

Service Manual

Chassis & Mast

MC

GP15N	CT25C-55001-up	GPE15N	CT34-00001-up	DP15N	CT16D-54001-up
GP15ZN	CT34-52001-up	GPE18N	CT34-40001-up	DP18N	CT16D-74001-up
GP18N	CT25C-75001-up	GPE20CN	CT34-30001-up	DP20CN	CT16D-24001-up
GP18ZN	CT34-72001-up	GPE20N	CT17D-20001-up	DP20N	CT18C-20001-up
GP20CN	CT34-22001-up	GPE20ZN	CT35-20001-up	DP25N	CT18C-70001-up
GP20N	CT17D-10001-up	GPE25N	CT17D-70001-up	DP30N	CT14E-10001-up
GP20ZN	CT35-10001-up	GPE25ZN	CT35-70001-up	DP35N	CT14E-80001-up
GP25N	CT17D-60001-up	GPE30N	CT13F-10001-up		
GP25ZN	CT35-60001-up	GPE35N	CT13F-80001-up		
GP30N	CT13F-40001-up				
GP35N	CT13F-60001-up				

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2. Applicable Truck Model

This Service Manual provides servicing and maintenance information for the following trucks:

Engine mounted	Gasoline engine truck	Dual fuel gasoline/LPG engine truck	Diesel engine truck
Non-electric controlled	MC	MC	MC
Electric controlled	MC	MC	

Truck type	Electric controlled gasoline engine, Electric controlled dual fuel gasoline/LPG engine models			Non-electric controlled diesel engine models		
	Truck model	Serial number	Engine mounted	Truck model	Serial number	Engine mounted
1 ton class	GP15N	CT25C-55001 up	K15	DP15N	CT16D-54001 up	S4Q2
	GP15ZN	CT34-52001 up	K21	DP18N	CT16D-74001 up	S4Q2
	GPE15N	CT34-00001 up	K21E	DP20CN	CT16D-24001 up	S4Q2
	GP18N	CT25C-75001 up	K15	-	-	-
	GP18ZN	CT34-72001 up	K21	-	-	-
	GPE18N	CT34-40001 up	K21E	-	-	-
	GP20CN	CT34-22001 up	K21	-	-	-
	GPE20CN	CT34-30001 up	K21E	-	-	-
2 ton class	GP20N	CT17D-10001 up	K21	DP20N	CT18C-20001 up	S4S
	GP20ZN	CT35-10001 up	K25	DP25N	CT18C-70001 up	S4S
	GPE20N	CT17D-20001 up	K21E	-	-	-
	GPE20ZN	CT35-20001 up	K25E	-	-	-
	GP25N	CT17D-60001 up	K21	-	-	-
	GP25ZN	CT35-60001 up	K25	-	-	-
	GPE25N	CT17D-70001 up	K21E	-	-	-
	GPE25ZN	CT35-70001 up	K25E	-	-	-
3 ton class	GP30N	CT13F-40001 up	K25	DP30N	CT14E-10001 up	S4S
	GPE30N	CT13F-10001 up	K25E	DP35N	CT14E-80001 up	S4S
	GP35N	CT13F-60001 up	K25	-	-	-
	GPE35N	CT13F-80001 up	K25E	-	-	-

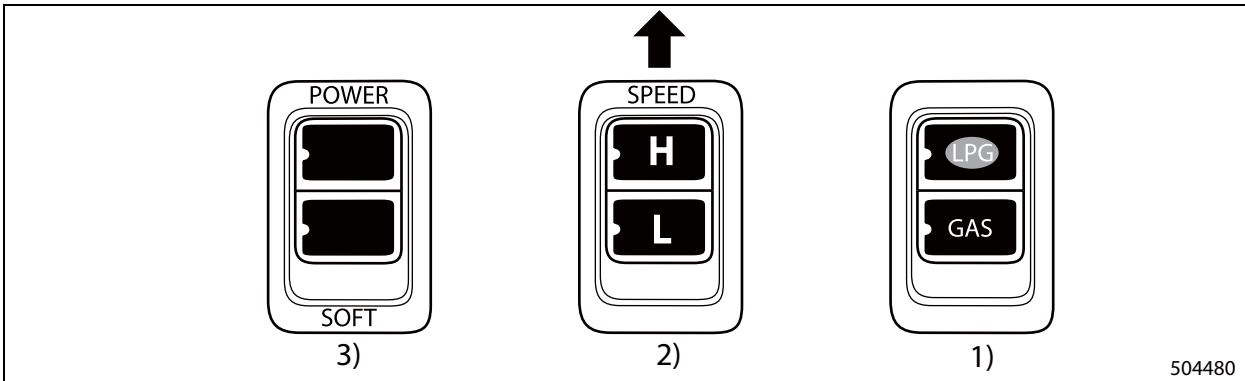
Note: Characters at the end of truck model should be read as follows:

None: MC Truck

Z: High-power engine model

C: Short wheel base model

3.5 Select Switch

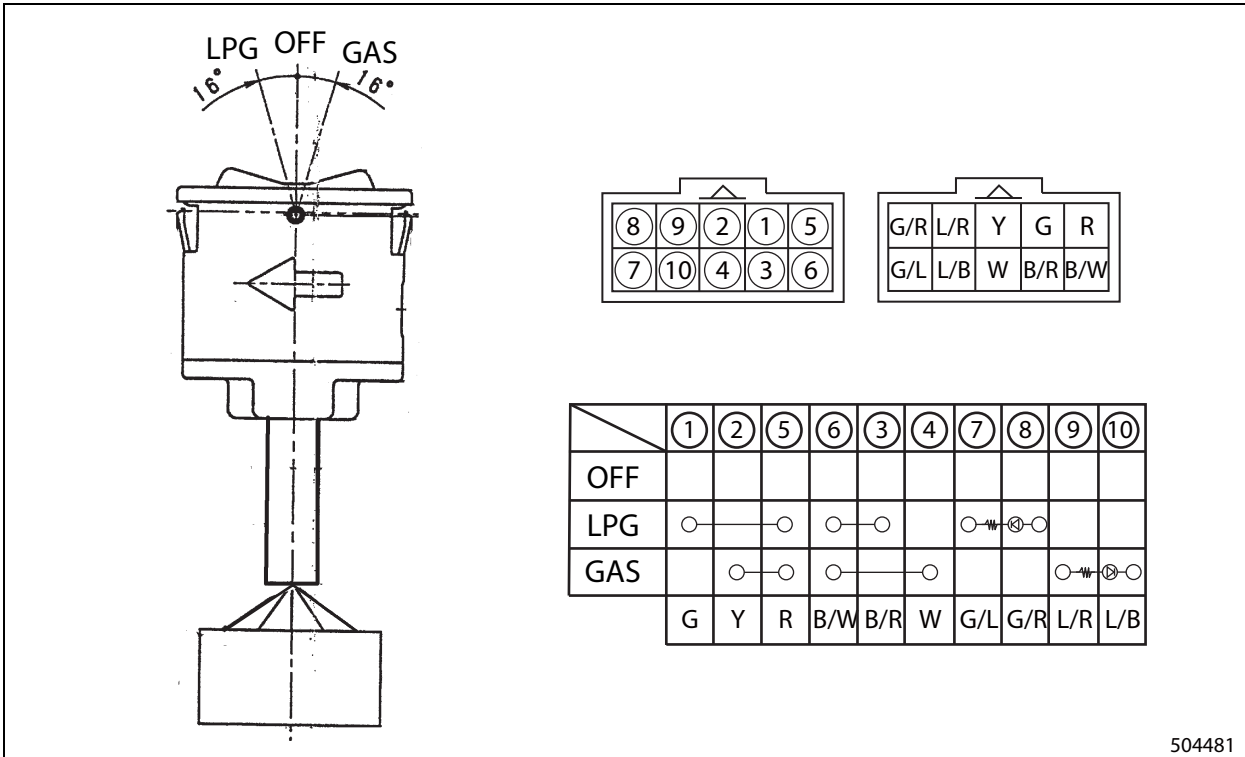


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- 1) Gasoline/LPG select switch
- 2) Speed select switch
- 3) Power select switch

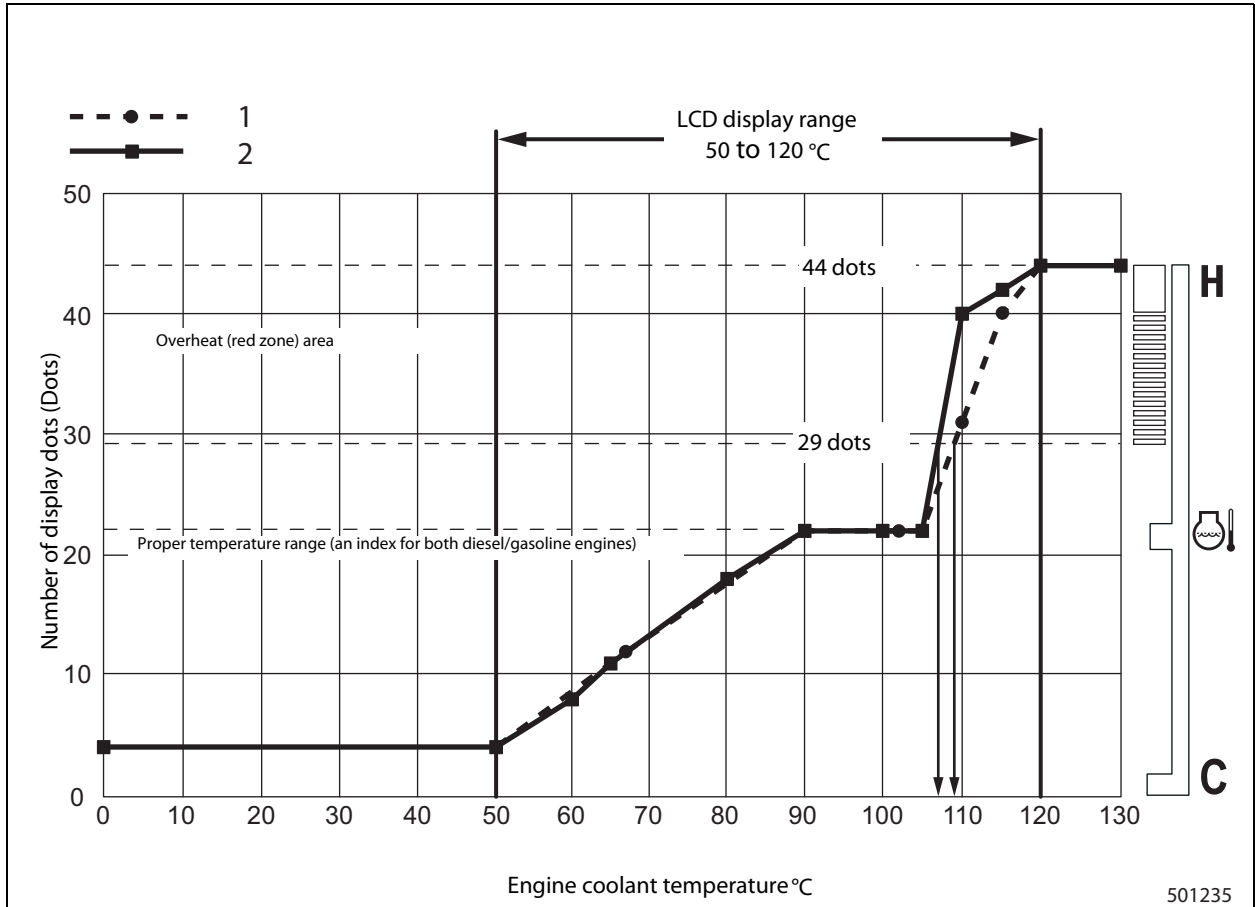
Note: Arrow indicates the front of truck.

Gasoline/LPG Select switch



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Engine coolant temperature - the number of dots on screen



1. Diesel engine models
2. Gasoline engine models

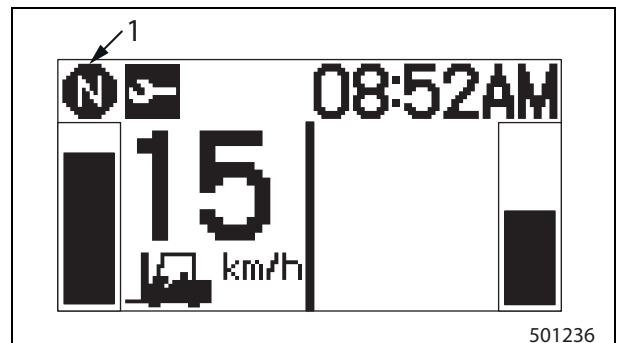
Note: Red zone is 29 dots or more.
 Diesel models: about 109 °C (228 °F) or higher
 Gasoline models: about 107 °C (225 °F) or higher

Travel direction display

The truck traveling direction is displayed. If the direction lever is not in the N (NEUTRAL) position when starting the engine, the symbol "N" blinks and the engine will not start. If an operator leaves the seat while the engine is running and the direction lever is not in the N (NEUTRAL) position, the symbol "N" blinks and the transmission is electrically shifted to the NEUTRAL.

Note:

- Travel direction display is switched by the signal from the direction lever.
- Manual T/M truck shows N (NEUTRAL) only, and does not show forward and reverse.
 Also, blinking N (Driving interlock indication) is not shown.



1. Truck direction indicator

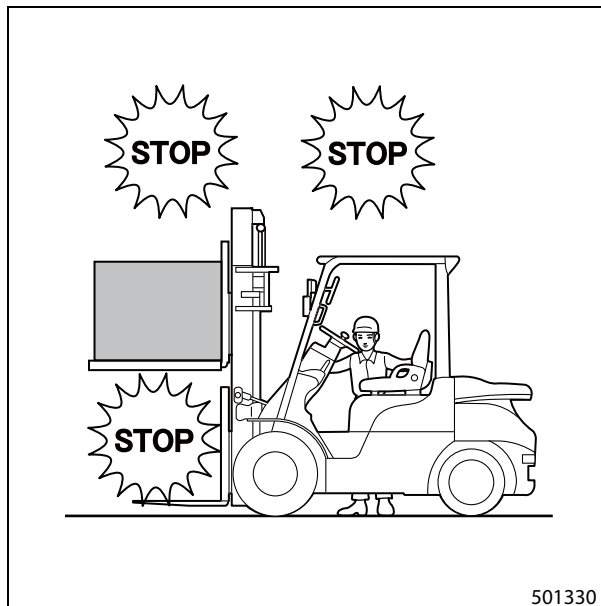
7.5 Battery-related problem

Condition	Possible cause		Action
Weak battery	Alternator belt slip		Adjust the tension
	Alternator	Stater coil open circuit	Repair or replace
		Rotor coil open circuit	Replace
		Poorly-seated brushes on slip rings	Replace brushes if worn-out, (clean the folder) and polish slip rings
		Short-circuited or open-circuited diode	Replace
	Regulator	Low output voltage	Adjustment
	Battery	Electrolyte level low or inappropriate quality	Refill or adjust the S.G.
		Defective cell plates (internal short-circuit)	Replace
		Poor connection of terminals	Clean and tighten
	Wiring	Open circuit or loose connection between key switch and regulator IC terminal	Repair
		Blown out fuse in the circuit above or loose connection on the holder	Replace fuse or repair the holder contact part
Open circuit or loose connection between regulator terminal and alternator terminal		Repair	
Battery overcharge	Wiring	Incorrect connection or short circuit between regulator IC and terminal	Repair
		Faulty grounding of regulator terminal F	Repair
	Regulator	Pressure coil open circuit	Replace
		Output voltage too high	Readjust

4. Mast Interlock System

4.1 Mast Interlock Function

When an operator leaves the operator seat while the engine is running, the built-in seat switch is activated to lock the mast. The mast will not move even if the lift or the tilt lever is operated.



Key switch position	Engine operating condition	Operator seat Vacant or Occupied	Meter panel	Control lever	
			Mast interlock indicator light	Lift	Tilt
○(OFF)	Stop	Occupied	OFF	Not active	Not active
		Vacant	OFF	Not active	Not active
I(ON)	Stop	Occupied	OFF	Lowering only	Not active
		Vacant	Blinking	Not active	Not active
⊖(START)	Running	Occupied	OFF	Active	Active
		Vacant	Blinking	Not active	Not active

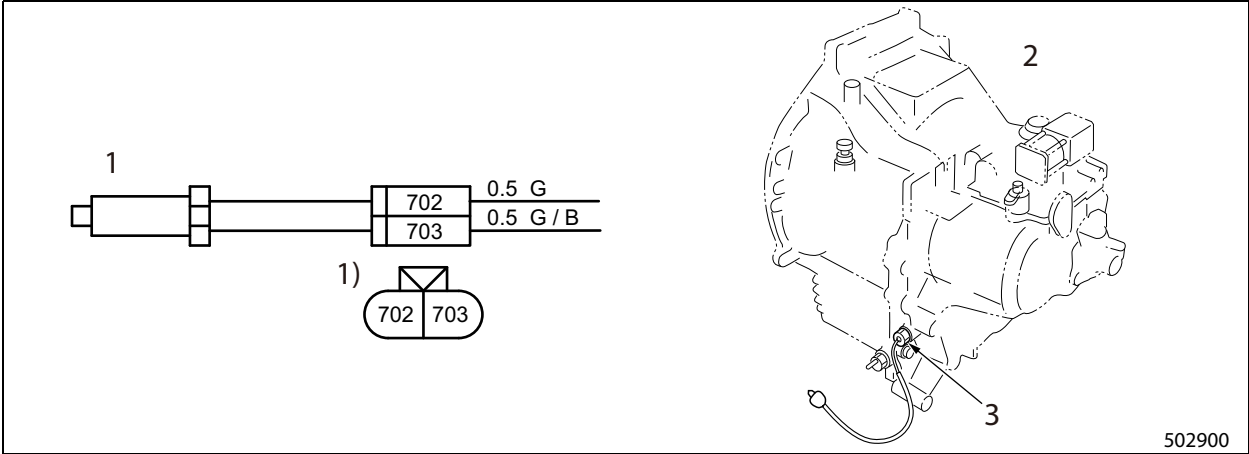
Controller function

The controller monitors the seat switch and if the operator is not seated, the controller locks the lift and tilt motions.

VCM-1M controller, Mast interlock function

The VCM-1M controller interrupts electric current supply to the unload solenoid and the lift lock solenoid if an operator is not seated.

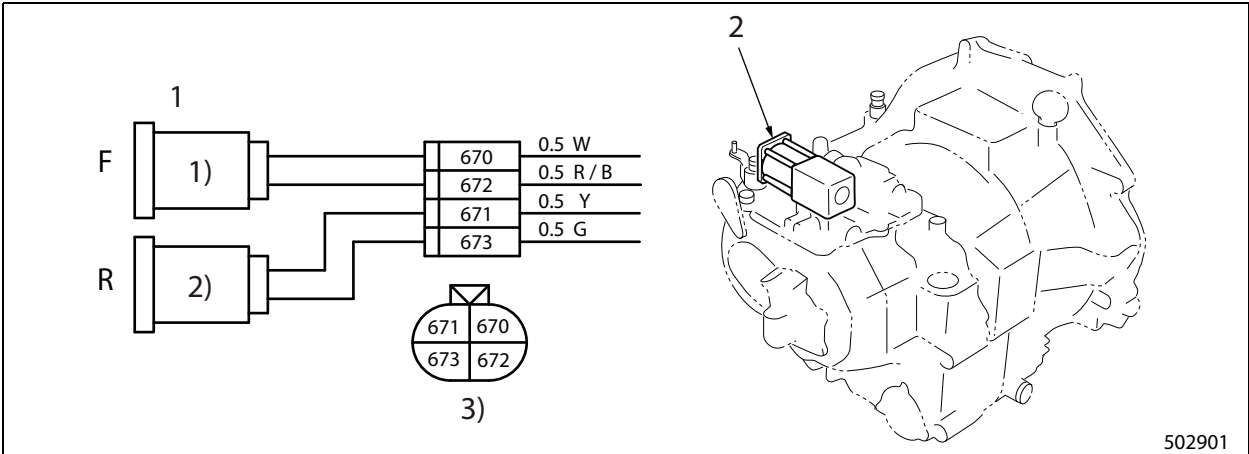
9.5 Vehicle Speed Sensor



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- 1. Vehicle speed sensor
- 2. Transmission (right side)
- 3. Vehicle speed sensor
- 1) (BLACK)

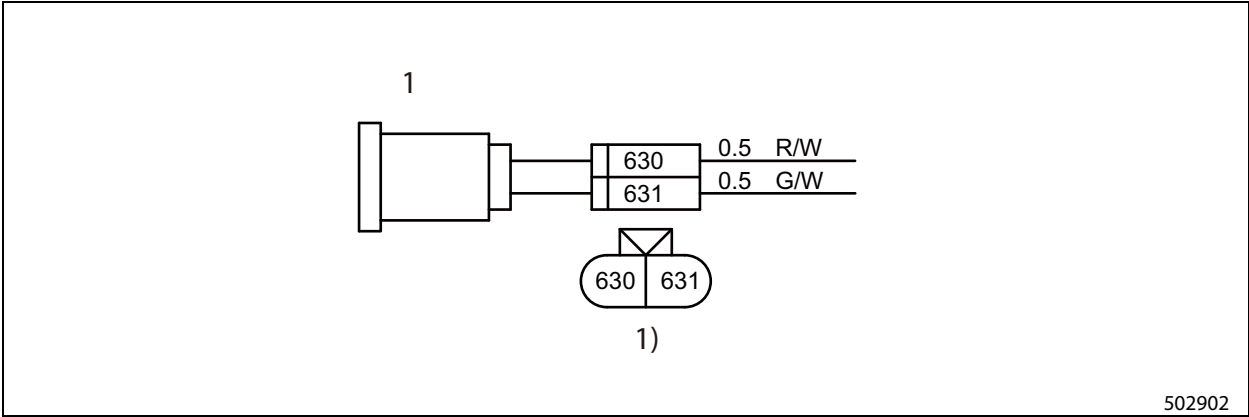
9.6 T/M Solenoid



502901

- 1. T/M Solenoid
- 2. T/M forward/backward solenoid
- 3) (GRAY)
- 1) Forward
- 2) Reverse

9.7 Unload Solenoid



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- 1. Unload solenoid
- 1) (BLACK)

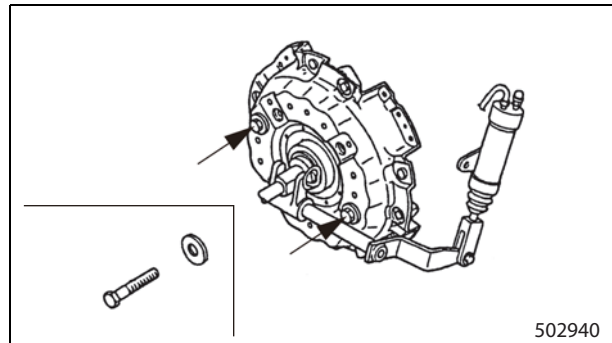
CHAPTER 4 CONTROLLER

Diagnostic code	Diagnostic code name	Probable cause	Check items
S-07	MP Communication warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Meter panel bad	3. Communication line check
		4. Controller bad	
S-08	TMS communication warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. TMS bad	3. Communication line check
		4. Controller bad	
S-10	APS1 input warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-11	APS2 input warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-13	APS1/APS2 relative warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-14	Idle switch warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Idle switch bad	3. Idle switch check
S-40	Service brake solenoid warning	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Service brake solenoid bad	4. Service brake solenoid conductivity check
		5. Controller bad	
S-41	Service brake solenoid leak warning	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Service brake solenoid bad	4. Service brake solenoid conductivity check
		5. Controller bad	

2.2 Suggestions for Disassembly

Securing pressure springs

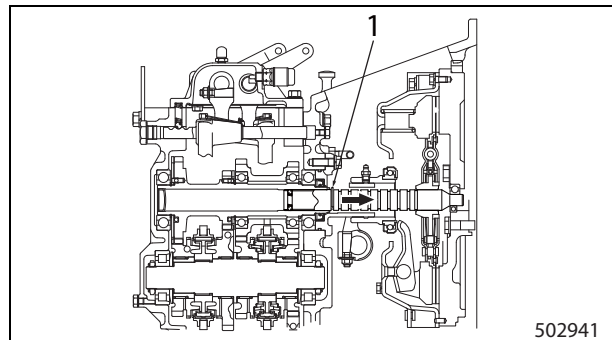
Press the clutch pedal and tighten two bolts (M10 x 1.5, L=50 mm (1.97 in.)) (for pressure plate removal/installation) and washer (ϕ 40 mm (1.57 in.)) to bring the pressure spring into a compressed state.



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Removing stopper ring from the input shaft

The stopper ring can be easily removed by slightly pulling out the input shaft to the flywheel side. Remove stopper ring from input shaft.

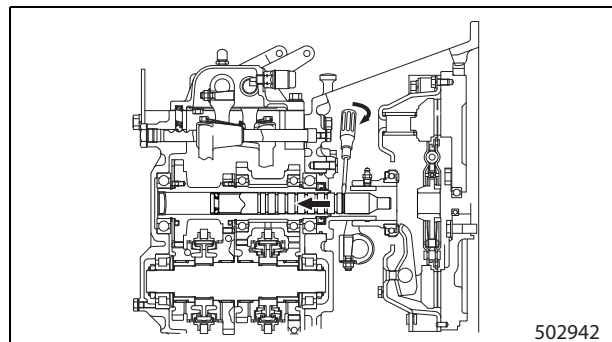


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1. Stopper ring

Moving input shaft into transmission side

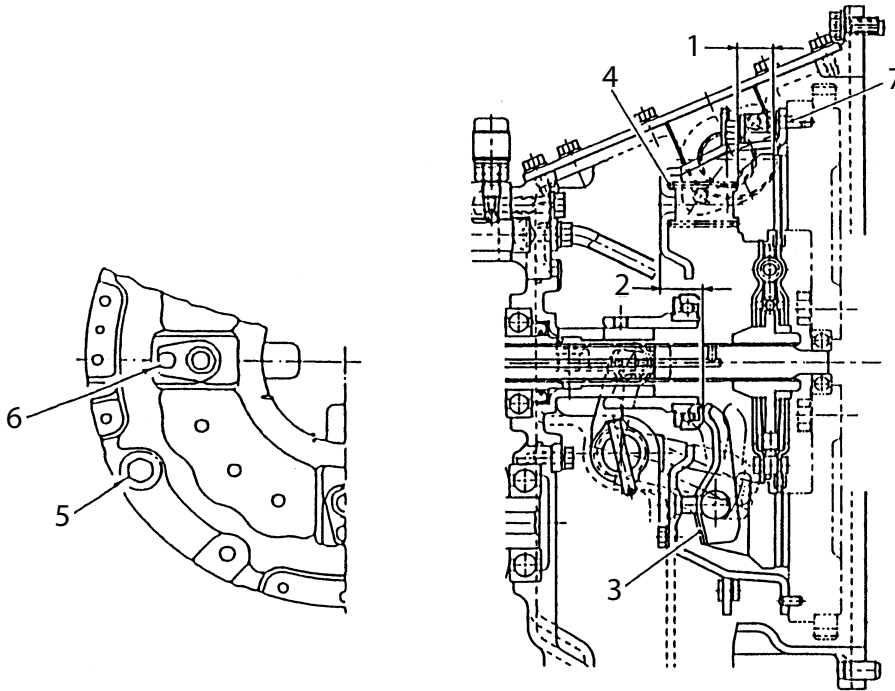
The input shaft is held in position by steel ball so that it takes effort to move at first.



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Pressure plate

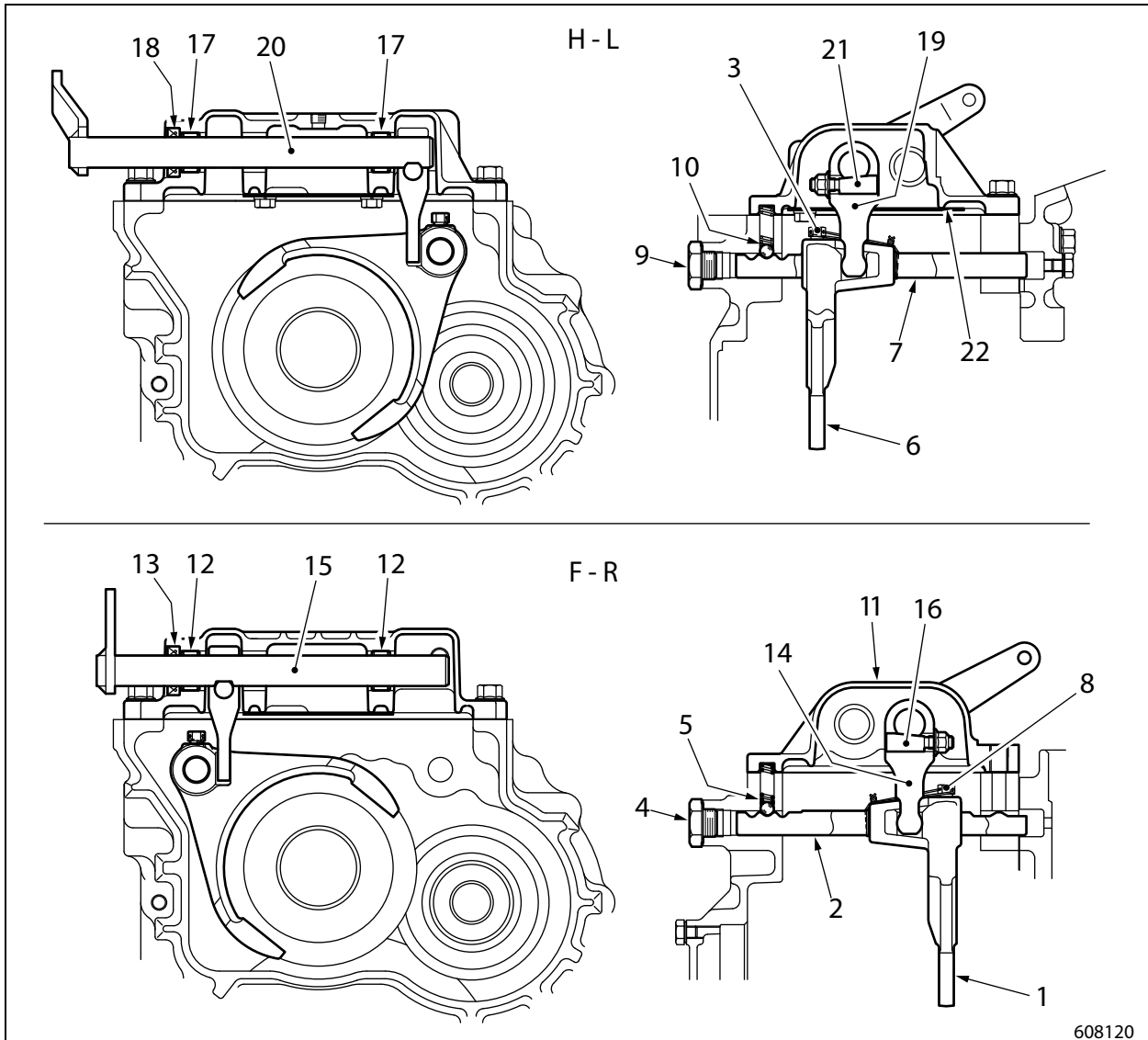
Item		Specified value	
-	Flatness of plate	Standard	0.05 mm (0.0020 in.) or less
		Limit	0.2 mm (0.008 in.)
1	Thickness of plate (from spring seat to friction plate)	Standard	22.8 mm (0.898 in.)
		Limit	21.0 mm (0.827 in.)
2	Release lever height (with 2.1 mm (0.0827 in.) of the disc wear amount)	Standard	26.5 mm (1.043 in.)
		Limit	16.5 mm (0.650 in.)
3	Maximum permissible difference between heights of all release levers	Standard	0.7 mm (0.028 in.)
4	Pressure spring	Quantity per clutch	S4Q2,S4S models: 12 pcs K15,K21,K25 models: 10 pcs
		Free length	78.8 mm (3.102 in.)
		Installed length/installed load	48.2 mm (1.898 in.)/643 ± 5% N
5	Washer mounting bolt	Tightening torque	39 to 59 N·m (4.0 to 6.0 kgf·m) [28.76 to 43.52 lbf·ft]
6	Lockplate mounting bolts	Tightening torque	5.8 to 7.8 N·m (0.59 to 0.80 kgf·m) [4.278 to 5.753 lbf·ft]
7	Pressure plate	Tightening torque	17 N·m (1.7 kgf·m) [12.54 lbf·ft]



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15. Fork and Shift Rails and Control Cover, Assembly

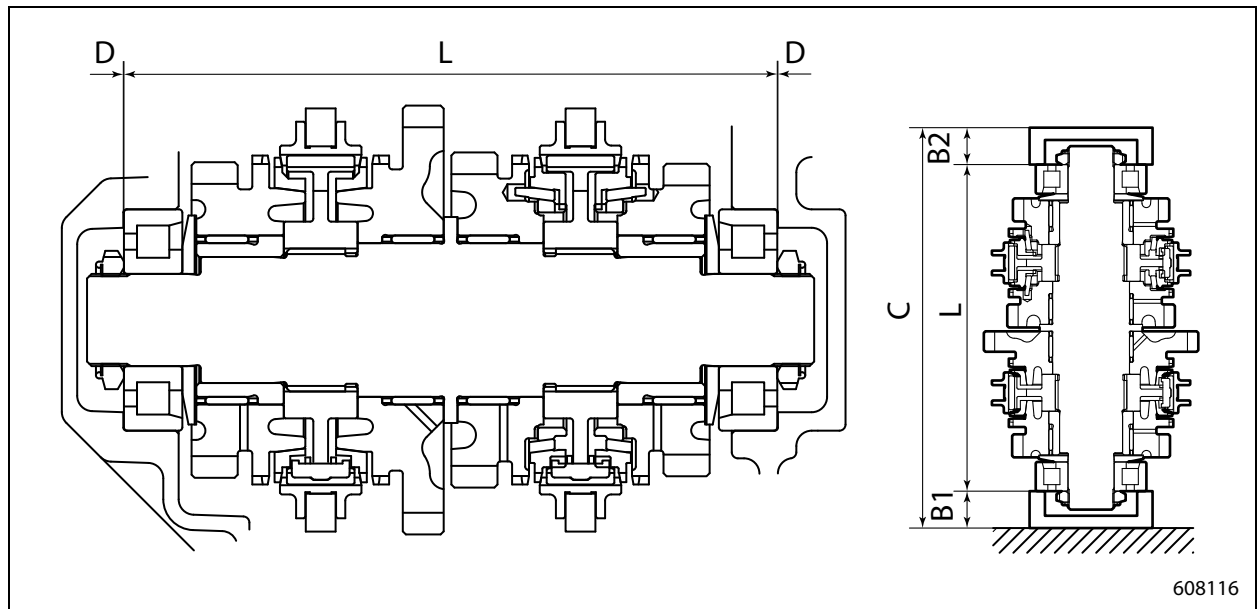
15.1 Assembly Sequence



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- | | |
|---------------------------|---|
| 1. Shift fork (F-R) | 12. Needle roller bearing |
| 2. Shift rail (F-R) | 13. Oil seal |
| 3. Screw | 14. Fork lever |
| 4. Plug, Gasket | 15. Control lever (F-R) |
| 5. Spring and Steel ball | 16. Lock pin, Nut |
| 6. Shift fork (H-L) | 17. Needle roller bearing |
| 7. Shift rail (H-L) | 18. Oil seal |
| 8. Screw | 19. Fork lever |
| 9. Plug, Gasket | 20. Control lever (H-L) |
| 10. Spring and Steel ball | 21. Lock pin, Nut |
| 11. Control cover | 22. Control cover plate, Bolts, Washers |

13.3 Selection of Shims



Note: L shows the distance between bearing outer races.

