CAT® Lift Trucks

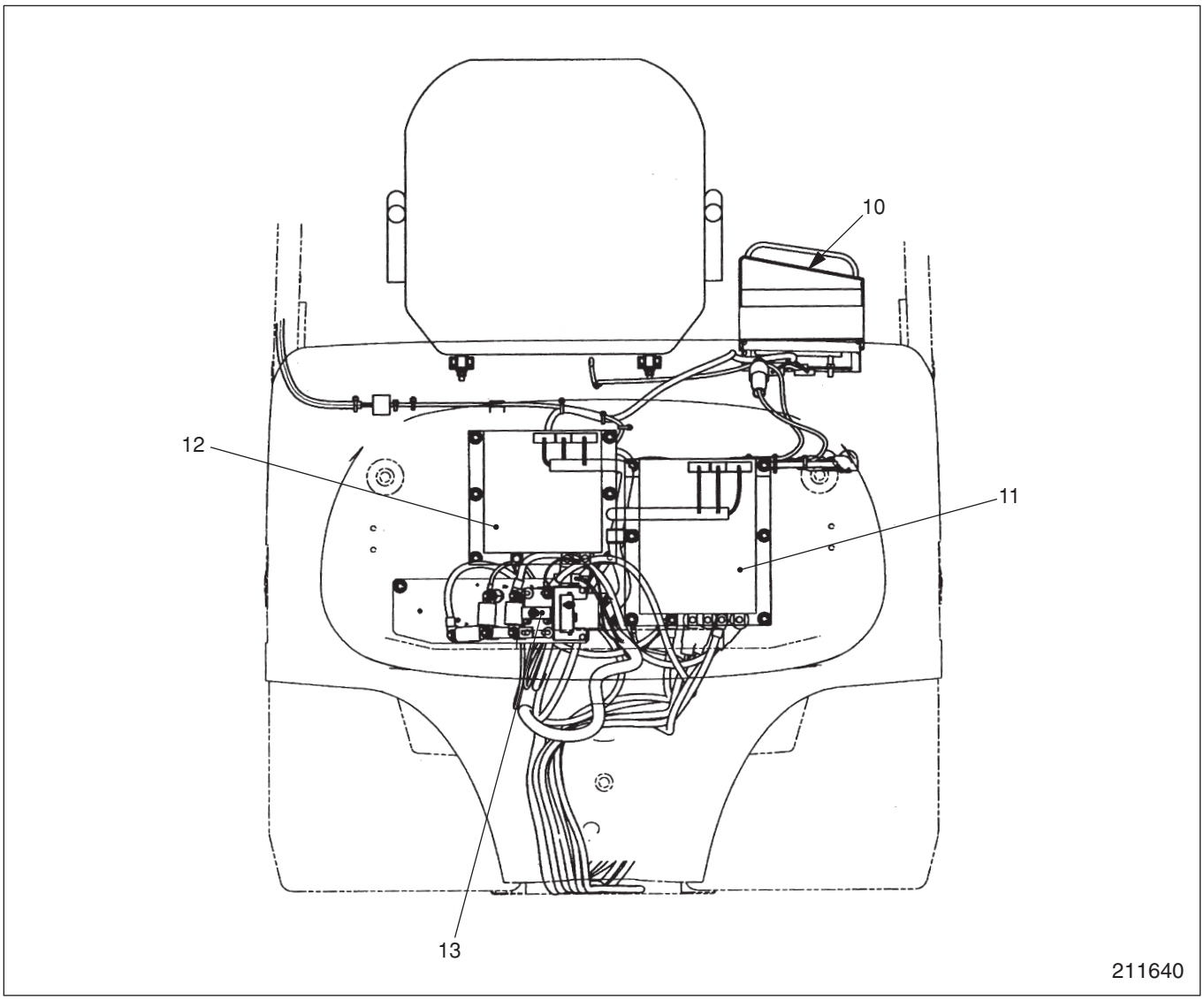
Service Manual

Chassis, Mast & Options

EP20K	**ETB8B-00011-up**
EP25K	**ETB8B-50001-up**
EP30K	**ETB9B-00011-up**
EP35K	**ETB9B-50001-up**

For use with EP20K-EP35K Controller Service Manual.

99759-6D100



10 Joystick box (FC only)
11 Traction controller
12 Hydraulic controller
13 Contactor

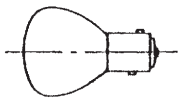
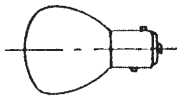
Fuses

Capacity (A)	Location	Main connecting device
325	Contactor assembly	Traction motor
325		Pump motor
50		Steering pump motor
15	Fuse holder	Horn switch, Lighting switch
10		Key switch, Contactor

NOTE

Refer to Parts Manual for proper replacement fuses.

Lamp Specification Chart

Item / Lamp	Quantity	Bulb color	Bulb		Remarks
			80 V	External diagram	
Head lamps	2	Clear	55 W		
Working lamp	1	Clear	55 W		

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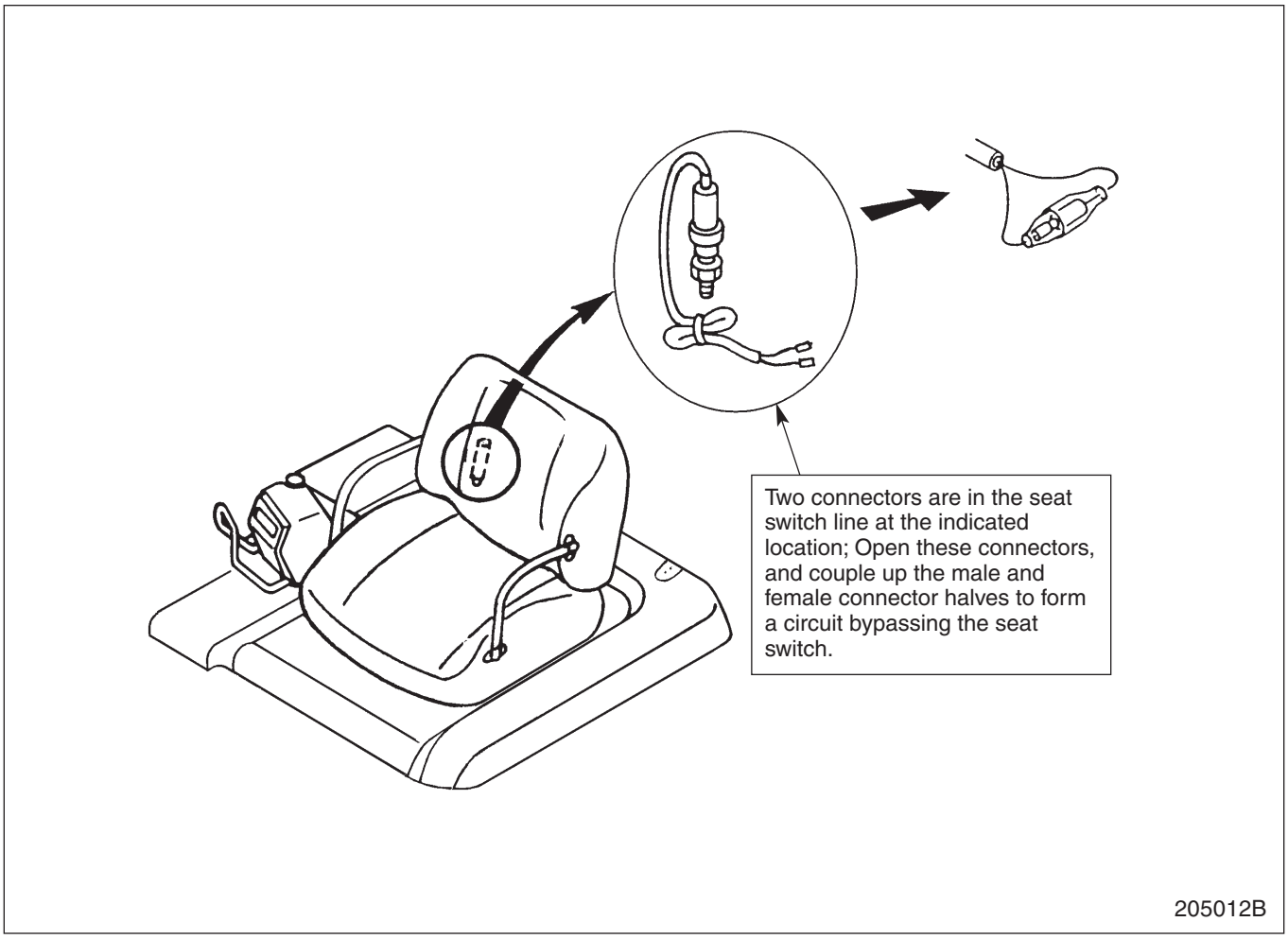
(2) How to cope with a failed (open-circuit) seat switch.

Your troubleshooting investigation might reveal that the seat switch is an open-circuit or otherwise faulted and will not function.

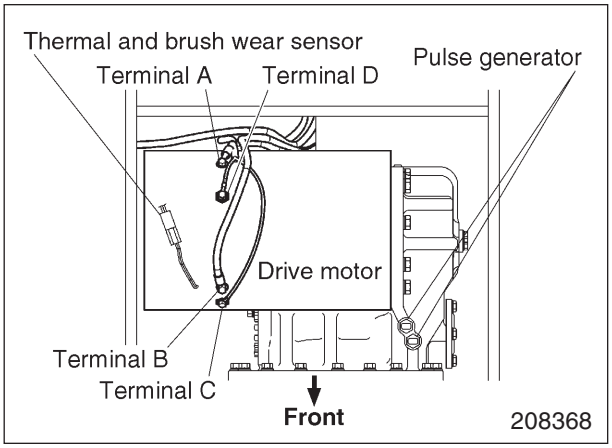
In such a case, you can create a temporary circuit through the seat switch wiring. The method is explained in this illustration. The seat switch is a safety part. Be sure to replace it with a new one as soon as possible.

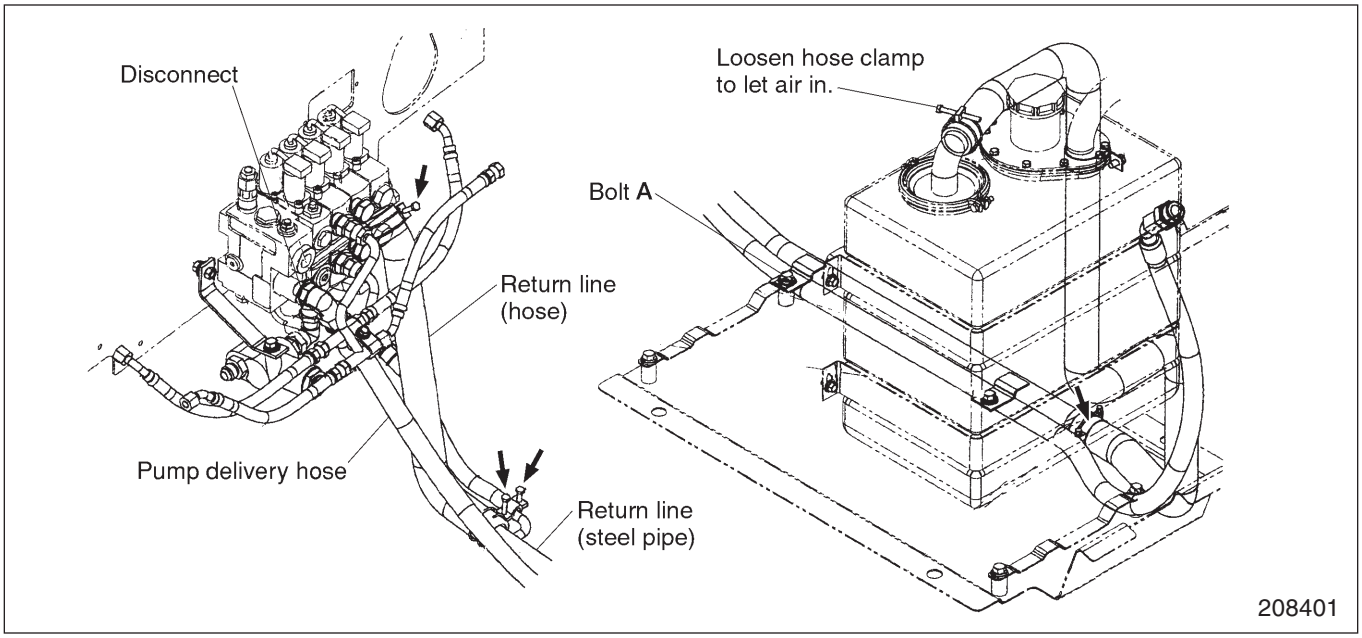


⚠ CAUTION

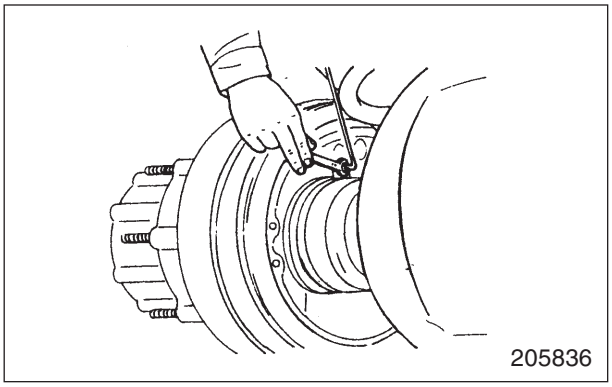
Illustrated above is a band-aid method permissible only in an emergency situation. Be sure to restore the seat switch line to the normal hookup after replacing the failed switch.

6. Put matching marks on the terminals (4 places) of the drive motor and disconnect the drive motor cables from the terminals.
7. Disconnect the thermal sensor and brush wear sensor wire harness from the main harness B at the connector.
8. Disconnect the pulse generator from the harness at their connectors (2 places). Provide matching marks on the connectors before disconnection.
9. Ready an oil pan with a capacity of 10 liters (3 U.S.gal) or so to receive oil that flows out when hoses and pipes are removed from the hydraulic system.



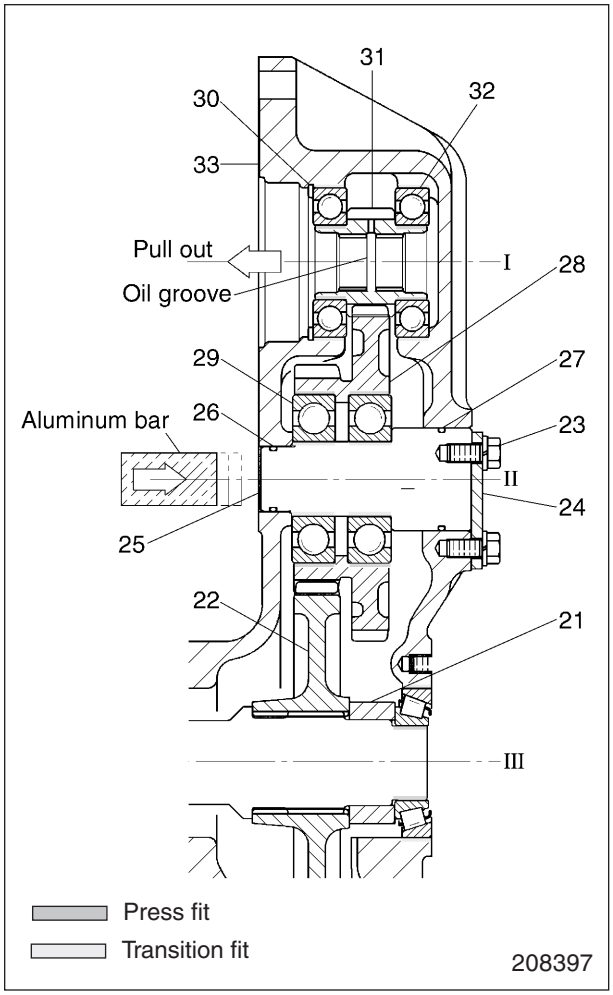


10. Remove the return line from the hydraulic control valve.
    (1) Loosen the hose clamp on the hydraulic tank side end of the return line to let air in the air line. (This is to prevent oil in the tank from being siphoned when the return line is disconnected.)
    (2) Remove the bolt A.
    (3) Loosen the arrow-marked hose clamps and remove the return line hose and pipe.
11. Disconnect the pump delivery hose at the hydraulic control valve.
12. Disconnect the service brake hydraulic pipe at the brake side joint.
13. Unclamp the parking brake cable and disconnect it at the parking brake lever.



14. Remove the axle drain plug and let oil out where necessary. [8.5 liters (2.3 U.S.gal)]

6. Remove the spacer 21, then remove the third gear 22. The third shaft 19 is fitted with the bearing inner race 20. The inner race 20 may be left fitted to the third shaft 19 if it is in a satisfactory condition for reuse. If it needs to be replaced, remove it using an appropriate puller.
7. Remove three bolts 23, then remove the lock plate 24. Apply an aluminum bar to the second shaft 25 from the drive motor fitted side, and hammer the bar lightly to force the second shaft 25 out of place with O-rings 26 and 27 fitted to it.
8. Remove the second gear 28 with the ball bearing 29 attached. The ball bearing 29 may be left fitted to the second gear 28 if it is in a satisfactory condition for reuse. If it needs to be replaced, remove it using an appropriate puller.
9. Remove the snap ring 30. Remove the input gear 31 fitted with the ball bearings 32 from the transfer case 33 using a slide hammer puller. The ball bearing 32 may be left fitted to the input gear 31 if it is in a satisfactory condition for reuse.



2. Installation of oil seal retainer and bearing inner race

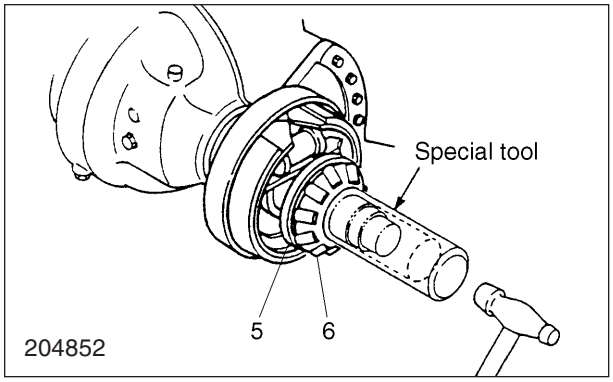
(1) Pack the taper roller bearing inner race 6 with AUTOLEX A or equivalent grease; force grease inside the bearing cage using your palm.

(2) Install the seal retainer 5 in the illustrated direction using the special tool.

(3) Install the bearing inner race 6 using the special tool.

Special tool needed

Installer	64309-12300



3. Reassembly of wheel hub and drum sub-assembly

(1) Once the wheel hub 7 and the brake drum 8 have been separated, always replace the bolts 9 and the nut 10 with new ones. Stake the bolt end crisscross using a flat tip chisel.

Nut tightening torque	59 ± 5.9 N·m (6.0 ± 0.6 kgf·m) [43.4 ± 4.3 lbf·ft]

(2) Press-fit the bearing outer race 11 in the hub 7 using the special tool.

Special tool needed

Installer	91268-05700

(3) Install the oil seal 12 in the illustrated direction into the hub 7 using the bearing and seal driver.

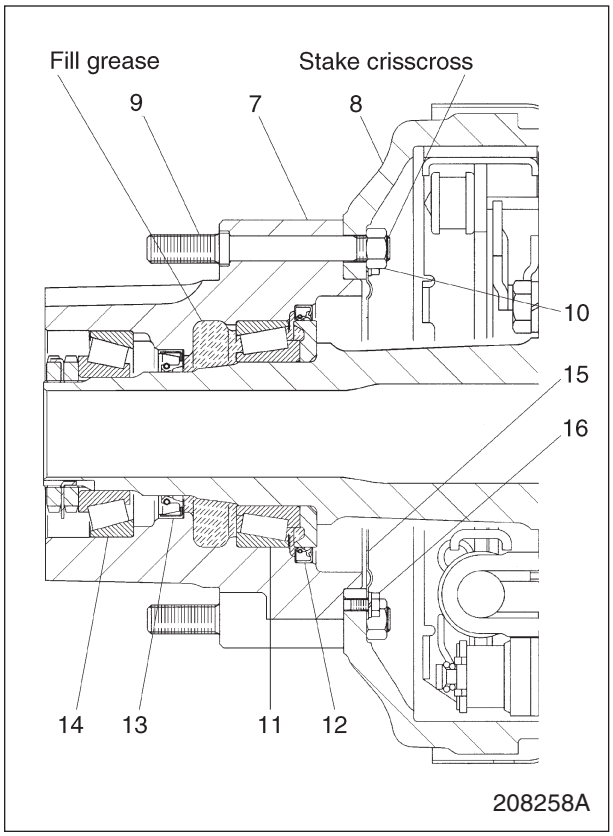
(4) Install the oil seal 13 in the illustrated direction into the hub 7 using the bearing and seal driver.

