CAT® Lift Trucks

Service Manual

Chassis & Mast

P30001	AT34-10121-up
P35001	AT34-10121-up
PC40001	AT34-60121-up
P40001	AT35-10121-up
P50001	AT35-10121-up
P55001	AT36-10121-up
P60001	AT13F-10121-up
P65001	AT13F-60121-up
P70001	AT13F-60121-up
P40001	AT18C-10121-up
P50001	AT18C-10121-up
P55001	AT37-10121-up
P60001	AT14E-10121-up
P65001	AT14E-60121-up
P70001	AT14E-60121-up

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

99719-89120

FOREWORD

This service manual is a guide for servicing Cat® Lift Trucks. For your convenience the instructions are grouped by systems as a ready reference.

Long productive life of your lift trucks depends on regular and proper servicing. Servicing consistent with what you will learn by reading this service manual. Read the respective sections of this manual carefully and familiarize yourself with all of the components before attempting to start a test, repair or rebuild job.

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

The trucks listed in this manual are powered by K21-K25 gasoline engines or 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:

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

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. 99719-89120

SAFETY

WARNING

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

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

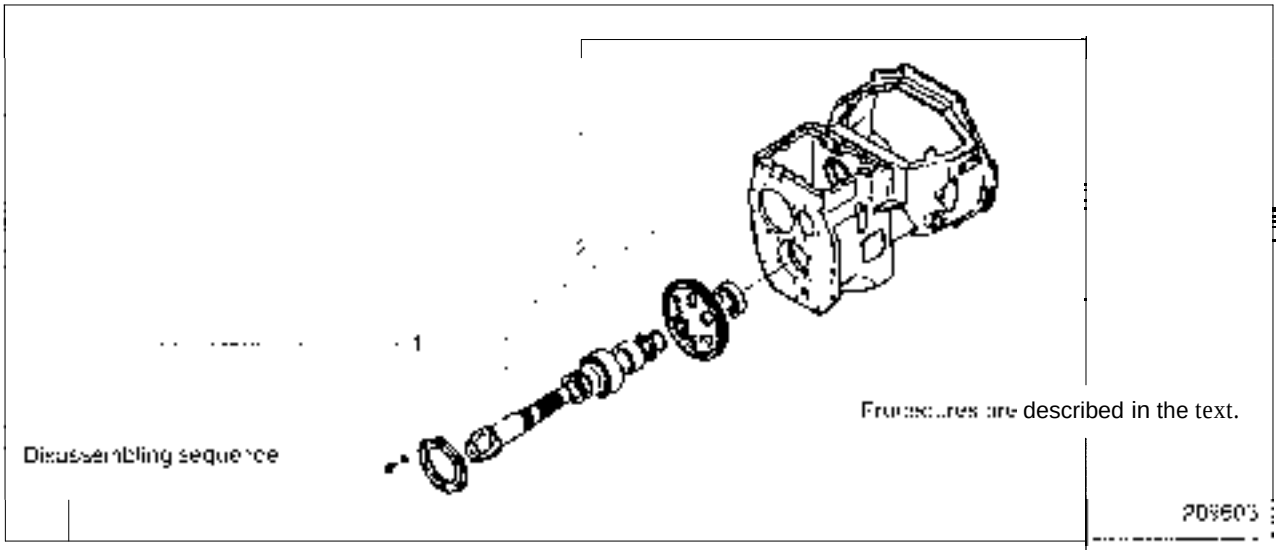
Do not operate these trucks unless you have read and understood the instructions in the OPERATION & MAINTENANCE MANUAL. Improper truck operation is dangerous and could result in injury or death.

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.

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

Disassembly diagram (example)



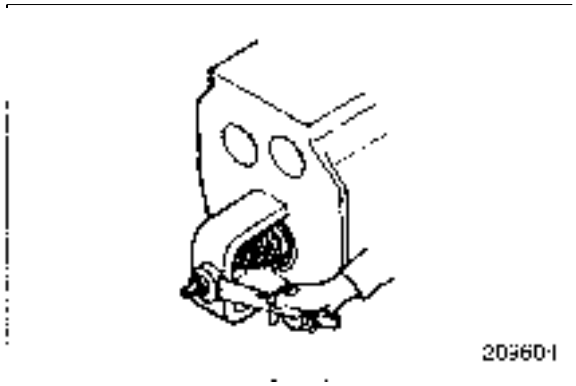
Sequence

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
	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) 118 inch (formerly PT1/8)
G1/4A	Straight pipe thread (external) 1/4 inch (formerly [illegible])
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	0.10[illegible] kgf
Pressure	1 kPa	0.0102 kgf/cm²
Torque	1 N·m	0.1012 kgf·m

GROUP INDEX

GROUP INDEX	Items	
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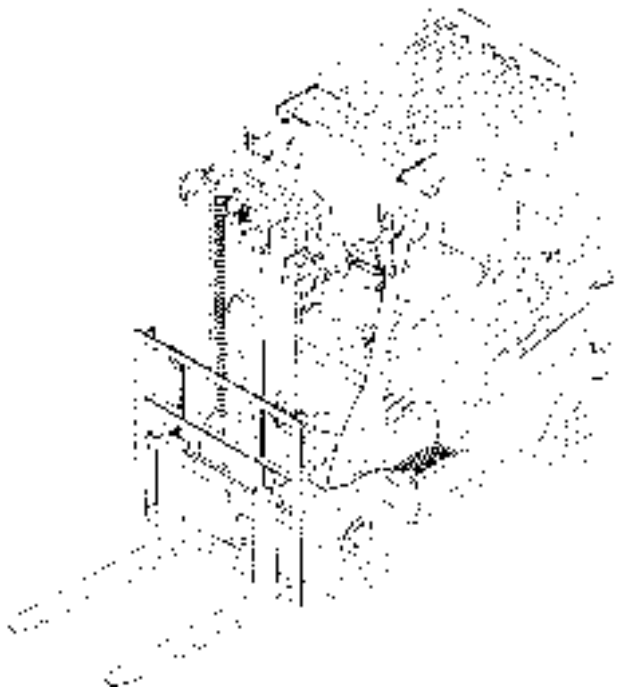
GENERAL INFORMATION

Model View



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Truck Models Covered

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

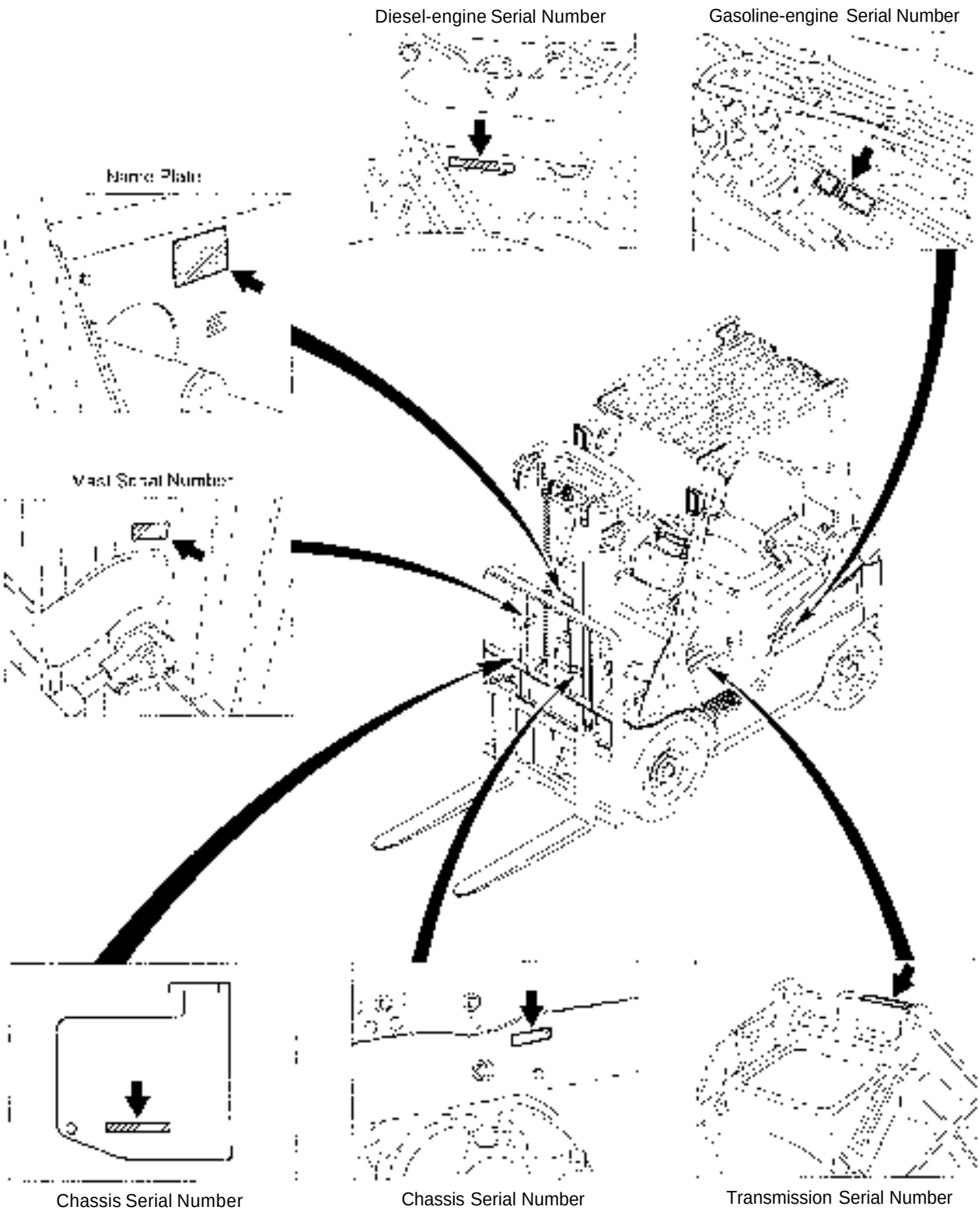
Truck class	Gasoline-engine models			Dual fuel gasoline-engine models		
	Truck model	Serial number	Engine mounted	Truck model	Serial number	Engine mounted
1 ton class	P30001	AT34-10121-up	K21	P30001	AT34-10121-up	K21
	P35001	AT34-10121-up	K21	P35001	AT34-10121-up	K21
	P[illegible]0001	AT34-60121-up	K21	P[illegible]0001	AT34-60121-up	K21
2 ton class	P40001	AT35-10121-up	K25	P40001	AT35-10121-up	K25
	P50001	AT35-10121-up	K25	P50001	AT35-10121-up	K25
	P55001	AT36-10121-up	K25	P55001	AT36-10121-up	K25
3 ton class	P60001	AT13F-10121-up	K25	P60001	AT13F-10121-up	K25
	P65001	AT13F-60121-up	K25	P65001	AT13F-60121-up	K25
	P70001	AT13F-60121-up	K25	P70001	AT13F-60121-up	K25

Truck class	LPG-engine models			Diesel-engine models		
	Truck model	Serial number	Engine mounted	Truck model	Serial number	Engine mounted
1 ton class	P30001	AT34-10121-up	K21			
	P35001	AT34-10121-up	K21		—	—
	P[illegible]0001	AT34-60121-up	K21			
2 ton class	P40001	AT35-10121-UP	K25	P40001	AT35-10121-up	S4S
	P50001	AT35-10121-up	K25	P50001	AT35-10121-up	S4S
	P55001	AT36-10121-up	K25	P55001	AT36-10121-up	S4S
3 ton class	P60001	AT13F-10121-up	K25	P60001	AT13F-10121-up	S4S
	P65001	AT13F-60121-up	K25	P65001	AT13F-60121-up	S4S
	P70001	AT13F-60121-up	K25	P70001	AT13F-60121-up	S4S

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

C: Short body model

Serial Number Locations



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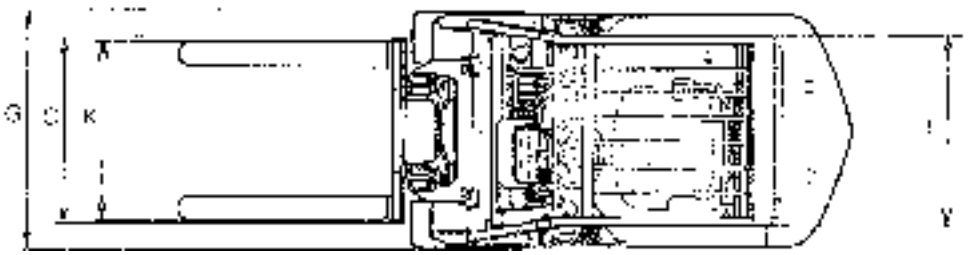
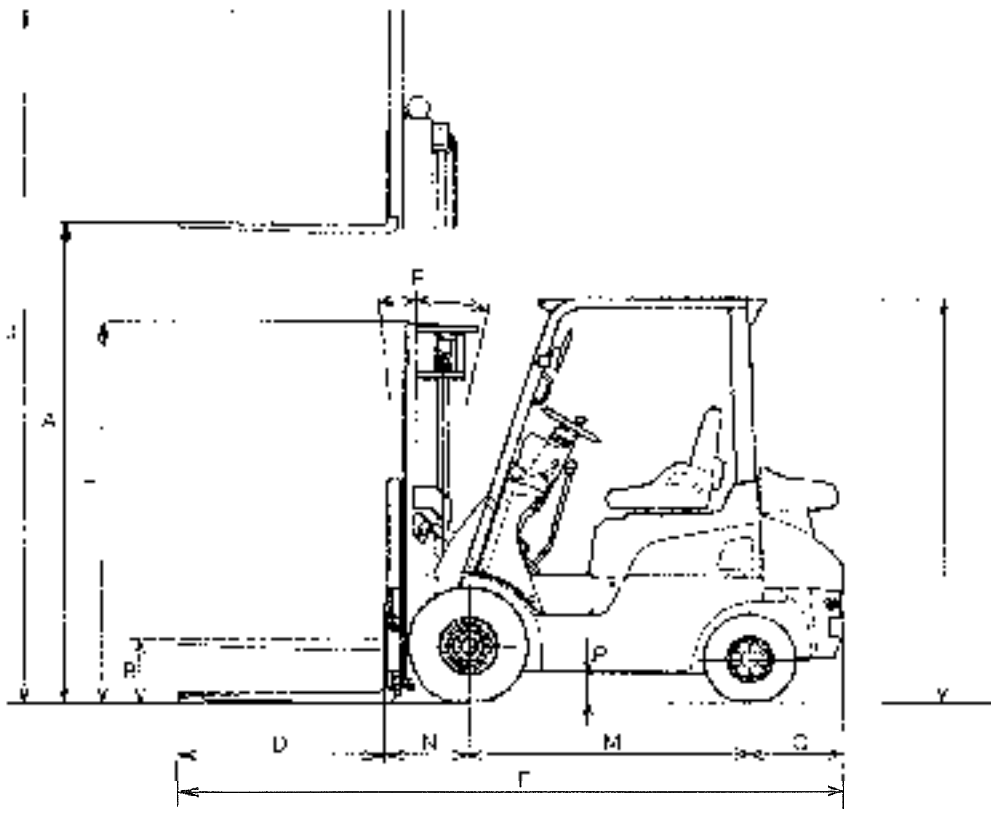
Dimensions





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Technical Data

Unit: mm (in.)

Ref. No.	Item \ Model: Gasoline-engine Truck / Diesel-engine Truck		[illegible]	[illegible]	[illegible]
A	Maximum lift		3000 (118)		
B	Free lift		115 (4.5)		
C	Fork spread (outside)		[illegible]		220 to 1050 (8.7 to 39.1)
D	Fork length		920 (36.2)		
E	Tilt angle (forward – backward)		6° – 12°		
F	Overall length		3180 (125.2)	3321 (126.8)	3279 (129.1)
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		[illegible]		[illegible]
O	Rear overhang		[illegible]	[illegible]	[illegible]
P	Underclearance (at center)		[illegible]		

Unit: mm (in.)

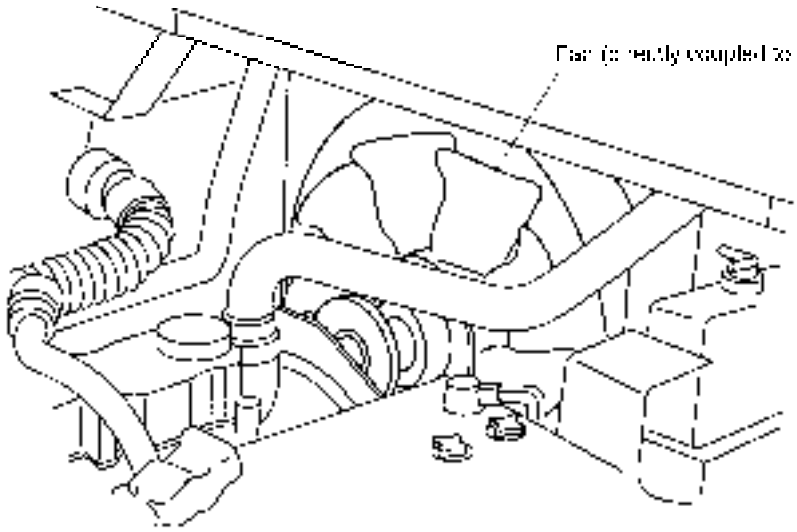
E4000	P5000	P5500	P6000	P6500	P7000
P4000	P5000	P5500	P6000	P6500	P7000
4000 (157.5)					
140 (5.5)		150 (5.9)			
220 to 1000 (8.7 to 39.4)		250 to 1000 (9.8 to 39.4)			
920 (36.2)		1070 (42)			
6° – 12°					
3408 (134.3)	3625 (142.8)	3720 (146.6)	3795 (149.4)	3827 (150.8)	3860 (152.0)
1150 (45.3)		1275 (50.2)		1290 (50.8)	
1480 (58.3)		1490 (58.7)			
1995 (78.5)		2045 (80.5)		1280 (50.4)	
2070 (81.5)		2095 (82.5)		2105 (82.9)	
4055 (159.8)		4085 (160.9)		4055 (159.8)	
960 (37.8)		1060 (41.7)			
1140 (44.9)					
980 (38.6)					
1600 (63)		1620 (63.8)	1700 (67)		
355 (13.9)		495 (19.5)			
355 (14)	500 (19.7)	540 (21.3)	535 (21.1)	567 (22.3)	600 (23.6)
160 (6.3)		190 (7.5)		200 (7.9)	

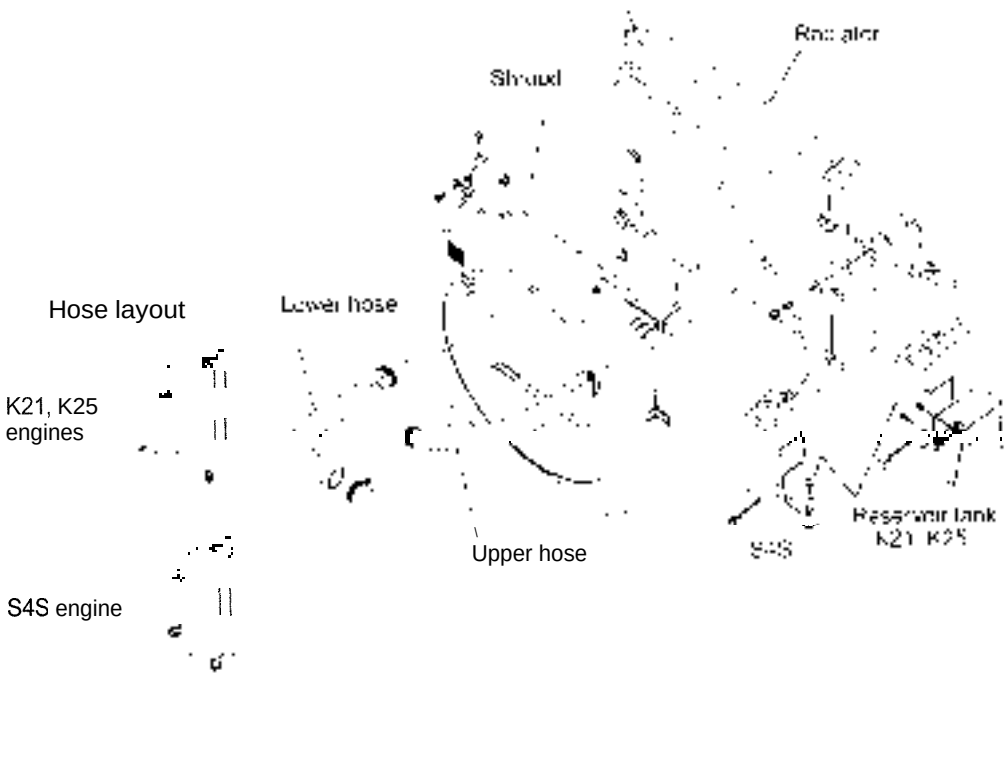
COOLING SYSTEM

Specification

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

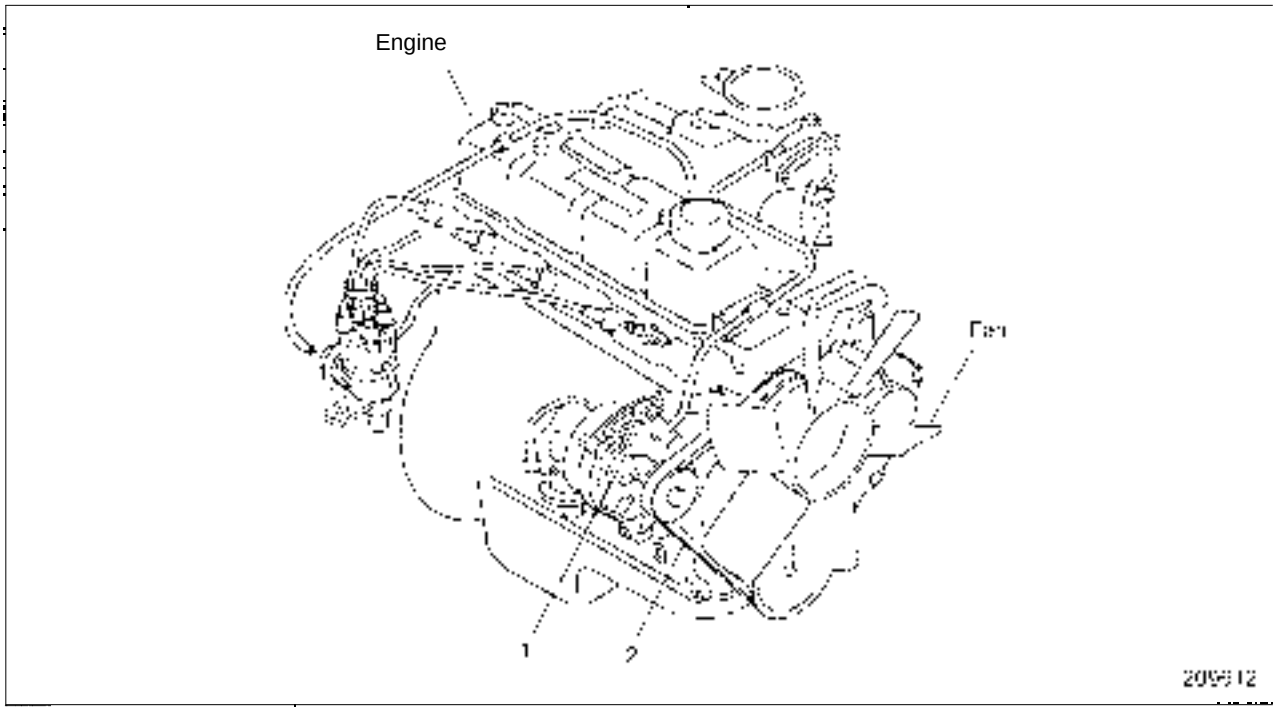
Structure





Removal and Installation

Fan Belt Removal



Sequence

1 Tension pulley assembly, Bolt
2 Fan belt

Start by:

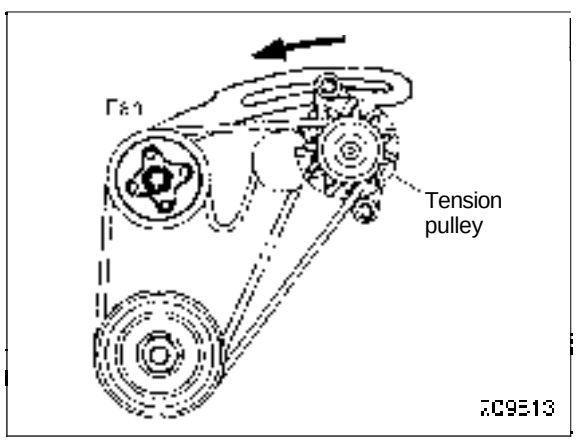
Remove the radiator cover.

Suggestions for Removal

(I) 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.

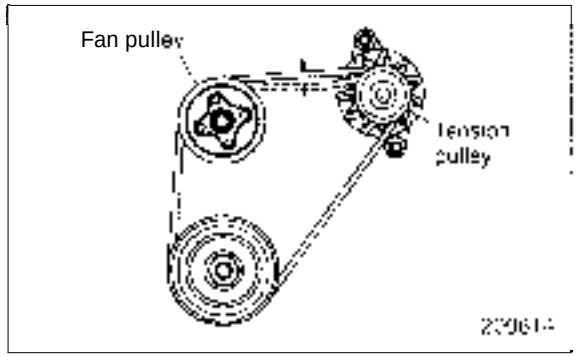
(2) After installing the belt, push it to make sure that the tension pulley moves, then tighten the pulley lock bolt firmly.

Inspection and Adjustment

Fan Belt Inspection

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

(2) During the engine overhaul or belt tension adjustment, check the condition of the belt. Replace the belt if it has any damage.

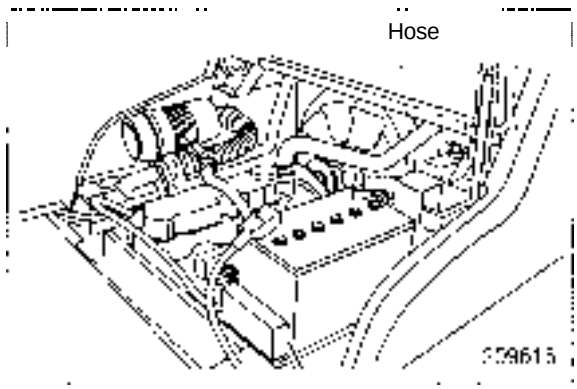


Fan Belt Tension

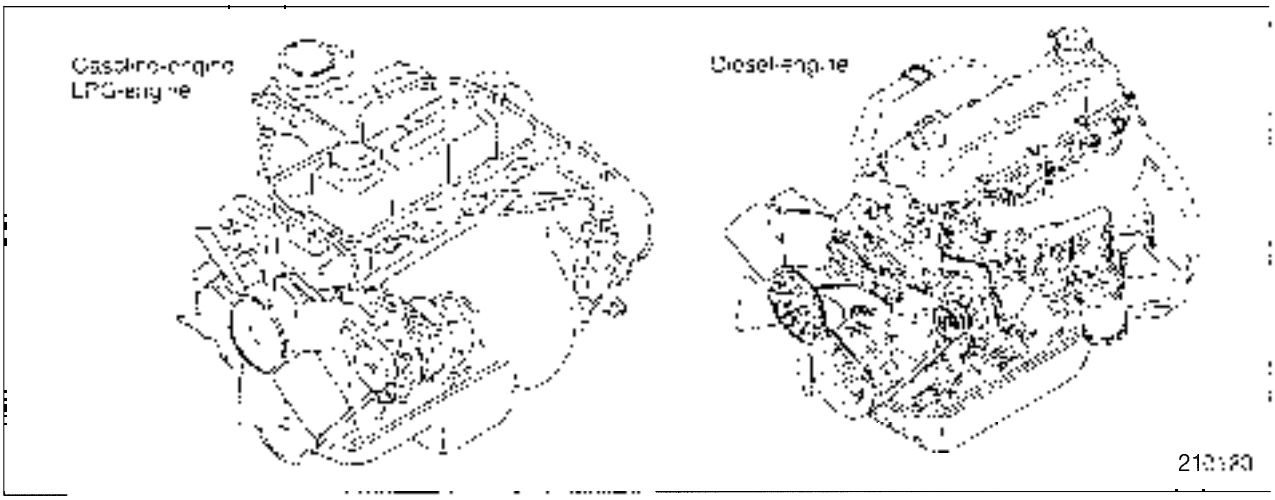
Apply a force of 98 N (10 kgf) [22 lbf] perpendicularly to the belt at a point midway between the fan pulley and tension pulley. Adjust the tension until belt deflection is between 11 to 13 mm (0.43 to 0.51 in.).

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 over the flare of the fitting.



Unit Layout



Coolant

Fill the radiator with coolant containing antifreeze. After starting the engine and letting it warm up during operation, check for abnormal noises. Check the coolant level in the reserve tank to ensure it meets specifications.

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)	[illegible]	[illegible]	[illegible]
Oil cooler	0.094 (0.02)	—	—

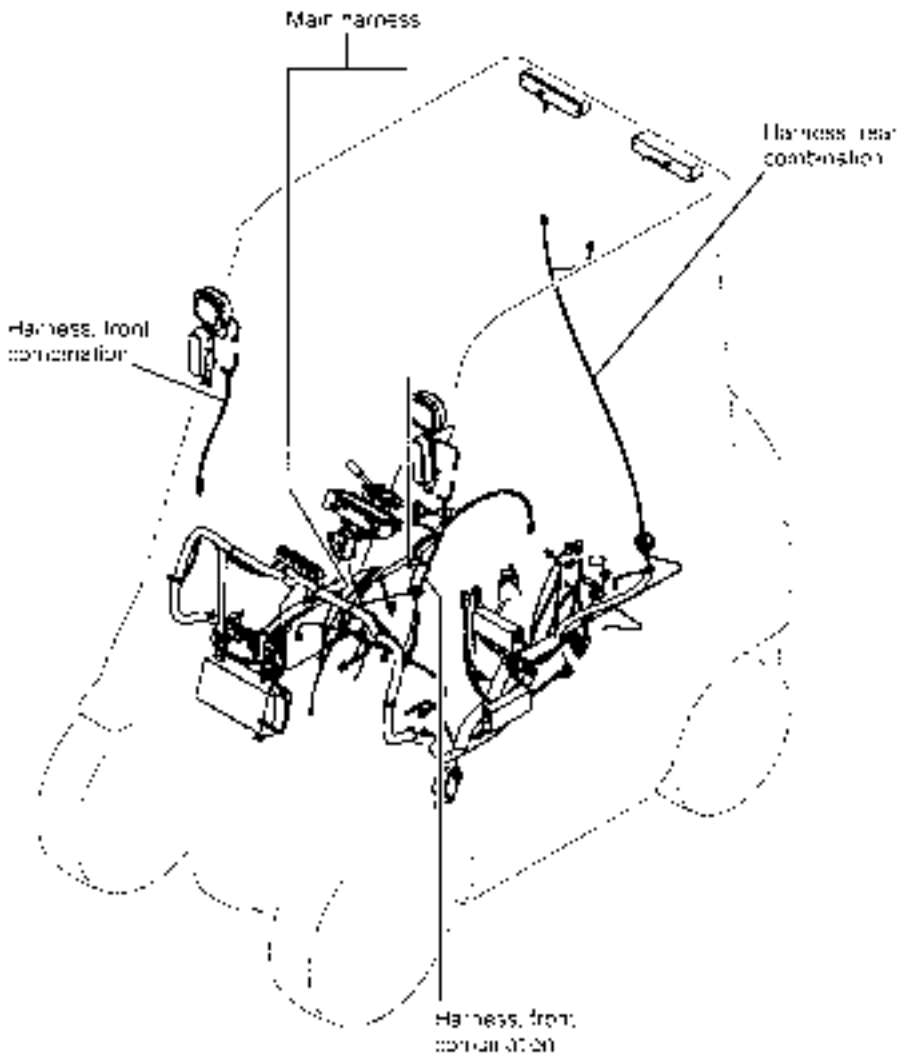
Radiator Cap

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]

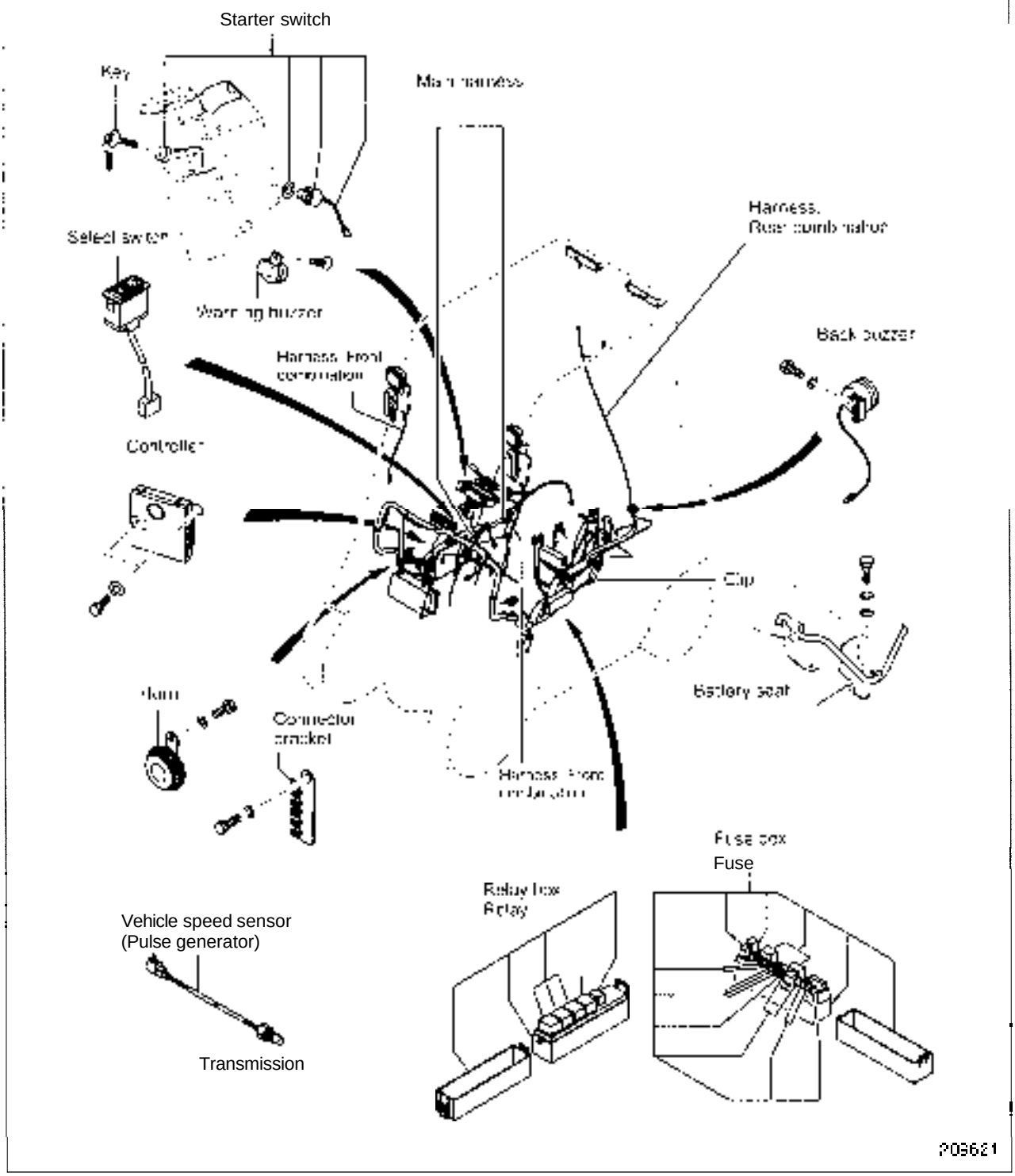
ELECTRICAL SYSTEM

3

Chassis Electrical Devices Wiring Outline (No. 1)

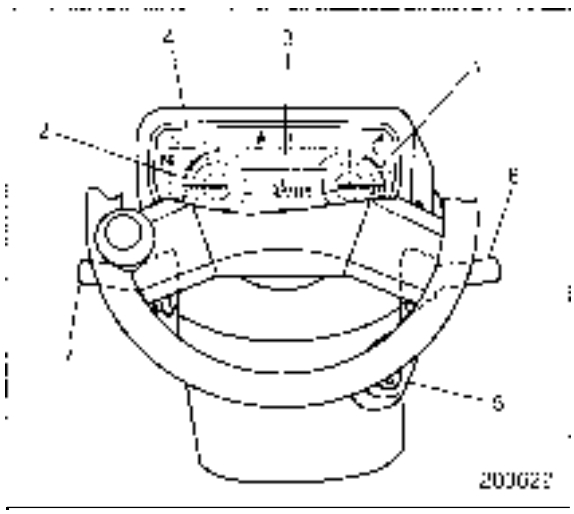


Chassis Electrical Devices Wiring Outline (No. 2)



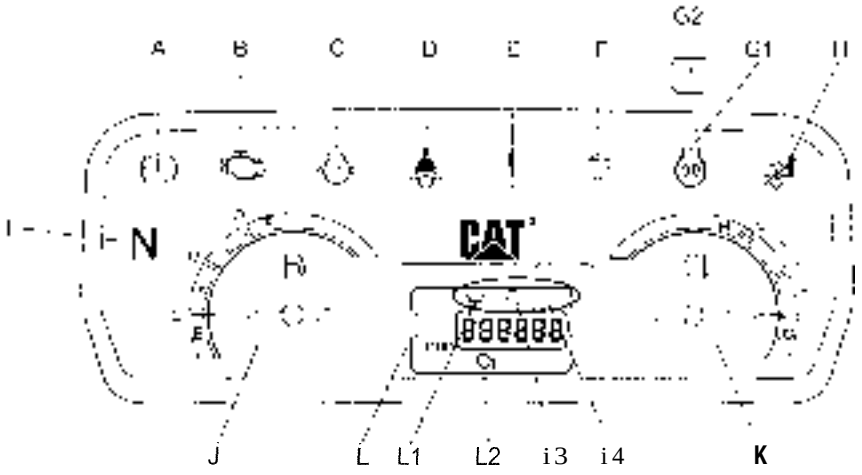
Structure

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	Park ing brake fluid warning lamp	Parking brake released /normal level	Parking brake applied low level	—
B	ECM warning lamp	Normal	ECM abnormal	Gasoline-engine truck
C	Engine oil pressure warning lamp	Normal oil pressure	Low oil pressure	—
D	Seat belt reminder warning lamp	Fastened	Not fastened	—
	Multi-purpose warning lamp (illuminates when warnings indicated by printed symbols occur or minor failures occur)	Normal	Malfunction	Printed symbol
	Charge warning lamp	Normal charging	Abnormal charging system	—
G1	Glow pilot lamp	Preheating completed	Engine being preheated	Diesel-engine truck
G2	LP-Gas warning lamp	Normal	LPG fuel level low or pressure low	LP Gas truck
H	Loadiunload interlock lamp	Free	Locked	—
I	Fr, Re interlock lamp	Free	Locked (flashing)	—
	Neutral lamp	F or R	Neutral	—
J	Fuel gauge	Indicates remaining fuel amount with key in "ON" position.		
K	Water temperature gauge	Indicates "Overheat" condition if pointer enters the red zone.		
L	Liquid crystal (normally acting as hour meter)	Indicates operating hours with key in "ON" position.		
L1	Fuel filter warning lamp	Normal	Water should be drained	Diesel-engine truck
L2	Torque converter oil warning lamp	Normal temperature	Overheat	
L3	Coolant level warning lamp	Normal level	Low level	Option
L4	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

All warning and indicator lamps are normal if they illuminate when the starter switch is turned ON, and no bulbs are blown.

Major Electrical Components

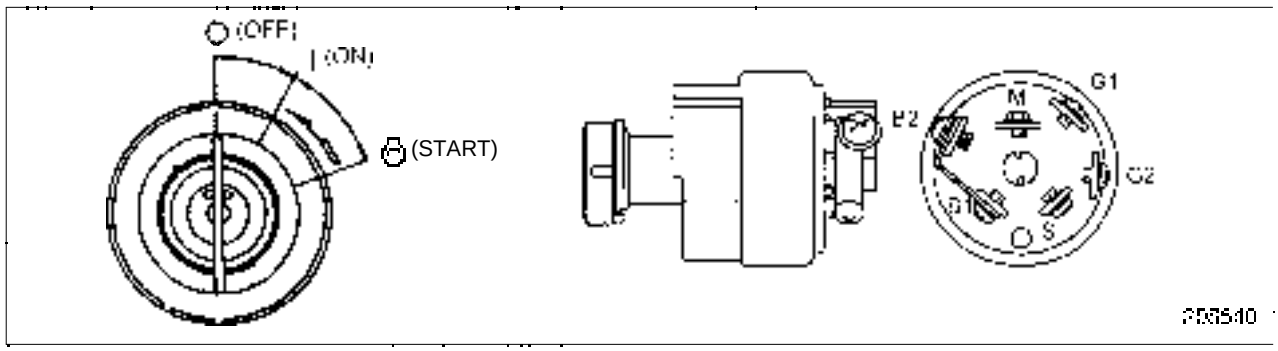
Starter switch

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

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

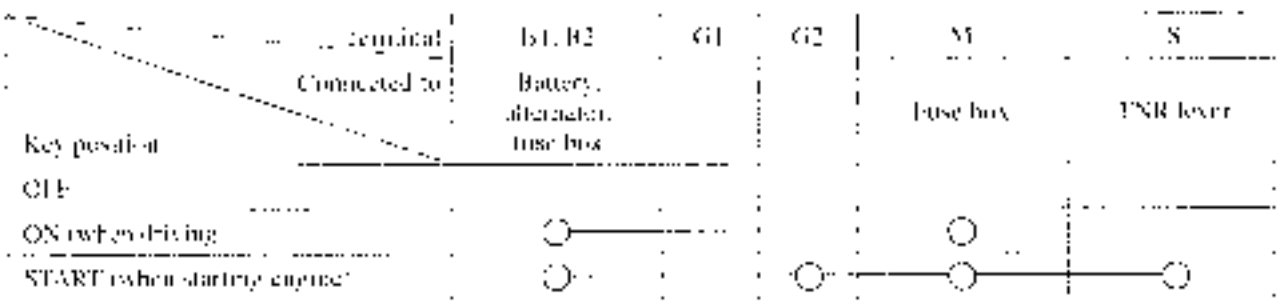
Starter switch (with Anti-Restart Lock)

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

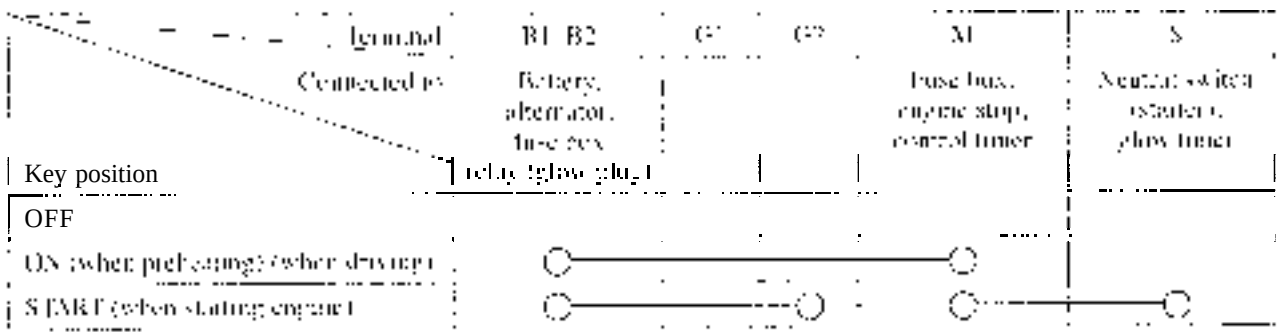


Connection Table

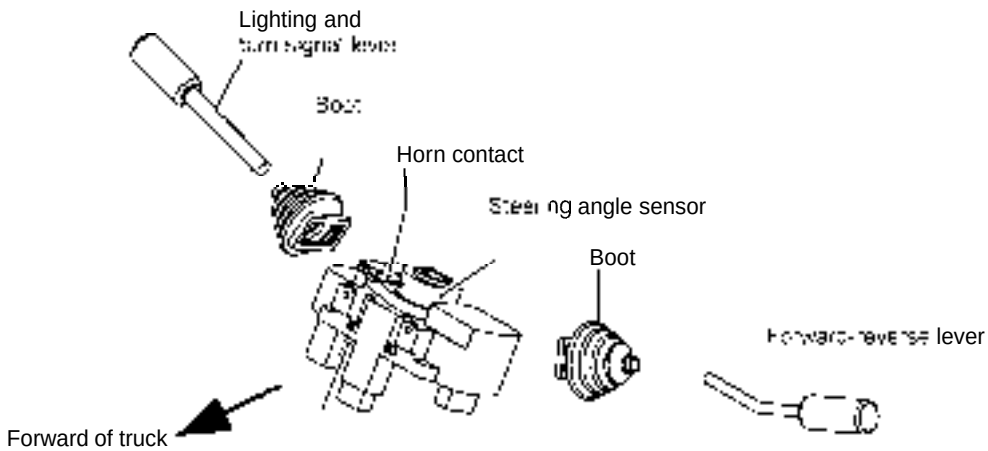
Gasoline-engine truck



Diesel-engine truck

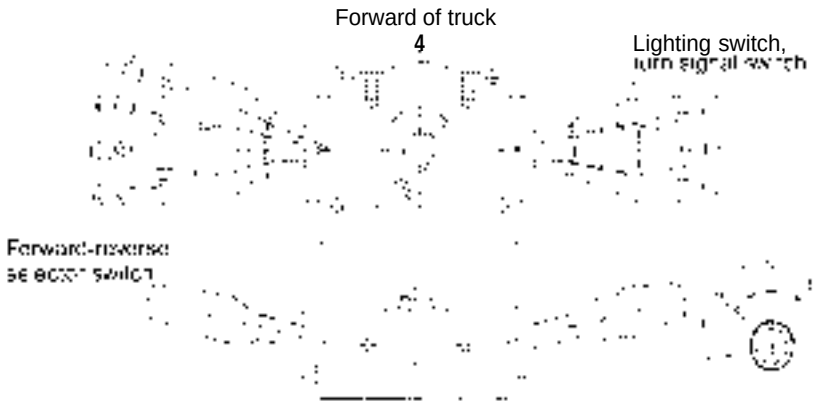


Lighting switch and turn signal switch

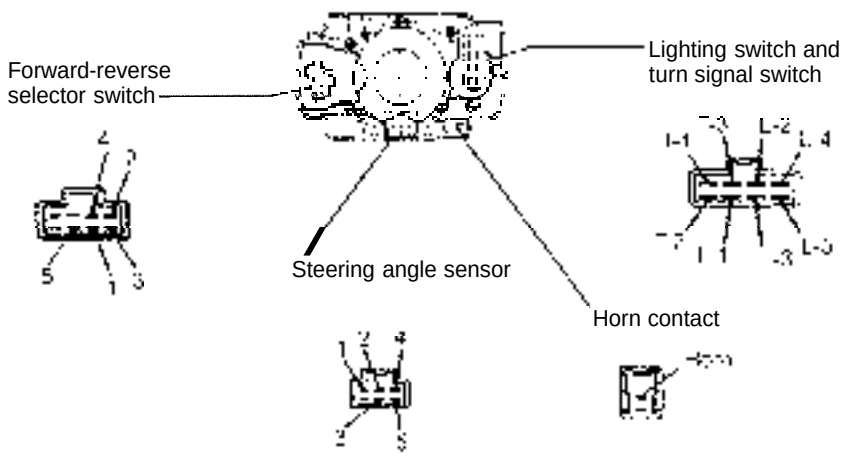


Lighting switch, turn signal switch

209625



209626



209627

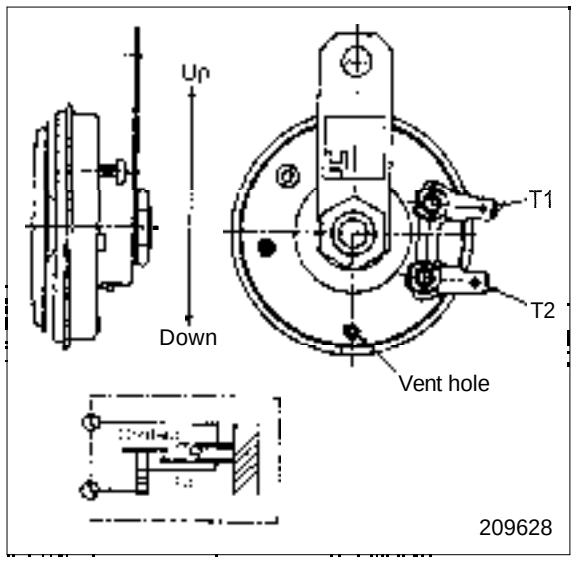
Morn

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

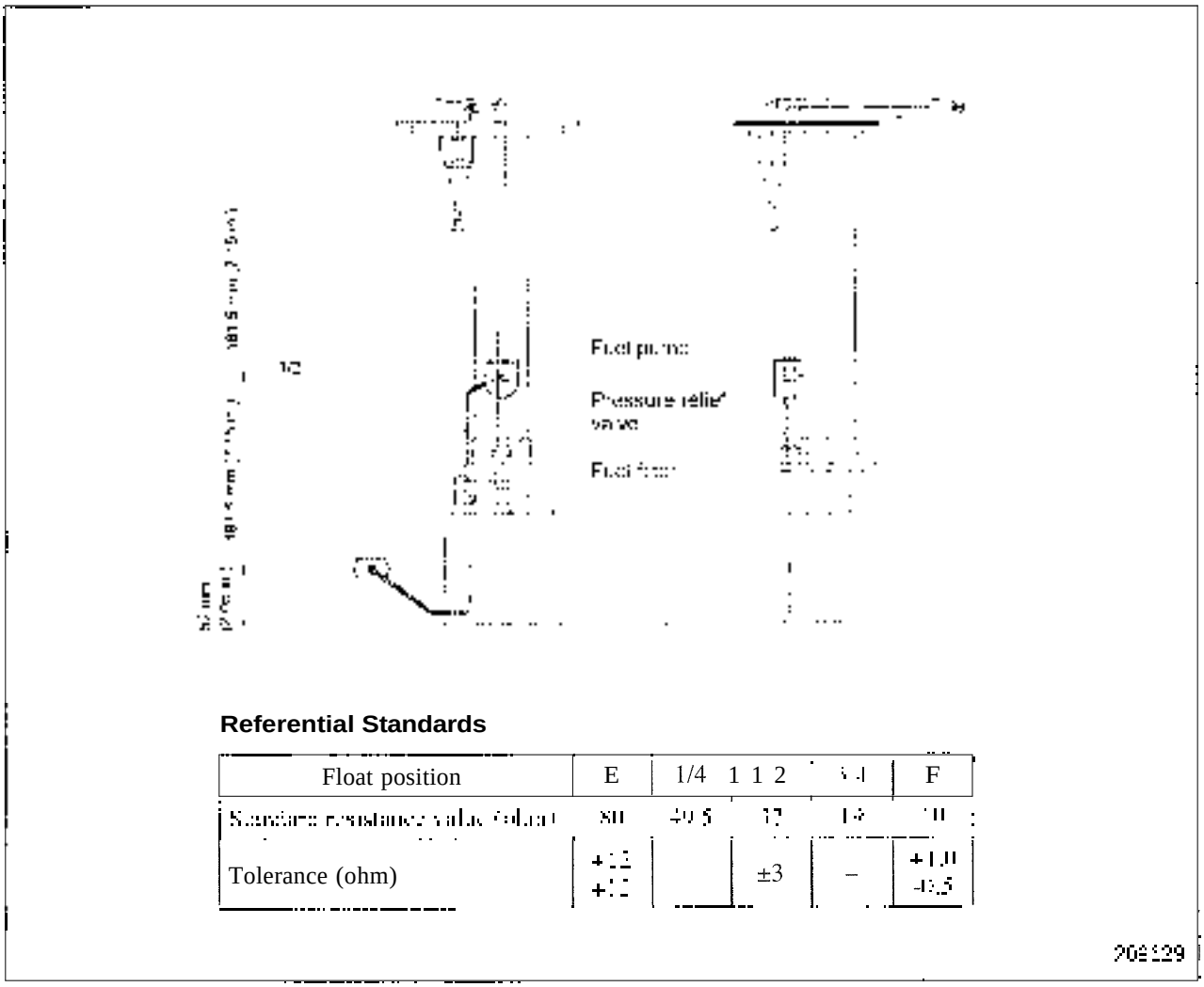
Replace the horn if it does not sound or its sound is abnormal.

Operating voltage: DC 12 V

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



Tank Unit

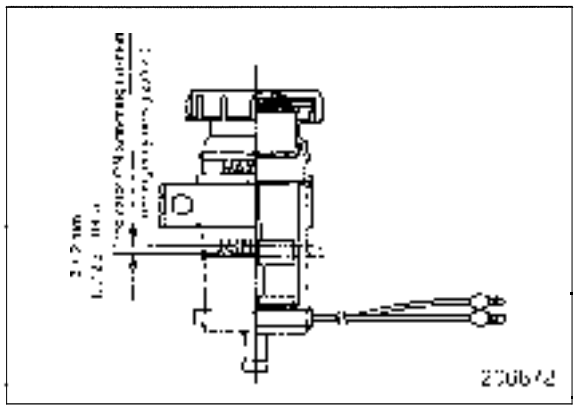


Referential Standards

Float position	E	1/4	1	1	2		F
Standard resistance value (ohm)	80	29.5		12		1.5	10
Tolerance (ohm)	+1.5 +1.2			±3		–	+1.0 -0.5

Brake fluid sensor

Refer to the brake system.

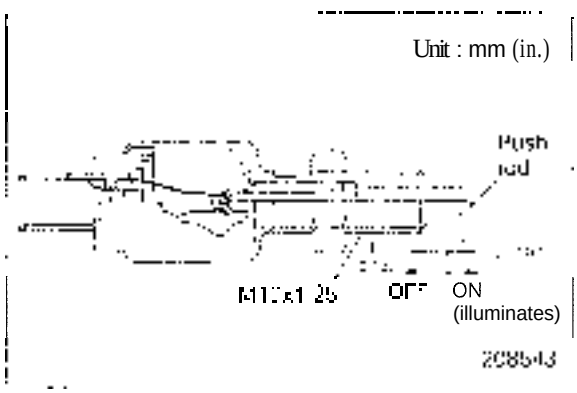


Stop lamp switch

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.

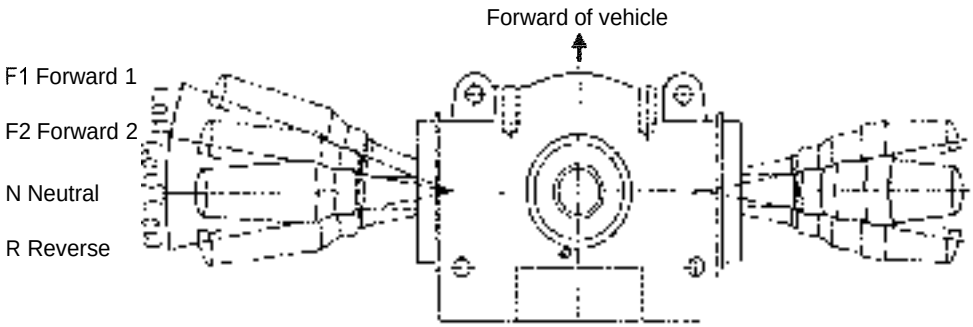
Replace the switch if the measured insulation resistance value is not more than the value listed below.



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

Rated voltage: DC 12 V

Forward-reverse lever assembly



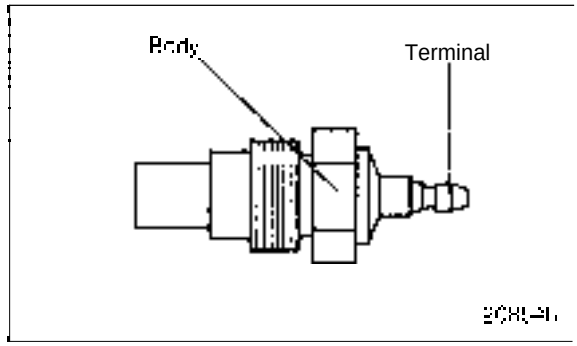
Connection table

Terminal	2	3	4	5
Wire color	GR/L	B	GIR	B	L/W
Lever position				
F (Forward)				
N (Neutral)				
R (Reverse)				

Sender unit (engine coolant temperature)

1. Apply an ohmmeter between the terminal and body of the sender unit and check for continuity (resistance value).
2. Replace the sending unit 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)	66 (150)	98 (208)	120 (248)	150 (302)
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 sending unit, tighten it to the specified torque.

Sending 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 an ohmmeter between the terminal and body and check for continuity (resistance value). Replace the thermoswitch 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

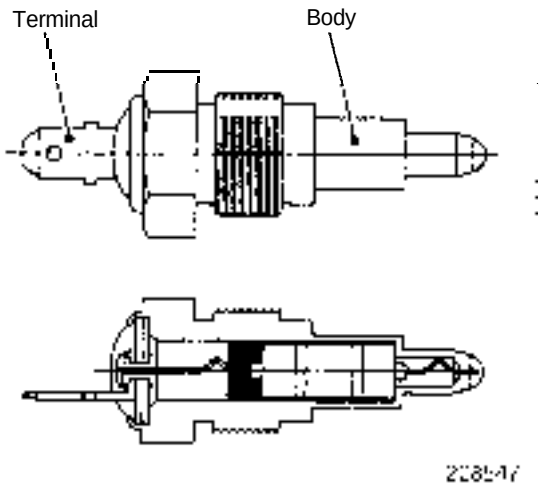
Note: When installing the thermoswitch, tighten it to the specified torque.

Tightening torque	[illegible]

CAUTION

Replace the thermoswitch if it was dropped or abused.

Main specifications		
Operating temperature	OFF → ON	123 ± 5 °C (253.4 ± 37.4 °F)
	ON → OFF	115 °C (239 °F) or more
Insulation resistance (with contact OFF)		1 M ohm or more



228547

Power relay (Backup lamps)

Inspection of coil

Apply an ohmmeter across terminal 1 and terminal 2 and measure the resistance value of the relay coil. If there is no continuity or the resistance value measured is outside the standard resistance value, replace coil.

Resistance value of coil	[illegible]

Inspection of contact

1. Measure the insulation resistance value between terminal **3** and terminal 4. Replace the contact 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 an ohmmeter across 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 between terminal **3** and terminal 4. Replace the relay if it was dropped or abused.

CAUTION

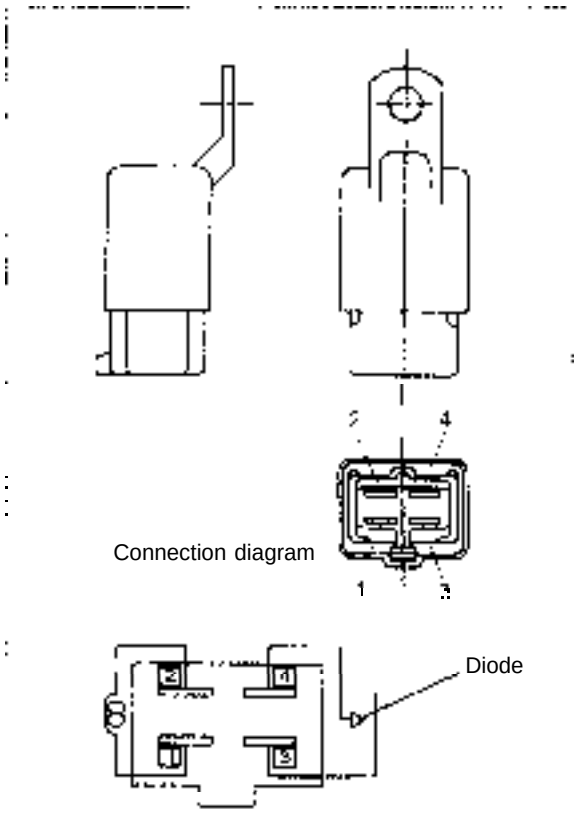
This part operates on DC 12 V power supply.

CAUTION

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

Coil rating [at 20°C (68°F)]

Rated operating voltage	DC 12 V
Working voltage	DC 8 V or less
Operation voltage	DC 0.6 to 6 V or more
Coil resistance	[illegible]
Rated exciting current	[illegible]



Glow timer (diesel-engine truck)

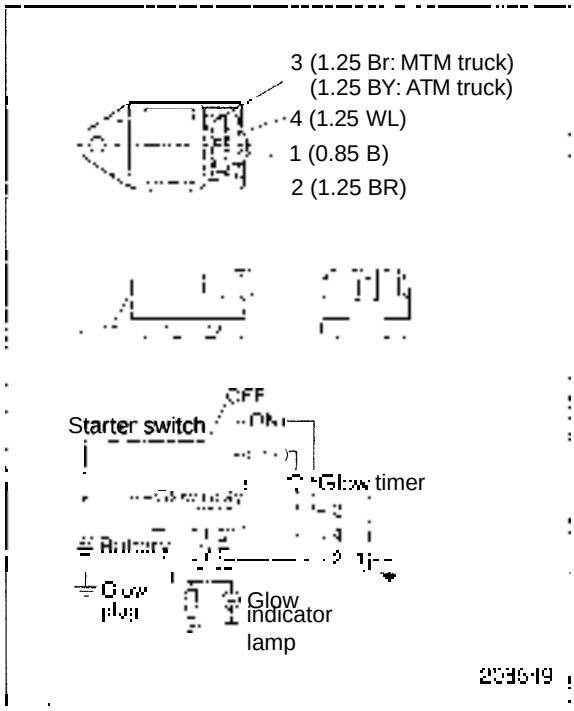
Inspection of output time when starter switch is turned to ON

When an ohmmeter 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 1.5 seconds at room temperature. Replace the glow timer with a new one if it does not operate properly.

Inspection of output time when starter switch is turned to START

When an ohmmeter 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

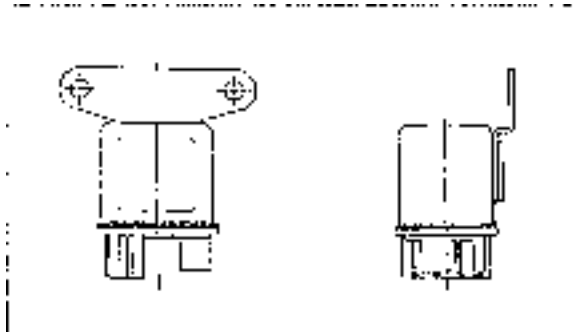


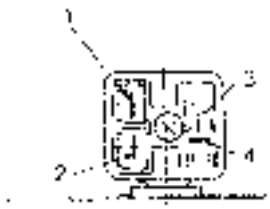
Glow relay (diesel-engine truck)

Inspection of coil

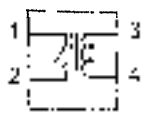
Apply an ohmmeter across terminal 3 and terminal 4 and measure the resistance value of the relay coil. If there is no continuity or the measured resistance value is outside the standard resistance value. Replace the coil.

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





Connection diagram



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.

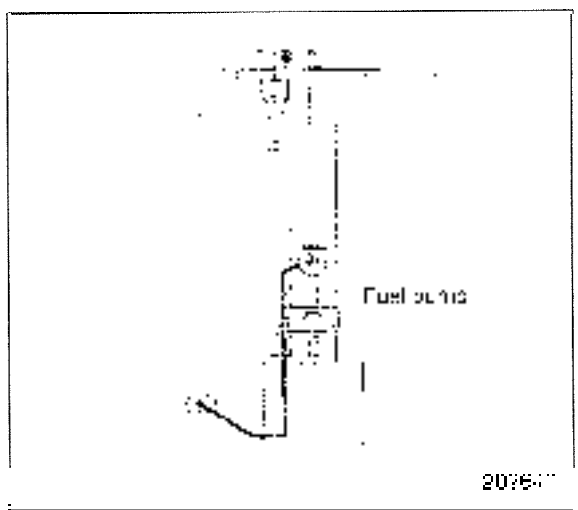
Coil rating [in case of 20°C (68°F)]

Rated operating voltage: DC 12 V

Coil resistance: 52 ohm

Rated exciting current: 80 mA

Fuel pump (gasoline-engine truck)



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 12V (gasoline-engine truck, resin color: grey)

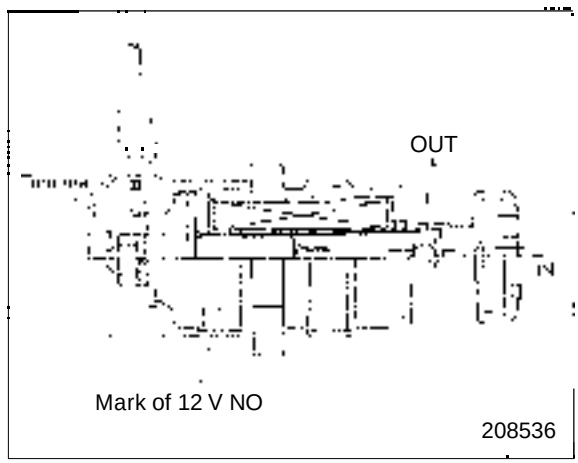
: DC 12V (diesel-engine truck, resin color: brown)

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 12V



Wiring to the solenoid valve terminal on SR side

Wire gauge and color 1.25 Br / [illegible] tag is attached.

Wiring to the solenoid valve terminal on SF side

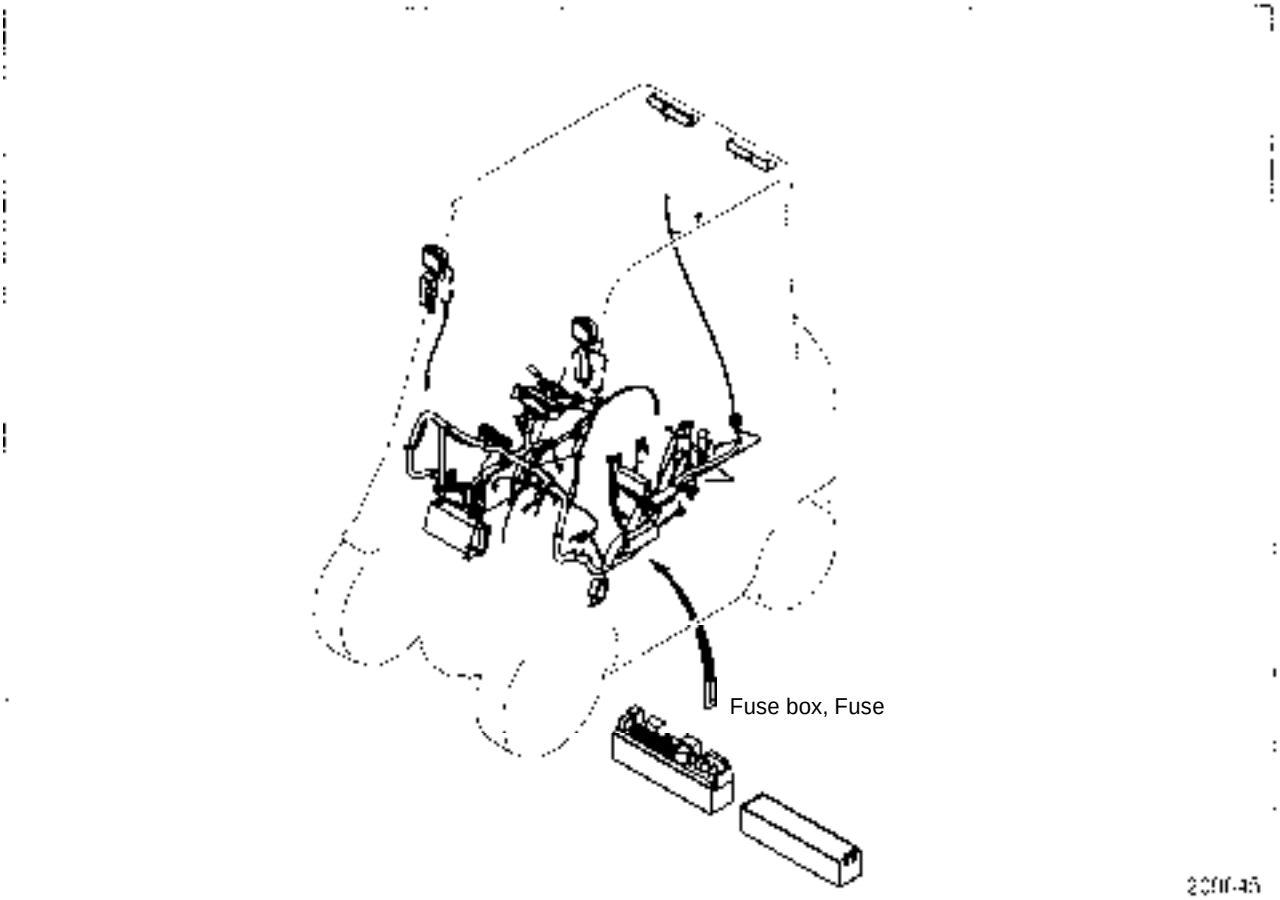
Wire gauge and color 1.25 LgR / [illegible] is attached.

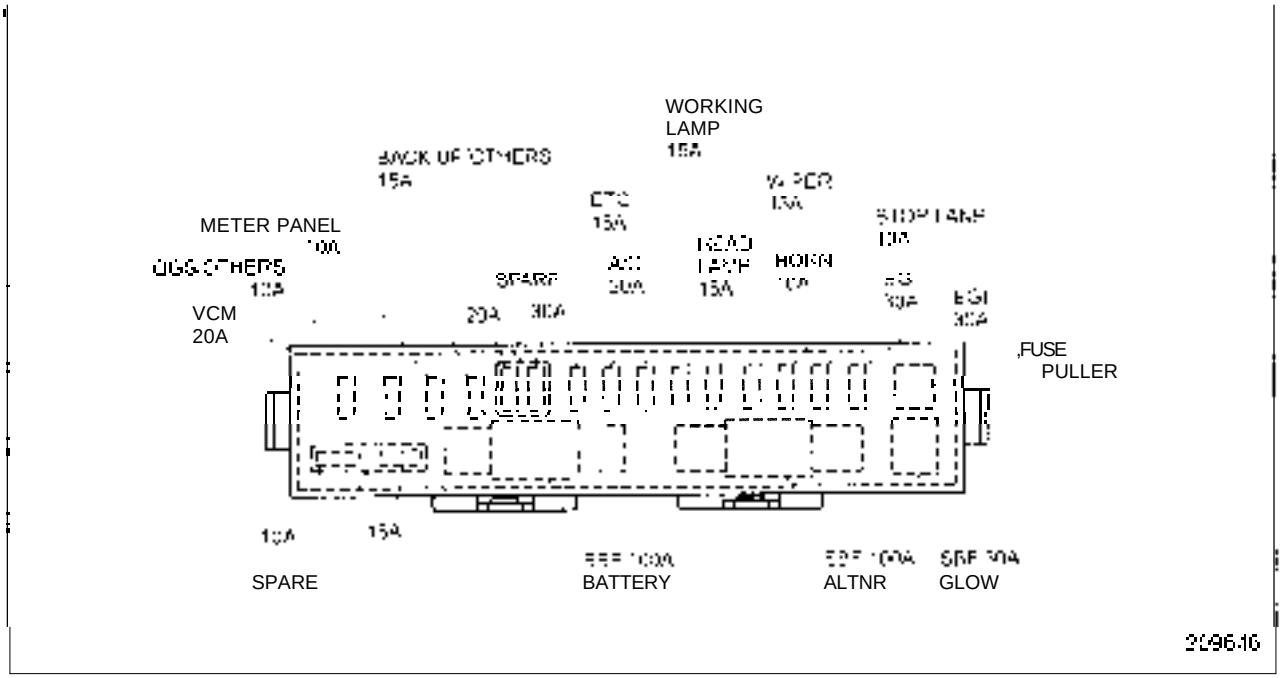
CAUTION

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

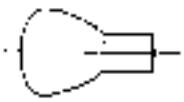
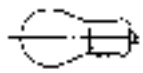
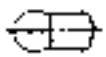
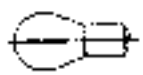
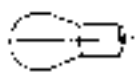
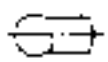
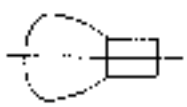
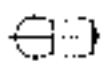
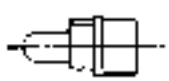
Be careful not to supply DC 24 V to the valve to avoid damage.

Fuse Box





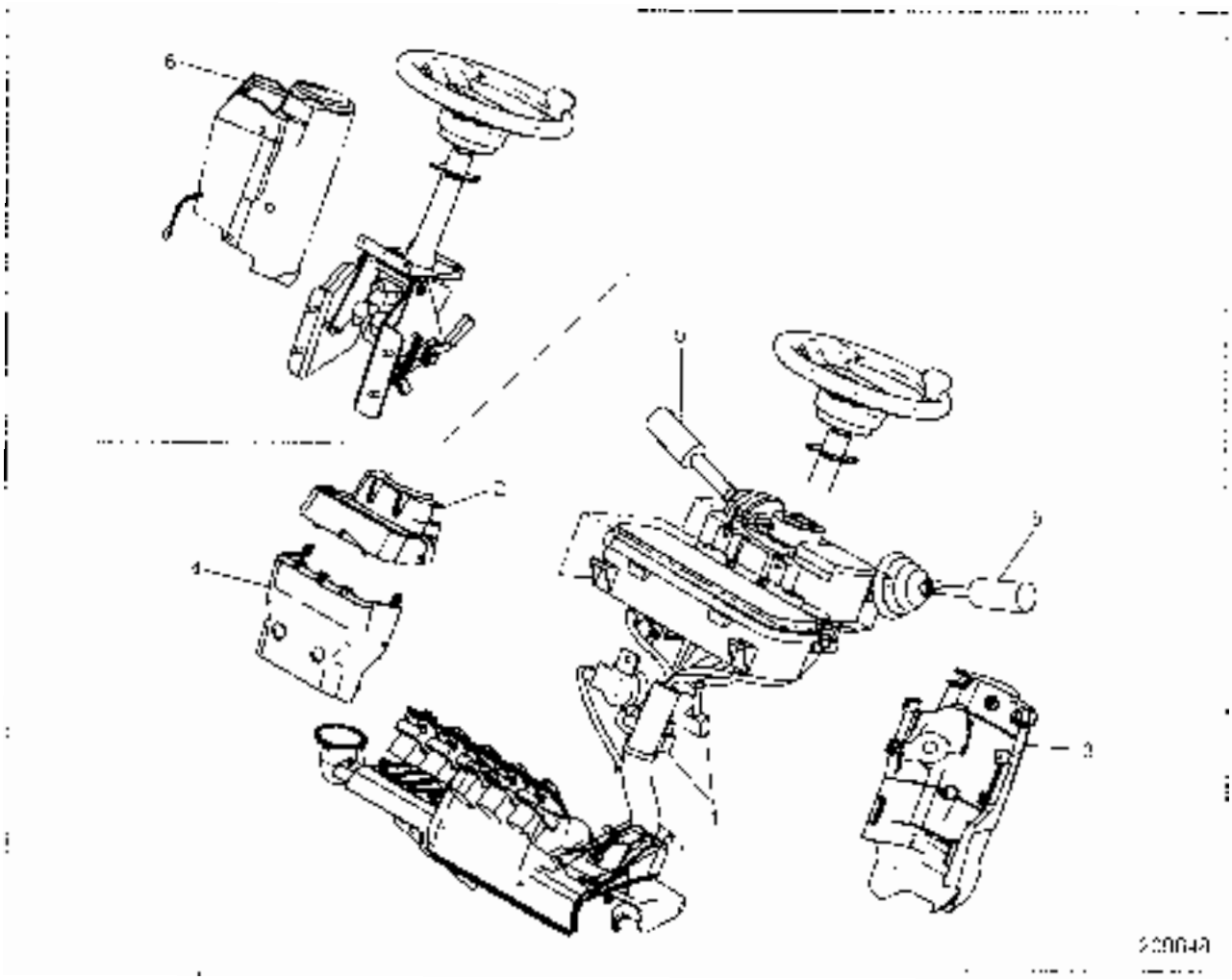
Lamp Bulb Specifications

Item / Type of Lamp		No. of bulbs	Color of lens	Watts 12 volt	Watts 24 volt	Shape	Remarks
Head lamps		2	Colorless	45	60		
Combination lamps (front)	Turn signal	2	Amber	27	25		Standard installed on overhead guard
	Clearance lamps	2	Amber	10	12		
	Turn signals	2	Amber	27	25		
Combination lamps (rear)	Tail-stop lamps	2	Red	8.23	10.25		
	Back-up 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		

E20016

Console Box

Disassembly



(1) Disconnect the electrical wiring from connector 1.

(2) Remove the screw using a flatblade 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.

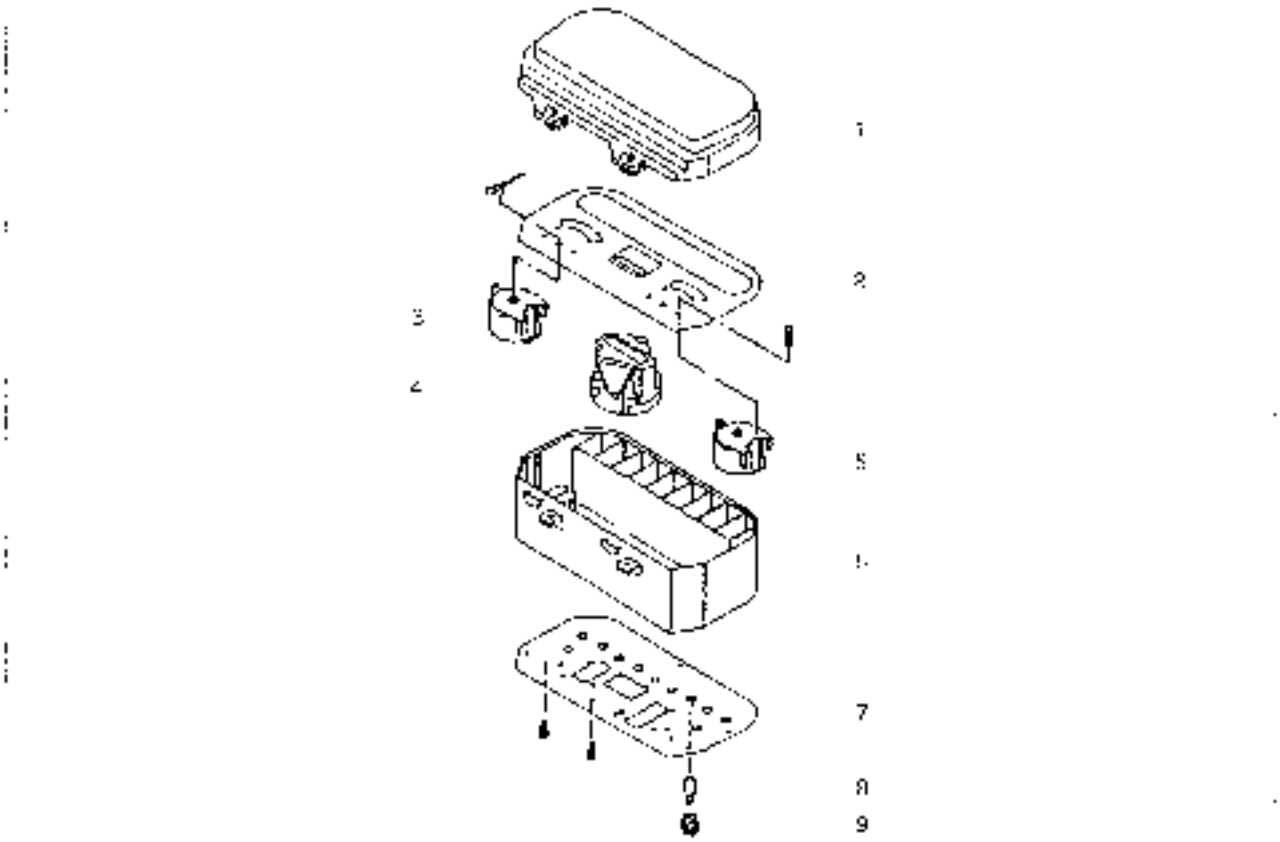
(6) Rernove the bolt and then, remove console box assembly 6.

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 or 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 [illegible] 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.

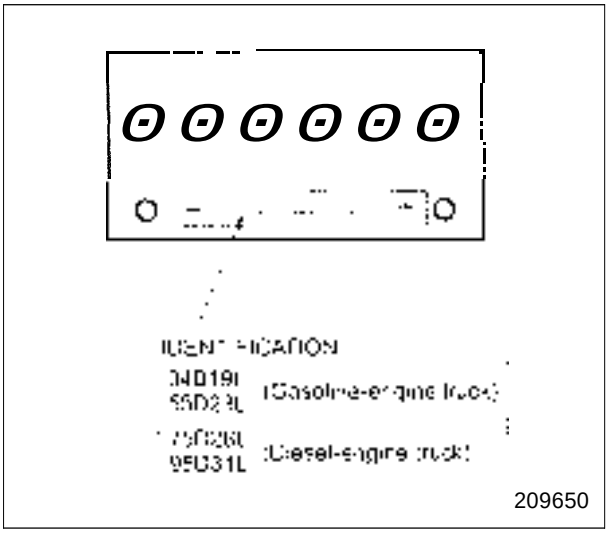
(2) In quick charging, the battery capacity in ampere should not be exceeded.

(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 by installing the cable to the positive (+) terminal. When disconnecting them from the battery, begin by removing 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 [illegible] 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.

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

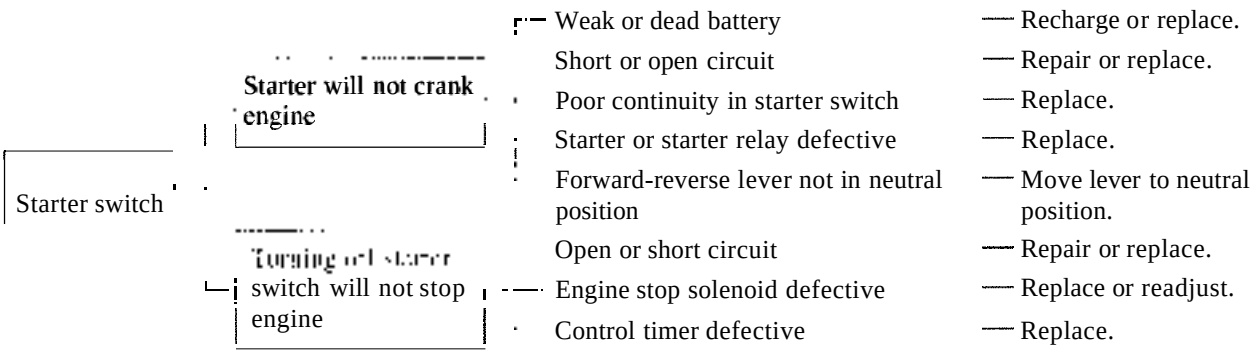
Be careful that allowable current differs between solid wires and stranded wires even if they are of the same gauge.