- The required thickness of shims (for one side) can be obtained from the formula:
 $D = (212.7 \text{ mm} - L) / 2$
 $D = (8.374 \text{ in.} - L) / 2$

Note: The nominal value of D is 0.1. Round off to one decimal place.

- Using special tools with known B1 and B2 dimensions, measure the dimension C while pressing the bearing outer races evenly.
 Calculation of L dimension: $L = C - B1 - B2$
- From the list below, select a shim(s) that meets to the dimension D.

Thickness (t)	Part number
t = 0.1 mm (0.004 in.)	91A25-05100
t = 0.2 mm (0.008 in.)	91A25-05200
t = 0.3 mm (0.012 in.)	91A25-05300
t = 0.4 mm (0.016 in.)	91A25-05400
t = 0.5 mm (0.020 in.)	91A25-05500
t = 0.6 mm (0.024 in.)	91A25-05600

4.4 Transmission Housing, Removing

Transmission housing mounting bolts, Removing (Part 1)

Remove three bolts from the inside of torque converter housing.

Servo case, Removing

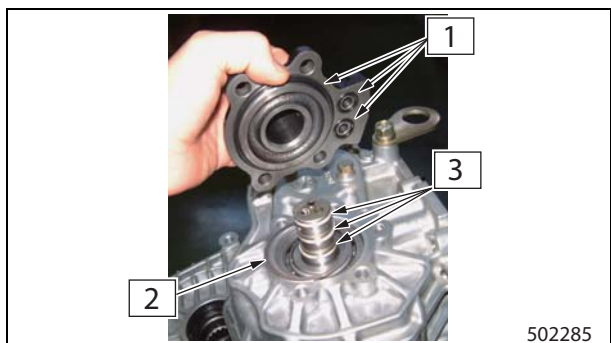
- (1) Lift the transmission, remove the stand kit (special tool), and lay down the transmission with the torque converter housing faced down.



- (2) Remove servo case together with O-ring and shim.
- (3) Remove seal rings from input shaft.



1. Servo case

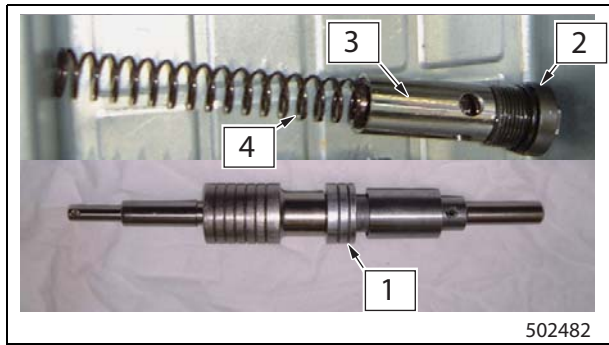


1. O-ring
2. Shim

3. Seal ring

Valve, Removing

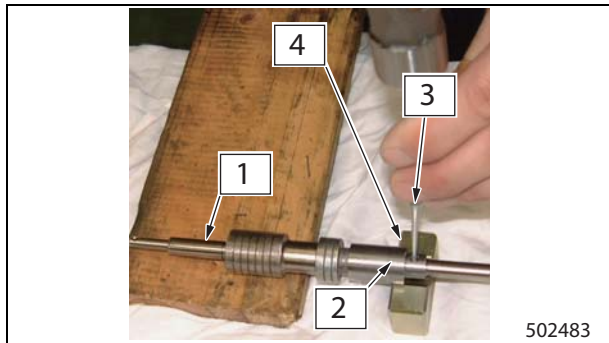
- (1) Remove inching plug together with O-ring.
- Note: Slowly remove the inching plug while pressing it with a tool to prevent the inching spring from popping out.
- (2) Remove inching spring, inching stopper 1, inching rod, inching valve spring, inching valve, and return spring.



1. Inching valve assembly
2. Inching plug
3. Inching stopper 1
4. Inching spring

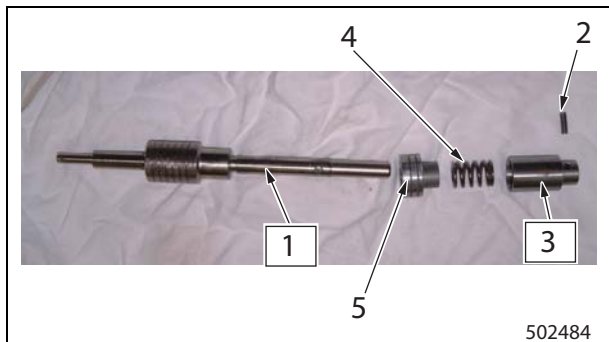
Inching valve assembly, Disassembling

- (1) Remove the spring pin from inching stopper 2 using the stand (special tool).



1. Inching valve assembly
2. Inching stopper 2
3. Pin
4. Special tool (Stand)

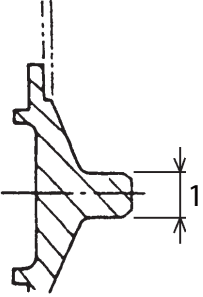
- (2) Remove spring pin from inching rod, and remove inching stopper 2, inching valve spring and inching valve.



1. Inching rod
2. Spring pin
3. Inching stopper 2
4. Inching valve spring
5. Inching valve

10.2 Pilot Boss

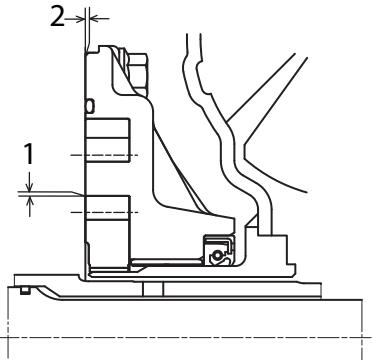
Ref.	Item	Specified value	
		1	Pilot boss diameter (where flywheel inserted)
		Limit	14.95 mm (0.5886 in.)



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10.3 Oil Pump

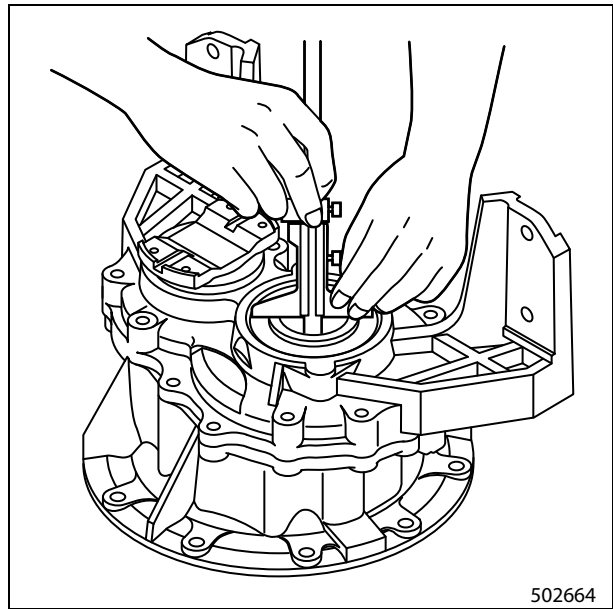
Ref.	Item	Specified value	
		1	Side clearance
		Limit	0.35 mm (0.0138 in.)
2	Top clearance	Standard	0.040 to 0.083 mm (0.0016 to 0.0033 in.)
		Limit	0.15 mm (0.0059 in.)
-	Backlash	Standard	0.1 to 0.2 mm (0.004 to 0.008 in.)



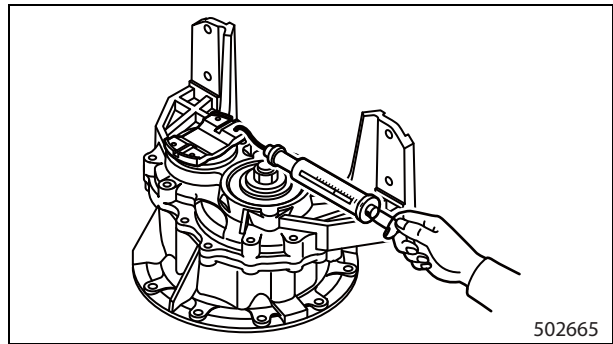
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Adjusting preload of reduction pinion

- After the tapered roller bearing is installed, measure gap between the differential cover and tapered roller bearing to determine the required total shim thickness. The standard value of total shim thickness is 1.25 mm (0.0492 in.).
- Select the proper shim according to the measurement, and tighten the nut. Five different thicknesses of shims are available: 0.05 mm (0.0020 in.), 0.1 mm (0.004 in.), 0.2 mm (0.008 in.), 0.5 mm (0.020 in.) and 1.0 mm (0.039 in.).



- Hook a spring scale onto the bolt hole of the input flange, and pull it in the tangential direction. Read the force to start moving to measure the preload of tapered roller bearing. Increase or decrease shims until specified tangential force is obtained.



Item	Standard
Tangential force (spring scale reading)	34.3 to 49.0 N (3.50 to 5.00 kgf) [7.711 to 11.016 lbf]

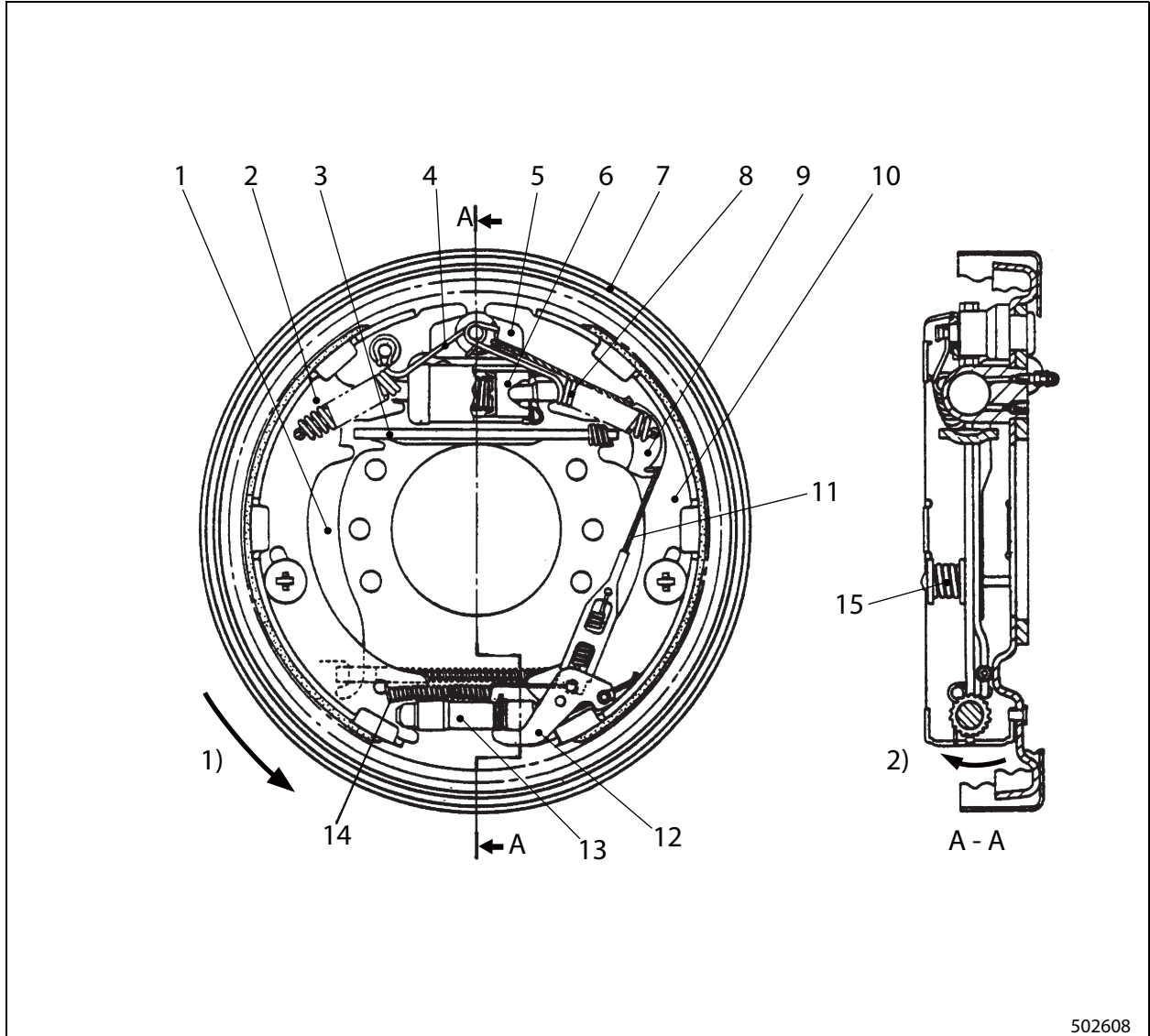
Tightening bearing caps

After reduction gear tooth contact inspection, tighten bearing cap bolts to the specified torque, and bend the lockplate to clinch the bearing cap.

Item	Standard	
Bearing cap tightening torque	1 ton class	157 ± 5.9 N·m (0.60 kgf·m) [4.352 lbf·ft]
	2, 3 ton classes	235 ± 6.8 N·m (0.69 kgf·m) [5.015 lbf·ft]

5. Structure of Wheel Brakes

5.1 1 Ton Class

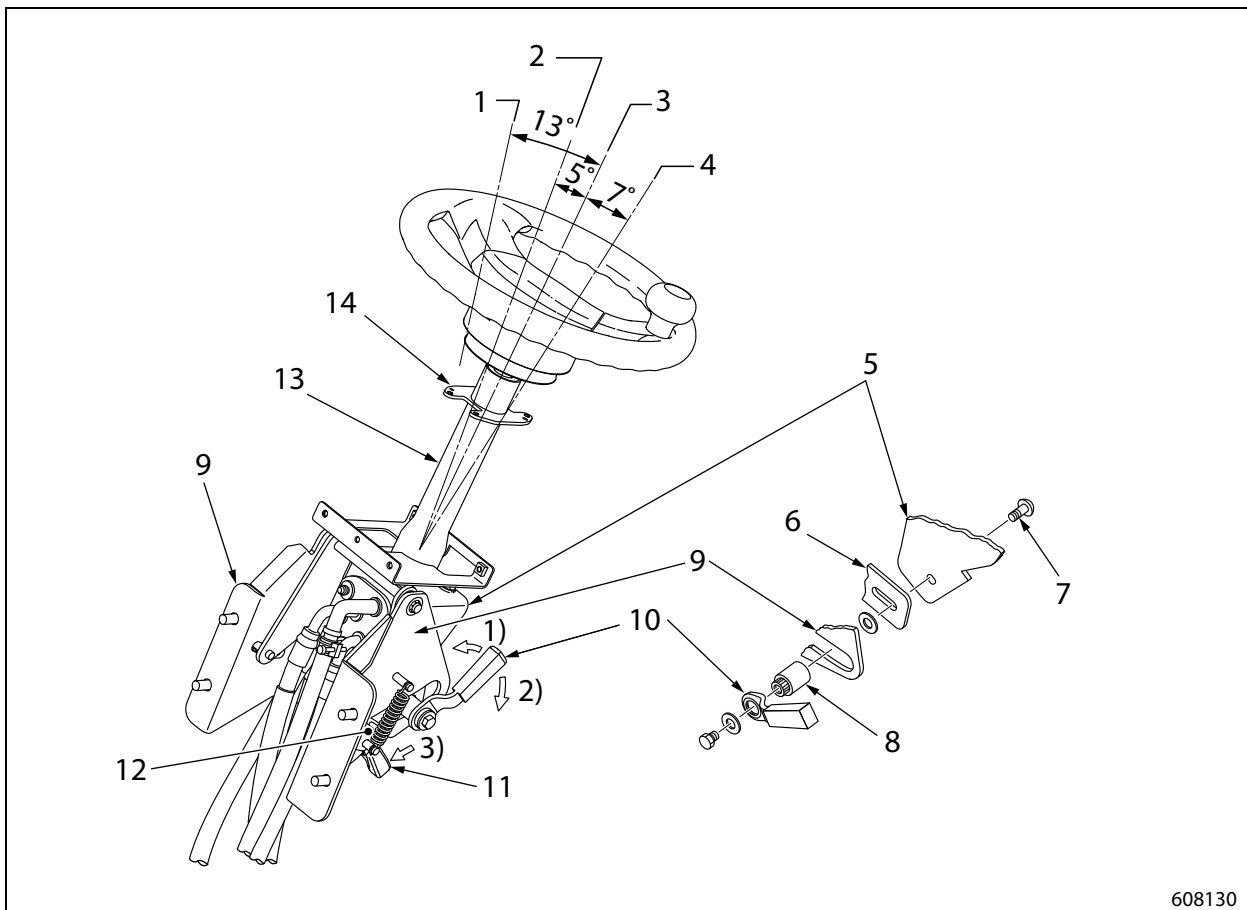


- | | |
|------------------------------|--|
| 1. Parking brake lever | 10. Shoe and lining (secondary) |
| 2. Shoe and lining (primary) | 11. Cable with spring |
| 3. Strut | 12. Adjusting lever |
| 4. Return spring | 13. Adjusting screw |
| 5. Shoe guide plate | 14. Return spring
(between primary shoe and secondary shoe) |
| 6. Wheel cylinder | 15. Hold-down spring |
| 7. Backing plate | 1) Drum rotation direction during forward movement |
| 8. Return spring | 2) Adjusting screw rotation direction to expand shoes |
| 9. Sheave | |

Note: Shown in the figure is for the left.

1.4 Steering Column

Main components



- | | |
|---|---------------------------------------|
| 1. Column position when lock is released | 10. Tilt lock lever |
| 2. Column position when tilted fully forward | 11. Column lock lever |
| 3. Column position when NEUTRAL (non-tilt)
(tilted 30 degrees from the vertical) | 12. Lock pin |
| 4. Column position when tilted fully rearward | 13. Steering column |
| 5. Steering column mounting plate | 14. Combination switch mounting plate |
| 6. Tilt angle setting plate | 1) Fix |
| 7. Bolt | 2) Loosen |
| 8. Nut | 3) Lock release |
| 9. Bracket (secured to truck body) | |

Note: When the tilt lock lever is turned counter-clockwise, plate 5 and 6 are sandwiched between bolt and nut, and united.

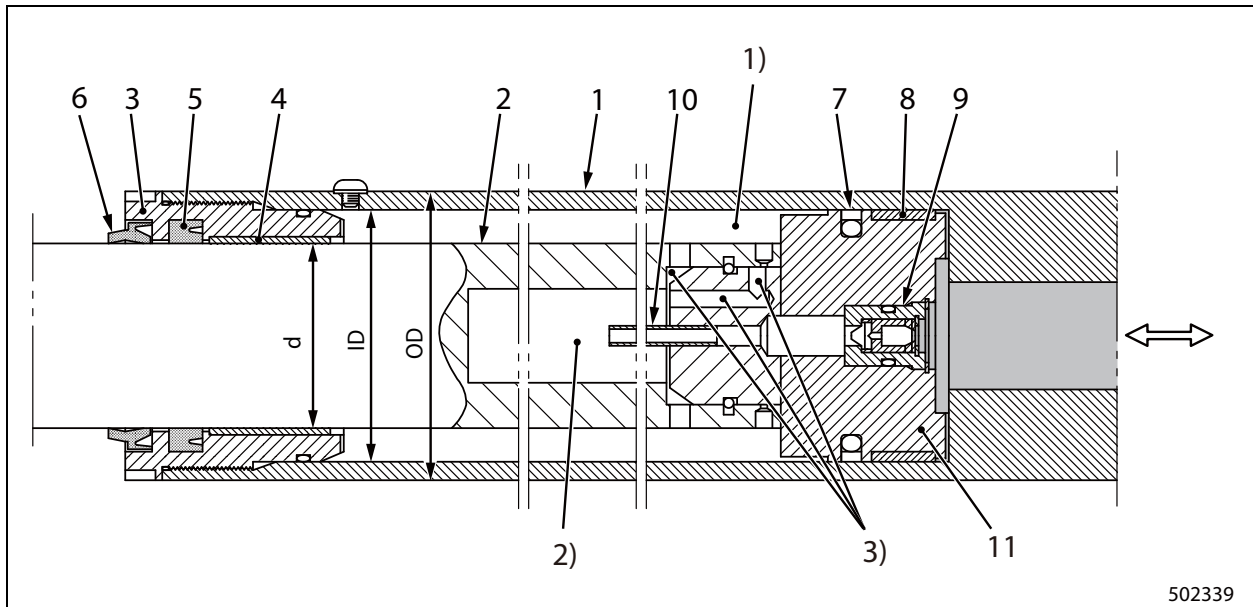
Tilt angle of steering column 13 is adjustable in the range of 5 degrees forward and 7 degrees backward as shown in the illustration.

To adjust tilt angle, lock column lock lever 11 first, and loosen tilt lock lever 10 by turning it clockwise. Then, tilt the steering column to the optimal angle and turn the tilt lock lever counterclockwise (pull upward) to lock.

The column lock lever is used to tilt the steering column forward for the operator's easy access to the seat or for service work. When the tilt lock lever is pushed to left, the column lock lever 11 is disengaged from lock pin 12, then the steering column will tilt forward.

1.7 Lift Cylinder (First Cylinder for Duplex and Triplex Masts)

Main components



- | | |
|---------------------------|---|
| 1. Cylinder tube assembly | 8. Slide ring |
| 2. Piston rod assembly | 9. Check valve |
| 3. Cylinder head | 10. Stand tube |
| 4. Bushing | 11. Piston |
| 5. U-ring | 1) Space (cushion oil enters this area) |
| 6. Wiper ring | 2) Air chamber |
| 7. Seal ring assembly | 3) Oil passage |

Operation

This cylinder, which is mounted on the center of the mast, moves during the first stage of forks ascending.

The piston rod 2 is extended from the cylinder tube 1 by pressure oil which acts on the piston bottom. Cushion oil is always present in the space 1) between the cylinder tube and the piston rod in order to prevent a sudden approach between the piston and the cylinder head 3 during the last stage of its ascending. Since the piston rod ascends while pushing the cushion oil into the air chamber 2), the approach speed of the piston rod slows down during the last stage of its ascent.

During the descending stroke of the piston rod, cushion oil in the air chamber 2) is sucked into the space 1). The air chamber, stand tube, and check valve are components used for cushioning.

Surplus oil such as oil leaks around the piston and oil in the space 1), will return to the cylinder bottom through the check valve 9 from the stand tube 10 during the last stage of the piston rod ascent.

The stand tube always retains a certain amount of oil as cushion oil. Note that cylinders must be filled with a certain amount of cushion oil after overhauls.

Cylinder dimensions (cylinder length and stroke vary depending on lift height)

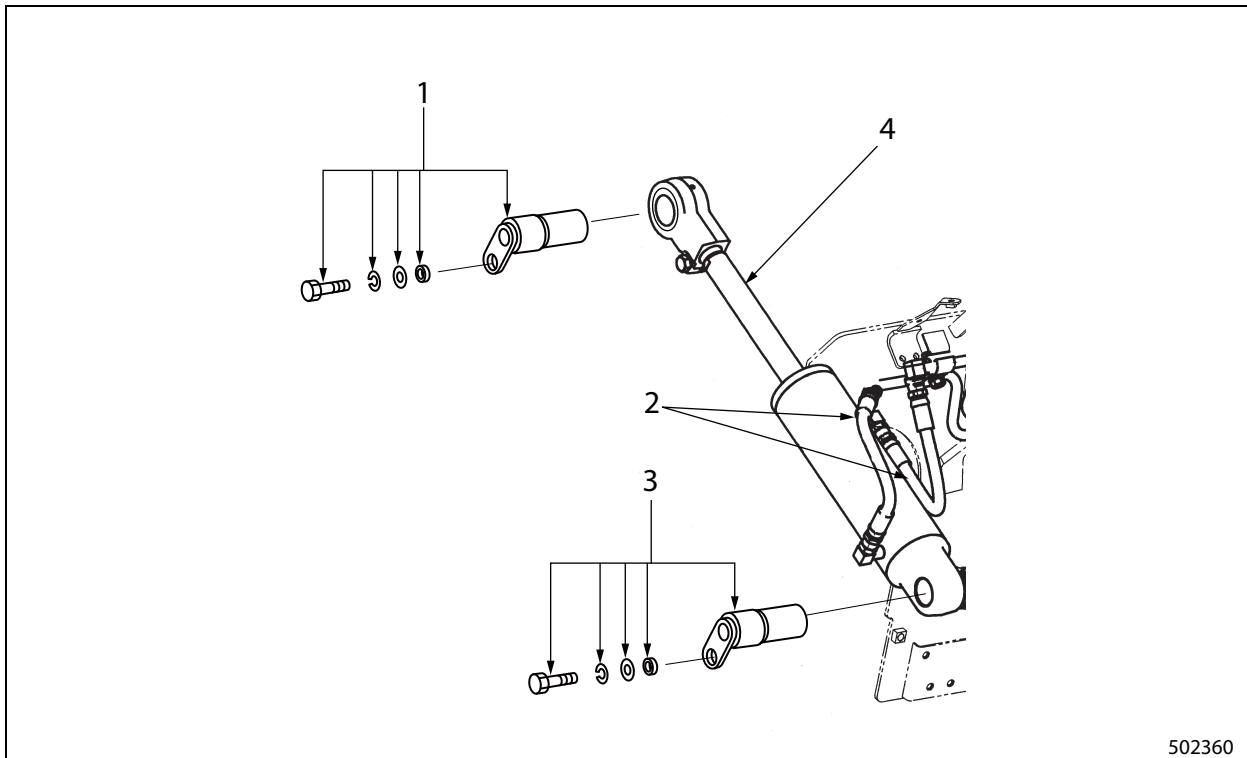
Truck class	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1, 2 ton classes	55.0 mm (2.165 in.)	70.0 mm (2.756 in.)	82.0 mm (3.228 in.)
2.5 ton class	55.0 mm (2.165 in.)	75.0 mm (2.953 in.)	86.0 mm (3.386 in.)
3 ton class	65.0 mm (2.559 in.)	85.0 mm (3.347 in.)	97.0 mm (3.819 in.)
3.5 ton class (duplex mast)	65.0 mm (2.559 in.)	90.0 mm (3.543 in.)	102.0 mm (4.016 in.)
3.5 ton class (triplex mast)	65.0 mm (2.559 in.)	90.0 mm (3.543 in.)	105.0 mm (4.134 in.)

20. Removing tilt cylinders

20.1 Preparation

- (1) Lower the forks to the ground, and tilt the mast fully forward.
- (2) Attach a lifting sling to the cross member of the outer mast, and support the mast with a hoist.

20.2 Removal Sequence



502360

- | | |
|----------------------------------|----------------------|
| 1. Tilt cylinder pin | 3. Tilt cylinder pin |
| 2. Hoses (2 places per cylinder) | 4. Tilt cylinder |

20.3 Suggestions for Removal

Retracting piston rod

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

Removing hoses

Disconnect hoses 2 from the connectors on cylinder side. Prepare an empty can to catch oil that will flow out. Attach caps to the cylinder nipples to protect the threads from damage and to prevent oil from flowing out through them during cylinder removal.

Removing tilt cylinders

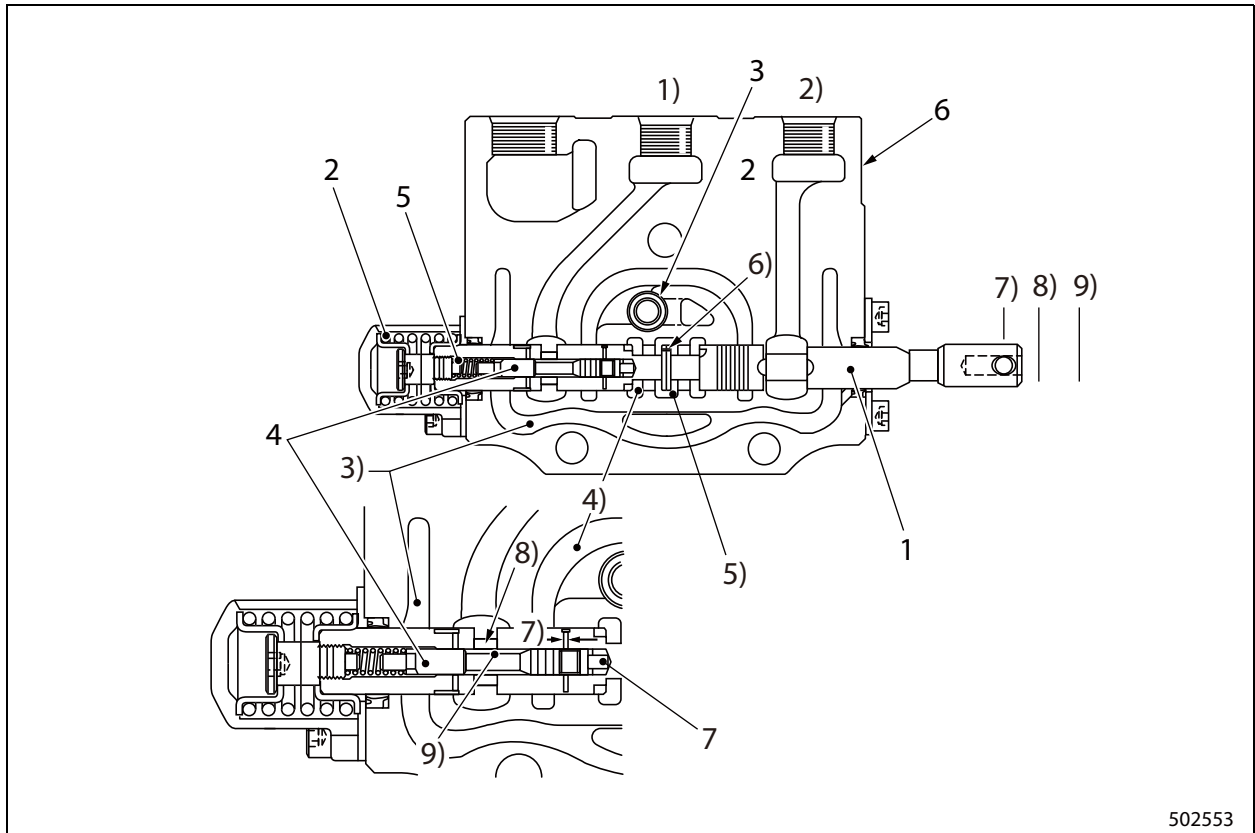
Remove tilt cylinder pin 3, and remove the cylinder.

21. Tilt Cylinders, Installing

For installation, follow the removal sequence in reverse.

21.1 Suggestions for Installation

After installing tilt cylinders, check balance of the mast tilt angle. Adjust as required. For adjustment, refer to CHAPTER "MAST AND FORKS".



- 1. Tilt spool
- 2. Return spring
- 3. Check valve
- 4. Tilt lock valve
- 5. Tilt lock valve spring
- 6. Valve body
- 7. Chamber

- 1) A2: To tilt cylinder rod
- 2) B2: To tilt cylinder head
- 3) T2: Tank port return passage
- 4) Passage A
- 5) Center bypass port
- 6) Hole
- 7) Forward tilt
- 8) Neutral
- 9) Backward tilt

Mast forward tilt position

The figure above shows the tilt control valve when spool 1 is at the "forward tilt position".

Spool 1 is pushed into body 6. Then, port B2 is connected to passage A.

At the same time the center bypass port is blocked. This blockage, however, is not complete because there is a hole under the land. This is designed to prevent abrupt movement of the cylinder, a characteristic of this valve.

As the center bypass port is blocked, pressure in the parallel feeder rises, by which check valve 3 is open and pressure oil flows to passage A.

