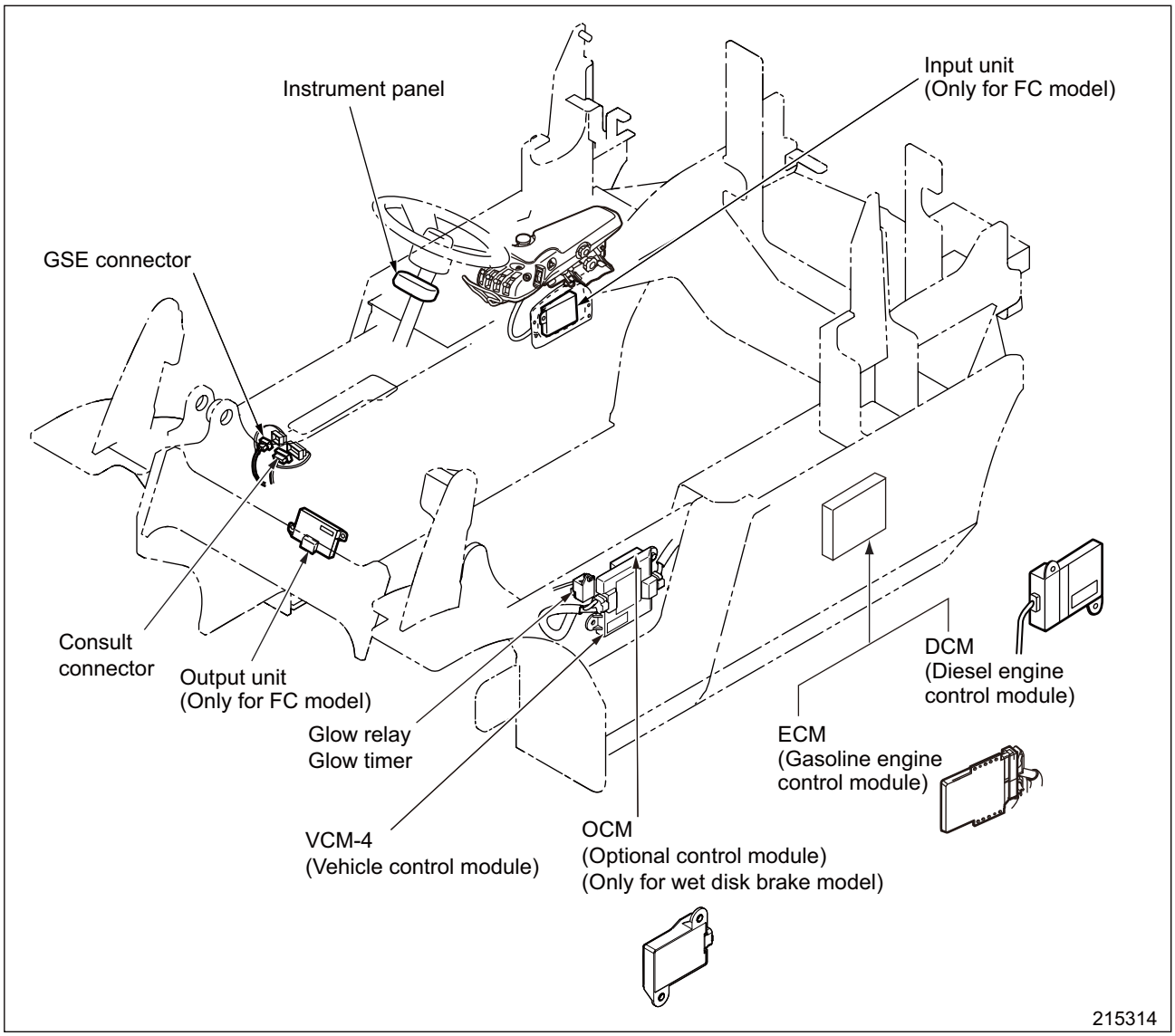
Chapter 1 GENERAL INFORMATION

1. Specifications

Item		Specified value
Cooling system	Cooling method	Water-cooled, forced circulation
	Radiator	Corrugated fin (pressure) type
	Water pump	Centrifugal type
	Thermostat	Wax pellet type

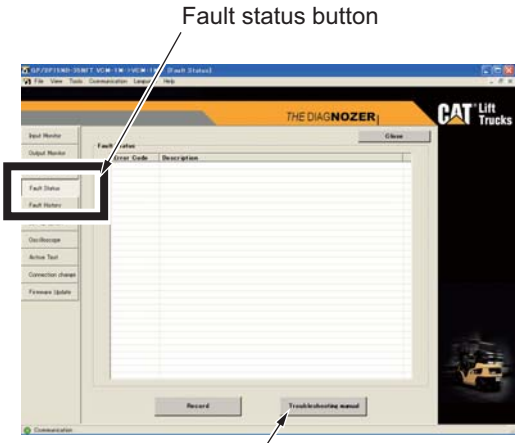
1. Outline

The controllers control both the lift truck body and the engine.
Each controller is located as shown below.



(4) Fault Status

Click the fault status button from the menu or toolbox to display the fault status monitor screen in the main window. The fault status monitor screen allows you to monitor a current fault status. Pressing the trouble-shooting manual button in the lower part of screen brings up a list of error code and the troubleshooting information.



4.2 Mast Interlock System of VCM-4 Controller, Checking Procedure

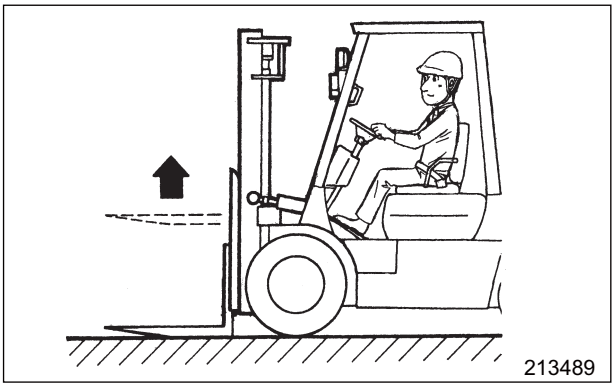
♦Mast Interlock System

(a) Raise the forks high enough to see them from the operator seat.

(b) Apply the parking brake and place the direction lever to the neutral position. Then, with the engine idling (without pressing the accelerator pedal), half rise from the operator seat.

(c) Check that the mast interlock indicator lamp blinks in a few seconds. Operate the lift lever to check that the forks do not move up and down.

(d) Operate the tilt lever to ensure the mast does not tilt forward or backward.



⚠ CAUTION

Make sure that sufficient space is available for the lift truck to move around and that no one or no obstacle is around the lift truck.

♦Mast Interlock System of VCM-4 Controller, Checking Procedure

(1) Connect the service tool to the VCM-4 controller.

(2) Turn the key switch to the ON position and start the engine.

(3) Display the input monitor screen of the service tool.

(4) While monitoring the input monitor screen, sit in the operator seat and make sure that the seat switch status and the seat switch timer are ON.

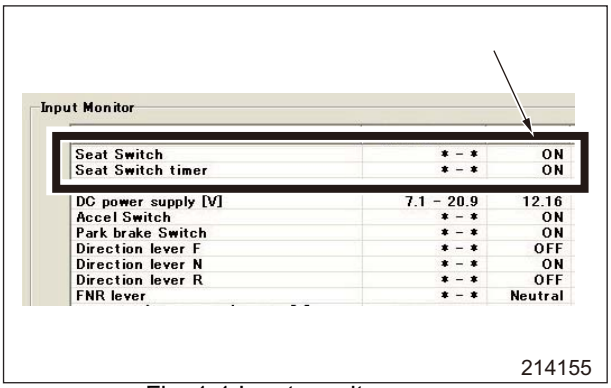


Fig. 1-1 Input monitor screen

(5) Display the service tool output monitor screen. When the status of the seat switch timer is ON, the controller unlocks the mast interlock and turns the unload output and the lift lock output ON. (Fig. 1-2)
You can operate the mast system under this condition.

♦Operate the lift lever to check that the forks move up and down, and operate the tilt lever to check that the mast tilts forward and backward.

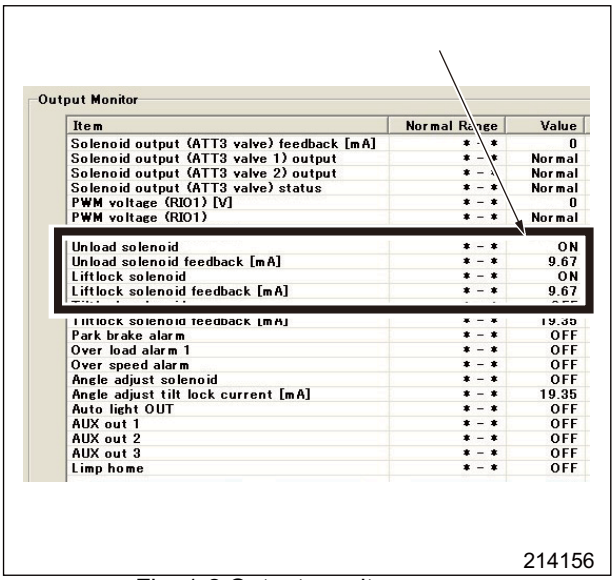


Fig. 1-2 Output monitor screen

(11)To unlock the interlock function, sit on the operator seat and return the direction lever to the neutral position. At this time, make sure that the driving interlock indicator lamp (N) changes from blink to glow.

♦If the seat switch will not turn ON

Check the seat switch operation and wiring connections by referring to the "Harness codes of section 8", the "VCM-4 controller of section 9.1", and the "Seat switch/Seat belt switch of section 9.2."

♦When T/M (F)/(R) Solenoid error occurs

Check the solenoid output according to "Active test inspection procedure" of section 5.3. If the solenoid output does not turn ON even after the active test inspection, refer to the "Error Codes and Troubleshooting of Section 10" and check for the possible causes of the error code F-85, F-87 and F-89.

♦When a speed or speed sensor error occurs

Refer to "Error Codes and Troubleshooting of Section 10" and check for the possible causes of the error code F-17 and F-34.

9. Controller Output Details

9.1 VCM-4 Controller

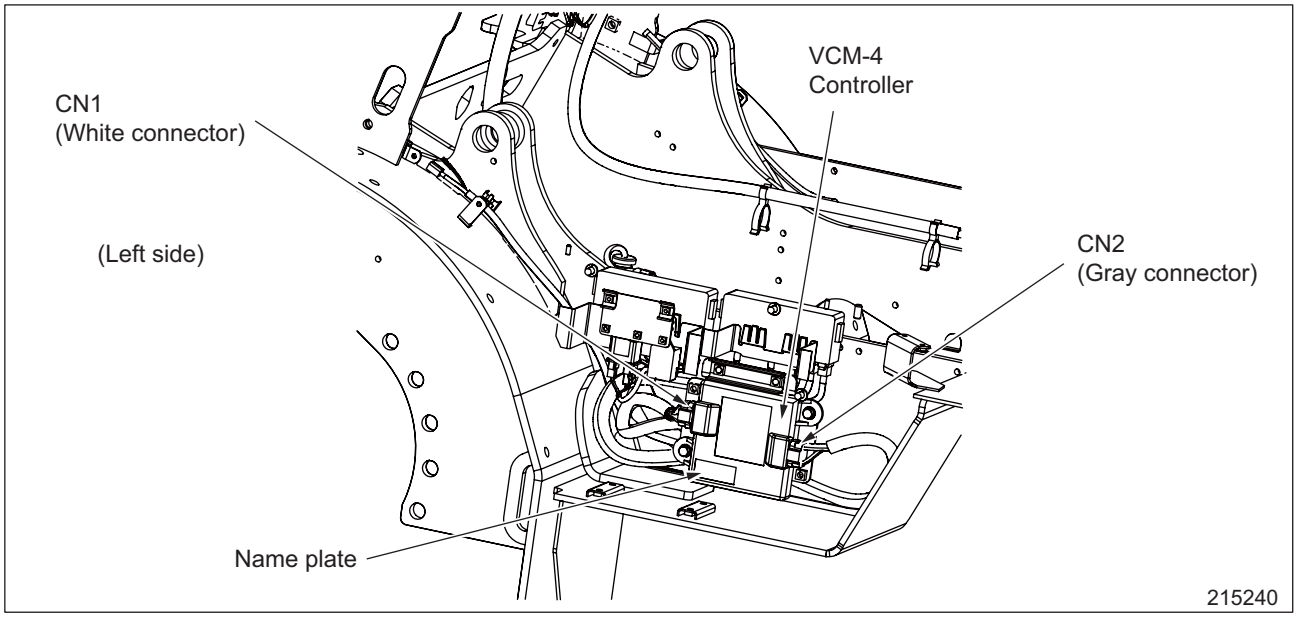


Fig. 7-1 Controller location

(1) VCM-4 Controller pin location

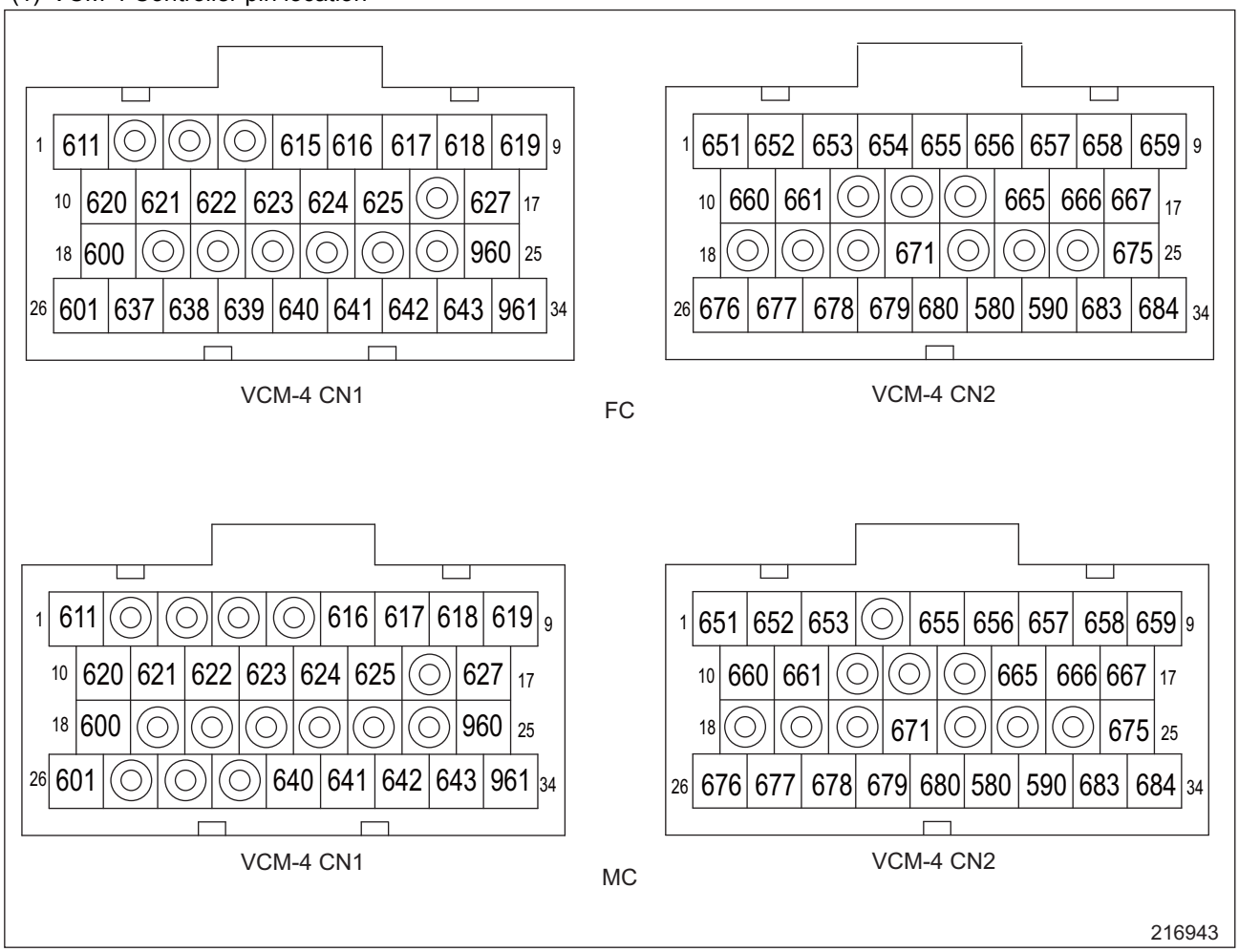


Fig. 7-2 Controller pin allocation (VCM-4)

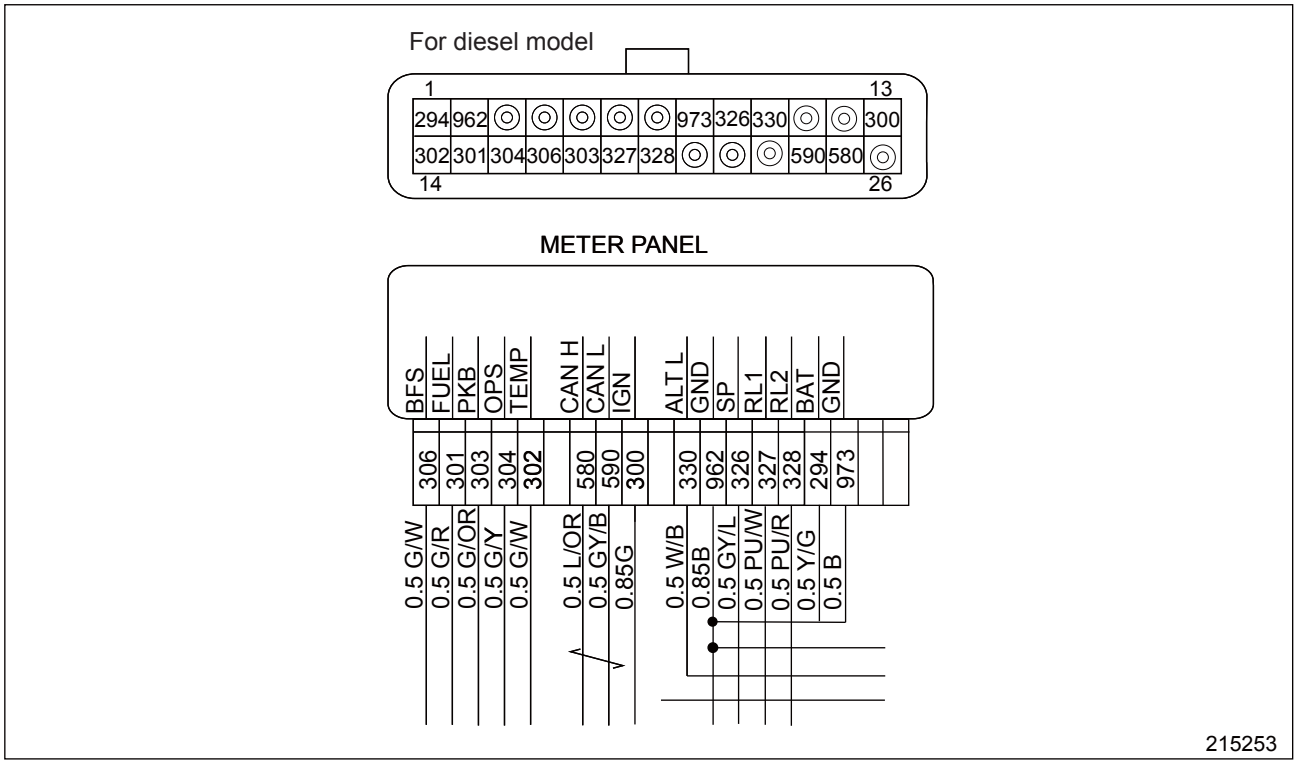


Fig. 7-18 Instrument panel circuit (diesel-engine model only)

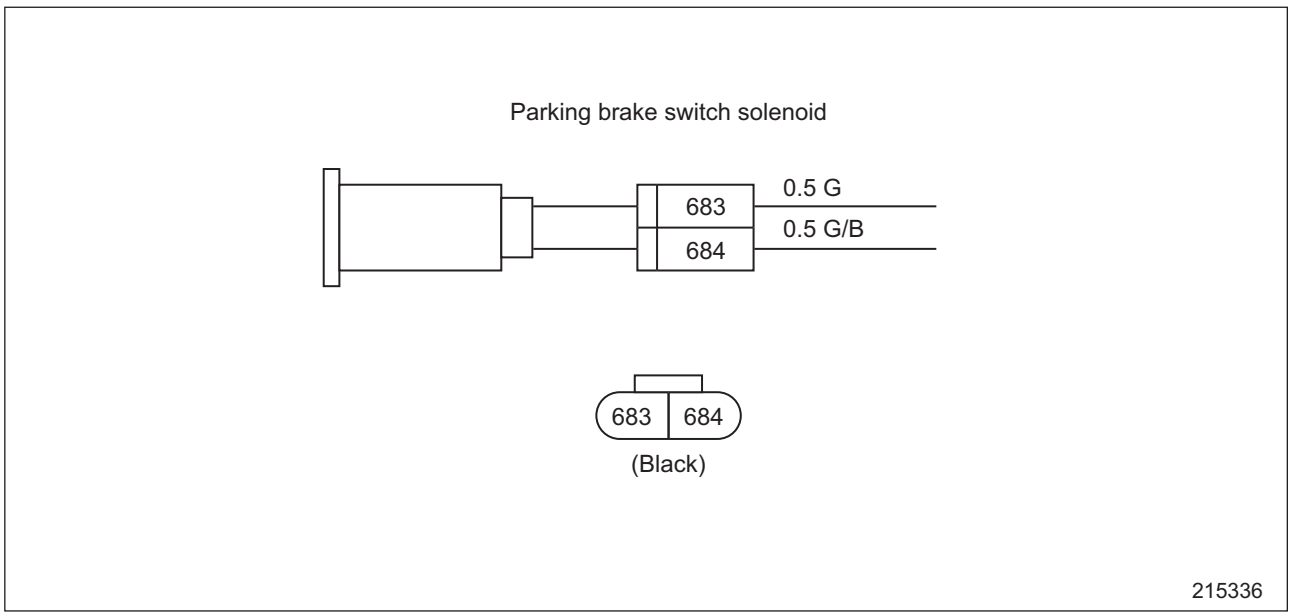
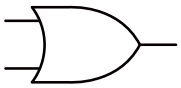
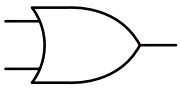


Fig 7-19 Parking brake switch solenoid

Diagnosis	Tilt angle sensor error (F38)
Logic conditions	· Input signal is 0.1 V or less · Input signal is 4.9 V or more (400-millisecond continuity)  F38
Recovery	Turn on power again.
Control action	· No tilt action with the tilt auto-stop ON.
LED blink pattern	D

Diagnosis	Steering error (F40)
Logic conditions	· Only wheel angle sensor has 2-second continuous change. · Steering wheel angle sensor input error  F40
Recovery	Turn on power again.
Control action	· No knob deviation correction control.
LED blink pattern	D

Diagnosis	RI01 error (F41)
Logic conditions	· CAN receiving abnormal flag from output unit. —— F41
Recovery	Recovers automatically
Control action	· Indication only
LED blink pattern	B

Diagnosis	RI01 PWM power error (F44)
Logic conditions	· CAN receiving abnormal flag from output unit. —— F44
Recovery	Recovers automatically
Control action	· Indication only
LED blink pattern	B

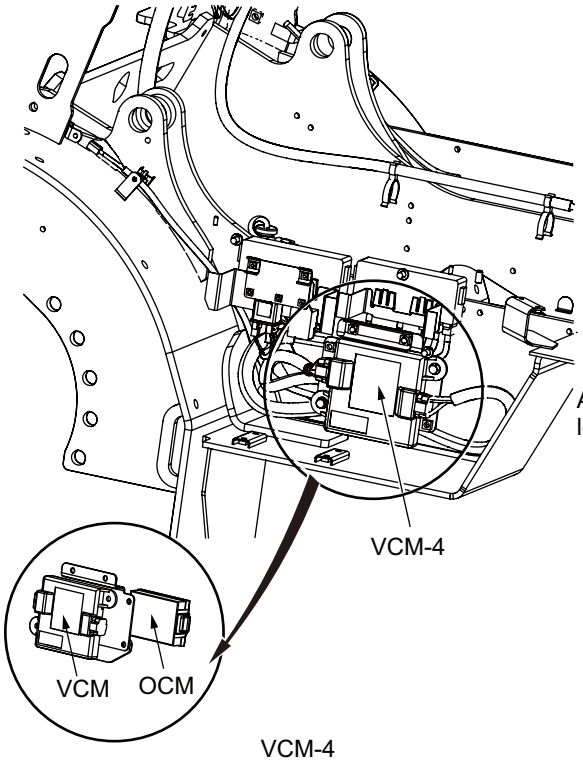
Diagnosis	RI01 communication error (F45)
Logic conditions	· CAN receiving from output unit is impractical. (100-millisecond continuity) —— F45
Recovery	Recovers automatically
Control action	· Activates with default values of output unit incoming data.
LED blink pattern	B

Diagnosis	RI02 error (F46)
Logic conditions	· CAN receiving abnormal flag from input unit. —— F46
Recovery	Recovers automatically
Control action	· Indication only
LED blink pattern	B

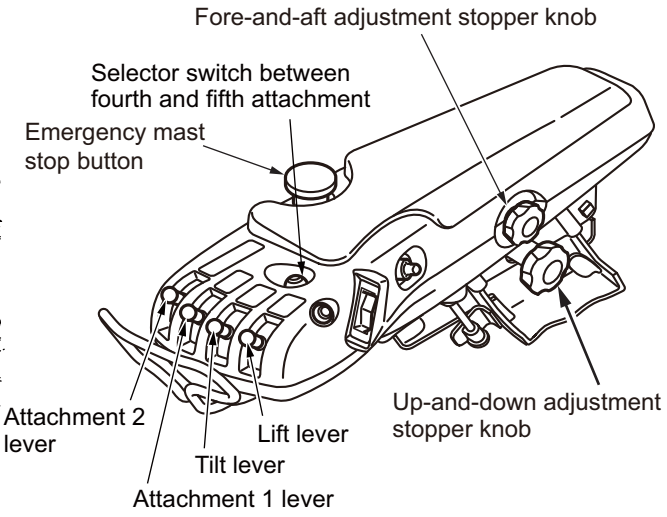
10.3 Error Codes and Troubleshooting

Error code	Diagnosis	Probable cause	Check item
F-01 D-51	Memory check error	1. Controller bad	
F-02 D-52	Battery voltage fault	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Controller bad	
F-03 D-53 E-03 L-03	VCM communication error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. VCM Controller bad	3. Communication line check
		4. Controller bad	
F-04 D-54 E-04 L-04	ECM communication error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. ECM Controller bad	3. Communication line check
		4. Controller bad	
F-07 D-57 E-07 L-07	MP communication error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Instrument panel bad	3. Communication line check
		4. Controller bad	
F-08 D-58 E-08 P-08 L-08	TMS communication error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. TMS Controller bad	3. Communication line check
		4. Controller bad	
F-09	Load type set error	1. Controller bad	1. Setting check using service tool
		2. Controller bad	
F-10	Lift lever neutral error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Lift lever bad	3. Lever connection check
		4. Controller bad	
F-11	Tilt lever neutral error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Tilt lever bad	3. Lever connection check
		4. Controller bad	
F-12	Att1 lever neutral error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att1 lever bad	3. Lever connection check
		4. Controller bad	
F-13	Att2 lever neutral error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att2 lever bad	3. Lever connection check
		4. Controller bad	
F-14	Att3 lever neutral error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att3 lever bad	3. Lever connection check
		4. Controller bad	

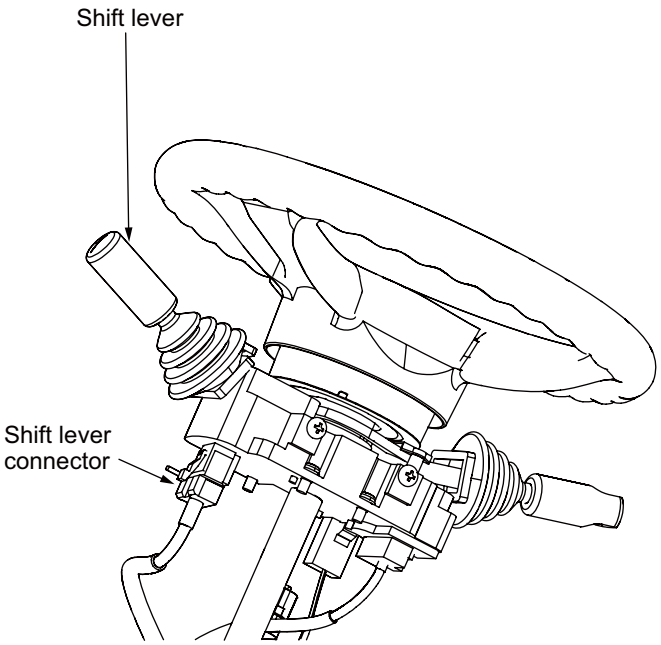
11. Locations of Sensors and Switches



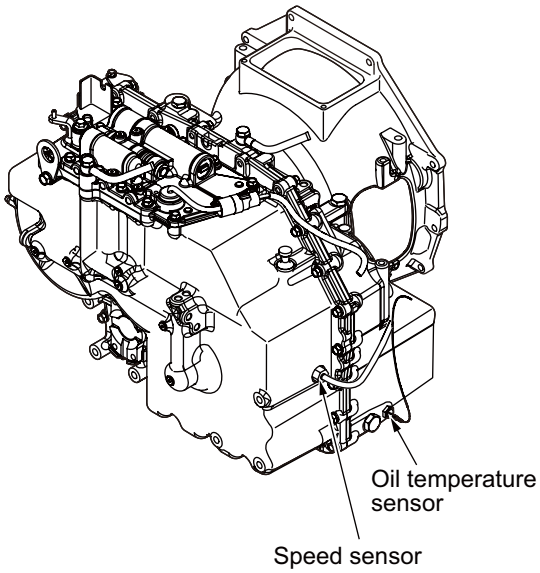
VCM-4
(frame left side)



FC Lever box (for FC model)



Shift lever



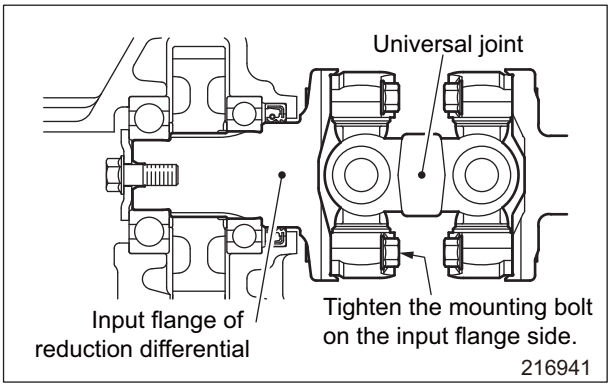
Transmission (left side)

215254

(5) Align the universal joint mounting bolts on the transmission with the input flange threaded holes on reduction differential, and tighten the bolts.

