CAT® Lift Trucks

Service Manual

Chassis & Mast

MC/FC

2P3000	AT34-30121-49999
2P3500	AT34-30121-49999
2PC4000	AT34-80121-99999
2P4000	AT35-30121-49999
2P5000	AT35-30121-49999
2P5500	AT36-30121-49999
2P6000	AT13F-30121-49999
2P6500	AT13F-80121-99999
2P7000	AT13F-80121-99999
2PD4000	AT18C-30121-49999
2PD5000	AT18C-30121-49999
2PD5500	AT37-30121-49999
2PD6000	AT14E-30121-49999
2PD6500	AT14E-80121-99999
2PD7000	AT14E-80121-99999
GP15NM	AT34-T0100-T9999
GP18NM	AT34-W0100-W9999
GP20CNM	AT34-P0100-P9999
GP20NM	AT17D-P0100-P9999
GP25NM	AT17D-T0100-T9999
GP25NM-HP	AT35-T0100-T9999
GP30NM	AT13F-P0100-P9999
GP35NM	AT13F-T0100-T9999

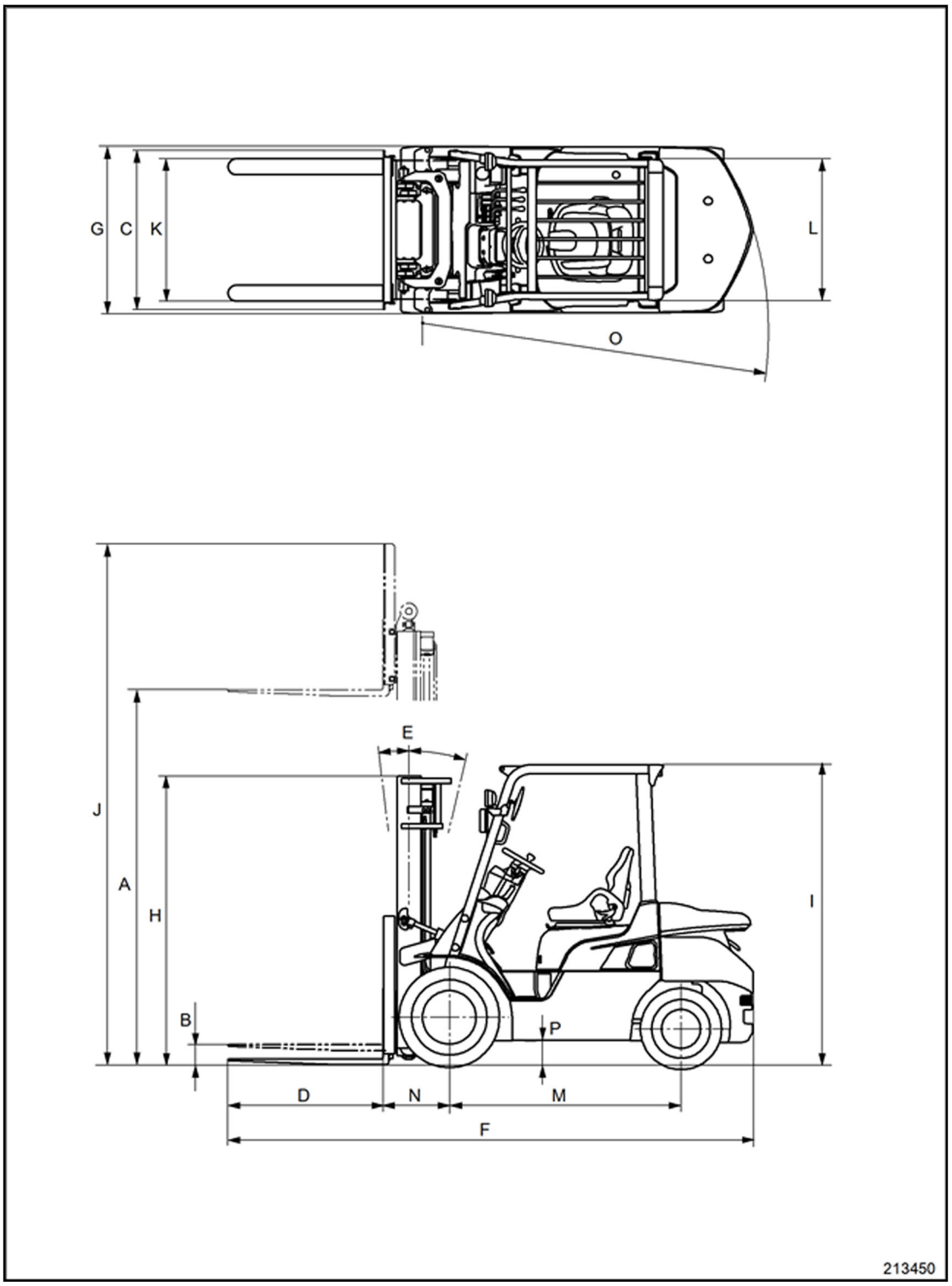
For use with S4S and K21 / K25 Engine Service Manuals.

99719-8M110

CHAPTER 5 POWER TRAIN

CHAPTER 6 POWERSHIFT TRANSMISSION

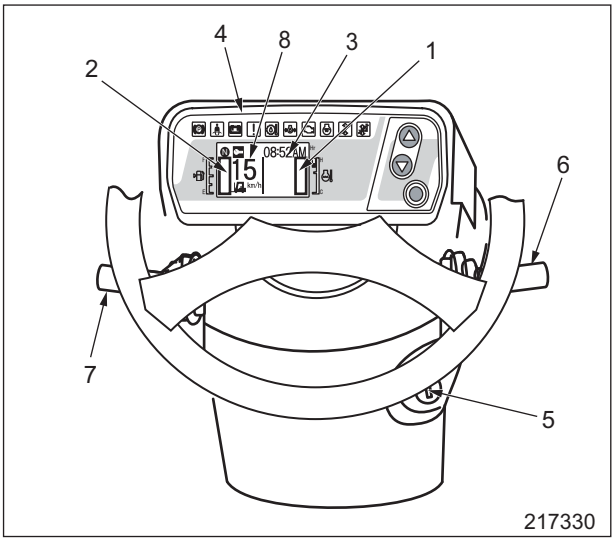
1.4 DIMENSIONS



2. Structure

2.1 Console Box

1 Water temperature gauge
2 Fuel gauge
3 Hour meter, various warning lamps
4 Instrument panel
5 Key switch
6 Lighting switch, turn signal switch
7 Forward-reverse lever



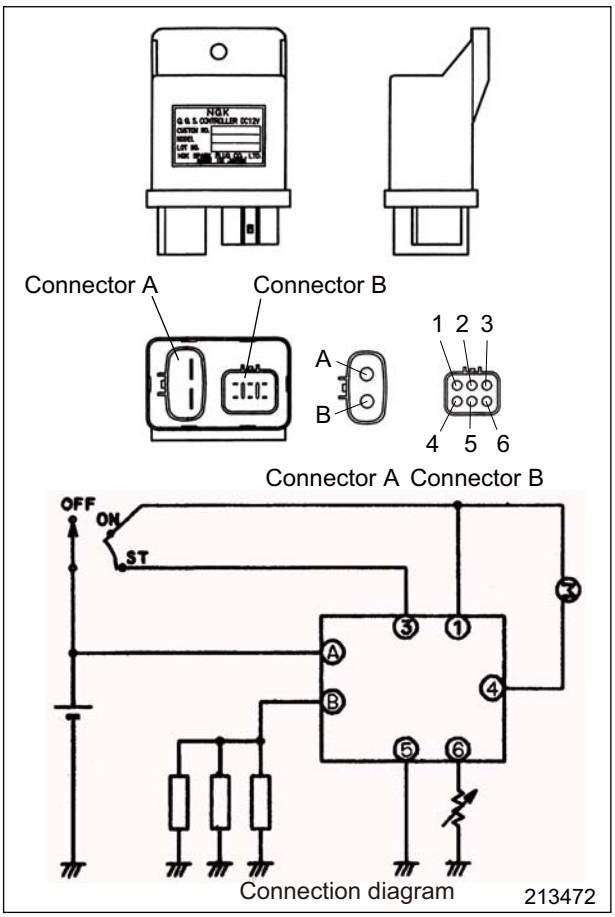
2.2.13 QGS controller (Diesel truck)

When the starter key switch turns from OFF to ON, the QGS controller turns the glow lamp and glow plugs to ON during the time period shown below.

When the key switch is turned to the START position, glow lamp and glow plugs are also turned ON.

Items	Water temperature (Resistance value)	ON time
Glow lamp Glow plug	-15°C(5°F) (12.1 K ohm)	10.0 ± 2.0 sec.
	0°C (5.9 K ohm)	6.4 ± 1.3 sec.
	+10°C(50°F) (3.8 K ohm)	3.0 ± 0.6 sec.

Rated voltage: DC12V



5.3.2 How to adjust the screen contrast

Turn the key switch to the ON position. Screen contrast can be adjusted while the engine is running.

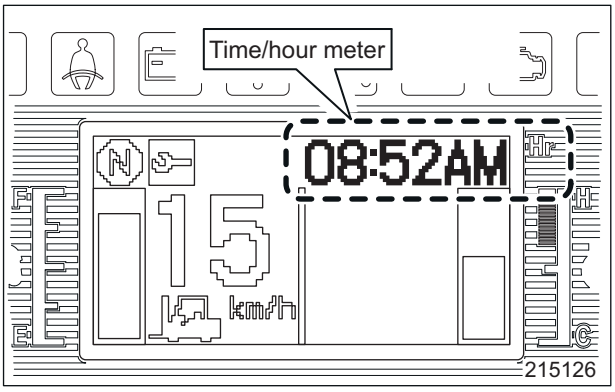
Button	Press	Display
△	Short	Light → Dark
▽		Dark → Light

Note: The screen becomes dark when the temperature inside the instrument panel (ambient temperature) is high, and the screen becomes light when the temperature is low.

5.3.3 How to display the clock time

Turn the key switch to the ON position. This operation is available while the engine is running. With a short press of ○ button, the display changes between the hour meter and the clock time.

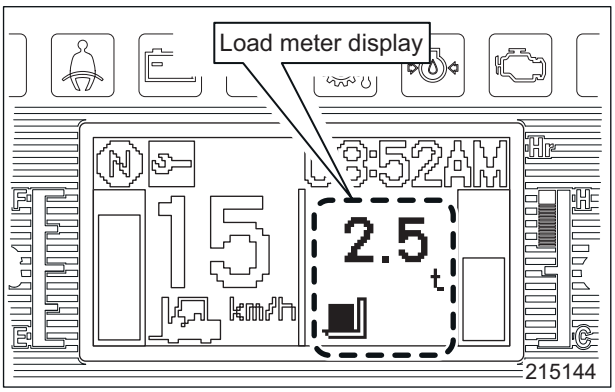
Button	Press	Display
○	Short	Hour meter ←→ clock



5.6.4 Load meter display (Maker option)

Loaded weight is detected and displayed. Service tool is required to set up the load weight display.
(For details, see the service tool manual.)

Note: 1. ONLY service engineers should set up and perform the load meter display setting.

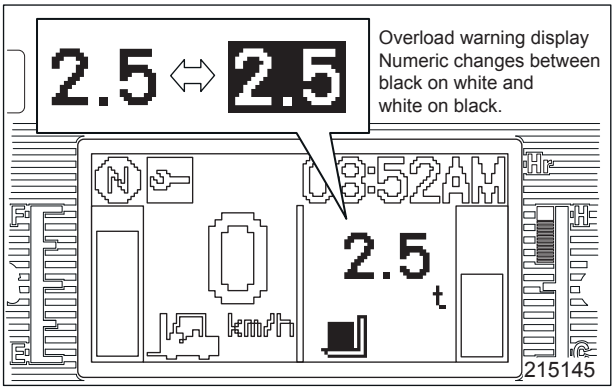


5.6.5 Overload warning display (Maker option)

When the pre-set load limit is exceeded, the image of the speedometer display in the LCD screen alternately changes between black characters on a white background and white characters on a background. Also warning buzzer activates. Service tool is required to set up the overload warning.
(For details, see the service tool manual.)

Note: 1. Only service engineers should set up and perform the overload warning display setting.

2. The setting of load meter display is required to use overload warning display.



7.3 Lighting System

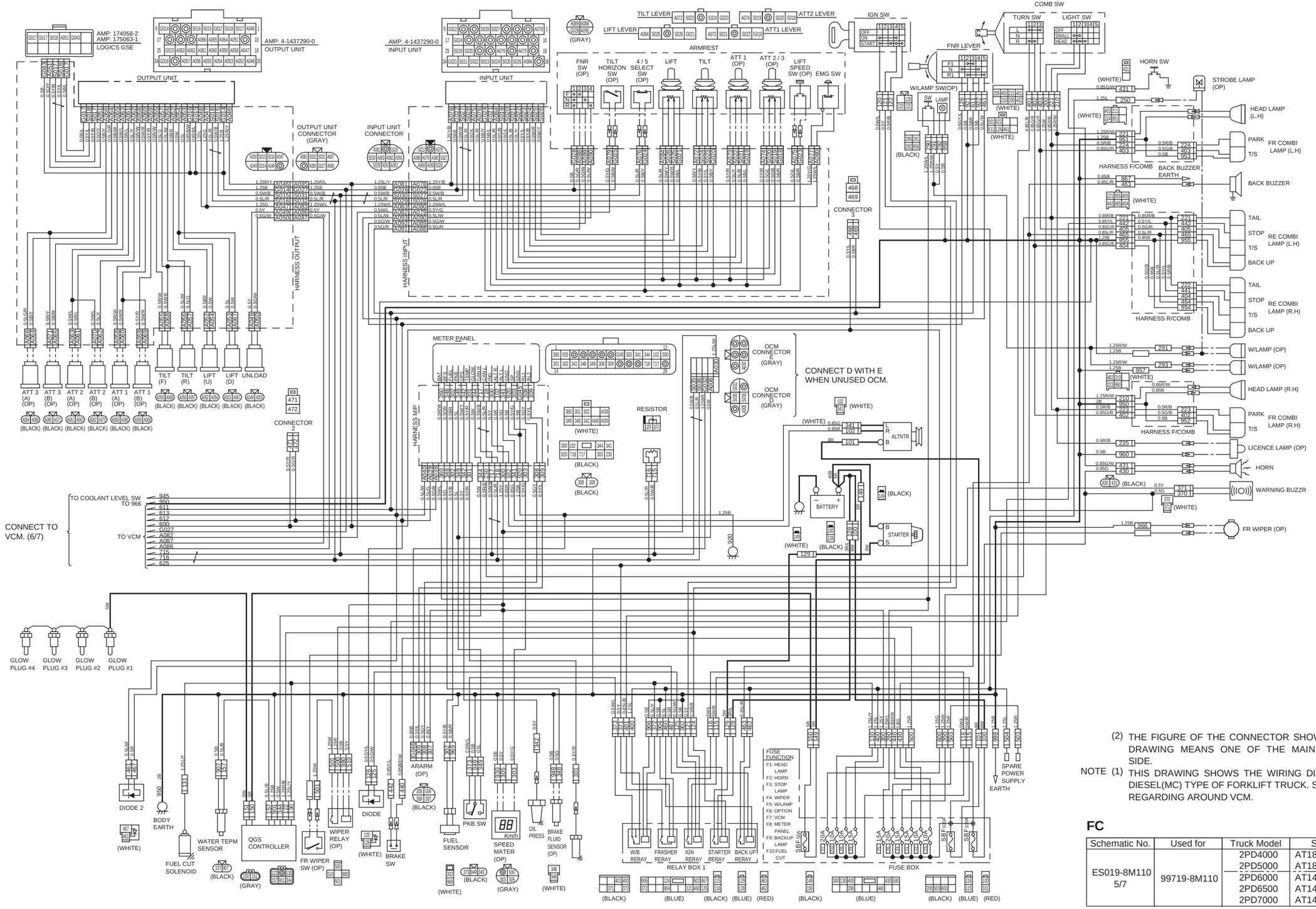
Lamps - general	Will not glow (blink) when turned ON.	Weak or dead battery	Recharge or replace.
		Fuses blown out	Check and replace.
		Short or open circuit	Repair or replace.
		Poor grounding	Remove corrosion from the terminal or retighten.
		Defective switch conductivity	Replace.
		Bulbs burnt out	Replace.
	Will glow dimly.	Weak battery	Check and recharge.
		Switch contact defect	Repair or replace.
		Loose terminals	Repair.
		Dirty lenses	Clean.
		Water drops inside lenses	Dry and replace packings.
		Bulbs service life expired	Replace.
Head lamp	Will not glow	Light switch conductivity defect	Replace.
		Bulbs burnt out	Replace.
Turn signal lamp	Will not blink.	Turn signal switch defect	Replace.
		Turn signal relay defect	Replace.
	Will not go out.	Turn signal relay defect	Replace.
	Will blink too slow.	Bulb wattage less than the rating	Replace it with specified bulb.
		Turn signal relay defect	Replace.
	Will blink too fast.	Bulb wattage greater than the rating	Replace it with specified bulb.
		Turn signal relay defect	Replace.
Other lamp	Back-up lamps will not glow	Back-up lamp switch defect	Correct if improperly installed, or replace if internally defective.
		Bulbs burnt out	Replace.
Horn	Will not activate.	Fuses blown out	Check and replace.
		Short or open circuit	Repair or replace.
		Horn switch defect	Replace.
		Horn defect	Replace.
		Horn button defect	Repair or replace.
	Will give an offensive sound.	Horn switch defect	Replace.
		Horn defect	Replace.

Chapter 2 COOLING SYSTEM

2.1 SPECIFICATIONS

Items		Truck class		
		1 ton class	2 ton class	3 ton class
Cooling system	Cooling method	Water-cooled, forced circulation		
	Radiator	Corrugated fin (pressure) type		
	Water pump	Centrifugal type		
	Thermostat	Wax pellet type		

Electrical Schematic (5/7)



(2) THE FIGURE OF THE CONNECTOR SHOWN IN THIS DRAWING MEANS ONE OF THE MAIN HARNESS SIDE.

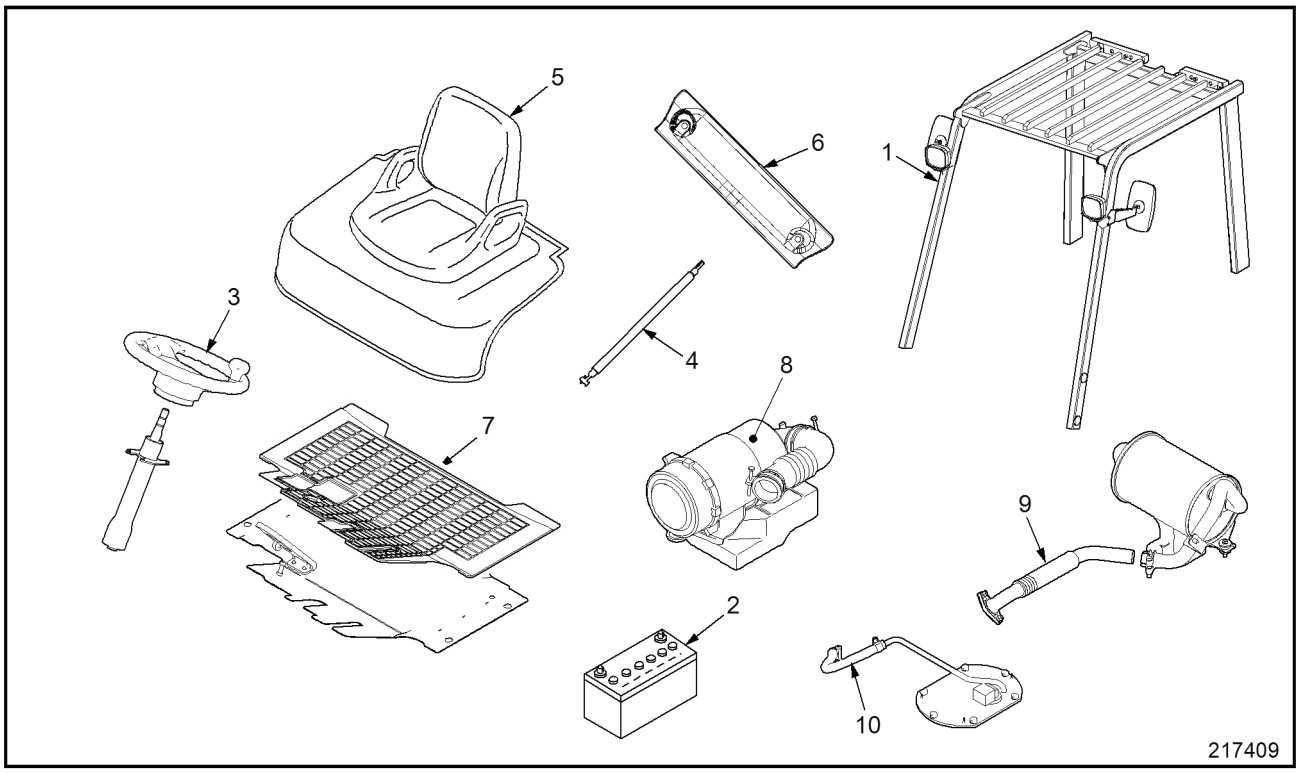
NOTE (1) THIS DRAWING SHOWS THE WIRING DIAGRAM OF DIESEL(MC) TYPE OF FORKLIFT TRUCK. SEE 6/7 REGARDING AROUND VCM.

FC

Schematic No.	Used for	Truck Model	Serial No.
ES019-8M110 5/7	99719-8M110	2PD4000	AT18C-30121 up
		2PD5000	AT18C-30121 up
		2PD6000	AT14E-30121 up
		2PD6500	AT14E-80121 up
		2PD7000	AT14E-80121 up

5.1.2.1 OVERHEAD GUARD, COVERS, AIR CLEANER, AND OTHER COMPONENTS

Removal sequence



1. OVERHEAD GUARD
2. BATTERY
3. STEERING WHEEL
4. GAS SPRINGS
5. ENGINE COVER, SEAT
6. RADIATOR COVER
7. FRONT COVER, FLOOR PLATE, FLOOR MAT
8. AIR HOSE, AIR CLEANER
9. EXHAUST PIPE
10. FUEL HOSES

Suggestions for Removal

(1) When removing the battery **2**, be sure to disconnect the ground (negative) cable first.

(2) Remove the floor plate **7**.

(3) Disconnect the exhaust pipe **9** from the engine.

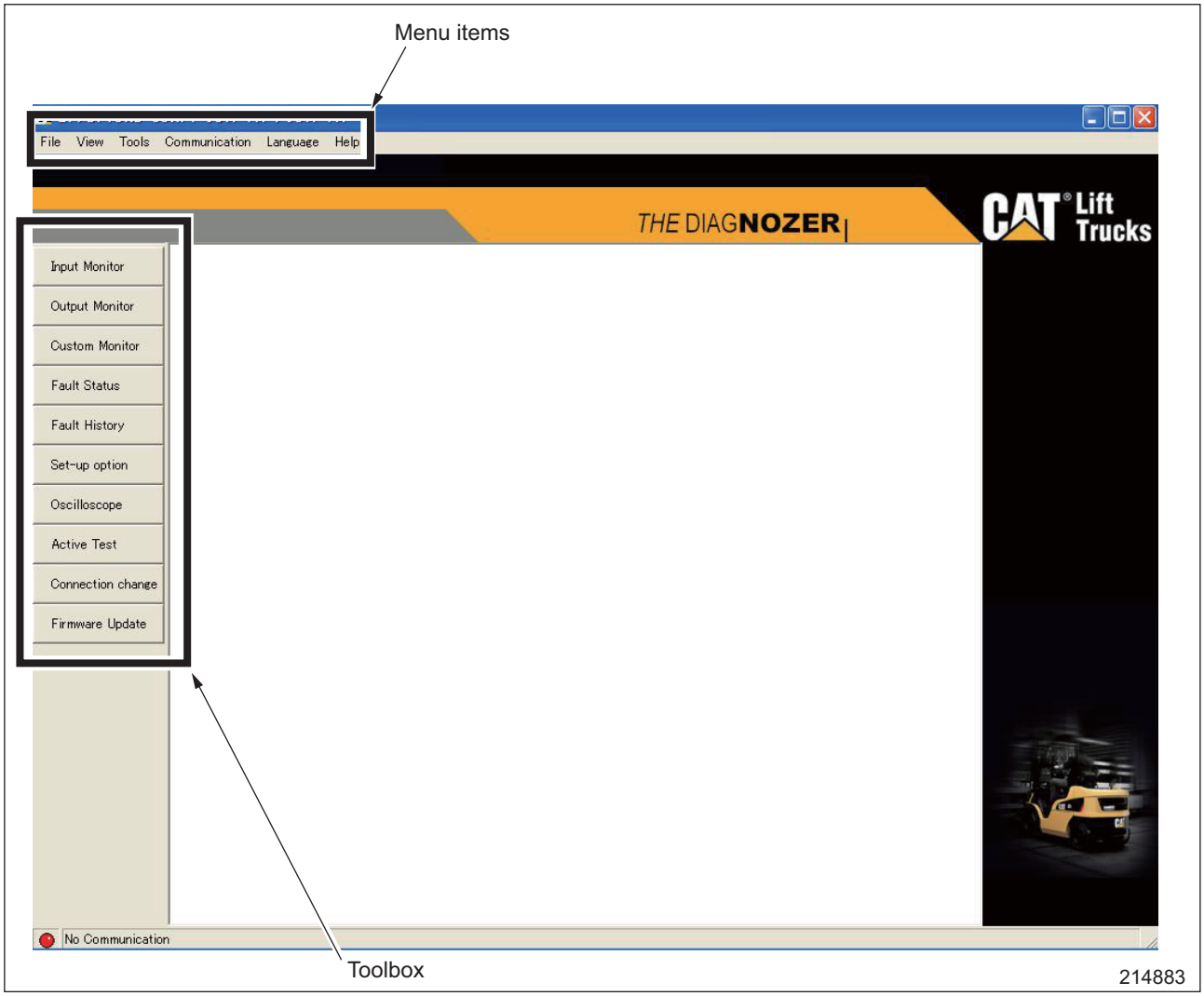
(4) Before removing the fuel hose **10**, make sure to close the drain cock on the fuel tank.

(5) After disconnecting the harness connectors from the sockets and terminals on the engine and transmission they should be attached on the main harness in order to avoid damaging them.

3. Service Tool Functions

3.1 Service Tool Menus

Select functions from the main menu window.



(1) File menu

- Print: allows you to print the screen being displayed.
- Exit: allows you to log out.

(2) View menu

- Input Monitor: allows you to monitor input values.
- Output Monitor: allows you to monitor output values.
- Custom Monitor: allows you to monitor customized input/output values.
- Fault Status: allows you to monitor the current fault condition.
- Fault History: allows you to view past faults.

(3) Tool menu

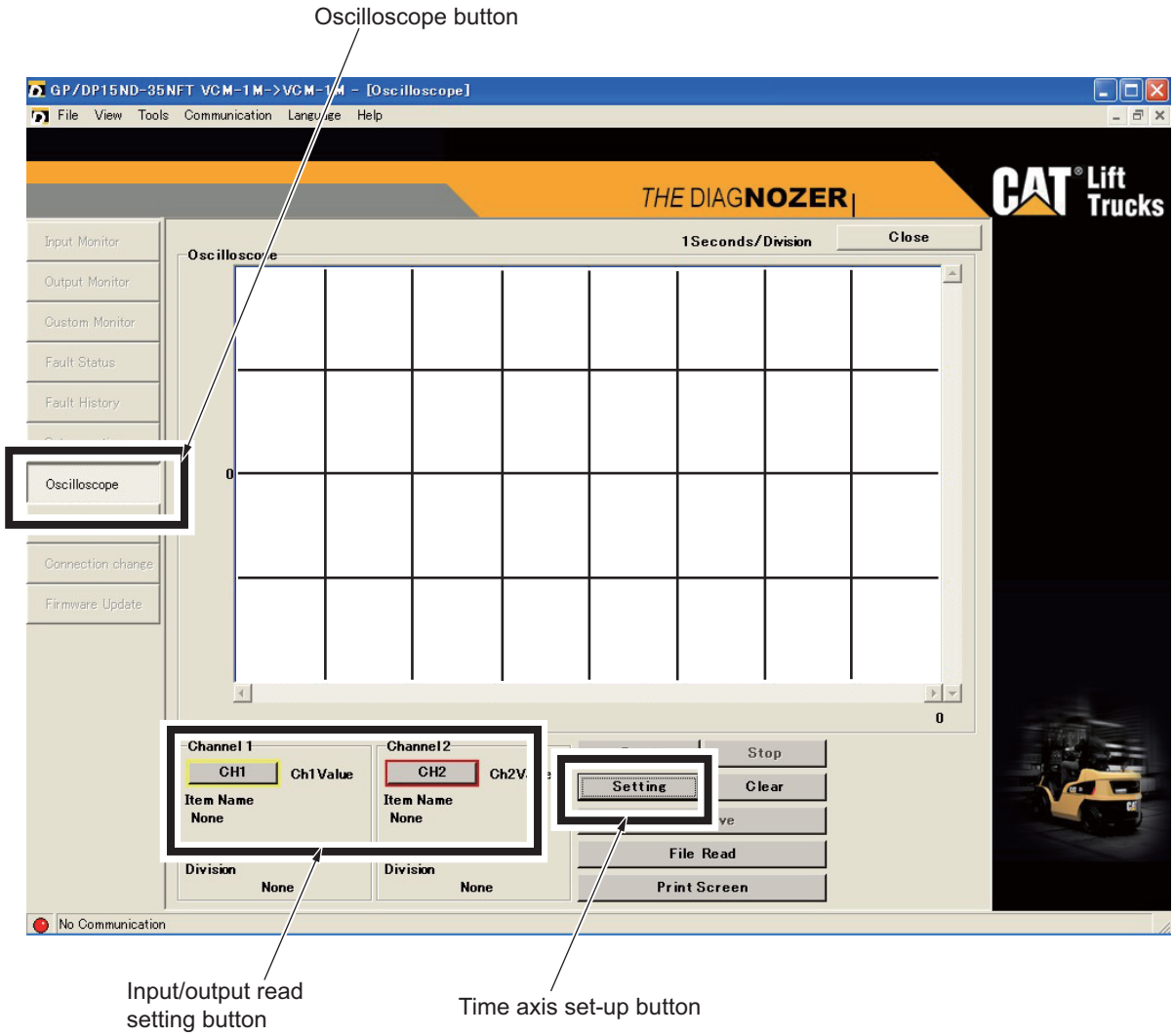
- Set-up option: allows you to monitor or change setup values.
- Oscilloscope: allows you to view a graph of input/output values. The graph data can be stored so that the graph can be re-displayed by reading the stored data.
- Active Test: Operating conditions can be checked automatically with signals being sent out.
- Connection change: allows you to change the connection and target controllers.
- Firmware Update: allows you to update the firmware of controller connected.

