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

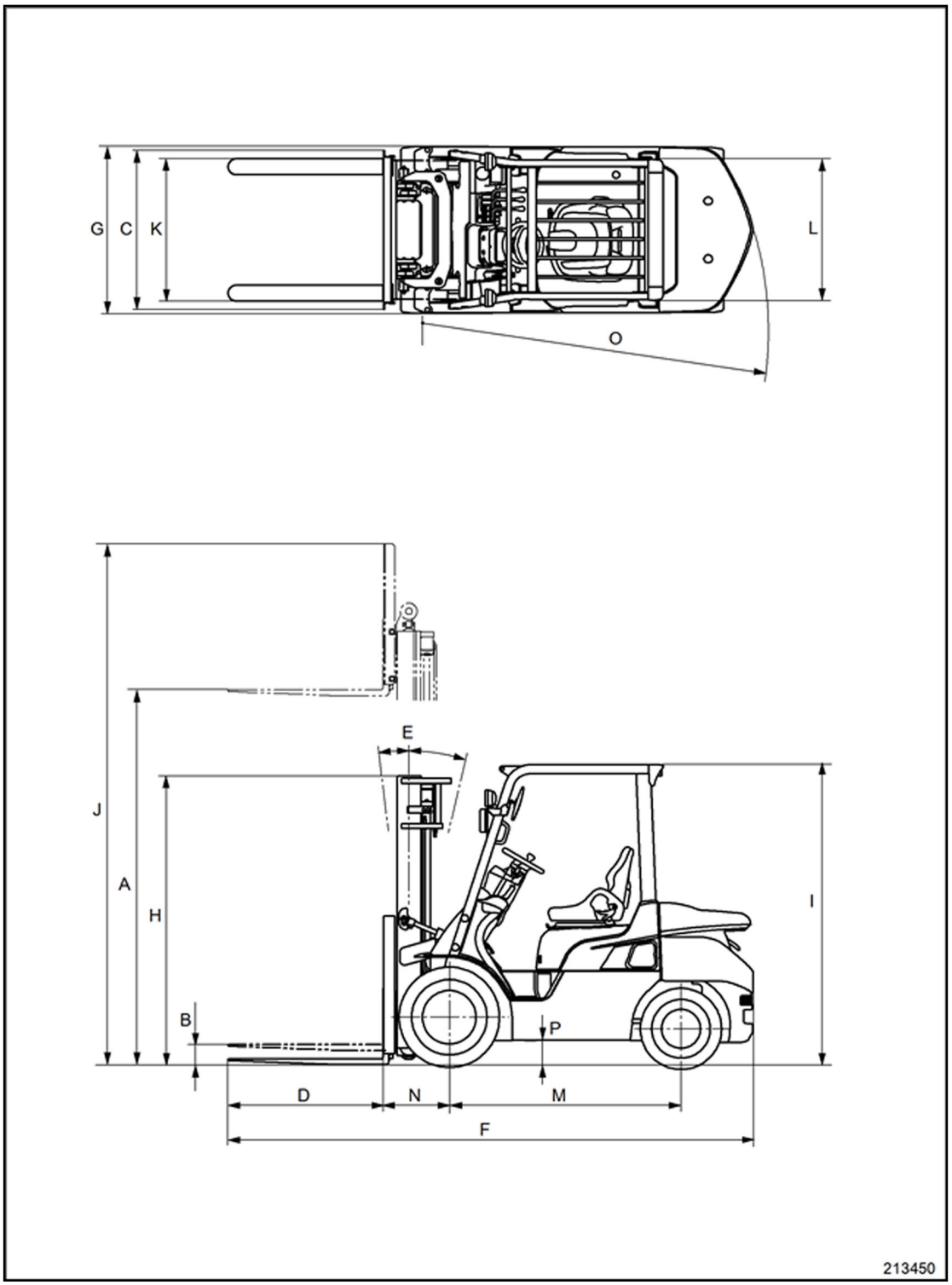
For use with S4S and K21 / K25 Engine Service Manuals.

99719-8M110

CHAPTER 5 POWER TRAIN

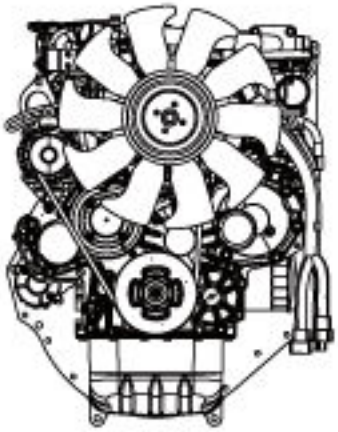
CHAPTER 6 POWERSHIFT TRANSMISSION

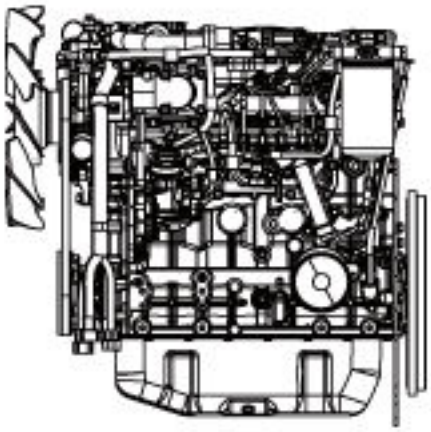
1.4 DIMENSIONS



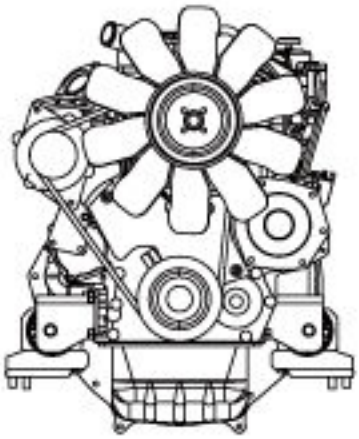
2.3.4 UNIT LAYOUT

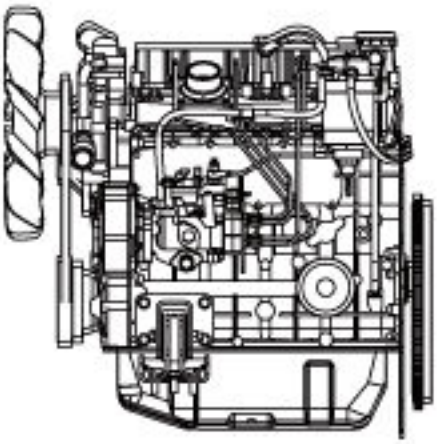
1)





2)





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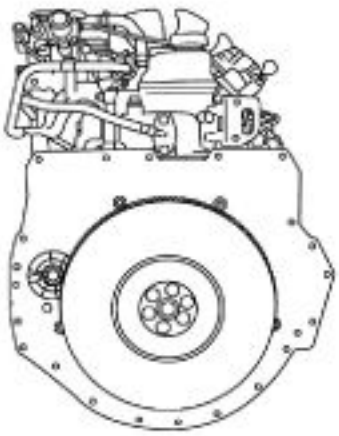

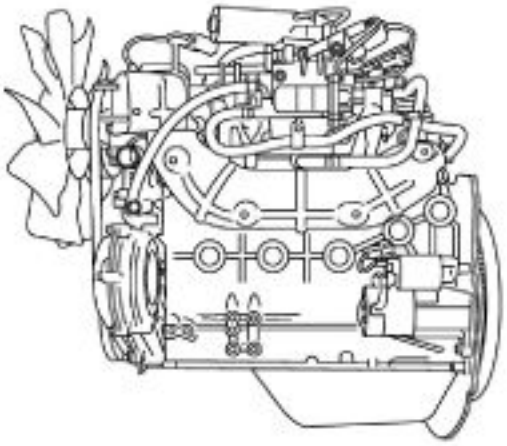

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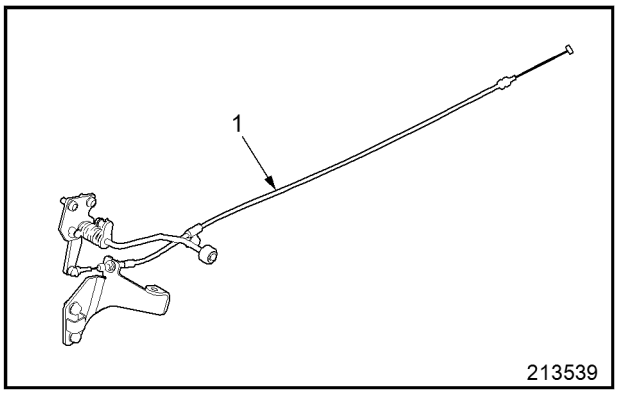
5.1.2.2 CONTROLS

This section describes only removal and installation procedures specific to mechanical controlled diesel engine models. Follow the instructions for the gasoline engine models in the preceding sections for the common procedures.

Removal sequence (specific to diesel engine lift trucks)

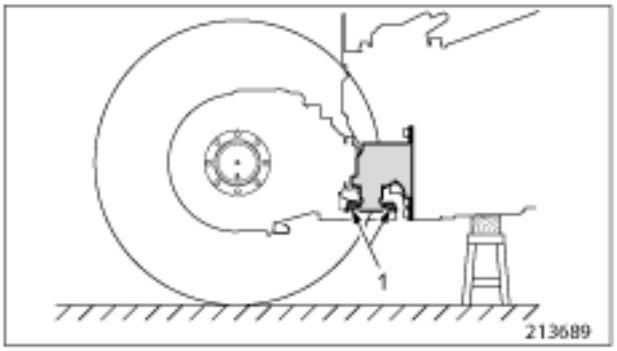


1. THROTTLE CABLE

NOTE:
1) For removal of the front wheel, see "Front Wheels, Page 7-4" IN THE PREVIOUS SECTION.
2) For removal of mast parts **2** through **8**, see Ch 12. MAST AND FORKS
3) Before removing the front axle and reduction differential, remove the front axle drain plug and drain transfer and differential oil.

7.2.2.1 REMOVAL

Suggestions for Removal



1. BOLT

(1) Removing bolt **12**
Bolts 12 are coupling the transmission with the differential. Before removing these bolts, place a jack stand under the transmission to support it.

(2) Removing parking brake cable
To remove the parking brake cable, remove the parking brake lever assembly from the dashboard and disconnect the cable from the lever.

NOTE: To dismount the reduction differential alone, remove the front axle as described above. To dismount the reduction differential, after removal of the engine and transmission, the front axle does not need to be removed from the lift truck

7.2.2.2 INSTALLATION

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

(1) After connecting the parking brake cable, make sure that the brake lever operating effort is within the specification.

Items	Truck type		
	1 ton class	2 ton class	3 ton class
Parking brake lever operating effort	150 to 200 (15.3 to 20.4) [33.7 to 45.0]	200 to 250 (20.4 to 25.5) [45.0 to 56.2]	230 to 250 (23.5 to 25.5) [51.7 to 56.2]

Unit: N (kgf) [lbf]

(2) Before installing the mast, bleed trapped air in the brake fluid circuits. For bleeding, see Ch 9. BRAKE SYSTEM

(3) After installing the mast, make sure that tilt angles, (forward and backward), are correct and that the lift chains, (right and left), are equal in tension. See Ch 12. MAST AND FORKS

(4) Fill the front axle housing with oil up to the plug hole level.

Items	Truck type		
	1 ton class	2 ton class	3 ton class
Refill capacity of transfer and differential	5.5 (1.5)	9.3 (2.5)	8.7 (2.3)

Unit: liter (US gal.)

1) 1 TON CLASS
2) 2 TON CLASS
3) 3 TON CLASS

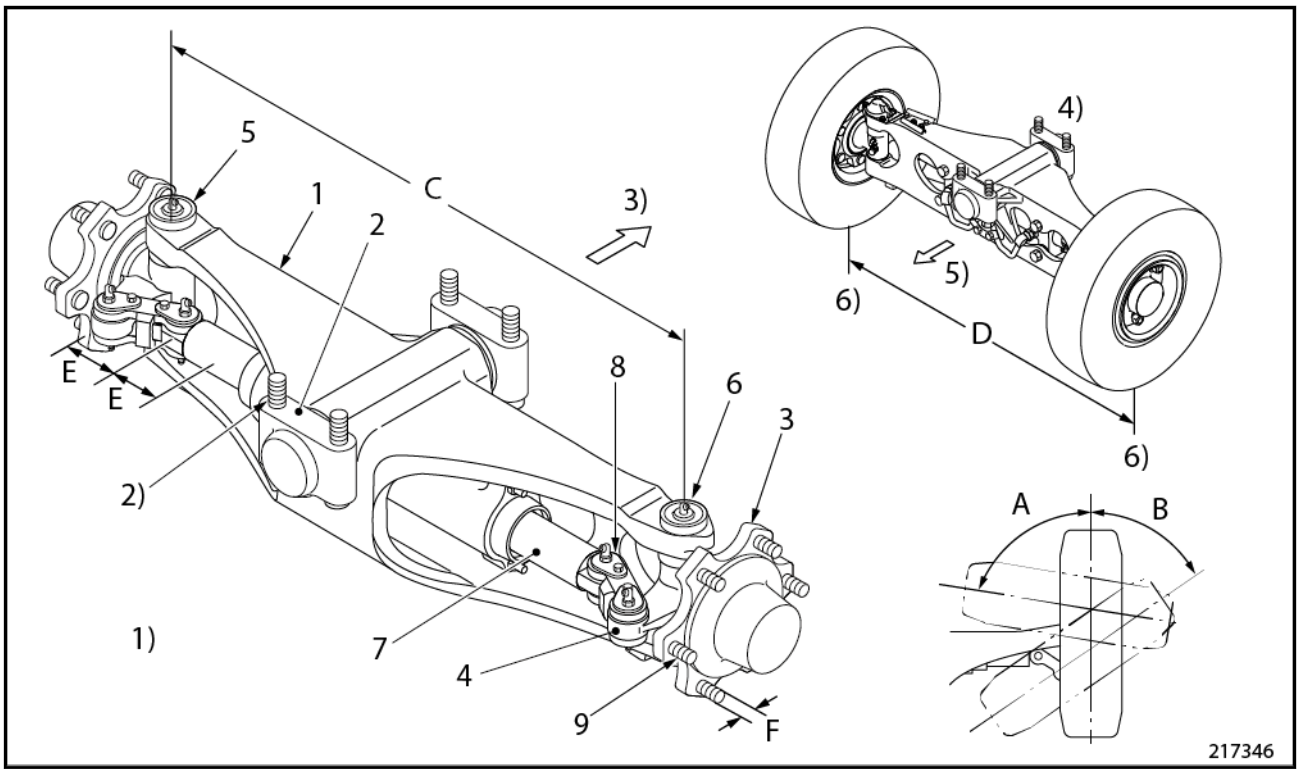
1. DIFFERENTIAL CASE
2. REDUCTION GEAR
3. BOLT
4. DIFFERENTIAL GEAR, THRUST WASHER
5. DIFFERENTIAL PINION, PINION THRUST WASHER (2, 3 TON CLASSES), DIFFERENTIAL SHAFT, SPRINGPIN
6. DIFFERENTIAL GEAR, THRUST WASHER
7. TAPERED ROLLER BEARING
8. DIFFERENTIAL CARRIER
9. BEARING CAP
10. ADJUSTING SCREW
11. CARRIER COVER
12. CARRIER COVER
13. BALL BEARING
14. INPUT FLANGE
15. DRIVE GEAR
16. BALL BEARING
17. PLATE
18. REDUCTION PINION, SHIMS, TAPERED ROLLER BEARING (INNER)
19. DRIVEN GEAR
20. TAPERED ROLLER BEARING
21. SHIM
22. LOCKNUT, O-RING, COVER
23. LOCK PLATE

Chapter 8 REAR AXLE

8.1 STRUCTURE AND FUNCTIONS

8.1.1 REAR AXLE IN GENERAL

Main Components



1) REAR AXLE VIEWED FROM REAR
2) BOLT FOR SECURING AXLE TO TRUCK
3) FRONT OF VEHICLE
4) REAR AXLE VIEWED FROM FRONT (WITH TIRES INSTALLED)
5) FRONT OF VEHICLE
6) CENTER OF TIRE

1. REAR AXLE MAIN UNIT
2. BUSHING SUPPORT (REAR AXLE SUPPORT)
3. WHEEL HUB
4. KNUCKLE
5. LEFT-SIDE KING PIN
6. RIGHT-SIDE KING PIN
7. STEERING CYLINDER
8. TIE ROD
9. WHEEL BOLT

(3) When replacing the dust seal and needle bearing, install them in the direction and dimensions shown in the illustration using a driving tool.

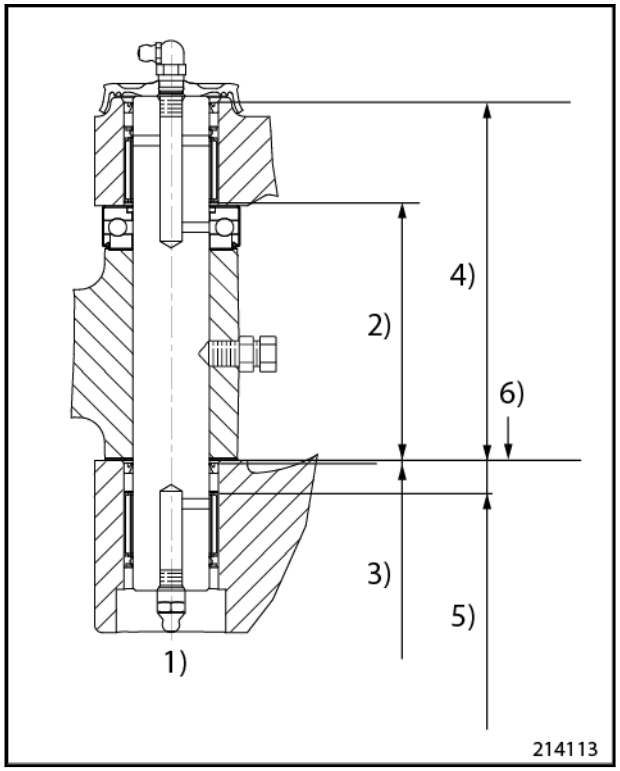
Tightening torque of locknut	31 to 42 (3.2 to 4.3) [22.9 to 31.0]

Unit: N·m (kgf·m) [lbf·ft]

(4) Place three tabs on plate **9** upward. Align the notch to locating springpin position protruded from king pin. Install snugly to the full depth.

(5) Apply a sufficient amount of grease after assembly. Apply grease until it comes out of the boundary between the axle and the knuckle.

(6) Dimensions after assembly are shown below:



1) KING PIN
2) 101 MM (4.0 IN.) (BEARING END FACE)
3) 1 MM (0.04 IN.) (SEAL END FACE)
4) 140.5 MM (5.5 IN.) (SEAL END FACE)
5) 12 MM (0.45 IN.) (BEARING END FACE)
6) REFERENCE SURFACE

8.3.3 STEERING CYLINDER, DISASSEMBLY AND ASSEMBLY

8.3.3.1 REMOVAL OF CYLINDER

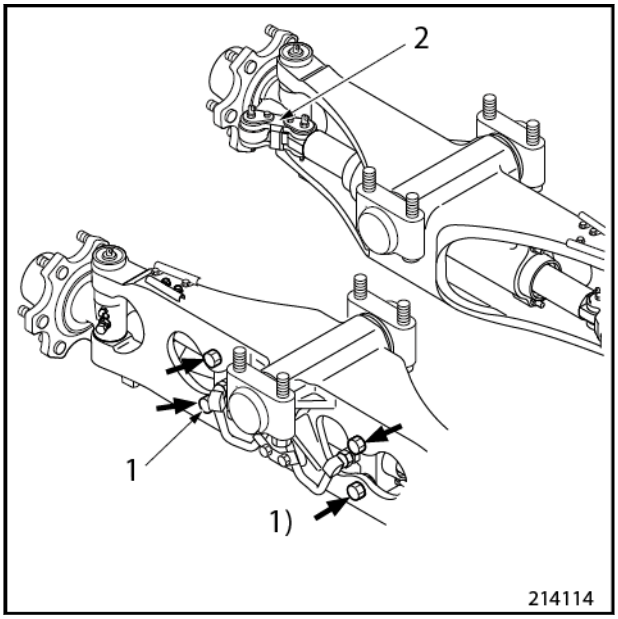
(1) Remove cylinder mounting bolts (4 pieces) to remove the steering cylinder.

8.3.3.2 SUGGESTIONS FOR REMOVAL

Start by

(1) Remove the rear axle assembly (with cylinder) from the lift truck.

(2) Pull out the tie rod pins (right and left) on the cylinder to disconnect the knuckle from the cylinder.



1) TIGHTENING TORQUE: 265 TO 292 N·M (27.0 TO 29.8 KGF·M) [195.5 TO 215.4 LBF·FT]

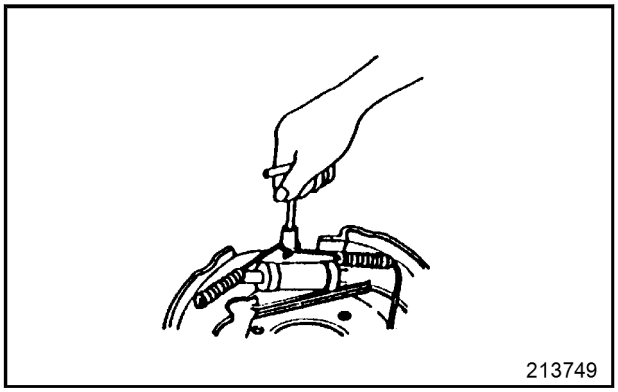
1. CYLINDER MOUNTING BOLT (TOTAL OF 4)
2. TIE ROD PIN

(4) Disconnect the brake pipe from the wheel brake assembly.

Suggestions for Disassembly

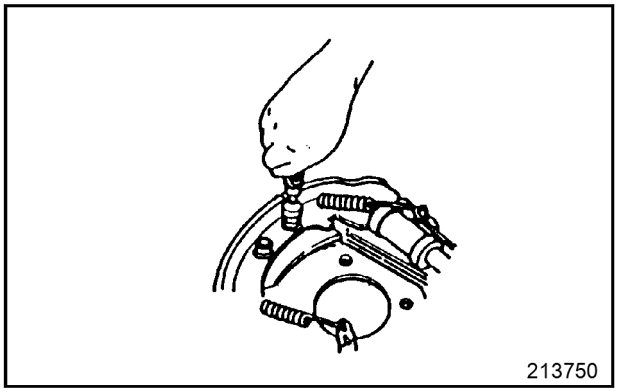
(1) Removing return springs
Use the spring remover to remove the return springs from the shoe guide plates.