List of wire colors

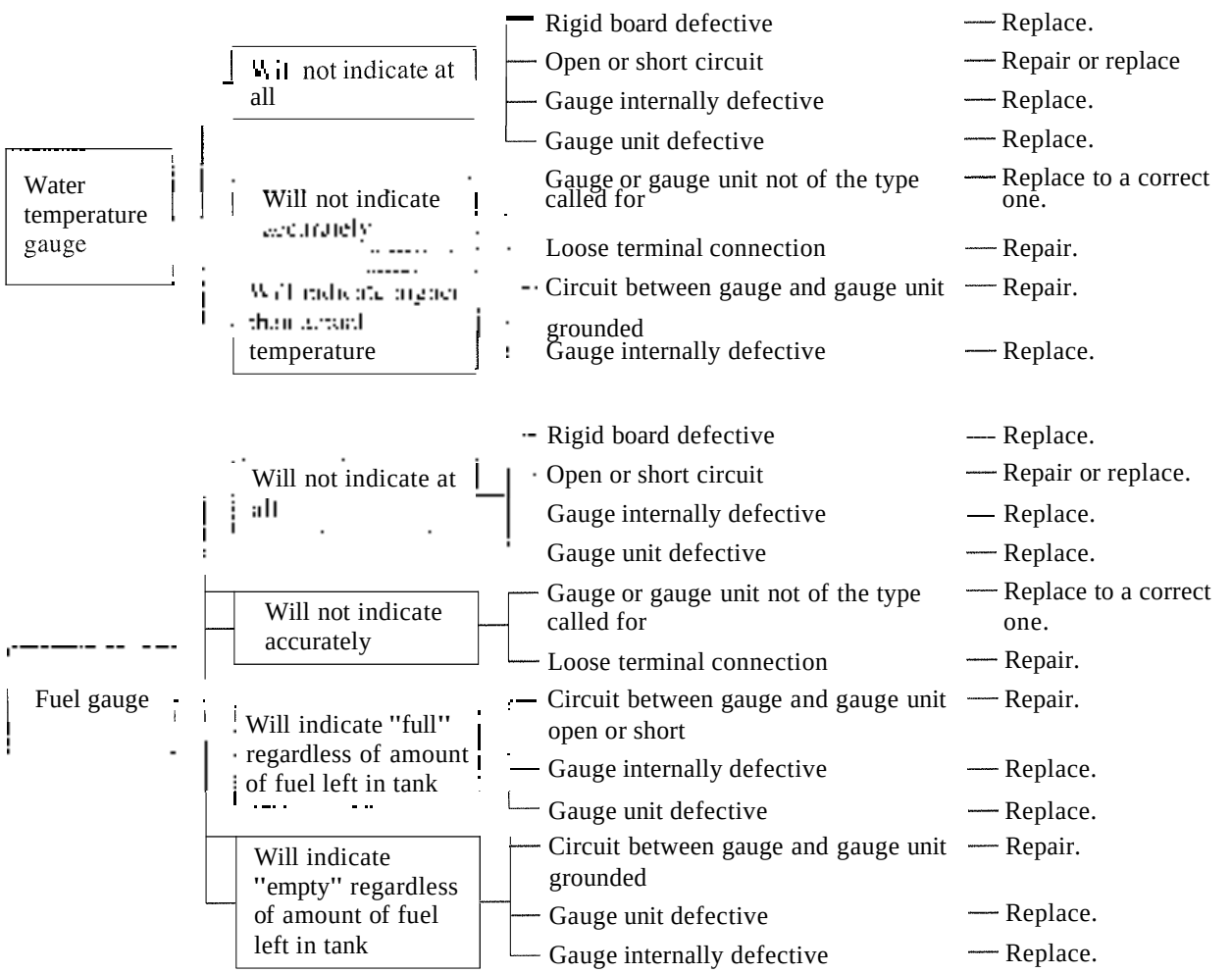
Wire color	Color
B	BLACK
W	WHITE
R	RED
G	GREEN
Y	YELLOW
Br	BROWN
L	BLUE
Lg	LIGHT GREEN
O	ORANGE
P	PINK
Gr	GRAY
Lb	LIGHT BLUE
Dg	DARK GREEN
ch	CHOCOLATE

Troubleshooting

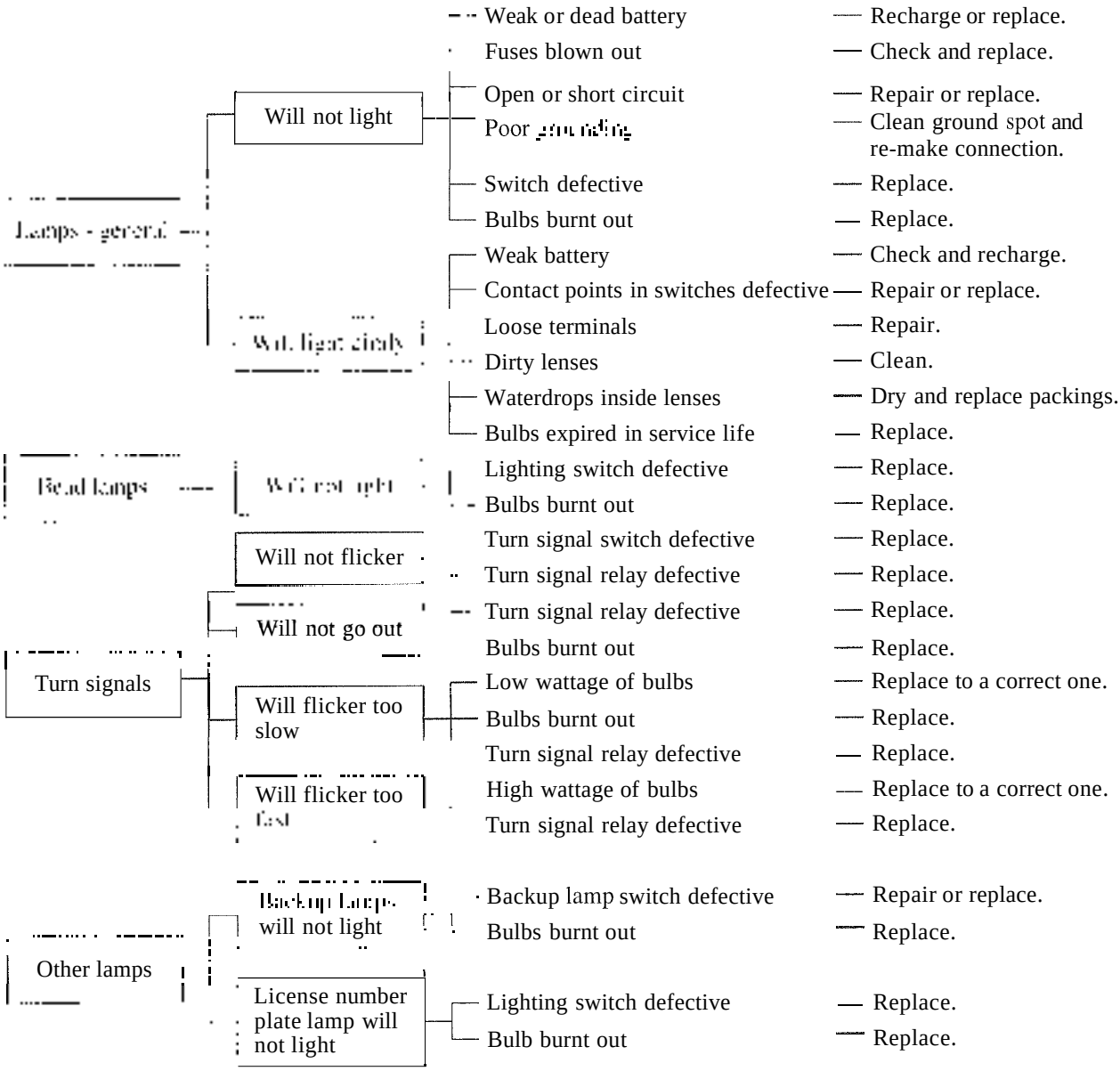
Starter System



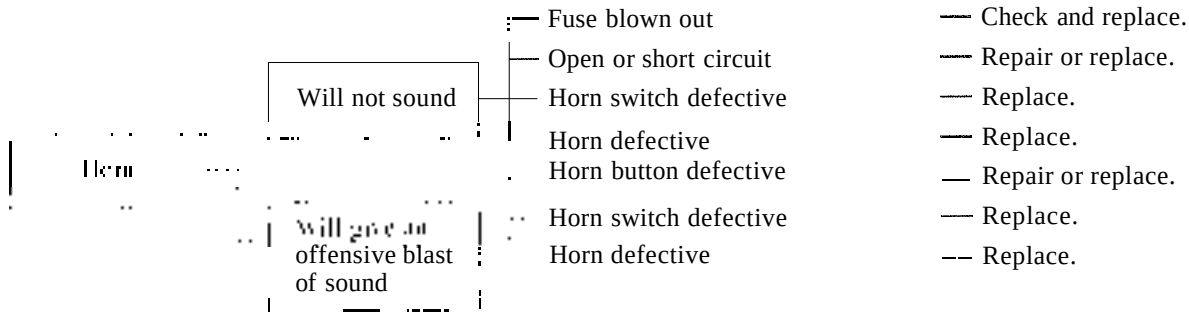
Gauges



Lighting System



Alarm Unit



Battery

	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	
Tends to run down rapidly	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.
	✻ Wiring	
	Regulator IC and F terminals shorted or miswired	— Repair.
Tends to get overcharged	Poor grounding of regulator F terminal	— Repair.
	✻ Regulator	
	Pressure coil open-circuited	— Replace.
	Regulated voltage too high	— Replace.

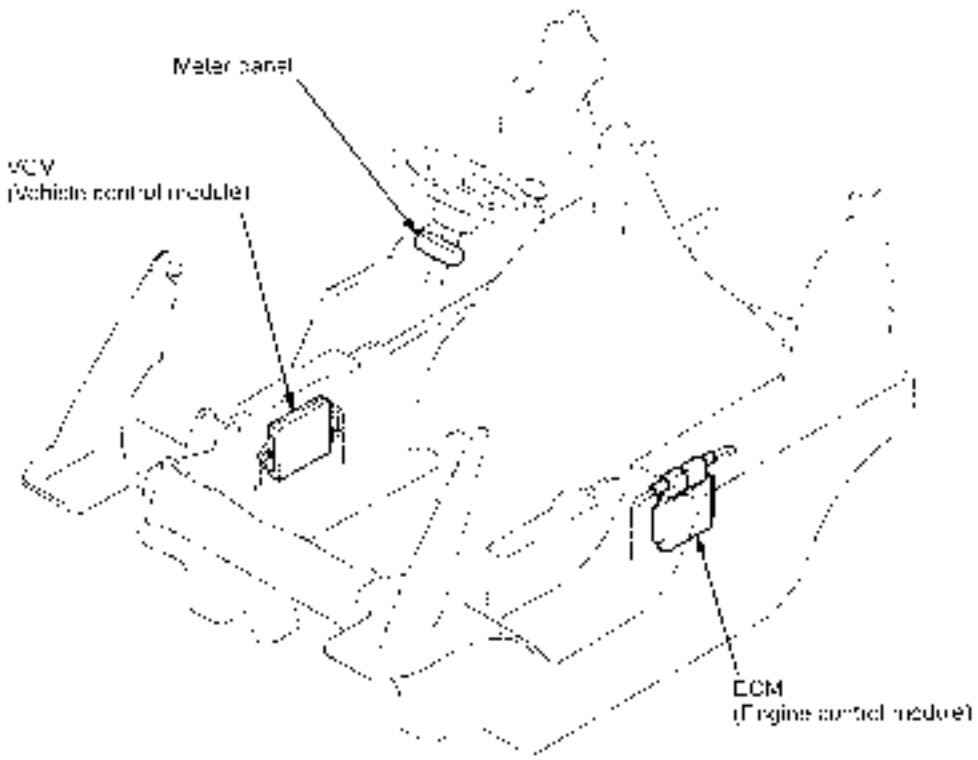
Electrical Schematic Diagram

CONTROLLERS

Outline

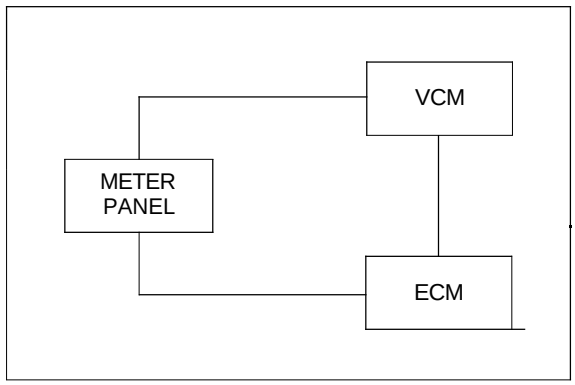
VCM and ECM control the vehicle and engine.

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.

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

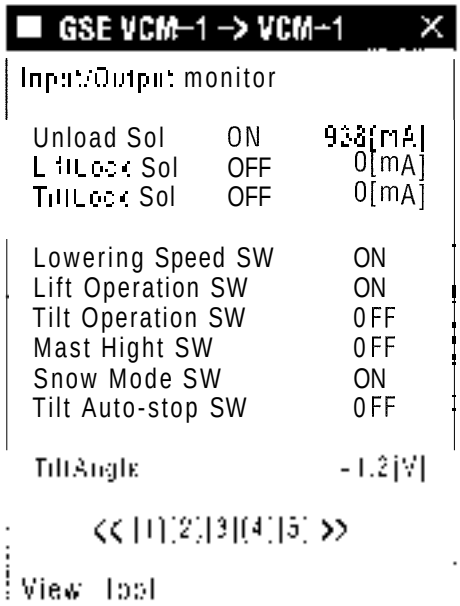
Input/Output Monitor

Monitors input and output of sensors and switches.

VCM

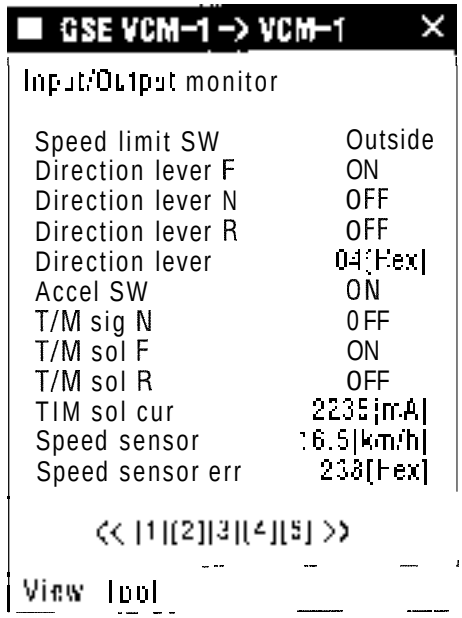
1. VCM-1 I/O Monitor: Mast control

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

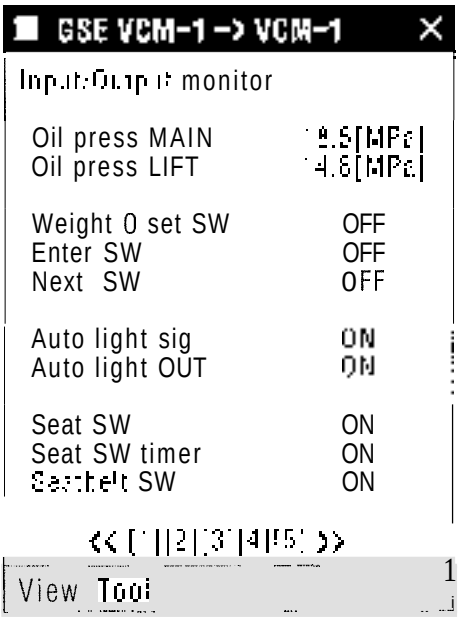
Speed limit SW	Outside/Inside
Direction lever F	ON/OFF
Direction lever N	ON/OFF
Direction lever R	ON/OFF
Direction lever	[Hex]
Accel SW	ON/OFF
TIM sig N	ON/OFF
TIM sol F	ON/OFF
TIM sol R	ON/OFF
TIM sol cur	[Hex,mA]
Speed sensor	[Hex,Hz,km/h]
Speed sensor err	[Hex,V]



Note: "Hex" denotes hexadecimal digit.

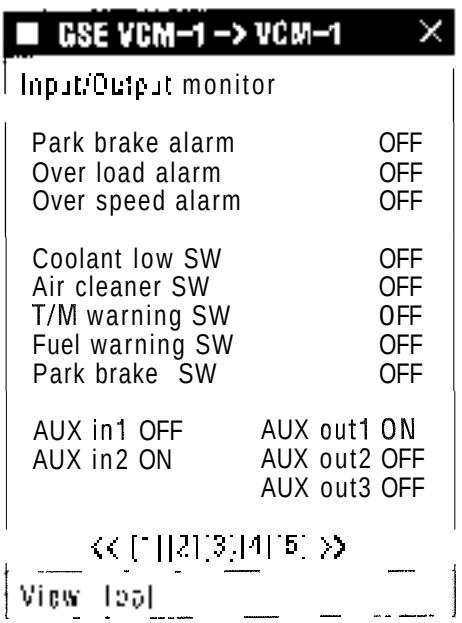
3. VCM-1 I/O Monitor: Other control 1

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



4. 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	ONIOFF
Air cleaner SW	ONIOFF
T/M warning SW	ONIOFF
Fuel warning SW	ONIOFF
Park brake SW	ONIOFF
AUX in1	ONIOFF
AUX in2	ONIOFF
AUX out1	ONIOFF
AUX out2	ONIOFF
AUX out3	ONIOFF



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. The table in the following pages lists the probable causes and check points for error codes.

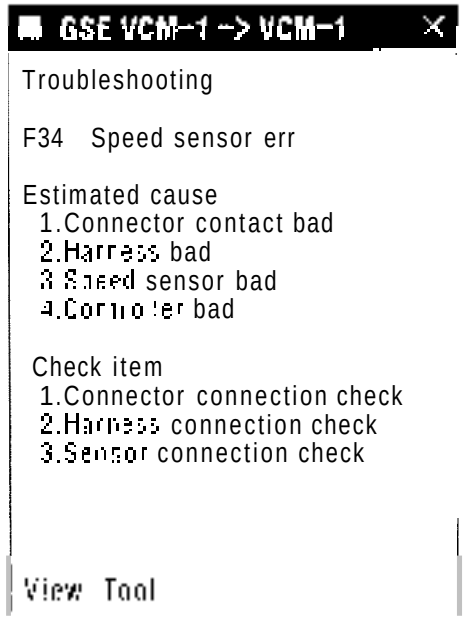
Error code F34 (speed sensor error)

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.

Error 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	
F14	Mn3 lever neutral	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Mn3 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	

Fail code	Description	Probable cause	Check point
F17	Speed error	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	
F32	Travel pump error	1. Connector contact bad	1. Connector connection check
		2. Harness bad	2. Harness connection check
		3. Travel pump sensor bad	3. Sensor connection check
		4. Controller bad	
F34	Speed sensor error	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 error	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	

Error 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	
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	

Err code	Description	Probable cause	Check point
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	
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	

Err code	Description	Probable cause	Check point
F85	TIM 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. TIM FW sol bad	4. T/M FW sol connection check
		5. Controller bad	
F87	TIM 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. TIM BW sol bad	4. T/M BW sol connection check
		5. Controller bad	
F89	TIM 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. TIM sol bad	4. T/M sol connection check
		5. Controller bad	

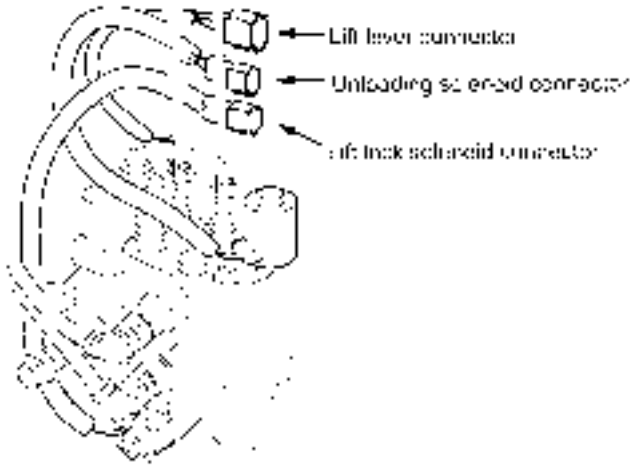
Error Codes and Explanation

Contact your Cat lift truck dealer when the error code is displayed.

Error Code	Explanation	Error Code	Explanation
[illegible]	[illegible]	[illegible]	[illegible]

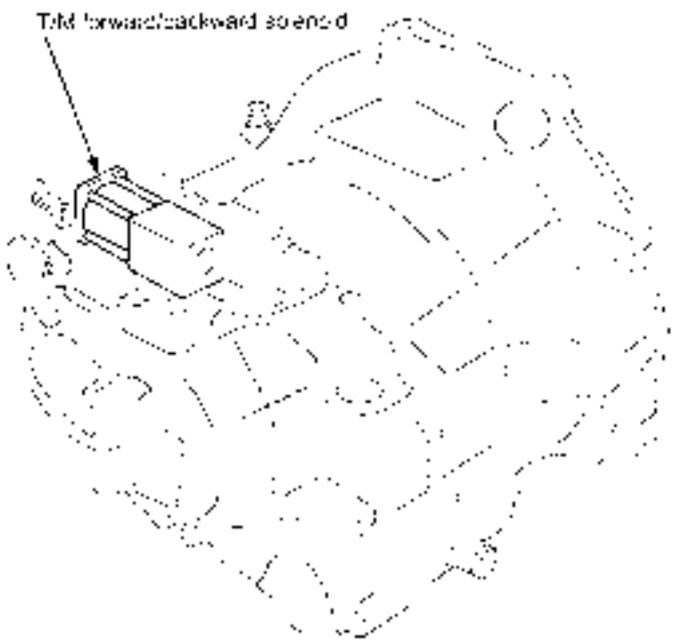
Error Code	Explanation
[illegible]	POS sensor error signal
[illegible]	PRSSL sensor error signal
[illegible]	Self shutdown system diagnostic result error signal
[illegible]	ECU SCC error signal
[illegible]	Electronic controlled throttle control error signal
[illegible]	Overheat signal (Stealth)
[illegible]	Overheat signal (Stealth)
[illegible]	Spark system error signal
[illegible]	LPG LPSL disconnection diagnostic result signal
[illegible]	LPG fuel pressure sensor diagnostic result signal
[illegible]	LPG fuel temperature sensor diagnostic result signal
[illegible]	LPG vaporizer diagnostic result signal
[illegible]	Mast height SW diagnostic result signal
[illegible]	Oil pressure sensor diagnostic result signal
[illegible]	Stop lamp SW error signal
[illegible]	Memory check error
[illegible]	Battery voltage error
[illegible]	VCM communication error
[illegible]	ECM communication error
[illegible]	DCM communication error
[illegible]	BST communication error
[illegible]	MP communication error
[illegible]	TMS communication error
[illegible]	Lift lever neutral error
[illegible]	Tilt lever neutral error
[illegible]	Attach 1 lever neutral error
[illegible]	Attach 2 lever neutral error
[illegible]	Attach 3 lever neutral error
[illegible]	Multi lever error
[illegible]	Spare error
[illegible]	Lift lever error
[illegible]	Tilt lever error
[illegible]	Attach 1 lever error
[illegible]	Attach 2 lever error
[illegible]	Attach 3 lever error
[illegible]	Main oil pressure sensor error

Error Code	Explanation
[illegible]	Lift oil pressure sensor error
[illegible]	Swing sensor error
[illegible]	Tilt angle sensor error
[illegible]	Tilt angle sensor error
[illegible]	Swing error
[illegible]	Lift up solenoid error
[illegible]	Lift down solenoid error
[illegible]	Lift solenoid leak
[illegible]	Tilt forward solenoid error
[illegible]	Tilt backward solenoid error
[illegible]	Tilt solenoid leak
[illegible]	Attach 1A solenoid error
[illegible]	Attach 1B solenoid error
[illegible]	Attach 1 solenoid leak
[illegible]	Attach 2A solenoid error
[illegible]	Attach 2B solenoid error
[illegible]	Attach 2 solenoid leak
[illegible]	Attach 3A solenoid error
[illegible]	Attach 3B solenoid error
[illegible]	Attach 3 solenoid leak
[illegible]	Unload solenoid error
[illegible]	Lift lock solenoid error
[illegible]	Unload solenoid leak
[illegible]	Knob position solenoid error
[illegible]	Tilt lock solenoid error
[illegible]	Knob position solenoid leak
[illegible]	TM forward solenoid error
[illegible]	TM backward solenoid error
[illegible]	TM solenoid leak
[illegible]	VCM communication error
[illegible]	ECM communication error
[illegible]	DCM communication error
[illegible]	BST communication error
[illegible]	MP communication error
[illegible]	TMS communication error
[illegible]	SAS error signal



Control valve

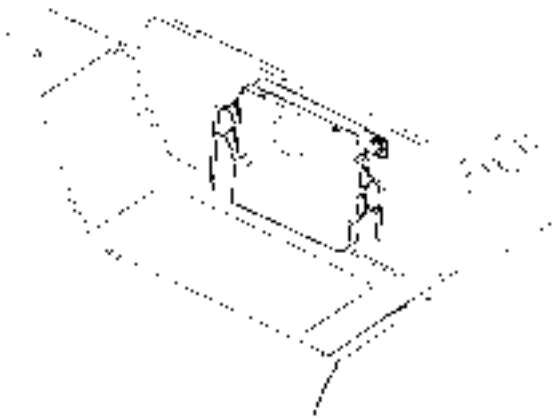
210116



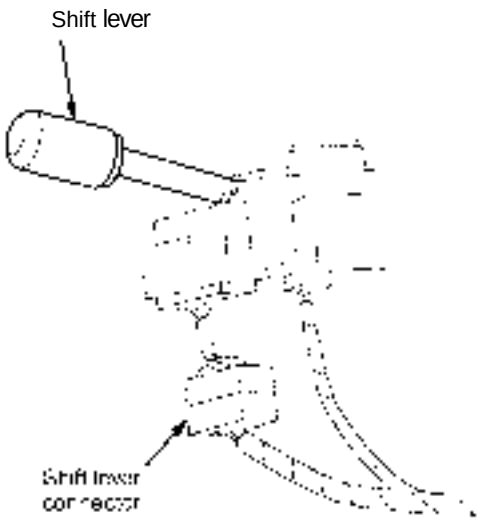
Transmission

210117

Locations of Sensors and Switches



VCM
(Body Right Side)



Shift lever
(for Powershift Truck)

Transmission
(Right side)

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

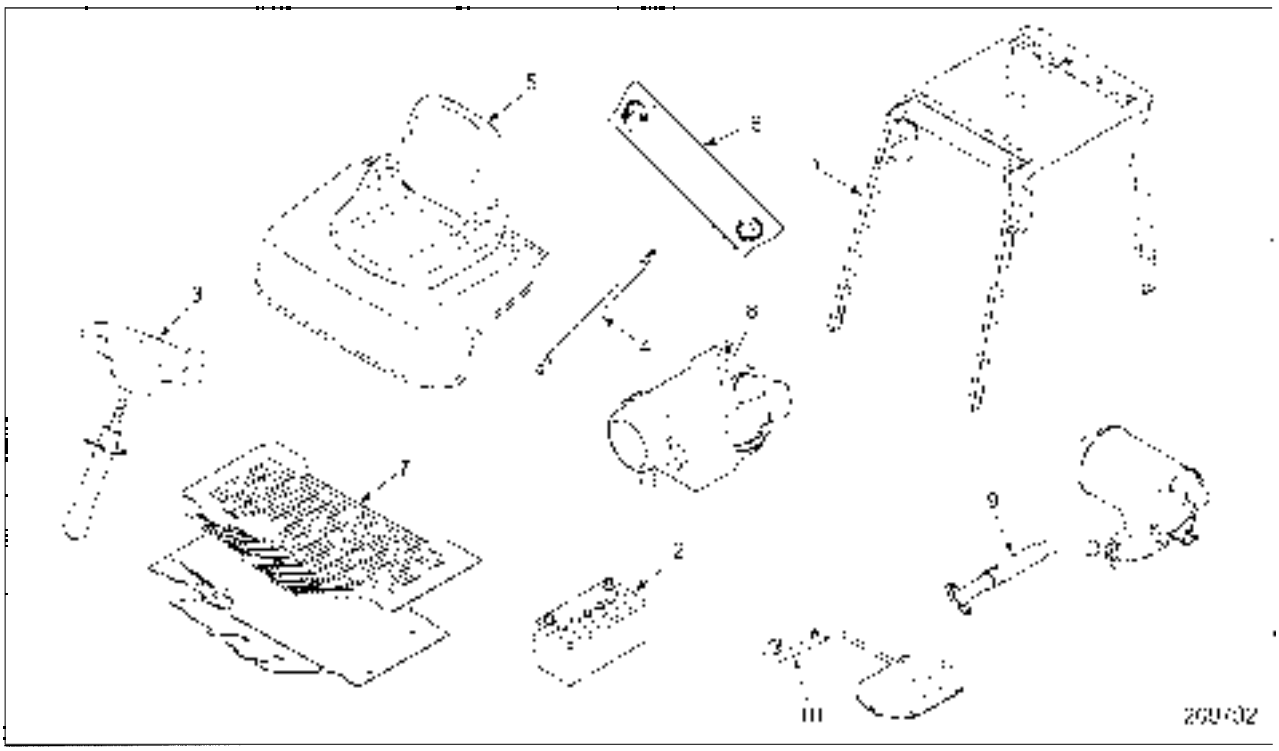
5

Removal and Installation

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.

Overhead Guard, Covers, Air Cleaner and Other Components



Sequence

1 Overhead guard, Headlamps
2 Batteries, Cables
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 hoses (without LPG engine models)

Suggestions for Removal

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

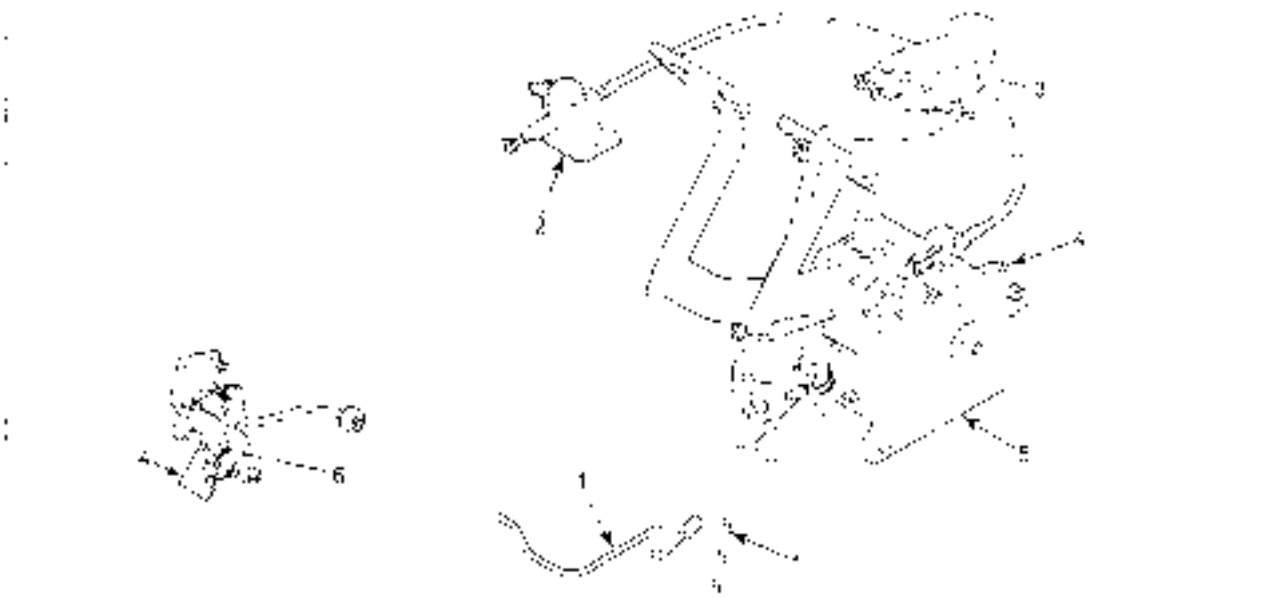
(2) Remove the floor plate and mat 7 together with the accelerator pedal after disconnecting the pedal from the linkage rod.

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

Controls



210' 18

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

Suggestion for Removal

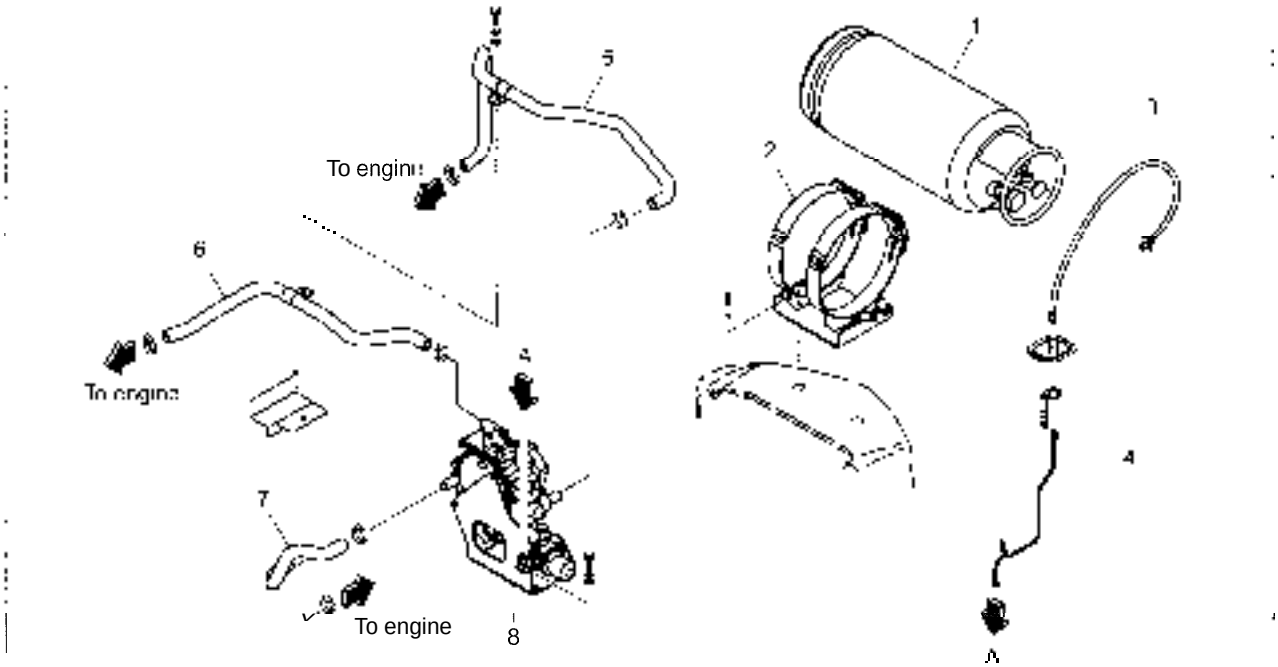
To remove the inching cable 2, disconnect the inching pedal end and the transmission end and loosen the lock nuts.

Installation

Follow the removal sequence in reverse.

LPG system (Dual Fuel Gasoline and LPG Model)

Disassembly



Sequence

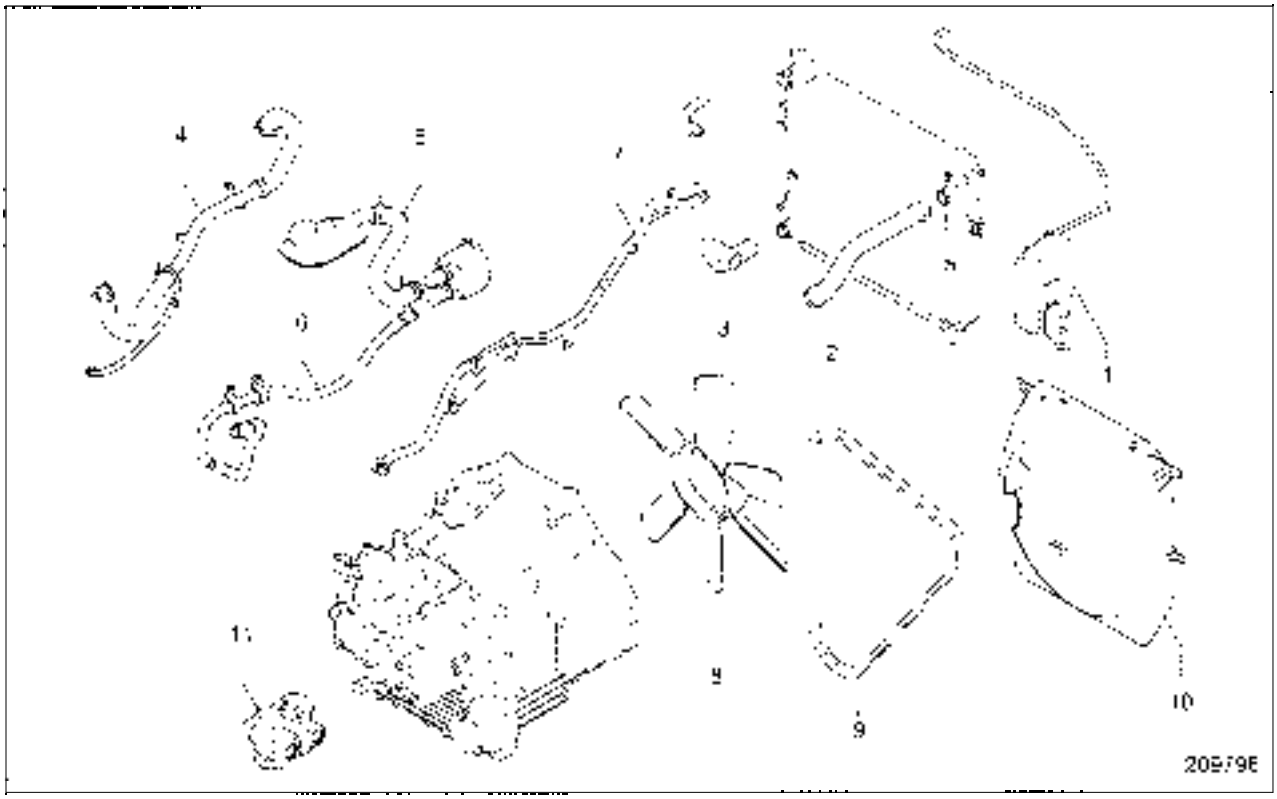
1 LPG tank
2 Tank bracket
3 LPG hose
4 LPG pipe
5 Water hose
6 LPG hose
7 Water hose
8 Vaporizer assembly

Start by:

(a) Drain the coolant from the engine by removing the drain plug.

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

Radiator and Pipes



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

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

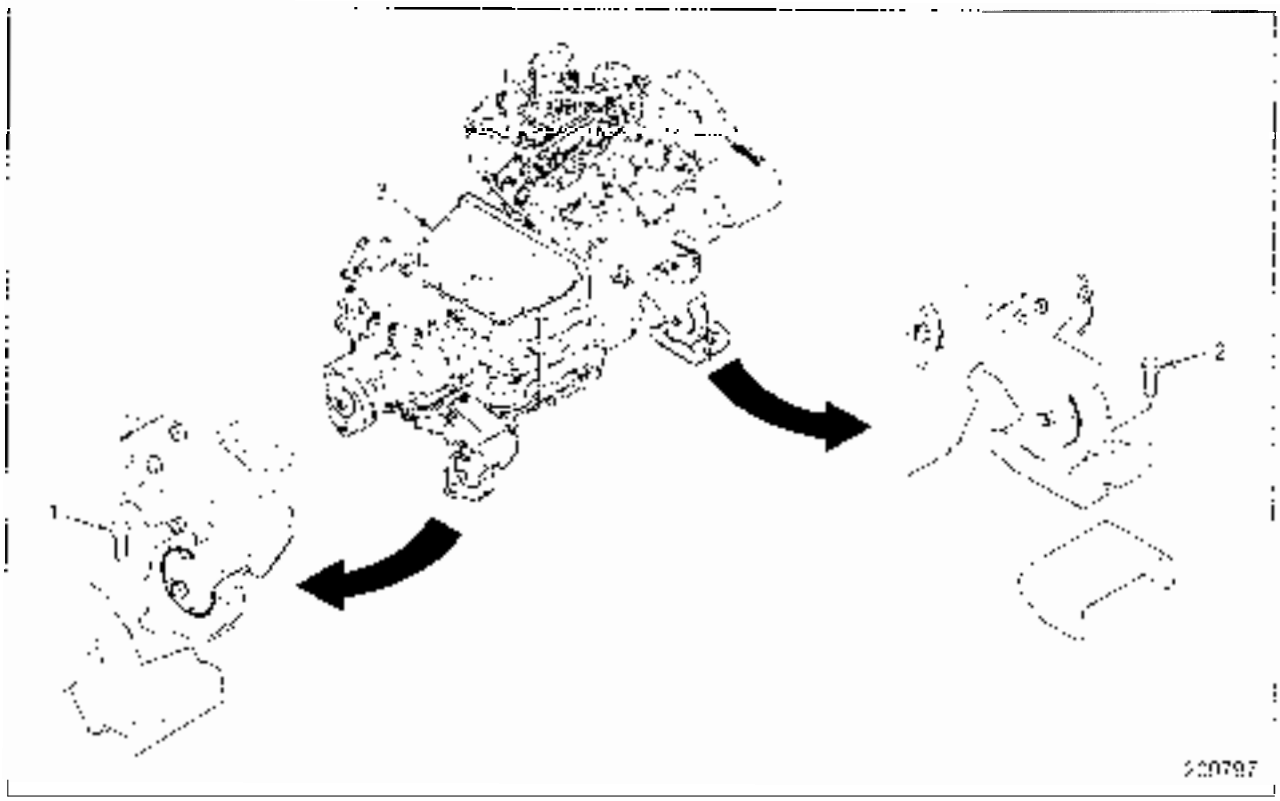
Suggestion for Removal

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 while maintaining its balance.

Note: (1) With the engine and transmission suspended, drain the transmission oil and clutch oil.

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

Installation

Follow the removal sequence in reverse.

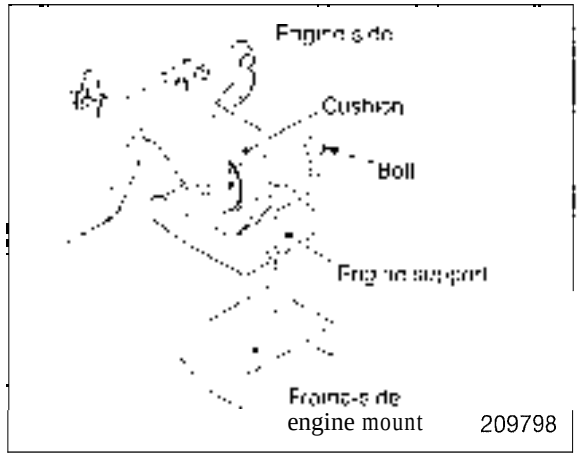
Suggestions for Installation

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

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

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

(6) Refill the engine, radiator, and transmission with [illegible] and check for leakage. Unless otherwise specified, use soft water (tap water) mixed with antifreeze at a concentration of 35%.

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

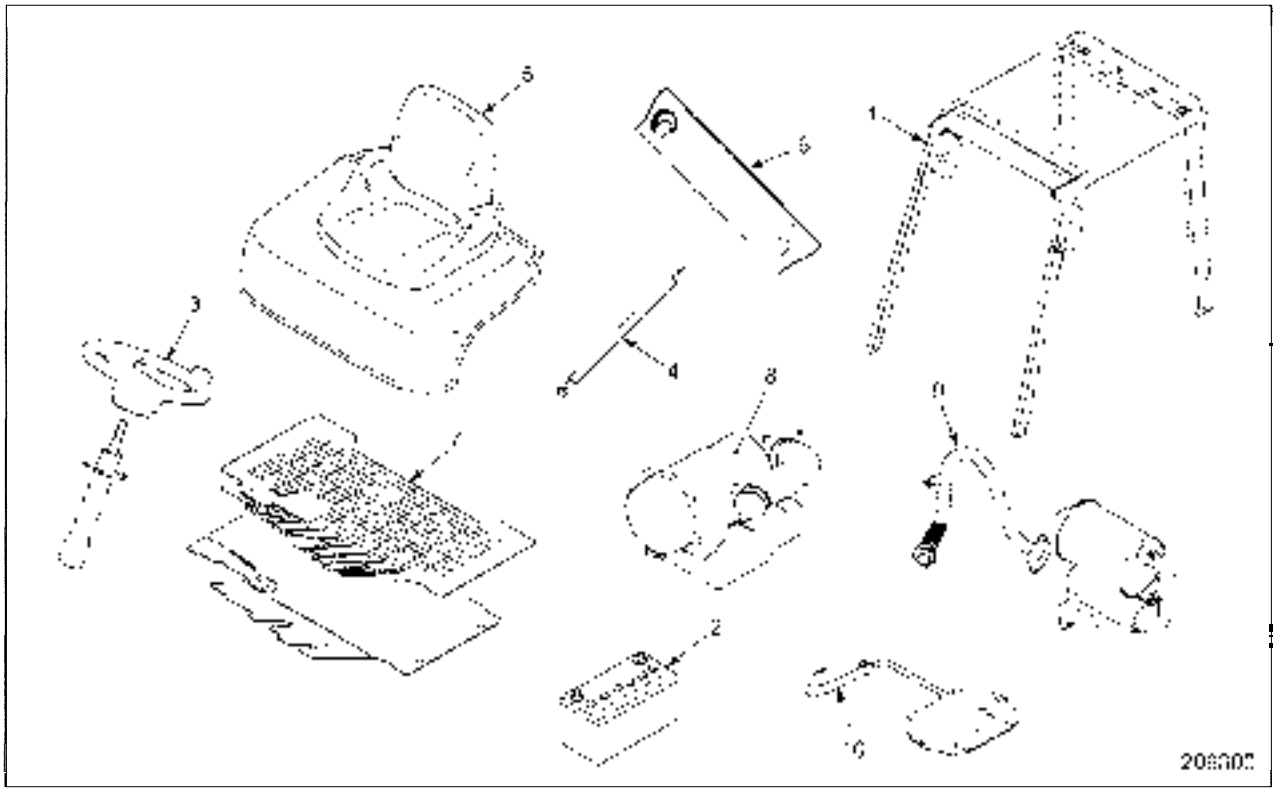
(8) After checking the parts, start the engine and check that the clutch booster functions properly (wet-type clutch transmission trucks only). Operate the mast [illegible] and steering, and check the hydraulic oil level. Also recheck the engine oil, coolant and transmission oil levels.

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, Headlamps
2 Batteries, Cables
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 after disconnecting the pedal from the linkage rod.

(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.

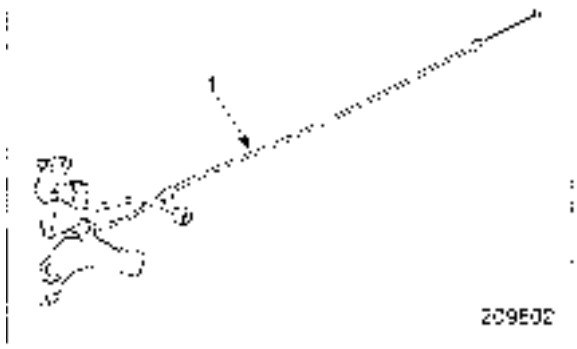
(5) After disconnecting the harness connectors from the sockets and terminals on the engine and transmission they should be attached to the main harness, in order to avoid damaging them.

Controls

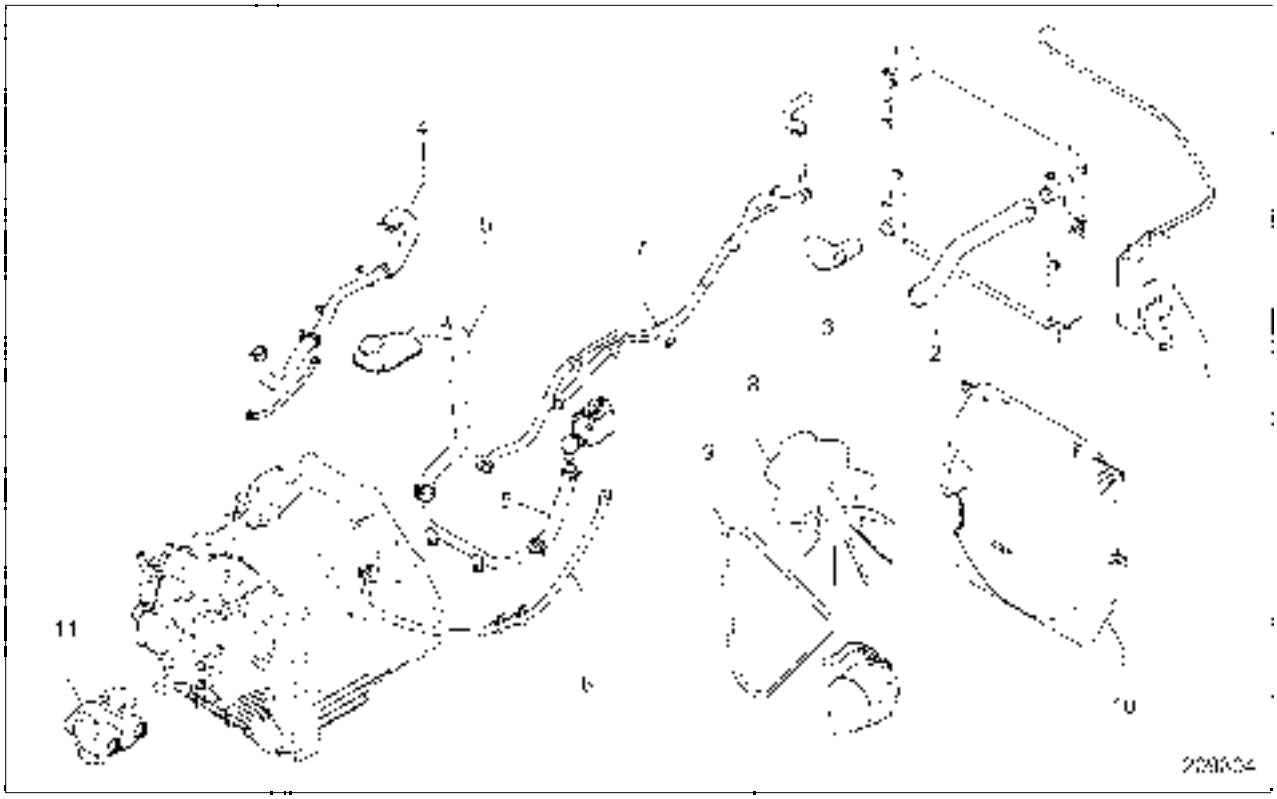
This section describes only removal and installation procedures specific to diesel-engine trucks. Follow the instructions for the gasoline-engine trucks in the preceding sections for the common procedures.

Sequence

1 Throttle cable



Radiator and Pipes



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

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

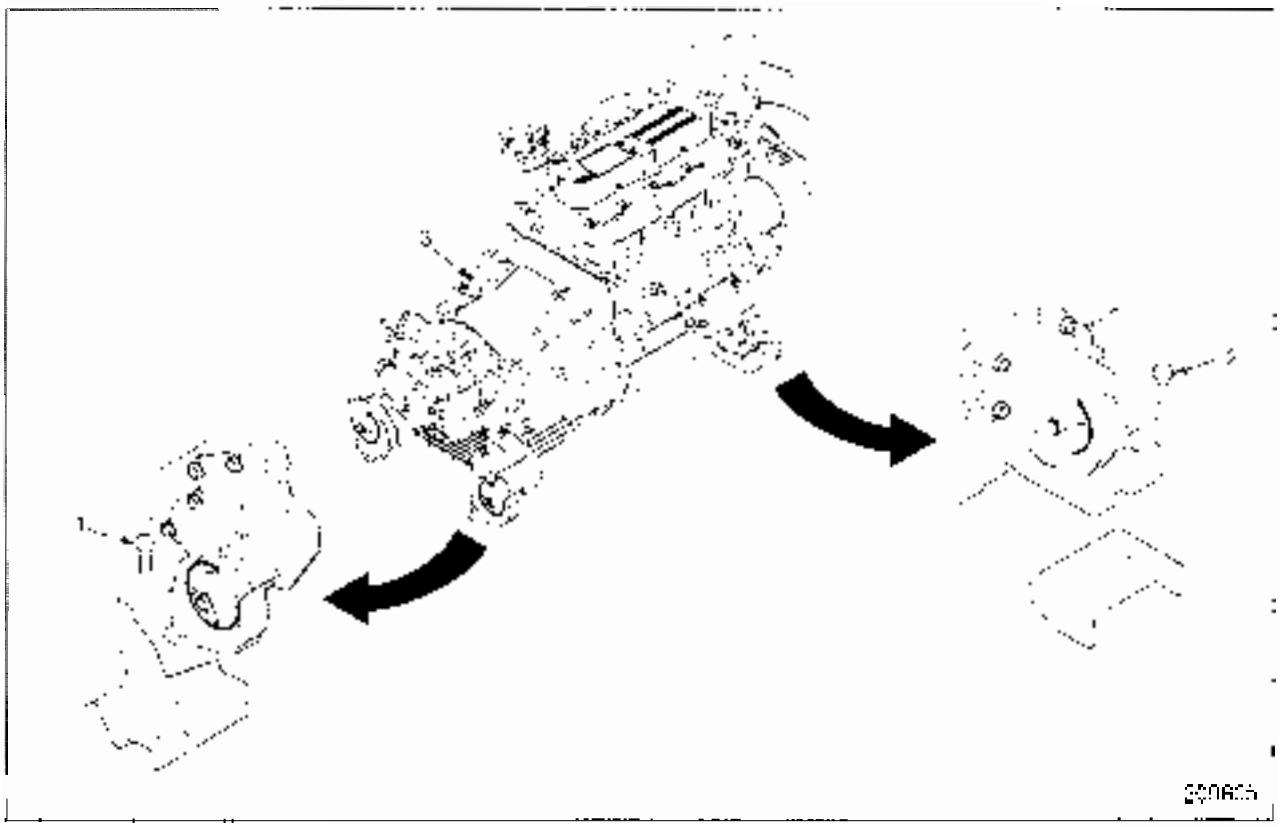
Suggestion for Removal

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 while maintaining its balance.

Note: Drain the powershift transmission oil with the engine and transmission assembly suspended.

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.

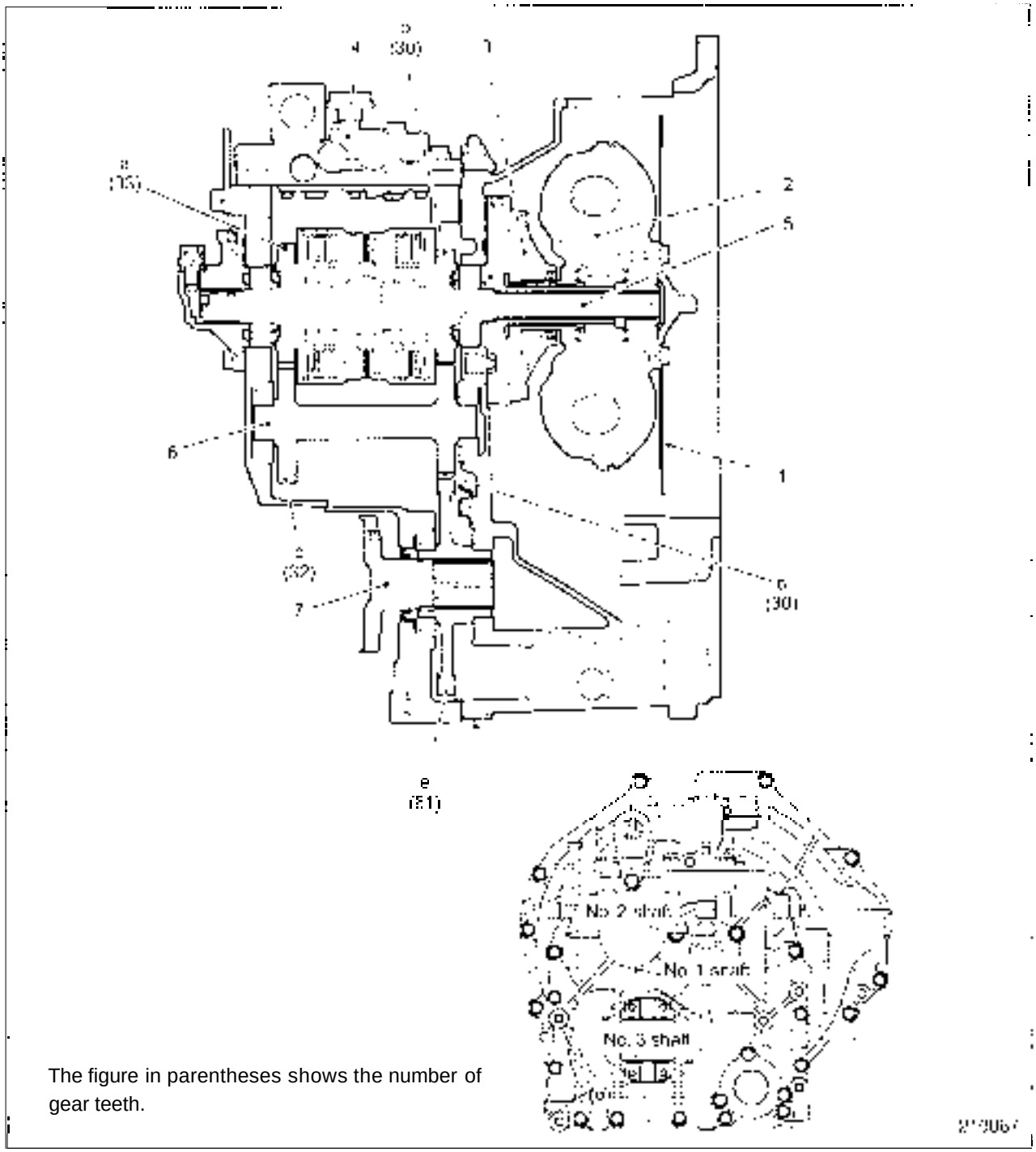
Suggestion for Installation (those not shared with gasoline-engine trucks)

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.

POWERSHIFT TRANSMISSION

Structure and Function

Transmission



The figure in parentheses shows the number of gear teeth.

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)

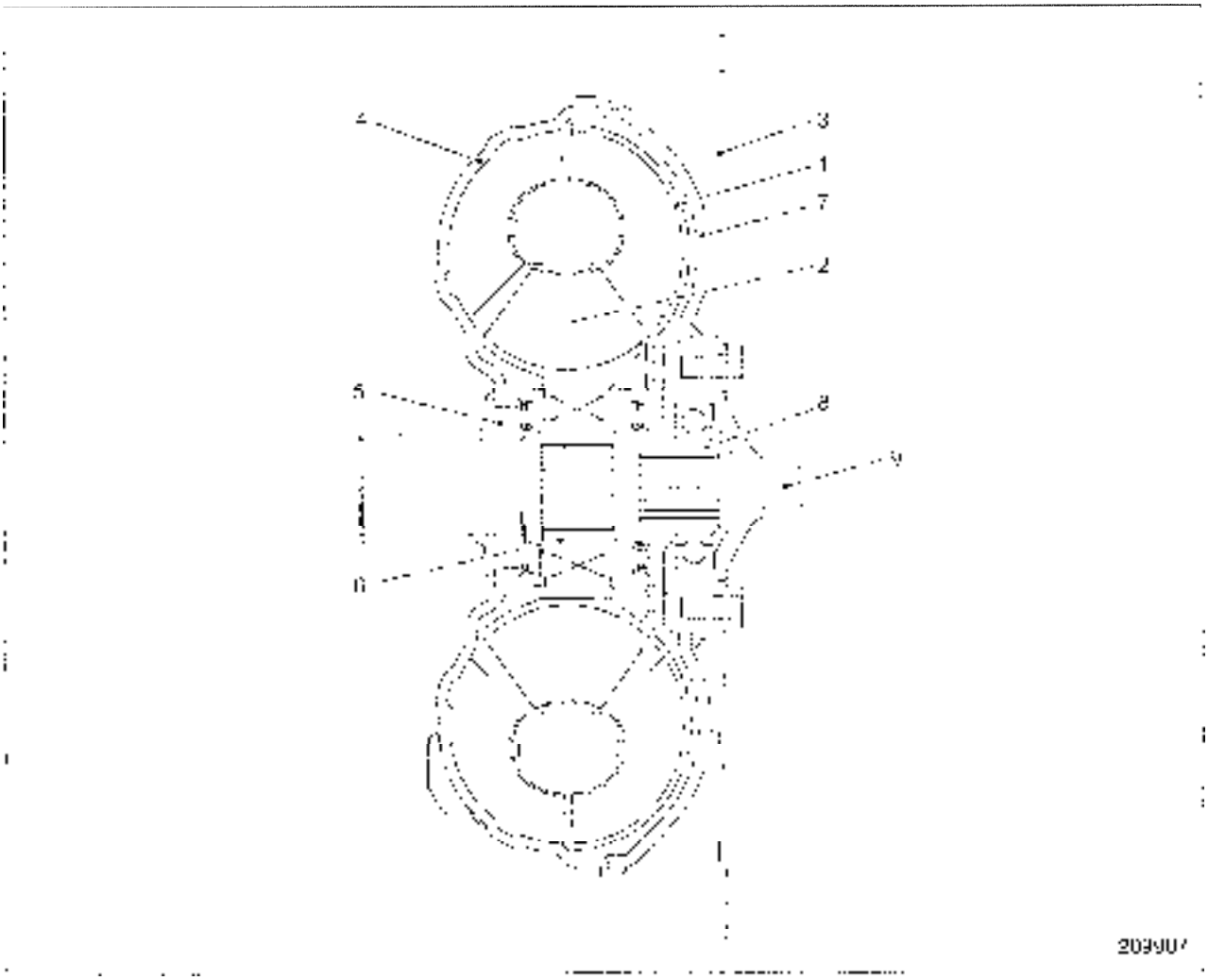
This transmission consists of one forward gear and one reverse gear. The forward-reverse changeover is accomplished by a powershift mechanism that uses hydraulically controlled multiple-disc clutches. The same transmission parts, except for the torque converter, clutch valve, output flange, and universal 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.

Type	Three-element, single-stage, two-phase
Range	Power path
F (Forward)	a → b → c
R (Reverse)	b → e

Transmission reduction ratio	
F (Forward)	$\frac{32}{33} \times \frac{41}{30} = 1.323$
R (Reverse)	$\frac{61}{30} = 2.033$

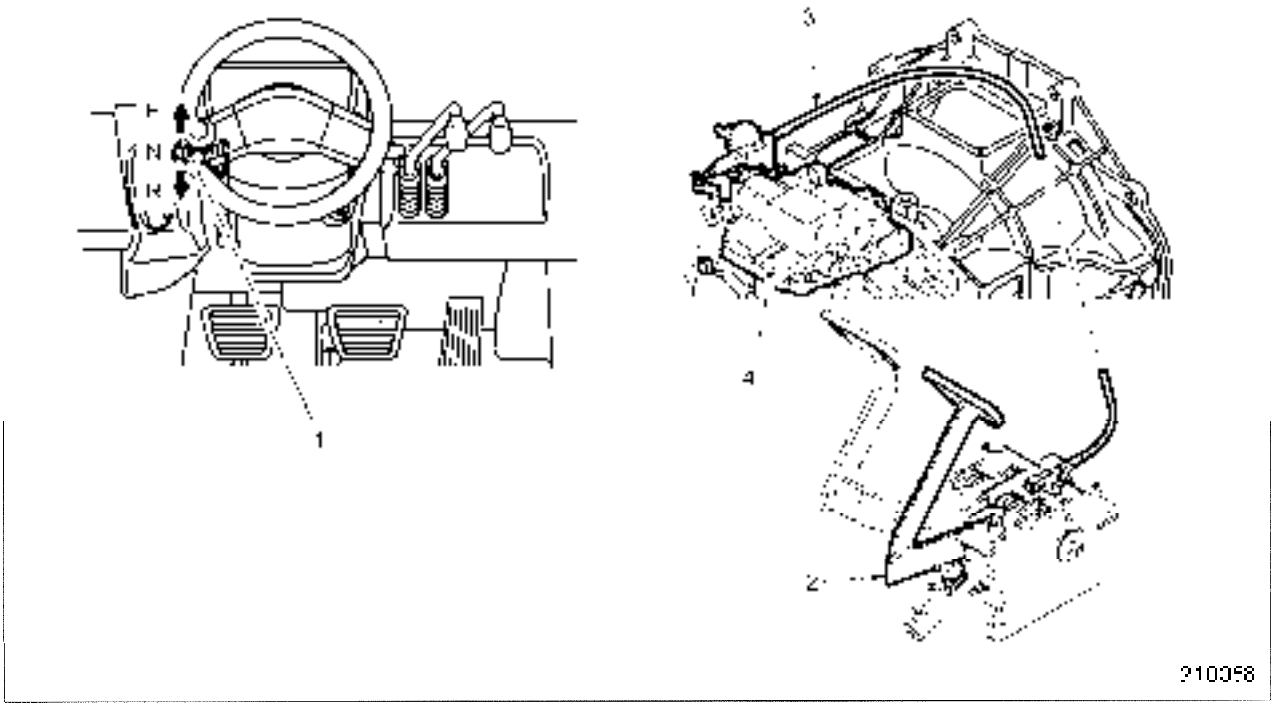
Torque Converter



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

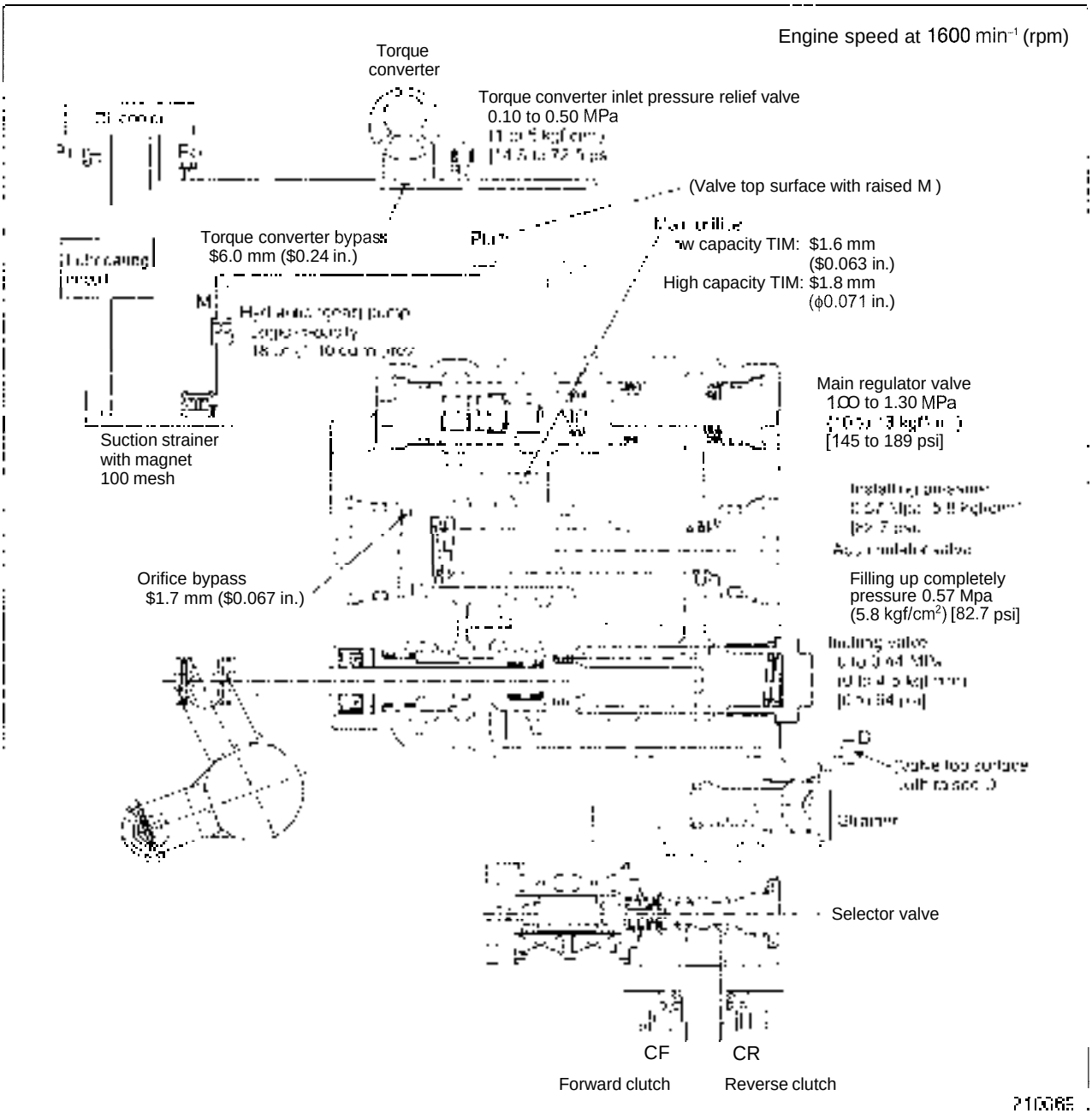
Note: Both gasoline-engine trucks and diesel-engine trucks use the same type of torque converter.

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.).

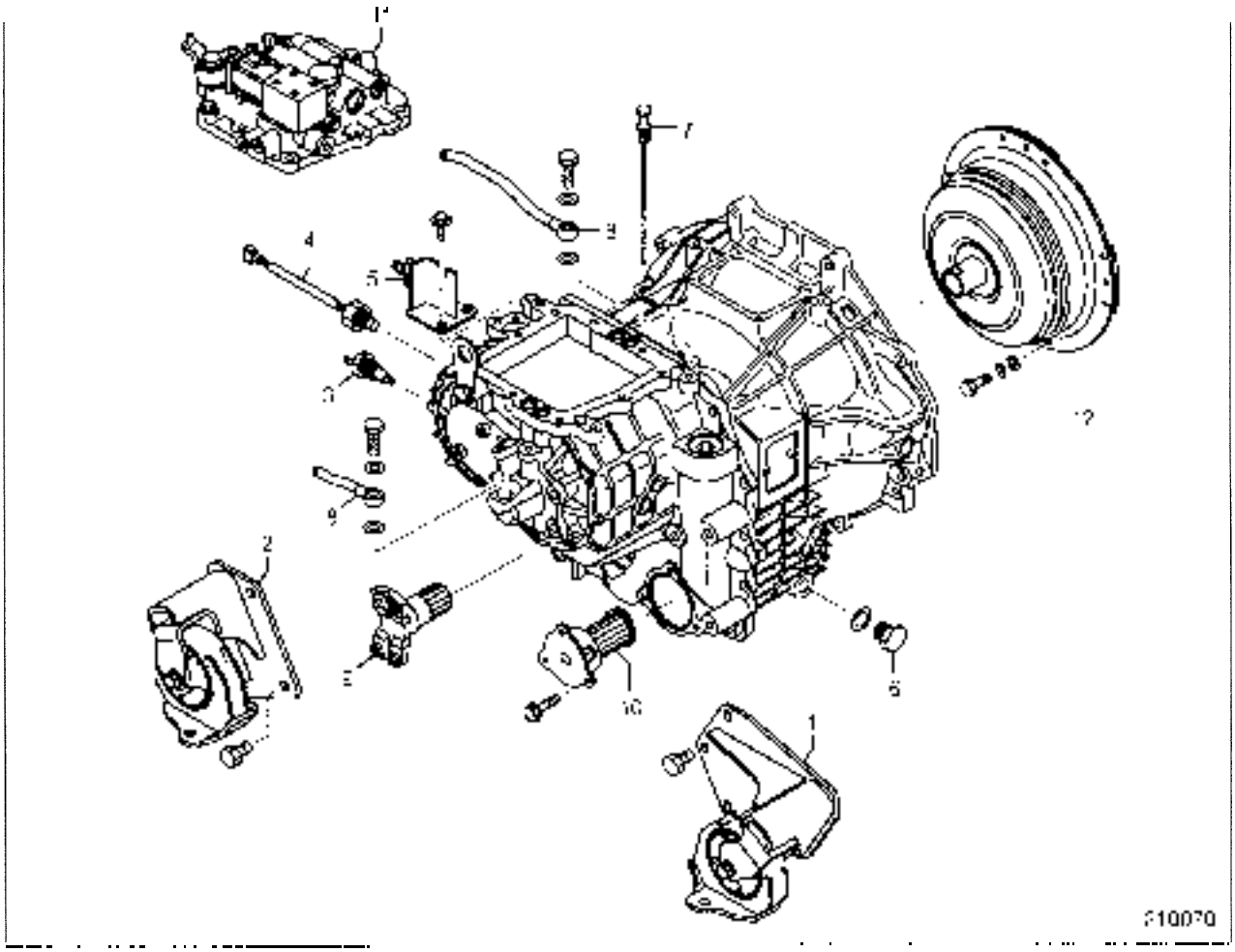
(2) Connect the flexible plate to the flywheel with the bolts through the access hole in the torque converter housing.

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

Disassembly and Reassembly

Transmission External Parts and Torque Converter Assembly

Disassembly

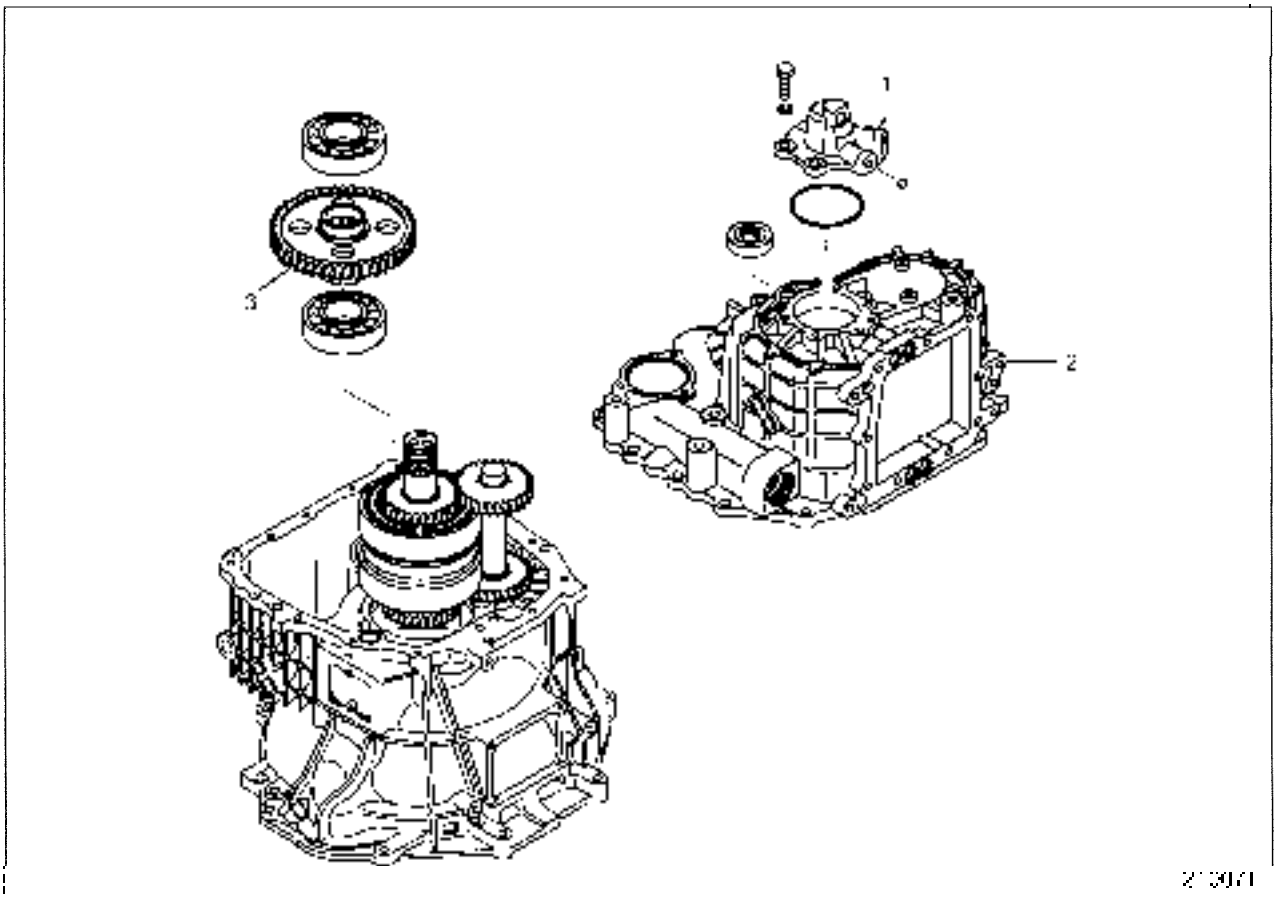


Sequence

1 Mount LH
2 Mount RH
3 Sending unit
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
12 Torque converter assembly

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.

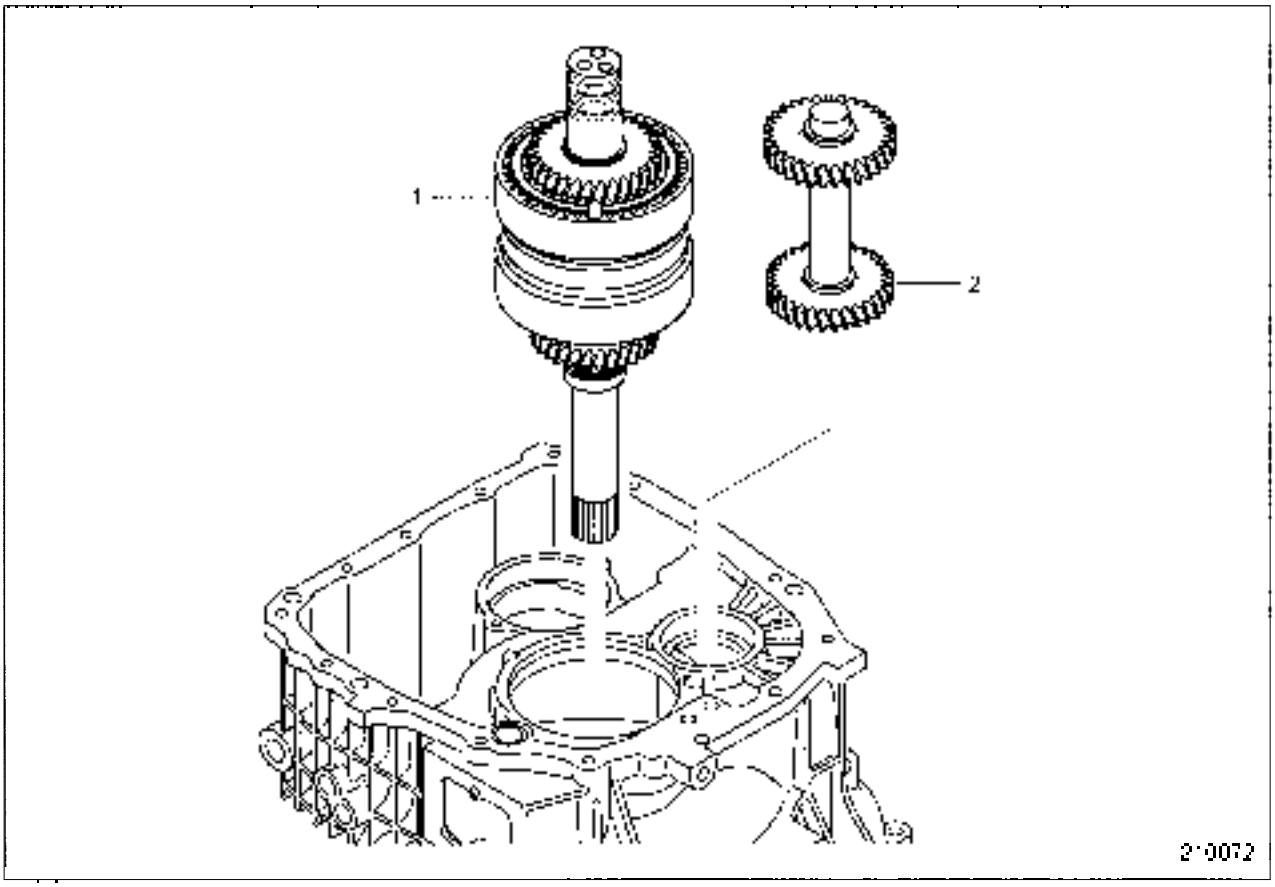
(4) Remove the transmission housing and place it with its mating flange facing down.

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

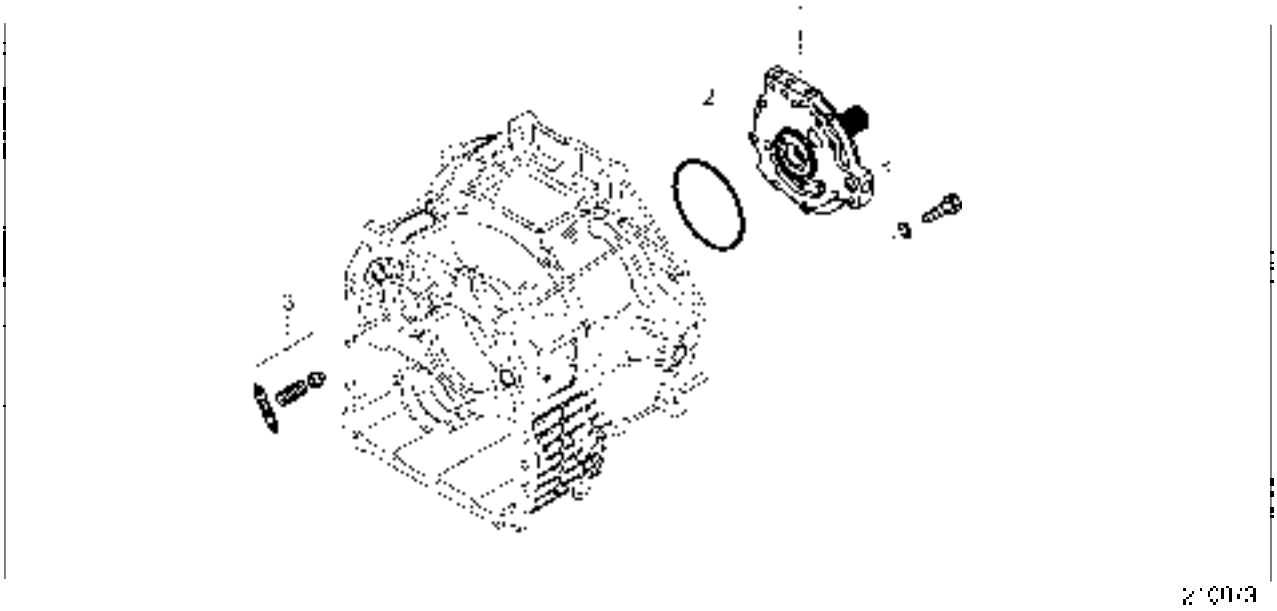
1 Input gear assembly
2 Idler shaft

Inspections after Disassembly

(1) Transmission housing
  (a) Check seal lips the seal rings for wear.
(2) Magnet strainer
  (a) Check for clogging and damage.
(3) Idler shaft
  (a) Check the splines for wear and other 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 Oil pump assembly
2 O-ring
3 Relief valve assembly

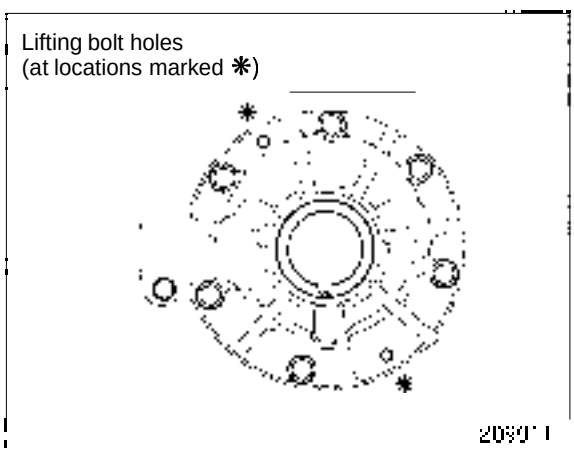
Suggestion for Disassembly

(1) Removal of oil pump assembly

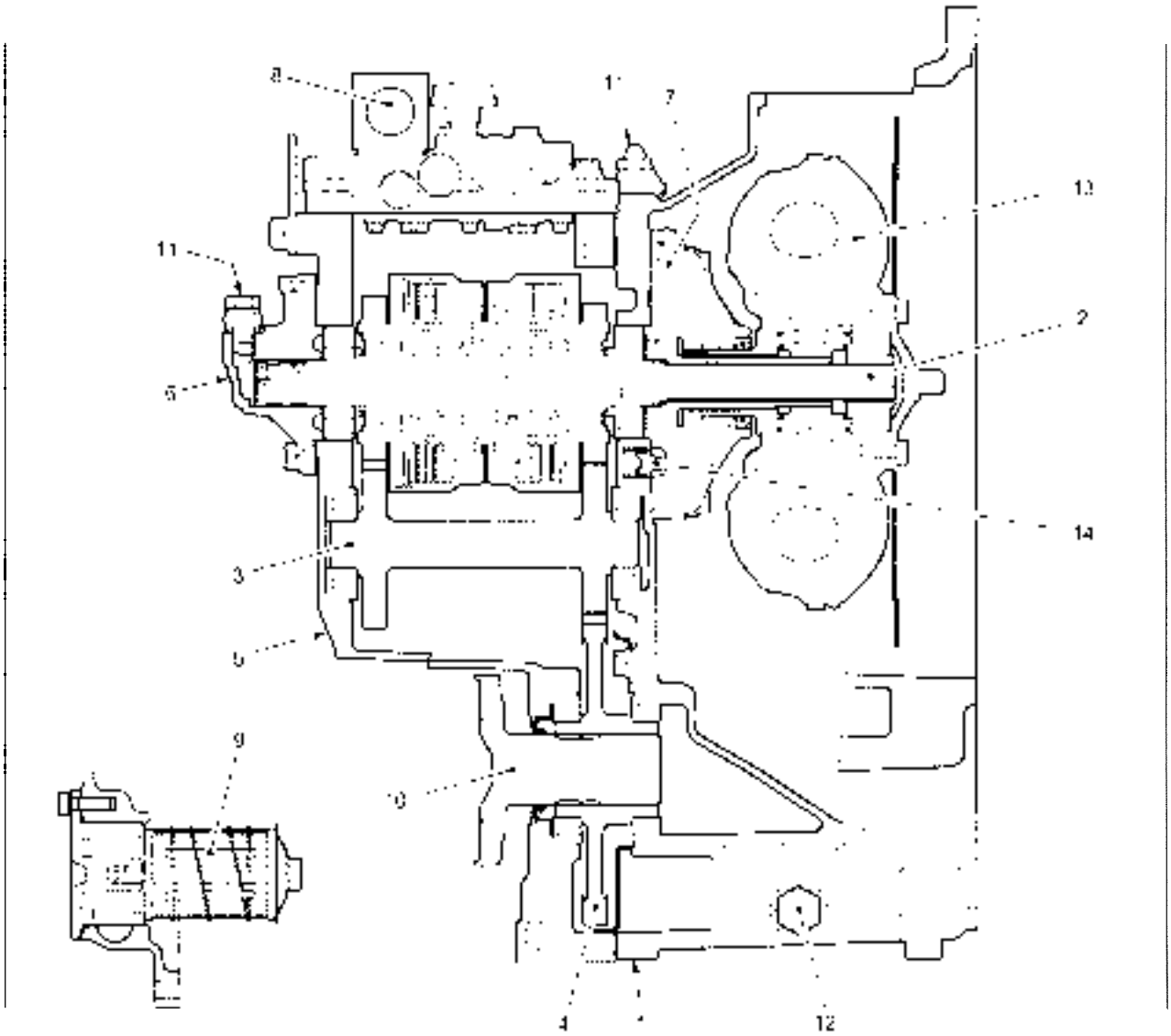
Unscrew the pump mounting bolts and screw two bolts (special tool) into the M8 x 1.25 holes in the pump body to remove the pump assembly. Be sure to tighten the bolts evenly, or the threads will be damaged. Use M8 × 1.25 bolts having an effective thread length of 55 mm (2.2 in.)

