



**R60-20 R60-22 R60-25 R60-30
R60-35 R60-40 R60-45 R60-50**

**Elektro Gabelstapler
Electric Fork Truck
Chariot élévateur électrique
Carretilla elevadora electrica**

**STILL
ELECTRONIC
DOCUMENTATION
SYSTEM**

STEDS

STILL GmbH



**Werk-
statt-
handbuch**

**Work-
shop
manual**

**Manuel
d'Atelier**

**Manual
de taller**

**R6022 R6023 R6024 R6025
R6026 R6027 R6028 R6029
R6042 R6043 R6044 R6045**



Note

The 6042 - 45 series is solely a facelift.

Changes are to be made to

- Counterweight**
- Lighting support**
- Seat**
- Plastic trim**
- Brand emblem**

Contents	page
Frame and counterweight	2
Inside dimensions of battery compartment	3
Jacking up the truck	4

Frame and Counterweight

Frame

The welded steel frame is of unit construction and has a bolt-on cast iron counterweight.

The hydraulic oil tank serves as a frame crossmember located underneath the floor plate.

Counterweight

The removable rear counterweight is secured to the Sframe by four bolts (see sketch).

1 = hex hd bolt M 24 x 85 / 8.8

2 = spherical washer

3 = ball cup

4 = hex hd bolt M 24 x 70 / 8.8

5 = locking washer

The four counterweight bolts (1 & 4) should be torqued to 660 Nm.

Weight of the counterweights :

6022 —> 650 kgs

6023 (short) —> 1078 kgs

6024 (long) —> 738 kgs

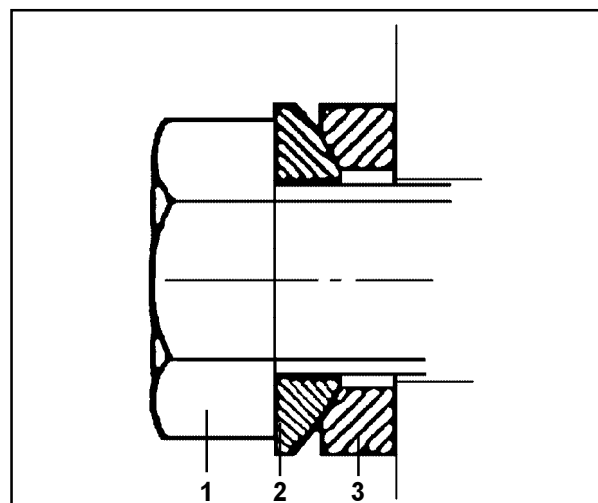
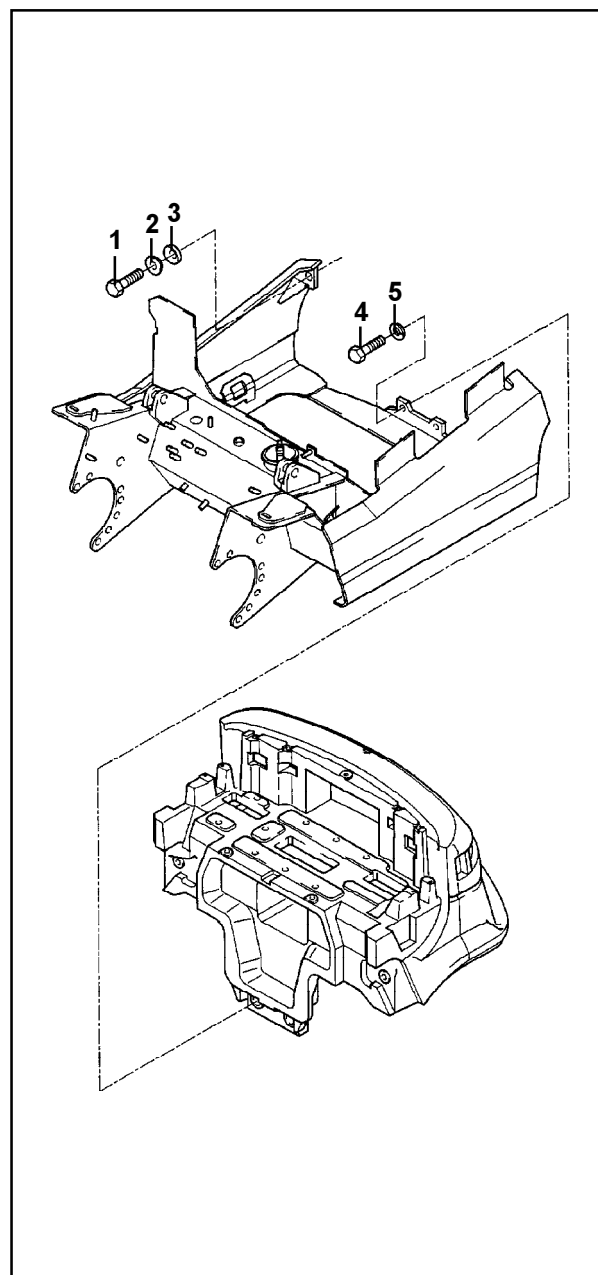
6025 —> 1143 kgs

6026 —> 1454 kgs

6027 —> 1401 kgs

6028 —> 1687 kgs

6029 ----> 1965 kgs



Inside dimensions of battery compartment

Inside dimensions of battery compartment

	6022 / 6023	6024 / 6025 / 6026	6027 / 6028
	2.0 t / 2.5 t	2.5 t / 3.0 t / 3.5 t	4.0 t / 4.5 t
*)	4 PzS 480	5 PzS 600	6 PzS 720
A	793 +/- 3	793 +/- 3	793 +/- 3
B	1032 +/- 2	1032 +/- 2	1032 +/- 2
C	722 +/- 3	865 +/- 3	1013 +/- 3

*) = standard battery size

A = height of battery compartment to under-side of —> handbrake cover

B = width of battery compartment

C = length of battery compartment

6023 —> 2.5 t short

6024 —> 2.5 t long

Battery dimensions and weight to DIN 43536 / 80 V

	Height	Width	Length	Weight (kgs)
4 PzS 480	784 (769)	1028 (1025)	711 (708)	1547
5 PzS 600	784 (769)	1028 (1025)	855 (852)	1872
6 PzS 720	784 (769)	1028 (1025)	999 (996)	2206

() = max. dimensions of battery tray in mm

Jacking up

Jacking up the truck

CAUTION :

Before jacking up the truck :
Disconnect the battery and apply the parking brake!

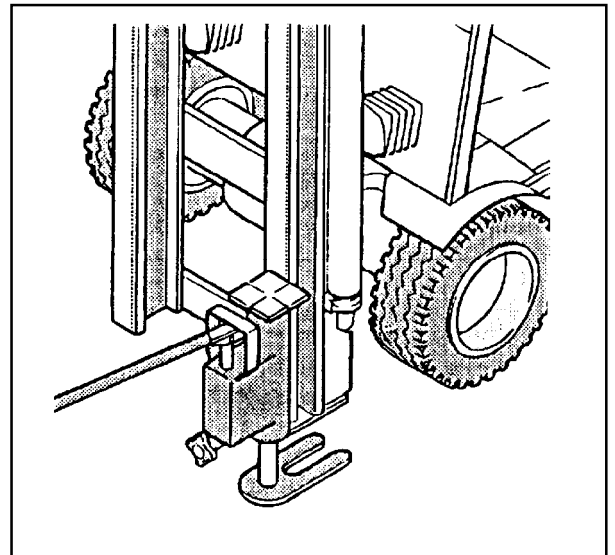
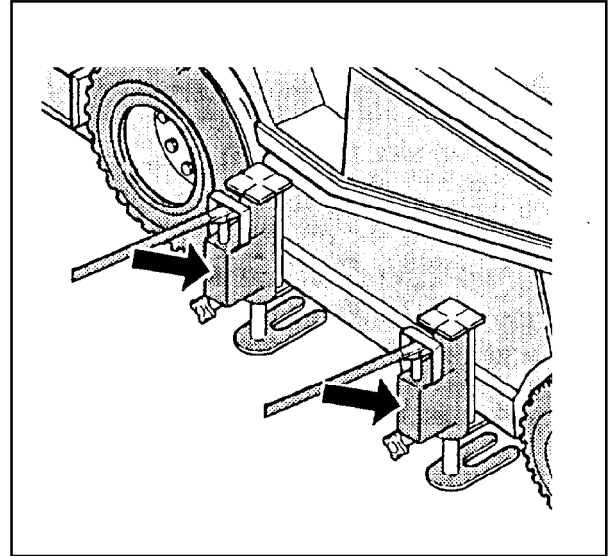
To carry out certain maintenance tasks the truck must be jacked up and securely chocked into position.
Always make sure only jacks of suitable capacity are used.

Before jacking up the truck, position it on level ground and secure against slipping or rolling.

Jack up the truck by placing a jack at locations shown in the figures, i.e. beneath the mast right or left and beneath the frame at the front or at the rear.

Never jack up the truck at rear counterweight!

When jacking up the truck observe safety rules covering maintenance and service jobs on the mast.



Steer axle

Contents	Page
Technical Data for Maintenance Service	1
Mechanical configuration of Steer axle	2
Steer axle removal	2
Steer axle installation	2
Wheel hub - Removal and Dismantling	3
Wheel hub - Reassembling and Installation	3
Wheel angle stop adjustment	4
Checking the steering angles	4
Stub axle - Removal and Dismantling	5
Stub axle - Reassembling and Installation	6
Lubricating the steer axle with grease	6
Track rod removal	7
Track rod installation	7
Steer cylinder removal	8
Steer cylinder installation	8

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Technical Data for Maintenance Service

Functional Group 02	
Steer axle	
Wheel lock angle	80 - 82 °
Toe-in	0 ± 1 mm
Wheel camber	0 °
Trail	0 °
Torque loading	
Wheel hub	MA = 225 Nm
Wheel nuts	MA = 195 Nm
Axle bearings	MA = 195 Nm
Steer cylinder fixing	MA = 210 Nm
Nut on king pin	MA = 290 Nm (6022-25)
	MA = 310 Nm (6026-29)
Lubricants	
Wheel hub bearings	Grease F to DIN 51825-KP2K-20 lithium soap based
	Grease F to DIN 51825-KP2K-30,lithium soap based
Stub axle bearings	Grease FL to DIN 51825 - KPF2N-20, lithium soap based
	STILL Ident No. 148659

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Steer axle

Configuration of steer axle

The articulating steer axle suspended from the counterweight is mounted in 2 neoprene blocks. The stub axles are supported in the axle beam on tapered roller bearings. Steering is limited by stop screws on the stub axles.

- | | |
|---|-----------------|
| 1 | axle beam |
| 2 | fixing plates |
| 3 | hex. hd. bolt |
| 4 | spring washer |
| 5 | neoprene blocks |

Steer axle removal

CAUTION: Remove steer axle only with mast in position on the truck! Risk of tipping!

- Apply the parking brake.
- Securely chock the front wheels to prevent rolling of the truck.
- Slacken steer wheel nuts.
- Jack up rear of the truck at counterweight (x) and place wooden blocks under the counterweight in front of the axle.
- Remove wheels.
- Disconnect the hydraulic connections at steer cylinder.

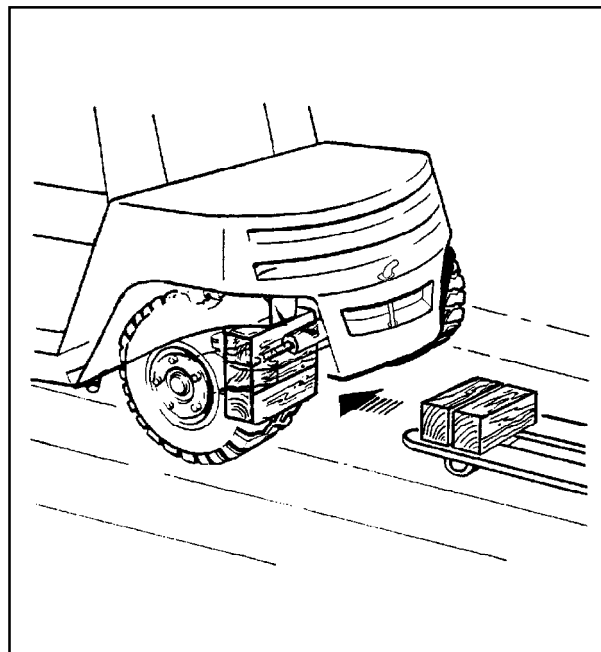
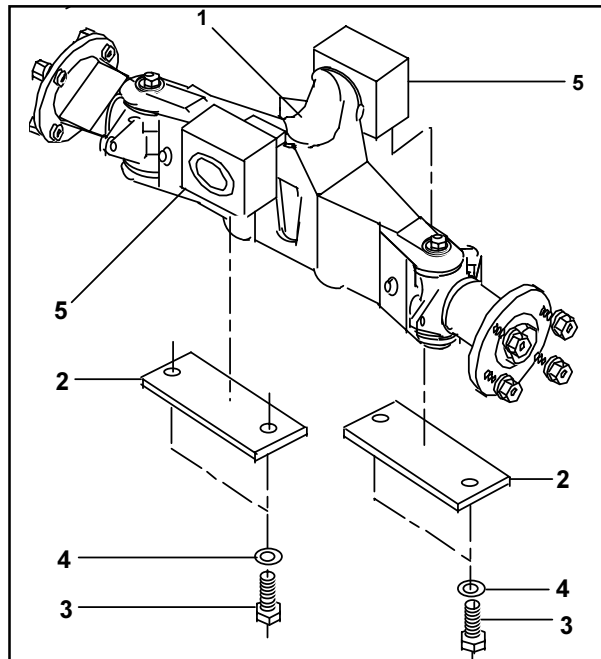
CAUTION: Prepare for oil spillage when disconnecting the hydraulic connections! Catch oil in a pan of adequate capacity and dispose of the used oil in accordance with laws and regulations.

- Remove the 4 socket head screws which retain the steer axle in place.
- Slide a hand pallet truck under the steer axle with wooden blocks placed on the fork ends of the hand pallet truck.
- Using a lever, drive steer axle out of roll pins and lower the axle onto the hand pallet truck.

Steer axle installation

- Reverse the removal procedure.
- The slots of the roll pins must face the direction of forward travel.
- Torque the 4 socket heads to: $M_A = 195 \text{ Nm}$

CAUTION: Do not swap hydraulic connections left and right!



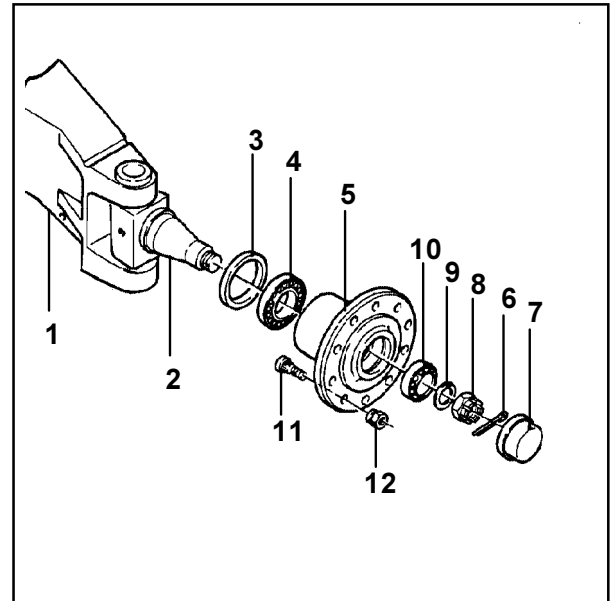
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Steer axle

Wheel hub - Removal and Dismantling

- 1 axle beam
- 2 stub axle
- 3 radial sealing ring
- 4 tapered roller bearing
- 5 wheel hub
- 6 roll pin
- 7 hub cap
- 8 nut
- 9 washer
- 10 tapered roller bearing
- 11 wheel bolt
- 12 ball seat nut



-Slacken ball seat nuts (12) and remove wheel.

-Pull hub cap (7) from wheel.

- Slacken nut (8)

- Remove washer (9) with roll pin (6).

-Withdraw the hub.

-Remove radial sealing ring (3) then remove tapered roller bearings (4) and (10) from hub.

-If necessary, drive out of wheel hub outer races of tapered roller bearings (4) and (10).

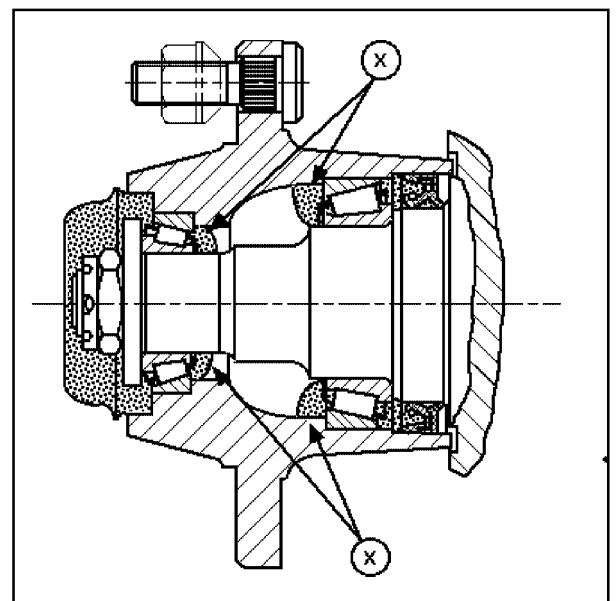
Wheel hub - Reassembling and Installation

-Apply a smear of grease to the sealing lips of the radial sealing ring.

-Before re-assembling the hub, repack with grease F: cavity between inner race and bearing cage of tapered roller bearings, and the bearing spaces identified by an 'x' on the drawing.

-To reassemble the hubs, reverse the procedure.

-Tighten nut (8) while rotating the wheel hub.
Torque loading: $M_A = 225 \text{ Nm}$



Steer axle

Checking the steering angles

The steering angle α must amount to $80^\circ - 82^\circ$. To facilitate the measurement use the complementary angle β for the setting. It should amount to $98^\circ - 100^\circ$.

IMPORTANT: Ensure that the wheel lock is limited by the stop screws (1) and not by the cylinder stroke.

Wheel angle stop adjustment

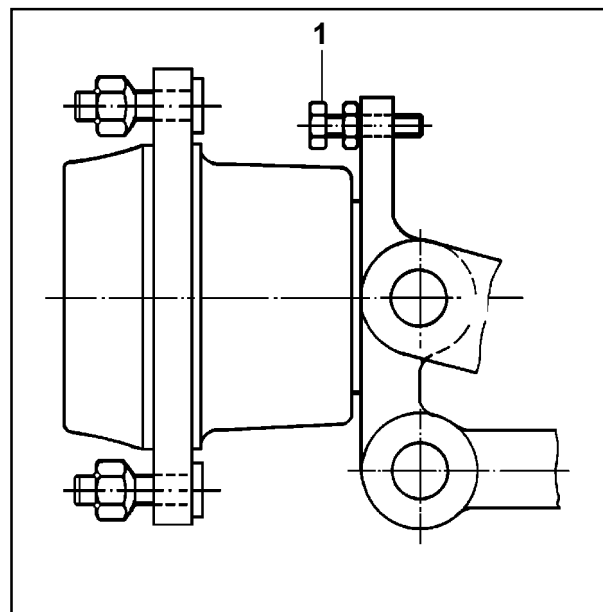
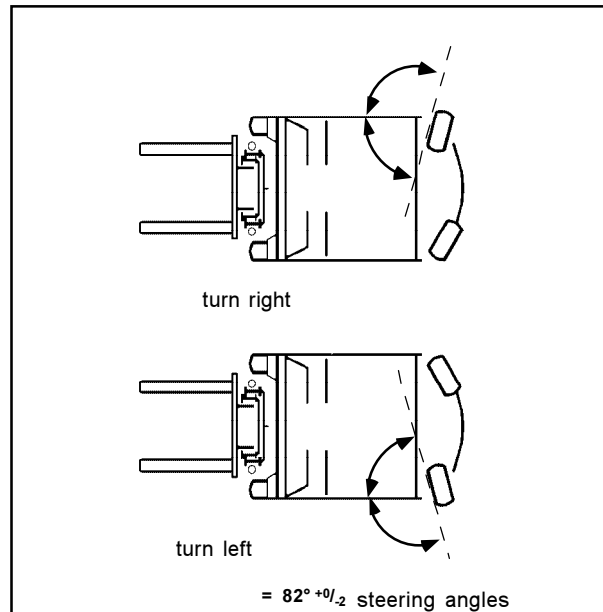
The wheel stop angle is limited by the stop screws (1).

-By operating on stop screws (1), set both steering angles to $80^\circ - 82^\circ$.

-Check opposite angles.

-Check for adequate clearance between wheels and truck frame.

-Check that the wheel lock is **not** limited by the cylinder stroke.



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Steer axle

Stub axle - Removal and Dismantling

- 1 nut
- 2 washer
- 3 king pin
- 4 plug
- 5 stub axle
- 6 hex. hd. screw
- 7 nut
- 8 spacing washer
- 9 wiper ring
- 10 tapered roller bearing
- 11 spacer
- 12 grease nipple
- 13 tapered roller bearing
- 14 wiper ring
- 15 O-Ring
- 16 spacing washer

-Remove the wheel.

-Press out the pin located between track rod and stub axle.

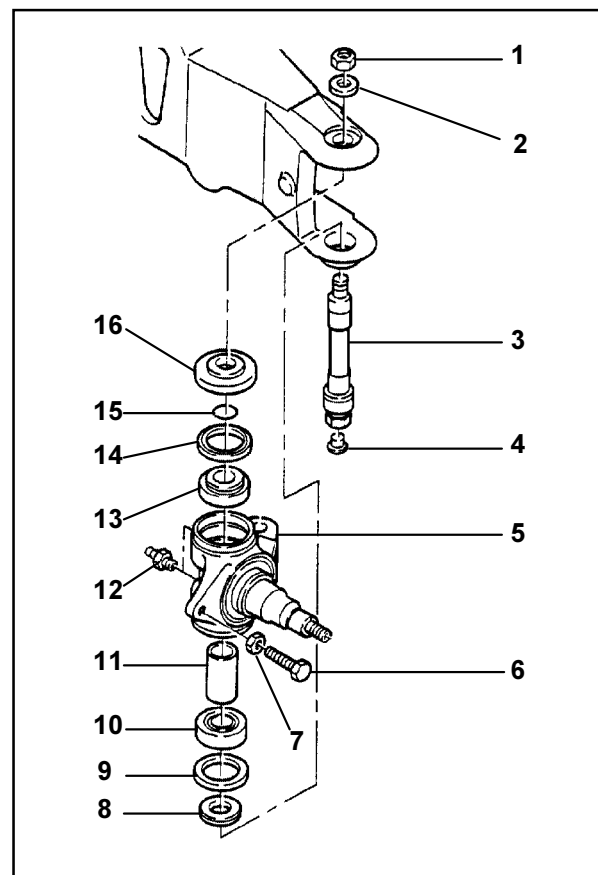
-Slacken nut (1).

-Remove washer (2).

-Press the king pin (3) down through the stub axle and remove the king pin.

-Remove the stub axle from the axle.

-Remove from the stub axle: spacing washers, 'O' ring, wiper rings, tapered roller bearings and spacer (items 8-16).



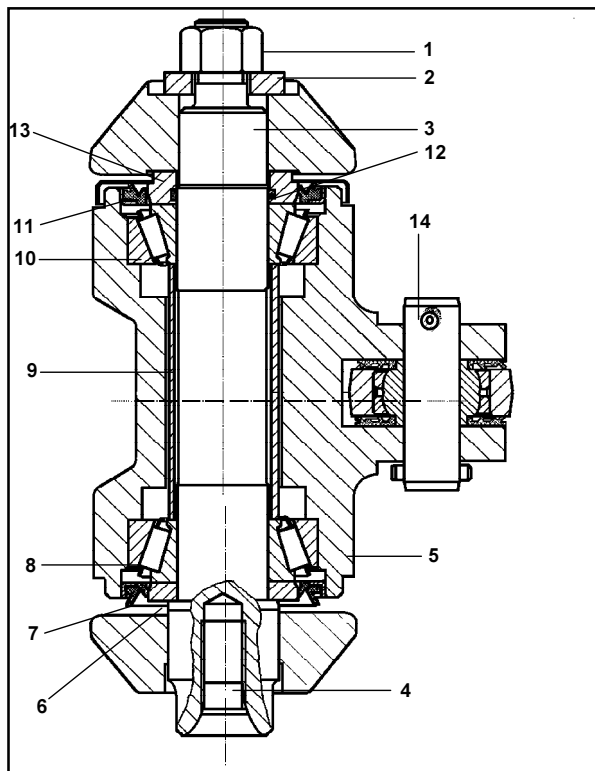
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Steer axle

Stub axle - Reassembling and Installation

- 1 nut
- 2 washer
- 3 king pin
- 4 plug
- 5 stub axle
- 6 spacing washer
- 7 wiper ring
- 8 tapered roller bearing
- 9 spacer
- 10 tapered roller bearing
- 11 wiper ring
- 12 O-Ring
- 13 spacing washer
- 14 pin



-Insert spacer (9) into the stub axle.

-Install both tapered roller bearings (8 & 10) after having first repacked them with a sufficient amount of **FL grade grease**!

-Apply a smear of **FL grade grease** to the sealing lips of the wiper rings (7 & 11).

-Install wiper rings (7 & 11), 'O' ring (11) as well as both spacing washers (items 13 & 6).

-Install the stub axle into the axle beam.

-Drive in the king pin (3) from below after having first applied a light smear of oil to it.

-Fit the washer (2) into position on the king pin.

-Install a new nut (1) and tighten to a torque of:

$M_A = 290 \text{ Nm (6022-25)}$

$M_A = 290 \text{ Nm (6026-29)}$

-Press the pin (14) into the track rod and secure with roll pins.

-Install wheel.

-Lubricate the steer axle with **FL grade grease**.

Lubricating the steer axle

-Operate the linkage during steering.

-Using a grease gun, lubricate with **FL grade grease** the fittings with which the steer axle is equipped until a small amount of fresh grease oozes out at the lubricating points.

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Steer axle

Track rod removal

The steer axle is fitted with two track rods arranged between the steering cylinder and the two stub axles.

- 1 stub axle
- 2 piston rod
- 3 sealing rings
- 4 roll pins
- 5 pin
- 6 track rod
- 7 ball joint

-Remove the roll pins (4).

-Using a press, press out the pins (5).

Track rod installation

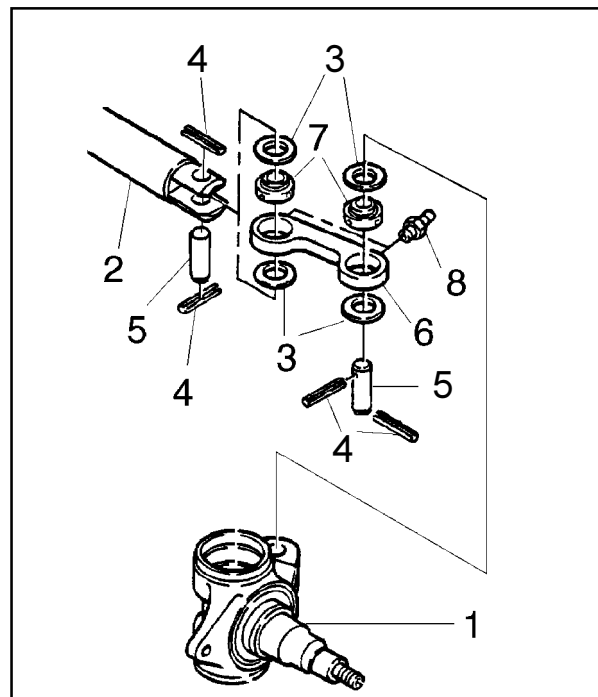
-Reverse the removal procedure.

Install pins cylinder end with a maximum press force of

max. 29 kN

and pins stub axle end with a maximum press force of

max. 38 kN



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Steer axle

Steering cylinder removal

- Remove track rods.
- Disconnect hydraulic connections after having marked them for identification.

WARNING: Hydraulic oil may spill when disconnecting lines; be prepared for oil spillage!

- Slacken the four fixing screws (1).

Steering cylinder installation

- Retighten the fixing screws (1).
Torque loading: $M_A = 210 \text{ Nm}$
- Reconnect hydraulic connections.

CAUTION:

Do not swap hydraulic connections!

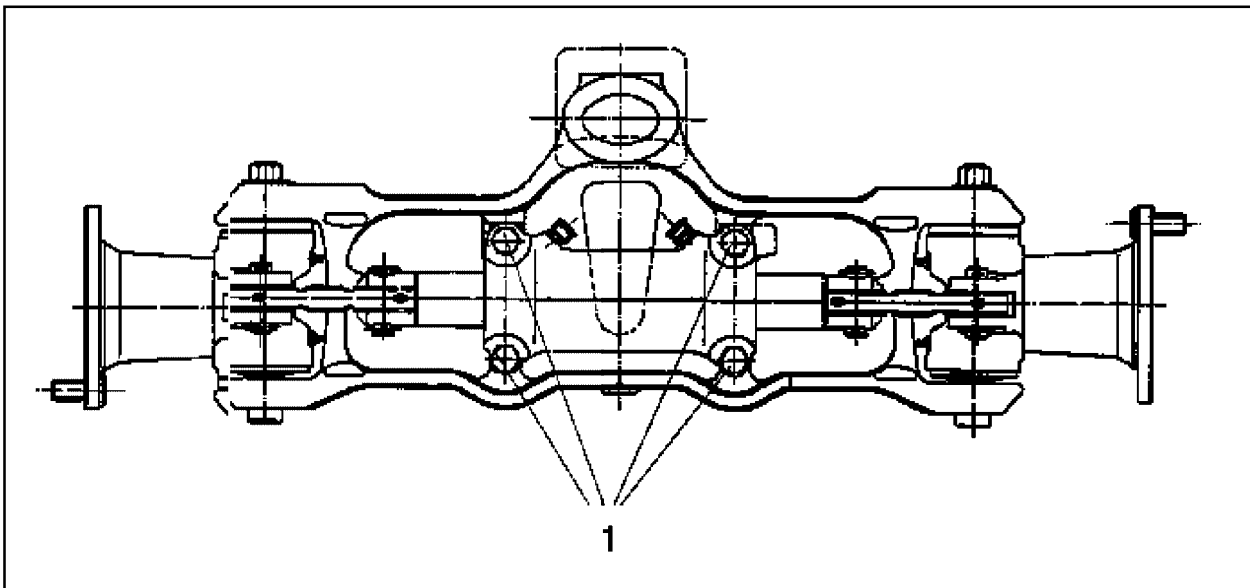
- Install track rods.

NOTE: For steering cylinder dismantling and reassembling refer to F.G. 06.

Lubricating the steer axle with grease

- Operate the linkage during greasing while the steer axle is off load.
- Using a grease gun, lubricate with **FL grade** grease the 8 fittings with which the steer axle is equipped until a small amount of fresh grease oozes out at the lubricating points.

NOTE: When lubricating the upper bearing, the grease need not ooze out of the upper sealing ring, it may also escape from the bottom.



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Contents

Technical Data for Maintenance Service

Power axle - Description

R.h. wheel reduction gear - sectional view

Power axle removal

Wheel reduction gears - Removal

Wheel hub installation

Ventilation of reduction gear casings

Refilling with oil / Oil level check

Technical Data for Maintenance Service

Functional Group 03	
For 6022 - 6025	
Bolts holding drive axle assembly to the frame	M 20 x1.5 x 40 10.9 WOF 30 600 Nm
Reduction gear at right end of drive axle	M 12 x 1.5x 50 10.9 110 Nm
Reduction gear at left end of drive axle	M 12 x 1.5x 50 10.9 110 Nm
Axle housing / Drive motor	M 10 x 1.5 x 35 8.8 46 Nm
Transmission oil: ARAL Fluid HGS	RH & LH sides: 1 litre capacity each
Wheel hub retaining bolts	M 16 x 2x 88 310 Nm
Breather	M10 X1 10 Nm
Oil drain plug	80 Nm
Oil level plug	20 Nm
For 6026- 6028	
Bolts holding drive axle assembly to the frame	M 24 x 50 10.9 WOF 36 930 Nm
Reduction gear at right end of drive axle	M 12 x 1.5x 50 10.9 110 Nm
Reduction gear at left end of drive axle	M 12 x 1.5x 50 10.9 110 Nm
Axle housing / Drive motor	M 10 x 1.5 x 35 8.8 46 Nm
Transmission oil: ARAL Fluid HGS	RH & LH sides: 1.4 litres capacity eac
Wheel hub retaining bolts	M 16 x 2x 88 310 Nm
Breather	M 10 x 1 10 Nm
Oil drain plug	80 Nm
Oil level plug	40 Nm

Power axle

Power axle

The power or drive axle consists of epicyclic reduction gears and drive motor.

The power axle includes the drive motor (1) as an integral assembly. The motor is located in the centre of the power axle.

The epicyclic reduction gears (3) are located at either end of the drive axle.

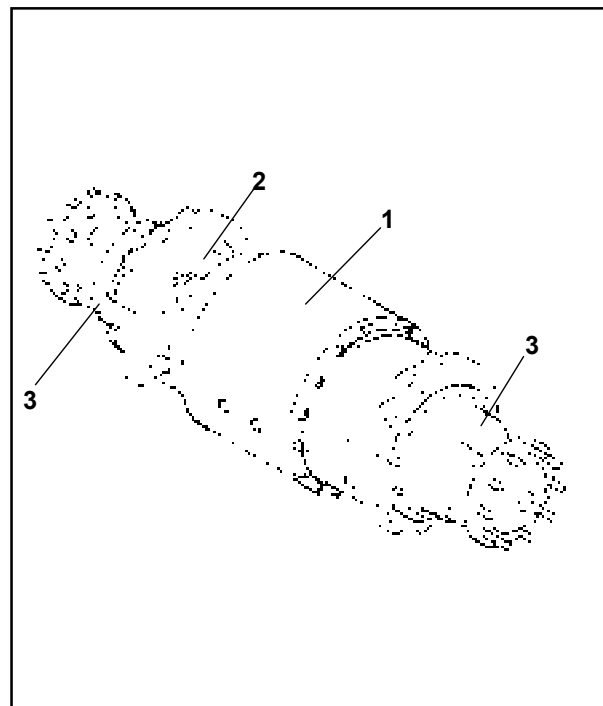
The r.h. drive axle housing incorporates the differential unit as well as the multiple disc brake.

Power from the drive motor is transferred from the right-hand side of the motor to the differential gear. The differential is a normal bevel gear differential which transmits torque via the half-shafts to both wheel reduction gears.

The bevel gears compensate for the rpm difference in the planetary gears of the reduction gears when driving in bends.

Together they are bolted to the drive motor.

The drive motor armature shaft is designed as a hollow shaft in which the left epicyclic reduction gear rotates.



Power axle

Power axle removal

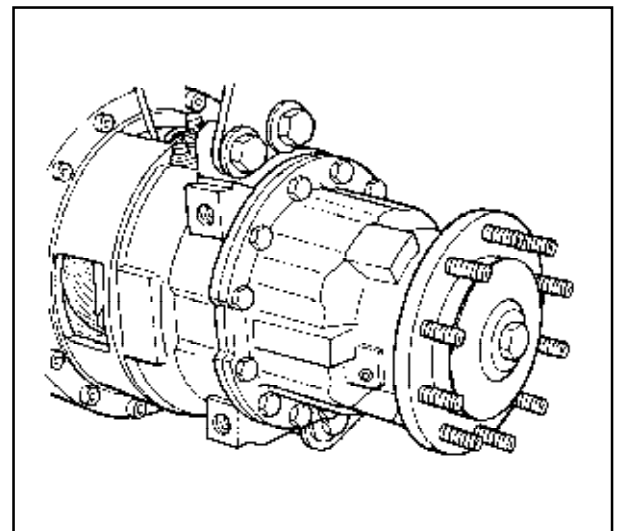
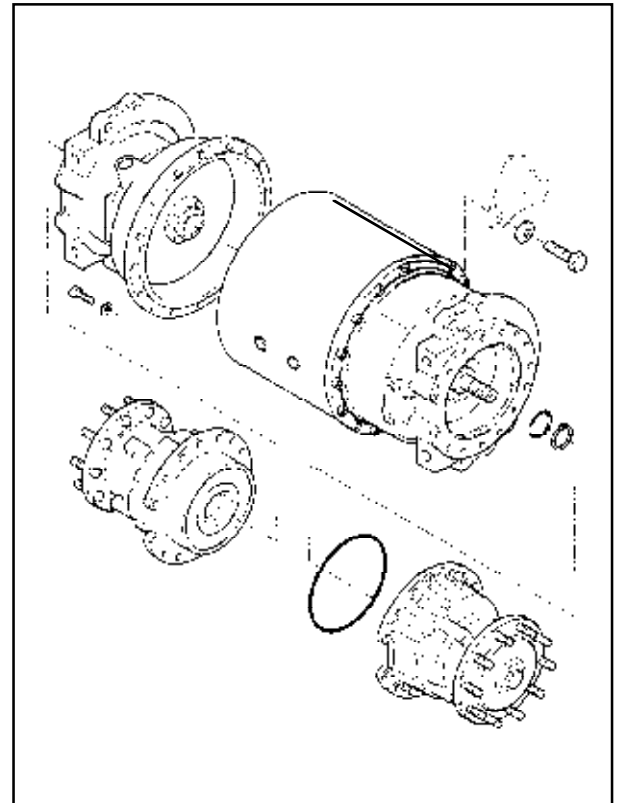
- Raise the front of the truck clear of the ground and securely chock into position.
- Slacken and remove M14 wheel nuts and withdraw both front wheels.
- Remove mast assembly. (Refer to F.G. 20).
- Drain the oil from both wheel reduction gear casings on both sides of power axle.
(for 6022 - 25 - approx. 1.0 litre each side)
(for 6026 - 28 - approx. 1.4 litres each side)
- Disconnect electrical connections.
- Remove parking brake cable.
- Disconnect the flexible brake feed pipe at the connection on the power axle. (See F.G. 07).
- Disconnect air hose of external cooling fan.
- Slacken screws securing the hydraulic pump (See F.G. 11).

For 6022 - 25

- Slacken and remove the fourteen M20x1.5x40 10.9 hex. hd. screws (see arrow) that hold the power axle to the frame.

For 6026 - 28

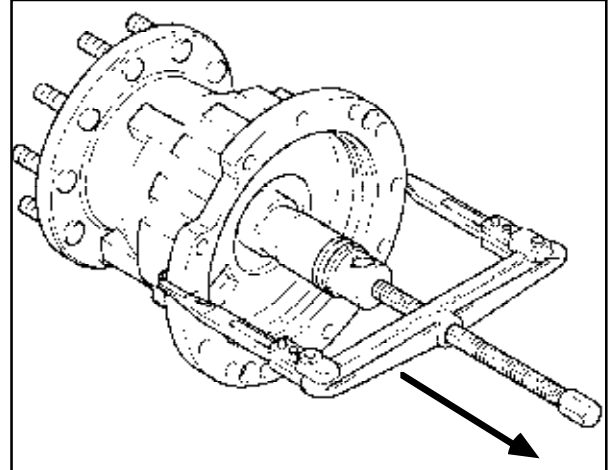
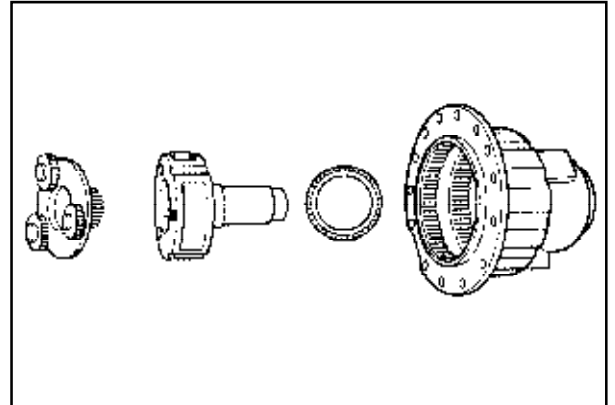
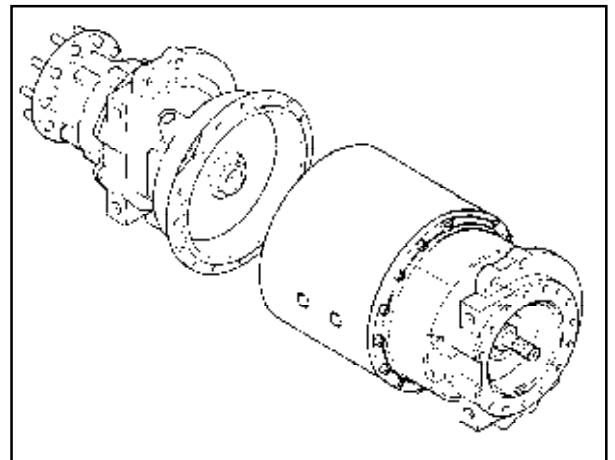
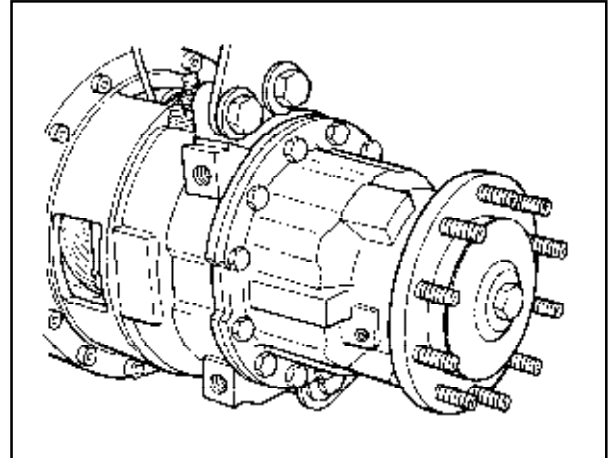
- Slacken and remove the sixteen M24x50 10.9 hex. hd. screws (see arrow) that hold the power axle to the frame.
- Disconnect frame / axle and remove.
- Disconnect remaining electrical connections from drive motor.
(F1 + F2) (A1 + A2)



Power axle

Wheel reduction gears - Removal

- Slacken and remove the twelve M10x35 hex-socket head screws with locking ring (item 1) securing the left drive axle housing.
- Press off the control ring (through side opening).
- Remove left wheel reduction gear.
- Withdraw the half-shaft.
- Undo and remove the hexsocket screws (item 3) that secure the right drive axle housing. (14 hex. hd. screws (item 4) M12x 50 10.9 Torque = 110 Nm).
- Remove differential/brake housing from drive motor.
- Remove the right wheel reduction gear, complete with the multiple disc brake.
- Remove screws, cup springs and back-up ring of multiple disc brake (**note the position of the cup springs to ensure they are repositioned correctly during assembly**). (See F.G. 07).
- Remove chevron seal.
- Remove circlip from differential cage.
- Using a press, press out differential cage.
- Remove multiple disc brake (see F.G. 07).
- Remove planetary gear set.
- Slacken M16x2x88 wheel hub retaining screw (item 5) (torque = 310 Nm).
- With a drift and hammer or an extractor, drive planetary gear housing out of the splined wheel hub.
- Remove wheel hub from wheel reduction gear casing.
- Press out the outer race of the tapered roller bearing.
- Dismantle the shaft sealing ring from the wheel hub after pulling off the tapered roller bearing.



Power axle

Wheel hub installation

The chevron seal must be positioned correctly into the wheel hub, leaving $1 \pm 0.025 \text{ mm}$ protruding above the outer border of the hub! (See arrow 1).

NOTE: Ensure that the chevron seal (lip seal) is fitted into the wheel hub with dimensional accuracy.

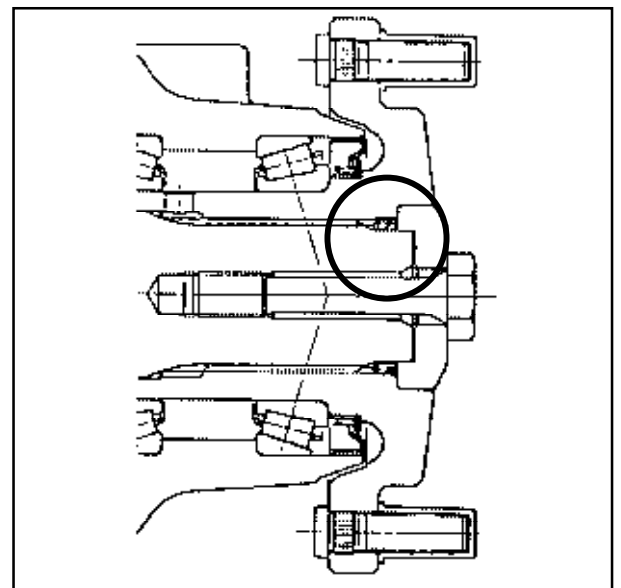
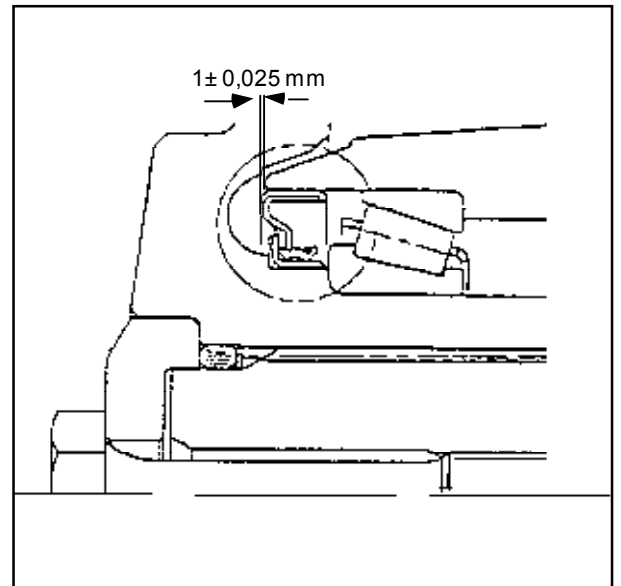
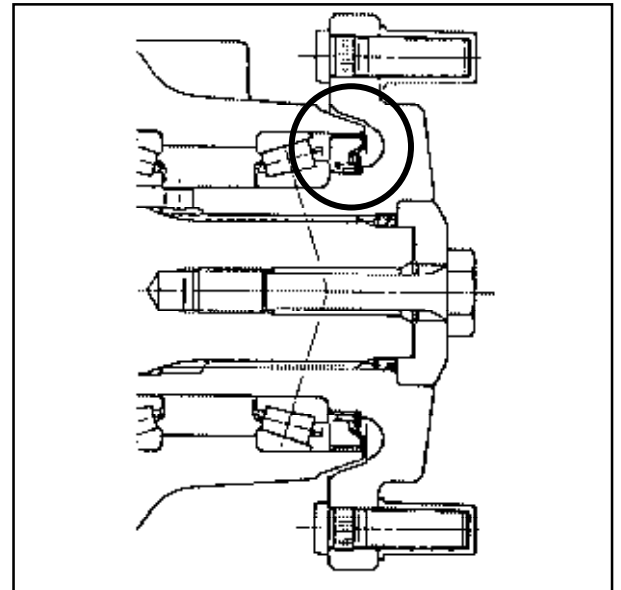
This is essential as the shaft too has been provided with a lip seal.

The combination of both seals prevents dirt ingress. (See arrow 2).

To secure the wheel hub, a washer (arrow 3) must first be inserted. The O-ring (arrow 4) and the back-up washer (arrow 5) must then be fitted.

Assemble the wheel hub onto the axle housing by means of the M16x2x88 hex. hd. bolt (arrow 6) which must be tightened
to a torque of 310 Nm

(Can be tighten on the truck after installation of the axle.)

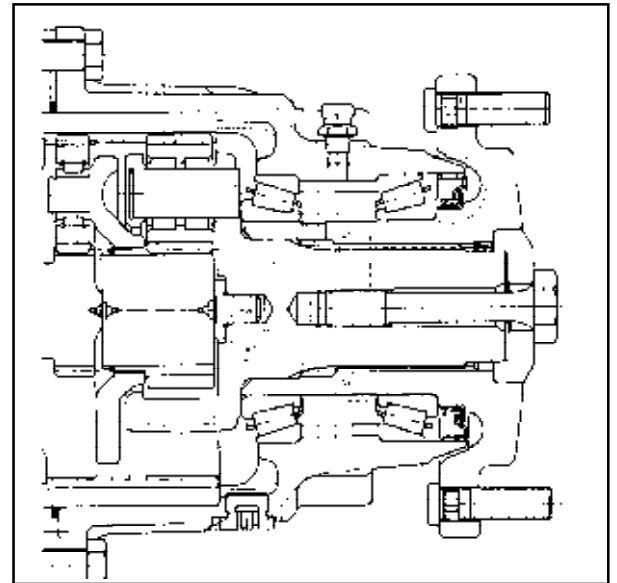


Power axle / ventilation

Ventilation of wheel reduction gear casings

Both reduction gear casings are provided with a breather (see arrow) whose function is to exclude air from the system liable to cause excess pressure in the reduction gear casing. Check that the breather is not blocked. It must be free from paint, dirt etc. liable to cause malfunction.

The M 10 x 1 breather has been tightened to a torque of **10 Nm**.



Power axle

Refilling the reduction gear casings with transmission oil / Oil level check**NOTE:**

When handling transmission oil, observe the product-related safety regulations.

Oil level check

To gain access to the oil level plugs (1), remove both front wheels and make sure that the truck is standing on level ground. Undo and remove the oil level plugs (1) located on the left- and right-hand sides of the power axle.

Oil must drain out of the plug holes.

Refilling with transmission fluid

Undo and remove the oil filler plugs (1) located at the top of both sides of power axle.

In compliance with the STILL booklet „Recommended Lubricants“, refill with new transmission fluid such as ARAL Fluid HGS.

For 6022 - 6025 (1.0 litre each side)

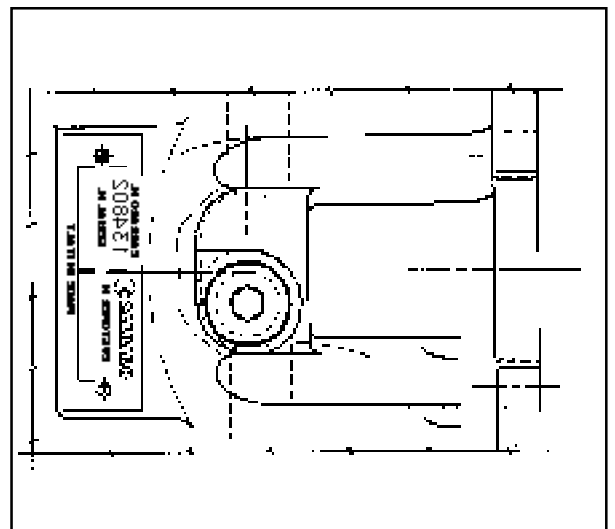
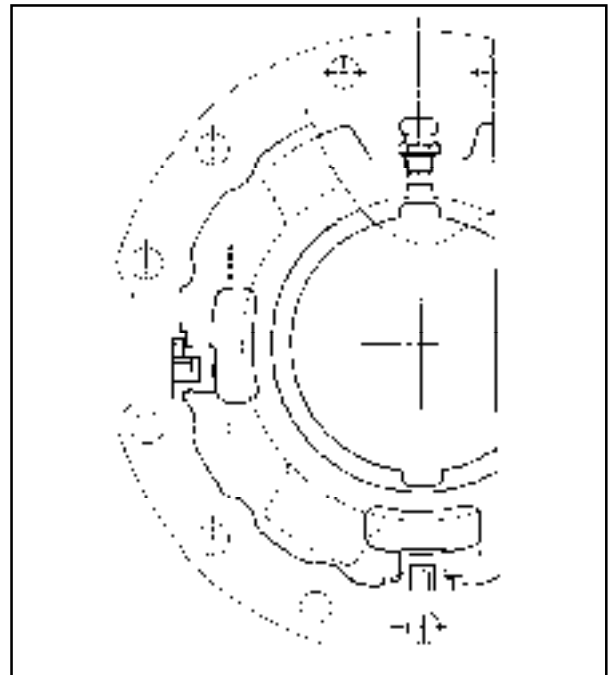
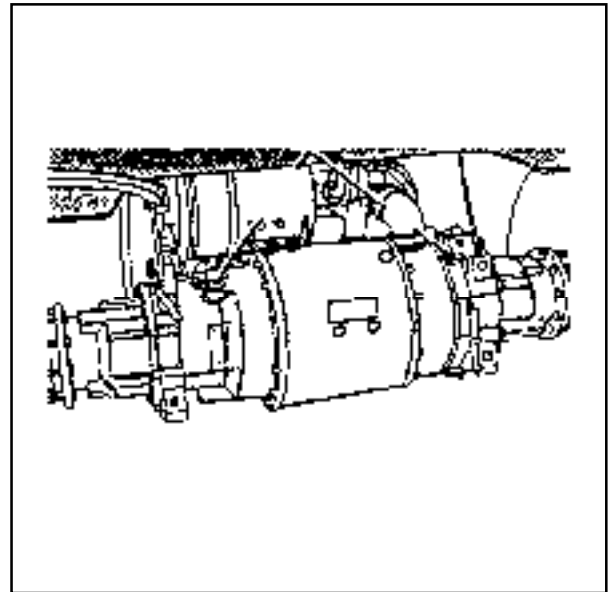
For 6026 - 6028 (1.4 litres each side)

Replace oil filler plugs (1).

Torque loading for plugs = 40 Nm

The oil drain plugs (see item 2) are positioned on the underside of the power axle.

Torque loading = 80 Nm.



Functional Group 04	
Whgeels and Tyres for 6022-25	Tool
Front wheels 10 M 14 wheel nuts	WOF 19 socket Torque loading 210 Nm
Rear wheels 5 M 14 wheel nuts	WOF 19 socket Torque loading 210 Nm
Tighten opposite wheel nuts	
Wheels and Tyres for 6026-28	Tool
Front wheels 10 M 20 wheel nuts	WOF 30 socket Torque loading 600 Nm
Rear wheels 5 M 14 wheel nuts	WOF 19 socket Torque loading 195 Nm

Steering

Contents	Page
Technical Data for Maintenance Service	1
Operation	2
Adjusting the steering column Steering control unit Steering control unit removal	3
Steering control unit installation Repairing the steering control unit	4
Priority valve - Dismantling Priority valve - Reassembly	5
Steer cylinder disassembly Steer cylinder reassembly	6

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Technical Data for Maintenance Service

Steering control unit	
Make	Danfoss
Type	OSPC 100 LS EL 150 – 1169
Pump capacity	100 cm ³ /rev
Pressure relief valve setting	100 +5/0 bar
Shock cushioning valve setting	170 +15/0 bar
Priority valve	
Make	Danfoss
Type	OLS 80 152 B 0261
Pre-load pressure	4 bar

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Steering

Operation

The truck is equipped with a hydrostatic servo-steering system operating according to the load-sensing (LS) principle. It acts on the power steer cylinder (7) which is linked to the steer axle.

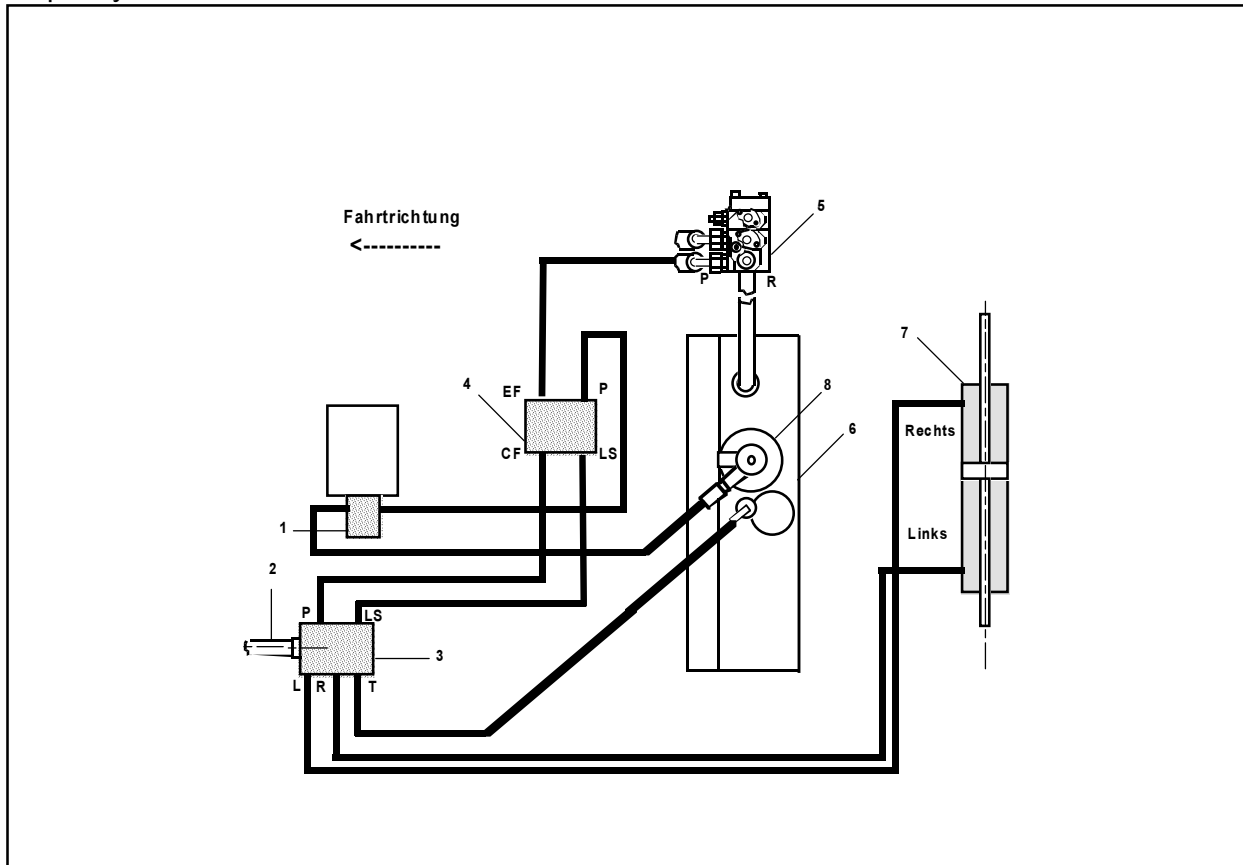
A steering control unit (3) is flange-connected to the lower end of the steering column (2). The steering control unit consists of a rotary valve and a rotary meter. When the steering wheel is turned, the steering control unit meters an oil volume proportional to the rate of rotation of the steering wheel. The rotary or directional valve directs the oil flow to one or other side of steer cylinder depending on direction of turn. In the LS steering system, hydraulic power for steering and truck main services is provided by a common pump and motor unit (1), with preferential flow control to steering circuit being assured by the priority valve (4).

The oil flow to the steering unit is thus always determined by the actual steering rate regardless of load pressures in steering system or truck main hydraulic system.

As the quantity of oil required for steering is small compared to the quantity of oil required for the truck main hydraulic system, the pump unit is regulated during steering down to a low number of revs, truck main hydraulic system being at rest. The pump unit is switched on via an oil pressure switch located on connector EL of the steering control unit.

In the event of hydraulic pressure failure the system automatically reverts to manual operation (emergency steering).

- | | |
|---------------------|-----------------------------|
| 1 = pump | 5 = hydraulic control valve |
| 2 = steering column | 6 = hydraulic tank |
| 3 = steering unit | 7 = steer cylinder |
| 4 = priority valve | 8 = filter in suction line |



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Steering column / Steering Control Unit

Adjusting the steering column

After slackening the star knob (2) the steering column can be tilted through an angle of about 10 deg. Once adjusted to the required position, the steering column must be locked in position by tightening the star knob by hand.

Steering control unit

The steering control unit is bolted to the flange of the steering column by four socket head screws. The steering unit incorporates the following valves which have been preset by the maker.

Pressure relief valve 100 $\pm 5/0$ bar
Shock cushioning valve 170 $\pm 15/0$ bar

DO NOT ADJUST - PRESET AT FACTORY!

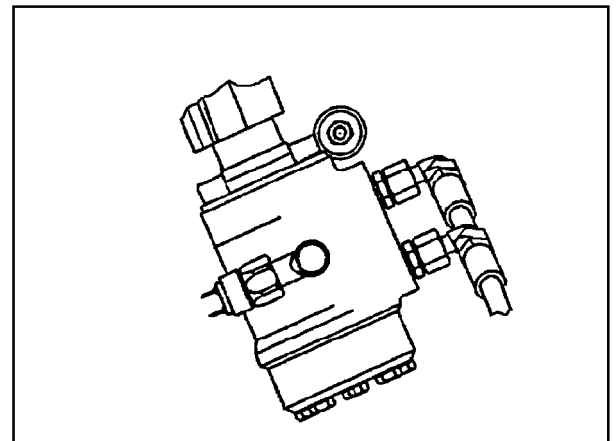
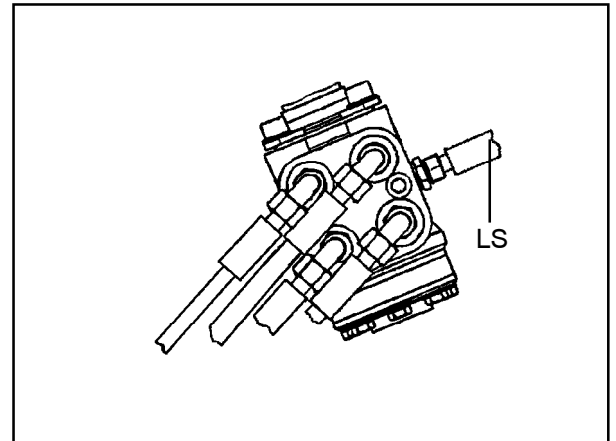
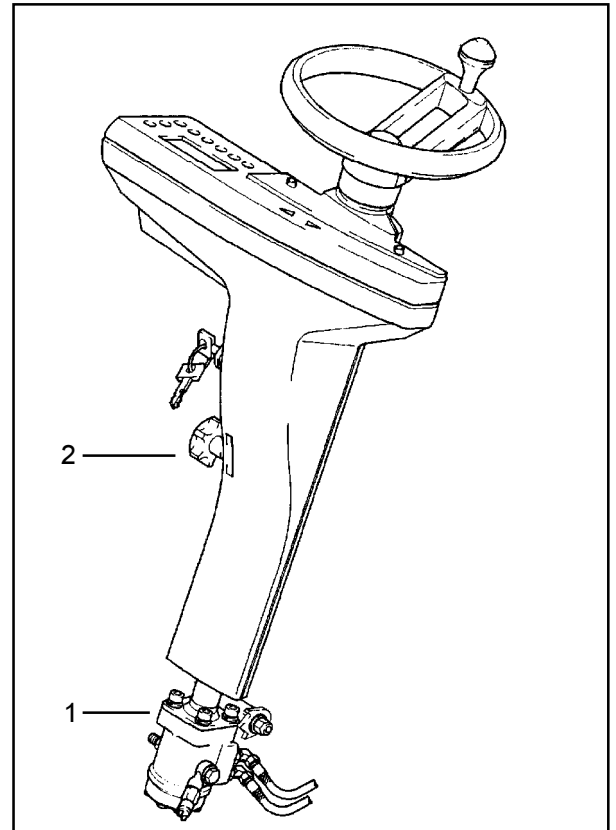
No adjustment to the valve settings may be carried out as the valves are preset.

Steering control unit removal

- Remove the floor plate.
- Remove inner shroud.
- Remove the screws which secure the rear cover to steering column
- Unscrew hydraulic connections T (tank), P (pump), L (LH connection), R (RH connection) and clearly mark them.

CAUTION: Prepare for oil spillage when disconnecting the hydraulic connections! Catch oil in pan of adequate capacity and dispose of the used oil in accordance with laws and regulations.

- Remove the four socket head screws that hold the manual (steering wheel operated) pump to the steering column, and clear pump from below. While slackening the screws the steering column must be tilted forward and backward respectively.



Steering control unit

Installation

Reinstall the steering unit in the reverse order of removal.

No	Description	Notes
1	socket hd screw	MA = 46 Nm
2	washer	
3	steering column	tilt forward and back
4	fitting	MA = 50 Nm
5	reducing adapter	MA = 100 Nm
6	h.p. hose	
11	pressure limiting valve	incorporated in steering unit
		MA = 50 ± 1 Nm

CAUTION: The hydraulic lines previously marked must absolutely be reconnected to their original position. Failure to do this could lead to an accident.

Repairing the steering control unit

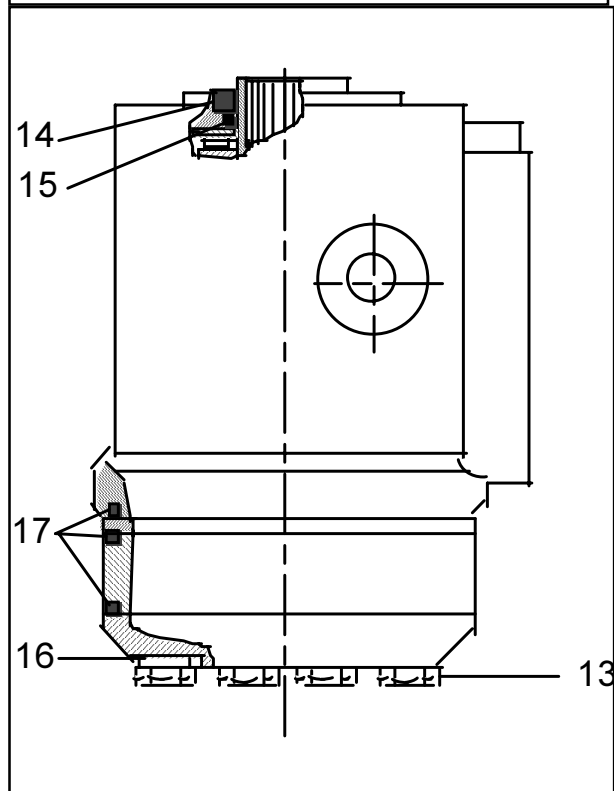
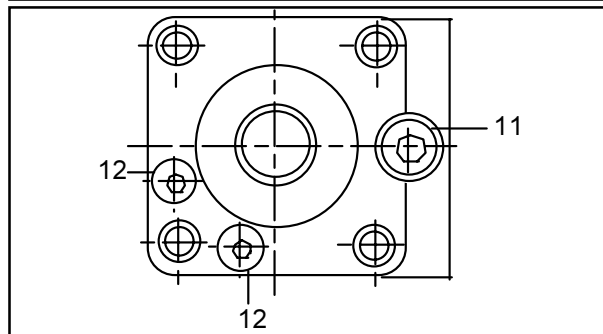
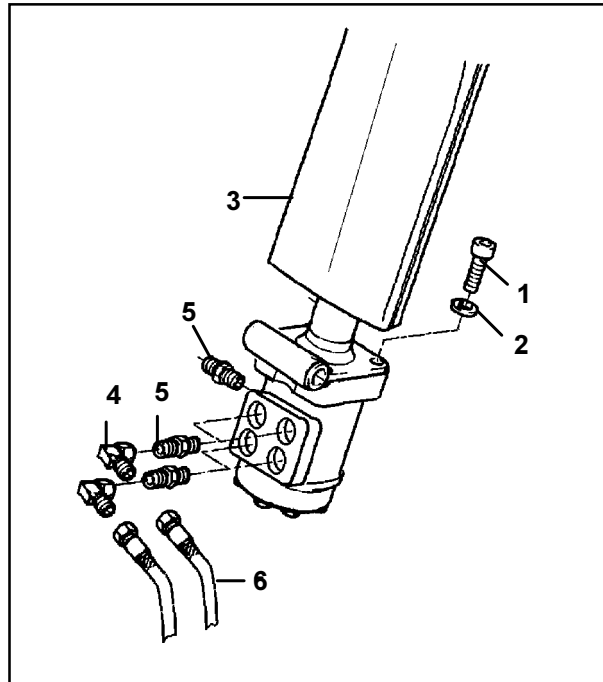
In the event of a failure the steering unit must be replaced with a new one.

Exception: Oil leakage. In that case we have available a repair kit **Part No. 144694** consisting of:

- 1x seal with sealing lip (14)
- 1x dust seal (15)
- 7x washer (16)
- 3x O-ring seal
- 1x Fitting instructions

NOTE: Changing the lip type seal as well as changing the dust seal requires a special tool of the Danfoss company.

To eliminate leaks which may have occurred at the fittings of the steering unit use the corresponding sealing rings which can be obtained from STILL Spares Dept. Prior to this operation check the fittings for proper torque loading.



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Priority valve

Priority valve

Bolted to the right side of the chassis, the priority valve (1) is a hydraulic control unit whose function it is to establish priority flow to the power steering circuit in all operating conditions.

When reconnecting the hydraulic pipes to the priority valve, tighten the connections with a torque spanner to the following requirements:

CF: $M_A = 100 \text{ Nm}$

EF: $M_A = 100 \text{ Nm}$

P : $M_A = 100 \text{ Nm}$

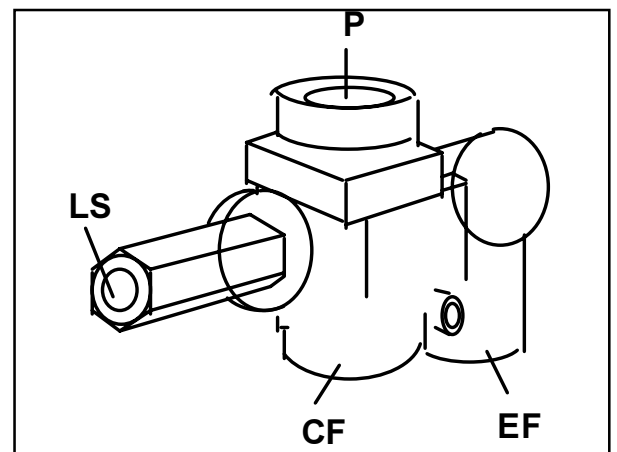
LS: $M_A = 45 \text{ Nm}$

Priority valve - Dismantling

Contaminants in the system hydraulic oil will cause improper operation of the priority valve. Freedom of movement of the spool (3) in the valve body will be impaired due to foreign particles, resulting in heavy steering.

- 1 = plug
- 2 = O-ring
- 3 = sliding spool
- 4 = pre-loaded spring
- 5 = LS (load-sensing) plug
- 6 = valve body

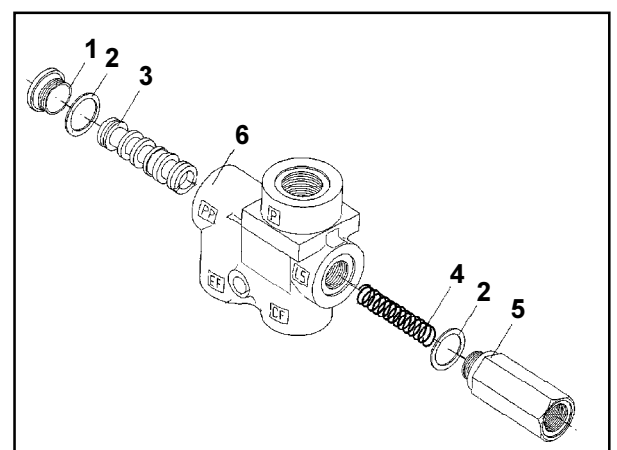
- Remove plug (1) and LS plug (5).
- Withdraw spool (3) from valve body.
- Clean all parts and dry with compressed air.



Priority valve - Reassembly

Reverse above procedure for assembly.
Tighten items (1) and (5) to 50 Nm.

NOTE: Following a repair work on the steering unit the LS banjo fitting must be slackened to bleed the system after which procedure it must be tightened to 45 Nm.



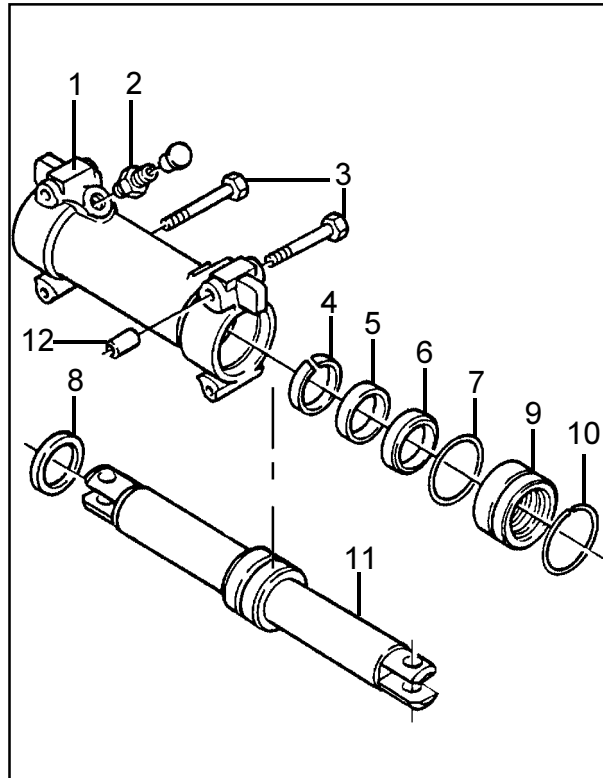
Steer cylinder

Steer cylinder disassembly

- 1 steer cylinder
- 2 fitting
- 3 hex, hd bolt
- 4 - 8 packings & seals (repair kit)
- 9 guide bush
- 10 retaining ring
- 11 piston rod

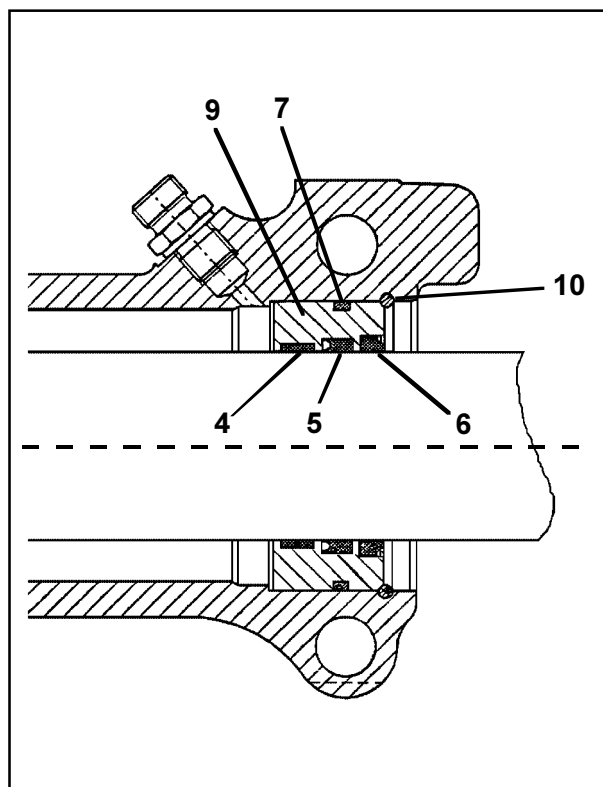
CAUTION: Hydraulic oil may spill when disconnecting hydraulic lines; be prepared for oil spillage! Catch oil in pan of adequate capacity and dispose of the used oil in accordance with laws and regulations.

- Remove steer cylinder. See Functional Group 02.
- Remove retaining ring (10).
- Withdraw guide bushing (9).
- Withdraw piston rod (11).
- Remove retaining ring and guide bush on the other end.



Steer cylinder reassembly

- Use a new repair kit.
- Install new seal (8).
- Install piston rod (11).
- Install guide bushes (9) together with packing rings & seals (4-7).
- Reinstall the steer cylinder.
For installation see Functional Group 02.



Bleed steering system by quickly turning the steering wheel several times to full lock in both directions.

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Contents		page
Service Brake - Removal	(6022 - 6025)	2
Service Brake - Installation	(6022 - 6025)	3
Service Brake (Operation)	(6022 - 6025)	5
Parking brake	(6022 - 6028)	6
Service Brake - Removal	(6026 - 6028)	7
Service Brake (Operation)	(6026 - 6028)	8
Automatic adjuster (Operation)	(6022 - 6028)	9
Replacing the brake discs	(6022 - 6028)	10
Replacing the 'O' rings	(6022 - 6028)	10

Service brake

Removal

The service brake is of the multiple-disc type which is enclosed within the r.h. wheel reduction gearbox and runs in an oil bath.

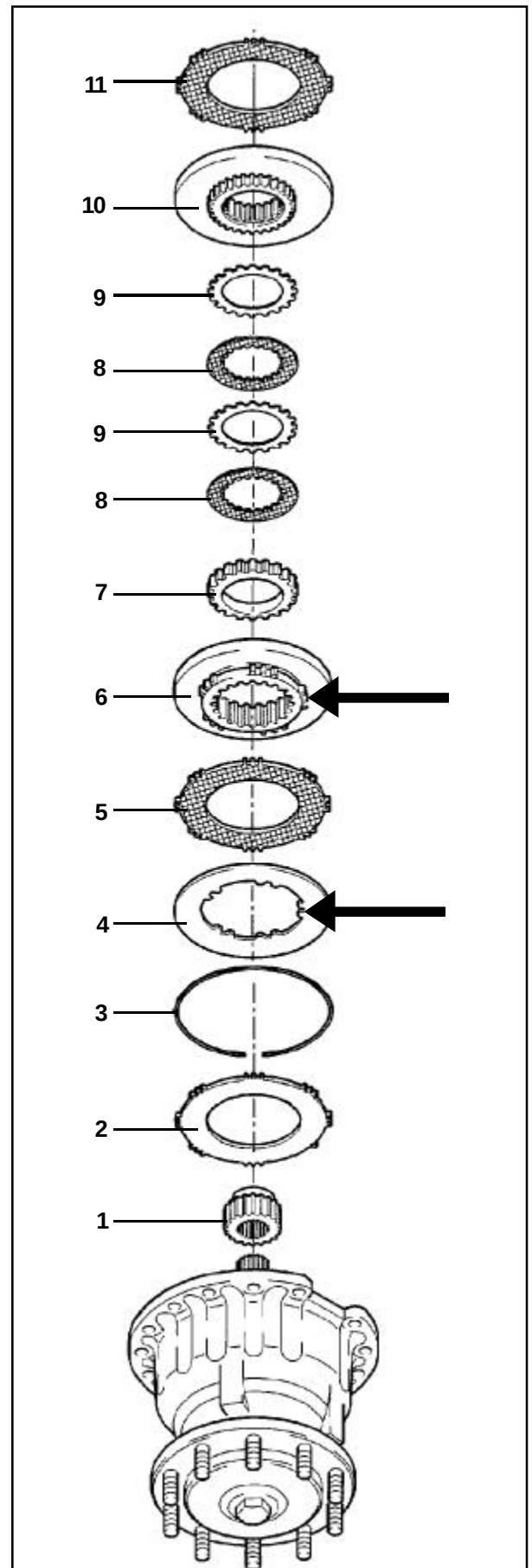
Before removing the wheel reduction gearbox, release the parking brake !

Do not operate the parking brake nor the service brake once the wheel reduction gearbox has been removed !

CAUTION: Mineral oil is used as a brake fluid (the same oil as that in the reduction gearbox).

- 1 - pinion
- 2 - brake disc of the non rotating type (lined with brake lining only on one side)
- 3 - locking ring
- 4 - reaction disc
- 5 - brake disc of the non rotating type (lined with brake lining on both sides)
- 6 - reaction disc (including circlip)
- 7 - ring gear
- 8 - brake disc
- 9 - reaction disc
- 10 - reaction disc
- 11 - brake disc (same as item 2)

For 6026 – 6028 models - see page 7



Service Brake

Installation

When installing the brake proceed as follows:

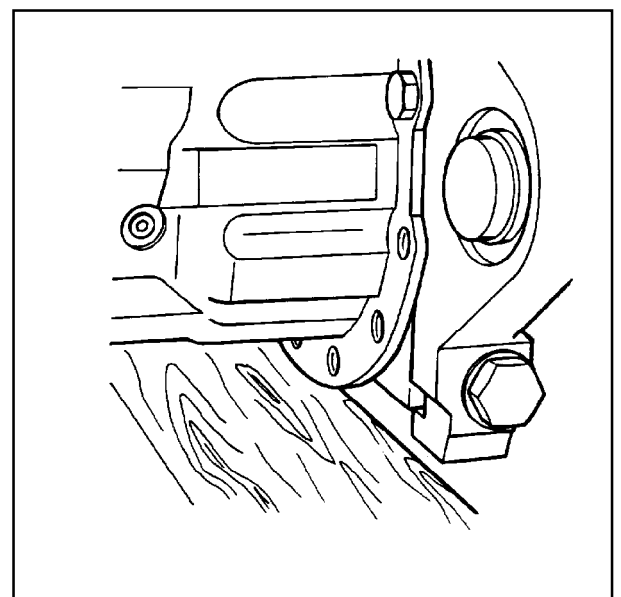
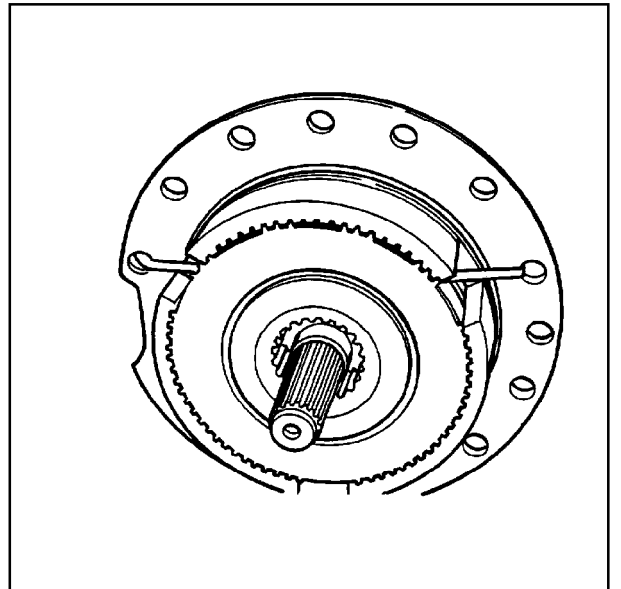
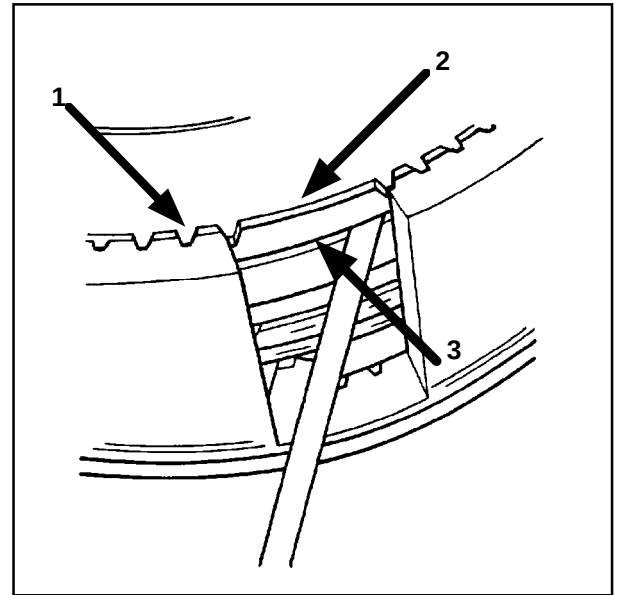
- 1) Install the brake- and reaction discs in the sequence shown in FIG 1.
- 2) The gear teeth (arrow) of item 4 must be in mesh with the teeth (arrow) of item 6 (see FIG page2).
- 3) The jags on the circumference of brake discs items 2, 5 and 11 must engage with the gear teeth inside the gear casing, i.e. the jags must not be located in the area of the three recesses (arrows 1 and 2 in the upper figure on the right).

During reduction gear installation the stack of discs must be retained firmly together by means of a flexible tape.

Apply a light smear of grease to the friction area of brake disc (11) before installation. The brake disc must then be pressed with its friction area firmly against the reaction disc (10). Brake disc (11) will then easily stick on the reaction disc (10) which will be sufficient for reduction gear installation. (Prior to this operation clean brake disc (11) and reaction disc (10) with a rag).

As shown in the figure in the middle, the tape must pass through 2 holes, and as shown in the upper figure (arrow 3) must be guided between two reaction discs (6 + 10). During reduction gear installation, and before the reduction gear flange makes contact, the tape must be cut as short as possible on one end and by pulling the tape at its long end it must be carefully removed. The installation must be carried out with utmost care and possibly free from vibration.

To facilitate the installation, place wooden blocks between floor and reduction gear flange to compensate for the distance between floor level and reduction gear flange.



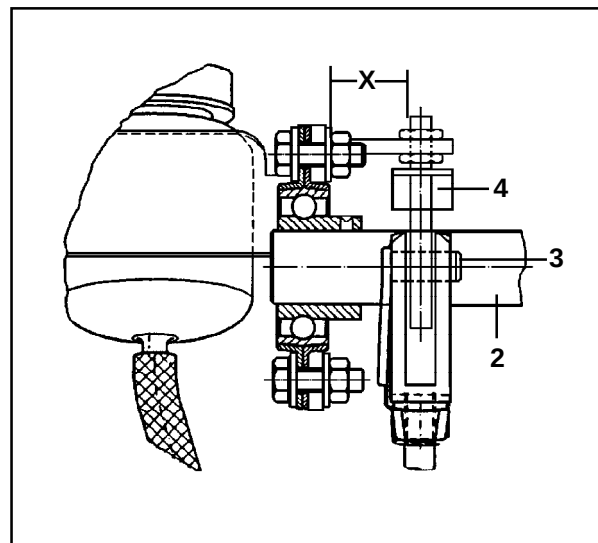
Service Brake

Axial adjusting dimension of shaft (2)

$$x = 28.5 \text{ mm}$$

Axial shaft securing means
(threaded pin)

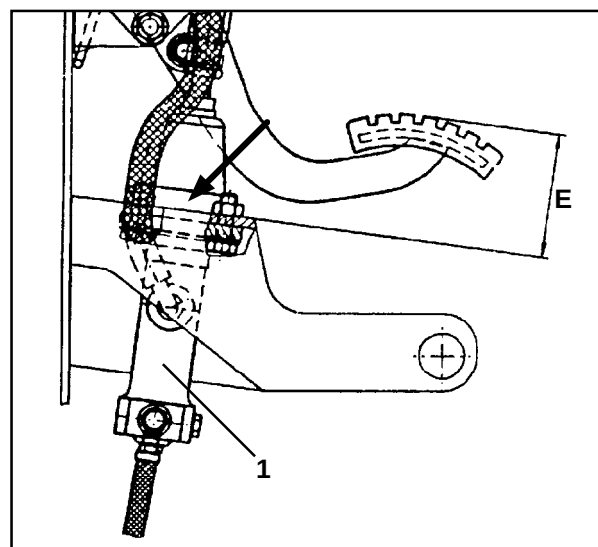
Grease pin (3) prior to installation!



Adjust footbrake pedal height to dimension „E“
above the floor plate by operating on stop block
item 4

Adjusting dimension $E = 54,0 \pm 4$
(Clearance between top edge of brake pedal ->
and top edge of brake master cylinder bracket)

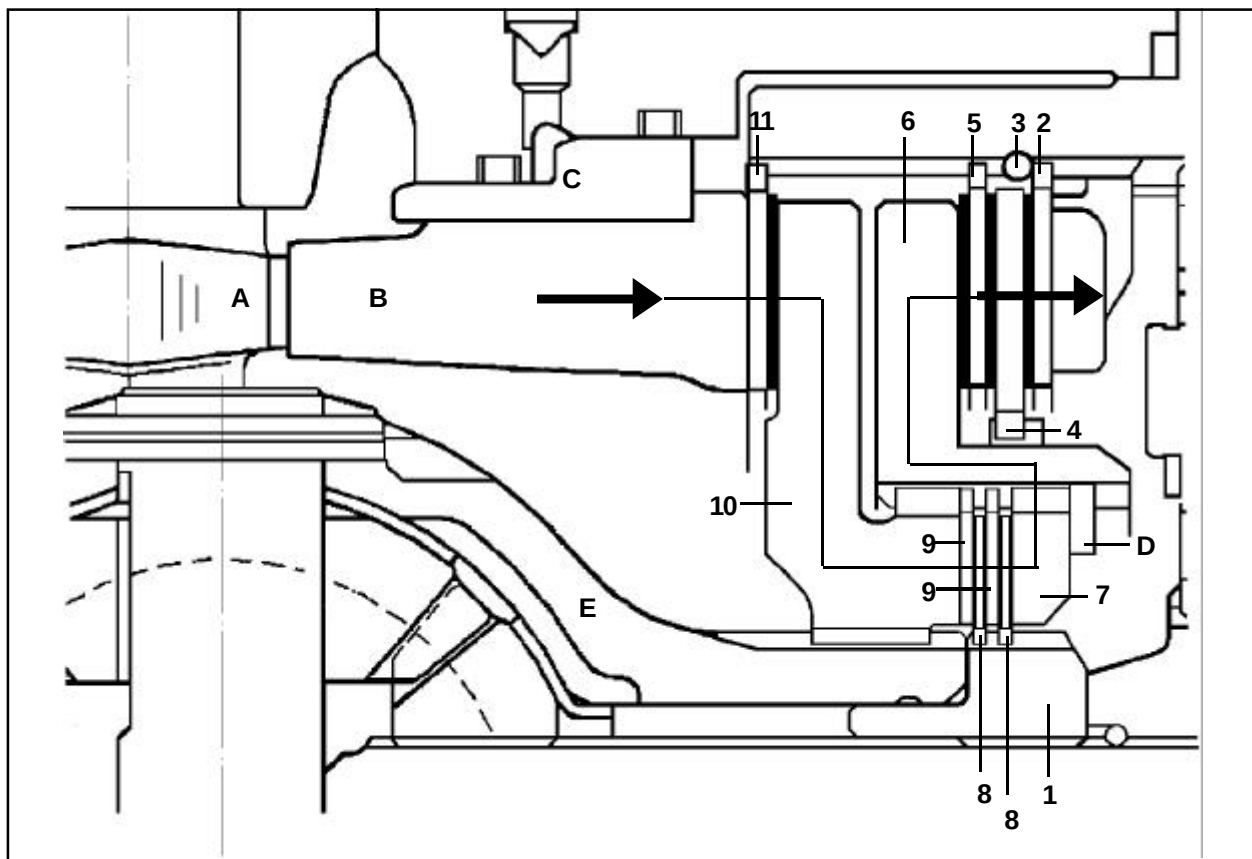
A clearance of 1 mm is necessary between the
pedal push-rod and master cylinder (1) piston: Lack
of clearance would result in the primary seal
blocking the compensation port!



Adjustment procedure

- Slacken the locknut on clevis
- Adjust clearance between rod and piston to 1 mm by rotating the push rod
- Lock the clevis in position by retightening the locknut

Service Brake

**Operation (transmission of force)**

- Pressure on the brake pedal causes piston (C) to press against actuator (B).
- Actuator (B) in turn applies pressure against the first brake disc (11) thus putting the reaction disc (10) into motion which then rotates together with the differential casing (E) as a unit.
- The axial movement of reaction disc (10) produces the compression pressure for reaction discs (9) and the ring gear (7) which rotate together with the differential casing, and for the brake discs (8) that rotate together with the pinion (1), which results in the differential lock being released.
- Circlip (D) transfers the axial force to brake disc (6).
- Reaction disc (6) presses the brake disc (5) against reaction disc (4) which rotates together with the differential casing, and then against brake disc (2).

For 6026 – 6028 models - see page 8

When the parking brake is applied, the axial motion is transmitted from cam (A) to the brake via actuator (B).

A - cam, parking brake

B - actuator

C - piston

D - circlip

E - differential casing

The locking ring (3) serves as a guarantee against any possible opposite motion of brake disc (2) against reaction disc (4). Such a motion may f.i. be produced due to vibration likely to cause heating of the friction area. To prevent this happening, locking ring (3) provides the minimum clearance between brake disc (2) and reaction disc (4).

Parking Brake

Adjustment

Parking brake adjustment is achieved by operating on the two nuts on the cable thread.

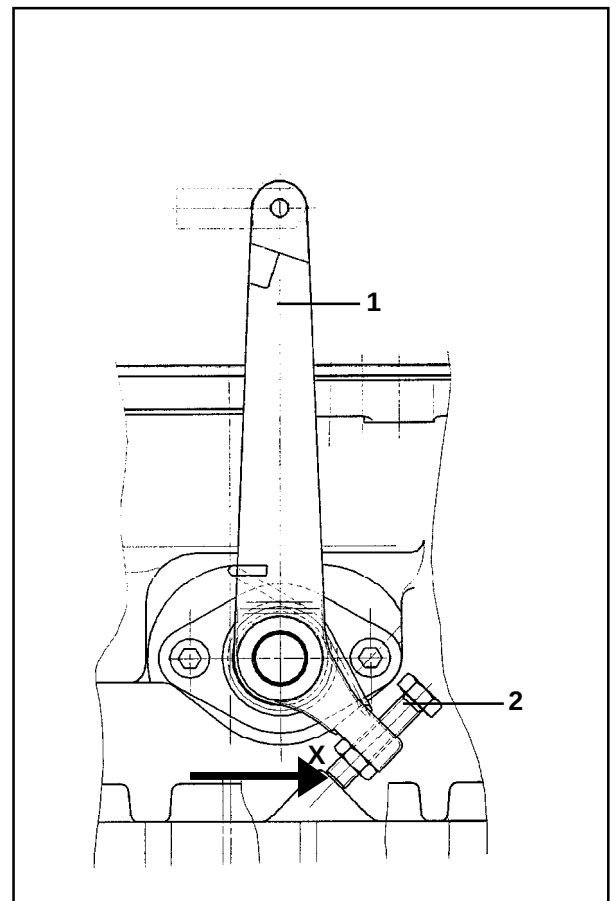
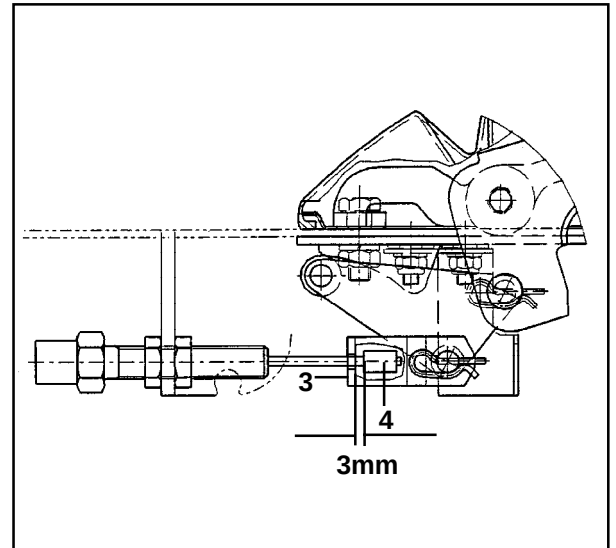
The microswitch must be so adjusted that power to the traction circuit is cut out the instant the parking brake lever is pulled until the 1st tooth of ratchet is engaged.