Special tool needed	
Spring remover	64309-15411



(2) Removing hold-down springs
Use the spring retainer to remove the hold-down springs from the backing plate.

Special tool needed	
Spring retainer	64309-15412



Inspections after Disassembly

(1) Backing plate

a. Check the backing plate for cracks.

(2) Shoes and linings

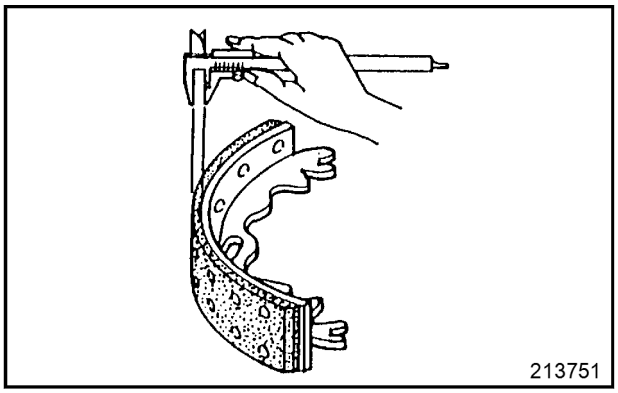
a. Check each shoe and lining for cracks.

b. Replace the lining if it is heavily fouled with grease, burnt, or otherwise deteriorated.

c. Measure the thickness of the lining. Replace if it is worn to less than the service limit.

Items		Truck type	
		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.)



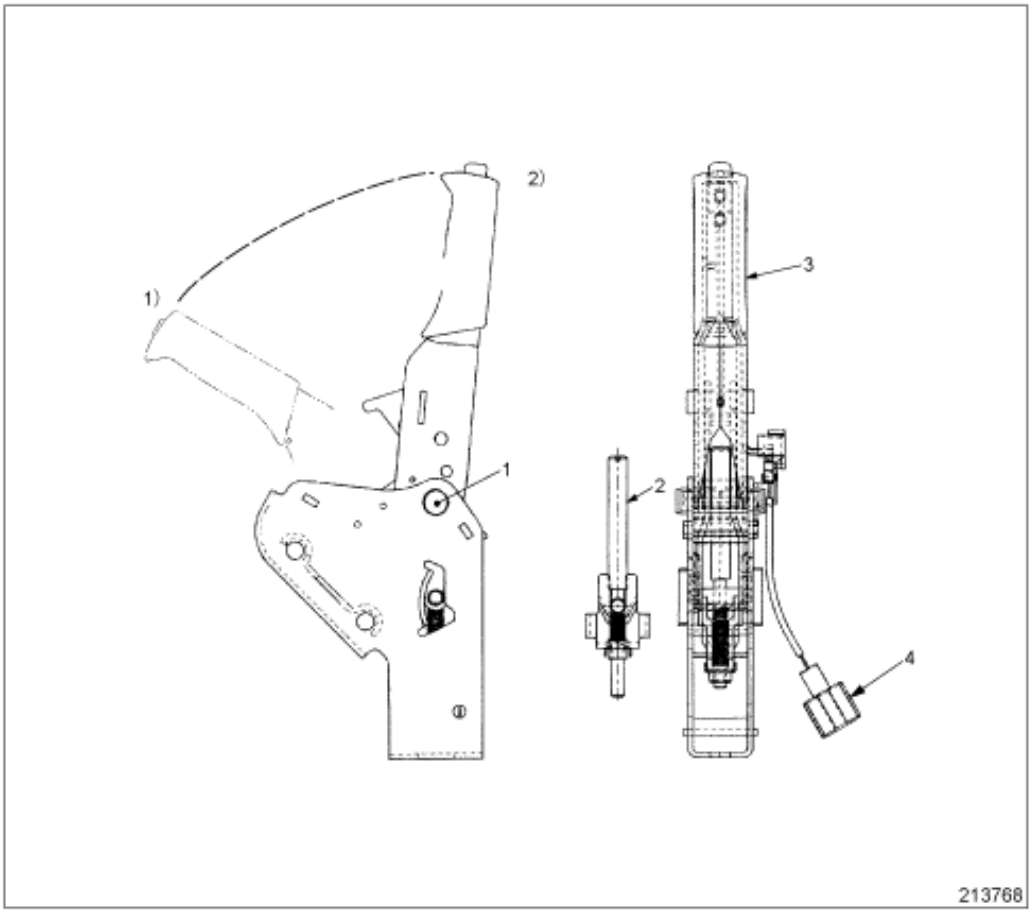
(3) Brake drums
Check the inside (friction) surface of the drum for abnormal wear, grooving and other defects. Minor grooving can be removed by grinding, provided that the inside diameter does not exceed the service limit.

Items		Truck type	
		1 ton class	2 ton class 3 ton class
Brake drums Inner diameter	A	254 (10.0)	310 (12.2)
	B	256 (10.1)	312 (12.3)

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

(4) Adjusting screw
Check the wheel teeth for wear. Turn the screw by hand to see if its rotating parts turn smoothly.

9.3.7 PARKING BRAKE LEVER



1) RELEASED
2) APPLIED
1. LEVER SUPPORT PIN
2. ADJUSTING SCREW
3. PARKING BRAKE LEVER ASSEMBLY
4. PARKING BRAKE SWITCH

9.3.7.1 INSPECTION AND REPAIR

(1) If the lever support pin and/or the pin hole in the lever are badly worn, replace the worn part(s).

(2) Replace the parking brake cable if it is stretched, damaged, or rusted.

9.3.7.2 ASSEMBLY

With the parking brake cable and lever connected, the effort required to pull the lever should be adjusted into the following range.:

Items	Truck type		
	1 ton class	2 ton class	3 ton class
Parking brake lever operating effort	150 to 200 (15 to 20) [34 to 45]	200 to 250 (20 to 25) [45 to 56]	230 to 250 (23 to 25) [52 to 56]

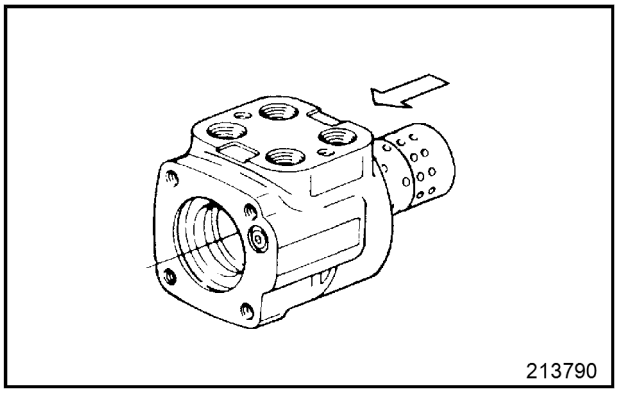
Unit: N (kgf) [lbf]

NOTE: When the tilt lock lever is turned counter-clockwise, plate (A) and (B) are sandwiched between bolt and nut, and locked.

The steering column tilt angle is adjustable in the range of **5** degrees forward and **7** degrees backward as shown in the illustration.

To adjust the tilt angle, lock the column lock lever **4** first, and loosen the tilt lock lever **3** by turning it clockwise. Then, tilt the steering column **1** to the optimal angle and turn the tilt lock lever **3** counterclockwise (pulling upward) to lock.

The column lock lever **4** is used to tilt the steering column forward for the convenience of the operator to get on and off the lift truck and during maintenance. Tilt the steering column forward by pushing down the tilt lock lever **3** to disengage the column lock lever **4** from the lock pin **5**.

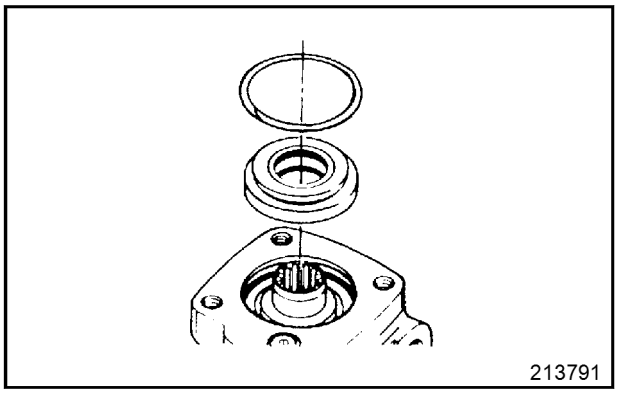


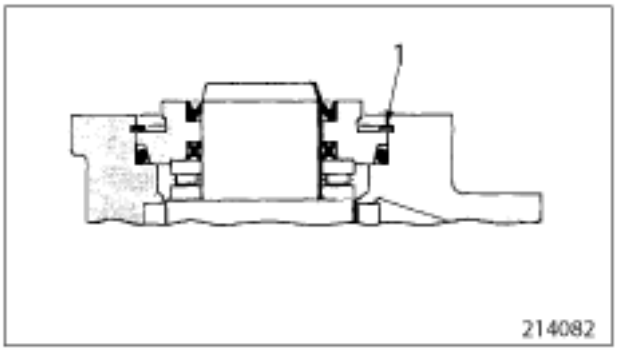
(4) Install O-ring and thrust bearing.

(5) Installing seal

a. Install dust seal on seal gland bushing. See the illustration in the "ASSEMBLY" in the previous page for orientation. Then install the X-ring seal.

b. After installing the O-ring, fit the seal gland bushing into the spool while turning the seal gland bushing. Drive the bushing into the specified position by a plastic hammer. Check that the bushing contacts the top face of the thrust bearing race evenly. Securely fit the retaining ring into the housing groove.



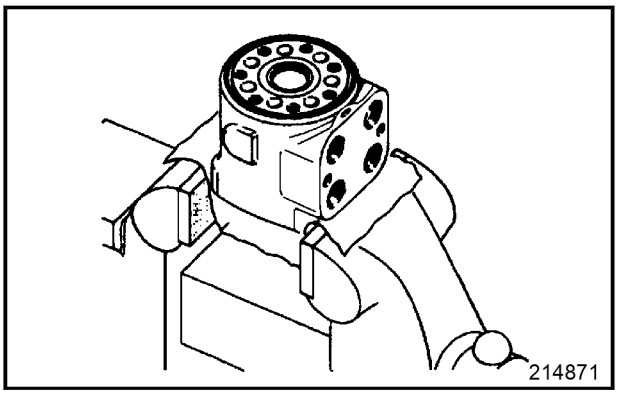


1. RETAINING RING

(6) Installing spacer plate

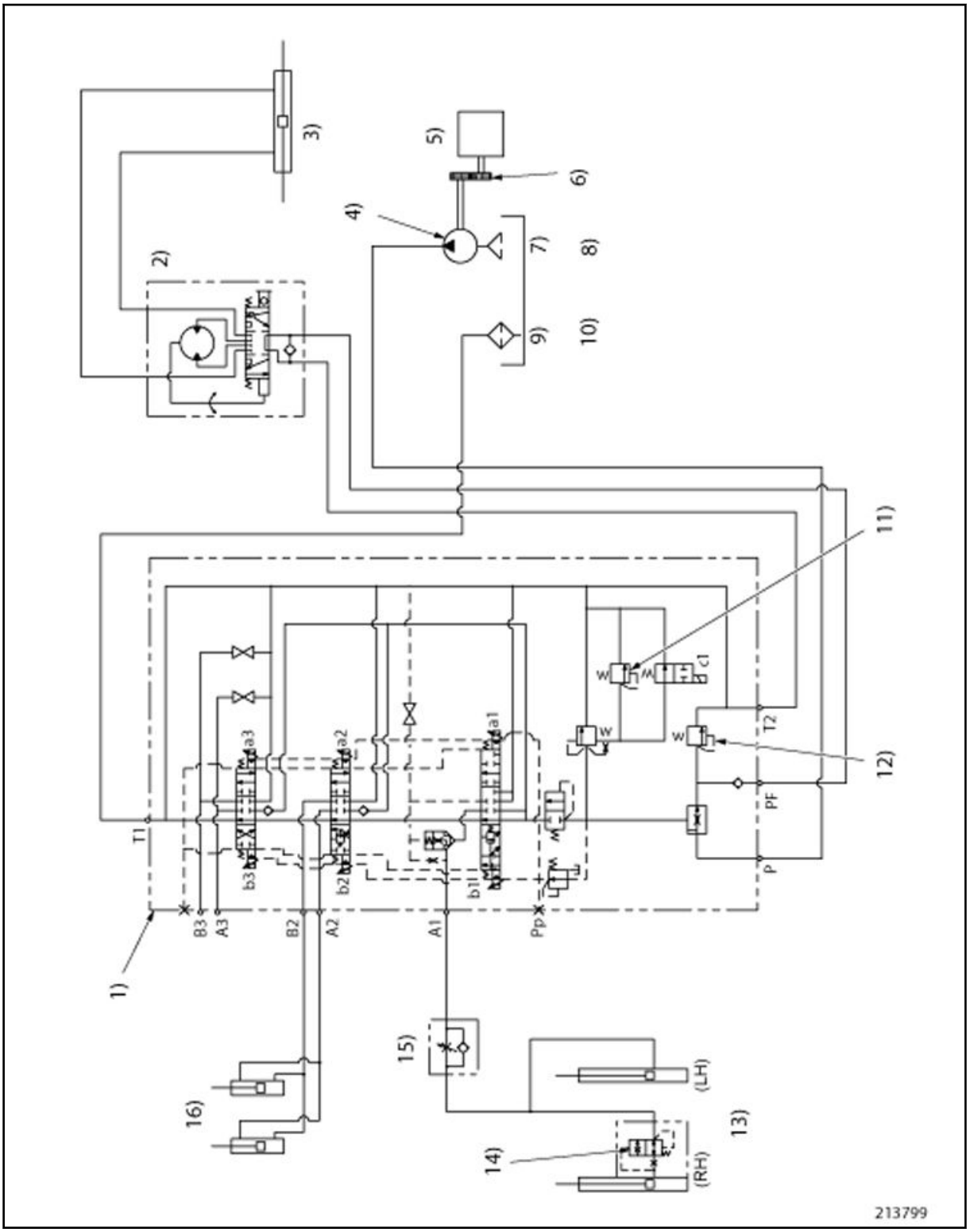
a. Before holding the housing in a vise, use a soft pad or wrap a soft cloth around the housing. Hold the flat section of flange in a vise. Do not hold it in a vise too tight.

NOTE: Make sure that the spool and sleeve are flush with or slightly lower than the surface of housing.



b. Install O-ring on the housing. Place the spacer plate on the housing, and align the bolt hole with the tap hole of housing.

11.1.3 HYDRAULIC CIRCUIT DIAGRAM (FOR MODELS WITH FC CONTROL VALVE)

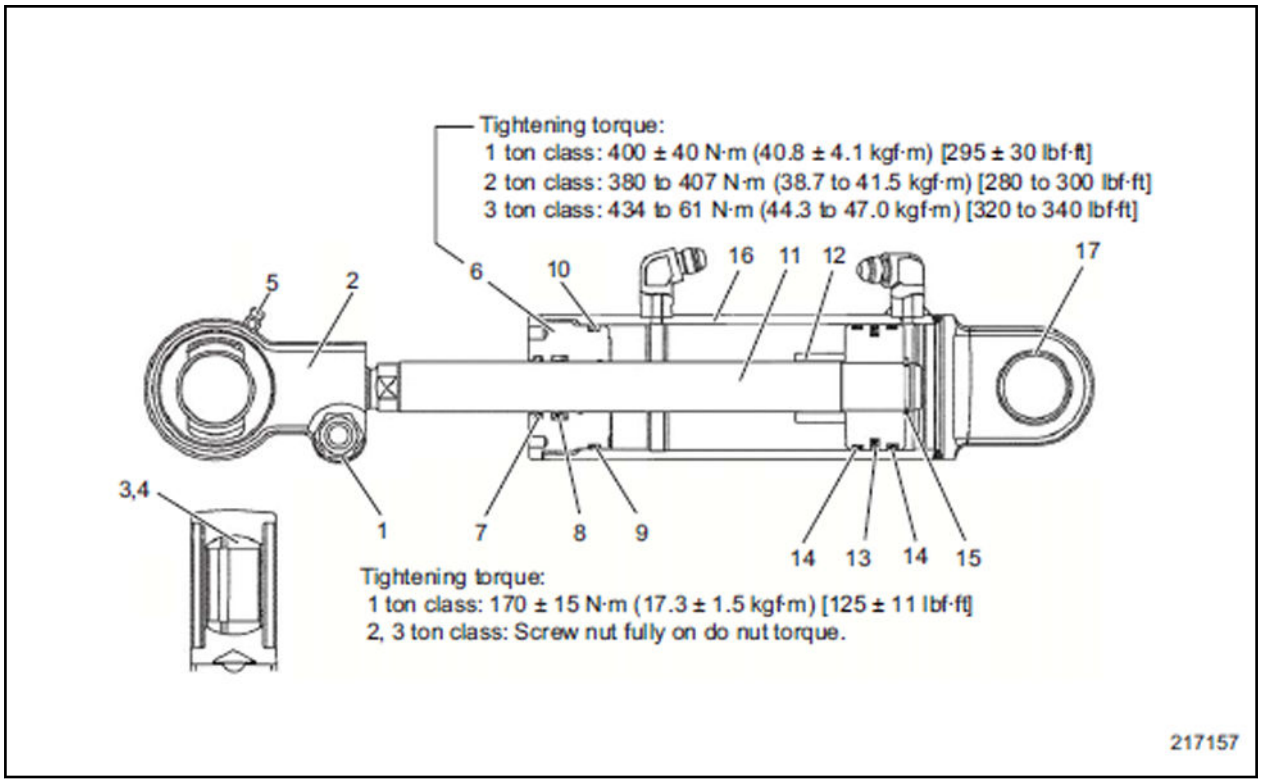


Model type	Mast type	Class	Lift height	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1 ton class	Simplex	15 - 20C	3290	35 (1.38)	45 (1.77)	53 (2.07)
	Triplex	15 - 20C	3290	35 (1.38)	45 (1.77)	53 (2.07)
2 ton class	Simplex	20 - 25	3300	40 (1.57)	50 (1.97)	58 (2.28)
		28 - 30	3270	42 (1.65)	55 (2.17)	65 (2.56)
	Triplex	20 - 25	3300	40 (1.57)	50 (1.97)	58 (2.28)
		28 - 30	3270	42 (1.65)	55 (2.17)	65 (2.56)
3 ton class	Simplex	33 -35	3300	45 (1.77)	60 (2.36)	70 (2.76)
	Triplex	33 - 35	3300	45 (1.77)	60 (2.36)	70 (2.76)

Unit: mm (in.)

Table 11-1. Cylinder dimensions (the length and stroke of cylinder vary depending on lift height.)

Main Components



1. BOLT, NUT
2. TILT SOCKET
3. INNER RING
4. BEARING
5. GREASE NIPPLE
6. ROD GUIDE
7. WIPER RING
8. NUT RING
9. BACK-UP RING
10. O-RING
11. PISTON ROD ASSEMBLY
12. COLLER
13. PISTON SEAL
14. GUIDE RING
15. SNAP RING
16. CYLINDER ASSEMBLY
17. BUSHING

The tilt cylinder is a double-acting type. To adjust right and left imbalance of tilt angles when the mast is attached, loosen the clamp bolt and turn the piston rod with a spanner applied on area A.

Seal **11** helps extends the greasing intervals. Installation of this seal has extended greasing intervals up to 500 service hours.

Cylinder dimensions

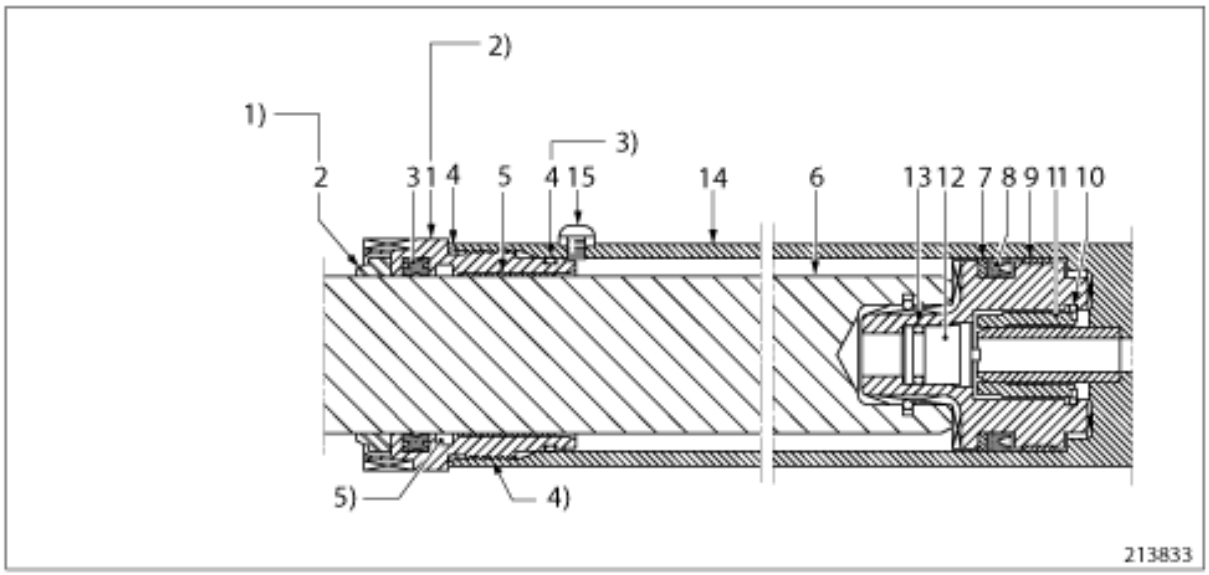
Cylinder length and stroke vary depending on tilt angles of forward and backward tilt.

Model type	Rod diameter	Cylinder I.D.	Cylinder O.D.
1 ton class	25 (0.98)	63 (2.48)	73 (2.87)
2 ton class	30 (1.18)	70 (2.76)	82 (3.23)
3 ton class	35 (1.38)	80 (3.15)	93 (3.66)

Unit: mm (in.)

Second lift cylinder for simplex mast and triplex mast

First, disassemble into the three main parts: I, II, and III.
Then disassemble each of the three main parts individually.



I HEAD SUB-ASSEMBLY (CONSISTING OF THE FOLLOWING PARTS, 1 THRU 5.)

1. CYLINDER HEAD
2. WIPER RING
3. X-RING
4. O-RING
5. BUSHING

II PISTON ROD SUB-ASSEMBLY (CONSISTING OF THE FOLLOWING PARTS, 6 THRU 13.)