(5) Press-fit the bearing outer race 14 in the hub 7 using the bearing and seal driver.

(6) Fill AUTOLEX A or equivalent grease into the portion shown with ▨ in the illustration. Apply the grease also to the oil seal lip. Take care that grease does not enter inside the brake drum 8.

(7) Install the deflector 15 and tighten the bolts 16 to the torque given below.

Bolt tightening torque	9.8 ± 1.0 N·m (1.0 ± 0.1 kgf·m) [7.2 ± 0.7 lbf·ft]

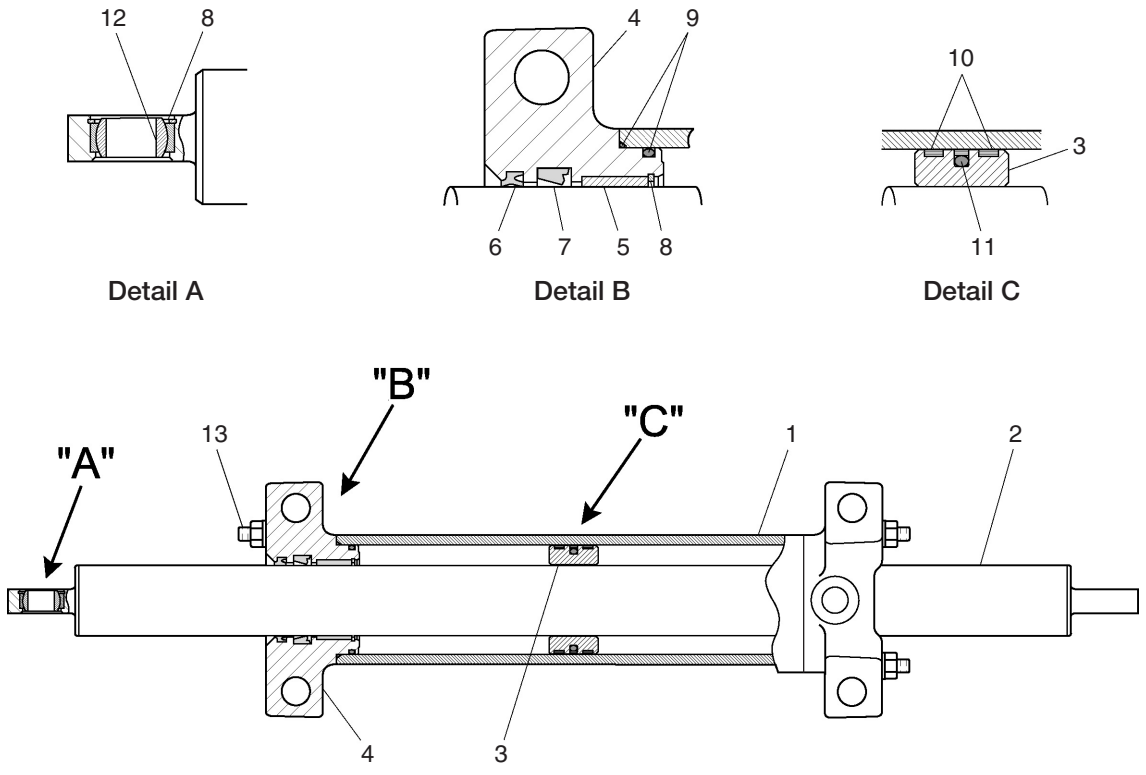


4. Installation of wheel hub and drum sub-assembly

(1) Carefully install the wheel hub and drum sub-assembly in the front housing while keeping it level.

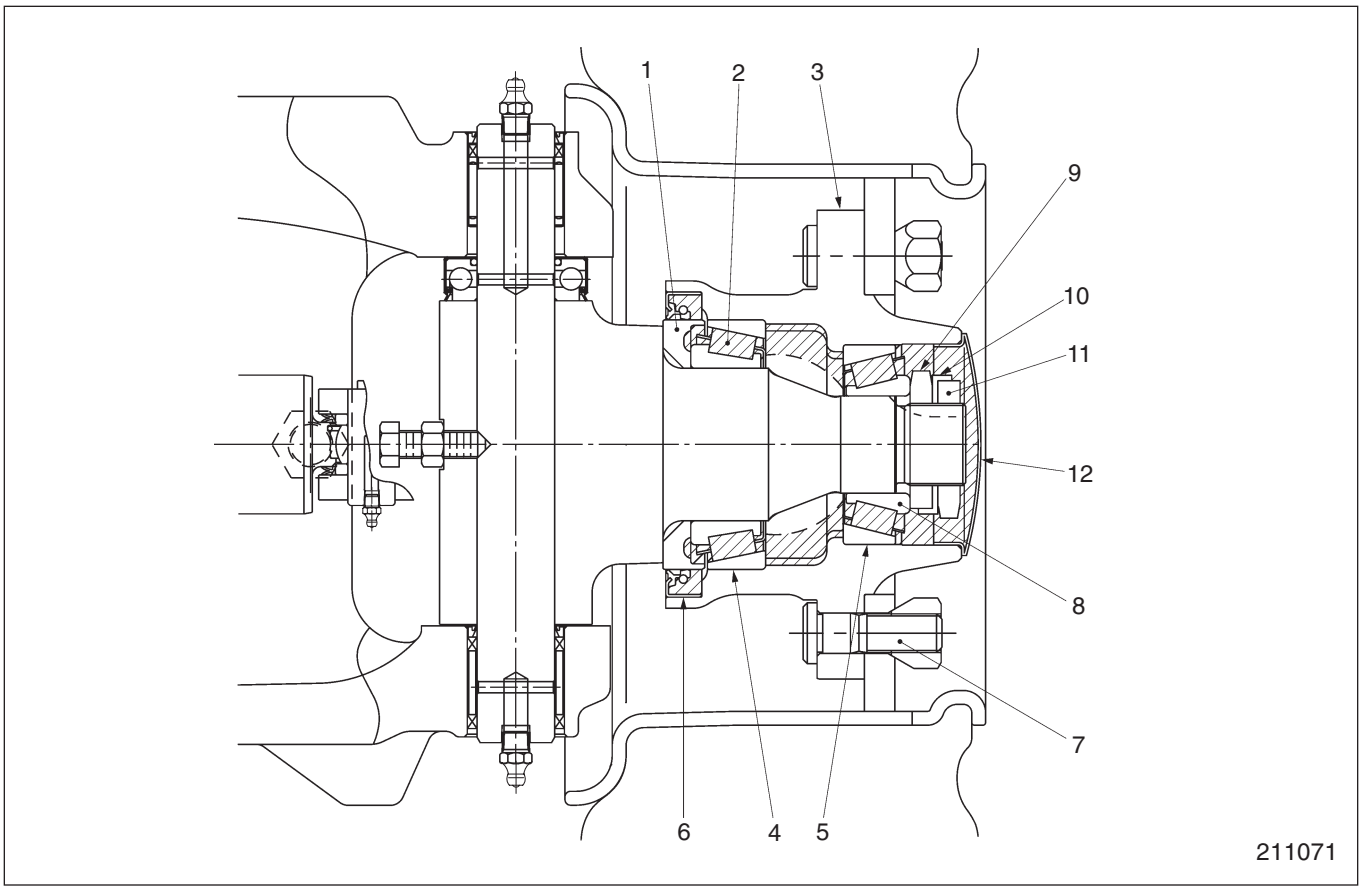
(2) Adjust the hub bearing preload.
Refer to "Adjusting Hub Bearing Preload" on the next page.

Steering Cylinder



1 Cylinder tube
2 Piston rod
3 Piston
4 Cylinder head
5 Bushing
6 Wiper
7 U-seal
8 Snap ring
9 O-ring
10 Guide ring
11 Piston seal
12 Spherical bearing
13 Tie rod

3. Assembling Rear Axle Hub



Sequence

1 Oil seal retainer
2 Bearing cone

Assembly parts 3 to 7 prior to final assembly.

3 Hub
4 Bearing cup
5 Bearing cup
6 Oil seal
7 Wheel bolt
8 Bearing cone
9 Inner nut
10 Lock washer
11 Outer nut
12 Cap

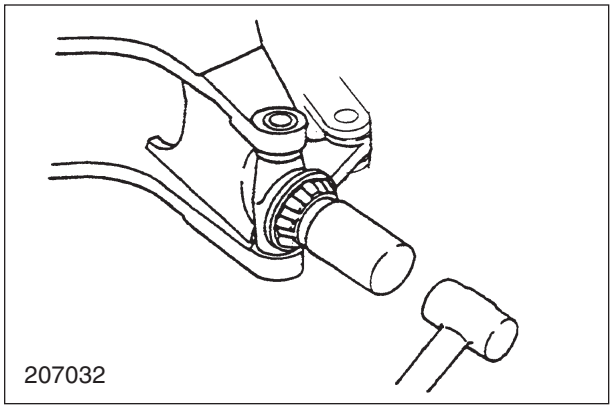
Suggestions for Reassembly

1. Install the seal retainer 1 in the illustrated direction with the special tool (64309 - 40400).
2. Install the bearing cone 2 with the special tool (64309-40400).

   Special tool needed

Bearing installer	64309 - 40400

3. Tapping with hammer, fit the wheel bolt 7 into the hub bolt hole.



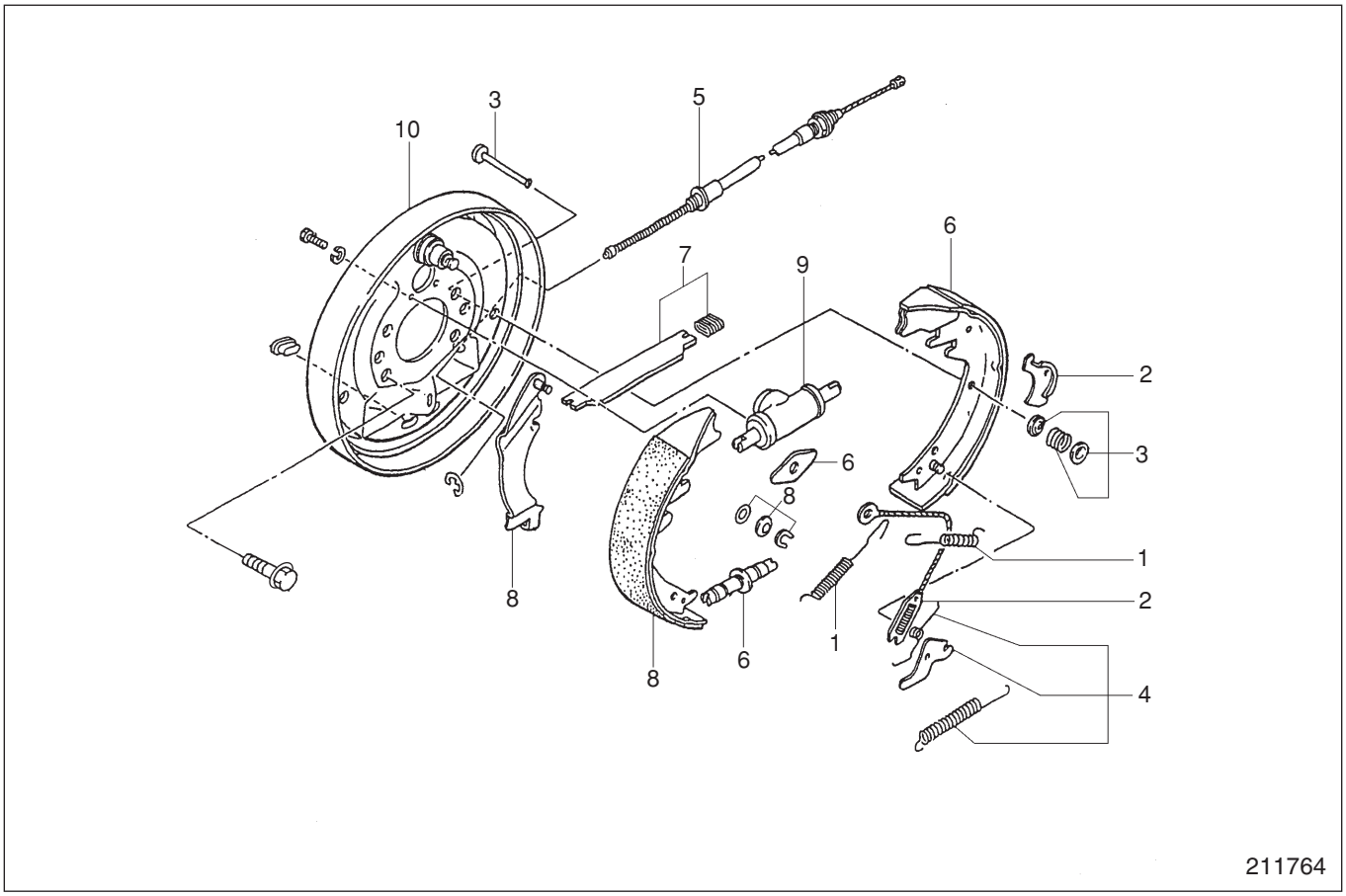
BRAKE SYSTEM

Procedures and Suggestions for Disassembly, Inspection and Reassembly

Wheel Brake

Disassembly

2 ton class and 2.5 ton class

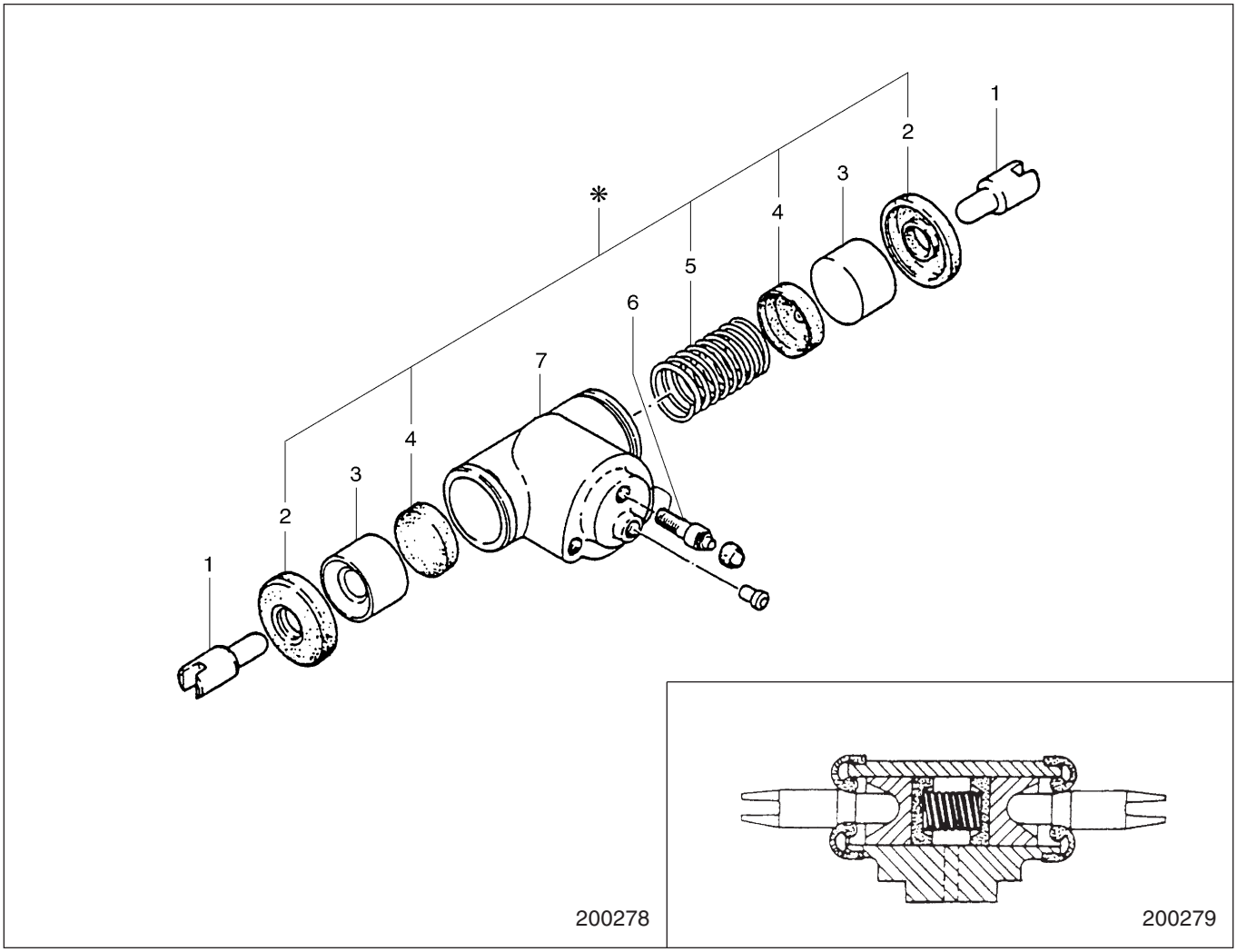


Sequence

1 Return springs
2 Fitting cable, Cable guide
3 Shoe hold pin, Shoe hold spring, Cup, Pin
4 Adjusting lever, Adjusting spring and Return spring
5 Brake cable
6 Shoe guide plate, Shoe and lining (secondary), Adjusting screw
7 Strut, Spring
8 Shoe and lining (primary), Parking brake lever, Retainer, Spring washer
9 Wheel cylinder
10 Backing plate

Wheel Cylinder

Disassembly



Sequence

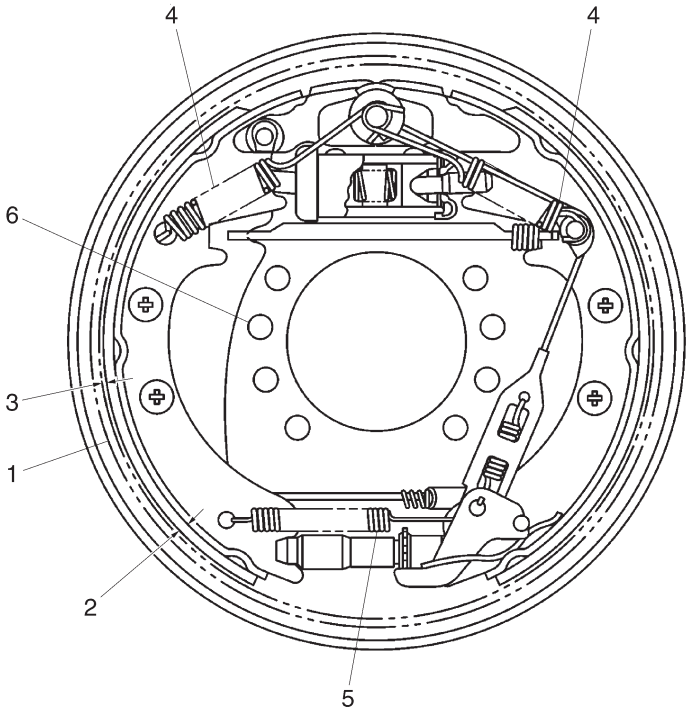
1 Connecting link
2 Boot
3 Piston
4 Piston cup
5 Return spring
6 Bleeder screw, Cap
7 Cylinder body

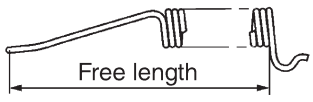
NOTE

Parts marked with (*) are included in the repair kit.

A: Standard value B: Repair or service limit
Unit: mm (in.)