Special tool needed

Bolt	67281-15400



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, etc.
13 Torque converter assembly
14 Relief valve

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 weighted 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

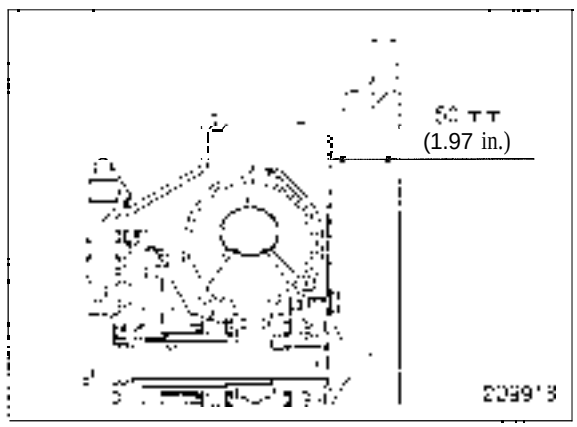
(a) Reinstall the transmission housing while hoisting it in the same procedure during disassembly. Pay attention that the input shaft is not yet stable at the center line.

(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) Shim adjustment

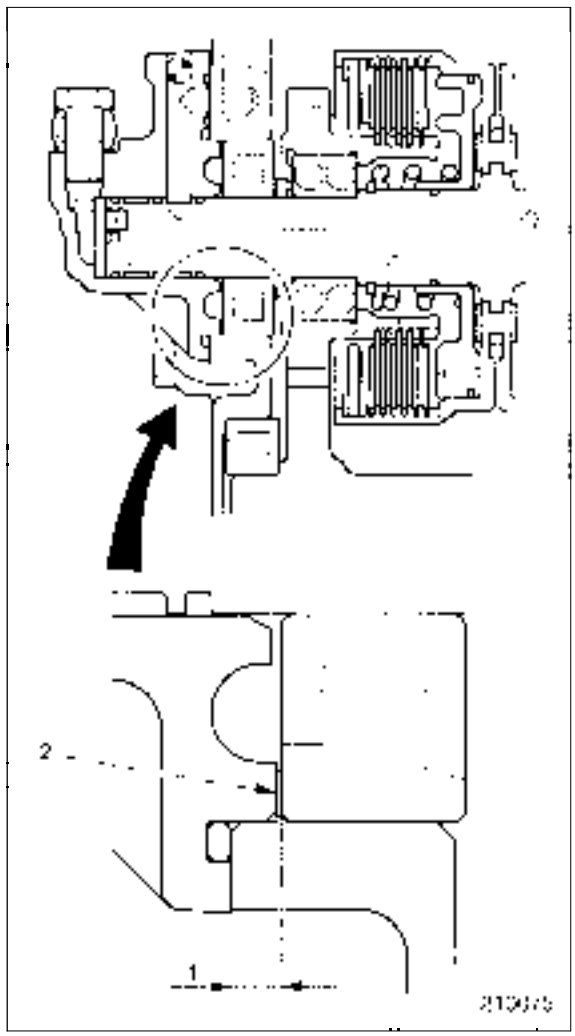
(a) Thrust the clutch pack, the input shaft and the support bearing toward the torque converter and measure the concave dimension between the contact surface of the servo case and the outer edge of bearing 1.

(b) Calculate the shim 2 thickness required as follows:
Concave dimension 1 - 4.8 mm (0.18912 in.)
= shim thickness.
Example; (5.1 mm - 4.8 mm = 0.3 mm)
[illegible] in. - 0.18912 in. = 0.01182 in.]

(c) Insert the calculate shims 2 between the bearing supporting clutch pack and servo case and assemble servo case. (This clearance axially is 0.3 to 0.4 mm [illegible] to 0.01576 in.])

Shims

Parts NO.	Thickness
91A25 - 05100	0.1 mm (0.00394 in.)
[illegible]	[illegible]
91A25 - 05300	0.3 mm (0.01182 in.)
[illegible]	[illegible]
91A25 - 05500	0.5 rnm (0.01970 in.)
91A25 - 05600	0.6 mm (0.02364 in.)



(6) 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 minute and then stop the engine.

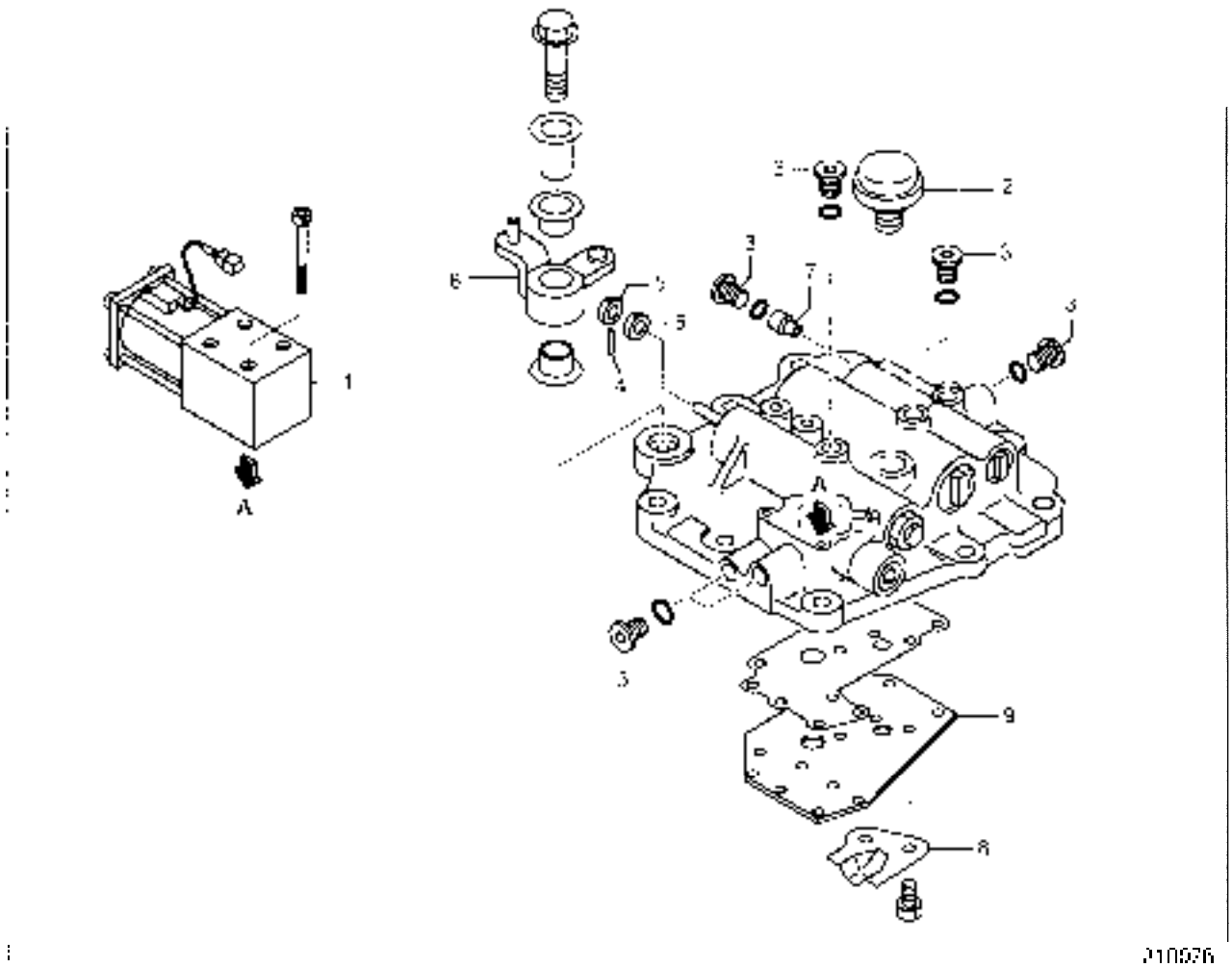
(d) Wait for about 30 second after stopping the engine, and then start the checking procedure.

(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)

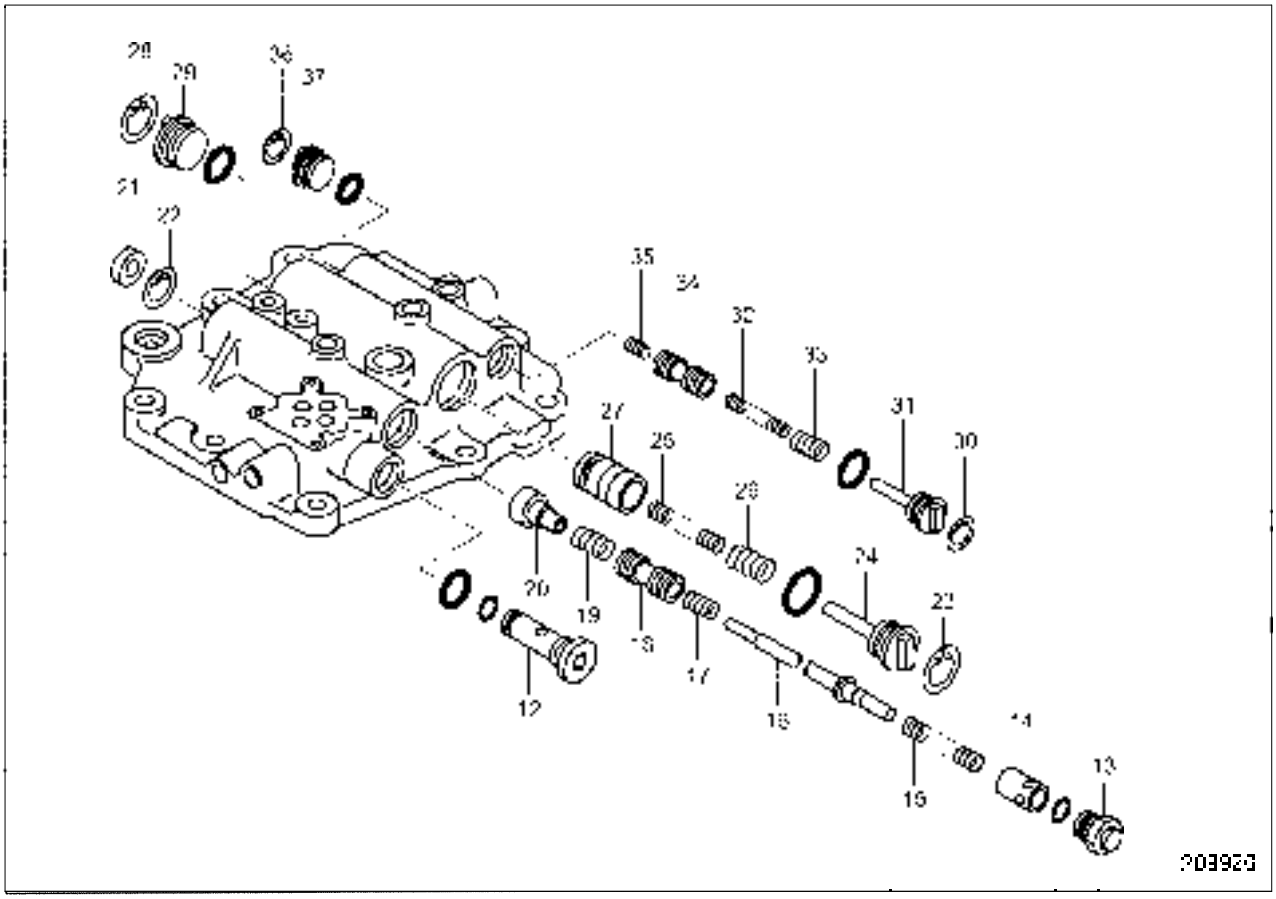


Sequence

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

Disassembly (Part 2)



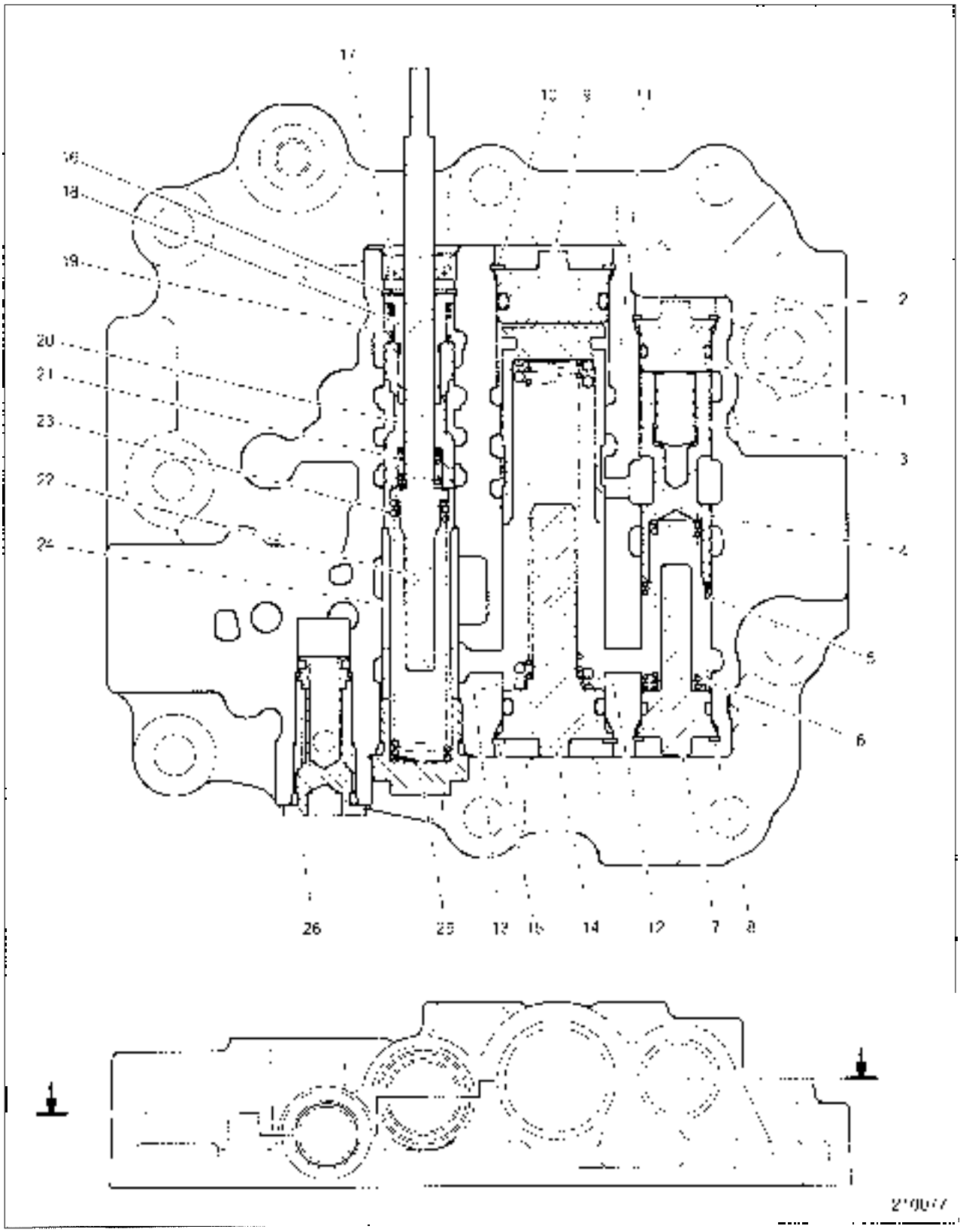
Sequence

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

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

1 Main relief plug
2 Snap ring
3 Slug
4 Regulator valve
5 Main relief spring (thick)
6 Main relief spring (thin)
7 Main spring seat, O-ring
8 Snap ring
9 Accumulator plug, O-ring
10 Snap ring
11 Accumulator piston
12 Outer spring
13 Inner spring
14 Accumulator spring seat, O-ring
15 Snap ring
16 Snap ring
17 Oil seal
18 Inching sleeve
19 Return spring
20 Inching valve
21 Inching valve spring
22 Inching rod
23 Inching return spring
24 Inching stopper
25 Inching plug, O-ring
26 Strainer, O-ring

Suggestions for Reassembly

(1) Cleaning oil passages

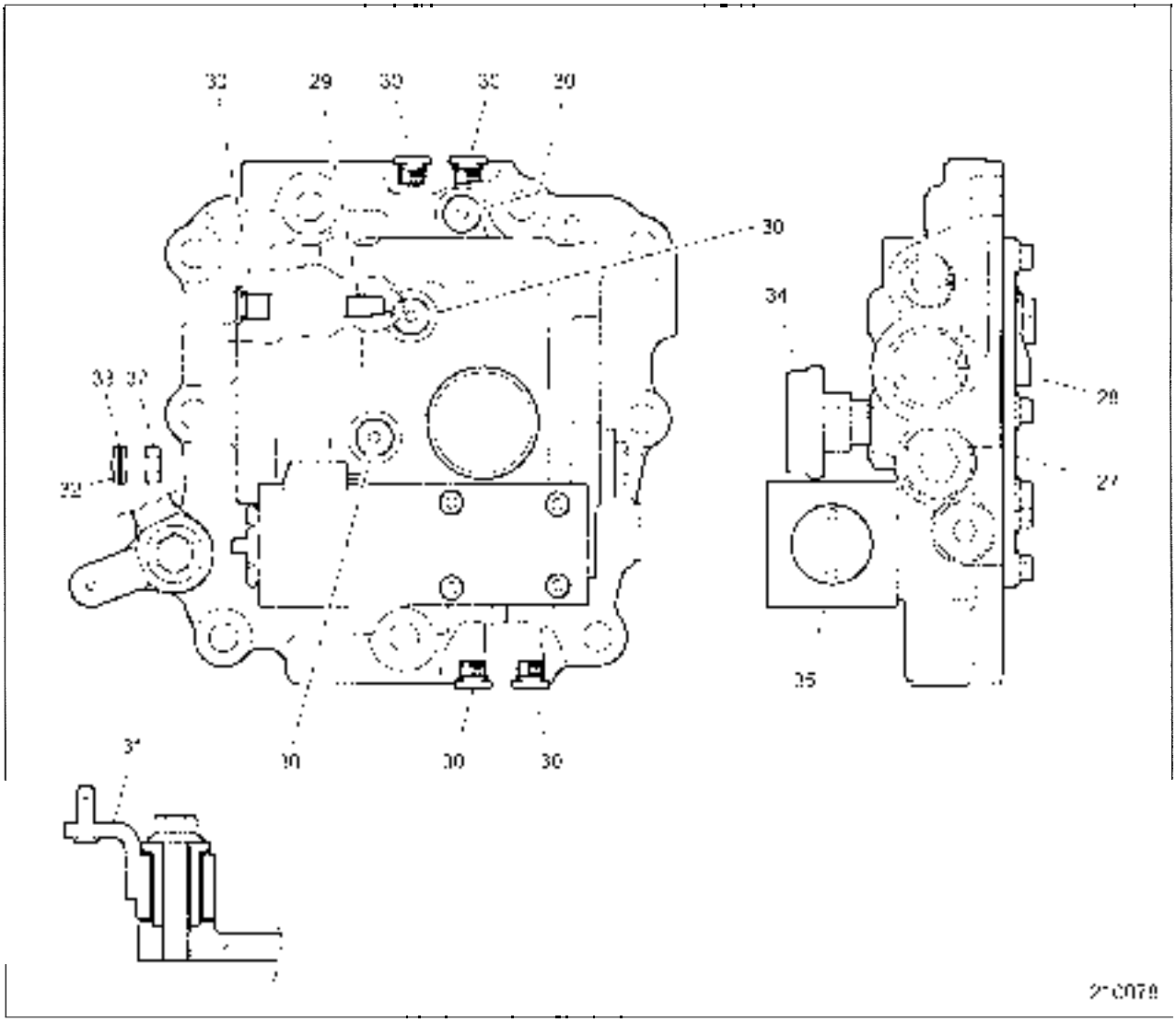
(a) The oil passages in the valve housing must be cleaned thoroughly. Make sure there is no clogging in any passage before reassembling the control valve.

(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

27 Valve plate, Gasket
28 Breather cover
29 Main orifice
30 Plug, O-ring
31 Inching lever, Retainer, Bushing
32 Inching rod plate
33 Spring pin
34 Breather
35 Solenoid valve

Suggestions for Reassembly

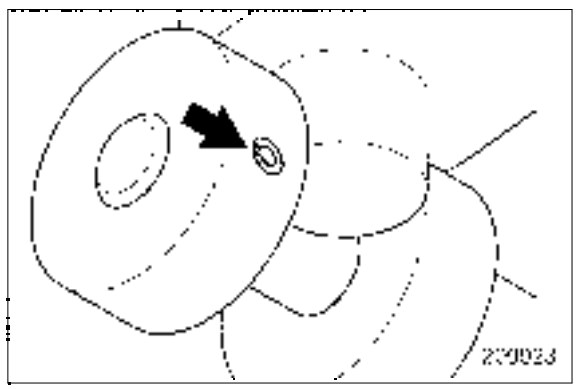
(1) Tightening torques

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

Bolts fastening valve plate 27 Interstitial cover 28 Plug 30	6.0 to 8.0 N·m (0.6 to 0.8 kgf·m) [4.4 to 5.9 lbf·ft]
Bolt for installing inching lever 31	35.3 to 43.1 N·m (3.6 to 4.4 kgf·m) [26 to 32 lbf·ft]
Plug 34 Plug 35 Bolt for installing solenoid valve 37	6.0 to 8.0 N·m (0.6 to 0.8 kgf·m) [4.4 to 5.9 lbf·ft]

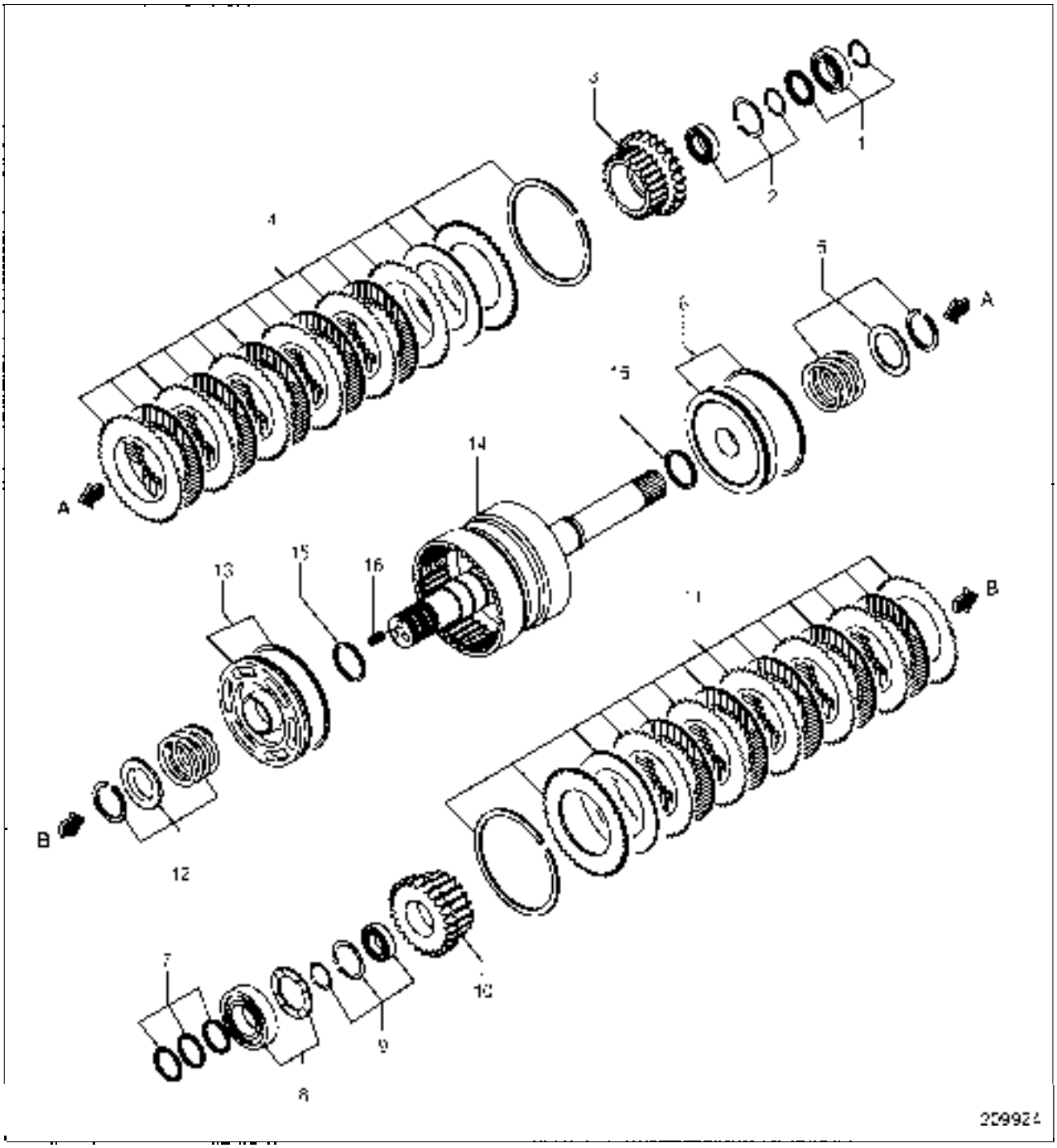
(2) Direction of spring pin slit

(a) The spring pin 33 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, Input shaft 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
15 Set screw (2 pieces)

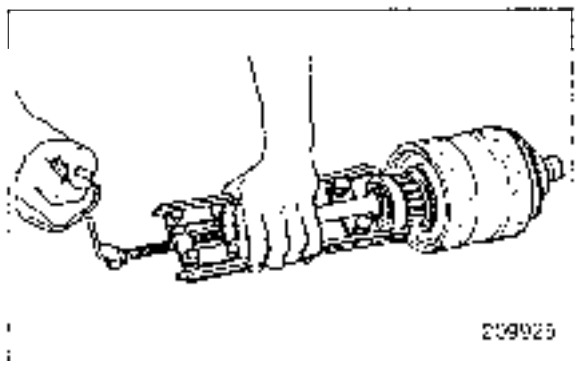
Suggestions for Disassembly

(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
[illegible]	F1035 - 10020
Gear puller (T24)	—

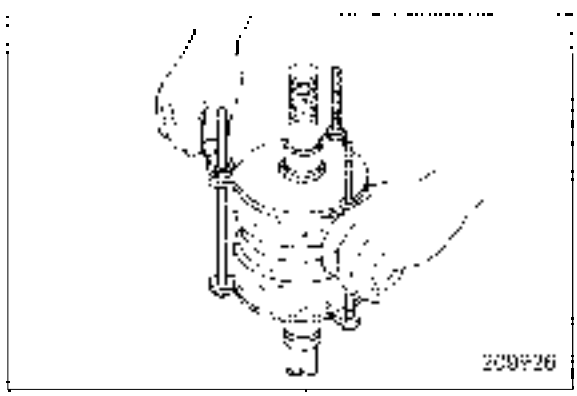


(2) Disassembling input shaft

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

Special tool needed

Piston tool	91268 - 17100



Inspection after Disassembly

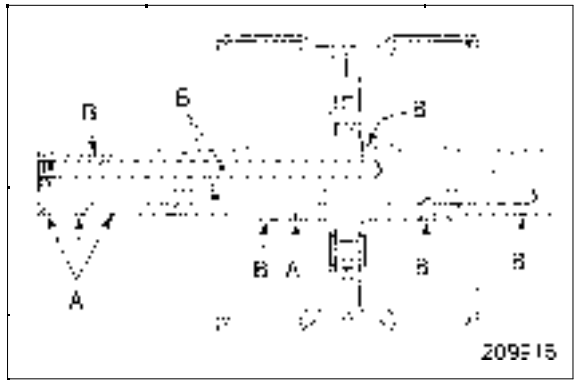
(1) Input shaft

(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.

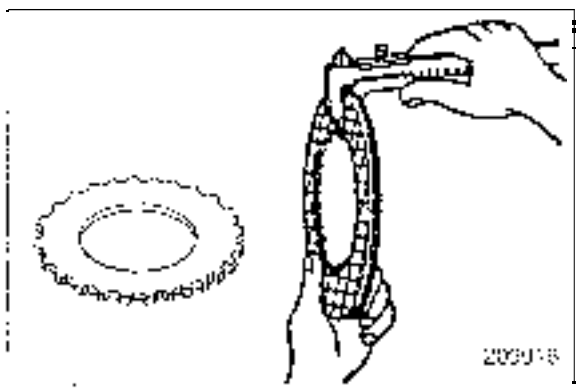
(4) Friction plates and mating plates

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

(b) Check splines for wear or other damage.

(5) Piston ring

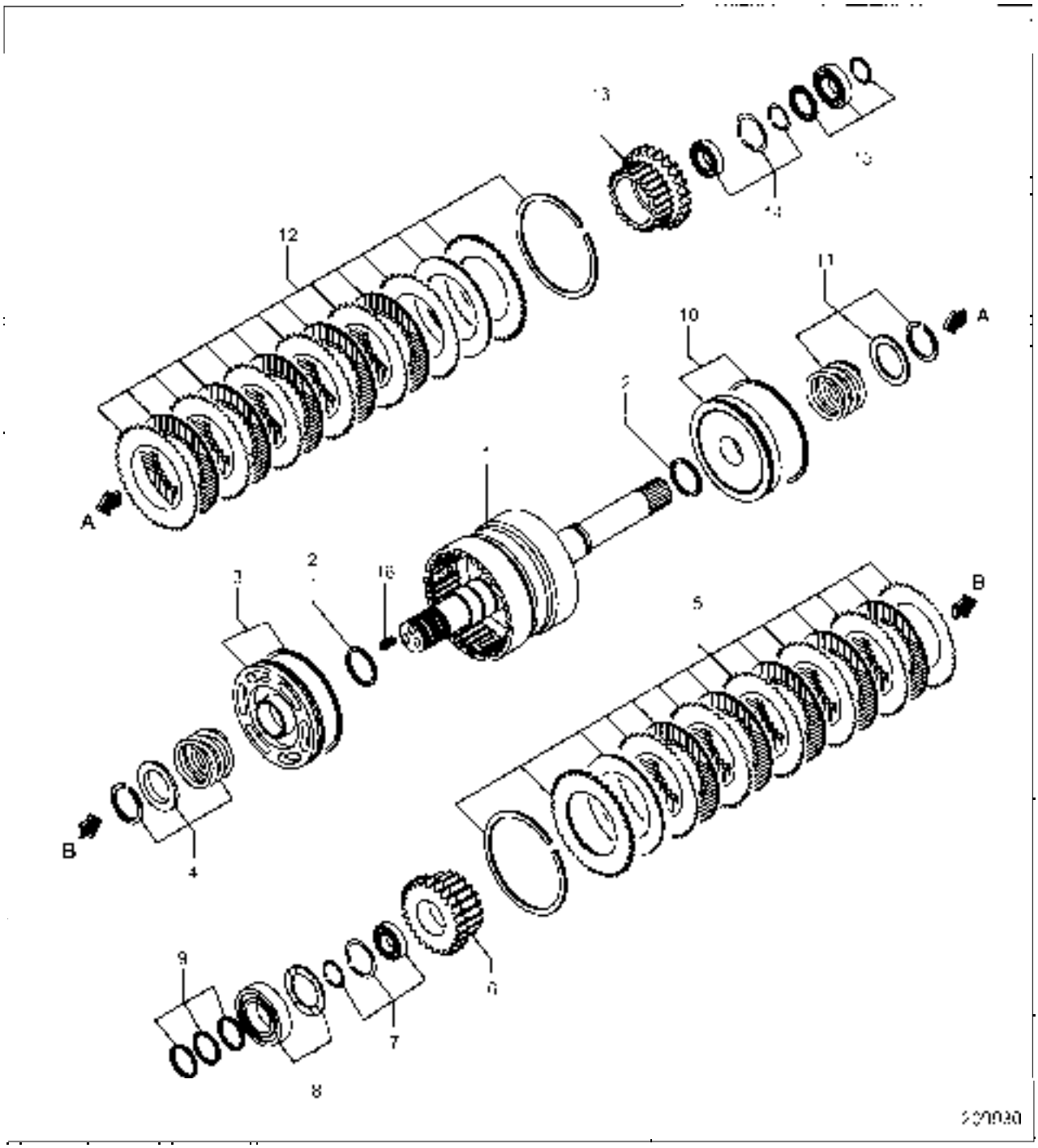
Check piston ring for wear or damage.



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	[illegible]
	B	[illegible]

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.

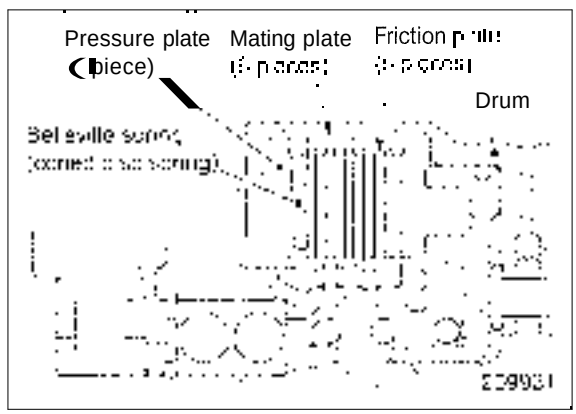
(2) Assembling plates

(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.

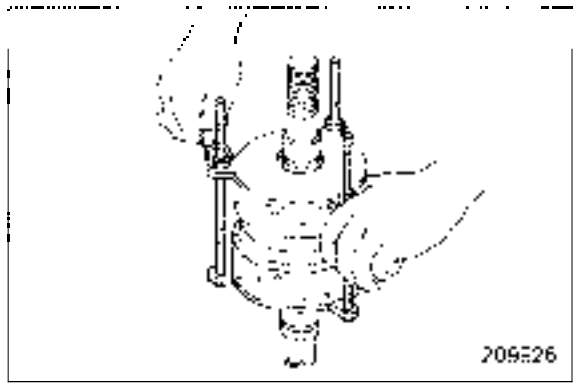


(3) Installing snap rings

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

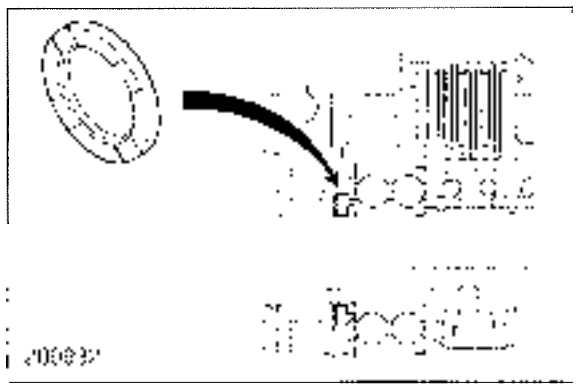
Special tool needed

Piston tool	91268 - 17100



(4) Installing spacer

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

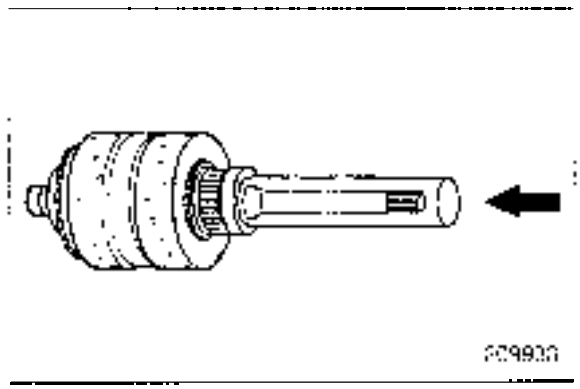


(5) Installing bearing

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

Special tool needed

Installer	[illegible]



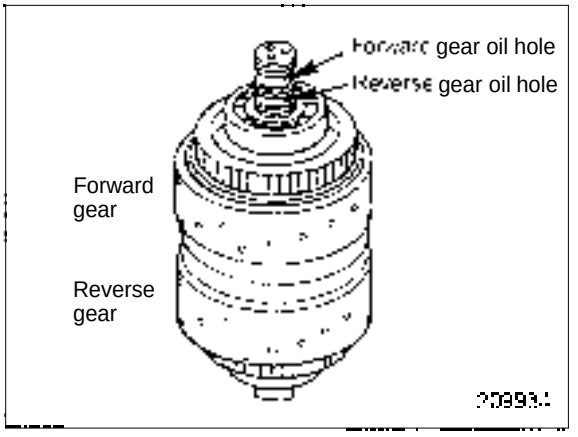
(6) Installing set screw

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

(7) Testing clutch piston operation

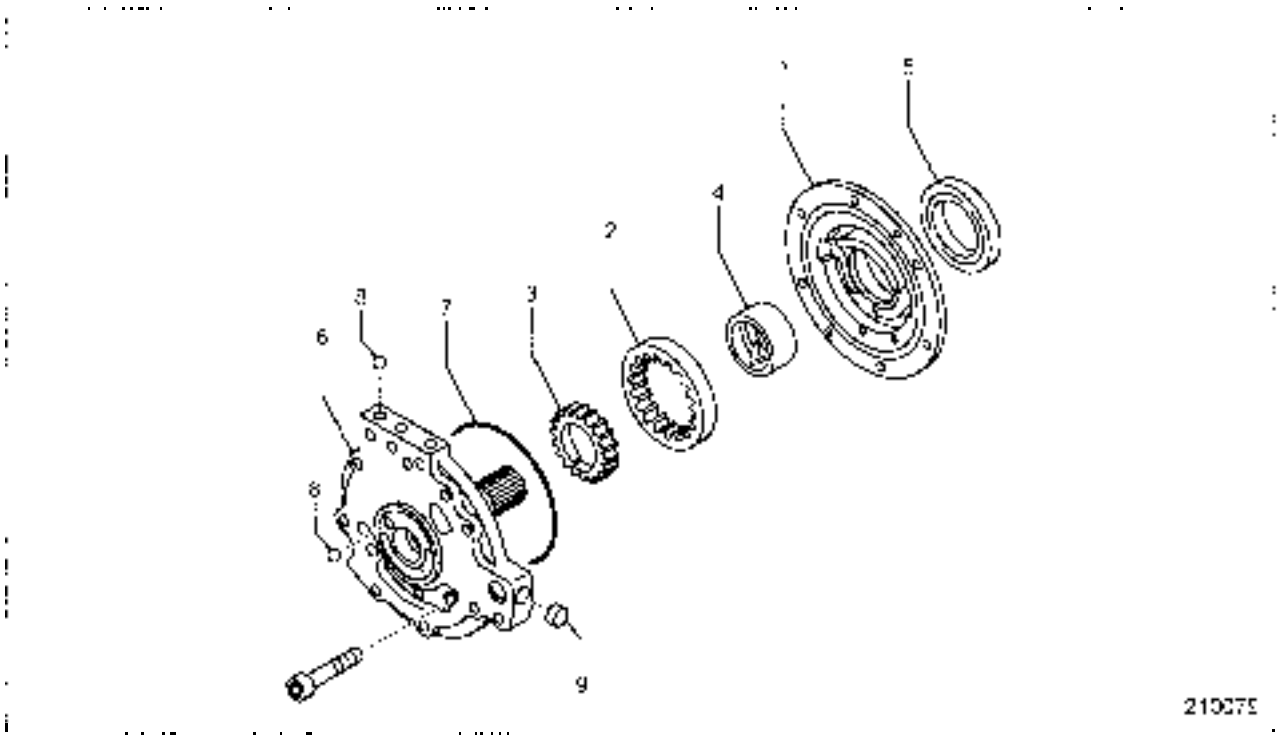
(a) Check that the clutch piston operates correctly by applying compressed air pressure through the forward (reverse) gear oil hole.

Note: Always use filtered, clean compressed air.



Oil Pump Assembly

Disassembly



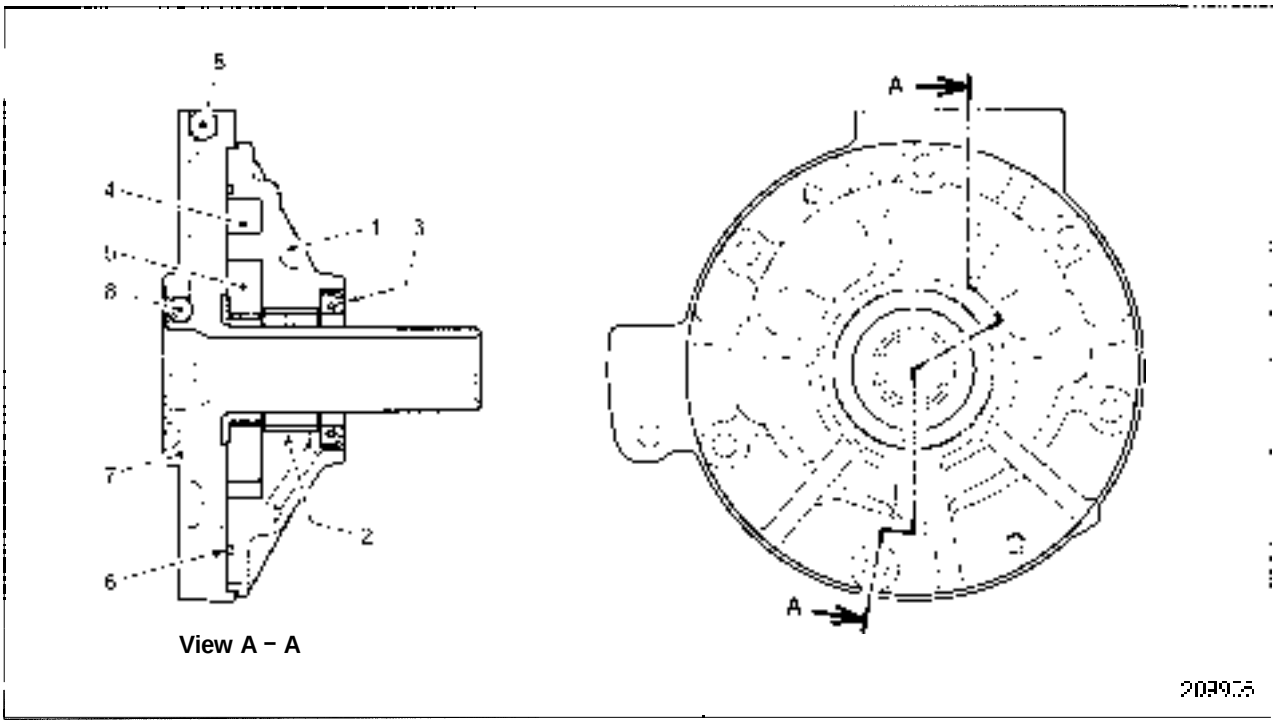
Sequence

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

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

Suggestions for Reassembly

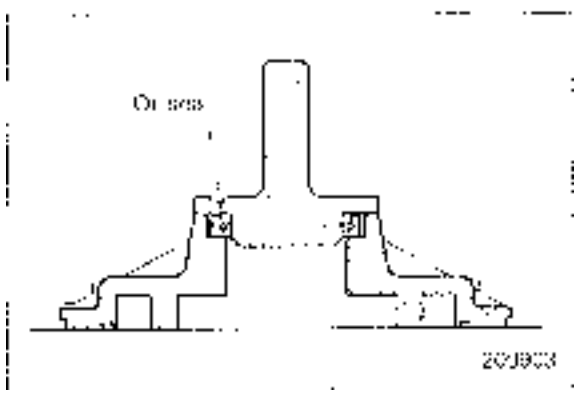
(1) Installing oil seal

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

Special tool needed

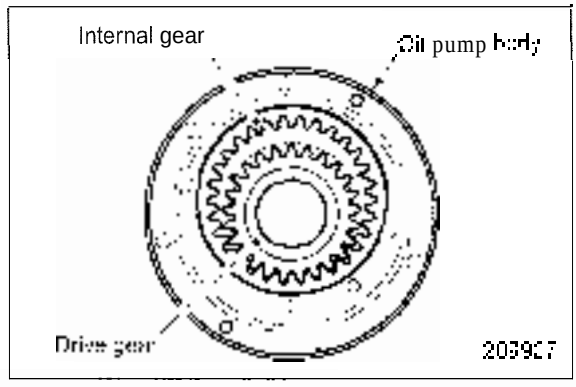
Installer	91268 - 15300

(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 second after stopping the engine, and check the level.

(d) The checking procedure must bc 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.

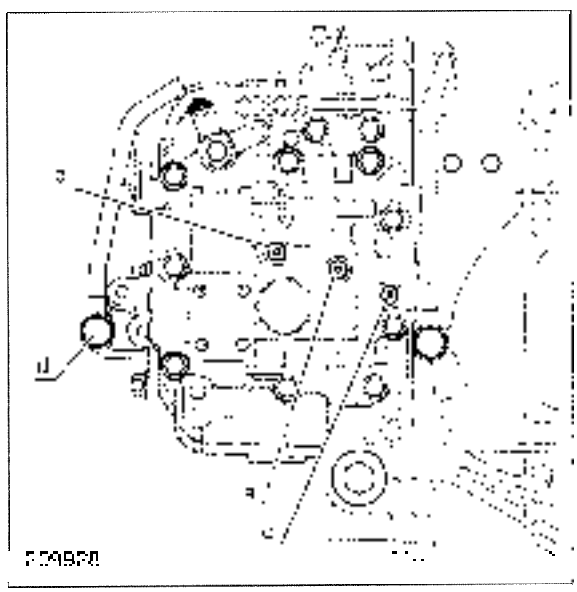
(b) Raise the front wheels completely clear of the ground either by jacking up the front axle housing or placing a wood block under the outer mast and tilting the mast forward.

(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	G (PF) 1/8 and Rc (PT) 118 thread	○	○	○	
*Connector 64309 - 17733	R (PT) 1/8 and G (PF) 3/8 thread	○	○	○	○
Connector [illegible]	[illegible]	–	–		○
*Gauge 64309 - 17714	G (PF) 3/8 thread	600 kpa (6 kgf/cm²) [87 psi]	–	○	○
*Gauge 64309 - 17713	R (PT) 3/8 thread	2000 kPa (20 kgf/cm²) [290 psi]	○	–	–
*Hose 64309 - 17722	Both side G (PF) 3/8 thread	◎	○	◎	◎
*Connector 64309 - 17731	Both side G (PT) 3/8 thread	For gauge connection	○	○	○

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

(5) Oil pressure measurement procedure

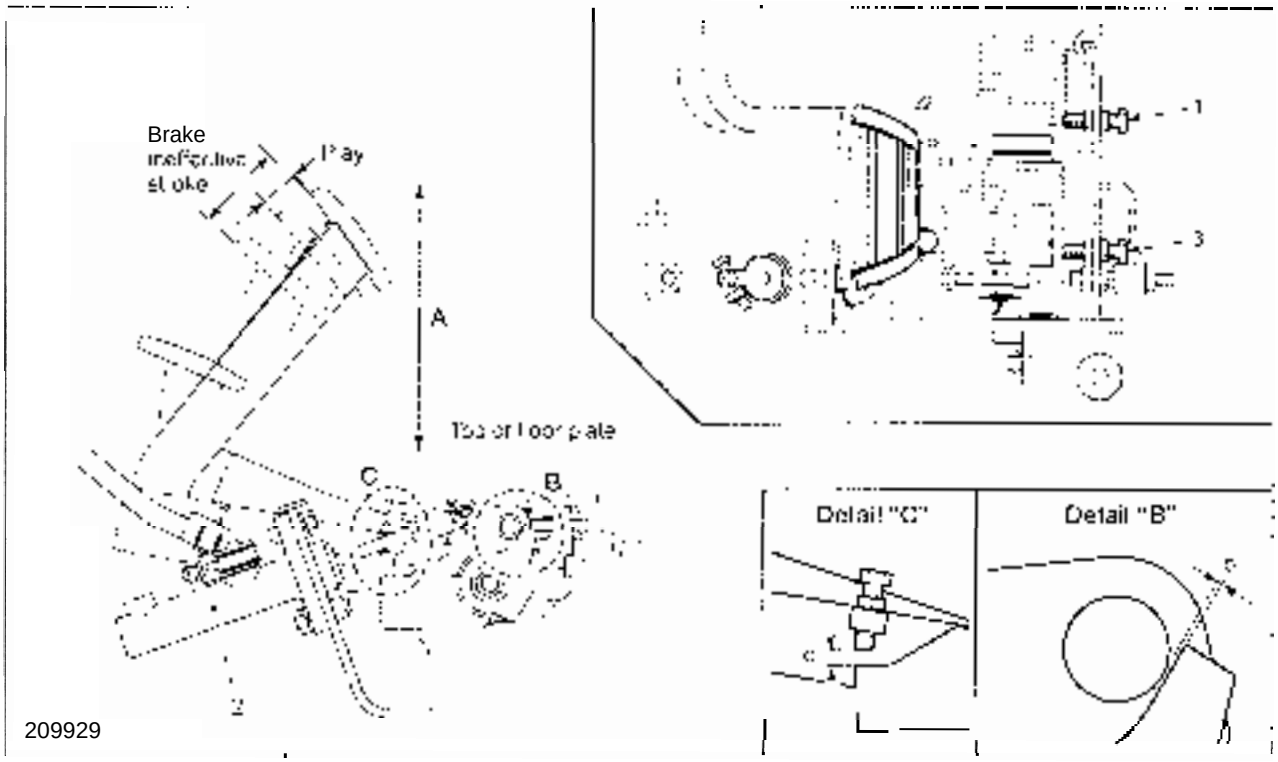
(a) Start the engine, shift the direction lever into the neutral position and measure the main pressure, torque converter inlet pressure, and lubrication oil pressure.

(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/cm²) [psi]

		Engine rprn	Shift		Oil pressure
a	Main pressure	800 ± 50 min⁻¹ (rprn)	N	A	1.09 to 1.25 (11.1 to 11.7) [158.1 to 166.8]
			Forward	A	1.09 to 1.18 (11.1 to 11.7) [158.1 to 166.8]
			Reverse	A	1.08 to 1.14 (11.0 to 11.6) [156.7 to 165.4]
		1600 It 100 min⁻¹ (rprn)	N	A	1.23 to 1.29 (12.5 to 13.2) [178.4 to 187.1]
			Forward	A	[illegible] [177.0 to 185.7]
			Reverse	A	1.22 to 1.28 (12.4 to 13.1) [177.0 to 185.7]
b	Clutch pressure	800 ± 50 min (rpm)	N	A	1.08 to [illegible] (11.0 to [illegible]) [156.7 to 163.4]
			Forward	A	1.06 to 1.12 (10.8 to [illegible]) [153.8 to 162.5]
			Reverse	A	1.03 to 1.09 (10.5 to [illegible]) [149.4 to 158.1]
		1600 ± 100 min⁻¹ (rprn)	N	A	1.20 to 1.26 (12.2 to 12.86) [174.1 to 182.8]
			Forward	A	1.18 to 1.24 (12.0 to 12.66) [171.2 to 179.9]
			Reverse	A	1.19 to 1.21 (12.1 to 12.3) [172.6 to 175.5]
c	Torque converter inlet pressure	800 ± 50 min (rprn)	N	A	0.14 to 0.18 (1.4 to 1.8) [20.3 to 26.11
			Forward	A	0.12 to 0.16 (1.2 to 1.6) [17.4 to 23.2]
			Reverse	A	0.10 to 0.14 (1.0 to 1.4) [14.5 to 20.31
		1600 ± 100 min (rprn)	N	A	0.38 to 0.42 (3.9 to 4.3) [55.1 to 60.91
			Forward	A	0.36 to 0.40 (3.7 to 4.1) [52.2 to 58.0]
			Reverse	A	0.36 to 0.40 (3.7 to 4.1) [52.2 to 58.0]
	Lubrication oil pressure	800 ± 50 min (rprn)	N	A	0 to 0.04 (0 to 0.4) [0 to 5.8]
			Forward	A	0 to 0.04 (0 to 0.4) [0 to 5.8]
			Reverse	A	0 to 0.04 (0 to 0.4) [0 to 5.8]
		1600 ± 100 min⁻¹ (rprn)	N	A	0.03 to 0.07 (0.3 to 0.7) [4.4 to 10.2]
			Forward	A	0.03 to 0.07 (0.3 to 0.7) [4.4 to 10.2]
			Reverse	A	0.03 to 0.07 (0.3 to 0.7) [4.4 to 10.2]

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	151 mm (5.94 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 (0.391 in.)	11.6 mm (0.457 in.)

Inching Valve Adjustment

Start by:

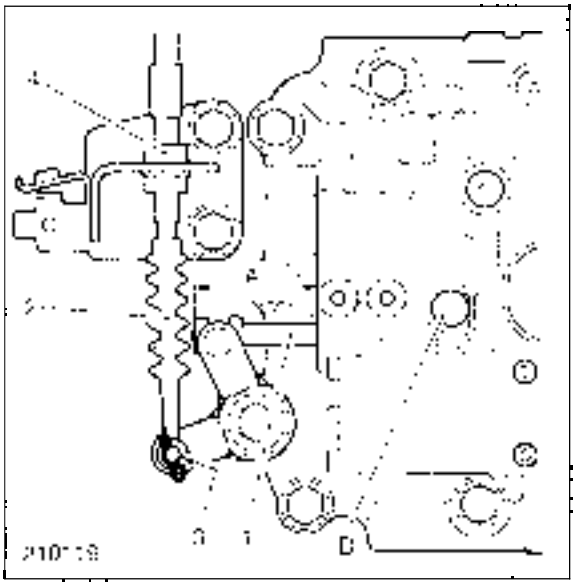
(a) Blocking the rear wheels, then raising the front wheels following the procedure described in the preceding oil pressure measurement section;

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

(c) Confirm that the inching rod 1 projects completely. The projection A of the inching rod (initial condition) is 48±0.5 mm [1.77–0.02 in.)

(d) Connect the inching cable 2 to the inching lever pin 3.

(e) Adjust the play of the inching cable to 0.5 to 1.5 mm (0.02 to 0.060 in.) and secure the cable by inching cable locking nut (outer) 4. Be sure to observe the lower limit (0.5 mm [0.02 in.]) to prevent over tensioning of the cable.



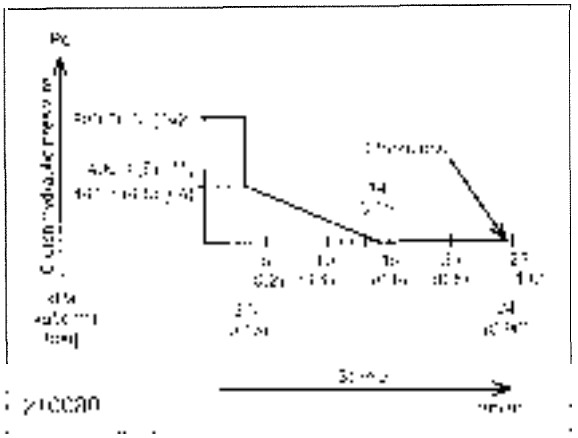
Procedure

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

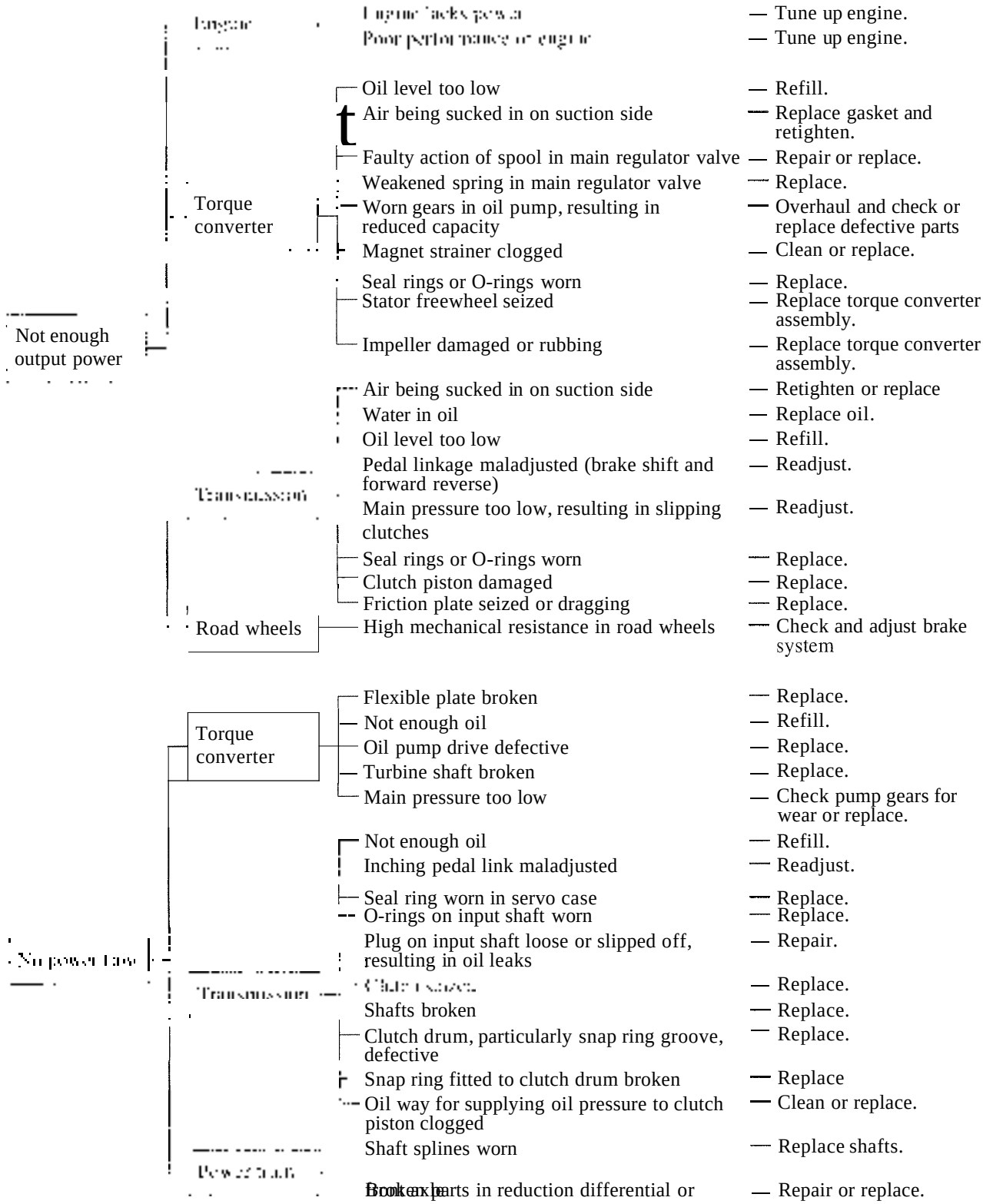
(b) Shift the lever into the forward (reverse) position.

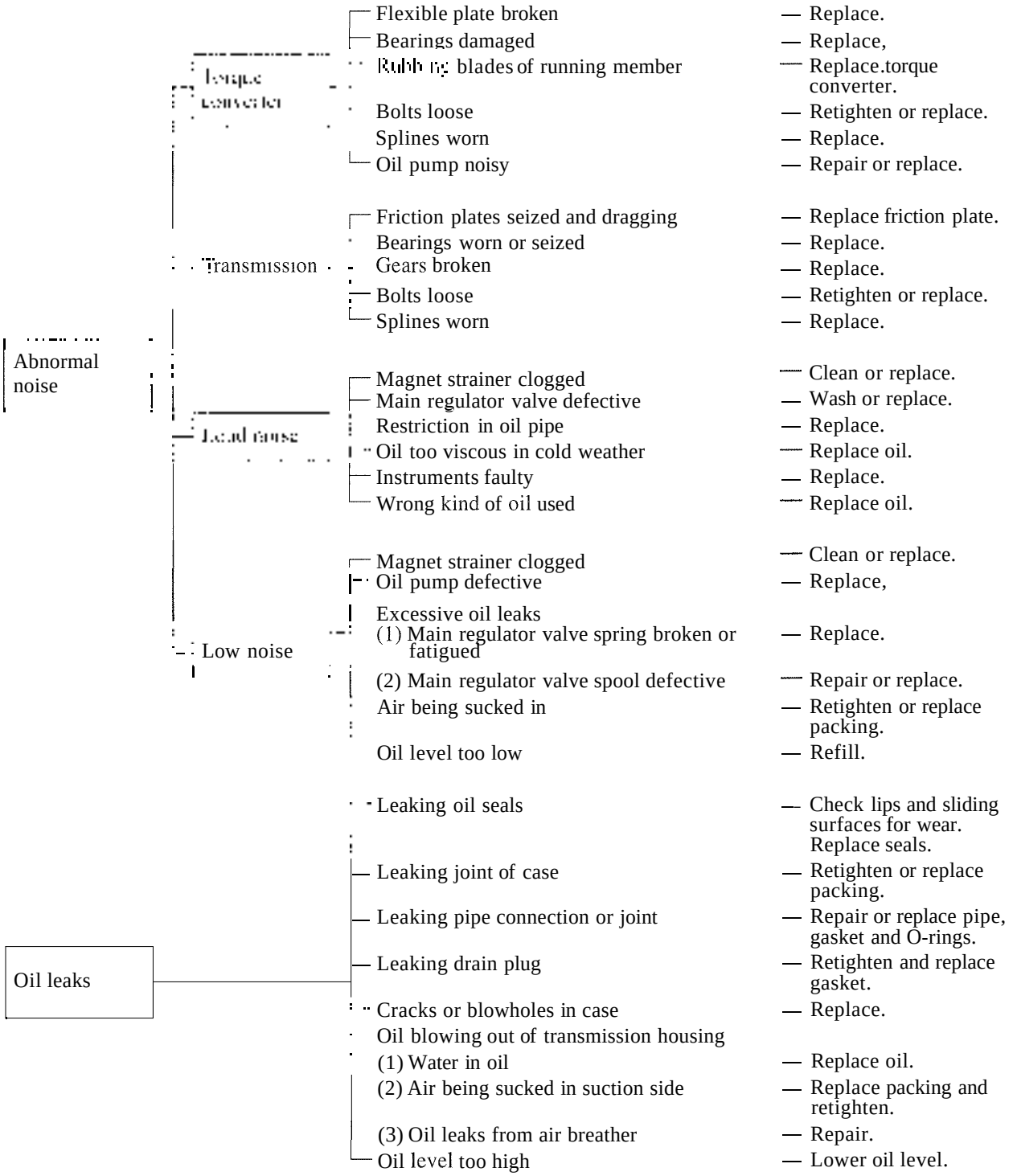
(c) Depress the inching pedal gradually to make the plunger 2 retract, while recording the clutch pressure (Pc) for each stroke distance of plunger 2 in order to know the relationship between them.

(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.



Troubleshooting





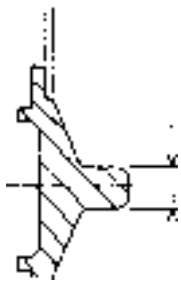
Oil temperature is too high	Torque converter	Oil level too high or too low — Refill or drain.
		Magnet strainer clogged — Clean or replace.
		Impeller rubbing — Replace torque converter assembly.
		Stator freewheel defective — Replace torque converter assembly.
		Air being sucked in — Retighten or replace O-ring.
		Water in oil — Replace oil.
		Restriction in oil pipe (resulting in reduced circulation flow) — Repair or replace.
	Transmission	Bearings worn or seized — Repair or replace.
		Instruments out of order — Replace.
		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.
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.
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.
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.
		Fautly 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.

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 stator assembly.
	Inching pedal linkage defective, or friction plates slipping if the speed is too high	— Repair or replace.

Service Data

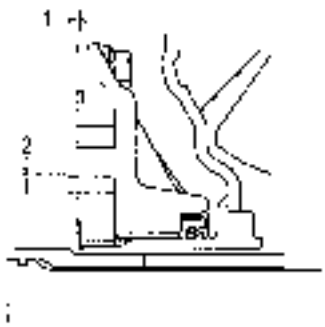
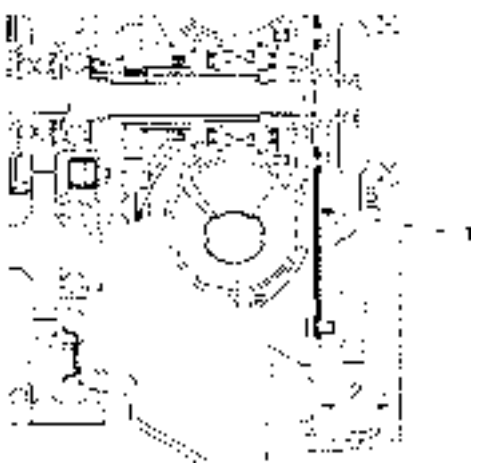
A: Standard value B: Repair or service limit

Unit: mm (in.)

Items \ Truck Models		1 ton class	2 ton class	3 ton class
Main pressure (engine at 1600 ± 100 rprn) MPa (kgf/cm²) [psi]	A	[illegible]		
Clutch pressure (engine at 1600 ± 100 rprn) MPa (kgf/cm²) [psi]	A	0.98 to 1.28 (9.99 to 13.1) [142.2 to 185.71		
Torque converter inlet pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]	A	0.10 to 0.50 (1.02 to 5.10) [14.5 to 72.5]		
Lubricating oil pressure (engine at 1600 ± 100 rpm) MPa (kgf/cm²) [psi]	A	1-speed T/M: 0.03 to 0.29 (0.31 to 2.95) [4.4 to 42.11 Automatic 2-speed T/M: 0.01 to 0.15 (0.1 to 1.5) [1.45 to 21.81		
Travel time for 100 m (330 ft) starting acceleration (no load)	A	5 seconds, maximum		
Pump Shaft: Diameter of fitting surface in contact with oil seal 1	A	42 $^{0}_{-0.085}$ (1.654 $^{0}_{-0.0033}$)		
	B	41.85 (16.4763)		
		 1 21089		
	A	15 $^{-0.007}_{-0.042}$ (0.590 $^{-0.0028}_{-0.0035}$)		
	B	14.93 (0.5878)		
		 2CC411		

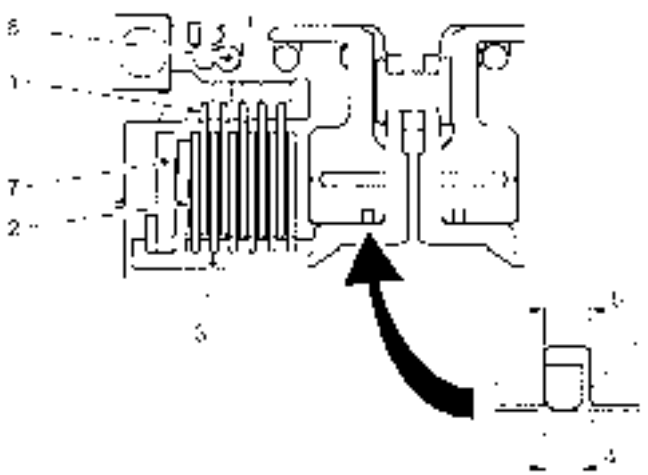
A: Standard value B: Repair or service limit

Unit: mm (in.)

Items			Truck Models: 1 ton class	2 ton class	3 ton class
Oil pump	Side clearance 1	A	0.040 to 0.083 (0.0016 to 0.00327)		
		B	0.15 (0.0059)		
	Top clearance 2	A	0.3 to 0.35 (0.0118 to 0.0138)		
		B	0.35 (0.0138)		
	Backlash	A	0.1 to 0.15 (0.0039 to 0.0059)		
		B	0.3 (0.0118)		
					
Flexible plate	Face runout of flexible plate 1 (in free state)	A	0.2 (0.0079)		
		B	0.5 (0.0197)		
	Distance between end face of transmission case and mating face of flexible plate 2	A	50 (1.97)		
					

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

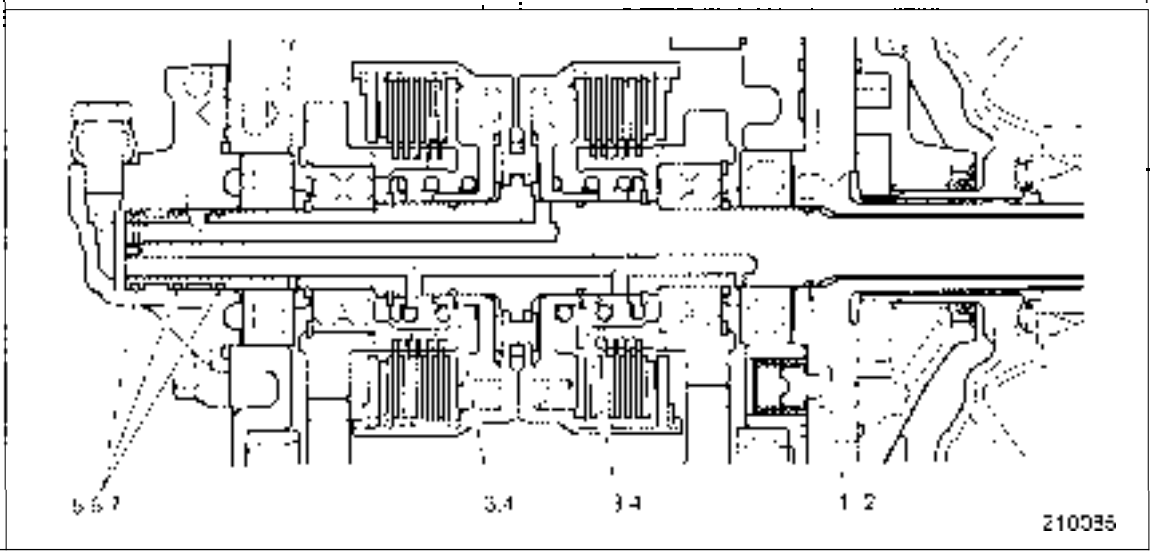
Items	Truck Models		1 ton class	2 ton class	3 ton class
Clutches	Thickness of mating plate 1	A	[illegible]		
		B	[illegible]		
	Thickness of friction plate 2	A	[illegible]		
		B	[illegible]		
	Backlash of friction plate and gear 3	A	0.13 to 0.29 (0.00512 to 0.01142)		
		B	0.5 (0.0197)		
	Width of seal ring 4	A	[illegible]		
		B	[illegible]		
	Width of piston seal ring groove 5	A	2.5 [illegible] (0.0984 [illegible]		
		B	2.65 (0.10433)		
	Free length of clutch spring 6 Spring constant: k = N/mm {kgf/mm} [lbf/in.]	A	[illegible] k = [illegible] {[illegible]} [[illegible]]		
	Thickness of pressure plate 7	A	[illegible]		
		B	[illegible]		



A: Standard value B: Repair or service limit

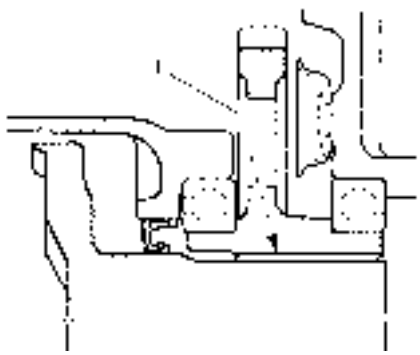
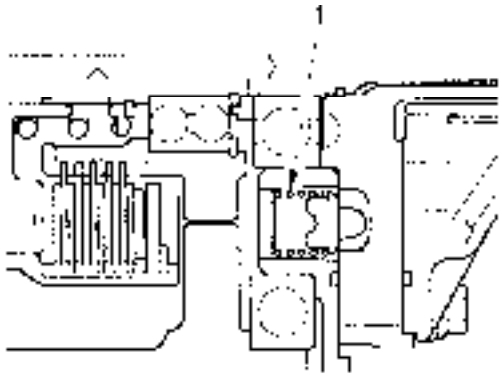
Unit: mm (in.)

Items	Truck Models		1 ton class	2 ton class	3 ton class
Input shaft assembly	Starter shaft seal ring width 1	A	[illegible]		
		B	[illegible]		
	Starter shaft piston seal ring groove width 2	A	2.5 [illegible] (0.0984 [illegible]		
		B	2.9 (0.1142)		
	Clutch piston seal ring width 3	A	[illegible]		
		B	[illegible]		
	Clutch piston seal ring groove width 4	A	2.8 ± 0.05 (0.110 ± 0.0020)		
		B	3.0 (0.1181)		
	Servo case shaft seal ring width 5	A	2.5 ± 0.05 (0.0984 ± 0.0020)		
		B	2.3 (0.0906)		
	Servo case shaft seal ring groove width 6	A	2.5 [illegible] (0.0984 [illegible]		
		B	2.9 (0.1142)		
	Servo case inside diameter contacting seal ring 7	A	30 [illegible]		
		B	30.2 (1.189)		



A: Standard value B: Repair or service limit

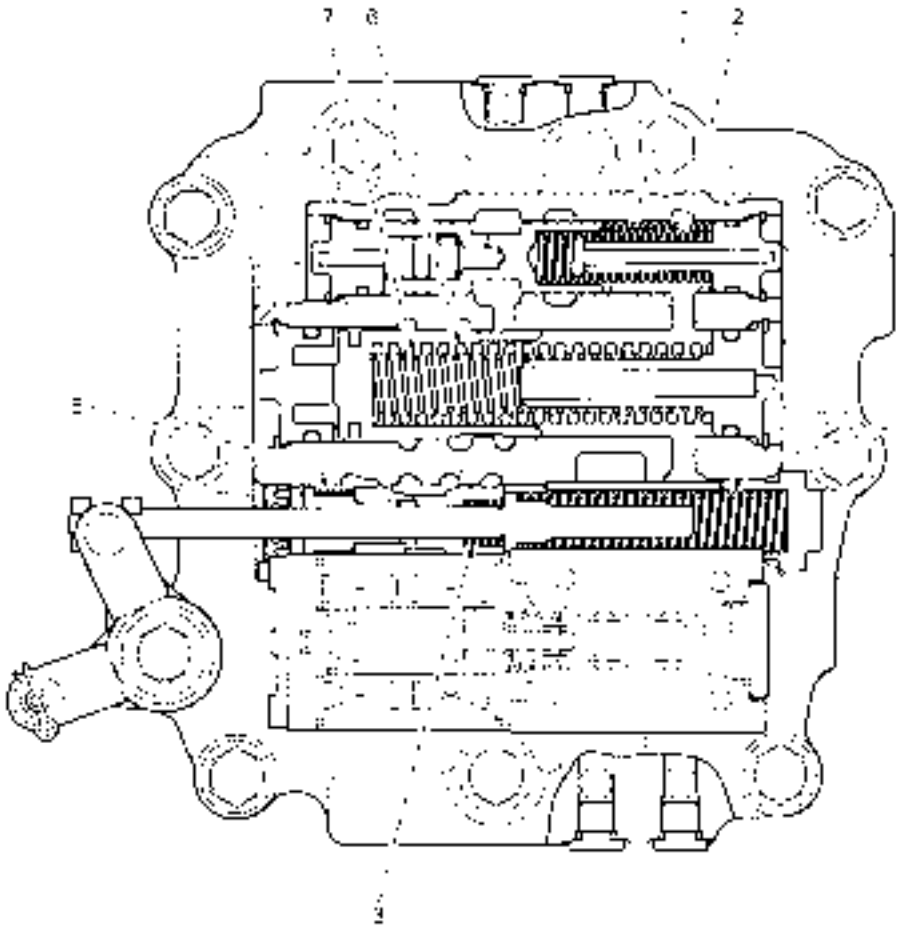
Unit: mm (in.)

Items	Truck Models		1 ton class	2 ton class	3 ton class
Output shaft	Free movement of output fringe gear (looseness of mating splines) 1	A	0.054 to 0.14 (0.00213 to 0.0055)		
					
Relief valve	Torque converter relief valve 1	Free length	A	35.15 (1.38)	
		Load at height 15.5 mm (0.61 in.)	B	29.4 ± 2.9N (3.0 ± 0.3 kgf) [6.6 lbf]	
					

A: Standard value B: Repair or service limit

Unit: mm (in.)

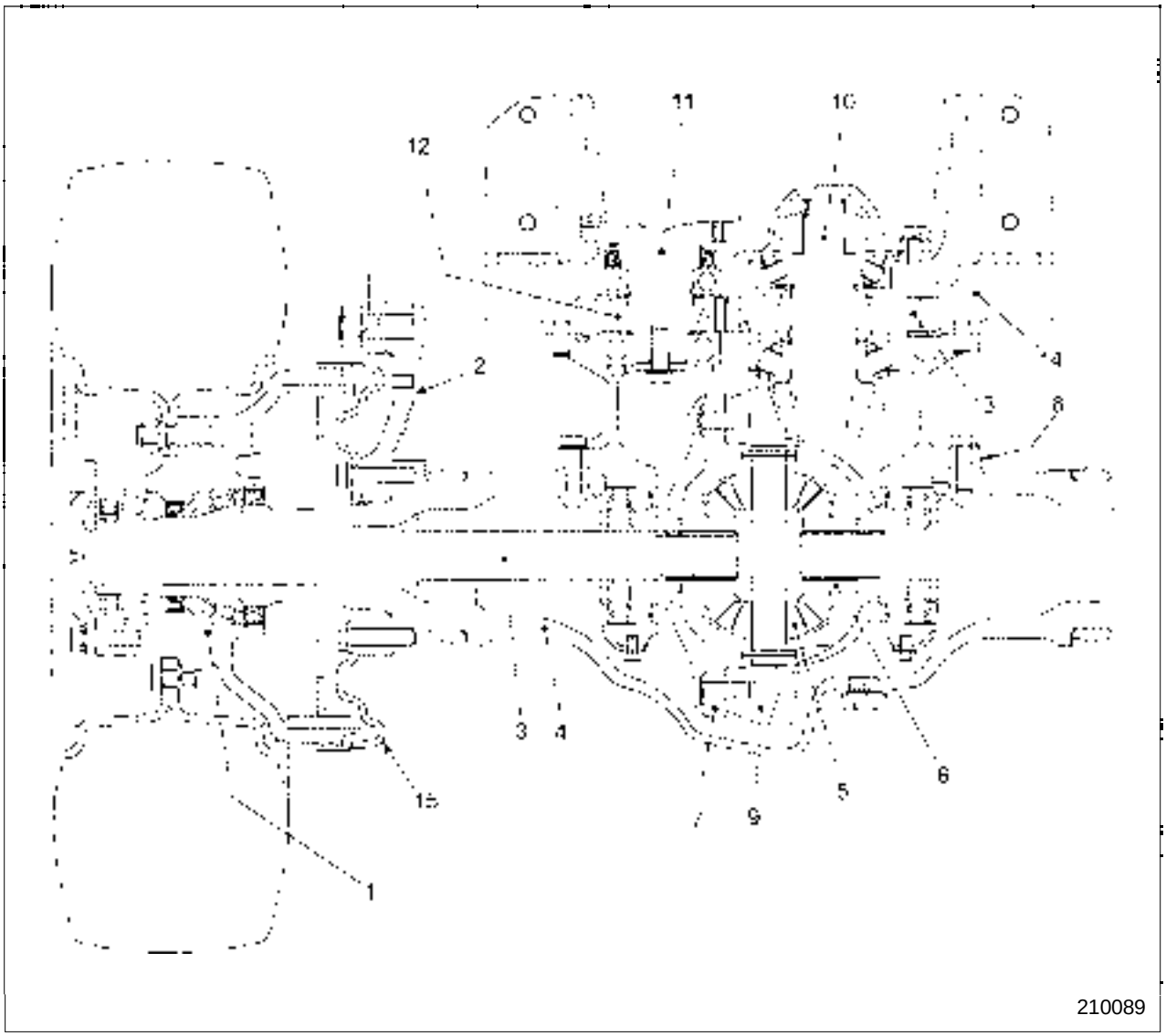
Items			Truck Models	1 ton class	2 ton class	3 ton class
Control valve	Main relief outer spring 1	Free length	A	80 (3.150)		
		Load at height 28.95 mm (1.140 in.)	B	19.6 ± 2 N (2 ± 0.2 kgf) [4.4 ± 0.5 lbf]		
	Main relief inner spring 2	Free length	A	78 (3.071)		
		Load at height 45.95 mm (1.810 in.)	B	71.3 ± 7.1 N (7.3 ± 0.1 kgf) [16 ± 1.6 lbf]		
	Inching valve spring 3	Free length	A	30.5 (1.201)		
		Load at height 17.7 mm (0.697 in.)	B	9.7 ± 1 N (1.0 ± 0.1 kgf) [2.2 ± 0.2 lbf]		
	Inching return spring 4	Free length	A	168 (6.614)		
		Load at height 70 mm (2.756 in.)	B	88.3 ± 7 N (9 ± 0.7 kgf) [19.8 ± 1.6 lbf]		
	Inching valve return spring 5	Free length	A	70.89 (2.791)		
		Load at height 18.2 mm (0.717 in.)	B	9.7 ± 1 N (1.0 ± 0.1 kgf) [2.2 ± 0.2 lbf]		
	Accumulator valve outer spring 6	Free length	A	91 (3.583)		
		Load at height 77.6 mm (3.055 in.)	B	98 ± 7.8 N (10 ± 0.8 kgf) [22 ± 1.8 lbf]		
	Accumulator valve inner spring 7	Free length	A	130 (5.118)		
		Load at height 50 mm (1.969 in.)	B	48 ± 3.9 N (4.9 ± 0.4 kgf) [10.8 ± 0.9 lbf]		



FRONT AXLE AND REDUCTION DIFFERENTIAL

Structure

1 Ton Class

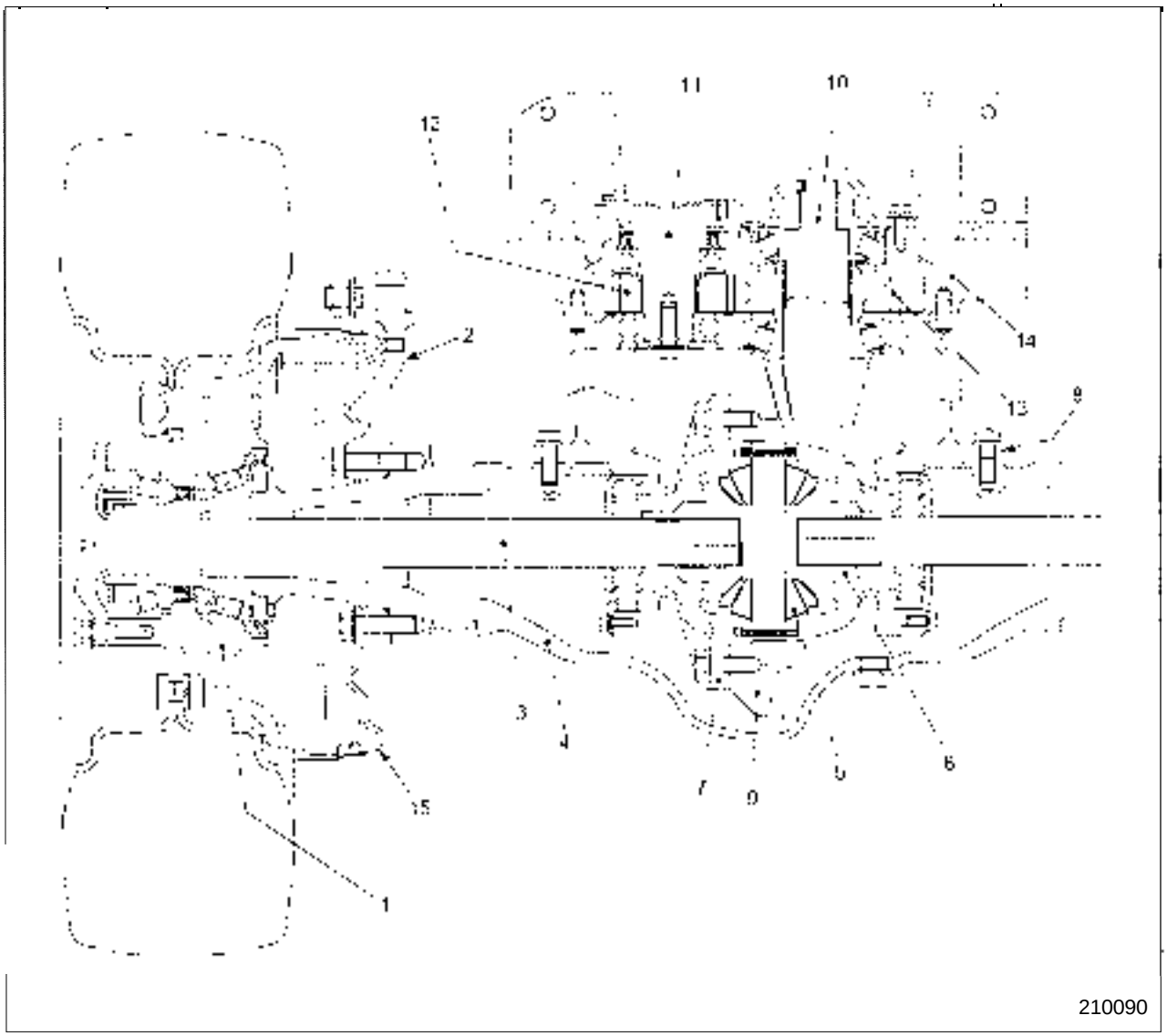


1	Front wheel hub	6	Differential gear	11	Input flange
2	Frame support	7	Differential case	12	Drive gear
3	Axle shaft	8	Differential carrier	13	Driven gear
4	Axle housing	9	Reduction gear	14	Carrier cover
5	Differential pinion	10	Reduction pinion	15	Backing plate

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

The reduction differential is mounted to front axle housing 4. The input Range 11 carries a drive gear which meshes with the driven gear mounted on the reduction pinion 10.

