MITSUBISHI FORKLIFT TRUCKS

Mitsubishi Caterpillar Forklift Europe B.V.
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Mitsubishi Forklift Trucks Service Manual FB10KRT PAC, FB12KRT PAC, FB15KRT PAC Chassis, Mast & Options 99759-5G100

MITSUBISHI FORKLIFT TRUCKS

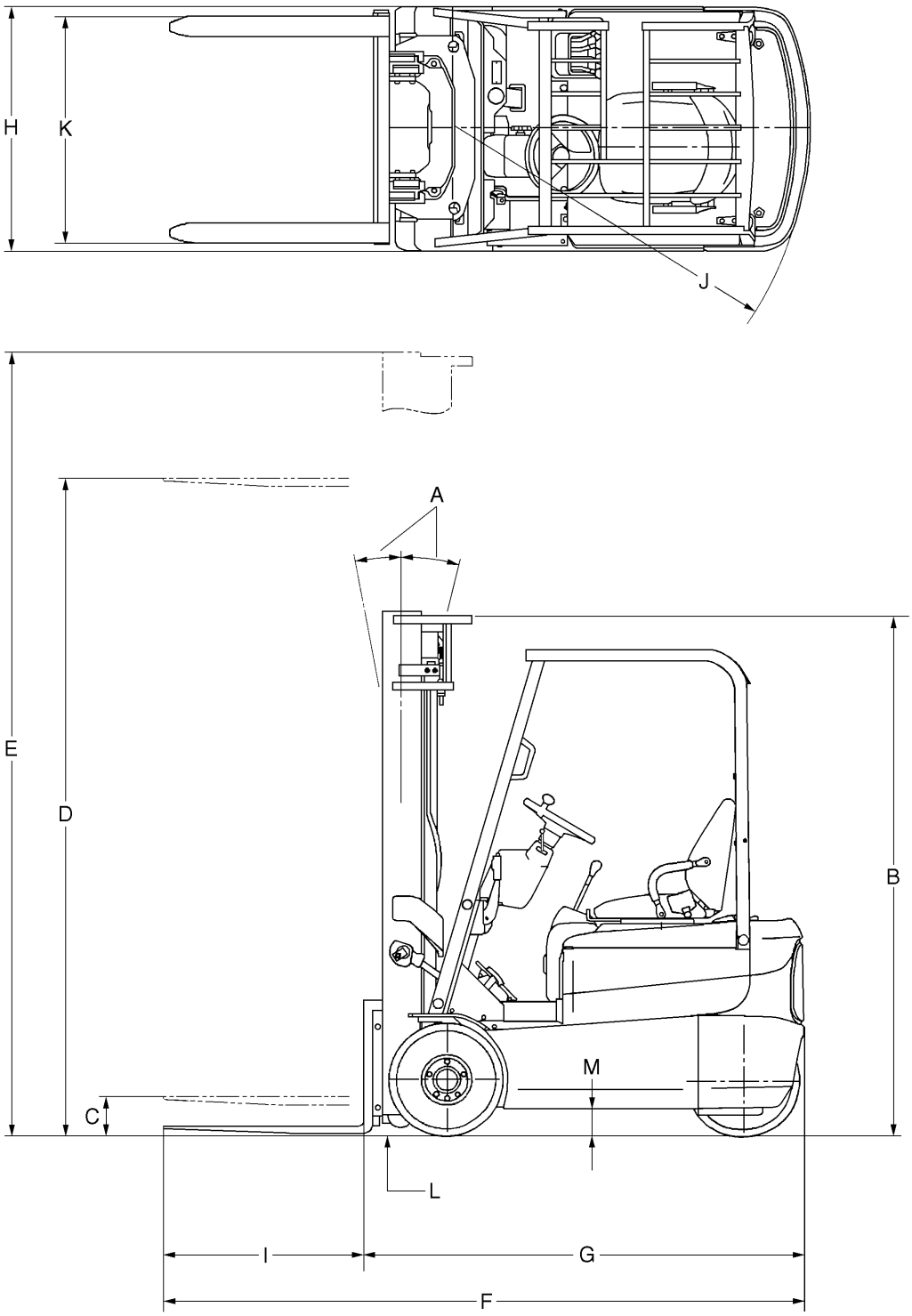
Service Manual

Chassis, Mast, & Options

FB10KRT PAC EFB10A-00011-up
FB12KRT PAC EFB10A-20001-up
FB15KRT PAC EFB10A-50001-up

99759-5G100

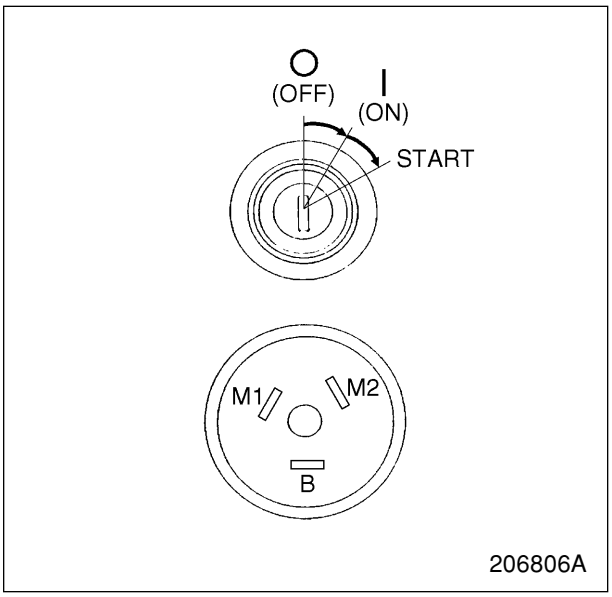
Dimensions



209011

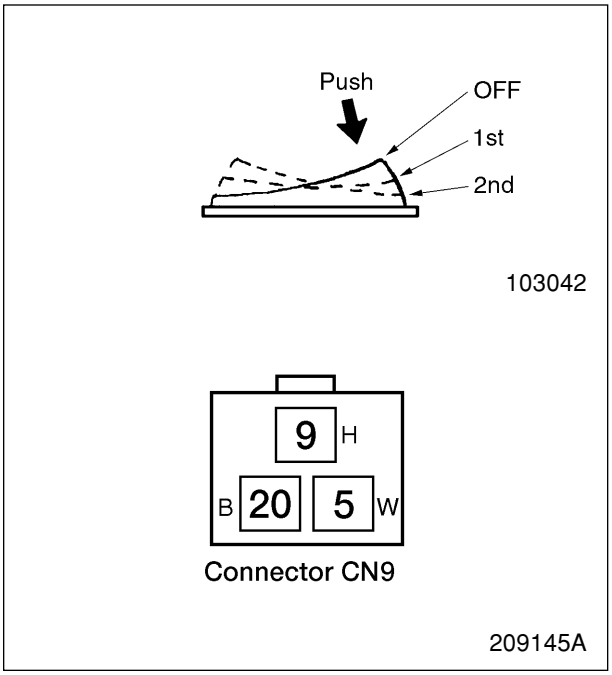
Key Switch

Terminal	B	M1, M2
Connection destination	Main fuse battery	Logic card
○ (OFF)		
I (ON)	○	○



Lighting Switch

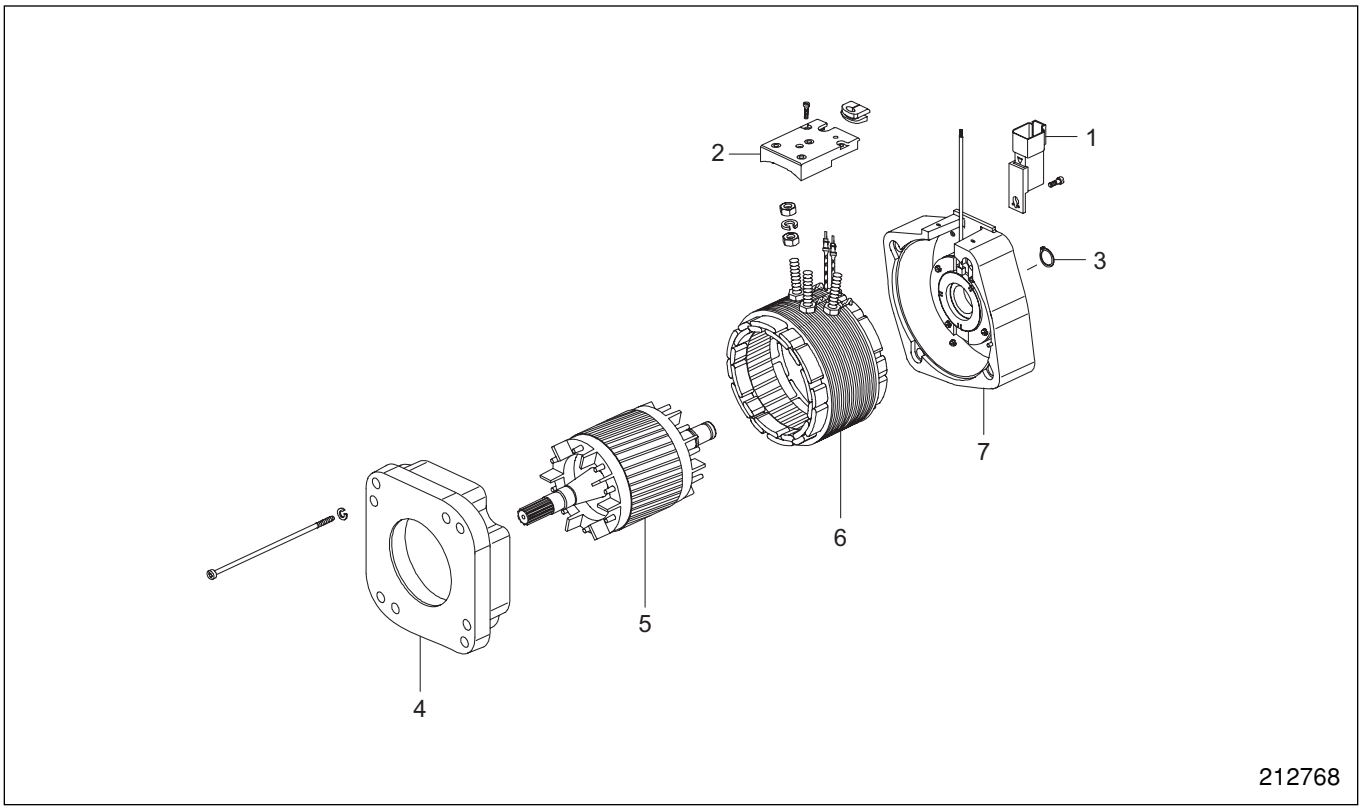
Terminal	B	W	H
Connection destination	Battery	Working lamp	Head lamps
1st position	○		○
2nd position	○	○	○



Disassembly and Reassembly

Disassembly

Drive Motor



Sequence

1 Connector
2 Connection plate
3 Snap ring
4 Drive end bracket
5 Armature
6 Stator
7 Brake end bracket

5. Preload adjustment and lock nut tightening

   Proceed as follows:

   (1) Tighten the inner nut 12 until the hub 4 can no longer be turned by hand. Then loosen it by 60 to 80°.

   (2) Rotate the hub several times to settle the bearing.

   (3) Tighten the inner nut securely, and measure the torque required to start the rotation of the hub. If the measured value is not within the specified limit, perform the preload adjustment again.

   To measure preload, attach a spring scale to a wheel bolt, then read the tangential force generated when the hub starts rotating.

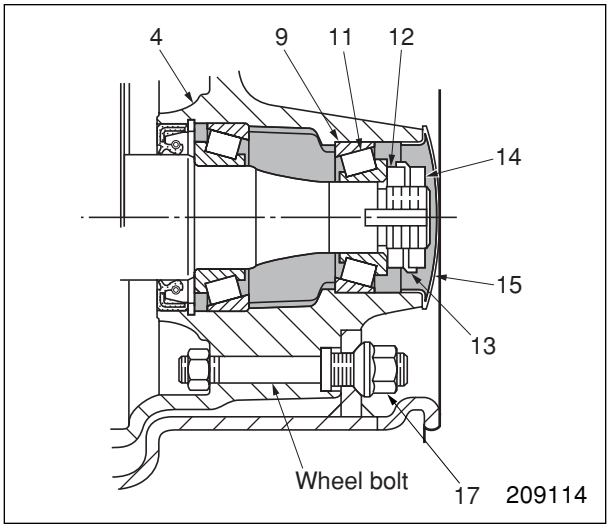
   (4) After adjusting the preload, tighten a new lock washer and an outer nut 14 to the specified torque.

   (5) Bend the lock washer 13 to both sides (inward and outward).

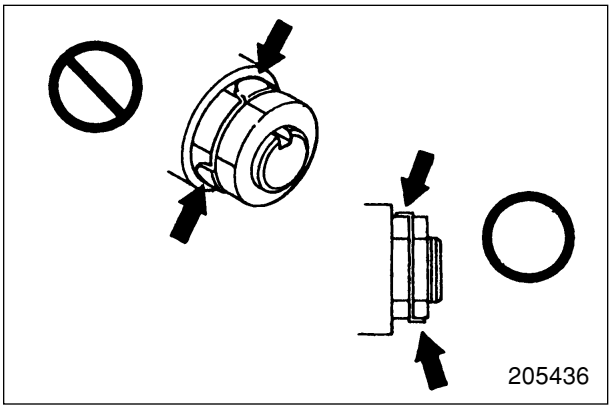
6. Fill the cap 15 with grease, and install the cap.

7. Install the solid tire assembly 16. Tighten the wheel nuts 17 to the following torque.

Wheel nut tightening torque	157 N·m (16 kgf·m)



Preload of hub bearing	2.9 to 4.9 N·cm (0.3 to 0.5 kgf·m)
Tangential force on hub bolt	40 to 68 N (4.1 to 7.0 kgf)
Outer nut tightening torque	157 N·m (16 kgf·m)



General Data

(1) Tightening torques

This tightening torque table is applicable only to the bolts used with a rear axle produced by ZF. For the standard tightening torques of the fasteners used with the components other than the rear axle, refer to "Group 12 Service Data".

Tightening torques for screws in N·m according to ZF-Standard 148

If not especially indicated, tightening torques can be taken from the following chart:

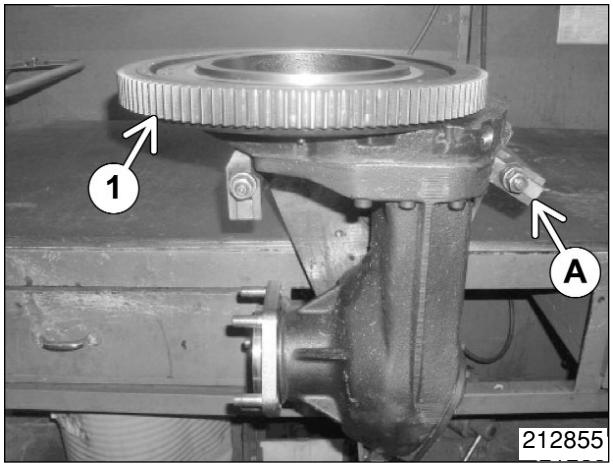
Metric ISO standard thread DIN 13, sheet 13				Metric ISO-fine thread DIN 13, sheet 13			
Size	**8.8**	**10.9**	**12.9**	**Size**	**8.8**	**10.9**	**12.9**
M4	2.8	4.1	4.8	M8 × 1	24	36	43
M5	5.5	8.1	9.5	M9 × 1	36	53	62
M6	9.5	14	16.5	M10 × 1	52	76	89
M7	15	23	28	M10 × 1.25	49	72	84
M8	23	34	40	M12 × 1.25	87	125	150
M10	46	68	79	M12 × 1.5	83	120	145
M12	79	115	135	M14 × 1.5	135	200	235
M14	125	185	215	M16 × 1.5	205	300	360
M16	195	280	330	M18 × 1.5	310	440	520
M18	280	390	460	M18 × 2	290	420	490
M20	390	560	650	M20 × 1.5	430	620	720
M22	530	750	880	M22 × 1.5	580	820	960
M24	670	960	1100	M24 × 1.5	760	1100	1250
M27	1000	1400	1650	M24 × 2	730	1050	1200
M30	1350	1900	2250	M27 × 1.5	1100	1600	1850
M33	1850	2600	3000	M27 × 2	1050	1500	1800
M36	2350	3300	3900	M30 × 1.5	1550	2200	2550
M39	3000	4300	5100	M30 × 2	1500	2100	2500
				M33 × 1.5	2050	2900	3400
				M33 × 2	2000	2800	3300
				M36 × 1.5	2700	3800	4450
				M36 × 3	2500	3500	4100
				M39 × 1.5	3450	4900	5700
				M39 × 3	3200	4600	5300

Friction coefficient: μ **total 0.12** for screws and nuts **without** aftertreatment as well as for **phosphatized** nuts.

