



# Service Manual

## Chassis, Mast, & Options

**EP10KRT PAC** ETB10A-00011-up

**EP12KRT PAC** ETB10A-20001-up

**EP15KRT PAC** ETB10A-50001-up

Cat Lift Trucks

Service Manual

EP10KRT PAC, EP12KRT PAC,  
EP15KRT PAC, Chassis, Mast & Options

99759-6G100

**Mitsubishi Caterpillar Forklift Europe B.V.**  
Hefbrugweg 77 1332 AM  
Almere, The Netherlands

CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

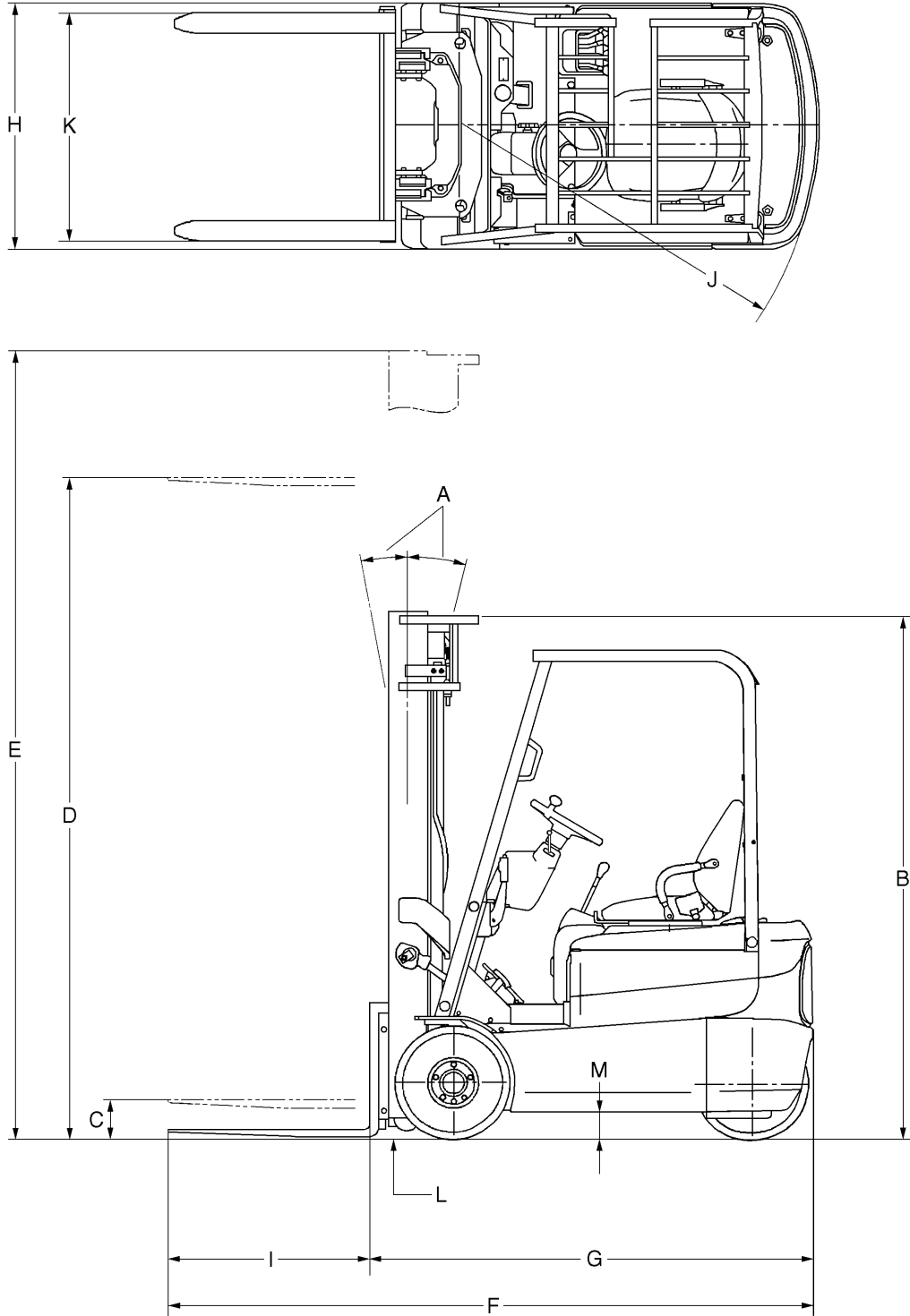
- Thank you very much for reading the preview of the manual.
- You can download the complete manual from: [www.heydownloads.com](http://www.heydownloads.com) by clicking the link below



- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

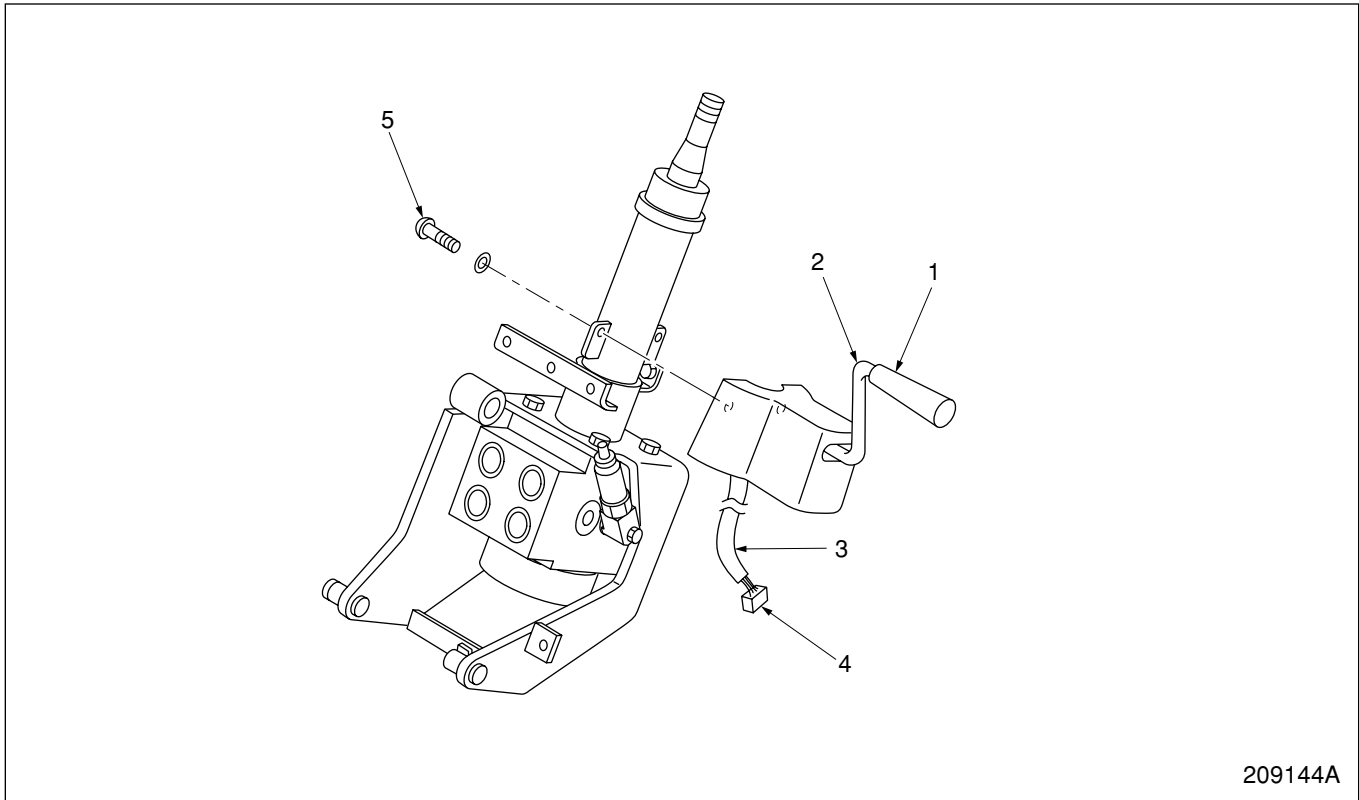
CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

**Dimensions**



## Direction Lever

### Structure



209144A

- 1 Knob
- 2 Lever
- 3 Harness

- 4 Connector
- 5 Screw, Spring washer

## Removal and Installation

### Drive Motor

#### Removal

- (1) Park the truck on a flat surface in the service area.
- (2) Turn off (press) the battery switch, then disconnect the battery cable by detaching the plug from the jack on the side of the battery box.
- (3) Remove the battery cover.
- (4) Remove the rear cover.
- (5) Disconnect all the cables and harnesses. Put marks as necessary to facilitate reconnection.
- (6) Screw an eyebolt (M10, 1.5 pitch) into the motor shaft and attach it to a hoist using a sling.
- (7) Remove the six motor mounting bolts (hex socket bolts), then hoist away the motor from the truck.

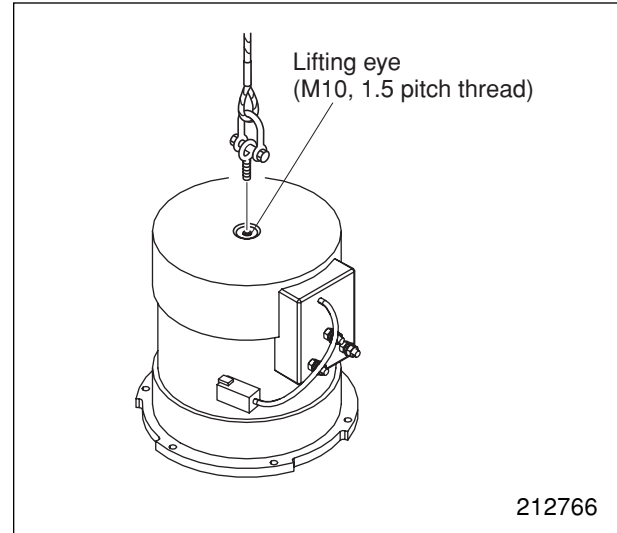
#### Installation

Follow the removal sequence in reverse while respecting the following instructions.

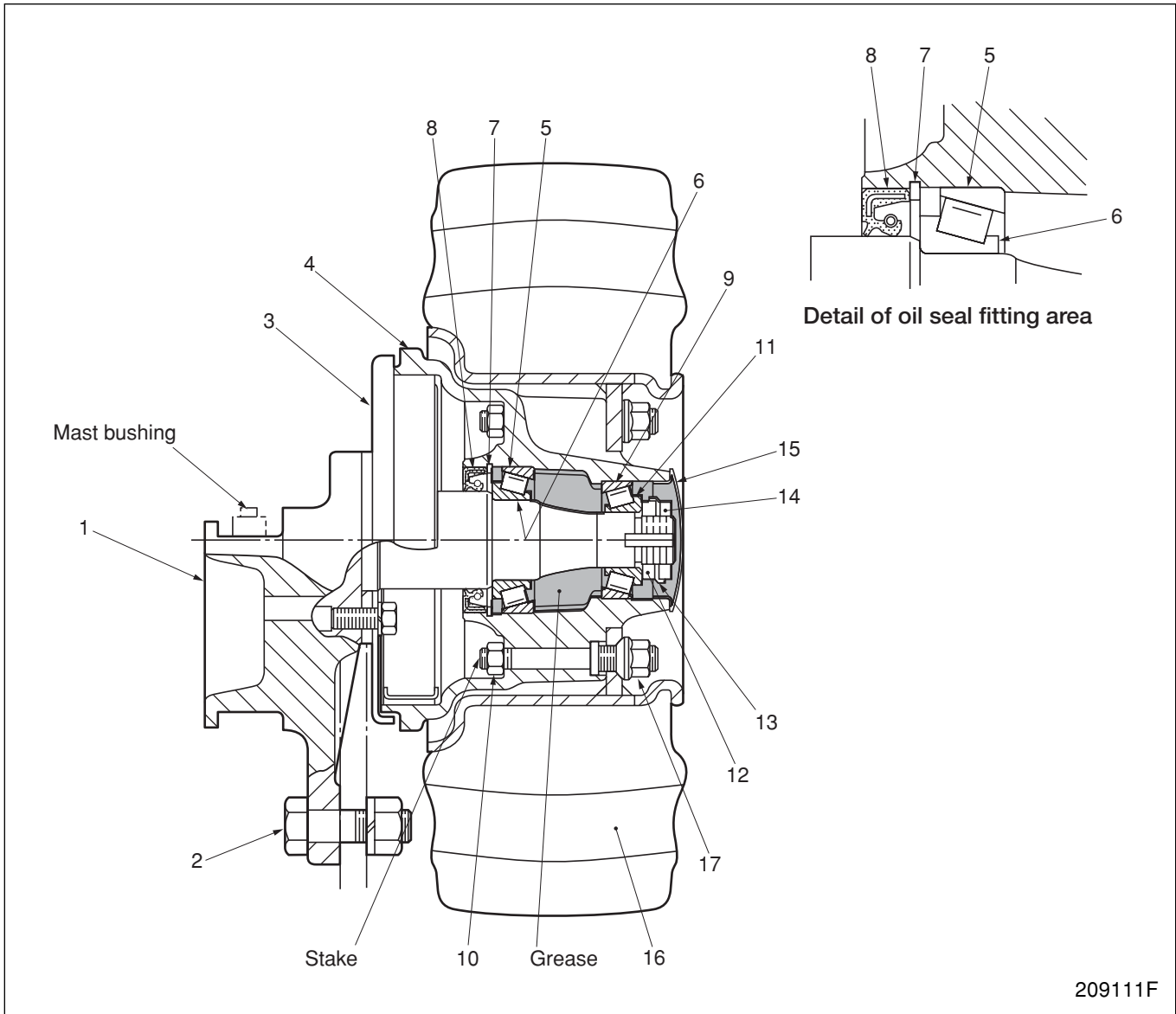
- (1) Apply molybdenum grease to the splines on the shaft.
- (2) When installing the motor on the truck, use guide bolts while making sure each section of the motor faces in the correct direction.
- (3) Tighten the motor mounting bolts to the following torque.

Tightening torque	38.1 N·m (3.9 kgf·m)
-------------------	----------------------

- (4) Install the terminal of each cable such that it does not interfere with another.
- (5) Each cable terminal should be properly covered with a boot.



## Reassembly of Front Axle Assembly



209111F

### Sequence

- |  |                        |
|--|------------------------|
| 1 Axle (if previously removed)                     | 11 Bearing cone        |
| 2 Bolt, lockwasher and nut (if previously removed) | 12 Nut (inner)         |
| 3 Brake assembly (if previously removed)           | 13 Lock washer         |
| Assemble parts 4 to 10 prior to final assembly.    |                        |
| 4 Hub and drum                                     | 14 Nut (outer)         |
| 5 Bearing cup                                      | 15 Cap                 |
| 6 Bearing cone                                     | 16 Solid tire assembly |
| 7 Snap ring  | 17 Wheel nut           |
| 8 Oil seal   |                        |
| 9 Bearing cup                                      |                        |
| 10 Wheel bolt and nut                              |                        |

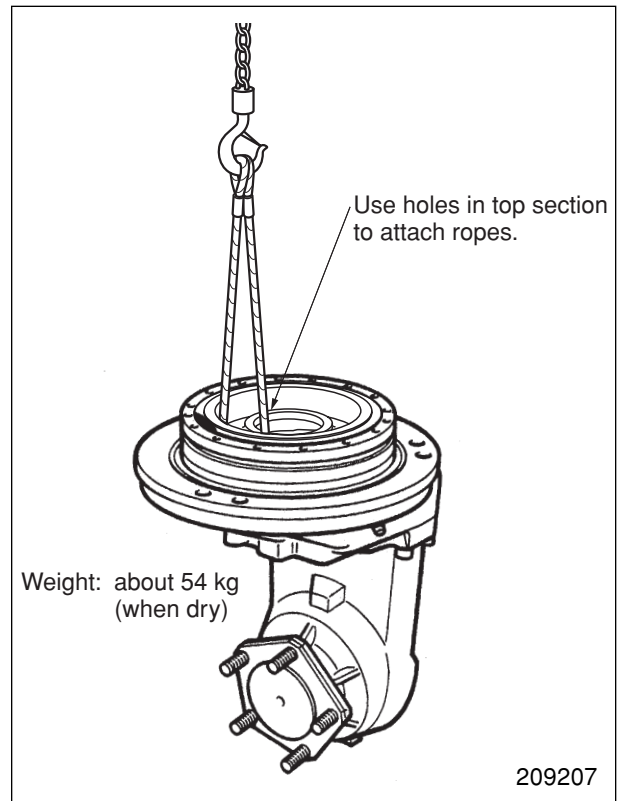
## Removal and Installation

### Removal – Rear Axle Assembly

#### NOTE

Put mating marks as necessary before disassembling to facilitate reassembly.