Unit: N·m (kgf·m) [lbf·ft]

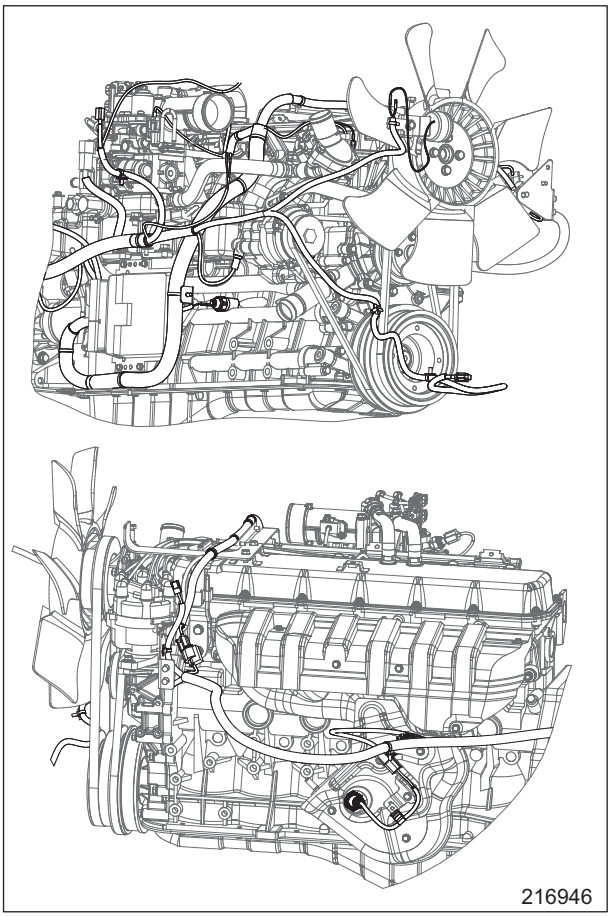
Tightening torque	54.0 to 63.8 (5.51 to 6.51) [39.85 to 47.08]



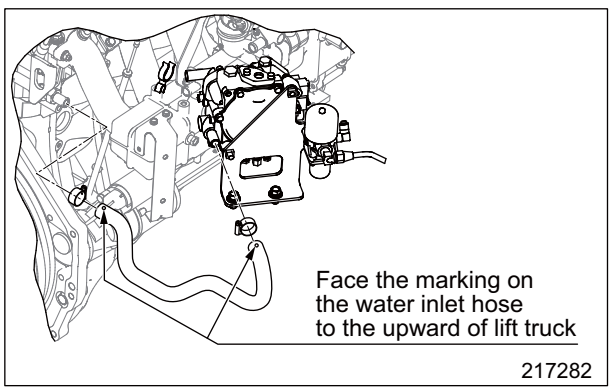
(6) When installing the exhaust pipe, replace the gasket with a new one.

(7) Check that all the harnesses on the engine and the transmission are correctly connected.

(8) Check the battery cable for any missing connections or wrong connections, and then connect the ground (negative) cable to battery.



(9) Face the marking on the water inlet hose to the upward of lift truck when installing the water inlet hose to the vaporizer.



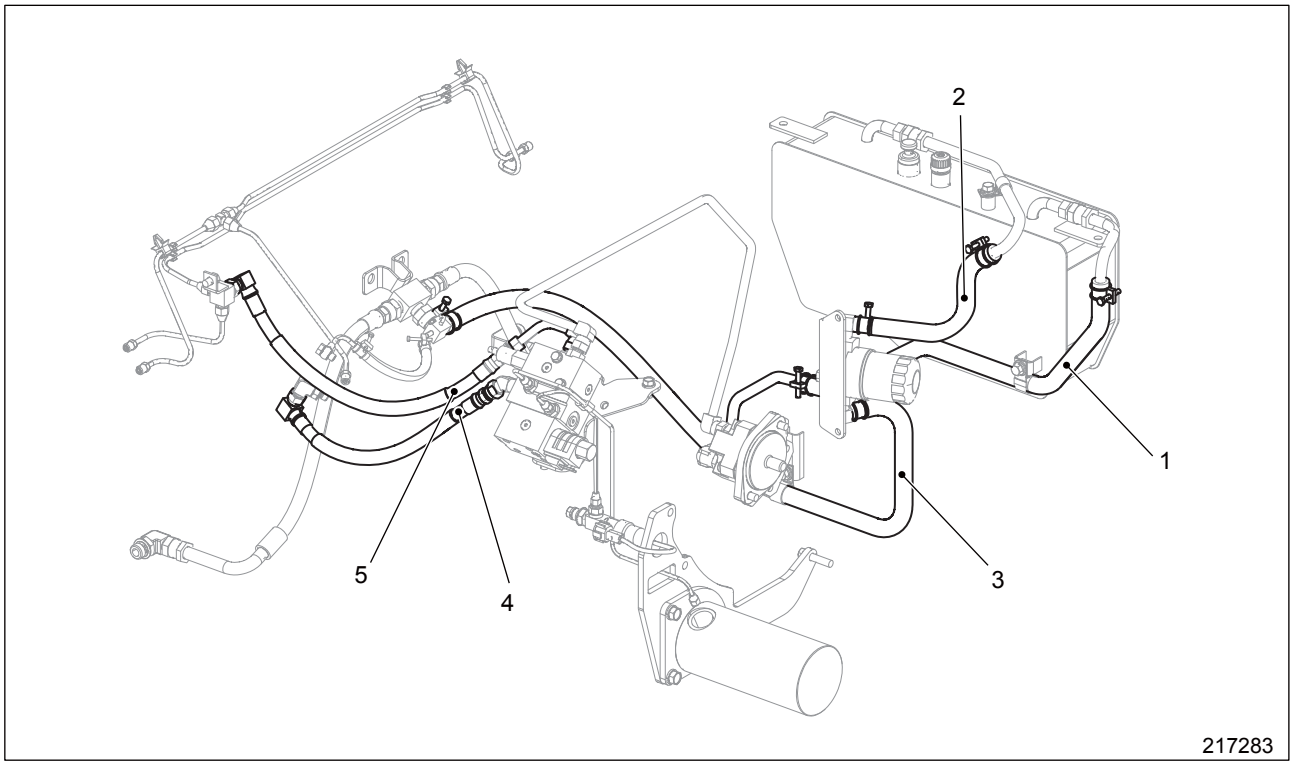
3. Removal and Installation (Wet disc brake)

3.1 Removal of Engine and Transmission Assembly

This section only provides the information on the removal and installation of the power line specific to the wet disc brake. For the information common to both wet disc brake and standard truck, refer to the removal and installation for the standard truck.

Suggestions for Removal

Removal of Wet Disc Brake Hoses



1 Suction hose
2 Return outlet hose
3 Return inlet hose
4 Rubber hose
5 Rubber hose

3.2 Shoe and Lining (Standard Truck)

Note: Removal and installation of brake shoes and linings can be done by removing the wheel brake drum (the work can be done without removing the axle shaft and wheel hub.) This section describes the removal and installation procedure of the shoes and linings. Refer to "9 BRAKE SYSTEM" for more details.

3.2.1 Preparation

Remove the front wheels. For removing front wheels, refer to the previous section.

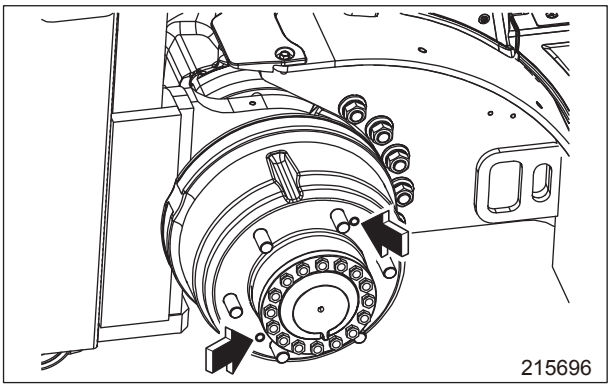
3.2.2 Removal

(1) Brake drums

Evenly tighten the two jack bolts into place as shown in the illustration, and remove the brake drum.

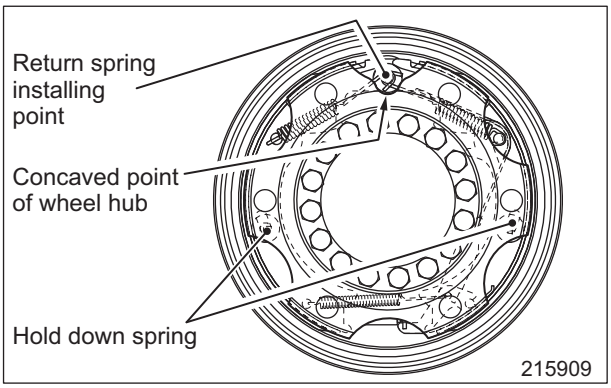
Unit: mm (in.)

Jack bolt	M14 x 1.5 Nominal length: 50 (1.97)



(2) Brake shoe

Use the notch in the wheel hub to remove shoe and lining. Refer to "9 BRAKE SYSTEM" for more details.



3.2.3 Inspection and Adjustment

Brake drums

(a) Thoroughly clean and remove any dirt on the friction surface with a clean rag.

(b) If oil or grease adheres to the lining or drum, use a brake cleaner.

3.2.4 Installation

Brake drums

Evenly tap the wheel fitting surface to secure the brake drum in place.

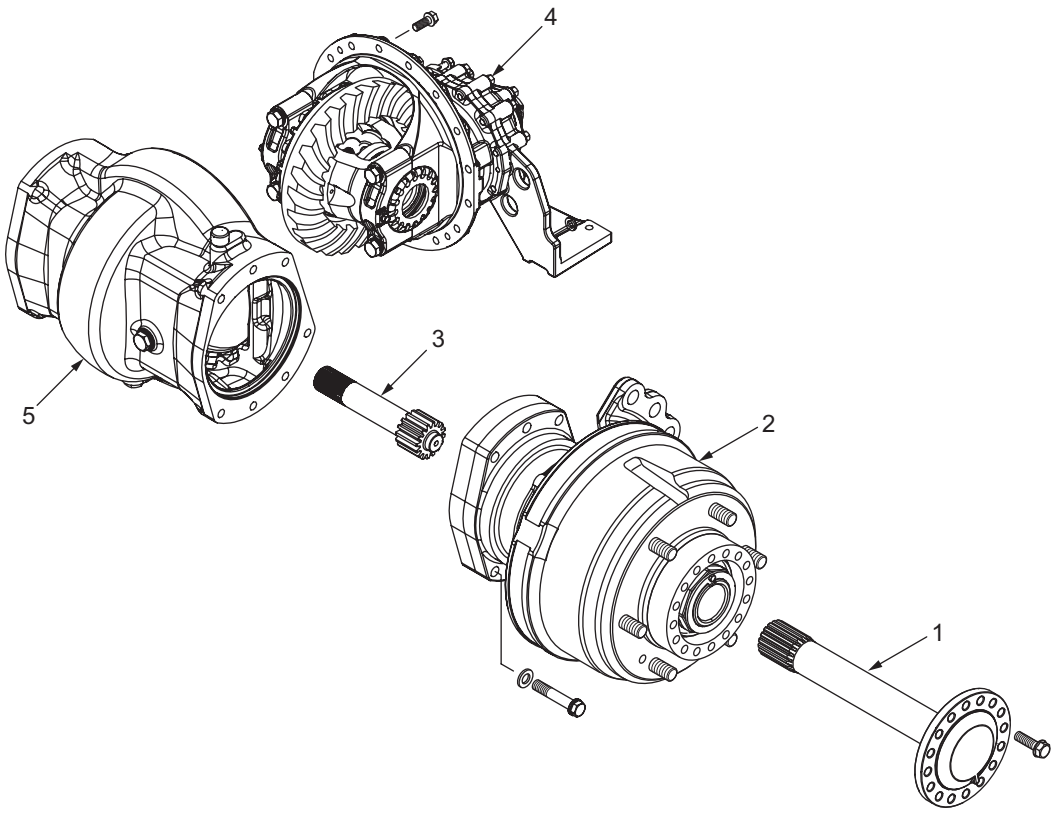
3.6 Removal and Installation of Each Assembly (Standard Truck)

3.6.1 Preparation

(1) Remove the front axle assembly. For removing the front axle assembly, refer to "Preparation" of "Front Axle Assembly (Standard Truck)".

3.6.2 Removal

The numbers indicate the removal sequence.



1 Axle shaft
2 Tube assembly and final reduction
3 Center shaft
4 Reduction differential assembly
5 Axle housing

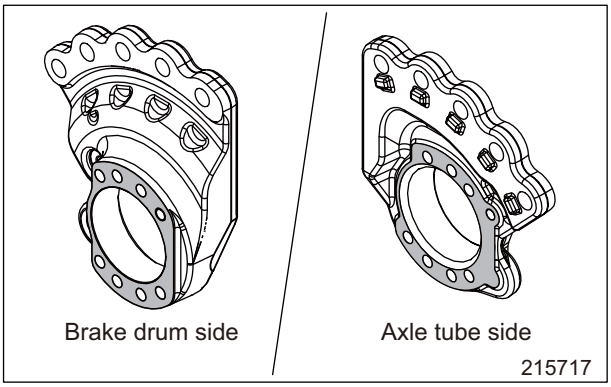
4.1.3 Reassembly

To reassemble, follow the disassembly sequence in reverse.

(1) Axle support

(a) Apply liquid gasket to the mating surfaces between the axle tube and the brake drum.

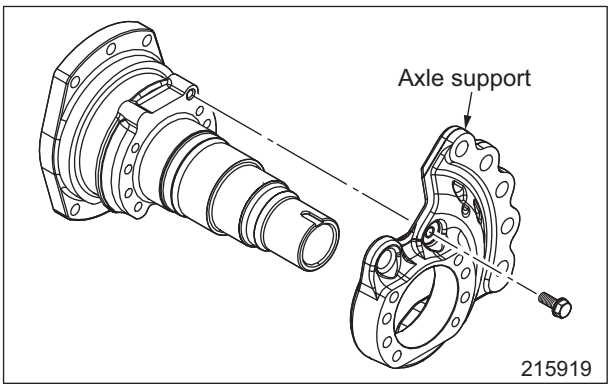
Liquid gasket	ThreeBond #1194 or equivalent



(b) Tighten the mounting bolts to the specified torque.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	214 (21.8) [157.9]



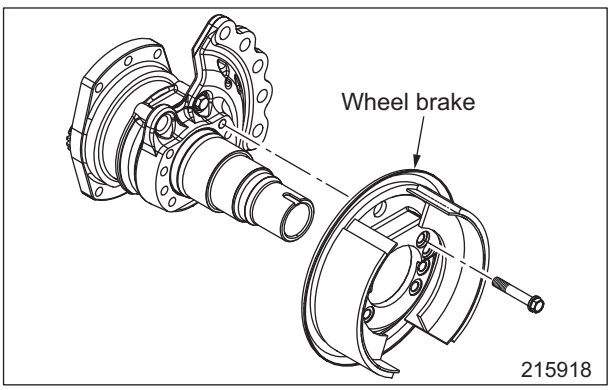
(2) Wheel Brake assembly

Thoroughly wash the mounting bolt threads, and apply sealing compound to the threads before tightening the bolts to the specified torque.

Sealing compound	LOCTITE #271 or equivalent

Unit: N·m (kgf·m) [lbf·ft]

Item	Truck model	
	4.0, 4.5 ton class	5.0C, 5.0, 5.5 ton class
Tightening torque	214(21.8)[157.9]	295(30.1)[217.7]



4.2.3 Reassembly

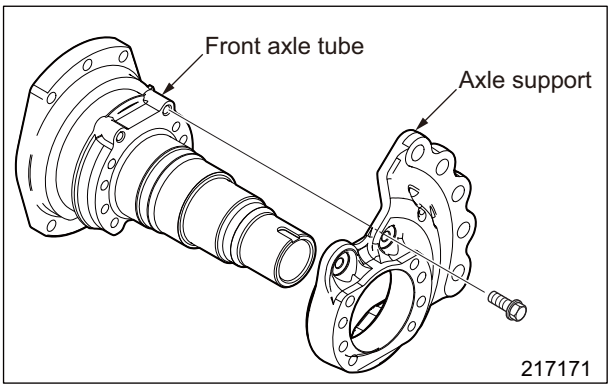
(1) Clean the installing bolt for the axle support fully, apply the sealing compound/

Sealing compound	LOCTITE #271 or equivalent

(2) Install the axle support to the axle tube to the specified torque.

Unit: N·m (kgf·m) [lbf·ft]

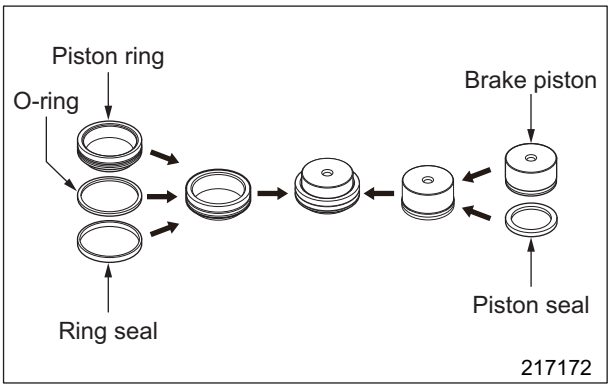
Tightening torque	214 (21.8) [157.9]



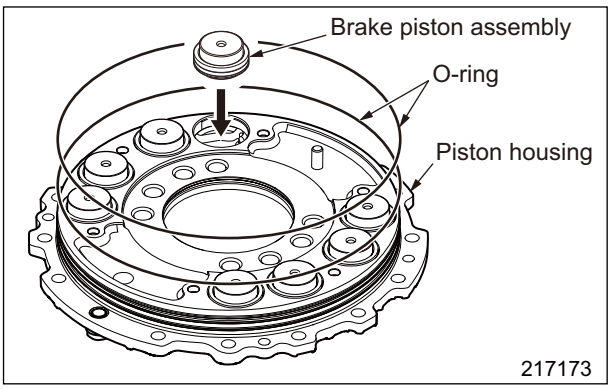
(3) Reassemble the wet disc brake assembly.

(a) Assemble the piston seal, piston ring, O-ring, ring seal to the brake piston as shown in the right illustration.

Note: Apply oil (SAE 10W-30 Engine oil CD) to the brake piston, piston seal, piston ring, O-ring, ring seal and sliding surface.



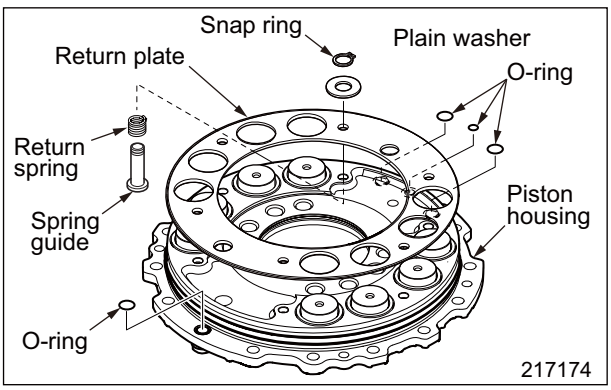
(b) Install the brake piston and O-ring to the piston housing.



(c) Insert the return spring and spring guide from the piston housing, and install the return plate, plain washer and snap spring.

(d) Install the O-ring to the piston housing.

Note: Be sure to install the multiple O-rings.

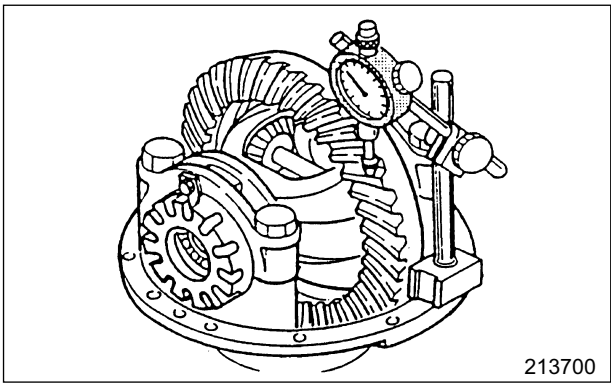


Suggestions for Disassembly

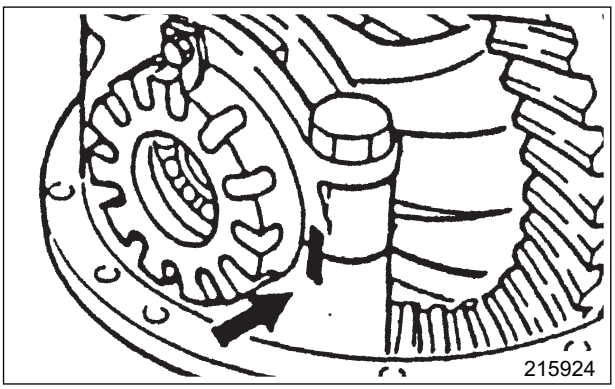
Note: 1. Before disassembling the reduction differential, be sure to measure and record gear backlash so that it will be used as a reference during reassembly, except when replacing the reduction gear set.

Unit: mm (in.)

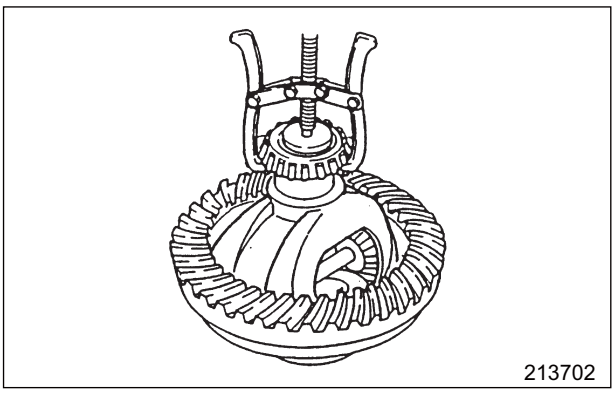
Reduction gear-to-reduction pinion backlash	0.20 to 0.26 (0.008 to 0.010)



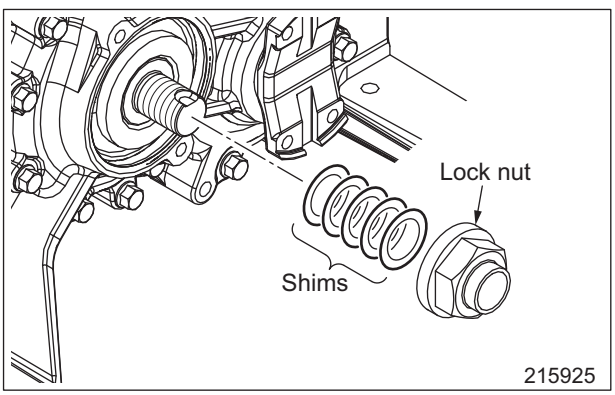
2. Put alignment marks across the bearing cap, adjusting screw, and the carrier for correct refitting.



(1) Removing tapered roller bearing from differential case, use a bearing puller to remove the bearing inner race.



(2) Removing shims
After removing lock nut 11 and shims, measure and record the total thickness of the shims. Tie all of the shims to the locknut with a string to prevent losing them.



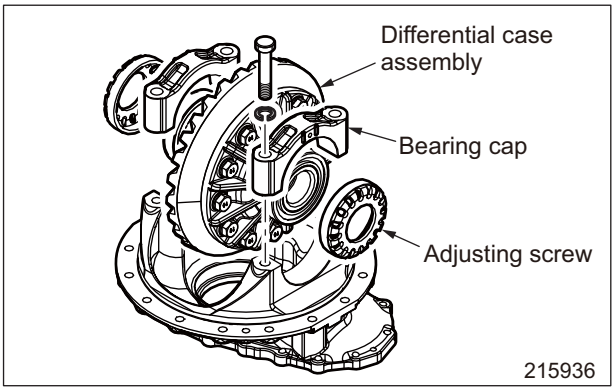
Reassembling Suggestions for Reduction Differential Assembly

(1) Adjusting backlash

(a) Turn over the differential carrier, and place the reduction differential assembly facing upward.

(b) Paying attention to the match mark made on the bearing cap and adjusting screw, reinstall the differential case to the differential carrier.

(c) Tentatively tighten the bearing cap mounting bolts.

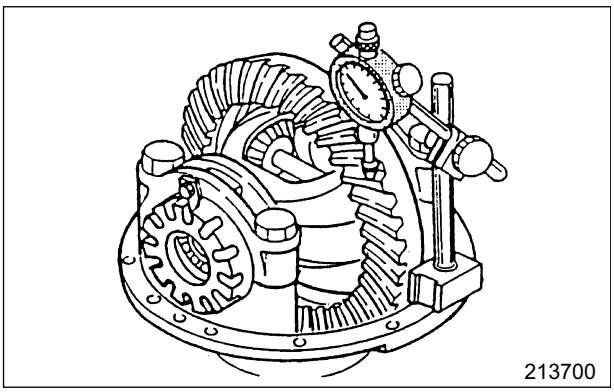


(d) Set a dial gauge on the reduction differential assembly with its probe positioned at a right angle to the tooth face of the reduction gear.

(e) Turn the gear back and forth, and read deflection on the dial gauge (backlash).

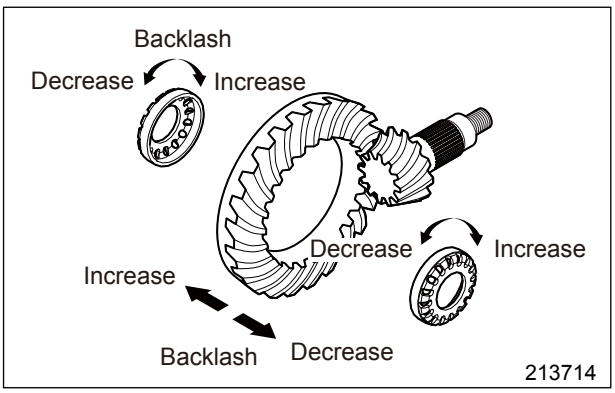
Unit: mm (in.)

Backlash	0.20 to 0.26 (0.008 to 0.010)



(f) If the backlash value falls out of the specified range, adjust backlash value by turning the adjusting screw.

Note: When turning the adjusting screws, turn the adjusting screws, right and left, by the same amount in the same direction in order not to affect the bearing preload.

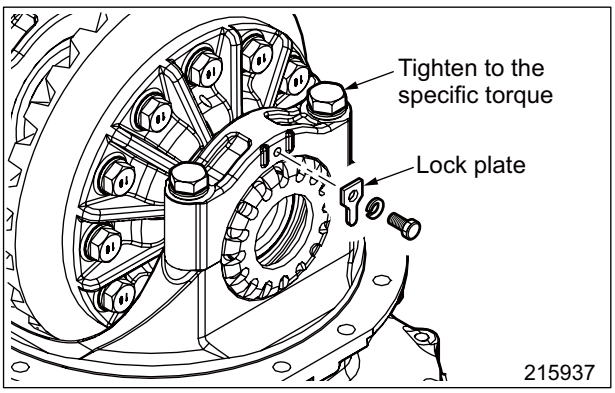


(2) Checking and adjusting reduction gear tooth contact.
Check the reduction gear for uneven tooth contact, and adjust it, if necessary, by referring to "4.2.4 Adjustment."