(4) Communication menu

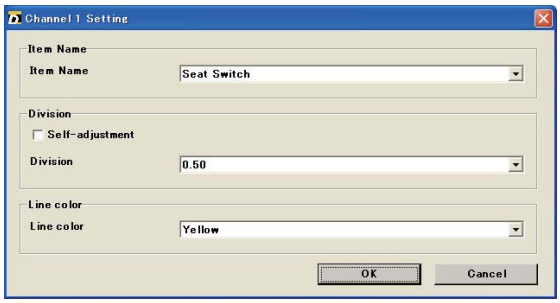
- Setup: allows you to set up communication port, communication speed and flow control.

(7) Oscilloscope

Click the oscilloscope button from the menu or toolbox to display the oscilloscope screen in the main window. The oscilloscope screen shows a graph of the specified input/output values. The user can set up two items (CH1 and CH2) as input/output values to be expressed in the graph. The time axis of the graph is expressed in seconds. The user also can store the data of the graph being displayed on the screen, and re-display the graph by reading it from the memory. The graph screen can be printed out on a printer by clicking the printing screen button. Because the function of this oscilloscope is simple, there will be some amount of lag in the wave pattern and a margin of error. For an accurate wave pattern, use a dedicated measuring instrument.

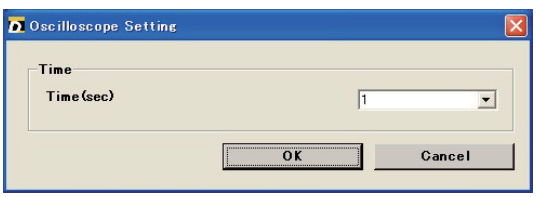


214897



Channel setting screen

214898



Time axis setting screen

214899

(3) Check the box of the active test flag, and press the write button. (Fig. 1-8)
When the write confirmation dialogue box is displayed, press the YES button.

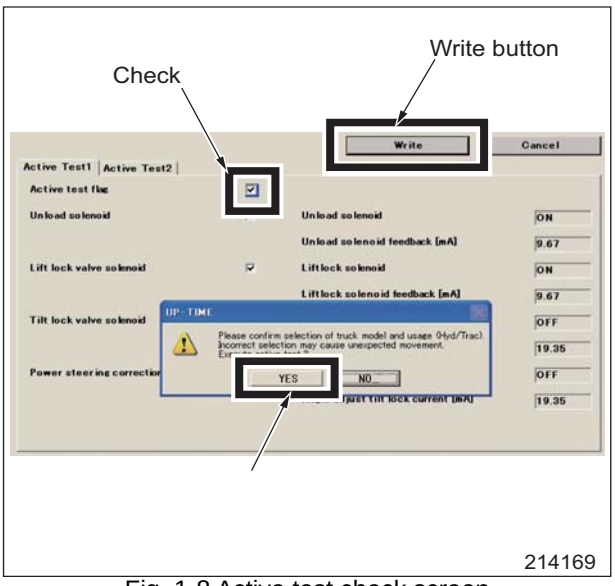


Fig. 1-8 Active test check screen

(4) When the write completed dialogue box is displayed, press the OK button. (Fig. 1-9)

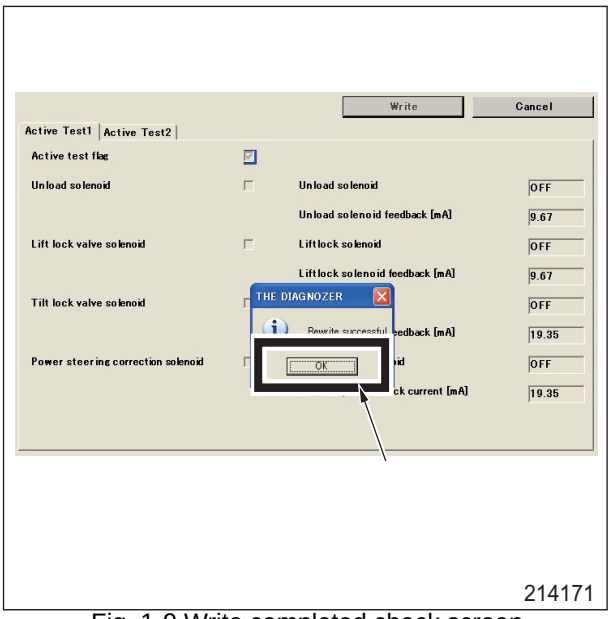


Fig. 1-9 Write completed check screen

(5) Check the box of the unload solenoid and the lift lock valve solenoid, and press the write button. (Fig. 1-10)

(6) When the write confirmation dialogue box is displayed, press the YES button same as item (3) above, and when the write completed dialogue box is displayed, press the OK button.

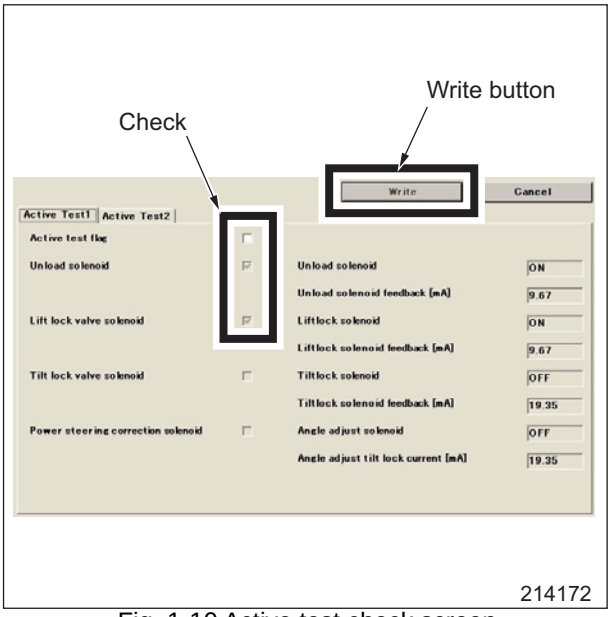


Fig. 1-10 Active test check screen

7.2 Parking Brake Warning Buzzer/Lamp Checking Procedure

(1) Connect the service tool to the VCM1-M controller.

(2) Turn the key switch to the ON position and start the engine. (Leave the parking brake engaged.)

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

(4) Sit on the operator's seat and make sure that the seat switch and the seat switch timer are ON on the input monitor screen. (Fig. 4-1)

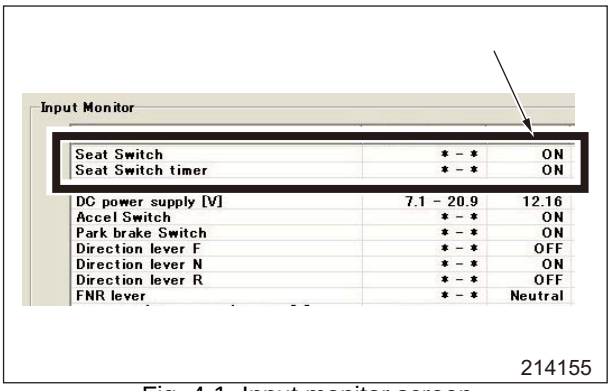


Fig. 4-1 Input monitor screen

(5) Make sure the parking brake switch turns ON, on the input monitor screen. (Fig. 4-2) Also check that the parking brake warming lamp glows on the instrument panel. (Fig. 4-3)

(6) Release the parking brake and leave the operator's seat.

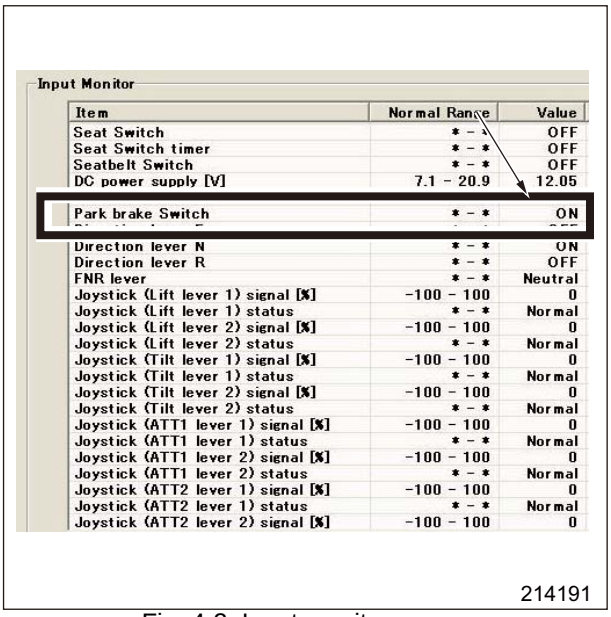


Fig. 4-2 Input monitor screen

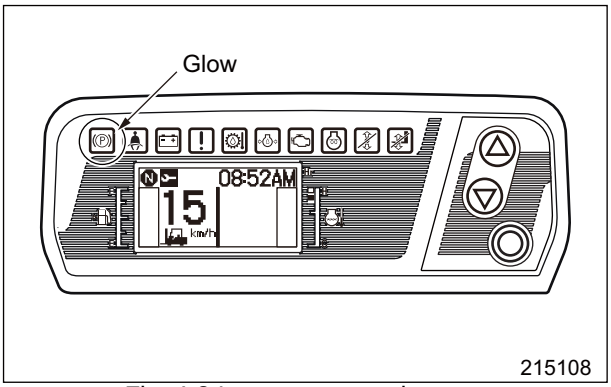


Fig. 4-3 Instrument panel screen

9.11 Warning Buzzer Circuit

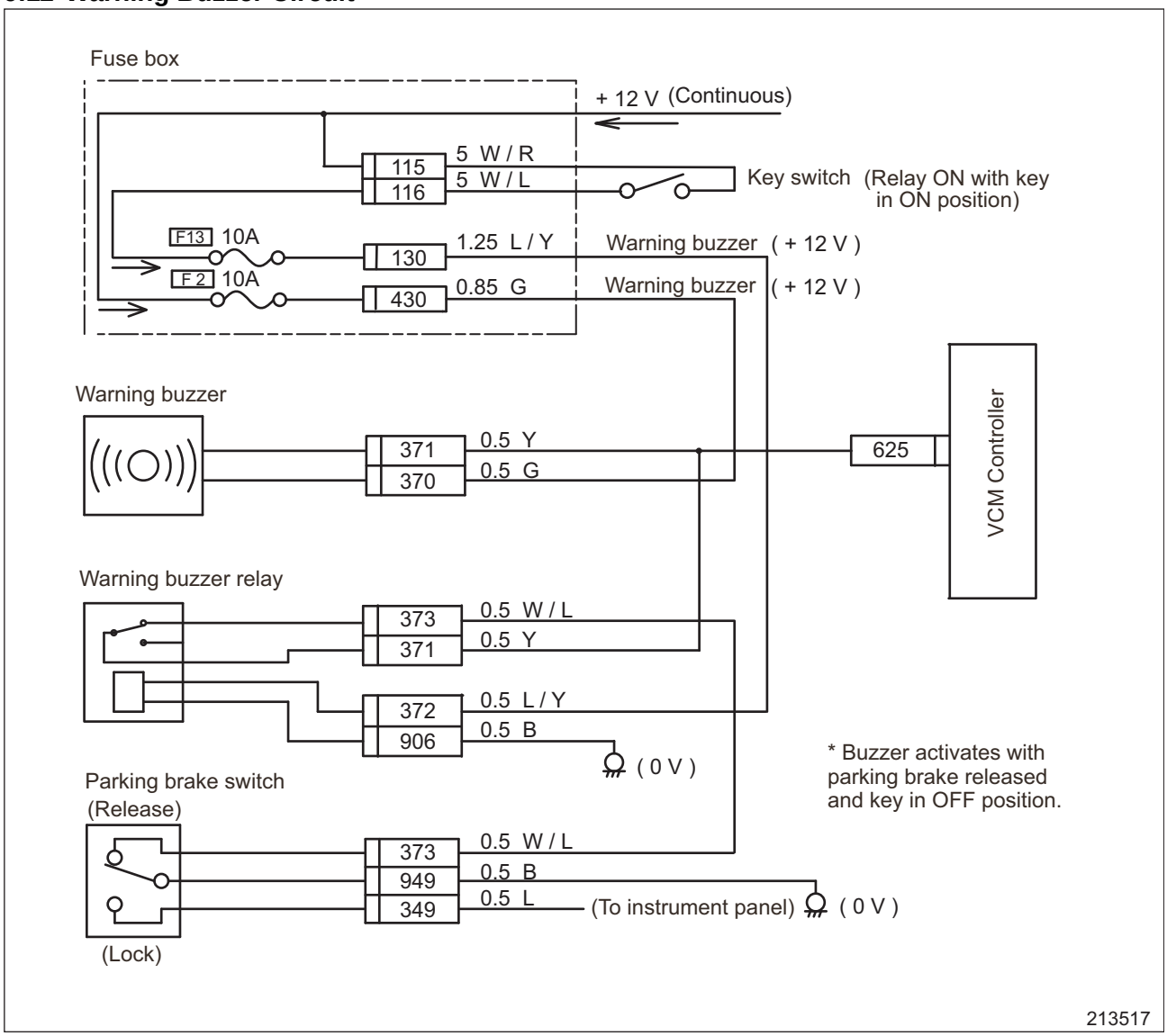


Fig. 7-15 Warning buzzer circuit

9.12 Instrument Panel

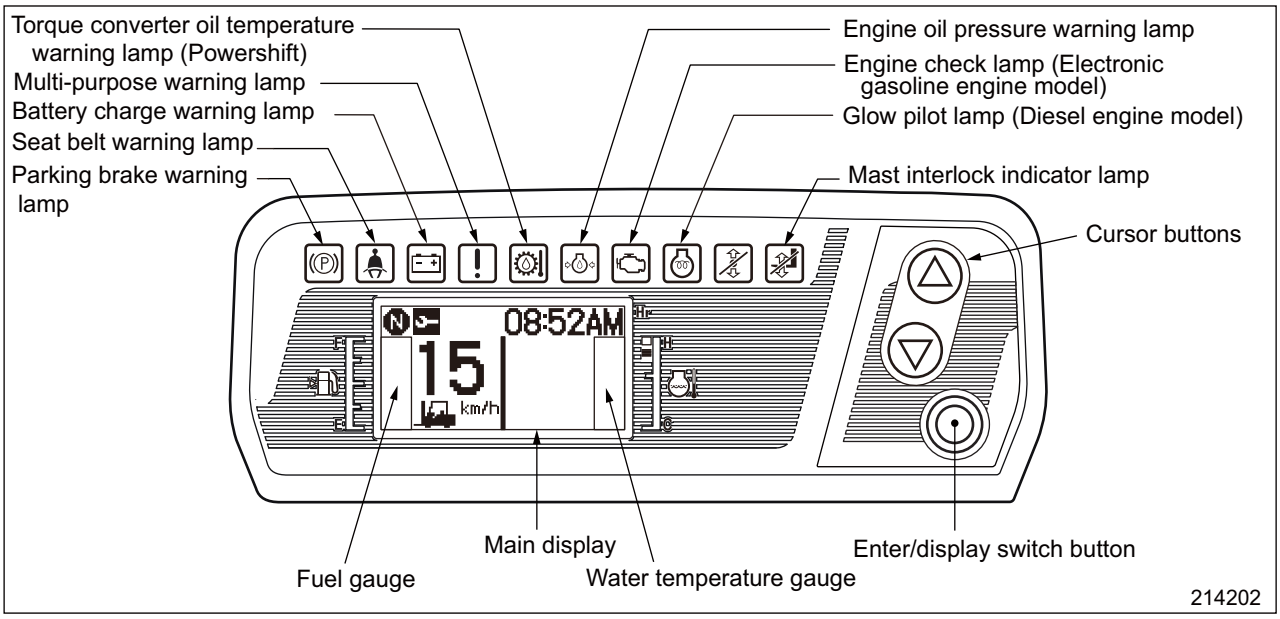


Fig. 7-16 Instrument panel

Diagnosis	RI02 communication error (F49)
Logic conditions	CAN receiving from input unit is impractical. (2 second's continuity) ——— F49
Recovery	Recovers automatically
Action	Activates with default values of output unit incoming data.
LED blink pattern	B

Diagnosis	Lift up solenoid error (F50)
Logic conditions	CAN receiving abnormal flag from output unit ——— F50
Recovery	Turn on power again.
Action	Set the lift current command value to 0mA.
LED blink pattern	E

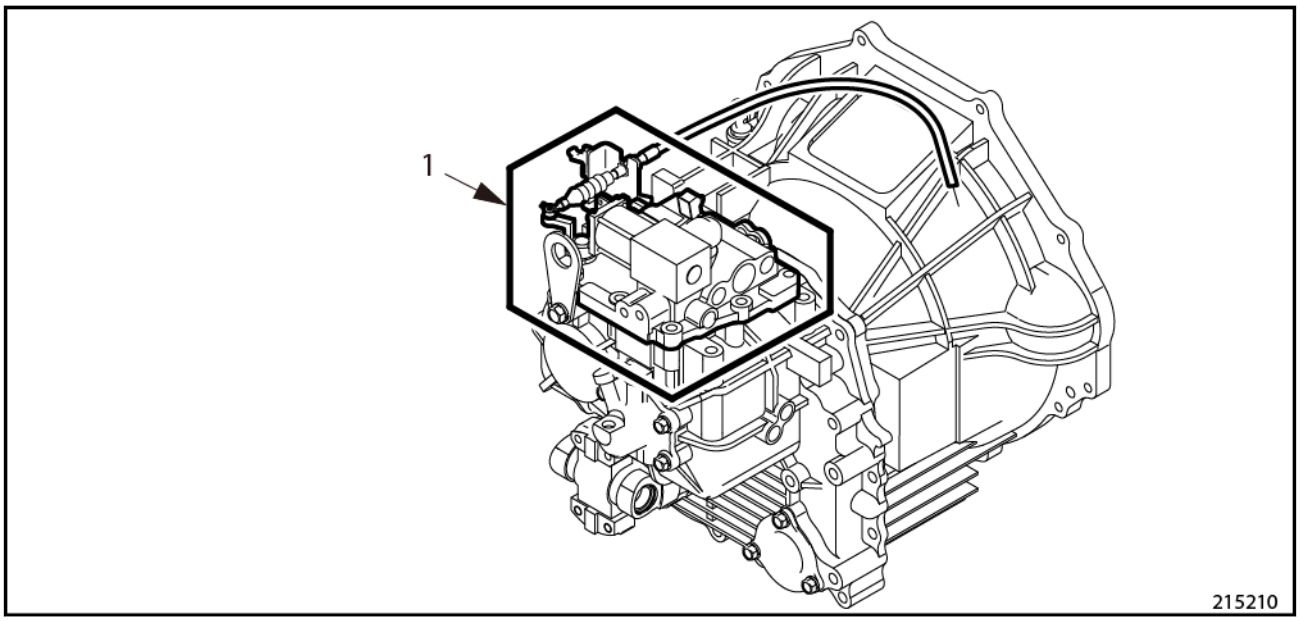
Diagnosis	Lift down solenoid error (F52)
Logic conditions	CAN receiving abnormal flag from output unit ——— F52
Recovery	Turn on power again.
Action	Set the lift current command value to 0mA.
LED blink pattern	E

Diagnosis	Lift solenoid leak (F54)
Logic conditions	CAN receiving abnormal flag from output unit ——— F54
Recovery	Turn on power again.
Action	Set the current command value to 0mA and turn OFF unload solenoid of all operating functions.
LED blink pattern	E

Diagnosis	Tilt forward solenoid error (F55)
Logic conditions	CAN receiving abnormal flag from output unit ——— F55
Recovery	Turn on power again.
Action	Set the lift current command value to 0mA.
LED blink pattern	E

Error code	Diagrosis	Probable cause	Check item
F-55	Tilt forward solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt FW solenoid bad	4. Tilt FW sol connection check
		5. Controller bad	
F-57	Tilt backward solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt BW solenoid bad	4. Tilt BW sol connection check
		5. Controller bad	
F-59	Tilt solenoid leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt solenoid bad	4. Tilt sol connection check
		5. Controller bad	
F-60	Att1A solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1A sol bad	4. Att1A sol connection check
		5. Controller bad	
F-62	Att1B solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1B sol bad	4. Att1B sol connection check
		5. Controller bad	
F-64	Att1 solenoid leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1 sol bad	4. Att1 sol connection check
		5. Controller bad	
F-65	Att2A solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2A sol bad	4. Att2A sol connection check
		5. Controller bad	
F-67	Att2B solenoid error	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2B sol bad	4. Att2B sol connection check
		5. Controller bad	
F-69	Att2 solenoid leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2 sol bad	4. Att2 sol connection check
		5. Controller bad	

6.3.2 OVERALL VIEW OF CONTROL VALVE



1. CONTROL VALVE

6.4 POWERSHIFT TRANSMISSION, DISASSEMBLY

6.4.1 PREPARATION

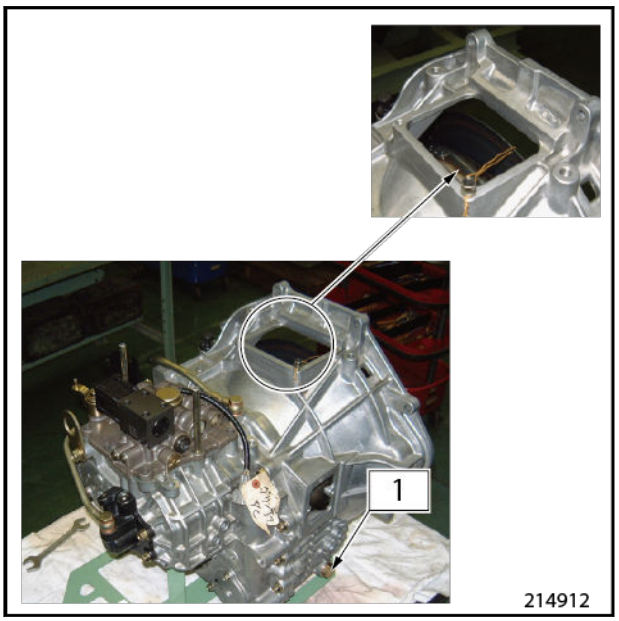
6.4.1.1 DRAINING TRANSMISSION OIL

(1) Before removing the transmission from the lift truck, attach a wire on the torque converter assembly to prevent it from slipping out.

(2) Remove the oil drain plug and drain transmission oil.

Transmission oil capacity	8 (2.11)

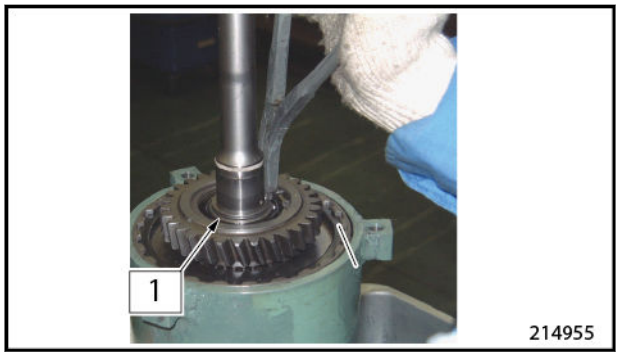
Units: L (US gal.)



1. OIL DRAIN PLUG

6.4.1.2 TRANSMISSION, SETTING ON THE STAND

Place the transmission on the stand.

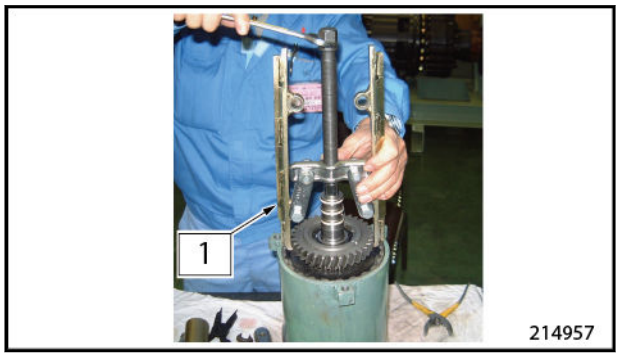


1. SNAPRING

(5) Using a screw driver, raise forward gear assembly.

1. FORWARD GEAR ASSEMBLY

(6) Using the puller (91A68-01800), remove forward gear assembly.



1. SPECIAL TOOL (PULLER, 91A68-01800)

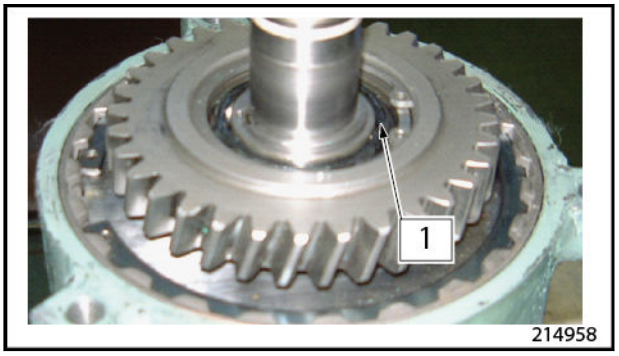
6.4.10.2 FORWARD GEAR ASSEMBLY, DISASSEMBLY

(1) Remove snapring.

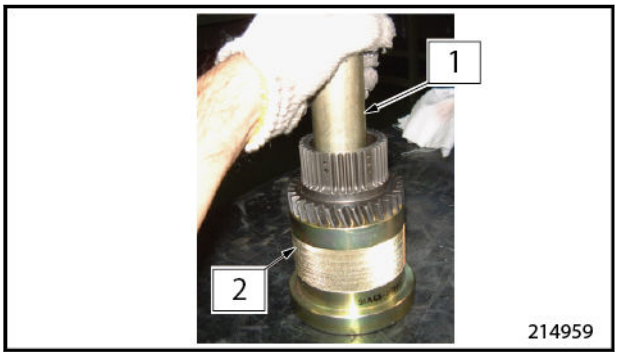
(2) With gear faced downward, place forward gear assembly on the stand (91A68-01700).

(3) Remove angular bearing using the installer (91268-04100).

Part name	Part number
Installer	91268-04100



1. SNAPRING



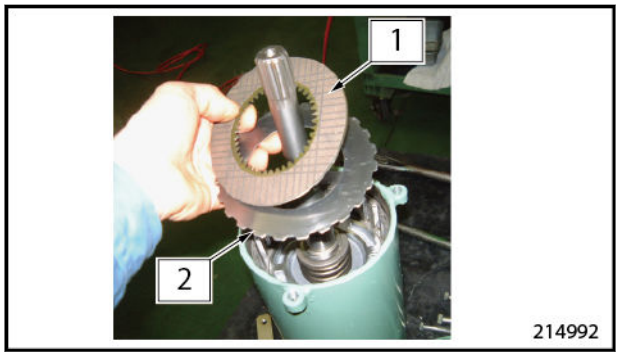
1. SPECIAL TOOL (INSTALLER, 91268-04100)
2. SPECIAL TOOL (STAND, 91A68-01700)

6.4.10.3 FORWARD SIDE GEAR INPUT SHAFT, DISASSEMBLY

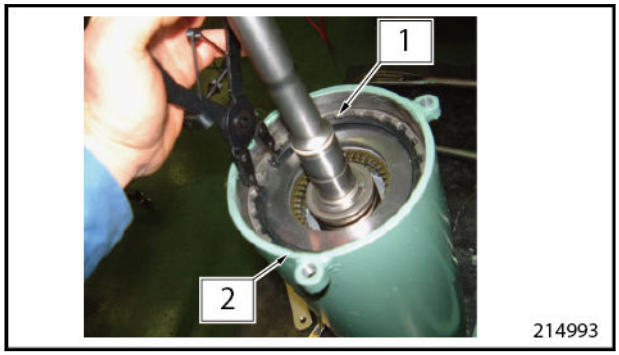
(1) Remove snapring.

(2) Remove one pressure plate, one Belleville spring, six mating plates, and five friction plates.

NOTE: When disassembling plates, record the position of each plate so that they can be assembled as they were.



1. FRICTION PLATE
2. MATING PLATE

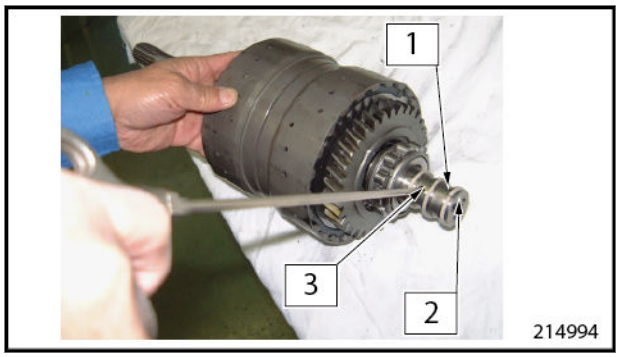


1. SNAPRING
2. SPECIAL TOOL (STAND, 91A68-01300)

6.5.6.3 FORWARD CLUTCH PISTON, MOTION CHECK

Check that the clutch piston is moving normally by applying compressed air through the gear oil hole on the forward side.

