.
Volume
cm³ | cu.in.
dm³ | cu.ft.
dm³ (ltr) | pint
dm³ (ltr) | gall
Mass
kg | lb
Density
kg/dm³ | lb./cu in.
Force
kp | N
25,4 mm = 1"
30,5 cm = 1'
6,45 cm² = 1 sq.in.
16,39 cm³ = 1 cu.in.
28,32 dm³ (ltr) = 1 cu.ft.
0,568 dm³ (ltr) = 1 pint
4,546 dm³ (ltr) = 1 gall
0,454 kg = 1 lb
2,77 kg/dm³ (ltr) = 0,1 lb./cu.in.
1 kp = 9,806 N

3200-245


ment of force
Energy,Work
Power
Pressure
Velocity
Temperature
kpm Nm
kpm ft.lb.
Nm (Joule) kWh
Nm ft.lbf.
hkh hph
hk kW
hk hp
kp/cm² lb.sq. in.
kp/cm² bar
km/h mph
°C °F
1kpm = 9,806 Nm
1kpm = 7,233 lb.ft.
1Nm = 0,277·10⁻⁶
1hkh = 0,738 ft.lbf.
1hkh = 0,986 hph
1hk = 0,736 kW
1hk = 0,986 hp
0,070 at = 1 lb/sq.in. (kp/cm²)
1kp/cm² = 0,981 bar
1,61 km/h = 1mph
5/9 °C = 1°F

STRENGTH CLASSES FOR BOLTS AND NUTS

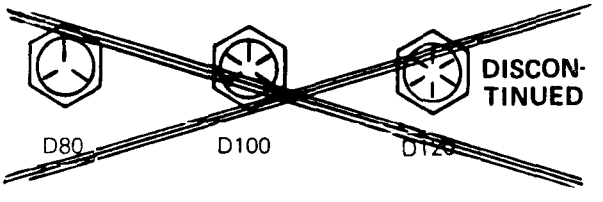
ISO (International Organization for Standardization) has drawn up recommendations for strength requirements, strength marking and testing as regards bolts and nuts. These recommendations have been adopted by both SIS (The Swedish Standards Association) as well as by standardization associations in other countries.

This means that we alter the strength classes to the new standard according to the table below. The older classes will, however, remain in being for a shorter transition period.

The designation for bolts in the new strength classes consists of two numbers separated by a dot e.g. 8.8. The figure before the dot 8.8 indicates one tenth of the material yield point in kp/mm^2. The figure after the dot, 8.8 indicates one tenth of the percentage ratio between yield point and tensile strength. Consequently, multiplication of the two numbers gives the min. material yield point in kp/mm^2.

Thus a bolt with designation 8.8 has a tensile strength of 80 kp/mm^2 and yield point of 64 kp/mm^2.

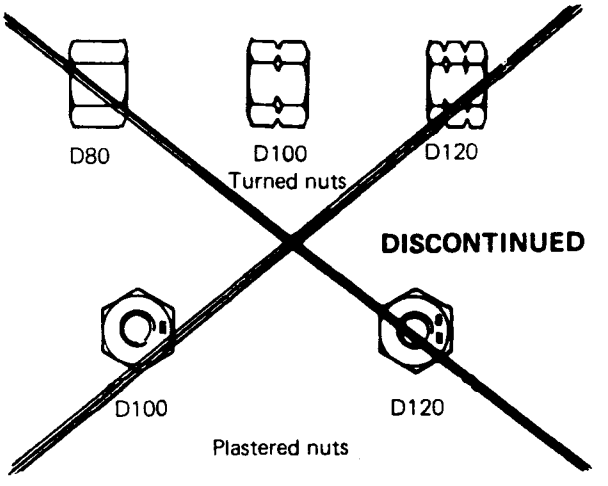
The marking of bolts with symbols for the different strength classes is discontinued.



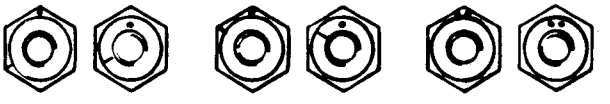
Instead of which the bolts are marked with the designation for the respective strength class. It can also occur that the dot is omitted. Consequently a bolt of strength class 8.8 is marked with 8.8 or 88.