6. PISTON ROD ASSEMBLY
7. BACKUP RING
8. U-RING
9. BUSHING
10. SNAPRING
11. CUSHION BEARING
12. CHECK VALVE
13. O-RING

III CYLINDER TUBE ASSEMBLY (CONSISTING OF THE FOLLOWING PARTS, 14 AND 15.)

14. CYLINDER TUBE SUB-ASSEMBLY
15. PLUG

Units: N·m (kgf·m) [lbf·ft]

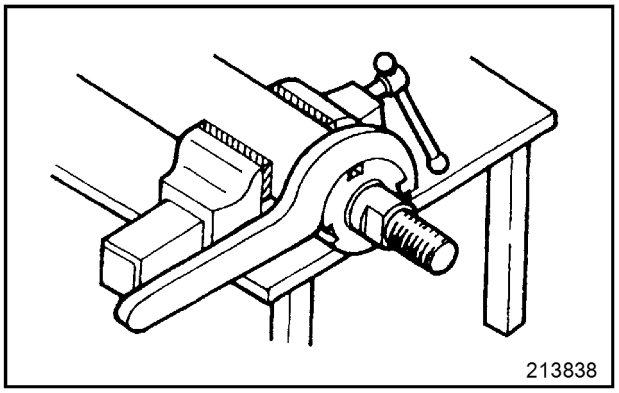
1) APPLY LIQUID GASKET TO CIRCUMFERENCE WHEN PRESSING IN.

2) TIGHTENING TORQUE
1 TON CLASS: 196±45.1 (20±4.6) [145±33] (M49X1.5)
2 TON CLASS: 235±53.9 (24±5.5) [173±40] (M54X1.5)

3) APPLY GREASE WHEN ASSEMBLING.

4) APPLY THREEBOND ®1901 WHEN SCREWING IN.

5) SEAL IN GREASE. (ADHESION TO BUSHING IS ACCEPTABLE.)



Inspections after Disassembly

(1) Cylinder tube

a. Check the bore wall for wear, grooving, scratches and rust.

b. Check the welds for cracks.

(2) Piston rod

a. Check for surface flaws such as grooving, scratches, rust, and wear. The rod must be replaced if its threads show a sign of stripping or any other damage.

(3) Rings and packings

a. Check each ring and packing for damage or distortion.

b. Also check for deterioration due to aging.

Suggestions for Assembly

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

(1) Carefully clean all parts to remove any foreign particle.

(2) Assemble the cylinder in the reverse sequence of the disassembly, apply hydraulic oil on the bore wall of the cylinder tube, and also to sealing parts; O-rings, piston seals, dust seals, and packings. Pay attention to the orientation of parts.

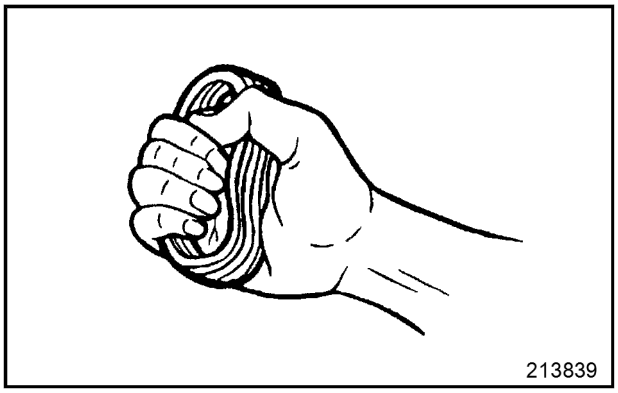
(3) When clamping the cylinder tube in the vise, be careful not to distort the tube.

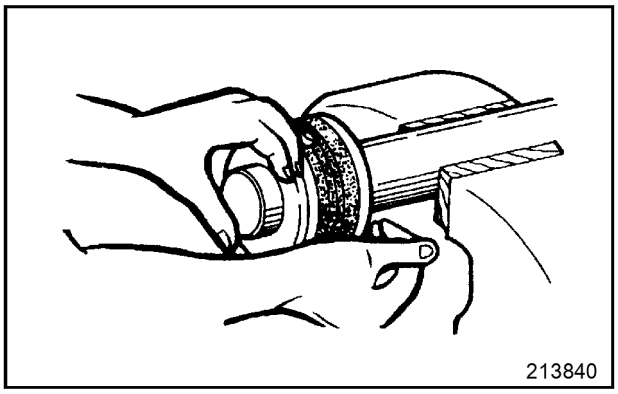
(4) Install the piston seal as follows:

a. Before fitting the piston seal, squeeze it by hand five or six times to soften it.

b. Hold the piston in a vise, making sure care not to damage any part of the piston. Apply a thin coat of hydraulic oil on the seal. Fit a portion of the seal to the groove, and push the other portion into the groove as shown.

(5) Tighten the thread to the specified torque. See "Figure 11-3, First, disassemble into four main parts: I, II, III and IV.Then disassemble each of the four main parts individually., Page 11-43Figure 11-3, First, disassemble into four main parts: I, II, III and IV.Then disassemble each of the four main parts individually., Page 11-43" for the tightening torque.





	Oil leakage	Oil leakage from spool ring cap	Replace O-ring; check spool for flaws and if any, repair or replace a leaky block assembly
		Loose plug	Tighten plug
		O-ring damaged	Replace O-ring
Lift and tilt cylinders	Mast will not lift or tilt forward or backward	Not enough oil in hydraulic tank	Replenish oil by seeing Chapter13.SERVICE DATA
		Relief valve out of order, because of: (1) Seized main valve (2) Broken valve spring	(1) Replace (2) Replace
		Gear pump defective	Replace
	Will not lift rated load	Relief valve out of order, because of: (1) Too low a relief valve setting (2) Defective plunger or poppet seat (3) Fatigued or damaged spring (4) Damaged O-ring in valve case	(1) Adjust pressure (2) Replace (3) Replace (4) Replace
		Gear pump defective	Replace
		Piston seals worn or damaged	Replace
	Lifting speed is too slow	Engine speed too low	Tune up engine
		Operating control lever installed loose, resulting in not enough spool stroke	Adjustment
		Tank strainer clogged	Clean or replace
		Pump not delivering enough oil	Repair or replace
	Lowering speed is too slow	Sleeve seized in flow regulator valve	Repair
		Dirt in flow regulator valve, abnormal resistance to flow due to flattened hose or local clogging	Clean, repair system and replace defective hose
	Cylinder vibrates when actuated	Piston rod distorted	Repair or replace
		Air trapped in oil circuit	Bleed air by operating cylinder through full stroke

To adjust, turn adjusting screw **3** to change preload of spring **4**.

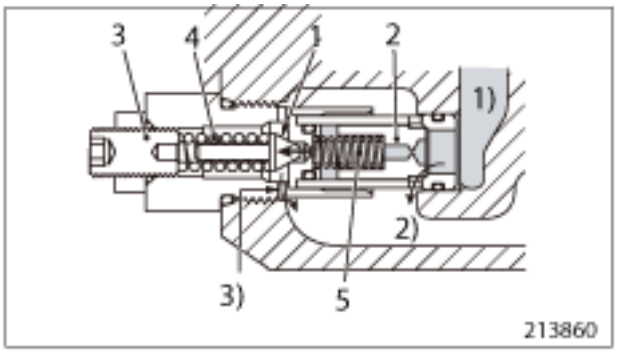


Figure 11-6.

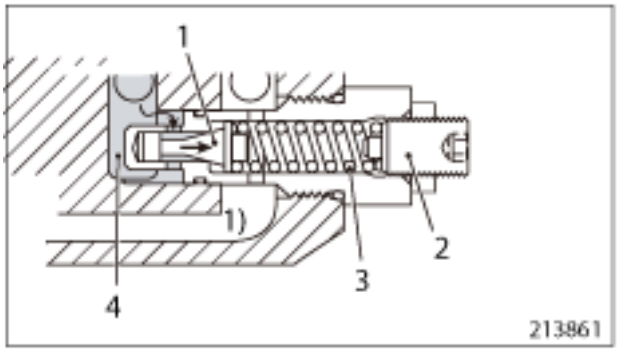
1) HIGH-PRESSURE PASSAGE
2) LOW-PRESSURE PASSAGE
3) DRAIN PASSAGE OF PILOT OIL

1. POPPET VALVE
2. DUMP VALVE
3. ADJUSTING SCREW
4. SPRING
5. SPRING CHAMBER

11.6..5 STEERING SYSTEM RELIEF VALVE (PF RELIEF VALVE)

This valve is a relief valve of direct-acting type, and acts when the steering wheel is fully turned.

This is a safety valve to protect the system. To adjust, turn the adjusting screw to change preload of the spring.



1) LOW PRESSURE PASSAGE

1. VALVE
2. PRESSURE ADJUSTING SCREW
3. SPRING
4. PF FLOW PASSAGE

Suggestions for Disassembly

(1) Remove spool **4** from the combination valve body with the return spring and cap screw attached.

(2) When removing the cap screw, hold the spool in a vise with soft jaws (hard wooden plate or plastic plate) and remove the cap screw using a hexagon wrench. Be careful of the spring jumping out.

(3) Do not, in principle, disassemble or adjust flow regulator valve **16**. If internal parts are damaged, replace it as an assembly. Remove it as an assembly without touching the adjusting screw and locknut. When disassembling, make a record of the protrusion amount of the set screw. Assemble it to the same dimension.

(4) Do not, in principle, disassemble or adjust shutoff valve **15**. When disassembling, make a record of the protrusion amount of the set screw. Assemble it to the same dimension.

Main Relief Valve, Pilot Relief Valve and Unload Valve

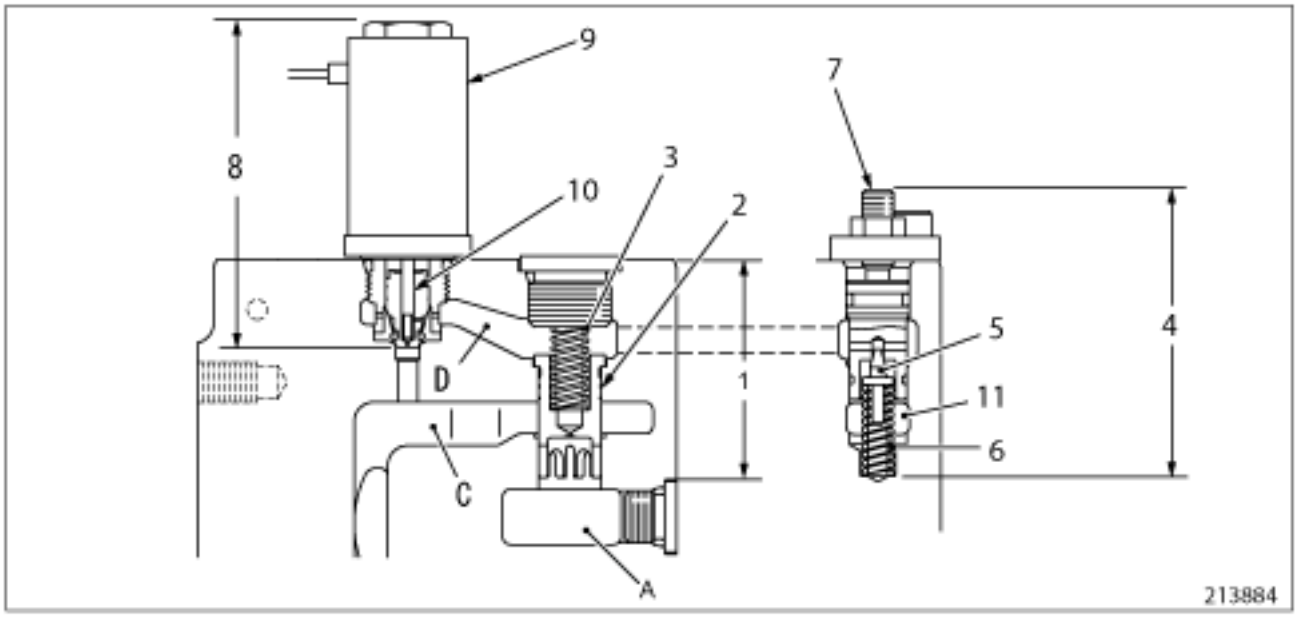


Figure 11-15.

A: EXTRA FLOW (EF FLOW) PASSAGE
C: DRAIN PASSAGE
D: OIL PASSAGE

1. MAIN RELIEF VALVE
2. DUMP VALVE
3. SPRING
4. PILOT RELIEF VALVE
5. POPPET VALVE
6. SPRING
7. PRESSURE ADJUSTING SCREW
8. UNLOAD VALVE
9. SOLENOID
10. NEEDLE VALVE
11. DRAIN PASSAGE

Function of Component Valves

The pilot relief valve **4** and unload valve **8** are arranged in parallel to serve as pilot valves for the main relief valve **1**.

To be more specific, when either valve **4** or **8** opens, the dump valve **2** overcomes the force of the spring **3** to lift, releasing high pressure oil in the oil passage A into the drain passage C.

Pilot Relief Valve 4

This is a pilot valve for the main relief valve. When pressure in the system exceeds the specified limit, the poppet valve **5** overcomes the force of the spring **6** to move downward, releasing oil in the back of the dump valve **2** into the drain passage. As a result, the dump valve of the main relief valve lifts to release some of EF flow into the drain passage.

The screw **7** is for set pressure adjustment. Turning it clockwise increases set pressure. For set pressure and setting procedure, see "Main Relief Valve, Page 11-50".

Unload Valve

The unload valve **8**, located between the back of the dump valve **2** and an oil passage connecting to the drain passage C as shown in Figure 11-15, Page 11-85, is a solenoid valve serving as a pilot relief valve for the main relief valve **1**.

When the solenoid is energized by electric current that flows through it, the needle valve **10** protrudes to close the oil passage D. When the solenoid is

With the tilt lever back in the "NEUTRAL" position, the unload valve of the inlet valve assembly is opened to release extra flow of oil into the drain passage through the main relief valve.

As a result, oil pressure in the passage **13** is reduced, and oil pressure of the damper (e) is also reduced. When this takes place, the tilt lock valve **3** is pushed to the right by the spring **7** and the route connecting the port A2 and low-pressure passage **10** is closed.

The tilt cylinder rod is brought into a locked state.

ASSEMBLY OF PILOT RELIEF VALVE (1 TO 9)

1. SPRING
2. VALVE
3. SLEEVE
4. O-RING
5. O-RING
6. PLATE
7. SCREW
8. LOCKNUT
9. BOLT

ASSEMBLY OF PRIORITY VALVE (10 TO 15)

10. SPOOL SET
11. PLUG
12. O-RING
13. SPRING (FREE LENGTH: 43.5 MM (1.7IN.))
14. PLUG
15. O-RING

ASSEMBLY OF RESISTANCE VALVE (16 TO 20)

16. SPOOL
17. SPRING (FREE LENGTH: 36 MM (1.4IN.))
18. SLUG
19. PLUG
20. O-RING

ASSEMBLY OF PF RELIEF VALVE (STEERING RELIEF VALVE) (21 TO 30)

21. SPRING
22. POPPET
23. RELIEF VALVE
24. O-RING
25. PLATE
26. SCREW
27. LOCKNUT
28. BOLT
29. PLUG (WITH O-RING 20)
30. O-RING

1) TIGHTENING TORQUE: 15.7 ± 1.6 N·M (1.6 ± 0.16 KGF·M) [11.5 ± 1.0 LBF·FT]
2) TIGHTENING TORQUE: 63.7 ± 6.4 N·M (6.5 ± 0.65 KGF·M) [47 ± 4.7 LBF·FT]
3) TIGHTENING TORQUE: TIGHTENING FIRST: 34.1 ± 3.4 N·M (3.5 ± 0.35 KGF·M) [25.3 ± 2.5 LBF·FT]
4) FURTHER TIGHTENING: 34.1 ± 3.4 N·M (3.5 ± 0.35 KGF·M) [25.3 ± 2.5 LBF·FT]
5) TIGHTENING TORQUE AFTER SET PRESSURE ADJUSTMENT: 9.8 ± 1.0 N·M (1.0 ± 0.1 KGF·M) [7.2 ± 0.7 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: 63.7 ± 6.4 N·M (6.5 ± 0.65 KGF·M) [47 ± 4.7 LBF·FT]
8) TIGHTENING TORQUE AFTER SET PRESSURE ADJUSTMENT: 9.8 ± 1.0 N·M (1.0 ± 0.1 KGF·M) [7.2 ± 0.7 LBF·FT]

Chapter 12 MAST AND FORKS

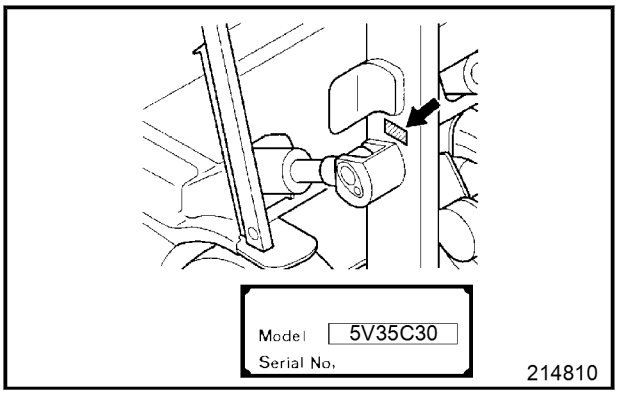
12.1 SIMPLEX MAST

12.1.1 MAST SYSTEM

The following table shows a combination of lift truck and mast models:

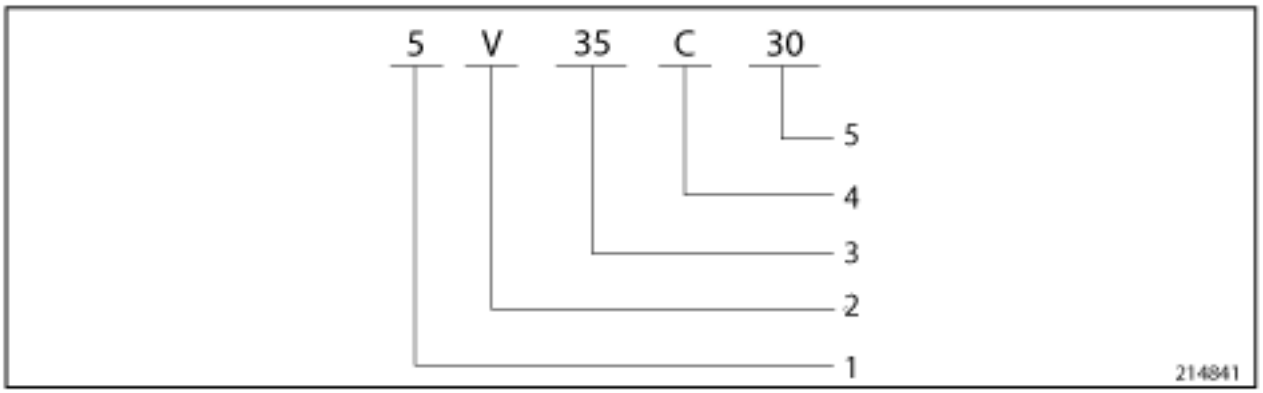
Truck type	Mast
1 ton class	5V15C□□
	5V20C□□
2 ton class	5V25C□□
3 ton class	5V30C□□
	5V35C□□

NOTE: "□□" represents maximum lift height.
Example: 30 = Lift height of 3000 mm (118 in.)



How to read mast model code

Mast type and code	
Code	**Mast type**
V	Simplex mast



1. TRUCK GENERATION (2→3→4...9)
2. INDICATES MAST TYPE
3. APPLICABLE TRUCK CLASS (EXAMPLE: 3.5 TON)
4. MAST GENERATION (A→B→C→...Z)
5. MAXIMUM LIFTING HEIGHT (30: 3000 MM)

- Clearance G
  Clearance between roller side surface and inner mast thrust surface (right-to-left play):
  Clearance G is used for determining the correct amount of shims at the bearing seat.
  Move the lift bracket to the top of the inner mast and slide the bracket to either the left-most or right-most position. Take measurements of clearance G between the side surface of roller and inner mast.

NOTE: It is unnecessary to adjust the lift bracket upper roller with shims.

Adjust the clearance to the specification with shims (a) and (b) for the middle roller and with shim (c) for the lower roller.

Clearance G	0.1 to 0.5(0.004 to 0.020)

Unit: mm (in.)

- Clearance F
  Clearance between roller circumference and inner mast thrust surface (back-to-front play):
  Clearance F is used for determining the proper size of the rollers.
  Select appropriate diameter rollers so that the clearance meets the specification.
  Make sure the rollers rotate smoothly when installed.

Clearance F	1.0 (0.04) or less

Unit: mm (in.)

- Clearance G1
  Clearance between side roller circumference and inner mast side roller thrust surface: Move the side roller to the upper end of the inner mast and slide the lift bracket to either the left-most or right-most position. Take measurement of clearance G1 between the roller circumference and inner mast.
  Adjust the clearance with shims (d) to the specification.

Clearance G1	0.1 to 0.5 (0.004 to 0.020)

Unit: mm (in.)

(1) Choosing correct roller diameters

- Measure clearance F for upper rollers **2**, middle rollers **3**, and lower rollers **4**. If the measured clearances do not conform to the standard values, replace with rollers of correct diameters listed in the below table

NOTE: For measuring procedures, see "Adjusting Clearance Between Lift Bracket Roller and Inner Mast, Page 12-23".

- Make sure that the rollers rotate smoothly when installed.

(2) Adjusting clearance G between the middle roller and thrust plate

NOTE: The following adjustment is not required for the upper roller.

- Measure clearance G between the middle roller and thrust plate. If the measured clearance does not conform to the standard value, adjust clearance G in the manner described below.:

NOTE: For measuring procedures, see "Adjusting Clearance Between Lift Bracket Roller and Inner Mast, Page 12-23".

- Adjusting method
  If clearance G is excessive, increase the thickness of shims (a) as required. Increase the thickness of shims (b) by the same amount that are added to shims (a). Shim (a) is available in two sizes: 1 mm (0.04 in.) and 0.5 mm (0.02 in). Shim (b) is available in only one size, 1 mm (0.04 in.). If shims (a) are increased by 0.5 mm (0.02 in.), shims (b) do not need to be increased by the equal amount.

At the factory, shims (a) and (b) are usually adjusted to the values shown in the below table.