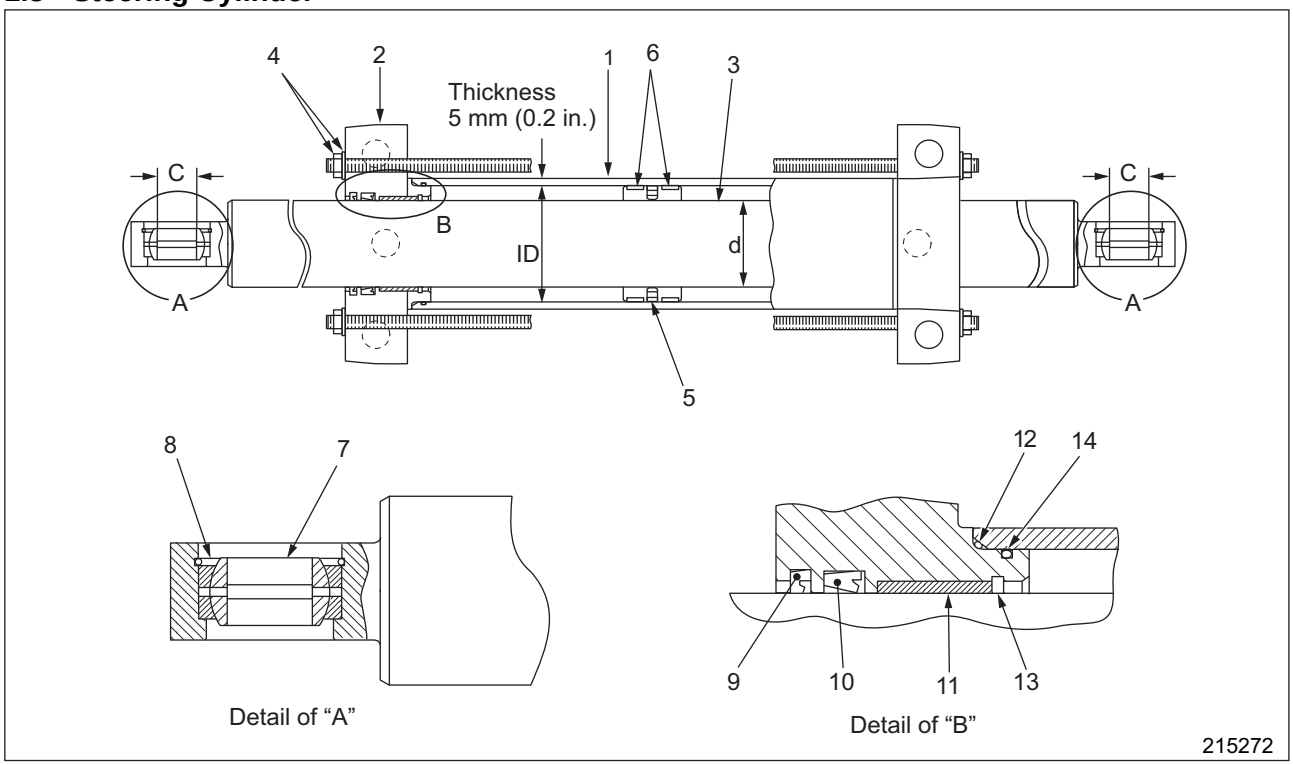
(3) Tightening bearing caps
After checking the tooth contact, tighten the bearing cap bolts to the specified torque, and bend the lock plate to clinch the bearing cap.

Unit: N·m (kgf·m) [lbf·ft]

Bearing cap tightening torque	235 ± 6.8 (23.96 ± 0.69) [173.45 ± 5.02]



1.3 Steering Cylinder



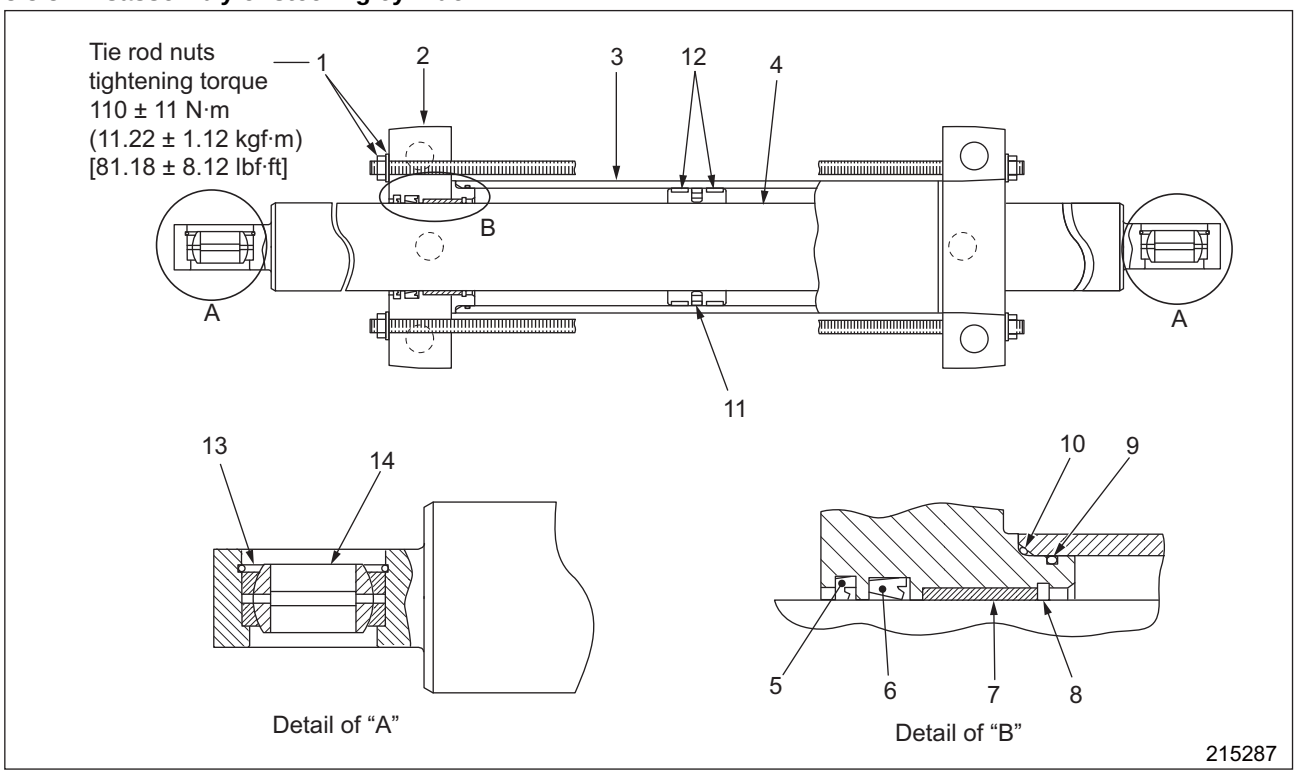
Unit: mm (in.)

Dimension	Specified value
ID	80 (3.15)
d	60 (2.36)
C	25 (0.98)

Main Components

1 Cylinder tube
2 Cylinder head
3 Rod assembly
4 Tie rod, Nut, Washer
5 Piston seal
6 Guide ring
7 Bushing
8 Snap ring
9 Dust seal
10 Rod seal
11 Bushing
12 O-ring
13 Snap ring
14 O-ring

3.3.3 Disassembly of steering cylinder



Sequence

1 Tie rod, Washer, Nut
2 Cylinder head (with parts 5 through 10 assembled)
3 Cylinder tube
4 Rod assembly (with parts 11 through 14 assembled)
5 Dust seal
6 Rod seal
7 Bushing
8 Snap ring
9 O-ring
10 O-ring
11 Piston seal
12 Guide ring
13 Snap ring
14 Bushing

Suggestions for Disassembly

Put markings on 2 and 3.
(Adjustment of cylinder mounting surface alignment)

(1) Activate the piston by blowing compressed air from the oil port to discharge oil in the inside.

(2) When tie rod 1 is removed, the cylinder is divided into three part: header 2, cylinder tube 3, and rod assembly 4.

(3) Remove damaged or worn seals as necessary. Do not reuse removed seals.

Suggestions for Reassembly

For reassembly, follow the disassembly sequence in reverse, while observing instructions below.

(1) Reassembling work should be conducted at a clean place where free of dust or abrasive foreign substances.

(2) Lubricate each part with hydraulic oil before reassembling.

(3) Replace seal kit parts with new ones.

(4) Be careful not to twist O-rings when installing.

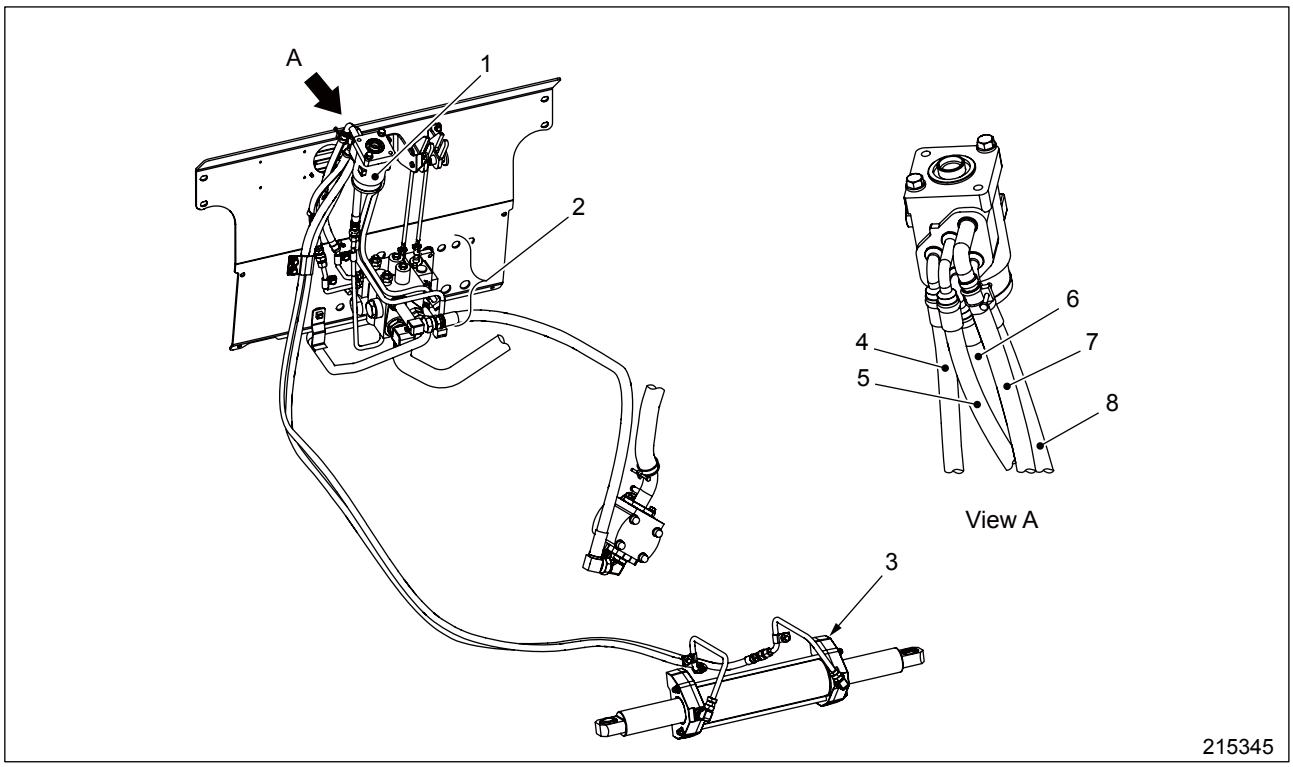
(5) Tighten tie rod nuts to the specified torque.

Unit: N·m (kgf·m) [lbf·ft]

Tie rod nuts tightening torque	110 ± 11 (11.22 ± 1.12) [81.18 ± 8.12]

2. Disassembly and Reassembly

2.1 Valves, Hoses and Pipes, Disassembly and Reassembly



Main components

1 Steering valve
2 Hydraulic control valve
(The illustration shows MC valve.)
3 Steering cylinder
4 Hose and pipe
(from port PF to steering valve port P)
5 Hose and pipe
(between steering valve port L and steering cylinder)
6 Hose and pipe
(between steering valve port R and steering cylinder)
7 Hose and pipe (from steering valve port T to port T2)
8 Hose and pipe (for load sensing)

Disassembly and Reassembly

(1) Be sure to perform the maintenance work of the hydraulic system in a clean place and be careful not to allow abrasive foreign substances to enter the hydraulic system.

(2) All O-rings attached to disassembled parts must be replaced with new ones at reassembly.

(3) Steering system hoses are critical safety parts. These hoses must be replaced at their specified time interval (every 2 years), even if damage is not found. For a replacement time interval, follow the "Operation & Maintenance Manual."

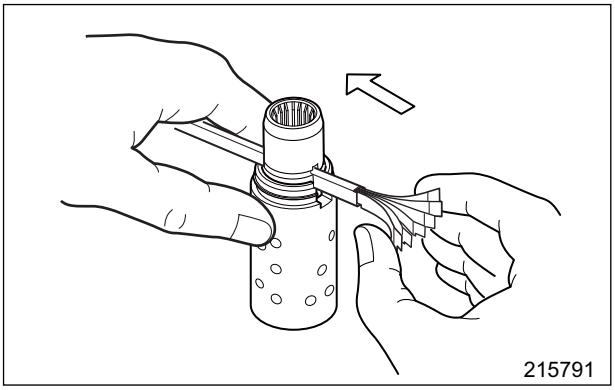
(4) When removing or installing hoses, use a double spanner as needed in order to prevent excessive force from being applied to the matching fittings.

(5) Bleed air after reassembly.
Air bleeding method:

(a) Raise the rear tires off the floor by placing jack stands under the lift truck body.

(b) While changing the speed of the engine by pressing the accelerator pedal, turn the steering wheel lock-to-lock to release air pressure.

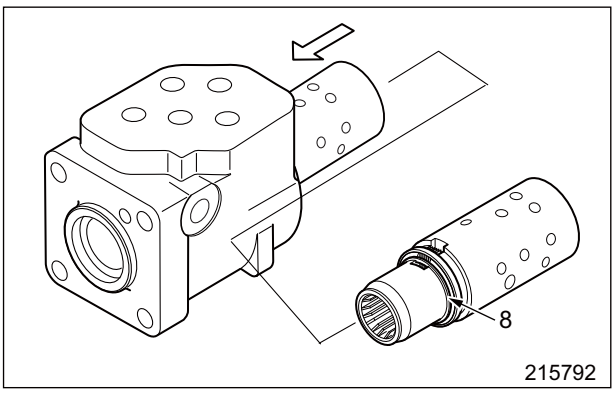
(5) Installing spring
Align the spring notches in the spool and sleeve assembly, and stand the spool and sleeve assembly on a flat workbench. Use the spring insertion tool to install springs. Make two sets of center springs, each consisting of three pieces, and fit the two sets of center springs together back to back, and then pinch the six pieces of center springs in the insertion tool with the notches on the both ends facing down. See the illustration on the right.
Hold one end of the center springs with fingers and push the springs into the notches of the spool/sleeve assembly as shown in the illustration, If the spring insertion tool is not available, insert the center springs one by one alternately from the right to left.



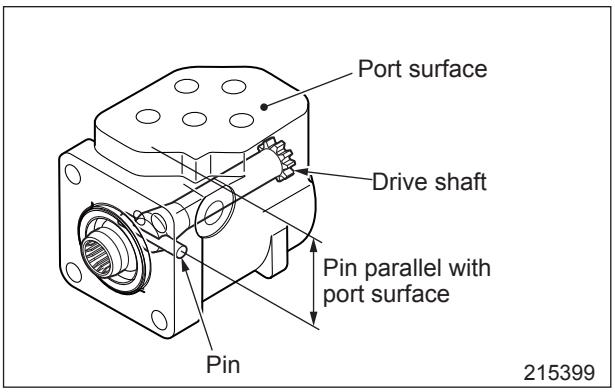
Spring insertion tool	97157-00100

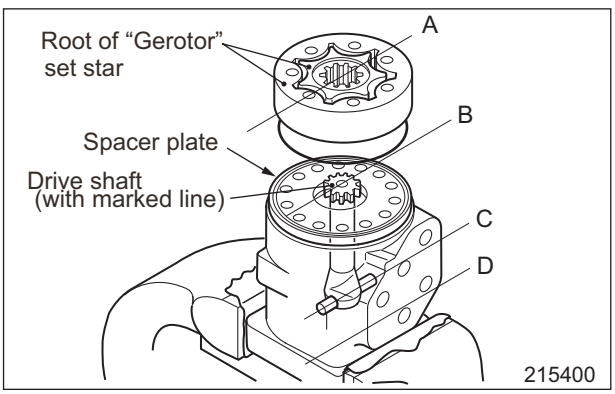
(6) Insert the spool/sleeve assembly into the housing, through the gerotor side.

Note: Be sure to insert the spool/sleeve assembly straight to prevent it from binding in the housing. Be careful not to let the spring retaining ring 13 come off. With the pin held in a horizontal position, insert the spool/sleeve assembly while rotating it slightly to both right and left sides. Make sure the spool/sleeve assembly rotates smoothly in the housing after the assembly is inserted.

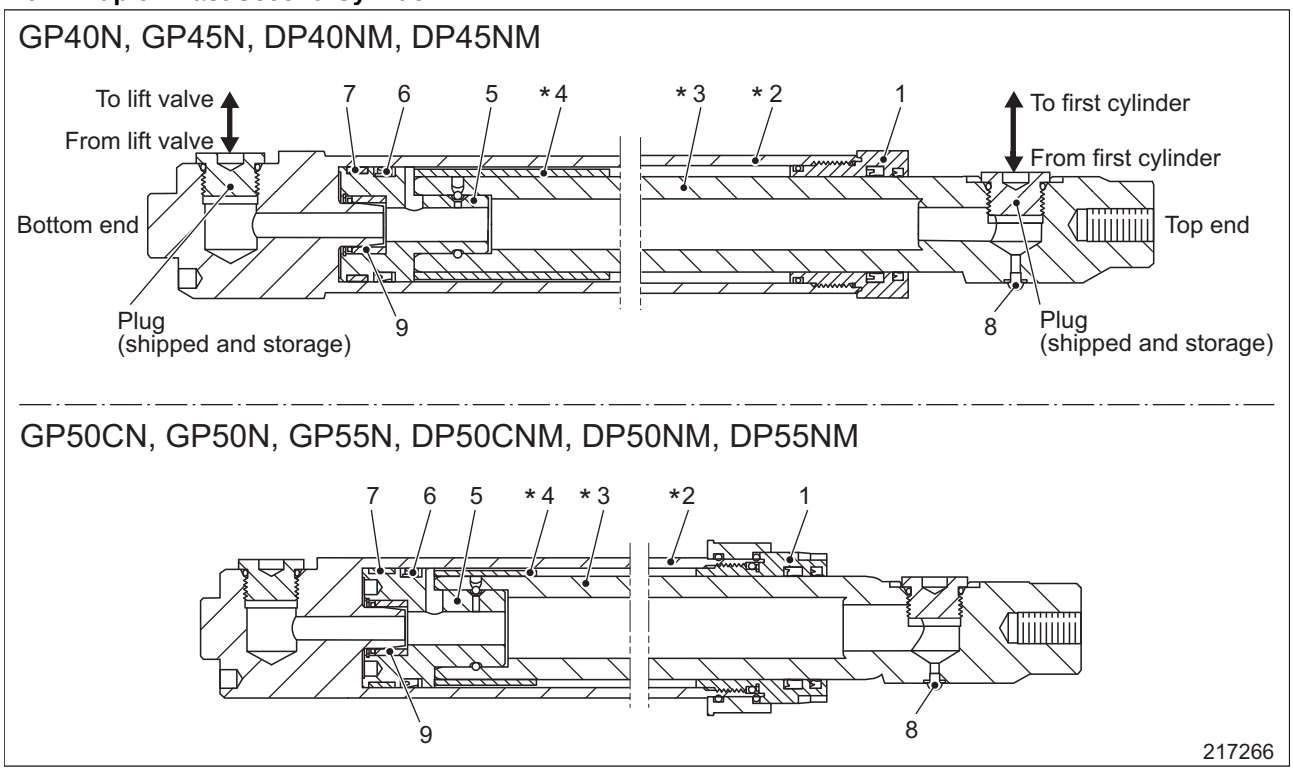


(7) Installing drive shaft
Rotate the spool/sleeve assembly to make the port surface of the housing parallel with the pin. Insert the drive shaft 12, and fit the pin in the yoke of the drive shaft 12. Draw an alignment mark like the line B in the illustration on the end face of drive shaft spline with a felt-tip pen to ensure the proper positioning during the following process.





1.9.2 Duplex Mast Second Cylinder



Main components

1 Retainer
2 Shell assembly
3 Rod
4 Spacer
5 Piston
6 Piston seal
7 Wear ring
8 Bleed screw
9 Sleeve

Note: Dimensions of the parts marked * vary according to specifications (lift height).

The duplex mast second cylinder has a function of raising and lowering the duplex inner mast. This cylinder starts to operate after the first cylinder has completed its operations.

When the operator performs mast raising control, the pressure oil from port A1 of the lift valve enters the inlet port of the cylinder. The oil then flows through the inside of the rod 3, comes out of the outlet port, and goes to the first cylinder. Since the bore of the first cylinder is larger than that of the second cylinder, the piston in the first cylinder receives oil pressure with a larger area than the piston in the second cylinder. This makes the first cylinder operate at a lower oil pressure than the second cylinder. In other words, the first cylinder operates first, with the second cylinder starting to operate only after the first cylinder has completed its operations.

Pressure oil acts on the bottom of the piston 5, pushing up the piston and rod 3 together.

The cushion sleeve 9 prevents the bottom of the piston 5 from ramming onto the cylinder head at the last stage of the piston down-stroke through the process described below.

In the mast lowering phase, the second cylinder operates before the first cylinder.

During a down-stroke of the piston, the oil at the bottom of the piston is forced to flow through the gap between the inner wall of the sleeve 9 and the cylinder head. The gap becomes smaller as the piston moves down, further limiting the flow of oil. This prevents large impact that would otherwise occur by hard contact between the piston and cylinder head, providing the cylinder with a down-stroke cushioning feature.

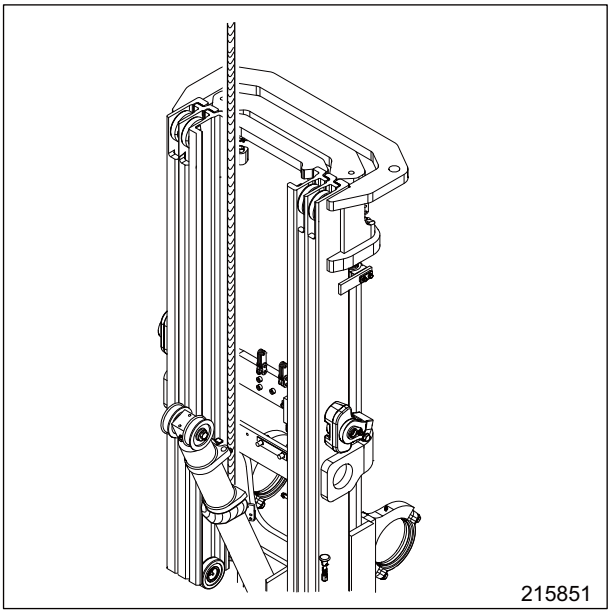
See the illustration (illustration No.217265) on page 11-9

The bleed screw 8 is provided to purge air from the system

(2) Removing first lift cylinder

(a) Tie a wire rope to the first lift cylinder 3, and suspend it with a hoist. Secure the wire rope firmly so that it will not slip.

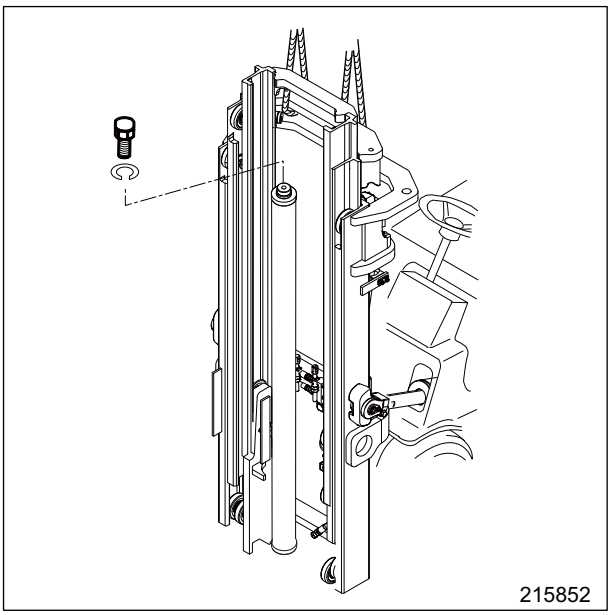
(b) Remove the mounting bolts from the lift cylinder 3, and slowly raise the first lift cylinder 3 to remove.



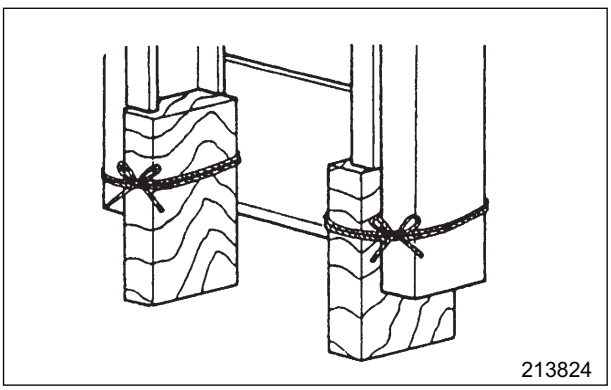
(3) Removing second lift cylinders

(a) Disconnect hoses from the second lift cylinders 5.

(b) Remove the set bolts from the top of the second lift cylinders 5. Tie a wire rope either to the middle or inner mast, and suspend the mast by approximately 550 mm (21.65 in.) off the ground.

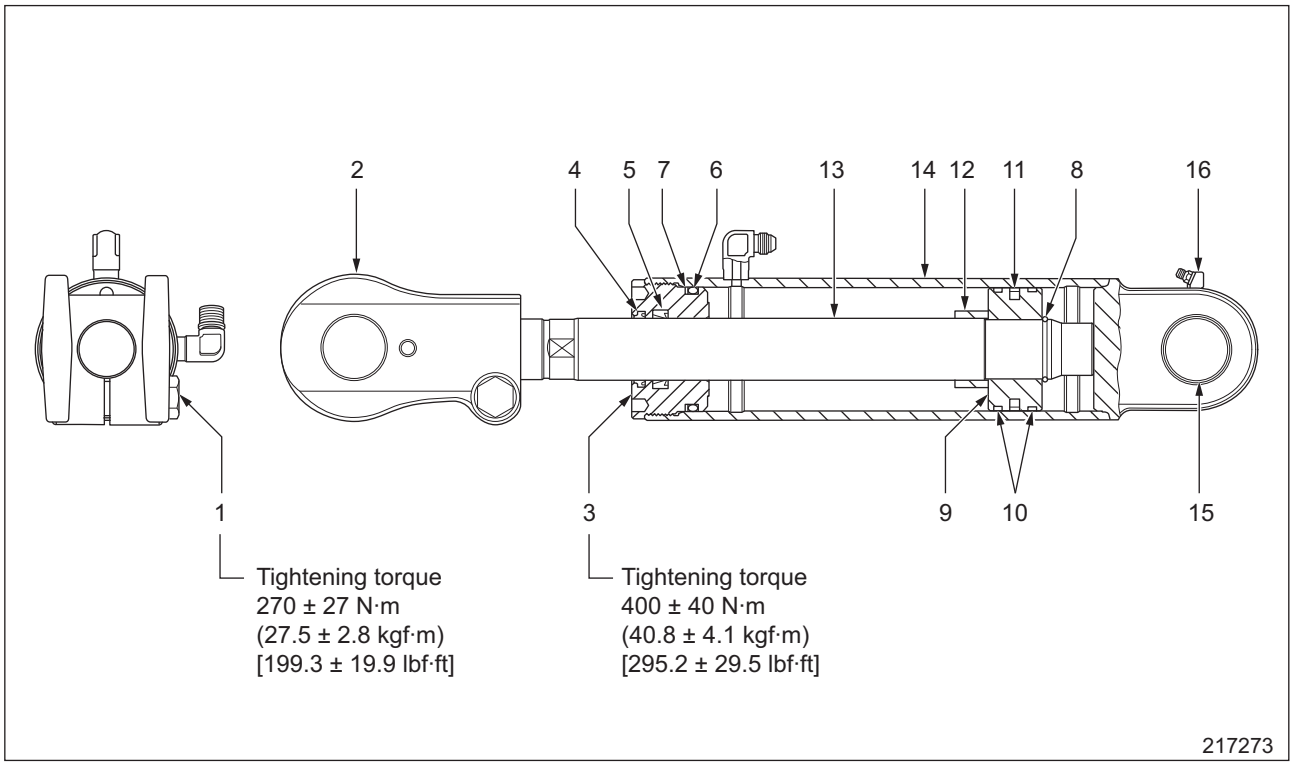


(c) Place wood blocks under the inner mast (for duplex mast) or the middle mast (for triplex mast). Make sure that both wood blocks are the same height.



