CAT® Lift Trucks

Service Manual

Chassis & Mast

MC/FC

GP15N	ET34L-00011-up	**DP15N**	ET16D-00011-up
GP18N	ET34L-40001-up	**DP18N**	ET16D-40001-up
GP20CN	ET34L-60001-up	**DP20CN**	ET16D-60001-up
GP20N	ET17DL-00011-up	**DP20N**	ET18C-00011-up
GP25N	ET17DL-50001-up	**DP25N**	ET18C-50001-up
GP30N	ET13FL-00011-up	**DP30N**	ET14E-00011-up
GP35N	ET13FL-50001-up	**DP35N**	ET14E-50001-up

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

99719-69100

FOREWORD

This service manual is a guide to servicing of Cat Lift Trucks. The instructions are grouped by systems to serve the convenience of your ready reference.

Long productive life of your lift trucks depends to a great extent on correct servicing – the servicing consistent with what you will learn from this service manual. We hope you read the respective sections of this manual carefully and know all the components you will work on before attempting to start a test, repair or rebuild job.

The descriptions, illustrations and specifications contained in this manual were of the trucks of serial numbers in effect at the time it was approved for printing. Cat Lift Trucks reserves the right to change specifications or design without notice and without incurring obligation.

The trucks are powered by K21/K25 gasoline engines or S4Q2/S4S diesel engines. For the engine servicing, please refer to the applicable engine service manual.

Safety Related Signs

The following safety related signs are used in this service manual to emphasize important and critical instructions:

⚠ WARNING Indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION Indicate a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or damage to your machine.

NOTE Indicates a condition that can cause damage to, or shorten service life of, the machine.

Pub. No. 99719-69100

⚠ WARNING

SAFETY

⚠ WARNING

The proper and safe lubrication and maintenance for this lift truck, recommended by Cat Lift Trucks, are outlined in the OPERATION & MAINTENANCE MANUAL for these trucks.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the OPERATION & MAINTENANCE MANUAL before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this truck. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the truck components, the serviceman or mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all warning plates and decals on the truck before operating, lubricating or repairing the product.
2. Always wear protective glasses and protective shoes when working around trucks. In particular, wear protective glasses when pounding on any part of the truck or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
3. Do not work on any truck that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the truck before performing any disassembly.

⚠ WARNING

Do not operate this truck unless you have read and understand the instructions in the OPERATION & MAINTENANCE MANUAL. Improper truck operation is dangerous and could result in injury or death.

4. Lower the forks or other implements to the ground before performing any work on the truck. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.
5. Use steps and grab handles (if applicable) when mounting or dismounting a truck. Clean any mud or debris from steps, walkways or work platforms before using. Always face truck when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.
6. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
7. To avoid burns, be alert for hot parts on trucks which have just been stopped and hot fluids in lines, tubes and compartments.
8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.
9. Be careful when removing filler caps, breathers and plugs on the truck. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the truck has just been stopped because fluids can be hot.

10. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary.
12. If possible, make all repairs with the truck parked on a level, hard surface. Block truck so it does not roll while working on or under truck.
13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on truck. Hang “Do not Operate” tag in the Operator’s Compartment.
14. Repairs, which require welding, should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
15. Do not damage wiring during removal operations. Reinstall the wiring so it is not damaged nor will it be damaged in operation by contacting sharp corners, or by rubbing against some object or hot surface. Place wiring away form oil pipe.
16. Be sure all protective devices including guards and shields are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
17. Always support the mast and carriage to keep carriage or attachments raised when maintenance or repair work is performed, which requires the mast in the raised position.
18. Loose or damaged fuel, lubricant and hydraulic lines, tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones which have been bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible close to the hose. This oil can penetrate the skin and cause personal injury. Use cardboard or paper to locate pin hole leaks.
19. Tighten connections to the correct torque. Make sure that all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields that protect against oil spray onto hot exhaust components in event of a line, tube or seal failure, must be installed correctly.
20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly and be alert for possible pressure when disconnecting any device from a system that utilizes pressure.
21. Do not operate a truck if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.
22. When handling the parts containing asbestos, be careful not to inhale the asbestos. Doing so is hazardous to your health.

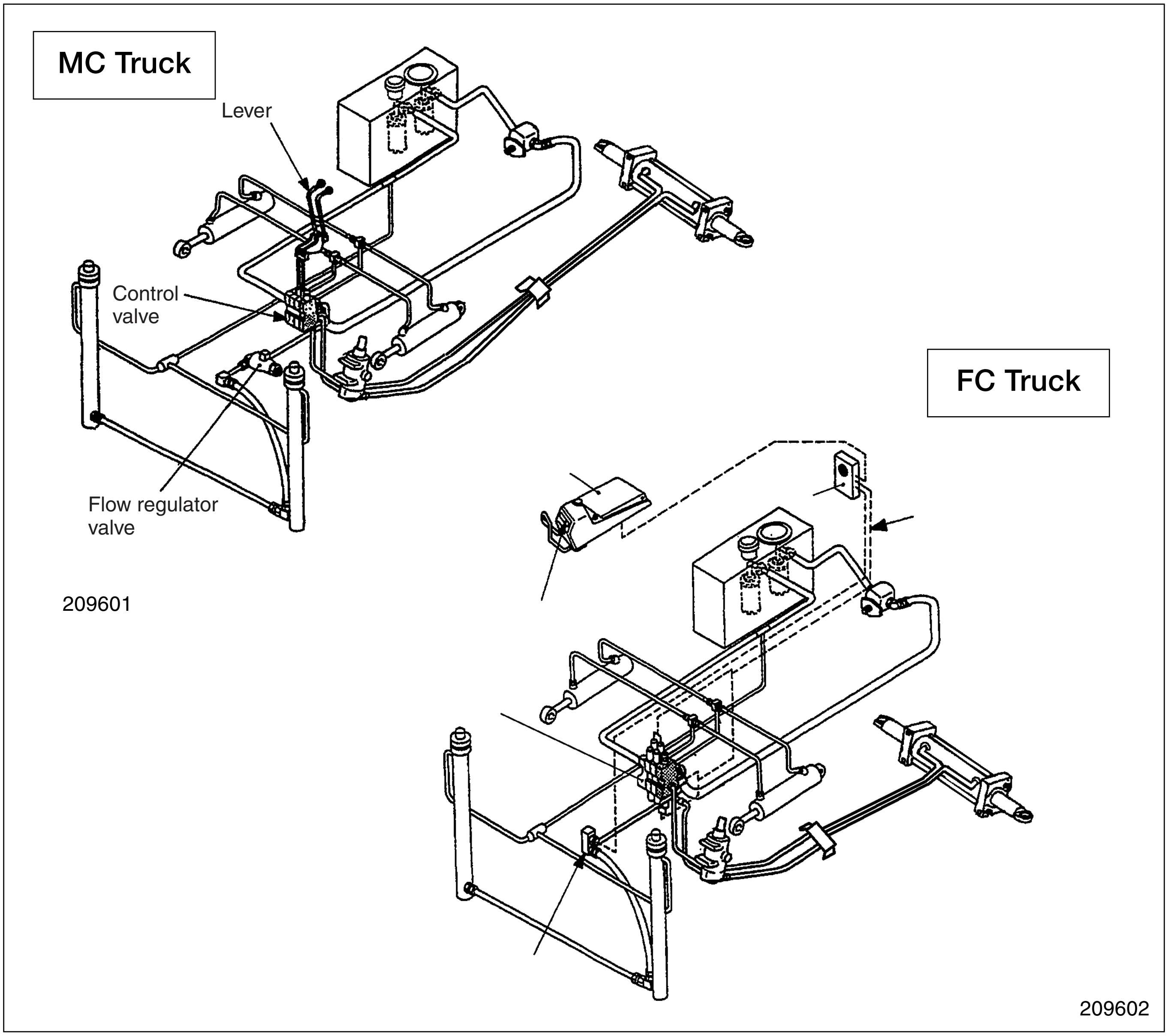
    If the shop dust may contain asbestos, follow the precautions described below.

    a. Do not use compressed air for cleaning.
    b. Do not brush or apply grinder on asbestos containing materials.
    c. To clean asbestos containing materials, wipe with moistened cloth or use a vacuum cleaner with particle filter.
    d. If you have to handle the parts containing asbestos for a long time, be sure to do it in a well-ventilated area.
    e. If the asbestos in the air cannot be removed, wear a mask.
    f. Be sure to observe the working rules and regulations.
    g. When disposing of materials with asbestos, be sure to observe the environmental protection regulations of your area.
    h. Avoid working in the atmosphere where asbestos particles may be suspended.

HOW TO USE THIS MANUAL

Truck models covered in this manual:

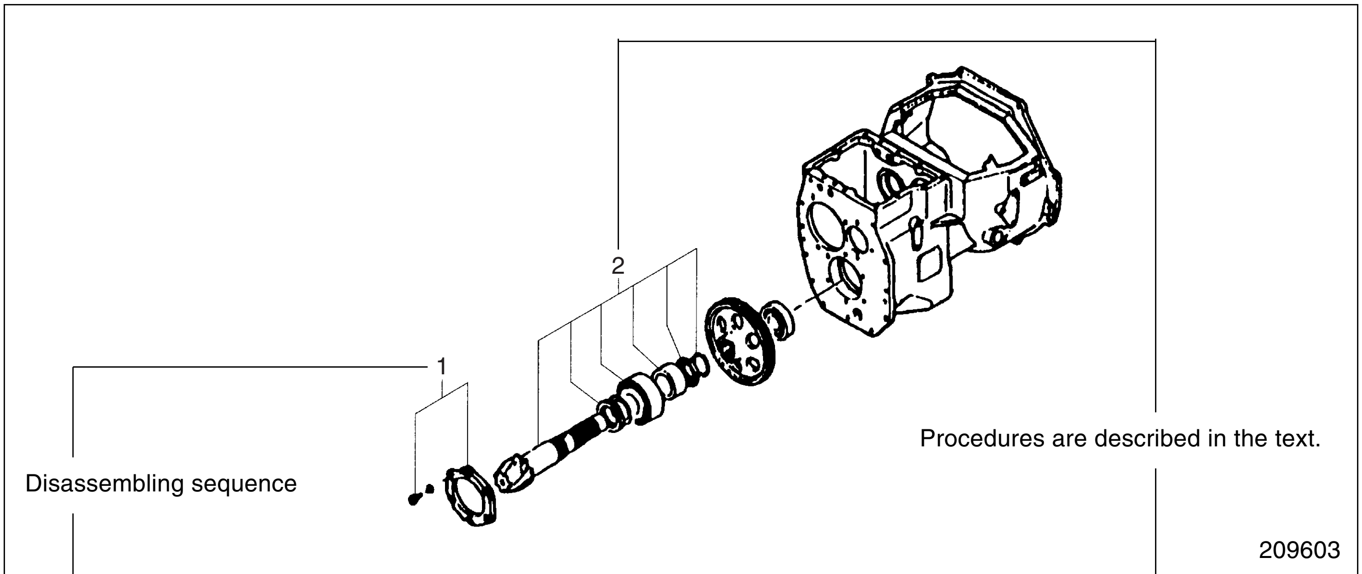
- MC Truck (Mechanical Control System)
  Mechanically controlled hydraulic system (conventional lever system)
- FC Truck (Finger-tip Control System)
  Electronically controlled hydraulic system



- Gasoline Engine Truck (GP) . . . . Equipped with K21 or K25 Gasoline Engine
- Diesel Engine Tuck (DP) . . . . Equipped with S4Q2 or S4S Diesel Engine
- Powershift Truck . . . . Equipped with Powershift Transmission
- Manual Truck . . . . Equipped with Manual Transmission

HOW TO USE THIS MANUAL (continued)
(Removal, Installation, Assembly and Disassembly)

Disassembly diagram (example)



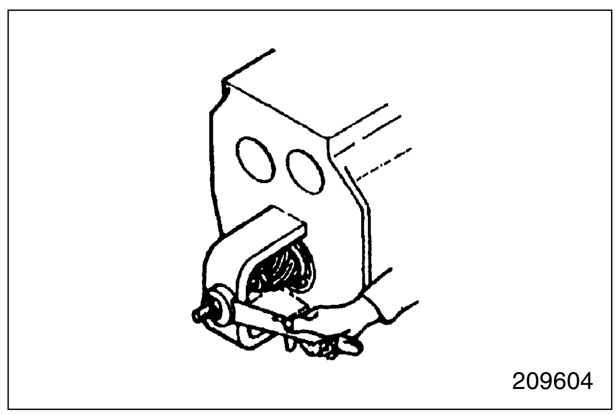
Sequence

1 Cover, Bolt, Washer (part name)
2 Snap ring .... (part name)

Suggestion for disassembling

1. Output shaft, Removing

   Remove output shaft using a special tool.



Service Data

Gear Backlash	A	0.11 to 0.28 mm (0.0043 to 0.0110 in.)
	B	0.5 mm (0.020 in.)

A: Standard Value
B: Repair or Service Limit

Symbols or abbreviation

OP	Option
R1/4	Taper pipe thread (external) 1/4 inch (formerly PT1/4)
Rc1/8	Taper pipe thread (internal) 1/8 inch (formerly PT1/8)
G1/4A	Straight pipe thread (external) 1/4 inch (formerly PF1/4-A)
Rp1/8	Straight pipe thread (internal) 1/8 inch (formerly PS1/8)

Units

1. SI Units are used in this manual.
2. The following table shows the conversion of SI unit and customary unit.

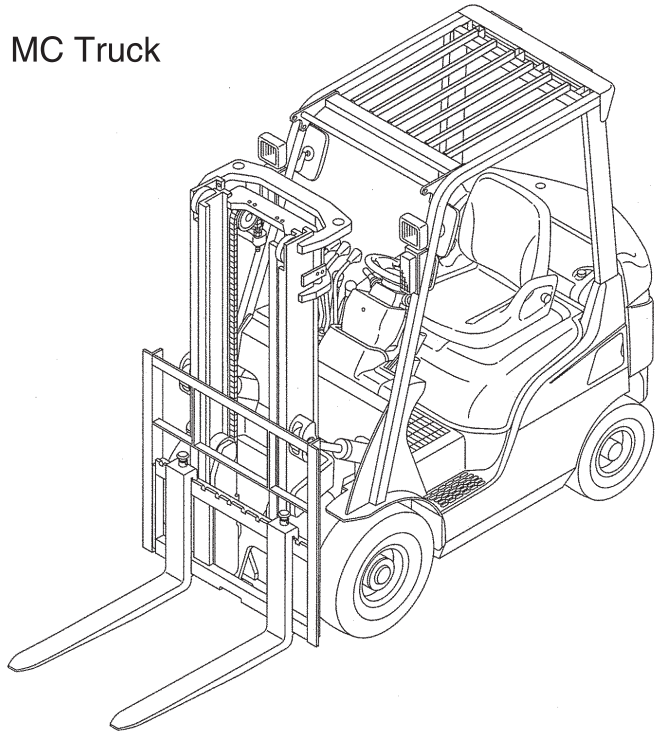
Item	SI unit	Customary unit
Force	1 N	0.1012 kgf
Pressure	1 kPa	0.0102 kgf/cm^2
Torque	1 N·m	0.1012 kfg·m

GROUP INDEX

GENERAL INFORMATION

Model View

MC Truck



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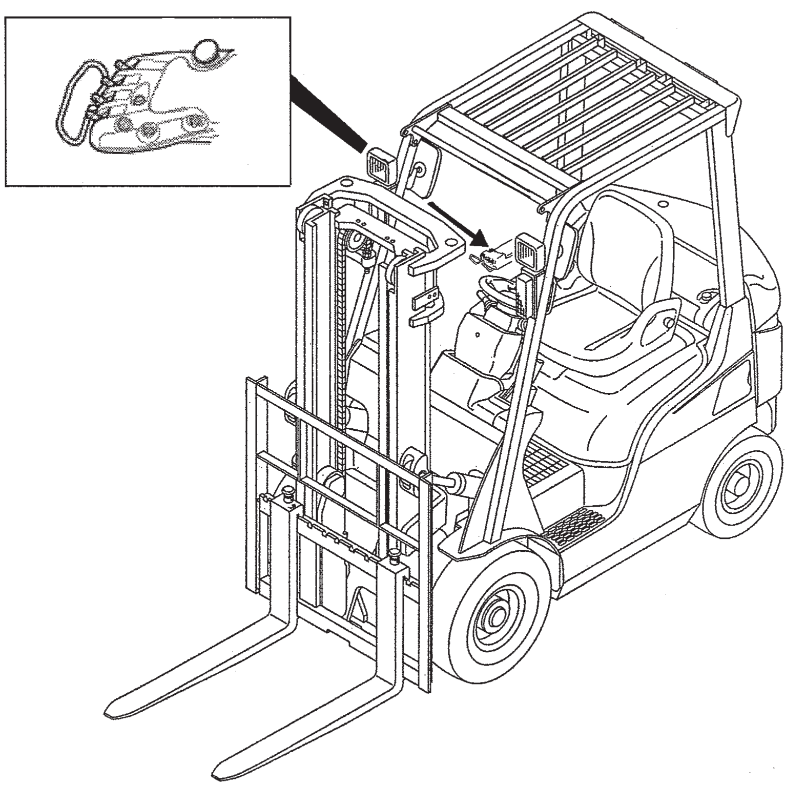
FC Truck



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Truck Models Covered

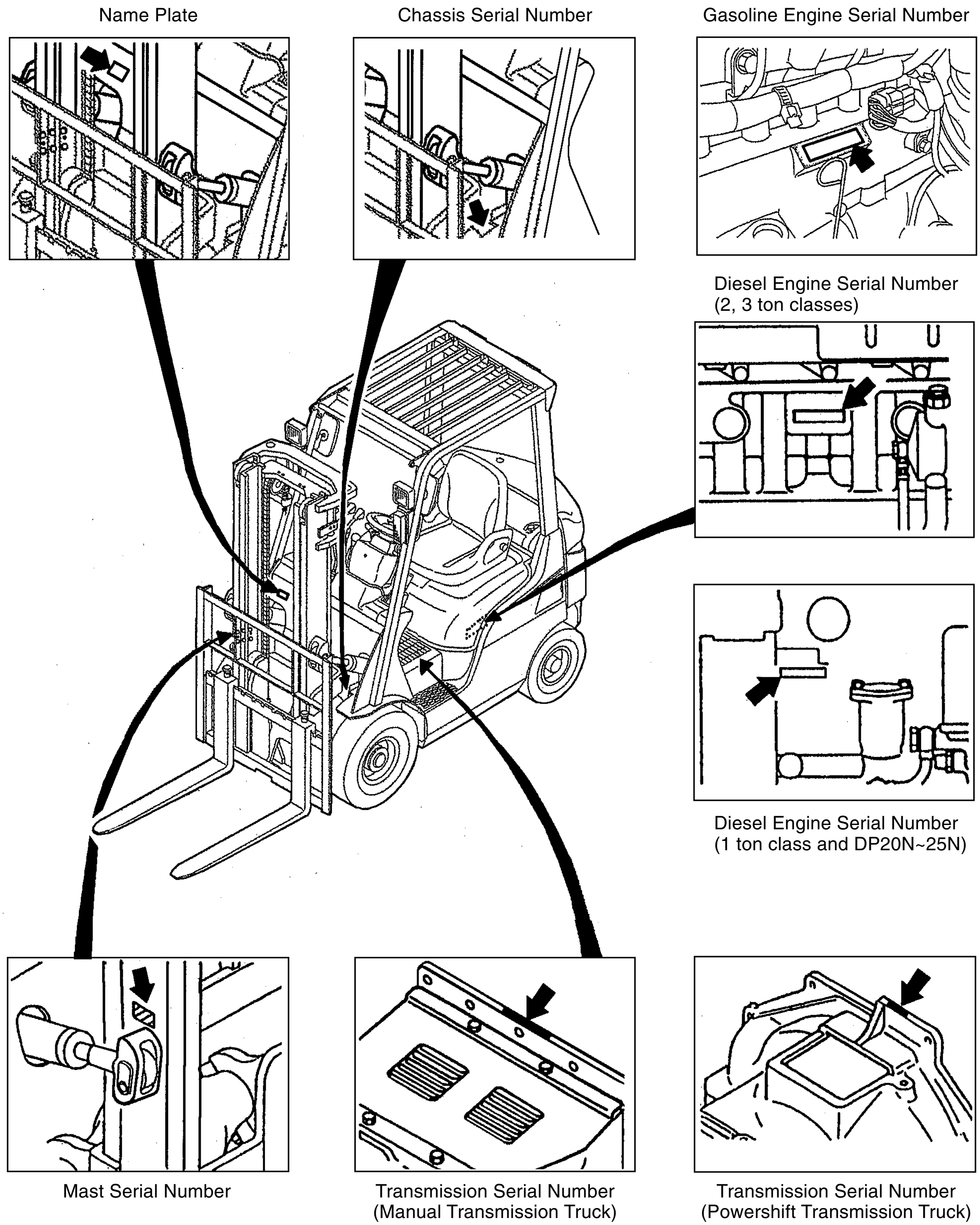
This Service Manual furnishes servicing and maintenance information for the following trucks:

Engine control	LPG engine	Diesel engine
Standard (Non-electronic control)	—	MC/FC7
Electronic control	MC/FC	—

(FC type is used in torque converter model only.)

Truck class	LPG engine models			Diesel engine models		
	Truck model	Model code - serial number	Engine mounted	Truck model	Model code - serial number	Engine mounted
1 ton class	GP15N	ET34L-00011-up	K21	DP15N	ET16D-00011-up	S4Q2
	GP18N	ET34L-40001-up	K21	DP18N	ET16D-40001-up	S4Q2
	GP20CN	ET34L-60001-up	K21	DP20CN	ET16D-60001-up	S4Q2
2 ton class	GP20N	ET17DL-00011-up	K21	DP20N	ET18C-00011-up	S4S
	GP25N	ET17DL-50001-up	K21	DP25N	ET18C-50001-up	S4S
3 ton class	GP30N	ET13FL-00011-up	K25	DP30N	ET14E-00011-up	S4S
	GP35N	ET13FL-50001-up	K25	DP35N	ET14E-50001-up	S4S

Serial Number Locations



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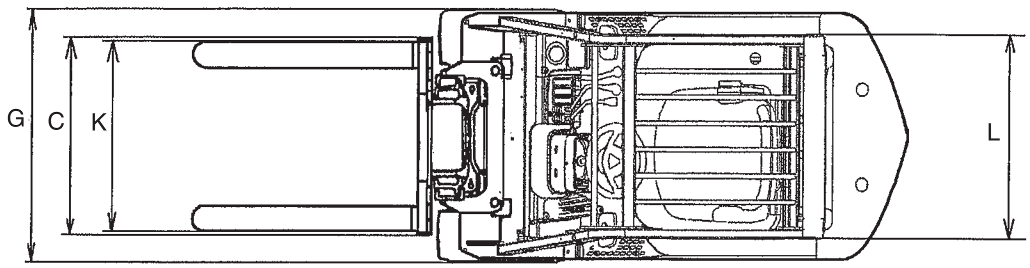
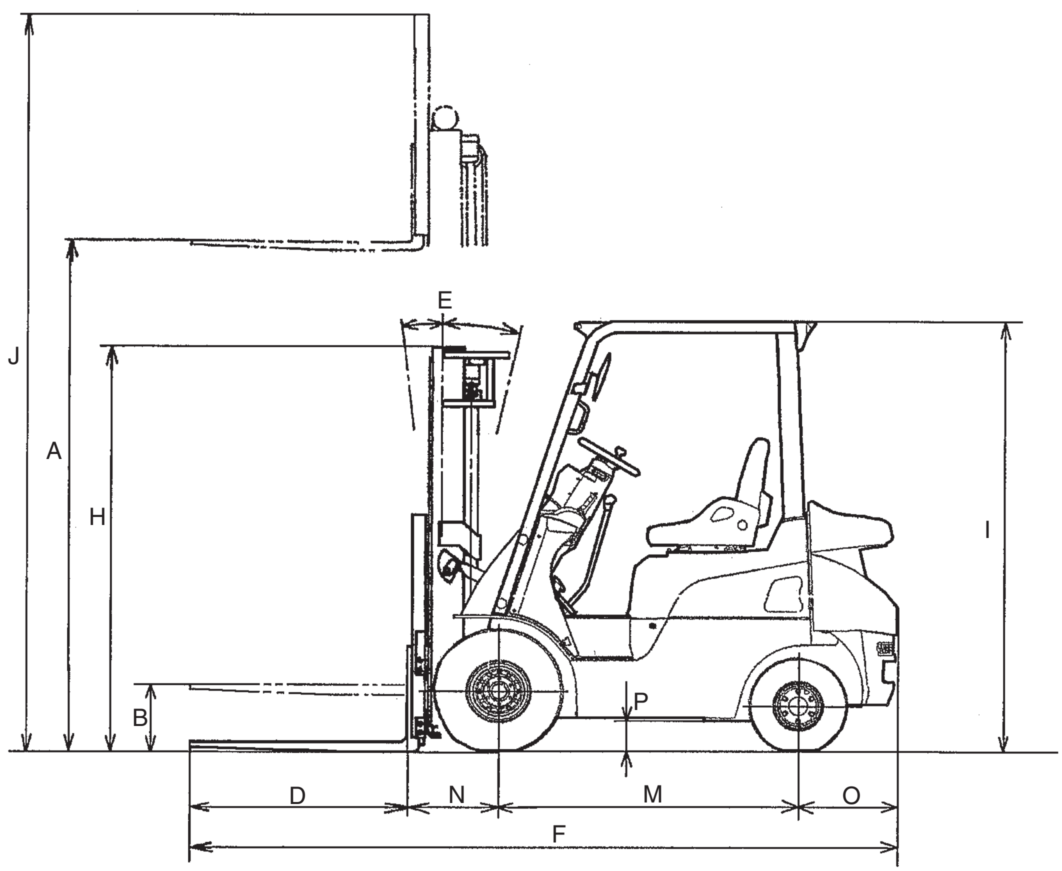
Dimensions





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Technical Data

Unit: mm (in.)

Ref. No.	Item \ Model		Gasoline-engine Truck / Diesel-engine Truck	GP15N (DP15N)	GP18N (DP18N)
A	Maximum lift			3000 (118)	
B	Free lift			115 (4.5)	
C	Fork spread (outside)			200 to 920 (7.9 to 36.2)	
D	Fork length			920 (36.2)	
E	Tilt angle (forward – backward)			6° – 12°	
F	Overall length			3180 (125.2)	3221 (126.8)
G	Overall width (outside of tires)	Single tire		1065 (41.9)	
		Dual tire		1330 (52.4)	
H	Overall height (to top of mast lowered)			1995 (78.5)	
I	Overall height (to top of overhead guard)			2065 (81.3)	
J	Overall height (mast extended)			4055 (159.6)	
K	Tread (front)	Single tire		890 (35)	
		Dual tire		1025 (40.4)	
L	Tread (rear)			900 (35.4)	
M	Wheelbase			1400 (55.1)	
N	Front overhang			400 (15.7)	
O	Rear overhang			460 (18.1)	501 (19.7)
P	Underclearance (at frame)			150 (5.9)	

Unit: mm (in.)

<table>
<tr><th>GP20CN
(DP20CN)</th><th>GP20N
(DP20N)</th><th>GP25N
(DP25N)</th><th>GP30N
(DP30N)</th><th>GP35N
(DP35N)</th></tr>
<tr><td colspan="5">3000 (118.1)</td></tr>
<tr><td>115 (4.5)</td><td colspan="2">140 (5.5)</td><td colspan="2">150 (5.9)</td></tr>
<tr><td colspan="3">220 to 1000 (8.7 to 39.4)</td><td colspan="2">250 to 1000 (9.8 to 39.4)</td></tr>
<tr><td colspan="2">920 (36.2)</td><td colspan="3">1070 (42.1)</td></tr>
<tr><td colspan="5">6° – 12°</td></tr>
<tr><td>3279 (129.1)</td><td>3408 (134.2)</td><td>3625 (142.7)</td><td>3795 (149.4)</td><td>3860 (152)</td></tr>
<tr><td>1065 (41.9)</td><td colspan="2">1150 (45.3)</td><td>1275 (50.2)</td><td>1290 (50.8)</td></tr>
<tr><td>—</td><td colspan="2">1480 (58.3)</td><td colspan="2">1490 (58.7)</td></tr>
<tr><td colspan="3">1995 (78.5)</td><td>2045 (80.5)</td><td>2180 (85.8)</td></tr>
<tr><td>2065 (81.3)</td><td colspan="2">2070 (81.5)</td><td>2095 (82.5)</td><td>2105 (82.9)</td></tr>
<tr><td colspan="3">4055 (159.6)</td><td>4085 (160.8)</td><td>4055 (159.6)</td></tr>
<tr><td>890 (35)</td><td colspan="2">960 (37.8)</td><td colspan="2">1060 (41.7)</td></tr>
<tr><td>—</td><td colspan="4">1140 (44.9)</td></tr>
<tr><td>900 (35.4)</td><td colspan="4">980 (38.6)</td></tr>
<tr><td>1400 (55.1)</td><td colspan="2">1600 (63)</td><td colspan="2">1700 (66.9)</td></tr>
<tr><td>415 (16.3)</td><td colspan="2">455 (17.9)</td><td colspan="2">490 (19.3)</td></tr>
<tr><td>544 (21.4)</td><td>433 (17)</td><td>500 (19.7)</td><td>535 (21.1)</td><td>600 (23.6)</td></tr>
<tr><td>150 (5.9)</td><td colspan="2">160 (6.3)</td><td>190 (7.5)</td><td>200 (7.9)</td></tr>
</table>

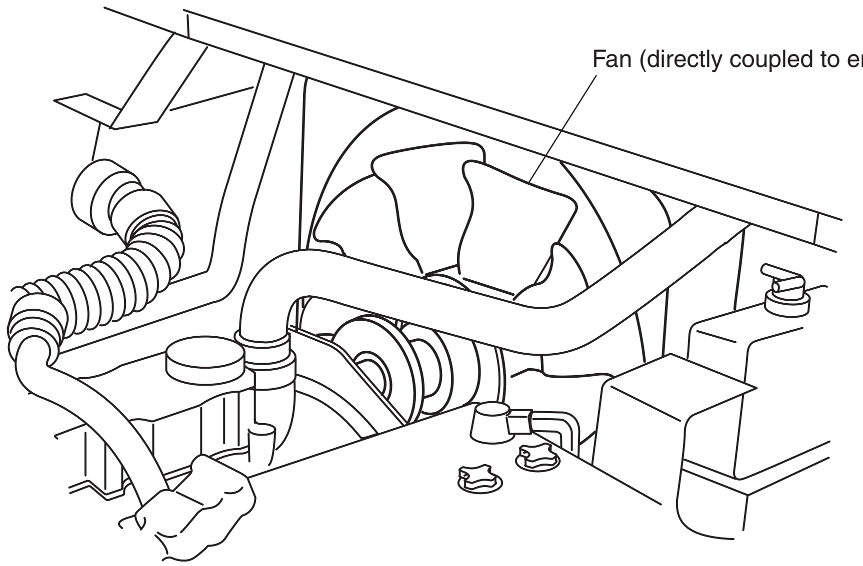
COOLING SYSTEM

2

Specification

Items \ Truck Models		1 ton class	2 ton class	3 ton class
Cooling System	Type	Water-cooled, forced circulation		
	Radiator	Corrugated fin (pressure) type		
	Water pump	Centrifugal type		
	Thermostat	Wax Pellet Type		

Structure



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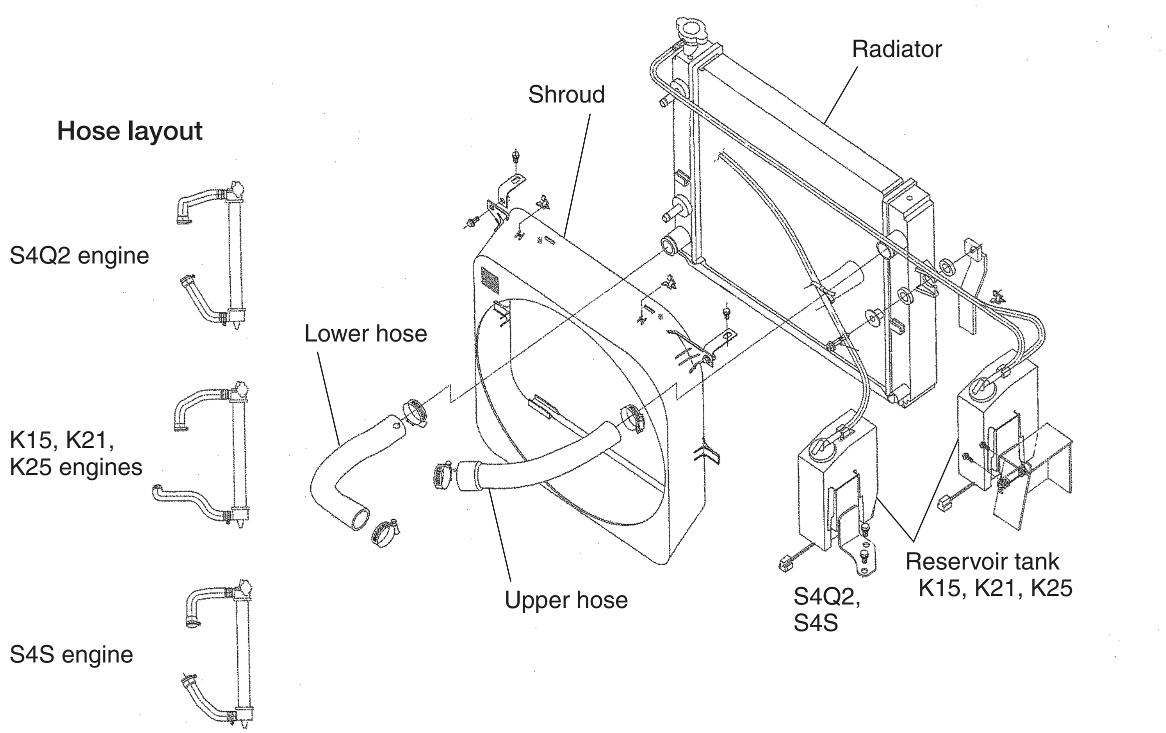

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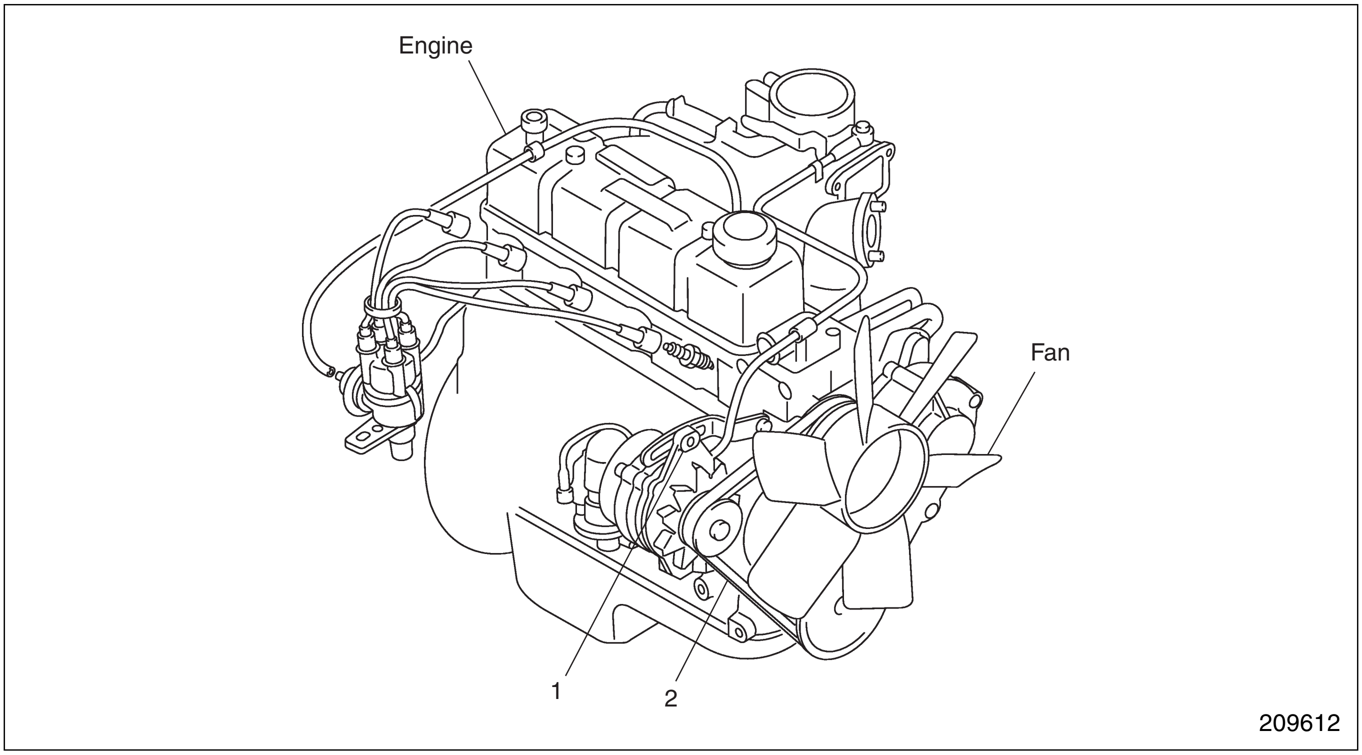
Removal and Installation

Fan Belt Removal



Sequence

1 Tension pulley assembly, Bolt
2 Fan belt

Start by:

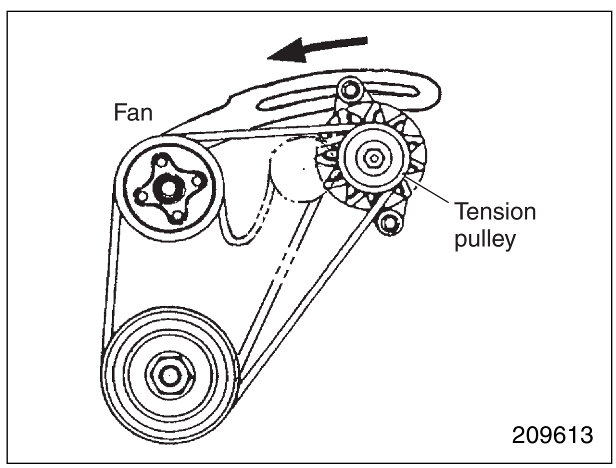
Remove the radiator cover.

Suggestion for Removal

(1) Loosen the tension pulley lock bolt by three or four turns. If the bolt is loosened insufficiently, the tension pulley will not be moved.

Note: Do not loosen the lock bolt to such an extent that the bolt would be removed.

(2) Move the tension pulley fully toward the fan, then remove the belt.



Installation

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

(1) Before installing the belt, turn the fan to check for smooth rotation. Replace the bearing if it generates abnormal sound.

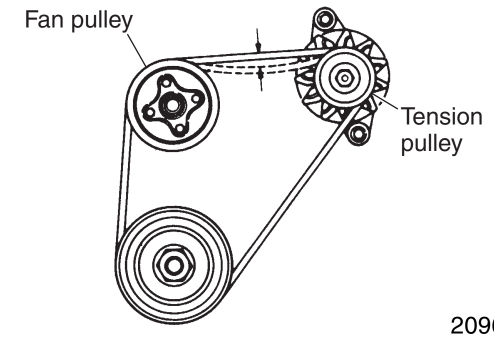
(2) After installing the belt, push it to make sure that the tension pulley moves, then tighten the pulley lock bolt firmly.

Inspection and Adjustment

Fan Belt Inspection

(1) Check the belt for contamination with oil, grease and dust. Replace the belt if required. When the contamination is slight, remove it and clean with rag or wiping paper. Do not use gasoline, oil or any other solvent to clean the belt.

(2) During engine overhaul or belt tension adjustment, closely check the belt's condition. Replace the belt with a new one if it has any sort of damage.



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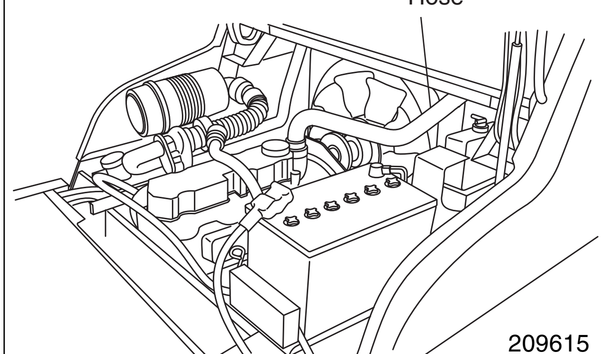
Fan Belt Tension

Apply a force of 98 N (10 kgf) [22 lbf] perpendicularly to the belt at a point midway between the fan pulley and tension pulley. Adjust the tension so that belt deflection becomes between 11 to 13 mm (0.43 to 0.51 in.).

Connecting Radiator Hoses

When connecting the hoses to the radiator, fit their ends fully on the fittings and secure them with clamps. Make sure that each hose is correctly connected and prevented from disconnection by the flare of the fitting.



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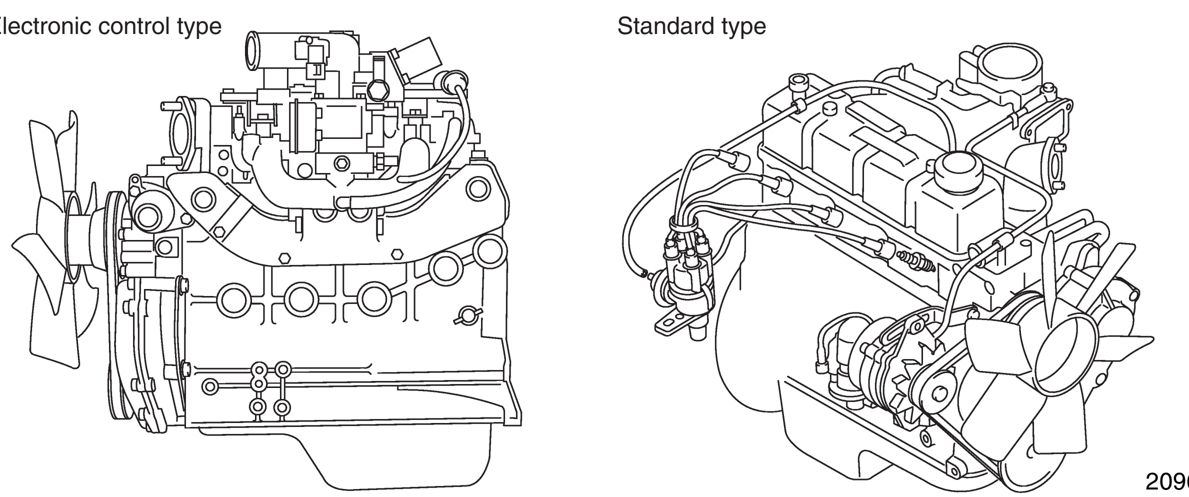
Unit Layout



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Coolant

Fill the radiator with coolant containing antifreeze. Start and operate the engine to let it warm up while checking for abnormal noise. Make sure that the quantity of coolant is as specified by checking the level in the reserve tank.

Quantity of coolant

Unit: liter (U.S. gal.)

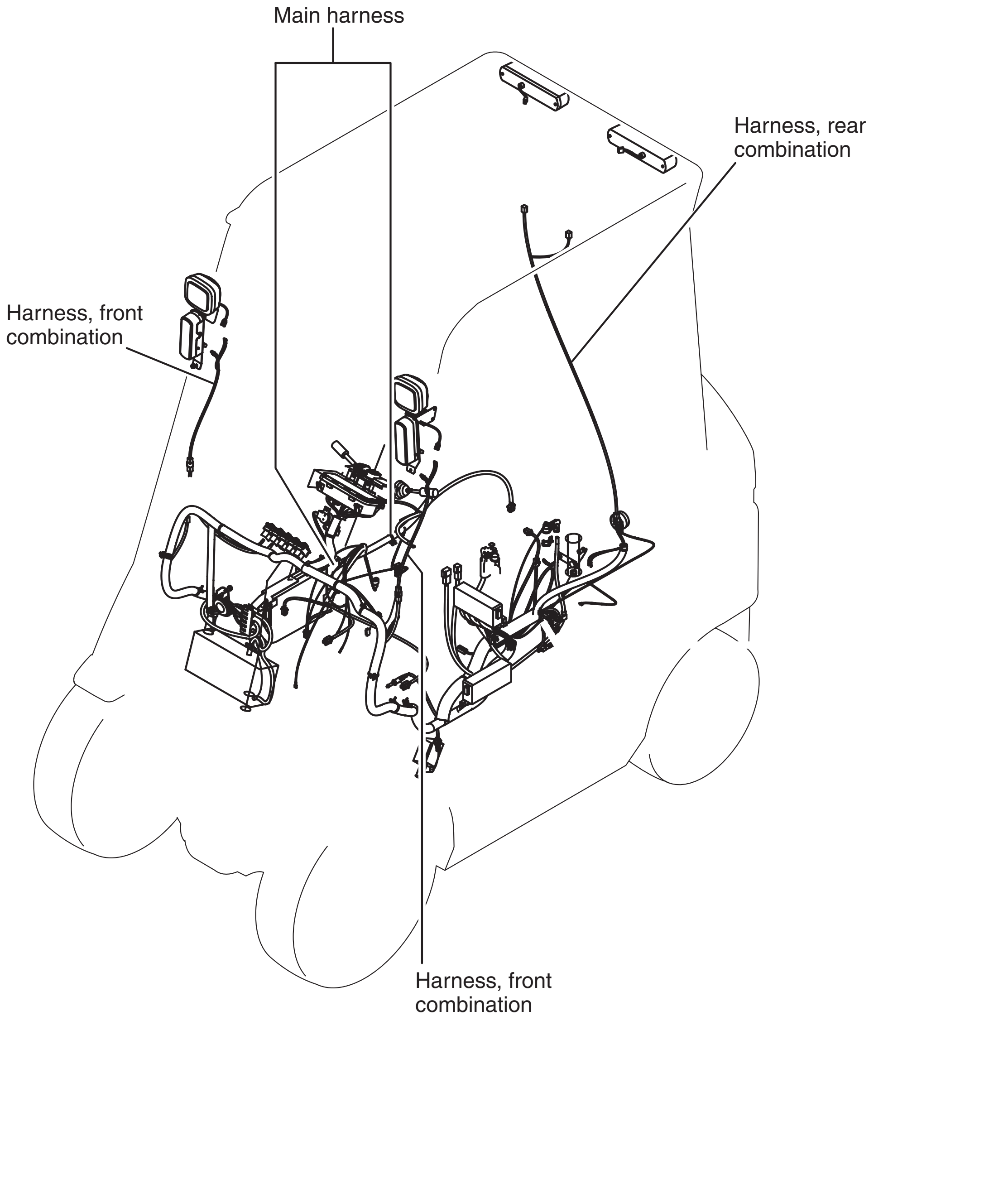
Items \ Truck Models	1 ton class	2 ton class	3 ton class
Engine	3.95 (1.04)	—	—
Radiator	2.2 (0.58)	—	—
Reserve tank (FULL level)	0.65 (0.17)	0.65 (0.17)	0.65 (0.17)
Total quantity of coolant (including coolant in hoses)	6.8 (1.80)	7.4 (1.96)	8.7 (2.30)
Oil cooler	0.094 (0.02)	—	—

Radiator Cap

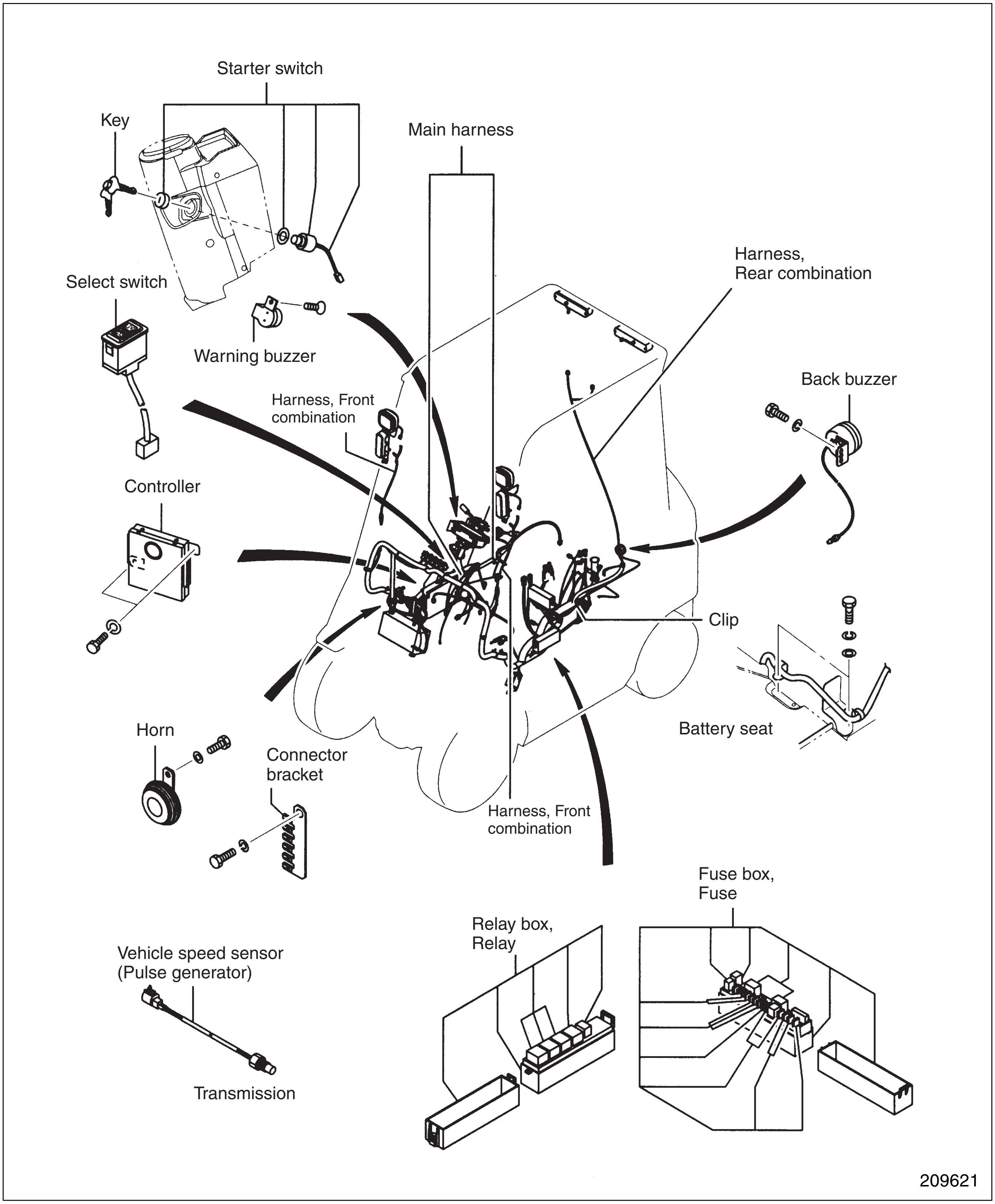
Opening pressure	90 ± 15 kPa (0.92 ± 0.15 kgf/cm^2) [13.1 ± 2.2 psi]
Vacuum valve	0 to 5 kPa (0 to 0.05 kgf/cm^2) [0 to 0.73 psi]

ELECTRICAL SYSTEM

Chassis Electrical Devices Wiring Outline (No. 1)



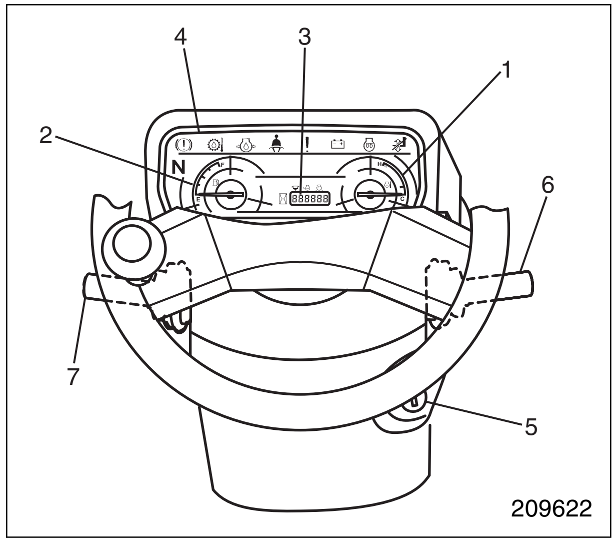
Chassis Electrical Devices Wiring Outline (No. 2)



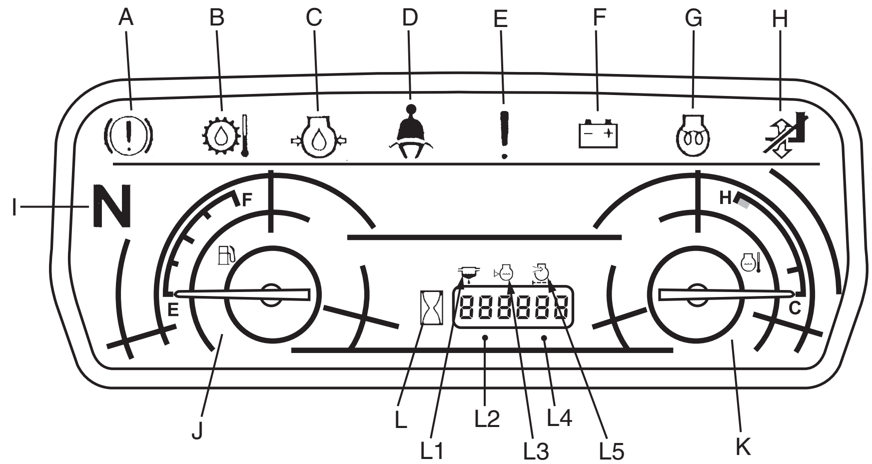
Structure

Console box

1 Water temperature gauge
2 Fuel gauge
3 Various warning lights
4 Instrument panel
5 Starter switch
6 Lighting switch, turn signal switch
7 Forward-reverse lever



Function of Instrument Panel



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Description of function

Code	Name of monitor	When not illuminated	When illuminated or flashing	Remarks
A	Parking / Brake fluid warning lamp	Parking Brake released / Normal level	Parking Brake applied / Low level	—
B	ATM: Torque converter fluid temperature warning lamp	Normal temperature	Overheat	ATM truck
	MTM: Clutch wear lamp	Normal	Clutch worn	MTM truck
C	Engine oil pressure warning lamp	Normal oil pressure	Low oil pressure	—
D	Seat belt reminder warning lamp	Fastened	Not fastened	—
E	Multi-purpose warning lamp (illuminates when warnings indicated by printed symbols occur or minor failures occur)	Normal	Malfunction	Printed symbol
F	Charge warning lamp	Normal charging	Abnormal charging system	—
G	Glow pilot lamp	Preheating completed	Engine being preheated	Diesel-engine truck
H	Load/unload interlock lamp	Free	Locked	—
I	Fr, Re interlock lamp	Free	Locked (flashing)	—
	Neutral lamp	F or R	Neutral	—
J	Fuel gauge	Indicate remaining fuel amount with key in "ON."		
K	Water temperature gauge	Overheat if pointer enters the red zone.		
L	Liquid crystal (normally acting as hour meter)	Indicate operating hours with key in "ON."		
Position and content of printed symbols: L1	Fuel filter warning lamp	Normal	Water drain required	Diesel-engine truck
L2	Coolant level warning lamp	Normal level	Low level	Option
L3	Clogged air cleaner element warning lamp	Normal element	Clogged	Option
When major failures occur, bulbs A, C, D, E, and H simultaneously flash.				

Inspection method of blown bulbs for Instrument panel

Each warning lamp and indicator lamp are normal if they illuminate with the starter switch turned ON, and no bulbs are blown.

Major Electrical Components

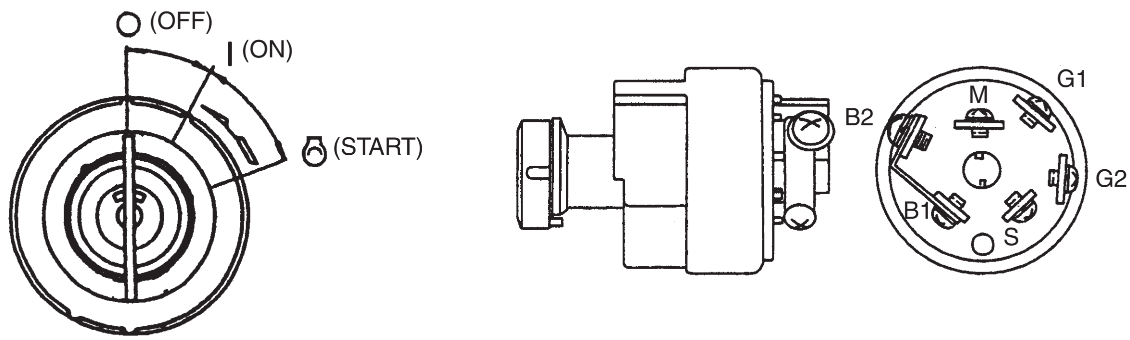
Starter switch

The diesel-engine truck, which uses a distributor type injection pump, is provided with an engine automatic stop mechanism of the fuel cut0ff system by the starter switch.

The gasoline-engine truck is also provided with an engine automatic stop mechanism of the fuel cutoff system.

Starter switch (with Anti-Restart Lock)

This switch has a built-in anti-restart lock, so the key cannot be turned from I (ON) to (START) position while the engine is running. This prevents the engine from troubles on starting or starter breakage caused by casual re-starting while the engine is running. The gasoline- and diesel-engine models use the same starter switch. In the diesel-engine models, I (ON) position of the switch is for energizing the glow plugs.



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Connection Table

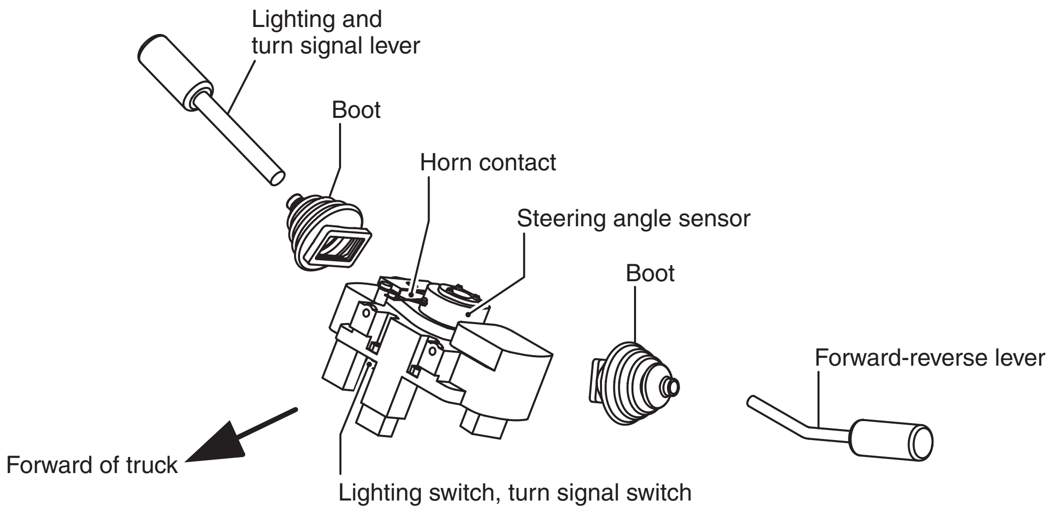
Gasoline-engine truck (12 V)

Terminal / Connected to / Key position	B1, B2	G1	G2	M	S
Connected to	Battery, alternator, fuse box			Fuse box	FNR lever
OFF					
ON (when driving)	○			○	
START (when starting engine)	○		○	○	○

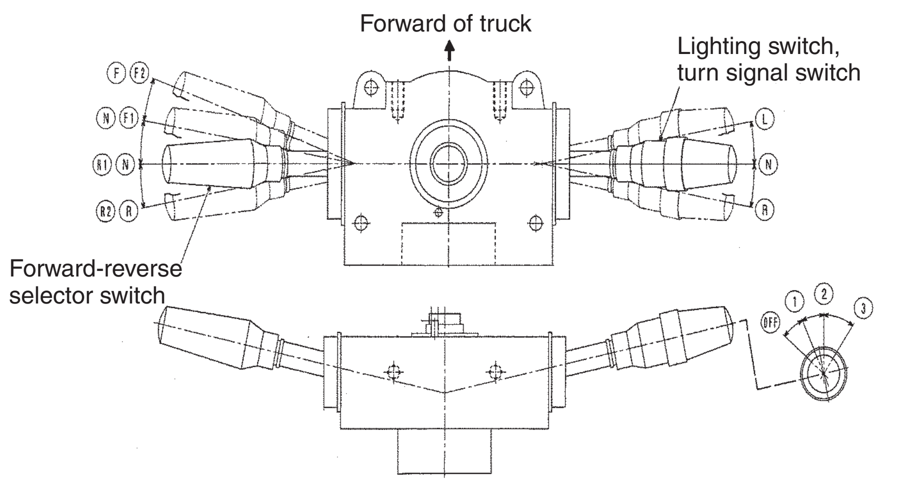
Diesel-engine truck (24 V)

Terminal / Connected to / Key position	B1, B2	G1	G2	M	S
Connected to	Battery, alternator, fuse box relay (glow plug)			Fuse box, engine stop, control timer	Neutral switch (starter), glow timer
OFF					
ON (when preheating) (when driving)	○			○	
START (when starting engine)	○		○	○	○

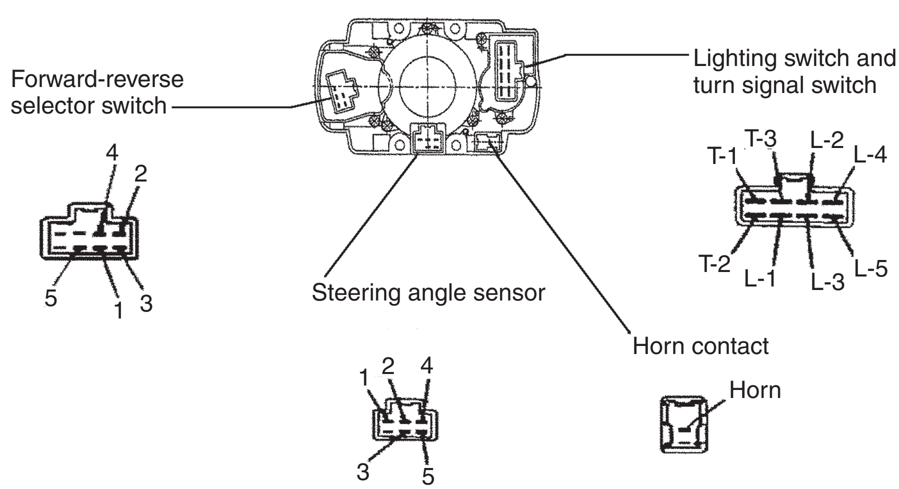
Lighting switch and turn signal switch



209625



209626



209627

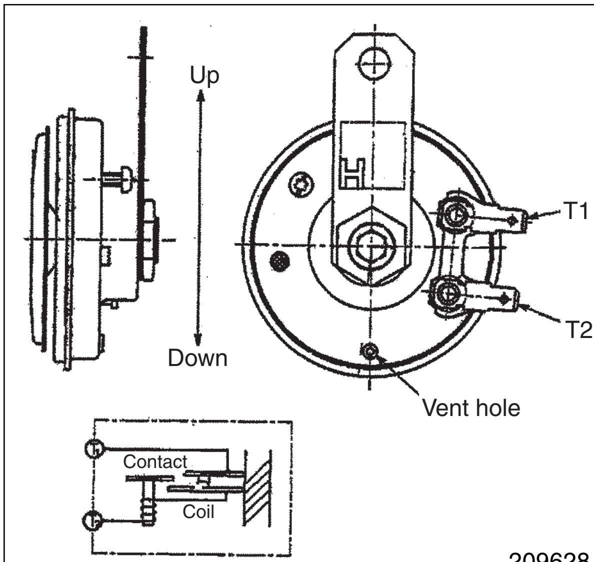
Horn

Check that the horn sounds when applying the specified voltage to both terminals of the horn, T1 and T2.

Replace the horn with a new one if it does not sound or its sound is abnormal.

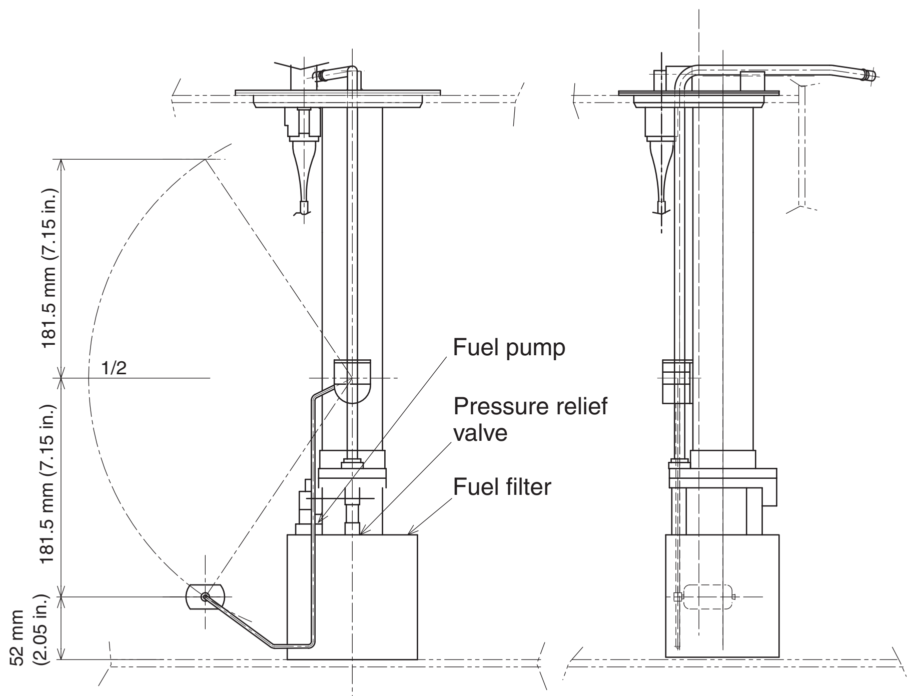
Operating voltage: DC 12 V (gasoline-engine truck)
: DC 12 V (diesel-engine truck)

Note: The installed position in an actual truck is as per the illustration.



209628

Tank Unit



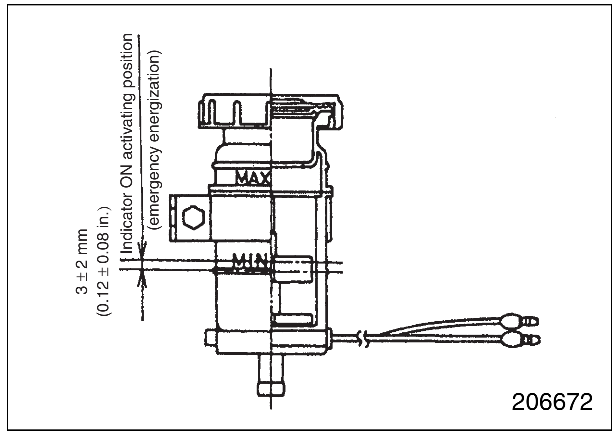
Referential Standards

Float position	E	1/4	1/2	3/4	F
Standard resistance value (ohm)	80	49.5	32	19	10
Tolerance (ohm)	+12 +12	–	±3	–	+1.0 -0.5

209629

Brake fluid sensor

Refer to the brake system.

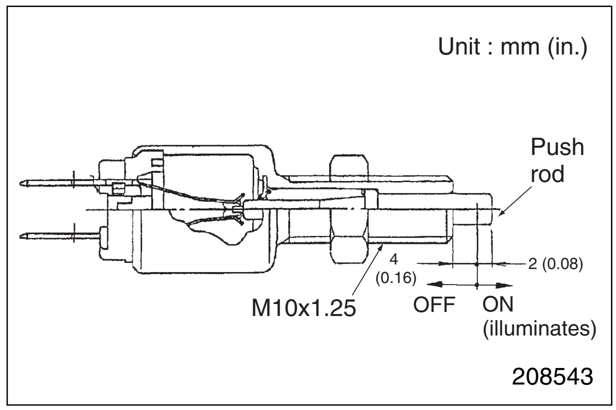


Stop lamp switch

Connect a tester across the terminals and check that the lamps turn ON and OFF when the push rod extended projection is to the specified value.

Measure the insulation resistance value across the terminals when the push rod is pushed in.

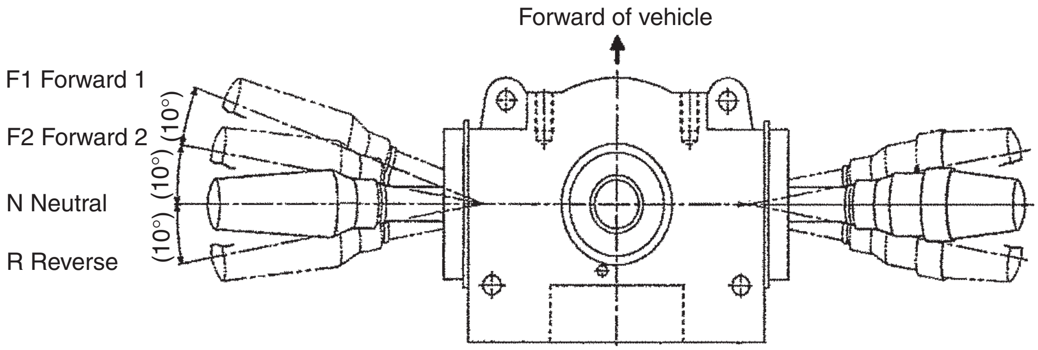
Replace the switch with a new one if the measured insulation resistance value is not more than the value listed below.



Insulation resistance value	1 M ohm or more (at 500 V megger)

Rated voltage: DC 12 V

Forward-reverse lever assembly (ATM truck)

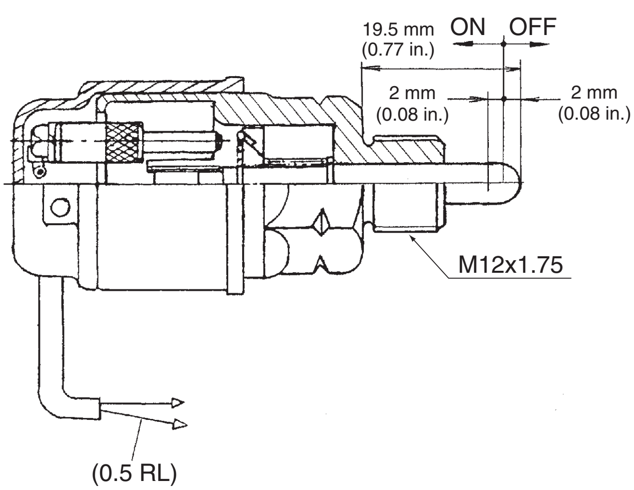


Connection table

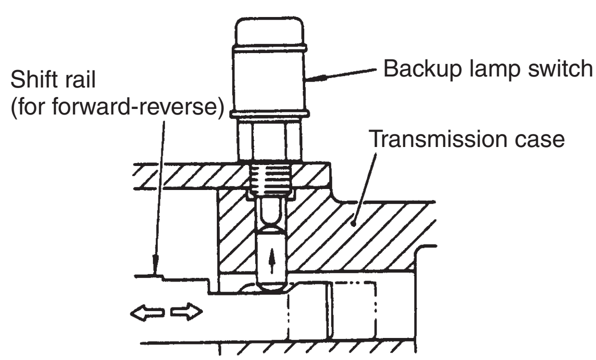
Lever position \ Terminal / Wire color	1 GR/L	2 B	3 G/R	4 B	5 L/W
F (Forward)		○	○		
N (Neutral)	○	—	—	○	
R (Reverse)		○	—	—	○

209632

Backup lamp switch (MTM truck)



208545

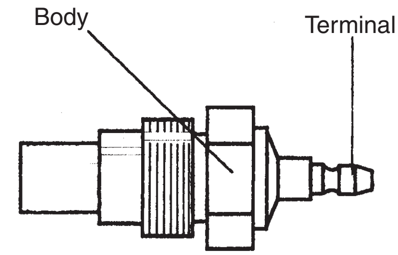


200013

Sender unit (engine coolant temperature)

1. Apply a tester to the sender unit between the terminal and body and check for continuity (resistance value).
2. Replace the sender unit with a new one if there is no continuity or the measured resistance value is outside the standard resistance value.

Note: The illustration is for a gasoline-engine truck.



Gasoline-engine truck

Temperature [°C (°F)]	50 (122)	70 (158)	100 (212)	110 (230)	120 (248)
Standard resistance value (ohm)	136	66	27.2	20.5	17.2

Diesel-engine truck

Temperature [°C (°F)]	50 (122)	60 (140)	80 (176)	100 (212)	106 (222.8)	120 (248)
Standard resistance value (ohm)	(80)	56.3	(29.5)	(16.5)	14.3	(10)

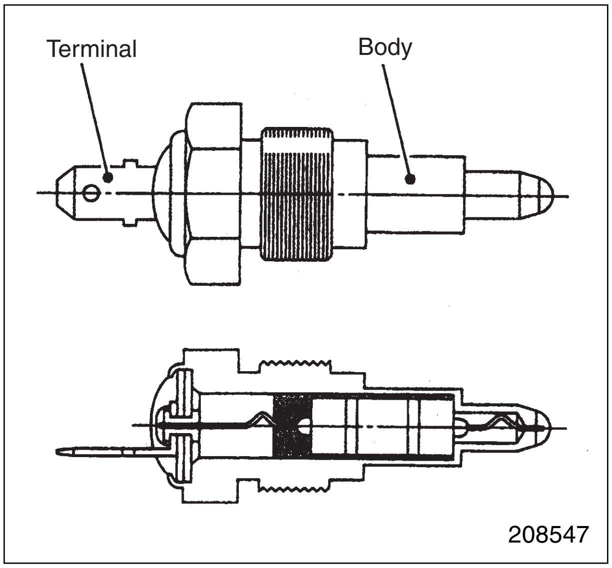
3. When installing the sender unit, tighten it to the specified torque.

Sender unit tightening torque	19.6 to 27.4 N·m (2.0 to 2.8 kgf·m) [14.5 to 20.2 lbf·ft]

Thermoswitch (T/C oil)

Apply a tester to the terminal and body and measure the insulation resistance value. Replace the thermoswitch with a new one if the measured insulation resistance value is not more than the value listed in the table below.

Insulation resistance value	1 M ohm or more (with contact OFF) (at 500 V megger)



Internal resistance: 0.5 ohm or less (with contact ON)

Allowable load: 0.5 A

Note: When installing the thermoswitch, tighten it to the specified torque.

Tightening torque	31.4 to 47.1 N·m (3.2 to 4.8 kgf·m) [23.2 to 34.7 lbf·ft]

CAUTION

Replace the thermoswitch with a new one if an impact is given to it or if it is dropped.

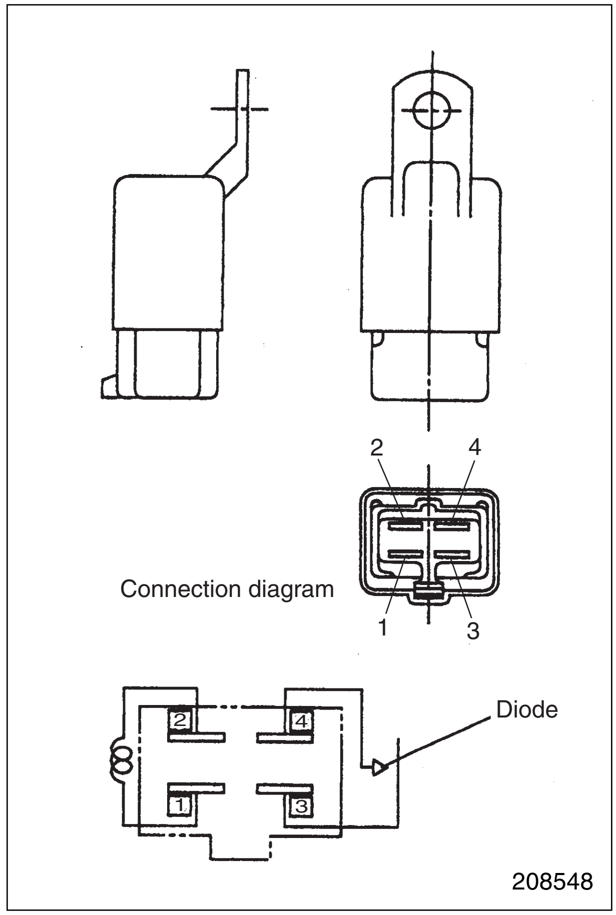
Main specifications		
Operating temperature	OFF→ON	122 ± 3 °C (251.6 ± 37.4 °F)
	ON→OFF	115 °C (239 °F) or higher
Insulation resistance (with contact OFF)		1 M ohm or more

Power relay (ATM truck, for backup lamps)

Inspection of coil

Apply a tester to terminal 1 and terminal 2 and measure the resistance value of the relay coil. Replace the coil with a new one if there is no continuity or the resistance value measured is outside the standard resistance value.

	Resistance value of coil
Gasoline/Diesel-engine truck	80 ohm ± 10 %



Inspection of contact

1. Measure the insulation resistance value between terminal 3 and terminal 4. Replace the contact with a new one if the measured insulation resistance value is not more than the value listed in the table below.

Insulation resistance value	10 M ohm or more (at 500 V megger)

2. Apply the tester to terminal 3 and terminal 4.
3. When applying a voltage of 12 V ON and OFF across terminal 1 and terminal 2 under the above condition, check to see if the relay activates to cause continuity or not between terminal 3 and terminal 4. Replace the relay with a new one if it does not activate properly.

CAUTION

This part operates on DC 12 V (Gasoline/Diesel-engine truck) power supply.

CAUTION

As the relay has an integrated diode between terminals, be careful about the polarity when inspecting. Replace the relay with a new one if an impact is given to it or if it is dropped.

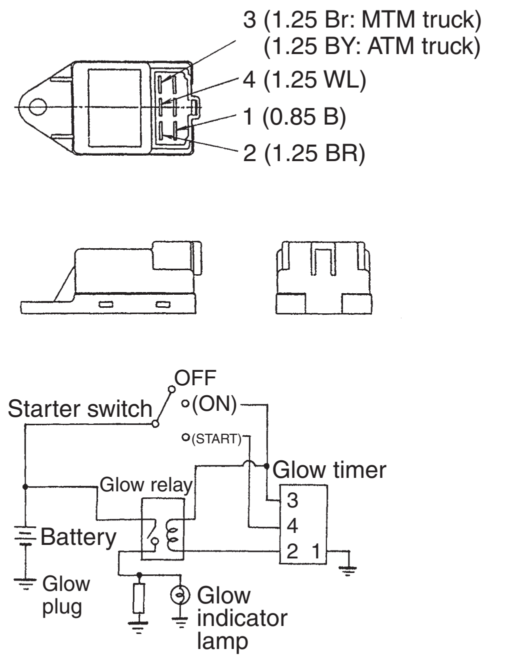
Coil rating [at 20°C (68°F)]

Item \ Truck type	Gasoline/Diesel-engine truck
Rated operating voltage	DC 12 V
Working voltage	DC 8 V or less
Open-circuit voltage	DC 0.6 to 6 V or more
Coil resistance	80 ohm ± 10 %
Rated exciting current	150 mA ± 10 %

Glow timer (diesel-engine truck)

Inspection of output time when starter switch is turned to ON

When a tester is applied to terminal 2 and terminal 1 and a voltage of 12 V is applied between terminal 3 and terminal 1, there is continuity between terminal 2 and terminal 1 for 15 seconds at room temperature. Replace the glow timer with a new one if it does not operate properly.



208549

Inspection of output time when starter switch is turned to START

When a tester is applied to terminal 2 and terminal 1 and a voltage of 12 V is applied between terminal 4 and terminal 1, there is continuity between terminal 2 and terminal 1 for 5 seconds. Replace the glow timer with a new one if it does not operate properly.

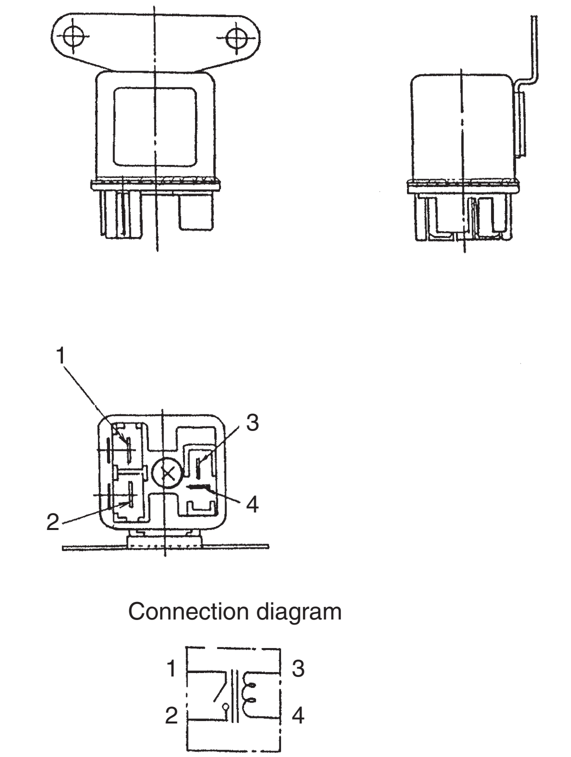
Rated voltage: DC 12 V

Glow relay (diesel-engine truck)

Inspection of coil

Apply a tester to terminal 3 and terminal 4 and measure the resistance value of the relay coil. Replace the coil with a new one if there is no continuity or the measured resistance value is outside the standard resistance value.

Resistance value of coil [at 20 °C (68 °F)]	52 ohm



208550

Inspection of contact

1. Measure the insulation resistance value between terminal 1 and terminal 2. Replace the contact with a new one if the measured insulation resistance value is not more than the value listed in the table below.

Insulation resistance valve	1 M ohm or more (at 500 V megger)

2. Apply a tester to terminal 1 and terminal 2.
3. When applying a voltage of 12 V ON and OFF across terminal 3 and terminal 4 under the above condition, check to see if the relay activates to cause continuity or not between terminal 1 and terminal 2. Replace the relay with a new one if it does not activate properly.

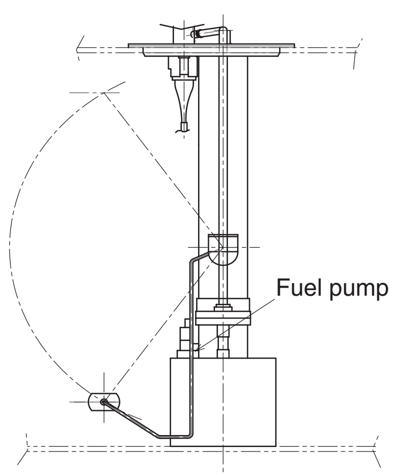
Coil rating [in case of 20°C (68°F)]

Rated operating voltage: DC 12 V

Coil resistance: 52 ohm

Rated exciting current: 80 mA

Fuel pump (gasoline-engine truck)



209640

Solenoid valve (for speed selector valve)

This is an ON/OFF valve (normal open type).

The valve opens the IN/OUT circuit in a non-energized condition.

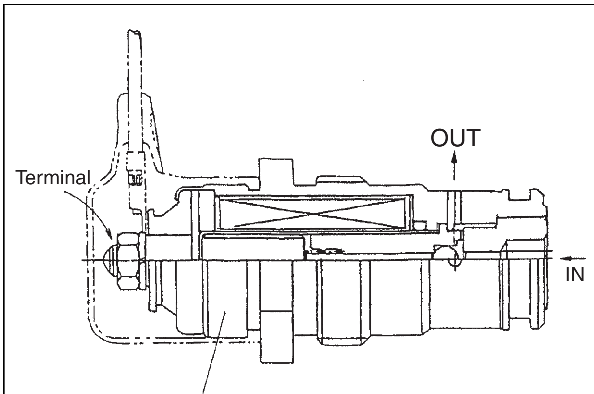
Rated operating voltage: DC 12 V (gasoline-engine truck, resin color: grey)
: DC 24V (diesel-engine truck, resin color: brown)

Solenoid valve (for SR-SF selector valve)

This is an ON/OFF valve (normal open type).

The valve opens the IN/OUT circuit in a non-energized condition.

Rated operating voltage: DC 12 V (gasoline-engine truck)
: DC 24V (diesel-engine truck)



Mark of 12 V NO (for gasoline-engine truck)
208536

Wiring to the solenoid valve terminal on SR side

Wire gauge and color 1.25 Br / $\boxed{R}$ tag is attached.

Wiring to the solenoid valve terminal on SF side

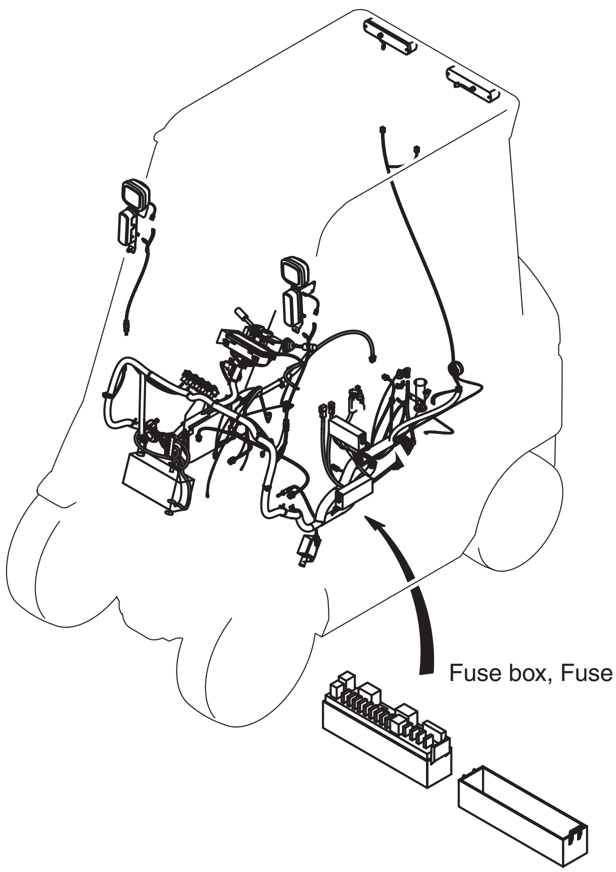
Wire gauge and color 1.25 LgR / $\boxed{F}$ tag is attached.

CAUTION

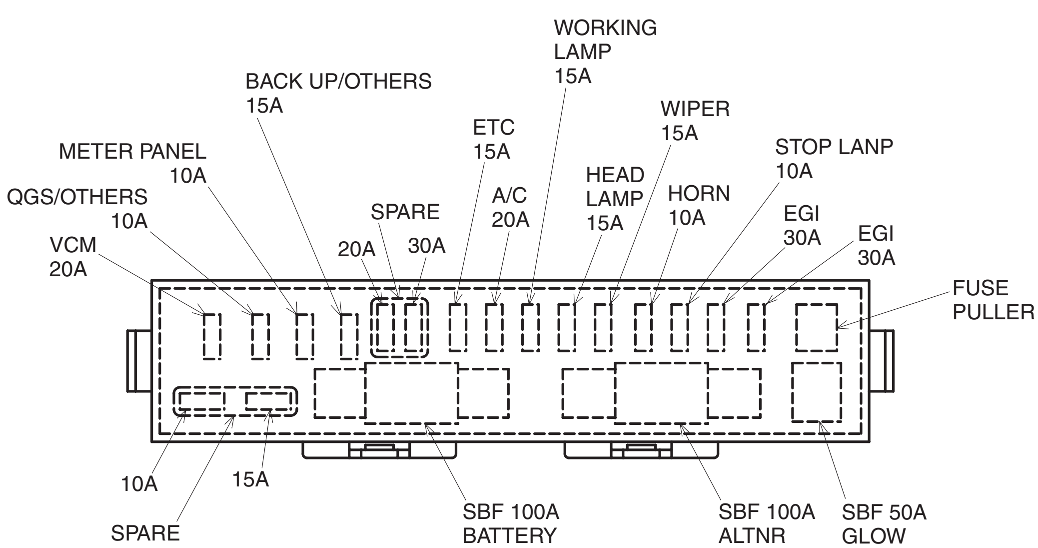
The valve for DC 12 V has an identification mark "12 V NO" on the body side.

Be careful not to supply DC 24 V to the valve to avoid damage.

Fuse Box

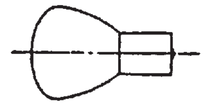
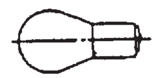
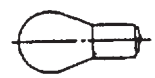
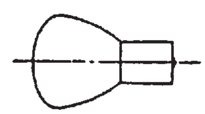
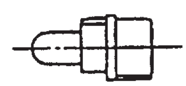


209645



209646

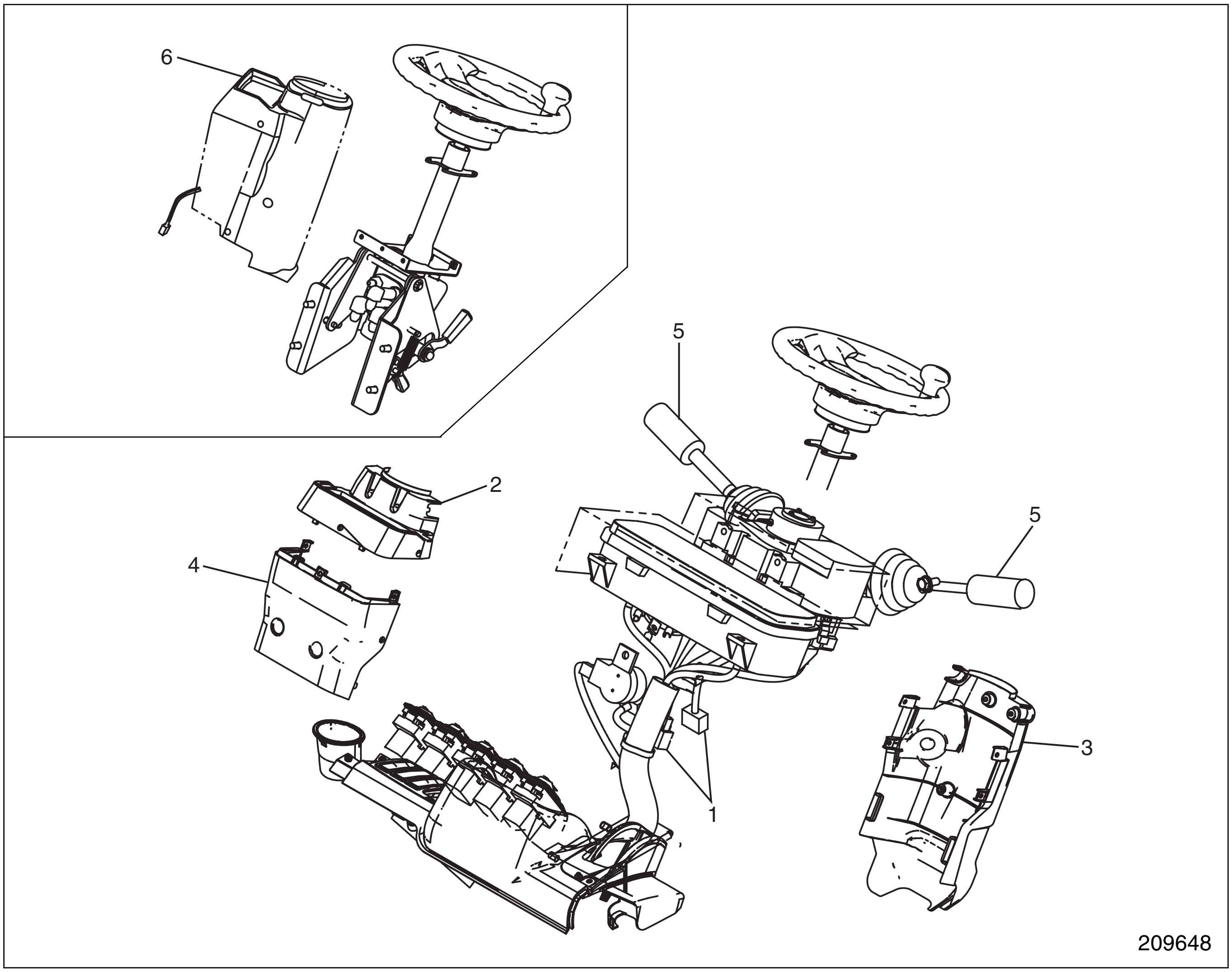
Lamp Bulb Specifications

Type of lamp \ Item		No. of bulbs	Color of lens	Watts		Shape	Remarks
				12 volt	24 volt		
Head lamps		2	Colorless	45	60		
Combination lamps (front)	Turn signals	2	Amber	27	25		Standard: Installed on overhead guard
	Clearance lamps	2	Amber	10	12		
Combination lamps (rear)	Turn signals	2	Amber	27	25		
	Tail/stop lamps	2	Red	8/23	10/25		
	Backup lamps	2	Colorless	10	12		
Working lamps (front and rear)		4	Colorless	45	60		Optional
License plate lamp		1	Colorless	10	12		Optional
Instrument panel lamps		7	Colorless	3	3		Socket color: 12 V (Blue) 24 V (Dark Gray)

200016

Console Box

Disassembly



(1) Disconnect the electrical wiring from connector 1.

(2) Remove the screw using a screwdriver and remove cover 2.

(3) Remove the screw and then, remove cover (U-Re) 3.

(4) Remove the screw and then, remove cover (U-Fr) 4.

(5) Remove the forward-reverse lever (FNR lever) and turn signal lever 5.

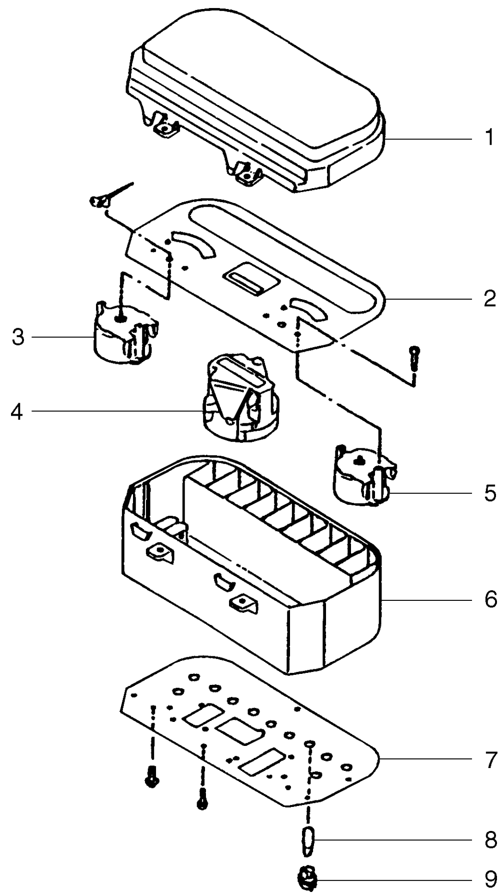
(6) Remove the bolt and then, remove console box assembly 6.

Reassembly

Follow the disassembly sequence in reverse.

Instrument Panel

Disassembly



Sequence

1 Meter cover
2 Dial
3 Water temperature gauge
4 Liquid crystal
5 Fuel gauge
6 Meter case
7 Rigid board
8 Bulb
9 Socket

CAUTION

Be careful not to damage the rigid board when disassembling the instrument panel.

Reassembly

To reassemble the instrument panel, follow the reverse of disassembly procedure.

Bulb replacement

For bulb replacement, remove the socket from the rigid board by turning it counterclockwise. For configuration of the indicator lights, refer to page 3-4.

Battery Maintenance

1. State of charge and electrolyte specific gravity (S.G.) adjustment

Specific gravity reading at 20°C (68°F)	State of charge	Adjustment
1.280 to 1.265	Fully charged	If difference in S.G. between any two cells is 0.020 or more, discharge the battery to minimize the difference and then recharge battery. Adjust S.G. during recharging.
1.260 to 1.225	One-half charged	Recharge battery and adjust electrolyte S.G. Make sure there is neither faulty components, loosely connected cord nor corroded connection.
1.220 or below	Discharged	Recharge battery. If difference in S.G. is large, adjust it during recharging.
If difference in S.G. is more than 0.040	A cell with a low S.G. is in shorted condition. Electrolyte leakage, or excessive/diluted electrolyte.	Recharge until voltage and S.G. stabilize and have remained constant for more than 2 hours. During recharging, adjust S.G. to 1.280 to 1.265. If difference in S.G. is more than 0.040 and a low S.G. is found in certain cells only, replace battery. After leaving battery for 12 to 96 hours, conduct a high current discharge test.

2. Specific gravity reading and state of charge

To check the battery for state of charge, take hydrometer readings on its electrolyte. The battery may be fully charged if the S.G. reading is 1.280 to 1.265 at 20°C (68°F). The state of charge can be told from the way the electrolyte level goes down to expose the cell plates. If addition of distilled water is necessary every month or so, the battery is overcharged. If addition is not required for more than 3 months, it is likely that the battery is inadequately charged.

3. Charging precautions

(1) In slow charging, the charging current should be about 1/10 the capacity of the battery to be charged.

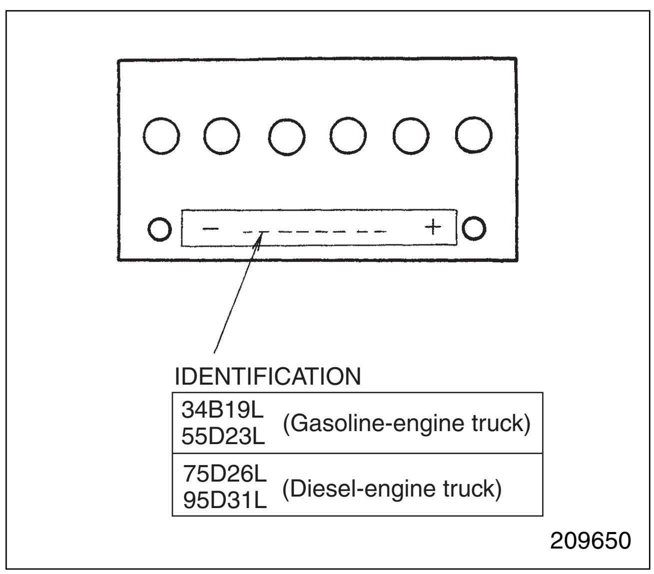
(2) In quick charging, the battery capacity in ampere should not be exceeded.

(3) During charging, adjust the charging current to prevent the electrolyte temperature from rising beyond 45°C (113°F).

(4) When connecting the cables to the battery, begin with the cable for the positive (+) terminal. When disconnecting them from the battery, begin with the cable for the negative (–) terminal.

CAUTION

Be sure to turn OFF the starter switch and lighting switch before disconnecting or connecting the battery cables to prevent the IC regulator from suffering damage.



Wire Color

Wire colors listed in the table below show standard colors (base colors). For wiring composed of two colors, the first color shows a base color and the second color a marking color.

Example: The wire color of BW shows that its base color is B with a marking W.

B W

Marking color

Base color

Note: For wiring identification, the same color, in principle, must be used for the circuit from the power supply to the load.

CAUTION

Be careful that allowable current differs between solid wires and stranded wires even if they are of the same gauge.

List of wire colors

Wire color	Color
B	BLACK
W	WHITE
R	RED
G	GREEN
Y	YELLOW
Br	BROWN
L	BLUE
Lg	LIGHT GREEN
O	ORANGE
P	PINK
Gr	GRAY
Lb	LIGHT BLUE
Dg	DARK GREEN
ch	CHOCOLATE

Troubleshooting

Starter System

Item	Symptom	Cause	Remedy
Starter switch	Starter will not crank engine	Weak or dead battery	Recharge or replace.
		Short or open circuit	Repair or replace.
		Poor continuity in starter switch	Replace.
		Starter or starter relay defective	Replace.
		Forward-reverse lever not in neutral position (ATM truck)	Move lever to neutral position.
	Turning off starter switch will not stop engine	Open or short circuit	Repair or replace.
		Engine stop solenoid defective	Replace or readjust.
		Control timer defective	Replace.

Gauges

Item	Symptom	Cause	Remedy
Water temperature gauge	Will not indicate at all	Rigid board defective	Replace.
		Open or short circuit	Repair or replace.
		Gauge internally defective	Replace.
		Gauge unit defective	Replace.
	Will not indicate accurately	Gauge or gauge unit not of the type called for	Replace to a correct one.
		Loose terminal connection	Repair.
	Will indicate higher than actual temperature	Circuit between gauge and gauge unit grounded	Repair.
		Gauge internally defective	Replace.

Item	Symptom	Cause	Remedy
Fuel gauge	Will not indicate at all	Rigid board defective	Replace.
		Open or short circuit	Repair or replace.
		Gauge internally defective	Replace.
		Gauge unit defective	Replace.
	Will not indicate accurately	Gauge or gauge unit not of the type called for	Replace to a correct one.
		Loose terminal connection	Repair.
	Will indicate “full” regardless of amount of fuel left in tank	Circuit between gauge and gauge unit open or short	Repair.
		Gauge internally defective	Replace.
		Gauge unit defective	Replace.
	Will indicate “empty” regardless of amount of fuel left in tank	Circuit between gauge and gauge unit grounded	Repair.
		Gauge unit defective	Replace.
		Gauge internally defective	Replace.

Lighting System

Lamps - general	Will not light	Weak or dead battery	Recharge or replace.
		Fuses blown out	Check and replace.
		Open or short circuit	Repair or replace.
		Poor grounding	Clean ground spot and re-make connection.
		Switch defective	Replace.
		Bulbs burnt out	Replace.
	Will light dimly	Weak battery	Check and recharge.
		Contact points in switches defective	Repair or replace.
		Loose terminals	Repair.
		Dirty lenses	Clean.
		Waterdrops inside lenses	Dry and replace packings.
		Bulbs expired in service life	Replace.
Head lamps	Will not light	Lighting switch defective	Replace.
		Bulbs burnt out	Replace.
Turn signals	Will not flicker	Turn signal switch defective	Replace.
		Turn signal relay defective	Replace.
	Will not go out	Turn signal relay defective	Replace.
		Bulbs burnt out	Replace.
	Will flicker too slow	Low wattage of bulbs	Replace to a correct one.
		Bulbs burnt out	Replace.
		Turn signal relay defective	Replace.
	Will flicker too fast	High wattage of bulbs	Replace to a correct one.
		Turn signal relay defective	Replace.
Other lamps	Backup lamps will not light	Backup lamp switch defective	Repair or replace.
		Bulbs burnt out	Replace.
	License number plate lamp will not light	Lighting switch defective	Replace.
		Bulb burnt out	Replace.

Alarm Unit

Horn	Will not give blast of sound	Fuse blown out	Check and replace.
		Open or short circuit	Repair or replace.
		Horn switch defective	Replace.
		Horn defective	Replace.
		Horn button defective	Repair or replace.
	Will give ugly blast of sound	Horn switch defective	Replace.
		Horn defective	Replace.

Battery

Symptom	Probable cause	Remedy
Tends to run down rapidly	Drive belt slipping	Readjust.
	❋ Alternator	
	Stator coil grounded or open-circuited	Repair or replace.
	Rotor coil open	Replace.
	Brushes poorly seating on slip rings	Replace brushes if worn. Clean holder and polish slip rings.
	Diode ruptured	Replace.
	❋ Regulator	
	Regulated voltage setting too low	Replace.
	❋ Battery	
	Not enough electrolyte or wrong concentration of acid to water	Refill and check specific gravity.
	Battery cell plates deteriorated (forming, possibly internal short-circuit)	Replace.
	Terminal connections loose	Clean and retighten.
	❋ Wiring	
	Open or loose connection between starter switch and regulator IC terminal	Repair.
	Fuse blown, or loosely set in holder	Replace and repair.
	Open or loose connection between F terminals of regulator and alternator	Repair.
Tends to get overcharged	**❋ Wiring**	
	Regulator IC and F terminals shorted or miswired	Repair.
	Poor grounding of regulator F terminal	Repair.
	❋ Regulator	
	Pressure coil open-circuited	Replace.
	Regulated voltage too high	Replace.

Electrical Schematic Diagram

Electrical Schematic Diagram (1/5)

Electrical Schematic Diagram (2/5)

Electrical Schematic Diagram (3/5)

Electrical Schematic Diagram (4/5)

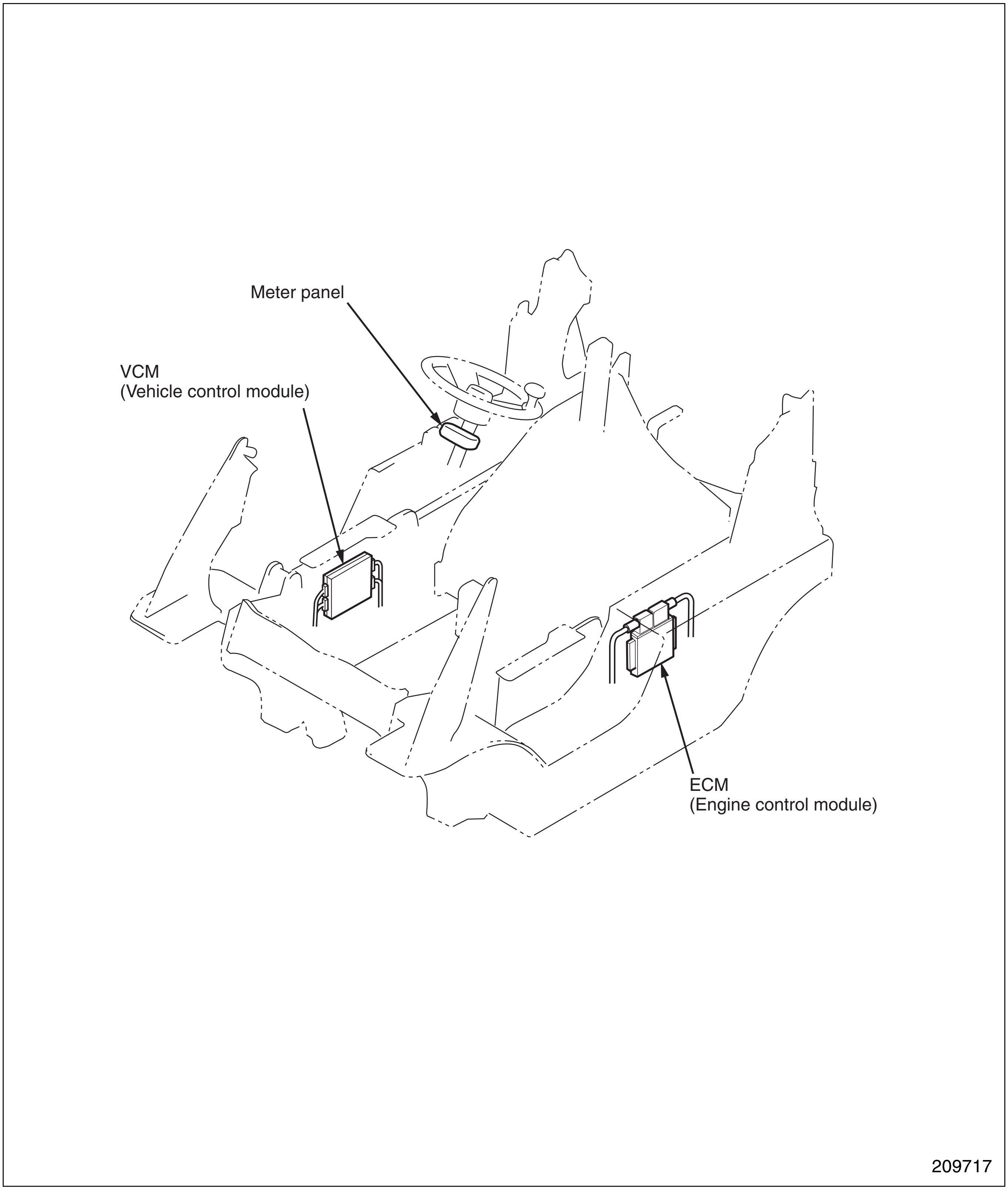
Electrical Schematic Diagram (5/5)

CONTROLLERS

Outline

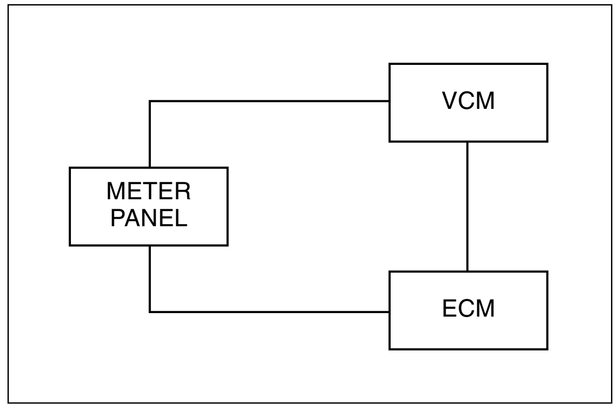
VCM and ECM control the vehicle and engine.

Controllers are located as shown below.



Main Functions

Meter panel, VCM and ECM are connected to each other and their mutual communication works as a distributed control system to control the truck.



Main functions of each controller are as follows:

Meter Panel

Located below the steering wheel and displays error codes. Refer to "GROUP 3 ELECTRICAL SYSTEM" for other functions.

VCM (Vehicle Control Module)

Located at the right side of the body and controls the vehicle overall. VCM-1 is for MC trucks and VCM-2 is for FC trucks.

ECM (Engine Control Module)

Located at the left side of the body and controls the engine. Refer to Engine Service Manual for details.

Service Tool Functions

Input/Output Monitor

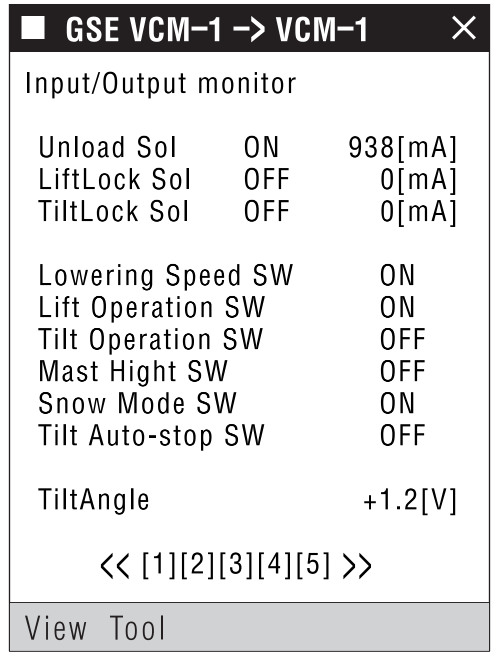
Monitors input and output of sensors and switches.

(1) VCM-1 (for MC Truck)

1. VCM-1 I/O Monitor: Mast control

Unload Sol	ON/OFF, Feedback [Hex,mA]
LiftLock Sol	ON/OFF, Feedback [Hex,mA]
TiltLock	ON/OFF, Feedback [Hex,mA]

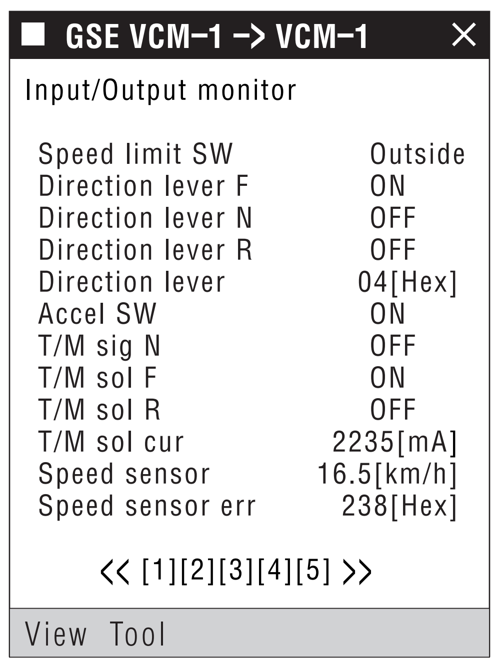
Lowering Speed SW	ON/OFF
Lift Operation SW	ON/OFF
Mast High SW	ON/OFF
Snow Mode SW	ON/OFF
Tilt Auto-stop SW	ON/OFF
Tilt Operation SW	ON/OFF
Tilt Angle	[Hex, V]



2. VCM-1 I/O Monitor: Engine and T/M control

Speed limit SW	Outside/Inside
Direction lever F	ON/OFF
Direction lever N	ON/OFF
Direction lever R	ON/OFF
Direction lever	[Hex]
Accel SW	ON/OFF

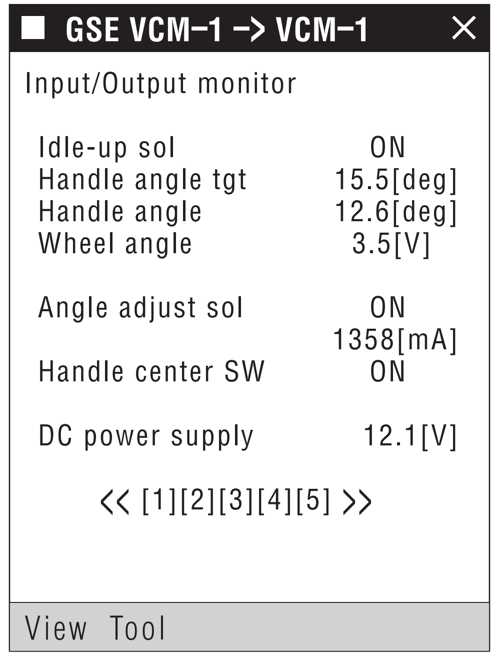
T/M sig N	ON/OFF
T/M sol F	ON/OFF
T/M sol R	ON/OFF
T/M sol cur	[Hex,mA]
Speed sensor	[Hex,Hz,km/h]
Speed sensor err	[Hex,V]



Note: “Hex” denotes hexadecimal digit.

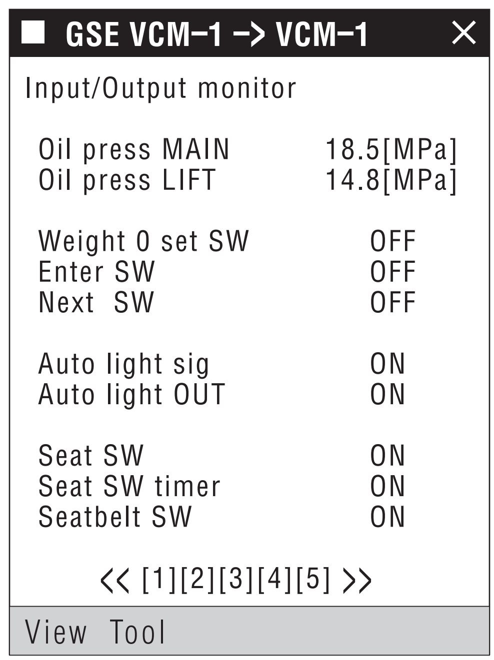
3. VCM-1 I/O Monitor: Steering control

Idle-up sol	ON/OFF
Handle angle tgt	[Hex,deg]
Handle angle	[Hex,deg]
Wheel angle	[Hex,V]
Angle adjust sol	ON/OFF
Angle adjust tilt lock cur	[Hex,mA]
Handle center SW	ON/OFF
DC power supply	[Hex,V]



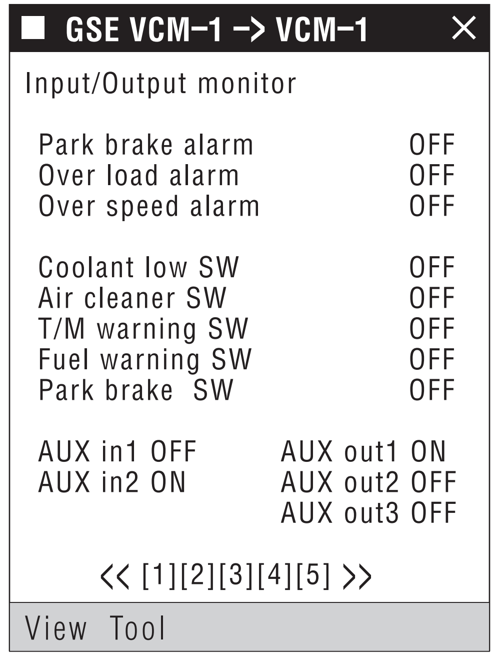
4. VCM-1 I/O Monitor: Other control 1

Oil press MAIN	[Hex,MPa]
Oil press LIFT	[Hex,MPa]
Weight 0 set SW	ON/OFF
Enter SW	ON/OFF
Next SW	ON/OFF
Auto light sig	ON/OFF
Auto light OUT	ON/OFF
Seat SW	ON/OFF
Seat SW timer	ON/OFF
Seatbelt SW	ON/OFF



5. VCM-1 I/O Monitor: Other control 2

Park brake alarm	ON/OFF
Over load alarm	ON/OFF
Over speed alarm	ON/OFF
Coolant low SW	ON/OFF
Air cleaner SW	ON/OFF
T/M warning SW	ON/OFF
Fuel warning SW	ON/OFF
Park brake SW	ON/OFF
AUX in1	ON/OFF
AUX in2	ON/OFF
AUX out1	ON/OFF
AUX out2	ON/OFF
AUX out3	ON/OFF



(2) VCM-2 (for FC Truck)

1. VCM-2 I/O Monitor: FC control

Solenoid output (LIFT Up)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (LIFT Down)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (TILT Fwd)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (TILT Rear)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT1A)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT1B)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT2A)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT2B)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT3A)	Output [Hex, mA], Feedback [Hex, mA]
Solenoid output (ATT3B)	Output [Hex, mA], Feedback [Hex, mA]
Joystick [LIFT] signal	[Hex, V]
Joystick [TILT] signal	[Hex, V]
Joystick [ATT1] signal	[Hex, V]
Joystick [ATT2] signal	[Hex, V]
Joystick [ATT3] signal	[Hex, V]
Joystick [LIFT] center	[Hex, V]
Joystick [TILT] center	[Hex, V]
Joystick [ATT1] center	[Hex, V]
Joystick [ATT2] center	[Hex, V]
Joystick [ATT3] center	[Hex, V]
4V-5V change SW	ON/OFF
Lever Func SW	ON/OFF

GSE VCM-2 -> VCM-2

Input/Output monitor

	Lever [V]		Output [mA]	Feedback [mA]
LIFT	3.54	up	745	750
	(2.51)	down	0	
TILT	1.52	Fwd	0	839
	(2.49)	Rear	840	
ATT1	0.00	A	0	0
	(2.49)	B	0	
ATT2	0.00	A	0	0
	(2.47)	B	0	
ATT3	0.00	A	0	0
	(2.50)	B	0	
4V-5V change		SW	OFF	
LeverFunc		SW	OFF	

<< [1][2][3][4][5][6] >>

View Tool

2. VCM-2 I/O Monitor: Other mast control

Unload Sol	ON/OFF, Feedback [Hex, mA]
LiftLock Sol	ON/OFF, Feedback [Hex, mA]
TiltLock Sol	ON/OFF, Feedback [Hex, mA]
Lower Speed SW	ON/OFF
Lift Operation SW	ON/OFF
Tilt Operation SW	ON/OFF
Mast High SW	ON/OFF
Snow Mode SW	ON/OFF
Tilt auto-stop SW	ON/OFF
Tilt Angle	[Hex,V]

GSE VCM-2 -> VCM-2

Input/Output monitor

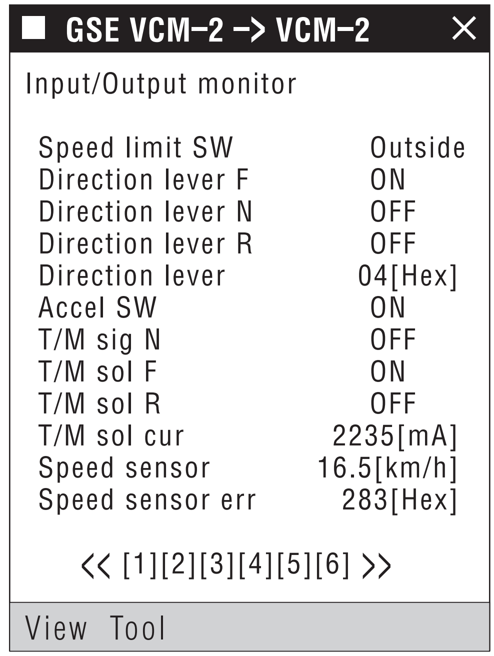
Unload Sol	ON	938[mA]
LiftLock Sol	OFF	0[mA]
TiltLock Sol	OFF	0[mA]
Lowering Speed SW		ON
Lift Operation SW		ON
Tilt Operation SW		OFF
Mast Hight SW		OFF
Snow Mode SW		ON
Tilt Auto-stop SW		OFF
TiltAngle		+1.2[V]

<< [1][2][3][4][5][6] >>

View Tool

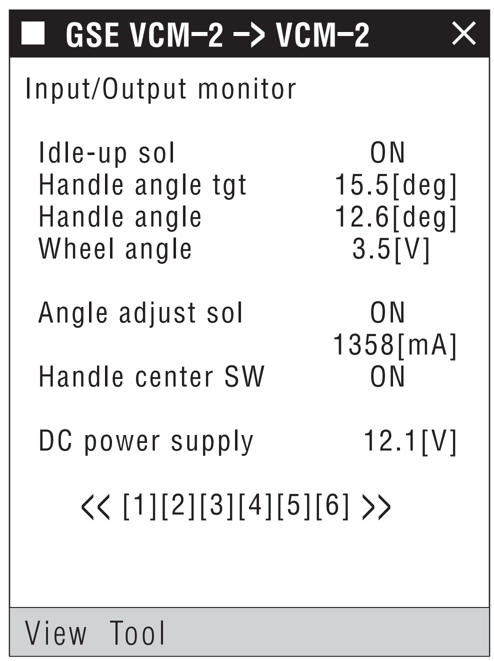
3. VCM-2 I/O Monitor: Engine and T/M control

Speed limit SW Outside	Outside/Inside
Direction lever F	ON/OFF
Direction lever N	ON/OFF
Direction lever R	ON/OFF
Direction lever	[Hex]
Accel SW	ON/OFF
T/M sig N	ON/OFF
T/M sol F	ON/OFF
T/M sol R	ON/OFF
Idle-up sol	ON/OFF
T/M sol cur	[Hex,mA]
Speed sensor	[Hex,Hz,km/h]



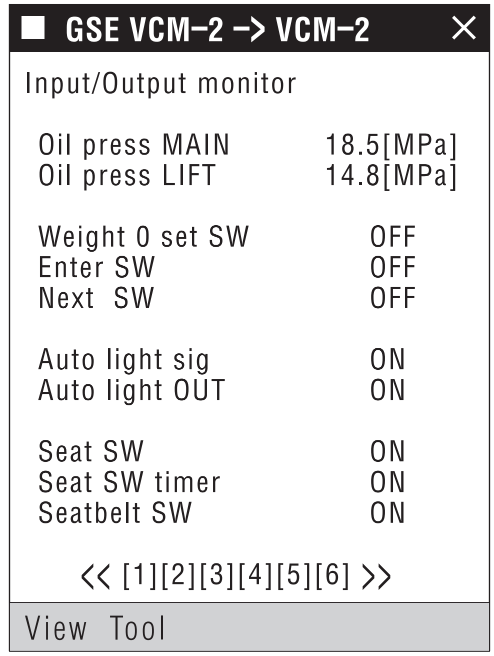
4. VCM-2 I/O Monitor: Steering control

Speed sensor err	[Hex,V]
Handle angle tgt	[Hex,deg]
Handle angle	[Hex,deg]
Wheel angle	[Hex,V]
Angle adjust sol	ON/OFF
Angle adjust tilt lock cur	[Hex,mA]
Handle center SW	ON/OFF
DC power supply	[Hex,V]



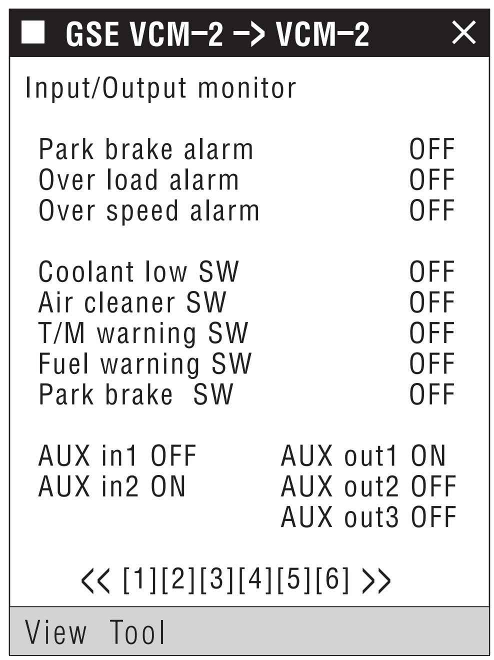
5. VCM-2 I/O Monitor: Other control 1

Oil press MAIN	[Hex,MPa]
Oil press LIFT	[Hex,MPa]
Weight 0 set SW	ON/OFF
Enter SW	ON/OFF
Next SW	ON/OFF
Auto light sig	ON/OFF
Auto light OUT	ON/OFF
Seat SW	ON/OFF
Seat SW timer	ON/OFF
Seatbelt SW	ON/OFF



6. VCM-2 I/O Monitor: Other control 2

Park brake alarm	ON/OFF
Over load alarm	ON/OFF
Over speed alarm	ON/OFF
Coolant low SW	ON/OFF
Air cleaner SW	ON/OFF
T/M warning SW	ON/OFF
Fuel warning SW	ON/OFF
Park brake SW	ON/OFF
AUX in1	ON/OFF
AUX in2	ON/OFF
AUX out1	ON/OFF
AUX out2	ON/OFF
AUX out3	ON/OFF



Error Codes and Troubleshootings

Error Code Display

All the error codes detected by VCM are displayed.

Troubleshooting

Tapping a displayed error code or error name reads the text file (***.txt, which can be edited with a Windows application) corresponding to the error code and displays the troubleshooting screen specific to the error code. If one screen cannot accommodate all data, the screen can be scrolled. The screen specifications are shown below. Table in the following pages lists the probable causes and check points for error codes.

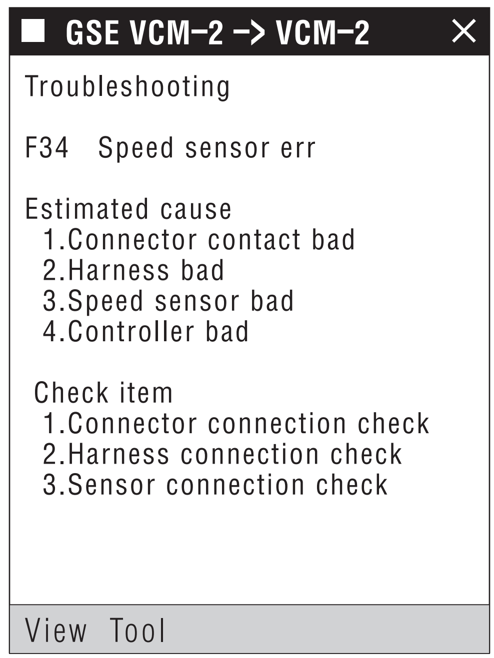
Error code F34 (speed sensor error)

Estimated cause

1. Connector contact error
2. Harness error
3. Speed sensor error
4. Controller error

Check items

1. Connector connection
2. Harness continuity
3. Sensor continuity



Error Codes and Troubleshootings are shown below.

Refer to “Locations of Sensors and Switches” on later pages.

Err code	Description	Probable cause	Check point
F01	Memory err	1. Controller bad	
F02	Battery voltage fault	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Controller bad	
F03	VCM communication err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. VCM Controller bad	3. Communication line check
		4. Controller bad	
F07	MP communication err	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	
F10	Lift lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Lift lever bad	3. Lever connection check
		4. Controller bad	

Err code	Description	Probable cause	Check point
F11	Tilt lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Tilt lever bad	3. Lever connection check
		4. Controller bad	
F12	Att1 lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att1 lever bad	3. Lever connection check
		4. Controller bad	
F13	Att2 lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att2 lever bad	3. Lever connection check
		4. Controller bad	
F14	Att3 lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att3 lever bad	3. Lever connection check
		4. Controller bad	
F16	Shift lever fault	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Shift lever bad	3. Shift lever check
		4. Controller bad	

Err code	Description	Probable cause	Check point
F17	Speed err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Speed sensor bad	3. Sensor connection check
		4. Controller bad	
F20	Lift lever err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Lift lever bad	3. Lever connection check
		4. Controller bad	
F22	Tilt lever err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Tilt lever bad	3. Lever connection check
		4. Controller bad	
F24	Att1 lever err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att1 lever bad	3. Lever connection check
		4. Controller bad	
F26	Att2 lever err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att2 lever bad	3. Lever connection check
		4. Controller bad	

Err code	Description	Probable cause	Check point
F28	Att3 lever err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Att3 lever bad	3. Lever connection check
		4. Controller bad	
F32	Lift oil prs err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Lift oil prs sensor bad	3. Sensor connection check
		4. Controller bad	
F34	Speed sensor err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Speed sensor bad	3. Sensor connection check
		4. Controller bad	
F36	Wheel sensor err	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Wheel sensor bad	3. Sensor connection check
		4. Joint and link bad	4. Joint and link check
		5. Controller bad	

Err code	Description	Probable cause	Check point
F38	Tilt sensor err	1. Connector contact bad	1. Link comes and damage check
			2. Connector connection check
		2. Harness bad	3. Harness connection check
		3. Tilt sensor bad	4. Sensor connection check
		4. Controller bad	
F40	Steering fault	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Wheel sensor bad	3. Sensor connection check
		4. Controller bad	
F50	Lift UP sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Lift UP sol bad	4. Lift UP sol connection check
		5. Controller bad	
F52	Lift DN sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Lift DN sol bad	4. Lift DN sol connection check
		5. Controller bad	

Err code	Description	Probable cause	Check point
F54	Lift sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Lift sol bad	4. Lift sol connection check
		5. Controller bad	
F55	Tilt FW sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt FW sol bad	4. Tilt FW sol connection check
		5. Controller bad	
F57	Tilt BW sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt BW sol bad	4. Tilt BW sol connection check
		5. Controller bad	
F59	Tilt sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tilt sol bad	4. Tilt sol connection check
		5. Controller bad	

Err code	Description	Probable cause	Check point
F60	Att1A sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1A sol bad	4. Att1A sol connection check
		5. Controller bad	
F62	Att1B sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1B sol bad	4. Att1B sol connection check
		5. Controller bad	
F64	Att1 sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att1 sol bad	4. Att1 sol connection check
		5. Controller bad	
F65	Att2A sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2A sol bad	4. Att2A sol connection check
		5. Controller bad	

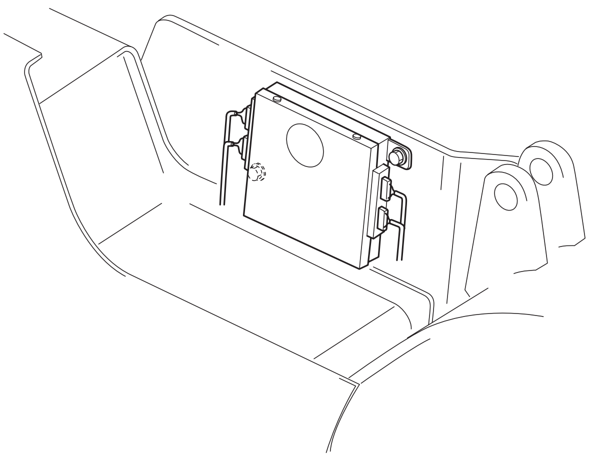
Err code	Description	Probable cause	Check point
F67	Att2B sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2B sol bad	4. Att2B sol connection check
		5. Controller bad	
F69	Att2 sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att2 sol bad	4. Att2 sol connection check
		5. Controller bad	
F70	Att3A sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att3A sol bad	4. Att3A sol connection check
		5. Controller bad	
F72	Att3B sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att3B sol bad	4. Att3B sol connection check
		5. Controller bad	

Err code	Description	Probable cause	Check point
F74	Att3 sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Att3 sol bad	4. Att3 sol connection check
		5. Controller bad	
F75	Unload sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Unload sol bad	4. Unload sol connection check
		5. Controller bad	
F77	Liftlock sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Liftlock sol bad	4. Liftlock sol connection check
		5. Controller bad	
F79	Unload sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Unload sol bad	4. Unload sol connection check
		5. Controller bad	

Err code	Description	Probable cause	Check point
F80	Knob pos sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Knob pos sol bad	4. Knob pos sol connection check
		5. Controller bad	
F82	Tiltlock sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Tiltlock sol bad	4. Tiltlock sol connection check
		5. Controller bad	
F84	Knob pos sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. Knob pos sol bad	4. Knob pos sol connection check
		5. Controller bad	
F85	T/M FW sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. T/M FW sol bad	4. T/M FW sol connection check
		5. Controller bad	

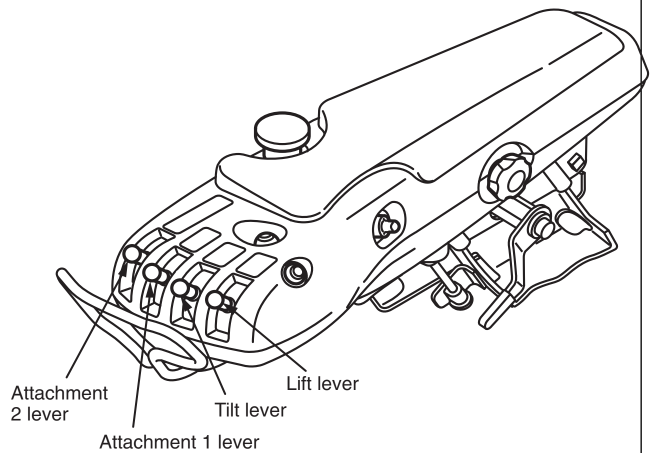
Err code	Description	Probable cause	Check point
F87	T/M BW sol err	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. T/M BW sol bad	4. T/M BW sol connection check
		5. Controller bad	
F89	T/M sol leak	1. Connector contact bad	1. Connector connection check
		2. Diode bad	2. Diode connection check
		3. Harness bad	3. Harness connection check
		4. T/M sol bad	4. T/M sol connection check
		5. Controller bad	

Locations of Sensors and Switches



VCM-1, VCM-2
(Body Right Side)

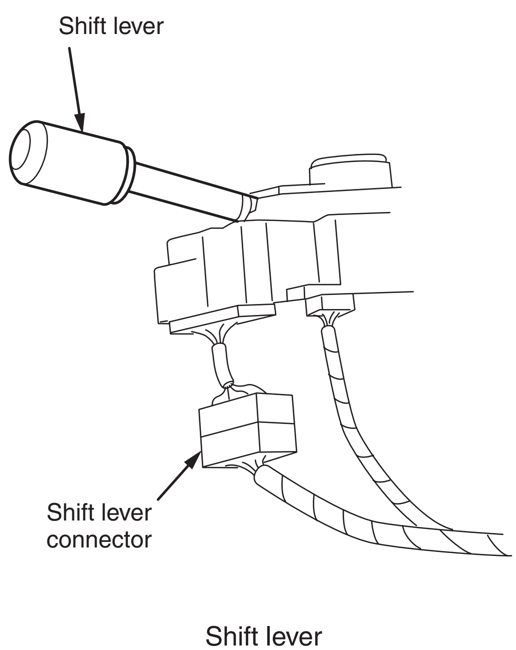
209718



FC Lever box

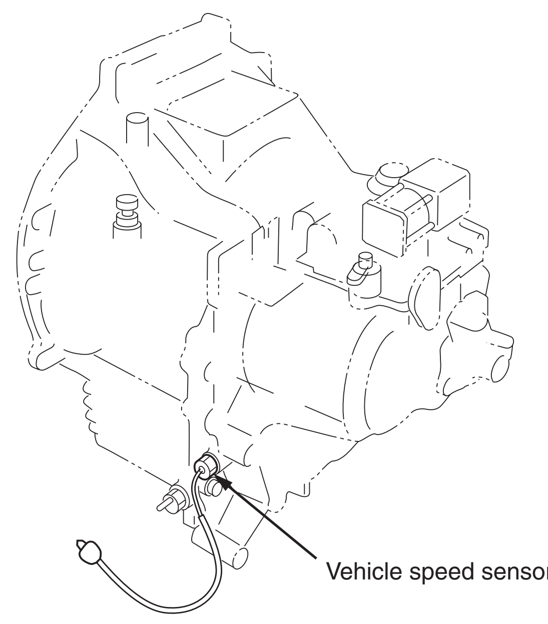
NOTE: Attachment 3 lever is equipped for the 5-valve control valve.