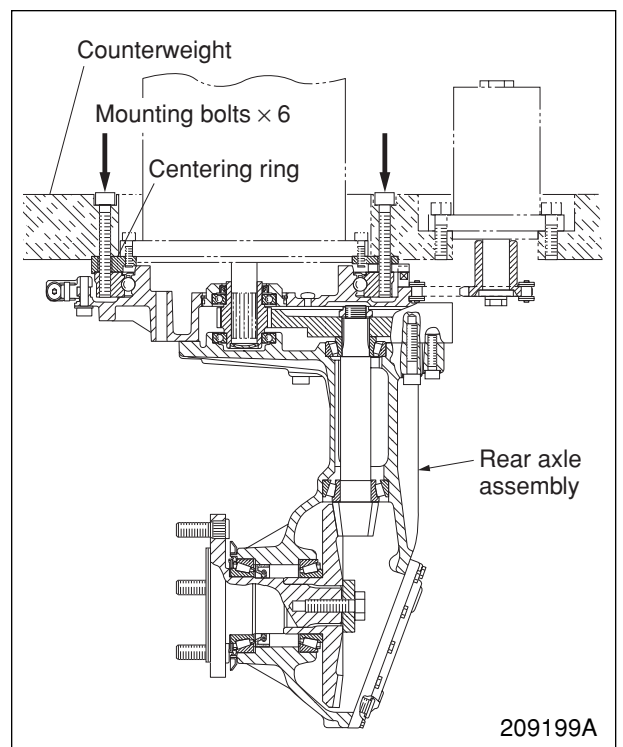
- (1) Park the truck over a pit in a service area.  
Lift the truck with jacks or a hoist so that the rear wheels are off the ground. As a safety measure, place wood blocks under the right and left rear parts of the frame, then lower the truck.
- (2) Remove the battery box.
- (3) Remove the drive motor. (Refer to the “Group 3 Motors”.)
- (4) Disconnect the hydraulic motor end of the hydraulic hose.
- (5) Remove the chain. (Refer to page 5-4.)
- (6) Remove the drive wheel. (Refer to page 5-3.)
- (7) Drain oil out of the rear axle.
- (8) Support the weight of the rear axle assembly using a hand chain hoist and wire ropes attached to the top section of the assembly as shown.
- (9) Remove the six socket head bolts.
- (10) While supporting the rear axle assembly by hand at the bottom, lower the assembly very carefully. The assembly weighs about 54 kg.



### Installation – Rear Axle Assembly

Follow the removal sequence in reverse while taking care of the following:

- (1) Be careful with the direction in which each part of the rear axle assembly should face. See the drawing on page 5-2.
- (2) Lift up the rear axle assembly in a manner appropriate for fitting the centering ring into the bore in the counterweight without any undue force.
- (3) Apply Loctite No. 271 to the threads of the mounting bolts.



## (7) General instructions for the correct disassembly and reassembly

Cleanliness is essential for a correct work.

Rear axle assembly removed from the truck have to be cleaned prior to opening.

Special care and cleanliness are essential for a correct disassembly and reassembly of the unit as well as for the installation of each spare part. A fault during installation can result in an early wear and chips as well as foreign particles in the unit could cause fatal damage in the axle. It is essential to replace all parts which were damaged or became unusable during disassembly of the axle, such as shaft seals, Viton-rings, rectangular rings, copper rings and O-rings, ball bearings, roller bearings and barrel-shaped bearings, cotter pins, lock plates, worn seal rings.

Burrs and other damages caused during removal on machined surfaces have to be eliminated.

The cavities of the rear axle, especially edges and corners, must be carefully rinsed with flushing oil, if required, with an appropriate cold cleaning agent.

Prior to reassembly all parts must be cleaned and inspected for wear and other defects.

It would be a false economy to reinstall parts which are not in a perfect condition.

Apply a sealing compound onto housing- and cover faces, which must be tight towards the outside (see 1-(3), page 5-11).

For heating of bearings etc. use heating plates, heating elements or heating furnaces.

Never heat directly with an open flame!

If there is no other possibility you may also heat an oil-filled container with the open flame and place the bearing into it, thus avoiding damage to the bearings.

**If not otherwise indicated heat ball bearings, gears, flanges etc. to approx. 90-100°C.**

Parts which have been installed in a warm condition must be subsequently driven in after cooling down to ensure a perfect contact.

Lubricate both parts before shafts, bearings etc. are pressed into position.

For reassembly all of the indicated setting values, test data and tightening torques must be observed.

Rear axle units will be filled with oil after repair work.

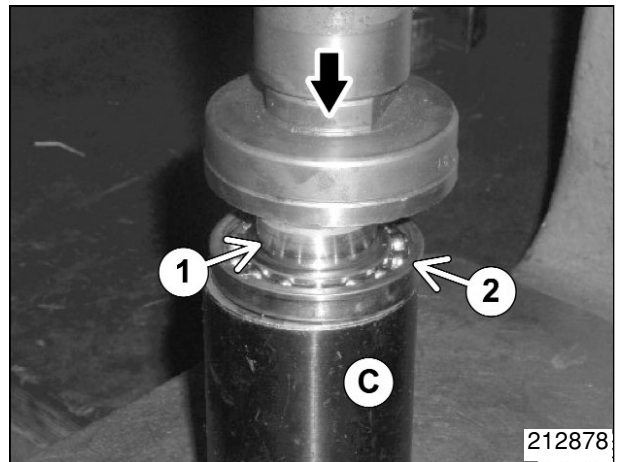
Procedure and admissible oil qualities are indicated in the "Rear Axle Oil Change" section on page 5-5.

If the rear axle assembly is found to be significantly different from the description in this manual during disassembly or reassembly, the model to which the assembly belongs may have undergone later modifications.

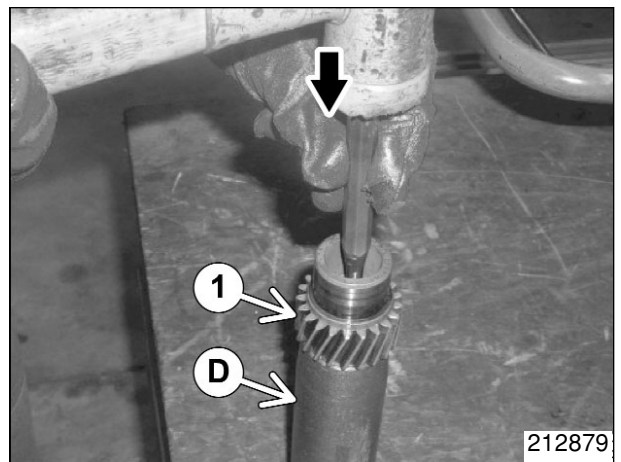
If this is the case, please contact our Service Engineering Department for the disassembly, reassembly and adjustment instructions appropriate for the particular assembly.

### 10. Single Component Removal

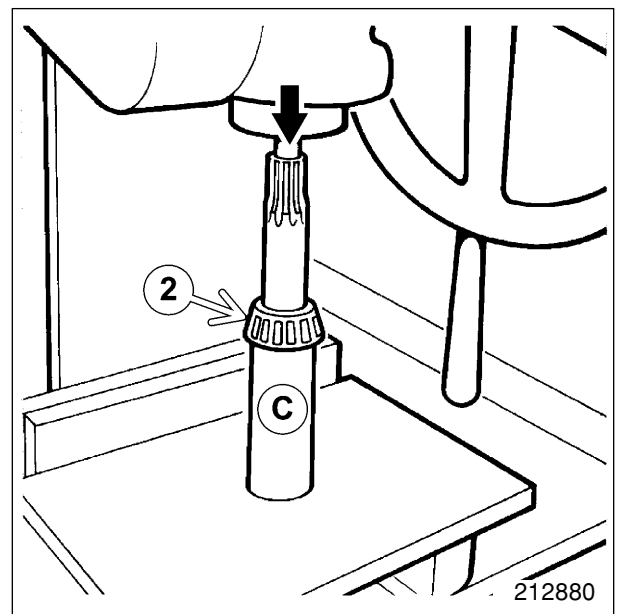
- (1) Put the removed assembly of drive pinion 1 and bearing 2 onto the sleeve C and place them together under a hand lever press.
- (2) Using the press, force the drive pinion into the sleeve, to separate it from the bearing.



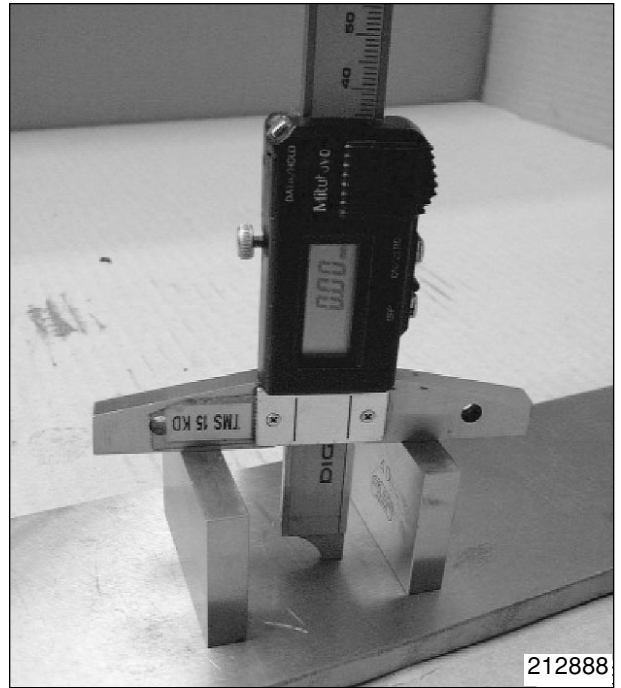
- (3) With the sealing cap faced downwards, put the drive pinion 1 onto the sleeve D. Use a suitable tool to loosen and remove the sealing cap.



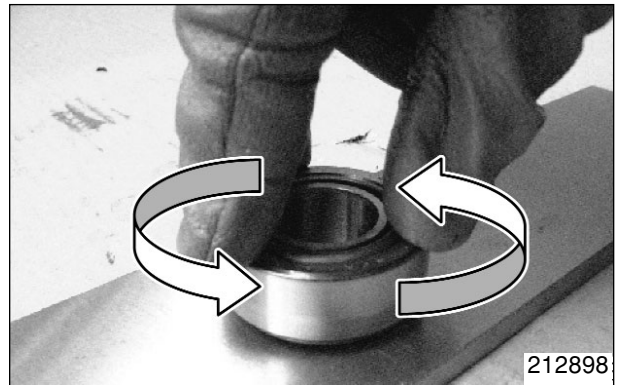
- (4) Using the sleeve C, press the bevel pinion shaft to separate the bearing inner ring 2 from the shaft.



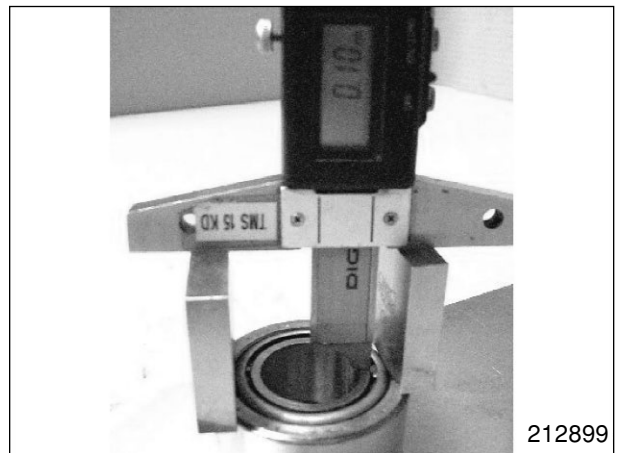
- (d) Place a depth gauge on gauge blocks and adjust it to zero.



- (e) Rotate the bearing to settle it.



- (f) Measure the bearing slack  $h$ .



The contact pattern becomes better visible when the bevel pinion shaft is decelerated slightly.

The contact patterns thus obtained are compared with the specified contact pattern for size and position.

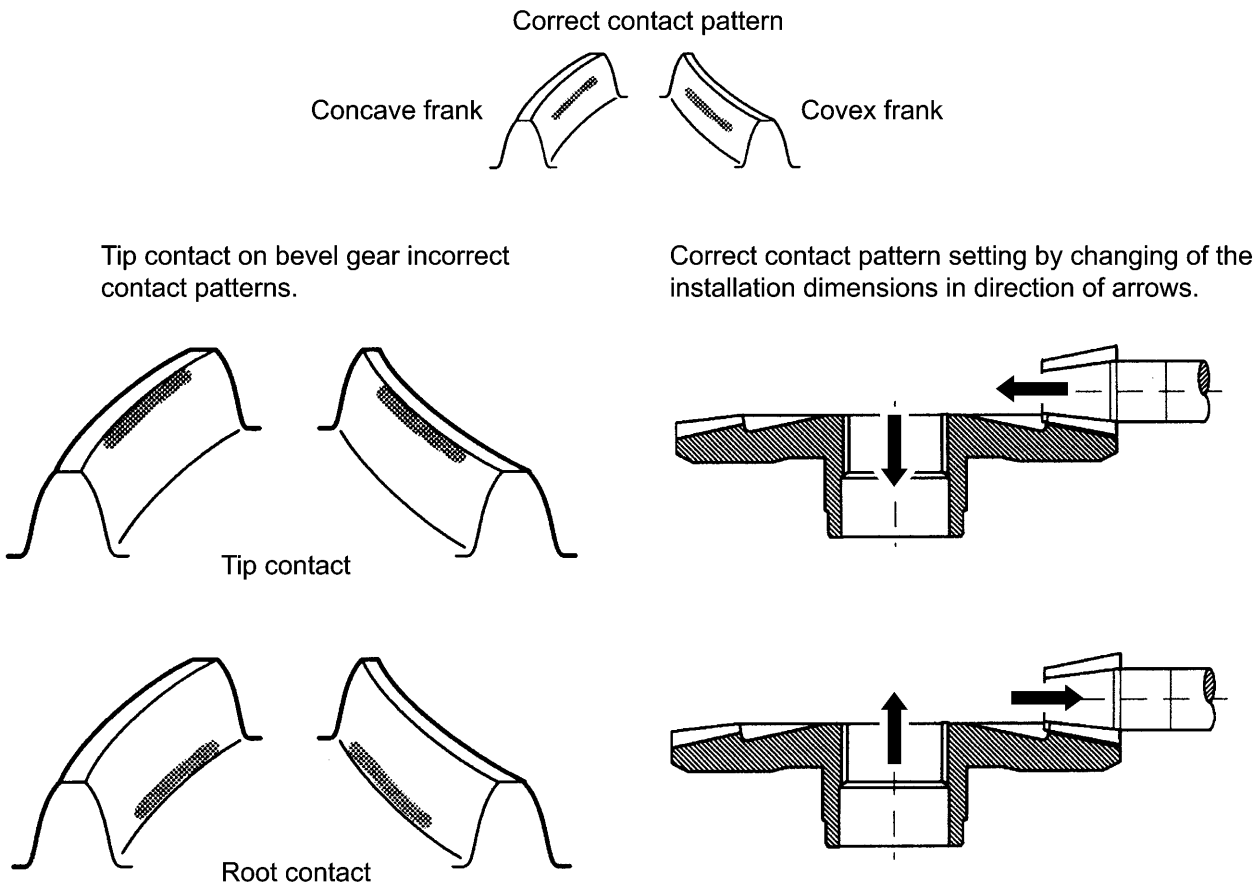
The contact patterns are indicated in the figure below.