Size (diameter)	**Truck Type**	
	1 ton class	**2 ton class 3 ton class**
S	99 (3.90)	113.8 (4.48)
M	100 (3.94)	115 (4.53)
L	101 (3.98)	116 (4.57)
LL	102 (4.02)	117 (4.61)

Unit: mm (in.)

- Maintenance shops may bend forks back into shape, weld on them, or drill holes through them. Lift Truck users can add attachments to the lift truck that will put stress on the forks. Drum clamps and portable booms can be supported on the forks, but what is contained in the drum or on the boom hook makes the difference in safety.
- Forks are often used to open rail car doors and break loads out or away from other loads. They are also used to pick up capacity loads not seated against the fork shank and to pick up off-balanced loads far from the side of the lift truck. The fork tips are sometimes inserted under other lift trucks to lift them during maintenance operations.
- Lift trucks may collide with building columns and walls, and though the forks show no discernible bend, they may be damaged beyond safety.
- Any time excessive heat is applied to any part of a fork during repair, hidden damage may occur.

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

12.6.2.1 DESIGNED TO TAKE A BEATING

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

12.6.3 CHAIN TENSION INSPECTION AND ADJUSTMENT

⚠ WARNING

Turn the key switch to the OFF position before inspecting or adjusting lift chains, anchor bolts and nuts. Place blocks under the forks when they are raised. Failure to do so can result in serious injury or death due to a sudden movement of heavy components.

Inspection of chain tension

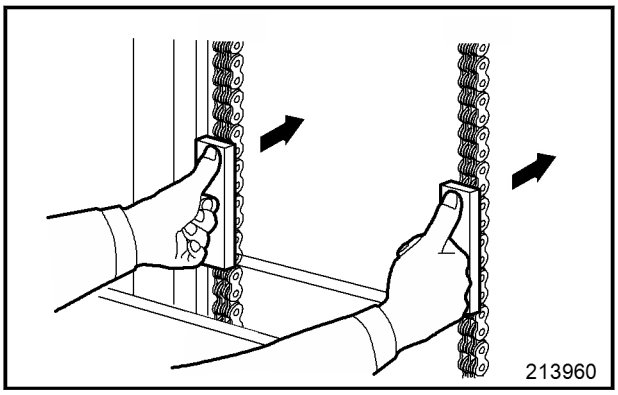
(1) Place the mast VERTICALLY on level and hard surface then lower the forks to the ground. Make sure that the lift cylinders are fully retracted.

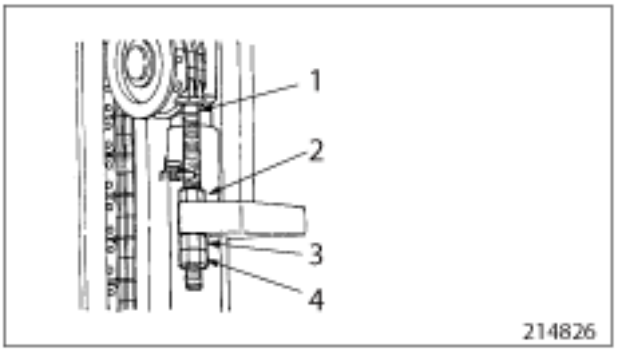
(2) Raise the forks approximately 100 mm (4.0 in.) from the ground.

(3) Turn the key switch to the OFF position.

(4) Place blocks approximately 90 mm (3.5 in.) high under the forks.

(5) Push the chains at the middle point between the chain wheel and chain fixed end on the lift bracket. Check the right and left chains for even tightness. If tension on the right and left chain is uneven, adjust the tension.





1. ANCHOR BOLT
2. CLAMP
3. DOUBLE NUT (UPPER)
4. DOUBLE NUT (LOWER)

12.9 DUPLEX MAST

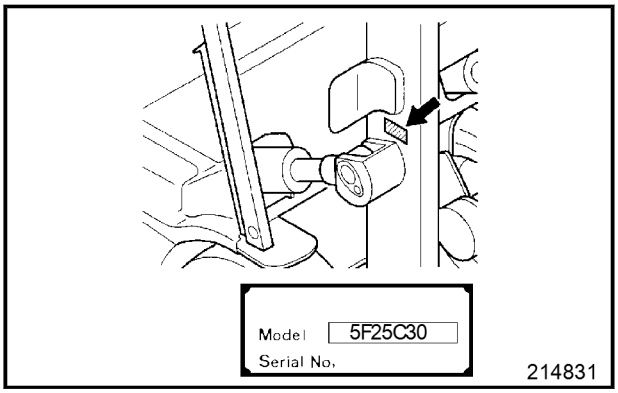
12.9.1 MAST SYSTEM

The following table shows a combination of lifttruck type and mast models:

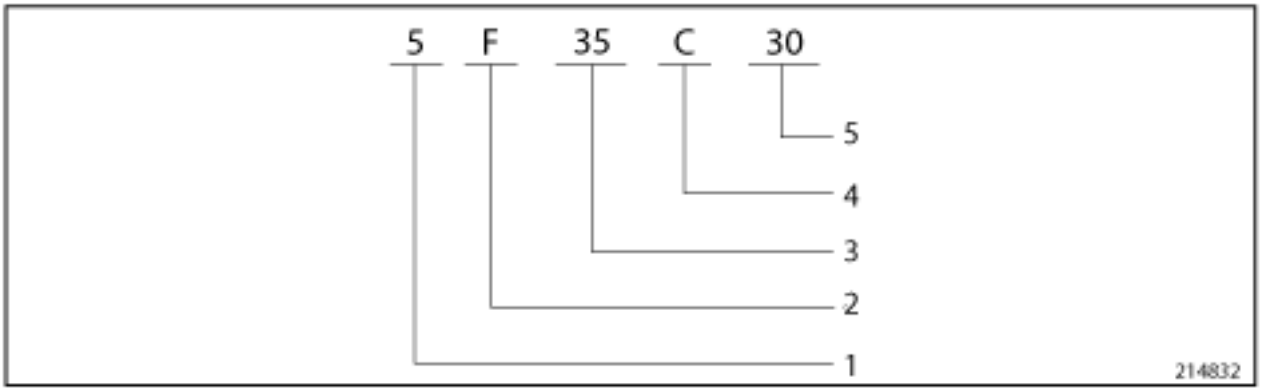
Truck type	Mast
1 ton class	5F15C□□
	5F20C□□
2 ton class	5F25C□□
3 ton class	5F30C□□
	5F35C□□

NOTE: "□□" represents maximum lift height.
Example: 30 = Lift height of 3000 mm (118.1 in.)

Mast type and code	
Code	**Mast type**
F	Duplex mast



How to read mast model code



1. TRUCK GENERATION (2→3→4→...9)
2. INDICATES MAST TYPE
3. APPLICABLE TRUCK CLASS (EXAMPLE: 3.5 TON)
4. MAST GENERATION (A→B→C...Z)
5. MAXIMUM LIFTING HEIGHT (30:3000 MM)

- Clearance G
  Clearance between roller side surface and inner mast thrust surface (right-to-left play):
  Clearance G is used for determining the correct amount of shims at the bearing seat.
  Move the lift bracket to the top of the inner mast and slide the bracket to either the left-most or right-most position. Take measurements of clearance G between the side surface of roller and inner mast.

NOTE: It is unnecessary to adjust the lift bracket upper roller with shims.

Adjust the clearance to the specification with shims (a) and (b) for the middle roller and with shim (c) for the lower roller.

Clearance G	0.1 to 0.5 (0.004 to 0.020)

Unit: mm (in.)

- Clearance F
  Clearance between roller circumference and inner mast thrust surface (back-to-front play):
  Clearance F is used for determining the proper size of the rollers.
  Select appropriate diameter rollers so that the clearance meets the specification.
  Make sure the rollers rotate smoothly when installed.

Clearance F	1 (0.04) maximum

Unit: mm (in.)

- Clearance G1
  Clearance between side roller circumference and inner mast side roller thrust surface: Move the side roller to the upper end of the inner mast and slide the lift bracket to either the left-most or right-most position. Take measurement of clearance G1 between the roller circumference and inner mast.
  Adjust the clearance with shims (d) to the specification.

Clearance G1	0.1 to 0.5 (0.004 to 0.020)

Unit: mm (in.)

(1) Choosing correct roller diameters

- Measure clearance F for upper rollers **2**, middle rollers **3**, and lower rollers **4**. If the measured clearances do not conform to the standard values, replace with rollers of correct diameters listed in the below table

NOTE: For measuring procedures, see "Adjusting Clearance Between Lift Bracket Roller and Inner Mast, Page 12-52".

- The rollers should rotate smoothly when installed.

(2) Adjusting clearance G between the middle roller and thrust plate

NOTE: The following adjustment is not required for the upper roller.

Measure clearance G between the middle roller and thrust plate. If the measured clearance does not conform to the standard value, adjust clearance G in the manner described below.

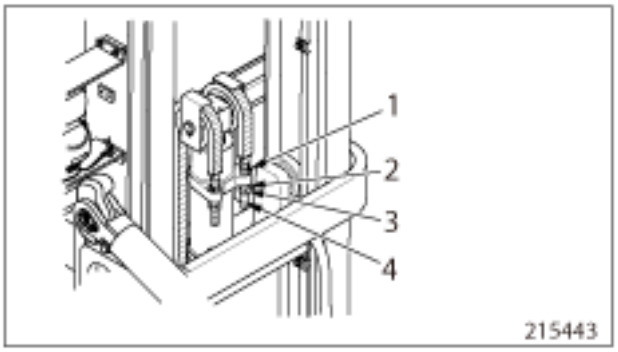
NOTE: For measuring procedures, see "Adjusting Clearance Between Lift Bracket Roller and Inner Mast, Page 12-52".

- Adjusting method
  If clearance G is excessive, increase the thickness of shims (a) as required. Increase the thickness of shims (b) by the same amount that are added to shims (a). Shim (a) is available in two sizes: 1 mm (0.04 in.) and 0.5 mm (0.020 in.). Shim (b) is available in only one size, 1 mm (0.04 in.). If shims (a) are increased by 0.5 mm (0.020 in.), shims (b) do not need to be increased by the equal amount.

At the factory, shims (a) are usually adjusted to 1 mm (0.04 in.) and shims (b) to 2 mm (0.08 in.) for shipment.

Size (diameter)	**Truck type**	
	1 ton class	**2 ton class 3 ton class**
S	99 (3.90)	113.8 (4.48)
M	100 (3.94)	115 (4.53)

Unit: mm (in.)



1. CLAMP
2. DOUBLE NUT (UPPER)
3. DOUBLE NUT (LOWER)
4. ANCHOR BOLT

Adjustment of right and left chain balance

(1) Remove the wood blocks under the forks. Start the engine.

(2) Lower the forks to the ground and tilt FORWARD until the tips come in contact with the ground. The chains are now slack to facilitate the adjustment.

(3) Turn the key switch to the OFF position.

(4) Loosen double nut (lower) **3**, then upper nut **2**.

(5) Turn double nut (upper) **2** to adjust the chain tension.

(6) Start the engine, and position the mast VERTICALLY again.

(7) Repeat Step (2), Page 12-50 through Step (5), Page 12-50 of the procedure in "Inspection of chain tension, Page 12-50" to check the chain tension and adjust it as needed.

Tightening of nuts after adjustment

(1) Hold the anchor bolt with a wrench so as not to twist the chain, then tighten the upper nut **2**.

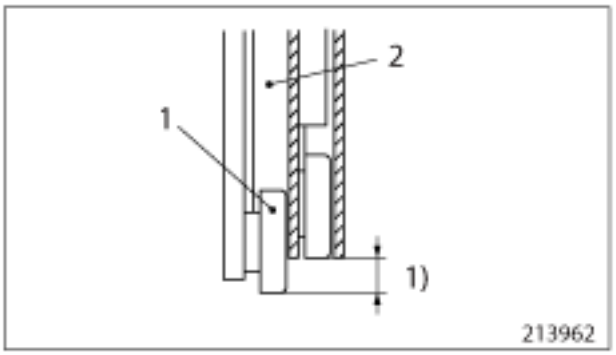
(2) Hold the double nut (upper) **2** with a wrench and tighten double nut (lower) **3** to the specified torque.

Tightening torque		
Item	Truck type	
	1 ton class 2 ton class	3 ton class
Nuts 1, 3	98 +49 -0 (10 +5 -0) [72 +36 -0]	147 +49 -0 (15 +5 -0) [108 +36 -0]

Unit: N·m (kgf·m) [lbf·ft]

⚠ CAUTION

After the adjustment, raise and lower the lift bracket several times. Then check the position of lift bracket when the lift cylinder is fully retracted. Make sure the protrusion of each lift bracket main roller must not exceed 40% of the roller diameter. If it exceeds, elongation of chains is suspected.



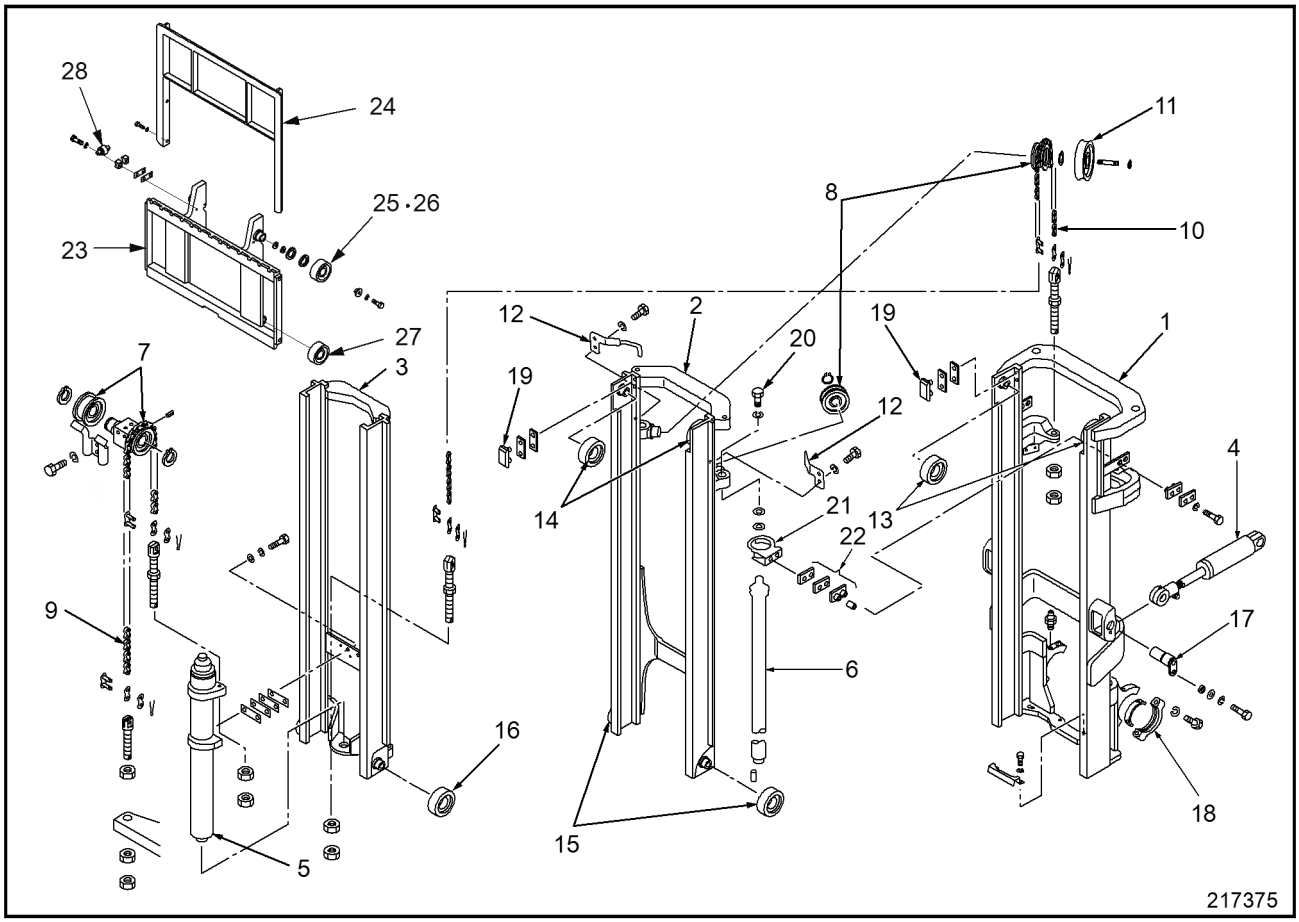
1) 40% OF THE ROLLER DIAMETER OR LESS

1. LIFT BRACKET LOWER ROLLER
2. INNER MAST

12.14.4 CHECKING CHAIN ELONGATION

(1) Apply maximum load evenly on both forks and expand the chains.

(2) Measure 20 links of chain. When the length exceeds the service limit specified in the below table, replace the chain.



MAJOR COMPONENTS (MOST PARTS COME IN PAIRS, LEFT AND RIGHT)

1. OUTER MAST
2. MIDDLE MAST
3. INNER MAST
4. TILT CYLINDER
5. FIRST LIFT CYLINDER (ONE)
6. SECOND LIFT CYLINDER
7. FIRST LIFT CHAIN WHEEL
8. SECOND LIFT CHAIN WHEEL
9. FIRST LIFT CHAIN
10. SECOND LIFT CHAIN
11. HOSE PULLEY
12. HOSE GUARD
13. OUTER MAST ROLLER
14. MIDDLE MAST UPPER ROLLER
15. MIDDLE MAST LOWER ROLLER
16. INNER MAST ROLLER
17. TILT SOCKET MOUNTING PIN
18. MAST SUPPORT CAP
19. MAST STRIP
20. LIFT CYLINDER UPPER MOUNTING BOLTS
21. CYLINDER BRACKET
22. CYLINDER CLAMPS
23. LIFT BRACKET
24. BACKREST
25. LIFT BRACKET UPPER ROLLER
26. LIFT BRACKET MIDDLE ROLLER
27. LIFT BRACKET LOWER ROLLER
28. SIDE ROLLER

12.20.2.1 INSTALLING LIFT BRACKET ROLLERS

The lift bracket has three main roller bearings at one side and a side roller at both sides as shown. Clearances F, G and G1 must be maintained between these rollers and thrust surface of the inner mast for smooth operation.

- Clearance G
  Clearance between roller side surface and inner mast thrust surface (right-to-left play):
  Clearance G is used for determining the correct amount of shims at the bearing seat.
  Move the lift bracket to the top of the inner mast and press the bracket to either the left-most or right-most position. Take measurements of clearance G between the side surface of roller and inner mast.

NOTE: It is not necessary to adjust the lift bracket upper roller with shims.

Adjust the clearance to the specification with shims (a) and (b) for the middle roller and with shim (c) for the lower roller.

- Clearance F
  Clearance between roller circumference and inner mast thrust surface (back-to-front play):
  Clearance F is used for determining the proper size of the rollers.
  Select appropriate diameter rollers so that the clearance meets the specification.
  Make sure the rollers rotate smoothly when installed.

Clearance F	1 (0.04) maximum

Unit: mm (in.)

- Clearance G1
  Clearance between side roller circumference and inner mast side roller thrust surface: Move the side roller to the upper end of the inner mast and press the lift bracket to either the left-most or right-most position. Take measurement of clearance G1 between the roller circumference and inner mast.
  Adjust the clearance with shims (d) to the specification.

Clearance G1	0.1 to 0.5 (0.004 to 0.020)

Unit: mm (in.)

(1) Choosing correct roller diameters

- Measure clearance F for upper rollers **2**, middle rollers **3**, and lower rollers **4**. If the measured clearances do not conform to the standard values, replace with rollers of correct diameters listed in the below table

NOTE: For measuring procedures, see "Adjusting Clearance between Lift Bracket Roller and Inner Mast, Page 12-83".

- The rollers should rotate smoothly when installed.

Size (diameter)	Truck type	
	1 ton class	2 ton class 3 ton class
S	99 (3.90)	113.8 (4.48)
M	100 (3.94)	115 (4.53)
L	101 (3.98)	116 (4.57)
LL	102 (4.02)	117 (4.61)

Unit: mm (in.)

(2) Adjusting clearance G between the middle roller and thrust plate.

NOTE: The following adjustment is not required for the upper roller.

- Measure clearance G between the middle roller and thrust plate. If the measured clearance does not conform to the standard value, adjust clearance G in the manner described below.

NOTE: For measuring procedures, see "Adjusting Clearance between Lift Bracket Roller and Inner Mast, Page 12-83".

- Maintenance shops may bend forks back into shape, weld on them, or drill holes through them. Lift Truck users can add attachments to the lift truck that will put stress on the forks. Drum clamps and portable booms can be supported on the forks, but what is contained in the drum or on the boom hook makes the difference in safety.
- Forks are often used to open rail car doors and break loads out or away from other loads. They are also used to pick up capacity loads not seated against the fork shank and to pick up off-balanced loads far from the side of the lift truck. The fork tips are sometimes inserted under other lift trucks to lift them during maintenance operations.
- Lift trucks may collide with building columns and walls, and though the forks show no discernible bend, they may be damaged beyond safety.
- Any time excessive heat is applied to any part of a fork during repair, hidden damage may occur.

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

12.22.2.1 DESIGNED TO TAKE A BEATING

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

12.22.3 CHAIN TENSION INSPECTION AND ADJUSTMENT

⚠ WARNING

Turn the key switch to the OFF position before inspecting and adjusting lift chains, anchor bolts and nuts. Place wood blocks below the forks when they are raised. Failure to do so can result in serious injury or death due to a sudden movement of heavy components.

Inspection of chain tension

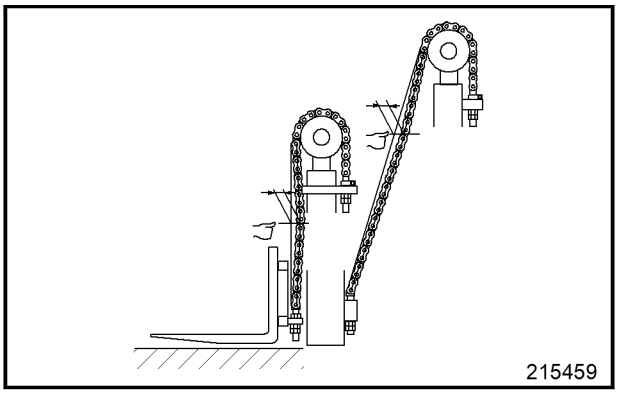
(1) Place the mast VERTICALLY on level and hard surface. Then lower the forks to the ground. Make sure that the lift cylinders are fully retracted.