2.3.2 Disassembly and Reassembly

Disassembly



Disassembly sequence: First, disassemble the tilt cylinder into the following four main parts (I through IV), and then disassemble the main parts into components.

I. Tilt socket sub-assembly (including parts 1 and 2)

1 Bolt, Spring washer
2 Tilt socket

II. Guide bushing sub-assembly (including parts 3 through 7)

3 Guide bushing
4 Wiper ring
5 Nut ring
6 O-ring
7 Back-up ring

III. Piston rod sub-assembly (including parts 8 through 12)

8 Snap ring
9 Piston
10 Guide ring
11 Piston seal
12 Spacer
13 Rod

IV. Cylinder sub-assembly (including parts 13 and 15)

14 Cylinder assembly
15 Bushing
16 Grease nipple

Note: 1. Before disassembly, record the distance from the holder edge to the socket edge with the rod in a fully retracted position. This will be helpful during reassembly.

2. Do not disassemble the tilt socket bearing and the cylinder tube bushing unless a defect is found during inspection.

3. Do not disassemble the piston and snap ring unless a defect is found during inspection.

4. Troubleshooting

Item	Condition	Possible cause	Action
Hydraulic tank	Hydraulic tank heats excessively.	Hydraulic tank oil level is too low.	Refill.
		Oil viscosity is improper.	Change oil referring to "4.2 Fuel and Lubricant Specifications" in "Chapter 13 SERVICE DATA."
		Overload	Check working conditions and, if overloaded, instruct the operator to stay within the load limit.
		Line is clogged, which generates a restriction to oil line flow and causes local overheating.	Clean oil line.
		Relief valve is improperly adjusted.	Readjust pressure setting.
		Set pressure drops due to spring settling or damage.	Disassemble or replace, and readjust pressure.
		Gear pump is worn.	Replace pump.
		Outlet pipe or tube is flattened, or flow is restricted.	Repair or replace.
	Cylinder movement is too slow.	Oil level is too low due to normal oil consumption.	Refill oil referring to "4.2 Fuel and Lubricant Specifications" of "Chapter 13 SERVICE DATA."
		Oil leaks due to damaged oil line, seals, etc.	Repair or replace
		Oil viscosity is too high.	Change oil referring to "4.2 Fuel and Lubricant Specifications" of "Chapter 13 SERVICE DATA."
Gear pump	Cylinder movement is too slow.	Gear pump does not suck oil.	Check pump and piping, repair or replace.
		Oil leaks from oil line.	Check oil level and condition, add or change oil.
		Gear pump internally leaks.	Replace pump.
	Pump is too noisy.	Pumping is poor.	Refill oil referring to "4.2 Fuel and Lubricant Specifications" of "Chapter 13 SERVICE DATA."
		Cavitation	(1) Check suction pipe for any flat portion or loose connection. Retighten or replace if necessary. (2) Check shaft oil seal for air tightness. Replace pump if necessary. (3) Check pump body for any outside interference. Repair if necessary.
	Pump case, drive gear or pump port flange is damaged.	Pressure is too high.	Replace pump. (Check to see if relief valve setting is correct.)
		Distortion or damage due to external strain or stress.	(1) Check to see if return line is blocked or restricted. Replace pump if necessary. (2) Check to see if pipe connections have been externally strained or stressed. Replace pump if necessary.
	Oil leaks from pump.	Oil leaks from oil seal.	Replace shaft seal.
		Oil leaks from drive shaft sliding surface.	Replace whole pump assembly.
		Loose pump securing bolts.	Retighten. Replace if needed.
		Seal performance inside pump is deteriorated.	Replace gasket.

6.3 Control Valve Operation

This control valve features a multi-directional control valve that controls actuators by changing oil flows. A lift valve assembly (lift body) is composed of an integrated combination of steering control circuits and lift control circuits, and to which the tilt section or attachments are connected.

The lift valve assembly (lift body) consists of a main relief valve, a steering circuit flow priority valve, a LS relief valve, an electromagnetic unload valve, an electromagnetic lift lock valve and a flow control valve (FRV). This manual multiple connection change-over valve assembly is available in 2, 3, 4 and 5 ports including a valve section.

6.3.1 Priority valve

A steering priority valve has a valve mechanism that feeds hydraulic oil to a power steering unit in preference to a load handling unit. This priority valve is a load-sensing priority-type valve that provides a dynamic signal to the steering unit, incorporating a built-in relief valve in the LS circuit (Fig. 4).

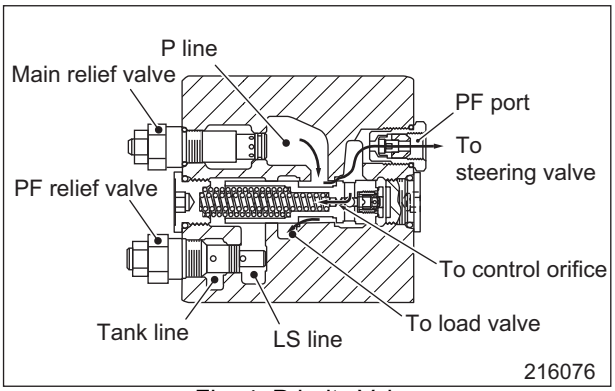


Fig. 4 Priority Valve

(1) The hydraulic oil from P port passes through a PF throttle section and a control orifice inside the spool, and flows out of LS port. When the flow from P port increases, the flow that passes through the control orifice also increases. Then a pressure difference before and after the control orifice is increased; as a result, the spool moves in the direction to close the PF throttle and to open an EF throttle. In other words, when the flow of input oil exceeds certain limits, the EF throttle is opened to drain excess oil, and thereby controlling the increases in pressure difference. As a result, the flow of oil out of LS port remains constant (Fig. 5).

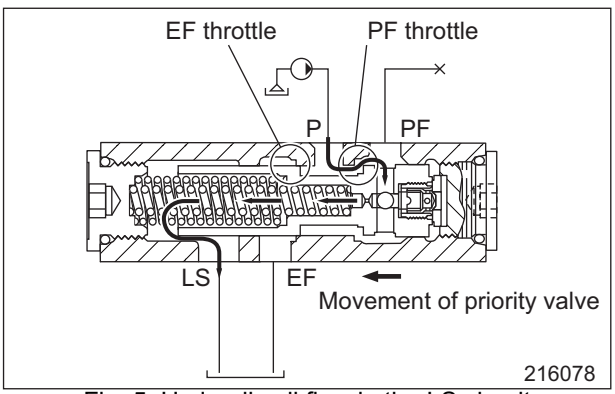


Fig. 5 Hydraulic oil flow in the LS circuit

(2) When the pressure in the LS port increases, the spool moves in the direction to close the EF throttle because the pressure difference before and after the control orifice decreases. This movement increases EF throttle resistance, and the EF throttle resistance causes the pressure in the pump to increase. As a result, the pressure difference before and after the control orifice remains constant (Fig. 6).

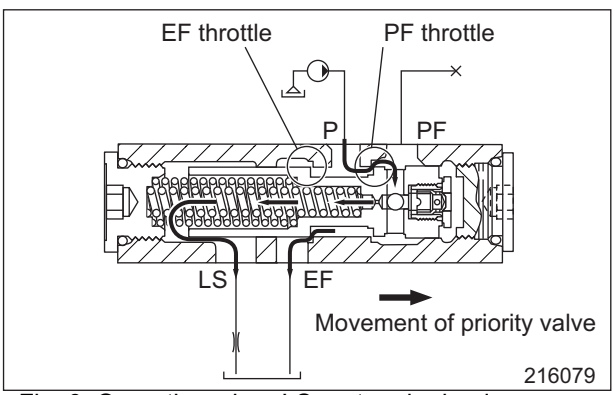


Fig. 6 Operation when LS port under load pressure

6.4.2 Steering System Relief Valve

A LS relief valve is a direct-acting valve in which a spring pushes the main poppet against the valve body seat. When the pressure in the LS flow exceeds a set pressure, the main poppet is forced open, thereby controlling the pressure (Figs. 22-1 and 22-2).

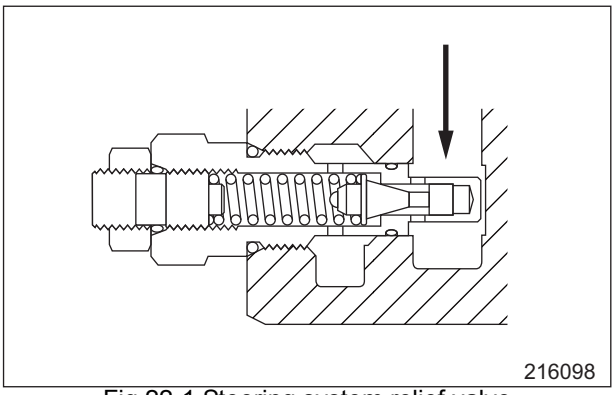


Fig.22-1 Steering system relief valve

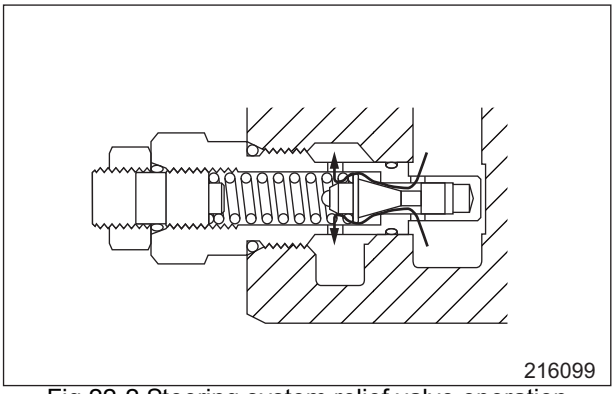


Fig.22-2 Steering system relief valve operation

Priority Valve

This valve directs the hydraulic oil delivered from the hydraulic pump to the steering system, giving it priority over the steering control circuits.

Incoming hydraulic oil from P port 1 enters priority valve 3 and pressure reducing valve 12.

The hydraulic oil having entered priority valve 3 then flows as follows:

(1) The hydraulic oil flows through passage 2, the hollow in spool 4, then orifice 17, where it is throttled before flowing into passage 5. The hydraulic oil then goes out of passage 5 through PF port 9 (ball check valve equipped connector) and is directed to the steering valve.

(2) Part of the hydraulic oil that flows through passage 2 and enters the hollow of spool 4 flows through valve 7 and reaches chamber 8. This hydraulic oil applies a leftward force to spool 4. This leftward force balances with the rightward force of spring 6 at a certain position of spool 4 and the spool settles there. In this condition, the hydraulic oil is supplied to the steering system at a certain rate and the excess hydraulic oil flows into passage 10 through passage 2.

(3) When the delivery rate of the hydraulic pump increases, spool 4 is moved left further allowing the excess hydraulic oil to flow through passages 2 into passage 10 and then to the bleed-off valve.
Valve 7 has a function of making the hydraulic oil flow into chamber. This function is necessary to cause spool 4 to move left slowly but to cause it to move right quickly such that the flow of excess hydraulic oil is limited before a shortage in supply of hydraulic oil to the steering system could occur.
Steering system relief valve 11 is a safety valve that protects the steering system against excessively high pressures. The set pressure of the valve is $11.8^{+0.5}_{0}$ MPa ($120^{+0.5}_{0}$ kgf/cm^2) [$1712^{+0.5}_{0}$ psi].

Pressure Reducing Valve

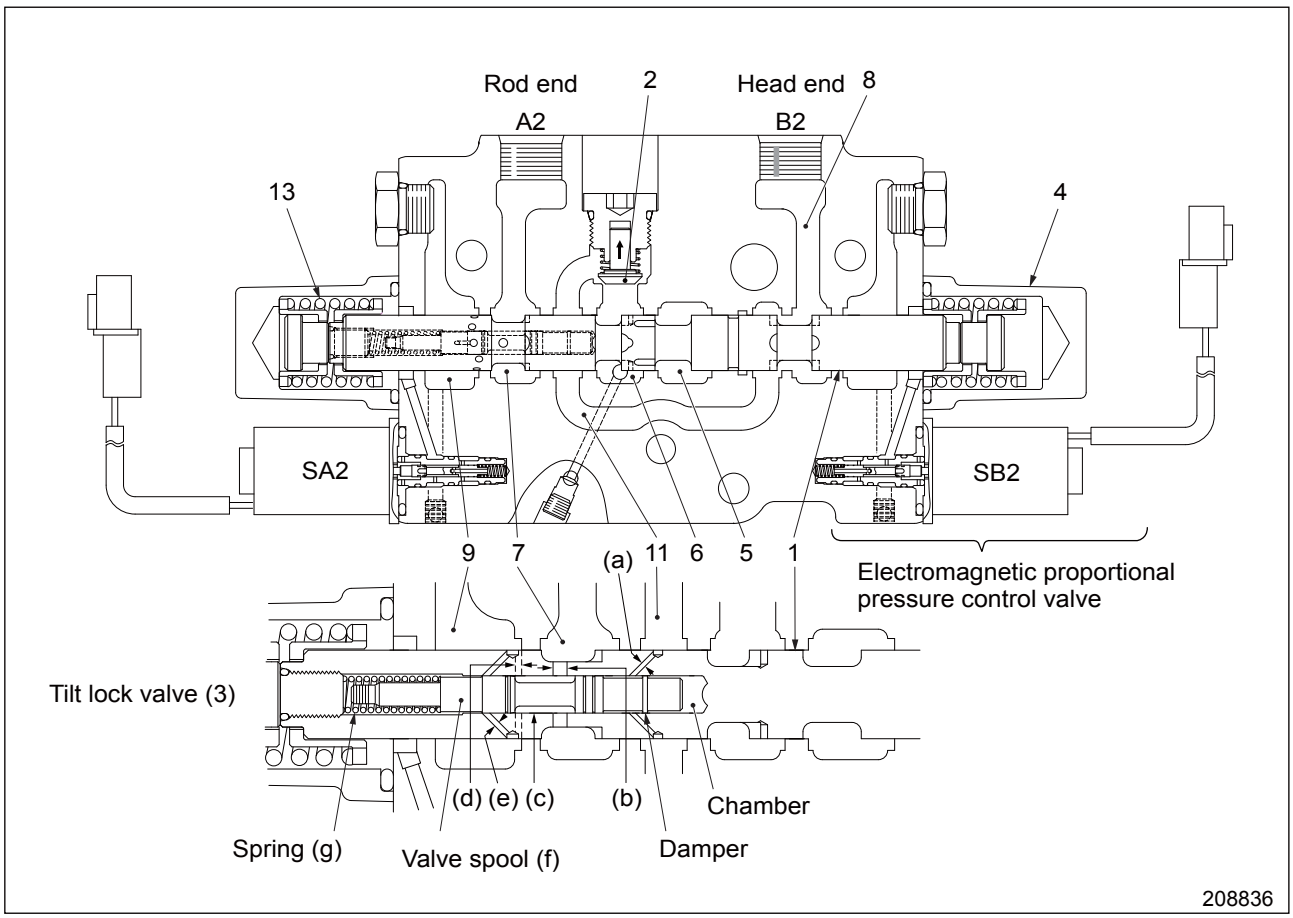
Pressure reducing valve 12 reduces the pressure of the pump-delivered oil to the pressure (pilot pressure) that is appropriate for being handled by the electromagnetic proportional pressure control valve.

The hydraulic oil entering pressure reducing valve 12 through P port 1 flows through the hollow in shuttle 13 that is sliding in the sleeve of valve 7 and is directed through pilot oil passage 15 to the electromagnetic proportional pressure control valve.

When the pressure of the oil in pilot oil passage 15 is high, shuttle 13 moves leftward against the force of spring 14.

This narrows the port whose opening varies with the relative position of the holes in the sleeve and shuttle 13, reducing the rate at which the hydraulic oil flows into the pressure reducing valve and thus lowering the pressure in passage 15 to the standard design pressure.

When the pressure in pilot oil passage 15 is low, actions of the valve components are reverse to those mentioned above, causing the pressure in passage 15 to increase back to the standard design pressure.



Operation with FC control lever in Tilt-forward Position

When an operator moves the FC control lever in the tilt forward direction, the controller supplies the electromagnetic proportional pressure control valve (SB2) with current that is proportional to the amount of movement of the FC control lever. The valve allows hydraulic oil of the pressure corresponding to the amount of movement of the FC control lever to flow into right cap 4. The pressure of the hydraulic oil having entered the cap pushes left tilt spool 1 against the force of spring 13.

The hydraulic oil in oil passage 5 of the lift/tilt circuit flows to passage 6. The hydraulic oil then makes its way pushing up load check valve 2 to passage 11. The hydraulic oil then enters passage 8, goes out of the B2 port and flows into the head end of the tilt cylinder, acting on the piston to extend the cylinder rod.

Part of the hydraulic oil in passage 11 also flows through hole (a) in tilt spool 1 into the chamber at the right end of tilt lock valve 3, pushing left spool (f) against the force of spring (g). The hydraulic oil in the spring chamber is drained through hole (e) as spool (f) moves left.

When spool "f" in tilt lock valve 3 moves left, the hydraulic oil in the passage connecting the rod end of the tilt cylinder and the A2 port as well as the hydraulic oil in passage 7 flows through the following passages in the order of mention before it is drained through passage 9 to the hydraulic tank.

Passage 7 → Passage (b) → Passage (c) → Passage (d) → Passage 9

By the two hydraulic oil flows created through the process mentioned above, the tilt cylinder rod extends such that the mast tilts forward.

Emergency Measure Taken by Operator

Should the main spool stick during forward tilting operation, an operator needs to take the following actions:

(1) Return the FC control lever to the neutral position. The SLA and SLB solenoid valves are opened, lowering the pressure in the system.

(2) Shut down the engine to stop supply of hydraulic oil to the circuit. The pressure in passage 11 will be released.

By taking the two actions described above, valve spool (f) moves right, preventing the rod end oil in the tilt cylinder from returning to the hydraulic tank. This stops forward tilting of the mast.

High-pressure selector valve 12

Remove the socket head plug 1 (valve body), then remove high-pressure selector valve as a set. If the steel ball needs to be inspected, remove plug 2 to take out the steel ball. The high-pressure selector valve is available only in the form of a set.

Connector assembly 13

Remove connector body 1, then remove the connector assembly. The connector is replaceable only in the form of an assembly.

Load check valve 14

Remove socket head plug 1, then remove valve 2 and the spring.

Suggestions for Reassembly

Filter

(1) Screw orifice 1 into the housing.

(2) Screw filter 2 into the housing and tighten it to the torque shown below. Do not overtighten the filter.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	7.8 (0.8) [5.7] max.

(3) Fit O-ring 4 on socket head plug 3, screw the plug into the housing and tighten it to the torque shown below.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	24.5± 2.5 (2.5 ± 0.25) [18 ± 1.8]

Shuttle valve

Fit O-rings 6 and 7 on valve set 5, screw the valve set into the housing and tighten it to the torque shown below.

Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	29.4± 2.9 (3 ± 0.3) [21.7 ± 2.1]

Load check valve

(1) Insert valve 8 into the housing.

(2) Install spring 9 in position.

(3) Fit O-ring 11 on socket head plug 10, screw the plug into the housing and tighten it to the torque shown below.

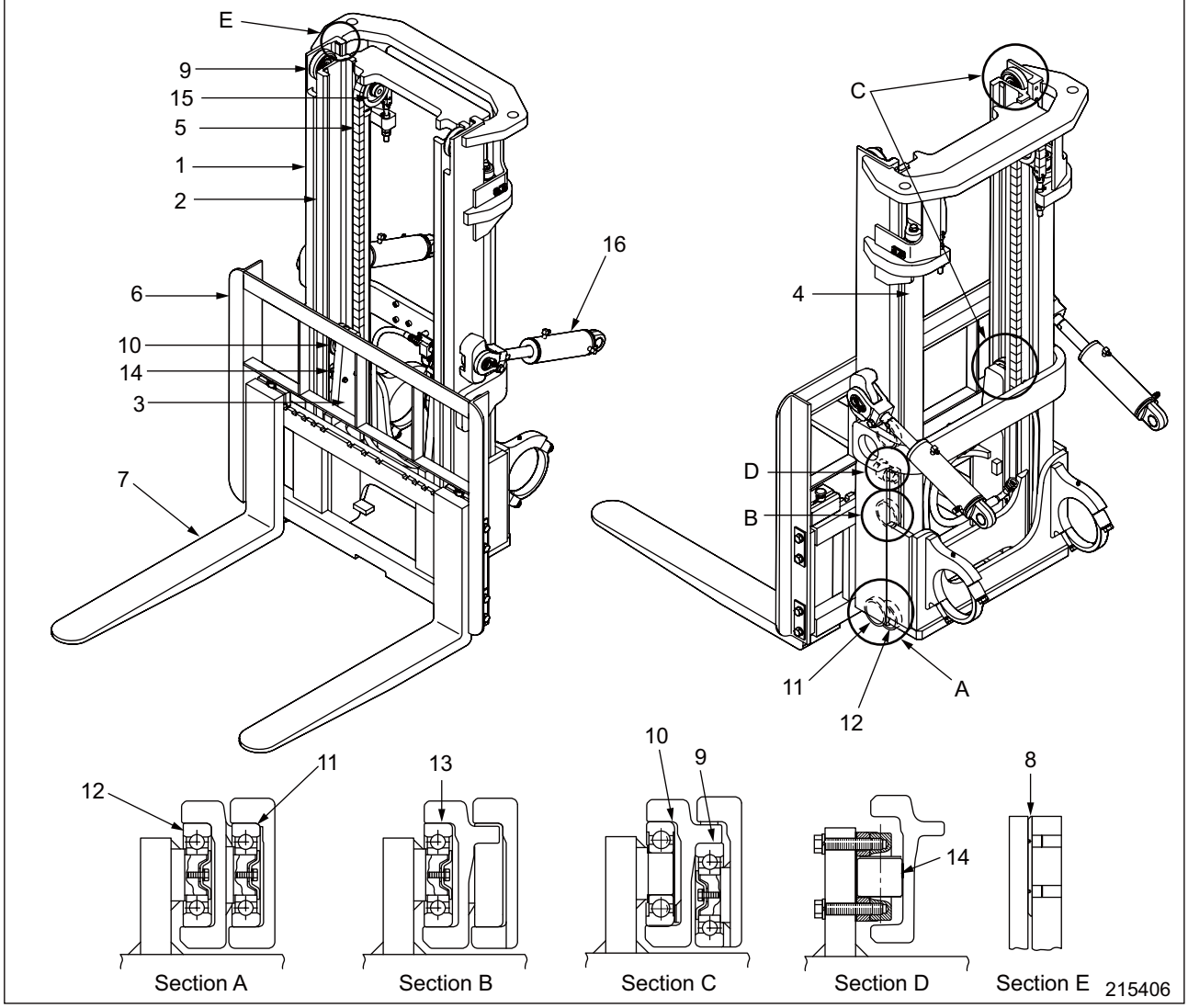
Unit: N·m (kgf·m) [lbf·ft]

Tightening torque	63.7± 6.4 (6.5 ± 0.65) [47 ± 4.7]

2. Structure and Functions

2.1 Simplex Mast (Dual Panoramic 5V40C to 5V50C)

Note: For hydraulic lines, refer to “Installing Hydraulic Lines.”



Main Components

1 Outer mast
2 Inner mast
3 Lift bracket
4 Lift cylinder
5 Lift chain
6 Load backrest extension
7 Forks
8 Mast strip
9 Outer mast main roller
10 Lift bracket upper roller
11 Inner mast main roller
12 Lift bracket lower roller
13 Lift bracket middle roller
14 Side roller
15 Chain wheel
16 Tilt cylinder

The simplex mast provides good visibility by placing both lift cylinders behind the outer mast columns.

Mast strips 8 are installed to the top end of outer mast in order to support the inner mast when the mast is tilted backward.

All lift cylinders are equipped with a cushion mechanism.

Lift cylinder 4 with a height of 4,000 mm (157.5 in.) or less is the internal drain type. Therefore, the cylinder has no return hose.

Lift cylinder 4 with a height of 4,500 mm (177.2 in.) or more has a return hose.

For mast operation, refer to "2.2 Mast Operation."

4.2.2 Installing Outer/Inner Mast Rollers

Mast rollers have the same shape and size as those of the lift bracket middle roller and the lower roller. Mast rollers have the same standard value for the clearances between the rollers and the masts.

Unit: mm (in.)

Clearance F	1 (0.04) maximum
Clearance G	0.1 to 0.5 (0.004 to 0.02)

(1) Measure clearance F between the rollers' rolling contact surfaces and the masts.
If the measured clearance does not meet one of the standard values shown in the table below, replace the roller with a roller of the correct diameter.

Note: For clearance measurement, refer to the "6.5 Mast Roller Clearance Adjustment."

Unit: mm (in.)

Size (diameter)	Truck model	
	4.0, 4.5 ton class	5.0C, 5.0, 5.5 ton class
S	117 (4.61)	129 (5.08)
M	118 (4.65)	130 (5.12)
L	119 (4.69)	131 (5.16)
LL	120 (4.72)	132 (5.20)

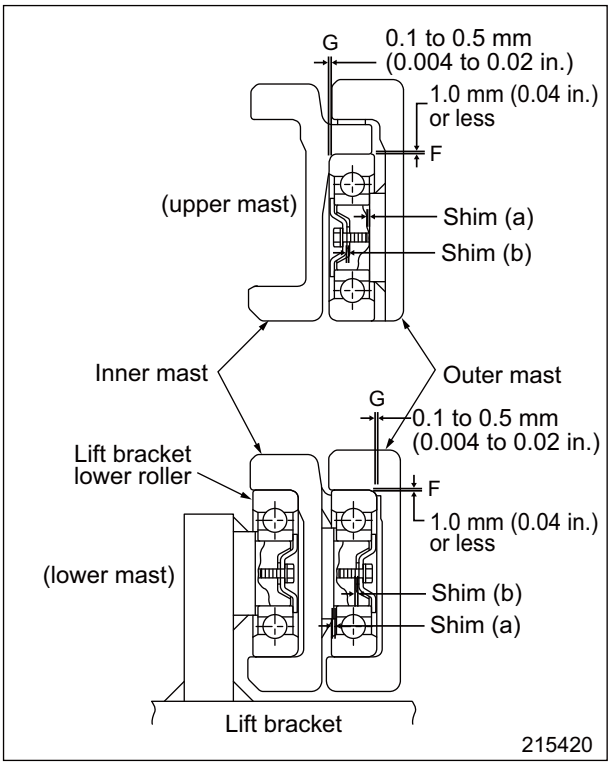
♦To install mast rollers with a driving tool, follow the installation instructions for the lift bracket rollers. Refer to the "4.2.1 Installing Lift Bracket Rollers, step (4)."

(2) Measure clearance G between the rollers and the masts. If measured clearance G is larger than the standard value, adjust clearance G by increasing the number of shims (a) and shims (b) under the roller seats.

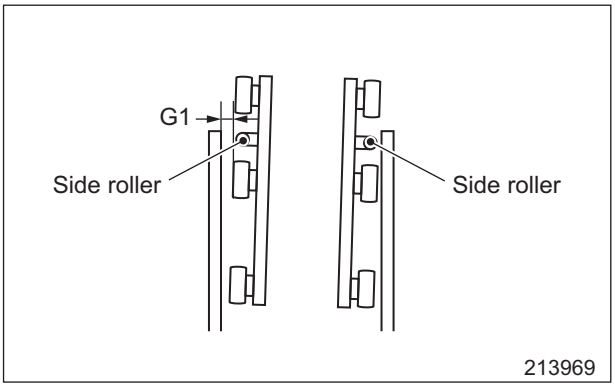
Note: For clearance measurement, refer to the "6.5 Mast Roller Clearance Adjustment."

♦Adjustment steps

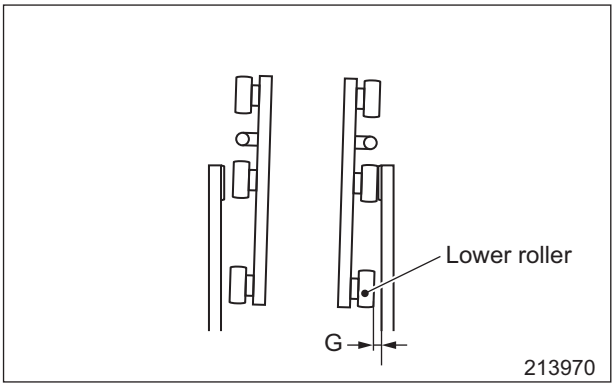
1) If clearance G is large, increase the number of shims (a) as required.
2) Adjust the number of shims (b) so that the shims (b) thickness equals that of shim (a).
3) Shims (a) is available in two thicknesses: 0.5 and 1 mm (0.02 and 0.04 in.) and shim (b) is available only 1 mm (0.04 in.) thickness.
4) If a 0.5 mm (0.02 in.) thick shim (a) is used, thickness adjustment using shim (b) is unnecessary.



(f) Lower the lift bracket slightly from the top so that the side roller comes in contact with the inner mast. Measure clearance G1 between the side roller and the inner mast. Adjust the number of shims as required. Refer to "4.2.1 Installing Lift Bracket Rollers, step (5)."