Full braking action must be achieved when the 7th tooth of ratchet is engaged.

During adjustment, care should be taken to ensure that with engine cover in the raised position, a clearance of at least 3 mm is maintained between clevis (3) and forced-on stop (4) on the end of the cable. Reason: When closing the engine cover there must be no movement of parking brake control lever (1) located at the bottom on the drive axle. This could easily happen in the event that there is a lack of clearance in which case brake failure will result during operation of the truck due to heating of brakes caused by brake disc slip.

To ensure that the brake discs are free from any pressure when parking brake lever is in neutral, the brake lever (1) has been adjusted at the factory with a clearance of 0.0 mm (X). When the parking brake is operated, pressure will thus be applied to the brake by cam (A) via the actuator (see page 4). No unnecessary empty stroke is therefore produced.

The position of screw (2) has been adjusted at the factory and should therefore not be modified!



Removal

The service brake is of the multiple-disc type which is enclosed within the r.h. wheel reduction gearbox and runs in an oil bath.

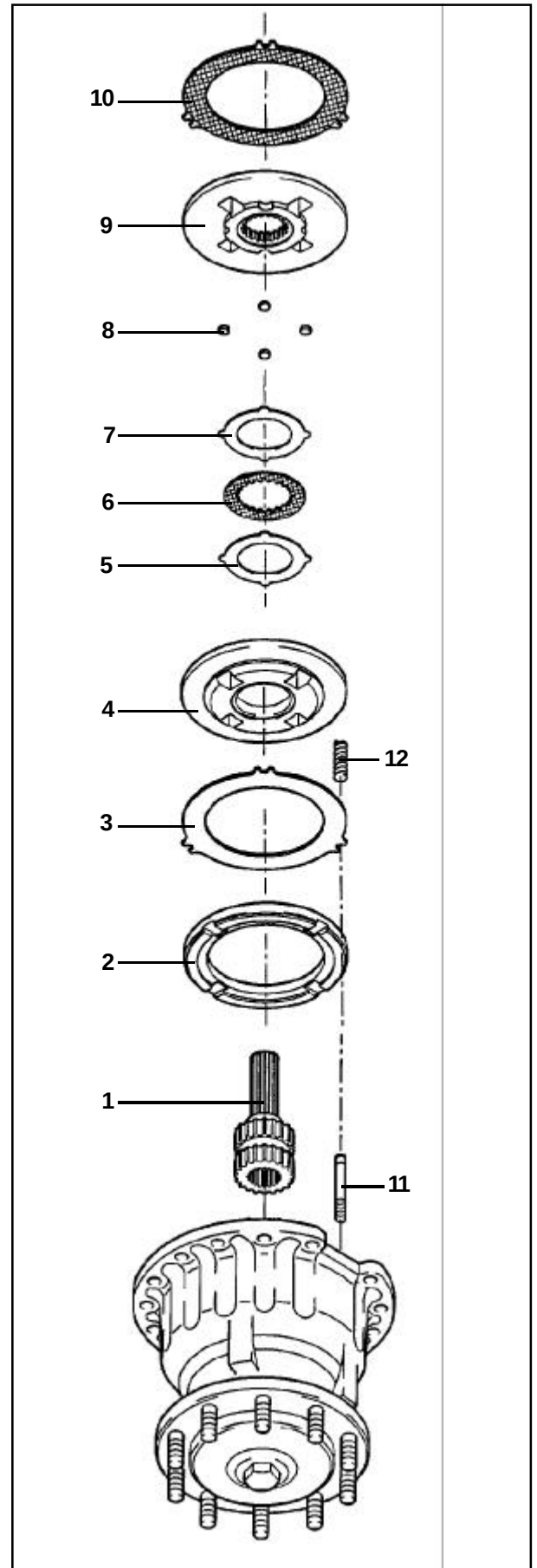
Before removing the wheel reduction gearbox, release the parking brake !

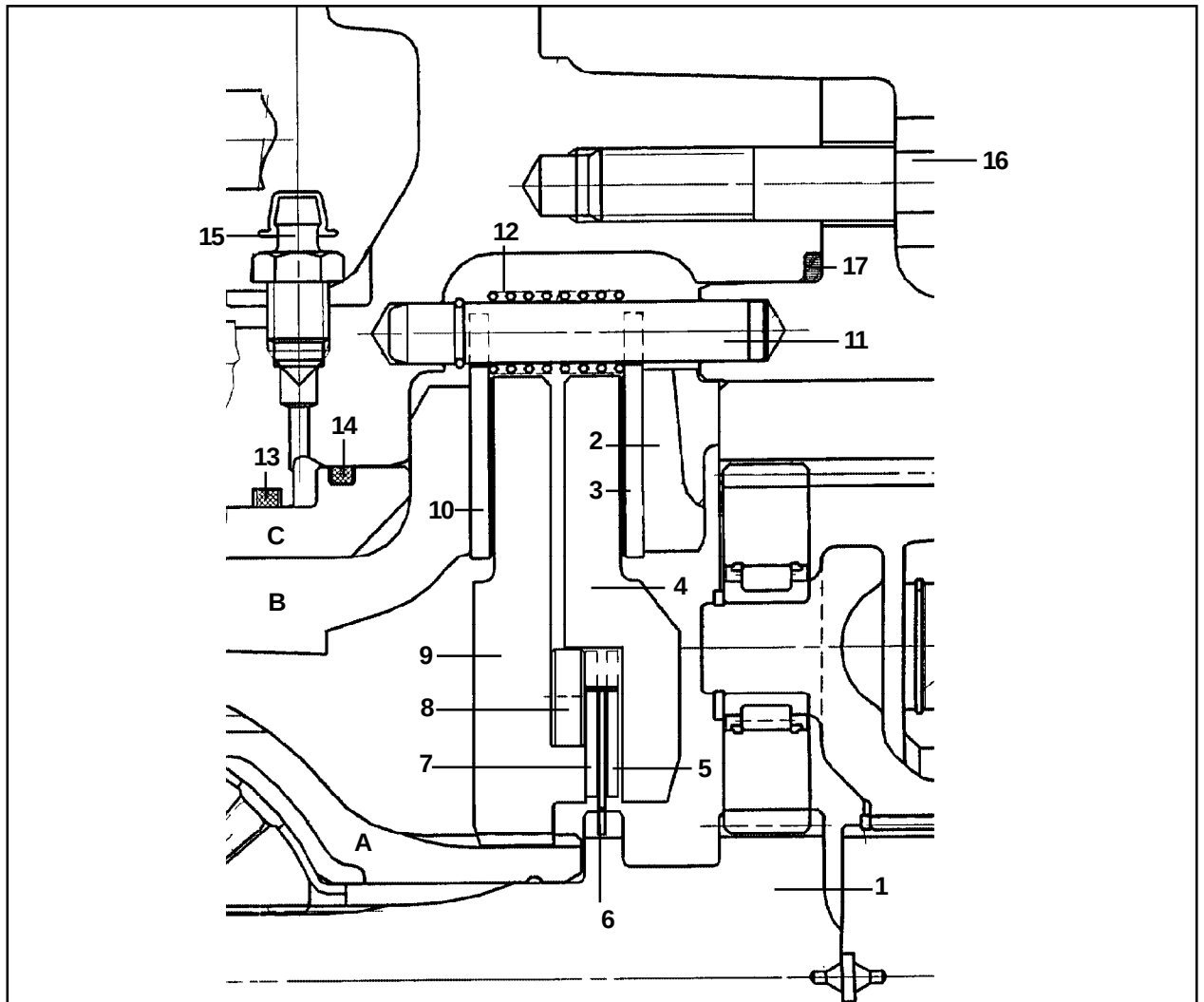
Do not operate the parking brake nor the service brake once the wheel reduction gearbox has been removed !

Mineral oil is used as a brake
same oil as that in the reduction

CAUTION:
fluid (the
gearbox).

- 1 - pinion shaft
- 2 - reaction disc
- 3 - brake disc
- 4 - reaction disc
- 5 - reaction disc
- 6 - brake disc
- 7 - reaction disc
- 8 - dog
- 9 - reaction disc
- 10 - brake disc
- 11 - stud
- 12 - pressure spring





A - differential casing

B - actuator

C - piston

1 - pinion shaft

2 - reaction disc

3 - brake disc

4 - reaction disc

5 - reaction disc

6 - brake disc

7 - reaction disc

8 - dog

9 - reaction disc

10 - brake disc

11 - stud

12 - pressure spring

13 - sealing ring

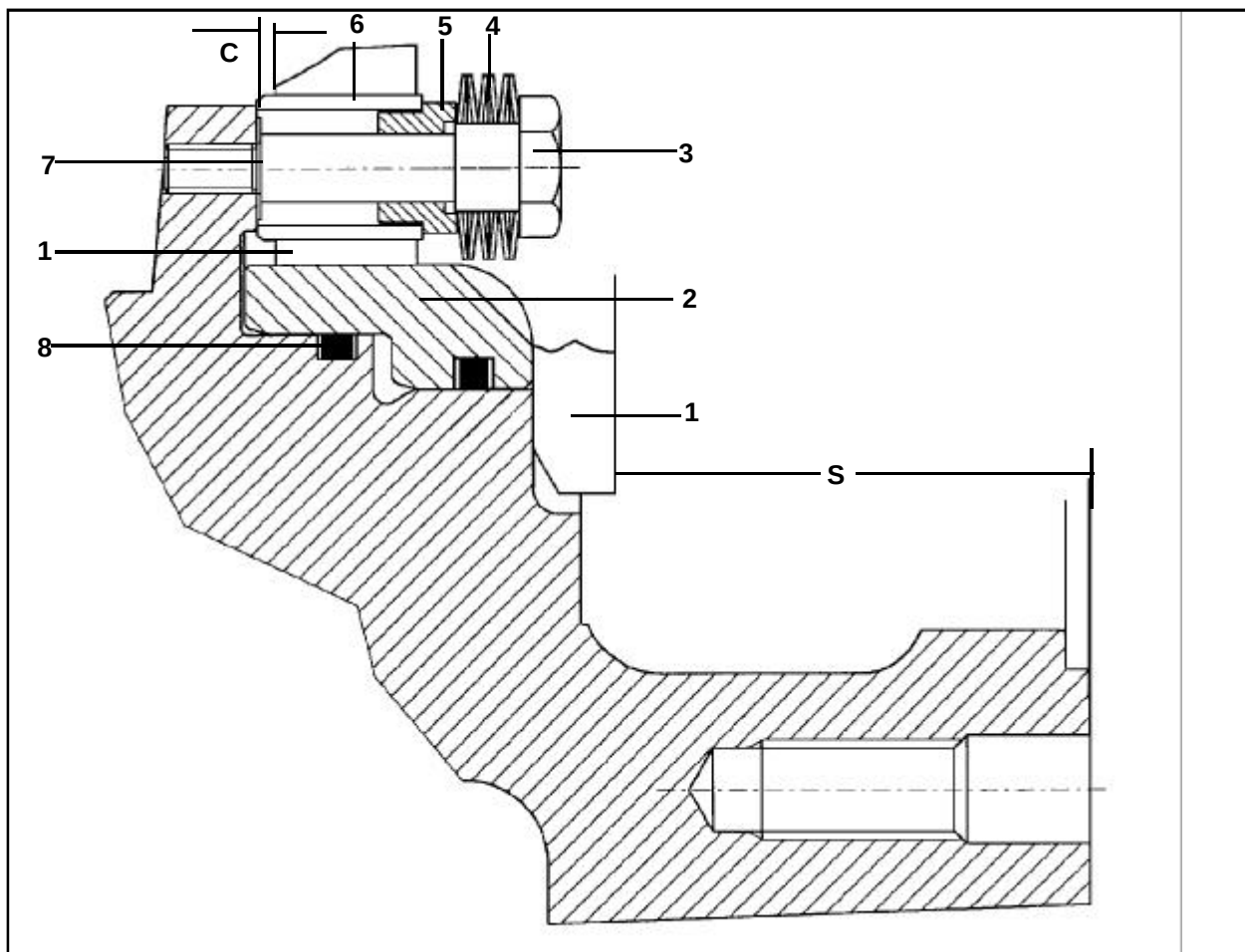
14 - sealing ring

15 - bleeder screw

16 - hex. hd. bolt M12x50
Torque loading: 110 Nm

17 - 'O' ring seal

Automatic readjusting



Operation

The self-adjusting feature ensures that during brake pedal operation, travel of the actuator will (1) always remain the same despite brake disc wear, i.e. the automatic adjusting function assures a constant travel of 1.2 mm.

The cup springs (4) force the the actuator (1) into the initial position when the brake pedal is released.

As brake disc wear increases, the actuator (1) will move via roll pins item 6 in an axial direction. This movement ensures that the length of travel (1.2 mm) of the actuator remains unchanged, i.e. dimension „C“ increases parallel with brake disc wear.

- 1 - actuator
- 2 - piston
- 3 - bolt M6
- 4 - cup spring
- 5 - spacer
- 6 - roll pin 16x20
- 7 - washer
- 8 - 'O' ring seal

Replacing the brake discs

Before replacing the brake discs, the actuator (1) must be reset to dimension „S“:

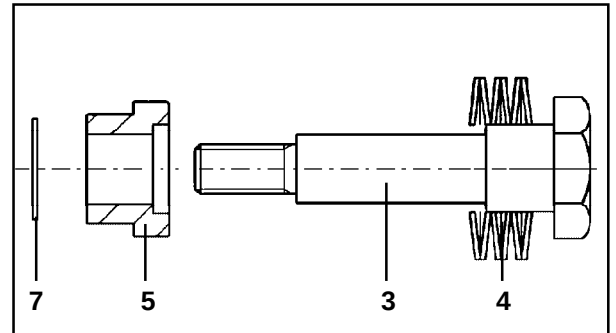
6022 - 6025 S = 47.5 - 0.3

6026 - 6028 S = 57.5 - 0.3

Resetting the actuator should be carried out with extreme care, using f.i. a rubber mallet. When resetting actuator item 1, piston (2) is moved against the frictional forces of the 'O' rings (8).

In addition, the three roll pins (6) within the actuator (1) slide to a degree corresponding to the amount of piston travel. Dimension „C“ will return to „0“ mm.

To prevent both piston (2) and actuator (1) from skewing, dimension „S“ must during the resetting operation be measured at several points on the circumference using a depth gauge.



Replacing the 'O' rings (8)

Replacement of the 'O' rings requires the removal of actuator (1) and of the automatic adjuster. When installing the actuator (1) and automatic adjuster make certain the cup springs (4) are fitted in their original position: In opposite direction and centred on screw (3).

Apply Loctite 243 to screw (3) and tighten to a torque of 10 Nm.

Dimension „S“ must be adjusted as detailed under 'Replacing the brake discs'.

Electrical installation

Table of contents	Page
Technical Data for Maintenance Service	2
Electrical installation	3
Controller block diagram	5
Insulation test	6
Console, general – R60S20	7
Console, operation	8
Console, password level	10
Console, plane text parameter	12
Transmitter / sensors / switches	
Keyswitch	15
Battery connector	16
Accelerator pedal	17
Accelerator pedal transmitter	17
Accelerator pedal, two-pedal control	18
Signal horn	19
Brake pedal transmitter	20
Parking brake switch	21
Seat switch	22
Pressure pick-up, hydraulics	23
Oil pressure switch / Pressure regulator unit / Oil filter switch	24
Drive and pump motor temperature sensors	BG11
Drive motor speed sensors	25
Pump motor speed sensor	26
Battery	27
STILL contactor	28
Main fuse	28
Fuse carrier – R60S20	30
Control fuses	30
Relay	30
Electronic control unit – R60S20	31
Replacing the electronic control unit	32
Replacing the control card	33
Field regulator	34
Console – R60S20	35
Replacing the console	35
Cold store version	35
FleetManager	36
Electronic control unit – R60S60	38
Proportional system - Joystick	47

Technical Data for Maintenance Service

Controller Drive motor speed control Pump motor speed control	Digital control R60 via a transistorized power circuit for four quadrants via a transistorized power circuit for one quadrant
Accelerator pedal Brake pedal transmitter for el. braking Transmitters, hydraulic	Potentiometer 4 kOhm Potentiometer 4 kOhm Electric pressure pick-ups
Rated voltage	80 Volt
Current limitation per traction motor Drive motor armature/field Hydraulic motor	440 A / 40 A reduction after 40 seconds 320 A
Speed Speed reduction	Adjustable via drive program, max. 16 km/h Adjustable via drive program
STILL contactor 1K1 — Coil — Contact tips / contact tip material	2 pins, with arc blow-out magnets 24 Volt (wired in series with a resistor and a diode) Replaceable, silver alloy
Relays K1, K2	24 Volt (coil 255 Ohm)
Fuses — Power circuit fuses — Control circuit fuses	1F2 (300 A) F1, F2, F3, F5, F7, F8 (5 A) F9 (10 A) F6 (15 A) F4 (20 A)
Traction battery G1	80 Volt / 480Ah (6022 / 23) 80 Volt / 600Ah (6024 / 26) 80 Volt / 720Ah (6027 / 29)
Insulation resistance — Electrical installation — Electrical machines — G1 traction battery	1000 Ohm / Volt — approx. 80 kOhm 1000 Ohm / Volt — approx. 80 kOhm 1000 Ohm
Electrical protection — Electrical installation — Electrical machines — Controller	IP 23 FM IP 22, HM IP 20 IP 23

Electrical installation

Mechanical configuration

The electrical installation consists of:

- Controller A9
- Fuse carrier A7
- Main or line contactor 1K1
- contactor, emergency cut out 7K1
- Power circuit fuse 1F2
- Console
- Transmitters, switches & sensors
- Drive motor FM1
- Hydraulic motor HM

Controller A9

- Control and regulating electronics
- Power electronics for FM1 and HM

Fuse carrier

- Control fuses, various
- Relays K1, K2

Dash panel

- Keyswitch S1
- Accelerator pedal transmitter switch 1S16
- Hazard flasher switch
- direction indicator switch (where fitted)
- Display, various keypads

In front part of truck/foot area:

- Horn push (floor plate) 4S1
- Accelerator pedal transmitter 1B1
- Brake pedal transmitter 1B2
- Pressure pick-up, hydraulic 2B1-B5
- Relay board, front (optional)

Under floor plate

- Signal horn (centre) 4H1

Drive motors / hydraulic motor

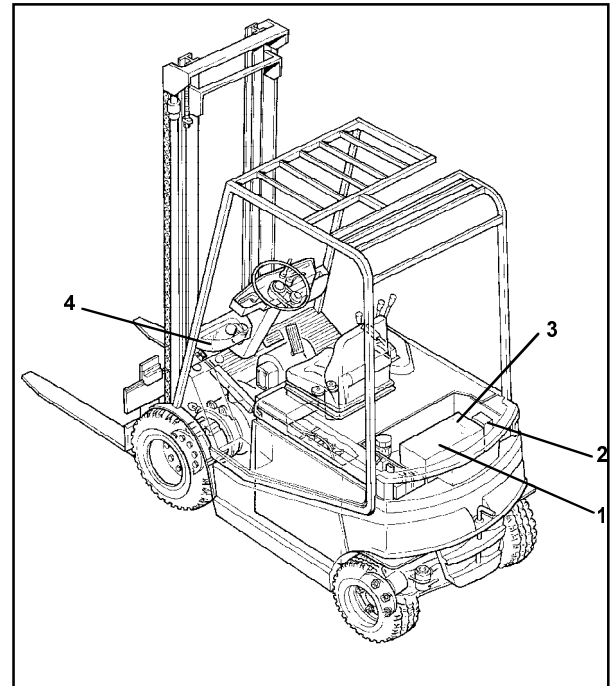
- Motor brush monitor
- Temperature sensors
- RPM sensor
- Fan

Battery compartment cover

- Parking brake switch 1S4
- Seat contact switch 7S1

In the counterweight

- Controller A9
- Main contactor 1K1
- contactor, emergency cut out 7K1
- Power circuit fuse (300A) 1F1
- Fuse carrier A7
- Power supply (optional) U1
- Relay board, rear (optional)



Electrical installation

General

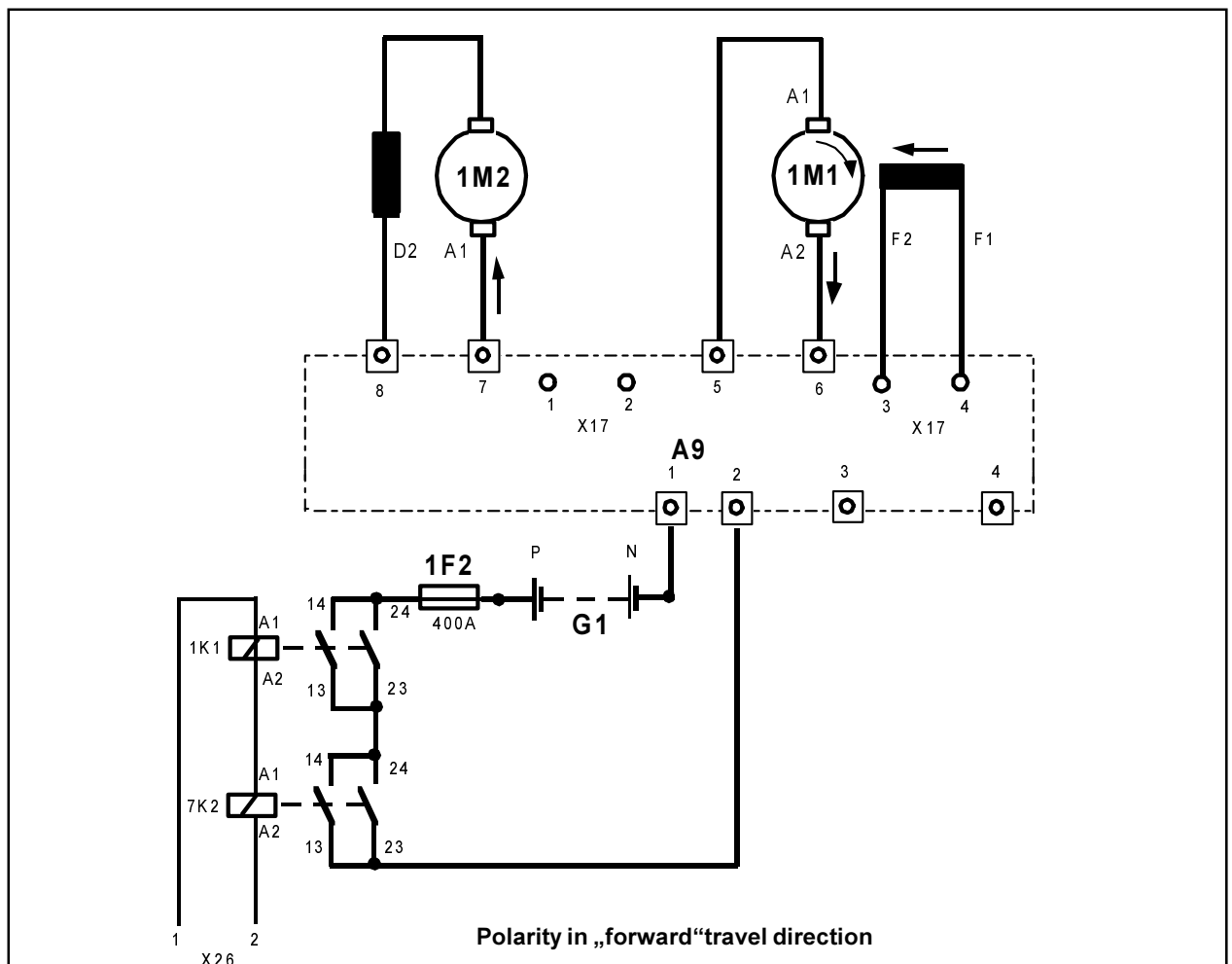
The vehicle has a variable-speed front-wheel drive with separately excited shunt-wound motor.

The circuit-breakers in the controller A9 are protected by overcurrent limitation.

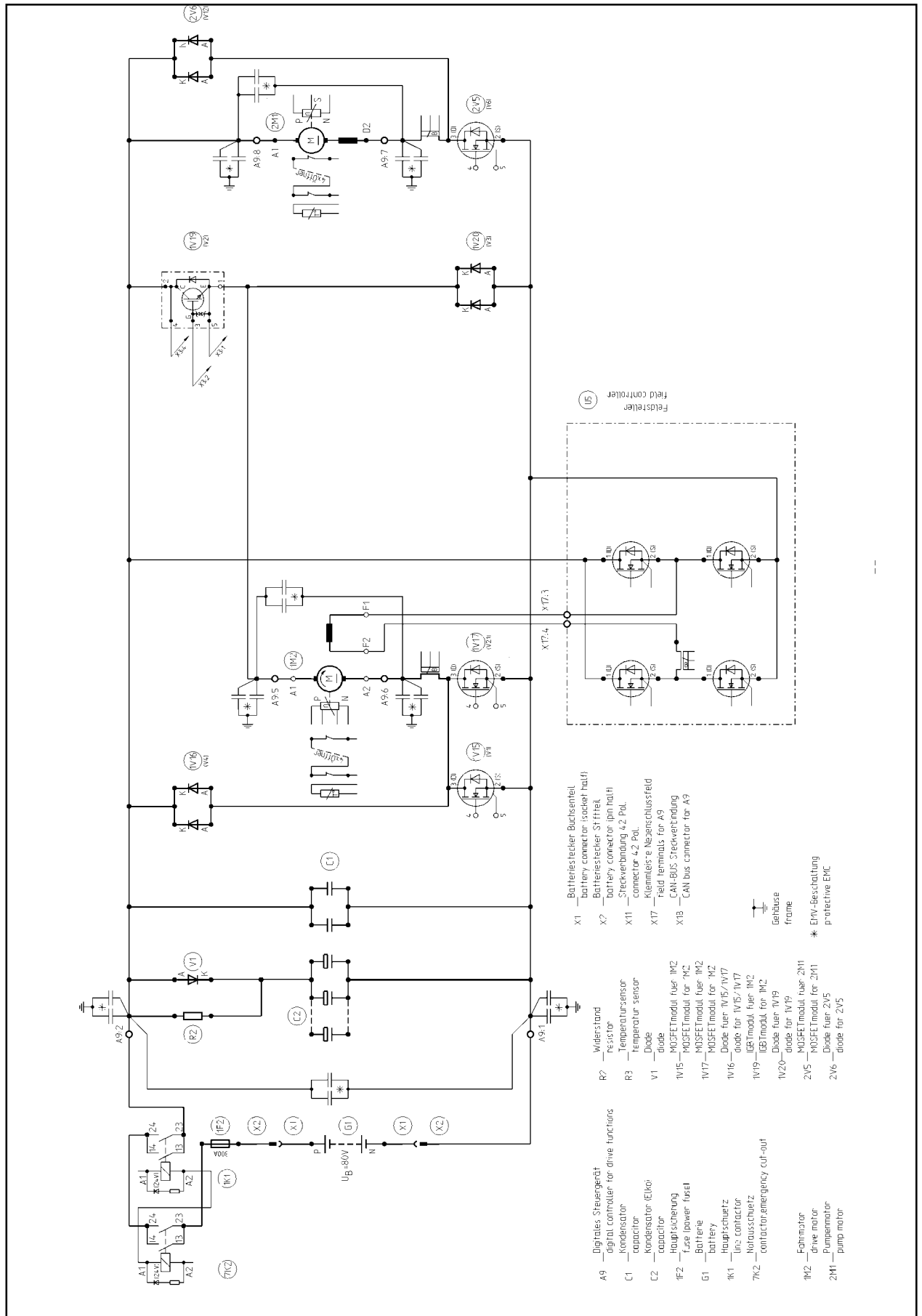
The control electronics are supplied from an internal 10V voltage transformer in the controller A9.

Additional electrical consumers are supplied directly with 80V or via the voltage transformer U1 with 24V.

The cables between the controller and exciter windings of the electric motors are two-pole and installed isolated.



Controller block diagram



Insulation test

Procedure

Disconnect the battery.

Disconnect all insulation displacement type connectors at base plate of controller A9.

Disconnect leads at voltage converter U1.

Disconnect leads at relay boxes.

Disconnect drive motor, hydraulic pump motor and battery leads at controller A9.

Measuring insulation resistance (earthing)

The resistance of the insulation material used on electrical components must amount to at least 80,000 ohms or 80 kOhms.

Testing the insulation resistance against chassis:

Leads to electrical machines

Motive power battery G1

Electrical machines (see F.G. 11)

Measuring instrument: e.g. Isolavi 8
 METRISO 500D
 Metra Hit 16i

The forward-reverse control switches, direction indicator switch, hazard flasher switch (if fitted), display and keypads are mounted on the console.

A CAN bus system interconnects the console and the controller.

Direction of travel

Direction of travel is controlled by one or two *touch sensitive levers* (depending on equipment level) positioned on the console, on the left and right sides of the steering wheel. The forward-reverse lever automatically returns to neutral upon being released. It can be converted to a 3-position *engaging type lever*, in which case only the LH forward-reverse control lever is needed, whereas the RH lever is replaced by a cover.

Indication of direction of travel

The selected direction of travel (forward or reverse) is indicated by *forward-reverse lights* located in the middle of the dash panel.

Direction (turn) indicator switch

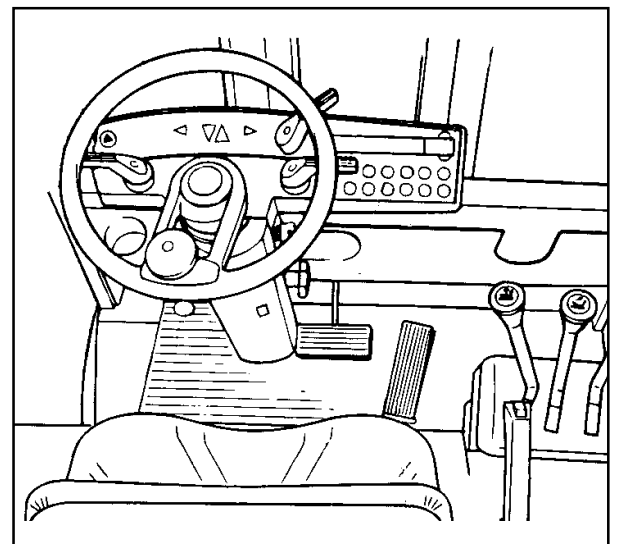
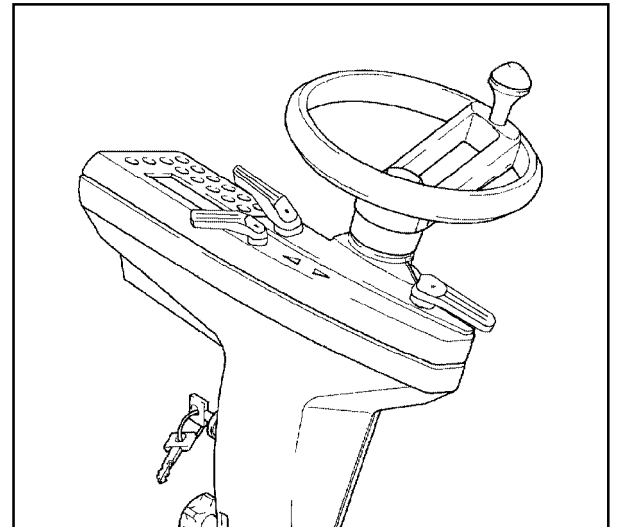
A direction indicator switch is only fitted in conjunction with flashing indicators. It is located on the dash panel, above the RH forward-reverse lever. The direction indicator switch normally functions as an *engaging type switch*, can however be converted to a *touch sensitive switch*. The direction indicator lights are arranged on the dash panel, on the left and right sides of the forward-reverse lights.

Converting touch sensitive levers to engaging type levers

Procedure:

- Detach the small plastic cover plate glued on the forward-reverse control lever.
- Loosen the screw at this stage exposed.
- Remove the RH forward-reverse lever and install a cover in its place.
- Slightly lift the LH forward-reverse control lever, allowing it to be released from its catch but still remain engaged with the hex. pin, which must be turned approx. 60° clockwise.
- Completely lift off the lever and replace it after having turned it 60° anti-clockwise.
- Secure the lever with the screw. Glue the small plastic plate into place again.

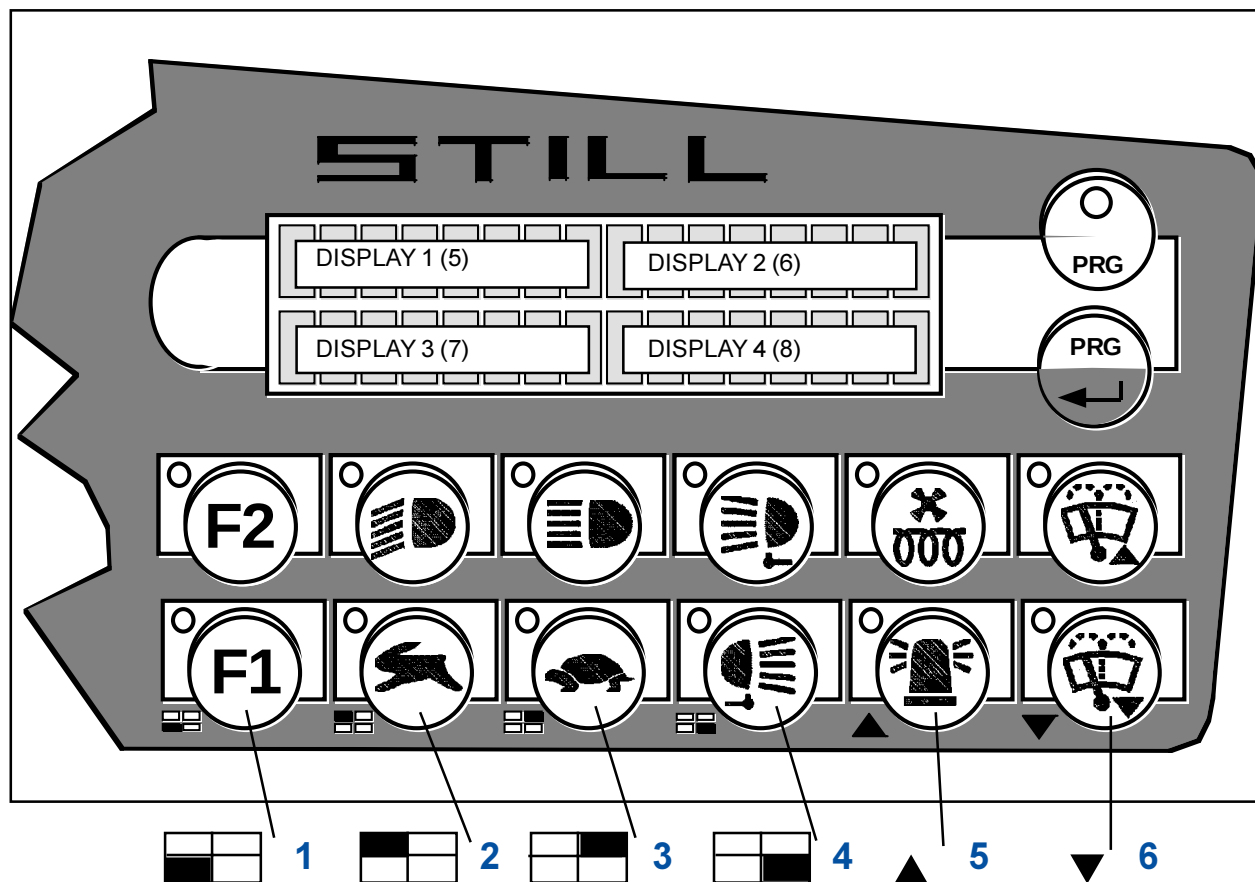
When converting the **direction indicator switch** or reconverting the forward-reverse switch to the touch sensitive function, the levers must be turned anti-clockwise.



Hazard flasher

The hazard warning system is activated with the "hazard flasher" keypad in the console at the left.

The hazard flasher switch is the only electrical component of the dash panel that is not connected to the controller via the CAN bus system.



Operating the keypads

Panel keypads

for selecting the displays directly

-  keypad calls display 3 or 7
-  keypad calls display 1 or 5
-  keypad calls display 2 or 6
-  keypad calls display 4 or 8

Function keypads identified by an arrow

for selecting menu items and for changing parameters (numeral/text)

-  scrolling/counting up
-  scrolling/counting down

The value that can be edited (modified) by the keypads identified by an arrow starts flashing.

- Adoption of the new value by pressing **PRG** 
- Abandoning the modification by pressing **O PRG**

O PRG Abandon / NO / Escape keypad

PRG  Acknowledge/ YES/ Enter keypad

Starting and terminating the programming mode:

Pressing **O PRG** and **PRG**  simultaneously.

Console

Display

The indications are via an LCD display in the dash panel.

Standard display of display level 1:

- Drive program (top left)
- Time (top right)
- Battery charge indicated by bar (bottom)

Standard display of display level 2:

(Changeover with keypad 13)

- Time remaining to next service
- Total service hours
- Hydraulic oil pressure for auxiliary hydraulics (standard display when option is installed)

The display remains on for approx. 50 sec after the truck is switched off.

Fault indication in case of malfunctions via messages on level 1:

- Service required
- Batt. discharged
- Overheating
- Service brake
- Motor brushes
- Parking brake
- Seat switch

Keypads

14 keypads are integrated into the RH section of the dash panel for operating electrical consumers, presetting driving characteristics, auxiliary functions as well as for parametrization via addresses a certain number of truck functions.

1 Without function

2 **Hare**

Fast acceleration (drive program 1...5)

3 **Tortoise**

Slow acceleration (drive program 5...1)

4 / 10 **Spotlight (working light), rear/front**

Switching spotlight on/off

5 **Flashing beacon**

Switching flashing beacon on/off

6 / 12 **Screen wipers rear/front**

Pressing keypad momentarily: Intermittent wiper action, permanent wiping action, switching off. Pressing keypad and holding: Electric washer action then reverting to the last operating status

7 Without function

8 **Parking light**

Switching parking light on/off

9 **Headlights**

Switching headlights on/off

11 **Heater / demister**

Switching heater/demister on/off

13 **Return**

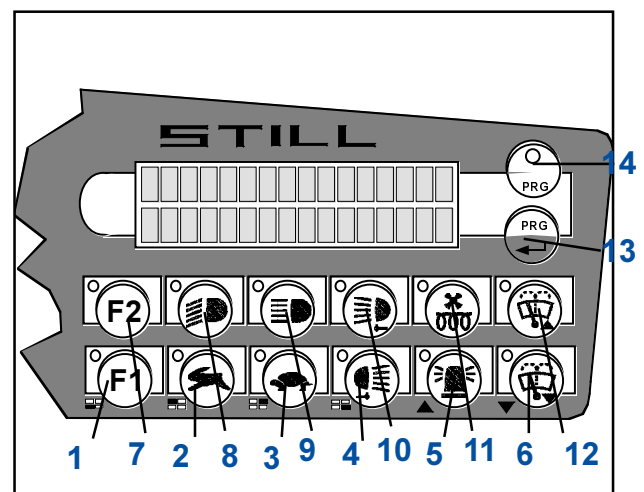
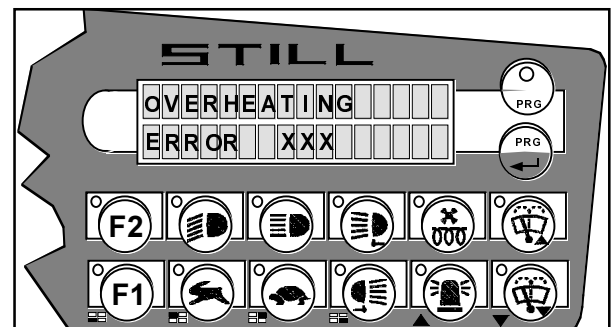
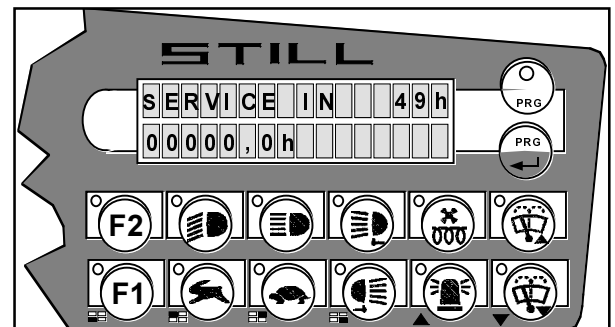
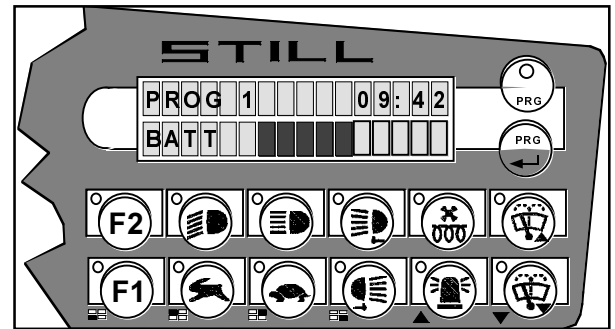
Switchover between display levels 1 and 2

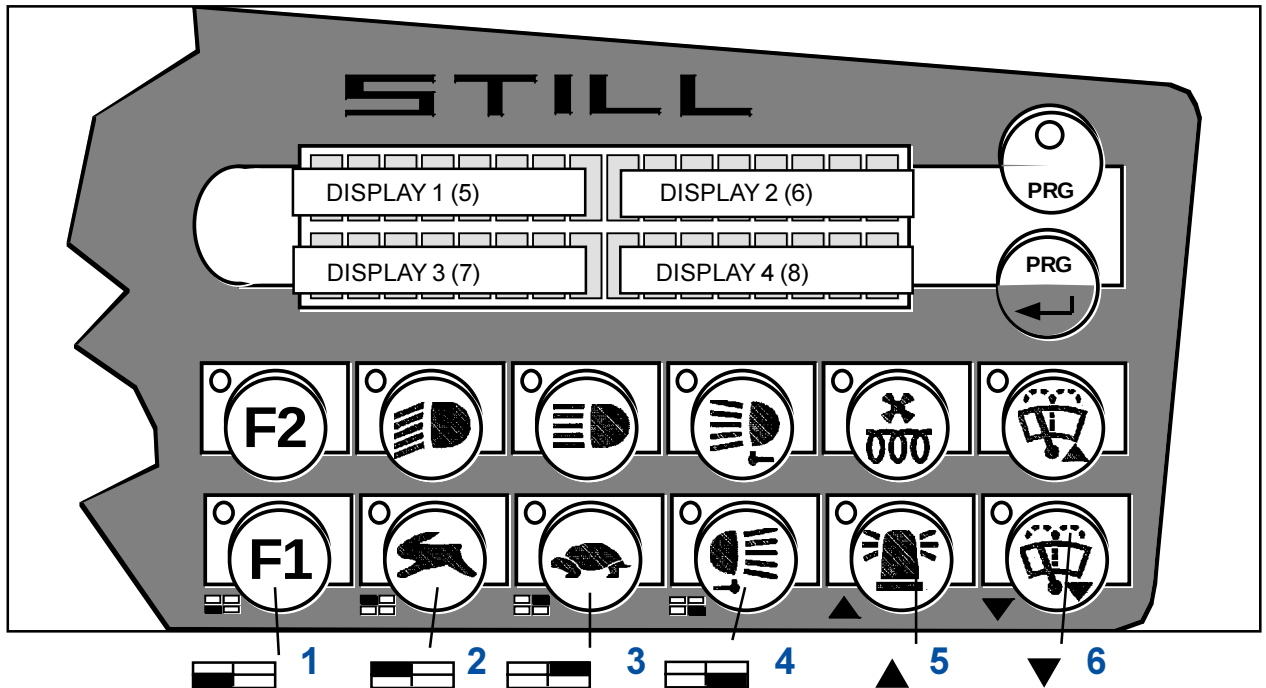
13 **Return**

Parameterization

14 **Zero**

Parameterization





Parameterization via the console

Displays 1 to 4: are selected by pressing keypads 1 to 4 and **PRG** ↵

Keypads 5 and 6: are used for scrolling and changing the entries.

PRG ↵ : serves for confirming the entry.

Pressing **PRG** ↵ and **O PRG** at the same time:
Activating and terminating the programming mode.

Note

Changes are stored in the truck controller when the console is switched off with the keypad switch and has switched off completely (after approx. 50 sec) or the battery plug was disconnected.

After the truck is switched on, display level 1 with the selected drive program, time and battery indication is shown:

PROG 3 14:37
BATT: ■■■■

Display level 2 is called with **PRG** ↵ .
It indicates the remaining hours until the next service and die service hours:

SERVICE IN 999h
00999,9h

You can return to display level 1 by pressing **PRG** ↵ .

Programming level 0 (without password)

Calling the programming level:

Press keypads **PRG** ↵ and **O PRG** simultaneously:

LANG. ENGLISH

by scrolling with **keypad 5**, the following flashing displays will appear in succession:

TIME 14:37
DATE 23:01:98
DAY-KM 15.4km/D
DAY-HR 3.6h/D
PASSWORD LEVEL 1
COD 0000

Scrolling down is by means of **keypad 6**.

Adjusting / Programming

Adjusting the time, line

TIME 14:37

The upper right-hand panel is selected by **keypad 3**.
The minutes will start flashing; the minutes are adjusted with **keypads 5 and 6** and confirmed by pressing keypad **PRG** ↵

The hours are flashing; adjust with **keypads 5 and 6** and confirm by pressing keypad **PRG** ↵

Line **TIME 14:37** flashes, adjustment is terminated.

Setting of **DATE** and **LANGUAGE** and resetting of **DAY-KM** and **DAY-HR** is done similarly.

Console – Password Level

Password level 1 (Fleet manager)

Password level 1 can be called from programming level 0.

PASSWORD LEVEL 1
CODE 0000

The upper line flashes. Press key 4, the last digit below on the right-hand side will start flashing. Set the desired digit with keys 5 and 6 confirm by pressing key PRG ←; the last-but-one digit will start flashing etc.

If the wrong CODE is entered, CODE 0000 will appear again after confirmation of the last digit.

If the correct CODE is entered, the display

BATTERY
TYPE LEAD
will appear.

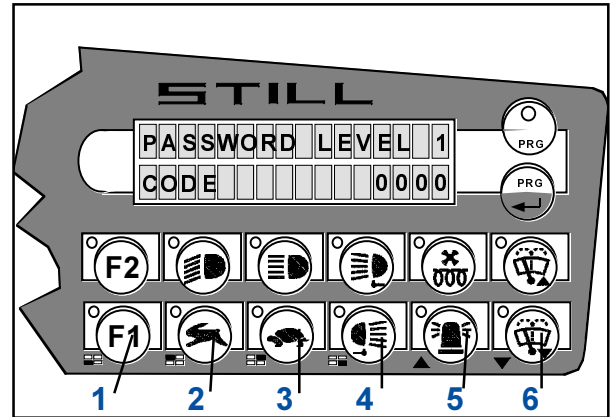
The upper line will flash. By scrolling up with key 5, the following displays will appear in succession (key 6 for scrolling down):

DISPLAY	1
PROG 5	
MAXPROGRAMS	5
PROG	1
VMAX,FW	16.0km/h
DRIVE	
MODE	1
HYDRAULICS	
LIFTING	100%
VERSION	1
	V1.17
RESET	NO
PASSWORD LEVEL	1
NEW CODE	XXXX

The top line flashes in each case.

The fields can be selected and changed from these displays.

In the bottom line of display fields further displays can be scrolled up.

**Password level 2 (Service)**

Password level 2 can be called from programming level 1.

PASSWORD LEVEL 2
CODE 0000

If the correct CODE is entered, the display

SERVICE IN 999h
F-ID 6022001234
will appear.

The upper line will flash. By scrolling up with key 5, the following displays will appear in succession (key 6 for scrolling down). These display appear in addition to the displays of password levels 0 and 1:

ERROR LIST	
RESET	NO
COUNTER MODE	1
SERVICE ADDR	000
VALUE	00
PASSWORD LEVEL	2
NEW CODE	XXXX

The upper line will flash in each case.

The fields can be selected and changed from these displays.

Via the SERVICEADDR. 000 display field, parameter values which influence the driving performance can be edited via the console.

Parameterisation via the console should only take place in emergencies. Parameterisation via Notebook is generally preferred for security reasons.

Batterie

BATTERY

TYPE

LEAD

The battery type can be changed. Possible selections are:

LEAD – CSM – GEL – SPE GEL – SPEC.1 – SPEC.2

Display

DISPLAY

1

PROG 1

The indication on the display occurs on two levels. Panels 1 to 4 are displayed on level 1 and panels 5 to 8 on level 2. Different information can be assigned to these panels. The display panel is selected by scrolling, the following indication will appear:

PROG 1 drive program
 BATT: ■■■■ battery charge bar
 BATT: 80 % battery charge in %
 00023.4 h hours totalized by the counter
 09:42 time
 10.03.00 date
 0.0 km/h speed
 8398 km kilometres totalized by the odometer
 0.0 km/D trip mileage odometer
 12.3 h/D daily hours counter
 SERVICE IN 999h - hours left before next service becomes due
 0 bar pressure regulator unit
 EMPTY no display

Number of drive programs

MAX PROGRAMS 5

The driver can choose between five different drive programs to suit the requirement.

If 3 has been selected, the driver can use only drive programs 1, 2 and 3.

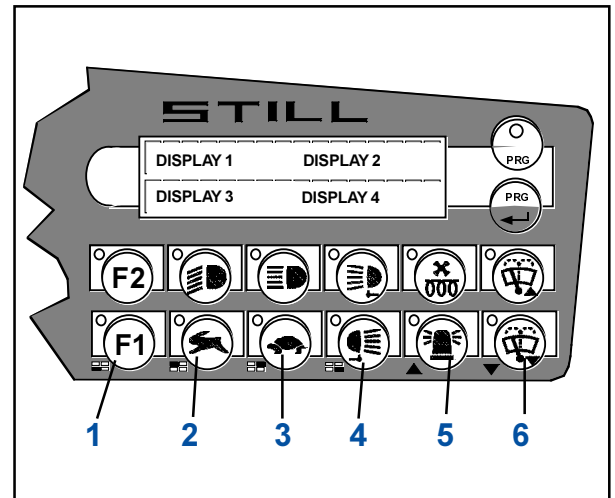
Adjustment of drive programs

PROG 1

VMAX,FW 16.0 km/h

There are 5 drive programs that are individually adjustable. The drive program is selected by scrolling, the following indication appears in the lower line:

VMAX,FW 16.0 km/h
 VMAX,RV 16.0 km/h
 ACCEL,FWD 80 %
 ACCEL,REV 80 %
 DECEL,FWD 80 %
 DECEL,REV 80 %
 MODE 0
 REVERSE, F 80 %
 REVERSE, B 80 %
 BRAKE DELAY 80 %

Console – plain text parameters

The values for speed, acceleration, delay and reversing for forward and reverse, as well as braking delay (electric braking assistance) can be set. The mode (driving mode) can also be set.

Driving mode

MODE 0

Distinction is made between a *speed-controlled* and *torque-controlled* driving mode:

speed-controlled 0
 torque-controlled 1

Standard setting of drive programs

Drive program	1	2	3	4	5
Travel speed km/h	16	16	16	16	16
Acceleration position	80	90	100	110	120
Deceleration position	80	90	100	110	120
Reverse forward / backward	80	90	100	110	120
Brake delay position	60	70	80	90	100

Switching to driving mode

DRIVE
MODE 1

By changing the mode, driving can be changed from single to two pedal operation and the driving direction changed via the joystick.

Selection:

- Mode 0 Two pedal
- Mode 1 Single pedal with CAN
- Mode 2 Single pedal without CAN
- Mode 3 Driving direction per console (CAN) and joystick (from console SW 0.17)
- Mode 4 Driving direction per joystick

Change of travel sender characteristics

By scrolling up with keypad, the following indication will appear in the lower line:

DRIVE
ACCEL. X 30 %
DRIVE
ACCEL. Y 10 %

This function has not yet been released.

HYDRAULICS settings

The motor rpm can be preset for each hydraulic function.

HYDRAULICS
LIFTING 100 %

By scrolling up with keypad, the following will appear in the lower line:

LIFTING 100 %
TILTING 500 / min
EXT1 2550 / min
EXT2 500 / min

LIFTING

Presetting motor speed for maximum hoisting speed in % (100% = 2550 rpm).

TILTING

Presetting motor speed for maximum tilt speed in rpm (setting range = 300/min....2550/min).

EXT 1

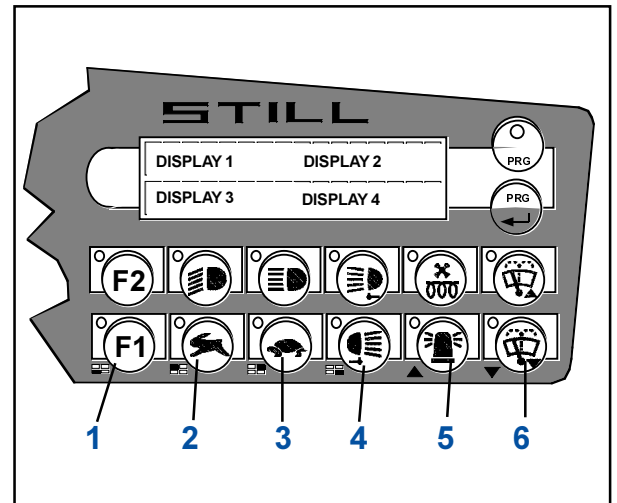
Presetting motor speed for maximum operating rpm of auxiliary hydraulic function 1 (setting range = 300 rpm....2550 rpm).

EXT 2 (4th hydraulic function)

Presetting motor speed for maximum operating rpm of auxiliary hydraulic function 2 (setting range = 300 rpm....2550 rpm).

Note:

If the keypads 5 or 6 are kept pressed, scrolling will be in steps of 5, 10 and 50 to accelerate scrolling.

Console – Plain text parameters**VERSION – Software Version**

All the versions of the control unit software are indicated by scrolling the top line:

VERSION 1
(Operating-software) V0.30
VERSION 2
(Basic-software) V0.06
VERSION 3
(L-controller EEPROM) V0.04
VERSION 4
(Hardware control card) V2.11

Vehicle reset

RESET NO

can change between YES and NO. A YES initiates a vehicle reset, where the main contactor 1K1 opens briefly and closes again.

Note:

Parameter changes are only effective after a vehicle reset!

New password for password level 1 and 2

PASSWORD LEVEL 1
NEW CODE XXXX

The upper line flashes.

Press keypad 4, the lower right digit in display 4 starts flashing. Select the desired digit with keypads 5 and 6 and confirm with keypad PRG ←

The last-but-one digit starts flashing.

Repeat the procedure until the desired setting has been achieved for all 4 digits.

Attention: The previous codes have been changed!

Console – plain text parameters

Service interval

SERVICE IN 999h
F-ID 6022001234

In the upper line, the service interval can be set. Hourly intervals from 000 to 990 can be defined. After lapse of a service interval, the message SERVICE REQUIRED appears in the display.

Truck serial number

SERVICE IN 999h
F-ID 6022001234

Shown in the lower line is the vehicle serial number. The serial number can only be changed via the Notebook.

The following appear in succession when paging with the 5 key:

S-ID 0160041
ID-No. of controller

VERSION 1.17
Software version of console

Error list

ERROR LIST
RESET NO

Setting the bottom reset line to YES will clear the fault list.

Hour meter

COUNTER MODE 2

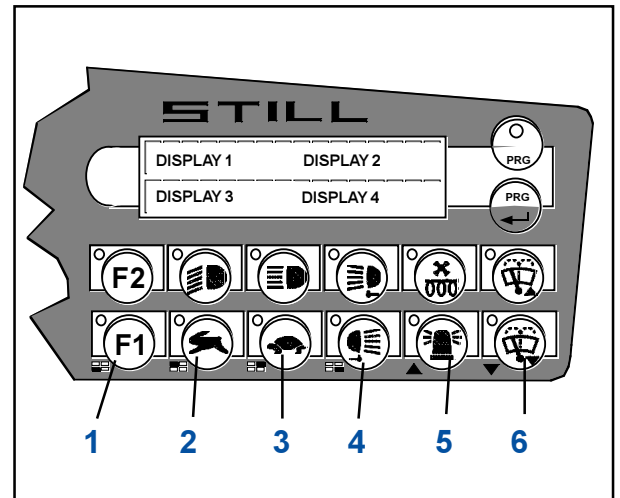
The mode of the hour meter can be selected with this function.

- 1 Meter runs when keyswitch S1 is turned on;
SERV.-ADDR 0C4, VALUE 01
- 2 Meter runs when traction motor or hydraulic motor runs;
SERV.-ADDR 0C4, VALUE 02
- 4 Meter runs when driver seats
SERV.-ADDR 0C4, VALUE 04

Reading parameters over service address

SERVICE ADDR. 000
VALUE 00

With the service address it is possible to change the truck and lighting parameters. A detailed description is included in Functional Group 09.



Keyswitch

Keyswitch S1

Keyswitch S1 is located on the right-hand side of the steering column. It is operated with a removable key.

The keyswitch secures the truck against unauthorized use.

Keyswitch S1 turns on the controller and the supply voltage for the console, signal horn and lighting as well as the fan motors for the drive and pump motors.

Keyswitch S1 has 2 positions:

0 = ON **1 = OFF**

(turned clockwise 90°)

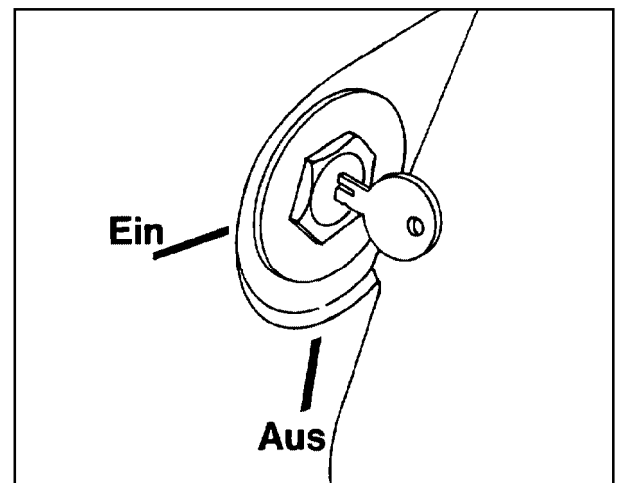
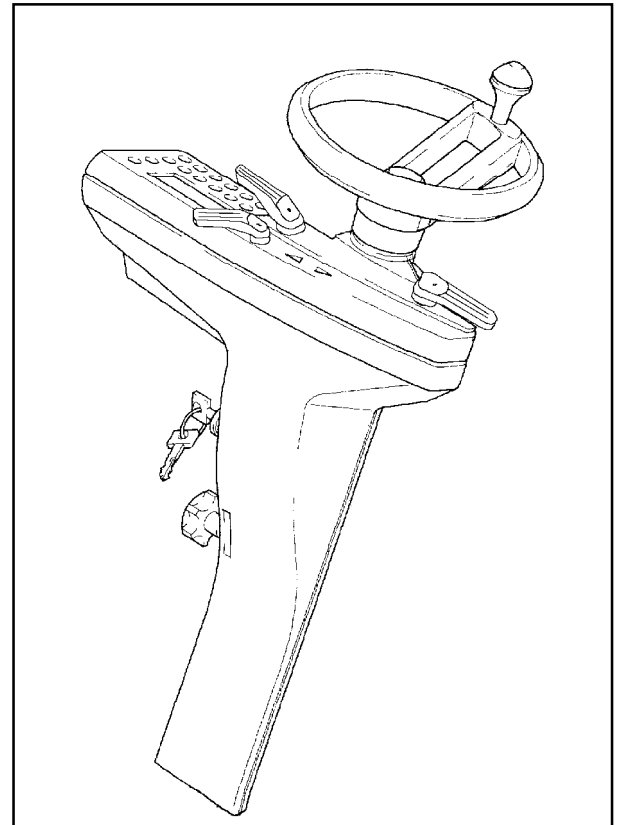
Electrical connections

From battery G1 to keyswitch S1:

G1 (+) – X40 – F9 – X53/1,2 – X47/1 – S1

From keyswitch S1:

S1 – X47/2 – X53/3,4 – controller A9 and fuses.



Battery connector

Battery connector X1/X2

The battery connector consists of two parts:

- battery connector X1 (socket half)
- battery connector X2 (pin half)

Type: Schaltbau 160 A

Battery connector X1 is provided with a handle and it is firmly connected to the battery. It also provides a breaking point for connecting the battery to a charger. The truck operator can at any time reach the connector with his left hand and disconnect it in an emergency.

Battery connector X1 serves as an emergency cut-out.

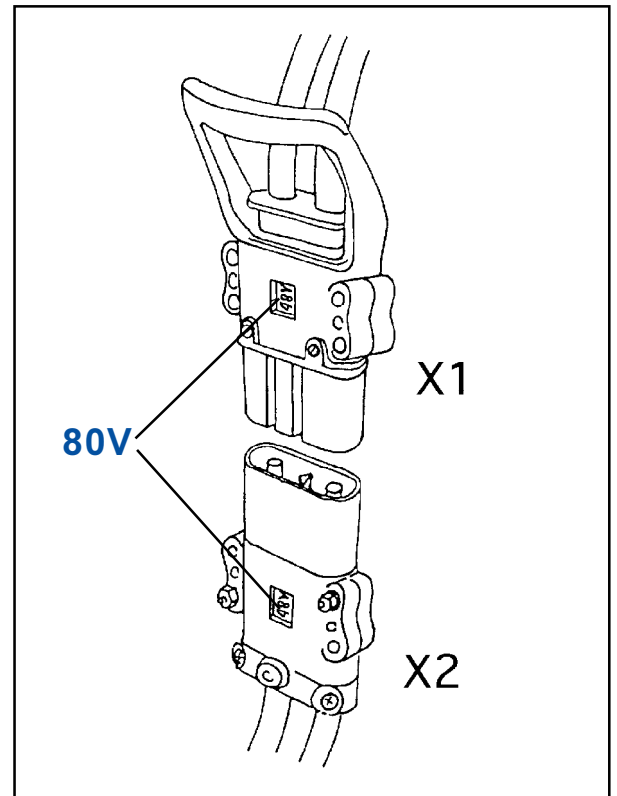
Battery connector half X2 is mounted at the right-hand side of the bulkhead.

Electrical connections

- Batt.(+) – 1F2 – 1K1 – terminal 2/A9
- Batt.(–) – terminal 1/A9

Coding system of battery connectors for wet and dry batteries with LB 160 AL

Both connector halves are each fitted with a keying plug between contacts to prevent accidental voltage mismatching. When mounting the connector, the keying plugs are adjusted to the relevant battery voltage (visible through a window in the connector housing). Connector halves can be mated only provided they are both set to the correct voltage.

**Coding of socket half - battery**

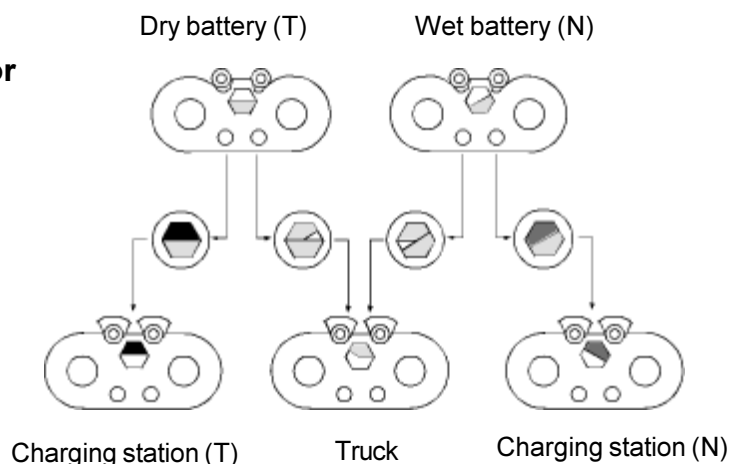
- gray marked with „T“ for dry battery
- gray marked with „N“ for wet battery

Coding of pin half - charging station

- gray, short for dry battery
- white for wet battery

Coding of pin half - truck

- yellow

Coding for 80V battery connector

Accelerator pedal – single pedal

Single pedal control

Linked to the accelerator, the accelerator pedal transmitter 1B1 is a transmitting device controlling travel speed.

Depression of the foot pedal closes safety switch 1S16 and controls potentiometer 1B1.

Two studs secure the accelerator pedal transmitter (transmitter) to the underside of the floor plate. Only the pedal passes through the floor plate. Made from fibre-glass-reinforced plastics, the pedal is articulated on a greased-for-life, sealed shaft mounted in a housing. It is maintained in the rest position by a return spring located on the lower end of the pedal.

Voltage checks:**Transmitter voltage – pedal un-operated**

yellow X16/4 (–) against red X16/3 (+)
= 4,7 Volt – 5,3 Volt

The voltage can be corrected to obtain correct setting by slackening screws (1) and adjusting potentiometer.

Transmitter voltage – pedal operated

yellow X16/4 (–) against red X16/3 (+)
= 8,5 Volt – 9,5 Volt

The voltage can be corrected to obtain correct setting by slackening screws (2) and adjusting position of support.

Voltage supply

yellow X16/4 (–) against green X16/8 (+)
= approx. 10 Volt

Safety switch un-operated

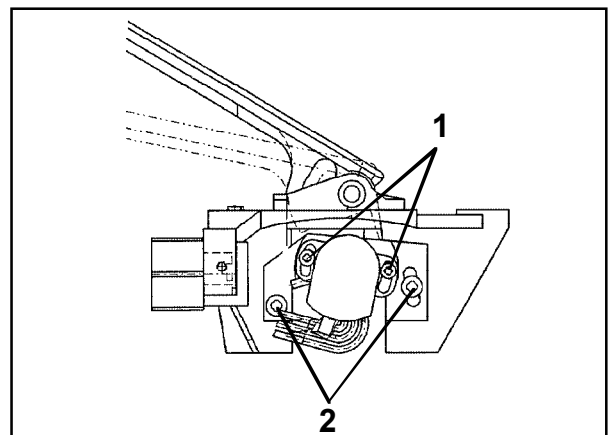
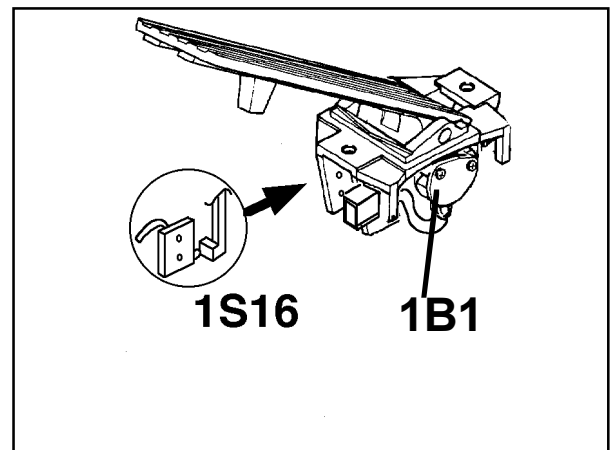
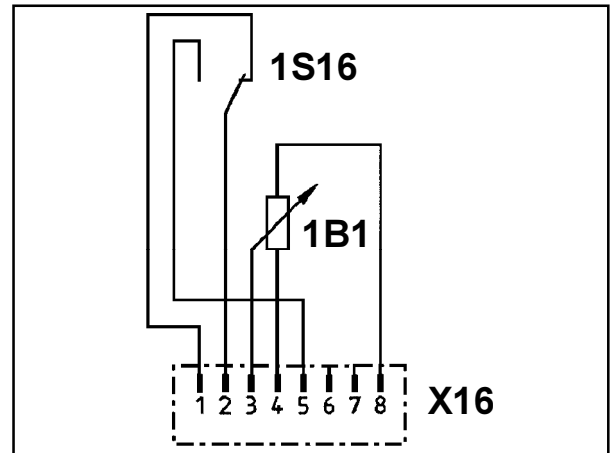
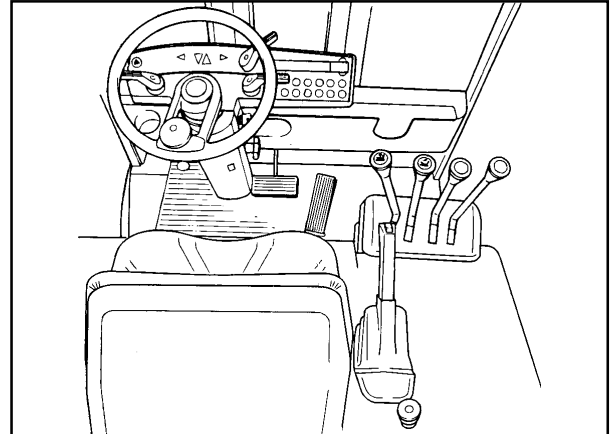
black X16/2 – blue X16/1 – continuity

Safety switch operated

black X16/2 – green X16/5 – continuity

Removal

- Lift floor plate from the LH side
- Pull out connector X16 from accelerator pedal transmitter
- Lift out floor plate
- Slacken locknuts
- Remove accelerator pedal transmitter from under the floor plate



Travel sender, two-pedal

Two-pedal control

The driving direction is determined by two direction-dependent pedals. The pedals are mechanically interconnected and move in opposite directions. Below the left pedal are two potentiometers (senders 1B3 and 1B4). These are moved by the action of the pedal and are located in the centre resting position. When a pedal is depressed, the sender is moved, while the other sender follows the movement due to its spring force.

Electrical connections

Sender 1B3:

+10Volt	–	X16/1
Set value	–	X16/2
GND	–	X16/5

Sender 1B4:

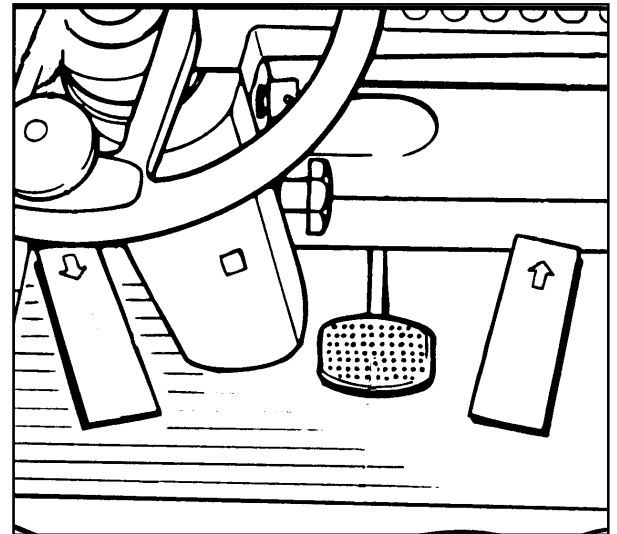
+10Volt	–	X16/8
Set value	–	X16/3
GND	–	X16/4

Basic adjustment

- Basic adjustment of threaded rod: 28mm
- Adjust **forward** pedal to a height of 81mm. Adjust **reverse** pedal to a height of 79mm. (Note material thickness of floor covering). Make fine adjustment via hexagon bolt X.
- Attach *Mark II plus measuring adapter* to connector X16 below the floor plate.
- Set lock switch to ON
- Measure voltage at measuring adapter:
Sender 1B3: X16/2 (+) – X16/5 (–)
Sender 1B4: X16/3 (+) – X16/4 (–)
- Pedals **not depressed**, potentiometers in centre position: Voltage: 4.7 – 5.3 V per potentiometer.
- **Reverse** pedal, fully depressed:
X16/2 (+) – X16/5 (–), voltage 8.8 – 9.3 V
X16/2 (+) – X16/4 (–), voltage 0.7 – 1.4 V
- **Forward** pedal, fully depressed:
X16/2 (+) – X16/5 (–), voltage 0.7 – 1.4 V
X16/3 (+) – X16/4 (–), voltage 8.8 – 9.3 V

Adjustment of forward pedal

- This adjustment is necessary if the voltage is > 9.3V and < 0.7V
- Reduce the dimension 81mm.
- Reduce threaded rod U, dimension 28mm by actuating the angular joint.
- Readjust centre position of potentiometer
- This adjustment is necessary if the voltage is < 8.8V and > 1.4V
- Increase the dimension 81mm.
- Increase threaded rod U, dimension 28mm by operating the angular joint
- Readjust centre position of potentiometer



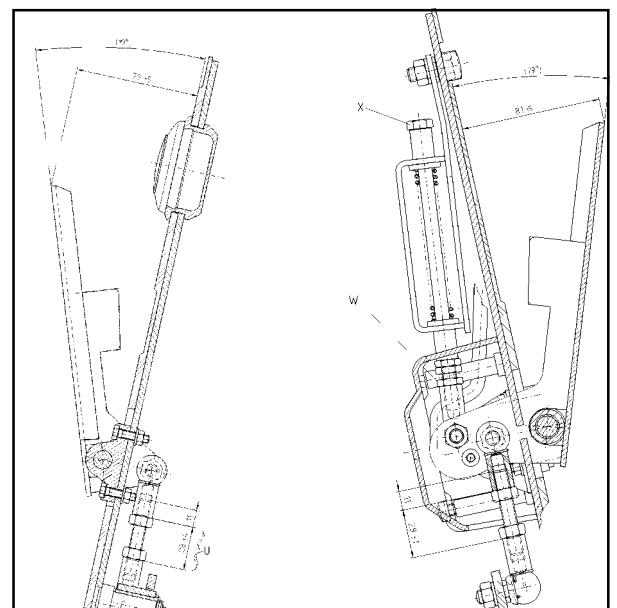
Adjustment of reverse pedal

The procedure is the same as for the forward pedal, however, in reverse

Retrofitting

When retrofitting a two-pedal control, the parameter address must be adjusted:

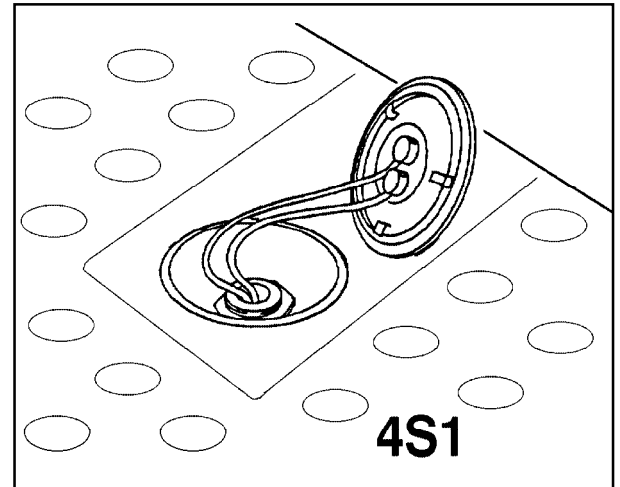
Address 08A to value 00



Signal horn / horn button**Horn button 4S1**

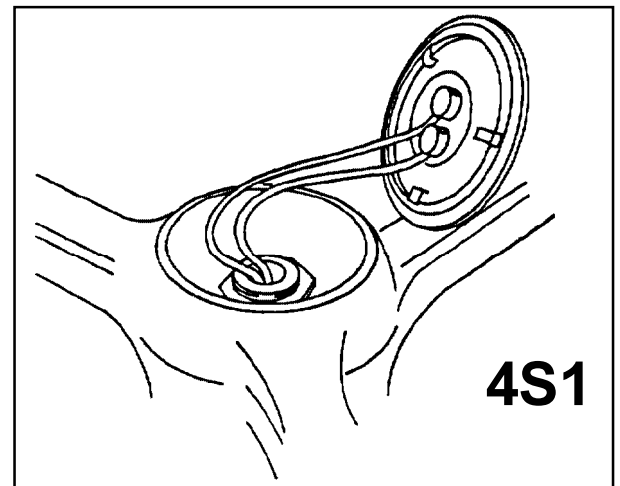
The horn switch is installed in the floor plate at the front left side.

For removal, the horn button can be levered out of the floor plate with a screwdriver. Then the lead to the horn button can be disconnected or connected.



Optional: Horn button located in centre of the steering wheel.

The horn button is pressed into the centre of the steering wheel and connected to the signal horn via two slip rings in the steering column. The contacts leading to the signal horn are located on the side of the steering column in the dash panel cover.

**Signal horn 4H1**

The signal horn is an audible warning device giving warning to other persons of a dangerous situation. The signal horn is therefore part of the safety equipment and it must always be in good working order.

The horn is arranged on the chassis, inside behind the gear drive.

An integrated circuit prevents interference with the electronic control when the signal horn button is pressed.

Brake sender – Brake fluid switch

Brake sender 1B2

The brake sender 1B2 is fixed to the right bearing bracket of the brake pedal shaft on the front cover plate. The sender is a potentiometer that is operated via pedal actuation.

Electrical connections

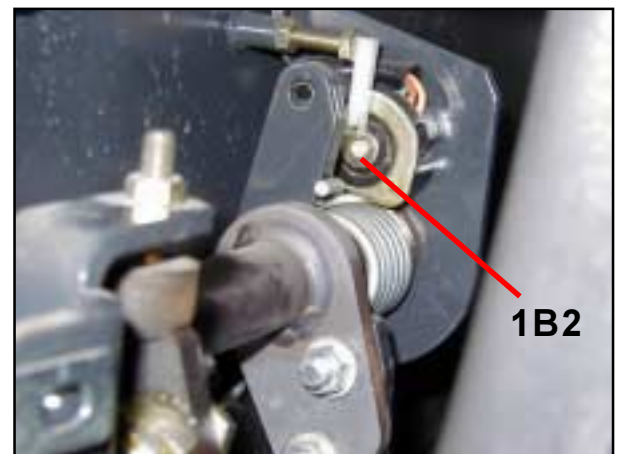
+10 Volt	– 1B2/3	green
Set value	– 1B2/2	red
GND	– 1B2/1	yellow

Checking the brake sender

- Plug *Mark II plus measuring adapter* into the connector 1B2.
- Connect digital multimeter to the measuring adapter: 1B2/2 (+) – 1B2/1 (–)
- Brake pedal unactuated:
The digital multimeter must give a reading of 1.20 – 1.80 Volt.
- Brake pedal actuated:
When the brake pedal is actuated, a sender voltage between 2.5 – 5.0 Volt must be indicated.
- At a sender voltage higher than 9.4 Volt, a fault is set, the controller detects an interruption GND.
- An excessive sender voltage can also be caused by misadjusted hammer head screws or worn brake linings.

Adjustment of brake sender

Adjust the adjusting screw or potentiometer with the brake pedal in a normal position, so that an output signal of 1.2-1.8V is given with a voltage of supply of 10V. Subsequently lock the adjusting screw with the lock nut.



Brake fluid switch 6S4

The brake fluid switch is fixed to the left bearing block of the brake pedal shaft on the front cover plate. The switch 6S3 is a NO contact, which generates an alarm with an insufficient level.

Electrical connections

	– 6S4/1
GND	– 6S4/2



Parking brake switch

Parking brake microswitch 1S3

Raising the engine hood will expose brake microswitch 1S3, which is located below the parking brake lever. Brake switch 1S3 is closed when the parking brake is released.

As soon as the parking brake is engaged, brake switch 1S4 will open, cutting out power to the traction circuit.

Brake switch adjustment is carried out by slackening screws item 1 and moving support item 2.

Electrical connections

Brake switch 1S3 is directly connected to controller A9.

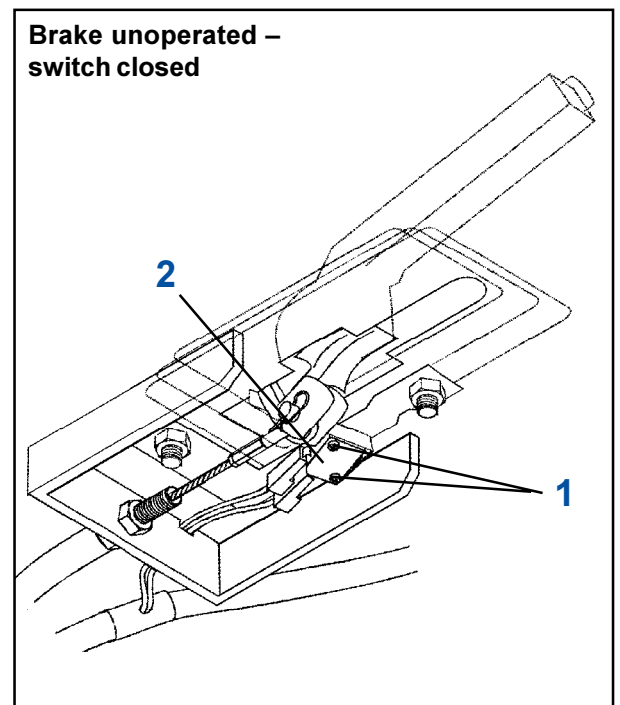
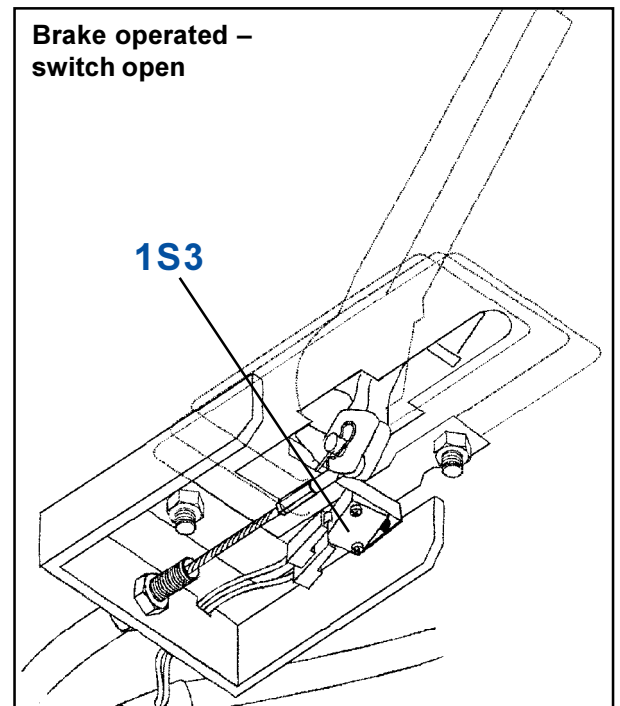
1S3/1 – X27/1	– X11/26
1S3/2 – X27/2	– GND

Note

Application of the parking brake cuts out the traction circuit.

If the truck is parked on an incline, apply the parking brake firmly.

If the parking brake is engaged only slightly on an incline, the truck is no longer braked electrically and will therefore roll back.



Seat switch

Seat switch 7S1

The mechanically operated switch is glued on the seat pan underneath the cushion. The seat switch will close even if only a light load is placed on it.

Seat switch 7S1 is caused to close immediately the driver sits on seat in which case the truck will be released by the controller for driving.

Electrical connections

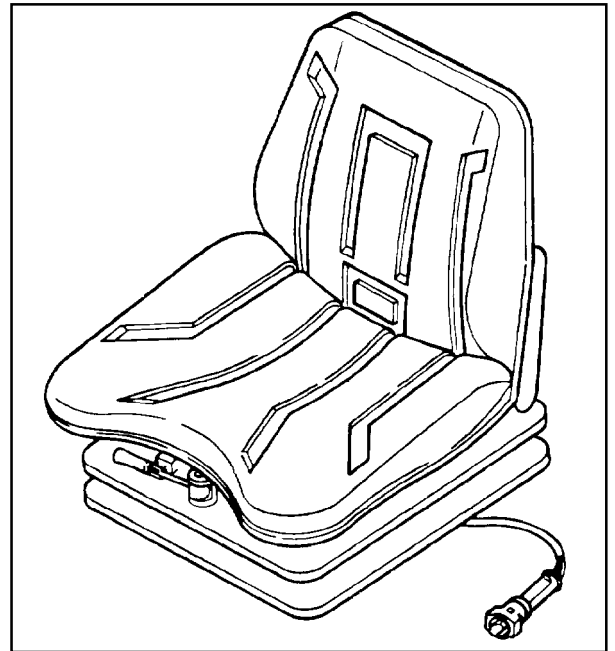
Seat switch 7S1 is connected directly to controller A9.

7S1/3 – X27/3 – X11/13

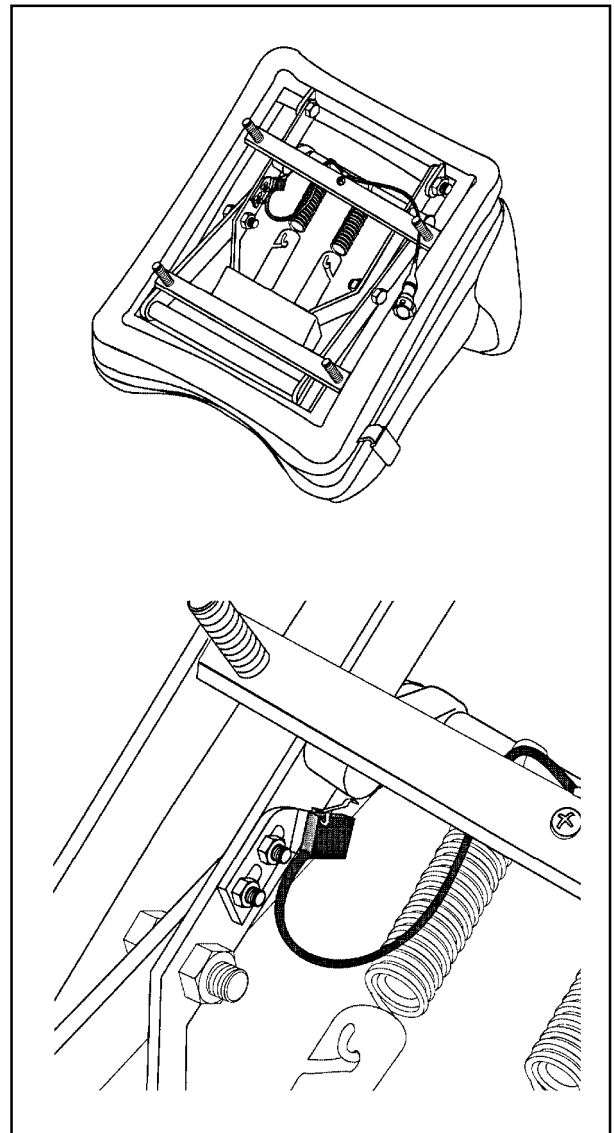
7S1/1 – X27/4 – GND

CAUTION

The seat switch is a safety device which may not be bridged. The seat switch will close even if only a light load is placed on it.

**Seat switch removal**

- Disconnect and remove the connector under the battery cover and remove the seat.
- Remove the cable ties (cut).
- Mount the mechanical switch at the scissors of the seat. The switch must be tightened slightly when no load is on the seat so that the switch lever still has a stroke of approx. 2-3 mm (see arrow).
- Place the seat on the four mounting pins and set the weight adjuster to the lowest weight.
- Place a light load of approx. 40 kg on the seat and remove it again. When the load is on the seat, the switch must be able to operate.



Transmitters (senders) for hydraulic functions

Transmitters for hydraulic functions 2B1 – 4

The transmitters transmit the rpm set-point values for pump motor for lift, tilt and auxiliary operations.

The following transmitters are installed:

- 2B1 transmitter for hoisting
- 2B2 transmitter for tilting
- 2B3 transmitter for aux. hydraulic functio1
- 2B4 transmitter for aux. hydraulic functio2

The transmitters involved are valve spool travel sensors whose output voltage variation is proportional to spool travel.

Electrical connections are made via 3-pin Timer connectors:

- Pin 3: +10 volts
- Pin 2: rpm set-point value
- Pin 1: GND

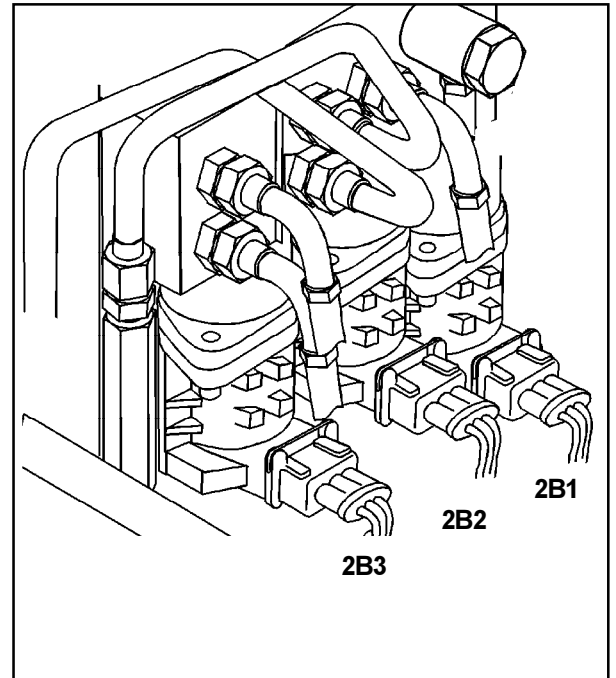
The transmitters are connected via connector X11 to controller A9.

Checking the transmitters

- Plug Mark II plus adapter into connector of corresponding control valve section.
- Turn the keyswitch ON.
- Connect a digital multimeter to the measuring adapter as per the table below and take voltage reading.

CAUTION: Watch mast movement !

Transmitter	Test points		Voltage in volts	
	Pos.	Neg.	Lever pulled back	Lever moved forward
2B1 hoisting	2	1	7.5	2.5
2B2 tilting	2	1		
2B3 a. h. f. 1	2	1		
2B4 a. h. f. 2	2	1		



Operation / Adjustment / Replacement

For a detailed description refer to Functional Group10.

Oil pressure switch / Pressure regulator unit / Oil filter switch

Oil pressure switch 6S3

The oil pressure switch is bolted via a bent tube to the steering control unit.

Electrical connections

6S3/2 –	XK5 –	X50/5 GND
6S3/1 –		X11/27

The switch is closed in the non activated state. It opens immediately the steering wheel is turned, in which case instant pump motor starting is produced.



Pressure regulator unit / Transmitter 2B5 / 5th hydraulic function

For operating a clamp, the additional hydraulics for the 4th hyd. function can be provided with a pressure regulator unit. The preset pressure is recorded via transmitter 2B5 -5th hyd. function- and indicated on the display on the dash panel.

The transmitter concerned is a pressure sensor whose output voltage varies depending on the pressure.

Electrical connections

2B5/3 –	+10 volts
2B5/2 –	signal supplied by sensor / oil pressure
2B5/1 –	GND



Oil filter switch 6S9

As an option, an oil filter switch 6S9 can be fitted for monitoring the suction line filter.

The switch is located in the suction filter cover. The switch is closed when the filter is clogged. The filter is connected on one side to the earthing point in the centre of the front scuttle, on the other side it is connected directly to controller A9.

Drive motor speed sensor

Speed sensor

Via two staggered proximity switches, the speed sensor senses the speed and direction of rotation of the motor. It is arranged (in direction of travel) on the right of the motor in the differential case.

The speed sensor is supplied with 10V by the controller. At its switching outputs it delivers voltages of < 0.9V or > 8V, depending on the position of the ring.

**Drive motor 1M2**

Sender (br) – X12/1	– +10 Volt
Sender (ge) – X12/4	– Signal
Sender (gn) – X12/2	– Signal
Sender (ws) – X12/3	– GND

Function test

In a fitted condition, a simple test of the proximity switch is possible.

- At controller A9, disconnect one of the armature cables (terminal 5 or 6).
- Connect a multimeter between X12/3 (–) – X12/2 (+)
- Turn the sender wheel of the hydraulic motor manually.
- Multimeter shows a distinct voltage jump **about 8 Volt**

Attention

The motor must be voltageless, disconnect armature cable!

Checking the sensor bearing

- Remove floor plate
- Plug *Mark II measuring adapter* with connected digital multimeter (with integrated pulse duty factor measurement, e.g. Metra Hit 15S) into the connector X12 on the axle.
- Connect digital multimeter to:

Positive	– Adapter, Pin 4
Negative	– Adapter, Pin 3
Positive	– Adapter, Pin 2
Negative	– Adapter, Pin 3
- Set lock switch to ON
- Pulse duty factor measuring range – AC %
- At full throttle, the digital multimeter must give a pulse duty factor reading of **40% – 60% (ideal 50%)**

Fitting and removal

A detailed description is provided under Group 11.

Hydraulic motor speed sensor

Pulse generator at 2M1

The hydraulic motor speed is measured by a pulse generator. It is arranged on the right of the pump motor on the brush-sided bearing bracket.

This is an inductive proximity switch. The switch responds to the proximity of iron. In this case, the cam on the sender wheel.

6022 - 6025	12 teeth
6026 - 6029	16 teeth

When the sender wheel rotates, the pulse generator delivers a positive voltage with each cam from which the A9 controller calculates the motor speed.



Electrical connections

The pulse generator is supplied with +10V by the controller.

Sender (br)	– X14/1	– +10volts
Sender (sw)	– X14/2	– Signal
Sender (bl)	– X14/3	– GND



Function test

In a fitted condition, a simple test of the proximity switch is possible.