Item				Truck Models: 3 ton class	3.5 ton class
Wheel brakes	Inside diameter of brake drum 1		A	$310\ ^{+0.15}_{0}$ ($12.20\ ^{+0.006}_{0}$)	
			B	312.0 (12.28)	
	Thickness of lining 2		A	5.67 (0.22)	
			B	3 (0.12)	
	Clearance between drum and shoe 3 (one side)		A	0.1 to 0.35 (0.004 to 0.014)	
	Return spring 4	Free length	A	Primary: 120 (4.72) Secondary: 139.2 (5.48)	
		Length under test force	A	Primary: 134 (5.28)	Secondary: 145.4 (5.72)
		Test force N (kgf) [lbf]	A	226 ± 23 (23 ± 2.3) [51 ± 5.1]	
	Spring 5	Free length	A	126 (4.96)	
		Length under test force	A	145.4 (5.72)	
		Test force N (kgf) [lbf]	A	78.5 ± 7.8 (8 ± 0.8) [17.6 ± 1.76]	
	Tightening torque for backing plate bolt 6 N·m (kgf·m) [lbf·ft]		A	215 ± 21.5 (21.9 ± 2.2) [158.6 ± 15.9]	





Primary return spring 4

Secondary return spring 4

Spring 5

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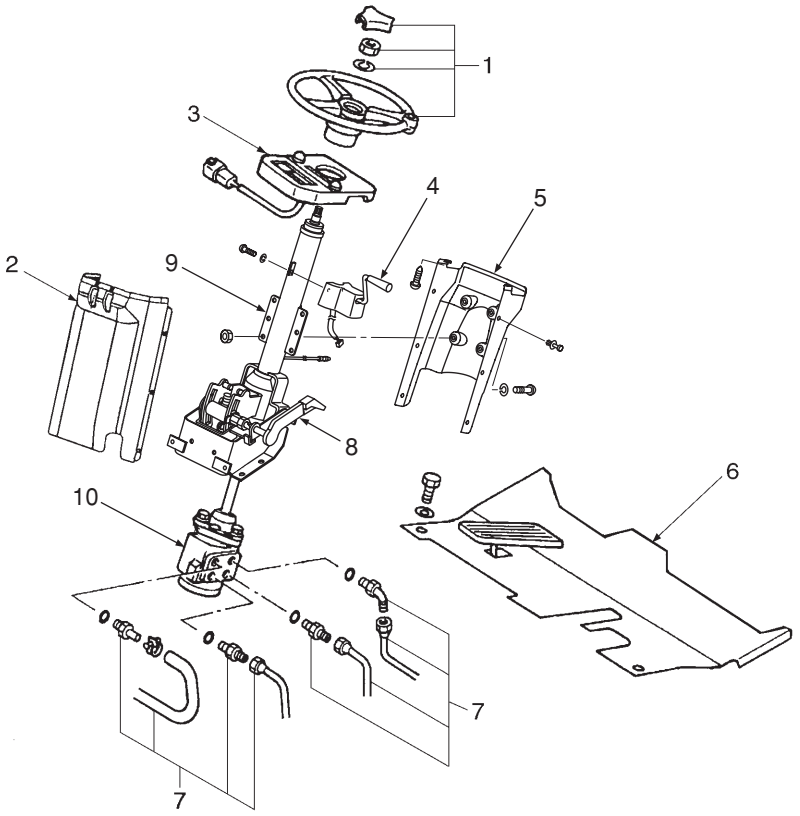
Procedures and Suggestions for Removal and Installation

Steering Column Assembly

Removal



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Sequence

1 Steering wheel, Cap, Nut, Washer
2 Console box (front panel)
3 Central vehicle monitor panel
4 Direction lever
5 Console box (rear panel)
6 Floor plate
7 Hose, Pipe, Hose clamp, Connector, O-ring
8 Tilt steering lock lever, Spacer, Lock bolt, Lock plate, Pin, Lock nut
9 Steering column assembly
10 Steering control valve

⚠ WARNING

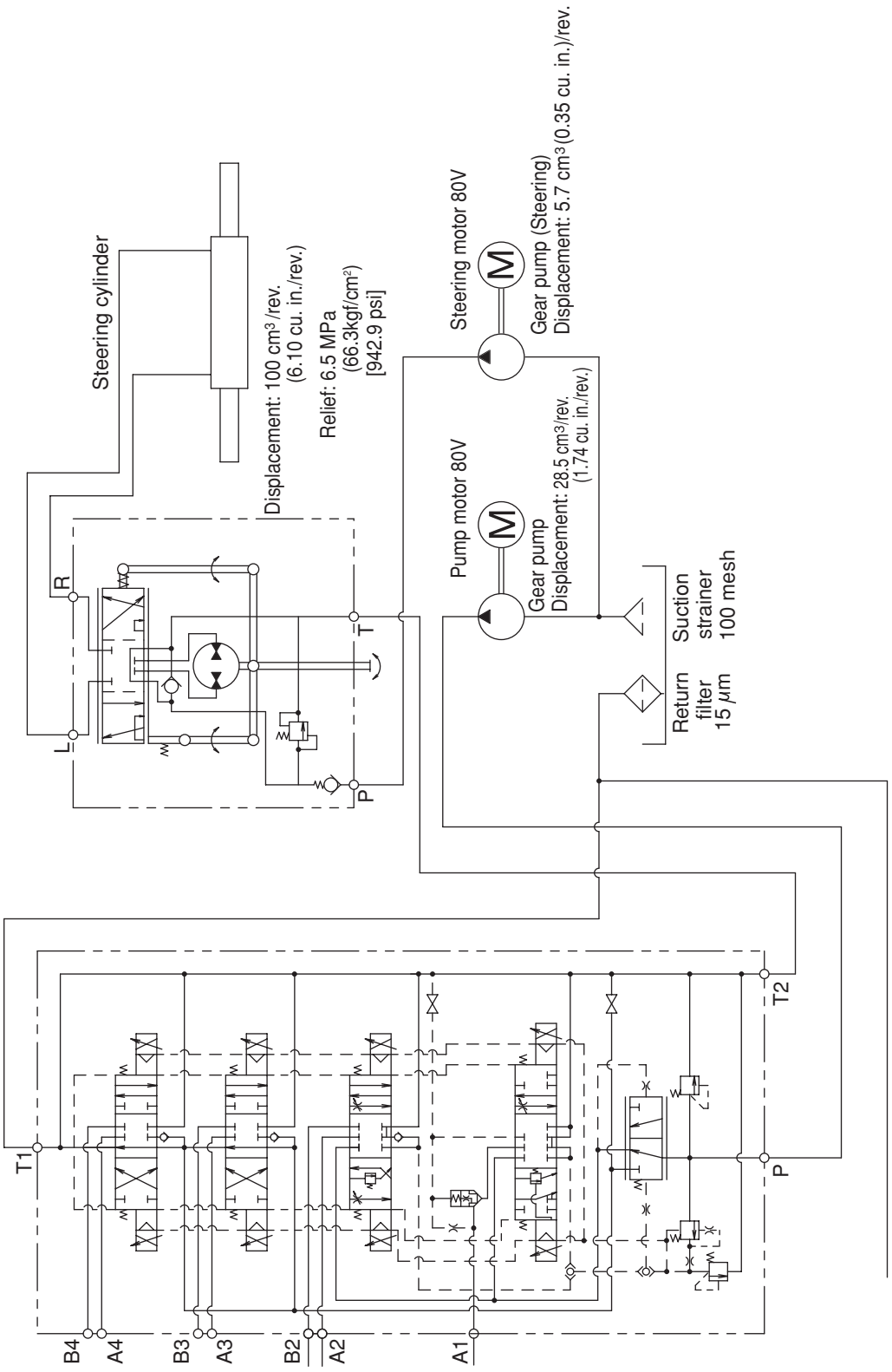
Hydraulic pressure can cause personal injury. Before any steering system hydraulic lines or components are disconnected, make sure all hydraulic pressure is released in the steering system. Move the steering wheels to the left and right, then straight.

NOTE

For servicing the steering cylinder, see “Group 6 REAR AXLE ”.

For servicing the pump and valve, see “Group 9 HYDRAULIC SYSTEM”.

Hydraulic Circuit Diagram (2 Ton Class and 2.5 Ton Class)



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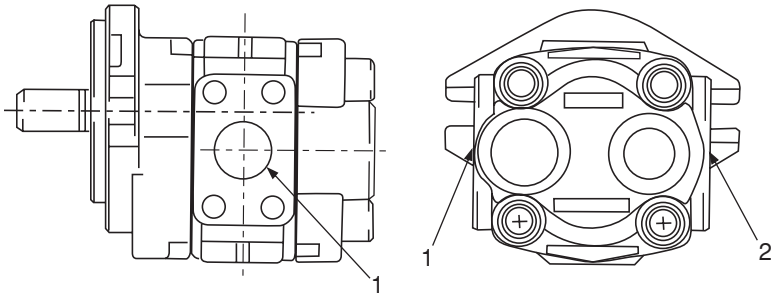
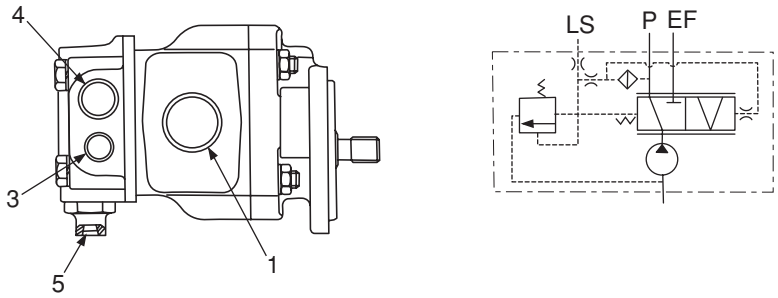
Hydraulic Pump



Hydraulic pump for 2 ton class and 2.5 ton class
Displacement: 28.8 cc/rev.
(1.76 cu. in./rev.)

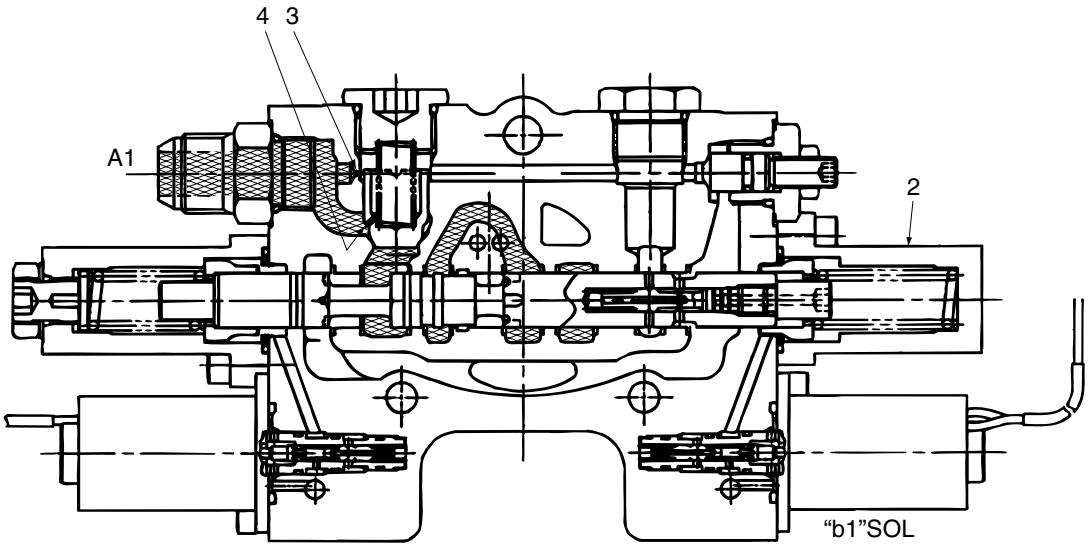


Hydraulic pump for 3 ton class and 3.5 ton class
Displacement: 29.0 cc/rev.
(1.77 cu. in./rev.)

211625

1 Inlet port
2 Outlet port
3 Priority port (P)
4 Secondary port (EF)
5 Load sensing port (LS)

Lift section



Blocking oil

207441

Emergency Lift Lock Mechanism

With the proportional electromagnetic pressure control valve on the "b1" SOL side in activation (lift in lowering operation), if spool sticking should occur, deactivation of the proportional electromagnetic pressure control valve cancels pilot pressure in cap 2. As a result, the lift lock valve moves to the position indicated in the diagram, and the pilot oil passage closes.

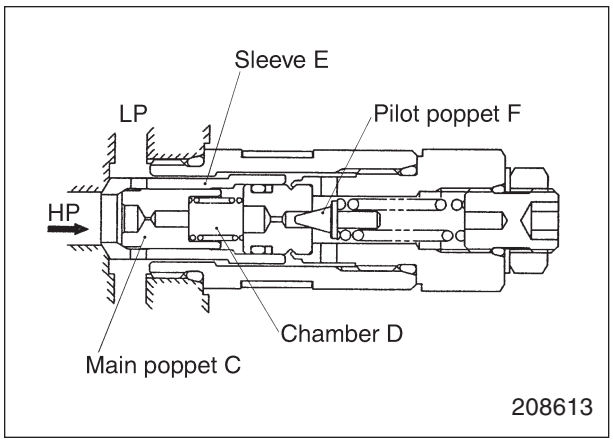
Consequently, pressure equalizes before and after orifices 3, 4, and the load check valve returns to its seat by spring force to lock the cylinder.

Main Relief Valve

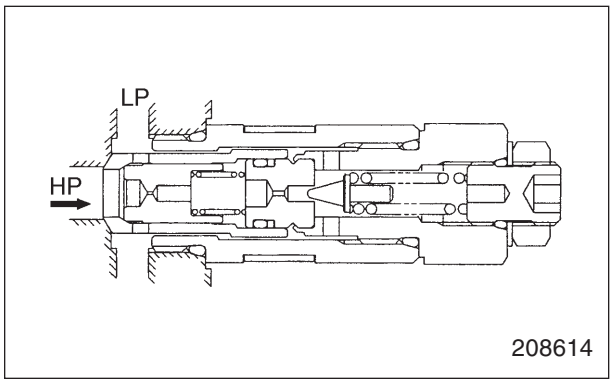
Main Relief Valve Operations

The main relief valves are installed between high-pressure oil passage HP and low-pressure oil passage LP, and perform the following operations.

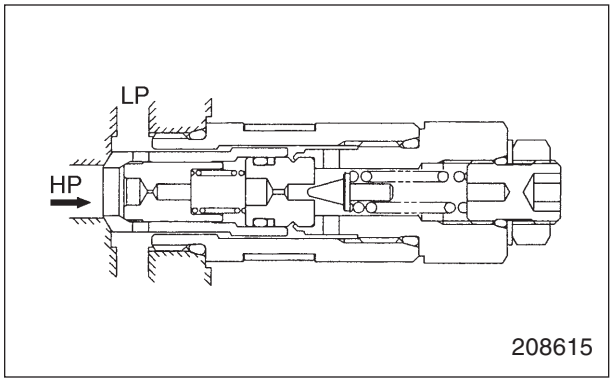
(1) Chamber D is filled with oil entering through orifices in main poppet C, thus main poppet C and sleeve E are firmly seated because of the difference in area sizes.



(2) When pressure in HP reaches the preset pilot spring force, pilot poppet F opens. Oil flows around the pilot poppet and passes through the holes and enters low-pressure passage LP.

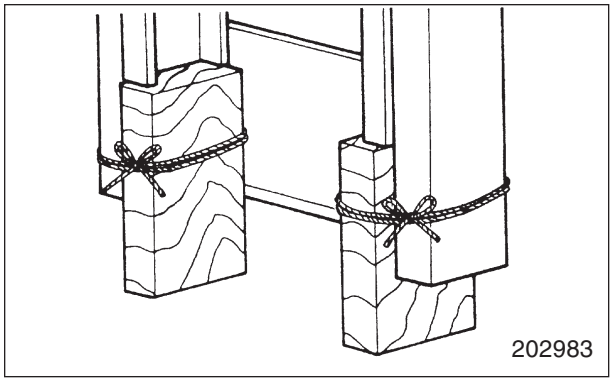


(3) Because pilot poppet F opens, oil flows from HP to chamber D through orifices in main poppet C. This oil flow results in pressure differences between HP and chamber D, thus causing main poppet C to open and allow oil to flow directly from HP to LP.



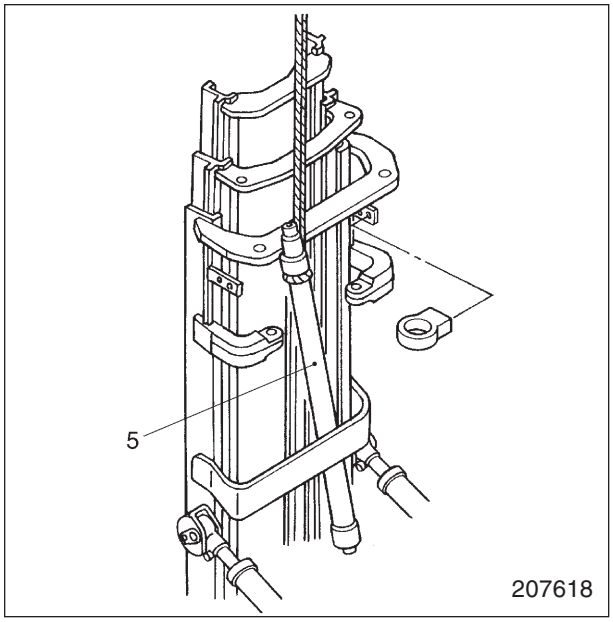
(3) Place wood blocks under the inner mast (dual-stage full free panoramic mast) or middle mast (triple-stage full free panoramic mast).

Make sure the right and left wood blocks are the same in height.



(4) Hitch a sling to the second lift cylinder 5 behind the mast, remove cylinder clamp retaining bolts, and gently remove the second lift cylinder 5.

Hitch the sling securely to the cylinder. The cylinder cannot be lifted straight up since the mast cross-member is located above the cylinder. Tilt the cylinder and move it away from the cross-member to remove. Be careful not place the hands between the cylinder and mast.



Installation

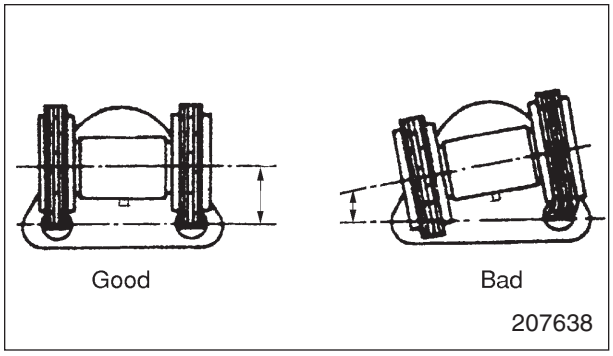
To reinstall, follow the removal sequence in reverse, and follow the instructions below:

(1) Install chain wheel support assembly 4 parallel to a line connecting the centers of chain anchor bolt holes on the first lift cylinder 3 to prevent chains from twisting.

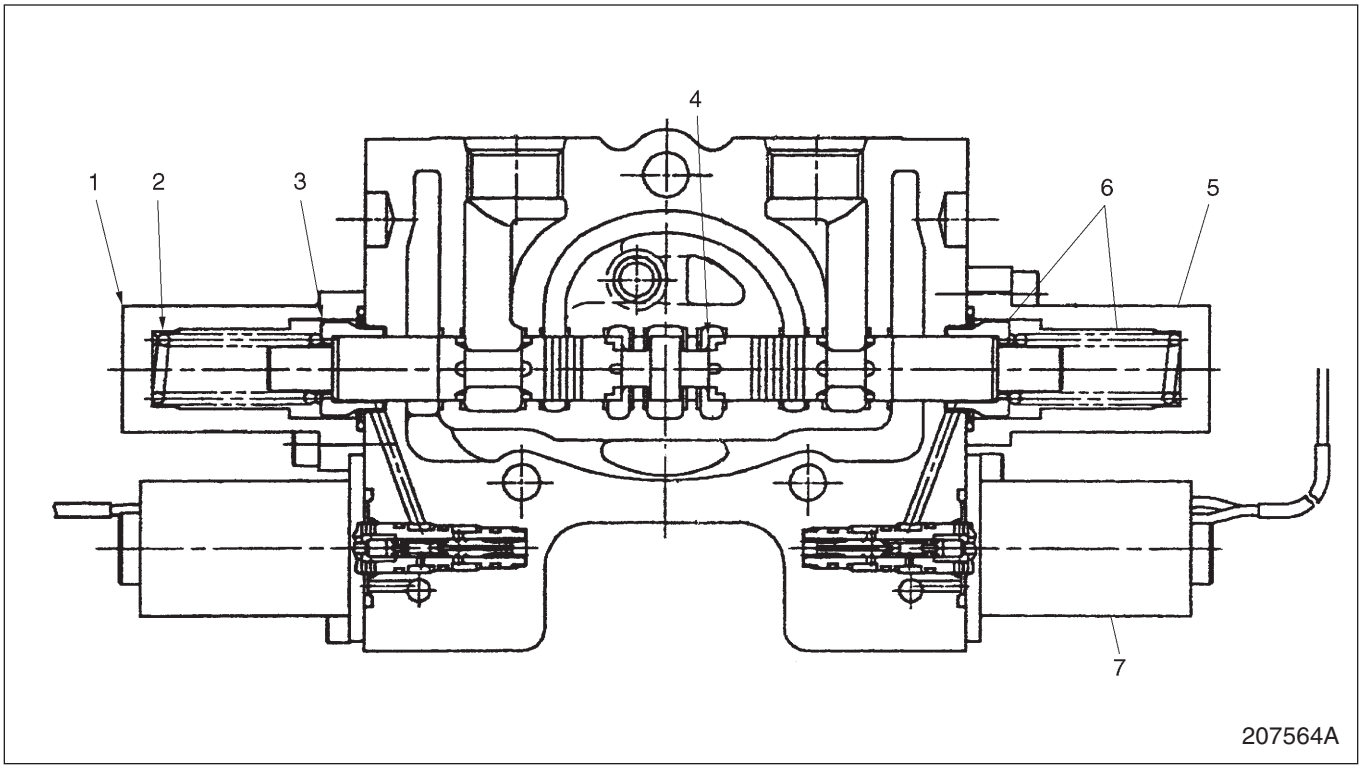
(2) Adjust the chain tensions.
(Refer to “Inspection and Adjustment” in “GROUP 10 MAST AND FORK”.)