2 Ton Class

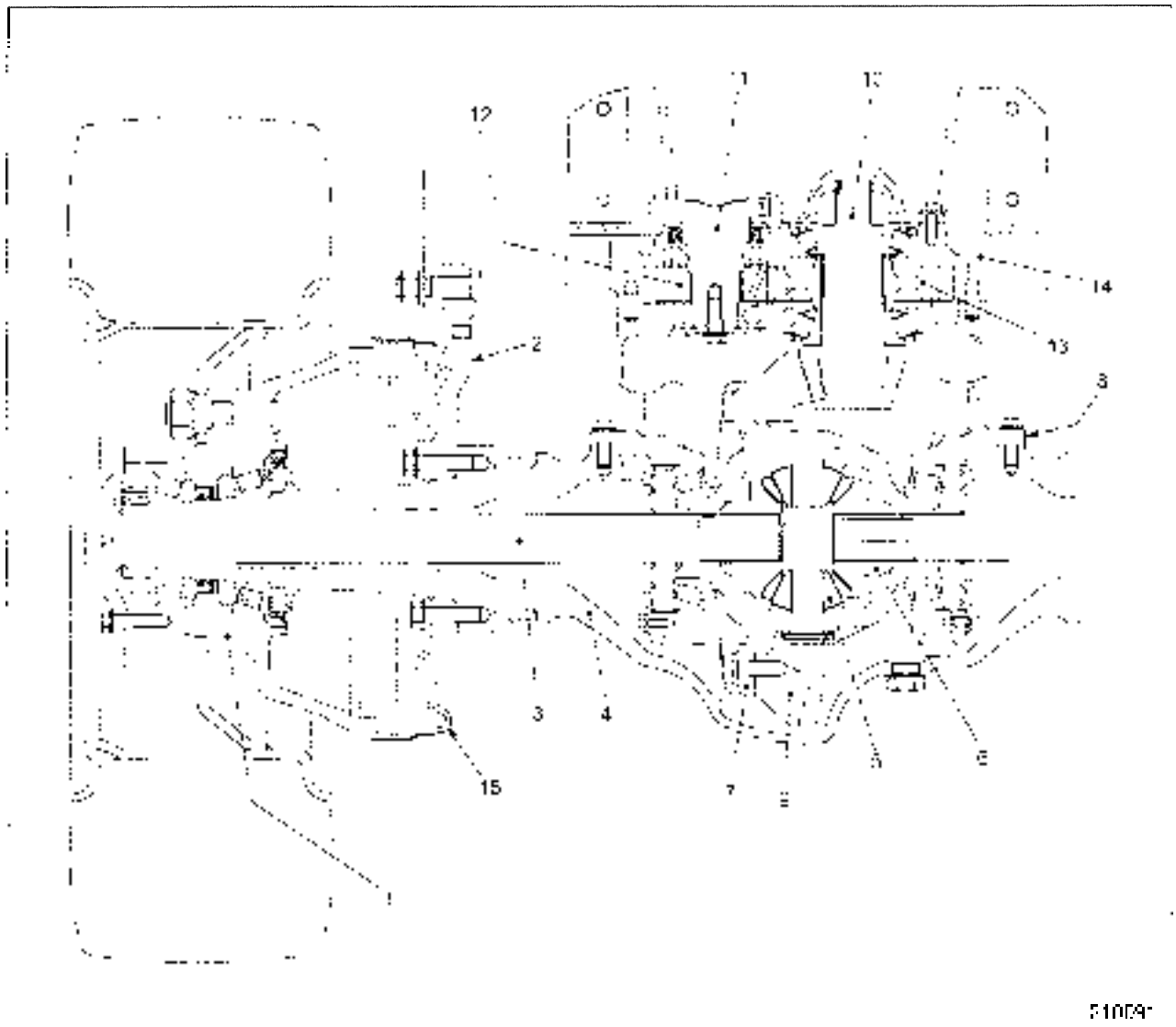


1	Front wheel hub	6	Differential gear	11	Input flange
2	Frame support	7	Differential case	12	Drive gear
3	Axle shaft	8	Differential carrier	13	Driven gear
4	Axle housing	9	Reduction gear	14	Carrier cover
5	Differential pinion	10	Reduction pinion	15	Backing plate

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

The reduction differential is mounted to the front axle housing 4. The input flange 11 carries a drive gear which meshes with the driven gear mounted on the reduction 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	Reduction gear	14	Carrier cover
5	Differential pinion	10	Reduction pinion	15	Backing plate

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

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

Removal and Installation

Front Wheels

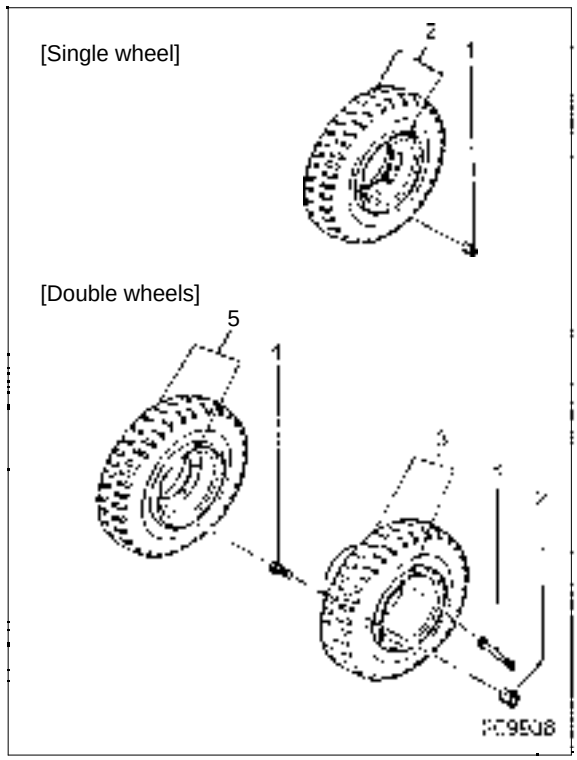
Removal

[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)



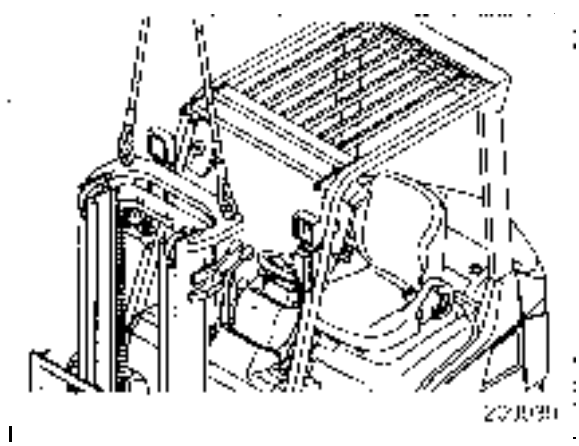
Start by:

(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.

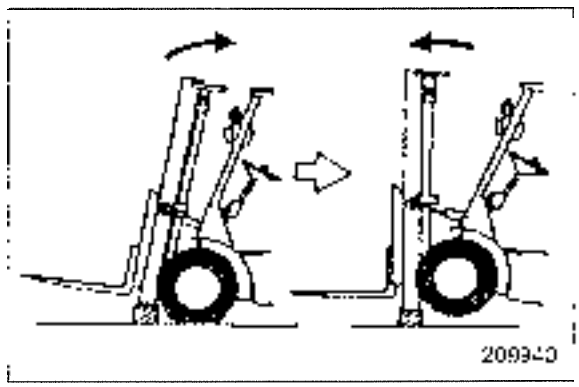
(1) Hoisting

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



(2) Using hydraulic system

Tilt the mast all the way back and place wood blocks under the mast in the appropriate places. Then, tilt the mast forward to raise the front end.

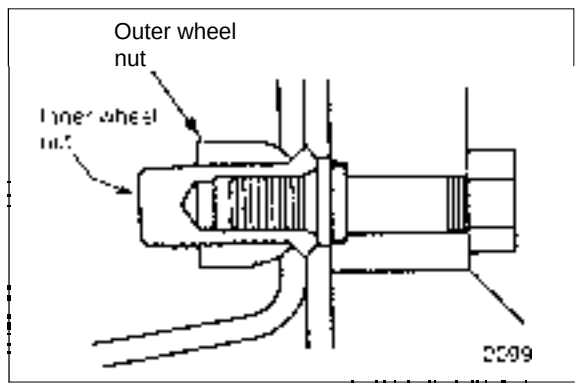


CAUTION

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

Suggestion 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.



Installation

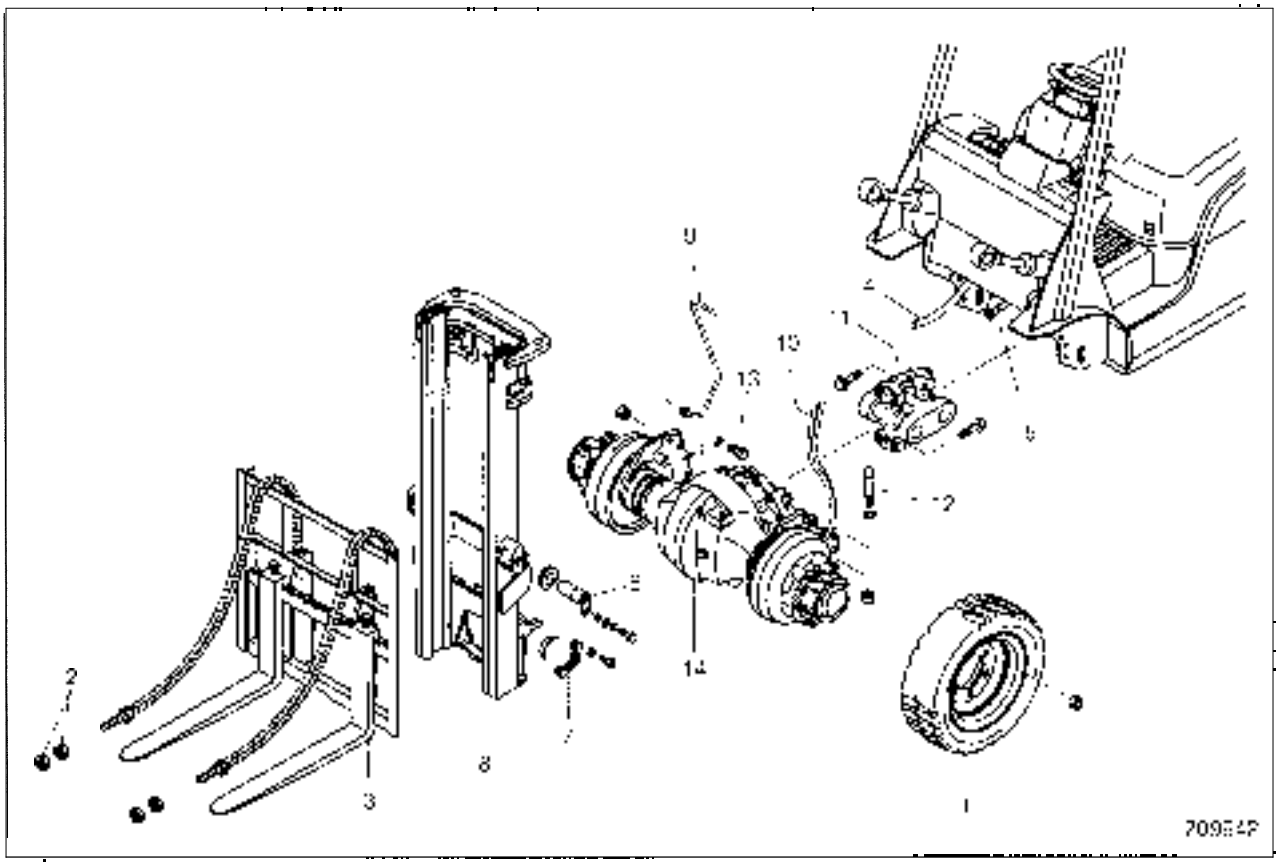
To install, follow the removal sequence in reverse, paying attention to the following points.

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

Item \ Truck Model	[illegible] class	[illegible] class
Tightening torque for wheel nuts N·m (kgf·m) [lbf·ft]	[illegible] (16 ± 1.6) [116 ± 11.61	377.6537.8 (38.5 ± 3.9) [279 5 27.91

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

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

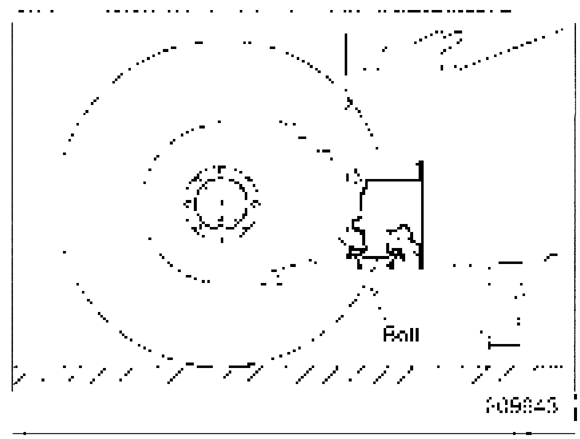
(2) For removal of mast parts 2 through 8, refer to "GROUP 12 MAST AND FORKS."

(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 as described above. To dismount the reduction differential after removal of the engine and transmission, the front axle does not need to be removed from the 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 '"CROUP 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 12 MAST AND FORKS "

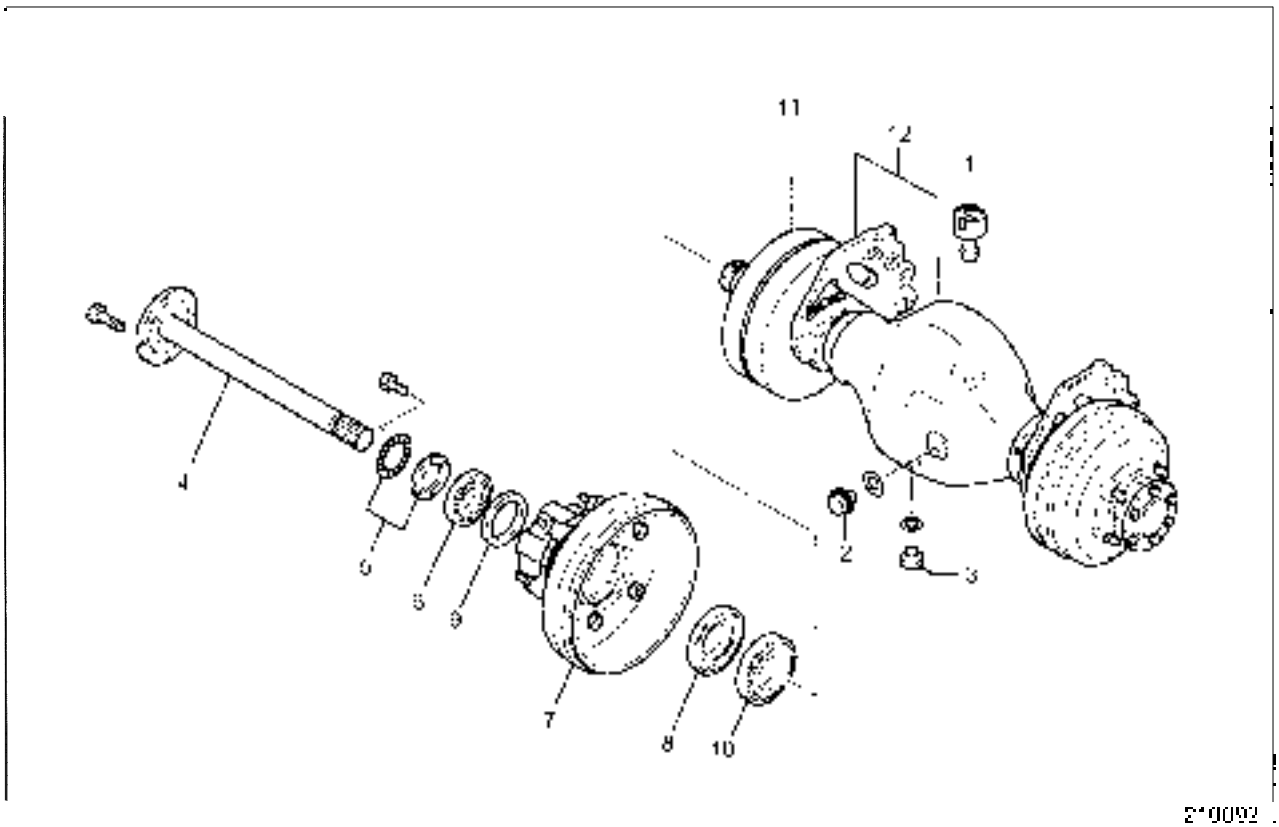
(4) Fill the front axle housing with oil up to the plug hole level.

Truck Model / Item	1-ton class	[illegible] ton class
Refill capacity (level limit) axle housing	1.2 liters ([illegible] U.S. gal)	[illegible] liters (2.1 U.S. gal)

Disassembly and Reassembly

Front Axle

Disassembly



Sequence

1 Air bleeder
2 Level plug
3 Drain plug
4 Axle shaft
5 Lock ring, Lock nut
6 Tapered roller bearing
7 Front wheel hub, Brake drum
8 Oil seal
9 Oil seal
10 Tapered roller bearing
11 Brakeassembly
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 or to drain the oil when removing the axle shaft or disassembling the wheel hub.

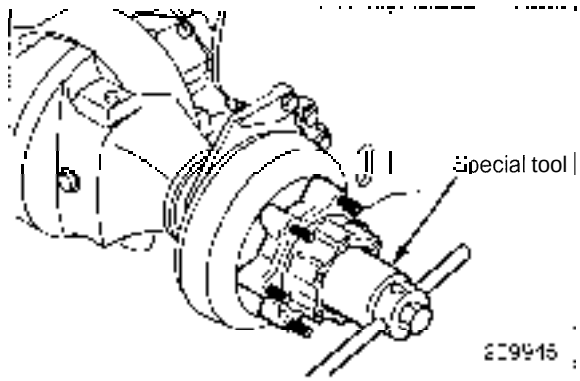
Suggestions for Disassembly

(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

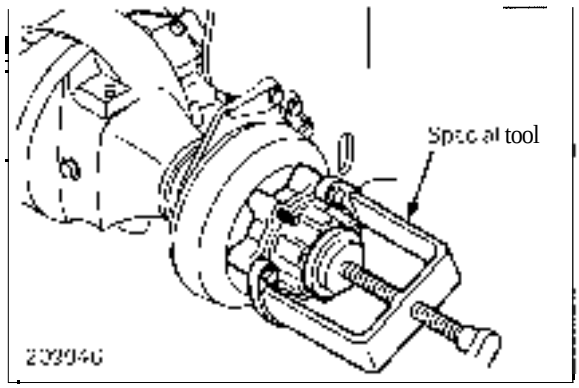


(2) Removing front wheel hub

Use the wheel hub puller (special tool).

Special tool needed

1 ton class	[illegible]
2, 3 ton classes	[illegible]

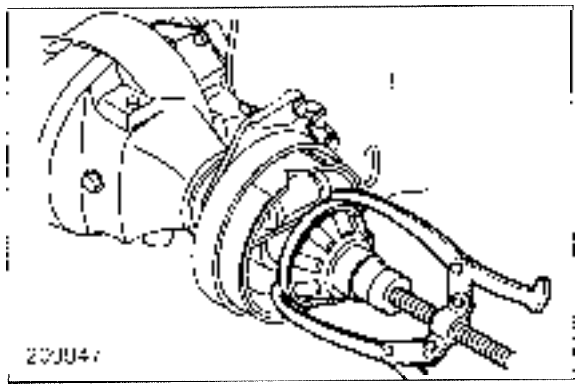


Note: It is not necessary to remove the oil seal from the hub nor disassemble the oil deflector unless the seal is defective.

(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.

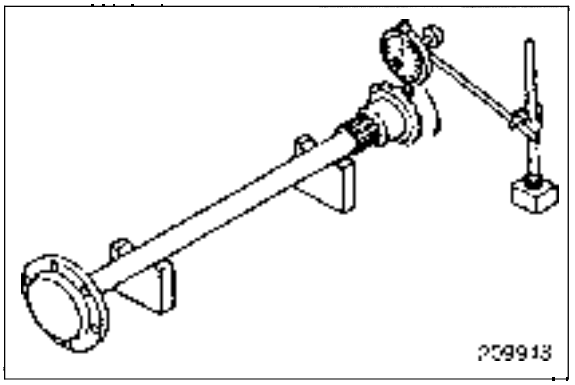


Inspection after Disassembly

(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).

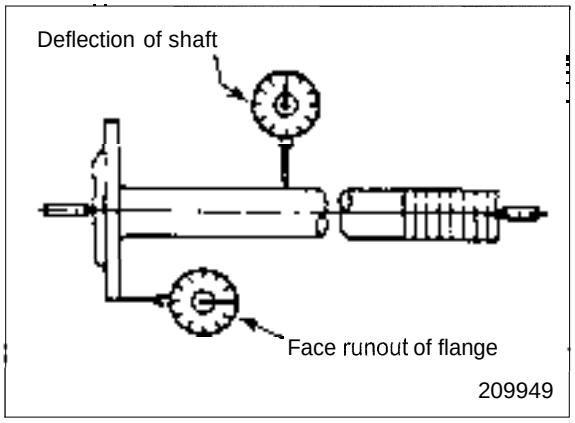


A: Standard value B: Repair or service limit

Free movement (looseness of mating splines)	A	0.20 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).



A: Standard value B: Repair or service limit

Deflection of axle shaft (1/2 of dial indicator reading)	A	1.0 mm (0.039 in.)
	B	2.0 mm (0.079 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	0.06 mm (0.0024 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

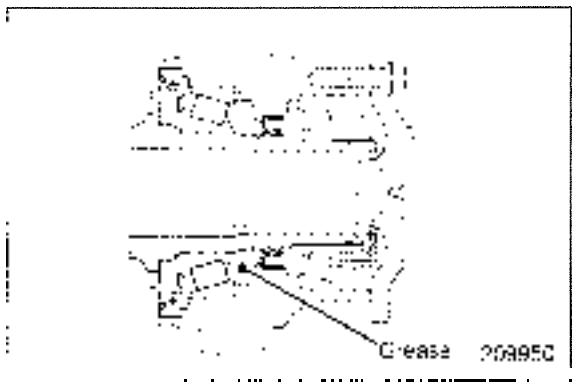
To reassemble, follow the disassembly sequence in reverse, paying attention to the following points.

(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.



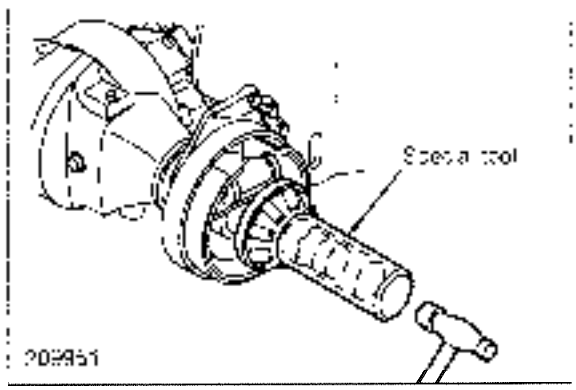
CAUTION

Use care not to let grease in the brake drum.

(b) Using the installer (special tool), install the inner race and oil seal retainer of the wheel hub bearing.

Special tool number

Item	Truck Model	1.5-ton class	2.5-ton classes
Installer		61309 - 12301	9.468 - 00064



(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]

Item \ Truck Model	1 ton class	2, 3 ton classes
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]	

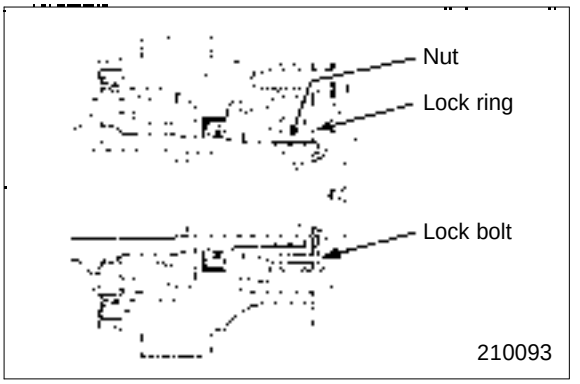
(d) Fit the lock ring into place and tighten the lock bolt.

(e) Check the preload again.

(3) Drain plug

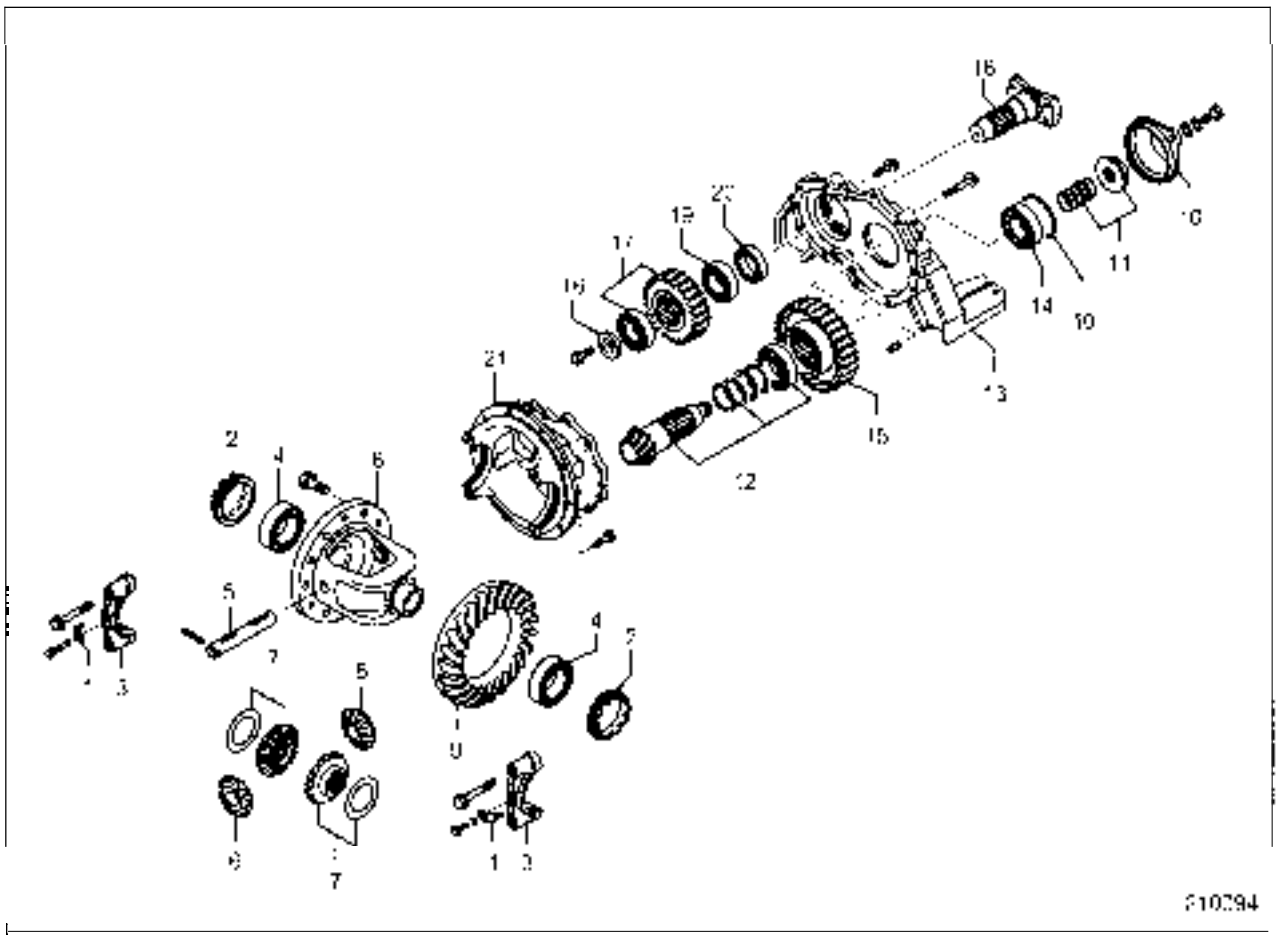
(a) Tighten the drain plug to the specified torque.

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

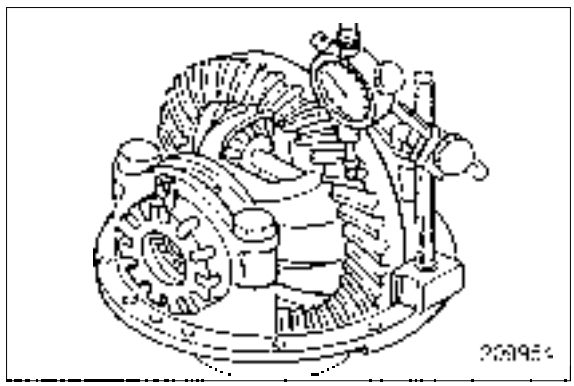
Remove parts 4 through 9 as an assembly

4 Tapered roller bearing
5 Pinion shaft
6 Differential pinion
7 Bevel gear, Spacer
8 Differential case
9 Bevel gear
10 Cover, O-ring
11 Lock nut, Shims
12 Reduction 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 case

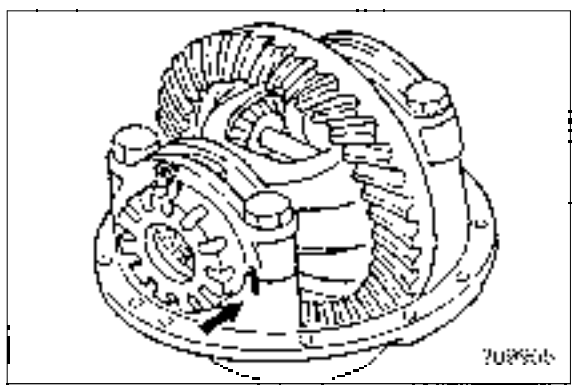
Suggestions for Disassembly

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 (0.00'79 to 0.0110 in.)	0.25 to 0.33 mm (0.0098 to 0.0130 in.)

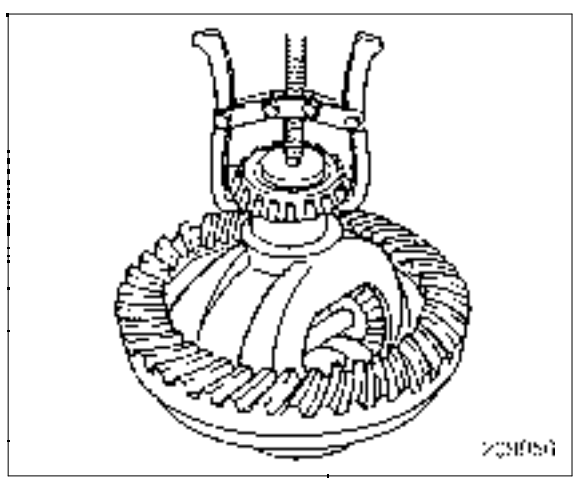


(2) Provide a matching mark across the bearing cap, adjusting screw and carrier on each side to ensure correct refitting.



(1) Removing bearing

Use a bearing puller to remove the inner bearing.



(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.

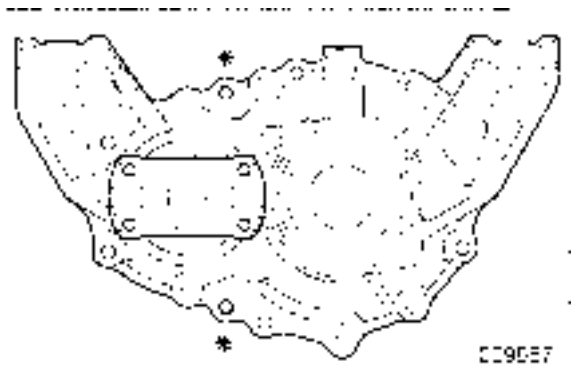
(3) Removing tapered roller bearing

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

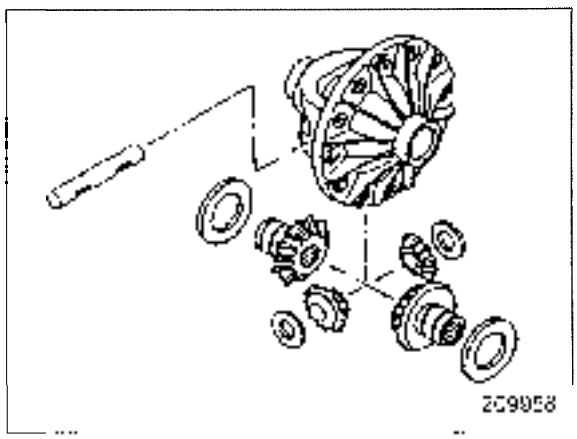
(a) Check the differential case and tapered roller bearing inner race to see if the seat surface is fretted.

(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).



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.

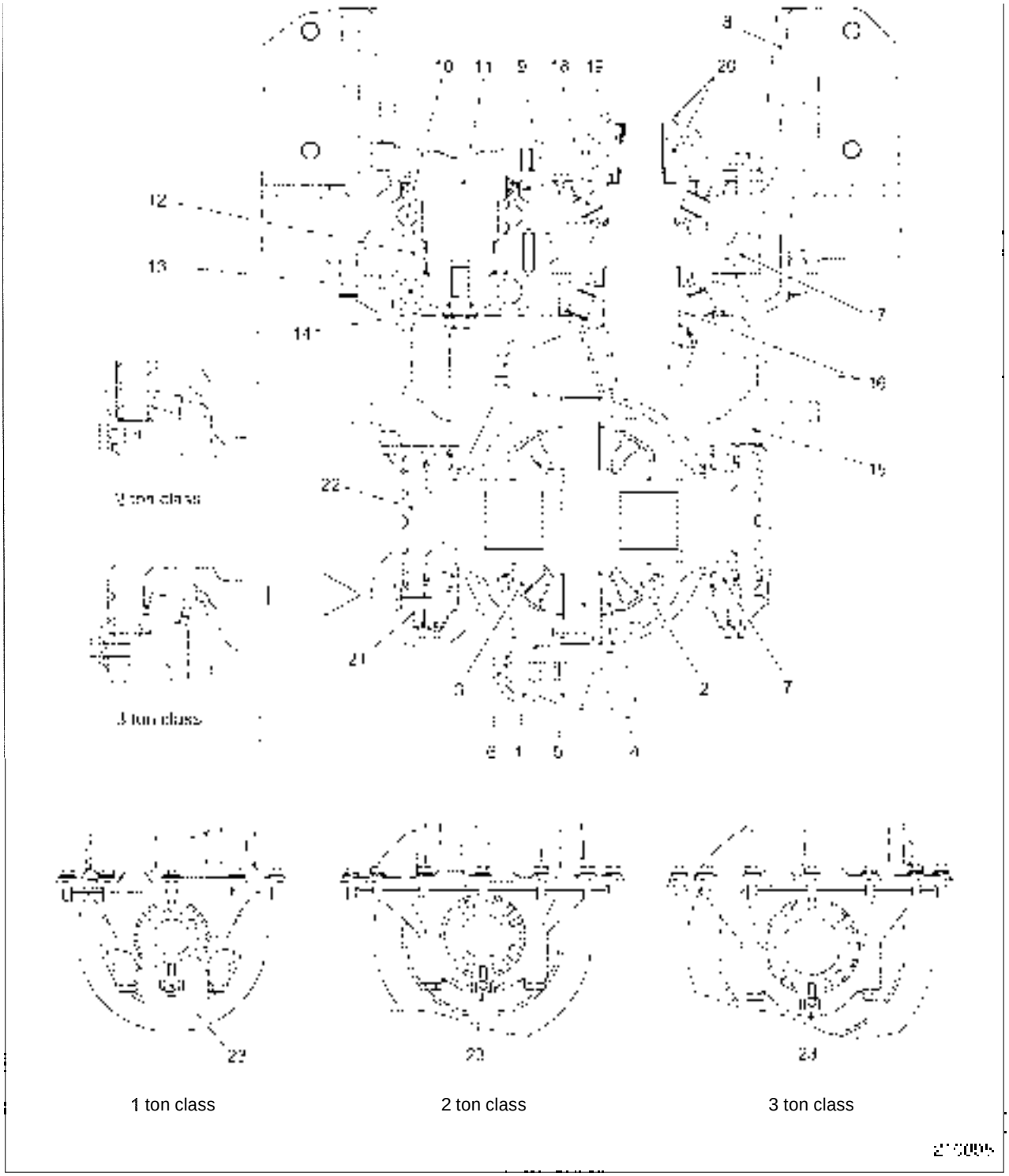
(b) Replace the gears as a set if they are defective.

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



1 ton class

2 ton class

3 ton class

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 Bail 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

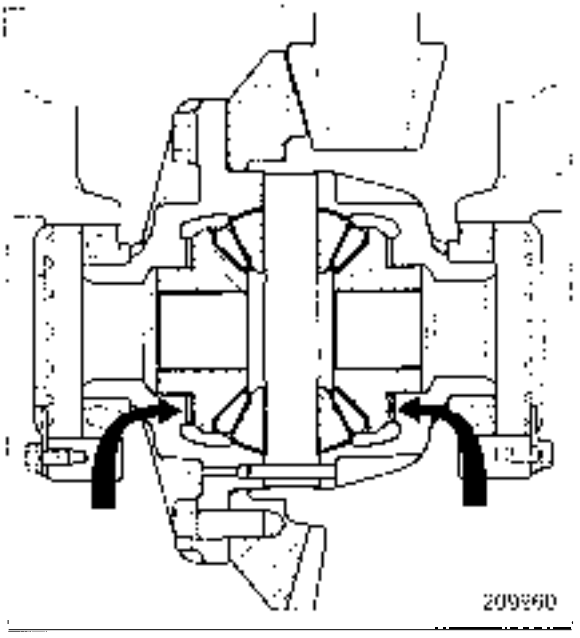
(1) Reassembling differential pinions

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	A	0.16 to 0.30	0.15 to 0.25



(2) Installing reduction gear

To install the bevel gear 2 to the differential case 1, apply LOCTITE No. 271 to the threads of bolts 6 and tighten the bolts to the specified torque.

Item \ Truck Model	1 ton class	2, 3 ton classes
Tightening torque	115 ± 9.8 N·m (12 ± 1.0 kg·m) [87 ± 7.2 lbf·ft]	226 ± 9.8 N·m (23 ± 1.0 kg·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 tentatively.

(4) Installing bearing caps

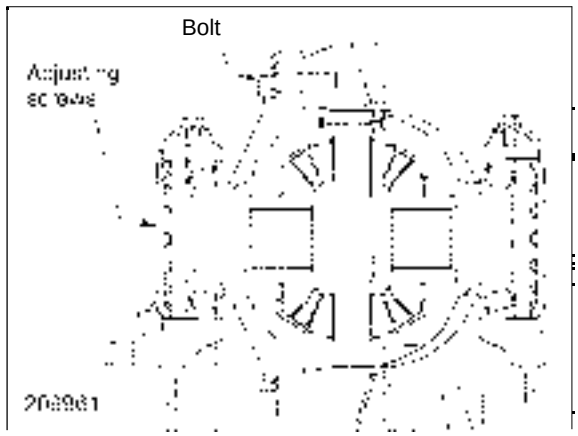
The bearing cap and differential carrier are machined in one process. Be sure to identify the left and right caps by matching marks and install them in place.

(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 6, 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.



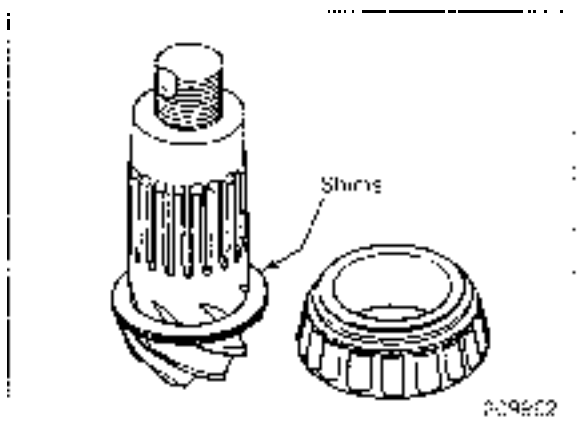
Item \ Truck Model	1 ton class	2, 3 ton classes
Preload	14.7 to 29.4 N (1.5 to 3.0 kgf) [3.3 to 6.6 lbf]	12.8 to 24.5 N (1.3 to 2.5 kgf) [2.9 to 5.5 lbf]

(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.



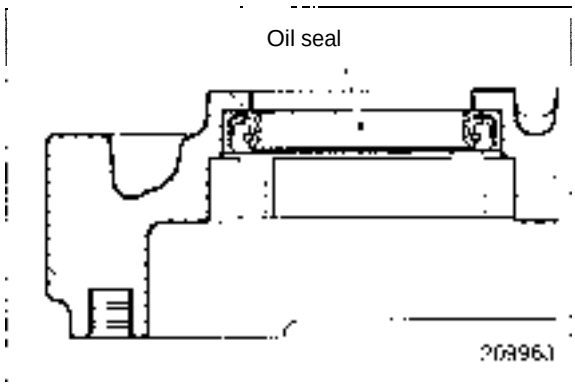
(8) Installing oil seal

Using the installer (special tool), fit the oil seal 9 in the carrier cover 8.

Special tool needed

Installer	91263-15400

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



(9) Applying grease to oil seal

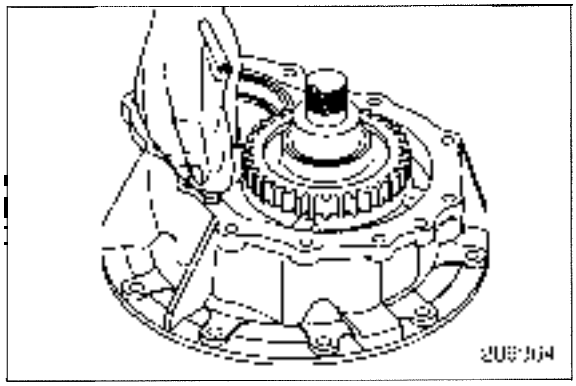
Apply grease to the oil seal installed to the carrier cover 8

Specified grease	[illegible]

(10) Applying sealant

When fitting the carrier cover 8 to the differential carrier 15, apply sealant to the flange.

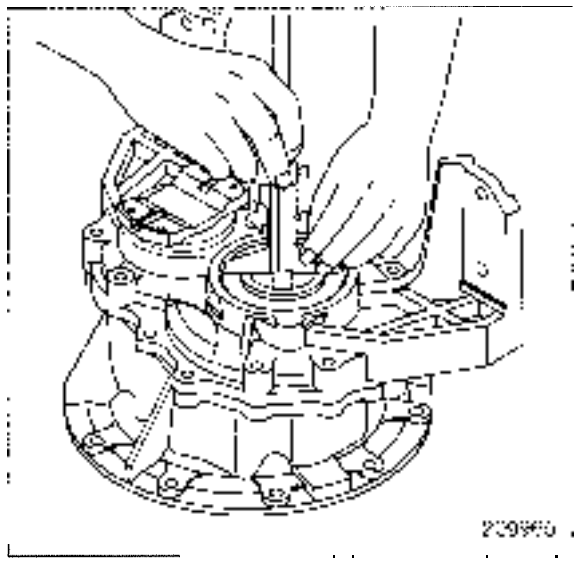
Sealant	ThreeBond #1104



(11) Adjusting reduction pinion preload

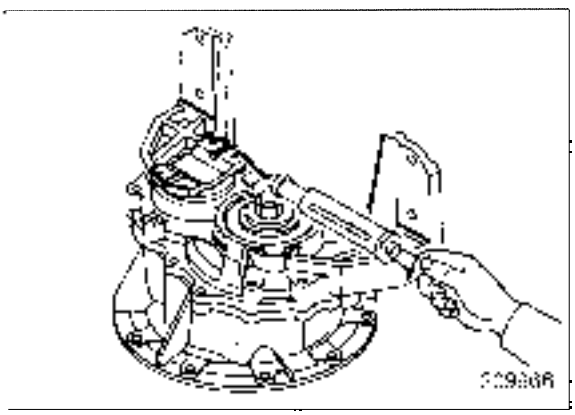
(a) After installing the tapered roller bearing 18, measure gap between the reduction pinion and tapered roller bearing to determine the required total shim thickness. The standard value of total shim thickness is 1.25 mm (0.049 in.).

(b) Five different thicknesses of shims are available - 0.05 mm (0.0020 in.), 0.1 mm (0.0039 in.), 0.2 mm (0.00'79 in.), 0.5 mm (0.020 in.) and 1.0 mm (0.0394 in.). Use appropriate shims and tighten the plate 14.



(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]



(12) Adjusting reduction gear and reduction pinion tooth contact

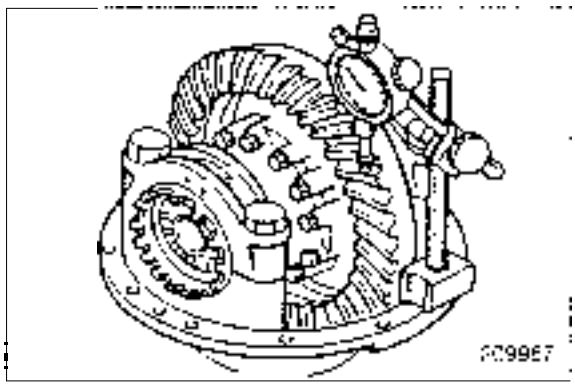
(a) After checking the reduction pinion preload, put the differential carrier upside down.

(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.

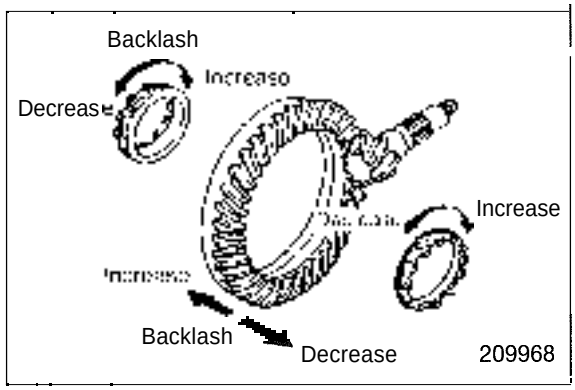
(c) Using the adjusting screws, adjust the backlash between the reduction gear and pinion.

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.

Backlash between reduction gear and pinion	0.15 to 0.25 mm (0.0059 to 0.0098 in.)

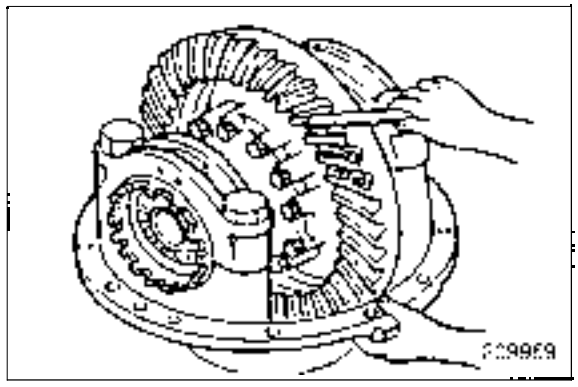


(d) When adjusting the backlash, turn the adjusting screws, right and left, equally in the same direction so as not to affect the bearing preload.



(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, and bend the lock plate to clinch the bearing cap.

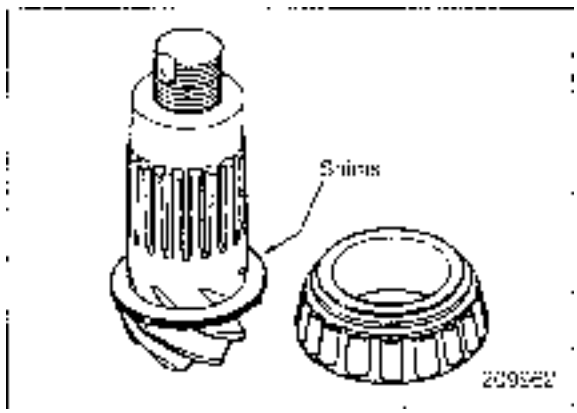
Truck Model / Item	1 ton class	2.5 ton classes
Tightening torque for bearing cap bolts	157 ± 5.9 N·m (16 ± 0.6 kgf·m, 116 ± 4.3 lbf·ft)	353 ± 6.8 N·m (36 ± 0.7 kgf·m, 260 ± 5.1 lbf·ft)

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. Put on the determined total thickness of shims and install the reduction gear and pinion.



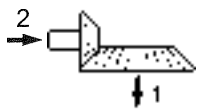
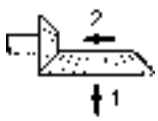
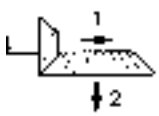
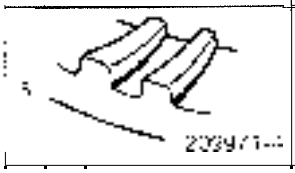
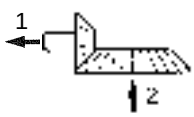
Total shim thickness required =
Standard value – (machining error)

(Example)
If the error is –0.10 rnrn (–0.004 in.), the total shim thickness is 1.9 mm (0.075 in.)

1.8 mm (0.071 in.) – (–0.1 rnm (–0.004 in.) =
1.8 mm (0.071 in.) + 0.1 rnm (0.004 in.) =
1.9 rnm (0.075 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	
	Extends from toe to middle portion, covering 50% or more of tooth length.	Correct tooth contact	
	Short contact at toe of tooth (Toe)		1. Move gear away from pinion. 2. Move pinion toward gear for correct backlash by increasing shim thickness.
	Short contact at heel of tooth (Heel)		1. Move gear toward pinion. 2. Move pinion away from gear for correct backlash by decreasing shim thickness.
	Heavy contact on face or top half (addendum) of tooth (Face)		1. Move pinion toward gear by increasing shim thickness. 2. Move gear away from pinion for correct backlash.
	Heavy contact on bottom half (addendum) of tooth (Flank)		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

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, damaged by wear	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			Truck Models	1 ton class	2 ton class	3 ton class
	Face runout of axle shaft flange	A		0.08 (0.0031)		
		B		0.5 (0.0197)		
	Runout of Axle shaft (1/2 of gauge reading)	A		0.5 (0.0197)		
		B		0.5 (0.0197), maximum		
	Preload for hub bearing 1 N (kgf) [lbf]	A		0.5 to 4.9 (5 to 50) [0.4 to 3.61		
Tightening torque N·m (kgf·m) [lbf·ft]	Hub bearing lock nuts (outer) 2	A		[illegible]		
	Axle shaft bolts 3	A		98 ± 9.8 (10 ± 1) [72.3 ± 7.21		
	Backing plate bolts 4	A		[illegible] (14.9 ± 1.5) [107.7 ± 11.11		213 ± 21.3 (21.7 ± 2.2) [157.1 ± 15.71
	Axle support nuts 5	A		378 ± 38 (38.5 ± 3.9) [278.8 ± 28]		
	Wheel nuts 6	A		[illegible]		[illegible]
	Rim bolts 7	A		[illegible]	[illegible]	

Hub and wheels

A: Standard value B: Repair or service limit

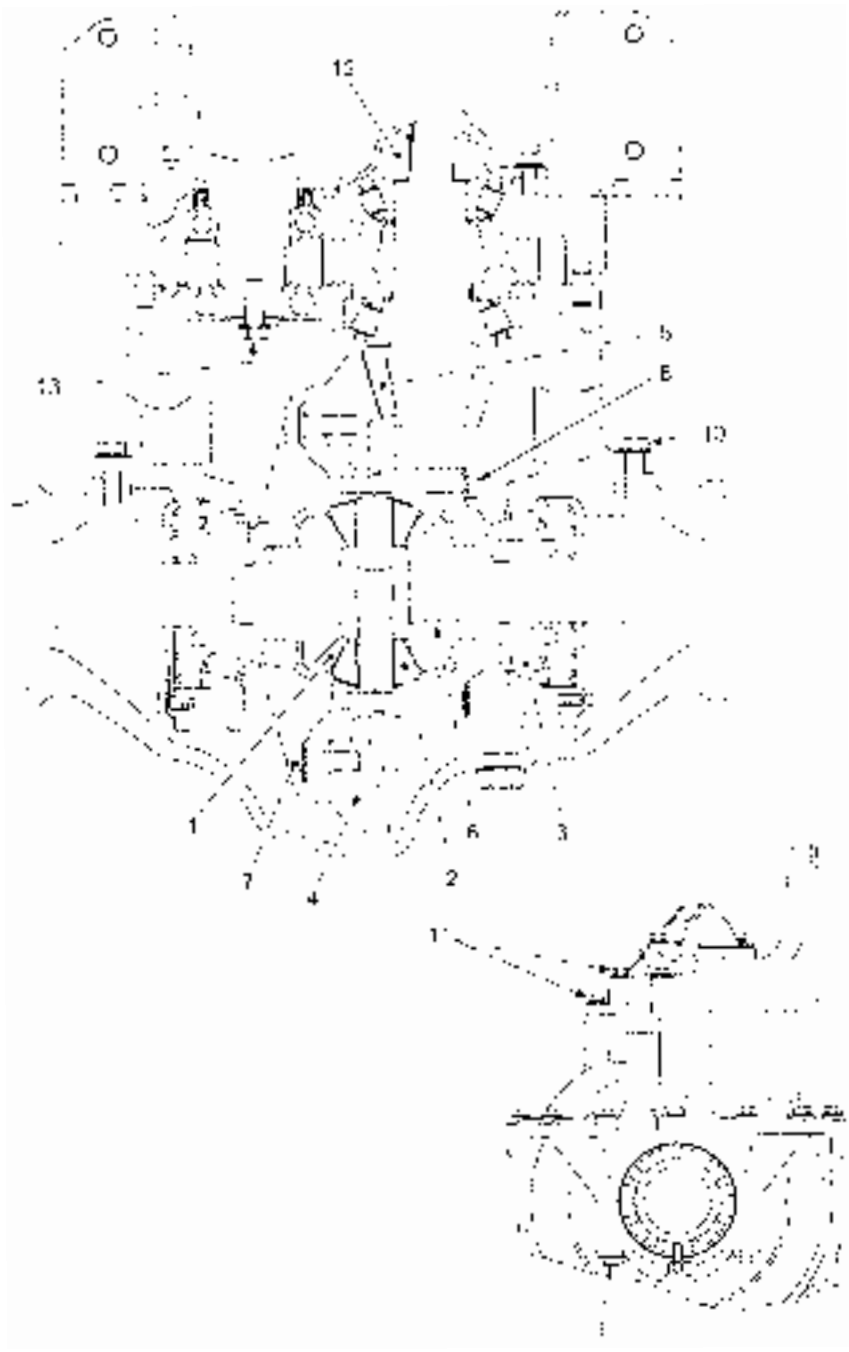
Unit: mm (in.)

Items	Truck Models		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 0.0099)	
		B	0.5 (0.0197)		
	Clearance between differential pinion and spider 2	A	0.02 to 0.07 (0.0079 to 0.0028)	0.02 to 0.09 (0.0079 to 0.0035)	0.17 to 0.27 (0.0067 to 0.0106)
		B	0.35 (0.0138)		
	Preload for differential case side bearing 3 N·m (kgf·m) [lbf·in]	A	14.7 to 29.4 (1.5 to 3.0) [13 to 26]		17.6 to 34.3 (1.8 to 3.5) [16 to 30]
		B	3.3 to 6.6 [2.9 to 5.8]		
	Face runout of reduction bevel gear 4	A	0.05 (0.0020)	0.15 (0.0059)	
		B	0.15 (0.0059)	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)
		B	0.5 (0.0197)		
	Free play of gear and shaft spline 6	A	0.03 to 0.25 (0.0012 to 0.0098)		
		B	0.3 (0.0118)		
	Tightening torque of reduction bevel gear mounting bolts 7 N·m (kgf·m) [lbf·ft]	A	118 19.8 (12 ± 1.O) [87 ± 7.2]	226 ± 9.8 (23 ± 1.0) [167 ± 7.2]	
	Tightening torque of differential case mounting bolts 8 N·m (kgf·m) [lbf·ft]	A	—		235 to 255 (24.0 to 26.0) [173 to 188]
	Tightening torque of side bearing cap bolts 9 N·m (kgf·m) [lbf·ft]	A	157 ± 5.9 (16 10.1) [116 14.41]	235 ± 6.8 (24 ± 0.7) [173 ± 5.0]	
	Tightening torque of differential carrier bolts 10 N·m (kgf·m) [lbf·ft]	A	108 ± 9.8 (11 ± 1.0) [79.7 ± 7.2]		
	Tightening torque of differential carrier cover bolts 11 N·m (kgf·m) [lbf·ft]	A	33.1 ± 6.9 (3.4 ± 0.7) [24.4 ± 5.1]		
	Tightening torque of lock nut 12 N·m (kgf·m) [lbf·ft]	A	294 to 490 (30 to 50) [217 to 362]		
	Tightening torque of input flange bolts 13 N·m (kgf·m) [lbf·ft]	A	108 ± 9.8 (11 ± 1.0) [79.7 ± 7.2]		

A: Standard value B: Repair or service limit

Unit: mm (in.)

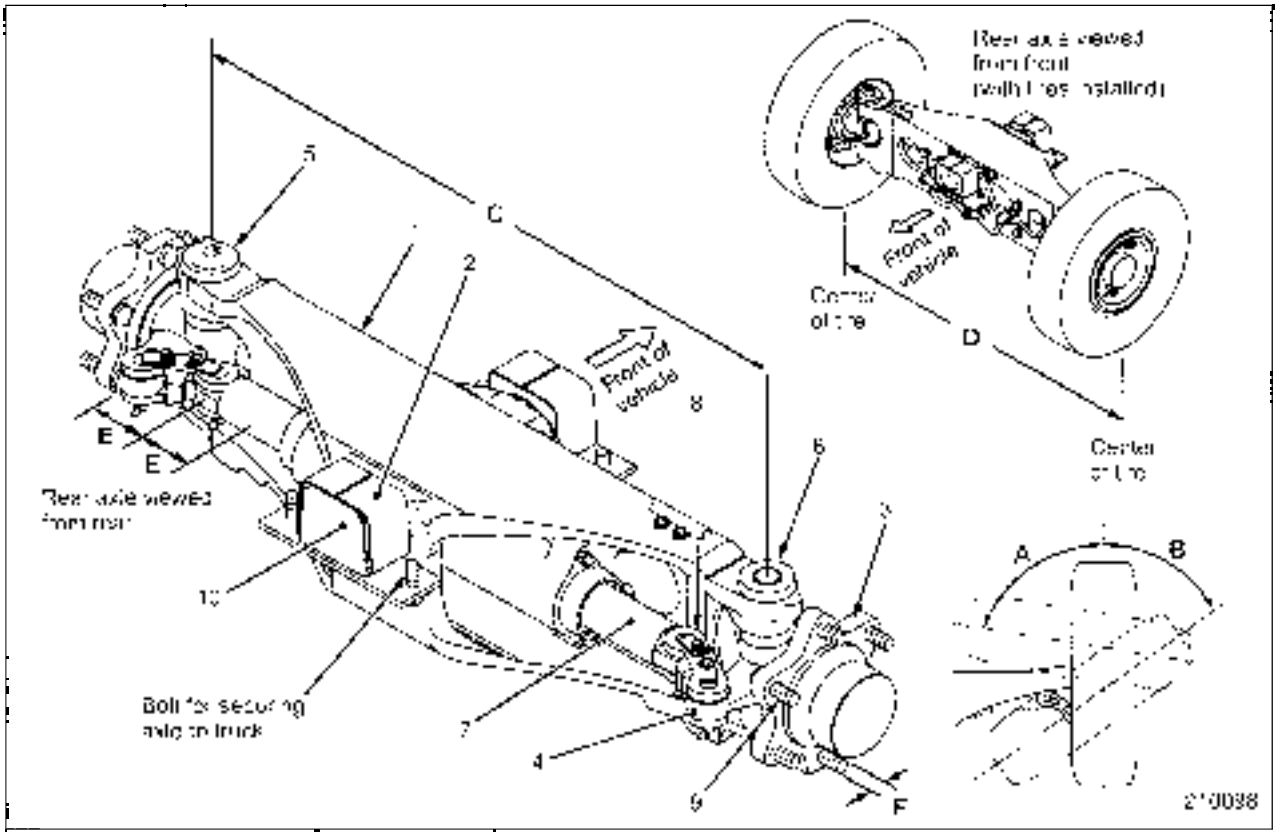
Iterns	Truck Models	1 ton class	2 ton class	3 ton class
Reduction differential				



REAR AXLE

Structure and Functions

Rear Axle in General



Main Components

1 Rear axle main unit
2 Mount bushing (rear axle support)
3 Wheel hub
4 Knuckle
5 Left-side king pin
6 Right-side king pin (with tire angle sensor)
7 Steering cylinder
8 Tie rod
9 Wheel bolt
10 Rubber shim (rear of vehicle only)

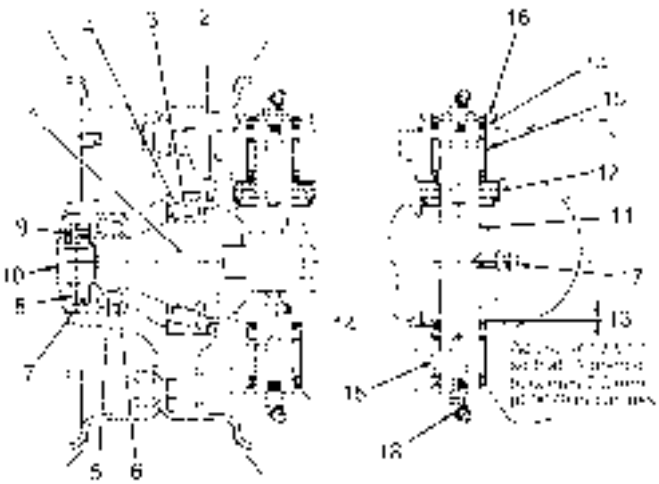
Specifications for wheel alignment and steering angle

Item \ 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°

Item \ 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.)	[illegible]	[illegible]	[illegible]
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	M18 × 1.5

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

Structure of Each Component



Detail of wheel hab

Detail of king pin

210299

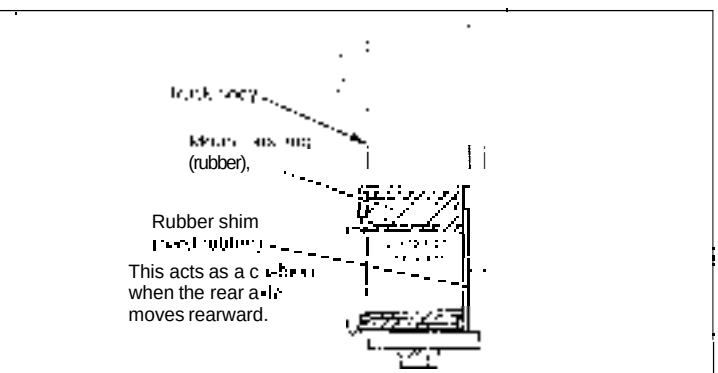
Main components of wheel hub

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

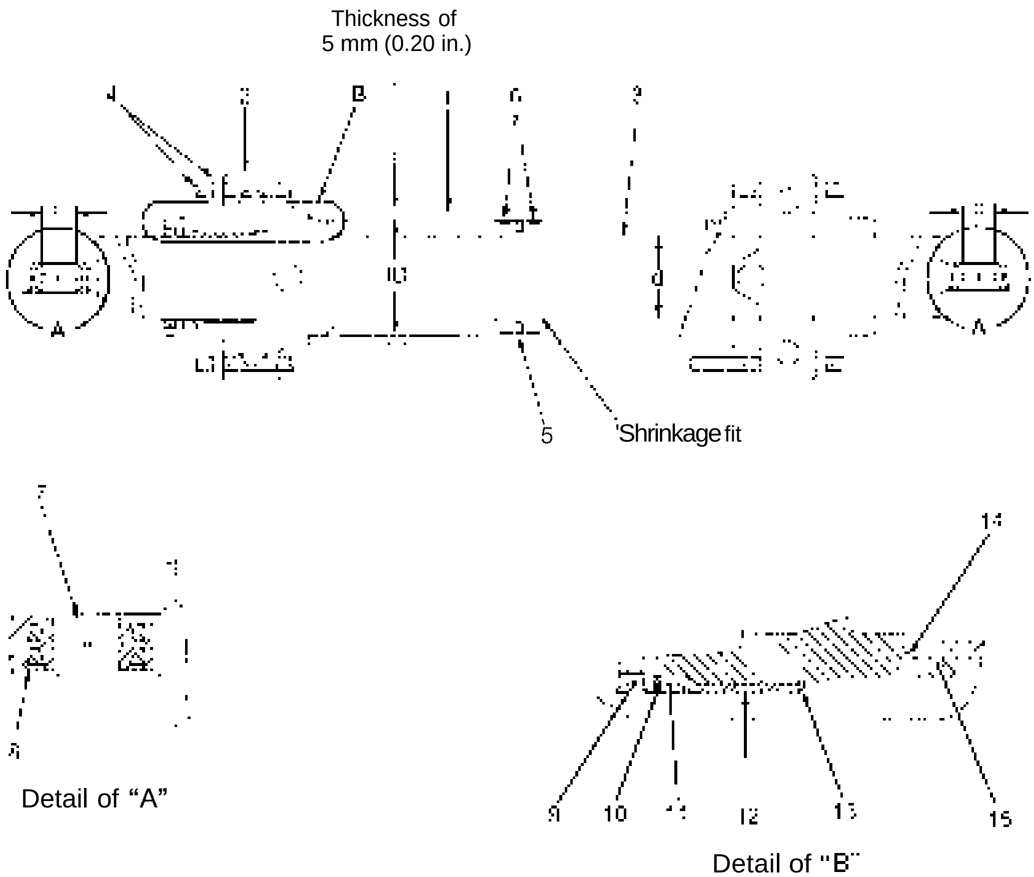
1 Tie rod
2 Tie rod pin
3 Dust seal
4 Bushing
5 Retainer
6 Dust seal
7 Bolt and washer assembly
8 Grease nipple



Center of rear axle

209689

Steering Cylinder



Unit: mm (in.)

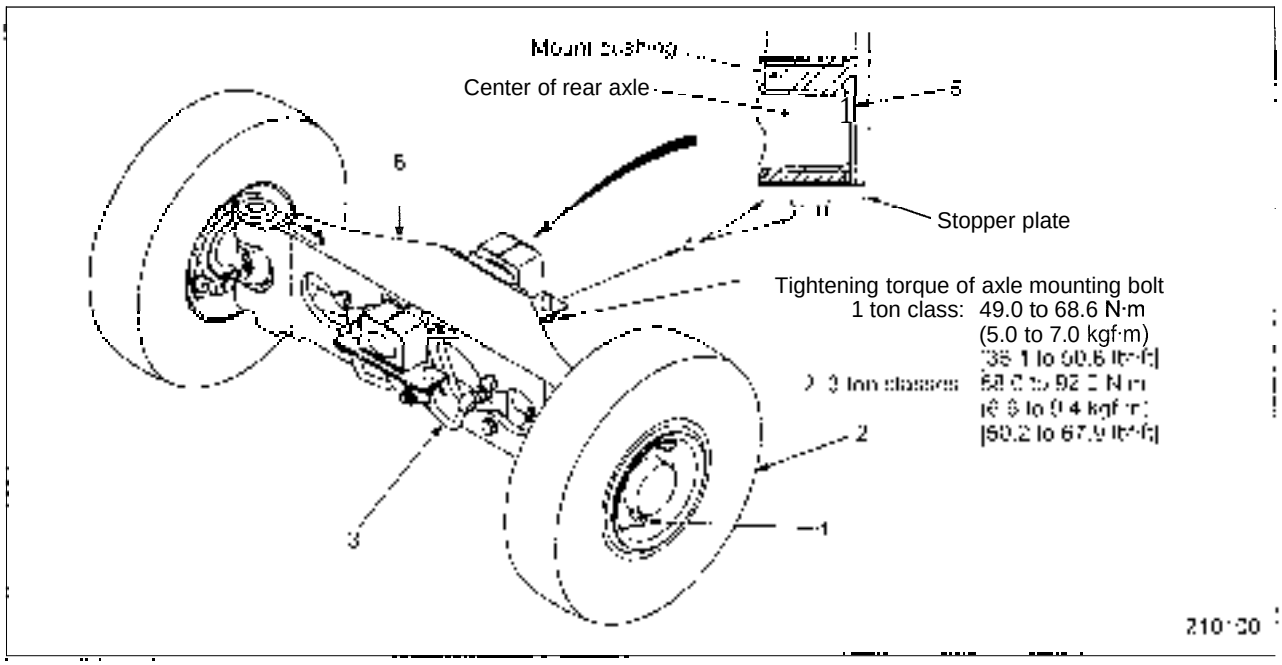
Truck Model / Dimension	1 ton class	2 ton class	3 ton class
d	65 (2.6)	70 (2.8)	75 (3.0)
ID	45 (1.8)	50 (2.0)	50 (2.0)
S	17 (0.7)	20 (0.8)	20 (0.8)

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 jack stands 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 jack stands. [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.

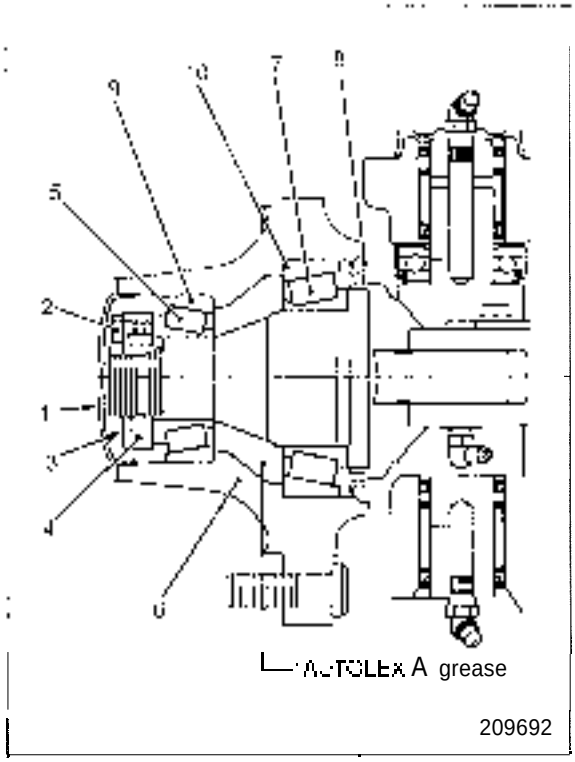
3. Oil seal

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.



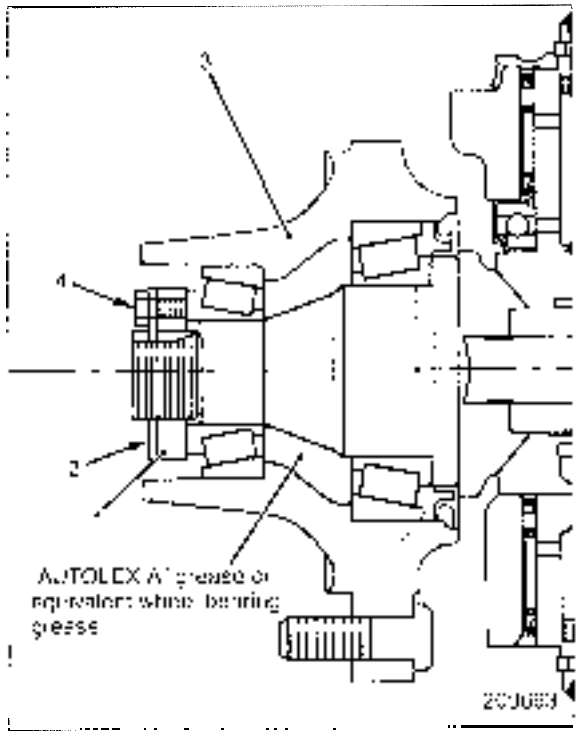
Disassembly sequence

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.)

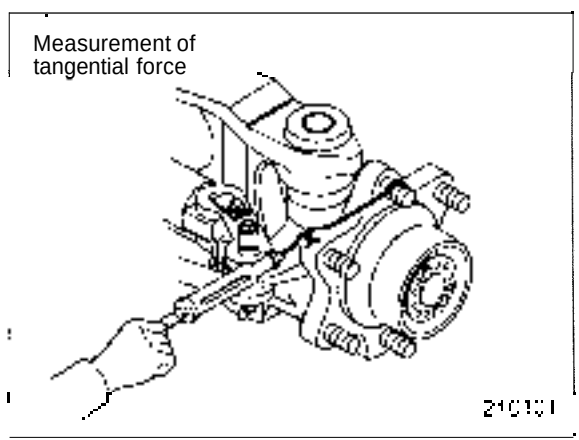


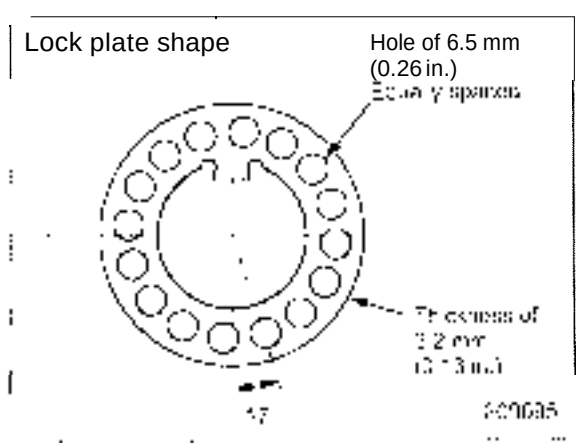
6. Turn the wheel hub back and forth two to three times and make sure that the rotational driving force or starting tangential force is within the range below. If out of the range, readjust. In case of a long-used bearing, aim a low value of the allowance.

Unit: N (kgf) [lbf]

Item \ Type of Model	1 ton class	2 ton class	3 ton class
Tangential force of hub bolt (increment from when preload is zero)	6.8 to 9.8 (0.7 to 1.0) [1.5 to 2.2]	5.6 to 8.6 (0.6 to 0.9) [1.2 to 1.9]	5.1 to 7.8 (0.52 to 0.8) [1.1 to 1.8]
Starting torque of hub rotation (increment from when preload is zero)	0.5 to 5 Nm (0.1 to 0.5 kgf·m) [0.35 to 3.7 lbf·ft]		

No looseness is allowed in the axial direction.





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 the king pin cover 3 and grease nipple 4.
3. Apply a soft metal piece 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.

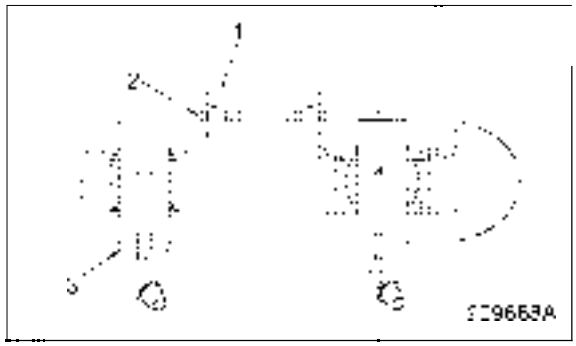
Needle bearing and thrust bearing: Replace the bearings with new ones if damage, seizure, peel, rotation failure or abnormal noises are found.

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

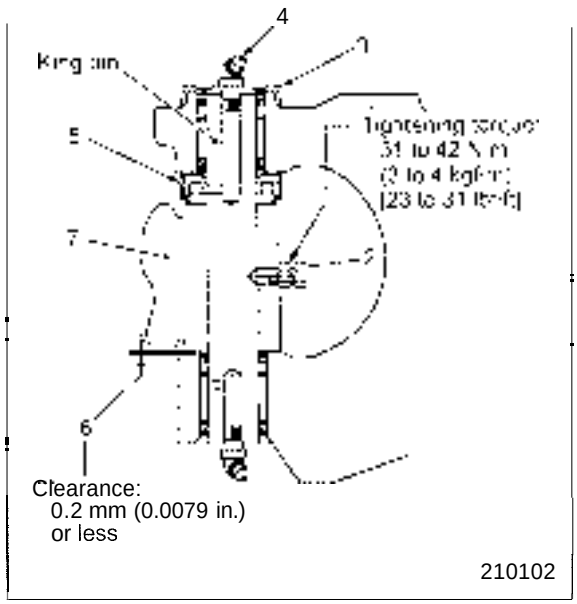
Reassembly

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

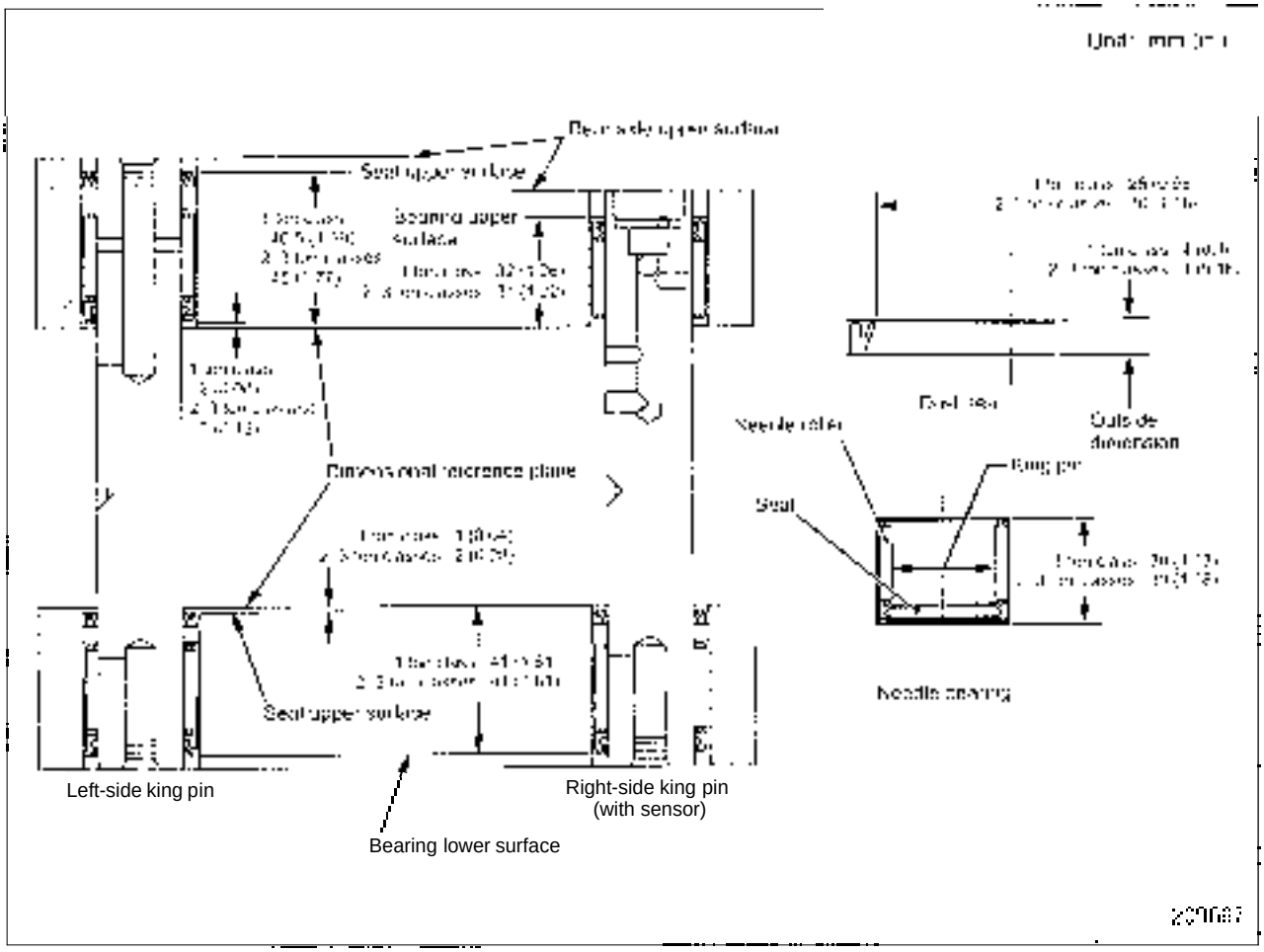
1. Reassemble the king pin inserting from the lower side toward the upper side. (Reassembly in the opposite direction may damage the shim 6.)
2. Reassemble the thrust bearing 5 in the direction as illustrated. Adjust with a shim 6 so that clearance in the axial direction becomes 0.2 mm (0.0079 in.) or 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.