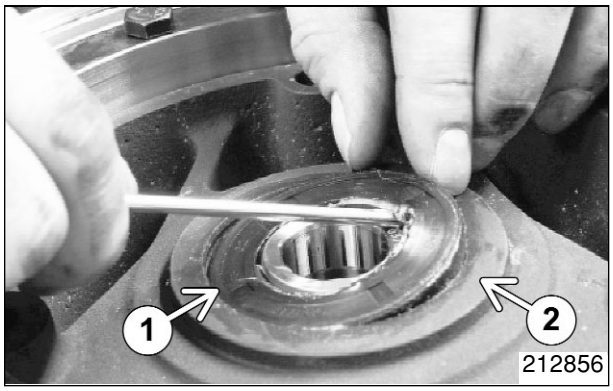
Tighten by hand!

2. Removal of Drive Pinion

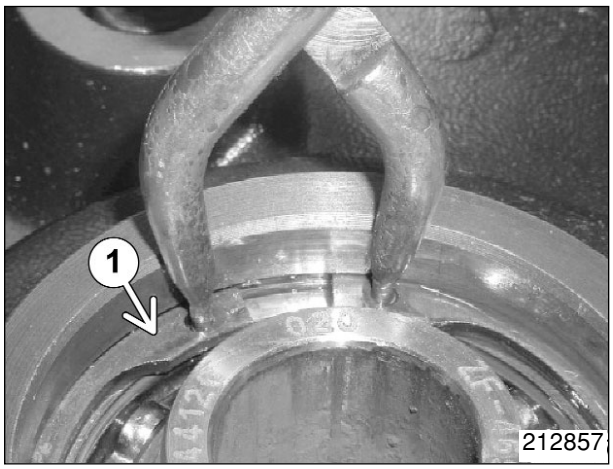
(1) Rotate the rear axle in the locating fixture A until the housing top section 1 faces upwards.



(2) Using a suitable tool, raise the radial shaft seal 1 to remove it out of the bore seat of the housing 2.



(3) Using a suitable tool, remove the retaining ring 1 from the housing bore.



Reassembly

1. Used Items and Symbols

You will find again all items used in the following sections and their calculations.

Item	Symbol
Width of a new bearing	b
Installation dimension	c
Difference dimension	d
Housing dimension	e
Housing difference dimension	f
Bearing slack	g
Clearance	h
Radius of the bearing	i
Length of measuring bush H	l
Width of an old bearing	o
Bearing width	t
Shim thickness lower bearing of bevel pinion shaft	x_1
Shim thickness upper bearing of bevel pinion shaft	x_2

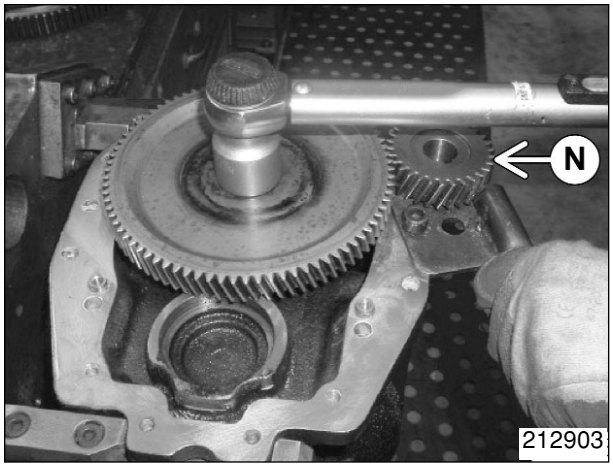
2. General Instructions for Reassembly

(1) Wash the metal parts clean with volatile cleaning solvent, and completely dry them with compressed air.

(2) Check all components for wear, damage and cracks. Replace components if necessary.

(f) While holding the helical gear with the gear lock N, tighten the new hexagon nut.

Tightening torque	150 N·m

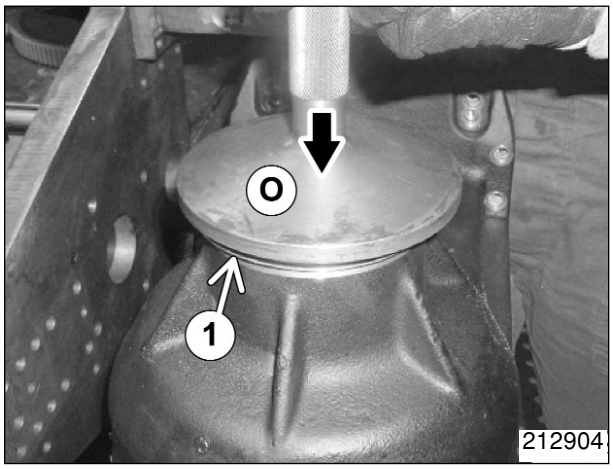


NOTICE: Do not damage the teeth of the helical gear when holding it. Damaged teeth might cause running noises later!

(5) Install the thread protective shield.

(a) Wet the gamma ring 1 evenly with LOCTITE 270 and put it on the housing neck.

(b) Force the gamma ring 1 into the housing neck using the striker mandrel O until it is seated completely.



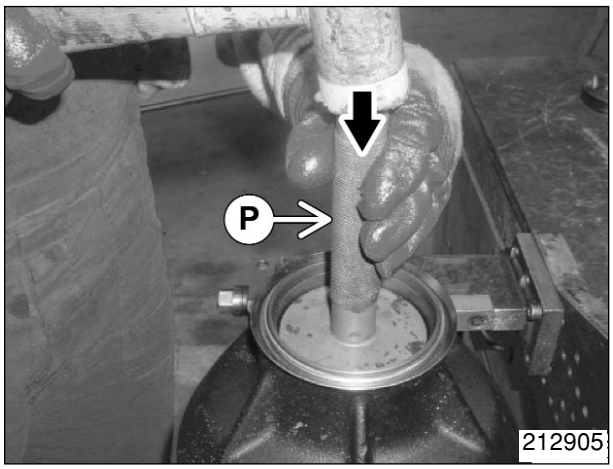
(6) Install the radial shaft seal.

NOTICE: (1) Pay attention that the radial shaft seal is not jammed during installation. Jamming seal will cause leakage.

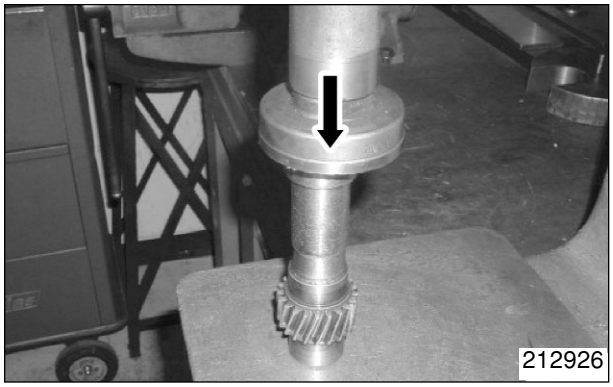
(2) Do not damage the sealing lip of the shaft seal!

(a) Apply a thin and even coat of LOCTITE 574 to the outer diameter of the shaft seal.

(b) Using the striker mandrel P, drive the shaft seal with the closed surface upwards into the housing seat until it bottoms out.

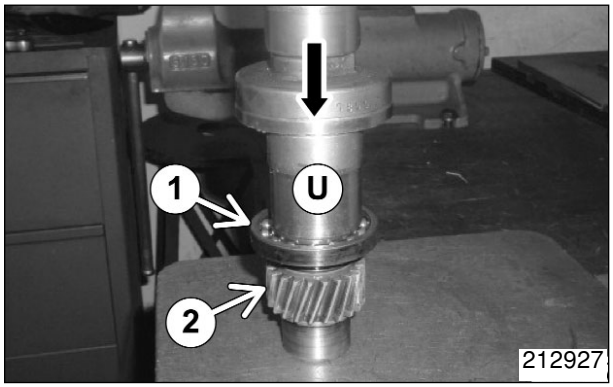


(b) Install the sealing cap under a press until it bottoms out (see below).



(4) Install the drive pinion.

(a) Using the sleeve U, install a new ball bearing 1 onto the drive pinion 2 until it bottoms out (see below).

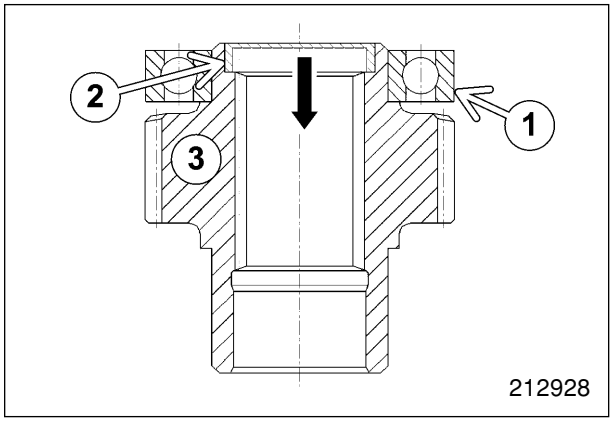


(b) Sketch (sectional view)

Ball bearing 1

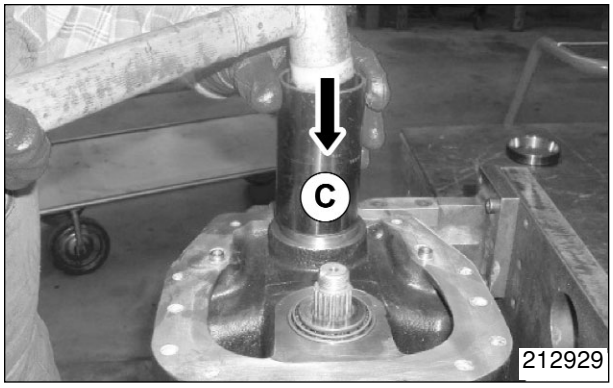
Sealing cap 2

Drive pinion 3



(c) Put the preassembled drive pinion into the housing with the sealing cap and ball bearing downwards.

(d) Using the sleeve C, install the drive pinion until it touches the bearing seat.



Troubleshooting

Refer to the “Post-Reassembly Tests” section (page 5-58).

Service Data

Manufacturer and model of the rear axle assembly:	Model GK25LD produced by ZF GOTHA GMBH
Manufacturer and model of the hydraulic motor:	Model TE0130CW260KAAD produced by PARKER
Standard of the chain:	DIN 8187-10B-1
Number of chain links excluding joint links at both ends:	67

Important setting data for the rear axle assembly

Bearing preload bevel pinion shaft:	0.02 to 0.07 mm
Bearing preload wheel shaft:	0.05 to 0.10 mm
Axial play input pinion:	0.1 to 0.4 mm
Torsional backlash, bevel drive:	0.03 to 0.11 mm
Max. bearing play pivoting bearing	0.03 mm

Tightening torques of the rear axle assembly

Hexagon nut for helical gear fastening:	150 N·m (15.3 kgf·m) locked by peening
Hexagon bolt on wheel shaft:	245 N·m (25 kgf·m)
Oil drain- and oil filler plug:	22 N·m (2.2 kgf·m)
Wheel nuts:	157 N·m (16.0 kgf·m)

If tightening torques are not separately indicated ref. is made to ZF-standard 148.

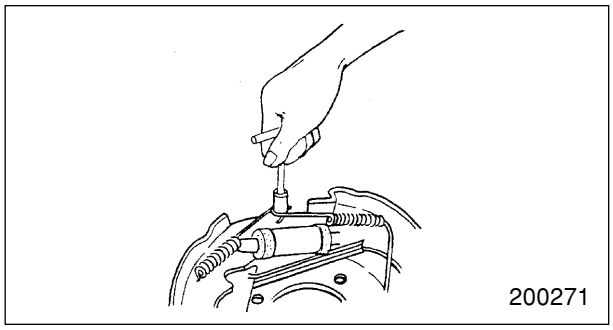
Suggestions for Disassembly

1. Removing return springs

Use the Spring Remover to remove the return springs.

Special tool needed

Spring remover	64309 - 15411

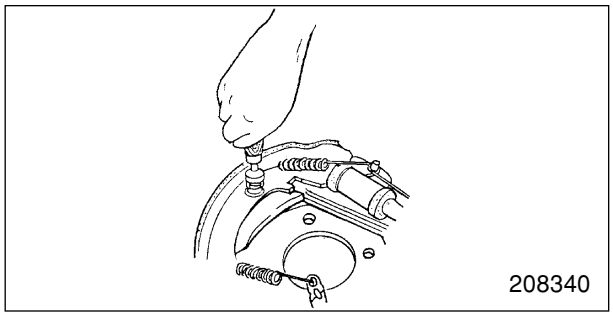


2. Shoe hold-down spring removal

Use the Spring Retainer to remove the shoe hold-down springs.

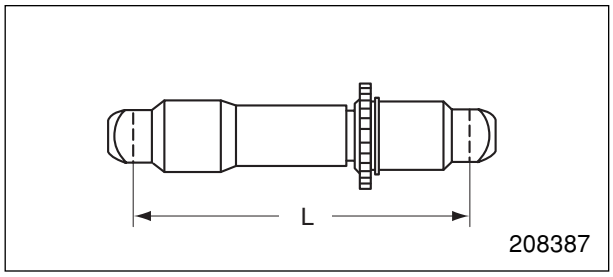
Special tool needed

Spring retainer	64309 - 15412



3. Adjusting screw

Measure and note the adjusting screw length L for reference during later reassembly.



Inspection after Disassembly

1. Backing plate

Check the backing plate for cracks.

2. Shoes and linings

(1) Check each shoe and lining for cracks.

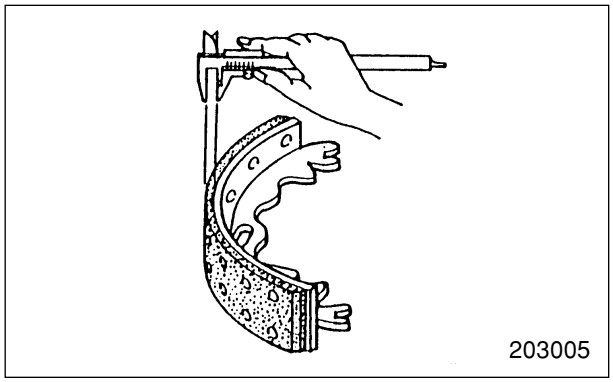
(2) Replace the shoe and lining assembly if it is fouled with grease matter, burnt or glazed.

(3) Check the thickness of the lining. Replace the shoe and lining assembly if it is worn to or in excess of the service limit.