(3) 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.

(4) After proper operation is confirmed, check the oil level.



Disassembly of Attachment Section Assembly



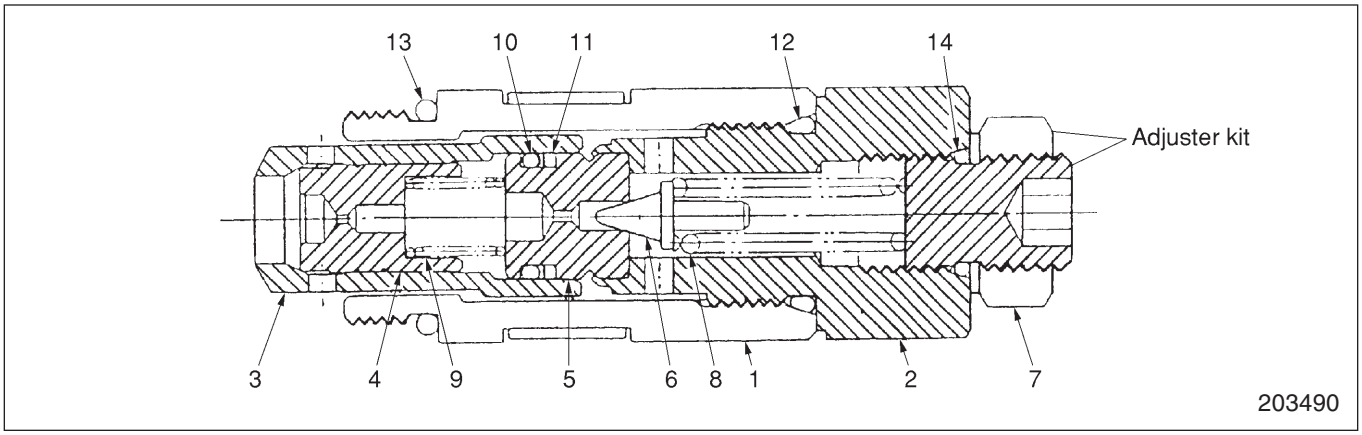
Sequence

1 Cap, Socket-head bolt
2 Spring
3 Spring seat
4 Spool
5 Cap, Socket-head bolt
6 Spring, Spring seat
7 Proportional electromagnetic pressure control valve

Suggestions for Disassembly

For disassembly procedures, refer to the tilt section.

Main Relief Valve



1 Cap
2 Plug
3 Sleeve
4 Main poppet
5 Pilot seat
6 Poppet
7 Lock nut
8 Pilot spring
9 Spring
10 O-ring
11 Back up ring
12 O-ring

The seal kit consists of parts 13 and 14.

13 O-ring
14 O-ring

Disassembly

Do not disassemble the main relief valve unless it fails to limit the pressure properly. If the main relief valve is disassembled, the relief pressure setting must be readjusted. The disassembly procedure is as follows:

(1) Loosen lock nut 7 of the adjuster kit, then turn the adjuster screw twice counterclockwise to reduce force of spring 8.

(2) Hold cap 1 in a vise, then unscrew and remove plug 2 to allow easy removal of the internal parts.

Inspection after disassembly

If an abnormality is evident and does not take the form of damage that can be rectified by lapping, replace the main relief valve assembly with a new one.

(1) Check whether main poppet 4 slides smoothly inside the sleeve. It must slide smoothly.

(2) Visually inspect the spring. It must not be bent or otherwise damaged.

(3) Visually inspect the contact surfaces of pilot poppet 6 and pilot seat 5. They must be free of damage and uneven wear.

(4) Visually inspect the orifice. Remove any blockage.

Reassembly

Only O-rings 13 and 14 are available as service parts.

(1) Hold cap 1 vertically in a vise with the plug end at the top.

(2) Insert the parts into cap 1 in appropriate sequence through opening in the top of the cap.

(3) Screw plug 2 (with the adjuster kit attached) into the cap by hand. It must be possible to screw the plug into the cap smoothly.

(4) Tighten plug 2 into cap 1 using a wrench.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	69 to 78 (7 to 8) [51 to 58]

Pressure adjustment

(1) Turning adjuster screw clockwise increases the relief pressure setting. Turning it counterclockwise decreases the relief pressure setting.

(2) Adjust relief pressure setting to 18.1 $^{+0.5}_{-0}$ MPa (185 $^{+5}_{-0}$ kgf/cm^2) [2631 $^{+71}_{-0}$ psi].

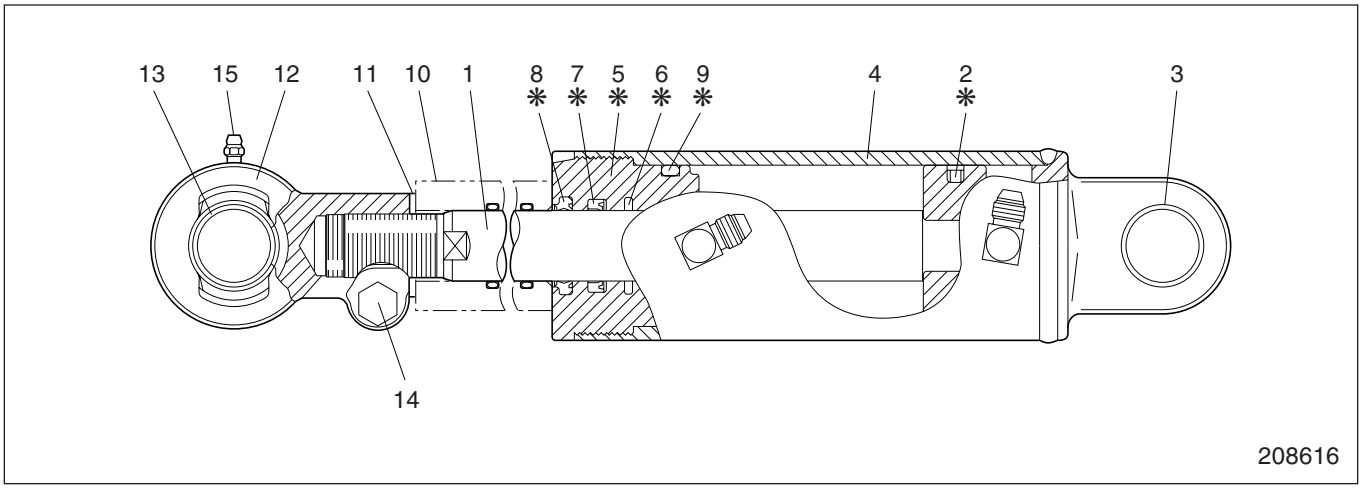
(3) Tighten lock nut to the torque shown below while holding the adjuster screw to prevent it from turning.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	27 to 31 (2.8 to 3.2) [20.2 to 23.1]

For instructions on pressure inspection and adjustment on the vehicle, see page 9-71.

Reassembly



Sequence

1 Piston rod assembly
2 Piston seal
3 Bushing
4 Cylinder tube
5 Guide bushing
6 Buffer ring
7 Rod packing
8 Dust seal
9 O-ring
10 Sleeve
11 Shim

NOTE: Parts 10 and 11 are used only in the 3° and 6° backward tilt cylinders.

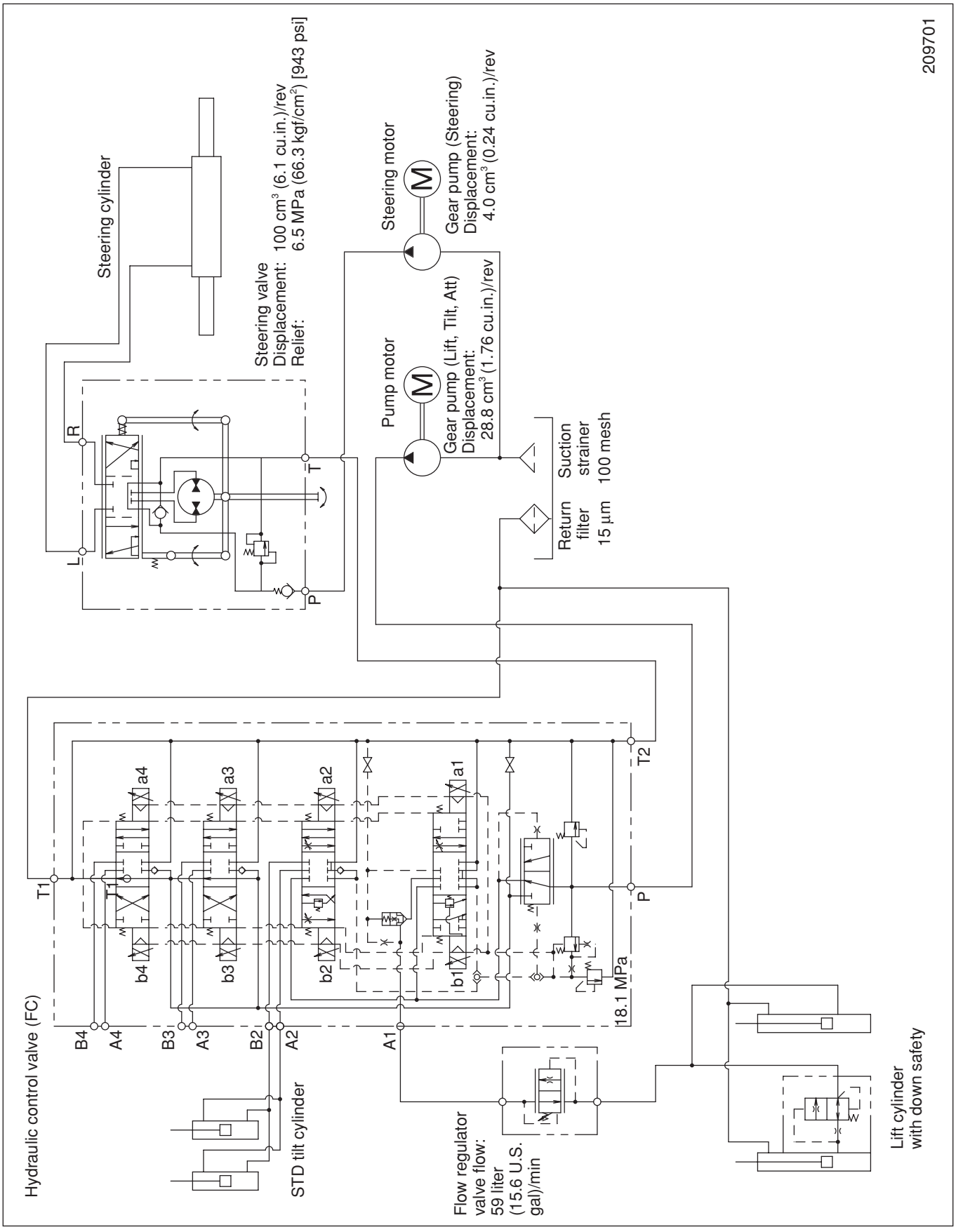
12 Tilt socket
13 Spherical bearing
14 Bolt, Nut
15 Grease nipple

NOTE

Parts marked with ✻ are included in the seal kit.

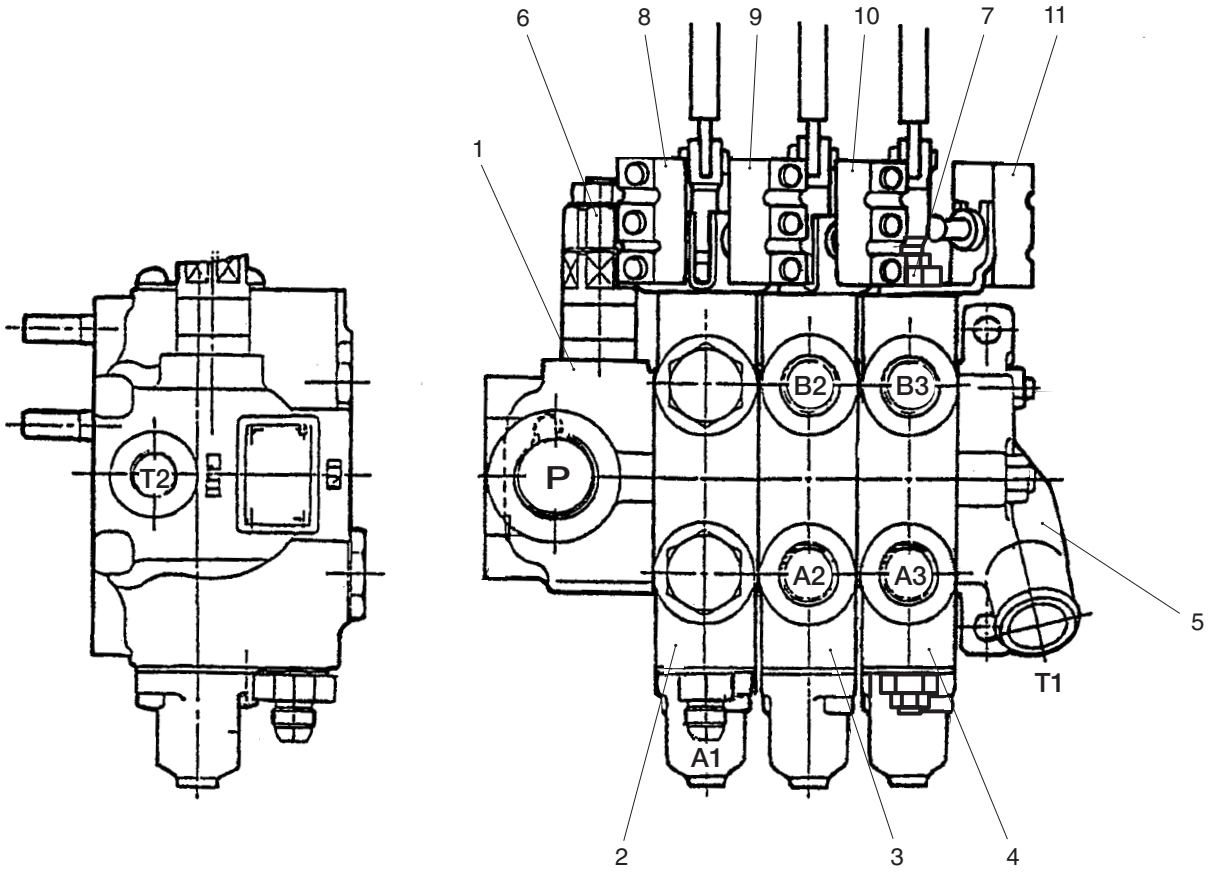
Hydraulic Circuit Diagram (FC)

2 Ton Class and 2.5 Ton Class



Control Valve

General



1 Inlet cover
2 Lift valve assembly
3 Tilt valve assembly
4 Attachment valve assembly
5 End cover
6 Main relief valve
7 Shut-off valve assembly (for attachment section)
8 Lift switch 1 (microswitch)
9 Lift switch 2 (microswitch)
10 Tilt switch (microswitch)
11 Attachment switch (microswitch)

P: From hydraulic pump
T1: To hydraulic tank
T2: From steering gear
A1: To lift cylinder
A2: To tilt cylinder (rod end)
B2: To tilt cylinder (head end)
A3: To attachment cylinder
B3: To attachment cylinder

The control valve structure is shown above. The parts are joined together by three tie-bolts.

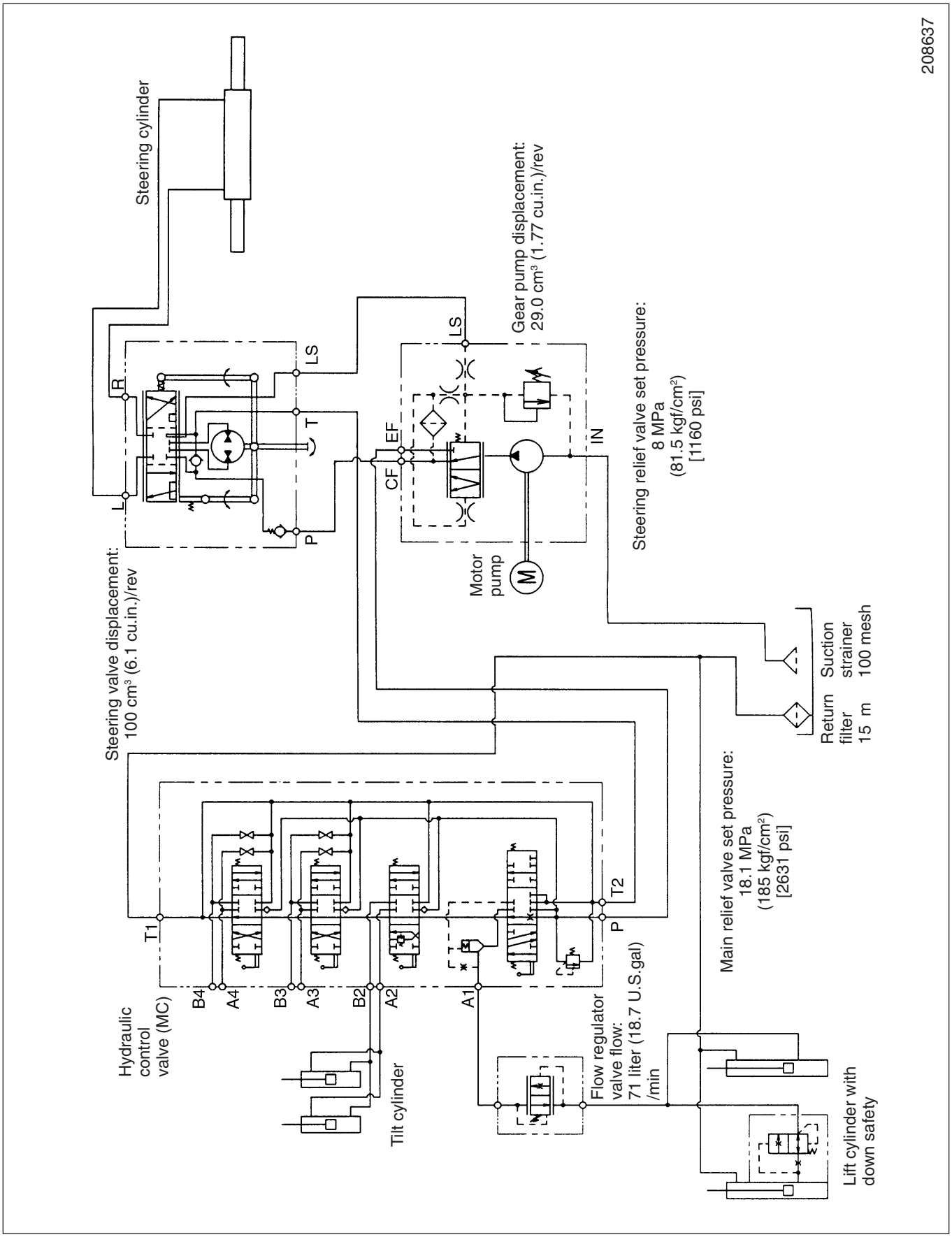
Since a lapping process is used for the coupling of the body and spool, the body and spool combination cannot be changed.

The inlet cover contains the main relief valve. The lift valve assembly contains the load check valve. The tilt valve spool contains the tilt lock valve.

The microswitches located on top of the control valve turn ON and OFF according to the spool movement, and send lift and tilt signals to the logic card.

The lift valve is equipped with two microswitches for two-step lift speed selection.

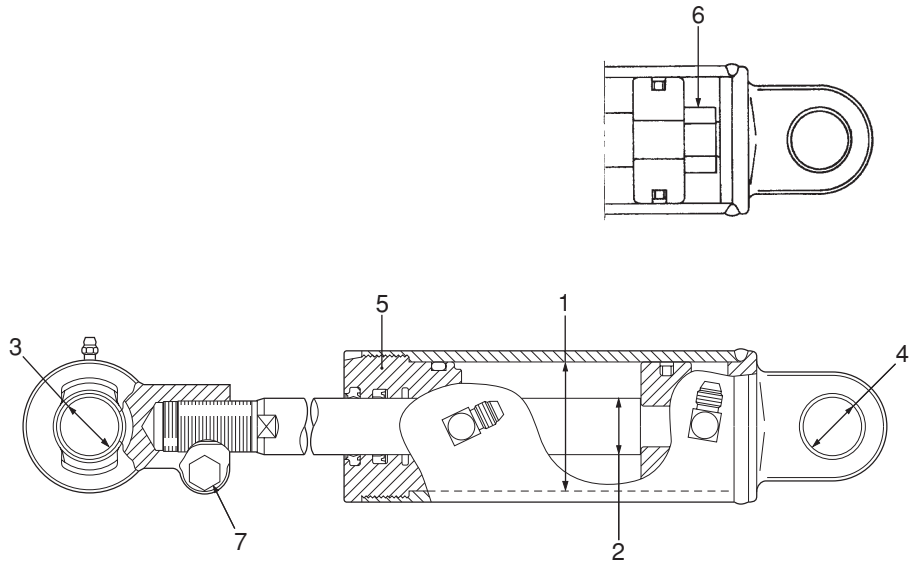
3 Ton Class and 3.5 Ton Class



A: Standard value

Unit: mm (in.)