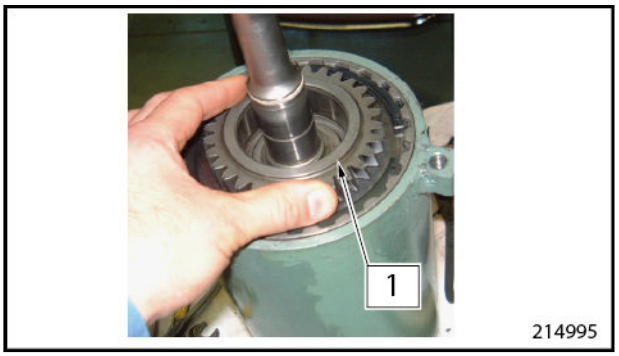
NOTE: BE SURE to use clean compressed air which is filtered through an air-filter.



1. FORWARD SIDE OIL HOLE
2. SET SCREW
3. REVERSE SIDE OIL HOLE

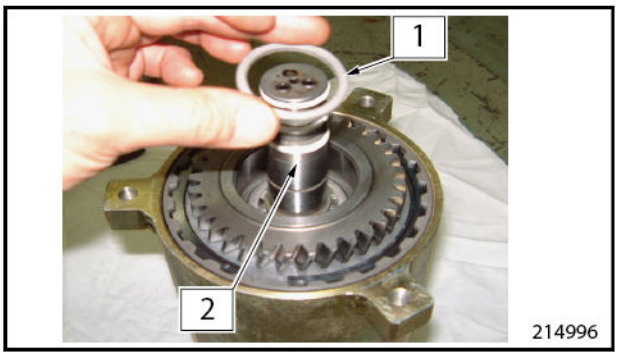
6.5.6.4 FORWARD GEAR ASSEMBLY, INSTALLATION

(1) Install forward gear.



1. FORWARD GEAR

(2) Install spacer.



1. SPACER
2. INPUT SHAFT

(3) Install angular bearing using the installer.

Part name	Part number
Installer	91268-04100

6.5.10.1 TRANSMISSION HOUSING BOLTS, TIGHTENING

(1) Insert transmission housing bolts to the holes and tighten them to the specified torque.

Transmission housing	39.2 ± 3.9 (4.00 ± 0.40) [28.9 ± 2.88]

Unit: N·m (kgf·m) [lbf·ft]

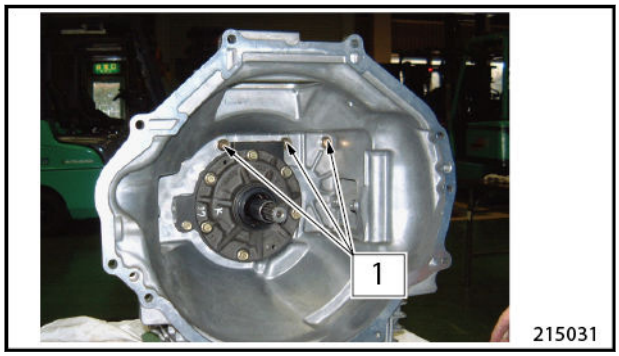
(2) Install transmission on the stand kit.

Part name	Part number
Stand kit	91A68-00020

(3) From torque converter mounting side, tighten three transmission housing bolts to the specified torque.

Transmission housing	39.2 ± 3.9 (4.00 ± 0.40) [28.9 ± 2.88]

Unit: N·m (kgf·m) [lbf·ft]



1. TRANSMISSION HOUSING BOLTS

6.5.11 SERVO CASE ASSEMBLY, INSTALLATION

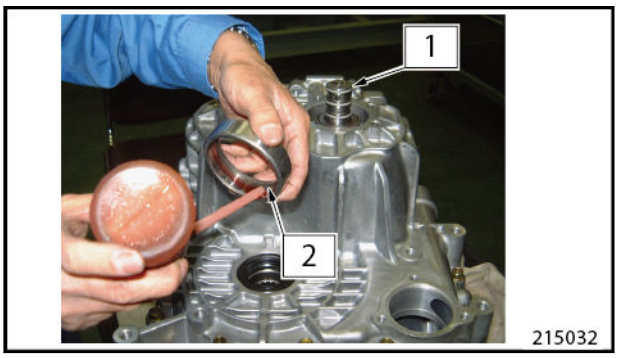
6.5.11.1 BEARING OUTER RACE, INSTALLATION

(1) Remove transmission with the stand kit (91A68-00200), and with torque converter housing side face down so that the case can be separated, lay the transmission.

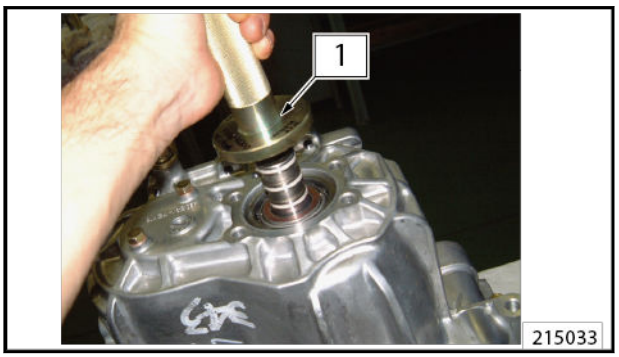
(2) Apply oil on outer race of input shaft gear assembly.

(3) Using the installer (91A68-02200), install outer race.

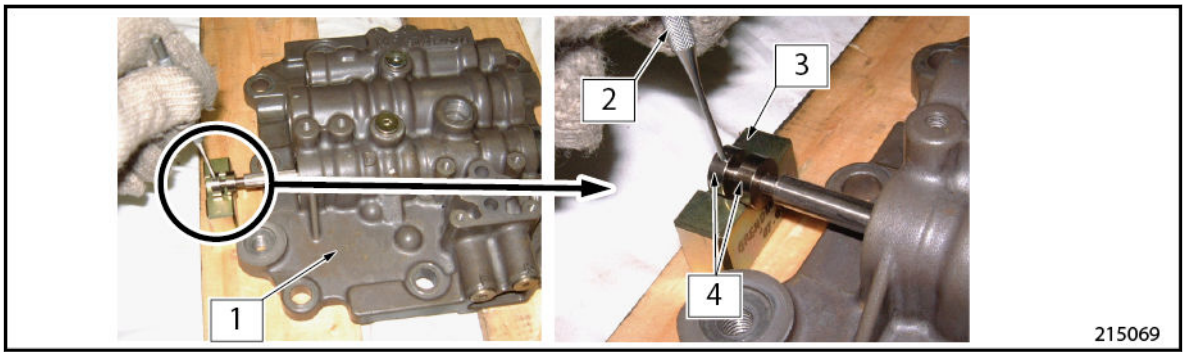
Part name	Part number
Installer	91A68-02200



1. INPUT SHAFT GEAR ASSEMBLY
2. INPUT SHAFT GEAR ASSEMBLY BEARING OUTER RACE



1. SPECIAL TOOL (INSTALLER, 91A68-02200)



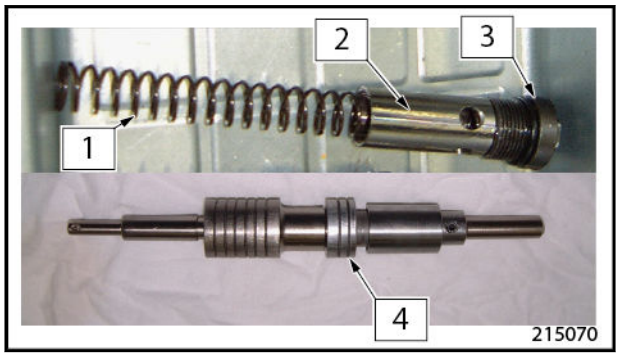
1. VALVE BODY
2. PIN REMOVER
3. SPECIAL TOOL (STAND, 91A68-02801)
4. INCHING ROD PLATE

6.6.7.2 VALVE, REMOVAL

(1) Remove the inching plug together with O-ring.

NOTE: When removing the inching plug, slowly remove the inching plug while pressing it with a tool. Otherwise inching spring will pop out.

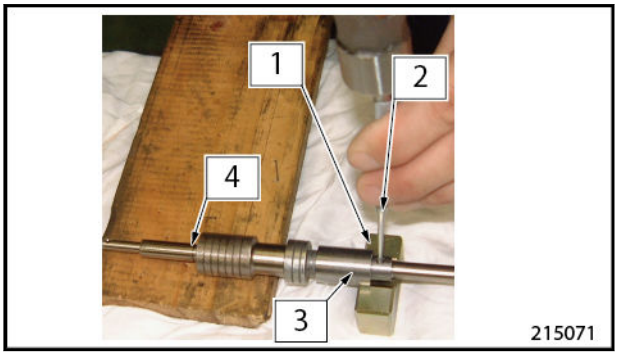
(2) Remove the inching spring, inching stopper 1, inching rod, inching valve spring, inching valve, and return spring.



1. INCHING SPRING
2. INCHING STOPPER 1
3. INCHING PLUG
4. INCHING VALVE ASSEMBLY

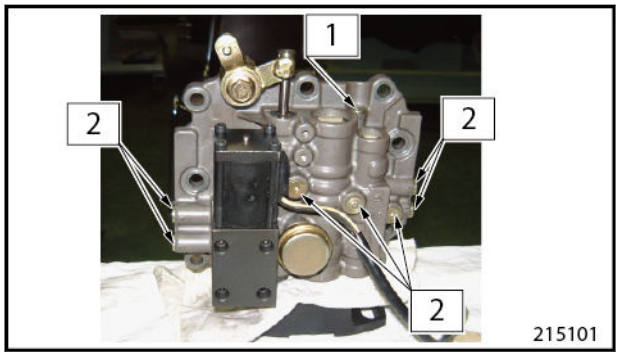
6.6.7.3 INCHING VALVE ASSEMBLY, DISASSEMBLY

(1) Using the stand (91A68-02701), remove springpin from inching stopper 2.



1. SPECIAL TOOL (STAND, 91A68-02701)
2. PIN REMOVER
3. INCHING STOPPER 2
4. INCHING VALVE ASSEMBLY

(2) Remove inching stopper 2, inching valve spring and inching valve from the inching rod.



1. MAIN ORIFICE PLUG
2. PLUGS

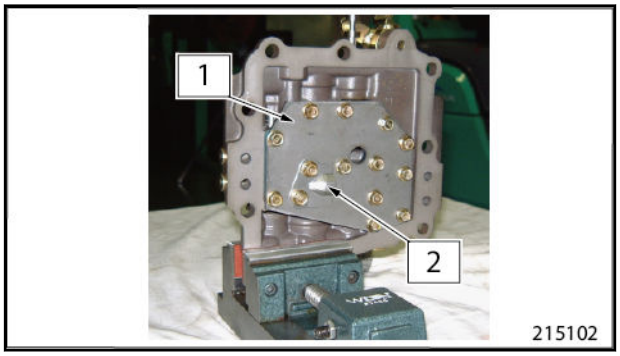
6.7.9 VALVE BODY PLATE, BREATHER COVER, INSTALLATION

6.7.9.1 VALVE BODY PLATE, INSTALLATION

Install the valve body plate together with gasket and tighten it to the specified torque.

Valve body plate	7.0 ± 1.0 (0.71 ± 0.10) [5.2 ± 0.74]

Unit: N·m (kgf·m) [lbf·ft]



1. VALVE BODY PLATE
2. BREATHER COVER

6.7.9.2 BREATHER COVER, INSTALLATION

Install breather cover and tighten it to the specified torque.

Breather cover	7.0 ± 1.0 (0.71 ± 0.10) [5.2 ± 0.74]

Unit: N·m (kgf·m) [lbf·ft]

6.7.10 CONTROL VALVE EXTERNAL PARTS, REMOVAL

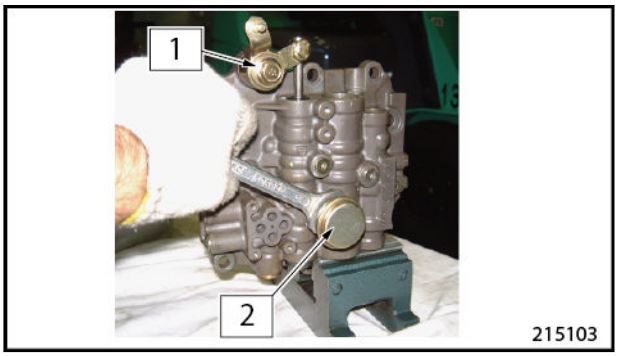
6.7.10.1 INCHING LEVER, INSTALLATION

Install the inching lever together with retainer and bushing, and tighten it to the specified torque.

NOTE: DO NOT reuse bushings. Make sure to use new bushings.

Inching lever	39.2 ± 3.9 (4.00 ± 0.40) [28.9 ± 2.88]

Unit: N·m (kgf·m) [lbf·ft]



1. INCHING LEVER
2. BREATHER

6.7.10.2 BREATHER, INSTALLATION

Install the breather.

6.7.10.3 SOLENOID VALVE, INSTALLATION

Install the solenoid valve together with O-ring, and tighten it to the specified torque.

NOTE: DO NOT reuse the mounting bolts that secure the solenoid valve or O-rings. Make sure to use new bolts.

Solenoid valve	7.0 ± 1.0 (0.71 ± 0.10) [5.2 ± 0.74]

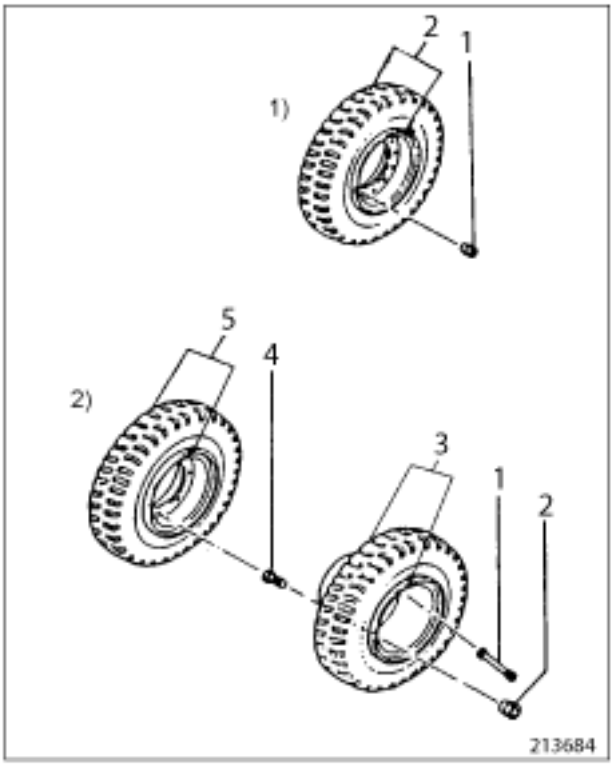
Unit: N·m (kgf·m) [lbf·ft]

		Turbine shaft broken	Replace
		Main pressure too low	Check pump gears for wear or replace
	Transmission	Oil level too low	Refill
		Inching pedal link misadjusted	Adjust
		Seal ring worn in servo case	Replace
		O-rings on input shaft worn	Replace
		Plug on input shaft loose or slipped off, resulting in oil leaks	Repair
		Clutch seized	Replace
		Shafts broken	Replace
		Clutch drum, particularly snapring groove, defective	Replace
		Snapring fitted to clutch drum broken	Replace
		Oil way for supplying oil pressure to clutch piston clogged	Clean or replace
		Shaft splines worn	Replace shafts
	Power train	Broken parts in reduction differential or front axle	Repair or replace
Abnormal noise	Torque converter	Flexible plate broken	Replace
		Bearings damaged	Replace
		Rubbing of impeller	Replace
		Bolts loose	Tighten or replace
		Splines worn	Replace
		Worn oil pump	Disassemble, check, or replace
	Transmission	Clutch seized and dragging	Replace clutch plate
		Bearings worn or seized	Replace
		Gears broken	Replace
		Bolts loose	Tighten or replace bolts
		Splines worn	Replace
	Loud noise	Oil strainer clogged	Clean
		Main regulator valve defective	Clean or replace
		Restriction in oil pipe	Replace
		Oil too viscous in cold weather	Replace oil
		Instruments faulty	Replace
		Wrong kind of oil used	Replace oil
	Low noise	Oil strainer clogged	Clean or replace

7.2 REMOVAL AND INSTALLATION

7.2.1 FRONT WHEELS

7.2.1.1 REMOVAL



1) SINGLE WHEEL

1. WHEEL NUTS
2. FRONT WHEELS

2) DOUBLE WHEELS

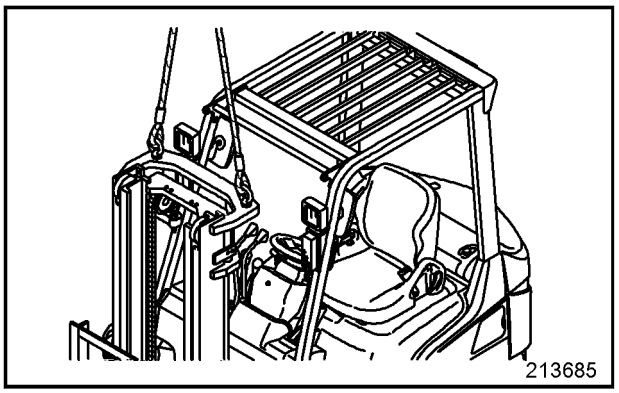
1. EXTENSION VALVE
2. OUTER WHEEL NUTS
3. FRONT WHEEL (OUTER)
4. INNER WHEEL NUTS
5. FRONT WHEEL (INNER)

Start by

(1) Apply the parking brake and block the rear wheels.

(2) Loosen the wheel nuts by two full turns. Then, raise the front end of the lift truck using a hoist or the hydraulic system.

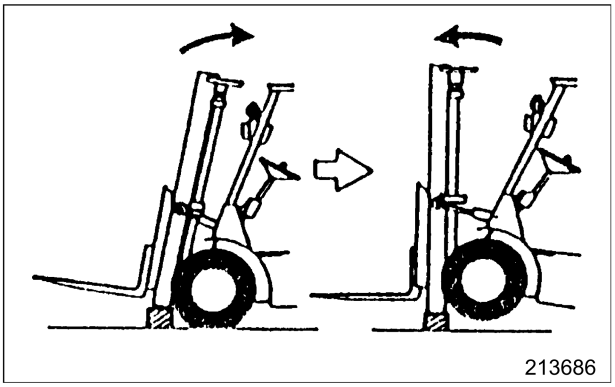
a. Method using a crane
Using slings and eye-bolts at both ends of the top crossmember on the outer mast, lift the front end of the lift truck with a hoist.



b. Using hydraulic system
Tilt the mast all the way back and place wood blocks under the mast. Then, tilt the mast forward to raise the front end.

⚠ CAUTION

After raising the front end, place jack stands under the frame to prevent the lift truck from falling.



Suggestions for Removal

In the case of double wheels, remove the outer wheel nuts and outer wheel. Then, remove the inner wheel nuts and inner wheel.

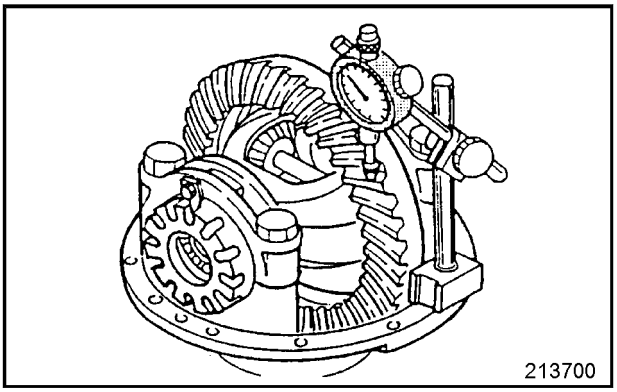
7.3.2.1 DISASSEMBLY

Suggestions for Disassembly

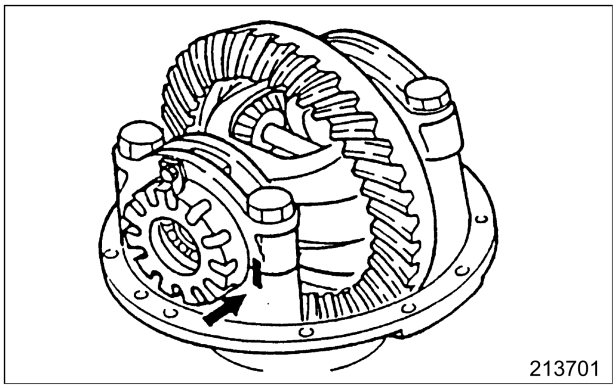
NOTE: 1) Before disassembling the differential, except for replacement of the reduction gear set, be sure to measure the gear backlash to ensure correct backlash at the time of assembly.

Items	Truck type	
	1 ton class 2 ton class	3 ton class
Backlash between reduction gear and reduction pinion	0.20 to 0.28 (0.0079 to 0.0110)	0.25 to 0.33 (0.0098 to 0.0130)

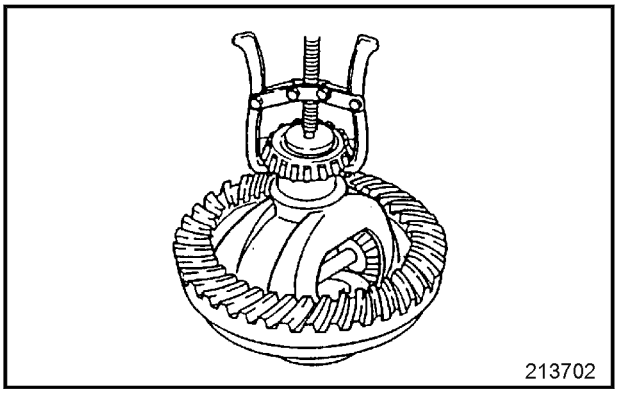
Unit: mm (in.)



NOTE: 2) Provide a matching mark across the bearing cap, adjusting screw and carrier on each side to ensure correct fitting.



(1) Removing bearing
Use a bearing puller to remove the inner bearing.



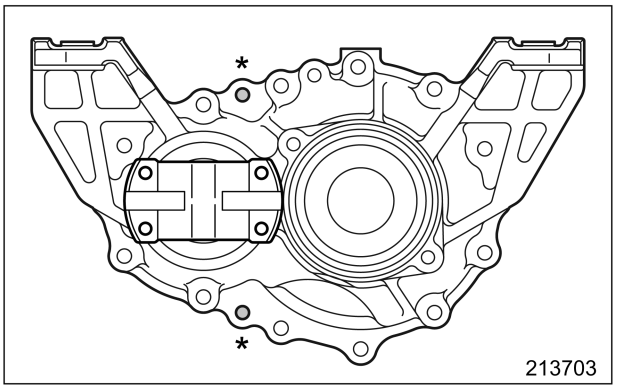
(2) Removing shims
After removing locknut **11** and shims, check and record the total thickness of the shims. Tie the shims to the locknut so as not to be lost.

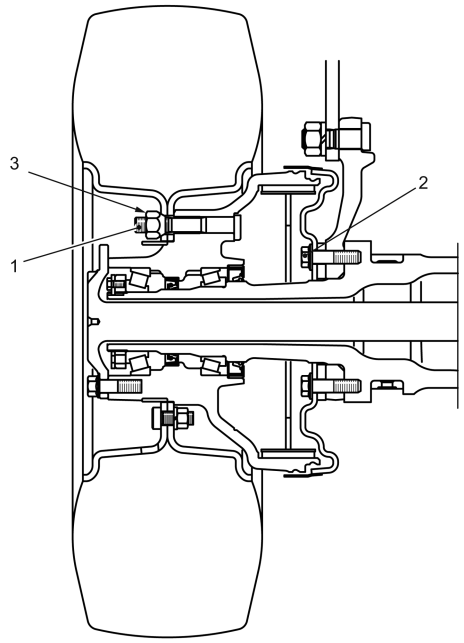
(3) Removing tapered roller bearing
Do not remove the tapered roller bearing (inner) from the reduction pinion **12** unless it is defective.

(4) Removing carrier cover
Screw jack bolts in two jack bolt holes (at the positions marked with *) and remove the carrier cover **15** while tapping near dowel pins (2 places) with a plastic mallet.

Jack bolt	Size	M10 × 1.25
	Nominal length	20 (0.79) or more

Unit: mm (in.)

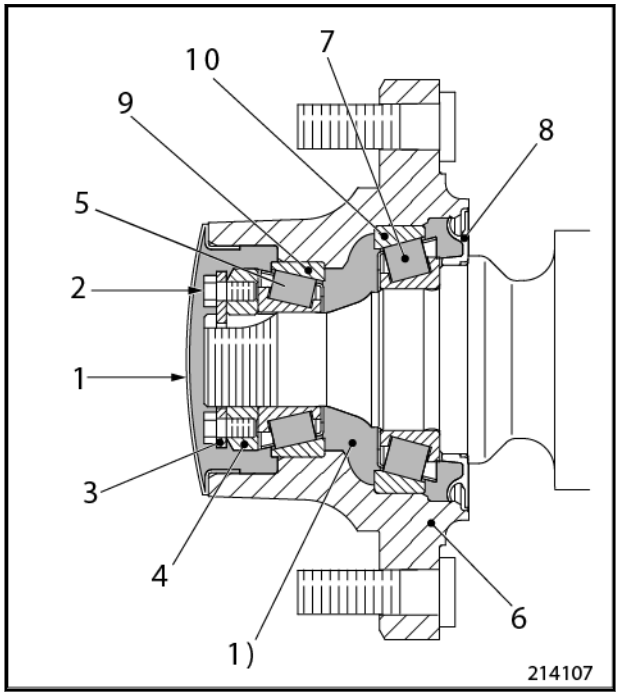


Item				Truck type		
				1 ton class	2 ton class	3 ton class
	Tightening torque of wheel nuts 3	N·m (kgf·m) [lbf·ft]	A	156.9 ± 15.7 (15.999 ± 1.601) [115.723 ± 11.580]	377.6 ± 37.8 (38.504 ± 3.855) [278.503 ± 27.880]	
	 213725					
A: Standard value B: Repair or service limit						

8.3 DISASSEMBLY AND REASSEMBLY

8.3.1 WHEEL HUB, DISASSEMBLY, AND ASSEMBLY

Assembly Sequence



1) AUTOLEX A OR EQUIVALENT

1. HUB CAP
2. BOLT
3. LOCK PLATE
4. LOCKNUT (HEXAGON NUT)
5. BEARING CONE
6. HUB (WITH BEARING CUP)
7. BEARING CONE
8. OIL SEAL
9. BEARING CUP
10. BEARING CUP

Suggestions for Disassembly

(1) Remove rear wheels as preparatory work.

(2) Check the hub for looseness. If there is looseness, the bearing may be worn.

(3) If the bearing is not damaged, it is unnecessary to remove it.

(4) The cup and the cone of the bearing make a pair. When replacing, replace them as a set.

(5) When removing the oil seal **8**, replace it with a new one. Do not reuse it.

(6) Use a special service tool to remove the bearing.

Inspections after Disassembly

(1) Bearing
Replace the bearing if damage, seizure, peel, rotation failure, or unusual noise is found.

(2) Hub
Replace the hub if cracks are detected by dye check.

(3) Oil seal
Replace a damaged or worn oil seal with a new one.

Suggestions for Assembly

To assemble, follow the disassembly sequence in reverse, paying attention to the following points.

(1) Fill grease (AUTOLEX A or equivalent) wheel bearing grease into the shaded area as shown in the below illustration Make sure to fill the roller retainer with sufficient grease. Also apply grease on the oil seal lip groove.

(2) Adjust the bearing. See "Adjusting procedure of wheel bearing assembly".

(3) Fill grease in the inside of the hub cup **1** before pushing in the hub cup **1**.