Insignificant deviations from the ideal shape are permissible. These deviations are mostly due to varying pressures applied during contact pattern inspection.

If there are considerable deviations, checked whether the installation dimensions are correct.

Wrong installation dimensions most of ten cause incorrect contact patterns.

Only when no correct contact patterns can be obtained after repeated checking of the installation dimensions, the position of the bevel pinion shaft should be corrected according to the figure below.

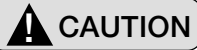


212922

**NOTICE:** In the case of a wrong contact pattern, the shim thickness must be changed depending on direction of the arrow. The rear axle has to be disassembled again.

12. Reassembly of Housing Cover

- (1) Apply LOCTITE 574 to the housing cover.



Wear safety gloves for working with adhesives and observe the LOCTITE instructions.



212947

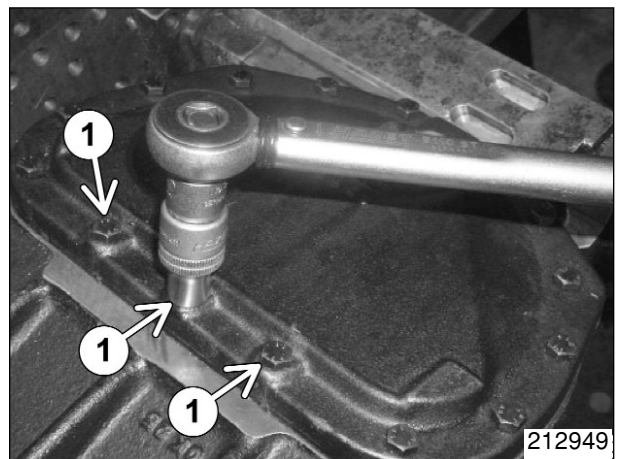
- (2) Wet the 15 hexagon screws M6 × 20 with LOCTITE 243.



212948

- (3) Tighten the 15 hexagon screws 1 M6 × 20.

Tightening torque	9.5 N·m
-------------------	---------

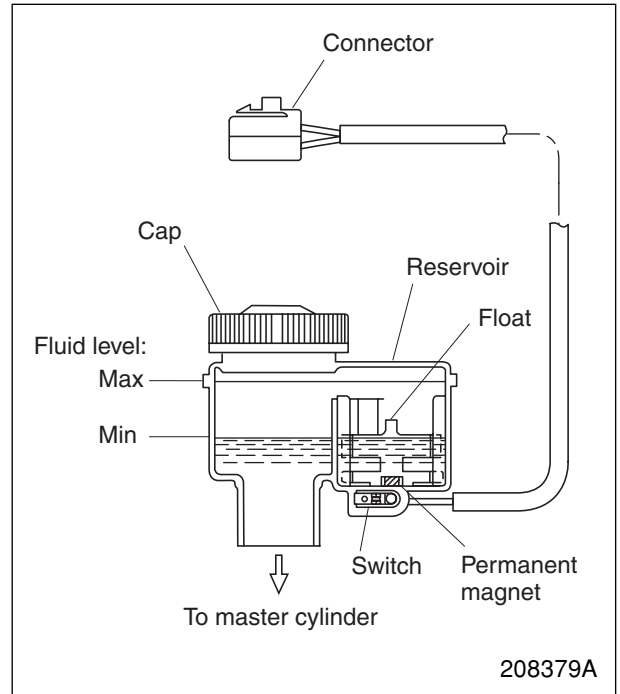


212949

## Reservoir Tank

The brake fluid reservoir tank is located just above the master cylinder, forming an integral part of the master cylinder. It incorporates a brake fluid level sensor, which consists of a reed switch (this is built into the bottom of the reservoir tank) and a float (this follows changes in fluid level). The float contains a permanent magnet.

When the fluid level drop below the minimum level marked on the tank, the switch closes, causing the brake fluid level indicator to illuminate. While the fluid level is sufficiently high, the switch remains open and the indicator remains off.



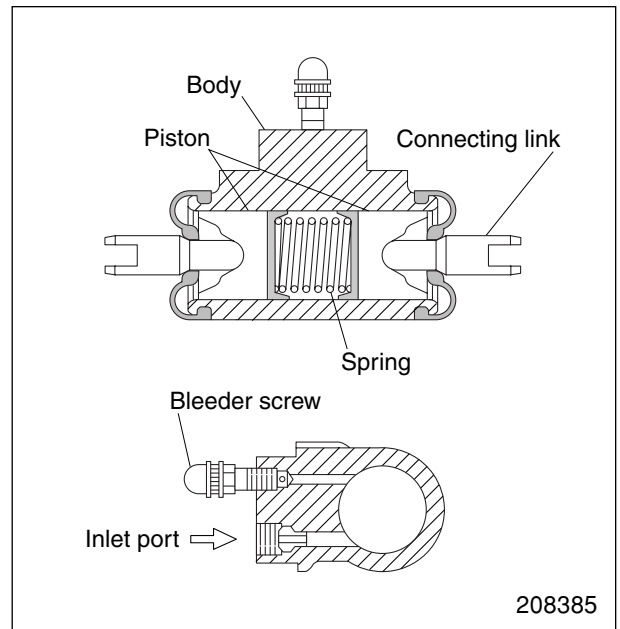
## Wheel Cylinder

A wheel cylinder is located in each wheel brake assembly.

When the brake pedal is depressed, pressurized brake fluid from the master cylinder enters the wheel cylinder body through the inlet port. The fluid acts on the left and right-hand pistons, causing them to expand the primary and secondary shoes via the corresponding connecting links.

When the brake pedal is released, the pistons are moved back to their original positions by the brake shoe return spring in the wheel brake assembly.

Each wheel cylinder has a bleeder screw, which is used to remove any air that enters the brake system when the system is serviced. The bleeder screw is loosened to remove the air.



## Inspection after Disassembly

### 1. Cylinder bodies

- (1) Check the bore for rusting, erosion and scoring.
- (2) Check the threads of bleeder screw and oil pipe for damage.

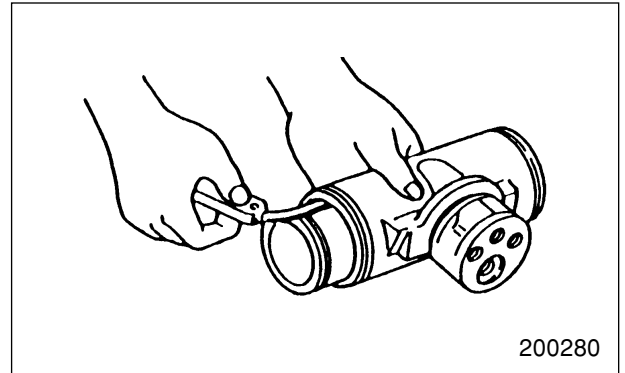
### 2. Pistons

- (1) Check the sliding surface for rusting and scratching.
- (2) Check the piston clearance in the cylinder body. Replace the cylinder body and piston if the clearance is in excess of the service limit.

A: Standard value    B: Repair or service limit

Unit: mm

Clearance between piston and cylinder	A	0.020 to 0.105
	B	0.15



### 3. Piston cups

Check for swelling or other defects. Replace the cups at the time of overhaul and every year.

### 4. Boots

Replace the boots if they are hardened, damaged or otherwise deteriorated.

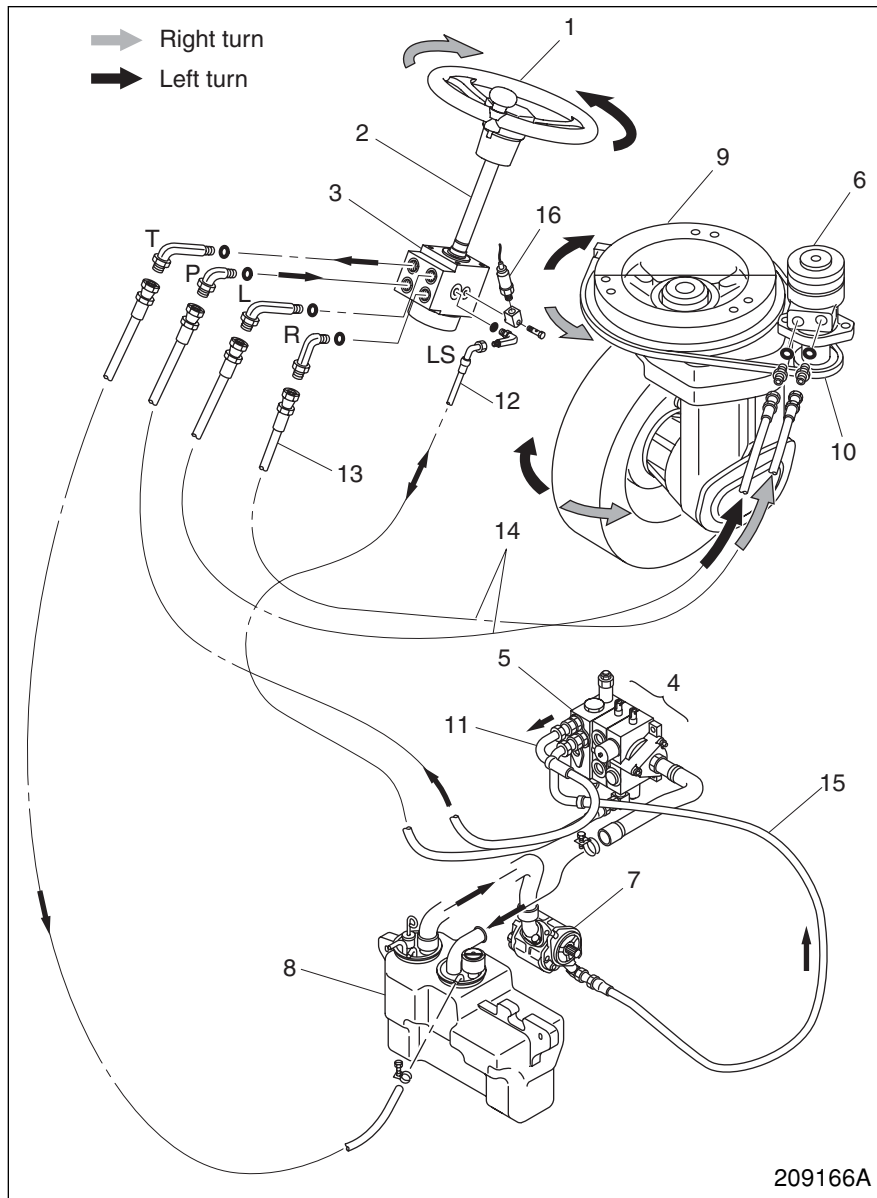
## Reassembly

Follow the disassembly procedure in reverse while observing the following instructions:

- (1) Coat the piston cups and the cylinder bore with brake fluid.
- (2) Be careful not to damage the lips of the cups.

## Structure and Functions

### General



### Main components

- 1 Steering wheel
- 2 Steering column shaft
- 3 Steering valve
- 4 Hydraulic control valve assembly
- 5 Priority valve (component of hydraulic control valve)
- 6 Hydraulic motor for steering
- 7 Hydraulic pump
- 8 Hydraulic tank
- 9 Rear axle assembly
- 10 Chain for steering
- 11 High-pressure oil hose connecting priority valve to steering valve
- 12 Load sensing pressure hose
- 13 Low-pressure return oil hose connecting steering valve to tank
- 14 High-pressure oil hoses connecting steering valve to hydraulic motor
- 15 High-pressure oil hose connecting hydraulic pump to hydraulic valve
- 16 Pressure switch

Entire steering system of this truck is controlled hydraulically. The core component of this system is the steering valve 3 which is linked to the steering wheel 1 through the steering column shaft 2.

When the operator turns the steering wheel 1, the rotary valve and hand metering pump in the steering valve 3 allows pressure oil to flow to the hydraulic motor 6 through either of the hoses 14 according to the direction in which the steering wheel is turned and at a rate corresponding to the angle through which the steering wheel is turned. The hydraulic motor 6 is then rotated by the pressure oil. Rotation of the hydraulic motor is transmitted to the rear axle assembly 9 via the chain 10. This turns the whole rear axle body and changes the moving direction of the truck.

Oil to the steering valve 3 is supplied from the hydraulic pump 7 by way of the priority valve 5 that is included in the control valve assembly 4. The priority valve preferentially directs to the steering system the hydraulic pump output oil which is also used for controlling operation of the mast.

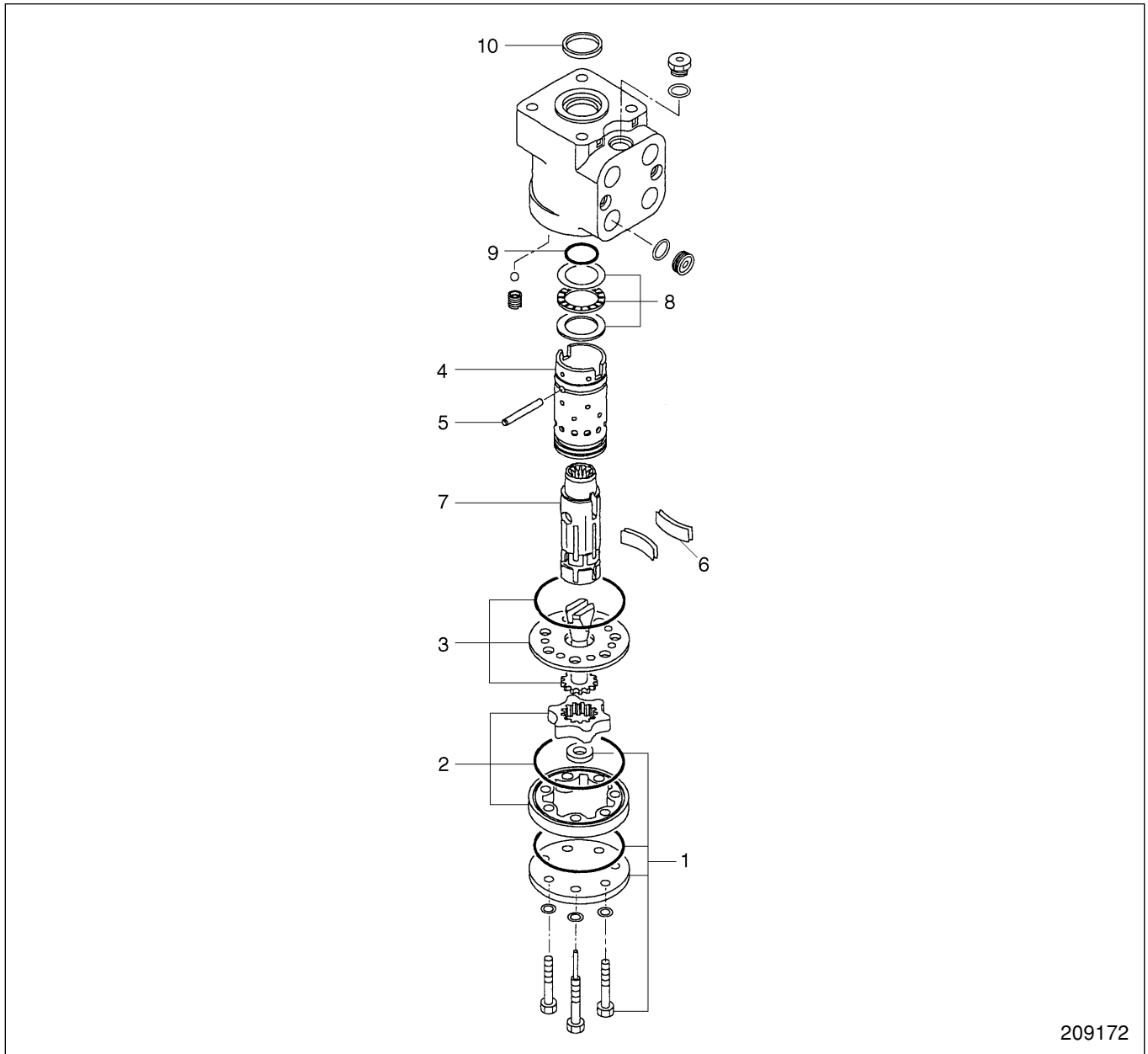
For detailed description of operation of the individual hydraulic system components, refer to the section relevant to each of them.