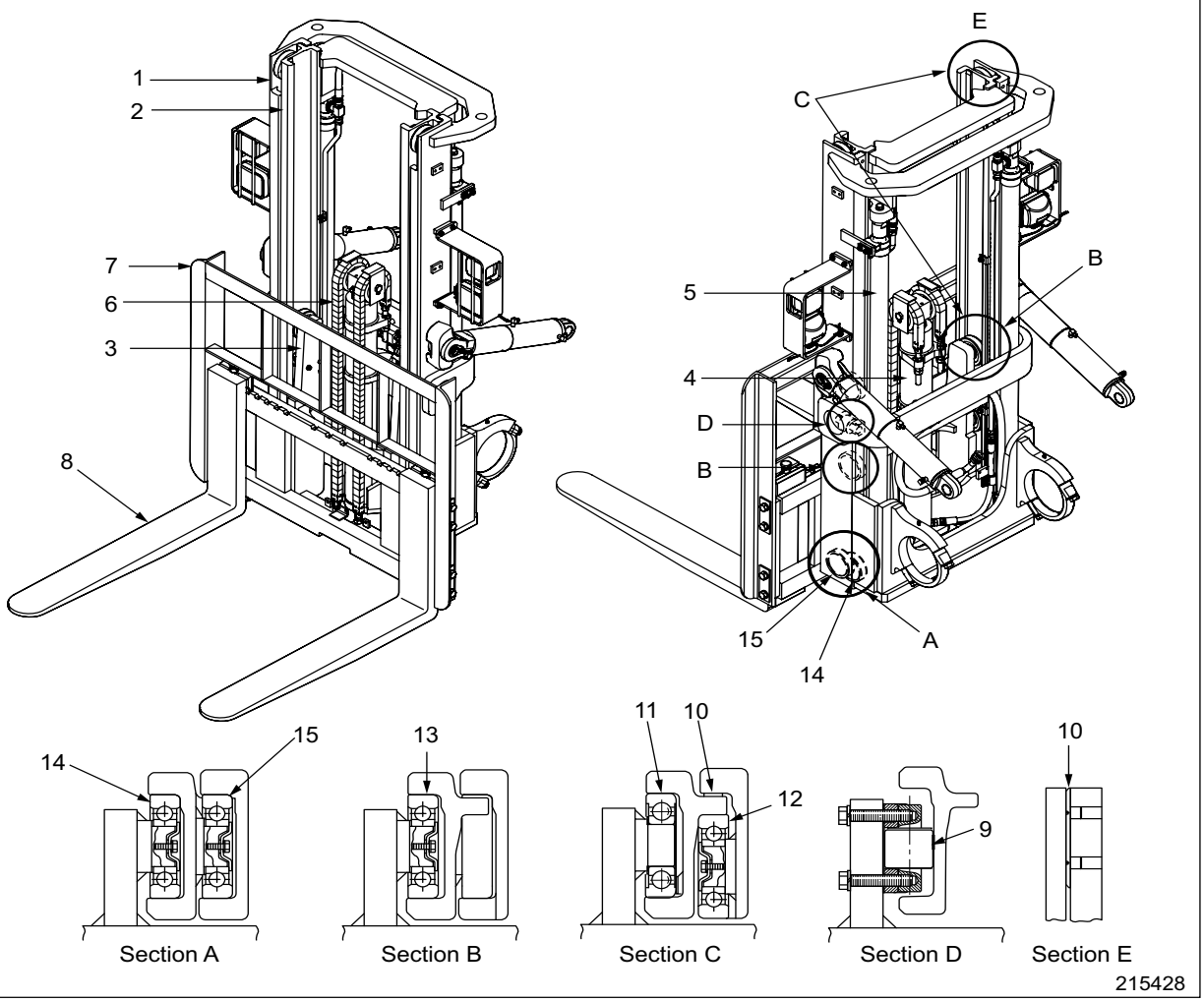
(g) Raise the lift bracket to the top of the inner mast, and measure clearance G between the lower roller and the inner mast. Adjust the number of shims as required. Refer to "4.2.1 Installing Lift Bracket Rollers, step (3)."



10.Structure and Functions

10.1 Duplex Mast (Dual Full-Free Panoramic 5F40C to 5F50C)

Note: For hydraulic lines, refer to “Installing Hydraulic Lines.”



Main Components

1 Outer mast
2 Inner mast
3 Lift bracket
4 First lift cylinder (single)
5 Second lift cylinder
6 Lift chain
7 Load backrest extension
8 Forks
9 Side roller
10 Mast strip
11 Lift bracket upper roller
12 Outer mast main roller
13 Lift bracket middle roller
14 Lift bracket lower roller
15 Inner mast main roller

On the duplex mast, the first cylinder raises the forks without increasing the overall mast height (free-lift) until the upper edge of the backrest exceeds the top of the mast.

The mast assembly consists of inner mast, outer mast, lift bracket, first lift cylinder, and two second lift cylinder.

The first lift cylinder is the internal drain type, and the second lift cylinder is equipped with a cushion mechanism.

The first lift cylinder is the internal drain type, and the second lift cylinder is equipped with cushion mechanism.

For mast operation, refer to "10.2 Mast Operation."

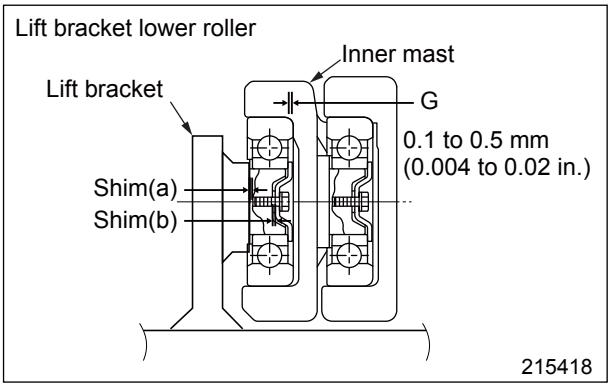
(3) Adjusting clearance G between the lower rollers and the inner mast

♦Measure clearance G between the lower rollers and the inner mast. If the measured clearance G does not meet the standard value, adjust clearance G by referring to the following steps.

Note: For clearance measurement, refer to "14.4 Adjusting Clearance between Lift Bracket Roller and Inner Mast."

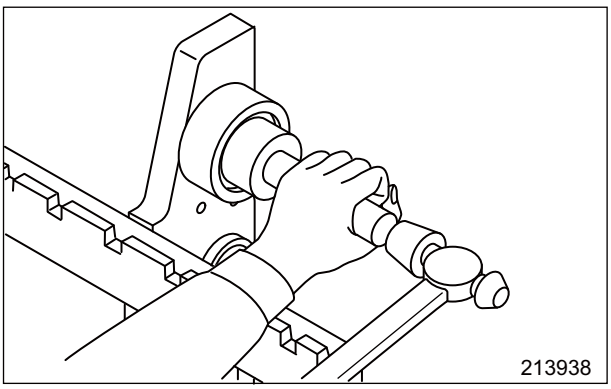
♦Adjustment steps

1) If clearance G is large, increase the number of shims (a) as required.
2) Adjust the number of shims (b) so that the shims (b) thickness equals that of shim (a).
3) Shims (a) are available in two thicknesses: 0.5 and 1 mm (0.02 and 0.04 in.) and shims (b) are available in only 1 mm (0.04 in.) thicknesses.
4) If a shim with a thickness of 0.5 mm (0.02 in.) is added to shim (a) thickness adjustment using shim (b) is unnecessary.



(4) Installing Main Rollers

To install main rollers on shafts, use a driving tool, and be careful not to strike the outer roller surface with the driving tool. The side of the roller with larger chamfering must face toward the outside. Make sure the rollers rotate smoothly when installed.



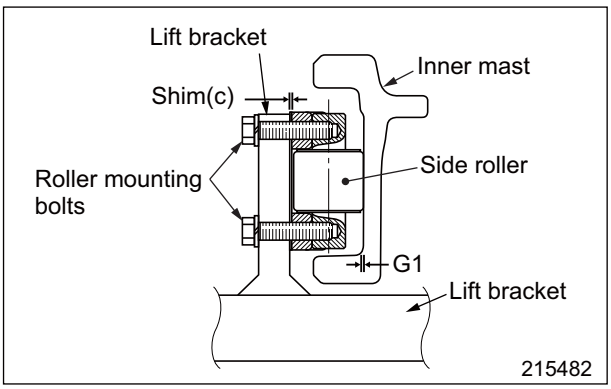
(5) Adjusting clearance G1 between the side roller and the inner mast

♦Measure clearance G1 between the side roller's rolling contact surface and the inner mast. If the measured clearance G1 does not meet the standard value, adjust clearance G1 by referring to the following steps.

Note: For clearance measurement, refer to "14.4 Adjusting Clearance between Lift Bracket Roller and Inner Mast."

♦Adjustment steps

If clearance G1 is large, increase the number of shims (c) as required. Shim (c) is available in two thicknesses: 0.5 and 1 mm (0.02 and 0.04 in.)

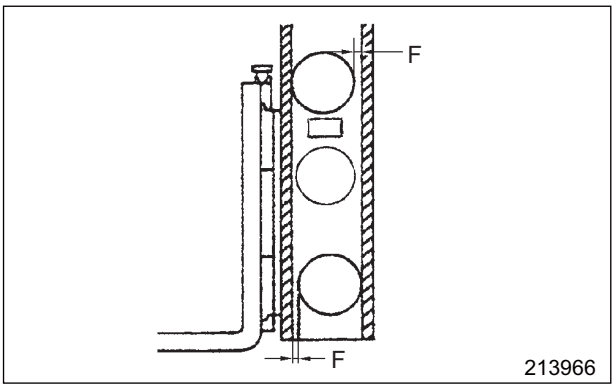


14.4 Clearance Adjustment between Lift Bracket Roller and Inner Mast

(1) Measuring back-to-front clearance on lift bracket main rollers

(a) Slightly lift the forks from the ground.

(b) Insert a claw bar between the upper part of the lift bracket and the inner mast, push the inner mast to either side. Measure clearance F between the main roller and the inner mast on the opposite side with a feeler gauge.



Unit: mm (in.)

F	1.0 (0.04) maximum

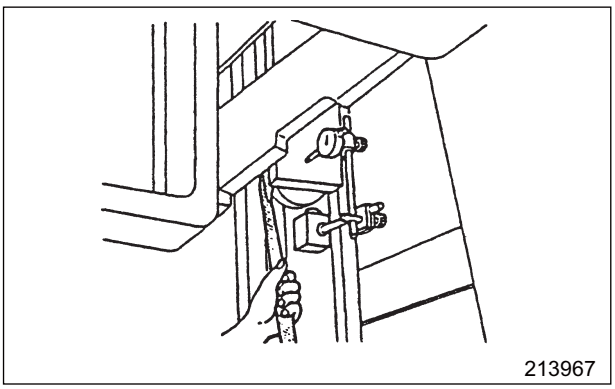
(c) If the clearance deviates from the specified value, replace it with an oversized roller.
For replacement of rollers, refer to the "12.2.1 installing Lift Bracket Rollers, step (1)."

(2) Measuring right-to-left clearance on lift bracket main rollers and side rollers

(a) Raise the lift bracket to the inner mast uppermost position.

⚠ CAUTION

Place wood blocks under the lift bracket to prevent it from falling.

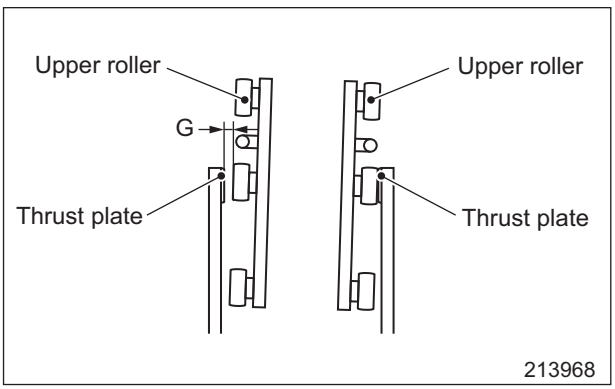


(b) Set a dial indicator on the inner mast with its contact point rested on the side of the lift bracket.

(c) With the main roller and the side roller being pushed to either side with a claw bar, then move over to the opposite side of the mast and set the dial indicator to zero.

(d) Insert a claw bar between the inner mast and the lift bracket on the dial indicator side, then push the lift bracket to the opposite side.

(e) Measure clearance G between the lift bracket middle roller and the thrust plate. Adjust the number of shims as required.



Note: Measurement and adjustment of the upper rollers is unnecessary.

Unit: mm (in.)

G	0.1 to 0.5 (0.004 to 0.02)

Refer to "12.2.1 Installing Lift Bracket Rollers, step (2)."

18.2 Mast Operation

18.2.1 Operation of Triplex Mast

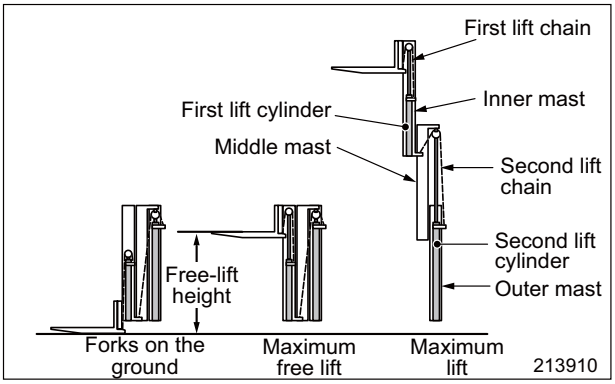
Mast Operation

The first lift cylinder extends to lift the forks to the maximum free-lift height.

When the first lift cylinder rod is fully extended, the second lift cylinder takes over to lift the middle mast while the second lift chain lifting the forks, the inner mast, and the first lift cylinder as an assembly.

The mast lowering mechanism is the reverse of lifting.

Refer to "1.9 Lift Cylinder" of "Chapter 11 Hydraulic System."



Free Lift

Free lift height means the maximum elevation of the forks with the mast in a vertical position and its height unchanged.

20.2.2 Installing Outer/Inner Mast Rollers

Mast rollers have the same shape and size as the lift bracket middle roller and the lower roller, and the mast rollers have the same standard value for clearances between the rollers and the masts.

Unit: mm (in.)

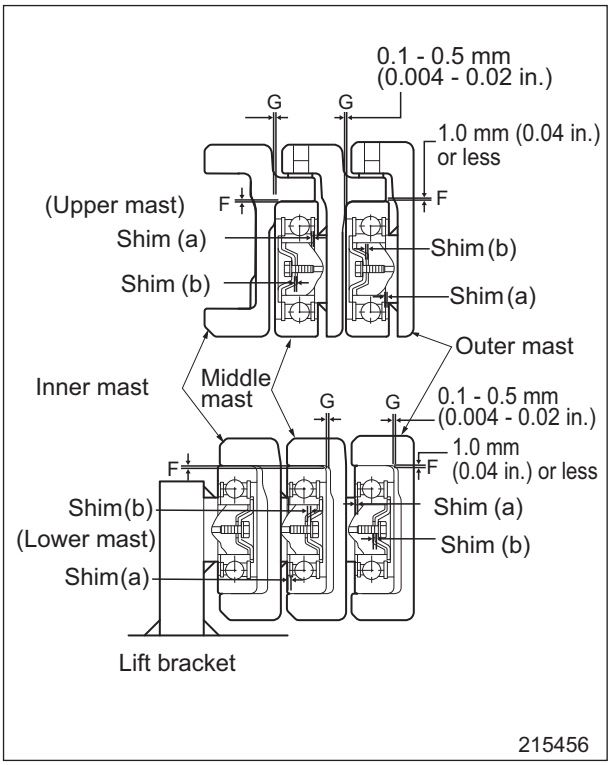
Clearance F	1 (0.04) maximum
Clearance G	0.1 to 0.5 (0.004 to 0.02)

(1) Measure clearance F between the rollers' rolling contact surfaces and masts.
If the measured clearance does not meet one of the standard values shown in the table below, replace the roller with the correct diameter roller.

Note: For clearance measurement, refer to "22.5 Mast Roller Clearance Adjustment."

Unit: mm (in.)

Size (diameter)	Truck model	
	4.0, 4.5 ton class	5.0C, 5.0, 5.5 ton class
S	117 (4.61)	129 (5.08)
M	118 (4.65)	130 (5.12)
L	119 (4.69)	131 (5.16)
LL	120 (4.72)	132 (5.20)



♦To install the mast rollers with a driving tool, follow the installation instructions for lift bracket rollers. Refer to "20.2.1 Installing Lift Bracket Rollers, step (4)."

(2) Measure clearance G between the rollers and the masts. If the measured clearance G is larger than the standard value, adjust clearance G by increasing the number of shim (a) and shim (b) under the roller seats.

Note: For clearance measurement, refer to "22.5 Mast Roller Clearance Adjustment."

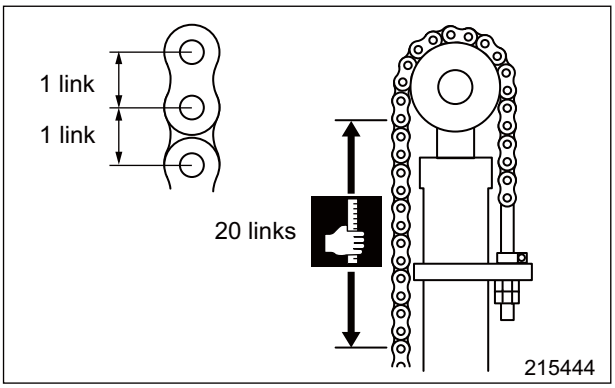
♦Adjustment steps

1) If clearance G is large, increase the number of shims (a) as required.
2) Adjust the number of shims (b) so that the shim thicknesses of shims (b) equals that of shims (a).
3) Shims (a) are available in two thicknesses: 0.5 and 1 mm (0.02 and 0.04 in.) and shims (b) are available in only 1 mm (0.04 in.) thickness.
4) If a 0.5 mm (0.02 in.) shim (a) thickness is used, thickness adjustment using shim (b) is unnecessary.

22.3 Chain Elongation Measurement

(1) Pull the chains taut by weighing a load close to the maximum load evenly on both forks.

(2) Measure 20 links of chain length. If the length exceeds the service limit value shown in the table below, replace the chain with a new one.



Chain elongation Unit: mm (in.) / 20 links

Item		Truck model	
		4.0, 4.5 ton class	5.0C, 5.0, 5.5 ton class
Tri-plex mast	A	508 (20.0)	635 (25.0)
	B	523 (20.6)	654 (25.7)

A: Standard value (when new) B: Service limit

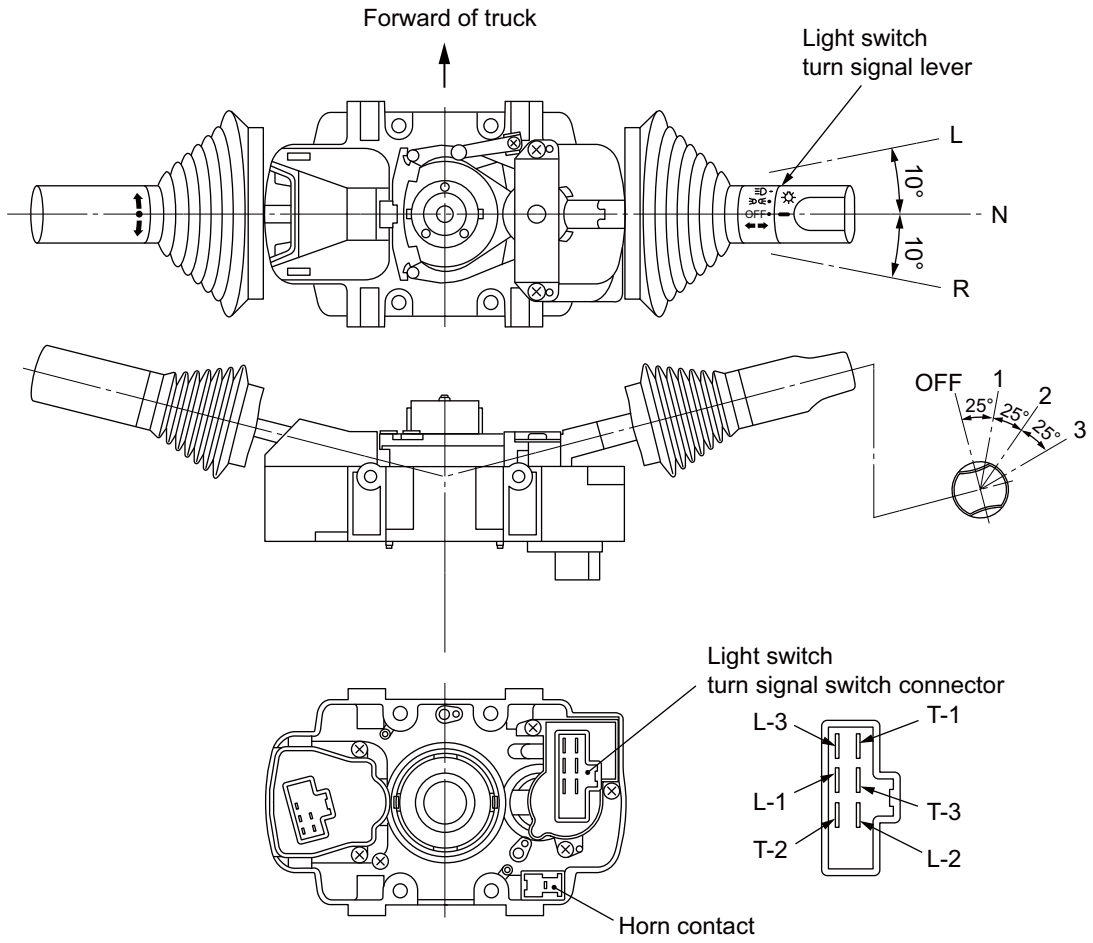
Unit: mm (in.)

Item		Truck model					
		GP40N1, GP45N1		GP50CN1		GP50N1, GP55N1	
		DP40NM1, DP45NM1		DP50CNM1		DP50NM1, DP55NM1	
		L=1070 to 1670	L=1870, 1970	L=1070 to 1220	L=1370 to1970	L=1070 to1220	L=1370 to 1970
		50×150	55×150	50×150	55×150	60×150	65×150
Fork thickness	A	50 (2.0)	55 (2.2)	50 (2.0)	55 (2.2)	60 (2.4)	65 (2.6)
	B	45 (1.8)	50 (2.0)	45 (1.8)	50 (2.0)	55 (2.2)	60 (2.4)

A: Standard value B: Repair or service limit

2.2.2 Combination switch

(1) Light switch, turn signal switch



Light switch connector

Terminal / Target / Knob position	L - 1	L - 2	L - 3
	Power	Tail, clearance lamp	Head lamp
OFF			
1	○——	——○	
2	○——	——○——	——○

Turn signal switch connector

Terminal / Target / Lever position	T - 1	T - 2	T - 3
	Flash unit	Turn signal lamp (Right)	Turn signal lamp (Left)
R (Right)	○——	——○	
N (Neutral)			
L (Left)	○——	——○——	——○

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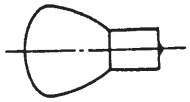
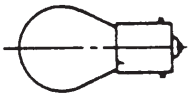
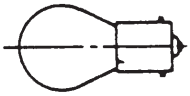
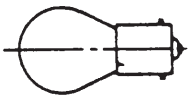
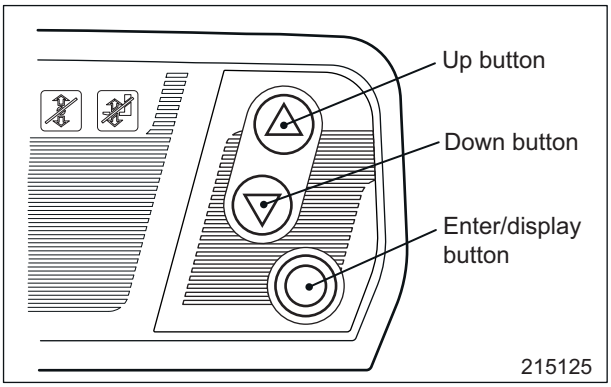
2.3 Table of Lamps

Item			Quantity	Lens color	LED color	Valve Illustration	Remark
Type of lamps	Head lamp		16	Colorless	Colorless		Standard
	Combination lamp (front)	Turn signal lamp	2	Amber	Colorless		Option (Installed to head guard)
		Clearance lamp	2	Amber	Colorless		
	Combination lamp (rear)	Turn signal lamp	8	Amber	Yellow		Standard
		Tail and stop lamp	8	Red	Red		Standard
		Back-up lamp	12	Colorless	Colorless		Standard

5.3.7 How to display the error history

Turn the key switch to the ON position. A long press on the three buttons at the same time brings up the error history display.

Button	Press	Display
△ ▽ ○	Multiple	Error history

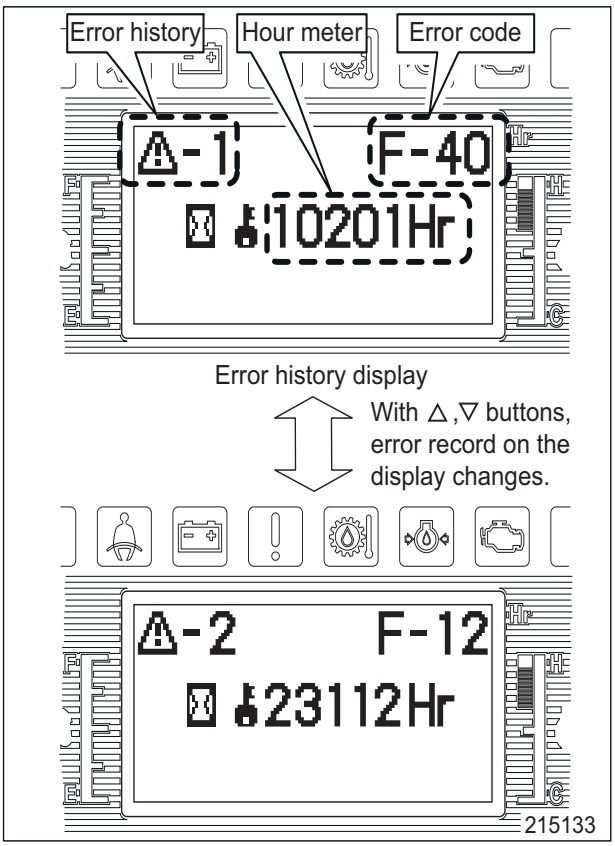


Error message displays only the F error codes. Error codes are displayed from the latest error (⚠-1) up to the past 32 errors (⚠-32). Oldest data (error) exceeding the limit (32 errors) is automatically erased.

Note: Use the service tool to erase the error message being displayed.

To change the error code display, operate the ▽ or the △ button.

Button	Press	Display
△	Short	Old → New
▽		New → Old

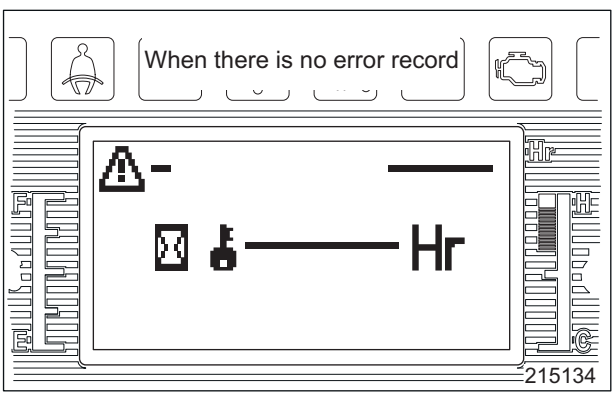


A long press on the three buttons at the same time returns to the standard display screen.

Button	Press	Display
△ ▽ ○	Multiple	Standard display screen

The illustration shows the error history screen when there is no error record.

Note: • If more than 3 minutes have passed since the last button operation, the display automatically returns to the standard screen.
• If the engine is started during the setup procedure, the setup being made is cancelled and the display returns to the standard screen.



7. Troubleshooting

7.1 Starter System

Symptom		Possible cause	Remedy
Key switch	Starter won't crank the engine even if the key switch is turned ON.	Battery discharge	Recharge or replace
		Short or open circuit	Repair or replace
		Poor continuity in starter switch	Replace
		Defective starter or starter relay	Replace
		Neutral switch is not in the neutral position.	Move the direction lever to neutral position.
	Engine won't stop even if the key switch is turned OFF.	Short or open circuit	Repair or replace
		Engine stop solenoid defect	Replace or adjust

7.2 Gauges

Symptom		Remedy
Water temperature gauge	Indicated value is low.	M/P - Water temperature meter disconnection
		① Check that the connectors are properly jointed.
		② Check the conductivity.
		③ Check the display with the water temperature sensor being warmed.
		④ Replace the water temperature sensor.
		⑤ Replace the instrument panel.
	Indicated value is inaccurate.	Check the part number.
		① Check that the parts meet the specification.
		② Check that the connectors are properly jointed.
		③ Replace the water temperature sensor.
	Indicated value blinks.	M/P - Water temperature meter disconnection
		① Correction of the short circuit.
Fuel gauge	Indicated value is not displayed.	Improper setting.
		① LPG model does not show the value.
		② Incorrect VCM setting.
	Indicated value is inaccurate.	Check the part number.
		① Check that the parts meet the specification.
		② Check that the connectors are properly jointed.
		③ Replace the fuel sensor.
		④ Remove fuel tank cap assembly and check it for bent float.
	Indicated value blinks.	① Correction of the short circuit.
		② Remove fuel tank cap assembly and check the wirings in the tank.