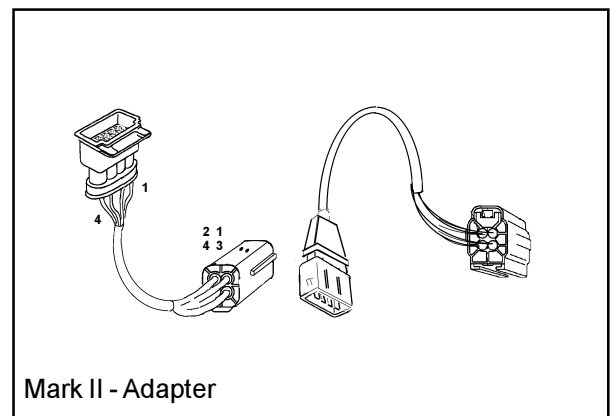
- At controller A9, disconnect one of the armature cables (terminal 7 or 8).
- Connect a multimeter between X14/3 (–) – X14/2 (+)
- Turn the sender wheel of the hydraulic motor manually.
- Multimeter shows a distinct voltage jump about 8 Volt

Attention

The motor must be voltageless, disconnect armature cable!

Fitting and removal

A detailed description is provided under Group 11.



Battery servicing

The specific gravity of the filled battery is 1.28 kg/l. In the discharged state, the specific gravity must not be lower than 1.14 kg/l.

Check the specific gravity with an acidimeter. The specific gravity can be read directly on the acidimeter.

After charging, it takes a certain time until the acid above the plates has balanced and mixed with the acid between the plates. Measurement should therefore initially take place about 30 minutes after charging has ended.

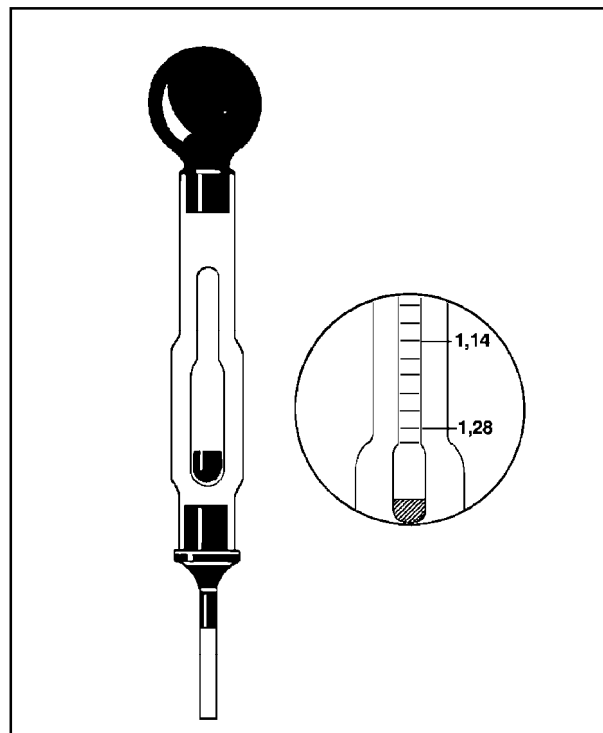
Check the acid density regularly. When the minimum mark is reached, replenish with distilled water only.

Battery capacity dependent on temperature

A fully charged battery reaches its full capacity at 27°C.

A drop in temperature of 1°C represents a reduction in capacity of 1 %.

This means that at 0°C there is a reduction in capacity of 27 %. In other words, only 73 % remain of the 100% battery capacity originally available.



STILL contactor

Main line contactor 1K1

As main line contactor, contactor 1K1 switches the power supply for the power electronics in the controller. It is located along with main line fuse 1F2 in the counterweight.

Control voltage

The contactor coil has been designed for 24Volt operating voltage. Controlled by controller A9, by which it is fed with regulated current, the contactor coil is thus not supplied with full operating voltage.

Mechanical configuration:

The contactor frame is made of impact resistant plastic; four M8 studs are embedded in the plastic material. The contact screws/tips are screwed from the inside into the top studs. The lower screws serve as terminals for connecting the contact bridges of the armature by means of contact bridges.

The coil assembly comprises:

- coil
- magnetic core
- frame
- protective circuitry

The protective circuitry connected in parallel to the coil consists of a resistor wired in series with a diode with the following data:

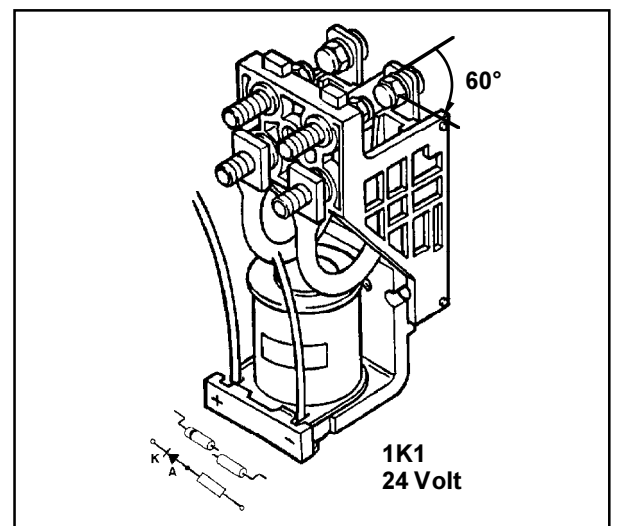
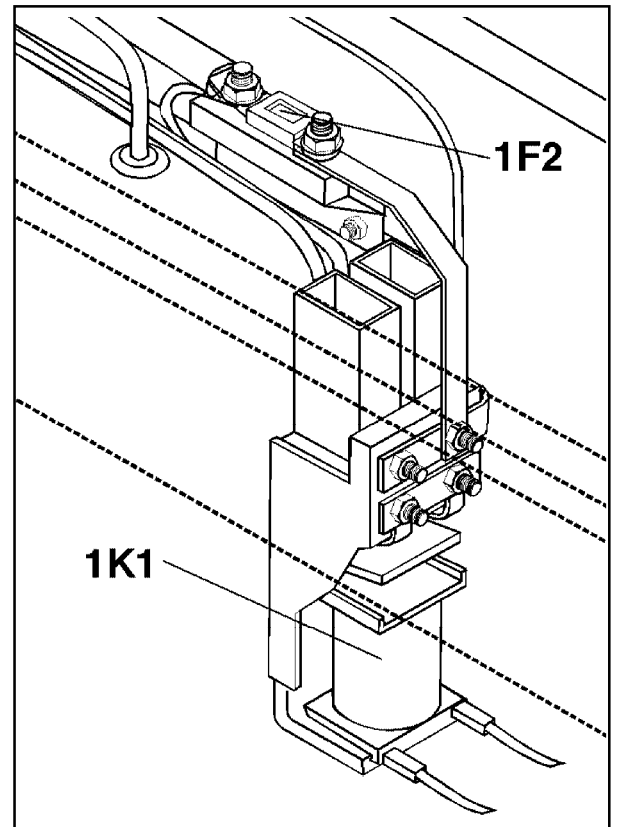
24 V	Resistor	47 Ohm
	Diode	1N4005
	Coil resistor	approx. 20 Ohm at 24 Volt operating voltage

The armature assembly is the movable part of the contactor, which is mounted between the contactor frame and the coil assembly.

The contact screws/tips of the contactor frame and armature assembly are identical.

Torque loading of contact screws should be 10+1 Nm, i.e.:

The contact screws must be screwed fully home (i.e. up to the thread root) and further tightened with 60° angle of rotation.



STILL contactor

Contact pressure

Contact pressure of contactor in the fully operated state:

Required value $\geq 9,0 \text{ N}$ for each contact, centre of contact taken as a reference.

Adjustment

- Fully actuate contactor (electrically or mechanically).
- Attach contacts centrally to a spring balance or scale and apply a load of 9.0 N .
- Contact pressure can now be accurately adjusted by operating on the hex. head screw passing through the contact spring. Rotating the hex. head screw in a clockwise direction will increase the pressure.

NOTE:

The contact spring is subjected to a certain degree of friction. The contact pressure is therefore correctly adjusted if when applying a pressure load of $10 \dots 10.5 \text{ N}$ the contact during slow approach does not yet close, but in the case of a rapid approach makes contact and remains closed.

Pull-in stroke

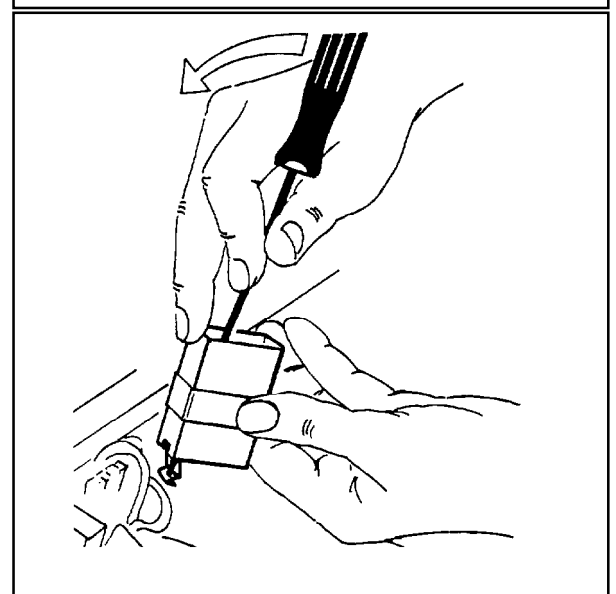
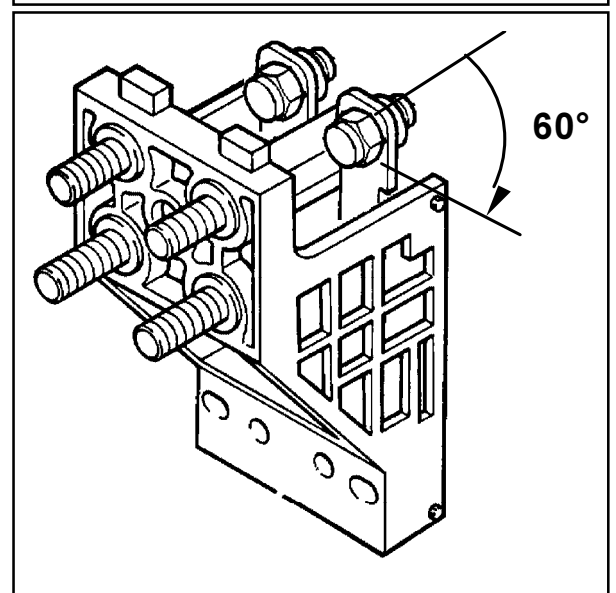
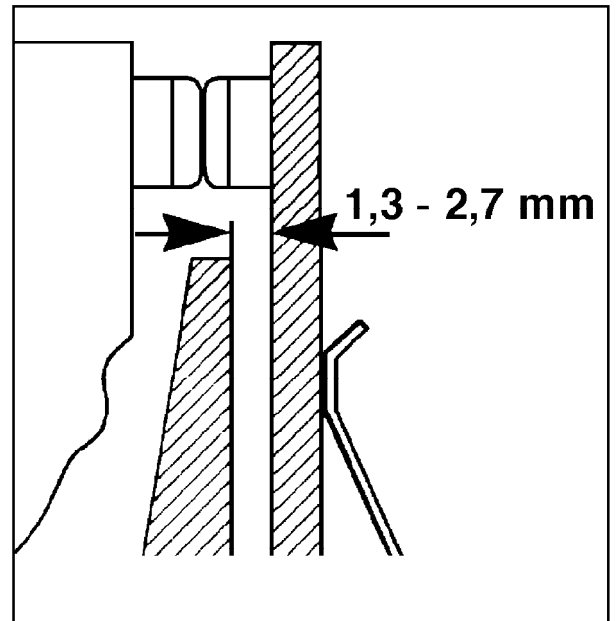
Provided the contactor is correctly assembled, a spacing of 1.3 to 2.7 mm between contact bridge and support finger must be achieved with contactor being pulled in.

Torque loadings

The contact screws must be tightened to a torque of 10^{+1} Nm . To achieve this torque loading without using a torque wrench, the contact screws must be screwed fully home and then rotated through a further 60° .

Mounting the arc blow-out magnets

To install the arc blow-out magnets or arc suppression chambers on the contactors, a screwdriver must be passed through a hole in the leaf spring. By exerting a light pressure on the leaf spring the latter is pressed inwards until the arc blow-out magnet has reached its final position. After withdrawal of the screwdriver the leaf spring will retain the arc blow-out magnet in position.

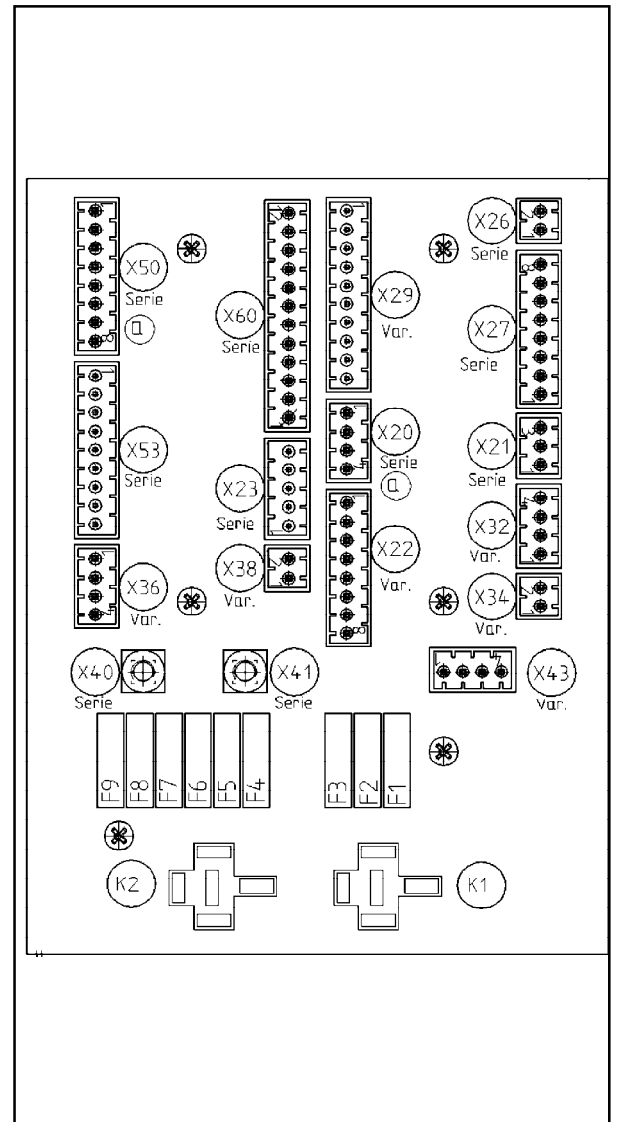


Fuse carrier – fuses — relays

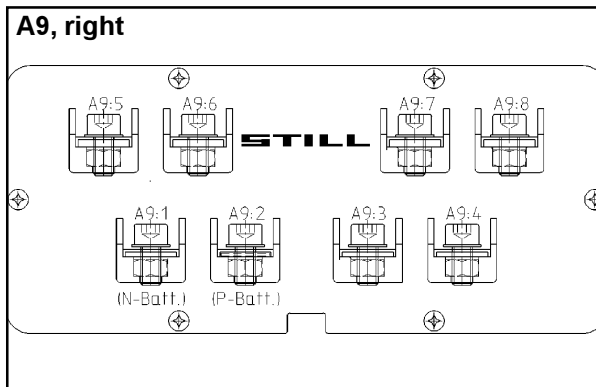
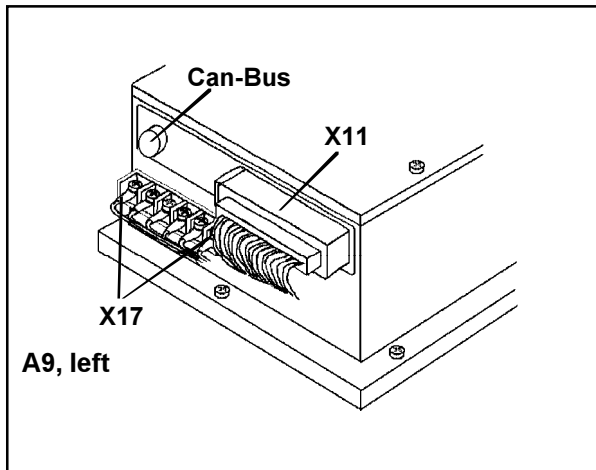
Fuse carrier A7

All the control circuit fuses required for the electrical installation and the optional relays are installed on the fuse board.

Des.	Value	Connection
F1	5 A	Signal horn 7H1
F2	5 A	emergency stop contactor
F3	5 A	Brush wear
F4	20 A	heater, Mobab (optional)
F5	5 A	Controller power supply
F6	15 A	24 Volt auxiliary loads
F7	5 A	Hydraulic controller
F8	5 A	Fan
F9	10 A	Main line fuse ahead of S1
K1	24 V 255Ohm	auxiliary loads, equipment A
K2	24 V 255Ohm	auxiliary loads, equipment A



Controller – R60S20

**Controller A9**

Since the end of 1999, the series has been fitted with a digital controller of the second generation. In order to clearly distinguish between controllers of the first and second generation, the designation **R60S20** is used for controllers of the the second generation and **R60S60** for the first generation in the following.

The controller is the central switchboard for nearly all electrical components. Provided with a micro-processor control, it assumes most of the control, switching and monitoring functions.

The controller includes the main groups:

Power electronics

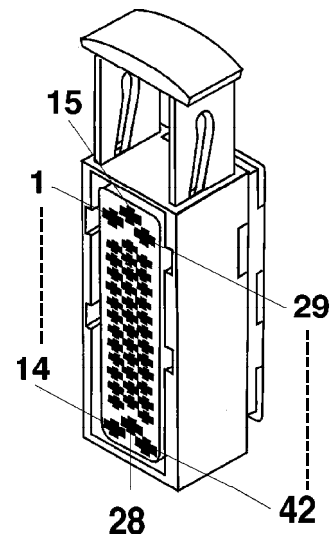
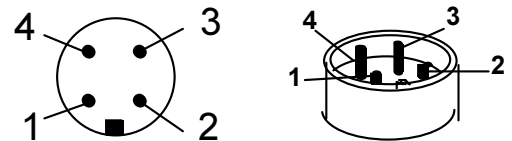
Armature regulator for drive and hydraulic motor
Field regulator for drive motors

Control electronics (cassette insert)

The signals for:

Keyswitch	S1
Accelerator pedal transmitter	1B1
Accel. pedal transmitter switch	1S16
Brake pedal transmitter	1B2
Transmitters hoisting/tilting /aux.	2B1 – 2B5
Speed sensors	
Motor brush monitors	
Temperature sensors	

are monitored and evaluated.

SAAB-connector, 42 pins**CAN-bus female connector****Main connections****Connector X17**

X17/1	–	not used
X17/2	–	not used
X17/3	–	F1 / motor field (–) for 1M1
X17/4	–	F2 / motor field (+) for 1M1
X17/5	–	not used
X17/6	–	not used

Terminal

1	–	Batt (–) 80 Volt
2	–	Batt (+) 80 Volt
3	–	not used
4	–	not used
5	–	B1 / armature for 1M1
6	–	A2 / armature for 1M1
7	–	A1 / armature for 2M1
8	–	D2 / armature for 2M1

CAN bus female connector

1	–	Bus signal approx. 2-3-Volt
2	–	Bus signal approx. 2-3-Volt
3	–	24 Volt
4	–	GND

R60S20 – Replacing the Controller

Replacing the controller

If the controller needs to be replaced because it is beyond repair, certain aspects must be considered before removing the faulty controller from the truck.

The replacement controller normally does not contain any data or parameters. The data and parameters are, as a rule, stored in the control unit and the console by continuous automatic data save. For data security reasons, however, a text file of the truck parameters should always be created.

The operating hours of replacement controllers are set to "0000". Currently, these can not yet be set to the previous meter count.

Procedure

- Safely park the truck on level ground.
- Disconnect the batteries.
- Disconnect all leads from the controller, including the earth lead.
- Thoroughly coat the controller mating surface with heat conducting paste.
- Tighten the M10 screws to **46 Nm**.

Caution:

The torque loading of the screws must be checked at the next inspection in order to ensure the optimum heat exchange.

- Connect the new controller; reconnect the earth lead to the controller!
- Reconnect the batteries.
- Turn keyswitch S1 to ON.

D – EEPROM VALID ?

>>are the parameters stored in the console valid?<< will be displayed on the LCD panel.

- As the controller was replaced and the parameters from the console are required, press **YES** (PRG ←) as confirmation.

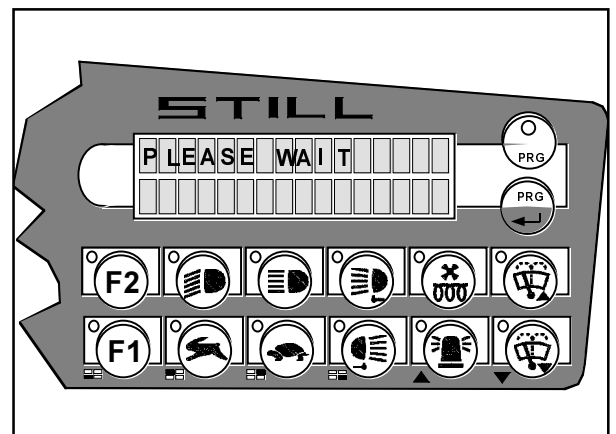
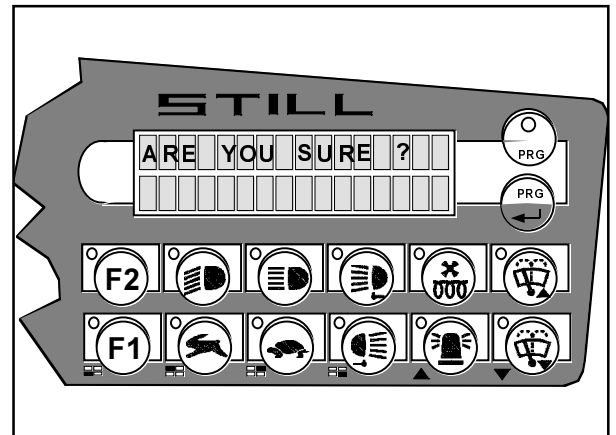
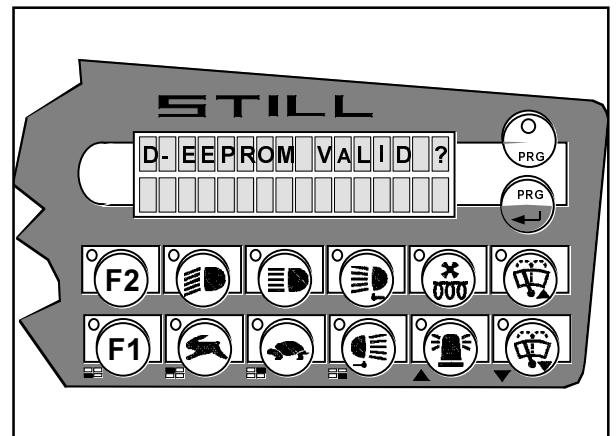
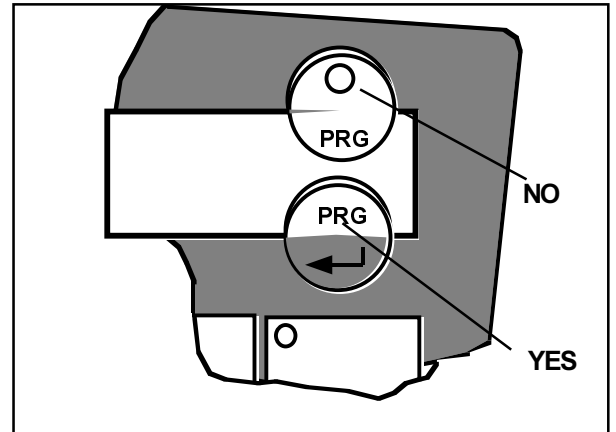
On the display appears the question:

ARE YOU SURE?

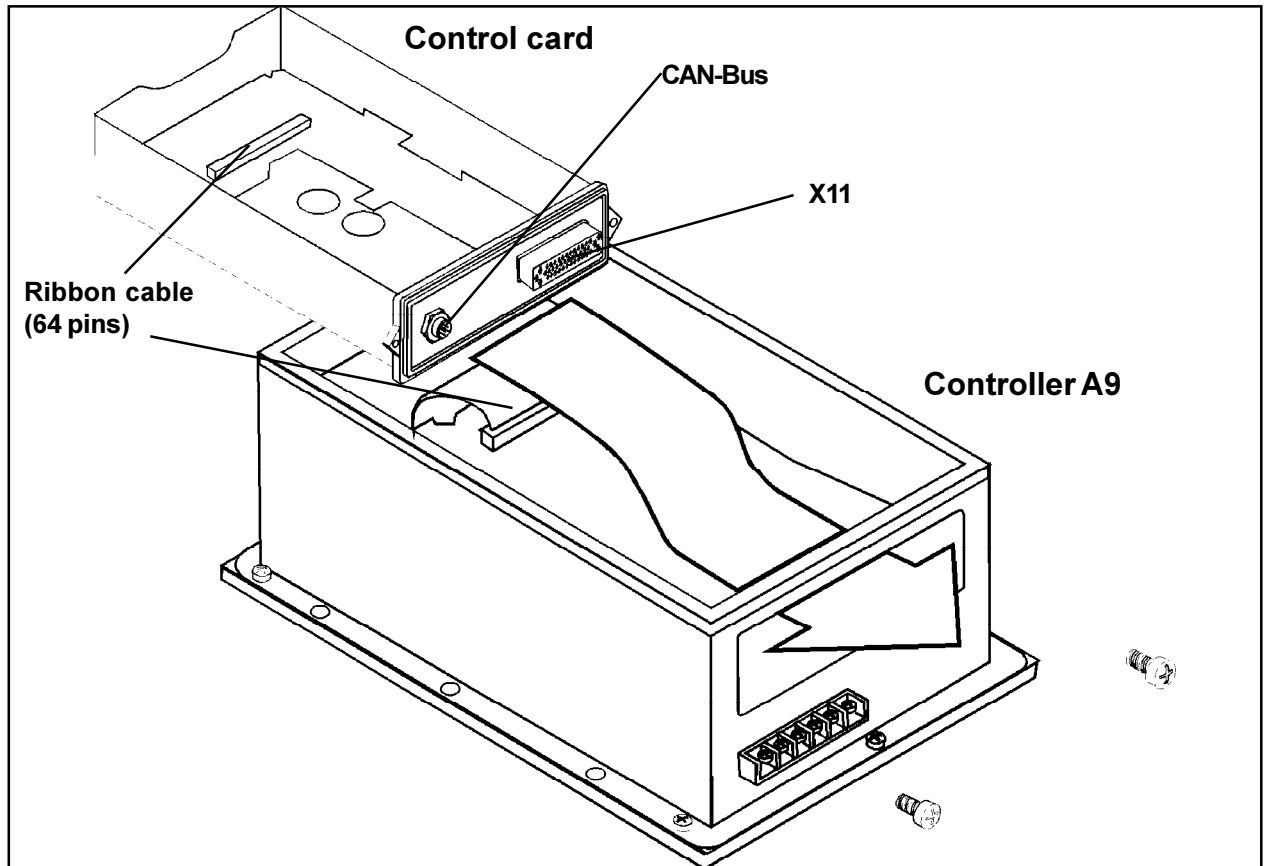
Press **YES** (PRG ←) as confirmation. The information data stored in the controller is now transmitted to the console and the display indicates:

PLEASE WAIT

- Then an automatic reset is performed.
- By calling up the truck number in the display, it is possible to check whether the correct drive parameters have been downloaded.



R60S20 – Replacing the control card

**Replacing the control card**

In some cases only the control card of the controller has to be renewed. The modular design of the control card allows a simple removal and installation.

The replacement controller normally does not contain any data or parameters. The data and parameters are, as a rule, stored in the control unit and the console by continuous automatic data saves. For data security reasons, however, a text file of the truck parameters should always be created. The operating hours of replacement controllers are set to "0000". Currently, these can not yet be set to the previous meter count.

Procedure

- Safely park the truck on level ground.
- Disconnect the battery plug.
- Disconnect connector X11 and the CAN bus and remove both screws on the controller.
- Disconnect the ribbon cable connector (64 pins) from the control card.
- Renew the control card and reassemble the controller in the reverse order of disassembly.
- Reconnect the battery plug.
- Set keyswitch S1 to ON.

D – EEPROM VALID ?

>>are the parameters stored in the console valid?<< will be displayed on the console-mounted LCD panel.

- As the control card was replaced and the parameters from the console are required, press **YES** (PRG ←) as confirmation.

On the display appears the question:

ARE YOU SURE?

Press **YES** (PRG ←) as confirmation. The information stored in the console is now transmitted to the controller and the display indicates:

PLEASE WAIT

- After a successful data transfer an automatic reset is performed.
- By calling up the truck number in the display, it is possible to check whether the correct drive parameters have been downloaded.

Note

If a control card with truck-specific parameters is installed, the query **D-EEPROM VALID ?** must be acknowledged with **NO**, otherwise the console will overwrite the control card parameters.

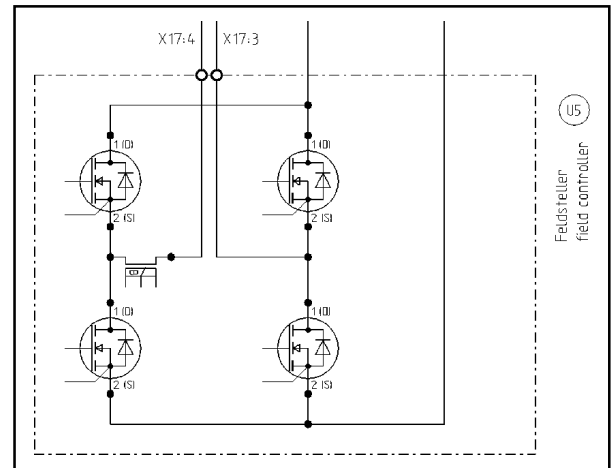
R60S20 – Field regulator

Field regulator

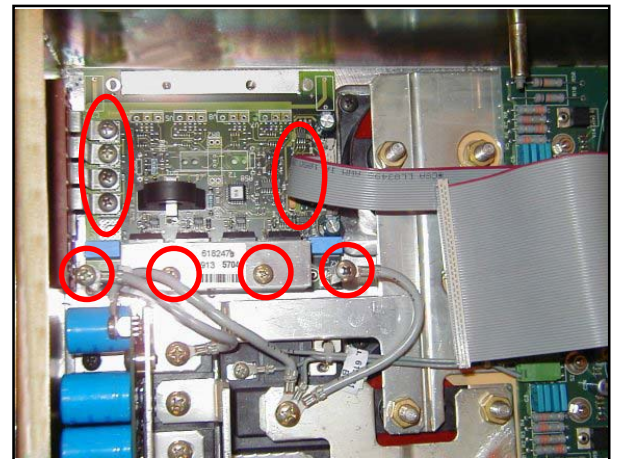
The power electronics of the controller A9 include one field regulator for the drive motor.

The field regulators consist of 4 MosFet transistors, which are controlled via measurement and control electronics. The field regulator operates as switched H-bridges and supplies the shunt field of the drive motor via the control electronics.

If the result of a vehicle diagnosis or console error message (error 174) refers to a faulty field regulator, only this regulator needs to be renewed. The modular design of the controller enables easy fitting and removal.

**Removal and fitting of the field regulator**

- Switch off vehicle
- Disconnect battery connector
- Remove control board
- The field regulator is located below the printed circuit board
- Loosen the fixing and terminal screws and ribbon cable of the field regulator
- Renew field regulator
- Before fitting the new field regulator, coat the heatsink with heat transfer compound
- To ensure good heat transfer, firmly tighten the screws (2,5 Nm)
- Reassemble the controller in reverse order
- Subsequent parameterisation is unnecessary



R60S20 – Replacing the console

Replacing the console

If the console must be replaced due to an unrepairable fault, the instructions relating to the replacement of the controller must first be read.

After any changes made to truck parameters it will be advisable to produce a new text file in the form of a backup diskette. Normally an empty console is used as a replacement part.

Procedure

- Safely park the truck on level ground.
- Disconnect the batteries.
- Remove steering column shroud
- Remove the faulty console and replace it with a new one.

Note:

To ensure perfect transmission of the angle lock pulses, the console must be adjusted.

- Refit the shroud.
- Reconnect the batteries.
- Turn keyswitch S1 ON.

PLEASE WAIT

will appear on the display panel of console.

- The complete data information stored in the controller memory is at this stage transferred to the console.
- After that a reset is effected automatically.
- The console is now ready for operation.

If a console from a different truck, i.e. already containing a software, is used as a substitute (which is feasible), proceed as follows:

- Turn keyswitch S1 ON.

D – EEPROM VALID ?

>>are the parameters stored in the console valid?<< will appear on the display of the console.

- As the console has been removed and as the operating parameters programmed into the controller are required for transfer to the console, answer **NO** (press upper PRG keypad)

ARE YOU SURE ?

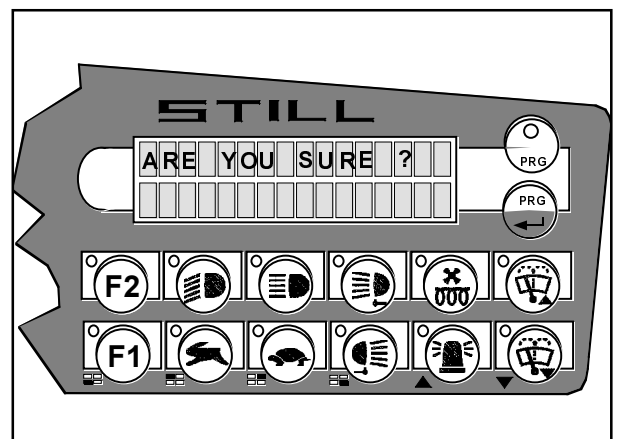
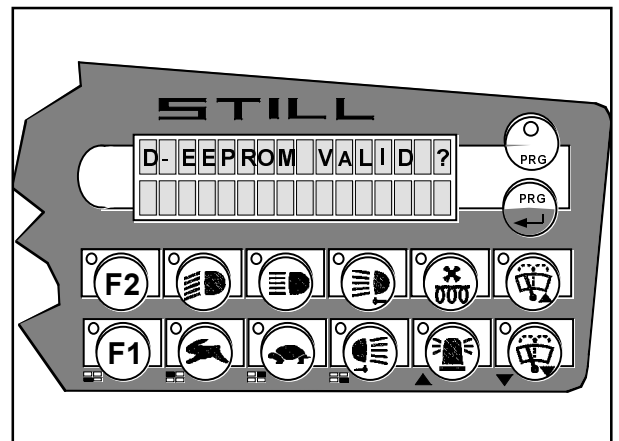
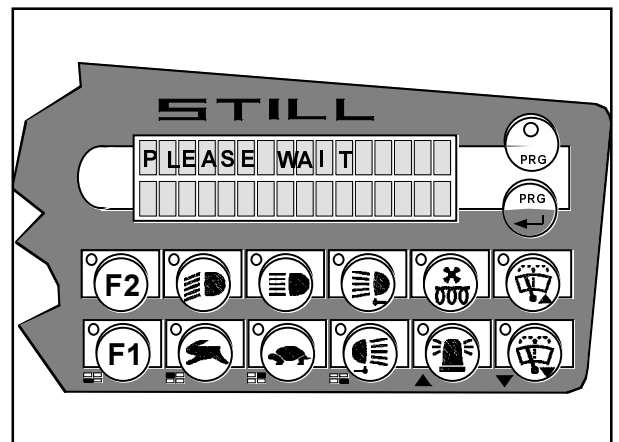
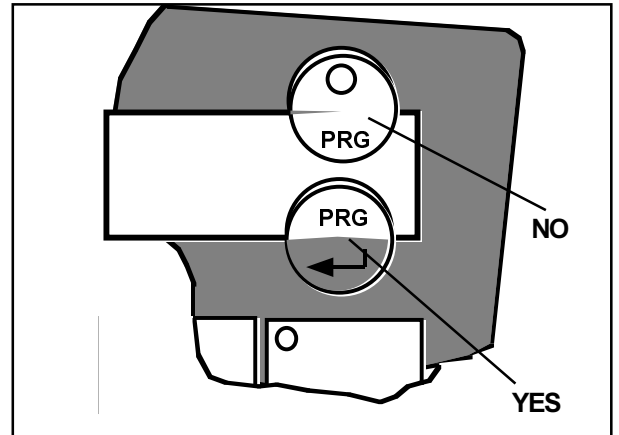
is displayed.

- Answer **YES** (PRG ←). The information data stored in the controller is now transmitted to the console – without display –
- After that a reset is effected automatically.
- By calling the truck number (which will be displayed), it is possible to check whether the correct drive parameters have been loaded.
- Turn keyswitch S1 OFF.

Cold store version

Heater cable terminals:

- Batt(+) – X47/2 in the console to S1.
- Batt(–) – X41 on the fuse board in the counterweight.



FleetManager

FleetManager

FleetManager is an operating data management (ODM) and analysis ODA) system that supports the fleet manager in the control, management and analysis of an industrial truck fleet.

FleetManager generally fulfils 4 main tasks:

- Acquisition of regular and event-orientated vehicle operating data
- Acquisition of special operating data in the event of an accident via accident recorder
- Access control to the vehicle via freely programmable data card
- Basic data management as well as the evaluation and display of all acquired operating data in FleetManager software in the evaluation PC of the fleet manager

Data transfer between the vehicle and evaluation PC takes place via a contactless data card. On the vehicle, the data card is read and written via a card reader (card device).

The card reader is an integral part of the console; a precondition is the FleetManager option.

Delivery condition

Vehicles with the FleetManager option are originally parameterised so that they cannot be moved without card. On switching on the vehicle via the keyswitch, the usual status indications appear on the console display.

As long as the vehicle is not yet integrated into the fleet via the configuration card (Mastercard) of the fleet manager, the vehicle can be moved without card.

The card reader is active in the background and registers when a card is inserted into the card holder. Depending on the inserted card type, various test messages and reactions, which are not described here further, appear on the display (see operating instructions).

Activate access control

To activate the access control function and record vehicle operating data, the vehicle must be integrated into the fleet with the Mastercard. This normally takes place at customers by the fleet manager and is not described here further (see operating instructions).

**Deactivate FleetManager**

After configuration by the fleet manager, a vehicle can only be operated with cards with appropriate authorisation.

After starting the vehicle via the switchlock, the following message appears on the display:

PLEASE INSERT
CARD

FleetManager can be deactivated by changing specific parameters in order to operate the vehicle without card for service and diagnostic purposes.

Address	144	Enable FleetManager function
Value	00	FleetManager is deactivated
	FF	FleetManager is activated

With FleetManager deactivated, the card reader is switched off; no reactions are initiated when test cards are inserted.

Attention:

FleetManager must be reactivated following service or diagnostic routines in any event!

Card reader write and read test

To carry out an internal card reader write and read test, a blank card can be used as a test card. A blank card is a card that has not yet been configured via the FleetManager PC program.

A test can only be carried out with FleetManager activated. During the test, the following messages appear on the display:

TESTING CARD

If the test was successful, the following message appears on the display:

CARD
OK

After removing the test card, the normal display reappears.

In the event of a fault, the displays constantly shows the message "CHECKING CARD" or the following message is displayed:

CARD
FAULT

Both types of faults indicate a write or read fault of the card reader (the test should be repeated with a second test card if necessary).

If the card reader is faulty, the console must be removed.

Card loss during operation

If the card or complete card holder should be mislaid during operation or accidentally removed, the vehicle switches to a parameterisable emergency mode.

There are two behaviour patterns:

- In the event of card loss, the vehicle slows down. When a valid card is inserted, the slow operating mode is cancelled. If a card without access authorisation is inserted, the drive is stopped (main contactor is opened).
- In the event of card loss, the vehicle control is deactivated the vehicle is braked electrically and the main contactor opens.

The available combinations and fine adjustments take place in parameterisation per Notebook.

**Card holder renewal**

The card holder can be renewed individually as a spare part. It is bonded to the console with a special adhesive foil. Adhesive residues of the old card holder must be removed from the console. The surfaces must be clean (free from dust and grease and dry). If possible, the card holder should not be touched for several hours to ensure optimal bonding.

Note

Suitable adhesive foils and cleaning agents have not yet been determined.

Retrofitting FleetManagers

In principle, any vehicle can be retrofitted by simply exchanging the console.

A requirement is the vehicle software version 0.24, 0.30 or higher.

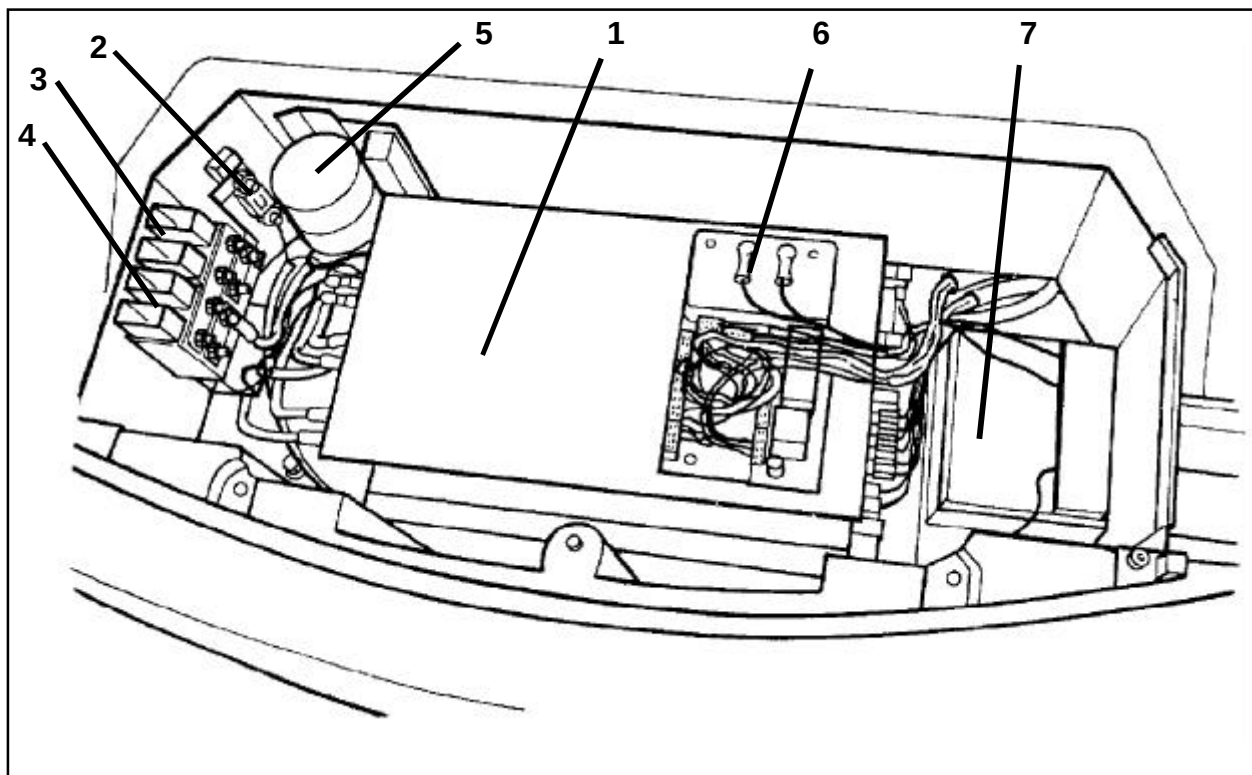
Note:

The FleetManager console is always also available in a type suitable for *cold store use*. The heater cables may only be connected for cold store use; connection for other purposes will cause the console to overheat.

Controler – R60S60

Table of contents	Page
Electronic control unit – R60S60	39
Connections	40
Replacing the controller	41
Fuse carrier – R60S60	42
Control fuses	42
Driving characteristics	43
Measuring drive and pump motor current	44
Console – R60S60	45
Plane text parameter	45
Error storage circuit	46

Controller – R60S60

**General**

Since 1996 until about October 1999, the series has been fitted with a digital controller of the first generation, designated as **R60S60** in the following.

The A9 controller contains the control and power electronics for the drive and pump motor.

The main power connections for the battery and drive and pump motor are located on the left side of the of the controller.

The connections for sender, switches, CAN bus and additional electrics are located on the mother board on the right on the controller.

- Item 1: Controller
- Item 2: Main fuse 1F2
- Item 3: Emergency Stop contactor 7K2
- Item 4: Main contactor 1K1
- Item 5: Circuitry
- Item 6: Relay box, rear (optional)
- Item 7: Power supply (optional)

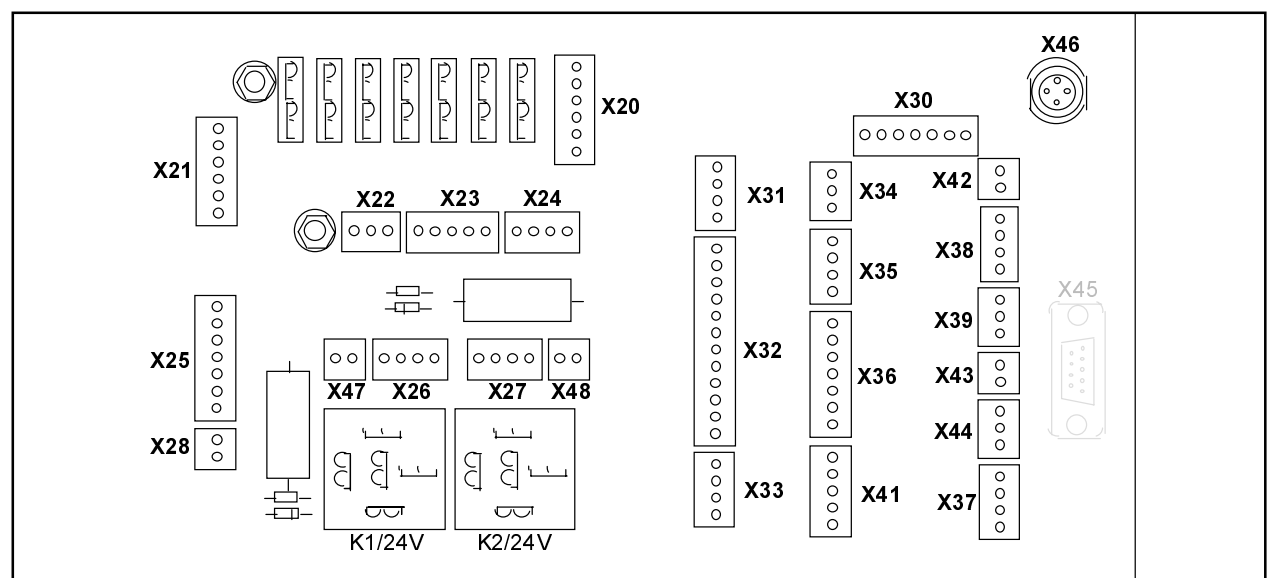
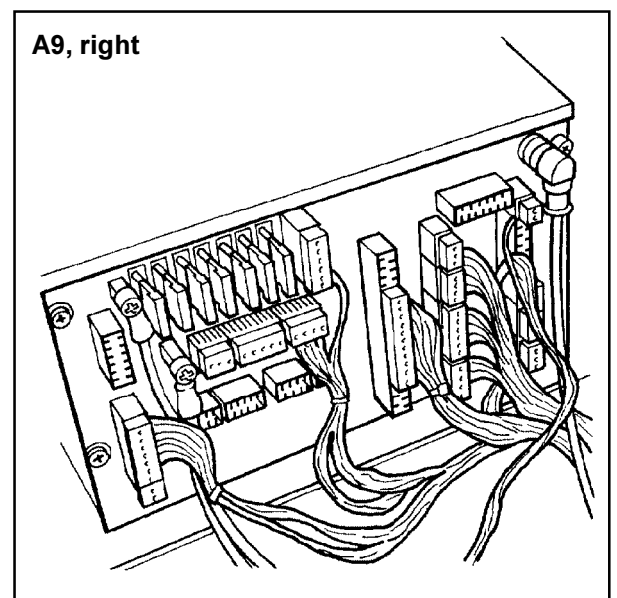
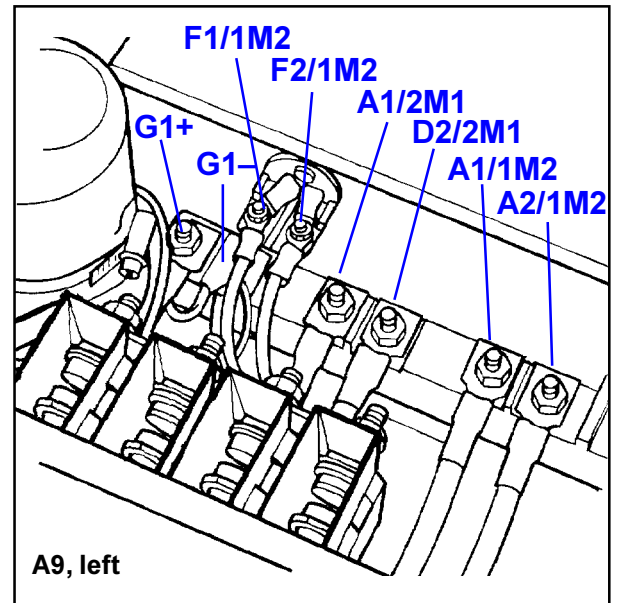
R60S60 – Controller – Connections

Connection of battery and motor cables

F1/1M2	connection drive motor field F1
F2/1M2	connection drive motor field F2
A1/1M2	connection drive motor armature A1
A2/1M2	connection drive motor armature A2
A1/2M1	connection pump motor armature A1
D2/2M1	connection pump motor series field D2
G1+	+80V battery, connected across main line contactor 1K1 & emergency stop contactor 7K2
G1–	–80V battery

Connectors on base plate

X25	keyswitch S1, hazard flasher switch
X41	accelerator transmitter 1B1
X34	transmitter microswitch 1S16
X32	transmitters, hydraulics
X39	transmitter, pressure regulator unit
X44	brake transmitter
X35	(oil filter switch 6S9), low fuel level switch 6S4, oil pressure switch 6S3
X42	seat switch 7S1
X43	parking brake microswitch 1S3
X22	fan motor 9M5
X37	temperature monitor, electrical machines
X20	warning horn 4H1, +80V for motor brush monitor
X24	motor brush monitor
X36	motor speed sensors
X28	emergency stop button
X23	main line contactor 1K1, emergency stop contactor 7K2
X46	CAN-Bus
X45	not used
X33, X21	voltage supply circuit for optional equipment
X26, X27	input relays K1, K2
X47, X48	output relays K1, K2



R60S60 – Renovar el dispositivo de mando

Recambio – dispositivo de mando R60S20

Si se tiene que reemplazar el dispositivo de mando debido a un fallo no reparable, antes del desmontaje es imprescindible tener en cuenta algunos aspectos.

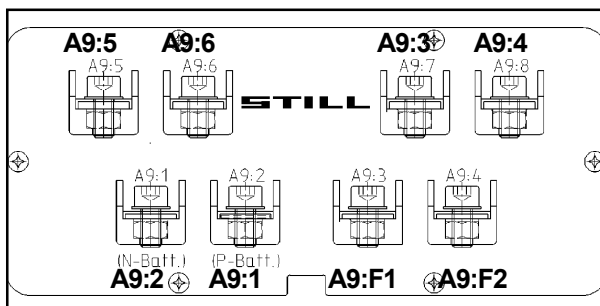
Desde el mes de septiembre de 2000 está disponible el dispositivo de mando R60S20 como dispositivo de mando de recambio.

El dispositivo de mando de recambio R60S20 tiene la misma funcionalidad que el actual dispositivo de mando de serie R60S20, sin embargo, la disposición de las conexiones de mando (técnica SKT) corresponde al antiguo dispositivo de mando R60S60.

Para un reequipamiento inicial está disponible un grupo de suministro completo (véase información rápida 17/2000).

Reequipamiento

- Aparcar el vehículo de forma segura.
- Desconectar el enchufe de batería.
- Desconectar todas las conexiones y la conexión a masa en el dispositivo de mando R60S60.
- Retirar el dispositivo de mando R60S60.
- **Importante:** Quitar el **conexionado**.
- Untar la superficie de apoyo del dispositivo de mando de recambio uniformemente con **pasta conductora de calor**. Sólo es necesario aplicar una capa delgada de pasta.
- Montar el dispositivo de mando de recambio en el contrapeso posterior usando tornillos M10x35 cortos.
- Apretar los tornillos M10 con un par de apriete de 46Nm.
- Después de soltar la abrazadera de sujeción en el compartimento de batería, los cables de energía eléctrica en dirección al dispositivo de mando de recambio se pueden volver a apretar.
- Los cables pueden ser prolongados alternativamente con los puentes de conexión que se incluyen en el grupo de suministro.
- Para las **conexiones de potencia** deberán ser usados tornillos M8x16.
- La disposición de las **conexiones de mando** corresponde al dispositivo de mando R60S60.
- En algunos pocos vehículos fueron conectados consumidores eléctricos en el conector de enchufe X33. El dispositivo de mando de recambio aquí tan sólo pone a disposición una salida conmutable en el enchufe X33/1 (24V/16W).
- Alternativamente se puede usar la alimentación de tensión „pequeña“.



¡La consola debe ser reemplazada siempre por una consola de serie!

- Por una consola estándar, una consola para cámaras frigoríficas o una consola FleetManager.

Sensor de revoluciones motor de tracción

- ¡Los primeros vehículos están equipados con un sensor de revoluciones, el cual no es compatible con el dispositivo de mando de recambio!
- El sensor de revoluciones se puede reconocer en la conexión por enchufe Mark II.
- Éste debe ser reemplazado por el sensor de revoluciones de serie y el juego de cables incluido en el grupo de suministro.

Introducción de parámetros:

La parametrización específica del cliente puede ser leída del antiguo dispositivo de mando R60S60 con la ayuda del programa de conversión de parámetros y escrita en el dispositivo de mando de recambio R60S20. El programa de conversión de parámetros y las instrucciones de servicio van incluidos en STEDS. Si el programa no está disponible, el conjunto de parámetros se lee mediante la maleta de diagnóstico y se transmite „manualmente“ al nuevo dispositivo de mando.

En todo caso, algunos parámetros deberán ser introducidos manualmente:

Ajustar el idioma en la consola, (alemán es valor estándar)

Dirección 13C	Valor 02	Vehículo estándar
	03	Variante de cabina Stocka/ScanCab
Dirección 133	Valor 22	Clave de tipo 6022
	23	Clave de tipo 6023
	24	Clave de tipo 6024
	25	

Calibrado:

- Poner la dirección 151 en el valor 03 a través de la consola.
- El proceso de calibrado arranca automáticamente.
- Todas las palancas de válvulas hidráulicas y el pedal de freno se deberán estar en su posición de reposo.
- La dirección 151 se repone automáticamente al valor 00.
- A continuación, se deberá llevar a cabo un reset (desconectar el enchufe de batería).

Fuse carrier

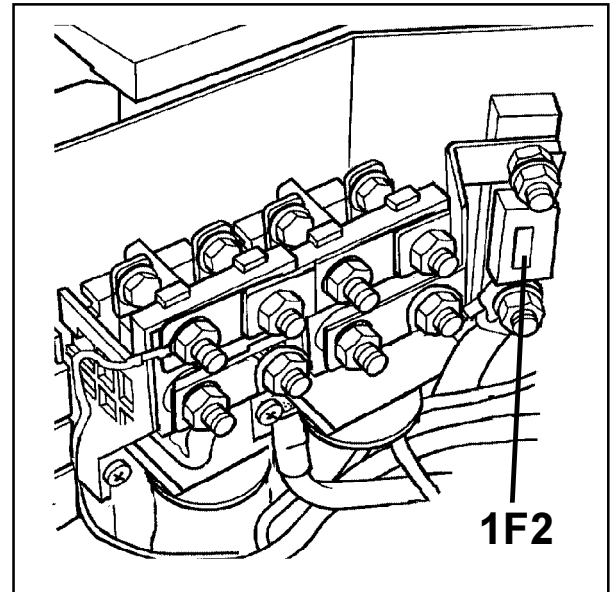
Main circuit fuse 1F2

The main circuit fuse 1F2 is located within the counterweight on the left-hand side. The electric motors are supplied with current via this 300 amp strip fuse.

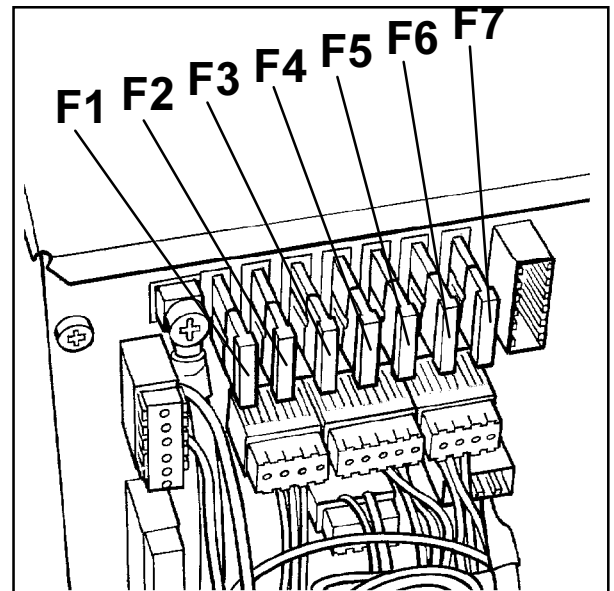
Control circuit fuses

Control circuit fuses are grouped on the metal panel on the r.h. side of the controller unit and on the relay board(s).

The fuses mounted on the metal panel are designed for protecting the 80 volt consumers, whereas the fuses located on the relay board(s) are provided as protection for the 24-volt consumers which are supplied with voltage by the voltage converter.

**Fuses on the metal panel (base panel)**

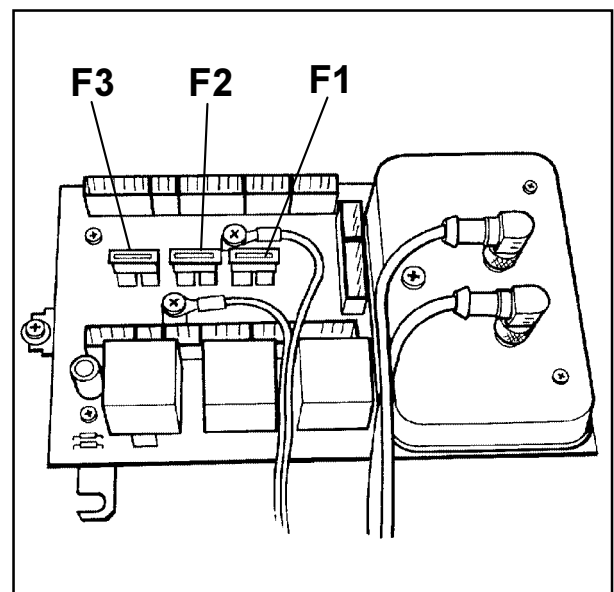
F1	15A	80V accessory consumers (optional)
F2	15A	Keyswitch, hazard warning flashers, supply circuit for F5, F6 and F7
F3	10A	Controller unit.
F4	5A	Fan motor
F5	5A	Option for emergency cut-out contactor/ bypass contactor
F6	5A	Warning horn
F7	5A	80V accessory consumers via keyswitch (optional)

**Fuses on the control relay board mounted in the counterweight**

F1	5A	Front windscreen wiper or vacant
F2	5A	Rear windscreen wiper
F3	5A	Interior lamp

Fuses on relay board in front scuttle

F1	5A	Front windscreen wiper
F2	5A	
F3	5A	



Driving characteristics

Driving characteristics – speed controlled

The truck is fitted with a speed regulated drive, i.e. truck speed is predetermined by the foot-operated accelerator control. Releasing the accelerator pedal will brake the truck electrically.

Maximum travel speed, acceleration and deceleration (electrical braking) can all be programmed in five different drive programmes by means of keypads on the dash panel.

These standard settings of the drive programmes can be changed by modifying the parameters (parametrization).

Standard setting of drive programmes					
Drive programme	1	2	3	4	5
Driving speed km/h	8	16	16	16	16
Acceleration position	1	1	2	3	3
Deceleration position	1	1	2	2	3

Stopping on a gradient

An anti-roll-back feature is provided so that the truck will hold at stall on a slope without the use of the foot brake provided key switch S1 is on with accelerator pedal being unoperated.

CAUTION:

If the parking brake is applied while the truck is on the gradient, parking brake microswitch 1S3 will open, breaking the main electrical circuit to cut off power to the drive motor in which case the truck may coast backward.

Driving characteristics – torque controlled

With exception of the electric brake, the driving characteristics in the torque controlled mode are similar to those in the speed controlled mode. In this case the truck is braked electrically to approximately walking speed and it then coasts to a stop. The braking torque with the accelerator pedal released can be set separately from the settings of the drive programme.

Stopping on a gradient

The truck will not hold on a slope without the use of the foot brake. In this operating mode, however, it is possible to start against the foot brake and the truck will not roll back.

Measuring drive and pump motor current

Measuring drive motor current

The drive motor is a remotely excited d.c. motor on which can be measured armature and field coil current.

Checking motor currents:

- Raise the drive wheels clear of the ground and chock the truck into position by placing chocks beneath the chassis.
- Using an appropriate length of wire, bridge parking brake microswitch on connector X43 (1 & 2).

The following tests must be of short duration only, as otherwise the commutator of the drive motor armature is liable to get damaged.

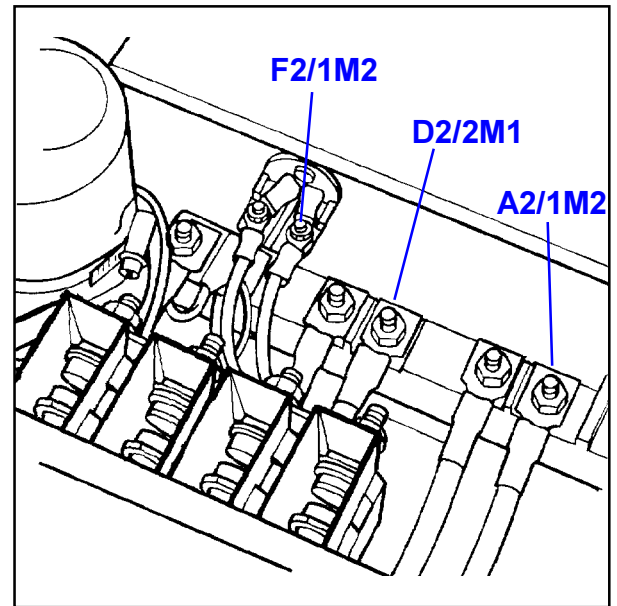
- Apply the parking brake
- Place directional control lever in either forward or reverse and fully operate the accelerator transmitter. The drive wheels must not turn.
- Measure the current flow in the armature by inserting a tong tester (current clamp) in line A2/1M2.
- The current flowing through the field coil is measured by inserting the tong tester in line F2/1M2.
- The parking brake must be released immediately the tests have been completed, whereas the accelerator transmitter must be operated momentarily to prevent vibration of the drive.
- After termination of the tests remove the bridge from X43.

Measuring pump motor current

The pump motor is a series-wound motor.

Checking motor current

- Raise the drive wheels clear of the ground and chock the truck into position by placing chocks beneath the chassis.
- Tilt the mast back against the by-pass pressure.
- Motor current is measured by inserting the current clamp in circuit D2/2M1.



	Current limit	
Drive motor	armature current	440A
	field current	40A
Pump motor	motor current	330A

Note

In this section, only those areas will be described, which deviate from the mode of operation of the actual standard console for R60S20.

Battery Discharge Indicator (BDI)

The useable battery capacity is shown on the display. Adjustment of battery discharge indicator is carried out on the basis of the following representation.

BATTERY	LEAD
WARN. LEVEL	10%

The upper line flashes. Press keypad 3, the upper r.h. panel 2 will start flashing. By leafing through with keypad 5 and 6, the battery type is selected. The upper line will start flashing when confirming with keypad 13. Press keypad 1, the lower line will start flashing. By leafing through with keypad 5 (keypad 6 for turning pages back), the following indications will appear in the lower line:

WARN. LEVEL	10%
CUTOUT MODE	0
CUTOUT	1,94V

Reset adjustment:

Press keypad 4 (panel 4 will start flashing), reset with keypads 5 and 6 and confirm with keypad 13.

Cutout

The cell voltage is now adjusted (1,70V....2,00V) for a discharged battery in which case the preset cutout or disconnect function is triggered.

Standard adjustment 1,94V

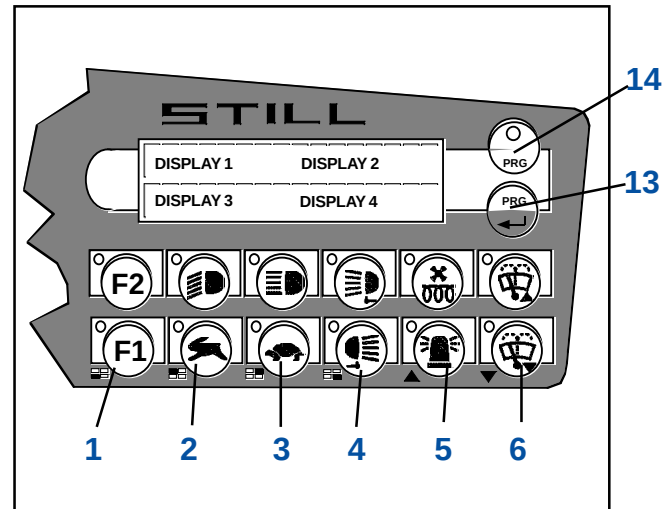
Cutout mode

- 0: No cutout (disconnection)
- 1: Hoisting at creep speed
- 2: Driving and hydraulics function on emergency
- 3: Driving function on emergency

Adjustments other than the ones mentioned above are liable to cause malfunction.

Warn. Level

Adjusting the discharge warning threshold in % (0%....40%) of useable battery capacity. A visual warning is provided via the display.

Console – Plane text parameter**Number of drive programmes**

The number of drive programmes the driver can select can be prest.

MAXPROGRAMS	5
-------------	---

Individually adjustable drive programmes

There exist 5 drive programmes that are individually adjustable.

PROG	1
VMAX,FW	8,0km/h

By leafing through with keypad 5 (keypad 6 for turning pages back), the following indications will appear in the lower line:

VMAX,FW	8,0km/h
VMAX,RV	8,0km/h
BESCHL,FWD	67%
BESCHL,REV	67%
VERZOE,FW	67%
VERZOE,REV	67%
MODE	0
ZERO BRAKE	50%

Zero braking adjustment

Zero braking is only possible in torque-controlled operation.

MODE	2
------	---

- 0: No zero braking
- 2: torque-controlled

Settings other than those indicated above are liable to cause malfunction.

ZERO BRAKE	50%
------------	-----

Adjustable from 0% to 150% in stages of 10%

10% acceleration fade-out

50% deceleration such as f.i. coasting on a level ground until truck comes to a standstill

150% perceivable braking action

Adjustments, driving control

Single- or two-pedal control, drive motor configuration as well as travel sender (accelerator pedal transmitter) characteristic curve are adjustable.

DRIVE	
MODE	5

By leafing through with keypad 5 (keypad 6 for turning pages back), the following indication will appear in the lower line:

ACCEL. X	25%
ACCEL. Y	25%
MODE	5

Mode

Serves to adjust the configuration for the accelerator pedal transmitter.

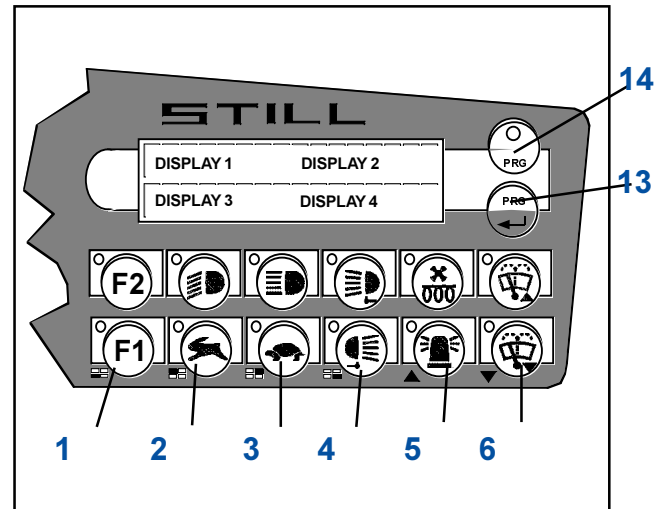
5:	single-pedal control
6:	two-pedal control

Adjustments other than those provided for are liable to cause malfunction.

Accel.

This function has not yet been released by our Engineering Department.

The characteristic curve of the accelerator pedal transmitter can be modified via accelerator pedal X and Y (even smoother acceleration).

Console – Plane text parameter**Error storage circuit**

The fault storage unit of the electronic vehicle control system memorizes the faults which have manifested within the vehicle. The last 8 faults can be displayed via the error list.

ERROR LIST	1
ERROR	80

The upper line flashes. Press keypad 2, the r.h. upper panel 2 starts flashing. Leafing through in the error list is by pressing keypad 5 and 6. Confirm with keypad 13; the upper line flashes.

Table of contents	Page
Proportional system components, Emergency Stop	48
Proportional system components, control	49
Horn control	50
Hydraulic controller	51
Communication – Safety function	52
Parameterisation	53
Controller renewal	54
Control valve block	55

Proportional system components, Emergency Stop

Design of the proportional system

The proportional system (Joystick system) consists of the following electronic components:

- Multifunction lever (Joystick)
- Hydraulic controller 2A7
- CAN bus power supply
- Horn control 4A1
- *Safety relay K1*
Since October 1999, replaced by integrated safety functions in the hydraulic controller 2A7

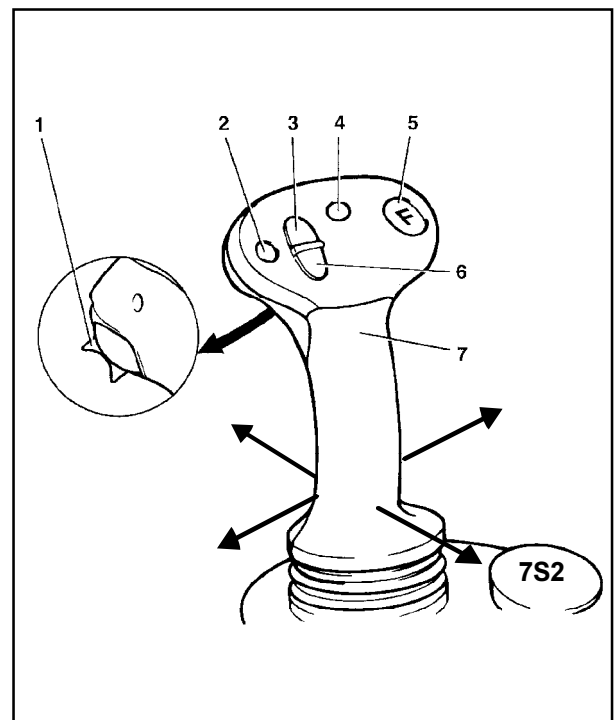
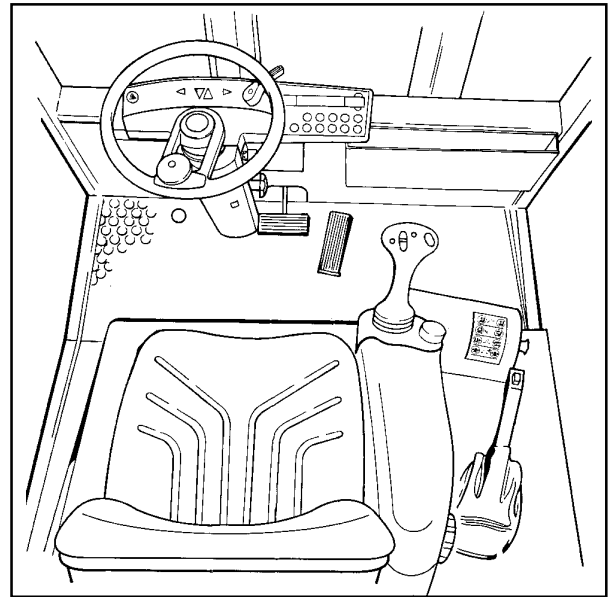
Joystick

The joystick includes the following electronic components:

- Integrated evaluation electronics
- CAN bus controller
- Emergency Stop switch (connections directly on A9)
- Joystick heating (connections directly on 2A7)

The following control functions are combined in the joystick and can be actuated by the driver with the right hand.

- | | |
|-----------------------|-------|
| • Forward/Reverse | 7 |
| • Left/Right | 7 |
| • Balance | 1 |
| • Fine control (Zoom) | 4 |
| • Direction switch | 3 / 6 |
| • Horn button | 2 |
| • Function button | 5 |



Emergency Stop switch 7S2

- Red Emergency Stop switch, right next to the joystick
- All vehicle functions can be deactivated by actuating the switch
- Functions can be reactivated by pulling out the Emergency Stop switch
- The Emergency Stop switch is jointly connected at the heater for the joystick via the 4-pole connector X49 to the hydraulic controller 2A7
- The actuated/closed switch simultaneously applies +48 V to:
 - terminal 2X1/4 of the hydraulic controller 2A7
> disabling of hydraulic function
 - terminal X11/2 of vehicle controller A9
> stopping of drive

On activation of the Emergency Stop switch, an appropriate message appears on the console display when the pedal is pressed with the direction selected.

Proportional system components, control

Controller 2A7

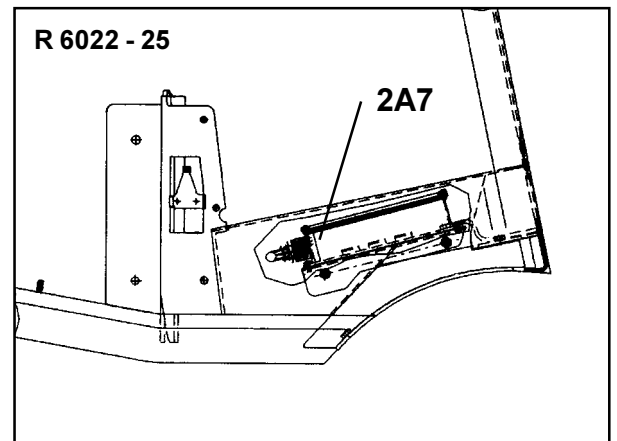
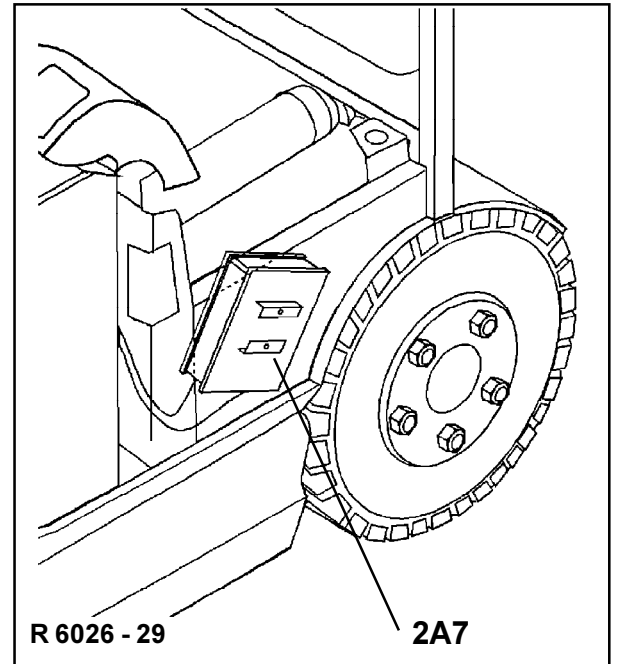
- Installation on the right on the lateral part chassis under floor plate.

includes:

- Control electronics
- Power electronics for lifting magnets
- Heater connections for Joystick

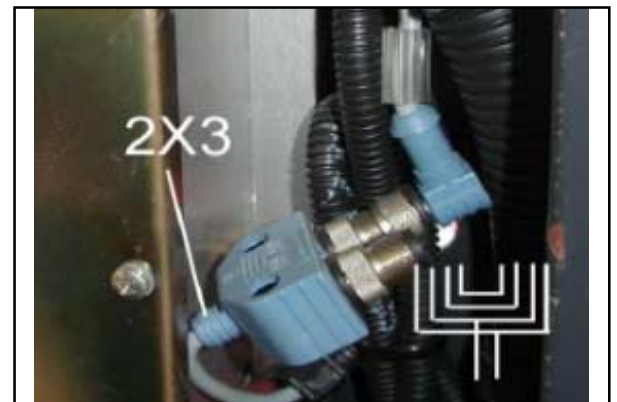
Safety relay K1

- Controlled via seat contact switch 7S1 it prevents lowering of the load when the drivers seat is unoccupied.
- **Since October 1999**
Safety relay K1 omitted, function integrated into hydraulic controller.



CAN bus 24V power supply

- Via T connection to CAN bus cable of the vehicle controller A9 in the steering column.



Horn control

Horn control 4A1

The control 4A1 enables the horn to be actuated from both the joystick and the horn button in the centre of the steering wheel or in the floor plate - without switching over or rearrangement.

The horn control is a closed block with three plug-in connections.

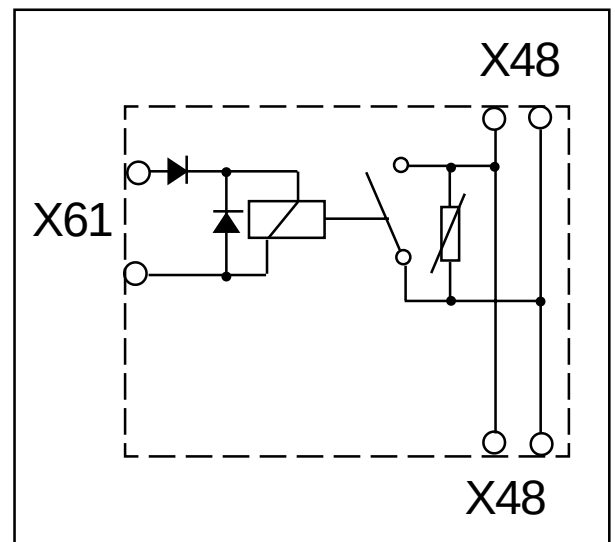
The block includes a 12-24V relay and semiconductor for switching.

**Function**

Via the horn button on the joystick, the relay coil is connected to operating voltage via connector X61. The relay contact is connected to the terminals of connector X48 and so arranged in parallel with the horn button in the floor plate.

In the event of failure of the control 4A1, connectors X48 can be disconnected from the block and directly interconnected.

The horn is then only actuated via the horn button in the floor plate.



Hydraulic controller

Hydraulic controller 2A7

The hydraulic controller 2A7 features a micro-processor control (16Bit) and processes the signals of the multifunction lever.

The multifunction lever is connected to the controller 2A7 via a CAN bus cable via socket 2X2.

The 24V power supply of the hydraulic controller 2A7 takes place via the CAN bus socket 2X3. This CAN bus cable is connected to the CAN bus main cable (vehicle controller A9) via a tee unit.

The hydraulic controller 2A7 includes:

Power electronics

for controlling the lifting magnets

Control electronics

The following signals are received and output:

Joystick**Zoom**

Lifting magnets 2Y1-10

Hydraulic motor speed

Driving direction

Horn button control 4A1

Joystick heater 9S3

Emergency Stop 7S2

CAN bus socket 2X2

1 – Bus signal about 2-3V

2 – Bus signal about 2-3 V

3 – 24V

4 – GND

CAN bus socket 2X3

24V power supply

1 –

2 –

3 – 24V

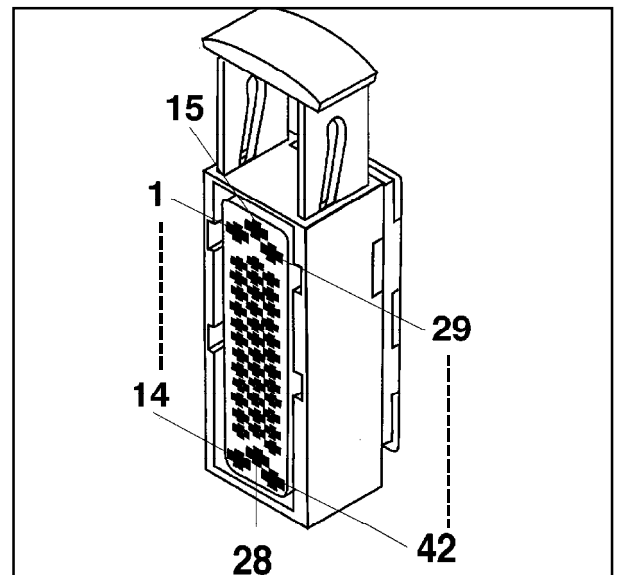
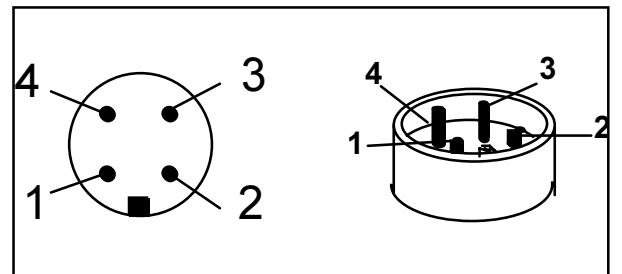
4 – GND

SAAB connector 2X1

Control cables, 42-pole



CAN bus socket 2X2 , 2X3



CAN bus connections

The hydraulic controller 2A7 communicates with the joystick exclusively via the CAN bus cable 2X2. A CAN bus connection to the vehicle controller A9 does not exist. Both controllers operate independent of the other and may not be interconnected via the CAN bus.

The CAN bus cable 2X3 serves solely for the 24V supply and does not transfer any information. Interchanging the CAN bus cables 2X2 and 2X3 at the controller is safe.

Communication

The control commands for the driving direction and the set value for the hydraulic speed are output by the joystick and sent via the CAN bus 2X2 to the hydraulic controller 2A7.

From the hydraulic controller 2A7, this information is passed on to the vehicle controller A9 via the following cables:

- Forward
2A7 2X1/16 – A9 X11/18
- Reverse
2A7 2X1/13 – A9 X11/33
- Hydraulic speed
2A7 2X1/12 – A9 X11/19

Communication – safety function

Safety function

The “*hydraulics shutdown with non-actuated seat switch*” safety function is available in two variants. Distinction is made between the variants “*External safety relay K1*” and “*Integrated safety function*”.

External safety relay K1

The relay K1, depending on the switching status of the seat switch 7S1, is controlled by the vehicle controller A9 and is connected in series with the Emergency Stop switch 7S2. With a non-actuated seat switch, the Emergency Stop circuit of the hydraulic controller 2A7 is interrupted and the hydraulics are shutdown.

- Emergency Stop circuit K1
2A7 2X1/4 – A9 X11/9

Note

For controlling the relay K1, the output of the optional relay K1 is used. In this variant, the relay K1 cannot be used for the additional electronics.

Integrated safety function

Since October 1999, the safety function is integrated into the hydraulic controller 2A7.

Depending on the switching status of the seat switch 7S1, a voltage level between 0V and 24V is output to the hydraulic controller 2A7 by the vehicle controller A9. The hydraulic controller 2A7 evaluates the voltage level and shuts down the hydraulics when the seat switch is not actuated.

- Emergency Stop circuit
2A7 2X1/6 – A9 X11/32

Note

In this variant, the relay K1 is unnecessary, so that the relay K1 can be used for the additional electronics.

Parameterisation

Parameterisation

All parameter changes for the hydraulic controller 2A7 and joystick can only be made via parameterisation of the service notebook.

As no CAN bus connection to the console exists, all changes made here are without effect.

Note:

In the console, the usual indications can be selected in the display. However, the indicated speed values bear no real relation to the actual hydraulic speeds.

HYDRAULIC	
LIFT	100 %
TILT	500/min
AUX.1	2550/min
AUX.2	500/min

Hydraulic speeds

The set value for the hydraulic speeds is transferred by the hydraulic controller 2A7 to the vehicle controller A9 via the "additional hydraulics1" connection.

2A7 2X1/12 – A9 X11/19

This means that all hydraulic speeds are only transferred via the "additional hydraulics1" connection. The speed value for the additional hydraulics1 set in vehicle parameterisation defines the maximum permissible speed for all hydraulic functions.

Standard value: max 2550 rpm

Note:

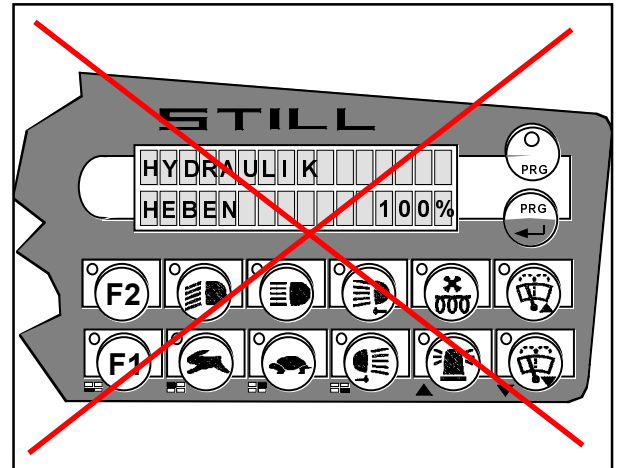
To ensure reliable operation, the standard value for the additional hydraulics1 should be set in vehicle parameterisation to the maximum permissible speed.

Hydraulic limitation

Via vehicle parameterisation, further hydraulic limitations can be parameterised. However, the parameterised hydraulic limitation is then active for all hydraulic functions, as the vehicle controller A9 only processes one speed signal.

Note:

Parameterised hydraulic limitations are always active for all hydraulics functions!



Conversion to joystick

If a vehicle is subsequently converted to the joystick system, the following addresses must be changed in the vehicle software.

Address	08A	Direction preselection
Value	00	only 2-pedal
	01	only 1-pedal
	03	via console and joystick
	04	via joystick

Address	128	Hydraulic configuration
Value	40	Hydraulic speed via hydraulic controller

Address	12A	Max. pump speed
Value	FF	max. 2550 rpm

For direction preselection via joystick, the direction switches on the console must be replaced with covers.

Transfer of direction information:

Forward		
2A7 2X1/16	–	A7 X11/18
Reverse		
2A7 2X1/13	–	A7 X11/33

Error messages

At transmitter voltages less than 2.0V and above 7.89V, the vehicle controller A9 detects a fault and generates an error message.

Controller renewal

Replacement of hydraulic controller 2A7

To avoid malfunctions, it is important to note the system used on the respective vehicle.

Distinction is made between the variants "External safety relay K1" (old) and "Integrated safety function" (series since October 1999).

When installing a hydraulic controller variant "Integrated safety function" in a vehicle variant "External safety relay K1", two retrofitting solutions are generally possible:

Continue to use variant "External safety relay K1":

- Check/change parameterisation
- Joystick parameterisation, page *Note/Extras* - safety function seat switch:

Value 12 (Hydraulic controller with external relay)

- Vehicle parameterisation, page *Reserve Block 5*
Input channel: *Driver seated*
Output channel: *Relay K1*

Conversion from variant "External safety relay K1" to variant "Integrated safety function"

- Establish cable connection from A9,X11/32 to 2A7,2X1/6.
- deactivate external relay K1
- Check/change parameterisation

- Joystick parameterisation, page *Notes/Extras* - Safety function seat switch:

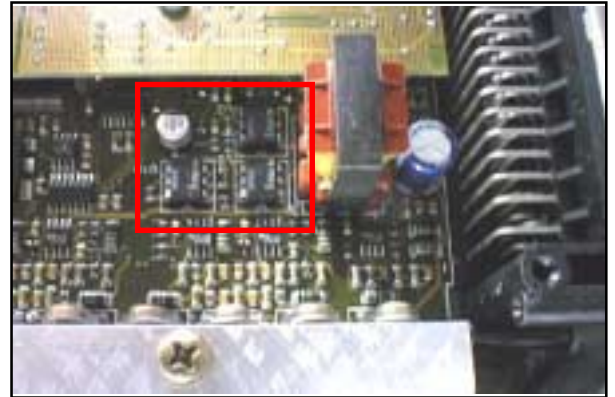
Value 0 (Hydraulic controller with internal relay)

- Vehicle parameterisation, page *Reserve Block 5*
Deactive input and output channel

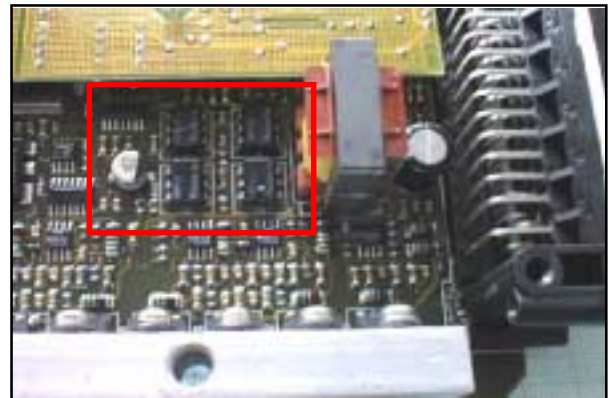
Differences between hydraulic controllers

By unscrewing the housing cover, a check can be made to see which controller hardware is provided if the controller is not clearly identified by a number.

Hydraulic controller variant "External safety relay K1"



Hydraulic controller variant "Integrated safety function" (series since October 1999)



Control valve block

Hydraulic lifting magnets 2Y1 – 2Y10

The actuating mechanism of the hydraulic valves consists of single and two-way acting lifting magnets.

The following lifting magnets are available:

- 2Y1 Lifting magnet, lifting
- 2Y2 Lifting magnet, lowering
- 2Y3 Lifting magnet, tilt back
- 2Y4 Lifting magnet, tilt forward
- 2Y5 Lifting magnet, additional hydraulics 1
- 2Y6 Lifting magnet, additional hydraulics 1
- 2Y7 Lifting magnet, additional hydraulics 2
- 2Y8 Lifting magnet, additional hydraulics 2
- 2Y9 Lifting magnet, release
- 2Y10 Lifting magnet, additional function

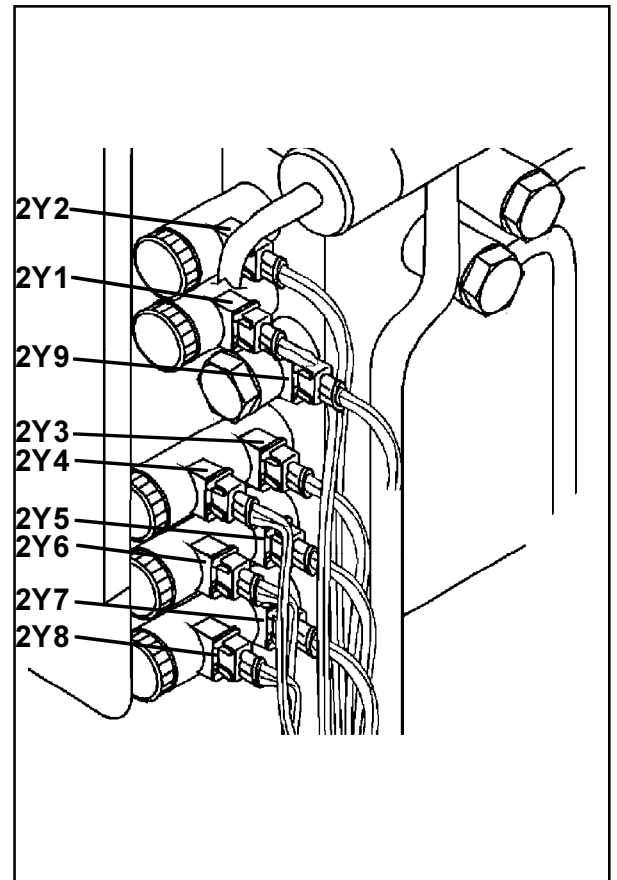
When a hydraulic function is actuated via the joystick, a current of 0 – 1.5A is applied to the magnet coil. The produced magnetic field moves a magnet core in the pressure pipe, which opens the proportional valve. The current of 0 - 1.5A corresponds to an actuator travel of 0 - 100%.

Electrical connection of the lifting magnets respectively takes place via a 2-pole timer plug.

PIN 1: Transformer

PIN 2: Pulse width modulator

The lifting magnets are connected to the controller 2A7 via the connector 2X1.

**Test**

An extensive electrical test is only possible with the aid of the diagnostic system!

Release valve 2Y9

The release valve 2Y9 is a safety valve which prevents accidental actuation of the way valves (e.g. accidental actuation of the joystick when opening the hood)

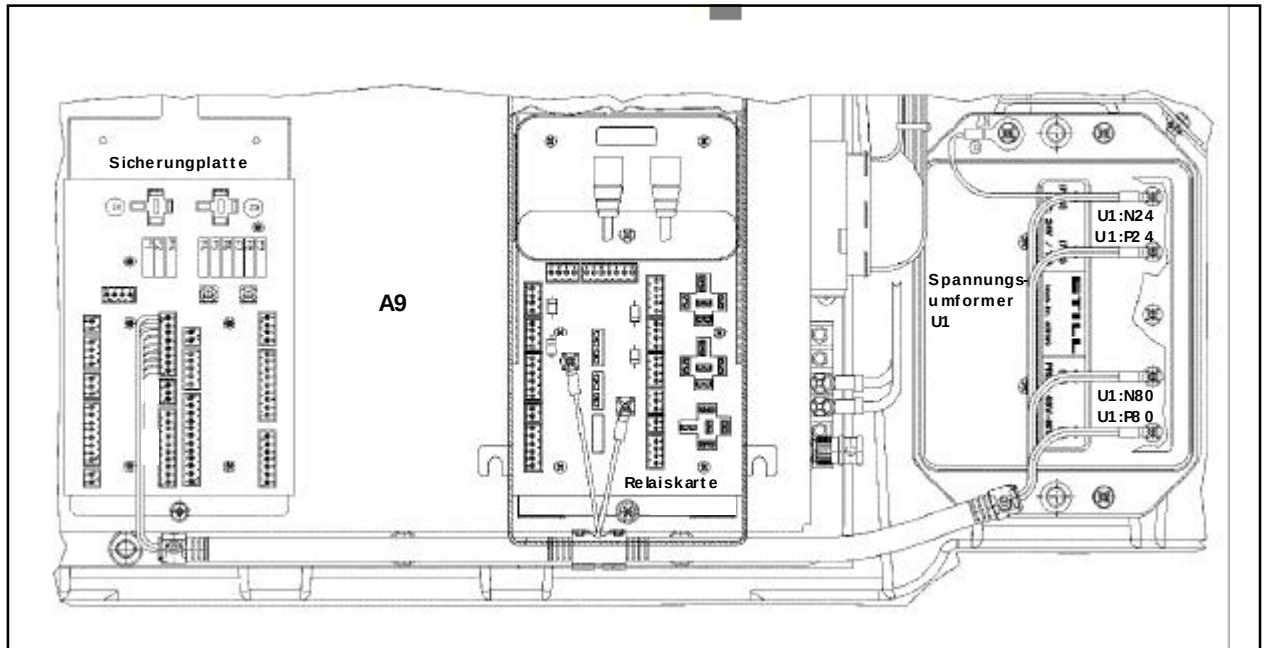
The release valve is only active when the driver's seat is occupied and the seat contact switch 7S1 is actuated.