The “Group 8 Hydraulic System” of this manual also provides general description of the hydraulic system (see “General” in the “Structure and Functions” section).

## Disassembly and Assembly

### Steering Valve

#### Disassembly



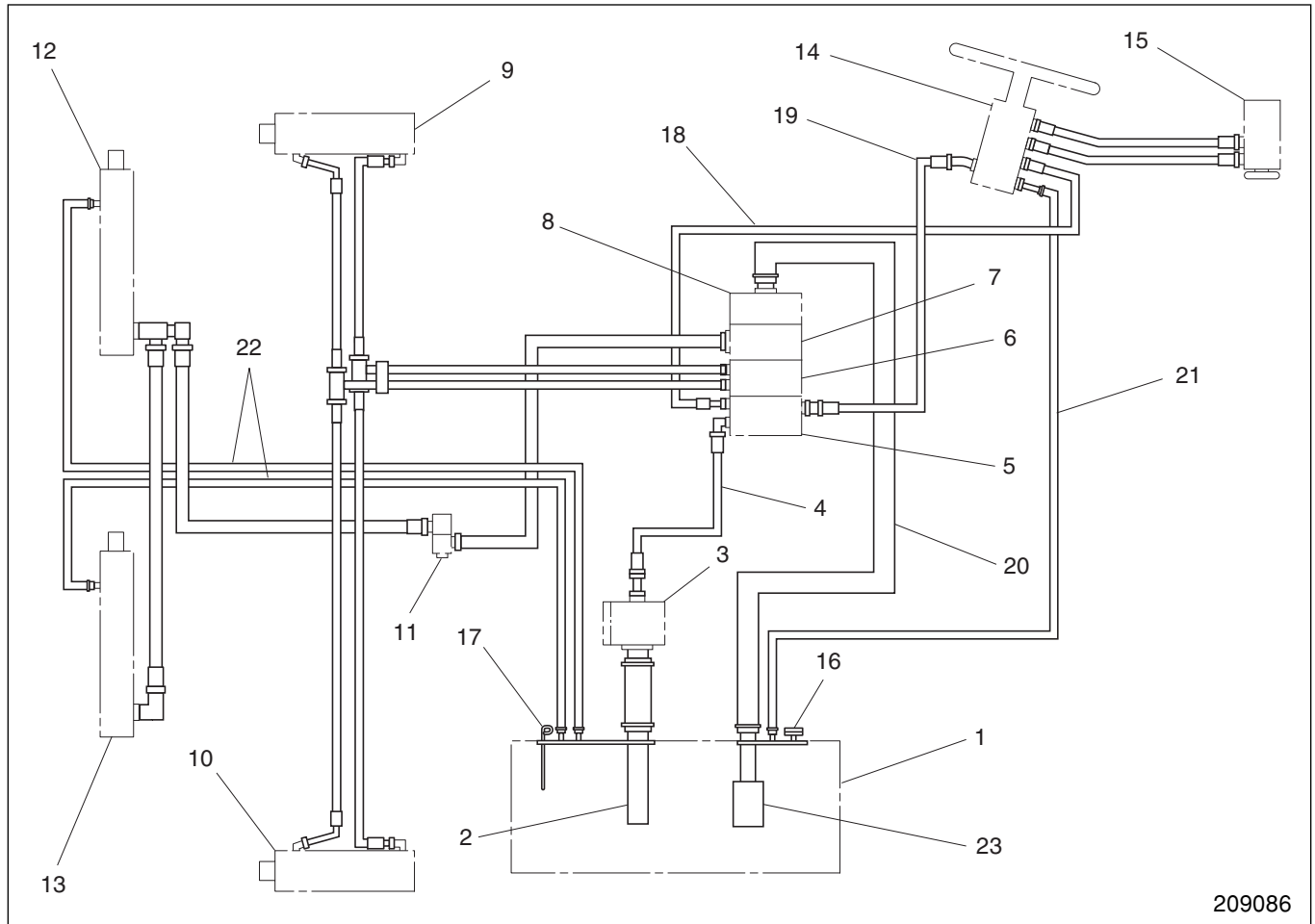
209172

#### Sequence

- |   |                                      |    |                       |
|---|--------------------------------------|----|-----------------------|
| 1 | End cap, Bolts, O-ring and spacer    | 6  | Centering spring      |
| 2 | "Gerotor" set, O-ring                | 7  | Control spool         |
| 3 | Drive shaft, Spacer plate and O-ring | 8  | Thrust needle bearing |
| 4 | Control sleeve                       | 9  | O-ring                |
| 5 | Pin                                  | 10 | Dust seal             |

## Structure and Functions

### General



- |                               |                         |                                    |
|-------------------------------|-------------------------|------------------------------------|
| 1 Hydraulic tank              | 9 Tilt cylinder (R.H.)  | 17 Oil level gauge                 |
| 2 Suction pipe                | 10 Tilt cylinder (L.H.) | 18 Oil feed line of steering valve |
| 3 Hydraulic pump              | 11 Flow regulator valve | 19 Oil sensing pressure line       |
| 4 Pump delivery hose          | 12 Lift cylinder (R.H.) | 20 Return line                     |
| 5 Control valve inlet section | 13 Lift cylinder (L.H.) | 21 Return line                     |
| 6 Control valve tilt section  | 14 Steering valve       | 22 Return line                     |
| 7 Control valve lift section  | 15 Hydraulic motor      | 23 Return filter                   |
| 8 Control valve end section   | 16 Breather             |                                    |

The hydraulic system of this truck includes the mast control circuit and the full-hydraulic steering system circuit.

The oil drawn by the hydraulic pump 3 from the hydraulic tank 1 flows into the control valve inlet section 5 through the pump delivery hose 4.

The flow priority valve in the control valve inlet section 5 preferentially distributes the oil to the steering valve 14 through the oil feed line 18. The priority valve distributes the remainder of the oil to the mast control circuit. In the standard configuration, the following two valve sections are used for the mast control purposes:

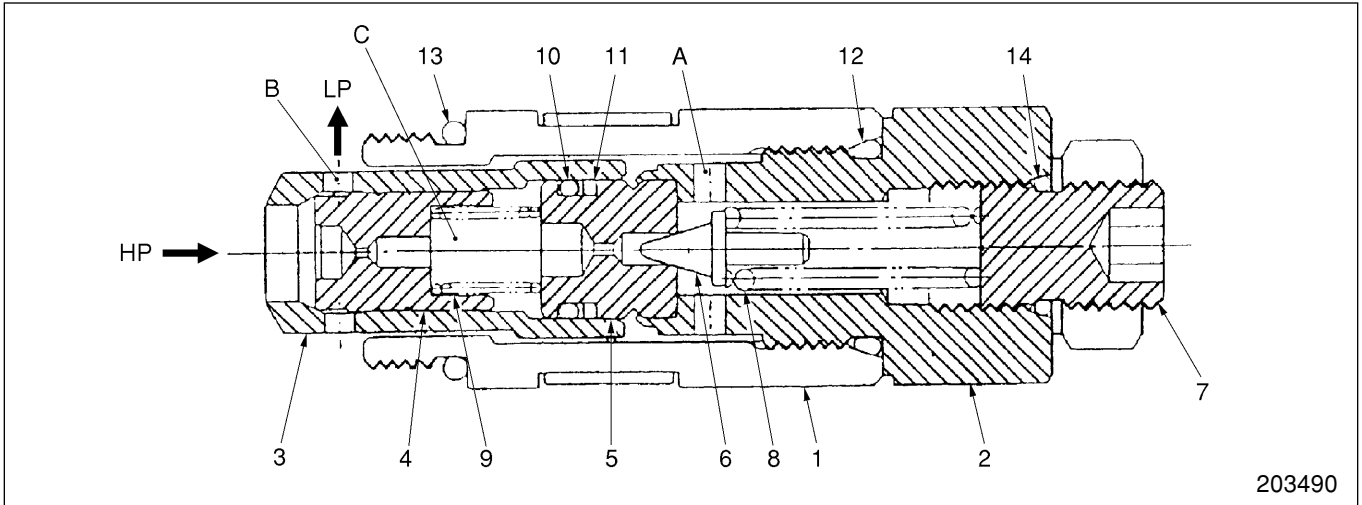
- (1) Lift control valve section
- (2) Tilt control valve section

The tilt control valve section controls extension and retraction of the tilt cylinders 9 and 10 to cause the mast to lean forward or backward.

The lift control valve section controls the operation of the lift cylinders 12 and 13 to raise or lower the mast.

The return oils from the steering valve and mast control system go to the hydraulic tank through the return lines 20, 21 and 22.

Main Relief Valve



203490

- |                   |                |                               |
|-------------------|----------------|-------------------------------|
| 1 Cap             | 8 Pilot spring | HP: High-pressure oil         |
| 2 Plug            | 9 Spring       | LP: Low-pressure oil          |
| 3 Sleeve          | 10 O-ring      | A: Pilot pressure relief port |
| 4 Main poppet     | 11 Backup ring | B: Main pressure relief port  |
| 5 Pilot seat      | 12 O-ring      | C: Spring chamber             |
| 6 Pilot poppet    | 13 O-ring      |                               |
| 7 Adjusting screw | 14 O-ring      |                               |

Pump pressure (HP) to the tilt and lift cylinders is always acting on the pilot poppet 6.

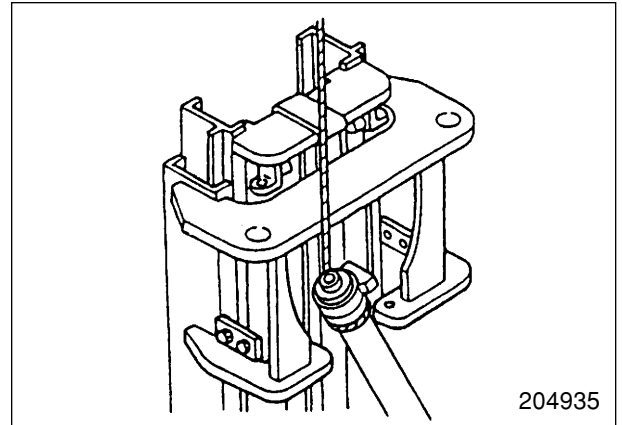
If the pump pressure exceeds the set pressure of the main relief valve, the poppet 6 moves to the right against the force of the spring 8. This allows the oil in the spring chamber C to escape through the A port into the low-pressure (LP) side of the system.

As a result, the pressure in the chamber C drops, which enables the pump pressure oil to push the main poppet 4 to the right. The high-pressure oil then flows through the B port into the LP side of the system.

To adjust the set pressure of the main relief valve, turn the adjusting screw 7 in or out to change the preload on the spring 8.

### 5. Removing lift cylinders 8

Hitch a sling to the lift cylinder from the rear side of the mast, and remove the cylinder. Hitch the sling before removing the cylinder clamp.



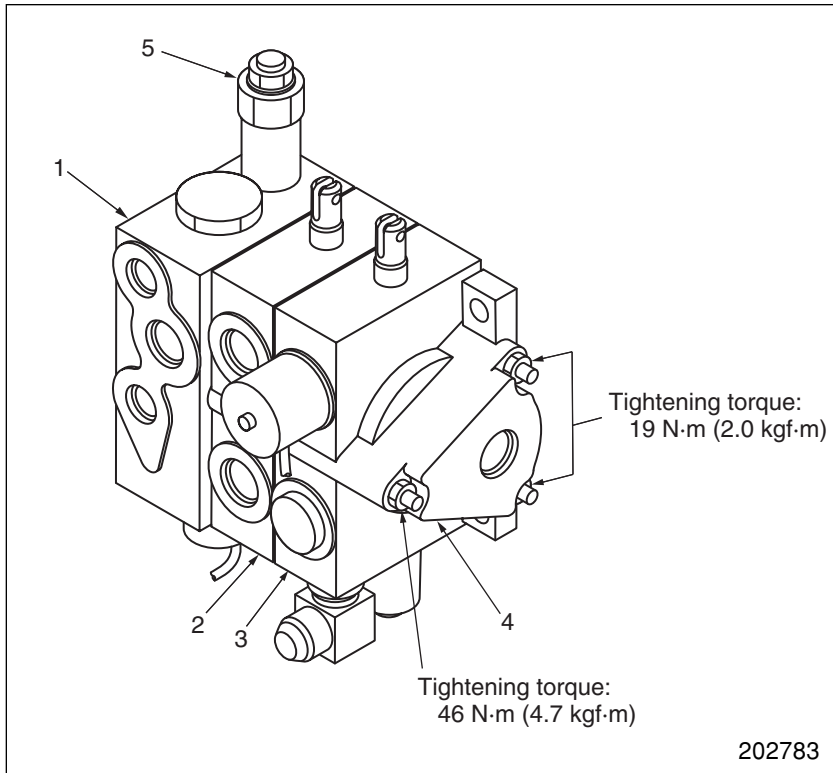
### Installation

To install, follow the reverse of removal sequence, and do the following steps:

1. Extend and retract the lift cylinders several times under no load condition to bleed air out of the cylinder circuits and to make sure that the cylinders move smoothly.
2. Check the oil level in the hydraulic tank with an oil level gauge.
3. Check to make sure that the lift height is correct.
4. After the lift cylinders or piston rods have been replaced, check for difference in stroke between the two cylinders. (Refer to “Group 9 Mast and Fork”.)

## Hydraulic Control Valve Assembly

### Disassembly and Reassembly



Control valve assembly (2-valve type)

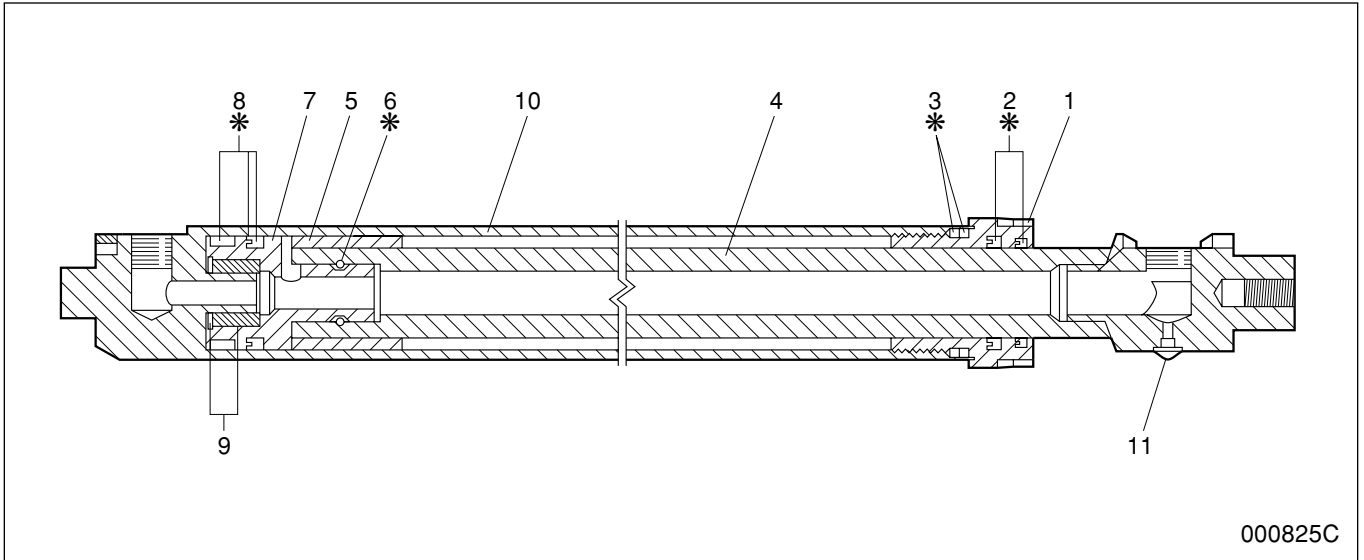
#### Main Component

- 1 Inlet valve section
- 2 Tilt valve section
- 3 Lift valve section
- 4 End cover
- 5 Main relief valve

### Suggestions for Disassembly and Reassembly

- (1) Do not disassemble main relief valve 1 or steering system relief valve 2 unless it is impossible to adjust the setting of the valve.
- (2) Tighten the tie bolts (securing the valve housings) as evenly as possible to prevent distortion of the housings. Remember, a failure to follow this precaution will result in sluggish movement of the spools.