Item				Truck Models: 2 ton class, 2.5 ton class	3 ton class, 3.5 ton class
Tilt cylinders	Inside diameter of cylinder tube 1		A	70 (2.76)	80 (3.15)
	Diameter of piston rod 2		A	30 (1.18)	35 (1.37)
	Inside diameter of tilt socket bushing (fitted) 3		A	$35\ ^{0}_{-0.012}$ ($1.38\ ^{0}_{-0.0005}$)	
	Inside diameter of cylinder tube head bushing (fitted) 4		A	$32\ ^{+0.085}_{0}$ ($1.26\ ^{+0.003}_{0}$)	
	Tightening torque N·m (kgf·m) [lbf·ft]	Guide bushing 5	A	314 ± 31 (32 ± 3.2) [232 ± 23]	373 ± 37 (38 ± 3.8) [275 ± 27]
		Nut 6	A	235 ± 19.6 (24 ± 2.0) [173 ± 14.5]	392 ± 25 (40 ± 2.5) [289 ± 18]
		Tilt socket bolt 7	A	157 to 182 (16.0 to 18.6) [116 to 134]	80 ± 10 (8.0 ± 1.0) [59 ± 7.4]

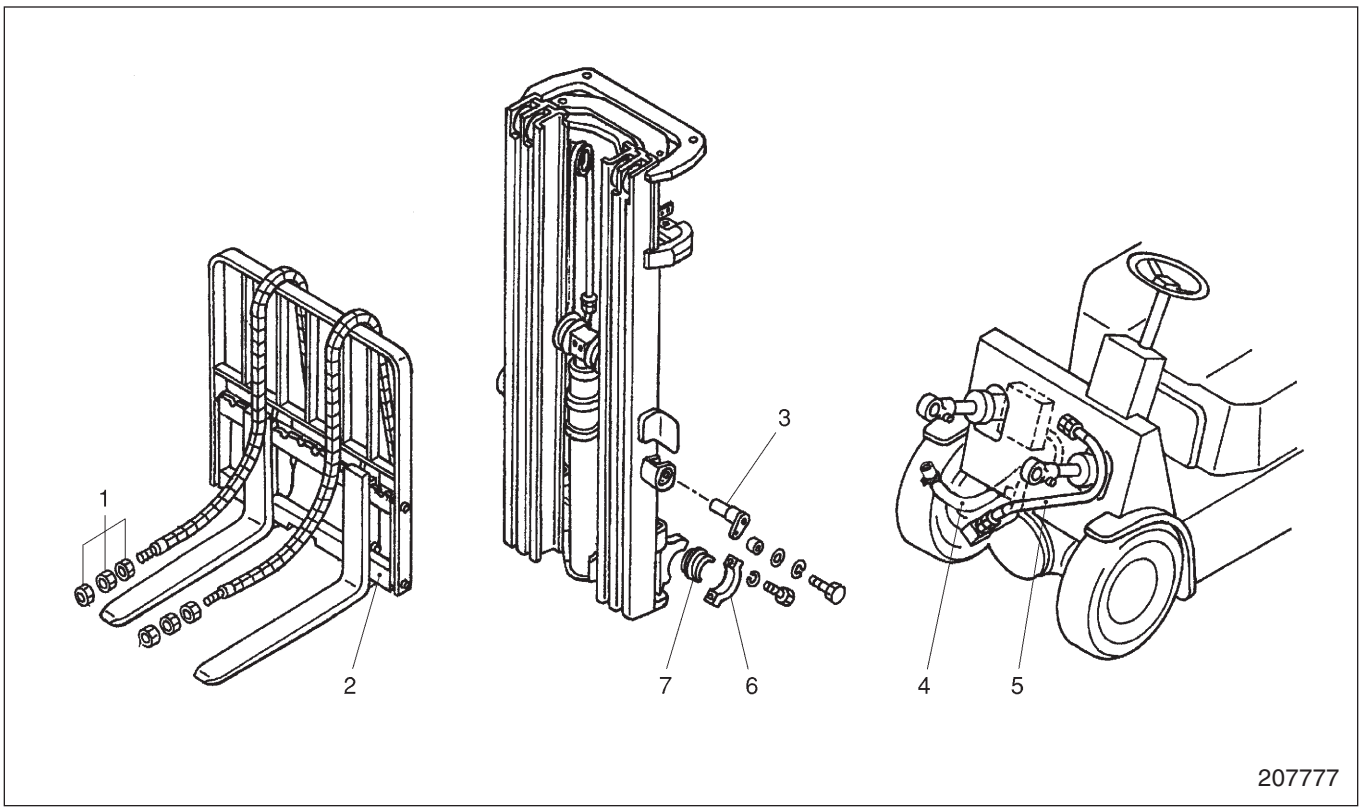


211630

Mast and Lift Bracket Assembly

The following describes the procedures for removing and reinstalling the mast assemblies of dual-stage full free panoramic mast (Duplex Mast) and triple-stage full free panoramic mast (Triplex Mast). Note that the triple-stage full free panoramic mast (Triplex Mast) is used as an example.

Triple-stage Full Free Panoramic Mast (Triplex Mast)



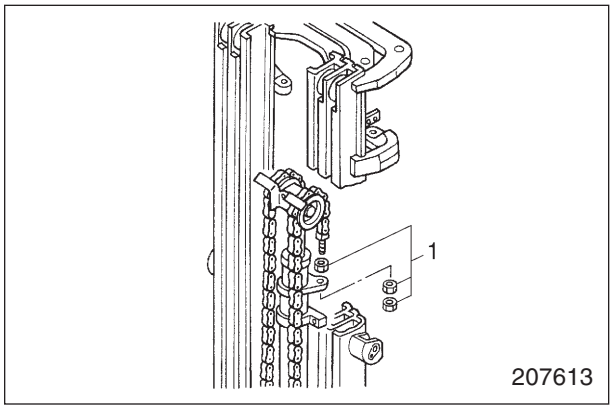
Sequence

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

Suggestions for Removal

1. Removing lift bracket assembly 2

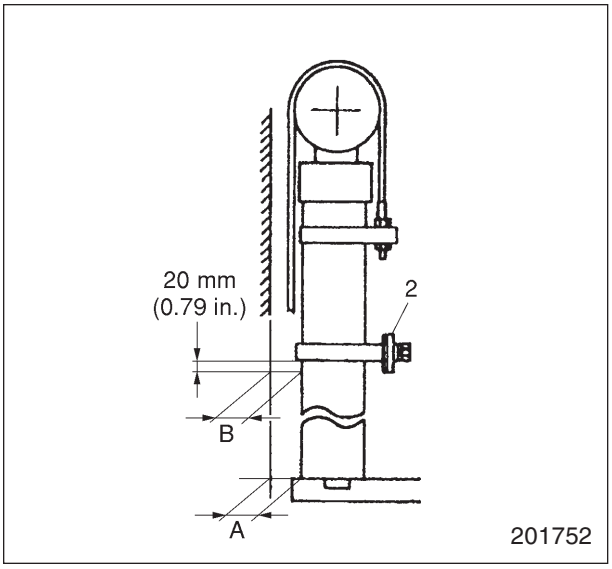
(1) Lower lift bracket assembly 2, and place wood blocks under the assembly. Tilt the mast forward, lower the inner mast to the bottom, then remove nuts 1 from the anchor bolts of the first lift chains.



3. Installing first lift cylinder

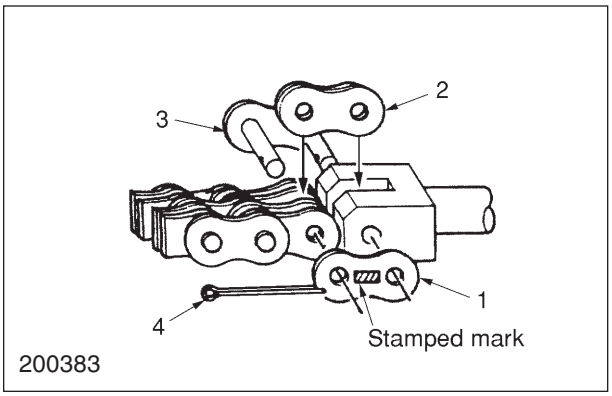
   The first lift cylinder must be installed parallel to the mast when the lift cylinder rod is contracted.

   Make sure the cylinder does not tilt forward. Using shims 2, adjust the backward inclination so that clearance at section B is 0 to + 0.5 mm (0 to + 0.02 in.) larger than clearance at section A.



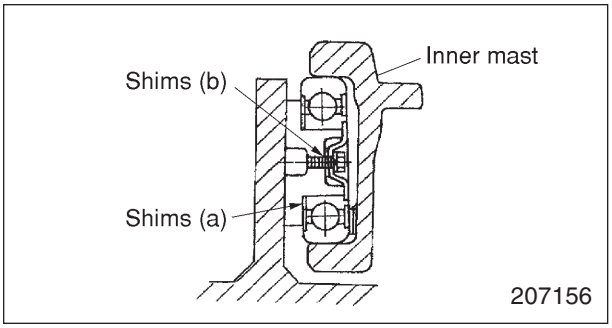
4. Precaution for installation of chain anchor kit

   Be careful not to confuse the center plate with the link plate.



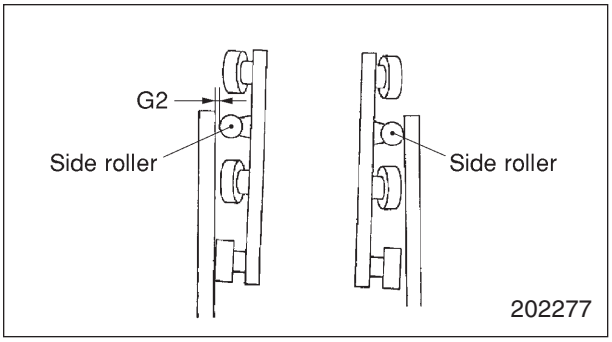
1 Link plate (stamped mark on surface)
2 Center plate (no stamped mark)
3 Link
4 Split pin

If clearance G1 is greater than 0.5 mm (0.020 in) by way of example, add a 0.5 mm (0.020 in) thick shim a on the inner side of the roller and remove shim b of the same thickness from the underside of the stopper, then tighten the bolt.

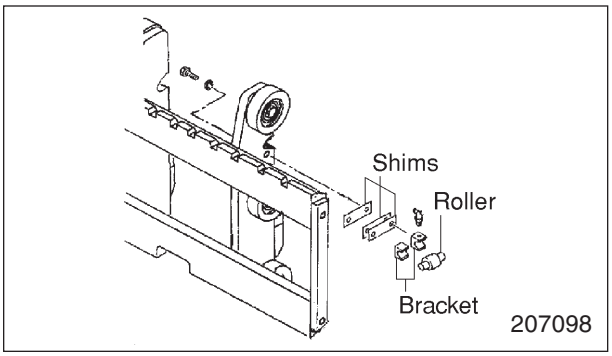


(7) Lower the lift bracket slightly from the top, then adjust clearance G2 between the side roller and mast by increasing or decreasing the thickness of the shims.

Clearance G2	0.1 to 0.5 mm (0.004 to 0.020 in.)

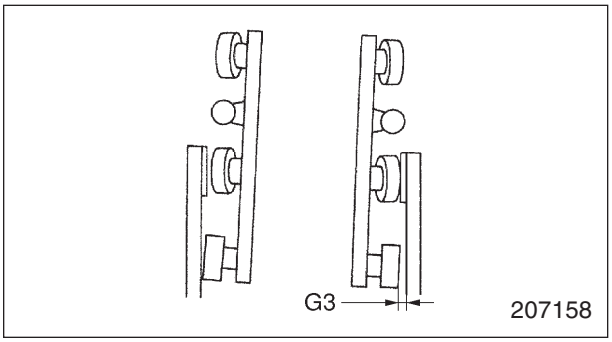


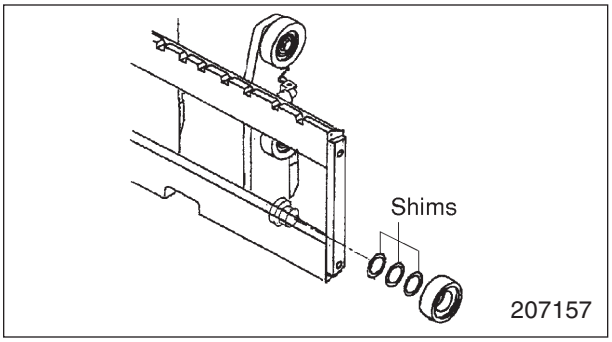
Adjust the side roller clearance by adding shims between the roller bracket and lift bracket.



(8) With the lift bracket at the top, adjust clearance G3 with shims.

Clearance G3	0.1 to 0.5 mm (0.004 to 0.020 in.)





Service Data

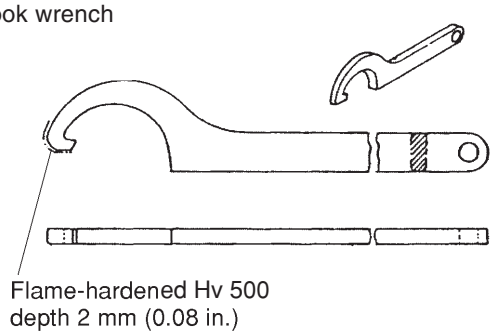
Simplex Mast, Duplex Mast

A: Standard value B: Repair or service limit
Unit: mm (in.)

Item \ Truck Models				2 ton class, 2.5 ton class	3 ton class, 3.5 ton class
Forks and chains	Difference in height between fork tips		A	5 (0.20)	
	Thickness of forks (width × thickness)		A	100 × 40 (3.9 × 1.57)	125 × 45 (4.9 × 1.77)
			B	100 × 38 (3.9 × 1.50)	125 × 43 (4.9 × 1.69)
	Length of lift chains (per 20 links)		A	381 (15.00)	508 (20.00)
			B	392 (15.43)	523 (20.59)
Rollers	Diameter of main roller	S	A	113.8 (4.48)	
		M	A	115 (4.53)	
		L	A	116 (4.57)	
		LL	A	117 (4.61)	
	Diameter of side roller		A	42 (1.65)	
Mast and lift bracket	Longitudinal clearance of lift bracket middle rollers (with forks slightly lifted) F		A	0.1 to 1.0 (0.004 to 0.039)	
	Lateral clearance of lift bracket middle main rollers (fully raised) G1		A	0.1 to 0.5 (0.004 to 0.020)	
	Lateral clearance of lift bracket side rollers (fully raised) G2		A	0.1 to 0.5 (0.004 to 0.020)	
	Lateral clearance of lift bracket lower main rollers (fully raised) G3		A	0.1 to 0.5 (0.004 to 0.020)	
	Longitudinal clearance of mast main rollers (in the whole lift range) H		A	0.1 to 1.0 (0.004 to 0.039)	
	Lateral clearance of inner mast main rollers (fully raised) J		A	0.1 to 0.5 (0.004 to 0.020)	
	Lateral clearance of outer mast main rollers (fully raised) K		A	0.1 to 0.5 (0.004 to 0.020)	
	Mast strip clearance (fully raised) L		A	0.1 to 0.5 (0.004 to 0.020)	
Distortion of finger bar			B	5 (0.2), maximum	

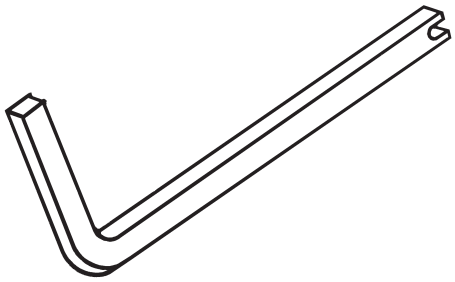
Inspection/Maintenance Location and Item		Pre-operation Inspection	Periodic Inspection Interval					Remarks Service Standard
			Every Week or 50 Hours	Every Month or 200 Hours	Every 3 Months or 600 Hours	Every 6 Months or 1200 Hours	Every 12 Months or 2400 Hours	
Chains and chain wheels	Length of lift chains (20 links)	○						Allowed lift chain stretch: 2 ton class, 2.5 ton class: 392 mm (15.43 in.) 3 ton class, 3.5 ton class: 523 mm (20.59 in.)
	Chain deformation, damage, lubrication and rusting			○				
	Chain bushing coupling, bolt deformation and damage			○				
	Chain wheel deformation and damage						○	
	Chain wheel bearing rattle			○				
Attachments	Attachment abnormality and mounting conditions	○						
Hydraulic system								
Cylinders	Looseness, deformation and damage of rods, rod bolts and rod ends						○	
	Cylinder operating condition	○						
	Drift lowering and forward tilting distances					○		Drift lowering distance: 2 ton class, 2.5 ton class: 50 mm (1.97 in.)/15 min 3 ton class: 40 mm (1.57 in.)/15 min 3.5 ton class: 35 mm (1.38 in.)/15 min Drift forward tilting distance: 2 ton class, 2.5 ton class: 20 mm (0.79 in.)/15 min 3 ton class, 3.5 ton class: 15 mm (0.59 in.)/15 min
	Cylinder oil leaks and damage	○						
	Wear and damage of piston and cylinder shaft bearings						○	
Oil pump	Oil leaks, abnormal noise, wear in drive unit, and mounting looseness	○						
Hydraulic tank	Oil level and contamination	○					⊗	N level: 28.2 liter (7.45 U.S.gal) H level: 30.0 liter (7.93 U.S.gal)
	Filter clogging					⊗		
Operation levers	Linkage looseness			○				
	Lever functions			○				
Control valves	Oil leaks	○						
	Safety valves	○						
	Release pressure measurement						○	18.1 MPa (185 kgf/cm^2) [2631 psi]