Function/Adjustment/Replacement

A detailed description of the proportional way valves is provided under Group 10.

Table of contents	Page
Lighting system design	2
Variants	
Status A: Controller, distributor panel	2
Status B: Controller, relay box, distributor panel	2
Status C: Controller, 2 x relay boxes	2
Transformer	3
Relay box	4
Distributor card/panel	5
CAN-Bus connections	6
Controller R60S20	
Parameterisation via console	7
Lighting/additional electrics	
Controller R60S60	
Variants additional electrics	18
Parameterisation via console	19

Configuration of the optional electrical equipment



Configuration of the optional electrical equipment

On truck models in this range, electrical loads such as working lights, windscreen wipers, heater, lighting, etc. are supplied by

- relays K1 and K2 on fuse carrier A7
- distributing circuit board
- control relay board and distributing circuit board
- 2 control relay boards

Electrical consumers with an operating voltage of 24Volt (48 Volt) can be connected. The electrical consumers are operated by pressing keypads integrated into the console and/or by switches/transmitters of the electrical system.

The control relay board / control relay boards are driven by controller A9 via the CAN bus. The wiring harness for the distributing circuit boards and control relay boards is pre-installed in the truck. For retrofits, only the electrical connection between the consumer and the corresponding distributing circuit / relay board is required.

Variants Controller R60S20

There are three different equipment variants for the lighting or optional electrical equipment.

Variant A

80 Volt version:

Controller A9, fuse carrier A7 with relays K1 and K2 and/or distributing circuit board (front scuttle)

24 Volt version:

Controller A9, fuse carrier A7 with relays K1 and K2, voltage converter U1 and/or distributing circuit board (front scuttle).

Variant C

Controller A9, fuse carrier A7, voltage converter U1, control relay boards (counterweight and front scuttle).

Transformer

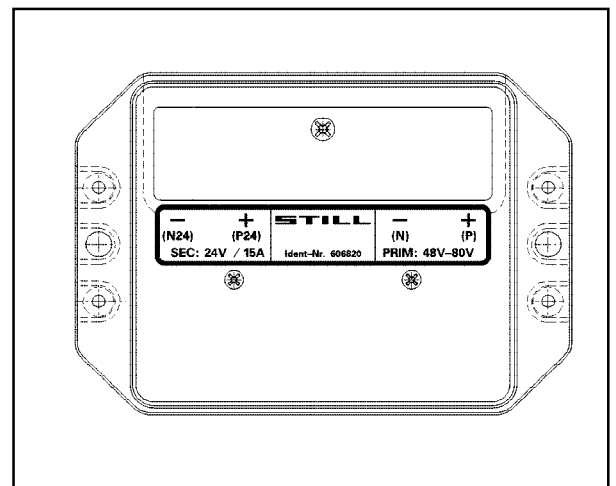
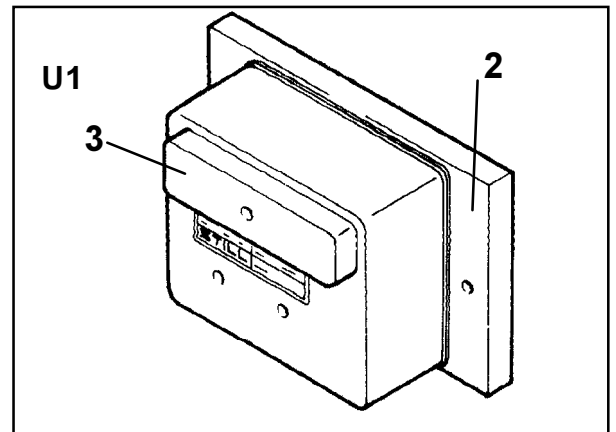
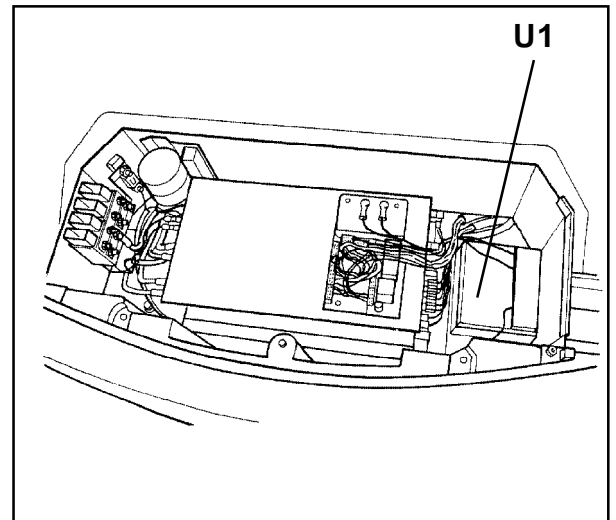
Transformer

The transformer (item 1) supplying 24 volts to electrical consumers is fitted.

The transformer is located in the counterweight at the r.h. side of the controller.

An aluminium heat sink (item 2) is mounted to the underside of the transformer. The heat sink is bolted to the counterweight for improved heat dissipation.

The electrical connections are made via bolted connections which are accessible after removal of the cover (item 3).



Technical Data	
Type	80V/24V
Input voltage range	35V....120V
Output voltage	24V regulated
Output current 100% cont. duty	15 A
Output power 100% cont. duty	360 W
Overload capability	Short-resistant
Residual ripple	20 mV _{RMS}
Overload behaviour	Current limitation at approx. 23 A
Overvoltage behaviour	Cut-off at approx. 140 V
Undervoltage behaviour	Cut-off at approx. 33 V
Overvoltage resistance	400 V
Insulation voltage	500 V
Effectivity	81% at I _{RATED}
Frequency	25 kHz
Idle power	approx. 3 W
Temperature protection	Cut off at heat sink temp. approx. 80°C
False polarity protection	yes
Radio interference suppress.	yes
Type of protection	IP 55

Relay box

Relay board

The relay board comprises a control unit, 3 relays (24 V) and 10 power transistors for switching the electrical consumers.

Control unit

The control unit is connected to controller A9 via the CAN bus, which supplies the relay board with a signal from controller A9 for switching consumers on or off. Two LED's indicate that the relay board is operational.

Logging in the relay board over the console:

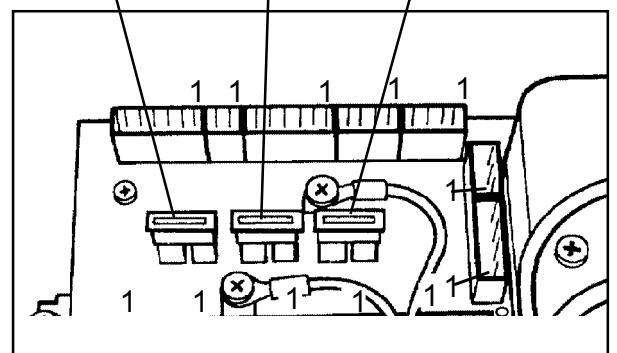
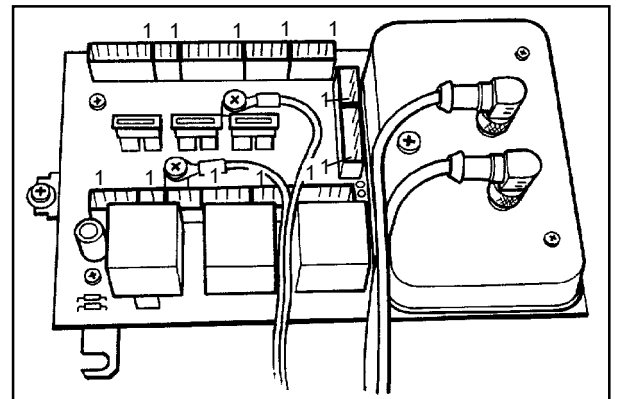
- Relay board, front
SERVICE ADDR. 0A6 – VALUE 41
- Relay board, rear
SERVICE ADDR. 0A5 – VALUE 40

The VALUES for the relay board inputs are shown in the drawing. Designations for the connectors to the consumers are the same on both relay boards.

Voltage supply

The front and rear relay boards are supplied with voltage, by:

- Fuse carrier A7 / voltage supply unit U1 via screw terminals X30 to the relay boards to screw terminal X77.



front: 0A6

rear: 0A5

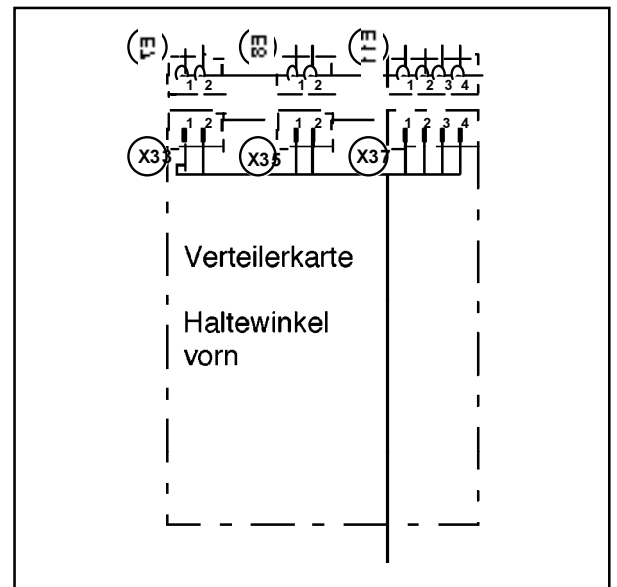
0B		
0C		
0D		
0E		
0F		
10		
11		
12		
13		
14		
18		
19		
1A		
01		X71 / 1, 3
02		X70 / 1, 3
03		X69 / 3
04		X69 / 1
05		X67 / 4, X68 / 4
06		X67 / 3, X68 / 3
07		X68 / 2
08		X68 / 1, 5
09		X67 / 2
0A		X67 / 1
15		X66
16		X65
17		X62

Distributing card

Distributing card

The distributing card replaces the distributing circuit board and takes over its functions since October 1999.

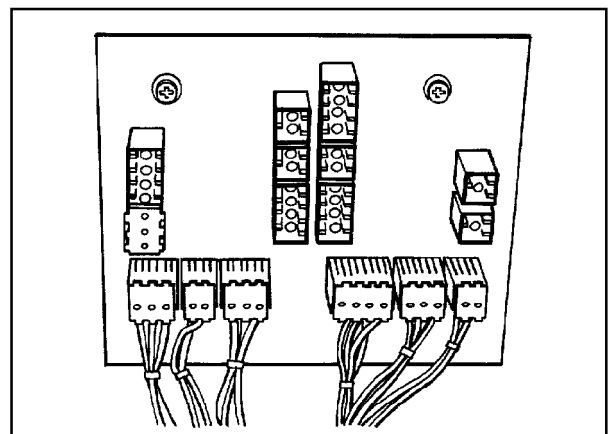
The distributing card consists of an angled holding plate with inserted connectors and takes over the distribution of the power supply for the consumers.



Distributing circuit board

The distributing circuit board is used for variants A for lighting and optional electrical equipment when only one or two consumers are switched on and off.

The function of the distributing circuit board is to distribute electrical power to the consumers.



CAN bus connections

The vehicle controller A9 is connected to the console directly via the CAN bus, or depending on the vehicle status, via the relay boxes.

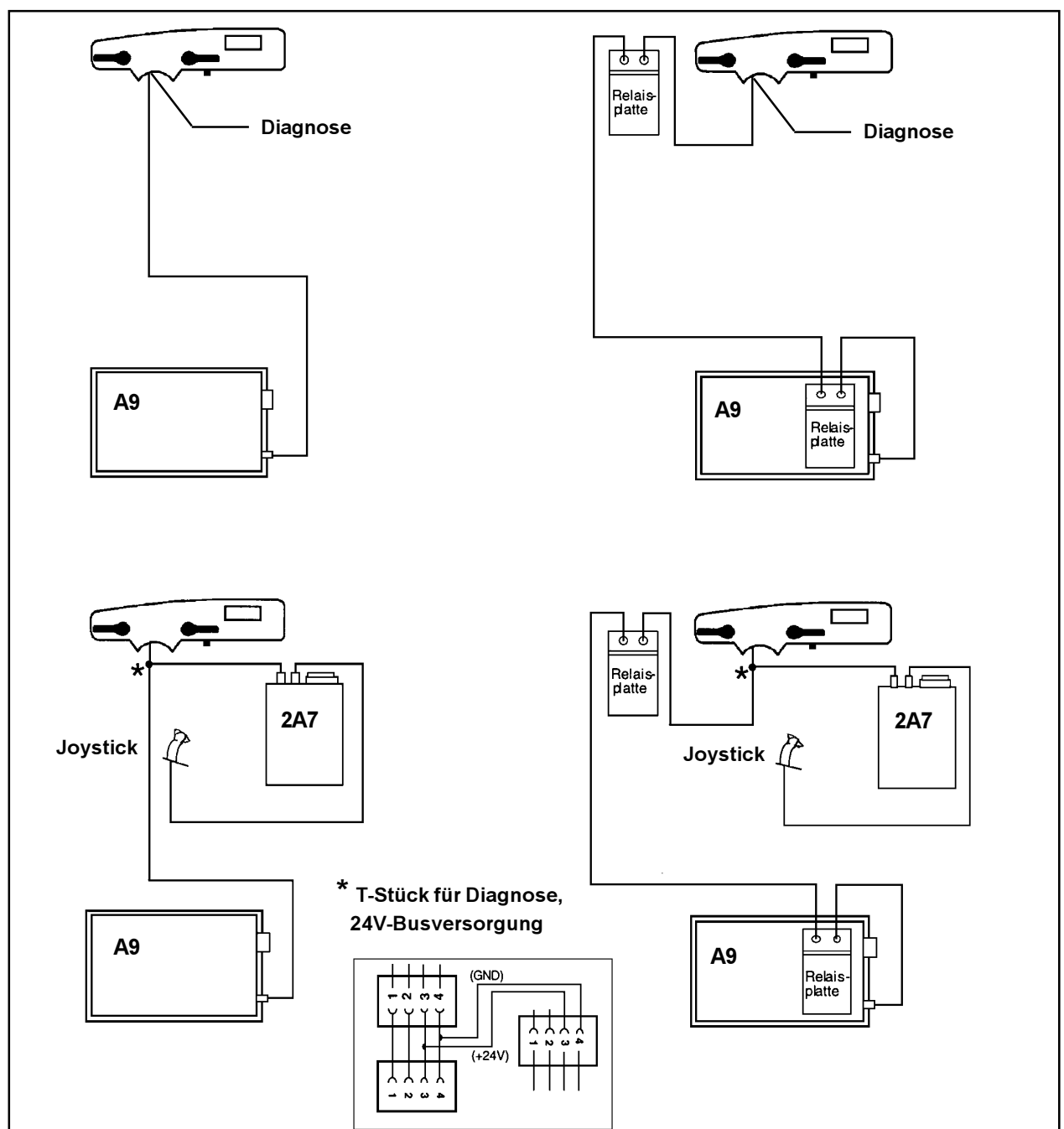
For vehicles with joystick, a second separate CAN bus circuit exists. The hydraulic controller 2A7 is connected directly to the joystick via the CAN bus. The hydraulic controller 2A7 receives the 24V supply from the vehicle controller A9 via a tee unit connection under the battery hood.

The signal cables are not looped-through. It is not possible to establish with the CAN bus connection of the console a connection to the hydraulic controller 2A7.

For diagnostic purposes, the CAN bus connection is established via the console in the case of vehicles without joystick.

In the case of vehicles with joystick, a tee unit must be inserted into the CAN bus connection below the battery hood for diagnostic purposes.

Possible CAN bus configurations are shown below.



R60S20 – Parametrization of electrical options via console

If a truck is to be retrofitted with spotlights, headlights or stop lights, the parametrization does not have to be performed with diagnostic case. The parameters of simple circuits can also be set via the console.

The condition for this is that the engineer is familiar with the handling of the console and has read the previous pages about parametrization.

Furthermore, for a better understanding some notes on the processing of the switching commands in the controller are necessary.

The controller has a SERVICE ADDRESS for each input and output of a functional block.

S	E	R	V	I	C	E		A	D	R	.		0	0	0	
W	E	R	T												F	F

So that the controller can recognize all keypads, switches, transmitters, relays and control relay boards, they have been assigned a VALUE.

Control relay board, front (2) has the SERVICE ADR **0A6** and the VALUE **41**.

Control relay board, rear (1) has the SERVICE ADR **0A5** and the VALUE **40**.

Registering a consumer:

First the 3-digit SERVICE ADDR. for the input of a function block and the VALUE of the desired switch are entered. Then the 3-digit SERVICE ADDR. for the **output** of this function block and the VALUE of the input channel from the control relay board or relays is entered.

Note

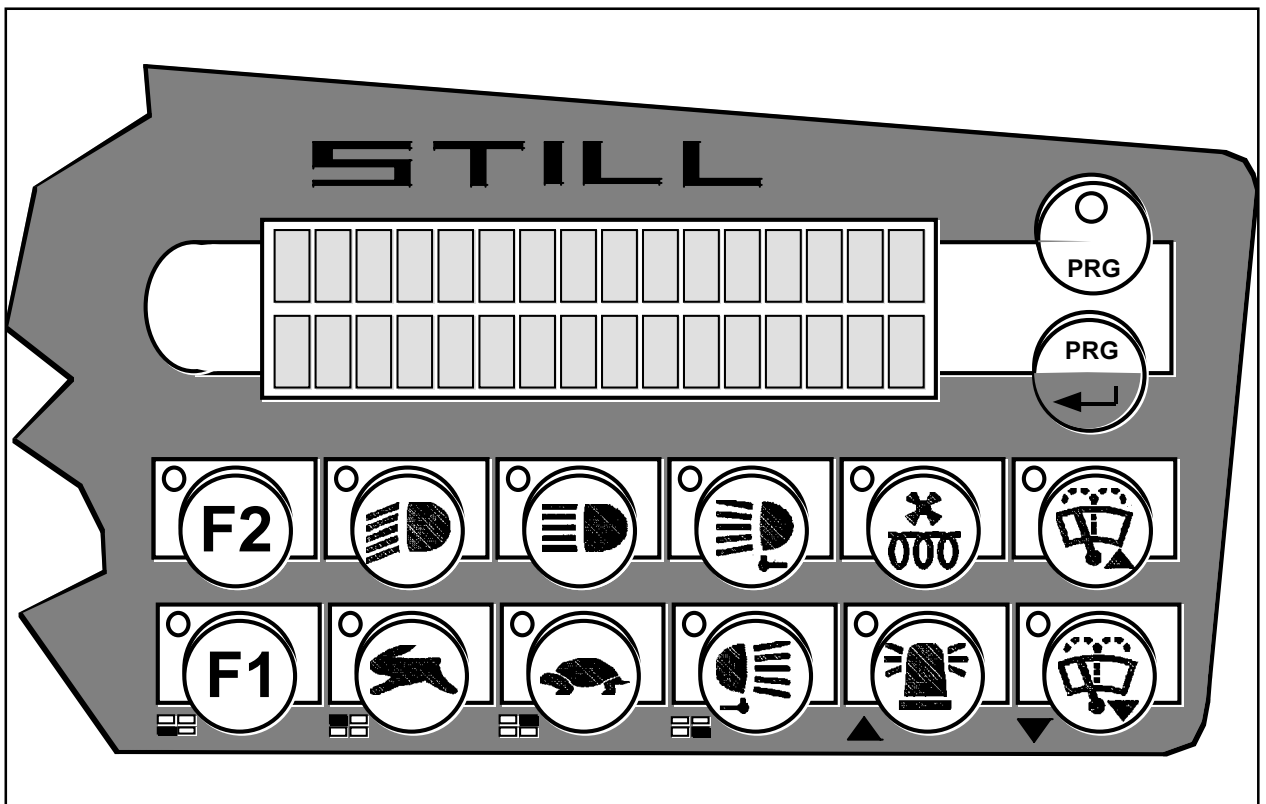
The VALUE will only be stored in memory when both characters are confirmed with PRG ← and the entire line is flashing.

Then further consumers can be registered or the inputs can be saved with a RESET.

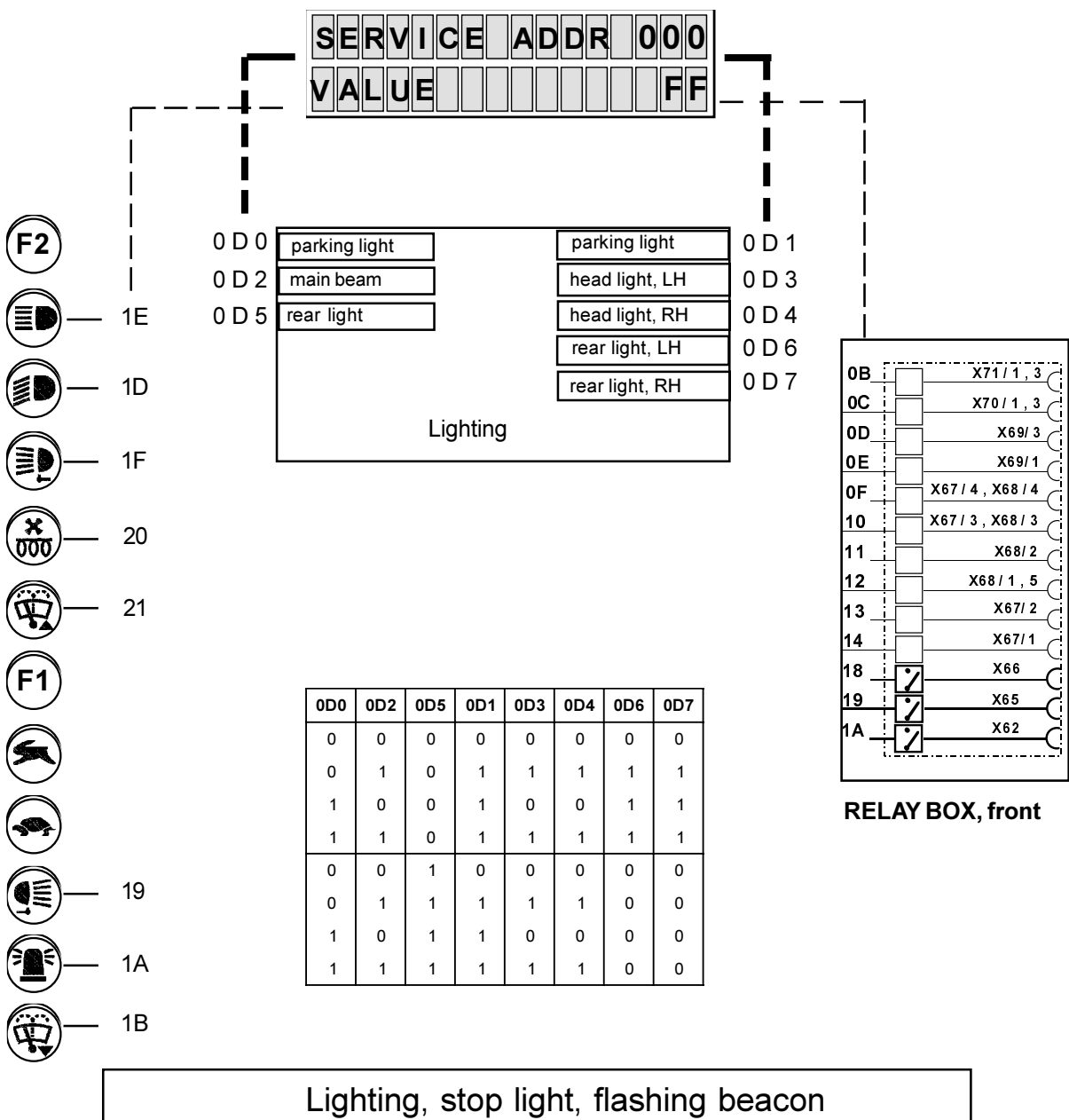
For a better overview, the SERVICE ADDR. and VALUE of frequently used function blocks, keypads, switches and transmitter are shown on the following double pages.

The selection of the relay and/or the input channel in the control relay board is done using the circuit diagrams for the lighting and optional electrical equipment in the appendix.

Relays K1 and K2 are only available with variant A.



R60S20 – Lighting / Optional electrical equipment

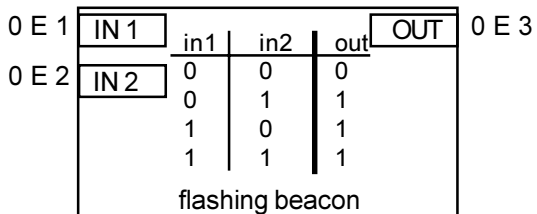
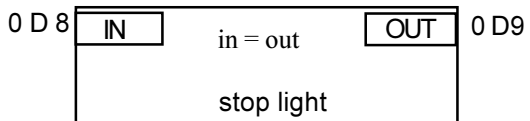
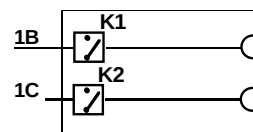


R60S20 – Lighting / Optional electrical equipment

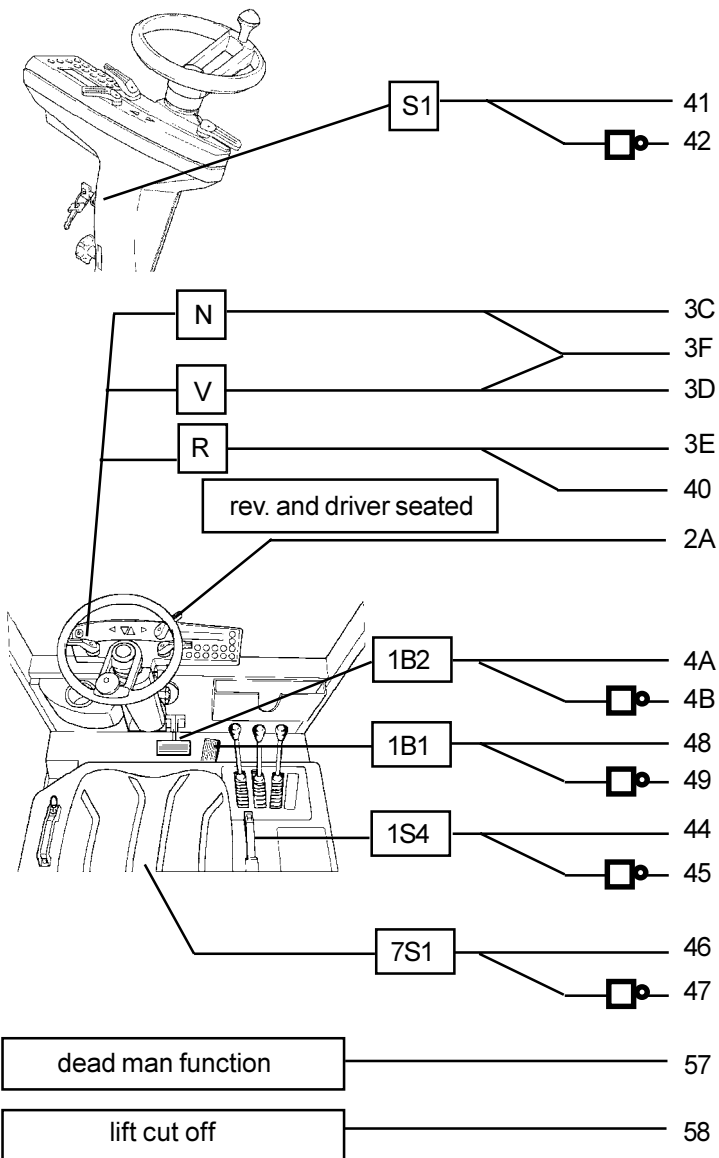
RELAY BOX, rear

01	X71 / 1, 3
02	X70 / 1, 3
03	X69 / 3
04	X69 / 1
05	X67 / 4, X68 / 4
06	X67 / 3, X68 / 3
07	X68 / 2
08	X68 / 1, 5
09	X67 / 2
0A	X67 / 1
15	X66
16	X65
17	X62

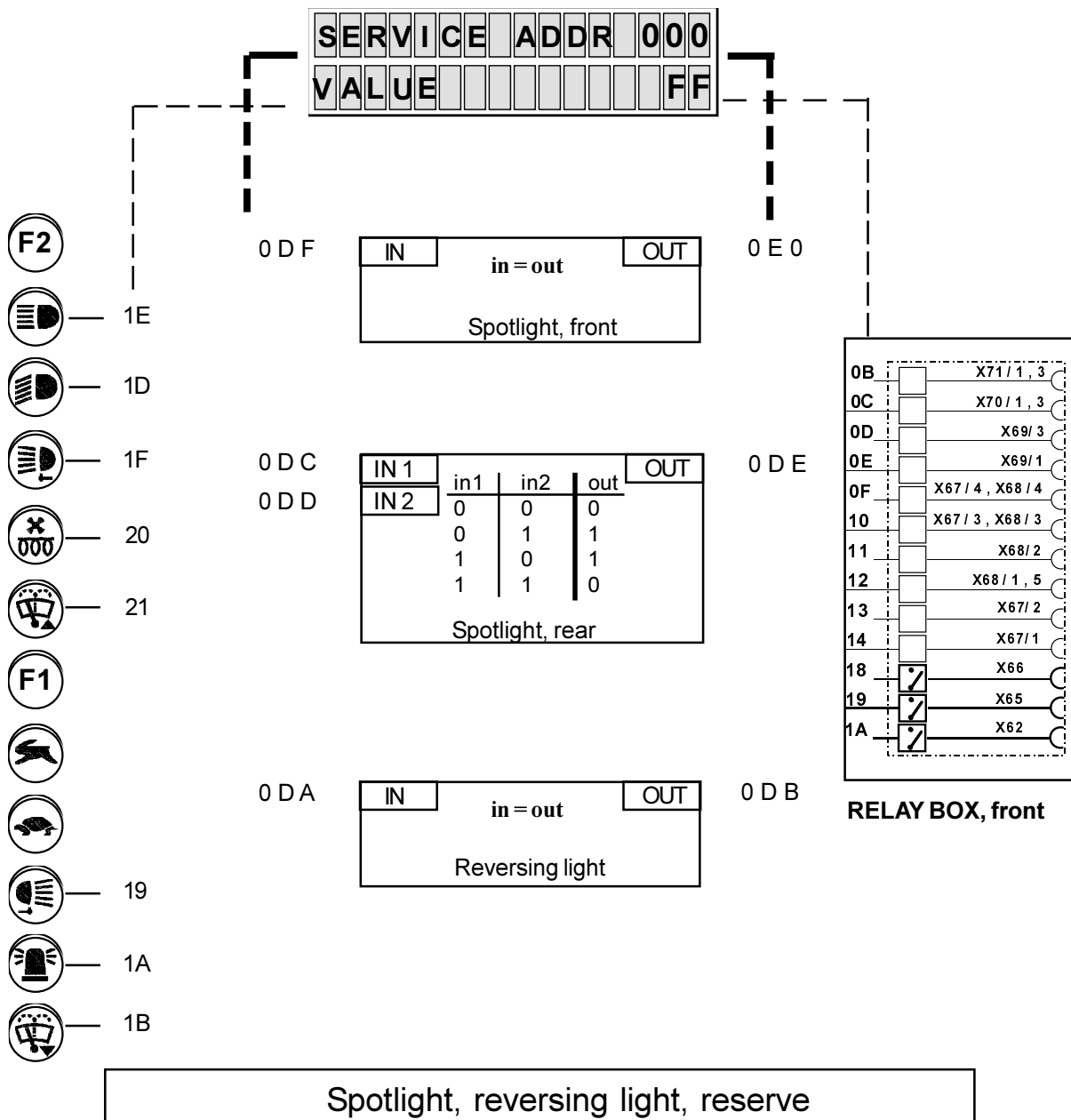
fuse board



= VALUE, when actuated
 = VALUE, when NOT actuated

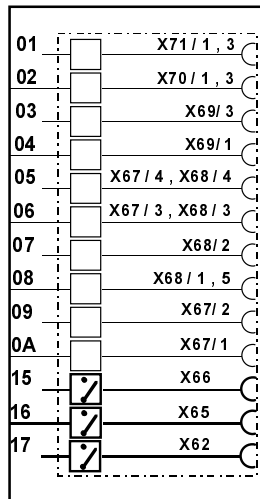


R60S20 – Lighting / Optional electrical equipment

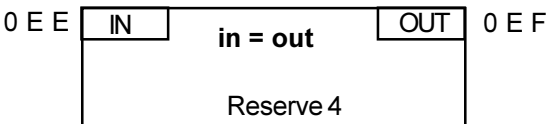
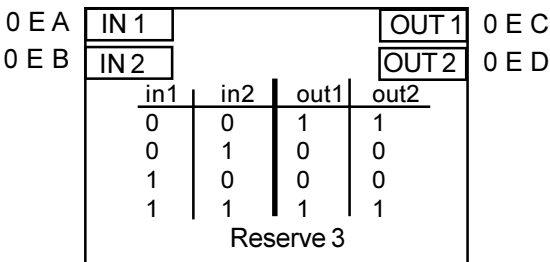
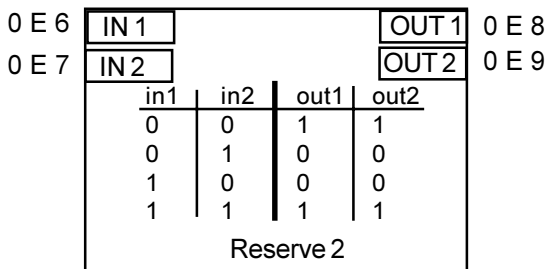
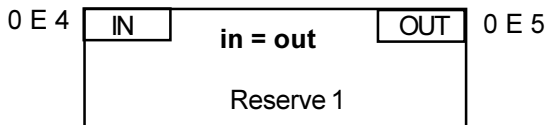
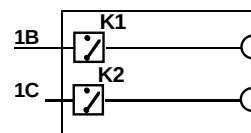


R60S20 – Lighting / Optional electrical equipment

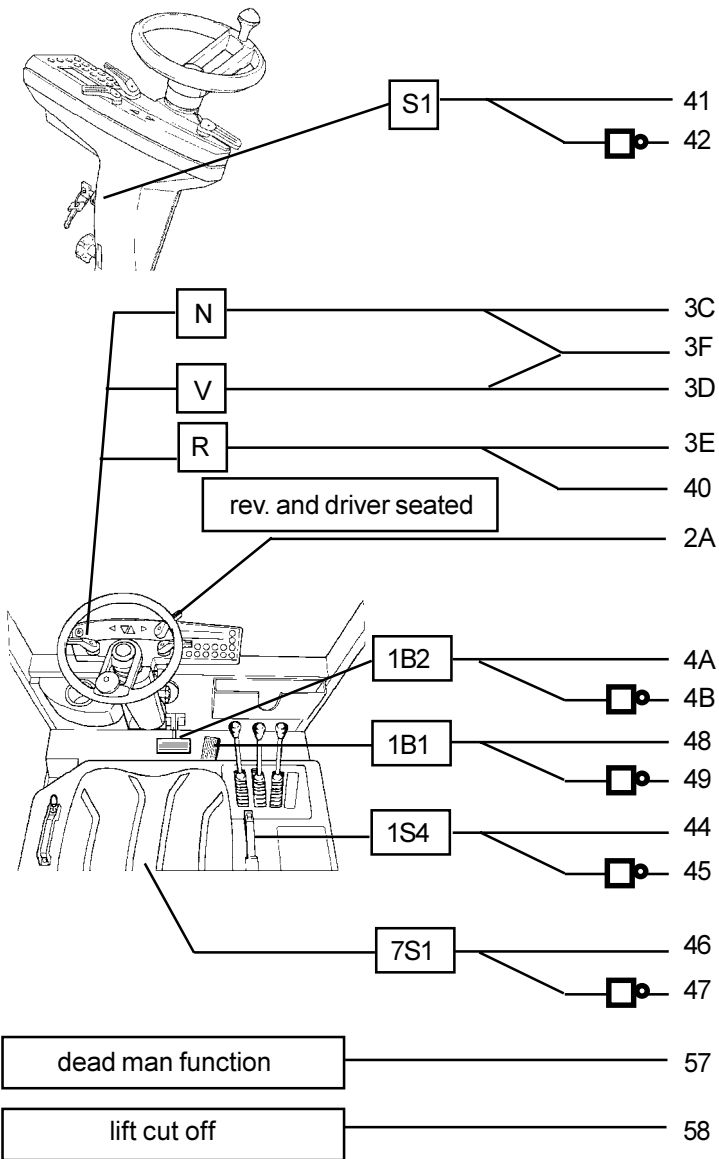
RELAY BOX, rear



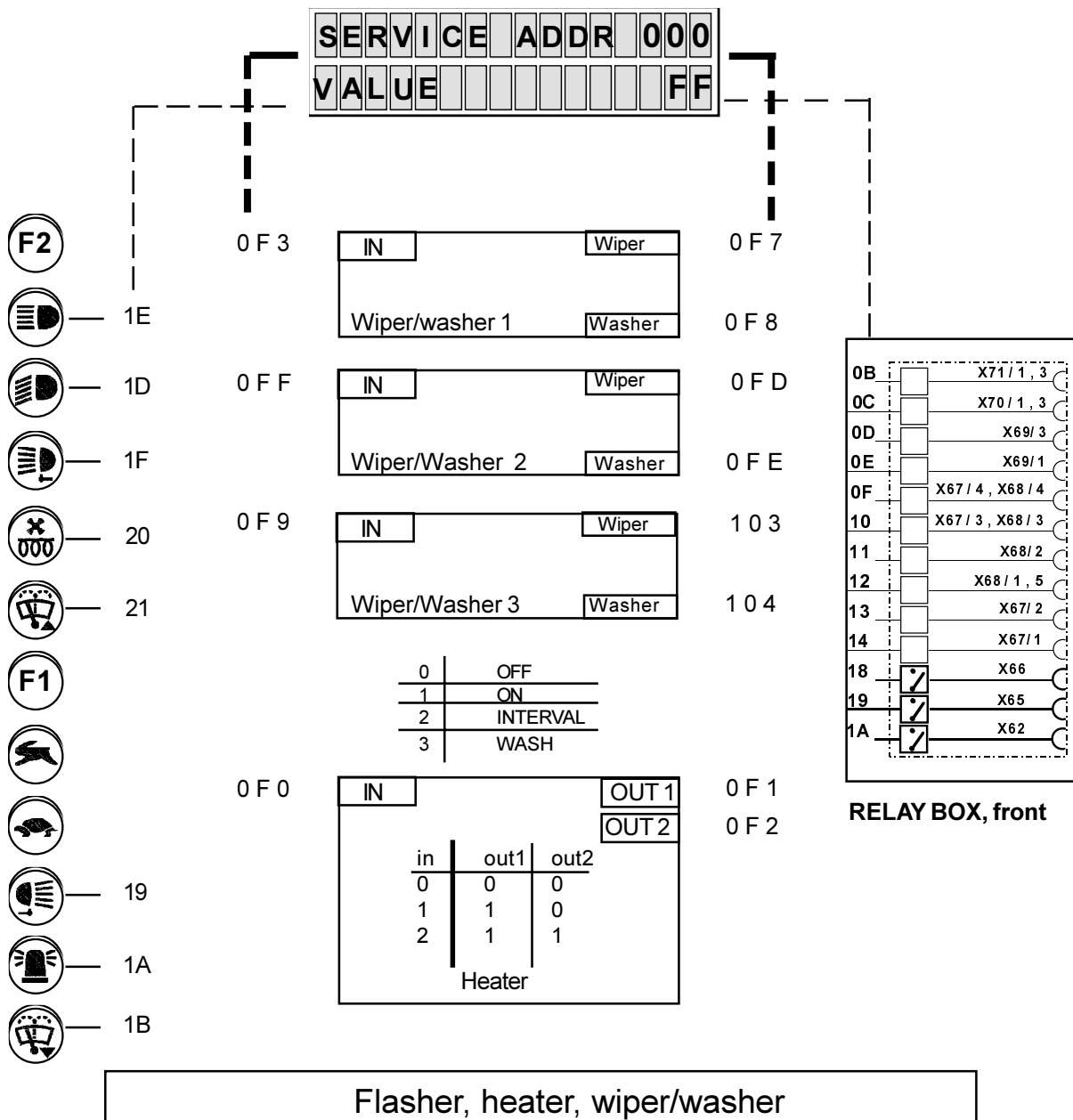
fuse board



— = VALUE, when actuated
 = VALUE, when NOT actuated



R60S20 – Lighting / Optional electrical equipment

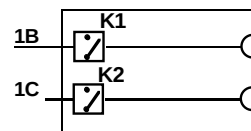


R60S20 – Lighting / Optional electrical equipment

RELAY BOX, rear

01	X71 / 1, 3
02	X70 / 1, 3
03	X69 / 3
04	X69 / 1
05	X67 / 4, X68 / 4
06	X67 / 3, X68 / 3
07	X68 / 2
08	X68 / 1, 5
09	X67 / 2
0A	X67 / 1
15	X66
16	X65
17	X62

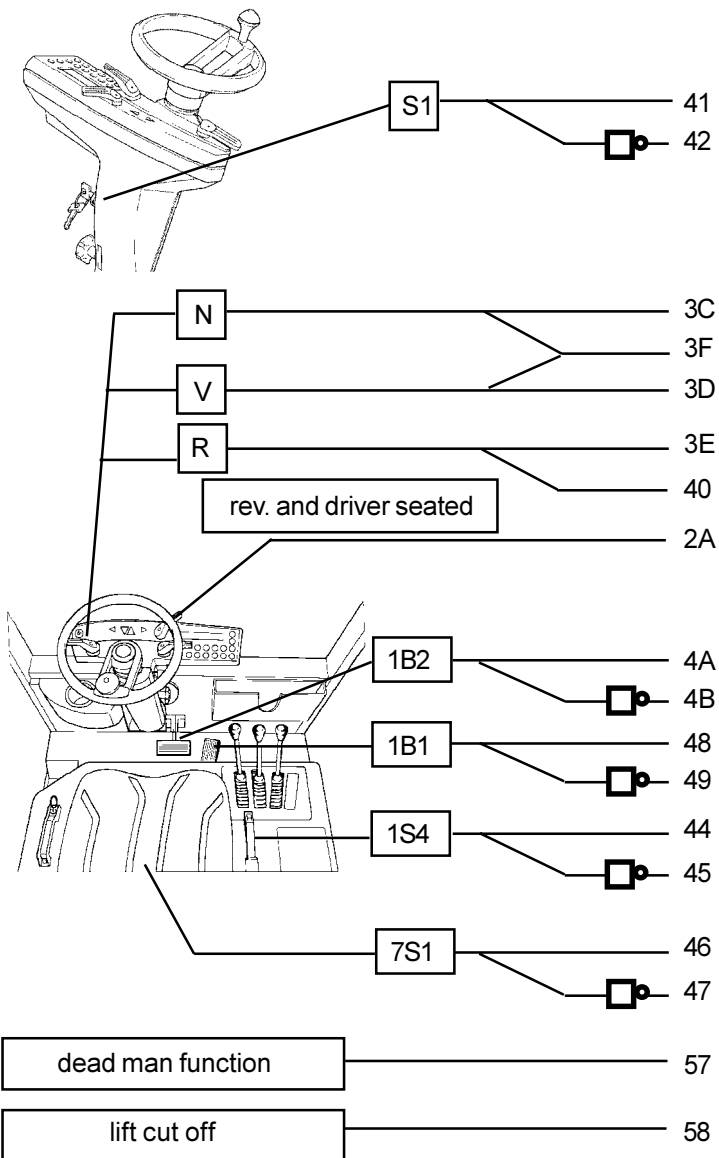
fuse board



0 C 9	RH / LH	front/right	0 C C
0 C 7	front	front/left	0 C D
0 C 8	hinten	rear/right	0 C E
0 C A	warning	rear/left	0 C F
	flasher		

Flasher

— = VALUE, when actuated
 = VALUE, when NOT actuated



R60S20 – Parameterising via the console

Interconnection of functional blocks

On the double page which follows here you will find a simplified representation of the interconnection of additional functions within the optional electrical equipment. Knowledge of the application of logic gates and truth tables is assumed when performing this type of parameterization.

The combination of different functions is effected by the simultaneous use of AND gates, OR gates and the functional blocks already dealt with, however with a VALUE on the output side.

The complete range of switches, senders, relays and relay boxes will in that case retain the VALUE assigned to each of them.

Procedure

To begin with, the 3 digit SERVICE ADDR. for the input of a functional block and the VALUE of the switch desired are entered. Then are entered the 3-digit SERVICE ADDR. for the output of that functional block and the VALUE of the input channel on the AND gate, OR gate, relay box, relay or of a different functional block. A further number of logging-in operations can then be carried out, or the entries can be stored in the memory unit by carrying out a RESET.

Relay and relay box

The choice of the relay or the input channel in the relay control board is made using the circuit diagrams for lighting and optional electrical equipment in the appendix.

Relays K1 and K2 are only available in variant A.

R60S20 – Parameterizing via the console

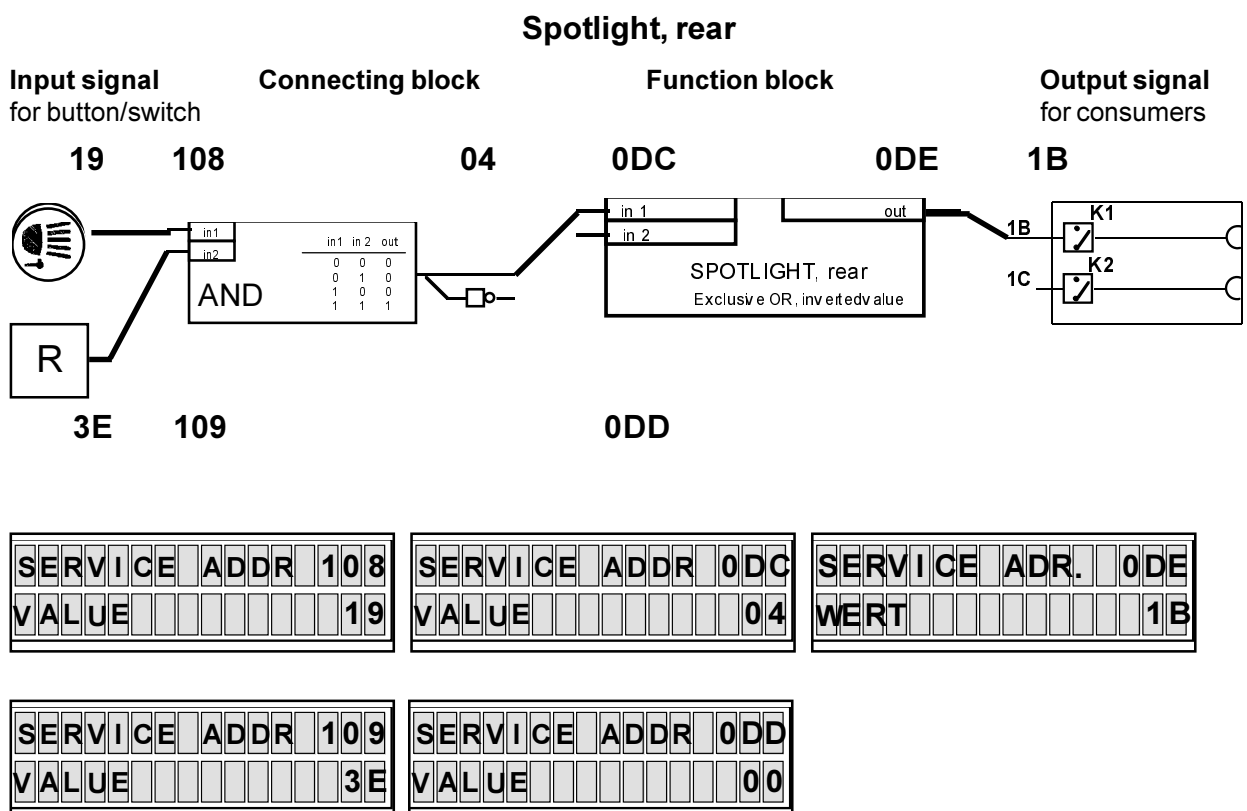
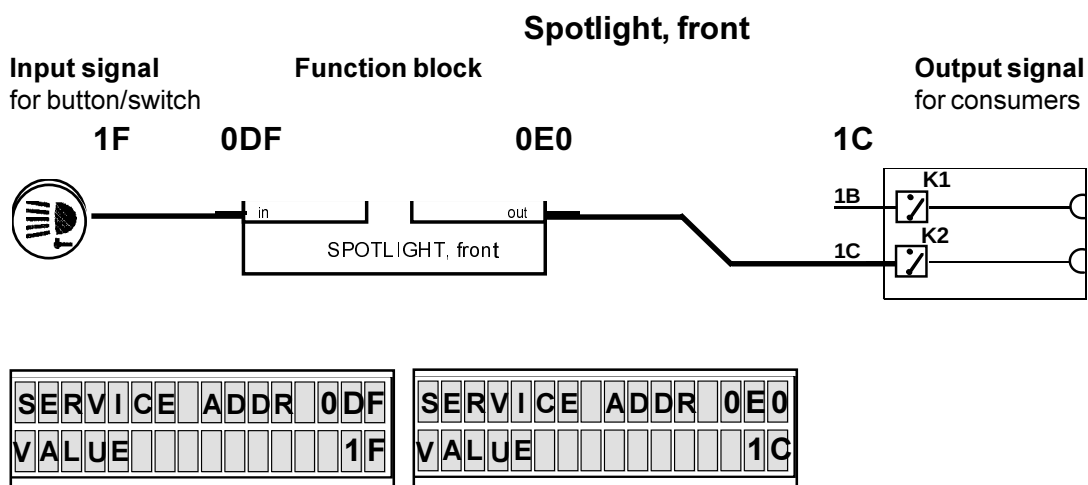
Example of parametrization

The *spotlight, front* and *spotlight, rear* are to be installed in equipment variant A.

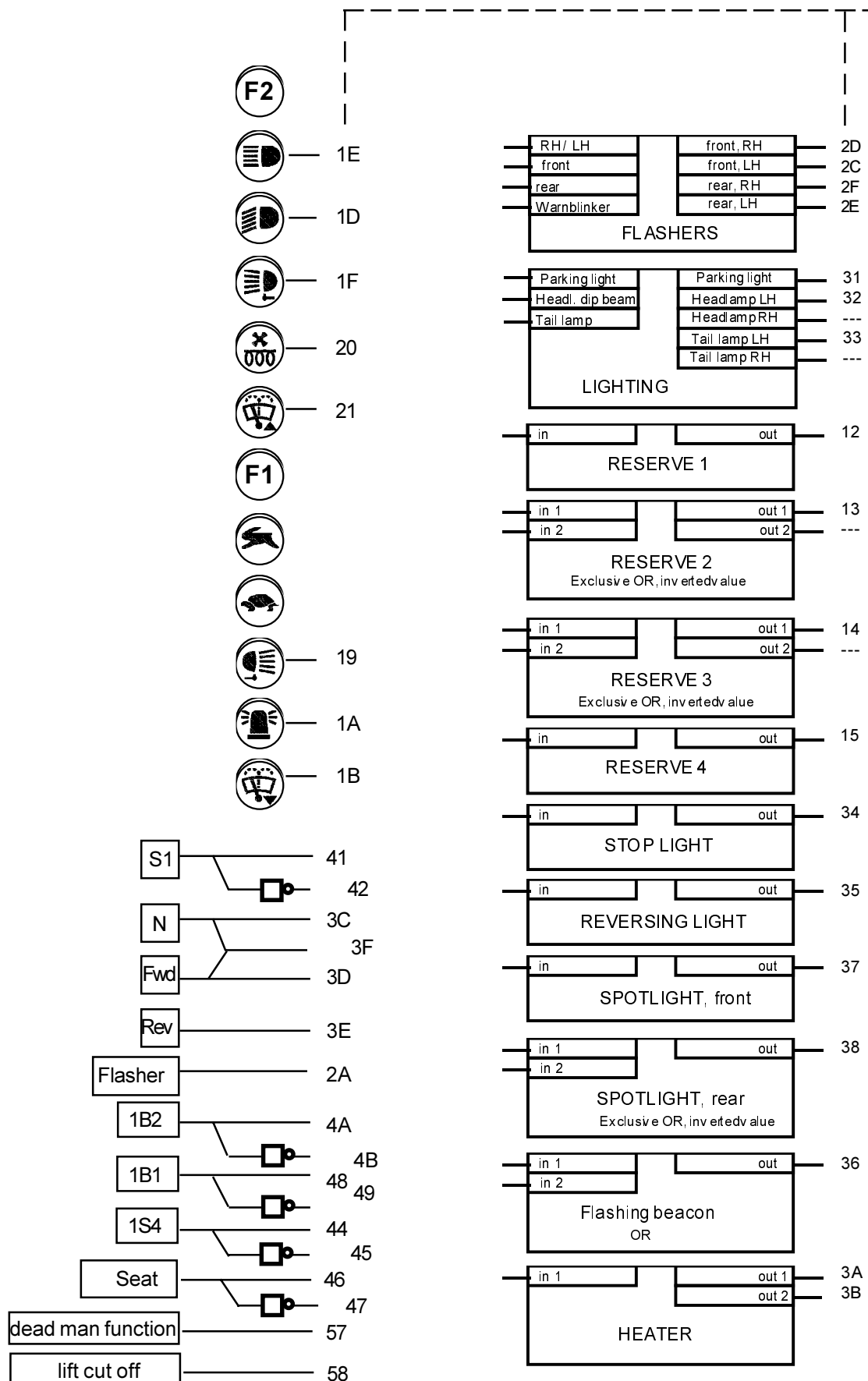
Switching is done with relays K1 and K2 on fuse carrier A7.

The *spotlight, front* is to be turned on and off with keypad 10.

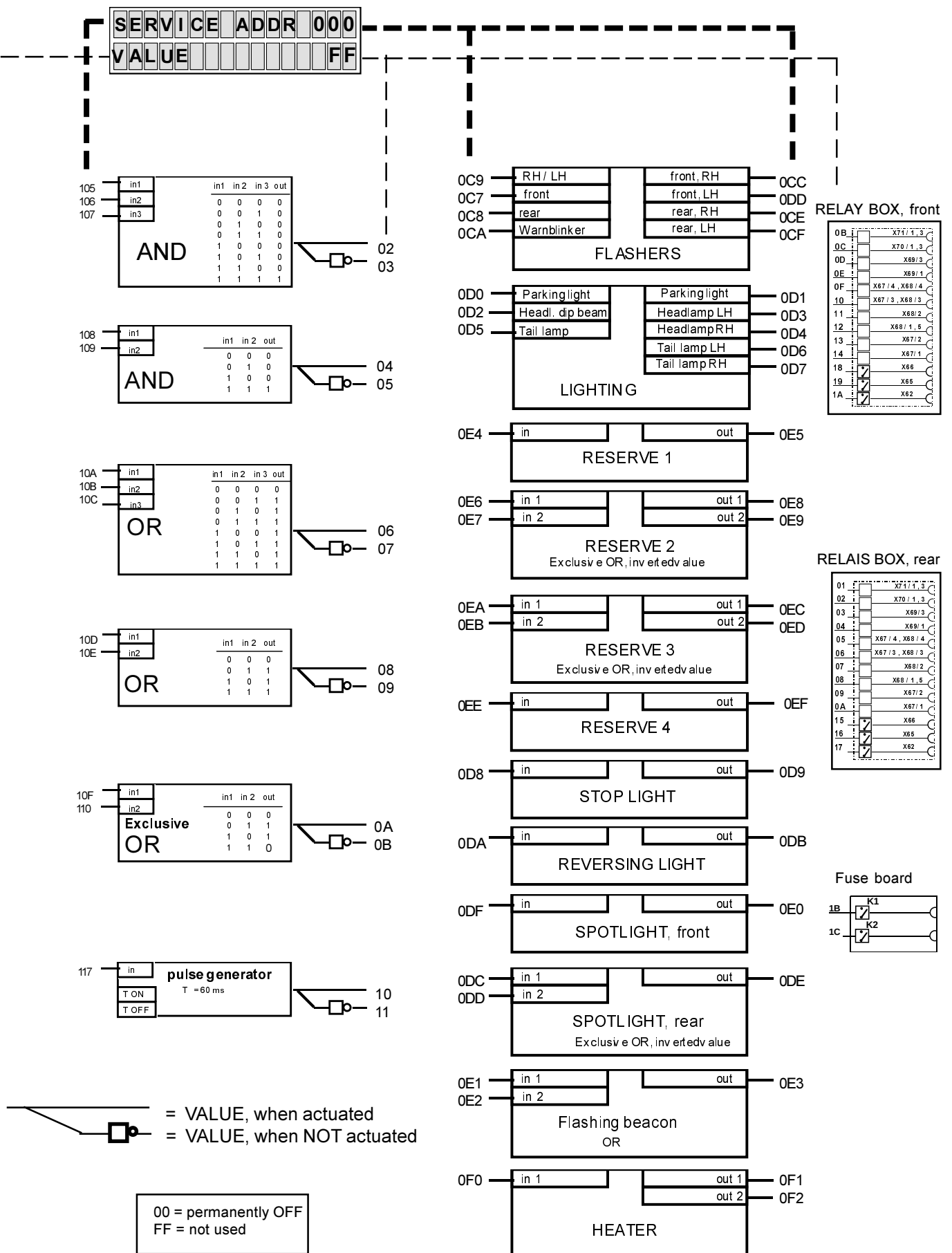
The *spotlight, rear* is to be turned on and off with keypad 4 in conjunction with the selection of “reverse” travel.



R60S20 – Lighting / optional electrical equipment



R60S20 – Lighting / optional electrical equipment



R60S60 Controller variants

R60S60 Controller variants

There are four different controller variants depending on the extent of lighting and electrical consumers.

Series variant

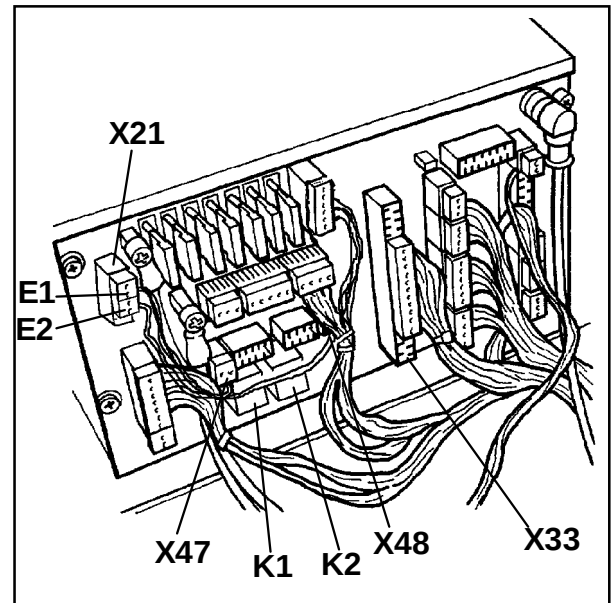
For supplying electrical consumers, the controller delivers:

- 80V Battery voltage (X21)
- 24V (max. 70 W) (X33)

The controller has two relay slots. These can be provided with relays (24V coil) if required. The relays can be used for switching 24V and 80V consumers.

Note

Connectors with various pole numbers are interconnected. Particular care must therefore be taken when plugging in the connectors.

**Variant A**

Controller and distributor plate in cowl.

Variant B

Controller, transformer, relay box on controller and distributor plate in cowl.

Variant C

Controller, transformer, relay box on controller and relay box in cowl.

R60S60 – Parametrization via console

Parametrization via service address

Values for vehicle and lighting parameters can be varied via the service address

SERVICE ADR.	00
VALUE	00

Once a service address has been called, the actual value of the relevant address will be displayed immediately. This value can be changed.

Important!

The new value will not be stored in memory unless both digits are confirmed and entire line is flashing!

Important Service Addresses (SA)**Work hour meter**

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|---------------------------------------|
| 04 | 00 - | Keyswitch on or hazard light flashing |
| | 01 - | Keyswitch on |
| | 02 - | Driving or operation of hydraulics |
| | 04 - | Seat switch |
| | 08 - | Driving or hydraulics or seat switch |

Any other settings will cause malfunctions

Participants in the CAN bus system

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|---------------------------------|
| 0E | 30 - | Dash panel available |
| 0F | 40 - | Relay board 1, rear is present |
| 10 | 41 - | Relay board 2, front is present |

Any other settings will cause vehicle breakdown

Direction switches / Indicator switch

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|---|
| 12 | 11 - | Direction switch engaging, indicator switch engaging |
| | 12 - | Direction switch engaging, indicator switch operating by touch |
| | 21 - | Direction switch operating by touch indicator switch engaging, |
| | 22 - | Direction switch operating by touch indicator switch operating by touch |

One of the above values must always be indicated here. On two-pedal variant this service address is not evaluated.

Error display and delete function

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|--|
| 13 | 00 - | Error display in normal mode |
| | 01 - | Erase error memory and list, error display in normal mode (from V1.06) |
| | 02 - | Switch error display to diagnostic mode (from V1.063) |
| | 03 - | Erase error counter, set error display to normal mode (from V1.08) |
| | 04 - | Erase error memory, error list and error counter (from V1.08) |

- | | |
|------|--|
| 05 - | same as 04, also switches display to diagnostic modes (from V1.08) |
| 06 - | same as 04, also switches display to normal mode (from V1.08) |
| 07 - | Resets controller |
| 08 - | Resets total mileage counter (from V1.08) |

In normal mode, only errors 1, 10, 16, 18, 20, 26, 40, 91, 93, 173 will be shown (from V1.08). In diagnostic mode all errors will be displayed.

Accelerator pedal transmitter adaptation

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|---|
| 22 | 0A - | Accel. pedal transmitter 1: zero position offset |
| 23 | DD - | Accel. pedal transmitter1: top end stop With 2-pedal control: D3 |
| 24 | 29 - | Accel. pedal transmitter 1: lower end stop (possible range:25 - 2D) |

Calculation of example

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|------------------|
| 28 | 05 - | Error tolerance |
| 29 | 04 - | Weighting factor |

Important: Do not change the values!

Drive configuration

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|---|
| 32 | 00 - | Travel direction per hardware - 1-pedal control |
| | 01 - | Travel direction per CAN-bus - 1-pedal control |
| | 02 - | 2-pedal control |
| | 03 - | Travel direction per CAN-bus + 2-pedal |
| | 04 - | Emergency operation when brushes worn + travel direction per hardware + 1-pedal control |
| | 05 - | Emergency operation when brushes worn + travel direction per CAN-bus + 1-pedal control |
| | 06 - | Emergency operation when brushes worn + 2-pedal control |
| | 07 - | Emergency operation when brushes worn + 2-pedal control |
| | 08 - | Increased starting current |

Current limit values for normal operation

<u>SA</u>	<u>VALUE</u>
-----------	--------------

- | | | |
|----|------|------------------------------|
| 34 | 64 - | max. hydraulic current: 319A |
| 35 | 87 - | max. traction current: 440A |

R60S60 – Parametrization via console

Current limit values for normal operationSA VALUE

- 36 28 - max. traction motor current 130A
 37 1F - max. hydraulics current 100A

09 = Hours per day

0A = Hours till next service

0B = Hydraulic pressure

0C = Steer angle (not active)

0D = Error number

Configuration of hydraulics transmittersSA VALUE

- 38 01 - Lifting transmitter active
 02 - Tilting transmitter active
 04 - Aux. hydraulics 1 transmitter active
 08 - Aux. hydraulics 2 transmitter active
 10 - Pressure sensor active
 20 - Oil filter switch available
 40 - Straight ahead switch available

The values of the available transmitters must be added.

Value 06 - 09: also see SA: E4

Configuration of hydraulic driveSA VALUE

- 4B 00 - No emergency operation in case of brush wear
 01 - Emergency operation in case of brush wear (fixed setting)
 00 - Potential free reading of brush contact switch (fixed setting)
 02 - Reading related o fixed potential
 00 - RPM controlled operation (fixed setting)
 04 - Controlled operation

Here only the values 00 and 01 are allowed; any other settings will causes error 20.

Adjustment of battery discharge indicatorSA VALUE

- 3A 00 - No emerg. operation & restriction
 01 - Restriction allowed
 02 - Emergency operation with discharged battery

Adjustment of hare / tortoise keySA VALUE

- 4C 23 - This value may not be changed, otherwise the keys will not function properly.

Cutout voltage of discharge indicatorSA VALUE

- 3B C2 - 1,94V cutout voltage

Any change in the cutout voltage will also change the indication in the display.

Regulator parametersSA VALUE

- 52 01
 53 7F
 54 18
 55 40
 56 7F
 57 1E
 58 80
 59 00
 5A 24
 5B 03
 5C 30
 5D 04 - Creep RPM on slope, setting range 00 - 0f
 5E FF
 5F FF
 60 FF
 61 FF

These values are only active during moment controlled operation and they may not be changed.

Configuration of power supplySA VALUE

- 3E 3B - Do not alter this value

Display configuration

The display consists of 2 x 4 fields, each field can be configured as desired.

SA Standard setting for field:

- 40 1 - 00
 41 2 - 04
 42 3 - 01
 43 4 - FF
 44 5 - 0A
 45 6 - FF
 46 7 - 03
 47 8 - 0B

- 00 = Drive programme
 01 = Battery state of charge in bar graph
 02 = Battery state of charge in digits
 03 = Service hour
 04 = Time of day
 05 = Date
 06 = Speed
 07 = Total mileage in km
 08 = Day mileage

R60S60 – Parametrization via console

Standard values of travel programs

Travel program 1

SA	VALUE
66	43 - Acceleration forwards
67	43 - Deceleration forwards
68	43 - Acceleration reverse
69	43 - Deceleration reverse
6A	50 - max. speed forwards
6B	50 - max. speed reverse
6C	05 - Setting speed-controlled / torque-controlled

Explanation for SA: 6C

(this also applies for SA 74, 7C, 84, 8C)

1st digit: 0 = speed-controlled
2 = torque-controlled

2nd digit: 00 - FF (0% - 150%) Brake delay with accelerator pedal release, applies only for torque-controlled operation

Travel program 2

SA	VALUE
6E	43 - Acceleration forwards
6F	43 - Deceleration forwards
70	43 - Acceleration reverse
71	43 - Deceleration reverse
72	A0 - max. speed forwards
73	A0 - max. speed reverse
74	05 - Setting speed-controlled / torque-controlled

Travel program 3

SA	VALUE
76	52 - Acceleration forwards
77	52 - Deceleration forwards
78	52 - Acceleration reverse
79	52 - Deceleration reverse
7A	A0 - max. speed forwards
7B	A0 - max. speed reverse
7C	05 - Setting speed-controlled / torque-controlled

Travel program 4

SA	VALUE
7E	64 - Acceleration forwards
7F	52 - Deceleration forwards
80	64 - Acceleration reverse
81	52 - Deceleration reverse
82	A0 - max. speed forwards
83	A0 - max. speed reverse
84	05 - Setting speed-controlled / torque-controlled

Travel program 5

SA	VALUE
86	64 - Acceleration forwards
87	64 - Deceleration forwards
88	64 - Acceleration reverse
89	64 - Deceleration reverse
8A	A0 - max. speed forwards
8B	A0 - max. speed reverse
8C	05 - Setting speed-controlled / torque-controlled

Restriction measures for hydraulic valve blocks 1 and 2 - fixed settings

Hydraulic valve block 1

SA	VALUE
92	FF - 00: Continuously off 01: Continuously on FF: open xx: Indication of function - see list of keys and truck conditions
93	03 - Type of restriction 01: Lifting 02: Tilting 04: Aux. hydraulics 1 08: Aux. hydraulics 2 10: Reserved 20, 40, 80: free

These values must be added hexadecimally.

94	32 - Restriction to stat. steering speed of 500 rpm
----	---

R60S60 – Parametrization via console

Hydraulic valve block 2SA VALUE

- 95 92 - This value should not be changed
 96 01 - Restriction lifting
 97 32 - to 500 rpm

Restriction to drive programme 1

- 98 FF - open

Restriction to truck stop

- 99 FF - open

Supplementary electrical installation (list of function blocks)

The list reflects equipment variant C.

SA VALUE

- 9A 18 - Sidemarker light input
 9B 19 - Headlight input
 9C 00 - Taillight input
 9D 00 - Lighting mode
 9E 10 - Front sidemarker light output
 9F 14 - Left headlight output
 A0 12 - Right headlight output
 A1 0A - Left taillight output
 A2 08 - Right taillight output
 A3 FF - Comparator 2 input
 A4 47 - Stop light input
 A5 05 - Stop light output
 A6 FF - Front directional indicator input
 A7 FF - Rear directional indicator input
 A8 32 - Left/right directional indicator input
 The directional indicator outputs are fixed and cannot be parametrized
 A9 33 - Hazard flashing 1 input
 AA 00 - Hazard flashing 2 input
 AB 4B - Back-up light input
 AC 06 - Back-up light output
 AD 04 - Rear spotlight 1 input
 AE 00 - Rear spotlight 2 input
 The inputs 1 & 2 are EXOR connected
 AF 01 - Rear spotlight 1 output
 B0 1A - Front spotlight input
 B1 0B - Front spotlight output
 B2 15 - Flashing beacon input 1
 B3 00 - Flashing beacon input 2
 The inputs 1 & 2 are OR connected
 B4 22 - Flasing beacon output
 B5 00 - Light 1 input (spare)
 B6 FF - Light 1 output (spare)
 B7 00 - Light 21 input (spare)
 B8 FF - Light 22 input (spare)
 The inputs 21 & 22 are EXOR connected
 B9 FF - Light 21 output
 BA FF - Light 22 output
 BB 1B - Heater screen input 1
 BC FF - Heater screen input 2
 The inputs 1 & 2 are EXOR connected

SA VALUE

- BD 23 - Heater screen output
 BE 24 - Seat heating output
 BF FF - Defroster input
 C0 FF - Defroster motor output
 C1 FF - Defroster heat resistor output
 C2 FF - Light 4 input (spare)
 C3 FF - Light 4 output (spare)
 C4 1C - Wiper-washer 1 input
 C5 3E - Interval period input
 C6 18 - Wiper 1 output
 C7 2E - Washer 1 output
 C8 16 - Wiper-washer 2 input
 C9 3E - Interval period input
 CA 16 - Wiper 2 output
 CB 2D - Washer 2 output
 CC FF - Wiper-washer 3 input
 CD FF - Interval period input
 CE FF - Wiper-washer 3 output
 CF FF - Washer 3 output
 D0 01 - Input 1 of logical AND1
 D1 01 - Input 2 of logical AND1
 D2 01 - Input 3 of logical AND1
 D3 14 - Input 1 of logical AND2
 D4 4B - Input 2 of logical AND2
 D5 00 - Input 1 of logical OR2
 D6 00 - Input 2 of logical OR2
 D7 00 - Input 3 of logical OR2
 D8 00 - Input 1 of logical OR2
 D9 00 - Input 2 of logical OR2
 DA 01 - Input 1 of EXOR 1
 DB 00 - Input 1 of EXOR 1
 DC FF - Input 1 of comparator 1
 DD FF - Input 2 of comparator 1
 switched threshold from high to low
 DE FF - Input 3 of comparator 1
 switched threshold from low to high
 DF FF - Input 1 of timer block
 E0 FF - Input 2 of timer block - on time
 (from 0 - FF; 64 ms per value)
 E1 FF - Input 3 of timer block - off time
 (from 0 - FF; 64 ms per value)
 E2 FF - Input 1 of comparator 2
 switched threshold from high to low
 E3 FF - Input 2 of comparator 2
 switched threshold from low to high

R60S60 – Parametrization via console

List of keys and truck conditions

Val.: Description:

00	Constantly off
01	Constantly on
02	Output of Block1 - AND
03	Output of Block1 - AND negated
04	Output of Block2 - AND
05	Output of Block2 - AND negated
06	Output of Block1 - OR
07	Output of Block1 - OR negated
08	Output of Block2 - OR
09	Output of Block2 - OR negated
0A	Output of Block XOR
0B	Output of Block XOR negated
0C	Output of comparator1
0D	Output of comparator1 negated
0E	Output of timer block
0F	Output of timer block negated
11	Key 1: function key 1
12	Key 2: hare drive programme
13	Key 3: tortoise drive programme
14	Key 4: rear spotlight
15	Key 5: flashing beacon
16	Key 6: rear wipers
17	Key 7: function key 2
18	Key 8: sidemarker light
19	Key 9: headlight
1A	Key 10: front spotlight
1B	Key 11: heater, fan and defroster
1C	Key 12: front wiper
1D	Key 13: return
1E	Key 14: escape
20	Indication of state of wiper 1
21	Setting of „on“ time of wiper 1
22	Setting of „off“ time of wiper 1
23	After-running time of wiper 1
24	Indication of state of wiper 2
25	Setting of „on“ time of wiper 2
26	Setting of „off“ time of wiper 2
27	After-running time of wiper 2
28	Indication of state of wiper 3
29	Setting of „on“ time of wiper 3
2A	Setting of „off“ time of wiper 3
2B	After-running time of wiper 3
32	State of direction indicator switch value range: 0, 1, 2
33	State of hazard warning switch value range: 0, 1
36	State: sidemarker lights or headlights are on
37	State: only sidemarker lights are on
38	State: headlights are on
39	State: taillights are on
3A	State: stop lights are on
3B	State: front LH turn signal light is on (active)

Val.: Description:

3C	State: front RH turn signal light is on (active)
3D	State: rear LH turn signal light is on (active)
3E	State: rear RH turn signal light is on (active)
3F	State: back-up lights are on
40	State: defroster motor is on
41	State: defroster motor and defroster resistance are on
47	State: truck delayed or brake transmitter is operated
48	State: brake transmitter is operated
49	State: neutral travel direction selected
4A	State: forward travel direction selected
4B	State: reverse travel direction selected
4C	State: forward or reverse travel direction selected
4D	State: reverse travel direction selected and driver seated
4F	State: keyswitch is on
50	State: driver seated
51	State: parking brake released
52	State: accelerator is operated
53	State: keyswitch is off
54	State: driver not seated
55	State: parking brake is applied
56	State: accelerator not operated
58	State: cycle at „reverse is selected“
59	State: cycle at „service brake operated“
5A	Indicates high as long as direction indicator cycle is on
5B	Indicates high as long as direction indicator cycle is off
60	State: traction motor power is active and running
80	Output comparator 2
81	Output comparator 2 negated
90	State: warning flag of discharge indicator
91	State: cutout flag 1 of discharge indicator
92	State: cutout flag 2 of discharge indicator
93	Speed indication; 1 value = 0.1km/h
94	State: traction motor brush fault for 8 hrs
95	State: hydr. motor brush fault for 8 hrs
96	Service interval meter expired 50 hrs ago

R60S60 – Parametrization via console

List of keys and truck conditions

Val.: Description:

A0	State: spare switch 1 (high)
A1	State: spare switch 1 (low)
A2	State: spare switch 2 (high)
A3	State: spare switch 2 (low)
A4	State: spare switch 3 (high)
A5	State: spare switch 3 (low)
A6	AD input for opt. oil pressure gauge Range: 0-10 V
A7	AD input for aux. transmitter 3 Range: 0-10 V or 2nd AD channel for 2-pedal control
B0	State: hydraulics active, lifting lever pulled
B1	State: hydraulics active, lifting lever pushed
B2	State: hydraulics active, lifting lever pulled or pushed
B3	State: hydraulics active, tilting lever pulled
B4	State: hydraulics active, tilting lever pushed
B5	State: hydraulics active, tilting lever pulled or pushed
B6	State: hydraulics active, aux. hydraulics 1 lever pulled
B7	State: hydraulics active, aux. hydraulics 1 lever pushed
B8	State: hydraulics active, aux. hydraulics 1 lever pulled or pushed
B9	State: hydraulics active, aux. hydraulics 2 lever pulled
BA	State: hydraulics active, aux. hydraulics 2 lever pushed
BB	State: hydraulics active, aux. hydraulics 2 lever pulled or pushed
BC	State: hydraulics active, lifting, tilting or lowering operated
BD	State: hydraulics active, aux. hydraulics 1, 2
BE	State: hydraulics active, lifting, lowering, aux. hydraulics 1, 2
BF	State: hydraulics active, tilting, aux. hydraulics 1, 2
C0	State: hydraulics active, lifting, lowering, tilting, aux. hydraulics 1, 2

Val.: Description:

D0	Flip-Flop output of spare switch 1; switches when input changes from high to low
D1	Flip-Flop output inverted of spare switch 1; switches when input changes from high to low
D2	Flip-Flop output of spare switch 1; switches when input changes from low to high
D3	Flip-Flop output inverted of spare switch 1; switches when input changes from low to high
D4	Flip-Flop output of spare switch 2; switches when input changes from high to low
D5	Flip-Flop output inverted of spare switch 2; switches when input changes from high to low
D6	Flip-Flop output of spare switch 1; switches when input changes from low to high
D7	Flip-Flop output inverted of spare switch 1; switches when input changes from low to high
D8	Flip-Flop output of spare switch 3; switches when input changes from high to low
D9	Flip-Flop output inverted of spare switch 3; switches when input changes from high to low
DA	Flip-Flop output of spare switch 3; switches when input changes from low to high
DB	Flip-Flop output inverted of spare switch 3; switches when input changes from low to high
FF	Constantly open.

Table of contents	Page
Technical service data	2
Hydraulic system	
Functional description of lift and tilt hydraulics	3
Control valve block	
Actuation (until 1998)	4
Actuation (from 1998)	5
Design (until 1996)	6
Design Installation information (until 1996)	7
Design (from 1997)	8
Design Installation information (from 1997)	9
Wiring diagram - Function (until 1996)	10
Wiring diagram - Function (until 1996)	11
Wiring diagram - Function (from 1997)	12
Wiring diagram - Function (from 1997)	13
Way valve	
Lift/lower	14
Lift/lower	15
Tilt (until 1996)	16
Tilt (until 1996)	17
Tilt (from 1997)	18
Tilt (from 1997)	19
Additional hydraulics	20
Additional hydraulics	21
Control valve block	
Relief valve - block seal	22
Sender - function, replacement pump motor speeds	23
Tilt cross-section reducer	24
Pressurising valve	
Function	25
Testing - Removal	26
Hydraulic pump	
Function	27
Hydraulic tank	
Hydraulic oil change - capacities	28
Air filter	
Function - Maintenance	29
Breather filter	
Function - Maintenance	30
Hydraulic unions	
Installation	31 - 34
Speeds	
Lift-Lower-Tilt	35
Hydraulic diagram	36
Hydraulic diagram	37
Joystick	38

Technical service data

Group 10 Hydraulic system								
Hydraulic pump								
Delivery	19 cm ³ / per rotation							
Direction of rotation	anticlockwise							
Screw tightening torques	6022-25 : 56 + 4 Nm 6026-29 : 120 + 5 Nm							
Pump motor speeds (basic setting)								
Steering	800 1/ min							
Lifting (telescopic mast)	without load: max. 2880 1/ min with load: max. 2560 1/ min							
Additional hydraulics (following attachment)	500 bis 2550 1 / min							
Tilting	at nominal lift 3500 = 1359 1 / min up to nominal lift 5000 = 753 1 / min above nominal lift 5000 = 485 1 / min							
Control valve block								
Relief valve	6022-25 set value = 230 bar 6026-29 set value = 250 bar Setting range = 100 - 260bar							
Screw tightening torque	25 + 8 Nm							
Thread	P + A = G 1/2 , R = G 3/4 , A + B = G 3/8							
Tilt cross-section reducer	from nominal lift 5000 mm = 1.4mm							
Permissible automatic forward tilt	nach UVV = max. 0.5 degrees per second							
Permissible automastic lowering	nach UVV = max. 100 mm in 10 minutes							
Pressurising valve - Pressurising pressure	Forward tilt : 6022-25 = 80 bar (until end of 1996) 6022-25 = 125 bar (from 1997) 6026-29 = 180 bar							
Air filter								
Filte fineness	15 μ (nominal)							
Operating pressure - bypass valve	0.25 ± 0.05 bar							
Hydraulic tank								
Capacity	6022-26 = 27 litres 6026-29 = 34 litres							
Hydraulic oil (OZ)	Quality according to DIN 51524 / Part 2 or ISO VG 46 HM							
Speeds								
Lifting with nominal load Lifting speed (m / sec.)		6022	6023/24	6025	6026	6027	6028	6029
	Tele	0.36	0.34	0.27	0.27	0.26	0.24	0.22
	Niho	0.36	0.32	0.26	0.24	0.23	0.19	0.19
	Triple	0.36	0.32	0.26	0.24	0.23	0.20	020
Tolerance ± 12 %								
Tilting with nominal load (forward tilt)	up to nominal lift 3500 mm min. 0.12 / max. 0.20 sec. per degree up to nominal lift 5000 mm min. 0.20 / max. 0.36 sec. per degree above nominal lift 5000 mm min. 0.36 / max. 0.56 sec per degree							
Lowering with nominal load	0.40 - 60 m / sec.							

Hydraulic system - Function

Functional description of lift and tilt hydraulics

The hydraulic oil sucked out of the tank (4) by gear pump (5) via filter (3) flows to a priority valve (6) connection - P -.

The oil volume required for the steering unit is distributed here.

The residual oil volume flows via the connection - EF - to the control valve block (2) connection - P -.

With only slight actuation (displacement) of a valve rod, the oil flows with low circulation pressure through the control valve block from connection - R - back into the tank.

With further actuation, an oil volume corresponding to the displacement of the control rod flows from connection - A1 - to the lift cylinders (7) and from - A2 - and - B - to the tilt cylinders (9) and in the additional hydraulics to an attachment (1).

The following functional components are contained in the control valve block (2) :

- A stop valve prevents excessive automatic lowering of the load.
- A relief valve protects the hydraulic system against overloads.

- A stop valve prevents automatic forward tilting of the load. Pressurising valve (10) serves for vibration damping of the stop valve (**type until end of 1996**).

Pressurising valve (10) prevents automatic forward tilting of the load. The stop valve in the control valve block is omitted (**type from 1997**).

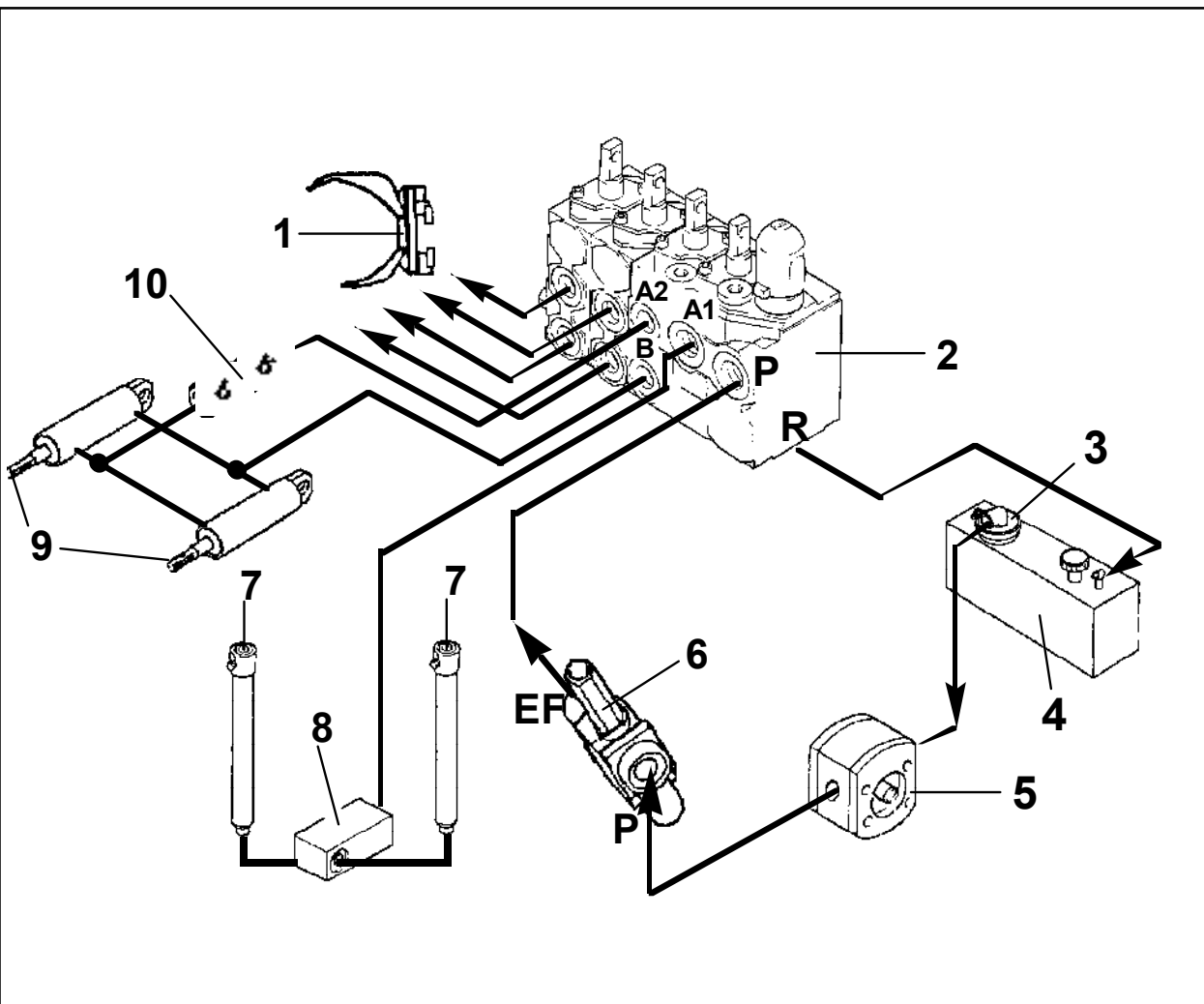
A lowering brake integrated into connection block (8) limits the load lowering speed.

For a functional description of lowering brakes and hose failure safety devices installed in the masts, see Group 20.

For a functional description of steering hydraulics, see Group 06.

Attention

Before carrying out any work on the hydraulic system, the fork carriage must be fully lowered and the battery plug disconnected.

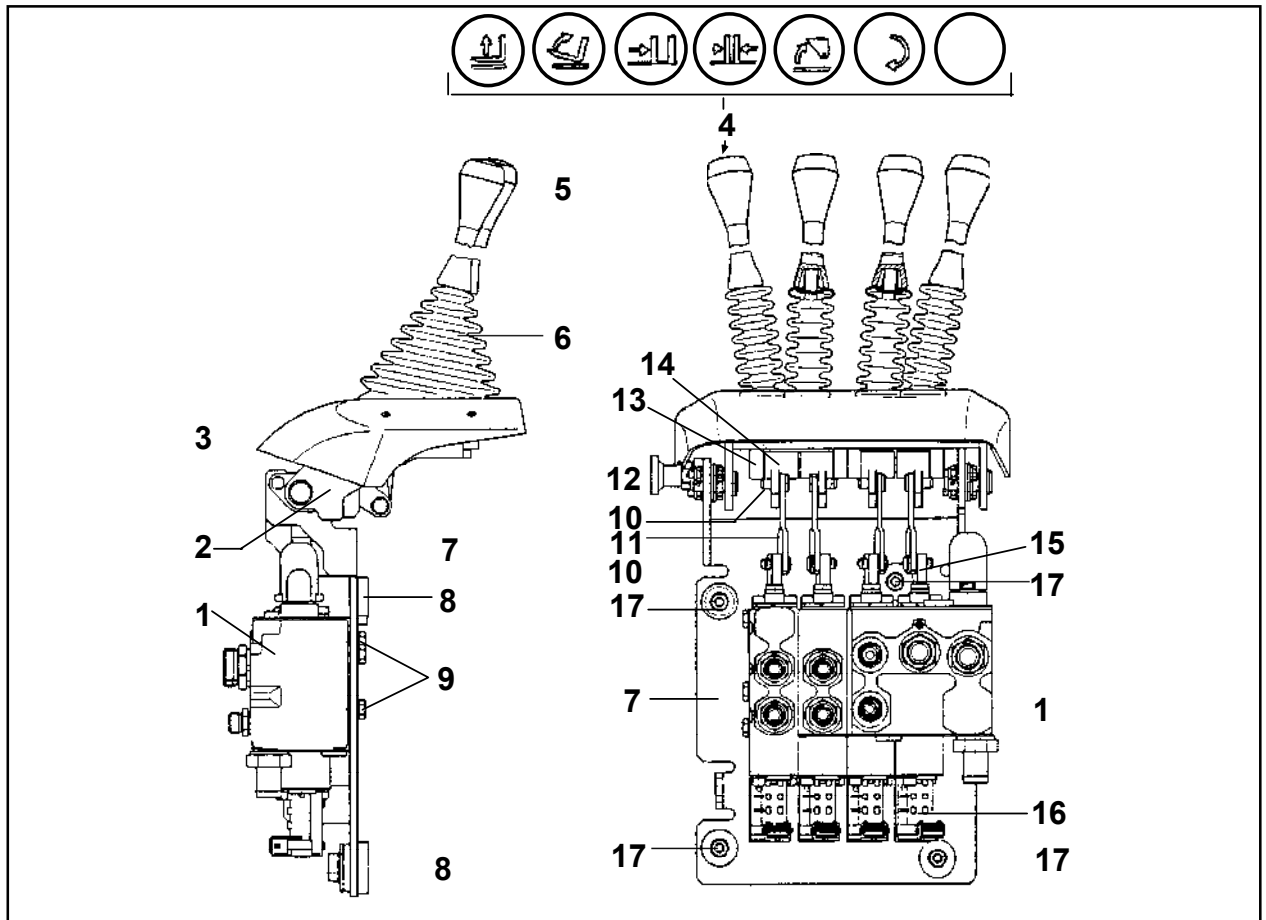


Position as per February 2000
(Replaces version:)

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Control valve block - actuation

Type until 1998



- | | |
|-------------------------------|--------------------------|
| 1. Control valve block | 2. Holder |
| 3. Hood | 4. Symbol plate |
| 5. Control lever | 6. Bellows |
| 7. Valve carrier | 8. Rubber pad |
| 9. Control valve block screws | |
| 10. Plug | 11. Strap |
| 12. Pin | 13. Bearing bracket |
| 14. Lever | 15. Valve rod |
| 16. Sender | 17. Valve carrier screws |

Function:

When a control lever (5) is actuated, valve rod (15) is pushed in or pulled out via two guides. Via the sender (16) flanged on to the control valve block (1) the pump motor is started.

Design

- The valve carrier (7) is flexibly fixed in rubber pads (8) to the chassis partition. The holder (2) with the control levers and guides is supported rotatable on the valve carrier (7). To open the battery cover, the same must be tilted forward after releasing the pin (12).
- At the top of the control lever (5), various control symbols (4) are provided appropriate to the functions.

Removal of control valve block

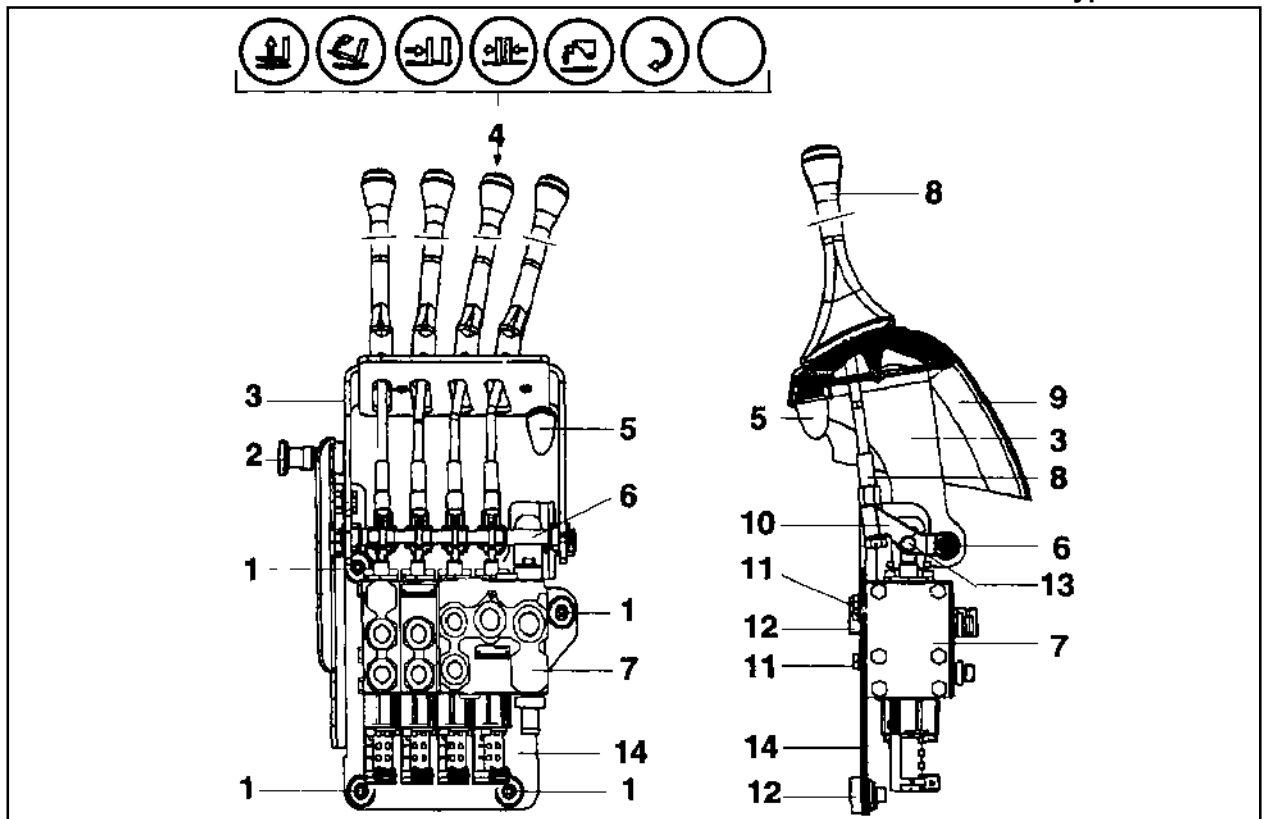
- Unscrew covering.
- Disconnect all electrical and hydraulic connections.
- Unscrew screws (17) of valve carrier (7) and remove complete valve carrier from chassis partition.
- Remove plug (10) at pin of strap (11) and remove strap.
- Separate slider bank (1) from valve carrier by loosening screws (9).