Oil in passage A flows to the tilt cylinder head through port B2 and acts to push the cylinder rod out.

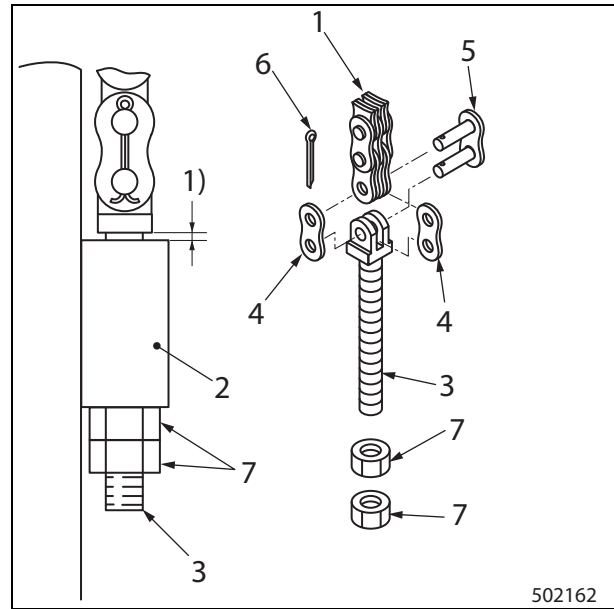
At the same time, pressure oil in passage A flows to the chamber on the right end of tilt lock valve 4 via orifice (a) and pushes the tilt lock valve to the left against spring 5. Then, return oil from the A2 port flows to the hole (b), passage (c), orifice (d) and passage T2.

The tilt cylinder tilts forward due to pressure oil supplied from port B2 port and "opening" of the return passage of port A2.

Tilt lock valve 4 will not be activated unless pressure oil is supplied from the pump when the engine is running. This valve is a kind of a safety valve.

1.14 Connecting Chains

Assemble chains on the lift bracket as shown in the figure.
 After assembly is completed, maintain clearance 1) between chains with locknuts in order to allow for chain tension.



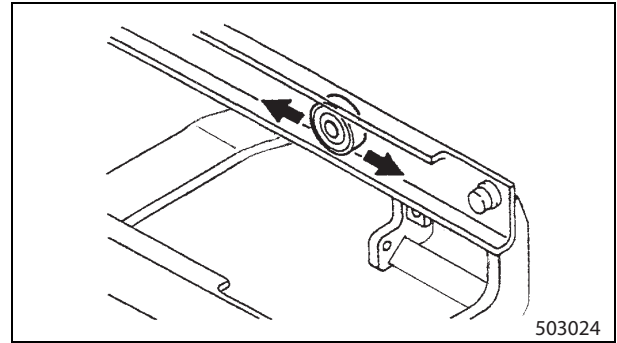
- 1. Chain
- 2. Lift bracket
- 3. Anchor bolt
- 4. Center plate
- 5. Link
- 6. Split pin
- 7. Nut
- 1) Clearance

Item		Specified value	
		1,2 ton classes	3 ton class
Locknut (double nut side)	Tightening torque	$98 \begin{smallmatrix} +49 \\ 0 \end{smallmatrix} \text{ N}\cdot\text{m}$ $(9.99 \begin{smallmatrix} +5.0 \\ 0 \end{smallmatrix} \text{ kgf}\cdot\text{m})$ $[72.28 \begin{smallmatrix} +36.14 \\ 0 \end{smallmatrix} \text{ lbf}\cdot\text{ft}]$	$147 \begin{smallmatrix} +49 \\ 0 \end{smallmatrix} \text{ N}\cdot\text{m}$ $(14.99 \begin{smallmatrix} +5.0 \\ 0 \end{smallmatrix} \text{ kgf}\cdot\text{m})$ $[108.42 \begin{smallmatrix} +36.14 \\ 0 \end{smallmatrix} \text{ lbf}\cdot\text{ft}]$

2.9 Mast and Lift Bracket, Inspection (All Mast Models)

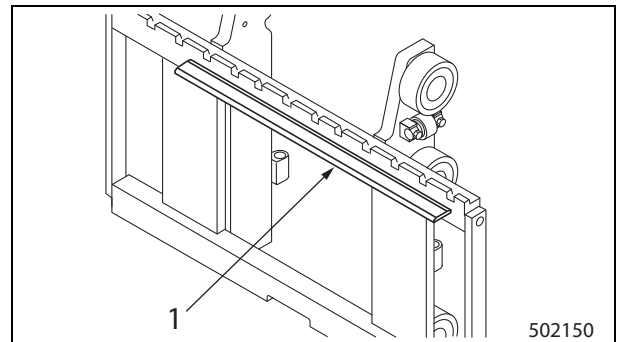
Mast

- (1) Check each roller for binding, wear, and cracks.
- (2) Check each roller on rolling surface for pitting or other defects.
- (3) Check the mast member and the welded joints of cross-members, shafts and supports for cracks.
- (4) Check the mast support bushings for wear or other defects.



Lift bracket

- (1) Check the main rollers and side rollers for binding, wear, and cracks.
- (2) Check the welded areas of lift bracket for cracks.
- (3) Check the finger bar for bend or distortion.



1. Straight edge

Item	Standard
Distortion of finger bar	5 mm (0.20 in.) or less

Lift chains, chain wheels and chain wheel supports

- (1) 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 and link binding and twisting.
- (2) Check each chain anchor bolt for cracks or thread damage.
- (3) Check the chain wheel support and the chain wheel for cracks, wear, and binding.

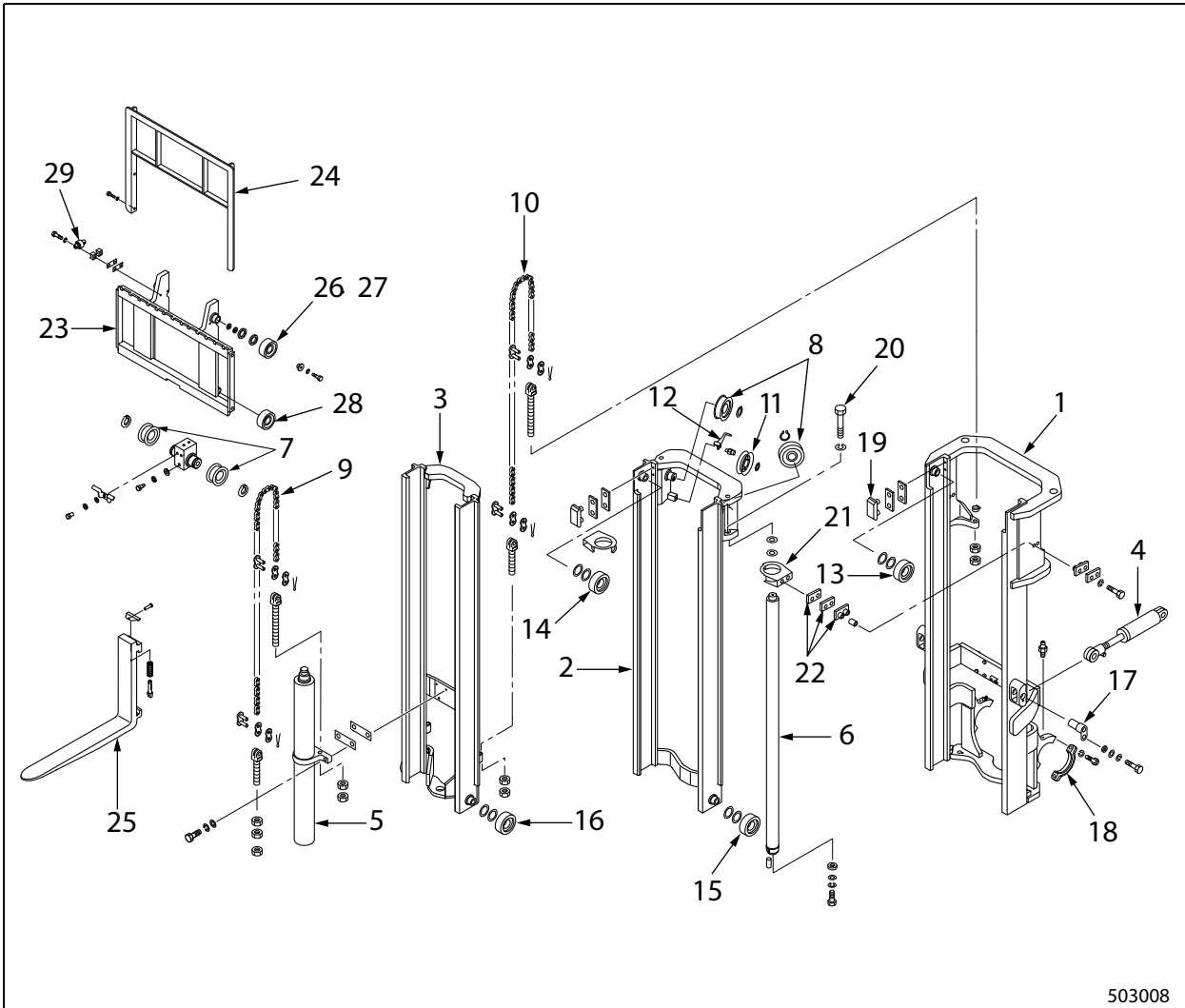
Item		Specified value		
		1 ton class	2 ton class	3 ton class
Chain length (20 links)	Standard	317.5 mm (12.500 in.)	381 mm (15.00 in.)	508 mm (20.00 in.)
	Limit	327 mm (12.87 in.)	392 mm (15.43 in.)	523 mm (20.59 in.)

Mast strip

Check for damage, scoring, or distortion.

3.2 Structure and Functions (5M15D to 5M35D)

Major components (most parts come in pairs, left and right)



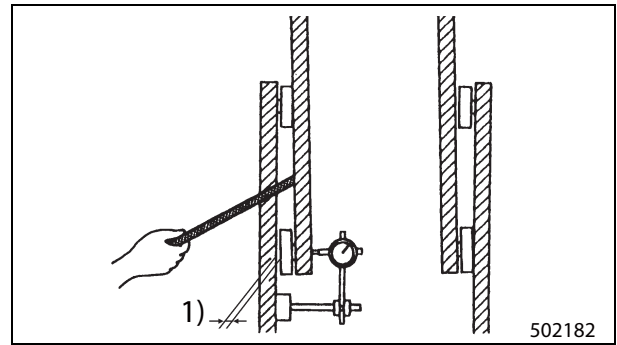
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- | | |
|---------------------------------|--|
| 1. Outer mast | 16. Inner mast main roller |
| 2. Middle mast | 17. Tilt socket mounting pin |
| 3. Inner mast | 18. Mast support cap |
| 4. Tilt cylinder | 19. Mast strip |
| 5. First lift cylinder (single) | 20. Lift cylinder upper mounting bolts |
| 6. Second lift cylinder | 21. Cylinder bracket |
| 7. First lift chain wheel | 22. Cylinder clamps |
| 8. Second lift chain wheel | 23. Lift bracket |
| 9. First lift chain | 24. Backrest |
| 10. Second lift chain | 25. Forks |
| 11. Hose pulley | 26. Lift bracket upper roller |
| 12. Hose guard | 27. Lift bracket middle roller |
| 13. Outer mast main roller | 28. Lift bracket lower roller |
| 14. Middle mast upper roller | 29. Side roller |
| 15. Middle mast lower roller | |

Note: For hydraulic piping, refer to CHAPTER "HYDRAULIC SYSTEM".

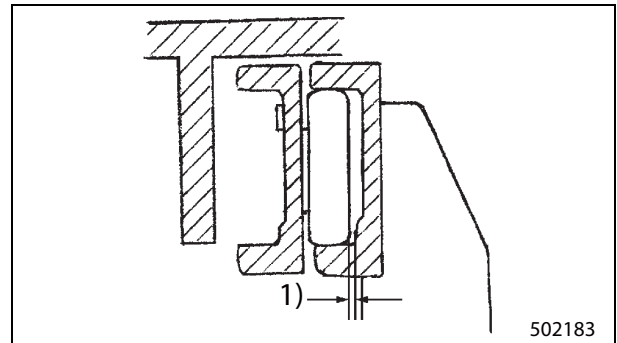
Measuring right-to-left clearance on inner mast main rollers

- (1) Raise the mast to the maximum lift position.
- (2) Set a dial indicator on the inside of the outer mast with its contact point rested on the inner mast.
- (3) Using a claw bar, push the inner mast roller against the outer mast's rolling surface. Then go over to the opposite side of the mast and set the dial indicator to zero.
- (4) Insert a claw bar between the outer mast and the inner mast on the dial indicator side, and push the inner mast to the opposite side.



1) Clearance between main roller side face and mast

- (5) Measure the clearance between outer mast and inner mast main roller.
- (6) If clearance deviates from the specified value, adjust shim thickness. For adjustment, refer to 14-76 "Installing Mast Rollers (All Mast Models)".

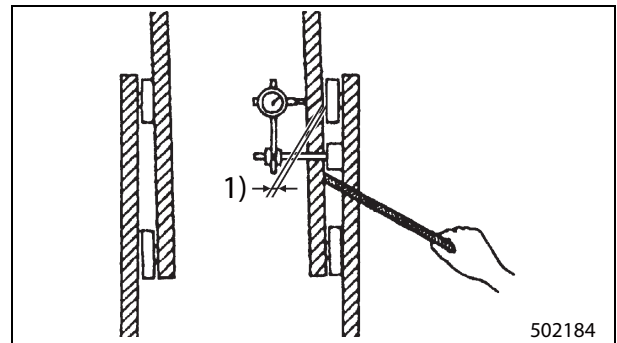


1) Clearance between main roller side face and mast

Ref.	Item	Standard
1)	Clearance between main roller side face and mast	0.1 to 0.5 mm (0.004 to 0.020 in.)

Measuring right-to-left clearance on outer mast main rollers

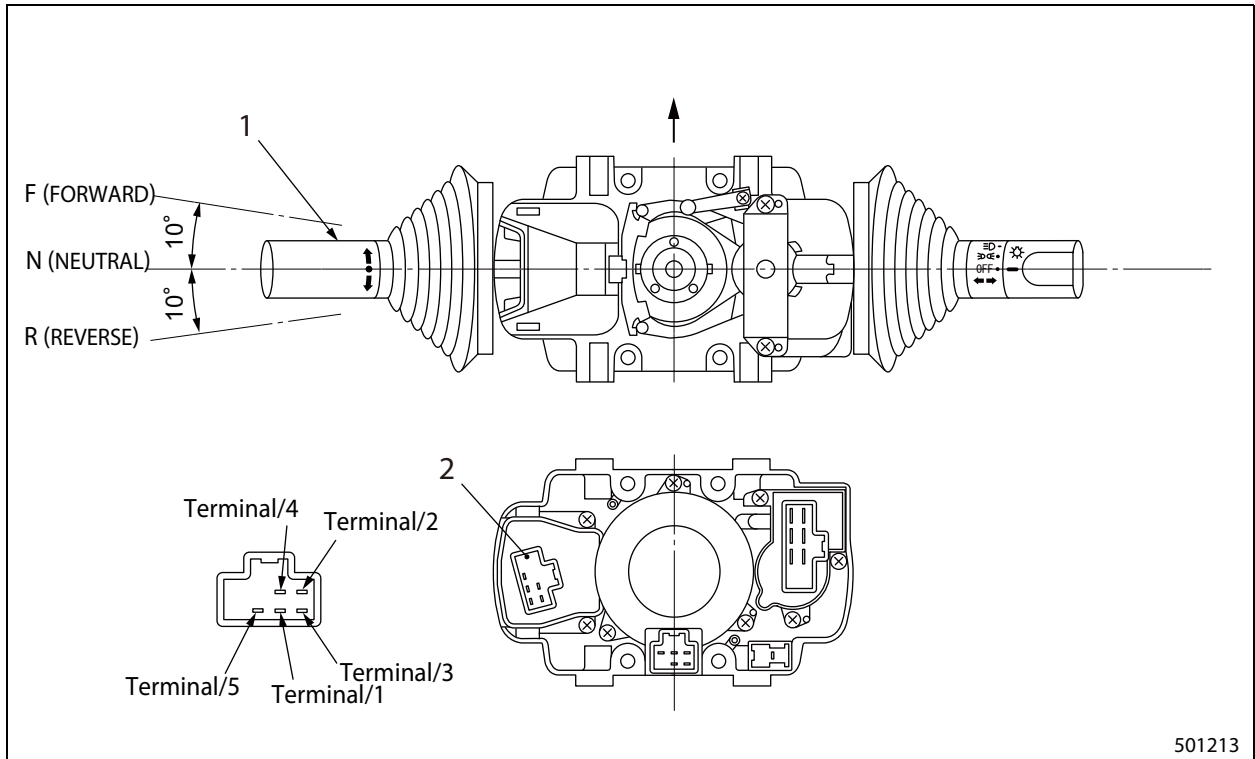
- (1) Raise the mast to the maximum lift position.
- (2) Set a dial indicator on the outer mast with its contact point rested on the inner mast.
- (3) Using a claw bar, push the outer main roller against the inner mast's rolling surface. Then go over to the opposite side of the mast and set the dial indicator to zero.
- (4) Insert a claw bar between the outer mast and the inner mast on the dial indicator side, and push the inner mast to the opposite side.



1) Clearance between main roller side face and mast

Item		Specified value				
		2Z ton class	3ton class		3.5ton class	
		Gasoline		Diesel	Gasoline	Diesel
Lift chain elongation limit (20 links)		392 mm (15.43 in.)	523 mm (20.59 in.)			
Fuel tank capacity		66 L (17.44 US gal.)				
Coolant quantity (reserve tank 0.65 liter [0.17 cu.in.] included)		6.8 L (1.797 US gal.)	8.7 L (2.299 US gal.)	6.8 L (1.797 US gal.)	8.7 L (2.299 US gal.)	
Engine oil	Engine	3.5 L (0.925 US gal.)	9.0 L (2.378 US gal.)	3.5 L (0.925 US gal.)	9.0 L (2.378 US gal.)	
	Oil filter	0.3 L (0.079 US gal.)	1.0 L (0.264 US gal.)	0.3 L (0.079 US gal.)	1.0 L (0.264 US gal.)	
	Total	3.8 L (1.004 US gal.)	10.0 L (2.642 US gal.)	3.8 L (1.004 US gal.)	10.0 L (2.642 US gal.)	
Transmission oil	Manual Truck	5 L (1.32 US gal.)				
	Powershift Truck	10 L (2.64 US gal.)				
Transfer and differential gear oil level		9.3 L (2.457 US gal.)	8.7 L (2.299 US gal.)			
Hydraulic oil		39 L (10.30 US gal.)				
Brake oil capacity		135 cc (8.24 cu. in.)				
Battery electrolyte specific gravity, corrected to 20°C (68°F)		1.26 to 1.28				

3.2 Direction (FNR) Switch



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1. Direction (FNR) lever

2. Direction (FNR) switch

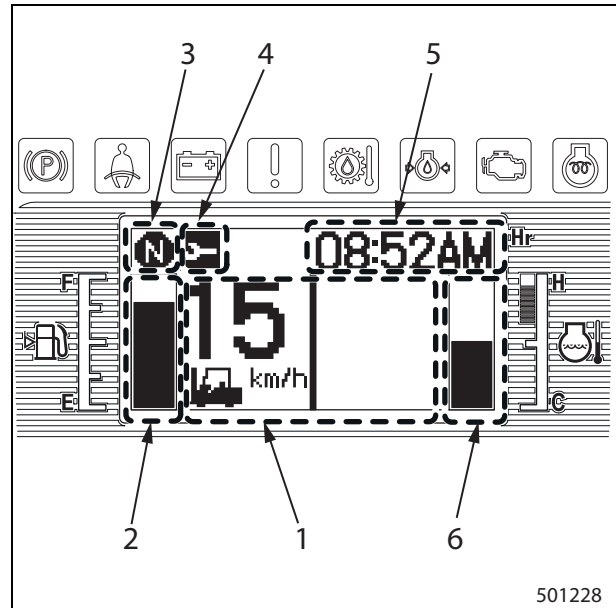
Note: Arrow indicates the front of truck.

Connection table

Lever position	Terminal	1	2	3	4	5
	Destination	Truck controller	Grounding	Truck controller	Grounding	Truck controller (backup alarm/buzzer)
F (FORWARD)			○-----	-----○		
N (NEUTRAL)		○-----	-----	-----	-----○	
R (REVERSE)			○-----	-----	-----	-----○

The LCD screen layout consists of six areas: main display, fuel gauge display, travel direction display, symbol display, clock/hour meter display, and coolant temperature display. Main display is divided into right and left areas.

Note: The meter panel has functions below to protect circuits in the panel.



- 1. Main display
- 2. Fuel gauge display
- 3. Travel direction display
- 4. Symbol display (option)
- 5. Clock/hour meter display
- 6. Coolant temperature gauge

Meter panel inside (environment) temperature	-
85 °C (185 °F) or higher	LCD display on the screen automatically hides.
105 °C (221 °F) or higher	Back-up light goes off automatically.

Note: The LCD back-up light illuminates the fuel mark (left

- The LCD back-up light illuminates the fuel mark (left side) and coolant temperature mark (right side) on the LCD screen.
- For safety measures, warnings will not go off.
- When the temperature is extremely low (0 °C (32 °F) or below), the response of the LCD display becomes slower.

5.2 Basic Display

Screen display with the key switch in the ON position

When the key switch is turned to the ON position, the LCD screen displays in the order of the brand logo screen, the password authentication screen, and the normal display screen. Also, truck history is displayed by the operation of button.

Brand logo screen

When the key switch is turned to the ON position, the brand logo screen is displayed for 2 seconds while light check is being executed.

7. Troubleshooting

7.1 Engine Startup Problem

Condition		Possible cause	Action
Key switch	Starter won't crank the engine when the key switch is turned ON	Battery is discharged	Charge or replace battery
		Disconnection or poor connection	Repair or replace
		Key switch continuity failure	Replace
		Defect in starter or starter relay	Replace
		Transmission shift lever not in the NEUTRAL position	Place the transmission shift lever to the NEUTRAL position
	Engine won't stop when the key switch is turned OFF	Disconnection or poor connection	Repair or replace
		Stop solenoid defective	Replace or adjust
Control linkage defective		Replace	

7.2 Gauge-related Problem

Condition		Possible cause	Action
Coolant temperature gauge	Gauge reading is low	Disconnection between meter panel and water temperature gauge	Make sure the connector is firmly inserted
			Check continuity
			Check the display by heating the water temperature sensor
			Replace water temperature sensor
			Replace meter panel
	Gauge reading is inaccurate	Check the part number	Make sure the specified part is used
			Make sure the connector is firmly inserted
Gauge reading blinks	Short circuit between M/P and water temperature gauge	Replace water temperature sensor	
		Correct the short circuit	
Fuel gauge	Gauge reading is not displayed	Setting is improper	On LPG model, the display is not available
			Incorrect VCM setting
	Gauge reading is inaccurate	Check the part number	Make sure the specified part is used
			Make sure the connector is firmly inserted
			Replace water temperature sensor
	Gauge reading blinks	Short circuit between meter panel and water temperature gauge	Remove fuel tank cap assembly and check for bent float, etc.
			Correct the short circuit
			Remove fuel tank cap assembly and check the wirings in the tank

4.2 Fuel and Lubricant Specifications

Fuel or Oil		Recommendation	Recommendation for Ambient Temperatures °C (°F)						
			-30 (-22)	-20 (-4)	-10 (14)	0 (32)	10 (50)	20 (68)	30 (86)
Fuel			Consult your authorized truck dealer.						
Engine oil	Gasoline / LPG models	API service classification SJ and above	SAE10W-30						
	Diesel models	API service classification CF and above	SAE10W-30						
Transfer and differential oil		API service classification multi-purpose type GL-4 or GL-5	SAE80W			SAE90			
Powershift Transmission Oil		Dexron II	Consult your authorized truck dealer.						
Hydraulic Oil	Powershift dry clutch	ISO VG32							
	Wet clutch	API service classification CF and above	SAE10W						
Brake oil		FMVSS No.116-DOT3 or DOT4 or SAE J1703							
Clutch oil		FMVSS No.116-DOT3 or DOT4 or SAE J1703							
Grease	Wheel bearings	NLGI No.2 grade multipurpose type (lithium base), consistency: 265-295							
	Chassis	NLGI No.1 grade multipurpose type (lithium base), consistency: 310-340							

Item			Value						
Antifreeze solution	Long Life Coolant (Non amine type)	Temperature °C (°F)	-45 (-81)	-39 (-70)	-30 (-54)	-25 (-45)	-20 (-36)	-15 (-27)	-10 (-18)
		Concentration (%)	60	55	50	45	40	35	30

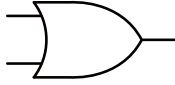
⚠ CAUTION


- The properties of oil vary depending on the oil maker. Do not mix different brands of oil.
- Anti freeze coolant must meet the specification of long life coolant for truck.
- Anti freeze coolant must be between 30 to 60 volume percent according to antifreeze specification and atmospheric temperature.


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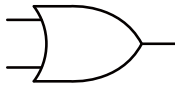
Chapter 5 POWER TRAIN


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Diagnosis	Abnormal APS2 input signal (S-11)	
Logic conditions	APS2 input signal ≤ 0.1 V APS2 input signal ≥ 4.95 V (300 ms continuity)	 S-11
Recovery	Power reset	
Control action	Throttle full close	
LED blink pattern	D	

Diagnosis	APS1/APS2 correlation error signal (S-13)	
Logic conditions	Difference between APS1 and APS2 input signals are greater than 0.085 V.	 S-13
Recovery	Power reset	
Control action	Throttle full close	
LED blink pattern	D	

Diagnosis	Abnormal idling SW input signal (S-14)	
Logic conditions	Acceleration input is equal to or more than 50% and Idling SW is ON.	 S-14
Recovery	Power reset	
Control action	Throttle full close	
LED blink pattern	D	

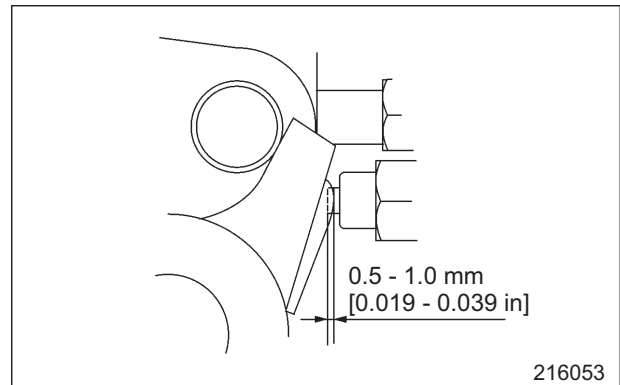
Diagnosis	Abnormal service brake solenoid (S-40)	
Logic conditions	Current value ≤ 160 mA (1800 ms continuity) Current value ≥ 1.6 A (200 ms continuity)	 S-40
Recovery	Power reset	
Control action	Set the parking brake solenoid outputs to OFF.	
LED blink pattern	E	

Diagnosis	Abnormal service brake solenoid leakage (S-41)	
Logic conditions	Current value at output OFF ≥ 180 mA (600 ms continuity)	 S-41
Recovery	Power reset	
Control action	Set all the solenoid outputs to OFF.	
LED blink pattern	E	

(3) Adjusting the stop lamp switch

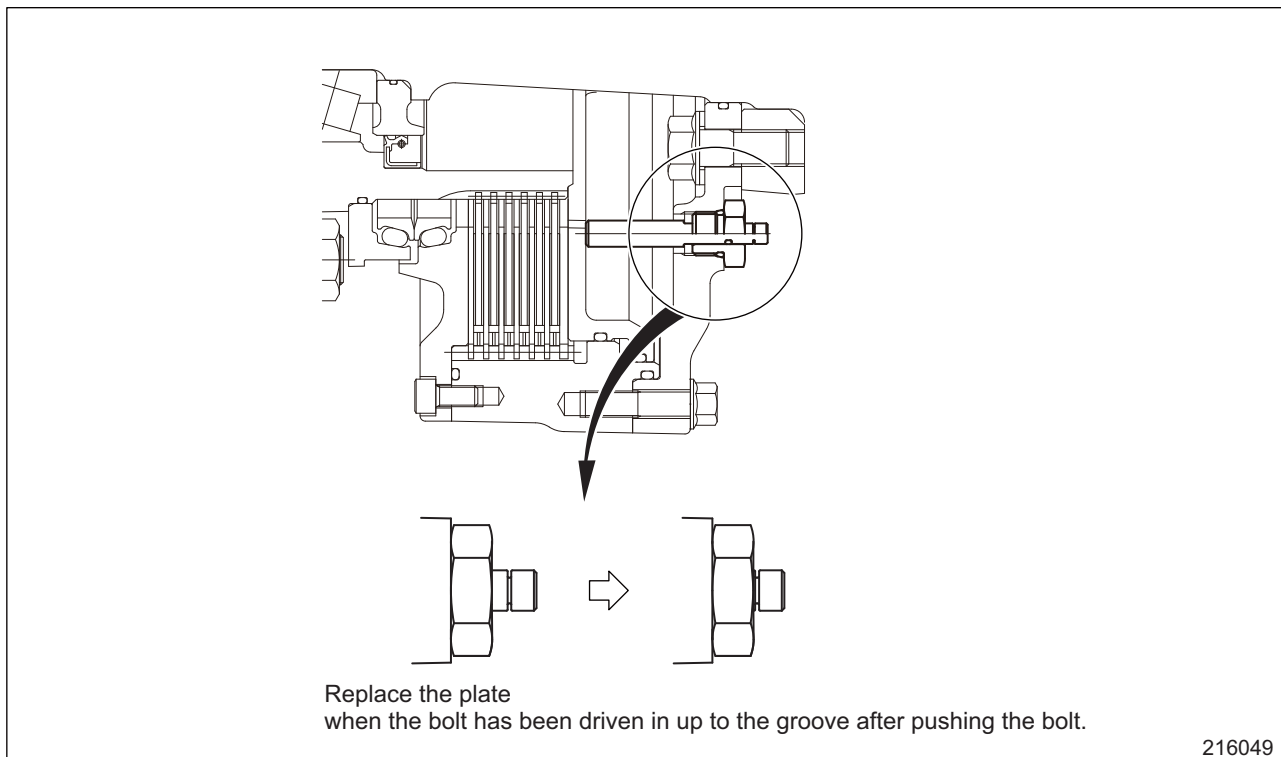
Adjust the stop lamp switch position so that the stop lamp glows when the brake pedal is pressed and then secure the switch into the correct position.

Stop lamp clearance after installation	0.5 - 1.0 mm (0.019 - 0.039 in)
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6. Wear Gauge for Wet Disc Brakes

Standard for replacing the plate of a wet disc brake



7. Forcible Release of Parking Brake

For the method of forcibly releasing the parking brake, refer to the chapter "Brake System."

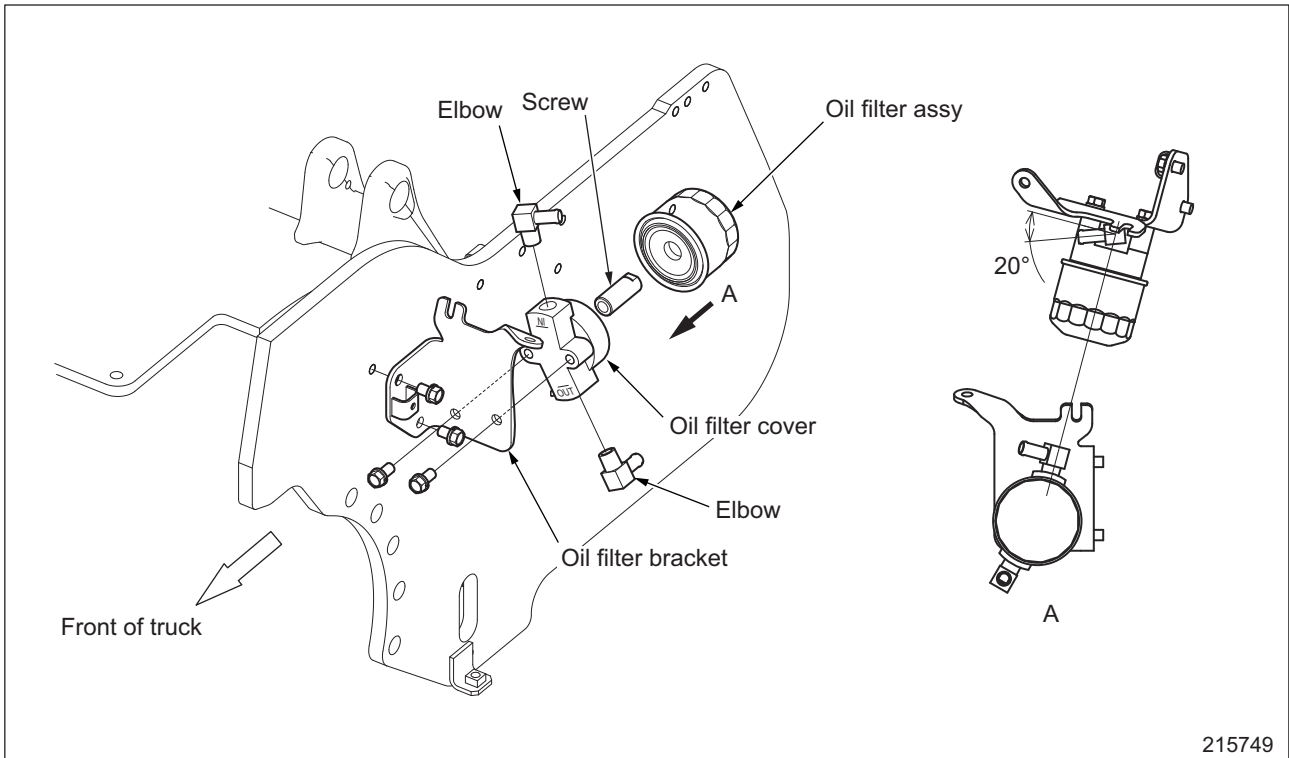
8. Reduction Differential

Refer to the service manual for standard models.