Reassembly



Sequence

- |                        |                                       |
|------------------------|---------------------------------------|
| 1 Retainer             | 6 Pull-in wire                        |
| 2 Wiper ring, Rod seal | 7 Piston                              |
| 3 Backup ring, O-ring  | 8 Backup ring, Piston seal, Wear ring |
| 4 Piston rod           | 9 Sleeve, Snap ring                   |

Install parts 1, 2, 3, 5, 6, 7 to Part 4.

- 5 Spacer

- 10 Cylinder tube  
11 Seal washer, Bleed screw

**NOTE**

Replacement parts marked with an asterisk (\*) are included in the seal kit.

Suggestions for Reassembly

- Use all parts in the seal kit to replace removed parts.
- Apply hydraulic oil to the bore surface of tube and also to the wiper ring, rod seal, and wear ring.
- When holding the tube in a vise, take care not to distort the tube.
- Fill the cavity between the shell and rod with 25 to 30 cm<sup>3</sup> of hydraulic oil before installing the retainer.
- Tighten the retainer 1 to the specified torque.
- Tighten the bleed screws 11 to the specified torque.

Unit: N·m (kgf·m)

Bleed screw tightening torque	4.5 to 5.0 (0.46 to 0.51)
-------------------------------	------------------------------

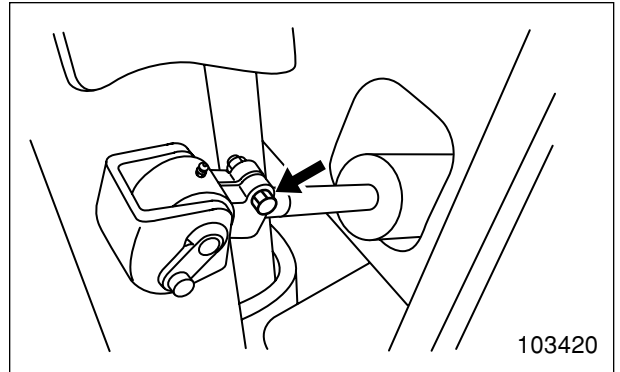
Unit: N·m (kgf·m)

Retainer tightening torque	170 to 240 (17.3 to 24.5)
----------------------------	------------------------------

## Lift Cylinders and Tilt Cylinders

### (1) Adjustment of mast tilt angle

- (a) Park the truck on a level ground.
- (b) Tilt the mast backward to the maximum position.
- (c) Measure the backward tilt angles of both right and left tilt cylinders.
- (d) To adjust, loosen the socket tightening bolt, turn the tilt cylinder rod and adjust the cylinder stroke until the right and left tilt cylinders are tilted at the same angle.



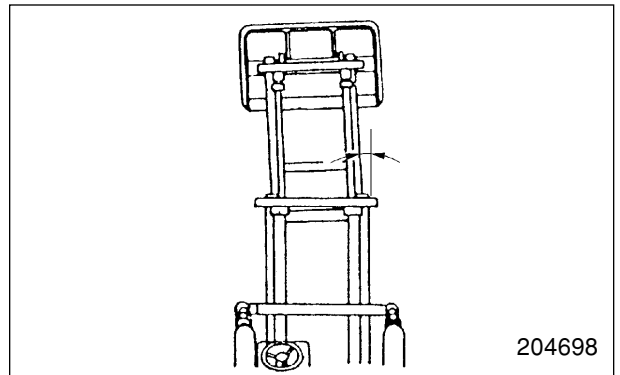
**NOTE**

The forward tilt angle of the masts is automatically set when the backward tilt angle is adjusted.

Forward tilt – Backward tilt (STD)	5° – 7°
------------------------------------	---------

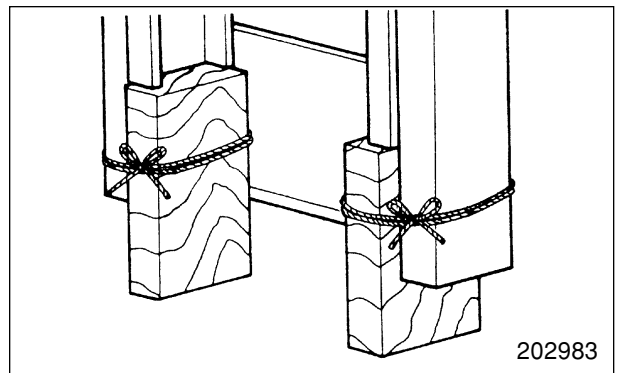
### (2) Adjustment of right and left lift cylinder strokes

- (a) Slowly raise the inner mast, and observe how the piston rods, left and right, stop at the moment the inner mast reaches its maximum height.
- (b) If the top of the inner mast jolts at that moment, make a shim adjustment. Abnormal condition can be detected by a little time lag in stopping between the piston rods, left and right, and shaking of the rod with a longer cylinder stroke.



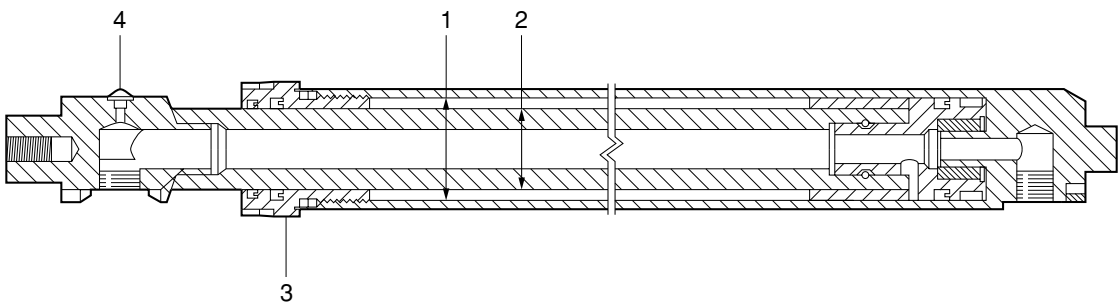
### Adjustment method

- (1) Raise the inner mast, and place wood blocks under the inner mast. Lower the mast until the inner mast contact the wood blocks. Use blocks strong enough to support the mast.



A: Standard value

Unit: mm

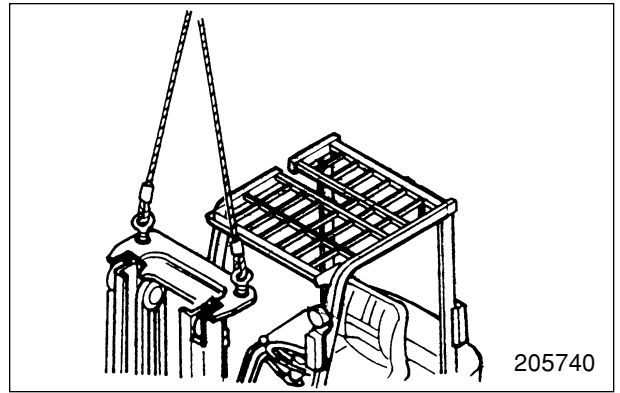
Item		Truck Model		
		EP10KRT PAC	EP12KRT PAC	EP15KRT PAC
Lift cylinders (Duplex mast second cylinders)	[Piston] Inside diameter of cylinder tube 1	A	45	
	Diameter of piston rod 2	A	32	
	Outside diameter of retainer 3	A	60	
	Tightening torque for retainer 3 N·m (kgf·m)	A	170 to 240 (17.3 to 24.5)	
	Bleed screw tightening torque 4 N·m (kgf·m)	A	4.5 to 5.0 (0.46 to 0.51)	
				
000825C				

2. Separating mast and tilt cylinders 4

- (1) Hitch a sling to the mast. Using two eye-bolts and a sling as shown and support the mast with a hoist.

**CAUTION**

Be sure to use a hoist having a capacity enough to support the mast assembly.



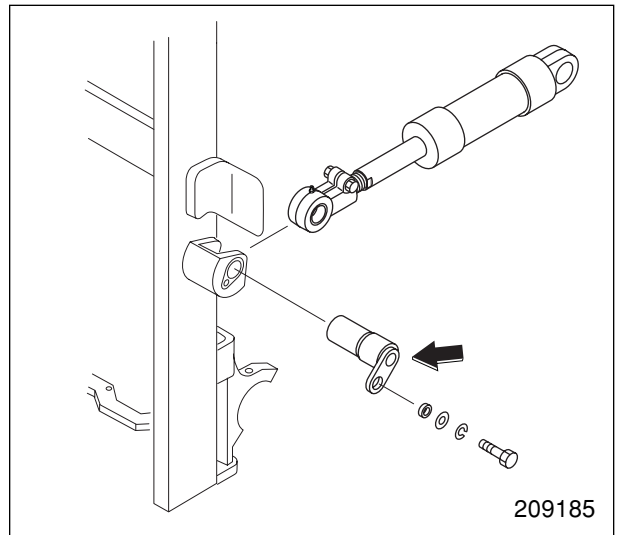
- (2) Place wood blocks under the tilt cylinder mounting section and remove the tilt socket pins, and separate the mast from the tilt cylinders.
- (3) Turn the key to ON and pull back the tilt lever to retract the tilt cylinder rods.

3. Disconnecting low-pressure hose for lift cylinder

Disconnect the hoses at the hydraulic tank.

4. Disconnecting high-pressure hoses for lift cylinder

Place the mast in the bottom position, disconnect the hoses at the flow regulator valve.

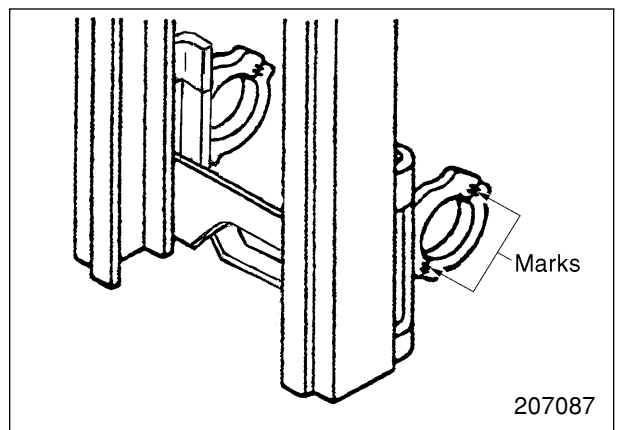


5. Removing mast support bearing caps 7

- (1) Mark the bearing caps to ensure the correct reassembling before removing them.
- (2) Remove the cap bolts and lift off the mast assembly. Lay it down flat on a level floor.

**NOTE**

Lay the mast assembly on a floor large enough to disassemble the parts.



CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

- Thank you very much for reading the preview of the manual.
- You can download the complete manual from: [www.heydownloads.com](http://www.heydownloads.com) by clicking the link below



- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

**NOTE**

The lift bracket disassembly procedure is the same as for the duplex mast.

**Start by:**

With the lift bracket side facing up, place the mast horizontally on wood blocks. Place a wood block as a wedge to prevent the inner and middle masts from sliding.

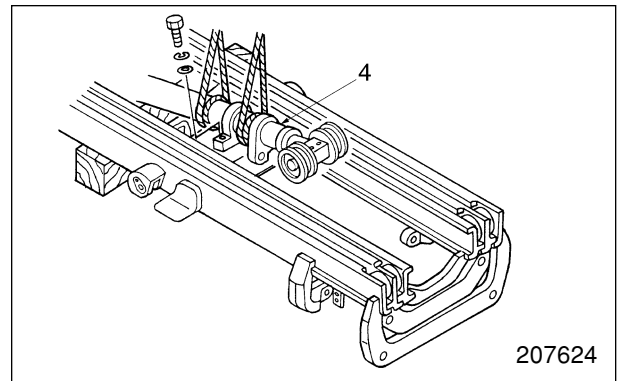
Before disassembling the mast and fork assembly, measure and record all clearances between each lift bracket and roller and between each mast and roller. Recorded measurements will be helpful when replacing rollers or selecting shims to adjust clearances. Refer to pages 9-30 through 9-33.

**Suggestions**

1. Removing first lift cylinder 4

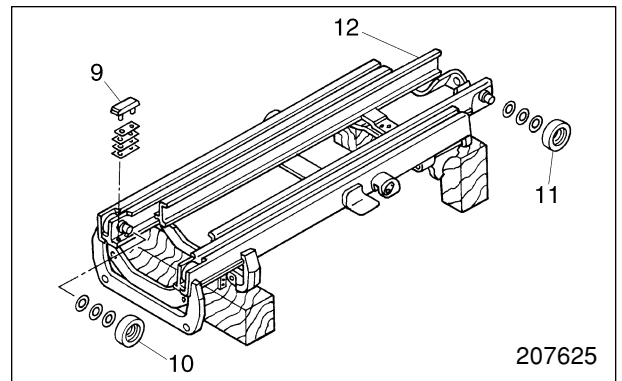
- (1) Remove retaining bolts from the first lift cylinder.
- (2) Hitch slings on lift cylinder 4, and gently remove the cylinder.

Use two slings. Wind or tie slings securely to prevent slipping.



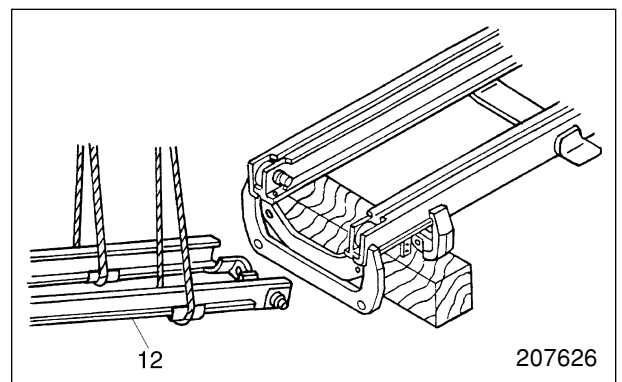
2. Removing inner mast and main rollers

Lower inner mast 12 until the main rollers can be removed. Remove main rollers 10, 11 and mast strips 9.