Maintenance information

Grease bearing points of strap (11) in valve rods and levers.

Control valve block- actuation

Type from 1998



1. Valve carrier screws
2. Pin
3. Balancer
4. Control symbols
5. Megapuffer
6. Axle
7. Control valve block
8. Control lever
9. Hood
10. Lever
11. Control valve block screws
12. Rubber pad
13. Bolt
14. Valve carrier

Function:

When a control lever (8) is actuated, the valve rod of the control valve block (7) is pushed in or pulled out. Via the sender flanged on to the control valve block (7), the pump motor is started.

Design

The valve carrier (14) is flexibly fixed in rubber pads (12) to the chassis partition.

At the top of the control lever (8), various control symbols (4) are provided appropriate to the functions.

Balancer (3) with hood (9) and control lever (8) are supported rotatable on the valve carrier (14).

To open the battery cover, the hood (9) must be tilted forward after releasing the pin (2).

Removal of control valve block

- Tilt mast fully forward and lower fork carriage.
- Disconnect battery plug
- Unscrew covering.
- Disconnect all electrical and hydraulic connections
- Unscrew screws (1) of valve carrier (14) and remove complete valve carrier from chassis panel.
- Remove all bolts (13) between levers (10) and valve rods (3).
- Separate slider bank (7) from valve carrier by loosening screws (11).

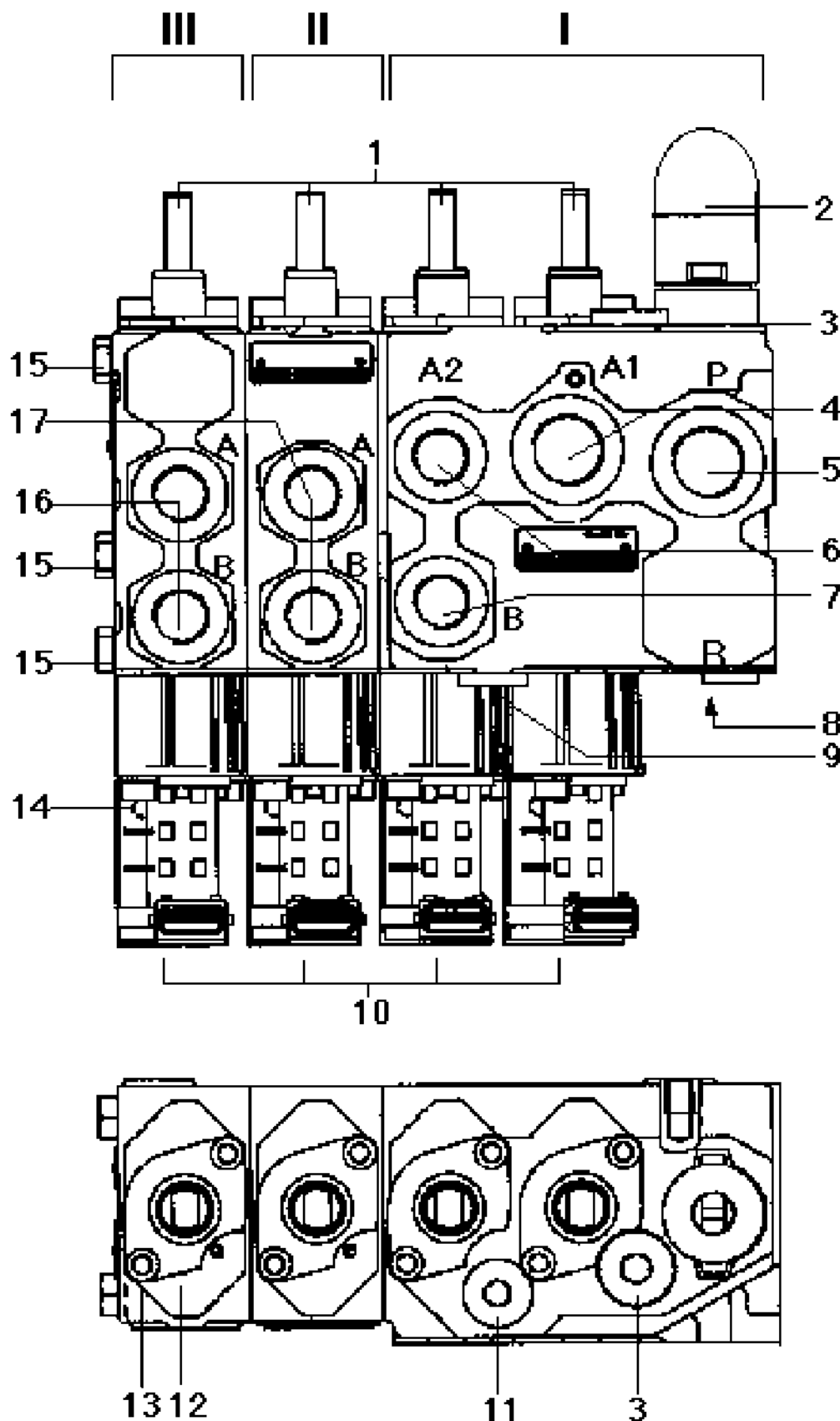
Maintenance information

The following bearing points must be greased:

- Bolt (13) connection between valve rod and lever (10)
- Lever (10) on axle (6).

Control valve block - Design

Type until 1996



Position as per: February 2000
(Replaces version:)

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Control valve block - Design

Type until 1996

Design

- I. Control valve block - lift/tilt
- II. Way valve - First additional hydraulics
- III Way valve - Second additional hydraulics

1. Valve rod
2. Relief valve
3. Screw plug - stop valve/lift
4. Connection "A1" - (lift/lower)
5. Connection "P" - (pump line)
6. Connection "A2" - (tilt - back)
7. Connection "B" - (tilt - forward)
8. Connection "R" - (return - tank)
9. Screw plug - stop valve/tilt
10. Sender (inductive displacement sensor)
11. Screw plug - stop valve/tilt
12. Shroud with wiper
13. Screws - shroud
14. Screws - sender
15. Block screws
16. Connections - Second additional hydraulics
17. Connections - First additional hydraulics

The slider bank (1) contains the valve rods (1) for the lift and tilt hydraulics. If no further way valves are provided for additional hydraulics, a plate is fitted to this block following the tilt valve rod.

The way valves (II) and (III) for the additional hydraulics are essentially identical with regard to function and design.

The way valve (III) for the additional hydraulics is simultaneously designed as a plate. When providing the control valve block with only one additional hydraulics, way valve (II) is replaced by way valve (III).

Sealing of the control valve blocks with respect to each other takes place with O-rings and retaining rings in the flange faces.

Installation information

- When carrying out repairs to the control valve block, particular care must be taken as any fouling and damage of the sealing surfaces can result in malfunctions and leaks.
- The tightening torques, particularly those for block screws (15) must be observed.
- The "lift/lower" valve rod (arrow) must not be rotated more than 55° to each side.

Relief valve setting

Setting : 6022 - 25 = 230 bar
6026 - 29 = 250 bar

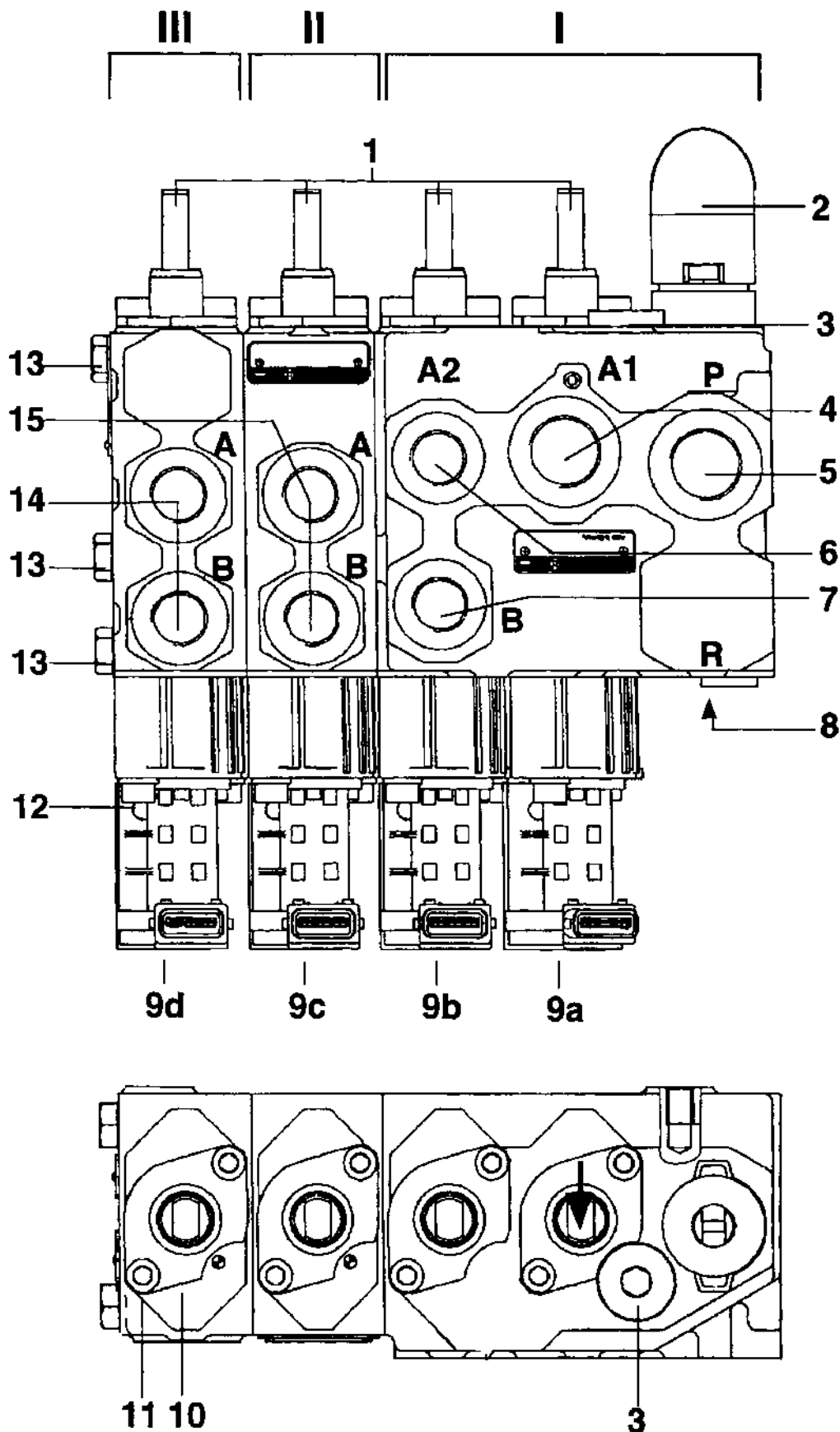
Setting range : 100 - 260 bar

Tightening torque

Item 2	=	46 + 15	Nm
Item 3	=	29 + 10	Nm
Item 9 & 11	=	23.5 + 8	Nm
Item 13	=	5.5 + 1.8	Nm
Item 14	=	3.5 + 1.2	Nm
Item 15	=	25 + 8	Nm

Control valve block - Design

Type from 1997



Position as per: February 2000
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Control valve block - Design

Type from 1997

Design

- I. Control valve block - lift/tilt
- II. Way valve - first additional hydraulics
- III. Way valve - second additional hydraulics

- 1. Valve rod
- 2. Relief valve
- 3. Screw plug - stop valve/lift
- 4. Connection "A1" - (lift/lower)
- 5. Connection "P" - (pump line)
- 6. Connection "A2" - (tilt back)
- 7. Connection "B" - (tilt forward)
- 8. Connection "R" - (tank return)
- 9a-d. Sender (inductive displacement sensor)
- 10. Shroud with wiper
- 11. Cover plate screws
- 12. Sender screws
- 13. Block screws
- 14. Connections - second additional hydraulics
- 15. Connections - first additional hydraulics

The slider bank (I) contains the valve rods (1) for the lift and tilt hydraulics. If no further way valves are provided for the additional hydraulics, a plate is fitted to this block following the tilt valve rod. The way valves (II) and (III) for the additional hydraulics are essentially identical with regard to function and design.

The way valve (III) for the additional hydraulics is simultaneously designed as a plate.
When providing the control valve block with only one additional hydraulics, way valve (II) is replaced by way valve (III).

Sealing of the control valve blocks with respect to each other takes place with O-rings and retaining rings in the flange faces.

Installation information

- When carrying out repairs to the slider bank, particular care must be taken as any fouling and damage of the sealing surfaces can result in malfunctions and leaks.
- The tightening torques, particularly those for block screws (15) must be observed.
- The "lift/lower" valve rod (arrow) must not be rotated more than 55° to each side.

Sender/Displacement sensor (9 a-d) :

ATTENTION

To exclude mutual influencing of the senders, with effect **from January 2000** senders with varying frequencies will be installed at the control valve block.

Sender 9a = Bosch No. 0 538 009 188

Sender 9b = Bosch No. 0 538 009 189

Sender 9c = Bosch No. 0 538 009 188

Sender 9d = Bosch No. 0 538 009 183

The Bosch numbers are provided on the sender housings.

Relief valve setting

Setting : 6022 - 25 = 230 bar
6026 - 29 = 250 bar

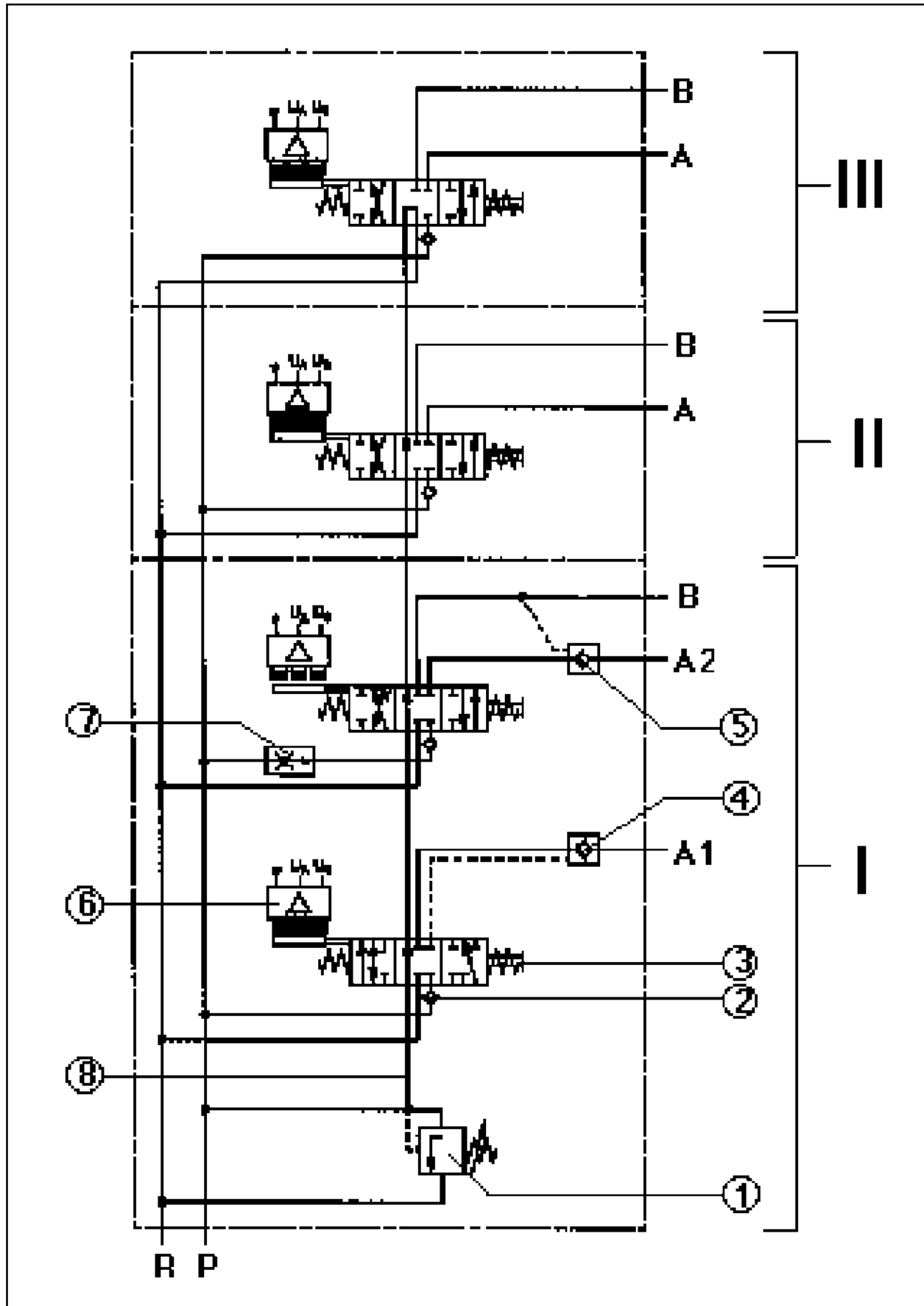
Setting range : 100 - 260 bar

Tightening torque

Item 2	= 46 + 15	Nm
Item 3	= 29 + 10	Nm
Item 11	= 5.5 + 1.8	Nm
Item 12	= 3.5 + 1.2	Nm
Item 13	= 25 + 8	Nm

Control valve block - Diagram

Type up to 1996



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Control valve block - Diagram

Type from 1997

Diagram/Function

I = Control valve block - lift/tilt
 II = Way valve - first additional hydraulics
 III = Way valve - second additional hydraulics

A1 = Connection - lift/lower
 A2 = Connection - tilt, back
 B = Connection - tilt, forward
 A+B = Connections - additional hydraulics
 P = Connection - pump line
 R = Connection - return line/tank
 1. Relief valve
 2. Check valve
 3. Valve rod
 4. Stop valve - lift/lower
 5. Stop valve - tilt
 6. Sender (inductive displacement sensor)
 7. Control valve
 8. Idle duct

Function

When a valve rod (3) is actuated, the pump motor speed and in turn the delivery of the hydraulic pump is controlled proportional to the valve rod stroke via sender (5). With only slight displacement of the valve rod, the oil entering at "P" flows via the idle duct (7) through the way valve up to the plate or final valve and from there via the return duct "R" back into the tank.

The idle duct is closed with increasing displacement of the valve rod and the oil flows via the pump duct "P" to the consumers.

During operation of a consumer, the relief valve opens when the set final pressure in the pump duct is exceeded and the oil flows via the return connection "R" to the tank.

Check valves (2)

The check valves installed between pump duct "P" and control rods (3) prevent the oil flowing back into the pump duct.

Stop valve - lift/lower (4)

The stop valve installed in connection "A1" to the lift cylinders prevents automatic lowering of the load with the valve rod in a neutral position.

Stop valve - tilt (5)

The stop valve installed in connection "A2" to the front tilt cylinder chambers prevents automatic tilting of the mast.

Tilting forward is only possible under a pressure build-up in connection "B" (tilting forward). The valve is opened hydraulically and the oil from the front tilt cylinder chambers is able to flow via connection "A" into the return.

Sender (6)

The senders (5) connected to the valve rods (3) set the set pump motor speeds appropriate to the valve rod displacement.

NOTE

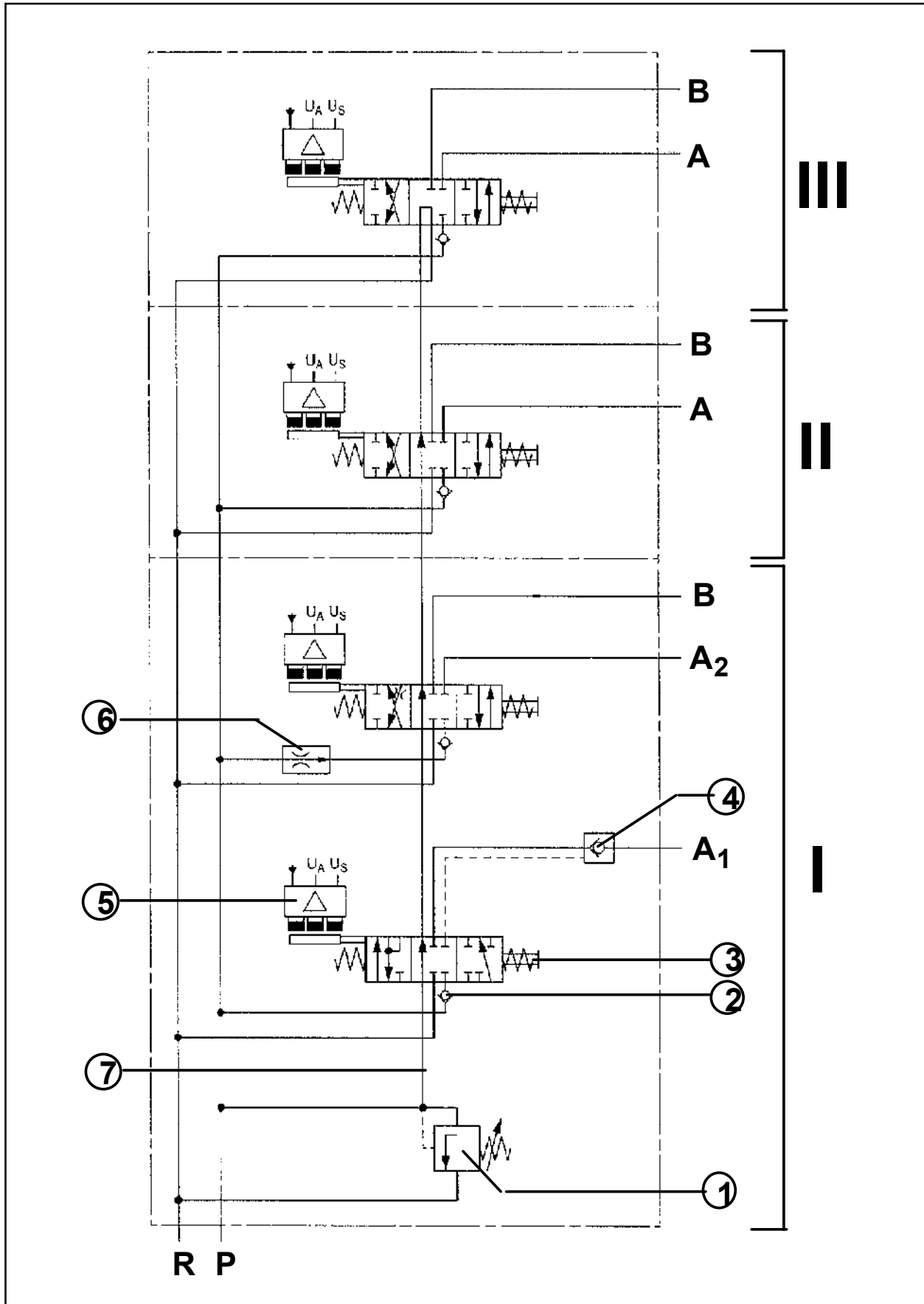
The pump motor speeds provided as a basic setting for the individual hydraulic functions, as well as replacement and adjustment of the sender are shown in the chapter "Sender - pump motor speeds" in Groups 10 and 13.

Control valve (7)

The control valve installed between the pump duct "P" and tilt control rod limits the oil flow for tilting to max 26 l / min.

Control valve block - Diagram/Function

Type from 1997



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Control valve block - Diagram/Function

Type from 1997

Diagram/Function

I = Control valve block - lift/lower
 II = Way valve - first additional hydraulics
 III = Way valve - second additional hydraulics

A1 = Connection - lift/lower
 A2 = Connection - tilt, back
 B = Connection - tilt, forward
 A+B = Connection - additional hydraulics
 P = Connection - pump line
 R = Connection - return line/tank
 1. Relief valve
 2. Check valve
 3. Valve rod
 4. Stop valve - lift/lower
 5. Sender (inductive displacement sensor)
 6. Control valve
 7. Idle duct

Function

When a valve rod (3) is actuated, the pump motor speed and in turn the delivery of the hydraulic pump is controlled proportional to the valve rod stroke via sender (5). With only slight displacement of the valve rod, the oil entering at "P" flows via the idle duct (7) through the way valve up to the plate or final valve and from there via the return duct "R" back into the tank. The idle duct is closed with increasing displacement of the valve rod and the oil flows via the pump duct "P" to the consumers. During operation of a consumer, the relief valve opens when the set final pressure in the pump duct is exceeded and the oil flows via the return connection "R" to the tank.

Check valves (2)

The check valves installed between pump duct "P" and control rods (3) prevent the oil flowing back into the pump duct.

Stop valve - lift/lower (4)

The stop valve installed in connection "A1" to the lift cylinders prevents automatic lowering of the load with the valve rod in a neutral position.

Sender (5)

The senders (5) connected to the valve rods (3) set the set pump motor speeds proportional to the valve rod displacement.

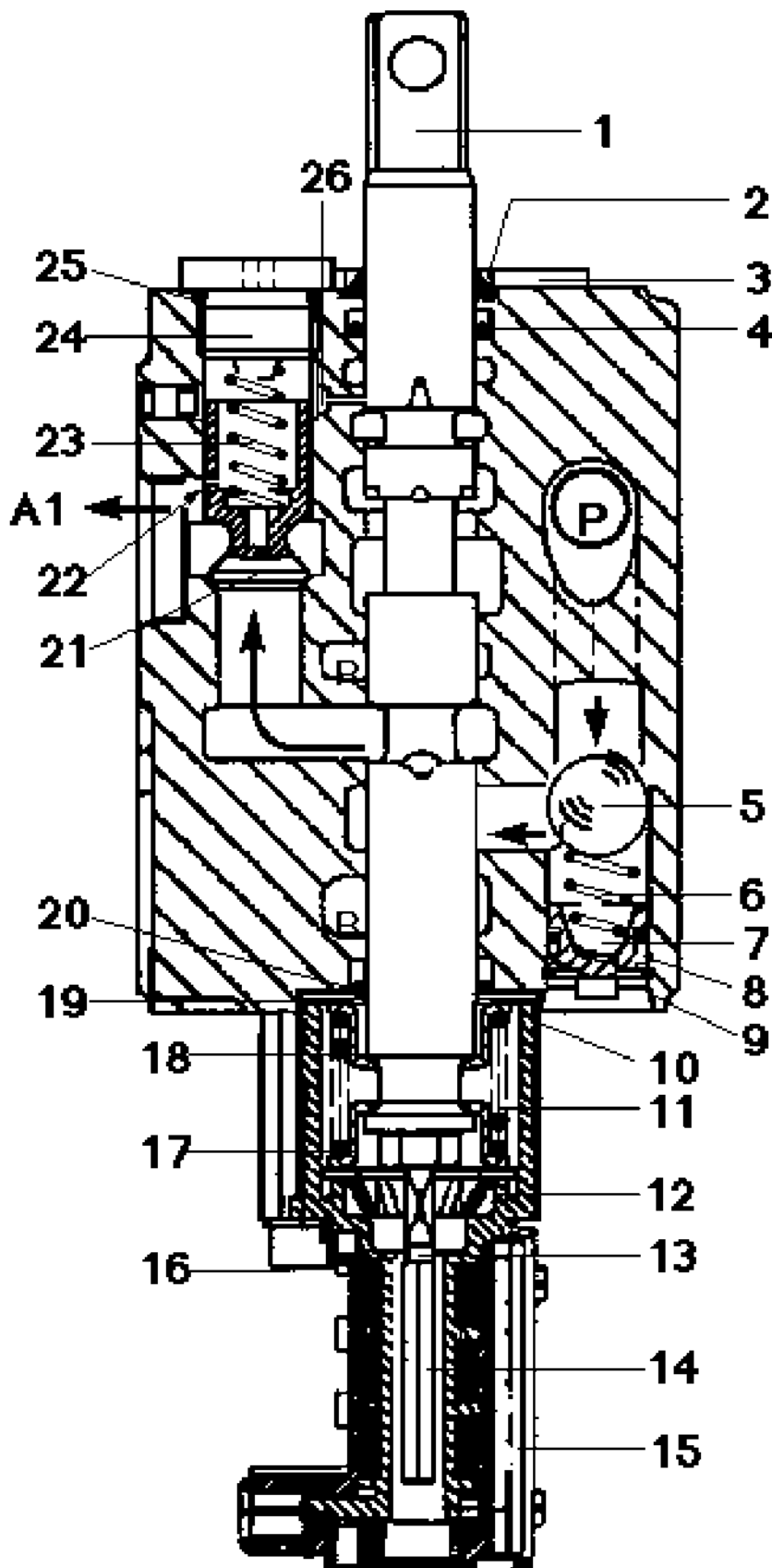
Note:

The pump motor speeds provided as a basic setting for the individual hydraulic functions, as well as replacement and adjustment of the sender are shown in the chapter "Sender - pump motor speeds" in Groups 10 and 13.

Control valve (6)

The control valve installed between the pump duct "P" and tilt control rod limits the oil flow for tilting to max. 26 l / min.

Way valve lift/lower



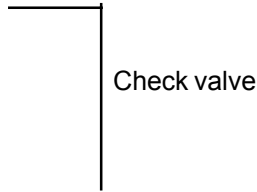
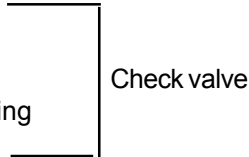
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Way valve lift/lower

A1 = Connection lift cylinder
P = Pump duct
R = Return duct

1. Valve rod
2. Wiper
3. Shroud
4. O-ring
5. Ball
6. Spring
7. Plug
8. O-ring + retaining ring
9. Circlip
10. Thrust washer
11. Restoring spring
12. Spacer
13. Sleeve holder
14. Sleeve
15. Sender (inductive displacement sensor)
16. Sender screw
- 17+18. Spring washer
19. Retaining ring
20. O-ring
21. Valve cone
22. Bore
23. Spring
24. Screw plug
25. O-ring
26. Bore

**Function**

When the valve rod (1) is moved downwards (lifting), the oil from the pump duct "P" flows via the ball (5) of the check valve and the raised valve cone (21) of the stop valve to the connection "A1" to the lift cylinders. After lifting the load and with the valve rod (1) in a neutral position (see Fig), the ball (5) of the check valve is forced into its seat by the spring (6). The valve cone (21) is additionally forced downwards into its seat by the spring (23) and consumer pressure active in the spring compartment via the bore (22) and prevents automatic lowering of the load.

When the valve rod is moved upwards (lowering), the spring compartment is connected via the bore (26) to the return ducts "R". This relieves the pressure in the spring compartment and the valve cone (21) is pushed upwards through the load pressure against the spring (23). The oil is able to flow from the lift cylinders into the return duct.

- Remove screw plug (24)
- Remove spring and valve cone
- Check that bore (22) is clear

Note:

According to the accident prevention regulations, the maximum permissible automatic lowering of the load can be 100 mm in 10 minutes.

Test:

- Lift nominal load about 0.5 m
- After a waiting time of two minutes, mark fork carriage and outer mast.
- Measure lowering distance after ten minutes.

Check valve (Item 5- 9)

If the load initially lowers a partial distance in the fine control range before being lifted, this can be due to fouling of the ball seat (5) or the spring (6) may be faulty.

In this case, the valve control block must be renewed.

Valve rod position (1)

The valve rod (1) must not be rotated more than 55° anticlockwise or clockwise, otherwise the stop valve may be liable to malfunction.

- The fork carriage cannot be lowered.
- The load lowers automatically too quickly.

Renewing valve rod seal (Item 2,4,19,20)

See chapter "Way valve additional hydraulics".

Sender (Item 12,13,14,15)

Replacement and adjustment, see chapter "Sender- pump motor speeds"

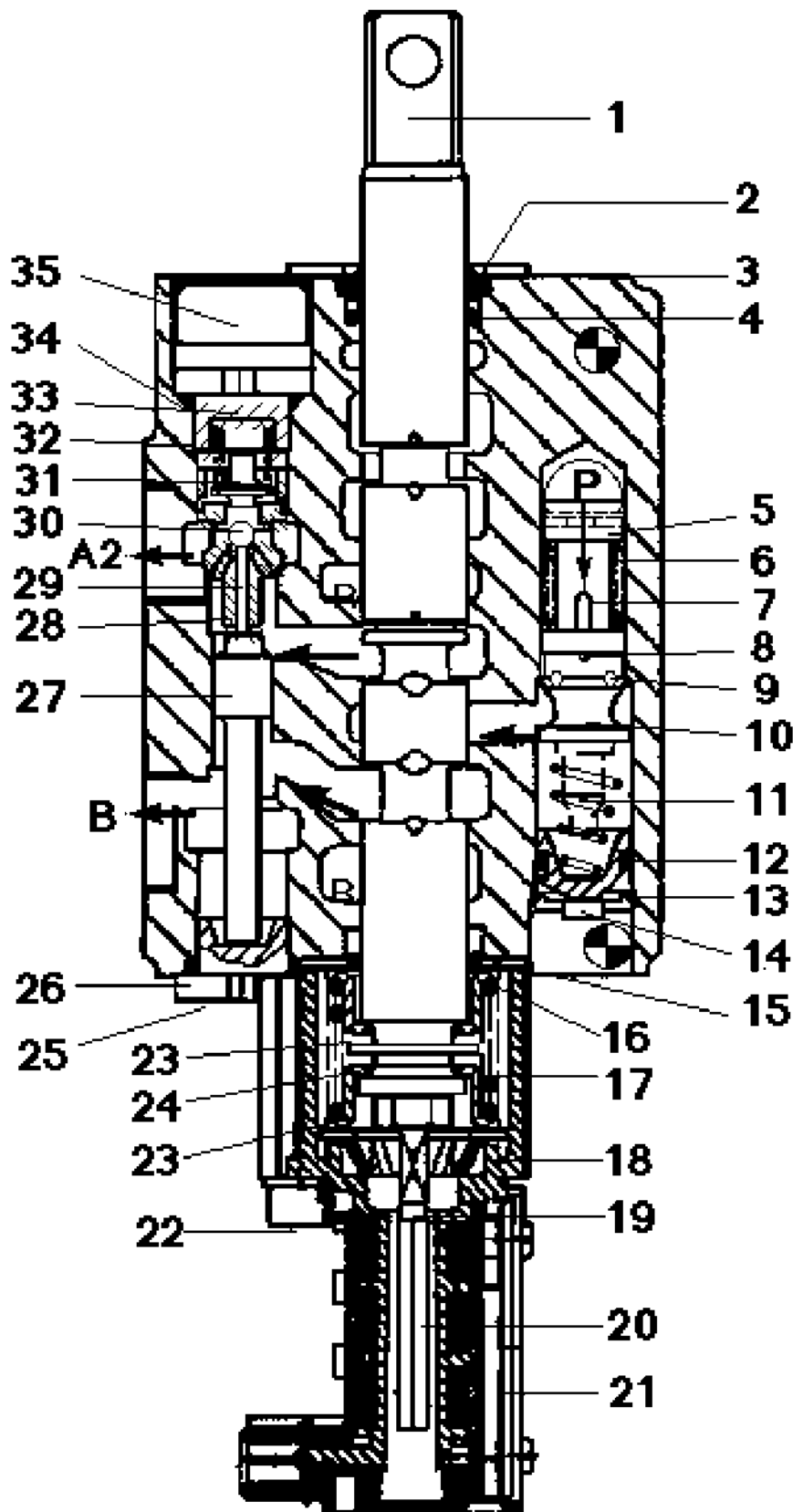
Tightening torques:

- Item 16 = 3.5 + 1.2 Nm
Item 24 = 29 + 10 Nm

Stop valve (Item 21- 26) With excessive automatic lowering of the load, the stop valve must be checked for fouling or damage.

Way valve - tilt

Type until 1996



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Way valve - tilt

Type up to 1996

A2 = Connection - tilt back

B = Connection - tilt forward

P = Pump duct

R = Return duct

1. Valve rod

2. Wiper

3. Shroud

4. O-ring

5. Cross-section reducer

6. Spring

7. Piston

8. Pin

9. Bores

10. Housing .

11. Spring

12. O-ring + retaining ring

13. Circlip

14. Screw plug

15. O-ring + retaining ring

16. Thrust washer

17. Restoring spring

18. Spacers

19. Sleeve holder

20. Sleeve

21. Sender (inductive displacement sensor)

22. Sender screw

23. Spring washer

24. Washer (stroke limiter)

25. Screw plug

26. O-ring

27. Plunger rod

28. Housing

29. Bolt

30. Ball

31. Spring washer

32. Spring

33. Screw plug

34. O-ring

35. Cap

Check and
control valve

Stop valve

Function

When the valve rod (1) is moved downwards (tilting back), the oil from the pump duct "P" flows via a control valve forced out of its seat and a check valve (Item 5-14) and via a stop valve (Item 27-35) similarly forced out of its seat to the connection "A2" to the front tilt cylinder chambers. After tilting and with the valve rod (1) (see Fig.) in a neutral position, the housing (10) of the control and check valve is forced into its seat by the spring (11). The housing (28) of the stop valve is also forced into its seat by the spring (32) and consumer pressure active in the spring compartment and prevents a return flow of oil from the front tilt cylinder

chambers, i.e. automatic forward tilting of the mast. When the valve rod (1) is moved upwards (tilting forward), the oil similarly flows from the pump duct "P" via the control and check valve to connection "B" to the rear cylinder chambers. With the pressure build-up in connection "B", the plunger rod (27) is pushed upwards and lifts via the bolt (29) the ball (30) from its seat. This relieves the pressure in the spring chamber (32) and the housing is pushed upwards out of its seat through the consumer pressure. The oil from the front tilt cylinder chambers is able to flow into the return duct "R".

Check and control valve (Item 5 - 14)

An oil volume of max 26 l/min. for the tilt function flows from the control valve via a cross-section reducer (5) and the bores (9).

For function of check valve see chapter "Way valve lift/lower".

Stop valve (Item 27 - 35)

Functional check: According to the accident prevention regulations, the mast must not automatically move forward more than 0.5 degrees per second. If tilting takes place too quickly, the stop valve must be checked for fouling or damage.

- Remove cap (35)

- Unscrew screw plug (33)

- Remove parts (28 - 32)

- Check that all bores in the housing (28) are clear and check all valve seats for damage and the pressure rod (27) for smooth movement in the bore.

Sender (Item 18,19,20,21) :

See chapter „Sender - pump motor speeds“

Renewing valve rod seal (Item 2,4,15) :

See chapter "Way valve additional hydraulics"

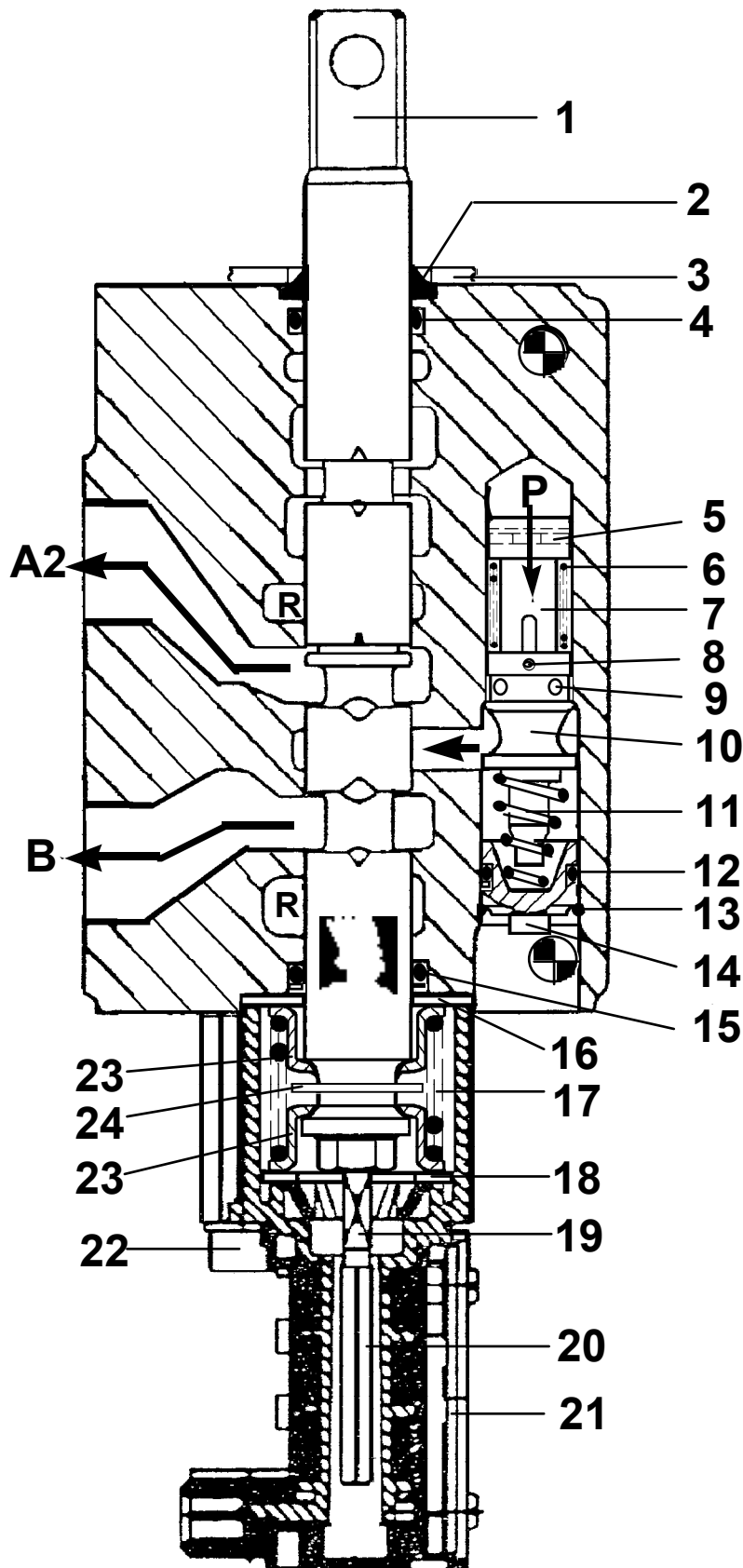
Tightening torques:

Item 22 = 3.5 + 1.2 Nm

Item 25+33 = 23.5 + 8 Nm

Way valve - tilt

Type from 1997



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Way valve - tilt

Version from 1997

A2 = Connection - tilt back
 B = Connection - tilt forward
 P = Pump duct
 R = Return duct

1. Valve rod
2. Wiper
3. Shroud
4. O-ring
5. Cross-section reducer
6. Spring
7. Piston
8. Pin
9. Bores
10. Housing
11. Spring
12. O-ring + retaining ring
13. Circlip
14. Screw plug
15. O-ring + retaining ring
16. Thrust washer
17. Restoring spring
18. Spacers
19. Sleeve holder
20. Sleeve
21. Sender (inductive displacement sensor)
22. Sender screw
23. Spring washer
24. Washer (stroke limiter)

Check and control valve

flows from the control valve via a cross-section reducer (5) and the bores (9).

For function of check valve, see chapter "Way valve lift/lower"

Sender (Item 18, 19, 20, 21) :

See chapter "Sender - pump motor speeds"

Renewing valve rod seal (Item 2, 4, 15):

See chapter "Way valve additional hydraulics"

Tightening torque:

Item 22 = 3.5 ± 1.2 Nm

Function

When the valve rod (1) is moved downwards (tilting back), the oil from the pump duct "P" flows via a control valve forced out of its seat and a check valve (Item 5 - 14) to the connection "A2" to the front tilt cylinder chambers.

The oil from the rear tilt cylinder chambers is able to flow via the connection "B" into the return duct "R".

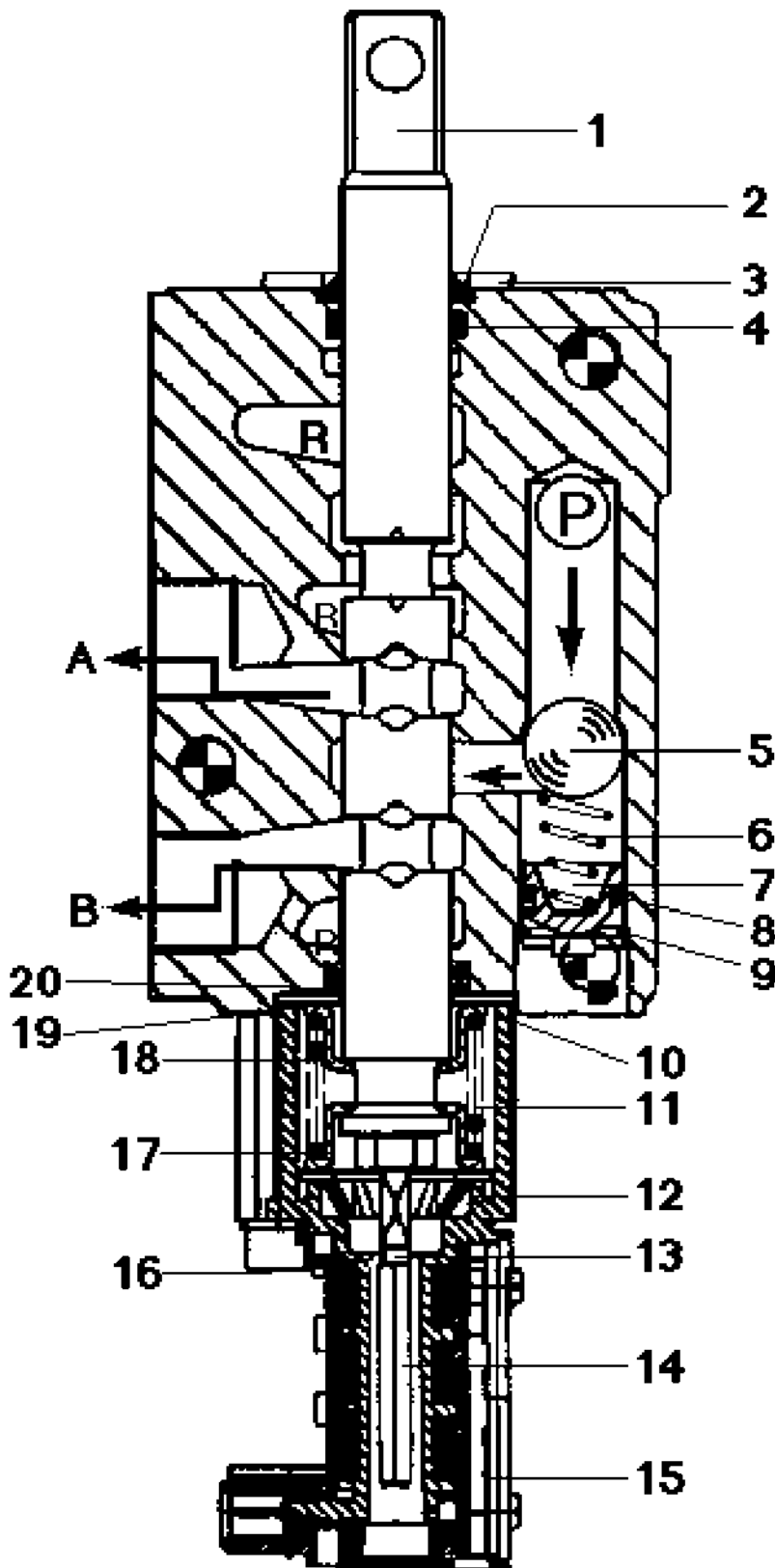
When the valve rod (1) is moved upwards (tilting forward, the oil similarly flows from the pump duct "P" via the control and check valve to the connection "B" to the rear tilt cylinder chambers.

The oil from the front tilt cylinder chambers is able to flow via the connection "A2" into the return duct "R". After tilting and with the valve rod (1) in a neutral position (see Fig.), the housing (1) of the control and check valve is forced back into its seat by the spring (11).

Check and control valve (Item 5 - 14)

An oil volume of max. 26 l/min. for the tilt function

Way valve - additional hydraulics



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Way valve - additional hydraulics

A + B = connection for attachment

1. Valve rod
2. Wiper
3. Shroud
4. O-ring
5. Ball
6. Spring
7. Screw plug
8. O-ring + retaining ring
9. Circlip
10. Thrust washer
11. Restoring spring
12. Spacers
13. Sleeve holder
14. Sleeve
15. Sender (inductive displacement sensor)
16. Sender screw
- 17.+18. Spring washer
19. Retaining ring
20. O-ring

Function

The way valve for the additional hydraulics is available in two variants.

- As an end block with integrated plate
- As a centre block (e.g. three- way valve for double additional hydraulics)

The function is essentially identical.

When the valve rod (1) is moved upwards or downwards, the oil from the pump duct "P" flows via the ball (5) of the check valve to the connections "A" and "B" to the attachment.

Renewing valve rod seals (Item 2,4,19,20)

The valve rod (1) must be sealed with particular care as it is adjusted in line with the senders (15) .

- Remove control valve block
- Remove shroud (3)
- Loosen screws (16)
- Carefully remove sender (15) from sleeve holder (13)
- Ensure that no spacers (12) are lost

ATTENTION : The sleeve (14) mounted on the sleeve holder (13) must not be moved as this would alter the output voltage of the sender.

- Mark position of valve rod (1) for lifting/lowering

(valve rod must be fitted correctly).

- Remove valve rod (1) downwards.
- Fit new wiper (2) and O-ring (4) in the block and fit shroud (3).
- Slip new O-ring (20) and retaining ring (19) along valve rod up to thrust washer (10).
ATTENTION: Seals can be damaged by the sharp edges of the valve rod.
- Refit valve rod (1) in block.
- Fit spacer in sender housing (15).
- Carefully slip sender (15) over sleeve holder and screw to valve block; tighten screws (16) alternately with the specified tightening torque.

Tightening torque: Item16 = 3.5 + 1.2 Nm

Sender (Item 12,13,14,15)

See chapter "Sender - pump motor speeds".

Check valve (Item 5 - 9) :

See chapter "Way valve lifting/lowering"

Control valve block DBV/Block seal

Relief valve

1. Cap
2. Lock nut
3. Washer
4. Adjusting screw
5. O-ring
6. Spring
7. Valve housing
8. O-ring
9. Valve disk (valve seat)
10. Valve cone

The relief valve in the "lift/lower" control valve block protects the hydraulic system against overloads.

If, for example, a load is fully lifted and the final pressure set at the valve is exceeded, the valve cone (10) is forced out of the valve seat (9) against the spring (6). The pressurised oil at "P" is able to flow into the return duct "R" to the hydraulic tank.

After loosening the lock nut (2), the pressure can be increased or reduced by tightening or unscrewing the adjusting screw (4).

Set final pressure:

6022 - 25 = 230 bar

6026 - 29 = 250 bar

(Setting range: 100 - 260 bar)

Attention:

Do not remove any washers (3). Do not set the pressure higher than the pressure specified above.

Note:

If fouling of the valve cone seat is suspected (e.g. with reduced lift or tilt), unscrew the valve housing (7), remove the spring (6) and valve cone (10) and inspect the valve seat for foreign bodies.

Tightening torques:

Valve housing (7) : 46 + 15 Nm

Lock nut (2) : 13.5 + 4.5 Nm

Block seal

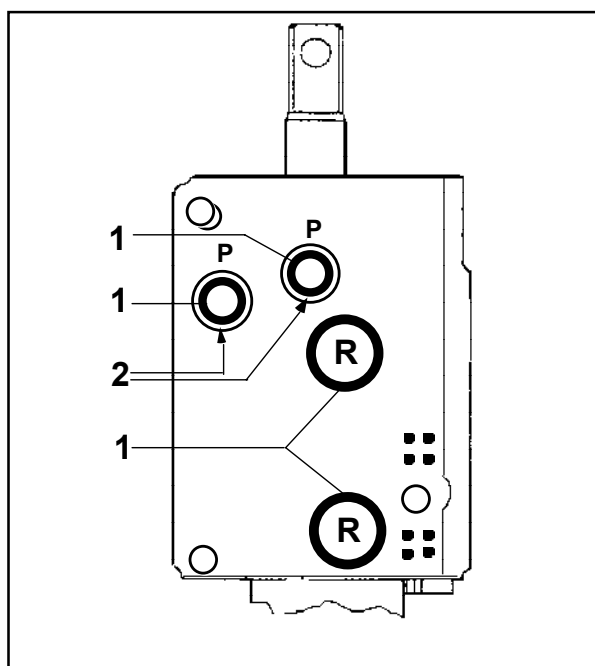
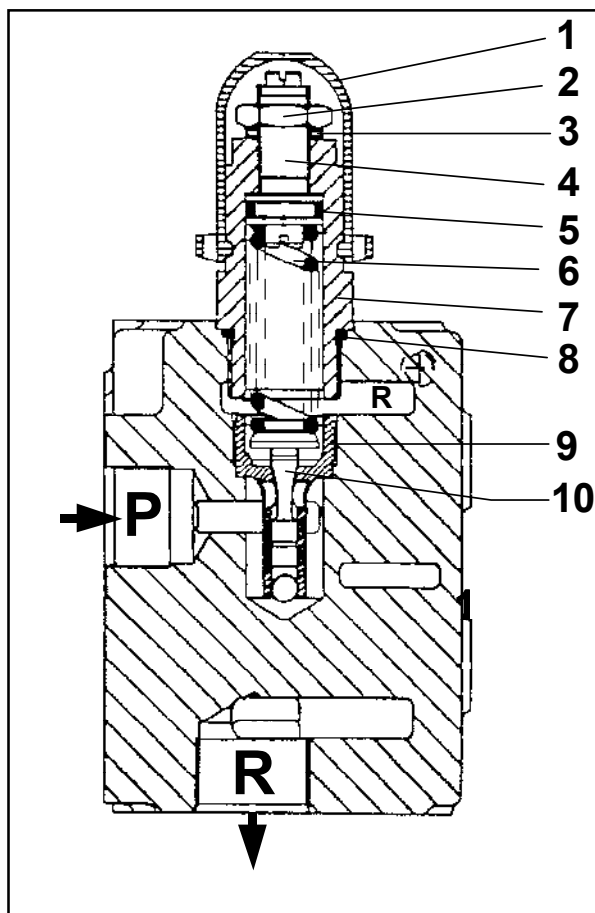
Pump ducts "P" and return ducts "R" are sealed on the flange faces of the way valves and plate by means of O-rings (1) and retaining ring (2).

Fitting information:

Do not clean the flange faces with cloths or paper towels. Fibres on the O-rings can impair the tightness.

It is recommended to clean the sealing surface with the ball of the hand.

In case of leaks at the flange seals, check the tightening torques of the tie rods.



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Control valve block - sender/speeds

Sender - function and replacement

1. Valve rod
2. Collar screw
3. Spacer
4. Sleeve holder
5. Sleeve
6. Displacement sensor
7. Cover
8. Screws

A = Supply voltage (+)

B = Output voltage

C = Ground (-)

The sender consists of the sleeve holder (4) screwed to the valve rod and displacement sensor (6) with plug connector. The sender is adjusted with spacers (3) to the valve rod stroke. The output voltage of the sender is adjusted via a sleeve (5) arranged moveable on the sleeve holder (4). The output voltage changes proportional to the displacement of the valve rod (1).

For replacement of the sender (replacement delivery consists of Items 4, 5, 6 and 7), the directions below should be followed:

Removal

- After loosening the screws (8), carefully remove the sender (6) from the sleeve holder (4), ensuring that no spacers (3) are lost.
- The sleeve holder is screwed into the collar screw (2) with Loctite. If the sleeve holder has to be renewed (normally unnecessary), the bonding point should be heated for unscrewing purposes if necessary (remove control valve block).
- Thoroughly clean the collar screw thread and fit the sleeve holder with Loctite 243.
- If readjustment of the sender should be necessary, the sleeve (5) must be removed to the extent that the end is located about 1mm above the sleeve holder and the cover (7) must be removed.

Fitting

- Carefully slide the displacement sensor with fitted spacers along the sleeve holder and screw to the valve block. Tighten the screws (8) alternately with the specified tightening torque.
- Install the control valve block.

Adjustment

With a supply voltage of 10 V (measure between connection "A" and "C"), an output voltage of 5.0 ± 0.2 V must be present at the displacement sensor at connection "B" (measure between connection "B" and "C") with the valve rod in a neutral position. The output voltage can be corrected if required by moving the sleeve (5) through the cover opening (7).

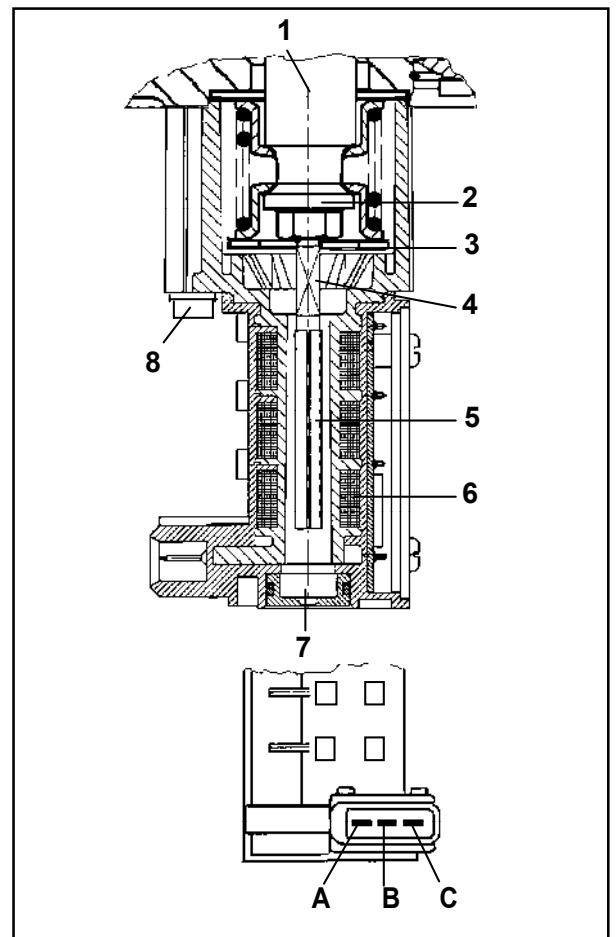
Note: Only tools of antimagnetic and electrically insulating material (plastic or ceramic) should be used (no steel, copper, etc.).

Check: With the valve rod (1) fully displaced, a voltage of > 7.3 V must be present at connection "B".

- Refit cover (7).

Tightening torque: Item 4 = 0.5 ± 0.17 Nm

Item 8 = 3.5 ± 1.2 Nm

**Pump motor speeds (without load):**

Lift	2880 1/ min
Tilt	
up to nominal lift	
3500 mm	1359 1/ min
up to nominal lift	
5000 mm	753 1/ min
above nominal lift	
5000 mm	485 1/ min
1st and 2nd additional hydraulics	See Group 13

Control valve block - tilt cross-section reducer

1. Union with cross-section reducer bore
2. Cross-section reducer mark (notch)

In order to counteract a possible malfunction of the pump motor control (excessive pump motor speed) in the event of the mast tilting too quickly, for masts

from a nominal lift of 5000 mm

installed in connection "B" of the tilt way valve is a union with the following cross-section reducer bore.

Up to the end of 2000 = 1.2 mm Ø
 From the beginning of 2001 = 1.4 mm Ø

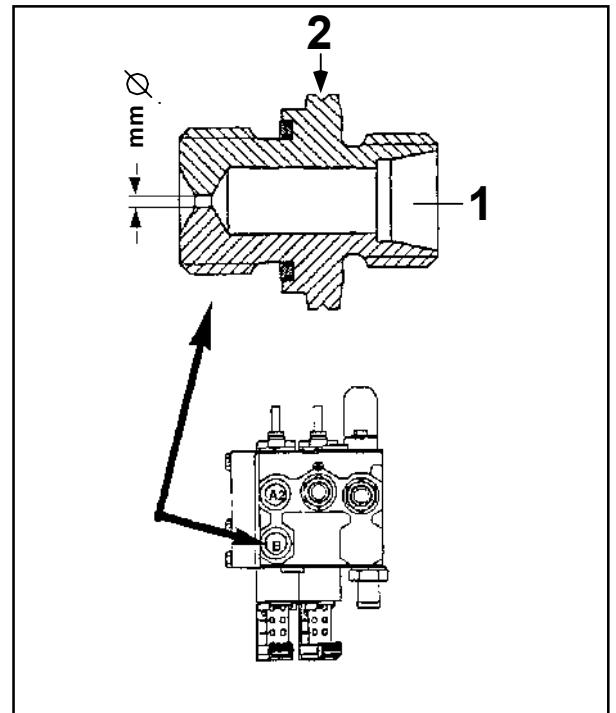
Union tightening torque: 66 Nm

NOTE

The installation of a cross-section reducer union (1) can be identified by the outer notch (2) on the hexagon.

ATTENTION

For mast replacement, it must be determined whether these cross-section reducer unions must be used depending on the type of mast or whether they can be omitted.



Pressurising valve - function

Type up to end of 1996 :

For damping the stop valve in the "tilt" way valve (3), a pressurising valve (1) is installed in the line connection "A2" to the front tilt cylinder connections (2).

Set pressurising pressure = 80 bar

By pressurising the oil, vibrations at the stop valve are prevented and jerk-free forward tilting is achieved.

Type from 1997 :

The stop valve in the "tilt" way valve is omitted. The holding function of the mast to prevent automatic forward tilting is taken over by a pressurising valve (1) with a high pressure setting.

Pressurising pressure: 6022 - 25 = 125 bar

Pressurising pressure: 6026 - 29 = 180 bar

The pressurising valves have the designations P and R at the connection points.

R ----> P = free flow

P ----> R = pressurised

Valve setting range:

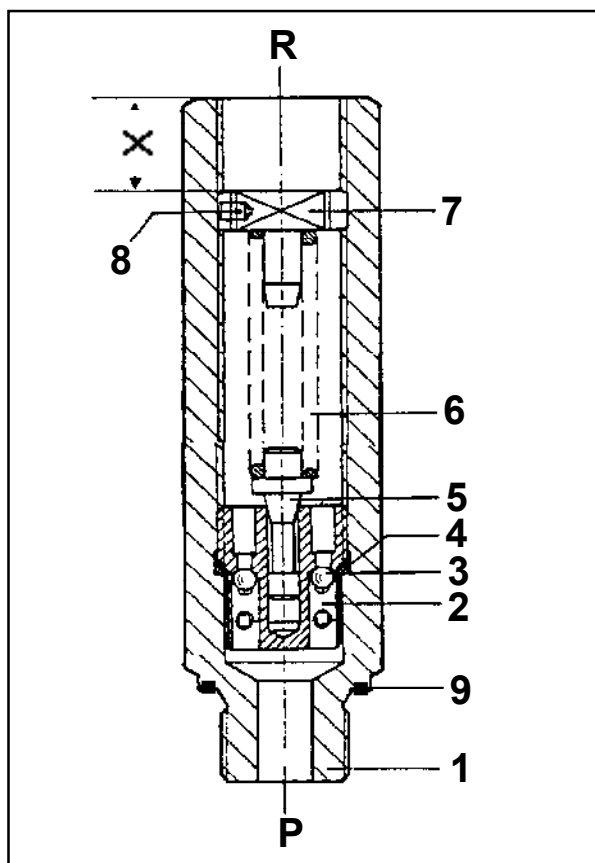
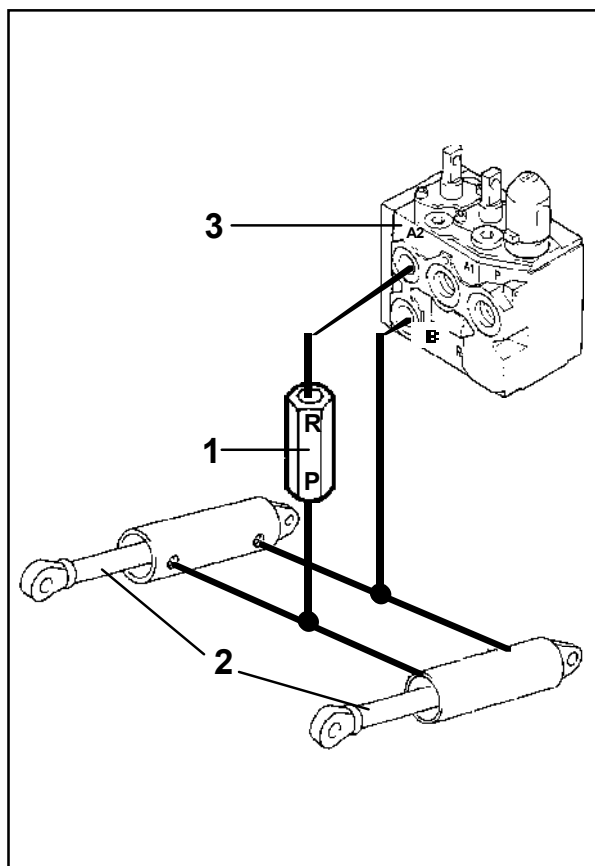
6022 - 25 = 0 - 130 bar

6026 - 29 = 130 - 190 bar

Design

1. Housing
2. Valve screw
3. Free flow balls
4. Seal
5. Sealing cone with damping
6. Spring
7. Adjusting screw
8. Plug
9. Seal

If jerky movements should occur whilst tilting the mast forward (**type until the end of 1996**), it can be assumed that the hydraulic oil is no longer pressurised. This may be due to fouling of the cone seat (5) of the pressurising valve.



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Pressurising valve - testing/removal

Testing pressurising valve (UVV) :

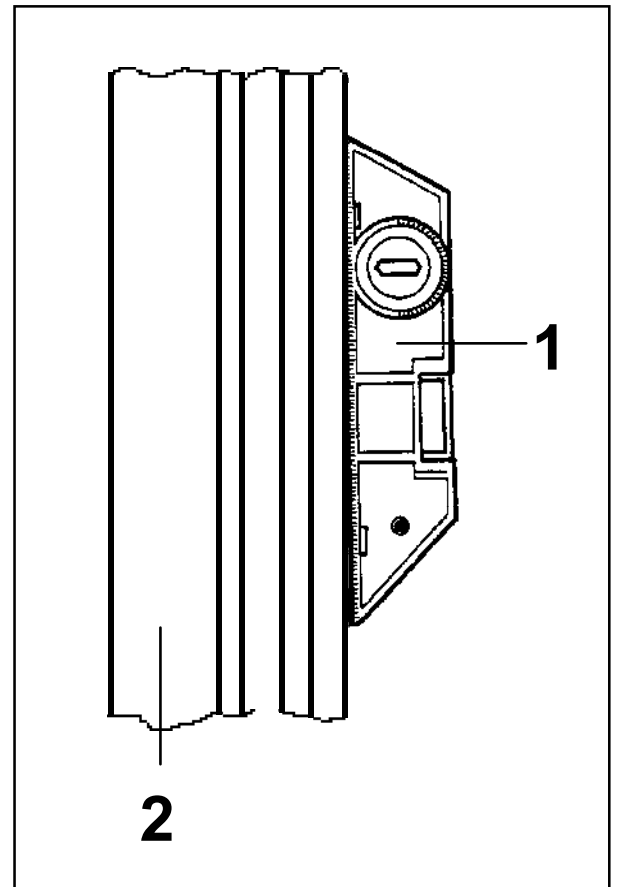
- Lift nominal load
- Park vehicle on level surface and place mast vertical.
- Attach angle measuring device (spirit level) (1) to mast (2).
- Set switch key to position O and check that tilt control rod of way valve is in a neutral position.

NOTE

According to the accident prevention regulations, the mast must now not tilt forward more than 0.5 degree per minute.

If the mast tilts forward at a higher rate, the cone seat (5) may be fouled.

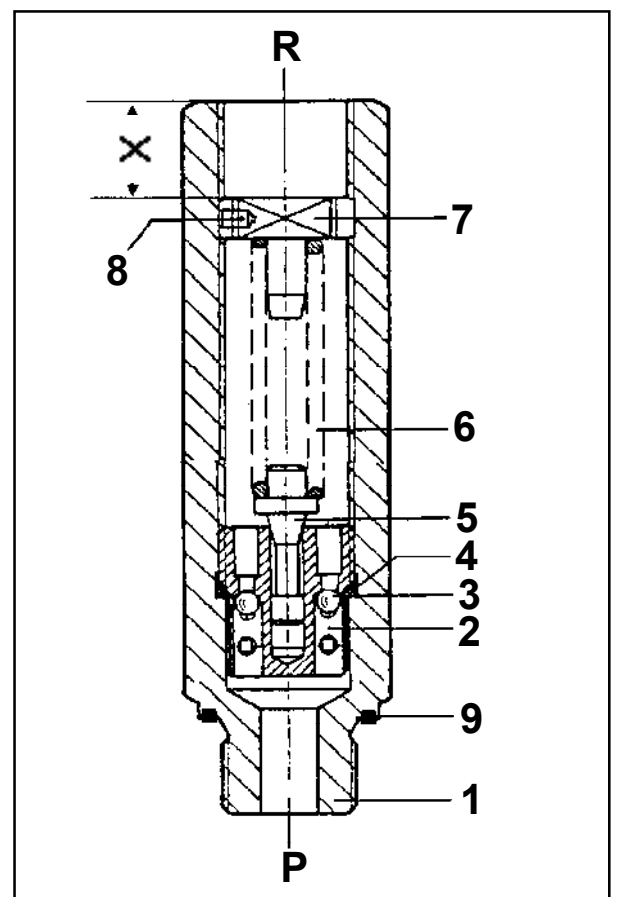
Remove pressurising valve and inspect for fouling.

**Removal**

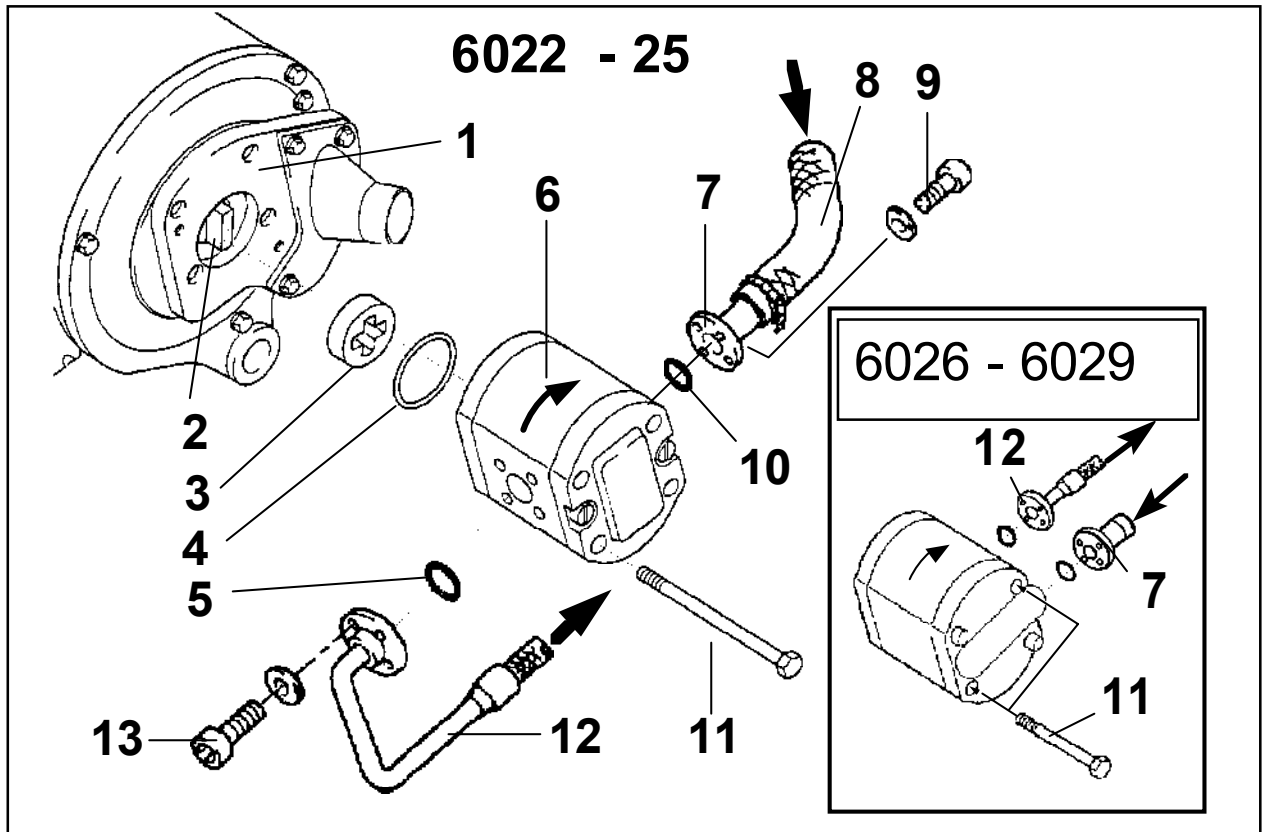
- Remove pressurising valve.
- Note dimension "X".
- Unscrew adjusting screw (7) with circlip plier.
- Remove spring (6) and valve cone (5).
- Inspect valve seat for fouling and damage.
- Fit Item (5) and (6) and tighten adjusting screw (7) to old position (**dimension X**).

NOTE

After being removed twice, the plug (8) will no longer function reliably.



Hydraulic pump - Function



Type	: Gear pump
Delivery	: 19 cm ³ /per revolution
Dir. of rot.	: Counterclockwise
Drive	: Pump motor (1) via pump shaft (2) and driver (3)
Sealing	: Radial seal in pump motor and O-ring (4)

Function

The hydraulic oil sucked out of the tank by pump (6) via line (8) is pumped under pressure via line (12) to the priority valve.

NOTE:

With the 6026- 29, the suction and pressure connection are located on one side of the pump. The sucked oil flows through the pump cover to the suction side of the pump.

Removal

- Fully lower fork carriage and tilt mast fully forward.
- Disconnect battery plug and remove plate.
- 6026 - 29 = remove shroud on front partition and remove fan.
- Disconnect air intake hose (8) from flange (7).
- Unscrew oil supply line (12) at priority valve.
- Unscrew screws (11).
6022 - 25 = 4 screws
6026 - 29 = 2 screws

and remove pump (6) from motor.

Fitting

- When fitting a new pump, seals (5 + 10) must be renewed.
- Fix flange (7) of air intake and flange of oil supply line (12) to the pump.
- **Tightening torque** for screws (9 + 13) : 12 Nm
- Position catch (3) on pump shaft journal.
- Grease O-ring (4) on pump neck.

- Fit pump in pump motor (1) so that shaft journal (2) of the motor engages in catch (3).

- Fix pump to motor with screws (11)

Tightening torque for screws (11) :

6022 - 25 = 56 ⁺⁴ Nm

6026 - 29 = 120 ⁺⁵ Nm

NOTE

In the event of pump noise, foaming of the oil in the tank, delayed or no consumer movement, a check must be made for leaks at the radial seal in the motor, at O-rings (4+10) or at other air intake connections (7+8).

Hydraulic tank - Oil change/Capacities

Type up to 1997

The hydraulic tank (1) is a welded construction and is integrated transversely into the chassis in front of the battery compartment.

1. Hydraulic tank
2. Air filter
3. Return connection - lift hydraulics
4. Breather filter with dipstick
5. Return connection - steering
6. Oil drain plug
7. Seal

Hydraulic oil change

Every 3000 operating hours, however minimum once a year

- Park vehicle on a level surface
- Tilt mast fully back
- Fully lower fork carriage
- Disconnect battery plug
- Remove plate
- Unscrew filter (4)
- Unscrew drain plug (6) and collect oil in a container
- Screw in new drain plug (6) with new seal (7) and tighten
- Fill new hydraulic oil via vent connection (4) or air filter (2)
- Check oil level

Hydraulic oil (OZ)

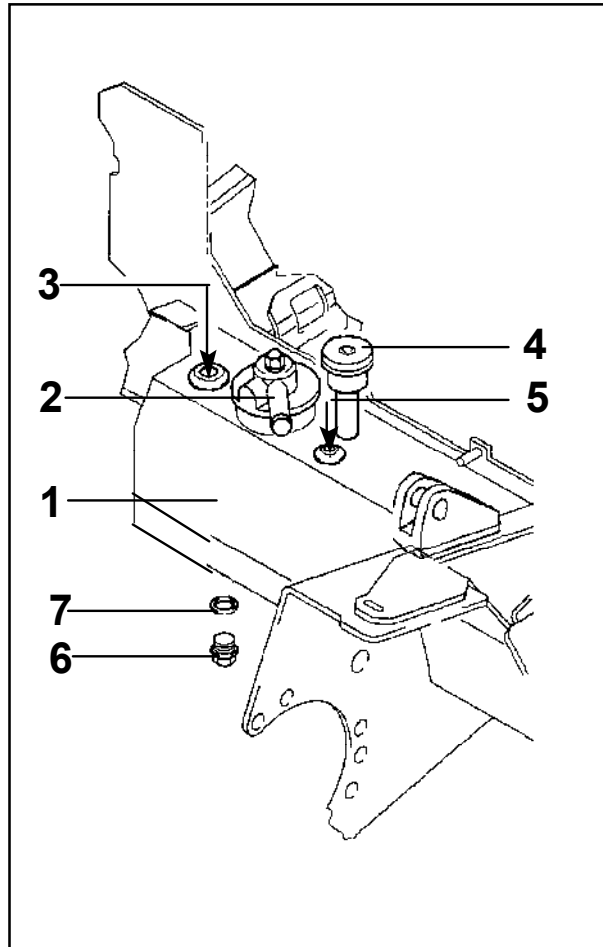
Quality according to DIN 51524, part 2/HLP ISO VG 46 HM

Capacities

The tank must be filled according to the overall height of the mast.

Capacity measurement:

- Park vehicle on a level surface
- Tilt mast fully back and fully lower fork carriage
- Unscrew breather filter (1)
- Check that oil level is at the mark 2, 3, or 4 according to the table opposite
- Refill hydraulic oil if necessary



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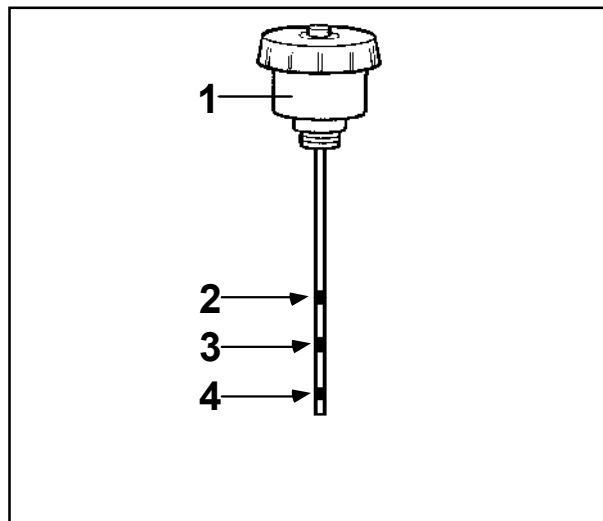
Mast type		Marker		
(Mast height/ mm)		6022-24	6025	6026-29
Tele	bis 2300	4	4	4
	bis 3250	4	3	3
HiLo	bis 2300	4	4	4
	bis 3250	4	3	3
Triplex	bis 2300	4	3	3

Mark 2 : 6022-25 = 37 litres/6026-29 = 38 litres

Mark 3 : 6022-25 = 32 litres/6026-29 = 34 litres

Mark 4 : 6022-25 = 27 litres/6026-29 = 28 litres

The specified capacities correspond to the total capacity of the hydraulic system.



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Hydraulic tank - Oil change/Capacities

Type from 1997

The hydraulic tank (1) is a welded construction and is integrated transversely into the chassis in front of the battery compartment

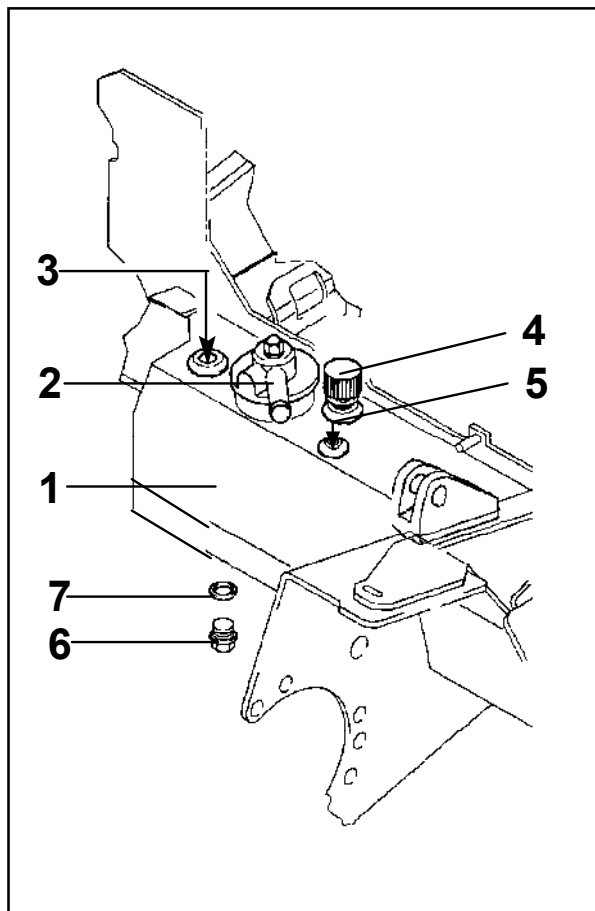
1. Hydraulic tank
2. Air filter
3. Return connection - lift hydraulics
4. Breather filter with dipstick
5. Return connection - steering
6. Oil drain plug
7. Seal

Hydraulic oil change

Every 3000 operating hours.

Minimum every two years.

- Park vehicle on a level surface
- Tilt mast fully back
- Fully lower fork carriage
- Disconnect battery plug
- Remove plate
- Remove filter (4)
- Unscrew oil drain plug (6) and collect oil in a container
- Screw in new drain plug (6) with new seal (7) and tighten
- Fill new hydraulic oil via vent connection (4) or air filter (2)
- Check oil level



Hydraulic oil (OZ)

Quality according to DIN 51524, part 2/HLP
ISO VG 46 HM

Breather filter

The breather filter (1) with dipstick has a filter fineness of 25 μ and serves to prevent dust and dirt entering the hydraulic tank. The breather filter with dipstick must be renewed every 3000 operating hours.

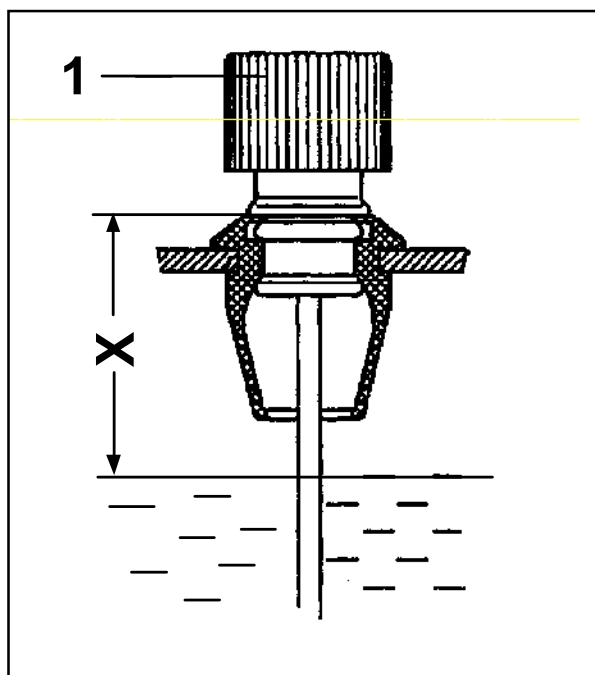
Capacities

Capacity measurement:

- Park vehicle on a level surface
- Tilt mast fully back and lower fork carriage
- Remove breather filter (1)
- Check oil level **dimension X**.
6022 - 25 = 85⁻¹⁵ mm
6026 - 29 = 66⁻¹⁰ mm
- Refill hydraulic oil if necessary
- Refit breather filter

Total capacity of hydraulic system:

- 6022 - 25 = 27 litres
- 6026 - 29 = 34 litres



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Air filter - Function/Maintenance

Type : Intake filter with paper filter cartridge with bypass valve and strainer.

Paper filter cartridge (3) :

Filter fineness = $15\ \mu$ (nominal)

Bypass valve (1): Operating pressure: $0.25 \pm 0.05\text{bar}$

Strainer (2) : $200\ \mu$

1. Bypass valve
2. Strainer
3. Paper filter cartridge
4. Seal
5. Filter cover
6. Nut with seal
7. Guide pipe with guide rod (welded into chassis)
8. Hydraulic tank
9. Air intake hose
10. Oil pressure switch connection (special type)
11. Breather filter
12. Seal

The oil sucked out of the tank by the hydraulic pump flows through the filter cartridge (3) from the outside to the inside.

For the protection of the hydraulic components (pump, slider bank, etc.), bypass valve (1) opens at a low pressure of $0.25 \pm 0.05\text{ bar}$ (filter cartridge clogged) and allows oil to flow via a strainer (2).

Note

In the event of no or jerky consumer movements, loud pump noise or foaming oil, the seal Item 4 and 6 and the connection Item 9 - 10 must be checked for possible air intake.

Replacement of paper filter cartridge (3)

- Loosen nut (6)
- Lift cover (5) and separate from filter cartridge (3)
- Remove filter cartridge
- Check seal (4) for damage and hardening
- Fit new filter cartridge (3) in guide pipe (7)

Fit cover (5) and screw tight.

Tightening torque Item 6 = 12 Nm

Note : Do not clean paper filter cartridges.

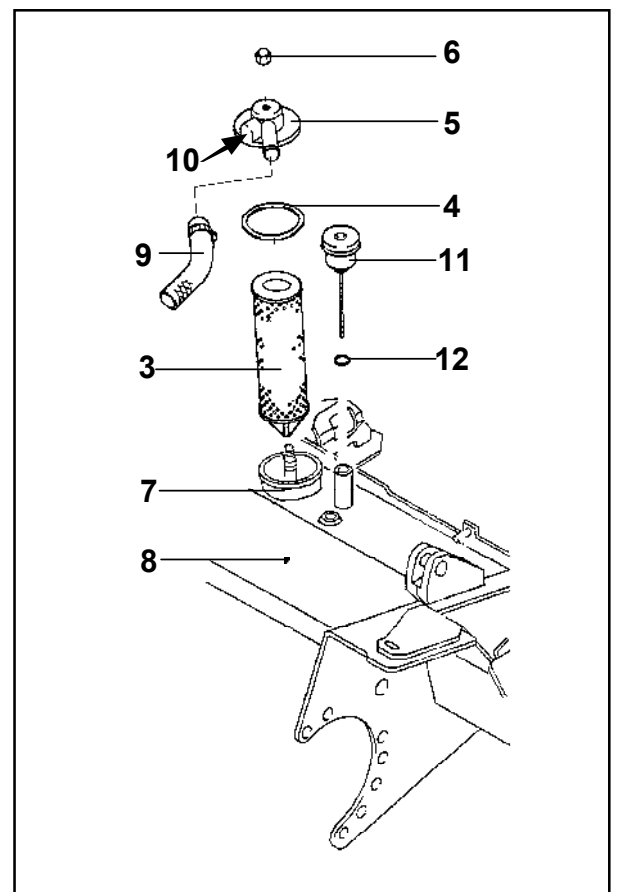
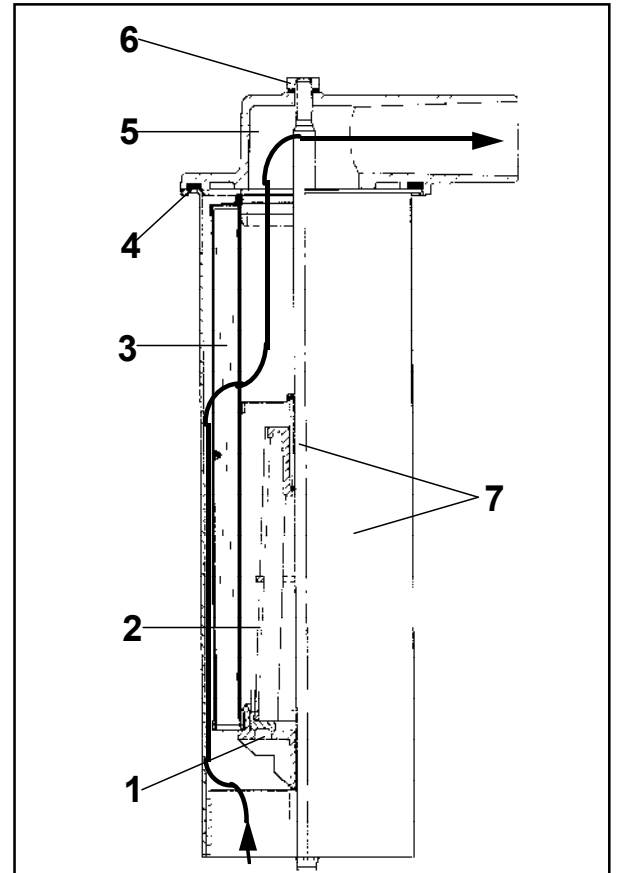
Replace if clogged.

Maintenance intervals

Replace paper filter cartridge (3):

- Every 3000 operating hours
- When following indication shows on the instrument panel display (special type) :

**OIL FILTER
FAULT 91**



Breather filter - Function/Maintenance

Type up to 1997

1. Housing
2. Cover with dipstick
3. Filter cartridge
4. Seal

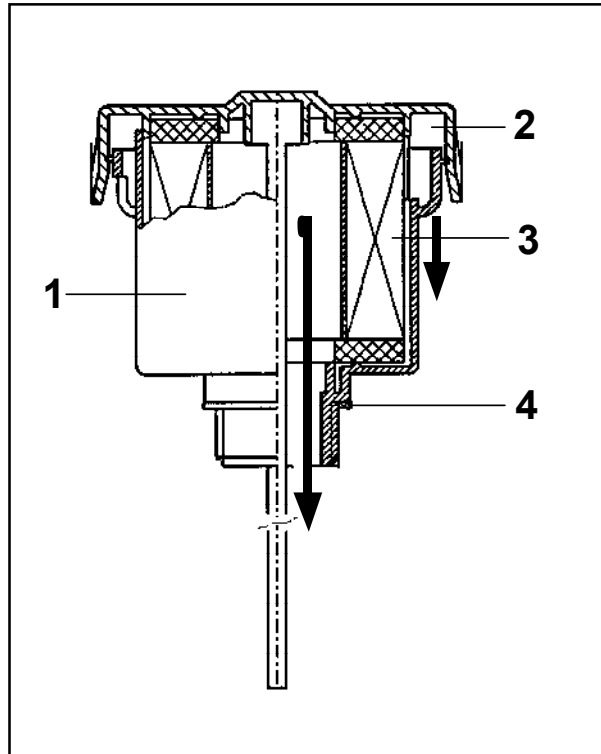
The air flowing into or out of the hydraulic tank with a consumer movement (e.g. lifting or lowering) flows in the breather filter through the cartridge (3).

The filter cartridge prevents the entry of dust and dirt as well as the discharge of oil vapours .

Maintenance intervals

Renew filter cartridge (3) every 3000 operating hours.

For this purpose, unscrew complete breather filter from tank connection, unscrew cover (2) with dipstick from housing (1), clean housing and fit a new filter cartridge (3).



Type from 1997

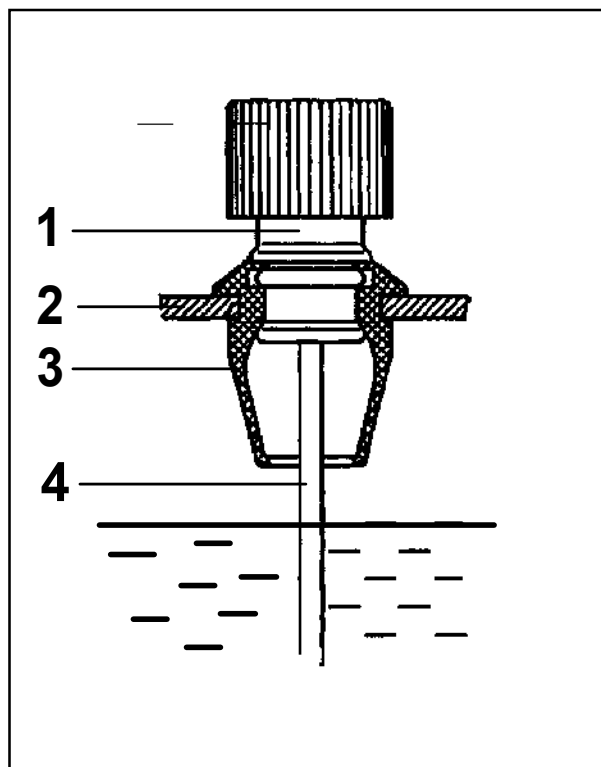
1. Breather filter
2. Tank plate
3. Seal
4. Dipstick

Breather filter (1) and dipstick (4) form a unit.