103564A



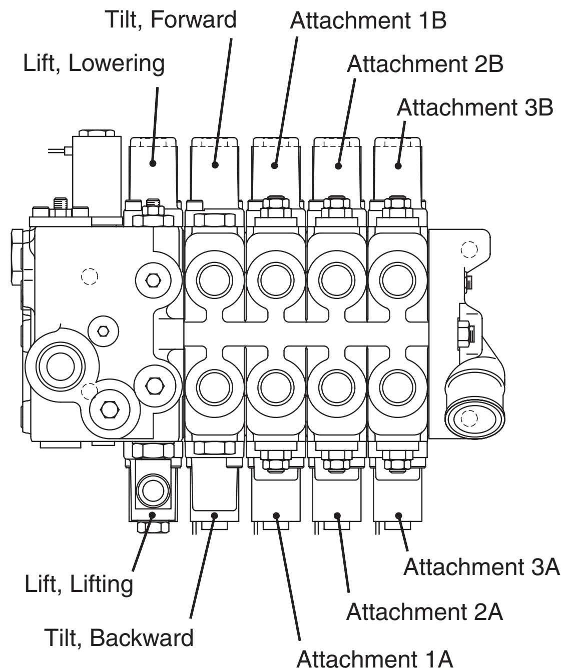
Shift lever
(for Powershift Truck)

209720



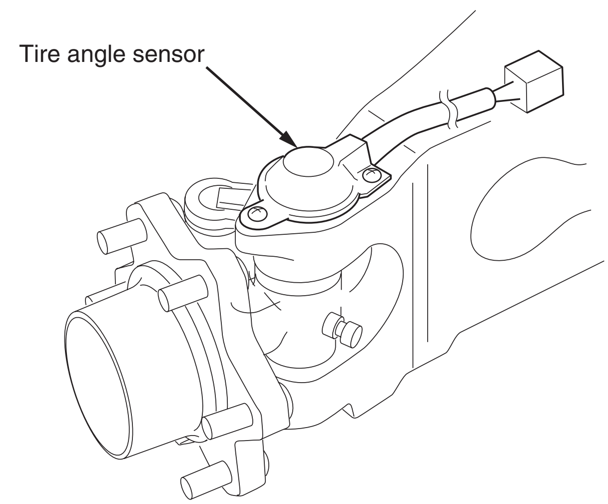
Transmission
(Right side)

209721



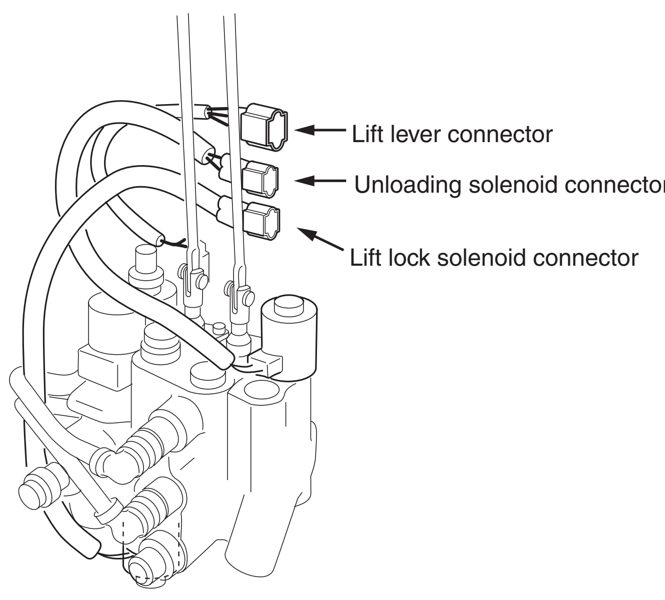
Control valve (for FC Truck)
Solenoid valves

209722



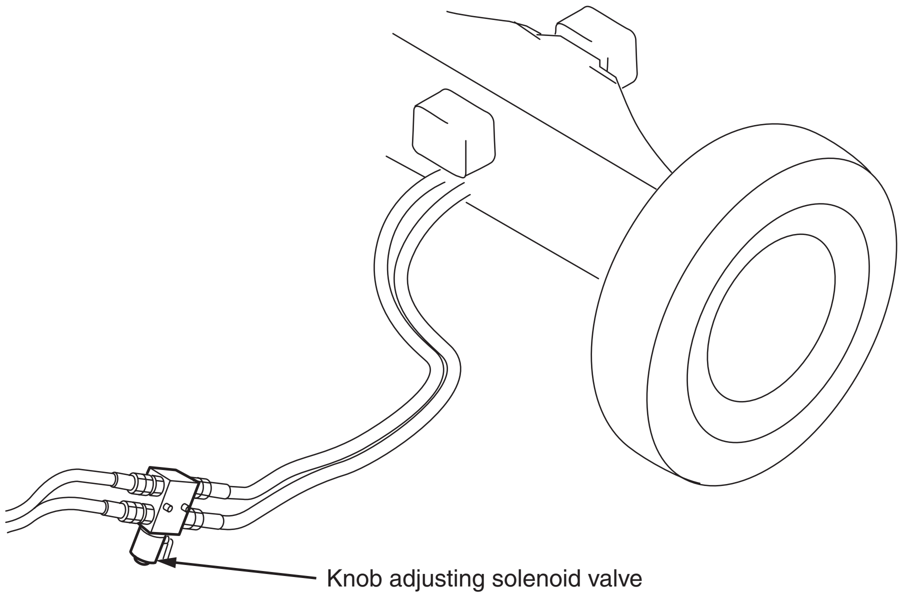
Rear axle
(right side)

209723



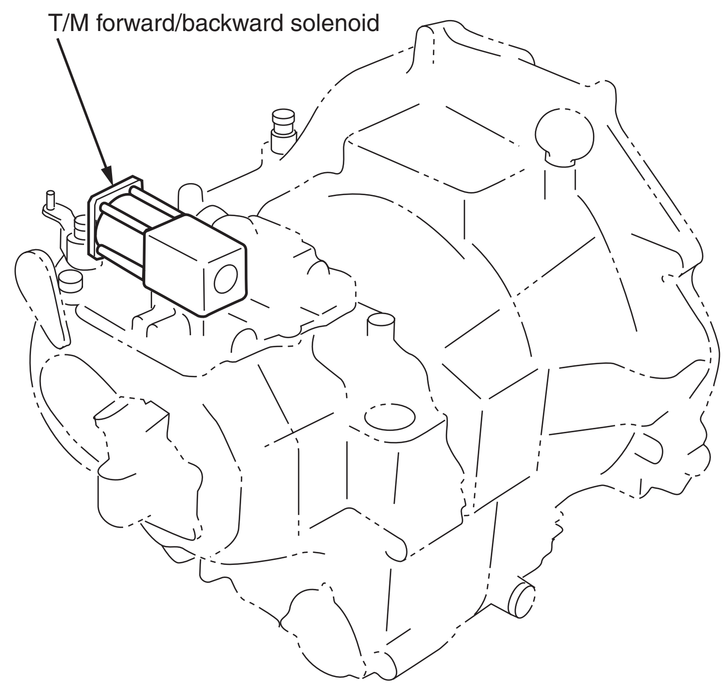
Control valve
(for MC Truck)

209726



Knob adjusting valve
(frame left side)

209725



Transmission
(for powershift truck)

209726

Others (Option)

Sensor	Location
Tilt Angle Sensor and Connector (for tilt automatic leveling option)	Tilt Cylinder Pin
Tilt Lock Solenoid and Connector (for tilt automatic leveling option)	Between Control Valve and Tilt Cylinder
Lift Pressure Sensor and Connector	Between Control Valve and Lift Cylinder

POWER TRAIN

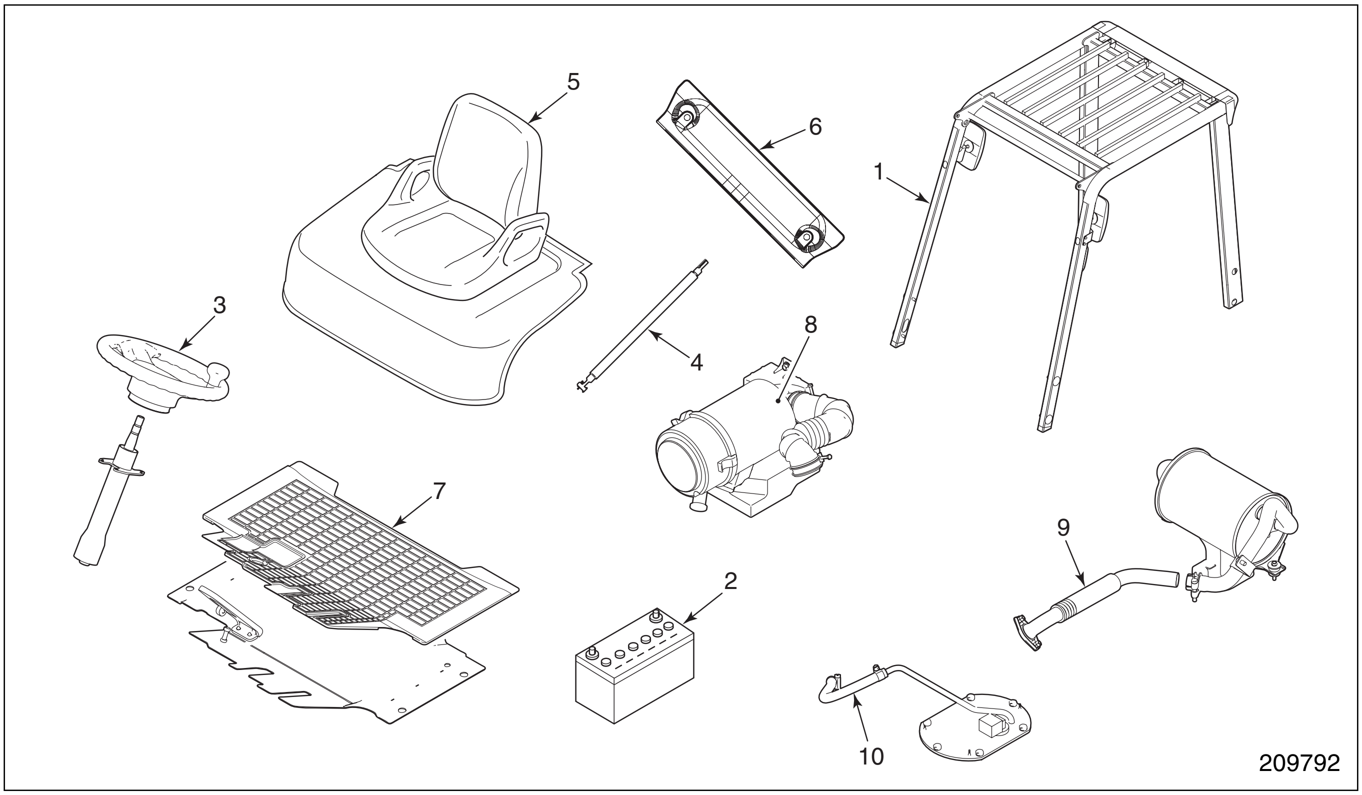
Removal and Installation (MC Models)

Removal of Engine and Transmission Assembly (for Gasoline-engine Trucks)

The engine and transmission are installed as an assembled unit. The engine may be removed independently of the transmission, but the transmission can only be removed together with the engine.

Note: There are two types of transmission, namely the torque converter drive type (powershift transmission) and the direct drive type (manual transmission). Removal procedures vary for direct drive type transmissions according to whether they have a dry-type clutch or a wet-type clutch.

Overhead guard, covers, air cleaner and other components



Sequence

1 Overhead guard
2 Battery
3 Steering wheel
4 Gas spring
5 Engine cover, Seat
6 Radiator cover
7 Floor plate, Floor mat
8 Air hose, Air cleaner
9 Exhaust pipe
10 Fuel hoses

Suggestions for Removal

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

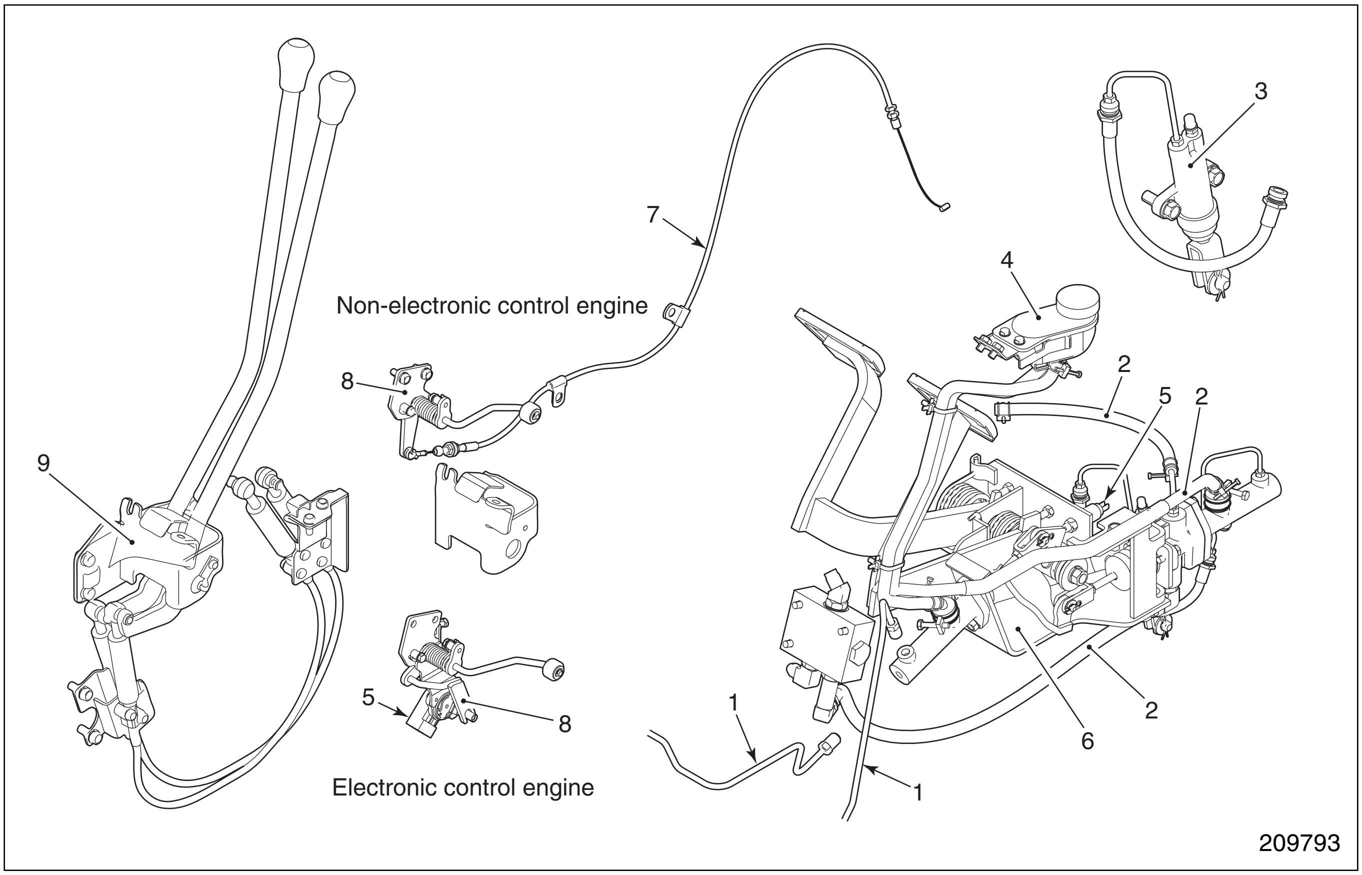
(2) Remove the floor plate and mat 7 together with the accelerator pedal.

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

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

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

Controls (Trucks with Manual Transmission)



Sequence

1 Brake pipe
2 Clutch hose (wet-type clutch)
3 Release cylinder bracket, Release cylinder, Pin, Washer, Snap pin
4 Oil tank
5 Connector (Throttle, Stop lamp switch)
6 Pedal assembly
7 Throttle cable (non-electronic control engine)
8 Accelerator bracket
9 Change lever, Cables

Suggestions for Removal

(1) Disconnect the release cylinder 3 and its bracket together from the clutch housing and attach them to the pedal assembly, making sure that the clutch oil does not leak out.

(2) Remove the four bolts attaching the bracket of the pedal assembly 6, then remove the pedal assembly together with the release cylinder 3 and the oil tank 4.

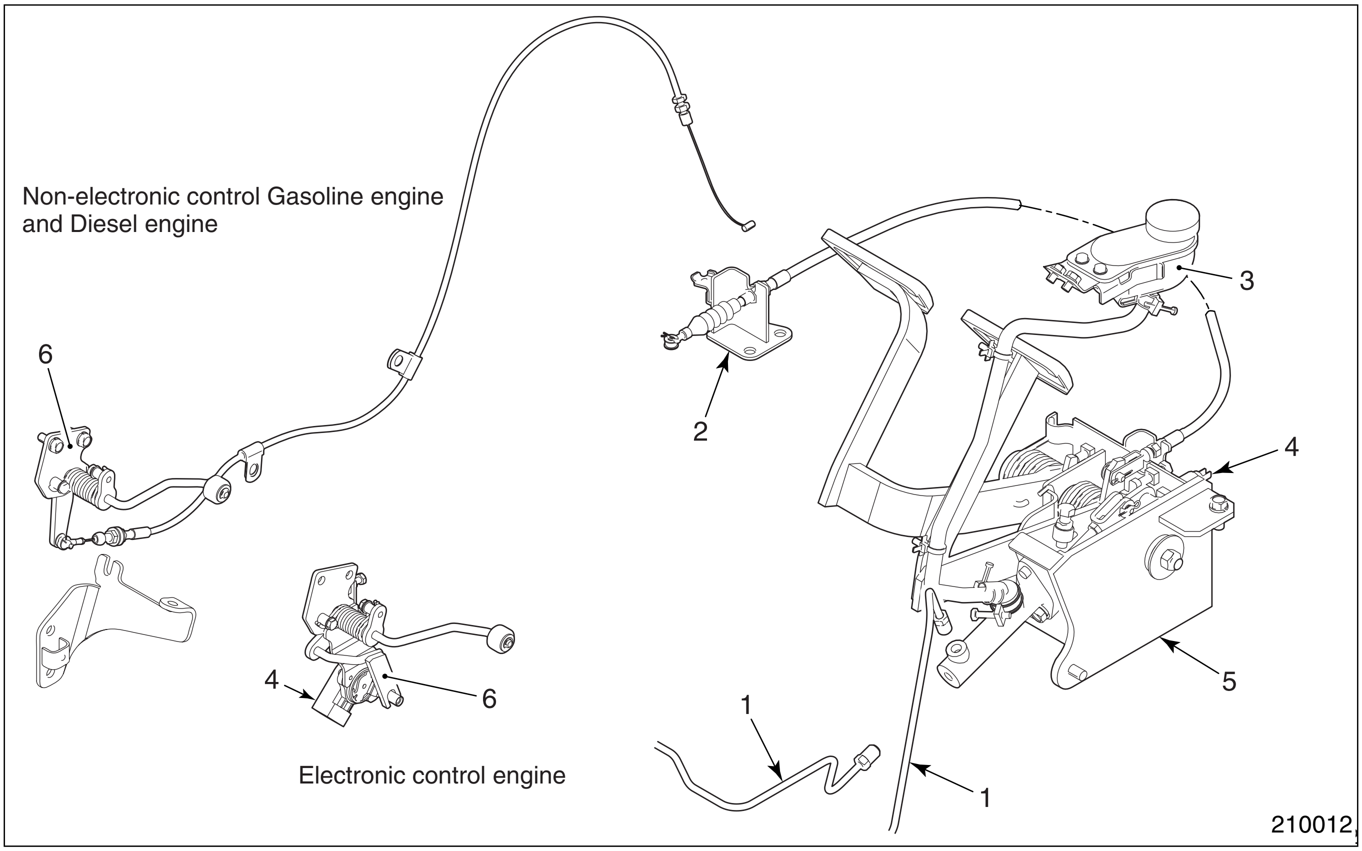
(3) For trucks with non-electronic control engine, disconnect the throttle cable 7 from the engine.

(4) To remove the change lever 9 from the bracket, remove the ball joint beneath the lever and remove the change lever shaft.

Installation

Follow the removal sequence in reverse.

Controls (Trucks with Powershift Transmission)



Sequence

1 Brake pipe
2 Inching cable, Clevis pin, Washer, Snap pin
3 Oil tank
4 Connector (Throttle, Stop lamp switches)
5 Pedal assembly
6 Accelerator bracket

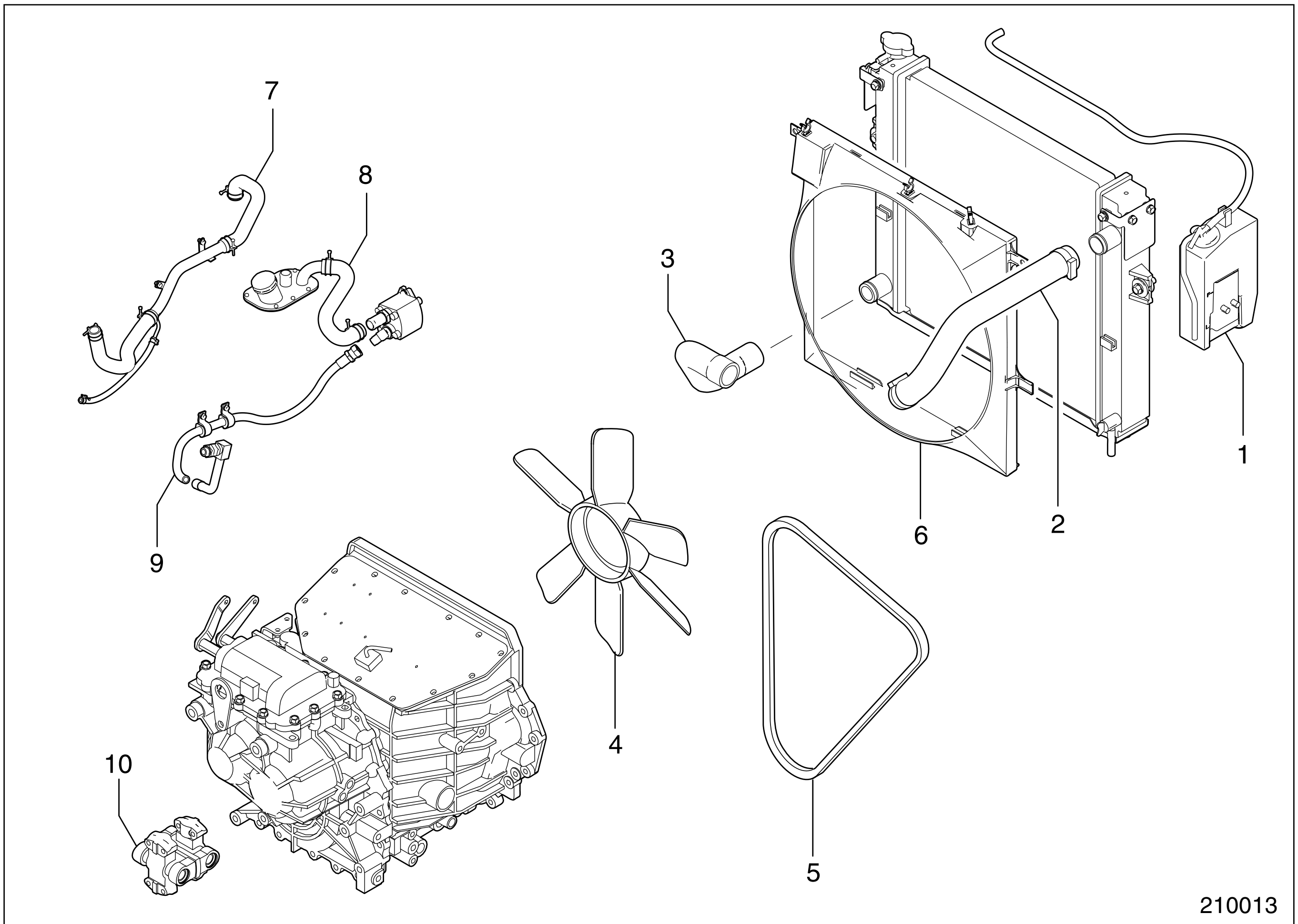
Suggestions for Removal

(1) To remove the inching cable 2, disconnect from both the inching pedal and the transmission and then loosen the lock nuts.

Installation

Follow the removal sequence in reverse.

Radiator and Pipes (Trucks with Manual Transmission)



Sequence

1 Reserve tank
2 Hose (upper)
3 Hose (lower)
4 Cooling fan
5 Fan belt
6 Fan guard
7 Hose (between hydraulic tank and control valve)
8 Hose (between hydraulic tank and oil pump)
9 Hose (between oil pump and steering control valve)
10 Universal joint (between transmission and reduction/differential gears)

Start by:

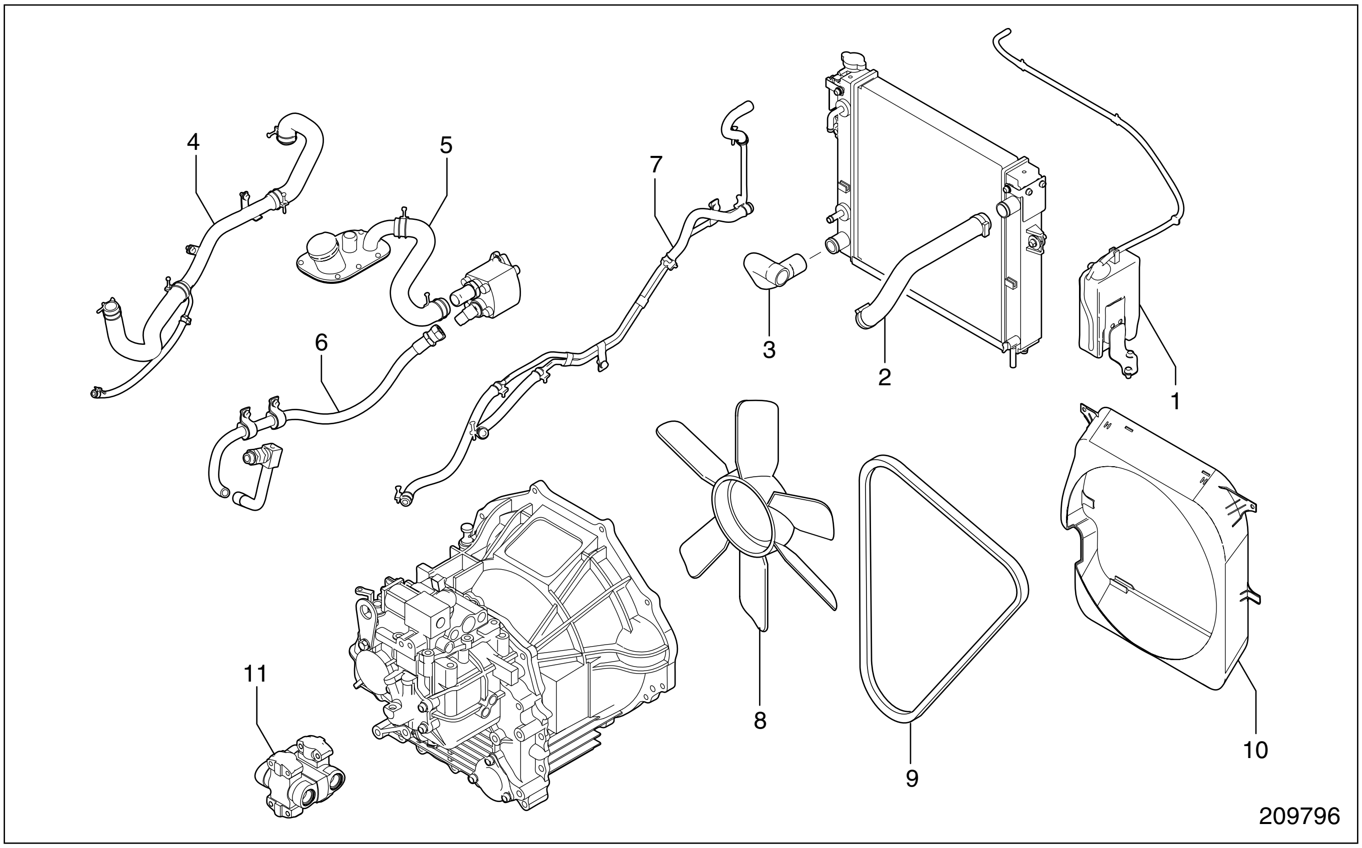
(a) Draining the coolant from the engine by removing the drain plug (note that the position of the drain plug differs by engine type).

(b) Draining the coolant from the radiator by loosening the cock at the bottom of the radiator.

Installation

Follow the removal sequence in reverse.

Radiator and Pipes (Trucks with Powershift Transmission)



Sequence

1 Reserve tank
2 Hose (upper)
3 Hose (lower)
4 Hose (between hydraulic tank and control valve)
5 Hose (between hydraulic tank and oil pump)
6 Hose (between oil pump and steering control valve)
7 Cooler hose (between radiator and powershift transmission)
8 Cooling fan
9 Fan belt
10 Fan guard
11 Universal joint (between transmission and reduction/differential gears)

Start by:

(a) Draining the coolant from the engine by removing the drain plug (note that the position of the drain plug differs by engine type).

(b) Draining the coolant from the radiator by loosening the cock at the bottom of the radiator.

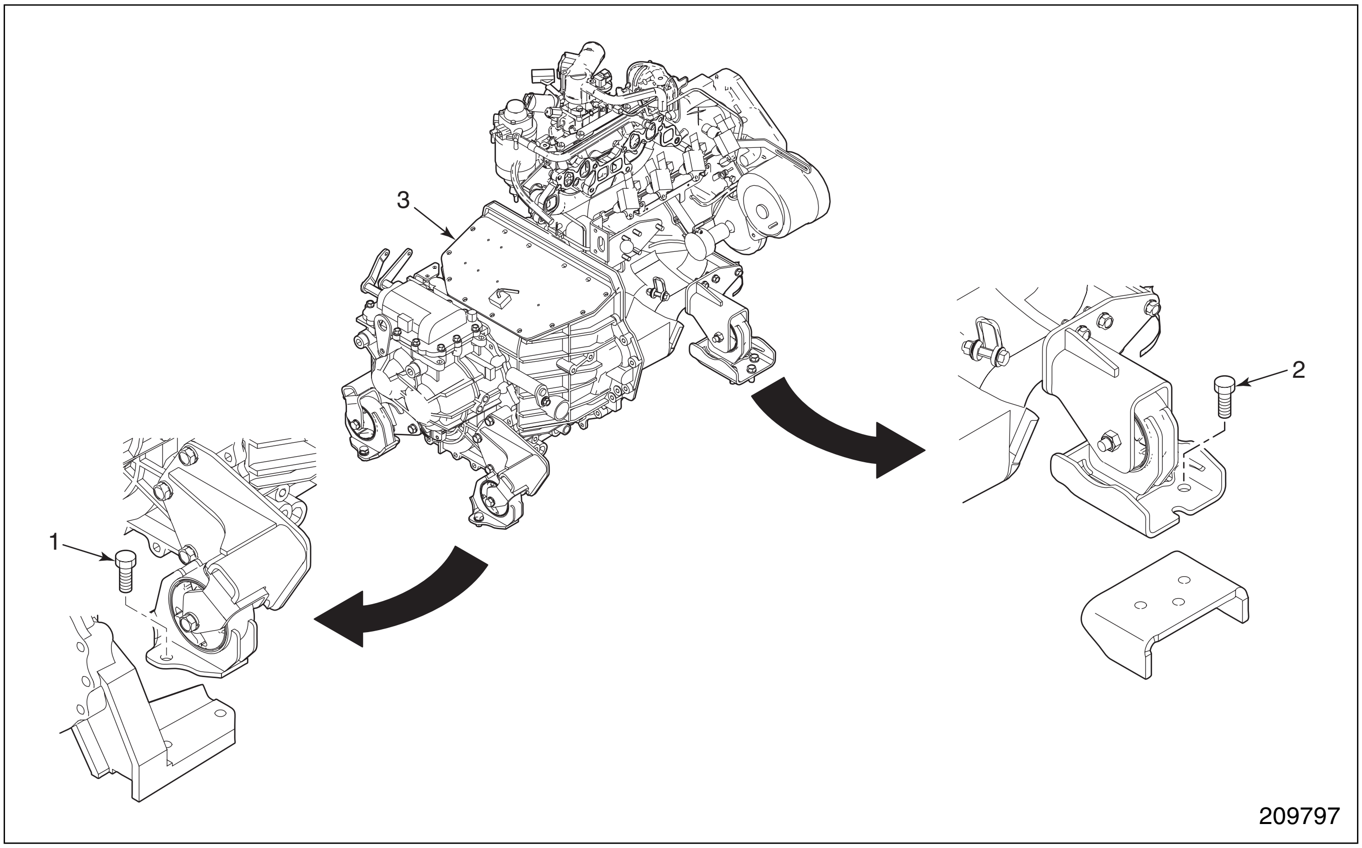
Suggestion for Removal

Disconnect the cooler hose 7 from the transmission side and temporarily attach it to the right side of the frame.

Installation

Follow the removal sequence in reverse.

Engine and Transmission Assembly



Sequence

1 Transmission mounting bolt
2 Engine mounting bolt
3 Engine and transmission assembly

Start by:

(a) Lifting the engine and transmission assembly with a hoist and slings.

Suggestions for Removal

(1) Lift the engine and transmission assembly just enough necessary to remove the load on the mounting cushion before removing the mounting bolts 1 and 2. Remove the engine support mounting bolts.

(2) Slowly lift the engine and transmission assembly 3 out by moving it backwards and checking the balance.

Note: (1) Drain the transmission oil and clutch oil with the engine and transmission assembly suspended.

(2) There is only one drain plug in the powershift transmission.

Installation

Follow the removal sequence in reverse.

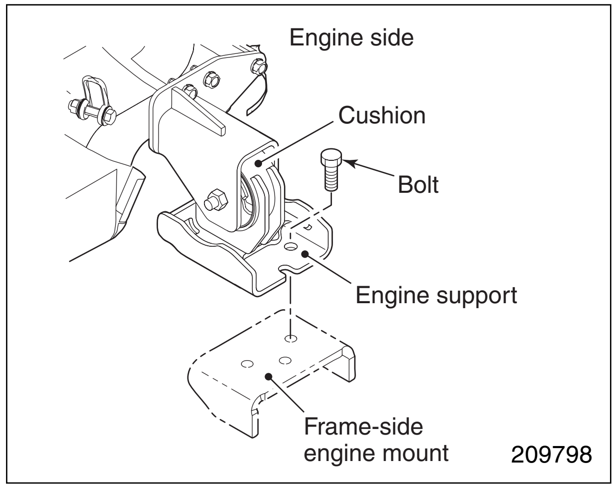
Suggestions for Installation

(1) Engine and transmission assembly

(a) Slowly lift the assembly.

(b) On the transmission side, tighten the bolts of the left and right mounts after aligning them with the holes in the differential case.

(c) On the engine side, tighten the bolts of the left and right engine supports after aligning them with the holes in the engine mounts.



(2) For powershift transmission trucks, check that the clutch valve plunger is pushed out completely when the cable is connected between the inching pedal and the transmission.

(3) Connect the accelerator pedal link on the floor plate to the throttle cable. Check that the throttle lever is at the full-open position when the accelerator pedal is fully depressed.

(4) Bleed the air out of the brake fluid circuit after connecting the brake pipe.

(5) When installing the exhaust pipe, use a new gasket.

(6) Connect the ground (negative) cable to the battery only after making sure that all wiring is connected properly.

(7) Refill the engine, radiator, and transmission with oils/coolant, and check for leakage. Unless otherwise specified, use soft water (tap water) mixed with antifreeze at a concentration of 35%.

(8) Bleed the air out of the fuel circuit of the engine.

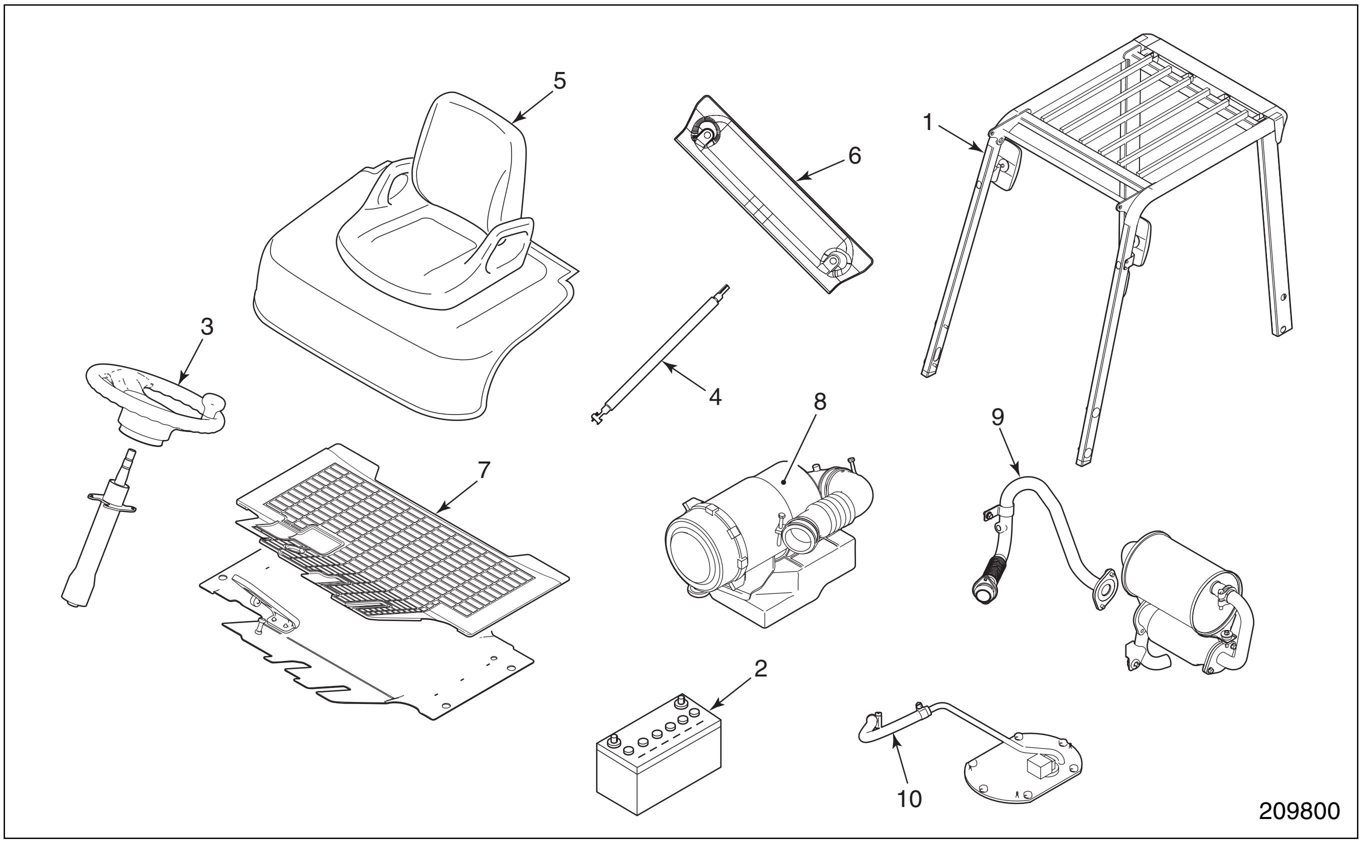
(9) After checking the parts, start the engine and check that the clutch booster functions properly (wet-type clutch transmission trucks only). Operate the mast lifting/tilting and steering, and check the hydraulic oil level. Also recheck the engine and transmission oil and coolant levels after a few minutes of operation.

Removal of Engine and Transmission Assembly (for Diesel-engine Trucks)

The engine and transmission are installed as an assembled unit. The engine may be removed independently of the transmission, but the transmission can only be removed together with the engine.

Note: There are two types of transmission, namely the torque converter drive type (powershift transmission) and the direct drive type (manual transmission). Removal procedures vary for direct drive type transmissions according to whether they have a dry-type clutch or a wet-type clutch.

Overhead guard, covers, air cleaner and other components



Sequence

1 Overhead guard
2 Battery
3 Steering wheel
4 Gas springs
5 Engine cover, Seat
6 Radiator cover
7 Floor plate, Floor mat
8 Air hose, Air cleaner
9 Exhaust pipe
10 Fuel hose

Suggestions for Removal

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

(2) Remove the floor plate and mat 7 together with the accelerator pedal.

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

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

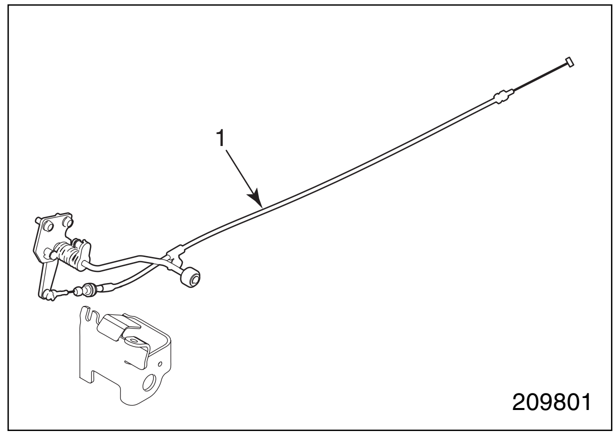
(5) The harness connectors should disconnected from the sockets and terminals on the engine and transmission should be attached to the main harness, in order to avoid damaging them.

Controls (Trucks with Manual Transmission)

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

Sequence
(specific to diesel-engine trucks)

1 Throttle cable

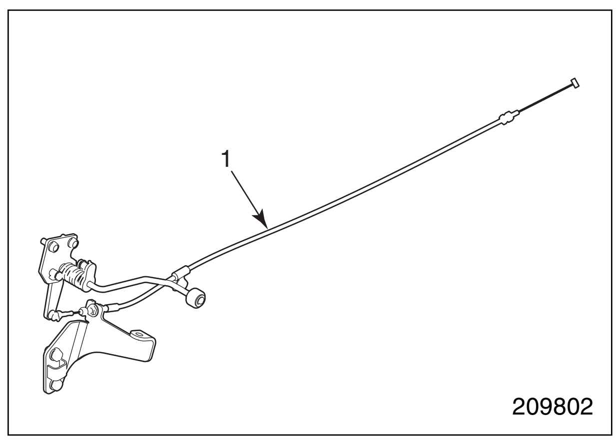


Controls (Trucks with Powershift Transmission)

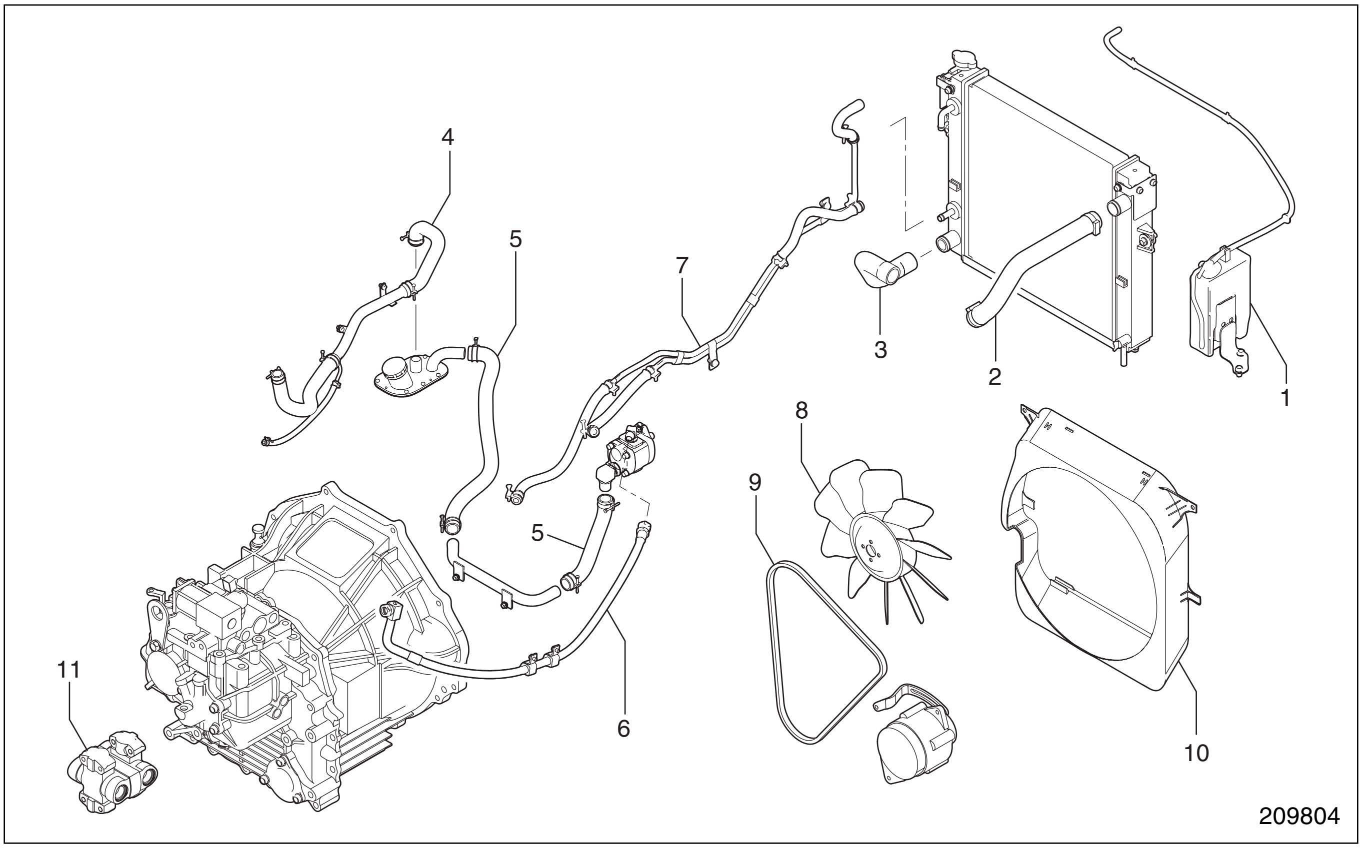
This section describes only removal and installation procedures specific to diesel-engine trucks. Follow the instructions for the gasoline-engine trucks in the preceding sections for the common procedures.

Sequence
(specific to diesel-engine trucks)

1 Throttle cable



Radiator and Pipes (Trucks with Powershift Transmission)



Sequence

1 Reserve tank
2 Hose (upper)
3 Hose (lower)
4 Hose (between hydraulic tank and control valve)
5 Hose (between hydraulic tank and oil pump)
6 Hose (between oil pump and steering control valve)
7 Cooler hose (between radiator and powershift transmission)
8 Cooling fan
9 Fan belt
10 Fan guard
11 Universal joint (between transmission and reduction/differential gears)

Start by:

(a) Draining the coolant from the engine by removing the drain plug (note that the position of the drain plug differs by engine type).

(b) Draining the coolant from the radiator by loosening the cock at the bottom of the radiator.

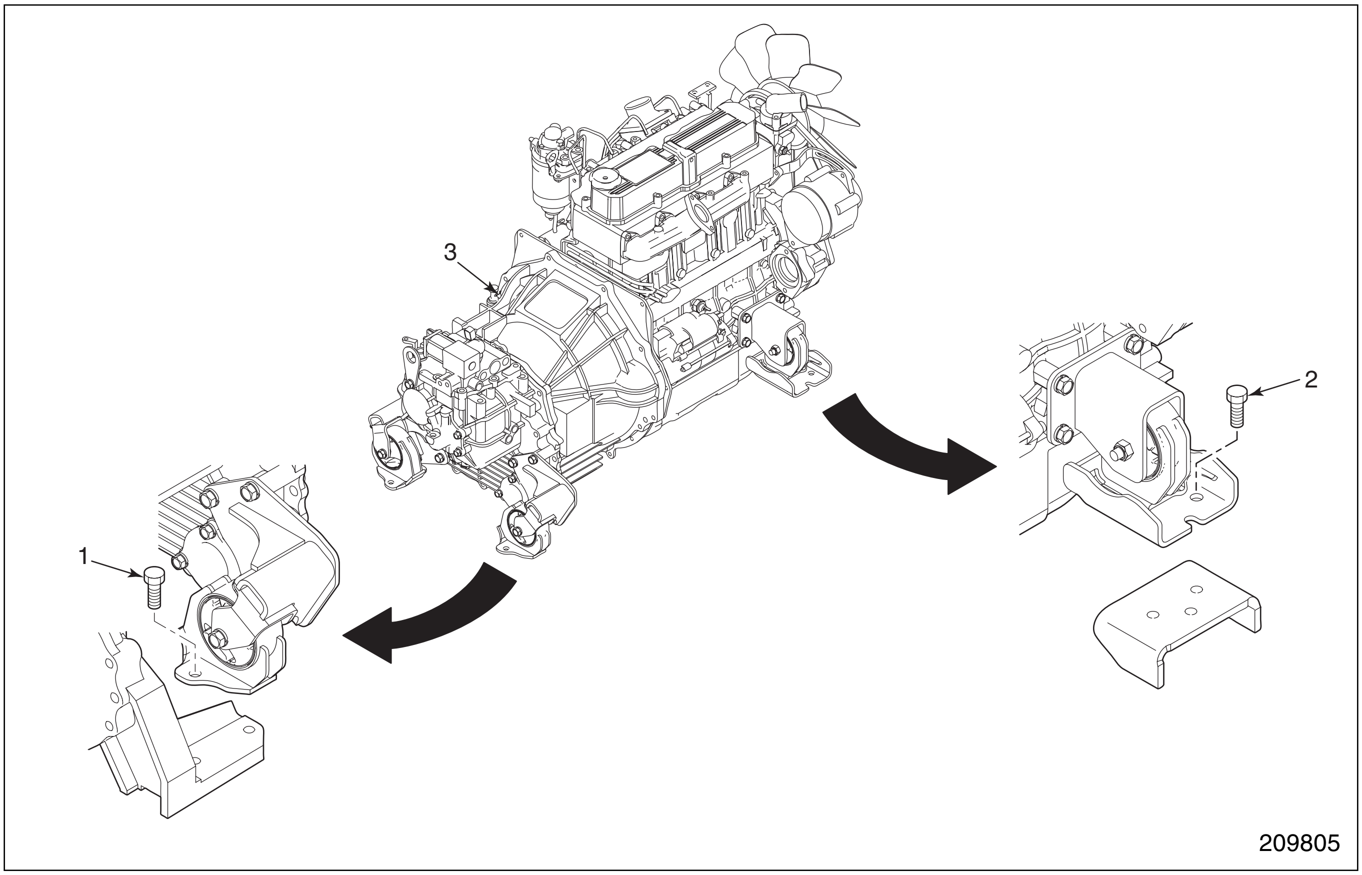
Suggestion for Removal

Disconnect the cooler hose 7 from the transmission side and temporarily attach it to the right side of the frame.

Installation

Follow the removal sequence in reverse.

Engine and Transmission Assembly



Sequence

1 Transmission mounting bolt
2 Engine mounting bolt
3 Engine and transmission assembly

Start by:

(a) Lifting the engine and transmission assembly with a hoist and slings.

Suggestions for Removal

(1) Lift the engine and transmission assembly just the amount necessary to remove the load on the mounting cushion before removing the mounting bolts 1 and 2. Remove the engine support mounting bolts.

(2) Slowly lift the engine and transmission assembly 3 out by moving it backwards and checking the balance.

Note: (1) Drain the transmission oil and clutch oil with the engine and transmission assembly suspended.

(2) There is only one drain plug in the powershift transmission.

Installation

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

Suggestions for Installation (those not shared with gasoline-engine trucks)

(1) Connect the accelerator pedal linkage on the floor plate to the throttle cable. Check that the injection pump lever at the full-open position when the accelerator pedal is fully depressed.

Removal and Installation (FC Models)

Removal of engine and transmission assembly

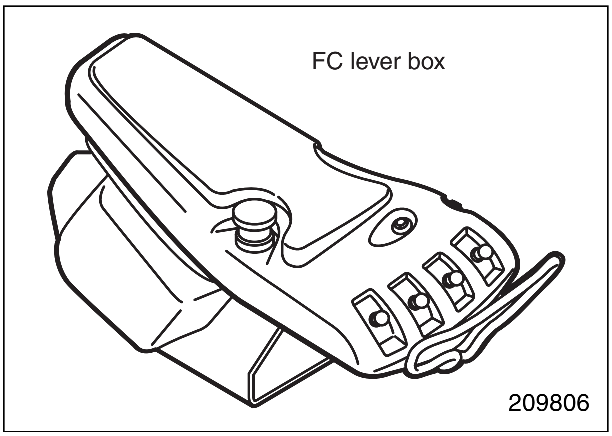
The main difference between the MC and the FC models is the control valve operation. In the MC models, the control valve plunger is operated manually. In the FC models, the valve operation is electronically controlled by way of a finger-tip control hydraulic lever. This section provides only the information specific to removal and installation of the FC model power train.

Suggestions for Removal

(1) Engine cover/seat

When removing the engine cover, disconnect the connectors behind the engine cover. Be careful not to damage the FC lever box, emergency stop button, and other items located to the right of the engine cover/seat.

Note: For the application of optional five-valve control, connectors and terminals are changed accordingly.



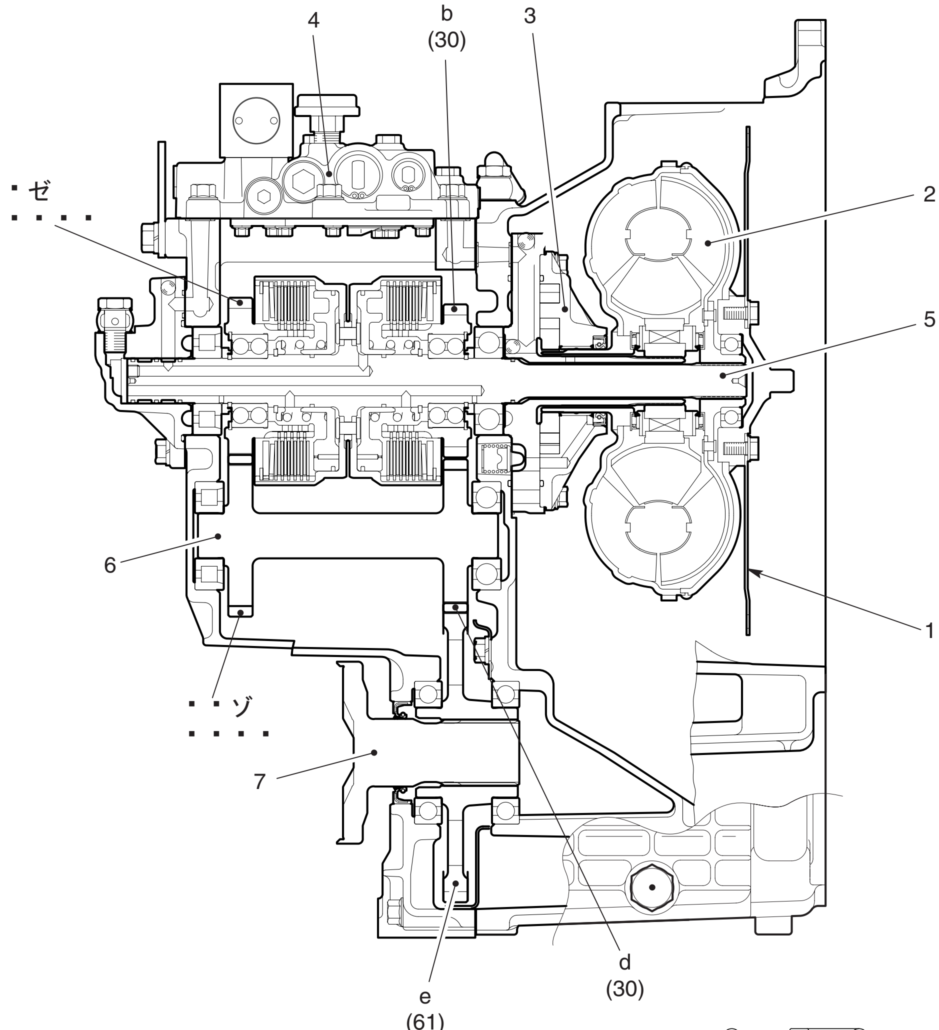
(2) Harnesses and cables
(between the transmission and frame)

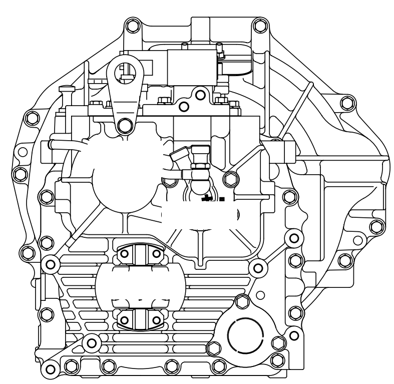
FC model harnesses are added to MC model harnesses on both gasoline-engine and diesel-engine FC trucks.

POWERSHIFT TRANSMISSION

Structure and Function

Transmission





The figure in parentheses shows the number of gear teeth.

210014

1 Flexible plate
2 Torque converter assembly
3 Oil pump assembly
4 Control valve assembly
5 Input shaft (No.1 shaft)
6 Idler shaft (No. 2 shaft)
7 Output shaft (No. 3 shaft)

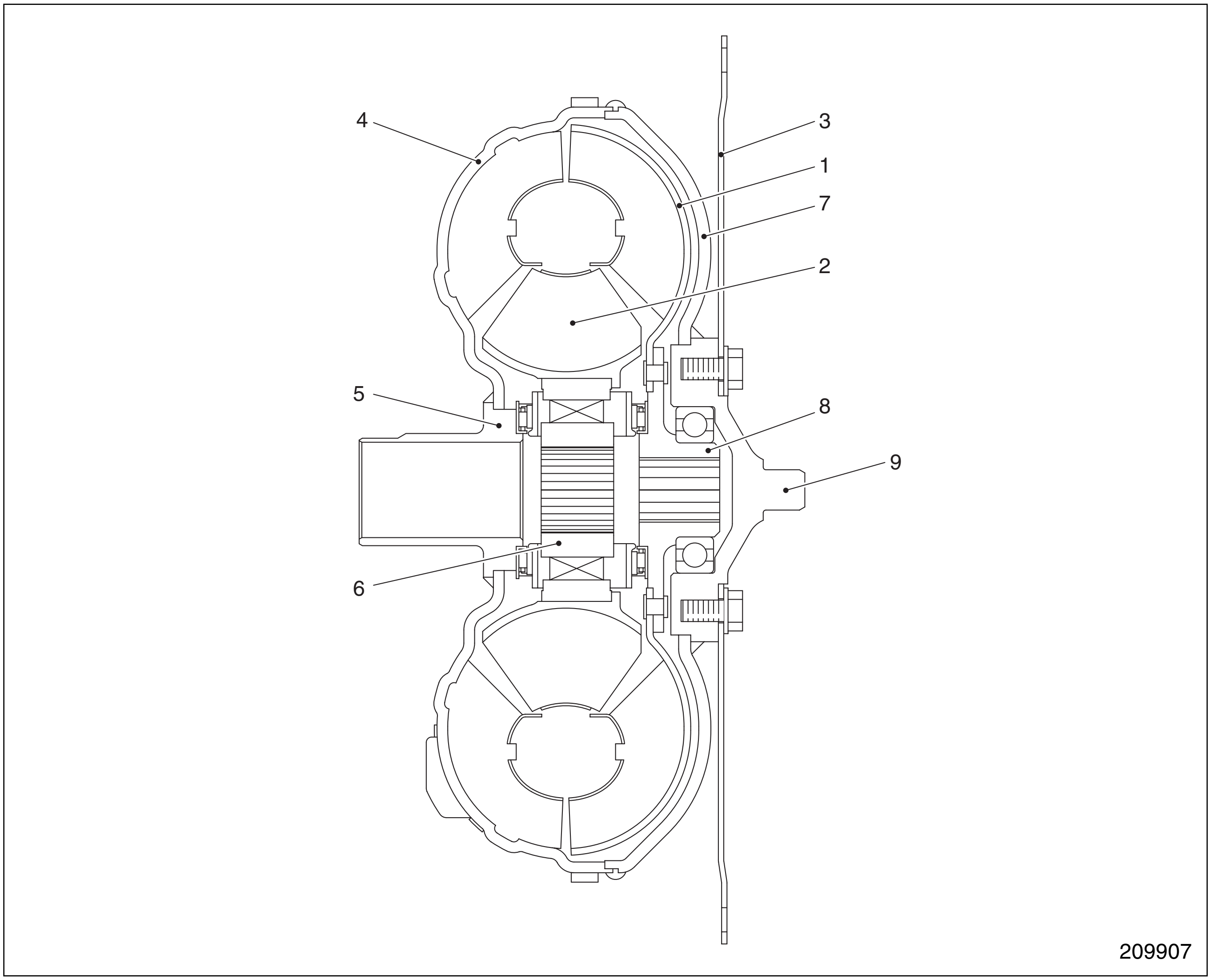
This transmission consists of one forward gear and one reverse gear. The forward-reverse changeover is accomplished by a powershift mechanism that uses hydraulically controlled multiple-disc clutches. The same transmission parts, except for the torque converter, clutch valve, output flange, and universal joints, are used in all the 1 to 3.5 ton class trucks. The transmission housing and torque converter housing can be separated from each other.

The torque converter shell is made of steel-plates welded in one body. For this reason, torque converter parts can be replaced as an assembled unit only.

Item \ Truck Model	1, 2, 3 ton classes
Type	Three-element, single-stage, two-phase
Range	Power path
F (Forward)	a → c d → e
R (Reverse)	b → e

Transmission reduction ratio	
F (Forward)	$\frac{32}{33} \times \frac{61}{30} = 1.972$
R (Reverse)	$\frac{61}{30} = 2.033$

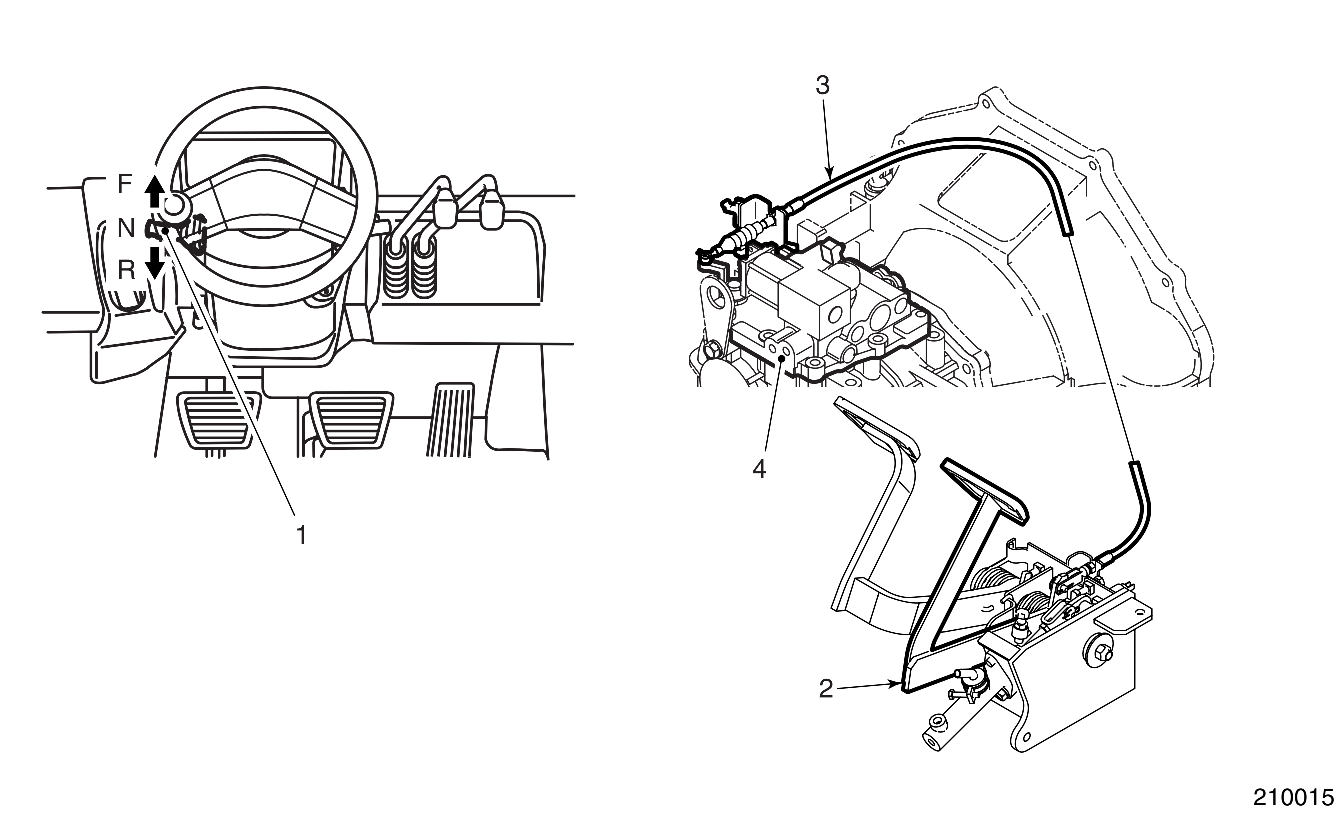
Torque Converter



1	Turbine runner	6	Clutch hub
2	Stator assembly	7	Drive cover
3	Flexible plate	8	Turbine boss
4	Pump impeller	9	Pilot boss
5	Pump boss		

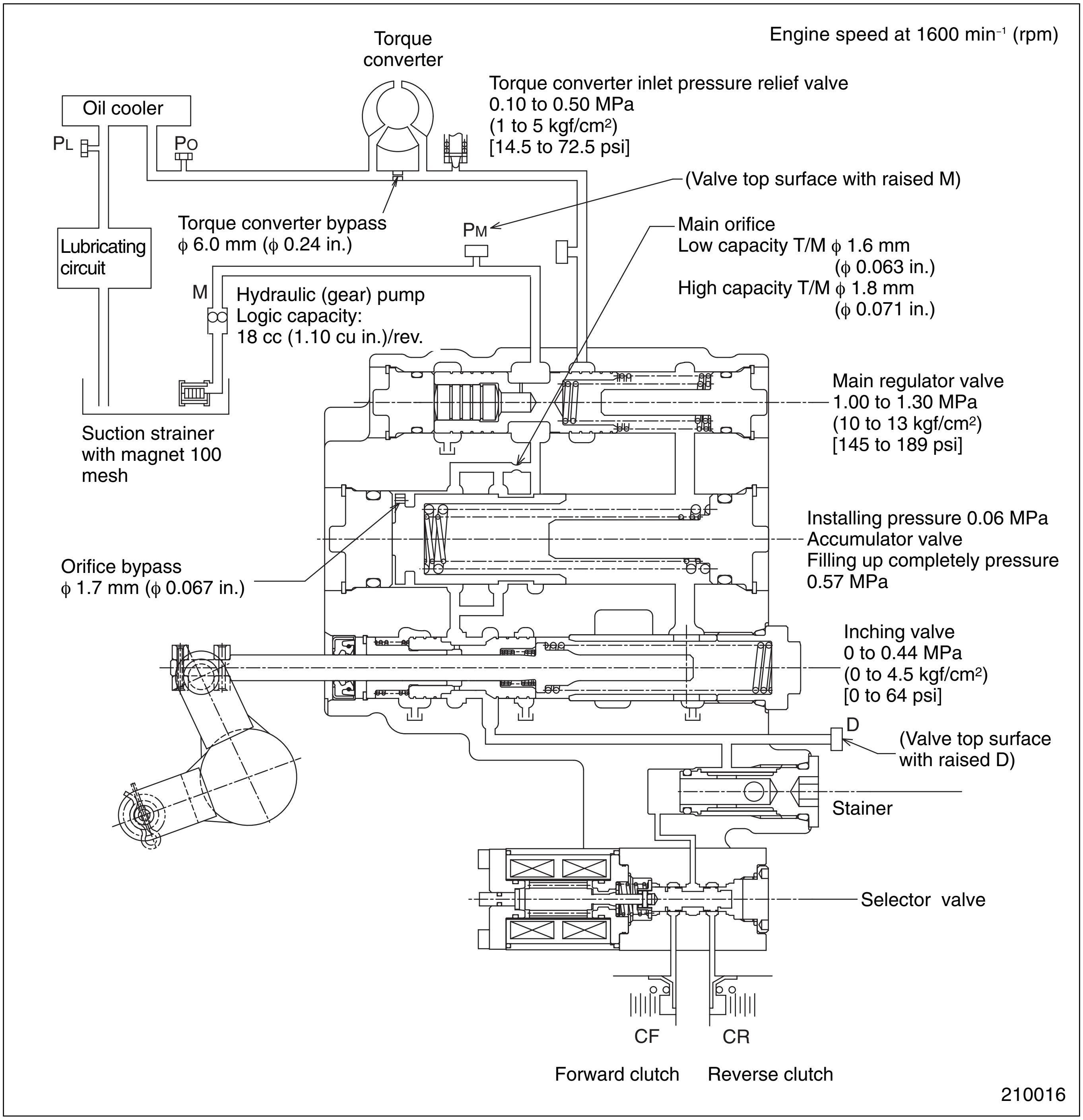
Note: Both gasoline-engine trucks and diesel-engine trucks use the same type of torque converter.

Control System of Powershift Transmission



1 Forward-reverse shift lever
2 Clutch (inching) pedal
3 Cable (inching)
4 Control valve assembly

Hydraulic System Schematic of Powershift Transmission



Removal and Installation

Removal

(1) Remove the engine and transmission as an assembly from the truck.

Note: Removal and installation procedures for the engine and transmission are covered in the "GROUP 5 POWER TRAIN." Drain oil out of the transmission housing when removing the engine and transmission.

(2) Remove the bolts securing the flexible plate through the access hole in the torque converter housing.

(3) Separate the torque converter and transmission assembly from the engine.

Installation

(1) Couple the torque converter and transmission assembly to the engine. To do this, push the torque converter toward the transmission as far as it goes so that the distance between the end surface of the torque converter housing and the flywheel connecting surface of the flexible plate is 50 mm (1.97 in.).

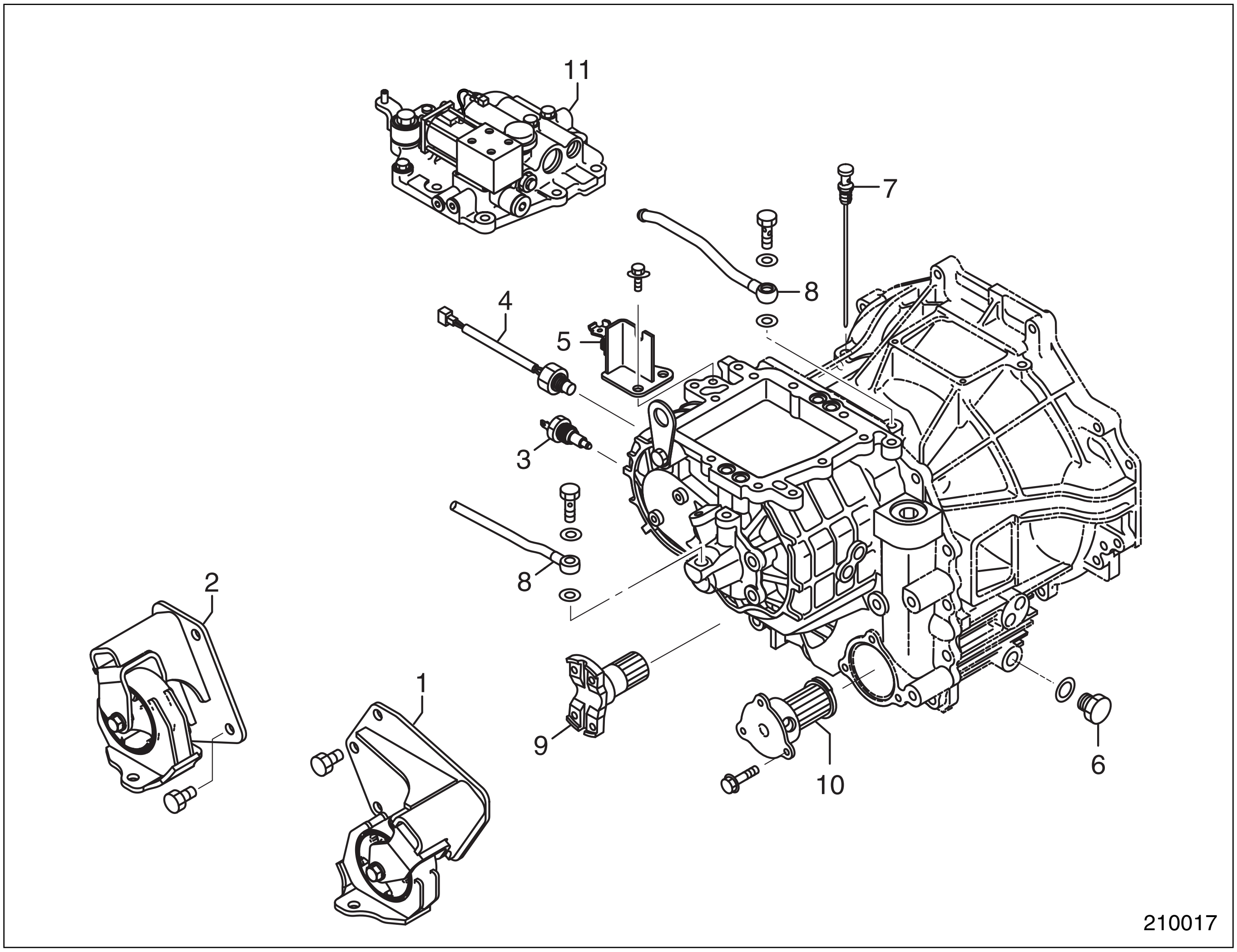
(2) Connect the flexible plate to the flywheel with the bolts through the access hole in the torque converter housing.

Note: Tighten the bolts evenly and progressively. Avoid giving strain to the flexible plate.

Disassembly and Reassembly

Transmission External Parts

Disassembly

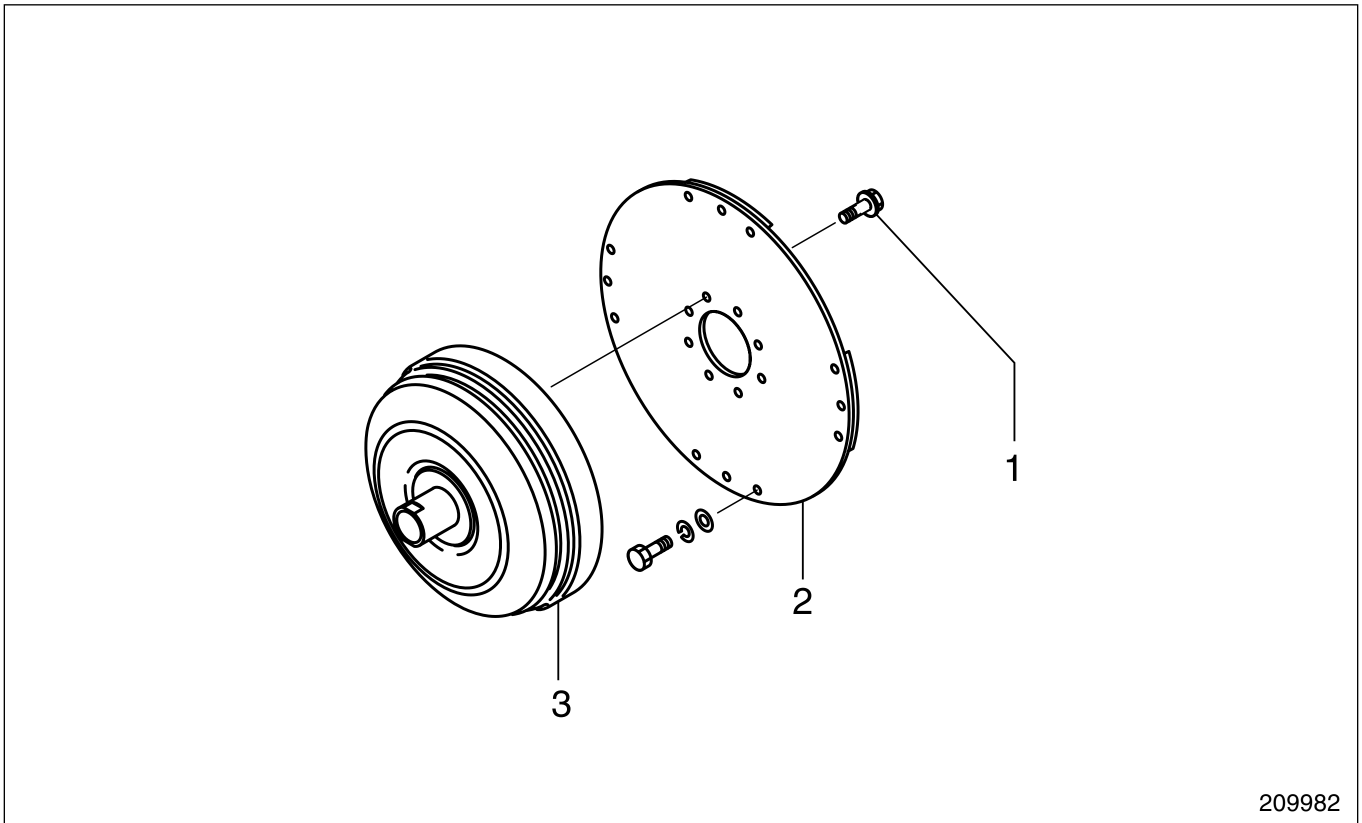


Sequence

1 Mount LH
2 Mount RH
3 Oil temperature sensor
4 Pulse generator
5 Cable bracket
6 Drain plug, Gasket
7 Oil level gauge
8 Oil pipe, Eye joint, Gasket
9 Output flange
10 Filter case, Magnet strainer
11 Control valve, Gasket, O-ring

Torque Converter

Overview



Sequence

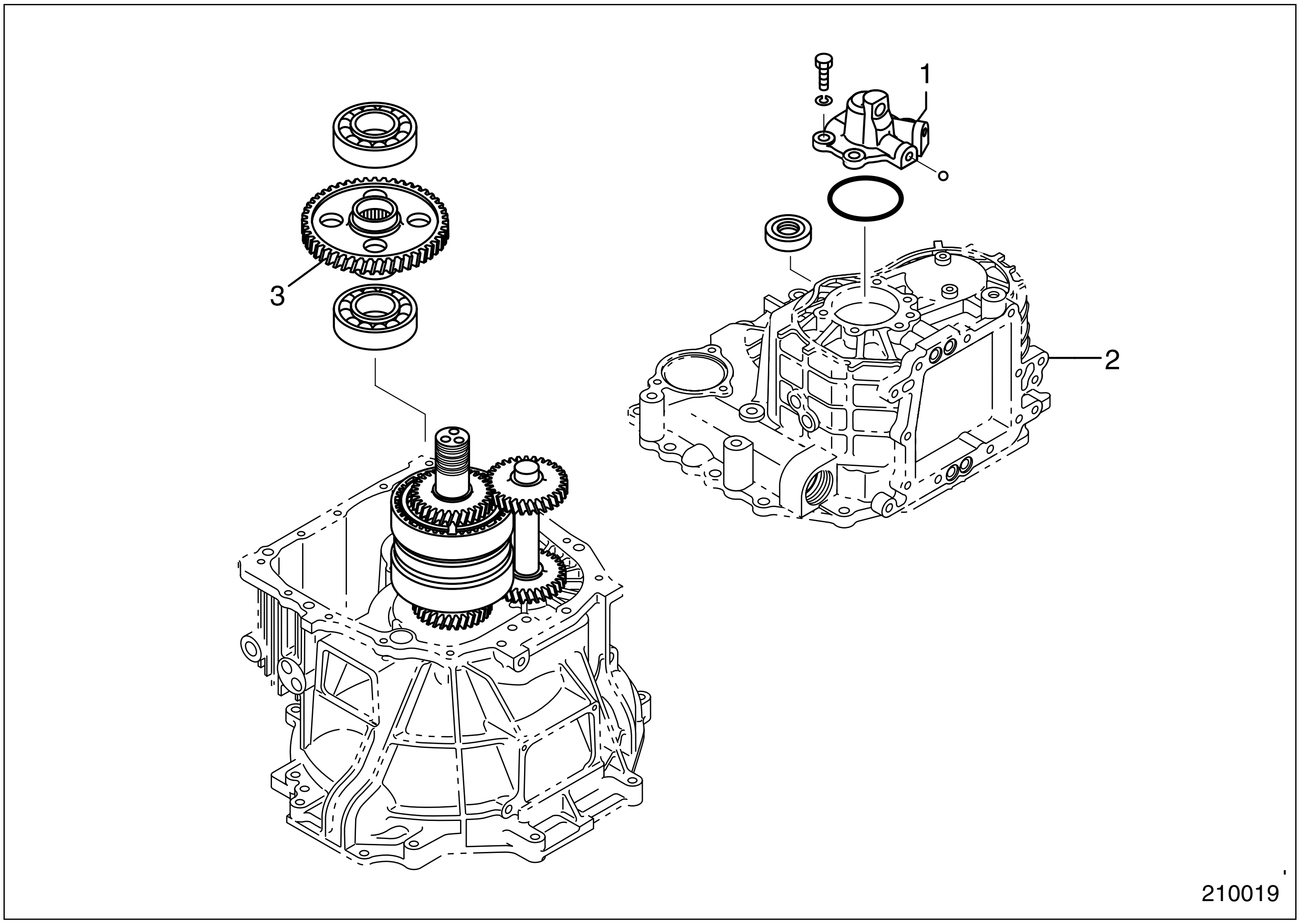
1 Bolts, Plain washers
2 Flexible plate
3 Converter-assembly

Suggestion for Removal

The torque converter assembly has no drain plug and cannot be drained completely. Drain the converter by facing the pump boss side down.

Transmission Housing and Output Gear

Disassembly



Sequence

1 Servo case assembly, O-ring, Steel ball
2 Transmission housing, Oil seal
3 Output gear, Ball bearing

Suggestions for Disassembly

(1) Place transmission assembly with the torque converter hosing end facing down. Remove the bolts fastening the transmission housing to the torque converter housing.

(2) Remove the servo case assembly. Lift the transmission housing using wire rope, lifting hardware, and the holes for the hardware and the mounting bolt holes on the housing.

(3) Keeping the wire ropes slightly taught, remove the transmission housing by tapping the area around the dowel-pin holes evenly with a plastic hammer.

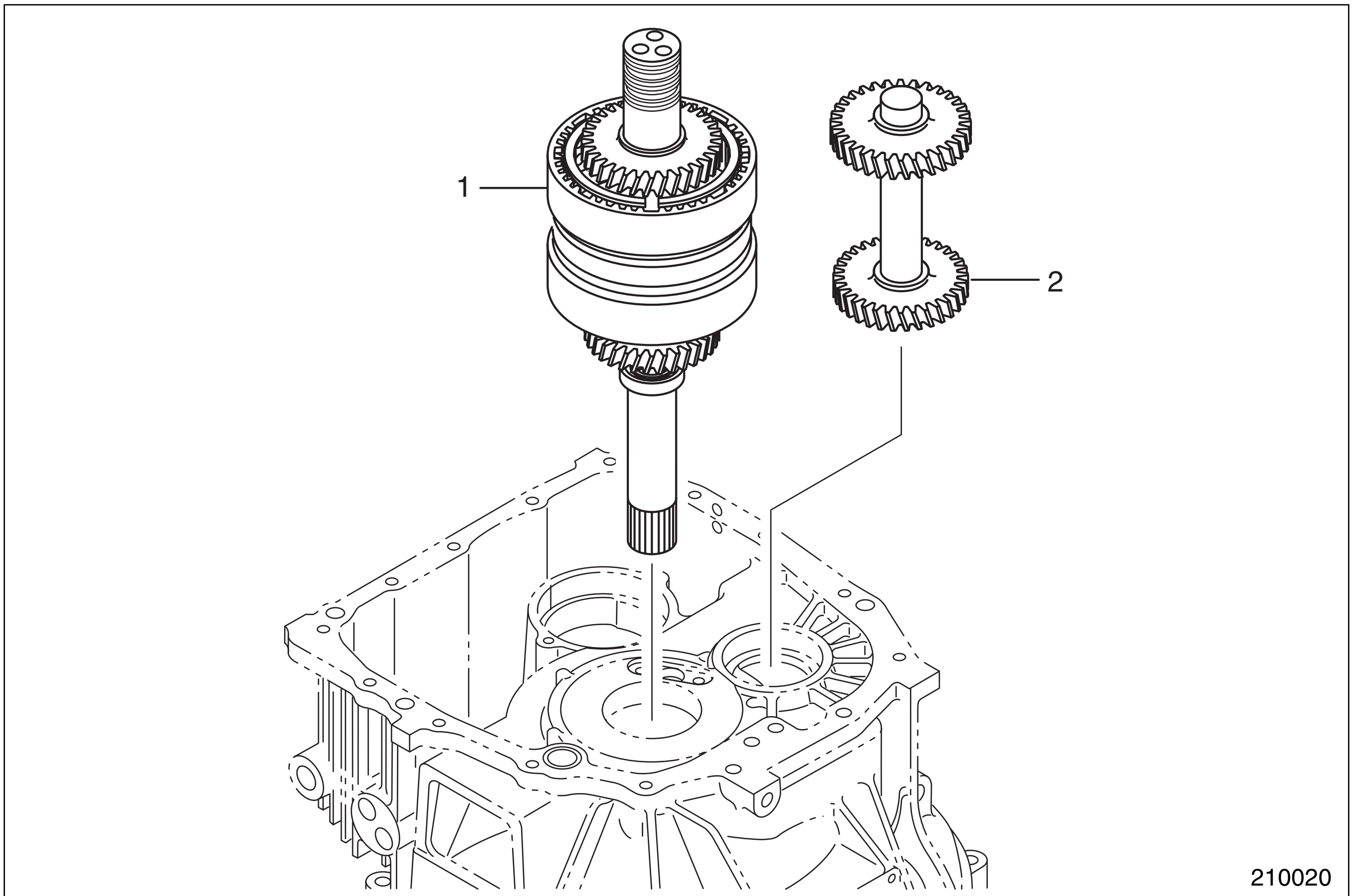
(4) Remove the transmission housing and place it with its mating flange facing down.

Note: (a) Do not remove any steel balls or sealing caps that are fitted in the transmission housing and torque converter housing.

(b) Inspect the oil seal in the transmission housing. It must not be removed unless defective.

Output Gear Assembly and Idler Shaft

Disassembly



Sequence

1 Clutch pack assembly

2 Idler gear

Inspections after Disassembly

(1) Torque converter housing and transmission housing

(a) Check for crack or wear.

(2) Magnet strainer

(a) Check for clogging and damage.

(3) Gear and shaft

(a) Check for wear and damage.

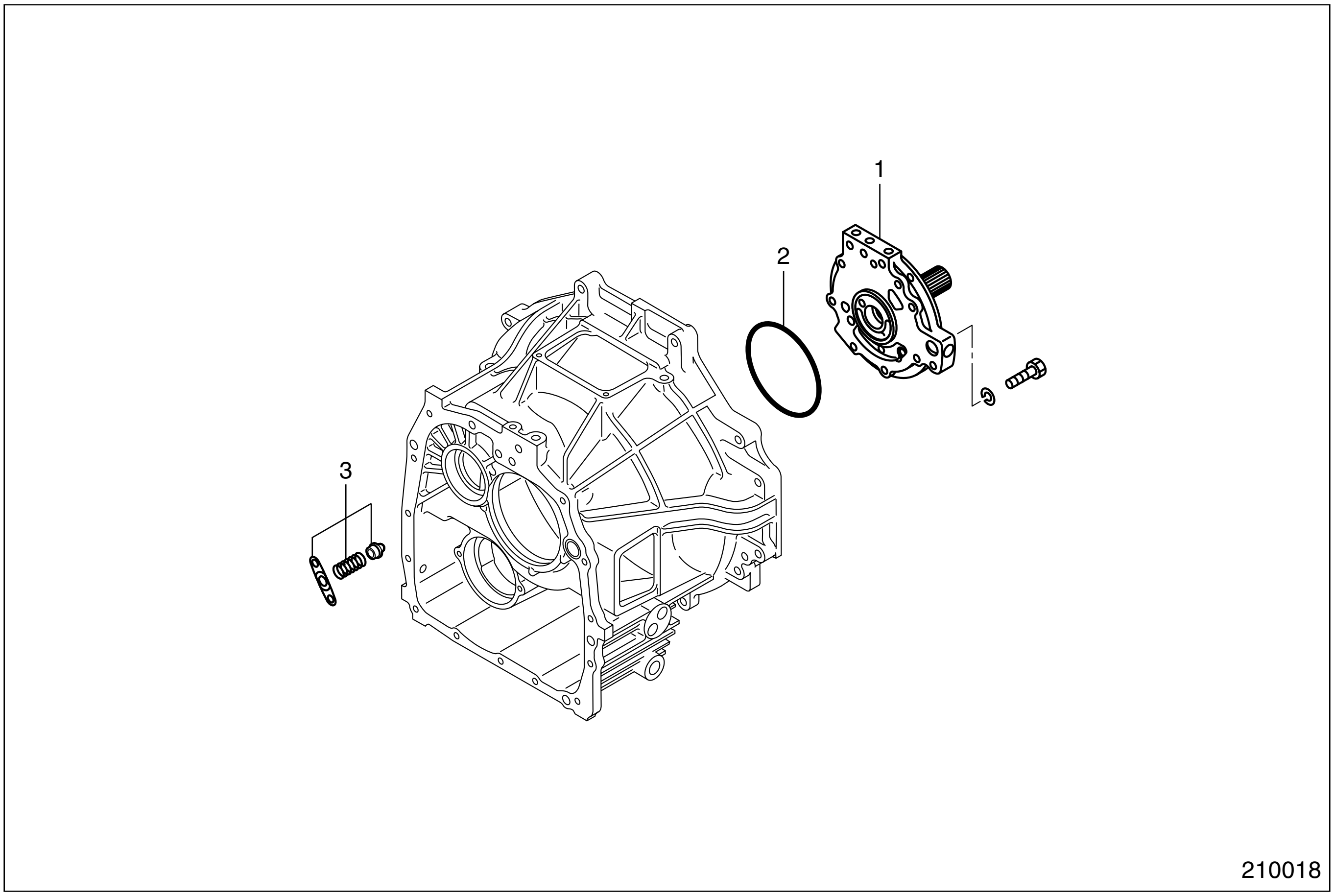
(4) Output flange

(a) Check the splines for wear and other damage.

(b) Check the sliding surface to the oil seal for damage.

Oil Pump Assembly

Disassembly



Sequence

1 Torque converter assembly
2 Oil pump assembly
3 O-ring

Suggestions for Disassembly

(1) Removal of torque converter assembly

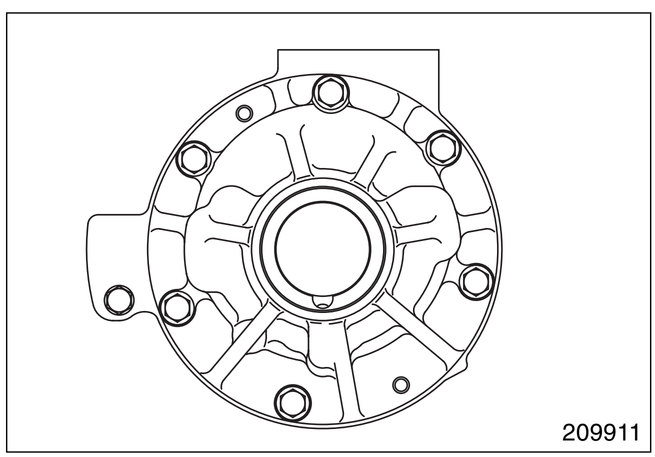
Prepare a drip to collect the remaining oil in the torque converter.

(2) Removal of oil pump assembly

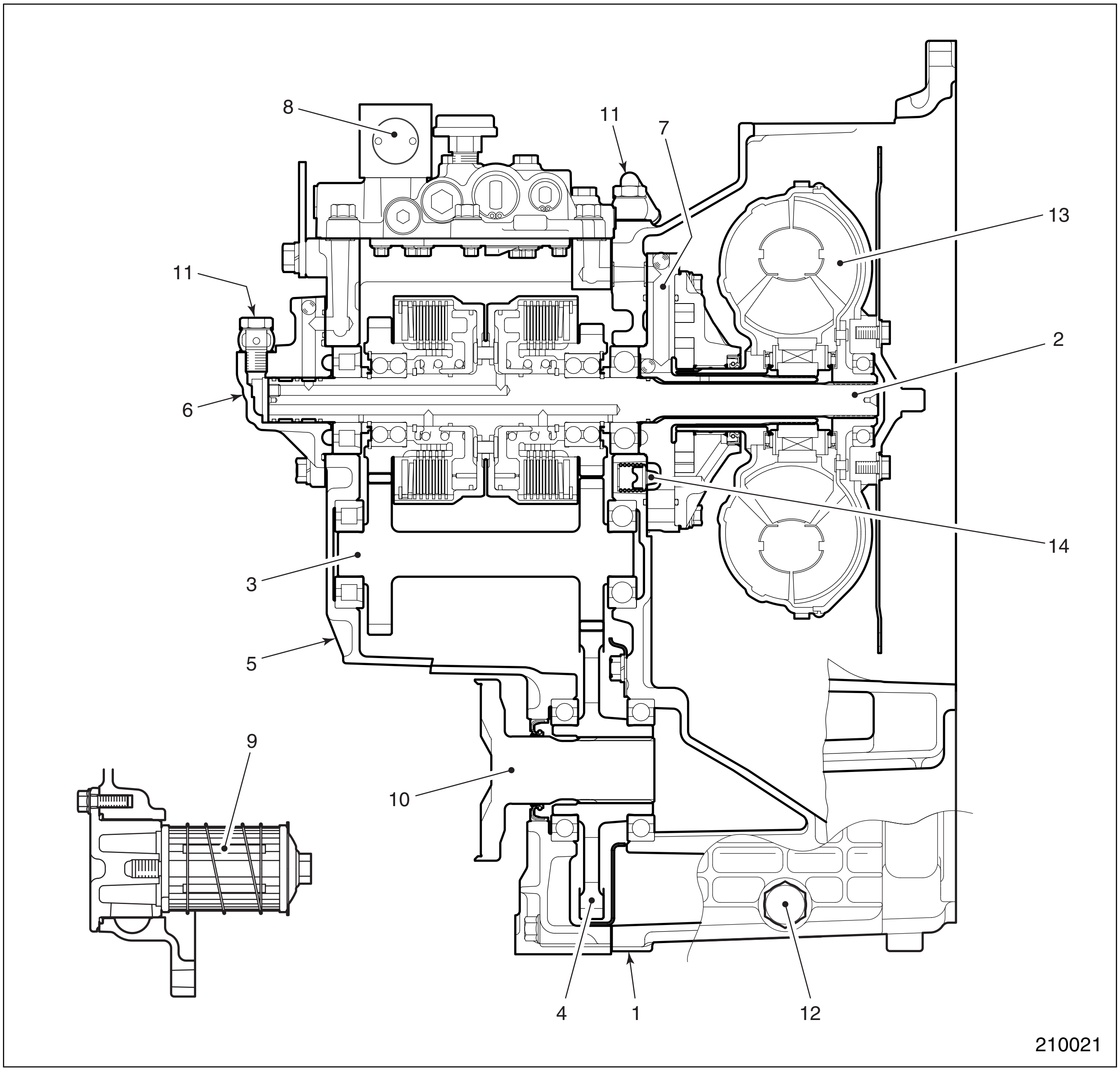
Unscrew the pump mounting bolts and screw two bolts (special tool) into the M8 x 1.25 holes in the pump body to remove the pump assembly. Be sure to tighten the bolts equally, or the threads will suffer damage. Use M8 x 1.25 bolts having an effective thread length of 55 mm (2.2 in.)

Special tool needed

Bolt	91268 - 05100



Reassembly



Sequence

1 Torque converter housing
2 Clutch pack assembly
3 Idler gear
4 Output gear
5 Transmission housing
6 Servo case
7 Oil pump assembly
8 Control valve assembly
9 Magnet strainer
10 Output flange
11 Oil pipe
12 Drain plug, Oil temperature sensor
13 Torque converter assembly

Reassembly is almost reverse of the disassembly sequence.

Suggestions for Reassembly

(1) Applying grease

(a) Apply grease to the lips of the oil seals in the transmission housing.

(2) Installing oil pump assembly

(a) Place the torque converter housing with its mating flange facing down.

(b) Install the relief valve and spring into the torque converter housing.

(c) Apply grease to the O-ring and install it into the torque converter housing. Then, install the oil pump assembly.

(3) Installing transmission housing

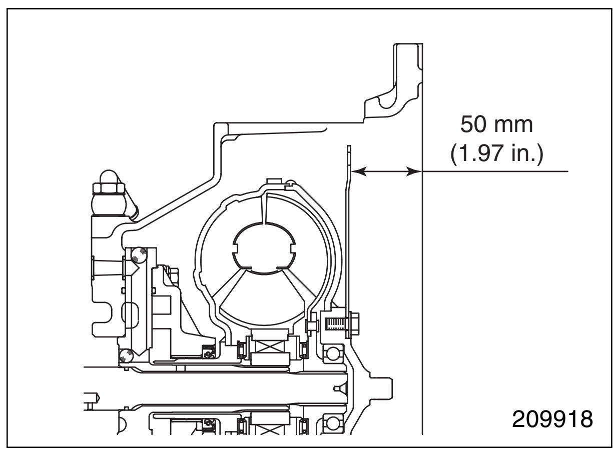
(a) Reinstall the transmission housing while hoisting it in the same procedure during disassembly. Pay attention that the input shaft is not yet stable at the center line.

(4) Installing torque converter

(a) Install the torque converter by aligning its splines with the splines on the stator shaft and input shaft of the transmission and the grooves in the oil pump drive gear.

(b) After the torque converter is installed, check the distance between the end surface of the torque converter housing and the flywheel fitting surface of the flexible plate referring to the specification below.

Distance between torque converter housing end surface and flywheel fitting surface of flexible plate	50 mm (1.97 in.)



(c) Secure the torque converter temporarily by tying part of the flexible plate to the torque converter housing using suitable wires until the assembly is fixed to the engine.

(5) Refilling transmission with oil

(a) Refill the transmission with oil only after the transmission is installed in the truck and the engine is ready to be started.

(b) Check the oil level using the level gauge.

(c) Start and run the engine at an idling speed for about 3 minutes and then stop the engine.

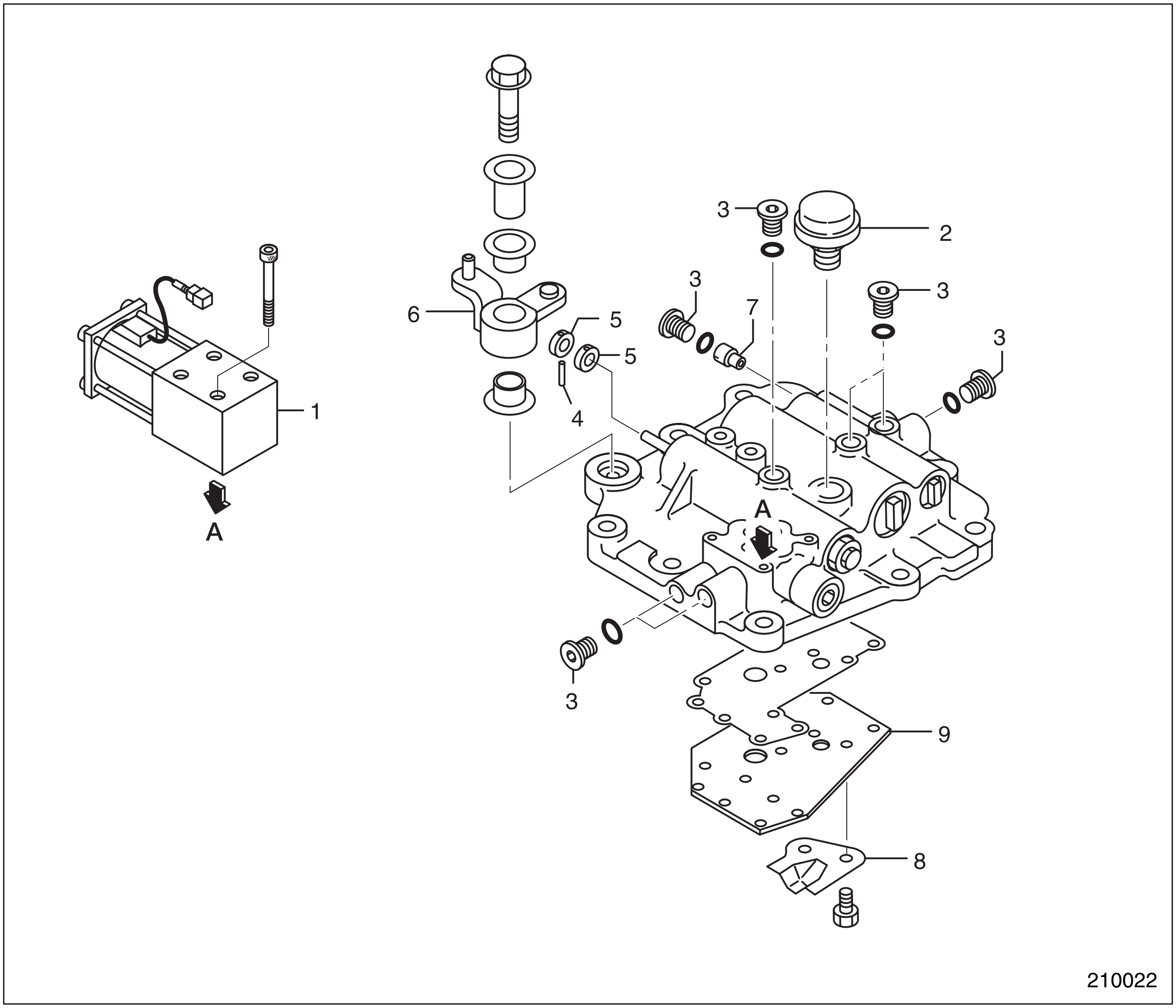
(d) Wait for about 30 seconds after stopping the engine, and then start the checking procedure.

(e) The checking procedure must be completed within 5 minutes after the engine has stopped.

Disassembly and Reassembly of Other Components

Control Valve

Disassembly (Part 1)

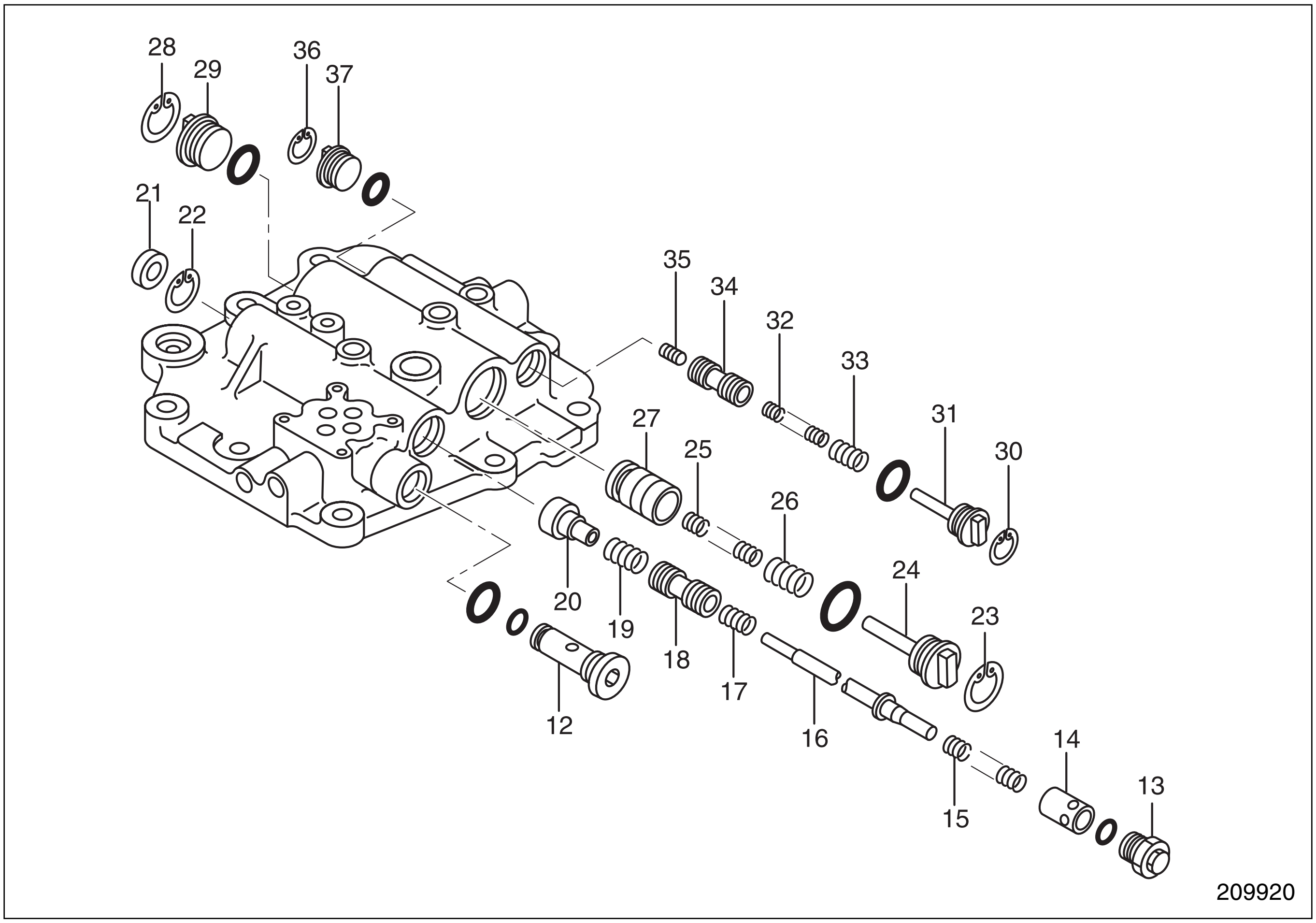


Sequence

1 Solenoid valve
2 Breather
3 Plug, O-ring
4 Spring pin
5 Inching rod plates
6 Inching lever, Retainer, Bushing
7 Main orifice
8 Breather cover
9 Valve plate, Gasket

When loosening the plugs 3, tap the plug head once or twice to make the work easier.

Disassembly (Part 2)



Sequence

12	Strainer, O-ring	21	Oil seal	29	Accumulator plug, O-ring
13	Inching plug, O-ring	22	Snap ring	30	Snap ring
14	Inching stopper	23	Snap ring	31	Main spring seat, O-ring
15	Inching return spring	24	Accumulator spring seat, O-ring	32	Main relief spring (thin)
16	Inching rod			33	Main relief spring (thick)
17	Inching valve spring	25	Inner spring	34	Regulator valve
18	Inching valve	26	Outer spring	35	Slug
19	Return spring	27	Accumulator piston	36	Snap ring
20	Inching sleeve	28	Snap ring	37	Main relief plug

Inspection after Disassembly

(1) Valve housing

(a) Check all oil holes for clogging.

(2) Valves

(a) Check for wear or damage. Make sure the sliding surfaces are smooth.

(b) Check the small holes for clogging.

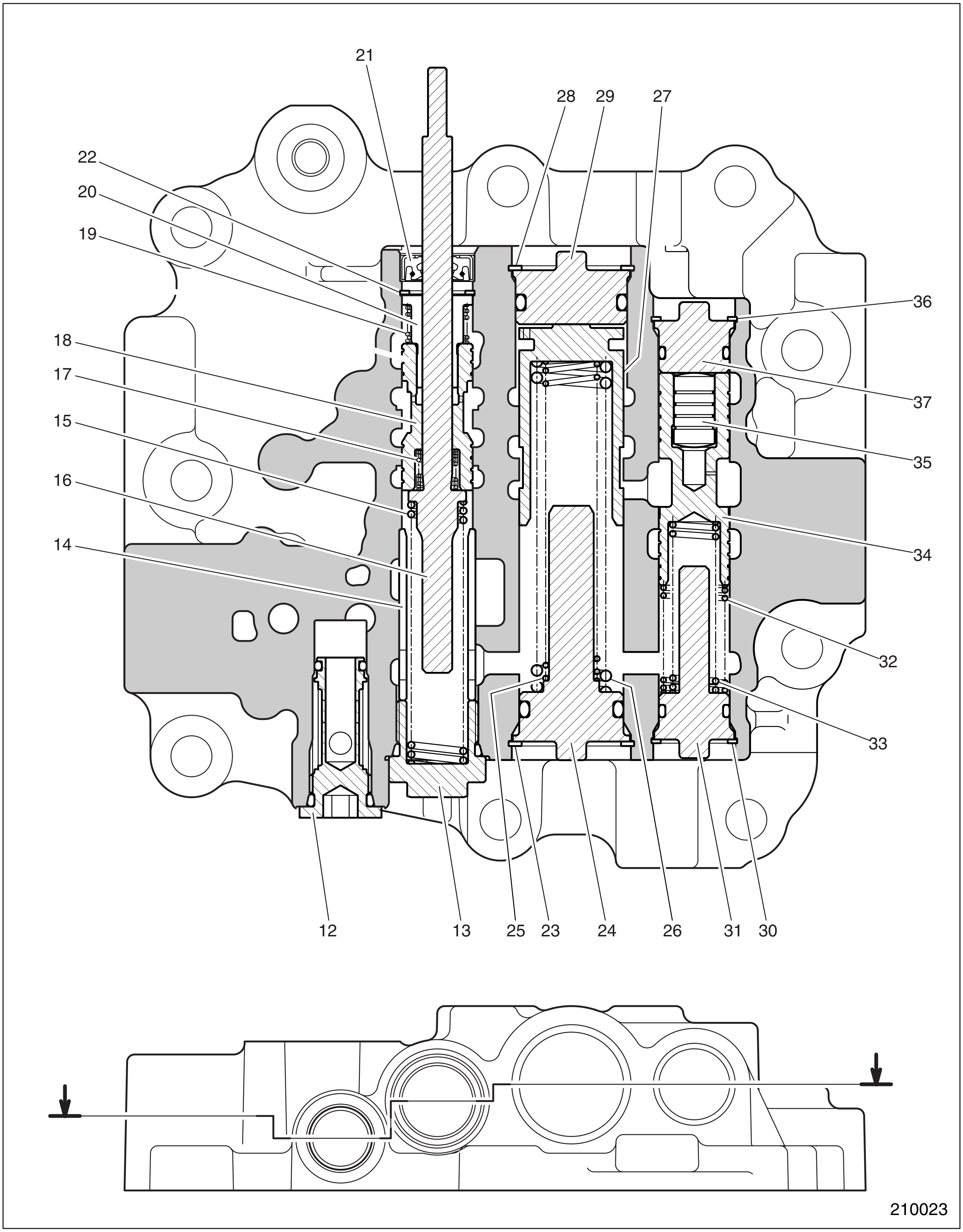
(3) Springs

(a) Check for fatigue and damage.

(4) Oil seal

(a) Check the lip for damage.

Reassembly (Part 1)



Sequence

12 Strainer, O-ring
13 Inching plug, O-ring
14 Inching stopper
15 Inching return spring
16 Inching rod
17 Inching valve spring
18 Inching valve
19 Return spring
20 Inching sleeve
21 Oil seal
22 Snap ring
23 Snap ring
24 Accumulator spring seat, O-ring
25 Inner spring
26 Outer spring
27 Accumulator piston
28 Snap ring
29 Accumulator plug, O-ring
30 Snap ring
31 Main spring seat, O-ring
32 Main relief spring (thin)
33 Main relief spring (thick)
34 Regulator valve
35 Slug
36 Snap ring
37 Main relief plug

Suggestions for Reassembly

(1) Cleaning oil passages

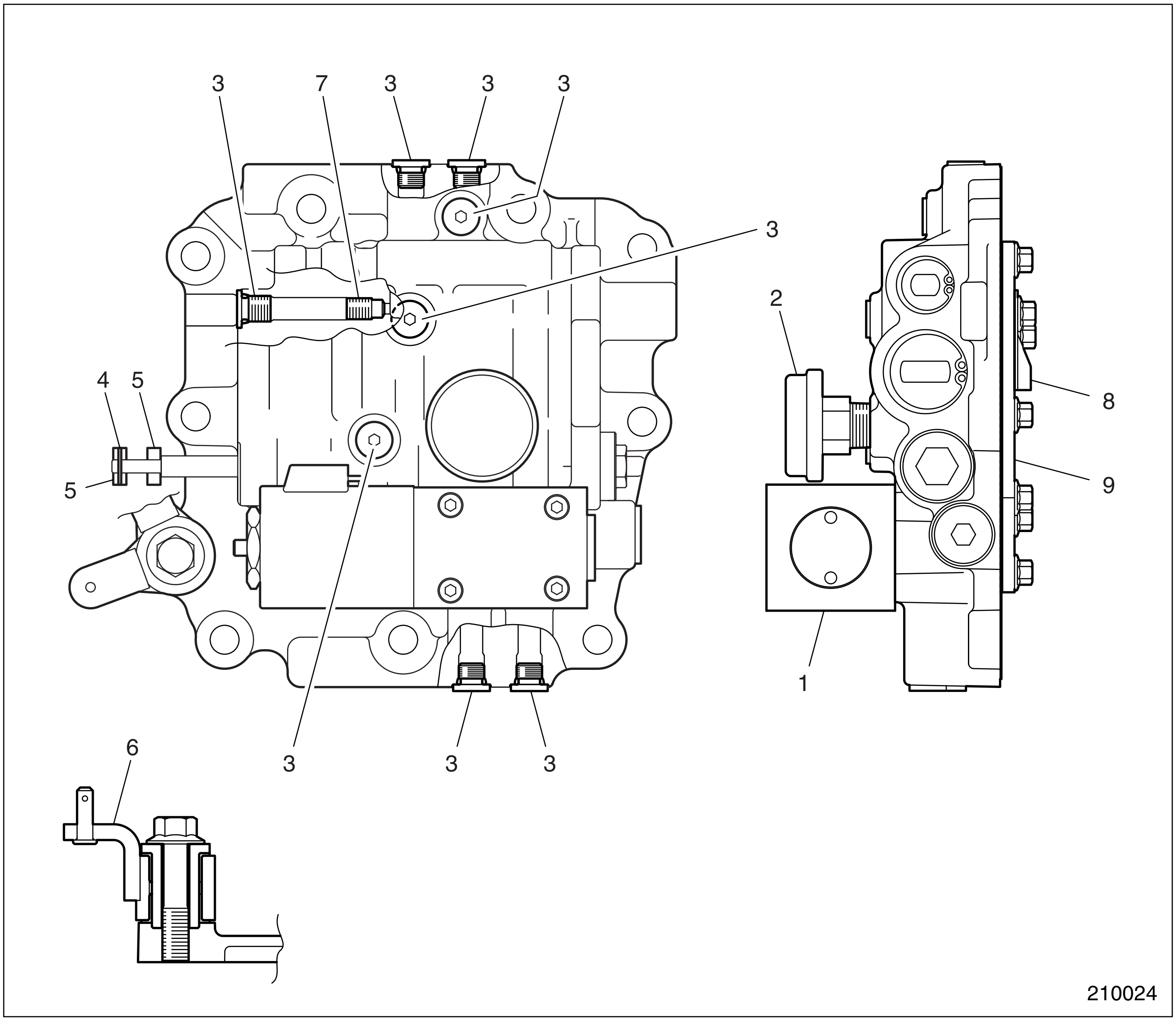
(a) The oil passages in the valve housing must be cleaned thoroughly. Make sure there is no clogging in any passage before reassembling the control valve.

(2) Tightening torques

(a) Tighten the following parts to the specified torques.

Inching plug 25	39.2 to 49 N·m (4.0 to 5.0 kgf·m) [29 to 36 lbf·ft]
Strainer 26	19.6 to 24.5 N·m (2.0 to 2.5 kgf·m) [14 to 18 lbf·ft]

Reassembly (Part 2)



Sequence

1 Solenoid valve
2 Breather
3 Plug, O-ring
4 Spring pin
5 Inching rod plate
6 Inching lever, Retainer, Bushing
7 Main orifice
8 Breather cover
9 Valve plate, Gasket

Suggestions for Reassembly

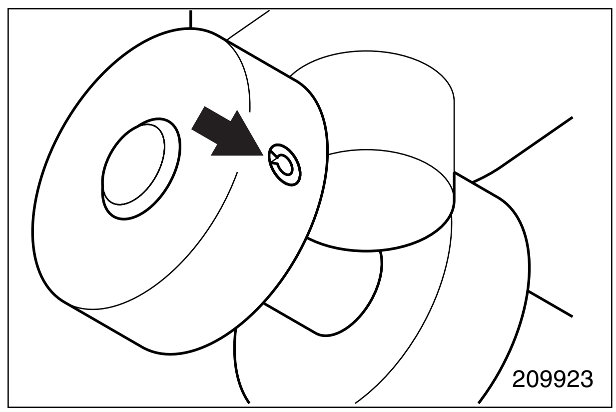
(1) Tightening torques

(a) Tighten the following parts to the specified torques.

Bolts fastening valve plate 9 to breather cover 8	6.0 to 8.0 N·m (0.6 to 0.8 kgf·m) [4.4 to 5.9 lbf·ft]
Plug 3	
Bolt for installing inching lever 6	35.3 to 43.1 N·m (3.6 to 4.4 kgf·m) [26 to 32 lbf·ft]
Bolt for installing solenoid valve 1	6.0 to 8.0 N·m (0.6 to 0.8 kgf·m) [4.4 to 5.9 lbf·ft]

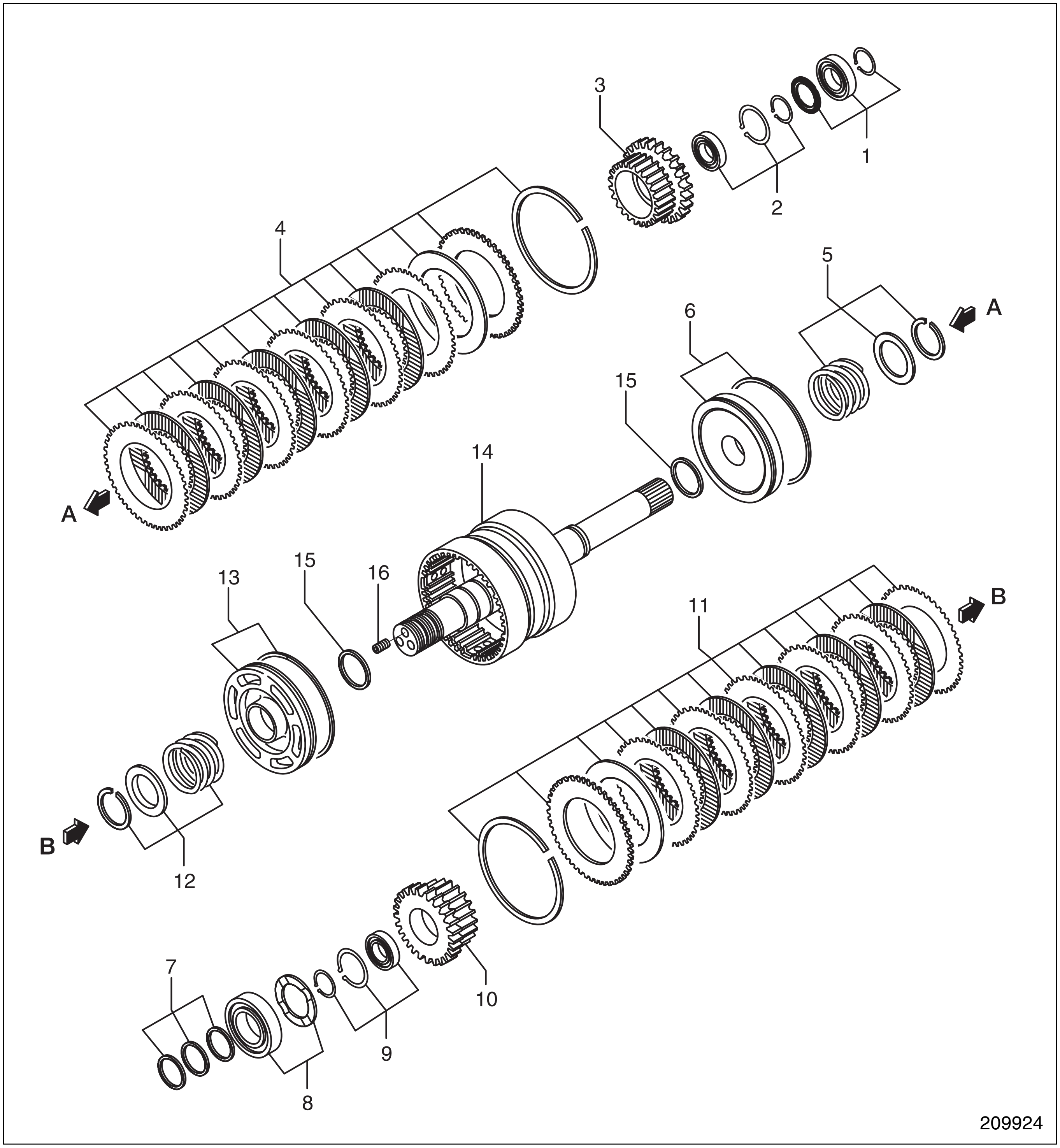
(2) Direction of spring pin slit

(a) The spring pin 4 should be installed with its slit toward the end of the inching shaft.



Input Shaft Assembly

Disassembly



Sequence

1 Ball bearing, Sealing ring, Spacer
2 Angular ball bearing, Snap ring (2 pieces)
3 Reverse gear
4 Pressure plate, Belleville spring (coned disc spring), Mating plate (6 pieces), Friction plate (5 pieces), Snap ring
5 Clutch spring, Snap ring, Spring retainer
6 Clutch piston, Piston ring
7 Sealing ring (3 pieces)
8 Roller bearing, spacer
9 Angular ball bearing, Snap ring (2 pieces)
10 Forward gear
11 Pressure plate, Belleville spring (coned disc spring), Mating plate (6 pieces), Friction plate (5 pieces), Snap ring
12 Clutch spring, Snap ring, Spring retainer
13 Clutch piston, Piston ring
14 Input shaft assembly
15 Seal ring
16 Set screw (2 pieces)

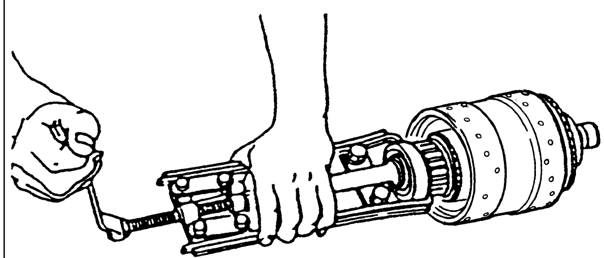
Suggestions for Disassembly

(1) Removing input shaft ball bearing

(a) Use the special tools to remove the ball bearing from the input shaft.

Special tool needed

Puller	91268 - 13810
Plate	91268 - 13820
Bolt	F1035 - 10020
Gear puller (T24)	—



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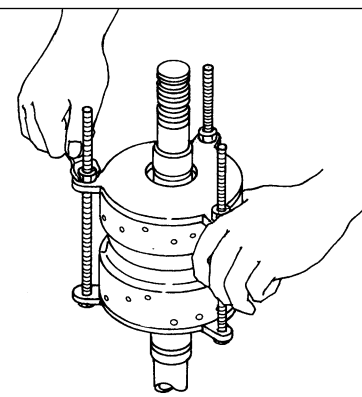
(2) Disassembling input shaft

(a) With the clutch spring compressed using the special tool or a press, remove the snap ring.

Special tool needed

Piston tool	91268 - 17100



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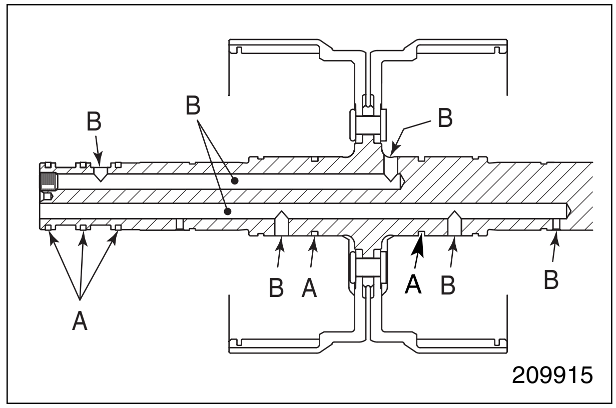
Inspection after Disassembly



(1) Input shaft

(a) Check splines for wear or other damage.

(b) Check the seal rings A and their grooves for wear or damage, and measure the width of each groove.

(c) Check the oil passages B for clogging.

(d) Check the clutch drum and input shaft for looseness.

(2) Gear

(a) Check gear and splines for wear or damage.

(3) Drum

(a) Check the plate sliding surfaces for wear or other damage.

(b) Check the clutch piston sliding surfaces for wear or other damage.

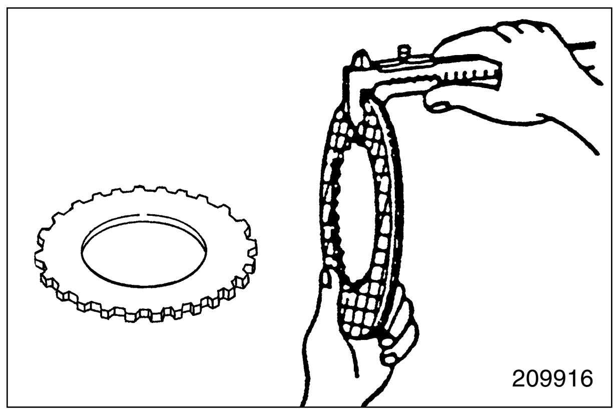
(4) Friction plates and mating plates

(a) Check for burns, trace of uneven contact, deformation and wear.

(b) Check splines for wear or other damage.

(5) Piston ring

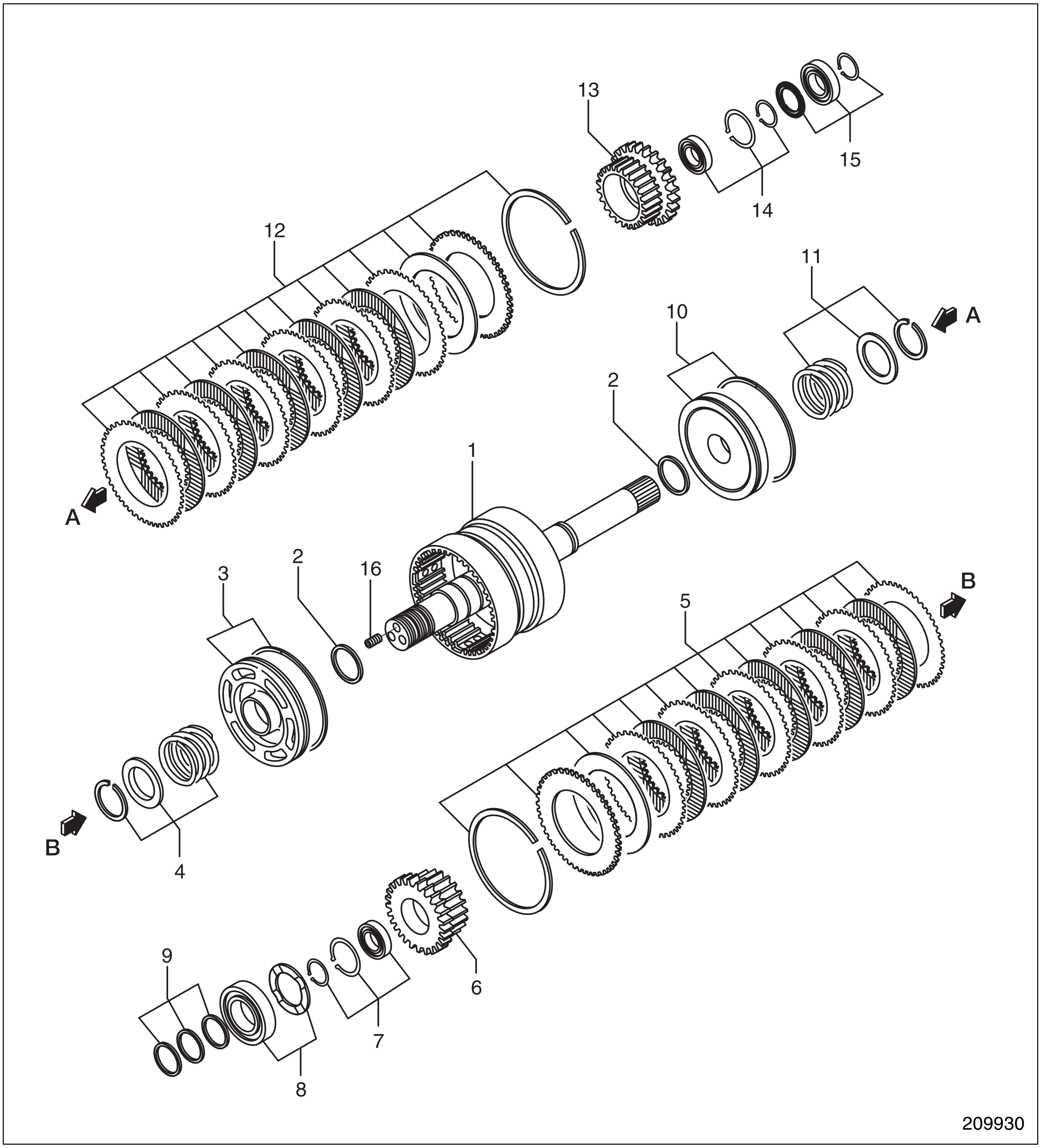
Check piston ring for wear or damage.



A: Standard value B: Repair or service limit

Thickness of friction plate	A	2.6 ± 0.10 mm (0.102 ± 0.004 in.)
	B	2.2 mm (0.087 in.)
Thickness of mating plate	A	1.6 ± 0.1 mm (0.063 ± 0.004 in.)
	B	1.3 mm (0.051 in.)

Reassembly



Sequence

1 Input shaft assembly
2 Seal ring
3 Clutch piston, Piston ring
4 Clutch spring, Snap ring, Spring retainer
5 Pressure plate, Belleville spring (coned disc spring), Mating plate (6 pieces), Friction plate (5 pieces), Snap ring
6 Forward gear
7 Angular ball bearing, Snap ring (2 pieces)
8 Roller bearing, Spacer
9 Seal ring (3 pieces)
10 Clutch piston, Piston ring
11 Clutch spring, Snap ring, Spring retainer
12 Pressure plate, Belleville spring (coned disc spring), Mating plate (6 pieces), Friction plate (5 pieces), Snap ring
13 Reverse gear
14 Angular ball bearing, Snap ring (2 pieces)
15 Bearing, Snap ring, Spacer
16 Set screw (2 pieces)

Suggestions for Reassembly

(1) Assembling clutch piston

(a) Install seal rings on the input shaft and apply a thin coat of ATF on the sliding surfaces of the clutch piston. Take care not to damage or bend the rings.

(b) Install the piston ring on the clutch piston, and apply a thin coat of ATF.

(c) Install the clutch piston onto the input shaft, being careful not to damage any of the parts.