Hook wrench



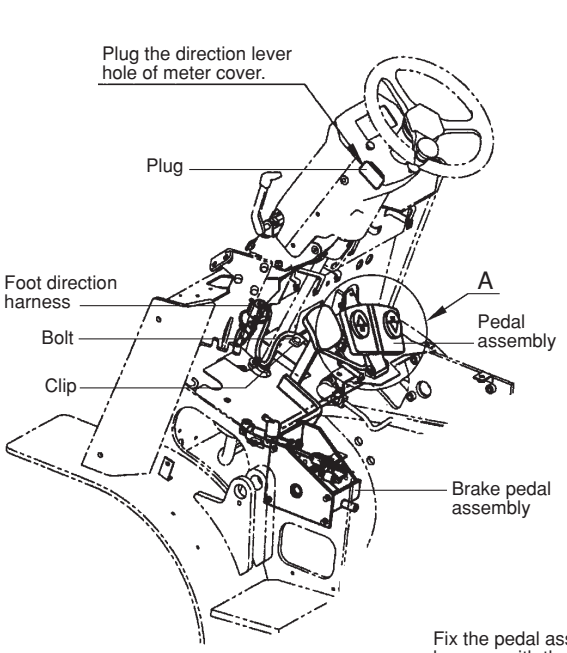
⑨ 203556

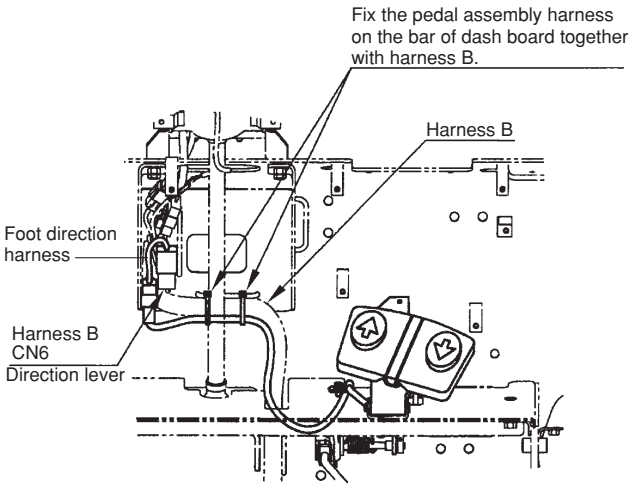
Spring installer



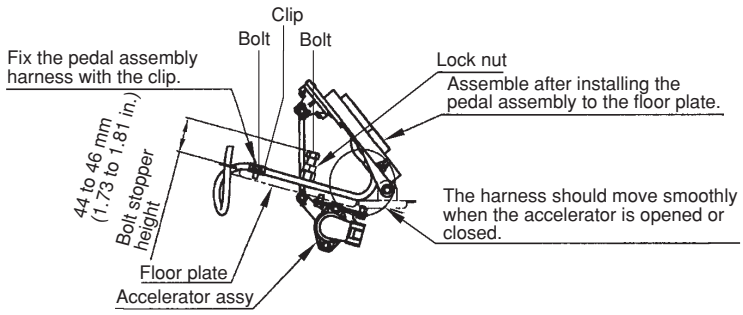
⑩ 206997

Foot Direction Control Kit





Detail of wiring

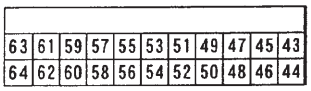


A: Detail of pedal assembly installation

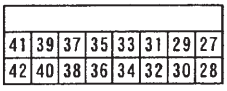
211686

MAIN CONTROLLER

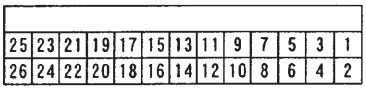
Hydraulic Control Logic Card



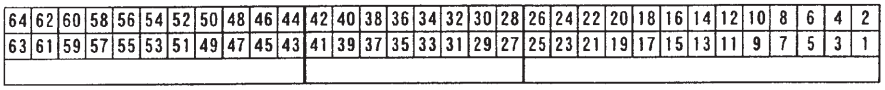
Harness side CN14



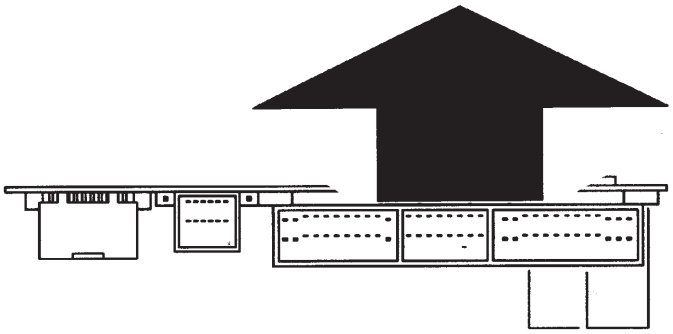
Harness side CN15

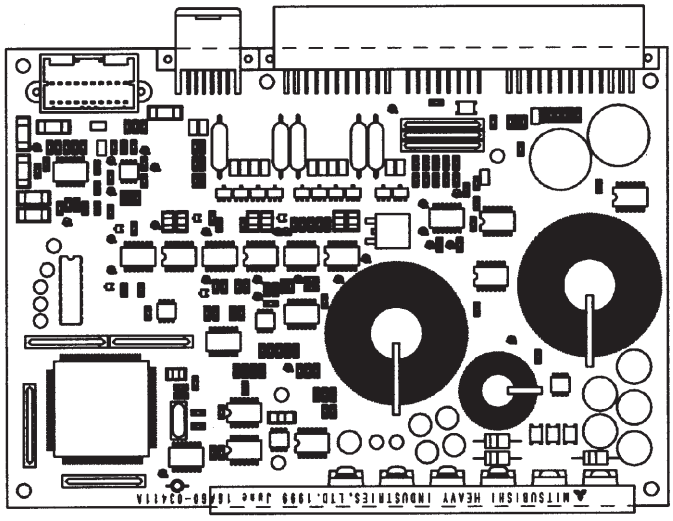


Harness side CN16



Logic card side CN1





208264

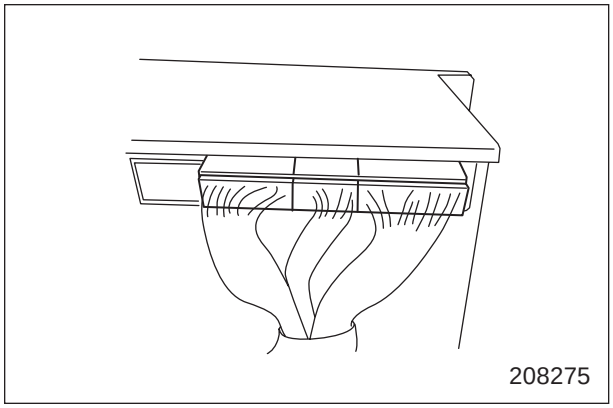
Setup Options (Group 1)

Option #	Title of Option	Description	Range	Default value
#1	Application pre-sets (truck operation mode)	There are 5 truck modes. This option sets combination of 7 option values, which are Top travel speed, Acceleration rate, Traveling power, Regen adjustment, Start lift speed, Top lift speed, Tilt speed.	A, B, C, D, E If any of these 7 option values are changed, A through E will flash in order to show that the truck mode is not in default setting.	A
#2	Start lift speed	This option sets starting lift speed. (when the first lift switch is on) Start lift speed cannot exceed top lift speed.	1 to 10	7
#3	Top lift speed	This option sets maximum lift speed. (when the second lift switch is on)	1 to 10	9
#4	Tilt speed	This option sets tilt speed. Tilt speed is prior to lift speed in case the two levers are simultaneously operated.	1 to 10	7
#5	Auxiliary 1 speed	This option sets speed setting for attachment 1.	1 to 10	3
#6	Auxiliary 2 speed	This option sets speed setting for attachment 2.	1 to 10	1
#7	Top travel speed limit	This option sets maximum travel speed.	5 to 16 km/h (3 to 10 mph)	14
#8	Acceleration rate	This option determines acceleration rate. (Slow, Moderate, Fast)	1, 2, 3	2
#9	Traveling power mode	This option determines powering characteristic. (Economy, Standard, High power)	1, 2, 3	2
#10	Service indicator	This option sets the maintenance time which is a reminder for service personnel. The time set is added to the truck's hourmeter and that value is stored in memory as maintenance time. When the truck's hourmeter reaches maintenance time, the service indicator LED turns on. It will flicker 20 hours before maintenance time. You can reduce the truck power when the LED is solid on by setting selection. You can also set the demo-mode, which shows the Service Indicator function in a short period of time.	100 to 500 hours in 50-hr. increments. Selecting '=' attached number makes the power reduction function effective. Setting 0.1 makes the truck demo-mode. 0: Disable	0

NOTICE:

(1) In #1 Application pre-sets, we add Traveling Power to the Gemini's function.

Disconnect connectors CN1, CN2 and CN3. (for hydraulic: CN14, CN15 and CN16)

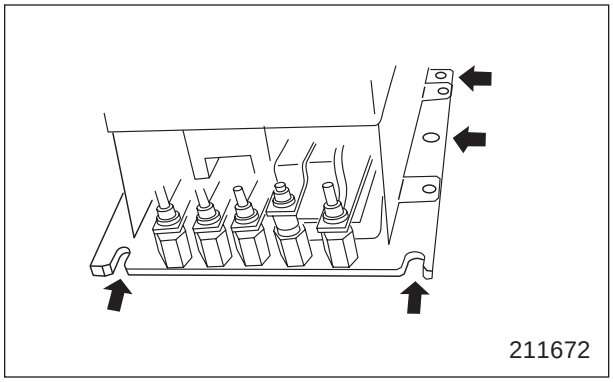

208275

NOTE

- Hold the connectors to unplug. Do not pull the harnesses to disconnect the connectors.

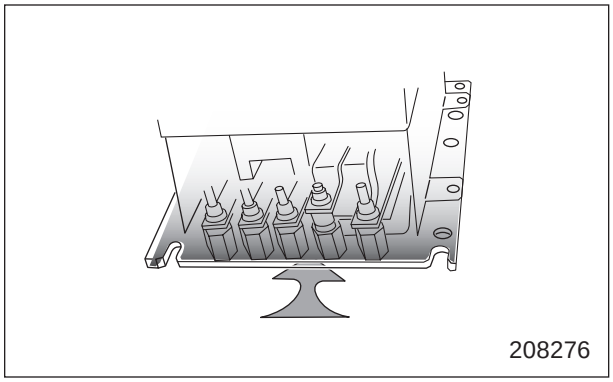
  Remove the controller mounting screws (M10: 6 places), and remove the controller.
- There is heatsink compound between the counterweight and controller. It is important to cool the controller. Clean off all of the old heatsink compound from the base of the controller and from the mounting surface of the counterweight. Replace with new heatsink compound.

Remove the controller mounting screws (M10: 6 places for traction controller and hydraulic controller. 3 places for contactor plate), and remove the controller.


211672

(3) Installation of controller

Follow the removal procedure in reverse.


208276

NOTE

There is heatsink compound between the counterweight and controller. It is important to cool the controller.

Spread the thermal cement evenly, then mount the controller on it.

Checking Current Sensor of Hydraulic Controller

(1) Turn the key switch off.

(2) Disconnect the battery plug.

(3) Disconnect the current sensor connector J4.

(4) Set the multimeter to 20-VDC range. Connect the positive (+) terminal of the multimeter to J4-4GR. Connect the negative (-) terminal of the multimeter to the NEG terminal.

(5) Connect the battery plug and turn the key switch ON.

Pin No.	Standard condition
J4-4GR	14 to 16 V

• If values measured in the above step deviate from the specified ranges, replace the hydraulic logic card.

(6) Then, connect the positive (+) terminal of the multimeter to J4-2YR.

Pin No.	Standard condition
J4-2YR	4 to 6 V

• If values measured in this step deviate from the specified ranges, replace the hydraulic logic card.

⚠ WARNING

To prevent the vehicle from moving suddenly, lift the front wheels off the ground by placing wood blocks under the vehicle. Do not approach the front wheels during testing.

(7) Turn the key switch off and disconnect the battery plug. Connect the current sensor connector.

(8) Place wood blocks under the vehicle to lift the front wheels off the ground. Engage the parking brake.

(9) Set the multimeter to 20-VDC range. Connect the positive (+) terminal of the multimeter to No. 2 pin of the current sensor.

Pin No.	Standard condition
J4-2YR	0 to 0.3 V

(10) Connect the battery plug and turn the key switch ON.

• If values measured in the above step deviate from the specified ranges, replace the current sensor.

(11) Shift the direction lever to Forward. Gradually depress the accelerator pedal (with front wheels raised) and read the voltage change.

Pin No.	Standard condition
J4-2YR	Increase

• If values measured in this step deviate from the specified ranges, replace the current sensor.

MITSUBISHI CATERPILLAR FORKLIFT AMERICA INC.

SCHEMATIC(S) INSERTION

Schematic(s) name/number

Replace this page with page 2 of 4

99759-6E100s.pdf

Problem: Traction Controller, Overheating (E3)

(1) Situation

Indication: Controller/motor overheat indicator ON. Check history folder and confirm "E3" stored.

(2) Possible cause

Overheating of traction controller panel, faulty traction contollrer thermistor, open wiring, faulty logic board, faulty display unit.

(3) How the error code is triggered

- Traction controller temperature is over 80°C (176°F). Software checks following signal and detects fault.
- Controller Thermo SW. (CN2-27)

(4) Checks

Let vehicle cool for 15 minutes.

Overheat indicator ON

Normal indication

(5) Disconnect battery plug. Wait until traction controller panel temperature comes close to room temperature. Open controller cover. Disconnect traction controller thermistor connector. Measure thermistor resistance. Measured resistance should be 8 kΩ or higher below 70°C (158°F).

8 kΩ or higher

Less than 8 kΩ

(9) Traction controllfer was overheated. Resume normal operation. If condition repeats, check the following.

- Operating cycle for excessive ramp climbing, towing or pushing
- Brake drag and parking brake adjustment
- Brake switch operation

(10) Replace thermistor. See page 1-5.

(6) Check continuity between wire J6-2 (black) of thermistor harness connector and NEG.

Continuity

No continuity

(11) Correct or replace wiring.

(7) Disconnect traction controller connector J2. Check continuity between thermistor J6-1 (blown) and J2-27.

Continuity

No continuity

(8) Replace logic board. See page 1-30.

(12) Correct or replace wiring.

Problem: Alarm Output, Fault (E8)

(1) Situation
Indication: Any indicators are not turned on. Alarm output OFF. Normal vehicle operations.
Check history folder and confirm "E8" stored.

(2) Possible cause
Faulty alarm equipment, short circuit, faulty traction logic board.

(3) How the error code is triggered
When short circuit current flows to traction logic board connector CN1-45 or CN1-46, alarm output bocomes off.

(4) Checks
Confirm speed alarm option (equipment) is installed into traction logic board connector CN1-45 or CN1-46.

Speed alarm option

No speed alarm option

(5) Replace traction logic board.
See page 1-30.

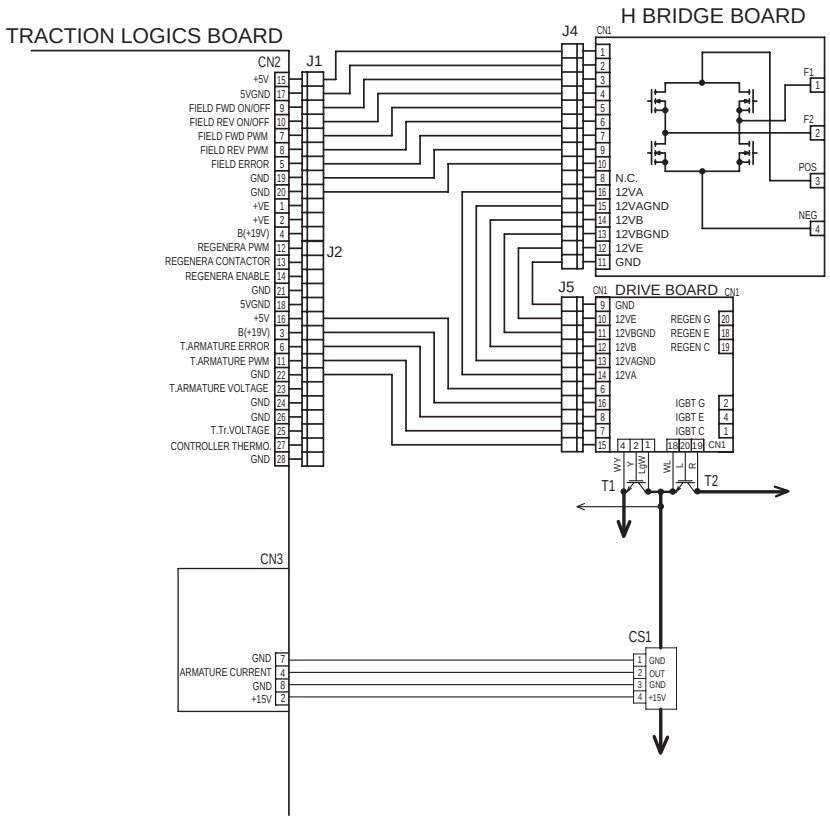
(6) Check short circuit on alarm wire. Check resistance between traction logic board connector CN1-45 (or CN1-46) and alarm POS.

Over 16 Ω

Below 16 Ω

(7) Replace traction logic board. See page 1-30.

(8) Correct or replace alarm option.


TRACTION LOGICS BOARD
H BRIDGE BOARD
DRIVE BOARD
CN2
J1
J2
J4
J5
CN1
CN3
CS1
+5V
5VGND
FIELD FWD ON/OFF
FIELD REV ON/OFF
FIELD FWD PWM
FIELD REV PWM
FIELD ERROR
GND
+VE
B(+19V)
REGENERA PWM
REGENERA CONTACTOR
REGENERA ENABLE
T.ARMATURE ERROR
T.ARMATURE PWM
T.ARMATURE VOLTAGE
T.Tr.VOLTAGE
CONTROLLER THERMO
ARMATURE CURRENT
+15V
N.C.
12VA
12VAGND
12VB
12VBGND
12VE
12VA
REGEN G
REGEN E
REGEN C
IGBT G
IGBT E
IGBT C
F1
F2
POS
NEG
T1
T2
OUT

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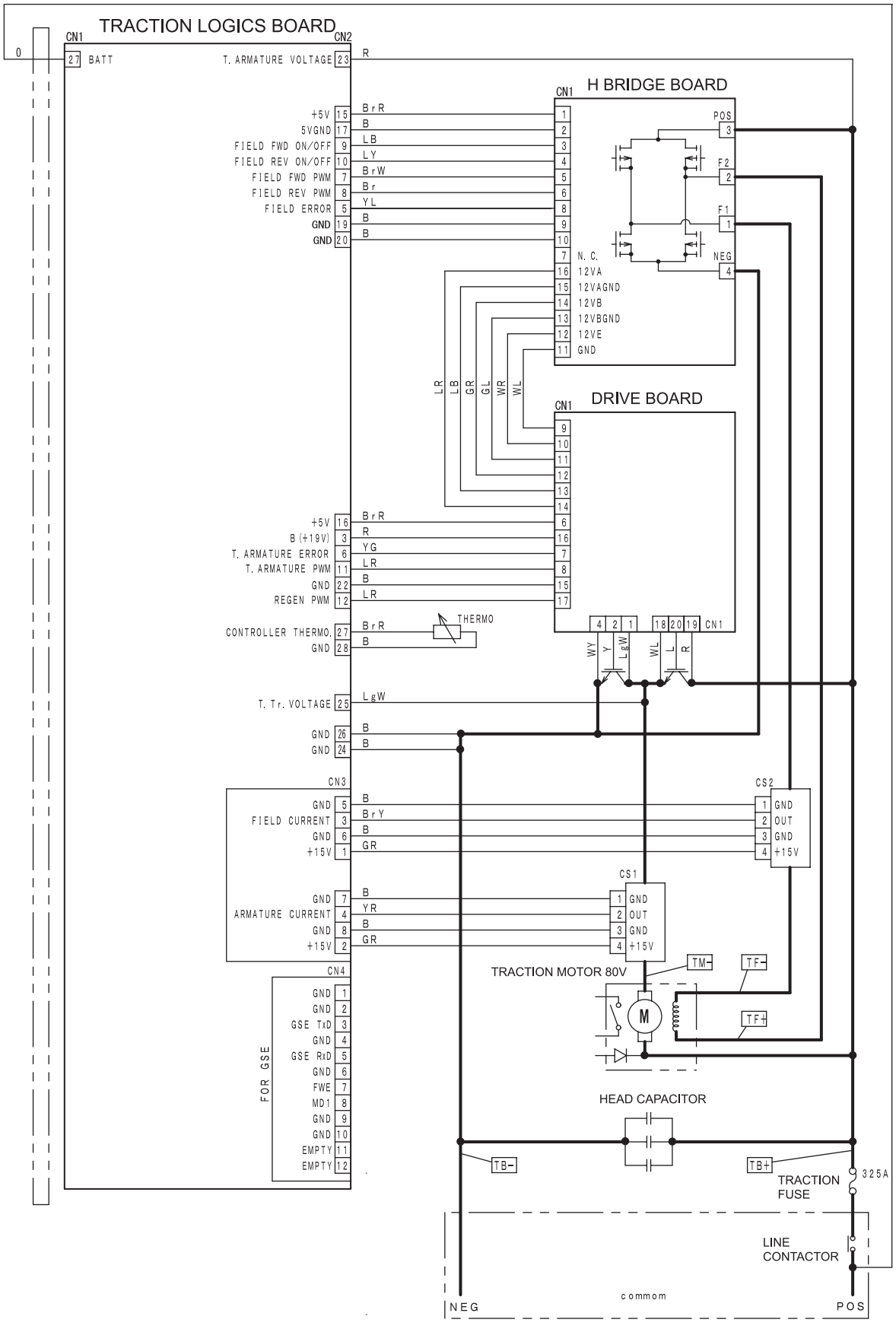
TRACTION LOGICS BOARD
CN1
CN2
BATT
T. ARMATURE VOLTAGE
+5V
5VGND
FIELD FWD ON/OFF
FIELD REV ON/OFF
FIELD FWD PWM
FIELD REV PWM
FIELD ERROR
GND
GND
H BRIDGE BOARD
POS
F2
F1
NEG
N. C.
12VA
12VAGND
12VB
12VBGND
12VE
GND
DRIVE BOARD
+5V
B (+19V)
T. ARMATURE ERROR
T. ARMATURE PWM
GND
REGEN PWM
THERMO
CONTROLLER THERMO.
GND
T. Tr. VOLTAGE
GND
GND
CN3
GND
FIELD CURRENT
GND
+15V
GND
ARMATURE CURRENT
GND
+15V
CS2
CS1
GND
OUT
GND
+15V
CN4
FOR GSE
GND
GND
GSE TxD
GND
GSE RxD
GND
FWE
MD1
GND
GND
EMPTY
EMPTY
TRACTION MOTOR 80V
TM-
TF-
TF+
M
HEAD CAPACITOR
TB-
TB+
TRACTION FUSE
325A
LINE CONTACTOR
commom
NEG
POS