Maintenance intervals

Renew complete breather filter every 3000 operating hours.

For this purpose, remove complete breather filter from seal (3) and fit a new breather filter.



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Hydraulic unions - Installation

Tilt cylinder - unions

The threaded pipes are plastic coated for providing a seal in the cylinder barrel at the thread (arrow).

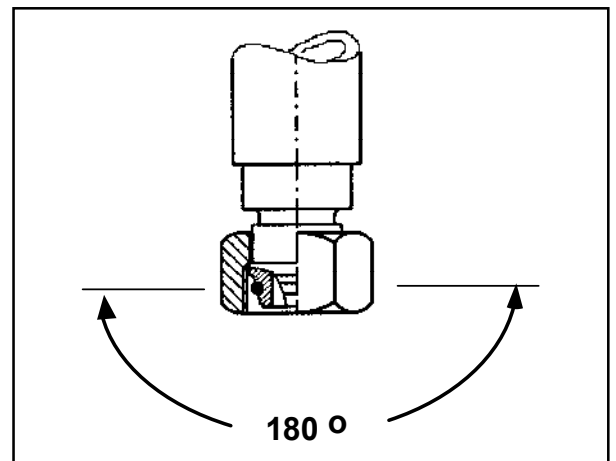
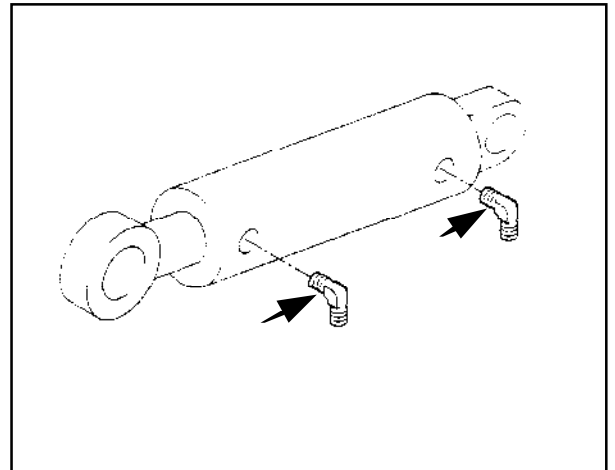
Installation:

After positioning the union in the cylinder barrel (max. 1 full turn), the following screwing depths must not be exceeded:

minimum = 4 full turns
maximum = 5 - „ -

NOTE

The union must be correctly positioned when screwing in. Each unscrewing action during or after screwing in will lead to leaks.

**Cone unions with O-ring (DKO)**

The union nuts must be finally tightened after tightening (noticeable resistance) with maximum a half turn (180 °). Tightening the union nuts beyond this value can result in deformations and leaks.

Hydraulic unions - Installation

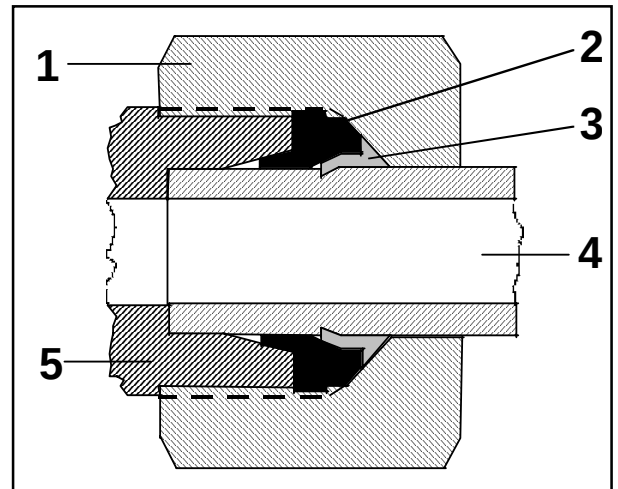
Pipe union with soft seal (EO2)

The previous antifriction collar pipe unions have been replaced by a new, improved sealing union system with soft seal.

The new unions consist of:

1. Function nut (union nut)
2. Seal
3. Retaining ring (antifriction collar)

Pipes (4) and threaded pipes (5) correspond to the old antifriction collar pipe union.

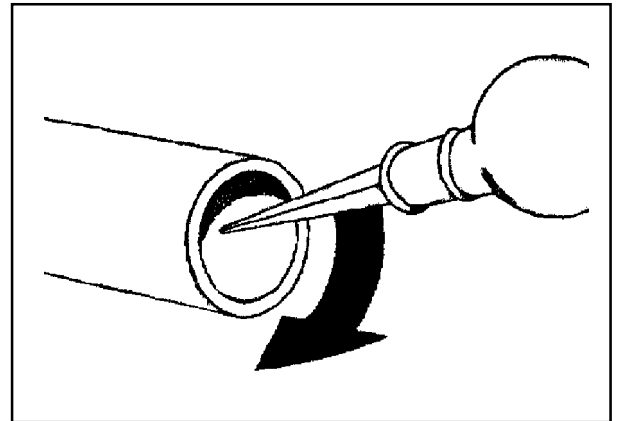
**Installation**

Cut off pipe at right angles

Deburr pipe inside and out

ATTENTION

Burr on the outside diameter of the pipe can damage seal (2).

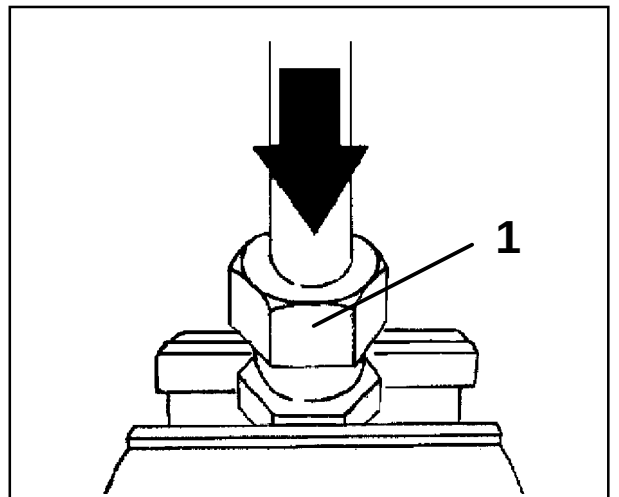


Tighten function nut (1) with retaining ring (3) and seal (2) hand-tight on pipe.

Insert end of pipe into the union and press against the stop in the inner cone.

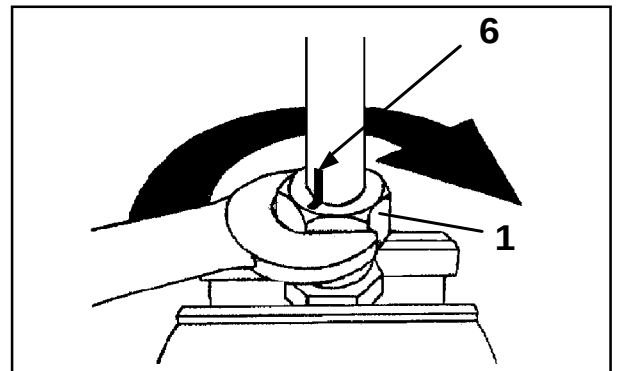
ATTENTION

The pipe must rest against the stop.



Tighten function nut (1) until an increase in force is noticeable (**about 1 to 1 1/2 turns**).

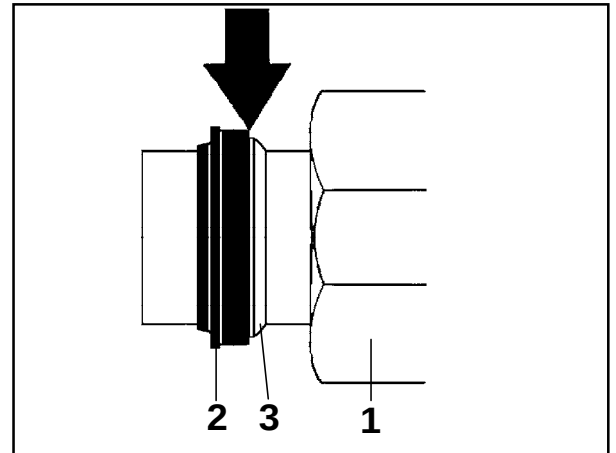
For this purpose, mark (6) the pipe and function nut.



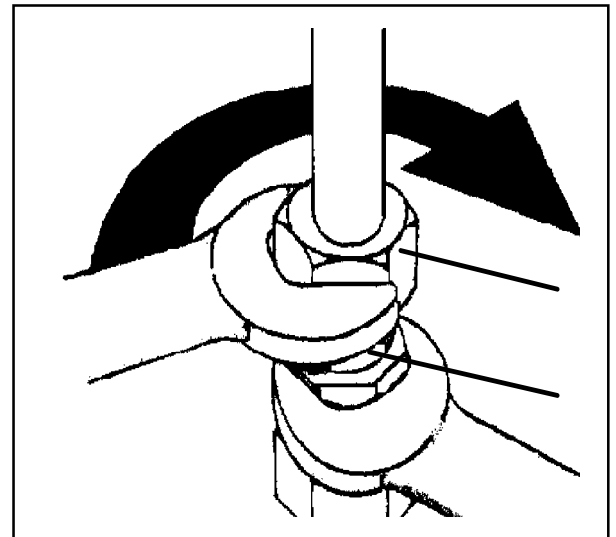
Hydraulic unions - Installation

Check

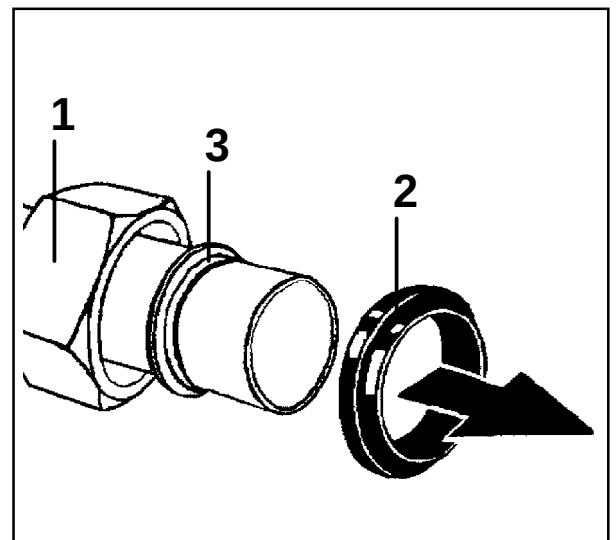
After installation, loosen function nut (1) and check that the gap between seal (2) and retaining ring (3) is closed.

**Repeat installation**

Each time the function nut (1) is loosened, repeat installation must take place with the same torque as for initial installation. The supports (7) must be counterheld.

**Seal replacement**

In the event of leaks at the union, the seal (2) can be removed from the free pipe end, checked for damage or hardening and replaced if necessary.



The vehicles are delivered with the following working speeds, **measured with nominal load**:

Lifting: (min. lifting speed m/sec)

	6022	6023/24	6025	6026	6027	6028	6029
Telescopic	0,36	0,34	0,27	0,27	0,26	0,24	0,22
Niho	0,36	0,32	0,26	0,24	0,23	0,19	0,19
Triple	0,36	0,32	0,26	0,24	0,23	0,20	0,20

(Tolerance $\pm 12\%$)

NOTE

For Niho and triple masts, the average from the measured speeds in lift I and lift II is decisive.

Lowering: 0.40 - 0.60 m/sec.

ATTENTION

0.60 m/sec. must not be exceeded

Tilting:

Tilt speed with load	
forward	
Nennhub - h3	Seconds per degree
above up to	Tilt angle
3500	min. about 0.13 max. about 0.23
3500 - 5000	min. about 0.23 max. about 0.40
5000	min. about 0.40 max. about 0.64

Tilt speeds with load	
backward	
Nennhub - h3	Seconds per degree
above up to	Tilt angle
3500	min. about 0.10 max. about 0.18
3500 - 5000	min. about 0.18 max. about 0.31
5000	min. about 0.31 max. about 0.61

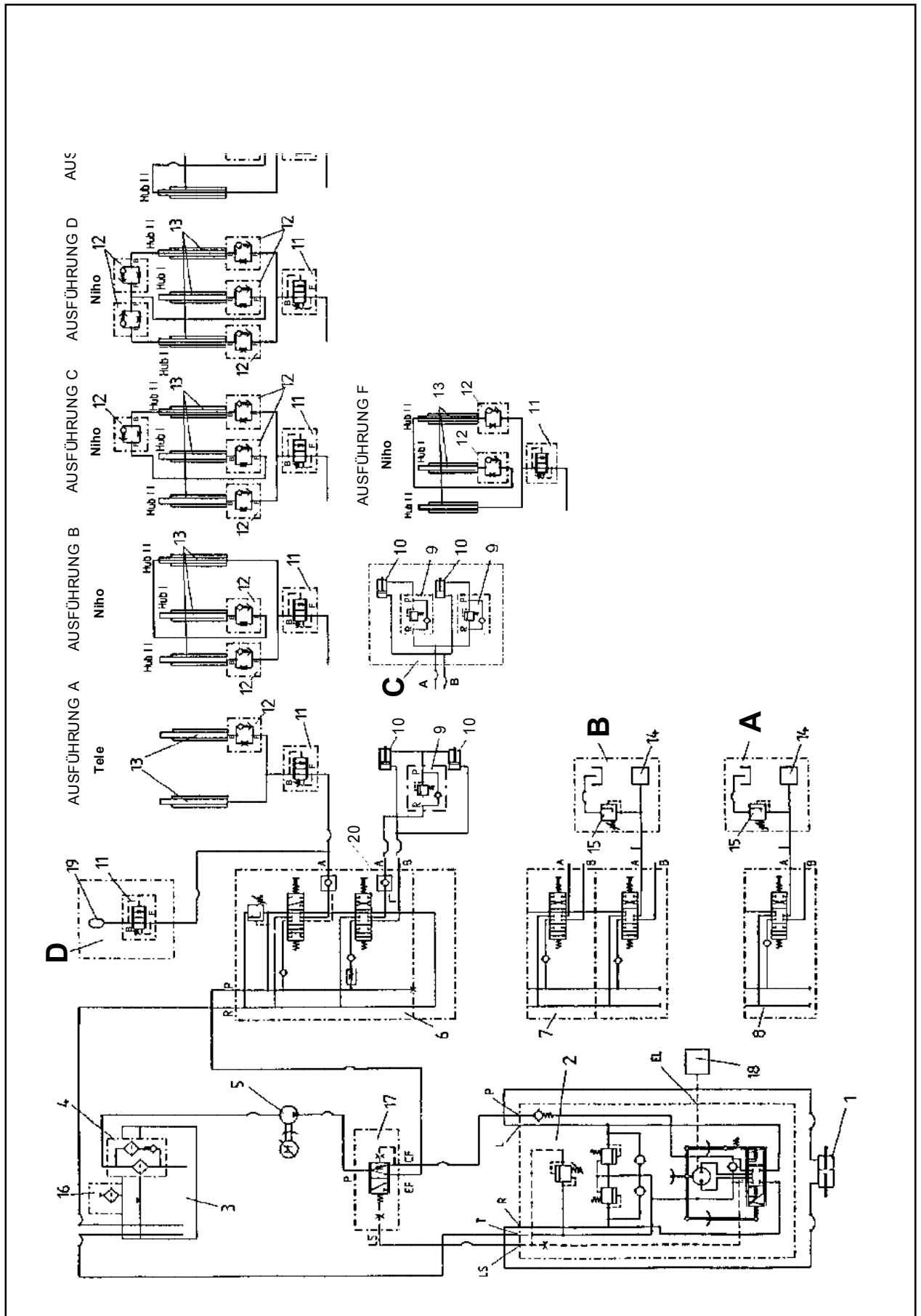
Tilt time = Tilt speed x Tilt angle

Measurement must be made over the entire tilt range.

NOTE

Special equipment on the vehicles may produce deviating values.

Hydraulic diagram



Hydraulic diagram

- A = Pressure regulator /double additional hydr.
(variant)
B = Pressure regulator/single additional hydr.
(variant)
C = Pressurising valves at tilt cylinder
(variant)
D = Hydraulic accumulator (variant)

- 1 Steering cylinder
2 Steering unit
3 Oil tank
4 Intake filter
5 Pump unit
6 Control valve block (lift/tilt)
7 Control valve block (double additional hydr.)
8 Control valve block (single additional hydr.)
9 Pressurising valve
10 Tilt cylinder
11 Lowering brake
12 Hose failure safety device
13 Lift cylinder
14 Sender (electr.displacement sensor for
pressure gauge)
15 Relief valve
16 Breather filter
17 Priority valve
18 Pressure switch (electr. NCC)
19 Hydraulic accumulator
20 Tilt stop valve (type up to end of 1996)

Types of mast			
	Tele	HiLo	Triplex
6022 / 23 / 24 up to & incl 2150 of OLH	A	B	E
6025 up to & incl 2550 of OLH	A	B	E
6022 / 23 / 24 from 2200 to 2800 of OLH	A	C	E
6022 / 23 / 24 from 2850 to 3200 of OLH	A	D	E
6026 / 27 / 28 / 29	A	F	E

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Table of contents	Page
Technical service data	39
Hydraulic system	
Functional description of lift and tilt hydraulics	40
Operation	
Joystick/function	41
Joystick/function	42
Installation information	
Emergency lowering	
Control valve block	
Installation	43
Design	44
Design	45
Wiring diagram - function	46
Wiring diagram - function	47
Way valve	
Connection block lif/lower	48
Connection block lift/lower	49
Tilting	50
Tilting	51
Additional hydraulics - end valve	52
Zusatzhydraulics - end valve	53
Control valve block	
Relief valve - block seal	54
Tilt cross-section reducer	55
Hydraulic diagram	
Circuit diagram	56
Legend	57

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Group 10 Hydraulic system								
Hydraulic pump								
Delivery	19 cm 3/per revolution							
Direction of rotation	Counter-clockwise							
Screw tightening torque	6022-25 : 56 + 4 Nm 6026-29 : 120 + 5 Nm							
Pump motor speed (basic setting)								
Steering	800 1/ min							
Lifting (Telescopic mast)	without load: max. 2880 1/ min with load max. 2560 1/ min							
Additional hydraulics (following attachment)	500 bis 2550 1 / min							
Tilting	up to nominal lift 3500 = 1359 1 / min up to nominal lift 5000 = 753 1 / min above nominal lift 5000 = 485 1 / min							
Control valve block								
Relief valve	Setting = 250bar Setting range = 200 -350 bar							
Screw tightening torque	25 + 8 NM and 13,5 +4,5 Nm							
Connection thread	P + A = G 1/2 , R = G 3/4 , A + B = G 3/8							
Tilt cross-section reducer	from nominal lift 5000 mm = 1.4mm							
Permissible automatic forward tilt	according to UVV = max. 0.5 degrees per second							
Permissible automatic lowering	according to UVV = max. 100 mm in 10 minutes							
Pressuring valve - pressurising pressure	Forward tilt : 6022-25 = 125 bar 6026-29 = 175 bar Backward tilt : 6022-29 = 40 bar							
Intake filter								
Filter fineness	20 µ (absolute)							
Bypass valve operating pressure	0.25 ± 0.05 bar							
Hydraulic tank								
Capacity	6022-26 = 27 litre 6026-29 = 34 litre							
Hydraulic oil (OZ)	Quality to DIN 51524/Part 2 or ISO VG 46 HM							
Speeds								
Lifting with nominal load Lifting speed (m / sec.)		6022	6023/24	6025	6026	6027	6028	6029
	Telesco- pic	0,36	0,34	0,27	0,27	0,26	0,24	0,22
	Niho	0,36	0,32	0,26	0,24	0,23	0,19	0,19
	Triple	0,36	0,32	0,26	0,24	0,23	0,20	020
Tolerance ± 12 %								
Tilting with nominal load (forward tilt)	up to nominal lift 3500 mm min. 0.12 / max. 0.20 sec. per degree up to nominal lift 5000 mm min. 0.20 / max. 0.6 sec per degree above nominal lift 5000 mm min. 0.36 / max. 0.56 sec per degree							
Lowering with nominal load	0.40 - 60 m / sec.							

Hydraulic system - function

Functional description of lift and tilt hydraulics

The hydraulic oil sucked out of the tank (4) by the gear pump (5) via the filter (3) flows to a priority valve (6) connection - P -, where the oil required for the steering is supplied to the steering unit.

The remaining oil flows via the connection - EF - to the control valve block (2) connection - P -.

The valve rod of the way valve is controlled proportionate to the operation of the joystick (1) by lifting magnets via an electrical signal. With only minimal operation of the joystick and in turn minimal movement of a valve rod, oil flows with minimal circulating pressure through the control valve block from connection - R - back into the tank. With further operation of the joystick, oil flows proportionate to the movement of the valve rod from connection - A - to the lift cylinders (7) and from - A - and - B - to the tilt cylinders (9) and in the additional hydraulics to an attachment (10).

The following functional parts are contained in the control valve block (2):

- A stop valve prevents excessive automatic lowering of the load.
- A relief valve protects the hydraulic system against overloads.
- Pressurising valves in the tilt valve (connections A and B) prevent automatic tilting of the mast.

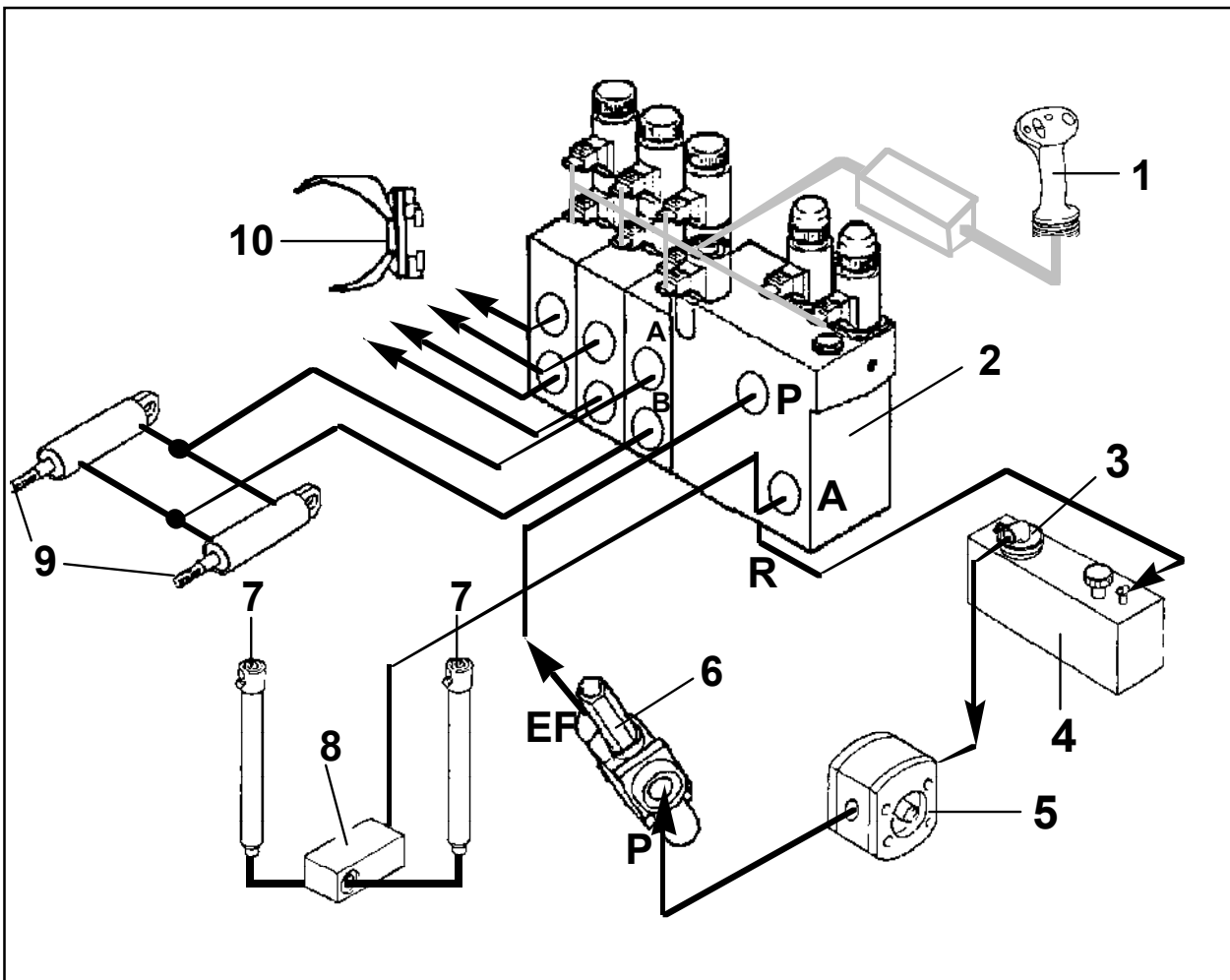
A lowering brake in the connection block (8) limits the load lowering speed.

For functional description of lowering brakes and hose failure safety devices in the masts, see Group 20.

For functional description of steering hydraulics, see Group 06.

Attention

Before carrying out any work on the hydraulic system, the fork carriage must be fully lowered and the battery plug disconnected for safety reasons.



Operation - function

The multi-directional joystick (1) is screwed to the armrest (2). The armrest can be adjusted in height and forward after loosening the screw (3).

CAUTION

To prevent damage to the joystick before opening the battery hood:

- Move the seat fully back
- Move the armrest fully downwards

1. Joystick (multifunction lever)
2. Armrest
3. Screw
4. Horn button (red)
5. Direction indicator switch, forward (yellow)
6. Fine control (dark grey)
7. Function button for attachments (light grey)
8. Direction indicator switch, reverse (yellow)
9. Balance

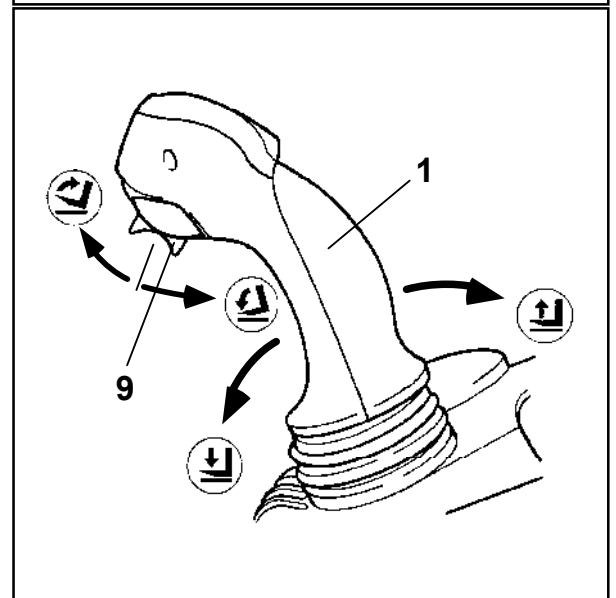
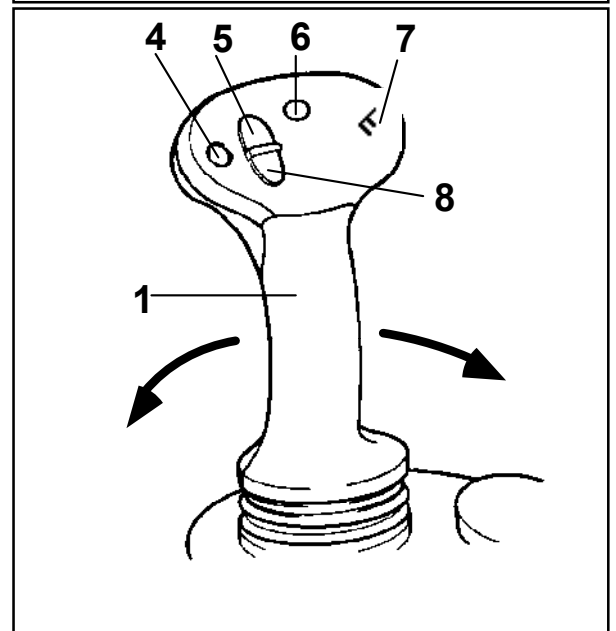
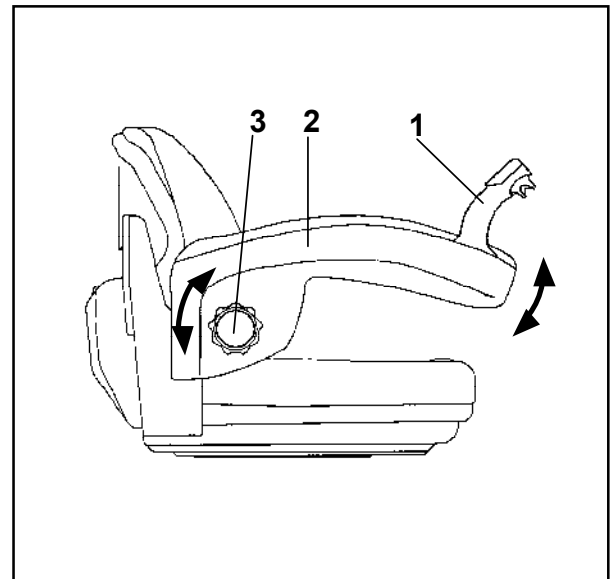
Moving the joystick to the left or right and in conjunction with the function button (7), activates various functions in the additional hydraulics, i.e. attachment movements.

Fine control (6)

When the fine control button is actuated, the working speeds of all consumers are halved.

NOTE

The joystick is only active when the seat contact is switched.



Moving the joystick forward or back lowers or lifts the load.

Moving the balance (9) up or down tilts the mast back or forward.

Operation - function

The following basic settings are provided for operation of the attachments.

Moving the joystick to the left or right:

- Turn rotating head or roll clamp to the left or right
- Move sideshift to the left or right

Moving the joystick to the left or right with the F function button depressed:

- Open or close fork spreader
- Open or close clamp

Moving the joystick forward or back:

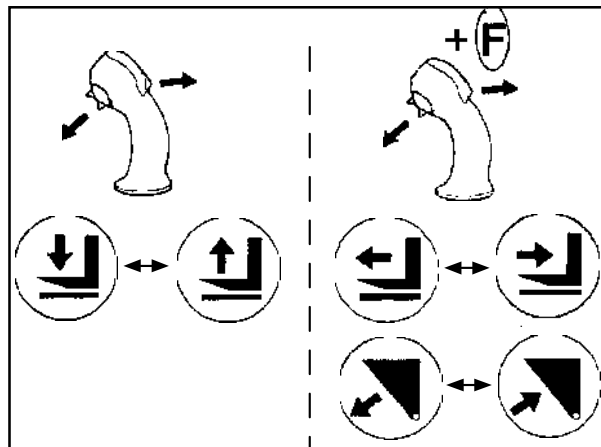
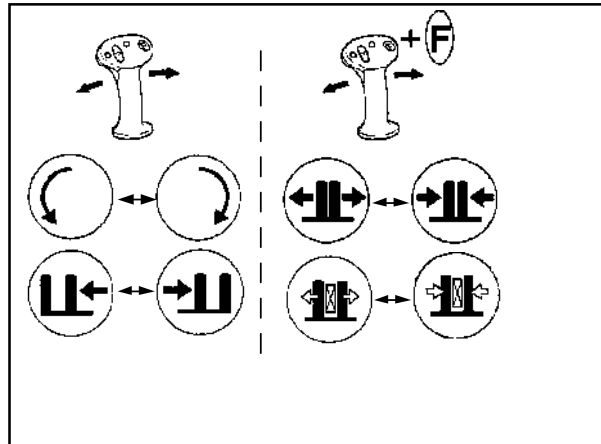
- Lower or lift load

Moving the joystick forward or back with F function button depressed:

- Lower or lift scoop
- Move fork forward or back

NOTE

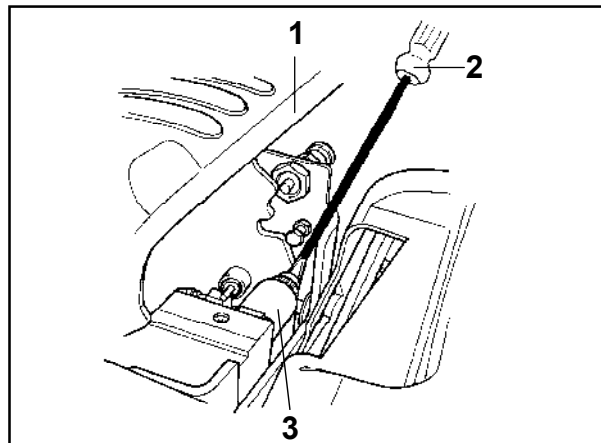
Further settings can be parameterised.



Emergency lowering

If a lifted load can no longer be lowered due to failure of the valve control, the load can be lowered manually in an emergency lowering mode.

- Open valve cover (1)
- Apply pressure to the upper solenoid valve (3) at rubber bellows with a screwdriver (2). The lowering speed can be regulated by the pressure exerted.



Removing the joystick

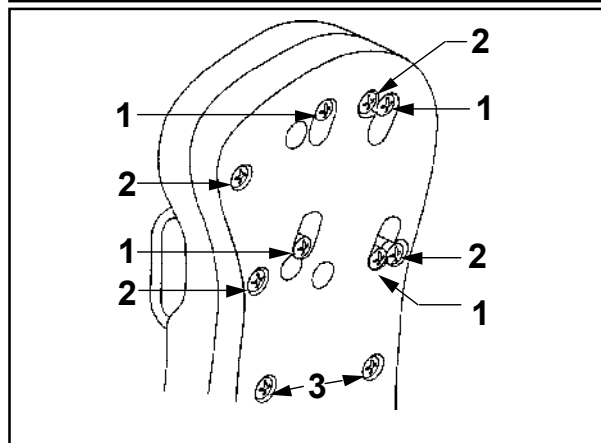
The joystick, emergency switch and cover are screwed to the underside of the armrest.

1 = Screws for joystick housing

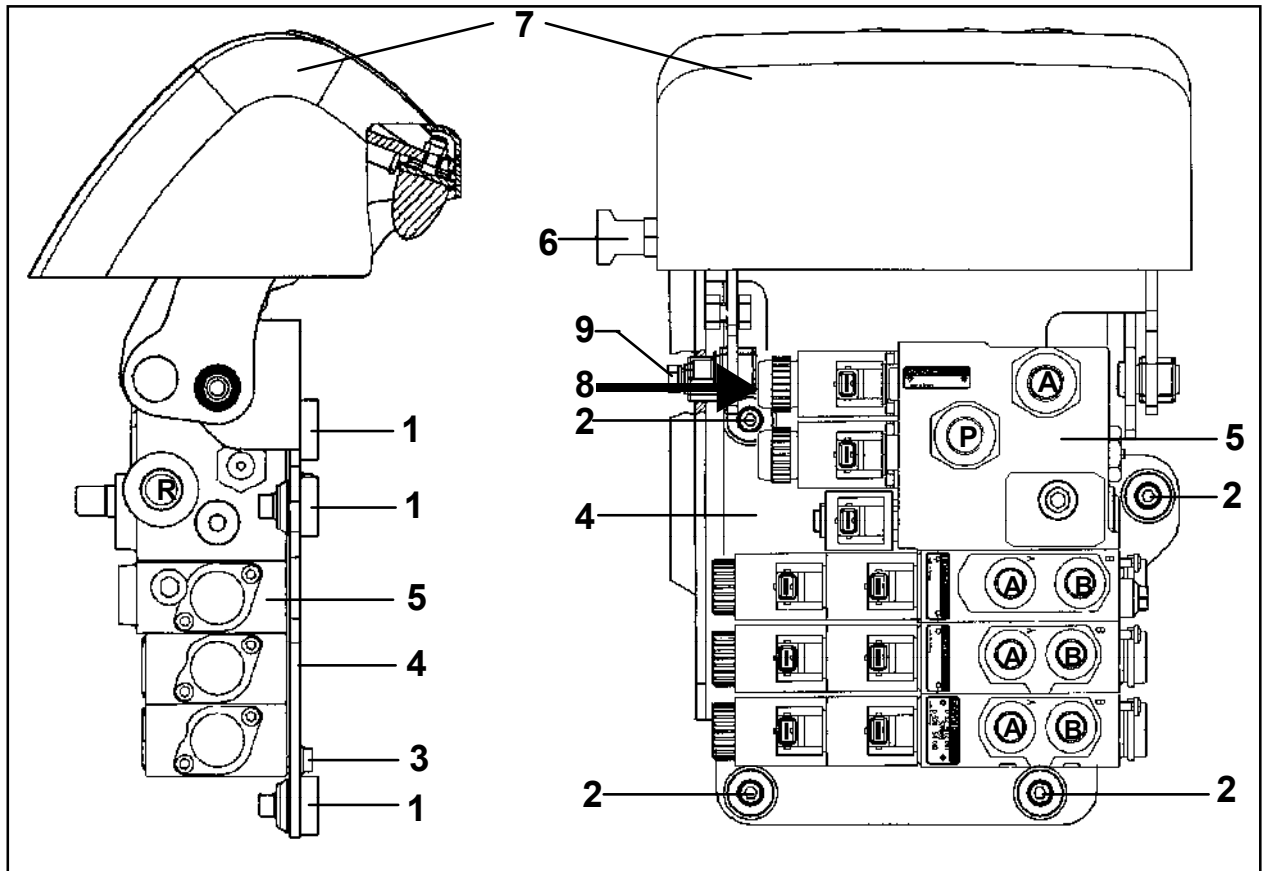
2 = Screws for joystick cover

3 = Screws for armrest cover

To remove the joystick, all screws 1 and 2 must be loosened.



Control valve block - installation



1. Rubber pad
2. Screws - valve carrier
3. Screws - control valve block
4. Valve carrier
5. Control valve block
6. Pin
7. Valve bonnet
8. **Emergency lowering**
9. Screw - valve bonnet

Design

- The control valve block is screwed to the valve carrier (4) with 3 screws (3).
- The valve carrier is fastened to the chassis partition flexibly supported in 4 rubber pads (1).
- The valve bonnet (7) is supported rotatable on the valve carrier (4).

To open the battery hood, the valve bonnet must be tilted forward after releasing the pin (6). A control symbol plate for the hydraulic functions is provided on the valve bonnet.

Removing the control valve block

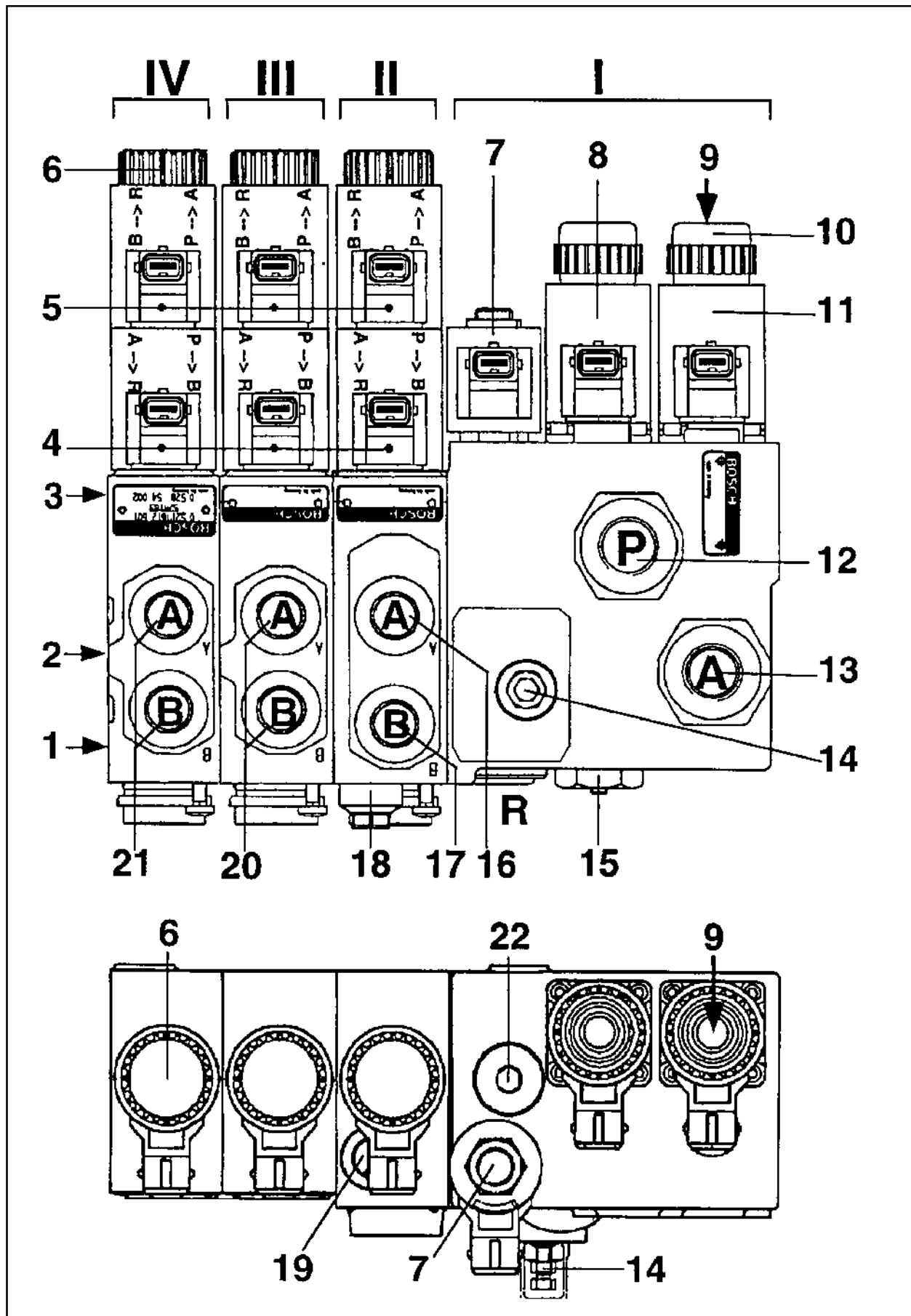
- Unscrew valve covering
- Remove plate
- Disconnect all electrical and hydraulic connections from the control valve block
- Loosen screws (2) of valve carrier (4) and remove the complete valve carrier with valve bonnet from the chassis panel
- Separate control valve block (5) from the valve carrier by loosening the screws (3).

NOTE

The valve bonnet (7) can only be removed from the valve carrier (4) with the control valve block removed.

- Remove screw (9) and remove valve bonnet (7) laterally.

Control valve block - design



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Control valve block - design

Design

- I = Control valve block - lift/lower
- II = Way valve - tilt
- III = Way valve - first additional hydraulics
- IV = Way valve - second additional hydraulics

- 1.- 3. Screws
- 4. Solenoids (push valve rod)
- 5. Solenoids (pull valve rod)
- 6. Union nuts
- 7. Solenoid isolating valve
- 8. Control solenoid - lift
- 9. Emergency lowering - manual
- 10. Cap
- 11. Control solenoid - lower
- 12. Connection "P" (pump line)
- 13. Connection "A" (lift/lower)
- 14. Relief valve 250 bar
- 15. Range adjustment - lift control rod
- 16. Connection "A" (tilt forward)
- 17. Connection "B" (tilt back)
- 18. Screw plug - pressurising valve
125 or 175 bar
- 19. Screw plug - pressurising valve
40 bar
- 20. Connections first additional hydraulics
- 21. Connections second additional hydraulics
- 22. Screw plug - pressure regulator

The control valve blocks are delivered complete only as 3 and 4-way blocks:

- 3-way = way valves I, II and IV
- 4-way = way valves I to IV

Way valves II - IV (tilt and additional hydraulics) are essentially identical in design. Way valve II (tilt) additionally contains two pressurising valves and one control valve.

Way valve IV is designed as an end plate.

Sealing of the way valves with respect to each other takes place with O-rings and retaining rings in the flange surfaces.

Function

Solenoids (4) force the valve rods downwards and open the connections "B" to the connection "P", as well as the connections "A" to the return "R".

Solenoids (5) draw the valve rods upwards and open the connections "A" to the connection "P", as well as the connections "B" to the return "R".

The control solenoid (8) pushes the lift valve rod downwards and opens the connection "A" to connection "P".

The control solenoid (11) opens the lowering valve and opens the connection "A" to the return "R".

(see also chapter diagram - function)

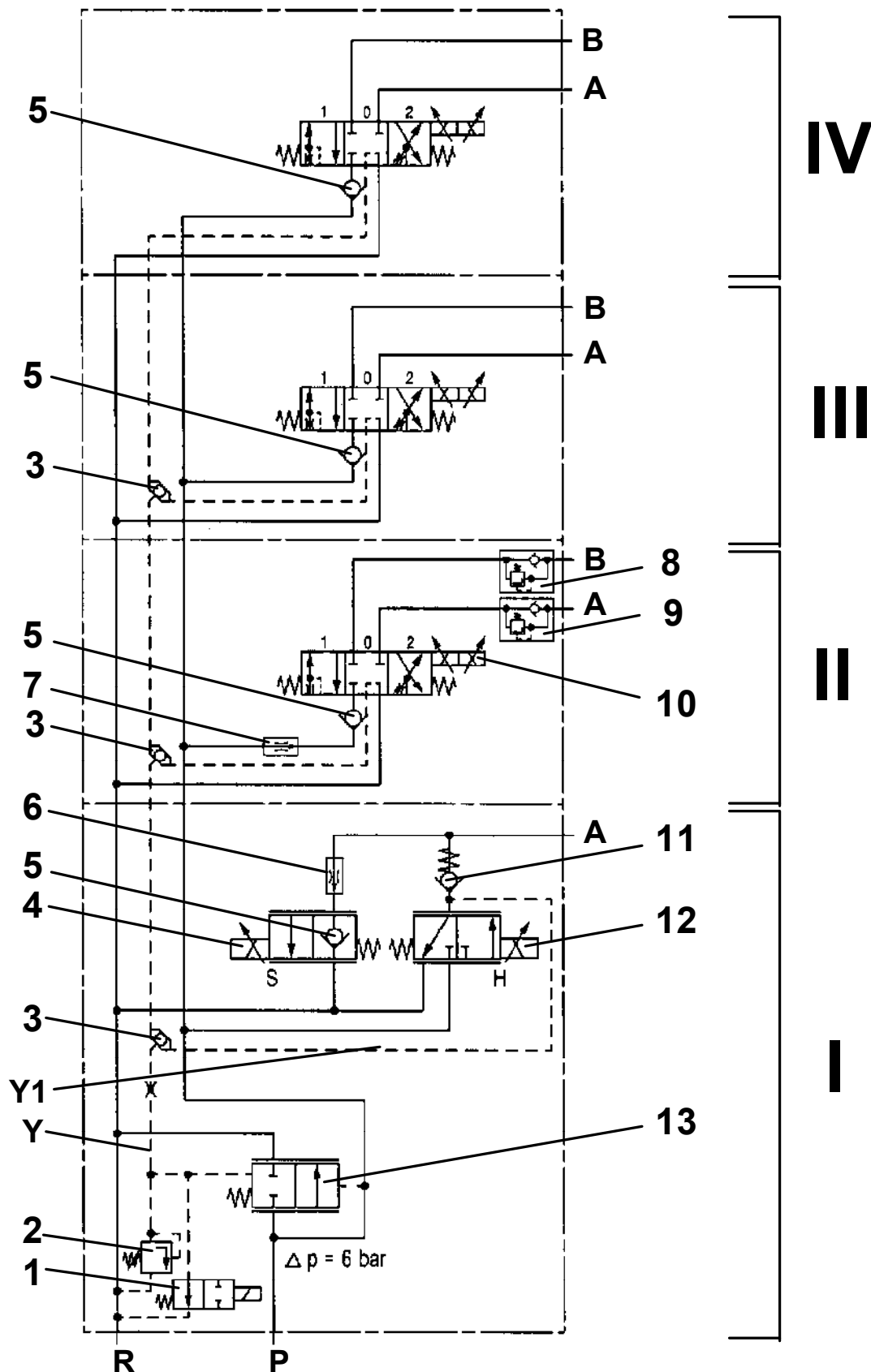
Installation information

- Repairs to the control valve block must be carried out with particular care as any fouling or damage to sealing surfaces can cause malfunctions (valve rod can no longer be moved by the control solenoid) and leaks.
- **The isolating valve (7)** can only be replaced as a complete unit (solenoid valve and valve cartridge).
Loosen solenoid nut, remove solenoid and unscrew valve cartridge.
- **The solenoid valves (4 + 5)** can be separated from the pressure pipe after loosening the union nut (6) and renewed.
- The screw tightening torques (1 to 3) must be observed.

Tightening torques

Item 1	=	13.5	+	4.5	Nm
Items 2 and 3	=	25	+	8	Nm

Control valve block - diagram



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Control valve block - diagram

- I = Control valve block - lift/lower
- II = Way valve - tilt
- III = Way valve - first additional hydraulics
- IV = Way valve - second additional hydraulics
- A + B = Consumer connections
- P = Pump connection
- R = Return - tank
- Y = Pilot port
- Y1 = Pilot port - consumer

1. Isolating valve
2. Relief valve
3. Shuttle valves
4. Valve - lower
5. Check valve
6. Control valve - lower
7. Control valve - tilt
8. Pressurising valve 125 or 175 bar
9. Pressurising valve 40 bar
10. Control solenoids
11. Check valve - lift
12. Valve - lift
13. Pressure regulator

Function

The control valve block works on the 3-way flow control principle. When the valve rod is in a neutral position, no pressure from the consumer side is active.

The pilot ports -Y1- and -Y- are therefore pressureless.

The oil flowing in at -P- is therefore able to open the pressure regulator (13) against spring force and the oil from the pump flows virtually pressureless at -R- directly back into the tank again.

When a valve rod moves, the pressure produced in the consumer is applied via the pilot ports -Y1- and -Y- to the pressure regulator and the same closes against spring force. The oil is supplied to the consumer.

The oil flow can be regulated via preset pump motor speeds and via the joystick.

When a consumer is lifted, the pressure in the pilot ports increases and the relief valve (2) opens when the set final pressure is reached. As a result of the now higher pressure in pump duct -P-, the pressure regulator is moved against spring force and the entire oil is able to flow via the open return into the tank.

Shuttle valves (3)

The shuttle valves ensure that the highest working pressure is applied to the pressure regulator via pilot ports -Y1- and -Y- when several consumers are operated simultaneously.

Check valve (5) in lowering valve (4)

The check valve in the lowering valve (4) prevents automatic lowering of the load when the valve (5) is in a neutral position.

Check valves (5)

The check valves in all way valves prevent unwanted consumer movements in the fine control range and with the simultaneous operation of several consumers.

Isolating valve (1)

A safety valve against unwanted energisation of the control valve block by the electronics. In a de-energised state, the valve establishes a connection from the control line "Y" to the return "R". The pressure regulator (13) is opened and the oil flows from "P" directly into the return. The isolating valve only closes when the joystick is operated and interrupts the connection from the control line "Y" to the return "R". The pressure regulator (13) is closed and the oil flows to the consumers.

Control valve tilt (7)**Control valve lower (6)**

The valves set to a specific oil flow rate limit the maximum oil volume to protect the control elements.

Pressurising valves (8 + 9)

The pressurising valves prevent automatic tilting of the load.

Pressurising pressure:

Item 8 6022 - 25 = 125 bar

6026 - 29 = 175 bar

Item 9 6022 - 29 = 40 bar

Check valve - lift (11)

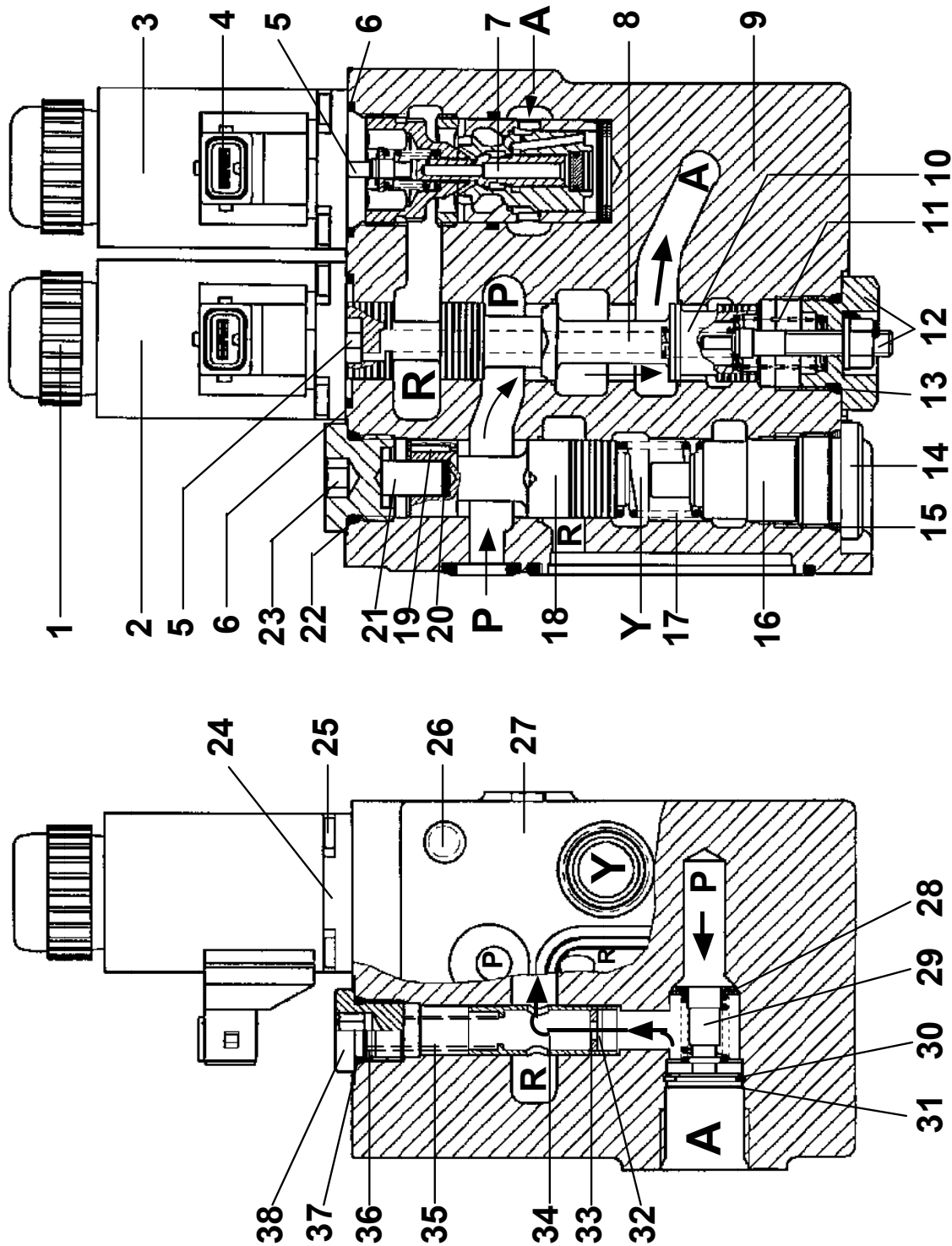
The valve is closed when the mast is lowered and when the lift valve (12) is in a neutral position.

When the mast is lowered, the oil flows to the lowering valve (4).

When the lift valve is in a neutral position, automatic lowering of the load is prevented.

With excessive automatic lowering of the load, the valve must be checked for foreign bodies and damage.

Way valve - connection block



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Way valve - connection block

- A = Consumer connection - lift
 P = Pump duct
 R = Return duct
 Y = Pilot port

1. Union nut
2. Control solenoid - lift
3. Control solenoid - lower
4. Plug connections
5. Plunger of control solenoid
6. O-ring
7. Valve - lower
8. Valve rod - lift
9. Valve housing
- 10.+11. Spring
12. Lock and adjusting screw
13. O-ring
14. Screw plug
15. O-ring
16. Stop
17. Spring
18. Valve rod
19. Bore
20. Distance spacers
21. Dowel pin
22. O-ring
23. Screw plug
24. Flange for pipe
25. Screw - flange
26. Screw - valve lower
27. Flange face to tilt valve
28. Valve seat
29. Valve with spring
30. Washer
31. Circlip
32. Circlip
33. Cross-section reducer
34. Sleeve
35. Spring
36. Washers
37. O-ring
38. Screw plug

Pressure regulator

Check valve
- liftControl valve
lower

Functions

Pressure regulator (14 - 23)

The oil entering the pressure regulator at "P" flows via the bore (19) into the upper space between the valve rod (18) and screw plug (23). If no valve is actuated, the valve rod (18) is forced downwards against the spring (17). The oil flows from "P" virtually pressureless into the return duct "R". When a valve is actuated, pressure builds up in the spring space (17) via the pilot port "Y". The valve rod (18) is forced upwards and the oil flow from "P" to "R" is partly or completely closed.

When the pressure in the spring chamber reaches the final pressure via pilot port "Y" set at the relief valve, the same opens and allows oil to flow into the return.

The pressure now above the valve rod pressure forces the same downwards and the entire oil is able to again flow from "P" to "R" into the tank.

NOTE

In the event of faults in the hydraulic system (e.g. no or only minimal consumer movement), this can be due to malfunctions of the pressure regulator due to foreign bodies.

- Check the pressure regulator.
 Unscrew screw plug (23).
 Check valve rod (18) for smooth movement by applying pressure.
 Withdraw valve rod and check for marks.
 Check spring (17).
 Blow out bore (19) with compressed air.

ATTENTION

When carrying out work on the pressure regulator, it must be ensured that the existing distance spacers (20) are refitted.

Valve rod, lift (8)

When the mast is lifted, the valve rod (8) is forced downwards by the control solenoid (2) via the plunger (5) against the springs (10+11) proportionate to joystick operation. The oil flows from "P" to "A" (lift cylinder).

The setting of the screw (12) that determines the opening range of the valve rod, must not be altered.

Valve, lower (7)

The valve is opened via the plunger (5) of the control solenoid (3) and the oil is able to flow from "A" into the return "R". The valve, like the check valve (28-31), prevents automatic lowering of the load. The valve (7) is locked with a screw (26) against rotation. This valve cannot be repaired.

Control solenoids (2 + 3)

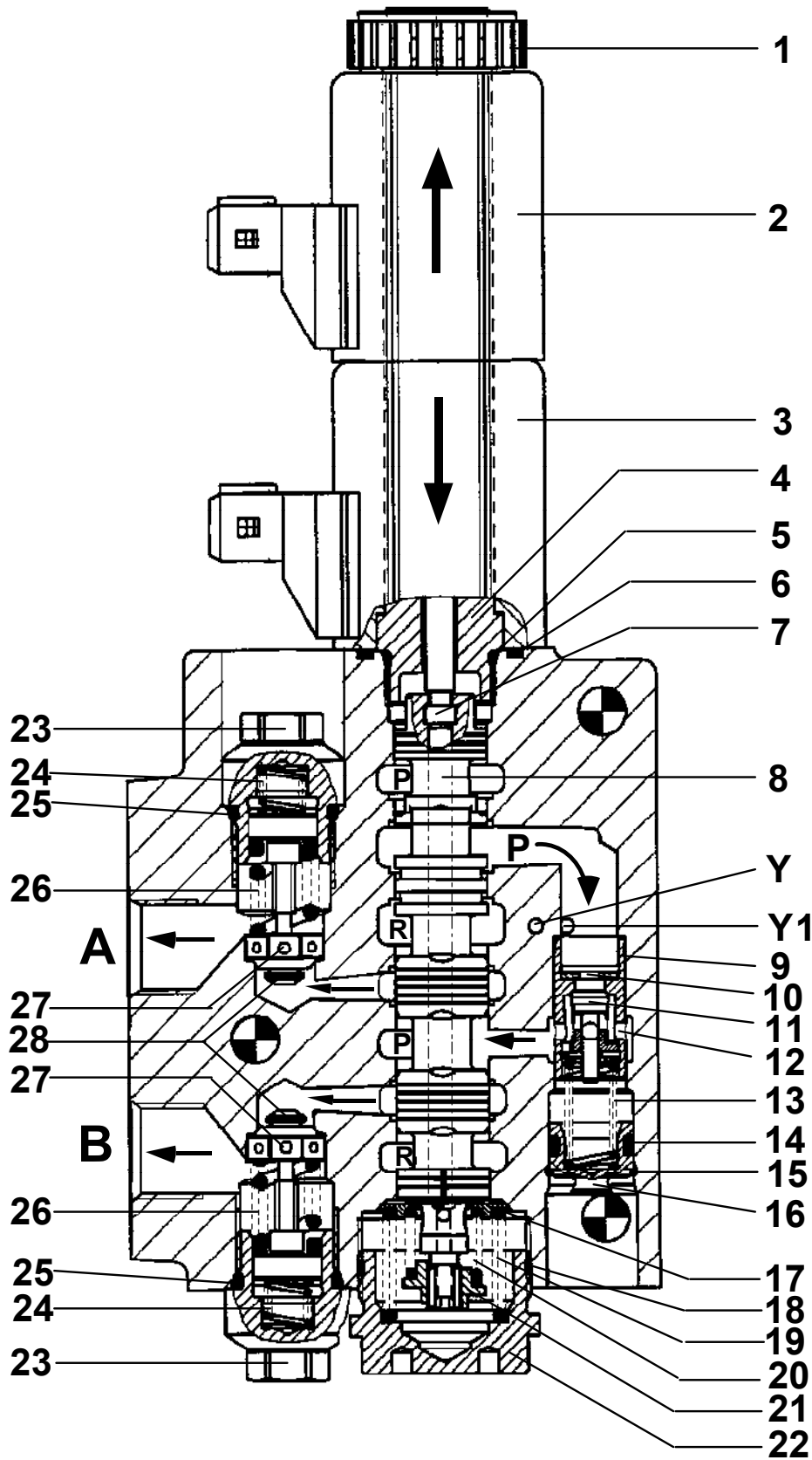
After unscrewing the union nut (1) the solenoid (2+3) can be removed from the pipe.

For fitting new O-rings (6), the flange (24) and pipe can be removed after loosening the screws (25). The control solenoids (2+3) are identical in design.

Control valve, lower (32 - 38)

When the mast is lowered, the oil flows via the cross-section reducer (33) through the bores in the sleeve (34) to the lowering valve (7) and into the return.

Way valve - tilt



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- A = Connection - tilt forward
 B = Connection - tilt back
 P = Pump duct
 R = Return duct
 Y = Pilot port
 Y1 = Pilot port - consumer

1. Union nut
2. Solenoid (tilt back)
3. Solenoid (tilt forward)
4. Pipe
5. O-ring
6. O-ring
7. Pull rod (magnet core)
8. Valve rod
9. Valve rod
10. Cross-section reducer
11. Valve cone
12. Bores
13. Spring
14. O-ring + retaining ring
15. Circlip
16. Screw plug
17. Washer
18. O-ring + retaining ring
19. Spring
20. Spring
21. Nut
22. Screw plug - valve rod
23. Screw plug - pressurising valve
24. Spring
25. O-ring
26. Spring
27. Valve disk
28. Valve cone

Control
and check valve

Pressurising valve

Function

Proportionate to joystick operation, the valve rod (8) is:

- Pulled upwards by the solenoid (2) via the pull rod (7) and opens the connection "A" (tilt forward) to the pump duct "P".
- Forced downwards by the solenoid (3) via the pull rod (7) and opens the connection "B" (tilt back) to the pump duct "P".

The oil flows from "P" via the cross-section reducer (10), the valve cone (11) lifted from its seat, the valve rod opening and the valve disk (27) lifted from its seat of the pressurising valve to the consumer connection "A" or "B".

The oil displaced from a tilt cylinder chamber flows via one of the consumer connections "A" or "B" to the pressurising valves (26 - 28).

When the set pressurising pressure is reached, the valve cone (28) is lifted from its seat and the oil is able to flow via the bores in the valve disk (27) and via the valve rod opening into the return "R".

Control and check valve (9 - 16)

Oil flows from this valve via a cross-section reducer (10) and bores (12) at a maximum rate of 26 litres per minute for tilting.

This valve also has the function of a check valve due to the valve cone (11).

Pressurising valves (26 - 28)

Set pressurising pressure:

Connection A = 40 bar

Connection B: 6022- 25 = 125 bar
 6026- 29 = 175 bar

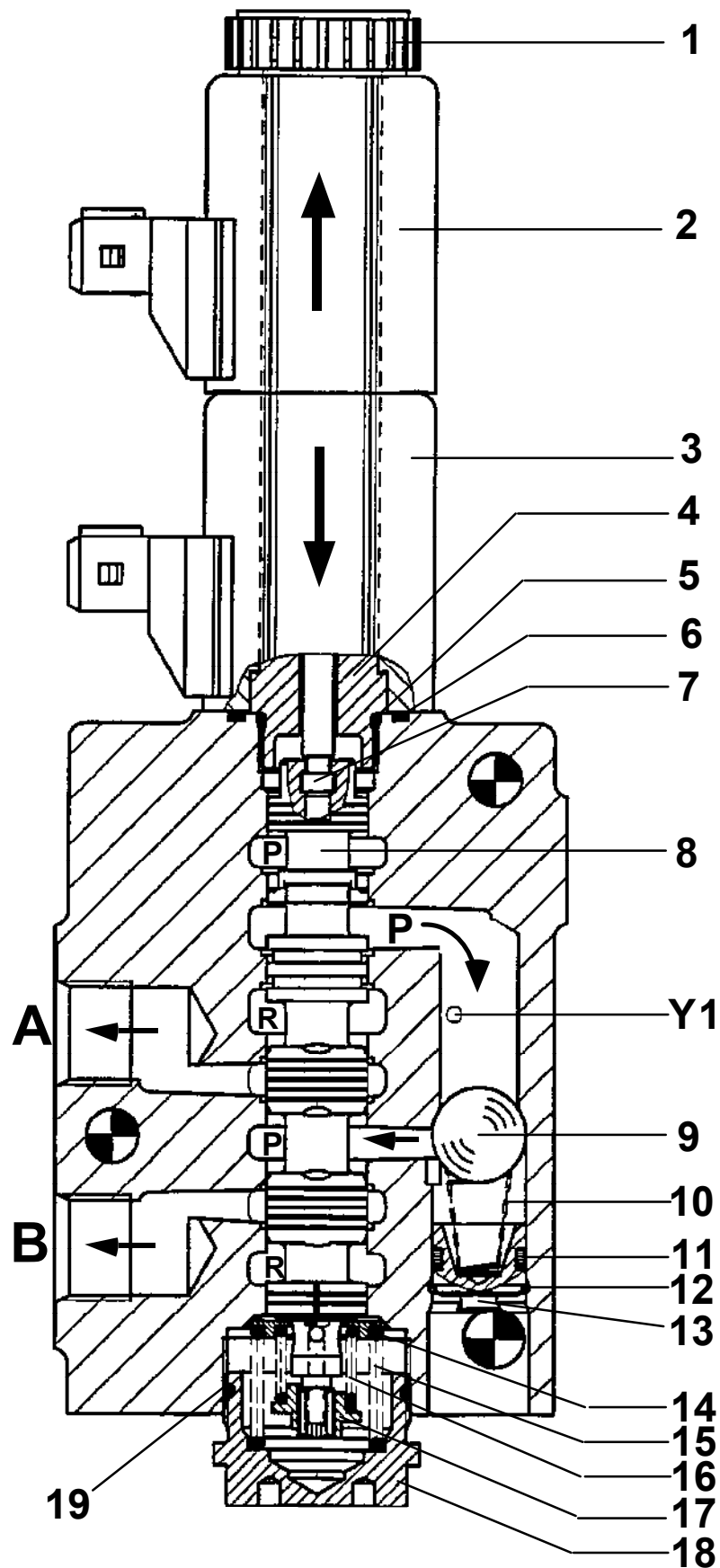
In the event of excessive automatic tilting of the load (see UVV test), the complete pressurising valve must be replaced.

ATTENTION

The screw plug - valve rod (22) as well as the nut (21) must not be loosened under any circumstances, as this will alter the valve rod travel exactly set by the manufacturer and give rise to malfunctions.

Resealing at the O-rings (6) and (18) and removal of the pipe (4) and valve rod (8) is therefore not possible.

Control valve block - additional hydraulics



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Way valve - additional hydraulics

A = Connection - attachment
 B = Connection - attachment
 P = Pump duct
 R = Return duct
 Y1 = Pilot port - consumer

1. Union nut
2. Solenoid
3. Solenoid
4. Pipe
5. O-ring
6. O-ring
7. Pull rod (magnet core)
8. Valve rod
9. Ball
10. Spring
11. O-ring + retaining ring
12. Circlip
13. Screw plug
14. Washer
15. Spring
16. Spring
17. Nut
18. Screw plug
19. O-ring + retaining ring

Check valve

Function

Proportionate to joystick operation, the valve rod (8) is:

- Pulled upwards by the solenoid (2) via the pull rod (7) and opens the connection "A" to the pump duct "P".
- Forced downwards by the solenoid (3) via the pull rod (7) and opens the connection "B" to the pump duct "P".

The oil flows from "P" via the ball (9) lifted from its seat and via the control rod opening to the consumer connection "A" or "B".

ATTENTION

The screw plug - valve rod (18) as well as the nut (17) must not be loosened under any circumstances, as this will alter the valve rod travel exactly set by the manufacturer and give rise to malfunctions.

Resealing at the O-rings (6) and (19), and removal of the pipe (4) and valve rod (8) is therefore not possible.

Control valve block - DBV/Block seal

Relief valve

Y = Pilot port

R = Return

1. Valve disk

2. Valve cone

3. Spring

4. Piston pin

5. O-ring

6. Lock nut

7. Adjusting screw

8. Washer

9. Valve housing

10. O-ring

11. Housing

Set value of relief valve: 250 bar

(Setting range = 200 - 350 bar)

When a consumer is lifted, the pressure in the control line -Y- increases.

When the final pressure set at the relief valve is reached, the valve cone (2) opens and allows oil to flow into the return. This causes the pressure regulator to open and allows the entire oil to flow into the return. The final pressure can be set higher or lower by tightening or unscrewing the adjusting screw (7).

ATTENTION

Do not remove any washers (8) and do not set the pressure higher than 250 bar. Lock the adjusting screw (7) with lock nut (6).

NOTE

Faults in the hydraulic system (e.g. no or only minimal lift or tilt) may be due to malfunctions of the relief valve due to foreign bodies

- Unscrew relief valve cartridge (1- 9).
- Remove valve disk (1) from valve housing (9) and inspect valve seat (2).

Block seals

Pump duct -P-, return ducts -R- and pilot port -Y- are sealed on the flange faces of the way valves by O-rings and retaining rings.

1. O-ring

4. Bores - block screws

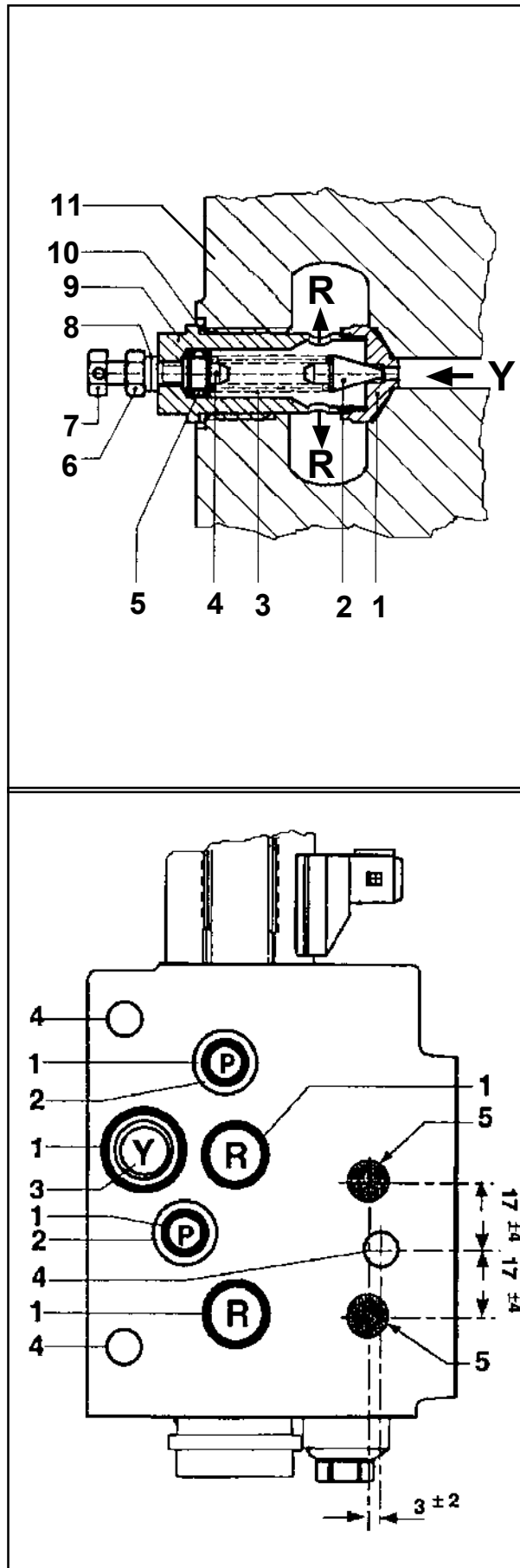
2. Retaining ring

5. Aluminium plate

3. Shuttle valve

INSTALLATION INFORMATION

- For resealing purposes, an additional two aluminium plates (5) must be bonded to the flange face of the way valves in the specified position.
- Do not clean flange faces with cloths or paper towels. Fibres on the O-rings can impair the tightness. It is recommended to clean the sealing surface with the palm of the hand.
- Observed tightening torque for tie rods (4).



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Control valve block - tilt cross-section reducer

Tilt cross-section reducer

1. Screw with cross-section reducer bore
2. Cross-section reducer mark (notch)

In order to prevent the mast tilting too quickly in the event of malfunction of the pump motor control (excessive pump motor speed), for masts from a nominal lift of 5000 mm

screws (1) with a cross-section reducer bore are provided in the connections of the tilt way valves.

Type until the end of 2000:

Screw in connections 'A' and 'B'.
Cross-section reducer bore 1.2 mm Ø

Type from beginning of 2001 :

Screw only in connection 'A'.
Cross-section reducer bore 1.4 mm Ø

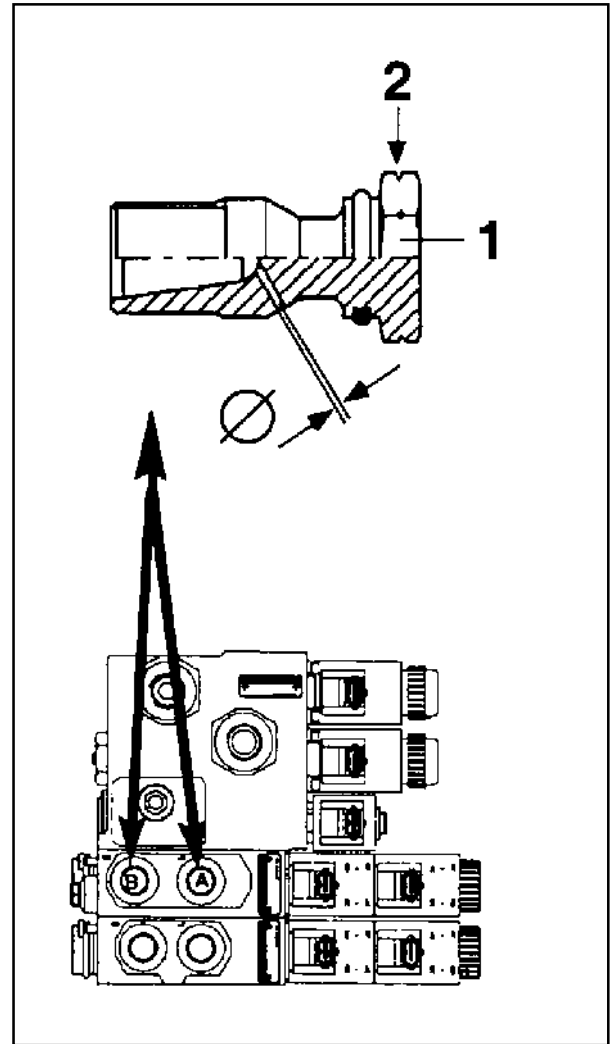
NOTE

The provision of a screw with cross-section reducer bore is recognisable by the notch (2) on the hexagon.

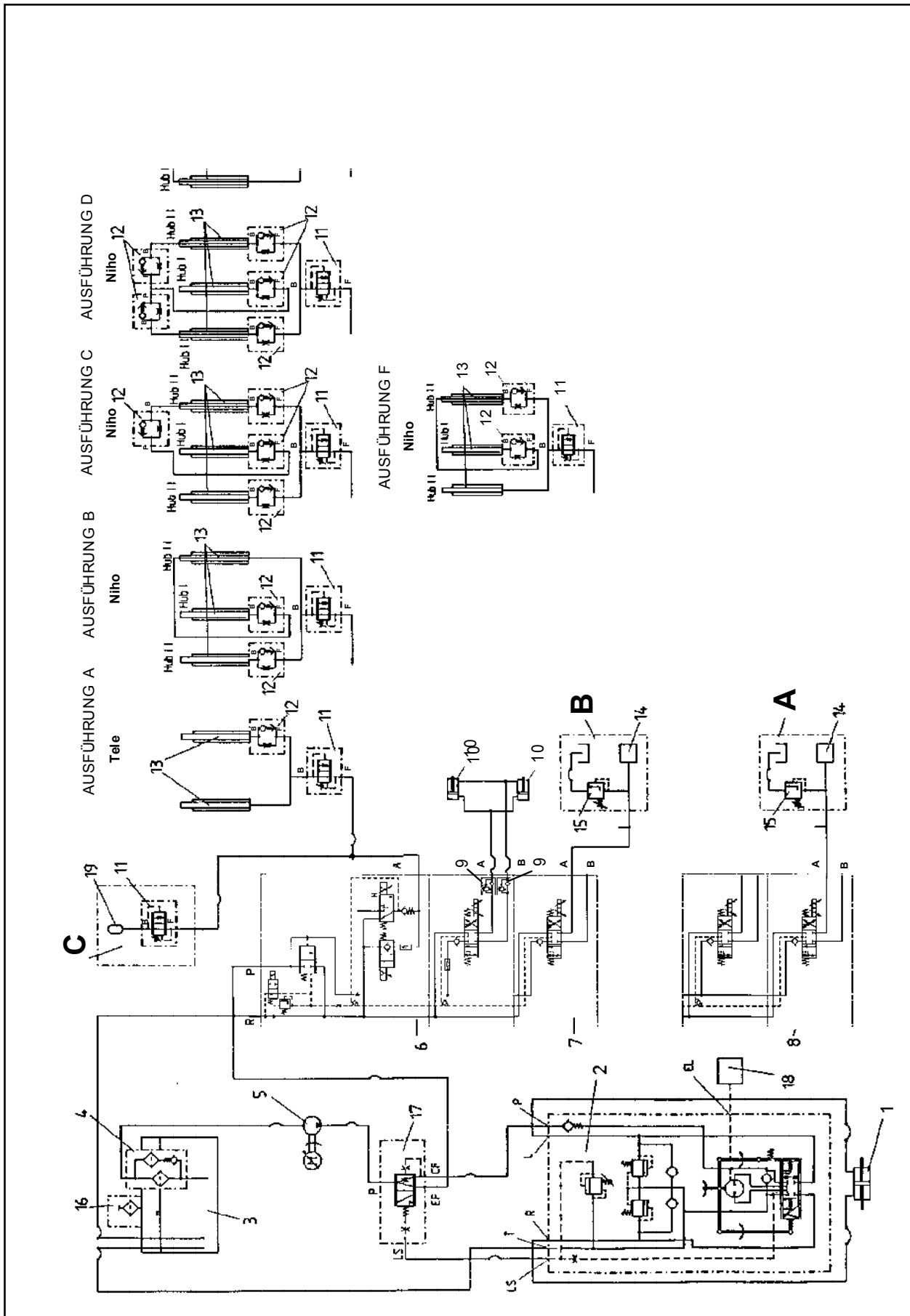
Tightening torque Item 1 = 66 Nm

ATTENTION

For mast replacement, it must be determined whether these screws (1) have to be used depending on the mast type or can be omitted.



Hydraulic diagram



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Hydraulik - Wirkschaltplan

- A = Pressure regulator/double additional hydr.
(variant)
- B = Pressure regulator/single additional hydr.
(variant)
- C = Hydraulic accumulator (variant)
- 1 Steering cylinder
- 2 Steering unit
- 3 Oil tank
- 4 Intake filter
- 5 Pump unit
- 6 Valve control block (lift/tilt)
- 7 Valve control block (single additional hydr.)
- 8 Valve control block (double additional hydr.)
- 9 Pressurising valve
- 10 Tilt cylinder
- 11 Lowering brake
- 12 Hose failure safety device
- 13 Lift cylinder
- 14 Sender (electr. pressure sensor for pressure gauge)
- 15 Relief valve
- 16 Breather filter
- 17 Priority valve
- 18 Pressure switch (electr. NCC)
- 19 Hydraulic accumulator

Types of mast			
	Tele	HiLo	Triplex
6022 / 23 / 24 up to & incl 2150 of OLH	A	B	E
6025 up to & incl 2550 of OLH	A	B	E
6022 / 23 / 24 from 2200 to 2800 of OLH	A	C	E
6022 / 23 / 24 from 2850 to 3200 of OLH	A	D	E
6026 / 27 / 28 / 29	A	F	E

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Contents	Page
Technical Data for Maintenance Service	2+3
Drive motor	
Drive motor, construction	4
Position of motor terminals	4
Connection diagram	4
Inspecting and changing the motor brushes	5
Armature removal with axle in situ	6
Replacing the chevron seals on commutator end	7
Drive motor removal and installation	7
Drive motor - Dismantling & Reassembling	8
Speed sensor	9
Pump motor	
Pump motor, construction	10
Position of motor terminals	10
Connection diagram	10
Inspecting and changing the motor brushes	11
Pump motor removal and installation	12
Pump motor - Dismantling & Reassembling	13
Speed sensor	14
Forced ventilation	
Operation	15
Cooling fan removal	15
Clean air filter	15
Brush wear monitoring facility	
Operation	16
Checking the brush wear monitoring facility	16
Thermal monitoring	
Operation	17
Checking the temperature sensors	17
General hints	
Insulation resistance	18
Turning down the commutator on a lathe	19

Technical Data for Maintenance Service

Functional Group 11 Drive motor	6022 - 6029
Type	GF 186 - 24 / 1.3
Maker	S T I L L
Construction	remotely excited, electric 4 pole type d.c. motor
Voltage rating (V)	80
Amperage rating (A)	180
Excitation	16 V / 22 A
Rated speed (rpm)	1150
Speed max. (rpm)	4000
Overspeed (rpm)	5000
Power output (kW)	12.5
Service rating	S2 1 hr. rating
Protection	IP 23
Insulation class	F
Motor brushes	
a) Dimension	10 x 32 x 40
b) Limit of wear	replace if worn down to a length of 15-17 mm
c) Qty	8
d) Brush wear monitoring	via N/C contacts cast in the carbon brush holders
Weight (kg)	
a) Total weight	145
b) Weight of armature	40
Ventilation	external fan cooling
Current draw of armature	max. 400 A * 440 A from Version 1.07 on
Current draw of field windings	max. 40 A

Technical Data for Maintenance Service

Functional Group 11 Pump motor	6022 - 6025	6026 - 6029
Type	GP 144 - 14 / 4.3	GP 164 - 24 / 2.3
Maker	S T I L L	S T I L L
Construction	4-pole series-wound motor	
Voltage rating (V)	80	80
Amperage rating (A)	200	320
Rated speed (rpm)	2550	2000
Speed max. (rpm)	4000	4000
Overspeed (rpm)	5000	5000
Power output (kW)	13.5	21
Service rating	S3 15 %	S3 20 %
Protection	bornes IP 00 / moteur IP23	
Insulation class	F	F
Motor brushes		
a) Dimension	12.5 x 40 x 40	12.5 x 25 x 40
b) Limit of wear	replace if worn to a length of 15 to 17mm	
c) Qty	4	8
d) Brush wear monitoring	via N/C contacts in brush holders	via N/C contacts in brush holders
Weight (kg)		
a) Ttal weight	47	73
b) Weight of armature	16	27
Ventilation	external fan cooling	external fan cooling
Current draw	max. 280 A	max. 320 A

Drive motor

Power axle

The power axle includes the drive motor (1) as an integral assembly. The motor is located in the centre of the power axle. Differential gear box and brake (2) are on the right of the motor. Two epicyclic reduction gears (3) are use at either end of the drive axle.

The power output from the electric drive motor is transmitted from the r.h. side of the motor to the gear box and differential unit. The drive motor armature shaft is designed as a hollow shaft in which rotates the shaft driving the left epicyclic reduction gear.

Drive motor, construction

Remotely excited 4-pole D.C. motor with brush wear monitoring device, temperature sensor and speed sensor. External fan cooling.

Position of motor terminals

The motor field-end terminals F1/F2 on the 6022-25 are mounted on top of the motor casing, whereas on the 6026-29 they are mounted with an offset of 90° to the rear.

The armature winding connections are located in the commutator end bracket (left). Connection A2 mounted at the top and connection A1 at the rear.

Connection of brush and temperature monitoring device

by means of a 6-pole connector on motor casing.

Speed sensor connection

by means of a 4-pole connector on motor casing.

At drive end:

armature shaft supported within the differential cage.

At commutator end:

armature shaft supported on a grooved ball bearing.

Connection diagram

A1/A2 = armature

F1/F2 = excitation winding (separately excited)

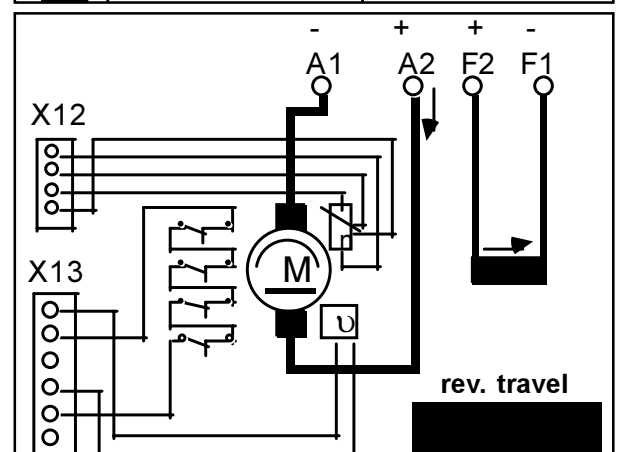
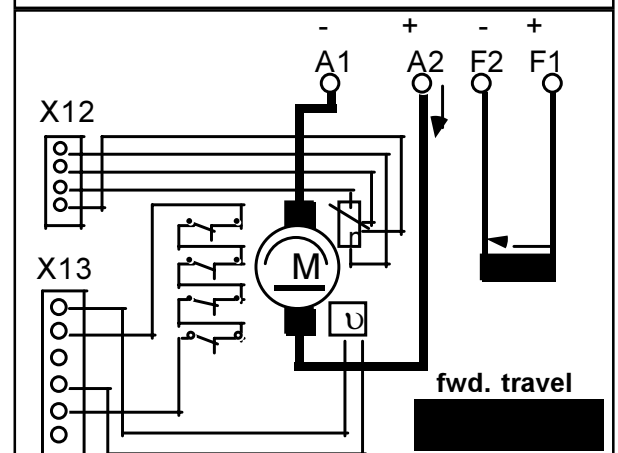
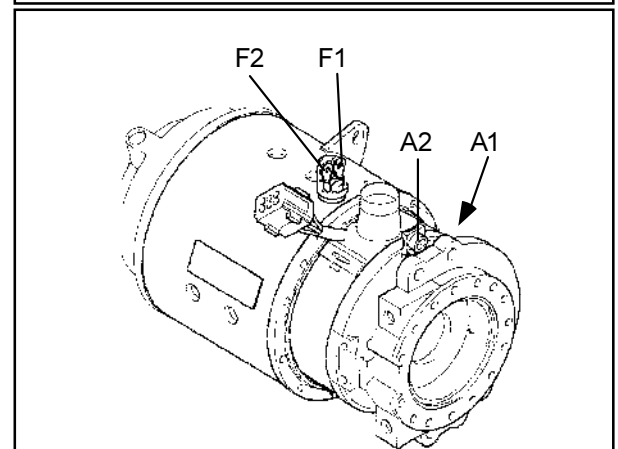
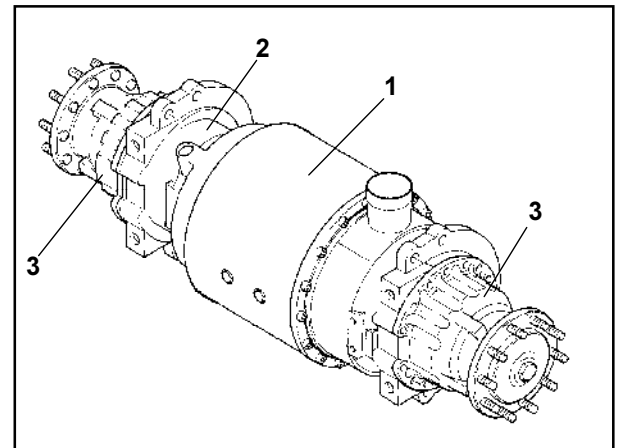
The direction of rotation is reversed by reversing the current flow in the field winding.

X13 = connection for brush and temperature monitoring device

X12 = connection for speed sensor

Neutral plane

The brush gear has been set to neutral at the factory. On no account should the adjustment

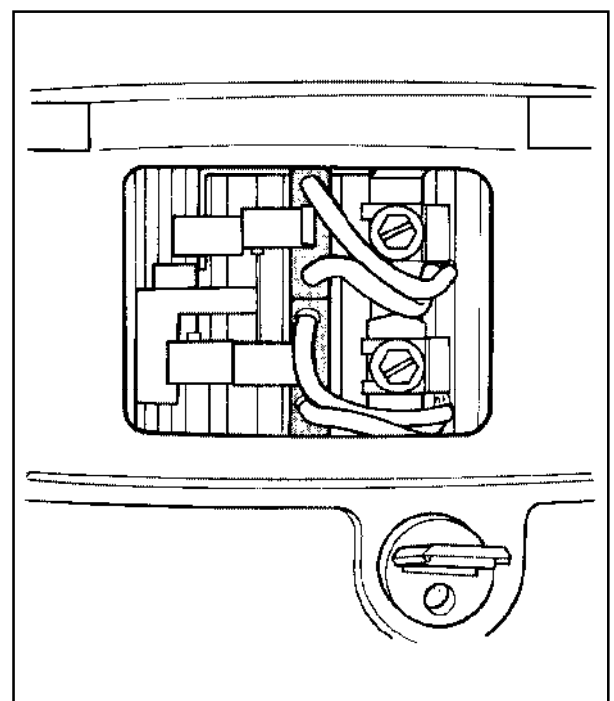
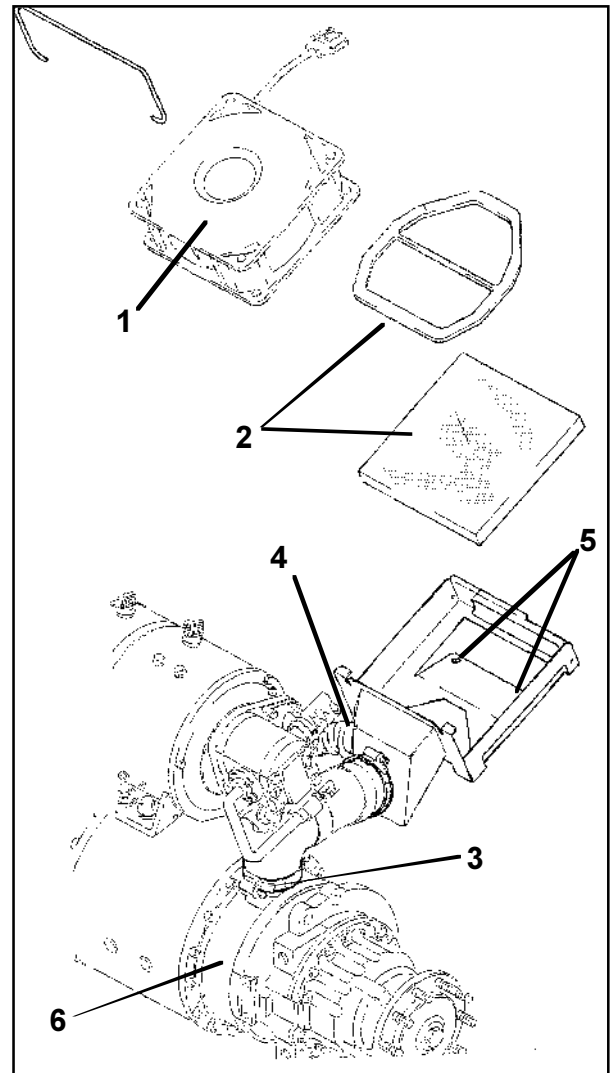


Drive motor

Inspecting and changing the motor brushes

Procedure:

- Raise the mast and secure in position by means of a suitable chain.
- Disconnect the battery.
- Remove the protective cover for the drive and pump motors (6026 - 29 only / 5 bolts).
- Remove the floor plate.
- Remove external cooling fan (1).
- Remove sealing frame and filter mat (2).
- Disconnect at brush inspection cover band (3) the hose conveying the air used to cool the drive motor.
- Disconnect at fan support (4) the hose conveying the air used to cool the pump motor.
- Remove the two M8 nuts (5) securing the fan support.
- Remove brush inspection cover band from around drive motor. (6 = two-piece cover band / the clamp is accessible from underneath).
- Three pairs of brushes are now accessible from the front. (The brushes are accessible through the mast which is secured in position by a chain against accidental lowering). The fourth pair of brushes is accessible from the rear.
- Raise the brush spring and lift the brush from the holder. Check length of drive motor brush; replace brushes if necessary.
- Once the brushes have been inspected or replaced, rear pair of brushes can be checked for correct position using a mirror.