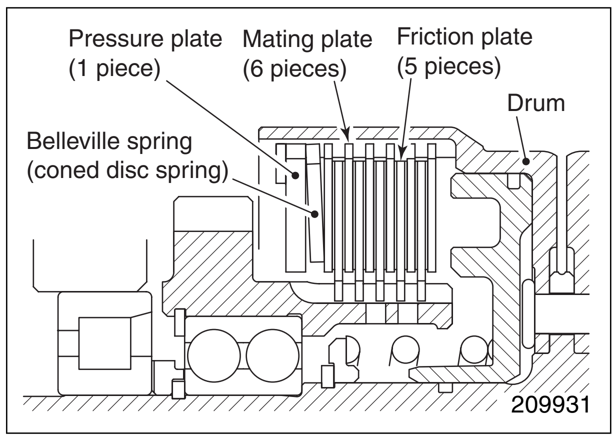
(2) Assembling plates

(a) When replacing the friction plates, also replace the mating plates.

(b) Follow the reassembly sequence carefully. Do not install a wrong number of plates.

(c) Apply ATF to each mating plate and friction plate before installing them.

(d) Install the Belleville spring (coned disc spring) with its convex side facing the mating plate.

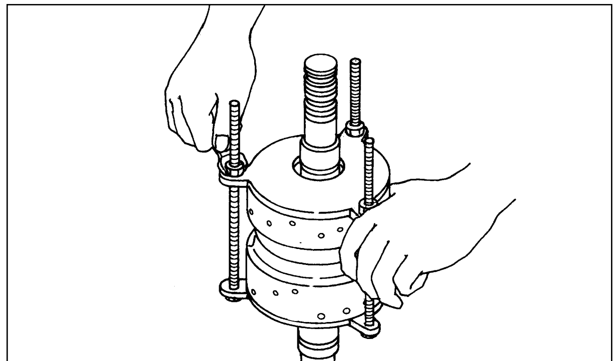


(3) Installing snap rings

(a) Install the snap rings with the clutch spring compressed using the special tool or a press.

Special tool needed

Piston tool	91268 - 17100



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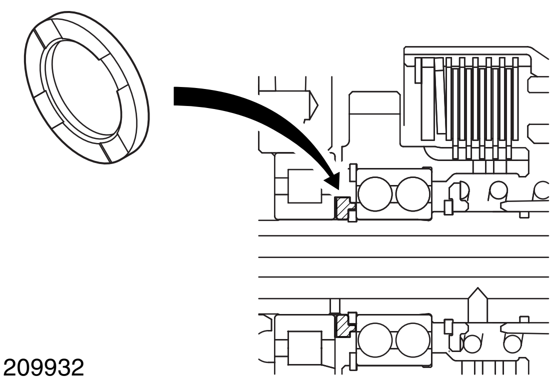
(4) Installing spacer

(a) Install the spacer with the oil grooves facing the ball bearing.



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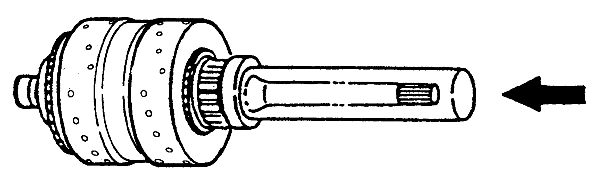
(5) Installing bearing

(a) Drive the ball bearing into position on the input shaft the using special tool.

Special tool needed

Installer	91268 - 05300



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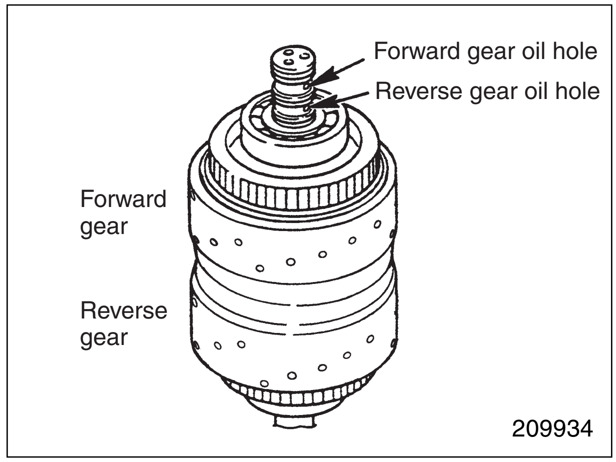
(6) Installing set screw

(a) Apply Loctite to the set screws before installing them.

(7) Testing clutch piston operation

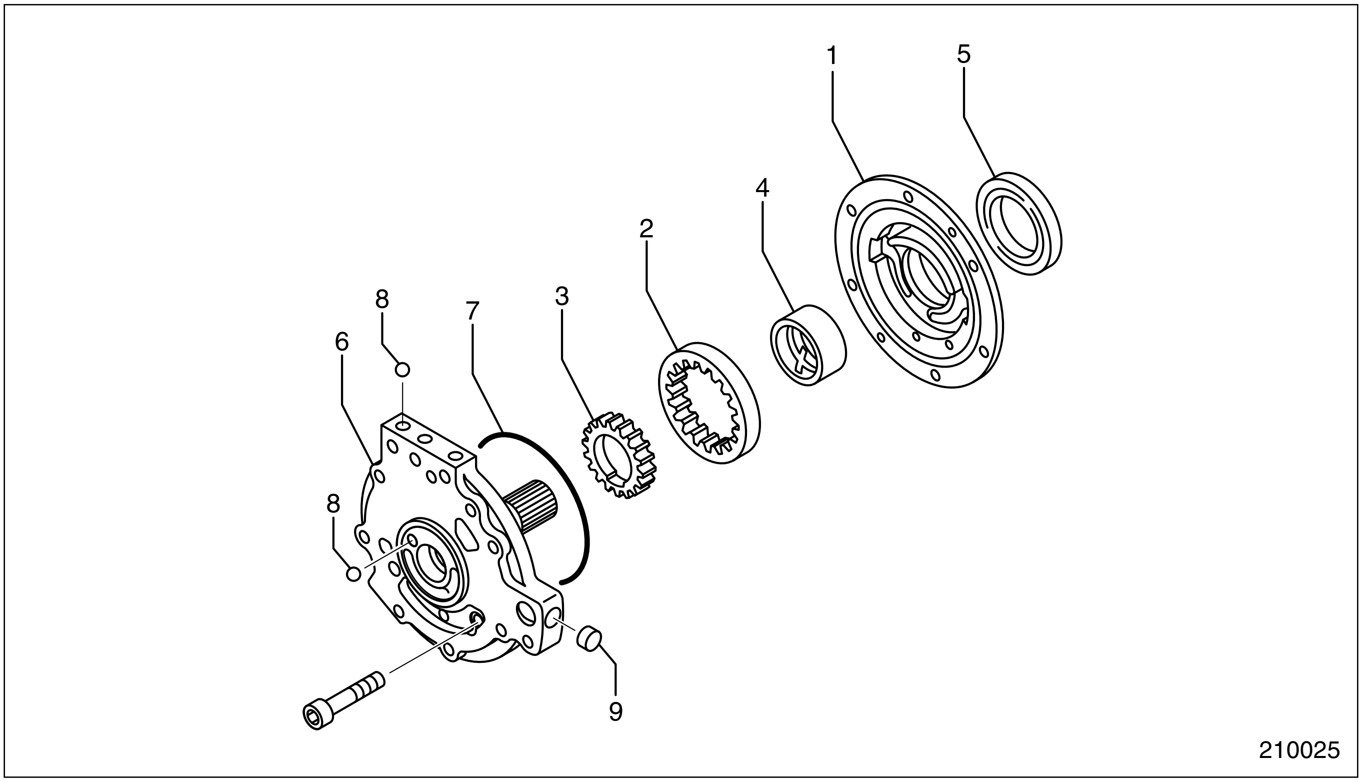
(a) Check that the clutch piston operates correctly by applying compressed air pressure through the forward (reverse) gear oil hole.

Note: Always use filtered, clean compressed air.



Oil Pump Assembly

Disassembly



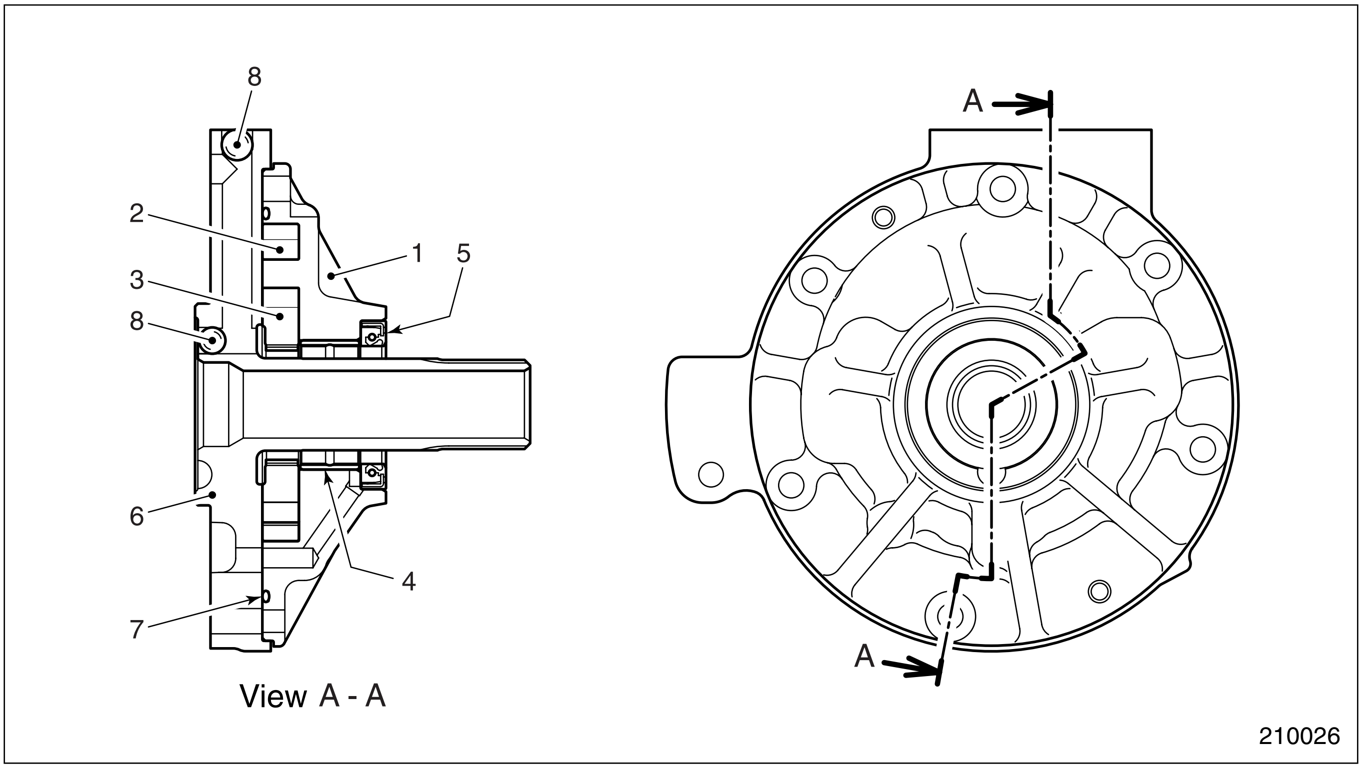
Sequence

1 Oil pump body
2 Internal gear
3 Oil pump drive gear
4 Bushing
5 Oil seal
6 Stator shaft assembly
7 O-ring
8 Steel ball
9 Sealing cup

Suggestions for Disassembly

Note: Inspect the oil seal in the oil pump body. Do not remove the oil seal unless defects are spotted during inspection.

Reassembly



Sequence

1 Oil pump body
2 Internal gear
3 Oil pump drive gear
4 Bushing
5 Oil seal
6 Stator shaft assembly
7 O-ring
8 Steel ball

Suggestions for Reassembly

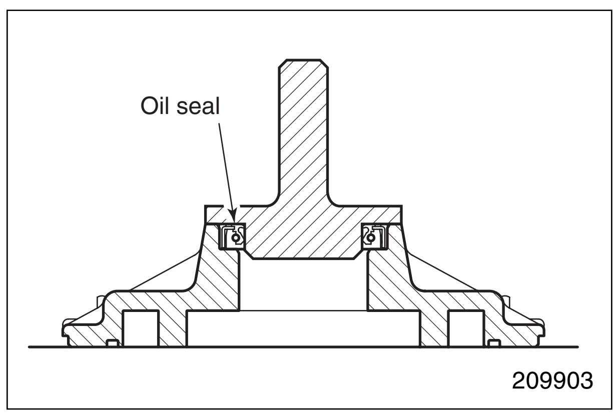
(1) Installing oil seal

(a) Press fit the oil seal into the pump body using the special tool.

Special tool needed

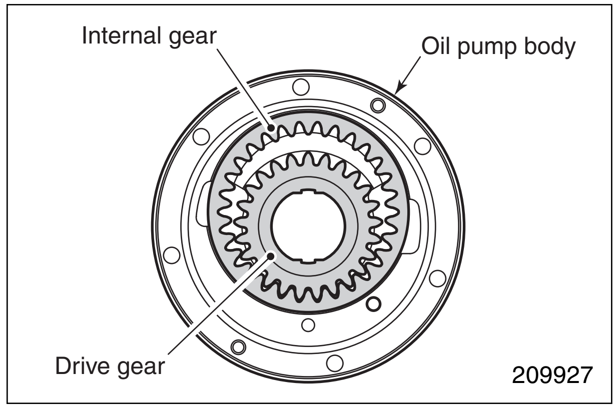
Installer	91268 - 15300

(b) Apply grease to the oil seal lip.



(2) Lubricating internal parts

(a) Apply ATF to the internal gear, drive gear and the inside surfaces of the oil pump body before reassembling them.



(3) Operation check

(a) Turn the drive gear of the reassembled oil pump assembly with your fingers to check that it turns smoothly.

Inspection and Adjustment

Oil Pressure Measurement

(1) Transmission oil level check

(a) Check the transmission fluid level with the level gauge.

(b) Start and run the engine at an idling speed for about 3 minutes, and then stop the engine.

(c) Wait for about 30 seconds after stopping the engine, and check the level.

(d) The checking procedure must be completed within 5 minutes after the engine has stopped.

(2) Engine warm-up

(a) Warm up the engine to raise the temperature of the transmission oil.

(3) Engine speed measurement

(a) After the engine is warmed up, measure the idling speed and maximum no-load speed according to the engine service manual. Make the necessary adjustments if either or both of the speeds do not meet the specifications.

(4) Preparation for oil pressure measurement

(a) Stop the engine after checking and adjusting the engine speeds.

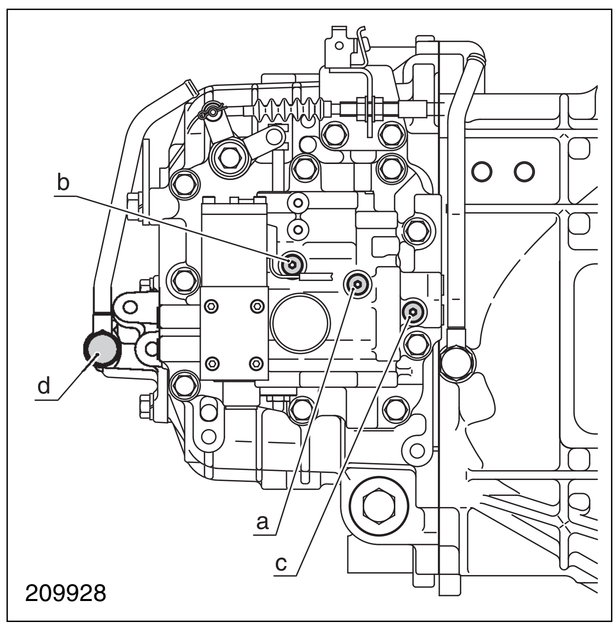
(b) Raise the front wheels completely clear of the ground either by jacking up the front axle housing or placing a wood block under the outer mast and tilting the mast forward.

(c) Block the rear wheels.

Note: The front wheels turn during the clutch pressure measurement. Be careful and stay away from the wheels.

(d) Connect the oil pressure gauge to each of the oil pressure taps indicated in the illustration.

a: Main pressure
b: Clutch pressure
c: Torque converter inlet pressure
d: Lubrication oil pressure



Note: When loosening the plugs a through d, tap the plug head once or twice to make the work easier.

(e) Use the following tools for the oil pressure measurements.

Oil pressure measurement tools

Special tool/ part number	Remarks	Main pressure Clutch pressure	Torque converter inlet pressure	Lubrication oil pressure
Connector 65628 - 00400	G1/8 → Rc 1/8 thread	○	○	—
*Connector 64309 - 17733	R(PT)1/8 thread → G(PF) 3/8	○	○	○
Connector 91268 - 02300	M14 × 1.5 → Rp 1/8 thread	—	—	○
*Gauge 64309 - 17714	600 kPa (6 kgf/cm^2) [87 psi] G 3/8 thread	—	○	○
*Gauge 64309 - 17713	2000 kPa (20 kgf/cm^2) [290 psi] G 3/8 thread	○	—	—
*Hose 64309 - 17722	G 3/8 → G 3/8 thread	○	○	○
*Connector 64309 - 17731	For gauge connection	○	○	○

Note: Tools marked with (*) are included in the gauge kit 64309 - 17701.

(5) Oil pressure measurement procedure

(a) Start the engine, shift the direction lever into the neutral position and measure the main pressure, torque converter inlet pressure, and lubrication oil pressure.

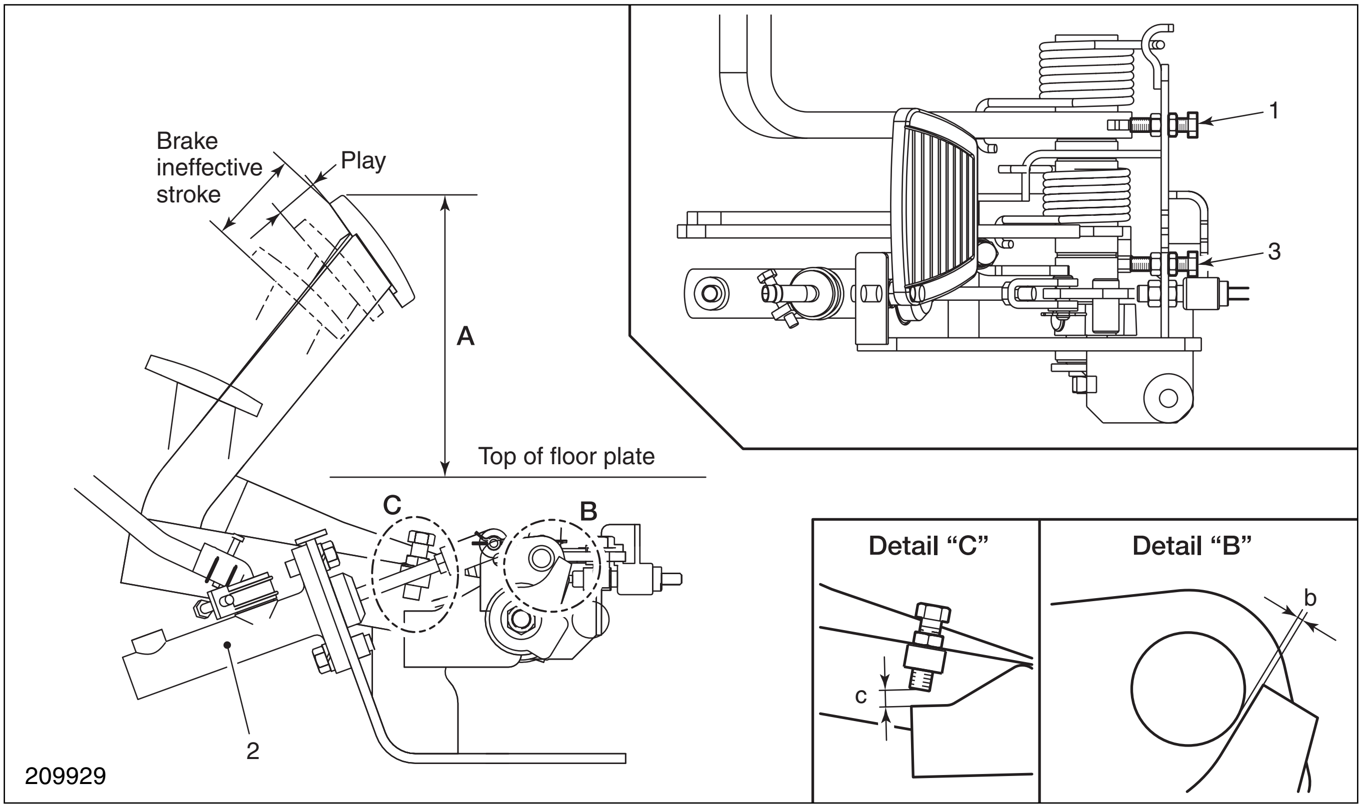
(b) Measure the clutch pressure with the lever shifted into the forward position, then measure it again with the lever in the reverse position.

A: Standard value

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

		Engine rpm		Oil pressure
a	Main pressure	800 ± 50 min^{-1} (rpm)	A	0.83 to 1.08 (8.5 to 11.0) [120.9 to 156.5]
		1600 ± 100 min^{-1} (rpm)	A	0.93 to 1.23 (9.5 to 12.5) [135.1 to 177.8]
b	Clutch pressure	800 ± 50 min^{-1} (rpm)	A	0.83 to 1.08 (8.5 to 11.0) [120.9 to 156.5]
		1600 ± 100 min^{-1} (rpm)	A	0.93 to 1.23 (9.5 to 12.5) [135.1 to 177.8]
c	Torque converter inlet pressure	800 ± 50 min^{-1} (rpm)	A	0.10 to 0.49 (1.0 to 5.0) [14.2 to 71.1]
		1600 ± 100 min^{-1} (rpm)	A	0.10 to 0.49 (1.0 to 5.0) [14.2 to 71.1]
d	Lubrication oil pressure	800 ± 50 min^{-1} (rpm)	A	0.03 to 0.29 (0.3 to 3.0) [4.27 to 42.7]
		1600 ± 100 min^{-1} (rpm)	A	0.03 to 0.29 (0.3 to 3.0) [4.27 to 42.7]

Clutch (Inching) Pedal Adjustment



The clutch (inching) mechanism is linked to the brake pedal. Depressing the brake pedal cuts the pressure acting on the transmission before the brakes take effect, bringing the transmission to a neutral condition.

A faulty inching mechanism may create such problems as failure in clutch disengagement and partial clutch engagement. This in turn may cause an abnormal increase in the transmission temperature, as well as braking malfunctions and clutch plate seizures. Be sure to make all the following adjustments carefully so that these problems may be avoided.

(1) Adjusting brake pedal

(a) Adjust the brake pedal height A (from the floor plate top surface to the brake pedal top surface) to the following standard value by turning the stopper bolt 1 and then lock it with the lock nut.

Brake pedal height A	191 mm (7.52 in.)

(b) Remove the clearance between the push rod pin of the brake master cylinder 2 and the piston (zero clearance).

(c) Turn the push rod of the brake master cylinder until the clearance b in the detail B adjusted to the range indicated below.

Item \ Truck Model	1 ton class	2, 3 ton classes
Clearance b	0.2 to 1.0 mm (0.0079 to 0.0394 in.)	0.2 to 0.8 mm (0.0079 to 0.0315 in.)

(d) Lock the clevis firmly with the lock nut.

(e) If the pedal has been properly adjusted, the brake pedal free play becomes the range indicated below.

Item \ Truck Model	1 ton class	2, 3 ton classes
Brake pedal free play	1.5 to 6.5 mm (0.0591 to 0.2559 in.)	1.5 to 5.5 mm (0.0591 to 0.2165 in.)

(2) Adjusting inching pedal

(a) Adjust the height A of the inching pedal (from the floor plate top surface to the inching pedal top surface) to the following standard value with the stopper bolt 3.

Inching pedal height A	191 mm (7.52 in.)

(b) Adjust the clearance c between the bolt and linkage in the portion C to the following value and lock it firmly with the nut.

Item \ Truck Model	1 ton class	2, 3 ton classes
Clearance c between bolt and linkage	10.0 mm (0.394 in.)	11.6 mm (0.457 in.)

Inching Valve Adjustment

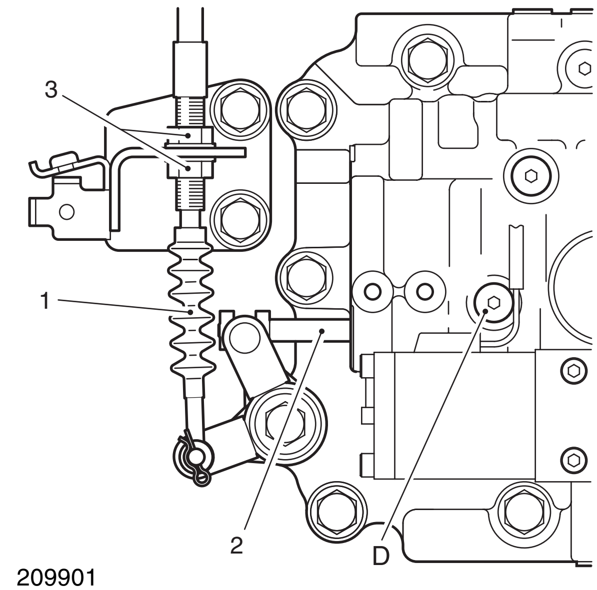
Start by:

(a) Blocking the rear wheels, then raising the front wheels following the procedure described in the preceding oil pressure measurement section;

(b) Connecting an oil pressure gauge to the oil pressure tap (position D in the illustration);

(c) Adjusting the length of the inching cable 1 so that plunger 2 is completely extended; and

(d) Tightening the lock nuts 3 firmly to lock the inching cable 1.



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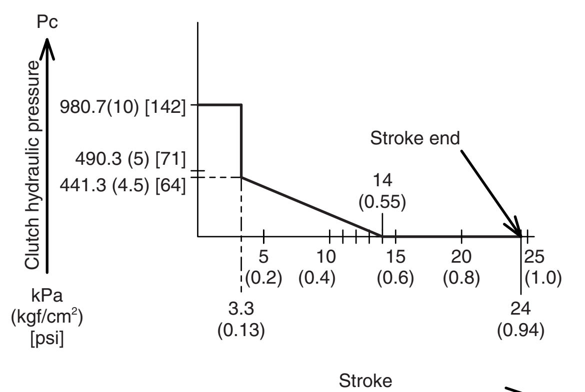
Procedure

(a) Run the engine at idle to raise the temperature of the transmission oil.

(b) Shift the lever into the forward (reverse) position.

(c) Depress the inching pedal gradually to make the plunger 2 retract, while recording the clutch pressure (Pc) for each stroke distance of plunger 2 in order to know the relationship between them.

(d) Check that the recorded values correspond to the values in the fig. on the right. The oil pressure must be exactly 0 (zero) when the plunger 2 is fully retracted.



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Troubleshooting

Problem	Location	Cause	Remedy
Not enough output power	Engine	Engine lacks power	Tune up engine.
		Poor performance of engine	Tune up engine.
	Torque converter	Oil level too low	Refill.
		Air being sucked in on suction side	Replace gasket and retighten.
		Faulty action of spool in main regulator valve	Repair or replace.
		Weakened spring in main regulator valve	Replace.
		Worn gears in oil pump, resulting in reduced capacity	Overhaul and check or replace defective parts.
		Magnet strainer clogged	Clean or replace.
		Seal rings or O-rings worn	Replace.
		Stator freewheel seized	Replace torque converter assembly.
		Impeller damaged or rubbing	Replace torque converter assembly.
	Transmission	Air being sucked in on suction side	Retighten or replace.
		Water in oil	Replace oil.
		Oil level too low	Refill.
		Pedal linkage maladjusted (brake shift and forward reverse)	Readjust.
		Main pressure too low, resulting in slipping clutches	Readjust.
		Seal rings or O-rings worn	Replace.
		Clutch piston damaged	Replace.
		Friction plate seized or dragging	Replace.
	Road wheels	High mechanical resistance in road wheels	Check and adjust brake system
No power flow	Torque converter	Flexible plate broken	Replace.
		Not enough oil	Refill.
		Oil pump drive defective	Replace.
		Turbine shaft broken	Replace.
		Main pressure too low	Check pump gears for wear or replace.
	Transmission	Not enough oil	Refill.
		Inching pedal link maladjusted	Readjust.
		Seal ring worn in servo case	Replace.
		O-rings on input shaft worn	Replace.
		Plug on input shaft loose or slipped off, resulting in oil leaks	Repair.
		Clutch seized	Replace.
		Shafts broken	Replace.
		Clutch drum, particularly snap ring groove, defective	Replace.
		Snap ring fitted to clutch drum broken	Replace.
		Oil way for supplying oil pressure to clutch piston clogged	Clean or replace.
		Shaft splines worn	Replace shafts.
	Power train	Broken parts in reduction differential or front axle	Repair or replace.

Problem	Location	Cause	Remedy
Abnormal noise	Torque converter	Flexible plate broken	Replace.
		Bearings damaged	Replace.
		Rubbing blades of running member	Replace torque converter.
		Bolts loose	Retighten or replace.
		Splines worn	Replace.
		Oil pump noisy	Repair or replace.
	Transmission	Friction plates seized and dragging	Replace friction plates.
		Bearings worn or seized	Replace.
		Gears broken	Replace.
		Bolts loose	Retighten or replace.
		Splines worn	Replace.
	Loud noise	Magnet strainer clogged	Clean or replace.
		Main regulator valve defective	Wash or replace.
		Restriction in oil pipe	Replace.
		Oil too viscous in cold weather	Replace oil.
		Instruments faulty	Replace.
		Wrong kind of oil used	Replace oil.
	Low noise	Magnet strainer clogged	Clean or replace.
		Oil pump defective	Replace.
		Excessive oil leaks	
		(1) Main regulator valve spring broken or fatigued	Replace.
		(2) Main regulator valve spool defective	Repair or replace.
		Air being sucked in	Retighten or replace packing.
		Oil level too low	Refill.
Oil leaks		Leaking oil seals	Check lips and sliding surfaces for wear. Replace seals.
		Leaking joint of case	Retighten or replace packing.
		Leaking pipe connection or joint	Repair or replace pipe, gasket and O-rings.
		Leaking drain plug	Retighten and replace gasket.
		Cracks or blowholes in case	Replace.
		Oil blowing out of transmission housing	
		(1) Water in oil	Replace oil.
		(2) Air being sucked in suction side	Replace packing and retighten.
		(3) Oil leaks from air breather	Repair.
		Oil level too high	Lower oil level.

Symptom	Area	Cause	Remedy
Oil temperature is too high	Torque converter	Oil level too high or too low	Refill or drain.
		Magnet strainer clogged	Clean or replace.
		Impeller rubbing	Replace torque converter assembly
		Stator freewheel defective	Replace torque converter assembly
		Air being sucked in	Retighten or replace O-ring.
		Water in oil	Replace oil.
		Restriction in oil pipe (resulting in reduced circulation flow)	Repair or replace.
		Bearings worn or seized	Repair or replace.
		Instruments out of order	Replace.
	Transmission	Friction plates dragging	Replace friction plates.
		Bearings worn or seized	Repair or replace.
		Control linkage defective	Repair or replace.
	Others	Truck not operated properly	Urge user to operate properly.
		Others	
		(1) Cooling fan belt damaged	Replace.
		(2) Oil cooler clogged	Clean or replace.
		(3) Brakes grabbing	Check and readjust.

Symptom	Cause	Remedy
Main pressure is too high	Main regulator valve defective	Repair or replace valve assembly.
	Oil viscosity too high because of low temperature	Replace oil.
	Wrong kind of oil used	Replace oil.

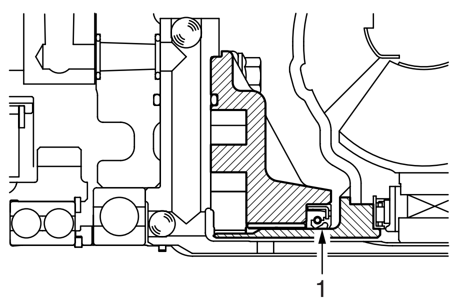
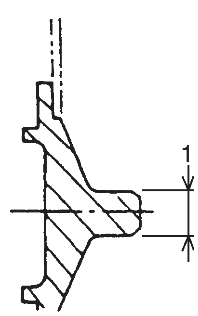
Symptom	Cause	Remedy
Main pressure is too low	Magnet strainer clogged	Clean or replace.
	Oil pump failure	Replace.
	Coil spring defective in main regulator valve	Replace.
	Faulty movement of main regulator valve spool	Repair or replace.
	Air being sucked in	Retighten or replace packing.
	Not enough oil	Refill.
	Control linkage defective	Repair or replace.
	Clutch valve out of order	Repair or replace.

Symptom	Cause	Remedy
Clutch pressure is too low	Magnet strainer clogged	Clean or replace.
	Oil pump worn or otherwise defective	Replace.
	Coil spring defective in main regulator valve	Replace.
	Faulty movement of main regulator valve spool	Repair or replace.
	Air being sucked in	Retighten or replace packing.
	Not enough oil	Refill.
	Control linkage out of order	Repair or replace.
	Inching valve defective	Repair or replace.
	Seal ring broken in servo case	Replace.
	Clutch piston seal rings broken	Replace.

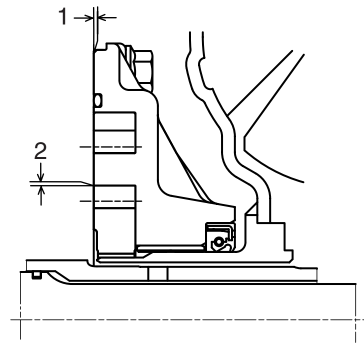
Problem	Possible cause	Remedy
Stall speed out of specification	Lack of engine power if the speed is slightly low in both forward and reverse drive	Tune up engine.
	Stator and freewheel damaged if the speed is excessively low in both forward and reverse drive	Replace torque converter assembly.
	Inching pedal linkage defective, or friction plates slipping if the speed is too high	Repair or replace.

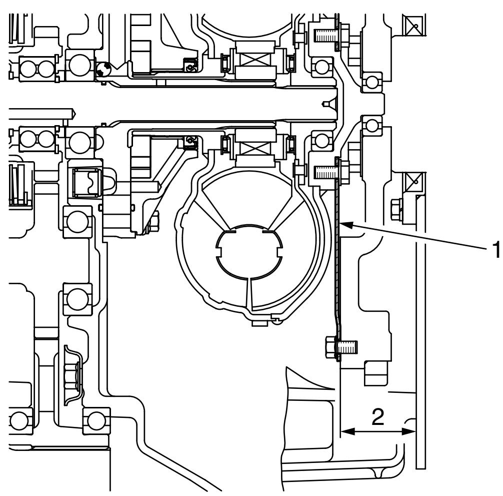
Service Data

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

<table>
<tr><th colspan="3">Items \ Truck Models</th><th>1 ton class</th><th>2 ton class</th><th>3 ton class</th></tr>
<tr><td colspan="2">Main pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]</td><td>A</td><td colspan="3">0.93 to 1.23 (9.5 to 12.5) [135.1 to 177.8]</td></tr>
<tr><td colspan="2">Clutch pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]</td><td>A</td><td colspan="3">0.93 to 1.23 (9.5 to 12.5) [135.1 to 177.8]</td></tr>
<tr><td colspan="2">Torque converter inlet pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]</td><td>A</td><td colspan="3">0.10 to 0.49 (1.0 to 5.0) [14.2 to 71.1]</td></tr>
<tr><td colspan="2">Lubricating oil pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]</td><td>A</td><td colspan="3">0.03 to 0.29 (0.3 to 3.0) [4.27 to 42.7]</td></tr>
<tr><td colspan="2">Travel time for 100 m (330 ft) starting acceleration (no load)</td><td>A</td><td colspan="3">5 seconds, maximum</td></tr>
<tr><td rowspan="3">Pump boss</td><td rowspan="2">Diameter of fitting surface in contact with oil seal 1</td><td>A</td><td colspan="3">$42^{-0.035}_{-0.085}$ ($1.65^{-0.001}_{-0.003}$)</td></tr>
<tr><td>B</td><td colspan="3">41.85 (1.64)</td></tr>
<tr><td colspan="5">210028</td></tr>
<tr><td rowspan="3">Pilot boss</td><td rowspan="2">Diameter of shank 1</td><td>A</td><td colspan="3">$15^{-0.007}_{-0.042}$ ($0.590^{-0.0003}_{-0.0002}$)</td></tr>
<tr><td>B</td><td colspan="3">14.93 (0.588)</td></tr>
<tr><td colspan="5">200411</td></tr>
</table>

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

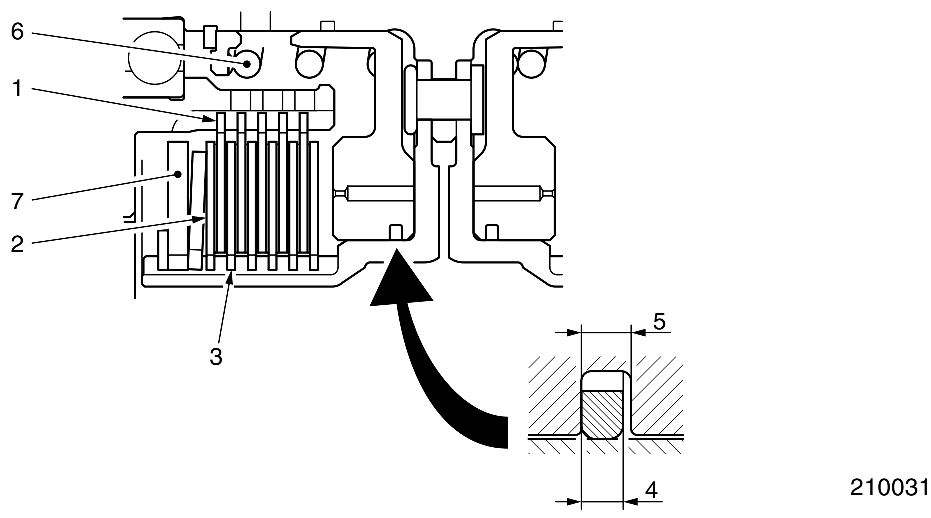
<table>
<tr><th colspan="3">Truck Models
Items</th><th>1 ton class</th><th>2 ton class</th><th>3 ton class</th></tr>
<tr><td rowspan="7">Oil pump</td><td rowspan="2">Side clearance 1</td><td>A</td><td colspan="3">0.040 to 0.083 (0.00157 to 0.00327)</td></tr>
<tr><td>B</td><td colspan="3">0.15 (0.0059)</td></tr>
<tr><td rowspan="2">Top clearance 2</td><td>A</td><td colspan="3">0.3 to 0.33 (0.0118 to 0.0130)</td></tr>
<tr><td>B</td><td colspan="3">0.35 (0.0138)</td></tr>
<tr><td rowspan="2">Backlash</td><td>A</td><td colspan="3">0.1 to 0.18 (0.00394 to 0.00709)</td></tr>
<tr><td>B</td><td colspan="3">0.3 (0.012)</td></tr>
<tr><td colspan="5">

210029</td></tr>
<tr><td rowspan="4">Flexible plate</td><td rowspan="2">Face runout of flexible plate 1
(in free state)</td><td>A</td><td colspan="3">0.2 (0.0079)</td></tr>
<tr><td>B</td><td colspan="3">0.5 (0.0197)</td></tr>
<tr><td>Distance between end face of transmission case and mating face of flexible plate 2</td><td>A</td><td colspan="3">50 (1.97)</td></tr>
<tr><td colspan="5">

210030</td></tr>
</table>

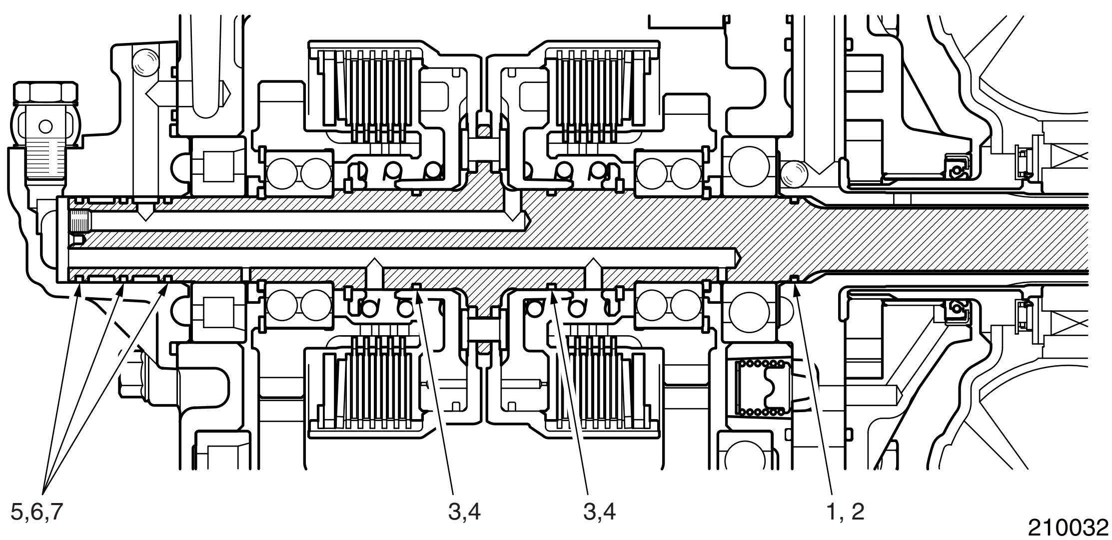
A: Standard value B: Repair or service limit
Unit: mm (in.)

Items		Truck Models	1 ton class	2 ton class	3 ton class
Clutches	Thickness of mating plate 1	A	1.6 ± 0.1 (0.063 ± 0.0039)		
		B	1.3 (0.0512)		
	Thickness of friction plate 2	A	2.6 ± 0.1 (0.1024 ± 0.0039)		
		B	2.2 (0.0866)		
	Backlash of friction plate and gear 3	A	0.13 to 0.29 (0.005 to 0.011)		
		B	0.5 (0.019)		
	Width of seal ring 4	A	2.1 ± 0.1 (± 0.0039)		
		B	1.8		
	Width of piston seal ring groove 5	A	2.5 $^{+0.1}_{0}$ (0.098 $^{+0.039}_{0}$)		
		B	2.65 (0.104)		
	Free length of clutch spring 6 Spring constant: k = N/mm (kgf/mm) [lbf/in.]	A	75.5 (2.97) k = 18.476 (1.886) [105.5]		
	Thickness of pressure plate 7	A	4.0 ± 0.3 (0,157 ± 0.012)		
		B	3.3 (0.130)		

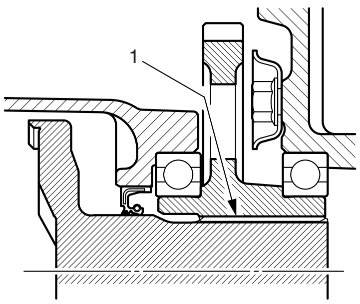


A: Standard value B: Repair or service limit

Unit: mm (in.)

<table>
<tr><th colspan="3">Items \ Truck Models</th><th>1 ton class</th><th>2 ton class</th><th>3 ton class</th></tr>
<tr><td rowspan="15">Input shaft assembly</td><td rowspan="2">Stator shaft seal ring width 1</td><td>A</td><td colspan="3">2.5 ± 0.05 (0.0984 ± 0.0020)</td></tr>
<tr><td>B</td><td colspan="3">2.3 (0.091)</td></tr>
<tr><td rowspan="2">Stator shaft seal ring groove width 2</td><td>A</td><td colspan="3">2.5 $^{+0.2}_{+0.1}$ (0.0984 $^{+0.0079}_{+0.0039}$)</td></tr>
<tr><td>B</td><td colspan="3">2.9 (0.114)</td></tr>
<tr><td rowspan="2">Clutch piston seal ring width 3</td><td>A</td><td colspan="3">2.5 ± 0.05 (0.098 ± 0.0020)</td></tr>
<tr><td>B</td><td colspan="3">2.3 (0.091)</td></tr>
<tr><td rowspan="2">Clutch piston seal ring groove width 4</td><td>A</td><td colspan="3">2.8 ± 0.05 (0.110 ± 0.0020)</td></tr>
<tr><td>B</td><td colspan="3">3.0 (0.118)</td></tr>
<tr><td rowspan="2">Servo case shaft seal ring width 5</td><td>A</td><td colspan="3">2.5 ± 0.05 (0.0984 ± 0.0020)</td></tr>
<tr><td>B</td><td colspan="3">2.3 (0.091)</td></tr>
<tr><td rowspan="2">Servo case seal ring groove width 6</td><td>A</td><td colspan="3">2.5 $^{+0.2}_{+0.1}$ (0.0984 $^{+0.0079}_{+0.0039}$)</td></tr>
<tr><td>B</td><td colspan="3">2.9 (0.114)</td></tr>
<tr><td rowspan="2">Servo case inside diameter contacting seal ring 7</td><td>A</td><td colspan="3">30 $^{+0.021}_{0}$ (1.18 $^{+0.0008}_{0}$)</td></tr>
<tr><td>B</td><td colspan="3">30.2 (1.189)</td></tr>
<tr><td colspan="5">
</td></tr>
</table>

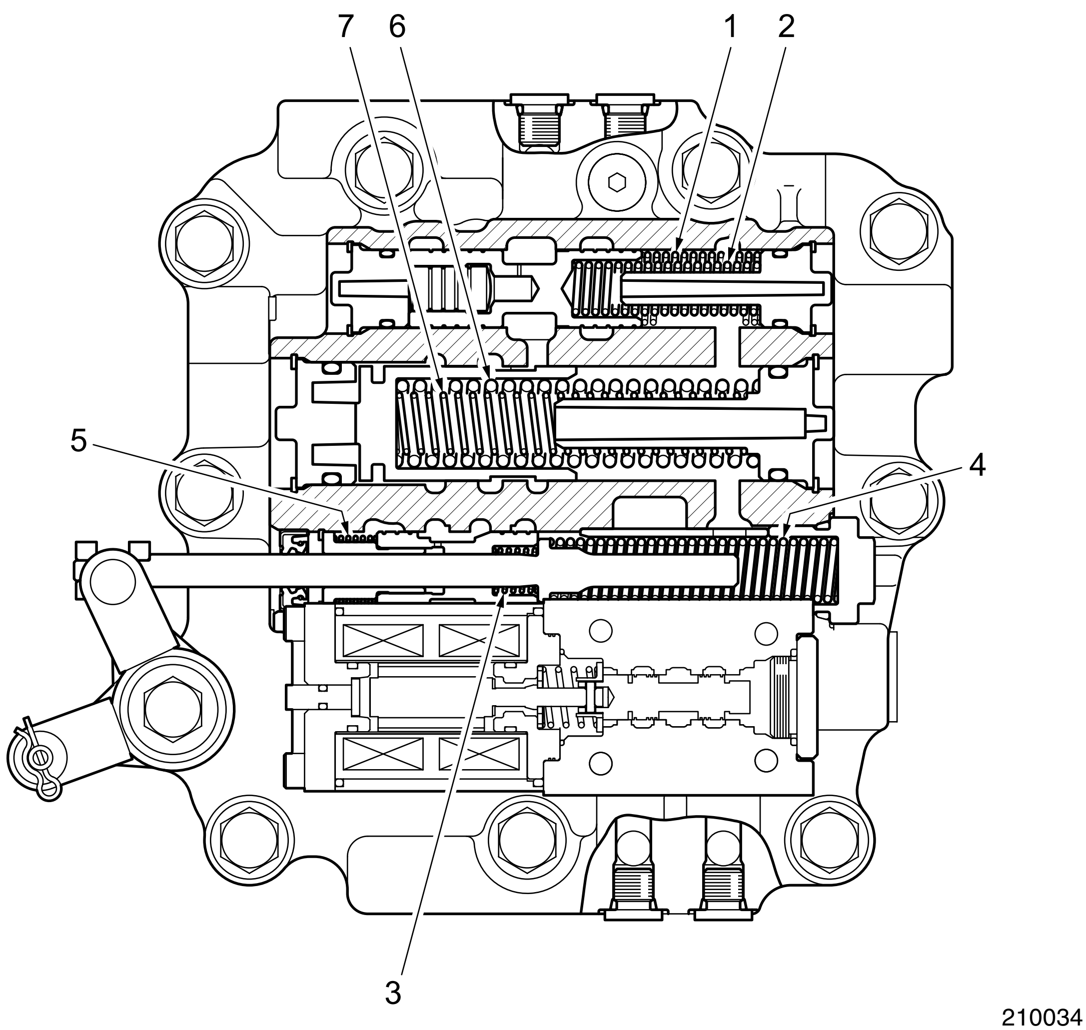
A: Assembly standard B: Repair or service limit
Unit: mm (in.)

Items			1 ton class	2 ton class	3 ton class
Output shaft	Free movement of output flange gear (looseness of mating splines) 1	A	0.054 to 0.14 (0.00213 to 0.0055)		
	210033				
Gear backlash		A	0.12 to 0.28 (0.0047 to 0.0110)		
		B	0.5 (0.020)		
Control valve	Free length of main relief valve spring (inner) 1 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	75 (2.95) [k= 2.112 (0.2154) [12.0525]]		
		B	72 (2.83)		
	Free length of main relief valve spring (outer) 2 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	50 (1.97) [k= 0.838 (0.0855) [4.784]]		
		B	48 (1.89)		
	Free length of clutch valve spring 3 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	36.8 (1.45) [k= 5.883 (0.6003) [33.59]]		
		B	35.5 (1.40)		
	Free length of clutch valve spring 4 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	28 (1.10) [k= 0.478 (0.0488) [2.730]]		
		B	26.5 (1.04)		

A: Assembly standard B: Repair or service limit

Unit: mm (in.)

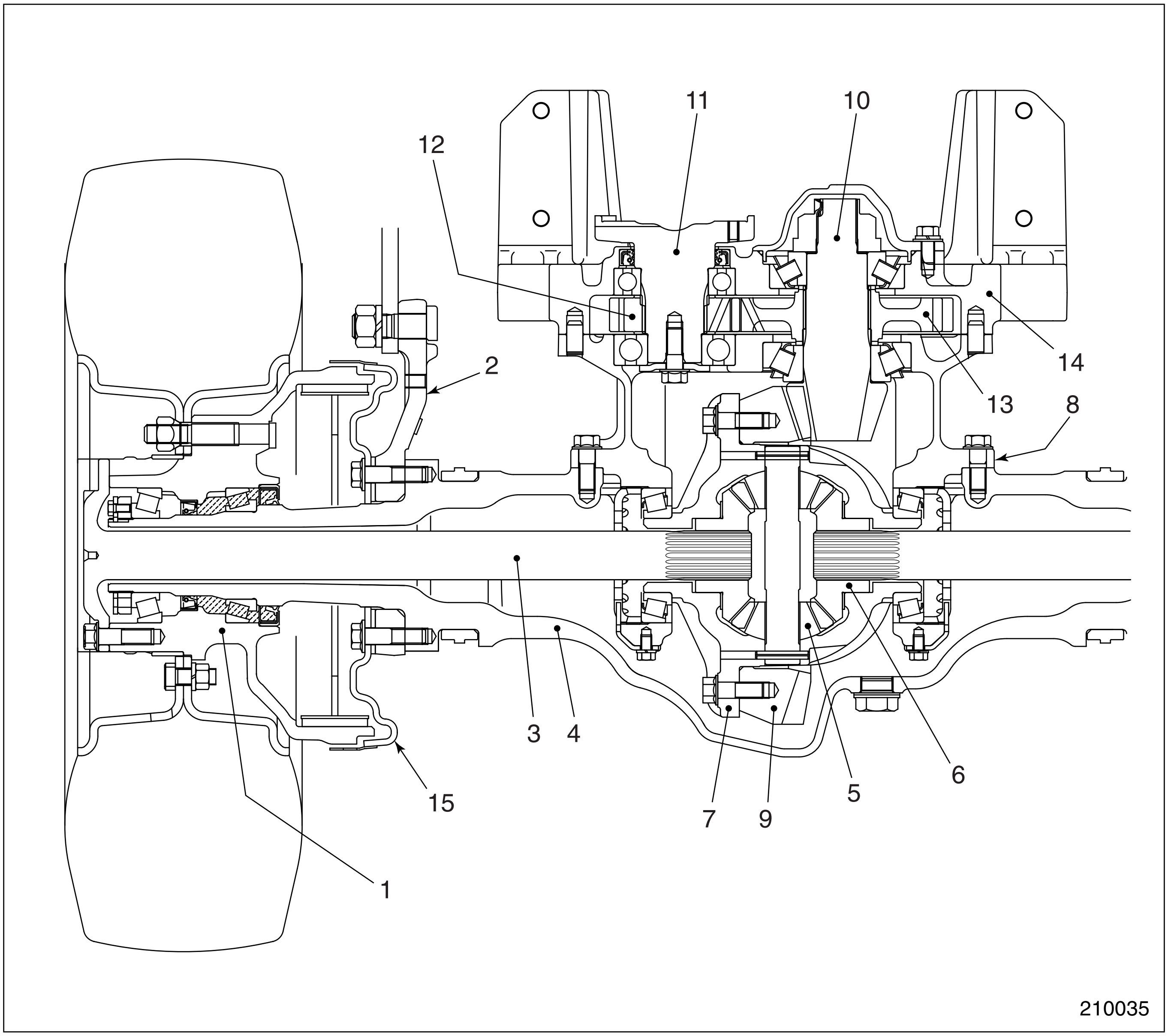
Items	Truck Models		1 ton class	2 ton class	3 ton class
Control valve	Free length of torque converter outlet and inlet regulator valve springs 5 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	25 (0.98) [k= 4.187 (0.427) [23.892]]		
		B	24 (0.94)		
	Free length of accumulator valve spring (inner) 6 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	130 (5.12) [k= 0.597 (0.0609) [3.408]]		
		B	128 (5.04)		
	Free length of accumulator valve spring (inner) 7 Spring constant [k= N/mm (kgf/mm) [lbf/in]]	A	91 (3.58) [k= 7.303 (0.7447) [41.669]]		
		B	89 (3.50)		



FRONT AXLE AND REDUCTION DIFFERENTIAL

Structure

1 Ton Class

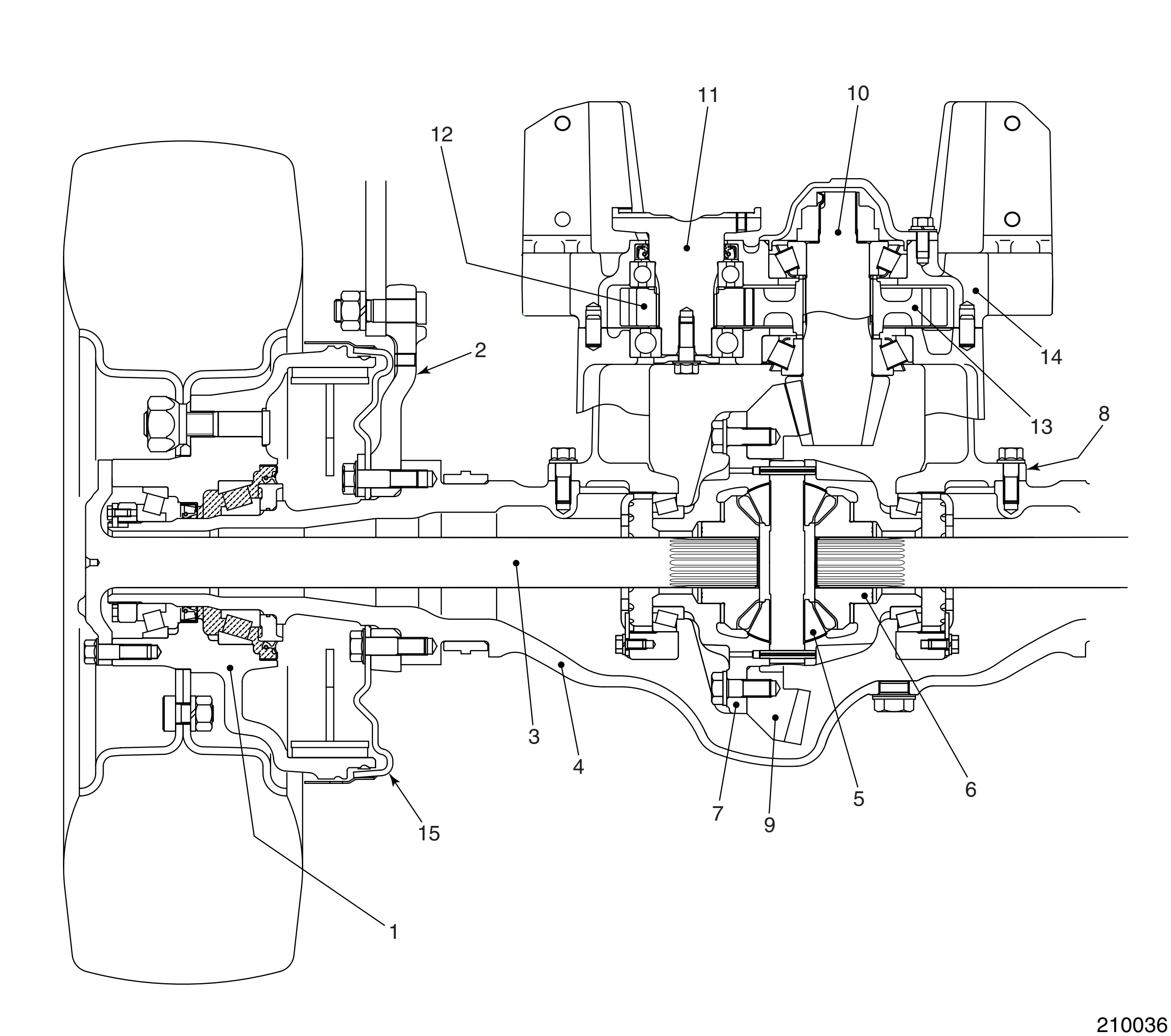


1	Front wheel hub	6	Differential gear	11	Input flange
2	Frame support	7	Differential case	12	Drive gear
3	Axle shaft	8	Differential carrier	13	Driven gear
4	Axle housing	9	Bevel gear	14	Carrier cover
5	Differential pinion	10	Bevel pinion	15	Backing plate

The frame support 2 is bolted to the front axle housing together with the backing plate 15 of the wheel brake assembly. While the front wheel hub 1 carries a single wheel, a double wheel can be mounted on it with optional rim.

The reduction differential is mounted on the front axle housing 4. The input flange 11 carries a drive gear which is in mesh with the driven gear mounted on the bevel pinion 10.

2 Ton Class

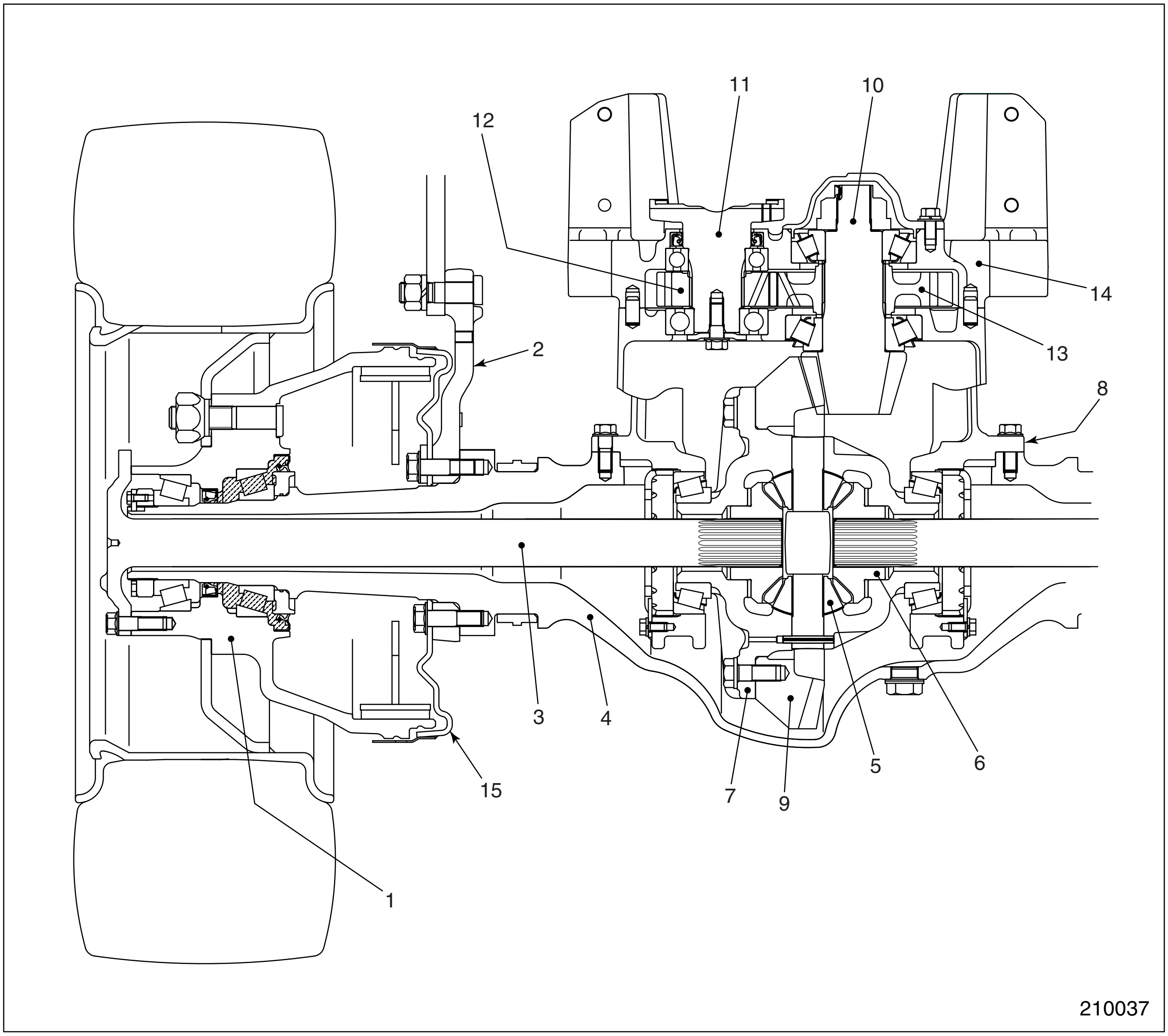


1	Front wheel hub	6	Differential gear	11	Input flange
2	Frame support	7	Differential case	12	Drive gear
3	Axle shaft	8	Differential carrier	13	Driven gear
4	Axle housing	9	Bevel gear	14	Carrier cover
5	Differential pinion	10	Bevel pinion	15	Backing plate

The frame support 2 is bolted to the front axle housing together with the backing plate 15 of the wheel brake assembly. While the front wheel hub 1 carries a single wheel, a double wheel can be mounted on it with optional rim.

The reduction differential is mounted on the front axle housing 4. The input flange 11 carries a drive gear which is in mesh with the driven gear mounted on the bevel pinion 10.

3 Ton Class



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

The frame support 2 is bolted to the front axle housing together with the backing plate 15 of the wheel brake assembly. While the front wheel hub 1 carries a single wheel, a double wheel can be mounted on it with optional rim.

The reduction differential is mounted on the front axle housing 4. The input flange 11 carries a drive gear which is in mesh with the driven gear mounted on the bevel pinion 10.

Removal and Installation

Front Wheels

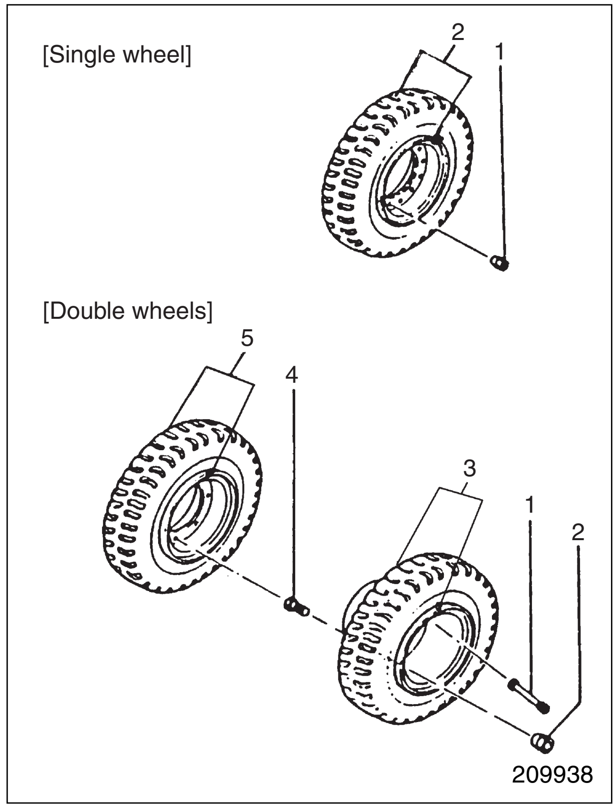
Removal

[Single wheel]

1 Wheel nuts
2 Front wheel

[Double wheels]

1 Extension valve
2 Outer wheel nuts
3 Front wheel (outer)
4 Inner wheel nuts
5 Front wheel (inner)



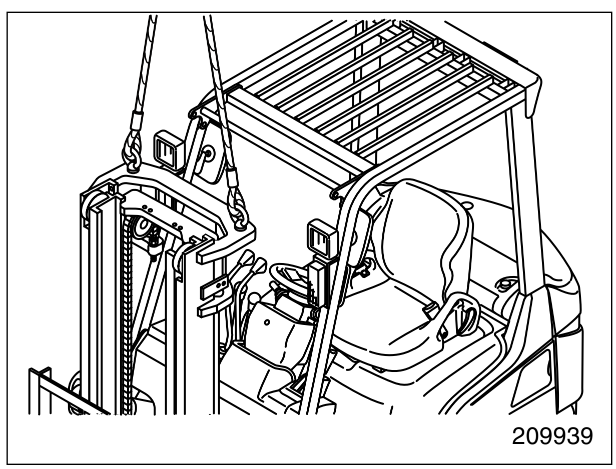
Start by:

(a) Pull the parking brake lever and block the rear wheels.

(b) Loosen the wheel nuts 1 by two turns. Then, raise the front end of the truck using a hoist or the hydraulic system.

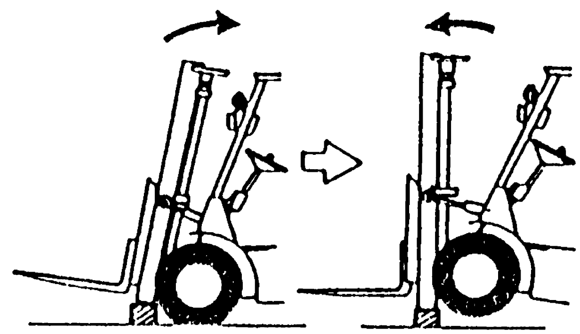
(1) Hoisting

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



(2) Using hydraulic system

Tilt the mast fully backward and place appropriate wood blocks under the mast. Tilt the mast forward back to raise the front end.



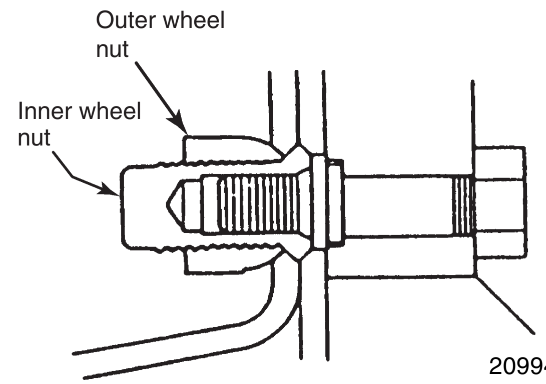
209940

CAUTION

After raising the front end, place wood blocks under the frame to prevent the truck from falling.

Suggestions for Removal

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



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Installation

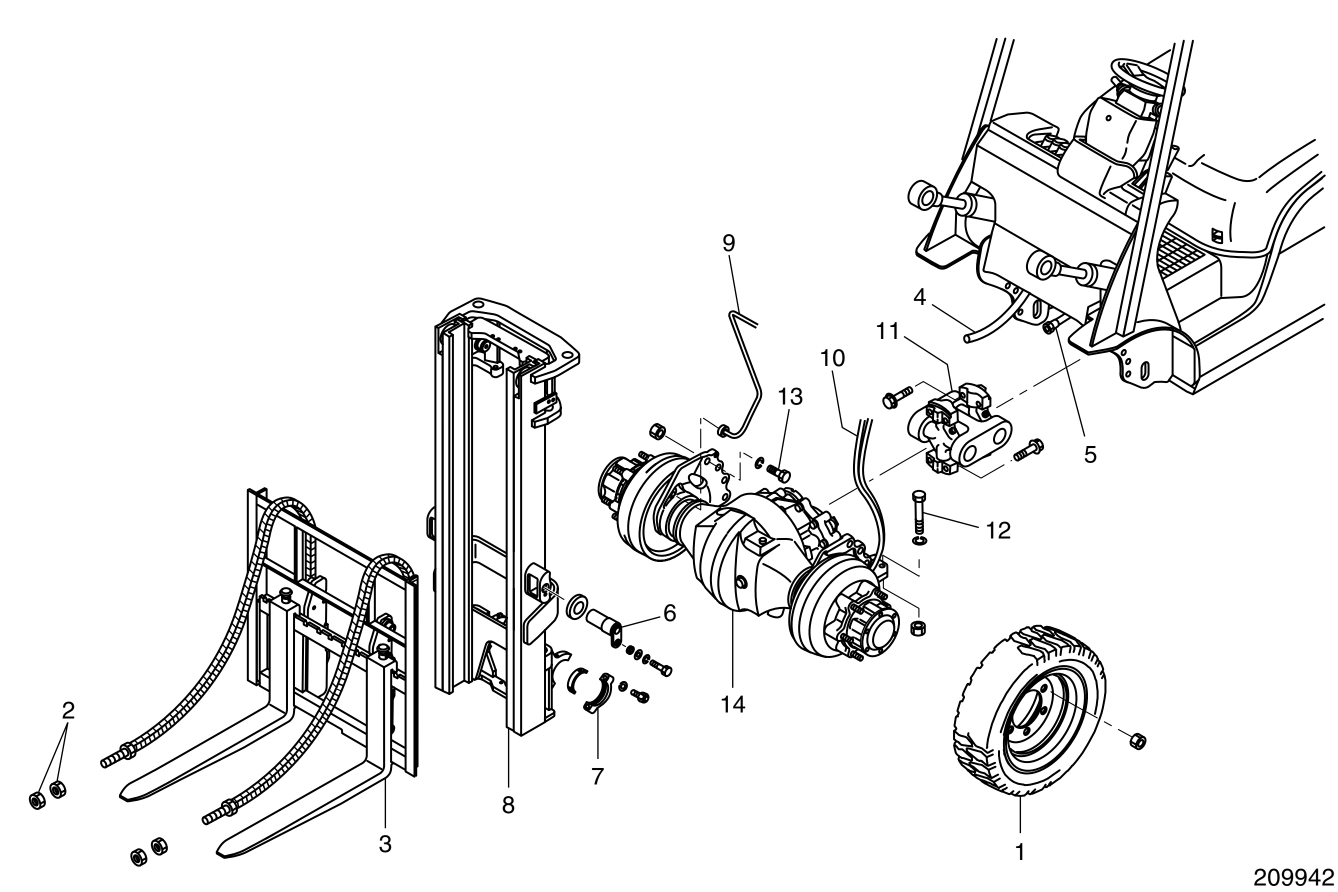
To install, follow the removal sequence in reverse, paying attention to the following points.

(1) Tighten the wheel nuts evenly to the specified torque so that the wheels will not wobble during operation.

Item \ Truck Model	1 ton class	2, 3 ton classes
Tightening torque for wheel nuts N·m (kgf·m) [lbf·ft]	156.9 ± 15.7 (16 ± 1.6) [116 ± 11.6]	377.6 ± 37.8 (38.5 ± 3.9) [279 ± 27.9]

Front Axle and Reduction Differential

Removal



Sequence

1 Front wheel
2 Nuts
3 Fork, Lift bracket
4 Return hose for lift cylinder
5 High-pressure hose for lift cylinder
6 Tilt cylinder socket
7 Mast support bearing cap
8 Mast
9 Brake pipe
10 Parking brake cable
11 Universal joint
12 Bolt, Nut
13 Bolt, Nut
14 Front axle and reduction differential assembly

Note:

(1) For removal of the front wheel 1, refer to "Front Wheels, Removal."

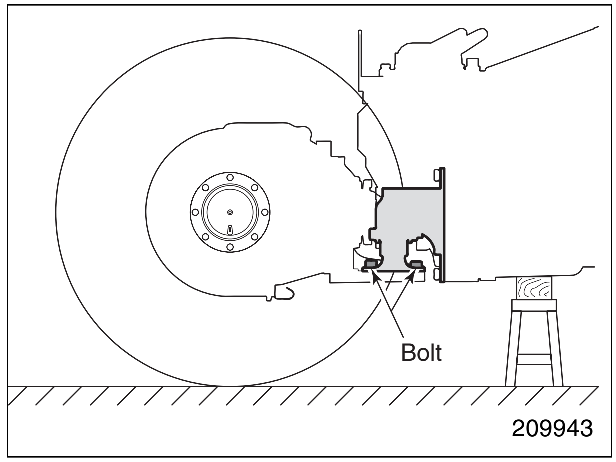
(2) For removal of mast parts 2 through 8, refer to "GROUP 12 MAST AND FORKS."

(3) Before removing the front axle and reduction differential, remove the front axle drain plug and drain transfer and differential oil.

Suggestions for Removal

(1) Removing bolt 12

Bolts 12 are coupling the transmission with the differential. Before removing these bolts, place a wood block under the transmission to support it.



(2) Removing parking brake cable

To remove the parking brake cable, remove the parking brake lever assembly from the dashboard and disconnect the cable from the lever.

Note: To dismount the reduction differential alone, remove the front axle and reduction differential assembly as described above. To dismount the reduction differential after removal of the engine and transmission, the front axle needs not to be removed from the truck.

Installation

To install, follow the removal sequence in reverse, paying attention to the following points.

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

Parking brake lever operating effort	245 to 294 N (25 to 30 kgf) [55 to 66 lbf]

(2) Before installing the mast, bleed the brake fluid circuits of trapped air. For bleeding, refer to "GROUP 9 BRAKE SYSTEM."

(3) After installing the mast, make sure that tilt angles, forward and backward, are correct and that the lift chains, right and left, are equal in tension. Refer to "GROUP 14 MAST AND FORKS "

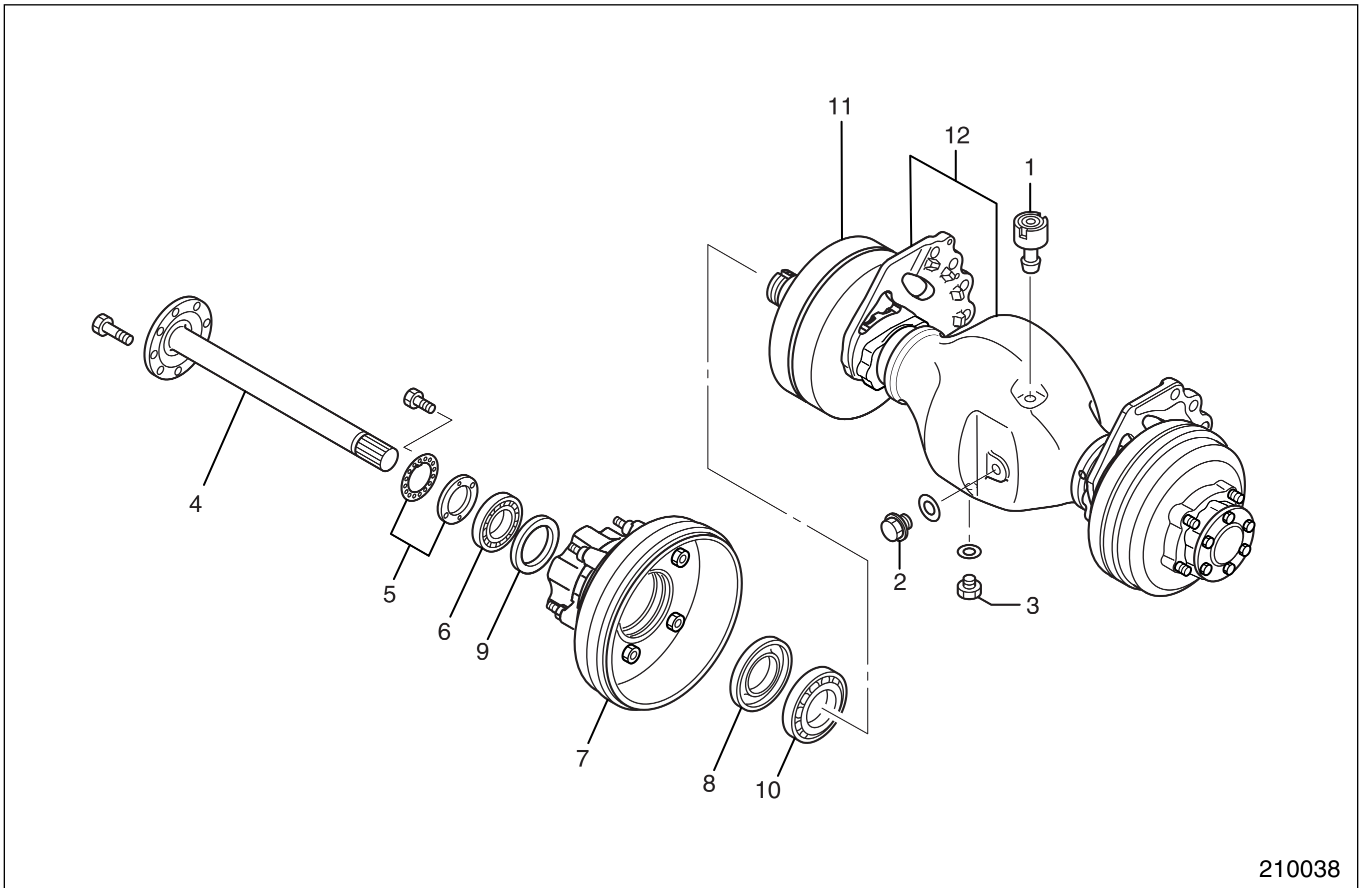
(4) Fill the front axle housing with oil up to the plug hole level.

Truck Model / Item	1 ton class	2, 3 ton classes
Refill capacity of front axle housing	about 4.2 liters (1.1 U.S. gal.)	about 9.0 liters (2.4 U.S. gal.)

Disassembly and Reassembly

Front Axle

Disassembly



Sequence

1	Air bleeder	7	Front wheel hub, Brake drum
2	Level plug	8	Oil seal
3	Drain plug	9	Oil seal
4	Axle shaft	10	Tapered roller bearing
5	Lock ring, Lock nut	11	Brake assembly
6	Tapered roller bearing	12	Frame support, Axle housing

Start by:

(a) Remove the mast. For replacement of the front axle housing and disassembly of the differential, refer to "GROUP 12 MAST AND FORKS."

(b) Jack up the truck.

(c) Support the front end of the truck with blocks or stands at both sides to keep the truck in the horizontal position.

(d) Remove the front wheels.

Note: It is not necessary to remove the axle housing for removing the axle shaft or disassembling the wheel hub.

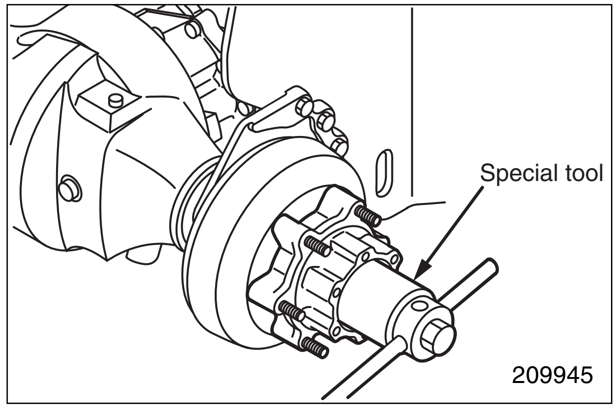
Suggestions for Disassembly

(1) Removing lock nut

Use the lock nut wrench (special tool).

Special tool needed

1 ton class	91268 - 00800
2, 3 ton classes	03703 - 59001



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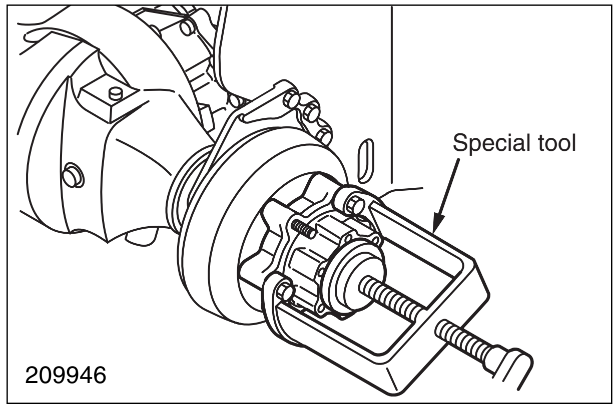
(2) Removing front wheel hub

Use the wheel hub puller (special tool).

Special tool needed

1 ton class	60309 - 40100 (60309 - 10601)
2, 3 ton classes	MH061017

Note: It is not necessary to remove the oil seal from the hub nor disassemble the oil deflector unless the seal is defective.



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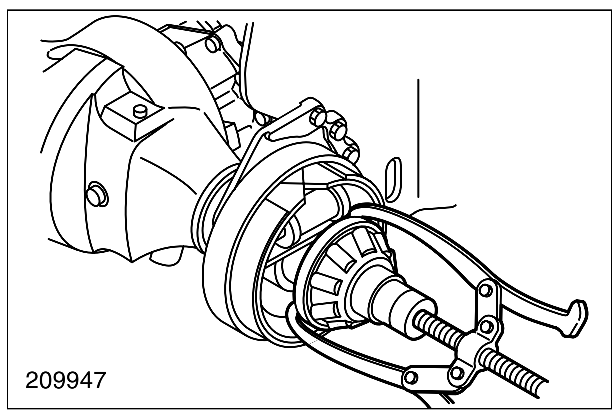
(3) Removing bearings

The inner race of the tapered roller bearing remains in the axle housing when the hub is drawn out. Remove this race together (with the seal retainer) with a bearing puller.

Note: Trucks of 1 ton class do not have the seal retainer.



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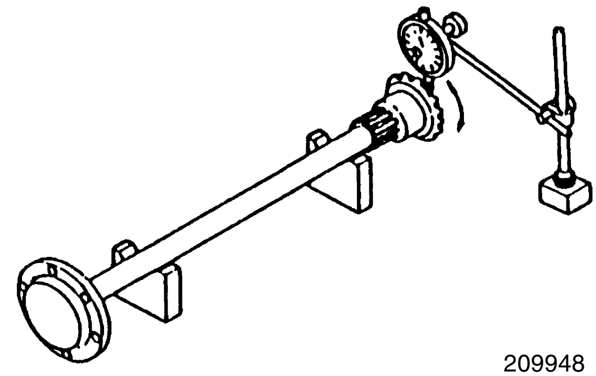
Inspection after Disassembly

(1) Axle shaft

(a) Looseness of mating splines

Mount the differential level gear on the splined end of the shaft and set a dial indicator as shown. Rotate the bevel gear in the direction shown and read the free play (looseness of mating splines).

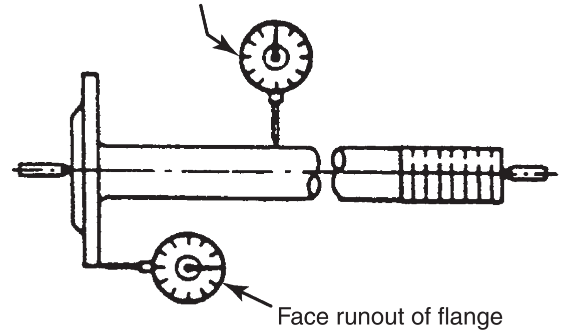

209948

A: Standard value B: Repair or service limit

Free movement (looseness of mating splines)	A	0.07 to 0.15 mm (0.0028 to 0.0059 in.)
	B	0.5 mm (0.020 in.)

(2) Shaft deflection and flange runout

(a) Set a dial indicator at the middle part of the axle shaft. Rotate the shaft and read the dial indicator (deflection of axial shaft).



209949

A: Standard value B: Repair or service limit

Deflection of axle shaft (1/2 of dial indicator reading)	A	0.5 mm (0.019 in.) maximum
	B	1.0 mm (0.039 in.)

(b) Set a dial indicator against the flange of the axle shaft as shown. Rotate the shaft and read the face runout of flange.

A: Standard value B: Repair or service limit

Face runout of axle shaft flange	A	0.08 mm (0.0031 in.)
	B	0.5 mm (0.020 in.)

(3) Axle housing

(a) Check the surfaces of axle housing in contact with the mast bearing for damage.

(b) Check the entire axle housing for distortion, dents and other defects. Pay particular attention to the welds to see if any weld is cracked to require repair.

(4) Others

(a) Check the outer surface of oil seal and retainer for wear or damage.

(b) Check the outer and inner oil seals for wear or damage.

Reassembly

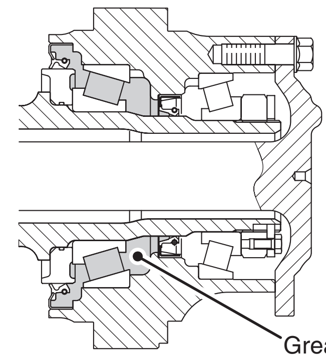
To reassemble, follow the disassembly sequence in reverse, paying attention to the following points.

(1) Front wheel hub

(a) Fill grease (Autolex A or equivalent) in the front wheel hub as shown.

Stuff grease in the roller holder of the tapered roller bearing (inner) using the palm.

Apply grease to the lip groove of oil seal.

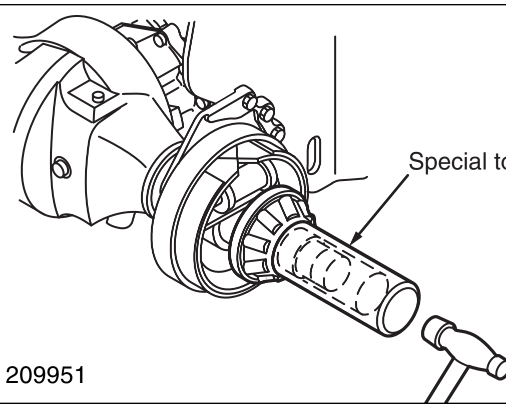


209950

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 wheel hub bearing.

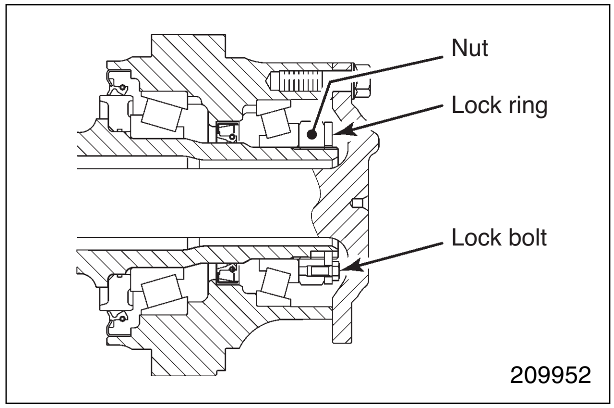


209951

Special tool needed

Item \ Truck Model	1 ton class	2, 3 ton classes
Installer	64309 - 12300	91468 - 00300

(c) Apply sealant (ThreeBond #1104) to the flange surfaces of the axle shaft.



(2) Hub bearing preload adjustment and lock nut

(a) Install the nut hand-tight with a socket wrench (special tool).

Special tool needed

Item \ Truck Model	1 ton class	2, 3 ton classes
Socket wrench	91268 - 10800	03703 - 59001

(b) Rotate the hub and tap its periphery with a soft-head mallet for snug assembling.

(c) Fully tighten the lock nut to obtain hub bearing preload within the specified limits.

Note: To check the hub bearing preload, hook a spring scale on the hub bolt, then pull it to measure the tangential force of the hub bolt.

Unit: N (kgf) [lbf]

	1 ton class	2,3 ton class
Tangential force of hub bolt (increment from when preload is zero)	5.6 to 56 (0.6 to 5.7) [1.2 to 12.5]	4.5 to 45 (0.5 to 4.6) [1.0 to 10.2]
Starting torque of hub rotation (increment from when preload is zero)	0.5 to 5 N·m (0.1 to 0.5 kgf·m) [0.35 to 3.7 lbf·ft]	

(d) Fit the lock ring into place and tighten the lock bolt.

(e) Check the preload again.

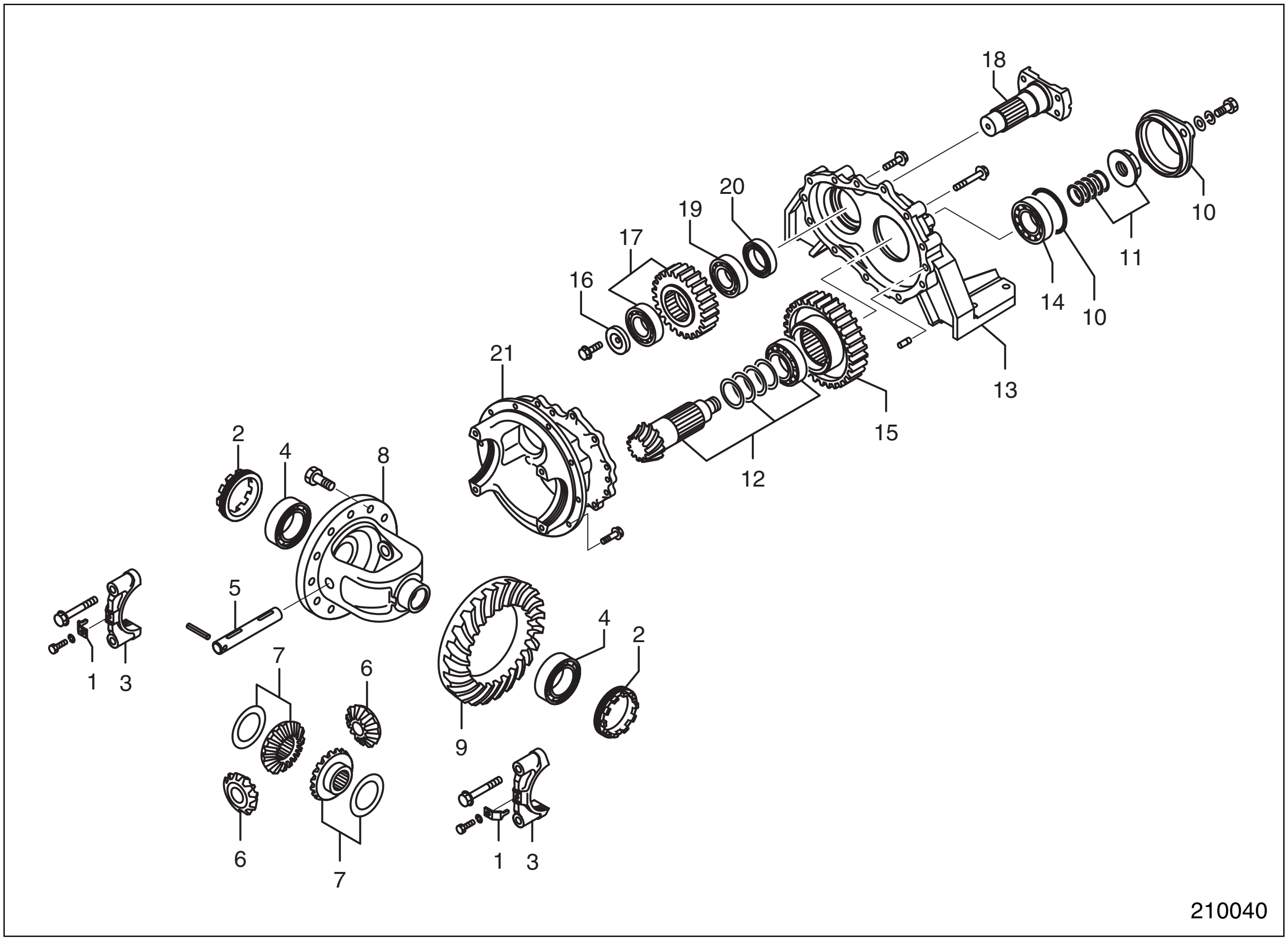
(3) Drain plug

(a) Tighten the drain plug to the specified torque.

Tightening torque	83.4 ± 7.8 N·m (8.5 ± 0.8 kgf·m) [61.5 ± 5.8 lbf·ft]

Reduction Differential

Disassembly



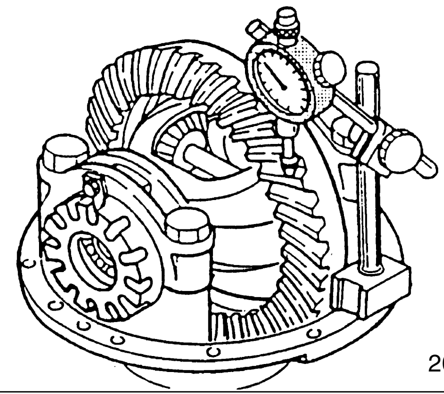
Sequence

1 Lock plate
2 Adjusting screw
3 Bearing cap
Remove parts 4 through 9 as an assembly.
4 Tapered roller bearing
5 Pinion shaft
6 Differential pinion, thrust washer (2.3 ton class)
7 Differential gear, thrust washer
8 Differential case
9 Bevel gear
10 Cover, O-ring
11 Lock nut, Shims
12 Bevel pinion, Tapered roller bearing (inner), Shims
13 Carrier cover
14 Tapered roller bearing
15 Driven gear
16 Plate
17 Drive gear, Ball bearing
18 Input flange
19 Ball bearing
20 Oil seal
21 Differential carrier

Suggestions for Disassembly

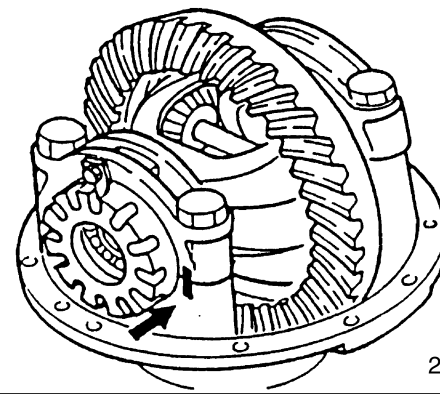
Note: (1) Before disassembling the differential, except for replacement of the reduction gear set, be sure to measure the gear backlash to ensure correct backlash at the time of reassembly.

Item \ Truck Model	1, 2 ton classes	3 ton class
Backlash between reduction gear and reduction pinion	0.20 to 0.28 mm (0.0079 to 0.0110 in.)	0.25 to 0.33 mm (0.0098 to 0.0130 in.)



209954

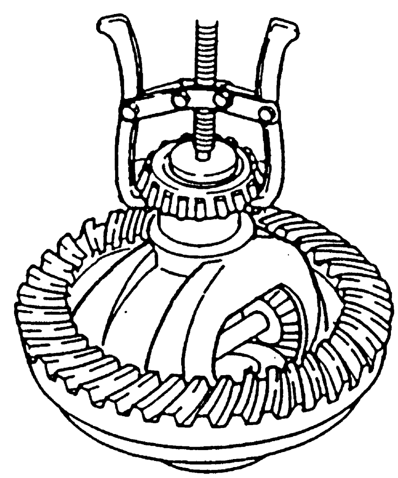
(2) Provide a match mark across the bearing cap, adjusting screw and carrier on each side to ensure correct refitting.



209955

(1) Removing bearing

Use a bearing puller to remove the inner bearing.



209956

(2) Removing shims

After removing the lock nut 11 and shims, check and record the total thickness of the shims. Tie the shims to the lock nut so as not to be lost.

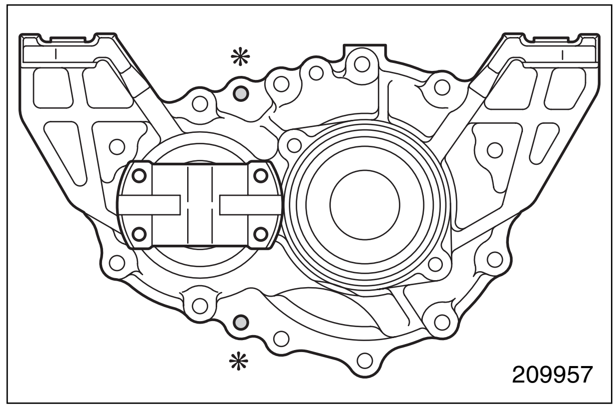
(3) Removing tapered roller bearing

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

(4) Removing carrier cover

Screw jack bolts in two jack bolt holes (at the positions marked ✻) and remove the carrier cover 13 while tapping near dowel pins (2 places) with a plastic mallet.

Jack bolt	Size	M10 × 1.25
	Nominal length	20 mm (0.79 in.)



(5) Checking oil seal

Do not remove the oil seal 20 from the carrier cover 13 unless it is defective.

Inspection and Repair

(1) Reduction bevel gear and pinion

(a) Check the gear and pinion for tooth contact, wear, pitting, flaking and chipping.

(b) Minor flaws on the tooth surfaces can be repaired by grinding with an oil stone or sandpaper.

(c) If the gear and/or pinion is badly damaged, replace them as a set.

(2) Differential

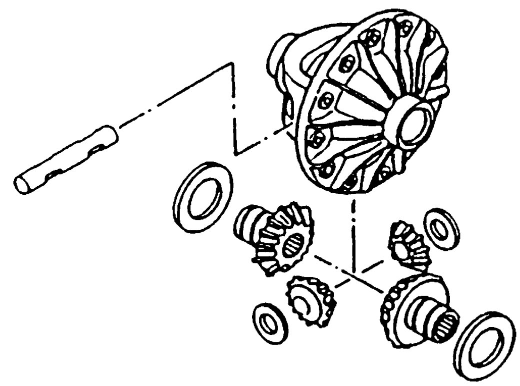
(a) Check the differential case and tapered roller bearing inner race to see if the seat surface is fretted.

(b) Check the differential case for cracks. Check the sliding contact surfaces of thrust washer and gears for wear and damage.

(c) Check the teeth of the differential pinions and gears for wear, pitting, chipping and galling.

(d) Check the pinions (inner surface) and pinion shafts (outer surface) for wear.

(e) Check the differential gears and axle shaft splines for wear and free play (looseness).


209958

A: Standard value B: Repair or service limit

Clearance between pinions and shafts	A	0.03 to 0.07 mm (0.0012 to 0.0028 in.)
	B	0.35 mm (0.0138 in.)

A: Standard value B: Repair or service limit

Free play (looseness) of differential gear and axle shaft splines	A	0.5 mm (0.020 in.)

(3) Drive gear and driven gear

(a) Check the gears for tooth contact, wear, pitting, galling and chipping.

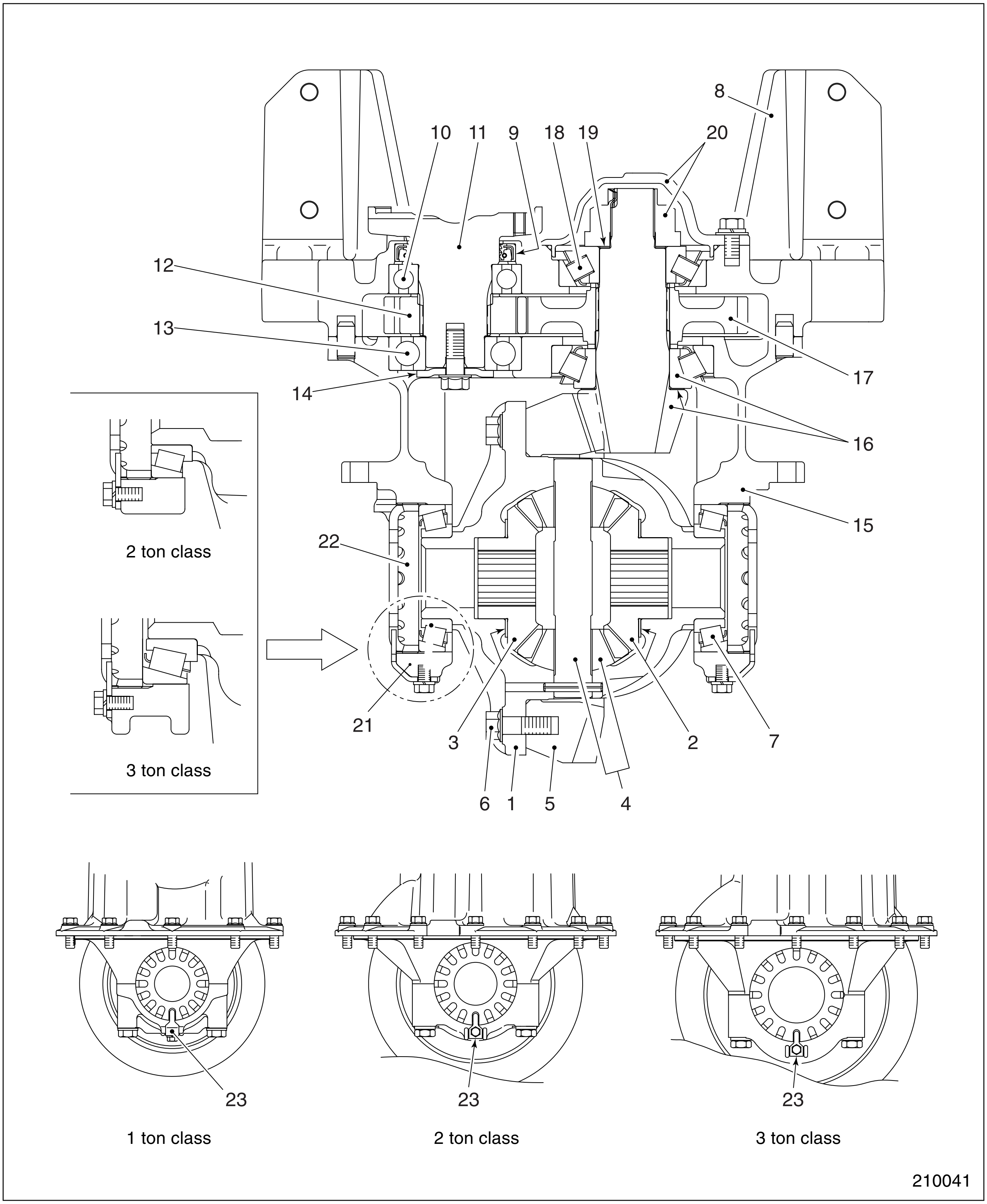
(b) Replace the gears as a set if they are defective.

Note: (1) The combination of drive and driven gears is different between one model of the truck and another.

(2) The combination can be identified by the alphabetical marks A up to F stamped on the side face of the gears.

(3) Before replacing the gears, always check the marks to make sure of the correct combination.

Reassembly


8
10
11
9
18
19
20
12
13
17
14
16
15
22
2 ton class
3 ton class
21
3
2
7
6
1
5
4
23
23
23
1 ton class
2 ton class
3 ton class
210041

Sequence

1 Differential case
2 Differential gear, Thrust washer
3 Differential gear, Thrust washers
4 Differential pinion, Pinion thrust washer (2, 3 ton classes), Pinion shaft, Spring pin
5 Bevel gear
6 Bolt
7 Tapered roller bearing
8 Carrier cover
9 Oil seal
10 Ball bearing
11 Input flange
12 Drive gear
13 Ball bearing
14 Plate
15 Differential carrier
16 Bevel pinion, Shims, Tapered roller bearing (inner)
17 Driven gear
18 Tapered roller bearing
19 Shims
20 O-ring, Cover
21 Bearing cap
22 Adjusting screw
23 Lock plate

Suggestions for Reassembly

(1) Reassembling differential pinions

For adjusting the backlash between the differential gears and pinions, use the thrust washers of the differential gears.

Measure the backlash and if it exceeds the standard value, replace the thrust washers.

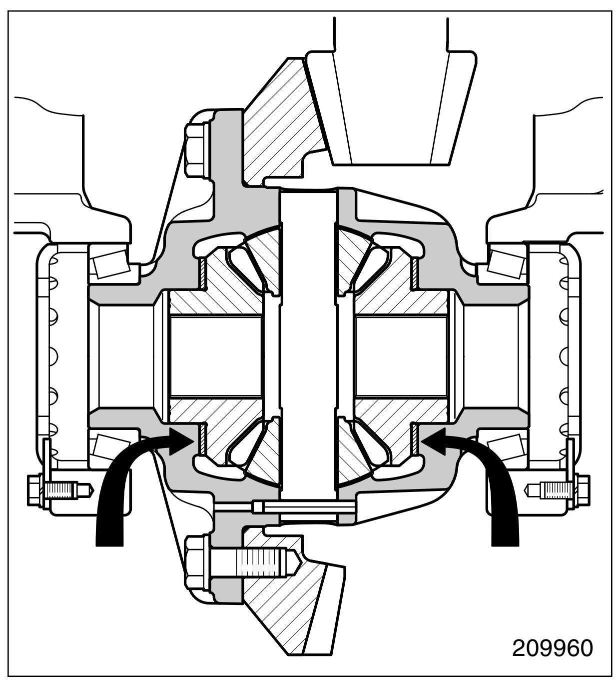
A: Standard value

Item \ Truck Model		1 ton class	2, 3 ton classes
Backlash mm (in.)	A	0.16 to 0.30 (0.0063 to 0.0118)	0.15 to 0.25 (0.0059 to 0.0098)

(2) Installing reduction gear

To install the bevel gear 2 to the differential case 1, apply LOCTITE No. 271 to the threads of bolts 3 and tighten the bolts to the specified torque.

Item \ Truck Model	1 ton class	2, 3 ton classes
Tightening torque	118 ± 9.8 N·m (12 ± 1.0 kgf·m) [87 ± 7.2 lbf·ft]	226 ± 9.8 N·m (24 ± 1.0 kgf·m) [167 ± 7.2 lbf·ft]



(3) Installing differential case assemblies

Place the case assembly on the carrier, and tighten cap bolts snugly to fit the bearing caps but do not torque at this time.

(4) Installing bearing caps

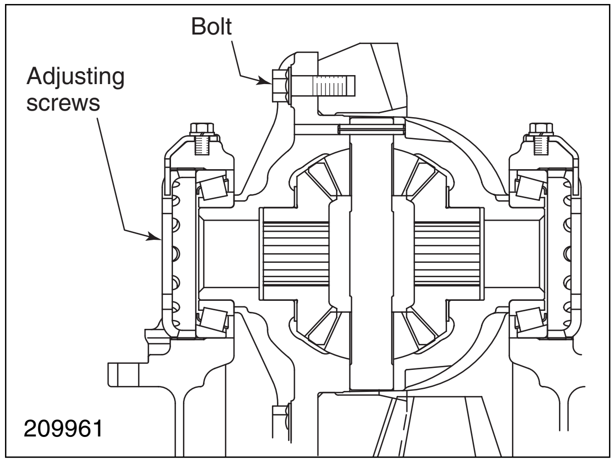
The bearing cap and differential carrier are parts machined in one process. Be sure to identify the left and right caps by match marks and install them in place.

(5) Adjusting bearing preload

(a) Rotate the reduction gear by hand, and tap its back side with a soft-head mallet for snug assembling.

(b) Hook a spring scale on the bolt 3, and pull it in the tangential direction to read the force when the gear starts rotating (preload for the bearing).

(c) Adjust the preload by means of the right and left adjusting screws.



209961

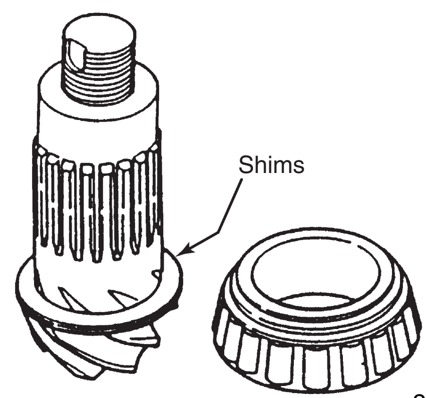
Item \ Truck Model	1,2 ton class	3 ton classes
Preload	14.7 to 29.4 N (1.5 to 3.0 kgf) [3.3 to 6.6 lbf]	12.8 to 24.5 N (1.3 to 2.5 kgf) [2.9 to 5.5 lbf]

(6) Removing differential cases

The preload can be determined by doing the steps (1) through (5) above. Provide match marks across the adjusting screws and bearing caps, and remove the differential cases from the carrier.

(7) Shimming reduction pinion

Refer to page 7-23.



209962

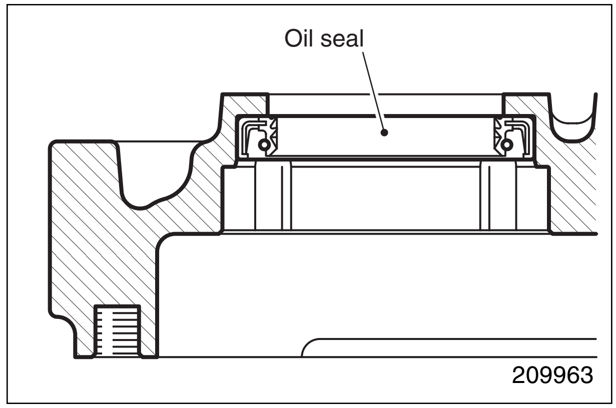
(8) Installing oil seal

Using the installer (special tool), fit the oil seal 12 in the carrier cover 11.

Special tool needed

Installer	91268 - 14200

Note: Be sure that the lip of oil seal faces in the right direction.



(9) Applying grease to oil seal

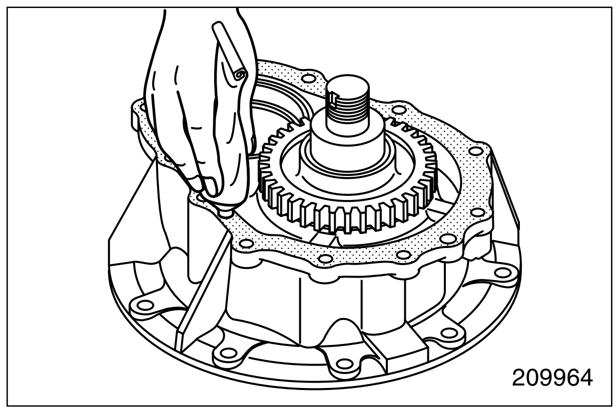
Apply grease to the oil seal installed to the carrier cover 11.

Specified grease	LG2

(10) Applying sealant

When fitting the carrier cover 11 to the differential carrier 8, apply sealant to the flange.

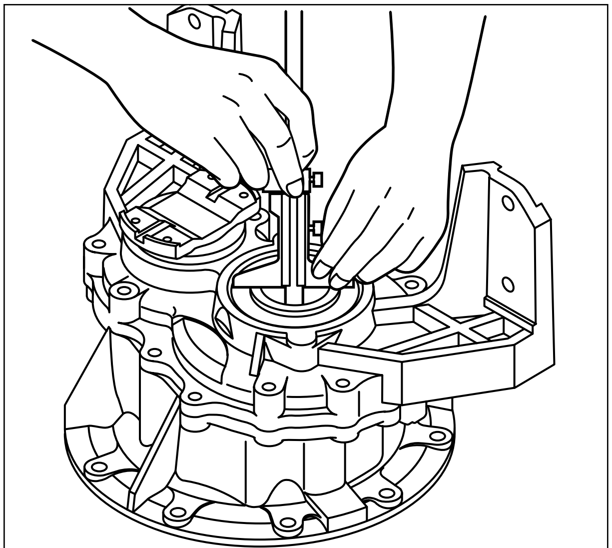
Sealant	ThreeBond #1104



(11) Adjusting reduction pinion preload

(a) After installing the tapered roller bearing 20, measure gap between the reduction pinion and tapered roller bearing to determine the required total shim thickness. The standard value of total shim thickness is 1.25 mm (0.049 in.).

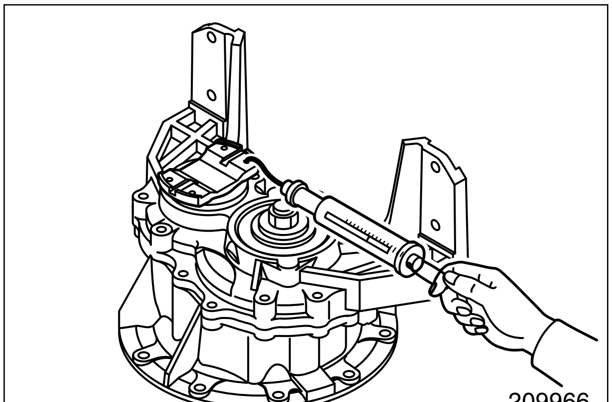
(b) Five different thicknesses of shims are available - 0.05 mm (0.0020 in.), 0.1 mm (0.0039 in.), 0.2 mm (0.0079 in.), 0.5 mm (0.020 in.) and 1.0 mm (0.0394 in.). Use appropriate shims and tighten the plate 17.



209965

(c) Hook a spring scale onto the bolt hole of the input flange, and pull it in the tangential direction to check the preload for the tapered roller bearing (the force when the flange starts rotating). Adjust the preload by increasing or decreasing the shims.

Tangential force (spring scale reading)	34.32 to 49.03 N (3.5 to 5.0 kgf) [7.7 to 11.0 lbf]



209966

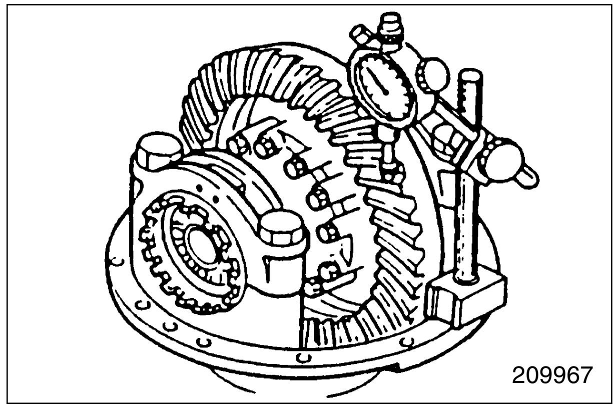
(12) Adjusting reduction gear and reduction pinion tooth contact

(a) After checking the reduction pinion preload, put the differential carrier upside down.

(b) Install the differential cases (removed at Step 6) to the carrier. Align the match marks on the bearing caps and adjusting screws on each side.

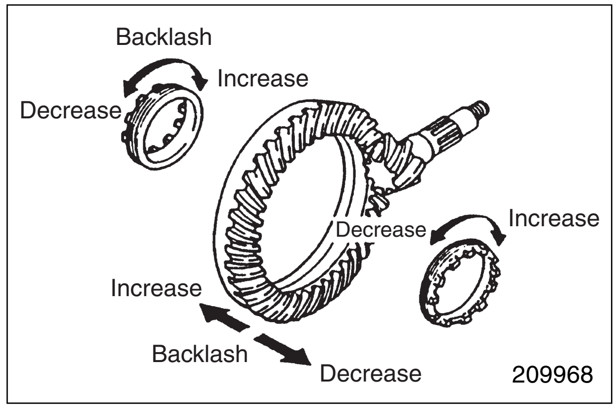
(c) Using the adjusting screws, adjust the backlash between the reduction gear and pinion.

Set a dial gauge with its probe at a right angle to the tooth face of the reduction gear as shown. Turning the gear back and forth, read the tangential play of the gear.



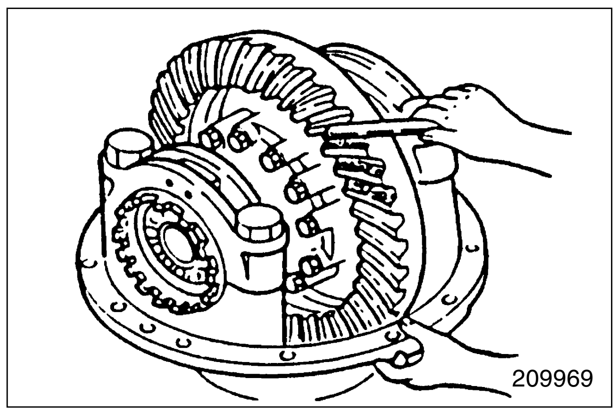
Item \ Truck Model	1 ton class	2, 3 ton class
Backlash of reduction bevel gear with pinion	0.20 to 0.28 (0.0078 to 0.0110)	0.25 to 0.33 (0.0098 to 0.0130)

(d) When adjusting the backlash, turn the adjusting screws, right and left, equally in the same direction so as not to affect the bearing preload.



(e) Apply a thin and even coat of colorant to a few reduction gear teeth, on both drive and coast sides. Rotate the reduction gear back and forth by hand until a contact pattern is located on both sides of the gear teeth.

Note: Refer to “Tooth Contact Patterns and Adjustment” on page 7-24.



(13) Tightening bearing caps

After checking the tooth contact, tighten the bearing cap bolts to the specified torque.

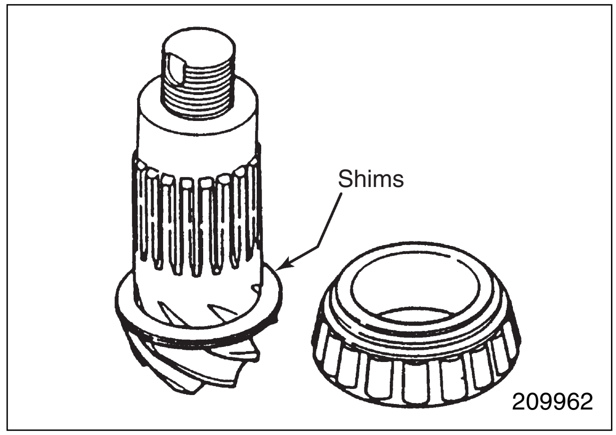
Item \ Truck Model	1 ton class	2, 3 ton classes
Tightening torque for bearing cap bolts	157 ± 5.9 N·m (16 ± 0.6 kgf·m) [116 ± 4.4 lbf·ft]	235 ± 6.8 N·m (24 ± 0.7 kgf·m) [173 ± 5.0 lbf·ft]

Adjustment

Adjusting reduction gear tooth contact

After the reduction gear and pinion have been replaced, adjust the tooth contact as follows.

(1) Determine the required total shim thickness by calculating on the basis of machining error marked on the end face of the reduction pinion as follows. Install the determined total thickness of shims and install the reduction gear and pinion.



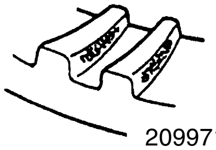
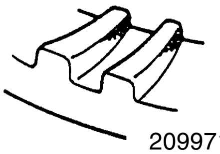
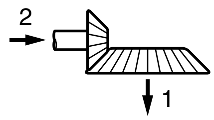
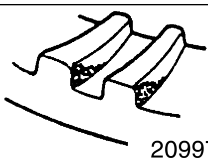
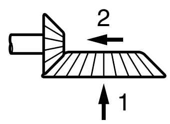
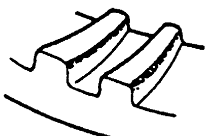
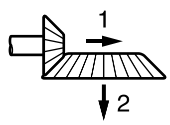
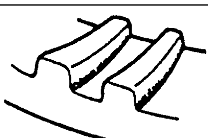
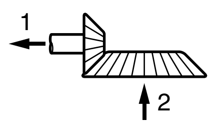
Total shim thickness required =
Standard value – (machining error)

(Example)
If the error is –0.10 mm (–0.004 in.), the total shim thickness is 0.9 mm (0.035 in.)

0.8 mm (0.031 in.) – (–0.1 mm (–0.004 in.) =
0.8 mm (0.031 in.) + 0.1 mm (0.004 in.) =
0.9 mm (0.035 in.)

(2) If the tooth contact of the gears assembled according to the reduction differential reassembling sequence is improper, adjust it as follows.

Tooth Contact Patterns and Adjustment

	Tooth contact		Adjustment	
1	 209971-1	Extends from toe to middle portion, covering 50% or more of tooth length.	Correct tooth contact	
2	 209971-2	Short contact at toe of tooth (Toe)	 209971-6	1. Move gear away from pinion. 2. Move pinion toward gear for correct backlash by increasing shim thickness.
3	 209971-3	Short contact at heel of tooth (Heel)	 209971-7	1. Move gear toward pinion. 2. Move pinion away from gear for correct backlash by decreasing shim thickness.
4	 209971-4	Heavy contact on face or top half (addendum) of tooth (Face)	 209971-8	1. Move pinion toward gear by increasing shim thickness. 2. Move gear away from pinion for correct backlash.
5	 209971-4	Heavy contact on bottom half (dedendum) of tooth (Flank)	 209971-9	1. Move pinion away from gear by decreasing shim thickness. 2. Move gear toward pinion for correct backlash.

Note: For “Toe” or “Heel” contact, see the contact pattern on the outside (convex) of the reduction gear tooth. In the case of “Face” or “Flank” contact, repeat the above adjustment until the correct tooth contact is obtained.

Troubleshooting

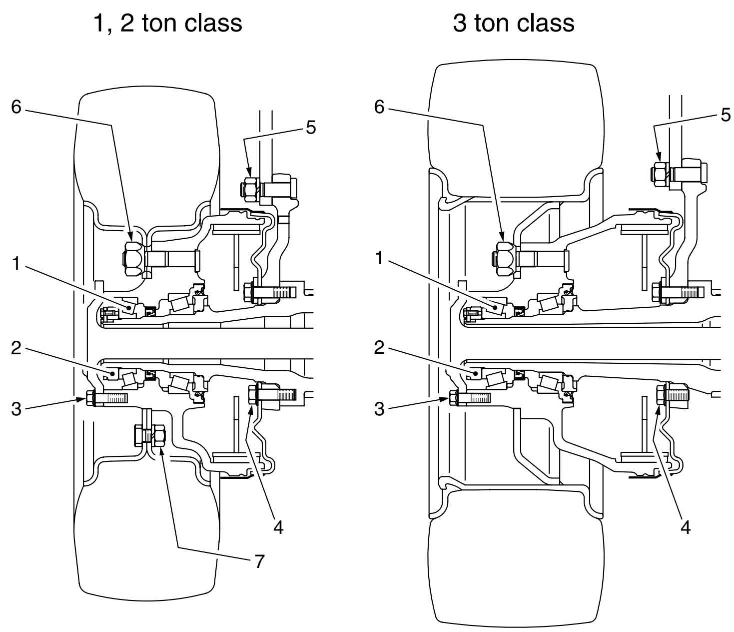
Symptom	Cause	Remedy
Gear noise comes out continuously during traveling	Reduction bevel gear teeth badly worn	Replace.
	Bearing preload too much or too little, or bearings worn excessively	Readjust or replace.
	Hub bearings damaged	Replace.
	Improper tooth contact between reduction bevel pinion and reduction gear	Readjust.
Irregular noise comes out during traveling	Reduction taper roller bearings or hub bearings broken	Replace.
	Differential gears having broken teeth, or thrust washers worn	Replace gears or washers.
	Foreign substance in axle housing	Clean and replace oil.
	Bolts securing axle shaft or differential carrier	Retighten.
Abnormal noise comes out when turning a corner	Fit of differential gears in differential case out of specification due to wear	Replace worn parts.
	Differential gear teeth broken or seized on spider, or damaged by wear gear or pinions.	Replace defective parts.
Overheated reduction case after traveling	Bearings damage due to excessive preload	Replace bearings and readjust preload.
	Backlash between reduction bevel pinion (on output shaft) and reduction bevel gear too small	Readjust tooth contact and backlash.

Service Data

A: Standard value B: Repair or service limit

Unit: mm (in.)

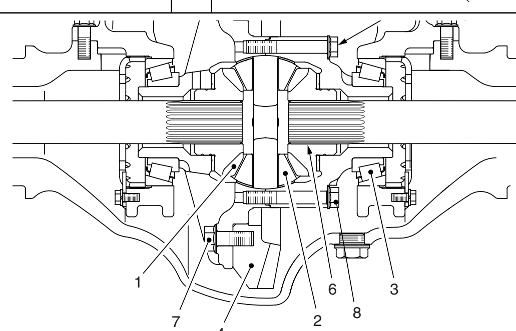
Items				1 ton class	2 ton class	3 ton class
Hub and wheels	Face runout of axle shaft flange		A	0.08 (0.0031)		
			B	0.5 (0.020)		
	Axle shaft runout (1/2 of gauge reading)		A	0.5 (0.02), maximum		
			B	1.0 (0.04)		
	Tangential force of hub bolt 1 (increment from when preload is zero) N (kgf) [lbf]		A	5.6 to 54 (0.6 to 5.7) [1.2 to 12.5]	4.5 to 45 (0.5 to 4.6) [1.0 to 10.2]	
	Starting torque of hub rotation (increment from when preload is zero) N (kgf) [lbf]			0.5 to 5 (0.1 to 0.5) [0.35 to 3.7]		
	Tightening torque of backing plate mounting bolts 4 N·m (kgf·m) [lbf·ft]		A	146 ± 15 (14.9 ± 1.5) [107 ± 11.1]	213 ± 21.3 (21.7 ± 2.2) [157 ± 15.7]	
	Tightening torque N·m (kgf·m) [lbf·ft]	Hub bearing lock nuts (outer) 2	A	196 ± 20 (20 ± 2) [145 ± 14.5]		
		Axle shaft bolts 3	A	98 ± 9.8 (8.8 ± 0.9) [64 ± 6.4]		
		Axle support bolts 5	A	378 ± 38	(38.5 ± 3.9)	[278 ± 27.8]
		Rim bolts 6	A	86 (8.8) [64]	202 (20.6) [149]	-
		Wheel nuts 7	A	157 (16) [116]	378 (38.5) [278]	



210042

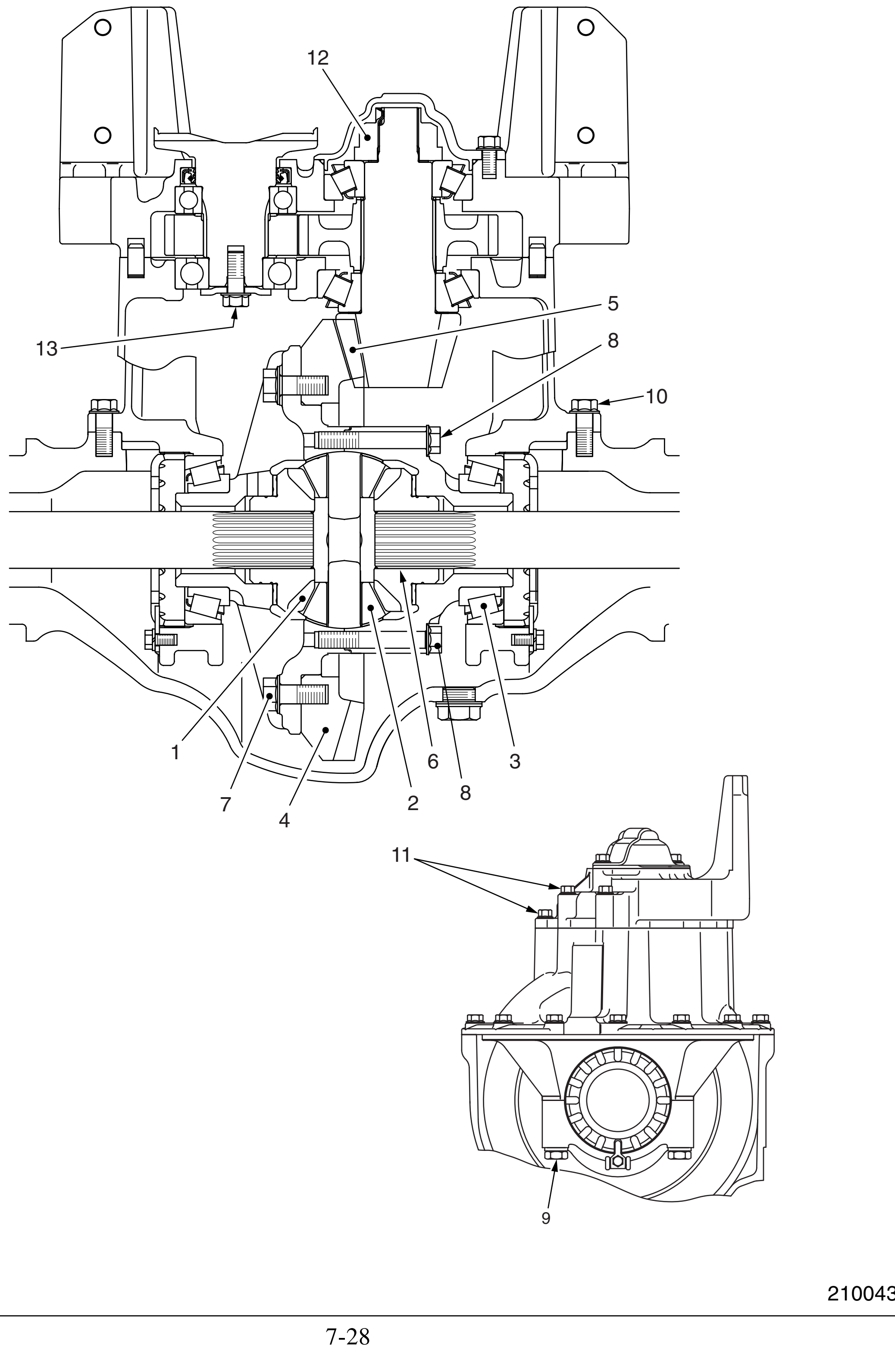
A: Standard value B: Repair or service limit
Unit: mm (in.)

Items				1 ton class	2 ton class	3 ton class
Reduction differential	Backlash of reduction differential gear 1		A	0.16 to 0.30 (0.0063 to 0.0118)	0.15 to 0.25 (0.0059 to 0.0098)	
			B	0.5 (0.020)		
	Clearance between differential pinion and spider 2		A	0.02 to 0.07 (0.0007 to 0.0028)	0.02 to 0.09 (0.0007 to 0.0035)	
			B	0.35 (0.0138)		
	Preload for differential case side bearing 3 N (kgf) [lbf]		A	14.7 to 29.4 (1.5 to 3.0) [3.3 to 6.6]		12.8 to 24.5 (1.3 to 2.5) [2.9 to 5.5]
	Face runout of reduction bevel gear 4		A	0.05 (0.0019)	0.15 (0.0059)	
			B	0.05 (0.0019)	0.15 (0.0059)	
	Backlash of reduction bevel gear and pinion 5		A	0.20 to 0.28 (0.0079 to 0.0110)		0.25 to 0.33 (0.0098 to 0.0130)
	Free play of gear and shaft spline 6		A	0.07 to 0.15 (0.0028 to 0.0059)		
			B	0.5 (0.020)		
	Tightening torque of reduction bevel gear mounting bolts 7 N·m (kgf·m) [lbf·ft]		A	118 ± 9.8 (12 ± 1.0) [87 ± 7.2]	226 ± 9.8 (24 ± 1.0) [167 ± 7.2]	
	Tightening torque of differential case mounting bolts 8 N·m (kgf·m) [lbf·ft]		A	—		123 (12.5) [90.7]
	Tightening torque of side bearing cap bolts 9 N·m (kgf·m) [lbf·ft]		A	157 ± 5.9 (16 ± 0.6) [116 ± 4.4]	235 ± 6.8 (24 ± 0.7) [173 ± 5.0]	
	N·m (kgf·m) [lbf·ft]	Carrier bolts 10	A	108 ± 9.8 (11 ± 1.1) [79.7 ± 7.9]		
		Differential carrier cover bolts 11	A	33.9 ± 6.9 (3.5 ± 0.7) [25 ± 0.5]		
		Mount bolts 12	A	78 ± 7.8 (8 ± 0.8) [58 ± 5.8]		
		Lock nut 13	A	294 ± 20 (30 ± 2) [217 ± 14]		
		Input flange bolts 14	A	108 ± 9.8 (11 ± 1.1) [79.1 ± 7.9]		



210043

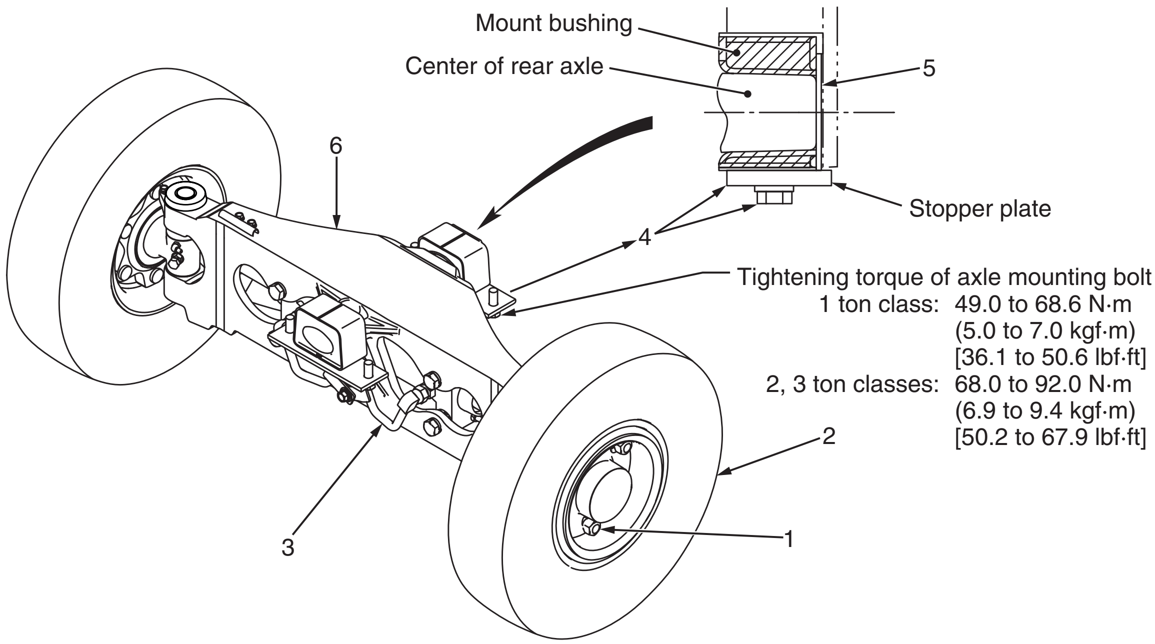
Unit: mm (in.)