3. Removing inner mast

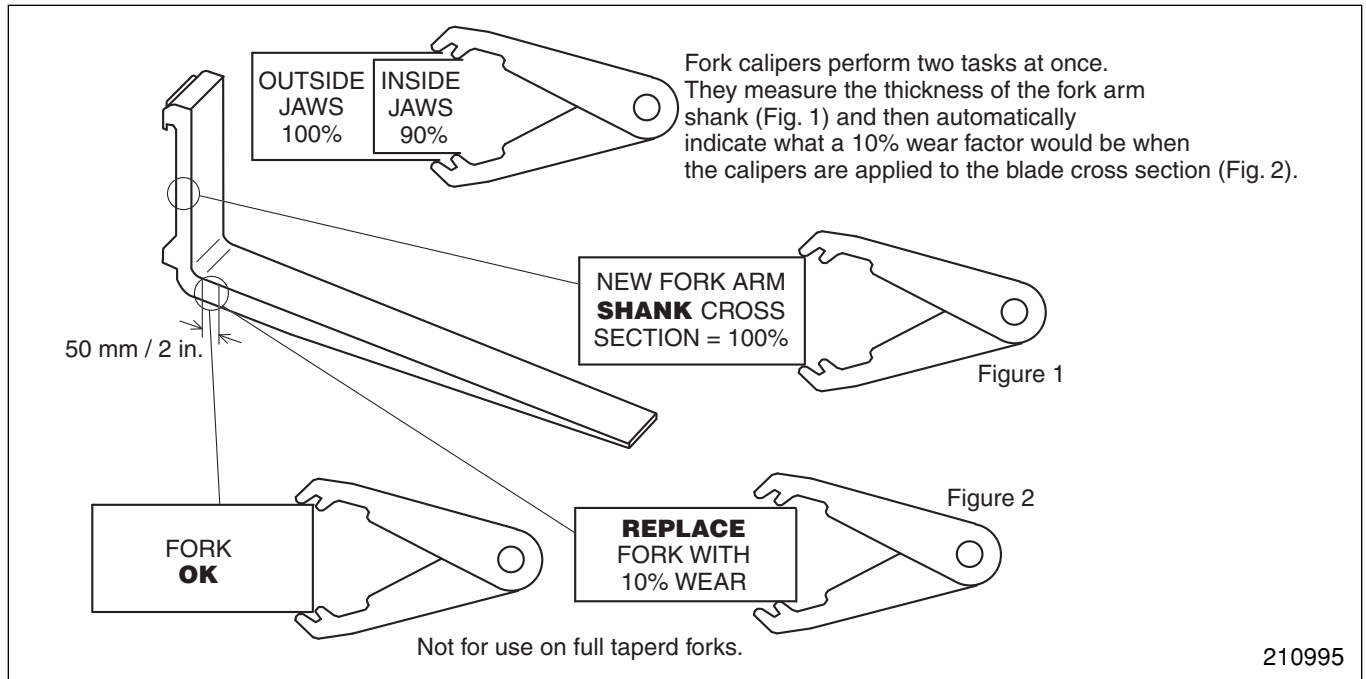
Using slings, lift and remove the inner mast 12, steering it clear of the roller shaft sections of the middle mast.



## Inspection and Adjustment

The inspection and adjustment in this chapter can be done without dismantling or disassembling. Conduct inspection whenever a defect is suspected.

### Forks (all mast models)



Forks are often mistreated and forgotten. As insubstantial as they seem, neglecting forks could make them dangerous.

Forks carry larger loads than almost any lifting device but there are no mandatory requirements for maintenance or inspection.

You can find thousands of extra parts for lift trucks in some fleet repair shops, but you'll seldom see spare forks. Even when all the trucks on the fleet are the same, fleet maintenance managers rarely order spare forks. Forks last a long time if treated properly, but they can deceive by looking as good from most viewing angles when they are worn as when they are new.

It's true that most forks are customized to the truck by model and capacity: they are big and heavy and thought of as indestructible. But forks can be abused or ruined in the course of daily work.

Here are some examples of ways that forks can be damaged:

- Forks can be overloaded either by picking up a load too far out on the forks, or simply by picking up loads heavier than the truck rating.
- Maintenance shops may bend forks back into shape, weld on them, or drill holes through them. Lift truck users can add attachments to the truck that stress the forks. Drum clamps and portable booms can be supported on the forks—but what is contained in the

drum or on the boom hook makes the safety difference.

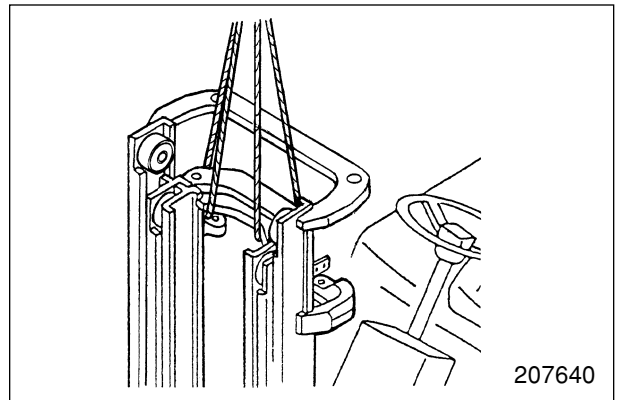
- Forks are often used to open rail car doors and break loads out or away from other loads. They are also used to pick up capacity loads not seated against the fork shank and to pick up off-balanced loads far from the side of the truck. The fork tips are sometimes inserted under other fork trucks to lift them during maintenance operations.
- Lift trucks may collide with building columns and walls, and though the forks show no discernible bend, they may be damaged beyond safety.
- Any time excessive heat is applied to any part of a fork—during repair, for instance—hidden damage may occur.

The fork itself is a concern but so are the hooks that secure them to the lift carriage.

### DESIGNED TO TAKE A BEATING

Forks for counterbalanced and straddle lift trucks are not just bent bars of steel. The manufacturing process is careful and precise with many checks and inspections critical to their safety. Some factors essential to fork manufacture include the steel, the bend and thickness of the heel, the welding of the hooks that hold them on the carriage, and the heat treatment of the finished product.

4. Position the middle mast lower than the outer mast by following operations.
  - (1) Lift the inner mast to the height of the middle mast, then place wood blocks for support.
  - (2) Hitch slings to both middle mast and inner mast, and suspend with a hoist.
  - (3) Remove set bolts from the upper sections of the middle mast lift cylinders, then lift the middle mast and inner mast.
  - (4) Remove two lift cylinder clamps, dismount the cylinders from the mounting sections at the lower outer mast section. Tilt the cylinders by moving the top sections towards the center of the vehicle, then secure the cylinders to the cross-member of the outer mast with a rope.
  - (5) Lower the middle mast and inner mast until main rollers can be removed.
  - (6) Place wood blocks under the middle mast and inner mast for support.
  - (7) Now the main rollers can be removed from the middle and outer masts. Remove the mast strips and shims in advance because they are apt to come off under this condition.



## Recommended Lubricants and Brake Fluid

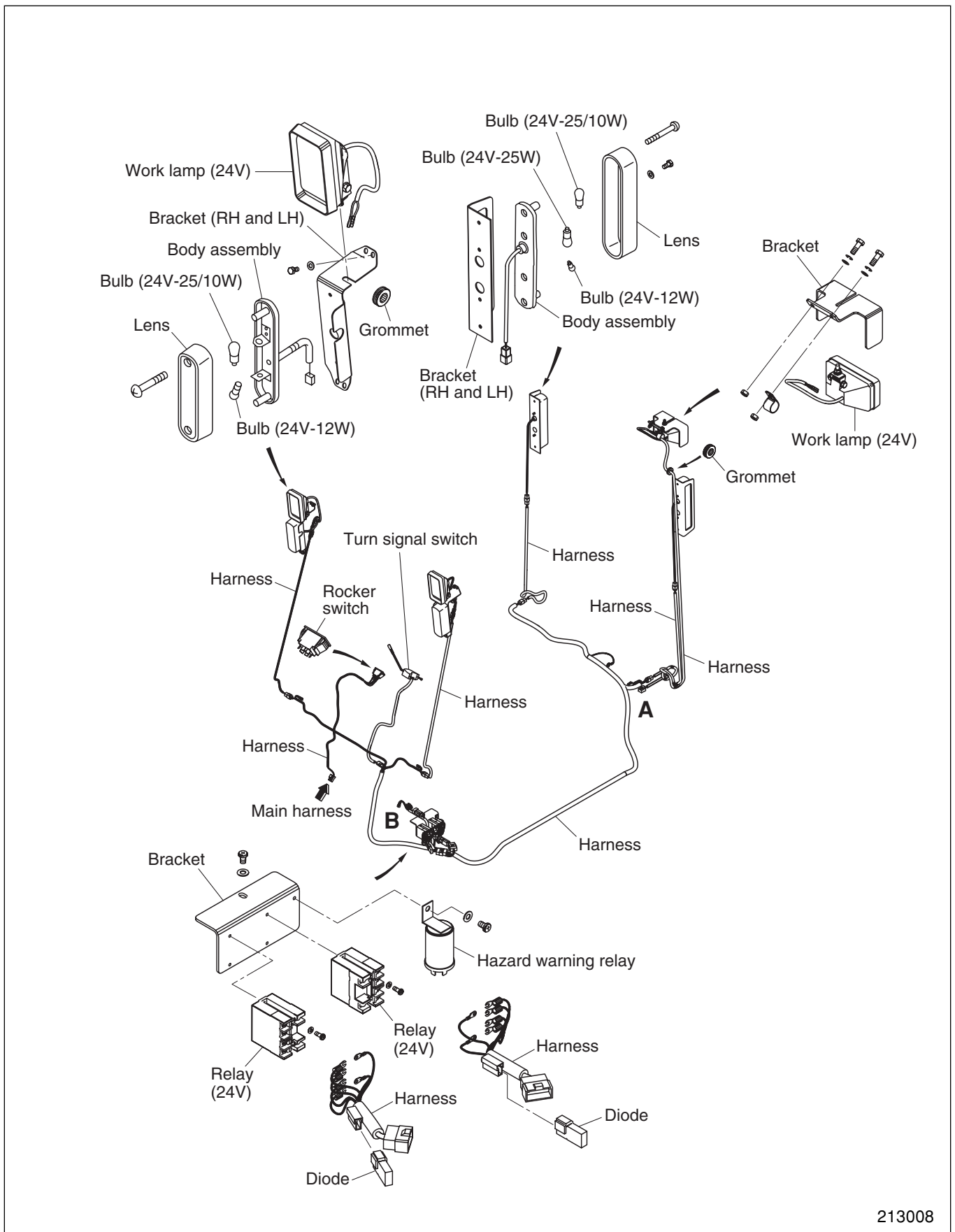
Lubricants/brake fluid	Specification	Recommendation for ambient temperature, °C (°F)						
		-30 (-22)	-20 (-4)	-10 (14)	0 (32)	10 (50)	20 (68)	30 (86)
Rear axle gear box oil	API GL-4 or GL-5 Gear oil	SAE 80W			SAE 80 to 90			
Hydraulic oil	Hydraulic oil	SAE 5W			SAE 10W			
Brake fluid	F.M.V.S.S. No. 116 – DOT 3 or DOT 4 (SAE J1703)							
Grease	Wheel bearings	NLGI No. 2 grade multipurpose type (lithium base), consistency: 265 to 295						
	Chassis	NLGI No. 1 grade multipurpose type (lithium base), consistency: 310 to 340						

**NOTICE:** Avoid mixing lubricants. In some cases, different brands of lubricants are not compatible with each other and deteriorate when mixed. It is best to stick with the same brand at successive service intervals.

## Refill Capacities (standard models)

Rear axle gear box	4.2 liter
Hydraulic tank	Normal level: 13.1 liter High level: 14.1 liter
Brake fluid reservoir	130 cm <sup>3</sup>

# Road Light Kit



213008



# Service Manual

## Controller

**EP10KRT PAC**    **ETB10A-10001-up**

**EP12KRT PAC**    **ETB10A-30001-up**

**EP15KRT PAC**    **ETB10A-60001-up**

Display Function.....	1 – 21
1. Normal operation display.....	1 – 21
2. Error display.....	1 – 22
3. Setup Option display.....	1 – 23
4. Self Diagnostic display.....	1 – 24
5. History folder display.....	1 – 25
Setup Option Function.....	1 – 26
1. Outline.....	1 – 26
2. Procedures for setting Setup Option.....	1 – 27
3. Details of Setup Options.....	1 – 29
Diagnostics Function.....	1 – 42
1. Outline.....	1 – 42
2. Operation procedure.....	1 – 42
Self Diagnostics Function.....	1 – 43
1. Outline.....	1 – 43
2. Procedure.....	1 – 44
3. Detail of Self Diagnosis.....	1 – 46
History Folder Function.....	1 – 54
1. Outline.....	1 – 54
2. Review the fault data.....	1 – 54
<b>Removal and Installation.....</b>	<b>1 – 55</b>
Inspection Before Replacing Controllers.....	1 – 55
1. Checking power supply.....	1 – 55
2. Checking inverter and DSP card.....	1 – 56
3. Checking logic card.....	1 – 57
4. Checking power supply card.....	1 – 58
5. Checking display unit.....	1 – 59
Discharging the Inverters.....	1 – 60
Replacing Inverter.....	1 – 61
Replacing DSP (Digital Signal Processor) Card.....	1 – 63
Replacing Logic Unit.....	1 – 65
Replacing Logic Card.....	1 – 66
Replacing Power Supply Card.....	1 – 67
<b>Basic Check.....</b>	<b>1 – 68</b>
Basic Items.....	1 – 68
Testing Tools.....	1 – 68
How to Lift Rear Wheel.....	1 – 69
Measurement of Card Voltage.....	1 – 69
Checking Contactor.....	1 – 73
1. Checking contactor coil.....	1 – 73
2. Checking contactor tip.....	1 – 73
Checking Inverter.....	1 – 74
Regeneration Check.....	1 – 75

## Function

### Traction Control Function

The line contactor closes when the following conditions listed below occur when the key switch is turned on. This enables the inverter to control the traction motor.

#### Conditions for closing line contactor

All the following must be satisfied.

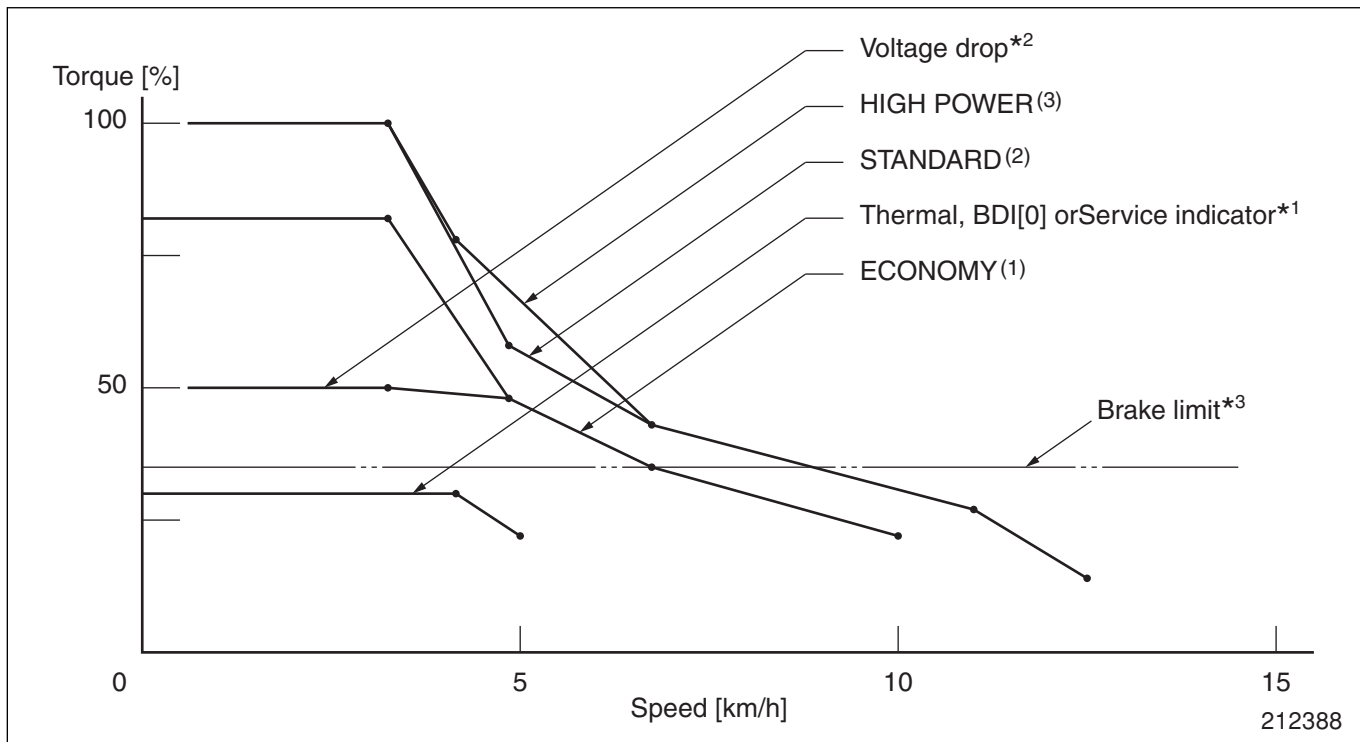
- The seat switch is turned on.
- The hydraulic operation is not performed (the hydraulic lever input does not occur).
- The traveling operation is not performed (the direction lever is placed to Neutral and the accelerator pedal is not pressed).
- Error related to the traveling and hydraulic operations does not occur.