9. Troubleshooting

Refer to the service manual for standard models.

2.6 Oil Filter

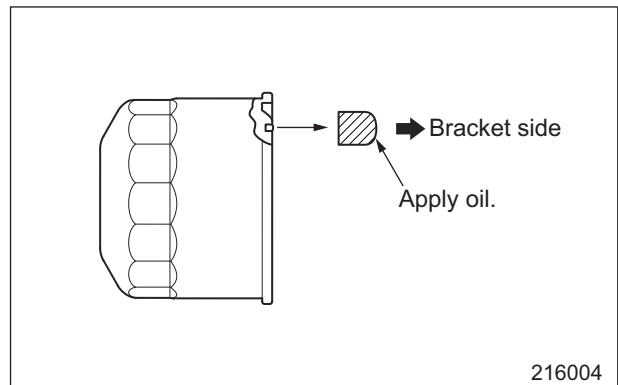


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Procedure for reinstallation

After thoroughly cleaning the mounting surface at the filter bracket side, apply a thin coat of brake oil to the O-ring of the filter, then fully hand-tighten the filter.

Note: Do not tighten the filter using a wrench, etc.



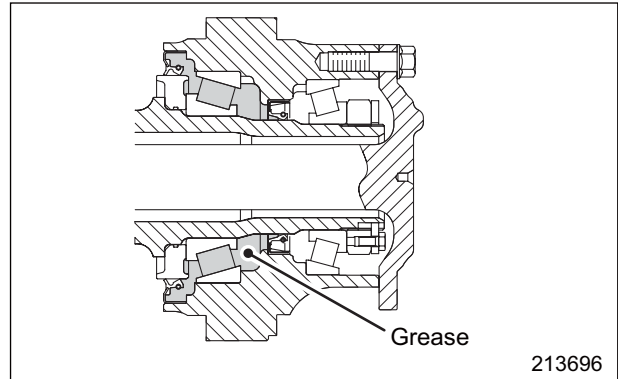
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3.1.2 Reassembly

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

(1) Front wheel hub

- (a) Fill grease (AUTOLEX A or equivalent) in the front wheel hub as shown. (See the illustration right.) Stuff grease in the roller holder of the tapered roller bearing (inner). Use palm to squeeze the grease into the holder. Apply grease to the lip groove of oil seal.



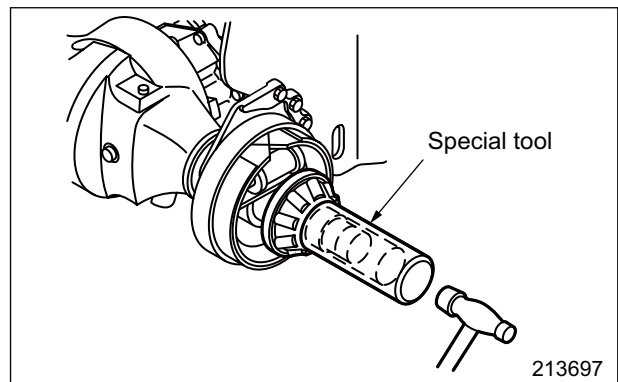
⚠ CAUTION

Use care not to get grease in the brake drum.

- (b) Using the installer (special tool), install the inner race and oil seal retainer of the tapered roller bearing.

Special tool (Installer)

Items	Truck type	
	1 ton class	2 ton class 3 ton class
Oil seal 8	91A68-00500	
Oil seal 9	91B68-00900	91E68-00700
Tapered roller bearing 6	91B68-01100	91E68-00900
Tapered roller bearing 10		91E68-00800



- (c) Apply sealant (ThreeBond #1194) to the flange surfaces of the axle shaft.

Adjusting procedure of wheel bearing reassembly

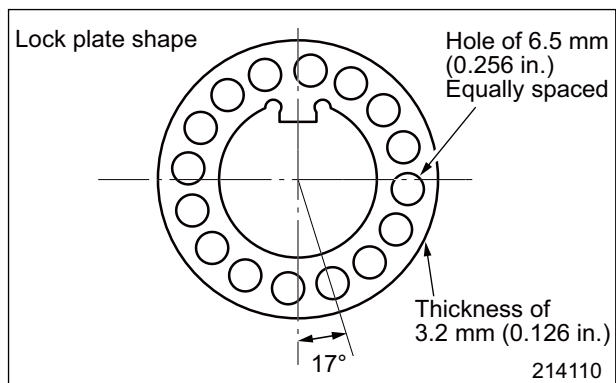
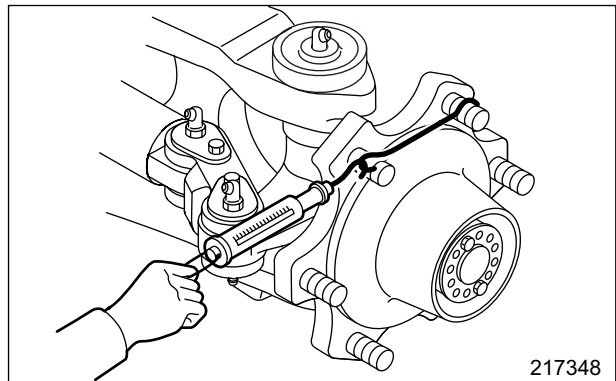
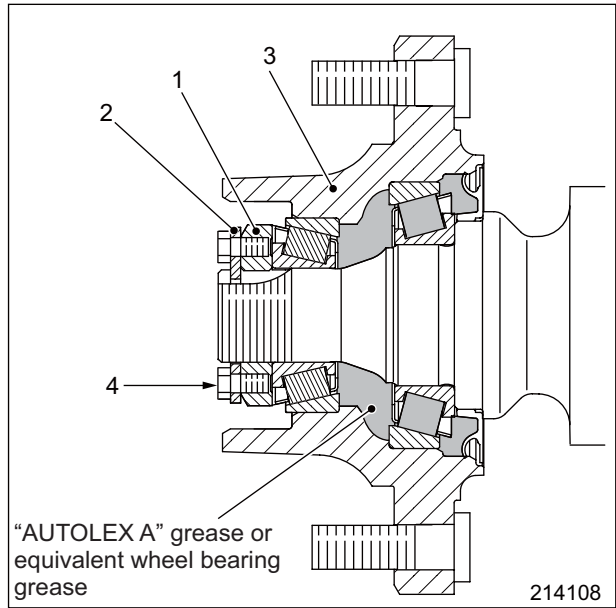
- (1) Apply oil or grease to the contact surface of the lock nut 1 with the wheel bearing.
- (2) Turn the wheel hub 3 by hand and tighten the lock nut 1 until the turn becomes difficult. Then, loosen the lock nut by approx. 60 degrees from that position.
- (3) Turn the rear wheel hub back and forth two to three times in the above condition to settle the cup and cone of the wheel bearing.
- (4) Measure and record the rotation starting torque or hub bolt tangential force when the preload is zero.
- (5) Turn the wheel hub 3 by hand again and tighten the lock nut 1 until the turn becomes heavy.
- (6) Insert the tab of the lock plate 2 aligning with the knuckle groove and gradually loosen the lock nut 1 until the hole position of the lock plate 2 aligns with the screw position of the lock nut 1. Then, secure the lock nut 1 and lock plate 2 with two bolts 4.

Note: Reversing the lock plate 2 changes the hole position. (See the illustration on the right.)

- (7) Turn the wheel hub 3 back and forth two to three times and make sure that the rotational driving force or starting tangential force is within the range shown below. If out of the range, readjust. In case of a long-used bearing, aim a low value of the allowance.

Unit: N (kgf) [lbf]

Items		Truck type	
		1 ton class	2-3 ton class
Tangential force of hub bolt (increment from when preload is zero)	2P	6.7 to 67 (0.68 to 6.8) [14.77 to 147.7]	5.6 to 56 (0.57 to 5.7) [12.35 to 123.5]
	4P	7.4 to 74 (0.75 to 7.5) [16.31 to 163.1]	6.3 to 63 (0.64 to 6.4) [13.89 to 138.9]
Starting torque of hub rotation (increment from when preload is zero)		0.5 to 5.0 N·m (0.051 to 0.510 kgf·m) [0.369 to 3.688 lbf·ft]	



3.5 Brake Lines Bleeding

Bleeding the brake lines is a two person operation. After any portion of the brake fluid lines has been disassembled for repair or service, or if the brake pedal feels spongy, bleed the lines as follows:

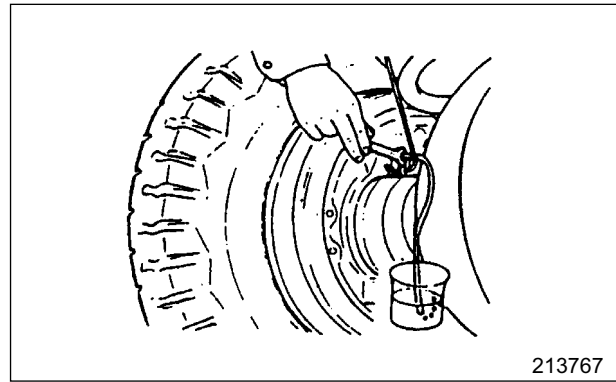
- (1) Install one end of a transparent vinyl tube onto the bleeder screw of the right-hand wheel cylinder, which is located farther from the master cylinder than the left hand wheel cylinder. Put the loose end of the tube into a container filled with brake fluid.
- (2) Check the brake fluid level in the reservoir tank. Fill up as necessary.
- (3) After cycling the pedal several times, depress the pedal and keep it depressed. With the pedal depressed, loosen the bleeder screw. While the brake fluid is flowing through the tube, tighten the bleeder screw.
- (4) Repeat the previous step until the fluid flowing through the tube is free of air bubbles. Repeat the same procedures for the left-hand wheel cylinder. With the brake lines free of air, fill brake fluid into the reservoir tank to the specified level.

Note: 1. Take care to maintain the brake fluid in the reservoir tank at sufficient levels while the bleeding operation is in progress.

2. Use only the brake fluid of specified brand and grade. Avoid mixing different types of fluids.

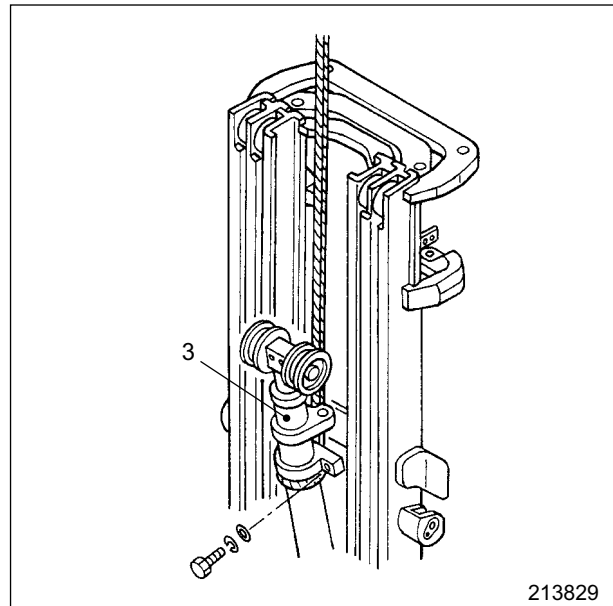
3.6 Braking Performance Test

With all of the required adjustments completed after disassembly/reassembly, check the braking force at a speed of 10 km/h (6.2 mph). Readjust as necessary by referring to "3.2 Manual Adjustment."



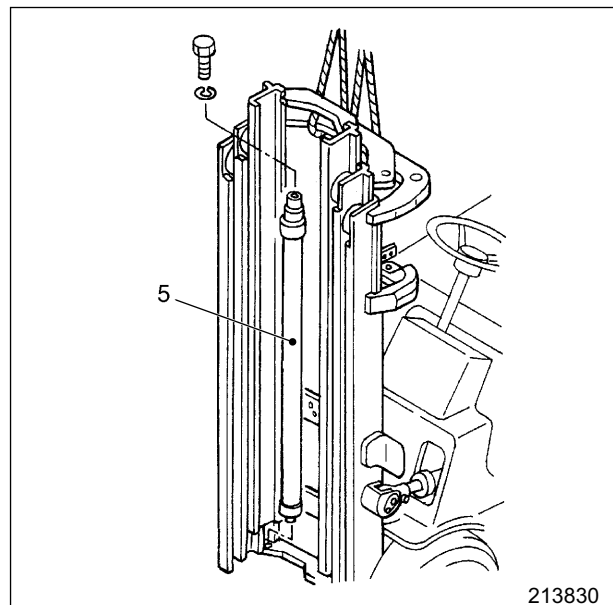
(2) Removing first lift cylinder

- (a) Hitch 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.

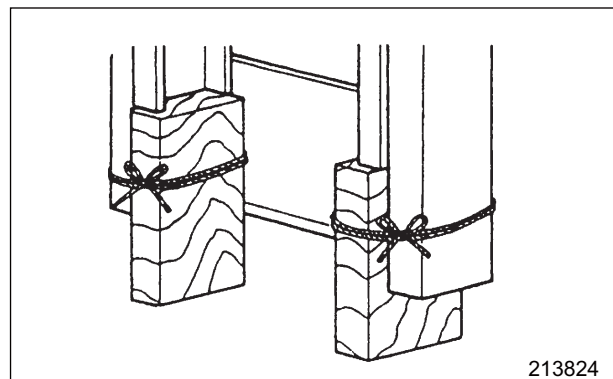


(3) Removing second lift cylinders

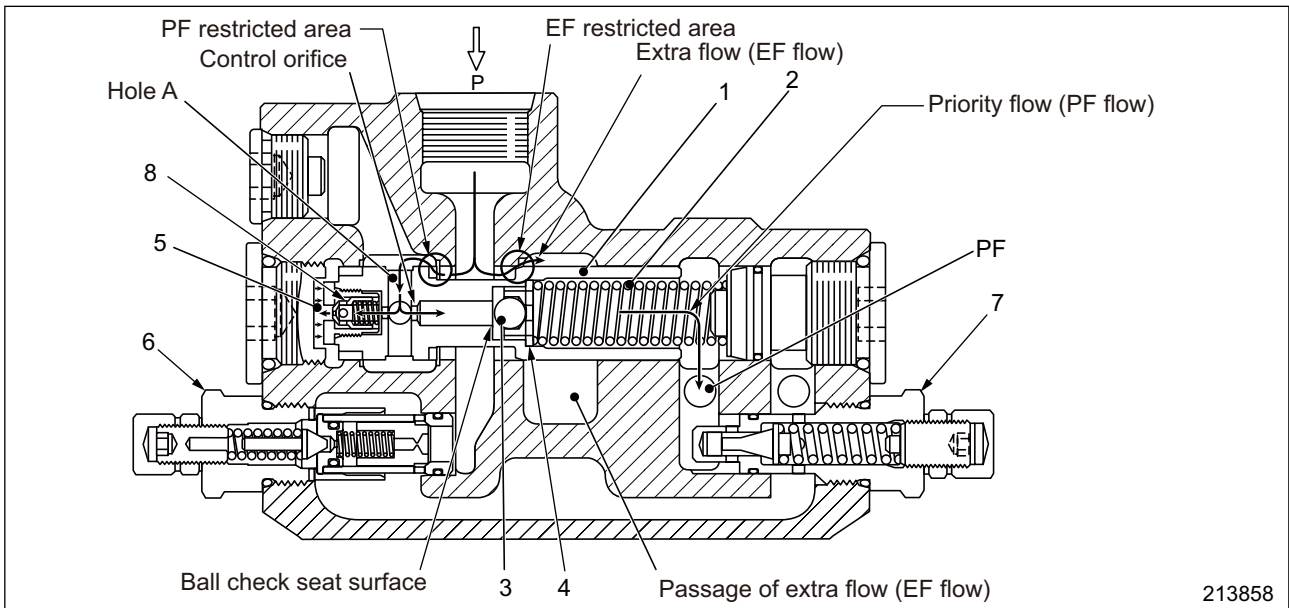
- (a) Disconnect hoses from the second lift cylinders 5.
- (b) Remove the set bolts at the upper sections of the second lift cylinders 5, and lift the inner mast for duplex mast or middle mast for triplex mast approximately 55 cm (21.67 in.) using slings.



- (c) Place wood blocks under the inner mast (for duplex mast) or middle mast (for triplex mast). Make sure the right and left wood blocks are the same height.



6.1.3 Inlet Cover Section



- 1 Priority valve spool
- 2 Spring
- 3 Ball check
- 4 Ball retainer
- 5 Damper chamber
- 6 Main relief valve
- 7 Steering system relief valve (PF relief valve)
- 8 Valve

- P : From hydraulic pump (pump port)
- PF : To steering valve (priority port)
- EF : To cargo-handling valve (extra port)

The inlet section of the control valve consists of the main relief valve 6, which limits the maximum pressure of the hydraulic system. The priority valve which feeds the pressure oil preferentially to the steering system, and the steering system relief valve 7, which limits maximum pressure of the supplied pressure oil.

The priority valve is a flow divider valve which divides supplied oil to a predetermined volume of priority flow (PF flow) and extra flow (EF flow). PF flow and EF flow are supplied to the steering system and the cargo-handling valves, respectively.

The above illustration shows the position of priority valve spool 1 during operation (during pump rotation).

The priority flow (PF flow) of pressure oil which flows in the port P flows in the following sequence: PF restricted area→Hole A→Control orifice →Groove between ball check 3 and ball retainer 4→Spring chamber →PF port.

This passage is always open and a certain volume of oil is flowing toward the steering valve during operation.

Extra flow (EF flow) passes the EF restricted area, flows in the EF port and then, in the center bypass port of the load-handling valve.

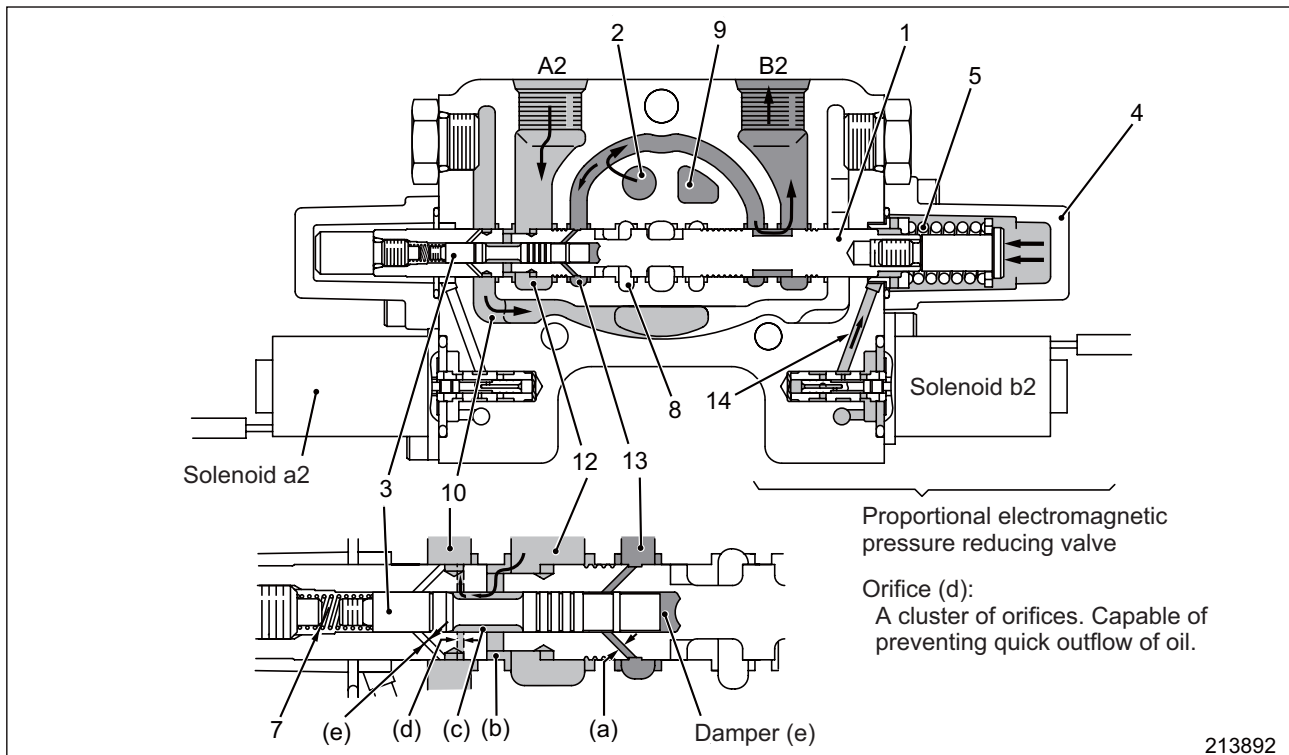
When the flow volume flowing in the port P from the pump increases, PF flow passing the control orifice is going to increase. Then, differential pressure before and after the control orifice becomes greater.

The left edge face of the valve spool 1 acts on the hydraulic pressure before the control orifice, namely pump pressure, and on the right edge face of the spool acts on the PF flow pressure.

Therefore, when differential pressure becomes greater, the valve moves to the right, closes the PF restricted area and opens the EF restricted area, releasing extra flow to the EF port. As a result, PF flow decreases and differential pressure also decreases.

On the other hand, when the flow volume of pressure oil flowing in the port P decreases, PF flow flowing through the control orifice decreases and differential pressure also decreases. The spool moves to the left and restricts extra flow. As a result, PF flow increases and differential pressure also increases.

Differential pressure varies between extra flow and PF flow not only by the flow volume but also by operation of the fork. Differential pressure before and after the control orifice, however, can be kept constant by adjusting angles of the PF restricted area and EF restricted area. As differential pressure is constant, PF flow becomes constant.



Actuation of Valve with Tilt Lever in "Forward Tilt" position

When the tilt lever is moved into the "forward tilt" position, an electric current proportional to the travel of the lever is fed from the controller to the solenoid b2.

The solenoid b2 is activated and pilot oil is released from the electromagnetic proportional pressure control valve into the cap 4 through the passage 14.

Pilot oil pressure in the cap is proportional to the movement of the lift lever.

The pressure of pilot oil in the cap, which is proportional to the travel of the tilt lever, causes the main spool 1 to move to the left against the force of the spring 5 and closes the neutral passage 8. As a result, pressure in the high-pressure passage 9 rises. Oil in the passage pushes open the check valve 2 to flow to the head side of the tilt cylinder through the passage 13 and port B2, causing the cylinder rod to expand.

At this point in time, part of pressure oil in the passage 13 flows into the oil passage (a) and enters the damper (e) to cause the tilt lock valve 3 to move to the left against the force of the spring 7.

As a result, oil at the rod side of the tilt cylinder, that is oil from the port A2, passes through the passage (b), passage (c) and orifice (d) in that order into the low-pressure passage 10.

The cylinder rod is extended by two actions combined, i.e., supply of oil pressure from the port B2 and release of pressure oil from the A2 port, and tilts the mast forward.

Actuation of Tilt Lock Valve in Case of Emergency

In case the main spool is stuck for some reason when the mast tilts forward, returning the tilt lever to the "neutral" position stops the movement of the cylinder rod.

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.

◆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 rightmost position. Take measurement of clearance G1 between the roller circumference and inner mast.

Adjust the clearance with shims (d) to the specification.

Unit: mm (in.)

Clearance G1	0.1 to 0.5 (0.004 to 0.020)
--------------	--------------------------------

(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 table on the right.

Note: For measuring procedures, refer to "6. Inspection and Adjustment (Simplex Mast)."

◆Make sure that the rollers rotate smoothly when installed.

Unit: mm (in.)

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)

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

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

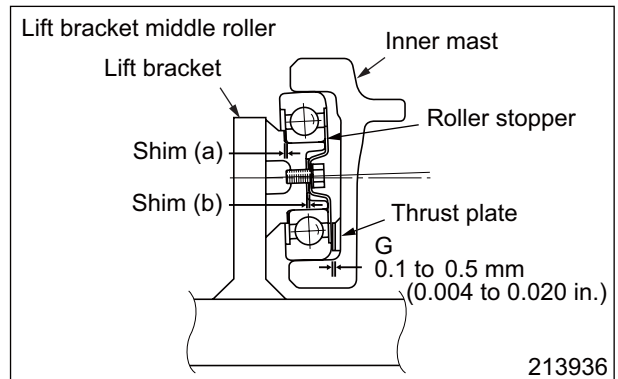
◆Measure clearance G between the middle roller and thrust plate. If the measured clearance does not conform to the standard value, adjust clearance G in the manner described below.

Note: For measuring procedures, refer to "6. Inspection and Adjustment (Simplex Mast)."

◆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 table on the right for the shipment.

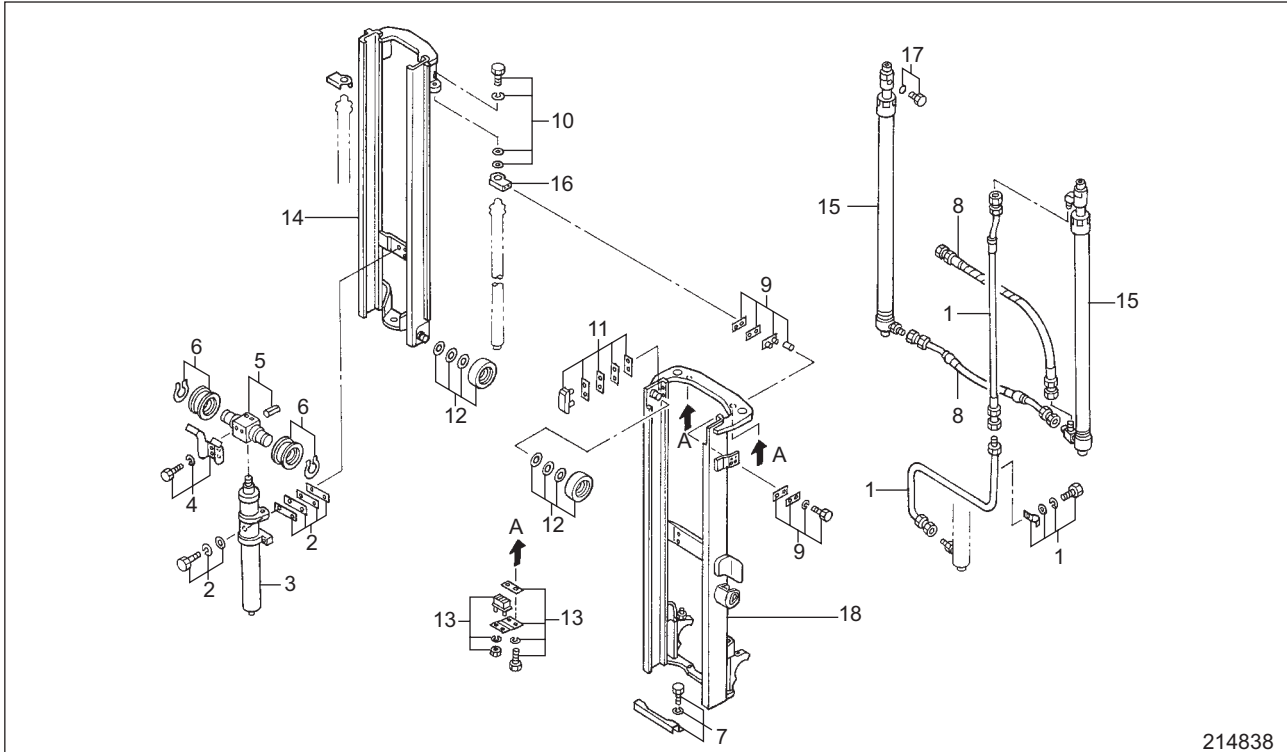


Unit: mm (in.)

Item	Truck type	
	1 ton class	2 ton class 3 ton class
Shim (a)	2 (0.079)	1.5 (0.059)
Shim (b)	2 (0.079)	

12. Disassembly and Reassembly

12.1 Duplex Mast Disassembly



Sequence

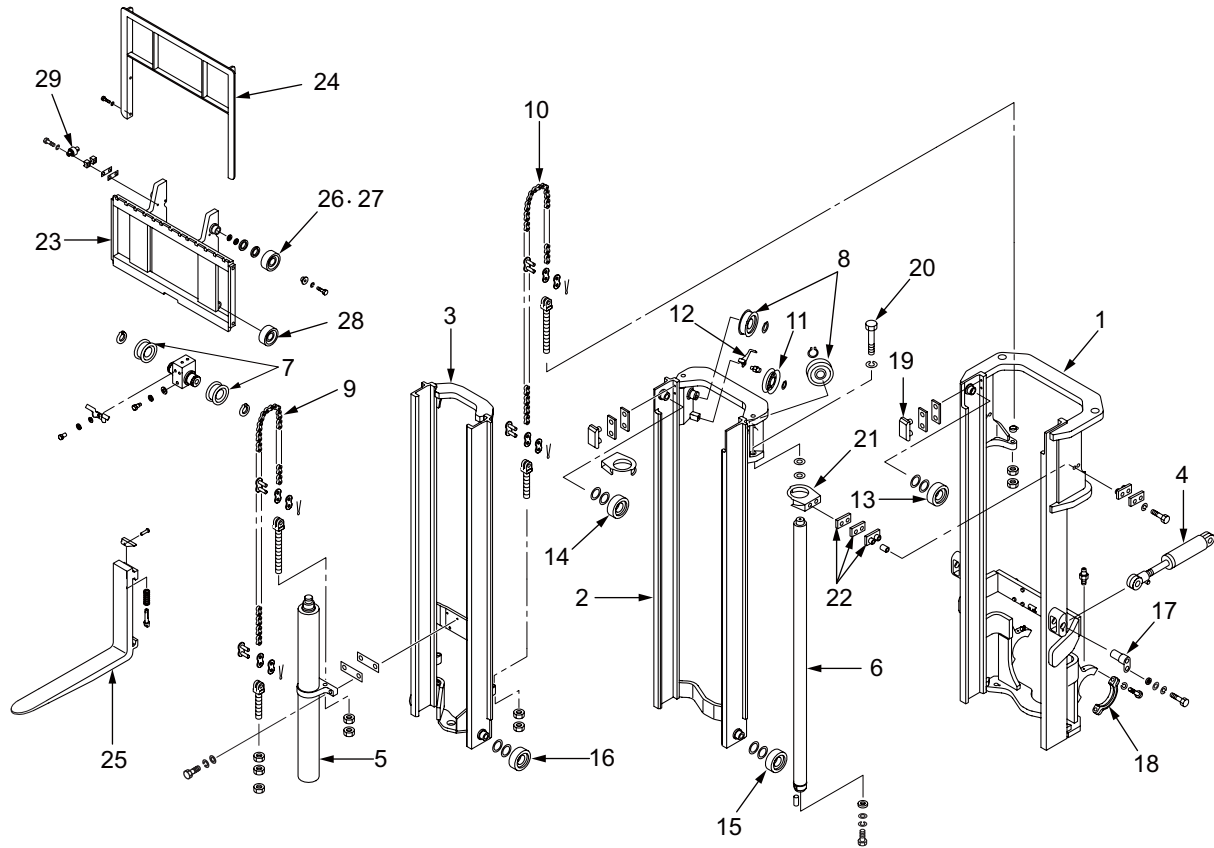
- | | |
|------------------------------------|---|
| 1 Lift hose (high pressure), Clamp | 11 Mast strips, Shims |
| 2 Shims, Bolts, Washers | 12 Mast rollers |
| 3 First lift cylinder | 13 Stopper cushion, Cushion plate,
Shims, Bolts, Washers |
| 4 Chain guard | 14 Inner mast |
| 5 Chain wheel support, Pin | 15 Second lift cylinder |
| 6 Chain wheels, Snap rings | 16 Cylinder bracket |
| 7 Hose guard, Bolt, Washer | 17 O-ring, Plugs |
| 8 High-pressure hose | 18 Outer mast, Grease nipples |
| 9 Seats, Shims, Cushions, Collars | |
| 10 Bolts, Washers, Shims | |

Note: The lift bracket disassembly procedure is the same as for the simplex mast.

18. Structure and Functions

18.1 Triplex Mast (Triple Full-Free Panoramic 5M15C to 5M35C)

Notice: For hydraulic lines, refer to "Installing Hydraulic Lines."



214836

Major Components (most parts come in pairs, left and right)

- | | | |
|-----------------------------|---------------------------------------|-------------------------------|
| 1 Outer mast | 11 Hose pulley | 21 Cylinder bracket |
| 2 Middle mast | 12 Hose guard | 22 Cylinder clamps |
| 3 Inner mast | 13 Outer mast roller | 23 Lift bracket |
| 4 Tilt cylinder | 14 Middle mast upper roller | 24 Backrest |
| 5 First lift cylinder (one) | 15 Middle mast lower roller | 25 Forks |
| 6 Second lift cylinder | 16 Inner mast roller | 26 Lift bracket upper roller |
| 7 First lift chain wheel | 17 Tilt socket mounting pin | 27 Lift bracket middle roller |
| 8 Second lift chain wheel | 18 Mast support cap | 28 Lift bracket lower roller |
| 9 First lift chain | 19 Mast strip | 29 Side roller |
| 10 Second lift chain | 20 Lift cylinder upper mounting bolts | |

In the triplex mast, the free-lift height extends to the top of the mast, and the overall mast height remains the same until the upper edge of the backrest exceeds the top of the mast.

The mast assembly consists of the inner mast, middle mast, outer mast, lift bracket, first lift cylinder and second lift cylinders.