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CAT® Lift Trucks

Service Manual

Chassis & Mast

MC/FC

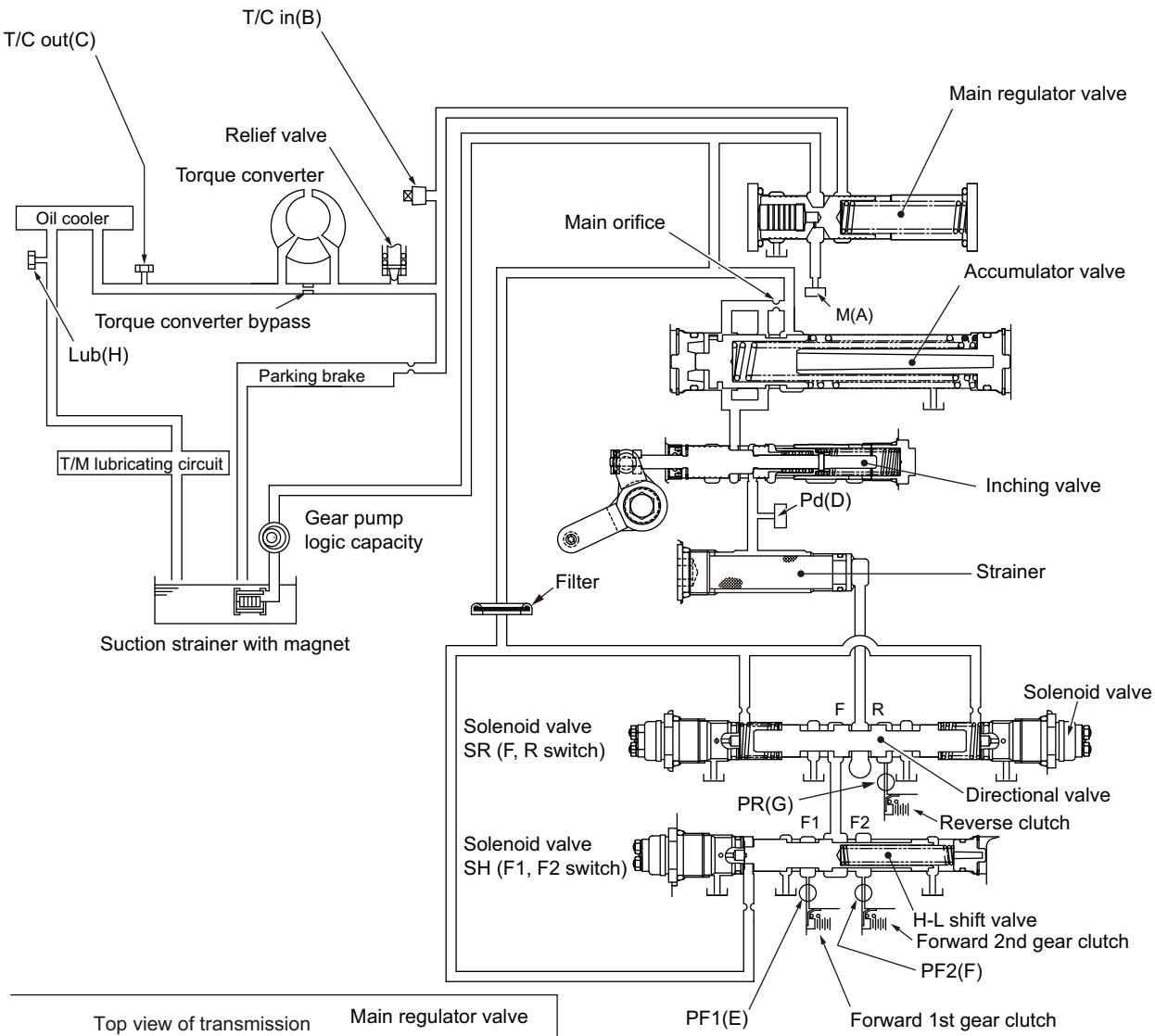
GP40N1	AT40-02011-up
GP45N1	AT29D-52011-up
GP50CN1	AT29D-82011-up
GP50N1	AT33C-52011-up
GP55N1	AT33C-82011-up

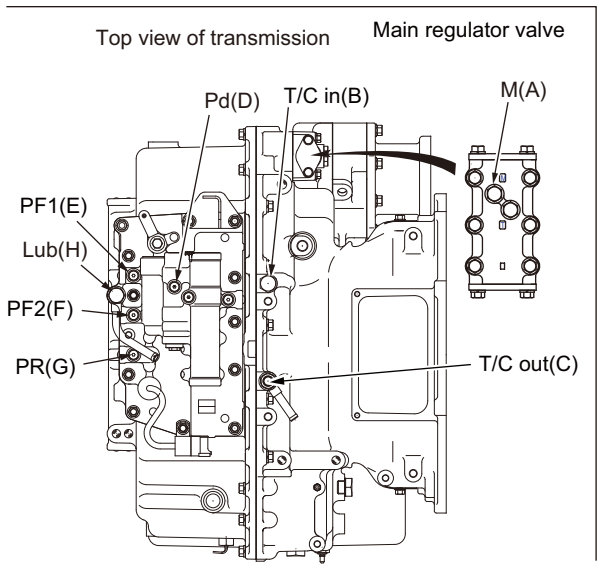
DP40NM1	AT12B-02011-up
DP45NM1	AT19D-52011-up
DP50CNM1	AT19D-82011-up
DP50NM1	AT28C-52011-up
DP55NM1	AT28C-82011-up

For use with TB45 Gasoline Engine & S6S Diesel Engine
Service Manual and Fuel System Supplements

99739-8B120
Vol.1

1.9 Schematic Diagram of Powershift Transmission Hydraulic System





M(A)	: Main oil pressure
T/C in(B)	: Torque converter inlet pressure
T/C out(C)	: Torque converter outlet pressure
Pd(D)	: Direction oil pressure
PF1(E)	: F1 clutch oil pressure
PF2(F)	: F2 clutch oil pressure
PR(G)	: R clutch oil pressure

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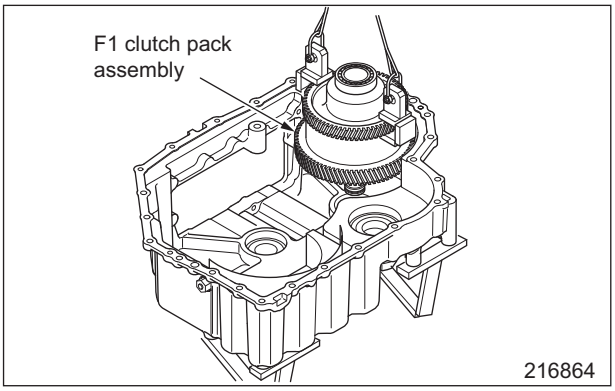
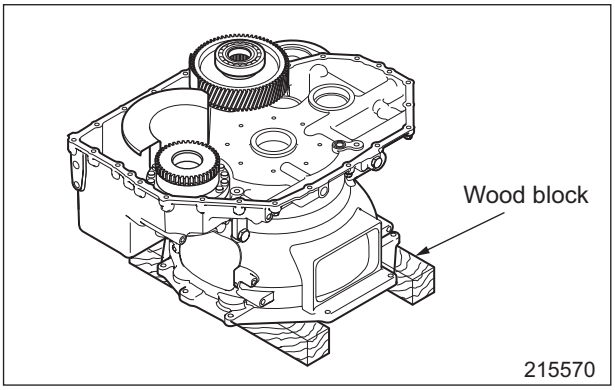
(13)Attach the lifting hooks and slings to the F1 clutch pack assembly. Slightly lift the assembly, and tap along the side shaft of the assembly with a plastic hammer to loosen the assembly.

(14)Remove the F1 clutch pack assembly.



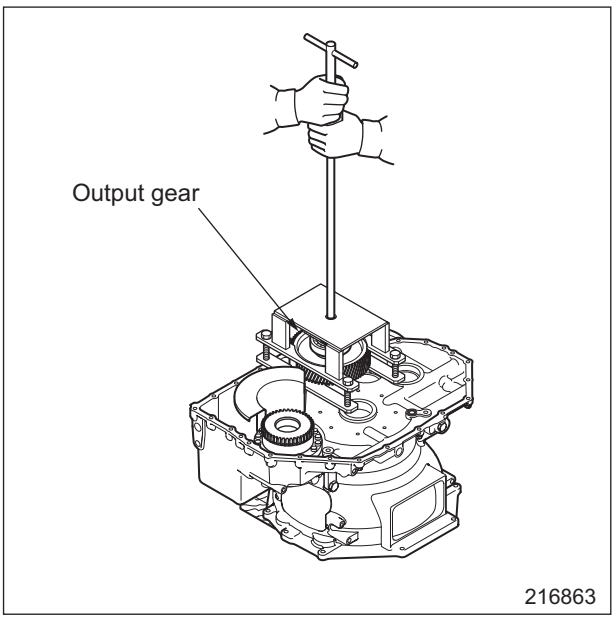
(15)Lift the torque converter housing and orient the transmission housing mating surface upward.

(16)Securely, lay the torque converter housing on wood blocks.



(17)Remove the output gear using the special tools (Puller 91K67-01200 and Plate 91K67-01300).

Part name	Part number
Puller	91K67-01200
Plate	91K67-01300

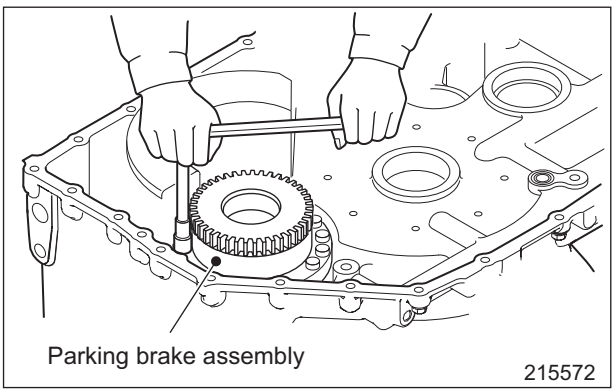


(18)Remove the ten parking brake assembly mounting bolts.

Part name	Part number
Bolt	91K24-03900 (M8×1.25 L=70)

Note: Do not remove the four black hexagon socket head bolts, as they are used for the parking brake assembly.

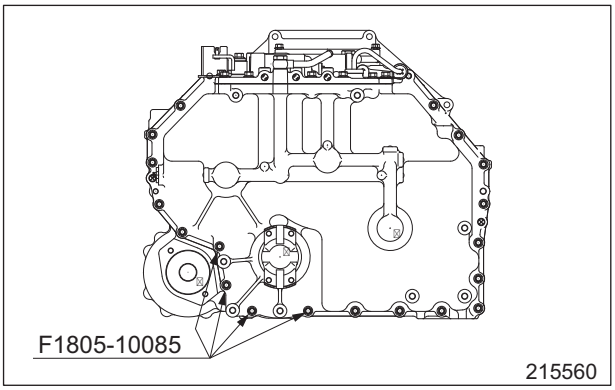
(19)Remove the parking brake assembly.



(23)Tighten the mounting bolts to the specified torque.

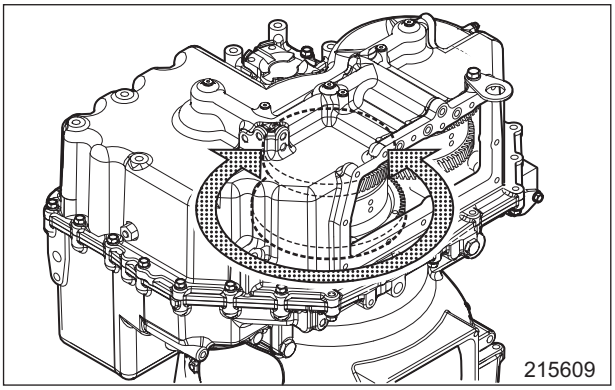
Unit: N·m (kgf·m) [lbf·ft]

Part number	Qty	Tightening torque
F1805-10085	4	33.3 ± 3.3 (3.40 ± 0.34) [24.56 ± 2.43]
F1805-10035	20	33.3 ± 3.3 (3.40 ± 0.34) [24.56 ± 2.43]



(24)After assembly, check the R1 clutch pack assembly for proper gear engagement and smooth rotation by turning the R1 clutch pack assembly by hand.

Note: Clutch gears that are meshed with the output gears will not turn unless the parking brake switch is released. Activation of the parking brake switch prevents the gears from turning.



(25)Refilling transmission with oil

(a) After the transmission is installed in the truck and the engine is ready to be started, be sure to refill the transmission oil.

(b) Use a level gauge to check oil level.

(c) Run the engine at idling speed, then stop the engine.

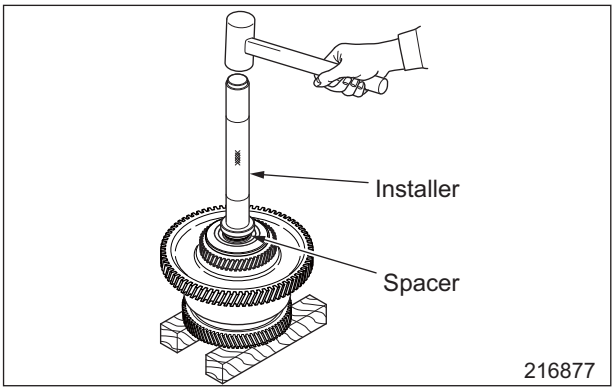
(d) Wait for 1 minute or more after stopping the engine, and check the oil level.

(e) The checking procedure must be completed within 3 minutes after the engine has stopped.

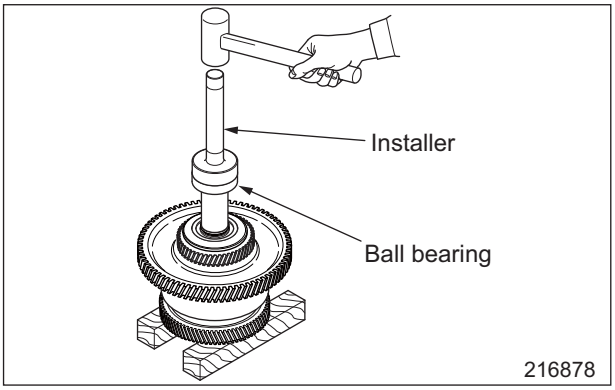
Note: Be sure to stop the engine before checking.

(17)Install the spacer using the installer (special tool, 91K67-02100).

(18)Insert the spacer into the shaft.

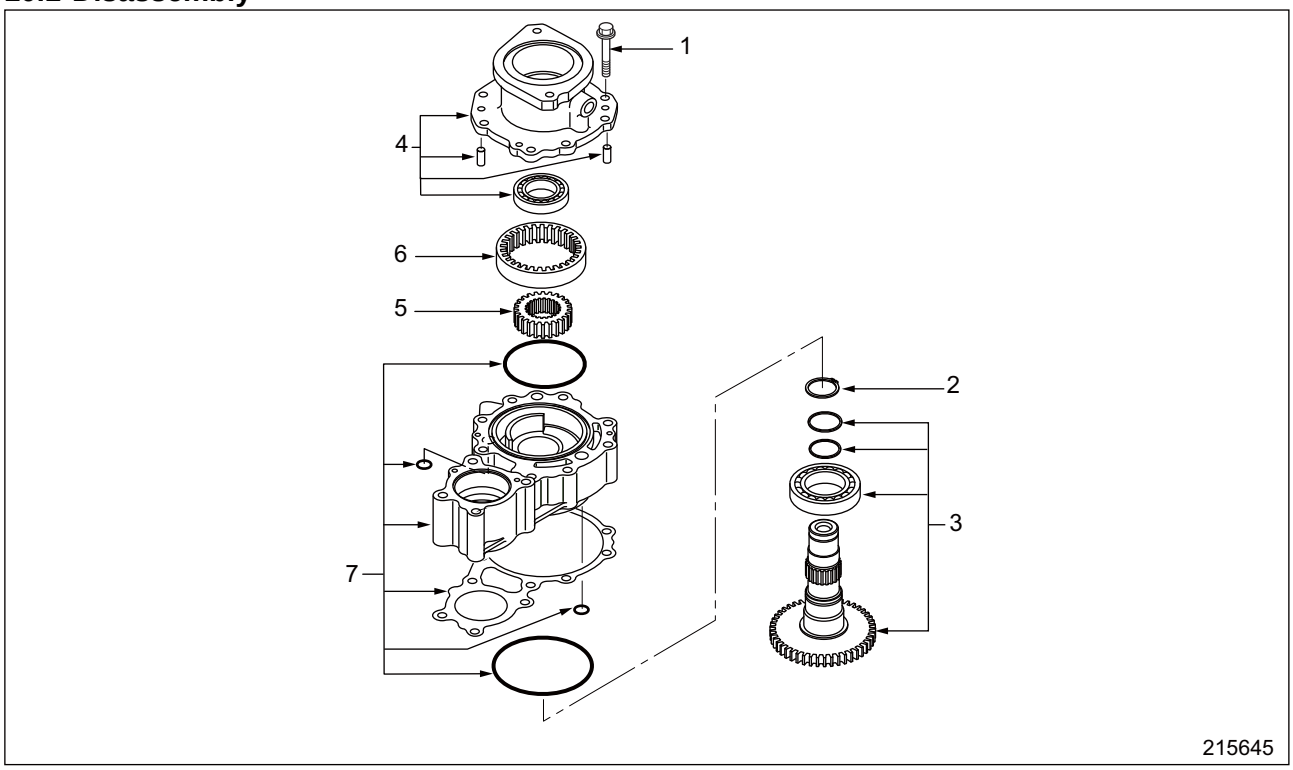


(19)Evenly hammer the ball bearing into the shaft.



10.Gear Pump Assembly

10.1 Disassembly

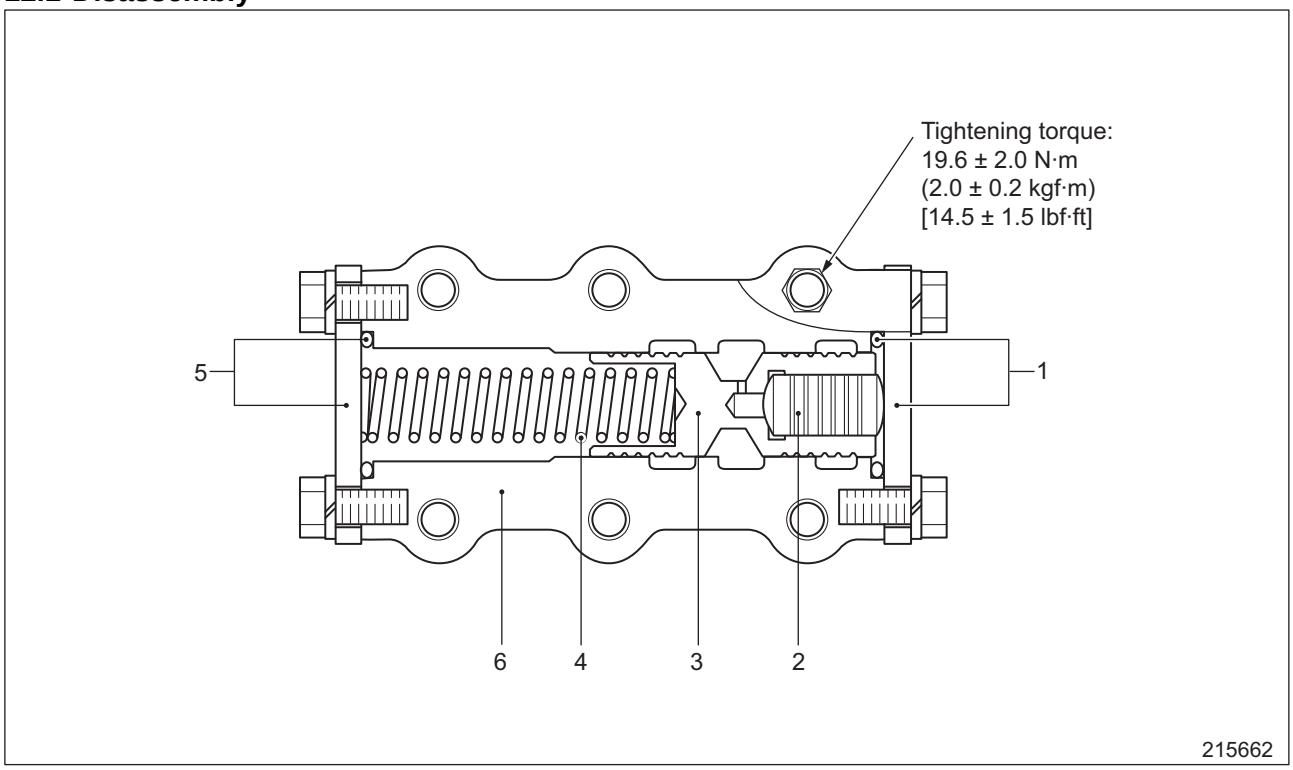


Disassembly sequence

1 Bolt
2 Snap ring
3 PTO driven gear, Ball bearing, Seal ring
4 Gear pump cover, Ball bearing, Pin
5 Oil pump drive gear
6 Internal gear
7 Gear pump case, O-ring, Gasket

12.Main Regulator Valve

12.1 Disassembly



Disassembly sequence

1 Cover, O-ring
2 Slug
3 Main relief valve
4 Spring
5 Cover, O-ring
6 Valve body

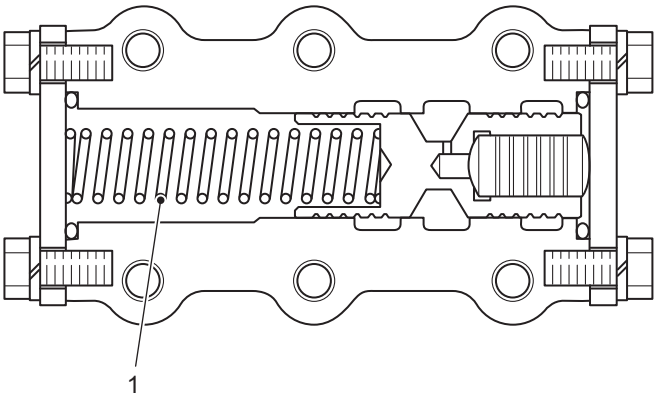
Suggestions for Disassembly

When removing the cover 1, slowly unscrew the bolts from the cover to prevent the spring, inside, from popping out.

Condition		Possible cause	Action
Stall speed not within specifications		Lack of engine power when the speed is slightly low in both forward and reverse drive.	Tune up engine
		Stator and freewheel is damaged when the speed is excessively low in both forward and reverse drive.	Replace stator assembly.
		Inching pedal linkage defective, or clutch slipping when the speed is too high.	Repair or replace
Brake does not work	Parking brake	Parking brake assembly is damaged.	Replace
		Oil line is clogged.	Disassemble the parking brake valve for inspection after bleeding oil out of the emergency relief port of the parking brake valve.
Brake can not be released.		Oil line pressure is low.	Measure and adjust oil pressure of the main relief valve and the reducing valve.
		Solenoid valve spool is defective.	Replace
		Parking brake assembly is damaged.	Replace
		Electrical wiring is damaged.	Check wirings for continuity.

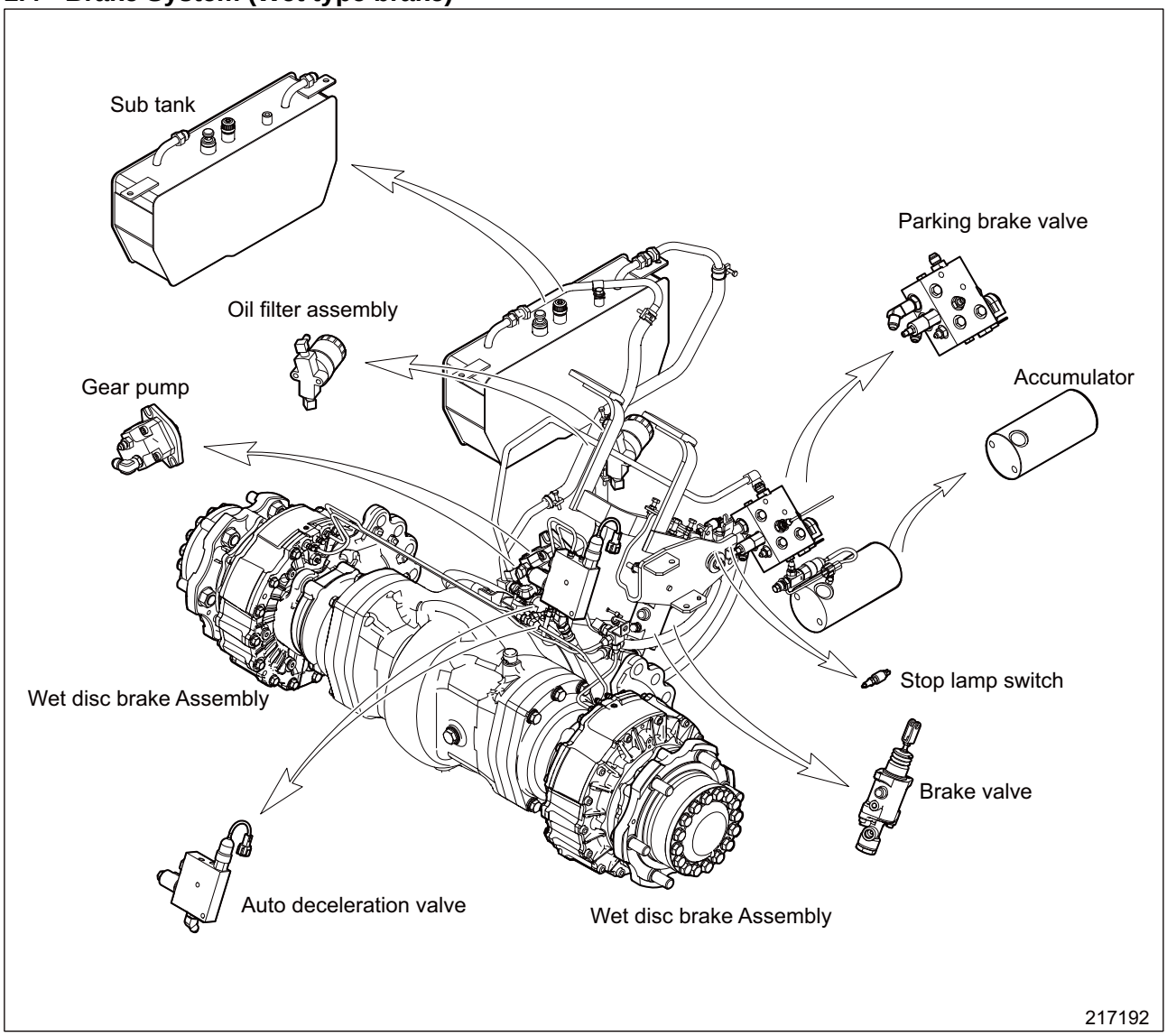
Note: For emergency parking brake release, refer to "3.7 Parking Brake Emergency Release" of "Chapter 9 Brake System."

Unit: mm (in.)