Left-side king pin



5. Dimensions after disassembly are shown below.



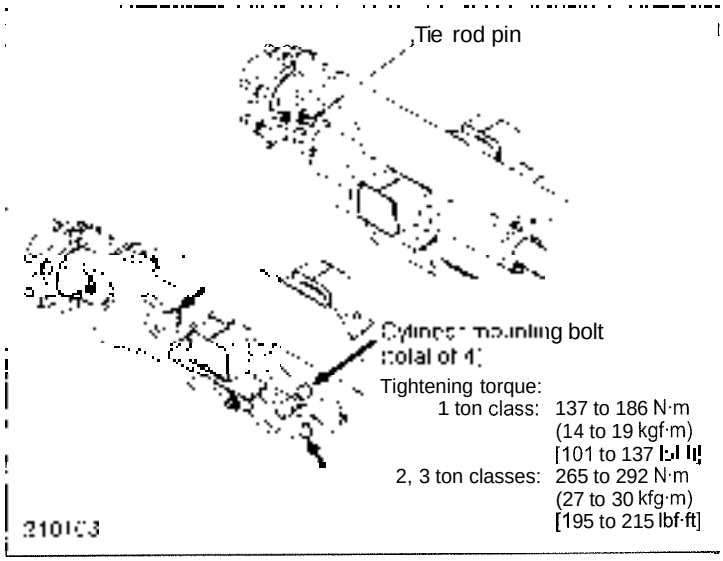
3. Disassembly and Reassembly of Steering Cylinder

Removal

Start by:

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

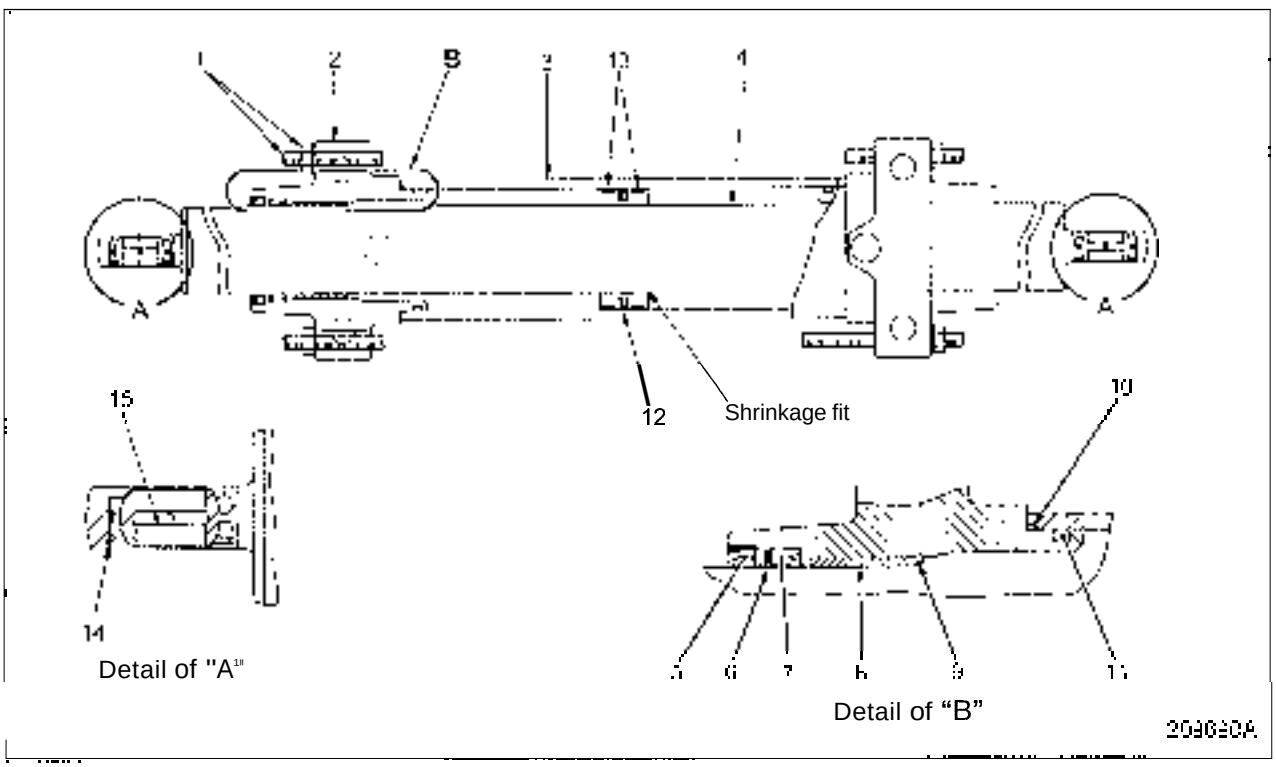
(b) Pull out right and left tie rod pins on the cylinder to disconnect the knuckle from the cylinder.



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
2 Header (with parts 5 through 10 assembled)
3 Body
4 Rod assembly (with parts 12 through 15 assembled)
5 Dust seal
6 Backup ring
7 Rod seal
8 Bushing
9 Snap ring
10 O-ring
11 O-ring
12 Piston seal
13 Guide ring
14 Snap ring
15 Bail joint

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.

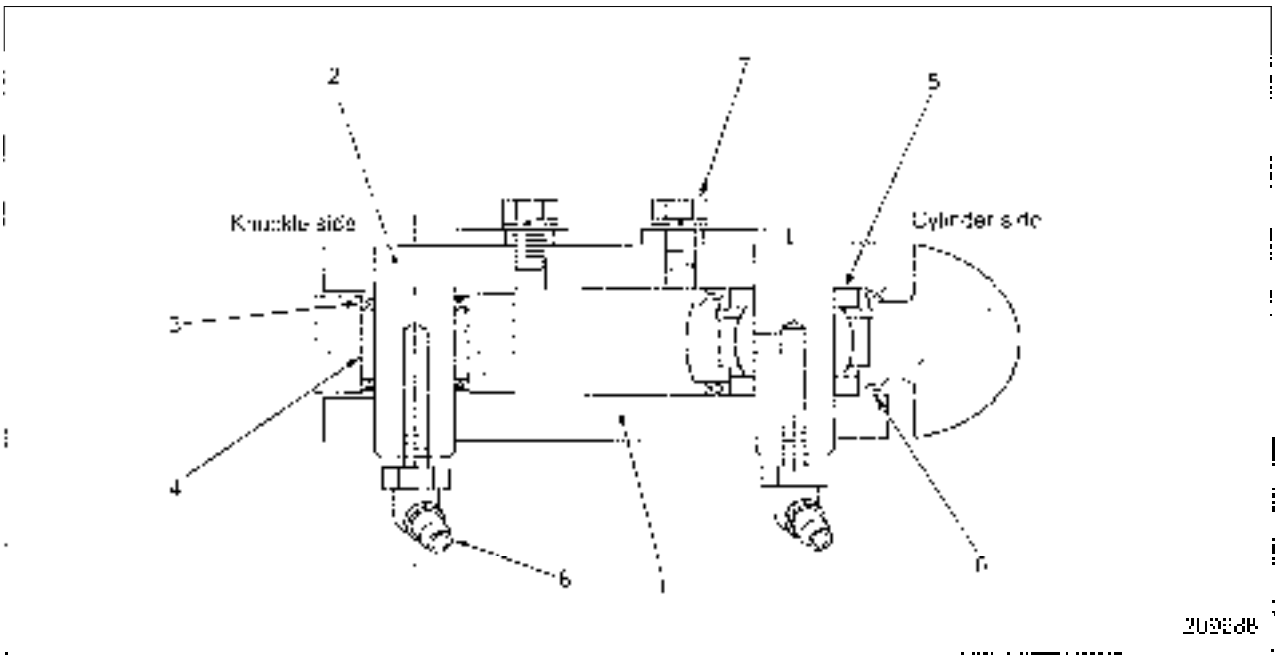
Reassembly

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 new ones as much as possible.
4. Be careful not to twist O-rings when installing.

4. Disassembly and Reassembly of Tie Rod

Disassembly



Sequence

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

Reassembly

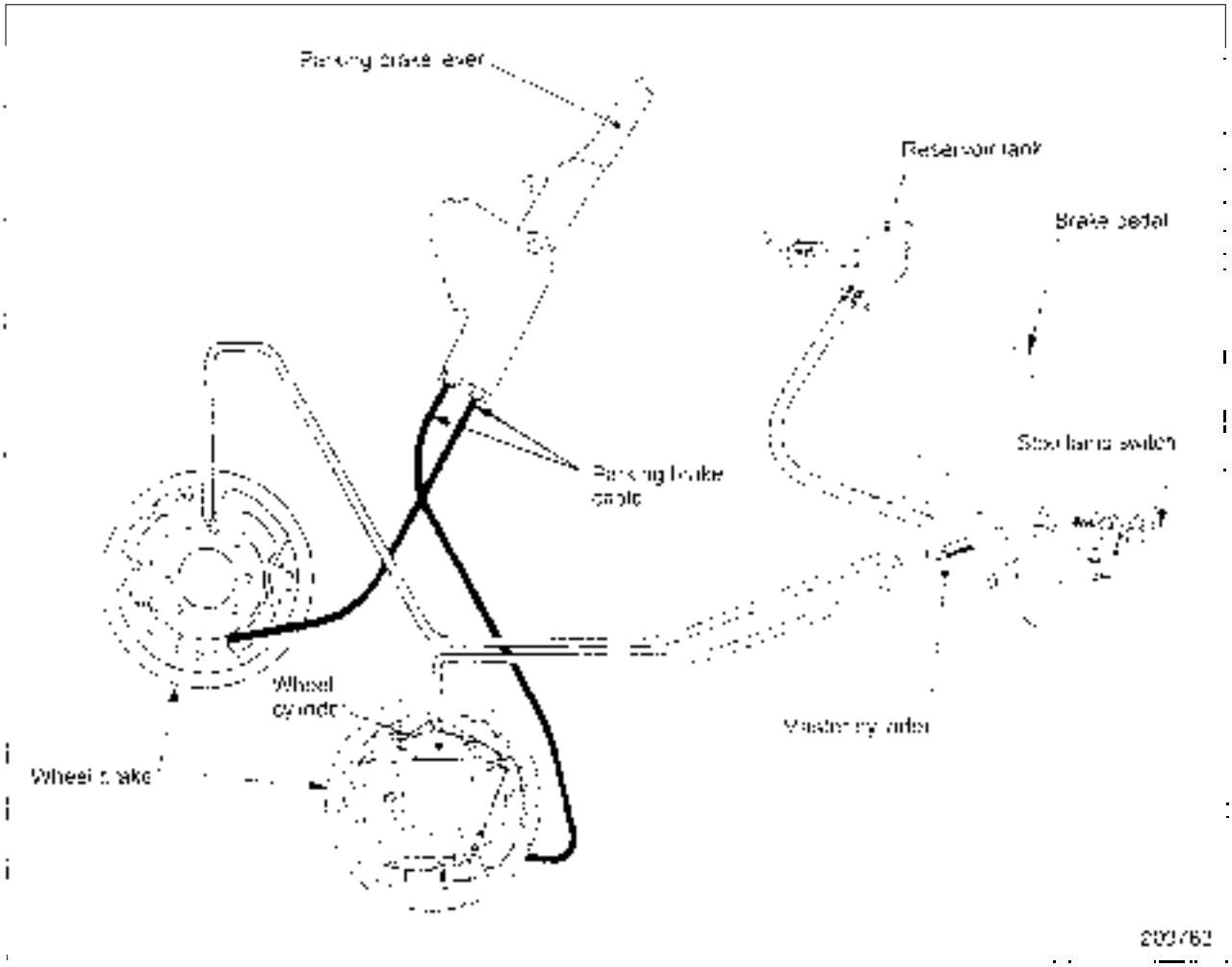
Follow the sequence of disassembly in reverse, paying attention to the following points.

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

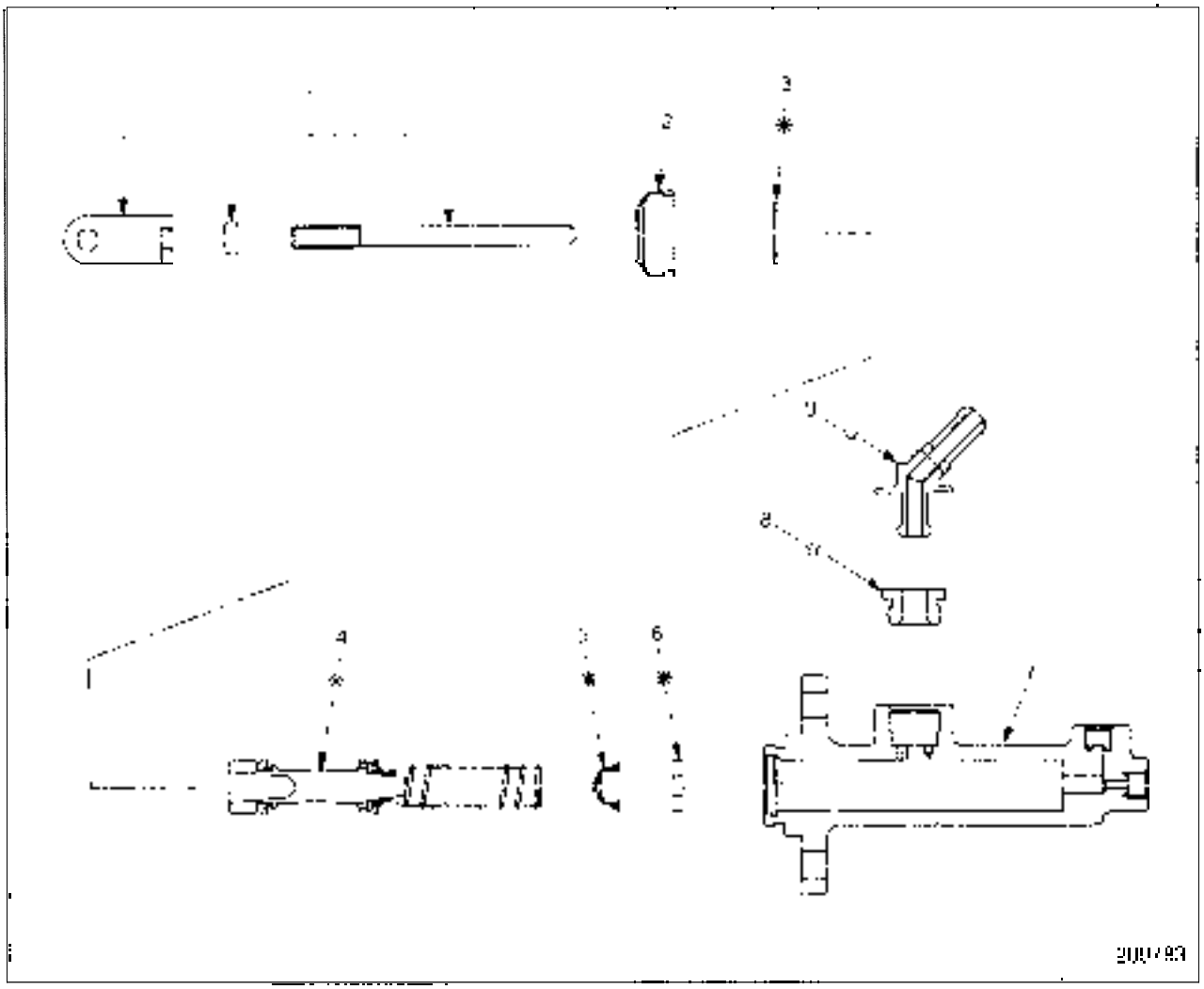
Brake System



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 (b) 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 severely damaged or its free length is at or less than the service limit.

A: Standard value B: Service limit

Spring free length	A	[illegible]
	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 bitten, 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 a safe and good practice to replace them whenever the master cylinder is disassembled.

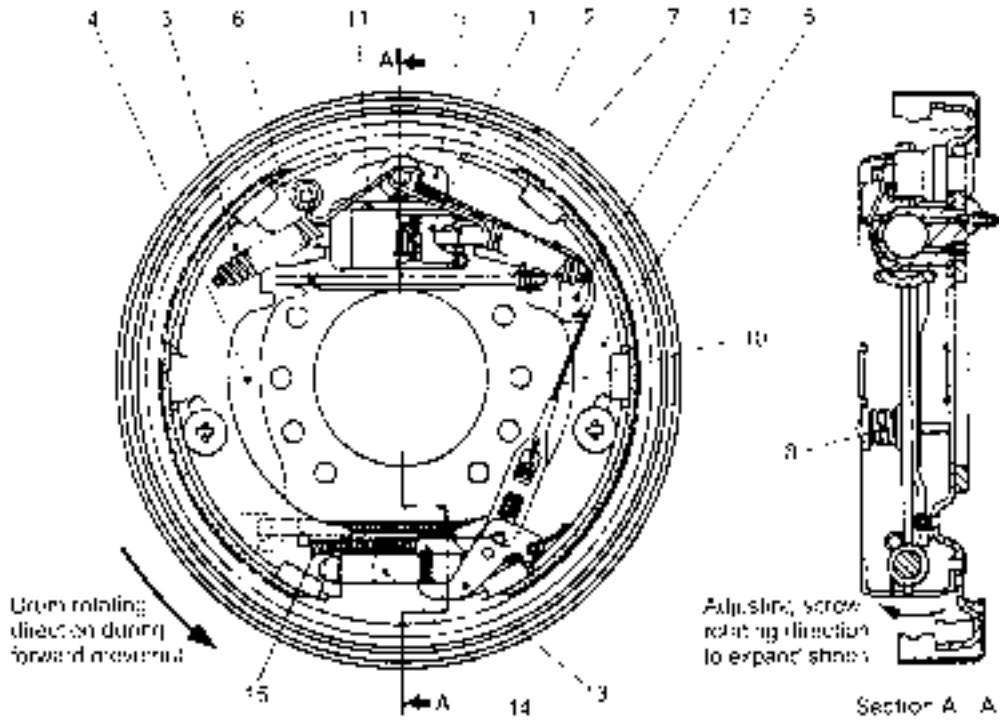
Reassembly

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

(1) Wash all metal parts 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)

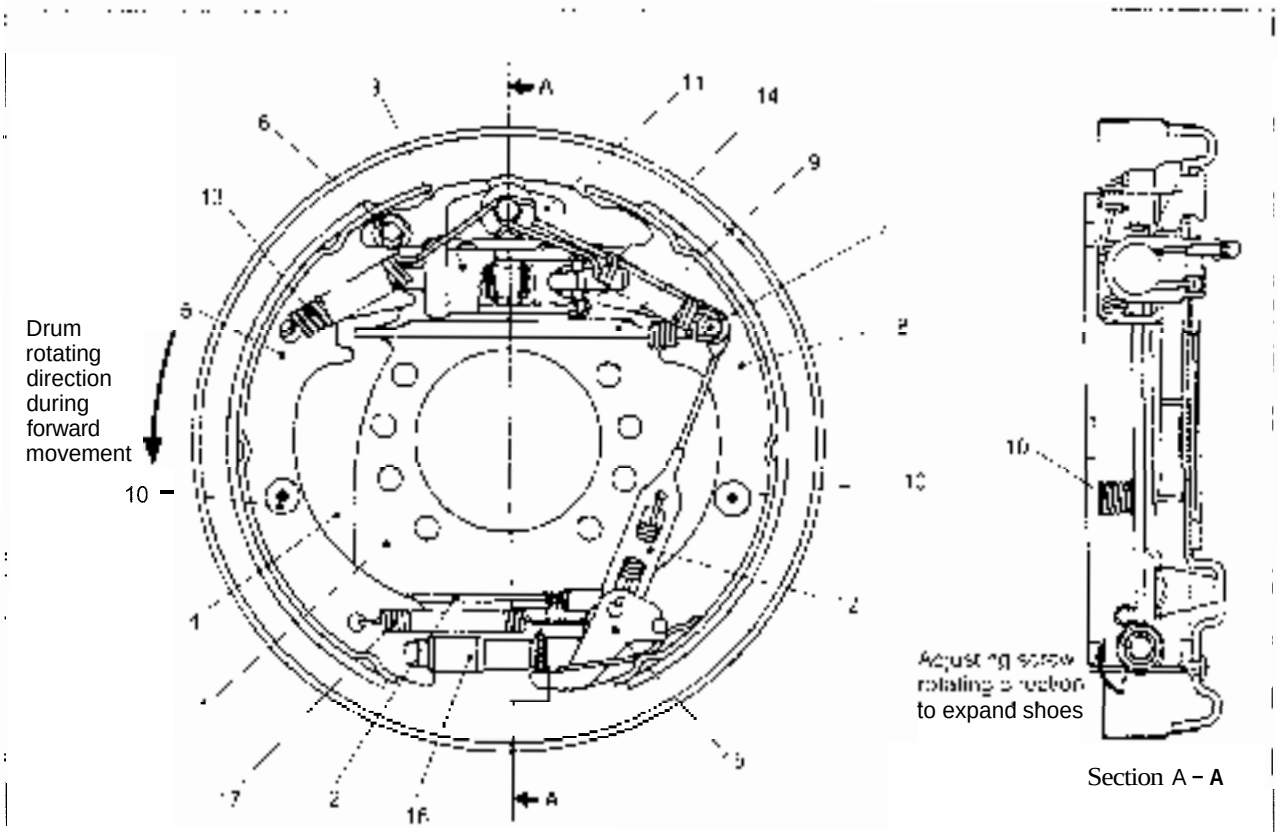


The illustration shows a left-hand wheel brake.

206522

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)



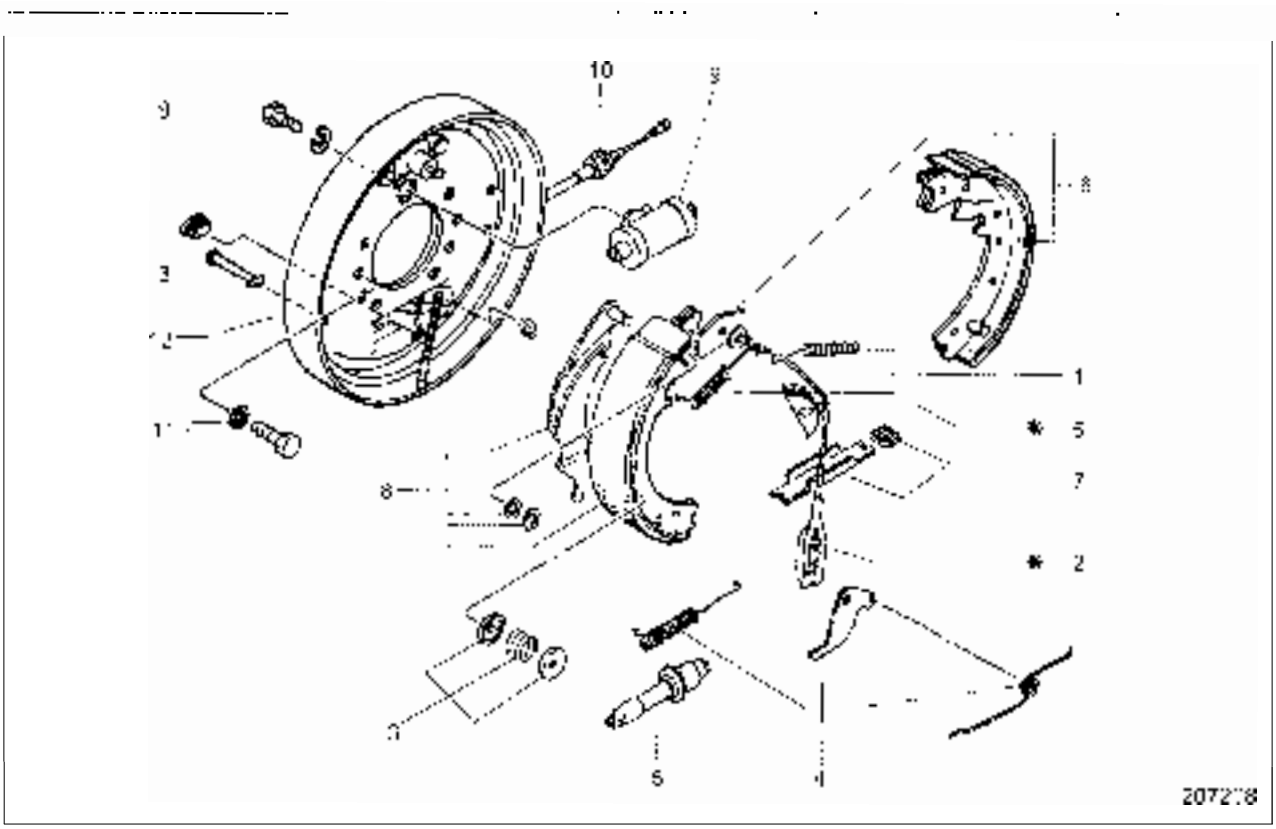
The illustration shows a left-hand wheel brake.

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.

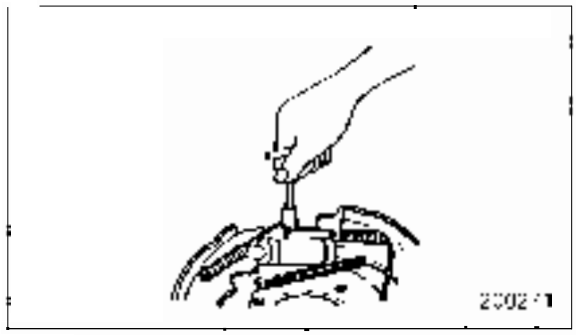
Suggestions for Disassembly

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

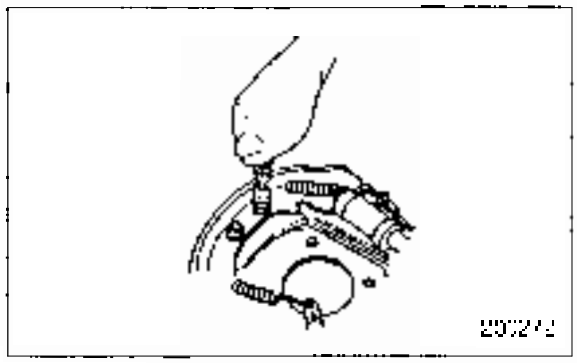


2. Removing hold-down springs

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

Special tool needed

Spring retainer	64309 - 15412



Inspection after Disassembly

1. Backing plate

(1) Check the backing plate for cracks.

2. Shoes and lining

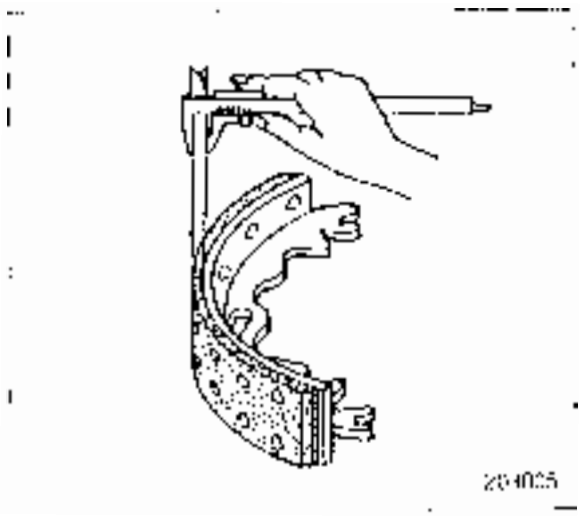
(1) Check each shoe and lining for cracks.

(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

Item \ Truck Model		1 ton class	2, 3 ton classes
Thickness of lining	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.)



3. Brake drums

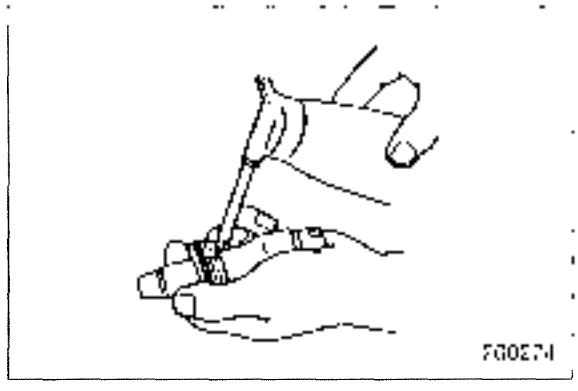
Check the inside (friction) surface of the drum for abnormal wear, grooving and other defects. Minor grooving can be removed by grinding, provided that the inside diameter does not exceed the service limit.

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.



5. Parking brake cable

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

6 Other parts

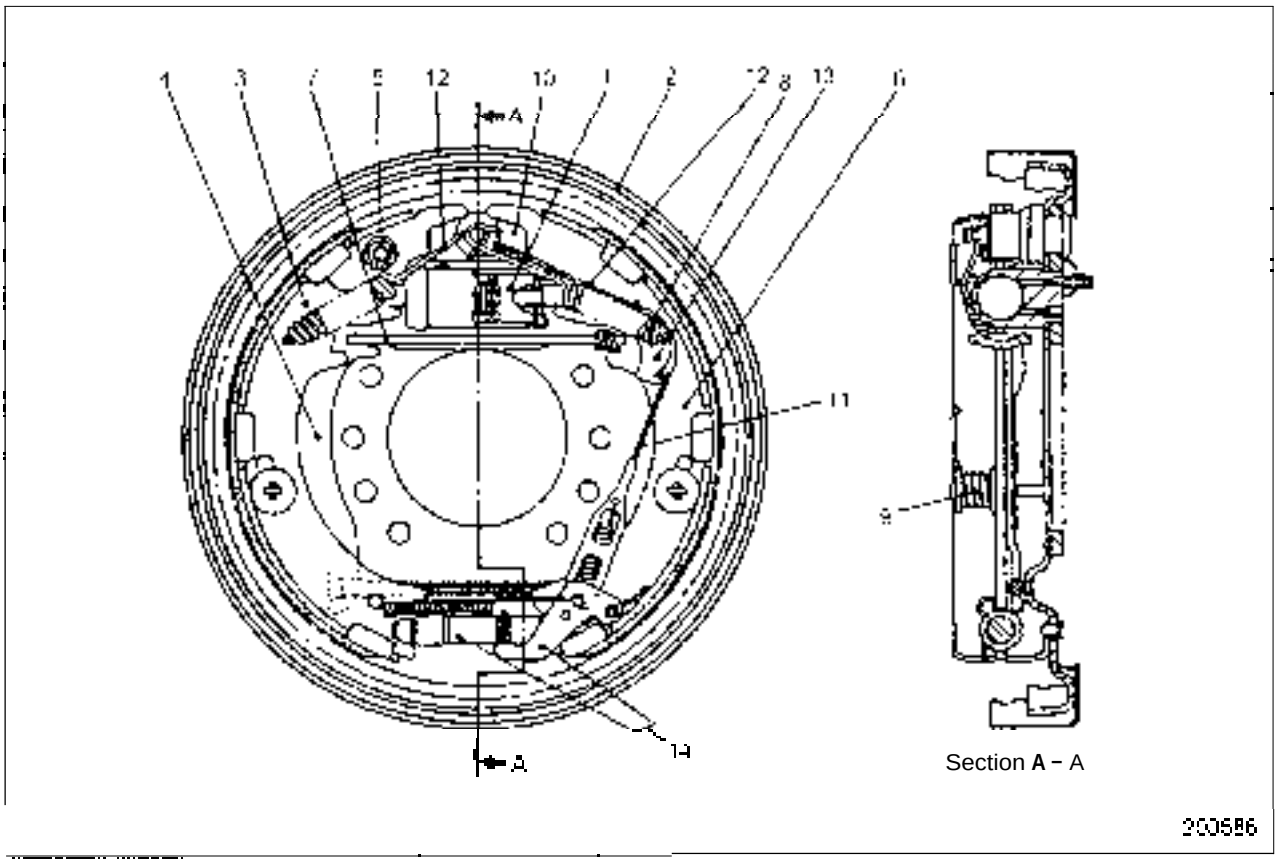
(1) Check the shoe return springs for cracks or fatigue.

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

(3) Check the cable with spring for stretching.

Reassembly

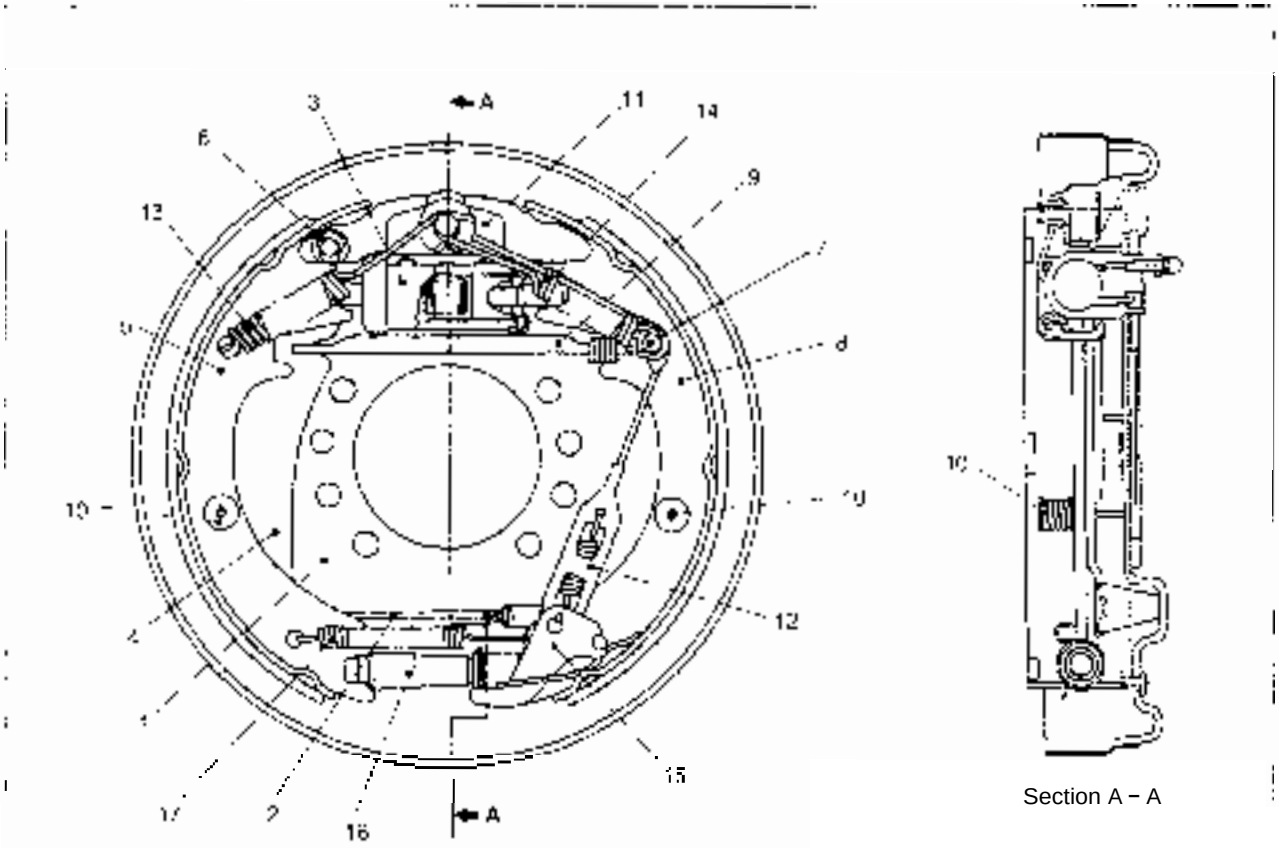
1 ton class



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.

209784

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

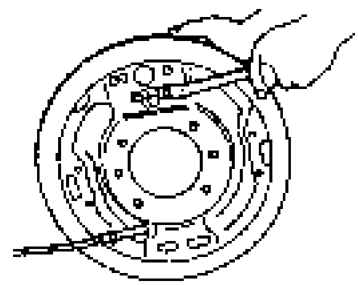
Prepare Parts 7 and 8 in assembly beforehand.

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.



200275

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.

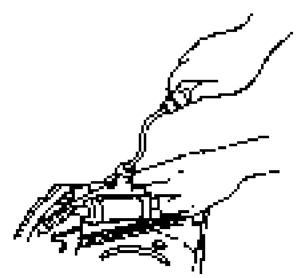
(2) Anchor pin surface in contact with the shoe ends

3. Shoe and lining installation

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

4. Return spring installation

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



200276

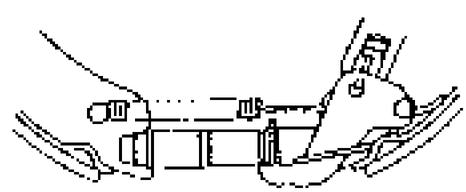
Special tool needed

Spring installer	65309 13413

5. Automatic adjuster installation

(1) Clean the adjusting screw and associated parts. 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.



200277

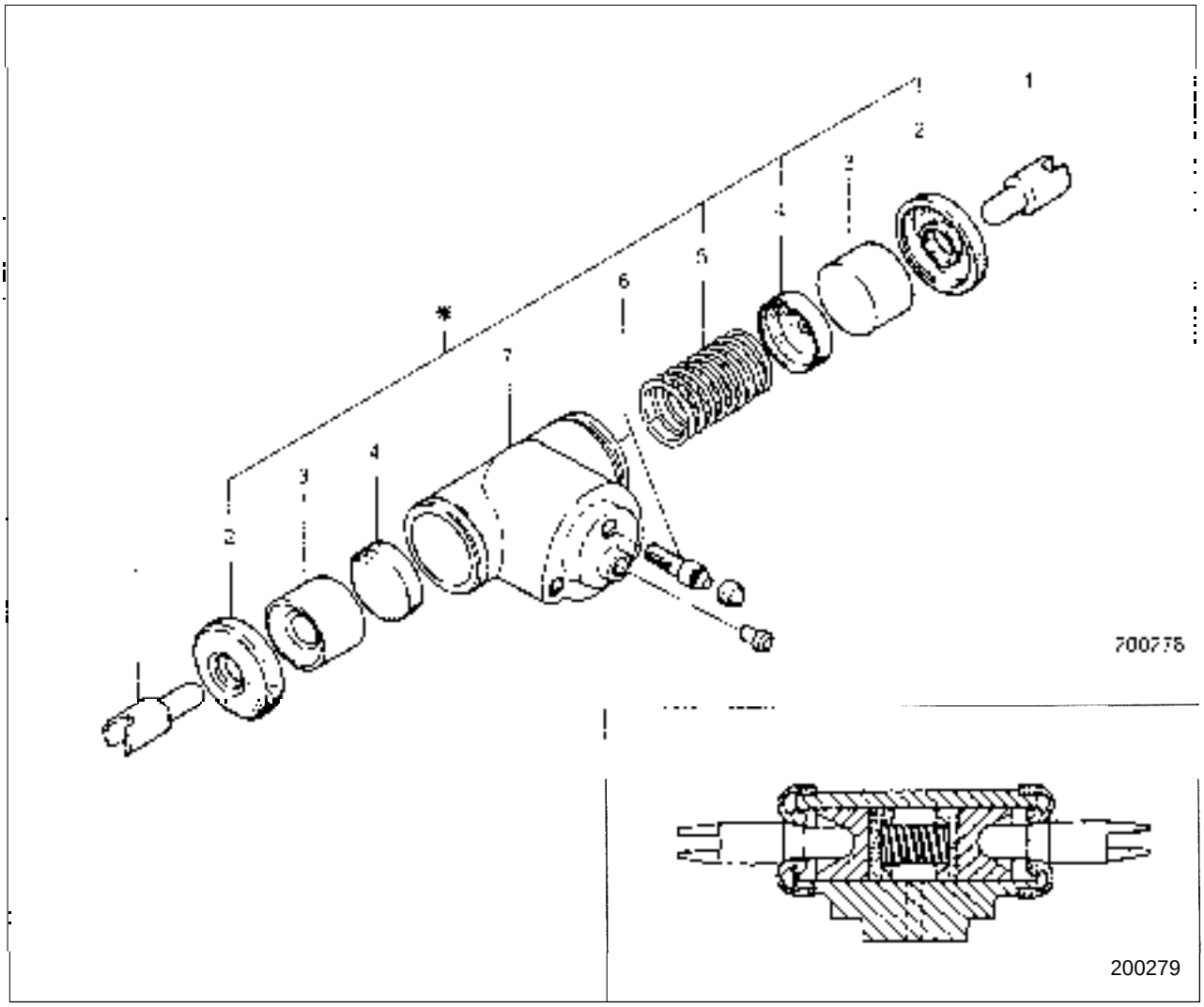
(2) Identification of adjusting screws and levers

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

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

Wheel Cylinder

Disassembly



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

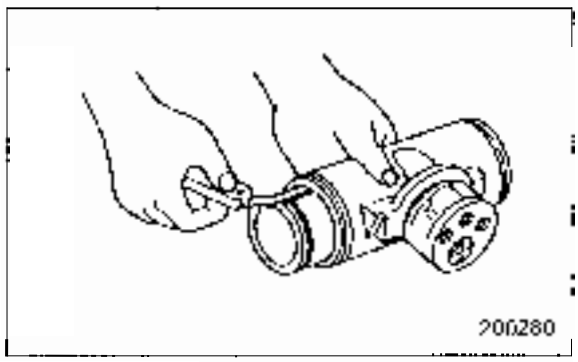
(a) Check the bore for rusting, erosion or scoring.

(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.



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 rnm (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 rnm (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 kfg·m) [4.3 to 6.5 lbf·ft]

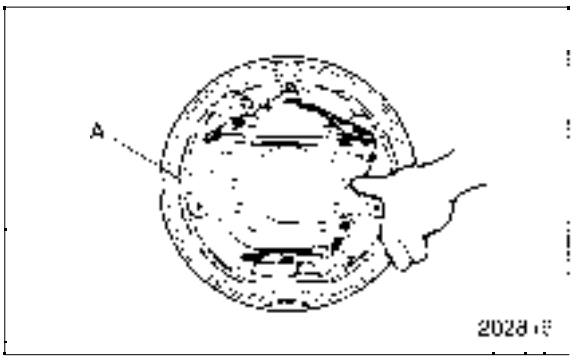
inspection and Adjustment

Automatic Adjuster Test

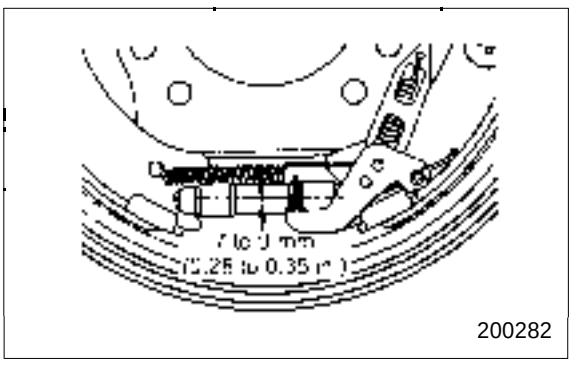
(I) With clearance A between the lining and drum, set approximate to specification, pull the cable with attached spring using a finger as shown. The lever should turn the adjusting screw wheel by one notch and, when the cable is released, return to the original position.

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.



(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.

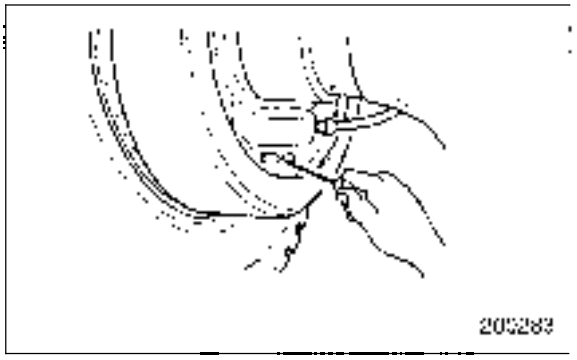
(c) Replace the lever.

(d) Replace the adjusting screw

Manual Adjustment

Using a screwdriver through the slotted 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.

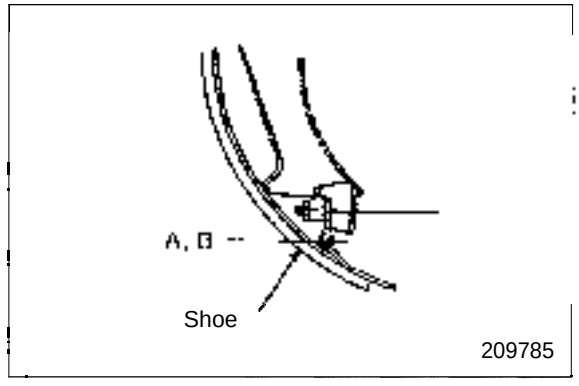


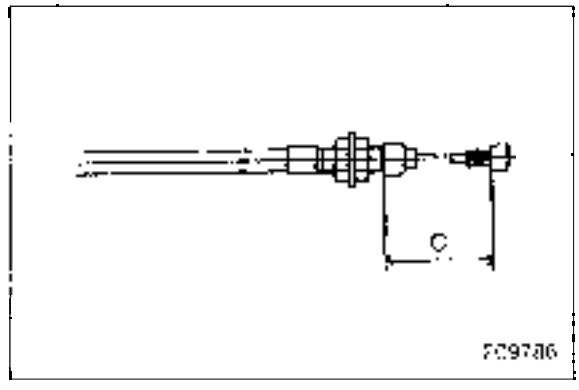
Parking Brake Cable Adjustment

(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.





Unit: mm (in.)

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

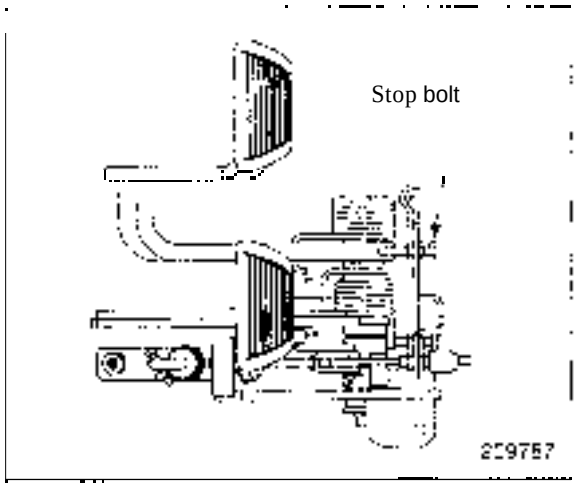
Brake Pedal Adjustment

(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.

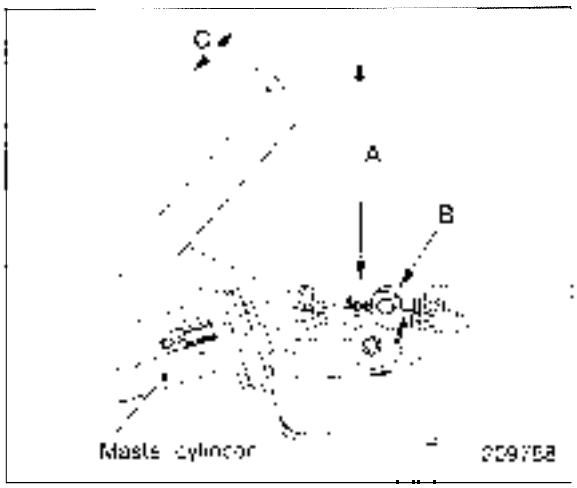


(3) Ensure that the pedal play is to specification.

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

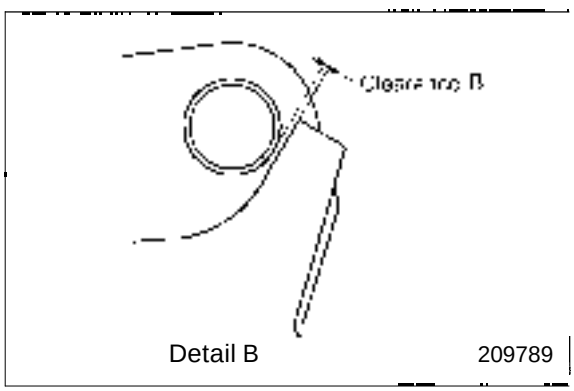
(b) Ensure that the snap pin is firmly engaged.

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

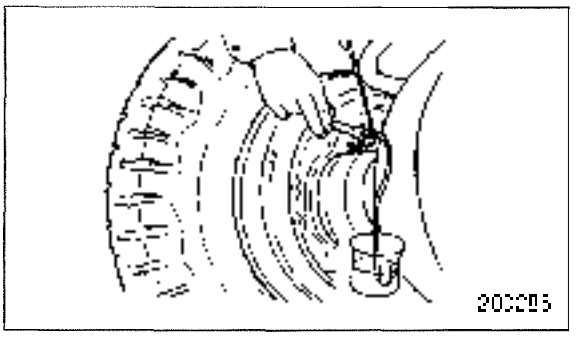


Unit: mm (in.)

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	0.2 to 1.0 (0.008 to 0.039)	0.2 to 0.8 (0.008 to 0.031)
Push rod-to-piston clearance	2 mm (0.08)	0 (0)
Pedal play C	2.5 to 6.5 (0.098 to 0.256)	1.5 to 5.5 (0.059 to 0.217)



Bleeding Brake Lines



After any portion of the brake fluid lines has been disassembled for repair or service, or if the brake pedal feels spongy, bleed the brake 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.

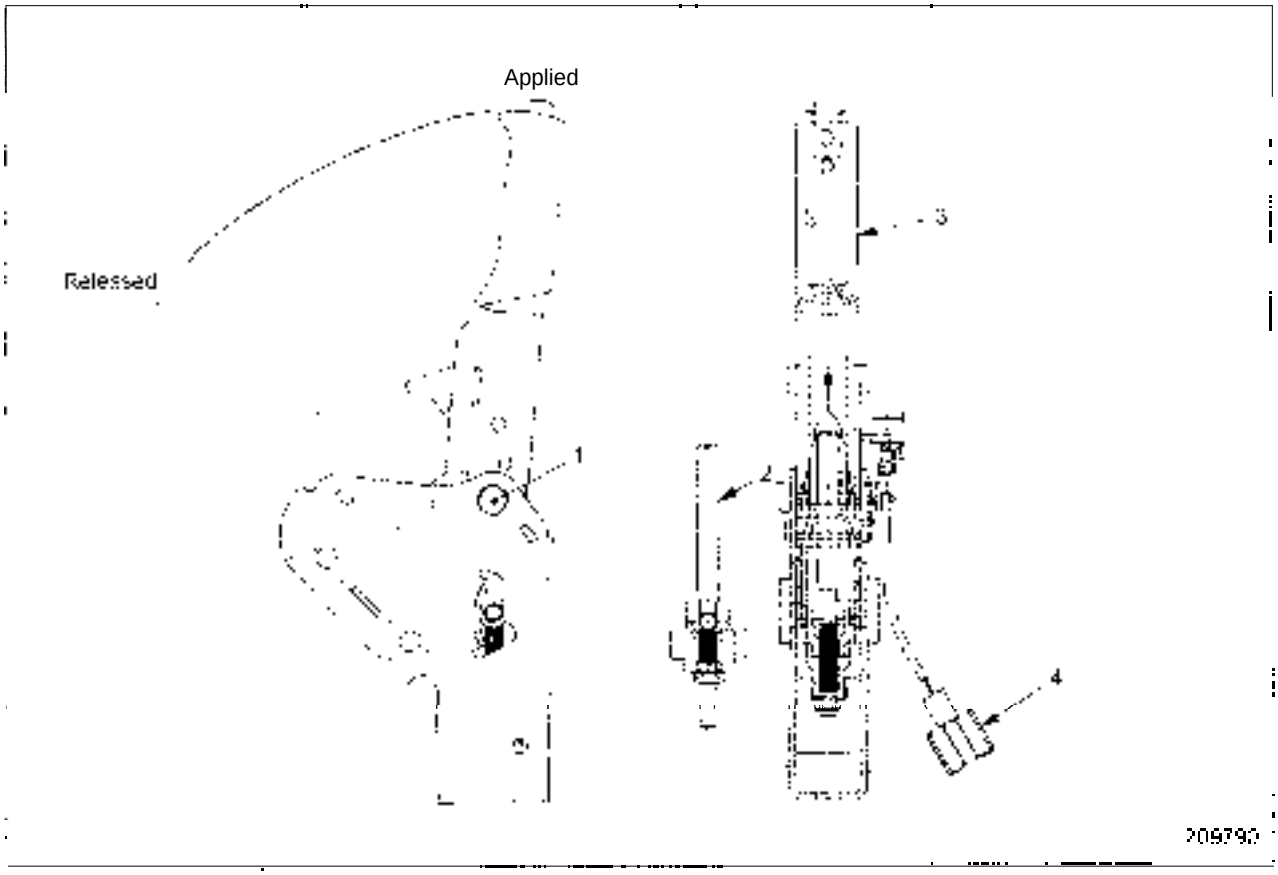
Note: (a) Take care to maintain the brake fluid in the reservoir tank at sufficient levels while the bleeding operation is in progress.

(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 re-assembly, check the braking force at a speed of 10 km/h. Readjust as necessary by referring to "Manual Adjustment."

Parking Brake Lever



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

Inspection and Repair

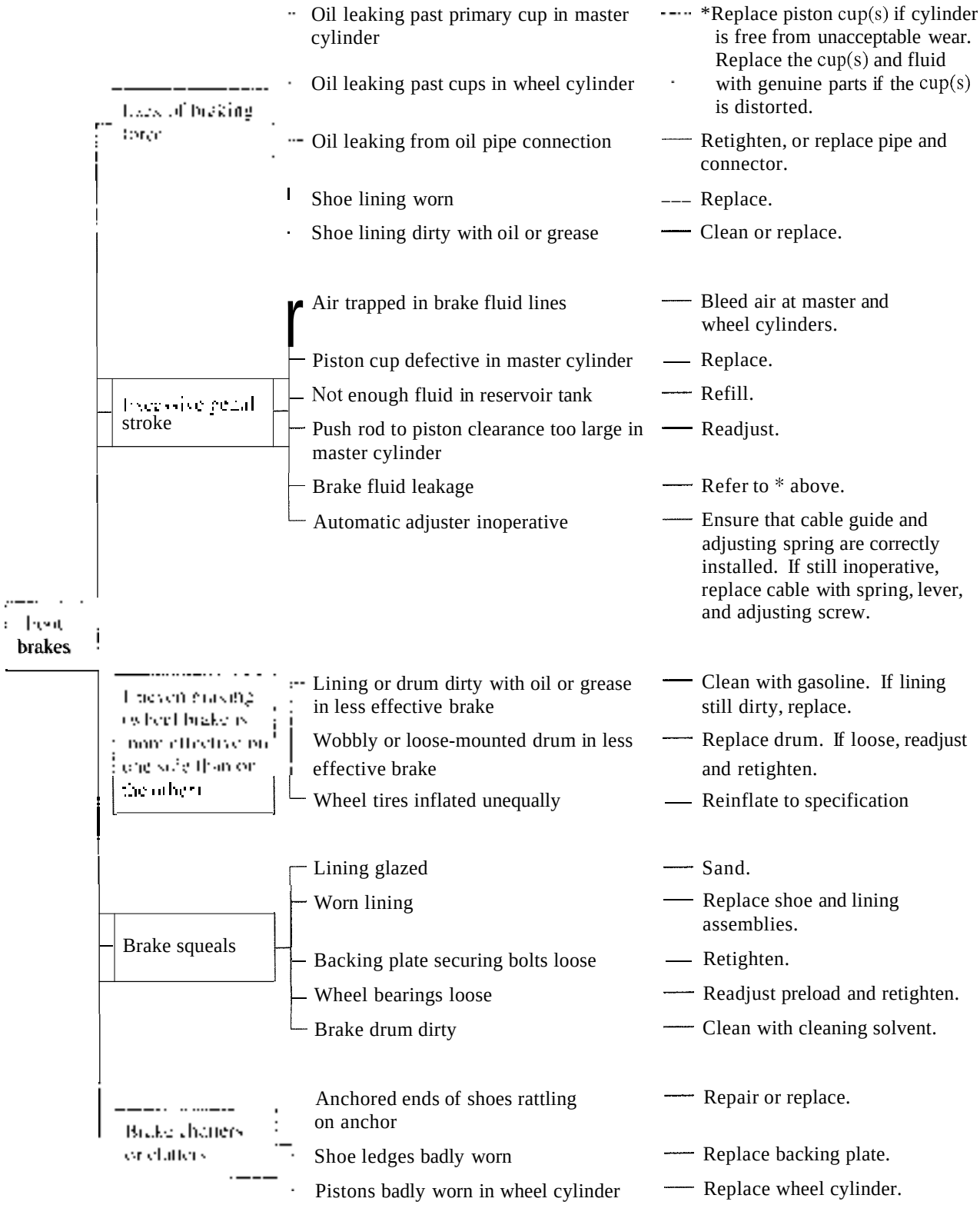
(1) If the lever support pin and/or the pin hole in the lever are badly worn, replace the worn part(s).

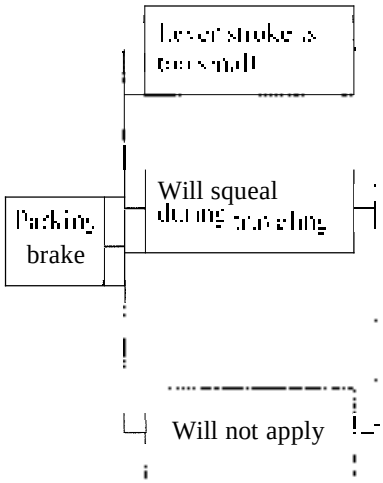
(2) Replace the parking brake cable if it is stretched, damaged or rusted.

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



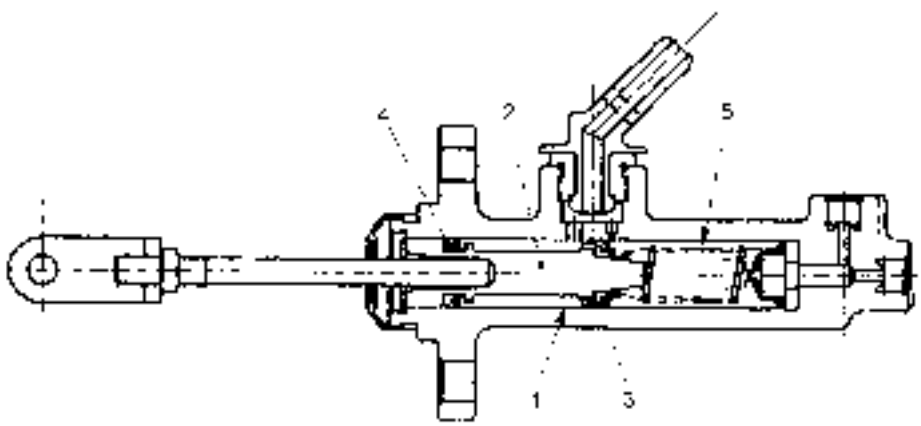


Lever stroke is too small	Lining to drum clearance too small	— Readjust.
Will squeal during traveling	Lining to drum clearance too small	— Readjust.
	Brake drum badly distorted	— Repair or replace.
Parking brake	Parking brake cable longer than specification	— Check lining to drum clearance. If brake will still not apply, readjust cable length.
Will not apply	lining 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		19.05 (0.7500)	
	Diameter of piston 2		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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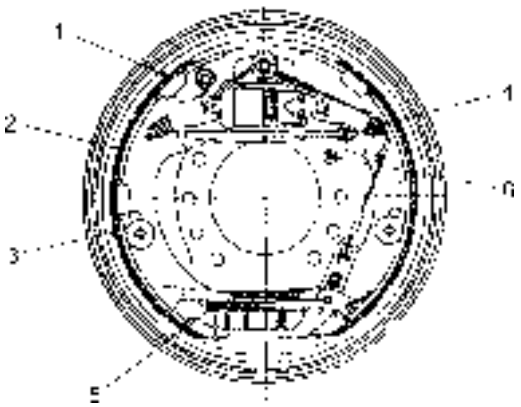
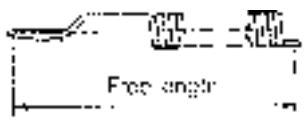
A: Standard value B: Service limit
Unit: mm (in.)

Items			Truck Models	1 ton class	2, 3 ton classes
Wheel brakes	Inside diameter of brake drum 1		A	254.0 (10.00)	318.0 (12.52)
			B	256.0 (10.08)	321.0 (12.64)
	Thickness of lining 2		A	4.87 (0.19)	6.70 (0.26)
			B	1.5 (0.06)	3.0 (0.12)
	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



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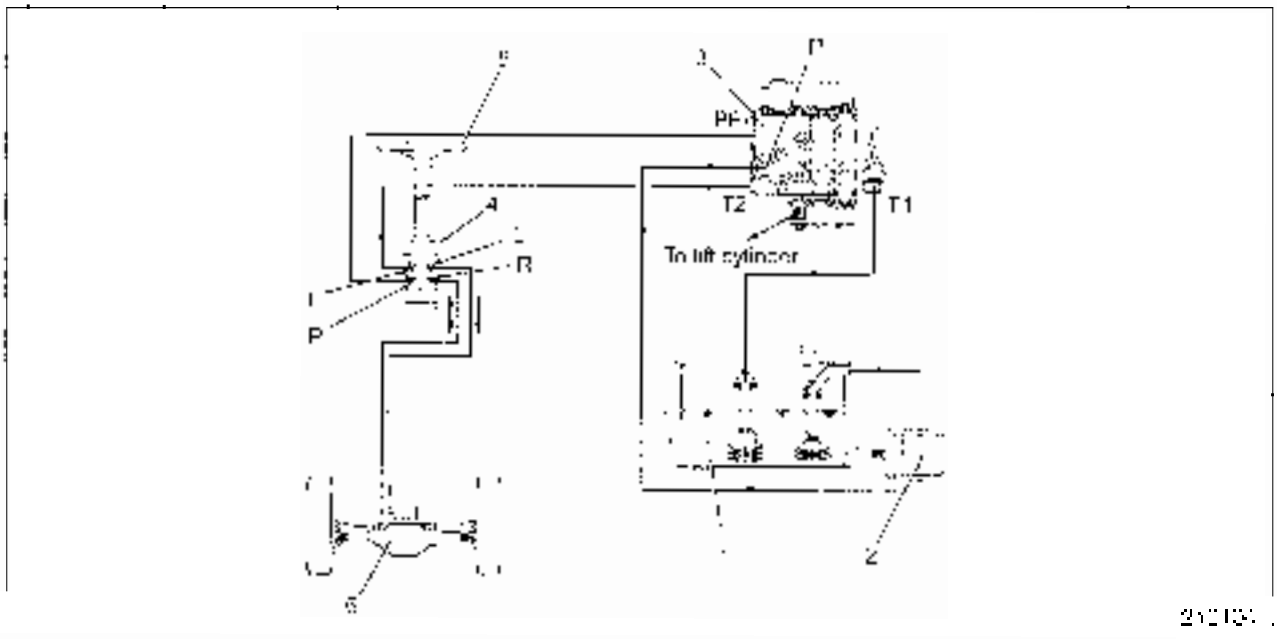
STEERING SYSTEM

10

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

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.

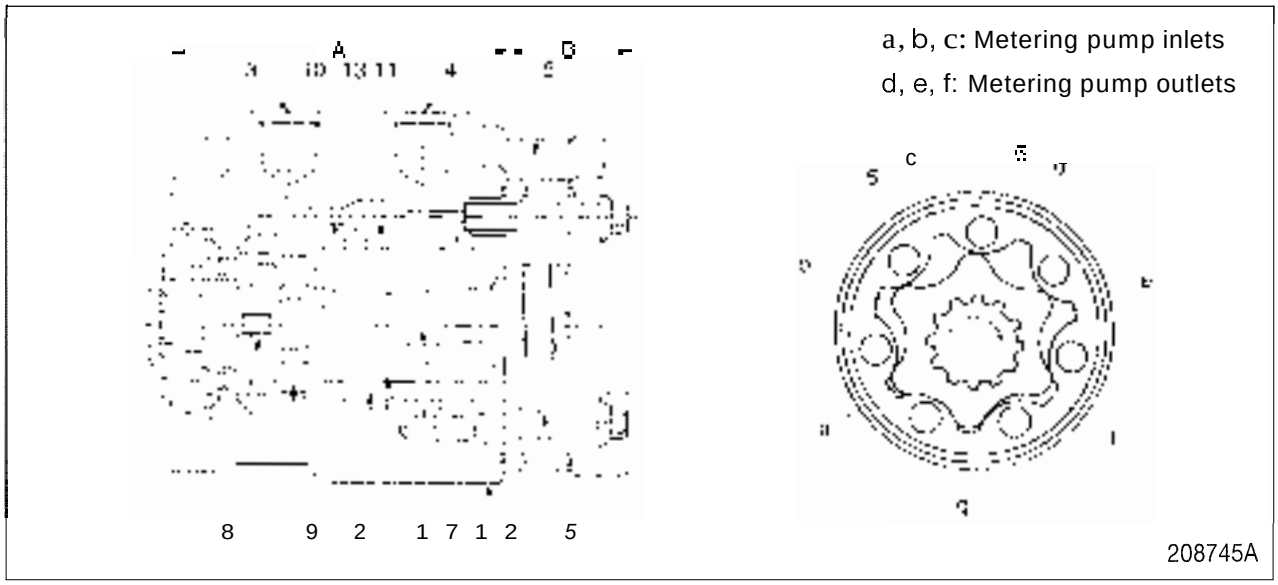
When the steering wheel is turned, the oil from the PF port enters the "Gerotor" passing through the P port and spool-and-sleeve valve in the steering valve 4. (The Gerotor is a small trochoid pump capable of delivering oil at a rate proportional to the number of turns in which the steering wheel is 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.

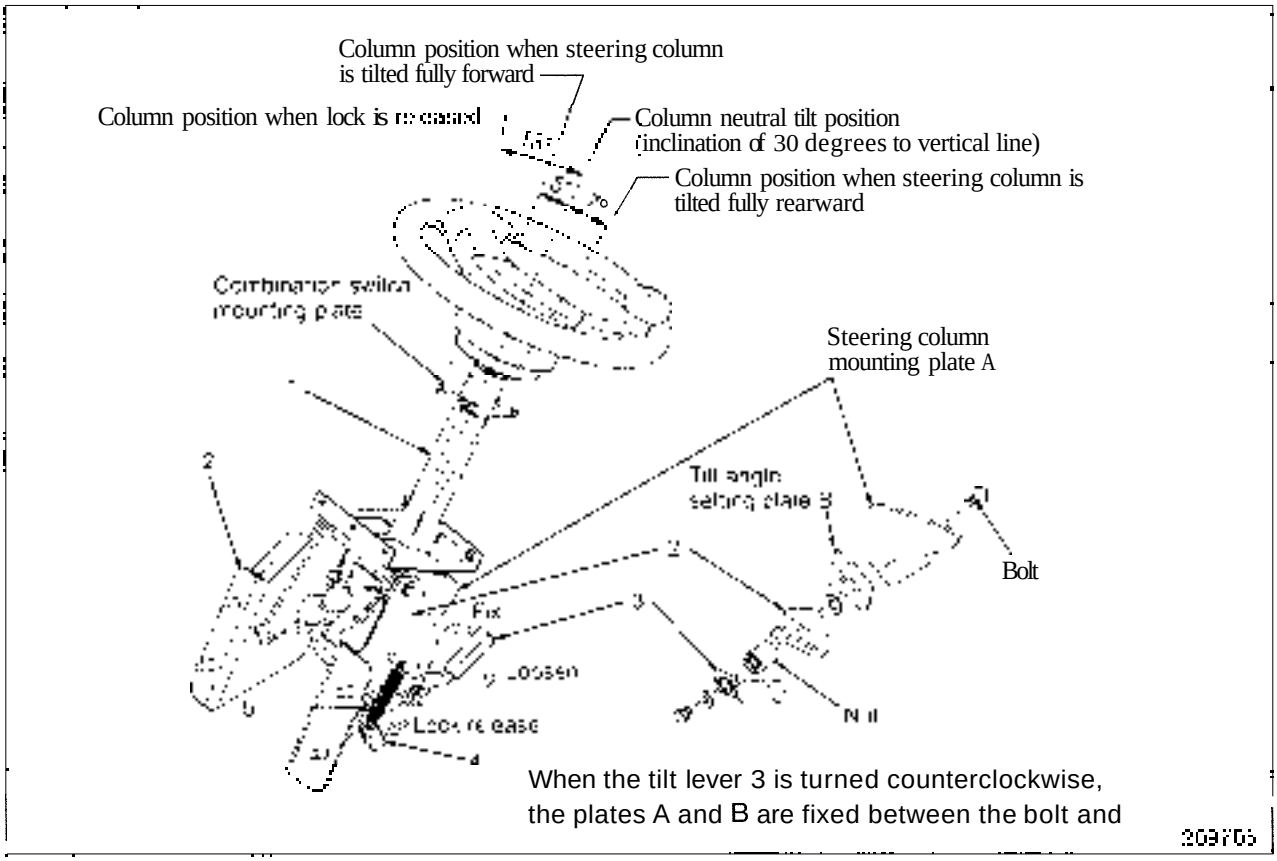
When the operator turns the steering wheel clockwise, the passage in the steering valve opens, allowing pressure oil to flow through inlet port 4 into areas a, b, and c.

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



Main components

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

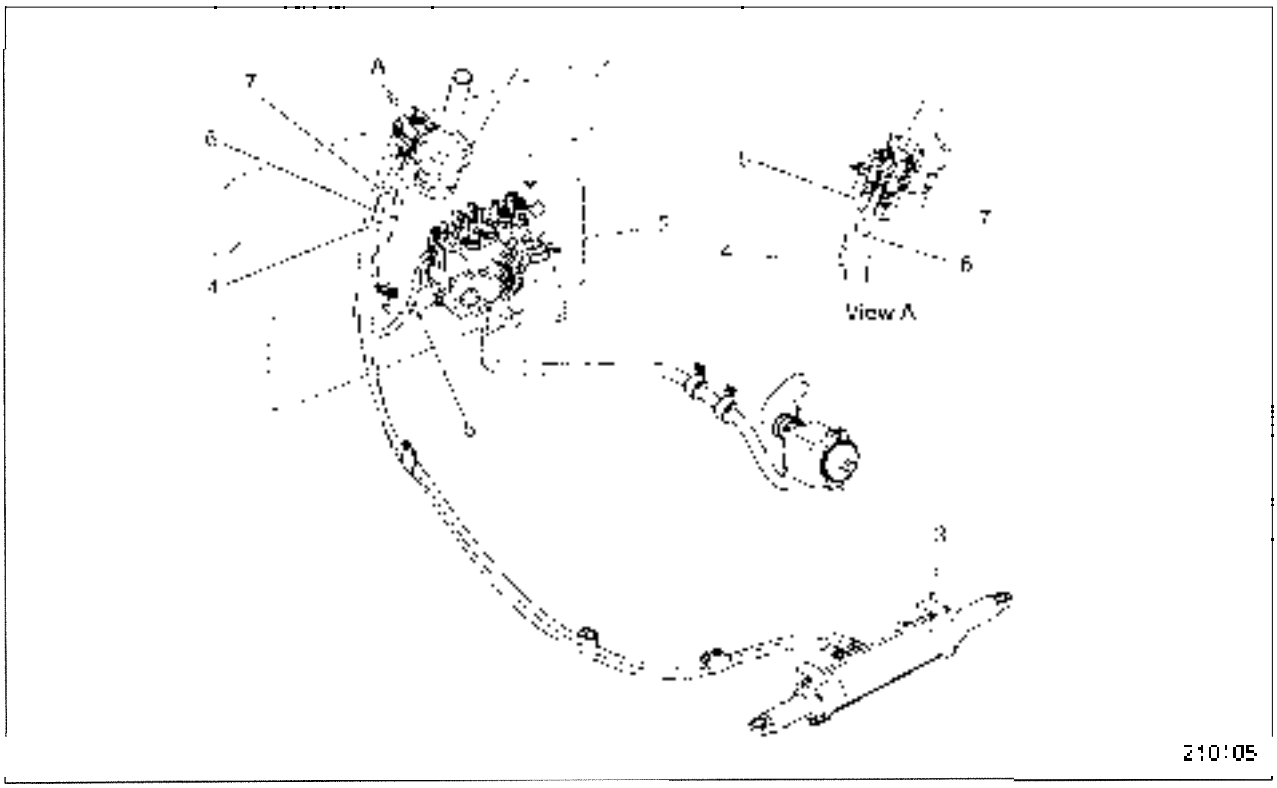
The steering column is tilt adjustable in the range of 5 degrees forward and 7 degrees rearward as shown in the illustration.

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)

Suggestions for disassembly and reassembly

(1) The most 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. These specially designed parts need to be replaced at specific periods, regardless of the presence or absence of damage. For replacement interval, follow the "Operation & Maintenance Manual".

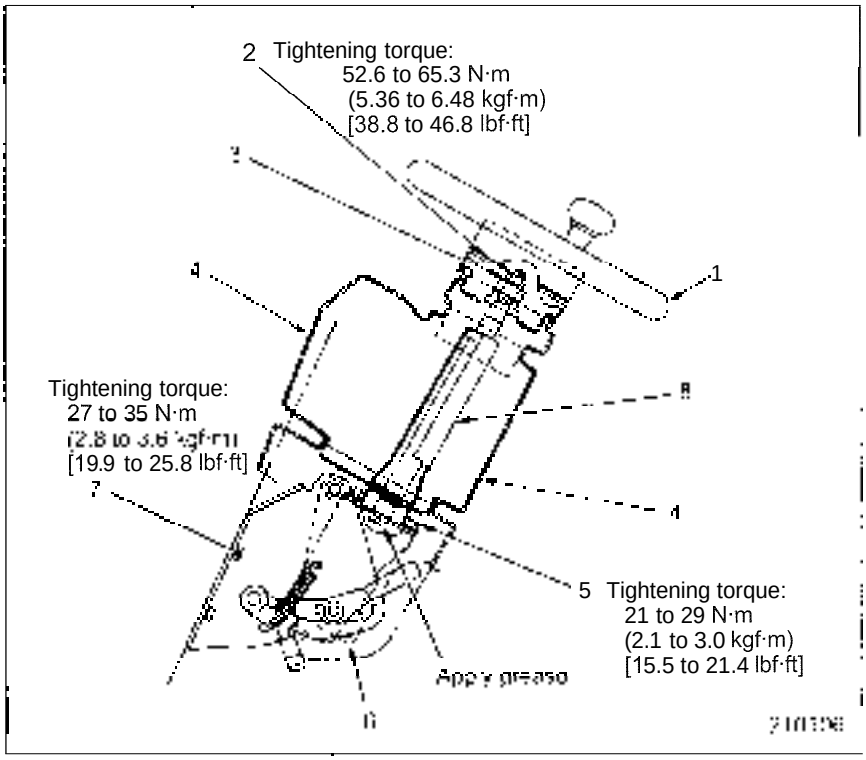
(4) When removing or installing hoses, use a double spanner as needed to prevent excessive force from being applied to the matching fittings.

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

(a) Raise the rear tires by placing jack stands 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

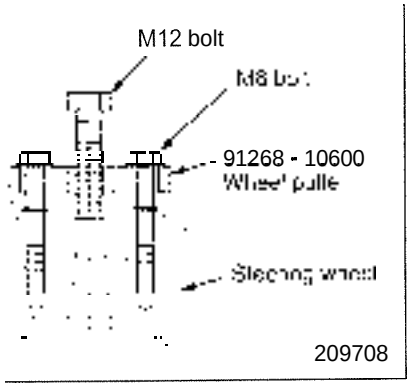
Removal

(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



Wheel puller setting

CAUTION

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

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.

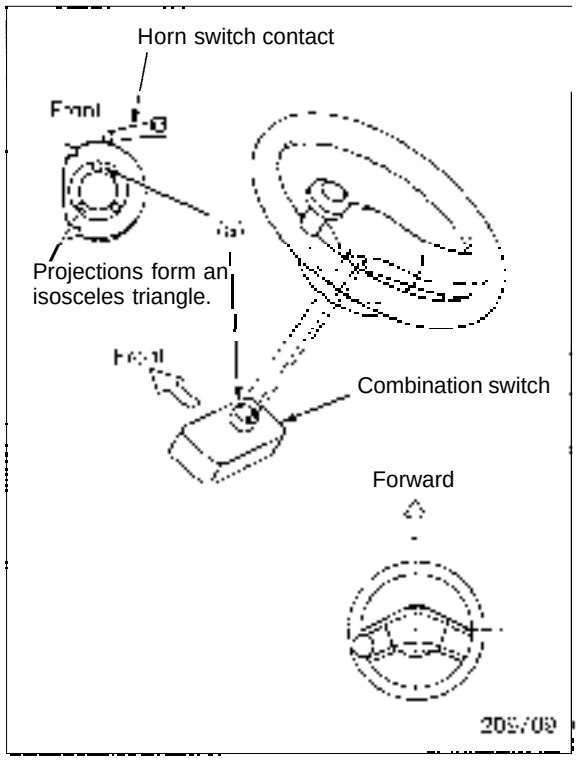
(2) Apply a light coating of grease to a sliding area of the horn contact under the steering wheel boss.

(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.



inspection after Installation

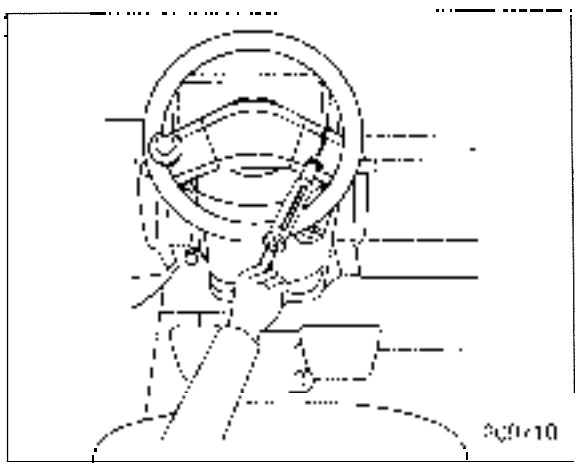
Steering effort

(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]



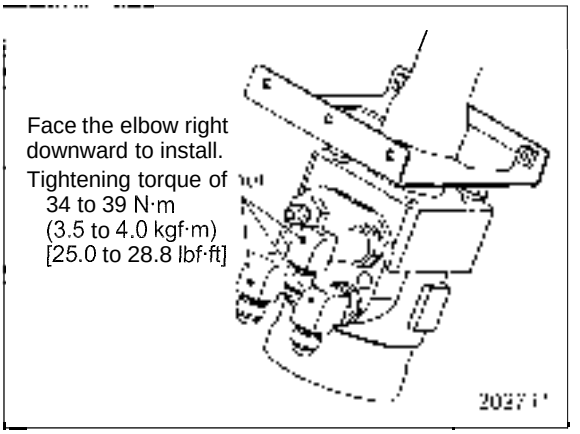
2. Steering valve

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

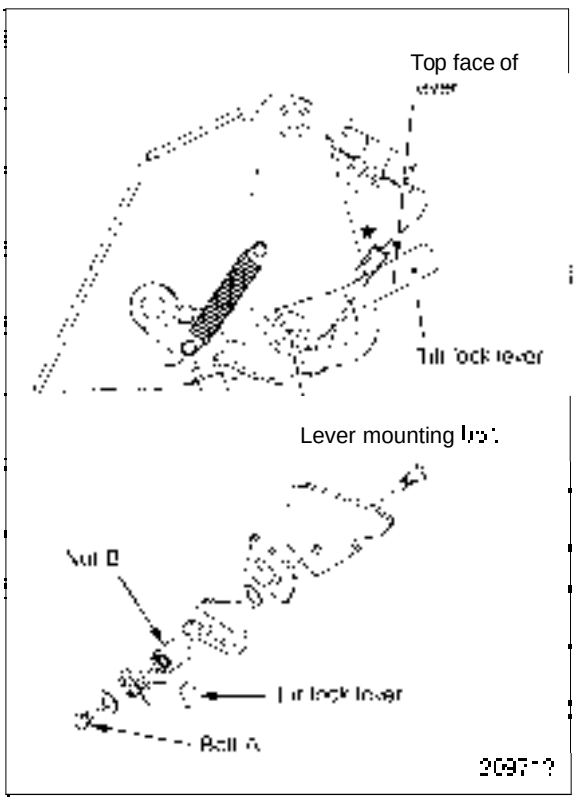
1. Put match marks on the tilt lock lever and the nut B for convenience of reassembly.
2. Remove the bolt A and then, remove the tilt lock cover.

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.)

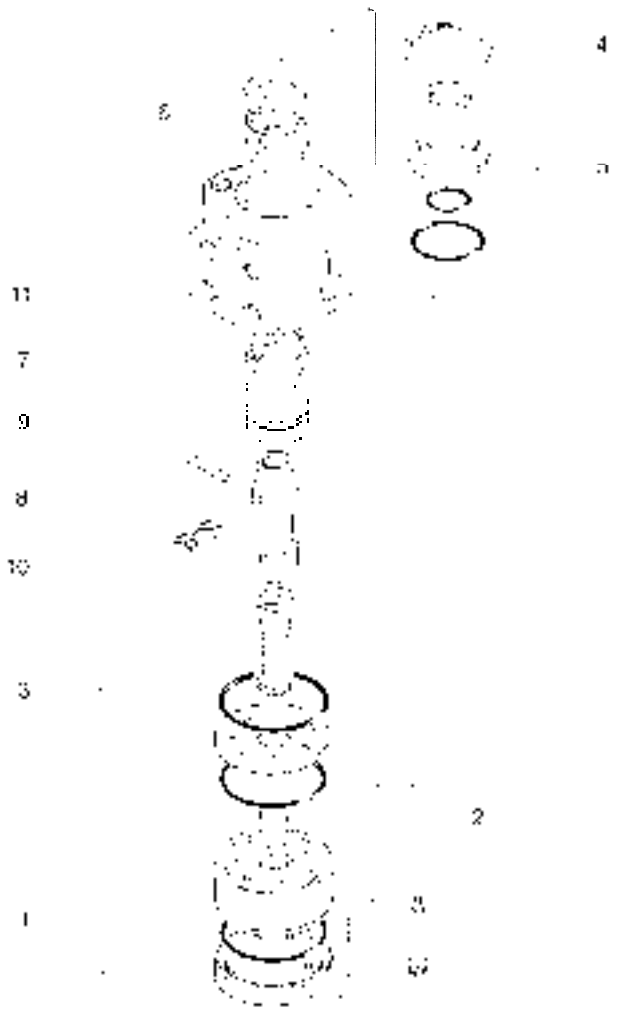
1. Tighten the nut B to the tightening torque of 11 to 15 N·m (1.1 to 1.5 kgf·m) [8.1 to 11.1 lbf·ft]. (This represents a lever-locked condition.)
2. Select the optimal position for the tilt lock lever in a locked condition and fit the tilt lock lever into the serration of the nut B.

   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



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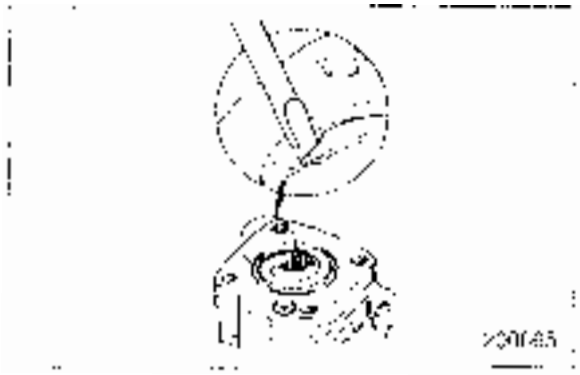
Sequence

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

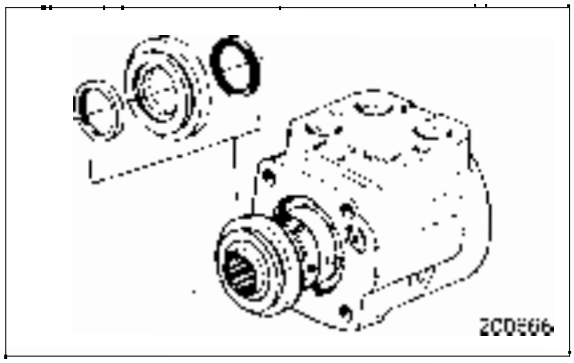
(1) Retaining ring removal

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



(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.

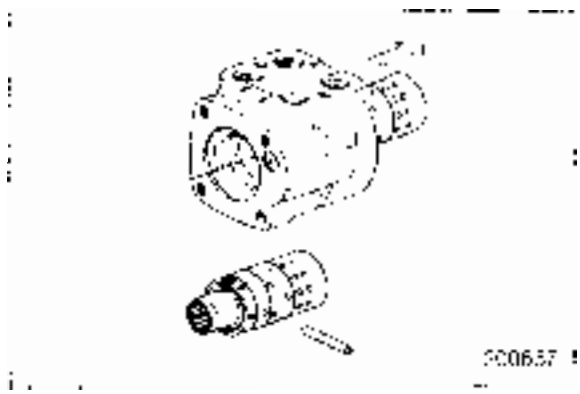


(3) Control spool and sleeve removal

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.

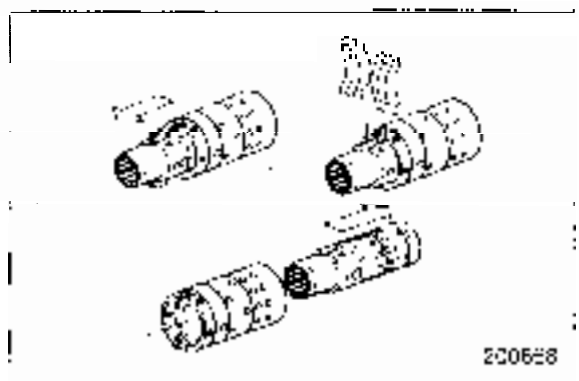


(4) Control spool and sleeve disassembly

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.