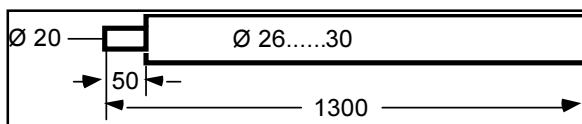


NOTE: Minimum brush length 15 -17 mm.
When the residual brush length is reached, an appropriate text appears on the display on the dash panel.

Drive motor

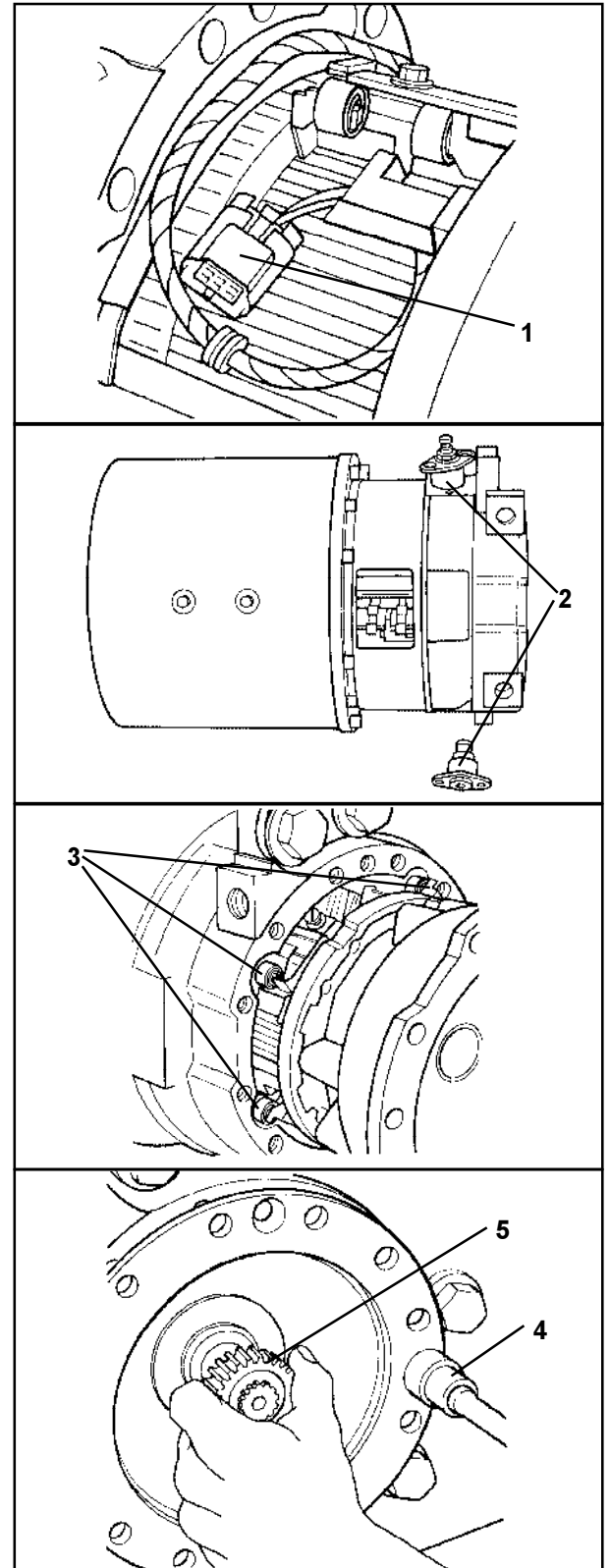
Armature removal with axle remaining in position on the truck**Removal**

- Raise the drive wheels clear of the ground and chock the truck into position by placing chocks beneath the chassis.
- Remove the left wheel from the truck.
- Drain oil from the left wheel reduction gearbox.
- Remove left wheel reduction gear (remove 14 M12x50 bolts).
- Remove motor brushes.
- Disconnect the 2 armature cables at brush gear, reinsert the screws into brush gear and tighten.
- Place the cable with connector (item 1) of brush monitor on the commutator.
- **Remove both oil bushes (item 2).**
- Remove two countersunk bolts (socket head) then reinsert them into the tapped holes provided in the vicinity for extraction purposes.
- By means of the countersunk bolts withdraw the bearing bracket to a small extent from motor then rotate bracket 45° in a clockwise direction. The brush springs must locate in the notches of the motor casing (item 3).
- Withdraw the half shaft (solid shaft) for the left wheel reduction gear from the hollow shaft of the armature.
- Insert the mounting shaft (of own manufacture according to drawing) into the armature shaft and withdraw the armature from the axle via this mounting shaft.

**Installation:**

- Insert the armature with mounting shaft into axle.
- Push armature in until it makes contact to the differential cage. Push solid shaft in until fully home.
- Pre-load the armature over the bearing bracket to a small extent by means of two M12 bolts (item 4) while rotating the solid shaft at the same time (item 5). The armature must at this stage rotate and engage with the differential cage provided the armature is sufficiently pre-loaded.
- Next, secure the bearing bracket with the 2 countersunk bolts (torque loading = 50 Nm). Remove M12 bolts again.
- Reconnect the 2 armature cables to brush gear.
- Reconnect the connector to the brush monitor.
- Install left wheel reduction gear using new O-ring. Torque loading of 14 M12x50 bolts = 110 Nm.
- Reinstall the motor brushes.

- Install left wheel reduction gear using new O-ring. Torque loading of 14 M12x50 bolts = 110 Nm.
- Reinstall the motor brushes.
- Reinstall both oil bushes (use new O-rings). Torque the socket head bolts to 23 Nm and refill gearbox with a fresh supply of oil (0.75 litres).

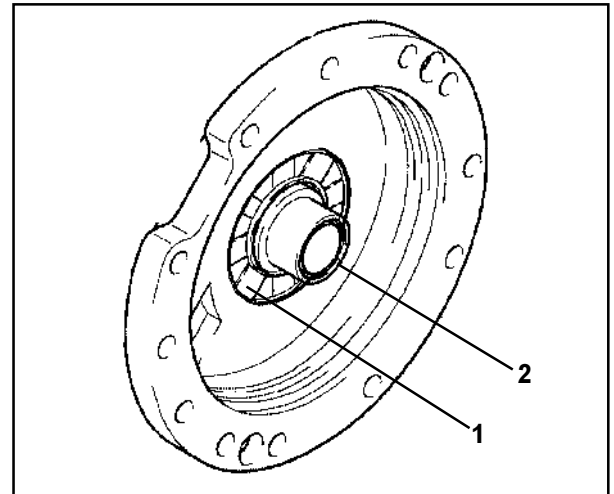


Drive motor

Replacing the chevron seals on commutator end

- Raise the front of the truck clear of the ground and chock into position.
- Remove the left wheel.
- Drain the oil from the left wheel reduction gearbox.
- Separate left wheel reduction gearbox from axle by removing 14 M12x50 bolts.
- Withdraw the drive shaft (half shaft = solid shaft) for the left wheel reduction gear.
- The chevron seals in the bracket (item 1) and the hollow shaft (item 2) of the armature can be replaced at this stage.

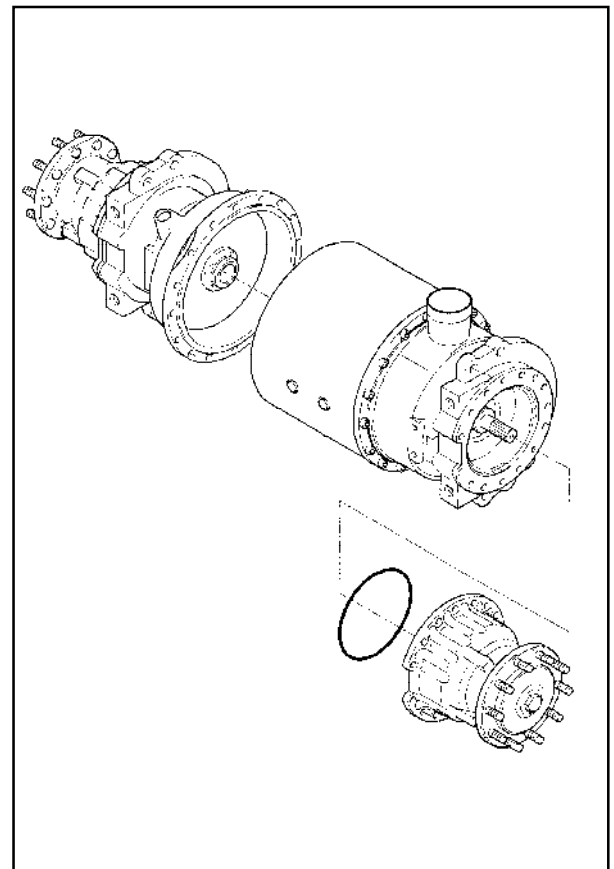
To reassemble the axle, reverse the dismantling procedure.

**Drive motor removal**

- Remove the mast assembly. Refer to Mast Removal, F.G. 20.
- Drain the oil from both wheel reduction gearboxes on both sides.
- Remove the power axle (see F.G. 03).
- Separate left wheel reduction gear from axle by removing M12x50 bolts.
- Remove screws securing differential/brake housing to drive motor (12 socket head screws M10x35 with locking ring).
- Remove differential/brake housing from drive motor.

Drive motor installation

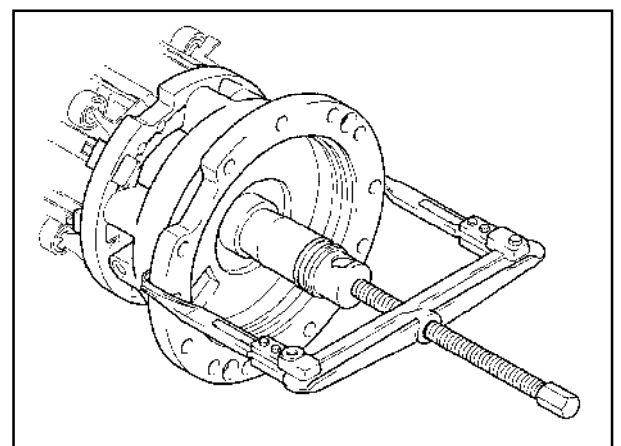
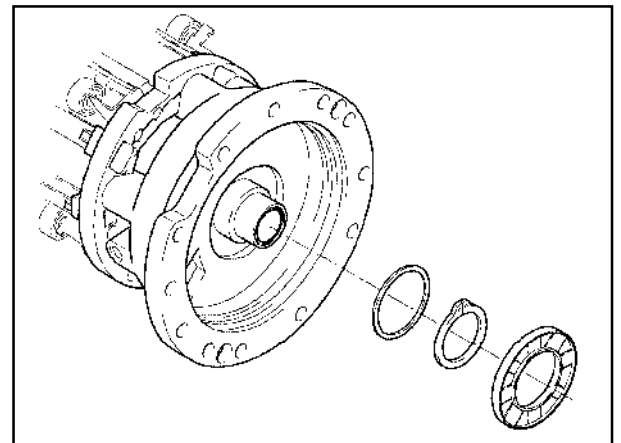
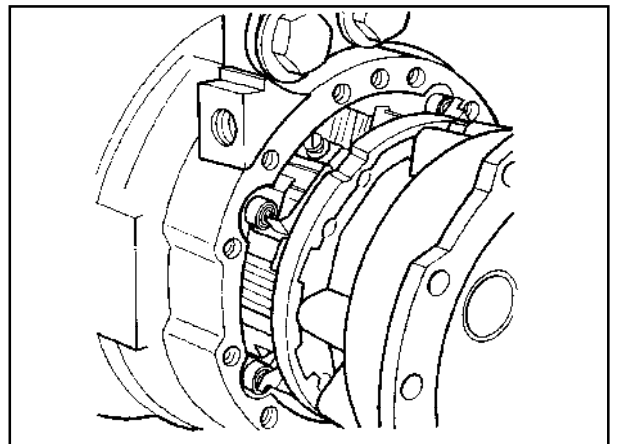
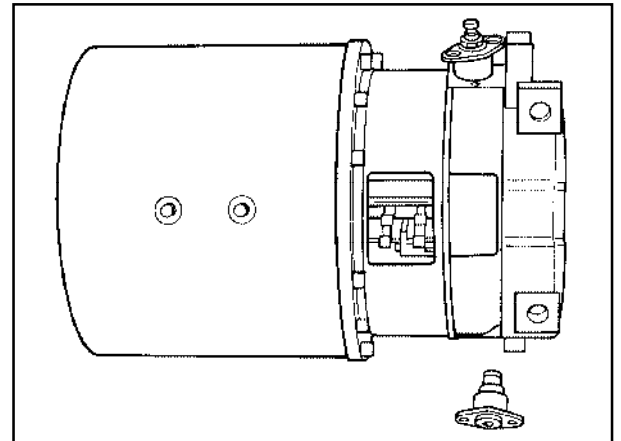
- Position the differential/brake housing against the r.h. side of the drive motor.
- Insert solid shaft (half shaft) for left wheel reduction gear into differential unit.
- Insert the armature into the differential cage by rotating it slowly by hand.
- Bolt the differential/brake housing to drive motor by inserting the 12 socket head screws M10x35 with locking ring and tightening them to a torque loading of 49 Nm.
- Install left wheel reduction gear using a new O-ring seal. Torque loading of the 14 M12x50 bolts = 110 Nm.
- Install power axle (see F.G. 03).
- Refill reduction gearboxes on both sides with a fresh supply of oil.
- Install mast (see F.G. 20).



Drive motor

Drive motor - Dismantling

- Remove motor brushes.
- Place the cable with connector of brush monitor on the commutator.
- Disconnect the two armature cables at brush gear, reinsert the screws into brush gear and tighten them.
- Remove both oil bushes.
- Remove two countersunk bolts (socket head) then reinsert them into the tapped holes provided in the vicinity for extraction purposes.
- By means of the countersunk bolts withdraw the bearing bracket to a small extent from motor then rotate bracket 45° in a clockwise direction. The brush springs must locate in the notches of the motor casing (see figure).
- Withdraw the armature; if necessary lift armature slightly at drive end.
- Withdraw from the armature the drive shaft (half shaft = solid shaft) for the left wheel reduction gear.
- Remove the chevron seal from the armature shaft.
- Remove circlip from armature shaft.
- Using an extractor, withdraw the bearing bracket from the armature.

**Drive motor - Reassembling**

Reassemble in the reverse order of dismantling.

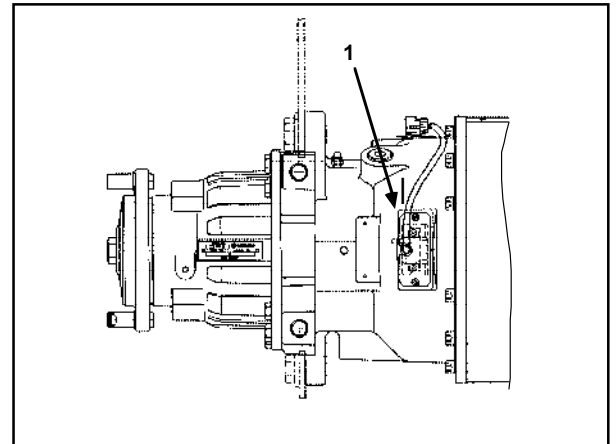
Drive motor

Speed sensor

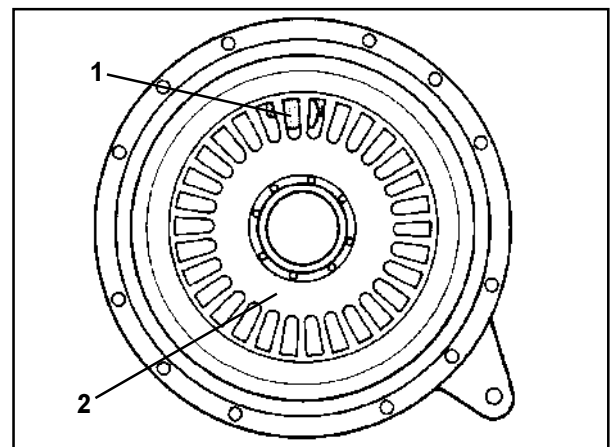
Drive motor speed and direction of rotation are sensed by a speed sensor (item 1) comprising two approach switches which are offset in relation to each other. The speed sensor assembly is located in the differential housing, to the right of the drive motor.

A timing ring (2) runs on the differential at motor speed. This ring is scanned by the speed sensor. The speed sensor is easily accessible from the front (when mast is raised and secured).

The timing ring is seated on the differential cage and can only be removed after the removal and disassembly of the axle.

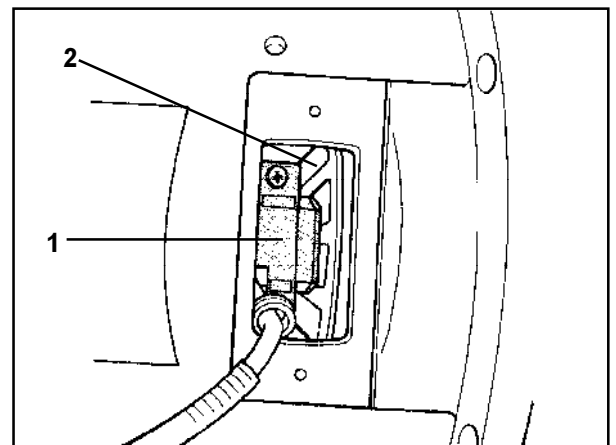
**Speed sensor removal**

- Raise the mast and secure in position by means of a suitable chain.
- Disconnect the battery.
- Unscrew the 2 cross-recessed head screws and withdraw the cover plate from the speed sensor.
- Unscrew the 2 cross-recessed head screws and remove the speed sensor.
- The spacing between crenellated ring and speed sensor is design-bound and cannot be adjusted.

**Electrical connections of the speed sensor**

The speed sensor is supplied by the controller with a voltage of +5 volts. Depending on the position of the crenellated ring, the outputs of the speed sensor supply the electronic circuit with a voltage of approx. 0.9 volts or approx. 4.8 volts in the form of signals.

+5V → X36/1 → X12/1 → speed sensor
Signal ← X36/2 ← X12/4 ← speed sensor
Signal ← X36/3 ← X12/2 ← speed sensor
0 V → X36/4 → X12/3 → speed sensor

**Checking the speed sensor**

- Raise the mast and secure in position by means of a suitable chain.
- Disconnect the battery.
- Raise the front of the truck clear of the ground and chock into position.
- Plug universal measuring SKT adaptor into connector X36 on controller.
- Connect a digital multimeter to the measuring adaptor:
positive → X36 Pin 2
negative → X36 Pin 4
- Remove speed sensor.
- Reconnect the battery.
- Meter reading should be approx. 0.9 volts.
- Hold sensor surface against a metal surface:

The meter must read approx. 4.8 volts.

- Reconnect digital multimeter to the measuring adaptor:
positive → X36 Pin 3
negative → X36 Pin 4
- Meter reading should be approx. 0.9 volts. Hold sensor surface against a metal surface:
The meter must read approx. 4.8 volts.

Note

The gap between timing ring and sensor can not be adjusted for design reasons.

Hydraulic pump motor

Pump and motor unit

Suspended from rubber mounts, the pump and motor unit is located above the drive motor. The hydraulic pump is driven by the motor via a driver.

Pump motor, construction

Series-wound, electric 4-pole motor with brush wear monitor, temperature sensor and speed sensor.

External fan cooling.

Position of motor terminals

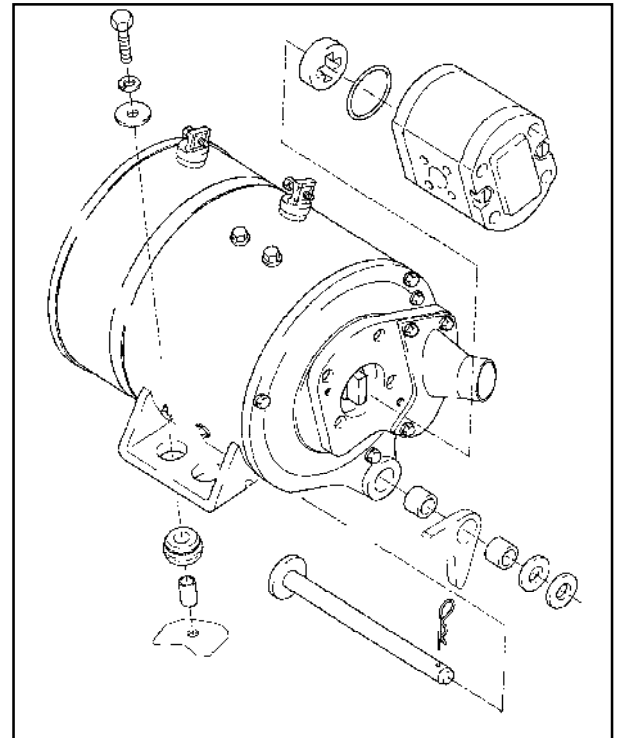
The motor terminals A1/D2 (6026 - 28 at the rear) are mounted on the top at the rear of the motor casing.

Connection of brush and temperature monitoring device

by means of a 6-pole connector.

Speed sensor connection

by means of 4-pole connector on motor casing.



At drive end:

armature shaft supported on a grooved ball bearing within the bearing bracket.

At commutator end:

armature shaft supported on a grooved ball bearing within the bearing bracket.

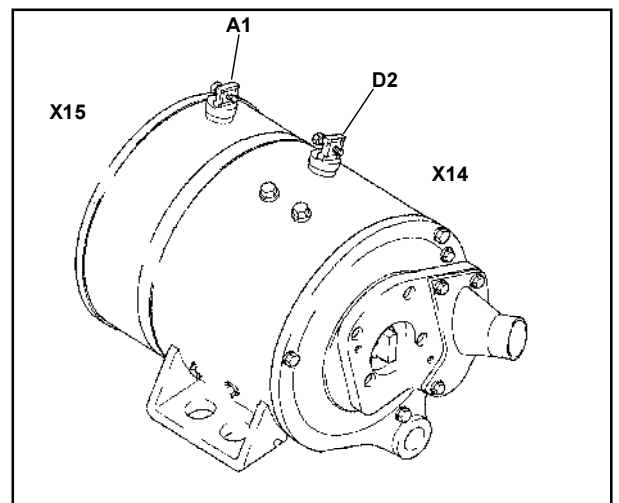
Connection diagram

A1/A2= armature

D1/D2= series winding (field windings connected in series with the armature coil)

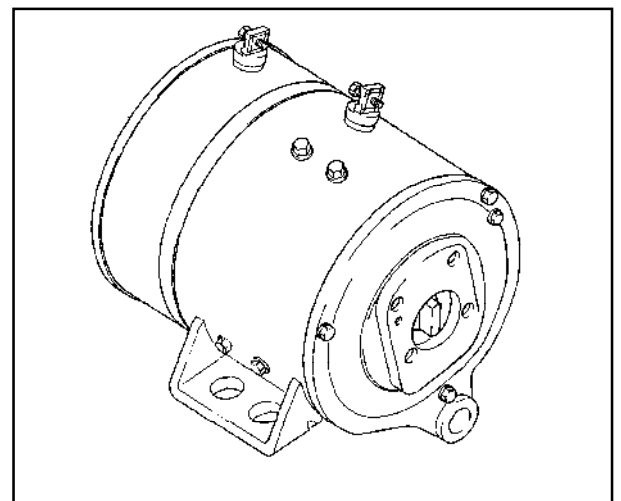
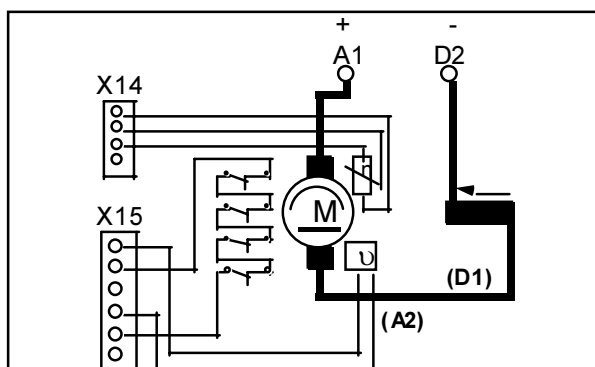
X15 = connector for brush and temperature monitoring device

X14 = connector for speed sensor.



Neutral plane

The brush gear has been set to neutral at the factory. On no account should the adjustment be tampered with.

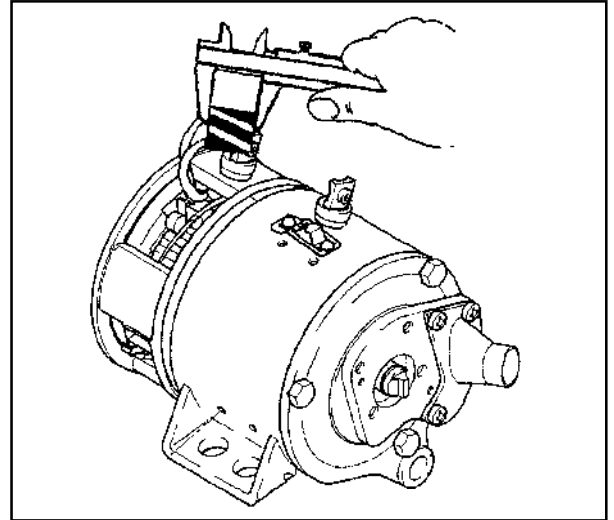


Hydraulic pump motor

Inspecting and changing the motor brushes

Procedure:

- Raise the mast and secure in position by means of a suitable chain.
- Disconnect the battery.
- Remove floor plate.
- Remove the protective cover for the drive and pump motor (6026 - 29 only / 5 screws).
- Disconnect connection A1 from pump motor.
- Open and remove cover band from around pump motor.
- **Two brushes** are now accessible from the front. (The brushes are accessible through the mast which is secured in position by a chain against accidental lowering). The other two brushes are accessible from the rear **(6022-25 only)**.
- **Four brushes** are now accessible from the front. (The brushes are accessible through the mast which is secured in position by a chain against accidental lowering). The other four brushes are accessible from the rear **(6026-29 only)**.
- Raise the brush spring and lift the brush from the holder. Check length of carbon brush; replace brushes if necessary.



NOTE: Minimum brush length 15 to 17 mm long. If the length of the brush is less than 15 mm it must be renewed. When the residual brush length is reached, an appropriate text appears on the display.

Hydraulic pump motor

Pump motor removal

Proceed as follows:

- Raise the mast and secure in position by means of a suitable chain.
- Disconnect the battery.
- Raise front of truck clear of ground and chock into position. Remove front drive wheels.
- Remove the floor plate.
- Remove the protective cover for the drive and pump motor (6026 - 29 only).
- *not required for 6026 - 29
- *Remove the cover plate located above the steering unit.
- *Remove the shroud from the hydraulic control valve.
- *Remove the shroud from steering column.
- *Remove the star knob (locking screw) locking the steering column in position.
- *Remove the pivot pin for the steering column, which is located above the steering unit.
- *Pull off plug of oil pressure switch 6S3.
- *Lay steering column aside and tie up.
- *Unscrew the support for the priority valve from the pump motor.
- *Slacken 4 M10x110 screws (two on 6026 - 29) securing the hydraulic pump and move the hydraulic pump to the side.

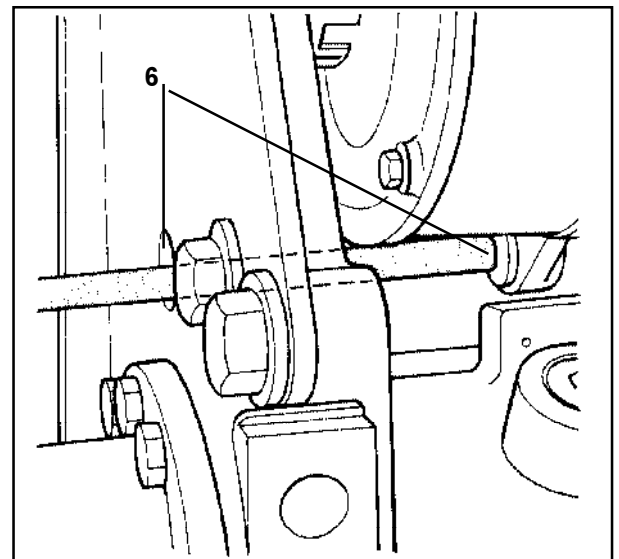
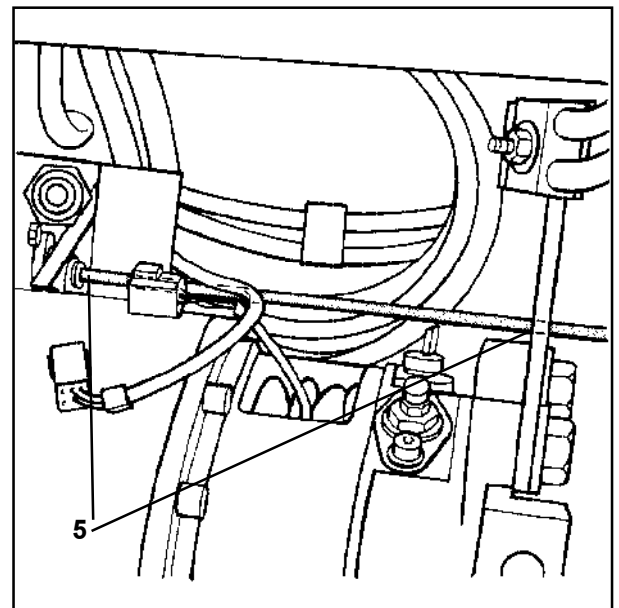
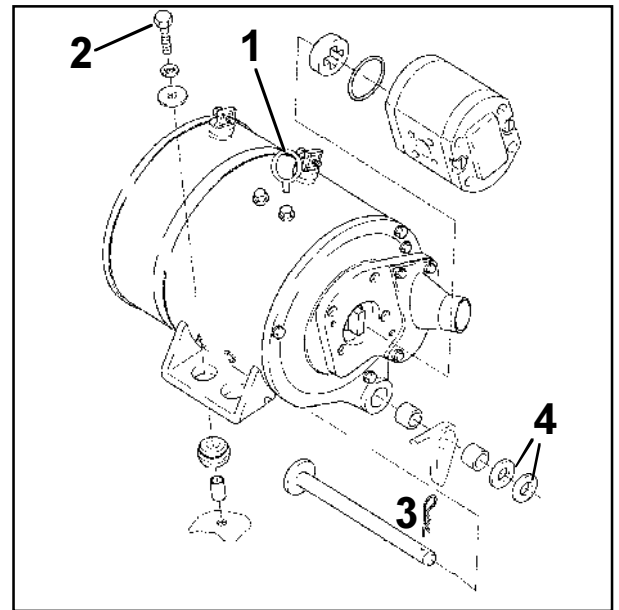
If necessary, the hydraulic pump can be removed completely in which case the steering column need not be removed.

- Disconnect motor cables at A1 and D2, pull out plugs X14 and X15.
- Screw an eyebolt (1) into the tapped hole provided in the motor casing for removal purposes. Sling the pump motor and take its weight with an overhead hoist or crane.
- Remove the two front securing bolts (2) securing the pump motor.
- Remove cotter pin (3) and 2 washers (4) from pivot pin of pump motor.
- Drive out pivot pin with a long rod which must pass through the opening in the lateral section of the chassis frame (5). On 6026 - 28 trucks remove the 3rd screw of the drive axle mounting and drive the pivot pin out through this opening using the rod.
- Lift pump motor away from truck.

Pump motor installation

Pump motor installation is a reversal of the removal procedure; the pivot pin is installed by passing it through the hole in the right lateral section of the chassis frame (6) or through hole of the removed fastening bolt on 6026 - 29.

Check the rubber mounts from which the pump and motor unit is suspended and replace with new ones, if necessary.



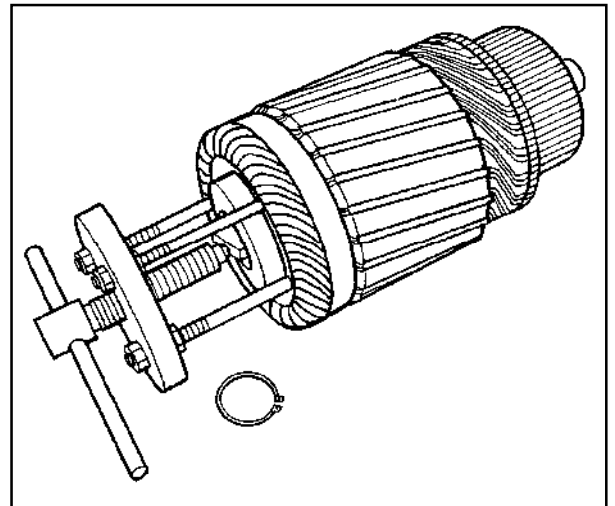
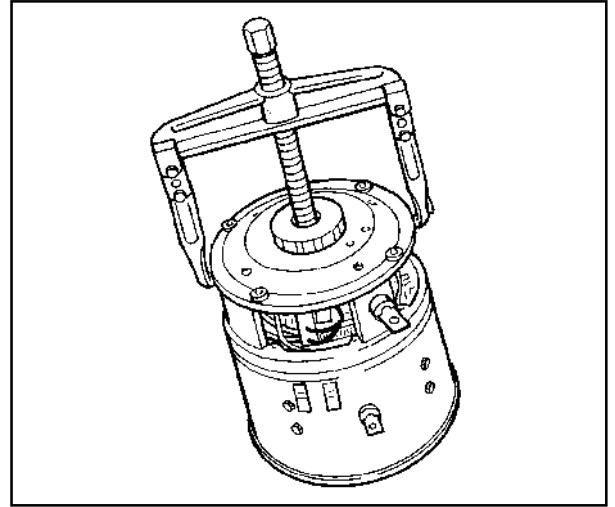
Hydraulic pump motor

Pump motor - Dismantling

- Raise the brush springs and lift the brushes from the holder.
- Remove bridge across brush gear and field coils.
- Unscrew four screws from the commutator end bracket.
- Withdraw the commutator end bracket from the armature shaft (in this operation the crenellated ring of the speed sensor is withdrawn at the same time).
- Unscrew three screws from the drive end bracket. Remove the drive end bracket together with the armature from the motor casing.
- Extract the drive end bracket from the armature shaft (the grooved ball bearing remains on the armature shaft).
- Remove the circlip (retaining the grooved ball bearing) from the armature shaft.
- Using an extractor type VMO891021 and three screws M8X100 (on three sides the screw heads must be removed by grinding), withdraw the grooved ball bearing from the armature shaft.

Pump motor - Reassembling

Pump motor reassembly is a reversal of the dismantling procedure.



Hydraulic pump motor

Speed sensor

The sensor sensing pump motor speed is located on the commutator end bracket on the r.h. side of the pump motor.

Located on the armature shaft, a crenellated ring rotates at motor speed. The crenellated ring is sensed by the speed sensor which is accessible from the r.h. side below the r.h. tilt cylinder.

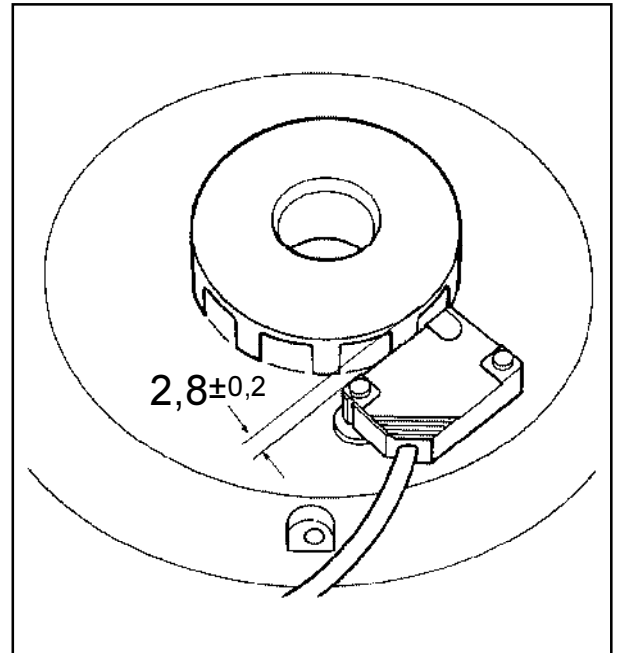
Positioned on the armature shaft, the crenellated ring can only be withdrawn from the armature shaft together with the bracket as one unit.

Speed sensor removal

Remove the sensor from the bracket by unscrewing two cross-recessed screws.

Speed sensor installation

- Secure the speed sensor to the bracket with the two cross-recessed head screws.
- Set the spacing between speed sensor and crenellated ring to 2.8 ± 0.2 mm.

**Electrical connections of the speed sensor**

The speed sensor is supplied by the controller with a voltage of +24volts. The output of the speed sensor supplies a square-wave signal whose frequency is a function of motor speed.

+24V → X36/5 → X14/1 → speed sensor
 Signal ← X36/6 ← X14/2 ← speed sensor
 0 V → X36/7 → X14/3 → speed sensor

Checking the speed sensor

- Disconnect the battery
- Plug universal measuring SKT adaptor into connector X36 on controller.
- Connect a digital multimeter to the measuring adaptor:
 positive → X36 Pin 6
 negative → X36 Pin 7
- Rotate pump motor at crenellated ring by hand until one of the gaps between the teeth of the crenellated ring is in front of the speed sensor.
- Reconnect the battery.
- The meter must read approx. 0.8 volts.
- Disconnect the battery
- Rotate pump motor until one tooth of the crenellated ring is in front of the speed sensor.
- Reconnect the battery.
- Meter reading should be approx. 4.8 volts.

Forced ventilation

Operation

The air drawn from below by the external cooling fan passes through a filter mat, whence it enters the drive and pump motors via hoses. On the drive motor the cooling air entry is through an opening formed in the cover band (inspection band). The air cooling the motor is evacuated at the drive end through a screen (On the 6026-29 the air is evacuated through a hose which is routed to below the hydraulic tank and dissipates the heat from there to the rear and downwards.)

The pump motor is provided on the drive end bearing bracket with a hose connection piece through which the air is blown into the motor and evacuated through louvers in the cover band (on 6026 - 29 same as drive motor).

Controlled by the electronic controller, the fan cuts in only when motor operating temperatures rise above a safe level.

The fan motor is continually supplied with 80 V via X22/1 and X22/3. The fan motor is turned on and off via a control cable (X22/2) with a control voltage of about 15 V.

Cooling fan removal (6022 - 25)

- Disconnect fan connector.
- Push the fan slightly down at the rear end and swing clamp (1) up and back.
- Raise fan at the rear, withdrawing it from under the front catches.

Cooling fan removal (6026 - 29)

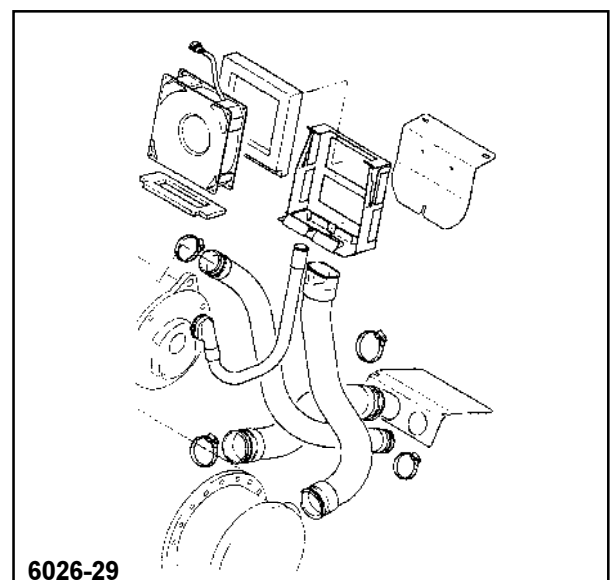
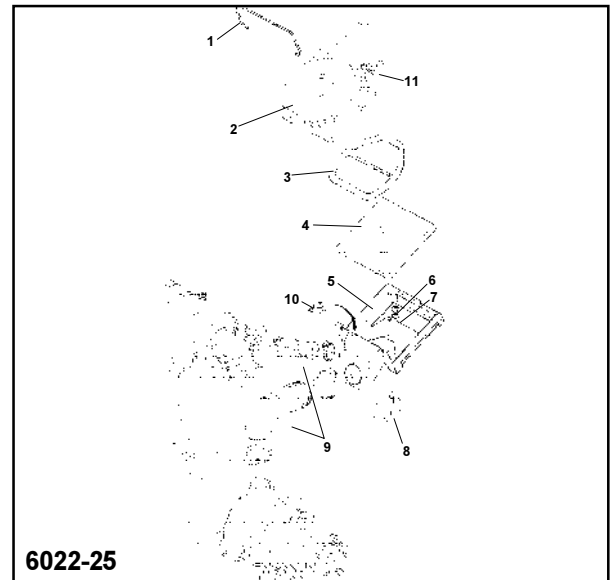
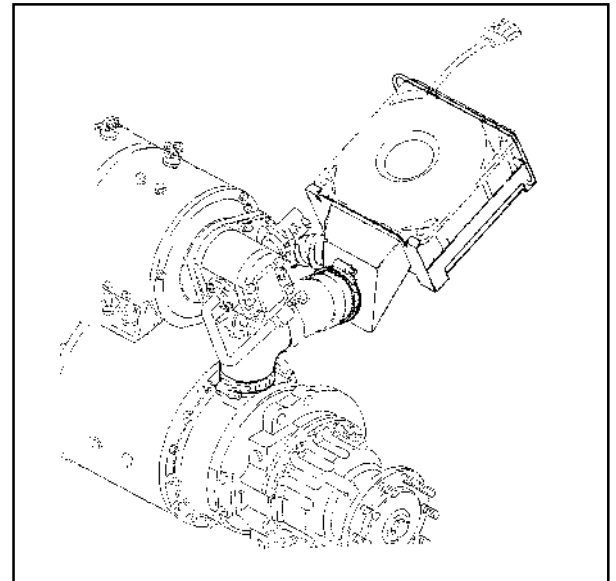
- Disconnect fan connector.
- Release the fan at the left and right catches (see bottom figure) and raise the fan slightly at the top to the front and pull it out upwards.

Clean air filter

- Remove cooling fan.
- Remove sealing frame.
- Remove filter mat.
- Blow filter mat with compressed air, wash and dry or replace with a new mat.

The fan mounting support is attached to the truck chassis frame by two mounting studs with M8 nuts and spring washers.

The air hoses are secured with hose clips to the connection pieces on the support.



Method of operation

The brush gear in the electric drive and pump motors are fitted each with a monitoring N/C contact for brush wear indication. These contacts perform a switching function when the brushes have worn down to their limit.

If there is an open circuit due to a contact opening or due to a broken wire, this is indicated by the display on the dash panel.

The reason for an error message can also be incorrect parametrization of the DRIVE MODE or HYDRAULIC MODE. For a correct adjustment see parametrization of F.G. 08.

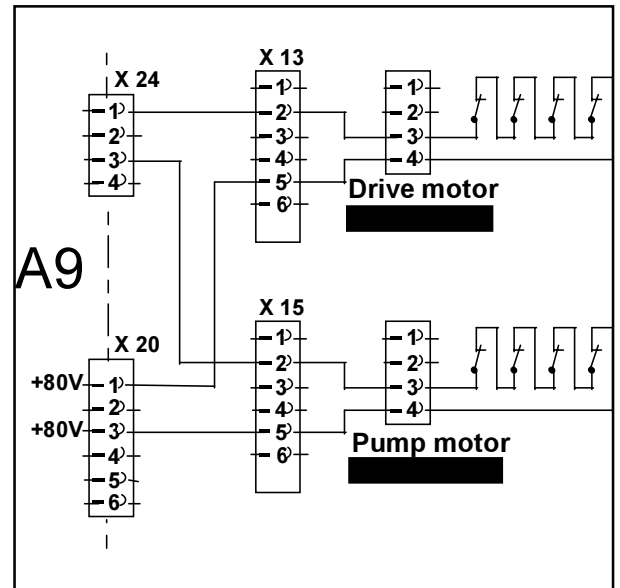
After the cause of an error message has been eliminated, the truck must remain switched on for about 10 min for the error message to be removed.

If the truck is switched off before the end of this period, the error message will appear when it is switched on, although no error has occurred.

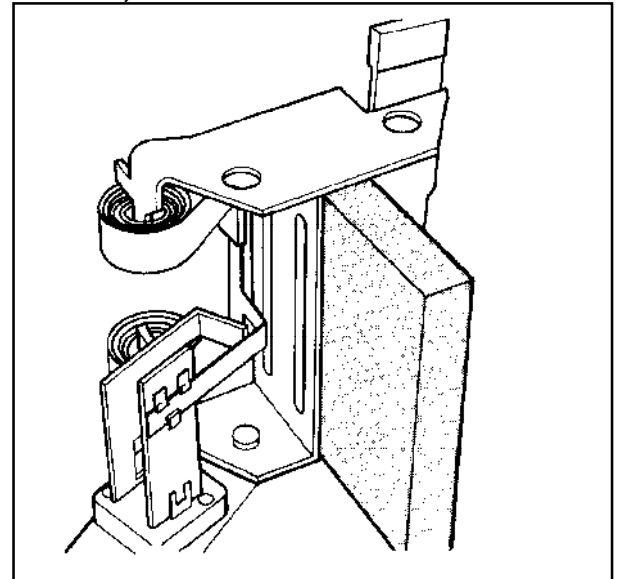
Checking the brush wear monitoring facility

- Disconnect the battery.
- Plug universal measuring SKT adaptor into connector X24. Controller X24 remains disconnected.
- Reconnect the battery.
- Turn on the key switch.
- Test for continuity:
X24/1 — X24/2 drive motor and
X24/3 — X24/4 pump motor.
- If the brush length is sufficient, the voltage must be about 80 V.

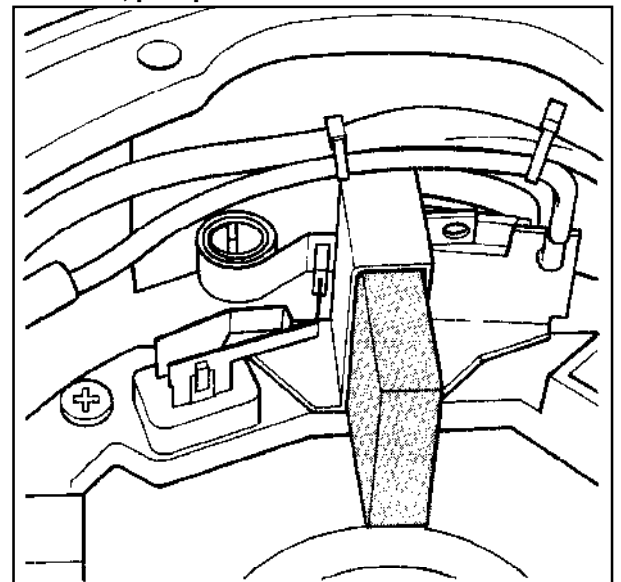
Brush wear monitoring facility



Contact, drive motor



Contact, pump motor



Thermal monitoring

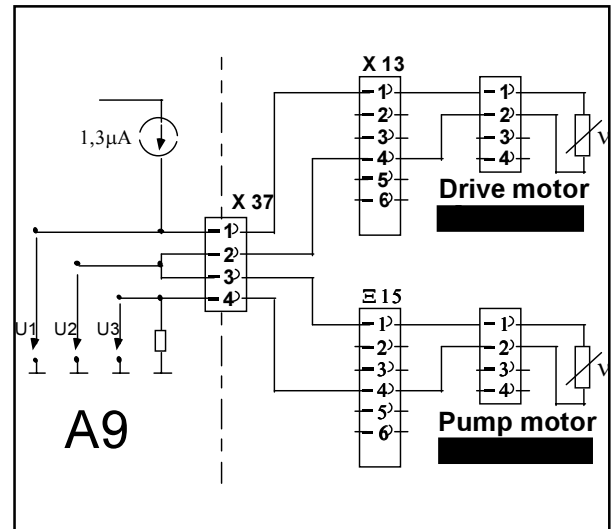
Method of operation

The brush gear of the drive and pump motors is fitted with silicon type temperature sensors.

Wired in series, the temperature sensors are supplied by a power source with a constant current of 1.3 mA. The voltages flowing through the temperature sensors vary with changing temperature.

The temperature of the electric motors is computed in the electronic controller by voltage measurement.

Due to the temperature sensors being connected in series an open electrical circuit in one of the motors will cause in both motors a failure of the temperature sensing circuit.



Checking the temperature sensors

The power source and the voltages traversing the sensors may be checked.

Checking the power source

- Disconnect the battery.
- Disconnect connector X37 on controller.
- Plug universal measuring SKT adaptor into X37 on controller. Plug X37 remains disconnected.
- Reconnect the battery.
- Connect a digital multimeter (**current measurement**) to pins 1 and 4 on universal measuring SKT adaptor.
- Meter reading should be approx. 1.3 mA.

Voltage flowing in the temperature sensors

- Disconnect the battery plug.
- Plug universal measuring SKT adaptor into connector X37.
- Reconnect the battery plug.
- Carry out a voltmeter check using the digital multimeter: Connect meter leads to pin 1 and 2 for drive motor and to pin 3 and 4 for pump motor.
- The voltage flowing in the temperature sensor in the event of a normal ambient temperature must be for both motors in the region of 0.7 volts.

Insulation resistance

The insulation material used on electrical machines must have a sufficiently high insulation resistance. The resistance of the insulation of all windings against housing is considered to be sufficient provided it is at least $1000\ \Omega$ per volt of voltage rating against housing.

Example:

On an electric motor with a rated voltage of 80 volt the resistance of the insulation must amount to at least $80.000\ \Omega$ or 80 k Ω .

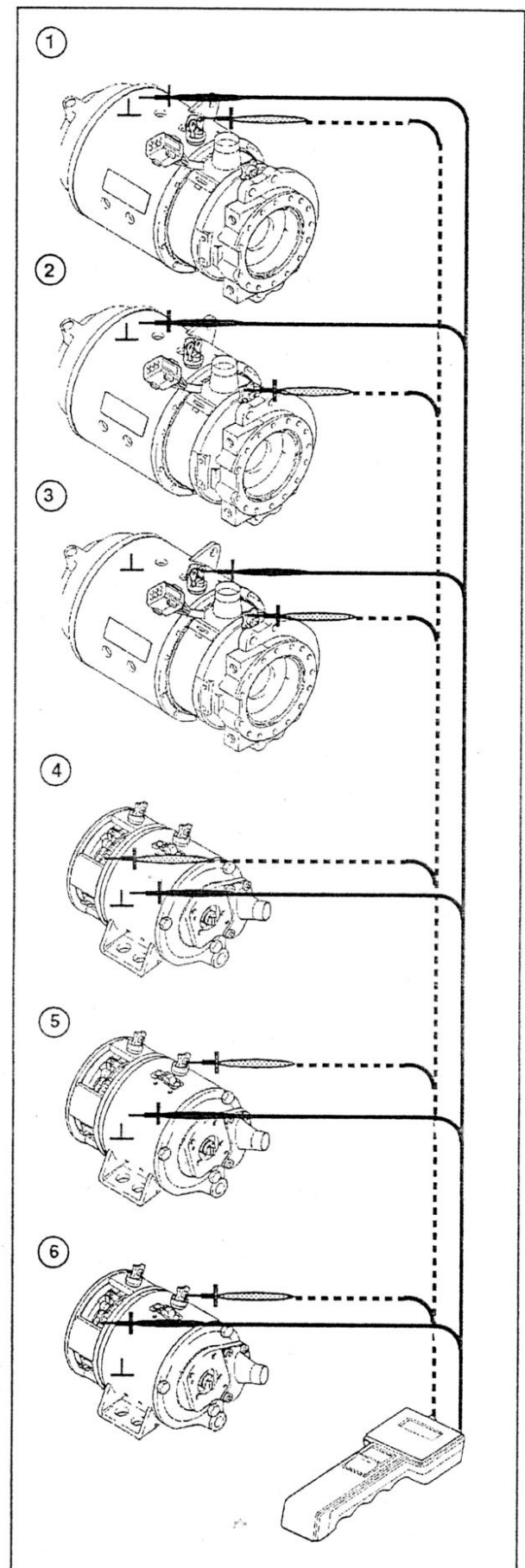
Measuring insulation resistance (earthing)

Testing the insulation resistance must be carried out after the machine has been disconnected from its circuit. To this end all power cables must be disconnected from motor. Testing the insulation resistance on the electrical machines can become necessary if:

- the coil is suspected to be shorted to the frame of the machine,
- a repair has been carried out.

If one wants to find out on which winding of the pump motor (series-wound motor) a possible insulation fault exists, all carbon brushes must be lifted from the commutator and clamped with the brush holder spring.

Lifting the carbon brushes is not necessary on the drive motor (DC shunt motor).



General hints

Turning down the commutator on a lathe

Permissible untrueness: 0.02 mm

If the commutator is out-of-round turn down the armature on a lathe. A better surface finish will be produced at high cutting speed combined with a fine feed.

Admissible minimum commutator diameter

The commutator is allowed to be turned down up to a minimum diameter only.

Drive motor	118 mm dia.
Pump motor	100 mm dia.

Undercutting the mica

Carefully undercut the mica with the aid of an appropriate saw blade or a milling machine. Make sure the full width of the mica is completely removed also at the sides of the segments. The mica insulation between the commutator segments must be recessed to a depth corresponding to the width of the mica.

Once the commutator has been turned down on a lathe and the mica undercut, it may be necessary to remove any burrs that may have been produced on the sides of the segments. To this end the commutator should be skimmed with fine emery cloth (grain 320) after which all mica or copper deposit must be removed with a dry air jet. Badly undercut mica or any residual mica insulation producing irregularities of the surface, as well as copper burrs on the segments will impair the brush contact surface, causing excessive brush wear.

1 = mica undercut properly.

2 = mica badly cut back - high mica still exists on the sides of the segments.

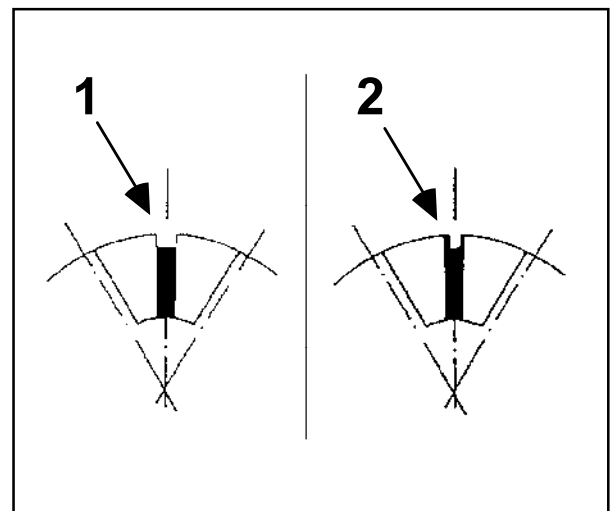
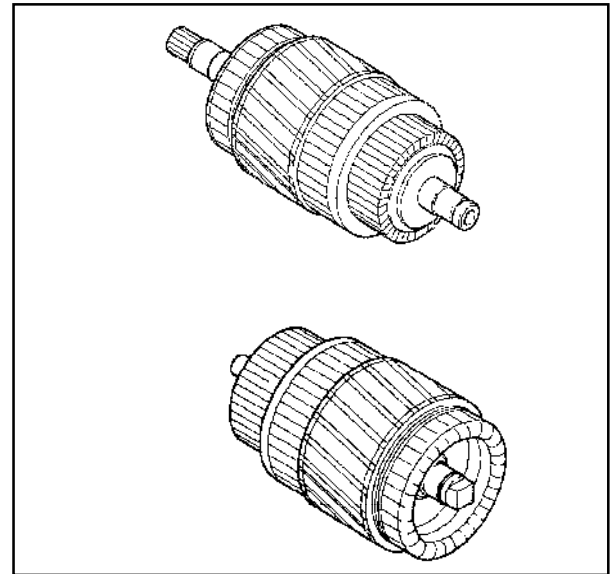
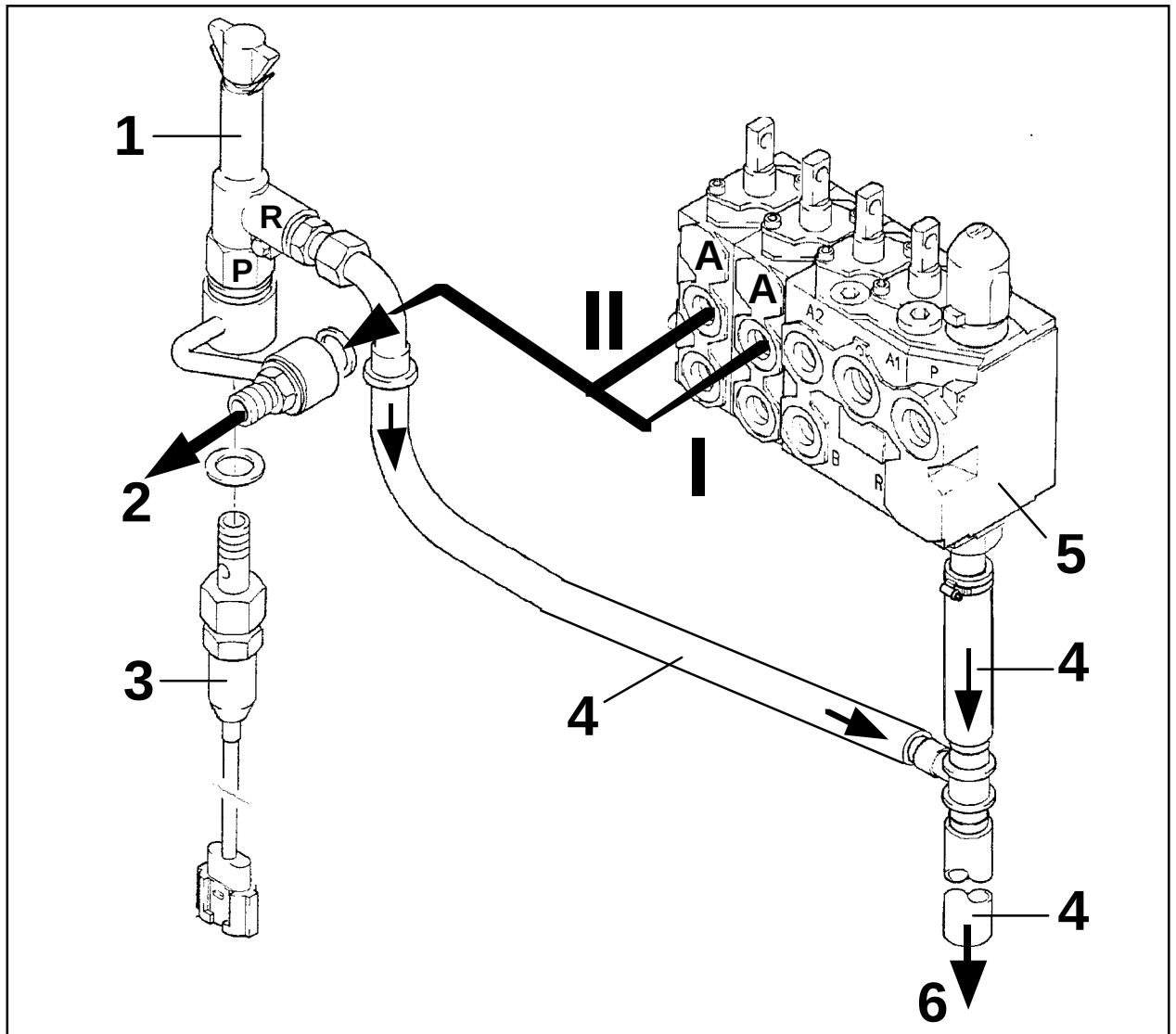


Table of contents	Page
Pressure regulator I and II	
Function	2
Pressure regulator	
Relief valve	3
Pressure gauge	
Pressure relief for clamps with integrated side shift	4
Control valve block	
Cross-section reducer for attachments with side shift	5
Cross-section reducer and pump motor speeds for attachments	6
Joystick	7

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Pressure regulator I and II - Function



1. Relief valve
2. Connection for attachment
3. Sender
4. Return hoses
5. Control valve block
6. Return to tank

For single additional hydraulics (I), connection takes place to the second way valve.
For double additional hydraulics (II), connection takes place to the third way valve

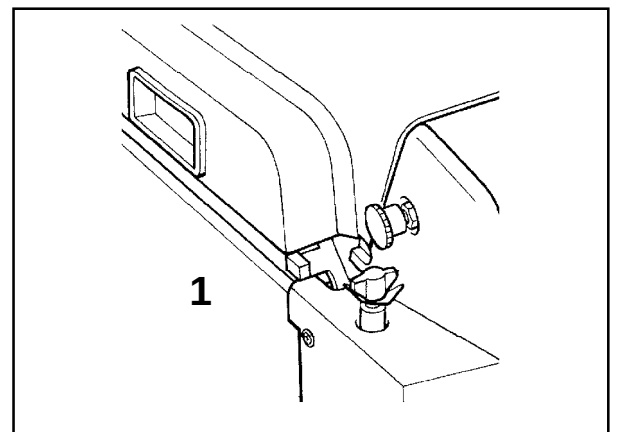
The connection of a clamp function must take place in any event to the outer way valve.

Function

For the protection of the attachment, e.g. when using a clamp function, a pressure regulator with a manually controllable pressure relief valve (1) is installed on the right next to the control valve block (5).

The respective pressure adjusted at the relief valve is received by a sender (3) and indicated on the instrument panel display.

Connection of the pressure regulator takes place at the upper connection bores "A" of the slider bank, e.g. for the "close clamp" function.



Pressure regulator - relief valve/pressure gauge

Relief valve

- Setting range : 0 - 160 bar
- manually controllable
- 1 = Handle
- 2 = Wing lock nut
- 3 = Distance spacers
- 4 = Housing
- 5 = Lock washer with screws
- 6 = Spring
- 7 = Washer
- 8 = Ball
- 9 = Damping piston
- 10 = Damping spring

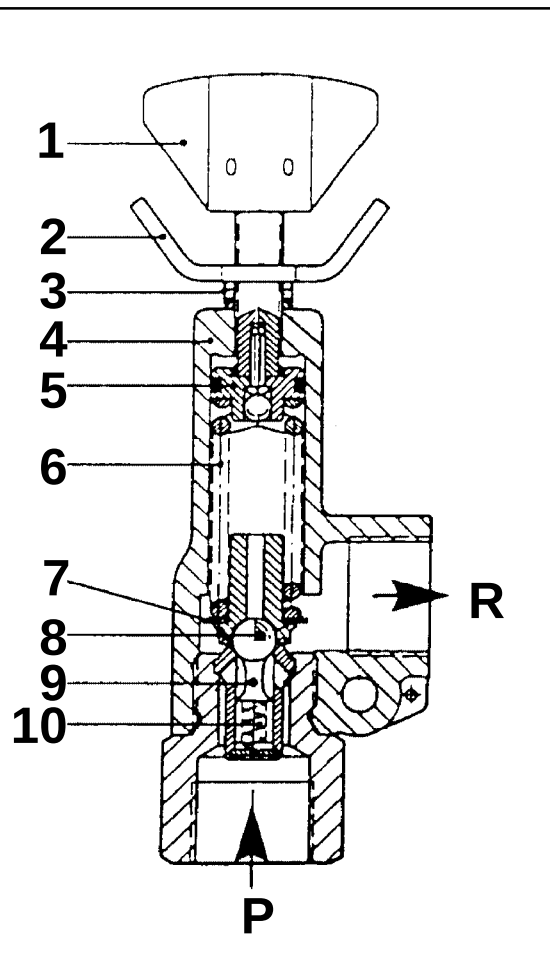
The oil flows from P → R

The pressure can be increased or reduced by tightening or unscrewing the hand screw (1).

The setting range and max. pressure are limited by distance spacers (3) to 160 bar.

ATTENTION

For setting purposes, the manufacturer's specifications in respect of the max. pressure loading capacity of the attachment must be observed (see attachment nameplate).



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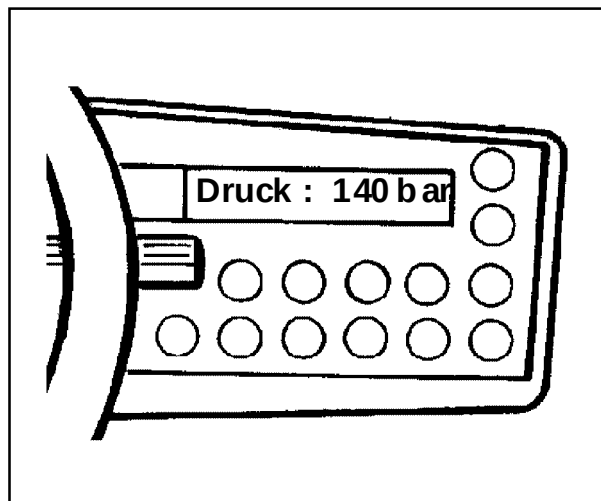
Pressure gauge/instrument panel

The pressure set at the relief valve is indicated on the instrument panel display.

NOTE

A drop in the displayed pressure, e.g. after clamping a load and neutral position of the valve rod is caused by leakage oil at the valve rod and is not a pressure drop at the attachment.

The attachment must be provided with a stop valve for the load holding function.



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Pressure relief for clamps

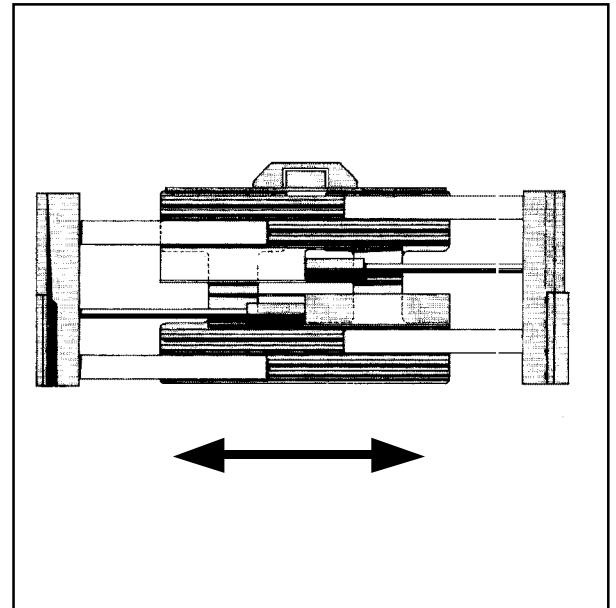
ATTENTION

In contrast to other truck types, trucks 6022 - 6029 are not provided with a pressure reducer for the function of an integrated side shift either in the control valve block or in the additional hydraulics.

When using these clamp types, it must be ensured that the clamp itself is provided with a pressure reducer for the side shift.

There is otherwise a risk of the clamp opening and the clamped product falling out when the side shift is moved to the left or right against the stop.

In case of doubt, the attachment supplier should be consulted and the clamp retrofitted if necessary.



Control valve block - cross-section reducers

Cross-section reducer for attachment with side shift

1. Union with cross-section reducer bore
2. Cross section reducer mark (notch)

For reduction of the side shift speed and to counteract too rapid side shift movement (stability) in the event of malfunction of the pump motor control (excessive pump motor speed), for attachments with side shift, threaded pipes (1) with a cross-section reducer bore of 1.2 mm diameter are connected to both connections "A" and "B" of way valve 1.

NOTE

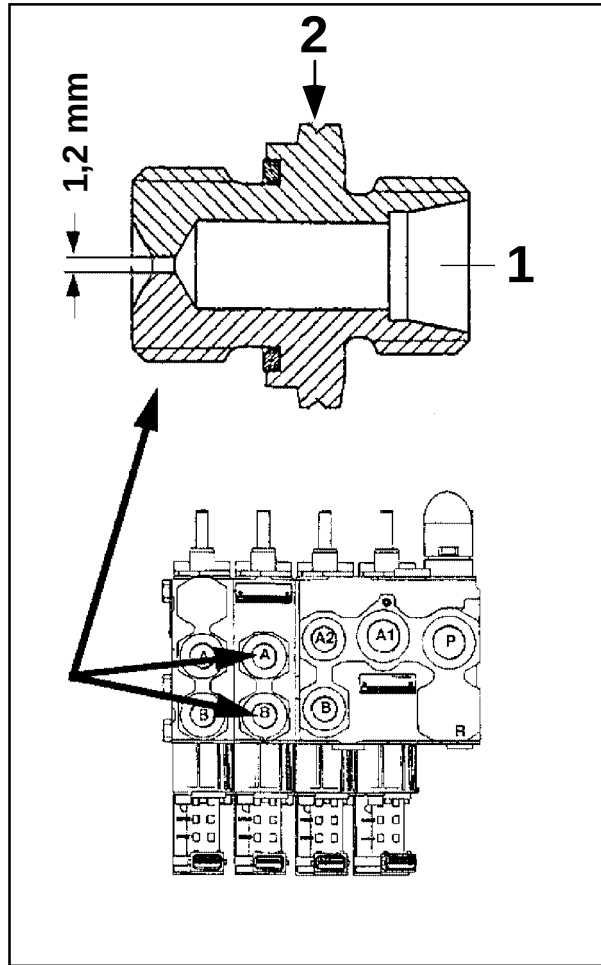
Connection of the threaded pipes (1) with cross-section reducer can be identified by the outer notch (2) on the hexagon.

ATTENTION

When retrofitting an attachment with side shift, it must be ensured that the threaded pipes are connected with cross-section reducer bore.

Trucks with additional hydraulics, **which are delivered without attachment**, are provided with cross-section reducer unions for safety reasons.

Pipe (1) tightening torque: **66 Nm**



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Control valve block - cross-section reducers/speeds

Pump motor speeds and cross-section reducers for attachments:

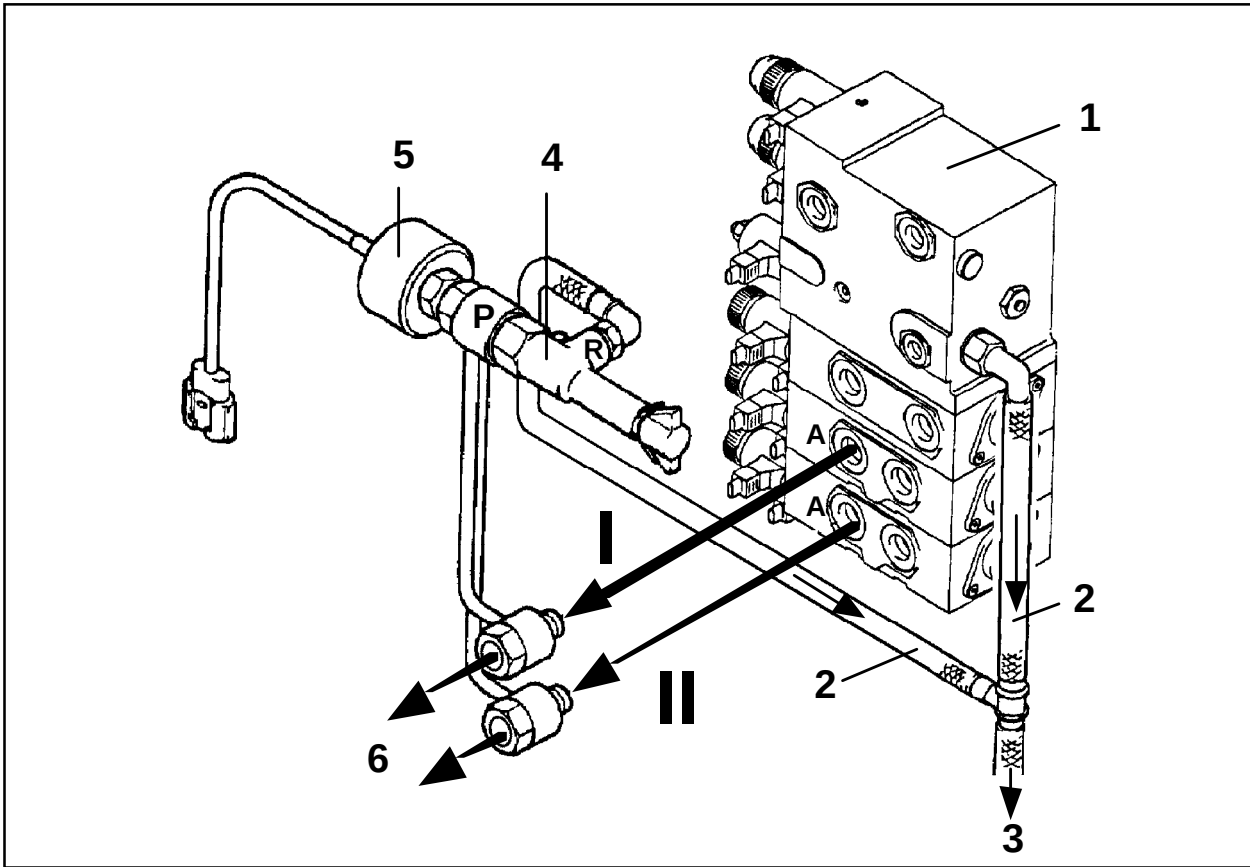
Attachment type	Make			Cross-section reducers 1.2 Ø 1st additional hydraulics
		1st add. hydr.	2nd add. hydr.	yes/no
With delivery without attachment		500	2550	yes
Rotating head 1 T 351 E	Kaup	1200		no
Rotating head 2 bis 3 T 351 E	Kaup	2550		no
Rotating head 5 - 1503	Meyer	800		no
Side shifter 2 T 151 P2 und P3 / 3 T 151 P2	Kaup	500		yes
Side shifter 4 T 151 P2	Kaup	800		yes
Side shifter 55 F/ 60 E	Cascade	500		yes
Side shifter 100 E	Cascade	100		yes
Side shifter SL 4 / SL 5	Saco / Bolzoni	500		yes
Side shifter SL 6	Saco / Bolzoni	1000		yes
Clamp fork (without side shift) 1.5 bis 4 T 401	Kaup	2550		no
Clamp fork (with side shift) 1.5 bis 3 T 411	Kaup	500	2550	yes
Clamp fork (with side shift) 4 T 411	Kaup	800	2550	yes
Clamp fork rotating 3 T 451	Kaup	1800	2550	yes
Pallet fork 6 - 5206 und 5204	Meyer	800	2550	no
Clamp fork 6 - 0106	Meyer	1000	2550	no
Bale clamp (without side shift) 2 to 4 T 403	Kaup	2550		no
Bale clamp (with side shift) 2 to 3 T 413	Kaup	500	2550	yes
Bale clamp (with side shift) 4 T 413	Kaup	800	2550	yes
Double pallet handler	Kaup	500	2550	yes
Rotating roll clamp 2 to 4 T 458	Kaup	2550	2550	no
Fork spreader 2 to 4 T 163	Kaup	500	800	yes
Fork spreader (without side shift) 6- 2404 /6 / 9	Meyer	2550		no
Fork spreader (without side shift) 6- 0107	Meyer	1200		no
Fork spreader (with side shift) 6- 2404 /6 / 9	Meyer	1000	2550	yes
Schaufel (1600 u. 1900 wide) 30.20.08 and 30.20.10	Seith	1500		no
Fork carriage 1- 3203	Meyer	1000	600	no
Roll clamp RA 15 ON	Auramo	753	2550	no

Table of contents	Seite
Additional hydraulics	
Function Pressure regulator I and II	8
Mounting attachments	
Additional hydraulics	
Cross-reducers for attachments	9

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Additional hydraulics- Pressure regulator

**Pressure regulator I and II**

- I = 1st additional hydraulics
 II = 2nd additional hydraulics
 1. Control valve block
 2. Return hoses
 3. Return to tank
 4. Relief valve
 5. Sender
 6. Connection for attachment

Mounting attachments

For mounting or removing attachments, the additional hydraulic system can be rendered pressureless for disconnection of the hydraulic connection (couplings at fork carriage). For this purpose, buttons 5 to 8 on the joystick must be pressed simultaneously with the keyswitch on.

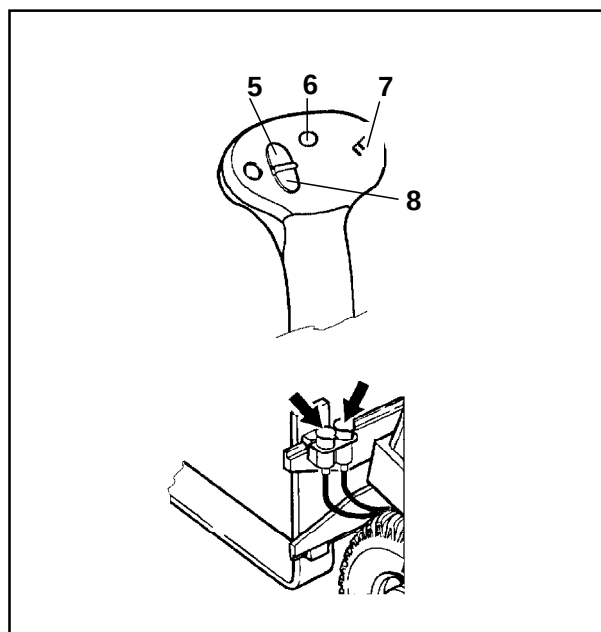
Function

For protection of the attachment, e.g. when using the clamp function, a pressure regulator with manually controllable relief valve (4) is installed above the control valve block.

The pressure occurring at the relief valve at "P" is received by a sender (5) and indicated on the instrument panel display.

Connection of the pressure regulator takes place at the connection bores "A" of the slider bank, e.g. for the "close clamp" function.

For single additional hydraulics (I), connection takes place at the third way valve. For double additional hydraulics (II), connection takes place at the fourth way valve.



Additional hydraulics - cross-section reducers for attachments

Cross-section reducers for attachments

1. Threaded pipe with cross-section reducer bore
2. Screw with bore with cross-section reducer bore
3. Cross-section reducer mark (notch)

Cross-section reducers (1) for attachments with side shift

For the reduction of side shift speeds and to counteract too rapid side shift movement (stability) in the event of malfunction of the pump motor control (excessive pump motor speed), for attachments with side shift, additional hydraulic threaded pipes (1) with a cross-section reducer bore of 1.2 mm diameter are connected to both connections "A" and "B" of way valve 1.

ATTENTION

When retrofitting an attachment with side shift, it must be ensured that the threaded pipes (1) are connected.

See Chapter "Pump motor speeds and cross-section reducers for attachments".

Trucks with additional hydraulics, which are delivered without attachment, are provided with cross-section reducer unions for safety reasons.

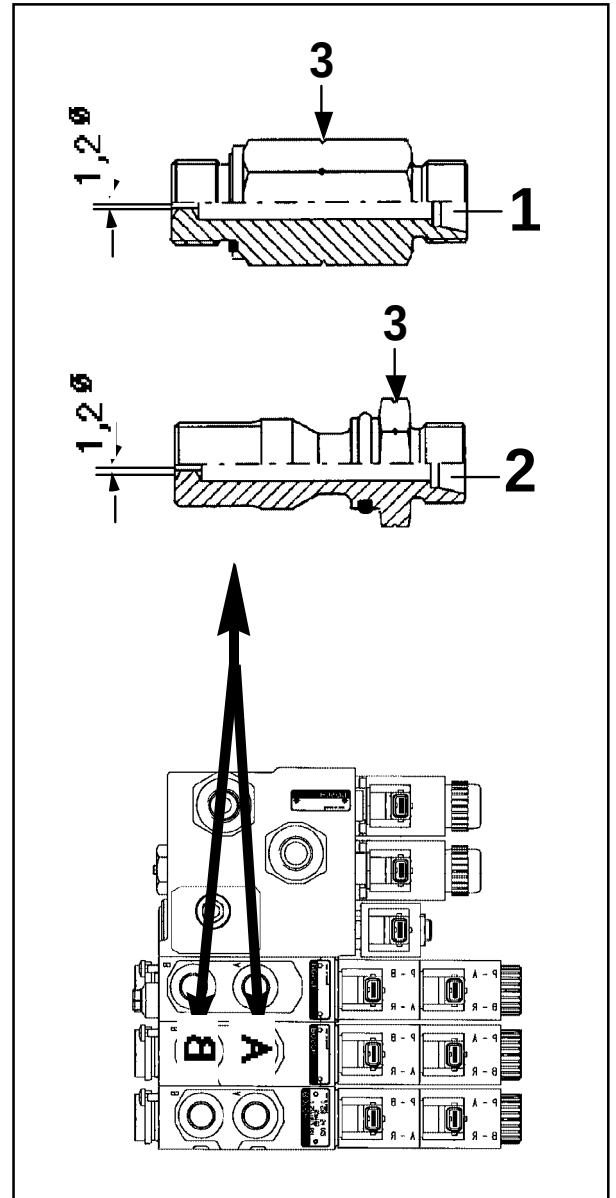
Cross-section reducers (2) for attachments with pressure regulator

For attachments to be operated via a pressure regulator with reduced or variable pressure, as special equipment in conjunction with a pump motor speed reducer for safety, screws with bores (2) with cross-section reducer bore can be provided in both swivel unions of connections "A" and "B" in the first or second additional hydraulics.

NOTE

The provision of threaded pipes (1) and screws with bores (2) with cross-section reducer bore, can be identified by the outer notch on the hexagon.

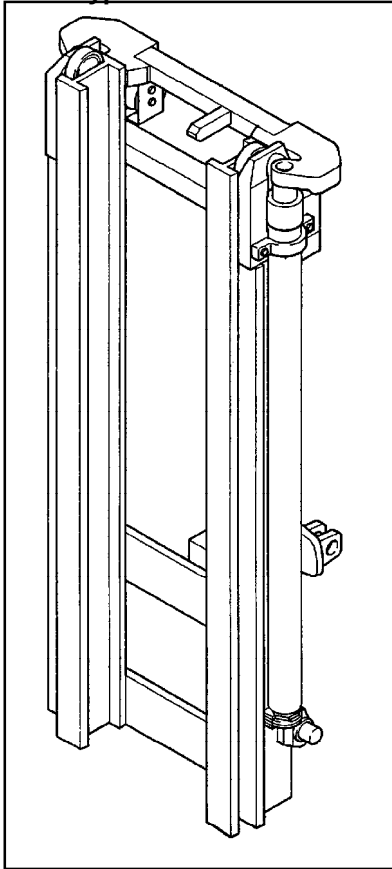
Tightening torques Items 1 and 2 = 66 Nm



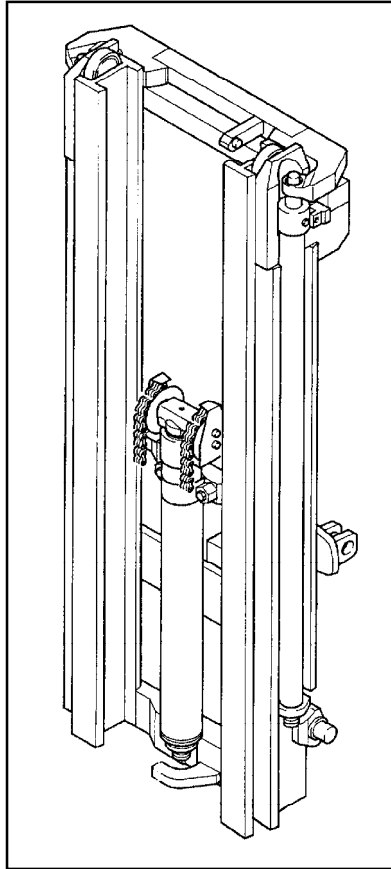
Contents	page
Group 20	
Technical Data for Maintenance Service	2
Mast types / Removal of mast	3
Telescopic mast	4
Hi-Lo mast	7
Triple mast	10
Carriage stops	13
Support rollers	14
Hoist cylinders	16
Lowering valve	19
Line failure safety device	20
Cushioning device for cylinder	21
Group 22	
Fork carriage removal	22
Changing the guide roller shafts (6022 - 6025)	23
Changing the guide roller shafts (6026 - 6029)	24
Group 25	
Tilt cylinders - Dismantling	25
Tilt cylinders - Assembling	26
Mast tilt angle	27

Technical Data for Maintenance Service

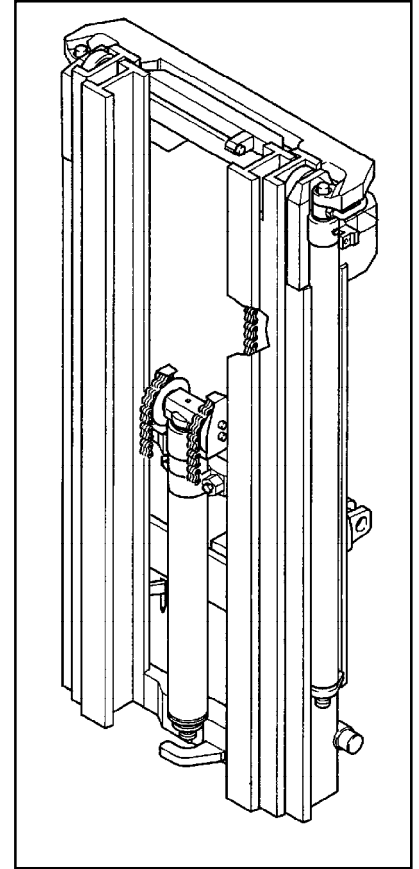
Functional Group 20	
Mast Unit	
Mast supporting bolts	Torque loading = 385 Nm
Guide roller bolts	R6022 - 6025 : Torque loading = 140 Nm $\pm$ 15 Nm
Guide roller bolts	R6026 - 6028 : Torque loading = 270 Nm $\pm$ 30 Nm
Line failure safety device	Torque loading = 20 Nm $\pm$ 2 Nm
Lift chain	max. permissible stretch = 3 % in compliance with the safety rules and regulations of the BAU, equivalent to society for the prevention of accidents
Lowering speed	max. permissible 0.6 m / sec

Mast types**Telescopic mast**

When the mast is raised, the inner section will extend beyond the height of the load. When operating in areas of limited headroom, the lift height of the inner section must be taken into account.

**Hil-Lo (full free-lift) mast**

During the lifting operation, the extending mast section will not exceed the height of the load. When operating in areas of limited headroom, the lift of the inner section need not be taken into account.

**Triple full free-lift**

Has similar features to full free-lift mast, but with an extended lift height for the same overall closed height. When operating in areas with limited headroom, the lift of the inner section need not be taken into account.

All mast types are clear-view masts. The section of the mast is an I beam. Fork carriage and mast sections are guided by support rollers which also take up side loadings.

Removal of mast

1. Secure the truck so that all mast removal work can be done.
2. With mast vertical secure above with wire rope or chain.
4. Loosen hoist cylinder hoses.
5. Pull out tilt cylinder pins from fixings on mast.
6. Screw out mast support fixing bolts.
7. Pull out mast from the front.

Installing the mast

This is done in reverse order.

NOTE: To reduce wear the running tracks on which the rollers roll must be lubricated with an extreme-pressure lubricant with high adhesive power in which case the lubricant

Still Part No. 147 873

should be used. Lubricate more or less frequently, depending on operating conditions.

Telescopic mast

Description of Operation

The two external cylinders lie in the profile of the outer mast.

They are connected hydraulically by one flexible hose line.

Both pistons are connected at the top to the crossmember of the inner mast.

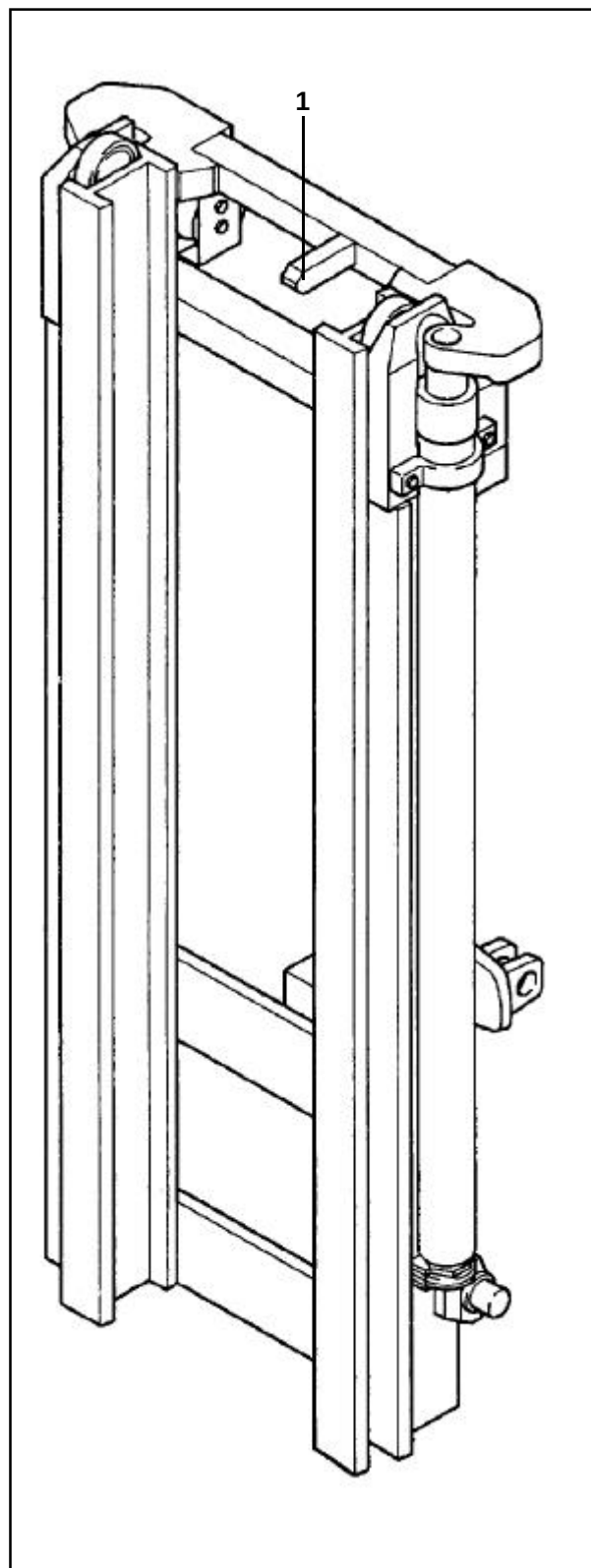
When the cylinders are pressurised both piston rods go out and lift the inner mast. Travel is limited by cylinder stroke.

The lift chains are fixed to the outer mast, run over chain sheaves on the inner mast and are fixed at the other end to the fork carriage.

Thus the ratio of inner mast to fork carriage travel is 1 : 2.

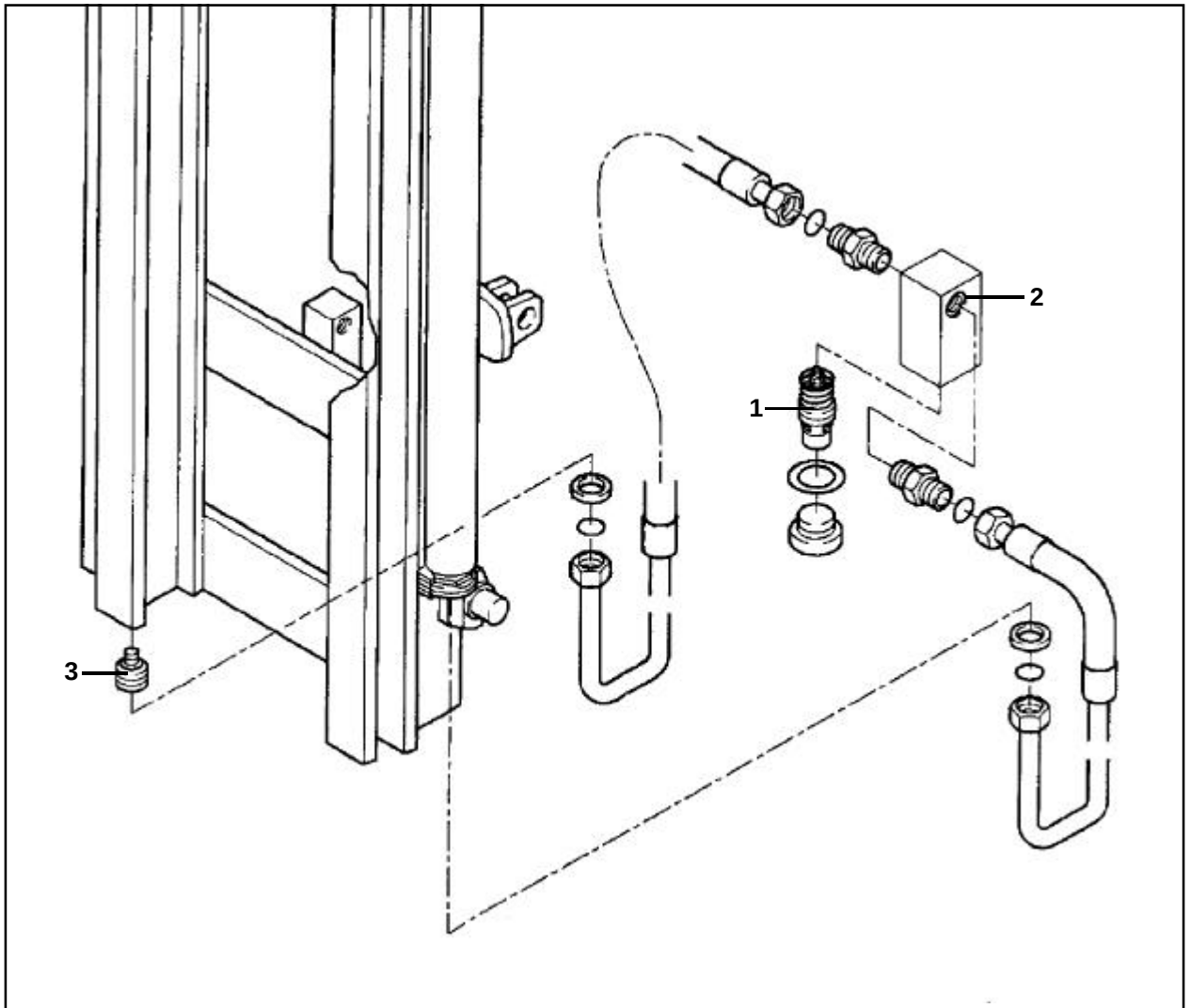
A lowering valve built into the pipework provides for a maximum lowering speed of 0.6 m/sec.