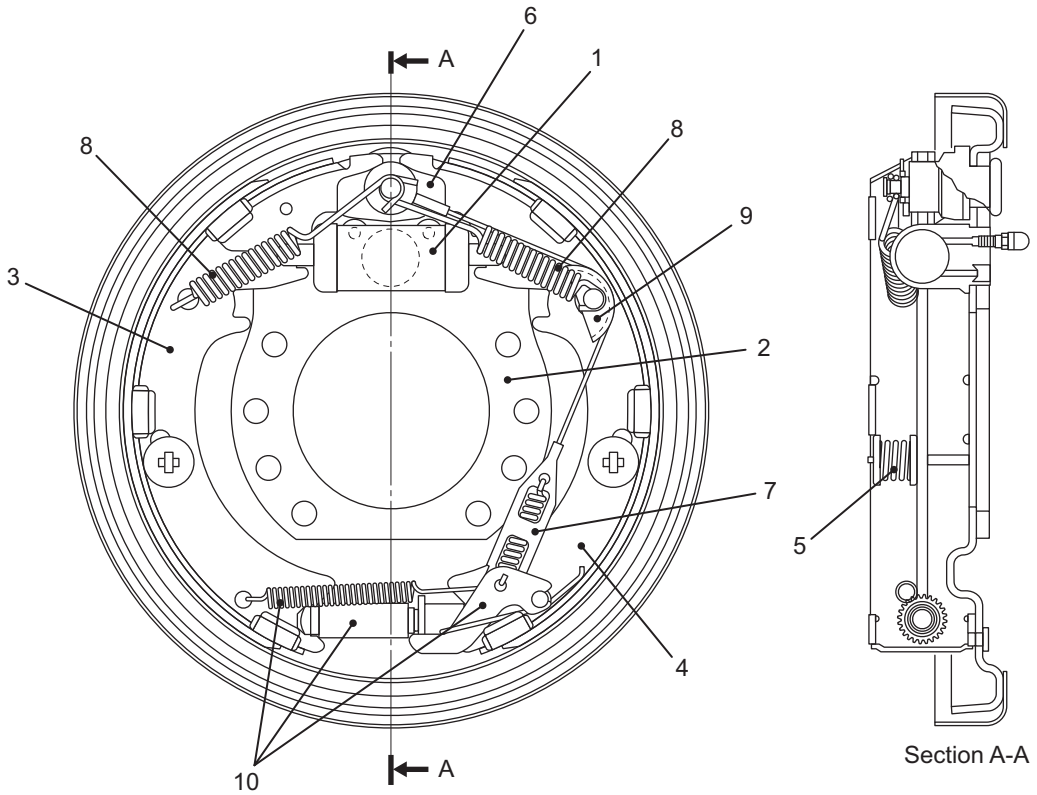
Item				Specified value
Main regulator valve	Valve spring 1	Free length	A	107 ± 3.5 (4.22 ± 0.14)
			B	102 (4.02)
		Height/under load	A	74.9 (2.95) / 160 ± 13N (16.3 ± 1.3 kgf) [36.0 ± 2.9 lbf]
			B	74.9 (2.95) / 140N (14.3 kgf) [31.5 lbf]
	 215592			

A: Standard value B: Repair or service limit

1.4 Brake System (Wet type brake)



2.1.3 Reassembly (4.0, 4.5 ton class)



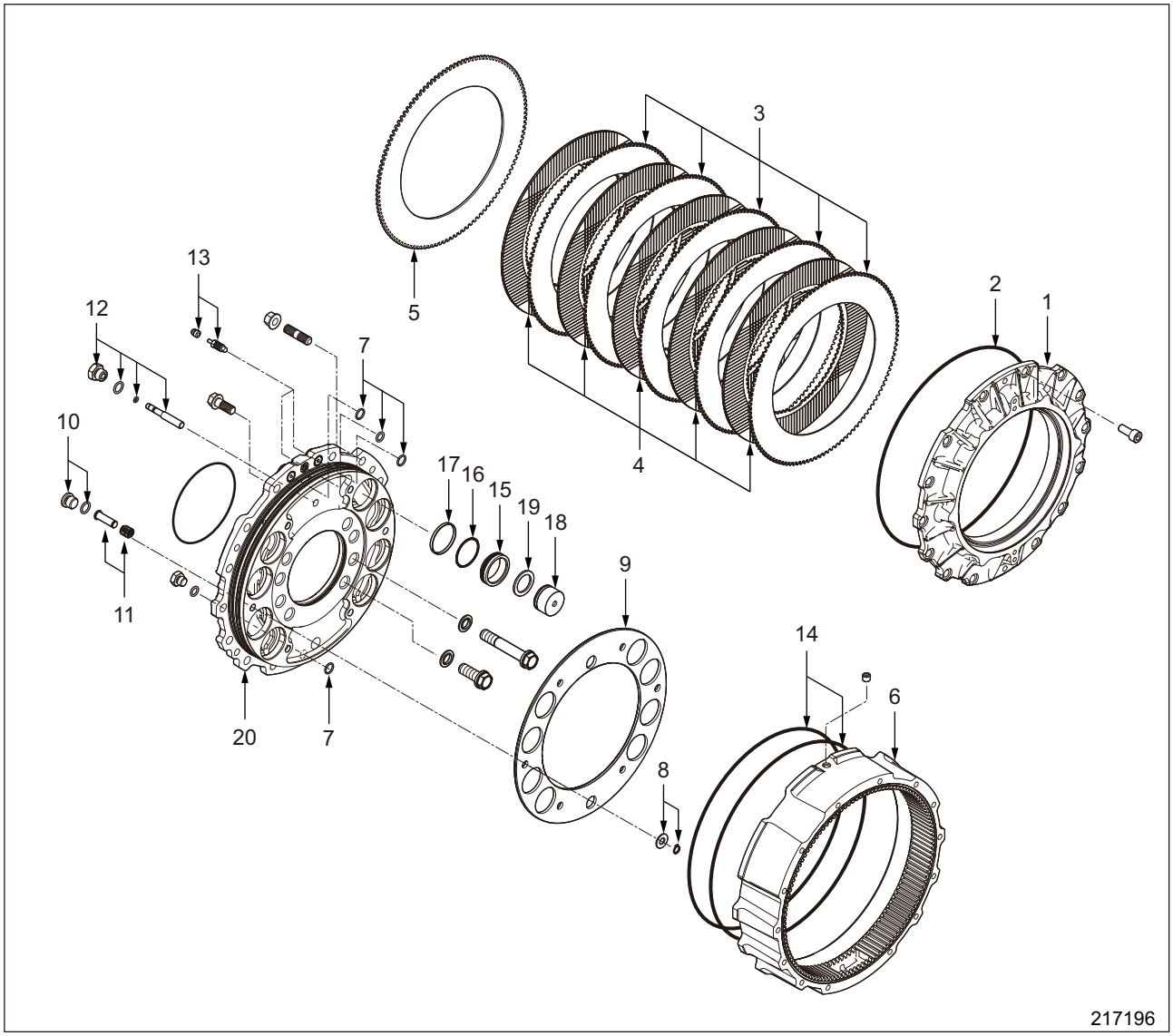
Reassembly sequence

1 Wheel cylinder
2 Backing plate assembly
3 Shoe and lining assembly (primary)
4 Shoe and lining assembly (secondary)
5 Hold-down spring, Cup, Pin
6 Shoe guide plate
7 Fitting cable
8 Return spring
9 Cable guide, Sheave, Pin, Washer
10 Adjusting lever, Adjusting screw, Adjusting spring

Note: The illustration shows a left-hand wheel brake.

2.4 Wet Disc Brake Assembly

2.4.1 Disassembly



Disassembly sequence

1 Brake cover
2 O-ring
3 Mating plate
4 Friction plate
5 End plate
6 Brake housing
7 O-ring
8 Snap ring, Plain washer
9 Return plate
10 Plug, O-ring
11 Spring guide, Return spring
12 Gauge plug, O-ring, Gauge rod, O-ring
13 Breeder screw, Cap
14 O-ring
15 Piston ring
16 Ring seal
17 O-ring
18 Brake piston
19 Piston seal
20 Piston housing

Note: The illustration shows a left-hand wet disc brake assembly.

Preparation

(1) Remove a front wheel.

Note: Refer to "chapter 7 FRONT AXLE AND REDUCTION DIFFERENTIAL".

(2) Place a container, then remove a brake pipe and cooler return hose from a wet disc brake assembly.

(3) Remove a wheel hub and wet disc brake assembly.

Note: For disassembling inspection, and assembling of a wheel hub and wet disc brake assembly, refer to "Chapter 7 FRONT AXLE AND REDUCTION DIFFERENTIAL".

3.9 Oil Pressure Measurement (Wet type brake)

(1) Block the rear wheels.

(2) Attach a hydraulic pressure gauge to the specific port of the parking brake valve.

(3) Use the hydraulic pressure measuring tool in the table shown below.

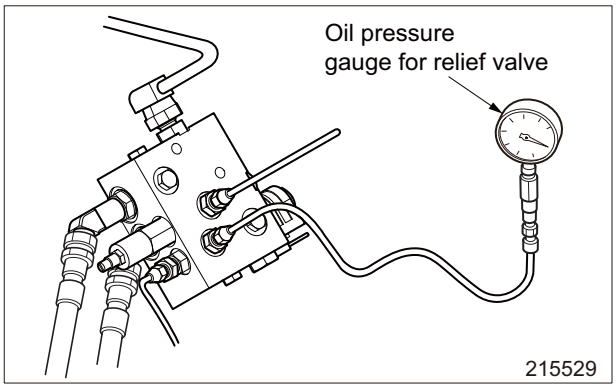
Relief valve	G1/8

(4) Oil Pressure Measurement
Start the engine and set all the levers in the neutral position, pull the parking brake switch, measure the oil pressure required to open the valve using a oil pressure gauge.

Unit: Mpa (kgf/cm^2) [psi]

Engine speed	Low idling
Oil pressure	7.0 (71.38) [1015.37]

(5) If the hydraulic pressure at the relief valve is different from the standard value, stop the engine, loosen the lock nut of the relief valve, then turn the screw with a screwdriver to tighten the lock nut.
Start the engine again and measure the hydraulic pressure.
When the hydraulic pressure reaches the standard value, firmly tighten the lock nut.



System	Check items	Pre-start (daily/10 hours)	Weekly (50 hours)	1st month (200 hrs) only	3 months (500 hours)	6 months (1000 hours)	12 months (2000 hours)	Others (See Note 1)
Electrical	Alternator			×		×		
	Battery electrolyte level	×						
	Battery electrolyte specific gravity (Not required if battery type is maintenance free)				×			
	Battery terminal loosen & damage	×						
	Driving interlock system	×						
	Electrical wire	×						
	Horn	×						
	Instrument panel lamps (Incl. parking brake switch & seat belt)	×						
	Mast interlock system	×						
	Parking brake buzzer & lamp	×						
	Starter			×		×		
	Voltage, current, other electrical system						×	
	Back-up lamp	×						
	Stop lamps, turn-signal lamps	×						
	Working & head lamps	×						
	Warning devices, lamps, and instruments						×	
Engine	Cylinder head bolt & manifold nut			×		×		
	Engine (Exhaust, noise, and vibration)	×						
	Engine idle speed (Diesel engine)				×			
	Engine idle speed (Gasoline / LP-Gas engine)						×	
	Engine oil (Dirt & level)	×						
	Intake & exhaust valve clearance			×	×			
	Positive crankcase ventilation valves & hoses				×			
	Engine oil (Diesel model)			R	R			
	Engine oil (Gasoline model)			R	R			
	Engine oil filter			R	R			
	Compressing & injection pressure						×	
	Exhaust pipe & muffler				×			
	Water separator (Diesel engine)					×		
	Water separator element (Diesel engine)					R		
Frame & Chassis	Assist grips	×						
	Loosen bolts & nuts			×	×			
	Overhead guard	×						
	Seat adjustment	×						
	Seat belt	×						
	Rear view mirror	×						

X: Check, C: Clean, L: Lubricate, R: Replace

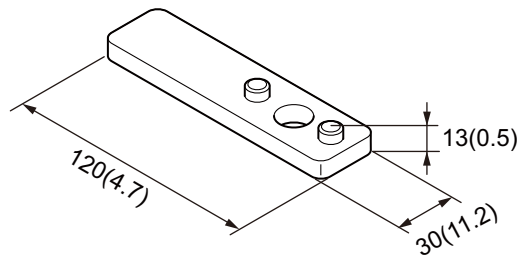
4.3 Adjustment Value and Oil Quantities

Note: The values in the table below are for the standard model.

Unit:mm (in.)

Item				Truck model				
				GP40N1	GP45N1	GP50CN1	GP50N1	GP55N1
Alternator drive belt deflection-when pushed inward with 98 N (10 kgf) [22 lbf] pressure				11 to 13 (0.43 to 0.51)				
Spark plug type				BPR4E				
Spark plug gap				0.8 to 0.9 (0.0315 to 0.0354)				
Engine idling speed			(min^{-1})	650 to 700				
Steering wheel free play-when measured at rim with engine idling				15 to 30 (0.59 to 1.18)				
Inching pedal free play				3 to 6 (0.12 to 0.24)				
Brake pedal free play				5 (0.20)				
Tire size	Front tire	Single		8.25-15-14PR (1)	300-15-18PR (1)			
		Double		7.50-16-12PR (1)				
	Rear tire			7.00-12-12PR (1)				7.00-12-14PR (1)
Tire pressure	Front tire	Single	kPa(kgf/cm^2)[psi]	800(8.2)[116.0]				
		Double	kPa(kgf/cm^2)[psi]	700(7.1)[101.5]				
	Rear tire		kPa(kgf/cm^2)[psi]	700 (7.1) [101.5]		850 (8.7) [123.3]		1000 (10.2) [145.1]
Wheel nuts tightening torque	Front tire		N·m(kgf·m)[lbf·ft]	600±60 (61.18±6.12) [442.54±44.25]				
	Rear tire		N·m(kgf·m)[lbf·ft]	377.3 (38.47) [278.45]				
Lift chain elongation limit			mm/20 links	518 (20.39)	648 (25.51)			
Fuel tank capacity			liter (cu.in.)	87 (5309)	105 (6407)			
Engine cooling system -0.65 liter (0.17 cu.in.) reservoir tank included			liter (cu.in.)	16 (976.4)				
Engine oil	Engine		liter (cu.in.)	8.3 (506.5)				
	Oil filter		liter (cu.in.)	0.3 (18.3)				
	Total		liter (cu.in.)	8.6 (524.8)				
Transmission oil			liter (cu.in.)	17 (1037.4)				
Transfer and differential gear oil level			liter (cu.in.)	7.9 (482.1)				
Hydraulic oil			liter (cu.in.)	72 (4394)		81 (4943)		
Battery electrolyte specific gravity, corrected to 20°C (68°F)				1.26 to 1.28				

Unit:mm(in.)



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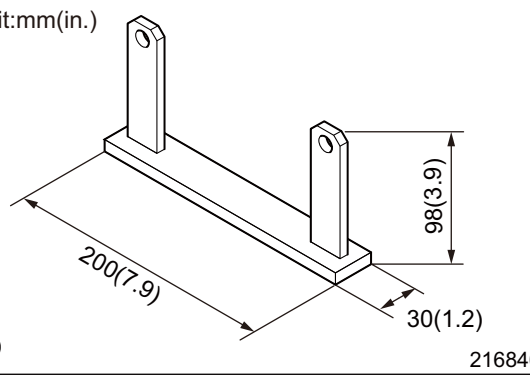
Unit:mm(in.)



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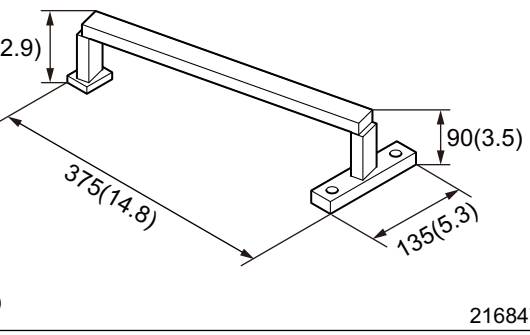

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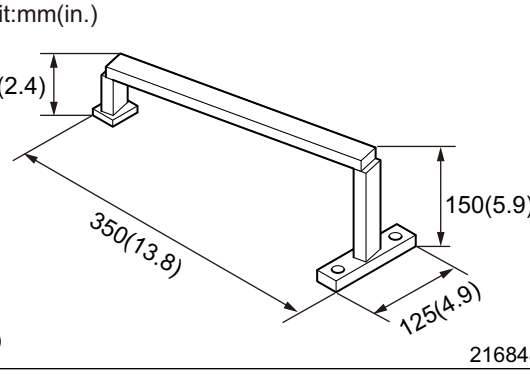

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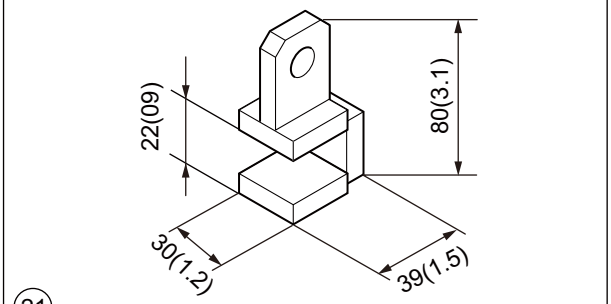

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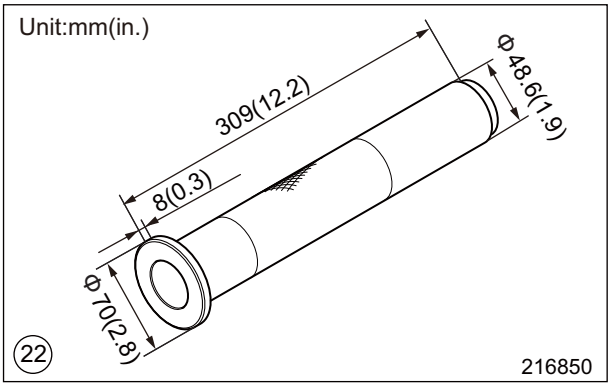

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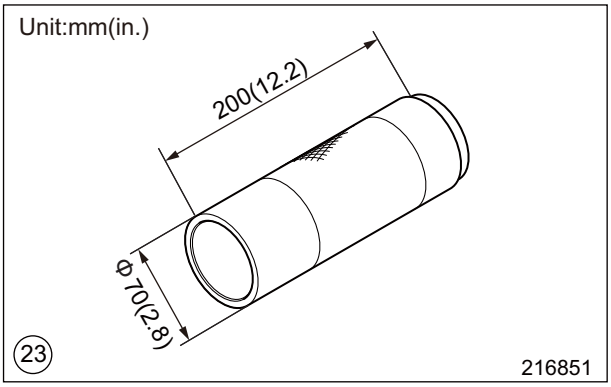

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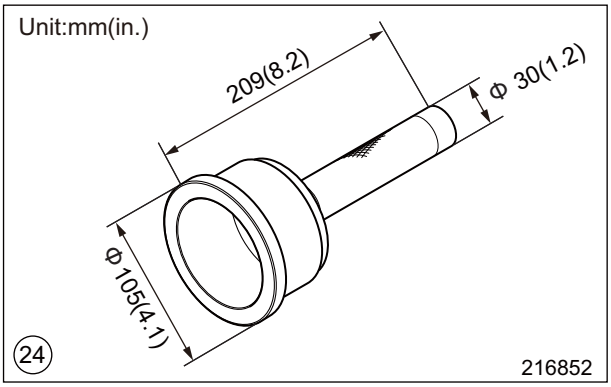

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How to use this manual

This service manual consists of several chapters, which are arranged so as to allow you to make reference quickly to specifications, maintenance standards, adjustment procedures and service procedures including methods for disassembly, inspection, repair and assembly of the Mitsubishi Diesel Engine (standard model for land use).

A short summary describing the content of each chapter is given in the General Contents page, and there is also a detailed table of contents at the beginning of each chapter.

Regarding the procedures for operation and periodical maintenance of the engine, refer to the Operation and Maintenance Manual. For information on the engine components and ordering of service parts, refer to the Parts Catalogue. Structure and function of the engine are described in the relevant training manuals.

Methods of presentation

(1) Index numbers allotted to parts in exploded views are not only a call-out of part names listed in the text but also an indication of the sequence of disassembly.

(2) Inspections to be conducted during disassembly process are indicated in boxes in the relevant exploded views.

(3) Maintenance standards required for inspection and repair works are indicated in the appropriate positions in the text. They are also collectively indicated in Group 2, the General Contents group.

(4) Fasteners to be tightened in “wet” condition, or with engine oil applied, are identified by [Wet] placed after tightening torque values. If no such indication is suffixed, the fastener should be tightened in “dry” condition, or without lubricating with engine oil.

(5) In this manual, important safety or other cautionary instructions are emphasized with the following marks headed.

DANGER	Indicates an immediately hazardous situation which, if not avoided, will result in death or serious injury.
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 minor or moderate injury.
CAUTION	Indicates a potentially hazardous situation which, if not avoided, can result in property damage.
Note	Emphasizes important matter, or indicates information useful for operation or maintenance of the engine.

Tips on disassembling and assembling

This service manual specifies the recommended procedures to be followed when servicing Mitsubishi engines. The manual also specifies the special tools that are required for the work, and the basic safety precautions to follow when working. Note that this manual does not exhaustively cover potential hazards that could occur during maintenance, inspection and service work of engine.

When working on an engine, follow the relevant directions given in this manual and observe the following instructions:

Tips on disassembling

- Use correct tools and instruments. Serious damage to the engine can result from using the wrong tools and instruments.
- Do not use jack bolts with sharp edges, as they may cause damage to the surface.
- Use an overhaul stand or work bench if necessary, and follow the disassembling procedures described in this manual. Do not place the engine parts on the floor directly. Place them on the work bench.
- Keep the engine parts in their order of removal to prevent losing them.
- If the engine parts are reused, install them to the original position unless there are any specific purpose.

  Pay attention to assembling marks. Put your marks on the parts, if necessary, to ensure correct assembling. Carefully check each part for defects during disassembling or cleaning. Do not miss symptoms which can not be detected after disassembling or cleaning. When lifting or carrying heavy parts, exercise utmost caution to ensure safety. Pay attention to the balancing of heavy parts when handling. (Get help, and use jacks, chain blocks and guide bolts as necessary.)

Tips on assembling

- Wash all engine parts, except such parts as oil seals, O-rings and rubber seats, in cleaning oil and dry them with compressed air. Use correct tools and instruments. Use only high-quality lubricating oils and greases of appropriate types. Be sure to apply oil, grease or adhesive to the part wherever specified. Use a torque wrench to tighten parts correctly when their tightening torques are specified. Refer to “Tightening torque table.” Replace all gaskets, packings and O-rings with new ones unless specified otherwise. Apply adhesive if necessary. Use only the proper amount of adhesive.

Main specifications

Engine model				S6S-E35AFL	S6S-E35BFL	S6S-E35CFL
Cooling system	Cooling method			Water-cooled, forced circulation		
	Coolant capacity (engine water jacket)			8 L [2.1 U.S.gal.]		
	Water pump	Type		Centrifugal		
		Speed ratio to crankshaft		1.2		
		Discharge rate		160 L [42.27 U.S. gal.]/min (at pump rotation of 3600 min^{-1}, 0.075 MPa {0.75 kgf/cm^2} [11 psi])		
	Cooling fan	Type		Push type (PP fan)		
		Outside diameter		ø400 mm [15.7 in.]		
	Thermostat	Type		Wax type		
		Valve opening temperature		76.5 ± 2°C [169.7 ± 35.6°F] (90°C [194.0°F] when fully opened)		
Electrical system	Voltage			12 V		
	Polarity			Negative (-) ground		
	Starter	Model number		M008T55472		
		Pinion meshing type		Pinion shift		
		Output		12 V, 3.0 kW		
		No. of pinion tooth/ring gear tooth		10/122		
	Alternator	Model number		A007TA0483A	A005TA5083A	A002TA7871
		Type		3-phase alternating current, with rectifier		
		Output		12 V, 50 A	12 V, 75 A	12 V, 25 A
		Speed in use		1000 to 18000 min^{-1}	1000 to 18000 min^{-1}	to 8000 min^{-1}
		Rated speed		5000 min^{-1}		
		Permissible speed		22000 min^{-1}	22000 min^{-1}	10000 min^{-1}
		Speed ratio to crankshaft		1.85		
	Glow plug	Type		Sheathed		
		Rated voltage		10.5 V		
		Current		9.7 A (When applying rated voltage for 30 sec.) x 6		
	Magnetic valve (Stop solenoid)	ETR type (RUN-ON)	Rated voltage	12 V		
			Power consumption	14 W		
			Starting voltage	6.3 V or below		
			Return voltage	2.5 V or more		
			Coil resistance	8 Ω		

2.3 Lubrication system

Description	Thread Dia. × Pitch (M-thread)	Torque			Remarks
		N·m	kgf·m	lbf·ft	
Oil pan	8 × 1.25	11.5 ± 1.5	1.2 ± 0.1	8.3 ± 1.1	
Oil pan drain plug	20 × 1.5	78 ± 5	8 ± 0.5	57 ± 3.7	
Oil pump gear	10 × 1.25	33 ± 5	3.4 ± 0.5	24 ± 3.7	
Relief valve	22 × 1.5	49 ± 4.9	5 ± 0.5	36 ± 3.7	
Relief valve plug	18 × 1.5	44 ± 4.9	4.5 ± 0.5	32.5 ± 3.6	

2.4 Cooling system

Description	Thread Dia. × Pitch (M-thread)	Torque			Remarks
		N·m	kgf·m	lbf·ft	
Thermostat case	8 × 1.25	18.5 ± 1.5	1.9 ± 0.1	13.6 ± 1.1	
Water drain plug	1/4-18NPSF	39.2 ± 3.9	4 ± 0.3	28.9 ± 2.8	
Water pump mounting bolt (tightening with water pump case cover)	8 × 1.25	9.8 ± 1	1 ± 0.1	7.2 ± 0.7	
Water pump mounting bolt (tightening with crankcase)	8 × 1.25	18.2 ± 3.4	1.9 ± 0.3	13.4 ± 2.5	
Water pump plug	R3/8	31.9 ± 2.4	3.3 ± 0.2	23.5 ± 1.8	

2.5 Inlet and exhaust system

Description	Thread Dia. × Pitch (M-thread)	Torque			Remarks
		N·m	kgf·m	lbf·ft	
Exhaust manifold (bolt only)	8 × 1.25	18.5 ± 3.5	1.9 ± 0.3	13.6 ± 2.5	

2.6 Electrical system

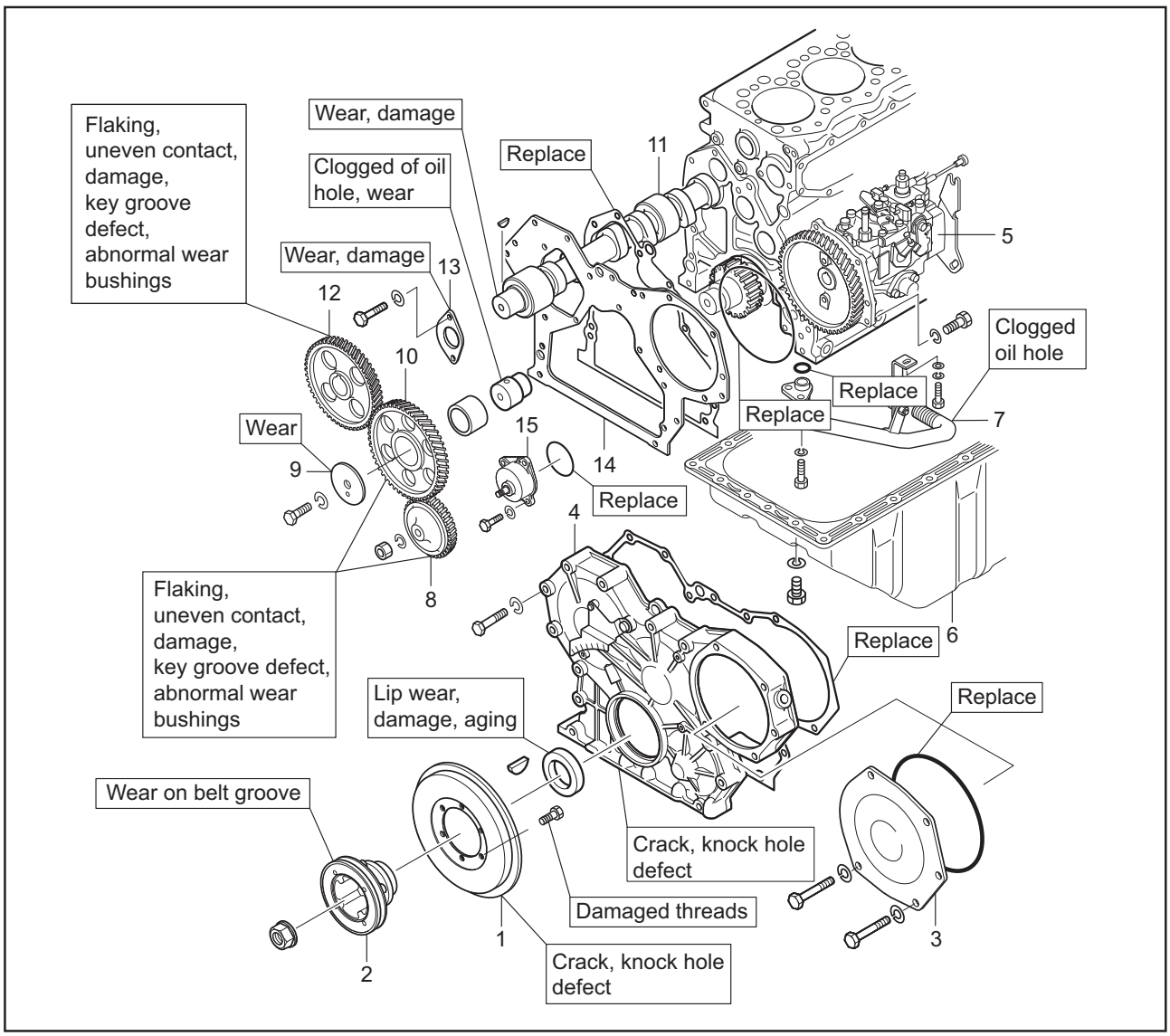
Description	Thread Dia. × Pitch (M-thread)	Torque			Remarks
		N·m	kgf·m	lbf·ft	
Starter terminal B	8 × 1.25	9.8^{+2}_{0}	$1^{+0.2}_{0}$	$7^{+1.5}_{0}$	
Starter mounting nut	10 × 1.25	45 ±15	4.6 ± 1.5	33.2 ± 11	
Glow plug (main)	10 × 1.25	25 ± 5	2.5 ± 0.5	18 ± 3.6	
Glow plug (terminal)	4 × 0.7	1.3 ± 0.2	0.13 ± 0.02	0.96 ± 0.22	

3. Front equipment - Disassemble and Inspect

Understanding the current condition of the engine before disassembling is very important in order to investigate the faulty part of the engine and to maintain the engine efficiently.

Depending on the maintenance purpose, inspect the following items before disassembling the engine.