The designation for nuts in the new strength classes consists of one number. This number indicates that the nut is of equal strength with a bolt the designation of which begins with the same number. A nut in strength class 8 is thus of equal strength with a bolt in strength class 8.8.

The marking of the nuts is also changed. The old symbols are discontinued.



The nuts are marked instead with figures, indicating strength class or with code symbols, so-called clock marking according to the figure.



Strength class 8 *Strength class 10* *Strength class 12*

Part Description	Strength Class: Old	Strength Class: New – Bolts	Strength Class: New – Nuts	Remarks
Hexagon headed bolts Studs Studs Allen screws and Nuts	D40 D60 D80 D100 D120 D140	4.6 5.8 8.8 10.9 10.9 12.9	8 8 8 10 10 12	
Slotted bolts	D60	5,8 4,8	8 8	for type FX and KFX for type RX

3200-671

Applies to: Bolts and nuts

SE, SF, SG, SH

LIST COVERING GENERAL TIGHTENING TORQUES FOR SCANIA PRODUCTS

The list applies to bolts with internal hexagon, hexagon-headed bolt and hexagon nut of steel in strength class 8 and 10 respectively when they have normal external width across the flats and cross-slotted bolt of steel in strength class 4.8 RX and 5.8 FX, KFX. The engagement length shall be minimum 0.8 d (d = external thread diameter) in material of corresponding strength class or higher.

The tightening torques indicated in this information apply provided that the following friction conditions are contained:

Surface treatment				Lubricating conditions
Bolt	Nut	Material	Washer BRB, FBB	
base	untreated	–	untreated	slightly oiled oiled
zinc coated	zinc coated	–	zinc coated	ungreased
zinc coated	–	cast iron or steel untreated	zinc coated	ungreased
phosphated	zinc coated untreated		untreated (HRB 400 min)	ungreased

HEXAGON-HEADED BOLT AND NUT

Metrical Coarse Thread

Strength class 8 (even D80)			Strength class 10 (even D100, D120)		
Thread	Tightening Torque		Thread	Tightening Torque	
	Nm	kgm		Nm	kgm
M4	2,4	0,24	M4	3	0,3
M5	5	0,5	M5	6,2	0,62
M6	8	0,8	M6	10	1
M8	20	2	M8	25	2,5
M10	39	3,9	M10	49	4,9
M12	70	7	M12	87	8,7
M14	112	11,2	M14	140	14
M16	180	18	M16	220	22
M18	240	24	M18	300	30
M20	350	35	M20	440	44
M22	490	49	M22	610	61
M24	600	60	M24	760	76

Metrical Fine Thread

Strength class 8 (even D80)			Strength class 10 (even D100, D120)		
Thread	Tighteninge Torque		Thread	Tightening Torque	
	Nm	kgm		Nm	kgm
M8 x1	21	2,1	M8 x1	27	2,7
M10x1,25	42	4,2	M10x1,25	52	5,2
M12x1,25	77	7,7	M12x1,25	96	9,6
M14x1,5	120	12	M14x1,5	150	15
M16x1,5	190	19	M16x1,5	240	24
M18x1,5	270	27	M18x1,5	340	34
M20x1,5	390	39	M20x1,5	490	49
M22x1,5	530	53	M22x1,5	670	67
M24x1,5	700	70	M24x1,5	870	87

CROSS-SLOTTED BOLT

Metrical coarse threads and UNC-threads
Strength class 4.8 RX, URX; 5.8 FX, UFX, KFX, UKFX (D60)

Thread		Tightening Torques				Remarks
		4.8		5.8		
M	UNC	Nm	kgm	Nm	kgm	
3		0,4	0,04	0,7	0,07	The values indicated in this table are adapted for tool with ± 30% spreading
3,5	Nr 6	0,6	0,06	1	0,1	
4	Nr 8	1,5	0,15	2	0,2	
5	Nr 10	2	0,2	3	0,3	
	Nr 12	3	0,3	5	0,5	
6	1/4	4	0,4	7	0,7	
8	5/16	9	0,9	15	1,5	
10	3/8	18	1,8	30	3	
12	7/16	30	3	50	5	

73.11738/3200 543

SAFETY PRECAUTIONS

EXHAUST GASES

The exhaust products of an internal combustion engine are toxic and may cause injury or death if inhaled. All engine installations, especially those within a closed shelter or building, should be equipped and maintained with an exhaust discharge pipe so that exhaust gases are delivered into the outside air. A closed building or shelter must be adequately vented. A means of providing fresh air into a closed building or shelter is necessary.