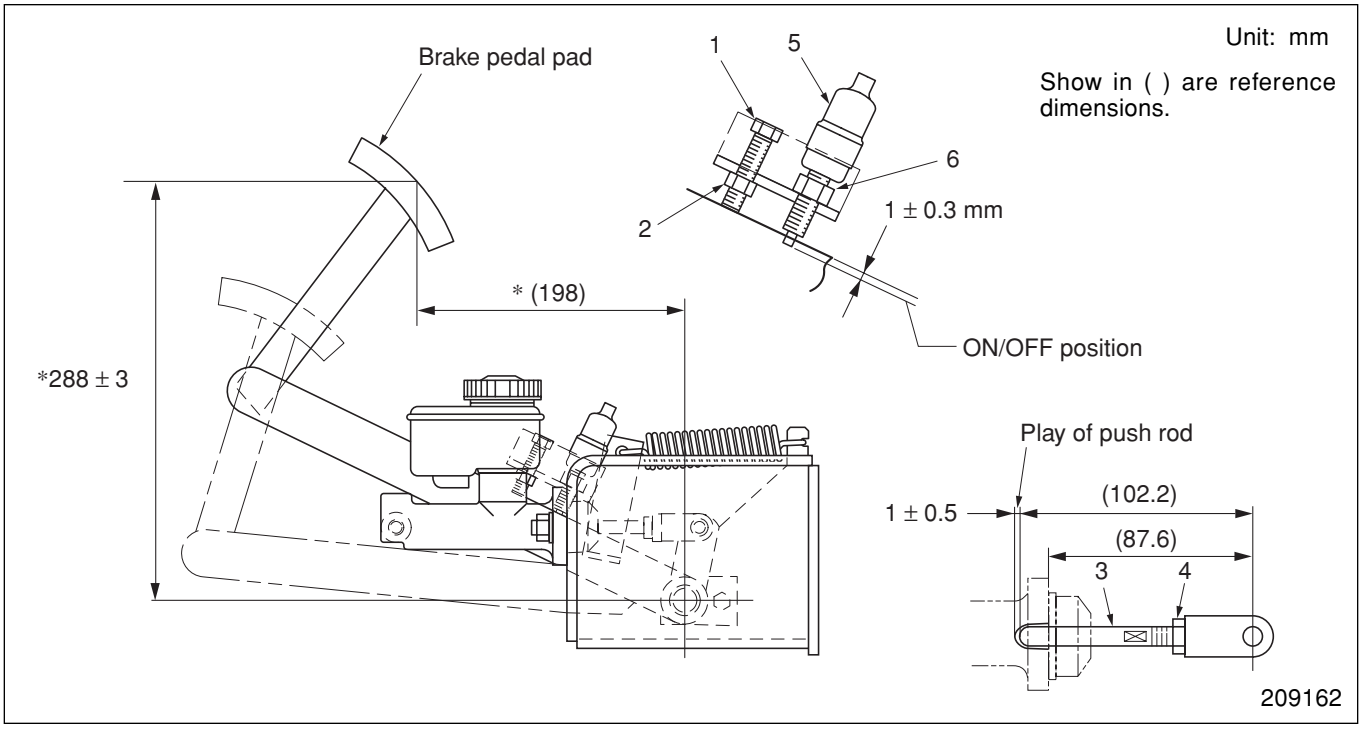
A: Standard value B: Repair or service limit

Unit: mm

Thickness of linings	A	4.88
	B	1.0



1. Brake Pedal Adjustment



Sequence

1 Stopper bolt
2 Lock nut
3 Push rod
4 Lock nut
5 Brake switch
6 Lock nut

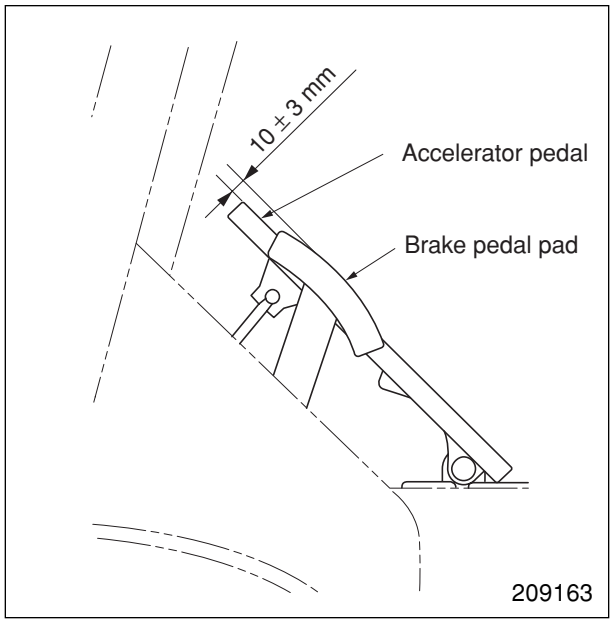
(1) Adjust the brake pedal pad position to the * marked dimensions using the stopper bolt 1.

(2) Check difference in height of the brake and accelerator pedals. The brake pedal should be higher than the accelerator pedal by 10 ± 3 mm.

If necessary, adjust the height of the brake pedal using stopper bolt 1. After adjustment, prevent the stopper bolt from turning using lock nut 2.

(3) Turn push rod 3 to adjust the clearance of its end from the piston to 1.0 ± 0.5 mm.

Retain the clevis in the adjusted position using lock nut 4. If correctly adjusted, the amount of movement of depressed pedal as measured at the top of the pedal pad should be 3 to 10 mm.



2. Brake Switch Installation

After the adjustment of brake pedal, adjust the brake switch 5 so that it activates when the brake pedal is pressed 6 to 13 mm. Then, tighten the lock nut 6.
The brake switch should turn ON and OFF with link lever movement of 0.7 to 1.3 mm.

The pressure oil from the hydraulic pump 1 enters the P port in the inlet section of the hydraulic control valve assembly. The oil is then distributed among the following three routes by way of the priority valve 2.

The first is the route through which the oil for operating the steering system is supplied. The oil flows through this route only while the steering wheel is being turned. The flow of oil is controlled such that a quantity of oil adequate to meet the requirement of the steering system is always supplied from the PF port to the system.

The second is the route through which oil flows when the steering system is not in operation. Letting oil flow through this route makes it possible for the spool 3 and the rotor valve in the steering valve 8 to be always ready for operating smoothly whenever operation of the steering system is commanded through steering wheel input. Oil flows through this route as follows: P → ⓒ → ⓓ → LS port → line 14 → steering valve 8 → T port → line 15 → Tank. Oil is flowing through this route at a low rate.

The third route is an "excess oil flow" route through which the P port oil remaining after flowing through the abovementioned two routes flows. The oil flows through passage EF to the mast control hydraulic system.

During operation of the truck, the flow rate and pressure of the P port oil, the PF port oil pressure and the steering resistance always change. The steering system must always be able to supply its hydraulic motor with oil in an amount proportional to a turning angle of the steering wheel regardless of such changes. The system achieves this as described below.

The priority valve 2, which is also called the "flow divider valve", uses the difference in pressure between the upstream and downstream of an orifice of the oil that flows passing through the rotary valve (a kind of variable throttle) in the steering valve 8 to control the flow of the PF port output oil that is directed to the steering valve. (In the following description, the oil pressures before and after the orifice are called the "PF port pressure" and "LS port pressure", respectively.)

The spool 3 in the priority valve operates as follows:

The PF port oil enters the chamber ⓩ through the orifice ⓔ of the check valve 5, pushing right the spool 3. The spool is also pushed left by the LS port oil and the spring 4. The drawing on page 7-2 shows the position of the spool 3 in this condition.

When the steering wheel is turned and pressure oil is flowing to the steering valve, the PF port pressure is higher than the LS port pressure.

The differential pressure then pushes right the spool 3 until it balances with the spring force; the spool stays there.

When the steering wheel is turned quickly, i.e., the variable throttle formed in the steering valve is narrowed only a little, the pressure difference between the PF port and LS port pressures is small. The spool 3 then moves left, opening the passage ⓐ wide and allowing flow of pressure oil in large amount from the PF port to the steering valve 8. The spool stays at a position determined by the amount of the differential pressure.

When the steering wheel is turned slowly, the variable throttle in the steering valve is narrowed to an extent that the differential pressure between the PF port and LS port pressures is significant.

This large differential pressure forces the spool 3 right, which narrows the passage ⓐ and allows pressure oil to flow at a restricted rate determined by the balance of the forces acting on both ends of the spool to the steering valve.

Check valve 5 affects the manner in which the spool 3 moves. When the spool 3 moves right, the check valve 5 blocks the passage ⓕ, causing pressure oil to flow only through the orifice ⓔ into the chamber ⓩ.

When the spool 3 moves left, on the other hand, the oil can flow out of the chamber ⓩ through both orifice ⓔ and passage ⓕ without restriction by the check valve 5. This enables the spool 3 to move left much quicker than when it moves right.

The function of the check valve 5 helps to supply oil responsively to demands by the system and prevent hunting of the spool 3; this assures smooth operation of the steering system.

Reassembly

Follow the disassembly sequence in reverse.

Start by:

(1) Replace worn or defective parts.

(2) Wash all metal parts and blow dry.

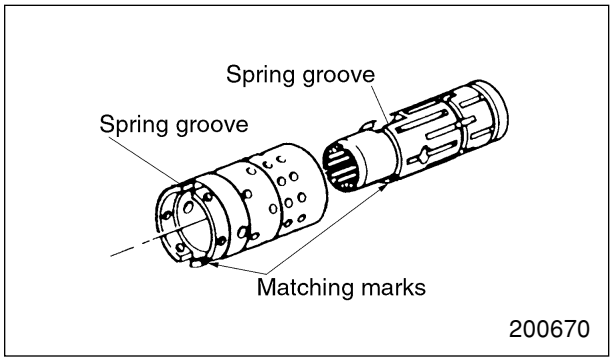
(3) Replace O-rings and seals.

(4) Apply grease to O-rings and other sealing parts.

Suggestions for Reassembly

(1) Control spool and sleeve assembling

Put the spool in the sleeve with the spring groove in alignment with the spring groove in the sleeve. Make sure the marks put during disassembly are in alignment.



NOTE

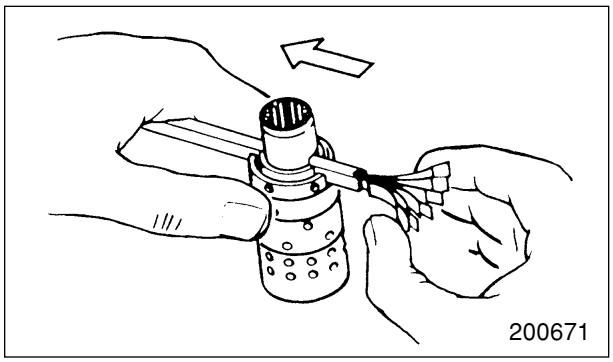
Make sure the spool rotates freely in the sleeve.

(2) Centering spring installation

Hold two sets of three springs back to back. Using Spring Inserting Tool, put these sets of the springs in the groove with the bevel ends at the bottom.

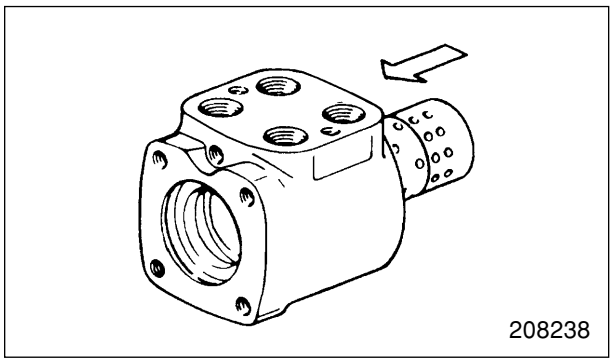
Special tool needed

Spring inserting tool	97157 - 00100



(3) Control spool and sleeve assembly installation to housing

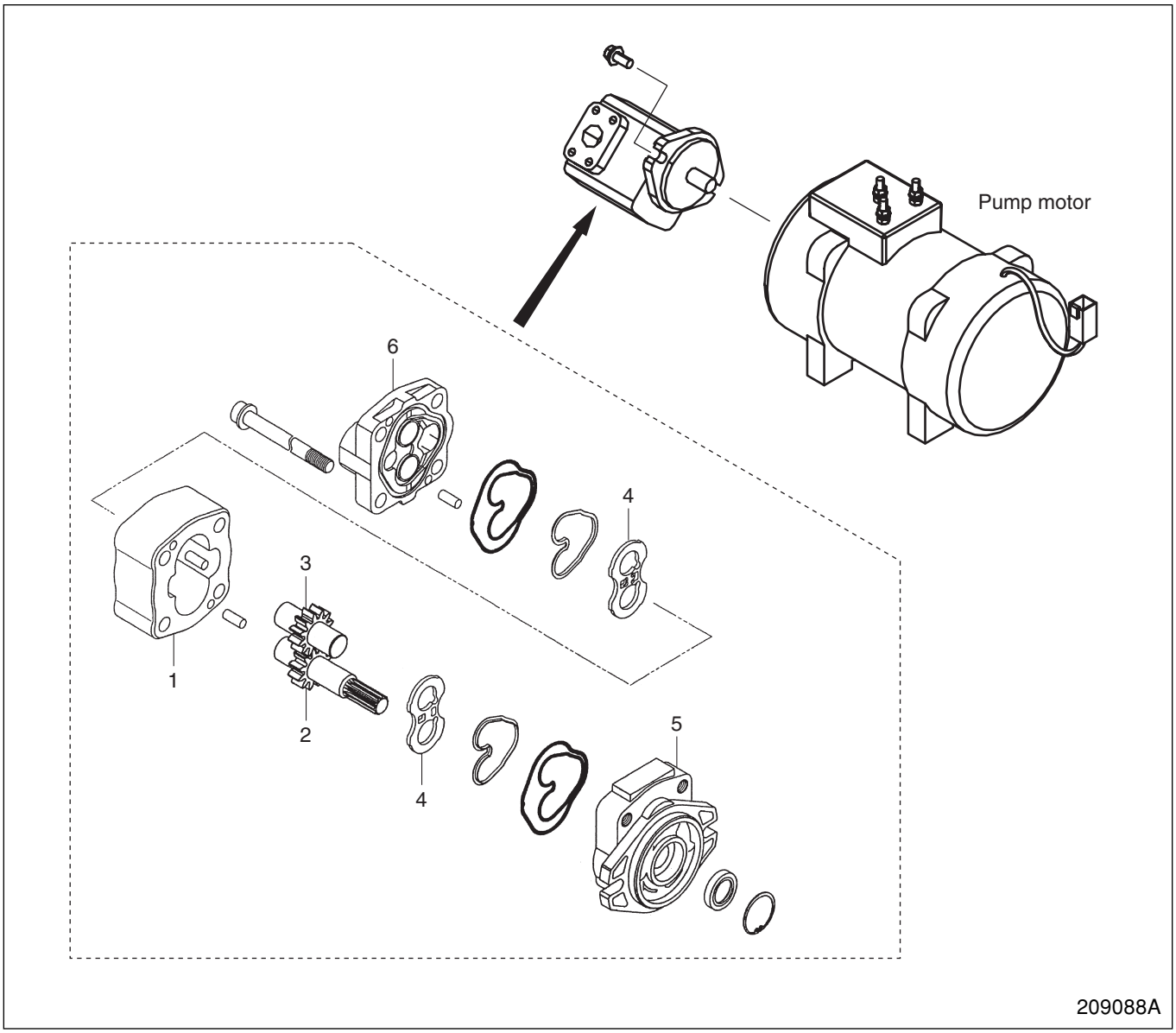
Put the pin in the holes in the spool and sleeve. Put the control spool and sleeve assembly in the housing from the rear side while rotating it in both directions with the pin kept level with center of the spool.



NOTE

Make sure the rear end of the spool and sleeve assembly is even with the rear end of the housing.

Hydraulic Pump



Main Parts

1 Gear plate
2 Drive gear
3 Driven gear
4 Side plate
5 Mounting flange
6 Cover

The hydraulic pump is a gear pump, driven by a pump motor.