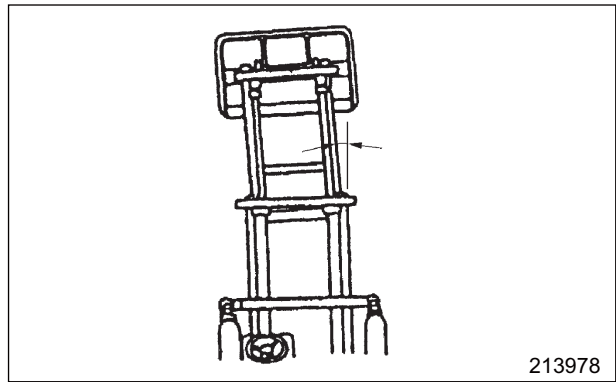
The first lift cylinder raises the lift bracket, while the second cylinder operates the three-stage telescopic mechanism and lift bracket.

The first lift cylinder is equipped with the upstroke cushioning and the second cylinder equipped with the down cushioning and both cylinders have no return hose by internal drain.

For mast operation, refer to "Mast Operation" on 18.2 Mast Operation.

22.8 Right and Left Lift Cylinder Stroke Inspection and Adjustment

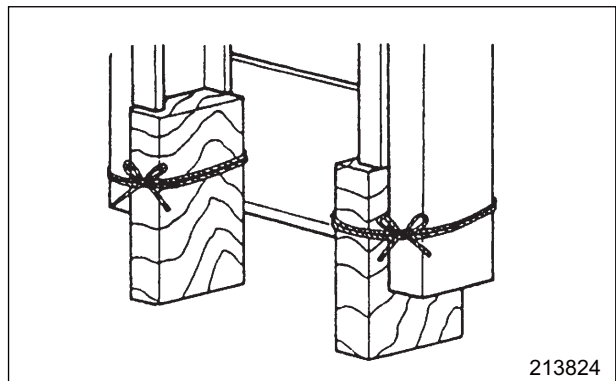
- (1) Slowly raise the inner mast, and observe how the piston rods, left and right, stop at the moment the inner mast reaches its maximum height.
- (2) If the top of the inner mast jolts at that moment, make a shim adjustment.
Abnormal condition can be detected by a little time lag in stopping between the piston rods, left and right, and shaking of the rod with a longer cylinder stroke.



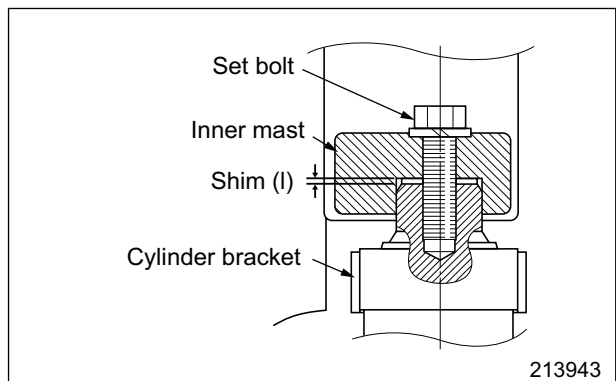
(3) Adjusting method

- (a) Raise the inner mast, place wood blocks under the right and left sides of the inner mast, and lower the mast until it rests on the wood blocks.
- (b) Remove the set bolt at the top of lift cylinder which showed earlier stroke end, retract the piston rod, and insert shims at the top of piston rod end.

Note: When retracting the piston rod, push the lift lever to lowering direction for releasing the oil in the cylinders.



- (c) Extend the piston rod, and tighten the cylinder set bolt. Remove the wood blocks from under the inner mast.
- (d) Slowly lower the inner mast to the bottom to ensure the piston rods move smoothly and that the left and right lift cylinders come to the end of stroke simultaneously at the maximum lift position of inner mast.



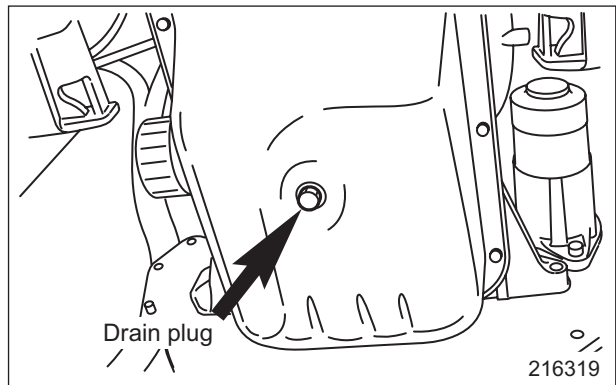
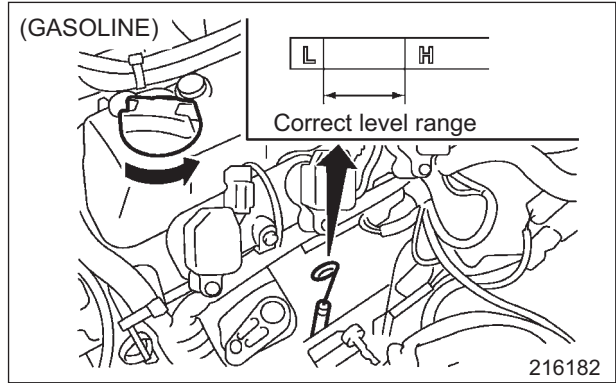
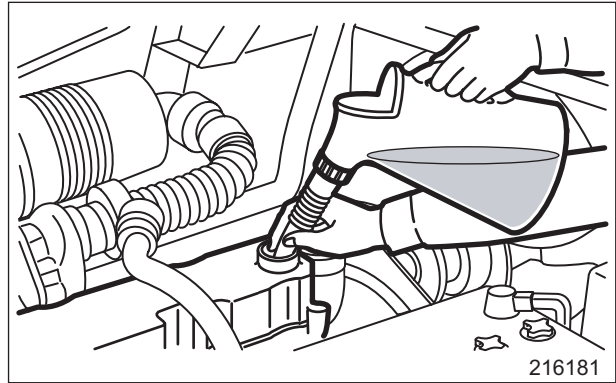
(7) Change engine oil.

Service Hours	1st Month (200 hrs) only
	Every 3 months (500 hrs)

- (a) Loosen the drain plug located in the engine oil pan, and drain the engine oil.
- (b) Remove the oil filler cap, and pour oil to the specified level.
- (c) Run the engine to circulate the oil through the engine.
- (d) Stop the engine. Wait for a while to let the engine oil to pour down to the oil pan, and then check the oil level.

Note: Refer to the appropriate engine service manual.

Engine oils	Gasoline-engine model	API service classification SJ or above
	Diesel-engine model	API service classification CF or above



2.13 Wheels and Tires

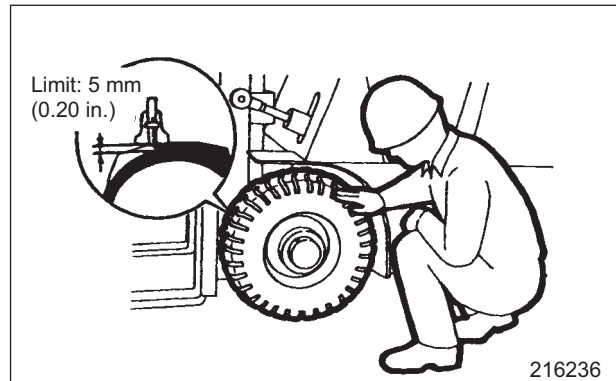
⚠ CAUTION

- ♦ Be sure to conduct maintenance work on level and hard ground.
- ♦ Stop the engine, and remove the starter key.
- ♦ 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)
---------------	-------------------------

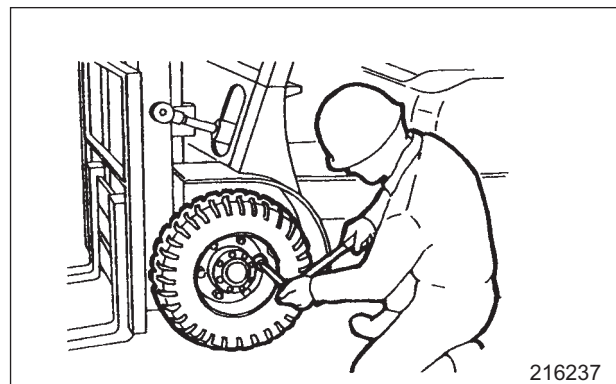
- ♦ Check the tires for damage or nails.
- ♦ Check the rims for deformation or damage.
- ♦ Check that the depths of tire grooves are 5 mm (0.20 in.) or more.



(2) Check wheel and nuts.

Service hours	Prestart (Daily/10 hrs)
---------------	-------------------------

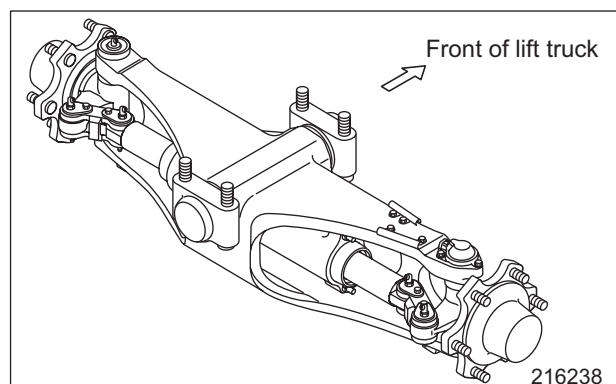
- ♦ Tighten the wheel nuts to the specified torque.



(3) Check knuckles.

Service hours	Yearly (2000 hrs)
---------------	-------------------

- ♦ Turn the steering wheel to the extreme right and left to check for smooth steering.



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Cat Lift Trucks

Service Manual

GP/GPE 15N-35N, DP15N-35N Lift Trucks

99719-38210

Service Manual

Chassis & Mast

MC

GP15N	CT25C-55001-up	GPE15N	CT34-00001-up	DP15N	CT16D-54001-up
GP15ZN	CT34-52001-up	GPE18N	CT34-40001-up	DP18N	CT16D-74001-up
GP18N	CT25C-75001-up	GPE20CN	CT34-30001-up	DP20CN	CT16D-24001-up
GP18ZN	CT34-72001-up	GPE20N	CT17D-20001-up	DP20N	CT18C-20001-up
GP20CN	CT34-22001-up	GPE20ZN	CT35-20001-up	DP25N	CT18C-70001-up
GP20N	CT17D-10001-up	GPE25N	CT17D-70001-up	DP30N	CT14E-10001-up
GP20ZN	CT35-10001-up	GPE25ZN	CT35-70001-up	DP35N	CT14E-80001-up
GP25N	CT17D-60001-up	GPE30N	CT13F-10001-up		
GP25ZN	CT35-60001-up	GPE35N	CT13F-80001-up		
GP30N	CT13F-40001-up				
GP35N	CT13F-60001-up				

Mitsubishi Caterpillar Forklift Asia Pte. Ltd.
RCB No.: 199203169H
No.1, Tuas West Street
Singapore 637444

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Printed in China
9/12

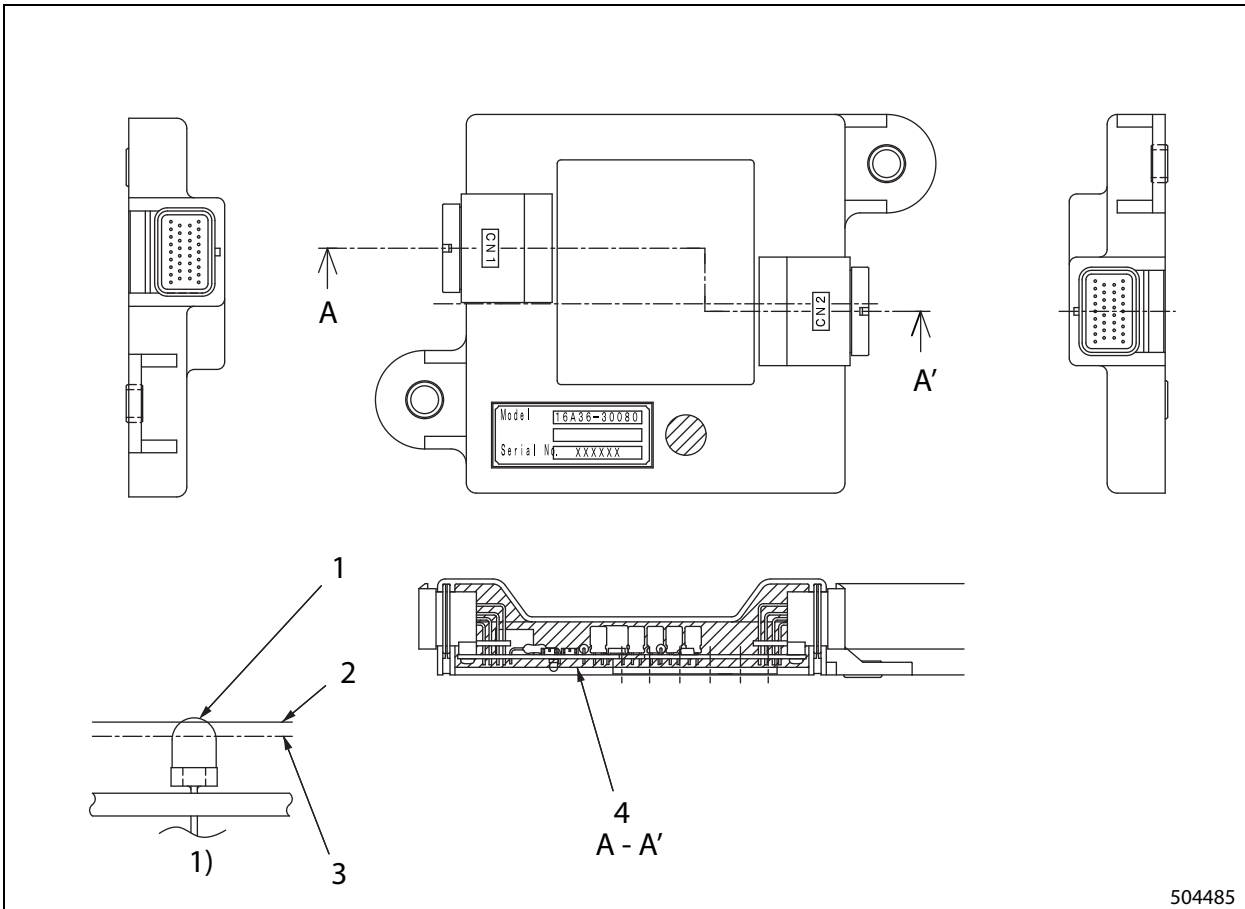
For use with K15, K21, K25, S4Q2 and S4S
Engine Service Manuals.

5. Technical Data

Unit: mm (in.)

Truck model		Class	1 ton class		
		Gasoline engine truck	GP15N GPE15N GP15ZN	GP18N GPE18N GP18ZN	GP20CN GPE20CN
		Diesel engine truck	DP15N	DP18N	DP20CN
1	Maximum lift		3000 (118.1)	3000 (118.1)	3000 (118.1)
2	Free lift height		115 (4.5)	115 (4.5)	120 (4.7)
3	Minimum turning radius		1950 (76.8)	1980 (78.0)	2020 (79.5)
4	Overall length		3180 (125.2)	3220 (126.8)	3280 (129.1)
5	Overall width (outside-to-outside of tires)	Single	1065 (41.9)	1065 (41.9)	1065 (41.9)
		Double	1330 (52.4)	1330 (52.4)	-
6	Overall height (with mast lowered)		1990 (78.3)	1990 (78.3)	1990 (78.3)
7	Overall height (with mast extended)		4055 (159.6)	4055 (159.6)	4055 (159.6)
8	Height of the overhead guard		2065 (81.3)	2065 (81.3)	2065 (81.3)
9	Fork size (T x W x L)		35 x 100 x 920 (1.4 x 3.9 36.2)	35 x 100 x 920 (1.4 x 3.9 36.2)	40 x 122 x 920 (1.6 x 4.8 x36.2)
10	Fork spread		200 to 920 (7.9 to 36.2)	200 to 920 (7.9 to 36.2)	200 to 920 (7.9 to 36.2)
11	Front overhang		400 (15.7)	400 (15.7)	415 (16.3)
12	Wheel base		1400 (55.1)	1400 (55.1)	1400 (55.1)
13	Tread (front wheel)	Single	890 (35.0)	890 (35.0)	890 (35.0)
		Double	1025 (40.4)	1025 (40.4)	-
14	Tread (rear wheel)		1025 (40.4)	1025 (40.4)	1025 (40.4)
15	Under clearance (at center of frame)		152 (6.0)	152 (6.0)	152 (6.0)
16	Tilt angle (forward – backward)		6 - 12°	6 - 12°	6 - 12°

3.9 VCM (Vehicle Control Module)




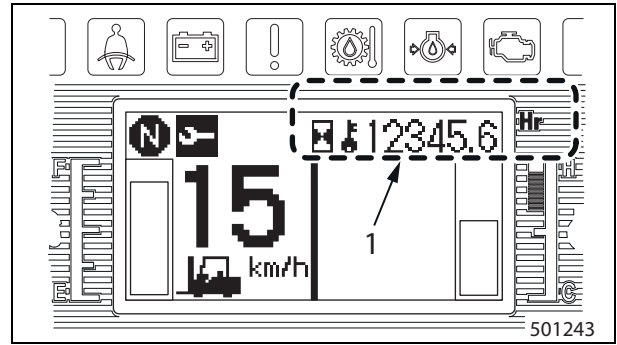
504485

- | | |
|------------------------|------------|
| 1. LED can be seen | 4. Potting |
| 2. Potting upper limit | 1) Potting |
| 3. Potting surface | |


Note: For the VCM connector pin location, refer to CHAPTER "CONTROLLER".

Hour meter display

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

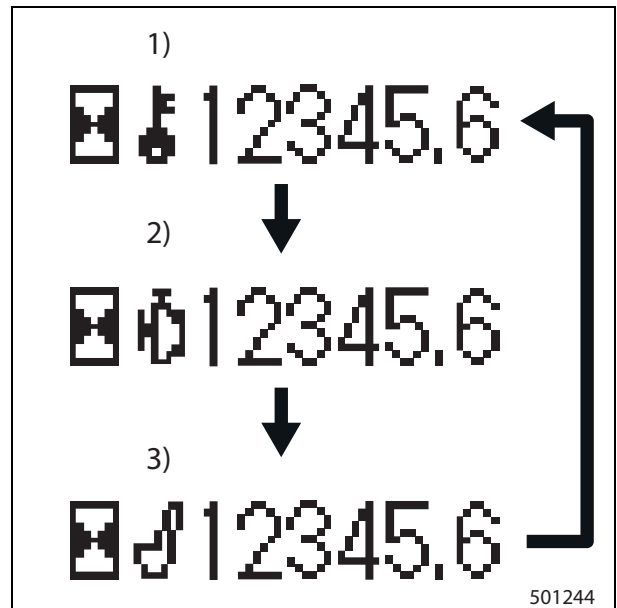


1. Hour meter display

Button	Press	Display
	Short press	Time ↔ Hour meter

Types of hour meters and Selection

To adjust, turn the key switch to the ON position. There are 3 hour-meter displays: key-on time, engine-on time, and seat switch-on time. The display changes with a long press of the UP button.



1) Key-on time display 3) Seat switch-on time display
2) Engine-on time display

Button	Press	Display
UP	Long press	Key-on time ↓ Engine-on time ↓ Seat switch-on time

Key-on time: Accumulated key switch ON time.

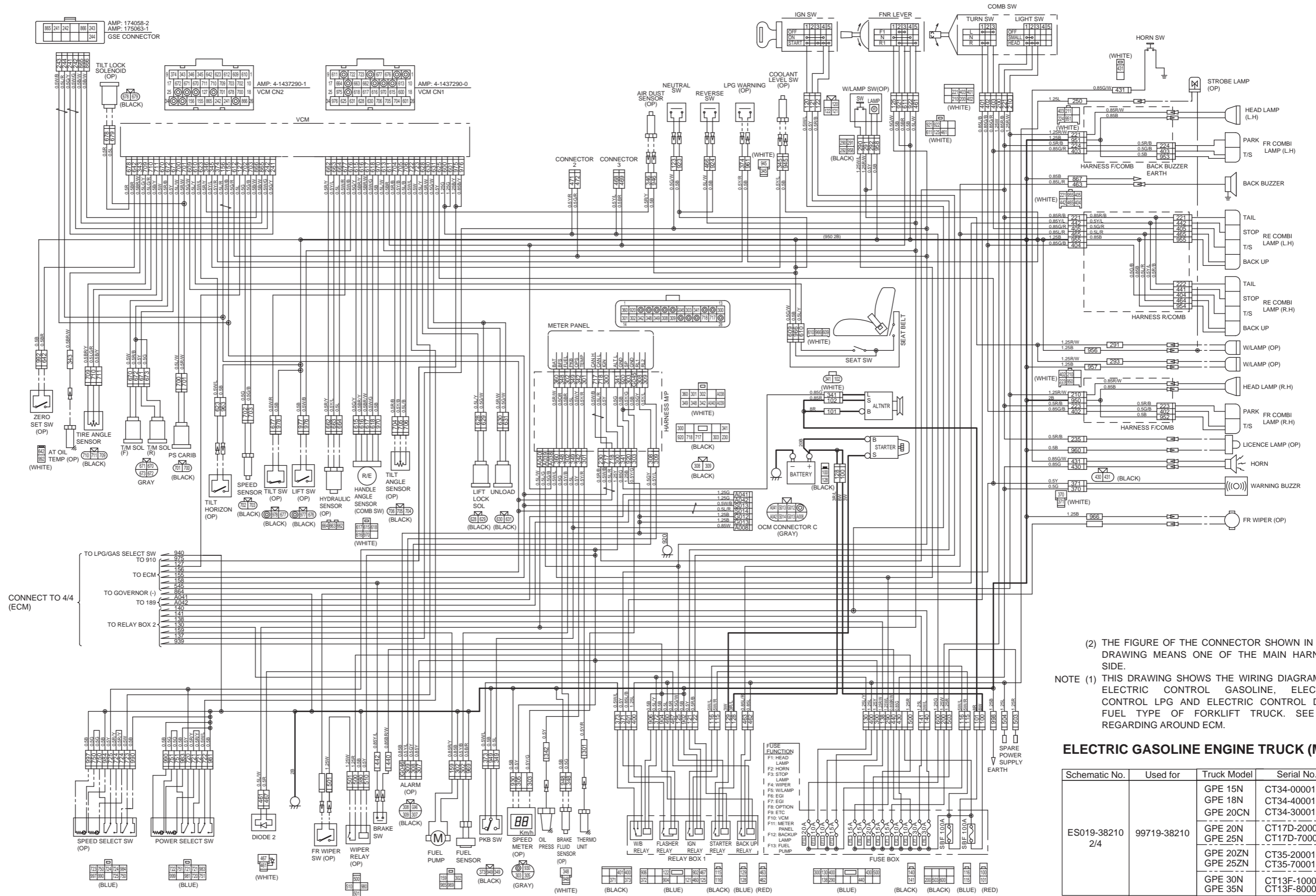
Engine-on time: Accumulated engine operation time.

Seat switch-on time: Accumulated time the operator has seated.

Note:

- "0.1" hour is added every 6 minutes.
- Warranty is terminated based on the key-on time.
- The engine-on time is effective for maintenance management of engine-related parts.
- Seat switch-on time is helpful to know an actual working hours.

Electrical Schematic (4/7)



(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 ELECTRIC CONTROL GASOLINE, ELECTRIC CONTROL LPG AND ELECTRIC CONTROL DUAL FUEL TYPE OF FORKLIFT TRUCK. SEE 4/4 REGARDING AROUND ECM.

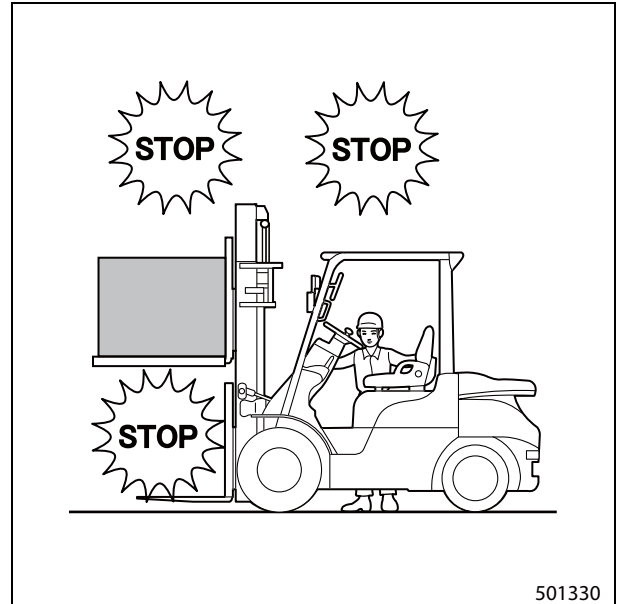
ELECTRIC GASOLINE ENGINE TRUCK (MC)

Schematic No.	Used for	Truck Model	Serial No.
ES019-38210 2/4	99719-38210	GPE 15N	CT34-00001 up
		GPE 18N	CT34-40001 up
		GPE 20CN	CT34-30001 up
		GPE 20N	CT17D-20001 up
		GPE 25N	CT17D-70001 up
		GPE 20ZN	CT35-20001 up
		GPE 25ZN	CT35-70001 up
		GPE 30N	CT13F-10001 up
		GPE 35N	CT13F-80001 up

4. Mast Interlock System

4.1 Mast Interlock Function

When an operator leaves the operator seat while the engine is running, the built-in seat switch is activated to lock the mast. The mast will not move even if the lift or the tilt lever is operated.



Key switch position	Engine operating condition	Operator seat Vacant or Occupied	Meter panel	Control lever	
			Mast interlock indicator light	Lift	Tilt
○(OFF)	Stop	Occupied	OFF	Not active	Not active
		Vacant	OFF	Not active	Not active
I(ON)	Stop	Occupied	OFF	Lowering only	Not active
		Vacant	Blinking	Not active	Not active
⊖(START)	Running	Occupied	OFF	Active	Active
		Vacant	Blinking	Not active	Not active

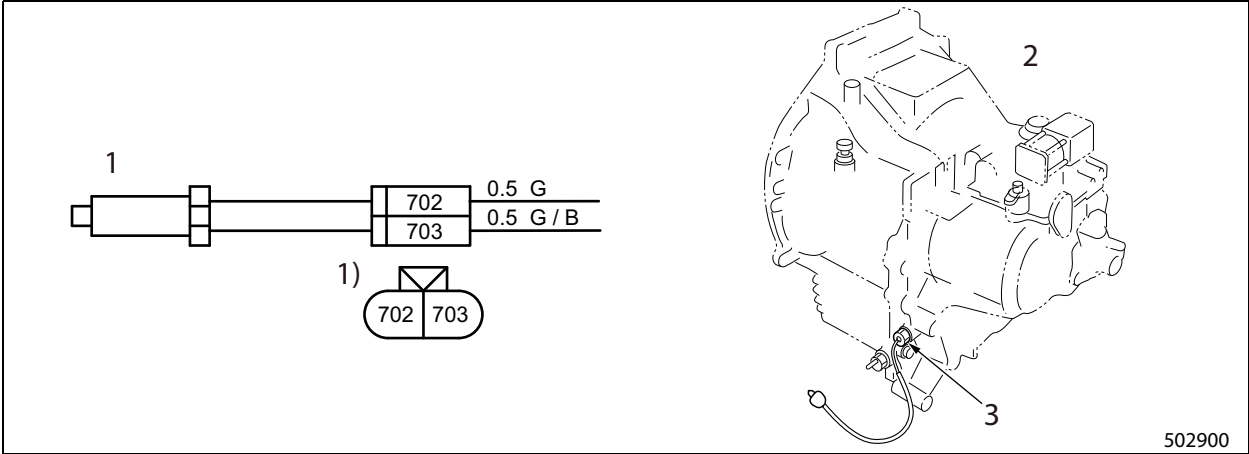
Controller function

The controller monitors the seat switch and if the operator is not seated, the controller locks the lift and tilt motions.

VCM-1M controller, Mast interlock function

The VCM-1M controller interrupts electric current supply to the unload solenoid and the lift lock solenoid if an operator is not seated.

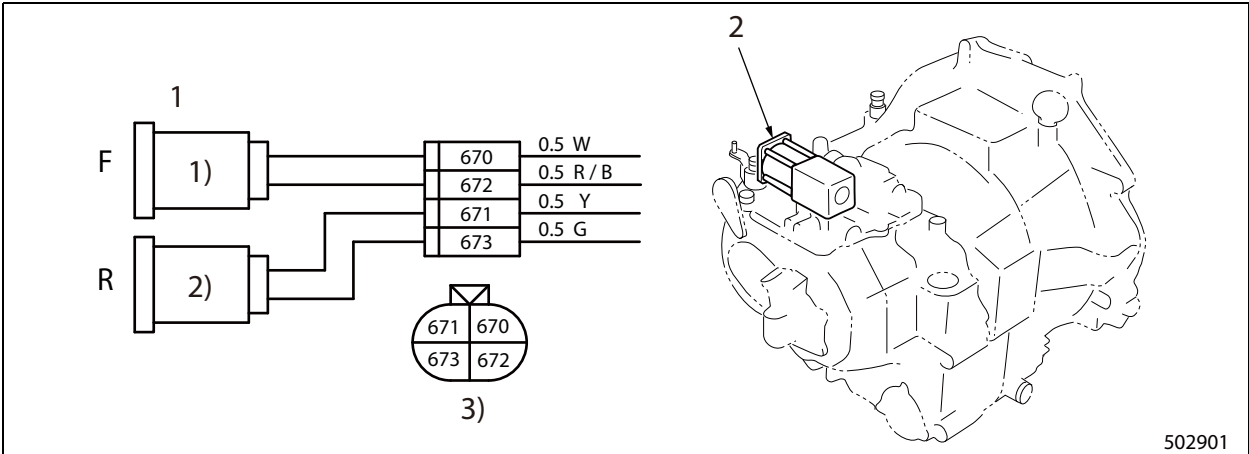
9.5 Vehicle Speed Sensor



502900

- 1. Vehicle speed sensor
- 2. Transmission (right side)
- 3. Vehicle speed sensor
- 1) (BLACK)

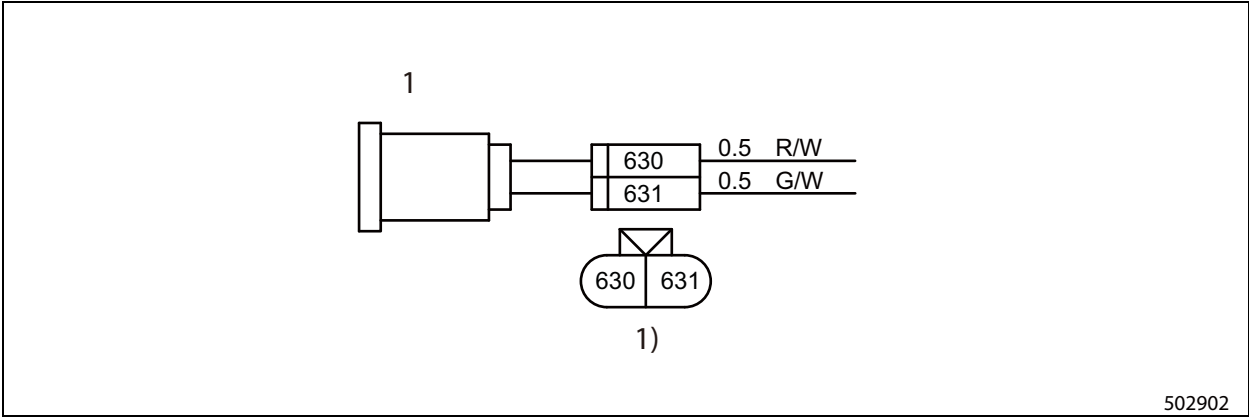
9.6 T/M Solenoid



502901

- 1. T/M Solenoid
- 2. T/M forward/backward solenoid
- 3) (GRAY)
- 1) Forward
- 2) Reverse

9.7 Unload Solenoid



502902

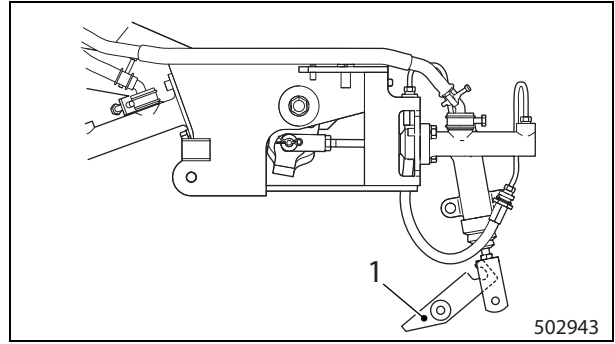
- 1. Unload solenoid
- 1) (BLACK)

CHAPTER 4 CONTROLLER

Diagnostic code	Diagnostic code name	Probable cause	Check items
S-07	MP Communication warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Meter panel bad	3. Communication line check
		4. Controller bad	
S-08	TMS communication warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. TMS bad	3. Communication line check
		4. Controller bad	
S-10	APS1 input warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-11	APS2 input warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-13	APS1/APS2 relative warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Accelerator position sensor bad	3. Accelerator position sensor check
		4. Controller bad	
S-14	Idle switch warning signal	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Idle switch bad	3. Idle switch check
S-40	Service brake solenoid warning	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Service brake solenoid bad	4. Service brake solenoid conductivity check
		5. Controller bad	
S-41	Service brake solenoid leak warning	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Service brake solenoid bad	4. Service brake solenoid conductivity check
		5. Controller bad	

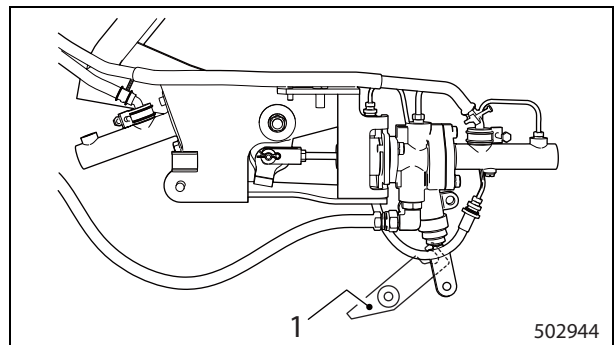
Raising clutch shifter shaft

Loosen the air bleeder valve of the clutch release cylinder to relieve oil pressure, and remove the clutch release cylinder mounting bolt. Then, lift up the clutch shifter shaft avoiding the clevis of the release cylinder rod.