ENGINE FUELS

All internal combustion engine fuels are highly combustible and may ignite or explode. Fuels must be conducted to the engine with proper piping, free from leaks, and designed to resist breakage from vibration. When filling fuel tanks, never smoke or use open flame in the immediate area. Fuel tanks should be grounded to prevent buildup of static electricity.

POSITIVE FUEL SHUT-OFF

All engine installations should be equipped with a means of positive fuel shut-off for emergency use when fuel is conducted to the engine from a remote source. Fuels under pressure such as natural gas or liquified petroleum gas, should be controlled by a positive shut-off valve, preferably automatic, other than those integral with the carburetor or gas pressure regulation equipment. It shall be the final responsibility of the engine owner to ensure that the installation is free from fuel or exhaust leakage, and such installation meets all applicable codes.

GAS USED TO ENERGIZE STARTERS

Gas used to energize starters must be discharged away from the engine into a harmless area. Ignition connections and electrical equipment on engines exposed to potentially explosive ambient atmospheres should be specially equipped to eliminate spark hazard and it is the responsibility of the engine owner to specify or provide such connections and equipment.

SAFETY GUARDS

Internal combustion engines must be properly provided with guards against hazards to persons or structures in close proximity to rotating or heated parts and it is the responsibility of the engine owner to specify or provide such protection.

CRANKCASE ANTI-EXPLOSION VALVES

These valves must be kept in proper working condition to relieve crankcase pressure when regulations require their installation on engine crankcases.

IGNITION SYSTEMS

Breakerless, magneto and battery ignition systems can cause electrical shocks. Avoid contacting these units or their wiring. The reaction from the shock could cause persons to fall or jerk their hands, thus striking other objects and injuries could occur.

ENGINE SURGE TANK AND RADIATOR PRESSURE CAPS AND CONNECTIONS

Do not remove the pressure caps while the engine is operating or while coolant is hot. The cooling system is under pressure and severe burns could result from the hot coolant spewing out when cap is removed. Wait until engine and coolant have cooled down before removing radiator or surge tank caps. Always replace weak hoses, lines, and fittings.

FUEL INJECTORS

Never allow an injector to spray against the skin. The fuel oil will penetrate the skin and may cause serious infection and injury.

GENERATOR SETS

The voltage produced by generator sets is dangerous to personnel coming in contact with any part of the electrical system during operation. Severe, possibly fatal, shock may result. Make sure the generator set is grounded before operation. Be extremely careful when the unit or surrounding area is damp or wet.

When servicing any part of the electrical system or making any connections, make sure main power switch is OFF. Clean or service generator set only when engine is shut down.

In case of an accident from electrical shock, shut down the generator set at once. If it cannot be shut down, free the victim from the live conductor. Avoid direct contact with the victim. Use a dry board, dry rope, or any nonconducting implement to free the victim. If the victim is unconscious, apply artificial respiration and get medical help.

Do not operate the generator set with the ammeter circuit open. Voltage, dangerous to both equipment and personnel, can be generated in an open secondary circuit of a current transformer.

If the generator set is stopped by operation of safety devices, do not attempt to operate it until the cause has been eliminated.

When the generator set is shut down after operation, disconnect all line switches to all external power load and parallel circuits.

ENGINE AND EQUIPMENT, REPAIR AND SERVICE

Always stop the engine before cleaning, servicing, or repairing the engine or driven equipment. Place all controls in off position to prevent accidental restarting. Before restarting, make sure that all tools and other material are removed from the engine and equipment.

Proper service and repair is important to the safe reliable operation of engines and related equipment. The procedures recommended by Waukesha in this manual are effective methods for performing service and repair operations. Some of these procedures require the use of specially designed tools. The special tools should be used when and as recommended. Anyone who uses a service, repair, or installation procedure not recommended by Waukesha must first satisfy themselves thoroughly that their safety will not be jeopardized by the service methods they select.

HOUSEKEEPING

Good housekeeping results in a clean, safe work area. An orderly work area with clean walkways and neatly arranged tools and equipment is conducive to better work performance and morale, and is a major factor in accident prevention. Accidents resulting from poor housekeeping include tripping over loose objects on the floor, stairs, or platforms, slipping on greasy, oily, wet, or dirty floors, falling of poorly piled material, and cuts from sharp edges.