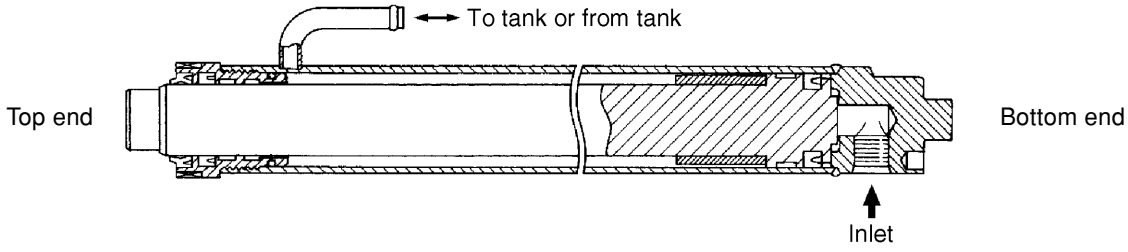
The drive gear 2 is splined to the armature shaft of the pump motor.

With a high-pressure gear pump, oil tends to leak from the high-pressure side to the low-pressure side through clearances at the ends of each pump gear (internal oil leakage). This leakage reduces pumping efficiency (or pump's volumetric efficiency).

Lift Cylinders

Lift cylinder

Type 1: Simplex mast and triplex mast second cylinder



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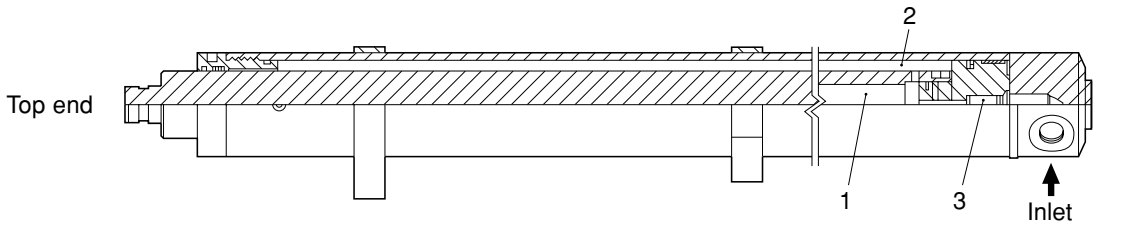
Type 2: Duplex and triplex mast first cylinder



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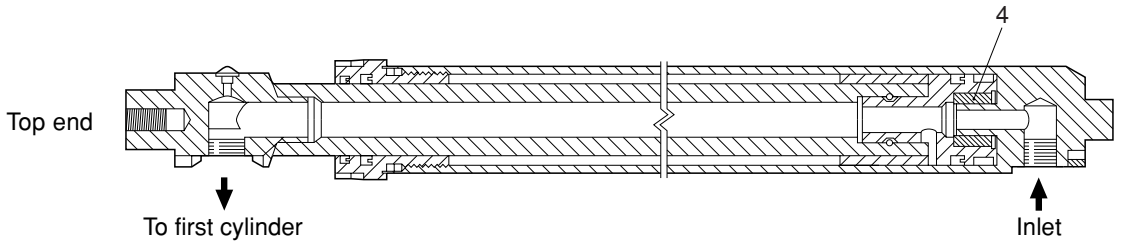
Type 3: Duplex mast second cylinder



000825C

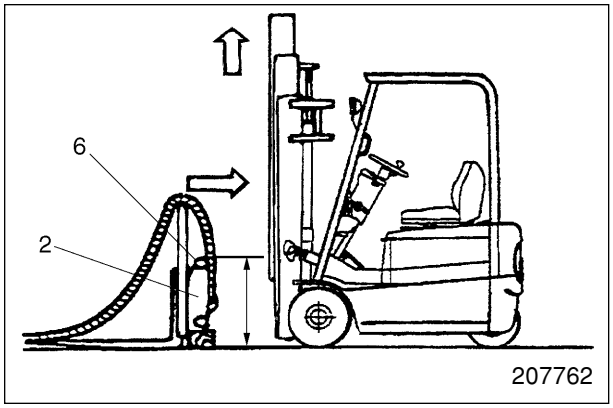
The lift cylinders (first cylinder and second cylinder) are of the single-acting type. The type 1 cylinder shown in the drawing above is used as the simplex mast's lift cylinder and as the triplex mast's second cylinder. When oil flows in from the bottom end, the rod is extended. Oil in the space between the rod and cylinder tube returns to the tank. When the rod moves downward, air from the tank is drawn into this space.

The type 2 cylinder is used as the duplex and triplex masts' respective first cylinders. When oil flows in from the bottom end, the rod is extended. Air and oil (mostly air) are contained in a chamber 1 inside the rod and in the space 2 between the rod and cylinder tube. As the piston moves upward, the oil in the chamber 1 and space 2 opens the check valve 3 and flows out of the inlet port. When the piston moves downward, the space 2 becomes empty.

The type 3 cylinder is used as the duplex mast's second cylinder. Oil flowing in from the bottom end first flows through a passage in the rod toward the first cylinder (see part 2 above). When the first cylinder's rod has been extended fully, the second cylinder's piston moves upward.

Part 4 is a down-stroke cushioning mechanism. This mechanism prevents the piston from bottoming hard against the head just as the rod completely retracts. This is achieved by narrowing the oil flowing gap between the piston and head further as the piston moves downward.

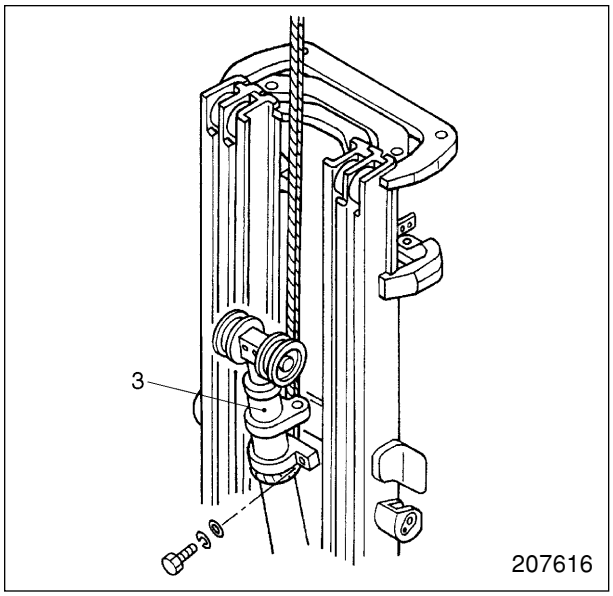
(2) Position the mast upright. Raise the inner mast until main rollers 6 of lift bracket assembly 2 become free. Then, slowly move the vehicle in reverse to separate from lift bracket 2.



2. Removing first lift cylinder 3

(1) Hitch a sling to first lift cylinder 3, and suspend the cylinder with a hoist. Wind the sling securely to prevent slipping.

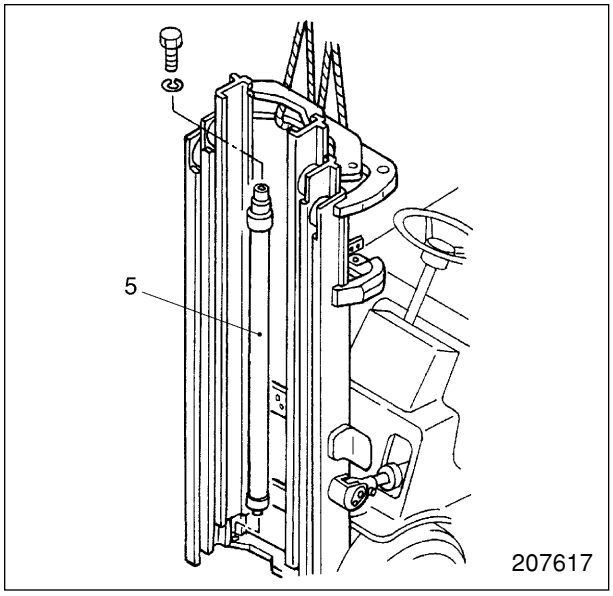
(2) Remove the lift cylinder connecting and mounting bolts, and gently dismount first lift cylinder 3.



3. Removing second lift cylinders 5

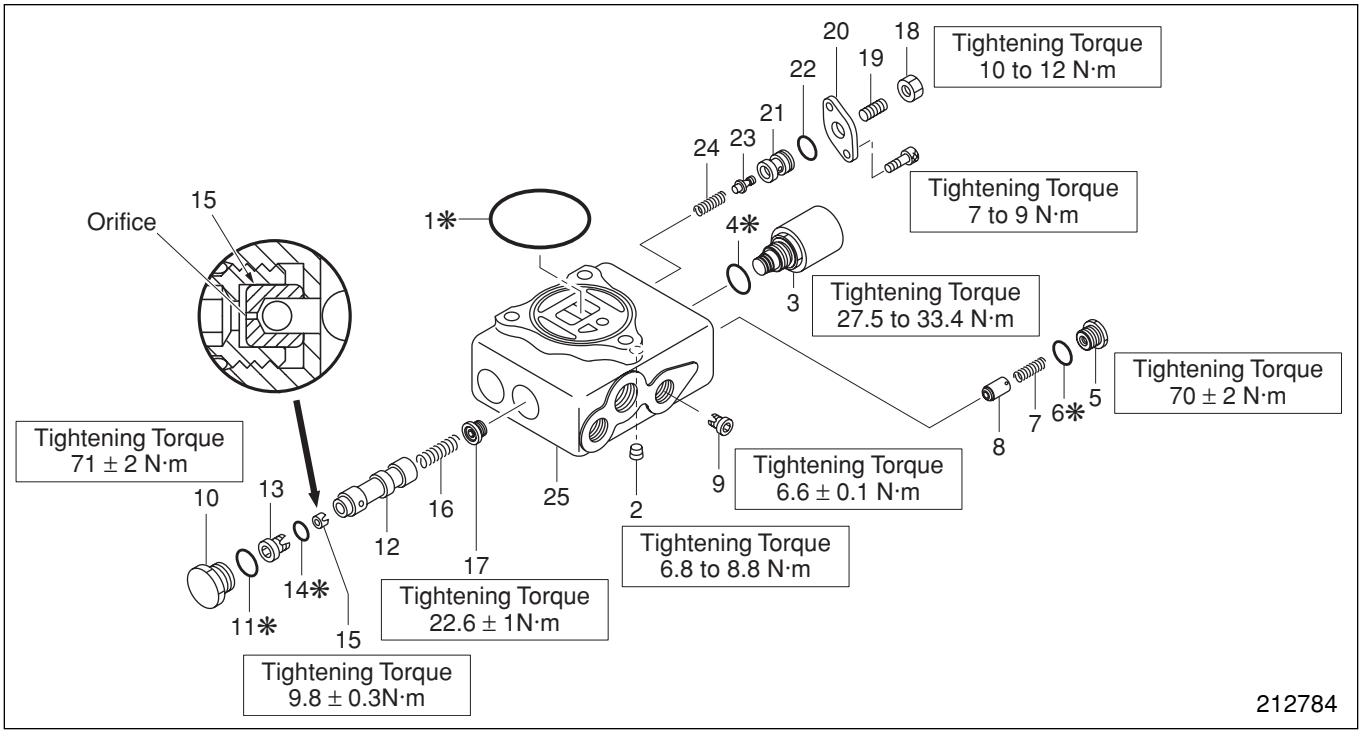
(1) Disconnect hoses from second lift cylinders 5.

(2) Remove stopper bolts at the upper sections of second lift cylinders 5, and lift the inner mast (duplex mast) or middle mast (triplex mast) approximately 550 mm using slings.



Inlet Valve Section

Disassembly and Reassembly



Disassembly sequence

1	O-ring	6	O-ring	11	O-ring	16	O-ring	21	Housing
2	Plug	7	Spring	12	Spool	17	Plug	22	O-ring
3	Solenoid vave	8	Poppet	13	Plug	18	Nut	23	Poppet
4	O-ring	9	Plug	14	O-ring	19	Set screw	24	Spring
5	Plug	10	Plug	15	Check valve	20	Plate	25	Inlet housing

NOTE

It is recommended that parts marked with ✻ in the drawing above be replaced with new parts whenever the inlet valve section is disassembled. These parts are available as a repair kit.

NOTE

Housing 21, O-ring 22 and poppet 23 are available only as an assembly. They are not supplied individually.

Suggestions for Disassembly and Reassembly

(1) Do not attempt to disassemble the steering system relief valve (consisting of parts 18 to 24) unless it is appearently faulty. Turning the set screw 19 will change the set pressure.

(2) Refer to page 8-32 for the general rules to be respected during disassembly and reassembly of the inlet valve section.

(3) Install the check valve 15 with their ends pointing in the correct directions as shown in the drawing above.

Suggestions for Disassembly

Removing bushing

Wrap the cylinder with a rag, and clamp it in a vise. Using a wrench, remove the guide bushing from the cylinder.

Inspection after disassembly

1. Cylinder tube

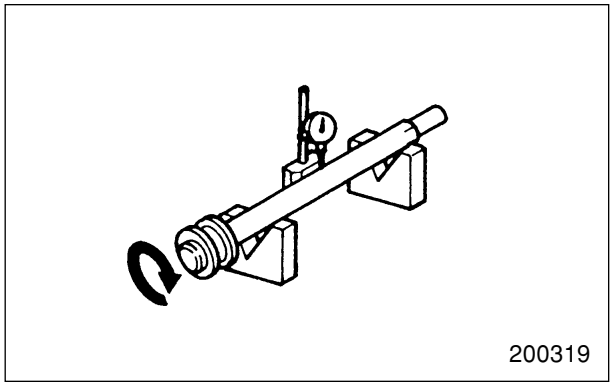
(1) Check the bore wall for wear, grooving, scratch marks and rusting.

(2) Check the welds for cracks.

2. Piston rod

(1) Check for deflection as shown.

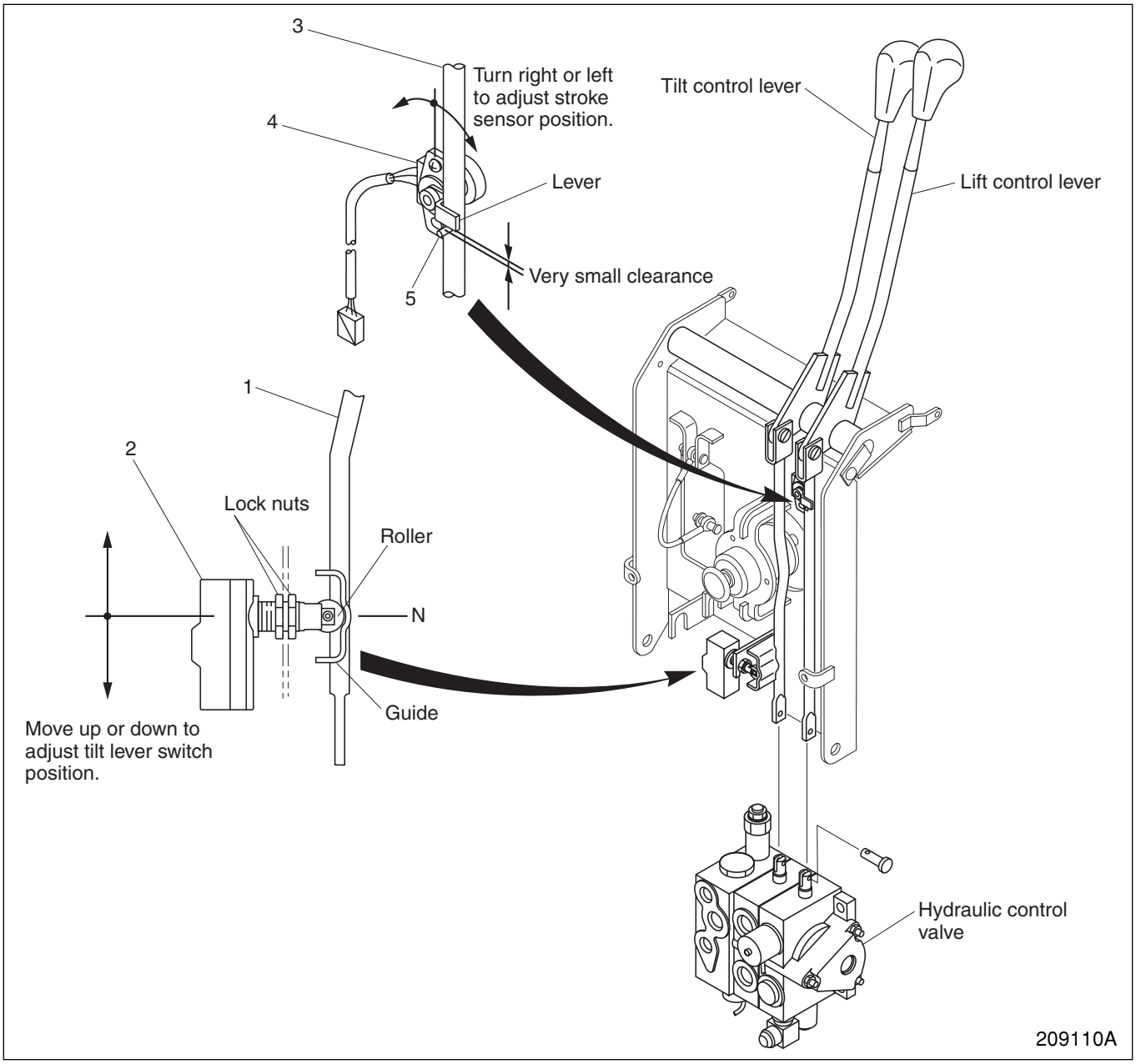
(2) Check for surface flaws such as grooving, scratch marks, rusting and wear. The rod must be replaced if its threads show a sign of stripping or any other damage.