Adjusting procedure of wheel bearing assembly

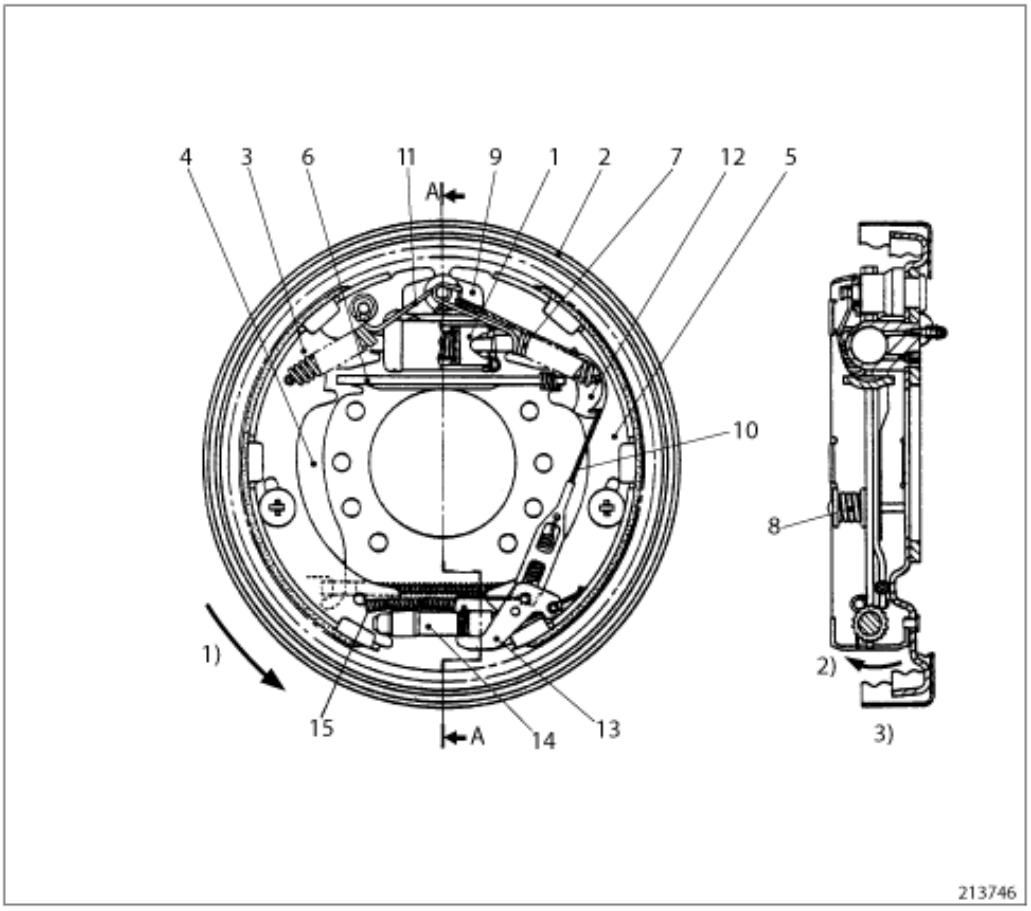
(1) Apply oil or grease on the contact surface of the locknut **1** with the wheel bearing.

(2) Turn the wheel hub **3** by hand and tighten the locknut **1** until the turn becomes difficult. Then, loosen the locknut by approximately 60 degrees from that position.

(3) Turn the rear wheel hub back and forth two to three times in the above condition to settle the cup and cone of the wheel bearing.

9.2.2 WHEEL BRAKES

1 ton class



1) DRUM ROTATING DIRECTION DURING FORWARD MOVEMENT
2) ADJUSTING SCREW ROTATING DIRECTION TO EXPAND SHOES
3) SECTION A-A

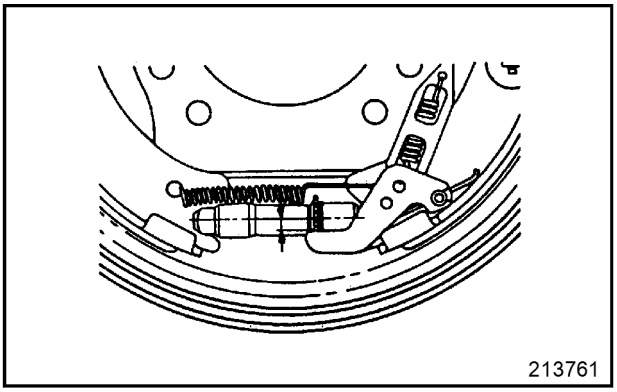
1. WHEEL CYLINDER
2. BACKING PLATE
3. SHOE AND LINING (PRIMARY)
4. PARKING BRAKE LEVER
5. SHOE AND LINING (SECONDARY)
6. STRAP
7. RETURN SPRING
8. HOLD-DOWN SPRING
9. SHOE GUIDE PLATE
10. FITTING CABLE
11. RETURN SPRING
12. SHEAVE
13. ADJUSTING LEVER
14. ADJUSTING SCREW
15. RETURN SPRING

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

Items	Truck type	
	1 ton class	2 ton class 3 ton class
Drum inside diameter	254 (10.0)	310 (12.2)
Drum-to-lining clearance A	0.25 to 0.5 (0.01 to 0.02)	0.1 to 0.35 (0.004 to 0.014)

Unit: mm (in.)

(2) If the lever fails, or turning the adjusting screw wheel is slow, check the position of the lever relative to the toothed wheel. The lever's actuating tip should touch the toothed wheel at approximately 7 to 9 mm (0.28 to 0.35 in.) below the center line of the screw. If the lever contact is out of range, the lever will not correctly engage with the toothed wheel, and the lever will either fail or the wheel will turn slowly.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(3) If the automatic adjuster fails to operate correctly, take the following actions.:

a. Ensure that the adjusting spring is correctly hooked to the primary shoe.

b. Replace the fitting cable.

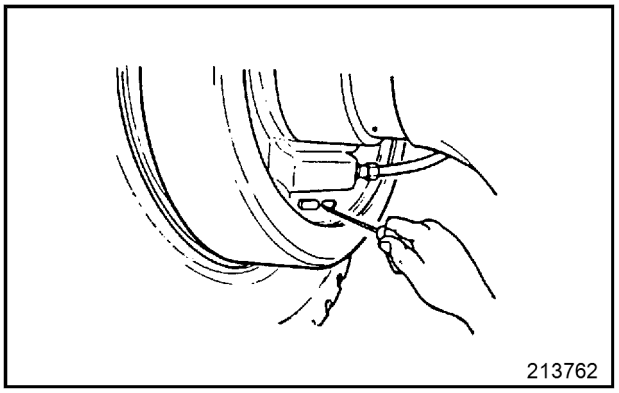
c. Replace the lever.

d. Replace the adjusting screw.

9.3.2 MANUAL ADJUSTMENT

Using a screwdriver through a hole on the back of the backing plate, adjust the drum-to-lining clearance to specification by rotating the adjusting screw wheel.

NOTE: Turning the wheel by one tooth corresponds to a change of 0.03 mm (0.0012 in.) in shoe diameter.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9.3.3 PARKING BRAKE CABLE ADJUSTMENT

(1) Install the parking brake cable to the parking brake lever. Set the lever "free" (the lever resting on the inner surface of the shoe as shown by the double-dashed chain line).

(2) With the lever setting "free", pull the cable until the shoe just starts working. The amount of cable pulled should meet the specified value below.

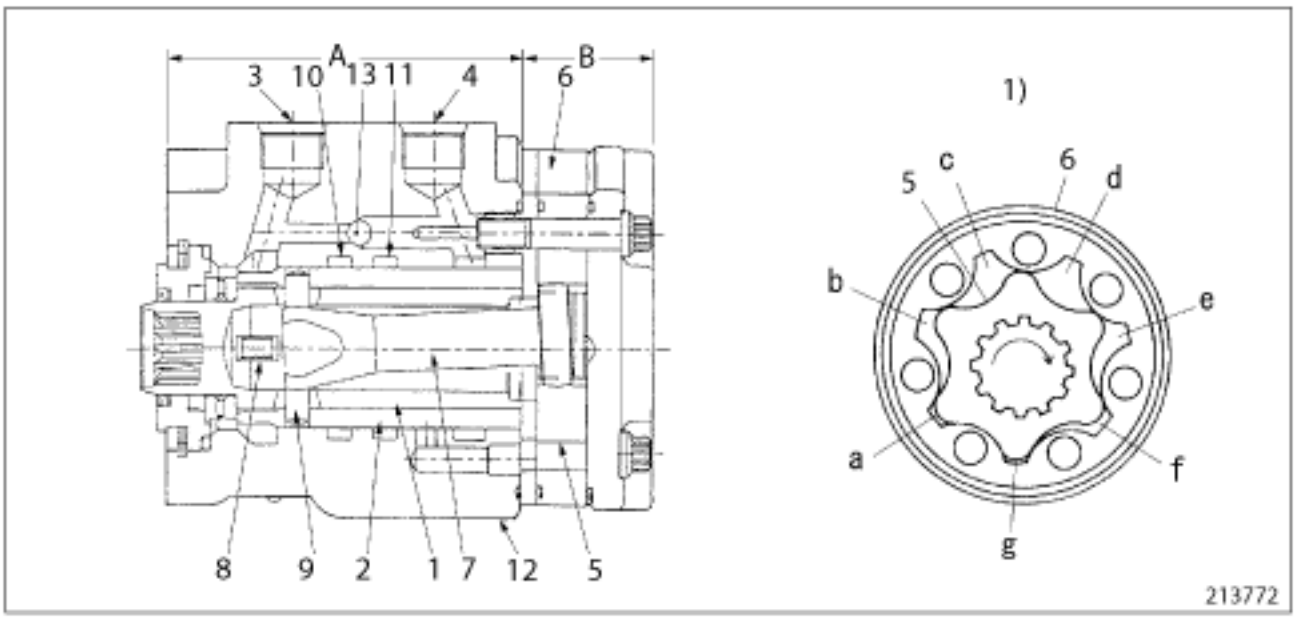
(3) Movement of parking brake lever for B distance from (1) position decides the NEUTRAL position. The inner cable length at this NEUTRAL position should be C length.

Items	Truck type	
	1 ton class	2 ton class 3 ton class
Free movement of cable before shoe starts working	10 (0.39) or less	14.3 (0.56) or less
Movement from free condition to NEUTRAL position	3 (0.12)	5 (0.20)
Inner cable length	44 ± 4 (1.73 ± 0.16)	

Unit: mm (in.)

For the priority valve and the steering cylinder, see Ch11. HYDRAULIC SYSTEM and Ch 8. REAR AXLE

10.1.1 STEERING VALVE



1) A, B, C : METERING PUMP INLETS D, E, F : METERING PUMP OUTLETS

A: CONTROL SECTION

B: METERING SECTION

1. SPOOL
2. SLEEVE
3. OUTLET PORT (PORT T)
4. INLET PORT (PORT P)
5. ROTOR
6. ROTOR RING
7. DRIVE SHAFT
8. CENTERING SPRINGS
9. PIN
10. PORT L
11. PORT R
12. HOUSING
13. CHECK VALVE

The steering valve consists of two sections: control section A and metering section B. Control section A is a rotary type directional control valve section that consists of spool **1**, sleeve **2**, and housing **12**.

The spool **1** is splined to the steering shaft.

When the spool **1** is turned, the sleeve **2** rotates, which causes the following passages to open.:

(1) A passage that allows oil to flow from the inlet port **4** to the metering section B.

(2) A passage that allows oil to flow from the metering section B to either port L or R.

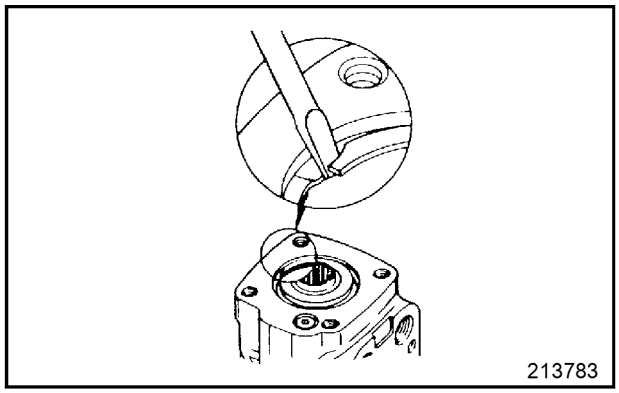
(3) A passage that allows the return oil from the steering cylinder to the outlet port T.

Metering section B is a small hydraulic pump called a "Gerotor" consisting of rotor ring **6** and rotor **5**. Both spool **1** and rotor **5** are coupled to the drive shaft **7**.

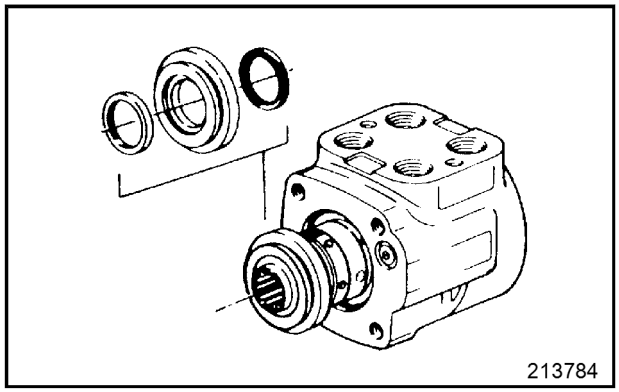
When the steering wheel is turned, the rotor **5** rotates in the same direction and at the same speed as the steering wheel does. When the

Suggestions for Disassembly

(1) Removing retaining ring
Remove the ring from the housing by gently prying its end out of the groove. Do not damage the machined surface.



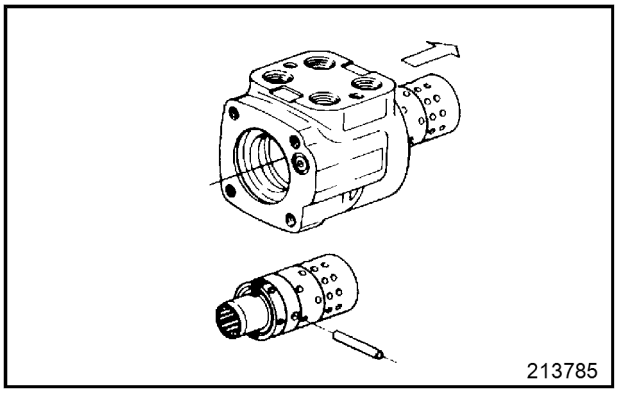
(2) Removing retaining ring
Position the control spool and control sleeve assembly so that the pin is even with the center of the assembly. Remove the gland bushing.



(3) Removing retaining ring
Remove the control spool and sleeve assembly from the housing by pulling it toward the end of the housing opposite to the flange. Remove the pin from the assembly.

⚠ CAUTION

To prevent damage to the housing, slowly pull out the assembly while twisting.



(4) Disassembling control spool and sleeved

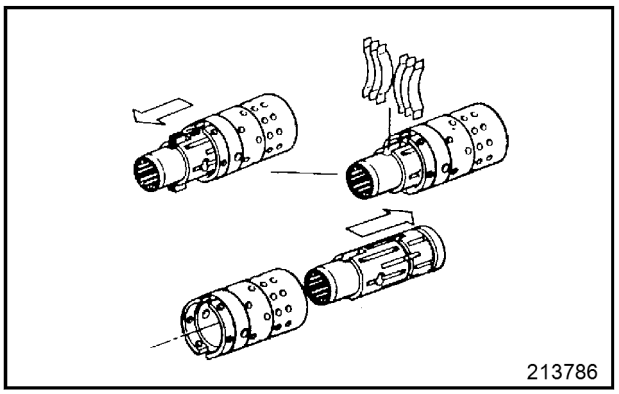
⚠ CAUTION

Before disassembly, put alignment marks across the spool and the sleeve for proper installation at assembly.

a. Pull the control spool from the sleeve enough to permit removal of the centering springs. Remove the centering springs.

b. Remove the centering springs.

c. Remove the spool from the sleeve by pulling it toward the rear end of the sleeve while turning slowly.



Inspections after Disassembly

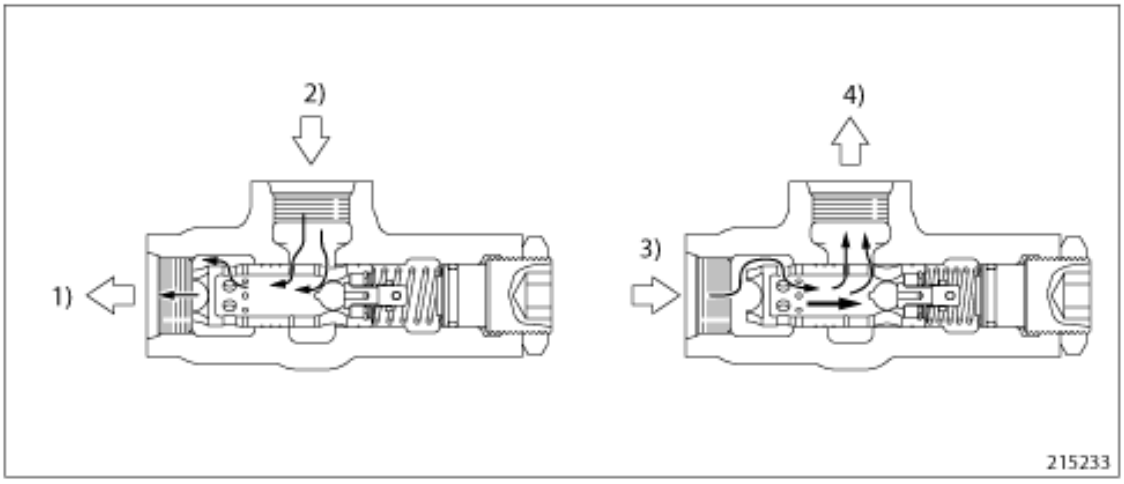
(1) Check sliding areas between the sleeve and the housing and between the sleeve and the spool.

a. Check for sliding movement in the sub-assembly condition.

MAIN COMPONENTS

1. PUMP SUCTION STRAINER: 100-MESH METAL STRAINER
2. HYDRAULIC PUMP (GEAR PUMP): A REGULAR GEAR PUMP IS DIRECTLY COUPLED TO THE ENGINE PTO. SEE "HYDRAULIC PUMP (GEAR PUMP), PAGE 11-8" FOR DETAILS.
3. HYDRAULIC PUMP DELIVERY HOSE: THE SHAPE OF THIS HOSE FOR THE DIESEL-ENGINE MODELS IS DIFFERENT FROM THAT OF THE GASOLINE ENGINE MODELS, AS THE HYDRAULIC PUMP LOCATIONS OF THESE TWO MODELS ARE DIFFERENT.
4. HYDRAULIC CONTROL VALVE: MC VALVE IS INSTALLED AS THE STANDARD VALVE. FC VALVE IS AVAILABLE AS AN OPTION. THE MC VALVE HAS A BUILT-IN FLOW REGULATOR VALVE. BUT THE FC VALVE DOES NOT HAVE A FLOW REGULATOR VALVE. BOTH MC AND FC MODELS TAKE ALMOST THE SAME PIPING ARRANGEMENT. FOR MORE DETAILS, SEE "PIPING, PAGE 11-47".
5. OIL LINE TO LIFT CYLINDER: FC TRUCKS HAVE A FLOW REGULATOR VALVE IN A DOWNSTREAM SECTION OF THIS LINE. THIS LINE ALSO HAS A HYDRAULIC PRESSURE SENSOR.
6. TILT CYLINDER
7. PIPING TO TILT CYLINDER
8. STEERING VALVE
9. RETURN OIL LINE FROM STEERING VALVE
10. OIL LINE TO STEERING CYLINDER
11. STEERING CYLINDER
12. RETURN LINE
13. LINE LEADING TO TOP OF LIFT CYLINDER PISTON: THIS LINE IS ONLY INSTALLED ON TRUCKS THAT HAVE A LIFT CYLINDER WITH A RETURN LINE. IT IS NOT INSTALLED ON TRUCKS WITH 3. 3 M (10.8 FT) OR SMALLER LIFT. IF THIS LINE IS NOT INSTALLED, THE BRANCHING HOLE FROM RETURN LINE 16 IS CLOSED WITH A BLIND PLUG.
14. RETURN FILTER: THIS CARTRIDGE-TYPE FILTER MUST BE REPLACED AT EVERY OIL CHANGE.
15. OIL CAP
16. LEVEL GAUGE

11.1.7 FLOW REGULATOR VALVE (FOR MODELS WITH FC CONTROL VALVE ONLY)

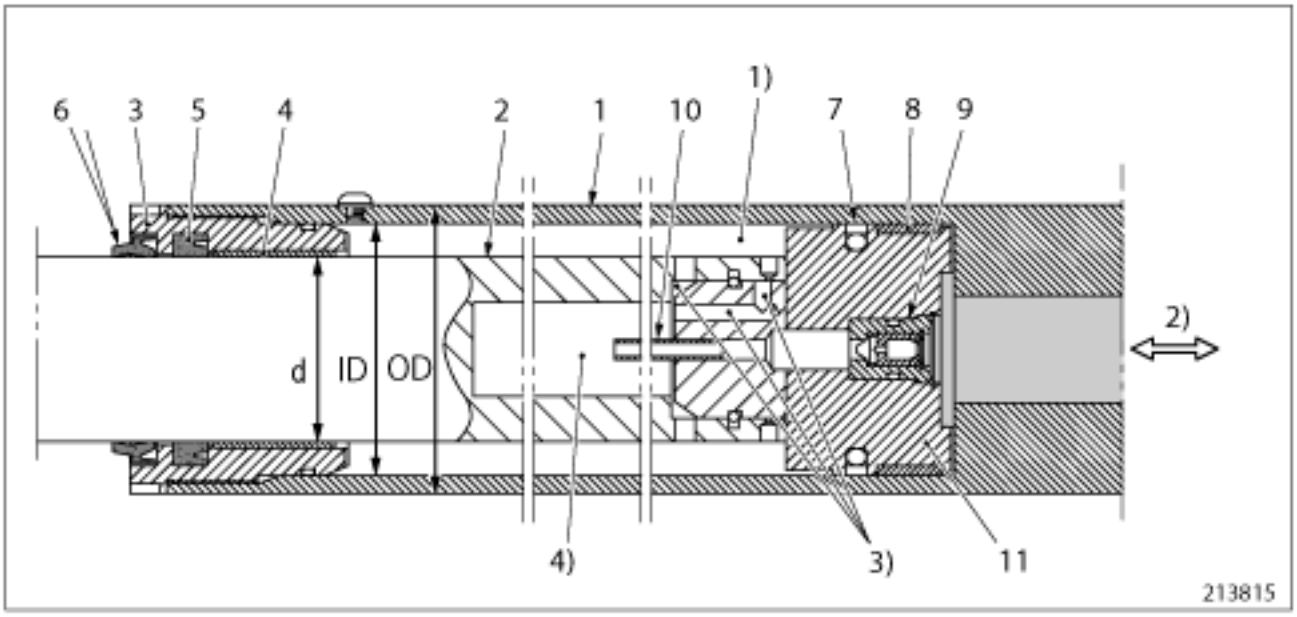


1) TO LIFT CYLINDER
2) FROM CONTROL VALVE
3) FROM LIFT CYLINDER
4) TO CONTROL VALVE

The flow regulator valve is connected between the control valve and the lift cylinder. When the forks are lowered, the valve regulates the oil flow as the load varies on the lift cylinder, thereby keeping the forks lowering speed constant, regardless of the load weight.

11.1.9.2 FIRST CYLINDER FOR DUPLEX MAST AND TRIPLEX MAST

Detail of inside



MAIN COMPONENTS

1) SPACE(B) CUSHION OIL IS FILLED IN THIS AREA.
2) INFLOW AND OUTFLOW
3) OIL PASSAGE
4) AIR CHAMBER(A)

1. CYLINDER TUBE ASSEMBLY
2. PISTON ROD ASSEMBLY
3. CYLINDER HEAD
4. BUSHING
5. U-RING
6. WIPER RING
7. SEAL RING ASSEMBLY
8. SLIDE RING
9. CHECK VALVE
10. STAND TUBE
11. PISTON

Action

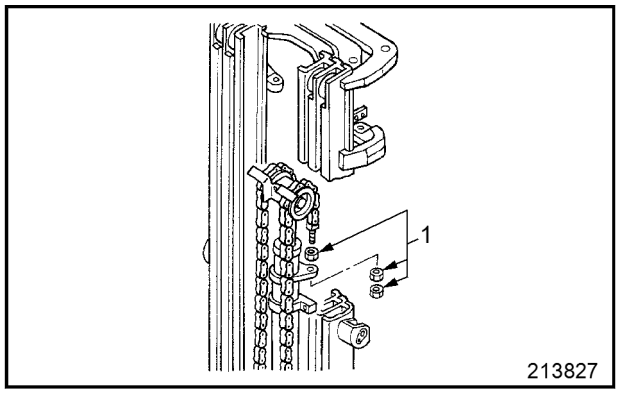
This cylinder, mounted on the center of the mast, acts first during the ascending stroke of the forks.

The piston rod extends from the cylinder tube by pressure oil acting on the piston bottom. To prevent an impulsive approach of the piston and the cylinder head at the last stage of its ascent, cushion oil is always filled in space B, between the cylinder tube and the piston rod. When the piston rod ascends, it ascends while pushing out cushion

Suggestions for Removal

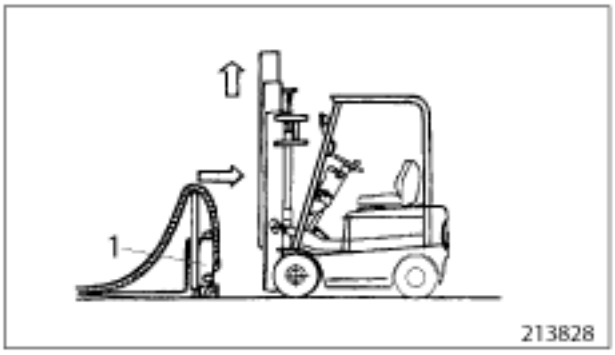
(1) Removing lift bracket assembly.

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



1. NUT

b. Position the mast upright. Raise the inner mast until the upper rollers of the lift bracket become free. Then, slowly move the lift truck in REVERSE to separate from lift bracket **2**.

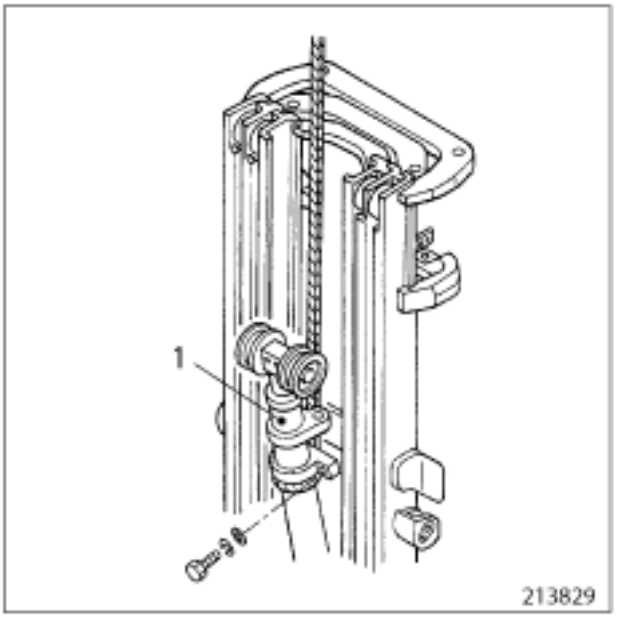


1. LIFT BRACKET

(2) Removing first lift cylinder

a. Attach a sling on the first lift cylinder **3**, and suspend it with a crane. Wind the rope securely to prevent slipping.

b. Remove lift cylinder mounting bolts, and gently remove the first lift cylinder **3**.



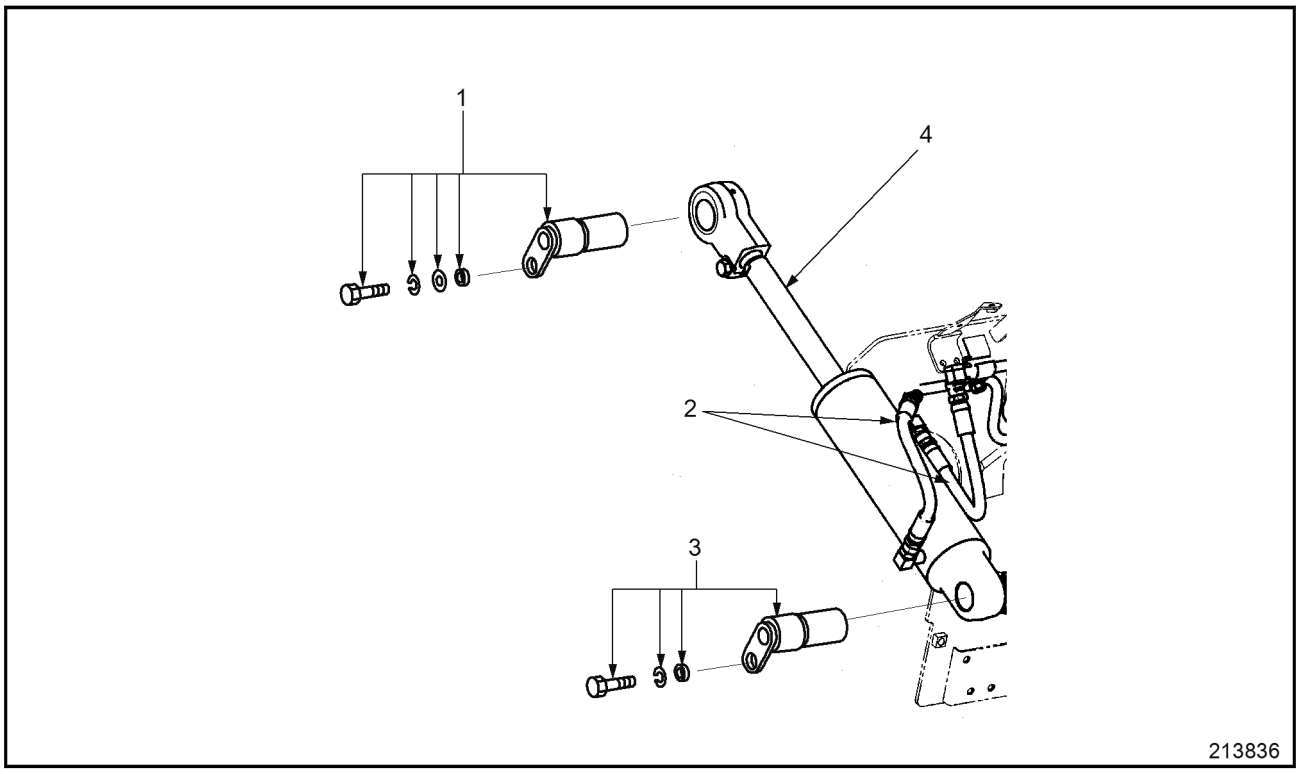
1. FIRST LIFT CYLINDER

(3) Removing second lift cylinders

a. Disconnect hoses from the second lift cylinders **5**.

b. Remove the set bolts at the upper sections of the second lift cylinders **5**, and lift the inner mast for duplex mast or middle mast for triplex mast approximately 55 cm (21.67 in.) using slings.