Inspection after disassembly

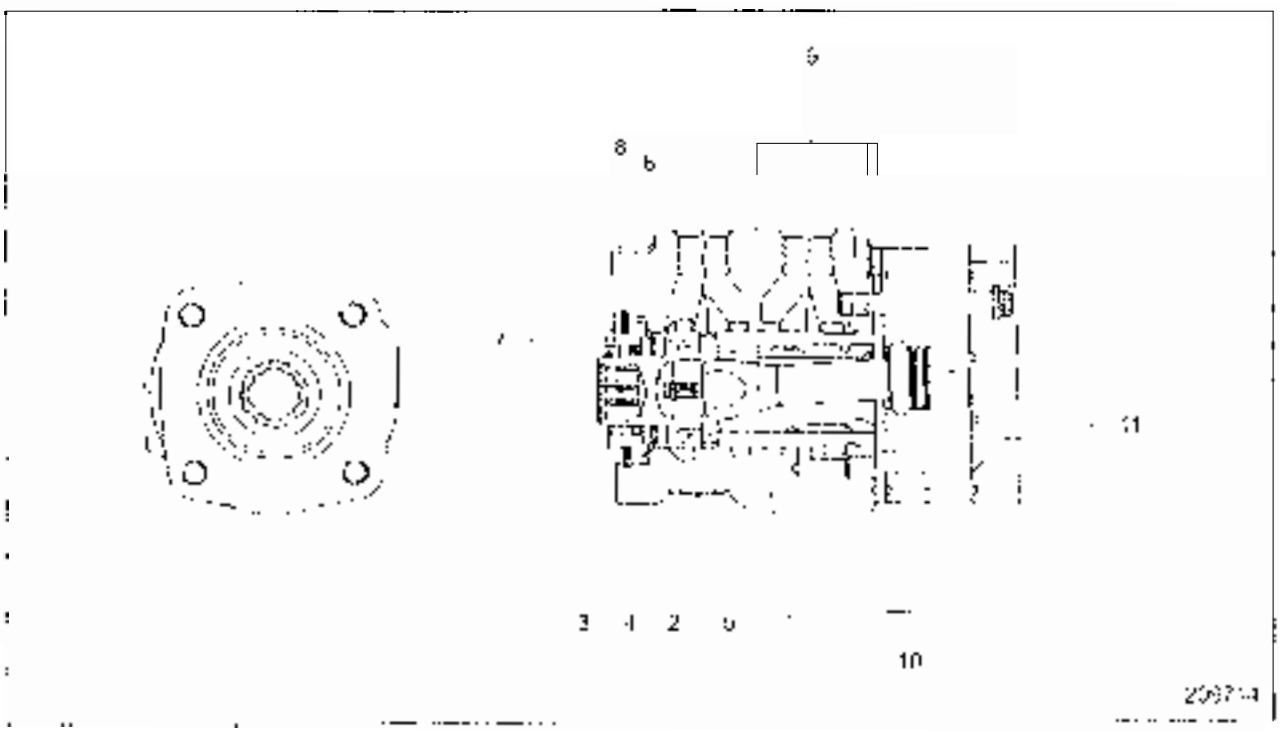
(1) Check sliding areas between the sleeve and the housing and between the sleeve and the spool.

(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.

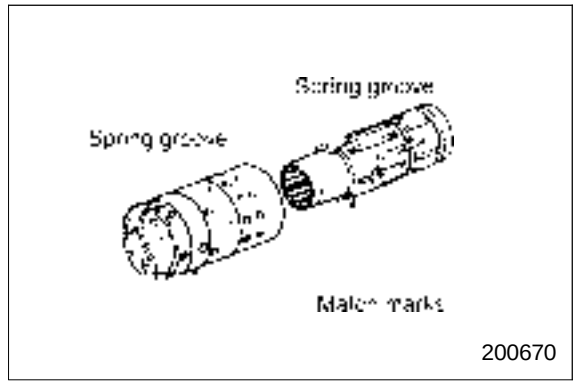
(3) Do not wear cloth gloves when reassembling. Lint may enter the valve.

Suggestions 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.



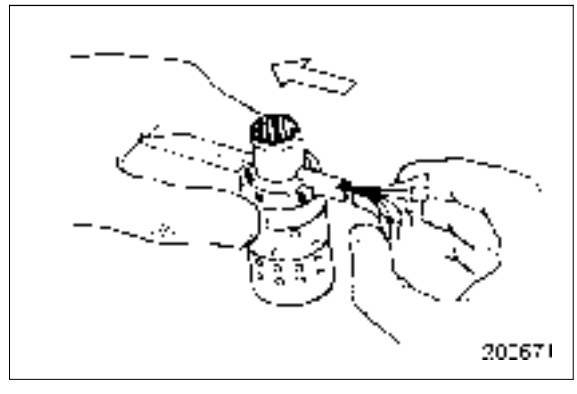
CAUTION

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.

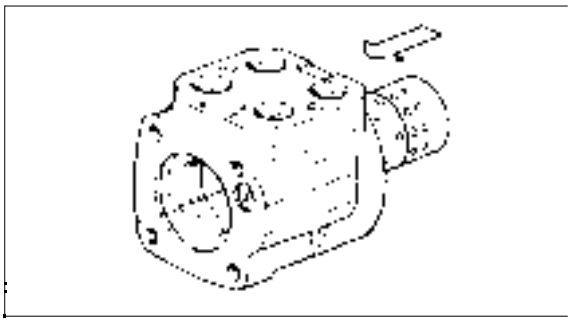
As shown in the illustration, push one end of the springs with fingers and push the springs into the spool-and-sleeve groove. In case there is no inserting tool, assemble the springs by inserting them one by one and right and left alternately.



Spring inserting tool	97157 - 00100

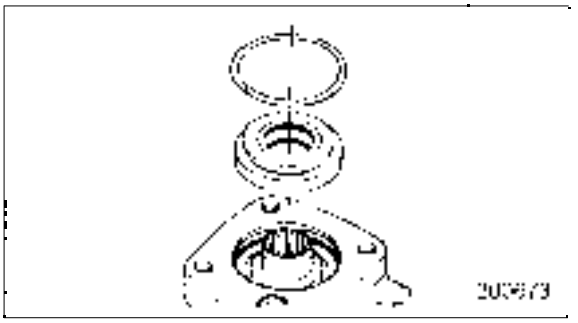
(3) Insertion of the control spool-and-sleeve assembly into the housing

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-sleevc 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.

(4) Installation of thrust bearing

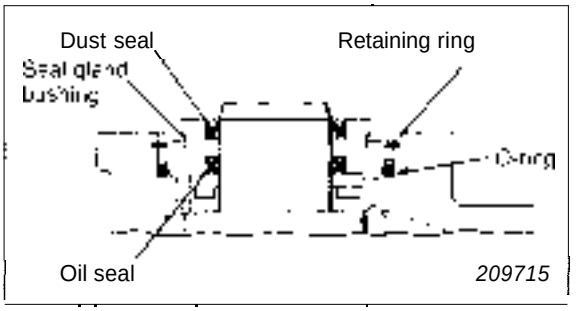


(5) Installation of seal gland bushing and seals

(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.

(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.

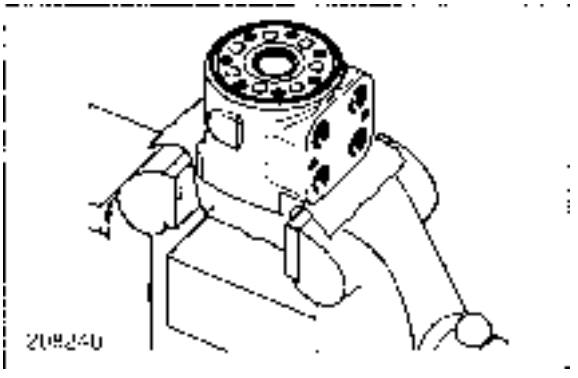


(6) Reassembling the spacer plate

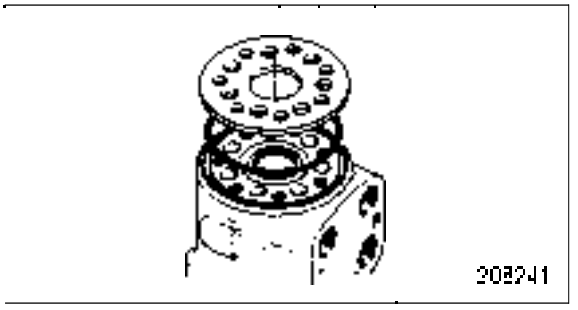
(a) Clamp the housing in a vise equipped with soft jaws or wrap the housing in a soft rag before clamping the housing in the vise. Clamp lightly over the flats of the flange. Do not over tighten the vise jaws.

NOTE)

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

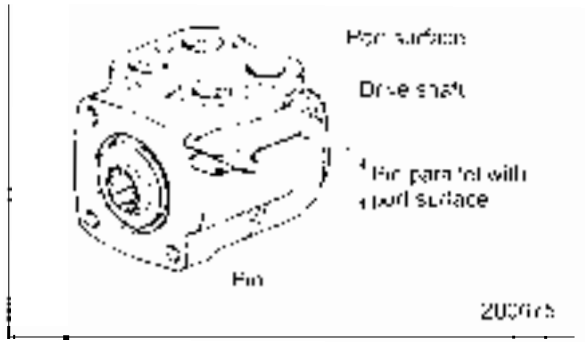


(b) Install the O-ring in the housing. Place the spacer plate on the housing and align the bolt holes with the tapped holes in the housing.



(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.



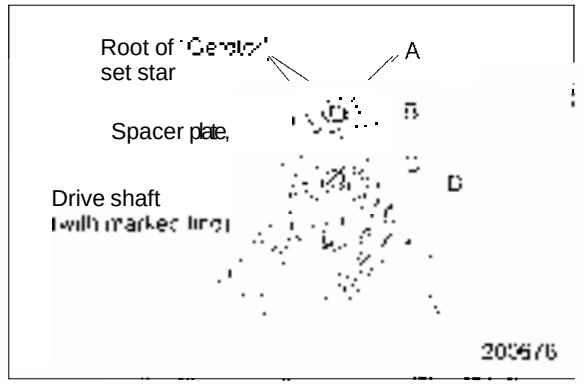
(8) Reassembling the gerotor set

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.

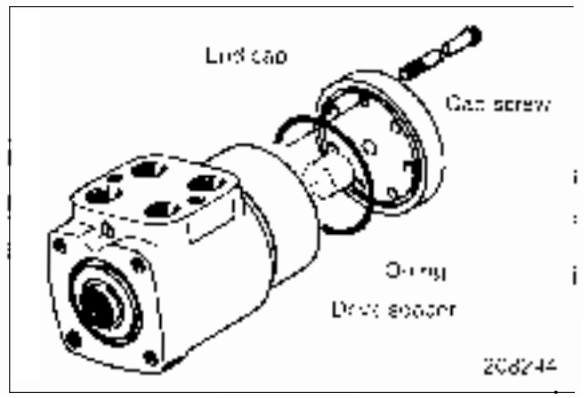
Align bolt holes of the "Gerotor" set with the drive shaft and star kept engaged.

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



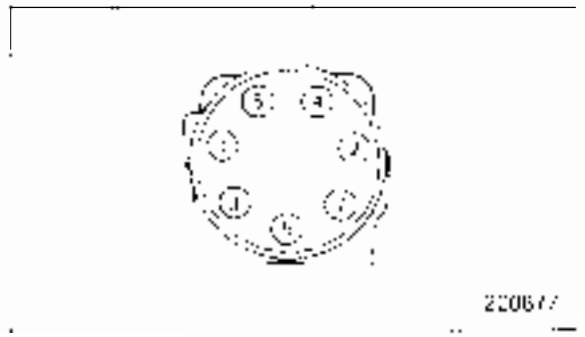
(9) Reassembling the end cap

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.



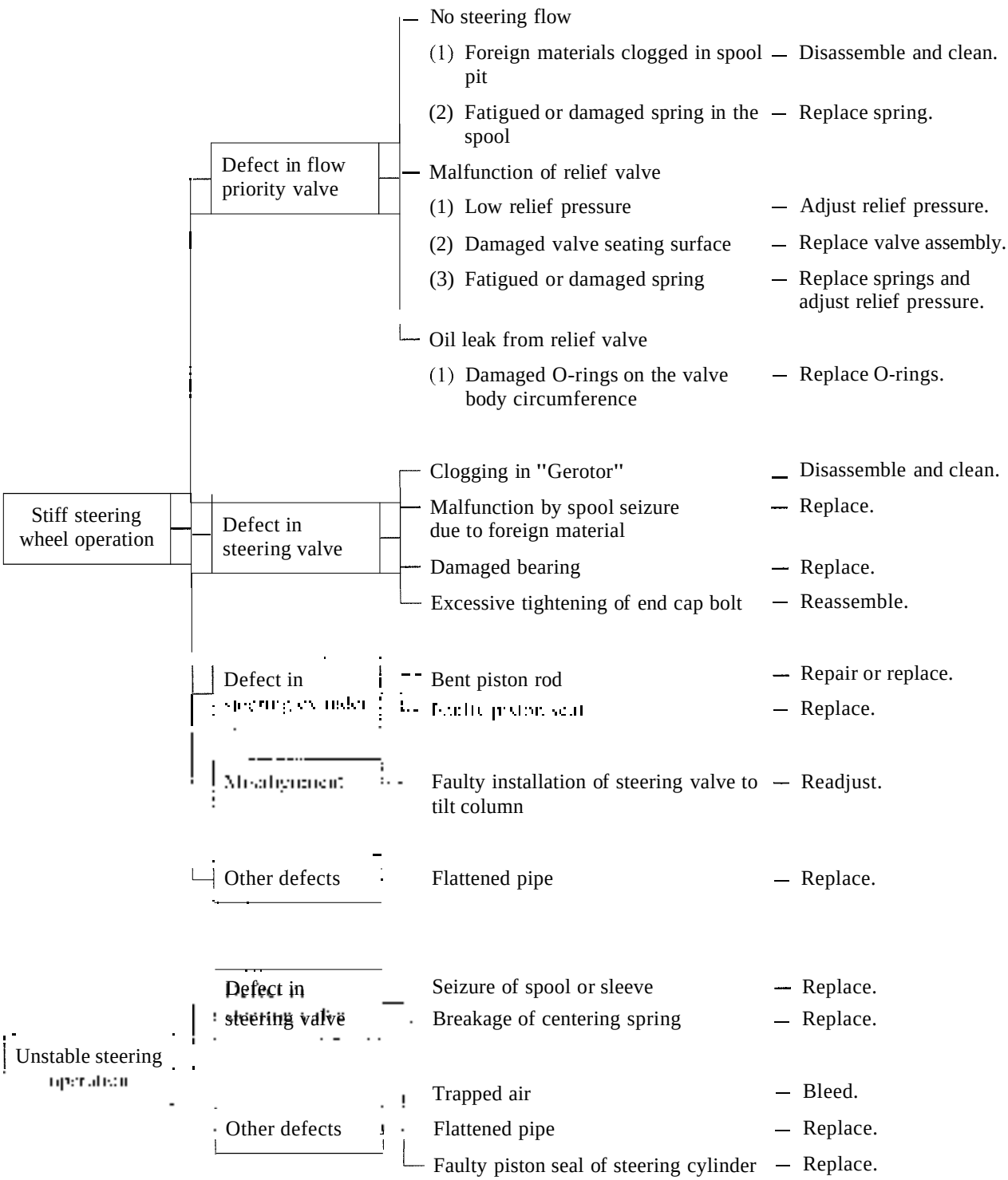
Apply oil to bolt threads and tighten bolts evenly in the sequence as shown in the illustration on the right. The tightening torque is shown in the table below.

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]

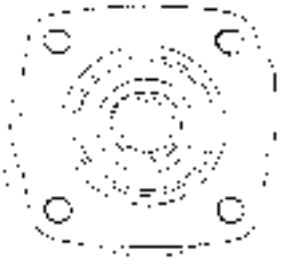
Troubleshooting



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	[illegible] or less	13 (1.3) [2.9] or less	[illegible] or less
Tightening torque of steering wheel nuts N·m (kgf·m) [lbf·ft]		A	52.6 to 63.5 [illegible] [38.8 to 46.8]	52.6 to 63.5 [illegible] [38.8 to 46.8]	52.6 to 63.5 (5.4 to 6.5) [38.8 to 46.8]
Tightening torque of steering bracket bolts N·m (kgf·m) [lbf·ft]		A	27 to 35 [illegible] [20.0 to 25.8]	27 to 35 [illegible] [20.0 to 25.8]	27 to 35 [illegible] [20.0 to 25.8]
Steering valve	Displacement cc (cu in)/rev.	A	[illegible]	[illegible]	[illegible]
	Rotating torque in normal operation N·m (kgf·m) [lbf·ft]	A	[illegible]	[illegible]	[illegible]
	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/cm²) [psi]		A	$8.8\ ^{+0.5}_{0}$ ($90\ ^{+5.1}_{0}$) [illegible]	$10.3\ ^{+0.5}_{0}$ ($105\ ^{+5.1}_{0}$) [illegible]	$10.3\ ^{+0.5}_{0}$ ($105\ ^{+5.1}_{0}$) [illegible]

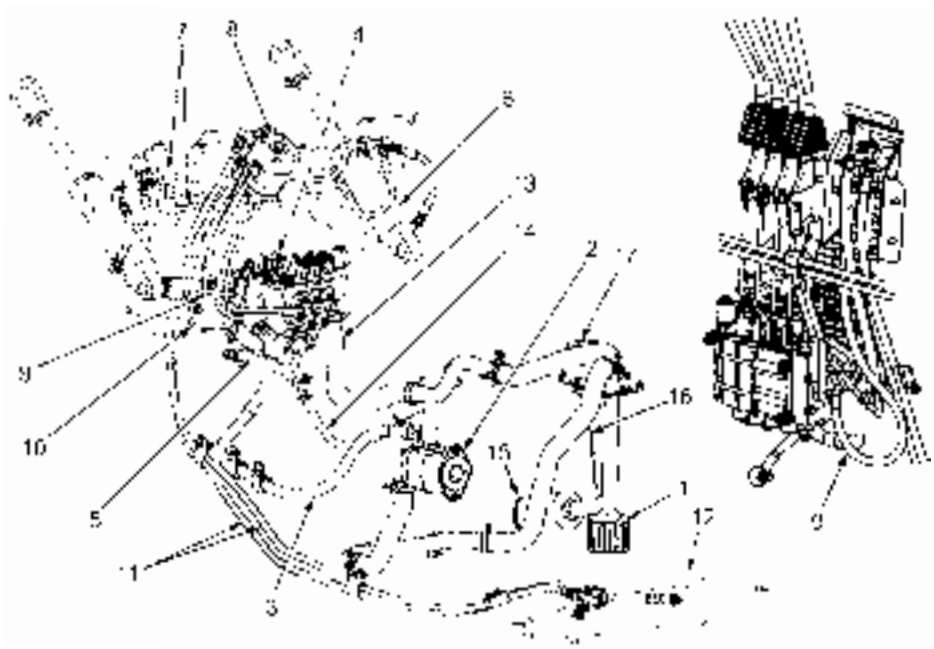


209-16

HYDRAULIC SYSTEM

Structure and Functions

Outline



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

21E107

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:
This valve has a built-in flow regulator valve.

5 Oil feed line to lift cylinder:

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.

10 Return line from steering valve

11 Oil feed line to steering valve

12 Steering cylinder

13 Return line

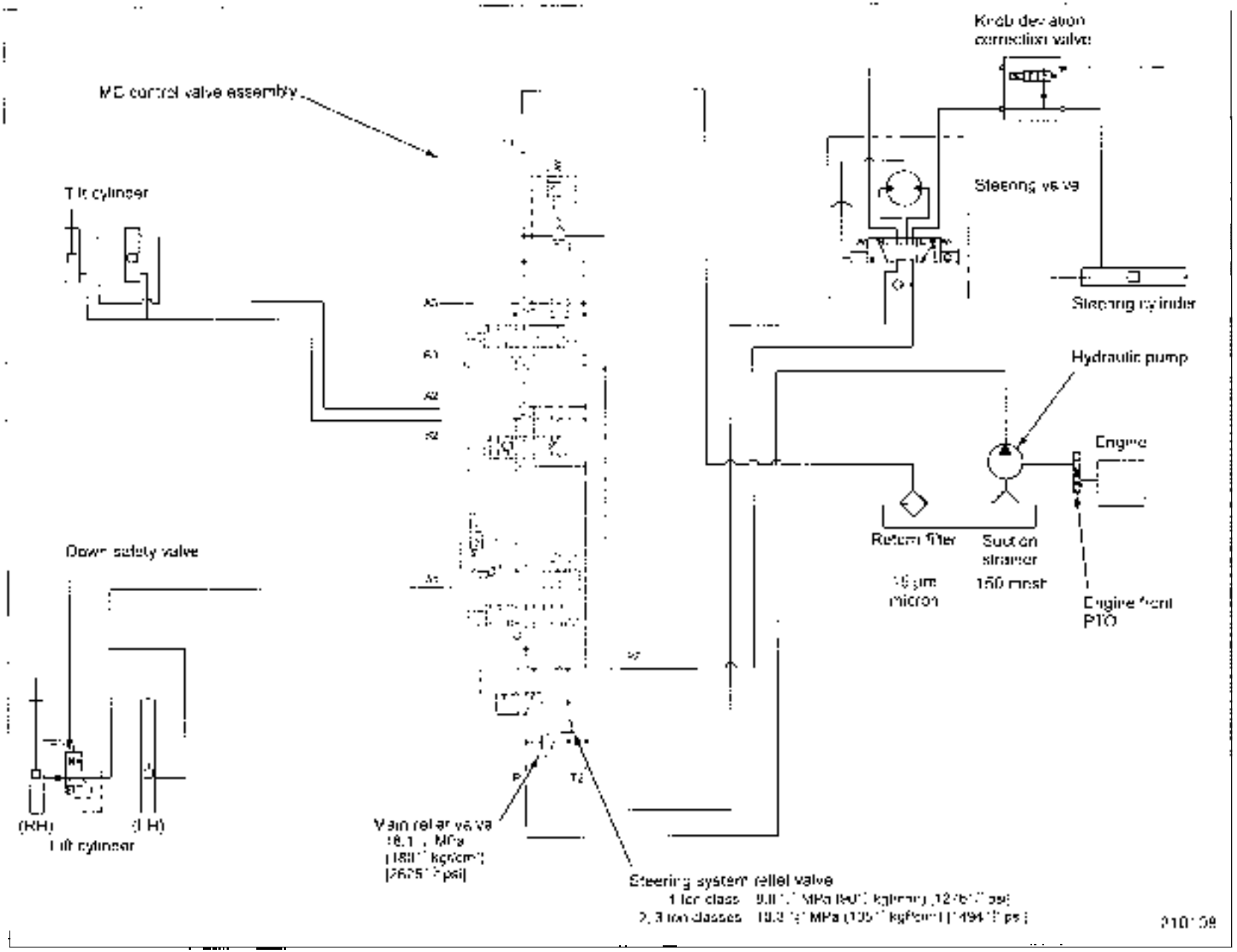
14 Line leading to top of lift cylinder piston:
This line is only installed in truck that have a lift cylinder with a return line. It is not installed in trucks with 3.3 m (10.8 ft) or smaller lift. If this line is not installed, the branching hole from return line 13 is closed with a blind plug.

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

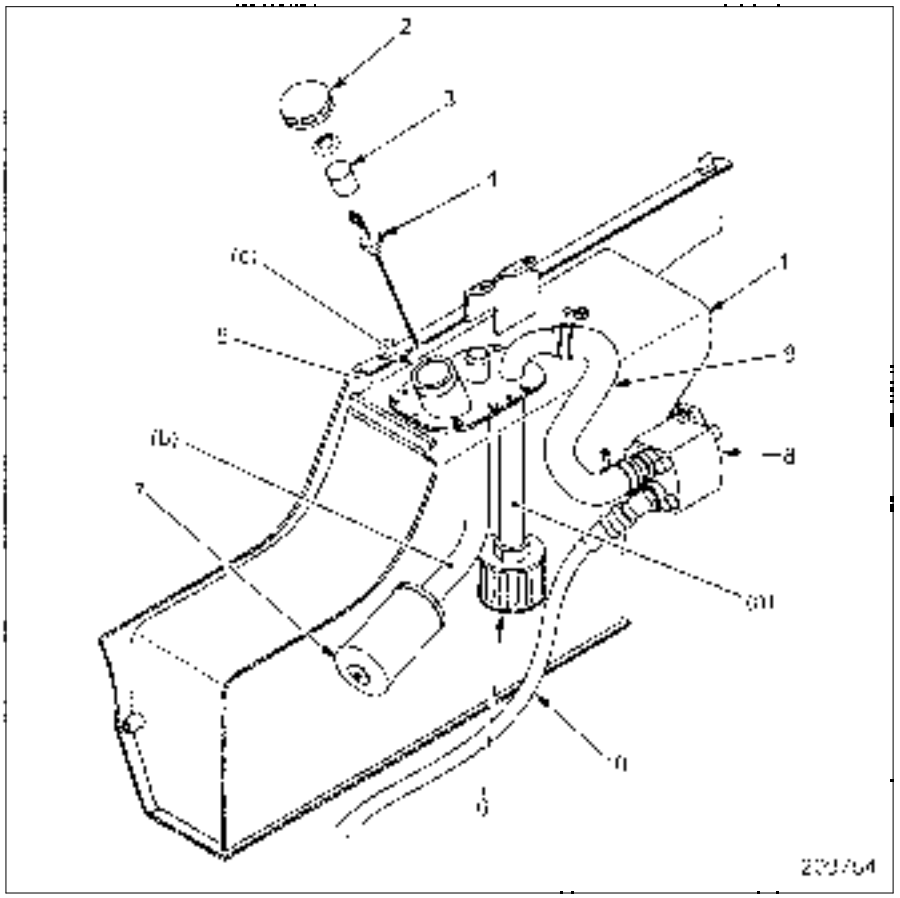
16 Level gauge

17 Oil filter cap

Hydraulic Circuit Diagram



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.

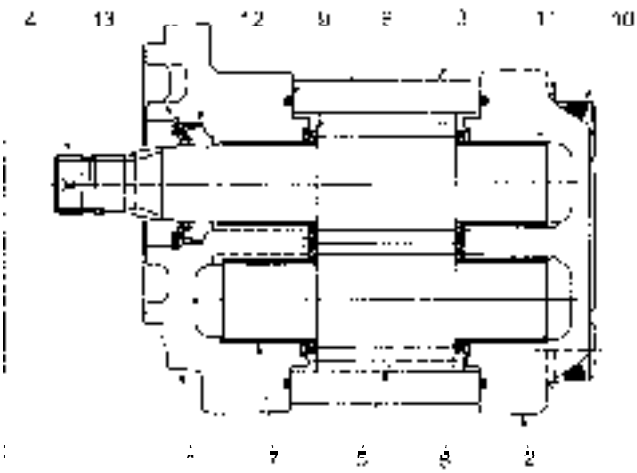
Return filter 7 is attached to the end of return pipe (b). The return filter is a cartridge type of 15 μm with an integral relief valve. When the filter is clogged, the relief valve activates and discharges unfiltered oil to the tank. Periodic replacement is important. In case of a new truck or a large-scale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

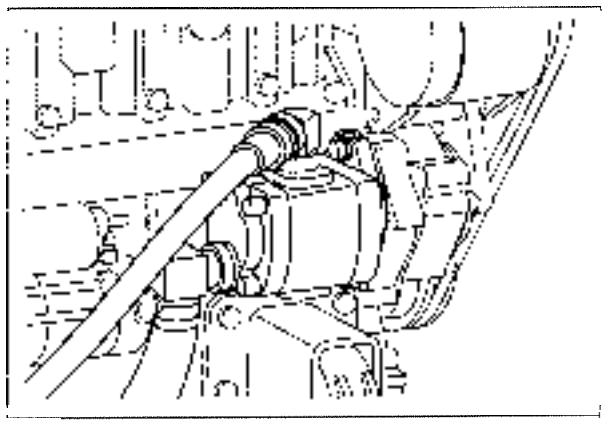
Suction strainer 6 of the pump is 150 mesh screen gauze. When replacing oil, clean the suction strainer.

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 at the bottom of the tank.

Hydraulic Pump (Gear Pump)





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

209755

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

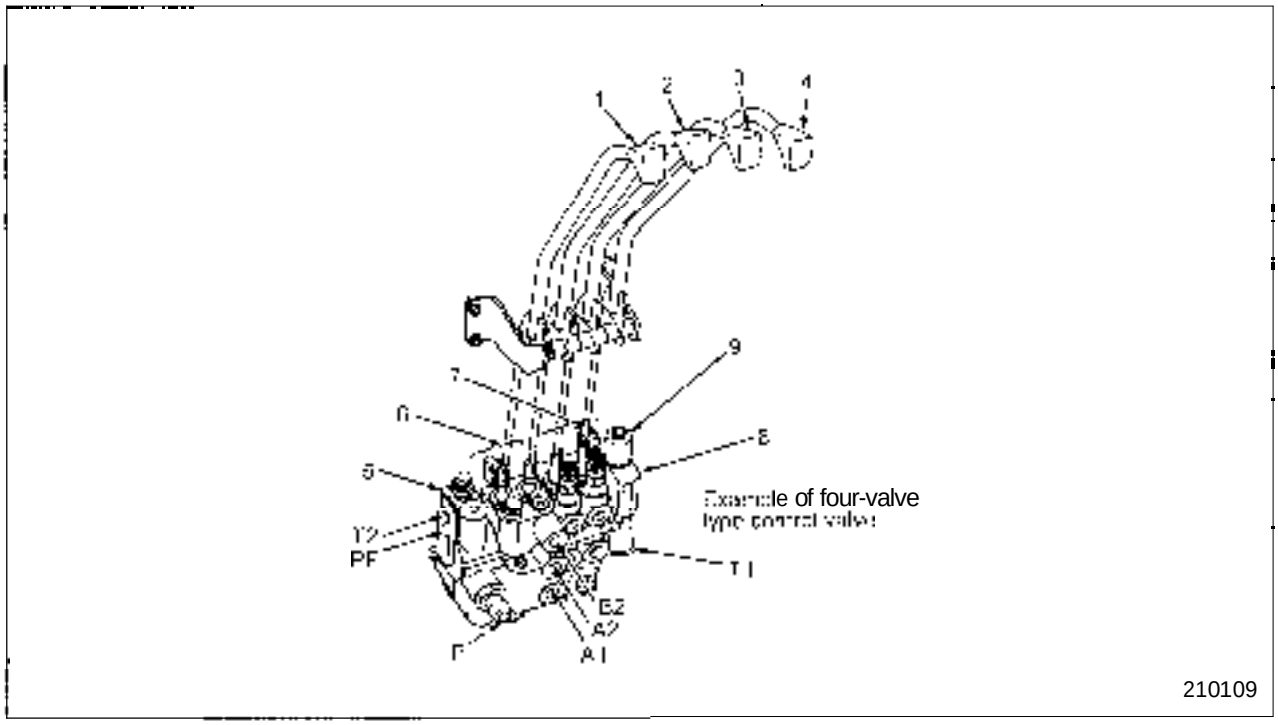
The pump is directly installed to the engine front PTO, but installed sides are reversed left to right for a gasoline engine and a diesel engine.

- 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

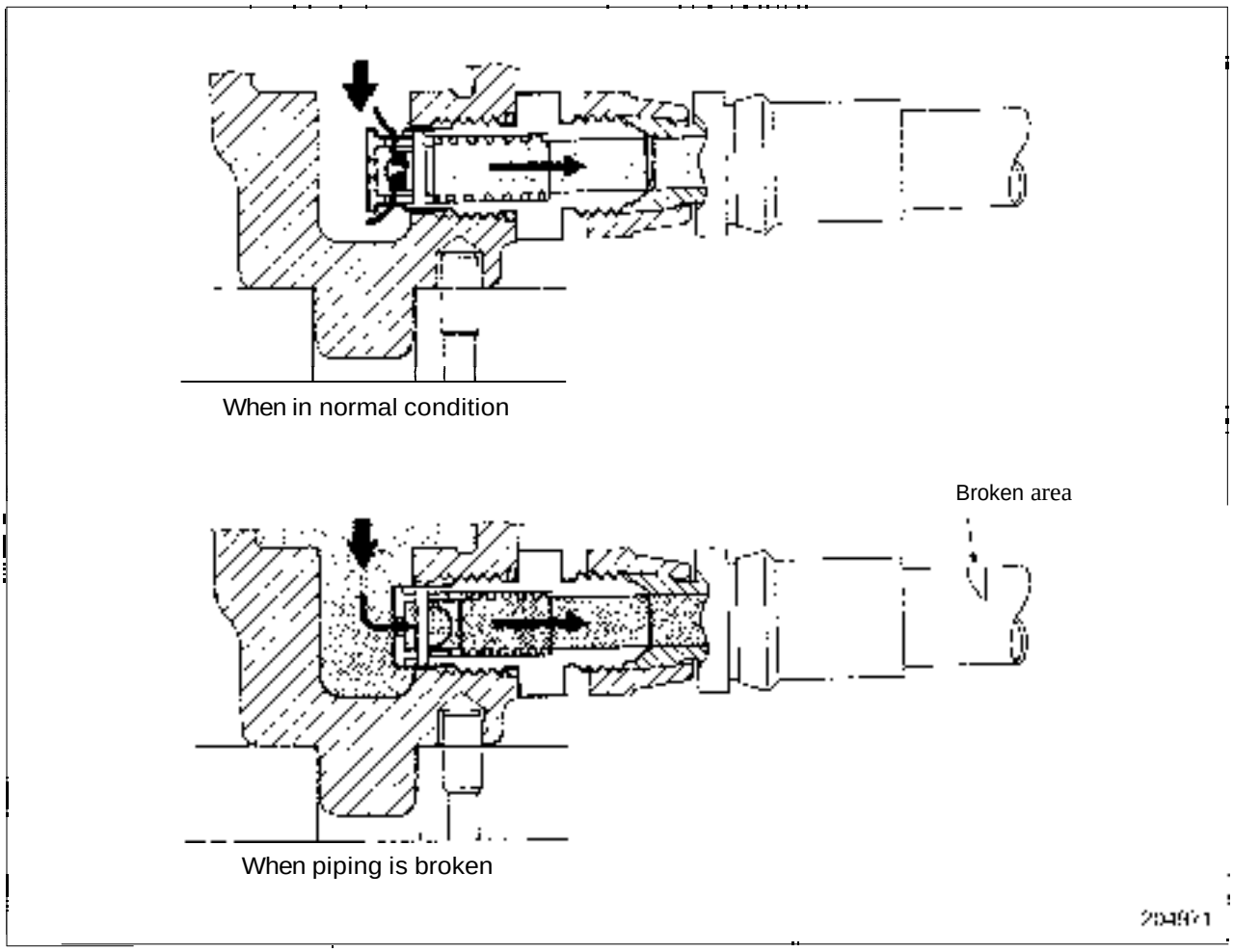


1 Lift control lever
2 Tilt control lever
3 Attachment (#1) control lever
4 Attachment (#2) control lever
5 Inlet cover section (with built-in flow priority valve)
6 Combination section (with built-in lift valve, tilt valve and flow divider valve)
7 Attachment section
8 End section (with built-in unloader valve [9])
9 Unloader valve (with solenoid)

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 "Control Valve" section (pages 11-43 to 11-58).

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

Down Safety Valve



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

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

Lift Cylinder

1. Second lift cylinder for simplex mast and triplex mast

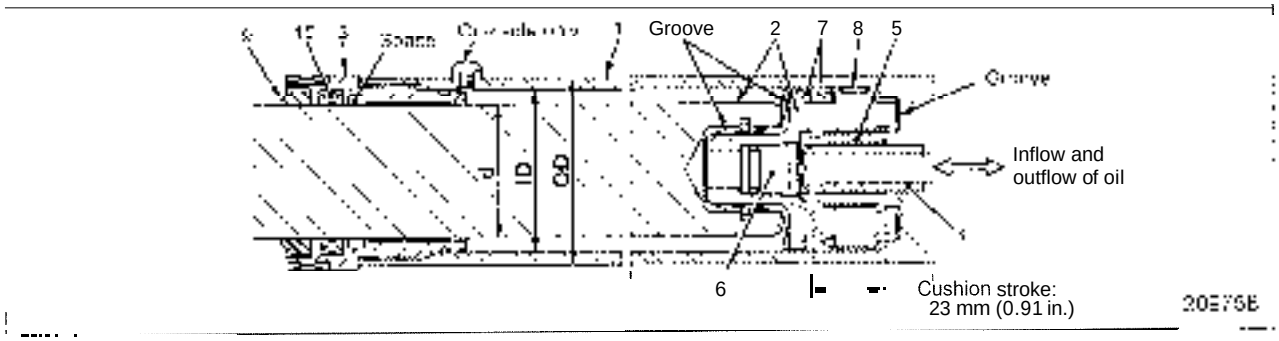
There are two types for the above lift cylinder: one with a return pipe and the other without a return pipe. The lift cylinder without a return pipe is provided with a check valve in the piston instead of a return pipe. This is called an internal drain type cylinder.

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



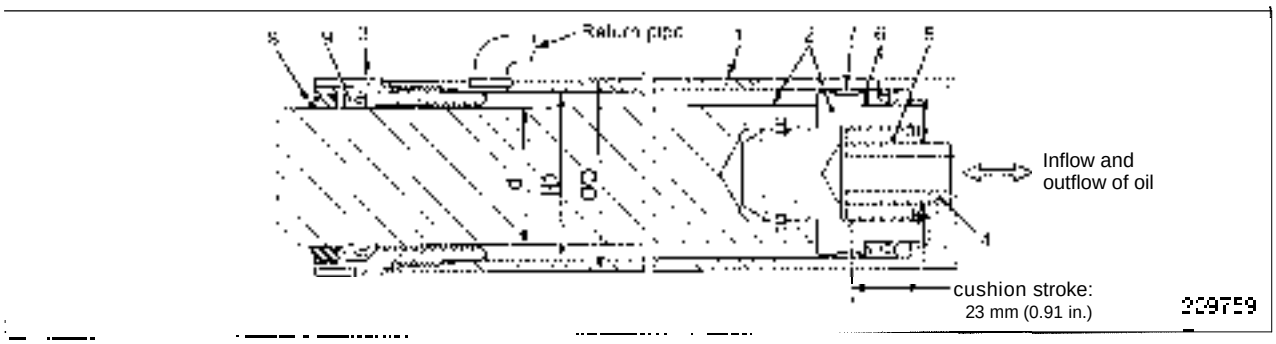
Main components

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

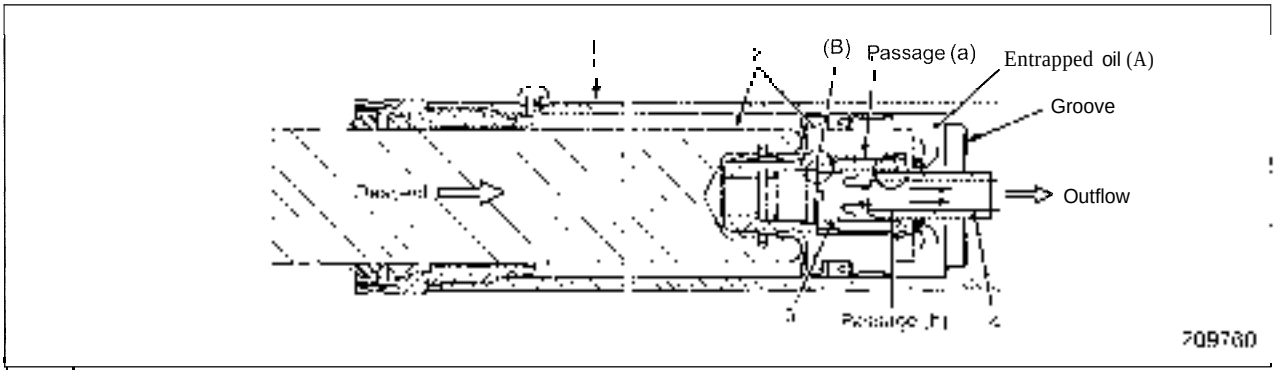
Cylinder dimensions (The cylinder length and stroke vary depending on raised height)

Unit: mm (in.)

Model	Mast type	Raised height	Rod diameter (d)	Cylinder inside diameter (D)	Cylinder outside diameter (OD)	Cylinder stroke	Presence of return pipe
1 ton class	Simplex	3.4 m (11.2 ft) or less	45 (1.77)	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
	Duplex	--	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
	Duplex	--	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 piston rod assembly 2 descends with its self weight 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 impulsive contact is avoided.

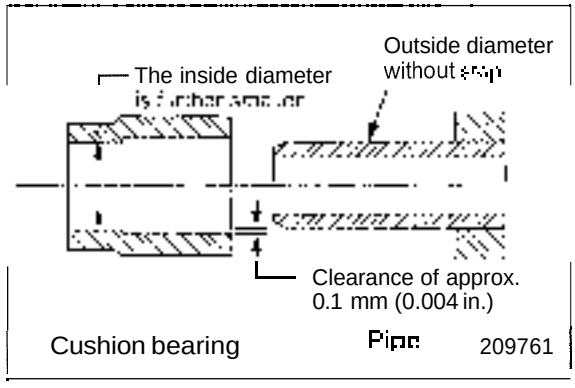
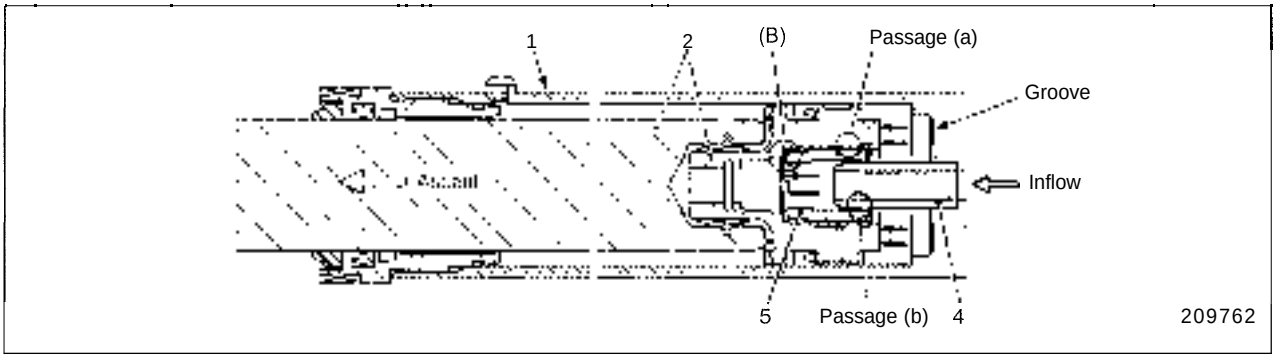


Image of pipe and cushion bearing

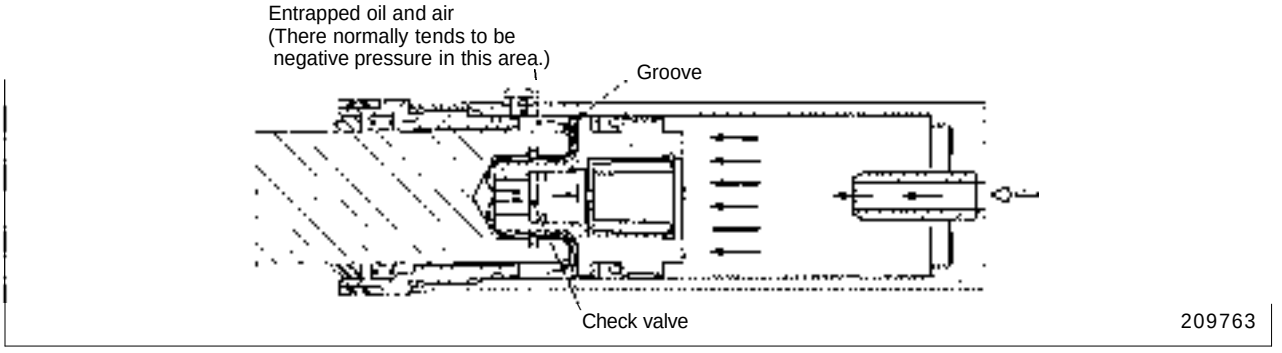
Action during piston ascent (initial stage)



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 thc (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.

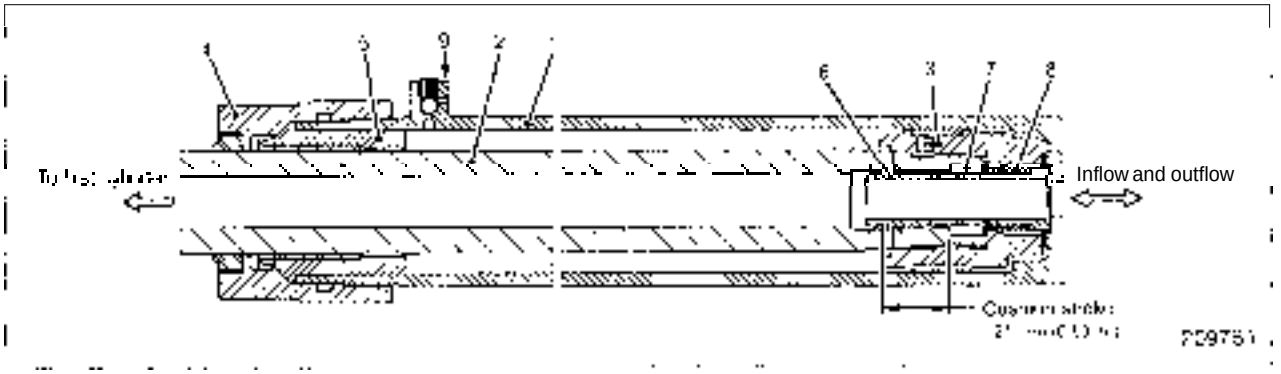
Cylinder of internal drain type



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 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



Main components

1 Cylinder tube
2 Rod
3 Piston
4 Holder
5 Cylinder head
6 Cushion spool
7 Check valve
8 Spring
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

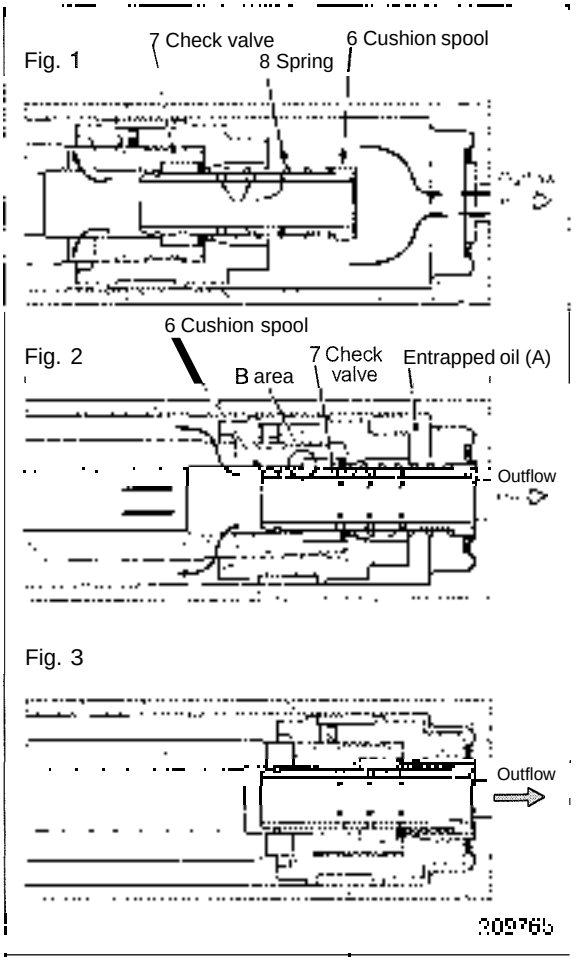
The illustration on the right explains movement of cushion spool 6 when the piston descends. (To the right of the illustration is the piston bottom.)

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 impulsive contact is avoided.



Action during piston ascent

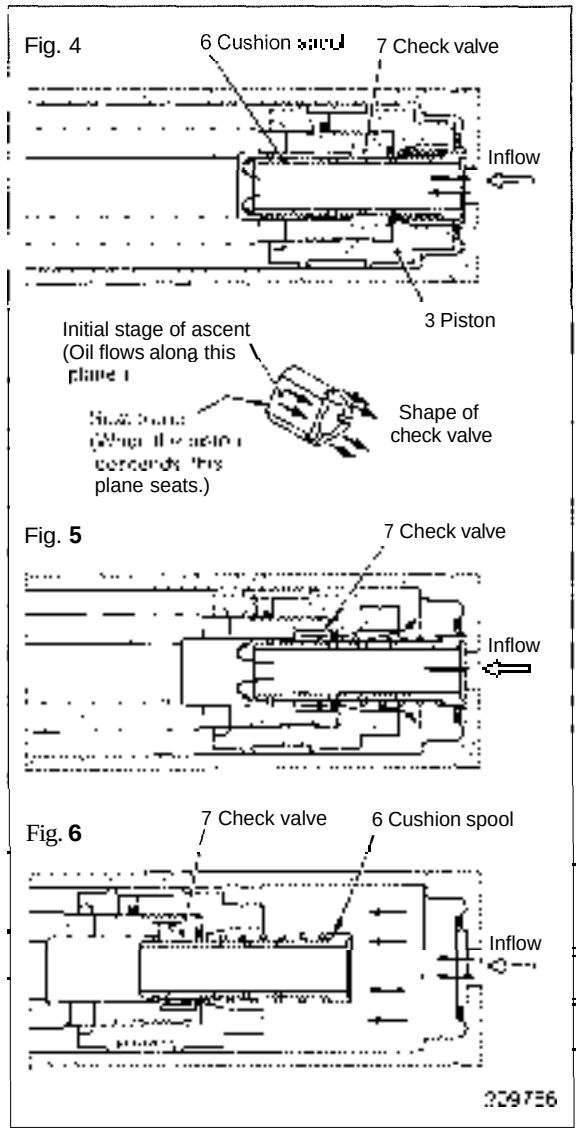
The illustration on the right explains movement of the check valve when the piston ascends.

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.

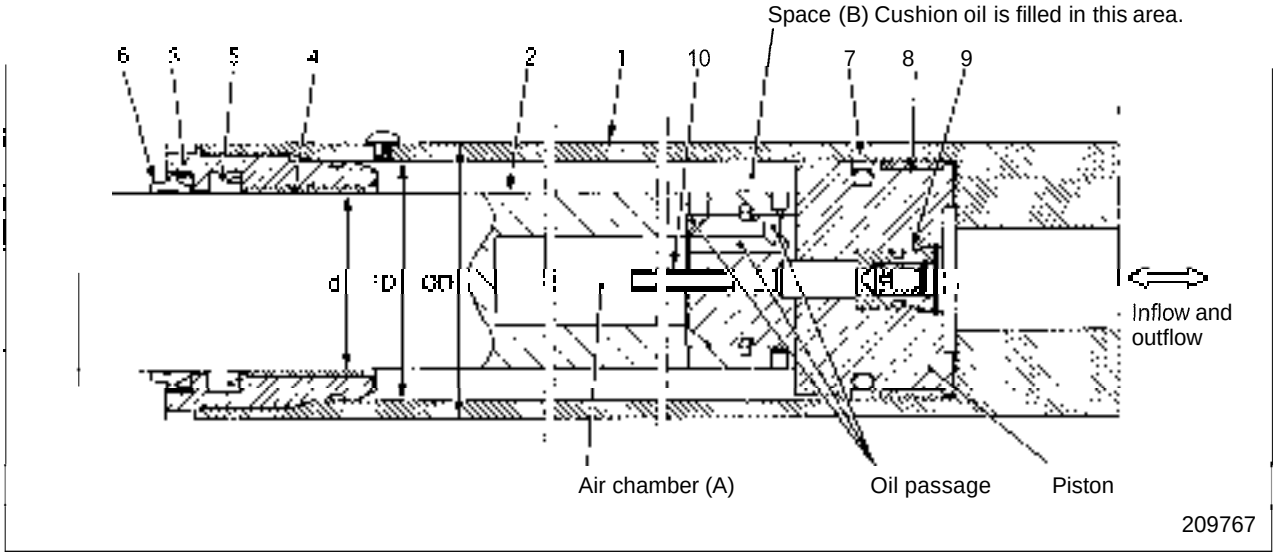
The piston starts to ascend.

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 no more impulsive.

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 leaked 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.

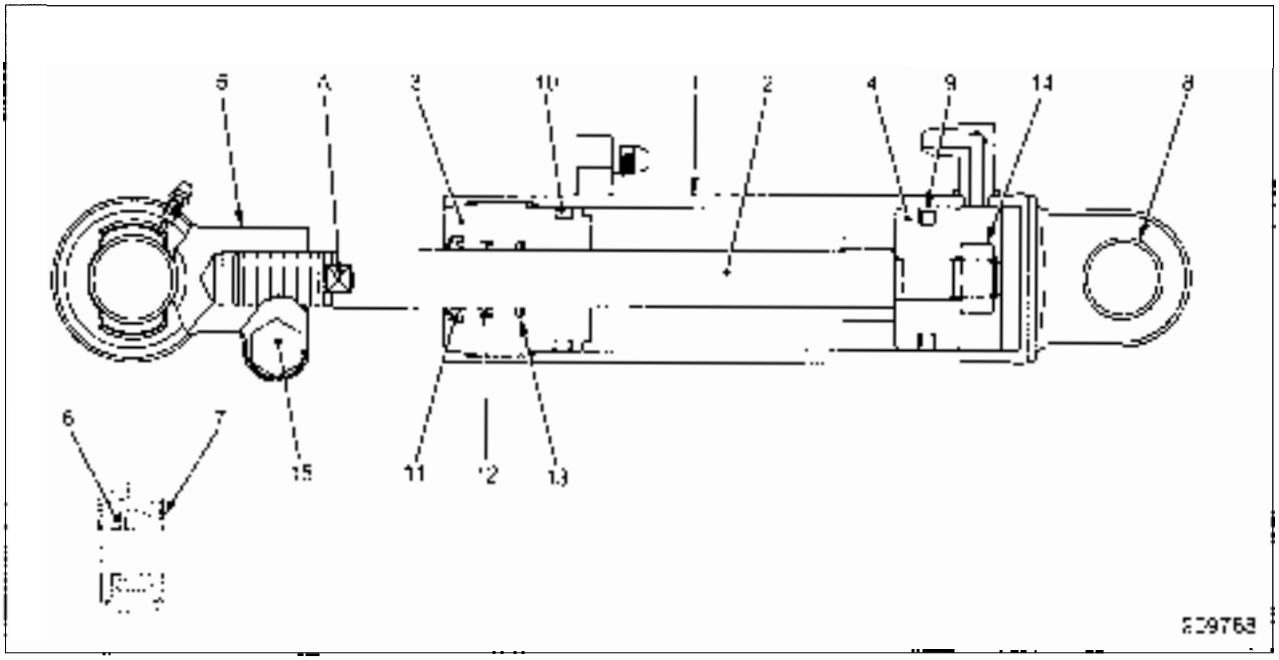
The stand tube always returns a certain amount of oil as cushion oil. A certain amount of cushioning oil must be filled in the overhauled cylinder.

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 imbalance 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 grease interval from the grease nipple. Installation of this seal has extended grease interval to 500 service hours.

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

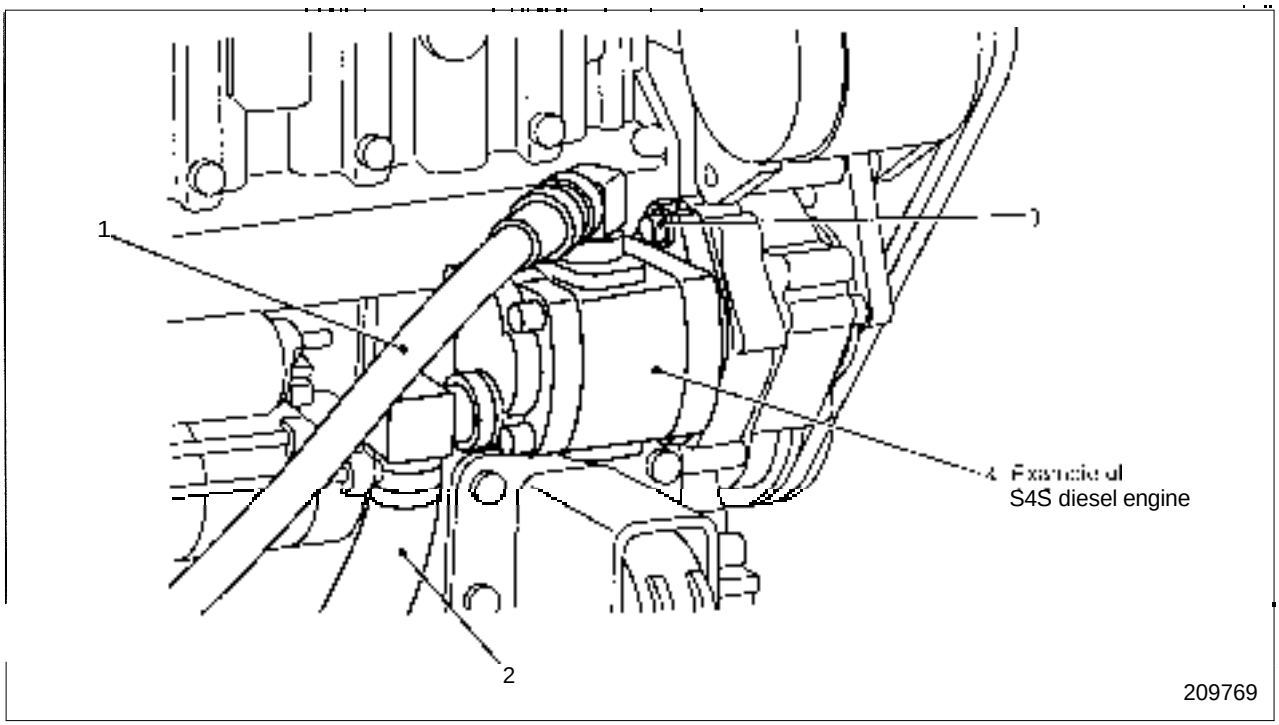
Unit: mm (in.)

Truck model	Rod diameter (d)	Cylinder inside diameter (ID)	Cylinder outside diameter (OD)
1 ton class	[illegible]	[illegible]	[illegible]
2 ton class	[illegible]	[illegible]	[illegible]
3 ton class	[illegible]	[illegible]	[illegible]

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 cloths in preparation for spilled oil.

(3) Take care not to allow foreign particles to enter the pump and hose from detached parts.

Installation

To install, follow the reverse of removal sequence, and do the following steps:

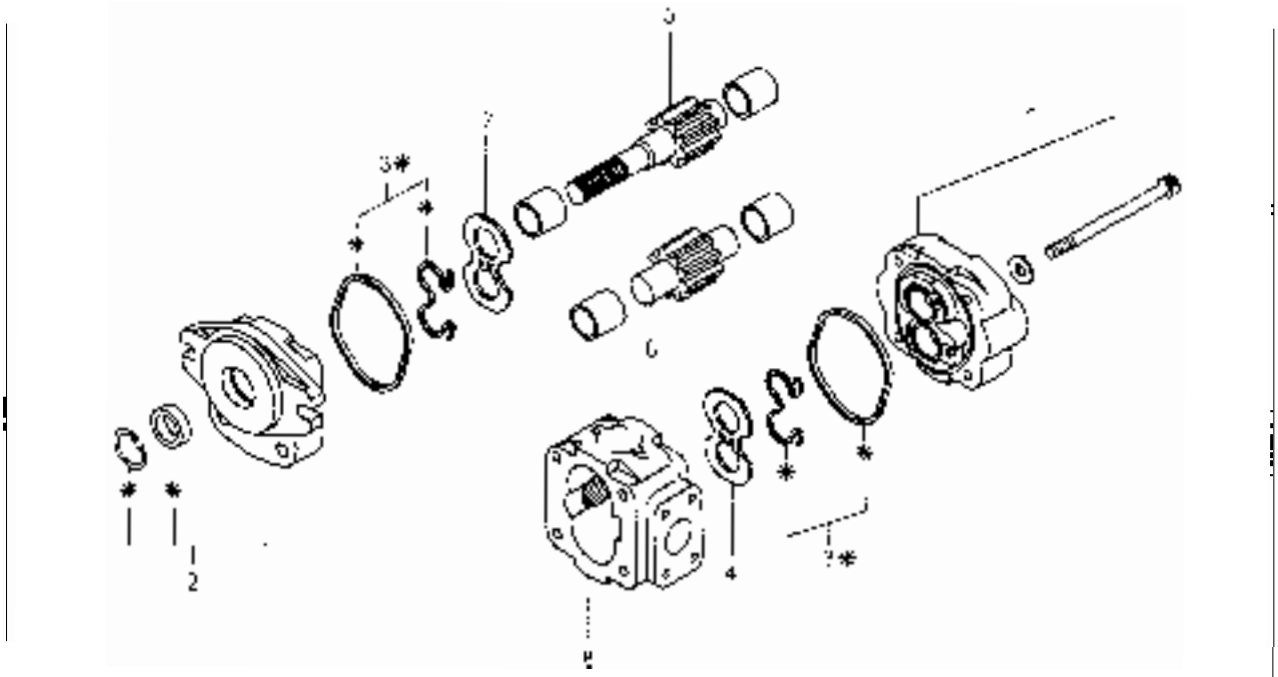
(1) Apply grease to the spline of the pump shaft before installation.

(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 11-16.

Disassembly and Reassembly

Disassembly



Parts marked with ✻ are components of the seal kit.
Parts not marked with ✻ are non-deliverable parts.

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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 warranty claims.

(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

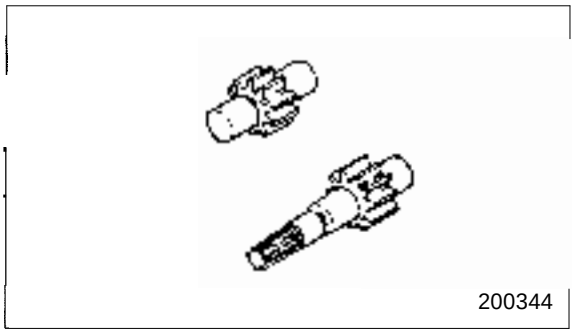
(1) Check the gear teeth for wear, chipping or other defects.

(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 11-33 "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 ן׳דוי 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.

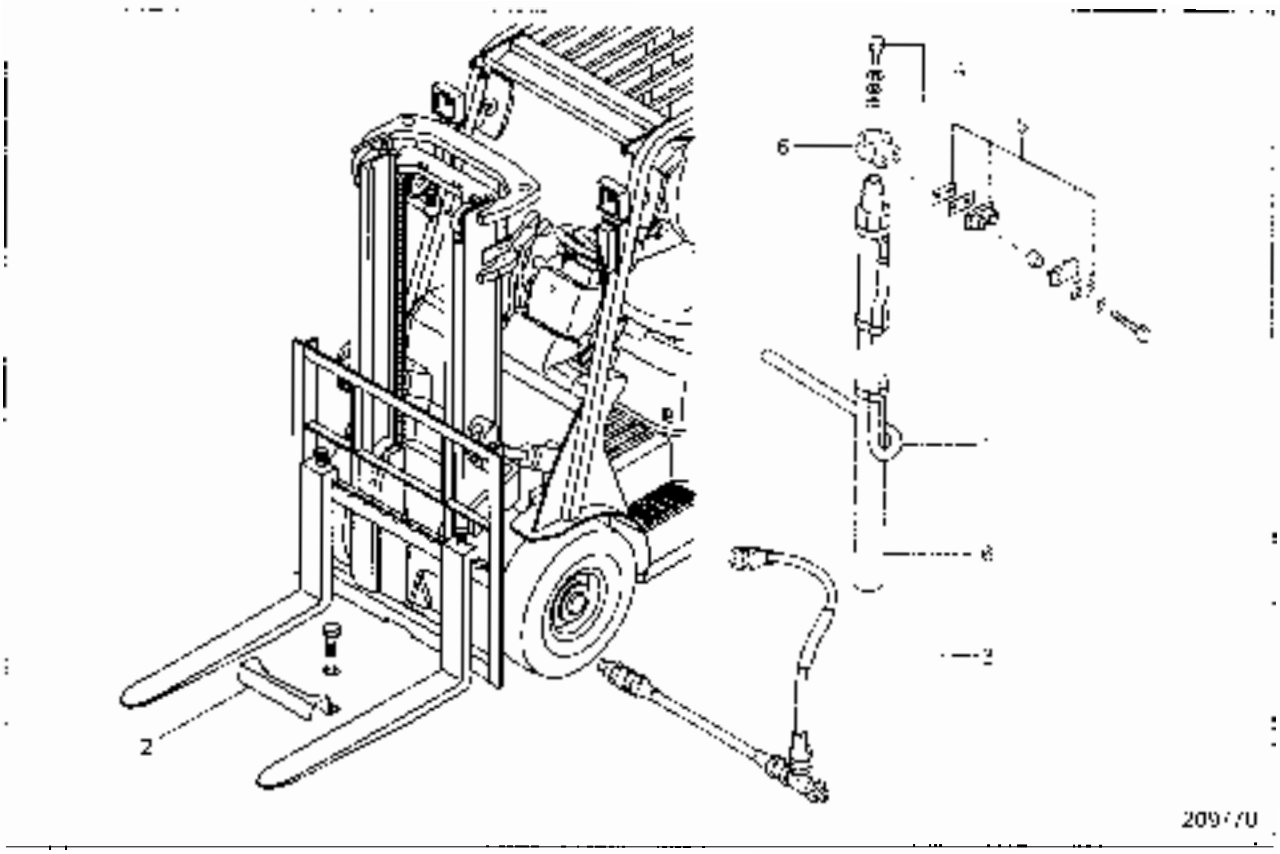
(5) Measure the lifting speed of the fork under no load. If the speed is to the specified value, the pump discharge volume is normal.

(6) Check that the fork operates normally by raising and lowering it under load.

Lift Cylinder

Removal and Installation

Simplex mast



Sequence

1 Hose guard
2 Return hose (if equipped)
3 High-pressure hose
4 Set bolt, Shim
5 Cylinder clamp (Cushion, Collar, Shim)
6 Lift cylinder, Bracket

Suggestions for Removal

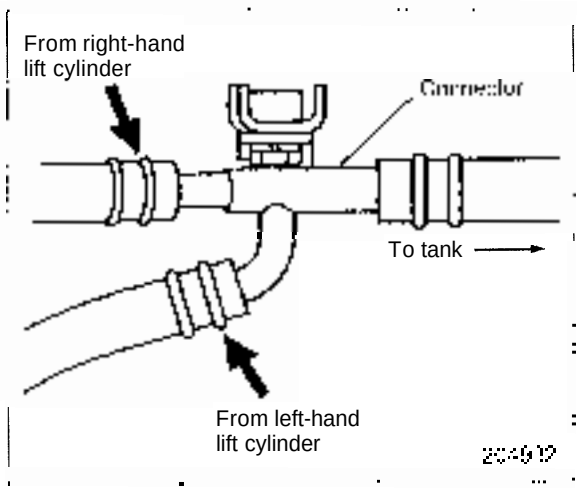
1. Removal of hose guard

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.

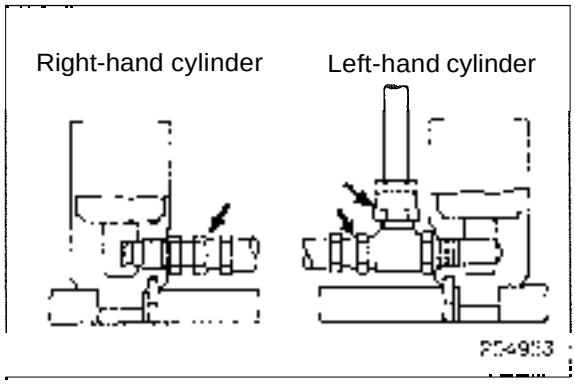


3. Lowering of lift bracket

Gently operate the lift lever to lower the lift bracket.

4. Disconnecting high-pressure hoses

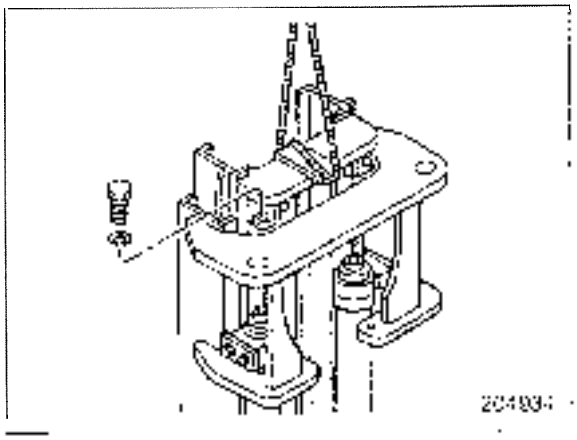
Disconnect the high-pressure hoses at the joints indicated by arrows. Use a drip pan to catch oil flowing out of the hoses.



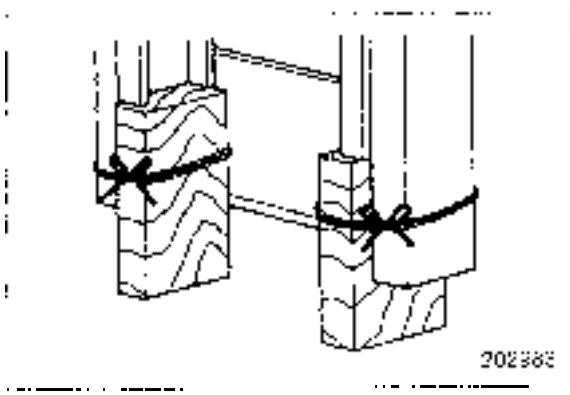
5. Removing set bolts

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.

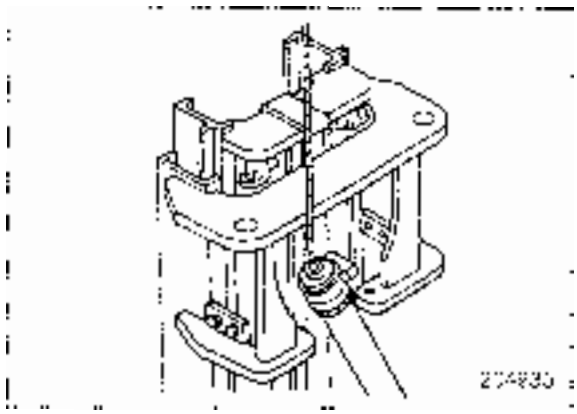


2) Tie wood blocks under the inner mast and detach the sling. Use the blocks strong enough to support the mast.



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.



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.

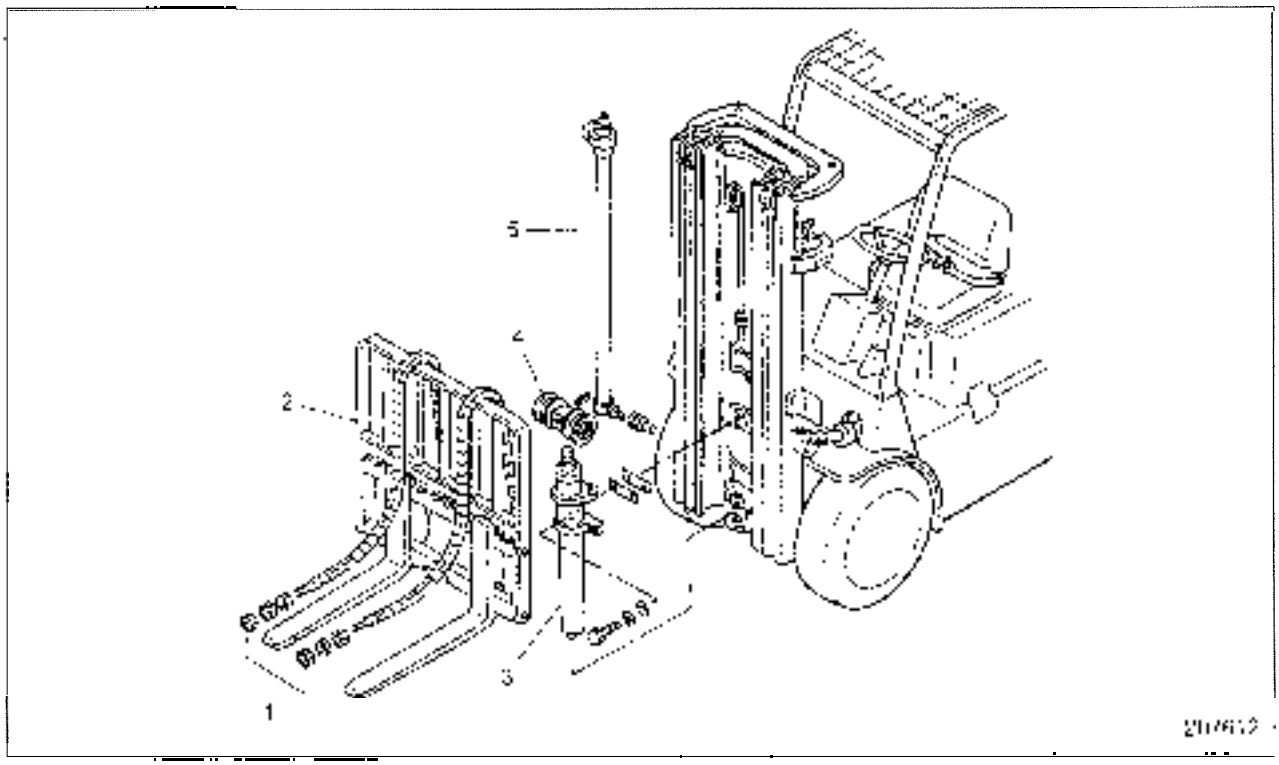
(2) Check the oil level in the hydraulic tank with an oil level gauge. (Refer to the topics "Hydraulic Tank" in the following section "Inspection and Adjustment.")

(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 12 MAST AND FORKS.")

Duplex and triplex mast removal

Note that the triplex mast is used as an example.



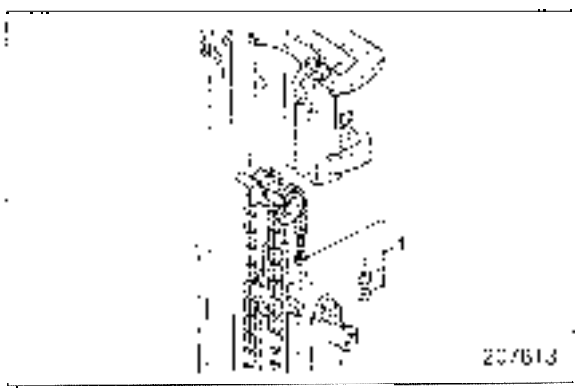
Sequence

1 Nuts
2 Lift bracket assembly
3 First lift cylinder
4 Chain wheel support assembly
5 Second lift cylinder

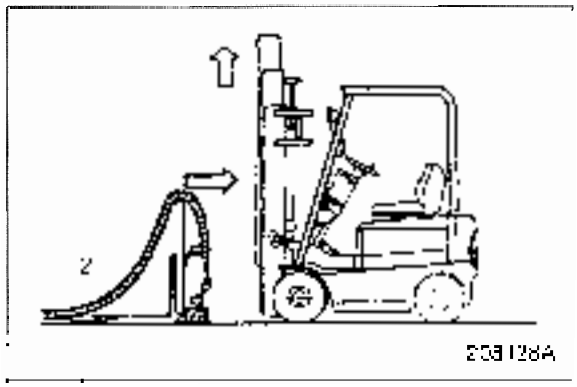
Suggestions for Removal

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.



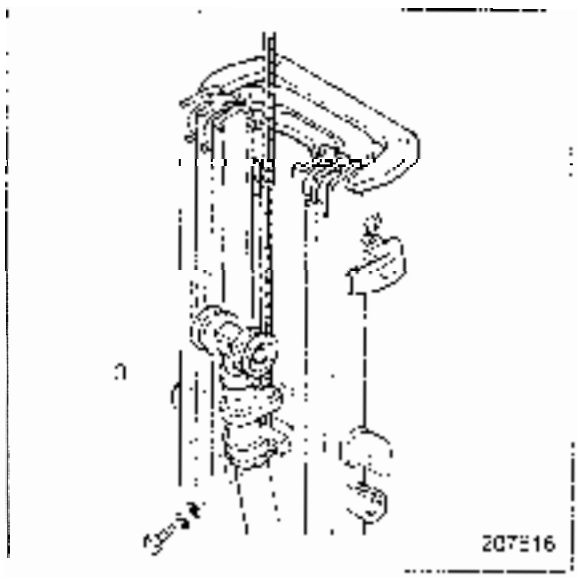
(2) Position the mast upright. Raise the inner mast until upper rollers 8 of the lift bracket become free. Then, slowly move the truck in reverse to separate from lift bracket 2.



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.

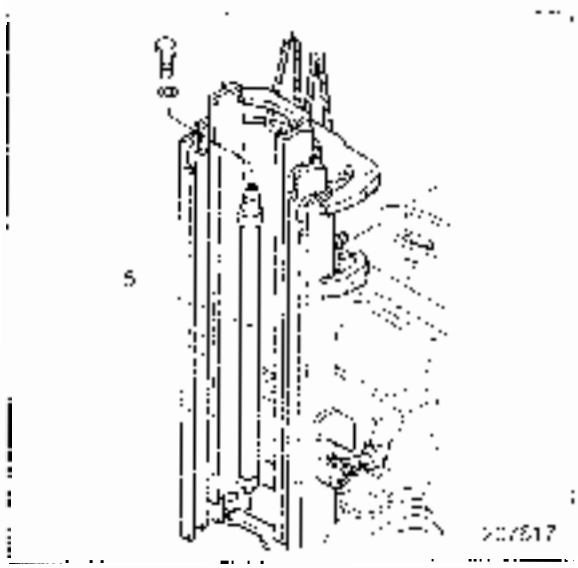
(2) Remove lift cylinder connecting bolts and mounting bolts, and gently remove the first lift cylinder 3.



3. Removing second lift cylinders 5

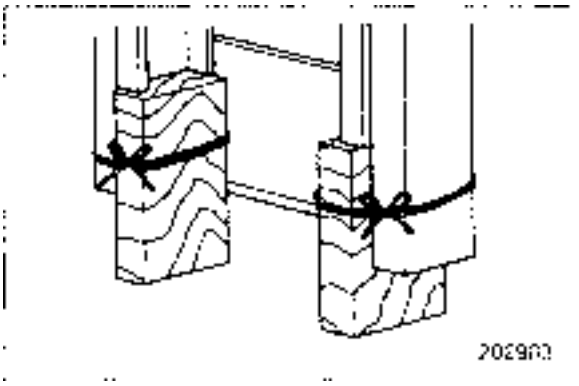
(1) Disconnect hoses from the second lift cylinders 5.

(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.



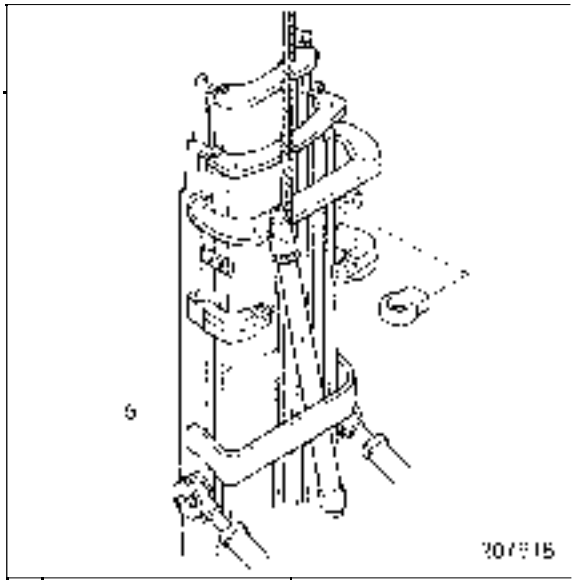
(3) Place wood blocks under the inner mast (for duplex mast) or middle mast (for triplex mast).

Make sure the right and left wood blocks are the same in height.



(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.



Installation

To reinstall, follow the removal sequence in reverse, and do the following steps:

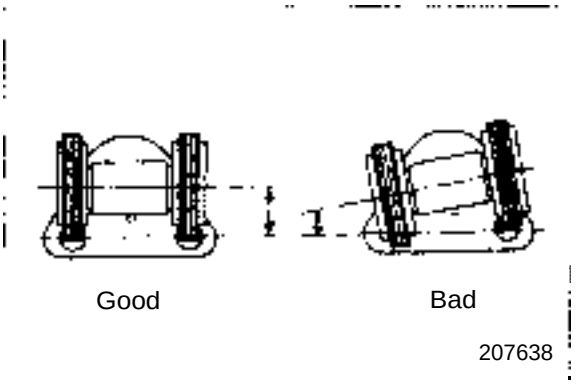
(1) Install chain wheel support assembly 4 parallel to a line connecting the centers of chain anchor bolt holes on first lift cylinder 3 to prevent chains from twisting.

(2) Adjust the chain tensions.

(Refer to "Chain Tension Inspection" on page 12-33.)

(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.

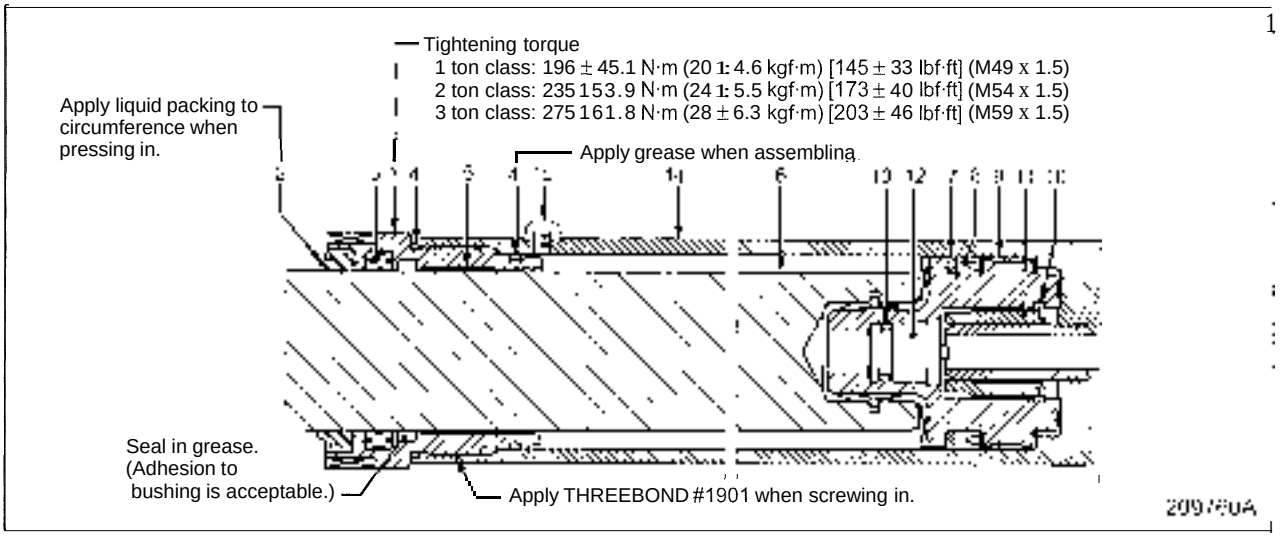
(4) After proper operation is confirmed, check the oil level.



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 11-7.

Suggestions for Disassembly

Pulling out piston

Be careful not to damage the piston seals and cylinder bore 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.

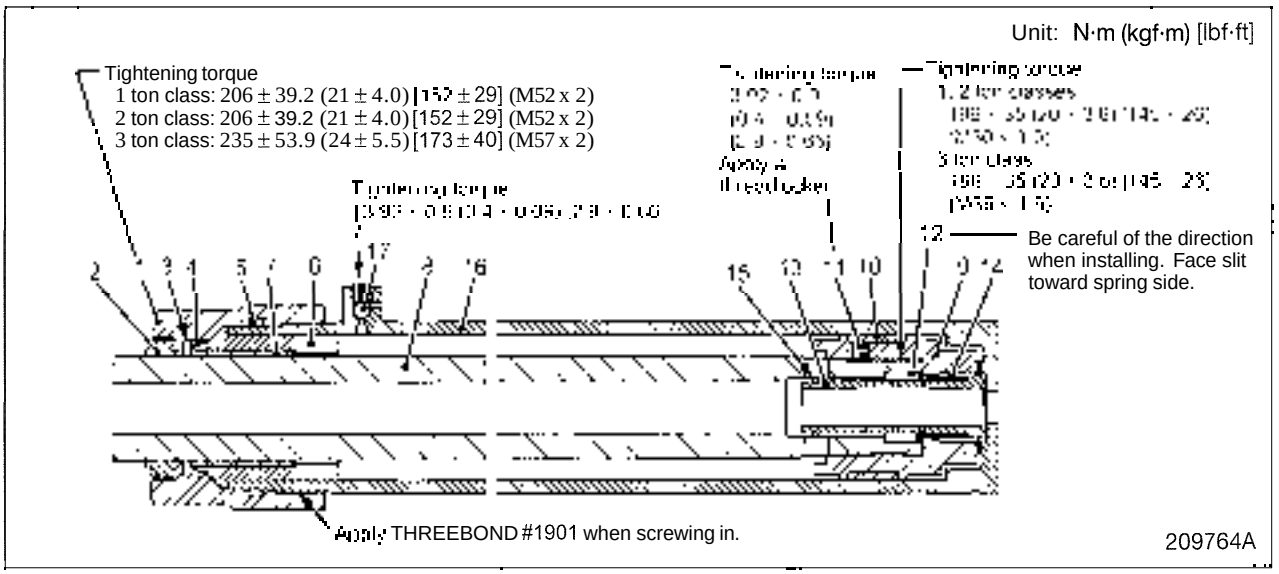
(2) Apply hydraulic oil to the bore surface of cylinder and also to the piston seal, O-ring, backup ring, buffer ring, packing and dust seal.