3. Packings and rings

Replace all parts contained in the seal kit, once disturbed.

Adjustment of Tilt Lever Switch and Lift Stroke Sensor



1 Tilt rod
2 Switch
3 Lift rod
4 Stroke sensor
5 Spring pin

Adjustment of Tilt Lever Switch

With the tilt control valve spool in the neutral position, the position of the tilt lever switch is correctly adjusted if the roller of the switch 2 extends completely to the right and seat in the recess of the guide, as shown in the drawing above. If the roller is not seated in the recess, move the switch 2 up or down to bring the roller into the recess. Tighten the lock nut after adjustment.

Adjustment of Lift Lever Stroke Sensor

With the lift control valve spool in the neutral position, the position of the lift lever sensor is correctly adjusted if there is a very small clearance between the lever of the stroke sensor 4 and the spring pin 5, as shown in the drawing above. If necessary, adjust the sensor position by turning the sensor to the right or left.

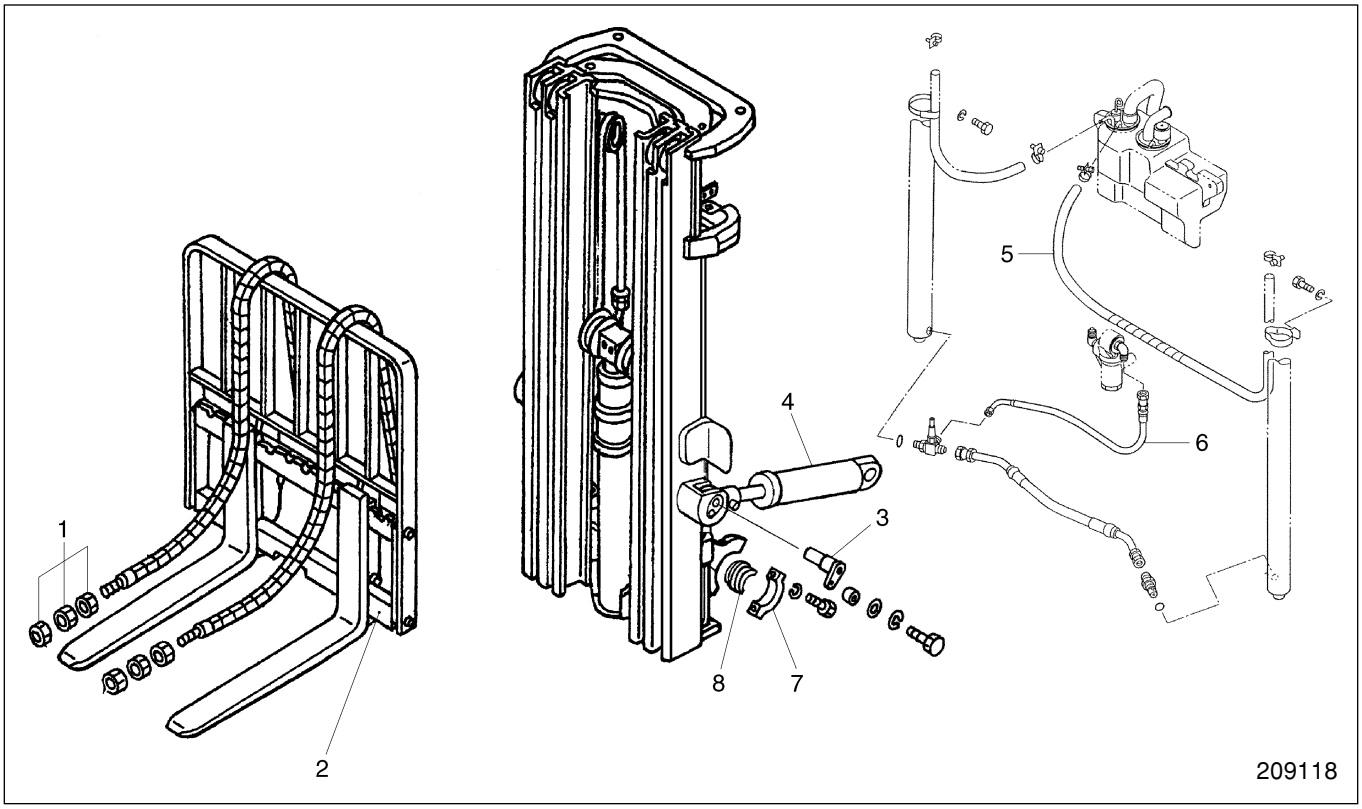
MAST AND FORKS

Mast and Lift Bracket Assembly

The following describes the procedures for removing and reinstalling the mast assemblies of Duplex Mast and Triplex Mast. Note that the Triplex Mast is used as an example.

Duplex Mast and Triplex Mast

Removal



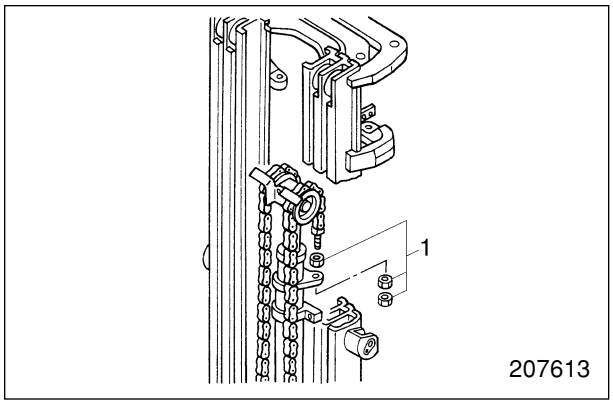
Sequence

1 Nuts
2 Fork, Lift bracket assembly
3 Tilt socket pin
4 Tilt cylinder
5 Low-pressure hose
6 High-pressure hose for lift cylinders
7 Mast support cap
8 Mast support bushing

Suggestions

1. Removing lift bracket assembly 2

(1) Lower lift bracket assembly 2, and place wood blocks under the assembly. Tilt the mast forward, lower the inner mast to the bottom, then remove nuts 1 from the anchor bolts of the first lift chains.



Inspection after Disassembly (All Mast Models)

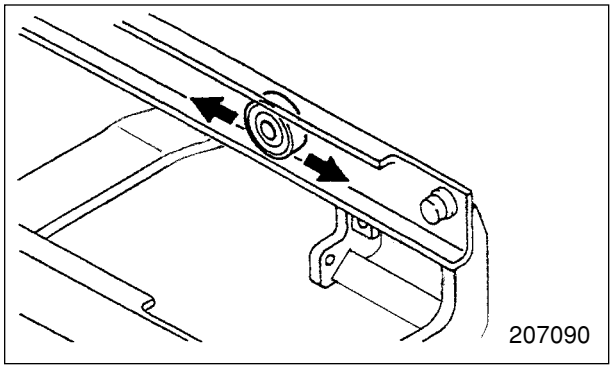
1. Mast

(1) Check each roller for wear, binding or other defects.

(2) Check each roller on rolling surface for pitting or other defects.

(3) Check the mast member and the welded joints of cross-members, shafts and supports for cracks.

(4) Check the mast support bushings for wear or other defects.



2. Lift bracket

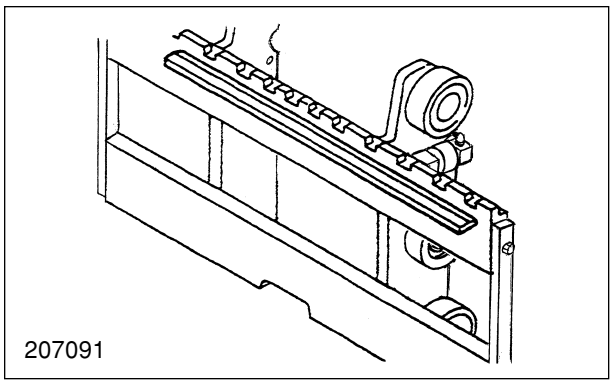
(1) Check the main rollers and side rollers for smooth rotation. Inspect each roller for wear an cracks.

(2) Check the welded portions of the bracket for cracks.

(3) Check the finger bar for bend or distortion.

A: Standard value
Unit: mm

Distortion of finger bar	A	5, maximum



3. Lift chains, chain wheels and chain wheel supports

(1) Measure the length of each chain to make sure that two chains are equal in length. Also check the chains for wear, indication of breakage, link binding and twist.

(2) Check each chain anchor bolt for cracks or defects on thread.

(3) Check each chain wheel support and chain wheel for crack or wear. Check that the wheels rotate smoothly.

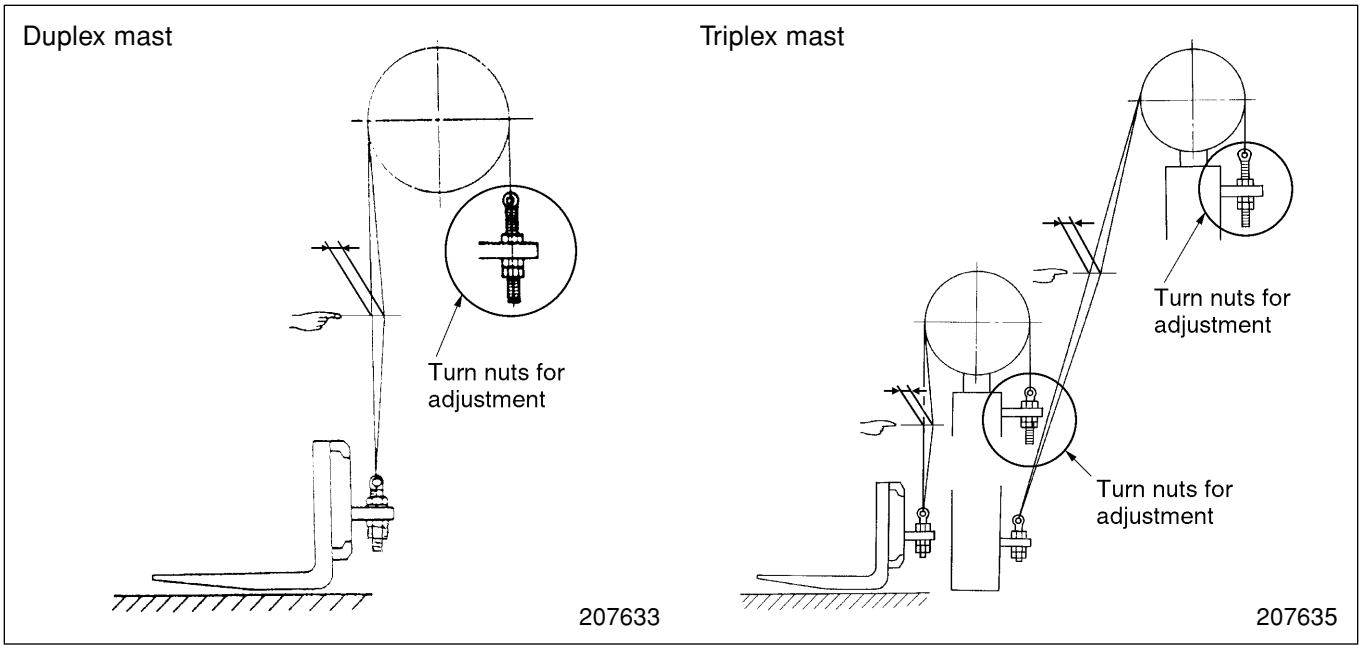
A: Standard value B: Repair or service limit
Unit: mm

Length of lift chain (per 20 links)	A	318
	B	327

4. Mast strips

Check the mast strips for damage, wear or distortion.

Duplex Mast and Triplex Mast



The inspection and adjustment procedures are completely the same as those for simplex mast models. Follow the procedures in the previous page to perform inspection or adjustment as necessary.

Chain, Chain Wheel Support and Chain Wheel

(1) Check the right and left chains for uneven length, wear, adhesion or torsion.

Lift the forks high enough to put their full weight on the carriage and chains.

Check to be sure the lift chains have equal tension.

(2) Check the chain anchor bolt for cracks or damaged thread.

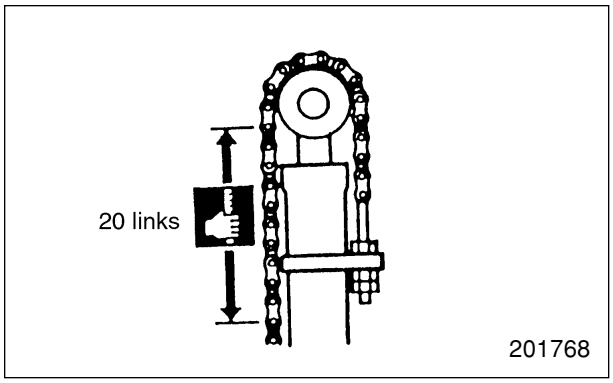
(3) Check the chain wheel support and the chain wheel for cracks, wear or adhesion.

(4) Replace chain or chain anchor bolt. If new parts are installed, refer to "Installing chain on lift bracket" on page 9-24.

NOTE

To lubricate lift chains, molybdenum disulfide oil (spray type) is recommended since it is easy to use and provides long lubrication.

Super chain guard oil: 9101M-00150

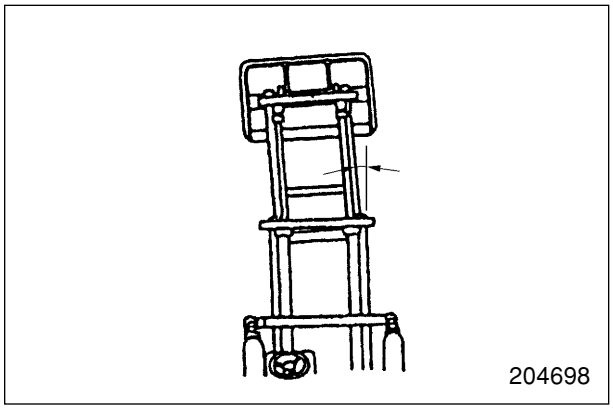


A: Standard value B: Repair or service limit

Chain extension mm/20 links	A	318
	B	327

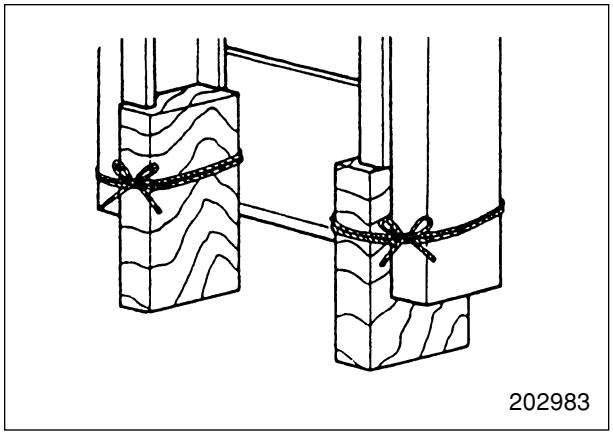
Lift Cylinder Stroke Inspection and Adjustment

1. 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.
2. 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.