Items / Truck Models		1 ton class	2 ton class	3 ton class
Reduction differential				

REAR AXLE

Structure and Functions

Rear Axle in General



Main Components

1 Wheel bolt
2 Wheel hub
3 Steering cylinder tube
4 Bolt, stopper plate
5 Rubber shim (rear of vehicle only)
6 Rear axle main unit

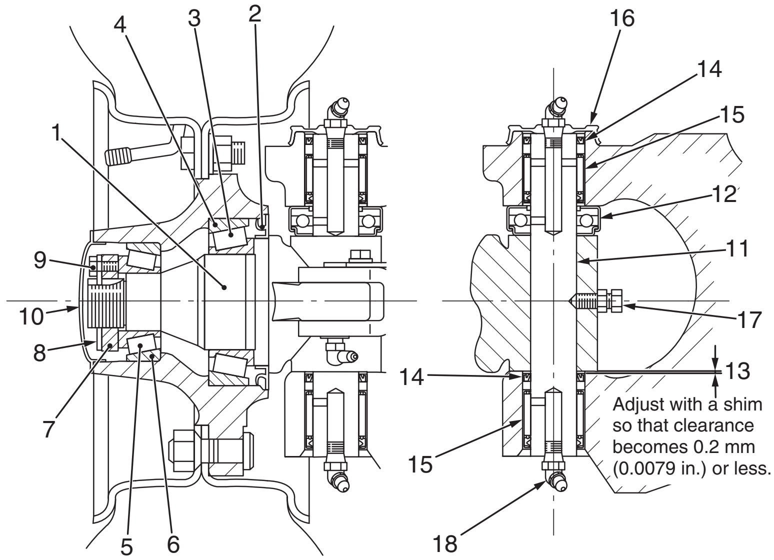
Specifications for wheel alignment and steering angle

Items \ Truck Model	1 ton class	2 ton class	3 ton class
King pin inclination angle	0°	0°	0°
Camber angle	0°	0°	0°
Caster angle	0°	0°	0°
Toe angle	0°	0°	0°
Maximum steering angle of inner wheel A	82.5°	80.6°	80.6°
Maximum steering angle of outer wheel B	57.3°	55.0°	55.0°

Items \ Truck Model	1 ton class	2 ton class	3 ton class
Distance between king pins C mm (in.)	740 (29)	818 (32)	818 (32)
Tread D mm (in.)	900.5 (35.5)	977.5 (38.5)	980.5 (38.6)
Stroke E mm (in.)	83.5 (3.29)	98.5 (3.88)	98.5 (3.88)
Wheel bolt size F	M14 × 1.5	M14 × 1.5	M16 × 1.5

Note: The steering angle is automatically determined by stroke of the steering cylinder. It is not so structured as to be changed by adjustment.

Structure of Each Component



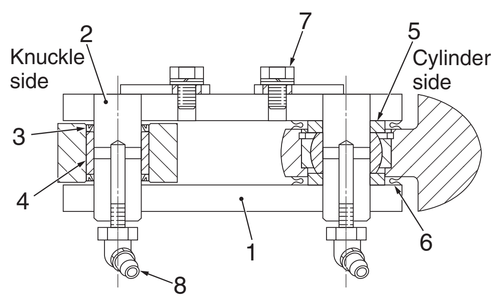
Detail of wheel hub

Detail of left-side king pin

209686

Main components of wheel hub

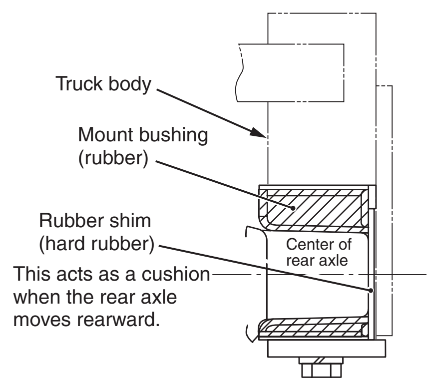
1 Spindle of knuckle
2 Oil seal
3 Bearing cone (inner race)
4 Cup (outer race)
5 Bearing cone (inner race)
6 Cup (outer race)
7 Nut (hexagon nut)
8 Lock plate
9 Bolt
10 Hub cup
11 Left-side king pin
12 Thrust bearing
13 Shim (for adjusting clearance)
14 Dust seal
15 Needle bearing
16 King pin cover
17 Bolt, Nut (for securing king pin)
18 Grease nipple



Detail of tie rod

209688

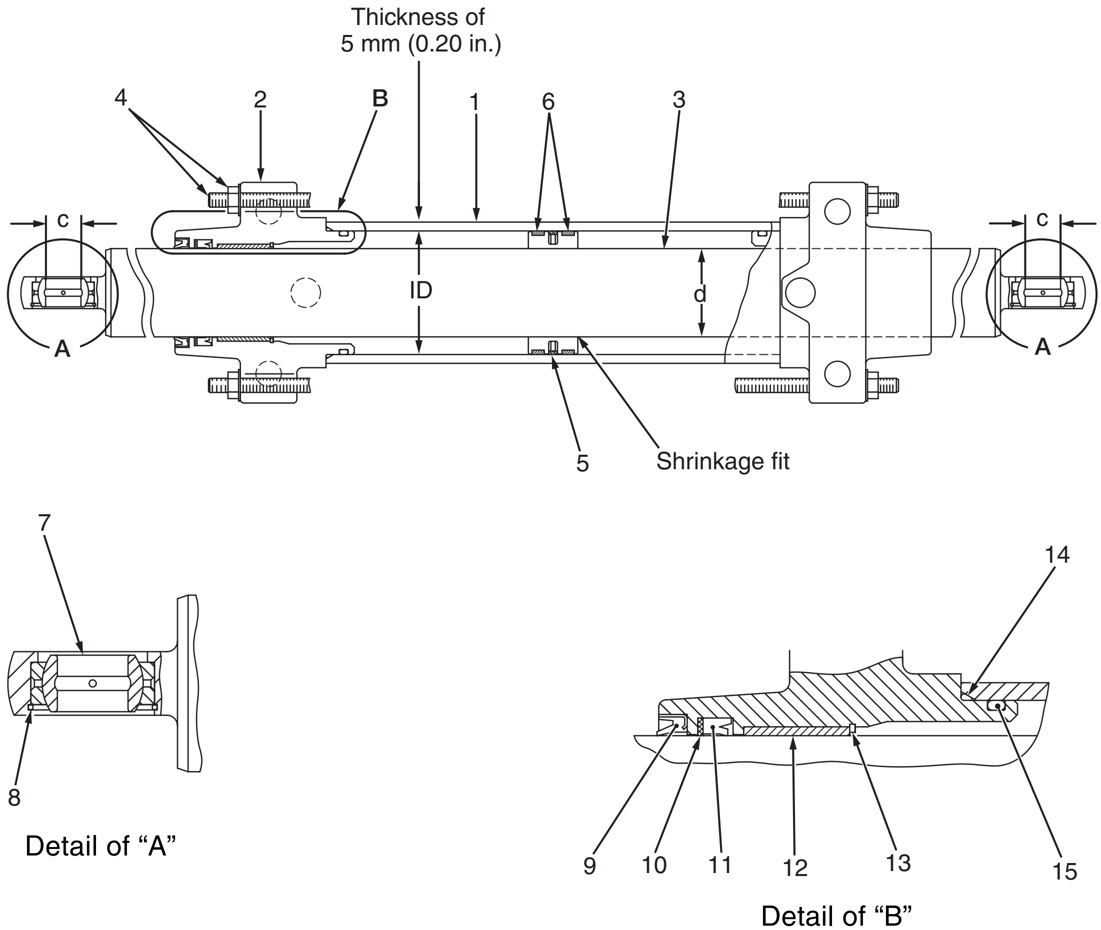
1 Tie rod
2 Tie rod pin
3 Dust seal
4 Bushing
5 Retainer
6 Dust seal
7 Bolt and washer assembly
8 Grease nipple



Center of rear axle

209689

Steering Cylinder



Unit: mm (in.)

Truck Model / Dimension	1 ton class	2 ton class	3 ton class
d	65 (2.6)	70 (2.8)	75 (3.0)
ID	45 (1.8)	50 (2.0)	50 (2.0)
c	17 (0.7)	20 (0.8)	20 (0.8)

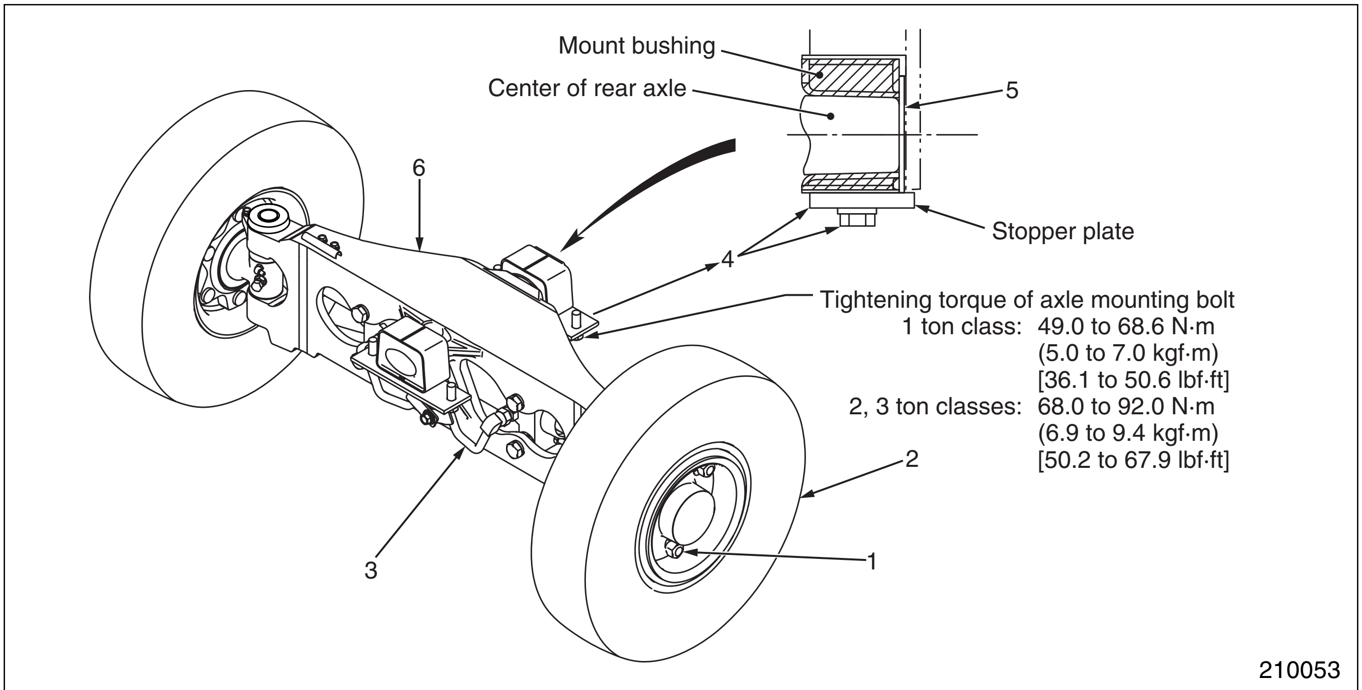
209690

Main components

1 Body
2 Header
3 Rod assembly
4 Stay rod, Nut, Washer
5 Piston seal
6 Guide ring
7 Ball joint
8 Snap ring
9 Dust seal
10 Backup ring
11 Rod seal
12 Bushing
13 Snap ring
14 O-ring
15 O-ring

Removal and Installation

Rear Wheel and Rear Axle Assembly



Removal of rear wheels

1. Set the parking brake, and block the front wheels.
2. Loosen the wheel nut about two turns and raise the rear end of the truck by using a jack or crane at the specified point.

   (1) Method using a jack

   Position the jack under the counterweight at the jacking point and raise the rear tire.

   (2) Method using a crane

   Attach lifting sling to the drawbar pin in the counterweight, and lift it.

CAUTION

When the truck is raised by either method, place wood blocks under the frame to support it securely.

3. Remove the wheels.

Installation of rear wheels

Follow the sequence of disassembly in reverse.

Note: Tighten wheel nuts evenly to the specified torque.

Removal sequence of axle assembly

1 Wheel nut (6 pcs.)
2 Rear wheel
3 Hose or pipe
4 Bolt, Stopper plate
5 Rubber shim
6 Rear axle (with cylinder)

Suggestions for Removal

1. Refer to "Removal of rear wheels" in previous pages to remove the rear wheels.
2. Raise the truck with a jack and support the bottom of both sides of the frame with wood blocks. [Approx. 500 mm (19.7 in.) is sufficient for the distance between the bottom of the frame and the ground.]
3. Disconnect the hose or pipe 3 from the cylinder elbow (2 places). Disconnect the tire sensor harness from the connector.
4. Place a garage jack under the axle to support the axle.
5. Remove rear axle mounting bolts, stopper plate 4 and rubber shim 5.
6. Lower the garage jack and pull out the rear axle (with cylinder) from the truck.

Installation

Follow the sequence of disassembly in reverse, paying attention to the following points.

1. Be sure to insert the rubber shim 5.
2. Tighten bolts 4 to the specified torque.

Disassembly and Reassembly

1. Disassembly and Reassembly of Wheel Hub

Suggestions for Disassembly

1. Remove rear wheels as preparatory work.
2. Check the hub for looseness. If there is looseness, the bearing may be worn.
3. If the bearing is not damaged, it is not necessary to remove it.
4. The cup and the cone of the bearing make a pair. When replacing, replace them as a set.
5. When removing the oil seal 8, replace it with a new one. Do not reuse it.
6. Use a special service tool to remove the bearing.

Inspection after disassembly

1. Bearing

Replace the bearing with a new one if damage, seizure, peel, rotation failure or abnormal noises are found.

2. Hub

Replace the hub with a new one if cracks are detected by dye check.

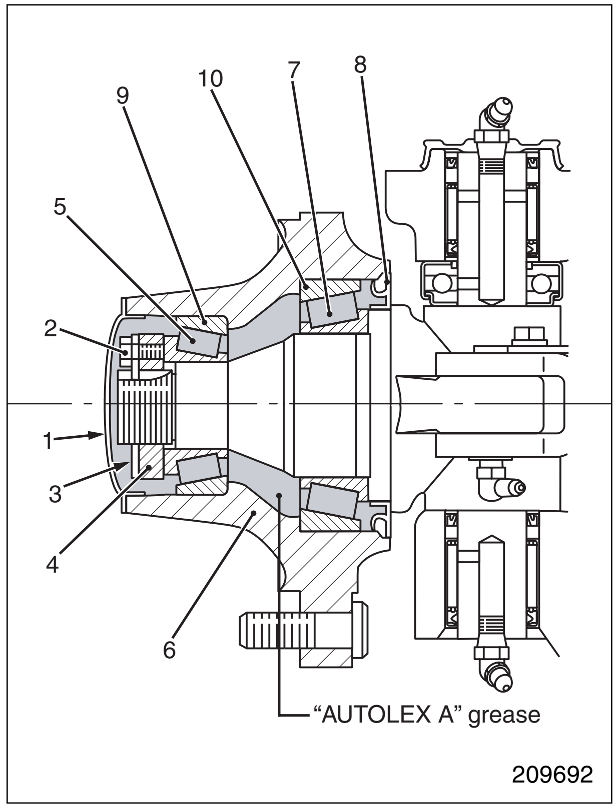
3. Oil seal

Replace a damaged or worn oil seal with a new one.

Reassembly

Follow the sequence of disassembly in reverse, paying attention to the following points.

1. Fill "AUTOLEX A" grease or equivalent wheel bearing grease in the shaded area in the illustration on the right. Be careful to sufficiently fill it in the roller retainer. Apply grease also to the oil seal lip groove.
2. Adjust the bearing. Refer to "Adjusting procedure of wheel bearing reassembly" on the following page.
3. Fill grease in the inside of the hub cup 1 before pushing in the hub cup 1.



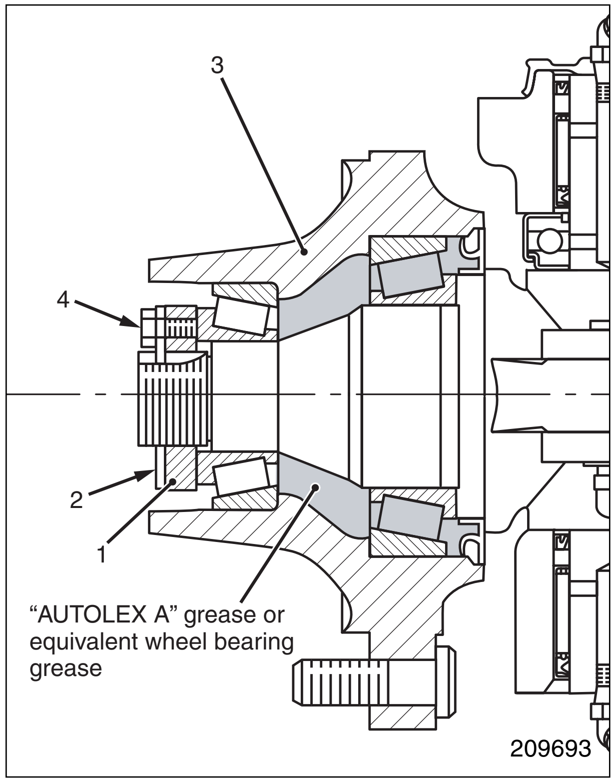
Disassembly sequence

1 Hub cup
2 Bolt
3 Lock plate
4 Lock nut (hexagon nut)
5 Bearing cone
6 Hub (with bearing cup)
7 Bearing cone
8 Oil seal
9 Bearing cup
10 Bearing cup

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 the 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. Turn the wheel hub 3 by hand again and tighten the lock nut 1 until the turn becomes heavy.
5. 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.)



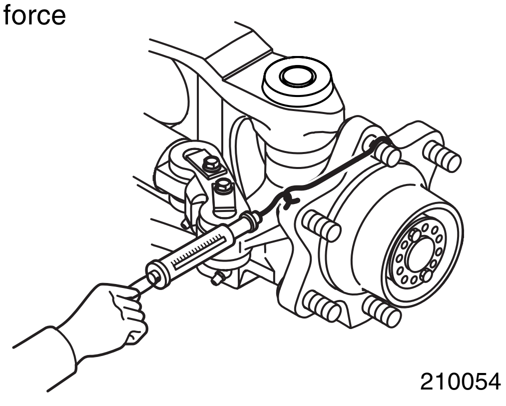
6. Turn the wheel hub back and forth two to three times and make sure that the rotational driving force or starting edge force is within the range below. If out of the range, readjust. In case of a used bearing, aim to a low value of the allowance.

Unit: N (kgf) [lbf]

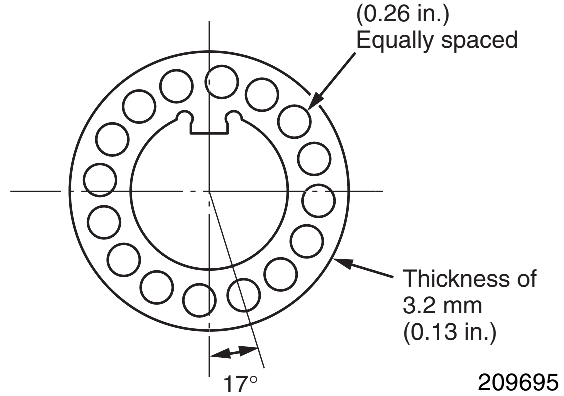
Truck Model / Item	1 ton class	2 ton class	3 ton class
Edge force of hub bolt to be added	5 to 50 (0.5 to 5.1) [1.1 to 11.2]	7 to 70 (0.7 to 7.1) [1.6 to 15.7]	6.3 to 62 (0.6 to 6.3) [1.4 to 13.9]

No looseness is allowed in the axial direction.

Measurement of edge force



Lock plate shape



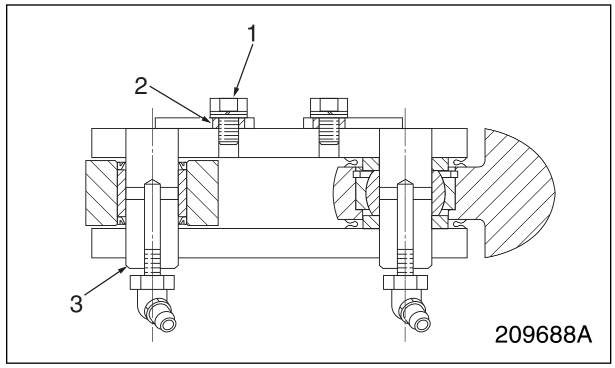
2. Disassembly and Reassembly of Knuckle (King Pin)

Suggestions for Disassembly

Start by:

(a) Remove rear wheels.

(b) Remove wheel hubs.

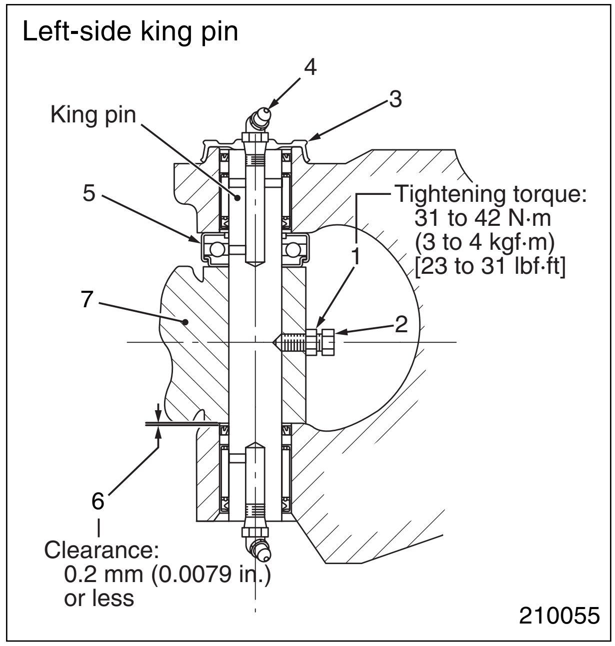


Separation of tie rod

1. For only separating the knuckle from the tie rod, remove the bolt washer assembly 1 and spacer 2 on the knuckle and pull out the tie rod pin 3.
2. Further disassemble to implement a full overhaul. For details, see the page 10-10.

Removal of king pin

1. Loosen the lock nut 1 and remove the stopper bolt 2.
2. Remove parts attached to the upper part of the king pin. For the left-side king pin, remove the king pin cover 3 and grease nipple 4.
3. Apply a soft metal rod to the king pin from above and drive the king pin downward. Support the king pin by hand so that it will not fall down.
4. Remove the thrust bearing 5, shim 6 and knuckle 7.
5. Pull out the dust seal and needle bearing from the rear axle body as necessary.



Inspection after disassembly

Clean and inspect disassembled parts.

Needle bearing and thrust bearing: Replace the bearings with new ones if damage, seizure, peel, rotation failure or abnormal noises are found.

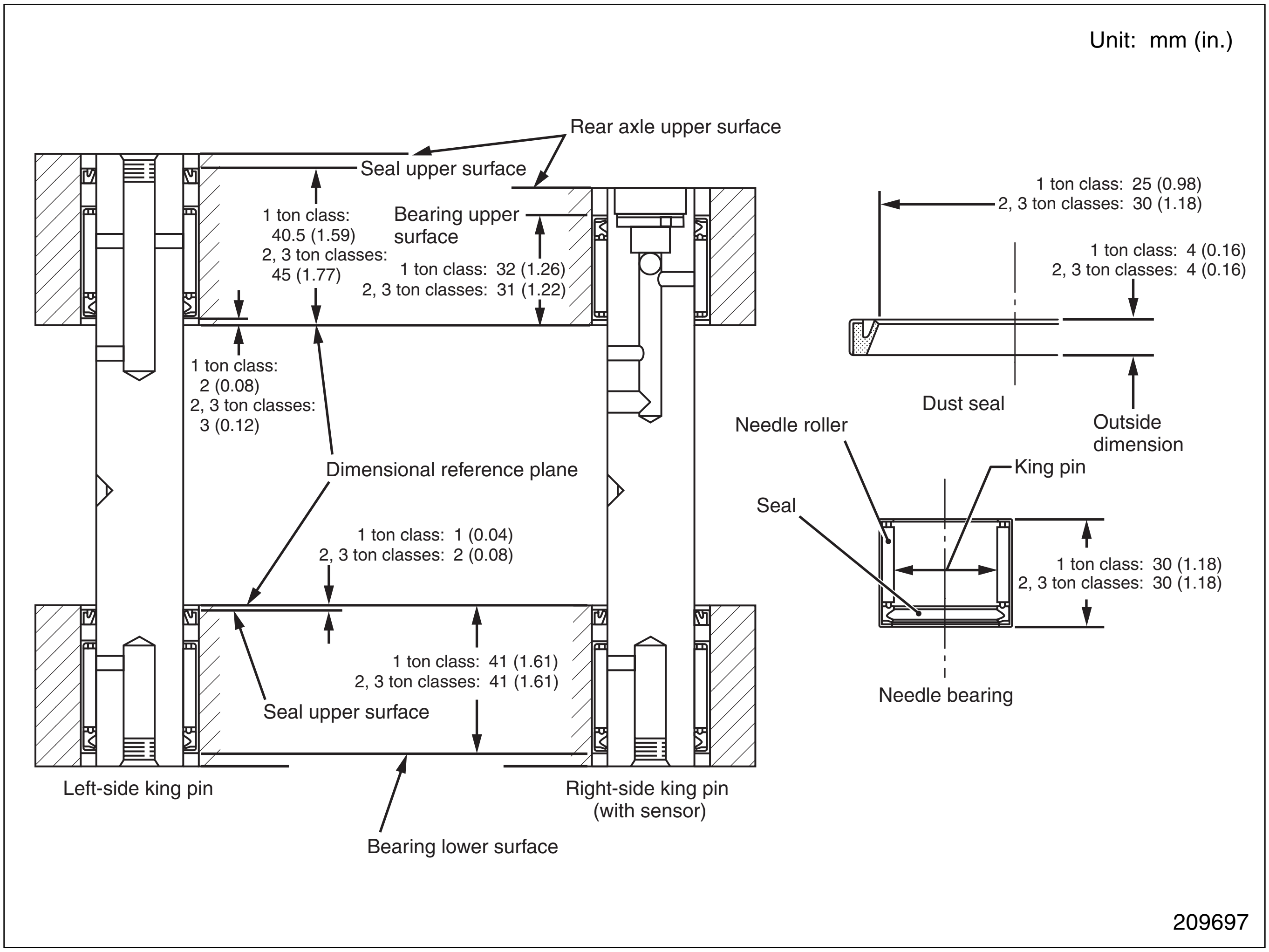
Dust seal: Replace a damaged or worn seal with a new one.

Reassembly

Follow the sequence of disassembly in reverse, paying attention to the following points.

1. Reassemble the king pin inserting from the lower side toward the upper side. (Reassembly in the opposite direction may damage the shim 6.)
2. Reassemble the thrust bearing 5 in the direction as illustrated. Adjust with a shim 6 so that clearance in the axial direction becomes 0.2 mm (0.0079 in.) or less.
3. When replacing the dust seal and needle bearing, install them to the direction and dimensions as shown in the illustration on the right using a driving tool.
4. Apply a sufficient amount of grease after reassembly. Apply grease until it comes out of the boundary between the axle and the knuckle.

5. Dimensions after disassembly are shown below.



3. Disassembly and Reassembly of Steering Cylinder

Removal

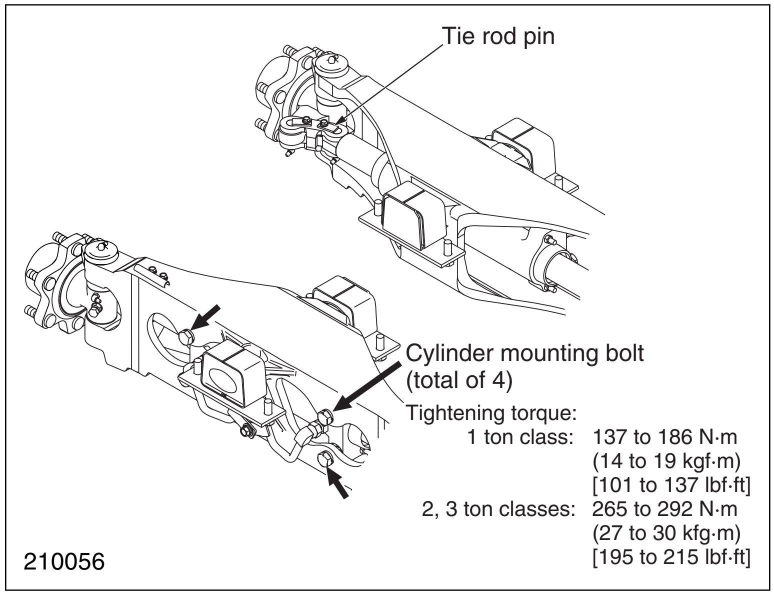
Start by:

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

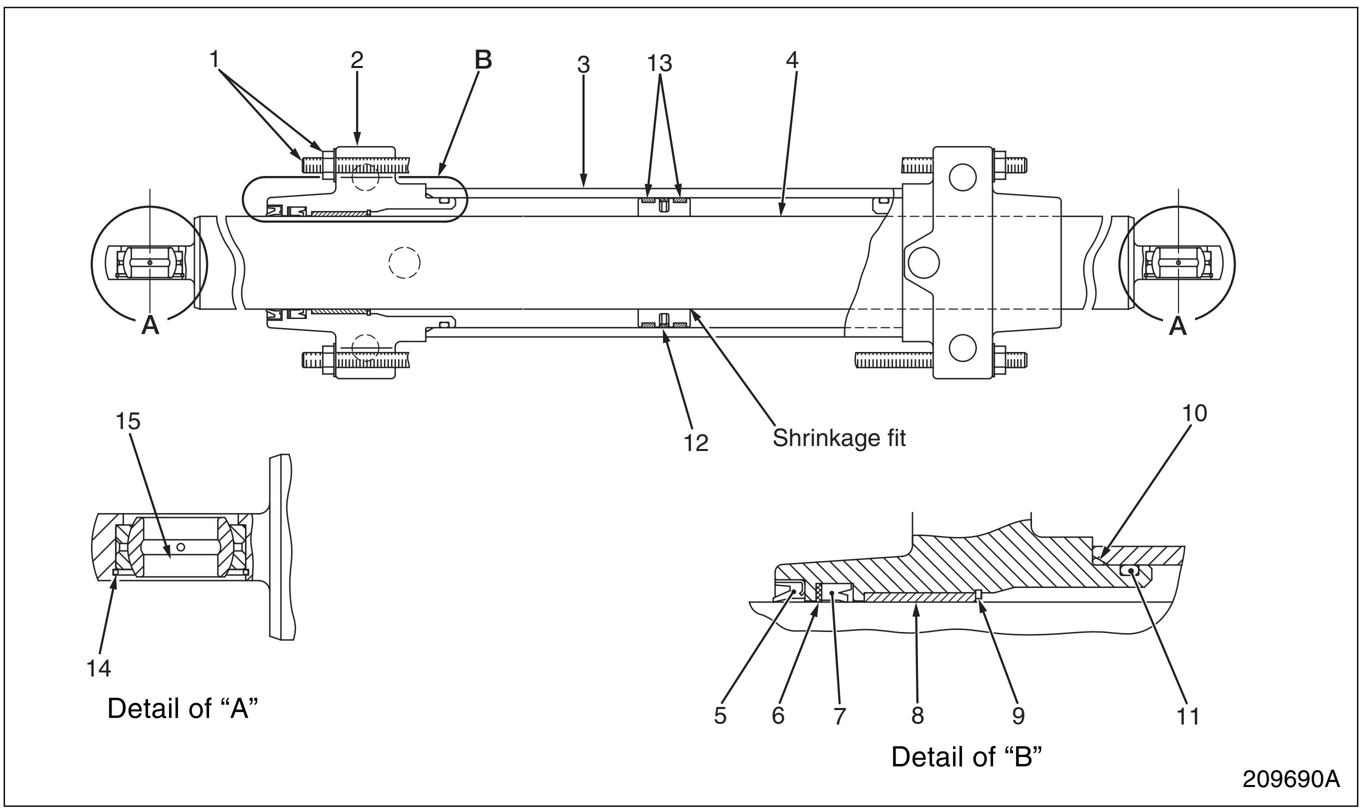
(b) Pull out right and left tie rod pins on the cylinder to disconnect the knuckle from the cylinder.

Removal of cylinder

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



Disassembly of steering cylinder



Sequence

1	Stay rod, Washer and Nut	5	Dust seal	11	O-ring
2	Header (with parts 5 through 10 assembled)	6	Backup ring	12	Piston seal
3	Body	7	Rod seal	13	Guide ring
4	Rod assembly (with parts 12 through 15 assembled)	8	Bushing	14	Snap ring
		9	Snap ring	15	Ball joint
		10	O-ring		

Suggestions for Disassembly

1. Activate the piston by blowing compressed air from the oil port to discharge oil in the inside.
2. When the stay rod 1 is removed, the cylinder is divided into three parts.
3. Remove damaged or worn seals as necessary. Do not reuse removed seals.

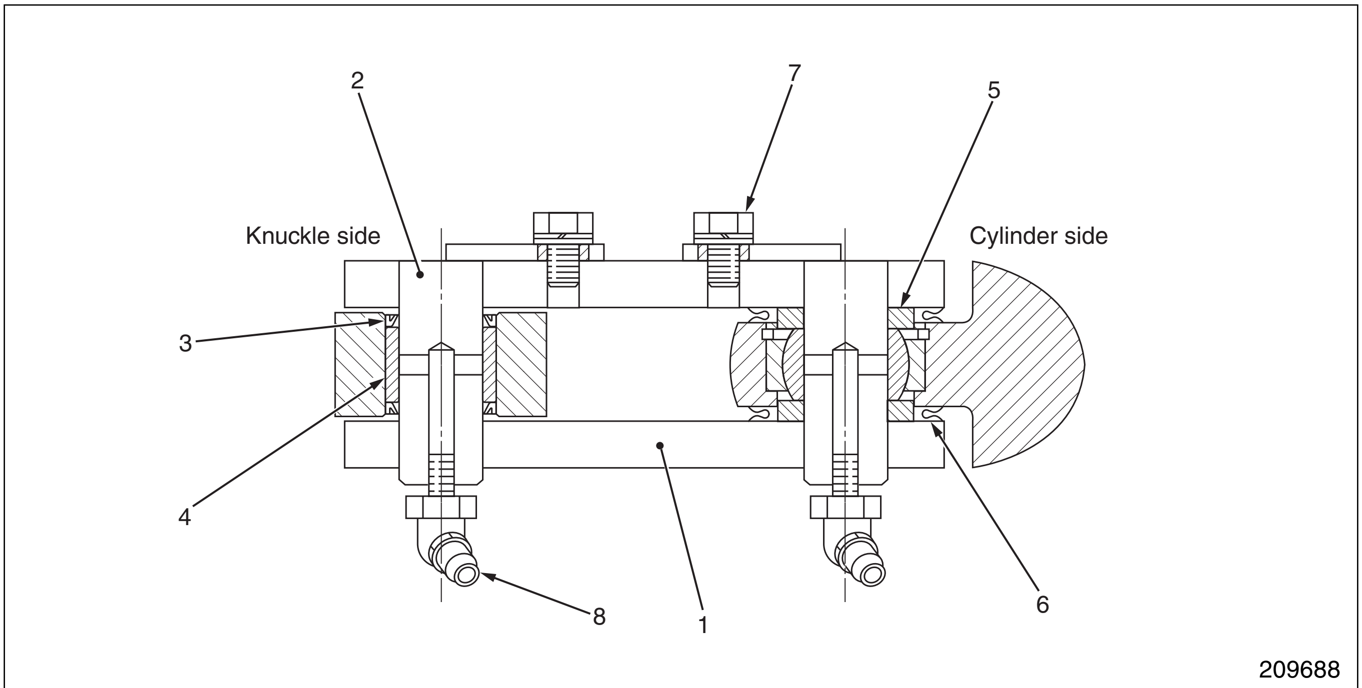
Reassembly

Follow the sequence of disassembly in reverse, paying attention to the following points.

1. Reassemble in a clean place where no dust or abrasive foreign substance enters.
2. Reassemble parts while lubricating them with hydraulic oil.
3. Replace seal kit parts with a new kit.
4. Be careful not to twist O-rings when installing.

4. Disassembly and Reassembly of Tie Rod

Disassembly



Sequence

1 Spacer
2 Tie rod pin
3 Dust seal
4 Bushing
5 Dust seal
6 Retainer
7 Bolt and washer assembly
8 Grease nipple

Reassembly

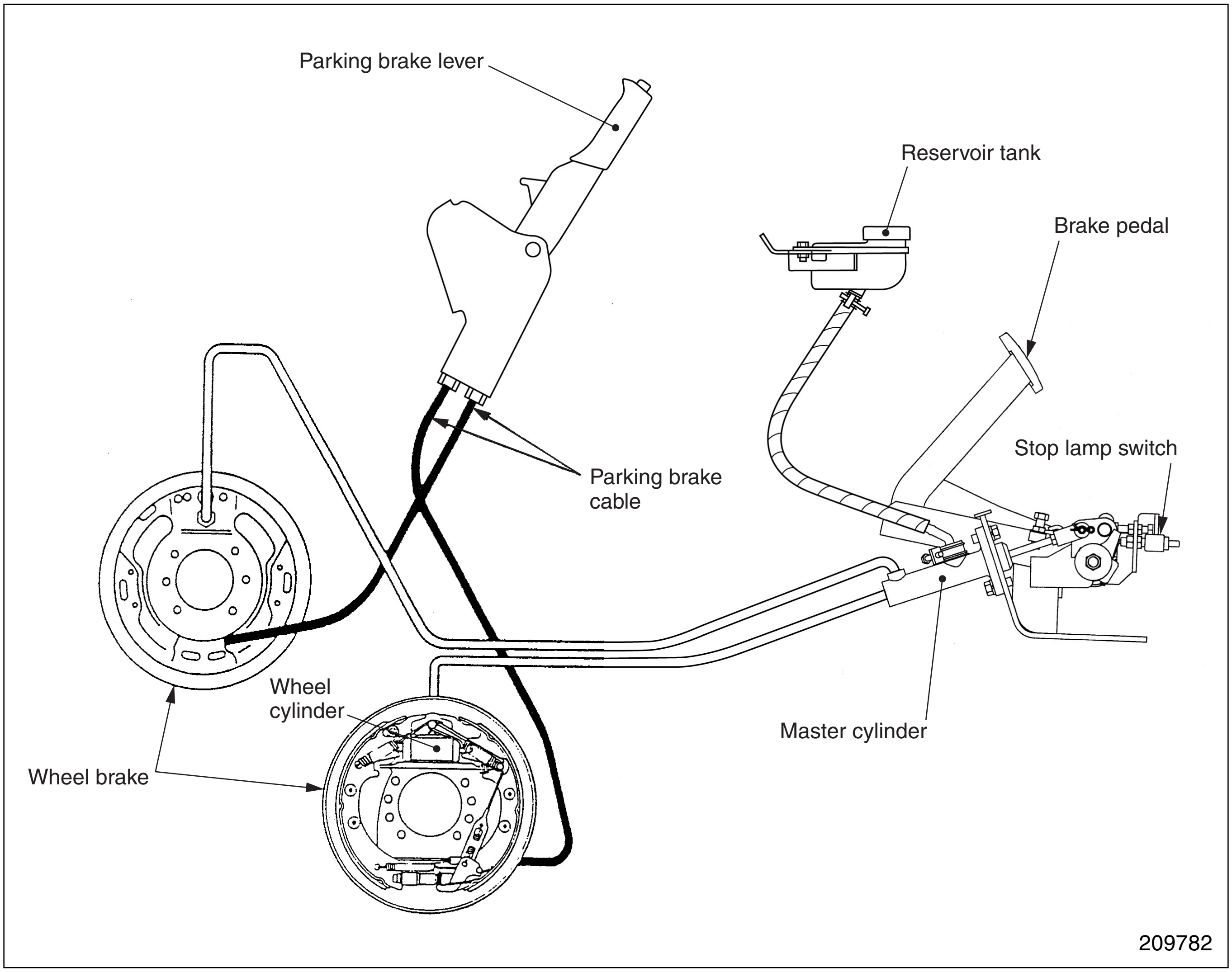
Follow the sequence of disassembly in reverse, paying attention to the following points.

1. Replace a damaged or worn dust seal with a new one.
2. Apply sufficient amount of grease after reassembly. Apply grease until it comes out of the dust seal.

BRAKE SYSTEM

Structure

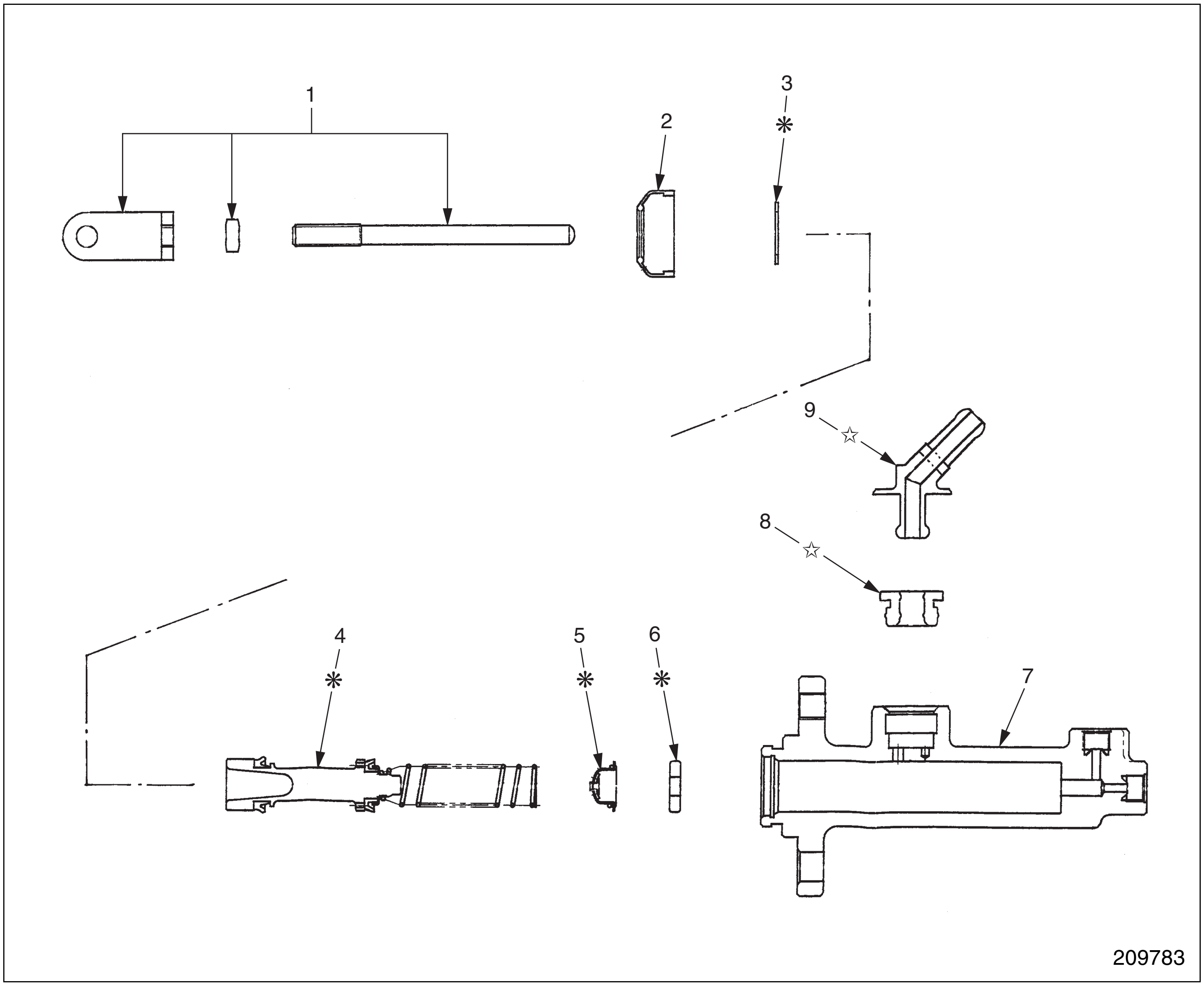
Brake System



Disassembly and Reassembly

Master Cylinder

Disassembly



Sequence

1 Clevis, Nut, Push rod
2 Boot
3 Snap ring
4 Piston assembly
5 Valve assembly
6 Valve seat
7 Cylinder
8 Bushing
9 Filler union

Note: The parts (❋) and (☆) to be changed periodically are included in the Repair Kit.

Inspection after disassembly

1. Cylinder

(1) Check the cylinder bore for rusting, erosion, abnormal wear, or scoring.

(2) Check the inlet and relief ports for restriction. Check the threads on each joint for damage. Also, check the boot and other parts for damage.

2. Piston

Check the piston for damage. Replace if it is damaged. Insert the piston into the cylinder, and measure the piston-to-cylinder clearance. If the clearance is in excess of the service limit, replace the cylinder and piston.

A: Standard value B: Service limit

Clearance between cylinder and piston	A	0.020 to 0.105 mm (0.00079 to 0.00413 in.)
	B	0.15 mm (0.0059 in.)

3. Return spring

Replace the spring if it is damaged or its free length is at or less than the service limit.

A: Standard value B: Service limit

Spring free length	A	59.2 mm (2.3 in.)
	B	53.9 mm (2.1 in.)

4. Cups in piston assembly

Check the rubber parts for damage or swelling. If the lips are damaged even slightly, the base is bent, or abnormal fatigue, wear or swelling is evident, replace the piston assembly. If the cup tightness is 0.4 mm (0.0157 in.) or less, replace the piston assembly.

Note: The cups must be replaced periodically. It is recommended and good practice to replace them whenever the master cylinder is disassembled.

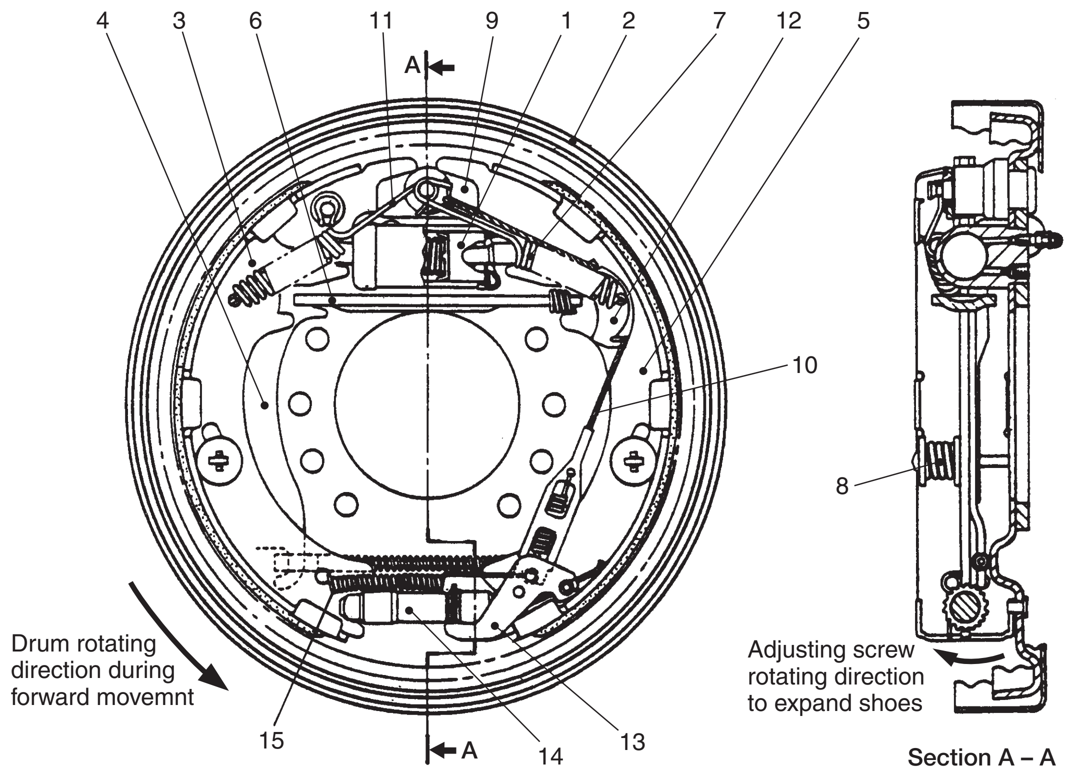
Reassembly

To reassemble, follow the disassembly procedure in reverse, paying attention to the following points.

(1) Wash all metal parts clean with volatile cleaning solvent, and completely dry them with compressed air.

(2) Apply a thin coat of rubber grease exclusively designed for brake components or brake fluid to the cylinder bore, piston cups, and the inner face of the filler union bushing mounting hole.

Wheel Brakes (1 ton class)

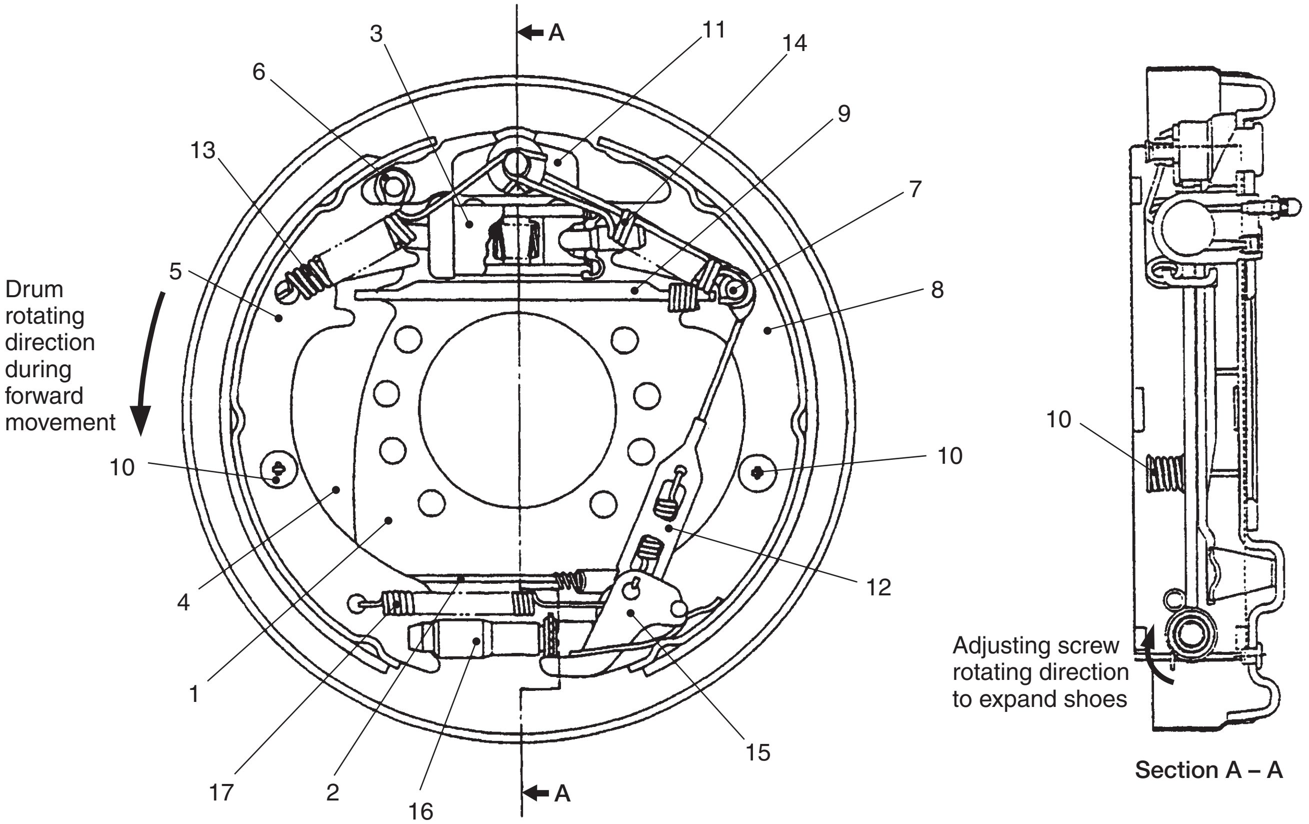


The illustration shows a left-hand wheel brake.

208523

- 1 Wheel cylinder
- 2 Backing plate
- 3 Shoe and lining (primary)
- 4 Parking brake lever
- 5 Shoe and lining (secondary)
- 6 Strap
- 7 Return spring
- 8 Hold-down spring
- 9 Shoe guide plate
- 10 Cable with spring
- 11 Return spring
- 12 Sheave
- 13 Adjusting lever
- 14 Adjusting screw
- 15 Return spring

Wheel Brakes (2, 3 ton classes)



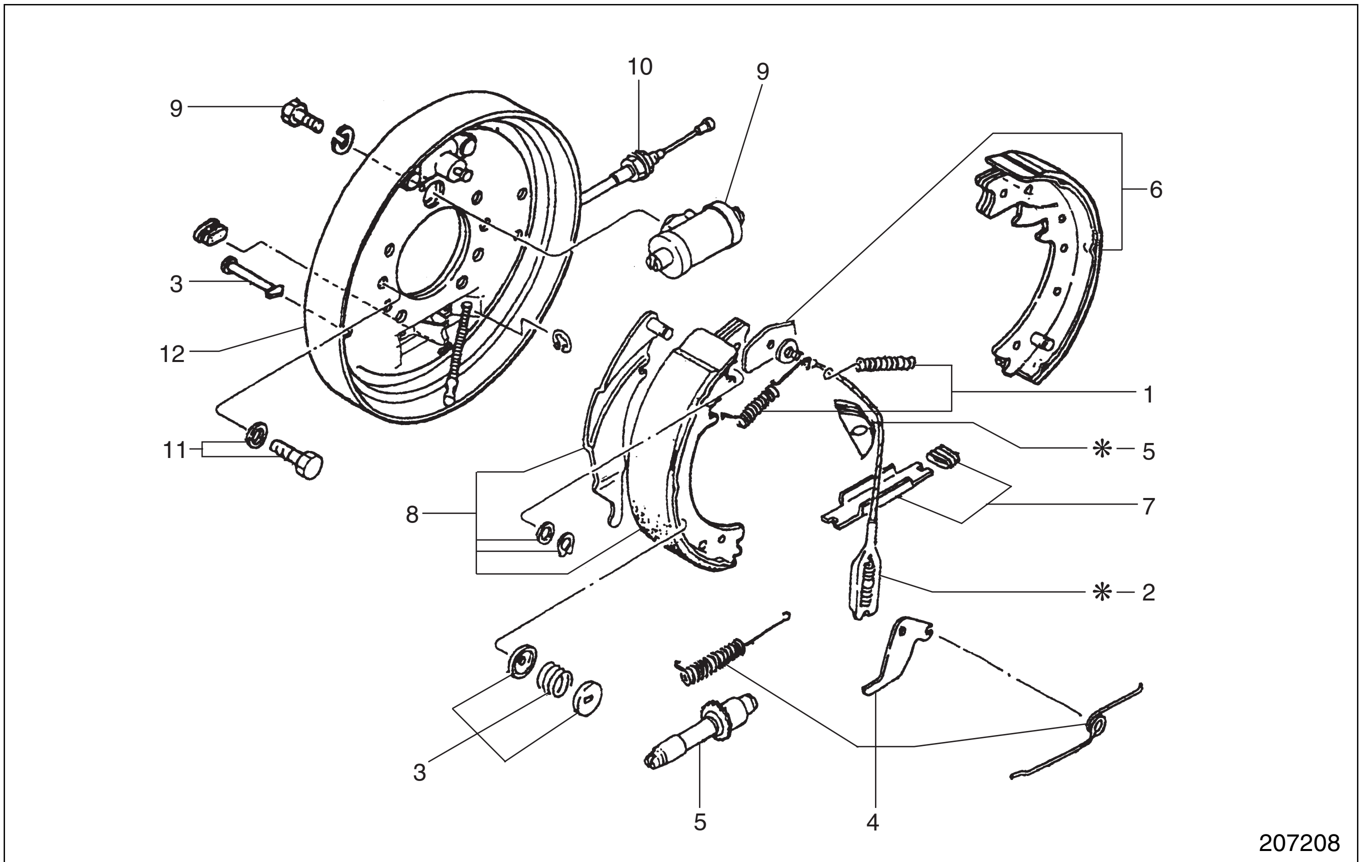
The illustration shows a left-hand wheel brake.

209784

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

Wheel Brakes

Disassembly



Sequence

1 Return spring
2 Cable with spring
3 Hold-down spring, Cup, Pin
4 Adjusting lever, Adjusting spring, Return spring
5 Cable guide, Sheave, Adjusting screw, Pin, Washer
6 Shoe guide plate, Shoe and lining (secondary)
7 Strap, Anti-rattle spring
8 Shoe and lining (primary), Parking brake lever, Retainer, Spring washer
9 Wheel cylinder
10 Parking brake cable
11 Mounting bolt, Spring washer
12 Backing plate

Note: The part (✻) to be changed periodically are included in the Brake Repair Kit.

Start by:

(a) Remove the front wheel.

(b) Remove the wheel hub and brake drum.

(c) Separate the parking brake lever and cable at the bottom of wheel brake.

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

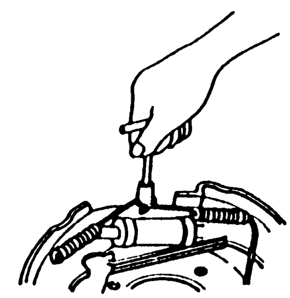
Suggestions for Disassembly

1. Removing return springs

Use a special tool to remove the return springs from the shoe guide plates.

Special tool needed

Spring remover	64309 - 15411



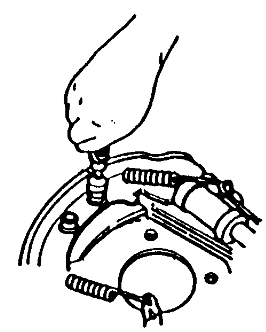
200271

2. Removing hold-down springs

Use a special tool to remove the hold-down springs from the backing plate.

Special tool needed

Spring retainer	64309 - 15412



200272

Inspection after Disassembly

1. Backing plate

(1) Check the backing plate for cracks.

2. Shoes and linings

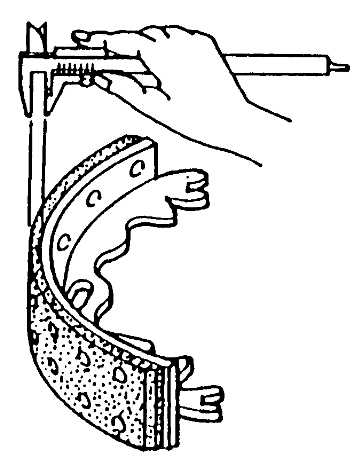
(1) Check each shoe and lining for cracks.

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

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

A: Standard value B: Service limit

Truck Model / Item		1 ton class	2, 3 ton classes
Thickness of linings	A	4.87 mm (0.19 in.)	5.7 mm (0.22 in.)
	B	1.0 mm (0.04 in.)	1.0 mm (0.04 in.)



203005

3. Brake drums

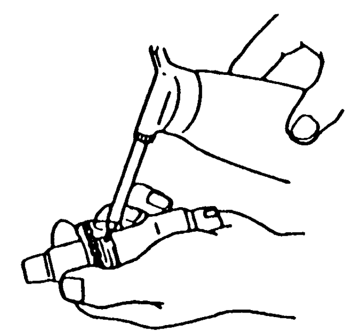
Check the inside (friction) surface of the drum for abnormal wear, grooving and other defects. Minor grooving can be removed by grinding, provided that the inside diameter does not exceed the service limit.

A: Standard value B: Service limit

Item \ Truck Model		1 ton class	2, 3 ton classes
Inside diameter of brake drum	A	254 mm (10.0 in.)	310 mm (12.2 in.)
	B	256 mm (10.1 in.)	312 mm (12.3 in.)

4. Adjusting screws

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



200274

5. Parking brake cable

Replace a cable if it shows stretching, rust or damage.

6 Other parts

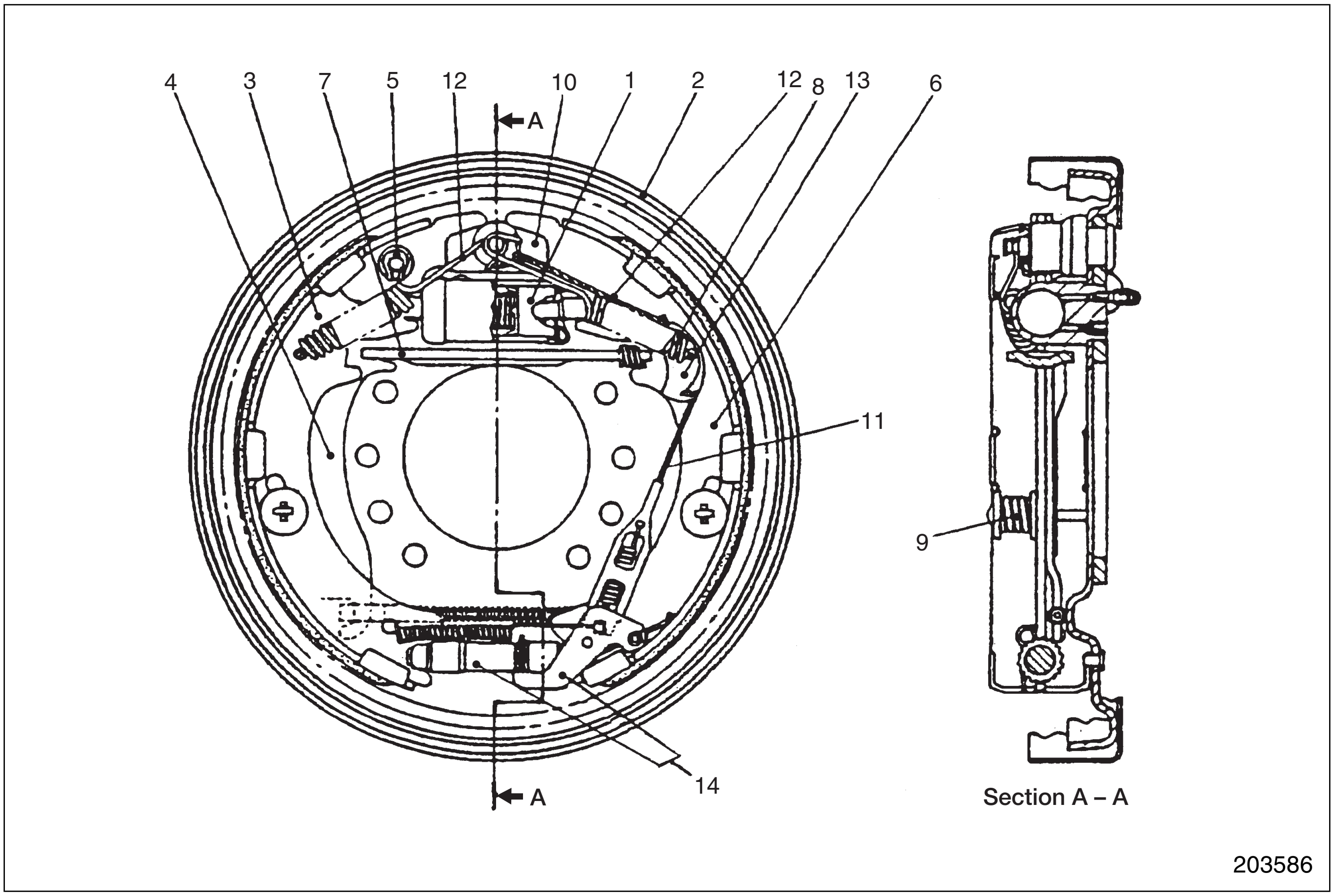
(1) Check the shoe return springs for cracks or fatigue.

(2) Check the adjusting springs for cracks or fatigue.

(3) Check the cable with spring for stretching.

Reassembly

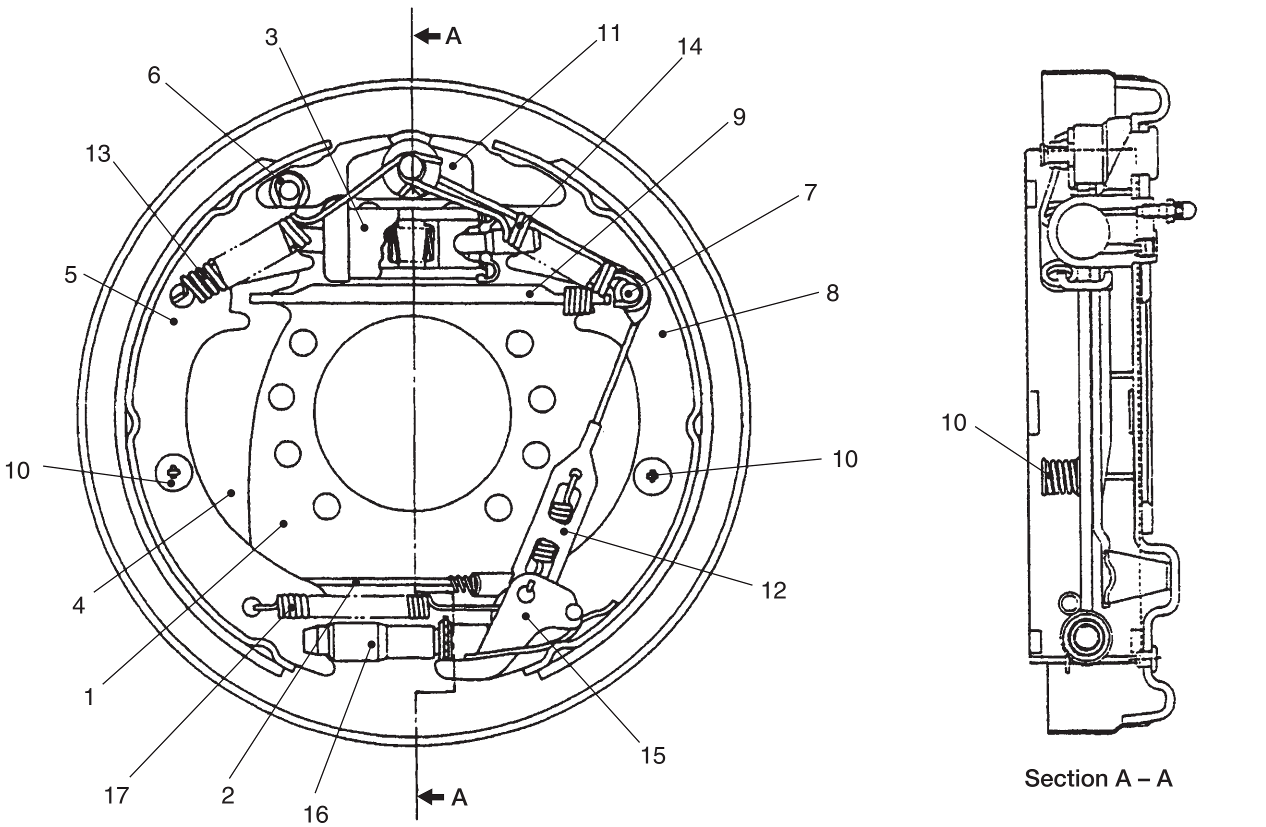
1 ton class



Sequence

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

2, 3 ton classes



The illustration shows a left-hand wheel brake.

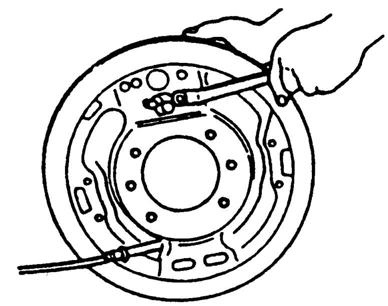
Sequence

1 Backing plate assembly
2 Parking brake cable, Snap ring
3 Wheel cylinder
Prepare Parts 4, 5 and 6 in assembly beforehand.
4 Parking brake lever
5 Primary shoe and lining assembly
6 Retainer, Washer
Prepare Parts 7 and 8 in assembly beforehand.
7 Pin, Sheave, Washer
8 Secondary shoe and lining assembly
9 Strut, Anti-rattling spring
10 Pin, Hold-down spring, Cup
11 Shoe guide plate
12 Cable with spring
13 Return spring (primary)
14 Return spring (secondary)
15 Adjusting lever, Adjusting spring
16 Adjusting screw
17 Return spring

Suggestions for Reassembly

1. Wheel cylinder installation

Apply liquid packing to the mounting face of the wheel cylinder before installing it. Tighten to the specified torque.



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Item \ Truck Model	1 ton class	2, 3 ton classes
Tightening torque	8 to 12 N·m (0.8 to 1.2 kgf·m) [6 to 9 lbf·ft]	18 to 26 N·m (1.8 to 2.7 kgf·m) [13 to 20 lbf·ft]

2. Greasing

Apply a thin coat of the specified brake grease to the following areas.

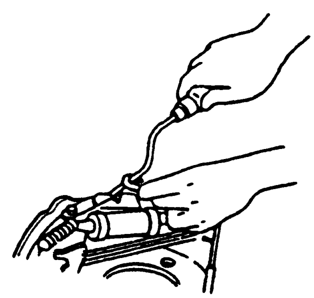
(1) Shoe ledges (6 locations)

The ledges are those portions of the backing plate in contact with the shoe.

(2) Anchor pin surface in contact with the shoe ends

3. Shoe and lining installation

Ensure that each connector link of the wheel cylinder has been correctly inserted into the shoe web.



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4. Return spring installation

Use a special tool to install the return springs to the backing plate pins.

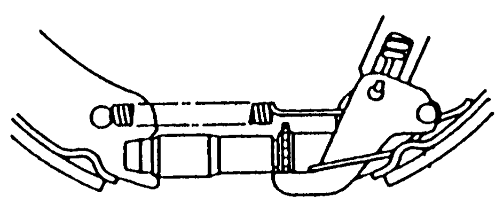
Special tool needed

Spring installer	65309 - 15413

5. Automatic adjuster installation

(1) Clean the adjusting screw and associated parts, and apply grease to the threaded portions and the screw socket. Ensure that the screw turns easily when rotated by hand.

If the screw is hard to turn, replace it with a new one.



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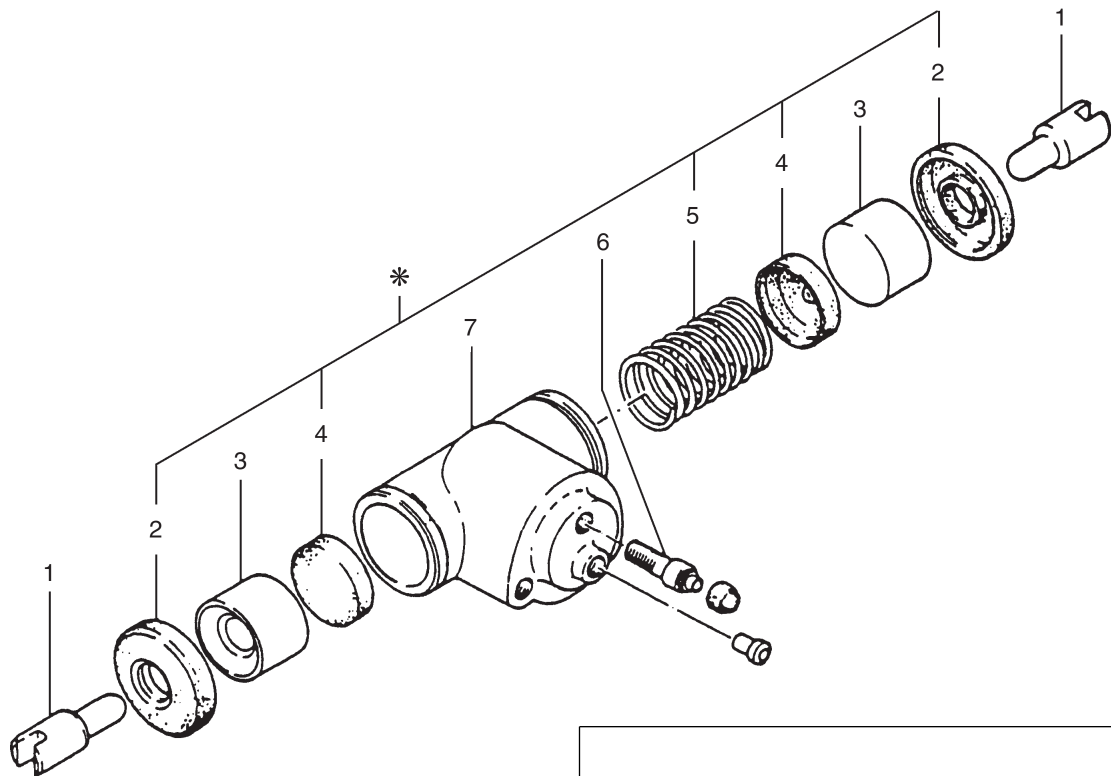
(2) Identification of adjusting screws and levers

Left-half parts (right-hand thread)	Plated in whitish color
Right-half parts (left-hand thread)	Plated in yellowish color

Note: After reassembly, bleed air out of the brake lines. (Refer to "Inspection and Adjustment.")

Wheel Cylinder

Disassembly



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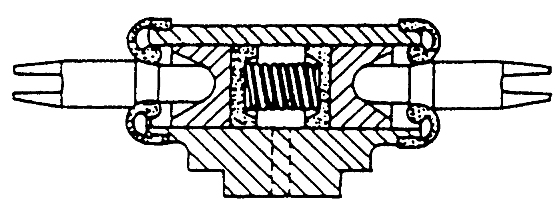

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Sequence

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

Note: The part (❋) to be changed periodically are included in the Brake Repair Kit.

Inspection and Repair

(1) Cylinder body

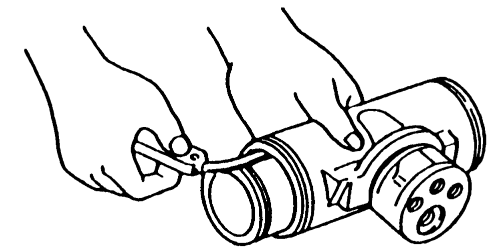
(a) Check the bore for rusting, erosion or scoring.

(b) Check the threads of bleeder screw and oil pipe for damage.

(2) Pistons

(a) Check the sliding surface for rusting or scratching.

(b) With the piston installed in the cylinder body, measure the piston-to-cylinder clearance. Replace if the clearance is in excess of the service limit.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A: Standard value B: Service limit

Clearance between piston and cylinder	A	0.020 to 0.105 mm (0.00079 to 0.00413 in.)
	B	0.15 mm (0.0059 in.)

(3) Piston cups

Check for swelling, damage or other defects. Replace the cup if defective even slightly.

A: Standard value B: Service limit

Tightness between piston cup and cylinder body	A	1.85 mm (0.07 in.)
	B	0.65 mm (0.025 in.)

(4) Boots

Replace the boots if they show damage or aged deterioration. In any event, the boots must be replaced every year.

Reassembly

To reassemble, follow the disassembly procedure in reverse, paying attention to the following points.

(1) Wash all metal parts clean with volatile cleaning solvent, and completely dry them with compressed air.

(2) Apply a thin coat of rubber grease exclusively designed for brake components or brake fluid to the cylinder bore and piston cups.

(3) Be careful not to damage the lips of the cups.

(4) Make sure that the cups face the correct directions when reassembled.

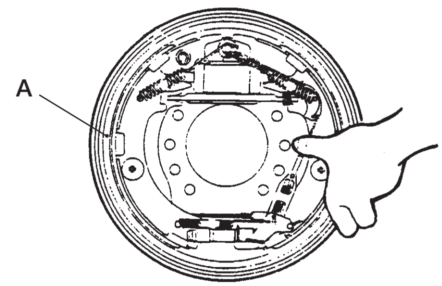
(5) Tighten the bleeder screw to the specified torque.

Tightening torque	5.9 to 8.8 N·m (0.6 to 0.9 kgf·m) [4.3 to 6.5 lbf·ft]

Inspection and Adjustment

Automatic Adjuster Test

(1) With the clearance A between the lining and drum set approximately to specification, pull the cable with spring with a finger as shown. The lever should turn the adjusting screw wheel by one notch and, when the cable is released, return to the original position.



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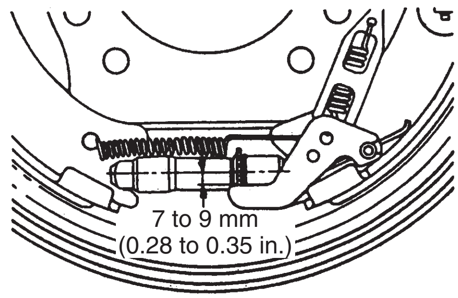
Unit: mm (in.)

Item \ Truck Model	1 ton class	2, 3 ton classes
Drum inside diameter	254 (10.1)	310 (12.2)
Drum-to-lining clearance A	0.5 to 0.5 (0.010 to 0.020)	0.1 to 0.35 (0.004 to 0.014)

(2) If the lever fails, or is slow, to turn the adjusting screw wheel, check the position of the lever relative to the toothed wheel. The lever's actuating tip should touch the toothed wheel at approximately 7 to 9 mm (0.28 to 0.35 in.) below the centerline of the screw. If the lever contact is out of the range, the lever will not correctly engage with the toothed wheel, therefore failing or slow to turn the wheel.



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(3) If the automatic adjuster fails to operate correctly, take the following actions.

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

(b) Replace the fitting cable.

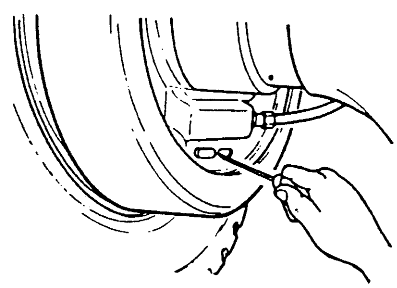
(c) Replace the lever.

(d) Replace the adjusting screw.

Manual Adjustment

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

Note: Turning the wheel by one tooth corresponds to a change of 0.03 mm (0.001 in.) in shoe diameter.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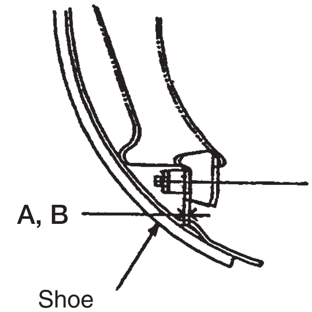
Parking Brake Cable Adjustment

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

(2) With the lever set "free," pull the cable until the shoe just starts to work on the drum. The amount of cable pulled A should meet the specification listed below.

(3) Move the parking brake lever by the amount specified below. This is the neutral position. In the neutral position, the inner cable length C should be as specified below.



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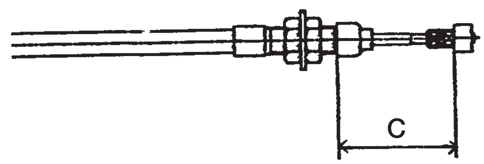


209786

Unit: mm (in.)

Item \ Truck Model	1 ton class	2, 3 ton classes
Cable pull A before shoe works on drum	10 (0.39) maximum	14.3 (0.56) maximum
Distance B to reach neutral	3 (0.12)	5 (0.20)
Inner cable length C	44 ± 4 (1.73 ± 0.16)	

Brake Pedal Adjustment

(1) Using the stop bolt, adjust the installed height A of the brake pedal (from the floor to the top of the pad). After adjustment, lock the stop bolt.

(2) Adjust the push rod length of the master cylinder.

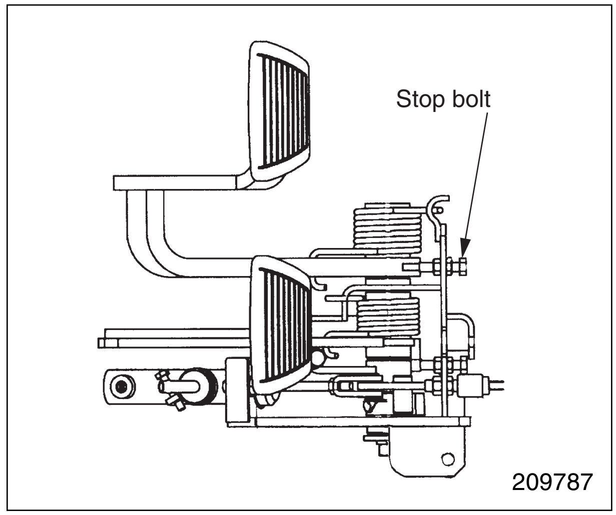
- Truck with powershift transmission
  With the push rod-to-piston clearance removed, adjust the clearance B to specification by turning the push rod. After adjustment, lock the clevis with the nut.
- Truck with manual transmission
  Adjust the push rod-to-piston clearance by turning the push rod. After adjustment, lock the clevis with the nut.

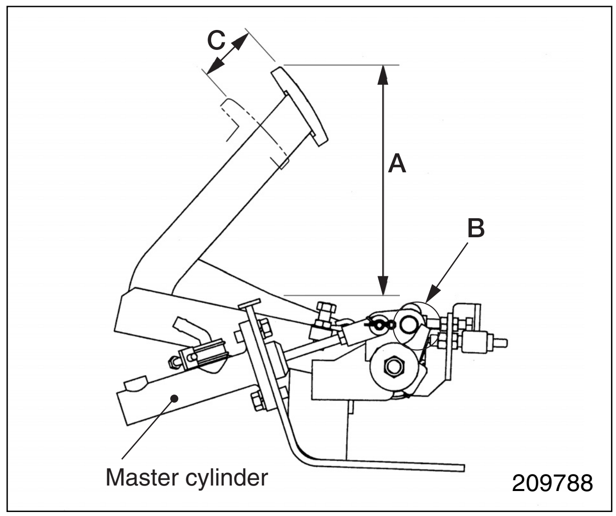
(3) Ensure that the pedal play is to specification.

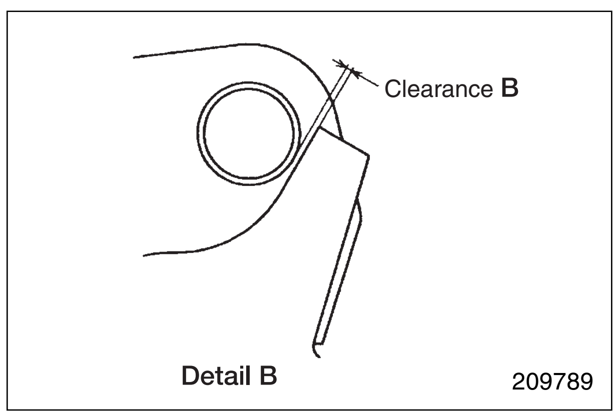
Note: (a) Ensure that the clevis pin between the brake pedal and push rod is firmly in place as illustrated.

(b) Ensure that the snap pin is firmly engaged.

(c) Ensure that the brake pedal operates smoothly without obstruction or other problems.







Unit: mm (in.)

Item \ Truck Model		1 ton class	2, 3 ton classes
Pedal height from floor A		182 to 200 (7.16 to 7.87)	
Clearance B	Powershift T/M model	0.2 to 1.0 (0.008 to 0.039)	0.2 to 0.8 (0.008 to 0.031)
	Manual T/M model	—	—
Push rod-to-piston clearance	Powershift T/M model	0 (0)	0 (0)
	Manual T/M model	1 (0.04)	1 (0.04)
Pedal play C	Powershift T/M model	1.5 to 6.5 (0.059 to 0.256)	1.5 to 5.5 (0.059 to 0.217)
	Manual T/M model	7 (0.28)	7 (0.28)

Bleeding Brake Lines

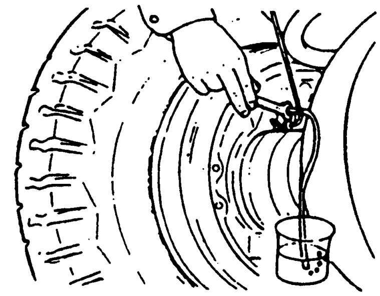
Bleeding the brake lines is a two person operation. After any portion of the brake fluid lines has been disassembled for repair or service, or if the brake pedal feels spongy, bleed the lines as follows.

(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 Step (3) 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.



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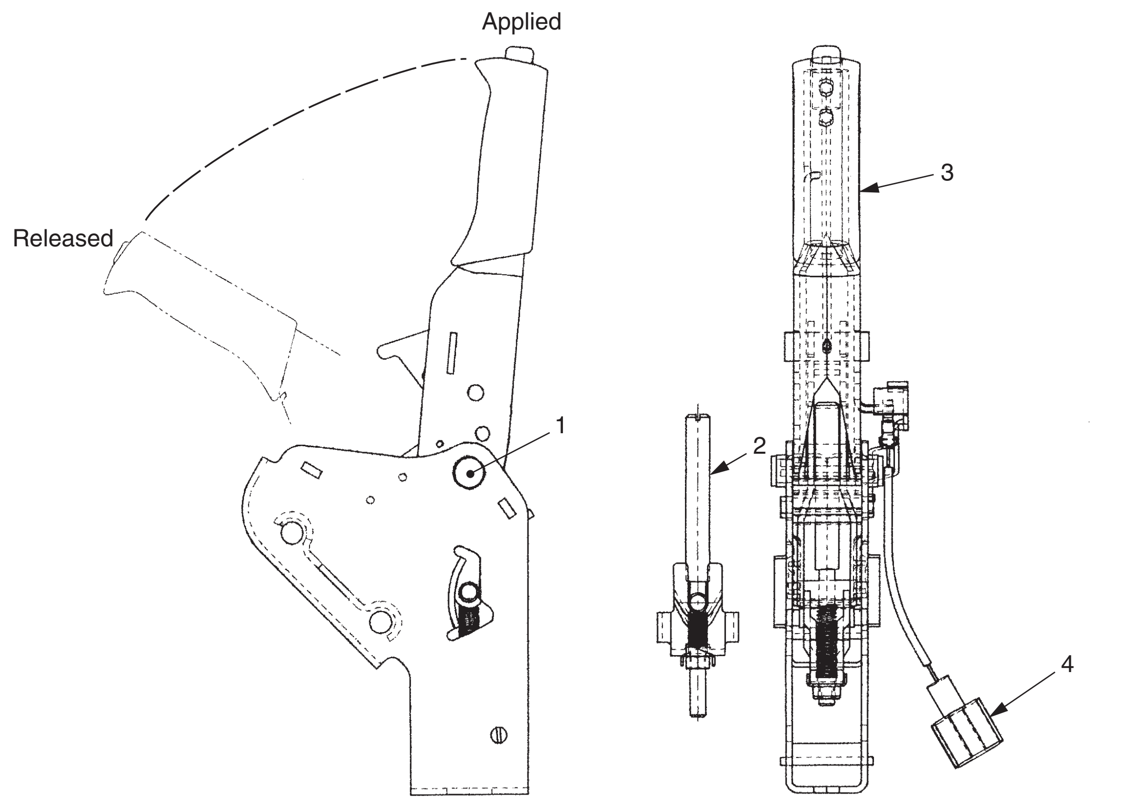
Note: (a) Take care to maintain the brake fluid in the reservoir tank at sufficient levels while the bleeding operation is in progress.

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

Braking Performance Test

With all of the required adjustments completed after disassembly/reassembly, check the braking force at a speed of 10 km/h. Readjust as necessary by referring to “Manual Adjustment.”

Parking Brake Lever



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1 Lever support pin
2 Adjusting screw
3 Parking brake lever assembly
4 Parking brake switch

Inspection and Repair

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

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

Reassembly

With the parking brake cable and lever connected, the force required to pull the lever should be 245 to 295 N (25 to 30 kfg) [55 to 66 lbf].

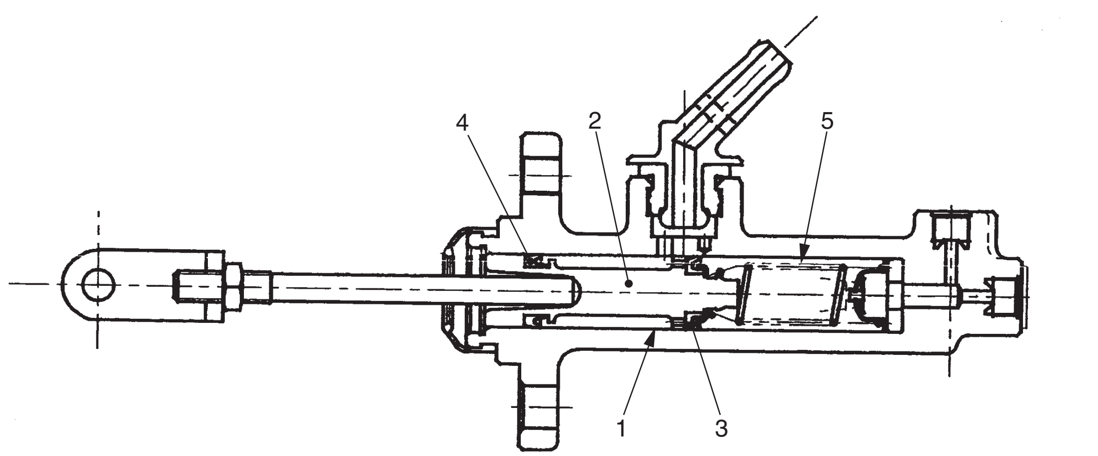
Troubleshooting

	Condition	Possible cause	Correction
Foot brakes	Lack of braking force	Oil leaking past primary cup in master cylinder	*Replace piston cup(s) if cylinder is free from unacceptable wear. Replace the cup(s) and fluid with genuine parts if the cup(s) is distorted.
		Oil leaking past cups in wheel cylinder	
		Oil leaking from oil pipe connection	Retighten, or replace pipe and connector.
		Shoe linings worn	Replace.
		Shoe linings dirty with oil or grease	Clean or replace.
	Excessive pedal stroke	Air trapped in brake fluid lines	Bleed air at master and wheel cylinders.
		Piston cup defective in master cylinder	Replace.
		Not enough fluid in reservoir tank	Refill.
		Push rod to piston clearance too large in master cylinder	Readjust.
		Brake fluid leakage	Refer to * above.
		Automatic adjuster inoperative	Ensure that cable guide and adjusting spring are correctly installed. If still inoperative, replace cable with spring, lever, and adjusting screw.
	Uneven braking (wheel brake is more effective on one side than on the other)	Lining or drum dirty with oil or grease in less effective brake	Clean with gasoline. If lining still dirty, replace.
		Wobbly or loose-mounted drum in less effective brake	Replace drum. If loose, readjust and retighten.
		Wheel tires inflated unequally	Reinflate to specification.
	Brake squeals	Lining glazed	Sand.
		Worn linings	Replace shoe and lining assemblies.
		Backing plate securing bolts loose	Retighten.
		Wheel bearings loose	Readjust preload and retighten.
		Brake drum dirty	Clean with cleaning solvent.
	Brake chatters or clatters	Anchored ends of shoes rattling on anchor	Repair or replace.
		Shoe ledges badly worn	Replace backing plate.
		Pistons badly worn in wheel cylinder	Replace wheel cylinder.

Parking brake	Lever stroke is too small	Lining to drum clearance too small	Readjust.
	Will squeal during traveling	Lining to drum clearance too small	Readjust.
		Brake drum badly distorted	Repair or replace.
	Will not apply	Parking brake cable longer than specification	Check lining to drum clearance. If brake will still not apply, readjust cable length.
		Linings worn to the service limit	Replace shoe and lining assemblies.
		Lining to drum clearance too large	Readjust.
		Lever lacks operating force	Readjust to specification.

Service Data

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

Items	Truck Models		1 ton class	2, 3 ton classes
Master cylinder	Cylinder bore size 1	A	19.05 (0.7500)	
	Diameter of piston 2	A	19.05 (0.7500)	
	Clearance between cylinder and piston	A	0.020 to 0.105 (0.00079 to 0.00413)	
		B	0.15 (0.0059)	
	Primary cup tightness 3	A	1.0 (0.039)	
		B	0.4 (0.016) (Replace every year or whenever overhauling)	
	Secondary cup tightness 4	A	1.1 (0.043)	
		B	0.4 (0.016) (Replace every year or whenever overhauling)	
	Free length of return spring 5	A	59.2 (2.3)	
		B	53.9 (2.1) (Replace every year or whenever overhauling)	
				

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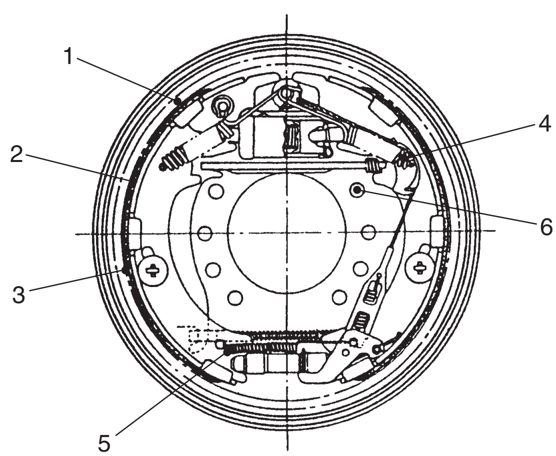
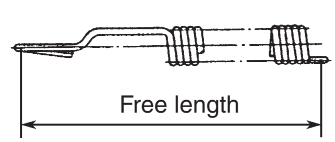
A: Standard value B: Service limit
Unit: mm (in.)

Items			Truck Models	1 ton class	2, 3 ton classes
Wheel brakes	Inside diameter of brake drum 1		A	254.0 (10.00)	310 (12.20)
			B	256 (10.08)	312 (12.28)
	Thickness of lining 2		A	4.87 (0.19)	6 (0.24)
			B	1 (0.039)	3 (0.118) or less
	Clearance between drum and lining 3 (Total)		A	0.5 to 1.0 (0.02 to 0.04)	0.2 to 0.7 (0.01 to 0.03)
	Return spring 4	Free length	A	102 (4.02)	Primary: 120 (4.72) Secondary: 139.3 (5.48)
		Length under set force	A	111 (4.4)	Primary: 134 (5.3) Secondary: 145.5 (5.8)
		Set force N (kgf) [lbf]	A	157 ± 16 (16 ± 1.6) [35 ± 3.6]	Primary: 226 ± 23 (23 ± 2.3) [51 ± 5.2] Secondary: 226 ± 23 (23 ± 2.3) [51 ± 5.2]
	Adjusting spring 5	Free length	A	79 (3.11)	104.5 (4.11)
		Length under set force	A	98.5 (3.9)	122 (4.8)
		Set force N (kgf) [lbf]	A	137 ± 14 (14 ± 1.4) [31 ± 3.1]	78 ± 8 (8 ± 0.8) [18 ± 1.8]
	Tightening torque for backing plate bolt 6 N·m (kgf·m) [lbf·ft]		A	215 (21.9) [158]	215 (21.9) [158]



4 secondary spirng

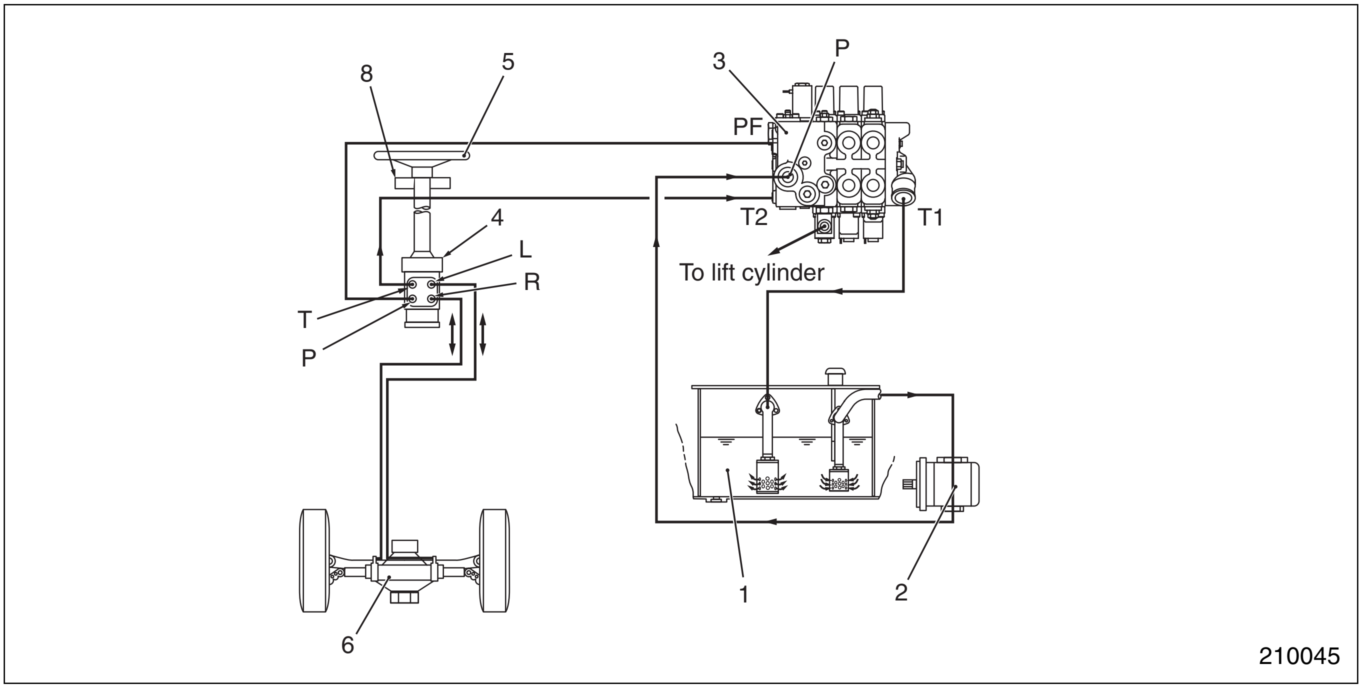


204962

STEERING SYSTEM

Structure and Function

Steering System



Main Components

1 Hydraulic tank
2 Hydraulic pump (Gear pump)
3 Inlet section of hydraulic control valve (Including flow priority valve)
4 Steering valve
5 Steering wheel
6 Steering cylinder
7 Knob control valve
8 Steering sensor

The steering system of this lift truck is full hydraulic. The oil drawn by hydraulic pump 2 from hydraulic tank 1 enters the inlet section of the hydraulic control valve 3 through the P port. There is built-in flow priority valve in the inlet section. The function of the flow priority valve is to deliver pressure oil preferentially to steering valve 4. From the PF port, the oil flows to the P port of the steering valve.

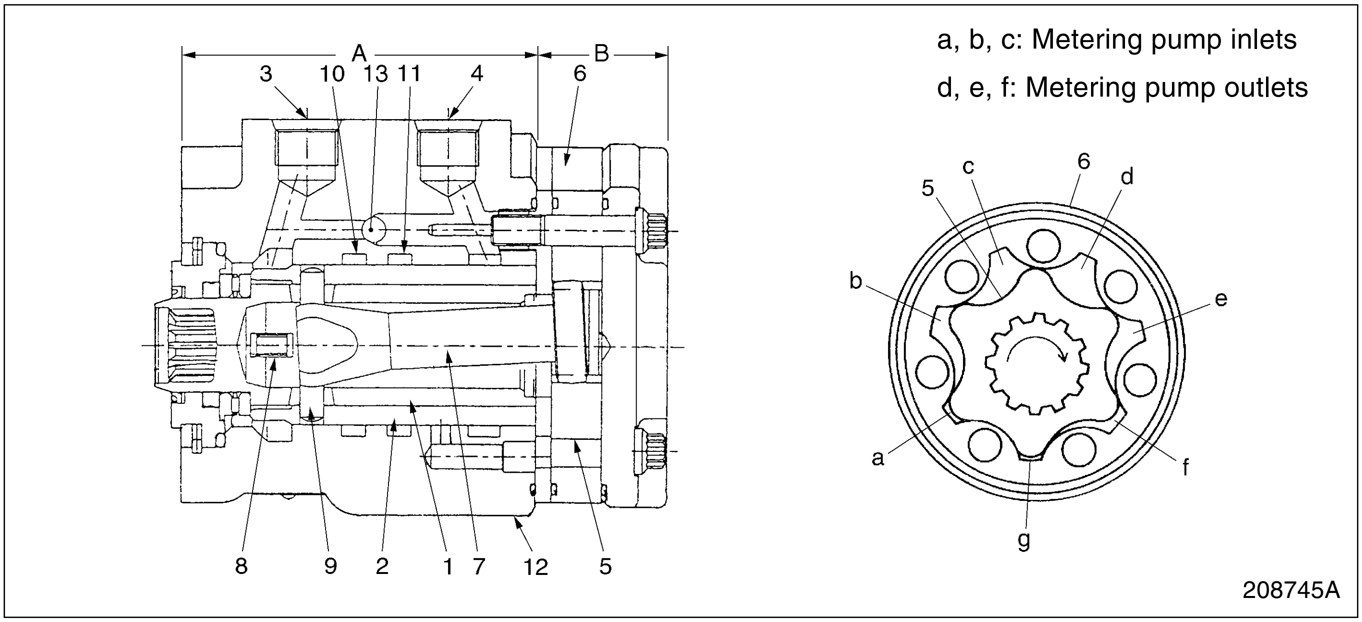
When the steering wheel is not turned (in the straight-ahead position), the oil flows through the steering valve's T port to the T2 port in the hydraulic control valve's inlet section and then returns to hydraulic tank 1.

When the steering wheel is turned, the oil from the PF port enters the "Gerotor" passing through the P port and spool-and-sleeve valve in the steering valve 4. (The Gerotor is a small trochoid pump capable of delivering oil at a rate proportional to the number of turns in which the steering wheel is turned.) The oil delivered from the Gerotor is directed to the left or right chamber of steering cylinder through the L or R port, applying a pressure to the cylinder rod. Simultaneously, the spool-and-sleeve valve in the steering valve 4 opens the return oil passage from the chamber of the steering cylinder to the hydraulic tank 1. (The return oil goes through the steering valve's T port and then the hydraulic control valve 3 to the hydraulic tank 1.)

Two actions of the steering cylinder piston, each of which supplies and returns pressure oil, respectively, extend the cylinder rod to the right or left. These actions turn the knuckle via the tie rod, steering rear wheels.

For the priority valve and the steering cylinder, refer to "GROUP 11 HYDRAULIC SYSTEM" and "GROUP 8 REAR AXLE," respectively.

Steering Gear



1 Spool	7 Drive shaft	A: Control section
2 Sleeve	8 Centering spring	B: Metering section
3 Outlet port (port T)	9 Pin	
4 Inlet port (port P)	10 Left turn port (port L)	
5 Rotor	11 Right turn port (port R)	
6 Rotor ring	12 Housing	

The steering valve consists of two sections: control section A and metering section B.

Control section A includes spool 1, sleeve 2, and housing 12, constituting a rotary type directional control valve. Spool 1 is spline-coupled to the steering shaft. When spool 1 is turned, sleeve 2 rotates, opening the following passages to form a hydraulic circuit:

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

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

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

Metering section B is a trochoid-gear type, small hydraulic pump called “Gerotor” consisting of rotor ring 6 and rotor 5. Spool 1 and rotor 5 are connected to each other with drive shaft 7. The rotor, therefore, turns in the same direction and at the same speed as the steering wheel.

When the operator does not turn the steering wheel, the oil flows from the P port to T port and finally returns to the hydraulic tank. The oil does not flow to the metering section B as it is blocked by the spool 1 and sleeve 2.

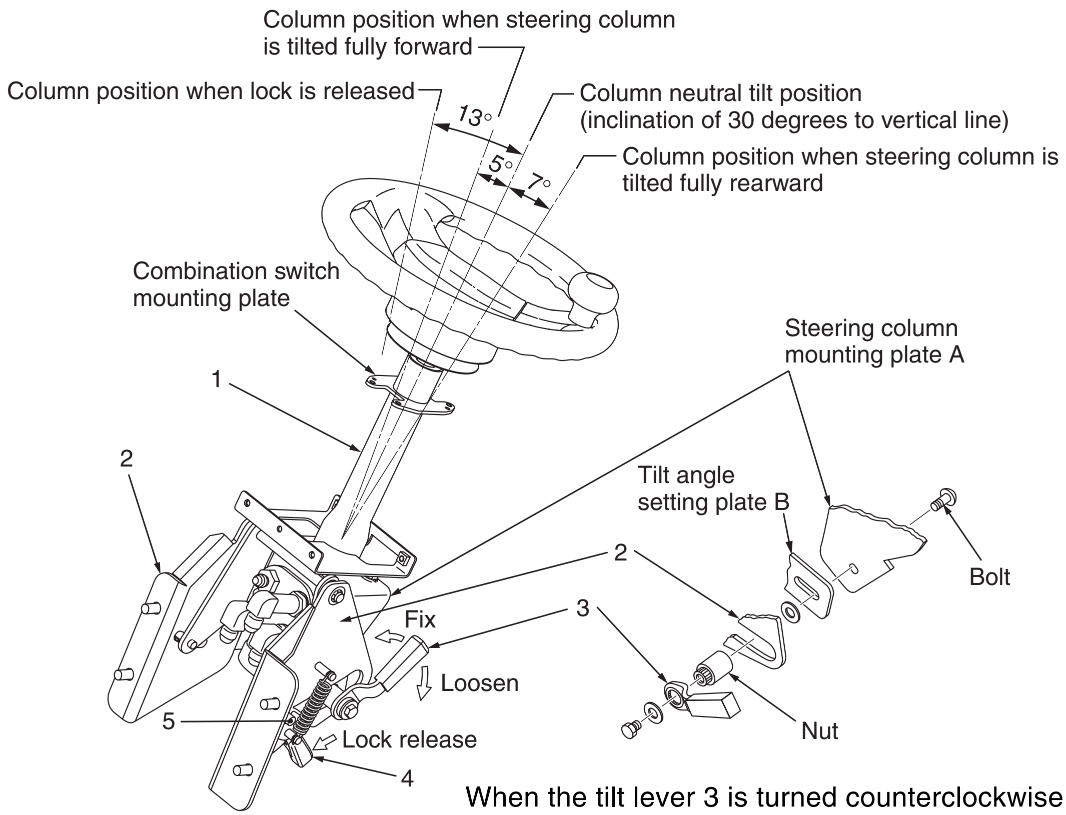
When the operator turns the steering wheel clockwise, the passage in the steering valve opens, allowing pressure oil to flow through inlet port 4 into areas a, b, and c.

As rotor 5 turns together with the steering wheel, the oil in areas d, e, and f is forced into the steering cylinder through right turn port 11. When the steering wheel is turned counterclockwise, oil flows in the direction reverse to the above, entering the steering cylinder through left turn port 10.

Since the pressure oil from port 4 applies rotating force to rotor 5, operator’s effort on the steering wheel is reduced.

Check valve 13 is normally pushed to the left direction by pressure oil in the inlet port, blocking the bypass passage. When oil supply from the PF port of the hydraulic valve stops for any reason, the bypass passage opens, allowing oil from the hydraulic tank to flow to the metering section B. When the operator turns the steering wheel, the metering section acts as a complete manually-operated pump, causing oil to flow to the steering cylinder.

Steering Column



When the tilt lever 3 is turned counterclockwise, the plates A and B are fixed between the bolt and nut.

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Main components

1 Steering column
2 Bracket (secured to truck body)
3 Tilt lock lever
4 Column lock lever
5 Lock pin

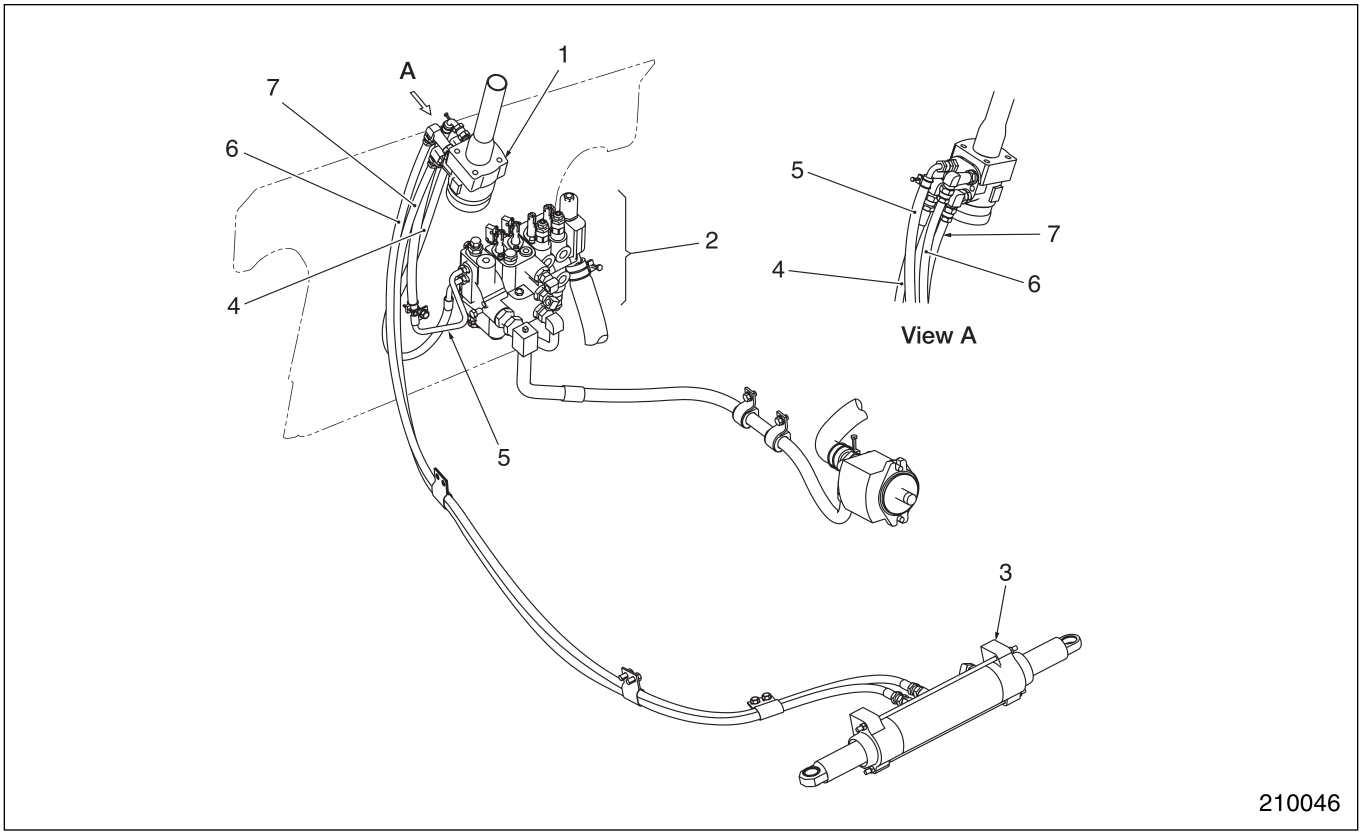
The steering column is tilt adjustable in the range of 5 degrees forward and 7 degrees rearward as shown in the illustration.

For adjustment, lock the column lock lever 4 and then, loosen the tilt lock lever 3 by turning it clockwise. Then, tilt the steering column 1 to an adequate angle and turn the tilt lock lever counterclockwise (pulling up) to lock.

The role of the column lock lever is to tilt the entire column forward by a large amount for the convenience of getting on and off, and of maintenance work. Push down the lock lever to disengage the lock lever 4 from the lock pin 6 and to tilt the steering column forward.

Disassembly and Reassembly

Disassembly and Reassembly of Piping



Main parts or devices

1. Steering valve
2. Hydraulic control valve (The illustration shows MC valve.)
3. Steering cylinder
4. Hose (PF port → steering valve P port)
5. Hose and pipe (steering valve T port → T2 port)
6. Hose (steering valve L port ↔ steering cylinder)
7. Hose (steering valve R port ↔ steering cylinder)

Suggestion for disassembly and reassembly

(1) The important point in maintenance of the hydraulic system is to perform work in a clean place and never allow abrasive foreign substance to enter the system.

(2) O-rings must be replaced, once disturbed.

(3) Hoses (especially high-pressure section) of the steering system are safety related parts. Replace them with new ones after a lapse of a predetermined time interval regardless of the presence or absence of damage. For a replacement interval, follow the “Operation & Maintenance Manual”.

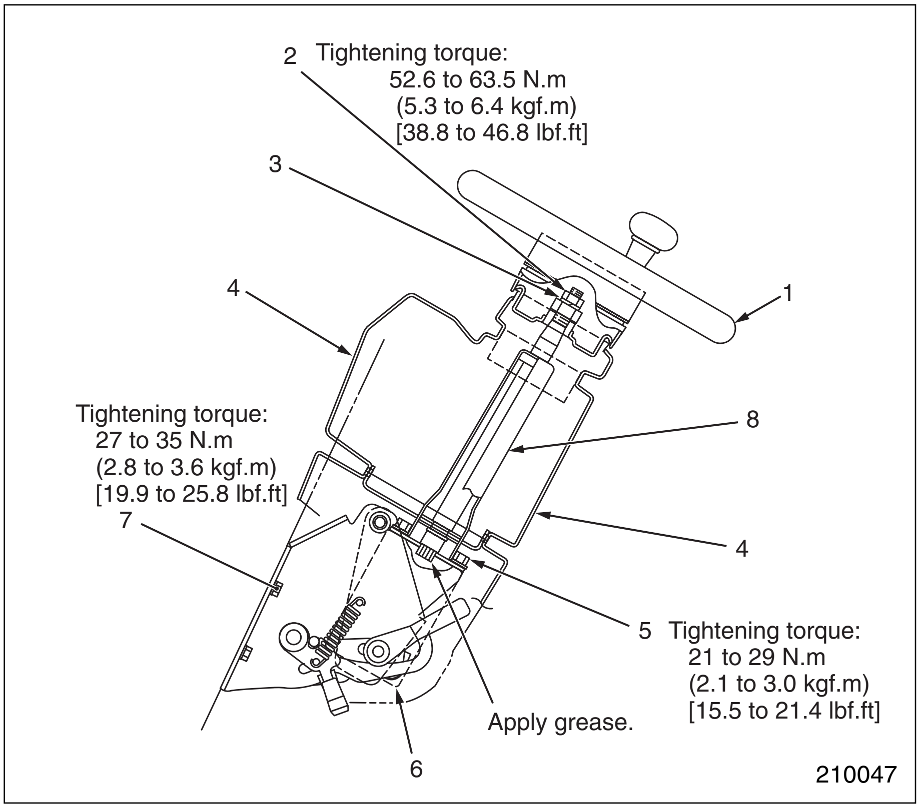
(4) When removing or installing hoses, use a double spanner as needed to prevent excessive force from being applied to the matching fittings.

(5) Bleed air after reassembly. Air bleeding method is as follows.

(a) Raise the rear tires by placing blocks under the truck body.

(b) While changing the engine revolution by depressing the accelerator pedal, turn the steering wheel lock-to-lock and relieve pressure to bleed air.

Removal and Installation of Steering Wheel and Steering Valve



Disassembly sequence

1. Steering wheel
2. Nut
3. Spring washer
4. Cover
5. Steering valve mounting bolt
6. Steering valve
7. Steering column assembly mounting bolt
8. Steering column assembly

1. Steering wheel

Removal

(1) Remove the horn button.

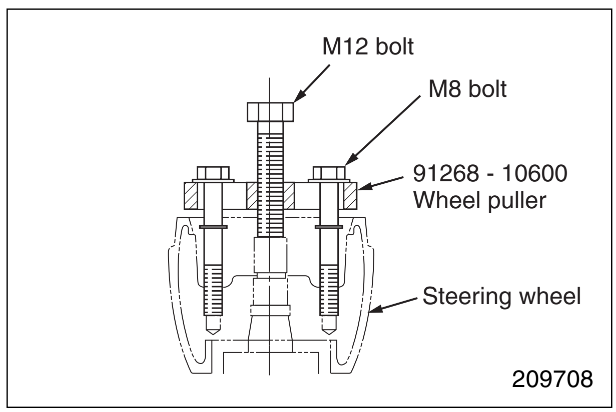
(2) Remove the steering wheel nut 2 and then, remove the steering wheel 1 using a wheel puller.

Special tool needed

Wheel puller	91268 - 10600

⚠ CAUTION

When removing the steering wheel, do not tap the top end of the steering shaft.



Wheel puller setting

Steering wheel

Installation

Install in the following sequence.

(1) Place the projection (a) on the steering sensor of the combination switch at the front as shown in the illustration.

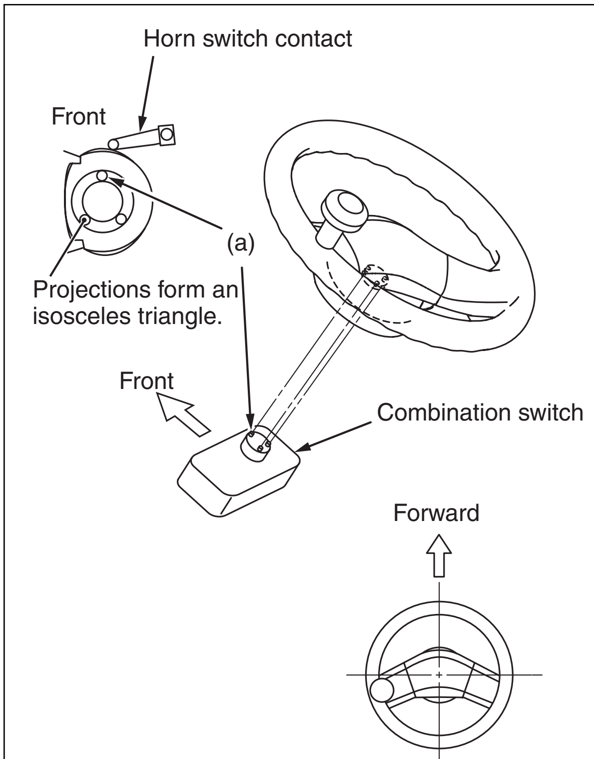
(2) Apply a light coating of grease to a sliding area of the horn contact under the steering wheel boss.

(3) Reassemble the steering wheel in a straight-ahead position. (The projections of the combination switch fit into the pits on the steering wheel.) Completely fit the projections into the pits by turning the steering wheel in the right and left directions several times.

(4) Before tightening the steering wheel nut, check that automatic return of the combination switch functions.

(5) If automatic return does not function, repeat the sequence (3) and (4) above.

(6) Tighten the steering wheel nut to the specified torque.



209709

Inspection after Installation

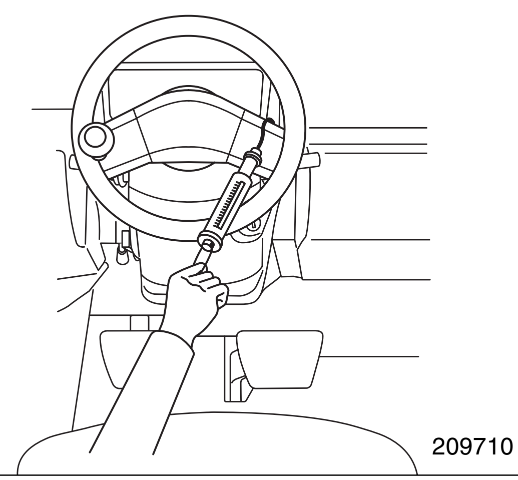
Steering effort

(1) Pull the hand brake lever.

(2) Run the engine to warm the hydraulic oil to an operation temperature of 40 to 60 °C (104 to 140 °F)

(3) Attach a spring scale to the rim (or a spoke) of the steering wheel, and measure the steering effort required to turn the steering wheel clockwise or counterclockwise from the straight-ahead position.

Steering effort (tangential force)	13 N (1.3 kgf) [2.87 lbf]


209710

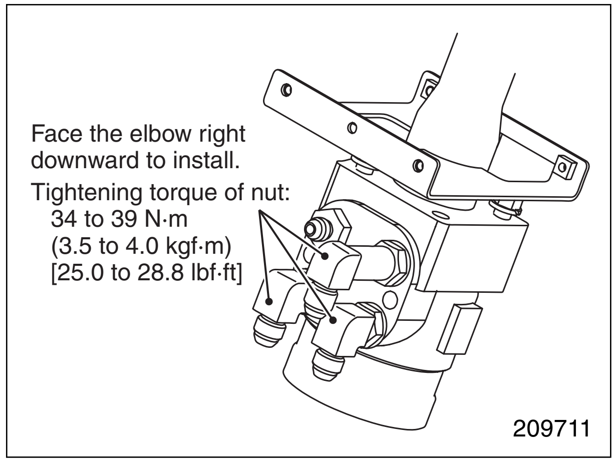
2. Steering valve

Removal

(1) Remove the cover 4 around the steering column.

(2) Disconnect four hoses connected to the steering valve.

(3) Remove the bolt 5 and then, remove the steering valve 6.



Installation

Follow the sequence of disassembly in reverse, paying attention to the following points.

(1) Apply grease to the serration area on the lower part of the steering shaft.

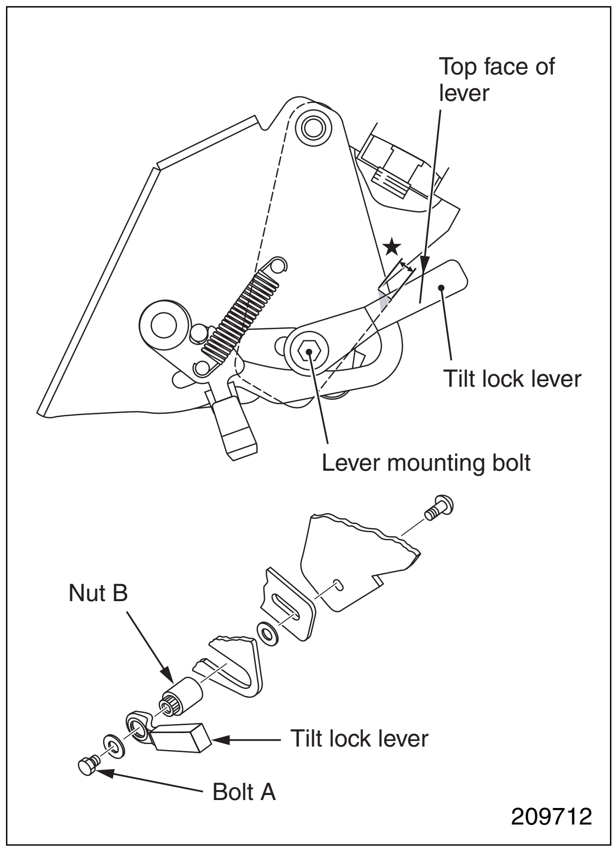
(2) Tighten the mounting bolt to the specified torque.

(3) Be careful about the orientation when installing the elbow on the steering valve. Tighten it to the specified torque.

3. Tilt lock lever

Disassembly

1. Put match marks on the tilt lock lever and the nut B for convenience of reassembly.
2. Remove the bolt A and then, remove the tilt lock cover.



Reassembly

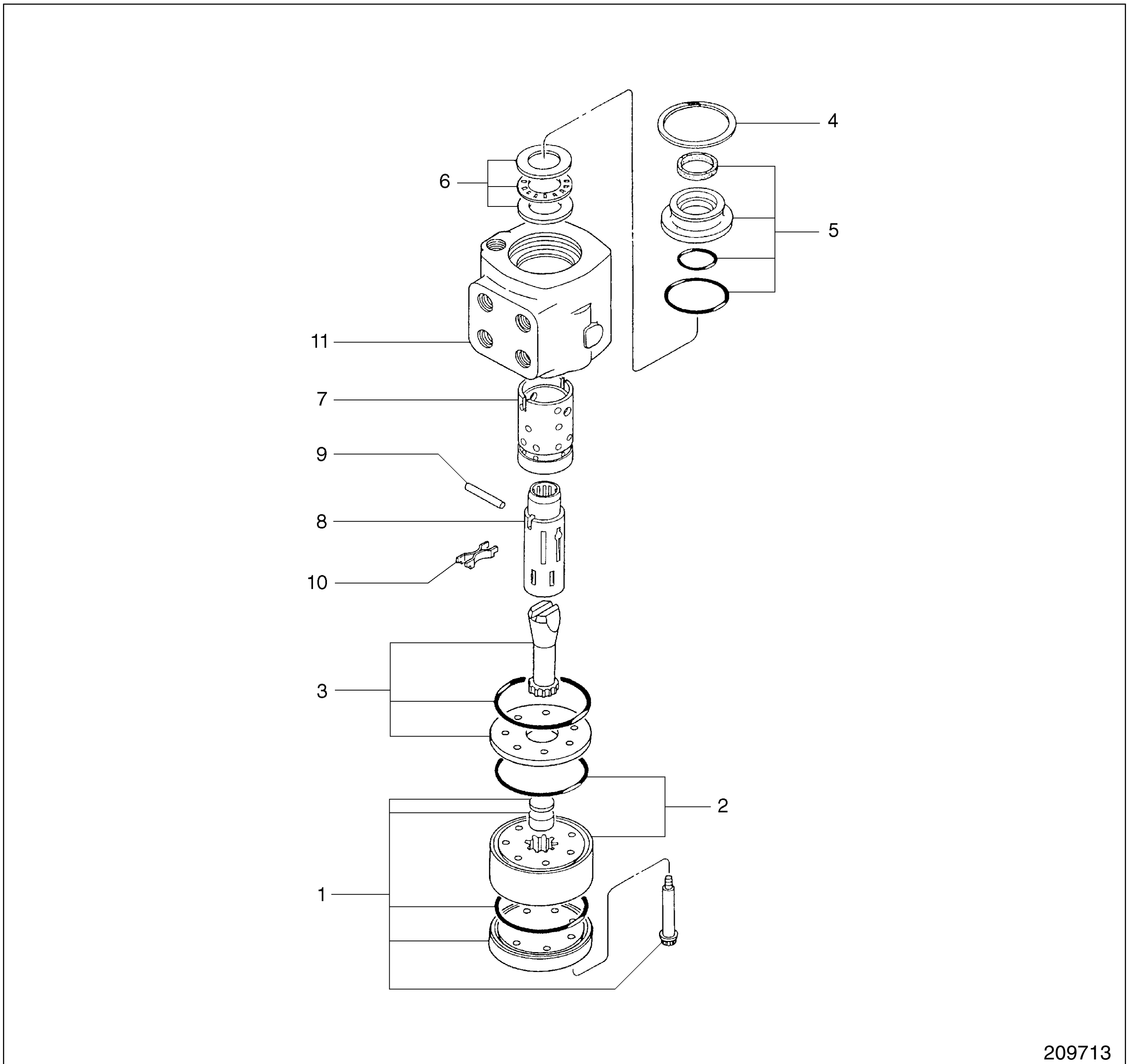
When match marks put at the time of disassembly disappear or when the lever is replaced with a new one, install the lever in the following sequence. (The illustration on the right shows the layout of related parts when the tilt position is neutral and the column lock lever is locked.)

1. Tighten the nut B to the tightening torque of 11 to 15 N·m (1.1 to 1.5 kgf·m) [8.1 to 11.1 lbf·ft]. (This represents a lever-locked condition.)
2. Select the optimal position for the tilt lock lever in a locked condition and fit the tilt lock lever into the serration of the nut B.

   The optimal position is in an area where the "★" notch on the bracket and the top face of the lever cross each other.
3. Tighten the bolt A.
4. Loosen the tilt lock lever and check that the bracket slides in the entire tilting area without interfering with other parts.

Steering Valve

Disassembly



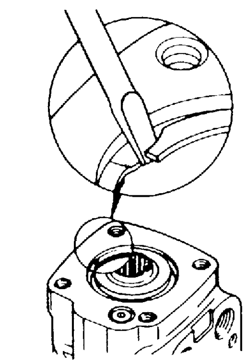
Sequence

1 End cap, Bolts, O-ring, Spacers
2 "Gerotor" set, O-ring
3 Drive shaft, Spacer plate, O-ring
4 Retaining ring
5 Seal gland bushing, O-ring, Oil seal, Dust seal
6 Thrust needle, Race bearing
7 Control sleeve
8 Control spool
9 Pin
10 Centering springs
11 Long housing

Suggestions for Disassembly

(1) Retaining ring removal

Remove the ring from the housing by prying its end out of the groove. Do not damage the machined surface.



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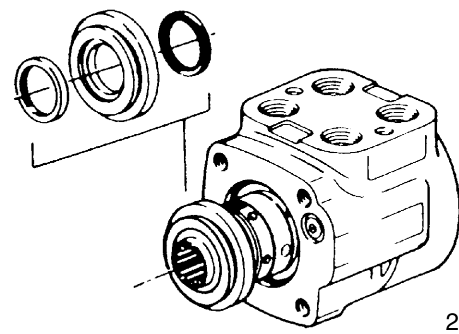
(2) Seal gland bushing removal

Position the control spool and control sleeve assembly so that the pin is even with the center of the assembly.
Remove the gland bushing.



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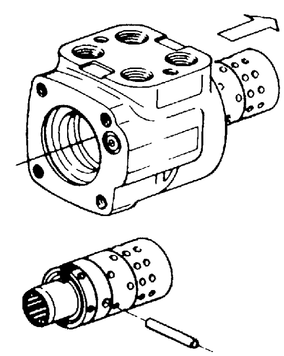
(3) Control spool and sleeve removal

Remove the control spool and sleeve assembly from the housing by pulling it toward the end of the housing opposite to the flange. Remove the pin from the assembly.

⚠ CAUTION

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



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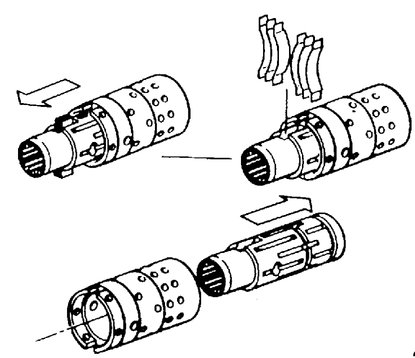
(4) Control spool and sleeve disassembly

⚠ CAUTION

Before removing the spool from the sleeve, put a mark across the spool and sleeve so that the spool can be installed in the same position.

Pull the control spool from the sleeve enough to permit removal of the centering springs. Remove the centering springs. Remove the spool from the sleeve by pulling it toward the rear end of the sleeve while turning slowly.



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Inspection after disassembly

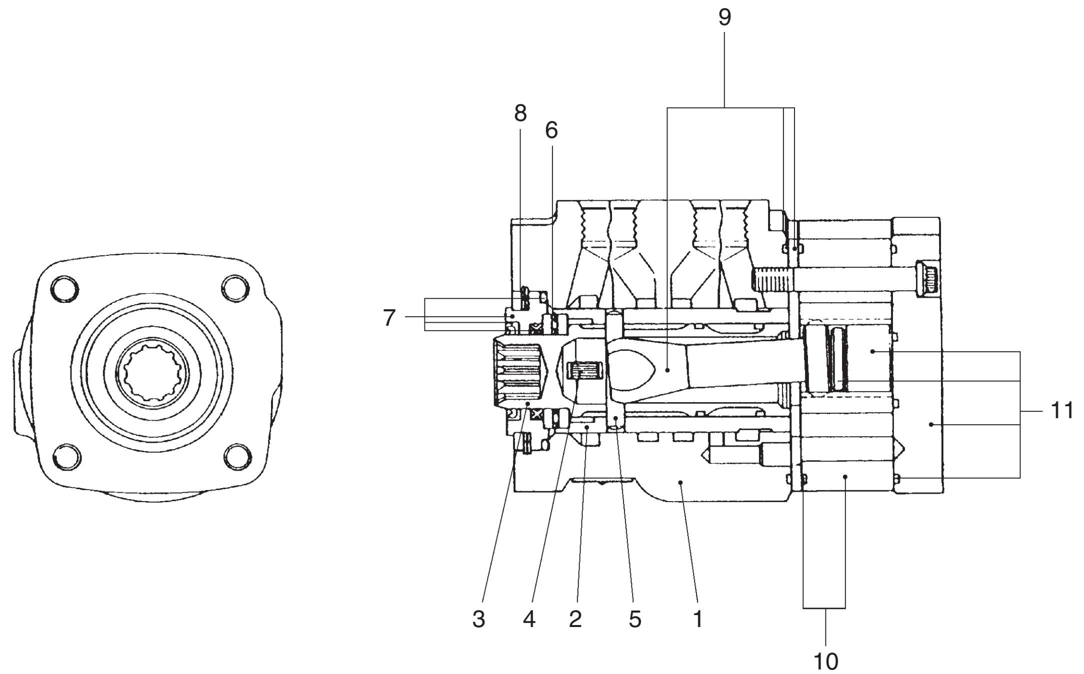
(1) Check sliding areas between the sleeve and the housing and between the sleeve and the spool.

(a) Check for sliding movement in sub-assembly condition.

(b) If any defective movement is found, check sliding surfaces.

If any defect such as abnormal wear, scratch, burr or rust is found, replace the entire unit with a new one.

Reassembly



Sequence

1 Long housing
2 Control sleeve
3 Control spool
4 Centering springs
5 Pin
6 Thrust needle, Race bearings
7 Seal gland bushing, Oil seal, Dust seal, O-ring
8 Retaining ring
9 Drive shaft, Spacer plate, O-ring
10 “Gerotor” set, O-ring
11 End cap, O-ring, Spacer, Bolts

⚠ CAUTION

Perform the following preparatory work before reassembly.
(1) For damaged parts, prepare new parts for replacement.
(2) Clean all metal parts, blow off foreign substances with compressed air and dry them.
(3) Prepare new parts for an O-ring seal and lip seal included in a seal kit.

⚠ CAUTION

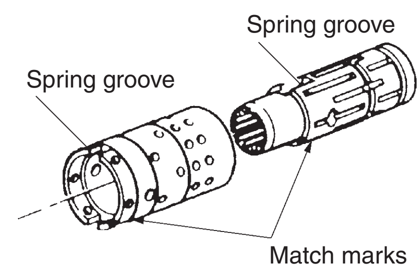
Precautions during reassembly
(1) Reassemble each part while applying a light coating of oil to them.
(2) Apply grease to O-rings.
(3) Do not wear cloth gloves when reassembling. Lint may enter the valve.