(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:

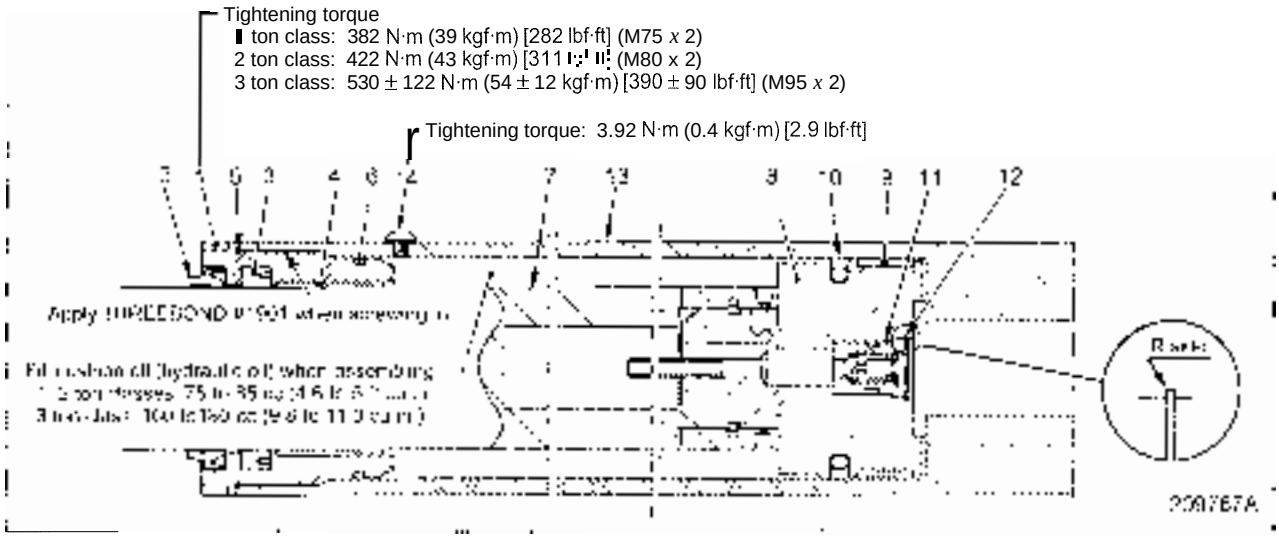
(1) Clean the disassembled parts with high flash-point solvent. Blow them dry with compressed air; however, this does not apply to rubber parts.

(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

(I) Check the rod for deflection.

(2) Check for surface flaws such as grooving, scratching, rusting or wear.

3. Rings, packings and threads

(I) 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.

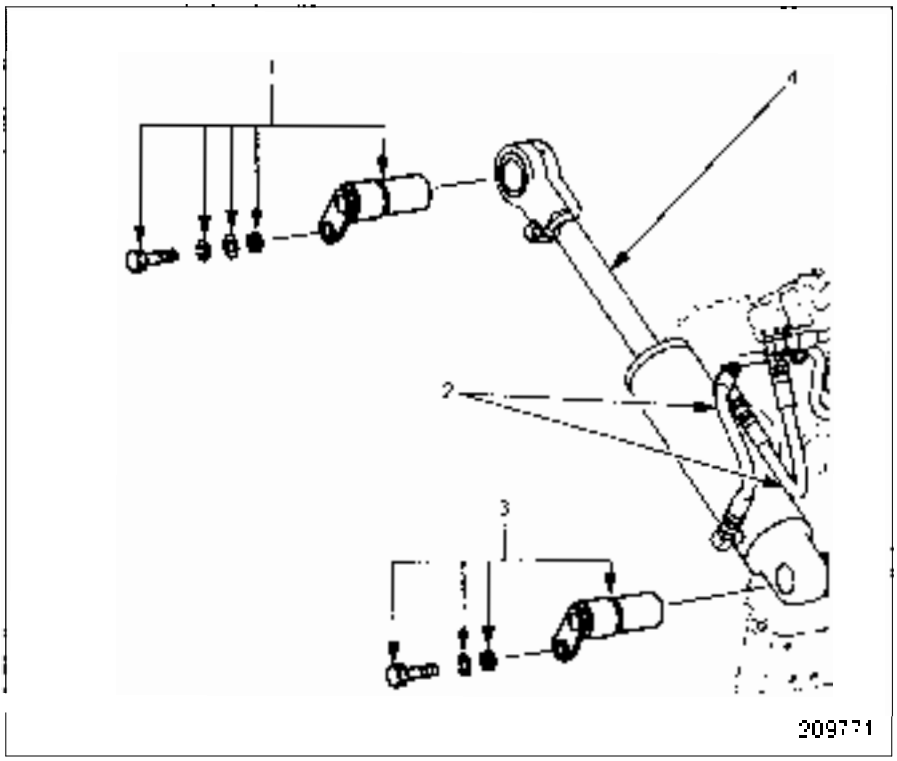
(4) Fill hydraulic oil as cushion oil in the space between the tube and rod before reassembling the cylinder head.

(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 carrier 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.

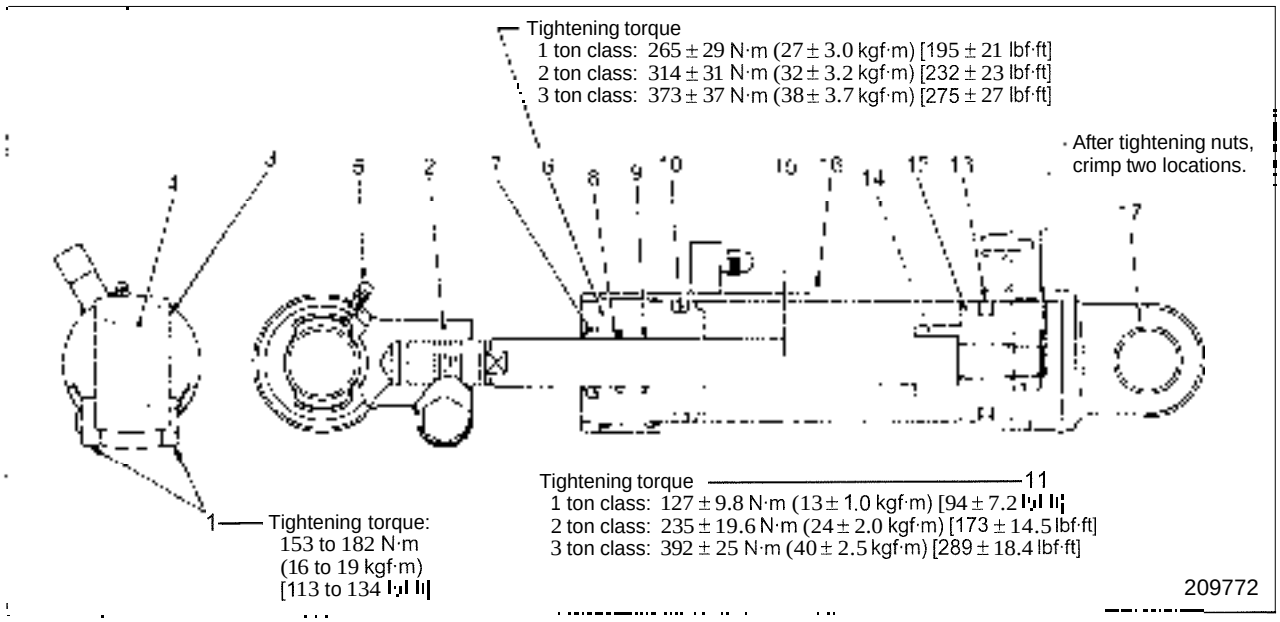
Installation

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 "Tilt Angle Adjustment (all mast models)" 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.

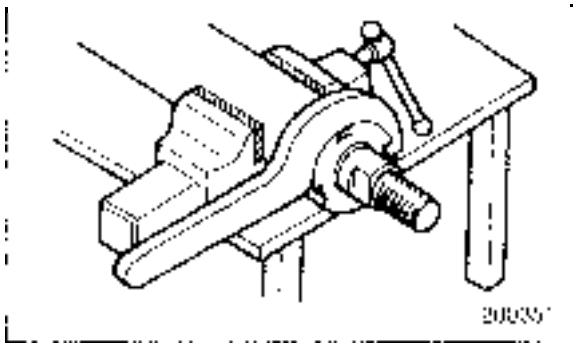
(c) Do not disassemble the piston and nuts unless abnormality, is found on inspection.

Suggestions for Disassembly

Removing bushing

(I) 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 damage the buffer ring, packing, O-ring against the threads of the piston rod.



Inspection after disassembly

1. Cylinder tube

(I) 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

(I) 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.

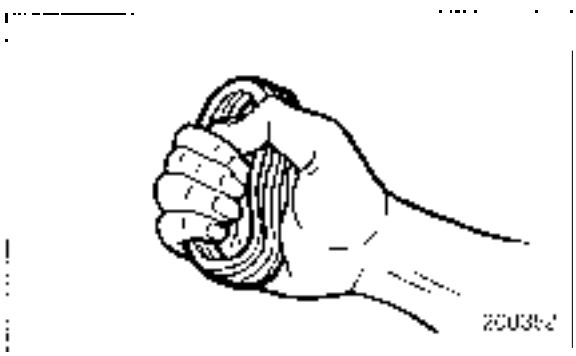
(3) When clamping the cylinder tube in the vise , be careful not to distort the tube.

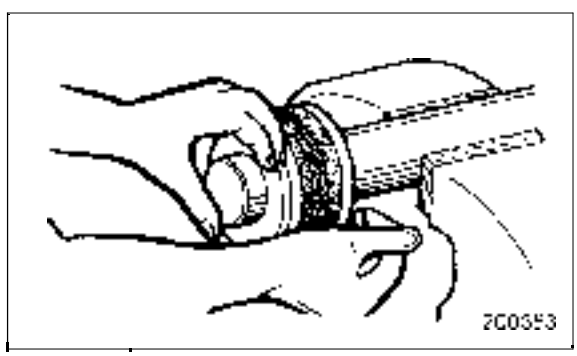
(4) Install the piston seal as follow:

(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.

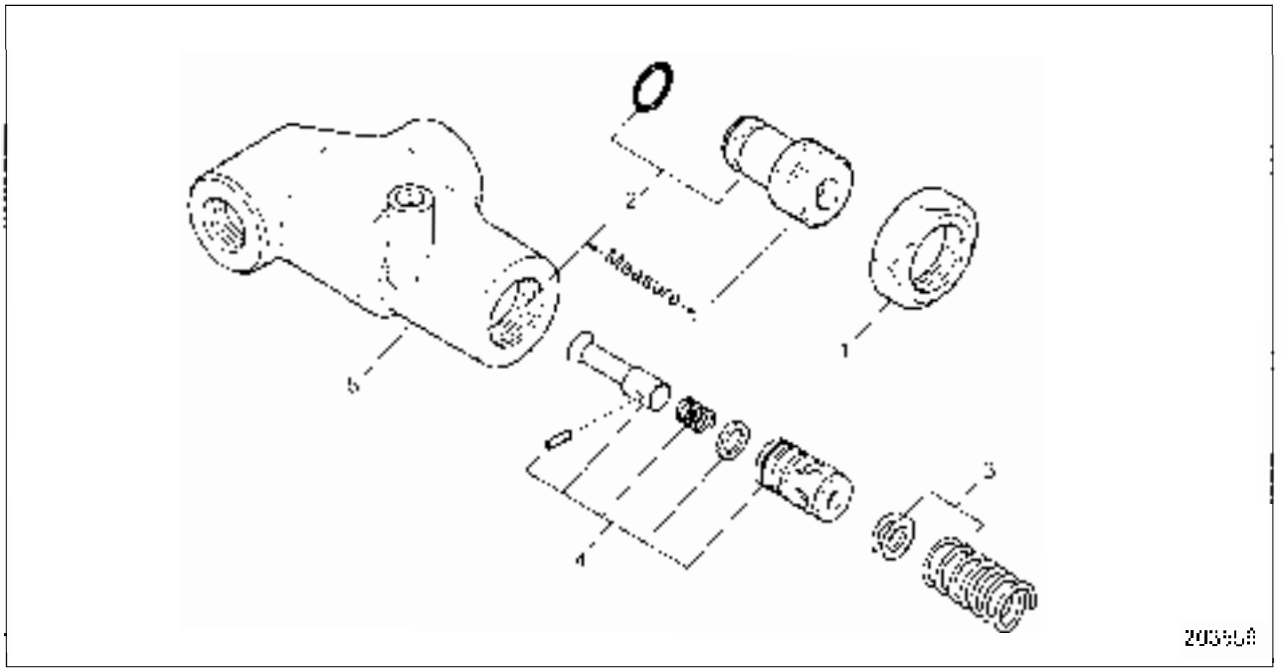




Flow Regulator Valve (Installed on trucks with FC control valve only)

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.

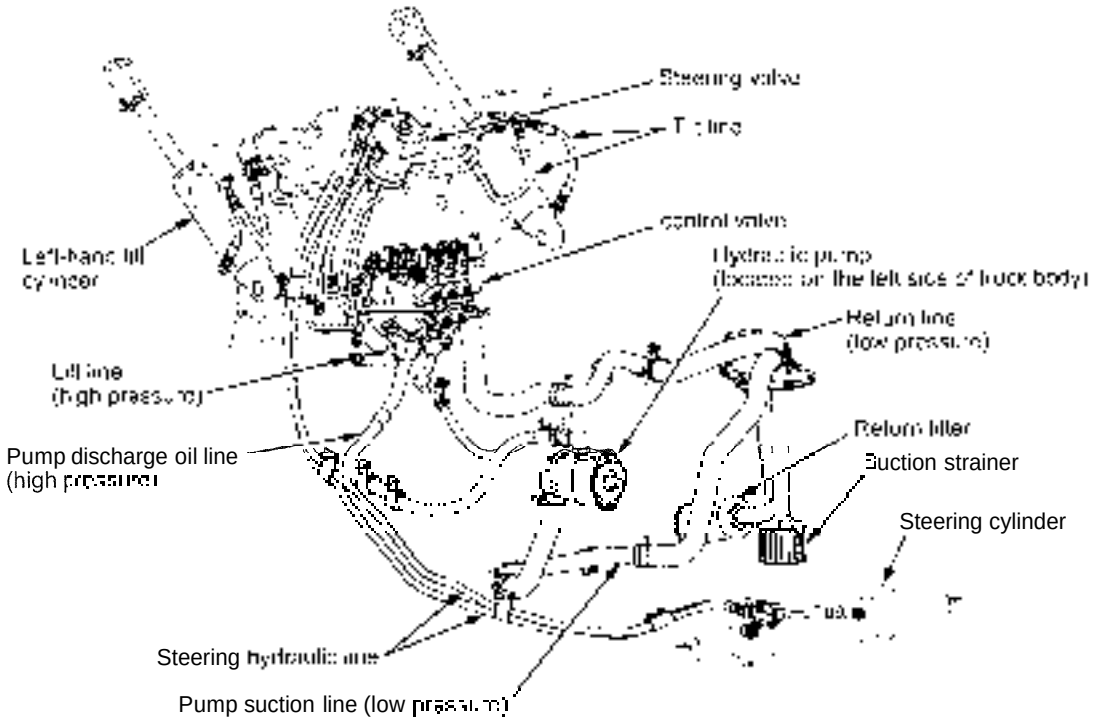
Reassembly

To reassemble, follow the reverse of disassembly sequence.

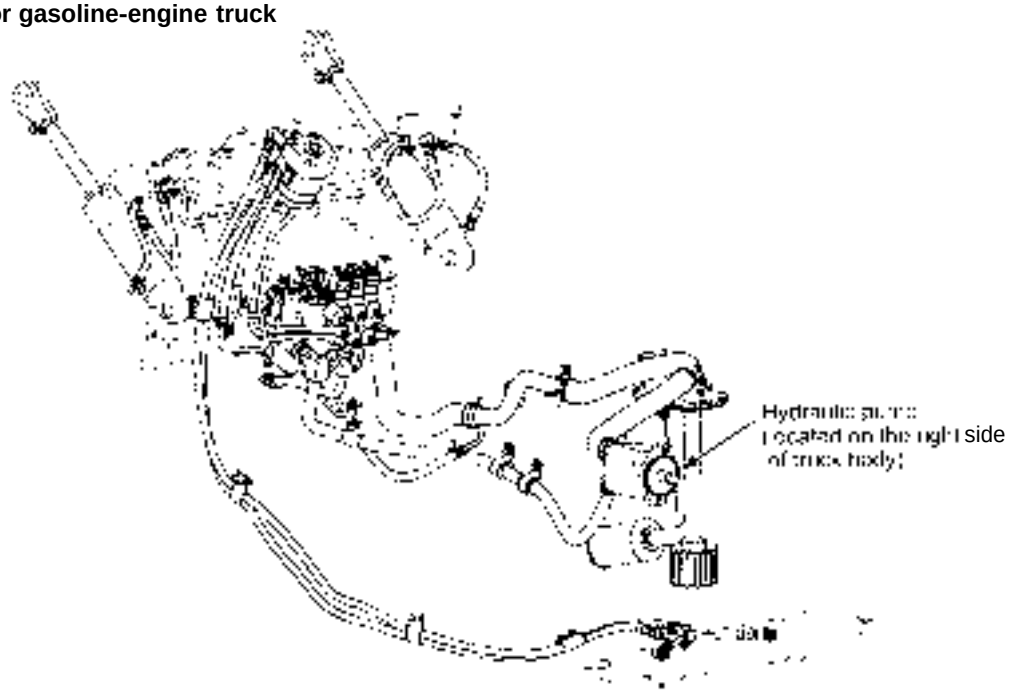
Piping

(For piping around the mast, refer to "GROUP 12 MAST AND FORKS.")

1. Piping for diesel-engine truck

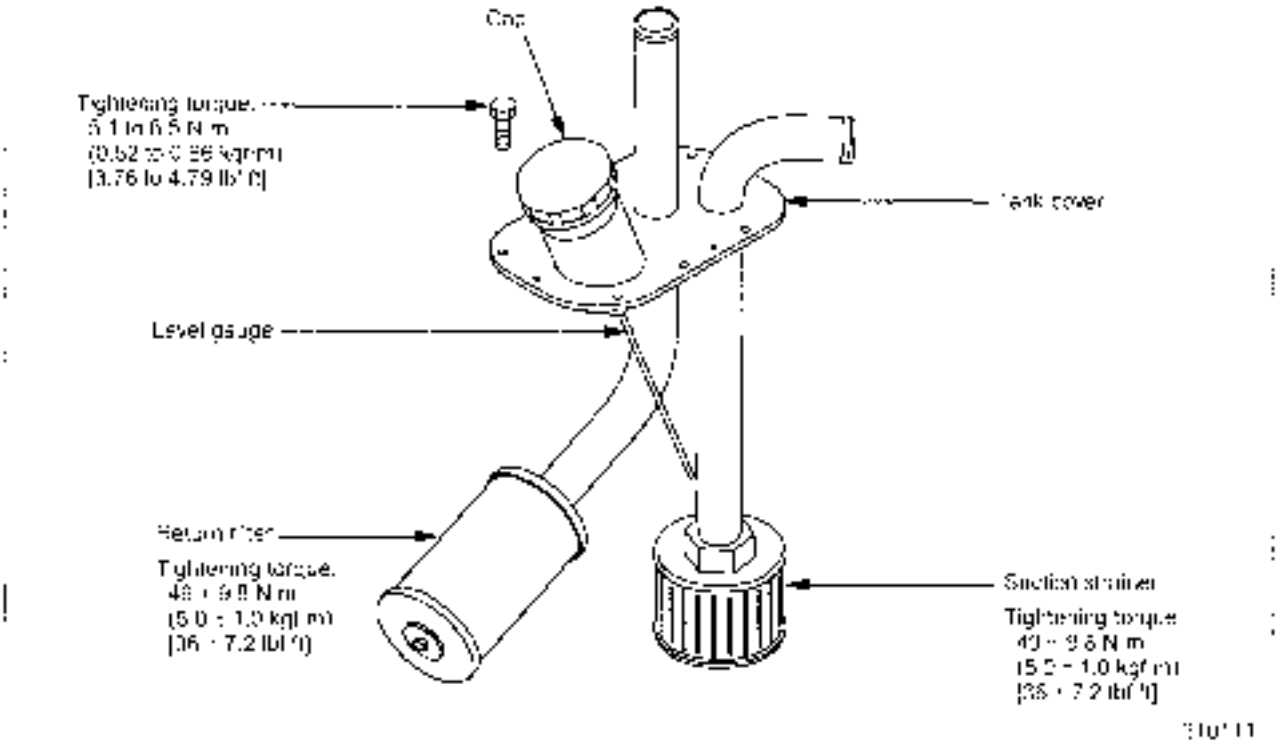


2. Piping for gasoline-engine truck



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, observing 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.

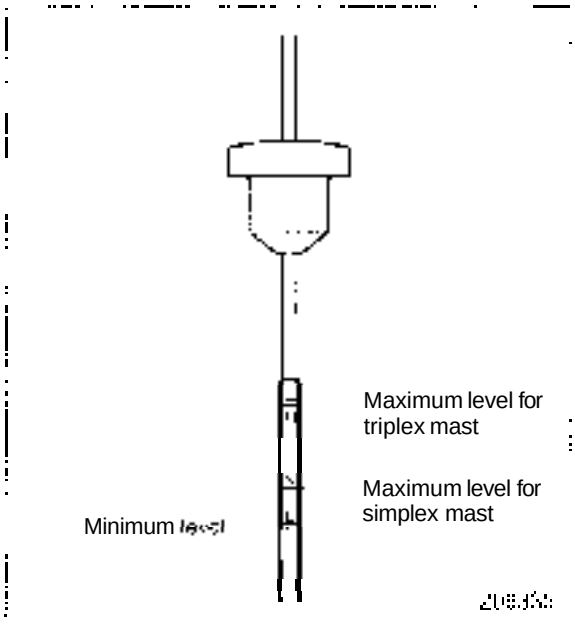
(3) Method of filling hydraulic tank with oil

- 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 11-31 "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/cm²) [3555 psi] to the delivery hose connector. Use the gauge, connectors and hose used for testing the gear pump.

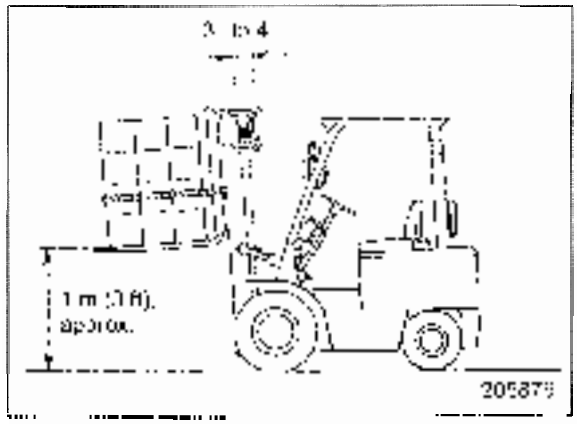
(b) Start the engine and run it at the maximum speed. Move the tilt control lever to the backward tilt position. If the pressure is relieved at 18142 $^{+490}_{0}$ kPa (185 $^{+5}_{0}$ kgf/cm²) [2631 psi] when the tilt cylinders reach the end of their stroke, the main relief valve setting is correct.

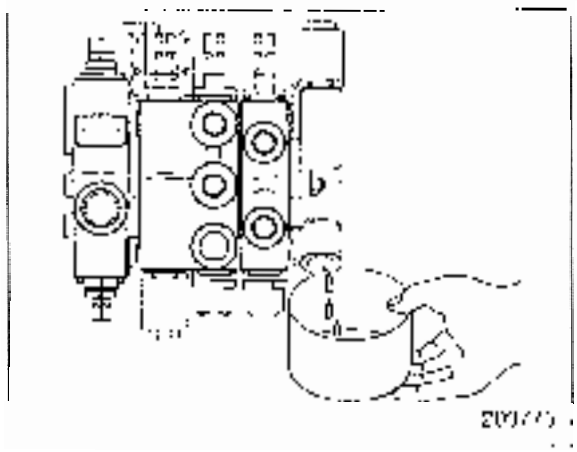
(c) If the setting is incorrect, loosen the lock nut of adjusting screw and, while observing the pressure gauge reading, slowly rotate the adjusting screw until the gauge indicates the prescribed set value.

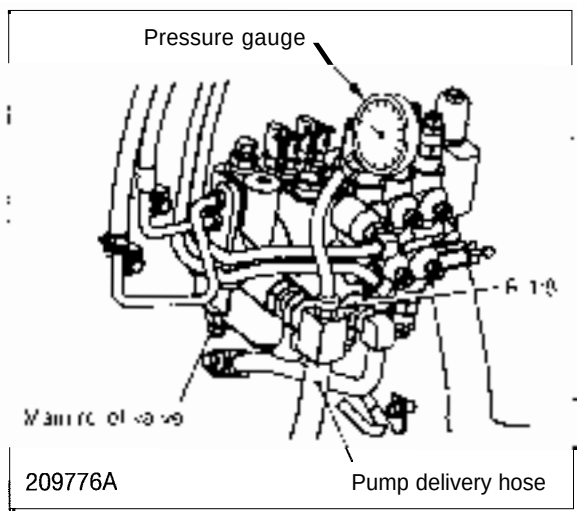
(d) While holding the adjusting screw, tighten the lock nut to secure the adjusting screw.

(e) After securing the adjusting screw, recheck the setting.

Main relief valve setting	(185 $^{+5}_{0}$ kgf/cm²) [2631 psi]







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

(4) Adjustment of steering system relief valve

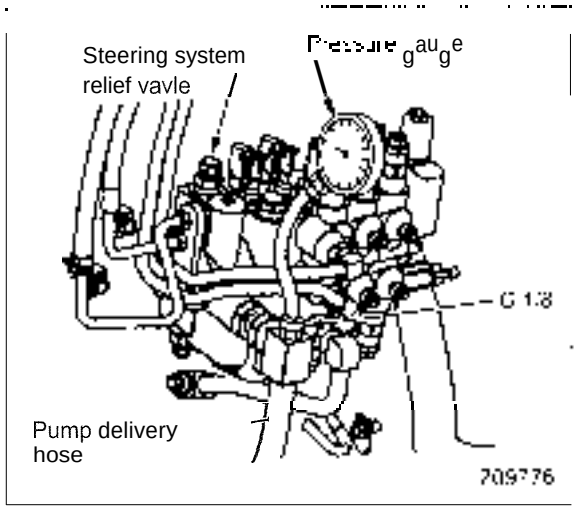
(a) Attach a pressure gauge capable of measuring up to 25000 kPa (250 kgf/cm²) [35.55 psi] to the pump delivery hose connector (illustration on the right).

(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.



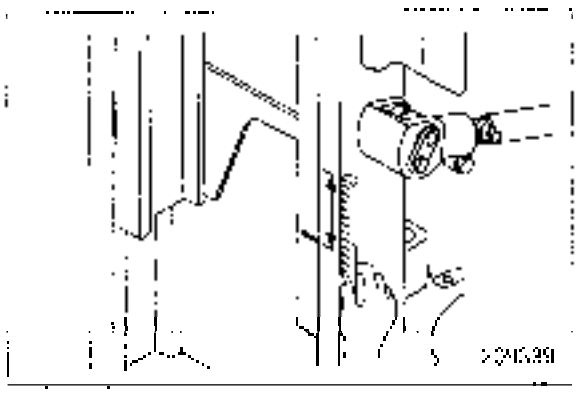
Unit: kPa (kgf/cm²) [psi]

Item \ Truck Model	1 ton class	2, 3 ton classes
Set pressure of steering system relief valve	8800 (90 $^{+5}_{0}$) [1276 $^{+71}_{0}$]	10300 (105 $^{+5}_{0}$) [1494 $^{+}$]

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.

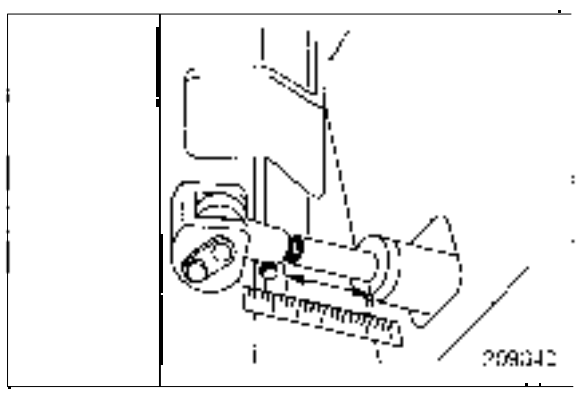


Descent (retraction of piston rods) with rated load for 15 minutes	50 mm (2 in.) maximum

4. Forward tilt test

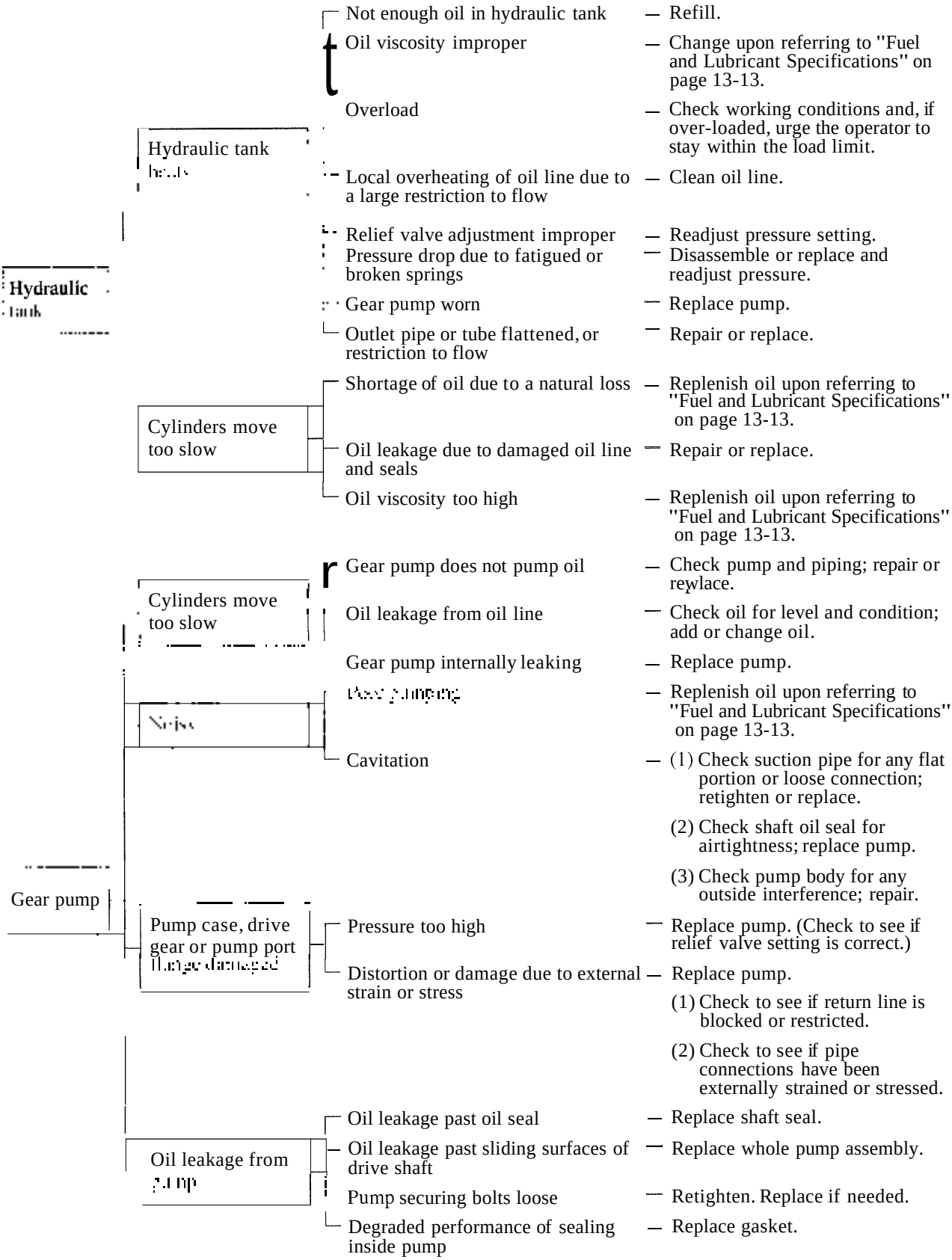
(1) Pick up a load equal to the rated capacity, place the mast to a vertical position, lift the fork about 50 cm (20 in.), and stop the engine.

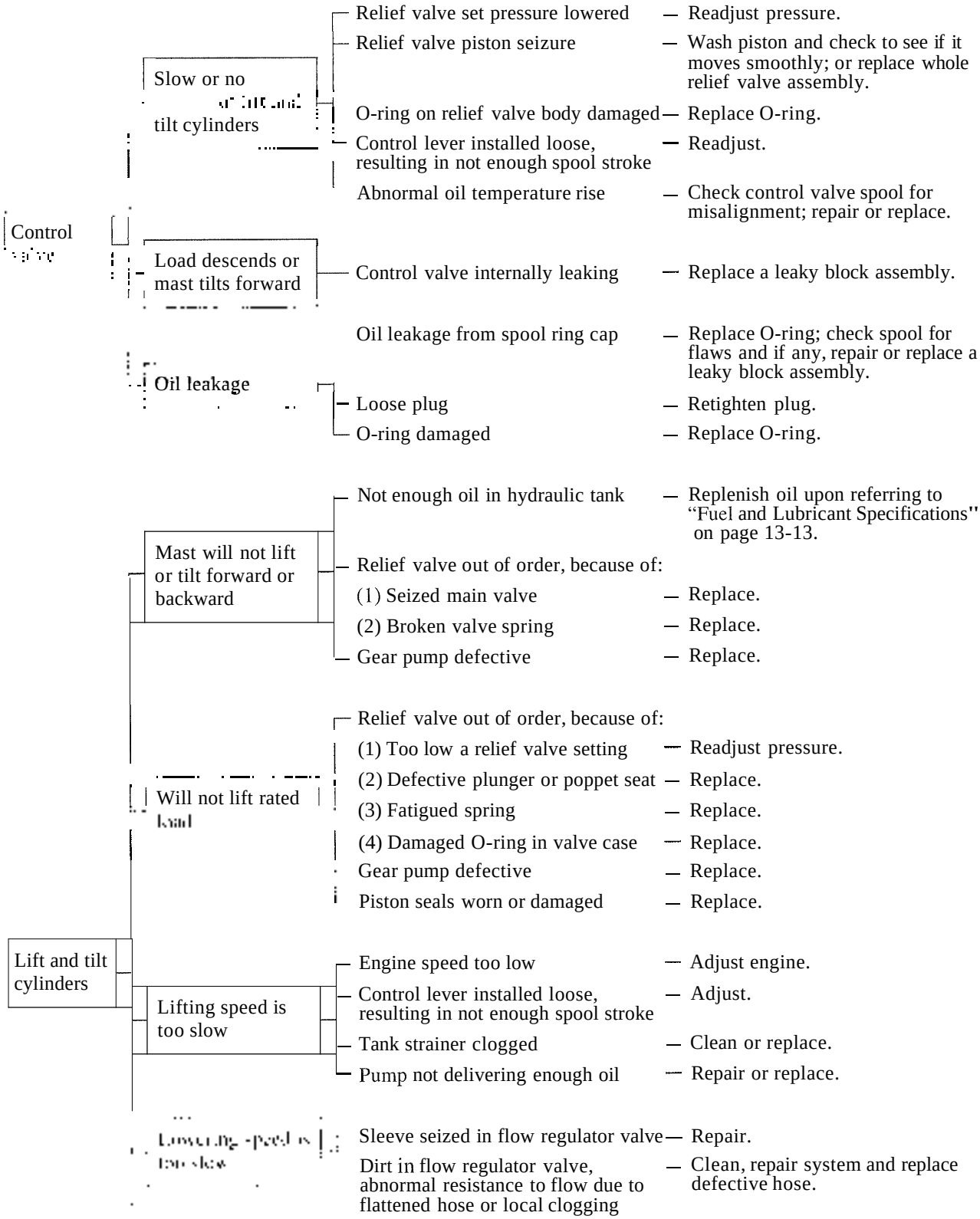
(2) Measure the extension of tilt cylinder piston rod for 15 minutes.

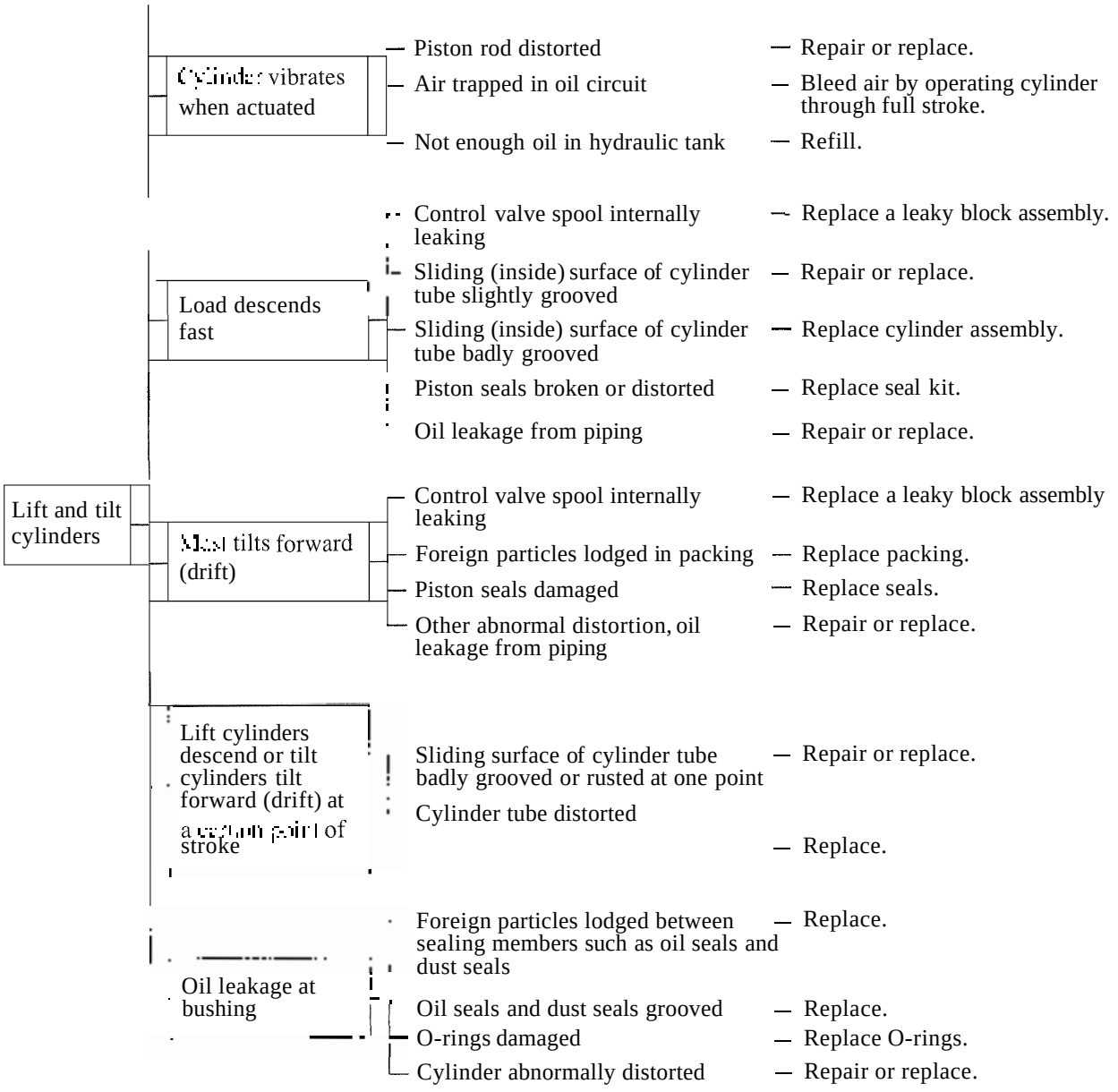


Amount of forward tilt (extension of piston rods) with rated load for 15 minutes	20 mm (0.8 in.) maximum

Troubleshooting







Service Data

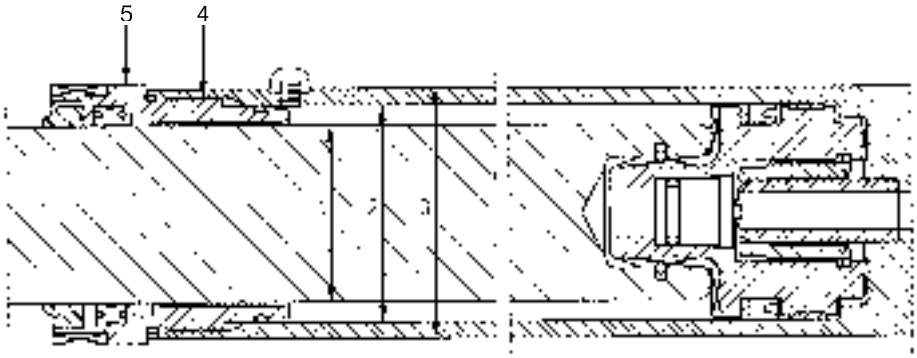
A: Standard value
Unit: mm (in.)

Items	Truck Models			
Forward tilt angle (standard truck with simplex mast) degrees	A	6		
Backward tilt angle (standard truck with simplex mast) degrees	A	12		
Lift cylinder descent amount (at rated load) [Retracted length of rod, oil temperature at 45°C (113°F)] mm (in.)/15 min.	A	50 (2) or less		
Tilt cylinder forward tilt amount (at rated load) [Extended length of rod, oil temperature at 45°C (113°F)] mm (in.)/15 min.	A	20 (0.8) or less		
Main relief valve setting MPa (kgf/cm²) [psi]	A	18.1 $^{+0.5}_{0}$ (185 [2635 $^{+725}_{0}$]		
Steering system relief valve setting MPa (kgf/cm²) [psi]	A	8.8 $^{+0.5}_{0}$ [1276]	10.3 (105 $^{+5}_{0}$) [1494 $^{+71}_{0}$]	10.3 $^{+0.5}_{0}$ (105 $^{+5}_{0}$) [1494 $^{+71}_{0}$]
Hydraulic pump (gear pump) Manufacturer		SHIMADZU CORPORATION		
Hydraulic pump (gear pump) Manufacturer's model name		SGP1 type single gear pump		
Manufacturer of control valves		SHIMADZU CORPORATION		
Tightening torque of return filter N·m (kgf·m) [lbf·ft]	A	49 ± 9.8 (5.0 ± 1.0) [36 ± 7.2]		
Tightening torque of suction strainer N·m (kgf·m) [lbf·ft]	A	[illegible]		

A: Standard value
Unit: mm (in.)

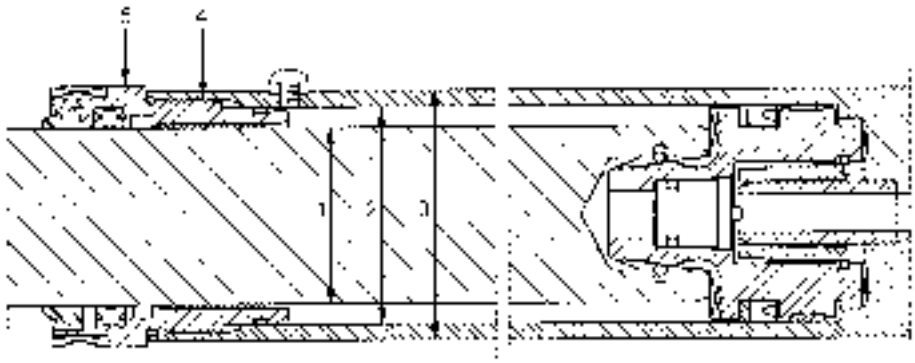
Items	Truck Models		1 ton class	2 ton class	3 ton class
Second cylinder for simplex mast and triplex mast	Rod outside diameter 1	A	35 (1.38)	40 (1.57)	45 (1.77)
	Cylinder inside diameter 2	A	[illegible]	[illegible]	[illegible]
	Cylinder outside diameter 3	A	52 (2.05)	57 (2.24)	63 (2.48)
	Thread size 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) [175 ± 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



209763

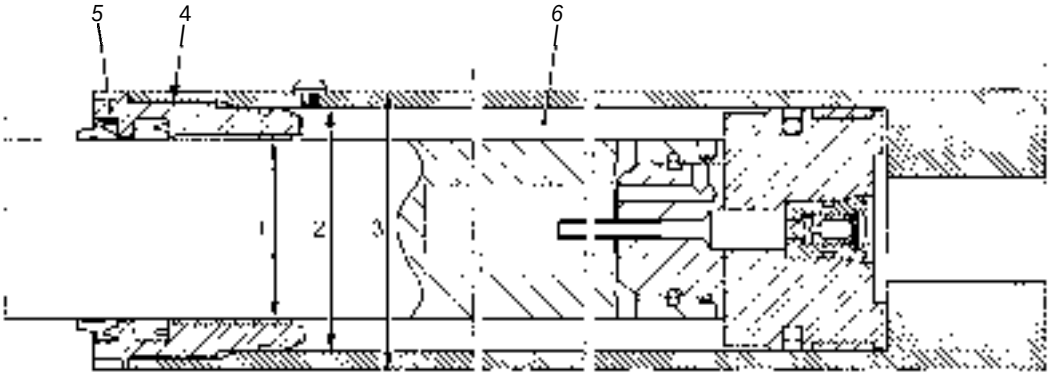
■ Simplex mast with raised height of 3.5 m (11.5 ft) or higher



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		[illegible]	[illegible]	[illegible]
	Cylinder inside diameter 2	A		70 (2.76)	75 (2.95)	90 (3.54)
	Cylinder outside diameter 3	A		[illegible]	[illegible]	[illegible]
	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)



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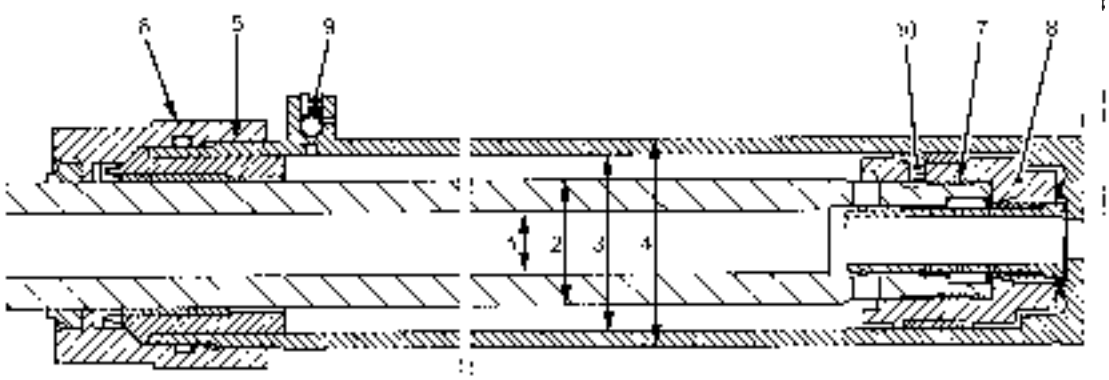
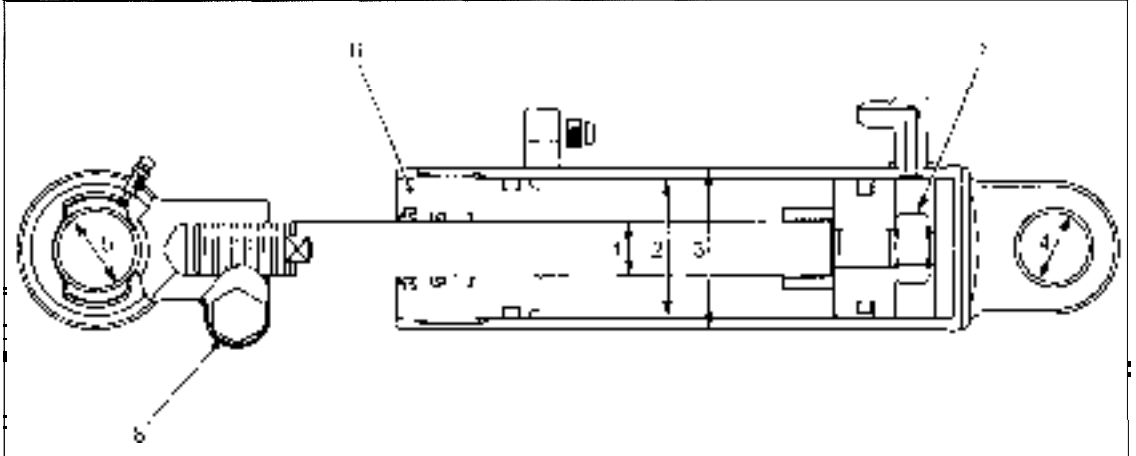
A: Standard value
Unit: mm (in.)

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 (2 1 4 0) [± 29]	206 ± 39.2 [± 29]	235 ± 53.9 [± 40]
	Thread size of piston 7	A	M30	M33	M36
	Tightening torque of piston 8 N·m (kgf·m) [lbf·ft]	A	196 ± 35 [145 ± 26]	196 ± 35 [145 ± 26]	196 ± 35 [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 ± 0.661	3.92 (0.4 ± 0.09) [2.9 ± 0.661	3.92 (0.4 ± 0.09) [2.9 ± 0.661



20876aG

A: Standard value
Unit: mm (in.)

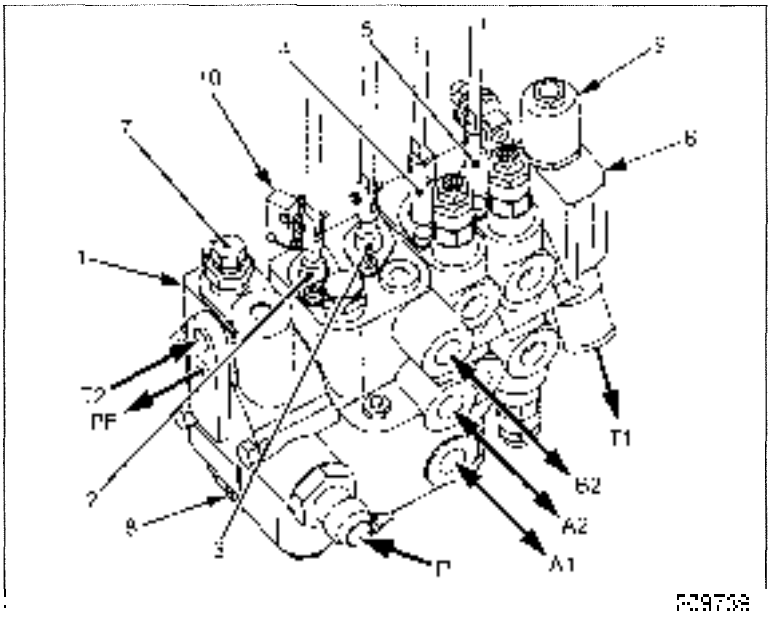
Items		Truck Models		1 ton class	2 ton class	3 ton class
Tilt cylinder	Rod outside diameter 1		A	25 (0.98)	30 (1.18)	35 (1.38)
	Cylinder inside diameter 2		A	63 (2.48)	70 (2.76)	80 (3.15)
	Cylinder outside diameter 3		A	73 (2.87)	82 (3.23)	93 (3.66)
	Bushing inside diameter on head side 4		A	$32^{+0.00335}_{0}$ ($1.26^{+0.00335}_{0}$)	$32^{+0.00335}_{0}$ ($1.26^{+0.00335}_{0}$)	[illegible]
	Bushing outside diameter on rod side 5		A	$35^{0}_{-0.02}$ [illegible]	[illegible]	$35^{0}_{-0.02}$ [illegible]
	Tightening torque of guide bushing 6 N·m (kgf·m) [lbf·ft]		A	265 ± 29 (27 13.0) [± 21]	314 ± 31 [illegible] [232 1 23]	373 ± 37 (38 13.7) [275 ± 2.7]
	Tightening torque of nut 7 N·m (kgf·m) [lbf·ft]		A	127 ± 9.8 (13 ± 1.0) [illegible]	235 ± 19.6 (24 ± 2.0) [± 14.51	392 ± 25 (40 ± 2.5) [289 ± 18.41
	Tightening torque of tilt socket clamp bolt 8 N·m (kgf·m) [lbf·ft]		A	153 to 182 (16 ± 19) [± 134]	153 to 182 (16 ± 19) [± 134]	153 to 182 (16 ± 19) [± 134]
						

2097 00

Control Valve

Structure and Operation

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 (if equipped)

The above illustration shows an external view of the four-valve type control valve. Any one of the two-valve to five-valve type valves is installed on a truck depending on forklift specifications. The most basic valve configuration is a two-valve type, combination of the lift and tilt. Adding attachment valves 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.

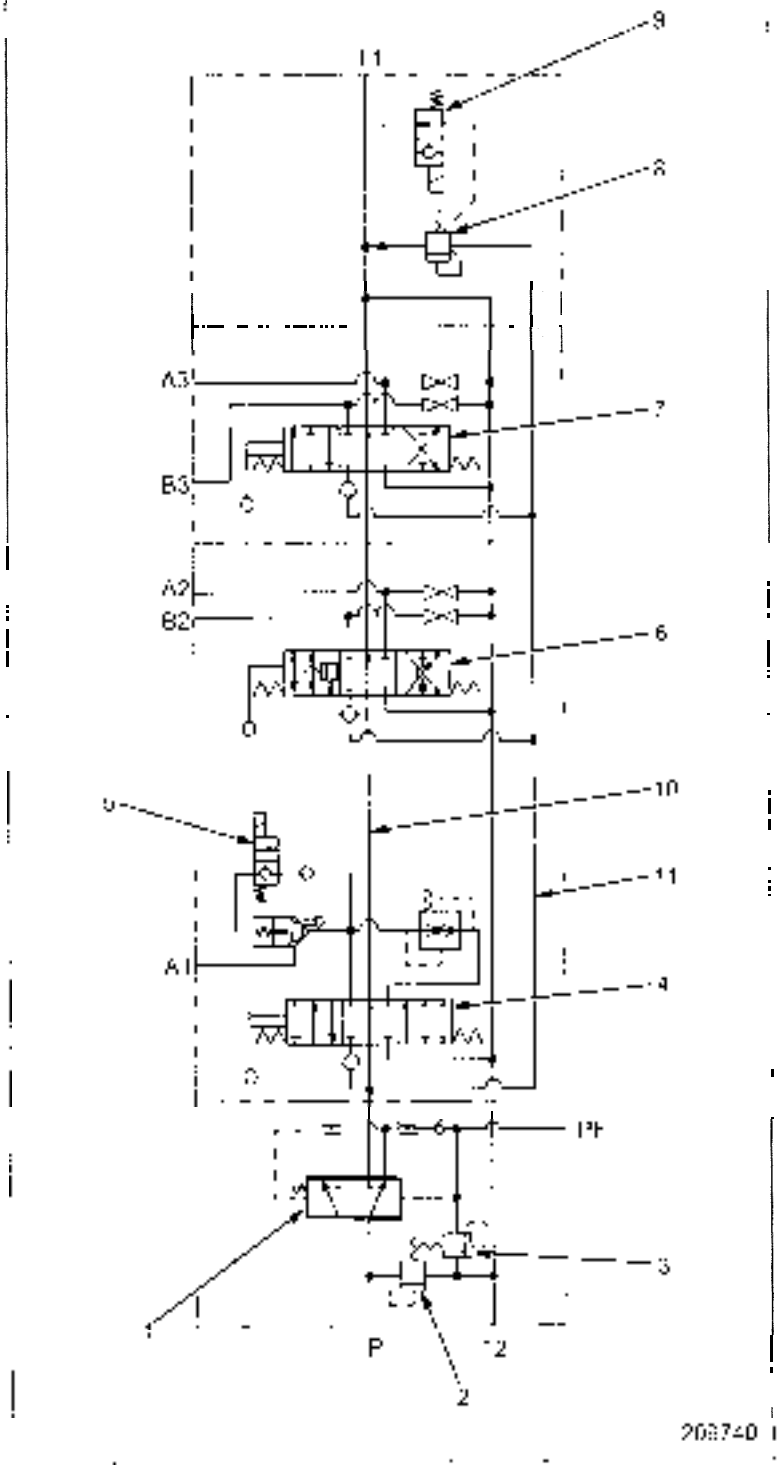
Tilt valve 3 feeds and returns pressure oil to and from the tilt cylinder which tilts the mast forward or backward. The tilt lock valve is assembled in the main spool to ensure safety when the mast is tilted forward.

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 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.



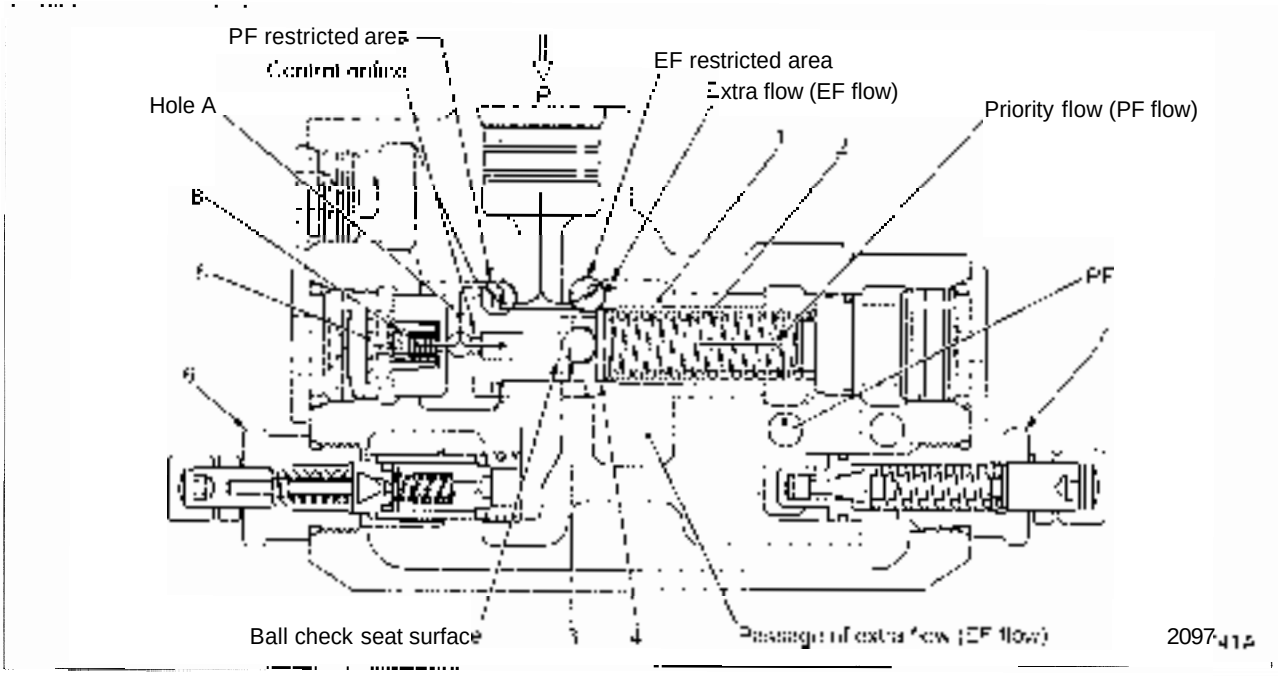
For the entire diagram of the hydraulic system, refer to page 11-2.

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 same 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 valve. 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.

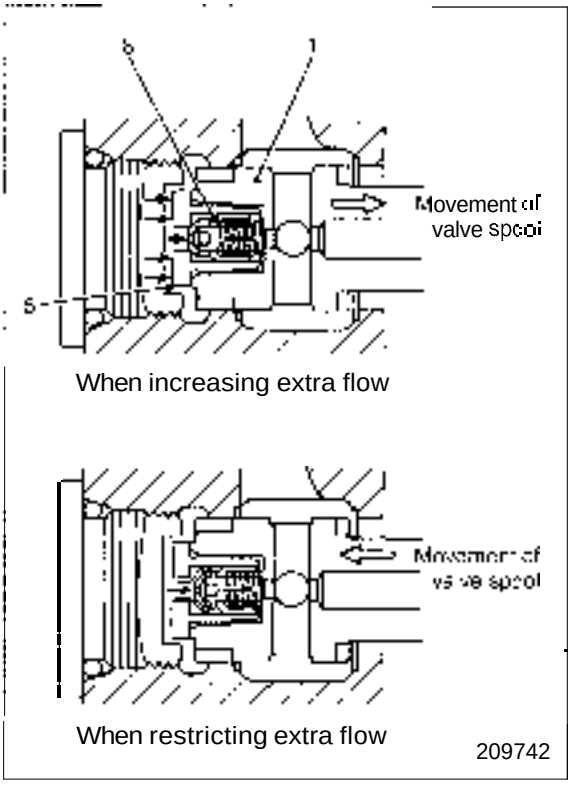
Valve 8 is an orifice provided in oil inflow and outflow passages of damper valve 5. This orifice diverts preferentially PF flow in a stable condition (no occurrence of surging) by controlling the moving speed of valve spool 1.

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.

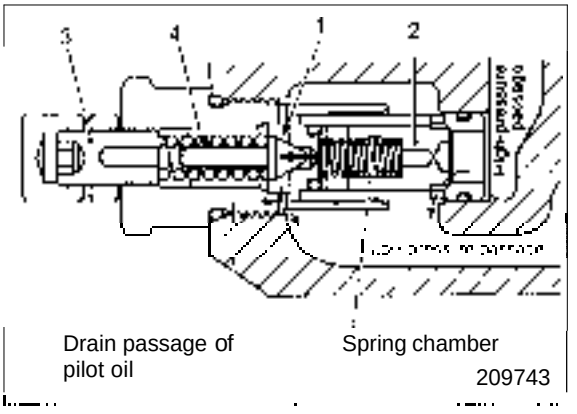
This action, when pressure of PF flow lowers, can prevent a kickback phenomenon caused on the steering wheel.

Ball check 3 prevents backflow of PF flow. This is a preventive measure for a kickback phenomenon.



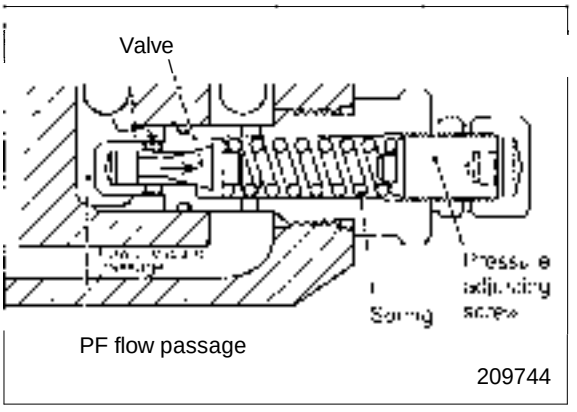
Main Relief Valve

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.

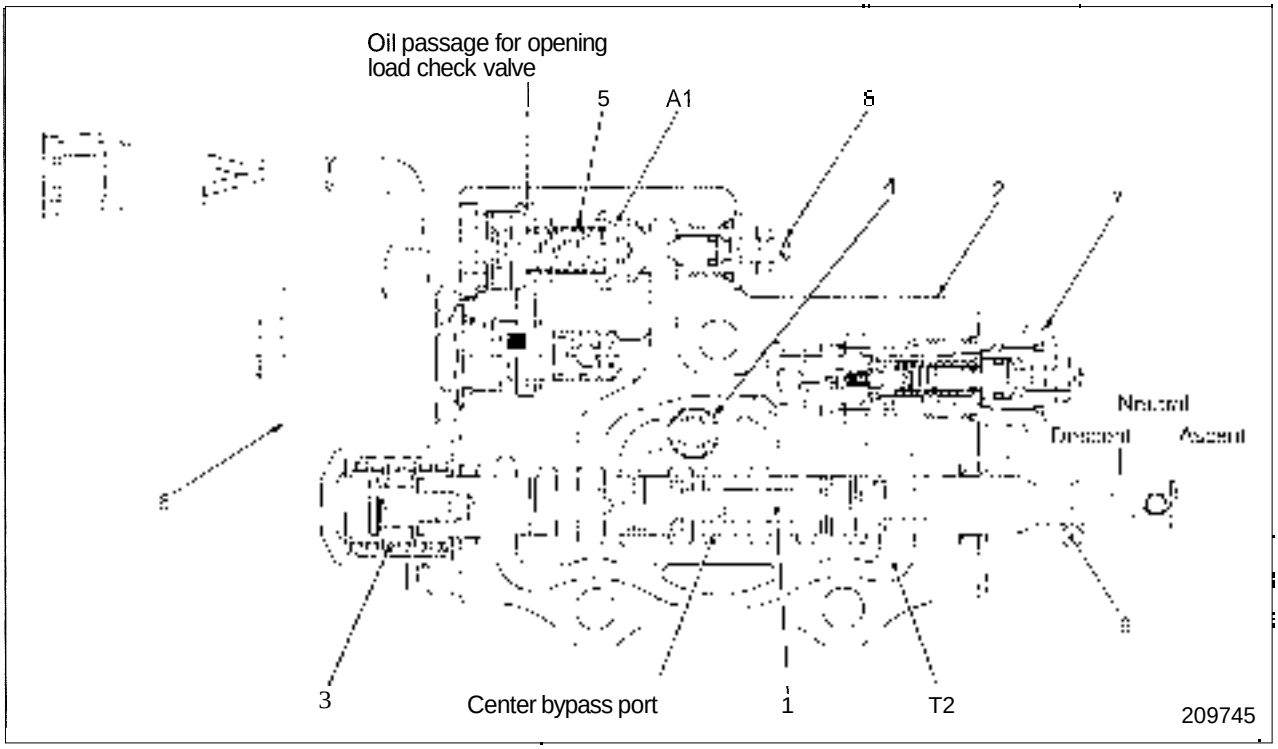


Steering System Relief Valve (PF relief valve)

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."

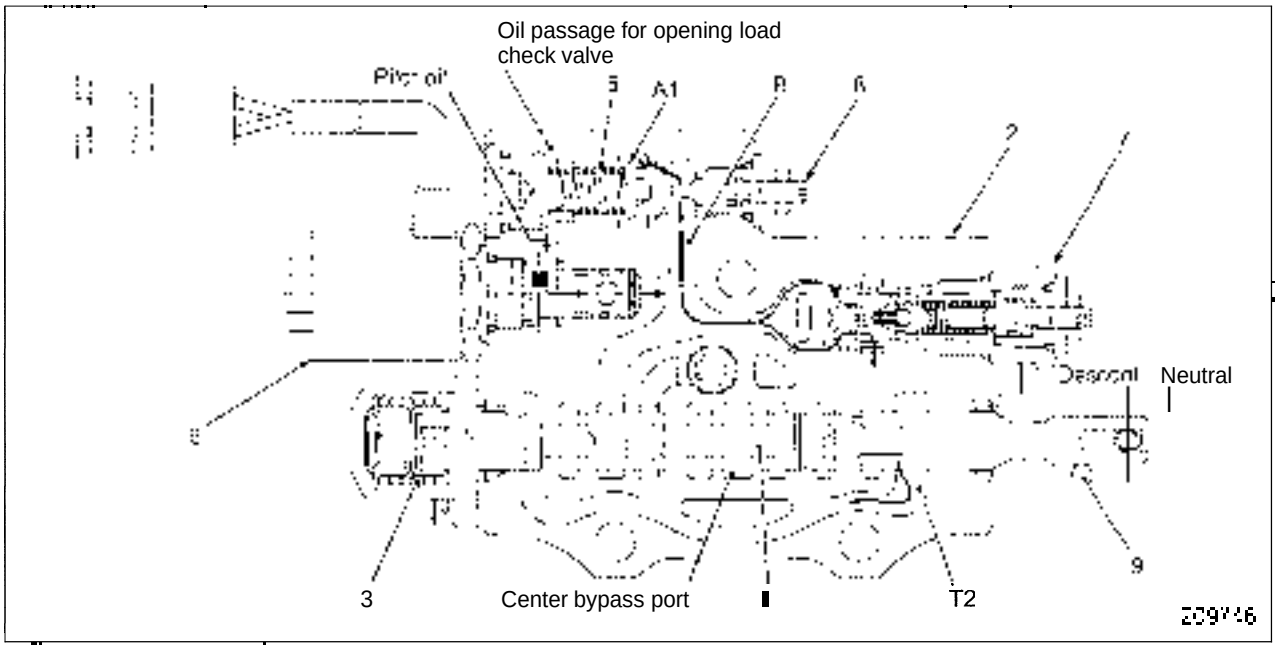
Neutral position:

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:

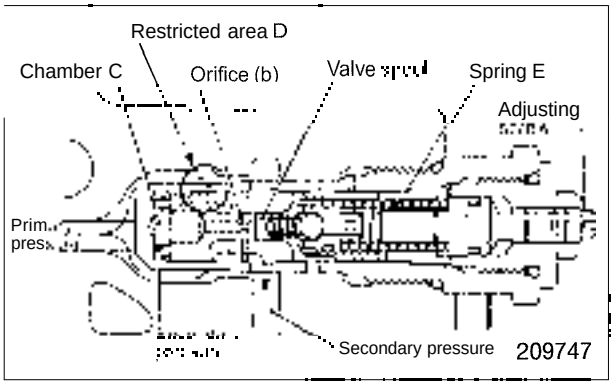
The above illustration shows the lift control valve when spool 1 is at "descending position."

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



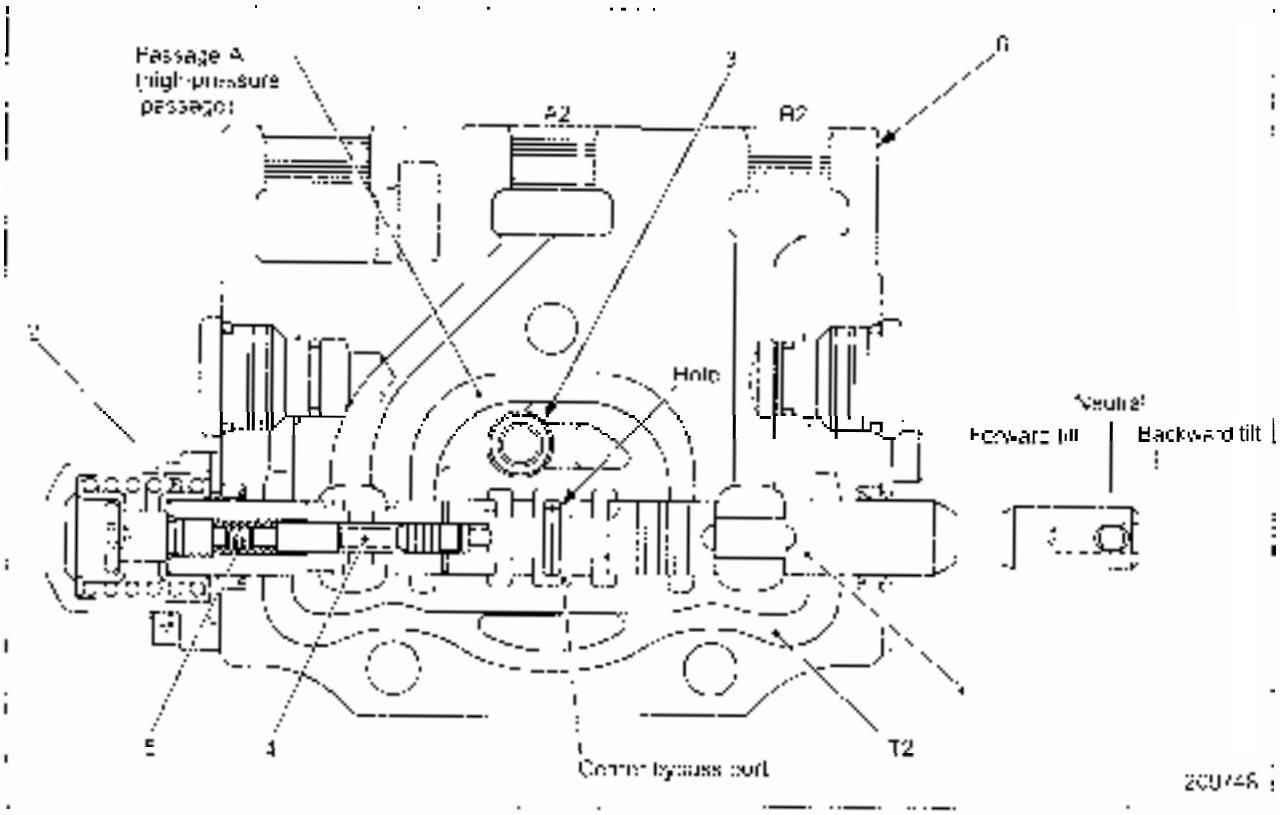
The flow regulator valve keeps the maximum speed constant during cylinder descent regardless of the load weight on the fork.

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 Checkvalve
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."

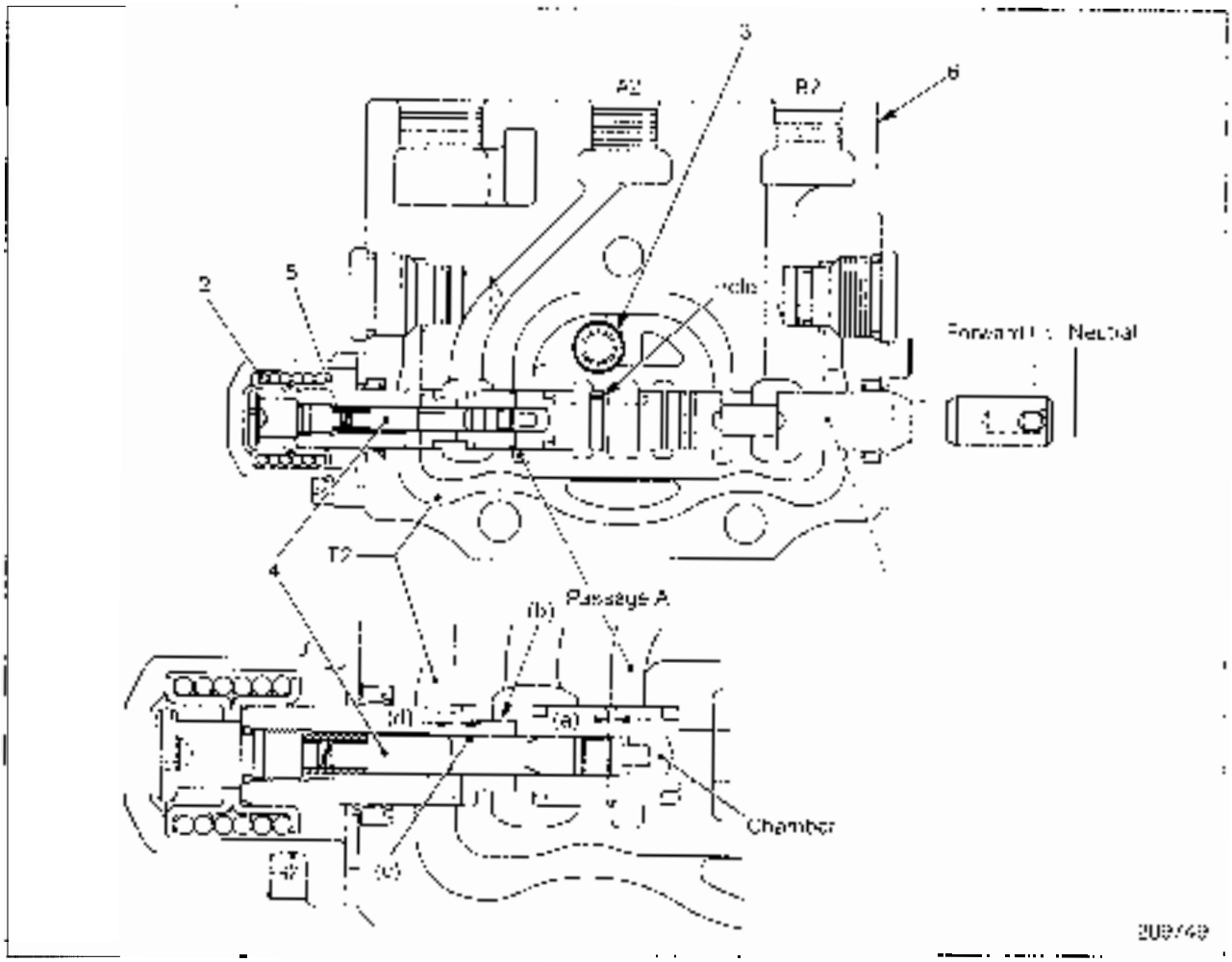
Neutral position:

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.

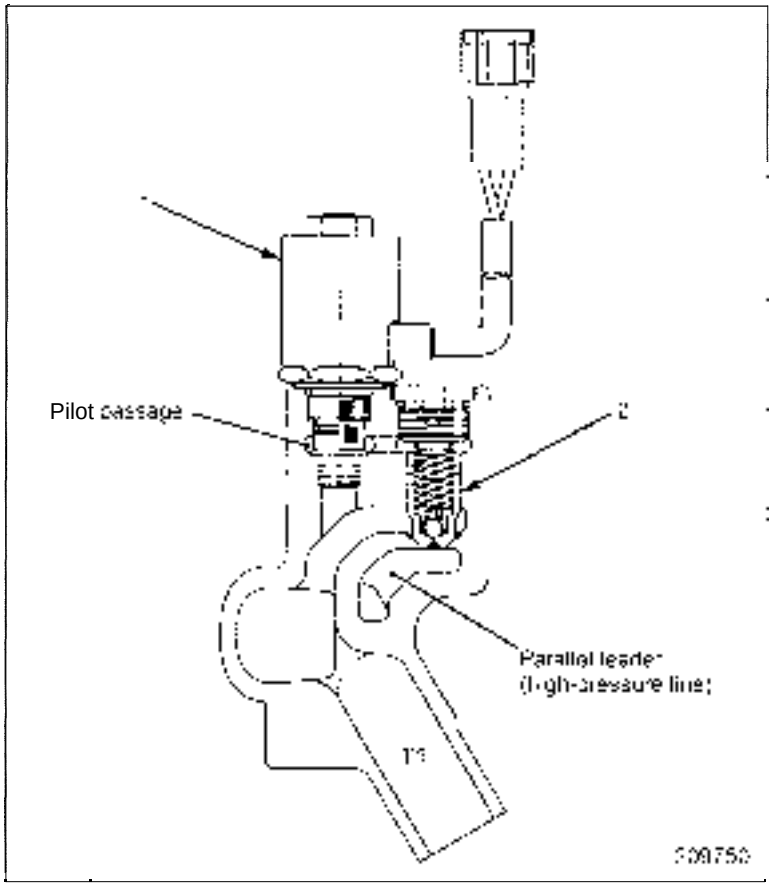


Mast forward tilt position:

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.

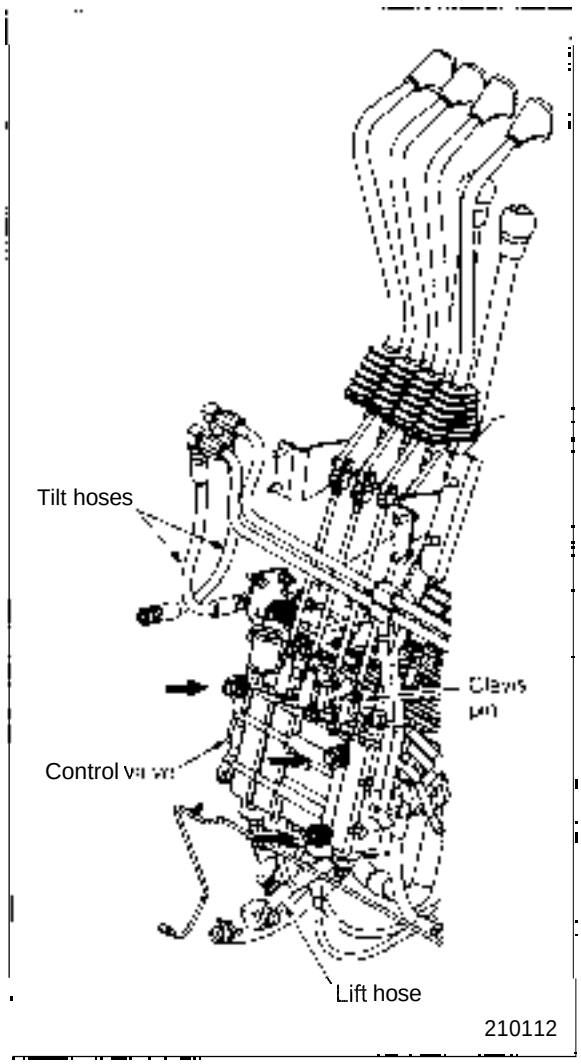
When an operator sits on the seat, the seat switch is turned ON, actuating solenoid valve 1 to block the pilot passage. Thus, the parallel feeder can hold oil pressure. This valve is an anti-disaster valve.