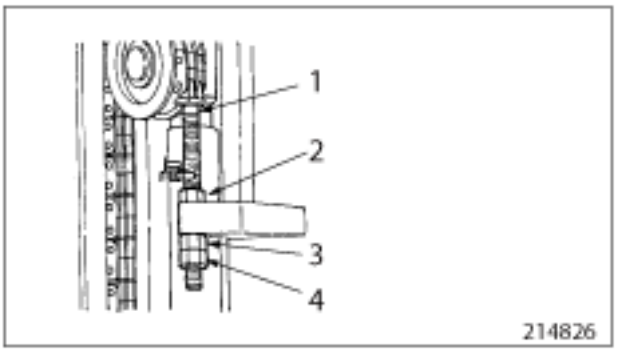
(2) Raise the forks approximately 100 mm (3.94 in.) from the ground.

(3) Turn the key switch to the OFF position.

(4) Place wood blocks approximately 90 mm (3.54 in.) high under the forks.

(5) Push the chains at the middle point between the chain wheel and chain fixed end on the lift bracket. Check the right and left chains for even tightness. If tension on the right and left chain is uneven, adjust the tension.





1. ANCHOR BOLT
2. CLAMP
3. DOUBLE NUT (UPPER)
4. DOUBLE NUT (LOWER)

Chapter 13 SERVICE DATA

13.1 MAINTENANCE SCHEDULE

Prestart Inspection (Daily or 10 Hours)

Component group	Item	Service	Note
General	Faulty Operation Found the Day Before	Check	
	Oil, Fuel, or Coolant Leaks	Check	
Brake System	Brake Hoses, Pipes, and Joints	Check	
	Brake Fluid	Check fluid level	
	Brake Pedal	Check	
	Parking Brake Lever	Check	
Cooling System	Engine Coolant	Check coolant level	
	Fan Belt	Check	
Electrical System	Electrical Wires	Check	
	Head Light and Working Light (If Equipped)	Check	
	Horn	Check	
	Stop Lights	Check	
	Icons of Meter Panel	Check	
	Backup Lights (If Equipped)	Check	
	Battery	Check electrolyte level	Not required if battery type is maintenance free
	Mast Interlock System	Check	
	Driving Interlock System	Check	
	Parking Brake Warning Alarm and Warning Icon	Check	
	Seat Belt Warning Alarm and Warning Icon	Check	
Engine	Engine (Exhaust, Noise, and Vibration)	Check	
	Engine Oil	Check oil level	
Fuel System	Fuel (level)	Check	
Frame and Chassis	Load Backrest Extension	Check	
	Overhead Guard	Check	
	Assist Grips	Check	
	Seat Belt	Check	

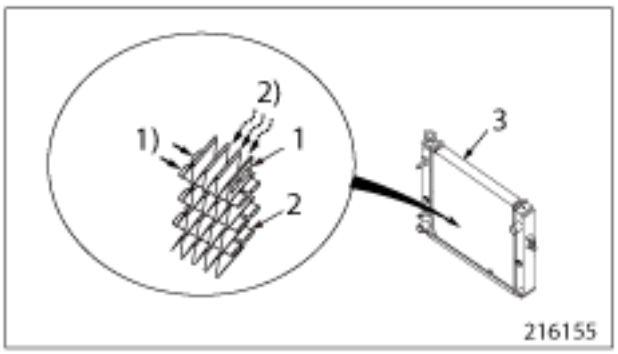
13.2.2 COOLING SYSTEM

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 and clean radiator fin.

Service Hours	1st Month (200 hrs) only

- Visually check the radiator fins for contamination.
- If the fins are too dirty, clean the fins using compressed air.



1) COOLING WATER
2) COOLING AIR

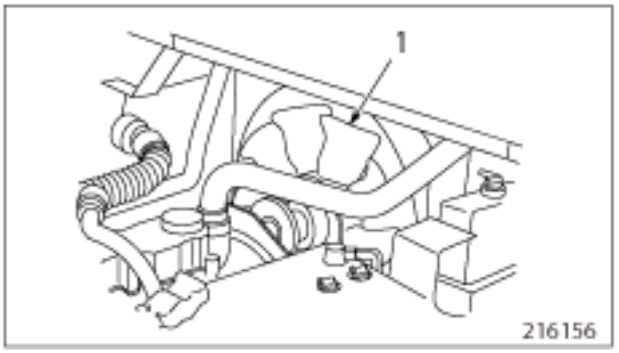
1. FIN
2. TUBE
3. RADIATOR

(2) Check cooling fan.

Service Hours	1st Month (200 hrs) only

- Check the fan for oil or dirt contamination.

NOTE: DO NOT use gasoline, kerosene, etc. for cleaning. Wipe contamination off the surface with a rag or paper.



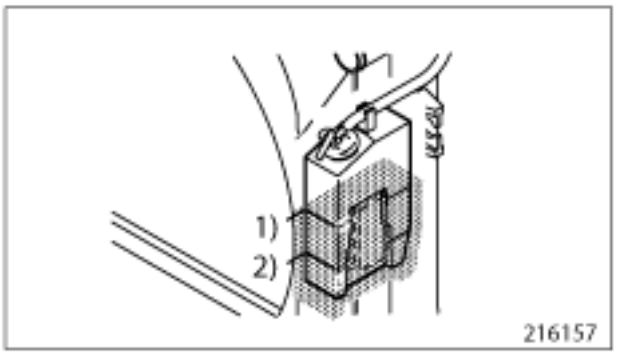
1. FAN

(3) Check engine coolant level.

Service Hours	Prestart (Daily/10 hrs)

- Make sure that the coolant level is between FULL and LOW marks on the reserve tank.

NOTE: See the appropriate engine service manual.



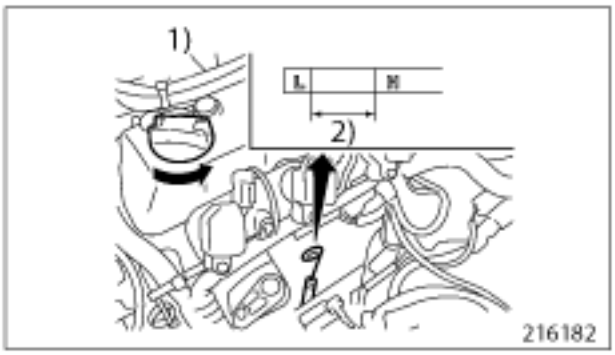
1) FULL
2) LOW

(4) Check radiator filler cap.

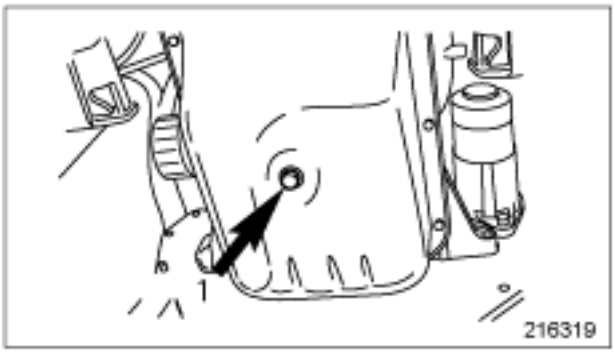
Service Hours	Yearly (2000 hrs)

- Check the cap for coolant leaks or oozing.
- Check the cap seal for damage.

Engine oils	Gasoline engine models	API service classification SJ or above
	Diesel engine models (D04EG)	API service classification CJ-4
	Diesel engine models (S4S)	API service classification CF or above



1) (GASOLINE)
2) CORRECT LEVEL RANGE



1. DRAIN PLUG

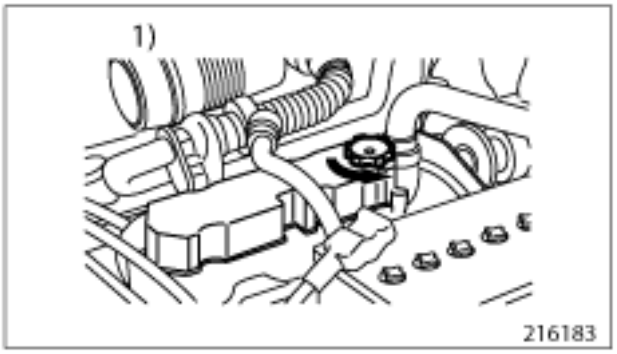
(9) Change engine oil filter.

Service Hours	Every 3 months (500 hrs)

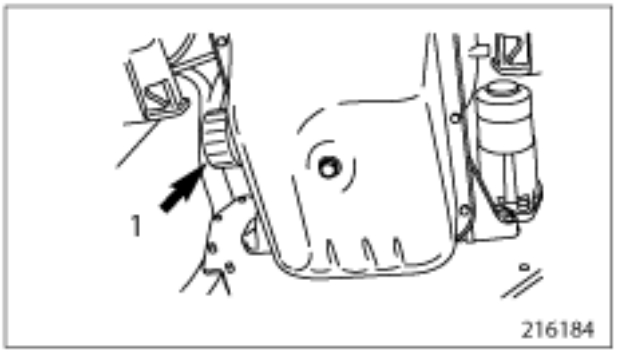
- Replace the oil filter at every oil change.
- Add the amount of oil that the filter holds.

NOTE: See the appropriate engine service manual.

Engine oils	Gasoline engine models	API service classification SJ or above
	Diesel engine models (D04EG)	API service classification CJ-4
	Diesel engine models (S4S)	API service classification CF or above



1) (DIESEL)



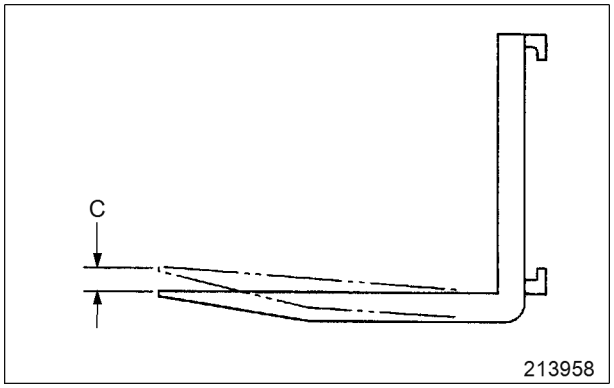
1. FILTER

13.2.5 FRAME AND CHASSIS

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.

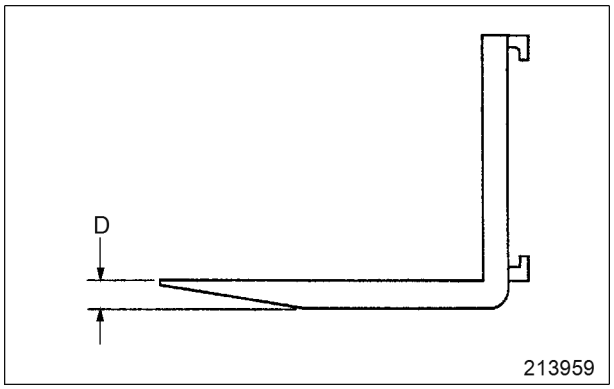
(1) Check frame assist grip.

- Check for bent fork tips.
  Check difference in fork tip elevation between the right and left fork tips.
  C: Fork tip elevation



- Check for worn fork tips.
  D: Fork blade thickness

NOTE: See MAST AND FORKS.

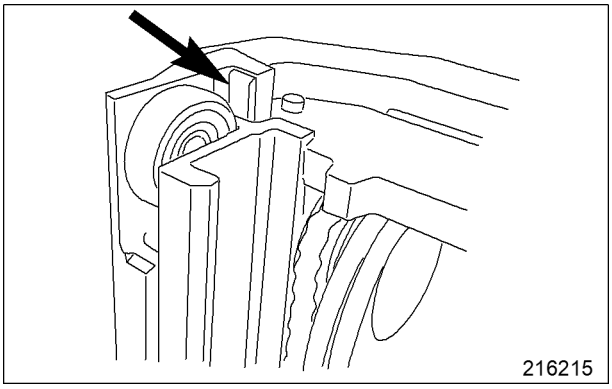


(5) Check mast strip sliding surfaces.

Service hours	Prestart (Daily/10 hrs)

- Check the mast strip sliding surface for wear, cracks, rust or chips.

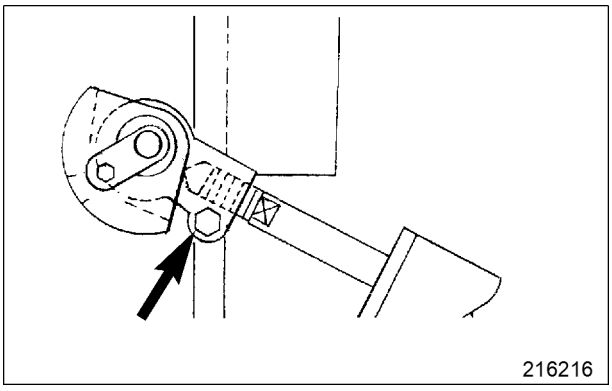
NOTE: See MAST AND FORKS



(6) Check tilt cylinder socket bolts.

Service hours	Prestart (Daily/10 hrs)

- Check the tilt socket bolts for looseness, chips, rust, and greasing condition.

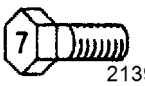


(7) Lubricate lift chains.

Service hours	Every 1 Month (200 hrs)

- Lubricate the lift chains.

Grease	Chassis	NLGI No. 1 grade multi-purpose type (calcium base), Consistency: 320 to 340

	33	1.30	1.5	0.06	1726.0	176.0	1273.0	2243.8	228.8	1654.9	3153.8	321.6	2326.1
	36	1.42	1.5	0.06	2256.5	230.1	1664.3	2934.1	299.2	2164.1	4114.0	419.6	3035.0
	39	1.54	1.5	0.06	2896.0	295.3	2135.9	3763.8	383.8	2776.0	5258.3	536.2	3878.3
	Nominal size		**Pitch**		**With spring washer**								
					 213982			 213983			 213984		
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
Metric coarse thread	10	0.39	1.5	0.06	33.3	3.4	24.6	43.1	4.4	31.8	67.7	6.9	49.9
	12	0.47	1.75	0.07	58.8	6.0	43.4	76.5	7.8	56.4	115.7	11.8	85.3
	14	0.55	2	0.08	96.4	9.8	70.9	124.5	12.7	91.9	182.4	18.6	134.5
	16	0.63	2	0.08	147.1	15.0	108.5	191.2	19.5	141.0	274.6	28.0	202.5
	18	0.71	2.5	0.10	203.0	20.7	149.7	264.8	27.0	195.3	383.4	39.1	282.8
	20	0.79	2.5	0.10	286.4	29.2	211.2	371.7	37.9	274.1	536.4	54.7	395.6
	22	0.87	2.5	0.10	383.4	39.1	282.8	499.2	50.9	368.2	725.9	74.0	535.2
	24	0.95	3	0.12	492.3	50.2	363.1	640.4	65.3	472.3	924.8	94.3	682.1
	27	1.06	3	0.12	724.7	73.9	534.5	942.2	96.1	695.1	1350.4	137.7	996.0
	30	1.18	3.5	0.14	969.9	98.9	715.3	1259.2	128.4	928.7	1843.7	188.0	1359.8
	33	1.30	3.5	0.14	1328.8	135.5	980.1	1727.0	176.1	1273.7	2477.2	252.6	1827.1
	36	1.42	4	0.16	1676.0	170.9	1236.1	2180.0	222.3	1607.9	3199.9	326.3	2360.1
	39	1.54	4	0.16	2219.2	226.3	1636.8	2884.1	294.1	2127.2	4118.8	420.0	3037.9
	42	16.5	4.5	0.18	2754.7	280.9	2031.8	3581.4	365.2	2641.5	5137.7	523.9	3789.4
	Nominal size		**Pitch**		**Without spring washer**								
					 213982			 213983			 213984		
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
Metric coarse thread	10	0.39	1.5	0.06	39.2	4.0	28.9	51.0	5.2	37.6	79.4	8.1	58.6
	12	0.47	1.75	0.07	69.6	7.1	51.4	90.2	9.2	66.5	135.3	13.8	99.8
	14	0.55	2	0.08	112.8	11.5	83.2	146.1	14.9	107.8	215.7	22.0	159.1
	16	0.63	2	0.08	172.6	17.6	127.3	224.6	22.9	165.6	323.6	33.0	238.7
	18	0.71	2.5	0.10	239.3	24.4	176.5	311.9	31.8	230.0	451.1	46.0	332.7
	20	0.79	2.5	0.10	336.4	34.3	248.1	437.4	44.6	322.6	630.6	64.3	465.1
	22	0.87	2.5	0.10	392.3	40.0	289.3	587.4	59.9	433.3	842.4	85.9	621.3
	24	0.95	3	0.12	578.6	59.0	426.7	753.2	76.8	555.5	1088.5	111.0	802.9
	27	1.06	3	0.12	852.2	86.9	628.5	1008.2	113.0	817.3	1588.7	162.0	1771.7
	30	1.18	3.5	0.14	1140.5	116.3	841.2	1481.8	151.1	1092.9	2168.3	221.1	1599.2
	33	1.30	3.5	0.14	1563.2	159.4	1153.0	2031.9	207.2	1498.7	2915.5	297.3	2150.4
	36	1.42	4	0.16	1972.1	201.1	1454.6	2564.4	261.5	1891.4	3765.8	384.0	2777.5

Items			Truck model		
			2P7000	**GP35NM**	**2PD7000**
Parking Brake Lever Operating Effort,	N (kgf) [lbf]		230 to 250 (23 to 25) [52 to 56]		
Tire size	Front single		250×15-16PR		
	Front dual		6.00×15-10PR		
	Rear		6.00×10-12PR		
Tire pressure, kPa (kgf/cm^2) [psi] (Pneumatic)	Front single		850 (8.5) [120]		
	Front dual		700 (7.0) [100]		
	Rear		900 (9.0) [130]		
Tightening torque for wheel nuts, N·m (kgf·m) [lbf·ft]	Front		378 (38.5) [278.8]		
	Rear	STD (2P)	157 (16) [115.8]	—	
		OP (4P)	210 to 256 (21 to 26) [155 to 189]	—	
		STD (4P)	—	210 to 256 (21 to 26) [155 to 189]	
Lift chain elongation limit mm (in.)/ 20 links			523 (20.6)		

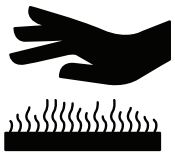
NOTE: Rear tires must have 1050 kg (2315 lb) capacity at 19 km/h (12 mph). 1 ton model

Items			Truck model		
			2P3000 2P3500	**GP15NM GP18NM**	**2PC4000 GP20CNM**
Refill Capacities (approx.), liter (U.S. gal.)	Fuel Tank		46 (12.2)		
	Engine Cooling System – 0.62 liter (1.3 pt) reserve tank included		7.4 (2.0)		6.8 (1.8)
	Engine Lubrication System	Crankcase	3.5 (0.9)		
		Oil Filter	0.3 (0.1)		
		Total	3.8 (1.0)		
	Powershift transmission		10.0 (2.6)		
	Transfer and Differential		5.5 (1.5)		
	Hydraulic Tank	N level	28 (7.4)		
	Brake Fluid Reserve Tank, cc		135 (8.2)		

⚠ WARNING

Be careful of burns

Do not touch the engine during or immediately after operation



Do not touch the engine during or immediately after operation to avoid risk of burns.

To conduct maintenance and inspection work, wait until the engine has cooled sufficiently, checking the temperature gauge.

Slowly and carefully open radiator cap

Never attempt to open the radiator cap while the engine is running or immediately after the engine stops. Give a sufficient cooling time to the engine coolant before opening the cap.

When opening the radiator cap, slowly turn the cap to release internal pressure. To prevent scalds with steam gushing out, wear thick rubber gloves or cover the cap with a cloth.

Close the radiator cap tightly without fail.

The coolant is very hot and under pressure during engine running or just after the engine stops. If the radiator cap is not closed tightly, steam and hot coolant may gush out and can cause scalds.

Add coolant only after the coolant temperature dropped

Do not add coolant immediately after the engine stops. Wait until the coolant temperature lowers sufficiently to avoid a risk of burns.

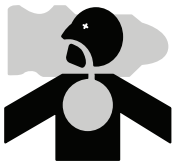
Never remove heat shields

The exhaust system, which becomes extremely hot while the engine is operating, is provided with various heat shields. Do not remove these heat shields. If any of these heat shields have been removed owing to unavoidable circumstances during the work, be sure to restore them after the work is completed.

⚠ WARNING

Be careful of exhaust fume poisoning

Operate engine in well-ventilated area



If the engine is installed in an enclosed area and the exhaust gas is ducted outside, ensure that there is no exhaust gas leak from duct joints.

Take care that the exhaust gas is not discharged toward plants or animals.

Exhaust gas from the engine contains carbon monoxide and other harmful substances. Operating the engine in an ill-ventilated area can produce gas poisoning.