Suggestion for Reassembly

(1) Reassembly of control spool and sleeve

Check the direction in which the spring groove of the sleeve is aligned with that of the spool and then, slide the spool into the sleeve while twisting the spool.

If there are any match marks put at the time of disassembly or marks put by a manufacturer, check such marks.



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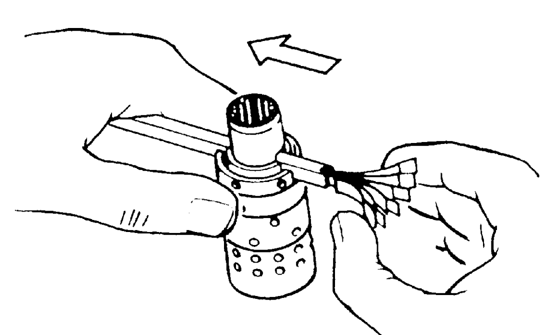
⚠ CAUTION

Check that the control spool rotates smoothly in the control sleeve.

(2) Installation of centering springs

Align the spring grooves of the spool-and-sleeve and stand the spool-and-sleeve on a flat bench. Use the spring inserting tool to install springs. Place each set of three springs back to back and pinch six springs in the tool with notches on both sides facing downward. See the illustration on the right.

As shown in the illustration, push one end of the springs with fingers and push the springs into the spool-and-sleeve groove. In case there is no inserting tool, assemble the springs by inserting them one by one and right and left alternately.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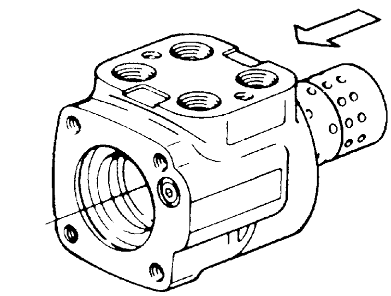
Spring inserting tool	97157 - 00100

(3) Insertion of the control spool-and-sleeve assembly into the housing

Insert the pin into the hole of the control spool-and-sleeve assembly and align both ends of the pin with the outside diameter of the sleeve. Insert the spool-and-sleeve assembly into the housing from the rear (in the direction as shown in the illustration).

Insert the spool-and-sleeve assembly while slowly twisting it with the pin kept at a horizontal position. Insert the spool-and-sleeve assembly until its rear edge face becomes flush with the edge face of the housing. Do not insert any further.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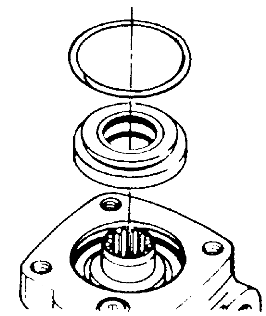
(4) Installation of thrust bearing

(5) Installation of seal gland bushing and seals

(a) Install the dust seal on the seal gland bushing to place the flat side facing the bushing. Then install the oil seal in the bushing.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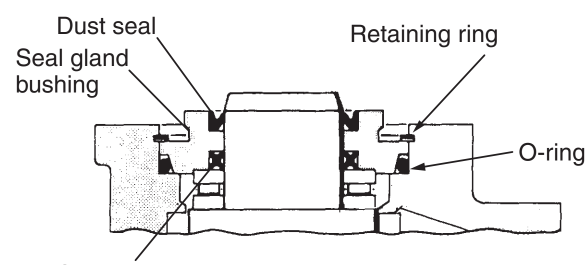
(b) After installing the O-ring, fit the seal gland bushing into the spool while turning the seal gland bushing. Drive the bushing into the specified position by a plastic hammer. Check that the bushing contacts the top face of the thrust bearing race evenly.

Securely fit the retaining ring into the housing groove.



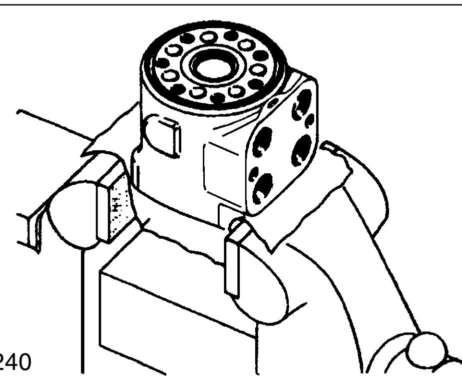
209715

(6) Reassembling the spacer plate

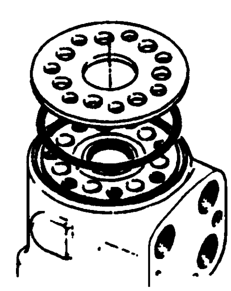
(a) Clamp the housing in a vise, equipped with soft jaws or softened with rag. Clamp lightly over the flats of the flange. Do not overtighten the vise jaws.

NOTE

Check that the spool and sleeve are flush with or slightly below the surface of the housing.


208240

(b) Install the O-ring in the housing. Place the spacer plate on the housing and align the bolt holes with the tapped holes in the housing.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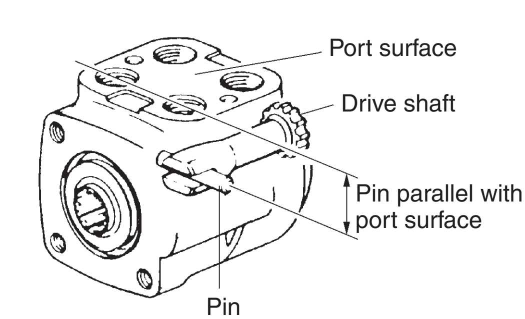
(7) Reassembling the drive shaft

Turn the control spool-and-sleeve assembly to make the port surface of the housing parallel with the pin. Insert the drive shaft to engage the pin in the yoke of the drive shaft. To insure positioning in the following work process, draw a line such as line B in the illustration right below on the end face of the drive shaft spline with a felt-tip pen.



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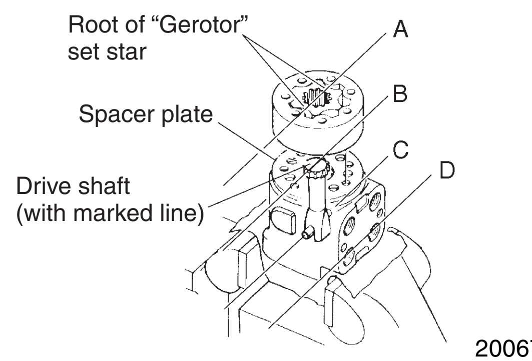
(8) Reassembling the gerotor set

Face the O-ring side of the rotor set toward the spacer plate side and fit the rotor set into the drive shaft by aligning the root (line A) of the rotor set with line B of the drive shaft.

Check that lines A, B, C, and D are in parallel with each other.

Align bolt holes of the "Gerotor" set with the drive shaft and star kept engaged.

This procedure is important in determining the valve timing of this unit.



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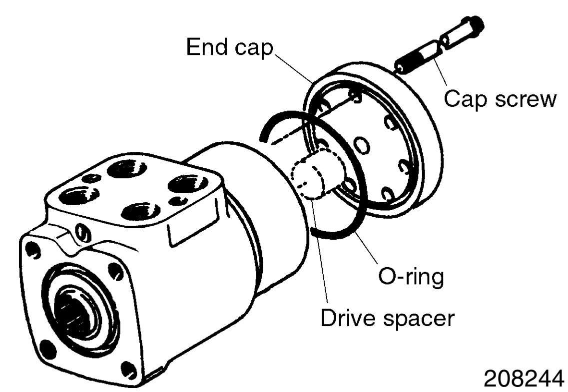
(9) Reassembling the end cap

Install the drive spacer in the gerotor set. Install the O-ring in the end cap. Install the end cap in the gerotor set and align the holes.



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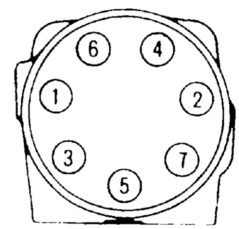
Apply oil to bolt threads and tighten bolts evenly in the sequence as shown in the illustration on the right. The tightening torque is shown in the table below.

Install the steering shaft in the spool and check that the spool turns smoothly.

Tightening torque of end cap mounting bolt	28.4 N·m (2.9 kgf·m) [2.1 lbf·ft]



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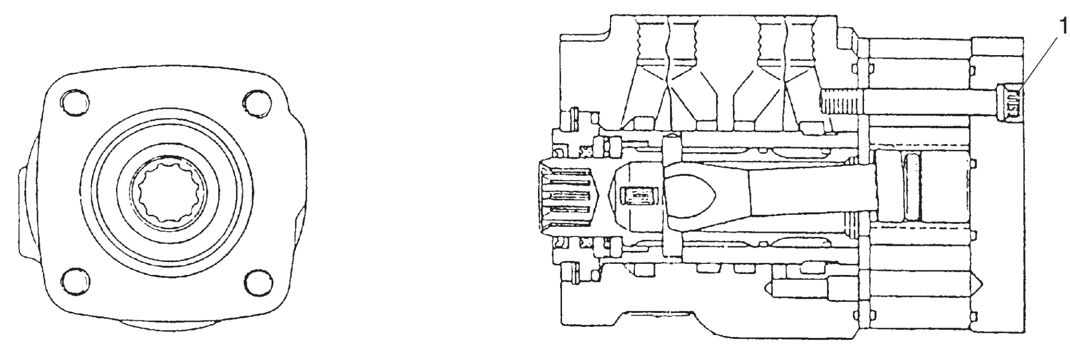
Troubleshooting

- **Stiff steering wheel operation**
  - Defect in flow priority valve
    - No steering flow
      - (1) Foreign materials clogged in spool pit — Disassemble and clean.
      - (2) Fatigued or damaged spring in the spool — Replace spring.
    - Malfunction of relief valve
      - (1) Low relief pressure — Adjust relief pressure.
      - (2) Damaged valve seating surface — Replace valve assembly.
      - (3) Fatigued or damaged spring — Replace springs and adjust relief pressure.
    - Oil leak from relief valve
      - (1) Damaged O-rings on the valve body circumference — Replace O-rings.
  - Defect in steering valve
    - Clogging in "Gerotor" — Disassemble and clean.
    - Malfunction by spool seizure due to foreign material — Replace.
    - Damaged bearing — Replace.
    - Excessive tightening of end cap bolt — Reassemble.
  - Defect in steering cylinder
    - Bent piston rod — Repair or replace.
    - Faulty piston seal — Replace.
  - Misalignment
    - Faulty installation of steering valve to tilt column — Readjust.
  - Other defects
    - Flattened pipe — Replace.
- **Unstable steering operation**
  - Defect in steering valve
    - Seizure of spool or sleeve — Replace.
    - Breakage of centering spring — Replace.
  - Other defects
    - Trapped air — Bleed.
    - Flattened pipe — Replace.
    - Faulty piston seal of steering cylinder — Replace.

Service Data

A: Standard value

Items \ Truck Models			1 ton class	2 ton class	3 ton class
Steering effort (at steering wheel rim) N (kgf) [lbf]		A	13 (1.3) [2.9] or less	13 (1.3) [2.9] or less	13 (1.3) [2.9] or less
Tightening torque of steering wheel nuts N·m (kgf·m) [lbf·ft]		A	52.6 to 63.5 (5.3 to 6.4) [38.8 to 46.8]	52.6 to 63.5 (5.3 to 6.4) [38.8 to 46.8]	52.6 to 63.5 (5.3 to 6.4) [38.8 to 46.8]
Tightening torque of steering bracket bolts N·m (kgf·m) [lbf·ft]		A	27 to 35 (2.8 to 3.6) [20.0 to 25.8]	27 to 35 (2.8 to 3.6) [20.0 to 25.8]	27 to 35 (2.8 to 3.6) [20.0 to 25.8]
Steering valve	Displacement cc (cu in.)/rev.	A	69 (4.2)	96 (4.2)	120 (7.3)
	Rotating torque in normal operation N·m (kgf·m) [lbf·ft]	A	1.5 (0.2) [1.1]	1.5 (0.2) [1.1]	1.5 (0.2) [1.1]
	Tightening torque of cap bolt 1 N·m (kgf·m) [lbf·ft]	A	28.4 (2.9) [20.9]	28.4 (2.9) [20.9]	28.4 (2.9) [20.9]
Steering system relief valve set pressure MPa (kgf/cm^2) [psi]		A	$8.8^{+0.5}_{0}$ ($90^{+5.1}_{0}$) [$1276.5^{+72.5}_{0}$]	$10.3^{+0.5}_{0}$ ($105^{+5.1}_{0}$) [$1494.1^{+72.5}_{0}$]	$10.3^{+0.5}_{0}$ ($105^{+5.1}_{0}$) [$1494.1^{+72.5}_{0}$]

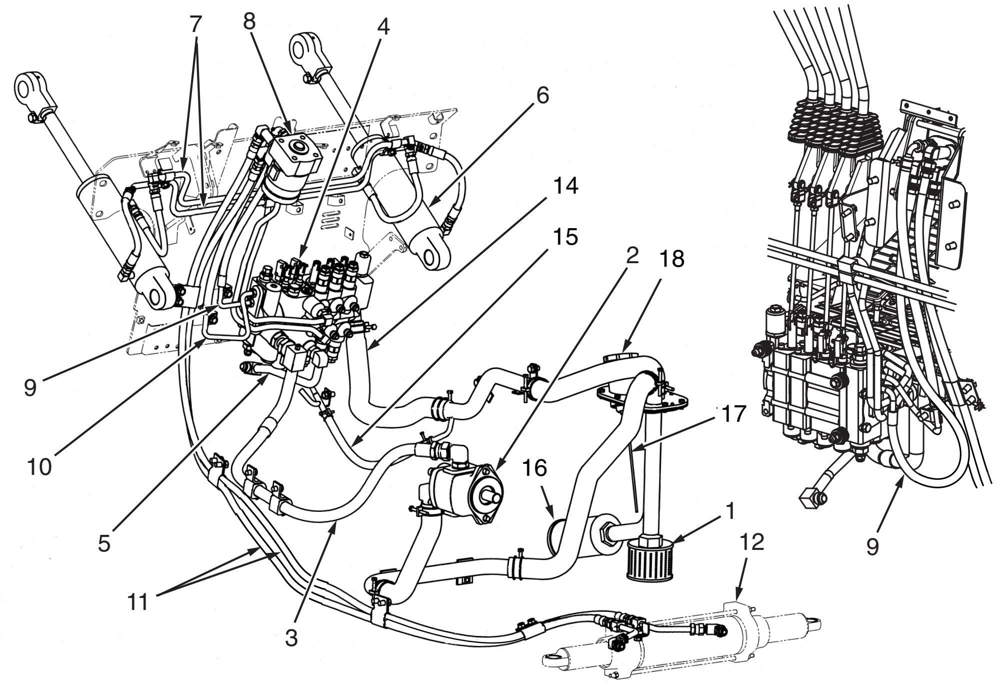


209716

HYDRAULIC SYSTEM

Structure and Functions

Outline



The illustrations show the load handling (pump motor) hydraulic system on a 2 ton class truck with S4S diesel engine and MC valves.

210048

Main components

1 Pump suction strainer:
150-mesh metal strainer

2 Hydraulic pump (gear pump):
A regular gear pump is directly coupled to the engine PTO. See the "Hydraulic Pump" section for details.

3 Hydraulic pump delivery hose:
The shape of this hose for the diesel-engine models is different from that of the gasoline-engine models, as the hydraulic pump locations of these two models are different.

4 Hydraulic control valve:
All trucks come standard with an MC valve, but an FC valve is also available as an option. The MC valve has a built-in flow regulator valve, but the FC valve does not.
MC trucks and FC trucks have roughly the same piping. See the "Piping" section (page 13-31) for details.

5 Oil feed line to lift cylinder:
FC trucks have a flow regulator valve in a downstream section of this line. This line also has a hydraulic pressure sensor.

6 Tilt cylinder

7 Piping to tilt cylinder

8 Steering valve

9 Oil feed line to steering valve P port:
This line constitutes a part of the PF flow passage. In trucks with wet-type single-disc clutches, the PF flow is directed through line 9 into flow divider valve 14, where it is distributed to the steering system and the wet clutch system (see the illustration on the right above).

10 Return line from steering valve

11 Oil feed line to steering cylinder

12 Steering cylinder

13 Flow divider valve:
This valve allows a certain amount of the PF flow from line 9 to flow into the booster of the wet clutch. The remainder of the PF flow is passed on to the steering valve.

14 Return line

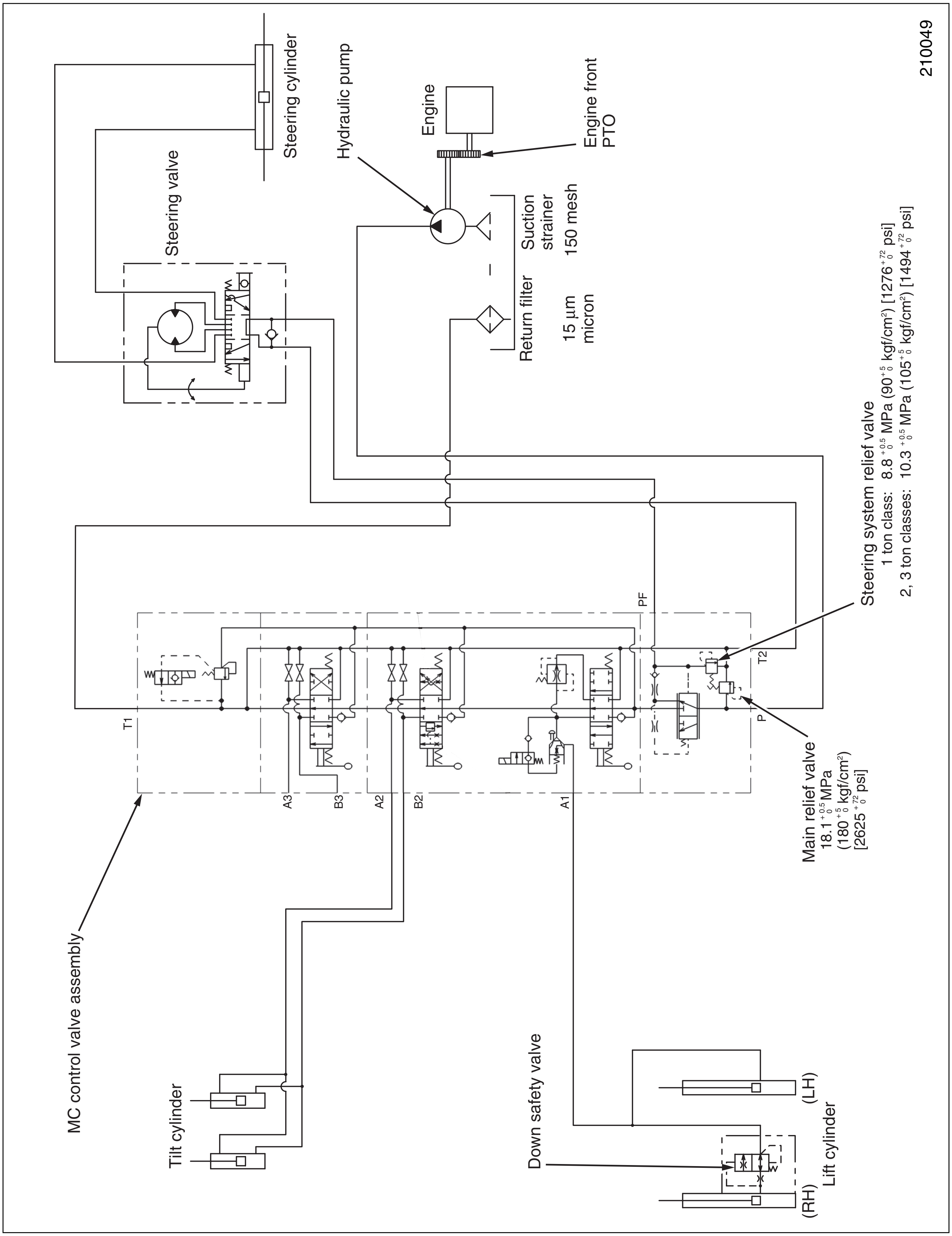
15 Line leading to top of lift cylinder piston:
This line is only installed in trucks that have a lift cylinder with a return line. It is not installed in trucks with 3.3 m (10.8 ft) or smaller lift. If this line is not installed, the branching hole from return line 16 is closed with a blind plug.

16 Return filter:
This cartridge-type filter should be replaced at every oil change.

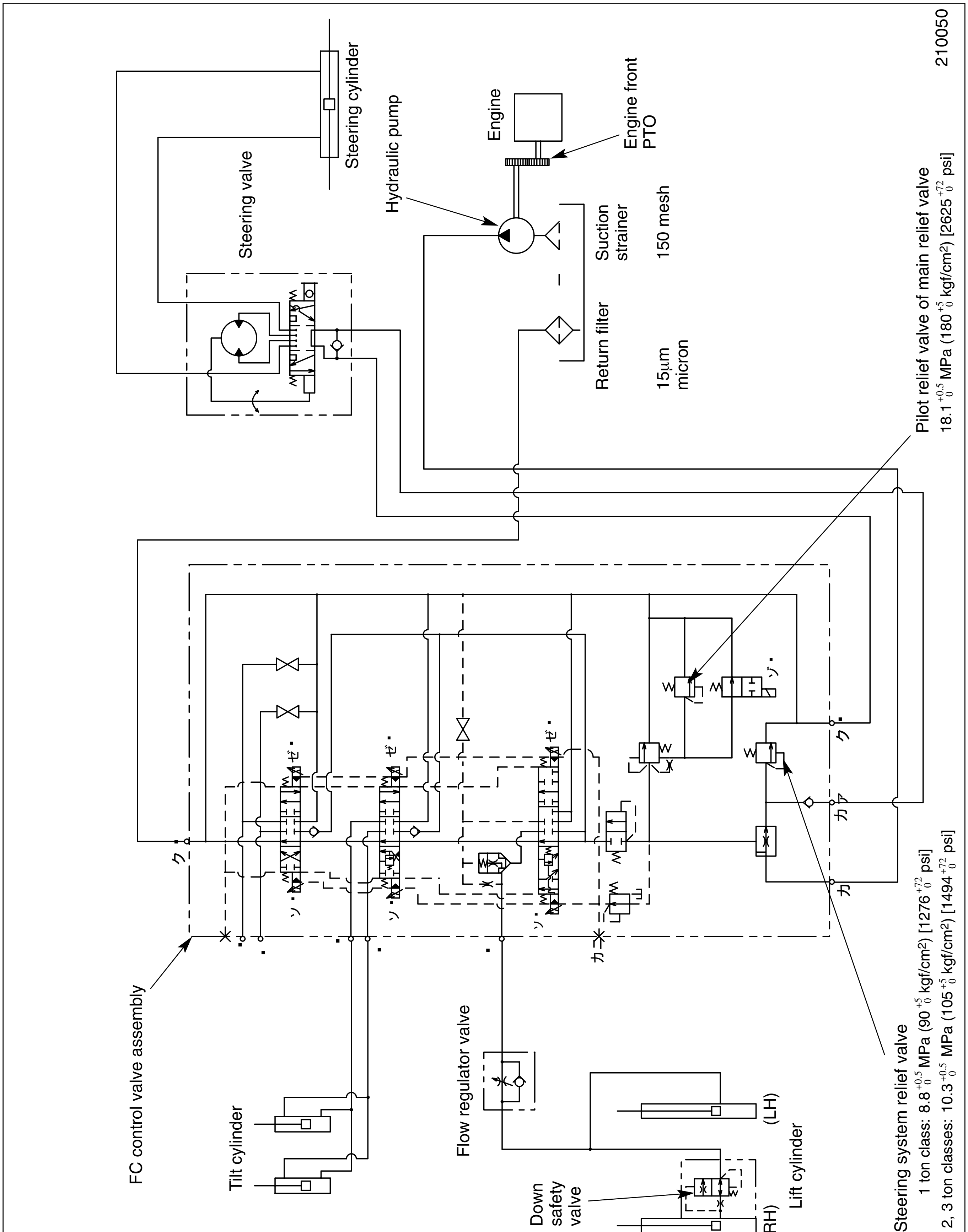
17 Level gauge

18 Oil filter cap

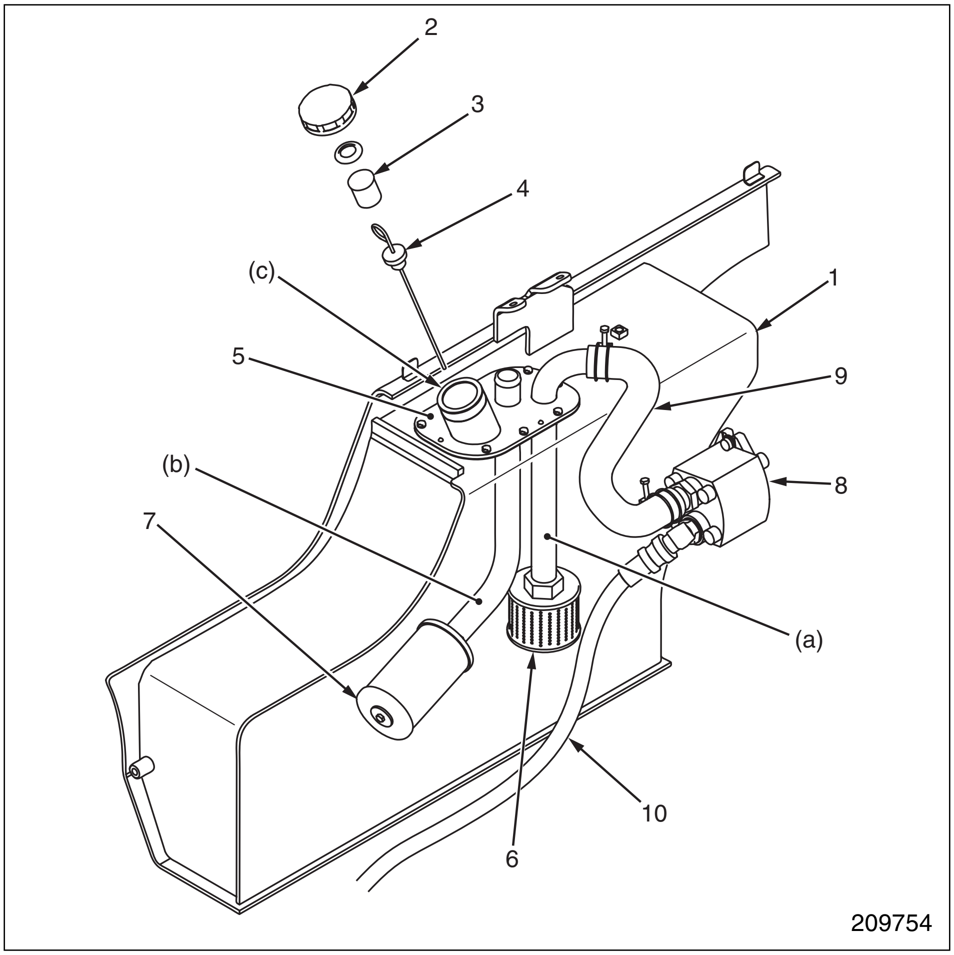
Hydraulic Circuit Diagram (for trucks with MC control valve)



Hydraulic Circuit Diagram (for trucks with FC control valve)



Hydraulic Tank



Main components

1 Hydraulic tank
2 Cap
3 Element
4 Level gauge
5 Tank cover
Parts welded to tank cover
(a) Suction pipe
(b) Pipe for return line
(c) Pipe for level gauge
6 Suction strainer
7 Return filter
8 Hydraulic pump
9 Pump suction line
10 Pump delivery line

The hydraulic tank is located in the center of the right side of the frame and composes a part of the frame structure.

Three pipes of (a), (b) and (c) are welded to tank cover 5 and to the end of each pipe are installed suction strainer 6, return filter 7, level gauge 4 and cap 2. Therefore, parts in the tank can be taken out as an assembly if the tank cover is removed. Replacement of the filter and cleaning of the strainer can be easily carried out if tank cover 5 is removed.

Level gauge 4 is inserted in pipe for a level gauge (c) and the opening of pipe (c) is blocked with cap 2 with an element.

Air moving in and out of the tank caused by fluctuation of oil level in the tank during operation occurs through two air holes provided on the side of cap 2. Element 3 assembled in cap 2 is a filter to prevent outside polluted air from entering the tank.

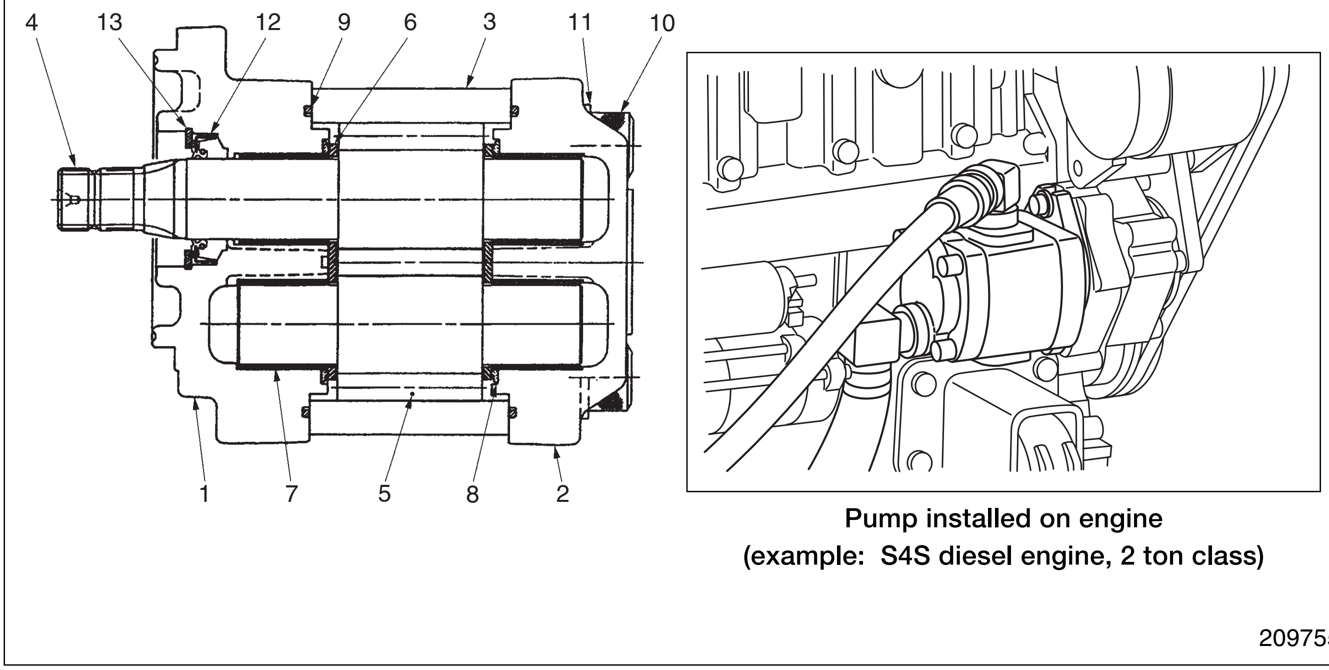
Return filter 7 is attached to the end of return pipe (b). The return filter is a cartridge type of 15 μm with an integral relief valve. When the filter is clogged, the relief valve activates and discharges unfiltered oil to the tank. Periodic replacement is important. In case of a new truck or a large-scale overhaul involving parts replacement, replacement of the oil filter after the first month is recommended.

Suction strainer 6 of the pump is 150 mesh screen gauze. When replacing oil, clean the suction strainer.

In case of a wet-type single disc clutch truck, the return oil line is installed to the side of the tank.

The drain plug is installed to the bottom of the tank.

Hydraulic Pump (Gear Pump)



Pump installed on engine
(example: S4S diesel engine, 2 ton class)

1 Front cover
2 Rear cover
3 Body
4 Drive gear
5 Driven gear
6 Side plate
7 Bushing
8 Gasket (shaped like 3)
9 Gasket
10 Hexagon socket head bolt
11 Washer
12 Shaft seal
13 Snap ring

Type of pump

The pump in a standard truck is a single-gear pump as shown in the above illustration.

A low-noise type pump is available as an option. This low-noise type has reduced noises produced by discharge pressure pulsation by making backlash between gears smaller, and thus leak amount between gears smaller compared to a normal type. The appearance and structure of the low-noise type are the same as those of the standard type except for the number of teeth.

Installation of pump

The pump is directly installed to the engine front PTO, but are reversed left to right sides for a gasoline engine and a diesel engine.

- Gasoline engine: The pump is installed to the left side viewed from the flywheel side.
- Diesel engine: The pump is installed to the right side viewed from the flywheel side.

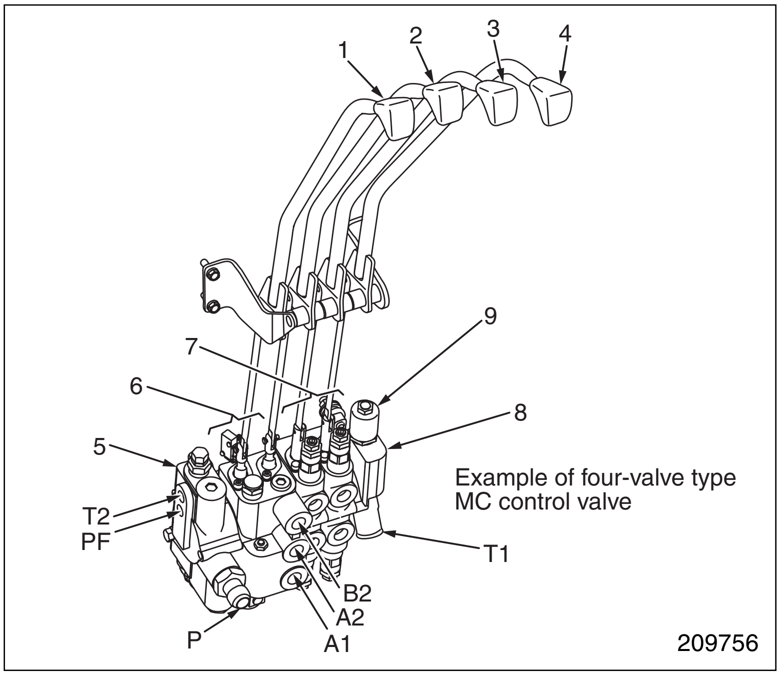
Piping around pump

As the installed location of the pump is different between the gasoline engine and diesel engine, shapes of the suction piping and delivery piping around the pump are different.

Control Valve

There are two types of control valves: MC control valve and FC control valve.

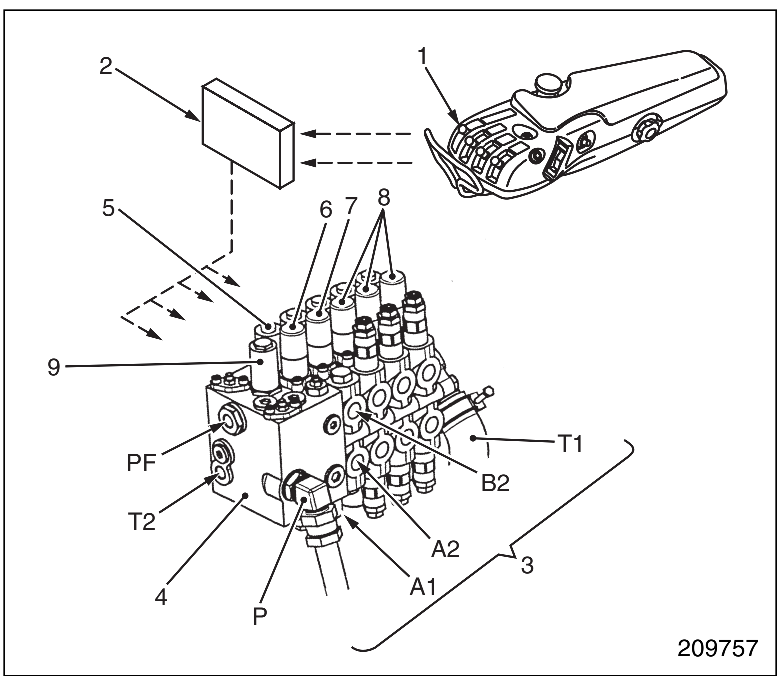
MC control valve



1 Lift control lever
2 Tilt control lever
3 Attachment (#1) control lever
4 Attachment (#2) control lever
5 Inlet cover section (with built-in flow priority valve)
6 Combination section (with built-in lift valve, tilt valve and flow divider valve)
7 Attachment section
8 End section (with built-in unloader valve [9])
9 Unloader valve (with solenoid)
P: Inflow port of pump pressure oil
PF: Supply port of pressure oil to steering system
T1: Return port to tank
T2: Return port from steering system
A1: Port to lift cylinder
A2: Port to tilt cylinder rod
B2: Port to tilt cylinder head

Most parts of this hydraulic valve move mechanically. When the operator moves the control levers (1 through 4), the spool valve moves up and down and supplies and returns pressure oil to corresponding hydraulic cylinders. For detailed structure and operation, and disassembly and reassembly, refer to the "MC Control Valve" section (pages 13-44 to 13-59).

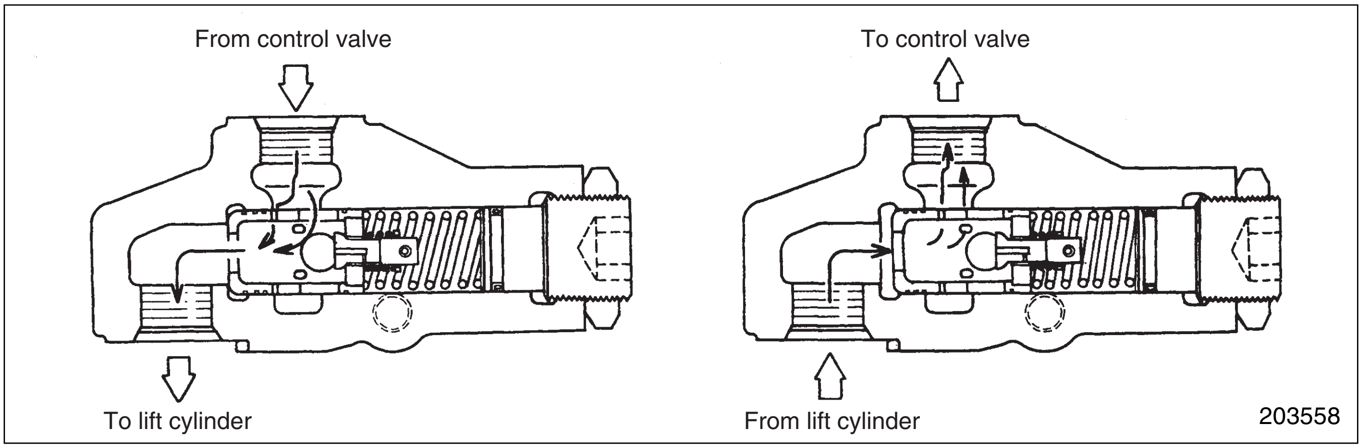
FC control valve



1 FC control box
2 VCM (vehicle control module)
3 FC control valve assembly
4 Inlet section (with built-in priority valve and lift valve)
5 Electromagnetic type proportional pressure reducing valve
6 Lift valve
7 Tilt valve
8 Attachment valve
9 Unloader valve (with solenoid)
P: Inflow port of pump pressure oil
PF: Supply port of pressure oil to steering system
T1: Return port to tank
T2: Return port from steering system
A1: Port to lift cylinder
A2: Port to tilt cylinder rod
B2: Port to tilt cylinder head

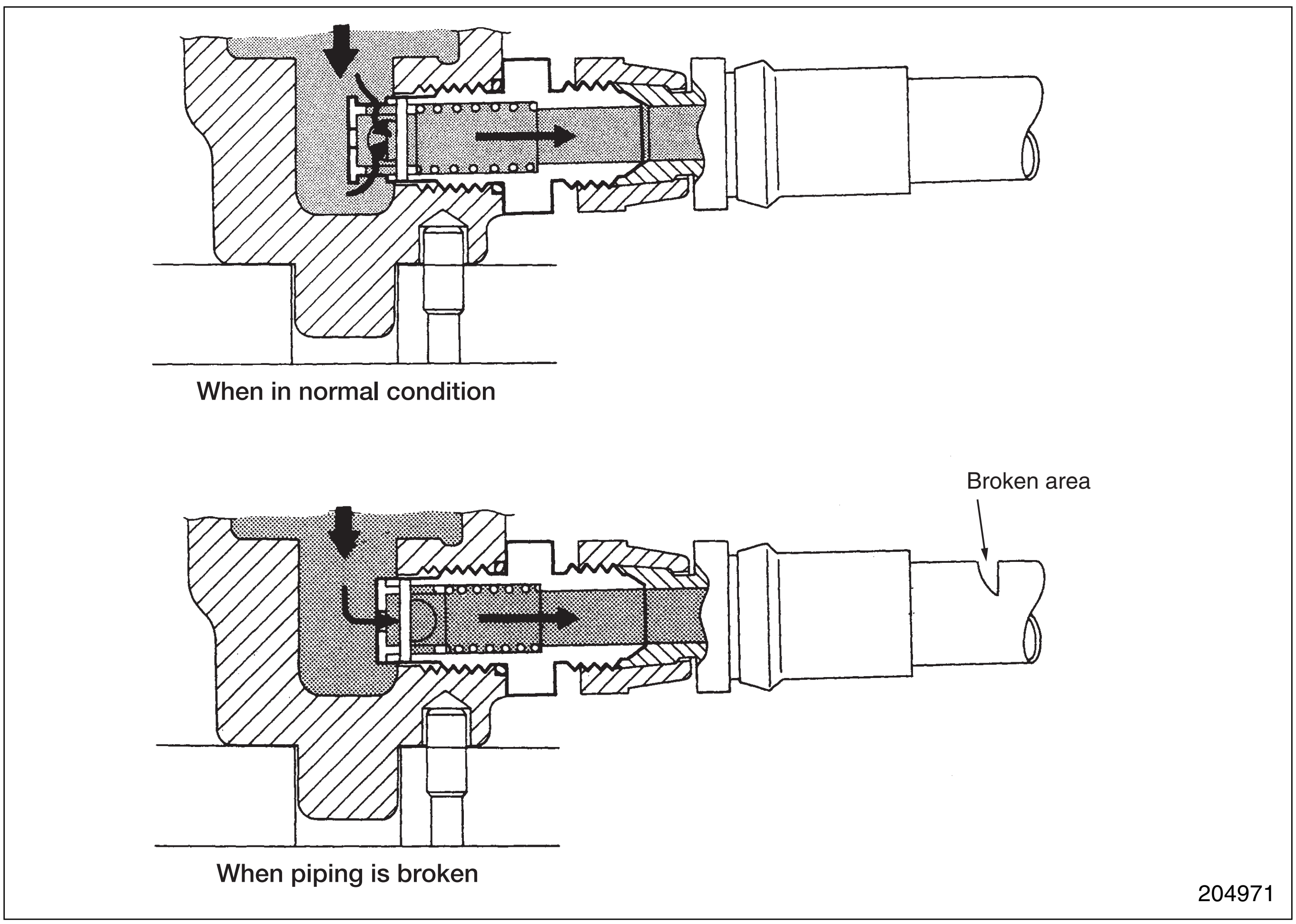
This hydraulic control is a mechatronic valve. As the valve spools move in proportion to control input of the FC control box operated by the operator, the controller and proportional electromagnetic pressure reducing valve are used. For detailed structure and operation, and disassembly and reassembly, refer to the "FC Control Valve" section (pages 13-60 to 13-85).

Flow Regulator Valve (for trucks fitted with FC control valve only)



The flow regulator valve is connected between the control valve and the lift cylinder. When the forks are lowered, the valve regulates and makes uniform the flow of oil that would otherwise vary with the load on the lift cylinder, so that the forks lowering speed is made constant irrespective of the load weight.

Down Safety Valve



The down safety valve is located at the bottom of the right lift cylinder.

This valve is a safety valve which, if the piping between the lift cylinder and flow regulator valve is broken or if the flow of return oil from the lift cylinder becomes excessive due to maladjusted regulator valve or a fault of another component, the down safety valve regulates the flow of oil to prevent the forks from moving down too quickly.

Lift Cylinder

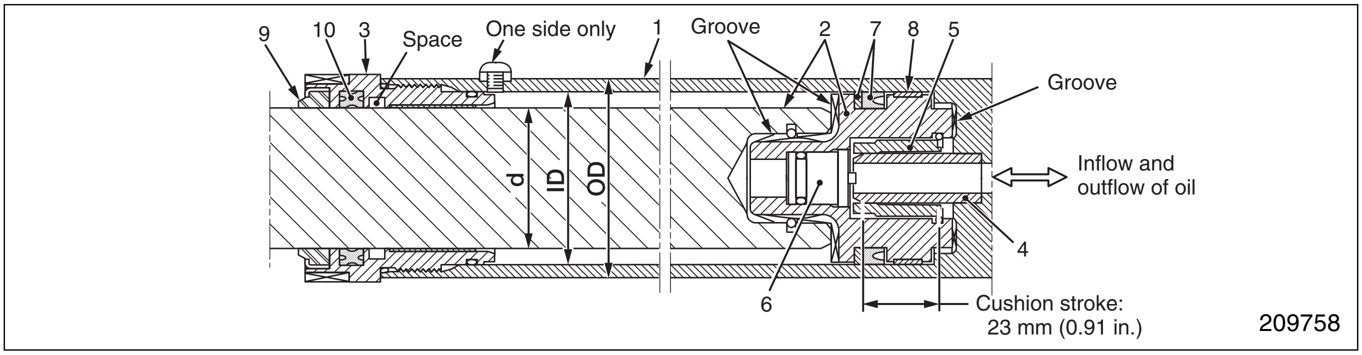
1. Second lift cylinder for simplex mast and triplex mast

- There are two types for the above lift cylinder: one with a return pipe and the other without a return pipe. The lift cylinder without a return pipe is provided with a check valve in the piston instead of a return pipe. This is called an internal drain type cylinder.
- Regardless of presence or absence of a return pipe, the bottom of the piston is provided with a cushion mechanism for soft landing.

(1) Cylinder without a return pipe

Mast used: (1) Simplex mast with raised height of 3.4 m (11.2 ft) or less
(2) All triplex masts

Detail of inside



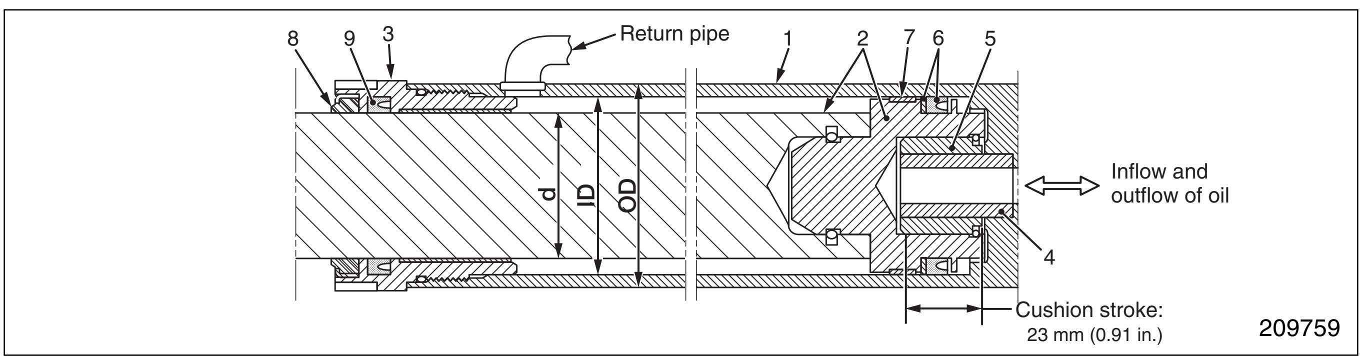
Main components

1 Cylinder tube
2 Piston rod assembly
3 Cylinder head
4 Pipe (integrated with cylinder tube)
5 Cushion bearing
6 Check valve
7 U-ring, Backup ring
8 Bushing
9 Wiper ring
10 X-ring

2. Cylinder with a return pipe

Mast used: Duplex mast with raised height of 3.5 m (11.5 ft) or higher

Detail of inside



Main components

1 Cylinder tube
2 Piston rod assembly
3 Cylinder head
4 Pipe (integrated with cylinder tube)
5 Cushion bearing
6 U-ring, Backup ring
7 Bushing
8 Wiper ring
9 U-ring

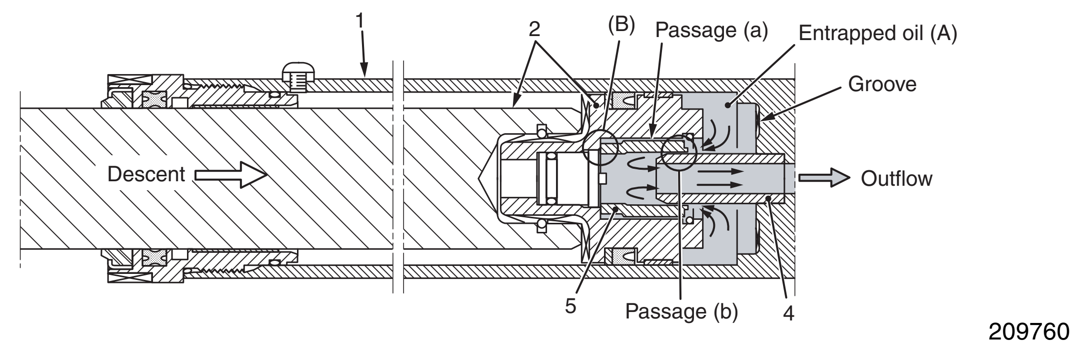
Cylinder dimensions (The cylinder length and stroke vary depending on raised height)

Unit: mm (in.)

Model	Mast type	Raised height	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)	Cushion stroke	Presence of return pipe
1 ton class	Simplex	3.4 m (11.2 ft) or less	35 (1.38)	45 (1.77)	52 (2.05)	23 (0.91)	No
		3.5 m (11.5 ft) or higher	35 (1.38)	45 (1.77)	52 (2.05)	23 (0.91)	Yes
	Triplex	—	35 (1.38)	45 (1.77)	52 (2.05)	23 (0.91)	No
2 ton class	Simplex	3.4 m (11.2 ft) or less	40 (1.57)	50 (1.97)	57 (2.24)	23 (0.91)	No
		3.5 m (11.5 ft) or higher	40 (1.57)	50 (1.97)	57 (2.24)	23 (0.91)	Yes
	Triplex	—	40 (1.57)	50 (1.97)	57 (2.24)	23 (0.91)	No
3 ton class	Simplex	3.4 m (11.2 ft) or less	45 (1.77)	55 (2.16)	63 (2.48)	23 (0.91)	No
		3.5 m (11.5 ft) or higher	45 (1.77)	55 (2.16)	63 (2.48)	23 (0.91)	Yes
	Triplex	—	45 (1.77)	55 (2.16)	63 (2.48)	23 (0.91)	No

Cushion mechanism when piston descends

Action during piston descent



The above illustration shows a condition in which the piston rod assembly 2 descends and pipe 4 and cushion bearing 5 are beginning to fit in. Cushion bearing 5 is pushed upward by entrapped oil (A) and the piston and cushion bearing 5 make surface contact at (B) area. This blocks the passage (a). The only outflow passage for entrapped oil (A) is clearance (b) between the bore of cushion bearing 5 and the outside of pipe 4. This passage (a) becomes narrower as the piston descends further. Therefore, the descending speed of the piston becomes gradually slower and hard contact is avoided.

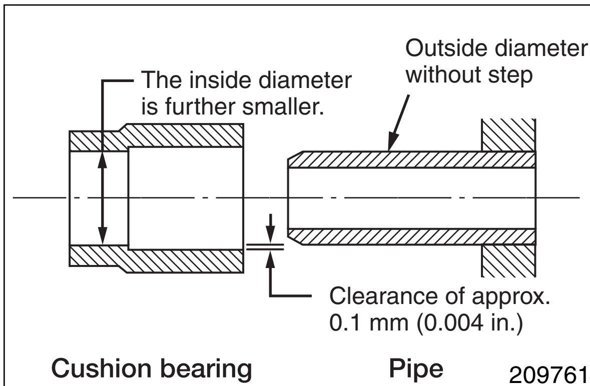
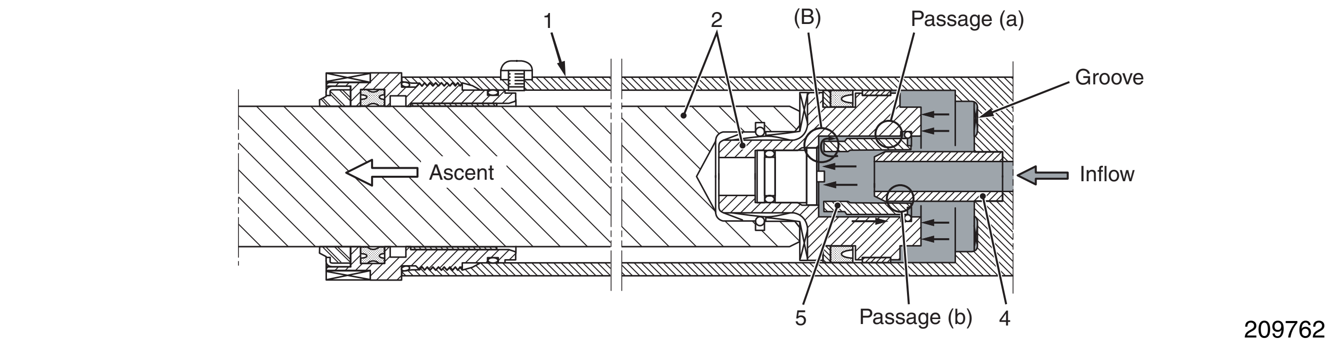


Image of pipe and cushion bearing

Action during piston ascent (initial stage)



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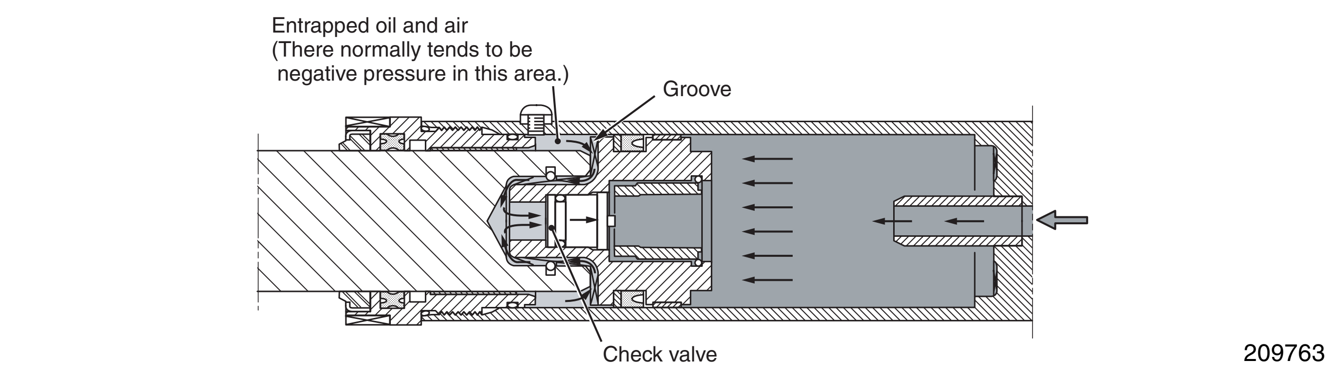
The above illustration shows a condition immediately after the piston rod assembly ascends. Oil that flows in acts on the center of the piston, ascending piston rod assembly 2 slightly. At the same time, cushion bearing 5 descends by being pushed by oil that flows in.

This action opens the (B) area, causing the passage (a) to open. Oil from the passage (a) and passage (b) which opens from the beginning flows in the piston bottom, acting on the entire bottom surface of the piston and pushing piston rod assembly 2 upward.

Cylinder of internal drain type



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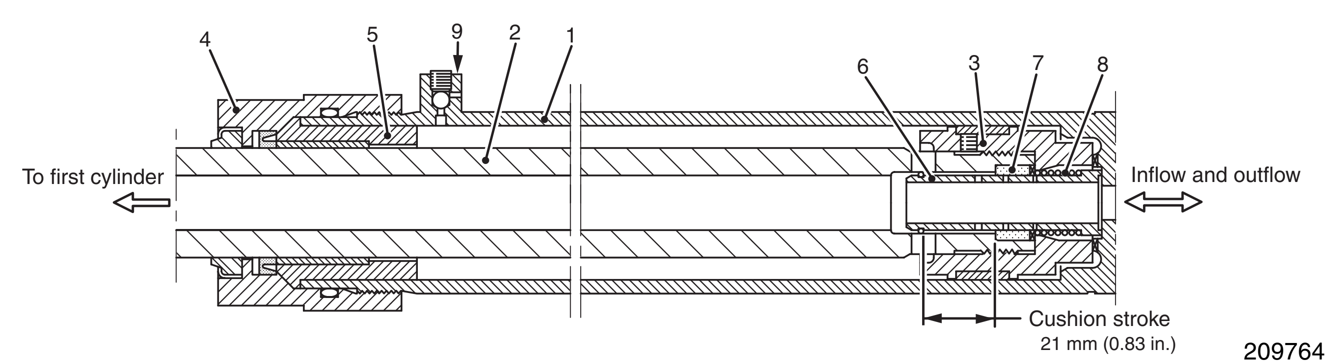
The above illustration shows a condition in which the piston rod assembly ascends to the vicinity of the highest position. When pressure of oil and air entrapped between the rod and cylinder exceeds the set pressure of the check valve, the check valve opens and discharges oil and air to the pressure oil (internal drain).

In the cylinder with a return pipe, this area is connected to the hydraulic tank.

2. Second lift cylinder for duplex mast



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Main components

1 Cylinder tube	4 Holder	7 Check valve
2 Rod	5 Cylinder head	8 Spring
3 Piston	6 Cushion spool	9 Bleed valve

Action

Pressure oil first flows through the hollow area inside piston rod 2 and enters the first lift cylinder. As the inside diameter of the first lift cylinder is larger than that of the second lift cylinder, the first lift cylinder ascends first. The second lift cylinder starts to ascend after the first lift cylinder has completed ascent.

This cylinder is provided with a cushion mechanism which prevents the piston bottom from impulsively contacting the cylinder bottom during piston descent. (Refer to the illustration below.)

Bleed valve 9 is a valve for bleeding air when the hydraulic system is overhauled.

Action during piston descent

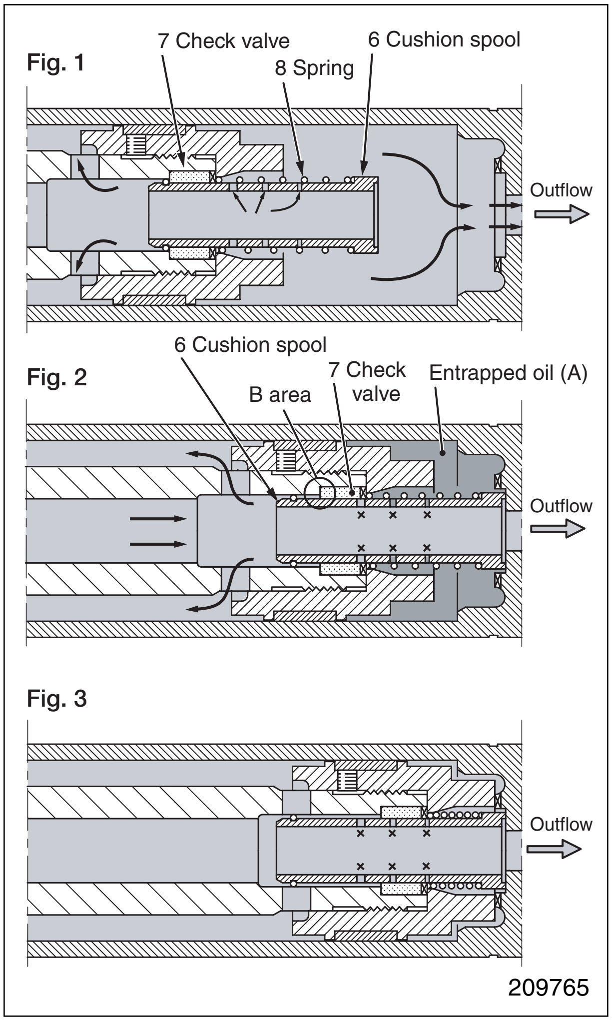
The illustration on the right explains movement of cushion spool 6 when the piston descends. (To the right of the illustration is the piston bottom.)

Fig. 1: This illustration shows a condition in which cushion spool 6 does not contact the cylinder bottom. Cushion spool 6 extends out by spring 8.

Fig. 2: This illustration shows a condition in which cushion spool 6 contacts the cylinder bottom and gets under check valve 7 slightly. The check valve moves to the left, blocking the B area. Oil (A) below the underside of the piston is discharged through holes (two rows on the right) of cushion spool 6.

For the shape of the check valve, refer to the image drawing on the following page.

Fig. 3: As the piston descends, cushion spool 6 gets under check valve further. As a result, the number of holes through which oil can pass decreases and discharge of entrapped oil (A) is restricted. The descending speed of the piston becomes slower and hard contact is avoided.



Action during piston ascent

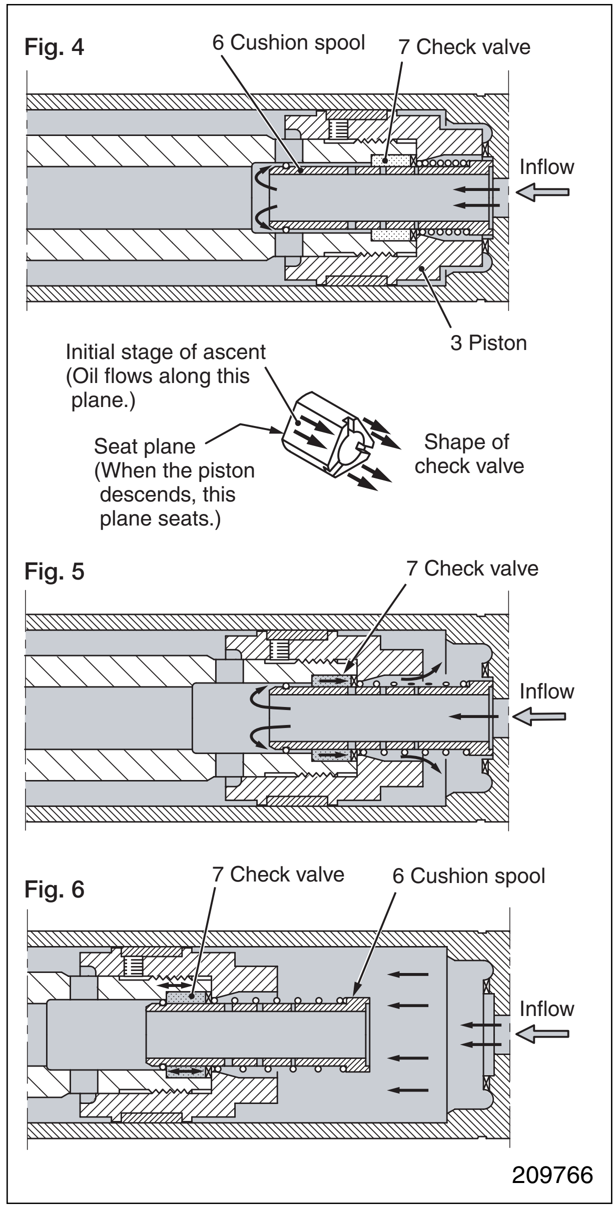
The illustration on the right explains movement of the check valve when the piston ascends.

Fig. 4: The illustration shows a condition immediately before piston ascent. Oil which flows through the hollow area in cushion spool 6 acts on check valve 7.

Fig. 5: Pressure oil pushes check valve 7 to the right. Pressure oil flows along the plane of the check valve and flows to the underside of the piston. The "triangular shape" of check valve 7 is designed to increase the initial inflow volume.

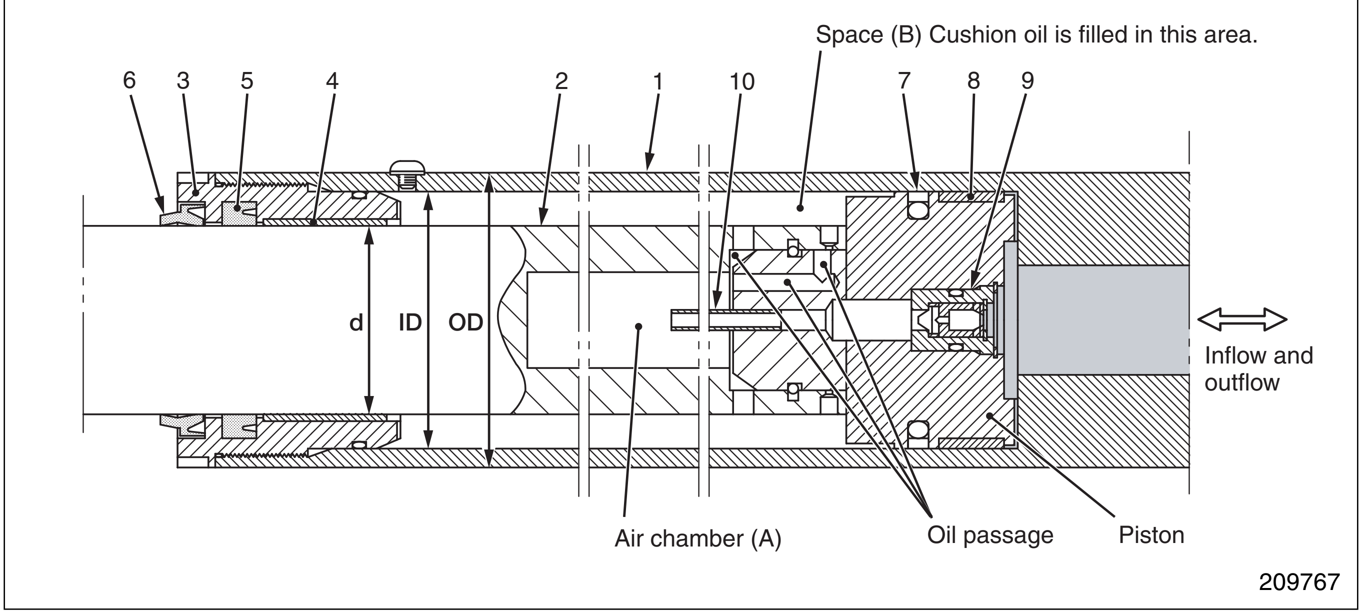
The piston starts to ascend.

Fig. 6: The illustration shows a condition in which cushion spool 6 has left the cylinder bottom and is ascending.



3. First cylinder for duplex mast and triplex mast

Detail of inside



Main components

1 Cylinder tube assembly
2 Piston rod assembly
3 Cylinder head
4 Bushing
5 U-ring
6 Wiper-ring
7 Seal ring assembly
8 Slide ring
9 Check valve
10 Stand tube

Action

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

The piston rod extends from the cylinder tube by pressure oil acting on the piston bottom. For prevention of an impulsive approach of the piston and the cylinder head at the last stage of its ascent, cushion oil is always filled in space B between the cylinder tube and the piston rod. When the piston rod ascends, it ascends while pushing out cushion oil to air chamber A at its last stage. Thus, the last stage becomes smooth.

In the descending stroke of the piston rod, cushion oil in air chamber A is sucked in space B. The air chamber, stand tube, and check valve are related parts for cushioning action.

Extra oil which leaks from around the piston and enters space B returns from stand tube 10 to the cylinder bottom via check valve 9 at the last stage of cylinder ascending.

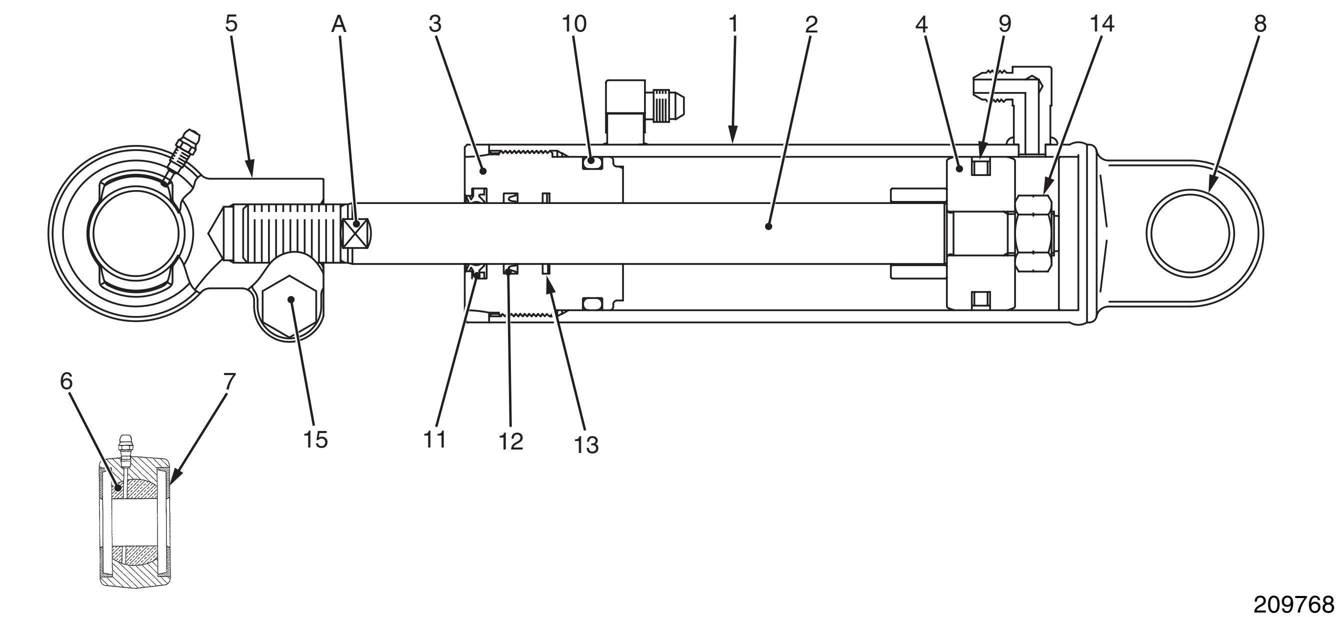
The stand tube always retains a certain amount of oil as cushion oil. A certain amount of cushioning oil must be filled in the overhauled cylinder.

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

Unit: mm (in.)

Truck model	Mast type	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1 ton class	Cylinders for the duplex mast and the triplex mast are of the same dimension and same type.	55 (2.16)	70 (2.76)	82 (3.23)
2 ton class		55 (2.16)	75 (2.95)	86 (3.39)
3 ton class		65 (2.56)	90 (3.54)	105 (4.13)

Tilt Cylinder



Main components

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

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

Seal 7 extends the greasing intervals. Installation of this seal has extended the grease interval to 500 service hours.

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

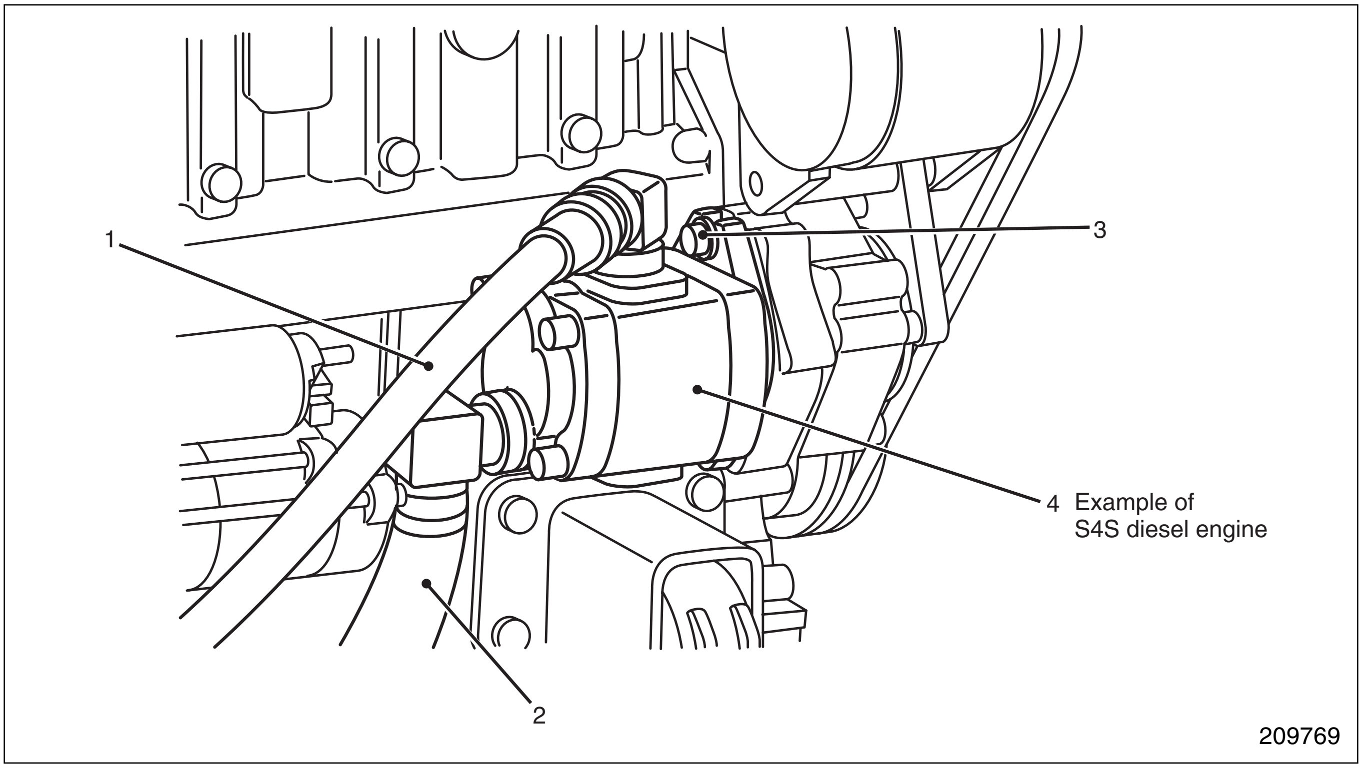
Unit: mm (in.)

Truck model	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1 ton class	25 (0.98)	63 (2.48)	73 (2.87)
2 ton class	30 (1.18)	70 (2.76)	82 (3.23)
3 ton class	35 (1.38)	80 (3.15)	93 (3.66)

Disassembly and Reassembly

Hydraulic Pump

Removal and Installation



Sequence

1 Pump delivery hose
2 Pump suction hose
3 Pump mounting bolt
4 Pump

Suggestion for Removal

Precautions for removal:

(1) The installed positions and sizes of the suction hose and delivery hose differ by model.

(2) Cover the pump and its surroundings with shop cloth in preparation for spilled oil.

(3) Take care not to allow foreign particles to enter the pump and hose from their detached parts.

Installation

To install, follow the reverse of removal sequence, and do the following steps:

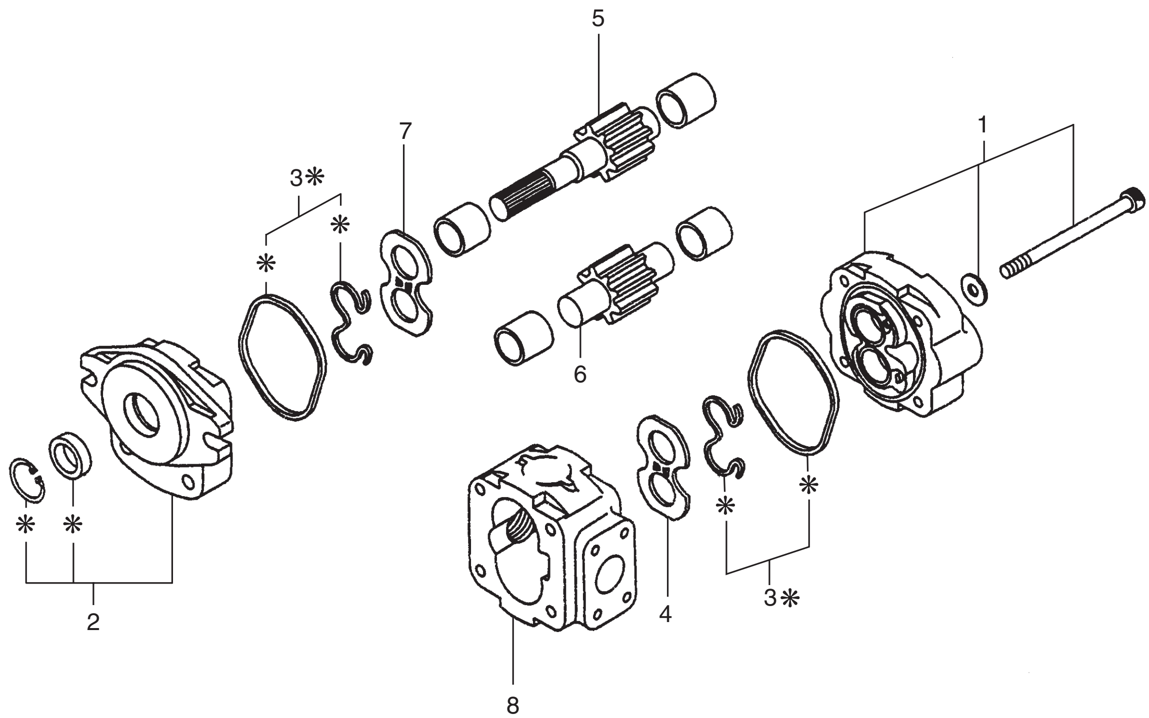
(1) Apply grease to the spline of the pump shaft before installation.

(2) Insert the gasket (diesel engine) or O-ring (gasoline engine) between the pump and engine PTO.

(3) Perform test operation after installing the pump. Refer to page 11-17.

Disassembly and Reassembly

Disassembly



Parts marked with ✻ are components of the seal kit.
Parts not marked with ✻ are non-deliverable parts.

209484

Sequence

1 Rear cover, Bolt, Washer, Bushing
2 Front cover, Snap ring, Shaft seal, Bushing
3 Gasket, Gasket (shaped like 3)
4 Side plate
5 Drive gear
6 Driven gear
7 Side plate
8 Body

Note: (1) The hydraulic pump is to be overhauled by the manufacturer. Where it has to be overhauled in field, be sure to follow the suggestions for disassembly. Remember, field overhauling will release the manufacturer from any guarantee.

(2) Do not remove oil seal 2 and bushings unless they are defective to require replacement.

Suggestions for Disassembly

(1) As front cover 2 and rear cover 1, made of aluminum alloy, get easily scratched, do not forcibly tap them with a hammer. Use a wooden hammer or plastic hammer.

(2) When disassembling, do not remove the body, gear and bushing by forcibly tapping them with a hammer.

(3) Place disassembled parts in orderly sequence. Especially, do not mistake the relative position of the gear and bushing side plate.

Inspection and Repair

1. Drive and driven gears

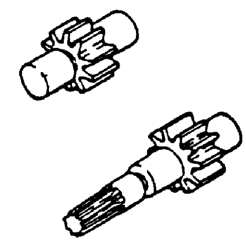
(1) Check the gear teeth for wear, chipping or other defects.

(2) Check the side faces of the gears for wear or damage.

(3) Check the shafts for wear or damage.

2. Covers, body and bushings

Check these parts for wear or damage.



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Reassembly

To reassemble, follow the reverse of disassembly sequence, and do the following steps:

(1) Replace the seal kit parts with new ones.

(2) Completely remove oil or grease on the mating surfaces of covers 1, 2 and body 8.

(3) Visually check all the parts for cleanliness and apply hydraulic oil to the inside surface of the body before reassembly.

(4) Apply grease to the lip of the shaft seal.

(5) Be careful not to give damage to the lip of shaft seal by spline edges of drive gear 5.

(6) Tighten the bolts evenly and progressively.

(7) The pump is assembled properly if the pipe wrench fitted on the pump shaft can be turned easily by hand.

Test operation

Perform test operation after installing the pump.

(1) Check that the oil amount in the hydraulic tank is sufficient.

(2) Attach a pressure gauge to the pump delivery hose. Refer to page 11-34 “Main Relief Valve.”

(3) Start the engine, raise the adjusting screw of the main relief valve in sequence from 0 to 18.1 MPa (0 to 180 kgf/cm^2) [0 to 2625 psi], and check the temperature rise of the pump body by touching it by hand. If the temperature rise of the pump body is substantial compared to the oil temperature rise, disassemble again for checking.

(4) Set the relief valve to the specified pressure.

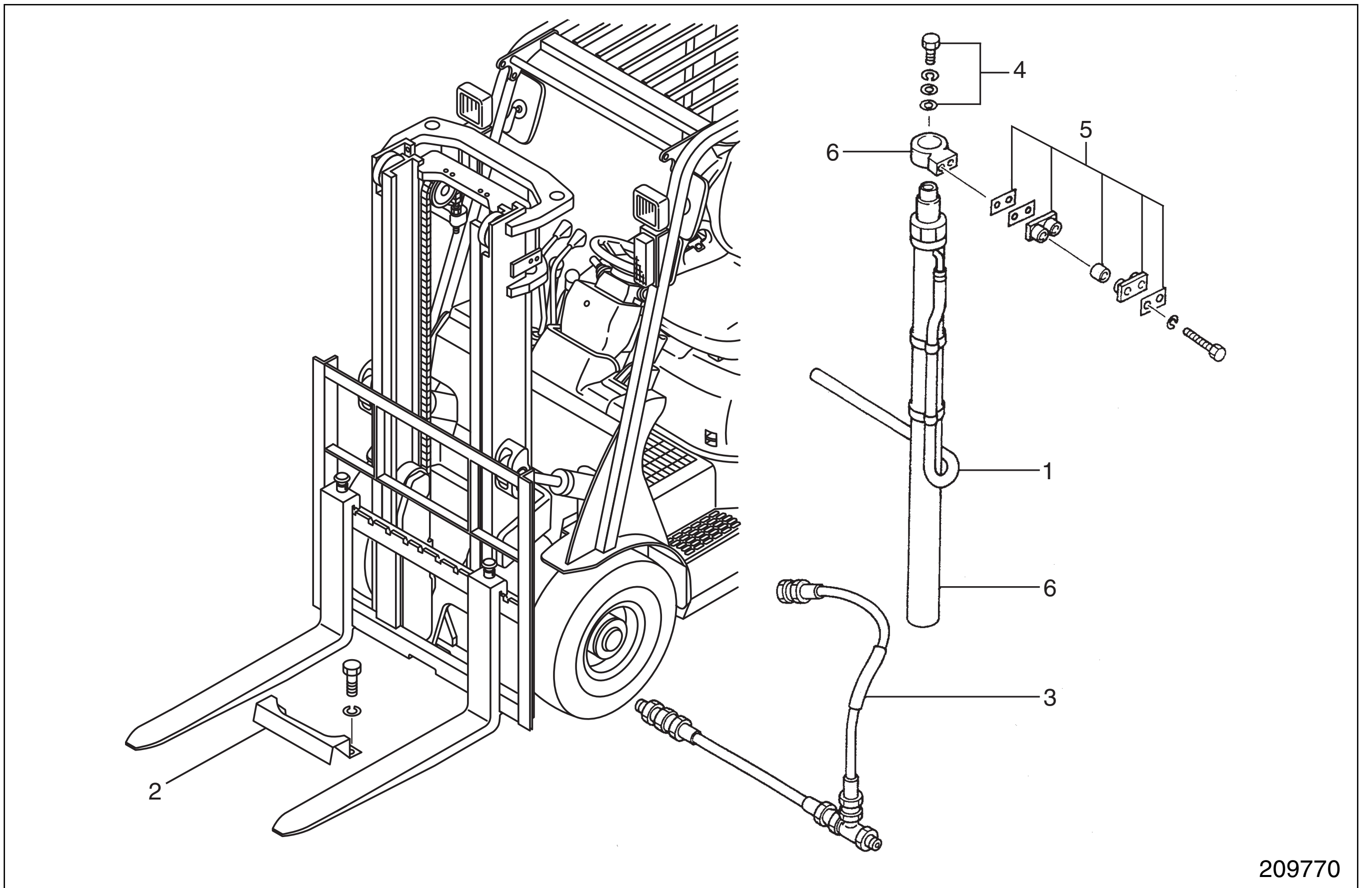
(5) Measure the lifting speed of the forks under no load. If the speed is to the specified value, the pump discharge volume is normal.

(6) Check that the forks operate normally by raising and lowering under load.

Lift Cylinder

Removal and Installation

Simplex mast



Sequence

1 Return hose (if equipped)
2 Hose guard
3 High-pressure hose
4 Set bolt, Shim
5 Cylinder clamp (Cushion, Collar, Shim)
6 Lift cylinder, Bracket

Suggestions for Removal

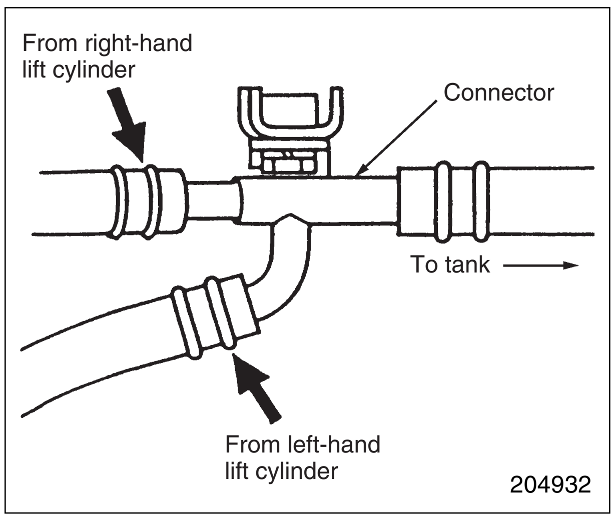
1. Removal of hose guard

Remove the hose guard from the front while the lift bracket is placed at the bottom.

2. Removal of return hose (if equipped)

Start the engine, raise the lift bracket to the highest position, and stop the engine. Then, remove return hoses on the right and left cylinders from the connector.

Note: Place a drip pan below the connector to catch the oil.

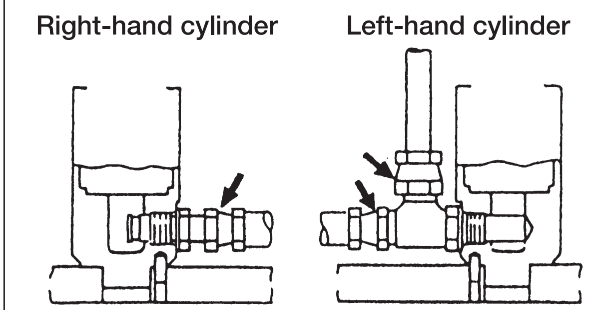


3. Lowering of lift bracket

Gently operate the lift lever to lower the lift bracket.

4. Disconnecting high-pressure hoses

Disconnect the high-pressure hoses at the joints indicated by arrows. Use a drip pan to catch oil flowing out of the hoses.



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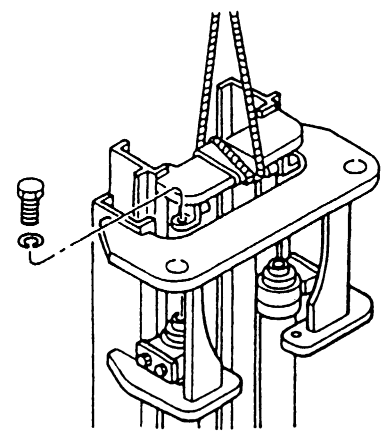
5. Removing set bolts

(1) Remove the set bolt at the top of each lift cylinder. Lift the inner mast to separate the cylinder rod ends. To lift the inner mast, hitch a sling around the mast with protective rag.

Note: The rod end of either lift cylinder is shim adjusted to eliminate the difference in stroke between the cylinders. Before removing the set bolts, make a record of the amount of shims fitted to each cylinder.



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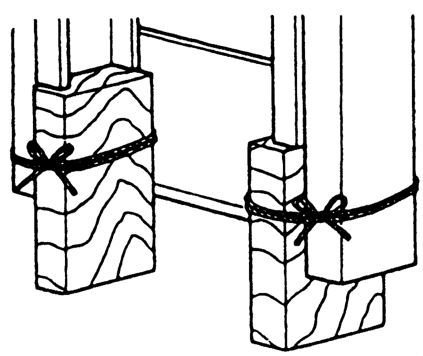
(2) Tie wood blocks under the inner mast and detach the sling. Use the blocks strong enough to support the mast.



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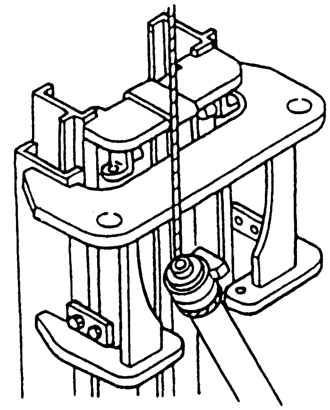
6. Removing lift cylinders

Attach a lifting sling before removing the cylinder clamp. Lift the cylinder from the rear side of the mast, and remove the cylinder.


204935

Installation

To install, follow the reverse of removal sequence, and do the following steps:

(1) Extend and retract the lift cylinders several times under no load condition to bleed air out of the cylinder circuits and to make sure that the cylinders moves smoothly.

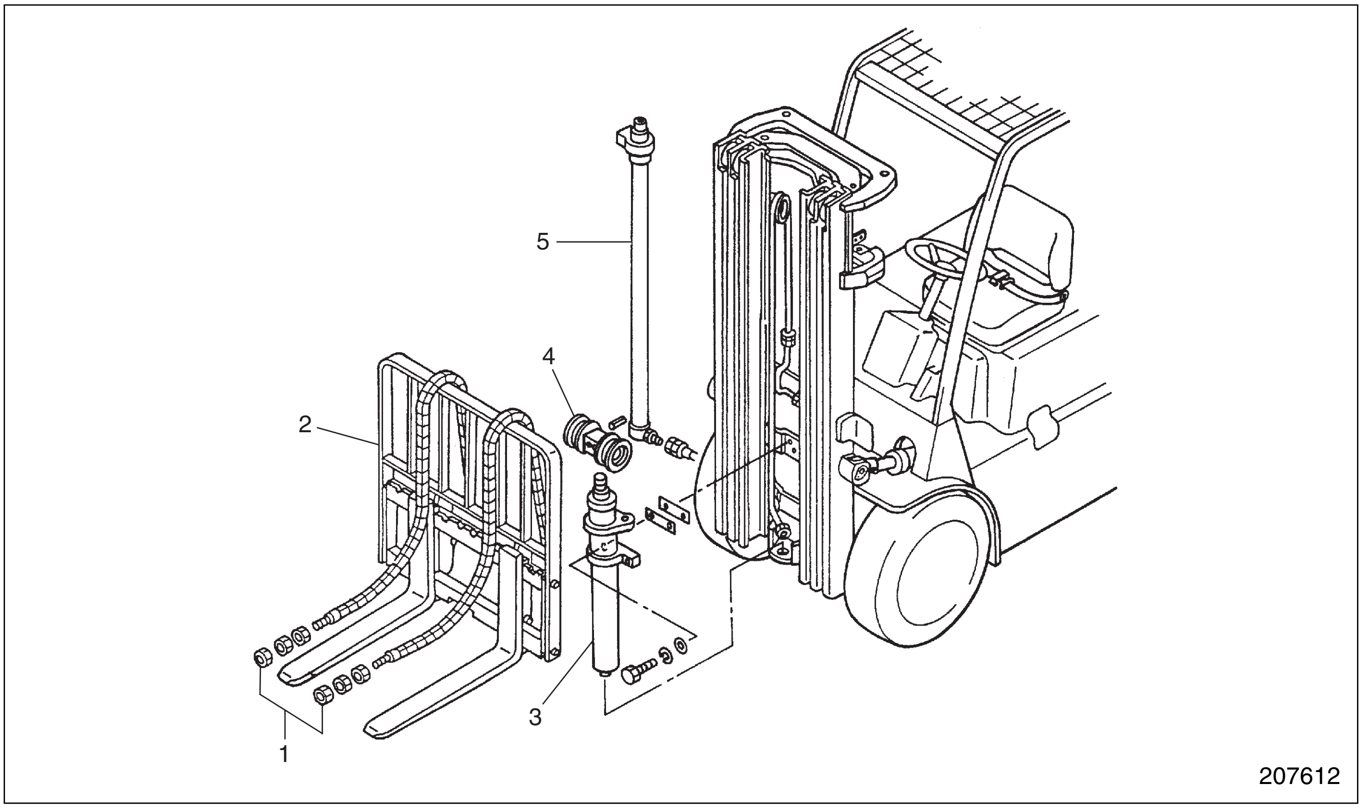
(2) Check the oil level in the hydraulic tank with an oil level gauge. (Refer to the topics "Hydraulic Tank" in the following section "Inspection and Adjustment.")

(3) Check the lift height.

(4) After the lift cylinders or piston rods have been replaced, check for difference in stroke between the two cylinders. (Refer to "GROUP 14 MASTS AND FORKS.")

Duplex and triplex mast removal

Note that the triplex mast is used as an example.



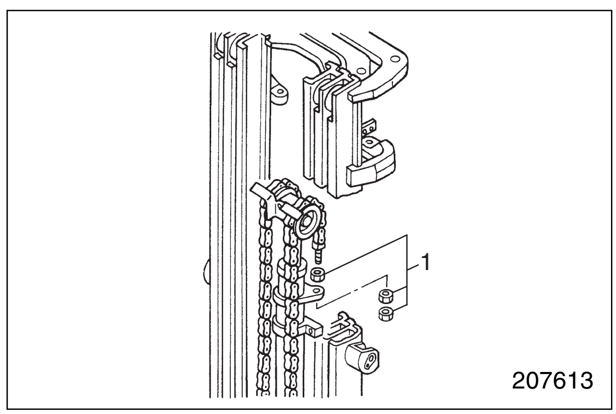
Sequence

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

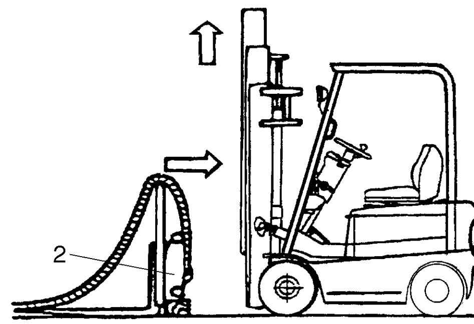
Suggestions for Removal

1. Removal lift bracket assembly

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



(2) Position the mast upright. Raise the inner mast until upper rollers 8 of the lift bracket become free. Then, slowly move the truck in reverse to separate from lift bracket 2.



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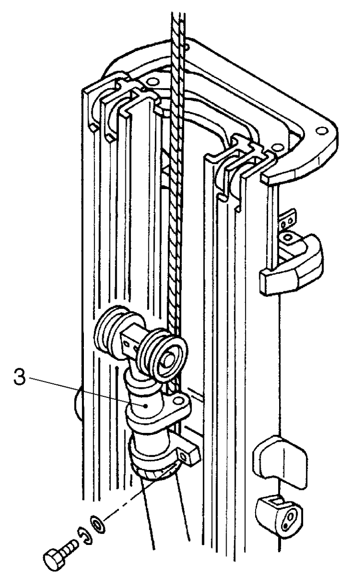
2. Removing first lift cylinder

(1) Hitch a sling on the first lift cylinder 3, and suspend it with a crane. Wind the rope securely to prevent slipping.

(2) Remove lift cylinder connecting bolts and mounting bolts, and gently remove the first lift cylinder 3.



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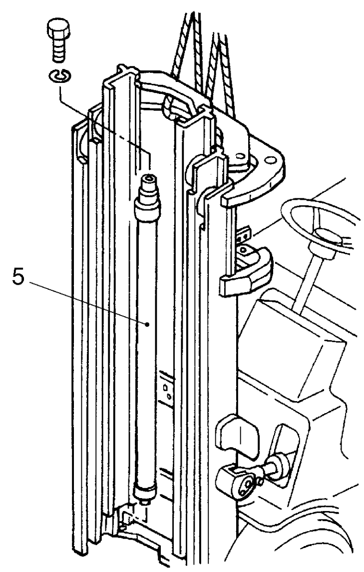
3. Removing second lift cylinders 5

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

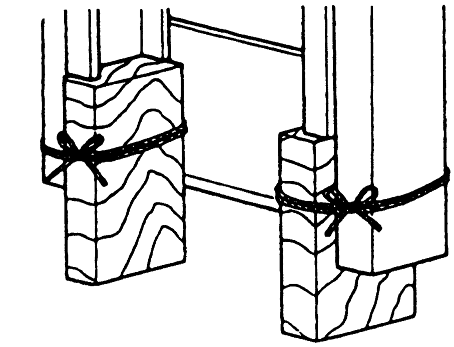
(2) Remove stopper bolts at the upper sections of the second lift cylinders 5, and lift the inner mast for duplex mast or middle mast for triplex mast approximately 55 cm (21.67 in.) using slings.



207617

(3) Place wood blocks under the inner mast (for duplex mast) or middle mast (for triplex mast).

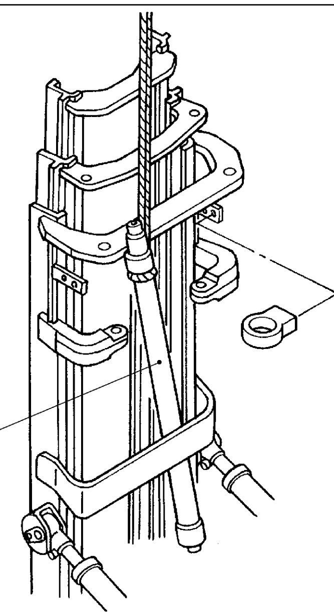
Make sure the right and left wood blocks are the same in height.



202983

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

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



207618

Installation

To reinstall, follow the removal sequence in reverse, and do the following steps:

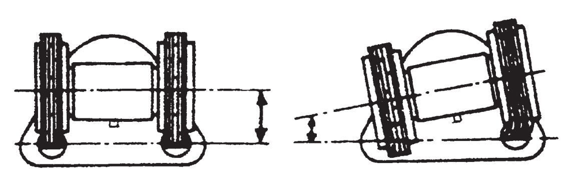
(1) Install chain wheel support assembly 4 parallel to a line connecting the centers of chain anchor bolt holes on first lift cylinder 3 to prevent chains from twisting.

(2) Adjust the chain tensions.

(See the "Inspection and Adjustment" section.)

(3) Extend and retract the lift cylinders several times under no load condition to bleed air out of the cylinder circuits and to make sure that the cylinders move smoothly.

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

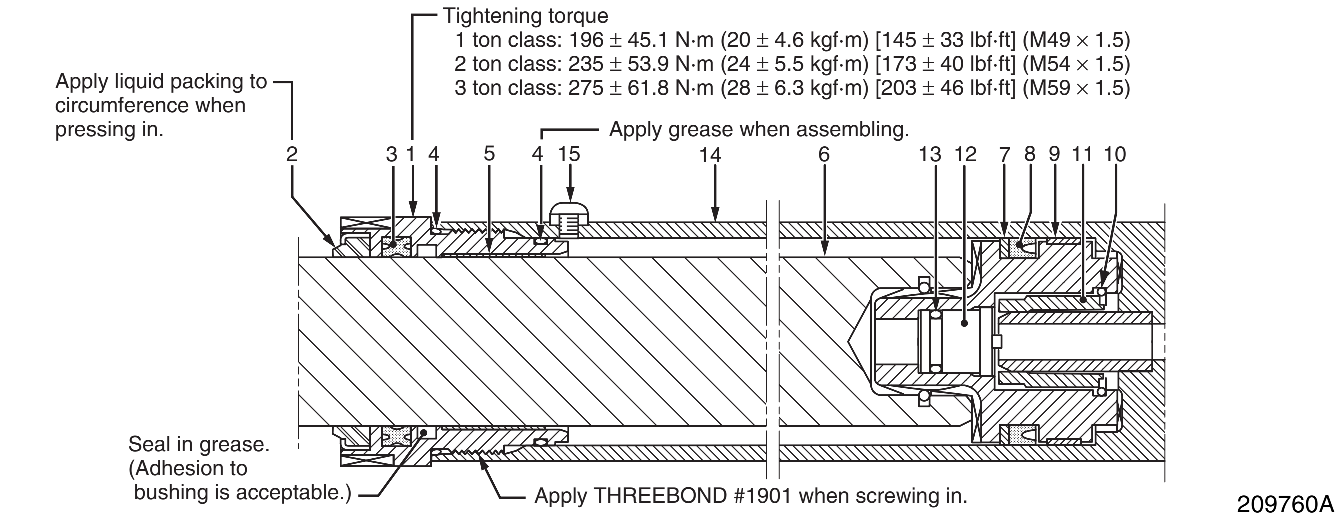


207638

Disassembly and Reassembly

1. Second cylinder for simplex mast and triplex mast

Disassembly



Sequence

First, disassemble into the three parts of the following I to III, and then disassemble the three parts.

I. Head sub-assembly
Consisting of the following parts, 1 thru 5.
1 Cylinder head
2 Wiper ring
3 X-ring
4 O-ring
5 Bushing

II. Piston rod sub-assembly
Consisting of the following parts, 6 thru 13.
6 Piston rod assembly
7 Backup ring
8 U-ring
9 Bushing
10 Snap ring
11 Cushion bearing
12 Check valve
13 O-ring

III. Cylinder tube sub-assembly
Consisting of the following parts, 14 and 15.
14 Cylinder tube assembly
15 Plug

Note: The illustration shows a cylinder of the internal drain type without a return pipe. For structure of the cylinder with a return pipe, refer to page 14-8.

Suggestions for Disassembly

Pulling out piston

Be careful not to damage the piston seals and cylinder bore wall when pulling out the piston from the cylinder.

Inspection after disassembly

1. Cylinder tube

(1) Check the bore wall for wear, grooving, scratching or rusting.

(2) Check the welds for cracks or other defects.

2. Piston rod

(1) Check the rod for deflection.

(2) Check for surface flaws such as grooving, scratching, rusting or wear.

3. Rings and packings

(1) Check lips for damage, wear, or deterioration.

Reassembly

To reassemble, follow the reverse of disassembly sequence, and do the following steps:

(1) Clean the disassembled parts with high flash-point solvent. Blow them dry with compressed air; however, this does not apply to rubber parts.

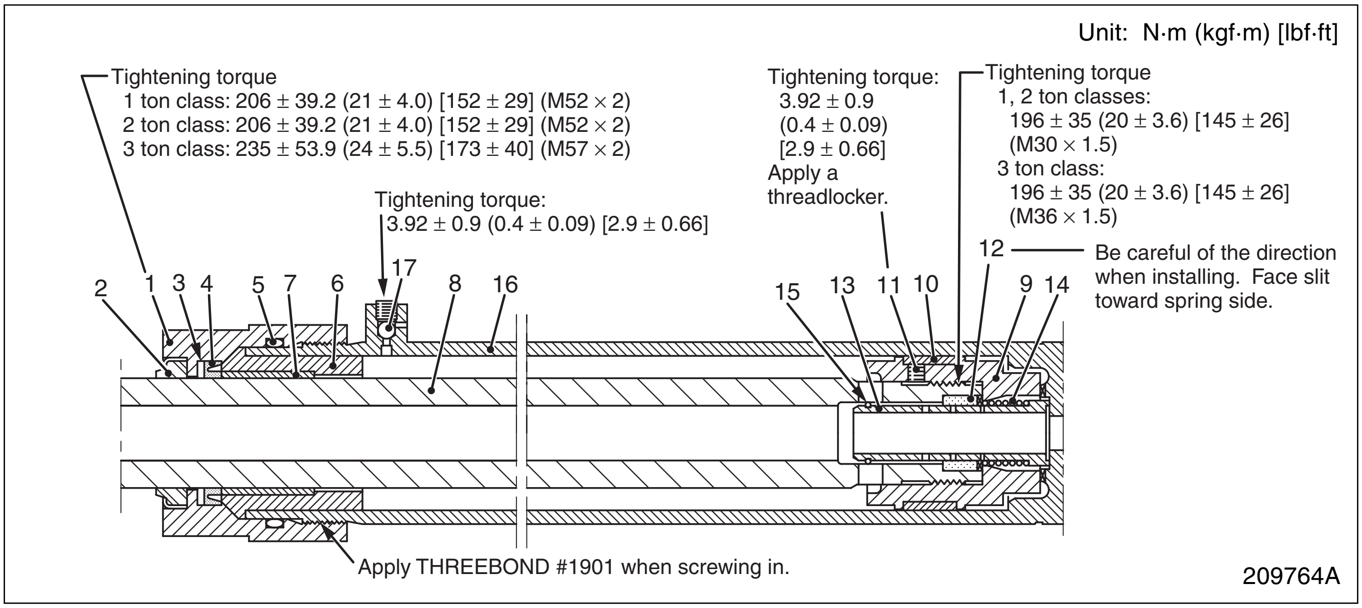
(2) Apply hydraulic oil to the bore surface of cylinder and also to the piston seal, O-ring, backup ring, buffer ring, packing and dust seal.

(3) Apply liquid gasket (THREEBOND #1901) to the thread.

Tighten to the specified torque using hook wrench.

2. Second lift cylinder for duplex mast

Disassembly



Sequence

First, disassemble into the three parts of the following I to III, and then disassemble the three parts.

I. Holder sub-assembly
Consisting of the following parts, 1 thru 5.
1 Holder
2 Wiper ring
3 Backup ring
4 U-ring
5 O-ring

II. Head sub-assembly
Consisting of the following parts, 6 and 7.
6 Head
7 Bushing

III. Piston rod sub-assembly
Consisting of the following parts, 8 thru 15.
8 Rod
9 Piston
10 Slide ring
11 Set screw
12 Check valve
13 Cushion spool
14 Spring
15 Snap ring

IV. Cylinder tube sub-assembly
Consisting of the following parts, 16 and 17.
16 Tube assembly
17 Plug

Suggestions for Disassembly

Pulling out piston

Be careful not to damage the piston seals and cylinder bore wall when pulling out the piston from the cylinder.

Inspection after disassembly

1. Cylinder tube

(1) Check the bore wall for wear, grooving, scratching or rusting.

(2) Check the welds for cracks or other defects.

2. Piston rod

(1) Check the rod for deflection.

(2) Check for surface flaws such as grooving, scratching, rusting or wear.

3. Rings, packings and threads

(1) Check lips for damage, wear or deterioration.

(2) Check threads for damage.

Suggestions for Reassembly

To reassemble, follow the reverse of disassembly sequence, and do the following steps:

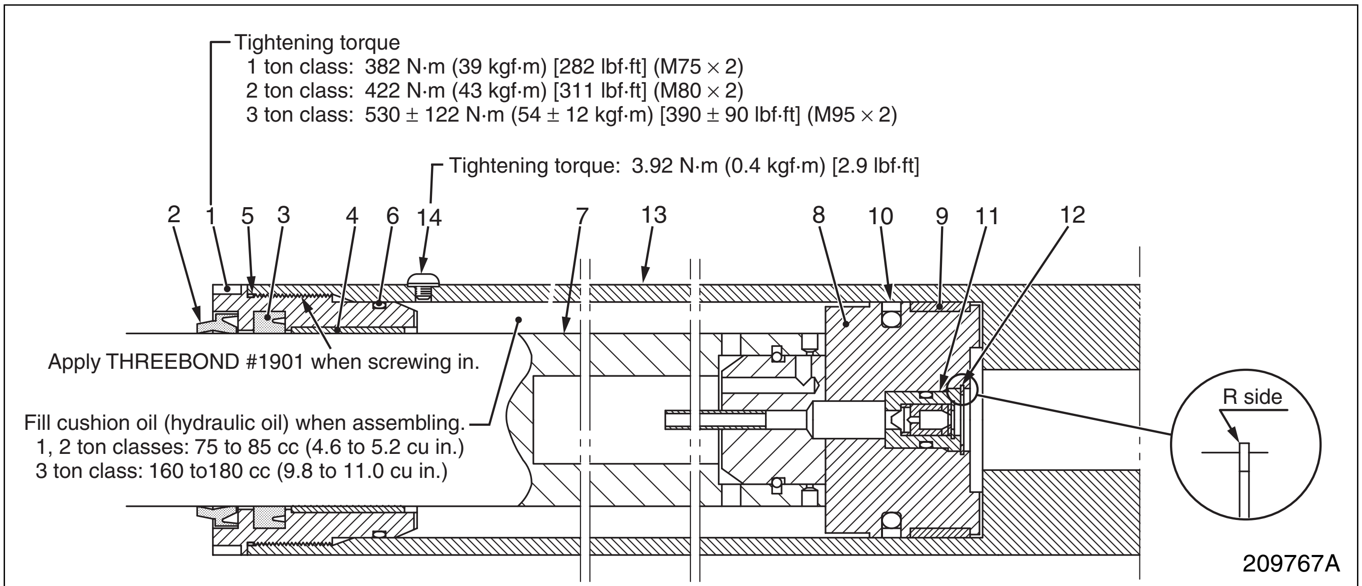
(1) Clean the disassembled parts with high flash-point solvent. Blow them dry with compressed air; however, this does not apply to rubber parts.

(2) Apply hydraulic oil to the bore surface of cylinder and also to the piston seal, O-ring, backup ring, buffer ring, packing and dust seal.

(3) Tighten threads of important parts to the specified torque as per the above illustration.

3. First lift cylinder for duplex mast and triplex mast

Disassembly



Sequence

First, disassemble into the three parts of the following I to III, and then disassemble the three parts.

I. Cylinder head sub-assembly
Consisting of the following parts, 1 thru 6.
1 Cylinder head
2 Wiper ring
3 U-ring
4 Bushing
5 O-ring
6 O-ring

II. Piston rod sub-assembly
Consisting of the following parts, 7 thru 12.
7 Rod
8 Piston
9 Slide ring
10 Seal ring assembly
11 Check valve
12 Snap ring

III. Cylinder tube sub-assembly
Consisting of the following parts, 13 and 14.
13 Cylinder tube sub-assembly
14 Plug

Suggestions for Disassembly

Be careful not to damage the cylinder bore wall when pulling out the piston rod from the cylinder.

Inspection after disassembly

1. Cylinder tube

(1) Check the bore wall for wear, grooving, scratching or rusting.

(2) Check the welds for cracks or other defects.

2. Piston rod

(1) Check the rod for deflection.

(2) Check for surface flaws such as grooving, scratching, rusting or wear.

3. Rings, packings and threads

(1) Check lips for damage, wear or deterioration.

(2) Check threads for damage.

Suggestions for Reassembly

To reassemble, follow the reverse of disassembly sequence, and do the following steps:

(1) Clean the disassembled parts with high flash-point solvent. Blow them dry with compressed air; however, this does not apply to rubber parts.

(2) Apply hydraulic oil to the bore surface of cylinder and also to the piston seal, O-ring, backup ring, buffer ring, packing and dust seal.

(3) Be careful of the direction when installing the snap ring 12 of the check valve.

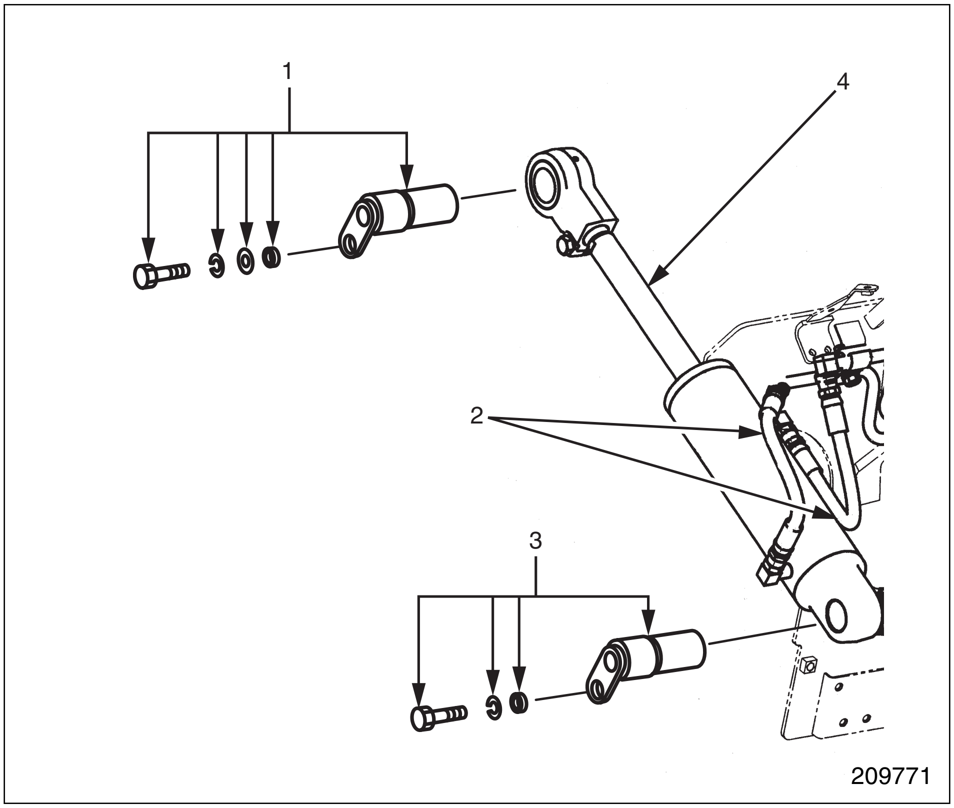
(4) Fill hydraulic oil as cushion oil in the space between the tube and rod before reassembling the cylinder head.

(5) Tighten threads of cylinder head 1 to the specified torque as per the above illustration.

Tilt Cylinder

Removal and Installation

Removal



Sequence

1 Tilt cylinder pin
2 Hoses (2 pcs. per one cylinder)
3 Tilt cylinder pin
4 Tilt cylinder

Start by:

(a) Lower the forks to the bottom, and tilt the mast fully forward.

(b) Attach a lifting sling to the round holes, right and left, in the top cross-member of outer mast, and support the weight of the mast with a hoist.

Suggestions for Removal

1. Retracting piston rod

Remove tilt cylinder pin 1, start the engine and retract the piston rod fully, then stop the engine.

2. Disconnecting hoses

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

3. Removing tilt cylinder

Remove tilt cylinder pin 3, and remove the cylinder.

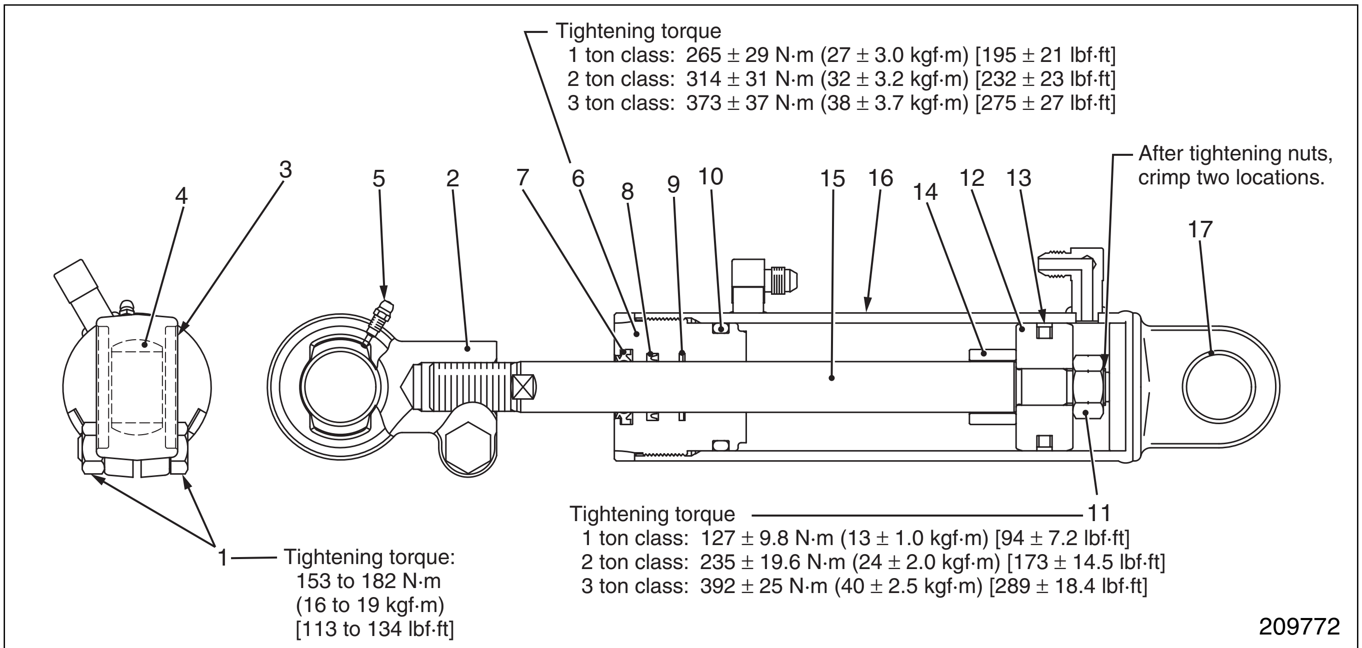
Installation

To install, follow the reverse of removal sequence, and do the following.

(1) After installing tilt cylinders, check the balance of mast tilting angle. Adjust if necessary. Refer to “Adjustment of Mast Tilt Angle” on page 12-38.

Disassembly and Reassembly

Disassembly



Sequence

First, disassemble into the three parts of the following I to III, and then disassemble the three parts.

I. Tilt socket sub-assembly
Consisting of the following parts, 1 thru 5.
1 Bolt, Nut
2 Tilt socket
3 Seal
4 Bearing
5 Grease nipple

II. Guide bushing sub-assembly
Consisting of the following parts, 6 thru 10.
6 Guide bushing
7 Dust seal
8 Packing
9 Buffer ring
10 O-ring

III. Piston rod sub-assembly
Consisting of the following parts, 11 thru 15.
11 Nut
12 Piston
13 Piston seal
14 Spacer
15 Rod

IV. Cylinder sub-assembly
Consisting of the following parts, 16 and 17.
16 Cylinder assembly
17 Bushing

Note: (a) Before disassembly, make a record of the dimension from the holder edge to the socket edge when the rod is fully pushed in. The record will be helpful for reassembly.

(b) Do not disassemble the tilt socket bearing and cylinder tube bushing unless abnormality, is found on inspection.

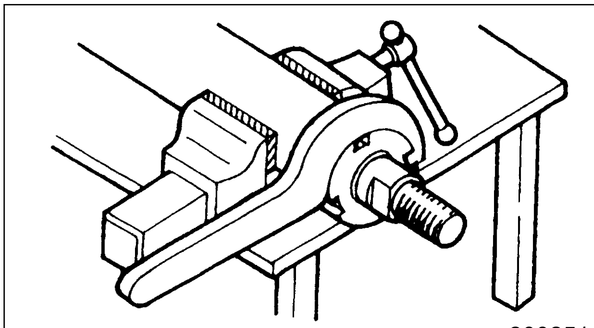
(c) Do not disassemble the piston and nuts unless abnormality, is found on inspection.

Suggestions for Disassembly

Removing bushing

(1) Wrap the cylinder with a rag, and clamp it in a vise. Using a wrench, remove the bushing from the cylinder.

(2) When removing the bushing from the piston rod, be careful not to rub the threads of the piston rod against the buffer ring, packing, O-ring.



200351

Inspection after disassembly

1. Cylinder tube

(1) Check the bore wall for wear, grooving, scratch marks and rusting.

(2) Check the welds for cracks.

2. Piston rod

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

3. Rings and packing

(1) Check each ring and packing for damage or distortion.

(2) Also check for deterioration due to aging.

Precautions for reassembly of lift and tilt cylinders

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

(2) Reassemble the cylinder in the reverse sequence of the disassembling, apply hydraulic oil to the bore wall of the cylinder tube, and also to sealing parts – O-rings, piston seals, dust seals and packings. Pay attention to the correct part arrangement.

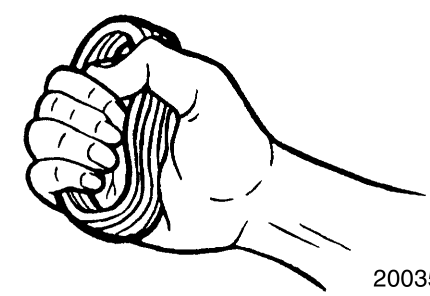
(3) When clamping the cylinder tube in the vise , be careful not to distort the tube.

(4) Install the piston seal as follow:

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

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

(5) Tighten the thread to the specified torque. Refer to the previous page for the torque.



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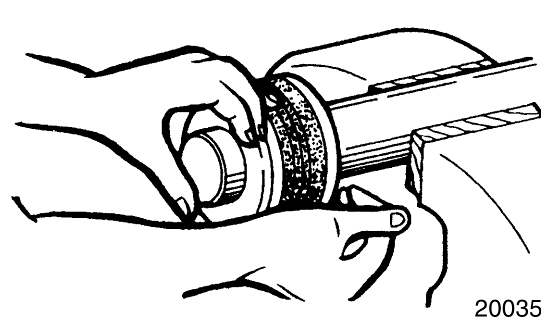
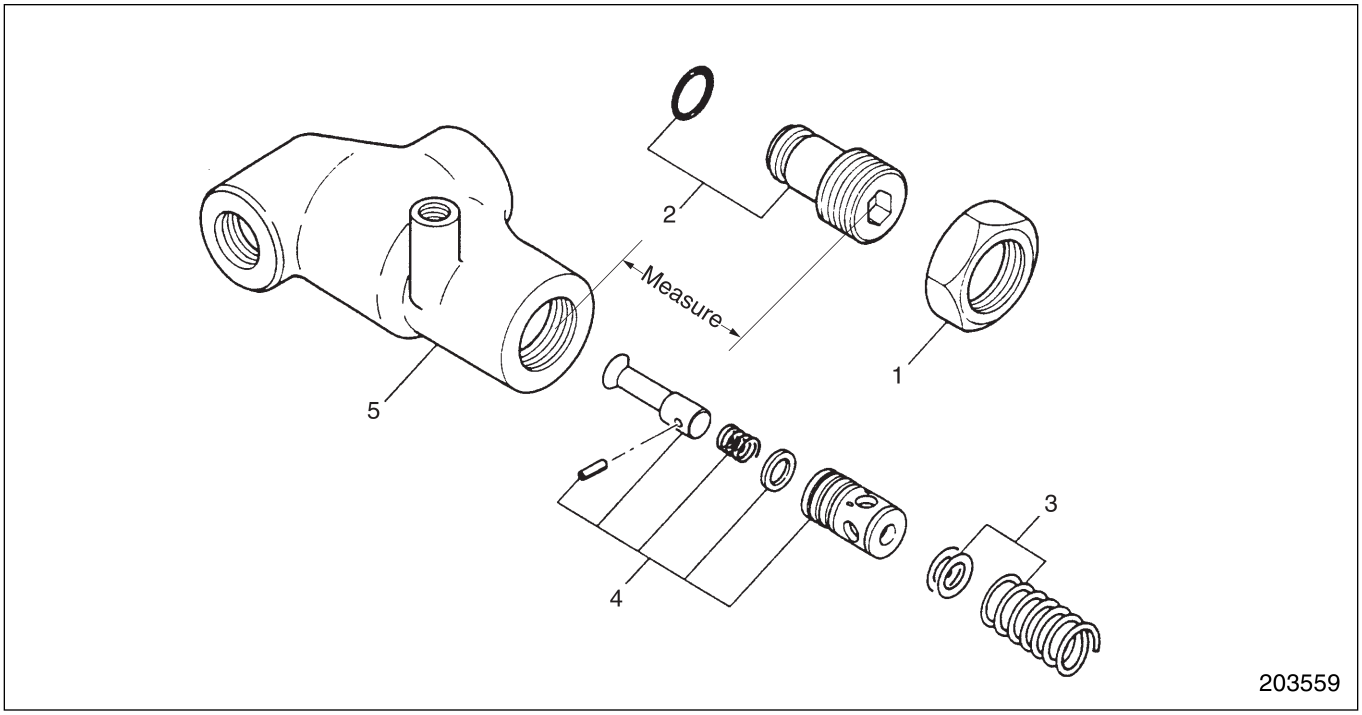


200353

Flow Regulator Valve (Installed on trucks with FC control valve only)

Disassembly and Reassembly

Disassembly



Sequence

1 Lock nut
2 Plug, O-ring
3 Spring, Shims
4 Piston, Pin, Washer, Spring, Valve
5 Valve body

Note: Before disassembling, measure the protrusion of the plug. On assembling, adjust the protrusion as before.

Inspection

(1) Check the spring for fatigue.

(2) Check the sliding and contact surfaces of valve and piston for damage.

(3) Check the sliding surfaces of piston and valve body for damage.

Note: Replace the flow regulator valve as an assembly if any part is defective.

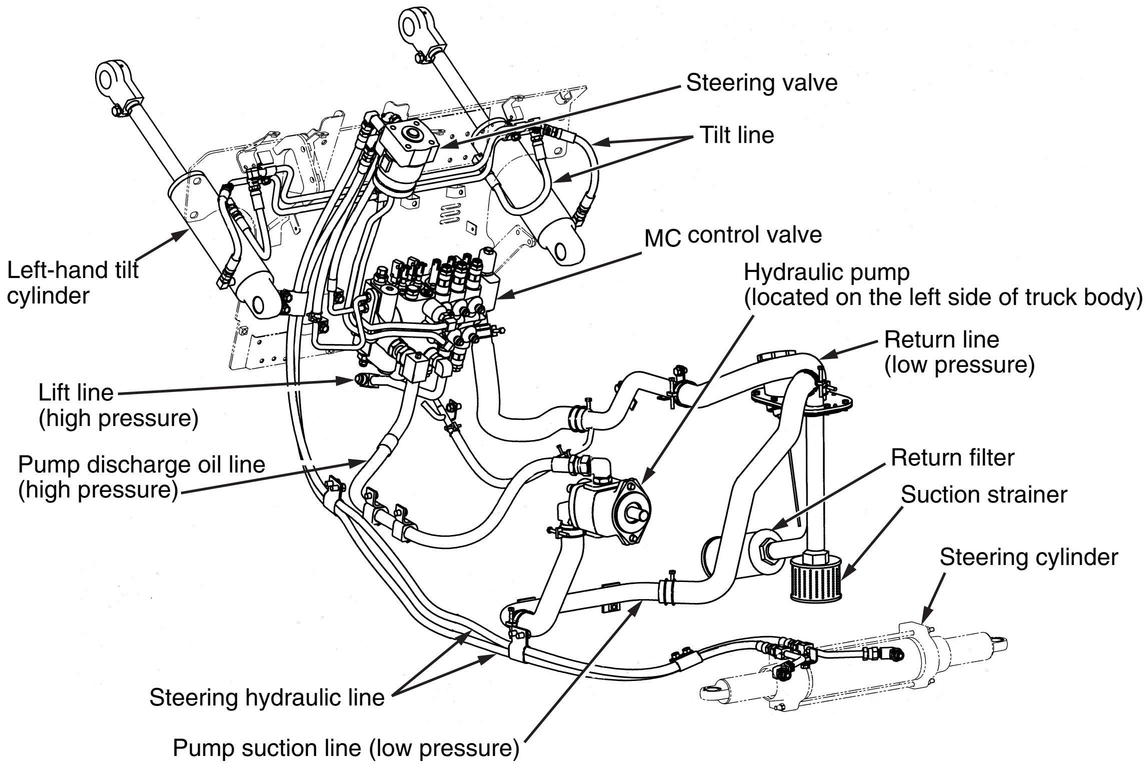
Reassembly

To reassemble, follow the reverse of disassembly sequence.

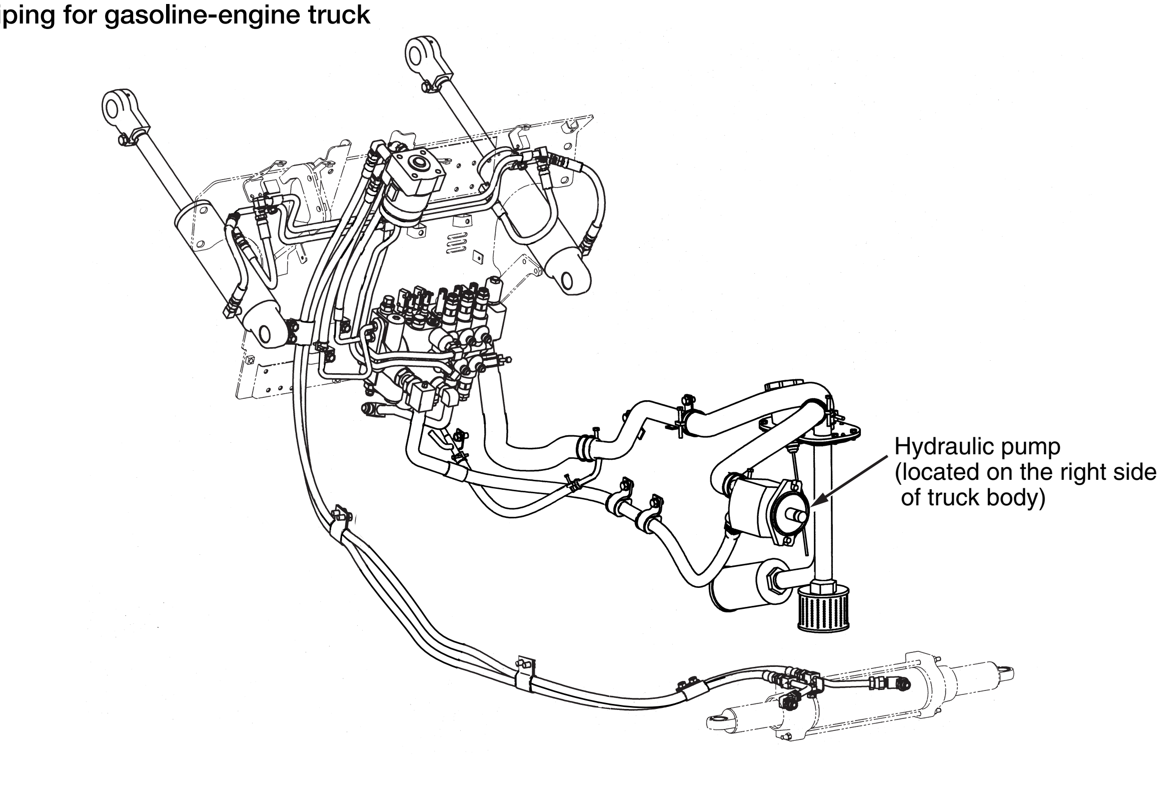
Piping

(For piping around the mast, refer to “GROUP 14 MASTS AND FORKS.”)

1. Piping for diesel-engine truck



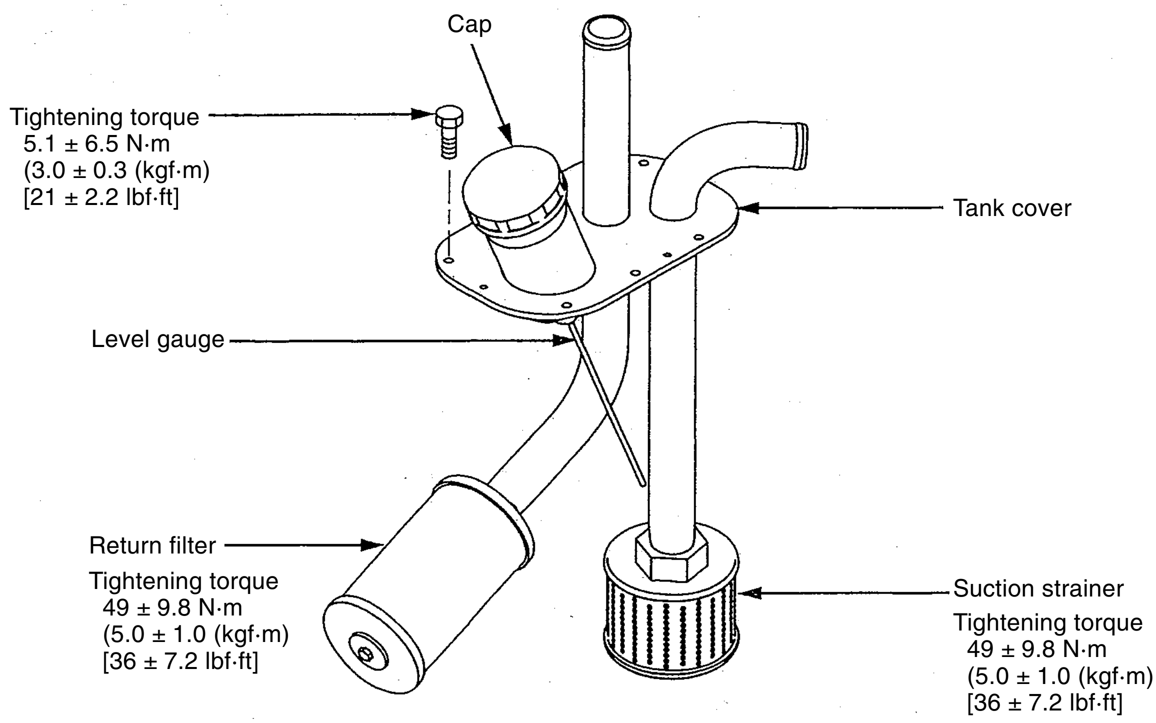
2. Piping for gasoline-engine truck



210051

Suction Strainer and Return Filter

Removal and Installation



Removal

(1) Remove the suction hose from the pump.

(2) Remove the hose of the return line from the control valve.

(3) Remove all of tank cover mounting bolts.

(4) Lift up the tank cover. It can be pulled out from the tank as shown in the above illustration.

(5) Remove the suction strainer and return filter.

Inspection

(1) Clean the suction strainer.

(2) The return filter is a periodic replacement part. Replace it when changing oil. In case of a new truck or carrying out an overhaul, replace it after the first month.

Installation

To install, follow the reverse of removal sequence, and do the following steps:

(1) Tighten the strainer and filter to the specified torque.

(2) Securely install the pump suction hose, exercising care to avoid sucking in air.