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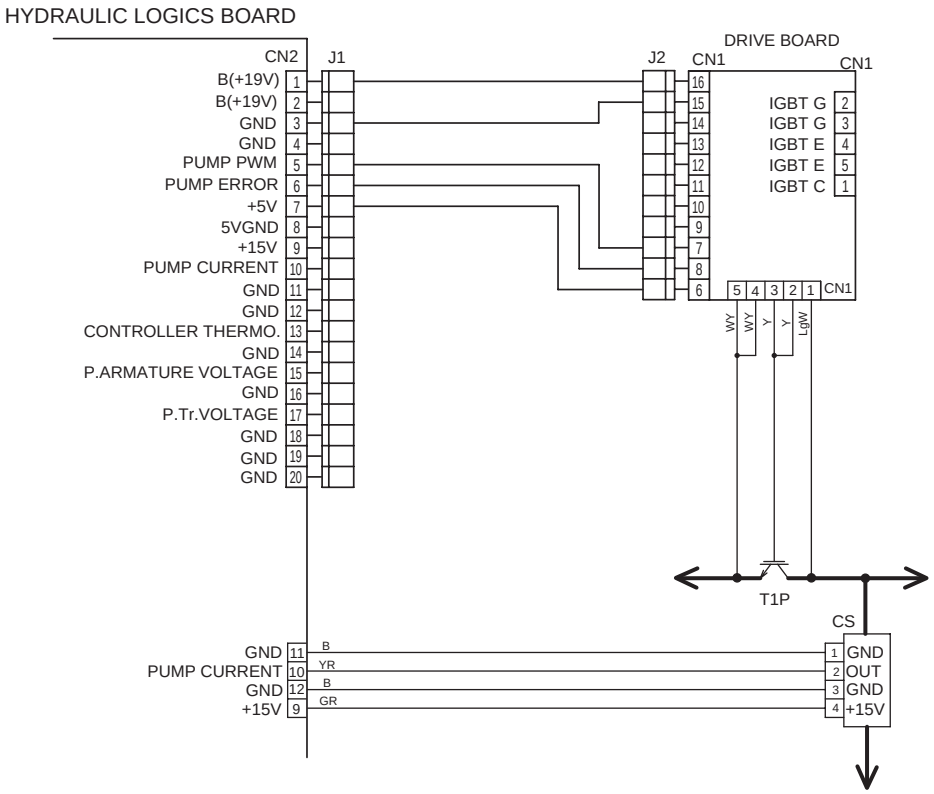
HYDRAULIC LOGICS BOARD
CN2
J1
B(+19V) 1
B(+19V) 2
GND 3
GND 4
PUMP PWM 5
PUMP ERROR 6
+5V 7
5VGND 8
+15V 9
PUMP CURRENT 10
GND 11
GND 12
CONTROLLER THERMO. 13
GND 14
P.ARMATURE VOLTAGE 15
GND 16
P.Tr.VOLTAGE 17
GND 18
GND 19
GND 20
DRIVE BOARD
J2
CN1
CN1
16
15
14
13
12
11
10
9
7
8
6
IGBT G 2
IGBT G 3
IGBT E 4
IGBT E 5
IGBT C 1
5 4 3 2 1 CN1
WY
WY
Y
Y
LgW
T1P
CS
GND 11
PUMP CURRENT 10
GND 12
+15V 9
B
YR
B
GR
1 GND
2 OUT
3 GND
4 +15V

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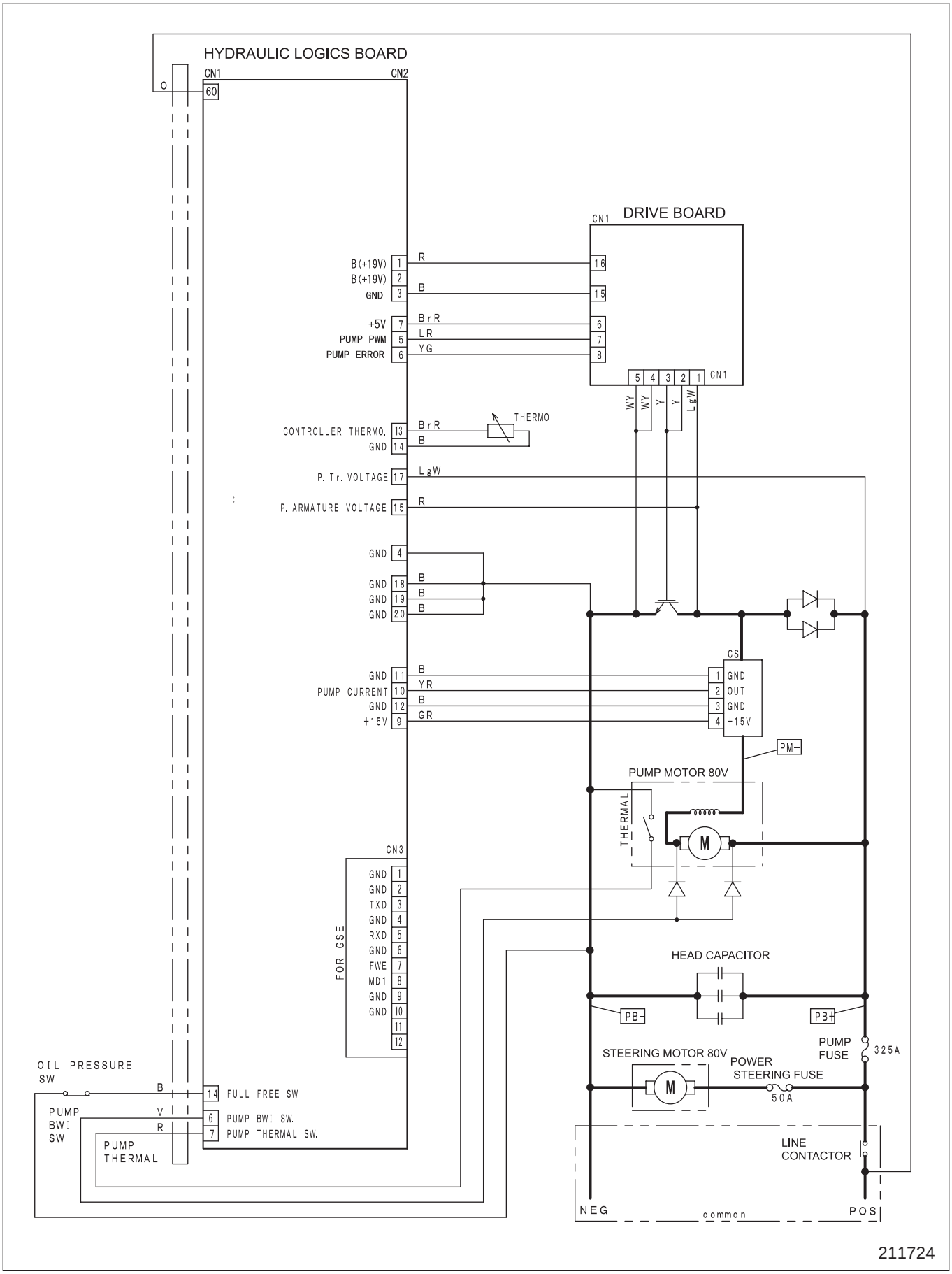

HYDRAULIC LOGICS BOARD
CN1
CN2
60
DRIVE BOARD
CN1
B(+19V) 1
B(+19V) 2
GND 3
+5V 7
PUMP PWM 5
PUMP ERROR 6
R
B
BrR
LR
YG
16
15
6
7
8
5 4 3 2 1 CN1
WY
WY
Y
Y
LgW
THERMO
CONTROLLER THERMO. 13
GND 14
BrR
B
P. Tr. VOLTAGE 17
LgW
P. ARMATURE VOLTAGE 15
R
GND 4
GND 18
GND 19
GND 20
B
B
B
CS
GND 11
PUMP CURRENT 10
GND 12
+15V 9
B
YR
B
GR
1 GND
2 OUT
3 GND
4 +15V
PM−
PUMP MOTOR 80V
THERMAL
M
CN3
FOR GSE
GND 1
GND 2
TXD 3
GND 4
RXD 5
GND 6
FWE 7
MD1 8
GND 9
GND 10
11
12
HEAD CAPACITOR
PB−
PB+
PUMP FUSE
325A
STEERING MOTOR 80V
POWER STEERING FUSE
50A
M
LINE CONTACTOR
OIL PRESSURE SW
B
14 FULL FREE SW
PUMP BWI SW
V
R
6 PUMP BWI SW.
7 PUMP THERMAL SW.
PUMP THERMAL
NEG
common
POS

211724

(9) Correct or replace wiring.

(10) Measure resistance of solenoids.

Acceptable

Unacceptable

(11) Replace hydraulic logic board.
See page 1-30.

(12) Replace solenoid.

Problem: Attachment 1 Lever, Faulty Setting (H3)

(1) Situation
Indication: "H3" display. All vehicle operations inhibited. Line contactor OPEN.

(2) Possible cause
Key switch turned on while attachment 1 lever was in ON position. Faulty attachment 1 lever switch, faulty hydraulic logic board.

(3) How the error code is triggered
Attachment 1 lever is not in neutral when logic software starts.
Software checks following signals and detects fault.
- Attach 1 Joystick (CN1-33) (FC model)
- Aux SW.1 (CN1-11) (MC model)

(4) Checks
Turn off power, then set attachment 1 lever to OFF (neutral position). Turn on power again, then set attachment 1 lever to ON (push or pull attachment 1 lever).

No change → MC models

Attachment 1 function operates → (5) Proper starting procedure requires that attachment 1 lever be in OFF (neutral) position when key switch is turned on.

FC models

MC models

(6) Disconnect hydraulic logic board connectors CN16 and CN14. Check continuity between CN16-11 and CN14-64.

No continuity → (7) Replace hydraulic logic board. See page 1-30.

Continuity → (8) Correct or replace wiring.

FC models

(9) Measure attachment 1 lever input voltage between CN15-33 and CN15-42.

2.4 V to 2.6 V → (10) Replace hydraulic logic board. See page 1-30.

Below 2.4 V or over 2.6 V → (11) Correct or replace attachment 1 lever switch.

(8) Disconnect battery plug. Check continuity between traction controller CN3-1R (red) and hydraulic controller CN16-1 and between CN14-63B (black) and NEG.

Continuity

No continuity

(10) Correct or replace wiring.

(9) Replace hydraulic logic board. See page 1-30.

No change

Normal vehicle operation

(11) Replace traction logic board. See page 1-30.

(12) Vehicle operates normally.

Problem: Contactor Coil, Fault (72)

(1) Situation
Indication: "72" display. All vehicle operations inhibited. Line contactor OPEN.

(2) Possible cause
Faulty contactor coil, faulty wiring, faulty traction logic board.

(3) How the error code is triggered
Over-current signal is input from contactor.
Software checks following signals and detects fault.
- VPOW (For Line Contactor) (CN1-29)
- Line contactor (CN1-31)

(4) Check
Disconnect battery plug. Check resistance of contactor coil. See page 1-37.

118 to 145 Ω

Lower than 118 Ω or over 145 Ω

(5) Replace contactor coil.

(6) Disconnect traction controller connector CN2.
Check continuity between CN2-29 and line contactor coil J4-R (red), and between CN2-31 and line contactor coil J5-G (green)

Continuity and not shorted

No continuity, or shorted

(7) Replace traction logic board. See page 1-30.

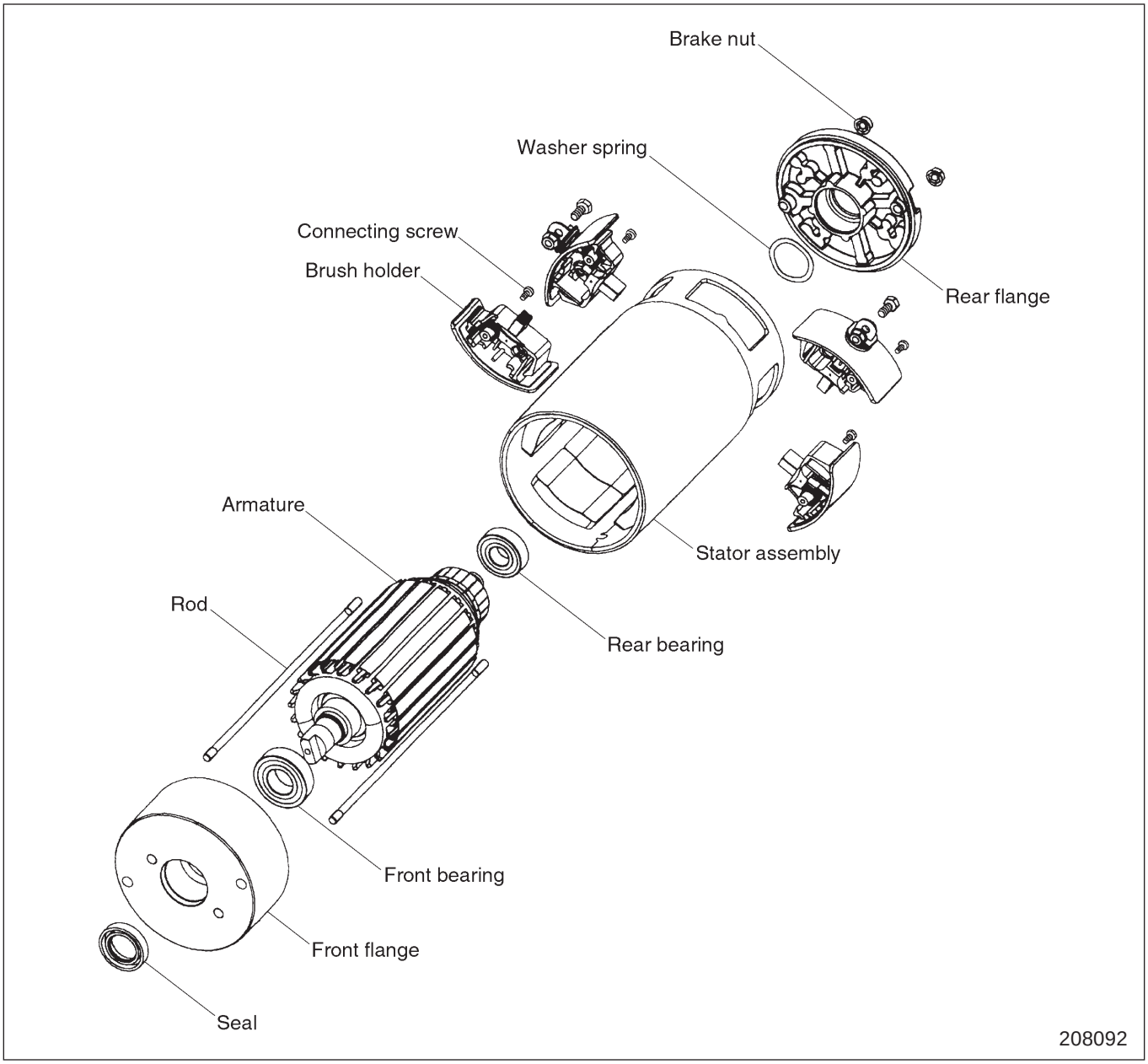
(8) Correct or replace faulty wiring.

- To increase the value, move the lever to F.
- To decrease the value, move the lever to R.

(3) To register data

Setting the DRS switch to R and S registers the data. When the DRS switch is set to R, the data is written, and the display indicates triple bars. When the last item is entered, the display indicates “done”.

Steering Pump Motor (2 ton class and 2.5 ton class only)



The power steering pump which supplies oil to the power steering system is driven by a permanent magnet type direct current (DC) motor.

The steering pump motor has four brushes, each being held by one brush holder. The brush holders are easy to remove from the motor housing. The brushes are not removable alone. When any of them is replaced, it must be removed together with the brush holder.

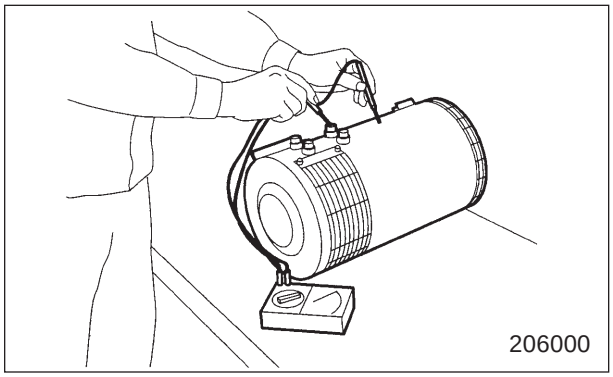
The motor is activated when the key switch is turned to ON and the seat is depressed to close the seat switch. The motor runs at a constant speed during operation.

Suggestions for Disassembly (Drive motor and pump motor)

(1) Using a 500 V megger or similar instrument, measure insulation resistance between each terminal and the motor unit.

Resistance limit	1 M ohm min.

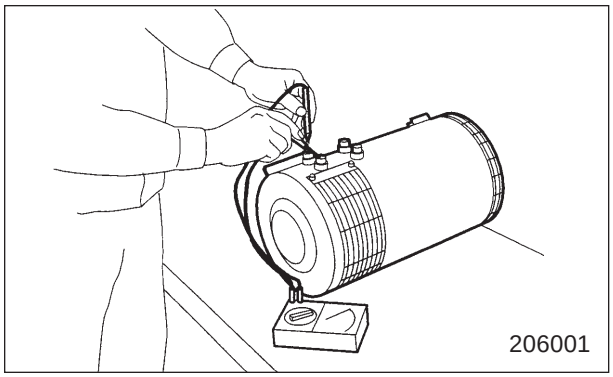
If the measured values are less than the limit value, there may be an internal short-circuit. Check wires for short-circuits during disassembly.



(2) Using a multimeter, measure continuity between terminals.

	Measuring terminals	Standard values
Drive motor	C – D	0 ohm
	A – B	0 ohm
Pump motor	D1 – A1	0 ohm

If the measured values deviate from the standard values, there may be a broken wire. Check wires for breakage during disassembly.

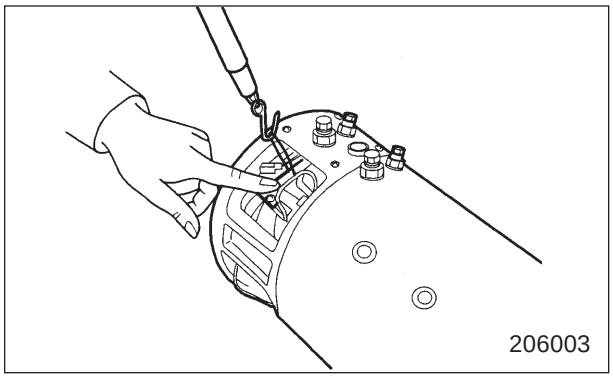


(3) Measure the brush spring tension. To measure the tension, hook a spring scale to the curled end of the brush spring.

Brush spring tension	9.8 to 19.6 N (1 to 2 kgf) [2.2 to 4.4 lbf]

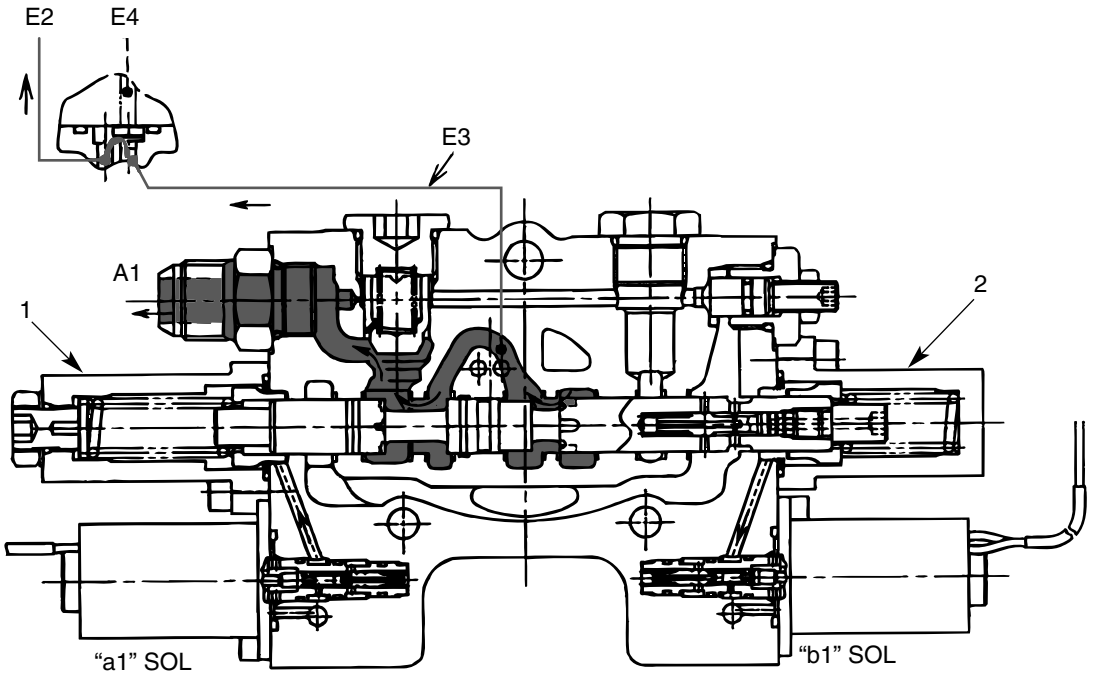
If the measured tension deviates from the standard value, replace the spring.