11.2.3 TILT CYLINDER



REMOVAL SEQUENCE

1. TILT CYLINDER PIN
2. HOSES (2 PIECES PER ONE CYLINDER)
3. TILT CYLINDER PIN
4. TILT CYLINDER

11.2.3.1 REMOVAL AND INSTALLATION

Start by

(1) Lower the forks to the bottom, and tilt the mast fully FORWARD.

(2) Attach a lifting sling on the round holes, (right and left), in the top crossmember of outer mast, and support the weight of the mast with a hoist.

Suggestions for Removal

(1) Retracting piston rod
Remove tilt cylinder pin **1**, and start the engine and retract the piston rod fully. Turn the engine OFF.

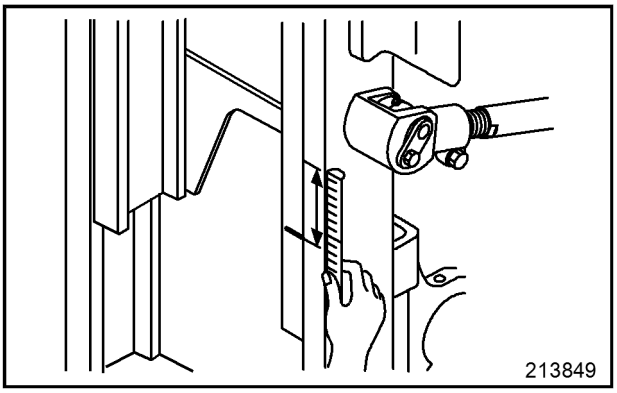
(2) Disconnecting hoses
Disconnect hoses **2** from the cylinder at the connectors. Use a drip pan to catch oil flowing out of the cylinder. Attach caps on the connectors of the cylinder to protect the threads of the connectors and to prevent oil from flowing out of the cylinder when the cylinder is removed.

(3) Removing tilt cylinder
Remove tilt cylinder pin **3**, and remove the cylinder.

Installation

To install, follow the removal sequence in reverse. Also follow the instructions shown below:

(1) After installing tilt cylinders, check the balance of mast tilting angle. Adjust if necessary. See Ch12. MAST AND FORKS for tilt angle adjustments.



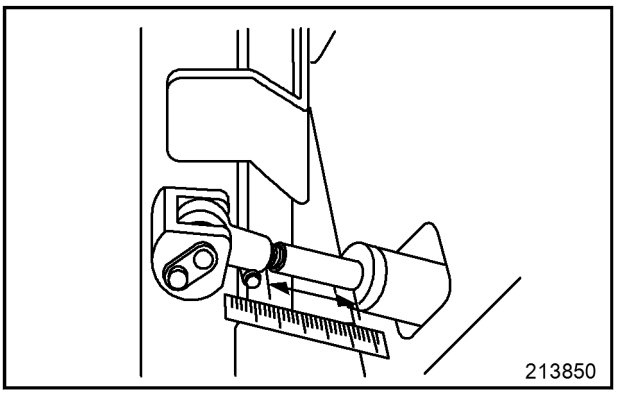
11.3.4 FORWARD TILT TEST

(1) Pick up a load equal to the rated capacity, place the mast to the VERTICAL position, lift the forks about 50 cm (20 in.), and turn the engine OFF.

(2) Measure the extension of tilt cylinder piston rod for 15 minutes.

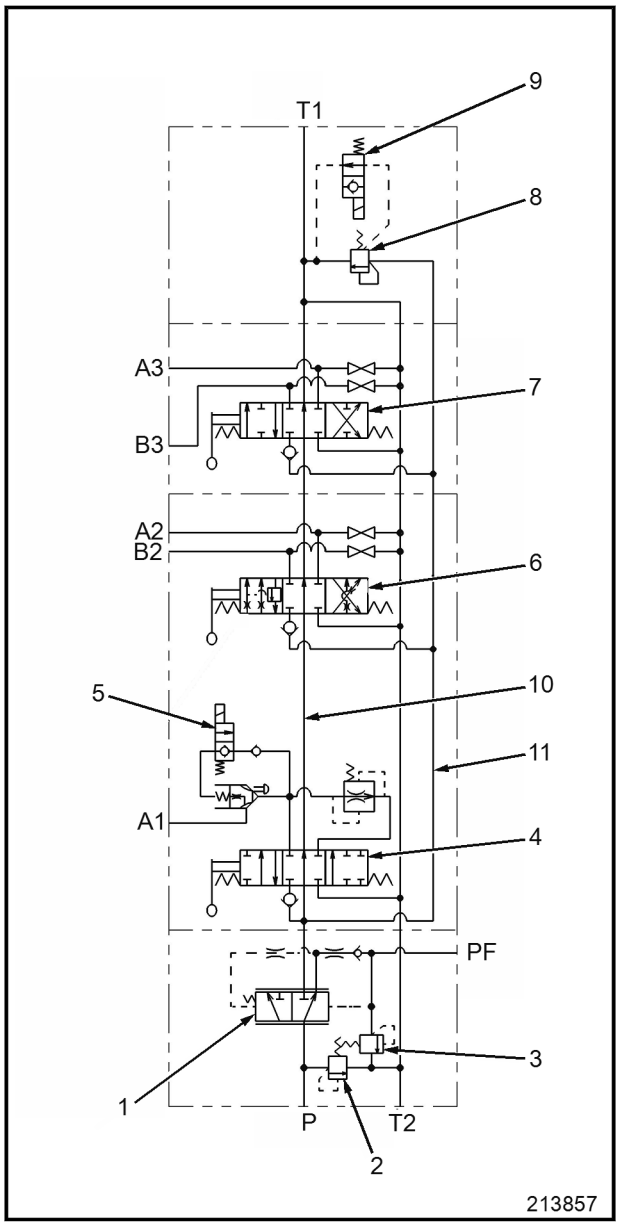
Items	Model type	
	1 ton class	2 ton class 3 ton class
Amount of forward (extension of piston rods) with rated load	20 (0.8) or less	

Unit: mm (in.)/15 min



11.6..2 HYDRAULIC CIRCUIT DIAGRAM OF MC HYDRAULIC CONTROL VALVE

- For the entire diagram of the hydraulic system, see "Hydraulic Circuit Diagram (for Models with MC Control Valve), Page 11-3".



P : SUPPLIED OIL FROM PUMP

PF : TO STEERING VALVE

T2 : RETURN FROM STEERING VALVE

T1 :TO HYDRAULIC TANK

A1 :TO LIFT CYLINDER

A2 : TO TILT CYLINDER ROD END

B2 : TO TILT CYLINDER HEAD END

A3 : TO ACTUATOR FOR ATTACHMENT VALVE

B3 : TO ACTUATOR FOR ATTACHMENT VALVE

1. PRIORITY VALVE
2. MAIN RELIEF VALVE
3. STEERING SYSTEM RELIEF VALVE
4. LIFT VALVE
5. SECOND VALVE (OPERATES IN CONJUNCTION WITH LIFT LOWERING SWITCH)
6. TILT VALVE
7. ATTACHMENT VALVE
8. UNLOAD VALVE
9. SOLENOID FOR UNLOAD VALVE
10. CENTER BYPASS PORT
11. PARALLEL FEEDER

Namely, as hydraulic pressure cannot be held, the cylinder cannot be moved even if the lift lever is moved.

When the operator sits on the operator seat, the seat switch is turned ON, actuating solenoid valve **1** to block the pilot passage. Thus, the parallel feeder can hold oil pressure.

This valve is a safety valve.

11.6.1 CONTROL VALVE, REMOVAL AND INSTALLATION

11.6.1.1 REMOVAL AND INSTALLATION

Removal

(1) Remove the floor plate.

(2) Remove the clevis pin of the control lever rod and separate the rod from the control valve spool.

(3) Disconnect each piping from the valve.

a. Pump delivery hose

b. Tilt pipe

c. Lift pipe

d. Return hose

e. Supply pipe to steering valve

f. Return hose from the steering valve

(4) Separate the solenoid valve and harness.

(5) Remove valve mounting bolts and nuts (arrows in Figure 11-12, Page 11-72) and remove the valve.

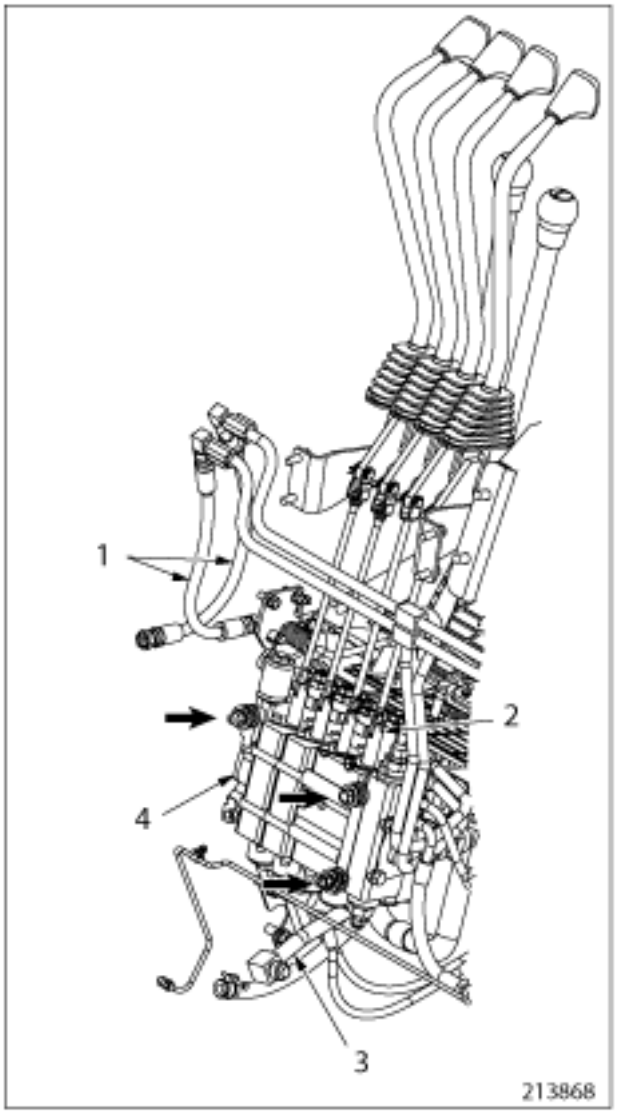


Figure 11-12.

1. TILT HOSES
2. CLEVIS PIN
3. LIFT HOSE
4. MC CONTROL VALVE

Installation

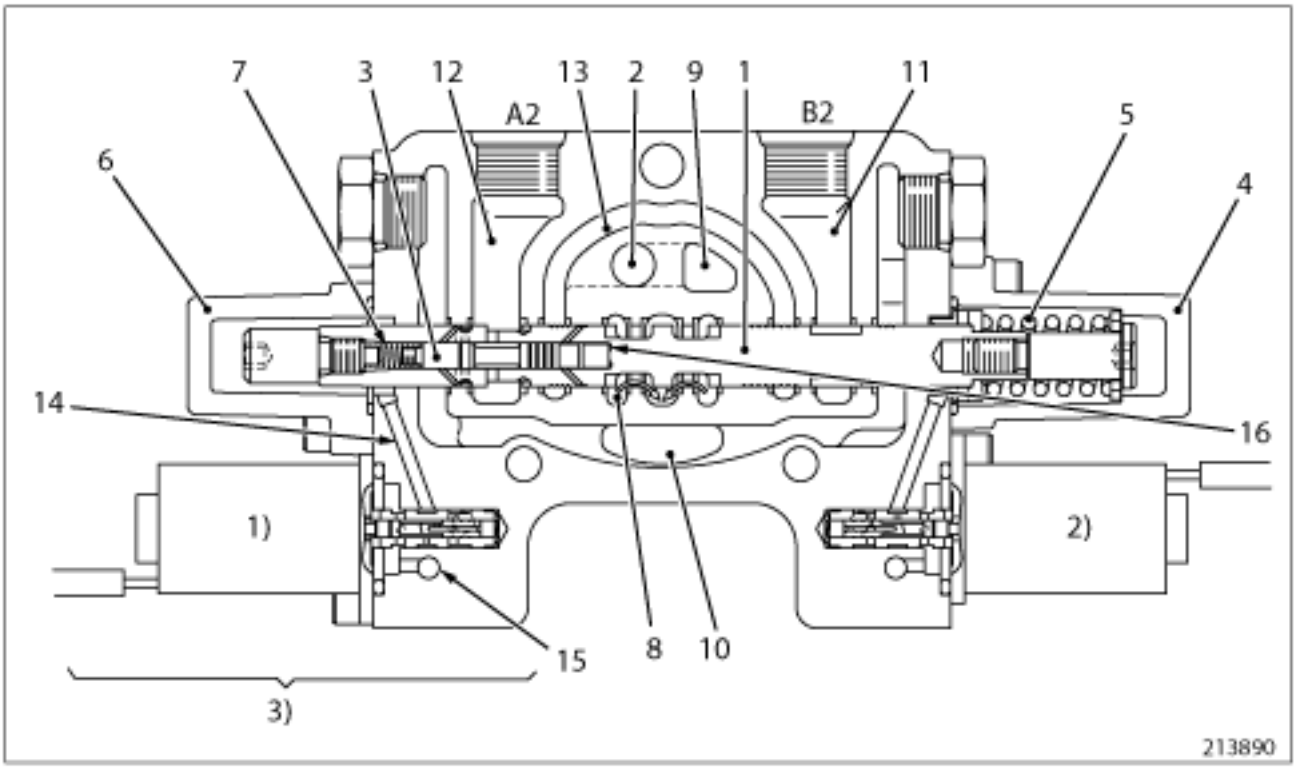
To install, follow the removal sequence in reverse. Also follow the instructions shown below:

Check the hydraulic oil level. Replenish it to the specified level if the level is low.

1) SECTION M - M
2) SECTION L- L
3) SECTION N - N
4) SECTION K - K
5) LIFT CONTROL VALVE 8

1. FLOW PRIORITY VALVE
2. PF RELIEF VALVE
3. MAIN RELIEF VALVE
4. MAIN RELIEF VALVE (PILOT)
5. UNLOAD VALVE
6. RESISTOR VALVE
7. PRESSURE REDUCING VALVE
8. LIFT CONTROL VALVE

11.7..4 TILT VALVE ASSEMBLY



MAIN COMPONENTS

1) SOLENOID A2
2) SOLENOID B2

1. MAIN SPOOL
2. CHECK VALVE
3. TILT LOCK VALVE
4. CAP (SOLENOID B2 SIDE)
5. SPRING (SOLENOID B2 SIDE)
6. CAP (SOLENOID A2 SIDE)
7. SPRING
8. NEUTRAL PASSAGE

3) PROPORTIONAL ELECTROMAGNETIC PRESSURE REDUCING VALVE

9. HIGH-PRESSURE PASSAGE (PARALLEL FEEDER)
10. LOW-PRESSURE PASSAGE (TO T1)
11. PASSAGE TO PORT (B2)
12. PASSAGE TO PORT (A2)
13. OIL PASSAGE
14. PASSAGE OF PILOT OIL FOR VALVE SPOOL
15. DRAIN PASSAGE
16. CHAMBER

Actuation of Valve with Attachment Lever in "NEUTRAL" Position

When the tilt lever is in the "NEUTRAL" position, the proportional solenoids a2 and b2 are inactive.

Since the electromagnetic proportional pressure control valve releases oil in the caps **4** and 6 into the drain passage **15** through the passage **14**, there is no pressure in the caps.

Therefore, the main spool **1** is maintained in the position shown in the above illustration, with the passages to ports A2 and B2 closed.

Extra flow of oil divided by the priority valve of the inlet valve assembly flows into the tank through the neutral passage.

ASSEMBLY OF LIFT CONTROL VALVE (1 TO 19)

1) TIGHTENING TORQUE: 20.6 ± 2.1 N·M (2.1 ± 0.2 KGF·M) [15.1 ± 1.6 LBF·FT]
2) TIGHTENING TORQUE: 34.3 ± 3.4 N·M (3.5 ± 0.3 KGF·M) [25.3 ± 2.5 LBF·FT]
3) TIGHTENING TORQUE: 63.7 ± 6.4 N·M (6.5 ± 0.6 KGF·M) [47 ± 4.7 LBF·FT]
4) TIGHTENING TORQUE: 3.43 ± 3.4 N·M (3.5 ± 0.3 KGF·M) [25.3 ± 2.5 LBF.FT]
5) TIGHTENING TORQUE: 48 ± 4.8 N·M (4.9 ± 0.5 KGF·M) [35 ± 3.0 LBF·FT]
6) TIGHTENING TORQUE: 15.7 ± 1.6 N·M (1.6 ± 0.16 KGF·M) [11.5 ± 1.0 LBF·FT]
7) TIGHTENING TORQUE: 15.7 ± 1.6 N·M (1.6 ± 0.16 KGF·M) [11.5 ± 1.0 LBF·FT]

1. LIFT SPOOL
2. SPRING
3. VALVE
4. SPOOL HEAD
5. CAP
6. SPRING SEAT
7. SPRING [FREE LENGTH: 31.2 MM (1.228 IN.)]
8. SPRING SEAT
9. O-RING
10. BOLT
11. CAP
12. ADJUSTER KIT
13. O-RING
14. SPRING SEAT
15. SPRING [FREE LENGTH: 31.2 MM (1.228 IN.)]
16. SPRING SEAT
17. BOLT
18. ELBOW
19. O-RING

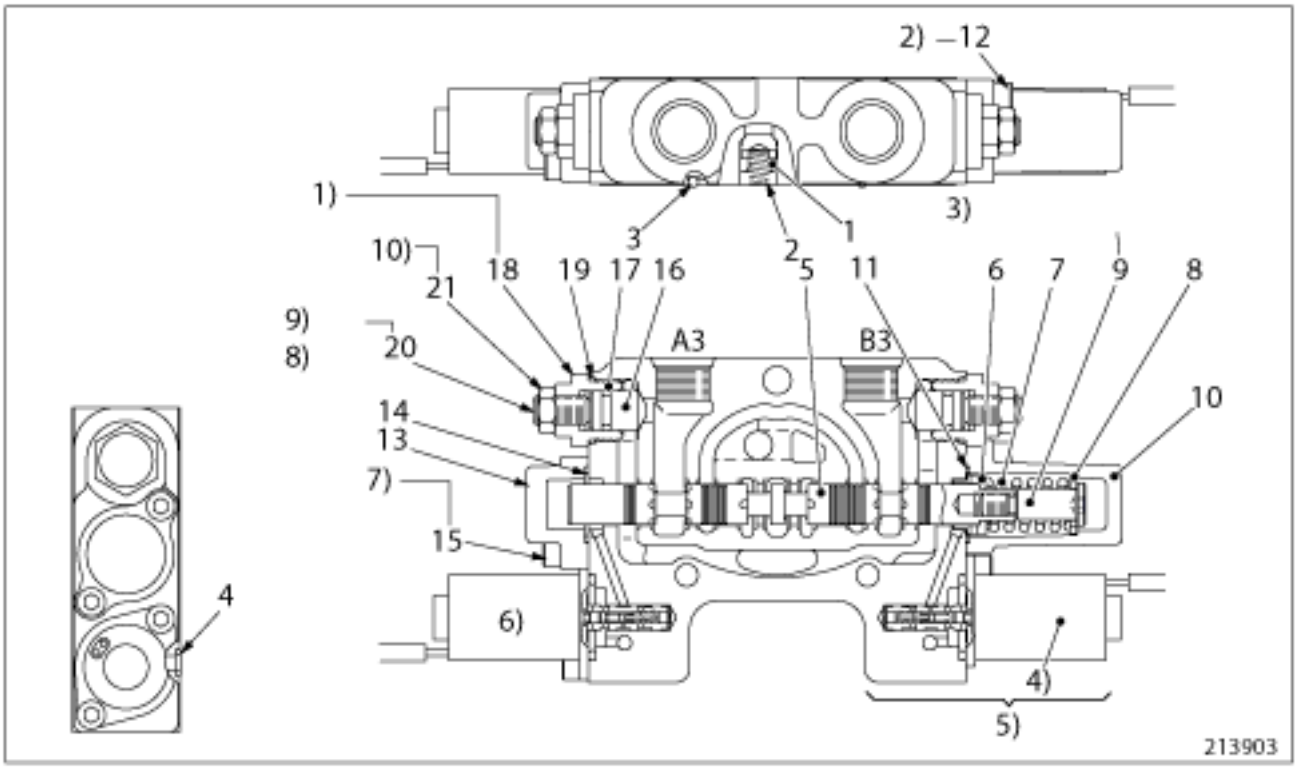
ASSEMBLY OF LIFT CONTROL VALVE (20 TO 24)

20. WAVE WASHER
21. VALVE SET
22. O-RING
23. SOLENOID VALVE ASSEMBLY
24. BOLT

ASSEMBLY OF LOAD CHECK VALVE AND ASSOCIATED PILOT OIL LINE (25 TO 31)

25. POPPET
26. SPRING
27. O-RING
28. PLUG
29. O-RING
30. PLUG
31. SHUTOFF VALVE

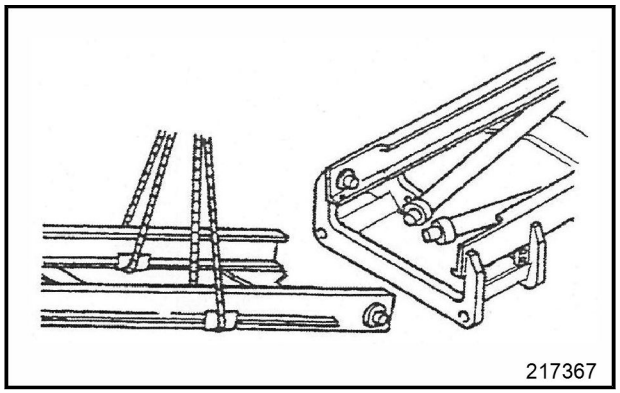
Attachment valve



Suggestions for Disassembly

(1) Removing mast strips and main rollers
Remove bolts **11** and **12** to free lift cylinder **18**. Cross the two lift cylinders at the tops. Slide the inner mast **16** toward the bottom of outer mast **19**, and remove main rollers **14** and **15** and mast strips **13**.

(2) Removing inner mast
After removing the main rollers, attach slings on the inner mast crossmember and slide the inner mast to the upper side of the outer mast to clear the outer mast roller shafts. Attach a slings on the inner mast again and remove it from the outer mast.



Inspections after Disassembly

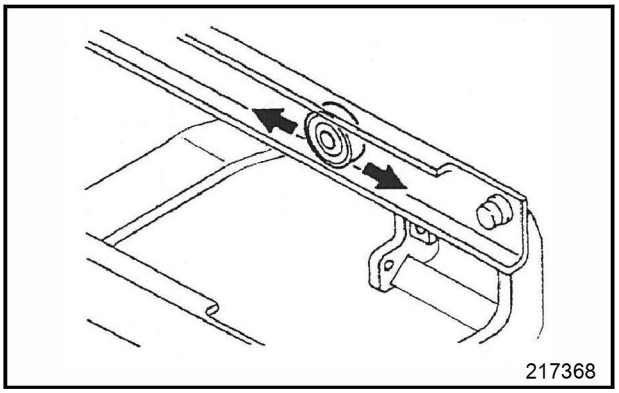
(1) Mast

a. Check each roller for wear, binding or other defects.

b. Check each roller on rolling surface for pitting or other defects.

c. Check the mast member and the welded joints of crossmembers, shafts, and supports for cracks.

d. Check the mast support bushings for wear or other defects.



(2) Lift bracket

a. Check the main rollers and side rollers for smooth rotation. Inspect each roller for wear and cracks.

b. Check the welded portions of the bracket for cracks.

c. Check the finger bar for bend or distortion.

Distortion of finger bar	A	5 (0.2) maximum

A: Standard value
Unit: mm (in.)

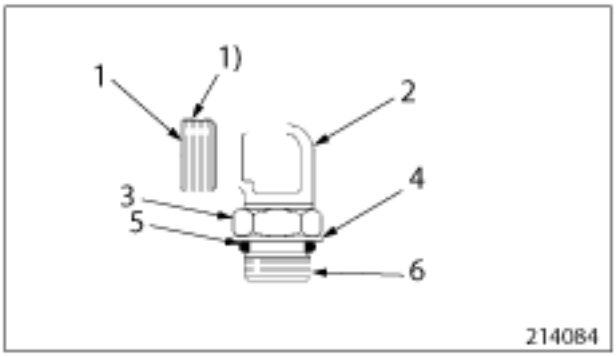
(3) Lift chains, chain wheels, and chain wheel supports

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

b. Check each chain anchor bolt for cracks or defects on thread.

c. Check each chain wheel support and chain wheel for cracks or wear. Check that the wheels rotate smoothly.

(4) Mast strip
Check the mast strips for damage, wear, or distortion.



1) SHAPE VARIES BY FITTING TYPE

1. END OF FITTING BODY (CONNECTS TO TUBE)
2. FITTING BODY
3. LOCKNUT
4. BACKUP WASHER
5. O-RING SEAL
6. END OF FITTING THAT GOES INTO HOUSING

12.5 REMOVAL AND INSTALLATION OF MAST ROLLERS AND STRIPS WITHOUT REMOVING MAST FROM TRUCK

12.5.1 SIMPLEX MAST

- The mast rollers and strips can only be removed or installed when the inner mast is positioned lower than the outer mast. This can be achieved as follows:

(1) Disconnect the lift bracket assembly.

(2) Lift the front of the lift truck by 150 to 200 mm (5.91 to 7.87 in.), and place blocks to support the lift truck.

(3) Remove the set bolts at the top of the lift cylinders. Place a sling around the inner mast. Lift the inner mast using a hoist connected to the sling in order to disengage the lift cylinders' piston rods from the inner mast. Remove the hose guard.

(4) Remove the lift cylinder clamp bolts, and separate the lift cylinders from the outer mast. Pull out the lift cylinders from the seats at the bottom of the outer mast. Tilt the cylinders until they rest on the outer mast cross member. Using a rope, fix the cylinders onto the crossmember.

(5) Using the hoist, slowly lower the inner mast until the mast contacts the lift cylinders.

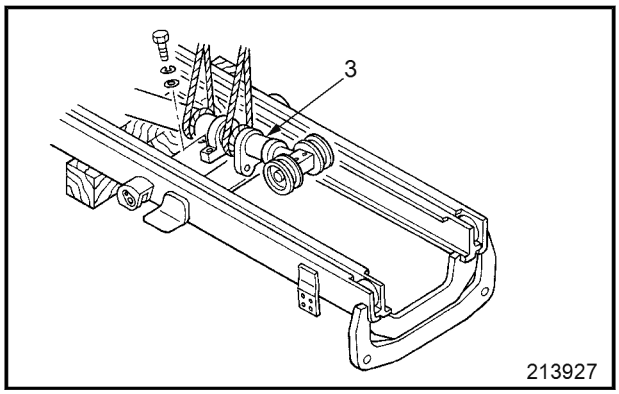
(6) The main rollers of the inner and outer masts can now be removed. Remove the mast strips and shims before attempting to remove the main rollers, as they tend to drop easily.

(7) Adjust shims for the main rollers and mast strips as required.

- To assemble, follow the disassembly sequence in reverse.

Lift bracket or inner mast are not in a level position	Too much clearance on side rollers	Adjust by adding shims
	Lift chains unequally tensioned	Adjust chain tension
	Shim adjustments unequally made on between left and right lift cylinders (at maximum height)	Remove or add shims
Mast makes noise	Rollers not rotating smoothly on their shafts	Check and adjust or replace rollers
Lift cylinder descends due to a load (Drift)	Lift cylinder packing damaged	Replace
	Sliding (inside) surface of lift cylinder tube damaged	Replace
Whole mast shakes	Mast-support bushing or metal worn	Tighten or replace
Mast is distorted	Off-center loading or overload	Replace mast assembly
Fork tips differ in height	Distortion of finger bar	Repair or replace
	Distortion of forks	
	Uneven loading	

Place a wood block as a wedge to prevent the inner mast from sliding.



3. FIRST LIFT CYLINDER

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

Suggestions for Disassembly

(1) Removing first lift cylinder

a. Remove retaining bolts **2** from the first lift cylinder.

b. Attach slings on the first lift cylinder, and gently remove the cylinder. Use two slings. Wind or tie slings securely to prevent slipping.

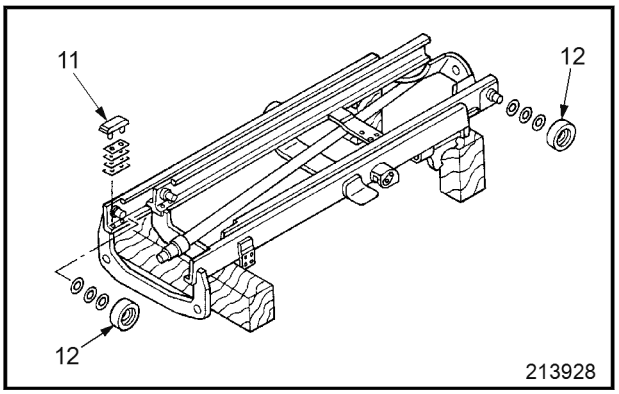
(2) Removing main rollers and mast strips

a. Remove clamp bolts **9** from the second lift cylinders.

b. Remove bolts **10** from the upper rod sections of the second lift cylinders, and place the cylinders on the outer mast.

c. Check the number of shims and shim thickness at the rod end sections.