### 1. Powering

#### (1) Normal traveling

Truck speed is controlled by pressing the accelerator pedal. The speed is also controlled by pressing the accelerator pedal when descending a grade and it is controlled only in the output torque range of the traction motor.

The controller supplies power to the traction motor according to the acceleration rate (set by SUO #8) and the torque characteristic (set by SUO #9) when the accelerator pedal is pressed. The controller returns power to the battery according to the deceleration rate and the torque characteristic that are set as fixed values when the truck is decelerated by returning the accelerator pedal (regeneration function).



\*1 Thermal, BDI [0] or Service indicator:  
Curve of limited torque under a condition of overheating, BDI [0] or maintenance time over.

\*2 Voltage drop: Curve of limited torque when battery voltage drops 16 volts or less.

\*3 Brake limit: Torque value resulting from reduction in current when the service brake or parking brake is applied.

### 5. Battery voltage monitor

This function restricts the traveling and lifting operations to protect the battery when the battery voltage drops.

Item	Traveling	Lifting
BDI level 1	Limits traveling power to "Economy."	Not limited
BDI level 0 and Battery voltage drops into range of 16V to 15V.	Limits traveling power. See "Powering" of Traction Control Function.	Limits lifting, and inhibits lifting operation during traveling.
Battery voltage drops less than 15V.	Stops truck (turns off line contactor). Error code: L0	

### #3 Top Lift Speed

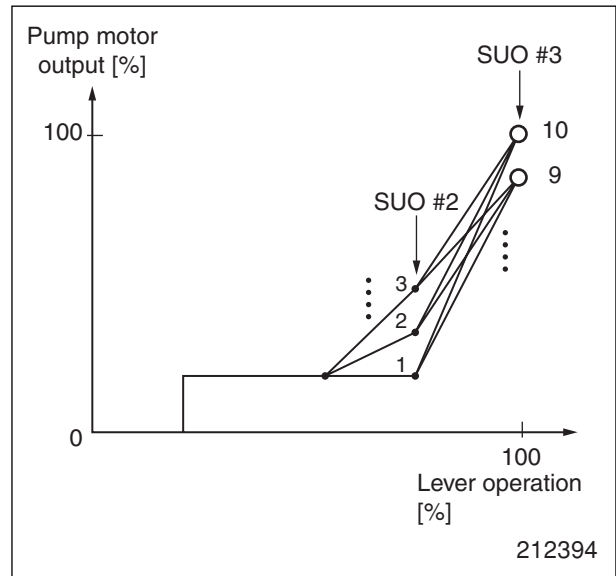
This setting affects pump speed when you pull the lift lever. If you set a smaller value than #2, then the #2 setting will be ignored.

Lifting speed will become faster if the value setting is increased.

The setting range is 1 to 10 for all models.

NOTICE: The setting range is 1 to 10 for all models and all modes.

But when #9 is set for “Economy”, maximum pump speed is reduced to about 85% of “Standard” or “High power”.



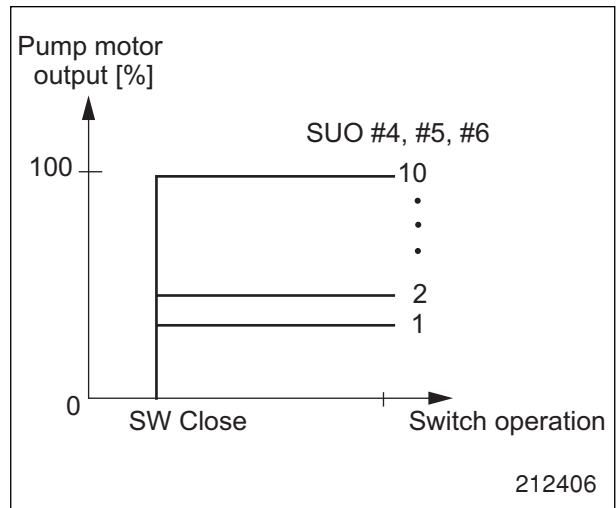
Pump motor output characteristics (lift-up operation)

### #4 Tilt Speed

This setting affects pump speed when you operate the tilt lever.

Tilt speed will be faster if the value setting is increased. The setting range is 1 to 10 for all models.

Tilt speed has priority over lifting speed, when the two levers are operated simultaneously.



Pump motor output characteristics (Tilt and attachment 1, 2 operations)

**CONTROLLER**

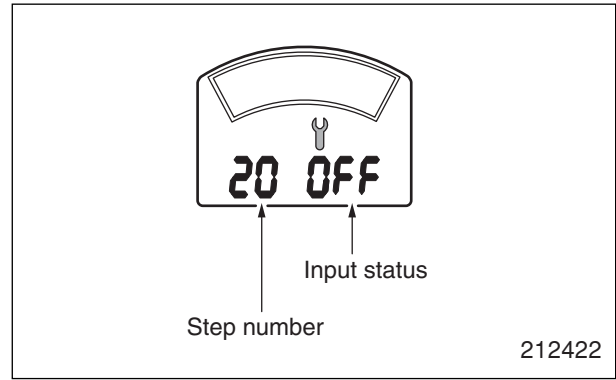
**Setup Options (Group 2)**

Option #	Title of Option	Description	Range	Default Value	Harness Pin No.
#11	Auxiliary Input for Lift 1	Not used	0 to 2	0	30
#14	Auxiliary Input for Lift 2	Not used	0 to 2	0	40
#17	Auxiliary Input for Lift 3	Not used	0 to 2	0	41
#20	Stall Timer	This option allows to shut down truck when the traction motor torque is too high.	2 to 10 [sec]	5	–
#21	Regen Adjustment for Brake Regen	5 steps for regen power on brake regen.	1 to 5	3	–
#22	Regen Adjustment for Lever Regen	5 steps for regen power on lever regen	1 to 5	4	–
#23	Regen Adjustment for Accelerator Regen	5 steps for regen power on accelerator regen	1 to 5	3	–
#27	Tire Size Adjustment	This option is used to adjust the amount of tire wear. It changes truck's speed recognition.	0 to 40 (Diameter -20 to +20 mm)	20 (±0 mm)	–
#30	Auxiliary Input for Travel Speed	When the auxiliary input signal is on, travel speed or traction power is limited at value of set. The amount of maximum speed is defined at #31. The amount of power reduction is defined at #32.	0: Disabled 1: Travel speed limit (switch closed) 2: Power reduction (switch closed) 3: Travel speed limit (switch opened) 4: Power reduction (switch opened)	0	31
#31	Auxiliary Maximum Travel Speed Setting	This option determines the maximum travel speed limit of #30.	5 to 14 [km/h] or 5 to 13 [km/h] (3)	8	31
#32	Auxiliary Output Power Limit	This option determines the output traction power limit in % of #30.	0 to 100 [%]	70	31

**Step 20 Power steering**

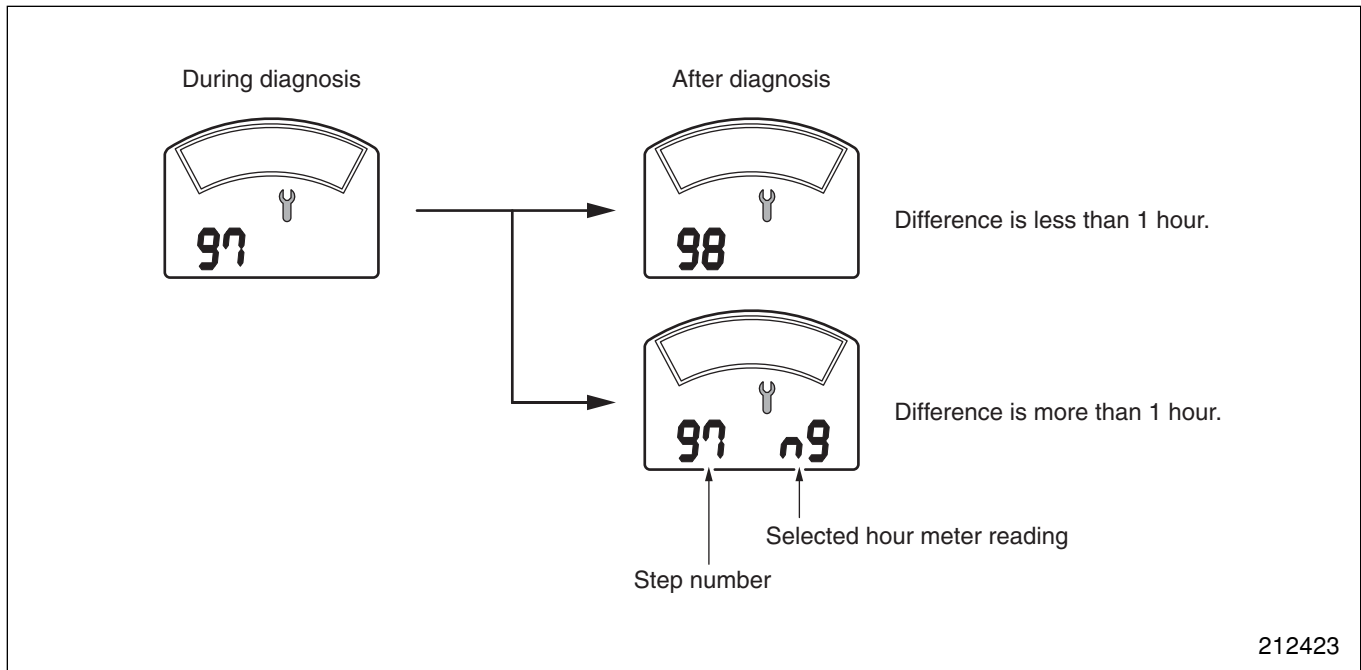
This step allows you to check the input signal from the steering pressure switch.

When the operator is seated, the pump motor starts rotating. Operate the steering wheel, so the status and the status of input signal from the steering pressure switch is indicated on the display. Check the indication on the display. The pump motor stops when the operator leaves the seat. Operate the DRS switch in positional order of DIAG→RUN→DIAG. “donE” appears on the display to end the self diagnostics.



**Step 97 Hour meter adjustment**

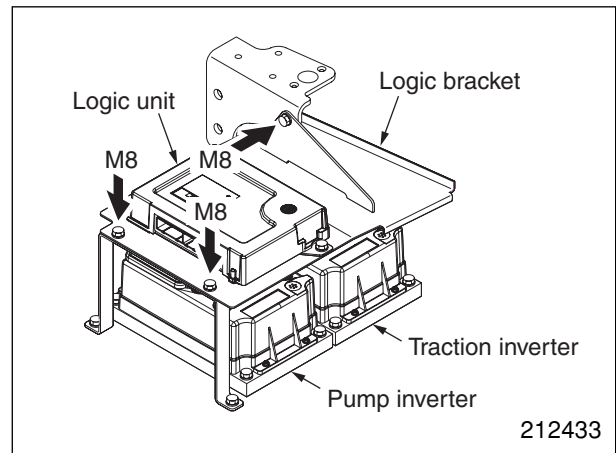
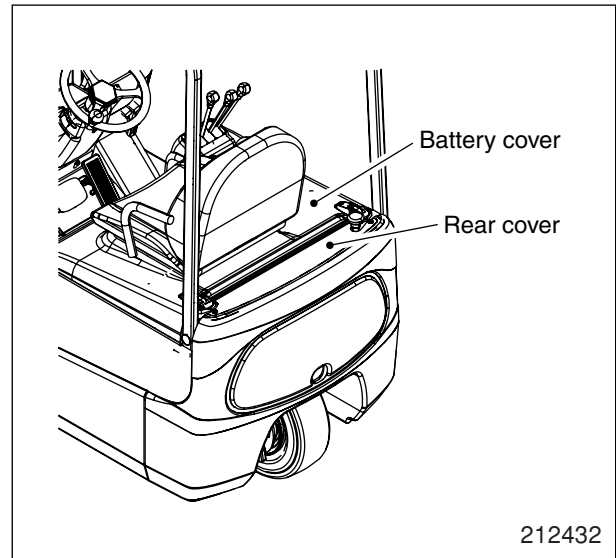
This step allows you to adjust the hour meter. If the difference in stored hour meter data between the display and logic unit is less than one hour, the self diagnostics check automatically proceeds to Step 98 Software version. If more than one hour, “97 ng” appears on the display, in which case, it is possible to select the display unit hour meter or logic unit hour meter as the reference.



## Discharging the Inverters

Discharge electric charges stored in the inverters by using the following procedure.

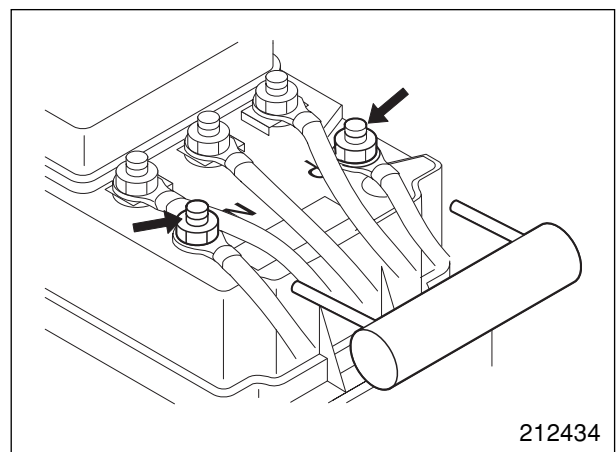
- (1) Turn off the key switch.
- (2) Disconnect the battery plug.
- (3) Remove the rear cover and open the battery cover.
- (4) Remove the logic unit. (See “Replacing Logic Unit.”)
- (5) Remove M8 bolts (three places) and remove the logic bracket.



- (6) Place a 150  $\Omega$ /25 W resistor between P and N terminals in the traction inverter to discharge electric charges stored in the inverter.
- (7) After touching the resistor to the P and N terminals for approx. five seconds, measure the voltage between the terminals with a multimeter and confirm a reading of 5 V or less.
- (8) Perform the same procedure for the pump inverter in order to discharge the all inverters.

Check whether the resistance between + and - of the battery plug on the truck side is 1 k $\Omega$  or more when connecting the battery plug for the first time after maintenance.

(Discharge electric charges completely before measuring. Longer measurement time reduces resistance value.)