Dry type clutch

1. Clutch shifter shaft



Wet type clutch

1. Clutch shifter shaft

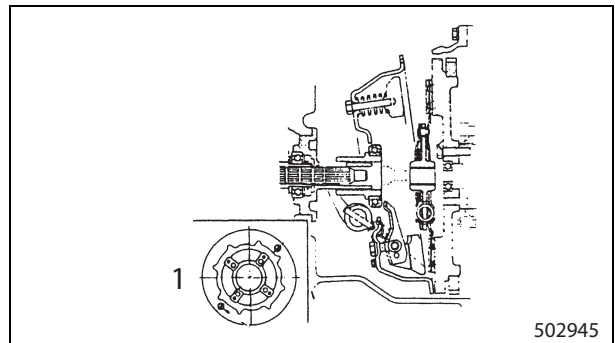
Clutch disc assembly and pressure plate

Assembly, Removing

Position the dowel pins as shown.

Input shaft, Replacing

When replacing input shaft, remove the engine and transmission assembly from the truck body.



1. Approx. 45°
(dowel pin position)

17.2 Wet Type Clutch

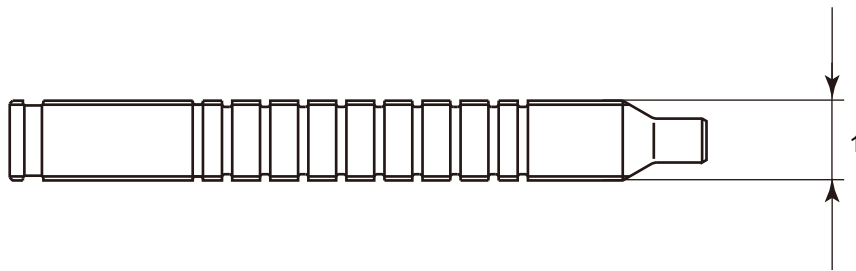
Clutch pedal

Item		Specified value	
1	Height of clutch pedal to the floor (from top of frame to top of pedal pad)	Standard	191.6 mm (7.543 in.)
2	Clutch pedal free play	Standard	0 to 6 mm (0.00 to 0.24 in.)

502979

Input shaft

Item		Specified value	
1	Spline diameter	Standard	$27.25 \begin{smallmatrix} 0 \\ -0.2 \end{smallmatrix}$ mm ($1.0728 \begin{smallmatrix} 0 \\ -0.0079 \end{smallmatrix}$ in.)
-	Free movement of clutch disc (looseness of mating splines) at rim of disc.	Limit	1 mm (0.04 in.)



15.2 Suggestions for Assembly

- (1) Apply Loctite to the screw before installing.
- (2) After the step above, firmly fix the screw to the shift rail using a wire.

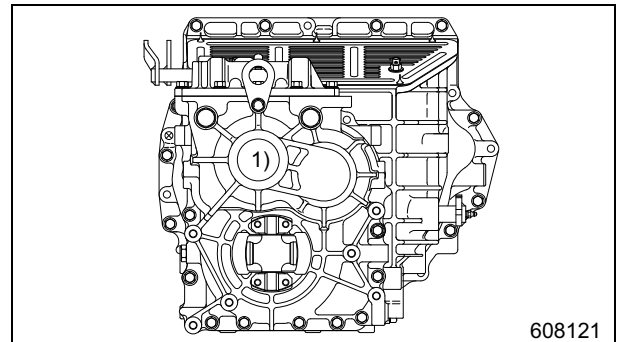
Ref.	Tightening torque
3	29.4 ± 2.9 N·m (3.00 ± 0.29 kgf·m) [21.684 ± 2.13 lbf·ft]
8	29.4 ± 2.9 N·m (3.00 ± 0.29 kgf·m) [21.684 ± 2.13 lbf·ft]

Control cover, Assembling

Install parts 10 through 20 onto the control cover. Then, install the cover to the transmission housing.

Gear rotation, Checking

- After the transmission is assembled, shift to 2nd forward and ensure the output flange turns freely by hand.
- If it does not turn by hand, inadequate fits of the roller bearing outer race is suspected. Tap the transmission case where the roller bearing is located several times, and try to turn again.
- If it still does not turn by hand, improper shim adjustment is suspected. Disassemble and adjust again.

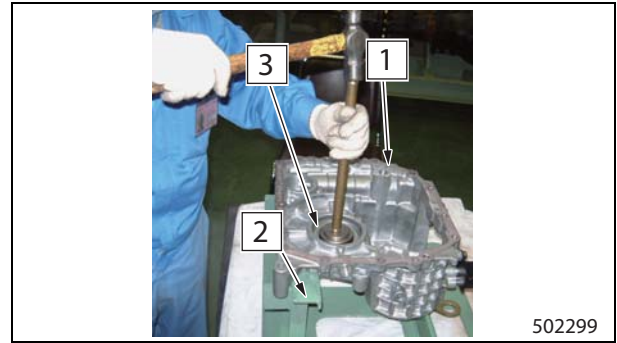


1) Roller bearing section

4.6 Transmission Housing, Disassembling

Output gear oil seal, Removing

- (1) Mount transmission housing on the stand kit (special tool).
- (2) Remove output gear oil seal.



1. Transmission housing
2. Special tool (stand kit)
3. Output gear oil seal

Special tool	Part number
Stand kit	91A68-00020

Input shaft bearing outer race, Removing

- (1) Remove the transmission housing from the stand kit (special tool) and lay the transmission housing on skids by turning it around.
- (2) Remove input shaft bearing outer race using special tool (installer/remover).



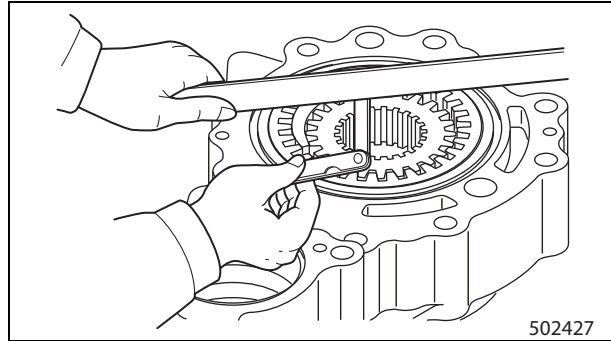
1. Special tool (Installer/remover)

Special tool	Part number
Installer/Remover	91A68-02300

- (4) Measure the clearance between pump drive gear and crescent-shaped part

Item	Specified value	
Clearance between pump drive gear and crescent-shaped part	Standard	0.04 to 0.10 mm (0.0016 to 0.0039 in.)
	Limit	0.15 mm (0.0059 in.)

- (5) Measure the clearance between gear pump case mounting surface and gear.

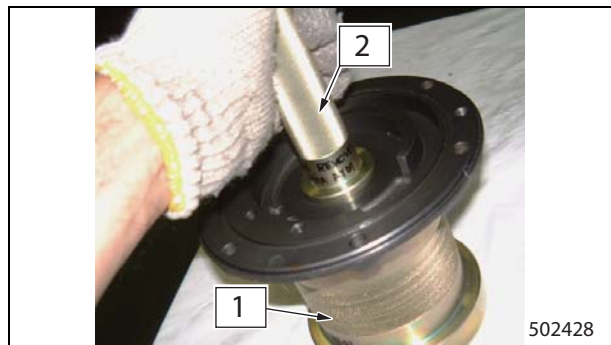


Item	Specified value	
Clearance between gear pump case mounting surface and gear	Standard	0.04 to 0.08 mm (0.0016 to 0.0031 in.)
	Limit	0.15 mm (0.0059 in.)

Bushing, Installing

Note: In general, replace the oil pump assembly if the bushing is badly damaged or worn.
 When bushing has been replaced, finish the inner bore of bushing as shown on the drawing on the next page.
 Failure to do so could result in serious damage of the oil pump assembly and transmission.

- (1) Remove internal gear and drive gear from pump body and place the pump body on the stand (special tool).
- (2) Install bushing using installer (special tool).

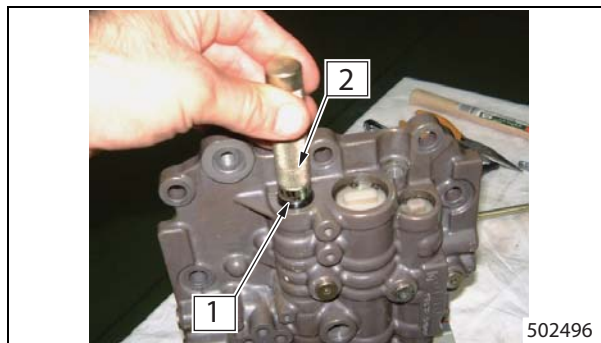


1. Special tool (Stand) 2. Special tool (Installer)

Special tool	Part number
Stand	91A68-01700
Installer	91A68-01600

- (3) Finish the bore of bushing.

- (2) Install oil seal to inching valve section using the installer (special tool).



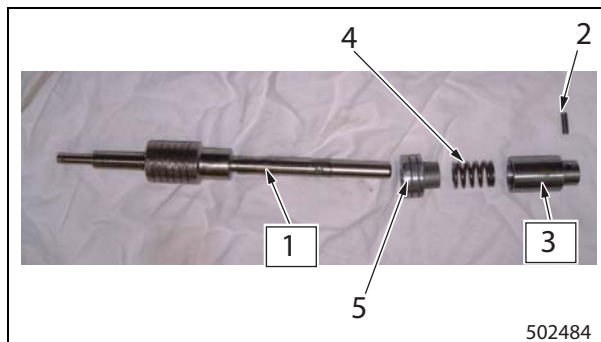
1. Inching valve section 2. Snapping

Special tool	Part number
Installer	91A68-02800

7.5 Inching Valve Section, Assembling

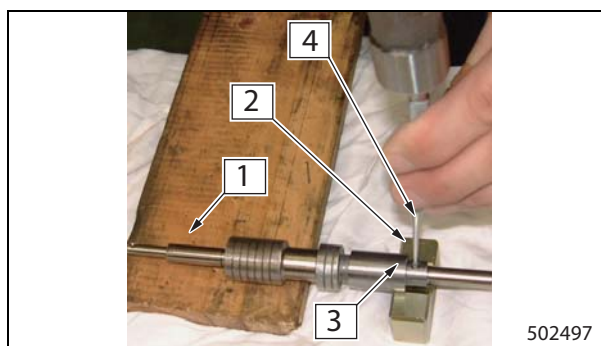
Valve assembly, Assembling

- (1) Install inching valve, inching valve spring and inching stopper 2 to inching rod.



1. Inching rod 4. Inching valve spring
 2. Spring pin 5. Inching valve
 3. Inching stopper 2

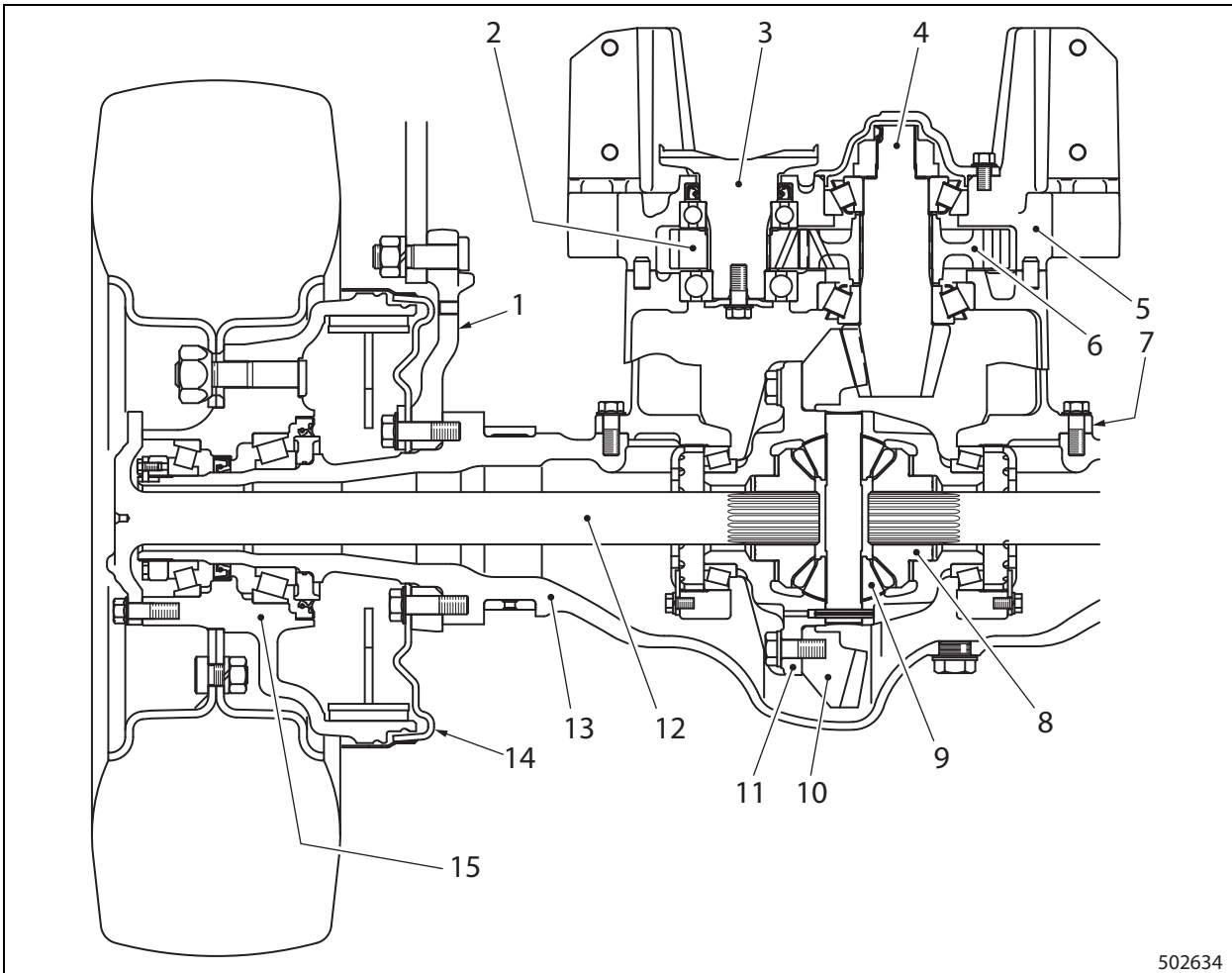
- (2) Align spring pin holes of inching rod and inching stopper 2 and install spring ping using stand (special tool).
- (3) Install inching valve assembly on inching valve section.



1. Inching valve assembly 3. Inching stopper 2
 2. Special tool (Stand) 4. Pin

Special tool	Part number
Stand	91A68-02701

2.2 2 Ton Class



502634

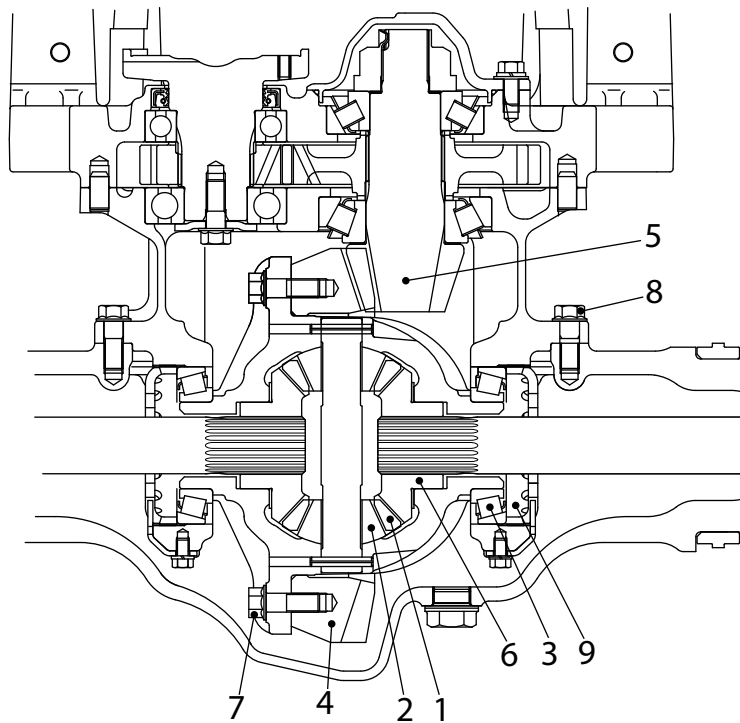
- | | |
|-------------------------|------------------------|
| 1. Frame support | 9. Differential pinion |
| 2. Drive gear | 10. Reduction gear |
| 3. Input flange | 11. Differential case |
| 4. Reduction pinion | 12. Axle shaft |
| 5. Carrier cover | 13. Axle housing |
| 6. Driven gear | 14. Backing plate |
| 7. Differential carrier | 15. Front wheel hub |
| 8. Differential gear | |

Frame support is bolted to the front axle housing together with the backing plate of the wheel brake. While front wheel hub carries a single wheel, a double wheel can be mounted to it with an optional rim.

The reduction differential is mounted to the front axle housing. The input flange carries a drive gear which meshes with the driven gear mounted on the reduction pinion.

Reduction differential

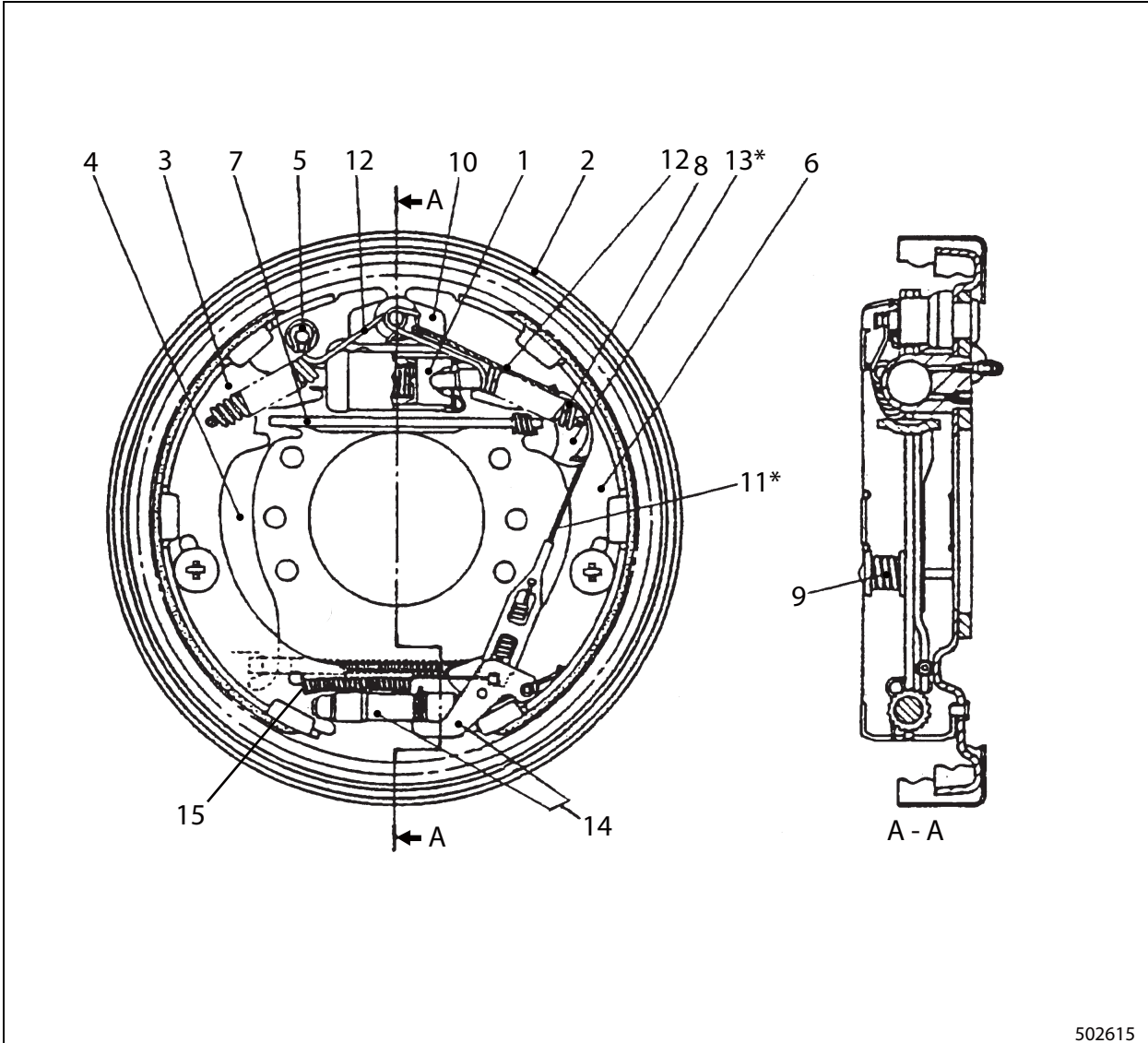
Item		Specified value	
1	Differential gear backlash	Standard	0.10 to 0.23 mm (0.0039 to 0.0091 in.)
		Limit	0.6 mm (0.024 in.)
2	Clearance between differential pinion and spider	Standard	0.02 to 0.085 mm (0.0033 in.)
		Limit	0.35 mm (0.0138 in.)
3	Preload of differential case side bearing	Standard	14.7 to 29.4 N·m (1.50 to 3.00 kgf·m) [10.842 to 21.684 lbf·ft] 12.8 to 24.5 N·m (1.31 to 2.50 kgf·m) [9.441 to 18.070 lbf·ft]
4	Face runout of reduction bevel gear	Standard	0.15 mm (0.0059 in.) or less
		Limit	0.20 mm (0.0079 in.)
5	Backlash between reduction bevel gear and pinion	Standard	0.20 to 0.28 mm (0.0079 to 0.0110 in.) 0.25 to 0.33 mm (0.0098 to 0.0130 in.)
6	Looseness of mating splines	Standard	0.15 mm (0.0059 in.)
7	Tightening torque for bevel gear mounting bolt	Standard	118 ± 9.8 N·m (1.00 kgf·m) [7.228 lbf·ft] 226 ± 9.8 N·m (1.00 kgf·m) [7.228 lbf·ft]
8	Tightening torque for differential case mounting bolt	Standard	108 ± 9.8 N·m (1.00 kgf·m) [7.228 lbf·ft]
9	Tightening torque for side bearing cap bolt	Standard	157 ± 5.9 N·m (0.60 kgf·m) [4.352 lbf·ft] 235 ± 6.8 N·m (0.69 kgf·m) [5.015 lbf·ft]



502679

8. Wheel Brakes, Assembling

8.1 Assembly Sequence (1 Ton Class)



502615

- | | |
|--------------------------------|--|
| 1. Wheel cylinder | 9. Hold-down spring, Cup, Pin |
| 2. Backing plate | 10. Shoe guide plate |
| 3. Shoe and lining (primary) | 11. Cable with spring* |
| 4. Parking brake lever | 12. Return spring |
| 5. Retainer, Washer | 13. Cable guide, Sheave*, Pin, Washer |
| 6. Shoe and lining (secondary) | 14. Adjusting lever, Adjusting screw, Adjusting spring |
| 7. Strut | 15. Return spring |
| 8. Anti-rattle spring | (between primary shoe and secondary shoe) |

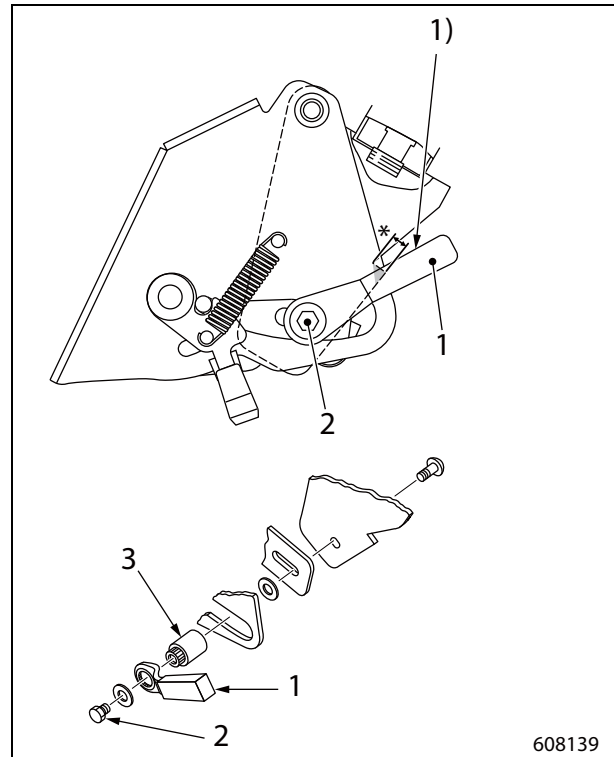
Note: The parts marked with * are included in the repair kit.

9. Tilt Lock Lever, Assembling

If the matchmark which made earlier, have disappeared, or when the lever is replaced with a new one, install the lever as instructed below:

(Figure shows relative positioning of tilt-neutral and column lock lever-lock)

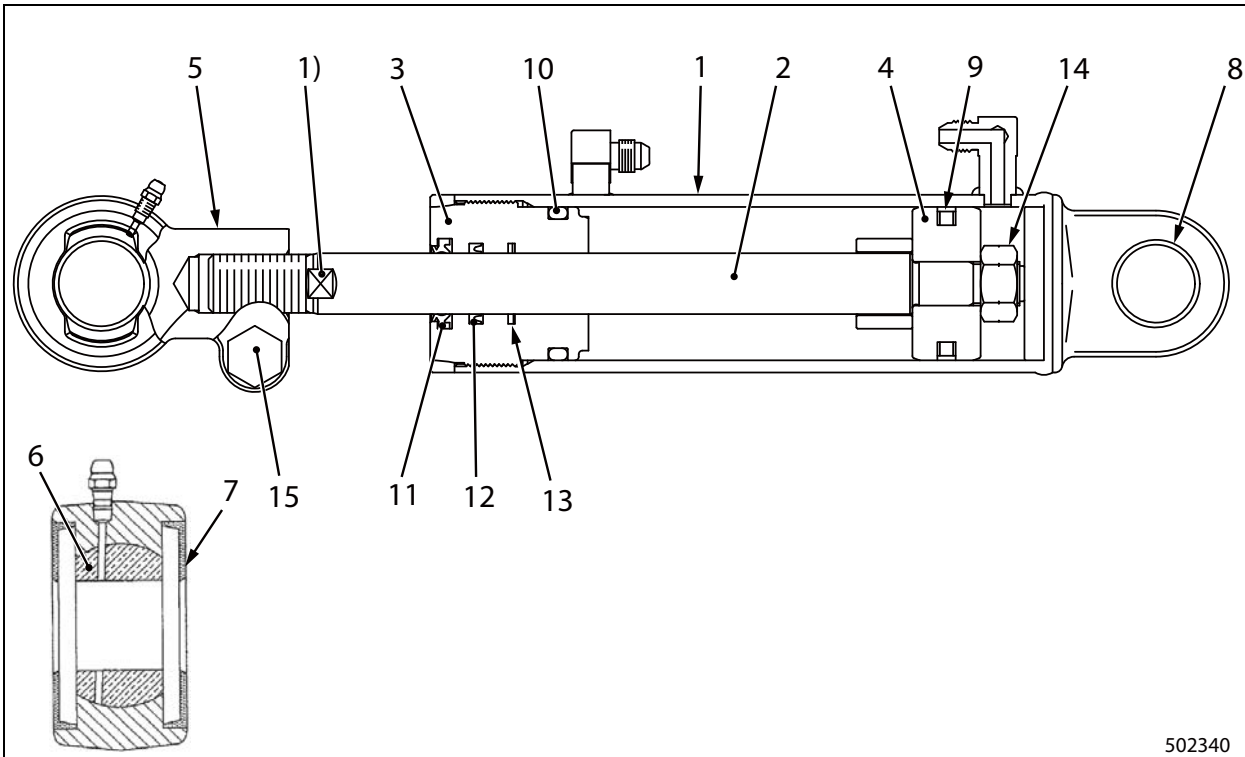
- (1) Tighten nut 3 to specified torque. (This is a lever locked state.)
- (2) With the lever locked, select optimal position for the tilt lock lever and fit tilt lock lever into the serration of nut 3. The optimal position is within the range where bracket notch marked with * is crossing the upper aspect of the lever.
- (3) Tighten lever mounting bolt 2.
- (4) Loosen the tilt lock lever and make sure the bracket slides in the entire tilting area without interfering with other parts.



1. Tilt lock lever
 2. Lever mounting bolt
 3. Nut
- 1) Lever aspect

Ref.	Item	Tightening torque
2	Lever mounting bolt	23 to 25 N·m (2.3 to 2.5 kgf·m) [16.96 to 18.44 lbf·ft]
3	Nut	11 to 15 N·m (1.1 to 1.5 kgf·m) [8.11 to 11.06 lbf·ft]

1.10 Tilt Cylinder



502340

- | | |
|------------------|-----------------|
| 1. Cylinder | 9. Piston seal |
| 2. Rod | 10. O-ring |
| 3. Guide bushing | 11. Dust seal |
| 4. Piston | 12. Packing |
| 5. Socket | 13. Buffer ring |
| 6. Bearing | 14. Nut |
| 7. Seal | 15. Clamp bolt |
| 8. Bushing | |

The tilt cylinder is a double-acting type. To adjust the right and left imbalances of the tilt angles when the mast is attached, loosen the clamp bolt and then turn the piston rod with a spanner fitted to area 1) of the piston rod.

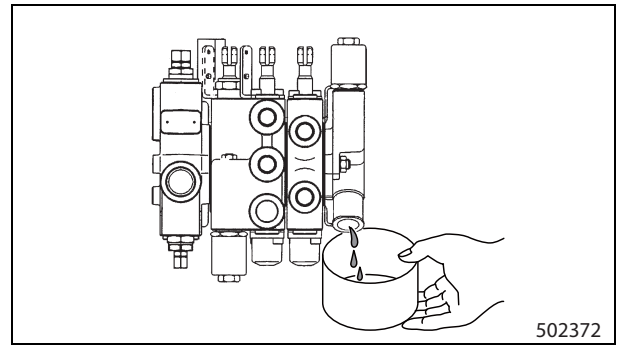
Seal helps to extend greasing intervals of grease nipples. Installation of this seal has extended greasing intervals to 500 hundred hours.

Cylinder dimensions

(Cylinder length and stroke vary depending on forward and backward tilt angle.)

Truck classifications	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1 ton class	25.0 mm (0.984 in.)	63.0 mm (2.480 in.)	73.0 mm (2.874 in.)
2 ton class	30.0 mm (1.181 in.)	70.0 mm (2.756 in.)	82.0 mm (3.228 in.)
3 ton class	35.0 mm (1.378 in.)	80.0 mm (3.150 in.)	93.0 mm (3.661 in.)

- Quickly disconnect the oil return hose, and catch the oil that comes out.

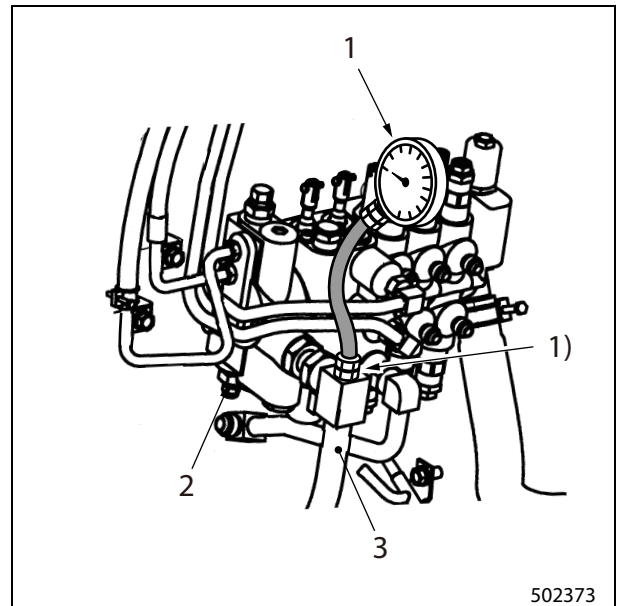


Item	Value
Amount of oil discharged in 15 minutes	20 cc (1.5 cu.in.) or less

- If the lift cylinders or tilt cylinders drift (the mast tilts forward or the forks lower) excessively even if the total amount of collected oil in 15 minutes is less than 20 cc (1.5 cu.in.), measure the internal oil leak of each cylinder. (The measurement is the standard value, not the service limit.)

Adjusting main relief valve

- Install a pressure gauge capable of measuring up to 25000 kPa to the delivery hose connector.
- Move the tilt lever to the tilt back position. When the relief valve is normal, the oil is relieved and the pointer of oil pressure gauge indicates $18.1^{+0.5}_0$ MPa ($184^{+5.10}_0$ kgf/cm²) [2625^{+72}_0 psi] when the tile lever is tuned to the backward tilt position and the tile cylinder reaches the backward tilt limit.
- If the relief pressure is incorrect, loosen the locknut of the relief valve, and then adjust by rotating the adjusting screw while observing the pressure gauge reading.
- While holding the adjusting screw, tighten the locknut to secure the adjusting screw.
- After securing the adjusting screw, check the main relief valve set pressure again.