- Damper face and radial runouts - Measure
- Timing gear backlash - Measure
- Idler gear and camshaft end play - Measure



Front equipment - Disassemble and Inspect

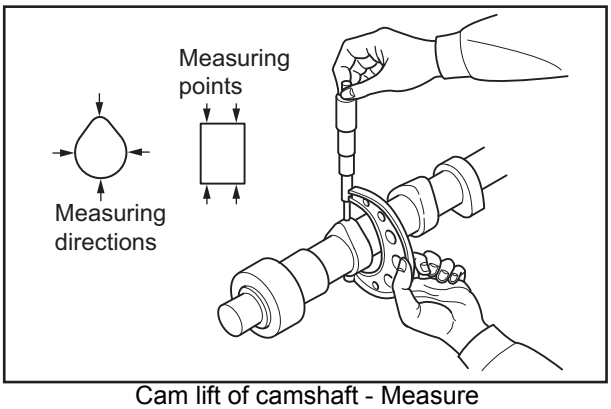
Disassembling sequence

1 Damper
2 Crankshaft pulley
3 Cover
4 Timing gear case
5 Fuel injection pump
6 Oil pan
7 Oil strainer
8 Oil pump gear
9 Thrust plate
10 Idler gear
11 Camshaft
12 Camshaft gear
13 Thrust plate
14 Front plate
15 Oil pump

3.4 Cam lift of camshaft - Measure

Measure the major axis and minor axis of cam to determine cam lift. If the measured value is less than the limit, replace the camshaft with a new one.

Item		Nominal	Standard	Limit
Cam lift of camshaft (major axis - minor axis)	Inlet	6.684 mm [0.2631 in.]	6.384 to 6.784 mm [0.2513 to 0.2671 in.]	6.184 mm [0.2435 in.]
	Exhaust	6.720 mm [0.2646 in.]	6.420 to 6.820 mm [0.2528 to 0.2685 in.]	6.220 mm [0.2449 in.]



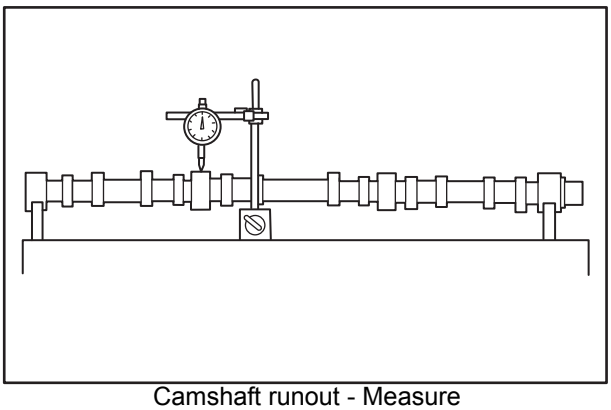
Cam lift of camshaft - Measure

3.5 Camshaft runout - Measure

Measure the camshaft runout. If the limit is exceeded, correct the camshaft using a press, or replace the camshaft with a new one.

Note: With a dial gauge set on the camshaft, rotate the camshaft one turn and read the gauge indication.

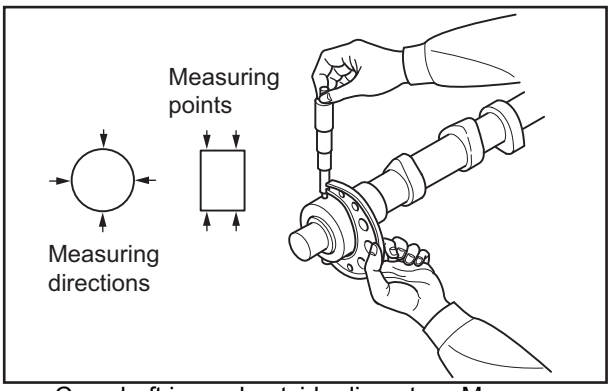
Item	Standard	Limit	Remarks
Camshaft runout	0.04 mm [0.0016 in.] or less	0.10 mm [0.0039 in.]	TIR


Camshaft runout - Measure

3.6 Camshaft journal outside diameter - Measure

Measure the diameter of each camshaft journal in two direction at right angles to each other. If the limit is exceeded, replace the camshaft with a new one.

Item		Nominal	Standard	Limit
Camshaft journal outside diameter	No.1, 2, 3 journal	φ 54	53.94 to 53.96 mm 2.1236 to 2.1244 in.]	53.90 mm [2.1220 in.]
	No.4 journal	φ 53	52.94 to 52.96 mm [2.0842 to 2.0850 in.]	52.90 mm [2.0827 in.]



Camshaft journal outside diameter - Measure

5.2 Crankcase top surface distortion - Measure

CAUTION

Refacing of crankcase should be kept to an absolute minimum.

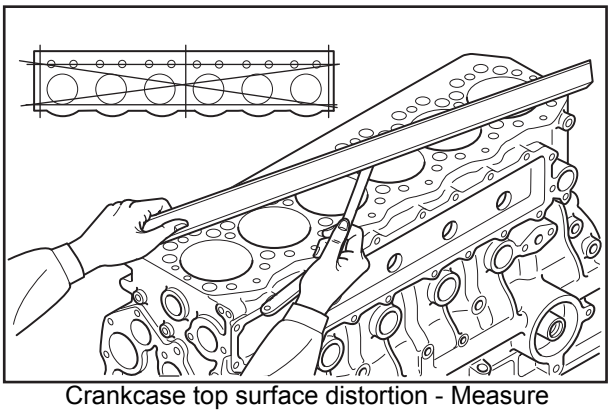
Excessive grinding of the crankcase may result in defects such as defective combustion and stamping (contact between piston and valve).

Apply a straight edge to the top surface of the crankcase and measure its distortion using a thickness gauge. If the distortion exceeds the limit, grind the cylinder head using a surface grinder.

Note: Do not overgrind the crankcase, as the piston protrusion deviates from the standard value.

Item	Standard	Limit
Crankcase top surface distortion	0.05 mm [0.0020 in.] or less	0.20 mm [0.0079 in.]

Note: Do not grind the surfaces more than 0.2 mm [0.0079 in.] in total (cylinder head bottom surface plus crankcase top surface).



Crankcase top surface distortion - Measure

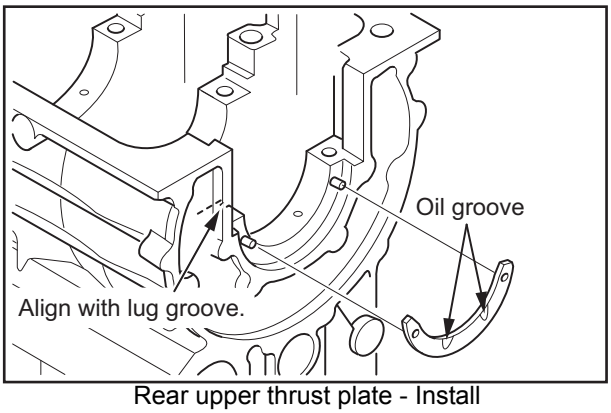
1.4 Rear upper thrust plate - Install

CAUTION

Do not damage the thrust plate when installing.

(1) Install the thrust plate to the dowel pin on the rearmost end of crankcase with facing the oil groove to the engine rear side.

(2) Apply engine oil evenly to the sliding surface.



Rear upper thrust plate - Install

1.5 Crankshaft - Install

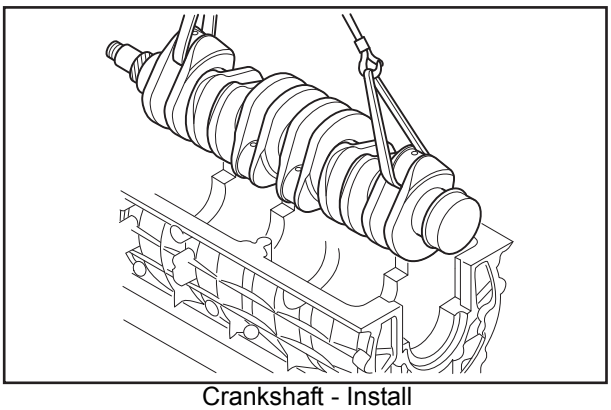
(1) Make sure that the upper main bearing shells that are installed in the crankcase bores have their inner periphery (the surface comes into contact with the journal) lubricated with an even coat of fresh engine oil.

(2) Wash the crankshaft thoroughly with cleaning oil and clean it completely by blowing compressed air. Then, apply an even coat of fresh engine oil to the crankshaft journals.

Note: When cleaning the crankshaft, pay special attention to the oil holes in the crank journals and crankpins. Make sure that oil holes are free from any burrs.

(3) Keeping the crankshaft in a horizontal position, slowly install into the crankcase.

Note: Do not attach a metal chain or other hoisting devices directly onto the crankshaft, as they could damage the crankshaft. Place cloth belts or pads in position where a chain or other hoists are hooked before raising crankshaft.



Crankshaft - Install

1.6 Lower main bearing and Lower thrust plate - Install

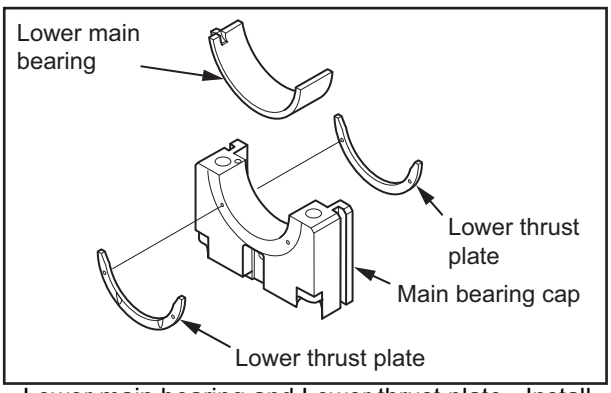
(1) Install the lower main bearing, aligning with the lug groove of the main bearing cap.

Note: Make a protrusion amount of bearings even.

(2) Apply an even coat of engine oil to the sliding surface of each lower main bearing.

(3) Install the lower thrust plate to the dowel pin on the rearmost main bearing cap.

Note: Install the lower thrust plate so that its oil groove faces outward.

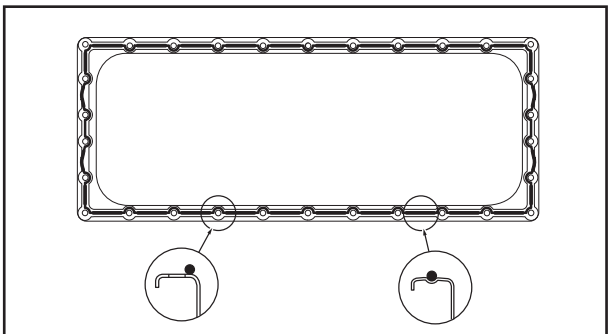


Lower main bearing and Lower thrust plate - Install

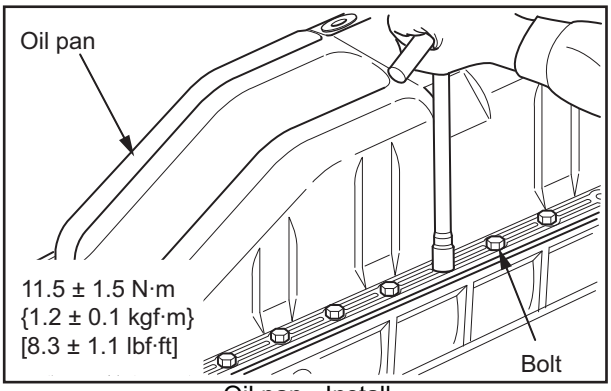
2.13 Oil pan - Install

(1) Clean the mount surfaces of the crankcase, timing gear case, and oil pan.
(2) Squeeze ThreeBond 1207C (32A91-051100: liquid gasket) in a 4 mm [0.16 in.] diameter bead all around the oil pan periphery, and spread it evenly.
(3) Install the oil pan to the crankcase within five minutes of applying the liquid gasket.
(4) Tighten the bolt with the specified torque.

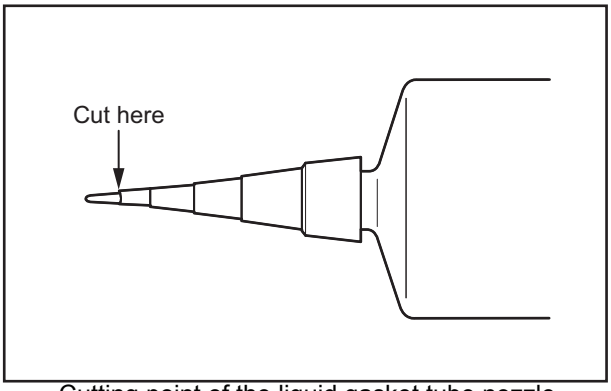
Note: Cutting the top of the sealant tube at the point shown in the illustration will provide a 4 mm [0.16 in.] bead.



Liquid gasket application position



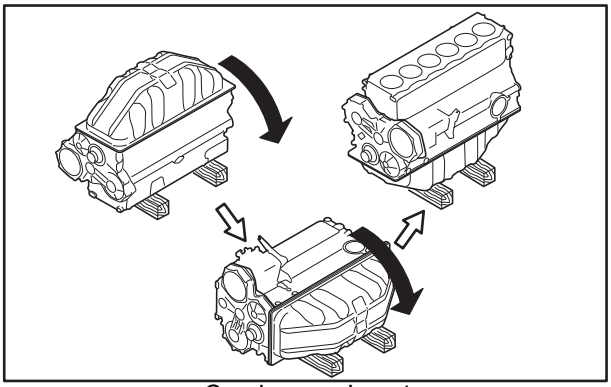
Oil pan - Install



Cutting point of the liquid gasket tube nozzle

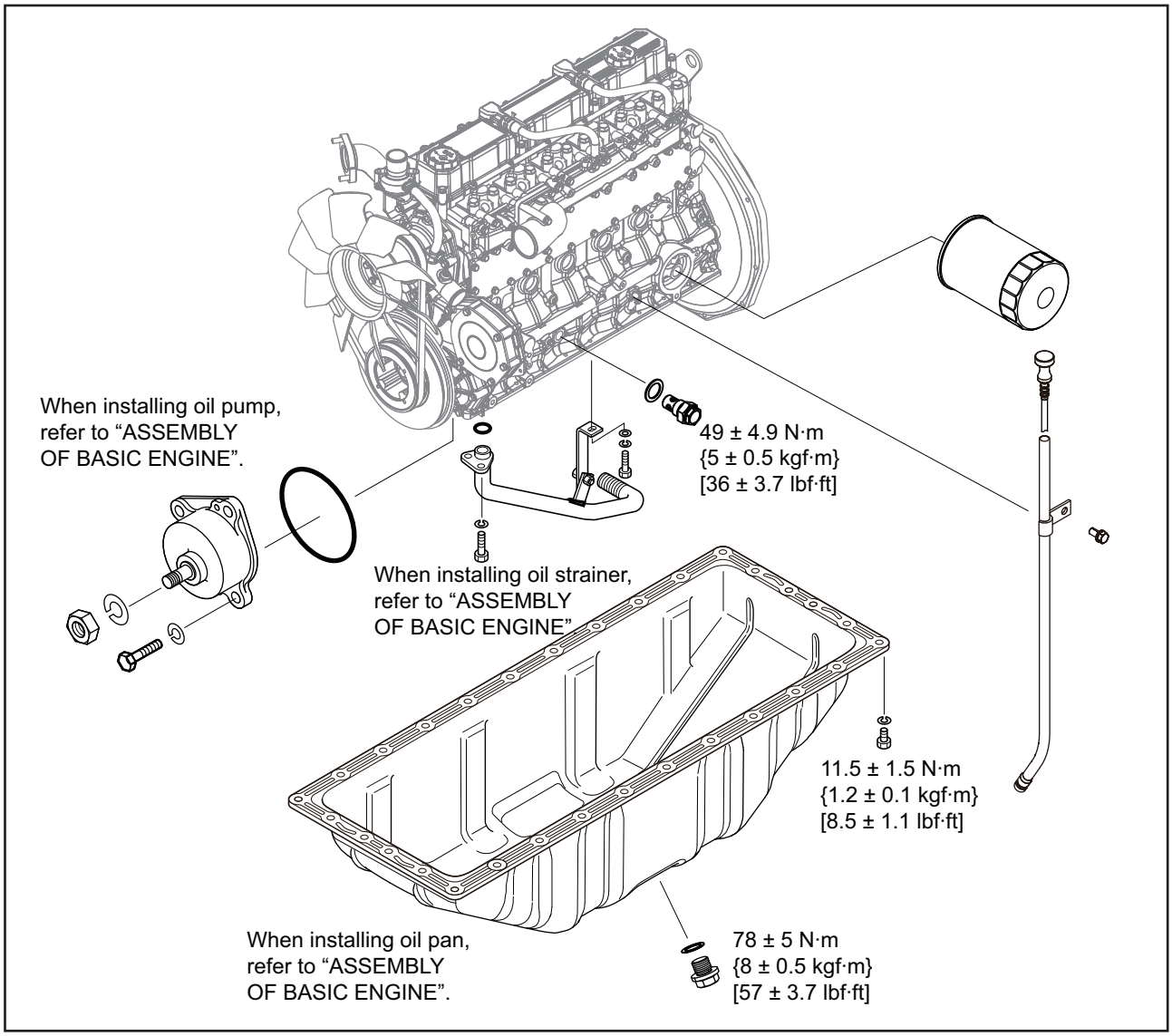
2.14 Crankcase - Invert

Using a chain block and tackle or similar tool, turn the crankcase to lay it on its side. Then, fasten wire ropes to the crankcase and turn to the original position.



Crankcase - Invert

3. Lubrication system - Install



Lubrication system - Install

2.1.2 Test at no load

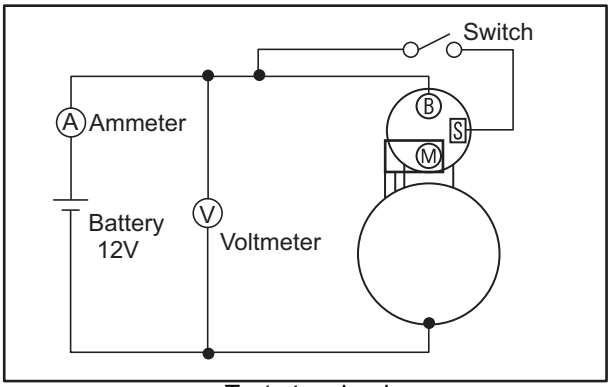
CAUTION

(a) Use a thick wire as possible and firmly tighten each terminal.

(b) Be careful that the pinion pops out during operation when measuring the rotation speed at the tip of the pinion.

(1) Connect the starter to the circuit as shown in the illustration.

(2) In normal condition, the pinion pops out when the switch is turned ON, and the starter rotates at more than the specified rotation speed. If the terminal voltage, current or rotation speed does not meet the standard, disassemble, inspect and repair the starter.

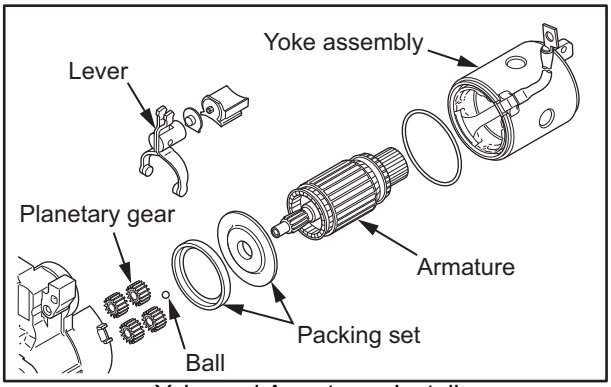


Test at no load

Item		Standard
Starter model number		M008T55472
Nominal output		12 V, 3.0 kW
Nonload characteristics	Terminal voltage	11 V
	Current	180 A or less
	Rotational speed	3800 min^{-1} or more

2.4.3 Yoke and Armature - Install

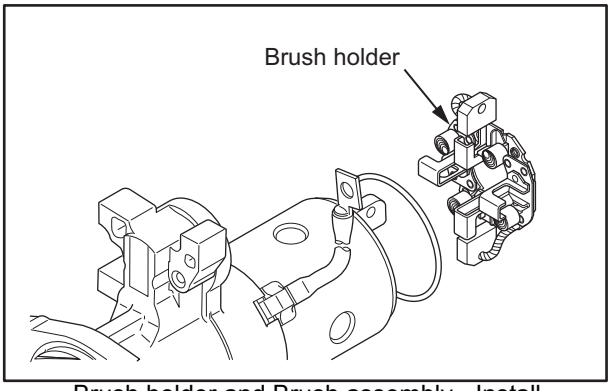
(1) Install the planetary gears on the gear shaft.
(2) Install the plate and packing.
(3) Install the yoke on the front bracket.
(4) Apply grease to the armature shaft end and install a ball on it.
(5) Install the armature.



Yoke and Armature - Install

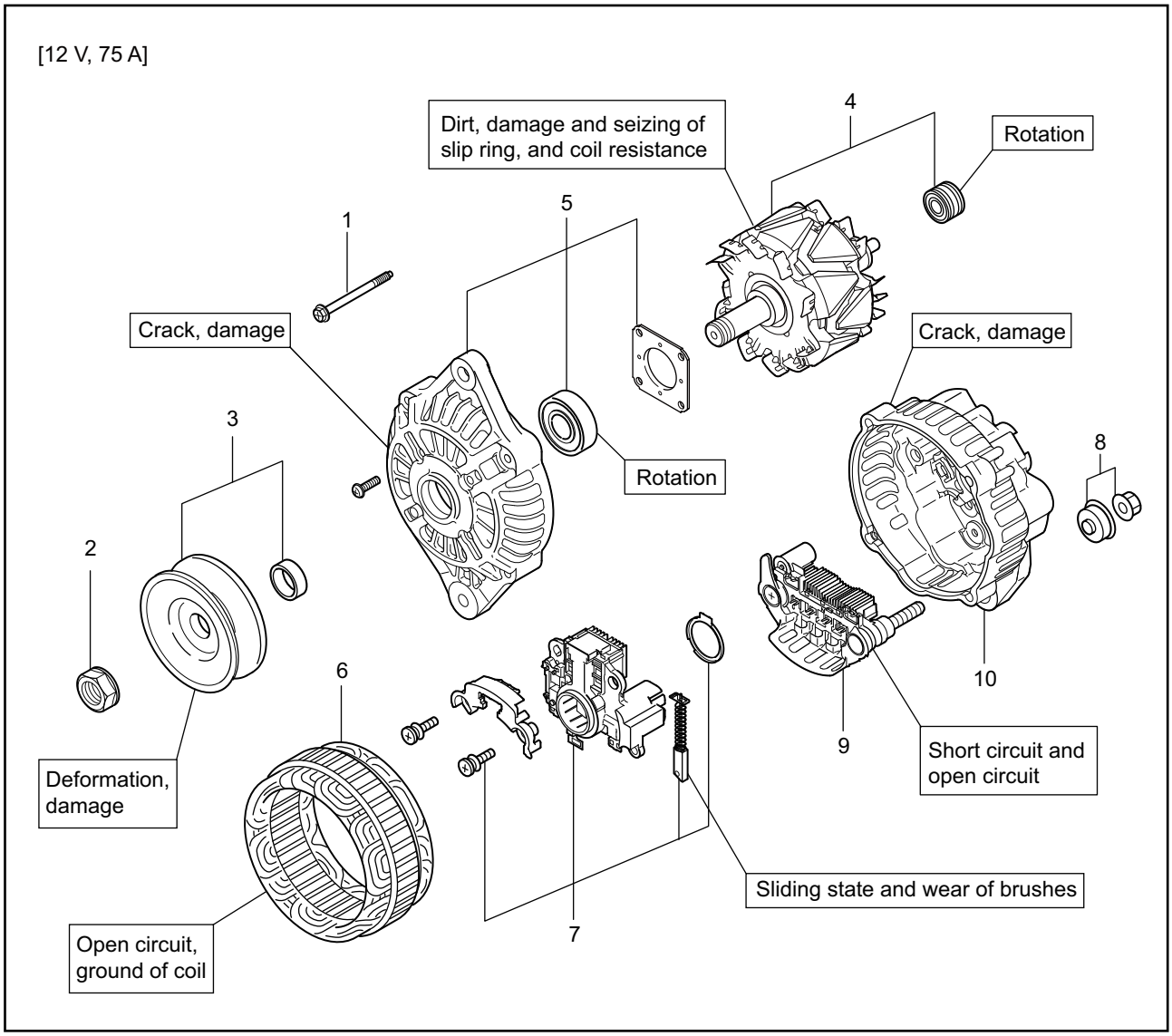
2.4.4 Brush holder and Brush assembly - Install

(1) Attach the socket to the commutator of the armature.
(2) While sliding the brushes on the socket, install the brush holder and brush assembly on the armature.



Brush holder and Brush assembly - Install

2.8 Alternator - Disassemble and Inspect (A005TA5083A)



Alternator - Disassemble and Inspect (A005TA5083A)

Disassembling sequence

1 Screw
2 Nut
3 Pulley assembly
4 Rotor assembly
5 Front bracket assembly
6 Stator
7 Regulator assembly
8 Nut set
9 Rectifier assembly
10 Rear bracket

2.11.1 Stator and Front bracket - Remove

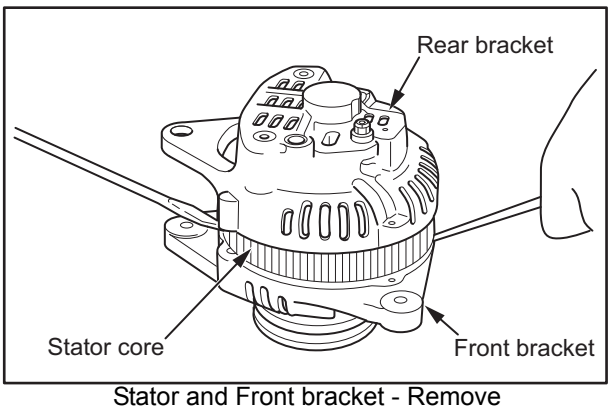
CAUTION

(a) Disassemble the alternator only when repair becomes necessary.

(b) Use care not to insert the screwdriver too deep, or its tip may damage the stator.

(1) Remove through bolts.

(2) Insert the tip of a flat-blade screwdriver between the stator and front bracket, and wrench them.



Stator and Front bracket - Remove

2.11.2 Pulley - Remove

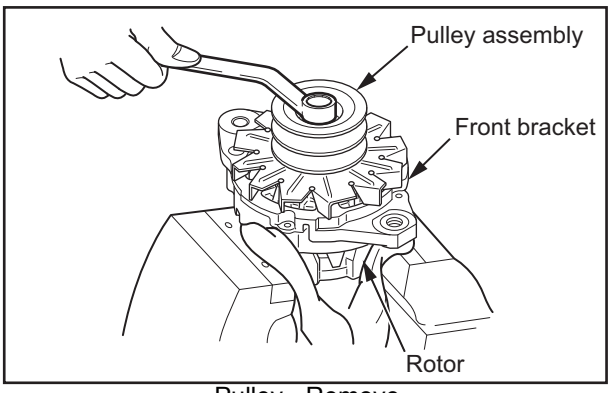
CAUTION

When holding a rotor with a vice, be sure to hold at the base of claw with a vice. Holding the tip of the claw can cause malfunctions.

(1) Attach the cloth to the rotor and fix it to the vise.

(2) Remove pulley nut, and then pull out the pulley.

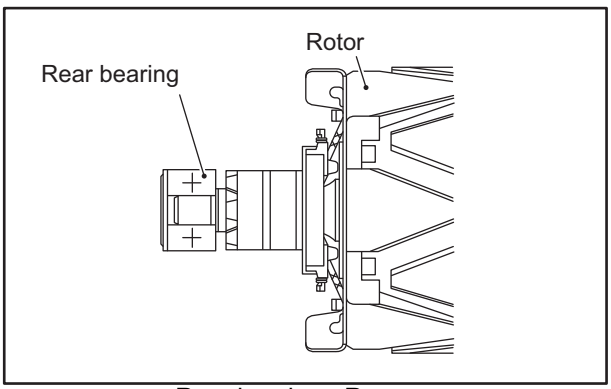
(3) Remove the rotor from the front bracket.



Pulley - Remove

2.11.3 Rear bearing - Remove

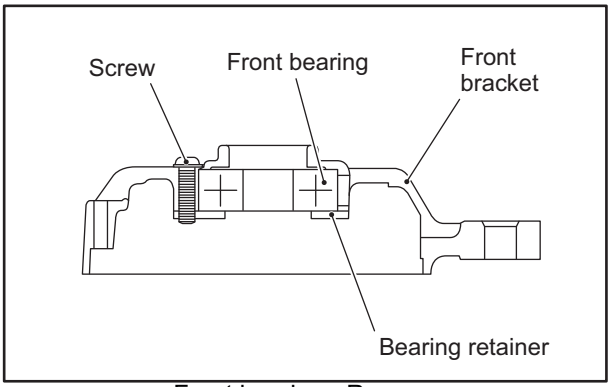
Remove the rear bearing from the rotor with the bearing puller.



Rear bearing - Remove

2.11.4 Front bearing - Remove

Remove screws, and then remove the bearing retainer and front bearing from front bracket.



Front bearing - Remove