A stop (1) prevents the fork carriage coming out and tipping forward (see page 13).



Telescopic mast

Oil flow in mast



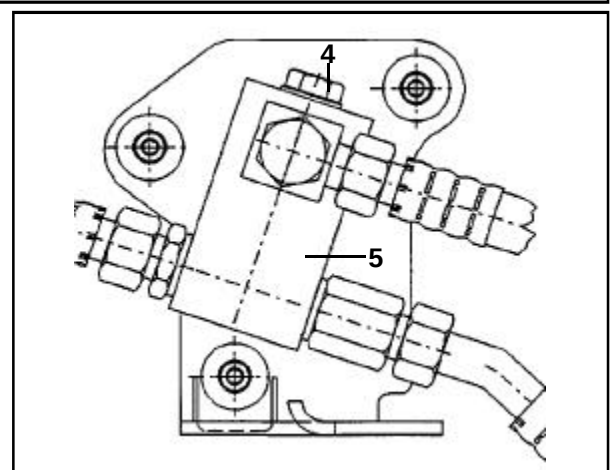
The oil enters at the lowering valve (1), whence it goes via flexible hose lines to the two cylinders. The line failure safety device in the r.h. cylinder prevents the load dropping too quickly if pipe fractures.

1 = Slow lowering valve
SB 29 C - 55 / 150 (6022 - 6024)
SB 35 C - 70 / 180 (6025)

2 = Fitting (6022 - 6025)

3 = Hose failure safety device
LB3 C 1.2 - 63 (6025 - 6029)
LB3 C 0.8 - 40 (6022 - 6024)

4 = Slow lowering valve
SB 3/4 - 82 - 120 (6026 - 6029)



4 = Slow lowering valve

5 = Slow lowering valve housing (6026 - 6029)
Mounted on r.h. frame side wall under
the floor plate

Telescopic mast

Lift chain adjustment

The lift chains are tensioned equally with the adjusters (1).

The centre of the upper fork carriage rollers (4-roller carriage) or the intermediate fork carriage rollers (6-roller carriage) must remain at least -> dimension "X" inside the inner mast section when piston is fully extended (to cylinder stops).

Under no circumstances must tyre wear be compensated for by adjusting lift chain tension!

When adjusting the lift chains, make sure that at least 2 mm clearance is maintained between block on carriage and stop on inner mast (see page 13).

1 - Lift chain

6022 - 6025 —> 1" 4x4

Torque of M16 locknuts —> 100 Nm

6026 - 6029 —> 1" 6x6

Torque of M20 locknuts —> 200 Nm

IMPORTANT :

The chains must be inspected for wear, damage and undue stretch in compliance with the safety rules and regulations of the BAU, equivalent to society for the prevention of accidents

Dimension "X"

6022 - 6024 Pneumatic / SE tyres X = 32

6022 - 6024 Solid-rubber tyres X = 12

6025 X = 14

6026 - 6029 X = 10

Nesting depth "E"

6022 - 6024 E = 425

6025 E = 415

6026 - 6029 E = 450

When installing the lift chains on the fork carriage, be sure that

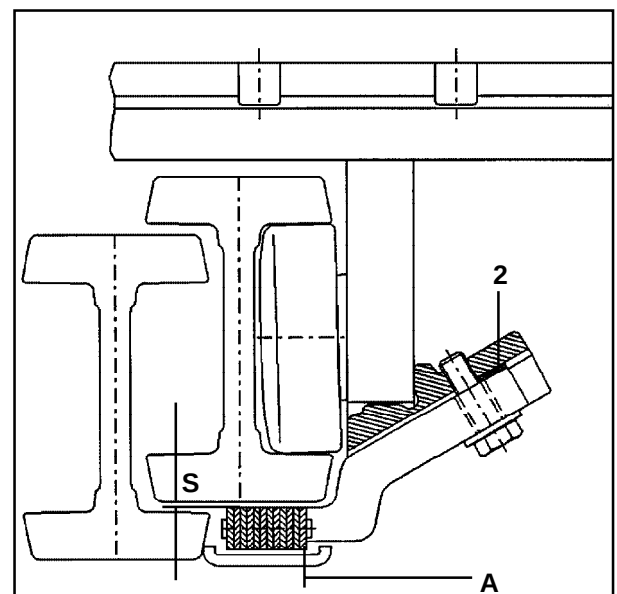
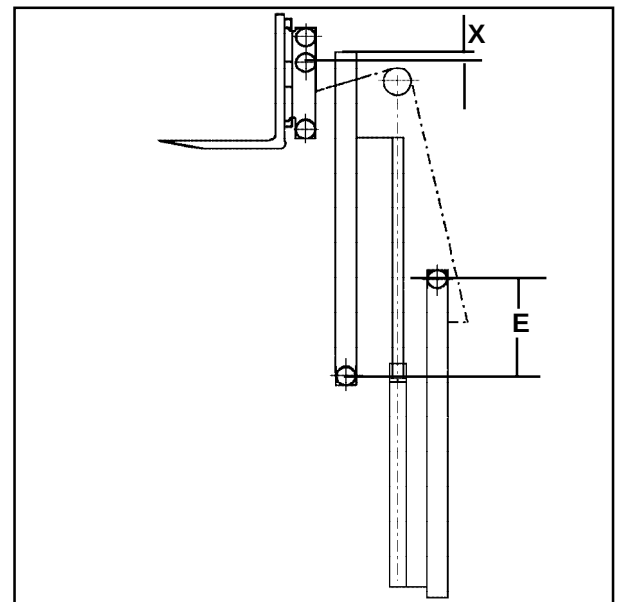
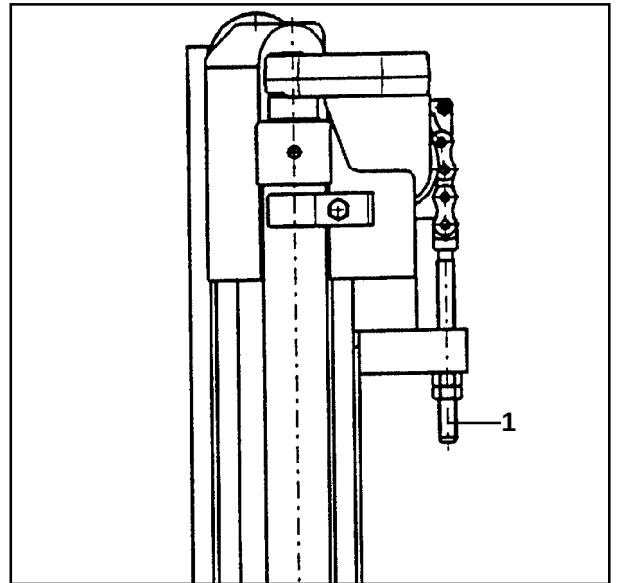
- gap "S" between lift chain and channel S = 1.5 +0.5. Gap "S" is adjusted with the aid of shims (2).

Shim 0.5 thick = No. 388 598.

- gap "A" of the two chains to each other is

"A" = 369 ±1 (6022 - 6025)

"A" = 328 ±1 (6026 - 6029).



Hi-Lo (full free-lift) Mast

Description of Operation

The mast has 3 cylinders.

The central cylinder provides the high free lift, extending within the inner mast but not exceeding the overall height of the mast.

The two outer cylinders are tucked into the I beam section of the outer mast.

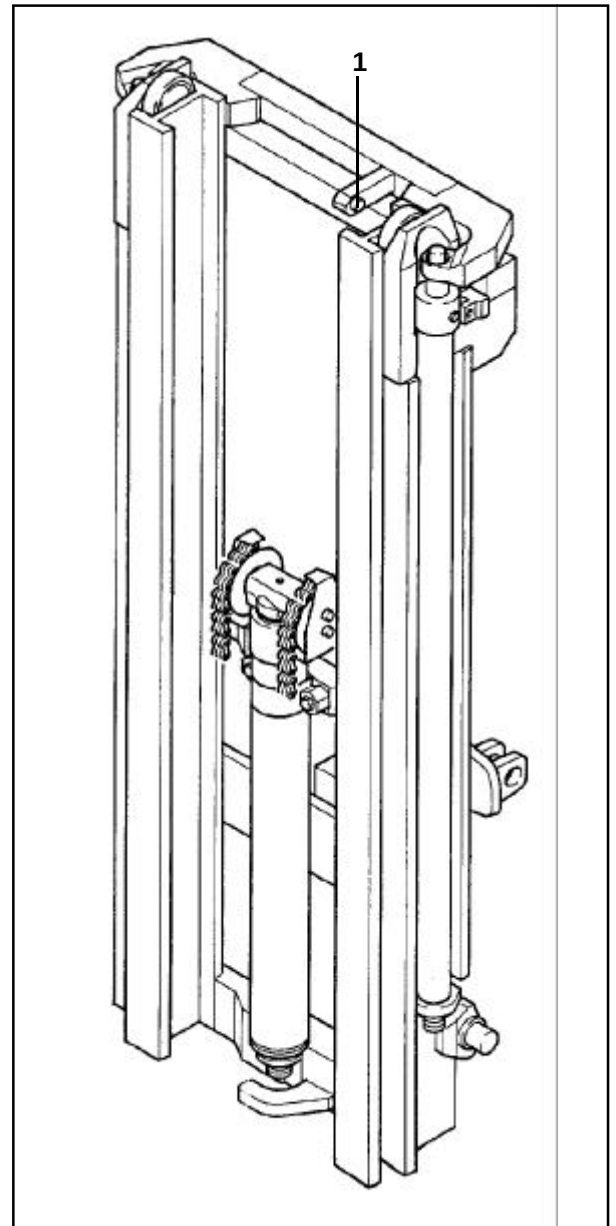
The piston rods of these cylinders are firmly secured to the inner mast.

When the cylinders are pressurised the central cylinder first goes out to its stop because of its greater piston area.

Then the two outer cylinders go out and lift the inner mast.

Screwed into the orifice block, a lowering valve provides a max. lowering speed of 0.6 m/sec.

A stop (1) prevents the fork carriage coming out and tipping forward. (For adjustment see page 13).



Hi-Lo (full free lift) mast

Oil flow in mast

The oil enters at the lowering valve (2), whence it is directed via flexible hose lines to the two outer cylinders.

On the Hi-Lo mast, the oil then flows into the central cylinder via the r.h. outer cylinder and the pipe (item 7).

Because of differential piston areas the piston of the central cylinder goes out first.

- 1st stage of lift only moves the fork carriage to accomplish free lift
- 2nd stage of lift causes the inner section to be raised

The line failure safety devices built into the outer cylinders prevent the load dropping too quickly if a pipe breaks.

1 = fitting

2 = slow lowering valve

SB 29 C - 55 / 150 (6022 - 6024)

SB 35 C - 70 / 180 (6025)

3 - 6 = line failure safety devices

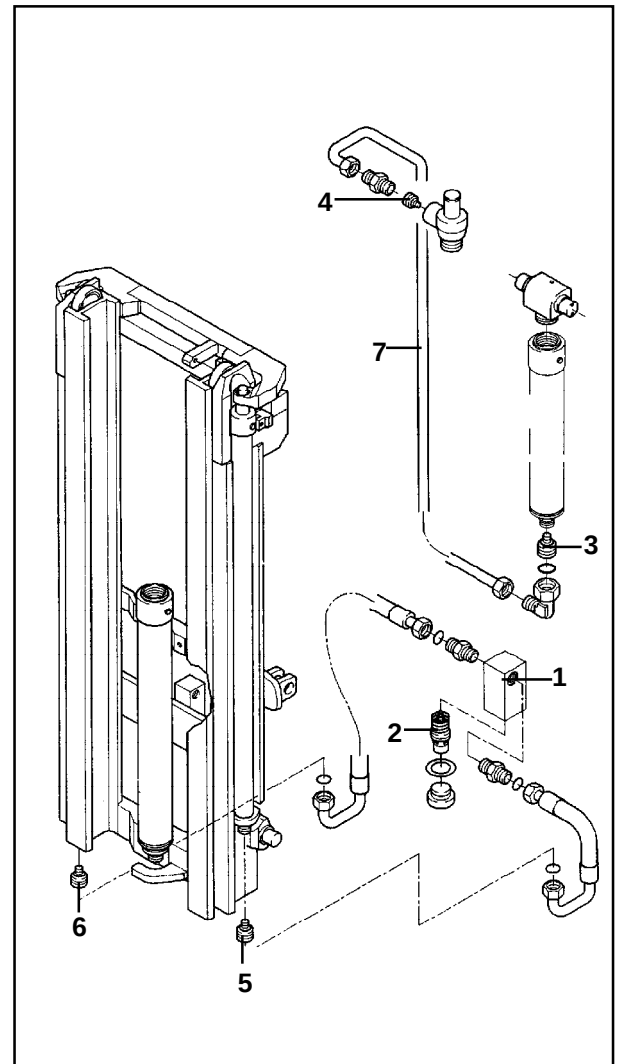
7 = pipe

8 = slow lowering valve

SB 3/4 - 82 - 120 (6026 - 6029)

9 = slow lowering valve housing (6026 - 6029)

Mounted on r.h. frame side wall under floor plate



6022 - 6024

LB3 C 0.8 - 40 at base of l.h. cylinder (5)

LB4 C 1.5 - 90 in central cylinder (3)

also - from overall lowered height 2550 mm:

LB3 C 0.8 - 80 at the base of r.h. cylinder (6)

LB3 C 0.8 - 80 screwed into adaptor (4) at top r.h. side

6025

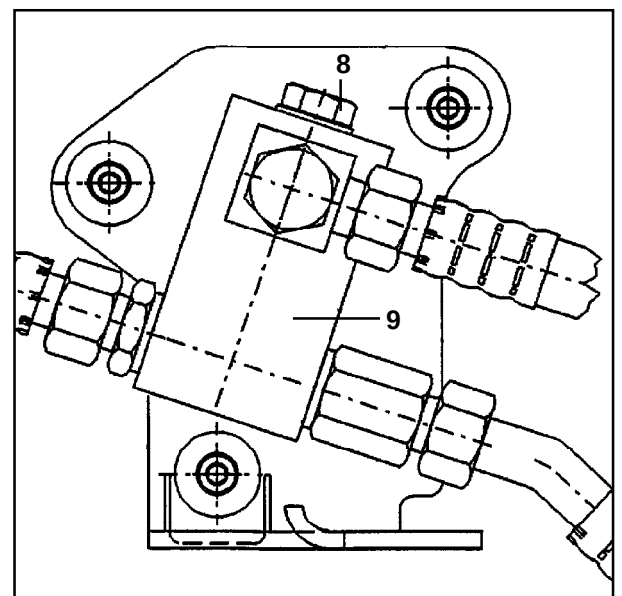
LB3 C 1.2 - 63 at base of l.h. cylinder

LB4 C 2 x 2.0 - 130 in central cylinder

6026 - 6029

LB3 C 1.2 - 63 at base of r.h. cylinder (6)

LB4 C 2 x 2.0 - 130 in central cylinder (3)



Hi-Lo (full free lift) mast

Lift chain adjustment

The lift chains are tensioned equally by the adjusters (1).

The centre of the upper fork carriage rollers (4-roller carriage) or intermediate fork carriage rollers (6-roller carriage) must remain ... mm (see .-> dimension "X") inside the inner mast section when piston is fully extended (to cylinder stops).

Under no circumstances must tyre wear be compensated for by adjusting the lift chain tension!

When adjusting the chains, make sure that at least 2 mm clearance is maintained between block on carriage and stop on inner mast. (For adjustment see page 13).

1 - Lift chain
6022 - 6025 —> 1" 4x4
Torque loading of M16 locknuts —> 100 Nm

6026 - 6029 —> 1" 6x6
Torque loading of M20 locknuts —> 200 Nm

IMPORTANT :

The chains must be inspected for wear, damage and undue stretch in compliance with the safety rules and regulations of the BAU, equivalent to society for the prevention of accidents

Dimension "X"

6022 - 6024 X = 15

6025 - 6029 X = 10

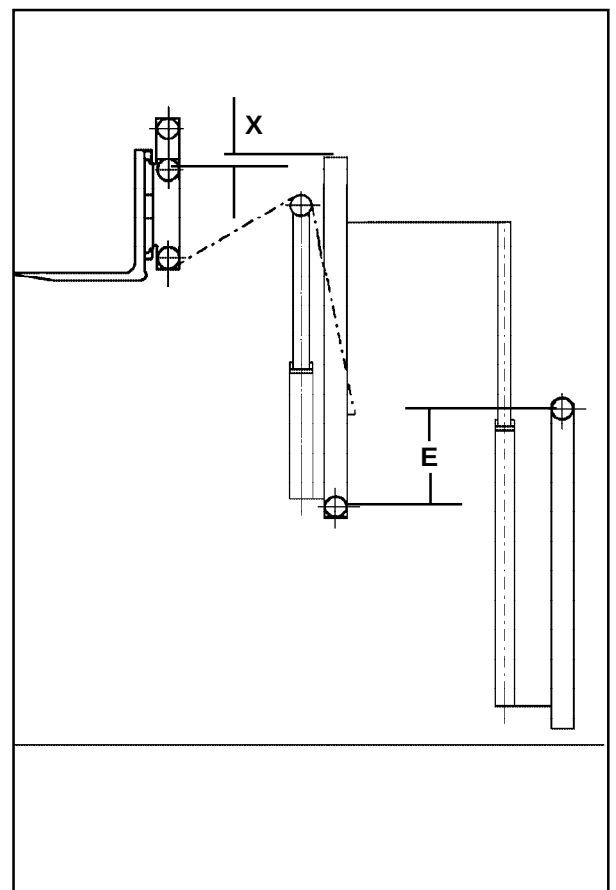
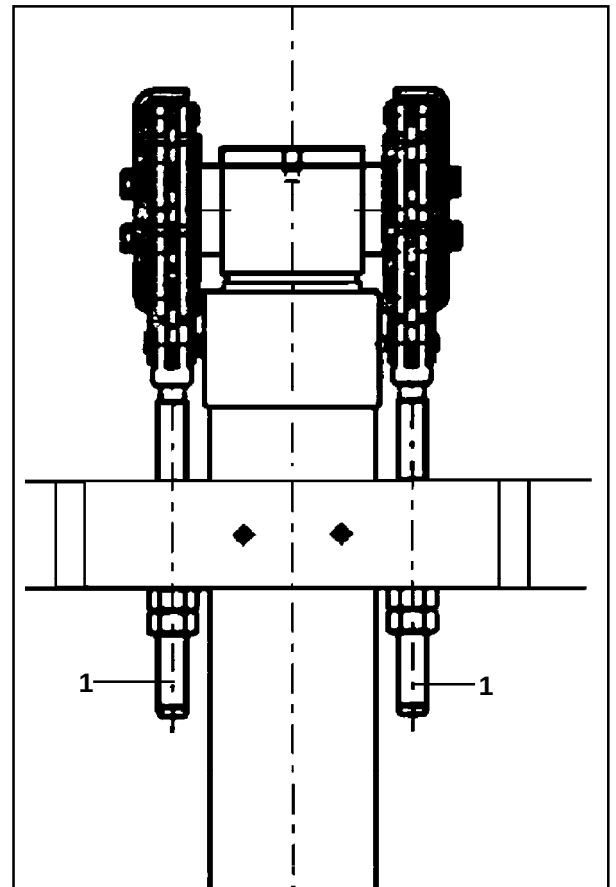
Nesting depth "E"

6022/6024 E = 375

6025 E = 415

6026/6027 E = 420

6028/6029 E = 470



Triple mast

Description of operation

The mast has 3 cylinders.

The central cylinder provides the high free lift, extending within the inner mast but not exceeding the overall height of the mast.

The two outer cylinders are tucked into the I beam section of the outer mast.

The piston rods of the outer cylinders are connected to the central mast.

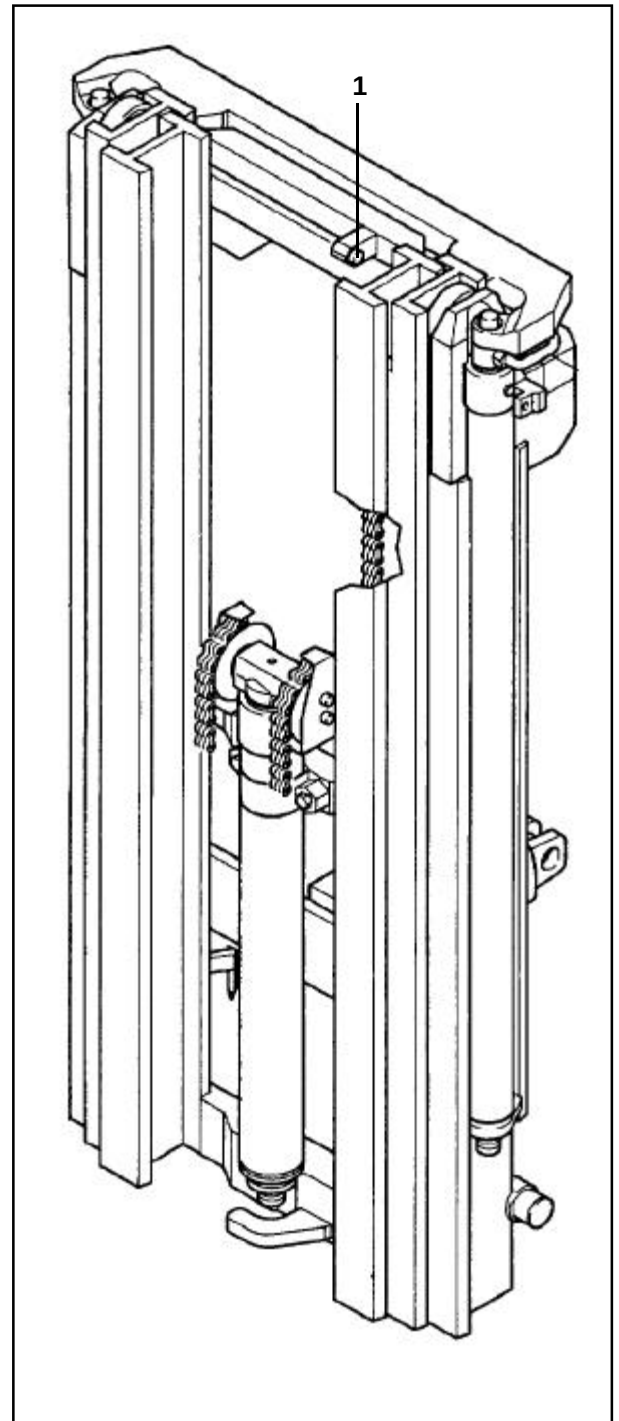
The chains for lift 2 (second stage of lift) are secured at the top of the outer mast and at the bottom of the inner mast.

When the cylinders are pressurised the centre cylinder first goes out to full stroke because of its greater piston area.

Then the two outer cylinders go out and lift the middle mast. This lifts the inner mast in the ratio of 1 : 2 via the chain connections.

A lowering valve screwed into the orifice block provides a max. lowering speed of 0.6 m/sec.

A stop (1) prevents the fork carriage coming out and tipping forward (see page 13).



Triple mast

Oil flow in mast

Oil enters at the lowering valve (2), whence it is directed under pressure to the two outer cylinders via a hydraulic hose line.

The oil then flows via a pipe through the l.h. outer cylinder (cylinder tube) before it enters the centre cylinder.

Because of differential piston areas the centre cylinder goes out first. When this has reached full stroke, the two outer cylinders go out simultaneously.

- 1st stage of lift only moves the carriage
- 2nd stage of lift cause the moving mast sections to be raised

The line failure safety devices (3/4) built into the r.h. outer and centre cylinder prevents the load dropping too quickly if a pipe fractures.

- 1 = Fitting (6022 - 6025)
- 2 = Slow lowering valve
SB 29 C - 55 / 150 (6022 - 6024)
SB 35 C - 70 / 180 (6025)

- 3/4 = Line failure safety device
6022 - 6024
LB4 C 1.5 - 90 at base of r.h. cylinder (3)
LB3 C 0.8 - 40 in centre cylinder (4)

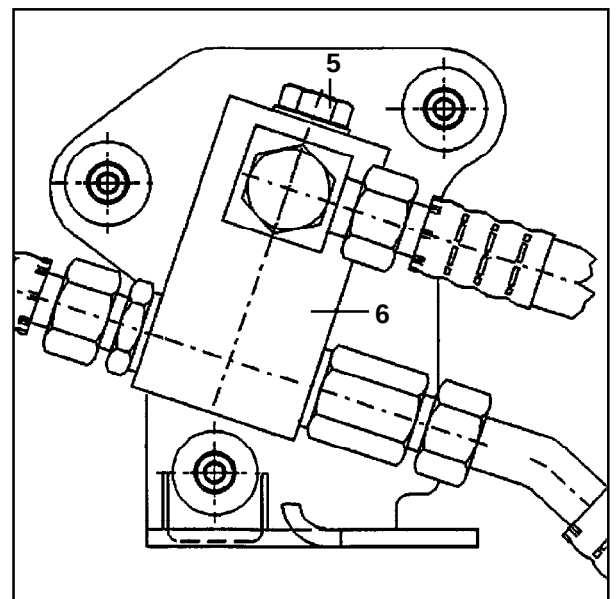
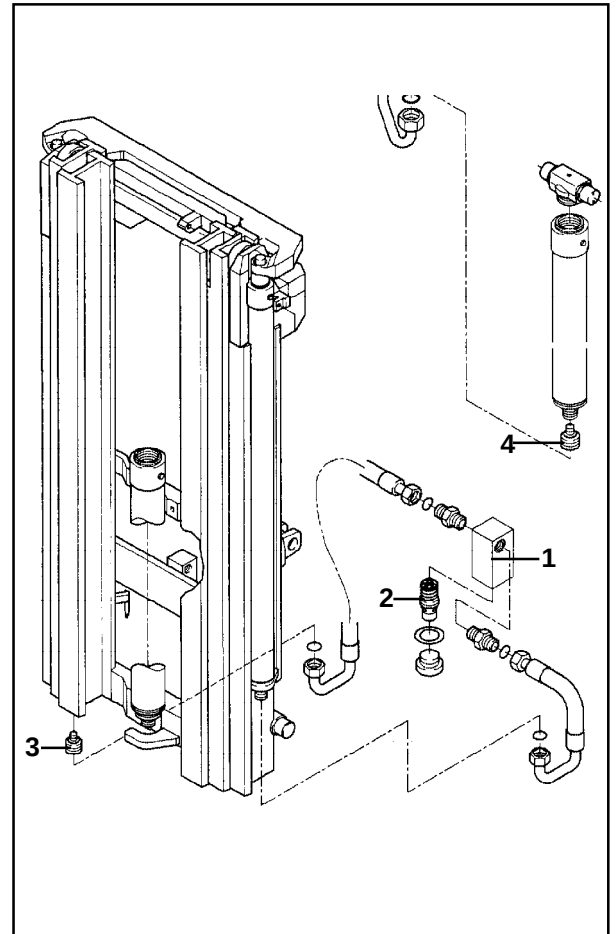
- 6025
LB3 C 1.2 - 63 at base of r.h. cylinder (3)
LB4 C - 2 x 2.0 - 130 in centre cylinder (4)

- 6026 - 6027
LB3 C 1.1 - 63 at base of r.h. cylinder (3)
LB4 C 2 - 140 in centre cylinder (4)

- 6028/6029
LB3 C 1.2 - 120 at base of r.h. cylinder (3)
LB3 C 2 - 140 in centre cylinder (4)

- 5 = Slow lowering valve
SB 3/4 - 80 - 120 (6026 / 6027)
SB 3/4 - 95 - 160 (6028 / 6029)

- 6 = Slow lowering valve housing (6026 - 6029)
Mounted on r.h. frame side wall under the floor plate



Triple mast

Lift chain adjustment

Outer chains :

The outer chains are adjusted equally by the adjusters (1) until the three mast sections are flush.

Centre chains :

The chains are tensioned by the tensioners (2).

The centre of the upper fork carriage rollers (4-roller carriage) or intermediate fork carriage rollers (6-roller carriage) must remain ... mm (see -> dimension "X") inside the inner mast section when piston is fully extended (to cylinder stops).

Under no circumstances must tyre wear be compensated for by adjusting the lift chain tension!

When adjusting the chains, make sure that at least 2 mm clearance is maintained between block on carriage and stop on inner mast. (See page 13).

1/2 - Lift chain

6022 - 6025 —> 1" 4x4

Torque of M16 locknuts —> 100 Nm

6026 - 6029 —> 1" 6x6

Torque of M20 locknuts —> 200 Nm

IMPORTANT :

The chains must be inspected for wear, damage and undue stretch in compliance with the safety rules and regulations of the BAU, equivalent to society for the prevention of accidents.

Dimension " X "

6022 - 6024 X = 15

6025 - 6029 X = 10

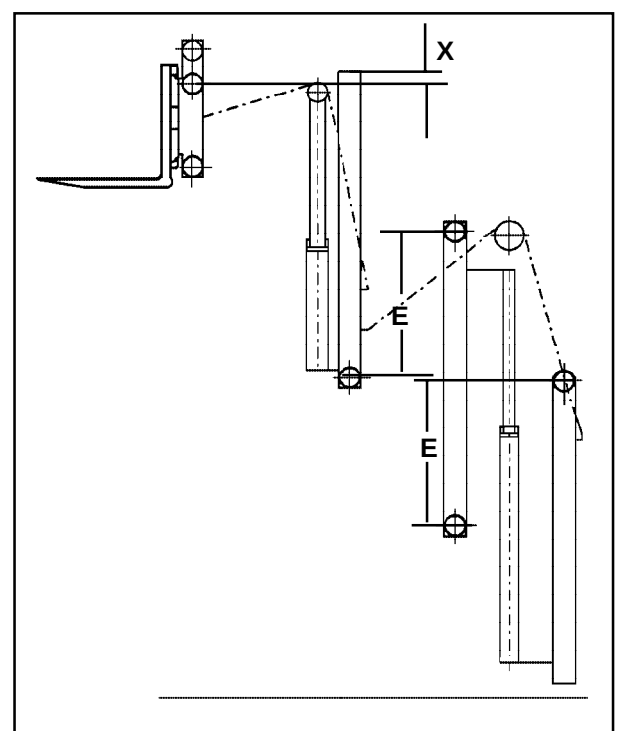
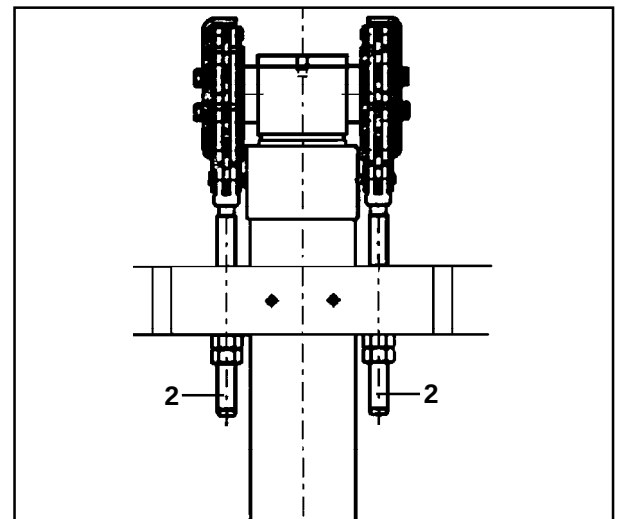
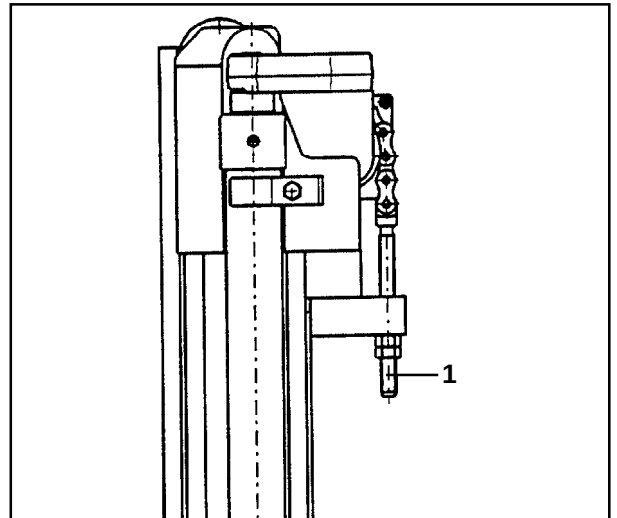
Nesting depth " E "

6022 / 6024 E = 445

6025 E = 485

6026 / 6027 E = 520

6028 / 6029 E = 570



Lift chain adjustment

Carriage stops

When adjusting the chains to take up any slackness, care should be taken that, with mast lifted to maximum height, the piston extends to its full stroke always inside the hoist cylinder.

IMPORTANT :

At full lift the fork carriage should never touch its mechanical stops. At least 2 mm clearance should therefore be maintained between block on carriage (4) and stop (5) on inner mast.

1 = fork carriage

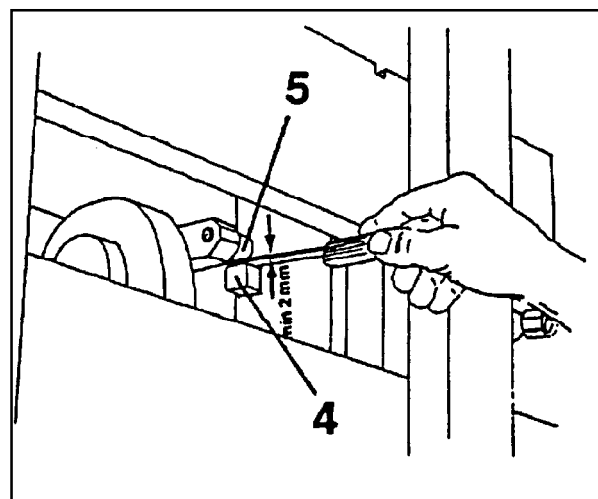
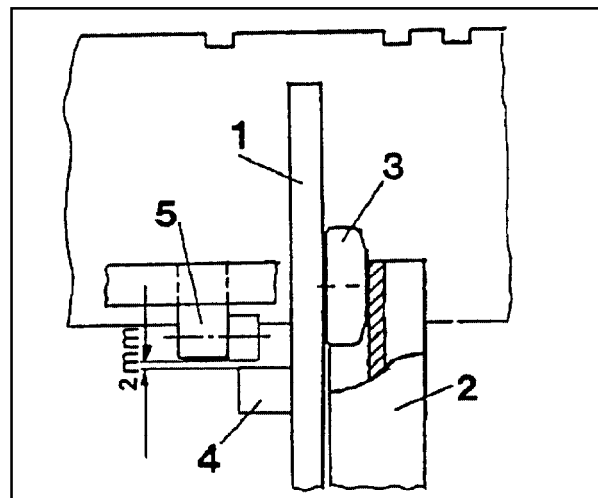
2 = inner mast section

3 = guide roller

4 = block (on carriage)

5 = stop (on inner mast cross member)

NOTE: Where masts of big overall lowered height are fitted, the amount of clearance can easily be checked by sticking a small amount of kneading mass on block item 4 then raising the fork carriage to maximum height, and with the aid of a vernier caliper measuring the thickness of the kneading mass.



Support rollers

Assembly
6022 - 6025

Roller	Dimension " A "		Dimension "X"
dia.	over	up to	
89.8	Ñ	91.2	1.4
90.3	91.2	91.7	1.4
90.8	91.7	Ñ	Ñ

6026 - 6029

Roller	Dimension " A "		Dimension "X"
dia.	over	up to	
105.2	Ñ	106.6	1.4
105.7	106.6	107.1	1.4
106.2	107.1	Ñ	Ñ

Note : Dimension „A“ must be measured at the point where the sliding surfaces on which the guide rollers run graduate into the radius.

1 = Support roller

2 = Shim

3 = Countersunk screw
6022 - 6025 → 140 Nm ±15 Nm
6026 - 6029 → 270 Nm ±30 Nm

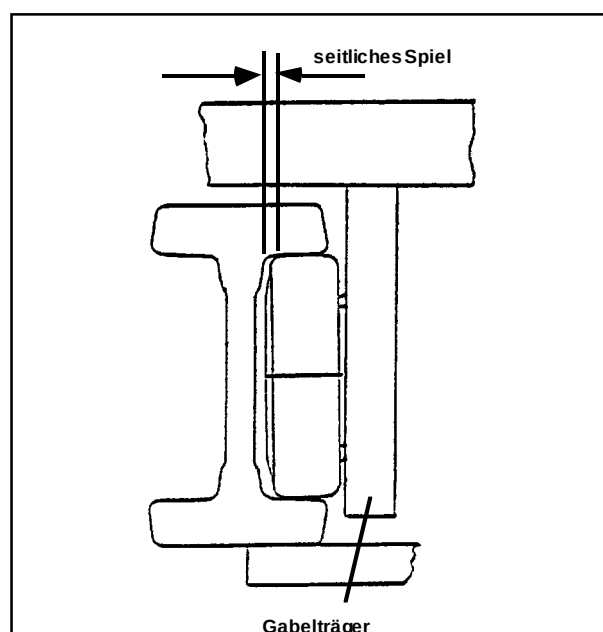
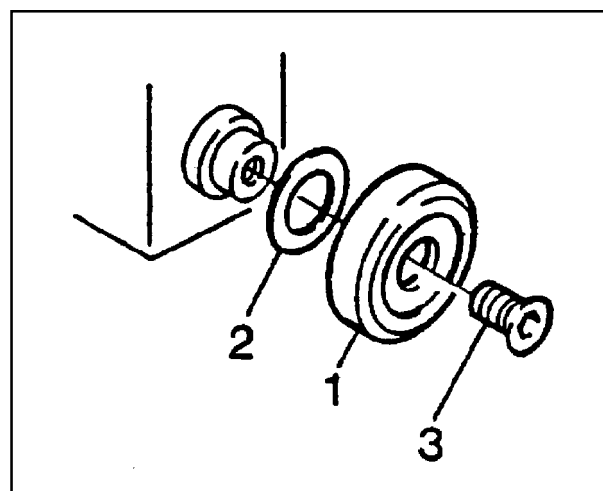
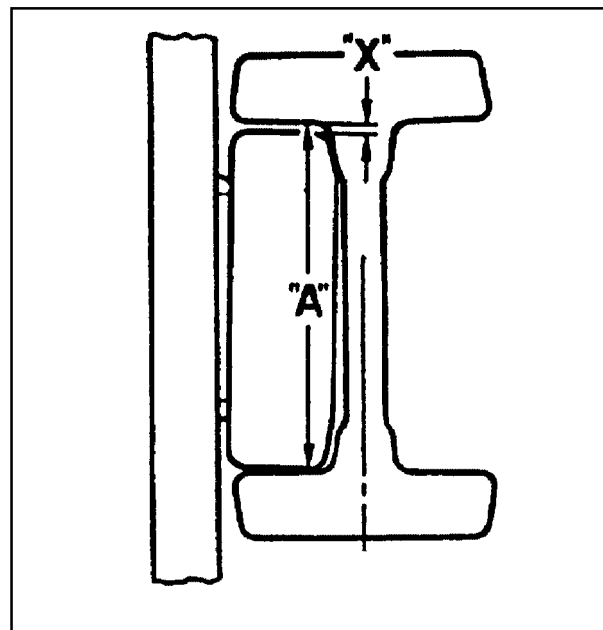
Lateral clearance**Carriage assy - inner mast**

min. 0.3 mm, max. 1.3 mm at the closest spot,
otherwise max 1.8 mm

Inner mast - (central mast) - outer mast

Upper roller : min. 0.3 mm
max. 1.3 mm at the closest
spot otherwise max.1.8 mm

Lower roller : min. 0.3 mm
max.1.3 mm at the closest
spot, otherwise max.1.8 mm



Support rollers

Checking the clearance

Using a feeler gauge determine the side clearance and dimension "X".

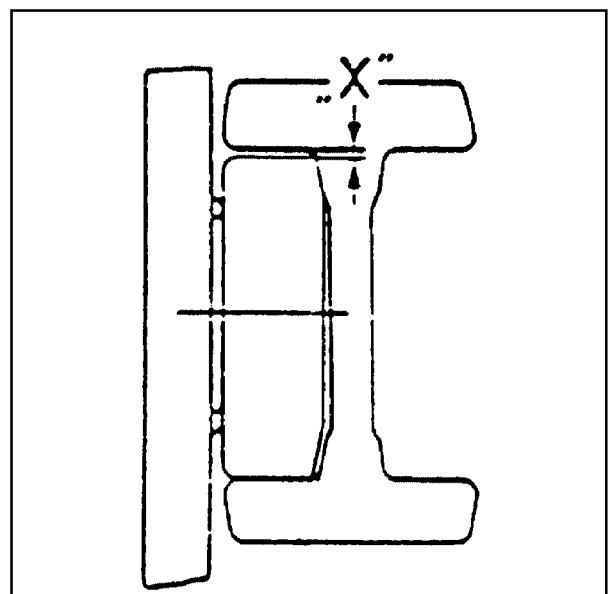
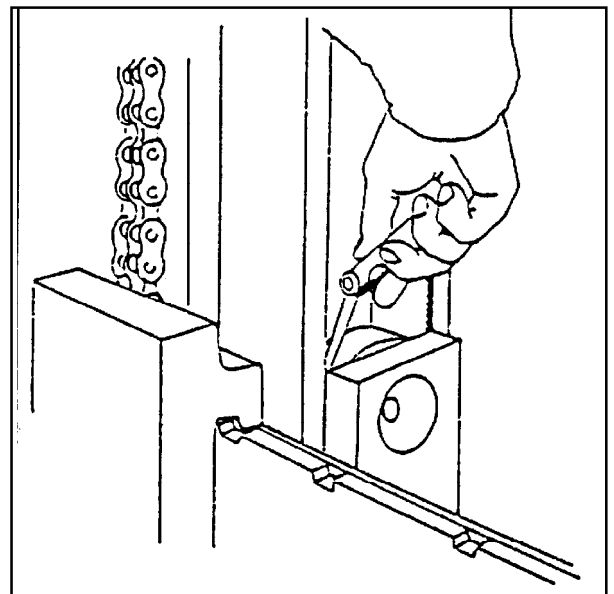
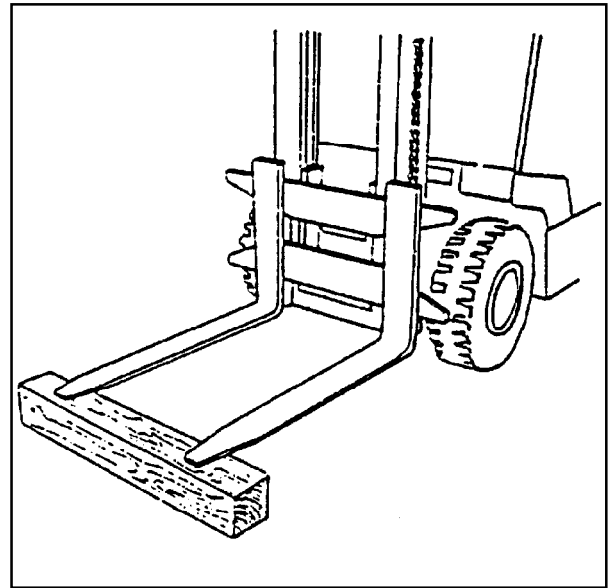
Dimension "X" = 1.4 mm serves as a standard value when fitting a guide roller of the next larger size during the run in period, i.e. on a new mast section (dimension "A" = 90 +1 / 105,5 +0,8) the material of the mast channel will in the beginning get rolled in the area where the guide or load rollers run.

At the end of a certain run in period whose length depends on the operating conditions, dimension "X" will thus hardly get changed any further.

In order to reduce wear to a minimum it is essential that the running surfaces of the guide rollers be lubricated with an adhesive type aerosol spray (Part No. 147 873) at regular intervals! Thoroughly clean running surfaces before spraying them.

The illustrations on the right show how to check dimension "X".

- Raise the fork carriage.
- Place a block of wood under the forks.
- Lower the carriage until the weight of the forks is on the chock. The guide rollers will come to rest against the side opposite the running surface.
- Dimension "X" can be measured at this stage.



Hoist cylinders

**Removal of outer cylinders
(Hi-Lo (full free lift) and triple masts)**

- Bring the mast to the vertical position
- Raise the fork carriage
- Extend outer cylinder pistons by approx. 20 cm
- Place a block of wood between the upper cross member of the outer mast and the upper cross member of the inner mast (for the triplex mast)
- Remove circlip from upper piston fixing (cross member)
- Completely lower the mast, allowing the system to become non-pressurized
- Disconnect upper and lower hydraulic connections
- Remove the fixing clamp
- Should the piston fail to lower by gravity, assist with a screwdriver or similar tool

Note:

Adaptor fitting (1) is secured and sealed with Loctite 275 (Part No. 524199).

Cylinder head (2) is fixed with Loctite 243 (three spots on circumference to ensure even spread).

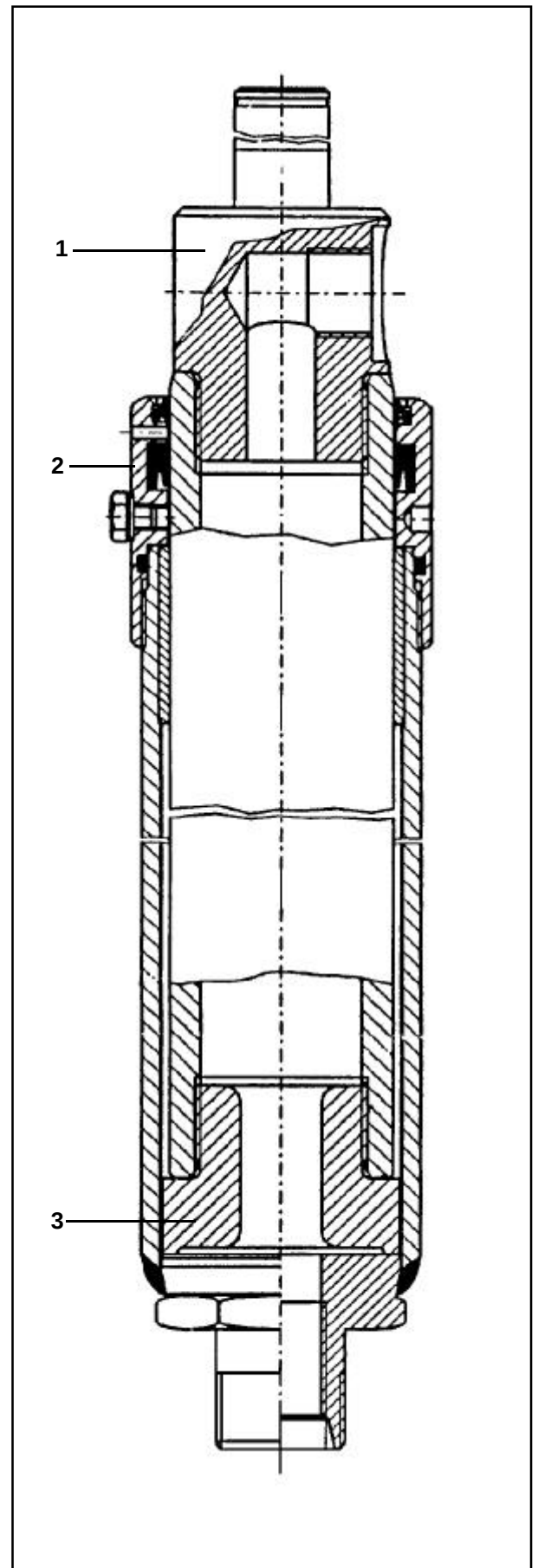
Piston cover (3) is secured and sealed with Loctite 275 (Part No. 524199) on the whole surface.

Torque loadings for piston cover vary according to piston diameter, viz.:

32 / 37 mm = 150 Nm (+ 30 Nm)

46 / 52 mm = 500 Nm (+100 Nm)

Do not remove piston cover when the replacing packing!



Hoist cylinders

Cylinder removal - Telescopic mast

- Bring the mast to the vertical position
- Extend hoist piston (by around 20 cm) until the upper fixing is accessible for circlip removal
- Remove circlip from upper piston fixing
- Place a block of wood between the upper cross member of the outer mast and the upper cross member of the inner mast
- Completely lower the mast, allowing the system to become non-pressurized
- Disconnect lower hydraulic connection
- Remove the fixing clamp

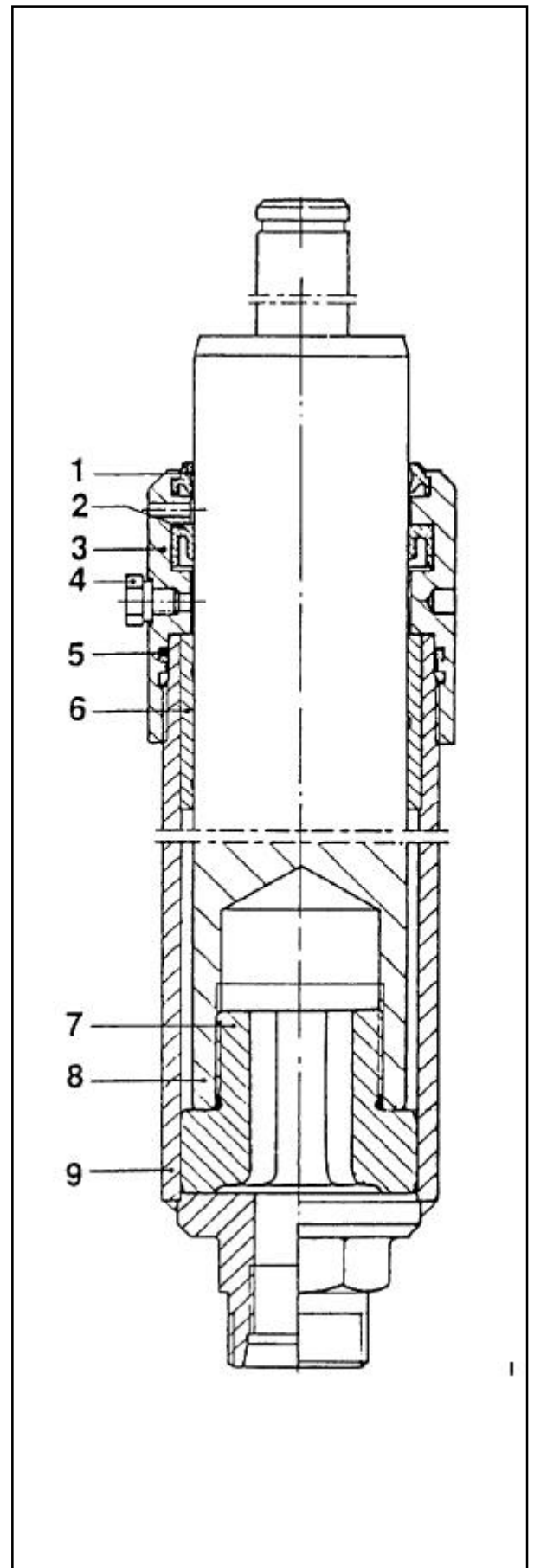
Changing the packing

- Grip cylinder body firmly in a vice
- Screw off cylinder head with sickle spanner B 52 - 55 . If cylinder head will not move, preheat with a flame

The cylinder head is secured with Loctite 243 (3 spots on circumference for even spread)

- 1 = Double wiper
- 2 = U-seal
- 3 = Cylinder head
- 4 = Bleeder screw
- 5 = O-ring seal
- 6 = Guide bush
- 7 = Piston cover
- 8 = Piston
- 9 = Cylinder tube

The piston cover is secured with Loctite 275
Torque loading = 500 Nm (+100 Nm)



Hoist cylinders

Central cylinder - Hi-Lo / Triple masts

The cylinder is a single-acting cylinder (plunger piston).

Cylinder tube and base are welded together. The cylinder head is screwed onto the tube and secured with Loctite 243.

The sealing between tube and head is by means of an O-ring.

The sealing between head and piston is by 'U'-shaped seal.

A piston cover screwed into the piston and fixed with Loctite 275 acts as a lifting stop.

A line failure safety device screwed into the cylinder base prevents the load dropping too quickly if a pipe breaks.

Dismantling the central cylinder

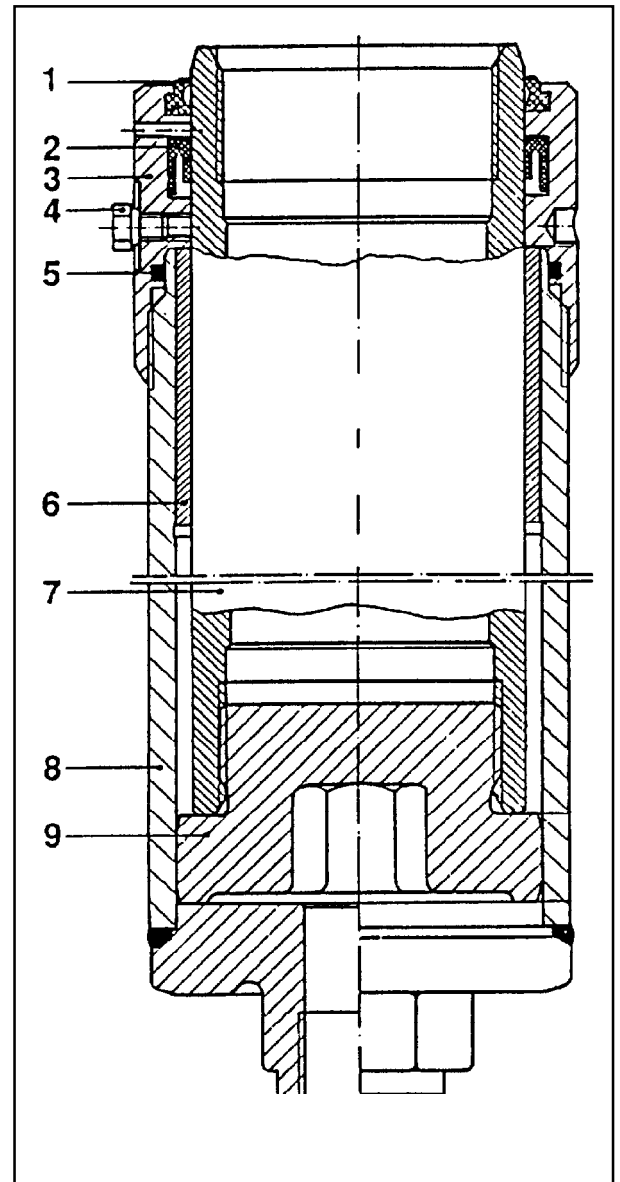
- Raise the fork carriage, place a block of wood beneath it, lower the carriage until its weight is on the block, unhook the lift chain at the carriage
- Disconnect the hydraulic connection at the base of the cylinder.
- Take off the clamp from the cylinder
- Lift out the hoist cylinder
- Grip cylinder body (tube) in a vice - at the base - otherwise tube may distort
- Screw off cylinder head with 'C' spanner B 68 - 75. If cylinder head will not move, preheat with a flame
- Withdraw piston from cylinder body or tube
- Clamp the piston in a bench vice fitted with soft jaws and screw off sheave fork. The sheave fork is secured with Loctite 243 (3 points on the circumference)
- Pull the cylinder head off the piston

Note :

Do not remove piston cover when replacing packing!

The piston cover is secured and sealed with Loctite 275 on the whole surface.

Torque loading = 1000 Nm (+200 Nm)



1 = Double wiper

2 = 'U'-seal

3 = Cylinder head

4 = Bleeder screw

5 = O-ring seal

6 = Guide bush

7 = Piston

8 = Cylinder tube

9 = Piston cover

Lowering valve

Lowering valve

The lowering valve provides a constant lowering speed, whatever the load.

Operation

As the load is lowered, the sliding orifice, due to the medium flowing through it, is moved to the metering position thus forming an annular restrictor inside the pilot plunger, whose resistance against flow in conjunction with the pre-loading of the plunger control spring (adjustable) determines the amount of flow.

NOTE:

Max. permissible lowering speed (with rated load):
0.6 m/sec.

Hoisting, direction of flow -> F —> B

Free unrestricted flow with low resistance is made possible by the sliding orifice at this stage retreating from the metering position (orifice effect inoperative in this direction).

Lowering, direction of flow -> B —> F

Flow is constant over a wide range as a result of the self adjusting balance between the internal pressure differential and the pre-load position on the plunger control spring.

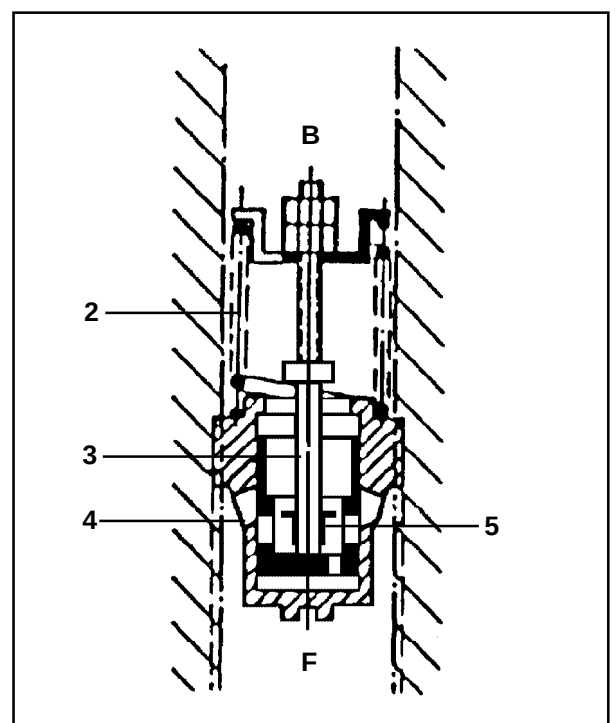
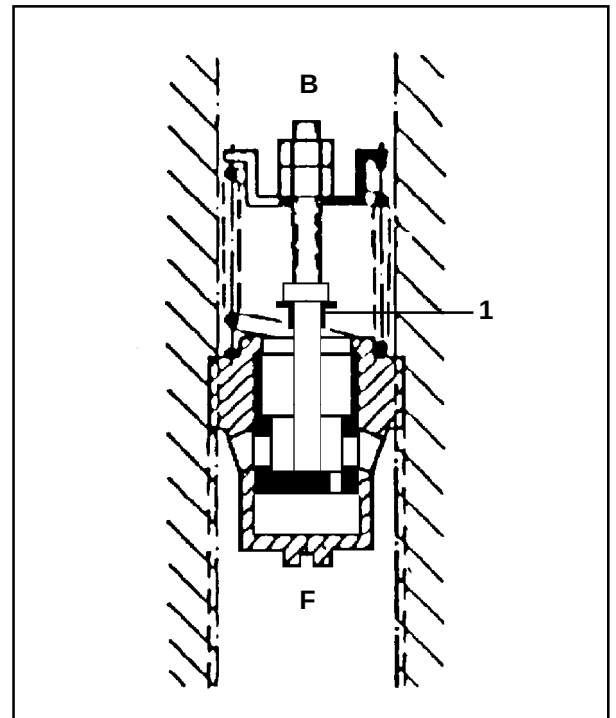
1 = sliding orifice in direction of unrestricted flow

2 = plunger spring

3 = pilot plunger

4 = control edges

5 = sliding orifice in metering position



Line failure safety device

The illustration shows the position of the line failure safety device in the cylinder base and the adaptor.

Torque loading = 20 Nm (± 2 Nm)

Operation :

The safety device for hose failure, a safety restrictor, prevents uncontrolled and abrupt dropping of the load in the event of hose or pipe failure.

The hose failure safety device is a plate valve whose valve disc is raised off the valve seat by spring action in the neutral state, thereby maintaining an open through-flow cross section of variable width.

The through-flow resistance and the back-pressure action at the valve disc in the through-flow direction B $\rightarrow$ F (operating or actuating direction) generate a force which during normal operation does not exceed the spring counterforce: the valve remains open.

If in the event of a burst in the hydraulic feed pipe or hose the through-flow increases due to the driving load, the flow forces will exceed the spring force and the valve will close immediately.

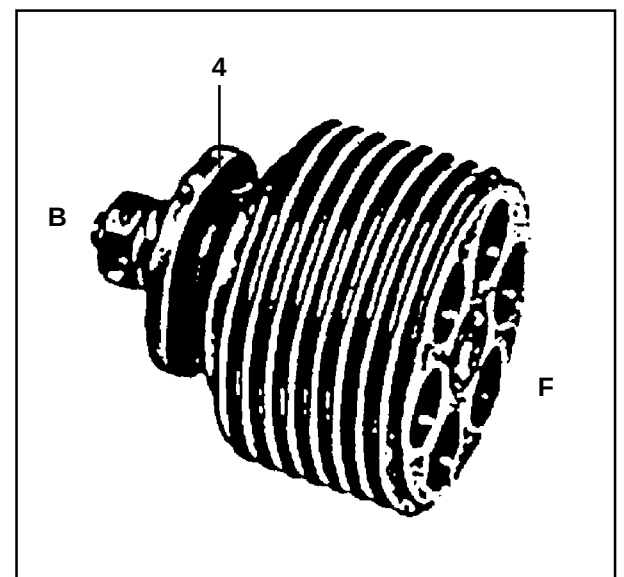
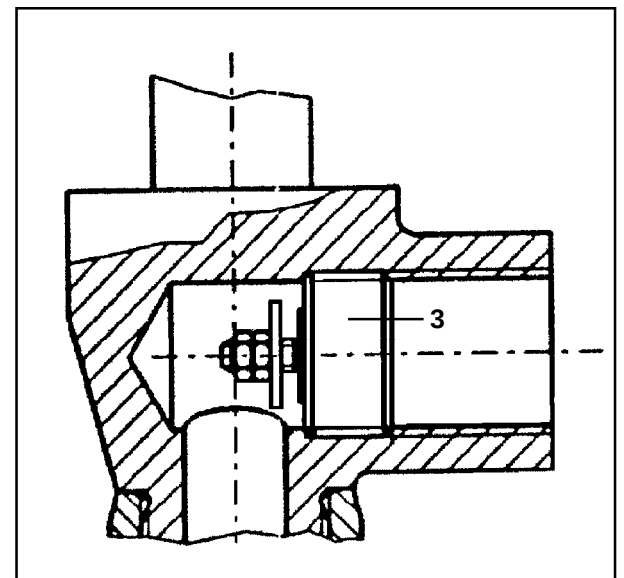
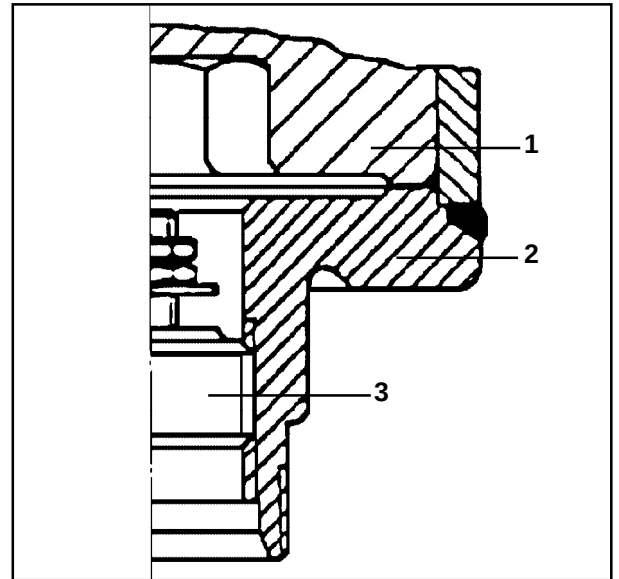
The valve plate contains an orifice hole through which oil can flow from B to F, irrespective of the magnitude of the load, thereby gradually lowering the load to the ground.

1 = piston cover

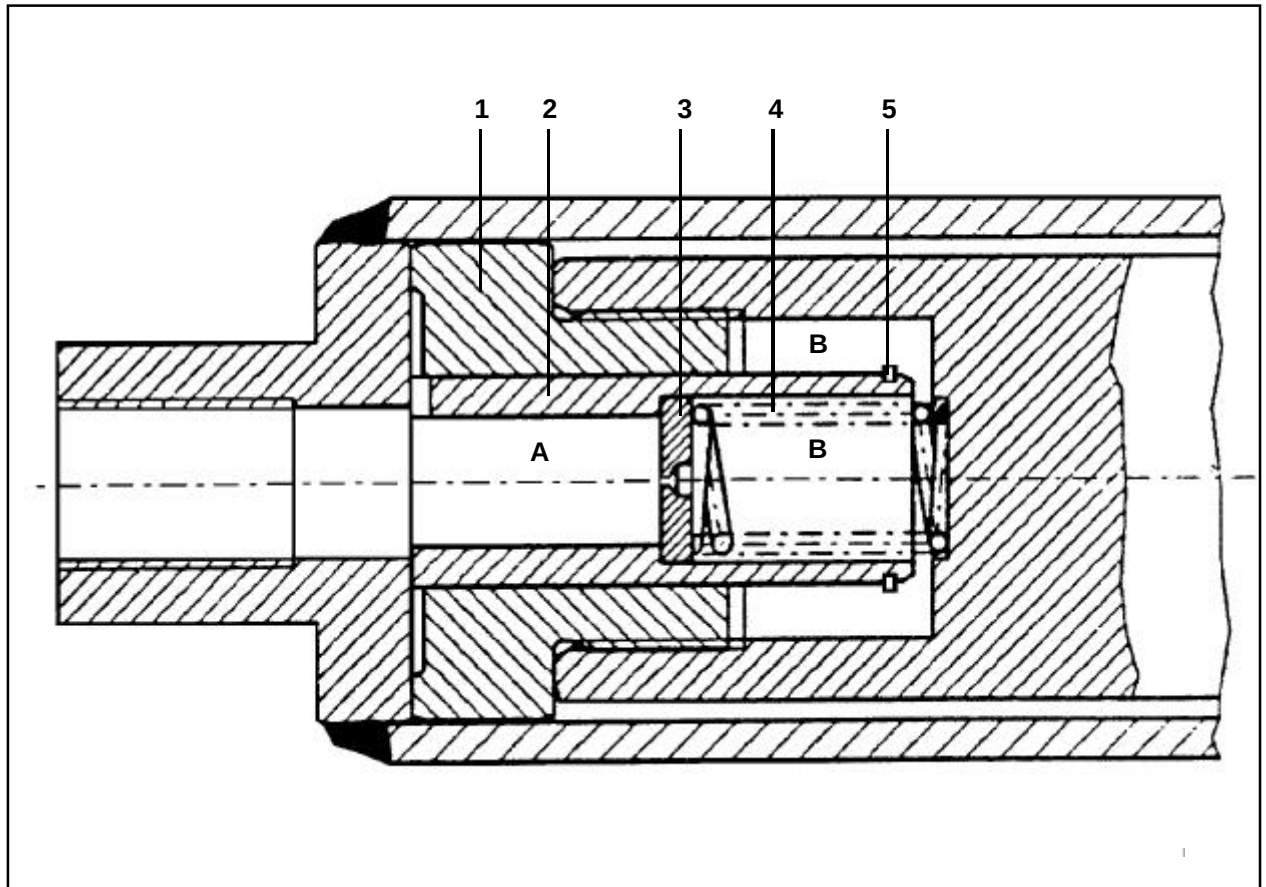
2 = cylinder base

3 = line failure safety device

4 = valve plate



Hoist cylinders

**Cushioning device for cylinders**

Fitted to Hi-Lo and triple-stage masts, the function of the cushioning device is (during transition from 2nd to 1st stage of lift) to hydraulically slow down the piston rod of the outer cylinder endowed with such a device just before it reaches the end of its stroke.

This feature reduces the hydraulic/mechanical shock normally encountered when the load is lowered completely.

- 1 - Piston cover
- 2 - Piston
- 3 - Restrictor orifice
- 4 - Pressure spring
- 5 - Snap ring

Operation

When the piston rods are pressurised the piston (2) by the force of compression spring (4) is, during the hoisting operation, moved towards the cylinder bottom until the snap ring (5) is against piston cover (1). Flowing from chamber A, the oil under pressure continues to pass via restrictor orifice (3) through chamber B until hydraulic balance has been achieved.

During the lowering operation, first piston (2) will (before the piston rod has reached the end of its stroke) contact the cylinder bottom. Piston (2) is shifted in direction of the piston rod, whereas the hydraulic fluid under pressure is directed from chamber B to chamber A via restrictor orifice (3) causing mast movement to be hydraulically slowed down through hydraulic balance.

Fork carriage

The Fork Carriage - Removal

Tilt mast to vertical.

Remove forks or attachment (where fitted).

Raise the fork carriage just enough to enable the lift chains to be disconnected. Place a suitable sling around the carriage and secure it to a hoist.

By moving the hoist control valve lever into its fully lowered position lower the inner mast completely.

Disconnect the lift chains from the fork carriage.

Remove the socket-head cap screw from stop on inner mast.

Using hoist, carefully slide the carriage off the upper end of the inner mast assembly.

Adjusting the guide or support rollers :

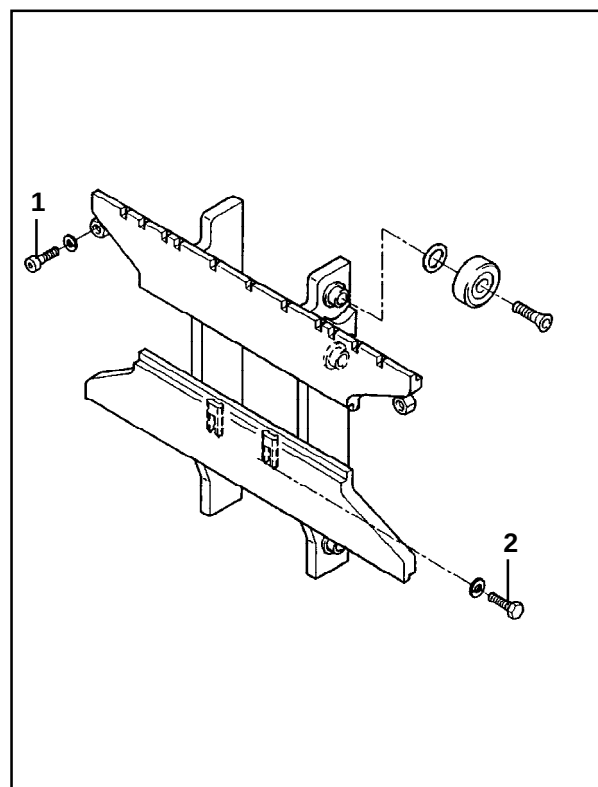
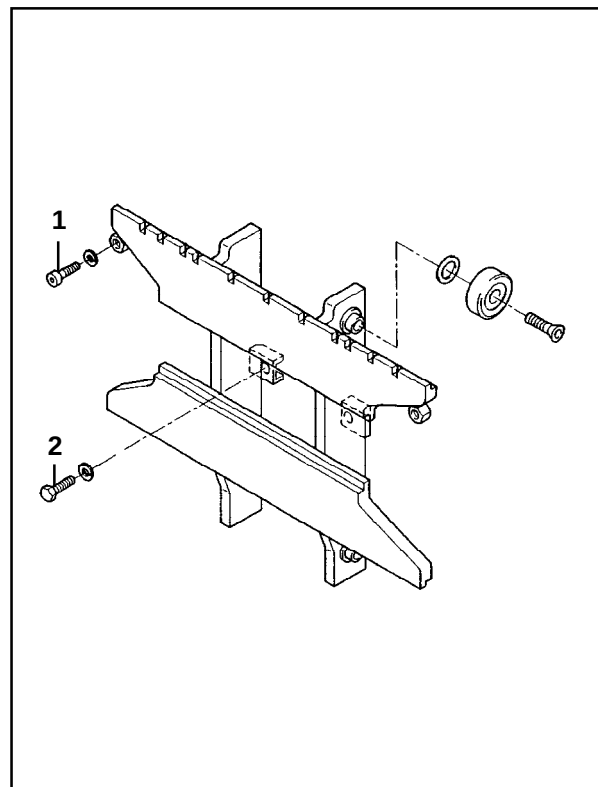
See F.G. 20, pages 14/15

Adjusting the carriage stops :

Refer to F.G. 20, page 13

1 = fork stop bolt

2 = chain end link anchor bolt



Roller retainers

Changing the guide roller shafts

The shafts (1) are welded to the roller retainer with a 5 mm circumferential flat-lap weld.

Before welding the shafts (1) onto the roller retainer note the position of the notch.

The welding operation is performed using a lime-base electrode.

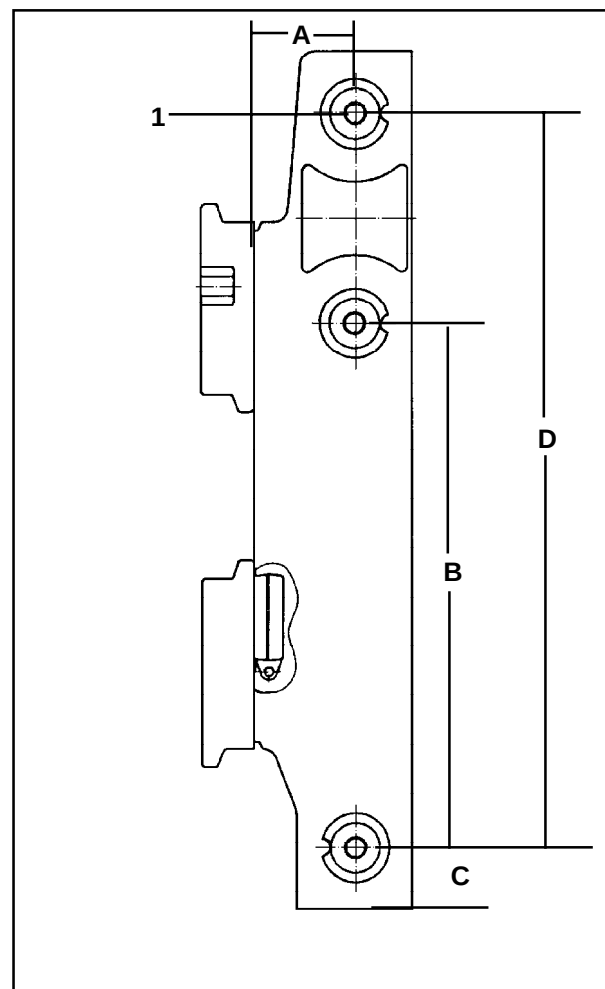
The shafts (1) and roller retainers are made of material St 52 - 3.

1 = Shaft Part No. 297 992

2 = LH chain retainer Part No. 323 950

3 = RH chain retainer Part No. 323 951

See figure at bottom right for replacement of chain retainers.



Telescopic mast

	A	B	C	D
				6 rollers
6022 - 6024	73	430	45	Ñ-
6025	73	450	45	600

Hi-Lo / Triple masts

	A	B	C	D
				6 rollers
6022 - 6024	73	380	45	530
6025	73	450	45	600

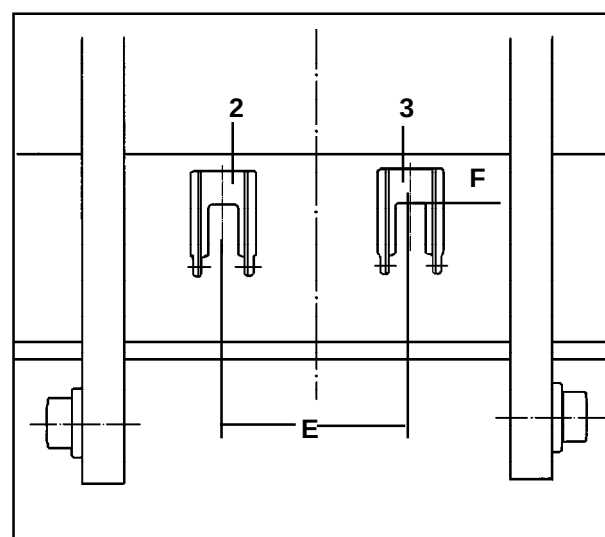
Tolerance for :

Dimension A = ± 0.2

Dimension B = ± 0.5

Dimension C = ± 1.0

Dimension D = ± 0.5



Dimension E = 137 (+1)

Dimension F = 35 (6022 - 6024)

= 85 (6025)

5mm flat-lap weld

Roller retainers

Changing the guide roller shafts

The shafts (1) are welded to the roller retainer with a 5 mm circumferential flat-lap weld.

Before welding the shafts onto the roller retainer note the position of the notch as shown in the figure on page 23.

The welding operation is performed using a lime-base electrode.

The shafts and roller retainers are made of material St 52 - 3.

1 = Shaft Part No. 390554

Note:

„N/D“ in tables below denotes Hi-Lo / Triple masts

6026 / 6027 → 4-roller fork carriage

	A	B	D	C
Tele Air/SE	83	500		53
N/D Air/SE	83	450		53
N/D Solid rub.	83	450		53

6026 / 6027 → 6-roller fork carriage

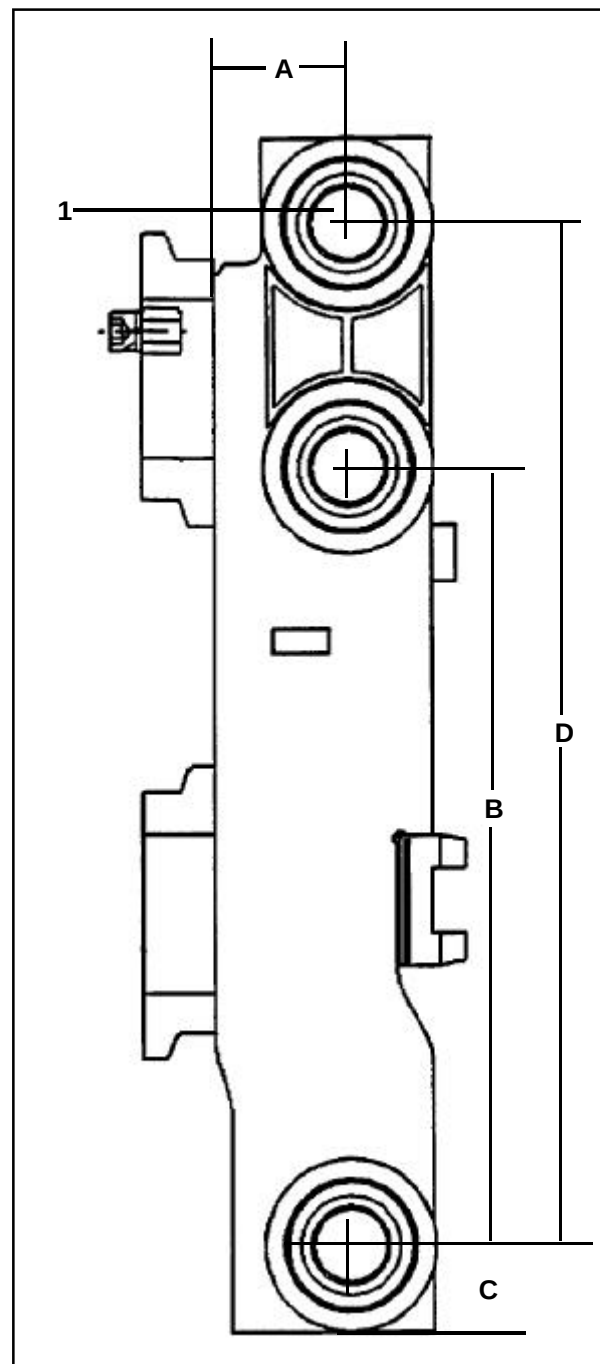
	A	B	D	C
Tele Air/SE	83	480	630	53
Tele Solid rub.	83	480	630	53
N/D Air/SE	83	450	600	53

6028 / 6029 → 4-roller fork carriage

	A	B	D	C
N/D Air/SE	83	500		53
N/D Solid rub.	83	500		53

6028 / 6029 → 6-roller fork carriage

	A	B	D	C
Tele Air/SE	83	480	630	53
Tele Solid rub.	83	480	630	53
N/D Air/SE	83	500	650	53
N/D Solid rub.	83	500	650	53



Tolerances for dimensions A,B,C and D are same as on page 23.

Tilt cylinders

Dismantling

Grip the cylinder body in a vice at its base.

Remove screw union from cylinder head (thread protrudes into the bore).

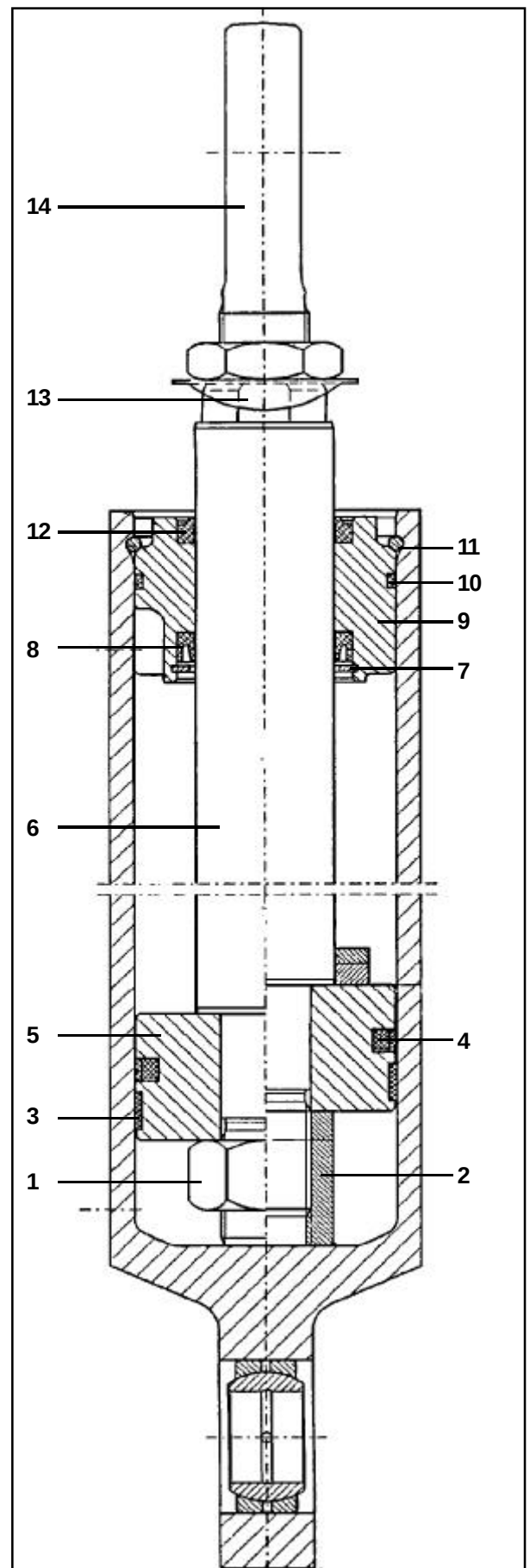
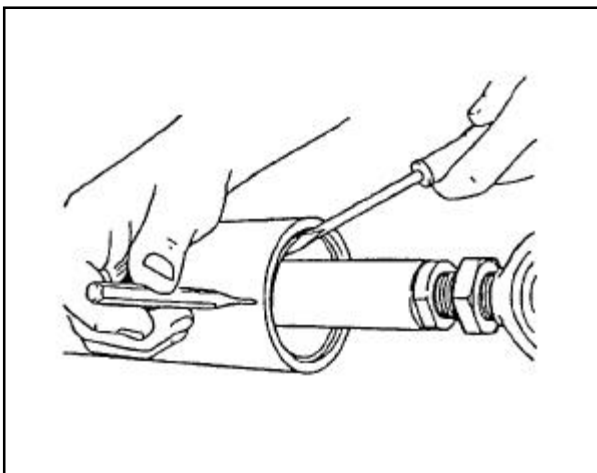
Knock down cylinder head (9) a bit with a punch..

Press in the snap ring (11) with a probe through the small hole in the cylinder and lever out with a screwdriver (see figure).

With a strong pull on the cylinder rod pull the head out of the body.

Grip piston rod in vice with —> protective jaws !

- 1 = hex nut
- 2 = spacer
- 3 = piston guide ring
- 4 = piston seal
- 5 = piston
- 6 = piston rod
- 7 = circlip
- 8 = 'U' seal
- 9 = cylinder head
- 10 = O-ring
- 11 = snap ring
- 12 = wiper
- 13 = washer
- 14 = eyebolt



Tilt cylinders

Assembling

Check all parts for wear..

Piston (5) is sealed on piston rod (6) with Loctite 270.

Hex nut (1) and spacer (2) are sealed with Loctite 270.

Torque loading = 450 Nm ($\pm$ 25 Nm).

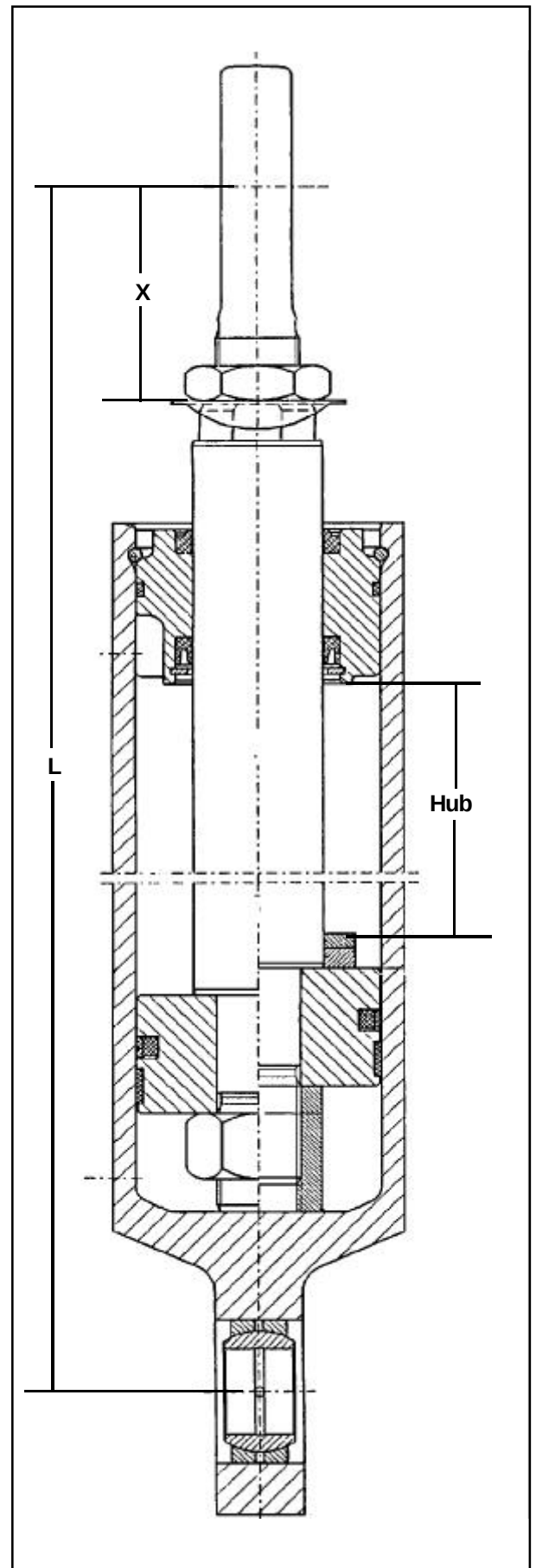
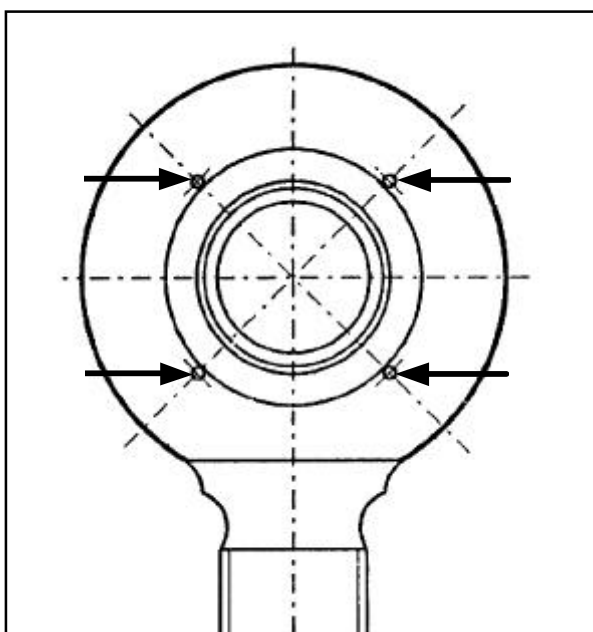
Once the piston guide ring, the piston seal and the cylinder rod packing have been installed, insert the cylinder head into body, ensuring cut out in cylinder head points towards connection hole.

During assembly observe dimension „X „ = 65 ± 8 mm !

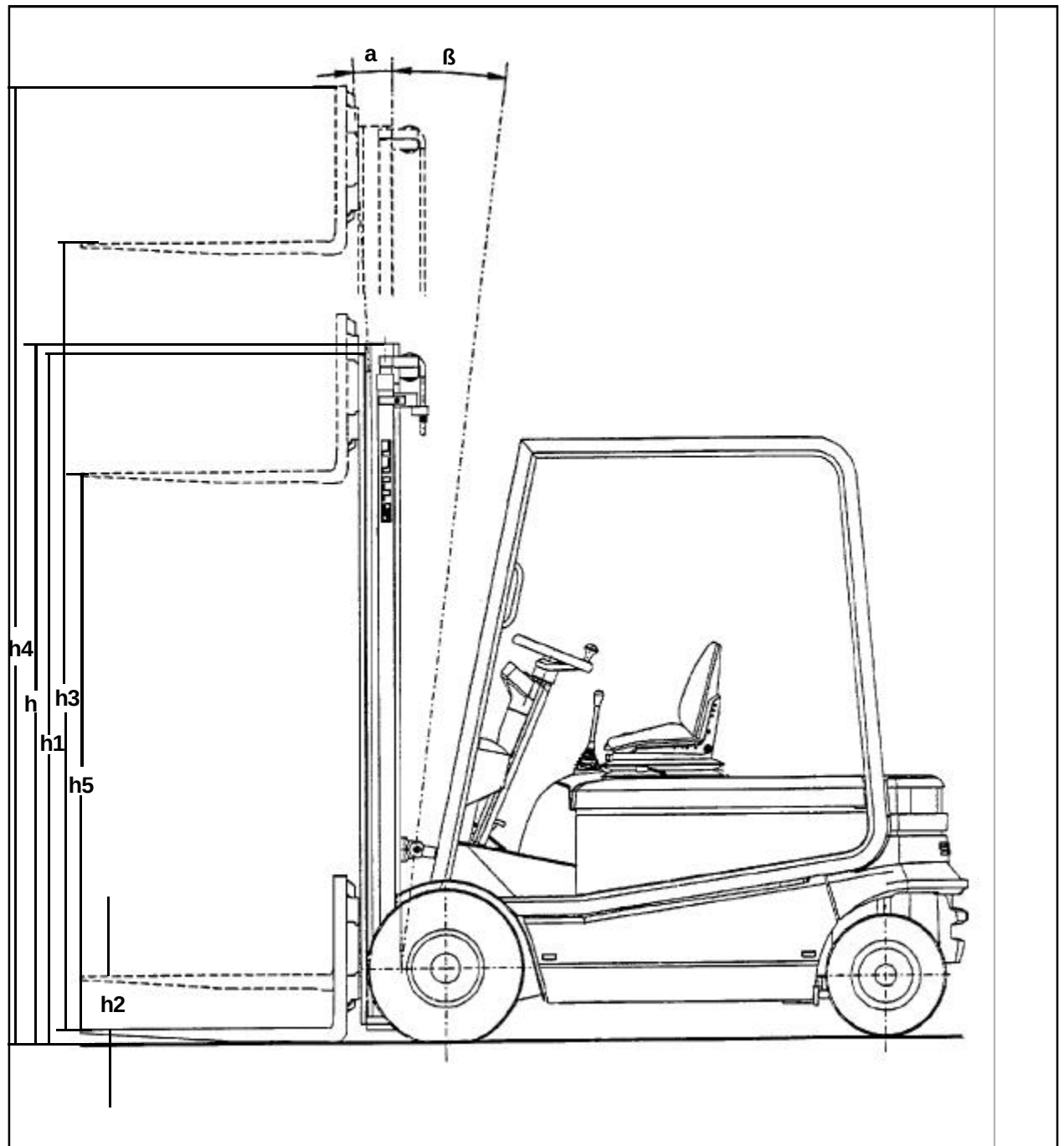
Before installing the cylinder pins lubricate with grease the bores into which they fit

The self-aligning spherical bushings at both tilt cylinder ends are peened over from both sides to prevent lateral displacement (see figure).

For dimension Land piston stroke see table page 4.



Mast tilt angle



When carrying out repairs on the tilt cylinder be careful not to modify the tilt angle as set at the factory, as otherwise stability will be impaired.

α = forward tilt

β = backward tilt

h = O.L.H. (Hi-Lo & Triple masts - $h = h_1$)

h_1 = height, mast lowered

h_2 = free lift :160 mm (telescopic mast)

h_3 = rated lift

h_4 = maximum height, mast extended

h_5 = free lift (Hi-Lo & Triple masts)

Tilt cylinders

Mast tilt angle (dimension L)

L	Stroke	Tilt-Angle		Mast-Type	O.L.H.	O.L.H.	O.L.H.
		Fwd.	Backw.		6022-6024	6025	6026-6029
387	76	3	6	Tele	1780 - 2050	1800 - 2050	
363	100	3	9	Tele	2080 - 3200	2100 - 3200	
387	76	3	6	Tele	Front screen	Front screen	
387	76	3	6	Hi-Lo	1780 - 1950	1800 - 1950	
363	100	3	9	Hi-Lo	1980 - 3200	2000 - 3200	
387	76	3	6	Hi-Lo	Front screen	Front screen	
387	76	3	6	Hi-Lo	Hydraulic hose	Hydraulic hose	
386	84	3	7	Triple	1780 - 3200	1800 - 3200	
394	76	3	6	Triple	Front screen	Front screen	
504	121	3	9	Tele / Hi-Lo			1782 - 2775
522	103	3	7	Tele / Hi-Lo			2782 - 3225
522	103	3	7	Triple			1782 - 3225