ENGINE FAN BLADES

If a fan blade or fan drive shaft is bent or damaged in any way, it should be replaced. No attempt should be made to repair the damaged parts. Fan assemblies must remain in proper balance. When damaged, an unbalanced fan can fly apart during use and create an extremely dangerous condition.

TURBOCHARGERS

Turbochargers are specifically designed for applicable engine horsepower and altitude ratings. Nozzle rings must not be changed without consulting the engine manufacturer since they limit turbocharger rpm. Excessive rpm may result in turbocharger failure with resultant personal safety hazards. Turbochargers operate at high temperatures. Therefore, all flammable material must be kept away from them. Engines must be shut down and at room temperature before working on turbochargers or burns will result.

ENGINE STORAGE CHEMICALS

Nucle-Oil contains Petroleum Distilate. Harmful or fatal if swallowed. Avoid contact with skin. Vapor is harmful. Causes irritation of eyes, nose, throat and skin. Use only with adequate ventilation. Avoid prolonged or repeated breathing of vapor. Avoid contact with skin, eyes, and clothing. Do not take internally. Keep container closed and away from heat. Always read and observe the "CAUTION" labels on the containers. Do not destroy the labels on the containers.

Generally speaking, heating of preservative compounds is confined to 200°F. (93°C.) or less. These temperatures are easily reached by placing the preservative container in heated water. If this is done, the container must be vented or opened to reduce the danger of explosion. Direct heating presents a dangerous and unnecessary fire hazard.

FIRE PROTECTION

Locate fire extinguishers so that they are easily accessible if a fire starts. Carefully maintain records of extinguisher inspection and recharging to ensure the fire extinguishing capabilities when required. Consult your fire extinguisher supplier or insurance engineer for recommendations on the type, size, and quantity of fire extinguishers required for the engine installation. Select alternate routes of escape from any engine installation and post such routes in accordance with local and government requirements.

CLEANING SOLVENTS

Use approved cleaning solvents in a well ventilated area. Avoid breathing fumes. Keep away from open flames or sparks. Do not use gasoline or paint thinners or other highly volatile fluids for cleaning. Breathing carbon tetrachloride or carbon disulfide fumes can be fatal. Always read and observe the "CAUTION" labels on containers. Do not destroy the labels on the containers. Cleaning solvents can cause various types of skin irritations.

WELDING EQUIPMENT

If a welding gas cylinder is damaged by falling or being struck, it could burst with destructive force. Cylinders must be stored in accordance with manufacturer's specifications and applicable safety requirements.

When welding, brazing or cutting with acetylene, check valves should be installed between the regulators and hoses to prevent flashback into the regulators and supply tanks. Without these check valves, the flashback could cause the regulators and supply tanks to explode.

Oily and greasy materials must be kept away from oxygen valves, hoses, etc. Oxygen may combine with such materials and an explosive reaction could result.

Always wear protective eye shields when welding, cutting or watching a welding operation. Protective clothing and face shields must be worn. Do not weld or cut near combustible materials.

ELECTRIC POWER TOOLS

Be certain the electric tool is properly grounded. Wear proper eye protection. Do not work in wet or damp conditions. Be sure the tool is in good condition and safety guards are in position. An electric trouble light must also be grounded. Do not carry electric power tools by the cord. Do not yank the cord when removing from outlet; instead grasp the plug to remove it from outlet.

LEAD ACID BATTERIES

Always disconnect the battery ground connection from batteries before performing any work on the engine or equipment. This will prevent sparks or burns when accidently shorting an electrical connection.

Never expose batteries to open flame or electric spark. Battery action generates hydrogen gas which is flammable and explosive. Don't allow battery fluid to contact skin, eyes, fabrics, or painted surfaces. Battery fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with batteries.

PRECAUTIONS WHEN USING BOOSTER BATTERIES AND CABLES

Do not attempt to jump start an engine having a frozen battery because the battery may rupture or explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, or if the electrolyte fluid cannot be seen, do not attempt to start with jumper cables.

Both charged and discharged batteries should be treated carefully when using jumper cables. The following procedures assist in reducing sparks and explosion hazards always present in both batteries when connecting charged batteries to discharged batteries.