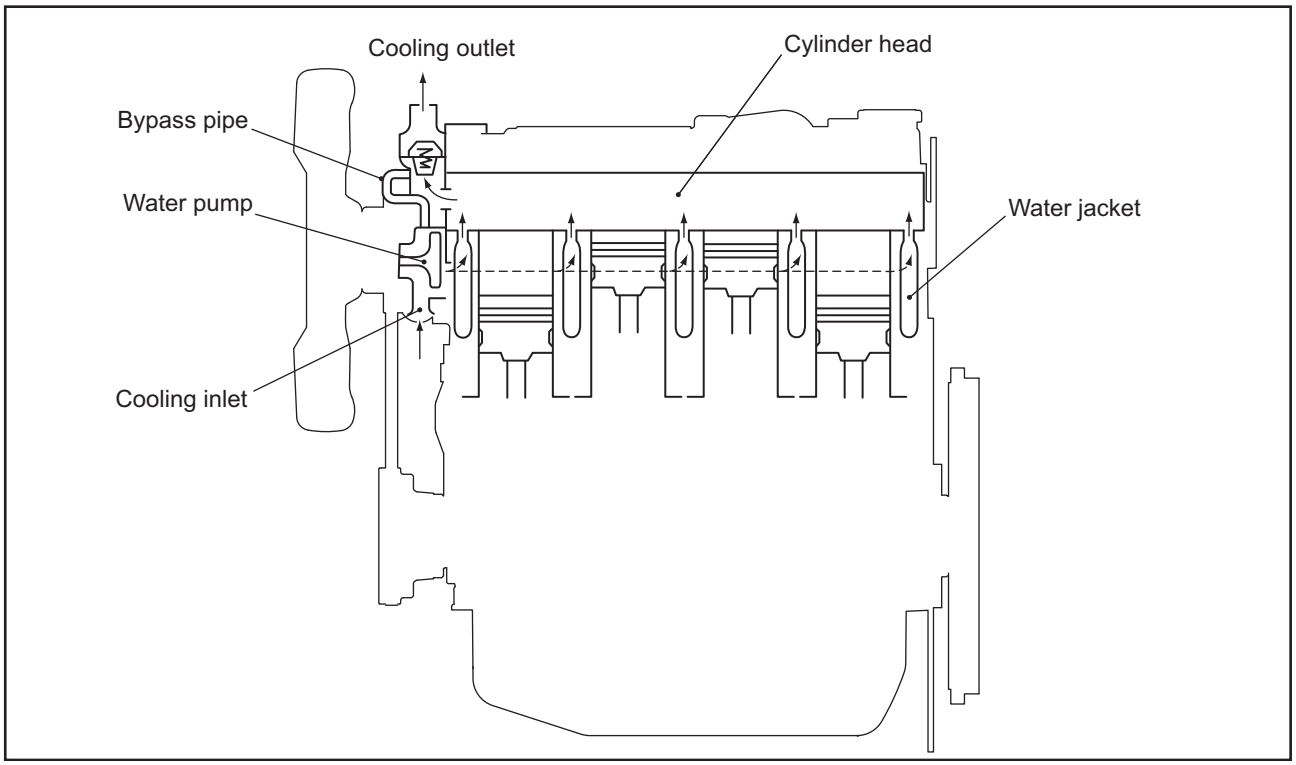
⚠ WARNING

Protect ears from noises

Wear ear plugs

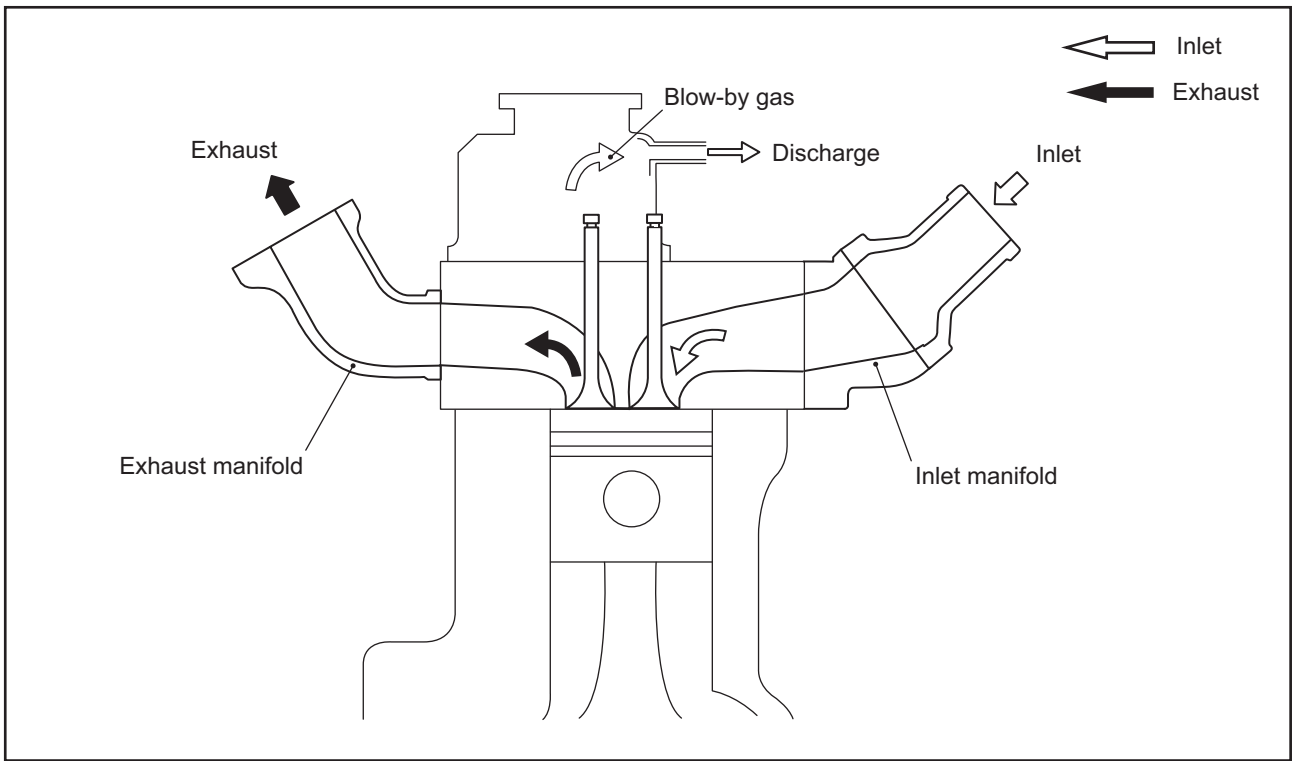
Always wear ear plugs when entering the machine room (engine room). Combustion sound and mechanical noise generated by the engine can cause hearing problems.

2.3 Cooling system - flow diagram



Cooling system - flow diagram

2.4 Inlet and exhaust system - flow diagram



Inlet and exhaust system - flow diagram

1.3 Fuel system

Table 2-3 Maintenance service data table - Fuel system Unit: mm [in.]

Inspection point		Nominal	Standard	Limit	Remark
Fuel injection nozzle	Valve opening pressure	11.77 MPa {120 kgf/cm²} [1707 psi]	11.77 to 12.75 MPa {120 to 130 kgf/cm²} [1707 to 1849 psi]		Make shim adjustment. Pressure varies by 1 MPa {10 kgf/cm²}[144 psi] per 0.1 [0.004] thickness of shim.
	Spray cone angle	0°			Check nozzle with a hand tester (at fuel oil temperature 20°C [68°F]). Replace the nozzle tip if the spray pattern is still bad after washing in clean fuel oil.
	Nozzle valve seat oil sealing	Seat shall hold a test pressure lower than valve opening pressure by 2 MPa {20 kgf/cm²} [285 psi] for 10 seconds.			Wash in clean fuel oil or replace nozzle tip.

1.4 Lubrication system

Table 2-4 Maintenance service data table - Lubrication system Unit: mm [in.]

Inspection point		Nominal	Standard	Limit	Remark
Oil pump	Clearance between outer rotor and case		0.20 to 0.30 [0.0079 to 0.0118]	0.50 [0.0197]	Replace pump assembly.
	Main shaft outside diameter (between case)	ø 16 [0.63]	15.985 to 16.000 [0.6293 to 0.6299]		
	Main shaft outside diameter (between oil pump bushing)	ø 14 [0.55]	13.957 to 13.975 [0.5495 to 0.5502]		
	Clearance between main shaft and pump case		0.032 to 0.074 [0.0013 to 0.0029]	0.150 [0.0059]	Replace pump case or replace pump assembly.
	Clearance between main shaft and oil pump bushing		0.025 to 0.111 [0.0010 to 0.0044]	0.200 [0.0079]	Replace oil pump bushing or replace pump assembly.
	Clearance between inner rotor and outer rotor		0.13 to 0.15 [0.0051 to 0.0059]	0.20 [0.0079]	Replace outer rotor and shaft assembly.
	Rotor and case end play		0.04 to 0.09 [0.0016 to 0.0035]	0.15 [0.0059]	Replace pump assembly.
Relief valve	Valve opening pressure	0.35 MPa {3.6 kgf/cm²} [51.20 psi]	0.35 ± 0.05 MPa {3.5 ± 0.5 kgf/cm²} [49.8 ± 7.1 psi]		

1.5 Cooling system

Table 2-5 Maintenance service data table - Cooling system Unit: mm [in.]

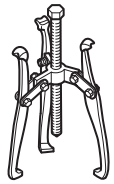
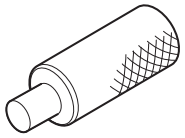
Inspection point		Nominal	Standard	Limit	Remark
Thermostat	Temperature at which valve starts opening		76.5 ± 1.5°C [170 ± 2.7°F]		
	Temperature at which valve lift is 9 [0.35], minimum		90 ± 1.5°C [194 ± 2.7°F]		

1.6 Inlet and exhaust system

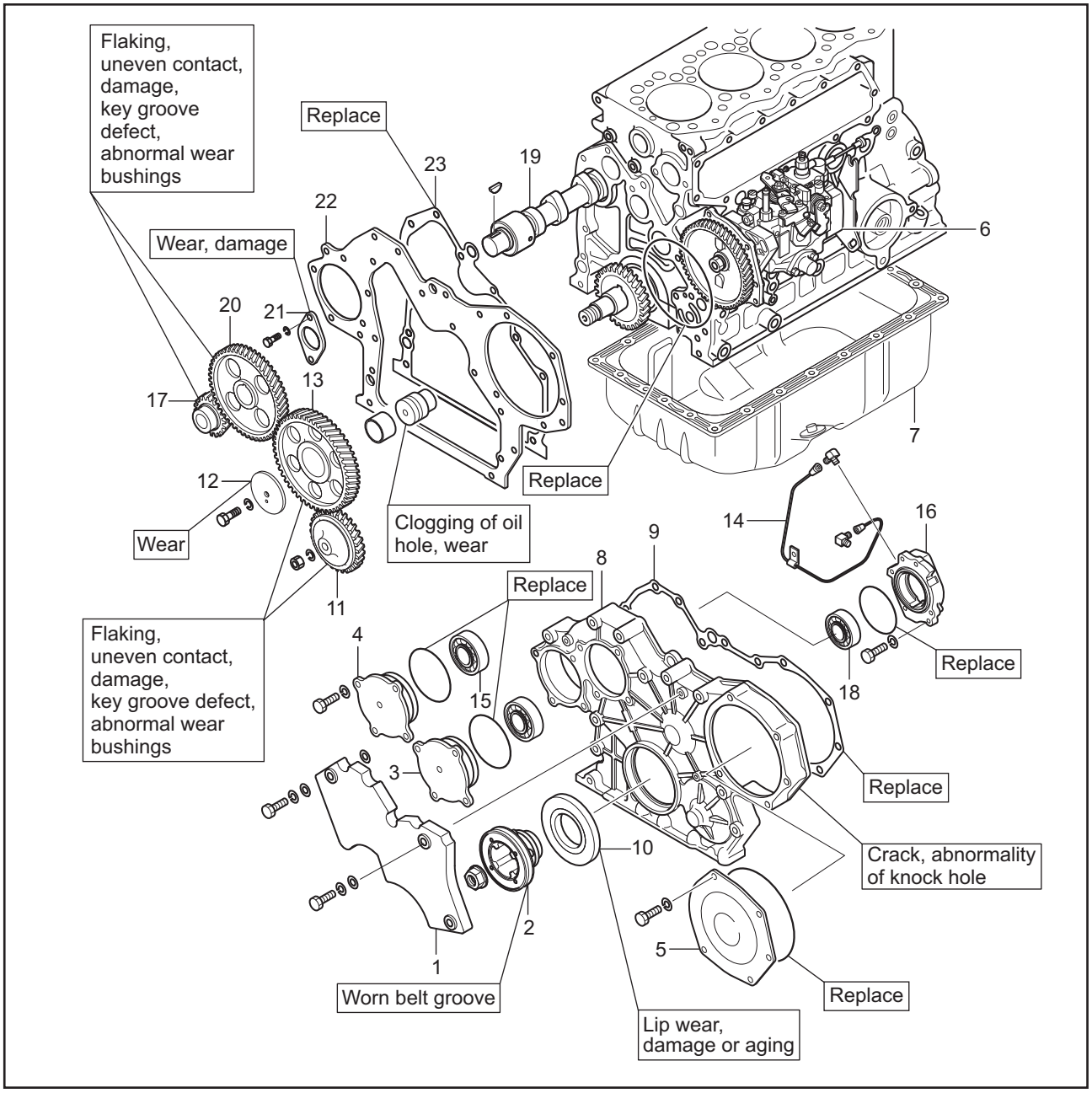
Table 2-6 Maintenance service data table - Inlet and exhaust system Unit: mm [in.]

Inspection point	Nominal	Standard	Limit	Remark
Distortion of exhaust manifold		0.2 [0.008] or less		Repair by grinding or replace.

Table 3-1 Special tool list (3 / 3)

Tool name	Part No.	Shape	Use
Gear puller	MH061326		Crank shaft gear removal
Oil pump bushing installer	32A91-00400		Oil pump bushing installation

3. Disassembling and inspecting gear case, timing gear and camshaft



Disassembling and inspecting gear case, timing gear and camshaft

Disassembling sequence

1 Insulator cover
2 Crankshaft pulley
3 Bearing case
4 Bearing case
5 Gear case cover
6 Fuel injection pump
7 Oil pan
8 Timing gear case
9 Gasket
10 Oil seal
11 Oil pump gear
12 Thrust plate
13 Idler gear
14 Oil pipe
15 PTO drive gear bearing
16 PTO bearing case
17 PTO drive gear
18 PTO drive gear bearing
19 Camshaft
20 Camshaft gear
21 Thrust plate
22 Front plate
23 Gasket

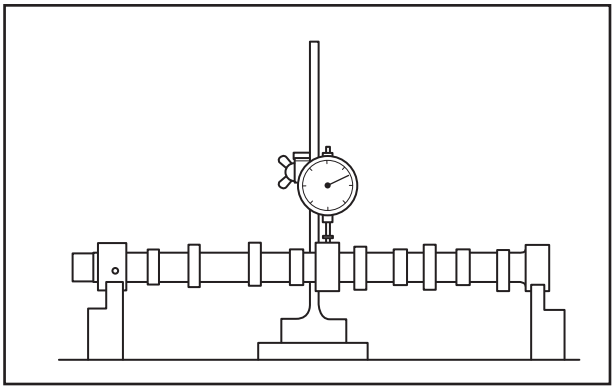
INSPECTION AND REPAIR OF BASIC ENGINE

3.4 Measuring camshaft runout

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

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

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

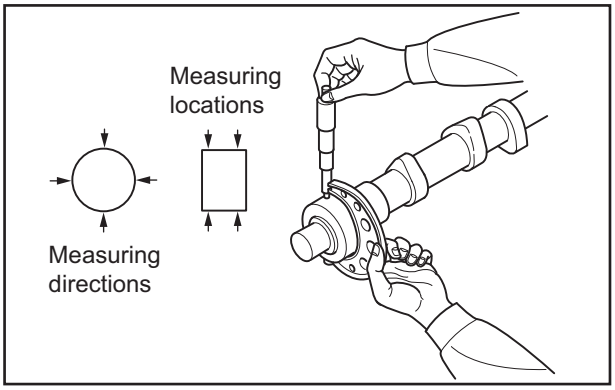


Measuring camshaft runout

3.5 Measuring camshaft journal outside diameter

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

Item		Standard	Limit
Camshaft journal outside diameter	Front, Middle	53.94 to 53.96 mm [2.1236 to 2.1244 in.]	53.90 mm [2.1220 in.]
	Rear	52.94 to 52.96 mm [2.0842 to 2.0850 in.]	52.90 mm [2.0827 in.]

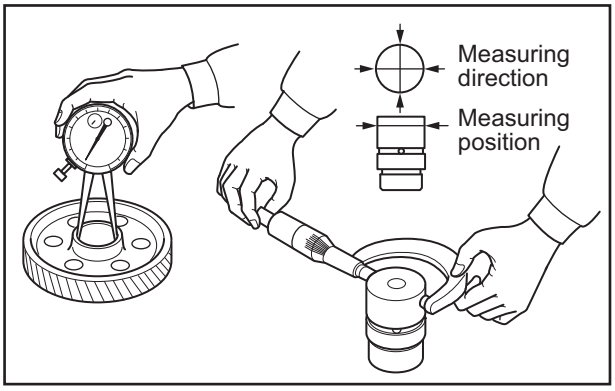


Measuring camshaft journal diameter

3.6 Measuring idler bushing inside diameter and idler shaft outside diameter

Measure the idler bushing inside diameter and idler shaft outside diameter, and calculate the clearance between them. If the measured value exceeds the limit, locate the defective part and replace it.

Item	Standard	Limit
Clearance between idler bushing and idler shaft	0.009 to 0.050 mm [0.0004 to 0.0020 in.]	0.100 mm [0.0039 in.]



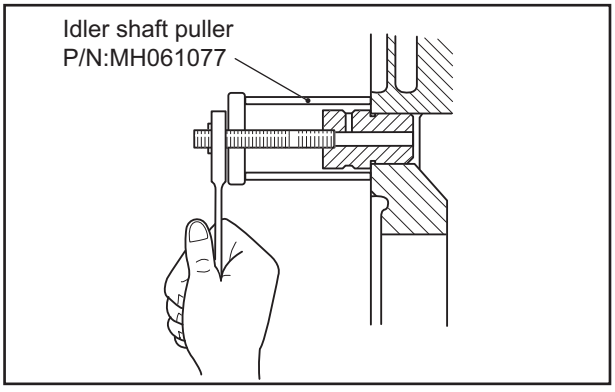
Measuring idler bushing inside diameter and idler shaft outside diameter

3.7 Replacing idler shaft

To remove the idler shaft, use the idler shaft puller.

Note: When installing the idler shaft into the crankcase, orient the idler shaft so that its oil hole faces the upper crankcase.

Item	Nominal	Standard
Interference between shaft and crankcase hole	ø 35 mm [1.38 in.]	0.035T to 0.076T mm [0.0014 to 0.0030 in.]

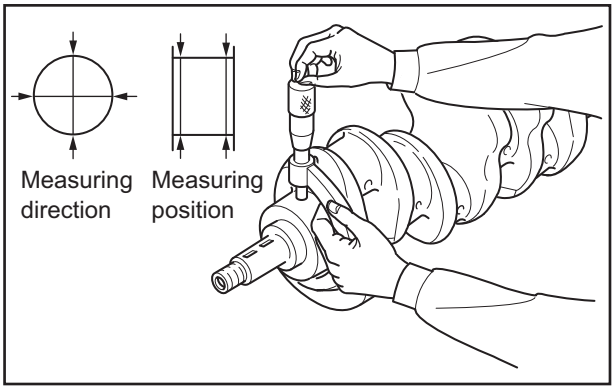


Replacing idler shaft

4.15 Measuring crankshaft journal outside diameter

Measure the crankshaft journal diameter using a micrometer. Check the crankshaft journal for circularity, cylindricity and clearance between the bearing and journal. If the measurement value is below the repair limit, grind the journal to fit the undersize bearing. If the measurement value is below the service limit, replace the crankshaft with a new one.

Item	Nominal	Standard	Limit
Outside diameter	ø 78 mm [3.07 in.]	77.955 to 77.970 mm [3.0691 to 3.0697 in.]	77.850 mm [3.0650 in.] (Repair) 77.100 mm [3.0354 in.] (Replace)
Roundness	-	0.01 mm [0.0004 in.] or less	0.03 mm [0.0012 in.]
Cylindricity	-	0.01 mm [0.0004 in.] or less	0.03 mm [0.0012 in.]
Parallelism	-	Pin maximum defection: 0.01 mm [0.0004 in.] or less	-

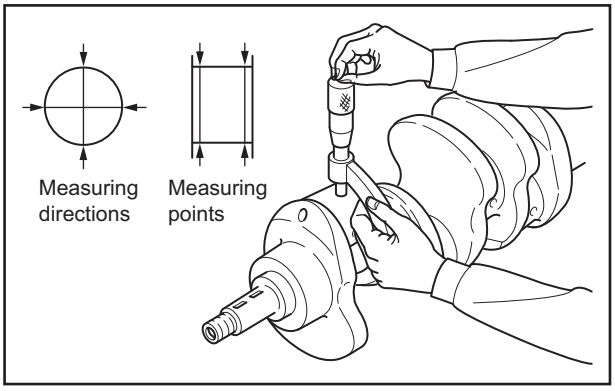


Measuring crankshaft journal outside diameter

4.16 Measuring crankshaft crankpin outside diameter

Measure the crankpin outside diameter using a micrometer. Check the crankpin for roundness, cylindricality, and the clearance with the bearing. If the measurement value is below the limit, grind the journal to fit the undersize bearing. If the measurement value is below the service limit, replace the crankshaft with a new one.

Item	Nominal	Standard	Limit
Outside diameter	ø 58 mm [2.28 in.]	57.955 to 57.970 mm [2.2817 to 2.2823 in.]	57.800 mm [2.2756 in.]
Roundness	-	0.01 mm [0.0004 in.] or less	0.03 mm [0.0012 in.]
Cylindricity	-	0.01 mm [0.0004 in.] or less	0.03 mm [0.0012 in.]
Parallelism	-	Pin maximum defection: 0.01 mm [0.0004 in.] or less	-



Measuring crankpin diameter

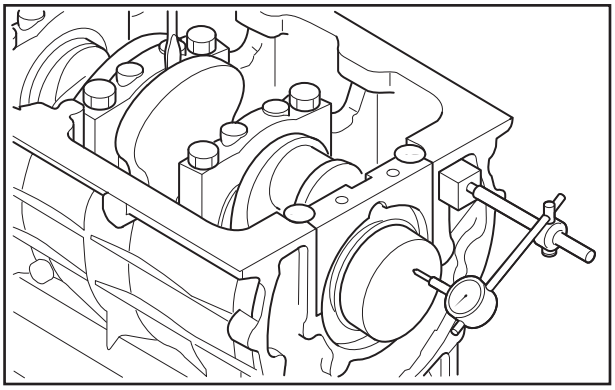
1.8 Measuring crankshaft end play

Attach a dial gauge to the end of the crankshaft to measure the end play.

If the end play deviates from the standard value, loosen the main bearing cap bolts and retighten.

Make sure that the crankshaft turns freely.

Item	Standard	Limit
Crankshaft end play	0.100 to 0.264 mm [0.0039 to 0.0104 in.]	0.300 mm [0.0118 in.]



Measuring crankshaft end play

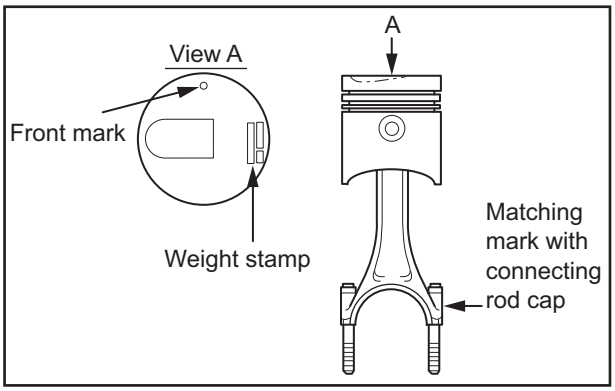
1.9 Reassembling piston and connecting rod

(1) Apply engine oil to the piston pin, and reassemble the piston and the connecting rod by inserting the piston pin, observing the orientation of piston and connecting rod shown in the illustration.