(4) Disconnect the wires. While pulling the curled section of the spring by a hooked wire, remove each brush from the holder.



Specifications

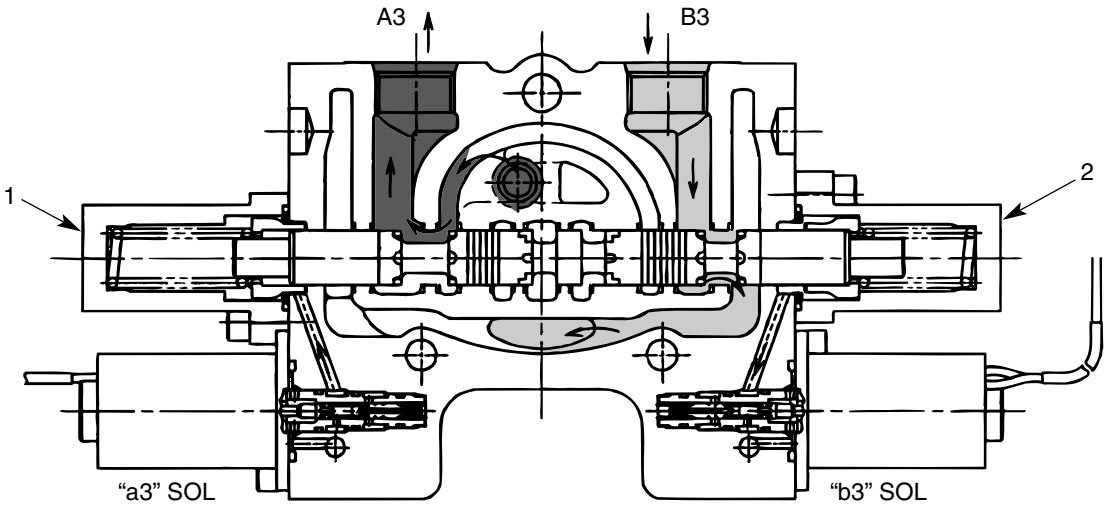
Item \ Truck Models			EP16K, EP18K, EP20KC
Hydraulic system	Hydraulic pump	Type	Gear pump
		Model type	WQA1-23
		Rated discharge volume cc/rev. (cu. in./rev.)	23 (1.40)
		Drive system	Direct connection with pump motor
	Control valve	Type	AC: KVSB-65PSL-3 MC: KVSF-65-3 (equipped with microswitches)
		Main relief pressure kpa (kgf/cm^2) [psi]	18142 (185) [2631]
	Flow regulator valve	Type	Variable type
		Control flowrate liter/min (U.S.gal./min)	50 (13.2)
	Simplex mast lift cylinder	Inside diameter mm (in.)	45 (1.77)
		Stroke mm (in.)	1645 (64.76)
	Duplex and Triplex mast first lift cylinder	Inside diameter mm (in.)	70 (2.75)
		Stroke mm (in.)	850 (33.46)
	Duplex mast second cylinder	Inside diameter mm (in.)	45 (1.77)
		Stroke mm (in.)	1595 (62.80)
	Triplex mast second lift cylinder	Inside diameter mm (in.)	45 (1.77)
		Stroke mm (in.)	1525 (60.00)
	Tilt cylinder	Inside diameter mm (in.)	63 (2.48)
		Stroke mm (in.)	82 (3.23)
	Operating oil volume liter (US.gal)		N level: 13.1 (3.5) H level: 16.7 (4.4)



"a1" Solenoid Operation in Spool Switching

Activation of the proportional electromagnetic pressure control valve on the "a1" SOL side results in the generation of pilot pressure in cap 1, which exceeds the force of spring in cap 2 and pushes the spool to the right.

Oil flows through the control channel and enters cylinder port A1. At the same time, oil flows through oil passage (E3) to the high-pressure selector.



"a3" Solenoid Operation in Spool Switching

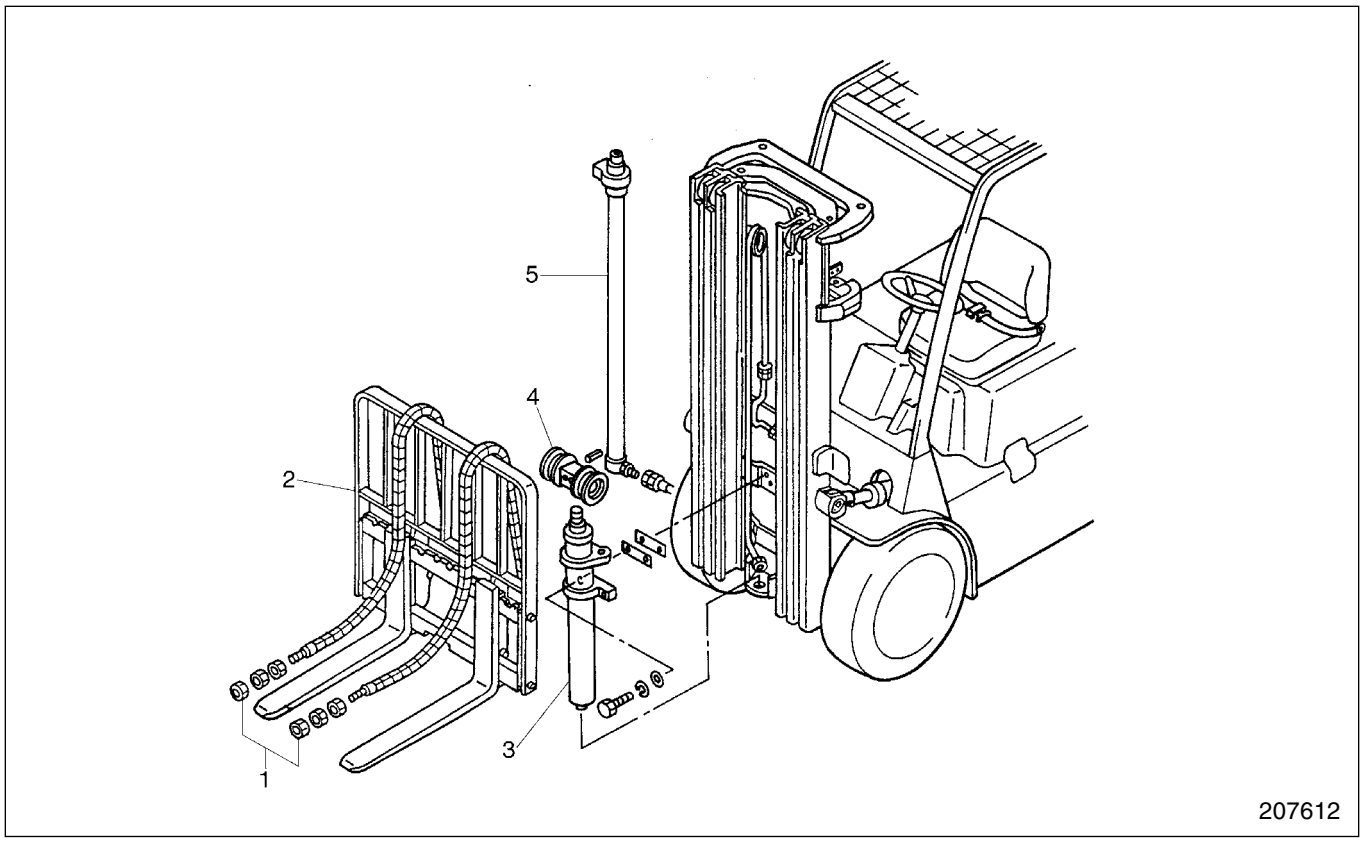
Activation of the proportional electromagnetic pressure control valve on the "a3" SOL side results in the generation of pilot pressure in cap 1, which exceeds the force of spring in cap 2 and pushes the spool to the right.

Oil from the control channel lifts the load check valve and flows through cylinder port A3 to the cylinder.

Return oil from the cylinder enters the low-pressure channel through cylinder port B3.

Duplex and Triplex Masts

Note that the Triplex Mast is used as an example.



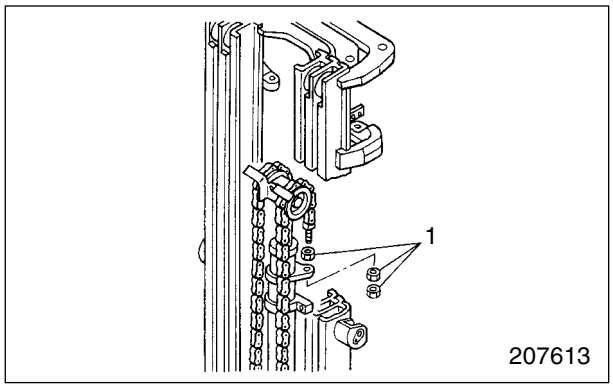
Sequence

1 Nuts
2 Lift bracket assembly
3 First lift cylinder
4 Chain wheel support assembly
5 Second lift cylinder

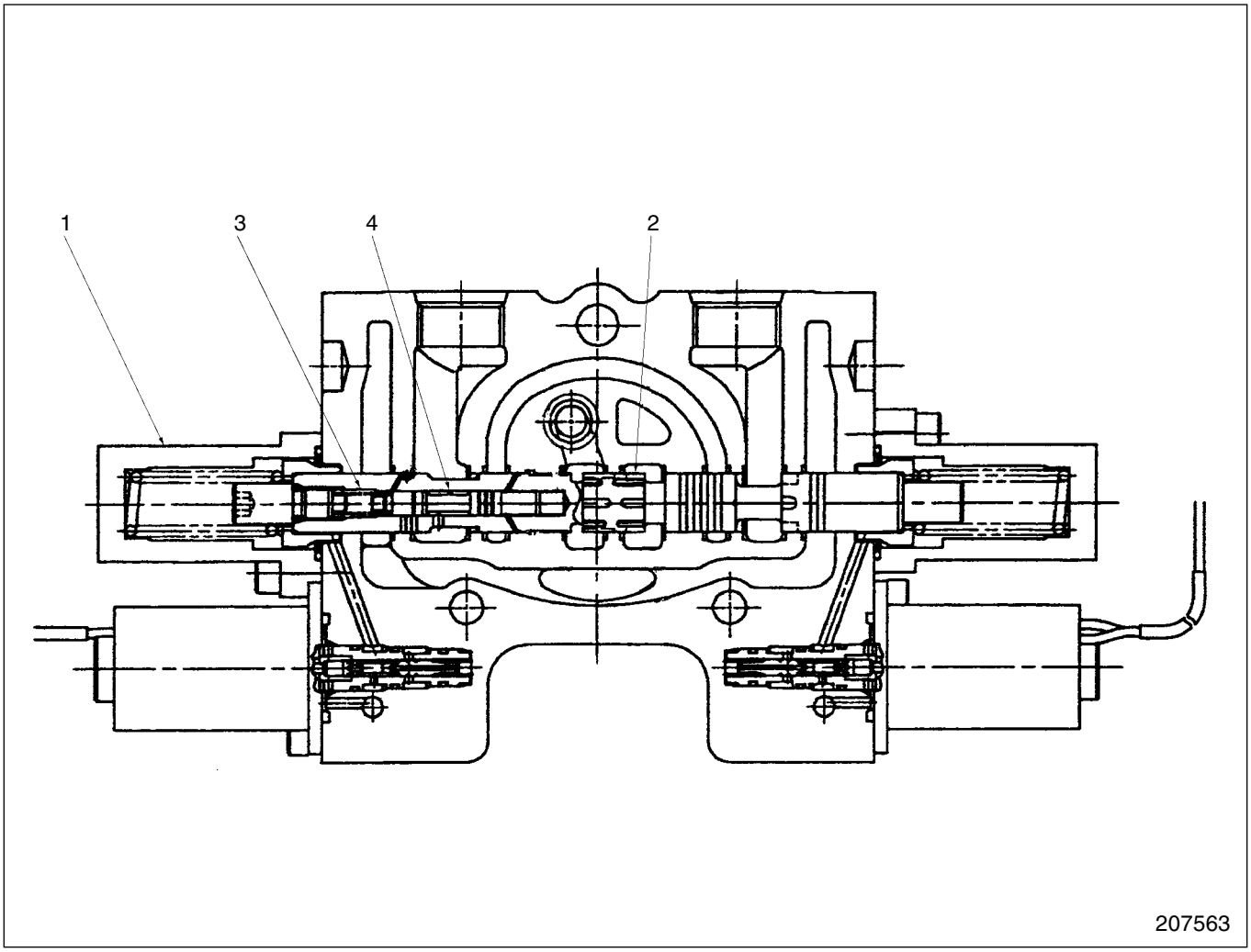
Suggestions

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.



Disassembly of Tilt Section Assembly



Sequence

1 Cap, Bolt, Spring
2 Spool
3 Spring
4 Valve

Key Points for Disassembly

Spool

(1) Unscrew socket-head bolt (5 Hex) from cap 1 (on one side), and remove cap 1.

(2) Remove spool 2 assembly from valve housing.

(3) Remove spring 3 and valve 4 from spool 2.

Reassembly of Attachment Section Assembly

The reassembly procedures are identical to those for the tilt section.

Reassembly of Valve Assembly

Arrange the assembled inlet section, spool section and outlet section assemblies in their original installation positions.

Position the inlet section so that its mating surface faces upward, and screw the tie rod.

NOTE

After tightening the tie rod by hand, tighten with pliers slightly more.

Mount each section and tighten with nuts, with attention given to O-rings and load check valve spring on the mating surfaces.

Place the assembled valve assembly on a flat and level surface or table to ensure that the valve mounting surface is horizontal. Tighten nuts to the specified torque. [Horizontal deviation of valve mounting surface: 0.3 mm (0.01 in.) or less]

Nut tightening torque

Unit: N·m (kgf·m) [lbf·ft]

Cylinder port side	46.1 (4.7) [34]
Valve mounting side	18.6 (1.9) [13.7]

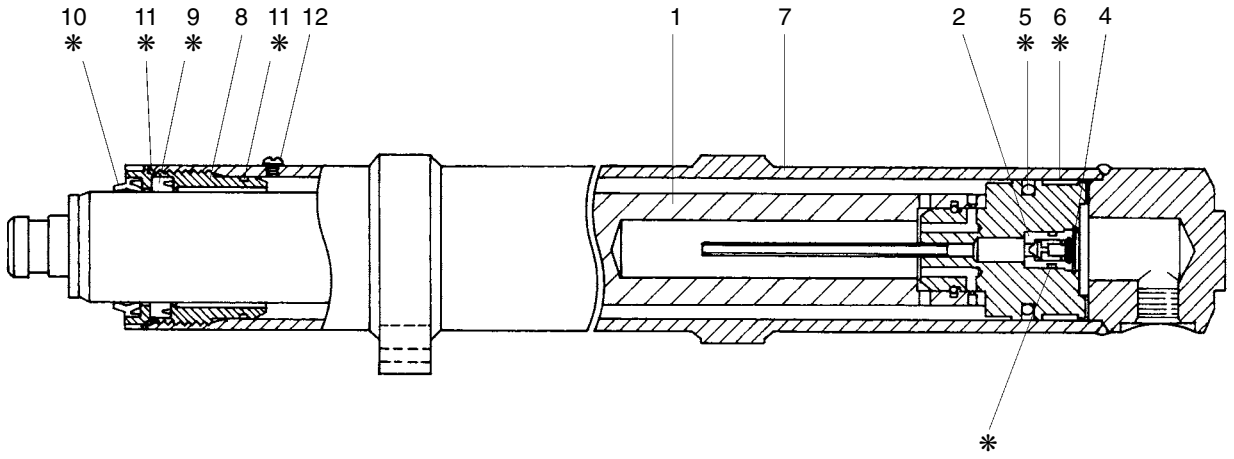
Install the main relief valve, overload relief valve and shut-off valve.

Relief valve service procedures are described in the following section.

To install the shut-off valve, follow the steps below.

Reassembly

✻: Parts contained in seal kit



Sequence

1 Piston rod, Piston
Install parts 2 through 6 to part 1.
2 Check valve
3 O-ring
4 Snap ring
5 Ring assembly
6 Slide ring
7 Cylinder tube
8 Cylinder head assembly
Install parts 9 through 11 to part 8.
9 U-ring
10 Wiper ring
11 O-rings
12 Plug, Gasket

Suggestions

1. Use all parts in the seal kit to replace removed parts.
2. After installing seal kit parts, apply hydraulic oil before installing to the cylinder tube or piston rod.
3. Fill the space between the cylinder tube and piston rod with the specified amount of hydraulic oil before installing the cylinder head.

Amount of hydraulic oil	70 to 85 cc (4.75 to 5.19 cu. in.)

4. Tighten the cylinder head to the specified torque.

Cylinder head tightening torque	382 ± 87.3 N·m (39 ± 8 kgf·m) [282 ± 57.9 lbf·ft]

5. Tighten the plug to specified torque.

Plug tightening torque	3.92 N·m (0.4 kgf·m) [2.9 lbf·ft]

Lift Cylinders and Tilt Cylinders

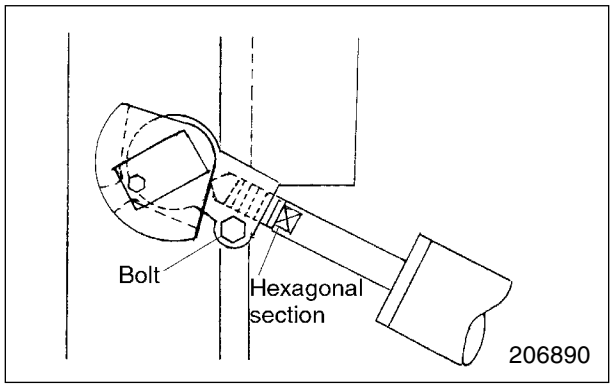
(1) Adjustment of mast tilt angle

(a) Adjust the air pressure of the tires, and place the vehicle on level ground.

(b) Tilt the masts 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.

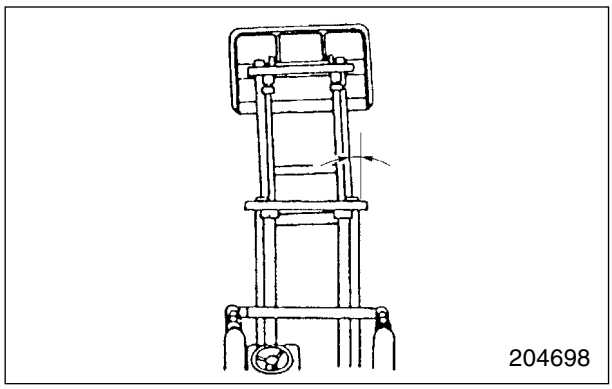
Forward tilt – Backward tilt (STD)	6° – 7°

(2) Adjustment of right and left lift cylinder strokes

(a) Gently raise the inner masts, and observe the right and left piston rod stopping conditions when they reach the maximum lift position.

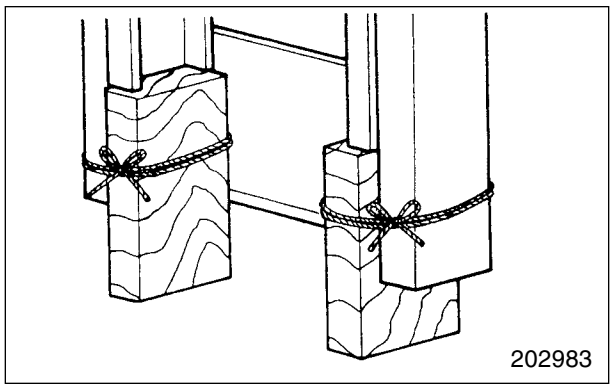
(b) If the upper parts of the inner masts shake at the moment they stop moving, make adjustment with shims.

Improper adjustment causes the inner masts to be slightly lopsided when they stop, and causes the lift cylinder with a longer cylinder stroke to shake when the lift cylinders stop moving.



Adjustment method

(1) Raise the inner masts, and place wood blocks under the inner masts. Lower the masts until the inner masts contact the wood blocks.



Mechanical Control Type

For the component descriptions other than control valve, refer to those for the Advanced Hydraulic Control Type.

Hydraulic Circuit Diagram (MC)