Turn off all electrical loads. Remove vent caps and lay a damp cloth over open vent wells of each battery. The charged booster battery or batteries must have the same voltage capacity as the discharged battery or batteries.

The positive post is identified by a +, pos. and red color and is larger in diameter than the negative post.

The negative post is identified by a -, neg. and gray color.

Negative Grounded Battery or Batteries

First, connect one jumper cable from the positive post on charged battery or batteries to positive post on discharged battery or batteries. If more than one battery is connected in "series" or "series parallel" connect jumper cable to positive post that has cable leading to starting motor.

Second, connect other jumper cable from negative post on charged battery or batteries to a good ground on engine.

When removing jumper cables, always disconnect the ground jumper cable from the engine before disconnecting the other jumper cable.

Positive Grounded Battery or Batteries

Same procedure as for negative grounded battery or batteries, except the negative post will have the cable leading to the starting motor and the positive post will be grounded.

COMPRESSED AIR

Compressed air or gases should never be used to clean clothing or body of foreign materials. A highly compressed stream of air flowing through a very small opening can pierce the skin and cause severe and very painful injury. Never use your hand to check air, gas, or liquid flow rates. Do not engage in "horseplay" with air, gas, or liquid hoses. Observe all applicable regulations as related to compressed gases.

SODIUM FILLED VALVES

When handling sodium filled valves always wear approved safety goggles, a hat or cap, long sleeves, and gloves. If refacing sodium filled valves is required, do not exert undue force at the grinding wheel as this could crack the hollow valve stem and allow the sodium to escape.

Do not handle broken sodium filled valves with bare hands as the sodium or sodium residue can cause severe burns. Sodium burns on the skin are of the same nature as caustic burns. They must be washed with large volumes of cold water before being neutralized with vinegar. The affected parts should then be treated as a burn and medical attention sought.

If a broken valve should ignite, it may be extinguished by smothering in dry soda ash or dry sand. The smoke and fumes are irritating; adequate ventilation should be provided and inhalation or contact with the smoke and fumes avoided. Water, carbon dioxide in any form, or carbon tetrachloride should never be used on sodium fires since these materials react violently with hot sodium.

Broken sodium filled valves may be stored prior to disposal in moisture free clean oil or kerosene. Unserviceable sodium filled valves must be disposed of in accordance with local, state and/or federal regulations as applicable.

INTOXICANTS AND NARCOTICS

Workers under the influence of intoxicants and/or narcotics are unsafe workers and are a hazard to themselves and other employees.

SAFE DRESS

When around machinery, loose clothing, neckties, rings, wrist watches, bracelets, etc., should not be worn. Severe injuries have resulted from this all too common practice.

HAIR LENGTH

Long hair worn around rotating equipment is dangerous. Hair is charged with static electricity and can be drawn to a piece of rotating machinery like a magnet. Persons with long hair must wear complete head covering when around rotating machinery.

NOISE PROTECTION

Wear O.S.H.A. approved hearing protection devices when around excessive noise.

FOOT PROTECTION

Wear O.S.H.A. approved steel tip safety shoes.

HEAD PROTECTION

Wear O.S.H.A. approved safety helmets.

EYE PROTECTION

Wear O.S.H.A. approved eye shields, safety glasses, and sweat bands.

RESPIRATORY SYSTEM PROTECTION

Wear O.S.H.A. approved equipment when near dust and toxic fumes to protect the eyes and respiratory system. This type of equipment must be checked and maintained on a regular basis.

REFERENCES

For details on safety rules and regulations in the United States, contact your local Occupational Safety and Health Administration (O.S.H.A.).

The publication of these safety precautions is done for your information. The Waukesha Engine Division, Dresser Industries, Inc. does not, by the publication of these precautions, imply or in anyway represent that these published precautions are the sum of all dangers present near industrial engines. If you are operating industrial engines, it is your responsibility to insure that such operation is in full accordance with all applicable safety requirements and codes. All requirements of the United States Federal Occupational Safety and Health Administration Act must be met when Waukesha Engines are operated in areas that are under the jurisdiction of that United States Department. Engines operated in countries other than the United States of America must be installed, operated and serviced in accordance and compliance with any and all safety requirements of that country which may be applicable.