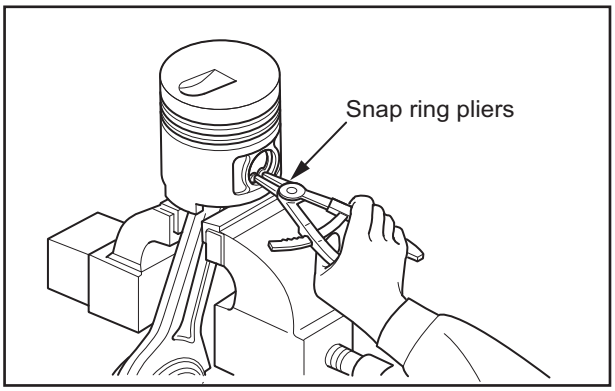
Note: The pistons and piston pins are assembled to each other in clearance fit. However, the piston pins are more easily inserted into the pistons if the pistons are warmed up with a heater or in hot water.

(2) Using ring pliers, install the snap ring. Check the snap ring for its tension, and make sure the ring fits snugly in the groove.

Note: Install all the snap rings so that their end gap faces toward the bottom of the piston.



Reassembling piston and connecting rod



Installing snap ring

3. Reassembling flywheel

3.1 Installing rear plate

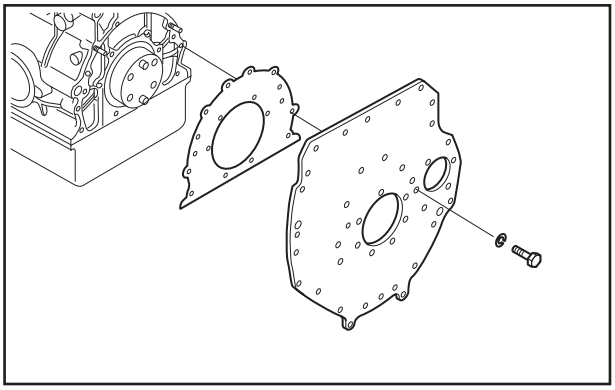
(1) Clean the mounting surface of the gasket.

(2) Apply sealant to the gasket to prevent it from falling off.

(3) Install the gasket.

(4) Install the rear plate, use a guide bar aligning its dowel pin holes and dowel pins, and tighten the bolts.

Note: When the dowel pins are worn or when the rear plate is replaced, replace the dowel pins with new ones.



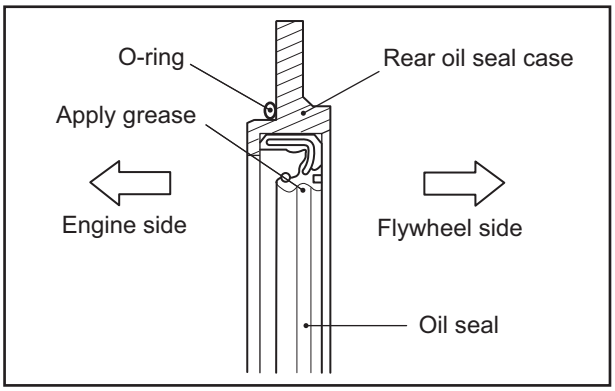
Installing rear plate

3.2 Installing oil seal

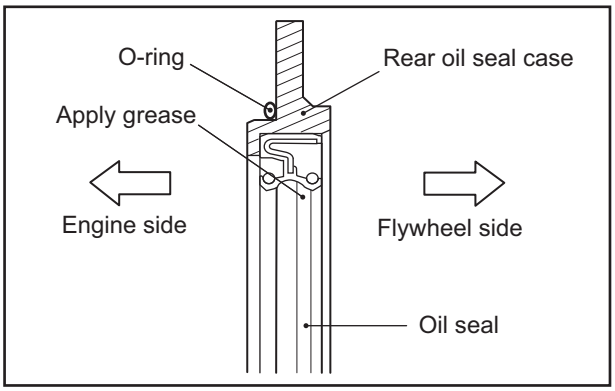
Apply a small quantity of grease to the new oil seal, and install the oil seal to the rear plate.

Be careful of the oil seal installation direction.

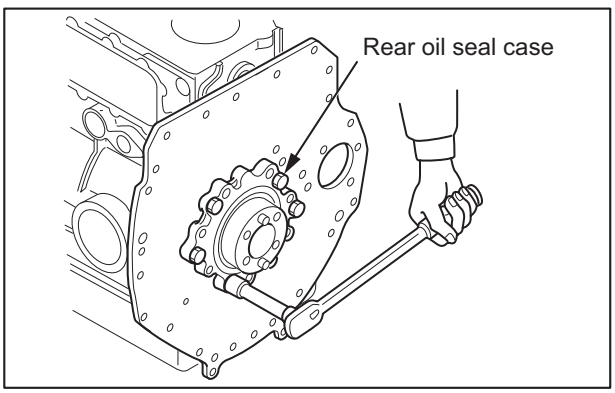
Note: Use an oil seal with a sleeve if the oil seal contacting surface of the crankshaft is worn.



Installing oil seal - Dry



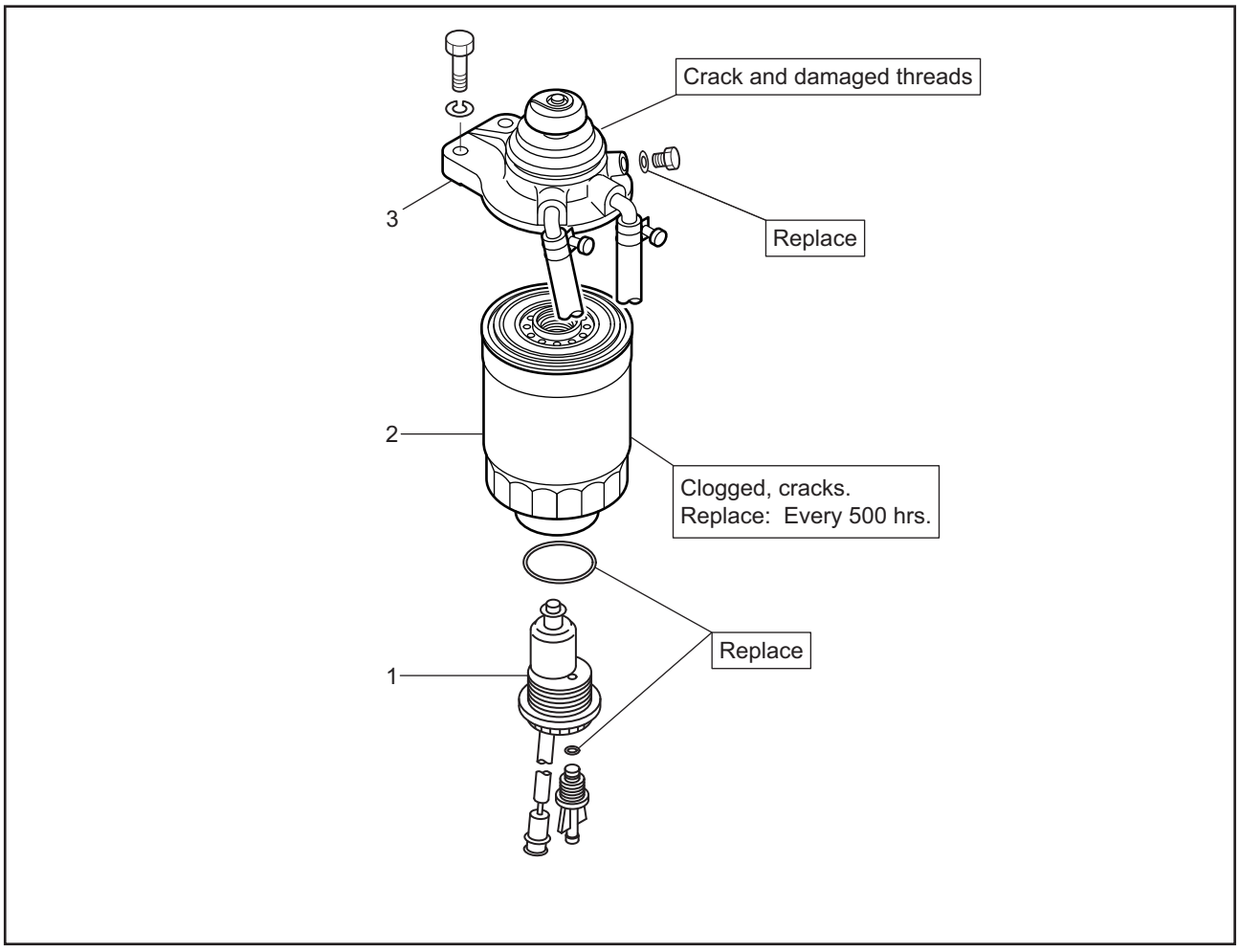
Installing oil seal - Wet



Installing rear oil seal

2. Disassembling, inspecting and reassembling fuel system

2.1 Disassembling and inspecting fuel filter



Disassembling and inspecting fuel filter

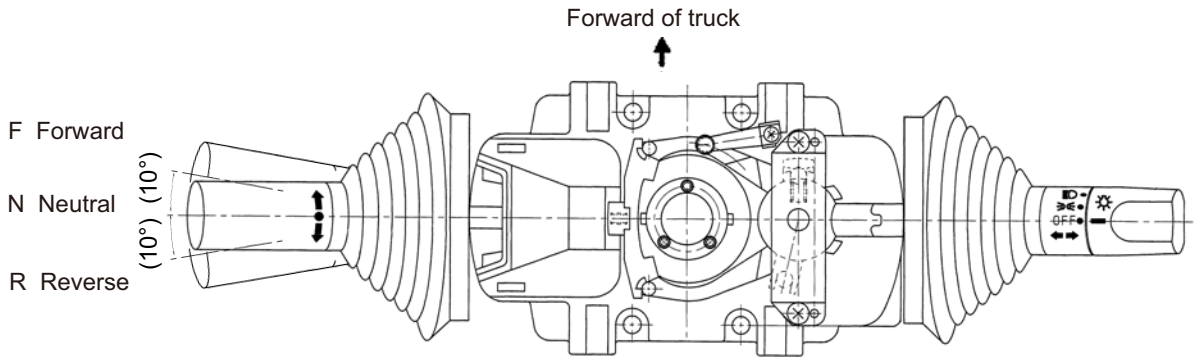
Disassembling sequence

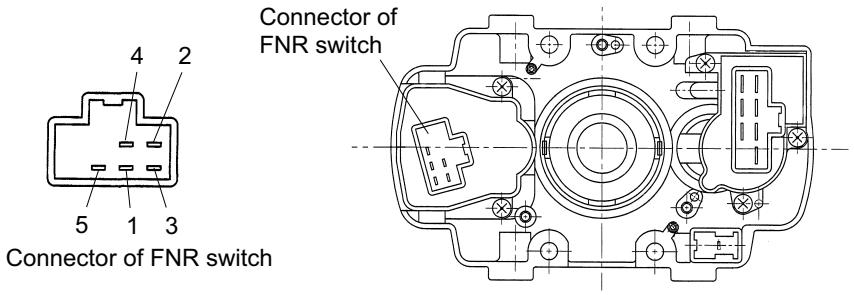
1 Level sensor
2 Filter element
3 Body

LUBRICATION SYSTEM

Chapter 3 ELECTRIC SYSTEM

2.2.7 Direction lever assembly (Powershift truck)





Connection table

Terminal / Wire color / Lever position	1	2	3	4	5
	G/W	B	B/R	B	L/W
F Forward		○	○		
N Neutral	○			○	
R Reverse		○			○

Abbreviations:
G/W = Green/White
B = Black
BR = Brown
L/W = Blue/White

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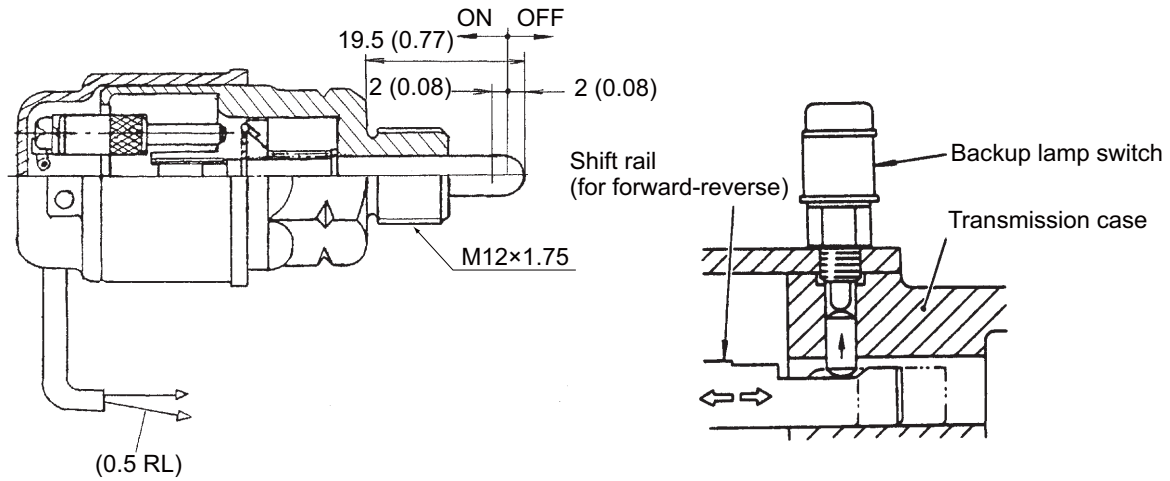
2.2.8 Backup lamp switch (Manual T/M truck)

Unit: mm (in.)



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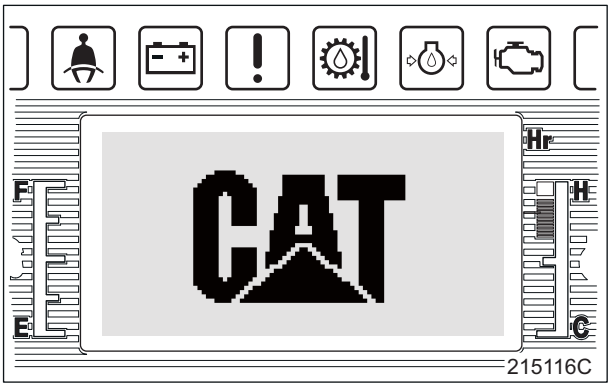
5.2 Basic Screen Display

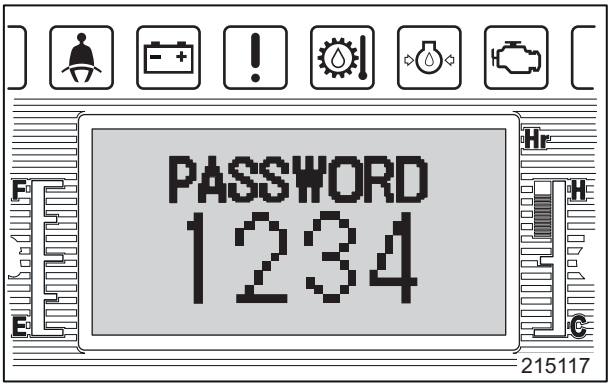
5.2.1 LCD screen display with the key switch in the ON position

With the key switch is turned to the ON position, the LCD screen displays the brand logo screen, the password authentication screen, and the standard display screen in this order. Also, error history is displayed by pressing a button.

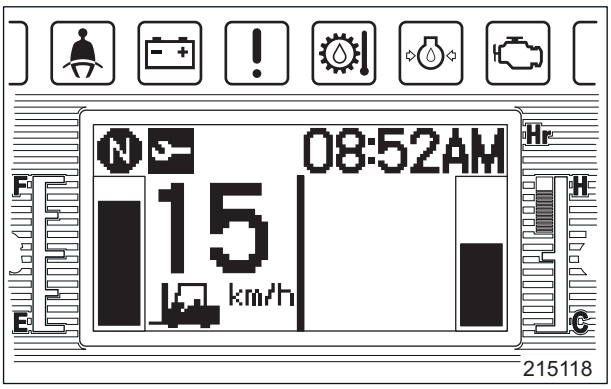
(1) Brand logo screen
When the key switch is turned to the ON position, the brand logo screen will be displayed for 2 seconds while the lamps are being checked.



(2) Password authentication screen
(Display by optional function)
Inputting the registered password in advance makes it possible to operate the lift truck.



(3) Standard display screen
The screen changes to the standard display screen that shows the conditions of the lift truck.



5.4.4 Error symbols

Error symbols displayed in the main area are as follows:

Symbol	Name/Meaning	Indicated condition
	Brake fluid level warning lamp	When brake fluid level is low (option)
	Fuel filter drain warning lamp	When fuel filter needs to be drained (diesel model)
	Coolant level warning lamp	When coolant level is low (option)
	Clogged air cleaner element warning lamp	When air cleaner element is clogged (option)
	Low fuel level warning lamp	When fuel level is low (on E level) (On LPG/gasoline dual models, when gasoline level is low.)
	LPG level warning lamp	When LPG level is low (LPG models) (option)

5.7.3 Instrument panel and/or VCM replacement

When replacing the instrument panel or VCM, be sure to observe the instructions described below to transfer the hour meter data to the new instrument panel or VCM.

(1) Replacing instrument panel only
When the instrument panel is replaced, the error (F-73) occurs. In this case, simply cancel the error code using service tool to sent the hour meter data (key-on time) stored in the VCM to the memory of the instrument panel. (For details, see the service tool manual.) After the recovery procedure is finished, turn the key switch ON and OFF several times to make sure that the hour meter reading is the same as VCM, and that the error (F-73) message has been erased.

(2) Replacing VCM only
When replacing VCM only, follow the usual procedure of installation of VCM. (For details, see the service tool manual.) After the usual procedure is finished, turn the key switch ON and OFF several times to make sure that the error (F-73) message has been erased.

(3) Replacing both instrument panel and VCM
Step 1:
Follow the procedure (1) above for replacing instrument panel.
Step 2:
Follow the procedure (2) above for replacing VCM.

Note: 1. When replacing instrument panel and/or VCM, be sure to replace them with new ones.

2. If the instrument panel and/or VCM are used from another lift truck, the error (F-73) occurs. Should the hour meter be replaced with an used hour meter, never conduct an error recovery procedure.
The error recovery procedure, in this case, results in overwriting the large value in order to erase the difference between the values of the hour meter and the VCM.

Note: When replacing the instrument panel, only key-on time is transferred over to the new instrument panel. (Meter readings of engine on-time and seat switch-on time will be zero on the new instrument panel.)

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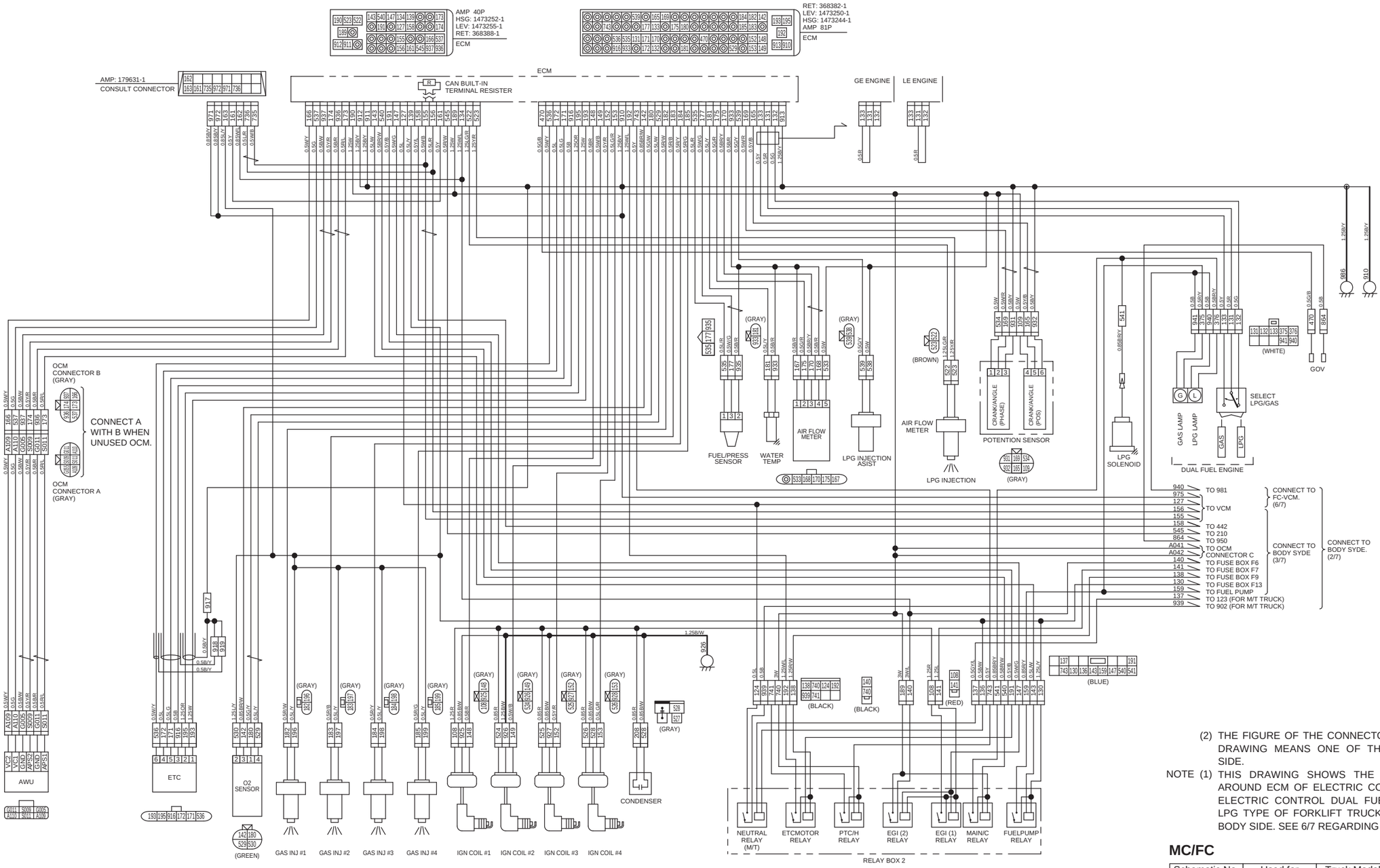
Electrical Schematic (7/7)