## CONTROLLER

### • Logic card voltage chart

#### CN3

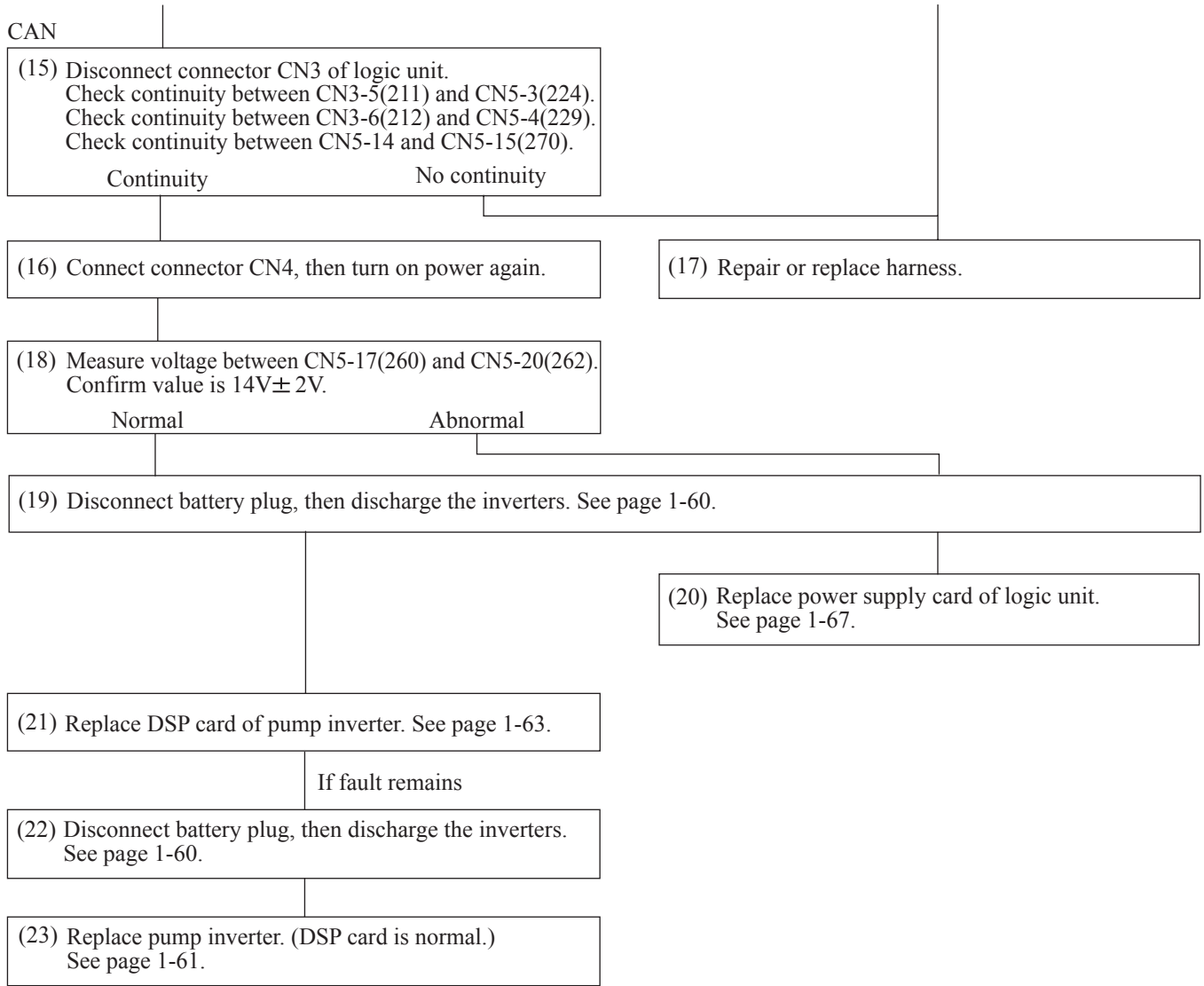
No.	Name	Stand-by voltage	Active voltage	Note
1	GND-L	0V	0V	
2	+15V-L	13.0V to 16.0V	13.0V to 16.0V	
3	GND-L	0V	0V	
4	+5V-L	5V	5V	
5	CAN_H	0 to 5V	0 to 5V	Do not measure the voltage between CAN and Logic GND terminal.
6	CAN_L	0 to 5V	0 to 5V	
7	BOOT	11.5V	0V	
8	FEW	11.5V	0V	
9	GND	0V	0V	
10	-			
11	-			
12	-			
13	-			
14	-			
15	-			
16	-			
17	TxD (GSE)	-	-	
18	RxD (GSE)	-	-	
19	POS VOLTAGE	Vbatt	Vbatt	Battery connector attached: Vbatt
20	ACCEL ANGLE	0V	0.2 to 4.8V	
21	-			
22	-			
23	GND	0V	0V	
24	+5V	5V	5V	
25	GND	0V	0V	
26	+5V	5V	5V	

Vbatt: Battery voltage

#### CN2

No.	Name	Stand-by voltage	Active voltage	Note
27	LIFT STROKE SENSOR	0V	0.1 to 4.9V	
28	-			
29	-			
30	LIFT LIMIT SW 3	11.5V	0V	
31	SPEED LIMIT SW	11.5V	0V	
32	SEAT BELT SW	11.5V	0V	
33	SEAT SW	11.5V	0V	
34	PARKING BRAKE SW	11.5V	0V	
35	SERVICE BRAKE SW	11.5V	0V	
36	REVERSE SW	11.5V	0V	
37	FORWARD SW	11.5V	0V	
38	BRAKE FLUID SW	11.5V	0V	
39	STEERING PRESSURE SW	11.5V	0V	
40	LIFT LIMIT SW 2	11.5V	0V	
41	LIFT LIMIT SW 1	11.5V	0V	
42	ACCEL IDOL SW	11.5V	0V	



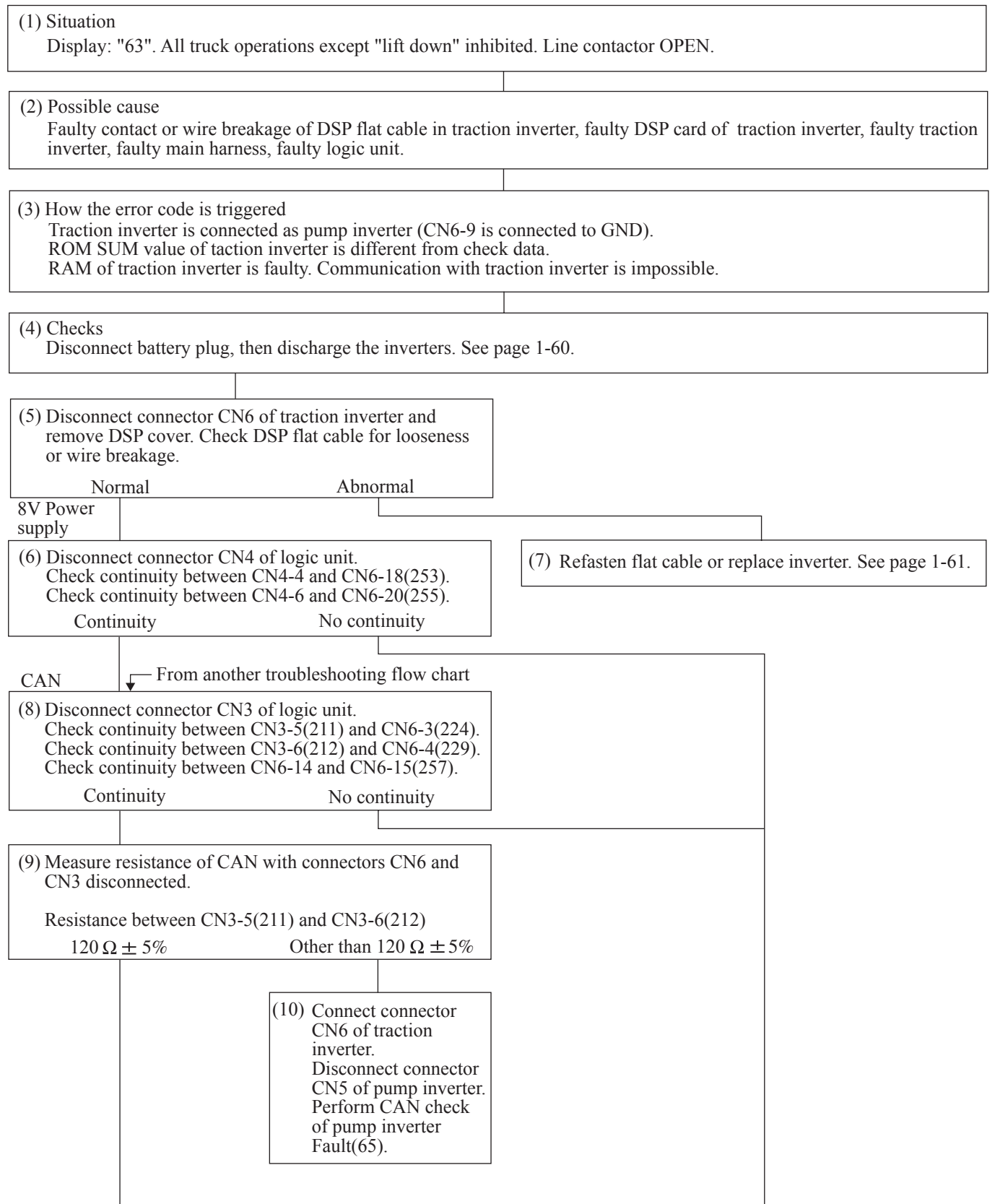




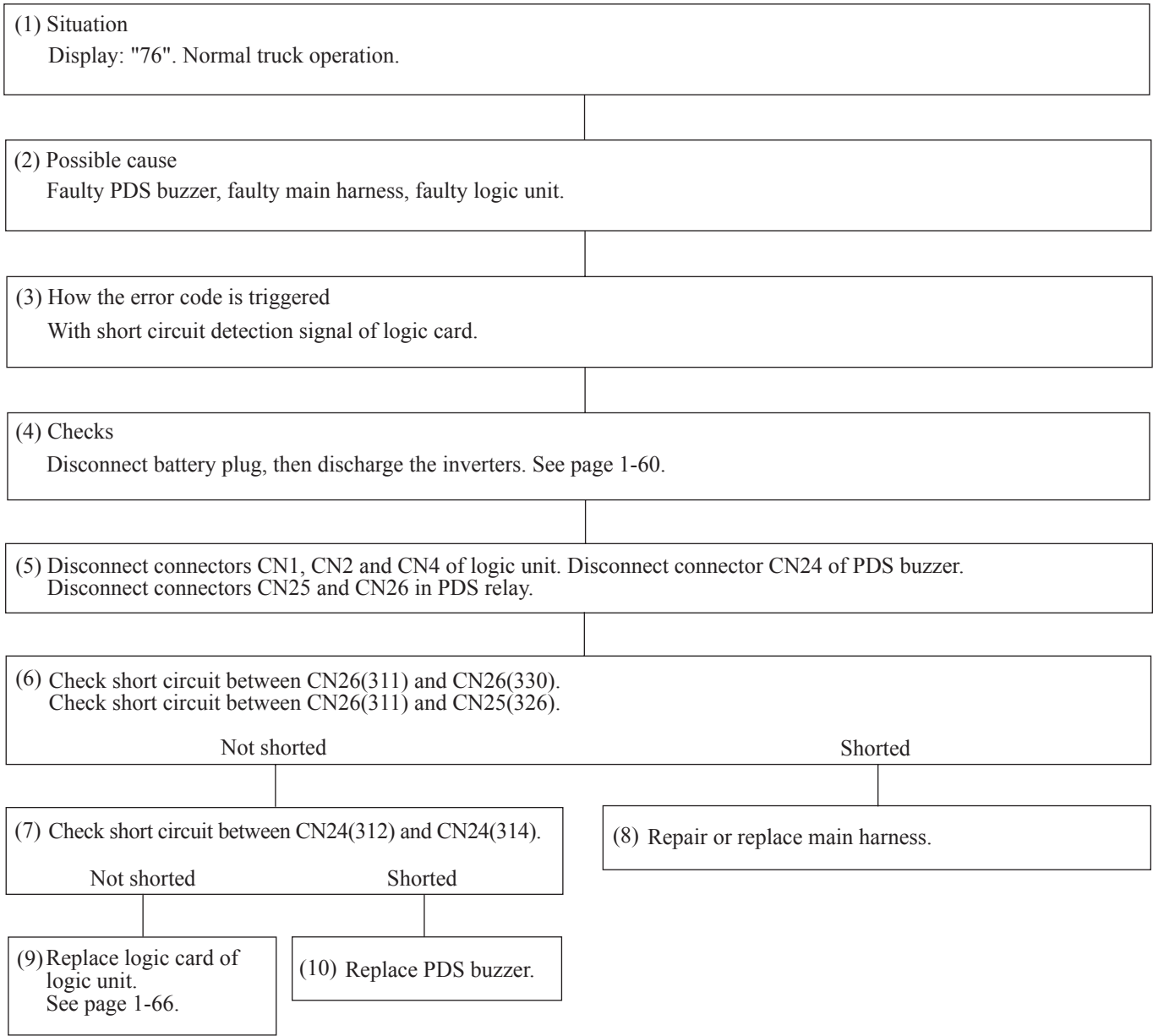




**Problem: Traction Inverter Fault (63)**

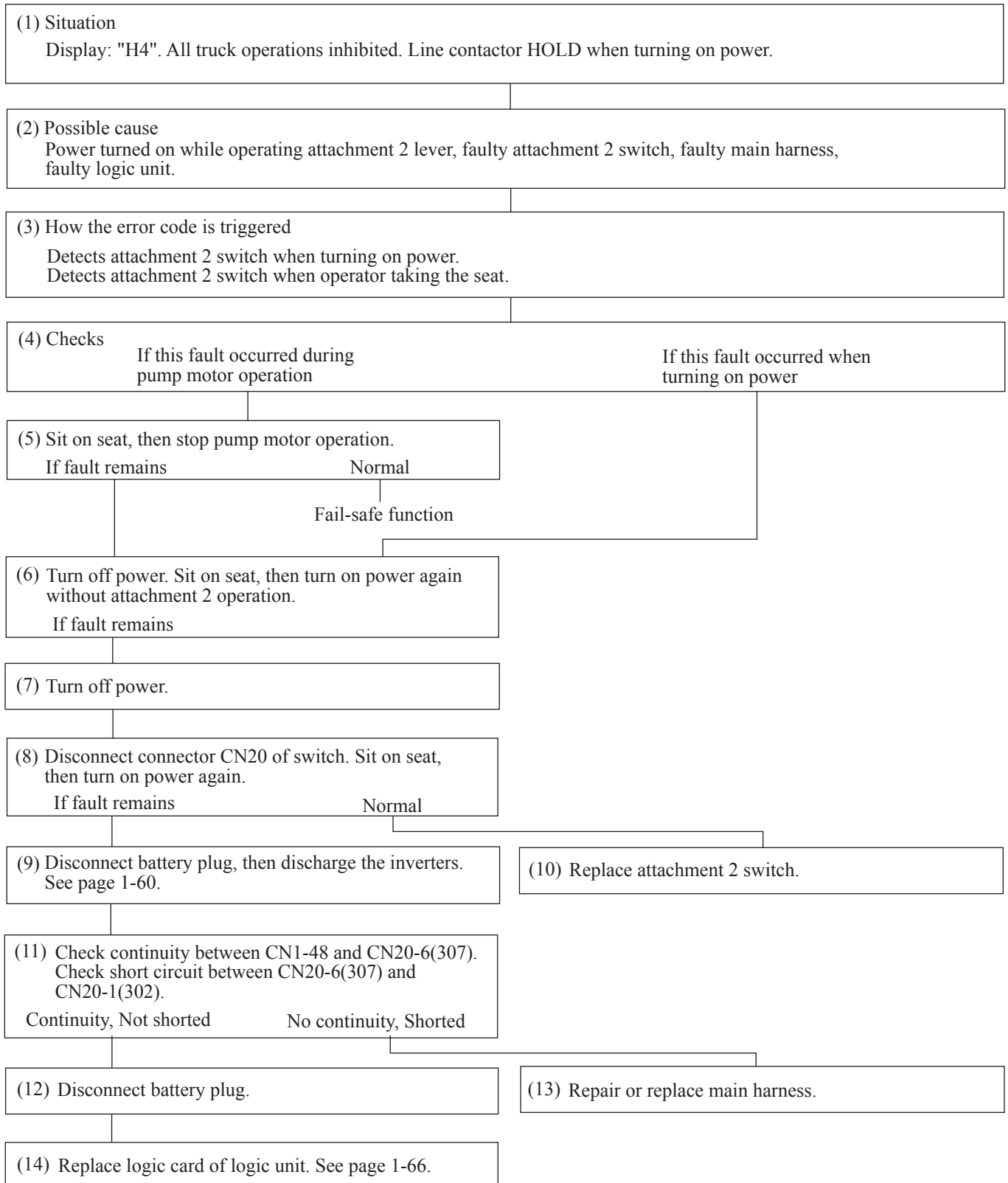


**Problem: PDS Buzzer Fault (76)**





**Problem: Attachment 2 Lever, Faulty Setting (H4)**



CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL

- Thank you very much for reading the preview of the manual.
- You can download the complete manual from: [www.heydownloads.com](http://www.heydownloads.com) by clicking the link below



- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

CLICK HERE TO **DOWNLOAD** THE COMPLETE MANUAL