Inspection and Adjustment

1. Hydraulic tank

(1) Daily check of oil

Check oil for level, dirt and white turbidity (entry of air, mixing of water).

(2) Adequate oil level during daily check

Check the oil level with the mast lowered.

Simplex mast: Between N and L level

Triplex mast: Between H and L level

- The oil level must not exceed the H level with any mast and attachment when they are lowered.

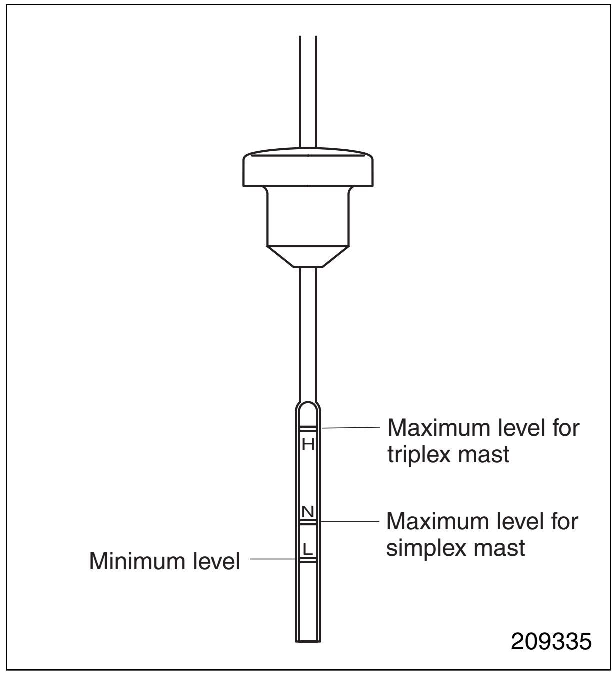
(3) Method of filling hydraulic tank with oil

- Use hydraulic oil SAE10W.

(a) Fill the hydraulic tank with oil with the mast lowered.

(b) Repeat ascent and descent of the mast a few times, and then lower the mast.

(c) Check the oil level with a level gauge. The maximum acceptable level is the N level for the simplex mast and the H level for the triplex mast. If the level is low, replenish oil.



CAUTION

The oil level in the tank must not exceed the H level with any combination of the mast and attachment when the mast is lowered.

(4) Inspection of suction strainer

Check the suction strainer for damage and clogging. Clean it if it is dirty.

(5) Inspection of return filter

Check the return filter for damage. As this part needs periodic replacement, replace it when the replacement interval is reached.

Refer to page 11-32 "Removal and Installation of Suction Strainer and Return Filter."

2. Control Valve

(1) External leakage

(a) Check for oil leaks from the joint between adjacent valve housings sealed by O-ring.

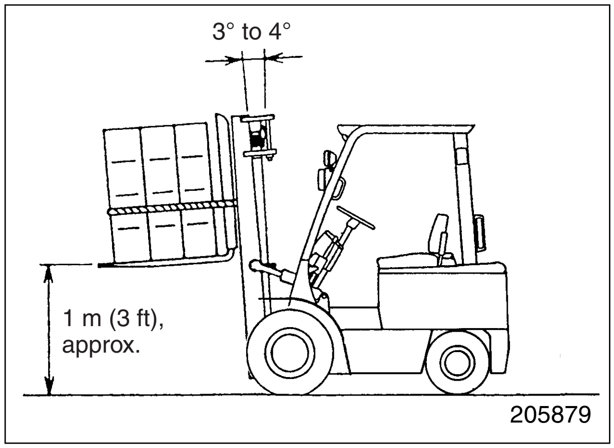
(b) Check for oil leaks from the screw connections.

(2) Internal leakage

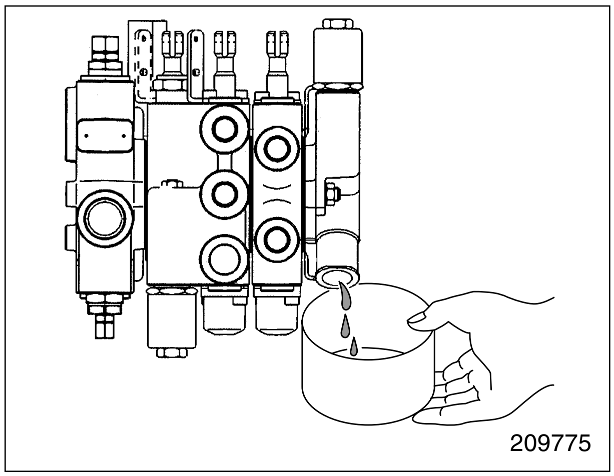
It is not practical to check the control valve alone for internal leakage. How to check the control valve in place (under normal operating conditions) will be described.

The internal leakage to be checked includes leakages occurring at the lift spool, tilt spool, tilt lock valve and check valves at the oil temperature of approximately 50°C (122°F).

(a) Pick up a load equal to the rated capacity, and lift it approximately 1 m (3 ft) high. Tilt the mast about 3° to 4° forward, and stop the engine.



(b) Quickly disconnect the oil return hose, and start collecting the oil coming out of this hose as shown.

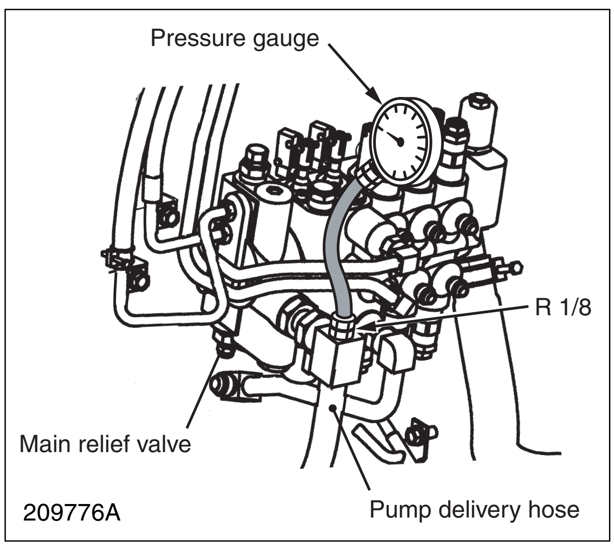


Amount of oil collected for 15 minutes	20 cc (1.2 cu in.) or less

(c) If the lift cylinders or tilt cylinders drift (the mast tilts forward or the fork lowers) excessively in spite of that the amount of oil collected for 15 minutes is less than 20 cc (1.2 cu in.), measure the internal leakage of each cylinder. (The measurement is the assembly standard and not the service limit.)

(3) Main Relief Valve

(a) Install a pressure gauge capable of measuring up to 25000 kPa (250 kgf/cm^2) [3555 psi] to the delivery hose connector. Use the gauge, connectors and hose used for testing the gear pump.



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

(b) Start the engine and run it at the maximum speed. Move the tilt control lever to the backward tilt position. If the pressure is relieved at 18142 $^{+490}_{0}$ kPa (185 $^{+5}_{0}$ kgf/cm^2) [2631 $^{+71}_{0}$ psi] when the tilt cylinders reach the end of their stroke, the main relief valve setting is correct.

(c) If the setting is incorrect, loosen the lock nut of adjusting screw and, while observing the pressure gauge reading, slowly rotate the adjusting screw until the gauge indicates the prescribed set value.

(d) While holding the adjusting screw, tighten the lock nut to secure the adjusting screw.

(e) After securing the adjusting screw, recheck the setting.

Main relief valve setting	18142 $^{+490}_{0}$ kPa (185 $^{+5}_{0}$ kgf/cm^2) [2631 $^{+71}_{0}$ psi]

(4) Adjustment of steering system relief valve

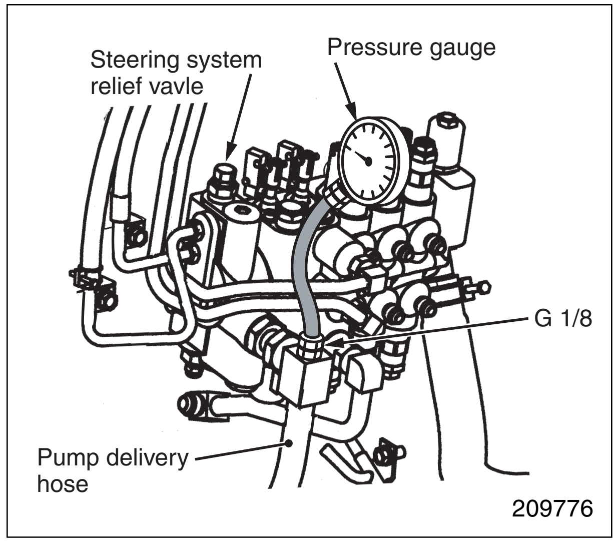
(a) Attach a pressure gauge capable of measuring up to 25000 kPa (250 kgf/cm^2) [35.55 psi] to the pump delivery hose connector (illustration on the right).

(b) Set the control lever to neutral.

(c) Start the engine and run it at the medium speed. Turn the steering wheel to the extreme right or to left to relieve oil in the steering system. The relief pressure must be within the range in the table below.

(d) If the relief pressure is outside the range, remove the cap and turn the adjusting screw for adjustment.

(e) If the pressure is correct, tighten the lock nut and check the relief pressure again.



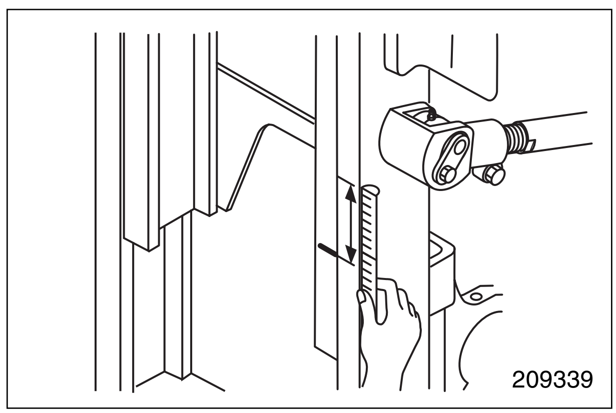
Unit: kPa (kgf/cm^2) [psi]

Item \ Truck Model	1 ton class	2, 3 ton classes
Set pressure of steering system relief valve	8800^{+490}_{0} (90^{+5}_{0}) $[1276^{+71}_{0}]$	10300^{+490}_{0} (105^{+5}_{0}) $[1494^{+71}_{0}]$

3. Descent test

(1) Pick up a load equal to the rated capacity, place the mast to a vertical position, lift the fork 1 to 1.5 m (3.3 to 4.9 ft), and stop the engine.

(2) Mark a reference line on the mast, and measure the descent (retraction of the piston rods) for 15 minutes. Divide the measured value by two to calculate the retraction of piston rods.

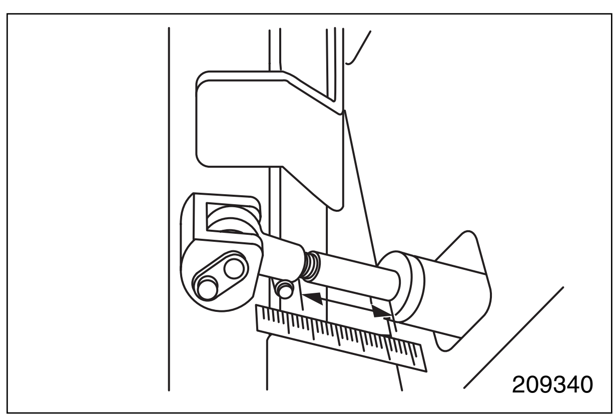


Descent (retraction of piston rods) with rated load for 15 minutes	50 mm (2 in.) maximum

4. Forward tilt test

(1) Pick up a load equal to the rated capacity, place the mast to a vertical position, lift the fork about 50 cm (20 in.), and stop the engine.

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



Amount of forward tilt (extension of piston rods) with rated load for 15 minutes	20 mm (0.8 in.) maximum

Troubleshooting

Component	Symptom	Cause	Remedy
Hydraulic tank	Hydraulic tank heats excessively	Not enough oil in hydraulic tank	Refill.
		Oil viscosity improper	Change upon referring to “Fuel and Lubricant Specifications” on page 13-13.
		Overload	Check working conditions and, if over-loaded, urge the operator to stay within the load limit.
		Local overheating of oil line due to a large restriction to flow	Clean oil line.
		Relief valve adjustment improper	Readjust pressure setting.
		Pressure drop due to fatigued or broken springs	Disassemble or replace and readjust pressure.
		Gear pump worn	Replace pump.
		Outlet pipe or tube flattened, or restriction to flow	Repair or replace.
	Cylinders move too slow	Shortage of oil due to a natural loss	Replenish oil upon referring to “Fuel and Lubricant Specifications” on page 13-13.
		Oil leakage due to damaged oil line and seals	Repair or replace.
		Oil viscosity too high	Replenish oil upon referring to “Fuel and Lubricant Specifications” on page 13-13.
Gear pump	Cylinders move too slow	Gear pump does not pump oil	Check pump and piping; repair or replace.
		Oil leakage from oil line	Check oil for level and condition; add or change oil.
		Gear pump internally leaking	Replace pump.
	Noisy	Poor pumping	Replenish oil upon referring to “Fuel and Lubricant Specifications” on page 13-13.
		Cavitation	(1) Check suction pipe for any flat portion or loose connection; retighten or replace. (2) Check shaft oil seal for airtightness; replace pump. (3) Check pump body for any outside interference; repair.
	Pump case, drive gear or pump port flange damaged	Pressure too high	Replace pump. (Check to see if relief valve setting is correct.)
		Distortion or damage due to external strain or stress	Replace pump. (1) Check to see if return line is blocked or restricted. (2) Check to see if pipe connections have been externally strained or stressed.
	Oil leakage from pump	Oil leakage past oil seal	Replace shaft seal.
		Oil leakage past sliding surfaces of drive shaft	Replace whole pump assembly.
		Pump securing bolts loose	Retighten. Replace if needed.
		Degraded performance of sealing inside pump	Replace gasket.

Control valve	Slow or no motion of lift and tilt cylinders	Relief valve set pressure lowered	Readjust pressure.
		Relief valve piston seizure	Wash piston and check to see if it moves smoothly; or replace whole relief valve assembly.
		O-ring on relief valve body damaged	Replace O-ring.
		Control lever installed loose, resulting in not enough spool stroke	Readjust.
		Abnormal oil temperature rise	Check control valve spool for misalignment; repair or replace.
	Load descends or mast tilts forward	Control valve internally leaking	Replace a leaky block assembly.
	Oil leakage	Oil leakage from spool ring cap	Replace O-ring; check spool for flaws and if any, repair or replace a leaky block assembly.
		Loose plug	Retighten plug.
		O-ring damaged	Replace O-ring.
Lift and tilt cylinders	Mast will not lift or tilt forward or backward	Not enough oil in hydraulic tank	Replenish oil upon referring to “Fuel and Lubricant Specifications” on page 13-13.
		Relief valve out of order, because of:	
		(1) Seized main valve	Replace.
		(2) Broken valve spring	Replace.
		Gear pump defective	Replace.
	Will not lift rated load	Relief valve out of order, because of:	
		(1) Too low a relief valve setting	Readjust pressure.
		(2) Defective plunger or poppet seat	Replace.
		(3) Fatigued spring	Replace.
		(4) Damaged O-ring in valve case	Replace.
		Gear pump defective	Replace.
		Piston seals worn or damaged	Replace.
	Lifting speed is too slow	Engine speed too low	Adjust engine.
		Control lever installed loose, resulting in not enough spool stroke	Adjust.
		Tank strainer clogged	Clean or replace.
		Pump not delivering enough oil	Repair or replace.
	Lowering speed is too slow	Sleeve seized in flow regulator valve	Repair.
		Dirt in flow regulator valve, abnormal resistance to flow due to flattened hose or local clogging	Clean, repair system and replace defective hose.

Component	Problem	Possible cause	Remedy
Lift and tilt cylinders	Cylinder vibrates when actuated	Piston rod distorted	Repair or replace.
		Air trapped in oil circuit	Bleed air by operating cylinder through full stroke.
		Not enough oil in hydraulic tank	Refill.
	Load descends fast	Control valve spool internally leaking	Replace a leaky block assembly.
		Sliding (inside) surface of cylinder tube slightly grooved	Repair or replace.
		Sliding (inside) surface of cylinder tube badly grooved	Replace cylinder assembly.
		Piston seals broken or distorted	Replace seal kit.
		Oil leakage from piping	Repair or replace.
	Mast tilts forward (drift)	Control valve spool internally leaking	Replace a leaky block assembly.
		Foreign particles lodged in packing	Replace packing.
		Piston seals damaged	Replace seals.
		Other abnormal distortion, oil leakage from piping	Repair or replace.
	Lift cylinders descend or tilt cylinders tilt forward (drift) at a certain point of stroke	Sliding surface of cylinder tube badly grooved or rusted at one point	Repair or replace.
		Cylinder tube distorted	Replace.
	Oil leakage at bushing	Foreign particles lodged between sealing members such as oil seals and dust seals	Replace.
		Oil seals and dust seals grooved	Replace.
		O-rings damaged	Replace O-rings.
		Cylinder abnormally distorted	Repair or replace.

Service Data

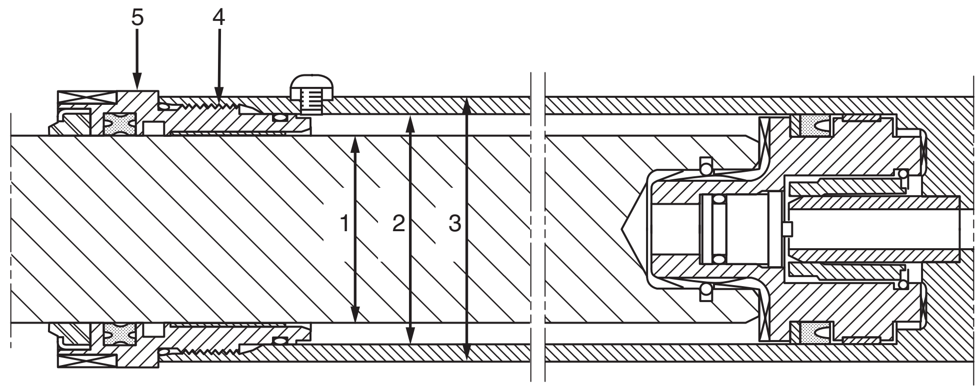
A: Standard value
Unit: mm (in.)

<table>
<tr><th colspan="2">Items \ Truck Models</th><th></th><th>1 ton class</th><th>2 ton class</th><th>3 ton class</th></tr>
<tr><td colspan="2">Forward tilt angle (standard truck with simplex mast) degrees</td><td>A</td><td colspan="3">6</td></tr>
<tr><td colspan="2">Backward tilt angle (standard truck with simplex mast) degrees</td><td>A</td><td colspan="3">12</td></tr>
<tr><td colspan="2">Lift cylinder descent amount (at rated load) [Retracted length of rod, oil temperature at 45°C (113°F)] mm (in.)/15 min.</td><td>A</td><td colspan="3">50 (2) or less</td></tr>
<tr><td colspan="2">Tilt cylinder forward tilt amount (at rated load) [Extended length of rod, oil temperature at 45°C (113°F)] mm (in.)/15 min.</td><td>A</td><td colspan="3">20 (0.8) or less</td></tr>
<tr><td colspan="2">Main relief valve setting MPa (kgf/cm²) [psi]</td><td>A</td><td colspan="3">18.1 $^{+0.5}_{0}$ (185 $^{+5.1}_{0}$) [2625 $^{+725}_{0}$]</td></tr>
<tr><td colspan="2">Steering system relief valve setting MPa (kgf/cm²) [psi]</td><td>A</td><td>8.8 $^{+0.5}_{0}$
(90 $^{+5}_{0}$)
[1276 $^{+71}_{0}$]</td><td>10.3 $^{+0.5}_{0}$
(105 $^{+5}_{0}$)
[1494 $^{+71}_{0}$]</td><td>10.3 $^{+0.5}_{0}$
(105 $^{+5}_{0}$)
[1494 $^{+71}_{0}$]</td></tr>
<tr><td rowspan="2">Hydraulic pump (gear pump)</td><td>Manufacturer</td><td></td><td colspan="3">SHIMADZU CORPORATION</td></tr>
<tr><td>Manufacturer's model name</td><td></td><td colspan="3">SGP1 type single gear pump</td></tr>
<tr><td rowspan="2">Manufacturer of control valves</td><td>MC control valve</td><td></td><td colspan="3">SHIMADZU CORPORATION</td></tr>
<tr><td>FC control valve</td><td></td><td colspan="3">Cat Heavy Industries, Ltd.</td></tr>
<tr><td colspan="2">Tightening torque of return filter N·m (kgf·m) [lbf·ft]</td><td>A</td><td colspan="3">49 ± 9.8 (5.0 ± 1.0) [36 ± 7.2]</td></tr>
<tr><td colspan="2">Tightening torque of suction strainer N·m (kgf·m) [lbf·ft]</td><td>A</td><td colspan="3">49 ± 9.8 (5.0 ± 1.0) [36 ± 7.2]</td></tr>
</table>

A: Standard value
Unit: mm (in.)

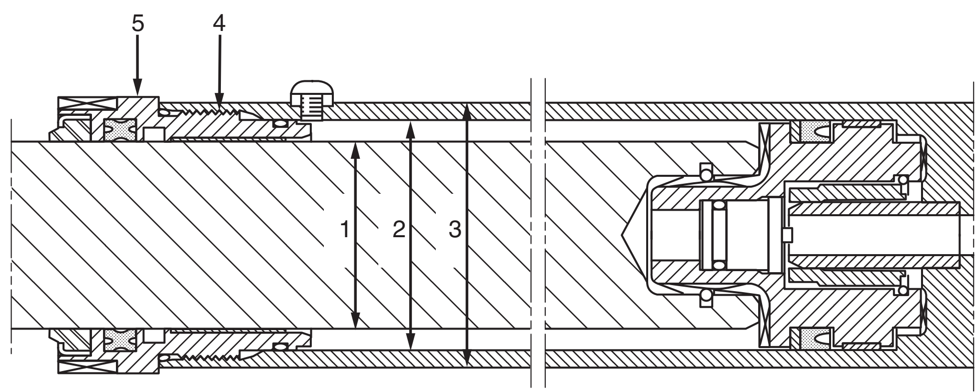
Items		Truck Models	1 ton class	2 ton class	3 ton class
Second cylinder for simplex mast and triplex mast	Rod outside diameter 1	A	35 (1.38)	40 (1.57)	45 (1.77)
	Cylinder inside diameter 2	A	45 (1.77)	50 (1.97)	55 (2.17)
	Cylinder outside diameter 3	A	52 (2.05)	57 (2.24)	63 (2.48)
	Thread size of cylinder head 4	A	M49	M54	M59
	Tightening torque of cylinder head 5 N·m (kgf·m) [lbf·ft]	A	196 ± 45.1 (20 ± 4.6) [145 ± 33]	235 ± 53.9 (24 ± 5.5) [173 ± 40]	275 ± 61.8 (28 ± 6.3) [203 ± 46]

- Simplex mast with raised height of 3.4 m (11.2 ft) or less
- All triplex masts



209760B

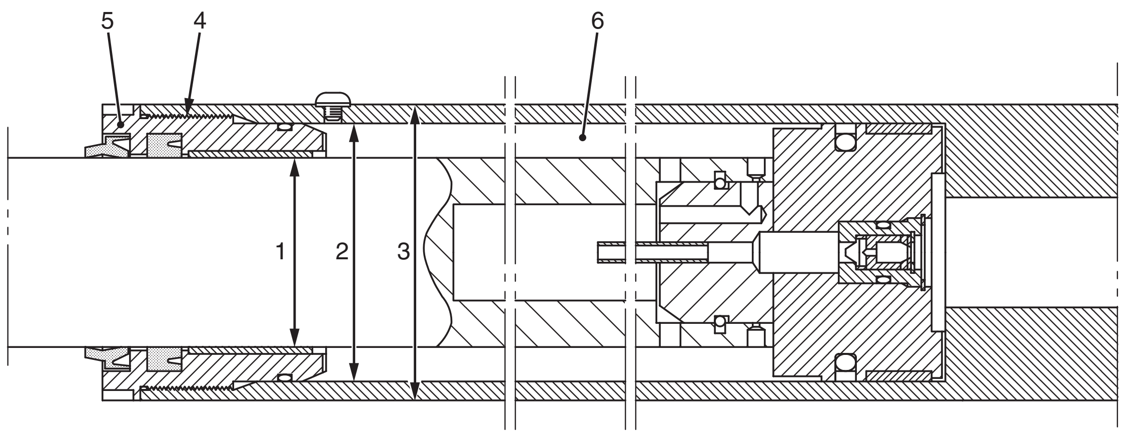
- Simplex mast with raised height of 3.5 m (11.5 ft) or higher



209759A

A: Standard value
Unit: mm (in.)

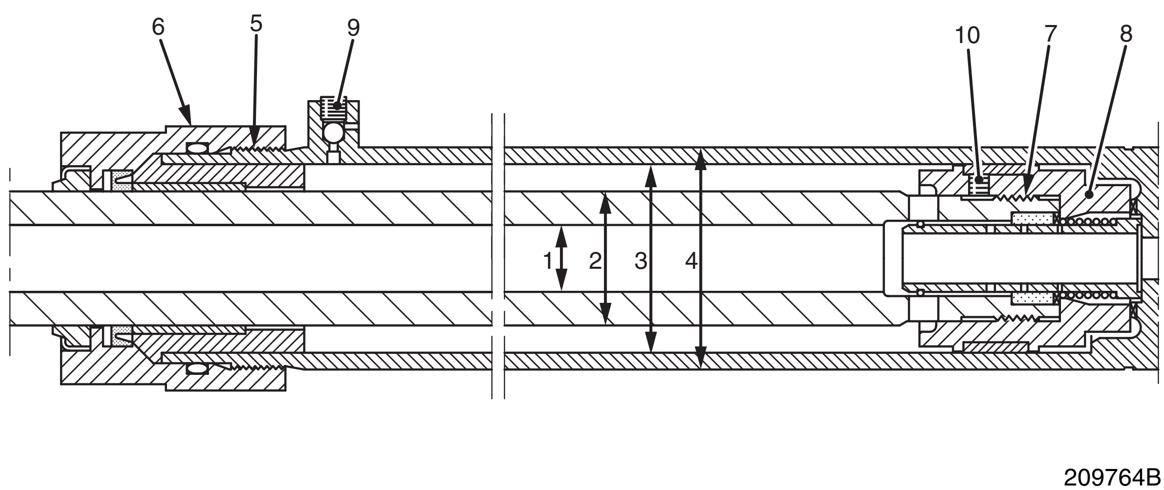
Items	Truck Models		1 ton class	2 ton class	3 ton class
First cylinder for duplex mast and triplex mast	Rod outside diameter 1	A	55 (2.16)	55 (2.16)	65 (2.56)
	Cylinder inside diameter 2	A	70 (2.76)	75 (2.95)	90 (3.54)
	Cylinder outside diameter 3	A	82 (3.23)	86 (3.39)	105 (4.13)
	Thread size of cylinder head 4	A	M75	M80	M95
	Tightening torque of cylinder head 5 N·m (kgf·m) [lbf·ft]	A	382 (39) [282]	422 (43) [311]	530 (54) [390]
	Sealed-in amount of cushion oil cc (cu in.)	A	75 to 85 (4.6 to 5.2)	75 to 85 (4.6 to 5.2)	160 to 180 (9.8 to 11.0)



209767B

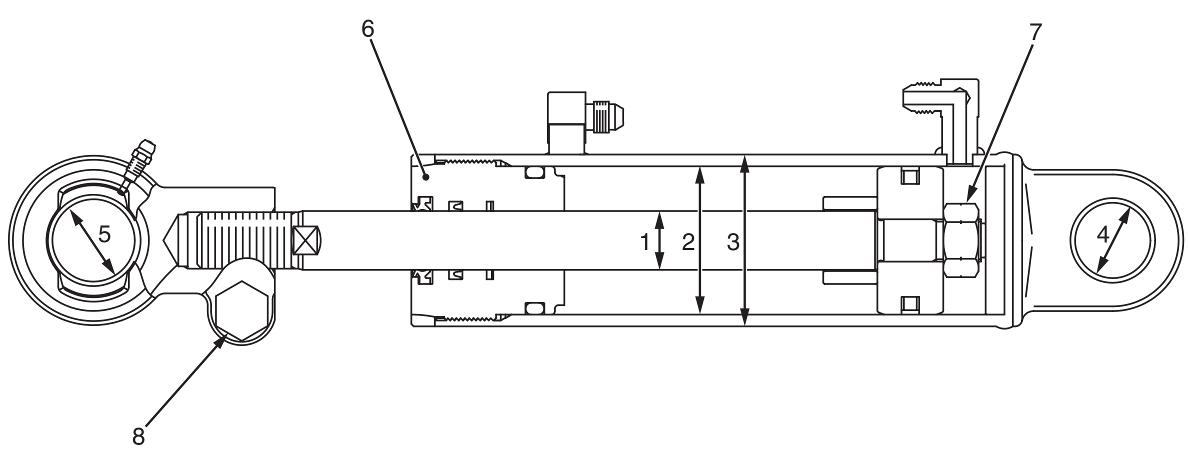
A: Standard value
Unit: mm (in.)

Items			Truck Models: 1 ton class	2 ton class	3 ton class
Second cylinder for duplex mast	Rod inside diameter 1	A	16 (0.63)	16 (0.63)	20 (0.79)
	Rod outside diameter 2	A	32 (1.26)	35 (1.38)	40 (1.57)
	Cylinder inside diameter 3	A	45 (1.77)	45 (1.77)	50 (1.97)
	Cylinder outside diameter 4	A	53 (2.09)	53 (2.09)	60 (2.36)
	Thread size of holder 5	A	M52	M52	M57
	Tightening torque of holder 6 N·m (kgf·m) [lbf·ft]	A	206 ± 39.2 (21 ± 4.0) [152 ± 29]	206 ± 39.2 (21 ± 4.0) [152 ± 29]	235 ± 53.9 (24 ± 5.5) [173 ± 40]
	Thread size of piston 7	A	M30	M33	M36
	Tightening torque of piston 8 N·m (kgf·m) [lbf·ft]	A	196 ± 35 (20 ± 3.6) [145 ± 26]	196 ± 35 (20 ± 3.6) [145 ± 26]	196 ± 35 (20 ± 3.6) [145 ± 26]
	Tightening torque of plug 9 N·m (kgf·m) [lbf·ft]	A	3.92 (0.4 ± 0.09) [2.9 ± 0.66]	3.92 (0.4 ± 0.09) [2.9 ± 0.66]	3.92 (0.4 ± 0.09) [2.9 ± 0.66]
	Tightening torque of set screw 10 N·m (kgf·m) [lbf·ft]	A	3.92 (0.4 ± 0.09) [2.9 ± 0.66]	3.92 (0.4 ± 0.09) [2.9 ± 0.66]	3.92 (0.4 ± 0.09) [2.9 ± 0.66]



A: Standard value
Unit: mm (in.)

Items \ Truck Models			1 ton class	2 ton class	3 ton class
Tilt cylinder	Rod outside diameter 1	A	25 (0.98)	30 (1.18)	35 (1.38)
	Cylinder inside diameter 2	A	63 (2.48)	70 (2.76)	80 (3.15)
	Cylinder outside diameter 3	A	73 (2.87)	82 (3.23)	93 (3.66)
	Bushing inside diameter on head side 4	A	$32^{+0.085}_{0}$ ($1.26^{+0.00335}_{0}$)	$32^{+0.085}_{0}$ ($1.26^{+0.00335}_{0}$)	$32^{+0.085}_{0}$ ($1.26^{+0.00335}_{0}$)
	Bushing outside diameter on rod side 5	A	$35^{0}_{-0.02}$ ($1.38^{0}_{-0.0008}$)	$35^{0}_{-0.02}$ ($1.38^{0}_{-0.0008}$)	$35^{0}_{-0.02}$ ($1.38^{0}_{-0.0008}$)
	Tightening torque of guide bushing 6 N·m (kgf·m) [lbf·ft]	A	265 ± 29 (27 ± 3.0) [195 ± 21]	314 ± 31 (32 ± 3.2) [232 ± 23]	373 ± 37 (38 ± 3.7) [275 ± 2.7]
	Tightening torque of nut 7 N·m (kgf·m) [lbf·ft]	A	127 ± 9.8 (13 ± 1.0) [94 ± 7.2]	235 ± 19.6 (24 ± 2.0) [173 ± 14.5]	392 ± 25 (40 ± 2.5) [289 ± 18.4]
	Tightening torque of tilt socket clamp bolt 8 N·m (kgf·m) [lbf·ft]	A	153 to 182 (16 ± 19) [113 ± 134]	153 to 182 (16 ± 19) [113 ± 134]	153 to 182 (16 ± 19) [113 ± 134]



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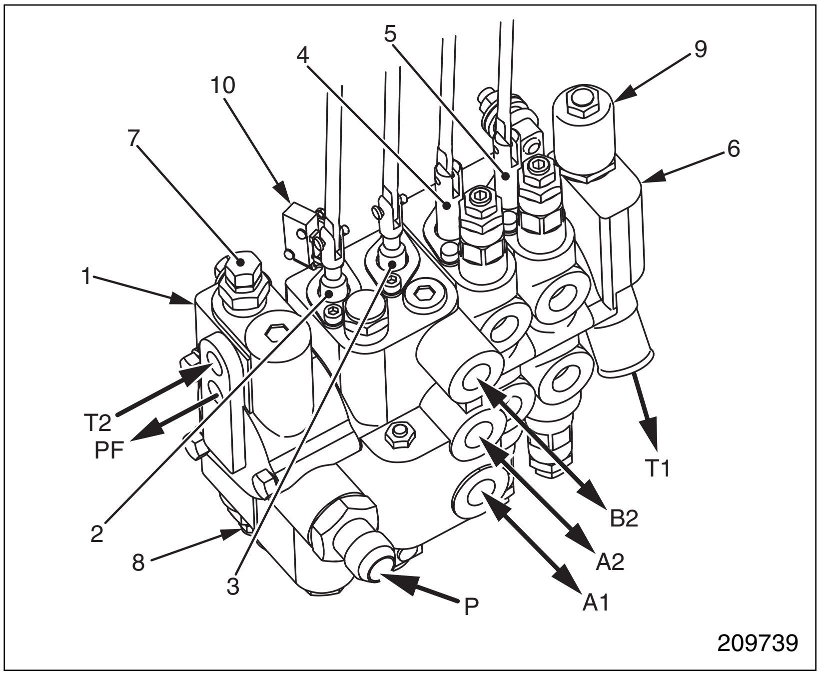
MC Control Valve

Structure and Operation

MC Control Valve



P : Pressure oil inflow port from pump
PF : To steering control valve
T1 : To hydraulic tank (return line)
T2 : Return from steering control valve
A1 : To lift cylinder
A2 : To tilt cylinder rod end
B2 : To tilt cylinder head end

Main valves

1 Inlet cover section (with built-in priority valve)
2 Lift valve (with built-in flow regulator valve)
3 Tilt valve
4 Attachment valve (1)
5 Attachment valve (2)
6 End cover section (with built-in unloader valve)
7 Steering system relief valve
8 Main relief valve
9 Unloader valve (with solenoid)
10 Lift lowering limit switch (OP)

The above illustration shows an external view of the four-valve type MC control valve. Any one of the two-valve to five-valve type valves is installed on a truck depending on lift specifications. The most basic valve configuration is a two-valve type, combination of the lift and tilt. Adding attachment valve(s) to this combination is three-valve type, four-valve type or five-valve type valve.

Inlet cover section 1 has a built-in priority valve. This valve is a flow divider valve which feeds a certain amount of the total inflow volume from the P port preferentially to the steering system and the extra flow volume to the cargo-handling valve. In addition, the inlet cover section is provided with main relief valve 8 and steering relief valve 7. Each of these valves limits the maximum pressure to protect the system.

Lift valve 2 and tilt valve 3 are assembled adjacent to the combination section.

Lift valve 2 is a direction control valve which feeds and returns pressure oil to and from the lift cylinder. The lift valve also has a built-in flow regulator valve.

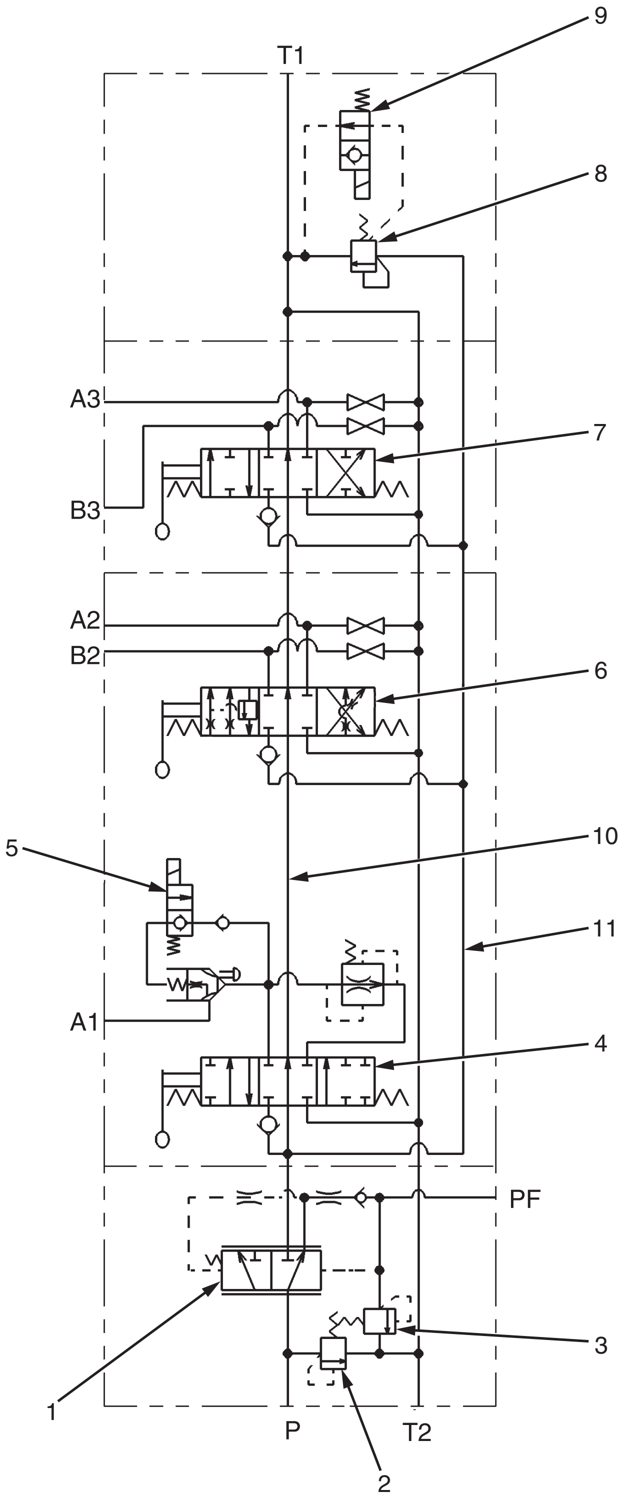
Tilt valve 3 feeds and returns pressure oil to and from the tilt cylinder which tilts the mast forward or backward. The tilt lock valve is assembled in the main spool to ensure safety when the mast is tilted forward.

Attachment valves 4 and 5 are direction control valves which feed pressure oil to actuators of the attachments.

End cover section 6 is provided with unloader valve 9. This valve is linked with the seat switch, and is a solenoid valve which closes the parallel feeder (high-pressure circuit) to hold pressure oil only when the seat switch is ON.

Hydraulic Circuit Diagram of MC Hydraulic Control Valve

This diagram is for the three-valve type control valve. For the four or five-valve type control valve, the attachment valve 7 is added.



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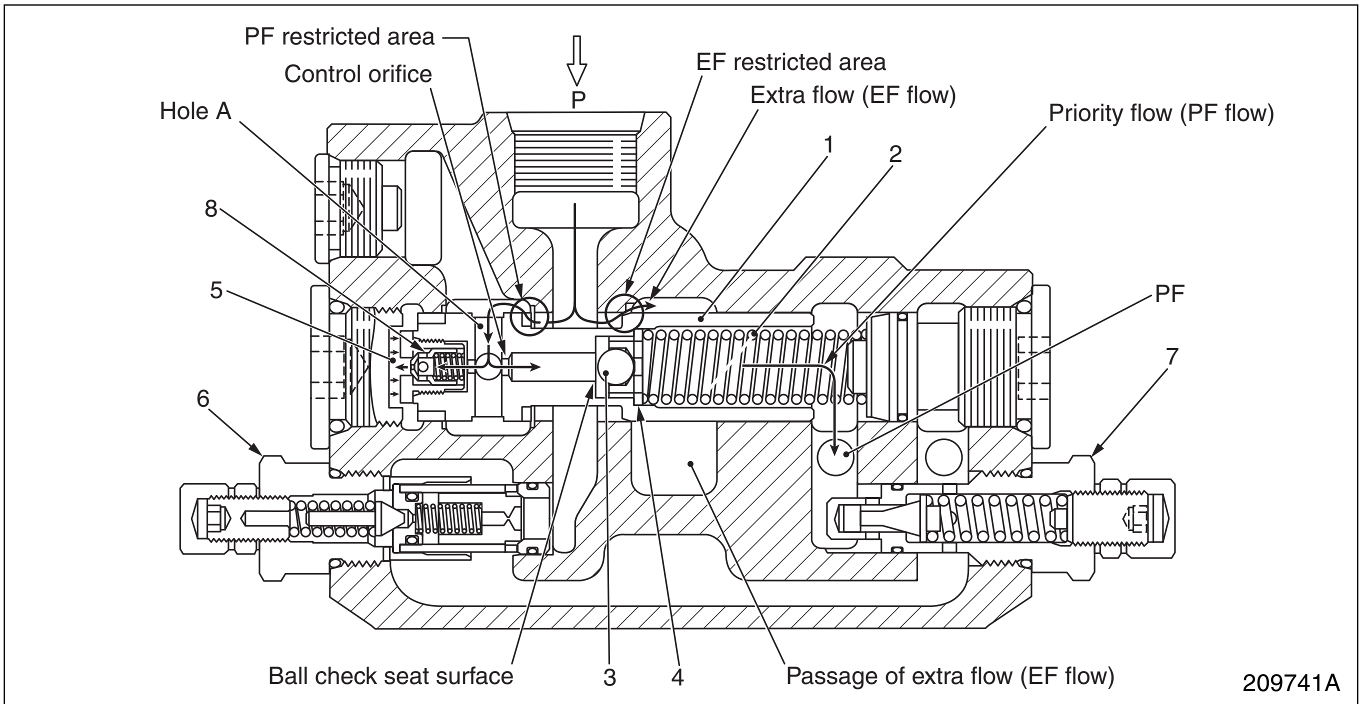
For the entire diagram of the hydraulic system, refer to page 11-2.

1 Priority valve
2 Main relief valve
3 Steering system relief valve
4 Lift valve
5 Solenoid valve (operates in conjunction with lift lowering switch)
6 Tilt valve
7 Attachment valve
8 Unloader valve
9 Solenoid for unloader valve
10 Center bypass port
11 Parallel feeder

P : Supplied oil from pump
PF : To steering valve
T2 : Return from steering valve
T1 : To hydraulic tank

A1 : To lift cylinder
A2 : To tilt cylinder rod end
B2 : To tilt cylinder head end
A3 : To actuator for attachment valve
B3 : To actuator for attachment valve

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

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

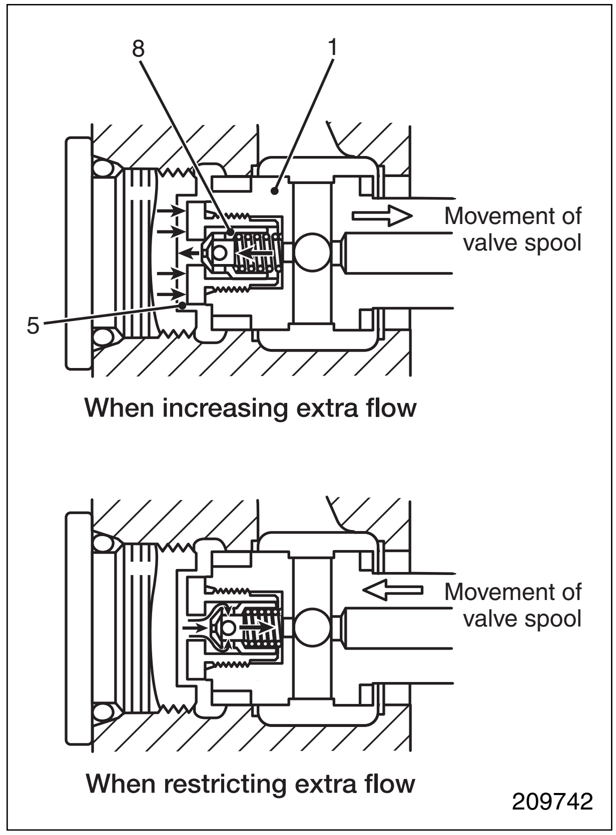
Valve 8 is an orifice provided in oil inflow and outflow passages of damper valve 5. This orifice diverts preferentially PF flow in a stable condition (no occurrence of surging) by controlling the moving speed of valve spool 1.

When extra flow (EF flow) is increased, pressure oil in the port P flows in damper chamber 5. As the passage is the orifice on the edge of valve 8 only, movement of valve spool 1 is slow.

When PF flow is insufficient, it is necessary to increase PF flow by quickly restricting the EF restricted area. For this, it is necessary to quickly discharge oil in damper chamber 5. As the orifice on the circumference as well as the orifice on the valve edge is provided in the passage at this time, the spool can move to the left quickly.

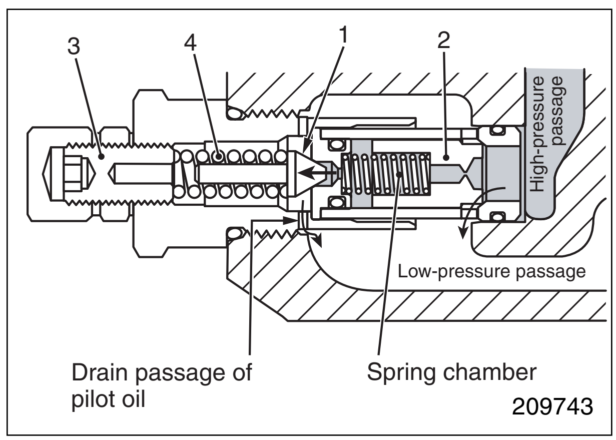
This action, when pressure of PF flow lowers, can prevent a kickback phenomenon caused on the steering wheel.

Ball check 3 prevents backflow of PF flow. This is a preventive measure for a kickback phenomenon.



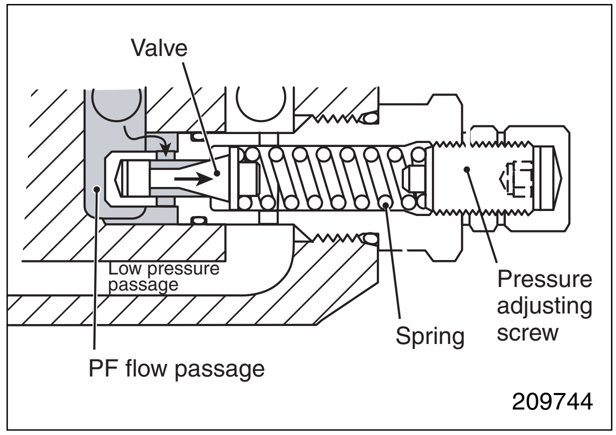
Main Relief Valve

This valve is a relief valve with a pilot valve. When pressure in the P port reaches the set value, poppet valve 1 is pushed to the left (in the illustration), leaving the seat. Pilot oil in the spring chamber flows in the drain passage. Then, dump valve 2 moves to the left, releasing a part or all of main flow to the low-pressure passage. This is a safety valve to protect the system. To adjust, turn adjusting screw 3 to change preload of spring 4.

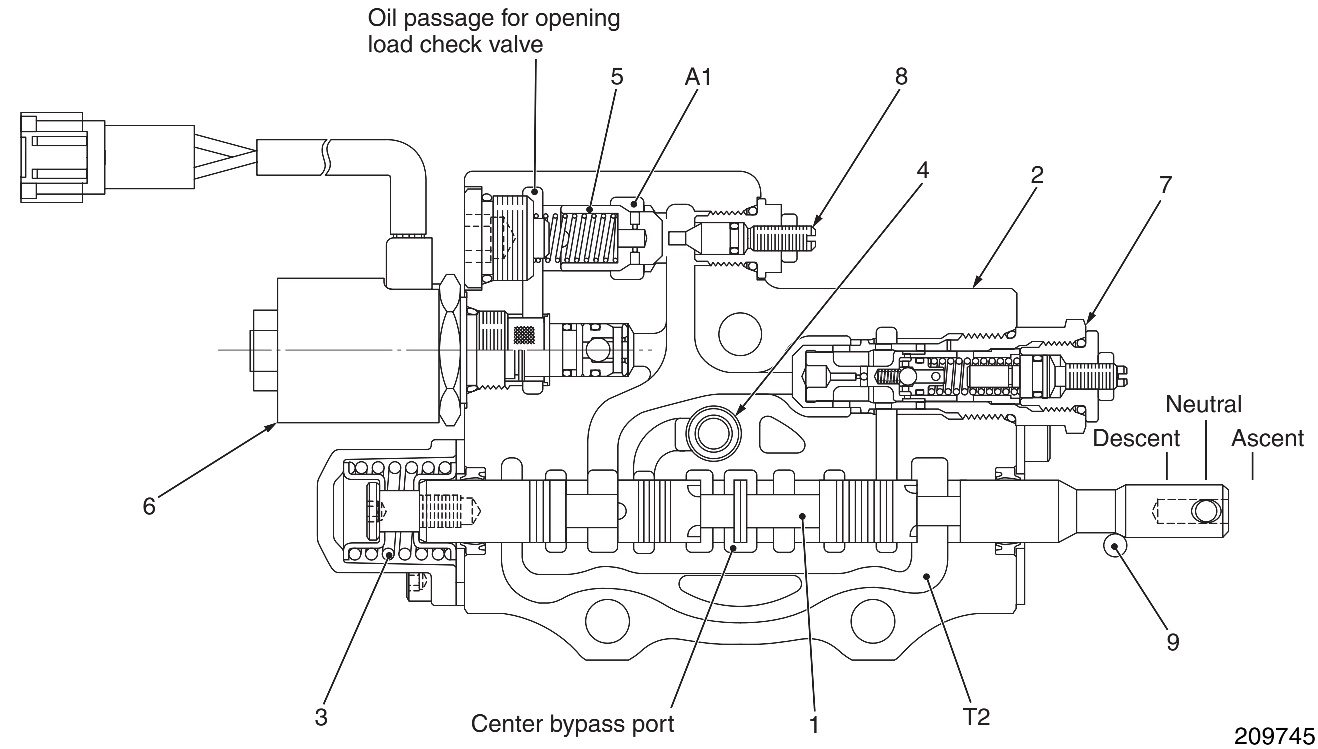


Steering System Relief Valve (PF relief valve)

This valve is a relief valve of direct-acting type, and acts when the steering wheel is fully turned. This is a safety valve to protect the system. To adjust, turn the adjusting screw to change preload of the spring.



Lift Valve



Main components

1 Lift spool
2 Valve body
3 Return spring
4 Check valve
5 Load check valve
6 Solenoid valve
7 Flow regulator valve
8 Shut-off valve
9 Roller for lift lowering limit switch

A1 : Lift cylinder port
T2 : Tank port

The above illustration shows the lift control valve when spool 1 is at the "neutral position."

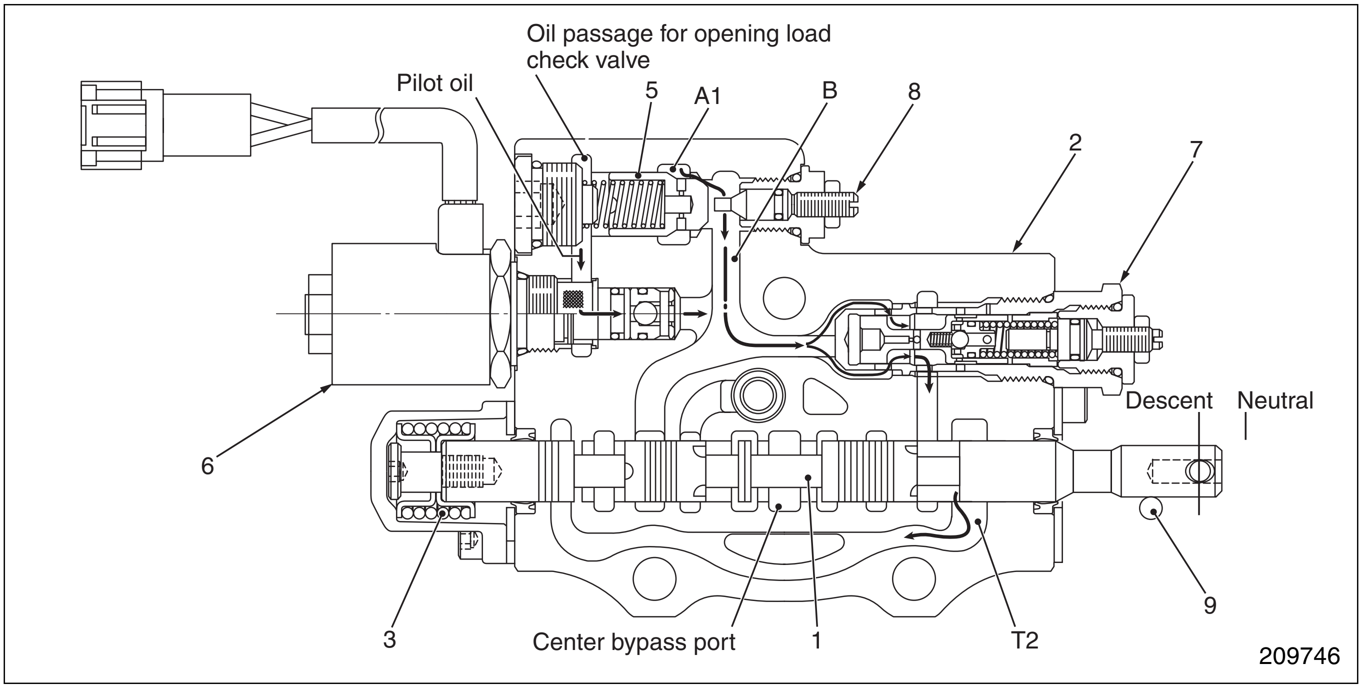
Neutral position:

Spool 1 is placed at the "neutral position" by return spring 3 and oil in the A1 port is blocked by load check valve 5.

As the center bypass port is open, pressure oil flows into the tilt valve without being blocked.

Ascending position of lift cylinder:

Spool 1 moves to the right (as in the above illustration) and blocks the center bypass port. Pressure in the parallel feeder (high-pressure passage) rises and pressure oil pushes open check valve 4, reaching load check valve 5. Furthermore, pressure oil pushes open load check valve 5, flows in the A1 port and in the bottom of the lift cylinder piston. And it pushes the cylinder rod upward.



Descending position of lift cylinder:

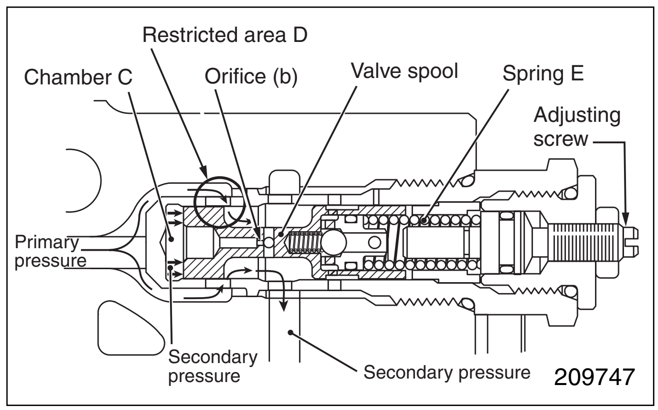
The above illustration shows the lift control valve when spool 1 is at "descending position."

Spool 1, pushed in body 2, is at the position as shown in the illustration. The center bypass port is not blocked. The secondary port of flow regulator valve 7 is open to the T2 port (return passage).

When spool 1 is pushed in the body, roller 9 of the lift lowering limit switch is pushed in, turning the switch ON. The truck body controller (VCM-1) detects this and feeds current to solenoid valve 6 to activate. When the solenoid activates, pilot oil behind load check valve 5 is released to the passage B. Thus, load check valve 5 moves to the left (in the illustration) by pressure of the A1 port and oil in the A1 port flows to the T2 port via flow regulator valve 7.

Shut-off valve 8 forcibly opens load check valve 5 if the load check valve does not automatically activate due to malfunction of solenoid 6 or any other reason. Just loosen the lock nut and push in the screw.

Action of flow regulator valve



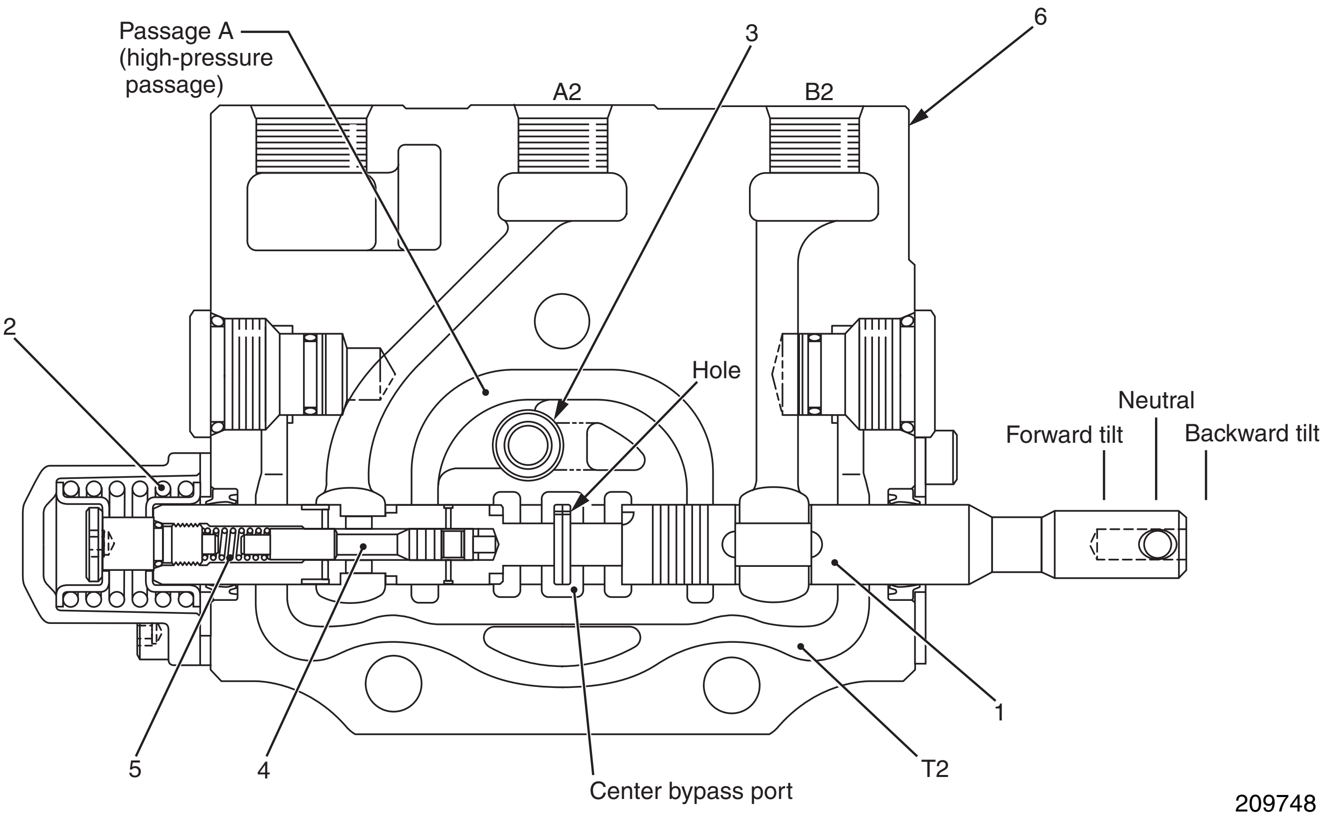
The flow regulator valve keeps the maximum speed constant during cylinder descent regardless of the load weight on the fork.

Oil from the A1 port (primary pressure) passes through the restricted area D and its pressure is reduced. This pressure-reduced oil (secondary pressure) flows to the chamber C through the orifice (b) and moves the valve spool to the right against the spring E, restricting the restricted area D. The degree of this restriction is greater as the primary pressure is higher. Thus, the secondary pressure is made constant. If the secondary pressure is constant, the outflow volume is constant.

The right part of this valve is a mechanism to stabilize valve spool movement.

To adjust the flow volume, turn the adjusting screw. However, do not adjust in field because it is difficult to determine whether it is good or bad.

Tilt Valve



Main components

1 Tilt spool
2 Return spring
3 Check valve
4 Tilt lock valve
5 Tilt lock valve spring
6 Valve body

A2 : To tilt cylinder rod
B2 : To tilt cylinder head
T2 : Tank port (return passage)

The above illustration shows the tilt control valve when spool 1 is at the "neutral position."

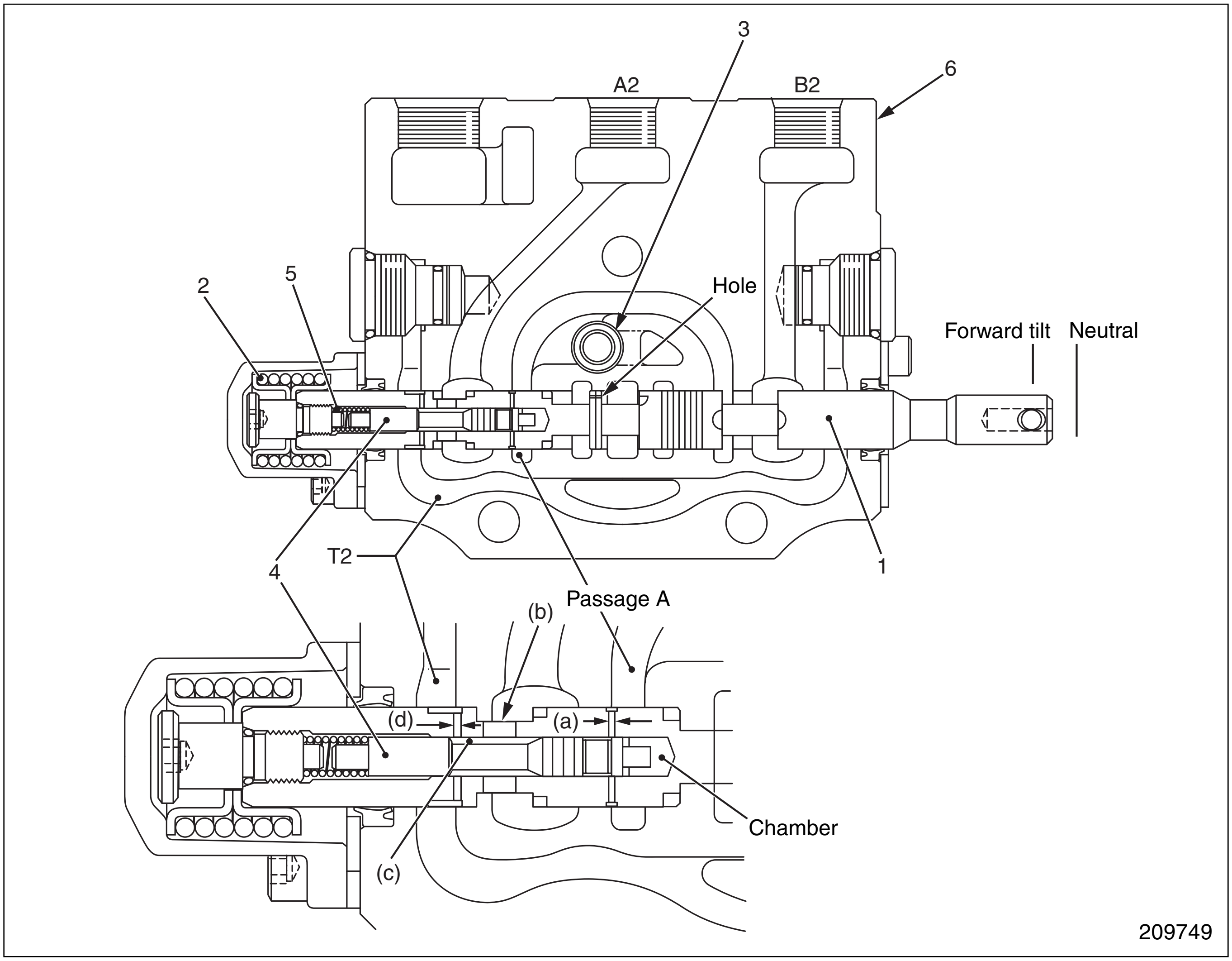
Neutral position:

Spool 1 is placed at the "neutral position" by return spring 2, and both the A2 port and B2 port are blocked by the spool.

As the center bypass valve is open, oil in the bypass port flows in the attachment valve.

Mast backward tilt position:

Spool 1 moves to the right. The B2 port is connected to the T2 port and the A2 port is connected to passage A. The spool is positioned to block the center bypass port, but as the spool is provided with a hole under the land, it does not block completely. This is designed to prevent a large amount of oil from flowing at a time to avoid abrupt movement of the cylinder, a characteristic of this valve. When the center bypass port is blocked, pressure in the parallel feeder rises. Pressure oil pushes open check valve 3, flows in passage A and flows to the tilt cylinder rod from the A2 port. At the same time, oil in the tilt cylinder head flows to the T2 passage. These two actions pull the rod into the tilt cylinder.

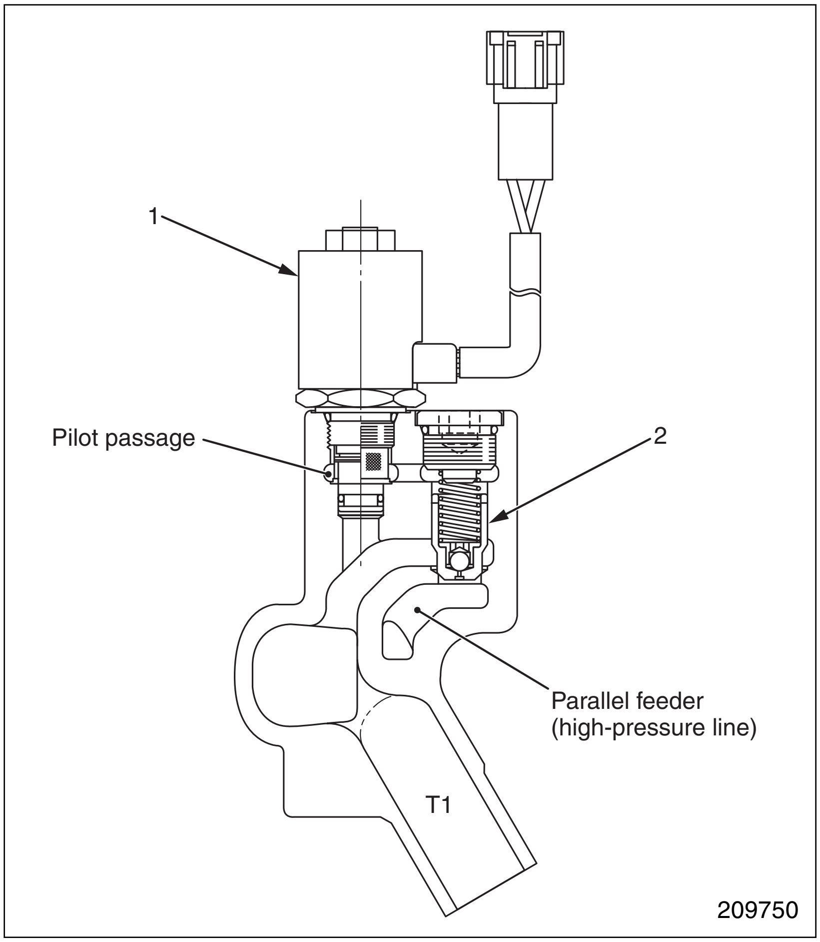


Mast forward tilt position:

The above illustration shows the tilt control valve when spool 1 is at the "forward tilt position." Spool 1 is pushed into body 6. Then, the B2 port 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, pushing open check valve 3 and pressure oil flows to passage A. Oil in passage A flows to the tilt cylinder head from the B2 port and acts to push out the cylinder rod. 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 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 the B2 port and "opening" of the return passage of the A2 port.

Tilt lock valve 4 does not operate unless the engine runs and pressure oil is supplied from the pump. This valve is a kind of an anti-disaster valve.

Unloader Valve



1 Solenoid valve
2 Valve

T1 : Tank port (return passage)

The above illustration shows the unloader valve when the engine stops.

When the seat switch is “open”, solenoid valve 1 is open and pilot oil in the back of valve 2 is connected to the T1 passage. Therefore, oil in the parallel feeder (high-pressure line) lightly pushes up valve 2, flowing to the T1 port. Namely, as hydraulic pressure cannot be held, the cylinder cannot be moved even if the valve operating lever is moved.

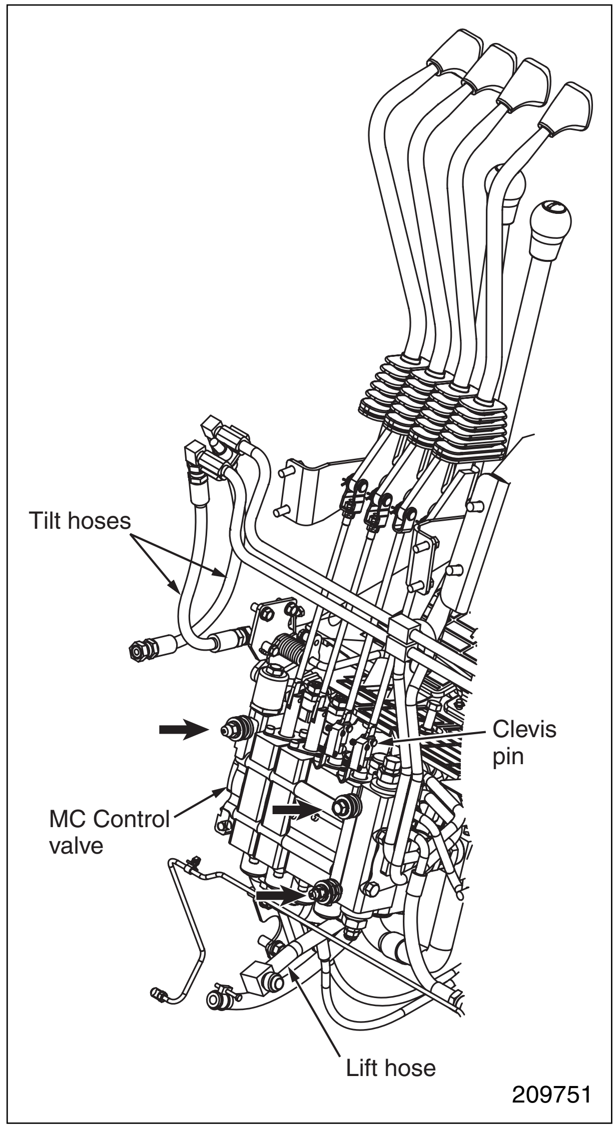
When an operator sits on the seat, the seat switch is turned ON, actuating solenoid valve 1 to block the pilot passage. Thus, the parallel feeder can hold oil pressure. This valve is an anti-disaster valve.

Removal and Installation of Control Valve

Removal and Installation

Removal

1. Remove the floor plate.
2. Remove the clevis pin of the control lever rod and separate the rod from the control valve spool.
3. Disconnect each piping from the valve.
   (1) Pump delivery hose
   (2) Tilt pipe
   (3) Lift pipe
   (4) Return hose
   (5) Supply pipe to steering valve
   (6) Return hose from the steering valve
4. Separate the solenoid valve and harness of the microswitch from the connector.
5. Remove valve mounting bolts and nuts (arrows in the illustration on the right) and remove the valve.



Installation

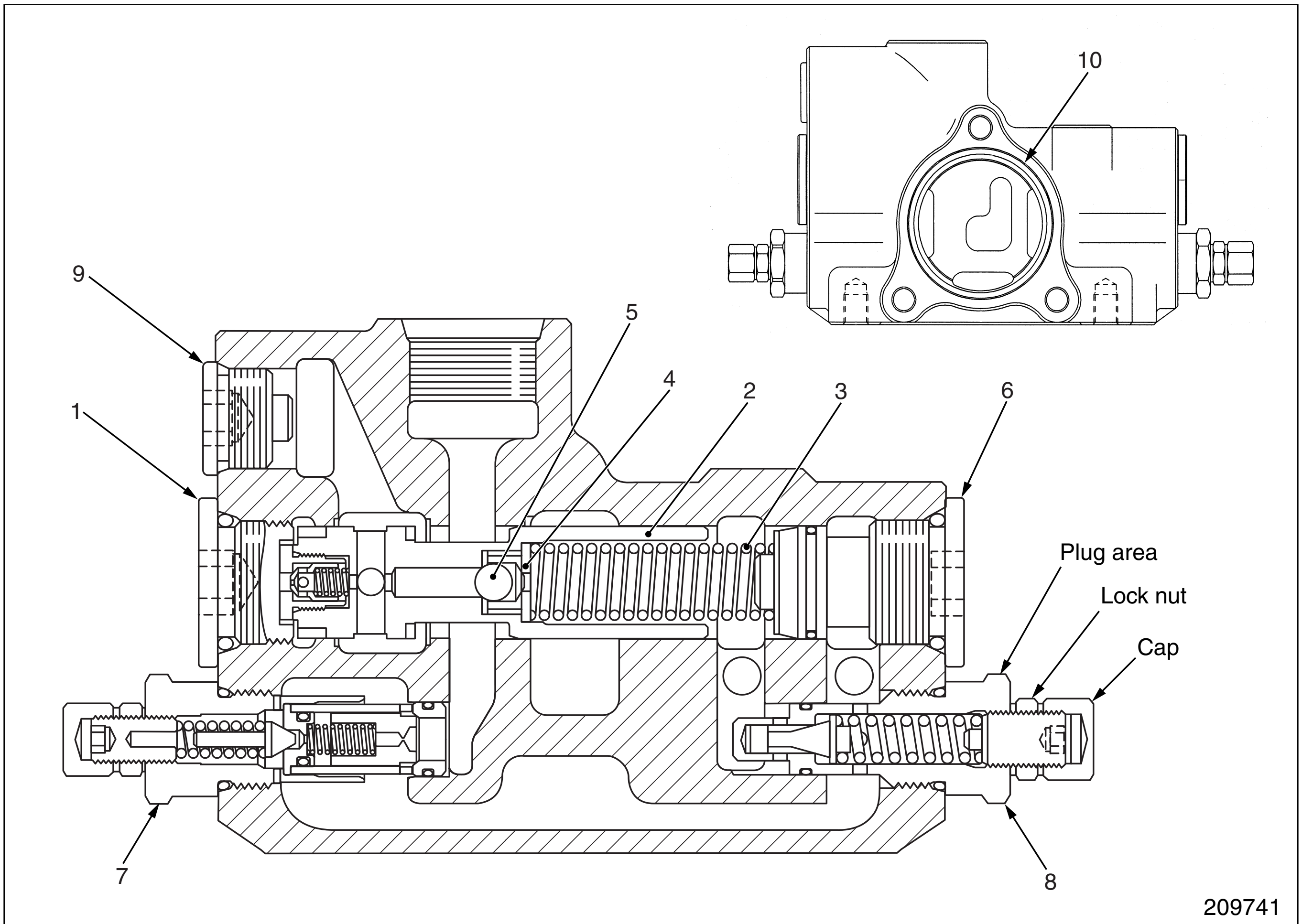
To install, follow the reverse of removal sequence, and do the following steps:

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

Disassembly and Reassembly

Valve of Inlet Cover Section

Disassembly



Sequence

I. Priority valve (1 thru 6)
  1 Plug, O-ring
  2 Spool assembly
  3 Spring
  4 Retainer
  5 Ball
  6 Plug, O-ring

II. Main relief valve (7)
III. Steering system relief valve (8)
IV. Other parts (9 and 10)
  9 Plug, O-ring
  10 O-ring

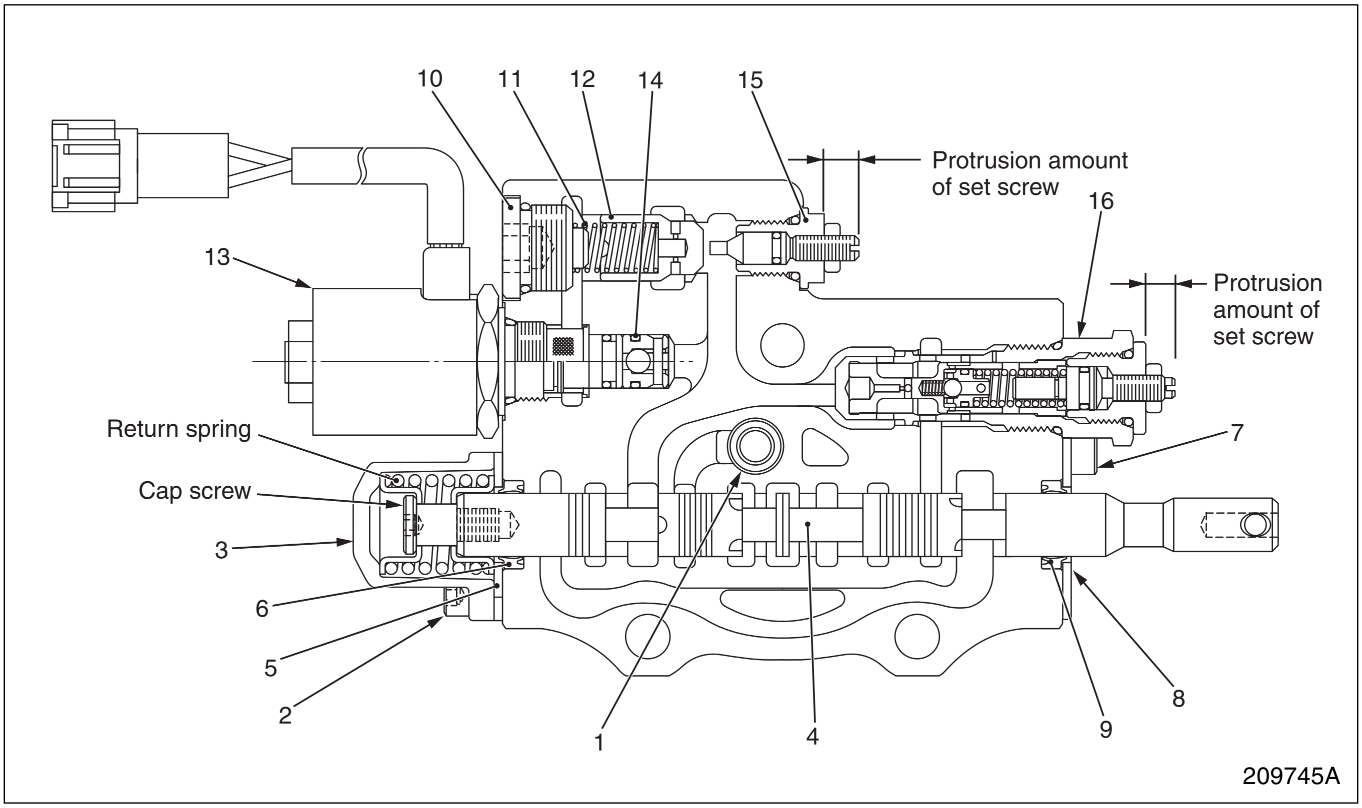
Suggestions for Disassembly

(1) Do not disassemble the main relief valve and the relief valve of the steering system unless there is any abnormality.

Note: When loosening the relief valve, apply a spanner to the plug area of the relief valve to remove. If the lock nut is loosened by mistake, the set pressure of the relief valve changes. If it is loosened by mistake, use a pressure gauge to reset.

Combination Section

Disassembly of Lift Valve



Sequence

I. Lift valve (1 thru 9)
 1 Check valve, spring
 2 Bolt
 3 Cap
 4 Spool, return spring
 5 Plate
 6 Seal
 7 Bolt
 8 Plate
 9 Seal

II. Load check valve (10 thru 15)
 10 Plug, O-ring
 11 Spring
 12 Check valve
 13 Solenoid valve
 14 O-ring
 15 Shut-off valve

III. Flow regulator valve (16)

Suggestions for Disassembly

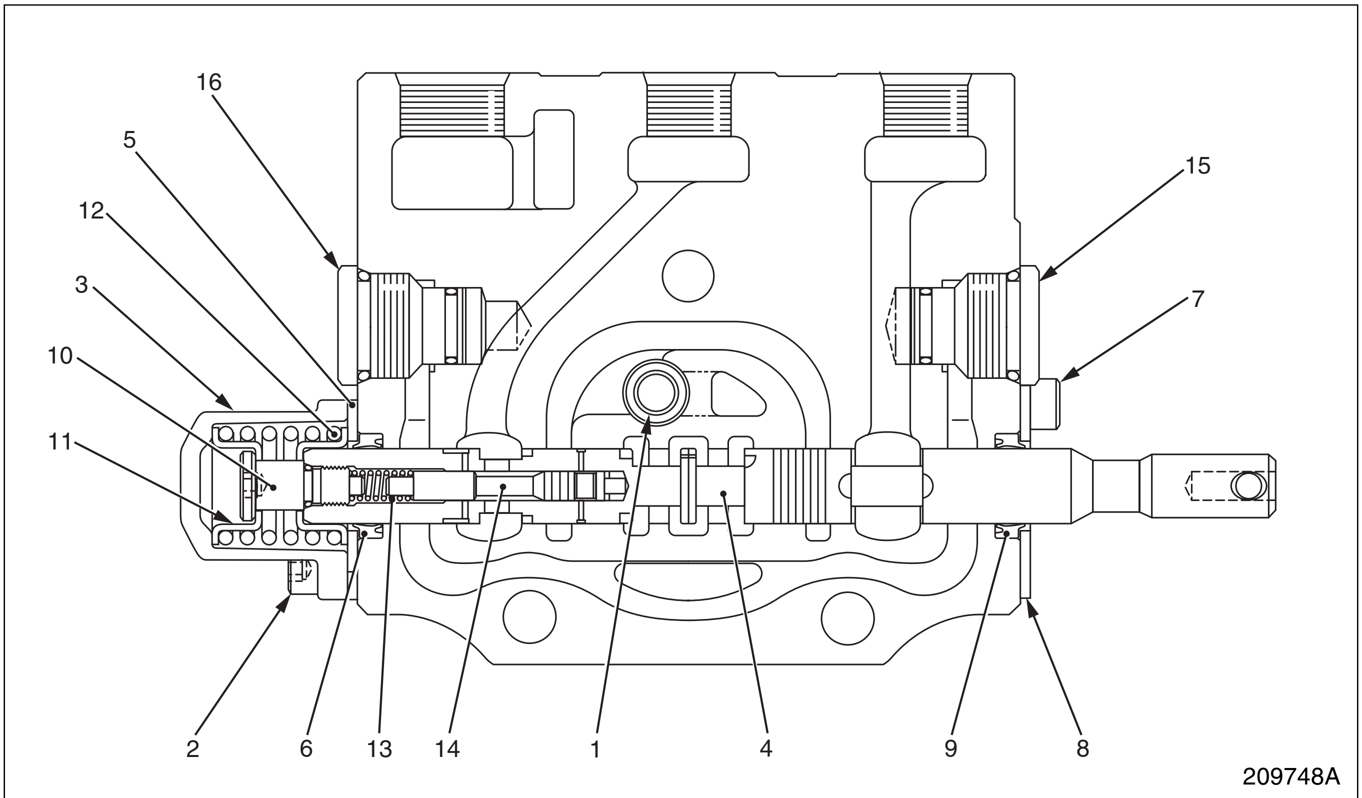
(1) Remove spool 4 from the combination valve body with the return spring and cap screw attached.

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

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

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

Disassembly of Tilt Valve



Sequence

1 Check valve, spring
2 Bolt
3 Cap
4 Spool sub-assembly
5 Plate
6 Seal
7 Bolt
8 Plate
9 Seal

Disassembly sequence of spool sub-assembly (10 thru 14)

10 Cap screw
11 Spring retainer
12 Spring
13 Spring
14 Tilt lock valve

Shut-off valve (15 and 16)

15 Shut-off valve on tilt cylinder head
16 Shut-off valve on tilt cylinder rod

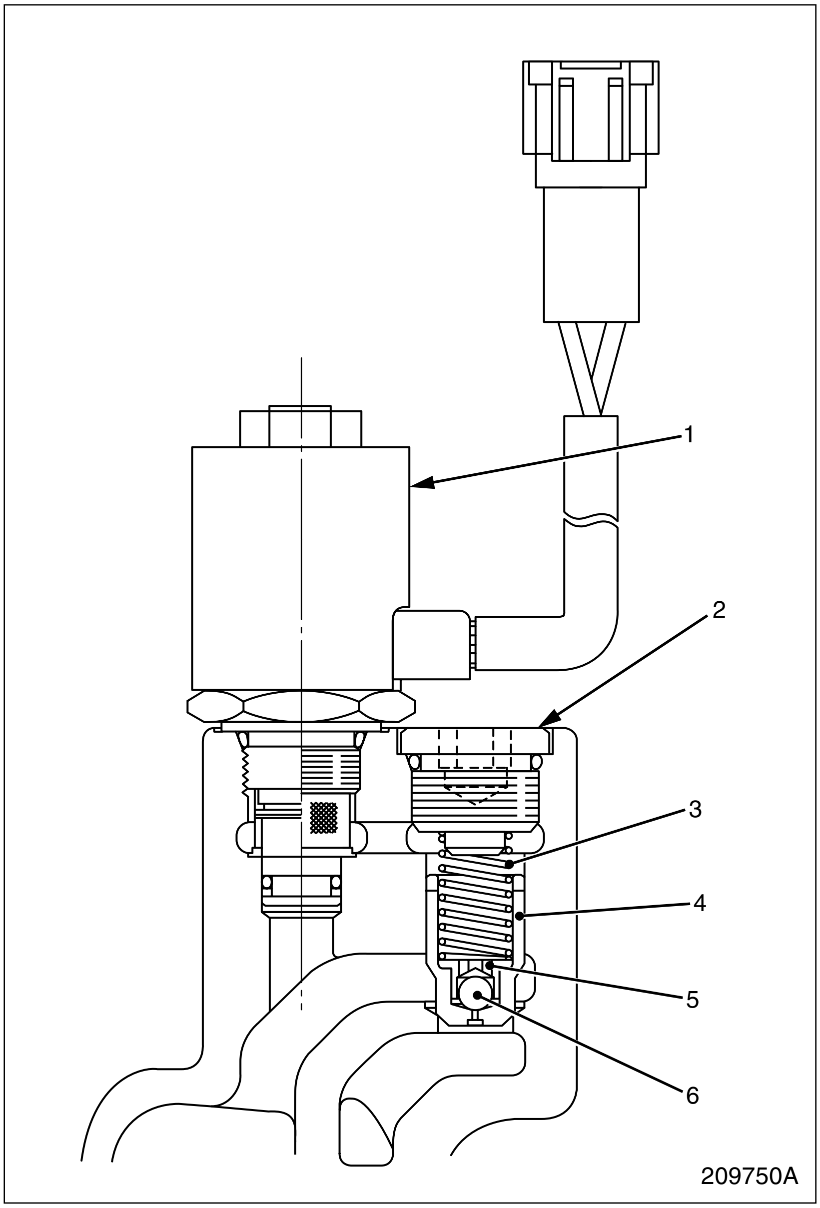
Suggestions for Disassembly

(1) Remove spool 4 from the body with spring 12 and cap screw 10 attached.

(2) When removing cap screw 10, hold the spool in a vise with soft jaws (hard wooden plate or plastic plate) and remove the cap screw using a hexagon wrench. Be careful of the spring jumping out. Remove also the tilt lock valve.

End Cover Section

Disassembly of Unloader Valve



Sequence

1 Solenoid valve
2 Plug, O-ring
3 Spring
4 Valve
5 Spring retainer
6 Ball

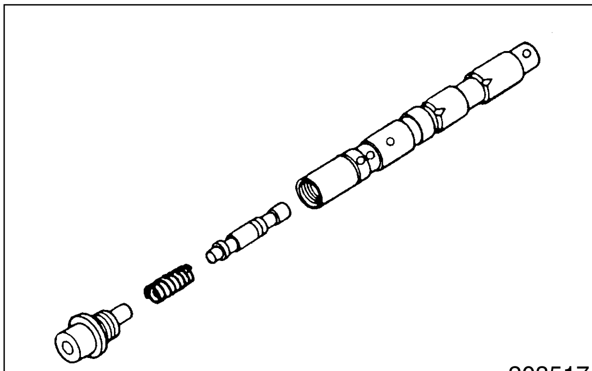
Inspection after Disassembly

Valve, spool and return spring

(1) Check the valve body for cracks, damaged sliding surface and wear of check valve seat.

(2) Check the spool for damage, seizure, bend and operating force.

(3) Check the tilt lock valve for damage and seizure.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Reassembly

To reassemble, follow the reverse of disassembly sequence, and do the following steps:

(1) Clean disassembled parts with an appropriate solvent. Remove foreign matters with compressed air.

(2) Apply hydraulic oil to all parts.

(3) Replace O-rings.

(4) Tighten tie bolts.

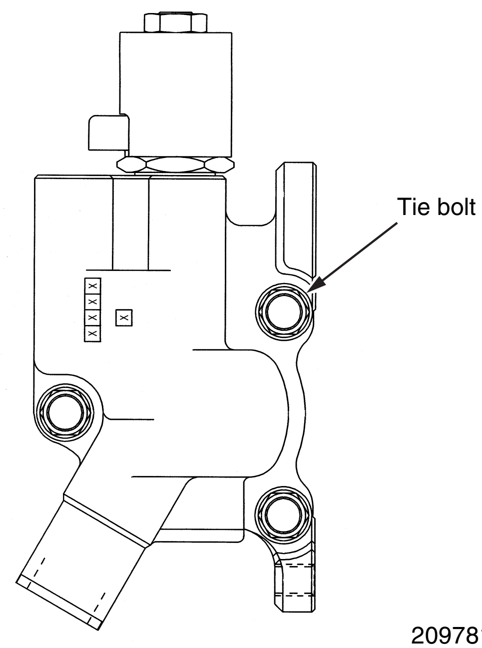
Tighten tie bolts evenly. Tightening them unevenly or to inadequate torque can distort the valve body, resulting in unsmooth movement of the spool.

(5) Install component valves after appropriate valve bodies are installed with tie bolts.

(6) Check that the spools slide smoothly.

Note: The valve body and spool have been lapped as a set. Do not change the combination. When either one of the two becomes necessary to replace, replace them together as an assembly.

(7) Check that the microswitch is in position. Adjust its position if necessary.



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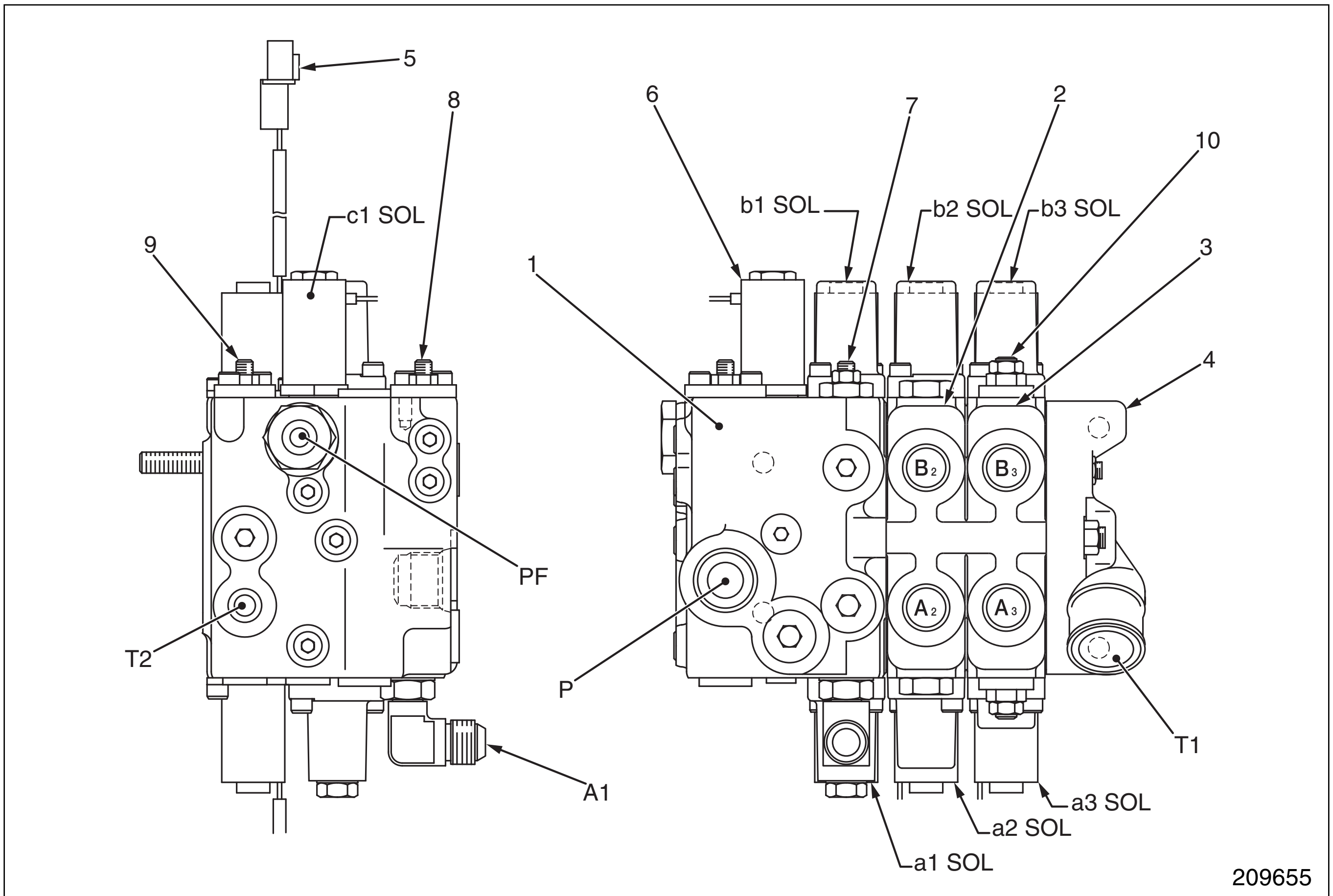
FC Control Valve

Structure and Operation

FC Control Valve – General



1 Inlet valve assembly
2 Tilt valve assembly
3 Attachment valve assembly
4 End cover assembly
5 Solenoid lead wire and connector
6 Solenoid for unloader valve
7 Emergency shut-off valve (for release of lift lock)
8 Main relief valve (pilot)
9 PF relief valve (steering system relief valve)
10 Emergency shut-off valve (for use as attachment)

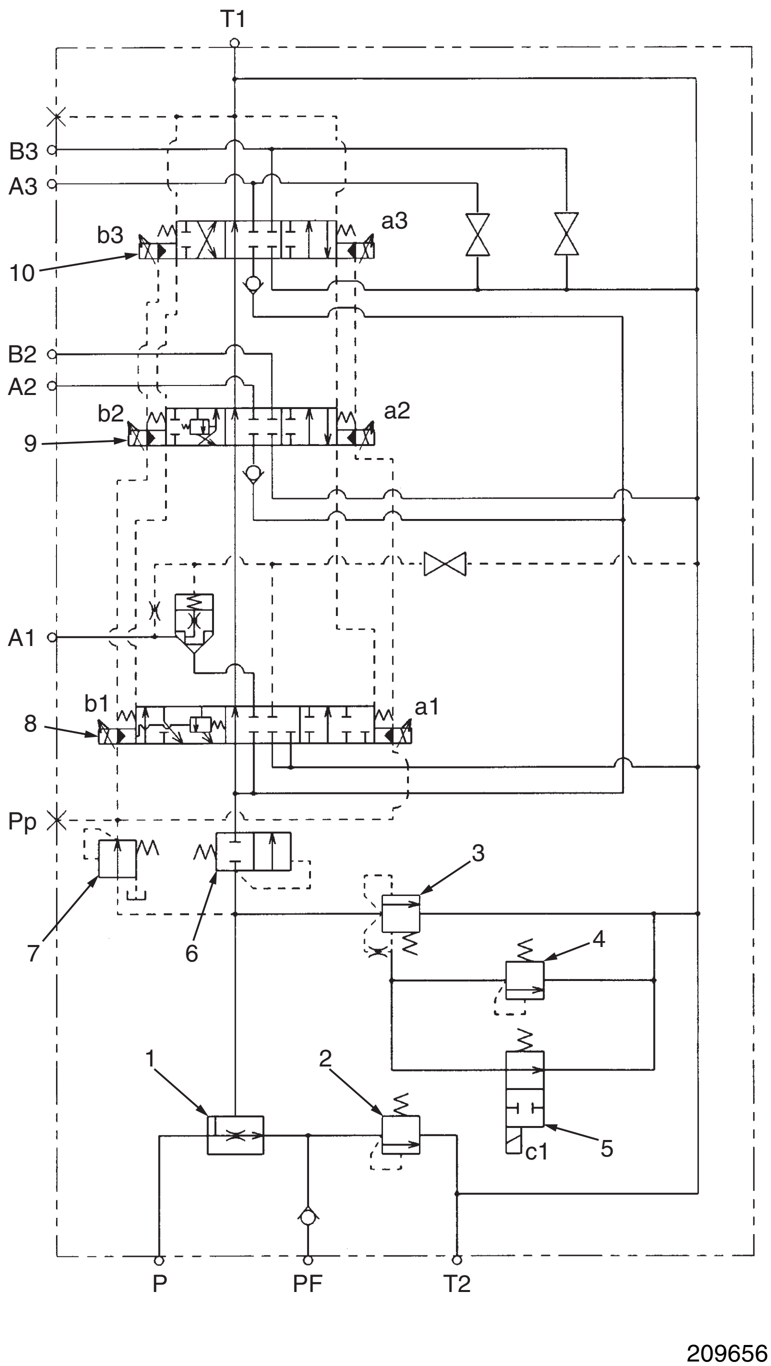
P : Supplied oil from hydraulic pump (oil inlet port)
T1 : To hydraulic tank (return oil)
T2 : Return from steering valve (oil return port)
PF : To steering system
A1 : To lift cylinder
A2 : To tilt cylinder rod end
B2 : To tilt cylinder head end
A3 : To actuator for attachment valve
B3 : To actuator for attachment valve
c1 SOL : Solenoid for unloader valve
a1 SOL, b1 SOL : Solenoids for lift valve
a2 SOL, b2 SOL : Solenoids for tilt valve
a3 SOL, b3 SOL : Solenoids for attachment valve

Note: The above illustration shows a three-valve type FC control valve. For a two-valve type control valve, eliminate the attachment valve. For four-valve type and five-valve type control valves, add the attachment valve(s) as appropriate.

Hydraulic Circuit of FC Control Valve

- For the entire hydraulic system diagram (for cargo handling and steering), refer to page 11-3.
- For the structures and actions of individual component valves, refer to the next and subsequent pages.

This is a circuit diagram of three-valve type control valve.

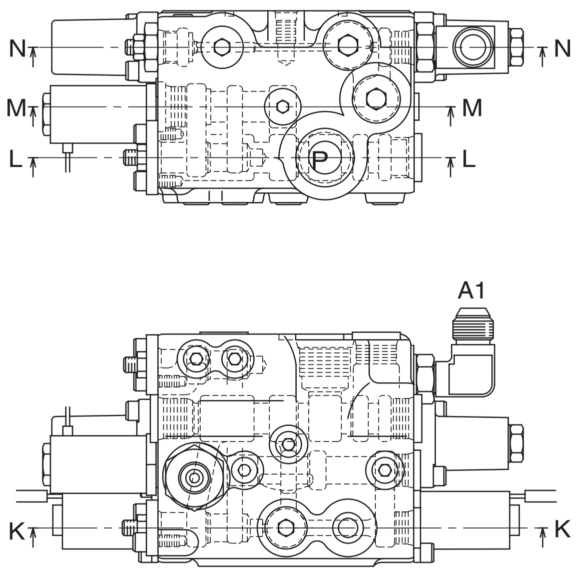


1 Flow priority valve
2 PF relief valve
3 Main relief valve
4 Pilot relief valve
5 Unloader valve
6 Resistance valve
7 Reducing valve for pilot oil
8 Lift valve
9 Tilt valve
10 Attachment valve

P : Supplied oil from pump
PF : To steering system
T1 : To hydraulic tank
T2 : Return from steering system
A1 : To lift cylinder
A2 : To tilt cylinder rod end
B2 : To tilt cylinder head end
A3 : To actuator for attachment valve
B3 : To actuator for attachment valve
c1 : Solenoid for unloader valve
a1, b1 : Solenoid for lift valve
a2, b2 : Solenoid for tilt valve
a3, b3 : Solenoid for attachment valve
Pp : Pilot oil line (blank capped) for proportional electromagnetic pressure reducing valve

Component Valves of Inlet Valve Assembly

The inlet valve assembly is complete with eight components valves as described below.



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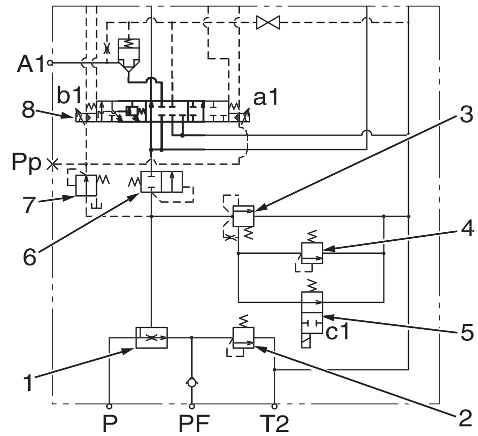

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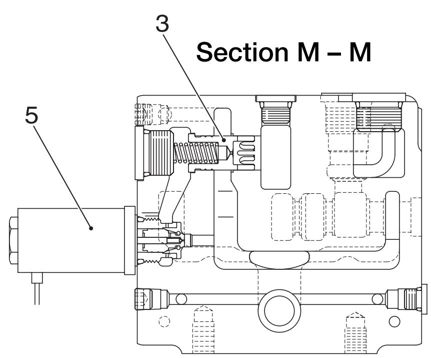
1 Flow priority valve
2 PF relief valve
3 Main relief valve
4 Main relief (pilot) valve
5 Unloader valve
6 Resistance valve
7 Reducing valve
8 Lift control valve



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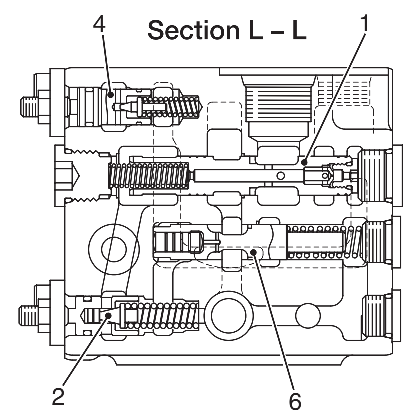

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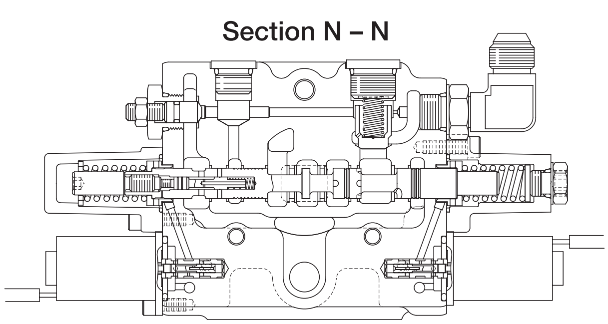

Lift control valve 8

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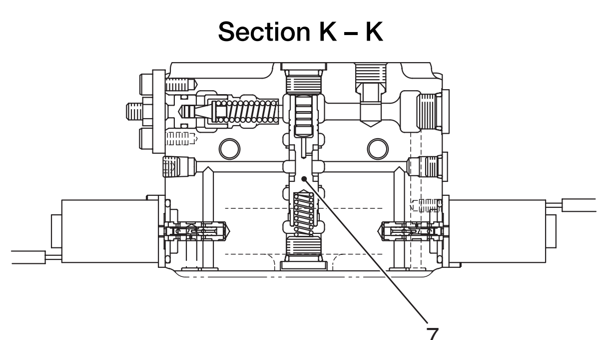

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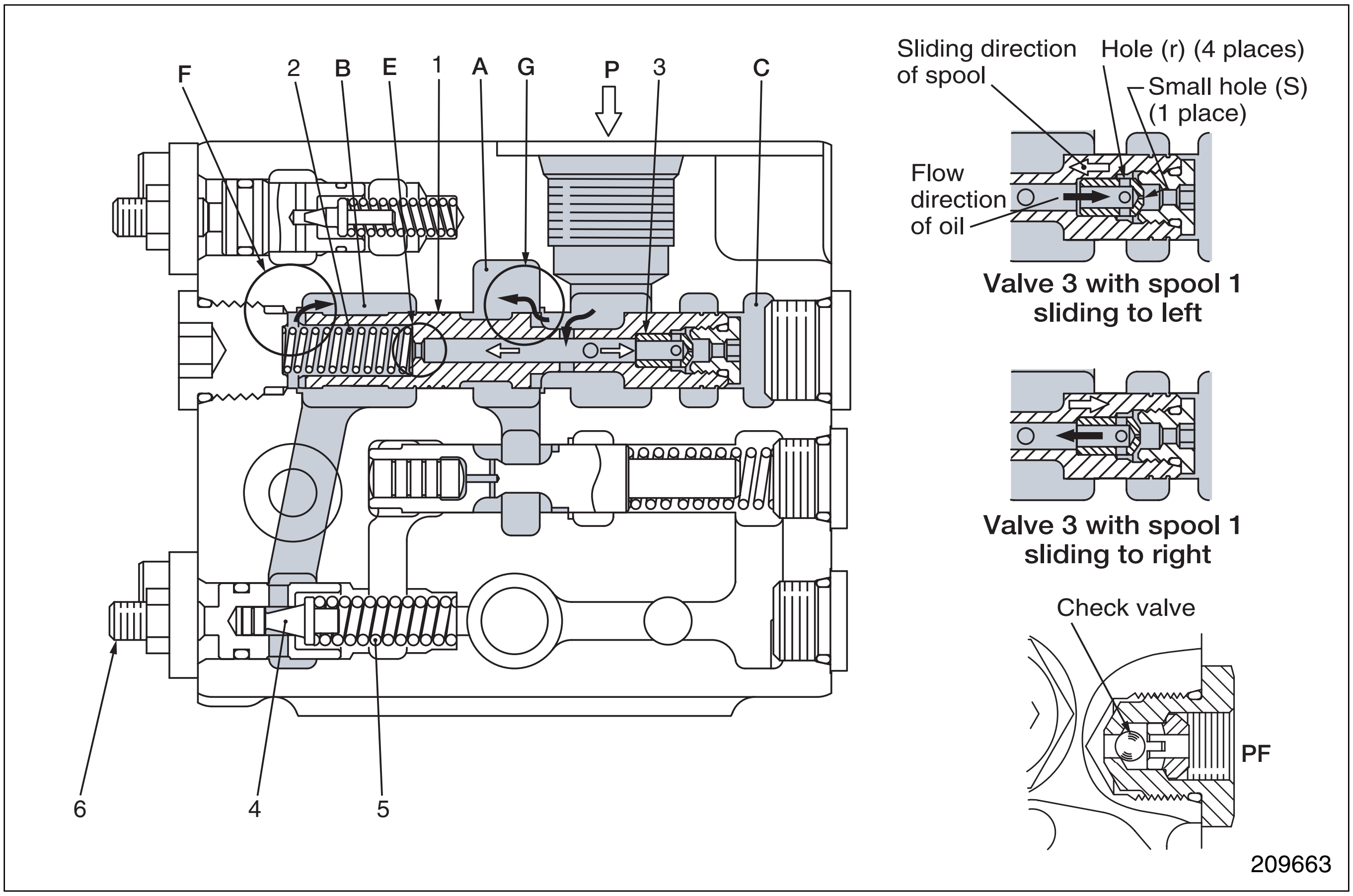
Flow Priority Valve and PF Relief Valve



1 Priority valve spool
2 Spring
3 Valve
4 PF relief valve poppet
5 Spring
6 Relief valve pressure adjusting screw

A : Passage of extra flow (EF flow)
B : Passage of priority flow (PF) connecting to port PF
C : Damper chamber
D : Inlet port for PF flow in hollow portion of spool (1)
E : Control orifice
F : PF restricted area
G : EF restricted area
P : Inlet port for oil from pump
PF : Control flow outlet port (feed port to steering system)

Function of Flow Priority Valve

The flow priority valve is a flow divider valve which divides supplied oil into predetermined volumes of priority flow (PF flow) and extra flow (EF flow).

PF flow of oil is supplied to the steering system. Extra flow of oil is supplied to the lift, tilt and attachment valves for mast operations.

In the case of wet-type clutch model, part of PF flow is used as hydraulic pressure for clutch booster operation.

Valve Operation

The illustrations on the previous page show the valve in operation. When the pump is not operating (the engine is stopped), the valve spool 1 is pressed by the spring 2 to the rightmost position. The extra flow restricted area G is closed.

When the valve is in operation, oil introduced from the port P enters the hollow portion of the valve spool from the inlet hole in the spool and passes through the control orifice E and PF restricted area F before it flows in the passage B. This is the PF flow of oil.

The pressure of PF flow acts on the left end of the valve spool 1 to join the force of spring 2 in pressing the valve spool 1 to the right. In the meantime, oil entering the hollow portion of the valve spool 1 and flowing in the direction of the damper chamber C presses the valve 3 to the right.

The oil is released into the chamber C from the small hole (s) in the forward end of the valve 3 and presses the valve spool 1 to the left.

When the volume of flow from the port P increases, PF flow in the hollow portion of the valve spool 1 increases as well. As a result, the pressure difference between before and after the control orifice E becomes greater, causing the valve spool 1 to move to the left and close the PF restricted area F. When the restricted area F is closed, PF flow decreases and the pressure difference decreases as well.

When the volume of flow from the port P decreases, PF flow in the hollow portion of the valve spool 1 decreases. As a result, the pressure difference between before and after the control orifice E decreases. The valve moves to the right to close the extra flow restricted area G. The extra flow decreases and PF flow increases, and as a result, the pressure difference becomes greater.

In actual load handling operations, not only the flow oil supplied from the pump varies but differential pressure occurs between PR flow and MF flow. In such cases, the valve spool 1 moves to make the pressure difference between before and after the control orifice E constant, stabilizing PF flow.

Action of Valve 3

The valve 3 and the orifice (s) in the forward end of the valve serve to control the moving speed of the valve spool 1 (especially when the restricted area G is opened) to prevent hunting due to sharp increase in the volume of flow when the valve spool moves, thereby stabilizing the flow of oil. In other words, when the extra flow restricted area G opens, oil flows into the damper chamber C, where the small orifice (s) in the forward end of the valve 3 is the only passage of oil so that the movement of the valve spool 1 is slow.

When the PF flow restricted area F opens, oil in the chamber C is released. The release takes place quickly because four holes (r) on the circumference of the valve 3 and the small orifice (s) in the forward end of the valve are used. As a result, the valve spool moves to the right quickly to open the restricted area F. This prevents a kickback phenomenon on the steering wheel.

Action of Port PF Check Valve

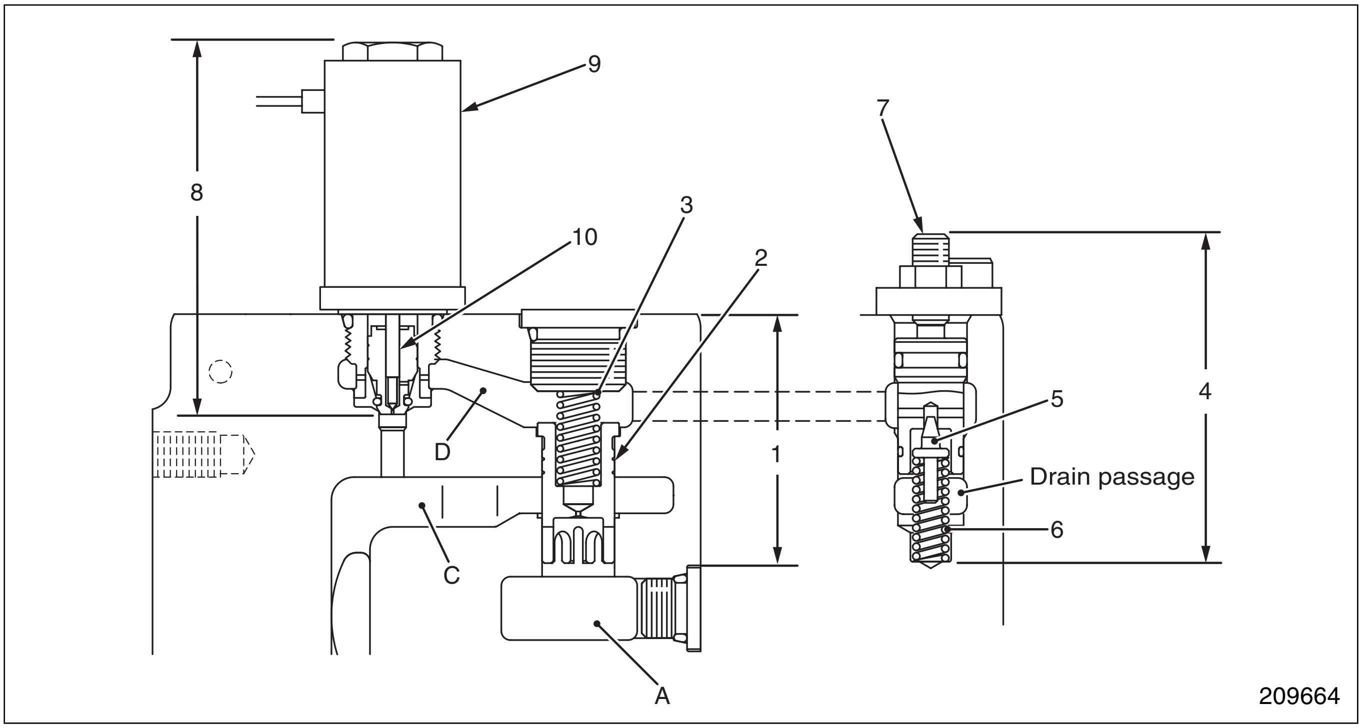
This valve holds pressure in the steering system to prevent a kickback phenomenon.

Note: Kickback phenomenon
This is a phenomenon in which steering pressure is affected by fluctuations in operating pressure during cargo handling operation and the steering wheel being handled is caused to kickback. It occurs when PF port pressure cannot be maintained. The valve 3 described above and port PF check valve are a means of preventing this kickback phenomenon.

PF Relief Valve

This is a relief valve for priority flow (PF flow), that is for the steering system. The pressure of oil in the oil passage B shown in the illustration on the previous page, or the oil pressure of PF flow, is always applied to the valve poppet 4. When the pressure of PF flow exceeds the specified value, the valve poppet 4 moves to the right against the force of the spring 5, releasing oil into the drain passage. In this way, oil pressure in the steering system is maintained below set value. The screw 6 is for set pressure adjustment. Turning it clockwise increases set pressure. For set pressure and setting procedure, refer to “Inspection and Adjustment.”

Main Relief Valve, Pilot Relief Valve and Unloader Valve



1 Main relief valve	6 Spring	A: Extra flow (EF flow) passage
2 Dump valve	7 Pressure adjusting screw	C: Drain passage
3 Spring	8 Unloader valve	D: Oil passage
4 Pilot relief valve	9 Solenoid	
5 Poppet valve	10 Needle valve	

Function of Component Valves

The pilot relief valve 4 and unloader valve 8 are arranged in parallel to serve as pilot valves for the main relief valve 1. To be more specific, when either valve 4 or 8 opens, the dump valve 2 overcomes the force of the spring 3 to lift, releasing high pressure oil in the oil passage A into the drain passage C.

Pilot Relief Valve 4

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

The screw 7 is for set pressure adjustment. Tightening it clockwise increases set pressure. For set pressure and setting procedure, refer to "Inspection and Adjustment."

Unloader Valve

The unloader valve 8, located between the back of the dump valve 2 and an oil passage connecting to the drain passage C as shown in the illustration, is a solenoid valve serving as a pilot relief valve for the main relief valve 1. When the solenoid is energized by electric current that flows through it, the needle valve 10 protrudes to close the oil passage D. When the solenoid is not energized, it has the needle valve 10 retracted in it. Therefore, the oil passage D is open.

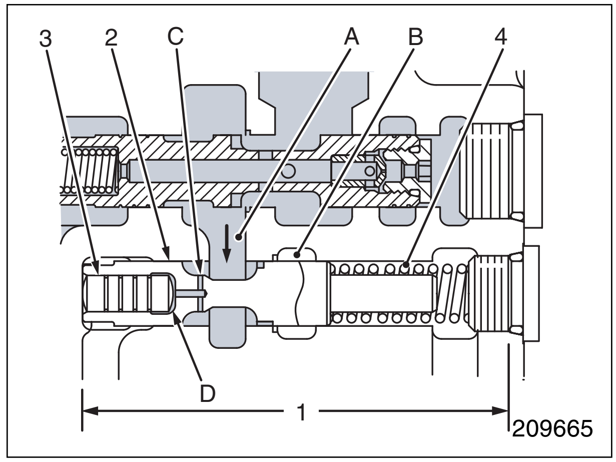
When the operator leaves the seat and the cargo handling levers are in the neutral position, the solenoid is not activated and oil in the passage D is released into the drain passage C. This causes the dump valve 2 of the main relief valve to lift, releasing all extra flow of oil into the drain passage C. This valve thus ensures safety and helps save engine output.

When the operator moves a cargo-handling lever, the solenoid 9 is energized. The needle valve 10 protrudes to close the oil passage D, making the entire extra flow line (including pilot oil for proportional electromagnetic pressure reducing valve) ready to work normally.

Resistance Valve

Function

This is a valve to maintain pilot oil pressure for the proportional electromagnetic pressure reducing valve of the spool valve. The illustration at the right shows a state where the unloader valve is open and the oil passage A has no oil pressure built in it. When the unloader valve is closed, oil pressure of extra flow in the oil passage A is increased. Oil enters the cavity D from the hole C to cause the spool 2 to move to the right against the force of the spring 4. As a result, the oil passages A and B are opened and oil in the oil passage is sent to the lift, tilt and attachment valves. In this way, the pressure in the oil passage A is maintained above a certain level during operation.



1 Resistance valve
2 Spool
3 Slug
4 Spring

A : Extra flow passage
B : Neutral passage in spool section
C : Hole
D : Cavity

Reducing Valve

Function

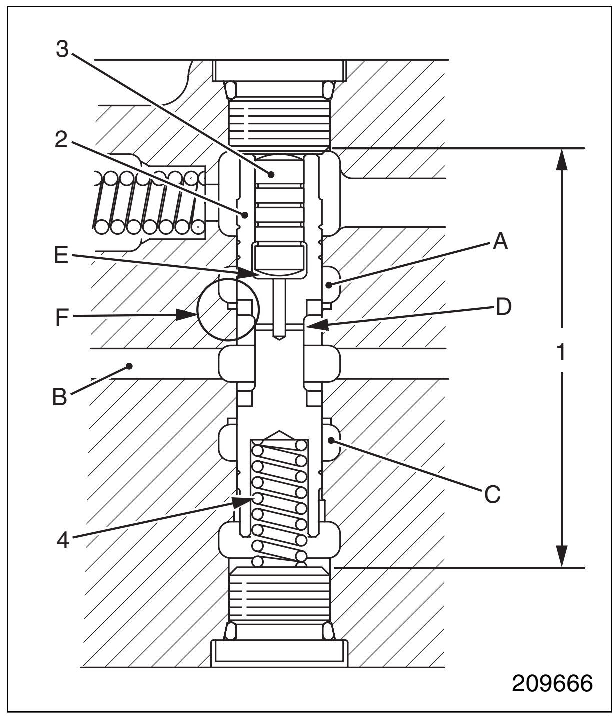
If extra oil is used directly as pilot oil for the proportional electromagnetic pressure reducing valve, the pressure is too high for the purpose. This valve reduces the pressure of extra flow to a proper level.

Action

When there is no oil pressure in the oil passage A, the spool 2 is pushed up by the spring 4 to the position shown in the illustration at the right. When the spool is in such state, the restricted area F is open to a maximum and the oil passages A and B are open.

When oil pressure in the passage A is built up, oil pressure in the passage B rises as well. Oil in the passage B enters the cavity E from the hole D and pushes down the spool 2 against the force of the spring 4. As a result, the restricted area F is closed, supplied oil to the passage B decreases and oil pressure (pilot oil pressure) in the passage lowers. When oil pressure in the passage B decreases, the spool 2 moves upward to increase supplied oil to the passage B, raising oil pressure in the passage B. In this way, the pressure of pilot oil in the passage B is maintained constant after pressure reduction.

When oil pressure in the passage B becomes extremely high, the passage B is opened to the drain passage C and some of pilot oil is drained.

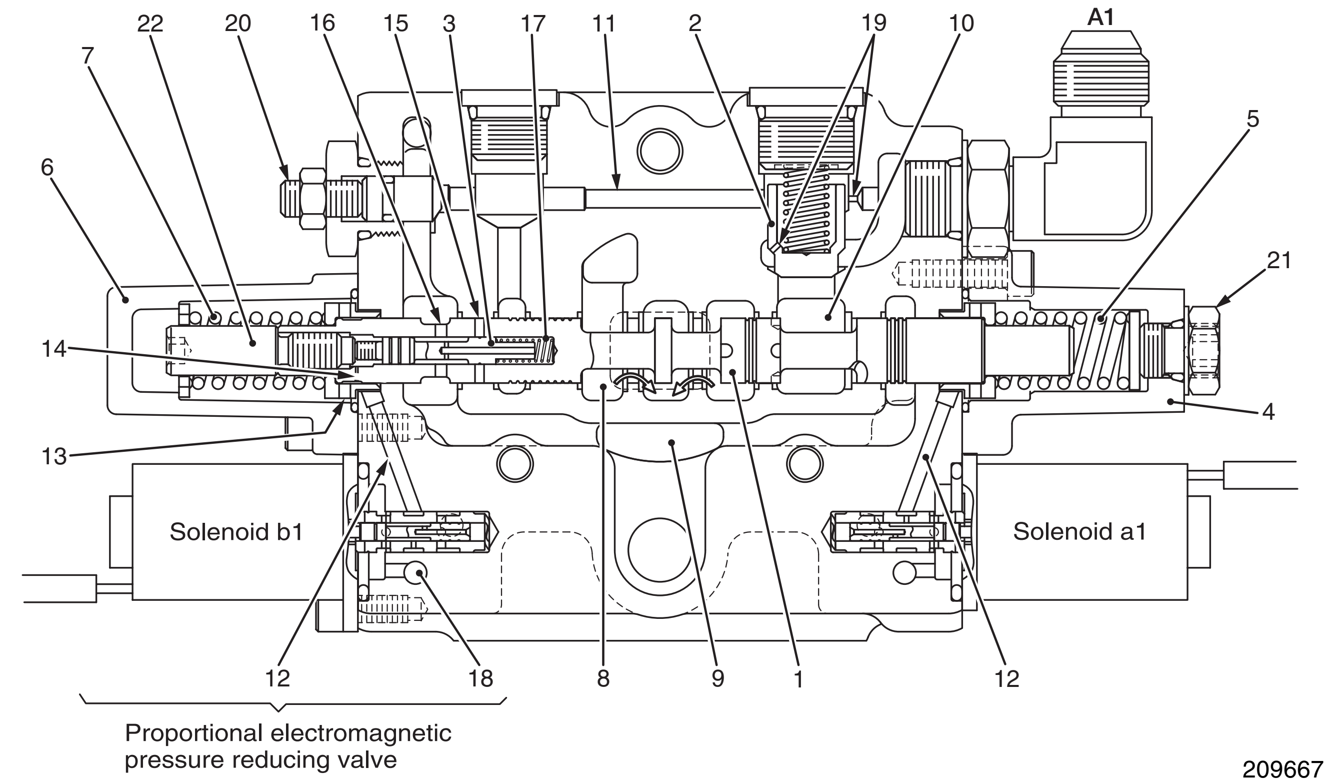


1 Pressure reducing valve
2 Spool
3 Slug
4 Spring

A : Passage connected to extra flow passage (oil before pressure reduction)
B : Passage of pilot oil supplied to proportional electromagnetic pressure reducing valve (oil after pressure reduction)
C : Drain passage
D : Hole
E : Cavity
F : Restricted area

Lift Valve

Neutral Position



Main Components

1	Main spool	9	Low-pressure passage	15	Oil passage
2	Load check valve	10	Passage to port (A1)	16	Oil passage
3	Lift lock valve	11	Passage of pilot oil for actuating load check valve	17	Spring
4	Cap (solenoid a1 side)	12	Passage of pilot oil for actuating spool	18	Drain passage
5	Spring (solenoid a1 side)	13	Oil passage	19	Orifice
6	Cap (solenoid b1 side)	14	Oil passage	20	Shut-off valve
7	Spring (solenoid b1 side)			21	Spring preload adjusting screw
8	Neutral passage			22	Spool head

Action of Valve with Lift Lever in “Neutral Position”

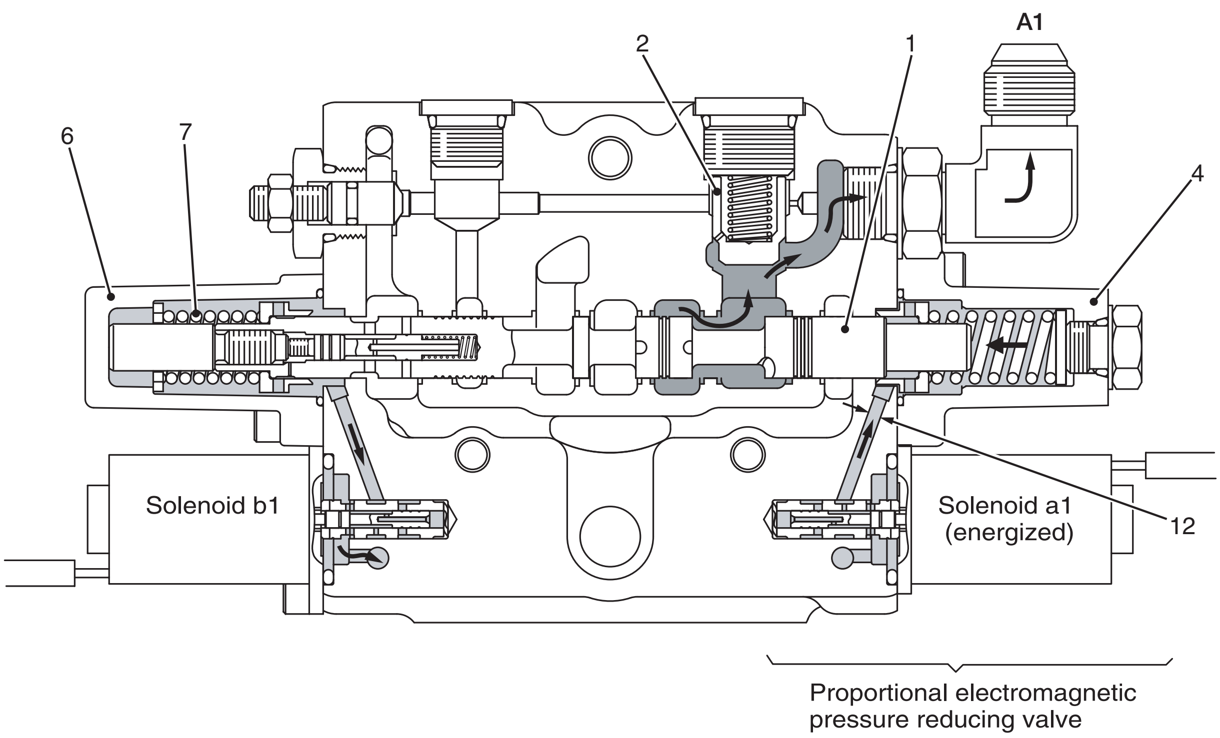
Proportional solenoids a1 and b1 are inactive when the lift lever is in the “neutral position.”

Since the proportional electromagnetic pressure reducing valve releases oil in the caps 4 and 6 into the drain passage 18 through the passage 12, there is no pressure in the caps. Therefore, the main spool 1 is maintained in the position shown in the illustration above by the springs 5 and 7 at both ends of the valve, with the passage to the port A1 closed.

Extra flow divided by the priority valve of the inlet valve assembly goes through the neutral passage to the tank.

For operation of the proportional electromagnetic pressure reducing valve, refer to the page 13-75.

Ascending Position of Lift Cylinder

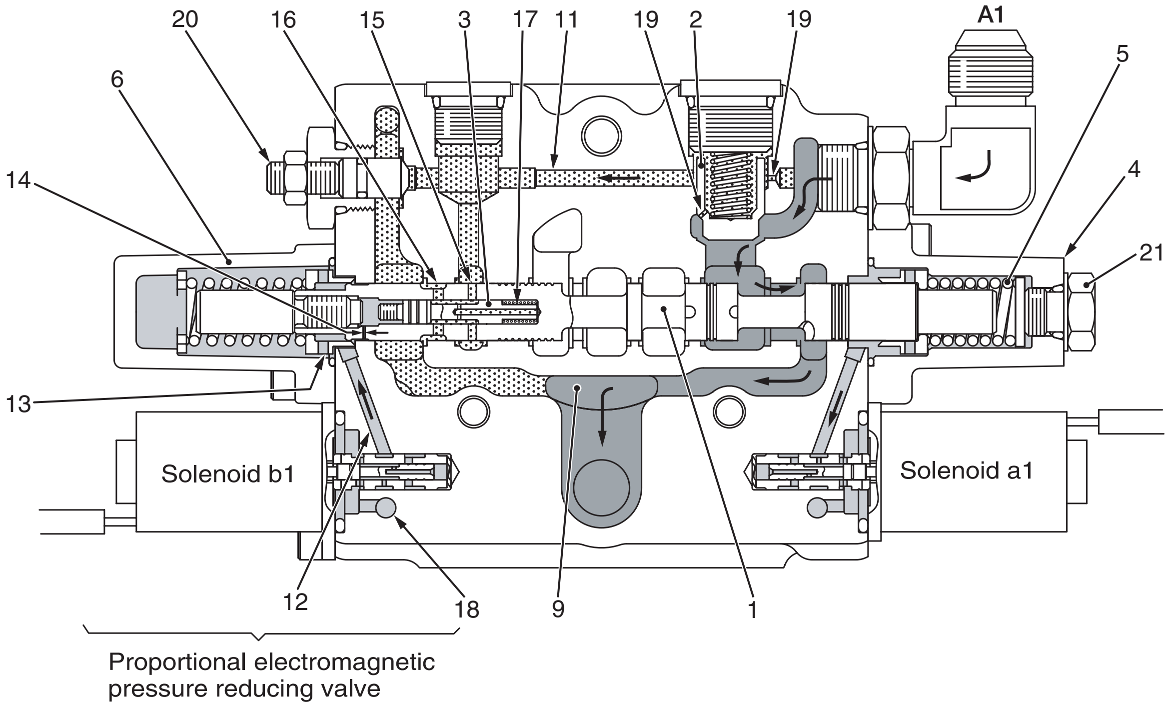


Action of Valve with Lift Lever in "Ascent" Position

When the lift lever is moved into the "ascent" position, an electric current proportional to the movement of the lever is fed from the controller to the solenoid a1. The solenoid is activated and pilot oil is released from the proportional electromagnetic pressure reducing valve into the cap 4 through the passage 12. Pilot oil pressure in the cap is proportional to the movement of the lift lever. Pilot oil in the cap moves the main spool 1 to the left against the force of the spring 7.

Oil in the neutral passage pushes up the load check valve 2 and flows into the lift cylinder from the port A1.

Descending Position of Lift Cylinder



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Action of Valve with Lift Lever in "Descent" Position

When the lift lever is moved into the "descent" position, an electric current proportional to the movement of the lever is fed from the controller to the solenoid b1. The solenoid b1 is activated and pilot oil is released from the proportional electromagnetic pressure reducing valve into the cap 6 through the passage 12. The pressure of pilot oil in the cap is proportional to the movement of the lift lever. Pilot oil in the cap moves the main spool 1 to the right against the force of the spring 5. At this point of time, pilot oil pressure passes the oil passages 13 and 14 into the cavity on the left end of the lift lock valve 3 and moves the lift lock valve to the right against the force of the spring 17.

When this takes place, oil in the pilot passage 11 of the load check valve 2 flows to the low-pressure passage 9 through the oil passages 15 and 16. This oil flow gives rise to a pressure difference between before and after the orifice 19, which causes the load check valve 2 to lift, releasing oil in the lift cylinder into the tank from the port A1 through the low-pressure passage 9.

In the meantime, extra flow of oil runs into the tank because the neutral passage is not closed despite full leftward stroke of the spool.

When the engine is stopped, even if the lift lever is moved into the "descent" position, the lift lock valve 3 cannot be actuated due to lack of pilot oil pressure, leaving the cylinder up as a result.

Action of Valve with Lowering Speed Selector Switch in ON Position:

When this switch is set to ON, the maximum oil pressure in the cap 6 can be held at a low level. This makes the stroke of the main spool 1 shorter and the return passage more restricted than when the switch is not used, and the maximum descending speed is decreased as a result.

Action of Lift Lock Valve 3 in Case of Emergency:

In case the main spool is stuck for some reason when the lift cylinder descends, the movement of the cylinder rod can be stopped by returning the lift lever to the "neutral position." With the lift lever back in the "neutral" position, pressure oil in the cap is released into the drain passage 18 via oil passage 12.