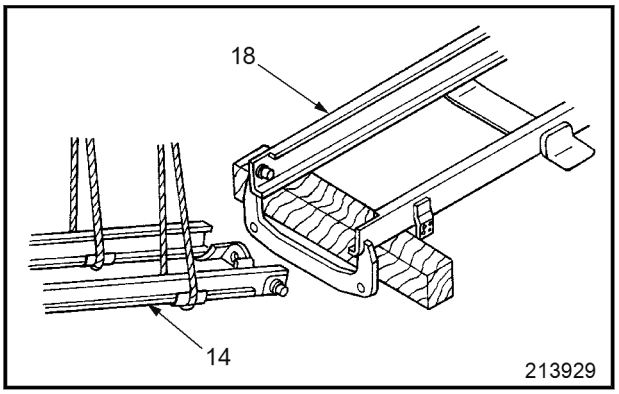
d. Lower the inner mast, then remove main rollers **12** and mast strips **11**.



11. MAST STRIPS, SHIMS

12. MAST ROLLERS

(3) Removing inner mast
Using slings, lift and remove inner mast, steering it clear of the roller shaft sections of outer mast.



14. INNER MAST

18. OUTER MAST

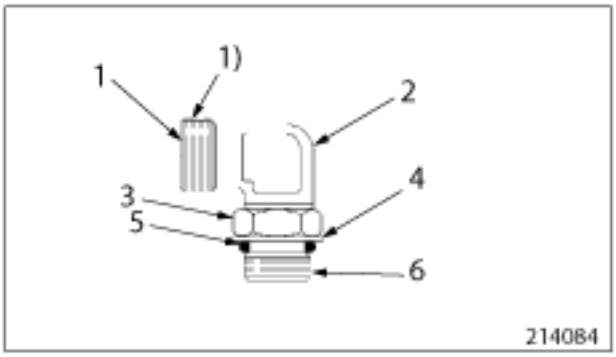
Inspections after Disassembly

(1) Mast

a. Check each roller for wear, binding, or other defects.

b. Check each roller on rolling surface for pitting or other defects.

c. Check the mast member and the welded joints of crossmembers shafts, and supports for cracks.



ELBOW WITH NUT

1) SHAPE VARIES BY FITTING TYPE

1. END OF FITTING BODY (CONNECTS TO TUBE)
2. FITTING BODY
3. LOCKNUT
4. BACKUP WASHER
5. O-RING SEAL
6. END OF FITTING THAT GOES INTO THE HOUSING

12.13 REMOVAL AND INSTALLATION OF MAST ROLLERS AND STRIPS WITHOUT REMOVING MAST FROM TRUCK

12.13.1 DUPLEX MAST

(1) Disconnect the lift bracket assembly.

(2) Remove the first cylinder as follows:

a. Attach a slings on the first lift cylinder, and suspend it with a crane. Wind the rope securely to prevent slipping.

b. Remove the cylinder mounting bolts. Using the hoist, slowly lift and remove the first cylinder.

(3) Place the inner mast lower than the outer mast. Follow the following procedures:

a. Lift the front of the lift truck by 150 to 200 mm (5.91 to 7.87 in.), and place wood blocks to support the lift truck.

b. Remove the set bolts at the top of the second lift cylinders. Place a sling around the inner mast. Lift the inner mast using a hoist connected to the sling in order to disengage the second lift cylinders' piston rods from the inner mast. Remove the hose guard.

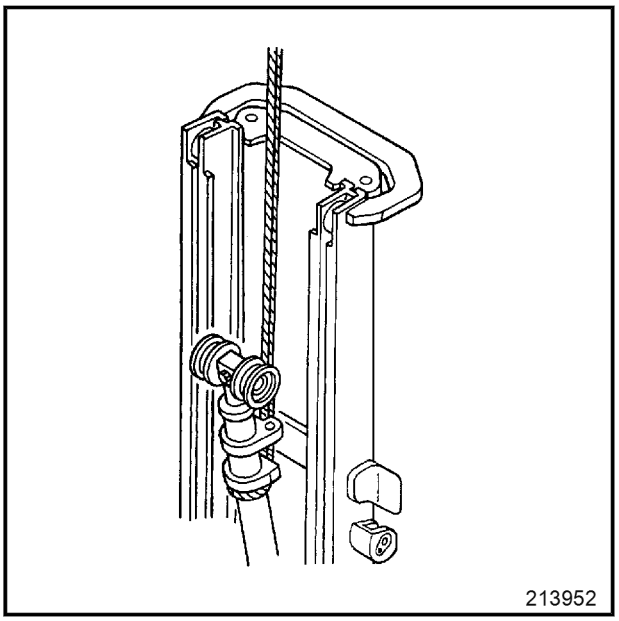
c. Remove the second lift cylinder clamp bolts and separate the lift cylinders from the outer mast. Pull out the second lift cylinders from the seats at the bottom of the outer mast. Tilt the cylinders until they rest on the outer mast crossmember. Using a rope, fix the cylinders onto the cross member.

d. Using the hoist, slowly lower the inner mast until the inner mast contacts the second lift cylinders fixed to the cross member.

e. The main rollers of the inner and outer masts can now be removed. Remove the mast strips and shims before attempting to remove the main rollers, as they tend to drop easily.

f. Adjust shims for the main rollers and mast strips as required.

- To assemble, follow the disassembly sequence in reverse.

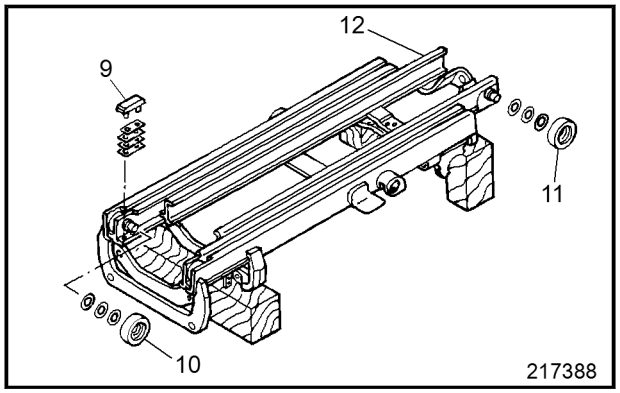


Item				Truck type		
				1 ton class	**2 ton class**	**3 ton class**
Dimension (Reference)	Duplex mast	Width of outer mast B	A	610 (24.02)	670 (26.38)	670 (26.38)
		Width of inner mast B2	A	516 (20.13)	568 (22.36)	568 (22.36)
		Width of lift bracket C	A	408 (16.06)	458 (18.03)	458 (18.03)
Clearances	Mast	Clearance between main roller circumference and mast thrust surface F	A	1 (0.04) or less		
		Clearance between main roller side surface and mast thrust surface G	A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between inner mast and mast strip G2	A	0.1 to 0.5 (0.004 to 0.020)		
	Lift bracket	Clearance between main roller circumference and inner mast F	A	1 (0.04) or less		
		Clearance between middle roller side surface and inner mast thrust plate G	A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between lower roller side surface and inner mast thrust surface G	A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between side roller circumference and inner mast surface G1	A	0.1 to 0.5 (0.004 to 0.020)		
Distortion of finger bar			A	5 (0.20) or less		

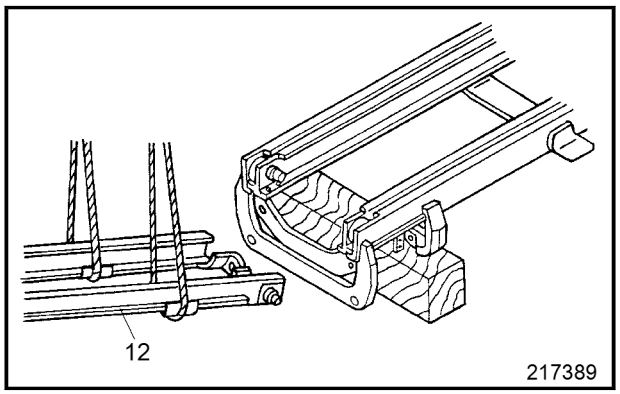
A: Standard value B: Repair or service limit

Unit: mm (in.)

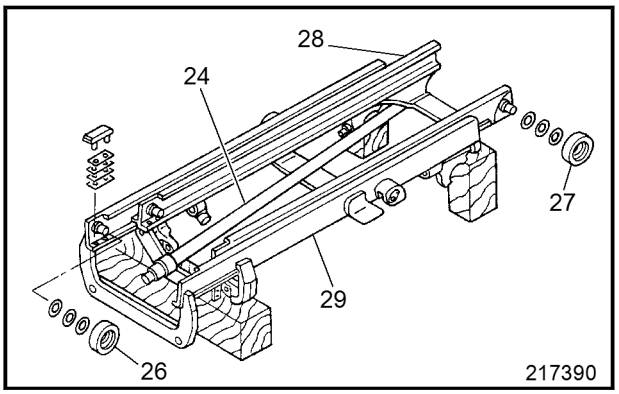
(2) Removing inner mast and main rollers
Lower inner mast **12** until main rollers **10**, **11** can be removed. Remove the rollers and mast strips **9**.



(3) Removing inner mast
Using slings, lift and remove inner mast **12**, steering it clear of the roller shaft sections of the middle mast.



(4) Removing main rollers **26**, **27** from middle mast **28** and outer mast **29**.
Remove the bolts that are holding second lift cylinders **24**. Place the cylinder rod ends on the outer mast. Lower middle mast **28** until main rollers **26**, **27** can be removed. Then, remove the main rollers.



12.20.1.1 INSPECTIONS AFTER DISASSEMBLY

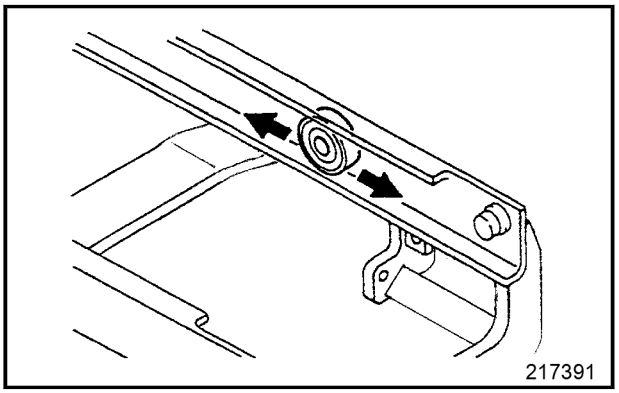
(1) Mast

a. Check each roller for wear, binding, or other defects.

b. Check each roller on rolling surface for pitting or other defects.

c. Check the mast member and the welded joints of crossmembers, shafts, and supports for cracks.

d. Check the mast support bushings for wear or other defects.



(2) Lift bracket

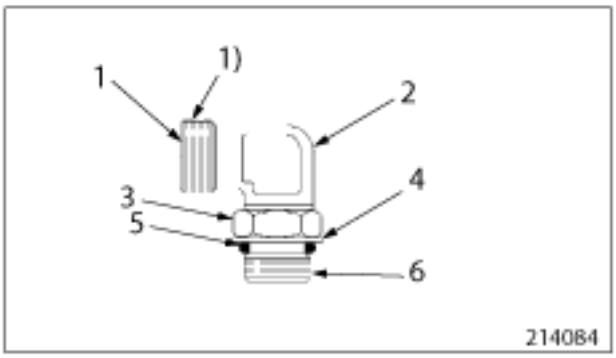
INSTALLATION OF A FITTING WITH STRAIGHT THREADS AND O-RING SEAL

(1) Apply grease or hydraulic oil on the O-ring and O-ring seat in the housing side.

(2) Turn locknut **3** to move it fully to the fitting body **2**. Place washer **4** and O-ring seal **5** against the locknut.

(3) Tighten the fitting by hand. Once O-ring seal **5** is placed in the position of housing and washer **4** comes in contact with the surface of housing, turn it back to adjust the mounting direction. DO NOT loosen more than 1 turn.

(4) Tighten locknut **3** to the specified torque.



ELBOW WITH NUT

1) SHAPE VARIES BY FITTING TYPE

1. END OF FITTING BODY (CONNECTS TO TUBE)
2. FITTING BODY
3. LOCKNUT
4. BACKUP WASHER
5. O-RING SEAL
6. END OF FITTING THAT GOES INTO THE HOUSING

12.21 REMOVAL AND INSTALLATION OF MAST ROLLERS AND STRIPS WITHOUT REMOVING MAST FROM TRUCK

12.21.1 TRIPLEX MAST

(1) Disconnect the lift bracket assembly.

(2) Remove the first lift cylinder as follows:

a. Place a sling around the cylinder. Using a hoist connected to the sling, slightly lift the cylinder. The sling should be attached firmly around the cylinder to prevent the cylinder from slipping down.

b. Remove the cylinder mounting bolts. Using the hoist, slowly lift and remove the first lift cylinder.

(3) Place the inner mast lower than the middle mast. Follow the following procedures:

a. Lift the front of the lift truck by 150 to 200 mm (5.91 to 7.87 in.), and place wood blocks to support the lift truck.

b. Place a sling around the upper crossmember of the inner mast. Using a hoist connected to the sling, slightly lift the inner mast.

c. Remove the guards for the second lift chain wheels.

d. Disconnect the second lift chains at the outer mast ends, and place the loose ends on the floor beyond the inner mast.

e. Lower the inner mast to such a height that allows the mast rollers to be removed.

f. Support the inner mast with wood blocks.

g. The main rollers of the inner and middle masts can now be removed. Remove the mast strips and shims before attempting to remove the main rollers, as they tend to drop easily.

h. Adjust shims for the main rollers and mast strips as required.

⚠ CAUTION

With the mast disassembled as above, the second lift cylinders cannot be removed.

12.23 TROUBLESHOOTING (TRIPLEX MAST)

12.23.1 TRIPLEX MAST

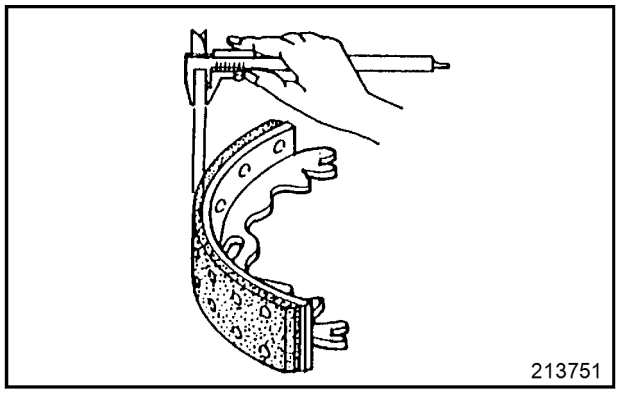
Lift bracket and inner mast do not move smoothly	Clearance between lift rollers and side rollers incorrect	Adjust clearance
	Rollers not rotating smoothly on their shafts	Lubricate side rollers and replace other rollers
	Mast strip clearance incorrect	Adjust shims
Lift bracket or inner mast are not in a level position	Too much clearance on side rollers	Adjust by adding shims
	Lift chains unequally tensioned	Adjust chain tension
	Shim adjustments unequally made on between left and right lift cylinders (at maximum height)	Remove or add shims
Mast makes noise	Rollers not rotating smoothly on their shafts	Check and adjust or replace rollers
Lift cylinder descends due to a load (Drift)	Lift cylinder packing damaged	Replace
	Sliding (inside) surface of lift cylinder tube damaged	Replace
Whole mast shakes	Mast-support bushing or metal worn	Tighten or replace
Mast is distorted	Off-center loading or overload	Replace mast assembly
Fork tips differ in height	Distortion of finger bar	Repair or replace
	Distortion of forks	
	Uneven loading	

- Measure the brake lining thickness. If the lining thickness exceeds a service limit, replace the lining with a new one.

Items		Weight class	
		1 ton class	2 ton class 3 ton class
Thickness of linings	A	4.87 (0.19)	5.7 (0.22)
	B	1.0 (0.04)	1.0 (0.04)

A: Standard value B: Service limit
Unit: mm (in.)

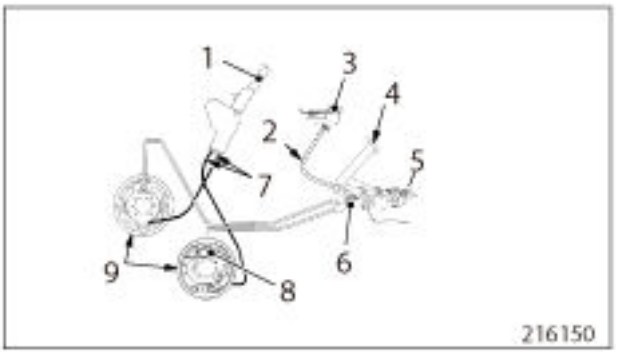
NOTE: See "Brake System, Page 9-1".



(3) Check brake hose, pipes, and joints.

Service Hours	Daily (10 hrs)

- Check hoses and pipes for cracks or damage.
- Check for joint looseness and brake fluid oozing.

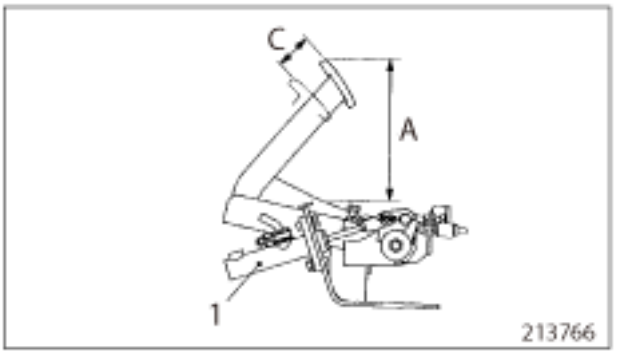


1. PARKING BRAKE LEVER
2. HOSE
3. RESERVE TANK
4. BRAKE PEDAL
5. BRAKE LAMP SWITCH
6. MASTER CYLINDER
7. WIRE CABLE
8. WHEEL CYLINDER
9. WHEEL BRAKE

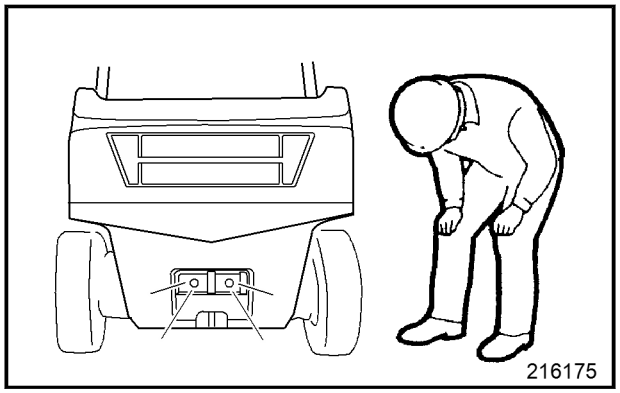
(4) Check brake pedal.

Service Hours	Prestart (Daily/10 hrs)

- Visually check the brake pedal for deformation or cracks.
- Depress the brake pedal, and check that the pedal moves smoothly without binding.
- Check that the pedal height A from the floor plate and play C are within the specified value.



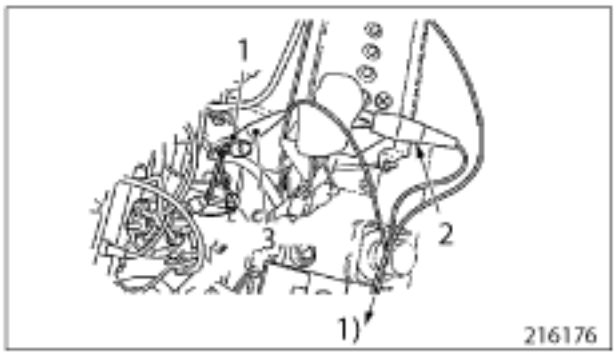
1. MASTER CYLINDER



(3) Check engine idle speed using a tachometer (for S4S diesel engine models and K21/25 gasoline engine models).

Service Hours	1st Month (200 hrs) only

NOTE: See the appropriate engine service manual.

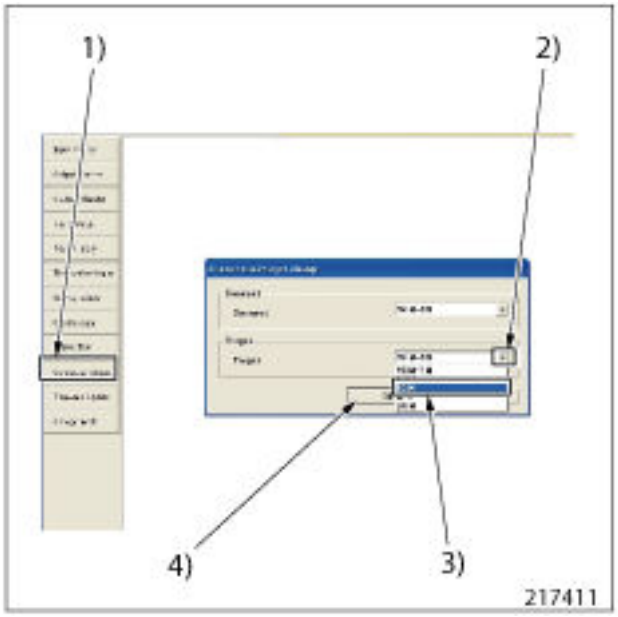


1) TACHOMETER

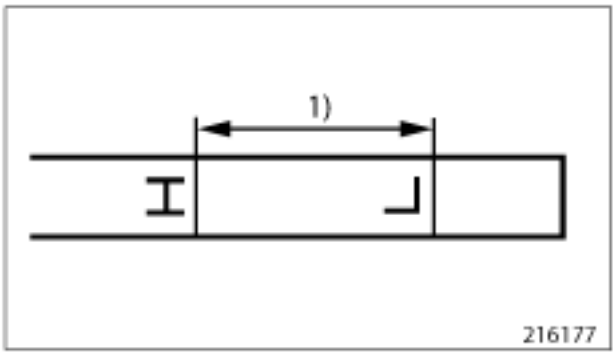
1. ADAPTER HARNESS (WITH GREEN CAP)
2. CLIP(RED)
3. CLIP(GREEN)

(4) Check engine idle speed using the service tool.

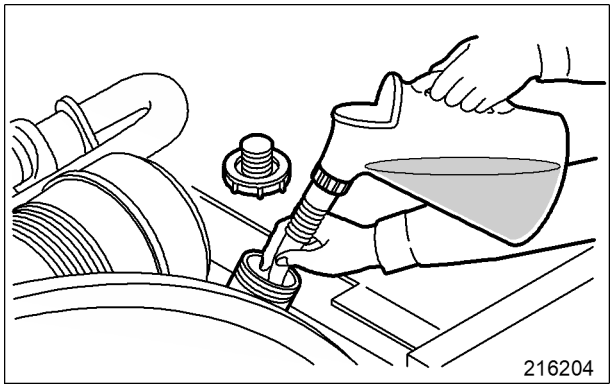
a. Click "Connection change button" from the menu to pop up "Connection/target change." Pull down the button of the pop-up window to select "ECM," and click OK button.



1) CONNECTION CHANGE BUTTON
2) PULL-DOWN BUTTON
3) SELECT ECM
4) OK BUTTON



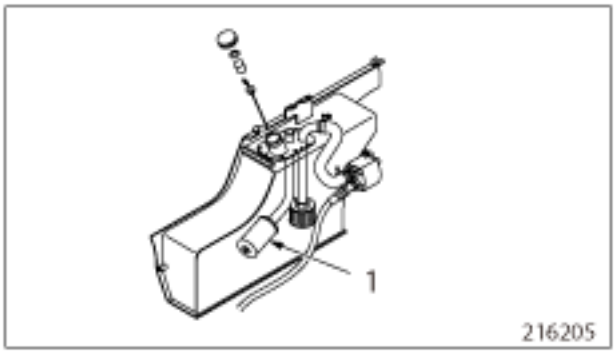
1) CORRECT LEVEL RANGE



(8) Change hydraulic tank return oil filter.

Service hours	1st Month (200 hrs) only
	Every 6 months (1000 hrs)

- Replace the return filter in the hydraulic tank with new one. (Filter contamination or damage)



1. RETURN FILTER

13.2.8 IGNITION SYSTEM

NOTE:
- BE SURE to conduct maintenance work on level and hard surface.
- Turn the engine OFF, and remove the key switch.
- 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.

(1) Check spark plug gap.

Service hours	1st Month (200 hrs) only

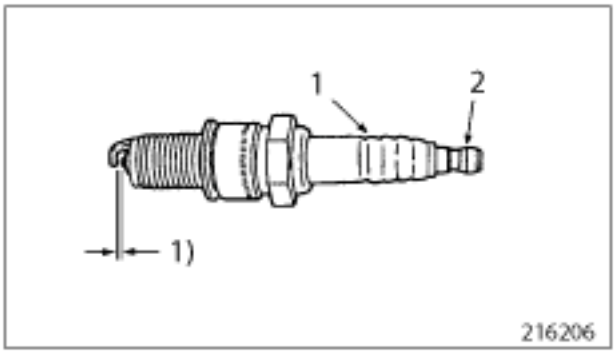
- Measure gaps between spark plug electrodes using a wire gauge.

Standard value

Gap between electrodes	0.9 (0.04)

Unit: mm (in.)

NOTE: See the appropriate engine service manual.



1) POINT GAP

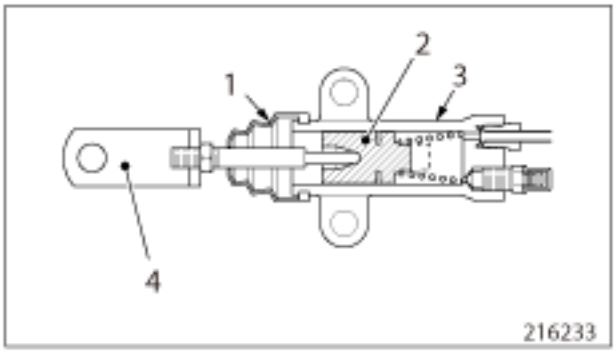
1. INSULATOR
2. TERMINAL

13.2.9 INTAKE SYSTEM

NOTE:
- BE SURE to conduct maintenance work on level and hard surface.
- Turn the engine OFF, and remove the key switch.
- 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.

Service hours	Yearly (2000 hrs)

- Replace the release cylinder hoses and the rubber parts inside the cylinder with new ones.



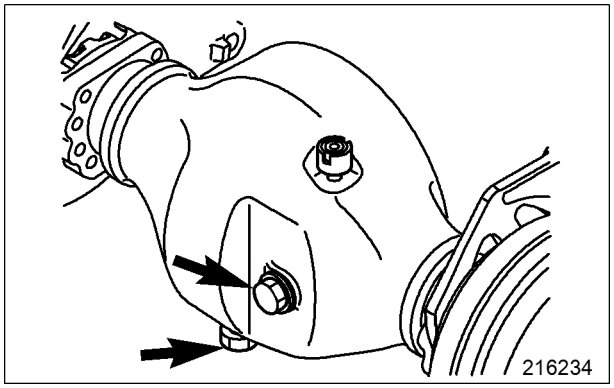
1. BOOT
2. PISTON
3. BODY
4. PUSH ROD COMPLETE

(11) Replace differential oil.

Service hours	Every 6 months (1000 hrs)

- Remove the drain plug, and drain the oil.
- Fill oil from the filler hole to the filler hole level.

Differential oil	GL-4 or GL-5



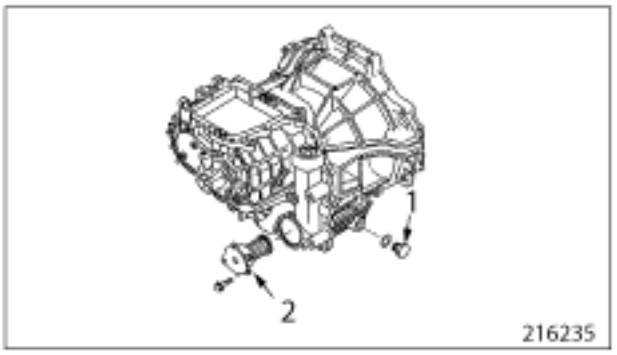
(12) Replace transmission oil.

Service hours	Every 6 months (1000 hrs)

- Loosen the drain plug to drain the oil.
- Clean the wash strainer and the last chance filter. See Step (6), Page 13-36 and Step (7), Page 13-37.
- Fill oil to the specified level from the filler hole.

NOTE: See POWERSHIFT TRANSMISSION.

Powershift transmission oil	Dexron III



1. DRAIN PLUG
2. OIL STRAINER

13.2.13 WHEELS AND TIRES

NOTE:
- BE SURE to conduct maintenance work on level and hard surface.
- Turn the engine OFF, and remove the key switch.
- 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.

(1) Check tire and rims.

Service hours	Prestart (Daily/10 hrs)

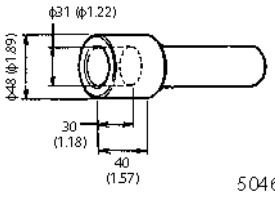
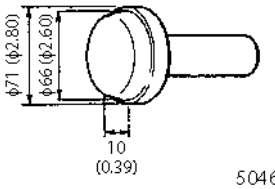
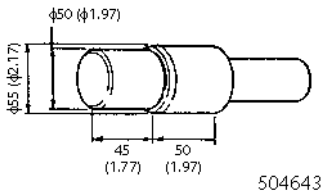
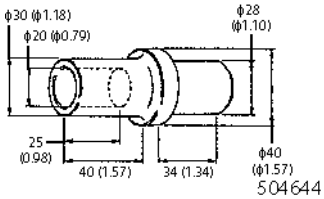
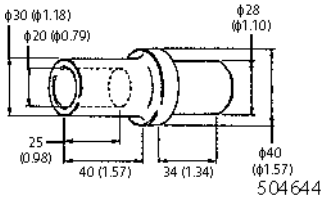
- Check the tires for damage or nails.
- Check the rims for deformation or damage.
- Check that the depths of tire grooves are 5 mm (0.20 in.) or more.