3. Adjusting method

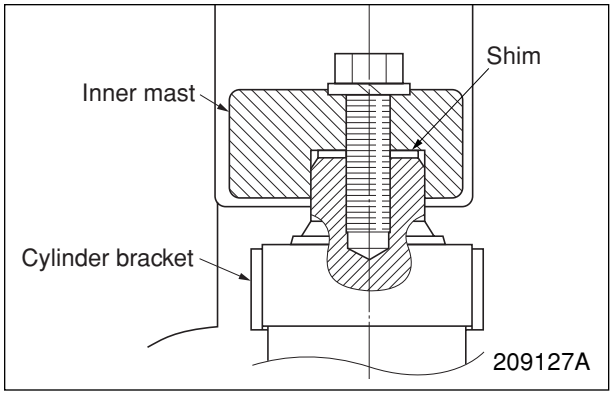
(1) Raise the inner mast, place blocks under the right and left sides of the inner mast, and lower the mast until its rests on the blocks.

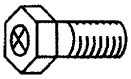


(2) Remove the set bolt at the top of lift cylinder which showed earlier stroke end, retract the piston rod, and insert shims at the top of piston rod end.

(3) Extend the piston rod, and tighten the cylinder set bolt. Remove the blocks from under the inner mast.

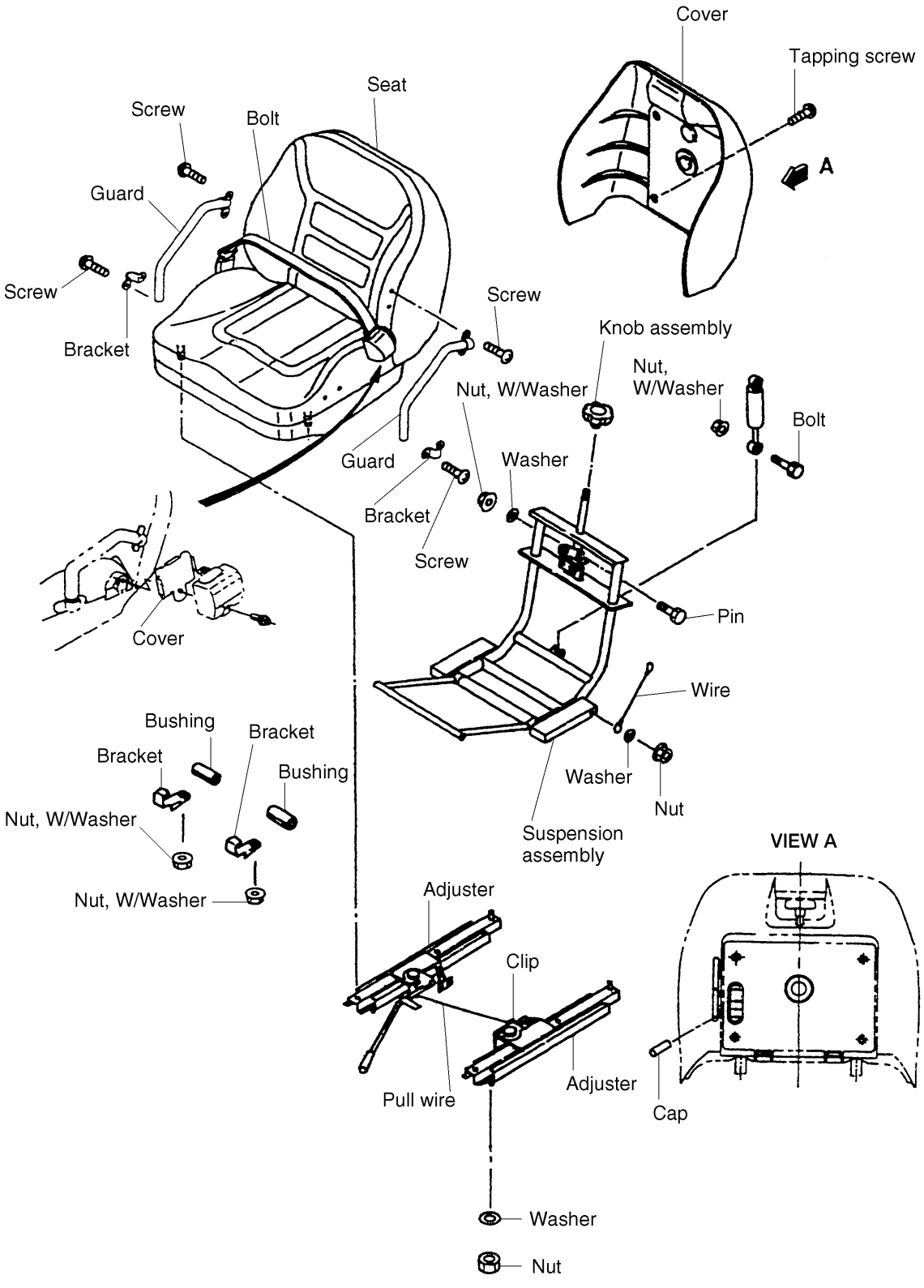
(4) Slowly lower the inner mast to the bottom to ensure the piston rods move smoothly and that the left and right lift cylinders come to the end of stroke simultaneously.



	Nominal Size		Pitch		With Spring Washer 101656								
													
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
Metric coarse thread	10	0.39	1.5	0.06	33.3	3.4	24.6	43.1	4.4	31.8	67.7	6.9	49.9
	12	0.47	1.75	0.07	58.8	6.0	43.4	76.5	7.8	56.4	115.7	11.8	85.3
	14	0.55	2	0.08	96.4	9.8	70.9	124.5	12.7	91.9	182.4	18.6	134.5
	16	0.63	2	0.08	147.14	15.0	108.5	191.2	19.5	141.0	274.6	28.0	202.5
	18	0.71	2.5	0.10	203.0	20.7	149.7	264.8	27.0	195.3	383.4	39.1	282.8
	20	0.79	2.5	0.10	286.4	29.2	211.2	371.7	37.9	274.1	536.4	54.7	395.6
	22	0.87	2.5	0.10	383.4	39.1	282.8	499.2	50.9	368.2	715.9	73.0	528.0
	24	0.95	3	0.12	492.3	50.2	363.1	640.4	65.3	472.3	924.8	94.3	682.1
	27	1.06	3	0.12	724.7	73.9	534.5	942.2	96.1	695.1	1350.4	137.7	996.0
	30	1.18	3.5	0.14	969.9	98.9	715.3	1259.2	128.4	928.7	1843.7	188.0	1359.8
	33	1.30	3.5	0.14	1328.8	135.5	980.1	1727.0	176.1	1273.7	2477.2	252.6	1827.1
	36	1.42	4	0.16	1676.0	170.9	1236.1	2180.0	222.3	1607.9	3199.9	326.3	2360.1
	39	1.54	4	0.16	2219.2	226.3	1636.8	2884.1	294.1	2127.2	4118.8	420.0	3037.9
	42	1.65	4.5	0.18	2754.7	280.9	2031.8	3581.4	365.2	2641.5	5137.7	523.9	3789.4
	Nominal Size		Pitch		Without Spring Washer 101656								
													
	10	0.39	1.5	0.06	39.2	4.0	28.9	51.0	5.2	37.6	79.4	8.1	58.6
	12	0.47	1.75	0.07	69.6	7.1	51.4	90.2	9.2	66.5	135.3	13.8	99.8
	14	0.55	2	0.08	112.8	11.5	83.2	146.1	14.9	107.8	215.7	22.0	159.1
	16	0.63	2	0.08	172.6	17.6	127.3	224.6	22.9	165.6	323.6	33.0	238.7
	18	0.71	2.5	0.10	239.3	24.4	176.5	311.9	31.8	230.0	451.1	46.0	332.7
	20	0.79	2.5	0.10	336.4	34.3	248.1	437.4	44.6	322.6	630.6	64.3	465.1
	22	0.87	2.5	0.10	392.3	40.0	289.3	587.4	59.9	433.3	842.4	85.9	621.3
	24	0.95	3	0.12	578.6	59.0	426.7	753.2	76.8	555.5	1088.5	111.0	802.9
	27	1.06	3	0.12	852.2	86.9	628.5	1108.2	113.0	817.3	1588.7	162.0	1171.7
	30	1.18	3.5	0.14	1140.5	116.3	841.2	1481.8	151.1	1092.9	2168.3	221.1	1599.2
	33	1.30	3.5	0.14	1563.2	159.4	1153.0	2031.9	207.2	1498.7	2915.5	297.3	2150.4
	36	1.42	4	0.16	1972.1	201.1	1454.6	2564.4	261.5	1891.4	3765.8	384.0	2777.5
	39	1.54	4	0.16	2610.5	266.2	1925.4	3393.1	346.0	2502.6	4845.5	494.1	3573.8
	42	1.65	4.5	0.18	3241.1	330.5	2390.5	4212.9	429.6	3107.3	6044.8	616.4	4458.4

Remarks : 1. The tolerance on these torques is ±10 %.
2. These torques are for “dry” condition.

Suspension Seat Kit



FOREWORD

This service manual is a guide for servicing Mitsubishi forklift trucks. For your convenience the instructions are grouped by systems as a ready reference.

The long productive life of your forklift trucks depend on regular and proper servicing. Servicing consistent with what you will learn by reading this service manual. Read the respective sections of this manual carefully and familiarize yourself with all of the components before attempting to start a test, repair or rebuild job.

The descriptions, illustrations and specifications contained in this manual are for trucks with serial numbers in effect at the time of printing. Mitsubishi forklift trucks reserves the right to change specifications or design without notice and without incurring obligation.

Safety Related Signs

The following safety related signs are used in this service manual to emphasize important and critical instructions:

⚠ WARNING — Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION — Indicates a potentially hazardous situation which, if not avoided, may result in death or serious injury or damage to the machine.

NOTE — Indicates a condition that can cause damage to, or shorten service life of, the machine.

Pub. No. 99759-5H100

Outline

1. Logic unit

The logic unit consists of the logic card and the power supply card.

The logic card has the following functions.

(1) The logic card controls all the jobs for the truck.
- Calculates the traction motor control command according to the traveling operation and sends the command to the traction inverter.
- Calculates the pump motor control command according to the hydraulic operation and sends the command to the pump inverter.
- Monitors and sends the display data to the display unit.

(2) The logic card detects malfunctions and activates the fail-safe function.
- Battery voltage fault
- Wire breakage or short circuit of the input equipment
- Over-current, wire breakage or short circuit of the output equipment

(3) The logic card monitors the malfunctions of each controller and activates the fail-safe function.

(4) The logic card stores the fault data detected.

(5) The logic card sets the truck parameters and stores the setting data into the internal memory.

(6) Others
- Equipped with the CAN interface.
- Software update available (with specific tools).
- Equipped with the serial communication for the Service Tool.

The power supply card has the following function.

(1) The power supply card changes the battery voltage and supplies the voltage to each card.

2. Inverter

The inverter consists of the Digital Signal Processor (DSP) card, Insulated Metal Substrate (IMS) module and their drive boards.

The DSP card has the following functions.

(1) The DSP card controls the AC induction motors (traction and pump motors).
- Controls the AC induction motors according to the motor control command sent from the logic unit.

(2) The DSP card detects the malfunctions and activates the fail-safe function.
- Overheat or fault of the IMS module and drive boards
- Sensor fault (current sensor, pulse encoder, etc.)
- Overheat, over-current, over-speed, wire breakage or short circuit of the motors

(3) Others
- Equipped with the CAN interface.
- Software update available (with specific tools).

The IMS module has the following function.

(1) The IMS module has multiple MOS-FET modules which converts battery direct current into the alternating current for the AC induction motors.

3. Display unit

The display unit has the following functions.

(1) The display unit displays the data according to the display data sent from the logic unit.
The display unit has the hour meter function.
The display unit hour meter counts according to the command from the logic unit.
Hour meter data are stored in the memory module in the display unit.

(2) Others
- Equipped with the CAN interface.

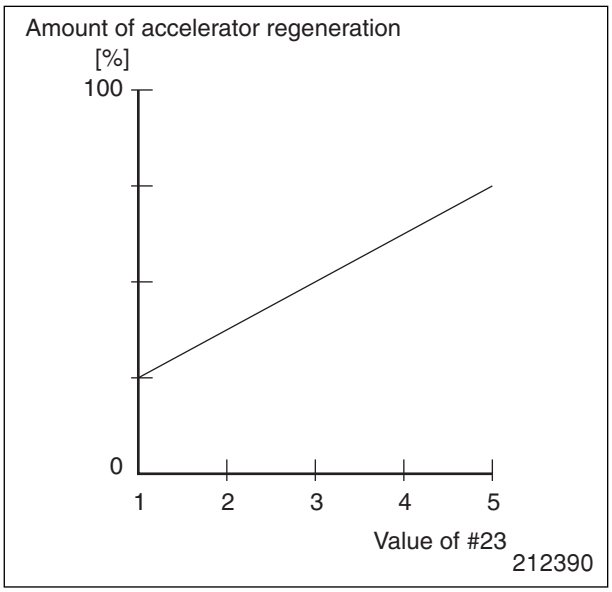
3. Regeneration

There are three types of regeneration control: accelerator regeneration, brake regeneration and lever regeneration.

(1) Accelerator regeneration

Accelerator regeneration starts when the accelerator pedal is released with the direction lever shifted into the forward or reverse position during traveling.

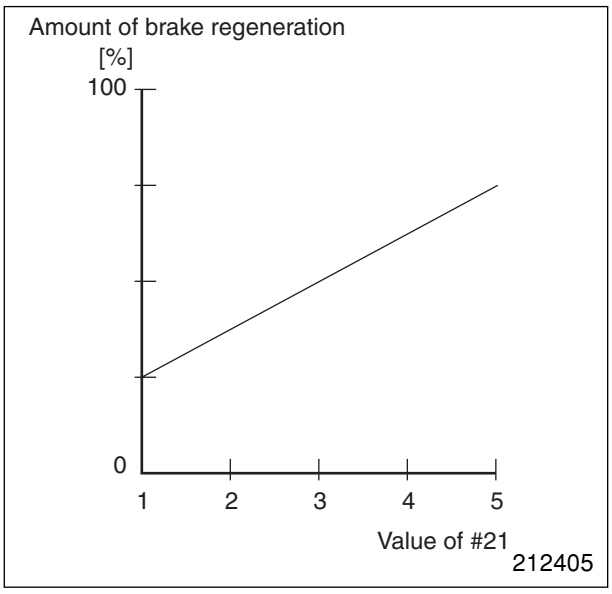
The amount of regeneration is determined by the accelerator regeneration characteristic (set by SUO #23).



(2) Brake regeneration

Brake regeneration starts when the service brake or parking brake is applied.