1. Pressure gauge
 2. Main relief valve
 3. Pump delivery hose
 1) R 1/8

Item	Value
Main relief valve set pressure	$18.1^{+0.5}_0$ MPa ($184^{+5.10}_0$ kgf/cm ²) [2625^{+72}_0 psi]

Remove the R 1/8 plug from the metal end fittings of the pump delivery hose and attach a pressure gauge to it.

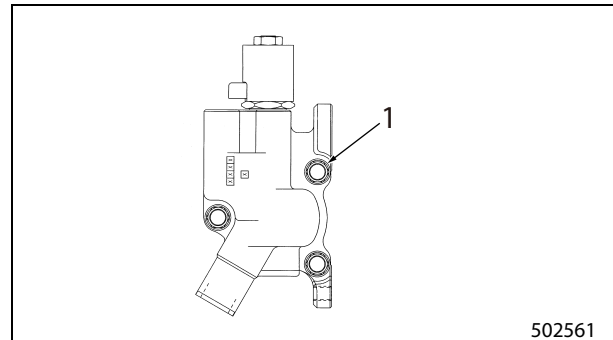
40. Control Valve - End Cover Section, Assembling

For assembly, follow the disassembly sequence in reverse.

40.1 Suggestions for Assembly

- (1) Clean parts that have been disassembled with an appropriate solvent, and apply compressed air to the parts to dry and remove foreign matter.
- (2) Apply hydraulic oil to each part.
- (3) Replace O-rings with new ones.
- (4) Tighten tie bolts.
Tighten bolts evenly. Tightening them unevenly or to inadequate torque can distort the valve body, resulting in unsmooth movement of the spool.
- (5) Install component valves after appropriate valve bodies are installed with tie bolts.
- (6) Ensure the spools slide smoothly.

Note: The valve body and spool have been lapped as a set. Do not change the combination. When replacing, replace as a set of body and spool.

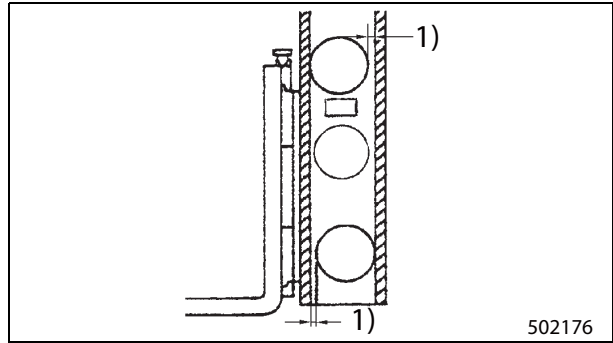


1. Tie bolt

1.21 Adjusting Clearance Between Lift Bracket Roller and Inner Mast (All Mast Models)

Measuring back-to-front clearance on lift bracket main rollers

- (1) Slightly lift the forks off the ground.
- (2) Insert a claw bar between the upper part of the lift bracket and the inner mast, push the inner mast to either side. Measure the clearance between the main roller and the inner mast on the opposite side with a feeler gauge.
- (3) If the clearance deviates from the specified value, replace with oversize roller. For replacement, refer to 14-10 "Selecting roller of correct outer diameter".



1) Clearance between main roller rolling face and inner mast

502176

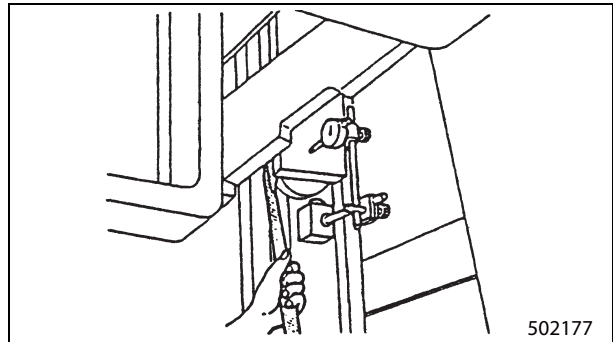
Ref.	Item	Standard
1)	Clearance between main roller rolling face and inner mast	1.0 mm (0.039 in.) or less

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

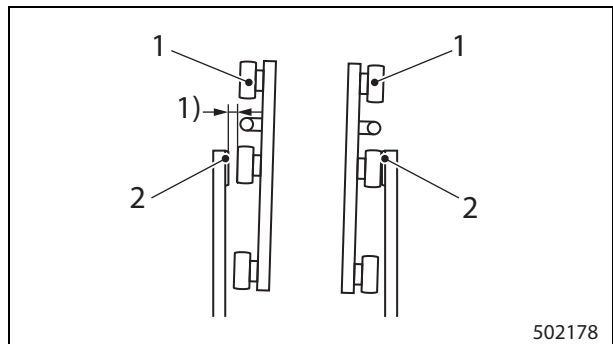
- (1) Raise the lift bracket to the inner mast uppermost position.
- (2) Set a dial indicator on the inner mast with its contact point rested on the side of the lift bracket.
- (3) Go over to the opposite side of the mast, and slide the lift bracket to one side with a bar. Set the indicator to zero.
- (4) Insert a claw bar between the inner mast and lift bracket on the dial indicator side, and push the lift bracket to the opposite side.
- (5) Measure the clearance between lift bracket middle roller and thrust plate. Adjust shim thickness as required.

Note: The upper rollers do not require any measurement and adjustment.

For adjustment, refer to 14-11 "Adjusting clearance between middle roller side face and thrust plate".



502177



1. Upper roller
2. Thrust plate

1) Clearance between middle roller side face and inner mast thrust plate

502178

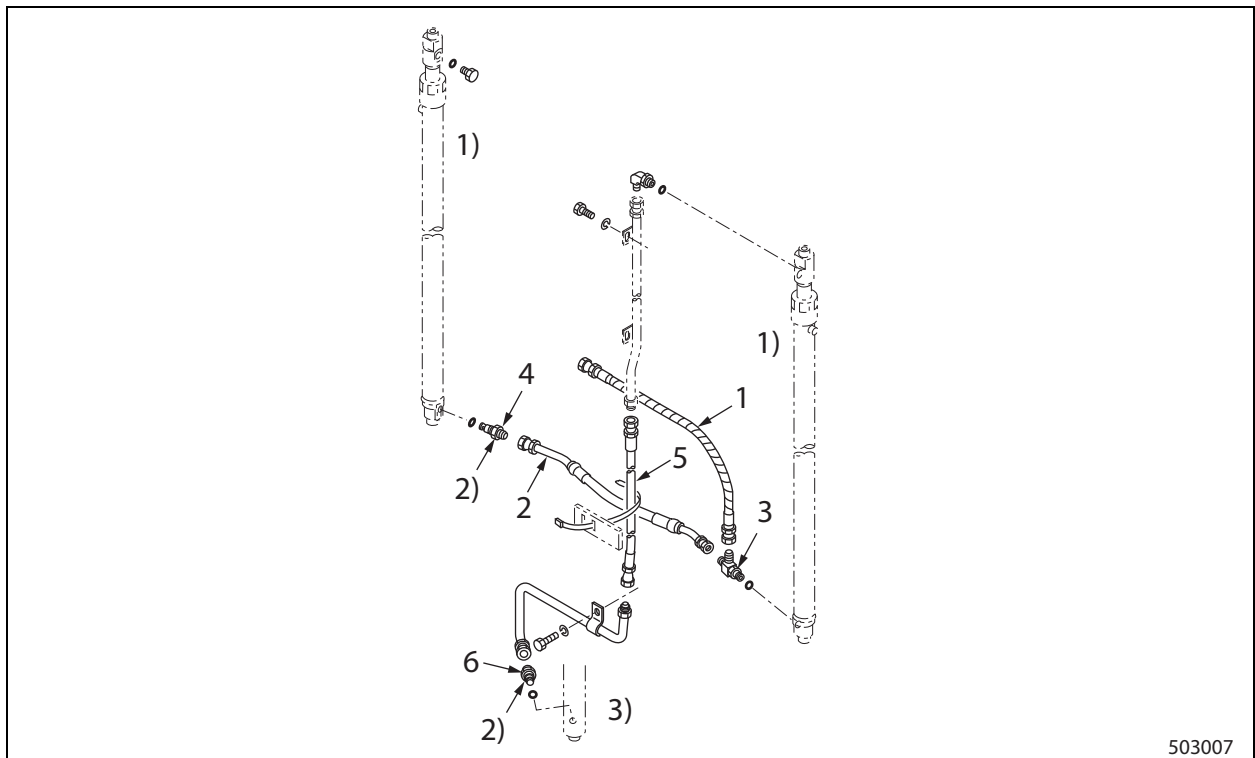
Item	Item	Standard
1)	Clearance between middle roller side face and inner mast thrust plate	0.1 to 0.5 mm (0.004 to 0.020 in.)

2.17 Installing Hydraulic Lines

General precautions

- Use care not to let abrasive dust or dirt to enter the hydraulic system during installation.
- Apply a coat of oil to O-rings before installation.
- Elbow connector 6 should be assembled with straight threads and O-ring seal observing the procedure "Installation of a fitting with straight threads and O-ring seal."

Tightening torque



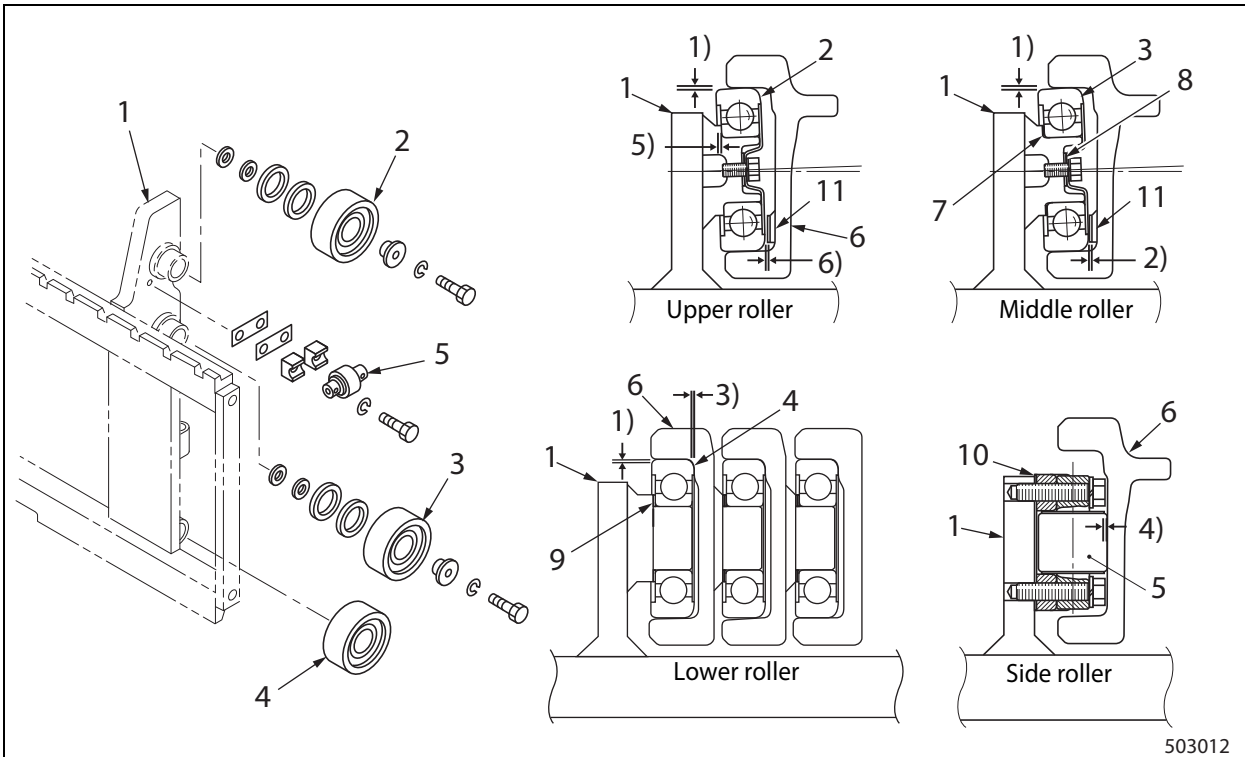
503007

- 1) Second cylinder
- 2) Down safety valve

- 3) First cylinder

Item	Specified value		
	1-2 ton class	3 ton class	
1	Nut	58.8 ± 5.9 N·m (6.00 ± 0.60 kgf·m) [43.369 ± 4.35 lbf·ft]	58.8 ± 5.9 N·m (6.00 ± 0.60 kgf·m) [43.369 ± 4.35 lbf·ft]
2	Nut	49.0 ± 4.9 N·m (5.00 ± 0.49 kgf·m) [36.141 ± 3.61 lbf·ft]	49.0 ± 4.9 N·m (5.00 ± 0.49 kgf·m) [36.141 ± 3.61 lbf·ft]
3	Nut	39.2 ± 3.9 N·m (4.00 ± 0.39 kgf·m) [28.912 ± 2.87 lbf·ft]	58.8 ± 5.9 N·m (6.00 ± 0.60 kgf·m) [43.369 ± 4.35 lbf·ft]
4	Nut		
5	Nut	58.8 ± 5.9 N·m (6.00 ± 0.60 kgf·m) [43.369 ± 4.35 lbf·ft]	
6	Nut		

3.10 Lift Bracket Roller, Assembly Sequence (All Mast Models)



503012

- | | |
|--|---|
| <ol style="list-style-type: none"> 1. Lift bracket 2. Lift bracket upper roller 3. Lift bracket middle roller 4. Lift bracket lower roller 5. Side roller 6. Inner mast 7. Shim (a) 8. Shim (b) 9. Shim (c) 10. Shim (d) 11. Thrust plate | <ol style="list-style-type: none"> 1) Clearance between main roller rolling face and inner mast 2) Clearance between middle roller side face and inner mast thrust plate 3) Clearance between lower roller side face and inner mast thrust face 4) Clearance between side roller rolling face and inner mast 5) No shim required 6) Minimum clearance |
|--|---|

System	Check items	Pre-start (daily/10 hours)	Every 50 hrs or weekly	1st month (200 hrs)	Every 500 hrs or 3 months	Every 1000 hrs or 6 months	Every 2000 hrs or 12 months	Others (see note 1)
Electrical	Check alternator			×		×		
	Check back lights	×						
	Check battery (electrolyte level)	×						
	Check battery (electrolyte specific gravity)			×	×			
	Check driving interlock system	×						
	Check electrical wires			×	×			
	Check horn	×						
	Check meter panel (instrument) lamp (incl. parking brake, seat belt)	×						
	Check mast interlock system	×						
	Check parking brake buzzer	×						
	Check starter			×		×		
	Check stop lights	×						
	Check working and head lamp	×						
Engine	Check cylinder head bolt and manifold nut			×				
	Check engine (exhaust, noise, vibration)	×						
	Check engine idle speed (for carburetor and diesel engine)			×	×			
	Check engine oil level	×						
	Check intake & exhaust valve clearance			×	×		×	
	Check positive crankcase ventilation valves and hoses				×			
	Change engine oil			R	R			
	Change engine oil filter			R	R			
Frame and Chassis	Check frame assist grip	×						
	Check loosen bolts or nuts			×	×			
	Check overhead guard	×						
	Check seat adjustment	×						
	Check seat belt	×						

TROUBLE DIAGNOSIS

Engine Adjust.

Condition	Cause	Action
1. Engine noise		
Slapping noise of bearing and crankshaft	Bearing looseness	Replace.
	Bearing seizure	Replace.
	Crankshaft bend	Repair or replace.
	Uneven wear of journal	Correct.
	Excessive end play	Replace center bearing.
Slapping noise of piston, connecting rod	Bearing looseness	Replace.
	Bearing seizure	Replace.
	Piston looseness	Replace piston pin(s) or bushing(s).
	Piston looseness relative to cylinder	Reselect.
	Piston ring damage	Replace.
	Poor rod alignment	Realign.
Slapping noise of camshaft	Bearing looseness	Replace.
	Excessive axial looseness	Replace bearing thrust plate(s).
	Rough gear tooth face(s)	Correct.
	Gear damage	Replace.
Timing chain noise	Inappropriate tension	Adjust.
	Damaged or sagged chain	Replace.
	Worn sprocket	Replace.
	Damaged or loose tensioner	Replace.
	Excessive camshaft-to-bearing clearance	Replace.
Slapping noise of valve gear	Inappropriate valve clearance	Adjust.
	Loose Adjust. screw(s)	Replace.
	Worn rocker face(s)	Replace.
	Worn valve guide(s)	Replace guide(s).
	Loose valve spring(s)	Replace.
	Valve seizure	Repair or replace.
Slapping noise of water pump	Inappropriate end play	Replace.
	Damaged impeller	Replace.
2. Other mechanical damage		
Stuck valve	Inappropriate clearance	Adjust.
	Valve stem - insufficient guide-to-guide clearance	Clean stem(s), ream guide(s).
	Loose or damaged spring	Replace.
	Seized or damaged valve stem(s)	Replace or clean.
	Poor fuel quality	Use good fuel.
Burnt valve seat(s)	Inappropriate valve clearance	Adjust.
	Deteriorated valve spring(s)	Replace.
	Edged valve end(s)	Replace bulb.
	Too narrow valve seat width	Correct valve seat(s).
	Engine over temperature (Overheat)	Repair or replace.
	Overrun	Operate in optimum speed range.
	Stuck valve guide(s)	Correct.

TROUBLE DIAGNOSIS

Condition	Possible causes	Action
Incident due to other factors		
Low oil pressure	• Use of inappropriate quality of oil	Replace specified oil.
	• Engine over temperature (Overheat)	Already described
	• Oil pump regulator valve malfunction	Overhaul or replace oil pump
	• Oil pump malfunction	Overhaul or replace oil pump
	• Oil filter malfunction	Replace with a new one.
	• Enlarged clearance of each sliding component	Disassemble and replace relevant sliding component(s).
	• Clogged oil strainer	Washing
	• Malfunction of oil pressure gauge pressure switch	Replace with a new one.
Excessive wear of sliding part(s)	• Low oil pressure	Already described
	• Poor quality of oil or foreign objects in oil	Replace oil element and oil with appropriate ones.
	• Poor performance of air cleaner	Inspect element
	• Overheat or excessive cooling	Already described
	• Inappropriate air-fuel ratio	Inspect fuel system
Bite of sliding parts	• Low oil pressure	Already described
	• Insufficient clearance	Adjust clearance to specified value.
	• Engine over temperature (Overheat)	Already described
	• Inappropriate air-fuel ratio	Inspect fuel system

TIGHTENING TORQUE

Tightening procedure

Tightening torque (Reference)		N · m (kgf · m)
①	19.6 – 23.52 (2.0 – 2.3)	Tightening for brake-in
②	68.6 (7.0)	
③	0.0	Return
④	19.6 – 23.52 (2.0 – 2.3)	Retightening
⑤	90° – 92°	

Assembly sequence

Precautions before assembling

- Do not allow oil or dust to get on cylinder head, mounting surface of cylinder block, and head gasket.
- Apply anticorrosive oil onto head bolt thread and surface under the head.

MAM0142

CYLINDER HEAD

Tightening torque for general service is 68.6 N·m (7.0 kgf·m) in the place of the tightening torque (5) as shown in the figure.

Assembly sequence

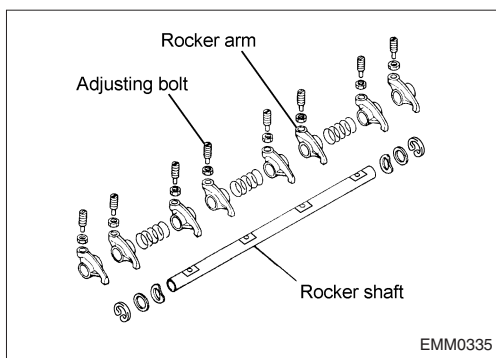
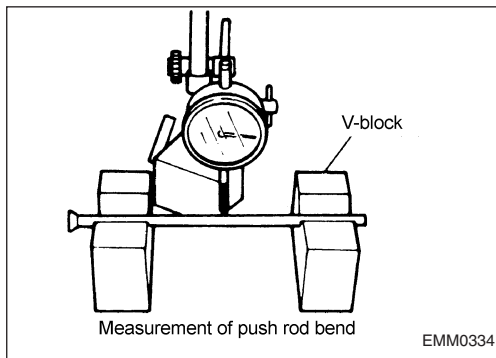
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MAIN BEARING CAP

☞ : 83.4 - 93.2 N·m (8.51 - 9.51kgf·m)

- Apply antirust oil or engine oil to the bolt threads and head bottom.
- Do not use any power tools such as an air runner for assembly.

Inspection and Correction (Cont'd)



18. Push rod

- Inspect the push rod and replace it if excessive wear, twist or damage is observed. If a bend of 0.05 mm or more is present, repair or replace the push rod.

19. Rocker shaft

- Check the rocker shaft for wear, damage or bend and replace it if wear of 0.05 mm or more is observed.

20. Rocker arm and adjusting bolt

- Inspect the valve stem-to-rocker shaft contact face of the rocker arm and adjusting bolt. If excessive wear is found or the rocker shaft clearance exceeds the specified limit, replace the rocker arm (adjusting bolt).

	Standard	Repair limit
Rock arm/shaft Clearance mm (in)	0.020 - 0.054 (0.0008 - 0.0021)	0.1(0.0039)

21. Flywheel

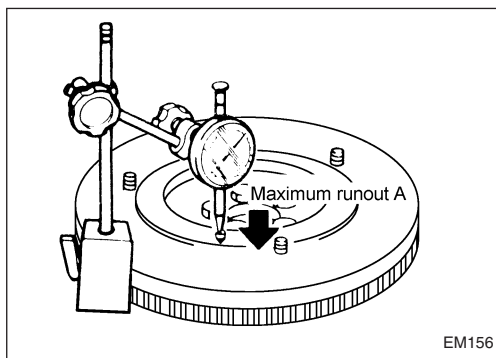
- Inspect the flywheel sliding face and the ring gear teeth.
- If excessive damage or wear is observed, repair or replace the relevant component.
- If the wear of the flywheel ring gear is relatively small, reuse the ring gear by shifting the installation position by 45 degrees.
To install a new ring gear, heat it to 180°C and use a compression fitting method.

MEASURING FLATNESS

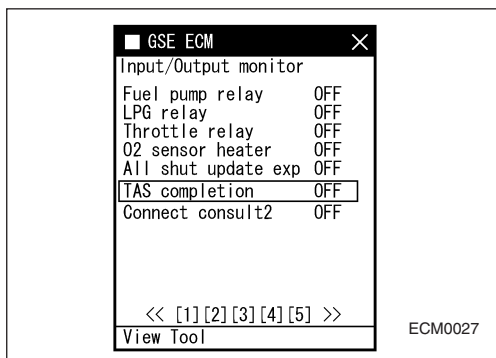
- Measure the flatness while turning the crankshaft using a dial gauge.
- The flatness limit A is the maximum allowable flatness measured vertically to the flywheel clutch sliding face.

Flywheel flatness limit

A: 0.1 mm (0.004 in) or less



Throttle Valve Closed Position Learning and Idle Air Volume Learning (Cont'd)



CAUTION:

It will take approximately 20 seconds to complete the idle air volume learning. Do not turn OFF the ignition switch until completion.

- Confirm whether or not the learning has been completed by checking the “TAS completion” in ECM Input/Output monitor.
Learning completed: ON
Learning not yet completed: OFF
- Make sure that idle speed and ignition timing are within the standard.
- Perform “Idle Air Volume Learning” again if values are outside the standard.

Accelerator Pedal Released Position Learning

DESCRIPTION

When the accelerator pedal assembly has been replaced or the accelerator pedal position sensor connector has been disconnected, the accelerator pedal released position needs to be learned after being repaired, so learn accelerator pedal in fully-released position.

OPERATION PROCEDURE

1. Turn ignition switch ON and wait at least 2 seconds.
2. Turn ignition switch OFF and wait at least 10 seconds.
3. Then turn ignition switch ON again and wait at least 2 seconds (learning completed).

Fuel pressure inspection

QUICK INSPECTION

With ST

1. Turn ignition switch ON (engine stopped).
2. Press “OK” in “Fuel Pressure Release” of ECM Active Test.
3. Pinch the fuel feed hose with the fingers. Hose should not feel hard.

Without ST

- When the fuel feed hose is squeezed while fuel pump is operating (immediately after the ignition switch is turned ON or while cranking), the hose should be swelling with pressure or pulsating.

FUEL PRESSURE RELEASE

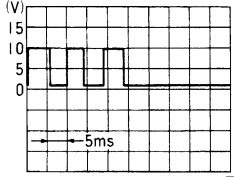
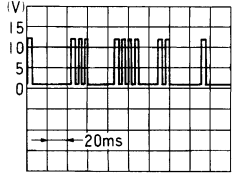
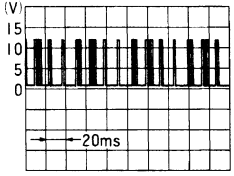


CAUTION:

Relieve fuel pressure before removing fuel piping to secure safety.

TROUBLE DIAGNOSIS

ECM Input/Output Signal Specifications (Cont'd)

Terminal signal	Signal name	Measurement condition	Measured value
14	Camshaft position sensor (PHASE)	At cranking	Approx. 0.15V  ECM0055
		At idle after warming up	Fluctuates between approx. 1.5 - 2V.  ECM0056
		At approx. 2,000 rpm	Approx. 2V  ECM0057
51	Mass air flow sensor	Ignition switch ON	Approx. 1V
		At cranking	Approx. 1.5V
		At idle after warming up	Approx. 1.3V
		At approx. 2,000 rpm	Approx. 1.5V
50	Throttle position sensor 1	At idle after warming up	Approx. 0.6V
		Ignition switch ON with engine stopped Accelerator pedal is fully depressed	Approx. 0.75V
		Ignition switch ON with engine stopped Accelerator pedal is released	Approx. 0.75V
		At approx. 2,000 rpm	Approx. 0.7V
69	Throttle position sensor 2	At idle after warming up	Approx. 4.5V
		Ignition switch ON with engine stopped Accelerator pedal is fully depressed	Approx. 4.35V
		Ignition switch ON with engine stopped Accelerator pedal is released	Approx. 4.35V
		At approx. 2,000 rpm	Approx. 4.4V
106	Accelerator pedal position sensor 1	At Idle	Approx. 0.6V
		Ignition switch ON with engine stopped Accelerator pedal is fully depressed	Approx. 0.6V
		Ignition switch ON with engine stopped Accelerator pedal is released	Approx. 4.2V
		At approx. 2,000 rpm	Approx. 0.65V

PNP SWITCH SYSTEM

ST Data Monitor Display

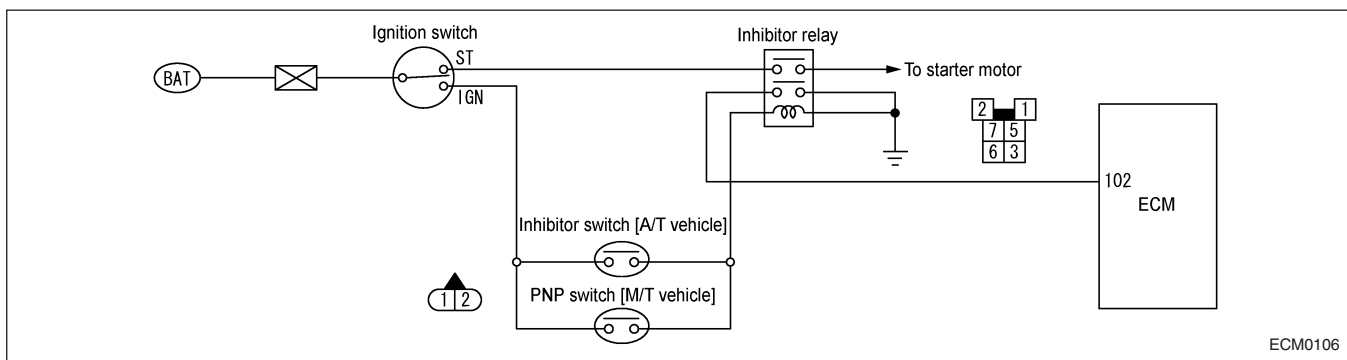
Monitor item	Neutral, or N position	Other than the left
Neutral SW	ON	OFF

ECM Input/Output Signal Specifications

Measure voltage between terminals shown below and ground using a circuit tester.

Terminal	Signal name	Neutral, or N position	Other than the left
102	PNP switch	Approx. 0V	Battery voltage (A/T models) Approx. 4.8V (M/T models)

Circuit Diagram



ENGINE COOLANT SYSTEM

Thermostat

REMOVAL

1. Remove the radiator upper hose from the water outlet and extract coolant.



WARNING:

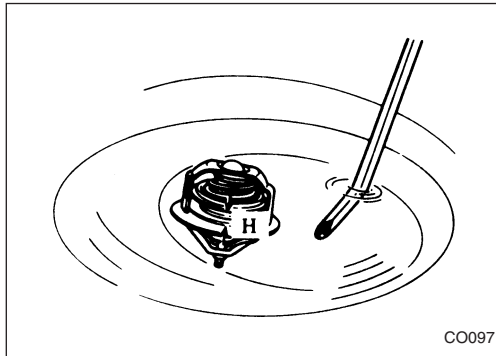
Do not drain coolant when engine is still hot. It may be a cause to get burned.

2. Remove water inlet and remove thermostat.

INSPECTION

Inspect the thermostat as instructed below and replace it as necessary.

1. Inspect valve seating status under ordinary temperature. The valve must be seated firmly.
2. Inspect the opening temperature and maximum valve lift by heating the valve in a container.



CAUTION:

if may be a cause to get burned. Do not touch the thermostat, container or hot water inside until the temperature lowers sufficiently.

3. Make sure that the valve closing temperature is approx. 5°C lower than the opening temperature. Also perform the same inspection before installing a new thermostat.

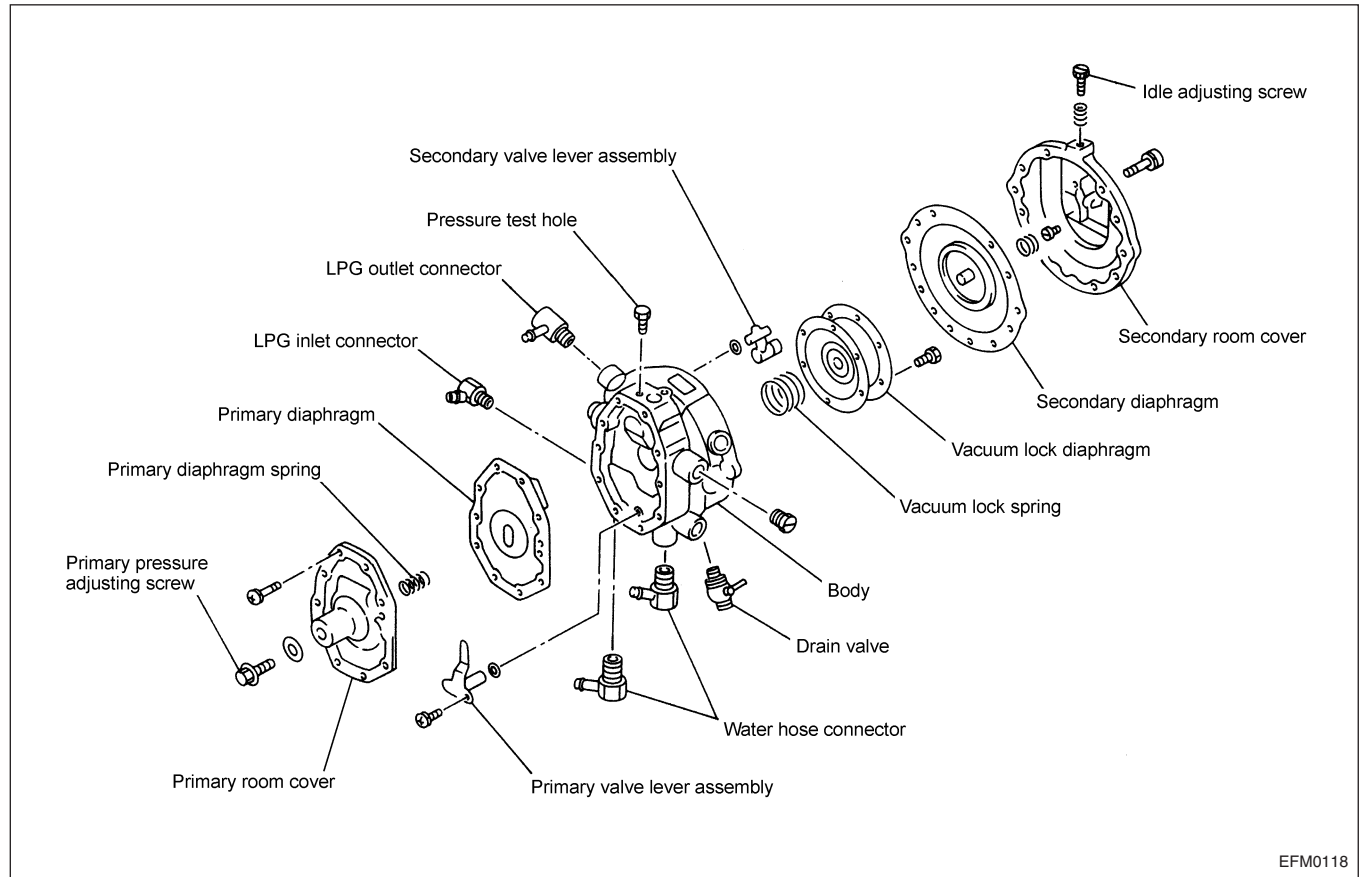
INSTALLATION

Install in the reverse order of removal.
Always use a new water inlet gasket.