The lift lock valve 3 is returned by the spring 17 and the pilot passage 11 is closed. The load check valve 2 is seated to block the flow from the port A.

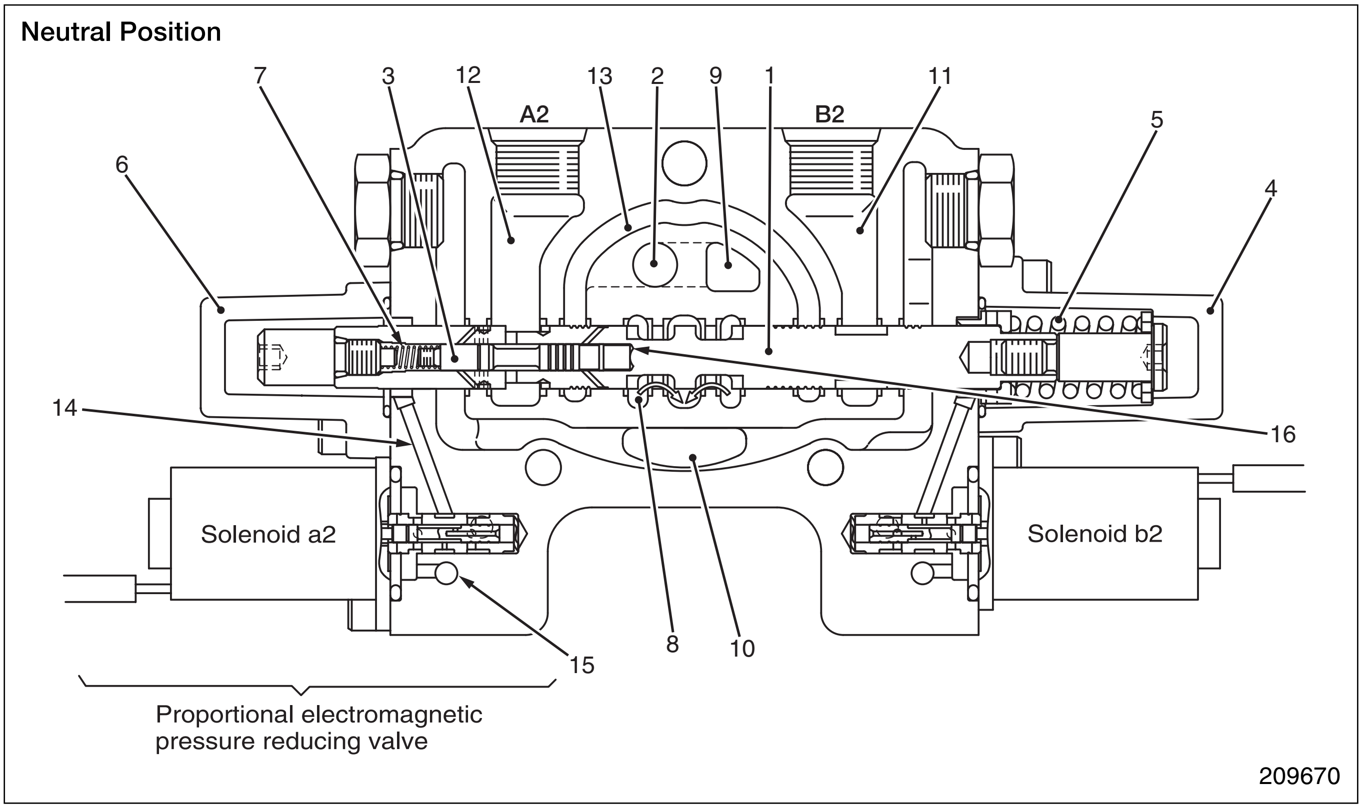
Action of Shut-Off Valve 20:

This is a valve used when the lift lock valve 3 is stuck for some reason to prevent the mast from lowering. Loosening the valve opens the pilot passage 11 of the load check valve 2. The load check valve 2 is then lifted to release oil in the lift cylinder into the low-pressure passage 9, allowing the mast to lower.

Working of Spring Force Adjusting Screw 21:

This screw is for adjusting preload of the spring 5. Where the pressure of pilot oil in the cap 6 is constant, if the preload of the spring changes, the spool stroke is changed, so is the descending speed. Use this screw for adjustment only when the descending speed is excessively different from set value. Usually, leave the screw intact. Do not remove it at the time of disassembly.

Tilt Valve Assembly



Main Components

1 Main spool
2 Check valve
3 Tilt lock valve
4 Cap (solenoid b2 side)
5 Spring (solenoid b2 side)
6 Cap (solenoid a2 side)
7 Spring
8 Neutral passage
9 High-pressure passage (parallel feeder)
10 Low-pressure passage (to T1)
11 Passage to port (B2)
12 Passage to port (A2)
13 Oil passage
14 Passage of pilot oil for valve spool
15 Drain passage
16 Damper

Action of Valve with Tilt Lever in “Neutral” Position

When the tilt lever is in the “neutral” position, the proportional solenoids a2 and b2 are inactive.

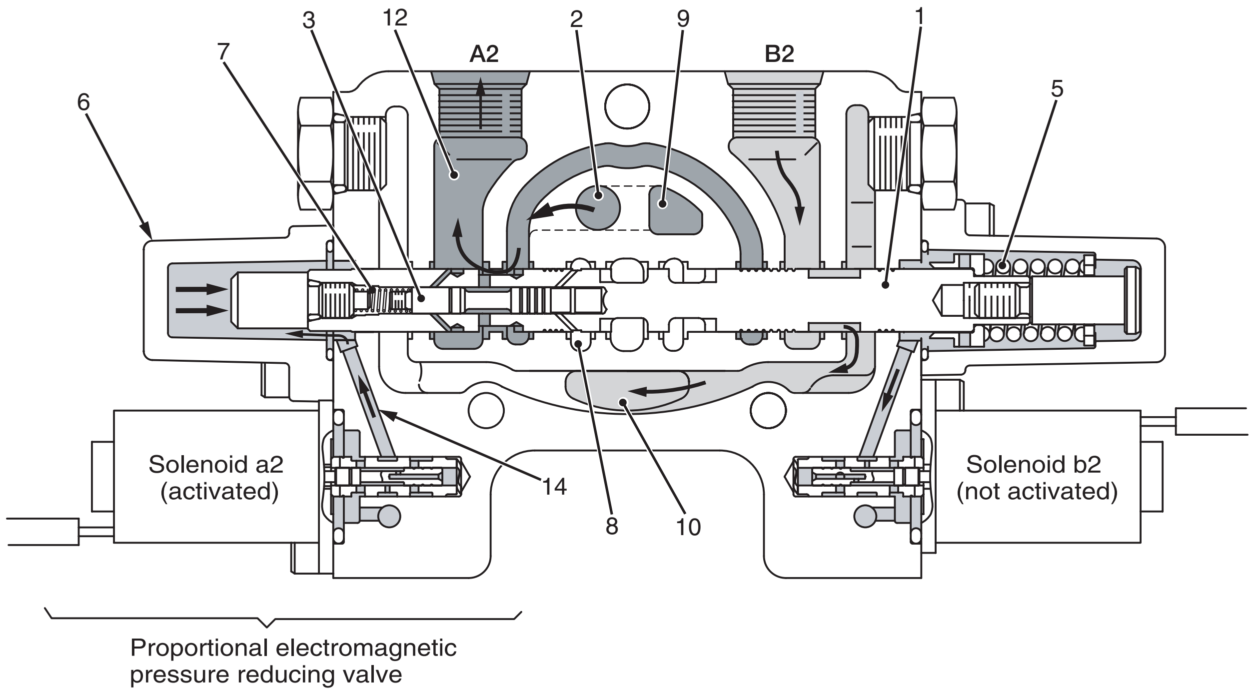
The proportional electromagnetic pressure reducing valve releases oil in the caps 4 and 6 into the drain passage 15 via the passage 14 so that there is oil pressure in the cap.

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

Extra flow of oil diverted by the priority valve of the inlet valve assembly goes to the tank through the neutral passage.

As pressure oil does not come in the chamber 16, the tilt lock valve 3 is pressed to the right by the spring 7.

Mast Backward Tilt Position

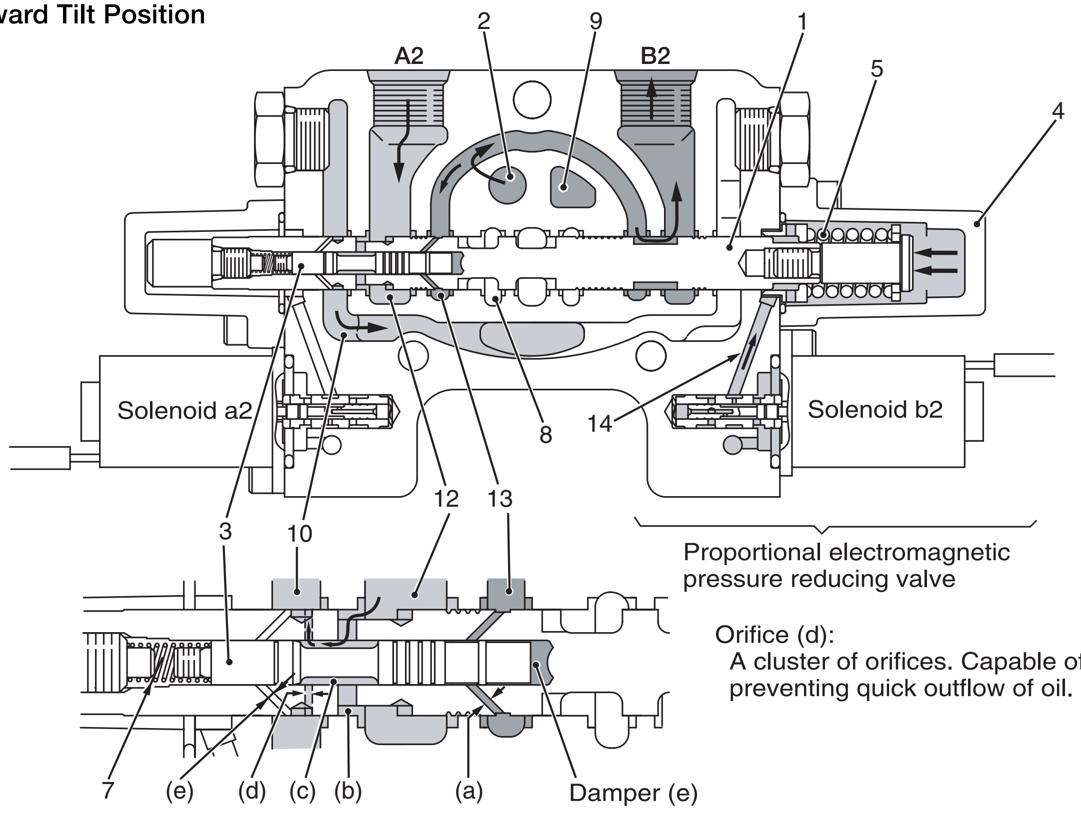


Action of Valve with Tilt Lever in "Backward Tilt" Position

When the tilt lever is moved into the "backward tilt" position, an electric current proportional to the travel of the lever is fed from the controller to the solenoid a2. The solenoid a2 is activated and pilot oil is released from the proportional electromagnetic pressure reducing valve into the cap 6 through the passage 14.

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 right against the force of the spring 5 and closes the flow in the neutral passage. 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 rod side of the tilt cylinder through the passage 12 and port A2. Oil from the port B2 flows into the tank through the low-pressure passage 10. The tilt lock valve 3 is pushed to the right by the spring 7.

Mast Forward Tilt Position



Action 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 b1. The solenoid b1 is activated and pilot oil is released from the proportional electromagnetic pressure reducing valve into the cap 4 through the passage 14.

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. 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 extend.

At this point of 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.

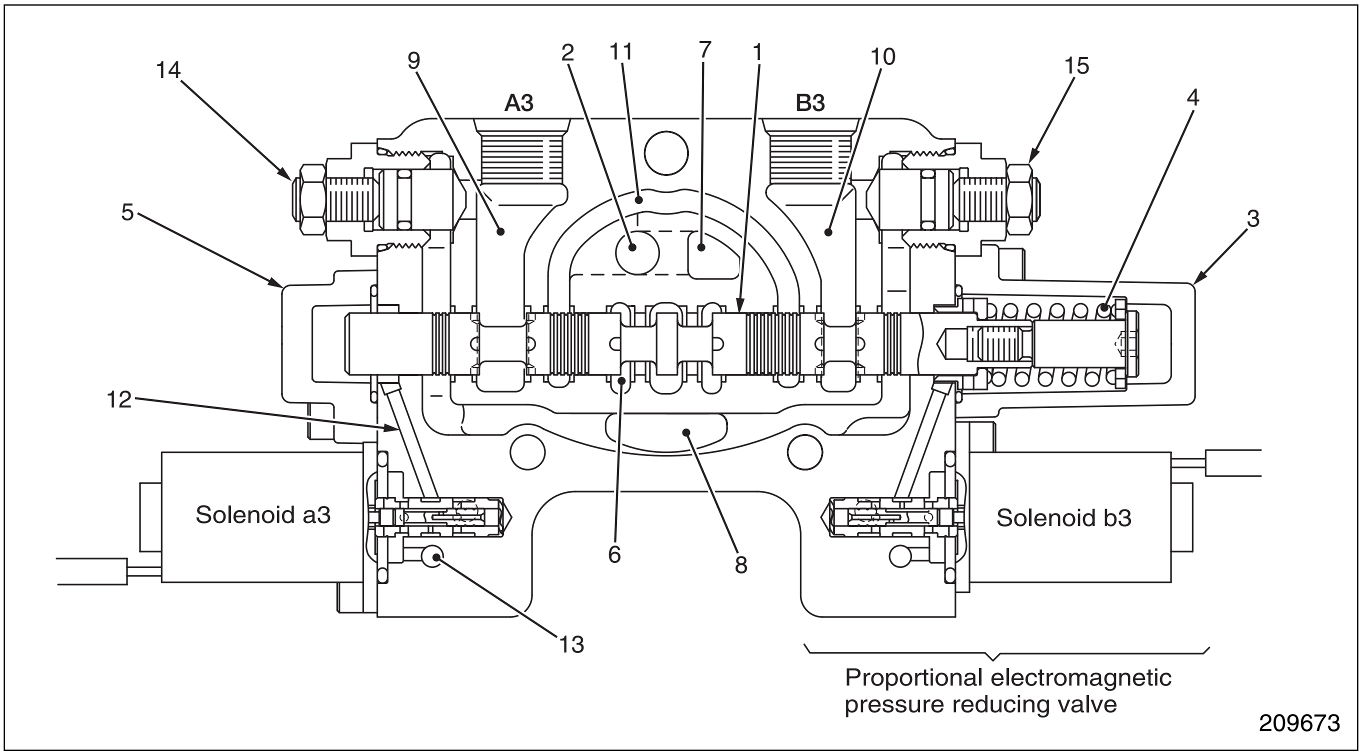
Action of Tilt Lock Valve in Case of Emergency

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 unloader 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 part A2 and low-pressure passage 10 is closed. The tilt cylinder rod is brought into a locked state.

Attachment Valve Assembly



Main components

1 Main spool
2 Check valve
3 Cap (solenoid b3 side)
4 Spring (solenoid b3 side)
5 Cap
6 Neutral passage
7 High-pressure passage (parallel feeder)
8 Low-pressure passage (to T1)
9 Passage to port (A3)
10 Passage to port (B3)
11 Passage (high-pressure passage)
12 Passage of pilot oil for valve spool
13 Drain passage
14 Shut-off valve
15 Shut-off valve

Action of Valve with Attachment Lever in "Neutral" Position

When the attachment lever is in the "neutral" position, the proportional solenoids a3 and b3 are inactive.

The proportional electromagnetic pressure reducing valve releases oil in the caps 3 and 5 into the drain passage 13 through the passage 12 so that there is no pressure in the caps. This maintains the main spool 1 in the position shown in the illustration above by the spring 4 with the passages connecting to the ports A3 and B3 closed.

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

Action of Valve When Solenoid a3 is Activated

When the solenoid a3 is activated, pilot oil flows into the cap 5 through the passage 12.

Pressure of pilot oil in the cap 5, which is proportional to the travel of the control lever, causes the main spool 1 to move to the right against the force of the spring 4 and close the neutral passage 6. As a result, pressure in the high-pressure passage 7 rises, and oil pushes open the check valve 2 and flows through the passages 11 and 9 into the attachment actuator via the port A3.

Oil from the port B3 flows to the tank from the low-pressure passage 8.

The shut-off valves 14 and 15 are for releasing oil from the ports A3 and B3 into the low-pressure passage 8, respectively, in case of an emergency.

Action of Valve When Solenoid b3 is Activated

Activation of the solenoid b3 results in the action of the valve reverse to that when the solenoid a3 is activated. To be more specific, the valve spool 1 moves to the left, and oil flows to the attachment actuator from the port B3 and returns to the tank from the port A3. For action of proportional electromagnetic pressure reducing valve, refer to page 13-75.

Action of Proportional Electromagnetic Pressure Reducing Valve

This is a solenoid-aided reducing valve that regulates (reduces) pilot oil pressure from the reducing valve in the inlet section to necessary level proportional to the travels of load-handling lever before it is delivered to the chamber 2.

Pressure in the chamber 2 is proportional to travel of load-handling lever; the larger the travel, the higher the pressure, hence the stroke of the main spool 3 increases. Inversely, if the travel is small, the pressure is low and the stroke of the main spool 3 is short.

The valve consists of a solenoid part A and a pressure regulator part B. The solenoid part A is activated by electric current fed from the controller to protrude the solenoid rod 4 and push the spool 5. The force of the solenoid rod 4 to push the spool 5, that is thrust F, is proportional to the travel of the lever, this is variance of electric current.

Flow of Oil with Cargo-Handling Lever in "Neutral" Position

When load-handling lever is in the "neutral" position, the solenoid is inactive with its rod retracted. There is no pressure of pilot oil from the reducing valve in the inlet section because the unloader valve is open and extra flow is released from the main relief valve into the drain passage. Also, the pilot oil passage 7 is closed by the spool 5.

Oil in the chamber 2 flows to the drain passage through the passages 8, (d), (c), (e), 9 and 10 in that order.

Flow of Oil When Solenoid is Activated

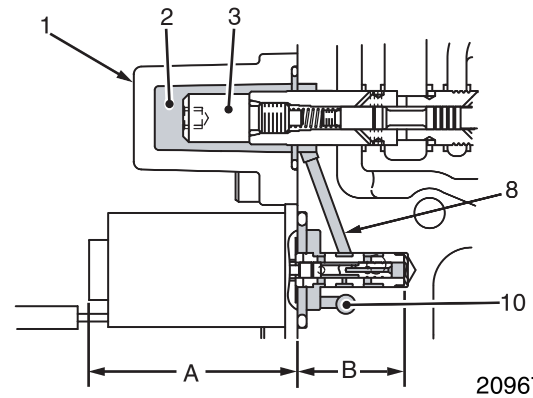
When the solenoid is activated, the solenoid rod 4 protrudes and the spool 5 moves to the left.

Pilot oil (Pp) entering the oil passage 7 flows through the oil passages (a), (c) and (d) into the chamber 2 via the passage 8.

At the same time, oil flows into the chamber 11 from the oil passage (b) and pushes the spool 5 to the left against the thrust of the solenoid rod 4.

- When the pressure of oil supplied into the chamber 2 overcomes the thrust of the solenoid rod 4, the spool 5 is allowed to push the rod to the left, closing the restricted area to the oil passages (a) and (c). The pressure of supplied oil lowers as a result. Inversely, when the pressure of oil supplied into the chamber 2 is overcome by the thrust of the solenoid rod 4, the spool 5 moves to the right, opening the restricted area to the oil passages (a) and (c). The pressure of supplied oil rises as a result.

In this way, the pressure in the chamber 2 is maintained proportional to the thrust of the solenoid rod 4.



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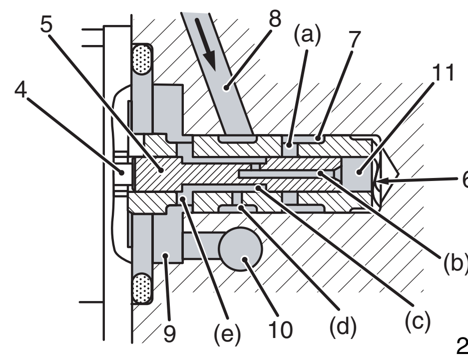
When solenoid inactive (with lever in "neutral" position)



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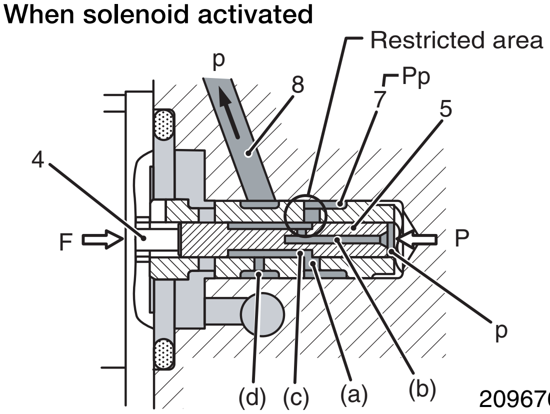
When solenoid activated



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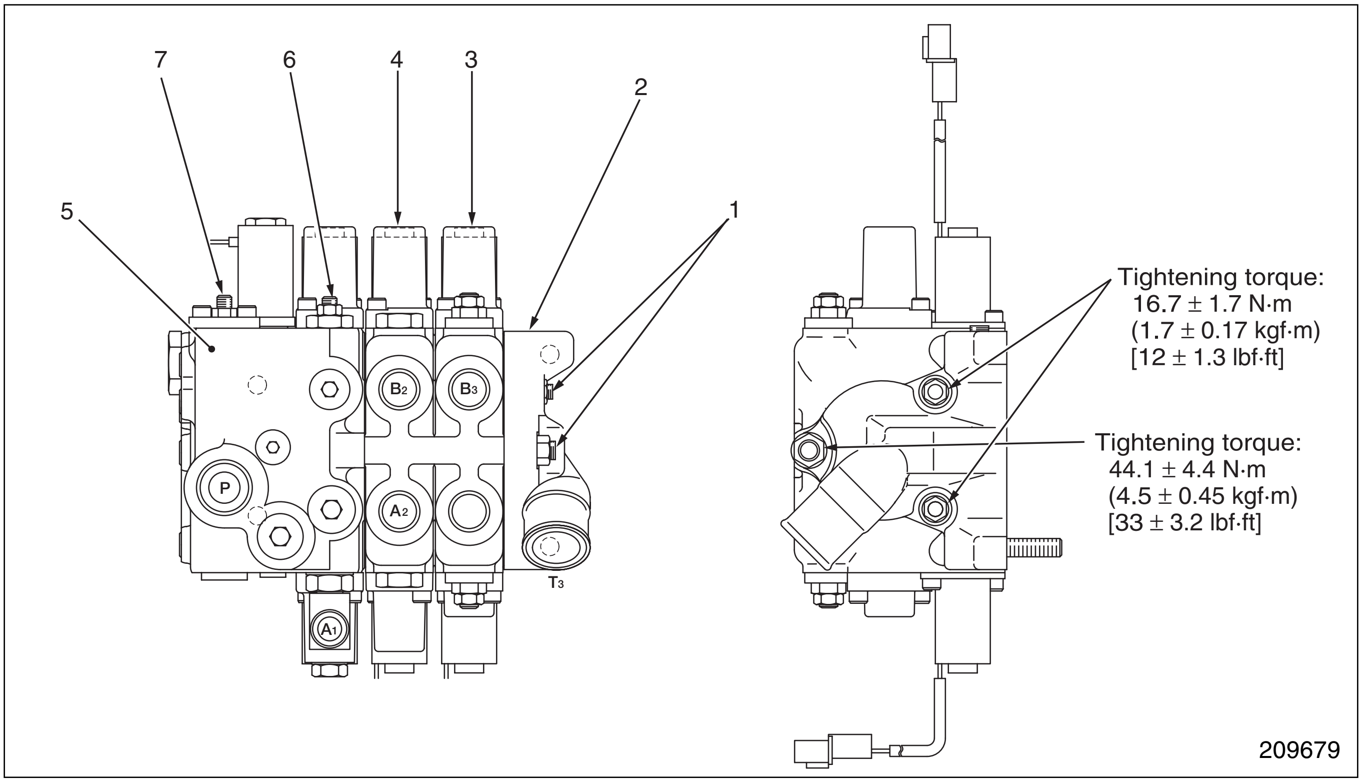
1 Cap
2 Chamber
3 Main spool
4 Solenoid rod
5 Spool
6 Wave washer
7 Oil passage receiving pilot oil from reducing valve
8 Passage of pilot oil for actuating valve spool
9 Return oil passage
10 Drain passage
11 Chamber

(a), (b), (c), (d), (e) : Small oil passages
p : Reduced oil pressure
p : Force to push spool to left with p
F : Thrust of solenoid rod

Disassembly and Reassembly

Control Valve Assembly

Disassembly



Sequence

1 Tie rod
2 End cover assembly
3 Attachment valve assembly
4 Tilt valve assembly
5 Inlet valve assembly
6 Emergency shut-off valve
7 Pilot relief valve

Suggestions for Disassembly

(1) Individual component valves can be removed separately, with tie rods tightened, that is as assembled.

(2) When disassembly becomes necessary, find the cause of fault and determine the scope of disassembly. Depending on the nature of fault, not only replacement of affected valve but extensive overhaul and flushing may be necessary.

(3) Prior to disassembly, clean the outside of the control valve assembly.

(4) During disassembly, check for dirt and other foreign matters in oil passages and stuck valves and poppets.

(5) In normal disassembling operation, do not loosen the lock nuts for adjusting screws of pilot relief valve, PF relief valve (steering relief valve) and flow adjuster kit. If the lock nuts are loosened and the adjusting screws are moved, readjustment after reassembly is required.

(6) Use care not to damage the machined surfaces.

(7) The main spool and valve body are in a set. If either the main spool or valve body is damaged, the whole valve section must be replaced in an assembly.

To avoid damage, when removing the lift lock valve, etc. from the main spool, do not hold the spool directly with a vise or pliers.

(8) Wash removed parts with clean solvent. Dry them using compressed air and place them on clean sheets of paper or cloth.

(9) For disassembly of individual valves, refer to “Reassembly of Valves.”

Inspection after Disassembly

Check valves for burrs, scratches, dents and other surface defects.

(1) Check that all moving and sliding contact parts move smoothly.

(2) Check for clogged orifices.

(3) Replace springs if they are broken or bent. Measure the free length of springs.

Reassembly

(1) Select a dust-free, clean place for reassembly.

(2) Perform reassembly, not section by section but by first assembling spool-less housing and tightening tie rod nuts to specified torque before proceeding to install spools and poppets.

(3) Tighten nuts on tie rod bolts to specified torque. Tighten bolts evenly. Tightening bolts unevenly or to improper torque may distort the valve body and make the movement of spool unsmooth.

(4) Reassemble each valve with proper knowledge of it. Pay particular attention to the position (direction) of valve.

(5) Reassemble valves with great care. Take care that parts do not hit each other or metal tools. Metal-to-metal collision damages the surfaces.

(6) Apply hydraulic oil to parts before they are installed. Do not install them dry. Application of grease facilitates the fitting of O-rings. Do not use grease in excess of necessary minimum quantity. Grease used must be clean.

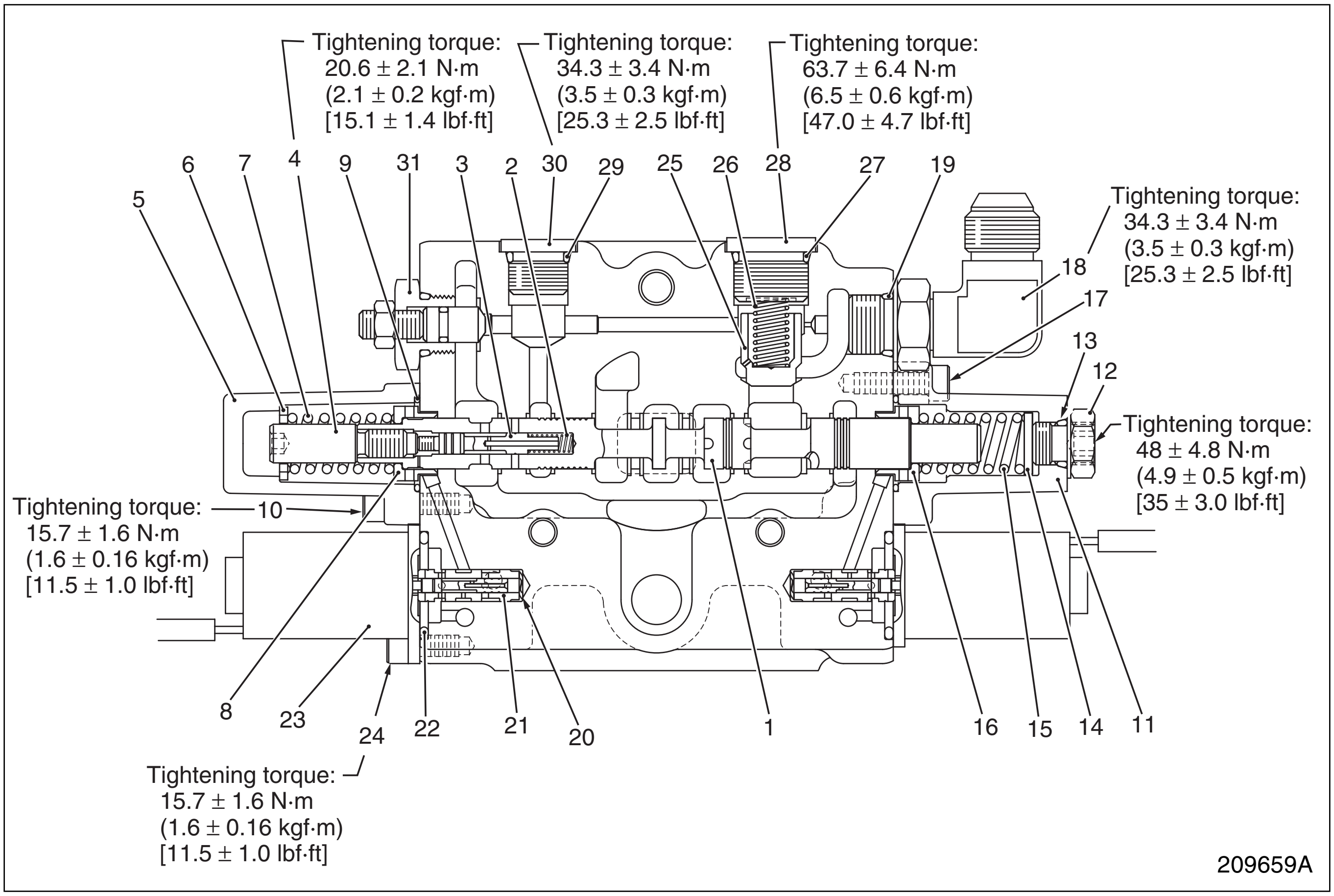
(7) Replace all O-rings. When fitting O-rings in the seal grooves, apply grease to them and seat them firmly in the grooves using care not to damage.

(8) After the spools are installed, check that they move smoothly.

(9) For reassembly of individual valves, refer to "Reassembly of Valves."

Reassembly of Valves

Valves in Inlet Valve Assembly (Part 1)



Reassembly of lift control valve (1 to 19)

Sequence

1 Lift spool
2 Spring
3 Valve
4 Spool head
5 Cap
6 Spring seat
7 Spring [free length: 31.2 mm (1.228 in.)]
8 Spring seat
9 O-ring
10 Bolt
11 Cap
12 Adjuster kit
13 O-ring
14 Spring seat
15 Spring [free length: 31.2 mm (1.228 in.)]
16 Spring seat
17 Bolt
18 Elbow
19 O-ring

Reassembly of proportional electromagnetic reducing valve (20 to 24)

Sequence

20 Wave washer
21 Valve set
22 O-ring
23 Solenoid valve assembly
24 Bolt

Reassembly of load check valve and associated pilot oil line (25 to 31)

Sequence

25 Poppet
26 Spring
27 O-ring
28 Plug
29 O-ring
30 Plug
31 Shut-off valve

Suggestions for Reassembly

Lift Control Valve

(1) Fit the spring 2 in the lift spool 1 and install the valve 3 in the direction shown in the illustration. Then, install the spool head finger-tight and tighten it up to the specified torque using a socket wrench.

(2) With hydraulic oil applied, insert the lift spool 1 into place in the housing with care. Check that the spool slides smoothly.

(3) Install the spring seat 6, spring 7, spring seat 8 and O-ring 9 in the cap 5.

(4) Install the cap 5 completed as above to the housing. Tighten the bolt 10 to the specified torque.

(5) Install the adjuster kit 12, O-ring 13, spring seat 14, spring 15 and spring seat 16 in the opposite cap 11.

If the adjuster kit was disassembled, it is necessary to adjust the descending speed while measuring after reassembly.

(6) Install the cap 11 completed as above to the housing, and tighten the bolt 17 to the specified torque.

(7) Fit the O-ring 19 on the elbow 18. Install the elbow to the housing, and after it is positioned to face in appropriate direction, tighten nut to the specified torque.

Proportional Electromagnetic Pressure Reducing Valve

(1) Install the valve set 21 with the wave washer 20 and O-ring 22. The valve set 21 is a set of parts and component parts cannot be replaced separately.

(2) Install the solenoid valve assembly 23 and tighten the bolt 24 to the specified torque.

Load Check Valve and Associated Pilot Oil Line

(1) Install parts in the sequence shown.

(2) Screw in the plugs 28 and 30 to the specified torques.

(3) If the shut-off valve assembly 31 was taken to pieces and removed, reassemble it in the following sequence. (See the illustration at the right.)

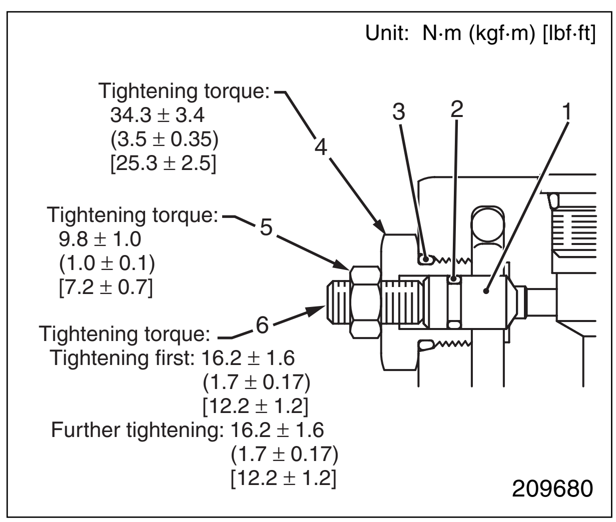
(a) Fit the O-ring 2 on the valve 1. Apply grease around the O-ring and insert the valve in the plug 4.

(b) Fit the O-ring on the plug 4. Screw the plug into the housing to the specified torque.

(c) Tighten the set screw 6 to a torque of 16.2 ± 1.6 N·m (1.7 ± 0.17 kgf·m) [12.2 ±1.2 lbf·ft].

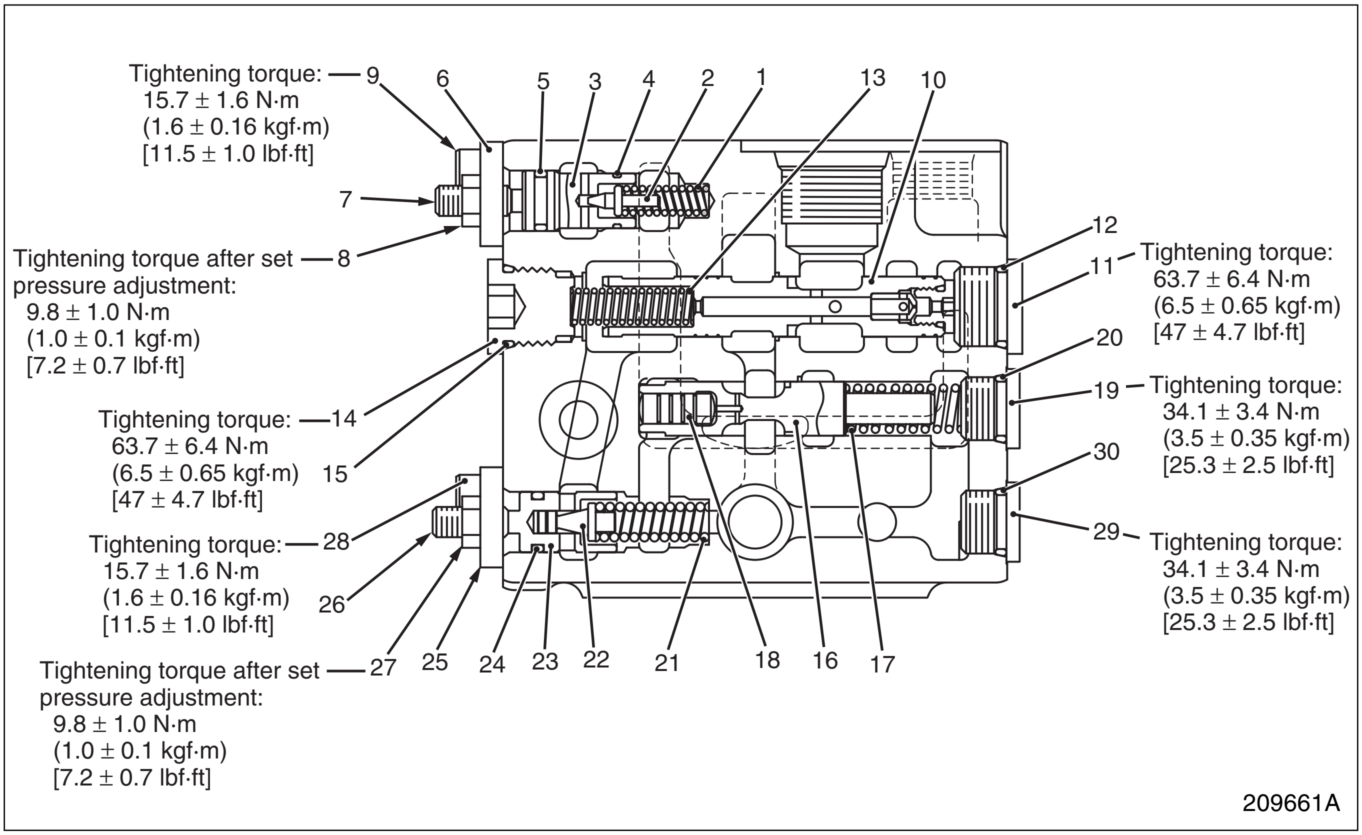
(d) Tighten the lock nut 5 to the specified torque.

(e) Further tighten the set screw 6 to a torque of 16.2 ± 1.6 N·m (1.7 ± 0.17 kgf·m) [12.2 ±1.2 lbf·ft].



1	Valve	4	Plug
2	O-ring	5	Lock nut
3	O-ring	6	Set screw

Valves in Inlet Valve Assembly (Part 2)



Reassembly of Pilot Relief Valve (1 to 9)

Sequence

1 Spring
2 Valve
3 Sleeve
4 O-ring
5 O-ring
6 Plate
7 Screw
8 Lock nut
9 Bolt

Reassembly of Priority Valve (10 to 15)

Sequence

10 Spool set
11 Plug
12 O-ring
13 Spring
[free length: 43.5 mm (1.713 in.)]
14 Plug
15 O-ring

Reassembly of Resistance Valve (16 to 20)

Sequence

16 Spool
17 Spring
[free length: 36 mm (1.417 in.)]
18 Slug
19 Plug
20 O-ring

Reassembly of PF Relief Valve (Steering Relief Valve (21 to 29)

Sequence

21 Spring
22 Poppet
23 Relief valve
24 O-ring
25 Plate
26 Screw
27 Lock nut
28 Bolt
29 Plug (with O-ring 20)

Pilot Relief Valve

(1) Insert the spring 1 and valve 2 into place in the housing.

(2) Fit the O-rings 4 and 5 on the sleeve 3. Apply grease around the O-rings and push the sleeve 3 into place in the housing.

(3) If the screw 7 for set pressure adjustment was disassembled, drive the screw in the plate 6 and install the lock nut 8 handtight.

(4) Install the plate completed as above using the bolt 9. Tighten the bolt to the specified torque.

(5) Install the valve to the truck and connect necessary pipes. Finally, adjust set pressure for the relief valve. Refer to "Inspection and Adjustment."

If the screw for set pressure adjustment is intact and set pressure for the relief valve remains unchanged, check for relief pressure only.

Priority Valve

(1) Complete the spool set 10. Apply grease around the completed spool set 10 and insert it carefully into place in the housing.

(2) Insert the spring 13 into place. Fit the O-ring 15 on the plug 14. Screw in the plug to the specified torque.

(3) Fit the O-ring 12 on the plug 11. Screw in the plug to the specified torque.

Resistance Valve

(1) Install the spring 17 and slug 18 in the spool 16. Apply hydraulic oil to the spool and insert it carefully into place in the housing.

(2) Fit the O-ring 20 on the plug 19, and screw in the plug to the specified torque.

PF Relief Valve (Steering Relief Valve)

(1) Insert the spring 21 and poppet 22 into place in the housing.

(2) Fit the O-ring 24 on the relief valve 23. Apply grease around the O-ring and insert the relief valve 23 into place in the housing.

(3) If the screw 26 for set pressure adjustment was disassembled, drive the screw in the plate 25 and install the lock nut 27 handtight.

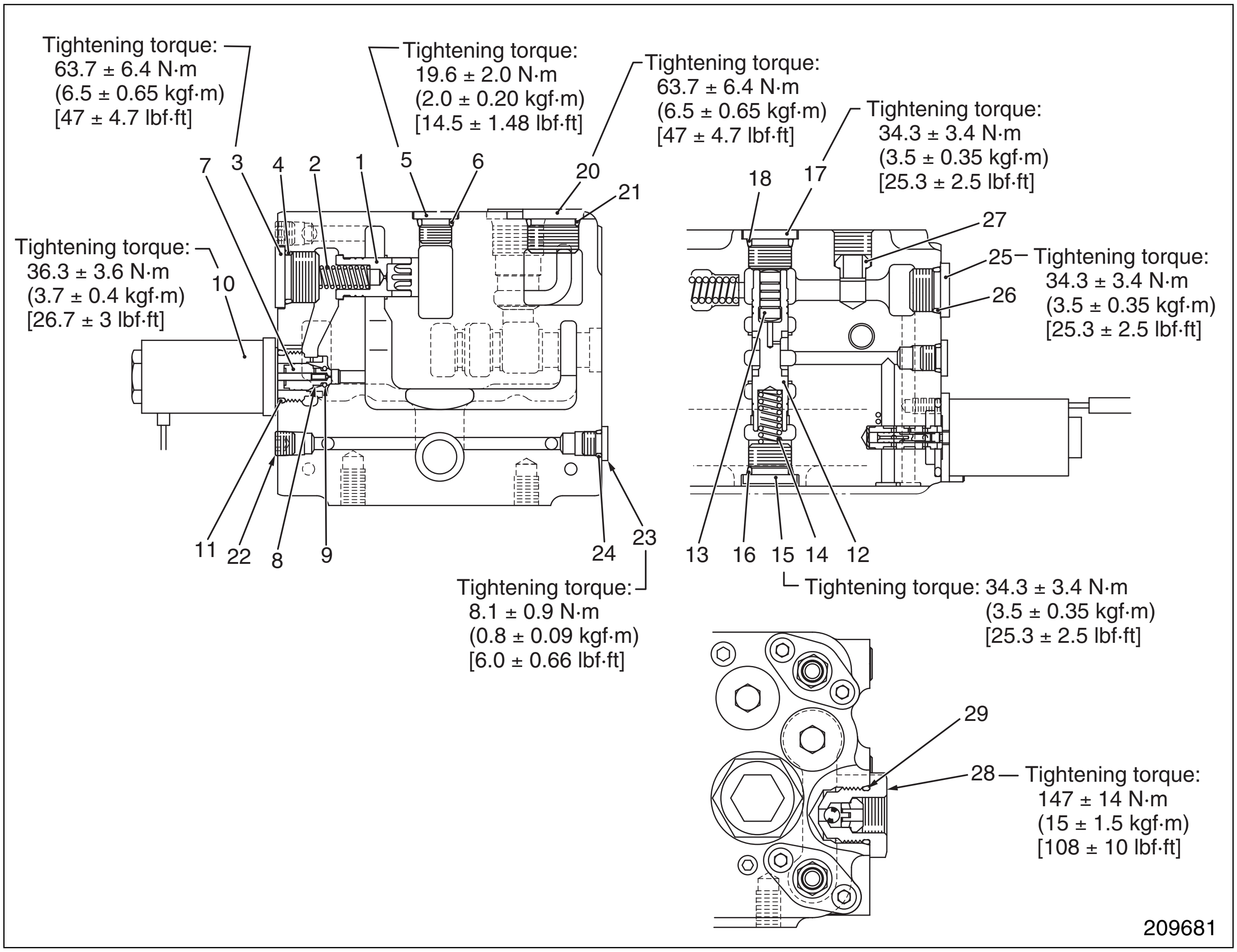
(4) Install the plate completed as above using the bolt 28. Tighten the bolt to the specified torque.

(5) Fit the O-ring 30 on the plug 29, and screw in the plug to the specified torque.

(6) Install the valve to the truck and connect necessary pipes. Finally, adjust set pressure for the relief valve. Refer to "Inspection and Adjustment."

If the screw for set pressure adjustment is intact and set pressure remains unchanged, check for relief pressure only.

Valves in Inlet Valve Assembly (Part 3)



Reassembly of main relief valve (1 to 6)

1 Valve	3 Plug	5 Plug
2 Spring [free length: 22 mm (0.866 in.)]	4 O-ring	6 O-ring

Parts of unload solenoid valve (7 to 11)

7 Poppet	9 O-ring	11 O-ring
8 Filter	10 Solenoid valve	

Reassembly of reducing valve (12 to 19)

12 Spool	15 Plug	17 Plug
13 Slug	16 O-ring	18 O-ring
14 Spring [free length: 23 mm (0.906 in.)]		

Installation of oil passage plugs

20 Plug	24 O-ring	27 Plug
21 O-ring	25 Plug	28 Connector assembly
22 Plug	26 O-ring	29 O-ring
23 Plug		

Main Relief Valve

(1) Install the spring 2 in the valve 1. Apply hydraulic oil to the valve and insert it into place in the housing.

(2) Fit the O-ring 4 on the plug 3, and screw in the plug to the specified torque.

(3) Fit the O-ring 6 on the plug 5, and screw in the plug to the specified torque.

Reassembly of Unload Solenoid Valve

(1) Fit the filter 8 and O-ring 9 to the poppet 7, and insert the poppet into place in the housing.

(2) Fit the O-ring 11 on the solenoid valve 10, and screw in the valve to the specified torque.

Reassembly of Reducing Valve

(1) Install the slug 13 and spring 14 in the spool 12. Apply hydraulic oil to the spool and insert it into place in the housing.

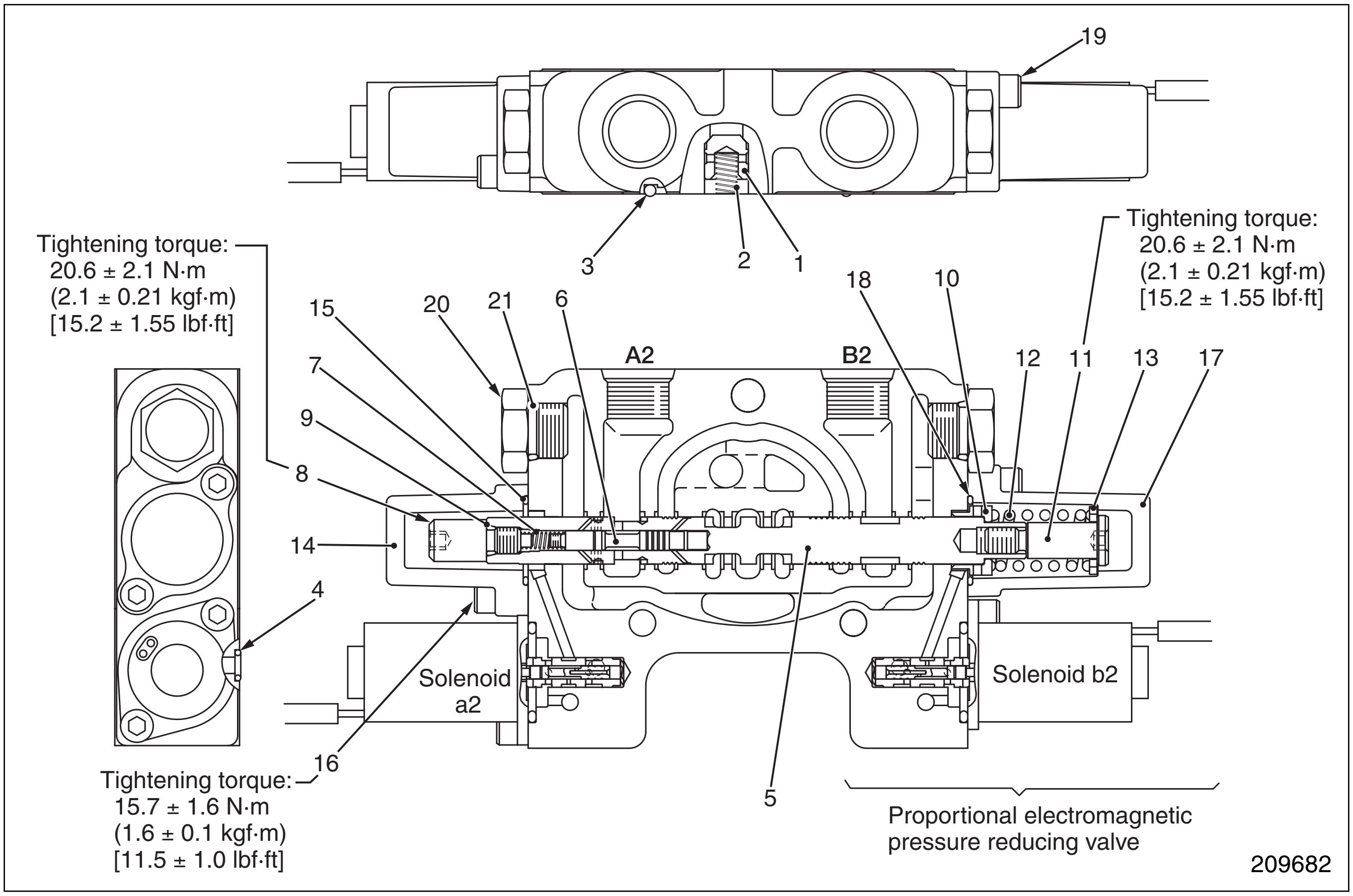
(2) Fit the O-ring 16 on the plug 15, and screw in the plug to the specified torque.

(3) Fit the O-ring 18 on the plug 17, and screw in the plug to the specified torque.

Installation of Oil Passage Plugs

Most plugs are fitted with O-rings. Apply a thin coat of grease to O-rings, and screw in the plugs to appropriate specified torques.

Tilt Valve



Reassembly of tilt control valve

Sequence

1	Poppet	9	O-ring	15	O-ring
2	Spring	10	Spring seat	16	Bolt
3	O-ring	11	Cap screw	17	Cap
4	O-ring	12	Spring [free length: 31.2 mm (1.228 in.)]	18	O-ring
5	Spool			19	Bolt
6	Valve	13	Spring seat	20	Plug
7	Spring	14	Cap	21	O-ring
8	Spool head				

Tilt Control Valve

(1) Install the parts 1 to 4 before combining the section housings.

(2) Install the valve 6 in the spool 5 in the direction shown in the illustration above, then install the spring 7 in position. Fit the O-ring 9 on the spool head 8, and install the spool head finger-tight.

(3) Apply hydraulic oil to the spool 5, and insert the spool carefully into place in the housing. Check that the spool slides smoothly.

(4) Install the spring seat 10 in position. Fit the spring 12 and spring seat 13 to the cap screw 11, and drive the cap screw 11 in the spool with fingers.

(5) Tighten the spool head 8 and cap screw 11 to the specified torque using hexagon wrenches.

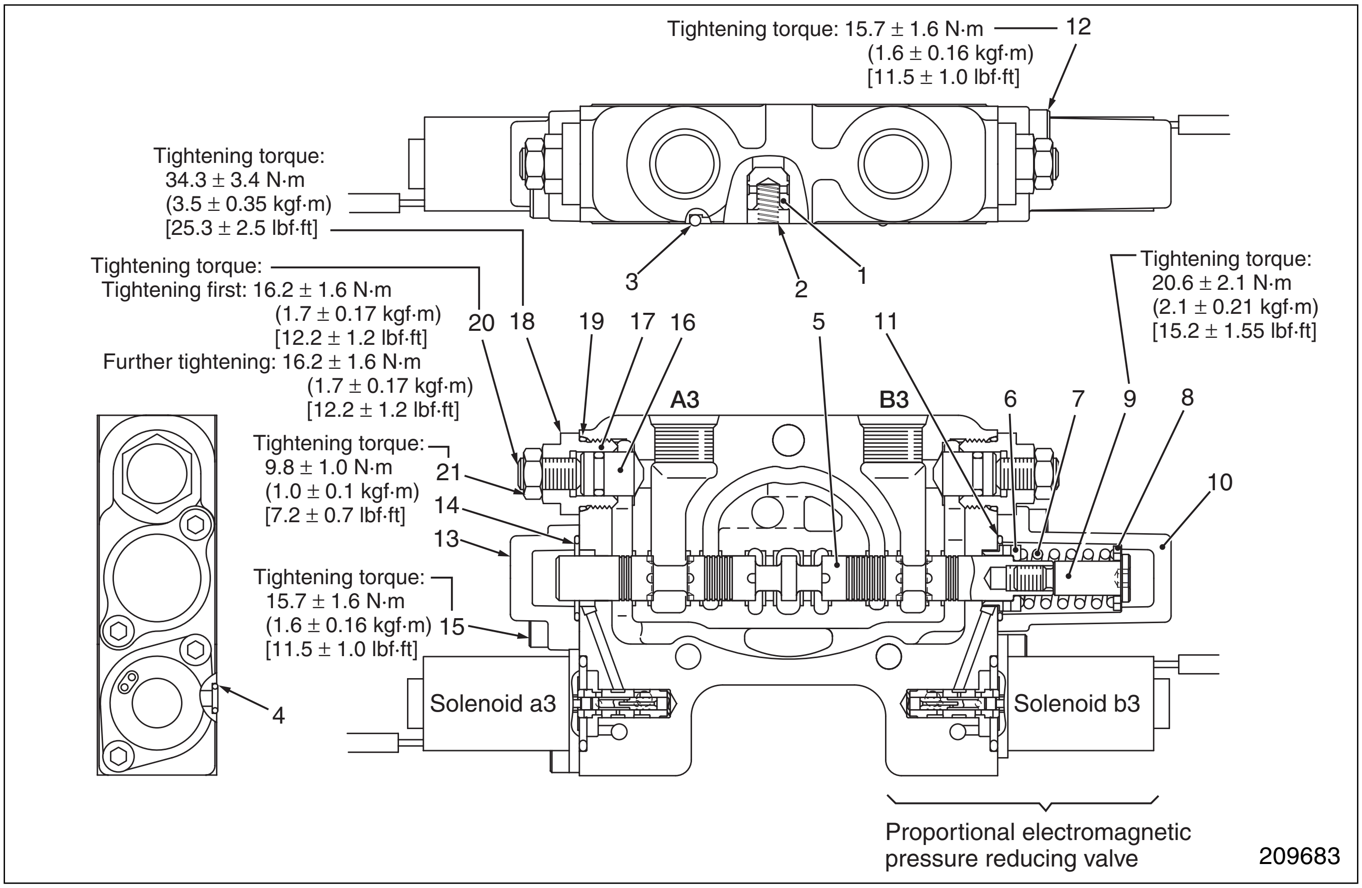
(6) Fit the O-ring 15 on the cap 14. Install the cap to the housing using the bolt 16. Tighten the bolt to the specified torque.

(7) Fit the O-ring 18 on the cap 17. Install the cap to the housing using the bolt 19. Tighten the bolt to the specified torque.

(8) Fit O-ring 26 on the plug 25. Screw the plug in the housing to the specified torque.

(9) Install the other plug.

Attachment Valve



Reassembly of attachment control valve

Sequence

1	Poppet	8	Spring seat	15	Bolt
2	Spring	9	Cap screw	16	Valve
3	O-ring	10	Cap	17	O-ring
4	O-ring	11	O-ring	18	Plug
5	Spool	12	Bolt	19	O-ring
6	Spring seat	13	Cap	20	Set screw
7	Spring [free length: 31.2 mm (1.228 in.)]	14	O-ring	21	Lock nut

Attachment Control Valve

(1) Install the parts 1 to 4 before combining the section housings.

(2) Apply hydraulic oil to the spool 5, and insert the spool carefully into place in the housing. Check that the spool slides smoothly.

(3) Install the spring seat 6, spring 7 and spring seat 8 in position, and tighten the cap screw 9 to the specified torque.

(4) Fit the O-ring 11 on the cap 10, and install the cap to the housing using the bolt 12. Tighten the bolt to the specified torque.

(5) Fit the O-ring 14 on the cap 13, and install the cap to the housing using the bolt 15. Tighten the bolt to the specified torque.

(6) Fit the O-ring 17 on the valve 16, and insert the valve into place in the plug 18. Fit the O-ring 19 on the plug, and screw the plug in the housing to the specified torque.

(7) Tighten the set screw 20 to a torque of 16.2 ± 1.6 N·m (1.7 ± 0.17 kgf·m) [12.2 ± 1.2 lbf·ft].

(8) Tighten the lock nut to the specified torque.

(9) Further tighten the set screw 20 to a torque of 16.2 ± 1.6 N·m (1.7 ± 0.17 kgf·m) [12.2 ± 1.2 lbf·ft].

(10) Install the other shut-off valve.

MAST AND FORKS

Mast System

Following table shows a combination of truck and mast models:

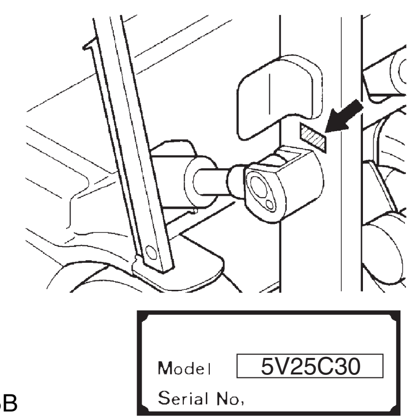
Model \ Mast	Simplex Mast	Duplex Mast	Triplex Mast
1 ton class	5V15C□□	5F15C□□	5M15C□□
	5V20C□□	5F20C□□	5M20C□□
2 ton class	5V25C□□	5F25C□□	5M25C□□
3 ton class	5V30C□□	5F30C□□	5M30C□□
	5V35C□□	5F35C□□	5M35C□□

Note: □□ presents maximum lift height.

Example:

30: Lift Height of 3000 mm

Mast Serial Number Location



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Mast Model Code

Code	Mast Model
V	Simplex Mast
F	Duplex Mast
M	Triplex Mast

How to Read Mast Model Code

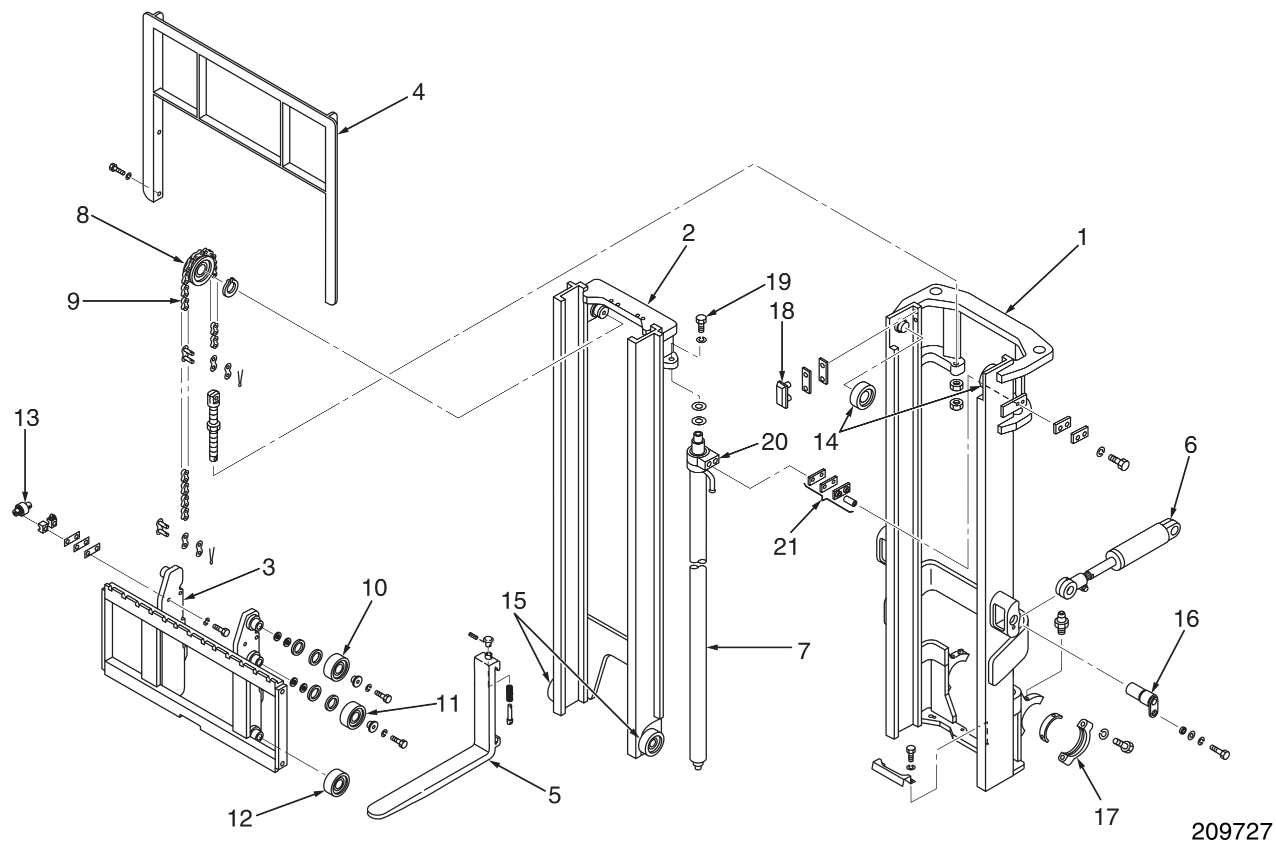
Example: 5 V 25 C 30

- 30 — Maximum lifting height ["30" stands for 3000 mm (118 in.)]
- C — Order of the minor change ("A" for the original, "B" for the first change, "C" for the second change, and so on)
- 25 — Applicable truck model designation (Example: GP25)
  15: 1 ton class
  20, 25: 2 ton class
  30, 35: 3 ton class
- V — Kind of mast
  V: simplex mast
  F: duplex mast
  M: triplex mast
- 5 — Major change ("2" for the original, "3" for the first change, and so on up to "9")

Structure and Function

Simplex (Dual Panoramic) Mast (5V15C to 5V35C)

Note: (1) Illustration shows 5V25C model.
(2) For hydraulic lines, refer to "Installing Hydraulic Line" on the page 14-25.



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

1	Outer mast	9	Chain	17	Mast support cap
2	Inner mast	10	Lift bracket upper roller	18	Mast strip
3	Lift bracket	11	Lift bracket middle roller	19	Lift cylinder upper mounting bolts
4	Backrest	12	Lift bracket lower roller	20	Cylinder bracket
5	Forks (2)	13	Side roller	21	Cylinder clamps
6	Tilt cylinder	14	Outer mast roller		
7	Lift cylinder	15	Inner mast roller		
8	Chain wheel	16	Tilt cylinder, Tilt socket mounting pin		

Simplex mast features two lift cylinders placed behind the mast columns, right and left, to provide maximum visibility.

Mast strips are fitted to the top end of outer mast. These strips are for backing up the inner mast when the mast is tilted backward.

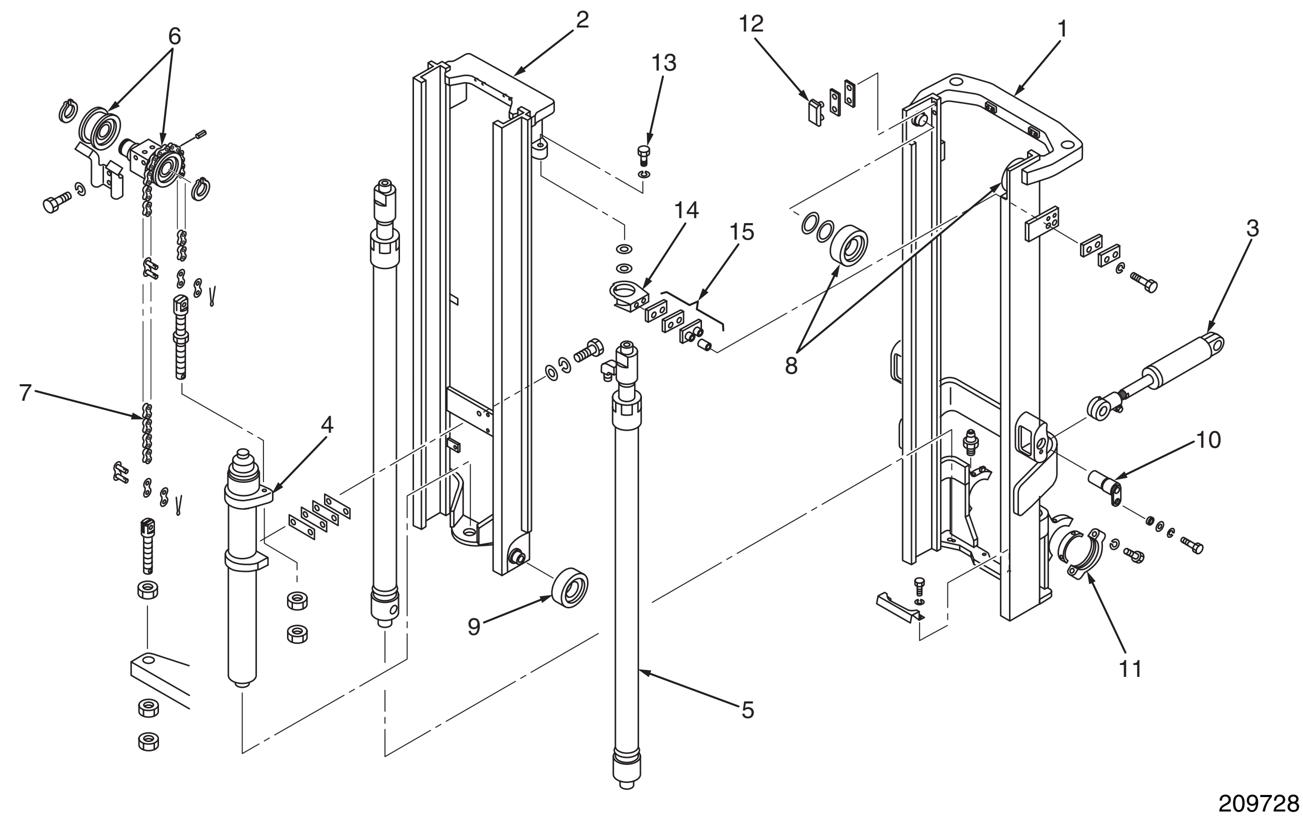
Lift cylinder 7 of a lift height of 3300 mm (130 in.) or less is equipped with down cushioning and no return hose by internal drain.

Lift cylinder of a lift height of 3500 mm (138 in.) or more is equipped with drain hose.

For mast operation, refer to "Mast Operation" on page 12-5.

Simplex (Dual Full-free Panoramic) Mast (5F15C to 5F35C)

Note: (1) Illustration shows 5F25C model.
(2) For hydraulic lines, refer to "Installing Hydraulic Line" on the page 14-25.
(3) For lift bracket, fork, and backrest, refer to "Illustration of Simplex Mast Structure." Main parts are almost the same in all models.



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

1	Outer mast	6	Chain wheel	11	Mast support cap
2	Inner mast	7	Chain	12	Mast strips
3	Tilt cylinder	8	Outer mast roller	13	Lift cylinder upper mounting bolt
4	First lift cylinder (one piece)	9	Inner mast roller	14	Cylinder bracket
5	Second lift cylinder	10	Tilt cylinder, Tilt socket mounting pin	15	Cylinder clamp

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

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

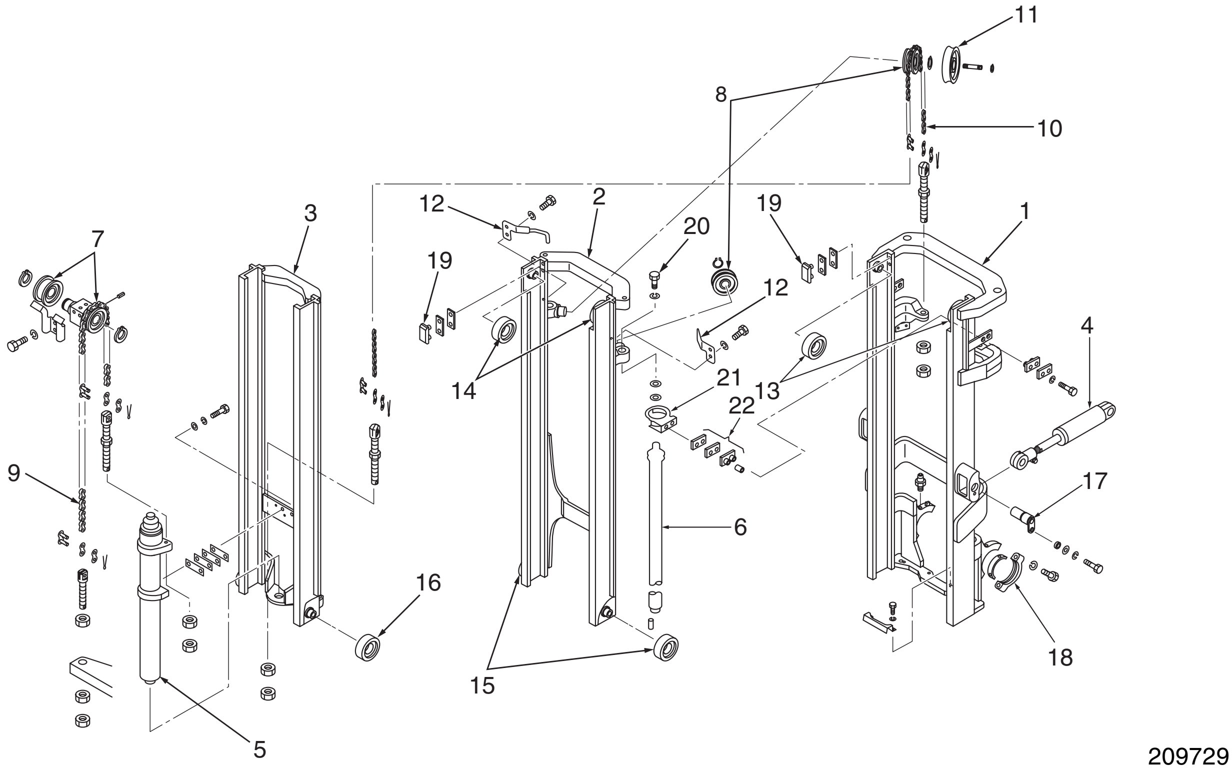
The first lift cylinder raises the lift bracket, while the second cylinders operate the inner mast and lift bracket.

First cylinder is equipped with upstroke cushioning with internal drain and second cylinder equipped with down cushioning.

For mast operation, refer to "Mast Operation" on page 12-5.

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

Note: (1) Illustration shows 5M25C model.
(2) For hydraulic lines, refer to “Installing Hydraulic Line” on the page 14-25.
(3) For lift bracket, fork, and backrest, refer to “Illustration of Simplex Mast Structure.” Main parts are almost the same in all models.



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

1 Outer mast
2 Middle mast
3 Inner mast
4 Tilt cylinder
5 First lift cylinder (one piece)
6 Second lift cylinder
7 First lift chain wheel
8 Second lift chain wheel
9 First lift chain
10 Second lift chain
11 Hose pulley
12 Chain guard (Right or left type)
13 Outer mast roller
14 Middle mast upper roller
15 Middle mast lower roller
16 Inner mast roller
17 Tilt cylinder, tilt socket mounting pin
18 Mast support cap
19 Mast strips
20 Lift cylinder upper mounting bolt
21 Cylinder bracket
22 Cylinder clamps

In 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.

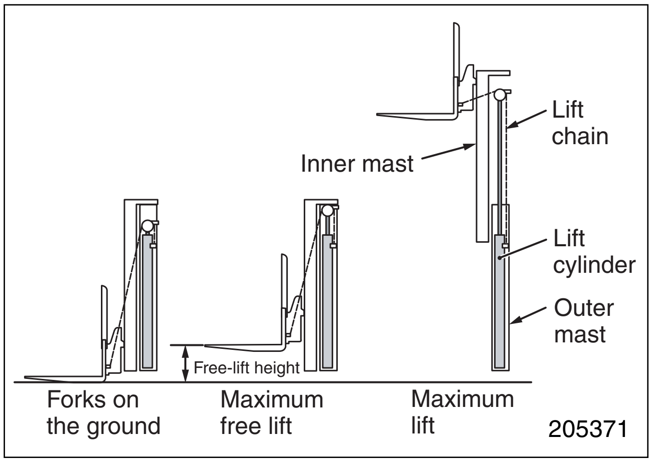
The first lift cylinder raises the lift bracket, while the second cylinder operates the three-stage telescopic mechanism and lift bracket.

First cylinder is equipped with upstroke cushioning and second cylinder equipped with down cushioning and both cylinders have no return hose by internal drain.

For mast operation, refer to “Mast Operation” on page 12-5.

Mast Operation

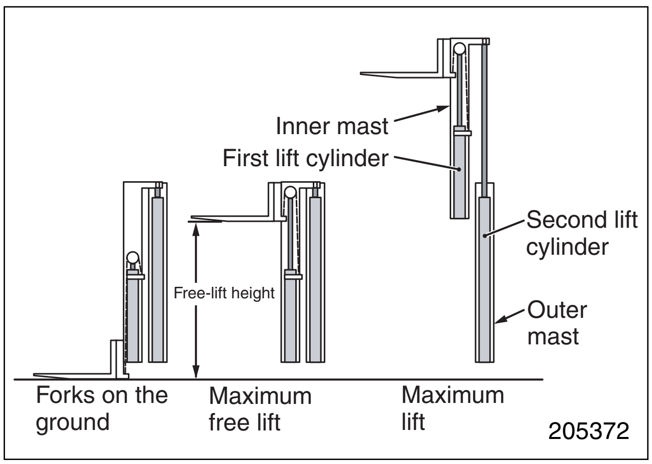
1. Operation of Simplex Mast



Operation of Mast

The lift cylinders extend, which lifts the forks until the maximum free-lift height is reached.
The cylinders extend further, causing the inner mast to lift at the same speed as the rods while at the same time causing the forks to lift at the speed twice as fast as the inner mast.

2. Operation of Duplex Mast

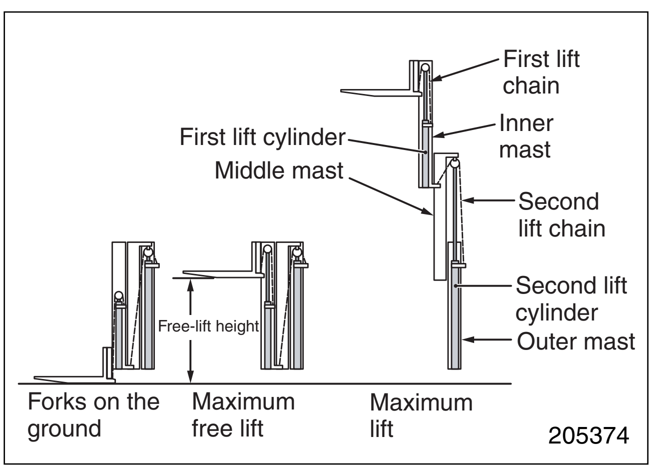


Operation of Mast

The first lift cylinder extends, bringing the forks to the maximum free-lift height.
When the first lift cylinder rod reaches the end of the stroke, the second lift cylinders take over to directly lift the inner mast to the maximum lift height.

The lowering mechanism is the reverse of lifting.

3. Operation of Triplex Mast



Operation of Mast

The first lift cylinder extends, bringing the forks to the maximum free-lift height.
When the first lift cylinder rod reaches the end of the stroke, the second lift cylinders take over to lift the middle mast while at the same time the second lift chain lifts an assembly of the forks, inner mast and first lift cylinders.

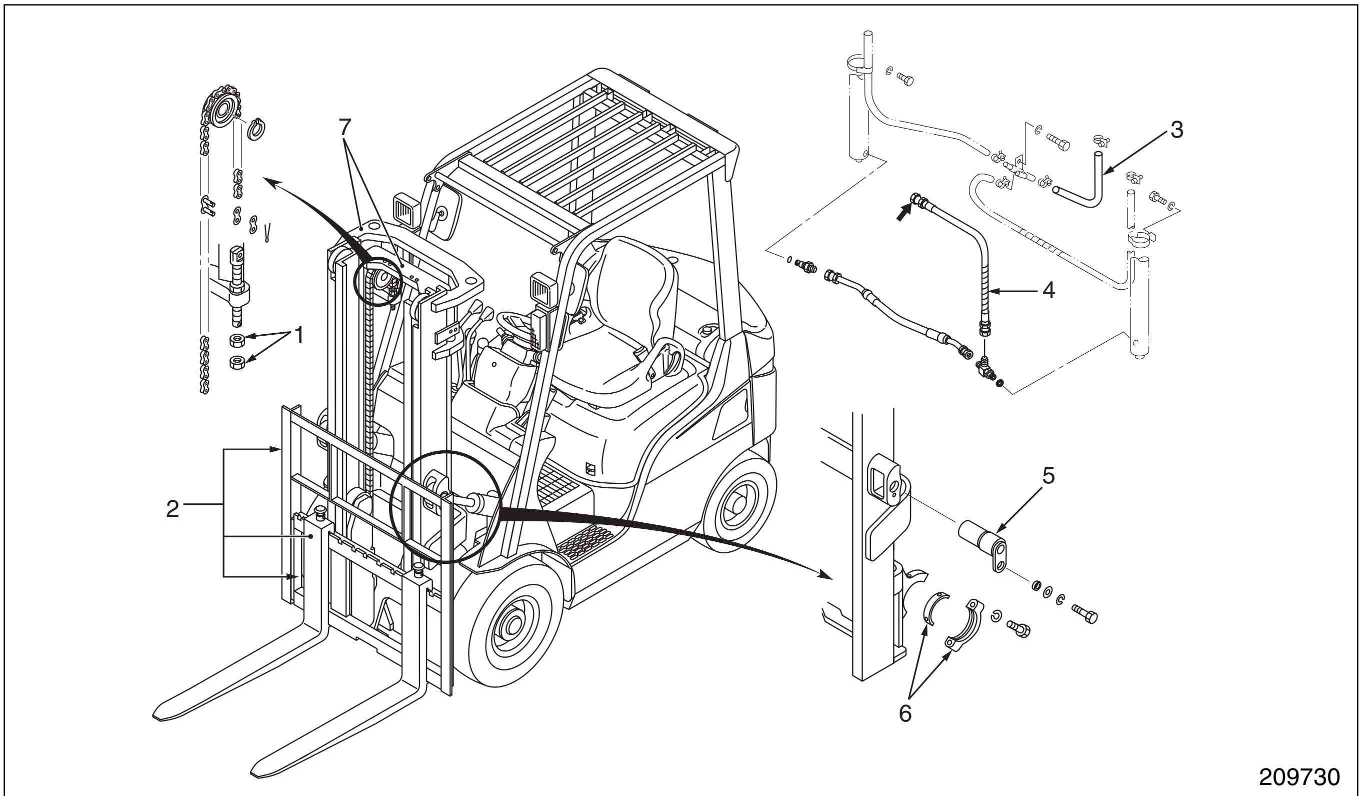
The lowering process takes place in the reverse order of lifting.

Removal and Installation

Note: For replacing mast roller without removing mast from track, refer to page 12-28.

Mast and Lift Bracket Assembly

Simplex Mast Removal



Sequence

1 Nuts
2 Backrest, Lift bracket, Forks
3 Return hose (hi-lift model)
4 High-pressure hose
5 Tilt socket pin
6 Mast support bearing cap, Bushing
7 Inner mast, Outer mast, Lift cylinder

Suggestions for Removal

1. Removing lift bracket

(1) Tilt the mast forward, and lower the inner mast to the bottom. Slacken the lift chains, and remove the nuts 1 from the anchor bolts.

(2) Tilt the mast back to vertical position. Raise the inner mast until the lift bracket 2 becomes free. Then, slowly back the truck away, from the lift bracket and fork assembly.

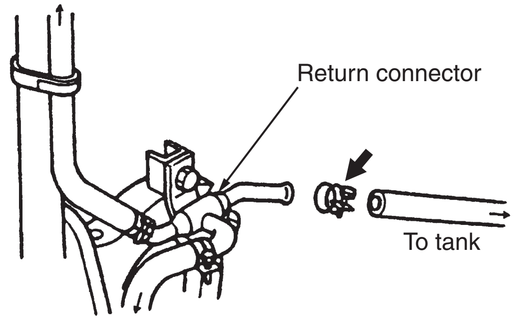
Note: Before proceeding any mast overhaul, measure the clearance between mast and rollers. Knowing which roller should be replaced or which shims need adjustment in advance allows efficient maintenance work.

2. Disconnecting return hose for lift cylinder
(For high-lift cylinder model)

(1) Start the engine and raise the mast in the highest position.

(2) Stop the engine and disconnect the hose 3 at the hose clamp (Allow) of return connector.

(3) Lower the mast.



204874

3. Disconnecting high-pressure hoses for lift cylinder

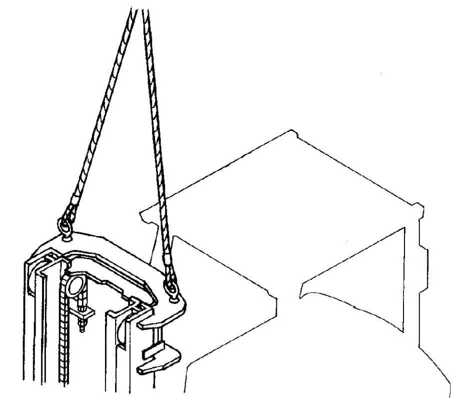
Place the mast in the bottom position, disconnect the hose 4 at the arrow position in the illustration on the previous page.

4. Separating tilt cylinders

(1) Hitch a sling to the upper cross-member of the outer mast, then lift with a hoist.

⚠ CAUTION

Be sure to use a hoist having a capacity enough to support the mast assembly.


207393A

(2) Place wood blocks under the tilt cylinder mounting section and remove the tilt socket pins, and separate the mast from the tilt cylinders.

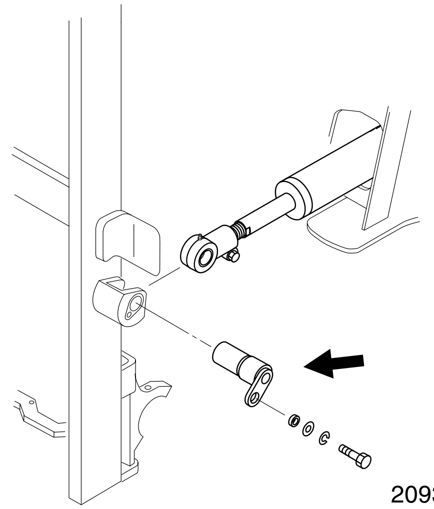
(3) Start the engine, and pull back the tilt lever to retract the tilt cylinder rods.

⚠ CAUTION

Do not touch any levers except the tilt lever while the engine is running.

⚠ CAUTION

Never loosen tilt socket bolts except for tilt cylinder disassembling.

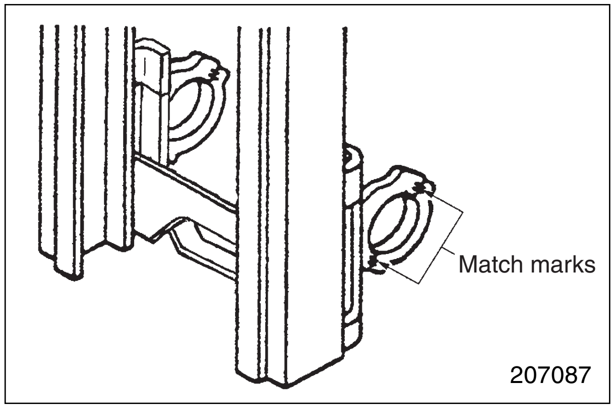

209373A

5. Removing mast support bearing caps

(1) Mark caps to ensure the caps are reinstalled in original positions during reassembly.

(2) Remove cap mounting bolts. Dismount the mast assembly from truck in the suspended condition. With the lift bracket side facing up, place the mast assembly horizontally on wooden blocks on a level ground.

Note: Lay the mast assembly on a space large enough to disassemble the parts.



Installation

To install, follow the removal sequence in reverse with following in mind.

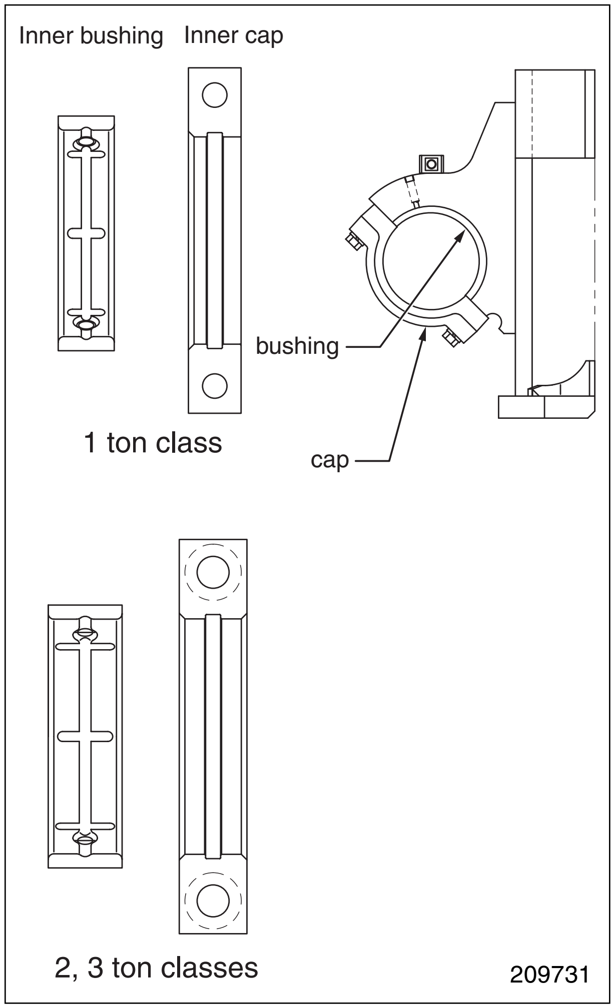
1. Mast Support

(1) Apply grease to the inner surfaces of caps and mast support bushings.

(2)-a 1 ton class:
When installing caps, make sure the wider chamfered side faces toward the center of the chassis.

(2)-b 2, 3 ton classes:
Chamfering is the same both in the right and left sides. Be sure to reassemble in the same position as it was.

(3) When applying grease, place wood blocks under the mast. By doing so, it is easily greased.



2. Adjust the chain tensions

Refer to the “Chain Tension Adjustment.”

3. Bleeding lift cylinders

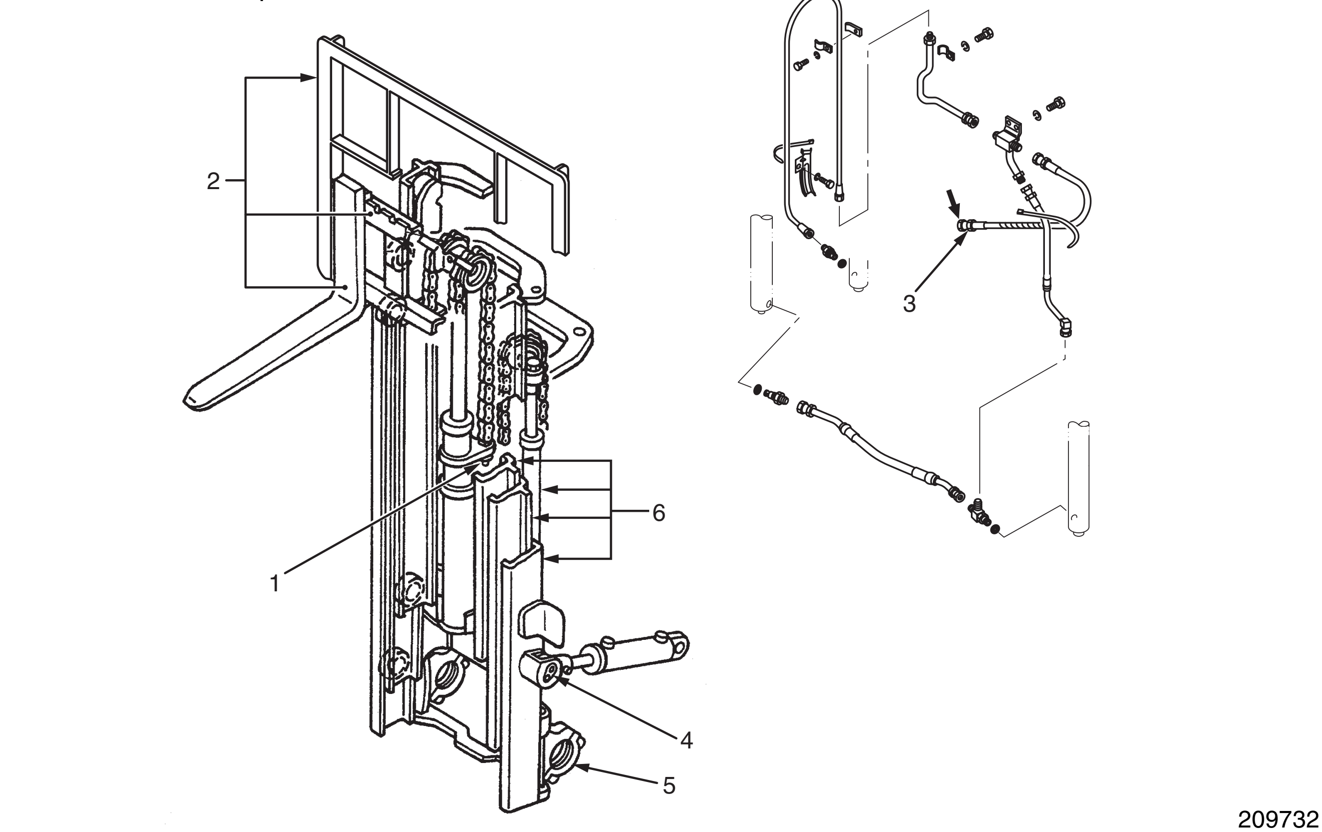
Start the engine, raise and lower the lift bracket with several strokes to bleed the cylinder.

After proper operation is confirmed, check the oil level in hydraulic tank.

Duplex Mast and Triplex Mast Removal

Note: For replacing mast roller without removing mast from track, refer to page 12-29 or 12-30.

Illustration shows triplex mast.



Sequence

1 Nuts
2 Backrest, Lift bracket, Fork
3 High-pressure hose
4 Tilt socket pin
5 Mast support bearing cap, Bushing
6 Mast, Lift cylinders

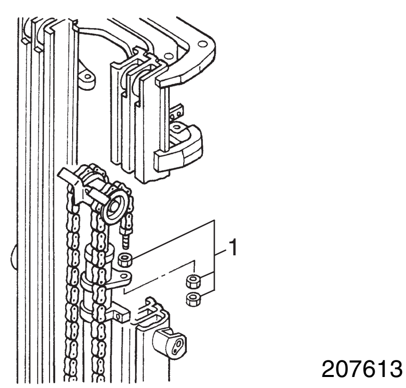
Suggestions for Removal

1. Removing lift bracket

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

(2) Tilt the mast back to vertical position. Raise the inner mast until main rollers of the lift bracket become free. Then, back the truck away, from the lift bracket.

Note: Before proceeding any mast overhaul, be sure to measure the clearance between mast and rollers. Knowing which roller should be replaced or which shims need adjustment in advance allows efficient maintenance work.



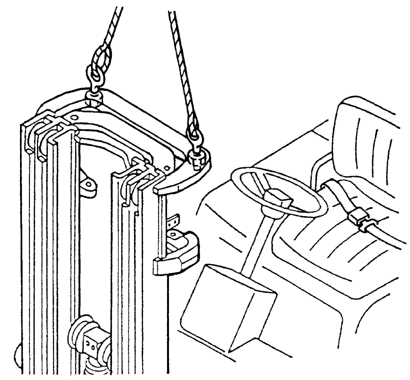
2. Disconnecting high-pressure hoses for lift cylinder

Place the mast in the bottom position, disconnect the hose 3 at the arrow position in the illustration on the previous page.

3. Separating tilt cylinders

(1) Hitch a sling to the upper cross-member of the outer mast, then lift with a hoist.

> **⚠ CAUTION**
>
> **Be sure to use a hoist having a capacity enough to support the mast assembly.**



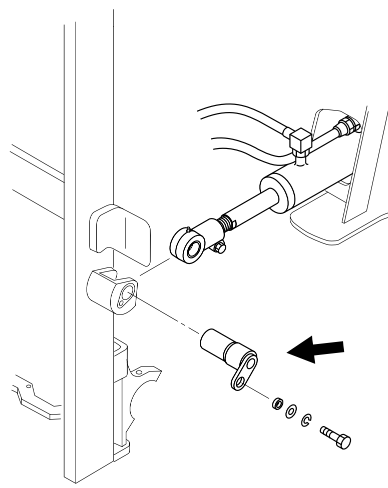
207614

(2) Place wood blocks under the tilt cylinder mounting section and remove the tilt socket pins, and separate the mast from the tilt cylinders.

(3) Start the engine, and pull back the tilt lever to retract.

> **⚠ CAUTION**
>
> **Do not touch any levers except the tilt lever while the engine is running.**

> **⚠ CAUTION**
>
> **Never loosen tilt socket bolts except for tilt cylinder disassembling.**



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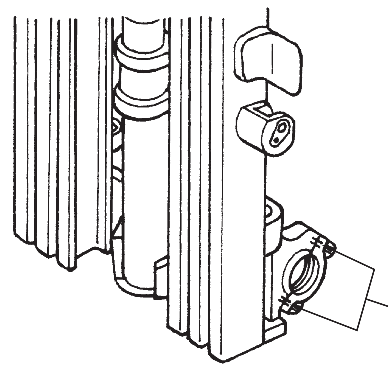
4. Removing mast support bearing caps

(1) Mark caps to ensure the caps are reinstalled in original positions during reassembly.

(2) Remove cap mounting bolts. Dismount the mast assembly from truck in the suspended condition. With the lift bracket side facing up, place the mast assembly horizontally on wooden blocks on the level ground.

Note: Lay the mast assembly on a space large enough to disassemble the parts.



207615

Installation

To install, follow the removal sequence in reverse with following in mind.

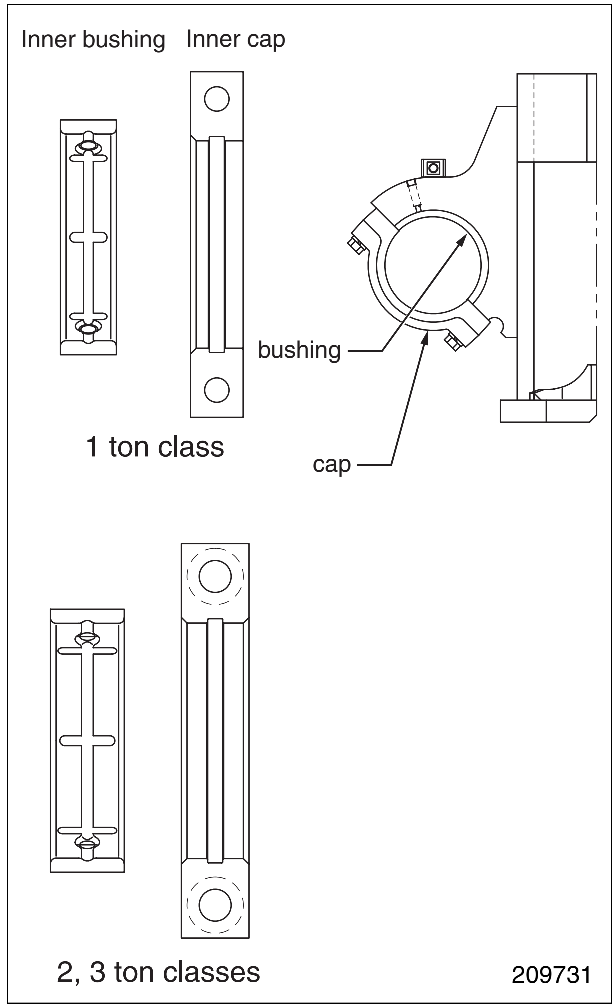
1. Mast Support

(1) Apply grease to the inner surfaces of caps and mast support bushings.

(2)-a 1 ton class:
When installing caps, make sure the wider chamfered side faces toward the center of the chassis.

(2)-b 2, 3 ton classes:
Chamfering is the same both in the right and left sides. Be sure to reassemble in the same position as it was.

(3) When applying grease, place wood blocks under the mast. By doing so, it is easily greased.



2. Adjust the chain tensions

Refer to the “Chain Tension Adjustment.”

3. Bleeding lift cylinders

In the duplex mast, the second lift cylinders are provided with air bleeding screws.
After installing the mast, start the engine, raise and lower the lift bracket with several strokes and loosen the screws to bleed.

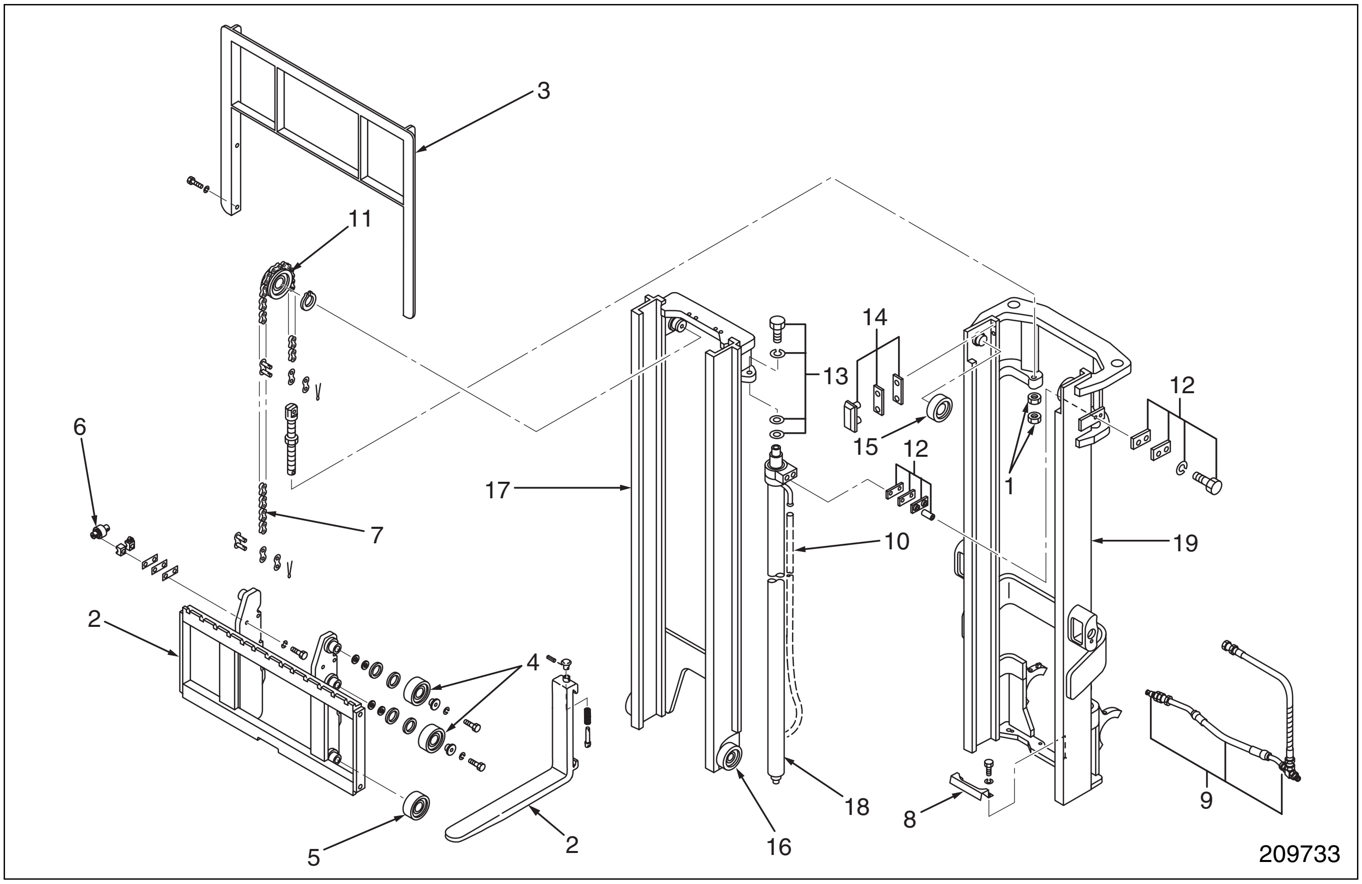
In the triplex mast, no air bleeding screws are provided. Raise and lower the lift bracket with several strokes to bleed the air trapped below the piston.

After proper operation is confirmed, check the oil level in hydraulic tank.

Disassembly and Reassembly

Simplex Mast

Disassembly



Sequence

1 Nuts
2 Forks, Lift bracket
3 Backrest
4 Lift bracket upper, Lower rollers
5 Lift bracket lower rollers
6 Lift bracket side rollers
7 Chain
8 Hose guard
9 Lift hose (high pressure), Rubber hose, T-joint, Down safety valve
10 Return hose (high lift mast)
11 Chain wheel
12 Cylinder clamps, Seats, Shims, Cushion, Collar, Bolts
13 Bolt, Shims
14 Mast strips, Shims
15 Outer mast main rollers
16 Inner mast main rollers
17 Inner mast
18 Lift cylinders
19 Outer mast

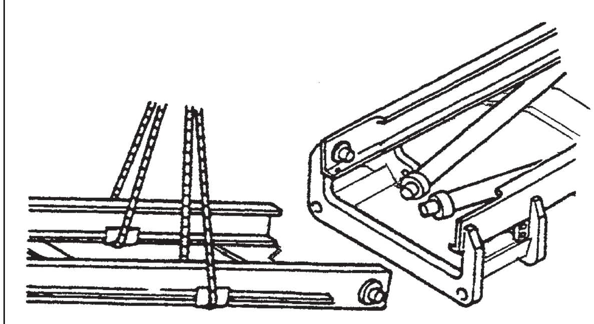
Suggestions for Removal

1. Removing mast strips and main rollers

Remove bolts 12, 13 to free lift cylinder 18. Displace the tops of the two lift cylinders from inner mast 17. Slide inner mast toward the bottom of outer mast 19, and remove main rollers 15, 16 and mast strips 14.

2. Inner mast removal

After removing the main rollers, hitch a sling to the inner mast cross-member and slide the inner mast to the upper side of the outer mast to clear the outer mast roller shafts. Hitch a sling to the inner mast again and remove it from the outer mast.



207089

Inspection after disassembly (all models)

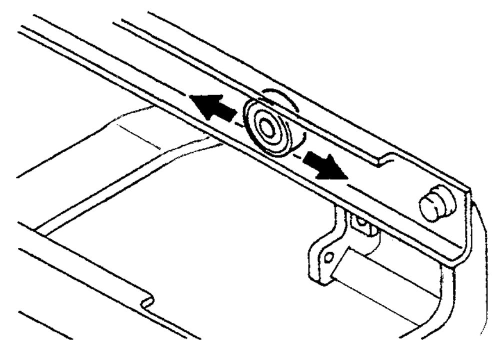
1. Mast

(1) Check each roller for wear, binding or other defects.

(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.



207090

2. Lift bracket

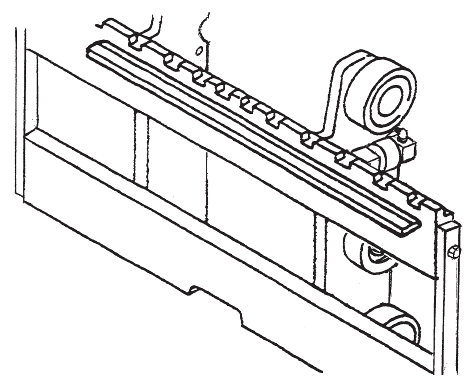
(1) Check the main rollers and side rollers for smooth rotation. Inspect each roller for wear and cracks.

(2) Check the welded portions of the bracket for cracks.

(3) Check the finger bar for bend or distortion.

A: Standard value

Distortion of finger bar	A	5 mm (0.2 in.) maximum



207091

3. Lift chains, chain wheels and chain wheel supports

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

(2) Check each chain anchor bolt for cracks or defects on thread.

(3) Check each chain wheel support and chain wheel for crack or wear. Check that the wheels rotate smoothly.

4. Mast strips

Check the mast strips for damage, wear or distortion.

Chain elongation

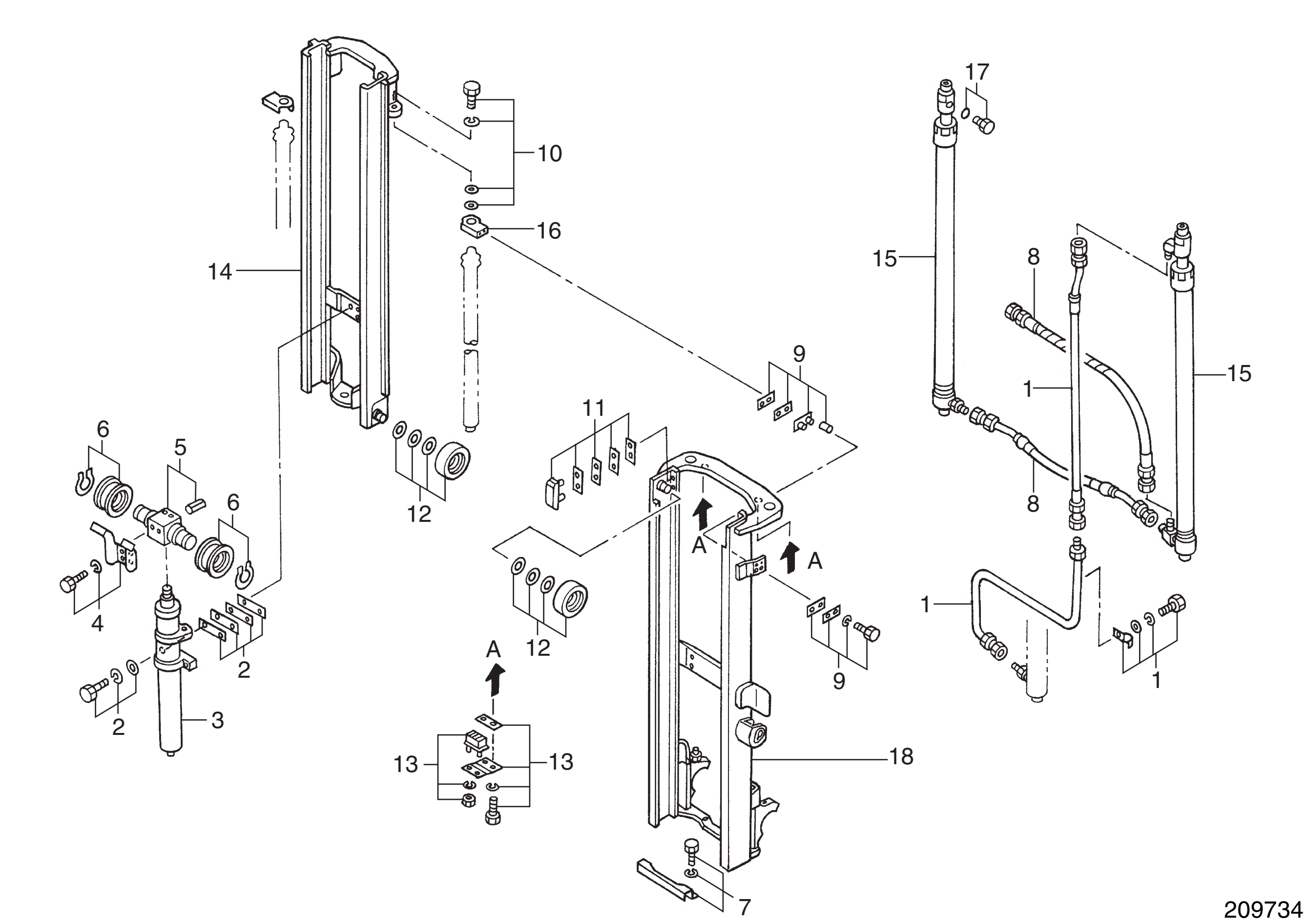
A: Standard value B: Repair or service limit

Unit : mm (in.)/20 links

Item \ Truck Model		1-ton class	2-ton class	3-ton class
Simplex mast	A	381 (15)	381 (15)	508 (20)
	B	392 (15.4)	392 (15.4)	523 (20.6)
Duplex mast/ Triplex mast	A	317.5 (12.5)	381 (15)	508 (20)
	B	327 (12.9)	392 (15.4)	523 (20.6)

Duplex Mast

Disassembly



Sequence

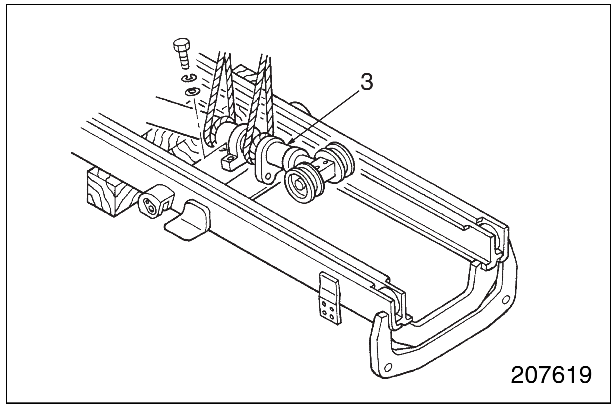
1 Lift hose (high pressure), Clamp
2 Shims, Bolts, Washers
3 First lift cylinder
4 Chain guard
5 Chain wheel support, Pin
6 Chain wheels, Snap rings
7 Hose guard, Bolt, Washer
8 High-pressure hose
9 Seats, Shims, Cushions, Collars
10 Bolts, Washers, Shims
11 Mast strips, Shims
12 Mast Rollers
13 Stopper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

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

Start by:

(a) With the lift bracket facing up, place the mast horizontally on wood blocks. Place a wood block as a wedge to prevent the inner and middle masts from sliding.

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



Suggestions for Disassembly

1. Removing first lift cylinder 4

(1) Remove retaining bolts 2 from the first lift cylinder

(2) Hitch slings on first lift cylinder, and gently remove the cylinder.

Use two slings. Wind or tie slings securely to prevent slipping.

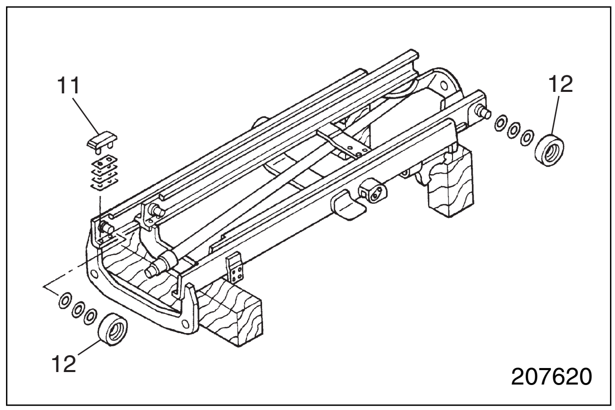
2. Removing main rollers 12 and mast strips 11

(1) Remove clamp bolts 9 from the second lift cylinders.

(2) Remove bolts 10 from the upper rod sections of the second lift cylinders, and place the cylinders on the outer mast.

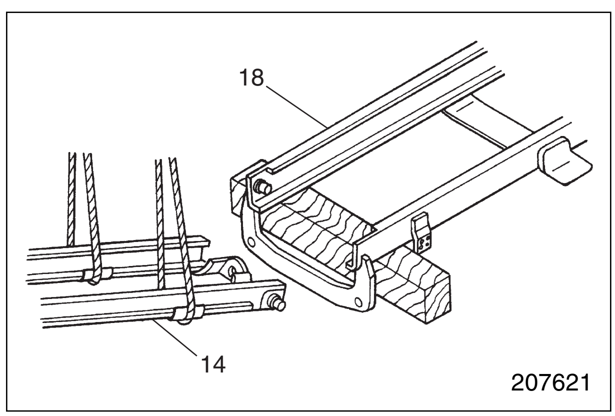
(3) Check the number of shims and the shim thickness at the rod end sections.

(4) Lower the inner mast, then remove main rollers 12 and mast strips 11.



3. Removing inner mast 14

Using slings, lift and remove inner mast 14, steering it clear of the roller shaft sections of outer mast 18.

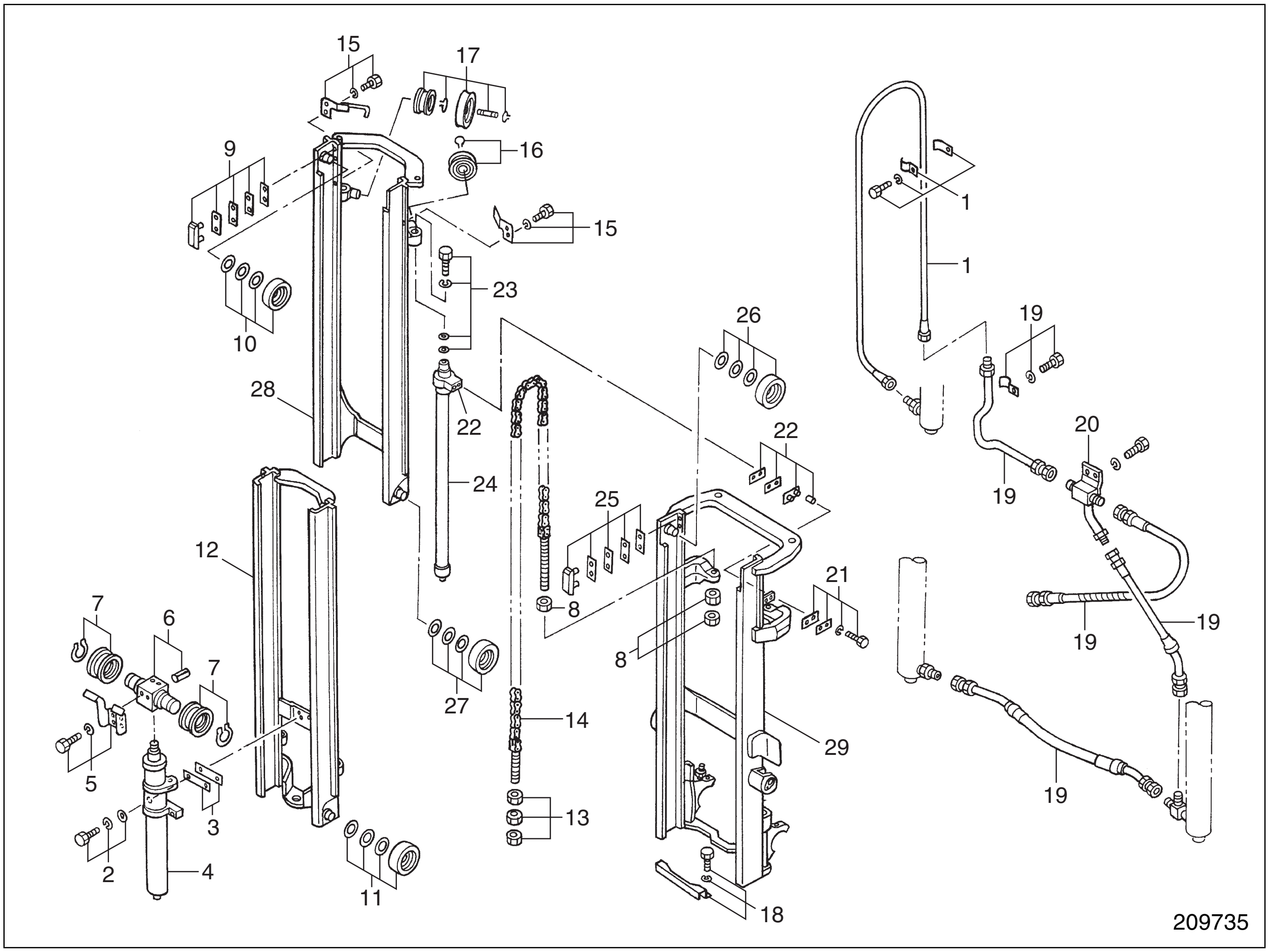


Inspection after disassembly

Follow the same inspection procedure as for the simplex mast.

Triplex Mast

Disassembly



Sequence

1 Hose for first lift cylinder, Clamp, Bolt, Washer
2 Bolts, Washers
3 Shims
4 First lift cylinder
5 Chain guard
6 Chain wheel support, Pin
7 Snap rings, Chain wheels
8 Nuts (chain for second lift cylinder)
9 Mast strips, Shims
10 Main rollers, Shims
11 Main rollers, Shims
12 Inner mast
13 Nuts
14 Lift chains (for second lift cylinders)
15 Chain guards, Bolts, Washers
16 Snap rings, Chain wheels
17 Snap rings, Hose pulleys, Shafts, Snap rings, Chain wheels
18 Hose guard, Bolt, Washer
19 Hose, Clamp, Bolt, Washer
20 Joint, Connector, Bolt, Washer
21 Bolts, Seats, Cushions, Collars
22 Cushions, Shims, Bracket
23 Bolts, Washers, Shims
24 Second lift cylinders
25 Mast strips, Shims
26 Main rollers, Shims
27 Main rollers, Shims
28 Middle mast
29 Outer mast, Grease nipples

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

Start by:

(a) With the lift bracket facing up, place the mast horizontally on wood blocks. Place a wood block as a wedge to prevent the inner and middle masts from sliding.

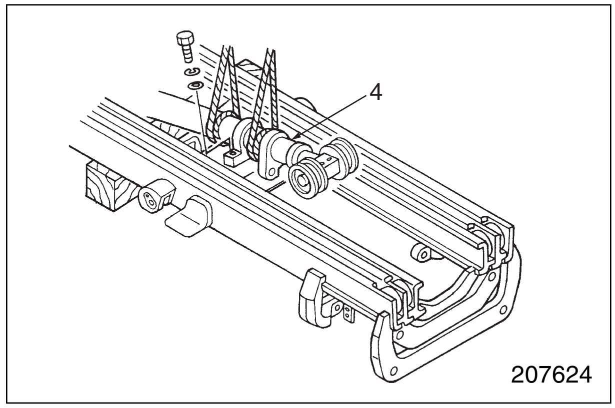
(b) Before disassembling the mast and fork assembly, measure and record all clearances between each lift bracket and roller and between each mast and roller. Recorded measurements will be helpful when replacing rollers or selecting shims to adjust clearances.

Suggestions for Disassembly

1. Removing first lift cylinder 4

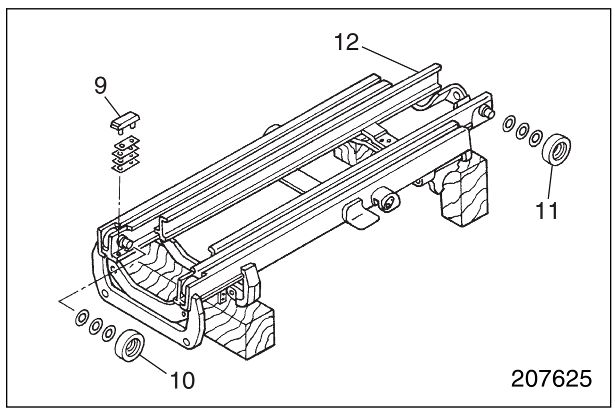
(1) Remove retaining bolts from the first lift cylinder.

(2) Hitch slings on the cylinder, and gently remove the cylinder.
Use two slings. Wind or tie slings securely to prevent slipping.



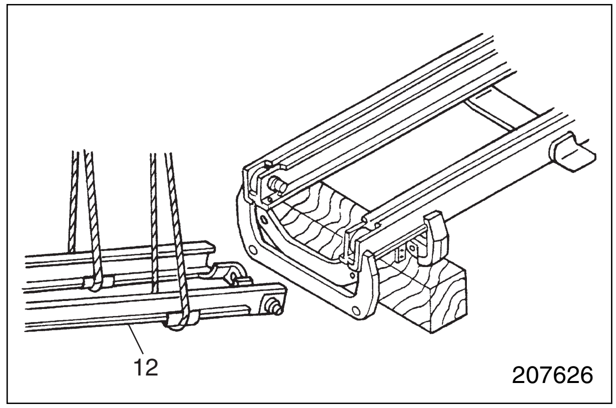
2. Removing inner mast 12 and main rollers 10, 11

Lower inner mast 12 until the main rollers 10, 11 can be removed. Remove the rollers and mast strips 9.



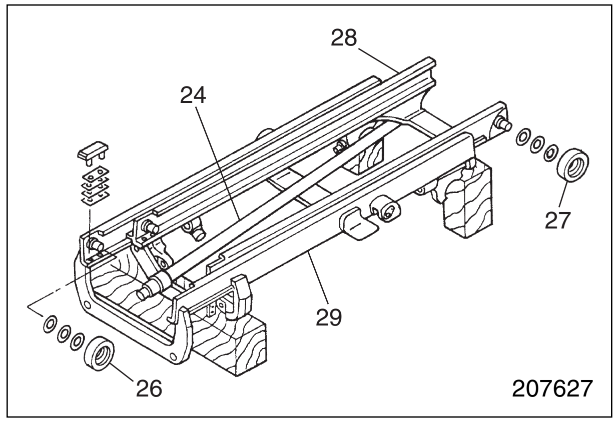
3. Removing inner mast 12

Using slings, lift and remove the inner mast 12, steering it clear of the roller shaft sections of the middle mast.



4. Removing main rollers 26, 27 from middle mast 28 and outer mast 29

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



Inspection after disassembly

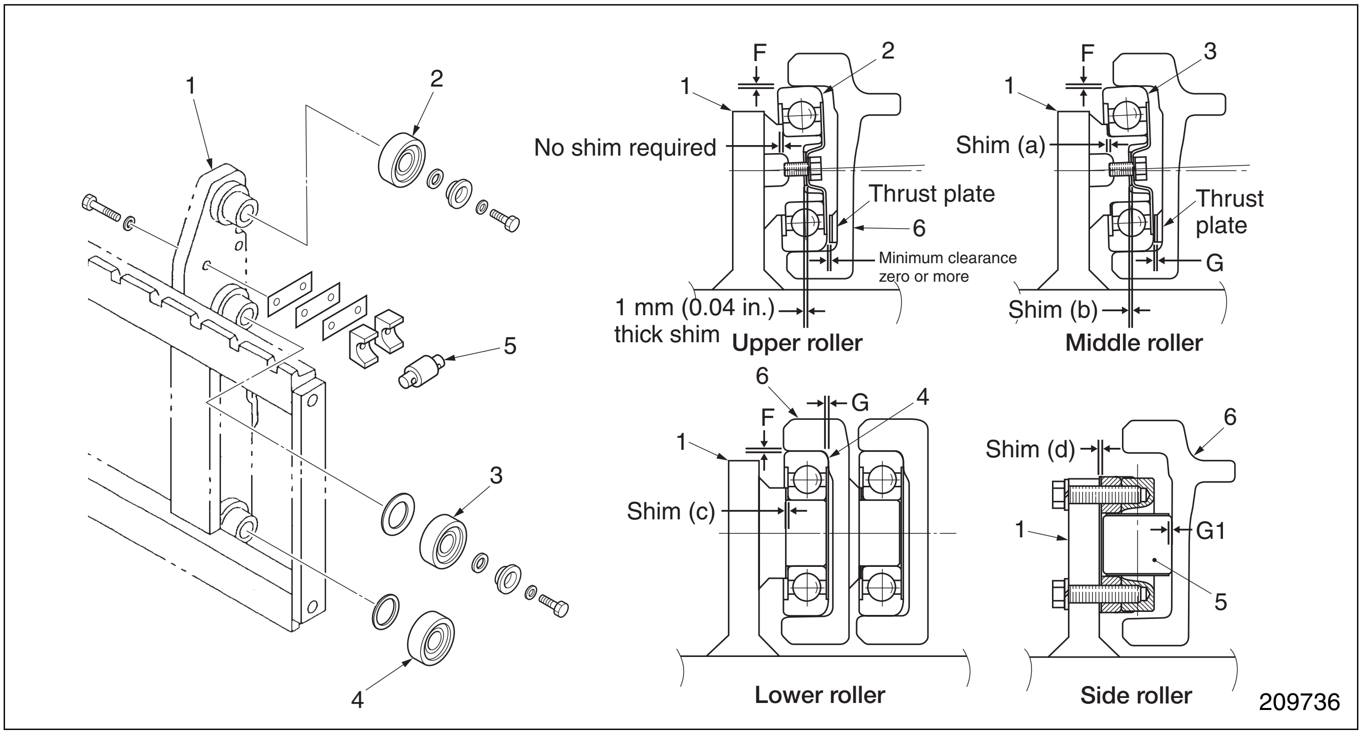
Follow the same inspection procedure as for the simplex mast. Refer to page 12-13.

Reassembly

Follow the disassembly sequence in reverse. Be careful with the following .

Suggestions for Reassembly

1. Installing lift bracket rollers (all mast models)



Sequence

1 Lift bracket	3 Lift bracket middle rollers	5 Side rollers
2 Lift bracket upper rollers	4 Lift bracket lower rollers	6 Inner mast

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

- Clearance G

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

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

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

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

- Clearance F

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

Clearance F	1.0 mm (0.04 in.) or less

- Clearance G1

Clearance between side roller circumference and inner mast side roller thrust surface:
Move side roller to the upper end of the inner mast and press the lift bracket to either the leftmost or rightmost position.
Take measurement of clearance G1 between the roller circumference and inner mast.
Adjust the clearance with shims to the specification.

Clearance G1	0.1 to 0.5 mm (0.004 to 0.020 in.)

(1) Choosing correct roller diameters

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

Note: For measuring procedures, refer to "Inspection and Adjustment."

- The rollers installed should rotate smoothly.

Unit : mm (in.)

Size (Diameter) \ Truck Model	1 ton class	2, 3 ton classes
S	99 (3.9)	113.8 (4.5)
M	100 (3.9)	115 (4.5)
L	101 (4)	116 (4.6)
LL	102 (4)	117 (4.6)

(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 "Inspection and Adjustment."

- Adjustment

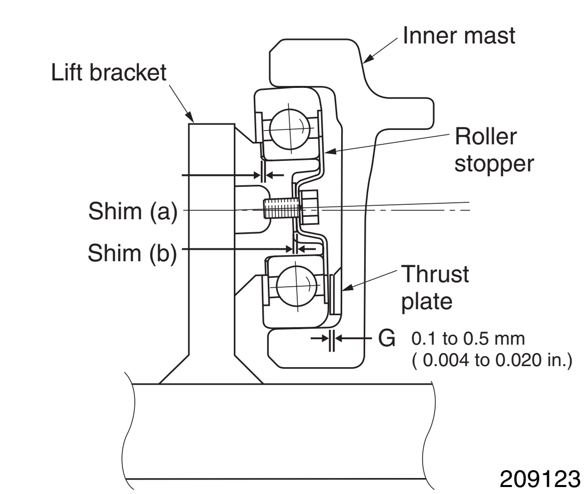
If clearance G is excessive, increase the thickness of shims (a) as required. Increase the thickness of shims (b) by the same amount that are added to shims (a).

Shim (a) is available in two sizes: 1 mm (0.04 in.) and 0.5 mm (0.020 in.). Shim (b) is available in only one size, 1 mm (0.04 in.).

If shims (a) are increased by 0.5 mm (0.020 in.), shims (b) do not need to be increased by the equal amount.

Remarks: At the assembly plant, shims (a) are usually adjusted to 1 mm (0.04 in.) and shims (b) to 2.0 mm (0.08 in.) for the shipment.

Lift bracket middle roller



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

- Measure clearance G between the lower rollers and inner mast. If the measured clearance does not conform to the standard value, adjust clearance G in the manner described below.

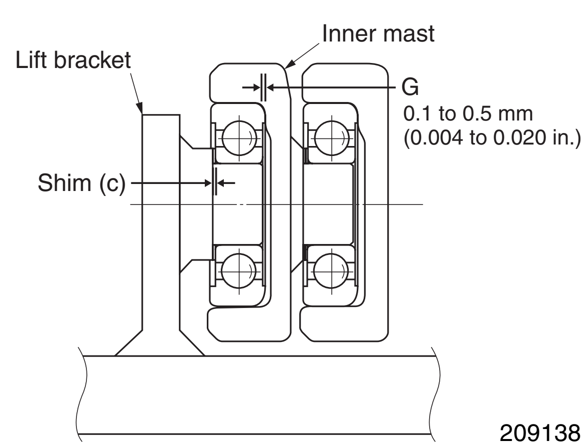
Note: For measuring procedures, refer to "Inspection and Adjustment."

- Adjustment

If clearance G is excessive, increase the thickness of shims (c) as required.

Remarks: At the assembly plant, shims (c) are usually adjusted to 1 mm (0.04 in.) for the shipment.

Lift bracket lower roller

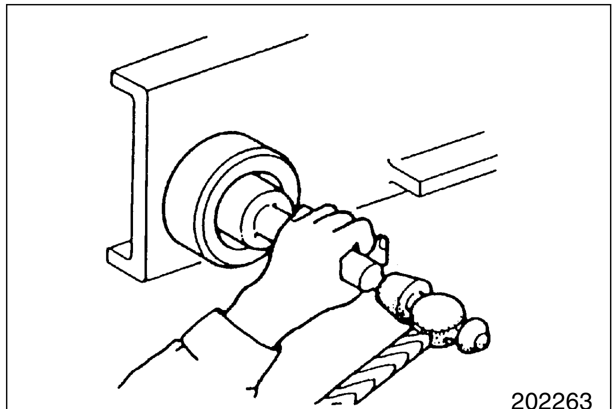


(4) Installing main rollers

To install main rollers on shafts, use a driving tool. Be carful not to strike the outer roller surface with the driving tool.

The side of the roller with larger chamfering must face toward the outside.

Make sure the rollers rotate smoothly when installed.



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

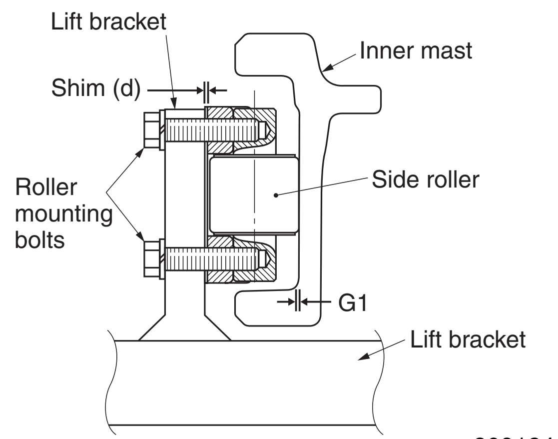
Measure clearance G1 between the side roller's rolling contact surface and inner mast. If the measured clearance does not conform to the standard value, adjust clearance G1 in the manner described below.

Note: For measuring procedures, refer to "Inspection and Adjustment."

- Adjustment

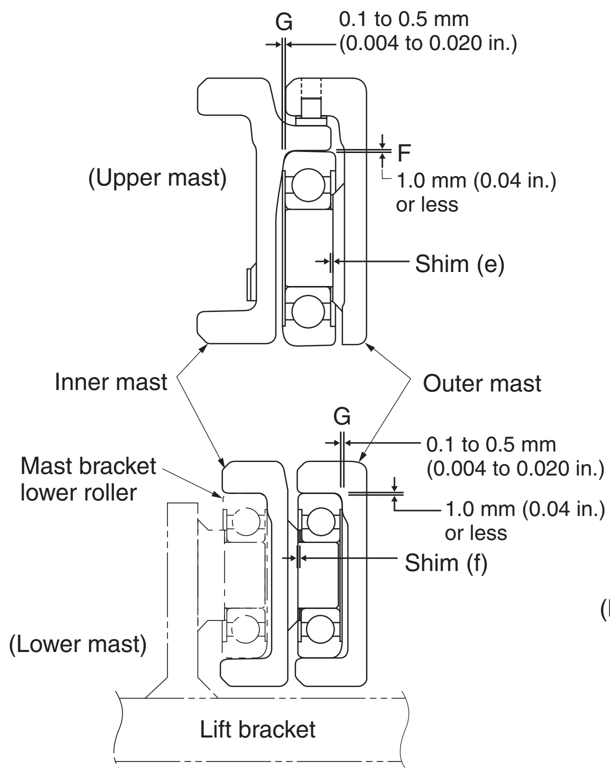
If clearance G1 is excessive, increase the thickness of shims (d) as required.

Remarks: At the assembly plant, shims (d) are usually adjusted to 1 mm (0.04 in.) for the shipment.