13.5.3 ADJUSTMENT VALUE AND OIL QUANTITIES

NOTE: The values in the following table are based on the standard model.

<table>
<tr><th colspan="3" rowspan="2">Items</th><th colspan="3">Truck model</th></tr>
<tr><th>2P3000
2P3500</th><th>GP15NM
GP18NM</th><th>2PC4000
GP20CNM</th></tr>
<tr><td colspan="3">Alternator drive belt deflection (½ TIR) - when pushed onward with 98 N (10kgf) [22 lbf] pressure mm (in.)</td><td colspan="3">11 to 13 (0.4 to 0.5)</td></tr>
<tr><td rowspan="2">Spark plug</td><td>Type</td><td>NGK</td><td colspan="3">FR2A-D</td></tr>
<tr><td colspan="2">Gap mm (in.)</td><td colspan="3">0.9 (0.04)</td></tr>
<tr><td colspan="3">Engine Idling Speed, min^{-1}</td><td colspan="3">700</td></tr>
<tr><td colspan="3">Steering Wheel Free Play when measured at rim with engine idling, mm (in.)</td><td colspan="3">15 to 30 (0.6 to 1.2)</td></tr>
<tr><td colspan="3">Clutch pedal free play (dry clutch), mm (in.)</td><td colspan="3">0 to 6 (0 to 0.24)</td></tr>
<tr><td colspan="3">Inching Pedal Free Play, mm (in.)</td><td colspan="3">2.5 to 7.5 (0.1 to 0.3)</td></tr>
<tr><td colspan="3">Brake Pedal Free Play, mm (in.)</td><td colspan="3">7 (0.3)</td></tr>
<tr><td colspan="2">Parking Brake Lever Operating Effort,</td><td>N (kgf) [lbf]</td><td colspan="3">150 to 200 (15 to 20) [34 to 45]</td></tr>
<tr><td rowspan="3">Tire size</td><td colspan="2">Front single</td><td colspan="2">6.50×10-10PR</td><td>6.50×10/5.00</td></tr>
<tr><td colspan="2">Front dual</td><td colspan="2">4.50-12-8PR</td><td>—</td></tr>
<tr><td colspan="2">Rear</td><td colspan="2">5.00×8-8PR</td><td>5.00×8/3.00</td></tr>
<tr><td rowspan="3">Tire pressure, kPa (kgf/cm^2) [psi] (Pneumatic)</td><td colspan="2">Front single</td><td colspan="3">700 (7.0) [100]</td></tr>
<tr><td colspan="2">Front dual</td><td colspan="3">700 (7.0) [100]</td></tr>
<tr><td colspan="2">Rear</td><td colspan="3">700 (7.0) [100]</td></tr>
<tr><td rowspan="3">Tightening torque for wheel nuts, N·m (kgf·m) [lbf·ft]</td><td colspan="2">Front</td><td colspan="3" rowspan="3">157 (16) [115.8]</td></tr>
<tr><td rowspan="2">Rear</td><td>STD (2P)</td></tr>
<tr><td>OP (4P)</td></tr>
<tr><td colspan="3">Lift chain elongation limit mm (in.)/ 20 links</td><td colspan="2">327 (12.9)</td><td>392 (15.4)</td></tr>
</table>

<table>
<tr><th rowspan="2">Items</th><th colspan="3">Truck model</th></tr>
<tr><th>2P4000
2P5000</th><th>GP20NM
GP25NM</th><th>2PD4000
2PD5000</th></tr>
<tr><td>Alternator drive belt deflection (1/2 TIR) - when pushed onward with 98 N (10kgf) [22 lbf] pressure mm (in.)</td><td colspan="2">11 to 13 (0.4 to 0.5)</td><td>10 to 12 (0.4 to 0.5)</td></tr>
</table>

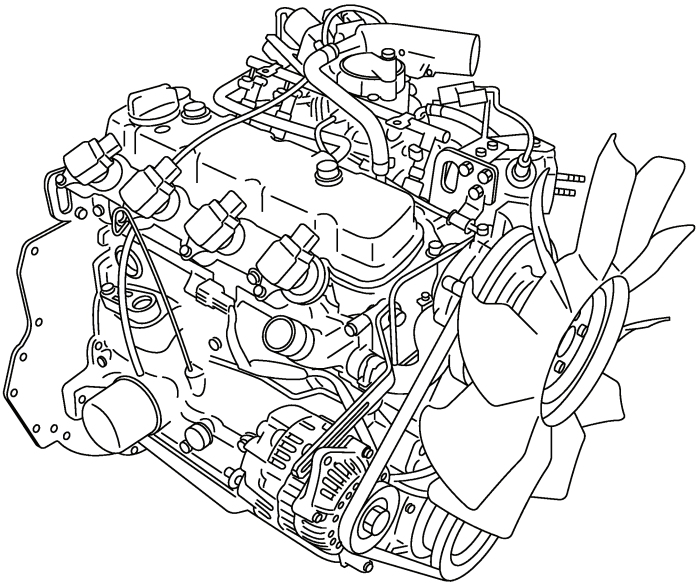
Ref No.	Part number	Part name	Figure	Used for	Truck model		
					1 ton class	2 ton class	3 ton class
24	91268 - 01400	Installer	 1. UNIT: MM (IN.)	Installation of rear axle outer bearing inner race	X	—	—
25	91468 - 00400	Installer	 1. UNIT: MM (IN.)	Installation of rear axle outer bearing outer race	—	X	X
26	91468 - 00500	Installer	 1. UNIT: MM (IN.)	Press-fitting of rear axle pivot bushing	—	X	X
27	91468 - 00100	Installer	 1. UNIT: MM (IN.)	Installation of bell crank bearing and king pin bearing	X	X	X
28	91468 - 00200	Installer	 1. UNIT: MM (IN.)	Removal of bell crank bearing and king pin bearing	X	X	X

GENERAL INFORMATION

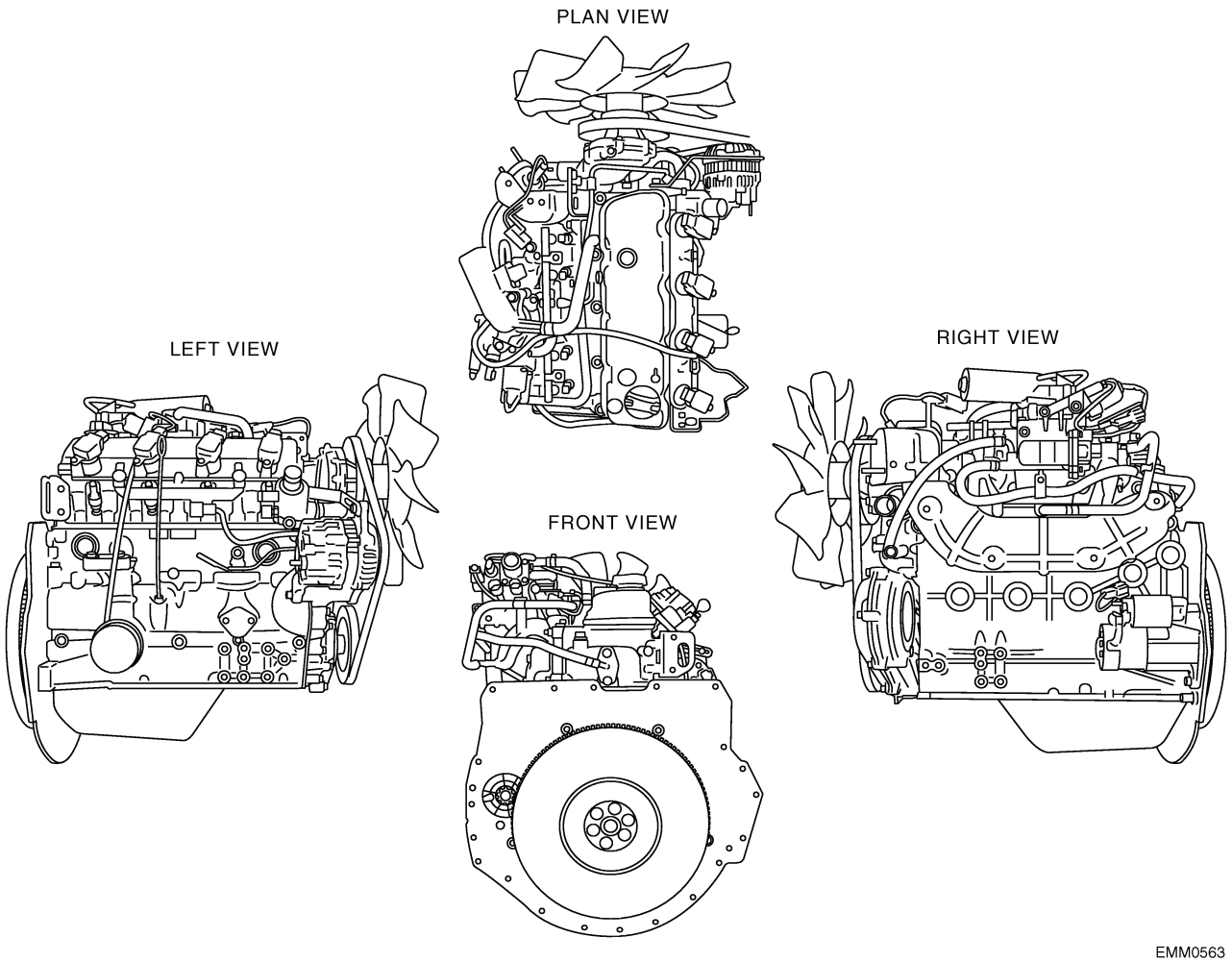
SECTION GI

CONTENTS

ELECTRIC CONTROLLED SPECIFICATION



EMM0562



EMM0563

Refer to each section for details.

Condition	Possible causes	Action	Application		
			Common	Electric controlled specifications	Carburetor specifications
Incident in ignition system	• Malfunction of low-voltage electronic distribution ignition coil	Replace.		√	
	• Condenser malfunction	Replace.	√		
	• Electric leakage from rotor cap and rotor	Clean or replace.			√
	• Spark plug malfunction	Clean, adjust gap or replace.	√		
	• Inappropriate ignition timing	Adjust.			√
	• Ignition coil malfunction	Replace.	√		
	• Open circuit in high-tension cable	Replace.			√
	• Loose or open primary wire connection	Repair or replace.	√		
Incident in fuel system Refer to EF section for the LPG model.	• Insufficient fuel	Fill.	√		
	• Contaminated fuel filter	Replace.	√		
	• Plugged or contaminated fuel piping	Wash.	√		
	• Plugged or contaminated fuel injector	Clean or replace.		√	
	• Fuel pump malfunction	Repair or replace.	√		
	• Carburetor choke malfunction	Check and adjust.			√
	• Inappropriate carburetor float level	Correct.			√
	• Inappropriate idling	Adjust.			√
Lowered compression pressure	• Poor tightening of spark plug or inappropriate gasket	Tighten to correct torque or replace.	√		
	• Inappropriate engine oil grade or deteriorated viscosity	Replace with appropriate grade of oil.	√		
	• Inappropriate valve clearance	Adjust.	√		
	• Compression pressure leak from valve seat	Remove head and perform fine grinding to valve.	√		
	• Stuck valve stem	Repair or replace cylinder head and valve.	√		
	• Broken or chip valve spring	Replace valve spring.	√		
	• Compression pressure leakage from head gasket	Replace head gasket.	√		
	• Worn or stuck piston ring	Replace piston ring.	√		
	• Worn piston ring or cylinder	Engine overhaul (Diagnosis procedure) a. Put a small amount of engine oil from the ignition plug hole and measure the compression pressure. b. If the pressure builds up, a possible cause is in the cylinder or piston ring. c. If the pressure remains unchanged, the leakage can be attributed to the valve, cylinder head or head gasket.	√		

Specifications (Cont'd)

- Large end oil clearance (mm)
  Standard 0.030 - 0.066 (K15, K21, K25)
  Repair limit 0.10
- Difference of weight (Piston combination) (g)
  Standard 4 or less

CRANKSHAFT

- Bend (mm)
  Repair limit 0.05
- End play (mm)
  Standard 0.05 - 0.18
  Repair limit 0.20
- Journal dimension (mm)
  Standard 62.942 - 62.955
- Pin standard dimension (mm)
  Standard 44.961 - 44.974 (K15, K21, K25)
- Journal oil clearance (mm)
  Standard 0.020 - 0.073
  Repair limit 0.10
- Pin oil clearance (mm)
  Standard 0.032 - 0.066

FLYWHEEL

- Flywheel surface swing (mm)
  Repair limit 0.10
- Ring gear surface swing (mm)
  Repair limit 0.50
- Flatness (mm)
  Repair limit 0.30

CAMSHAFT

- Bend (mm)
  Repair limit 0.05
- Camshaft height (mm)
  Standard 36.750 - 36.800 (For both intake and exhaust)
  Size reduction limit 36.5
- Journal dimension (mm)

Standard	Front	45.434 - 45.447
	Center	43.897 - 43.910
	Rear	41.218 - 41.231

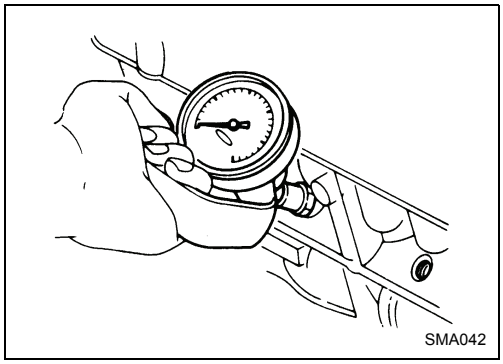
- End play (mm)
  Standard 0.025 - 0.255
  Repair limit 0.40
- Journal oil clearance (mm)

Standard	Front	0.025 - 0.051
	Center	0.038 - 0.064
	Rear	0.025 - 0.051
Repair limit	Front	0.10
	Center	0.15
	Rear	0.10

Items	Engine type	K15	K21	K25
Valve clearance (Hot) mm (in)	Intake	0.38 (0.015)		
	Exhaust			
Fan belt deflection	mm (in)	11 - 13 (0.43 - 0.51)		
Belt push force	N (kg, lb)	98 (10,22)		
Engine oil amount	L (US qt, Imp qt)			
(including oil filter)		3.8 (4, 3-3/8)		
(not including oil filter)		3.5 (3-3/4, 3-1/8)		
Compression pressure	MPa (bar, kgf/cm^2)/rpm			
Gasoline/Combined		1.4 (14.5 / 250)	1.45 (14.8 / 250)	1.51 (15.4 / 250)
Limit		1.22 (12.4 / 300)	1.25 (12.7 / 300)	1.31 (13.4 / 300)
Spark plug type		FR2A-D		
Plug gap	mm (in)	0.9 (0.035)		
Distributor gap	mm (in)	(Carburetor model only) 0.35 - 0.45 (0.0138 - 0.0177)		
High-tension cable resistance	Ω	(Same as above) 30,000 or less		
Ignition timing/idle speed	BTDC deg./rpm	700±50		
Maximum engine speed without load	rpm (instantaneous)	3,600		
Maximum engine speed with load	rpm	3,000		

Engine Body Related (Cont'd)

COMPRESSION PRESSURE INSPECTION


SMA042

1. Warm up the engine sufficiently and then stop it.
   Release the fuel pressure. (Electric controlled specifications)
2. Remove the spark plug.
3. Apply a compression gauge correctly to the cylinder plug hole to be measured.
4. Set the throttle valve to the fully-open position. Depress the throttle pedal to the fully-open position.
5. Crank the engine and read the gauge.
   (The same operations can be used for both the carburetor and electric control models)
   - Keep the engine speed at approximately 250 rpm.
   - Finish the pressure measurement in as short a time as possible.

Standard compression pressure

K15	1,400 kPa (14.0 bar, 14.3 kg/cm^2, 203 psi)
K21	1,450 kPa (14.5 bar, 14.8 kg/cm^2, 210 psi)
K25	1,510 kPa (15.1 bar, 15.4 kg/cm^2, 219 psi)

6. The compression pressure differences between cylinders must not exceed 98 kPa (1.0 bar, 1 kg/cm^2, 14 psi) /250 rpm. If any cylinder shows an extremely low compression pressure, put a small amount of oil into the cylinder through the spark plug hole and remeasure the pressure.
   - If the pressure rises after filling oil, the piston ring is worn or damaged.
   - If the pressure remains unchanged even after filling oil, the valve is stuck or inappropriately seated.
   - If low compression pressure is observed in two adjacent cylinders and the pressure is not restored even after filling oil, the head gasket is leaking. In this case, oil and water may enter in the combustion chamber.
   - If the engine RPM is not in the specified range: Measure the battery specific gravity.

Precautions for Draining Engine Coolant

- Drain coolant only after the engine has cooled down.

Precautions for Disconnecting Fuel Piping

- Operation should be done in a place free from fire.
- Release fuel pressure before operation. (Electric controlled specifications): Refer to “Release of Fuel Pressure” in EC section.
- After disconnecting, plug the pipe to prevent fuel from draining.

Precautions for Removing and Disassembling

- Use correct STs in the specified position. Always pay attention to safety.
- Be careful not to lose surface accuracy of mating or sliding surfaces.
- To prevent foreign material from entering the engine, close openings with appropriate tape as necessary.
- Arrange disassembled parts in their normal positions in order to simplify locating the cause of damage or excessive wear and to ensure correct reassembly.
- As a rule, nuts and bolts must be loosened in a diagonal manner starting from an outer one. If a particular tightening sequence is provided separately, follow the sequence.

Precautions for Inspection, Correction, and Replacement

- Following the inspection procedure, inspect the parts adequately and repair or replace as necessary. Perform the same inspections even for new parts and replace them if necessary.

Precautions for Assembly and Installation

- Always use a torque wrench when tightening nuts and bolts.
- Unless otherwise specified, tighten bolts and nuts from inside to outside in a crisscross pattern. Tighten them gradually and evenly in 2 to 3 steps.
- Always replace gasket, packing, oil seals, and O-rings with new ones.
- For each part, perform adequate cleaning/washing and drying with a dryer. In particular, ensure that the oil and coolant passages are free from plugging and clogging.
- Remove any dirt and lint on sliding and mating surfaces. Before assembly, apply ample amount of engine oil to sliding surfaces.
- If coolant was drained, bleed air from the system.
- After assembly, start engine and increase the engine speed, then check coolant, fuel, oil, grease, and exhaust gas for leakage.

TAPER SCREW TIGHTENING TORQUE

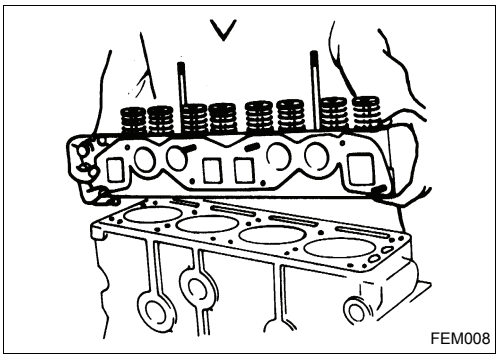
Allowable materials for tightening / Normal size	Unit	Aluminum		Cast iron	
		Standard	Max. value	Standard	Max. value
R1/8	N•m	7.8	11.8	15.7	21.6
	kg-m	0.796	1.2	1.6	2.2
	ft-lb, in-lb*	69*	9	12	16
R1/4	N•m	19.6	29.4	34.3	44.1
	kg-m	2.0	3.0	3.5	4.5
	ft-lb	14	22	25	33
R3/8	N•m	39.2	54.9	53.9	73.5
	kg-m	4.0	5.6	5.5	7.5
	ft-lb	29	41	40	54

Engine Part Tightening Torque

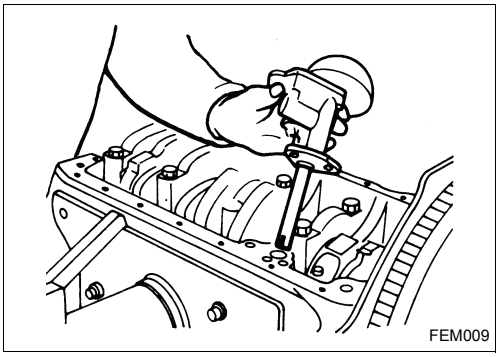
TIGHTENING TORQUE AT VARIOUS POINTS OF ENGINE

Tightening point	Unit	Standard	Max. value
Cylinder head (lubricated)	Separately given		
Main bearing cap (lubricated)	Separately given		
Crankshaft pulley bolt	N•m	220.5	240.1
	kg-m	22.5	24.5
	ft-lb	163	177
Flywheel bolt (lubricated)	N•m	132	142
	kg-m	13.47	14.49
	ft-lb	97	105
Connecting rod nut (lubricated)	N•m	31.4	37.3
	kg-m	3.2	3.81
	ft-lb	23	28
Rear plate bolt	N•m	44.1	58.8
	kg-m	4.5	6.0
	ft-lb	33	43
Camshaft sprocket bolt	N•m	39.2	49
	kg-m	4.0	5.0
	ft-lb	29	36
Oil filter stud	N•m	29.4	39.2
	kg-m	3.0	4.0
	ft-lb	22	29
Oil filter element	N•m	14.7	20.6
	kg-m	1.5	2.1
	ft-lb	11	15
Spark plug	N•m	19.6	29.4
	kg-m	2.0	3.0
	ft-lb	14	22
Engine slinger bolt	N•m	22.6	25.5
	kg-m	2.31	2.6
	ft-lb	17	22
Rocker cover nut	N•m	14.7	16.7
	kg-m	1.5	1.7
	ft-lb	11	13
Water temperature gauge	N•m	15.7	19.6
	kg-m	1.6	2.0
	ft-lb	12	14
Oil pressure switch	N•m	15.7	21.6
	kg-m	1.6	2.2
	ft-lb	12	16
Exhaust manifold nut	N•m	41.2	48.1
	kg-m	4.2	4.91
	ft-lb	30	36
Straight screw plug (For head top face)	N•m	44.1	53.9
	kg-m	4.5	5.5
	ft-lb	33	40
Oil pan drain plug	N•m	29.4	39.2
	kg-m	3.0	4.0
	ft-lb	22	29
Mass air flow sensor mounting screw	N•m	1.27	1.67
	kg-m	0.13	0.17
	in-lb	11	15
Fuel tube flare nut	N•m	16.0	23.0
	kg-m	1.63	2.35
	ft-lb	12	17
Thermo-housing relief plug	N•m	6.37	7.45
	kg-m	0.65	0.76
	in-lb	56	66

Engine Disassembly (Cont'd)

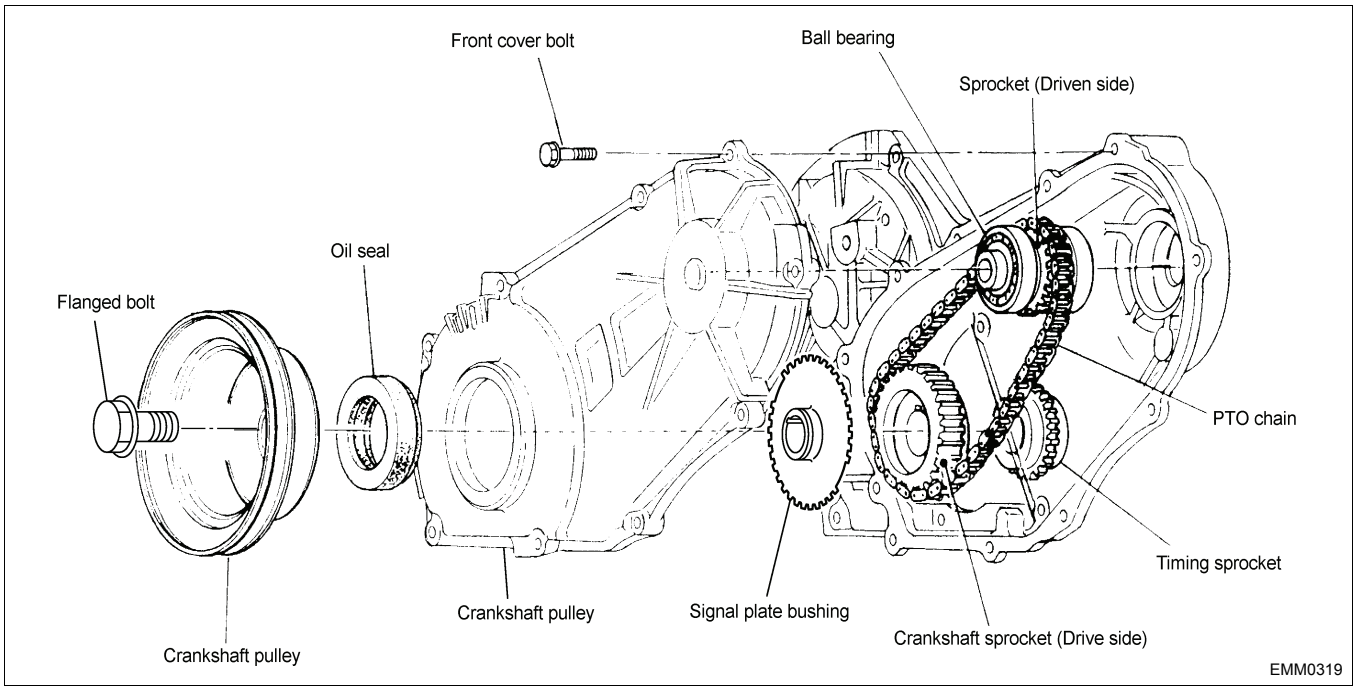

FEM008

8. Remove oil pan.
   Remove any sealant.


FEM009

9. Remove oil pump with strainer.

10. Disassembly of PTO device



- Remove crankshaft pulley bolt.
- Remove crankshaft pulley.
- Remove the sprocket bushing.

Inspection and Correction (Cont'd)

9. Piston pin

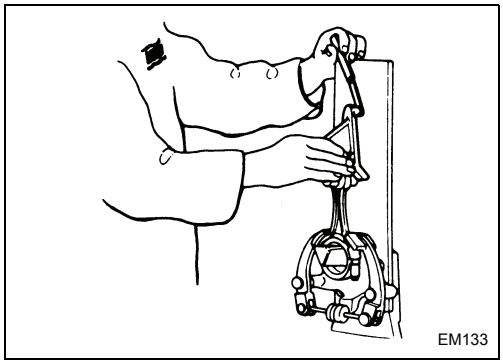
FITTING PISTON PIN TO PISTON

- In ordinary temperatures, the piston pin should rotate when turned by hand or the pin should go smoothly when inserted.
- If the piston pin behavior is unusual, replace the piston and piston assembly.

Engine type	K15, K21, K25
Piston pin outer diameter	19.993 - 19.998

10. Connecting rod

MEASURING BEND, TWIST


EM133

- Measure the bend and twist using a connecting rod aligner. If the measured bend or twist is excessive, replace the component.
  Usable limit: Bend 0.05 mm (per 100 mm)
  Twist 0.05 mm (per 100 mm)

CAUTION:
The center distance between both end holes must be
143.97 to 144.03 mm. (K25)
152.47 - 152.53 (K15, K21)

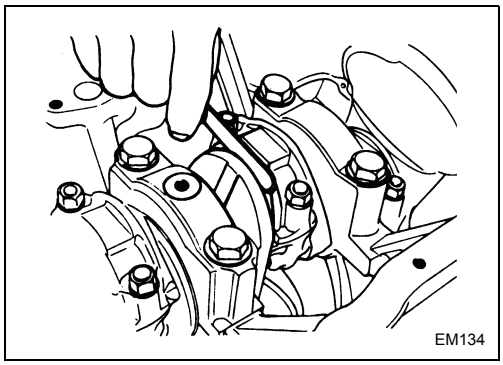
	Standard	Repair limit
Bend Twist Parallelism [per 100 mm (3.94in)] mm (in) for every 100 mm	0.025(0.0010)	(B) 0.05 (0.002)
		(T) 0.05 (0.002)

11. Connecting rod weight

WEIGHT ADJUSTMENT

- When replacing the connecting rod assembly, ensure that the maximum difference in the connecting rod assembly weight between any two cylinders does not exceed 4 g.

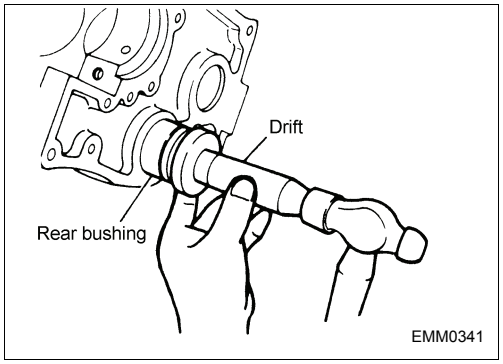
MEASURING CONNECTING ROD THRUST CLEARANCE


EM134

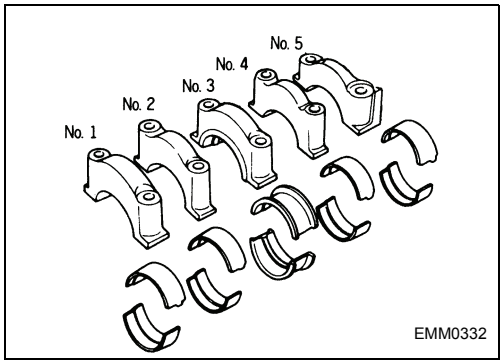
- Measure the thrust clearance using a feeler gauge.
- Measure the connecting rod side clearance. If the clearance exceeds the limit, replace the connecting rod.
  Standard clearance: 0.2 - 0.3 mm
  Max. clearance: 0.4 mm

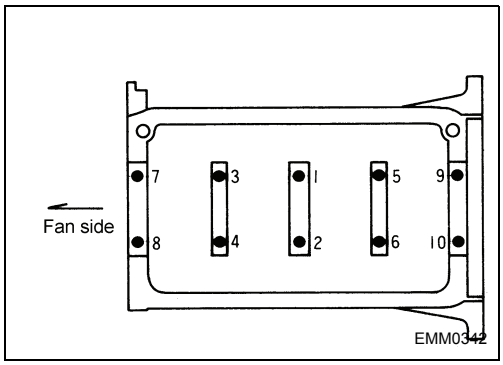
Engine Assembly (Cont'd)

5. Rocker shaft assembly
   - Assemble the bracket and intermediate spring to the rocker shaft. The shaft has four installation holes.
   - The large hole located on the lateral face also serves as the oil passage.
   - Ensure that this comes to the front.
   - Following the rocker arms at both ends, assemble the rock washers and spacers.
6. Assembly of camshaft bushing
   - Assembly of center bushing
     Turn the cutout toward the distributor driving direction and drive in the bushing with the jig.
   - Assembly of rear bushing
     Locate the bushing so that the arrow on the bushing faces upward. Align the bushing to the oil hole on the cylinder block and drive in the bushing as shown.
   - The bushing has a slightly larger diameter toward its rear end. This ensures that the bushing is press fit into the cylinder block.