VAPORIZER MECHANISM AND OPERATION

Secondary Valve Room (Cont'd)

CARBURETOR SPECIFICATION VAPORIZER COMPONENTS



HOW TO USE THIS MANUAL

Description

This manual explains how to use “removal, installation, disassembly, assembly, inspection and adjustment” and “diagnosis.”

Definition of Terms

WARNING: Instructions and precautions that may lead to fatal hazards and/or serious injuries if not observed properly.

CAUTION: Instructions and precautions that require special attention and may lead to problems and/or accidents as well as damages to the vehicle and/or components.

NOTE: Provides additional information that facilitates operation.

Standard: Indicates tolerances for inspection and adjustment.

Repair limit: Indicates maximum or minimum values allowed for inspection and adjustment.

Definition of Units

The units and numerical values in this Standard are SI units, and those given in () in this Standard are based on the conventional unit system and are appended for informative reference.

Example: Tightening torque 59 - 78 N·m (6.0 - 8.0 kgf·m)

SI (Metric system)

Main unit changes

Measure	SI	Conventional unit	Conversion factor to SI
Acceleration	m/s ²	G	9.80665
Torque, moment	N·m	kgf·m	9.80665
Force	N	kgf	9.80665
Pressure	MPa	kgf/cm ²	0.0980665
	kPa	mmHg	0.133322
Power efficiency	kW	PS	0.735499
	W	kcal/h	1.16279
Volume	cm ³	cc	1
Spring constant	N/mm	kgf/mm	9.80665
Fuel consumption	*g/kW·h	g/PS·h	1.3596

* The conventional unit can be used for SI.

Description

Caution: At the beginning of each section, the precautions exclusive to the section are described.

Preparation: At the beginning of each section and during the trouble diagnosis items, the Special Tools (STs), gauges, and other tools to be prepared before operation are described. Some commercial service tools, assumed to be available in any workshop, are omitted.

Description: To perform correct operations, operational procedures, notes, STs, and other service information are described.

CAUTION: Descriptions of visual inspections and cleaning of removed parts are generally omitted. Please remember that actual operations require these processes.

TROUBLE DIAGNOSIS

Engine LPG Fuel System

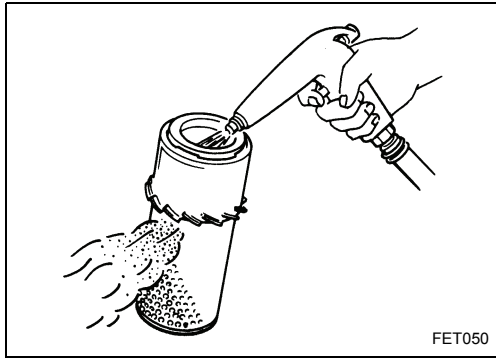
Condition	Possible causes	Action
Fuel leakage		
Nasty smell	• Looseness of piping connection	Tighten.
	• Operating malfunction of vaporizer	Repair and adjust.
	• Poor connection or some foreign object is caught in between plunger rubber seat and valve seat of solenoid valve	Clean and rub.
	• Operating malfunction of lock off mechanism	Adjust.
Excessive fuel consumption	• Looseness of piping connection	Retighten and adjust.
	• Primary side room pressure at idle is excessively high.	Clean and adjust.
	• Clogged air cleaner	Wash.
	• Adjusting malfunction of LPG mixer main adjusting screw	Adjust.
Low output	• Operating malfunction of vaporizer	Repair and adjust.
	• Looseness of piping connection or clogged filter	Clean and retighten.
	• Adjusting malfunction of vaporizer primary and secondary room pressures	Adjust.
	• Adjusting malfunction of LPG mixer main adjusting screw	Adjust.
	• Use improper fuel.	Use proper fuel.
	• Clogged fuel passage	Clean.
Inconsistent or rough idle	• Improper position of vaporizer idle Adjust. screw or carburetor throttle valve, or operating malfunction of electric throttle control actuator	Adjust.
	• Operating malfunction of vaporizer	Repair and adjust.
	• Operating malfunction of vaporizer valve (It is closed improperly.)	Clean, adjust or replace.
Engine hesitation or hunting	• Operating malfunction of vaporizer	Adjust.
	• Adjusting malfunction of idle speed	Adjust.
Poor starting engine	• Insufficient fuel	Refill fuel.
	• Operating malfunction	Make sure that manual valve is opened.
	• Operating malfunction of solenoid valve	Check and repair wiring, switch, and solenoid valve.
	• Operating malfunction of vaporizer	Replace.
	• Water pump malfunction	Repair and adjust
	• Adjusting malfunction of idle speed	Adjust.
Operating malfunction of vaporizer	• Adjusting malfunction of vaporizer primary and secondary room pressures	Adjust.
	• Leakage from primary and secondary valve seats of vaporizer	Clean, adjust, or replace.
	• Damage of diaphragm	Replace.
	• Foreign materials enter vaporizer inside	Clean and adjust.
	• Leakage by looseness of setscrew	Tighten.
	• Overcool of vaporizer (For deposits, damage to hose, poor coolant circulation)	Check, clean, and adjust.
	• Tar deposit in valve	Remove tar and clean.

Ignition and Fuel Systems

CLEANING OR REPLACEMENT OF AIR CLEANER ELEMENT

Dry filter type

It requires periodical cleaning and replacement. If the engine is used in a heavily contaminated environment, perform maintenance more frequently.



FUEL FILTER

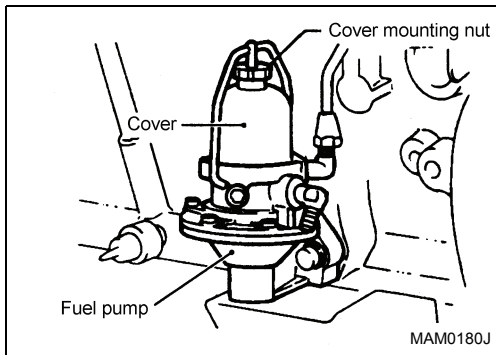
Cleaning and replacement (carburetor model only)

Periodically inspect, clean and replace the fuel filter.

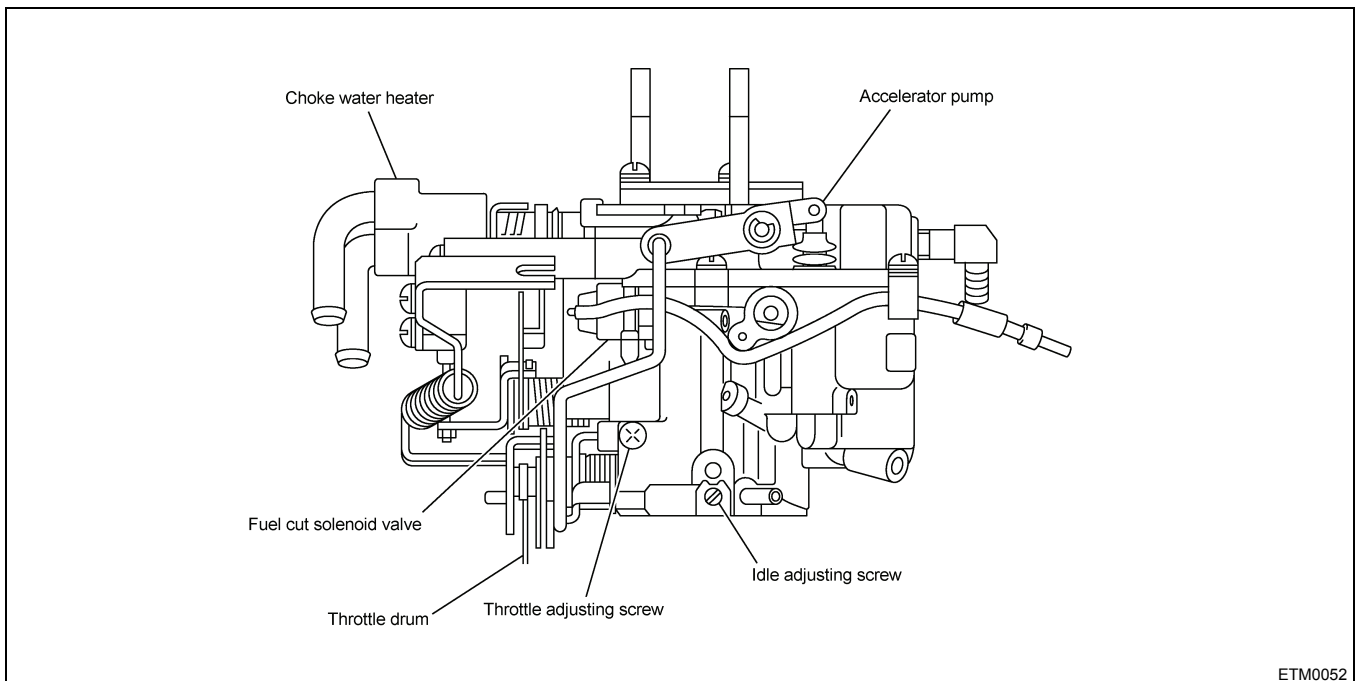
Fuel piping inspection

(Hoses, tubes, fittings)

Check the fuel piping for proper installation as well as leakage, cracks, and loose connections and replace damaged or malfunctioning parts as necessary.



CARBURETOR INSPECTION



Inspecting link mechanism and valves

- Remove the air horn and visually inspect the link system and internal components.
- Check the throttle shaft for wear by attempting to move it by hand. The throttle shaft must not move.
- Check the throttle valve and choke valve for proper operation. (Open, close)

Installation

Note the following, and install in the reverse order of removal.

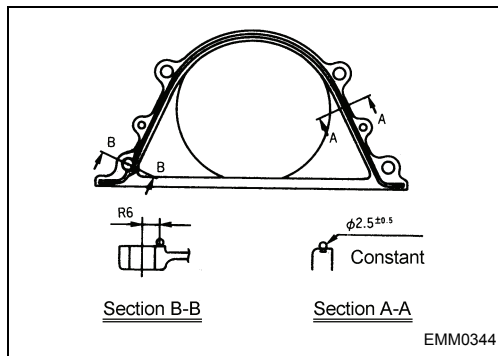
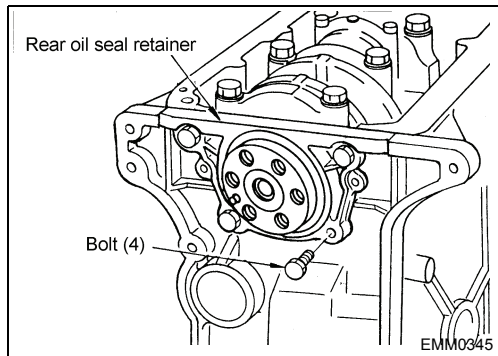
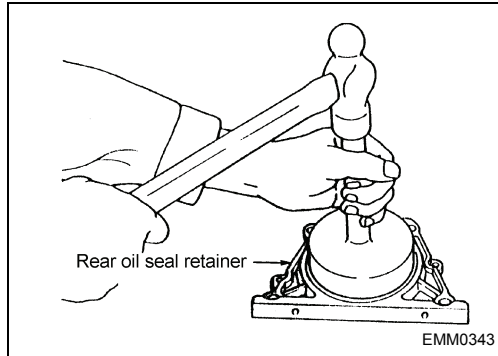
- Do not allow oil to get on the engine mount insulator. Be careful not to damage the engine mount insulator.
- Securely insert positioning stopper pin into mating side hole.
- Make sure all mount insulators are seated properly, then tighten mount nuts and bolts.

Inspection

- Before starting engine, check amount of engine coolant, oil and grease. Refill as necessary.
- Start engine and check for any unusual noise and vibration.
- Warm up engine, and then check engine coolant, oil and grease, fuel, and exhaust gas for leakage.

Engine Assembly (Cont'd)

8. Assembly of rear oil seal retainer



- Assemble the oil seal to the rear oil seal retainer. To drive in the oil seal, use the special service tool (91H20-09070).
- Install rear oil seal retainer to cylinder block.
Rear oil seal retainer retaining bolt:
 - ☒ 2.1 - 3.7 kgf-m
 - ☒ 20.6 - 26.5 N•m

CAUTION:

- Before installing the rear oil seal retainer, apply liquid packing to the retainer as shown in the figure.
- Once attaching the retainer and tightening the bolts, do not make additional tightening or remove the retainer (and retighten).
- For the mounting face, apply a continuous bead of sealant along the groove. For the bolt holes, apply sealant so that it does not run off the inner edges.
- Make sure to finish the assembly within 5 minutes after sealant application.
- After the assembly, leave the assembled parts as is for 30 minutes or more.

PRECAUTIONS BEFORE APPLICATION:

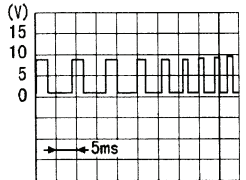
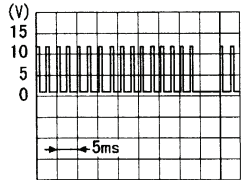
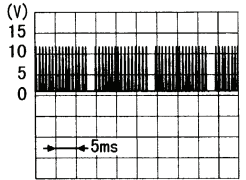
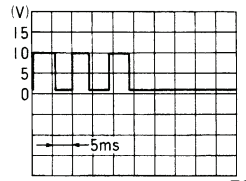
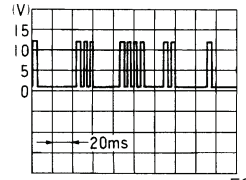
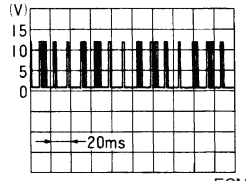
- The mounting faces (both sides) shall be free from moisture, oil, grease, waste, dust and other foreign objects.
- Make sure to remove any sealant from the flange/mounting faces and threads when reassembling the part that has once been attached and disassembled.

9. Assembly of piston

- Assemble the bearing to the connecting rod.
- To each cylinder, assemble the corresponding connecting rod and piston subassembly according to the cylinder number.
- When assembling, turn the bottom mark of the piston toward the front.
- Set the crankshaft pin positions to TDC or BDC.

TROUBLE DIAGNOSIS

ECM Terminal (Cont'd)

Terminal signal	Description	Measurement condition	Measured value
13	Crankshaft position sensor (POS)	At cranking	Approx. 2.6V  ECM0052
		At idle after warming up	Approx. 3V  ECM0053
		At approx. 2,000 rpm	Approx. 3V  ECM0054
14	Camshaft position sensor (PHASE)	At cranking	Approx. 0.15V  ECM0055
		At idle after warming up	Fluctuates between approx. 1.5 - 2V.  ECM0056
		At approx. 2,000 rpm	Approx. 2V  ECM0057
24	Heated oxygen sensor heater	At idle after warming up	Approx. 0.3V
31	LPG fuel pressure sensor	At idle after warming up	Approx. 0.78V

BASIC INSPECTION

Inspection of Idle Speed and Ignition Timing SERVICE DATA AND SPECIFICATIONS (SDS)

Fuel pressure [(kPa, bar, kg/cm ² , psi)]		0.35 (0.0035, 0.0036, 0.051)
Idle speed (rpm)	A/T model (at N position)	700±50
Ignition timing (°BTDC/rpm)	A/T model (at N position)	0±2/700
Firing order		1-3-4-2
Spark plug	Manufacturer/type/gap mm (in)	NGK/FR2A-D/0.8 - 0.9 (0.0031 - 0.035)
Ignition advance device		Electrically controlled ignition advance
Density of CO at idle speed (%) / Density of HC at idle speed (ppm)		0.1/50 or less

- Turn ignition switch ON, and then make sure that no malfunction is detected by self-diagnosis.
- Make sure that engine is free of oil pressure pump loads and any electrical loads. Perform the inspection with the shift lever in the neutral or N position.
- Warm up engine and transmission to the normal operating temperature.

IDLE SPEED

With ECM Input/Output monitor:

Displayed "Engine speed" on ECM Input/Output monitor, then make sure that idle speed is 700±50rpm.

CAUTION:

Perform "Idle Air Volume Learning" when idle speed is outside the standard.

Without ECM Input/Output monitor:

1. Connect an induction type (current detection type) tachometer to the primary wire of the 1 cylinder to check idle speed.
 - The primary wire for the 1 cylinder is looped and longer than the wires for other cylinders. It is used for detecting idle speed and ignition timing.
2. Make sure that idle speed is 700 ±50 rpm.

CAUTION:

Perform "Idle Air Volume Learning" when idle speed is outside the standard.

IGNITION TIMING INSPECTION

1. Install a timing light to the primary wire for 1 cylinder.
2. Make sure that ignition timing and idle speed are 0 ±2°BTDC/700 rpm.

CAUTION:

Perform "Idle Air Volume Learning" when ignition timing is outside the standard.

ENGINE FUEL

SECTION **EF**

CONTENTS

EMISSION CONTROL SYSTEM (ELECTRIC CONTROLLED SPECIFICATION)	EF-2
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K-Engine System Diagram (Gasoline)	EF-4
K-Engine System Diagram (Combined Use) ...	EF-5
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Secondary Valve Room

This prevents excessive fuel that is not corresponding with intake air amount of carburetor from flowing in by decompressing fuel pressure until it nearly reaches atmospheric pressure.

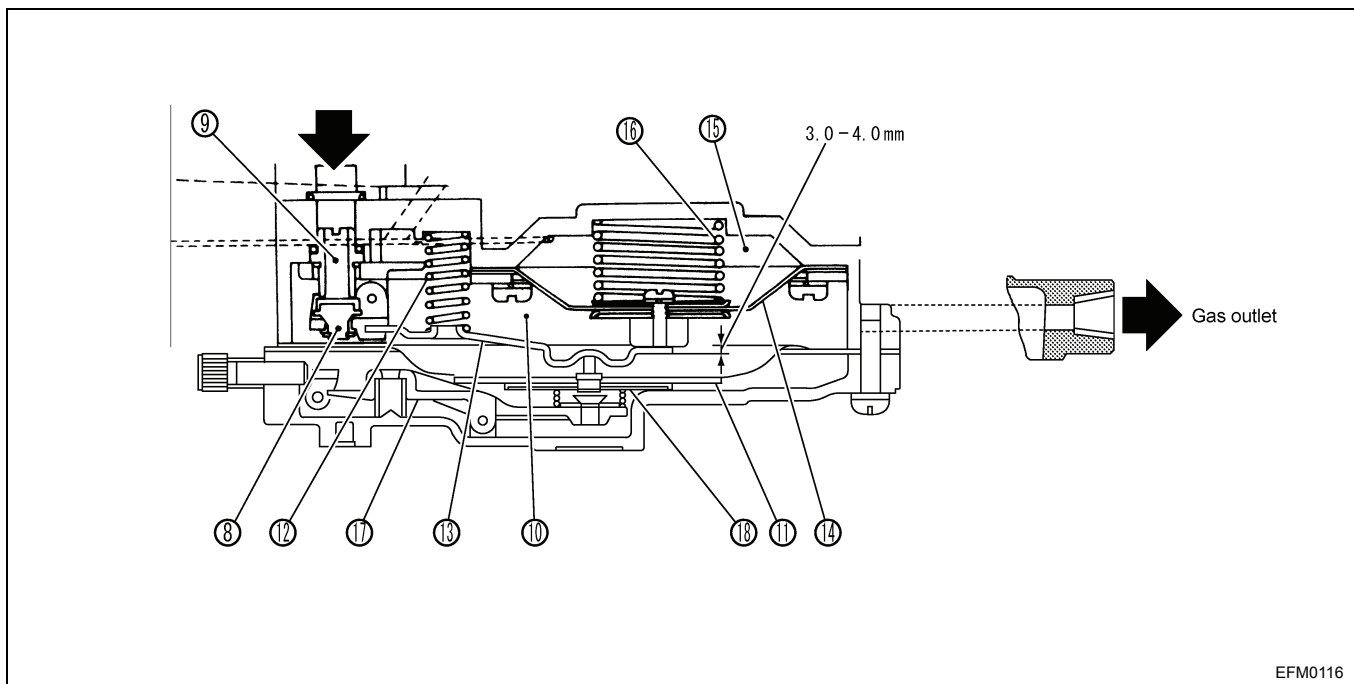
- (3) Secondary side valve
- (4) Secondary side valve seat
- (5) Secondary (decompression) room
- (6) Secondary diaphragm
- (7) Secondary diaphragm spring
- (8) Secondary side valve lever
- (9) Vacuum lock off diaphragm
- (10) Vacuum lock off room
- (11) Vacuum lock off diaphragm spring
- (12) Balance lever
- (13) Balance spring

☐ :

LPG pipe flare nut: 18 - 26 N•m (1.8 - 2.7 kg-m)

Hot water piping clamp: 35 - 83 N•m (3.5 - 8.5 kg-cm)

Clamp between hose and adopter: 53 - 113 N•m (5.4 - 11.6 kg-cm)



Fuel decompressed approximately 0.3 kgf/cm^2 is supplied to secondary room (10) through the gap between secondary valve (8) and valve seat (9) to decompress to the same pressure as atmospheric pressure.

Vacuum from intake manifold not only lifts up secondary diaphragm (11) but also secondary valve lever (13) while engine is running. Secondary diaphragm (11) is moved at same time.

Therefore, secondary valve (8) opens, and then fuel flows in.

Vacuum from intake manifold does not occur while engine is stopped. Diaphragm spring (12) pushes secondary diaphragm (11) down. Secondary valve closes as a result, and then fuel stops flowing in.

TROUBLE DIAGNOSIS

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.			√
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.	√			

TROUBLE DIAGNOSIS

Condition	Possible causes	Action
Inappropriate idling		
Incident in fuel system Refer to EF section for the LPG model.	• Plugged or damaged carburetor jet	Clean or replace
	• Damaged or plugged fuel injector	Clean or replace
	• Inappropriate idle adjustment	Adjustment
	• Plugged air cleaner	Replace element
	• Damaged manifold gasket or carburetor insulator	Replace gasket or insulator.
	• Inappropriate carburetor float level adjustment	Adjustment
Lowered compression pressure		Already described
Engine power does not increase to an appropriate level		Adjustment
Lowered compression pressure		Already described
Incident in ignition system	• Inappropriate ignition timing	Adjustment
	• Spark plug malfunction	Clean, adjust or replace.
Incident in fuel system Refer to chapter EF section for the LPG model.	• Malfunction of carburetor choke system	Adjustment
	• Plugged fuel piping	Clean
	• Plugged or contaminated fuel filter	Replacement
	• Fuel pump malfunction	Repair or replace
	• Plugged carburetor jet or needle valve	Disassemble and clean.
	• Poor throttle valve opening	Adjustment
	• Fuel pump malfunction	Adjustment
Incident in intake system	• Plugged air cleaner	Replace element
	• Air leakage from electronic throttle insulator	Replace insulator.
	• Air leakage from manifold gasket or carburetor insulator	Replace gasket or insulator.
Engine over temperature (Overheat)	• Insufficient amount of coolant	Fill coolant.
	• Loose fan belt.	Belt tension adjustment
	• Worn or loose fan belt	Replacement
	• Malfunctioning thermostat	Replacement
	• Water pump malfunction	Replacement
	• Plugged or leaking radiator	Wash, repair, or replace
	• Radiator cap damage	Replacement
	• Air in cooling system piping	Retighten cooling system piping, bleed system.
	• Improper engine oil grade	Replace with appropriate grade of engine oil.
	• Inappropriate ignition timing	Adjust.
	• Carburetor malfunction (too lean air-fuel mixture)	Overhaul carburetor
Overcool	Malfunctioning thermostat	Replacement
Other	• Inappropriate octane rating of fuel	Replace with specified octane rating of fuel.
	• Insufficient tire air pressure	Charge to specified air pressure.
	• Brake dragging	Adjustment
	• Clutch slippage	Adjustment

TIGHTENING TORQUE

Standard Bolt Tightening Torque

Upper: Lubricated (Antirust oil is applied to abrasive faces of threads and seating faces)

Lower: No lubrication (Threads and seating faces are completely degreased)

	Thread size		Unit	4T (Bolt)	7T (Bolt)	9T (Bolt)
	Diameter	Pitch				
Hexagon head bolt and nut	M6	1	N•m	3.82 - 4.41	6.37 - 7.45	9.22 - 10.8
			(kgf-m)	(0.39 - 0.45)	(0.65 - 0.76)	(0.94 - 1.1)
			N•m	5.00 - 6.47	8.43 - 10.8	11.8 - 15.7
			(kgf-m)	(0.51 - 0.66)	(0.86 - 1.1)	(1.2 - 1.6)
	M8	1.25	N•m	9.32 - 10.8	15.7 - 17.7	22.6 - 25.5
			(kgf-m)	(0.95 - 1.1)	(1.6 - 1.8)	(2.3 - 2.6)
			N•m	12.7 - 15.7	20.6 - 26.5	29.4 - 37.3
			(kgf-m)	(1.3 - 1.6)	(2.1 - 2.7)	(3.0 - 3.8)
	M10	1.25	N•m	19.6 - 22.6	32.4 - 38.2	47.1 - 53.9
			(kgf-m)	(2.0 - 2.3)	(3.3 - 3.9)	(4.8 - 5.5)
			N•m	25.5 - 33.3	43.1 - 54.9	61.8 - 78.5
			(kgf-m)	(2.6 - 3.4)	(4.4 - 5.6)	(6.3 - 8.0)
1.5		N•m	18.6 - 21.6	30.4 - 36.3	44.1 - 52	
		(kgf-m)	(1.9 - 2.2)	(3.1 - 3.7)	(4.5 - 5.3)	
		N•m	24.5 - 31.4	41.2 - 52	58.8 - 74.5	
		(kgf-m)	(2.5 - 3.2)	(4.2 - 5.3)	(6.0 - 7.6)	
Flanged bolt	M6	1	N•m	4.9 - 5.69	8.14 - 9.51	11.8 - 13.7
			(kgf-m)	(0.5 - 0.58)	(0.83 - 0.97)	(1.2 - 1.4)
			N•m	5.98 - 7.65	9.81 - 12.7	14.7 - 18.6
			(kgf-m)	(0.61 - 0.78)	(1.0 - 1.3)	(1.5 - 1.9)
	M8	1.25	N•m	11.8 - 13.7	19.6 - 23.5	28.4 - 33.3
			(kgf-m)	(1.2 - 1.4)	(2.0 - 2.4)	(2.9 - 3.4)
			N•m	14.7 - 18.6	24.5 - 31.4	35.3 - 45.1
			(kgf-m)	(1.5 - 1.9)	(2.5 - 3.2)	(3.6 - 4.6)
	M10	1.25	N•m	24.5 - 29.4	41.2 - 48.1	59.8 - 69.6
			(kgf-m)	(2.5 - 3.0)	(4.2 - 4.9)	(6.1 - 7.1)
			N•m	30.4 - 39.2	51.0 - 64.7	73.6 - 93.2
			(kgf-m)	(3.1 - 4.0)	(5.2 - 6.6)	(7.5 - 9.5)
1.5		N•m	23.5 - 27.5	39.2 - 46.1	56.9 - 65.7	
		(kgf-m)	(2.4 - 2.8)	(4.0 - 4.7)	(5.8 - 6.7)	
		N•m	29.4 - 37.3	49.0 - 61.8	69.6 - 89.2	
		(kgf-m)	(3.0 - 3.8)	(5.0 - 6.3)	(7.1 - 9.1)	

CAUTION:

- Except special nuts and bolts.
- The bolts applicable to this table have one of the following marks embossed on their heads.

4T.....4

7T.....7

9T.....9

Inspection and Correction (Cont'd)

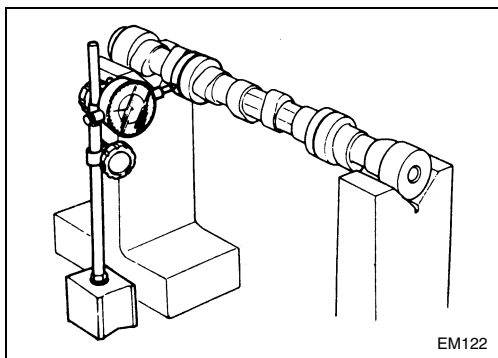
14. Camshaft

INSPECTION OF CAMSHAFT BEND

- Apply the probe of a dial gauge to the center journal and measure the fluctuation while turning the camshaft. Determine half of the reading as the camshaft bend.

Bend limit: 0.05 mm

- Replace if necessary.



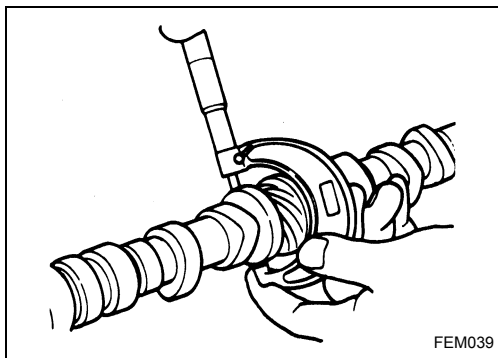
EM122

Measuring camshaft bend

	Standard (Shall not exceed the value)	Usable limit
Camshaft bend mm (in)	0.02 (0.0008)	0.05 (0.0020)

CAMSHAFT JOURNAL INSPECTION (Carburetor spec.)

- Inspect the camshaft journal and replace it if any damage or uneven wear is observed.
- If the wear is found to exceed the limit by measurement with a micrometer, replace the camshaft.



FEM039

Camshaft journal inspection

Camshaft journal	Standard (Shall not exceed the value)	Usable limit
Taper out-of-round mm (in)	0.01(0.0004)	0.03 (0.0012)
Journal wear mm (in)		0.05 (0.0020)

MEASURING CAMSHAFT HEIGHT (Carburetor spec.)

- Measure the camshaft height by applying calipers to the camshaft nose.

(mm)

	Camshaft height
Standard	Intake/exhaust 36.750 - 36.800
Usable limit	36.5

- Inspect the oil pump and distributor drive gear. If excessive wear or damage is observed, replace the camshaft.

VALVE TIMING (Carburetor spec.)

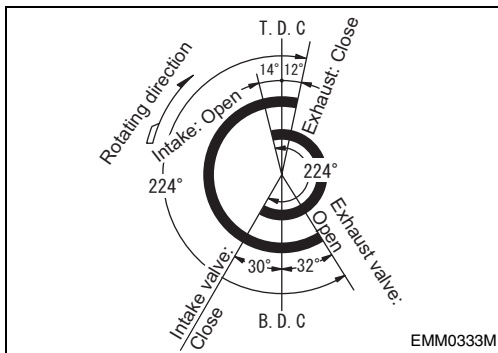
The figure on the left is applicable to all cylinders.

If any of the valves deviate from the specifications, the camshaft ridges may be worn out or damaged. The camshaft must be replaced.

Camshaft bushing inspection

- Check for bend, melting, uneven contact or peeling.
- If any damage is found, replace the camshaft bushing.

Measuring camshaft journal clearance



EMM0333M

DESCRIPTION

Description (Cont'd)

SENSORS AND ACTUATORS CONTROL ITEMS

Main sensors and actuators related to the ECM are listed below.

Control Item	Gasoline	std	std	std	std	—	std	std	std	std	opt	Combined	std	std	
	LPG	std	std	std	—	std	std	std	std	std	opt	Combined	std	std	
Control Item	Fuel injection control				Fuel pump control	PTC heater control at cold area	Ignition timing control	Idle speed control	Maximum engine speed control	Maximum vehicle speed control	Power ECO mode control	Fuel changing (Gasoline and LPG)	Self-diagnosis	Fail-safe	
	Fuel injection control	A/F feedback control	Fuel cut off												
Sensors	Crankshaft position sensor (POS, PHASE)	⊕	⊕	⊕	⊕		⊕	⊕	⊕	⊕			◆		
	Mass air flow sensor	⊕	⊕	◆			⊕						◆	◆	
	Intake air temperature sensor	◆				⊕		◆							
	Engine coolant temperature sensor	◆		◆		⊕	◆	◆						◆	◆
	Heated oxygen sensor		⊕											◆	◆
	Vehicle speed sensor	◆	◆	◆				◆		⊕					◆
	Throttle position sensor	◆	◆	⊕			◆	◆	◆	◆	◆			◆	◆
	Accelerator pedal position sensor	◆	◆	◆			◆	◆	◆	◆	◆			◆	◆
	Ignition switch	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕				
	P/N POSI SW	◆	◆	◆			◆	◆							
	Stop lamp switch													◆	
	Headlamp (electrical load) switch							◆							
	Power ECO mode switch (opt)										⊕				
	Battery voltage	◆				⊕	◆	◆	◆	◆					
	LPG fuel pressure sensor	◆	⊕			⊕								◆	
	Fuel changing switch	⊕	⊕	⊕	⊕								⊕		
Actuators	Gasoline injector	⊕	⊕	⊕											
	Ignition system	Power transistor						⊕						◆	
		Ignition coil						⊕							
	Throttle control motor relay							⊕			⊕		◆		
	Throttle control motor							⊕			⊕		◆	◆	
	Gasoline fuel pump relay				⊕							⊕			
	Gasoline fuel pump				⊕								◆		
	Ignition relay				⊕										
	ECM relay	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕		
	LPG injector	⊕	⊕	⊕										◆	
	LPG assistance injector	⊕	⊕	⊕											◆
	LPG interception valve relay	⊕										⊕		◆	
	LPG interception valve	⊕											◆		
LPG PTC heater relay					⊕										
LPG PTC heater					◆										

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