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

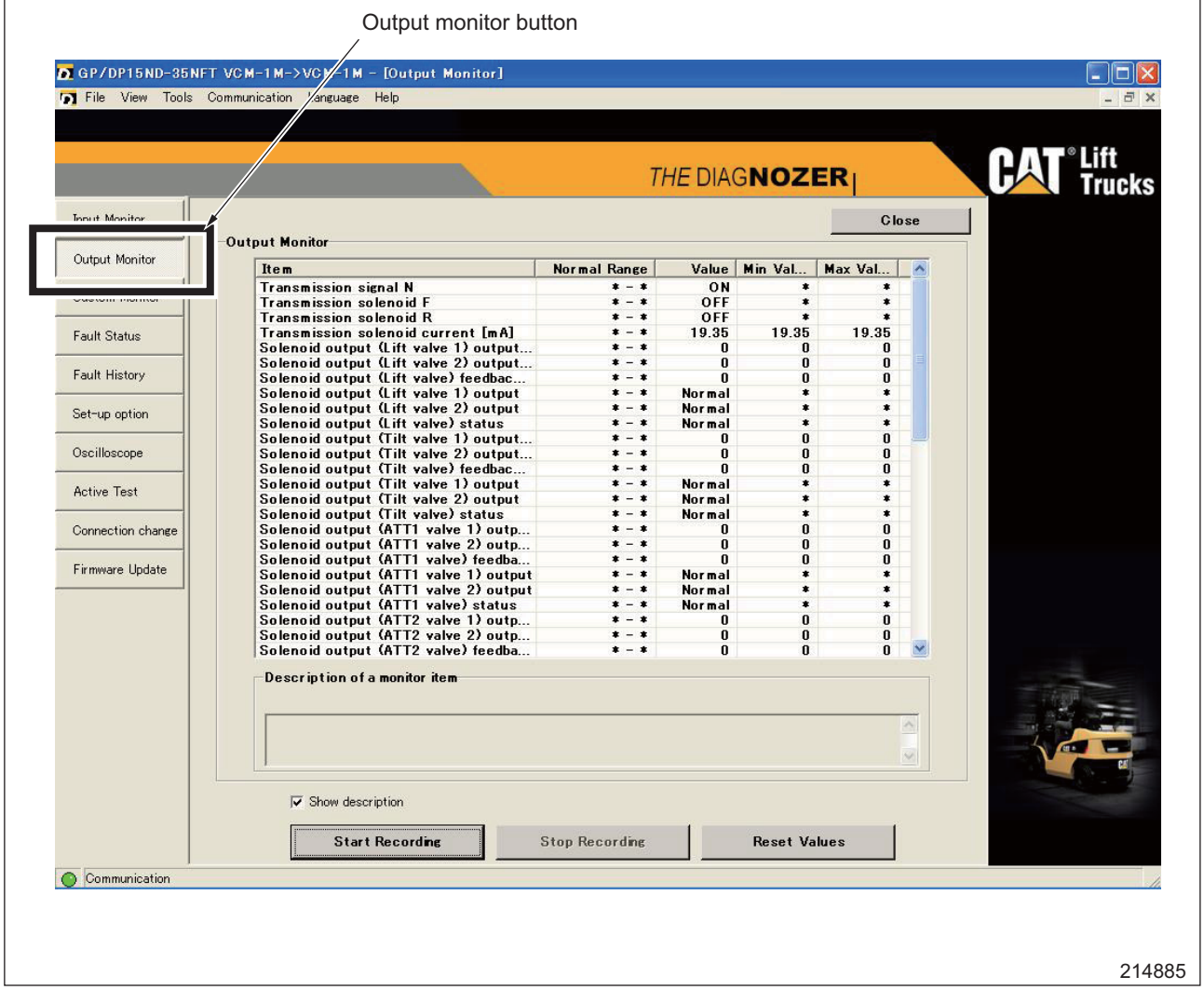
NOTE (1) THIS DRAWING SHOWS THE WIRING DIAGRAM AROUND ECM OF ELECTRIC CONTROL GASOLINE, ELECTRIC CONTROL DUAL FUEL GASOLINE AND LPG TYPE OF FORKLIFT TRUCK. SEE 2/7, 3/7 FOR BODY SIDE. SEE 6/7 REGARDING AROUND VCM.

MC/FC

Schematic No.	Used for	Truck Model	Serial No.
ES019-8M110 7/7	99719-8M110	2P3000	AT34-30121 up
		2P3500	AT34-30121 up
		2PC4000	AT34-80121 up
		2P4000	AT35-30121 up
		2P5000	AT35-30121 up
		2P5500	AT36-30121 up
		2P6000	AT13F-30121 up
		2P6500	AT13F-80121 up
		2P7000	AT13F-80121 up

(2) Output Monitor

Monitors output of sensors and switches.



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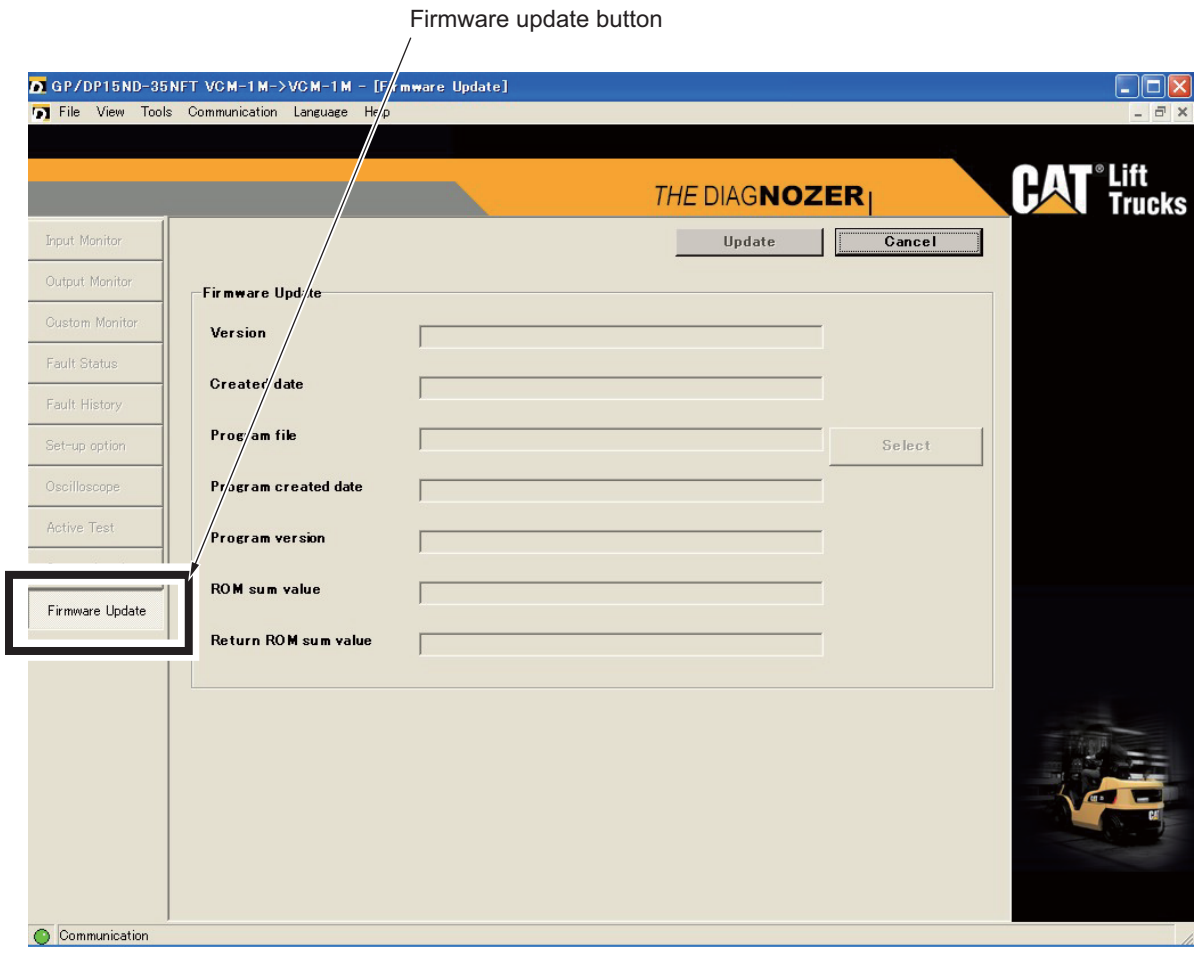
Signals monitored are as shown below.

Transmission signal N		Solenoid output (Tilt valve) status	
Transmission solenoid F		Solenoid output (ATT1 valve 1) output	[mA]
Transmission solenoid R		Solenoid output (ATT1 valve 2) output	[mA]
Transmission solenoid current	[mA]	Solenoid output (ATT1 valve) feedback	[mA]
Solenoid output (Lift valve 1) output	[mA]	Solenoid output (ATT1 valve 1) output	
Solenoid output (Lift valve 2) output	[mA]	Solenoid output (ATT1 valve 2) output	
Solenoid output (Lift valve) feedback	[mA]	Solenoid output (ATT1 valve) status	
Solenoid output (Lift valve 1) output		Solenoid output (ATT2 valve 1) output	[mA]
Solenoid output (Lift valve 2) output		Solenoid output (ATT2 valve 2) output	[mA]
Solenoid output (Lift valve) status		Solenoid output (ATT2 valve) feedback	[mA]
Solenoid output (Tilt valve 1) output	[mA]	Solenoid output (ATT2 valve 1) output	
Solenoid output (Tilt valve 2) output	[mA]	Solenoid output (ATT2 valve 2) output	
Solenoid output (Tilt valve) feedback	[mA]	Solenoid output (ATT2 valve) status	
Solenoid output (Tilt valve 1) output		Solenoid output (ATT3 valve 1) output	[mA]
Solenoid output (Tilt valve 2) output		Solenoid output (ATT3 valve 2) output	[mA]

(10)Firmware Update

Click the firmware update button from the menu or toolbox to display the firmware update screen. The contents displayed vary depending on the controller being connected. On firmware update screen, the user selects software version of controller that is connected, or the user can select a write software, or conduct update. Firmware can be updated in a setup mode only. Note that updates are available at any time on the controller without entering the setup mode.



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(5) Display the output monitor screen of the service tool (VCM1-M).

(6) Place the direction lever in the FORWARD position. Make sure that shift lever (F) Input and T/M control valve (F) output indicate ON and the T/M control valve current is around 2000 mA on the screen. (Fig. 2-2)

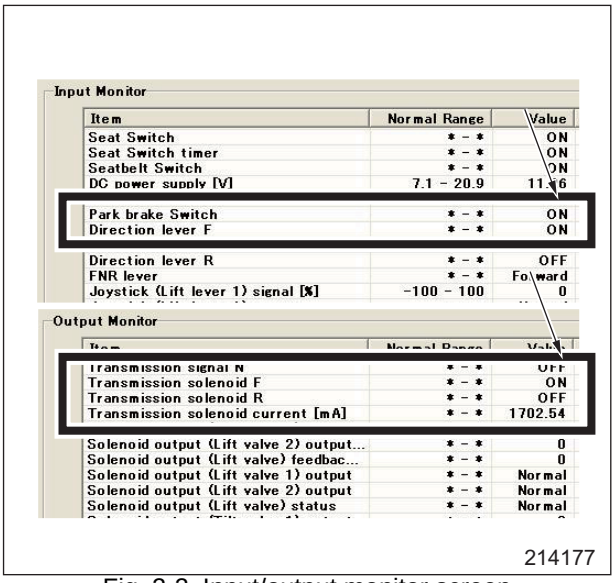


Fig. 2-2 Input/output monitor screen

(7) Leave the operator's seat. Check that the seat switch turns OFF on the input monitor screen and the seat switch timer turns OFF a few seconds later with the seat delay counter function. (Fig. 2-3 and Fig. 2-4)

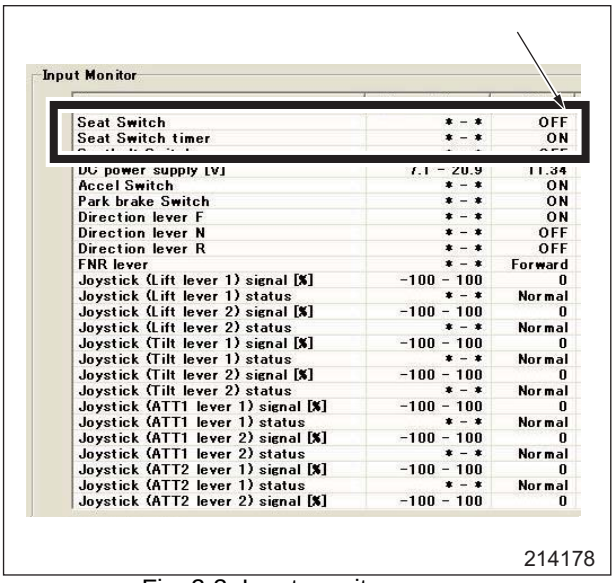


Fig. 2-3 Input monitor screen

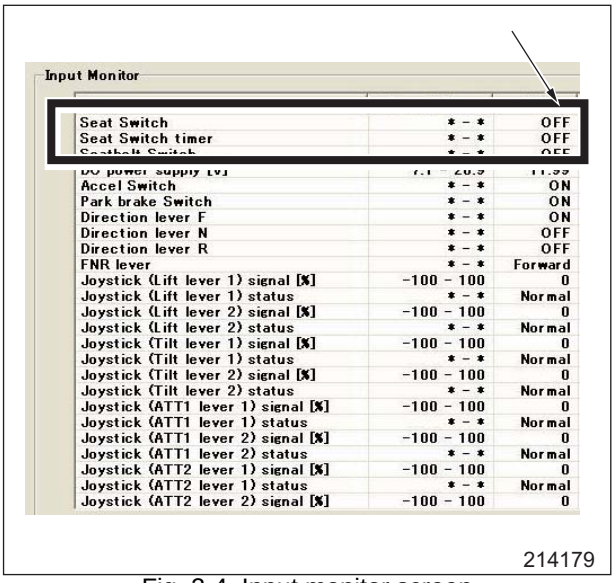


Fig. 2-4 Input monitor screen

9. Controller Details

9.1 VCM1-M Controller

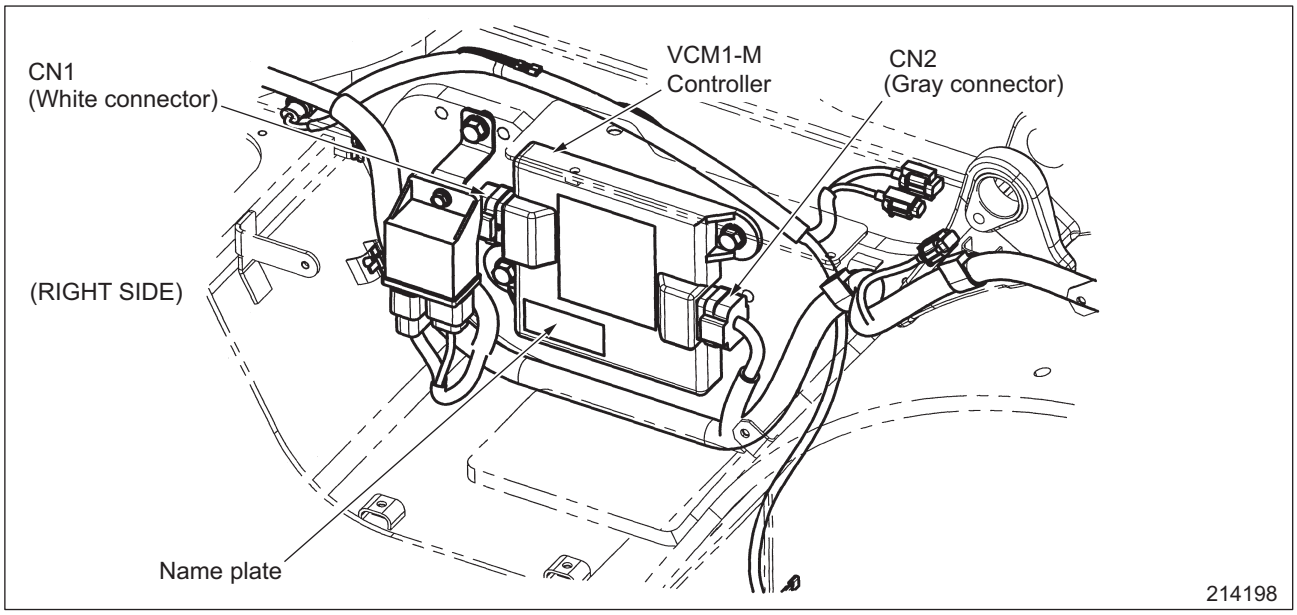


Fig. 7-1 Controller location

(1) VCM1-M Controller

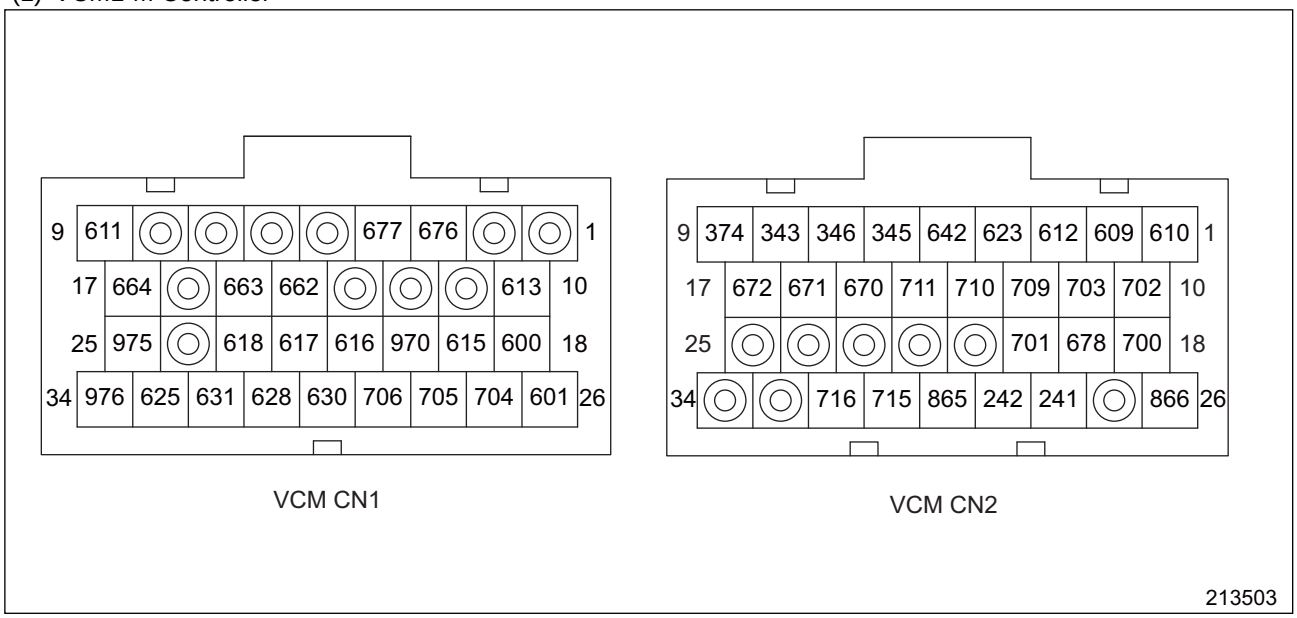


Fig. 7-2 Controller code allocation (VCM1-M)

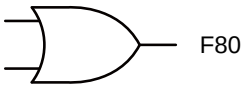
Diagnosis	VCM communication error (F03)
Logic conditions	CAN transmission from VCM1-M is impractical. (2 second's continuity) ——— F03
Recovery	Recovers automatically
Action	Error indication only, the operation continues.
LED blink pattern	B

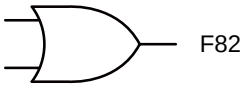
Diagnosis	ECM communication error (F04)
Logic conditions	CAN receiving from ECM is impractical. (2 second's continuity) ——— F04
Recovery	Recovers automatically
Action	Activates with default values of ECM incoming data.
LED blink pattern	B

Diagnosis	DCM communication error (F05)
Logic conditions	CAN receiving from DCM is impractical. (2 second's continuity) ——— F05
Recovery	Recovers automatically
Action	Activates with default values of DCM incoming data.
LED blink pattern	B

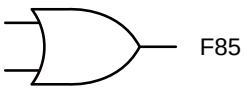
Diagnosis	OCM communication error (F06)
Logic conditions	CAN receiving from OCM is impractical. (2 second's continuity) ——— F06
Recovery	Recovers automatically
Action	Activates with default values of OCM incoming data.
LED blink pattern	B

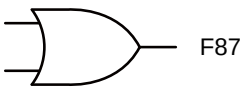
Diagnosis	MP communication error (F07)
Logic conditions	CAN receiving from instrument panel is impractical. (2 second's continuity) ——— F07
Recovery	Recovers automatically
Action	Activates with default values of instrument panel incoming data.
LED blink pattern	B

Diagnosis	Knob position solenoid error (F80)
Logic conditions	Current value is 160mA or less (400 milliseconds continuity) Current value is 3.54A or more (200 milliseconds continuity) 
Recovery	Turn on power again.
Action	Set knob position solenoid error output to OFF.
LED blink pattern	E

Diagnosis	VCM tilt lock valve error (F82)
Logic conditions	Current value is 160mA or less (1800 milliseconds continuity) Current value is 2.88A or more (200 milliseconds continuity) 
Recovery	Turn on power again
Action	Set tilt lock valve output to OFF.
LED blink pattern	E

Diagnosis	Knob position solenoid leak (F84)
Logic conditions	Current value is 180mA or more with output OFF (600 milliseconds continuity)
Recovery	Turn on power again.
Action	Set knob position solenoid error output to OFF.
LED blink pattern	E

Diagnosis	T/M forward solenoid error (F85)
Logic conditions	Current value is 250mA or less (1800 milliseconds continuity) Current value is 3.8A or more (200 milliseconds continuity) 
Recovery	Turn on power again.
Action	Turn OFF the T/M forward solenoid output.
LED blink pattern	E

Diagnosis	T/M backward solenoid error (F87)
Logic conditions	Current value is 250mA or less (1800 milliseconds continuity) Current value is 3.8A or more (200 milliseconds continuity) 
Recovery	Turn on power again.
Action	Turn OFF the T/M backward solenoid output.
LED blink pattern	E