7. Assembly of crankshaft
   - Assemble the main bearing bushing to the cap.
   - As shown below, the main bearing bushings in use are classified in two types.
     Nos. 1, 2, 4 and 5 are common.
     No.3 (center) is provided with a thrust bushing.
   - Assemble crankshaft.
   - Assemble main bearing caps.
   - For the front bearing cap, align the cap to the cylinder block so that they are flush with each other.





   - Apply engine oil to the cap bolts and tighten them to the specified torque from inside to outside as shown in the figure on the left.
   - Make sure that the crankshaft can be turned with a light force every time one bolt is tightened.
     : 83.4 - 93.2N•m (8.5 - 9.5Kgf-m)

NOTE:
Cranking torque 1.5 kgf-m or less

CAUTION:
For assembly, see the front of the part. An (embossed) arrow and numbers indicating the assembly position can be seen.

ENGINE CONTROL

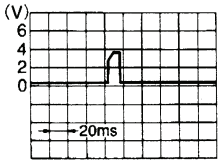
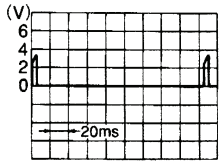
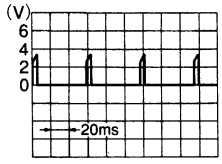
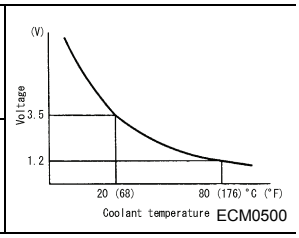
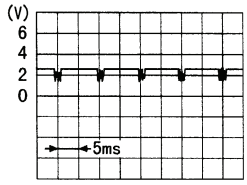
SECTION EC

CONTENTS

ECM Component

Component	Location	Specifications			NOTE		
		Gasoline	LPG	Combined	Actuator	Sensor	Other
Gasoline injector	Intake manifold	○		○	○		
LPG injector	Integrated in injector holder (on intake manifold)		○	○	○		
Throttle control motor	Integrated in electronic throttle control actuator	○	○	○	○		
Throttle position sensors 1 and 2		○	○	○		○	
Ignition coil	Cylinder head (on each spark plug)	○	○	○	○		
Crankshaft position sensor (POS)	Front cover	○	○	○		○	
Camshaft position sensor (PHASE)	Front housing	○	○	○		○	
Mass air flow sensor	Air horn	○	○	○		○	
Intake air temperature sensor	With air flow meter	○	○	○		○	
Engine coolant temperature sensor	Water outlet	○	○	○		○	
Accelerator pedal position sensors 1 and 2	Integrated in accelerator work unit (accelerator pedal assembly)	○	○	○		○	
Fuel pump	Integrated in fuel tank	○		○	○		
Fuel pressure regulator		○		○	○		
Heated oxygen sensor	(Vehicle side)	○	○	○		○	
Vehicle speed sensor	(Vehicle side)	○	○	○		○	
ECM	(Vehicle side)	○	○	○			○
ECM & IGN coil relay	(Vehicle side)	○	○	○			○
Stop lamp switch	(Vehicle side)	○	○	○			○
Throttle control motor relay	(Vehicle side)	○	○	○			○
Fuel pump relay	(Vehicle side)	○		○			○
Vaporizer	(Vehicle side)		○	○			○
LPG interception valve	(Vehicle side)		○	○	○		
Relative pressure sensor	LPG injector holder		○	○		○	
Fuel changing switch	(Vehicle side)	○	○	○			○
Electrical load switch	(Vehicle side)	○	○	○			○
Neutral switch	(Vehicle side)	○	○	○			○
Ignition switch	(Vehicle side)	○	○	○			○

ECM Terminal (Cont'd)

Terminal signal	Description	Measurement condition	Measured value
61 62 80 81	Ignition signal (power transistor drive signal)	At cranking	Approx. 0.2V  ECM0047
		At idle after warming up	Approx. 0.1V  ECM0048
		At approx. 2,000 rpm	Approx. 0.1V  ECM0049
73	Engine coolant temperature sensor signal	Engine coolant temperature is approx. 20°C (68°F).	Approx. 3.5V
		Engine coolant temperature is approx. 80°C (176°F).	Approx. 1.2V  ECM0500
85 (K LINE)	Signal line for service	When connected to Service tool	Approx. 6.6 - Battery voltage
		When not connected to Service tool	Approx. 6V
86	CAN communication line L	Always	Approx. 2.2V (Varies depending on communication status.)  ECM0051

Diagnosis Chart by Symptom (Cont'd)

Symptoms		Impossible to start		Poor starting		Poor idle					Poor driving							Engine stall				Other		Description/notable characteristics of the symptom
		No initial combustion	Initial combustion	When engine is cold	When engine is warming up	Fast idle is not effective	High idle rpm	Low idle rpm	Inconsistent idle when engine is cold.	Inconsistent idle when warming up	Poor power output	Poor acceleration	Engine rpm does not increase smoothly.	During surge and acceleration	During surge and constant speed driving	Knocking	Backfire	After-burn	At Idle	Driving	During deceleration	During a heavy load	Engine over temperature (Overheat)	Poor fuel consumption efficiency	
⊕: Highly possible ♦: Possible ▽: Not very possible																								
Compression pressure	Improper bulb contact	▽	♦	⊕	⊕				⊕	⊕	⊕	⊕	⊕	⊕	⊕			♦	♦	♦	♦	♦			• Symptom varies depending on contact condition and the number of cylinders.
	Worn piston ring	▽	♦	⊕	⊕				⊕	⊕	⊕	⊕	⊕	⊕	⊕			♦	♦	♦		♦			• Symptom varies depending on degree of wear and the number of cylinders.
Other	Clogged three-way catalytic converter /exhaust system		▽	♦	♦				♦	♦	♦	♦	♦	♦	♦				♦	♦	♦	♦		♦	• In some cases, after engine stall, restarting is possible.
	Low idle base speed			▽	▽				▽	▽									♦	♦	♦	♦			• Engine stall may occur by power steering load and cargo load during deceleration or at idling.
	Dragging of brakes										♦	♦	♦											♦	• Tires/wheels are hot.
	Belt tension too high (excessive tension)																		♦	♦	♦	♦		♦	—
	High A/T load											▽							▽		♦	▽		♦	• Insufficient ATF amount, improper oil specification (This symptom may especially occur in the cold.)
	High HYD PUMP load (PS, Cargo)								▽	▽	▽	♦	♦	▽	▽							▽		♦	• Malfunctioning oil pressure relief valve, improper oil specification (This symptom may especially occur in the cold.)
	Foreign material in fuel tank (such as dust)	▽	♦	♦	♦				♦	♦	♦	♦	♦	♦	♦				♦	♦	♦	♦			• With low fuel, this may easily occur.
	Damaged fan, malfunctioning water pump																						♦		• Noise
	Clogged/restricted radiator/ condenser																						♦		—

Also check the following items other than the above:

- Check harness tension.
- Check each connector connection.
- Check ground wire for looseness.
- Check battery connection for looseness or corrosion.
- Check water and oil condition.
- Check fan belts for looseness.

ECM Active Test

ECM active test has the following items.

(1) Idle Air Volume Learning
If the idle speed or the ignition timing is outside the standard (engine status is malfunctioning) or if the electronic throttle control actuator or ECM is replaced, perform Idle Air Volume Learning.

Standard
Idle speed: 700±50 rpm
Ignition timing: 0±2/700 (°BTDC/rpm)

(2) Air-fuel ratio adjustment
If the values of “Air-fuel ratio” in ECM input/output monitor are outside the standard, adjust the air-fuel ratio.

Proper value: 100%
Adjustment range: 75 - 125%

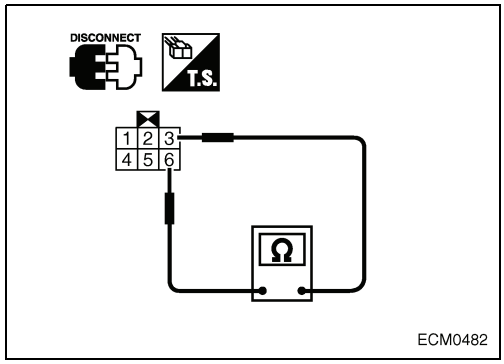
(3) Ignition timing adjustment
If the values of “Ignition timing” in ECM input/output monitor are outside the standard, adjust the ignition timing.

Proper value: 0°
Adjustment range: 0 - 10°

(4) Fuel pressure clear
Relieve fuel pressure before removing fuel piping to secure safety.

(5) Power balance
When the engine does not run smoothly or misfires occur in some of the cylinders, forcibly stop each cylinder in "Power balance", and then check for which cylinder has the malfunction.

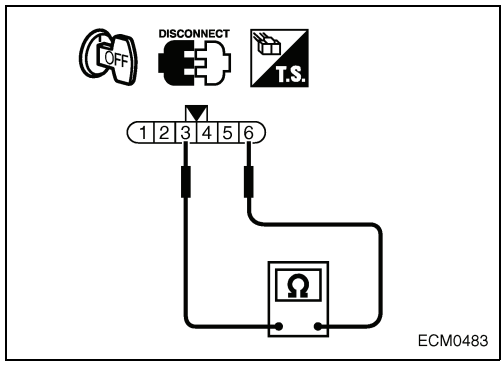
Fuel Pump



Check resistance between terminals 3 and 6.

Resistance: Approx. 1 Ω (at room temperature)

Electric Throttle Control Motor (Electric throttle control actuator assembly)



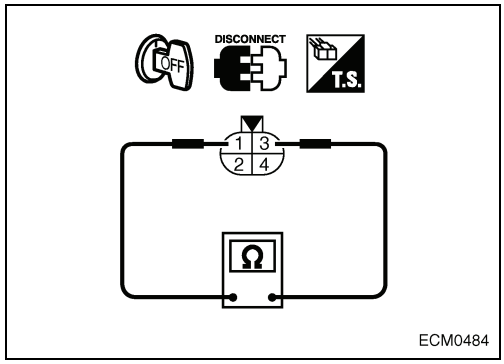
Check resistance between electric throttle control motor (throttle position sensor connector) terminals 3 and 6.

Resistance: Approx. 1 -15 Ω [at 25°C (77°F)]

CAUTION:

- **Make sure that there is no moisture around connector when removing and installing throttle position sensor connector. Completely wipe off water drops if there are any.**
- **Do not apply voltage to electric throttle control motor terminal.**
- **Perform "Throttle Valve Closed Position Learning" if disconnecting connector. Perform "Throttle Valve Closed Position Learning and Idle Air Volume Learning" if replacing electric throttle control actuator. (Refer to "Throttle Valve Closed Position Learning and Idle Air Volume Learning".)**
- **Do not disassemble electric throttle control actuator.**

Heated Oxygen Sensor

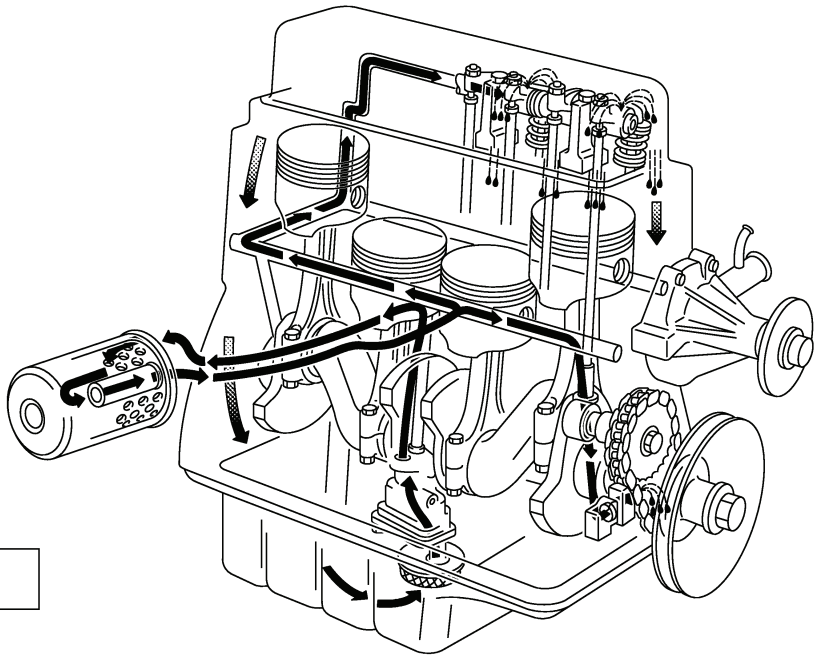


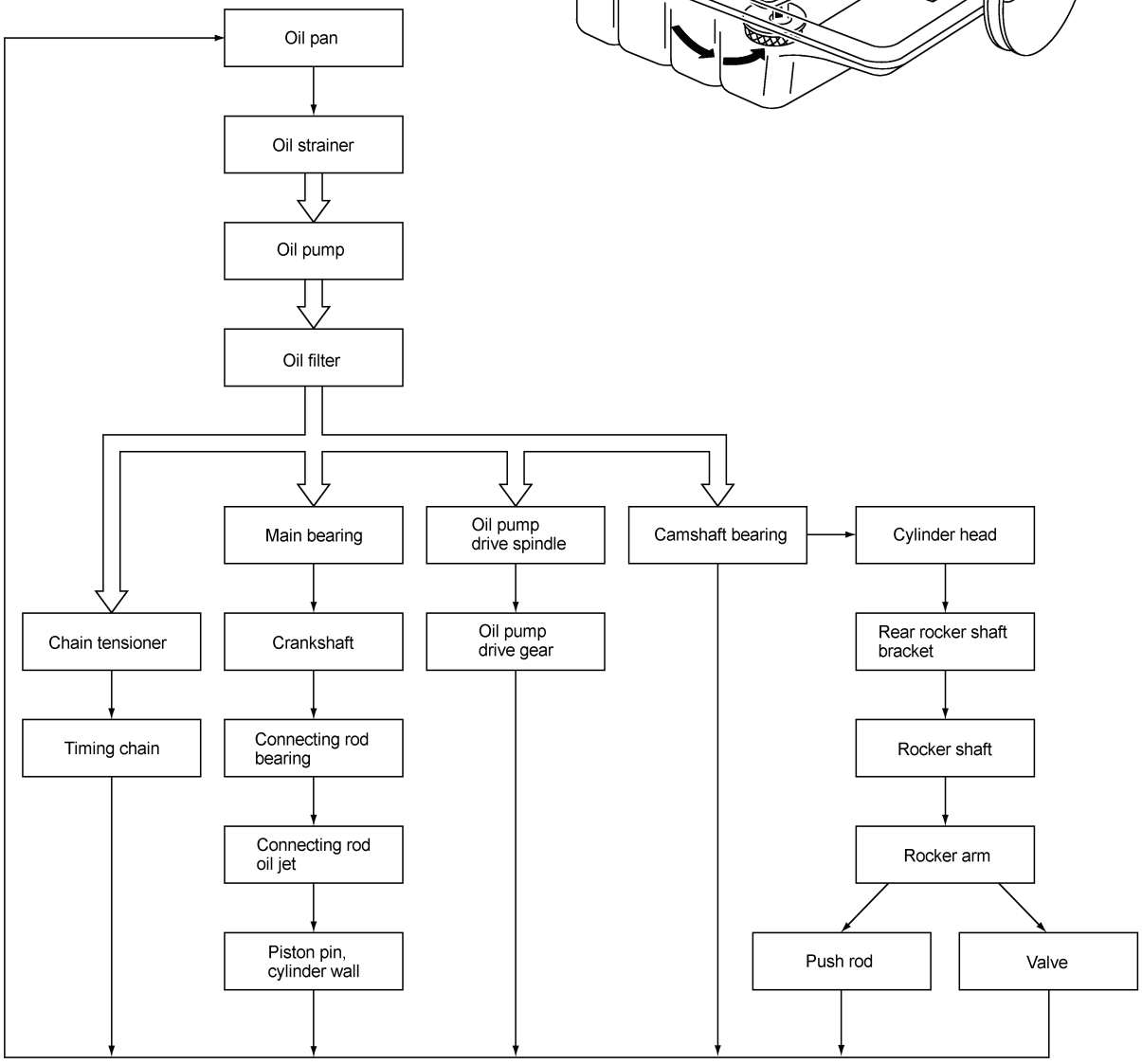
Check resistance between heated oxygen sensor terminals 2 and 3.

Resistance: Approx. 3.3 - 3.5 Ω

Lubrication Schematic Diagram

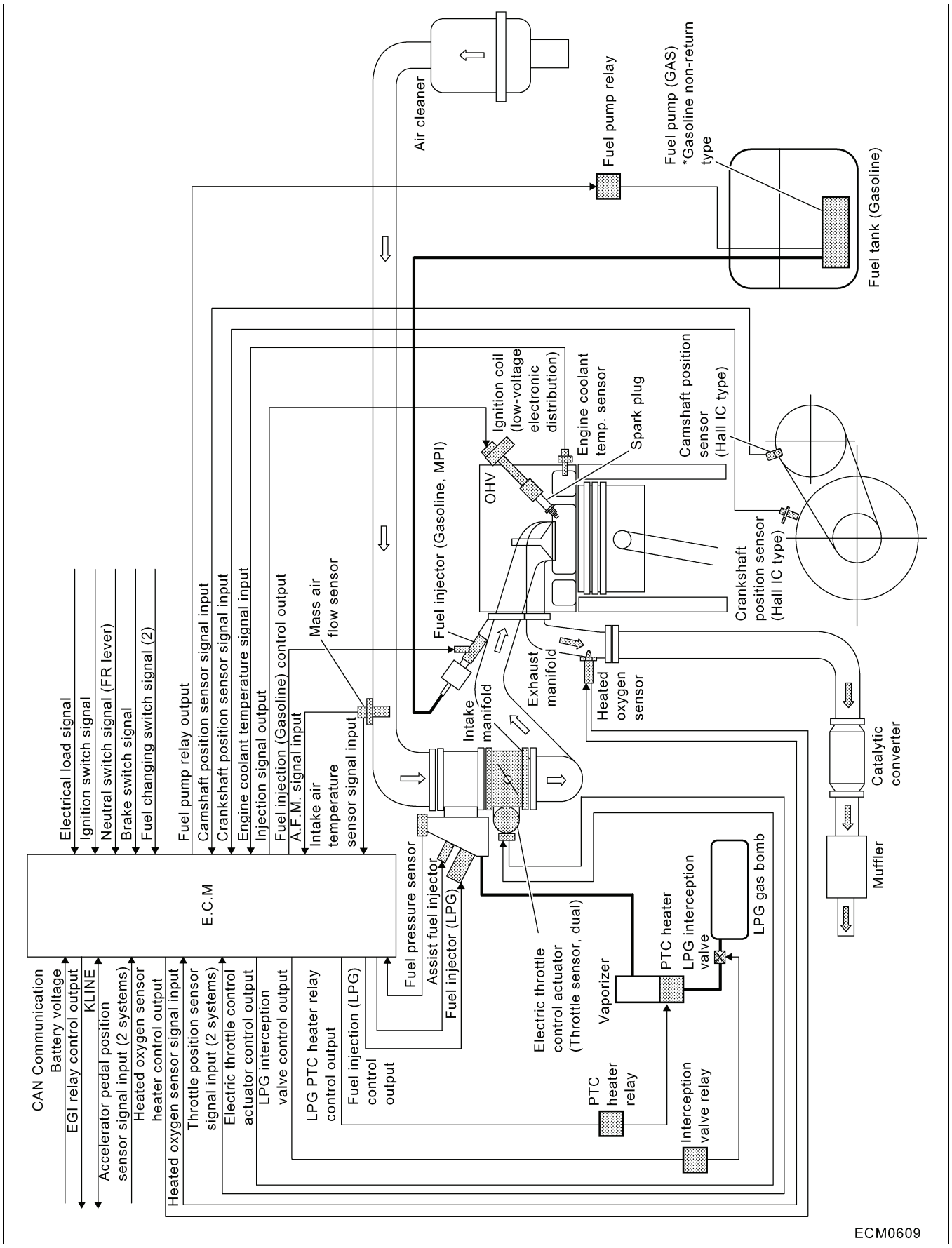
LUBRICATION CIRCUIT





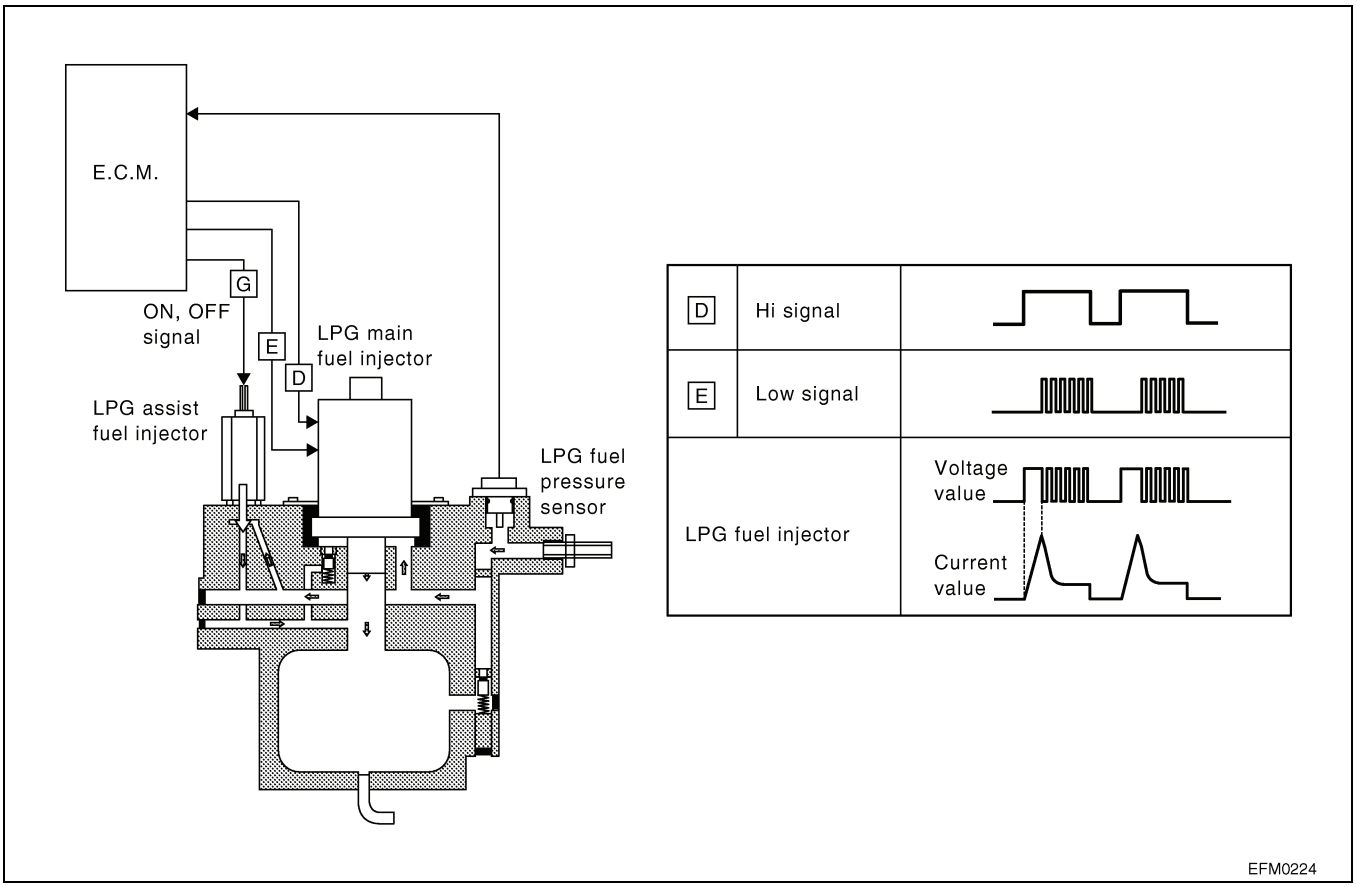
LCM0022

K-Engine System Diagram (Combined Use)



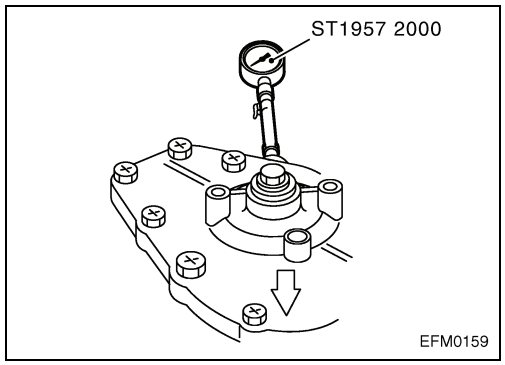
LPG Device (Specifications for LPG and Combined Use) (Cont'd)

LPG INJECTION SYSTEM DRIVE METHOD



Tar drain, Removal, Installation, Disassembly and Inspection of Vaporizer (Cont'd)

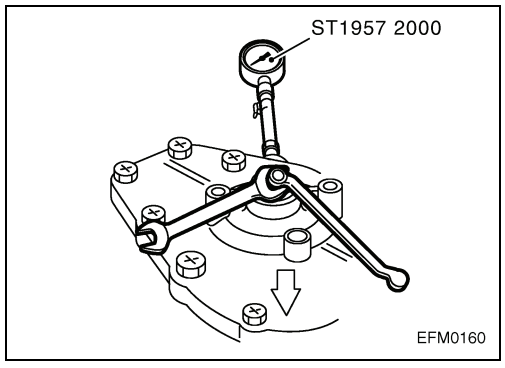
- In the reverse order of disassembly, place primary diaphragm over the body, slide it to the center, and then secure primary diaphragm.
- Place primary chamber cover over the body.
  (At this time, be careful not to drop primary adjusting spring from primary chamber cover.)
- Tighten 2 screws of mounting bolts using SST, and then tighten the other 8 screws using commercial service tool.
- Tightening torque N·m (kg-m, ft-lb):
  3.8 - 5.1 (0.39 - 0.52, 2.8 - 3.7)



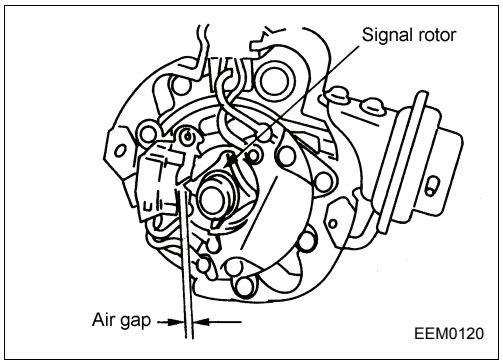
- Perform primary chamber adjustment.
- Remove plug of primary oil pressure output port, install adopter (SST), and then set LPG pressure gauge (SST).
- Install #100 JET to fuel outlet connector. (Flow: approx. 10 Liter (10-5/8 US qt, 8-3/4 Imp qt)/min)
- Apply air pressure of 0.29 MPa (2.9 bar, 3 kg/cm^2, 43 psi) from fuel inlet connector.
  Standard: 32.1 - 33.5 kPa
  (0.32 - 0.33 bar, 0.327 - 0.342 kg/cm^2, 4.6 - 4.8 psi)
- If the value is outside the standard, adjust it as described below.

Adjust primary chamber with the following procedure if adjustment with vaporizer only is difficult.

- Install vaporizer to the vehicle.
- Remove plug of primary oil pressure output port, install adopter (SST), and then set LPG pressure gauge (SST).
- Start and warm up the engine.
- Check pressure of pressure gauge at idle after warming up.
  Standard: 30.7 - 33.1 kPa
  (0.30 - 0.33 bar, 0.313 - 0.338 kg/cm^2, 4.4 - 4.8 psi)
- If the value is outside the standard, adjust it as described below.
  - Vaporizer primary pressure setting value is different between the unit condition and the condition of installing vaporizer to engine and having hot water flowing (approximately 80 °C (176 °F)).



- Tighten lock nut after setting to standard pressure by rotating primary pressure adjusting screw.
- Tighten primary pressure adjusting screw using double spanner.
- Tightening torque N·m (kg-m, ft-lb): 11.8 - 26.5 (1.2 - 2.7, 9 - 19)
- Apply soapy water to mating surface of cover. Check for leakage.
- Place tamperproof bracket over primary chamber cover, and then tighten mounting screw using SST.
- Tightening torque N·m (kg-m, ft-lb):
  3.8 - 5.1 (0.39 - 0.52, 2.8 - 3.7)



Inspection After Assembly

- Measure the air gap between the signal rotor and the pickup assembly.
  Standard: 0.35 - 0.45 mm