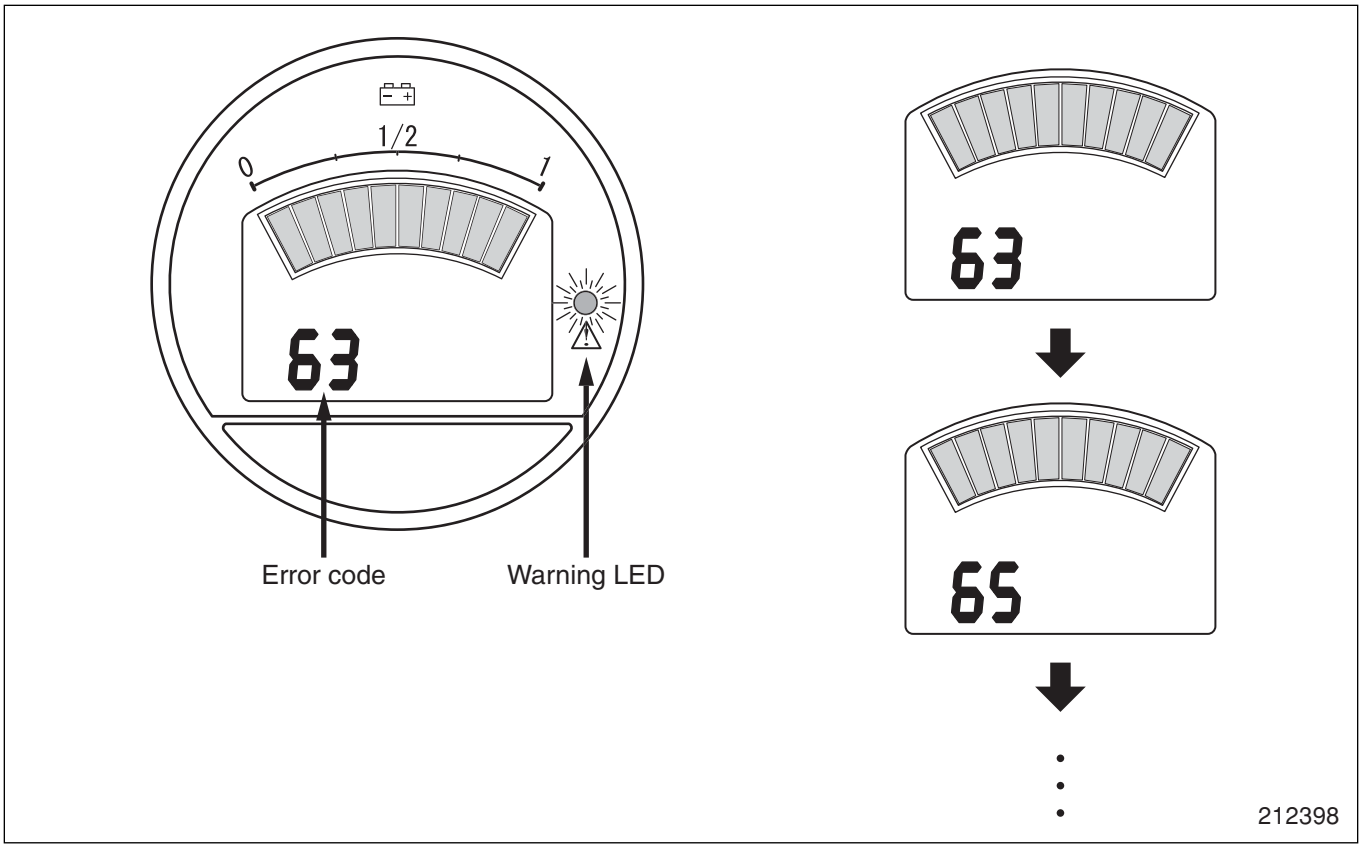
The amount of regeneration is determined by the brake regeneration characteristic (set by SUO #21).



2. Error display

An error code is displayed when a malfunction occurs.

When multiple faults occur simultaneously, the errors are displayed successively as shown in the figure below.



Item	Description
Error code	Indicates the code assigned to the fault.
Warning LED	Lights while the fault is occurring.

#9 Power

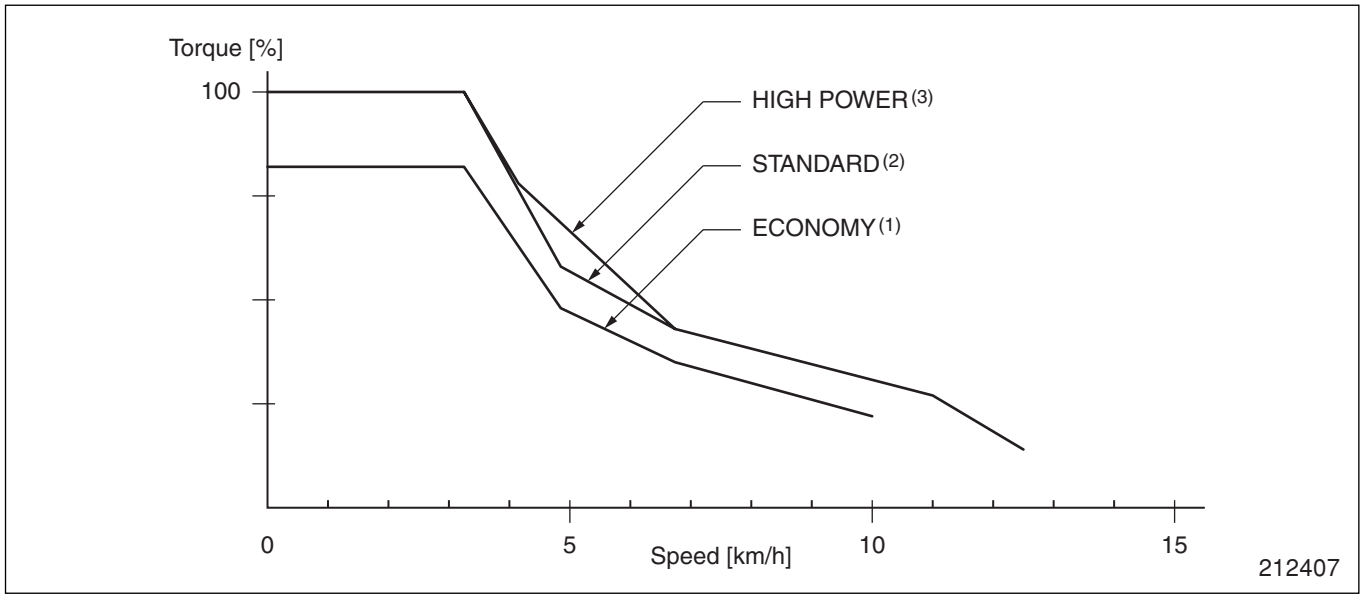
This setting affects speed order which is calculated from accelerator pedal position.

The values are selected from three types : ECONOMY, STANDARD and HIGH POWER.

The figure is a torque characteristic at the time of Powering.

This setting affects also pump speed order when you pull the lift lever.

If “ECONOMY” is selected, maximum pump speed is reduced to about 85% of “STANDARD” or “HIGH POWER”.



#10 Service Indicator

This setting sets the maintenance time. The time set here is added to the truck’s hour meter and that value is stored in memory as the “maintenance time.”

When the truck’s hour meter reaches maintenance time, the service reminder icon turns on.

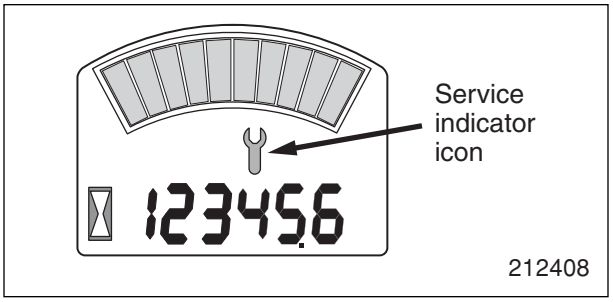
It will flash 20 hours before the time.

You can reduce the truck power when the icon flashes by setting the service indicator selection. You can also set the demo-mode, which shows the Service Indicator function in a short period of time.

The setting value is as follows.

Maintenance time [hour]		–	6 min (test)	100	150	In increments of 50	950	1000
Setting	Not activated	0						
	Service indicator icon turns on		0.1	100	150	·····	950	1000
	Drive performance reduced		L0.1	L100	L150	·····	L950	L1000

The present hour meter time will be registered if the DRS switch is operated after the display of #10.



Diagnostics Function

1. Outline

The controller monitors status of various input/output equipment to allow diagnosis of truck's malfunction. There are two types of diagnosis: Run Time Diagnostics, diagnostics during normal operation, and Self Diagnostics, performing equipment check during maintenance.

Diagnosis

Diagnosis	Description
Self diagnostics	Check function of electrical systems
Run time diagnostics	Diagnosis during normal operation

The logic unit incorporates a memory module. When a fault is detected by the Run Time Diagnostics, the fault data will be stored in the memory module.

The fault data stored in the memory module can be reviewed by means of the History Folder function.

2. Operation procedure

To perform the Self Diagnostics or review the History Folder (the fault data stored by the Run Time Diagnostics), perform the following procedure.

Turning on the key switch allows to enter each diagnosis mode. You can not transfer to another mode unless the source power is turned off.

Entry to diagnosis mode

Function	DRS switch	Seat	Lift lever	Tilt lever
Self diagnostics	D	—	—	—
History folder	D	Not sit	ON	ON

Self Diagnosis Item List

Step	Checking	Do this	Controller check this	Result	Display	Contactor operation
0	Power line voltage (Fuse check)	Turn on key switch.	Close line contactor and check power line voltage.	Pass	01	Contactor closes and opens.
				Pass	20	
				Fail	dd	
1	Seat switch	Release & press & release seat SW.	Input OFF→ON→OFF	Pass	02	
				Fail	01	
2	Direction switch	Cycle direction lever. N→R→N→F→N	Input N→R→N→F→N	Pass	03	
				Fail	02	
3	Parking brake switch	Release, apply and release parking brake.	Input OFF→ON→OFF	Pass	04	
				Fail	03	
4	Service brake switch	Depress and release service brake.	Input OFF→ON→OFF	Pass	05	
				Fail	04	
5	Accelerator	Depress and release accelerator. And see display.		Pass	*1	
				Fail	–	
		DIAG→RUN→DIAG		–	06	
6	Steering	Operate steering and see display.		Pass	*2	
				Fail	–	
		DIAG→RUN→DIAG		–	07	
7	Battery voltage	Automatic	Check battery voltage.	Pass	08	
				Fail	07	
8	Lift lever	Pull and release lift lever.	Input OFF→ON→OFF	Pass	09	
				Fail	08	
9	Tilt lever	Pull and release tilt lever.	Input OFF→ON→OFF	Pass	10	
				Fail	09	
10	Attachment 1 lever	Pull and release attachment 1 lever.	Input OFF→ON→OFF	Pass	11	
				Fail	10	
11	Attachment 2 lever	Pull and release attachment 2 lever.	Input OFF→ON→OFF	Pass	13	
				Fail	11	
13	Hydraulic speed check	Pull any lever and see display.		Pass	*3	
				Fail	–	
		DIAG→RUN→DIAG		–	14	
14	Line contactor	See line contactor close.		Pass	14	Contactor closes.
				Fail	14	Contactor does not close.
		DIAG→RUN→DIAG See line contactor open.		Pass	17	Contactor opens.
				Fail	17	Contactor does not open.
17	Seat belt	Release & fasten & release seat belt.	Input OFF→ON→OFF	Pass	97	
				Fail	17	

⚠ CAUTION

Use the correct power cables and terminate marked cable ends to the correct terminals marked on the motor.

Cables terminated at the wrong terminals on the motor may cause the motor to rotate in the opposite direction when activated.

Tightening torque

M8 nut	11.77 ± 1.96 N·m (1.20 ± 0.20 kgf·m) [8.68 ± 1.45 lbf·ft]

(5) Connect the main harness connector to the inverter.

⚠ CAUTION

Forcibly pressing the connector may cause damage to the DSP card. Hold the connector housing and press the connector, if not easy to lock.

NOTICE: It is recommended to check or replace the inverters every 10,000 hours of service operation.

• **DSP card voltage chart**

CN5, CN6

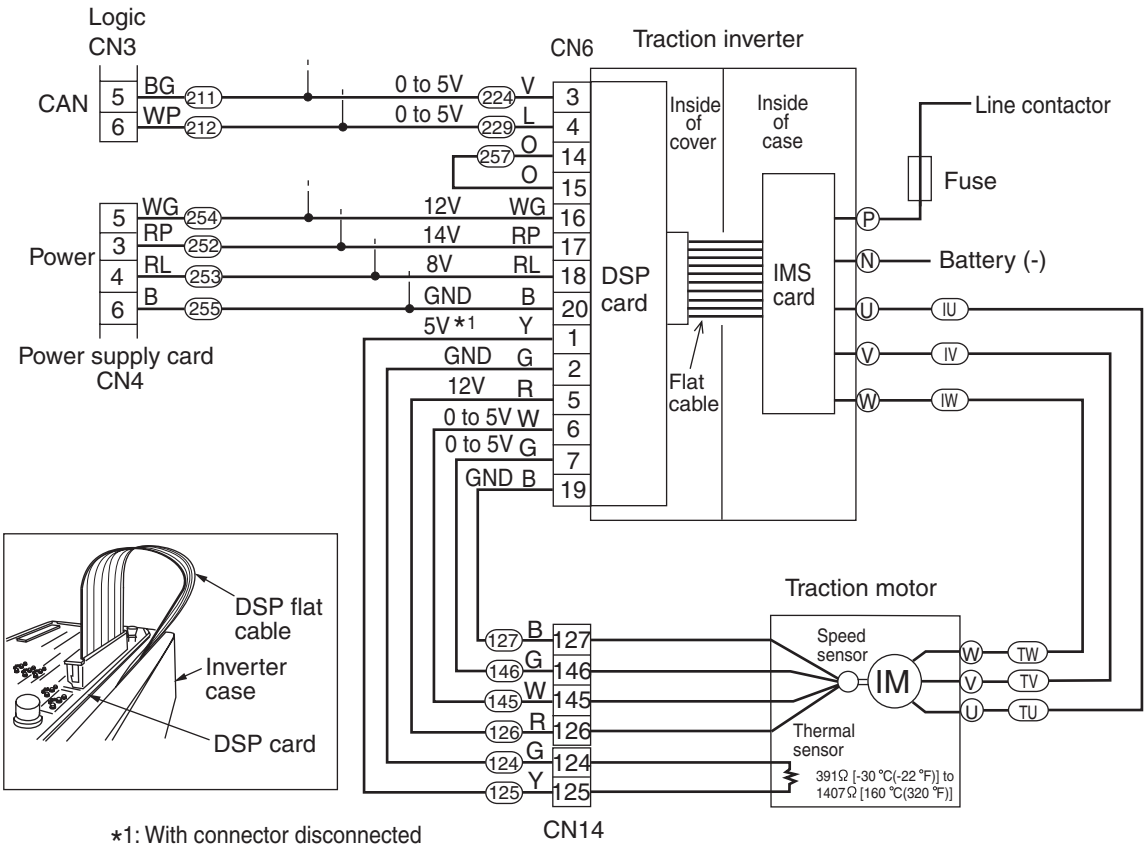
No.	Name	Stand-by voltage	Active voltage	Note
1	MOTOR THERMAL +	0 to 5V	0 to 5V	
2	MOTOR THERMAL -	0 to 5V	0 to 5V	
3	CAN_H	0 to 5V	0 to 5V	Do not measure the voltage between CAN and Logic GND terminal.
4	CAN_L	0 to 5V	0 to 5V	
5	ROTARY SENSOR +15V	12V	12V	
6	ROTARY SENSOR A+	0 to 5V	0 to 5V	
7	ROTARY SENSOR B+	0 to 5V	0 to 5V	
8	MODE1	11.5V	0V	
9	MODE2	11.5V	0V	
10	BOOT	11.5V	0V	
11	GND	0V	0V	
12	TxD (GSE)	-	-	
13	RxD (GSE)	-	-	
14	CAN_R+	-	-	
15	CAN_R-	-	-	
16	+15V-G	12V	12V	
17	+15V-L	13.0 to 16.0V	13.0 to 16.0V	
18	+5V-L	8V	8V	
19	GND	0V	0V	
20	GND	0V	0V	

• **Display unit card voltage chart**

CN17

No.	Name	Stand-by voltage	Active voltage	Note
1	COMMON	0V	0V	
2	BATTERY	Vbatt	Vbatt	
3	CAN_H	0 to 5V	0 to 5V	Between CAN H and CAN L Do not measure the voltage between CAN and Logic GND terminal.
4	CAN_L	0 to 5V	0 to 5V	

Vbatt: Battery voltage



*1: With connector disconnected

AMBIENT TEMPERATURE		RESISTANCE		
(℃)	(˚F)	MIN.	TYP.	MAX.
-30	-22	370	391	411
-10	14	437	460	483
0	32	474	498	522
10	50	514	538	563
30	86	599	626	652
50	122	694	722	750
70	158	797	826	855
90	194	910	940	970
110	230	1029	1062	1096
130	266	1152	1194	1235
150	302	1282	1334	1385

212052

Problem: Brake Oil, Low Level

(1) Situation
Lower brake oil indicator ON. Normal truck operation.