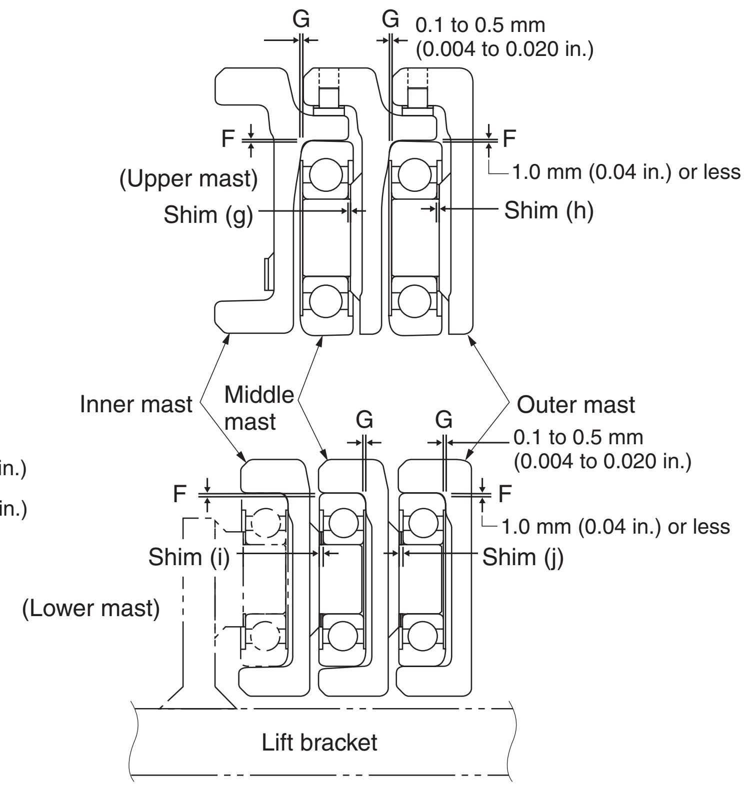
209124

2. Installing mast rollers (all mast models)



Mast Roller for Simplex Mast and Duplex Mast

209375



Mast Roller for Triplex Mast

209376

Mast rollers are identical in shape and size with lift bracket lower rollers.

Therefore:

- Clearance F should be 1.0 mm (0.04 in.) or less.
- Clearance G should be 0.1 to 0.5 mm (0.004 to 0.020 in.).

(1) Measure clearance F between the rollers' rolling contact surfaces and masts. If the measured clearances do not conform to the standard value, replace with rollers of correct diameters listed in the table below.

Note: For measuring procedures, refer to "Inspection and Adjustment."

Unit : mm (in.)

Size (Diameter) \ Truck Model	1 ton class	2, 3 ton classes
S	99 (3.9)	113.8 (4.48)
M	100 (3.93)	115 (4.52)
L	101 (3.97)	116 (4.57)
LL	102 (4.0)	117 (4.60)

- Installation of mast rollers follows the same procedures for the lift-bracket rollers.

(2) Measure clearance G between the rollers and masts. If the measured clearances exceed the standard value, increase the thicknesses of shims (e) - (j) under the roller seats as required.

Remarks: At the assembly plant, shims (e) - (j) are usually adjusted to the values shown in the table below for the shipment.

Unit : mm (in.)

Item \ Truck Model	1 ton class	2, 3 ton classes
Shim (e)	2 (0.079)	1 (0.039)
Shim (f)	2 (0.079)	1 (0.039)
Shim (g)	1 (0.039)	1 (0.039)
Shim (h)	2 (0.079)	1 (0.039)
Shim (i)	2 (0.079)	1 (0.039)
Shim (j)	2 (0.079)	1 (0.039)

3. Installing mast strip (all mast models)

(1) Measuring and adjusting clearance G2 between mast strip and inner mast (all mast models)

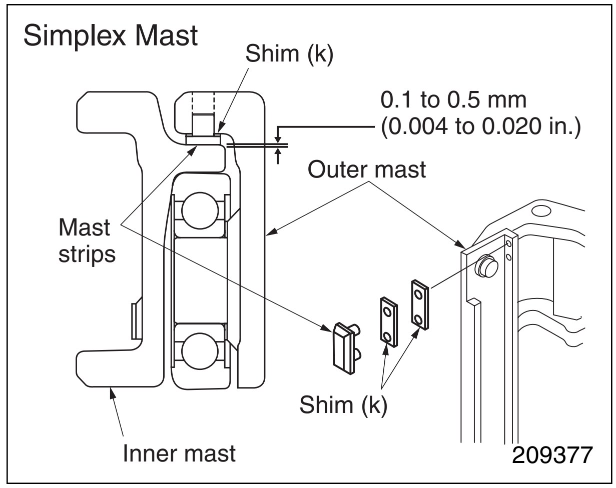
- Measurement

Make a clearance between the mast strip and inner mast. Insert a thickness gage to measure the clearance G2.

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

- Adjustment

If clearance G2 is excessive, add a proper amount of shims under the mast strip. Check the smooth movement by moving slowly up and down the bracket. Usually, a 1.0 mm (0.04 in.) thick shim is used in a new truck.

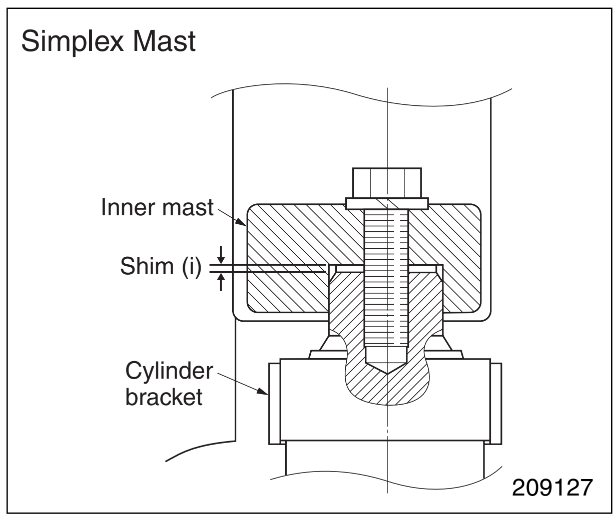


4. Installing second lift cylinders (all mast models)

Note: Second lift cylinders have basically the same structure across all mast models, except that some details are different illustration.

(1) Install the cylinder brackets to the lift cylinders as shown in the right illustration.
(2) Place the lift cylinders complete with the brackets between the outer and inner masts.
(3) Install the lift cylinder rods to the inner mast as shown in the illustration. If shims (I) are used, be sure to reinstall them. Usually shims (I) are not used.
(4) With the cylinder rods fully retracted and the cylinders set vertically, measure clearance H. Adjust the clearance at 1.6 mm (0.063 in.) or less by adding or removing shims (m).

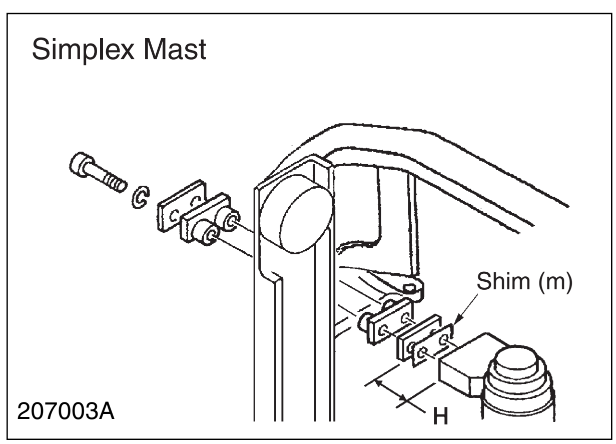
Clearance H	1.6 mm (0.063 in.) or less



- Adjustment

If clearance H is excessive, add shims (m). Normally on a new truck, the second lift cylinders are not fitted with shims (m). If the clearance is 3.2 mm (0.126 in.) or more, make sure to include a 3.2 mm (0.126 in.) thick sheet in the shim pack that is to be installed.

(5) After reassembly, perform an operation test to check if the stroke of the left and right cylinders is the same. For the checking procedure, refer to page 12-39.



5. Installing first lift cylinders

(1) With the masts set vertically and lowered fully, temporarily install the first lift cylinders complete with the original shims to the inner mast.

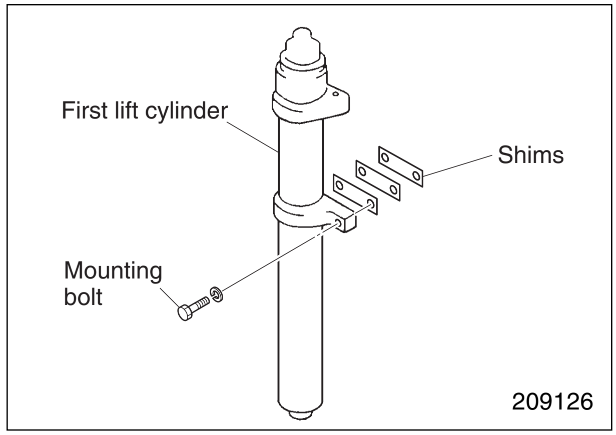
(2) Set the first lift cylinders vertically, and measure the clearance, if any, between the cylinder brackets and the cylinder mounts on the inner mast. Remove any clearance by adding shims.

- The perpendicularity of each cylinder in the lateral direction can be checked by measuring the parallelism between the cylinder and the side face of the inner mast. Error of the parallelism should be ± 1 mm (± 0.04 in.).
- The perpendicularity of each cylinder in the longitudinal direction can be checked by visually inspecting for the parallelism between the cylinder and the front face of the inner mast. The cylinder slightly inclined to the rear is acceptable. The cylinder should not be inclined forward even slightly.
- Each shim is 1 mm (0.04 in.) thick.

Remarks: At the assembly plant, a shim pack of 2.0 mm (0.08 in.) is usually inserted between the cylinder bracket and the inner mast for the shipment.

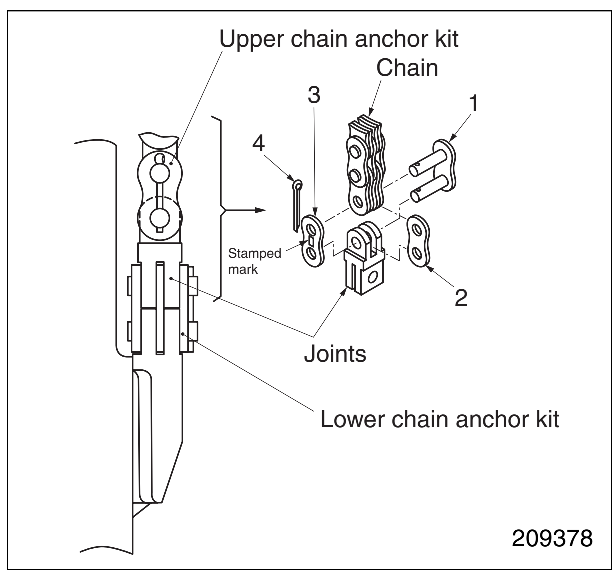
(3) After shimming is completed, install and tighten the mounting bolts.

Note: Depending on the truck model, the direction in which the mounting bolts are inserted may be different from what is shown in the illustration.



6. Connecting chain (Simplex mast, 1 ton class)

The lift chain is connected to the lift bracket by assembling the upper chain anchor kit as shown in the right illustration. Make sure that link plate 3 with a stamped mark is installed on the outside of the chain.



1 Link
2 Center plate (without stamped mark)
3 Link plate (with stamped mark)
4 Sprit pin

7. Installing hydraulic lines

General precautions

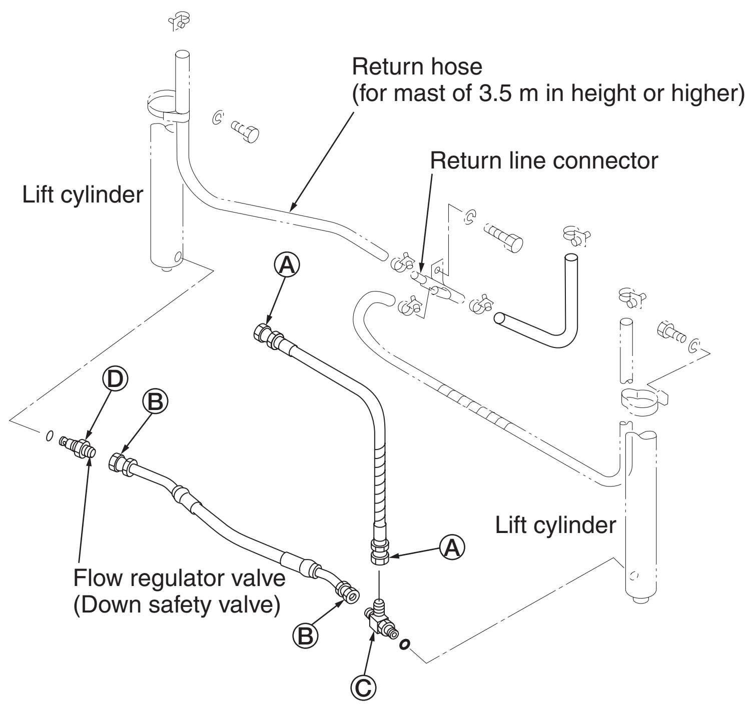
- Use care not to let abrasive dust or dirt to enter the hydraulic system.
- Apply a film of oil to O-rings before installation.
- For assembling Elbow Connector (a fitting with straight threads and O-ring seal) indicated by Ⓒ, follow the procedure "Installation of a fitting with straight threads and O-Ring seal" shown below.

(1) Simplex Mast

Tightening torques

Unit : N·m (kgf·m) [lbf·ft]

Item \ Truck Model	1, 2 ton classes	3 ton class
Nut Ⓐ	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut Ⓑ	49 ± 4.9 (5.0 ± 0.5) [36.2 ± 3.6]	49 ± 4.9 (5.0 ± 0.5) [36.2 ± 3.6]
Nut Ⓒ	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut Ⓓ	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]



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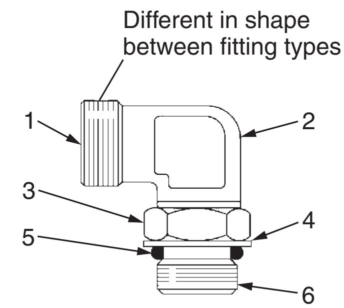
Installation of a fitting with straight threads and O-ring seal

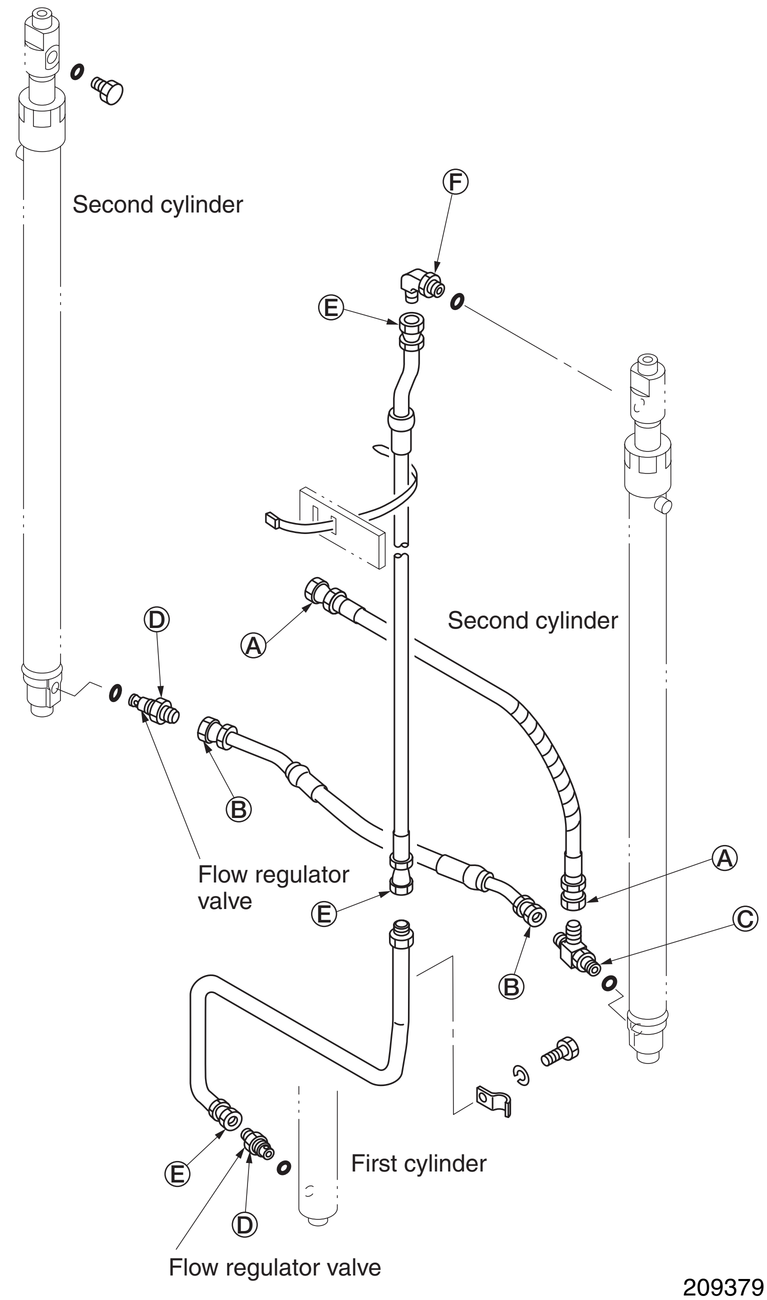
1. Apply grease or hydraulic oil to O-ring and O-ring seat in the housing side.
2. Turn lock nut 3 to move it as close to fitting body 2 as possible. Place washer 4 and O-ring seal 5 against the lock nut.
3. Tighten the fitting by hand. Once O-ring 5 is placed in the position of housing and washer 4 comes in contact with the surface of housing, turn it back to adjust the mounting direction. Never loose more than 1 turn.
4. Tighten lock nut 3 to the specified torque.



Elbow body assembly

1 End of fitting body (connects to tube)
2 Fitting body
3 Locknut
4 Backup washer
5 O-ring seal
6 End of fitting that goes into other part

(2) Duplex Mast



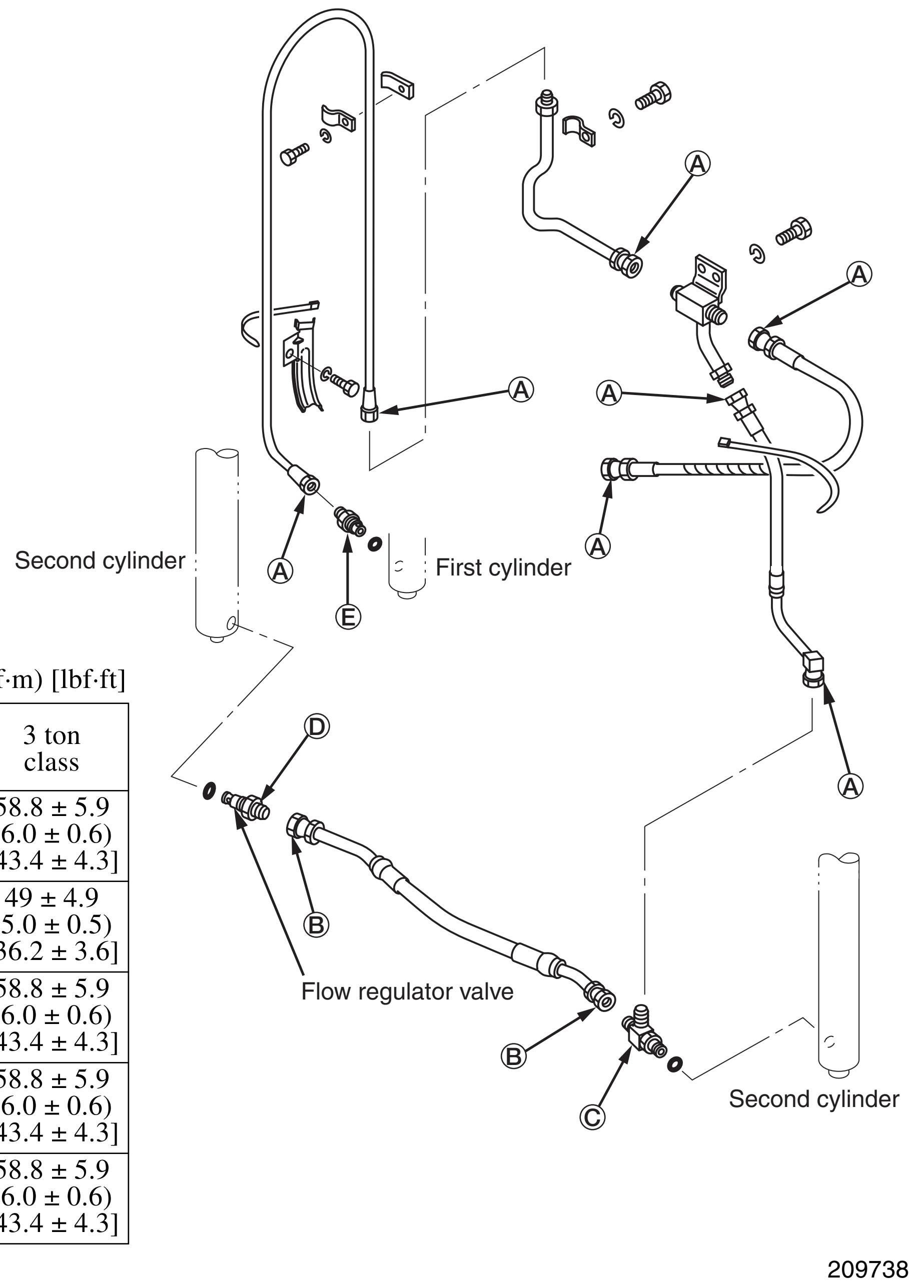
Tightening torques

Unit : N·m (kgf·m) [lbf·ft]

Item \ Truck Model	1, 2 ton classes	3 ton class
Nut A	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut B	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	49.9 ± 4.9 (5.1 ± 0.5) [36.9 ± 3.6]
Nut C	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut D	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut E	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut F	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]

Note: When installing fittings C and E → F, follow the procedure under "Installation of a fitting with straight threads and O-ring seal" on page 12-25.

(3) Triplex Mast



Tightening torques

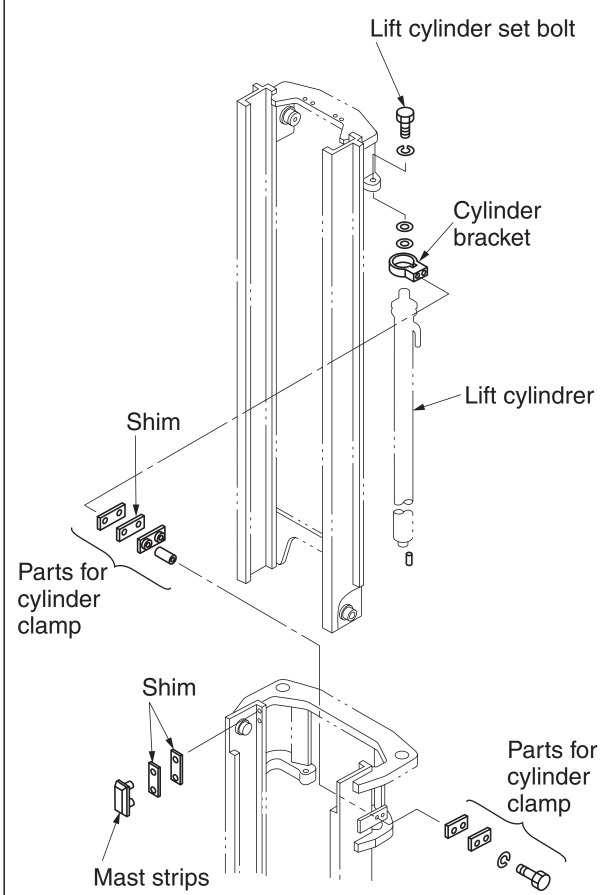
Unit : N·m (kgf·m) [lbf·ft]

Item \ Truck Model	1, 2 ton classes	3 ton class
Nut A	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut B	49 ± 4.9 (5.0 ± 0.5) [36.2 ± 3.6]	49 ± 4.9 (5.0 ± 0.5) [36.2 ± 3.6]
Nut C	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut D	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut E	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]

Note: When installing fittings C, follow the procedure under "Installation of a fitting with straight threads and O-ring seal" on page 12-25.

Removal and Installation of Mast Rollers and Strips without Removing Mast from Truck

1. Simplex Mast

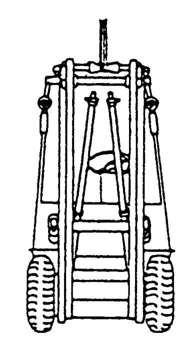


209381

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

(1) Disconnect the lift bracket assembly.
(2) Lift the front of the truck by 15 to 20 cm (5.9 to 7.9 in.), and place blocks to support the truck.
(3) Remove the set bolts at the top of the lift cylinders. Place a sling around the inner mast. Lift the inner mast using a hoist connected to the sling in order to disengage the lift cylinders' piston rods from the inner mast. Remove the hose guard.
(4) Remove the lift cylinder clamp bolts, and separate the lift cylinders from the outer mast. Pull out the lift cylinders from the seats at the bottom of the outer mast. Tilt the cylinders until they rest on the outer mast cross member. Using a rope, fix the cylinders onto the cross member.
(5) Using the hoist, slowly lower the inner mast until the mast contacts the lift cylinders.
(6) The main rollers of the inner and outer masts can now be removed. It is recommended that before attempting to remove the main rollers, remove the mast strips and shims as they tend to drop easily.
(7) Adjust shims for the main rollers and mast strips as required.

- Reassembly follows the above-described disassembly procedures in reverse.


202961

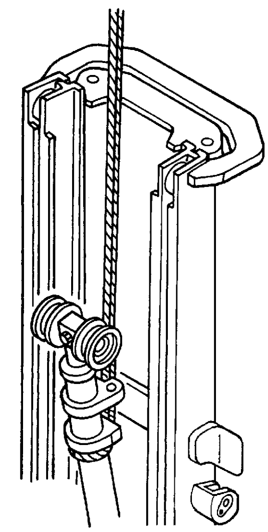
2. Duplex Mast

(1) Disconnect the lift bracket assembly.

(2) Remove the first lift cylinders as follows:

(a) For each of the cylinders: Place a sling around the cylinder. Using a hoist connected to the sling, slightly lift the cylinder. The sling should be hitched firmly around the cylinder to prevent the cylinder from slipping down.

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



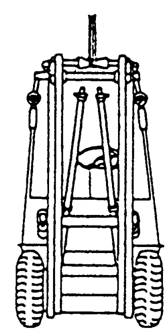
209132

Note: The remaining procedures are exactly the same as those for the simplex mast models.

(3) Place the inner mast lower than the outer mast as follows:

(a) Lift the front of the truck by 15 to 20 cm (5.9 to 7.9 in.), and place blocks to support the truck.

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



202961

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

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

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

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

- Reassembly follows the above-described disassembly procedures in reverse.

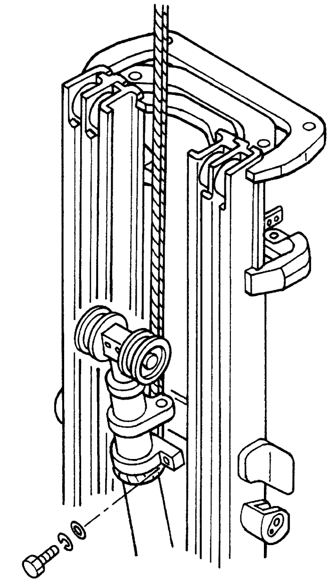
3. Triplex Mast

(1) Disconnect the lift bracket assembly.

(2) Remove the first lift cylinders as follows:

(a) For each of the cylinders: Place a sling around the cylinder. Using a hoist connected to the sling, slightly lift the cylinder. The sling should be hitched firmly around the cylinder to prevent the cylinder from slipping down.

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


207616

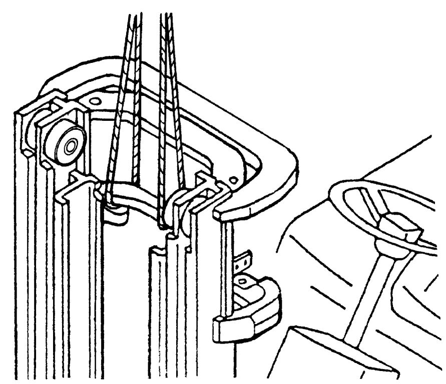
(3) Place the inner mast lower than the middle mast as follows:

(a) Lift the front of the truck by 15 to 20 cm (5.9 to 7.9 in.), and place blocks to support the truck.

(b) Place a sling around the upper cross member of the inner mast. Using a hoist connected to the sling, slightly lift the inner mast.

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

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


207639

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

(f) Support the inner mast with wood blocks.

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

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

⚠ CAUTION

With the mast disassembled as above, it is not possible to remove the second lift cylinders.

(4) Place the middle mast lower than the outer mast as follows:

(a) Lift the inner mast to the height of the middle mast, then place wood blocks for support.

(b) Hitch slings to both middle mast and inner mast, and lift them with a hoist.

(c) Remove set bolts from the upper sections of the second lift cylinders, then lift the middle mast and inner mast to separate the second lift cylinder from the middle mast.

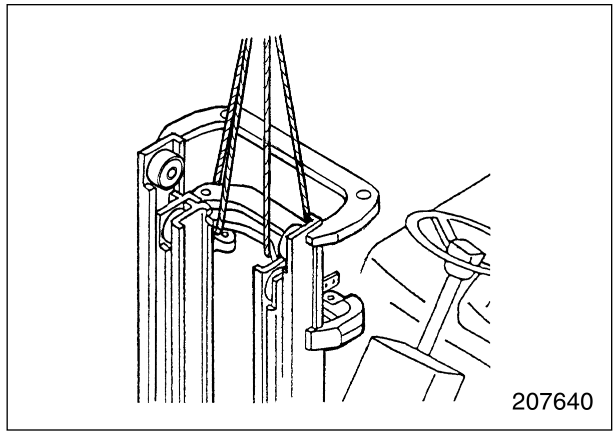
(d) Remove two lift cylinder clamps, dismount the second lift cylinders from the mounting sections at the lower outer mast section. Tilt the cylinders by moving the top sections towards the center of the truck. Using a rope, fix the cylinders onto the cross member.

(e) Lower the middle mast and inner mast until mast rollers (outer mast upper roller and middle mast lower roller) can be removed.

(f) Support the middle mast and inner mast with wood blocks.

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

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



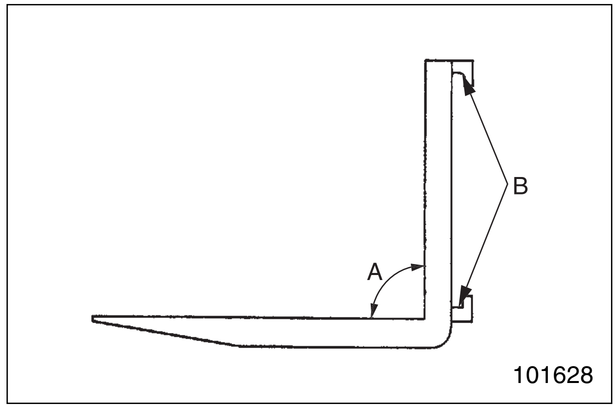
- For reassembling, follow the disassembly sequence in reverse.

Inspection and Adjustment

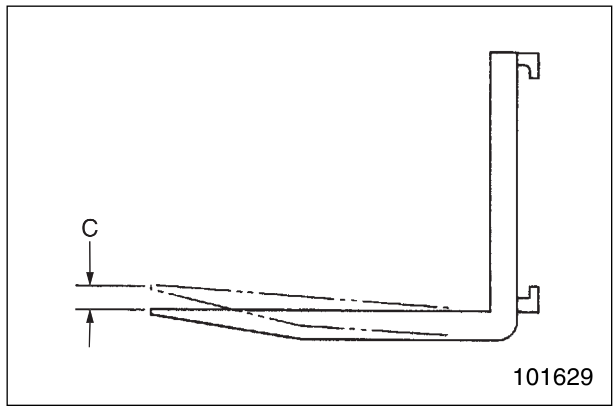
The inspection and adjustment in this chapter can be done without dismounting or disassembling. Conduct inspection whenever a defect is suspected.

1. Forks (all mast models)

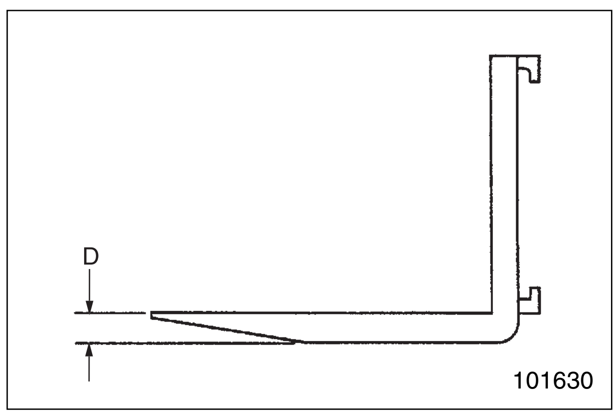
(1) Carefully inspect the forks for cracks. Special attention should be given to the heel section A, all weld areas and mounting brackets B.
Forks with cracks shall be removed from service.
Magnetic particle inspection is generally preferred due to its sensitivity and the ease of interpreting the results.
For correct inspection, remove the painting from the inspecting portion.



(2) Check the difference in height of one fork tip to the other when mounted on the fork carrier. A difference in fork tip height can result in uneven support of the load and cause problems when loaded.
The maximum allowable difference in fork tip elevation C is 5 mm (0.20 in.) for pallet forks.
Replace one or both forks when the difference in fork tip height exceeds the maximum allowable difference.



(3) Check the fork blade D. The fork should be withdrawn from service if the thickness is reduced to less than the allowable thickness.



A: Standard value B: Repair or service limit

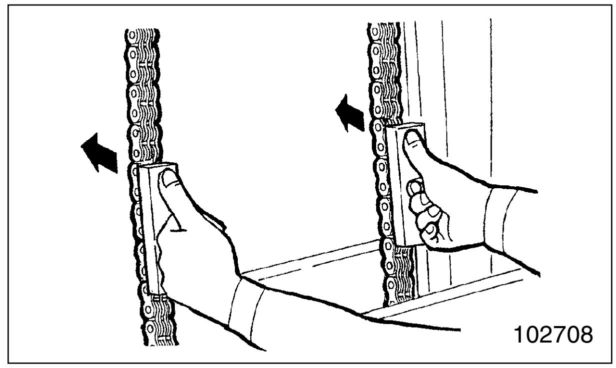
Unit : mm (in.)

Truck Model / Item		GP15N DP15N	GP18N DP18N	GP20N GP20CN DP20N, 20CN	GP25N DP25N	GP30N, 35N DP30N, 35N
Fork thickness	A	34 (1.34) $^{+3\,(0.11)}_{0}$	35 (1.38) $^{+3\,(0.11)}_{0}$	37 (1.46) $^{+3\,(0.11)}_{0}$	42 (1.65) $^{+3\,(0.11)}_{0}$	50 (1.97) $^{+3\,(0.11)}_{0}$
	B	31 (1.22)	32 (1.26)	35 (1.38)	40 (1.57)	45 (1.77)

2. Chain Tension Inspection and Adjustment (Simplex Mast)

⚠WARNING

Turn the engine/main key to the ○ (OFF) position before making the inspection or adjustment of lift chains, anchor bolts and nuts. Place blocks below the forks when they are lifted.



Inspection of chain tension

(1) Place the mast vertical on a level ground, then lower the forks to the ground. Make sure that the lift cylinders are fully retracted.

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

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

(4) Place blocks approx. 90 mm (3.5 in.) high below the forks.

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

Adjustment of right and left chain balance

(1) Remove the blocks below the forks. Start the engine.

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

(3) Stop the engine.

(4) Loosen double nut (lower) ①, then upper nut ②.

(5) Turn double nut (upper) ③ to adjust the chain tension.

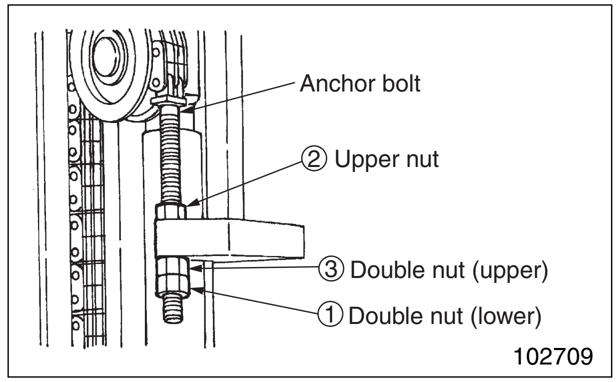
(6) Start the engine, and place the mast vertical again.

(7) Repeat (2) through (5) of procedure 1, to check the chain tension and adjust it as needed.

Tightening of nuts after adjustment

(1) Hold the anchor bolt at two flats with a wrench so as not to twist the chain, the tighten the upper nut ② to the specified torque.

(2) Hold the double nut (upper) ③ with a wrench and tighten double nut (lower) ① to the specified torque.

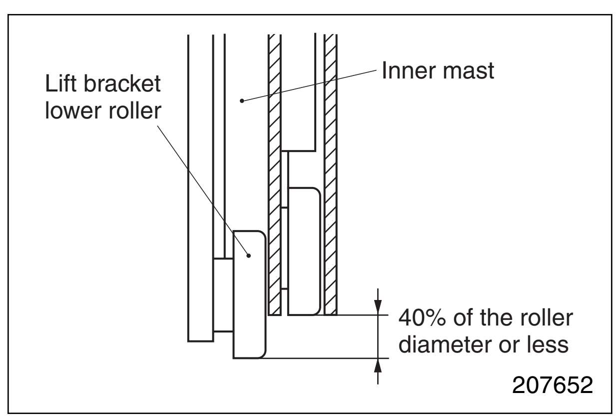


Tightening torque Unit : N·m (kgf·m) [lbf·ft]

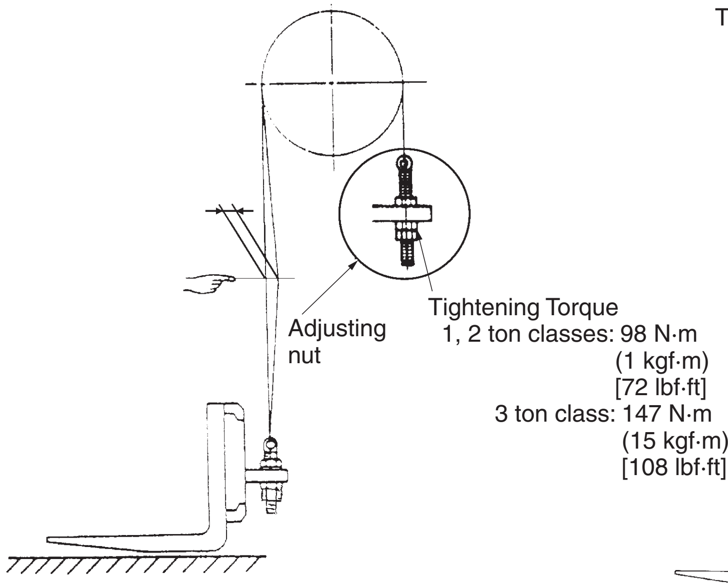
Item \ Truck Model	1, 2 ton classes	3 ton class
Nuts ①, ③	$98\ (3.86)^{+49\ (1.93)}_{0}$	$147\ (5.79)^{+49\ (1.93)}_{0}$

⚠ CAUTION

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



Duplex and Triplex Models



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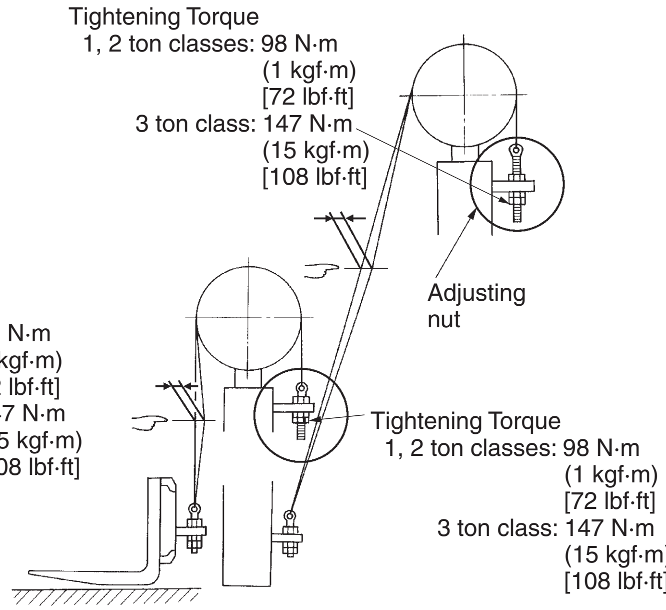

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Note: The inspection and adjustment procedures are completely the same as those for simplex mast models. Follow the procedures in the previous page to perform inspection or adjustment as necessary.

3. Checking Chain Elongation (all mast models)

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

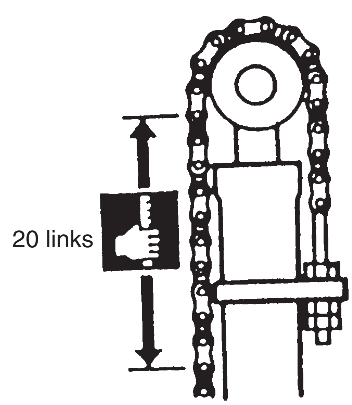
(2) Measure the length of 20 links of chain. When the length exceeds the service limit specified in the table below, replace the chain with new one.

Chain elongation

A: Standard value (New) B: Service limit

Unit : mm (in.)/20 links

Item \ Truck Model		1 ton class	2 ton class	3 ton class
Simplex mast	A	381 (15)	381 (15)	508 (20)
	B	392 (15.4)	392 (15.4)	523 (20.6)
Duplex mast/ Triplex mast	A	317.5 (12.5)	381 (15)	508 (20)
	B	327 (12.9)	392 (15.4)	523 (20.6)



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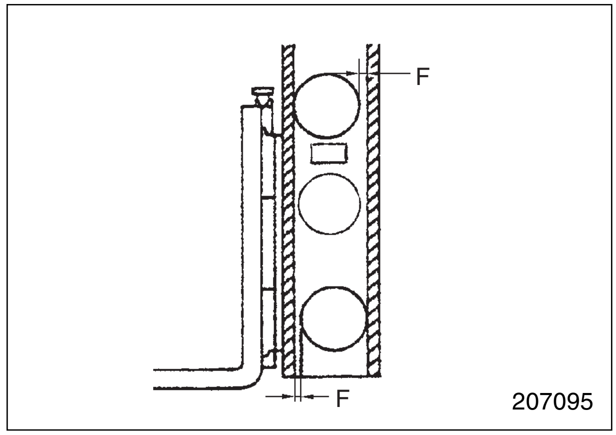
4. Adjusting Clearance between Lift Bracket Roller and Inner Mast (all mast models)

(1) Back-to-front clearance check on lift bracket main rollers

(a) Raise the forks a little from the ground.

(b) Insert a bar between the upper part of lift bracket and the inner mast, and push the inner mast to one side. Using feeler gauges, measure the clearance F between the main roller and inner mast on the opposite side.



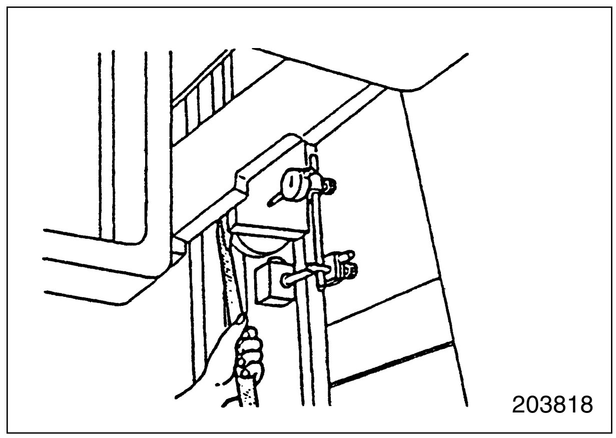
Clearance F	1.0 mm (0.04 in.) or less

(c) If clearance F is out of specification, use oversize rollers. Remove lift bracket from mast and replace rollers with proper sized rollers. For roller replacement procedure, refer to “Choosing rollers of correct diameters” on pages 12-20.

(2) Right-to-left clearance check on lift bracket main rollers and side rollers

(a) Raise the mast to the top.

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

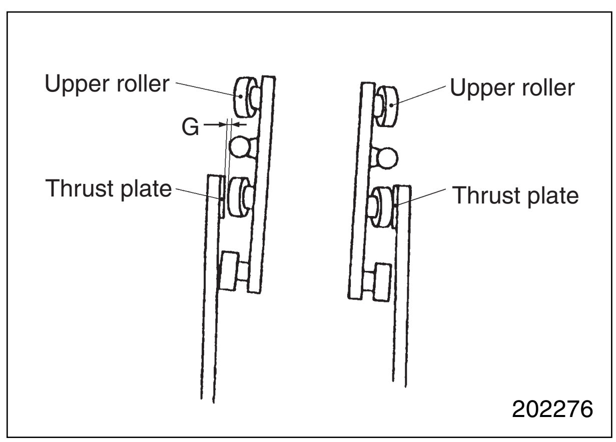


(c) Go over to the opposite side of the mast, and push the lift bracket to one side with a bar. Set the indicator to zero.

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

(e) Read the indicator. This reading is the clearance G between middle roller and thrust plate. If clearance G is out of specification, it is necessary to add shims to the seat of the roller to adjust to correct clearance.

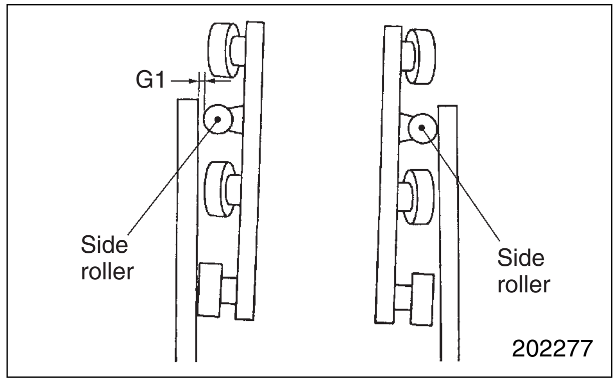
Note: Upper rollers are free from checking and adjusting.



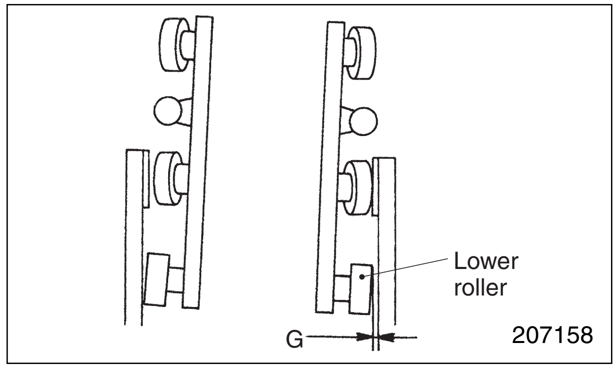
Clearance G	0.1 to 0.5 mm (0.004 to 0.020 in.)

For adjustment, refer to “Adjusting clearance G between the middle roller and thrust plate” on page 12-20.

(f) Lower the lift bracket slightly from the top, so that the side roller comes in contact with the inner mast, then check clearance G1 between the side roller. If clearance G1 is out of specification, it is necessary to add shims to the seat of the roller bracket to adjust to correct clearance. Remove lift bracket from mast and adjust the shim thickness. For adjustment and installation procedures, refer to "Adjusting clearance G1 between the side roller and inner mast" on page 12-21.



(g) With the lift bracket at the top, check clearance G between lower roller and mast. If clearance G is out of specification, it is necessary to add shims to the seat of the roller to adjust to correct clearance. Remove lift bracket from mast and adjust the shim thickness for the rollers. For adjustment and installation procedures, refer to "Adjusting clearance G between lower rollers and inner mast" on page 12-20.



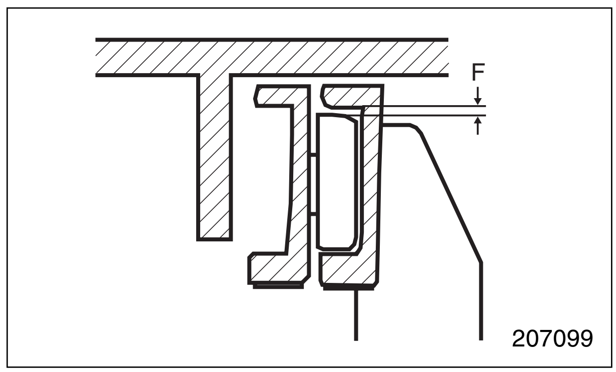
5. Mast Roller Clearance Adjustment (all mast models)

(1) Back-to-front clearance inspection on mast main rollers

(a) Tilt the mast fully backward.

(b) Using feeler gauges, measure the clearance F between the inner mast lower roller and outer mast.

Clearance F	1.0 mm (0.04 in.) or less



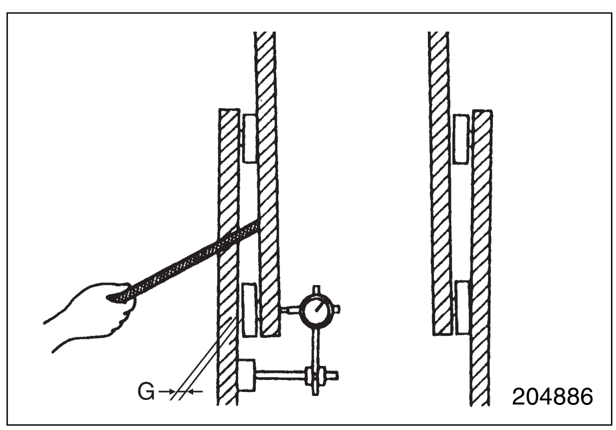
(c) If the clearance F is out of the specification, use oversize rollers. For mast roller replacement and installation procedures, refer to "Installing mast rollers" on page 12-22.

(2) Right-to-left clearance inspection on inner mast main rollers

(a) Raise the mast to the top.

(b) Set a dial indicator on the inside of the outer mast with its contact point rested on the inner mast.

(c) Go over to the opposite side of the mast, and push the inner mast against the outer mast. Set the indicator to zero.

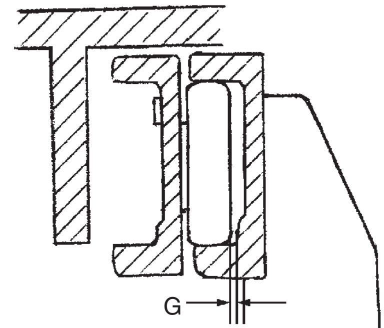


(d) Insert a bar between the outer and inner masts on the indicator side, and push the inner mast to the opposite side.

(e) Read the indicator. This reading is the clearance G between inner mast roller and outer mast.

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

(f) If the clearance G is out of specification, it is necessary to add shims to the seat of the roller to adjust to correct clearance. For adjustment and installation procedures, refer to “Installing mast rollers” on page 12-22.



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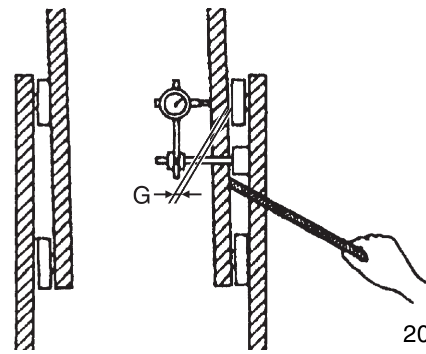
(3) Right-to-left clearance check on outer mast main rollers

(a) Raise the mast to the top.

(b) Set a dial indicator on the outer mast with its contact point rested on the inner mast.

(c) Go over to the opposite side of the mast, and push the outer mast against the inner mast with a bar. Set the indicator to zero.



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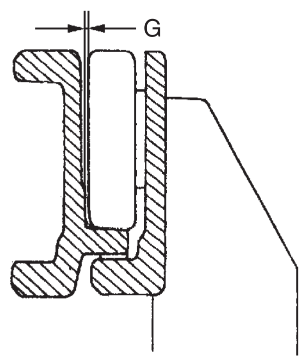
(d) Insert a bar between the outer and inner mast, and push the inner mast to the opposite side.

(e) Read the indicator. This reading is the clearance G between outer mast roller and inner mast.

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

(f) If the clearance G is out of specification, adjust it by shims.
It is necessary to add or remove shims at the seat of the roller to adjust to correct clearance. For adjustment and installation procedures, refer to “Installing mast rollers” on page 12-22.



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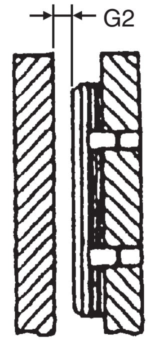
6. Mast Strip Clearance, Inspection and Adjustment (all mast models)



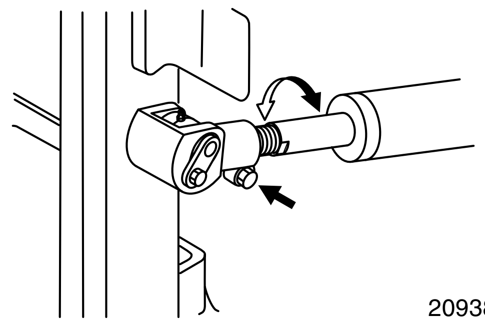
(1) Check the clearance G2 with the clearance between the outer mast rollers and inner mast rolling contact surface setting to zero (0) in maximum lift position.

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

(2) If clearance G2 is out of specification, adjust it by adding or removing shims. For adjustment procedure, refer to "Measuring and adjusting clearance G2 between mast strip and inner mast" on page 12-23.

(3) After adjusting the all clearance, move the mast and lift bracket slowly to ensure that they move smoothly through their full stroke.

7. Tilt Angle Adjustment (all mast models)



(1) Adjust the tire pressure correctly and park the truck on a level ground.

(2) Tilt the mast fully backward and stop the engine.

(3) Measure the backward tilt angle of the mast at both sides.

(4) To adjust the tilt angle, loosen the bolt of tilt cylinder socket, and adjust the rod length by turning the rod. Adjust cylinder so that there is no difference in stroke tilt angle between the cylinders, right and left.

Note: It is not necessary to adjust the forward tilt angle if the backward tilt angle is properly adjusted.

Standard tilt angle

Mast model	Forward	Backward
Simplex Mast	6°	12°
Duplex Mast	6°	12°
Triplex Mast	6°	6°

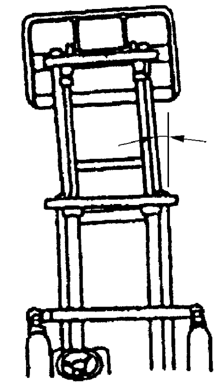
(5) After adjusting the tilt angle, tighten the socket bolts to the specified torque.

Tightening torque for tilt cylinder socket bolt	153 to 182 N·m (15.6 to 18.6 kgf·m) [112.8 to 134.5 lbf·ft]

8. Right and Left Lift Cylinder Stroke Inspection and Adjustment (all mast models)

(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.



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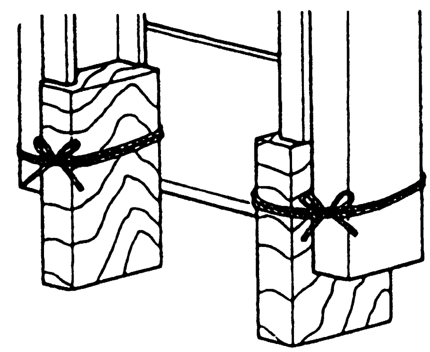
(3) Adjusting method

(a) Raise the inner mast, place blocks under the right and left sides of the inner mast, and lower the mast until its rests on the 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.



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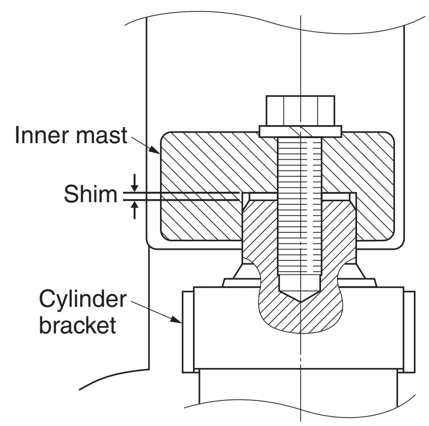
Note: When retracting piston rod, push the lift lever to lowering direction for releasing the oil in the cylinders.

(c) Extend the piston rod, and tighten the cylinder set bolt. Remove the 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.



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Troubleshooting

Symptom	Cause	Remedy
Lift bracket and inner mast will not move smoothly	Clearance between lift rollers and side rollers incorrect	Readjust clearance.
	Rollers binding on their shafts	Relubricate of replace.
	Mast strip clearance incorrect	Shim adjust. 0.1 to 0.5 mm (0.004 to 0.020 in.)
Lift bracket or inner mast binds	Too much clearance on side rollers	Readjust by adding shims.
	Lift chains unequally tensioned	Readjust.
	Shim adjustments unequally made on between left and right lift cylinders (at maximum height)	Readjust.
Mast makes noise	Rollers not rotating smoothly on their shafts	Relubricate or replace.
Load descends (drift)	Lift cylinder packing damaged	Replace.
	Sliding (inside) surface of lift cylinder tube damaged	Replace.
Whole mast shakes	Mast-support bushing or metal worn	Retighten or replace.
Mast is distorted	Off-center loading or overload	Replace mast assembly.
Fork tips differ in height	Finger bar bent Forks bent Un-even loading	Repair or replace.

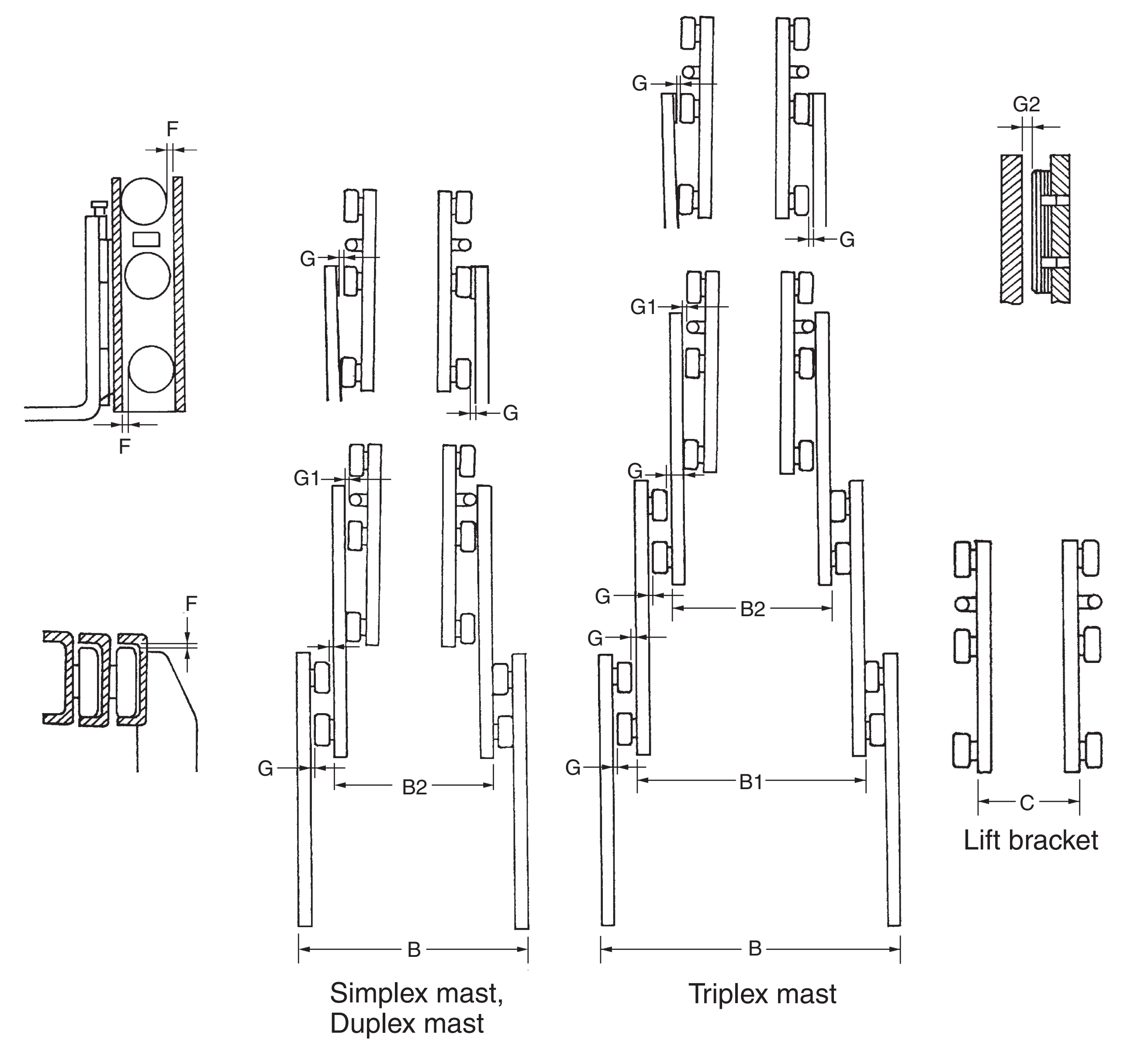
Service Data

A: Standard value   B: Repair or service limit

Unit: mm (in.)

Item				Truck Model	1 ton class	2 ton class	3 ton class
Chains	Chain extension (Duplex)	mm (in.)/20 links		A	381 (15)	381 (15)	508 (20)
				B	392 (15.4)	392 (15.4)	523 (20.6)
Rollers	Main roller external diameter		S	A	99 (3.9)	113.8 (4.5)	113.8 (4.5)
			M	A	100 (3.9)	115 (4.5)	115 (4.5)
			L	A	101 (4.0)	116 (4.6)	116 (4.6)
			LL	A	102 (4.0)	117 (4.6)	117 (4.6)
	Side roller external diameter			A	42 (1.7)	42 (1.7)	42 (1.7)
Dimensions (Reference)	Duplex mast	Width of outer mast B		A	610 (24)	670 (26.4)	670 (26.4)
		Width of inner mast B2		A	516 (20.3)	568 (22.4)	568 (22.4)
		Width of lift bracket C		A	408 (16.1)	458 (18)	458 (18)
	Triplex mast	Width of outer mast B		A	610 (24)	670 (26.4)	670 (26.4)
		Width of middle mast B1		A	516 (20.3)	568 (22.4)	568 (22.4)
		Width of inner mast B2		A	426 (16.8)	468 (18.4)	468 (18.4)
		Width of lift bracket C		A	318 (12.5)	358 (14.1)	358 (14.1)
Clearances	Masts	Clearance between main roller circumference and mast thrust surface F		A	1.0 (0.04) or less		
		Clearance between main roller side surface and mast thrust surface G		A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between inside mast and mast strip G2		A	0.1 to 0.5 (0.004 to 0.020)		
	Lift brackets	Clearance between upper and lower roller circumference and inner mast thrust surface F		A	1.0 (0.04) or less		
		Clearance between middle roller side surface and inner mast thrust plate G		A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between lower roller side surface and inner mast thrust surface G		A	0.1 to 0.5 (0.004 to 0.020)		
		Clearance between side roller circumference and inner mast surface G1		A	0.1 to 0.5 (0.004 to 0.020)		
Finger bar bend				A	5.0 (0.2) or less		

Item	Truck Model	GP15N DP15N	GP18N DP18N	GP20N GP20CN, DP20N, 20CN	GP25N DP25N	GP30N, 35N DP30N, 35N
Fork thickness	A	34 (1.34) $^{+3\,(0.11)}_{0}$	35 (1.38) $^{+3\,(0.11)}_{0}$	37 (1.46) $^{+3\,(0.11)}_{0}$	42 (1.65) $^{+3\,(0.11)}_{0}$	50 (1.97) $^{+3\,(0.11)}_{0}$
	B	31 (1.22)	32 (1.26)	35 (1.38)	40 (1.57)	45 (1.77)



Mast width is slightly wide at the lower portion than at the upper portion.
Measure the clearance at the mast upper position.

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SERVICE DATA

Maintenance Chart

Abbreviations:
- GP: Gasoline-engine models
- DP: Diesel-engine models

○: Check or clean
⊗: Change or adjust

Inspection point		How to check	Pre-start	Intervals		Service data
				1 month	12 months	
Cooling system	Water leaks	Visual	○	○	○	
	Radiator filler cap – function	Visual		○	○	
	Coolant level	Visual	○	○	○	
	Fan belt – tension and condition	Visual/measure		○	○	Adjust by means of tension pulley.
	Cooling fan – condition	Visual		○	○	
	Rubber hoses – condition	Visual		○	○	
Engine operation	Starting and noise	Test/listen	○	○	○	
	Idling and acceleration	Tachometer/ test		○	○	GP: 700 rpm DP: 650 to 700 rpm
	Exhaust smoke	Visual		○	○	
Ignition system	Distributor cap	Visual		○	○	
	Spark plugs – gap and cleanliness	Plug gauge		○	○	0.7 to 0.8 mm (0.028 to 0.031 in.)
	Ignition timing (with engine idling)	Timing lamp		○	○	D: EC 2 °BTDC: CAB
	Advance mechanism – vacuum advance	Timing lamp/ vacuum gauge			○	
	Ignition coil – resistance	Circuit tester			○	
Valves	Clearance for all valves	Thickness gauge			○	GP (hot) Inlet/exhaust: 0.38 mm (0.015 in.) DP (cold) Inlet/exhaust: 0.25 mm (0.0098 in.)
Air cleaner	Element – clogging or damage	Visual			⊗	Every 6 months or 1000 hours, change element.
Lubrication system	Oil leaks	Visual	○	○	○	
	Oil – level and contamination	Visual	○	Every 3 months or 500 hours, change element.		
	Oil filter element – clogging	Check		⊗	⊗	Every 3 months or 500 hours, change element.
Governor	No-load maximum speed	Tachometer		○	○	

Inspection point		How to check	Pre-start	Intervals: 1 month	Intervals: 12 months	Service data
Fuel system	Fuel leaks	Visual		○	○	
	Carburetor – cleanliness	Visual		○	○	
	Carburetor link – condition	Test		○	○	
	Carburetor throttle valve and choke valve	Test		○	○	
	Fuel filter – clogging	Check			⊗	Every 6 months or 1000 hours, change filter.
	Injection nozzles – injection pressure and discharge pattern	Nozzle tester			○	DP: 13729^{+1079}_{0} kPa (140^{+11}_{0} kgf/cm^2) [1991^{+156}_{0} psi]
	Injection timing (interval)	Test			○	DP10N thru 18N: 18°BTDC DP20N thru 35N: 20°BTDC
	Injection pump – injection quality	Bench tester			○	
	Feed pump – function	Test			○	
Compression pressure	All cylinders	Compression gauge			○	Refer to specification
Starter	Pinion – meshing action	Test		○	○	
Alternator	Charging	Test/visual		○	○	
Battery	Level of electrolyte	Visual	○	○	○	
	Specific gravity of electrolyte	Hydrometer		○	○	1.28 or above
Electrical wires	Insulators, connectors and battery terminals – looseness, damage or corrosion	Visual	○	○	○	
Steering wheel	Free play, looseness, rattle	Test/measure	○	○	○	15 to 30 mm (0.6 to 1.2 in.) with engine idling
	Centering	Test	○	○	○	
Steering gear box	Oil leaks	Visual	○	○	○	
	Mounting bolts – tightness	Wrench		○	○	59.8 N·m (6.1 kgf·m) [44 lbf·ft]
Rods and arms	Looseness, rattle, distortion, damage	Visual/wrench		○	○	
	Split pin – missing	Visual		○	○	
Knuckles	Rattle of kingpins	Feel			○	
Rear axle	Distortion, damage	Visual			○	
Bellcrank	Fit of bellcrank pin in bellcrank	Feel			○	
	Axial play	Feel			○	0.6 mm (0.024 in.) Service limit: 2.4 mm (0.094 in.)

Inspection point		How to check	Pre-start	Intervals: 1 month	Intervals: 12 months	Service data
Power steering cylinder	Oil leaks	Visual	○	○	○	
	Installation	Wrench			○	
Brake pedal	Free play and height of pedal depressed	Scale	○	○	○	Free play: 10 to 16 mm (0.4 to 0.6 in.)
	Braking distance	Test/measure	○	○	○	Stroke to the point where brake starts applying 1 ton class: 35 to 61 mm (1.4 to 2.4 in.) 2, 3 ton classes: 53 to 89 mm (2.1 to 3.5 in.)
Parking brake	Performance	Test/ spring scale	○	○	○	Lever lock position: 4° to 5° Operating effort: 245 to 294 N (25 to 30 kgf) [55 to 66 lbf]
Brake hoses and pipes	Fluid leaks, damage or installation	Visual	○	○	○	
Brake fluid	Level in reservoir	Visual	○	○	⊗	130 cc (7.9 cu in.)
Wheel brakes	Master cylinder and wheel cylinders – operation, wear and damage	Overhaul/ visual			⊗	
Brake drums and shoes	Drum to lining clearance (Total)	Feeler gauge		○	○	1 ton class: 0.5 to 1.0 mm (0.02 to 0.04 in.) 2, 3 ton classes: 0.2 to 0.7 mm (0.01 to 0.03 in.)
	Sliding surfaces of shoes and wear of lining	Disassemble/ calipers			○	Service limit: 1 ton class: 2.5 mm (0.10 in.) 2, 3 ton classes: 3 mm (0.12 in.)
	Drum – wear or damage	Visual/scale			○	Service limit: 1 ton class: 256 mm (10.08 in.) 2, 3 ton classes: 312 mm (12.28 in.)
	Free length of return springs	Scale		○		1 ton class: 102 mm (0.047 in.) 2, 3 ton classes: Primary: 120 mm (4.72 in.) Secondary: 139.3 mm (5.48 in.)
	Operation of shoes	Test			○	
	Anchor pins – seizure	Visual			○	
Backing plates	Distortion, cracks or damage	Dye check			○	
	Fitting cables – damage and length	Visual/scale			○	
	Ratchet – wear or damage	Visual			○	
Clutch	Slipping and dragging	Test	○	○	○	Freeplay: Dry: 1 to 10 mm (0.04 to 0.4 in.) Wet: 5 to 15 mm (0.2 to 0.6 in.)

Inspection point		How to check	Pre-start	Intervals: 1 month	Intervals: 12 months	Service data
Clutch fluid reservoir	Level of fluid	Visual	○	○	⊗	120 cc (7.3 cu in.)
Clutch release cylinder	Operation	Test	○	○	○	
	Leaks in pipes	Visual	○	○	○	
	Oil level and oil leaks	Visual	○	○	⊗	Every 12 months or 2000 hours, change oil.
	Rattle in link	Test		○	○	
Transmission	Gears, bearings and synchronizer – wear or damage	Test		○	○	
Powershift transmission	Oil level and oil leaks	Visual	○	○	⊗	Every 6 months or 1000 hours, change oil. 8.0 liters (2.1 U.S. gal.)
	Strainer – clogging	Visual		○	⊗	Every 6 months or 1000 hours, change oil. 8.0 liters (2.1 U.S. gal.)
	Clutch (inching) pedal – adjustment	Scale/test			○	Inching pedal height (above floor): 220 mm (8.7 in.) Clearance between inching and brake pedal connecting parts: 1 ton class: 9 to 9.5 mm (0.354 to 0.374 in.) 2, 3 ton classes: 0.1 to 0.5 mm (0.004 to 0.020 in.) Valve plunger projection: 1 ton class: 9 to 9.5 mm (0.354 to 0.374 in.) 2, 3 ton classes: 6 to 9.5 mm (0.236 to 0.374 in.) Valve plunger projection at which brake starts to be applied: 16.5 mm (0.65 in.)

Pressure (engine at 1500 ± 100 rpm)	Specification kPa (kgf/cm^2) [psi]
Main	883 to 1079 (9 to 11) [128 to 156]
Clutch	883 to 1079 (9 to 11) [128 to 156]
Torque converter inlet	196 to 490 (2 to 5) [28 to 71]
Torque converter outlet	147 to 294 (1.5 to 3) [21 to 43]
Lubrication	98 to 147 (1 to 1.5) [14 to 21]
Stall speed	See Service Data
10 m (33 ft) starting acceleration	Within 5 seconds

<table>
<tr><th colspan="3" rowspan="2">Inspection point</th><th rowspan="2">How to check</th><th rowspan="2">Pre-start</th><th colspan="2">Intervals</th><th rowspan="2">Service data</th></tr>
<tr><th>1 month</th><th>12 months</th></tr>
<tr><td rowspan="4">Front axle</td><td colspan="2">Cracks, distortion or other defects</td><td>Dye check/ visual</td><td></td><td></td><td>○</td><td></td></tr>
<tr><td colspan="2">Front wheel bearings – preload</td><td>Spring scale</td><td></td><td></td><td>○</td><td>Hub bearings preload:
0.5 to 4.9 N·m (5 to 50 kgf·cm)
[0.4 to 3.6 lbf·ft]</td></tr>
<tr><td colspan="2">Fore-aft play</td><td>Test</td><td></td><td></td><td>○</td><td></td></tr>
<tr><td colspan="2">Cracks, distortion or other defects</td><td>Visual</td><td></td><td></td><td>○</td><td></td></tr>
<tr><td rowspan="2">Differential and transfer</td><td colspan="2">Oil level and oil leaks</td><td>Visual</td><td></td><td>○</td><td>○</td><td>1 ton class: 4.2 liters (1.1 U.S. gal.)
2, 3 ton classes: 5 liters (1.3 U.S. gal.)</td></tr>
<tr><td colspan="2">Mounting bolts</td><td>Torque wrench</td><td></td><td></td><td>○</td><td></td></tr>
<tr><td>Rear axle</td><td colspan="2">Rear wheel bearings – preload</td><td>Spring scale/ torque wrench</td><td></td><td></td><td>○</td><td>Hub bearing preload:
0.5 to 4.9 N·m (5 to 50 kgf·cm)
[0.4 to 3.6 lbf·ft]
Lock nut (outside):
157 N·m (16 kgf·m) [116 lbf·ft]</td></tr>
<tr><td rowspan="2">Front and rear axle</td><td rowspan="2">Tire pressure</td><td>Front</td><td rowspan="2">Tire gauge</td><td rowspan="2">○</td><td rowspan="2">○</td><td rowspan="2">○</td><td>686 kPa (7 kgf/cm²) [100 psi]
GP/DP35N single:
834 kPa (8.5 kgf/cm²) [121 psi]</td></tr>
<tr><td>Rear</td><td>686 kPa (7 kgf/cm²) [100 psi]
GP/DP35N:
883 kPa (9 kgf/cm²) [128 psi]</td></tr>
<tr><td rowspan="6">Wheels</td><td colspan="2">Tires – cuts or gouges</td><td>Visual</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td colspan="2">Tires – wear</td><td>Depth gauge</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td colspan="2">Tires – imbedded objects</td><td>Visual</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td colspan="2" rowspan="2">Rim bolts and wheel nuts – tightness
N·m (kgf·m) [lbf·ft]</td><td>Torque wrench</td><td></td><td>○</td><td>○</td><td></td></tr>
<tr><td colspan="5"><table>
<tr><th colspan="2"></th><th>1 ton class</th><th>2, 3 ton classes</th></tr>
<tr><td rowspan="2">Rim bolts</td><td>Front wheel</td><td>68 (8.8) [64]</td><td>202 (20.6) [149]
excludes 3 ton class</td></tr>
<tr><td>Rear wheel</td><td>46 to 51
(4.7 to 5.2)
[34 to 38]</td><td>82 to 90
(8.4 to 9.2)
[61 to 67]</td></tr>
<tr><td rowspan="2">Wheel nuts</td><td>Front wheel</td><td rowspan="2">157 (16) [116]</td><td>378 (38.5) [278]</td></tr>
<tr><td>Rear wheel</td><td>157 (16) [116]
GP/DP35N: 233 (23.8) [172]</td></tr>
</table></td></tr>
<tr><td colspan="2">Rims, side rings and wheel discs – damage</td><td>Visual</td><td>○</td><td>○</td><td>○</td><td></td></tr>
<tr><td rowspan="3">Hydraulic tank</td><td colspan="2">Oil level and contamination</td><td>Visual</td><td>○</td><td>○</td><td>⊗</td><td></td></tr>
<tr><td colspan="2">Strainer – clogging</td><td>Visual</td><td></td><td></td><td>⊗</td><td></td></tr>
<tr><td colspan="2">Return filter – clogging</td><td>Visual</td><td></td><td>○</td><td>⊗</td><td></td></tr>
</table>

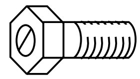
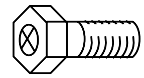
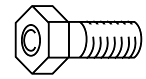
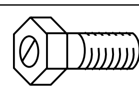
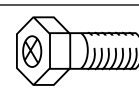
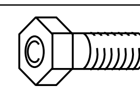
Inspection point		How to check	Pre-start	Intervals: 1 month	Intervals: 12 months	Service data
Hydraulic pump	Oil leaks or abnormal noise	Visual/listen		○	○	
Flow divider valve	Oil leaks	Visual	○	○	○	
	Relief valve setting (power steering)	Pressure gauge				7485 kPa (80 kgf/cm^2) [1138 psi] DP35N: 9807 kPa (100 kgf/cm^2) [1422 psi]
Control valve	Oil leaks	Visual	○	○	○	
	Main relief valve setting	Pressure gauge			○	18142 kPa (185 kgf/cm^2) [2631 psi]
	Overload relief valve setting (optional)	Pressure gauge			○	
	Control levers and links – rattle	Test	○	○	○	
Lift cylinders	Cracks, distortion or other defects	Visual	○	○	○	
	Rod drift (rated load)	Visual/watch/ scale				Drift test (rated load) GP/DP30N: 40 mm (1.57 in.)/15 min GP/DP35N: 35 mm (1.4 in.)/15 min Others: 50 mm (2.0 in.)/15 min, max.
	Attachment					
	Mounting bolts – tightness	Wrench		○	○	
Flow regulator valve	Oil leaks	Visual	○	○	○	
	Lowering speed	Watch/scale		○	○	MC: Lowering speed (rated load) 1 ton class: 520 mm/sec (102 fpm) 2 ton class: 500 mm/sec (98 fpm) 3 ton class: 530 mm/sec (104 fpm) GP/DP35N: 440 mm/sec (87 fpm) FC: 50 mm/sec (9.8 fpm)
Tilt cylinders	Cracks, distortion or other defects	Visual	○	○	○	
	Oil leaks	Visual	○	○	○	
	Forward rod drift (rated load)	Watch/scale		○	○	20 mm (0.8 in.)/15 min, max.
	Mounts – rattle or damage	Visual/feel	○	○	○	
	Rod socket bolt – tightness	Torque wrench	○	○	○	127 to 152 N·m (13 to 15.5 kgf·m) [94 to 112 lbf·ft]
Piping	Oil leaks	Visual	○	○	○	
	Rubber hoses – damage	Visual		○	○	
	Hose reels and swivel joint – distortion or other defects	Visual		○	○	

Inspection point		How to check	Intervals			Service data
			Pre-start	1 month	12 months	
Mast and lift bracket	Cracks, distortion or other defects	Visual/ dye check	○	○	○	
	Mast supports – rattle or damage			○	○	
	Main rollers – clearance, damage	Feeler gauge/ dial gauge		○	○	Each roller to mast clearance (at max. height): 0.1 to 0.5 mm (0.004 to 0.020 in.)
Lift chains and chain wheels	Length of lift chains (20 links)	Scale			○	Service limit 1 ton class: 327 mm (12.87 in.) 2 ton class: 392 mm (15.43 in.) 3 ton class: 523 mm (20.59 in.)
	Tension of lift chains	Scale	○	○	○	Both chains to be equal in tension
	Chain – damage or rusting	Visual	○	○	○	
	Chain wheels – wear, distortion or other defects	Visual		○	○	
	Chain wheel bearings – rattle	Feel		○	○	
	Chain anchor bolts – distortion or damage	Visual		○	○	
Forks and backrest	Forks – wear and distortion	Visual/scale	○	○	○	Fork thickness Refer to Service Data.
	Fork stopper pins – damage or distortion	Visual	○	○	○	
	Backrest mounting bolts – tightness	Torque wrench	○	○	○	171.6 N·m (17.5 kgf·m) [126 lbf·ft]
	Backrest – distortion or damage	Visual	○	○	○	
Lights	Operation	Test/visual	○	○	○	
Horn	Operation	Test/sound	○	○	○	
Turn signals	Operation	Test/visual	○	○	○	
Rear view mirrors	Rear vision	Visual	○	○	○	
Overhead guard	Installation and damage	Visual/wrench	○	○	○	
Chassis	Loosen bolts or nuts	Wrench			○	
	Operator's seat – damage and installation	Visual		○	○	
	Lubrication points	Lubricate		○	○	Lubricate mast supports every week.
	Oil change	Inspect		○	○	

Tightening Torques for Standard Bolts and Nuts

	Nominal size		Pitch		With spring washer								101656
					7			8			10		
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
Metric fine thread	6	0.24	1	0.04	7.4	0.75	5.4	9.6	0.98	7.1	12.7	1.3	9.4
	8	0.32	1.25	0.05	16.7	1.7	12.3	22.6	2.3	16.6	30.4	3.1	22.4
	10	0.39	1.25	0.05	34.3	3.5	25.3	45.1	4.6	33.3	69.6	7.1	51.4
	12	0.47	1.25	0.05	63.7	6.5	47.0	82.4	8.4	60.8	122.6	12.5	90.4
	14	0.55	1.5	0.06	102.0	10.4	75.2	132.4	13.5	97.6	192.2	19.5	141.8
	16	0.63	1.5	0.06	157.9	16.1	116.5	202.0	20.6	149.0	287.3	29.3	211.9
	18	0.71	1.5	0.06	224.6	22.9	165.6	292.2	29.8	215.5	413.8	42.2	305.2
	20	0.79	1.5	0.06	310.9	31.7	229.3	404.0	41.2	298.0	573.7	58.5	423.1
	22	0.87	1.5	0.06	413.8	42.2	605.2	537.4	54.8	396.4	763.0	77.8	562.7
	24	0.95	1.5	0.06	547.2	55.8	403.6	711.0	72.5	524.4	1006.2	102.6	742.1
	27	1.06	1.5	0.06	794.3	81.0	585.9	1032.6	105.3	761.6	1451.1	148.0	1070.5
	30	1.18	1.5	0.06	1100.3	112.2	811.5	1430.8	145.9	1055.3	2012.3	205.2	1484.2
	33	1.30	1.5	0.06	1467.1	149.6	1082.1	1907.4	194.5	1406.8	2680.2	273.3	1976.8
	36	1.42	1.5	0.06	1918.2	195.6	1414.8	2493.8	254.3	1839.4	3497.1	356.6	2579.3
	39	1.54	1.5	0.06	2461.5	251.0	1815.5	3198.8	326.2	2359.4	4469.9	455.8	3296.8
					With spring washer								101656
	Nominal size		Pitch		7			8			10		
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
	6	0.24	1	0.04	8.6	0.88	6.4	10.8	1.1	8.0	14.7	1.5	10.8
	8	0.32	1.25	0.05	19.6	2.0	14.5	26.5	2.7	19.5	36.6	3.7	26.8
	10	0.39	1.25	0.05	41.2	4.2	30.4	53.0	5.4	29.1	81.4	8.3	60.0
	12	0.47	1.25	0.05	74.5	7.6	55.0	97.1	9.9	71.6	144.2	14.7	106.3
	14	0.55	1.5	0.06	119.6	12.2	88.2	155.9	15.9	115.0	226.5	23.1	167.1
	16	0.63	1.5	0.06	182.4	18.6	134.5	237.3	24.2	175.0	338.3	34.5	249.5
	18	0.71	1.5	0.06	263.8	26.9	194.6	343.2	35.0	253.2	487.4	49.7	359.5
	20	0.79	1.5	0.06	365.8	37.3	269.8	475.6	48.5	350.8	674.7	68.8	497.6
	22	0.87	1.5	0.06	486.4	49.6	358.8	632.5	64.5	466.5	897.3	91.5	661.8
	24	0.95	1.5	0.06	643.3	65.6	474.5	836.5	85.3	617.0	1183.7	120.7	873.0
	27	1.06	1.5	0.06	934.6	95.3	689.3	1216.0	123.9	894.2	1707.3	174.1	1259.3
	30	1.18	1.5	0.06	1294.5	132.0	954.8	1682.8	171.6	1241.2	2367.3	241.4	1746.0
	33	1.30	1.5	0.06	1726.0	176.0	1273.0	2243.8	228.8	1654.9	3153.8	321.6	2326.1
	36	1.42	1.5	0.06	2256.5	230.1	1664.3	2934.1	299.2	2164.1	4114.0	419.6	3035.0
	39	1.54	1.5	0.06	2896.0	295.3	2135.9	3763.8	383.8	2776.0	5258.3	536.2	3878.3

Remarks: 1. The tolerance on the torque is ± 10%
2. The torques are for "dry" condition.

	Nominal size		Pitch					With spring washer			101656		
													
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
	10	0.39	1.5	0.06	33.3	3.4	24.6	43.1	4.4	31.8	67.7	6.9	49.9
	12	0.47	1.75	0.07	58.8	6.0	43.4	76.5	7.8	56.4	115.7	11.8	85.3
	14	0.55	2	0.08	96.4	9.8	70.9	124.5	12.7	91.9	182.4	18.6	134.5
	16	0.63	2	0.08	147.1	15.0	108.5	191.2	19.5	141.0	274.6	28.0	202.5
	18	0.71	2.5	0.10	203.0	20.7	149.7	264.8	27.0	195.3	383.4	39.1	282.8
	20	0.79	2.5	0.10	286.4	29.2	211.2	371.7	37.9	274.1	536.4	54.7	395.6
	22	0.87	2.5	0.10	383.4	39.1	282.8	499.2	50.9	368.2	725.9	74.0	535.2
	24	0.95	3	0.12	492.3	50.2	363.1	640.4	65.3	472.3	924.8	94.3	682.1
	27	1.06	3	0.12	724.7	73.9	534.5	942.2	96.1	695.1	1350.4	137.7	996.0
	30	1.18	3.5	0.14	969.9	98.9	715.3	1259.2	128.4	928.7	1843.7	188.0	1359.8
	33	1.30	3.5	0.14	1328.8	135.5	980.1	1727.0	176.1	1273.7	2477.2	252.6	1827.1
	36	1.42	4	0.16	1676.0	170.9	1236.1	2180.0	222.3	1607.9	3199.9	326.3	2360.1
	39	1.54	4	0.16	2219.2	226.3	1636.8	2884.1	294.1	2127.2	4118.8	420.0	3037.9
	42	1.65	4.5	0.18	2754.7	280.9	2031.8	3581.4	365.2	2641.5	5137.7	523.9	3789.4
Metric coarse thread	Nominal size		Pitch					With spring washer			101656		
													
	mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
	10	0.39	1.5	0.06	39.2	4.0	28.9	51.0	5.2	37.6	79.4	8.1	58.6
	12	0.47	1.75	0.07	69.6	7.1	51.4	90.2	9.2	66.5	135.3	13.8	99.8
	14	0.55	2	0.08	112.8	11.5	83.2	146.1	14.9	107.8	215.7	22.0	159.1
	16	0.63	2	0.08	172.6	17.6	127.3	224.6	22.9	165.6	323.6	33.0	238.7
	18	0.71	2.5	0.10	239.3	24.4	176.5	311.9	31.8	230.0	451.1	46.0	332.7
	20	0.79	2.5	0.10	336.4	34.3	248.1	437.4	44.6	322.6	630.6	64.3	465.1
	22	0.87	2.5	0.10	392.3	40.0	289.3	587.4	59.9	433.3	842.4	85.9	621.3
	24	0.95	3	0.12	578.6	59.0	426.7	753.2	76.8	555.5	1088.5	111.0	802.9
	27	1.06	3	0.12	852.2	86.9	628.5	1108.2	113.0	817.3	1588.7	162.0	1171.7
	30	1.18	3.5	0.14	1140.5	116.3	841.2	1481.8	151.1	1092.9	2168.3	221.1	1599.2
	33	1.30	3.5	0.14	1563.2	159.4	1153.0	2031.9	207.2	1498.7	2915.5	297.3	2150.4
	36	1.42	4	0.16	1972.1	201.1	1454.6	2564.4	261.5	1891.4	3765.8	384.0	2777.5
	39	1.54	4	0.16	2610.5	266.2	1925.4	3393.1	346.0	2502.6	4845.5	494.1	3573.8
	42	1.65	4.5	0.18	3241.1	330.5	2390.5	4212.9	429.6	3107.3	6044.8	616.4	4458.4

Remarks: 1. The tolerance on the torque is ± 10%
2. The torques are for “dry” condition.

Periodic Replacement Parts

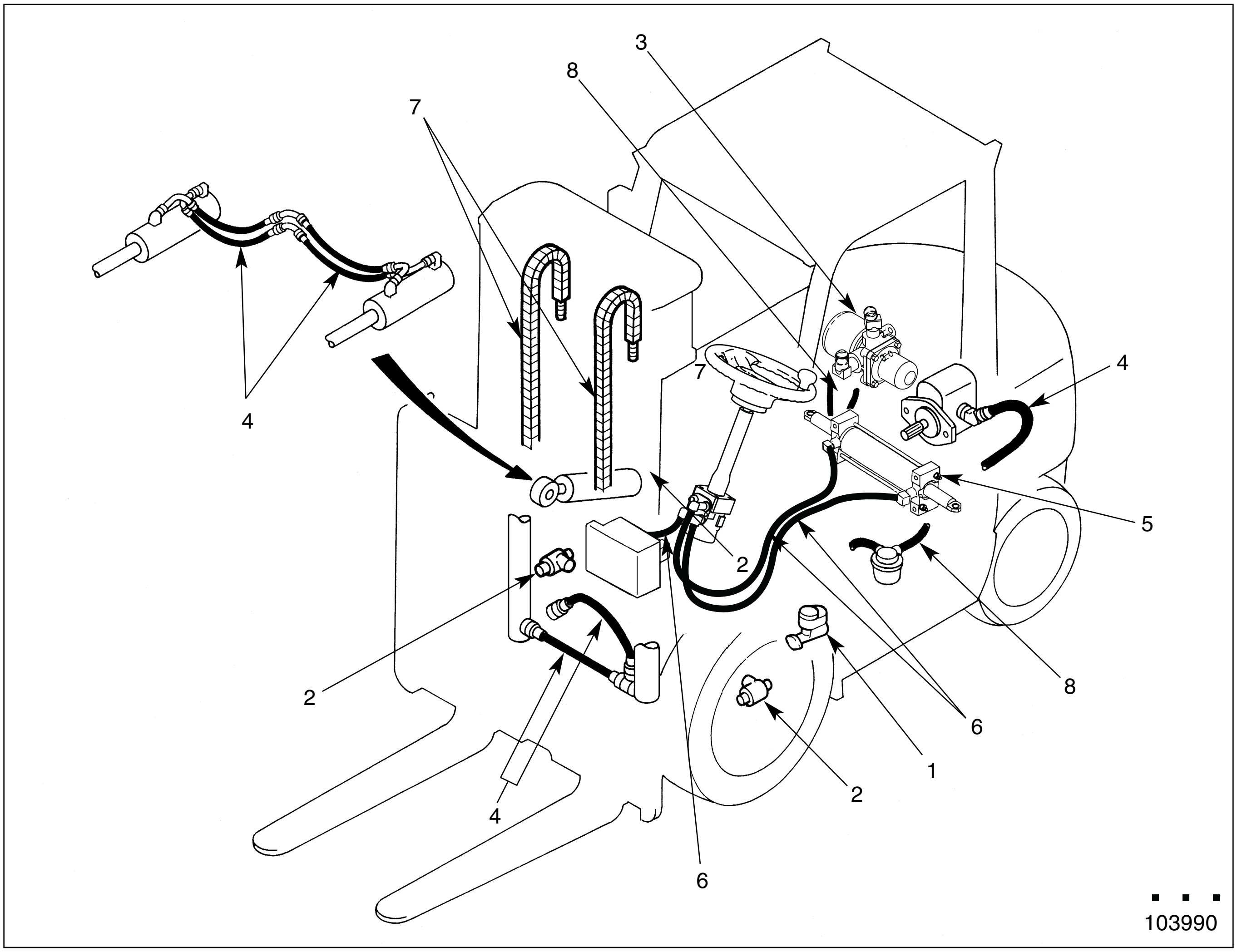
The following parts should be periodically changed as noted below.

These parts are made of materials which will deteriorate overtime. Further, it is difficult to determine visually whether or not they are still in good condition. Changing at proper intervals will reduce the risk of injury to the operator and damage to the truck.

Ref. No.	Parts to be changed	Interval
1	Rubber parts of brake master cylinder	2000 service hours or 1 year, whichever comes first
2	Rubber parts of brake wheel cylinders	2000 service hours or 1 year, whichever comes first
3	LP-Gas repair kit	2000 service hours or 1 year, whichever comes first
4	High pressure hoses of hydraulic system	2000 to 4000 service hours or 1 to 2 years, whichever comes first
5	Rubber parts of power cylinder	4000 service hours or 2 years, whichever comes first
6	Hydraulic hoses of steering system	4000 service hours or 2 years, whichever comes first
7	Lift chains	4000 to 8000 service hours or 2 to 4 years, whichever comes first
8	Fuel hoses	4000 to 8000 service hours or 2 to 4 years, whichever comes first

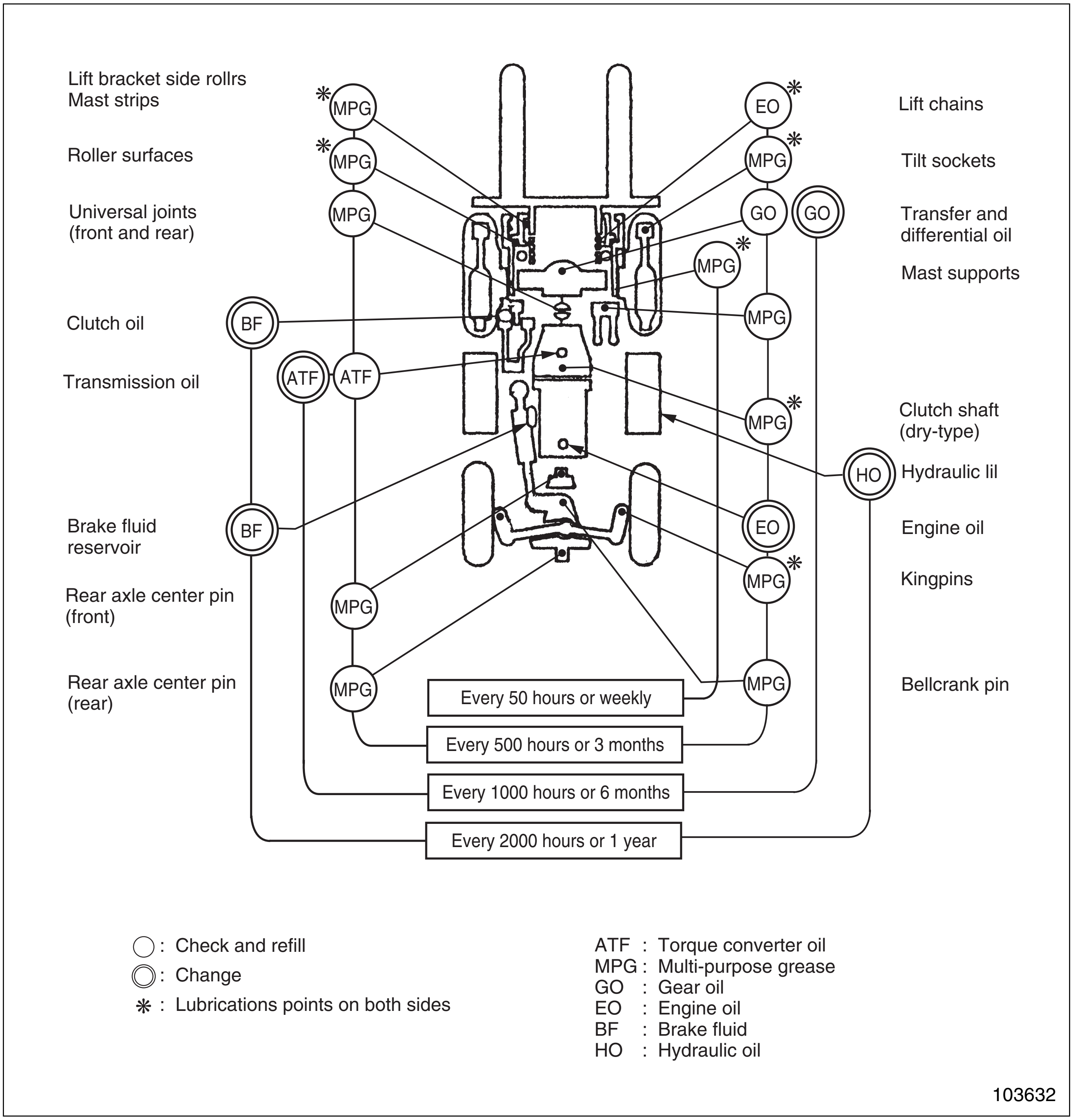
Note: Periodic changes of these parts are not covered by Warranty.

Location of Periodic Replacement Parts



Lubrication Instructions

Lubrication Chart



Fuel and Lubricant Specifications

<table>
<tr><th colspan="2" rowspan="2">Fuel or lubricant</th><th rowspan="2">Specification</th><th colspan="7">Recommendation for ambient temperature °C (°F)</th></tr>
<tr><th>-30
(-22)</th><th>-20
(-4)</th><th>-10
(14)</th><th>0
(32)</th><th>10
(50)</th><th>20
(68)</th><th>30
(86)</th></tr>
<tr><td rowspan="2">Fuel</td><td>Gasoline-engine model</td><td>Gasoline</td><td colspan="7">JIS No.2</td></tr>
<tr><td>Diesel-engine model</td><td>Diesel fuel</td><td colspan="2">JIS Special No.3</td><td>JIS No.3</td><td colspan="4">JIS No.2</td></tr>
<tr><td rowspan="2">Engine oils</td><td>Gasoline-engine model</td><td>API service classification SJ or above</td><td colspan="7" rowspan="2">SAE 10W-30</td></tr>
<tr><td>Diesel-engine model</td><td>API service classification CF or above</td></tr>
<tr><td colspan="2">Transfer and differential oil, transmission oil (manual transmission truck)</td><td>GL-4 or GL-5</td><td colspan="2">SAE 80</td><td colspan="5">SAE 90</td></tr>
<tr><td colspan="2">Powershift transmission oil</td><td>Dexron II</td><td colspan="7">Consult your dealer</td></tr>
<tr><td rowspan="2">Hydraulic oil</td><td>Torque converter or dry-type clutch truck</td><td>ISOVG32</td><td colspan="7"></td></tr>
<tr><td>Wet-type clutch truck</td><td>API service classification CD or above</td><td colspan="7">SAE 10W</td></tr>
<tr><td colspan="2">Brake fluid</td><td rowspan="2">FMVSS – DOT 3 or DOT 4
(SAE J1703)</td><td colspan="7" rowspan="2"></td></tr>
<tr><td colspan="2">Clutch fluid</td></tr>
<tr><td rowspan="2">Grease</td><td>Wheel bearings</td><td>NLGI No.2 grade multi-purpose type (lithium base),
Consistency: 271</td><td colspan="7"></td></tr>
<tr><td>Chassis</td><td>NLGI No.1 grade multi-purpose type (calcium base),
Consistency: 320
or
NLGI No.1 grade multi-purpose type (lithium base),
Consistency: 315</td><td colspan="7"></td></tr>
</table>

<table>
<tr><td rowspan="2">Antifreeze solution
(Long Lift Coolant)</td><td>Ambient temperature, °C (°F)</td><td>−39
(−38.2)</td><td>−30
(−22)</td><td>−25
(−13)</td><td>−20
(−4)</td><td>−15
(5)</td><td>−10
(14)</td></tr>
<tr><td>Concentration, %</td><td>55</td><td>50</td><td>45</td><td>40</td><td>35</td><td>30</td></tr>
</table>

⚠ CAUTION

Avoid mixing lubricants. In some cases, different brands of lubricants are not compatible with each other and deteriorate when mixed. It is best to stick with one and the same brand at successive service intervals.

Refill Capacities

Unit: liter (U.S. gal.)

Items \ Truck Models		1 ton class	2 ton class	3 ton class
Fuel tank		53 (14.0)	76 (20.1)	
Engine cooling system [including 0.65 liter (0.17 U.S. gal.) for reserve tank]	Diesel-engine models	6.8 (1.8)	8.7 (2.3)	
	Gasoline-engine models	7.4 (2.0)	6.8 (1.8)	7.4 (2.0)
	Electronic control gasoline-engine models	7.4 (2.0)		
Engine lubrication system (including oil filter capacity)	Diesel-engine models	8.5 (2.2)	10 (2.6)	
	Gasoline-engine models	3.8 (1.0)		
	Electronic control gasoline-engine models	3.8 (1.0)		
Transmission and differential oil	Powershift transmission models	8.0 (2.1)		
	Manual transmission models	4.0 (1.1)		
Differential gear oil		5.0 (1.3)	8.5 (2.2)	
Hydraulic tank		28 (7.4)	39 (10.3)	
Brake fluid reservoir		135 cc (8.2 cu in.)		

Weight of Major Components (Approximate)

Unit: kg (lb)

<table>
<tr><th colspan="2">Truck Models / Items</th><th>1 ton class</th><th>2 ton class</th><th>3 ton class</th></tr>
<tr><td colspan="2">Counterweight</td><td>970 (2140)</td><td>1500 (3330)</td><td>2200 (4850)</td></tr>
<tr><td rowspan="2">Engine service weight</td><td>Gasoline-engine model</td><td colspan="3">140 (300)</td></tr>
<tr><td>Diesel-engine model</td><td>180 (400)</td><td colspan="2">260 (570)</td></tr>
<tr><td rowspan="2">Power train
Engine, transmission (excl. reduction gear and differential)</td><td>Gasoline-engine model</td><td>280 (620)</td><td colspan="2">290 (640)</td></tr>
<tr><td>Diesel-engine model</td><td>350 (770)</td><td colspan="2">395 (870)</td></tr>
<tr><td colspan="2">Overhead guard</td><td colspan="3">60 (130)</td></tr>
<tr><td colspan="2">Rear axle</td><td>90 (200)</td><td colspan="2">130 (290)</td></tr>
<tr><td rowspan="5">Duplex mast [3 m (118 in.)]</td><td>Outer mast</td><td>160 (350)</td><td>220 (485)</td><td>245 (540)</td></tr>
<tr><td>Inner mast</td><td>130 (290)</td><td>150 (330)</td><td>165 (360)</td></tr>
<tr><td>Lift bracket
(incl. backrest)</td><td>90 (200)</td><td>130 (290)</td><td>165 (360)</td></tr>
<tr><td>Forks (two)</td><td>80 (180)</td><td>130 (290)</td><td>165 (360)</td></tr>
<tr><td>Lift cylinder and related parts</td><td>55 (120)</td><td>65 (140)</td><td>105 (230)</td></tr>
</table>

Special Service Tools

Special Service Tools

Ref No.	Part number	Part name	Truck model / Used for	1 ton class	2 ton class	3 ton class
1	91268 - 00100	Wrench	Removal and installation of pulley (To be used with 91268 - 00200)	○	○	○
2	91268 - 00200 91868 - 00100	Wrench Wrench	Removal and installation of pulley	○	○	○
3	91268 - 00701	Socket wrench	Removal and installation of rear wheel nut and weight bolt	○	○	○
4	91268 - 01900 92301 - 02700 F2300 - 10000	Bolt Washer Nut	Replacement of clutch pressure plate (To be used with washer and nut)	○ ○ ○	○ ○ ○	○ ○ ○
5	F1145 - 10050 92301 - 02700	Bolt Washer	Replacement of clutch disc (To be used with washer)	○ ○	○ ○	○ ○
6	91268 - 00400	Clutch shaft	Installation of clutch disc (When installing a disc to an engine)	○	○	○
7	91268 - 02200	Clutch gauge	Adjustment of release lever clearance	○	○	○
8	91268 - 05100	Bolt	Removal of pump body (FC) and shifter case (MC)	○	○	○
9	91268 - 05300	Installer	Installation of pump body oil seal	○	○	○
10	91268 - 05500	Installer	Installation and tightening of transmission output shaft oil seal	○	○	○
11	91268 - 05200	Installer	Installation of oil seal on shifter case (MC)	○	○	○
12	91268 - 13810 91268 - 13820 F1035 - 10020 T-24	Puller Plate Bolt Puller	Removal of bearing (FC) (To be used with plate, bolt and puller) (Commercially available, BANZAI)	○ ○ ○	○ ○ ○	○ ○ ○
13	91268 - 04100	Installer	Installation of ball bearing (FC)	○	○	○
14	91268 - 07100	Piston tool	Removal and installation of clutch return spring (FC)	○	○	○
15	91268 - 00500	Ring puller	Removal and installation of snap ring (FC)	○	○	○
16	64309 - 17701	Gauge kit	Measurement of transmission hydraulic pressure	○	○	○
17	91268 - 04400	Connector	Measurement of hydraulic pressure (FC) (To be used with 64309 - 17701 Gauge kit)	○	○	○
18	91268 - 00800	Socket wrench	Removal and installation of front wheel hub nut	○	—	—
19	03703 - 59001	Socket wrench	Removal and installation of front wheel hub nut	—	○	○
20	64309 - 40100 64309 - 10601 MH061017	Bevel pinion puller Puller seat Wheel hub puller	Removal of front wheel hub Removal of front wheel hub Removal of front wheel hub	○ ○ —	— — ○	— — ○

Ref No.	Part number	Part name	Truck model / Used for	1 ton class	2 ton class	3 ton class
21	91468 - 00300 64309 - 12300	Installer Installer	Installation of front axle wheel bearing inner race	— ○	○ —	○ —
22	91268 - 05400	Installer	Installation of oil seal into carrier cover input flange	○	○	○
23	91268 - 05600	Installer	Installation of bevel pinion taper roller bearing into differential carrier	○	○	○
24	91268 - 05700	Installer	Installation of bevel pinion taper roller bearing into carrier cover	○	○	○
25	91268 - 05800	Installer	Installation of bevel pinion taper roller bearing	○	○	○
26	91268 - 05900	Installer	Installation of drive gear ball bearing into carrier cover	○	○	○
27	91268 - 01500	Installer	Installation of rear axle inner bearing inner race	○	—	—
28	64309 - 40400	Installer	Installation of rear axle inner bearing inner race	—	○	○
29	91268 - 01400	Installer	Installation of rear axle outer bearing inner race	○	—	—
30	91468 - 00400	Installer	Installation of rear axle outer bearing outer race	—	○	○
31	91468 - 00500	Installer	Press-fitting of rear axle pivot bushing	—	○	○
32	91468 - 00100	Installer	Installation of bell crank bearing and king pin bearing	○	○	○
33	91468 - 00200	Installer	Removal of bell crank bearing and king pin bearing	○	○	○
34	91268 - 01200	Installer	Removal and installation of king pin bearing (To be used with 91468 - 00100 and 91468 - 00200 Installers)	○	○	○
35	64309 - 15411	Spring remover	Removal of return spring	○	○	○
36	64309 - 15412	Spring retainer	Removal and installation of brake shoe	○	○	○
37	64309 - 15413	Spring hook	Installation of return spring (Tools No. 35, 36 and 37 are included in 64309 - 15400 Tool Set)	○	○	○
38	91268 - 10600	Steering wheel puller	Removal of steering wheel	○	○	○
39	91268 - 01800	Pitman arm puller	Removal of pitman arm	○	○	○
40	91268 - 13400	Socket	Removal and installation of power cylinder guide	○	○	○
41	91268 - 13600	Rod cap	Insertion of power cylinder guide	○	○	○
42	91268 - 03300	Plate	Assembly of steering gear control valve	○	○	○
43	91268 - 06200	Connector	Measurement of power steering relief pressure (To be used with 64309 - 17701 Gauge kit)	○	○	○

Ref No.	Part number	Part name	Truck model / Used for	1 ton class	2 ton class	3 ton class
44	91268 - 01600	Installer	Installation of tilt cylinder tube bushing	○	○	○
45	09305 - 00680	Hook wrench	Removal and installation of tilt cylinder guide bushing	○	—	—
	09305 - 00750	Hook wrench	Removal and installation of tilt cylinder guide bushing	—	○	—
	09305 - 00880	Hook wrench	Removal and installation of tilt cylinder guide bushing	—	—	○
46	64309 - 16300	Pipe	Measurement of control valve main relief pressure and	○	○	○
	F4540 - 06300	Connector	overload relief pressure (FC)	○	○	○
			(To be used with 64309 - 17701 Gauge kit)			

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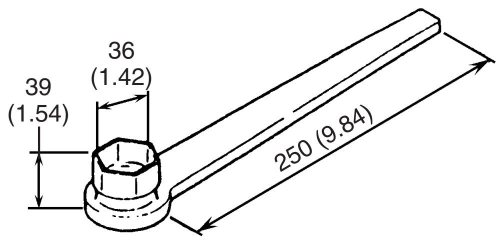

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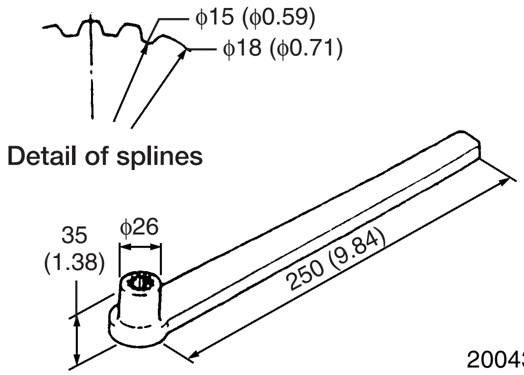

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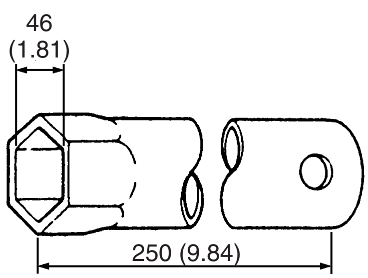

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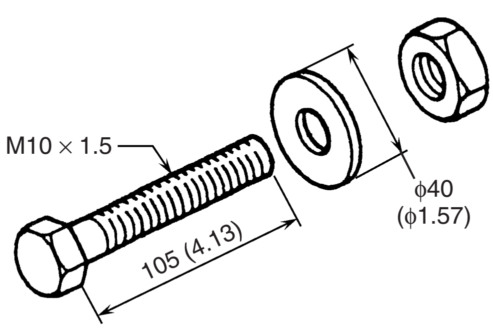

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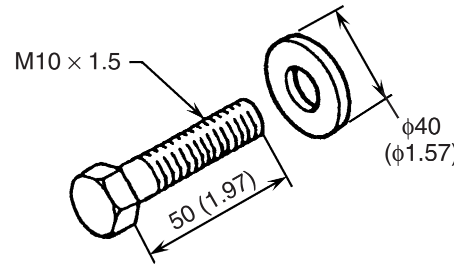

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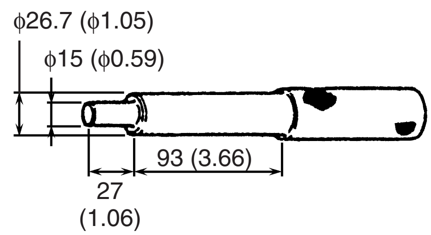

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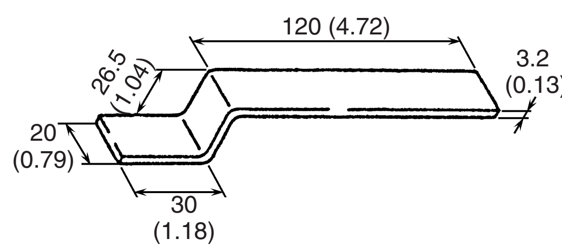

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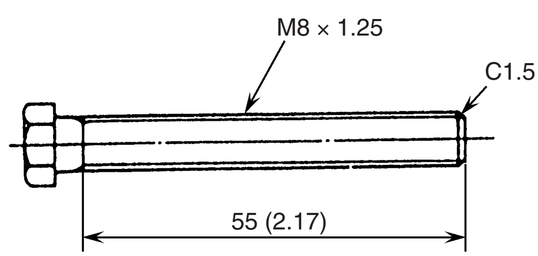

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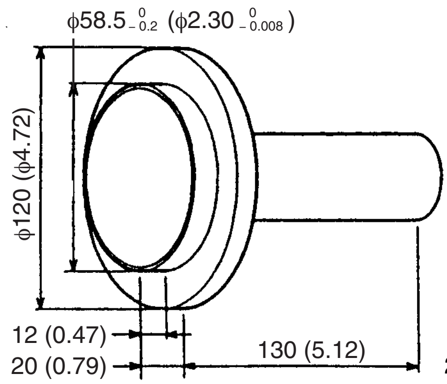

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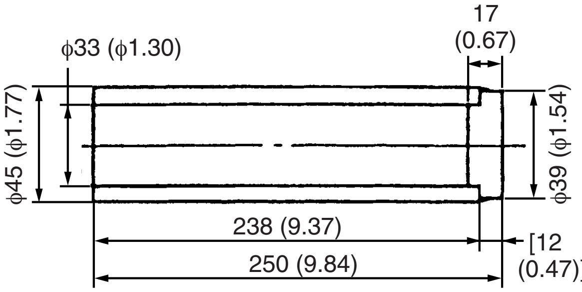

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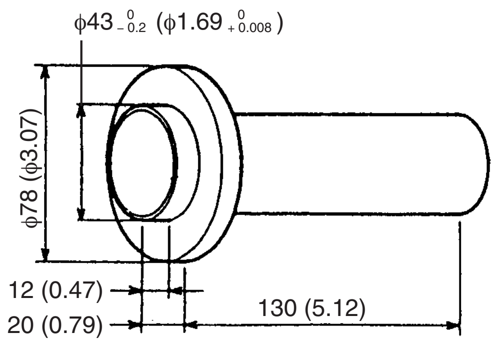

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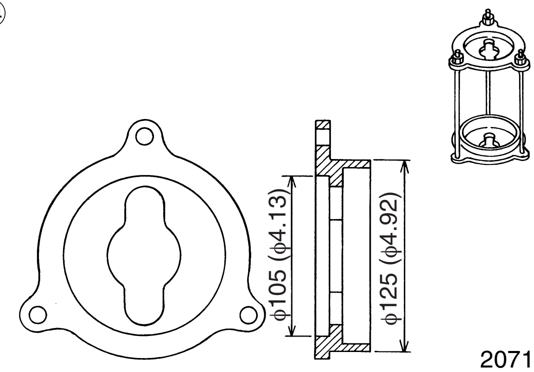

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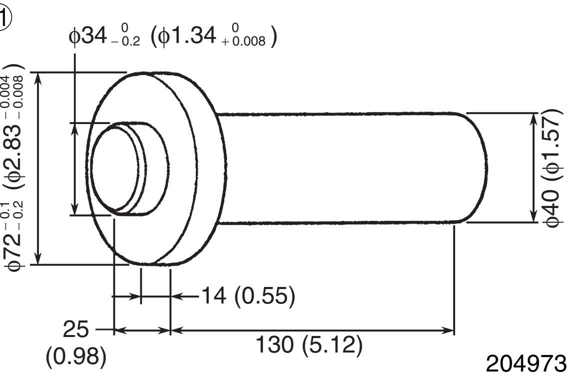

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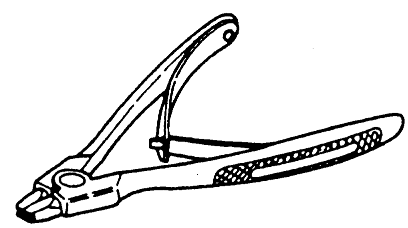

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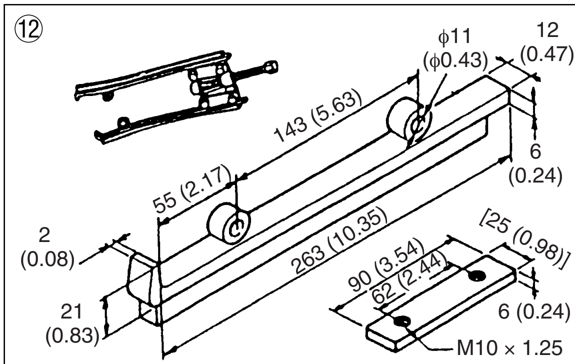

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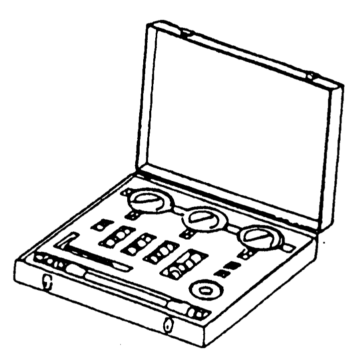

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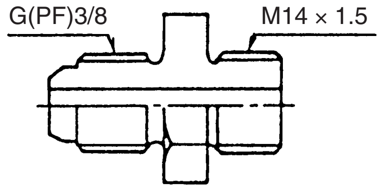

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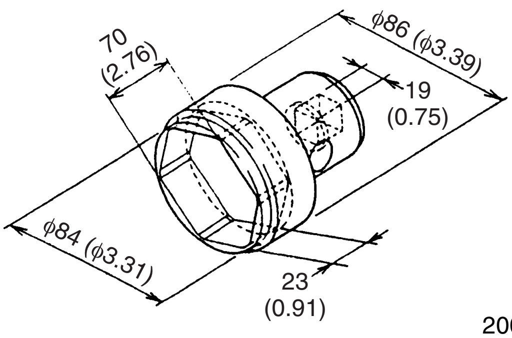

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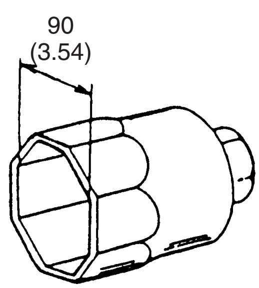

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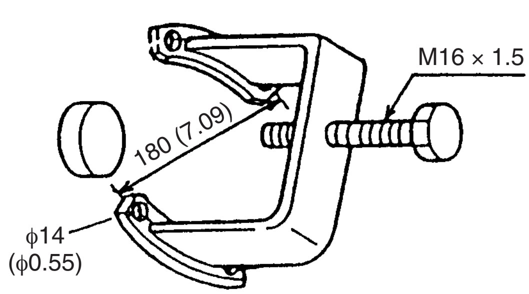

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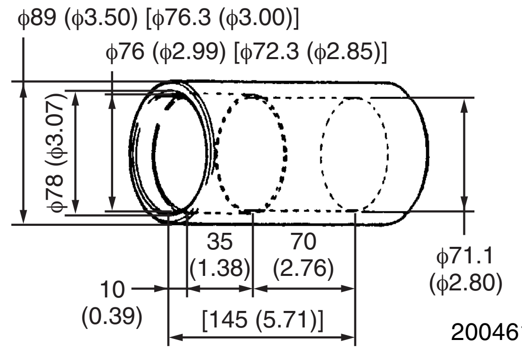

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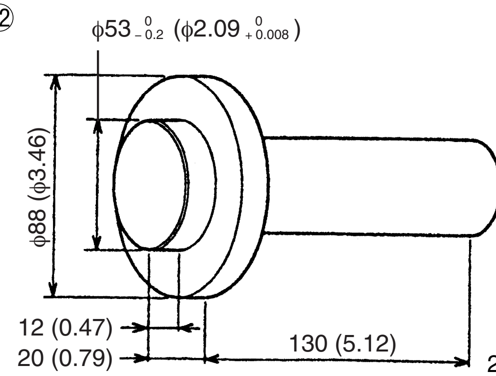

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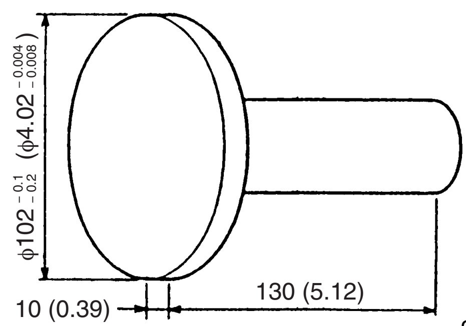

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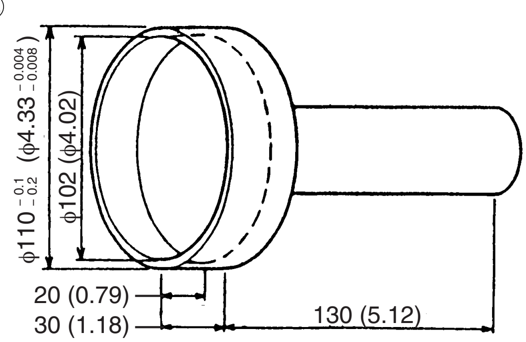

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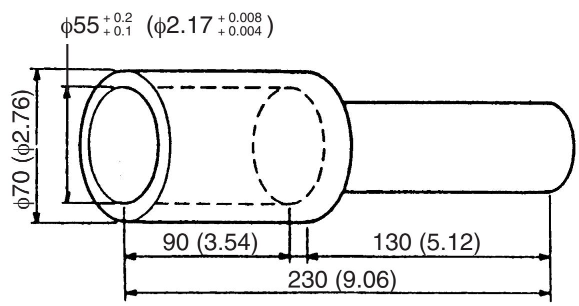

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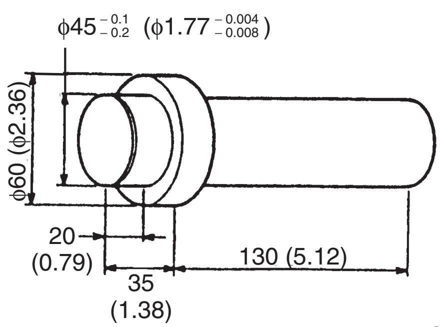

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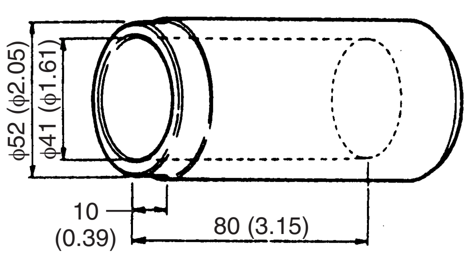

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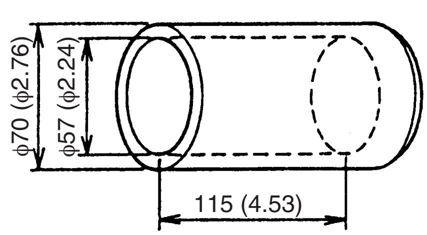

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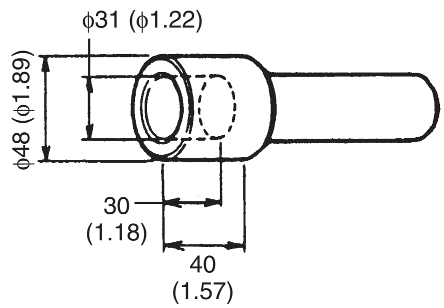

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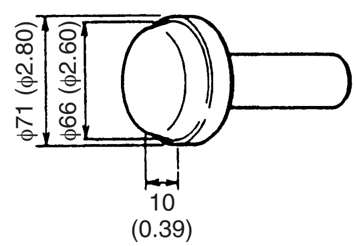

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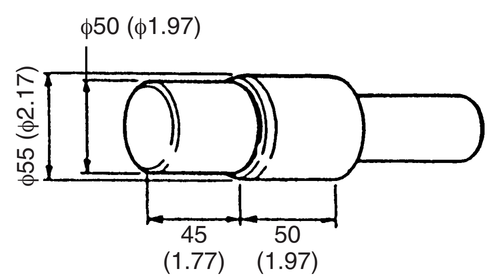

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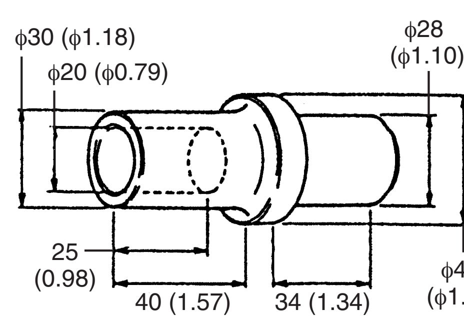

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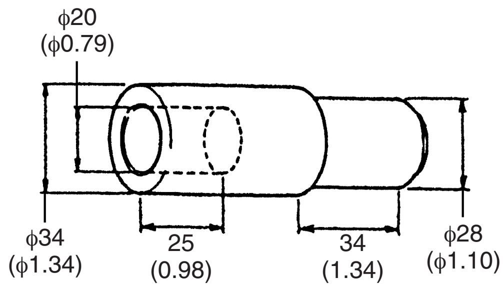

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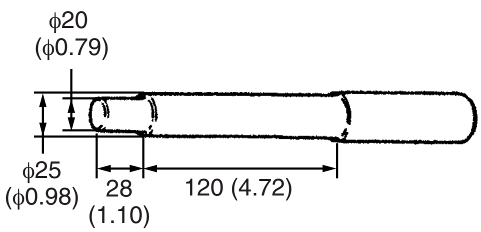

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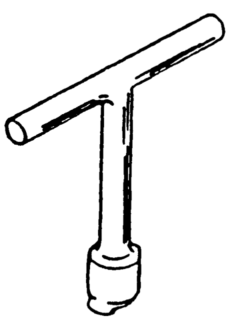

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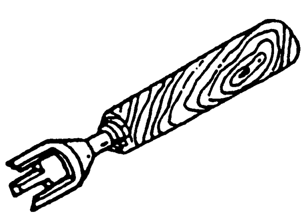

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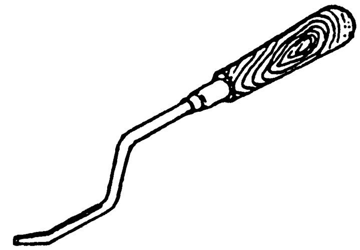

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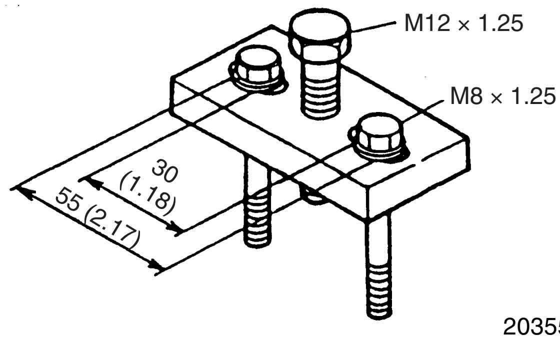

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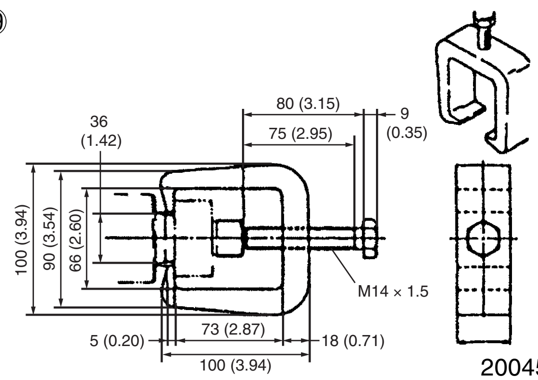

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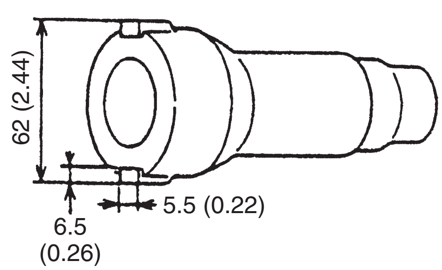

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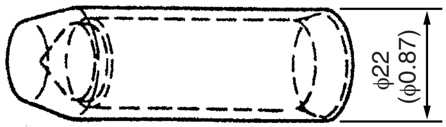

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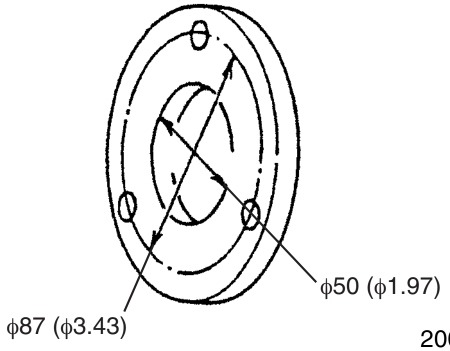

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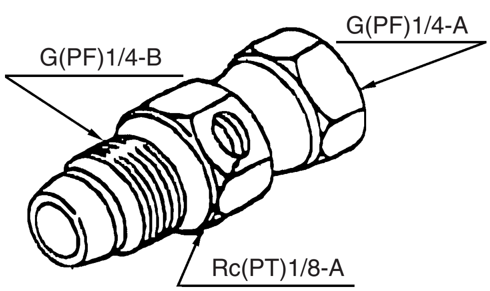

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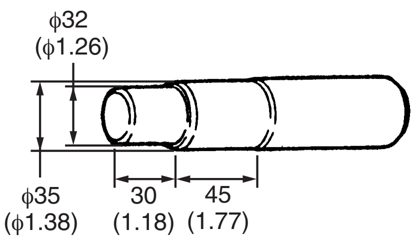

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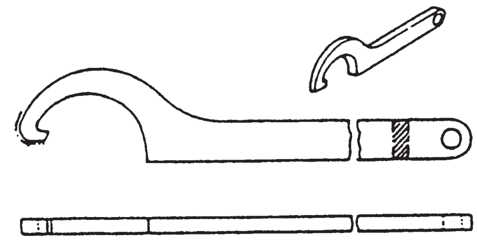

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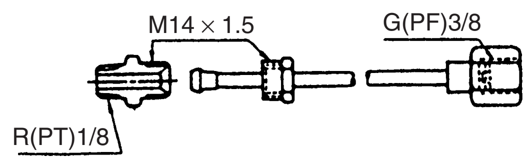
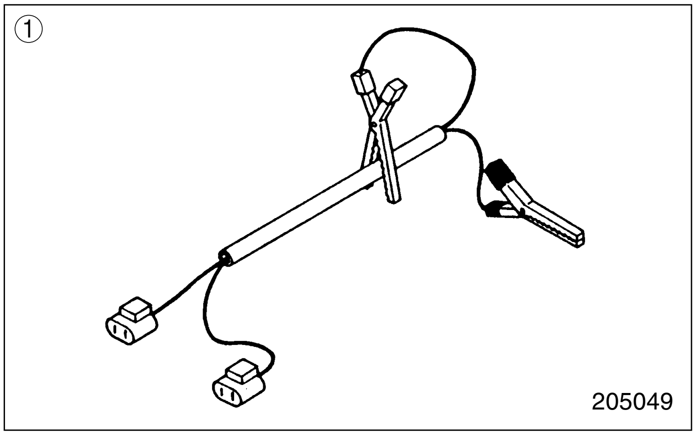
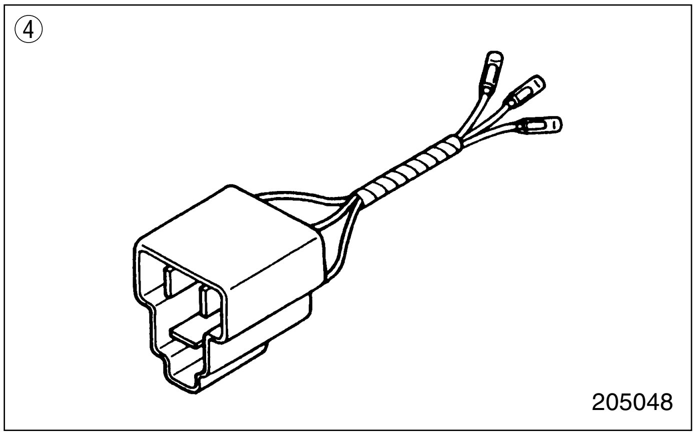


203557

Special Service Tools (FC Truck only)

Ref No.	Part number	Part name	Used for / Truck model	1 ton class	2 ton class	3 ton class
1	91105 - 00400	Emergency harness	For actuating control valve in an emergency (Connection of control valve to battery)	○	○	○
2	91105 - 00500	Inspection connector 2P-M	Male	○	○	○
3	91105 - 00600	Inspection connector 2P-F	Female	○	○	○
4	91105 - 00700	Inspection connector 3P-M	Male	○	○	○
5	91105 - 00800	Inspection connector 3P-F	Female	○	○	○
6	91105 - 00900	Inspection connector 6P-M	Male	○	○	○
7	91105 - 01100	Inspection connector 6P-F	Female	○	○	○
8	91105 - 01200	Inspection connector 2P-M	Male	○	○	○
9	91105 - 01300	Inspection connector 2P-F	Female	○	○	○
10	91105 - 01400	Inspection connector 3P-M	Male	○	○	○
11	91105 - 01500	Inspection connector 3P-F	Female	○	○	○
12	91105 - 01600	Inspection connector 6P-M	Male	○	○	○
13	91105 - 01700	Inspection connector 6P-F	Female	○	○	○
14	91105 - 01800	Inspection connector 8P-M	Male	○	○	○
15	91105 - 01900	Inspection connector 8P-F	Female	○	○	○
16	91105 - 02100	Inspection connector 12P-M	Male	○	○	○
17	91105 - 02200	Inspection connector 12P-F	Female	○	○	○
18	91105 - 02300	Inspection connector 7P-M	Male	○	○	○
19	91105 - 02400	Inspection connector 7P-F	Female	○	○	○
20	91105 - 02500	Inspection connector 64P-FM	Male	○	○	○





Note: There are a total of 19 types of the inspection connectors 2 thru 20. They are supplied as a set or individually. The connector 4 is shown.

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- ☐ Option Bulletin
- ☐ Part List/Manual
- ☐ Special Instruction
- ☐ Service Manual
- ☐ Service Data Manual
- ☐ Electronic Manual
- ☐ Other: ______________________________

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Cat Lift Trucks **Service Manual** **GP/DP15N-35N** **99719-69100**

Lift Trucks

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