(2) Possible cause
Insufficient brake oil, faulty brake oil level sensor, shorted wiring, faulty logic unit.

(3) How the error code is triggered
Sensor signal is close or short.

(4) Checks
Check oil level in brake oil reservoir tank.

Normal

Abnormal

(5) Add brake oil. See Chassis & Mast.

Without service tool

(6) Disconnect battery plug, then discharge the inverters. See page 1-60.

(7) Disconnect connectors CN2 and CN3 of logic unit and CN11 of sensor.
Check short circuit between CN2-38(139) and CN3-23(140) at harness side.

No shorted

Shorted

(9) Repair or replace harness.

(8) Check continuity of brake oil level sensor connector coupled to CN11.

No continuity

Continuity

(10) Replace brake oil level sensor.

If fault remains

(11) Replace logic card of logic unit. See page 1-66.

Problem: Pump Motor Current Sensor Fault (34)

(1) Situation
Display: "34". All truck operations except "lift down" inhibited. This fault occurs only when turning on power.
Line contactor OPEN.

(2) Possible cause
Faulty contact or wire breakage of DSP flat cable in pump inverter, faulty DSP card of pump inverter, faulty pump inverter, faulty main harness, faulty logic unit.

(3) How the error code is triggered
When turning on power, current sensor voltage is out of range of -120 A to 120 A.

(4) Checks
Disconnect battery plug, then discharge the inverters. See page 1-60.

(5) Disconnect connector CN5 of pump inverter and remove DSP cover. Check DSP flat cable for looseness or wire breakage.
Normal / Abnormal

8V Power supply

(6) Disconnect connector CN4 of logic unit.
Check continuity between CN4-4(253) and CN5-18(261).
Check continuity between CN4-6(255) and CN5-20(262).
Continuity / No continuity

(7) Secure DSP flat cable if loose.
Replace pump inverter if wire breaks. See page 1-61.

CAN

(8) Disconnect connector CN3 of logic unit.
Check continuity between CN3-5(211) and CN5-3(224).
Check continuity between CN3-6(212) and CN5-4(229).
Check continuity between CN5-14 and CN5-15(270).
Continuity / No continuity

(9) Connect connector CN4 to logic unit, then turn on power again.

(10) Repair or replace harness.

(11) Measure voltage between CN5-18(261) and CN5-20(262).
Confirm value is 8V±2V.
Normal / Abnormal

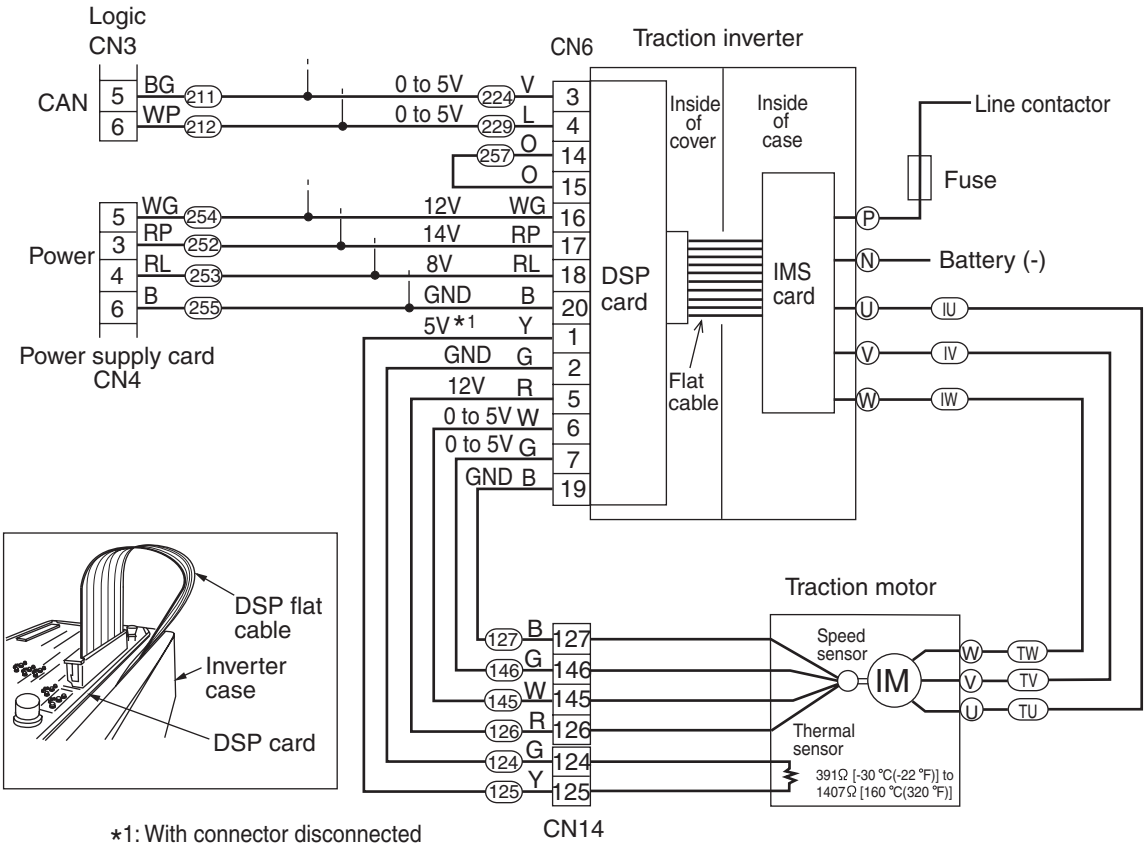
(12) Disconnect battery plug, then discharge the inverters. See page 1-60.

(13) Replace DSP card of pump inverter. See page 1-63.

If fault remains

(15) Discharge the inverters, then replace pump inverter. (DSP card is normal.) See page 1-61.

(14) Replace power supply card of logic unit. See page 1-67.


Logic
CN3
CAN
5 BG 211
6 WP 212
0 to 5V 224 V
0 to 5V 229 L
257 O
CN6
Traction inverter
3
4
14
15
Inside of cover
Inside of case
Line contactor
Fuse
Power
5 WG 254
3 RP 252
4 RL 253
6 B 255
12V WG 16
14V RP 17
8V RL 18
GND B 20
5V *1 Y 1
GND G 2
12V R 5
0 to 5V W 6
0 to 5V G 7
GND B 19
DSP card
IMS card
Flat cable
P
N
Battery (-)
U
V
W
IU
IV
IW
Power supply card
CN4
DSP flat cable
Inverter case
DSP card
Traction motor
Speed sensor
IM
Thermal sensor
391Ω [-30 °C(-22 °F)] to
1407Ω [160 °C(320 °F)]
127 B 127
146 G 146
145 W 145
126 R 126
124 G 124
125 Y 125
TW
TV
TU
CN14
*1: With connector disconnected

212054

Problem: Pump Motor Pulse Input Fault (57)

(1) Situation
Display: "57". All truck operations except "lift down" inhibited. Line contactor OPEN.

(2) Possible cause
Faulty contact of pump inverter connector, faulty connection of pump motor connector and cable, faulty 12V input voltage of pump inverter, faulty contact or wire breakage of pump motor speed sensor harness, faulty DSP card of pump inverter, faulty pump motor speed sensor.

(3) How the error code is triggered
Motor rotation speed is more than 4000 rpm. Motor rotation speed is zero while current flows to motor.
Motor rotates in reverse.

(4) Checks
Disconnect battery plug, then discharge the inverters. See page 1-60.

(5) Check to see if pump motor cables (U, V and W-phases) are connected to pump inverter properly.
Normal / Abnormal

Abnormal → (7) Connect cables properly.

Normal →

(6) Check to see if connector CN5 of pump inverter is fastened securely.
Normal / Abnormal

Abnormal → (9) Fasten connector securely.

Normal →

(8) Check to see if connector CN15 of pump motor speed sensor is fastened securely.
Normal / Abnormal

Abnormal → (11) Fasten connector securely.

Sensor

Normal →

(10) Disconnect connectors CN5 and CN15.
Check continuity between CN5-5 and CN15(131).
Check continuity between CN5-6 and CN15(147).
Check continuity between CN5-7 and CN15(148).
Check continuity between CN5-19 and CN15(132).
Continuity / No continuity

No continuity → (15) Repair or replace harness.

14V Power supply

Continuity →

(12) Disconnect connector CN4 of logic unit.
Check continuity between CN4-3(252) and CN5-17(260).
Check continuity between CN4-6(255) and CN5-20(262).
Continuity / No continuity

No continuity → (15) Repair or replace harness.

CAN

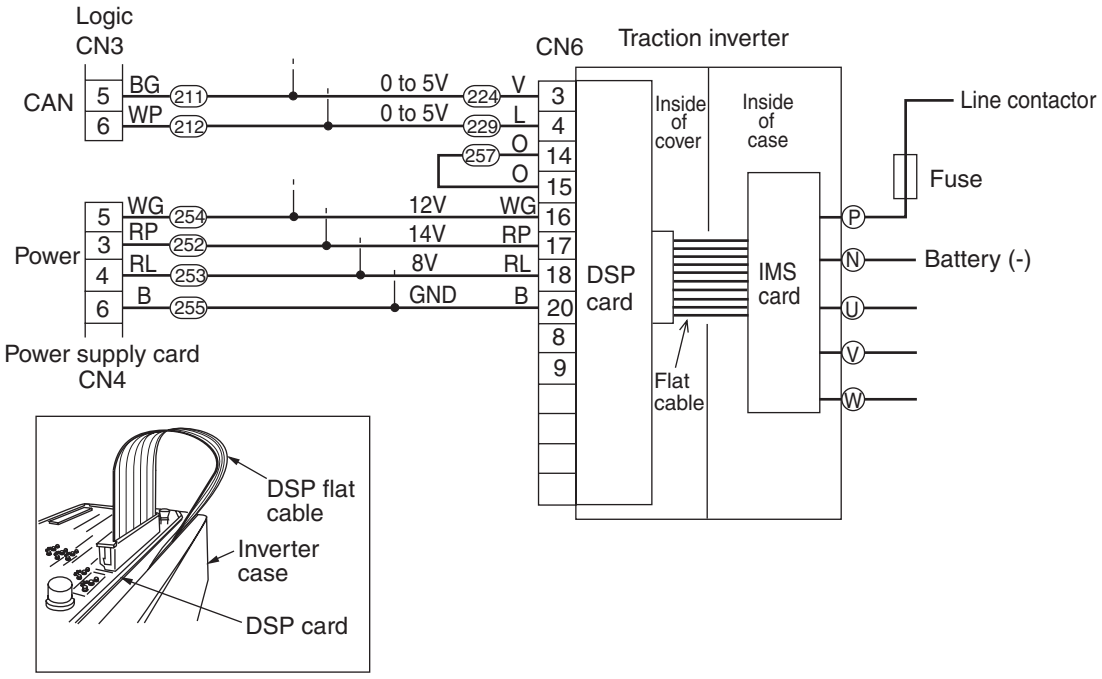
Continuity →

(13) Disconnect connector CN3 of logic unit.
Check continuity between CN3-5(211) and CN5-3(224).
Check continuity between CN3-6(212) and CN5-4(229).
Check continuity between CN5-14 and CN5-15(270).
Continuity / No continuity

No continuity → (15) Repair or replace harness.

Continuity →

(14) Connect connector CN4 to logic unit, then turn on power again.


Logic
CN3
CAN
5
6
BG
WP
211
212
0 to 5V
224
V
3
0 to 5V
229
L
4
257
O
14
O
15
Power
5
3
4
6
WG
RP
RL
B
254
252
253
255
12V
14V
8V
GND
WG
RP
RL
B
16
17
18
20
8
9
Power supply card
CN4
CN6
Traction inverter
DSP
card
Inside
of
cover
Inside
of
case
IMS
card
Flat
cable
Line contactor
Fuse
P
N
U
V
W
Battery (-)
DSP flat
cable
Inverter
case
DSP card

212060

Problem: Battery Voltage Too Low (78)

(1) Situation

Display: "78". All truck operations except "lift down" inhibited. Line contactor OPEN.

(2) Possible cause

Faulty or discharged battery, low voltage battery, improper battery voltage adjustment setting (Setup Option #46), faulty main harness, faulty logic unit.

(3) How the error code is triggered

Corrected battery voltage is too low. Battery voltage is corrected with #46 value.

24 V battery: less than 20 V

(4) Checks

Disconnect battery plug. Measure battery voltage with multimeter.

20V to 28 V

Abnormal

(5) Set #46 of Setup Option Group 3. See pages 1-36 to 1-38.

(6) Charge battery or replace with proper battery.

(7) Turn off power and turn on power again.

If fault remains

(8) Disconnect battery plug, then discharge the inverters. See page 1-60.

(9) Check continuity between CN3-19(269) and contactor POS.

Continuity

No continuity

(10) Discharge the inverters, then replace logic card of logic unit. See page 1-66.

(11) Repair or replace main harness.

Problem: Seat Switch, Faulty Setting For Hydraulic ((L))

(1) Situation
Display: "L" flickering. All truck operations inhibited. Line contactor HOLD when turning on power.

(2) Possible cause
Operator not on seat, seat switch turned off during pump motor operation, improper seat suspension adjustment, faulty seat switch, faulty main harness, faulty logic unit.

(3) How the error code is triggered
Detects seat switch opening when turning on power or during pump motor operation.

(4) Checks
If this fault occurred during pump motor operation
If this fault occurred when turning on power

(5) Sit on seat, then stop pump motor operation.
If fault remains
Normal
Fail-safe function

(6) Turn off power. Sit on seat, then turn on power again.
If fault remains

(7) Turn off power.

(8) Adjust seat suspension.
If fault remains
Normal
Faulty seat switch position

(9) Disconnect battery plug.

(10) Disconnect connector of seat switch, then short circuit between wire color Y(111) and B(110).
Connect battery plug, then turn on power again.
If fault remains
Normal

(11) Disconnect battery plug, then discharge the inverters.
See page 1-60.

(12) Replace seat switch.

(13) Disconnect connectors CN2 and CN3 of logic unit.
Check continuity between wire color B(110) and CN3-25(108).
Check continuity between wire color Y(111) and CN2-33(111).
Continuity
No continuity

(14) Replace logic card of logic unit. See page 1-66.

(15) Repair or replace main harness.

Problem: Battery Consumption Too Much (Lo)

(1) Situation
Display: "Lo". All truck operations except "lift down" inhibited.
Line contactor OPEN.

(2) Possible cause
Extremely consumed battery, faulty main harness, faulty logic unit.

(3) How the error code is triggered
Corrected battery voltage is less than 15V. Battery voltage is corrected with #46 value.

(4) Checks
Disconnect battery plug.

(5) Check battery voltage.
15V or more / Less than 15V

(6) Set #46 of Setup Option Group 3. See pages 1-36 to 1-38.

(7) Charge battery or replace with new battery.

If fault remains

(8) Discharge the inverters. See page 1-60.

(9) Check continuity between CN3-19(269) and contactor POS.
Continuity / No continuity

(10) Replace logic card of logic unit. See page 1-66.

(11) Repair or replace main harness.