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

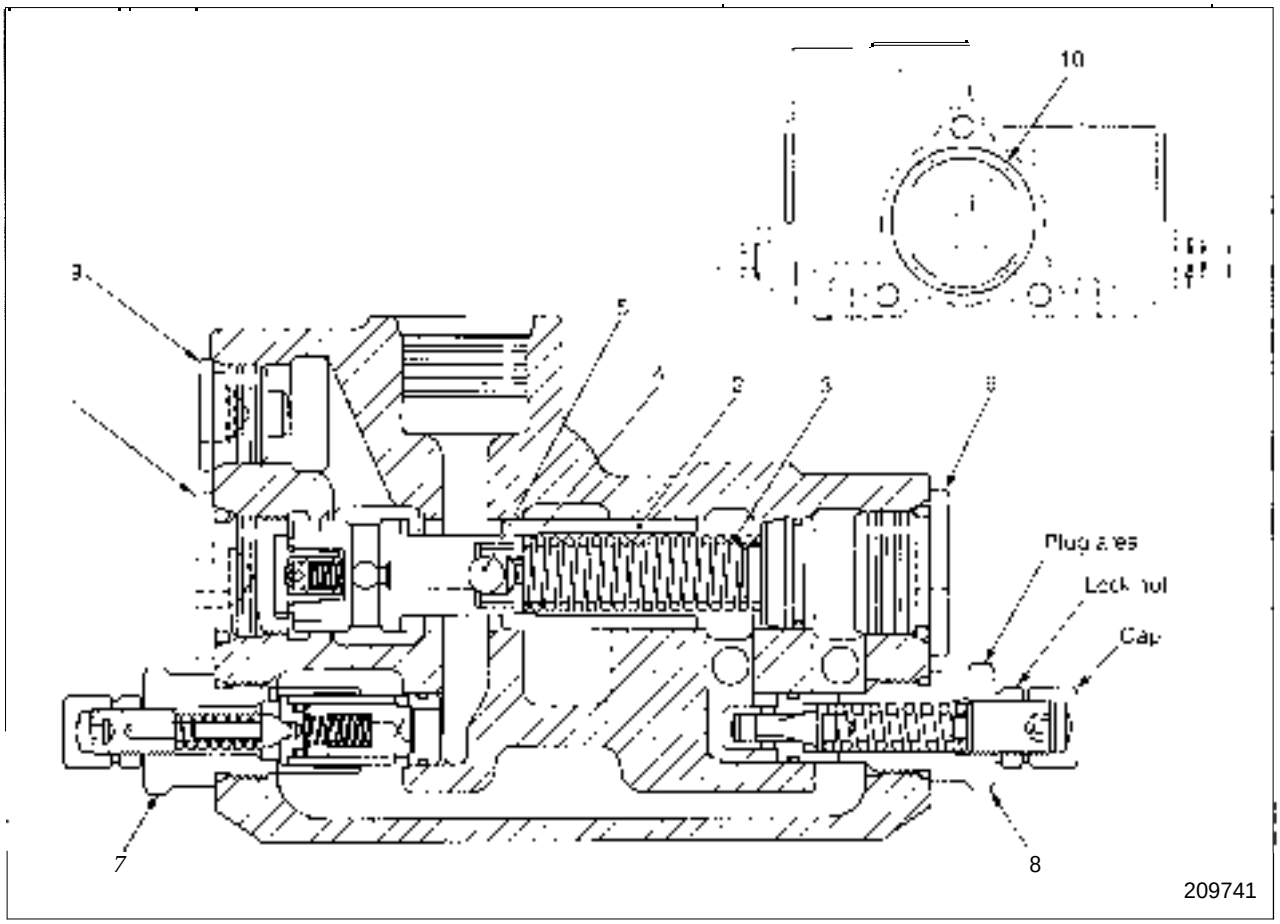
To install, follow the reverse of removal sequence, and do the following steps:

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

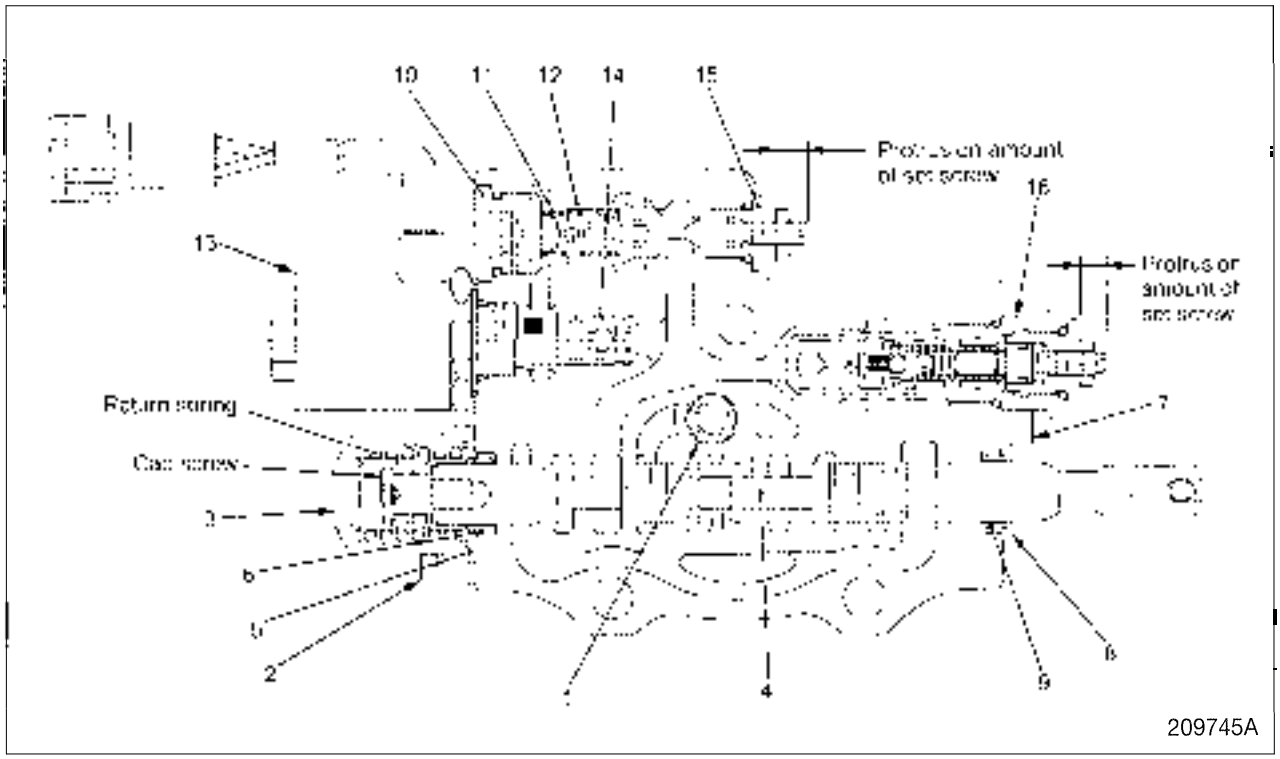
Suggestions for Disassembly

(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

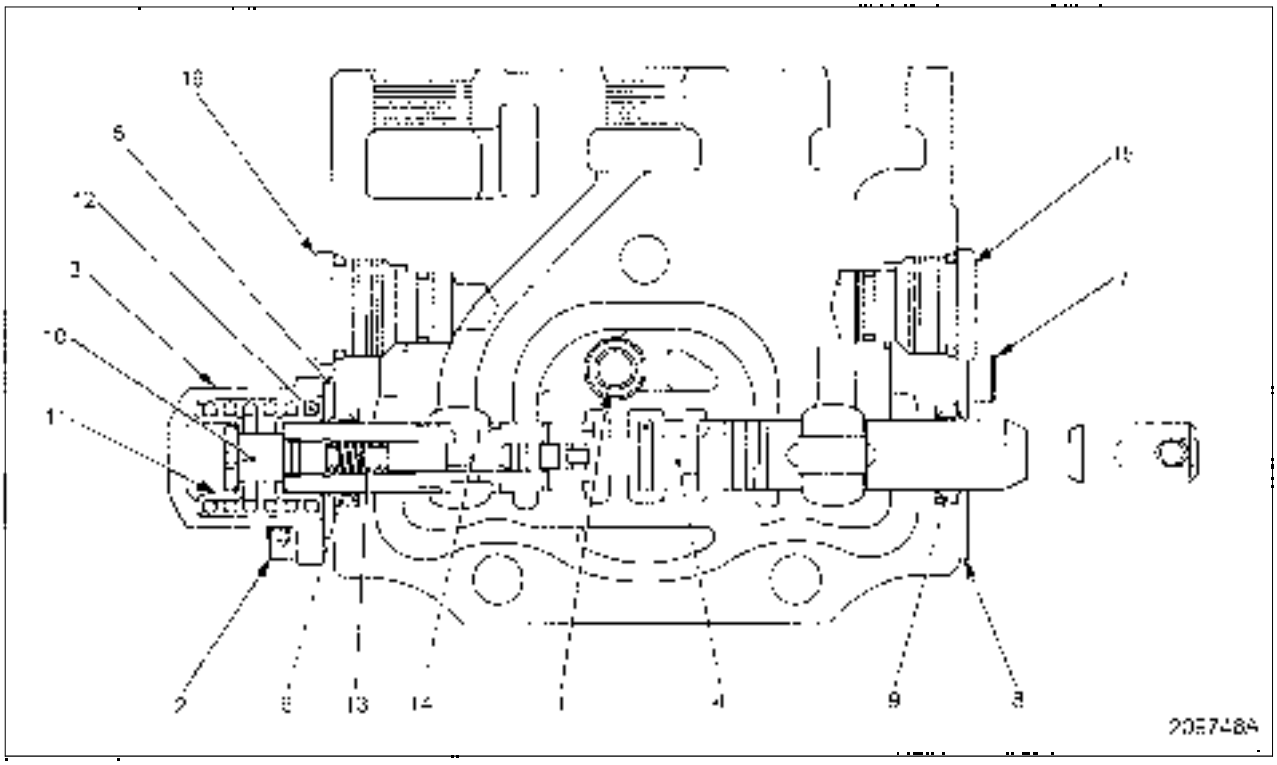
(1) Remove spool 4 from the combination valve body with the return spring and cap screw attached.

(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. Removc 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 lockvalve

Shut-off valve (15 and 16)

15 Shut-off valve on tilt cylinder head
16 Shut-off valve on tilt cylinder rod

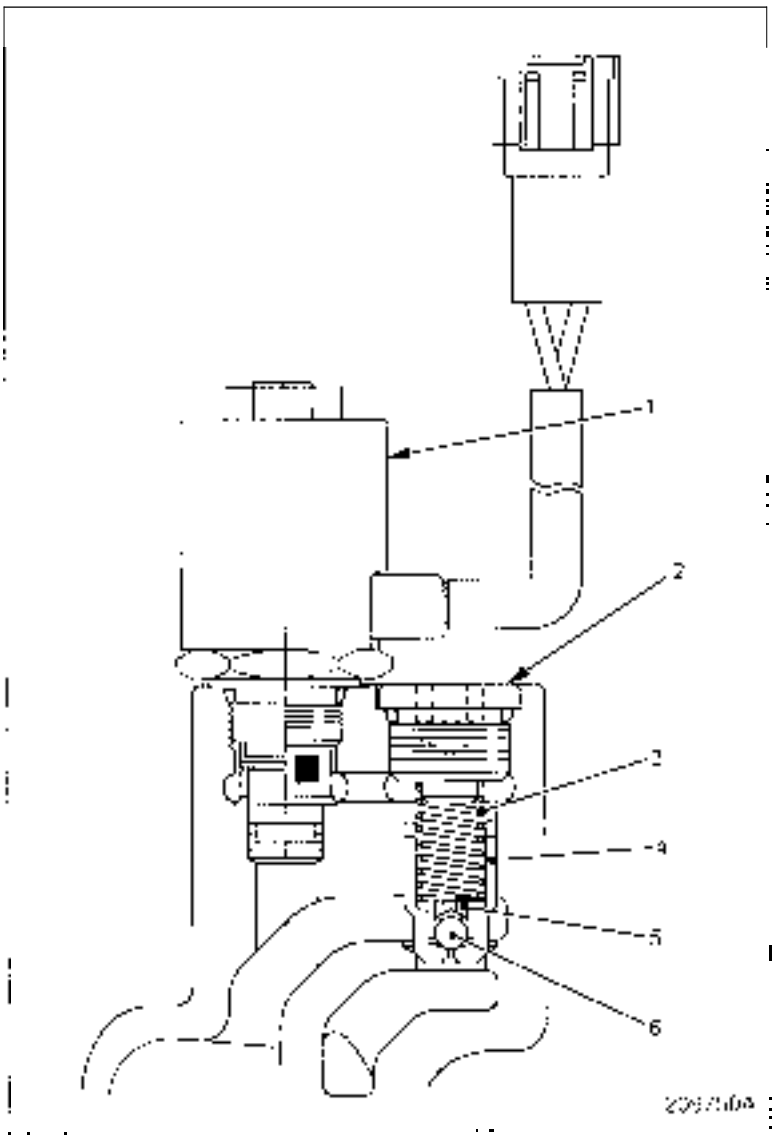
Suggestions for Disassembly

(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

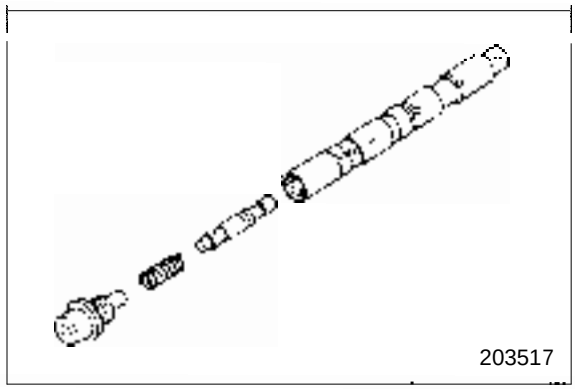
Inspection after Disassembly

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.



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.

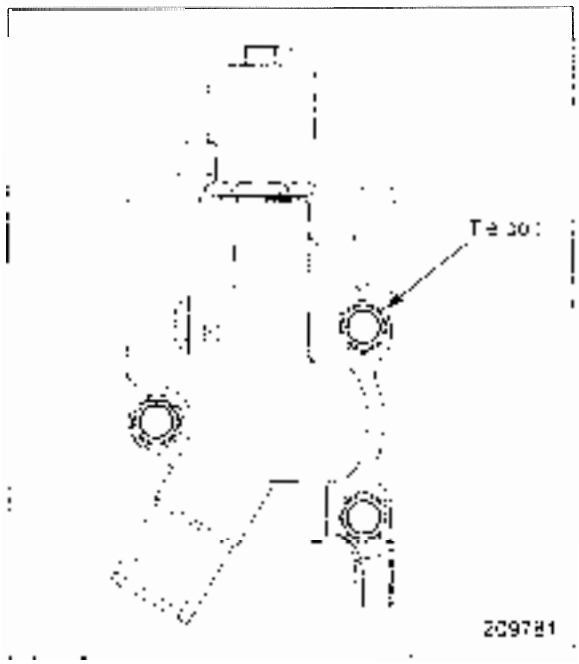
Tighten tie bolts evenly. Tightening them unevenly or to [illegible] torque can distort the valve body, resulting in unsrnooth movement of the spool.

(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 [illegible] is in position. Adjust its position if necessary.



MAST AND **FORKS**

Mast System

Following table shows a combination of truck and mast models:

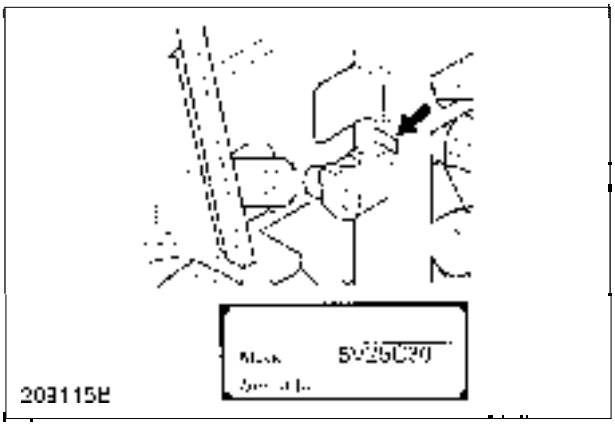
Model \ Mast	Simplex Mast	Duplex Mast	Triplex Mast
1 ton class			
2 ton class			
3 ton class			

Note: □□ presents maximum lift height.

Example:

30: Lift Height of 3000 mm

Mast Serial Number Location



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

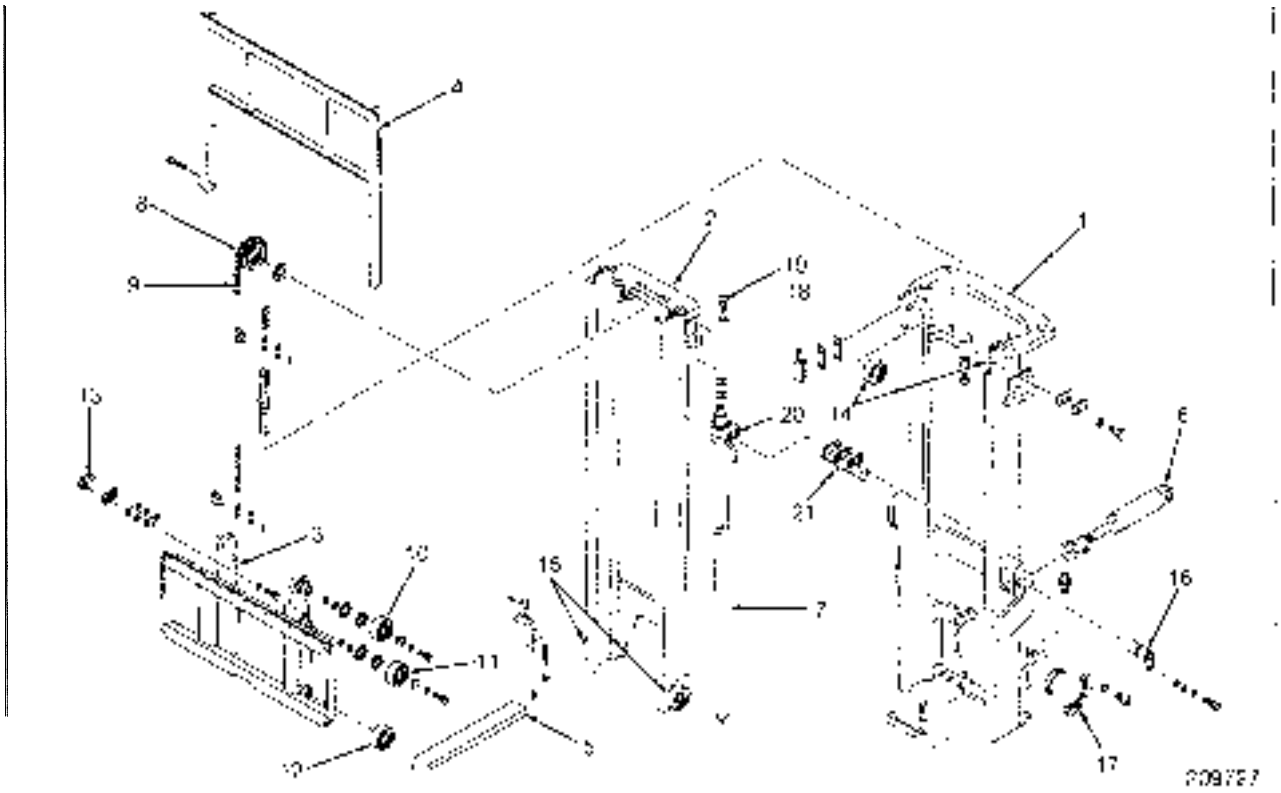
- Maximum lifting height ["30" stands for 3000 mm (118 in.)]
- Letter of the minor change ("A" for the original, "B" for the first change, "C" for the second change, and so on)
- Applicable truck model designation (Example: 5FD30)
  - 15: 1 ton class
  - 25: 2 ton class
  - 30, 35: 3 ton class
- Kind of mast
  - V: simplex mast
  - F: duplex mast
  - M: triplex mast
- 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 12-



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

1 Outer mast
2 Inner mast
3 Lift bracket
4 Backrest
5 Forks (2)
6 Tilt cylinder
7 Lift cylinder
8 Chain wheel
9 Chain
10 Lift bracket upper roller
11 Lift bracket middle roller
12 Lift bracket lower roller
13 Side roller
14 Outer mast roller
15 Inner mast roller
16 Tilt cylinder, Tilt socket mounting pin
17 Mast support cap
18 Mast strip
19 Lift cylinder upper mounting bolts
20 Cylinder bracket
21 Cylinder clamps

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.

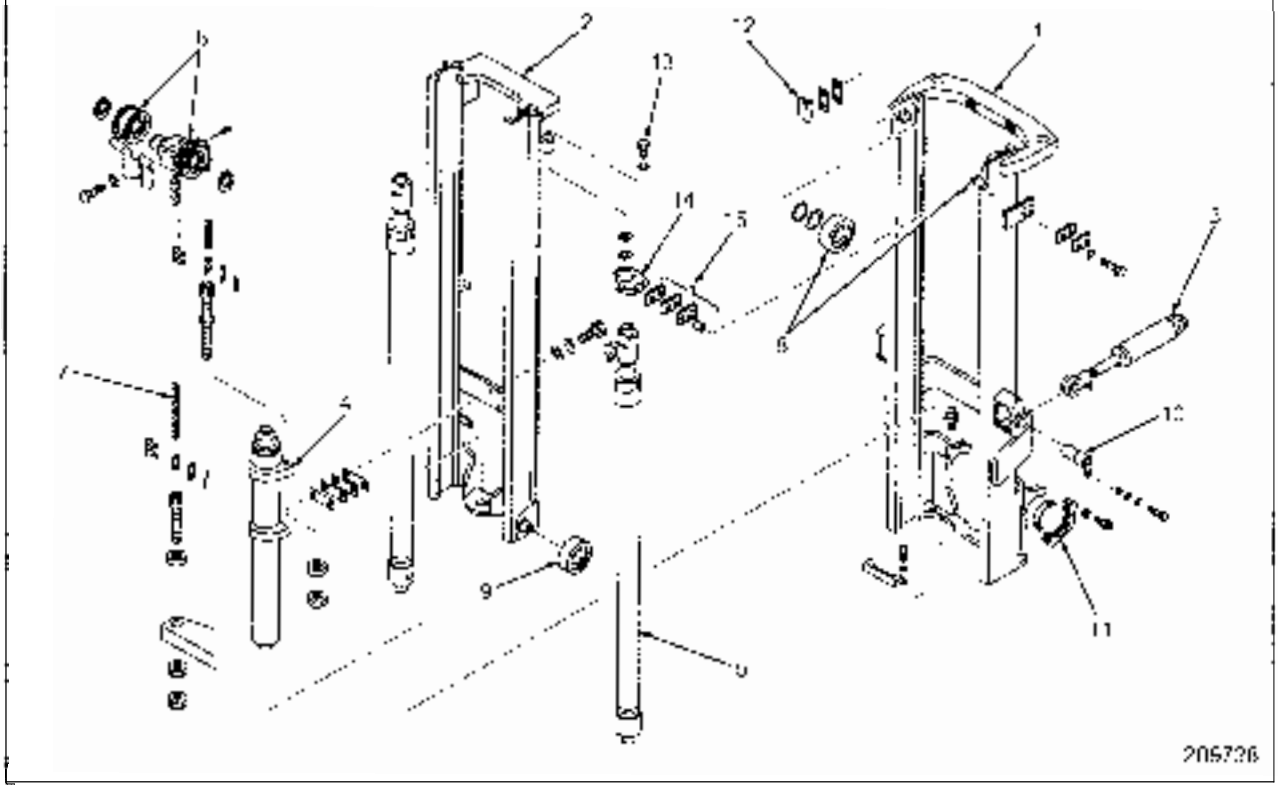
For mast operation, refer to "Mast Operation" on page 12-5.

Duplex (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 12-26.

(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 Inner mast
3 Tilt cylinder
4 First lift cylinder (one piece)
5 Second lift cylinder
6 Chain wheel
7 Chain
8 Outer mast roller
9 Inner mast roller
10 Tilt cylinder, Tilt socket mounting pin
11 Mast support cap
12 Mast strips
13 Lift cylinder upper mounting bolt
14 Cylinder bracket
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.

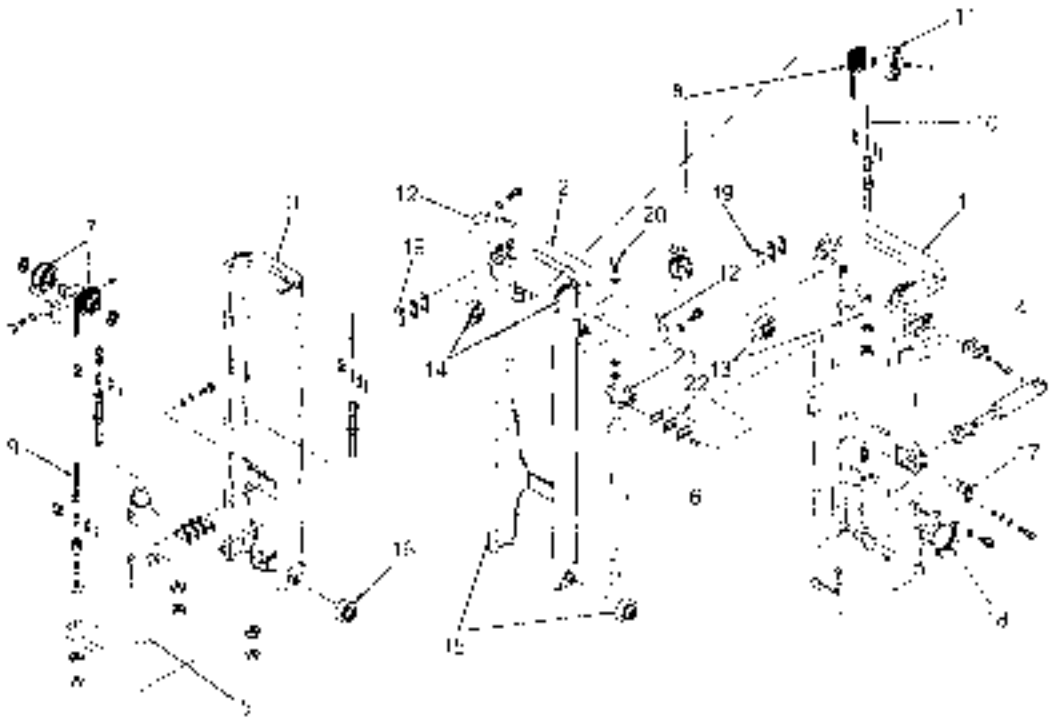
For mast operation, refer to "Mast Operation" on page 12-5.

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 12-27.

(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 Maststrips
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.

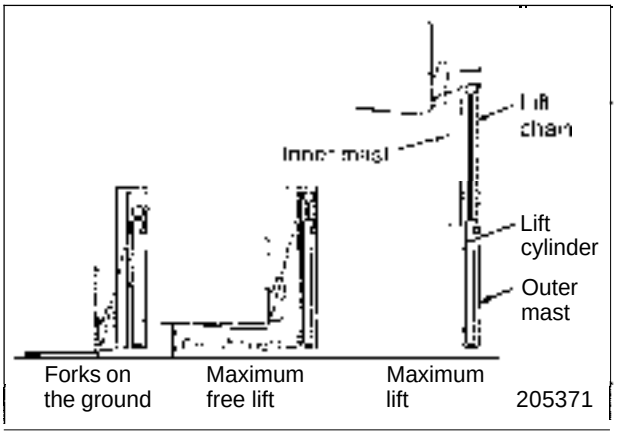
The first lift cylinder raises the lift bracket, while the second cylinder operates the three-stage telescopic mechanism and lift bracket.

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

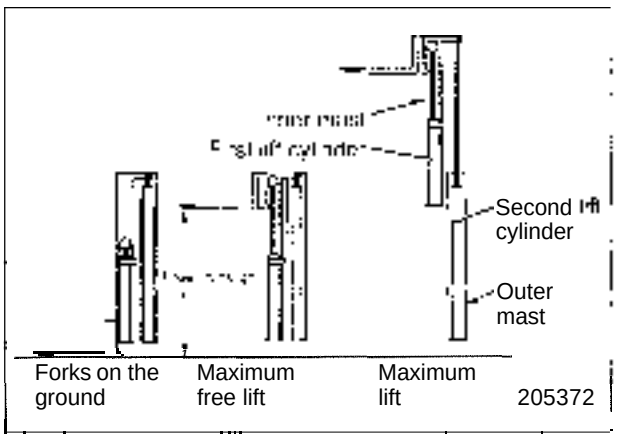
1. Operation of Simplex Mast



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

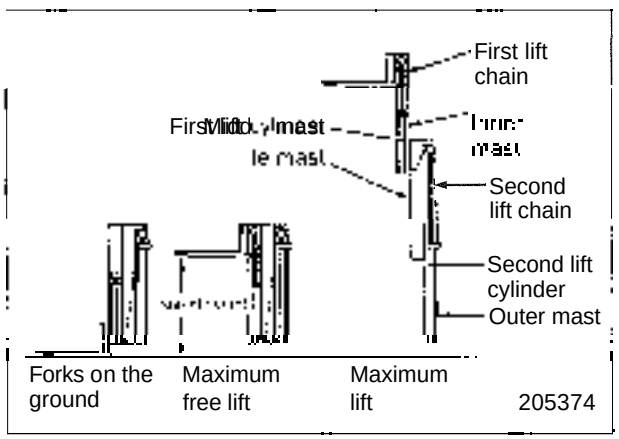


Operation of Mast

The first lift cylinders extend, bringing the forks to the maximum free-lift height.
When the first lift cylinder rods have reached 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 cylinders extend, bringing the forks to the maximum free-lift height.
When the first lift cylinder rods have reached 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.

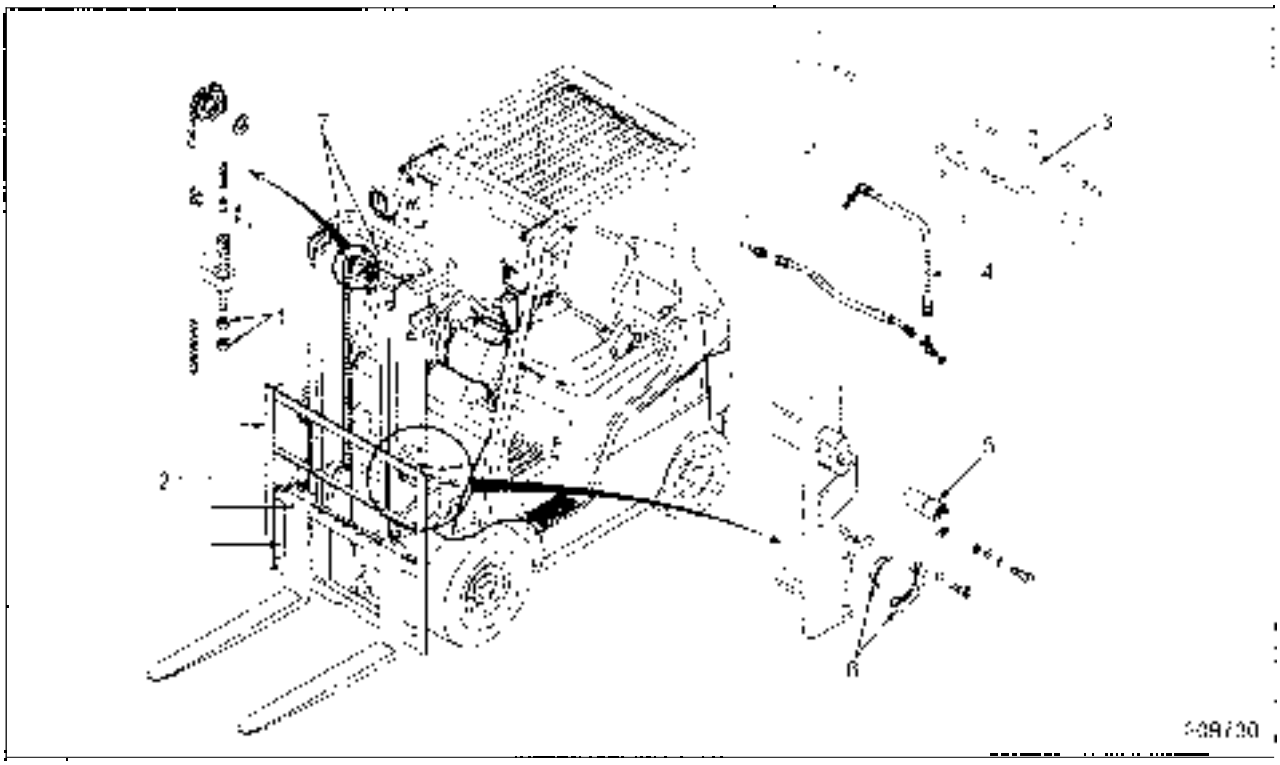
The lowering process takes place in the reverse order of lifting.

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)

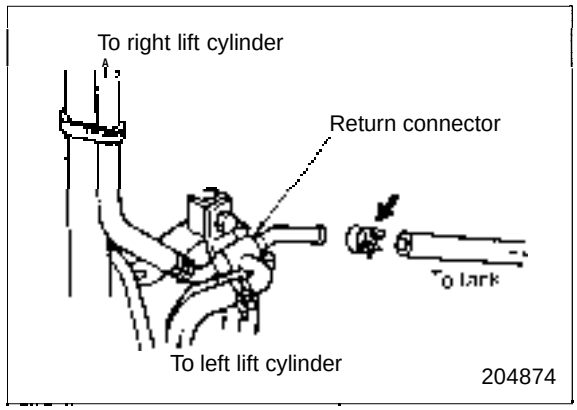
(1) Start the engine and raise the mast in the highest position.

(2) Stop the engine and disconnect the hose 3 at the hose clamp (Allow) of return connector.

(3) Lower the mast.

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.

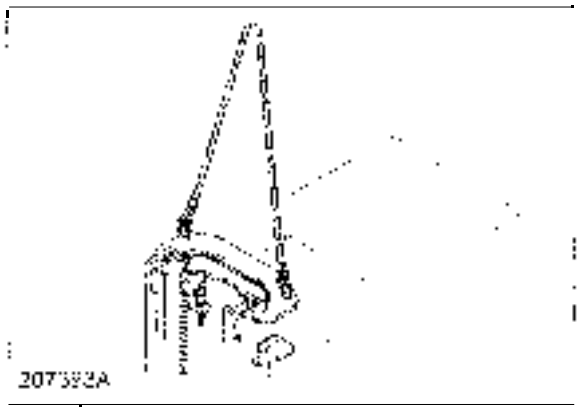


4. Separating tilt cylinders

(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.

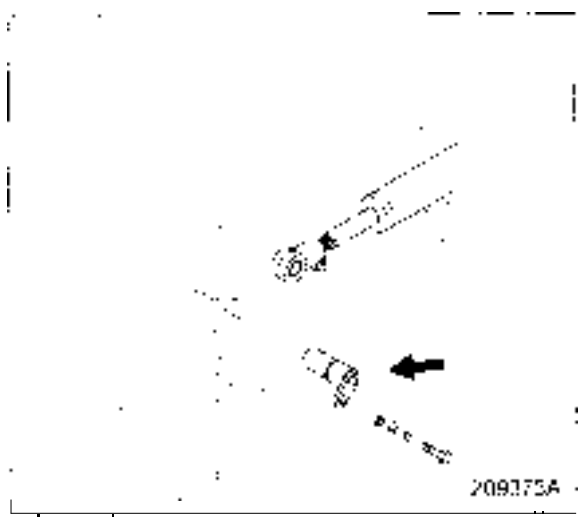


(2) Place wood blocks under the tilt cylinder mounting section and remove the tilt socket pins, and separate the mast from the tilt cylinders.

(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

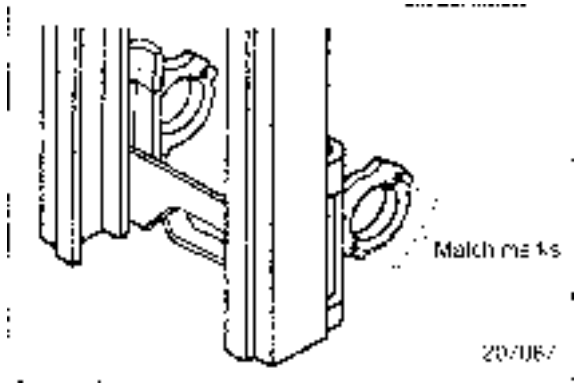
Never loosen tilt socket bolts except for tilt cylinder disassembling.

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 followings in mind.

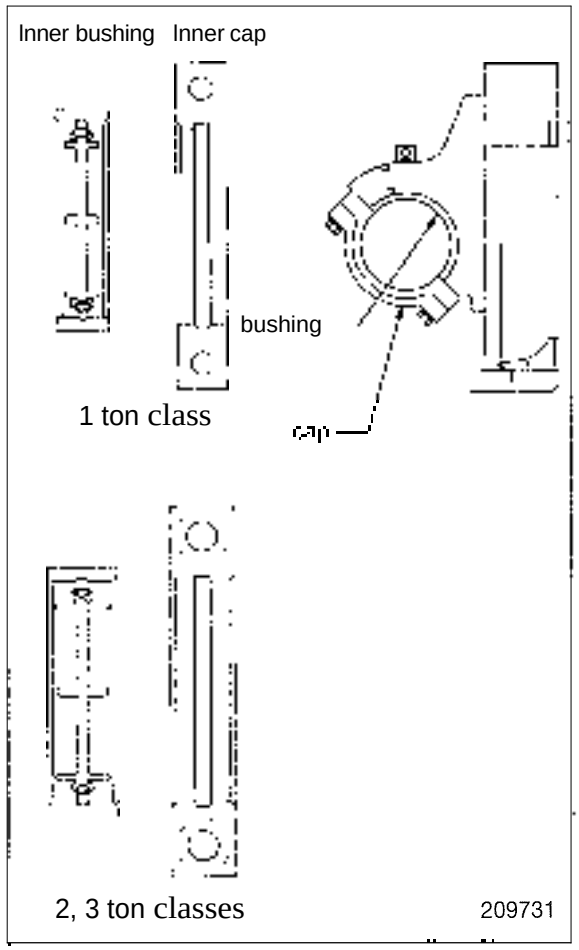
1. Mast Support

(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

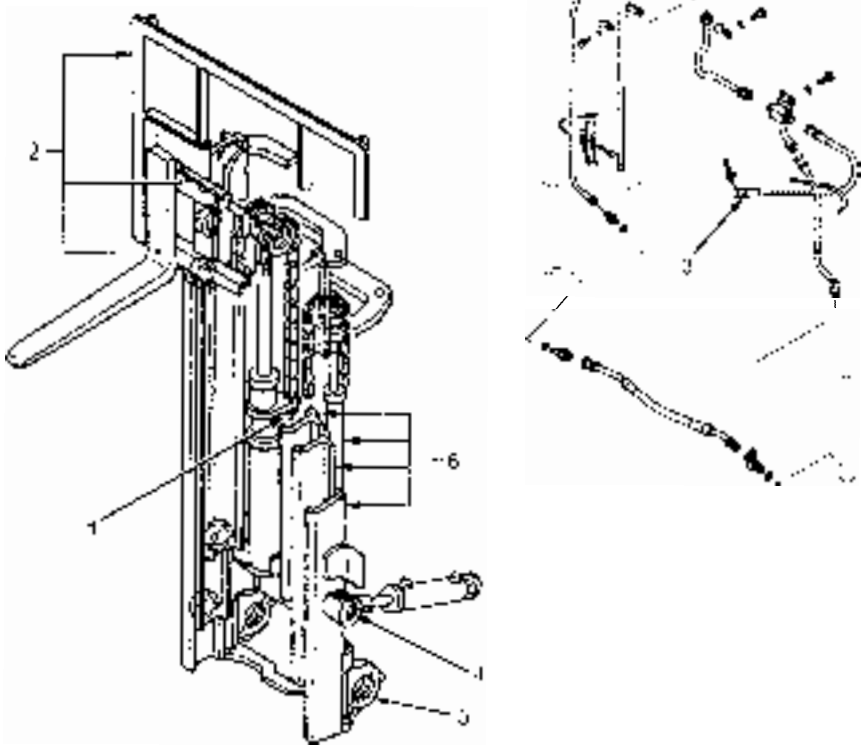
Start the engine, raise and lower the lift bracket with several strokes to bleed the cylinder.

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

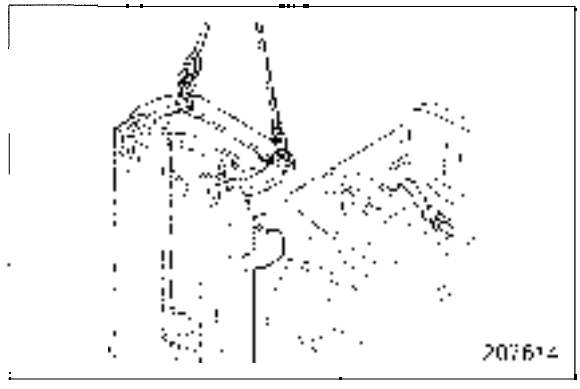
Place the mast in the bottom position, disconnect the hose 3 at the arrow position in the illustration on the previous page.

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.

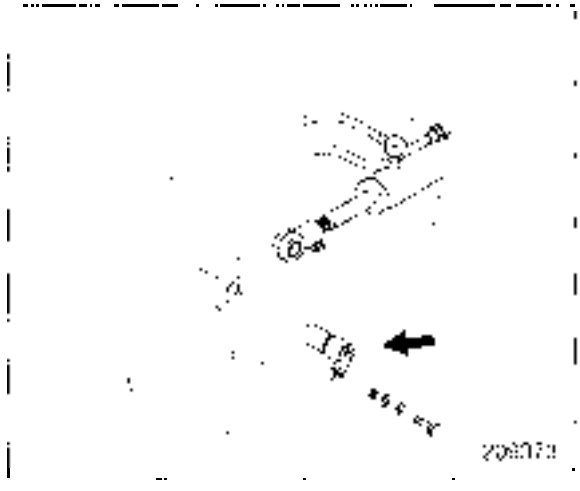


(2) Place wood blocks under the tilt cylinder mounting section and remove the tilt socket pins, and separate the mast from the tilt cylinders.

(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

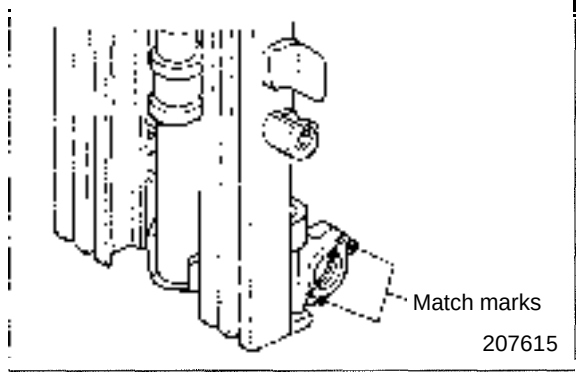
Never loosen tilt socket bolts except for tilt cylinder disassembling.

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.



Installation

To install, follow the removal sequence in reverse with followings in mind.

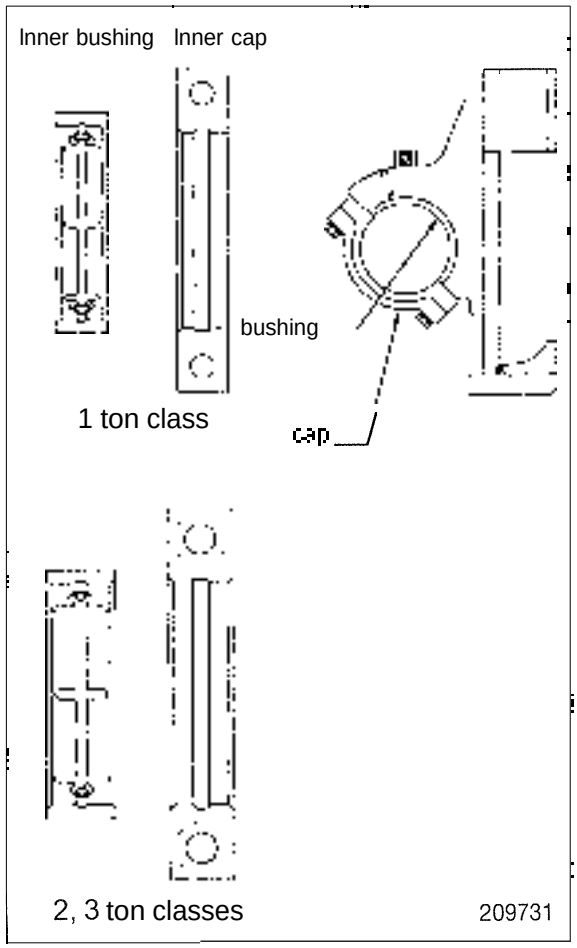
1. Mast Support

(1) Apply grease to 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.

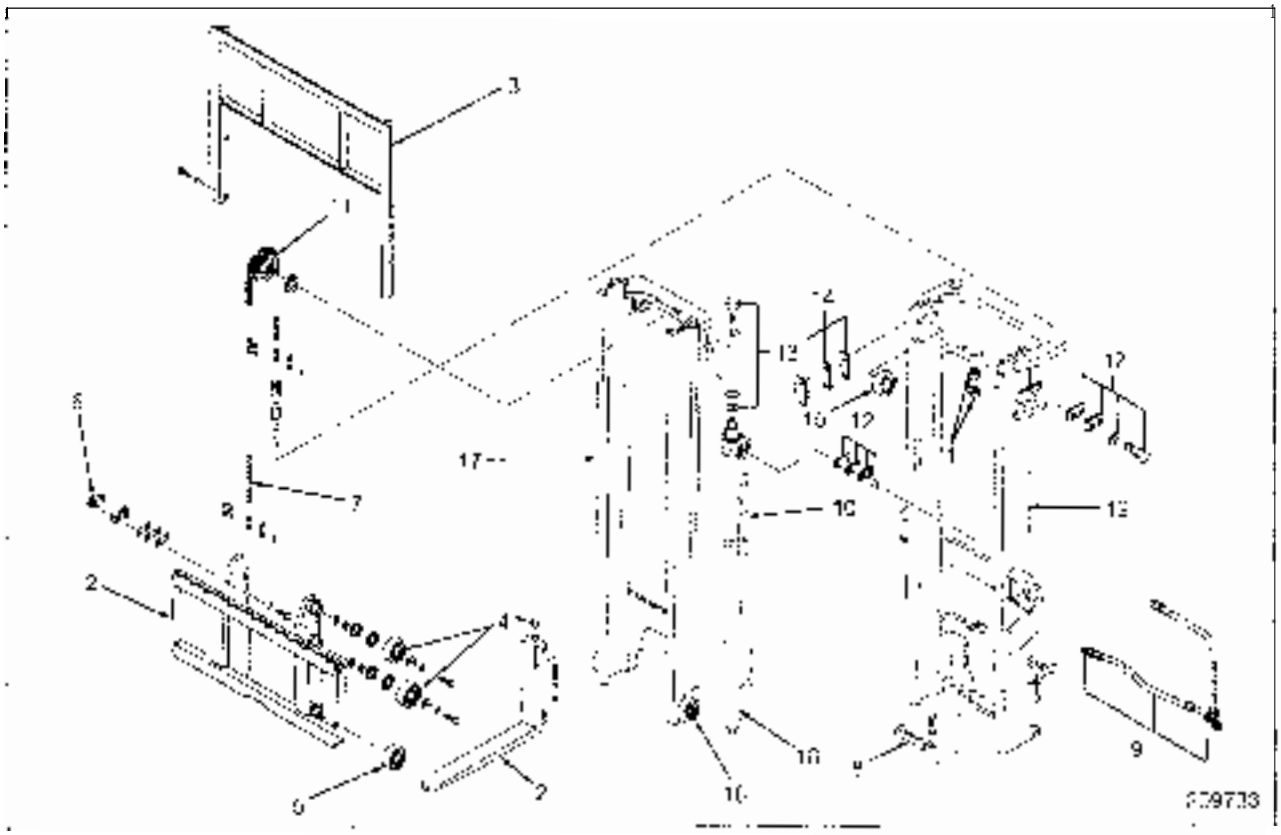
In the triplex mast, no air bleeding screws are provided. Raise and lower the lift bracket with several strokes to bleed the air trapped below the piston.

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

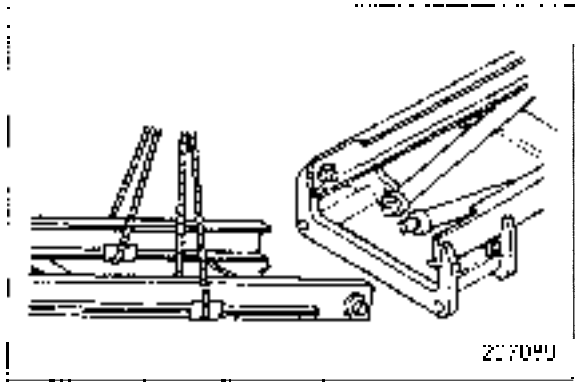
Suggestions for Removal

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.



Inspection after disassembly (all models)

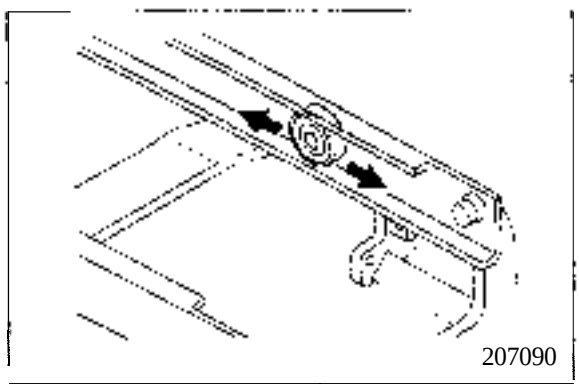
1. Mast

(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.



2. Lift bracket

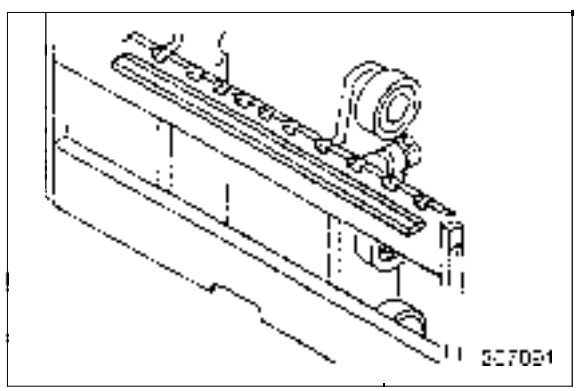
(1) Check the main rollers and side rollers for smooth rotation. Inspect each roller for wear and cracks.

(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



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

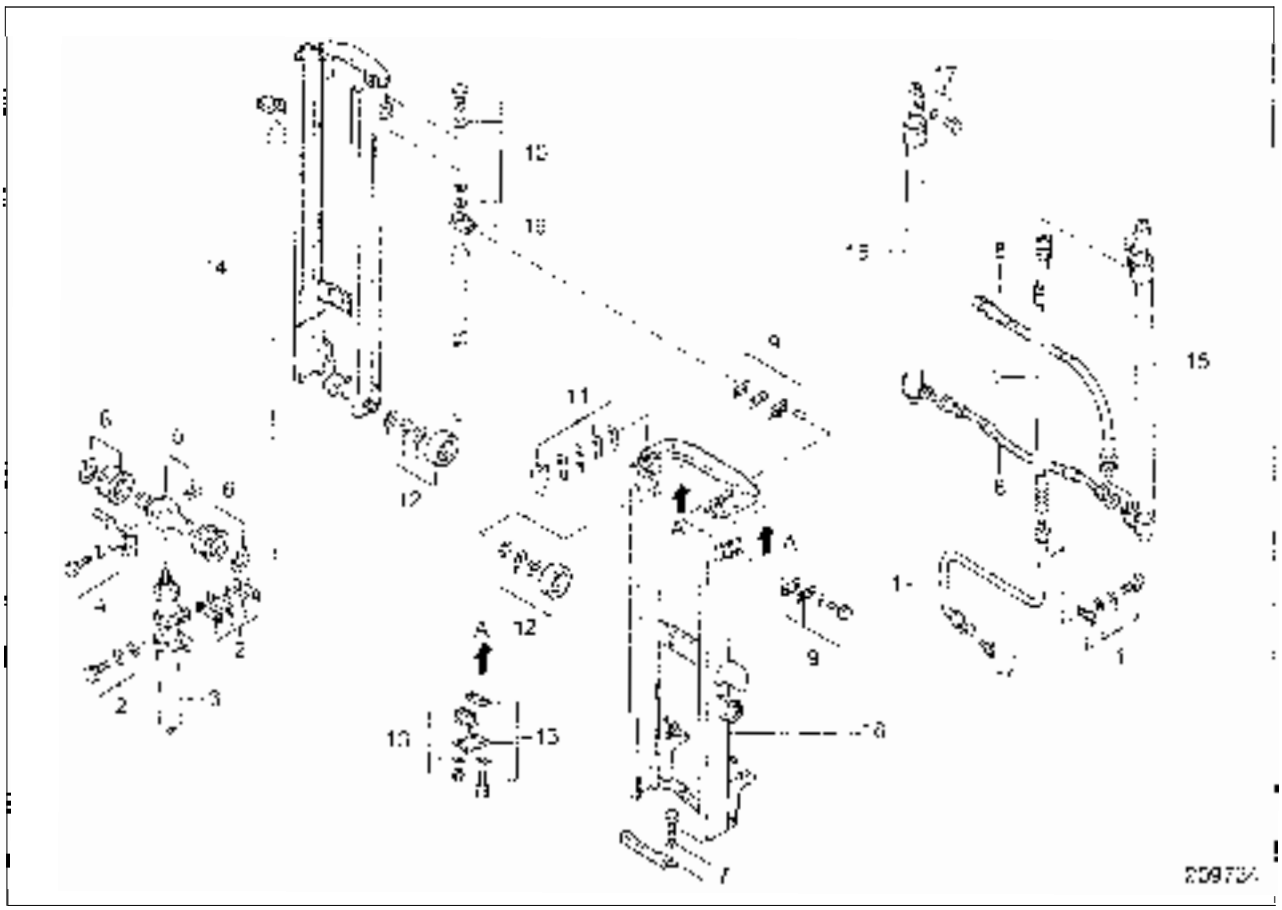
A: Standard value B: Repair or service limit

Unit : mm (in.)/20 links

Item		Class	Class	Class
Simplex mast	A	381	381	508
	B	482	482	635
Duplex mast	A	381	381	508
	B	482	482	635
Triplex mast	A	381	381	508
	B	482	482	635

Duplex Mast

Disassembly



Sequence

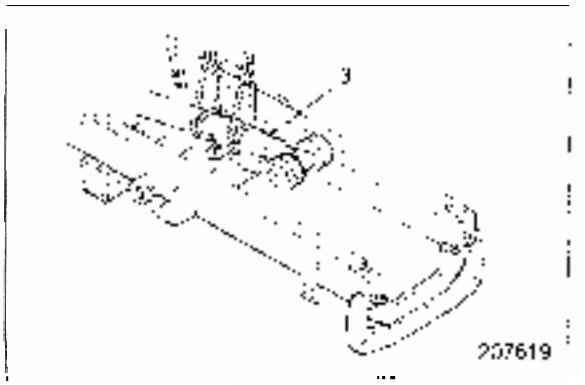
1 Lift hose (high pressure), Clamp
2 Shims, Bolts, Washers
3 First lift cylinder
4 Chain guard
5 Chain wheel support, Pin
6 Chain wheels, Snap rings
7 Hose guard, Bolt, Washer
8 High-pressure hose
9 Seats, Shims, Cushions, Collars
10 Bolts, Washers, Shims
11 Mast strips, Shims
12 Mast Rollers
13 Stopper 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.

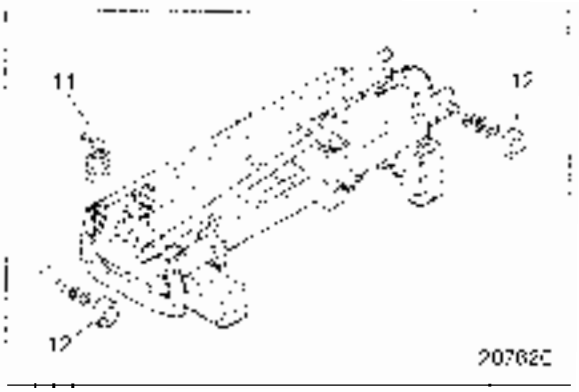
2. Removing main rollers 12 and mast strips 11

(I) 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.

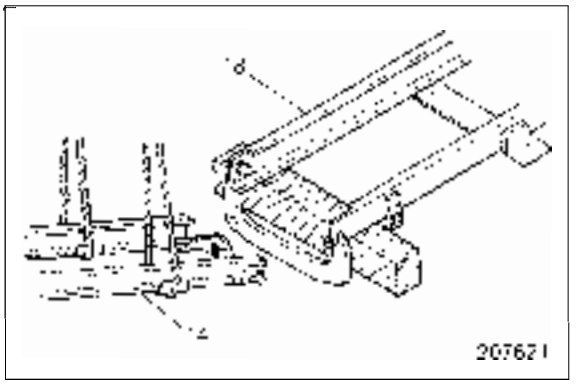
(3) Check the number of shims and the shim thickness at the rod end sections.

(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.

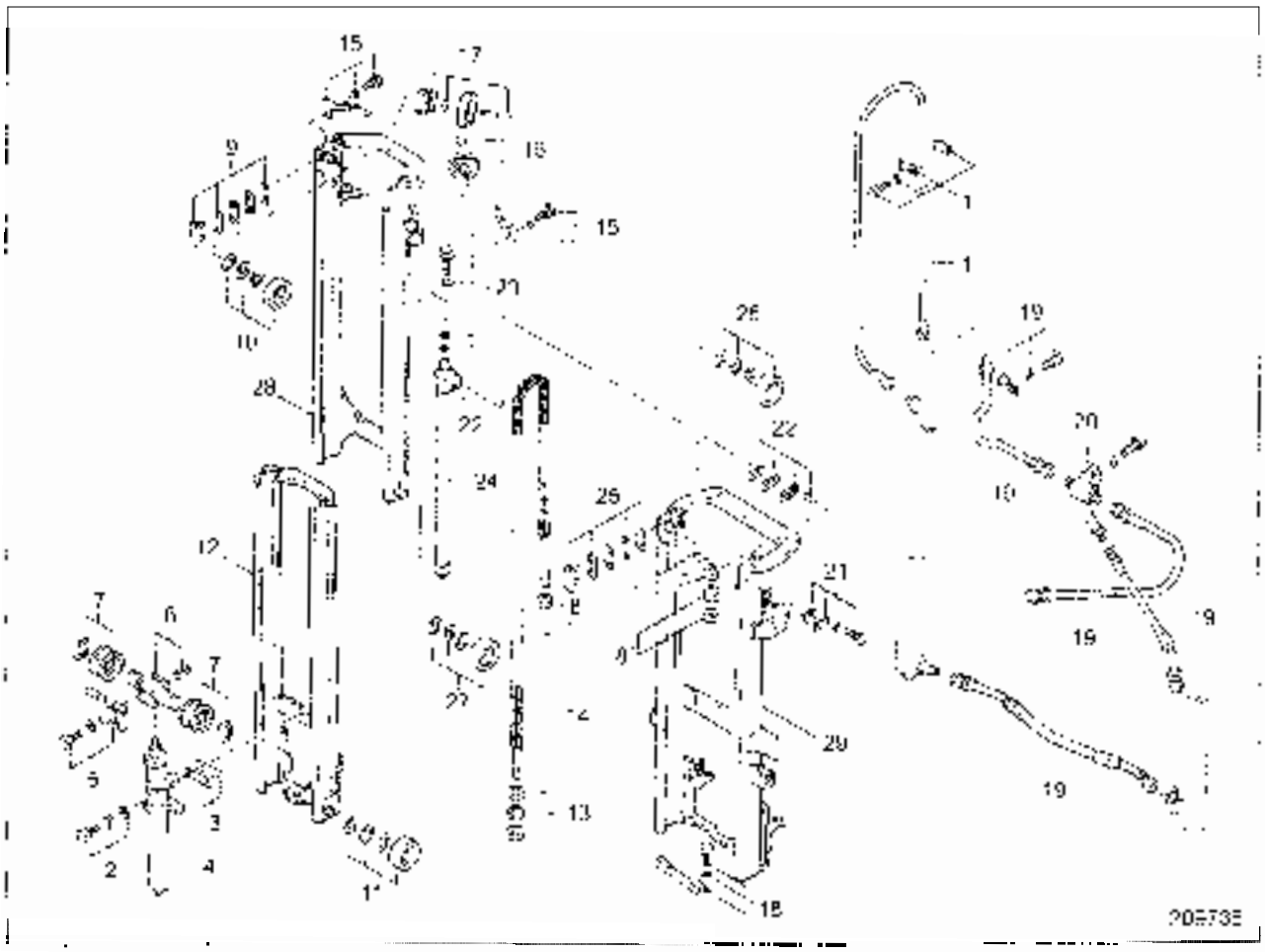


inspection after disassembly

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.

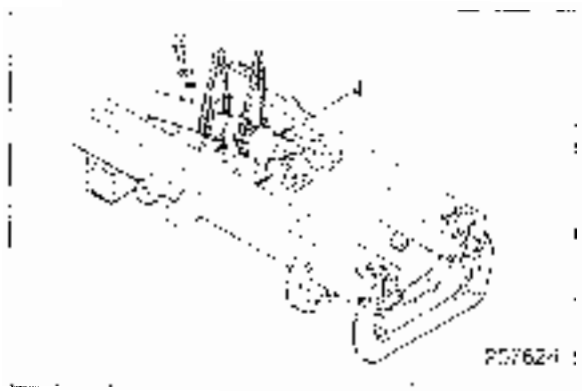
(b) Before disassembling the mast and fork assembly, measure and record all clearances between each lift bracket and roller and between each mast and roller. Recorded measurements will be helpful when replacing rollers or selecting shims to adjust clearances.

Suggestions for Disassembly

1. Removing first lift cylinder 4

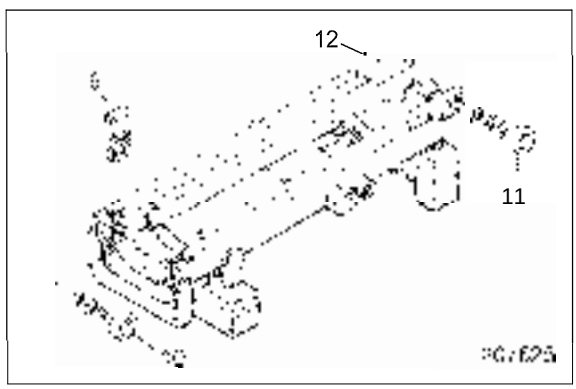
(1) Remove retaining bolts from the first lift cylinder.

(2) Hitch slings on the cylinder, and gently remove the cylinder.
Use two slings. Wind or tie slings securely to prevent slipping.



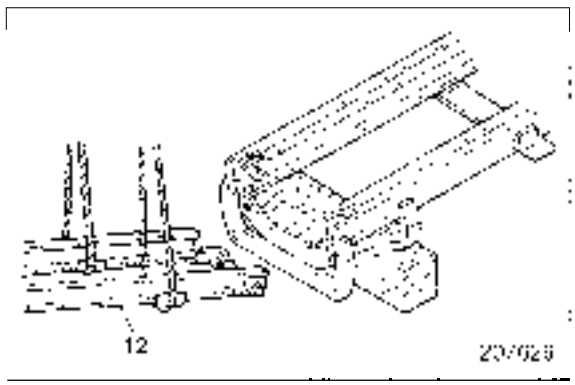
2. Removing inner mast 12 and main rollers 10, 11

Lower inner mast 12 until the main rollers 10, 11 can be removed. Remove the rollers and mast strips 9.



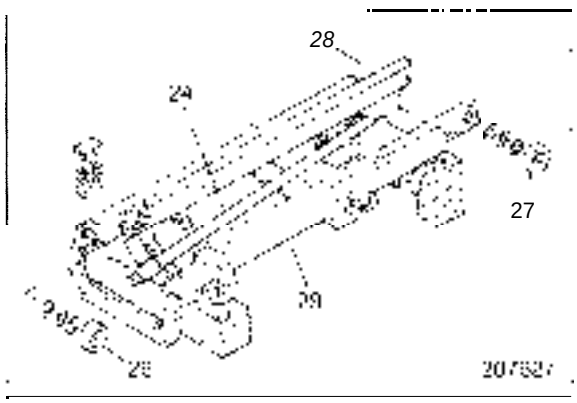
3. Removing inner mast 12

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

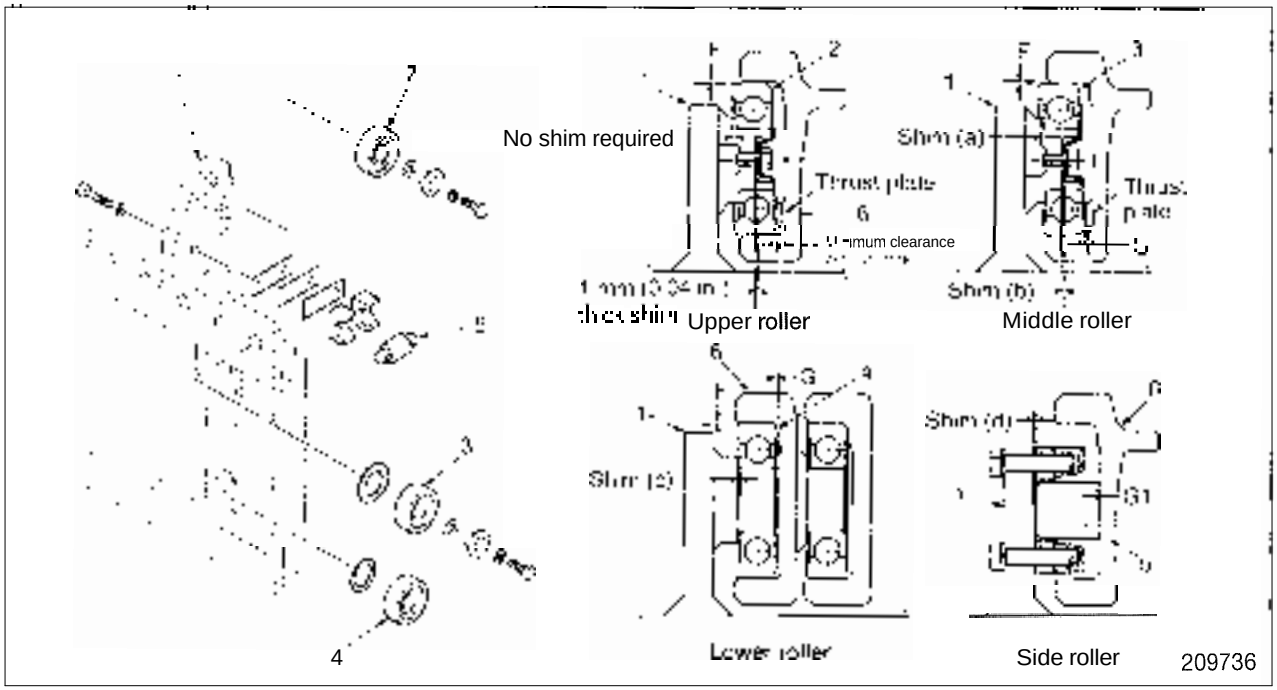
Follow the same inspection procedure as for the simplex mast. Refer to page 12-13.

Reassembly

Follow the disassembly sequence in reverse. Be careful with the followings .

Suggestions for Reassembly

1. Installing lift bracket rollers (all mast models)



Sequence

1 Lift bracket
2 Lift bracket upper rollers
3 Lift bracket middle rollers
4 Lift bracket lower rollers
5 Side 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 left most 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 left most or rightmost position.
Take measurement of clearance GI between the roller circumference and inner mast.
Adjust the clearance with shims to the specification.

Clearance GI	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.)

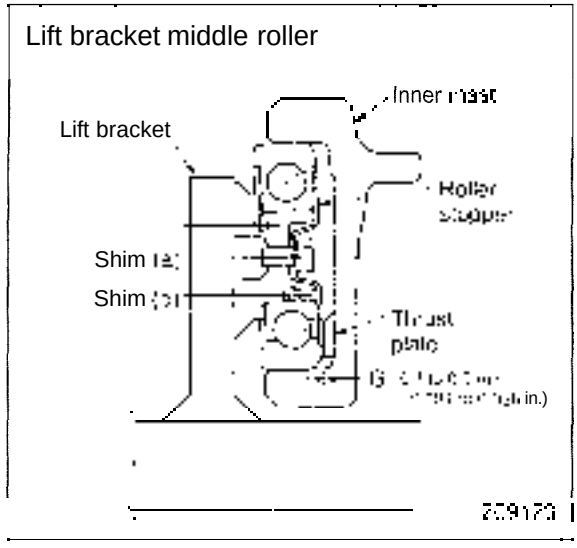
Truck Model / Size (Diameter)	1 ton class	2, 3 ton classes
S	[illegible]	[illegible]
M	[illegible]	[illegible]
L	[illegible]	[illegible]
LL	[illegible]	[illegible]

(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.).

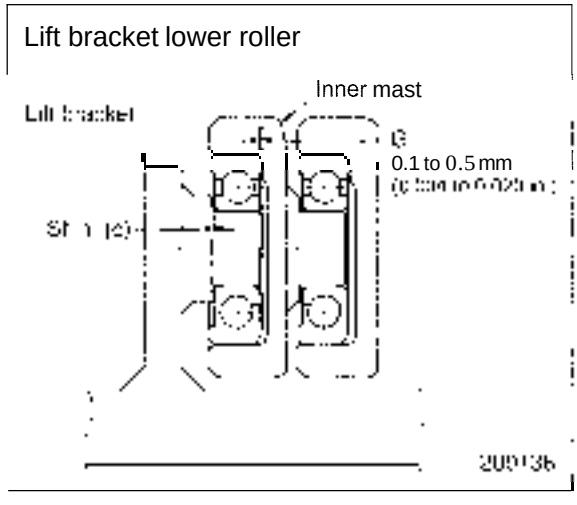
If shims (a) are increased by 0.5 mm (0.020 in.), shims (b) do not need to be increased by the equal amount.

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.

(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.

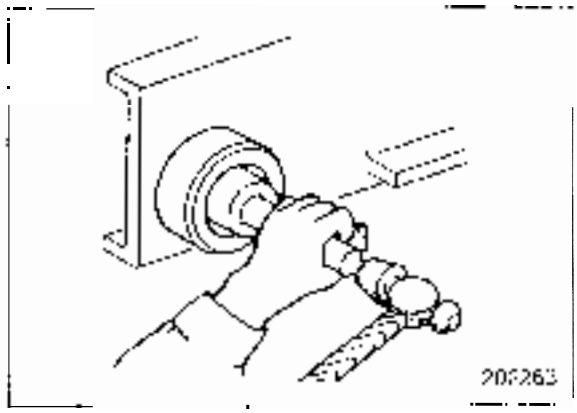
Remarks: At the assembly plant, shims (c) are usually adjusted to 1 mm (0.04 in.) for the shipment.

(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.

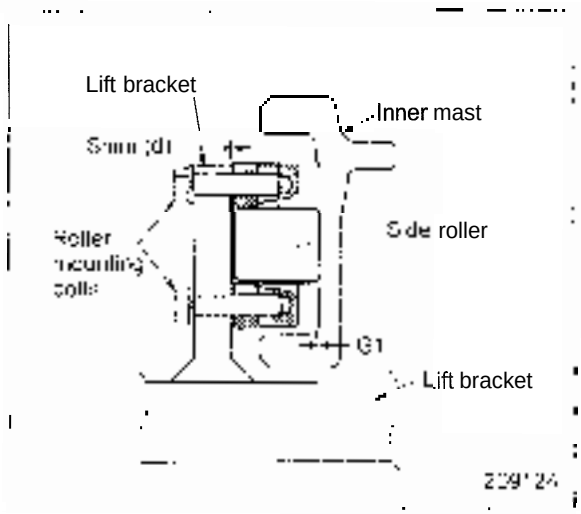
Make sure the rollers rotate smoothly when installed.



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

Measure clearance GI between the side roller's rolling contact surface and inner mast. If the measured clearance does not conform to the standard value, adjust clearance GI in the manner described below.

Note: For measuring procedures, refer to "Inspection and Adjustment."

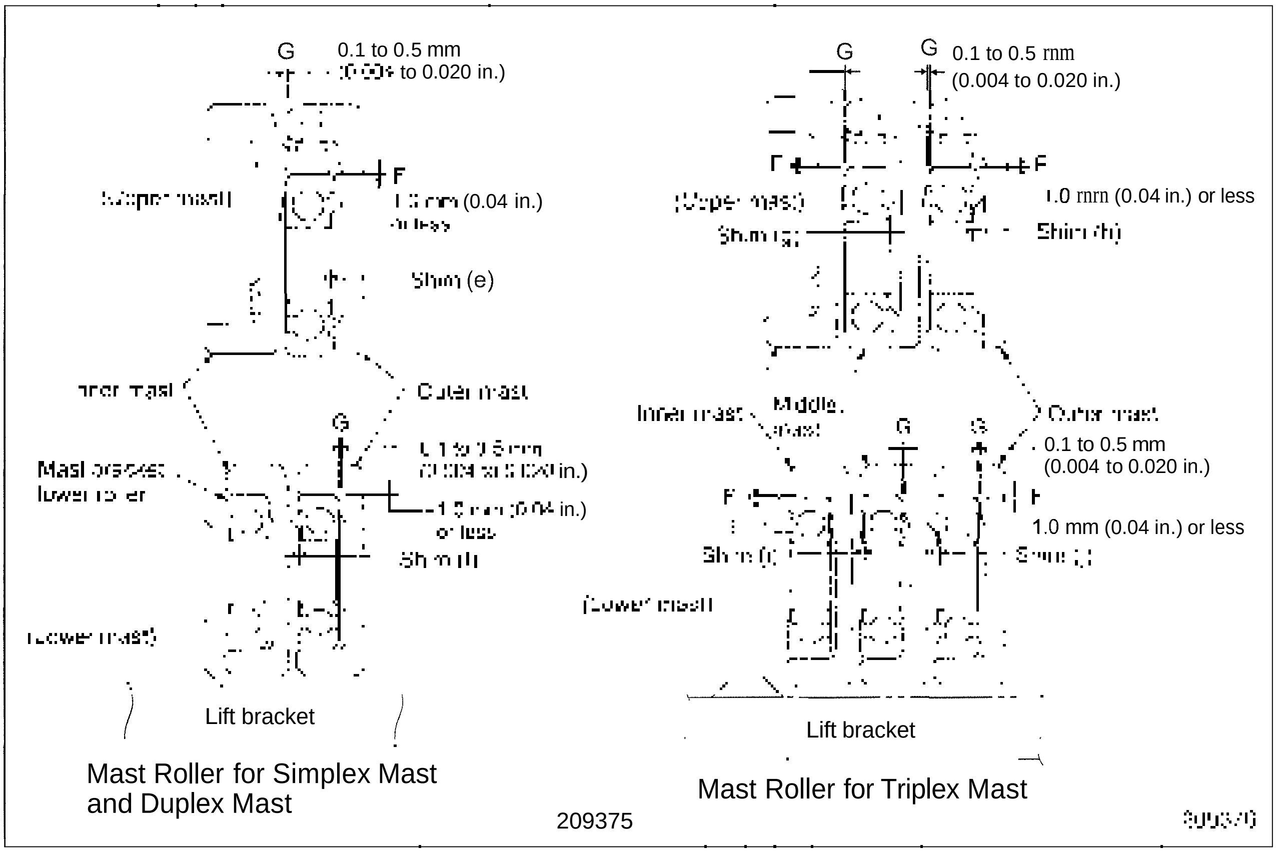


- Adjustment

If clearance GI 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.

2. installing mast rollers (all mast models)



Mast Roller for Simplex Mast and Duplex Mast

Mast Roller for Triplex Mast

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 (3.90)	113.8 (4.48)
M	100 (3.93)	115 (4.52)
L	101 (3.97)	116 (4.57)
LL	102 (4.02)	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)

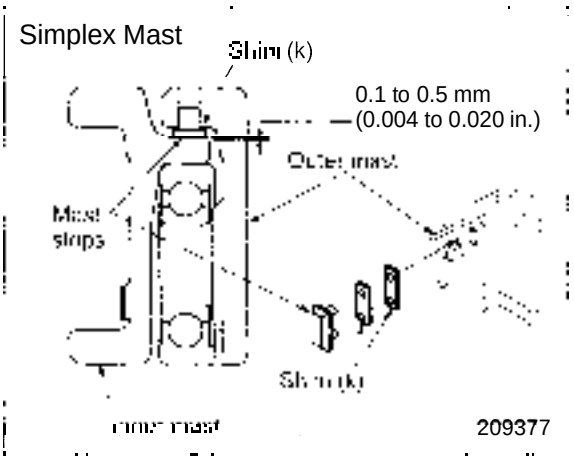
• Measurement

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.

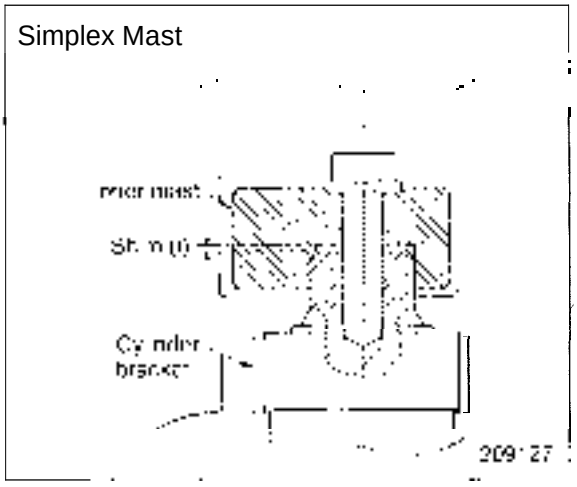
(1) Install the cylinder brackets to the lift cylinders as shown in the right illustration.

(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 (l) are used, be sure to reinstall them. Usually shims (l) 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).

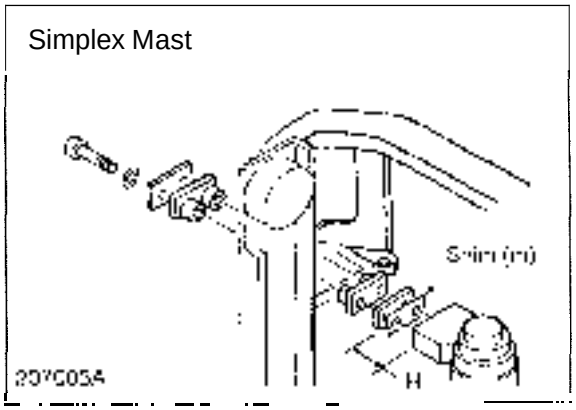
Clearance H	1.6 mm (0.063 in.) or less



• 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 fully lowered, temporarily install the first lift cylinder 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.).

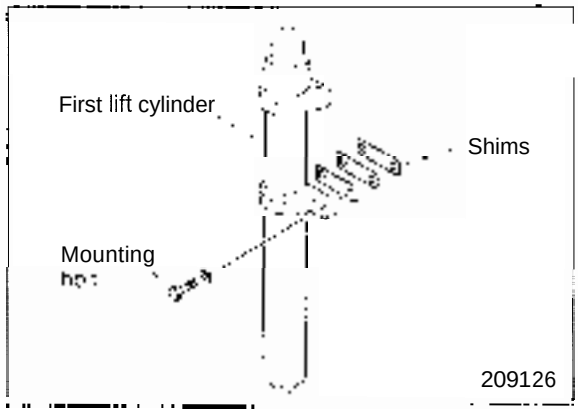
- The perpendicularity of each cylinder in the longitudinal direction can be checked by visually inspecting for the parallelism between the cylinder and the front face of the inner mast. The cylinder slightly inclined to the rear is acceptable. The cylinder should not be inclined forward even slightly.

Each shim is 1 mm (0.04 in.) thick.

Remarks: At the manufacturing facility, a shim pack of 2.0 mm (0.08 in.) is usually inserted between the cylinder bracket and the inner mast for the shipment.

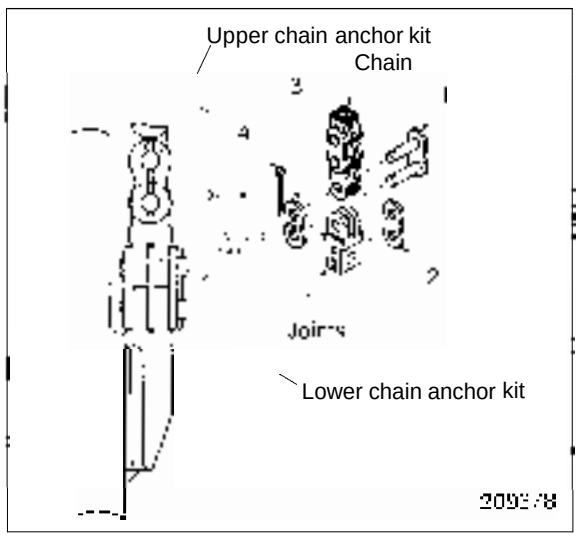
(3) After shimming is completed, install and tighten the mounting bolts.

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

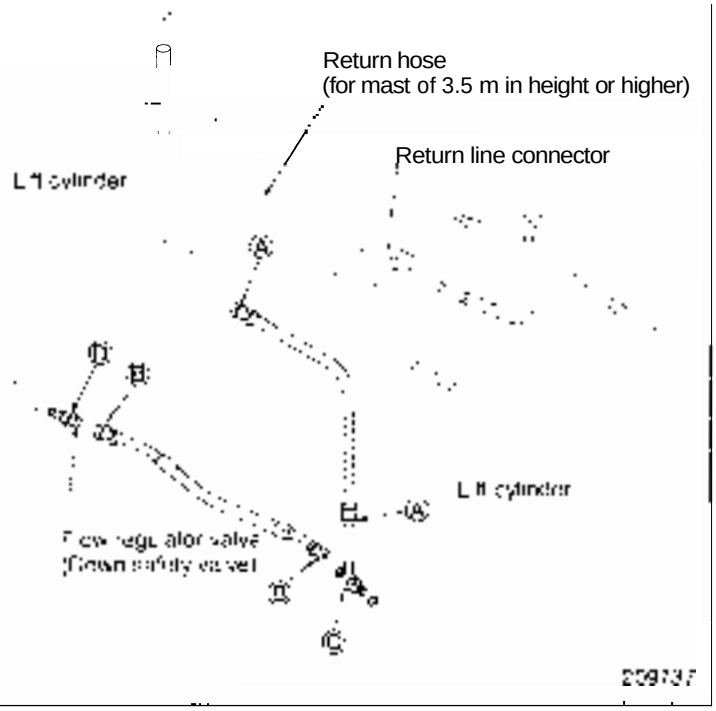
- Use care not to let abrasive dust or dirt to enter the hydraulic system.
  Apply a film of oil to O-rings before installation.
- For assembling Elbow Connector (a fitting with straight threads and O-ring seal) indicated by ⓒ. follow the procedure "Installation of a fitting with straight threads and 0-Ring seal" shown below.

(1) Simplex Mast

Tightening torques

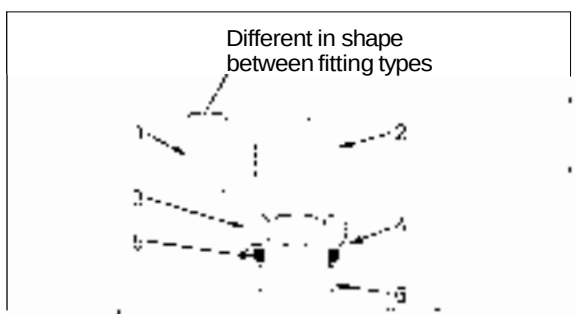
Unit : N·m {kgf·m} [lbf·ft]

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 Ⓑ		29±4.9 {3.0±0.5} [21.7±3.6]	29±4.9 {3.0±0.5} [21.7±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]



Installation of a fitting with straight threads and O-ring seal

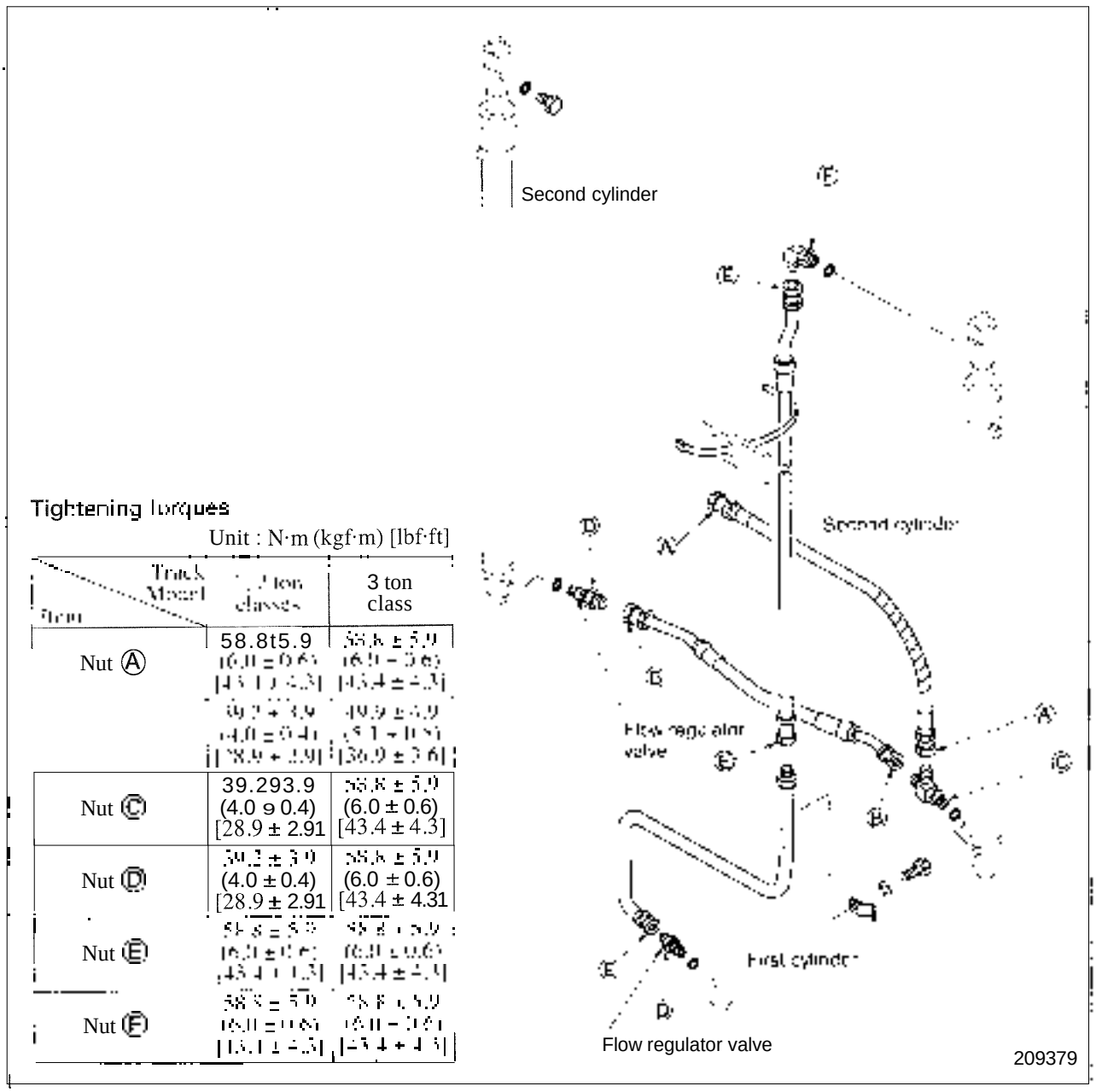
1. Apply grease or hydraulic oil to O-ring and O-ring seat in the housing side.
2. Turn lock nut 3 to move it as close to fitting body 2 as possible. Place washer 4 and O-ring seal 5 against the lock nut.
3. Tighten the fitting by hand. Once O-ring 5 is placed in the position of housing and washer 4 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)	4	Backup washer
2	Fitting body	5	O-ring seal
3	Locknut	6	End of fitting that goes into other part

(2) Duplex Mast



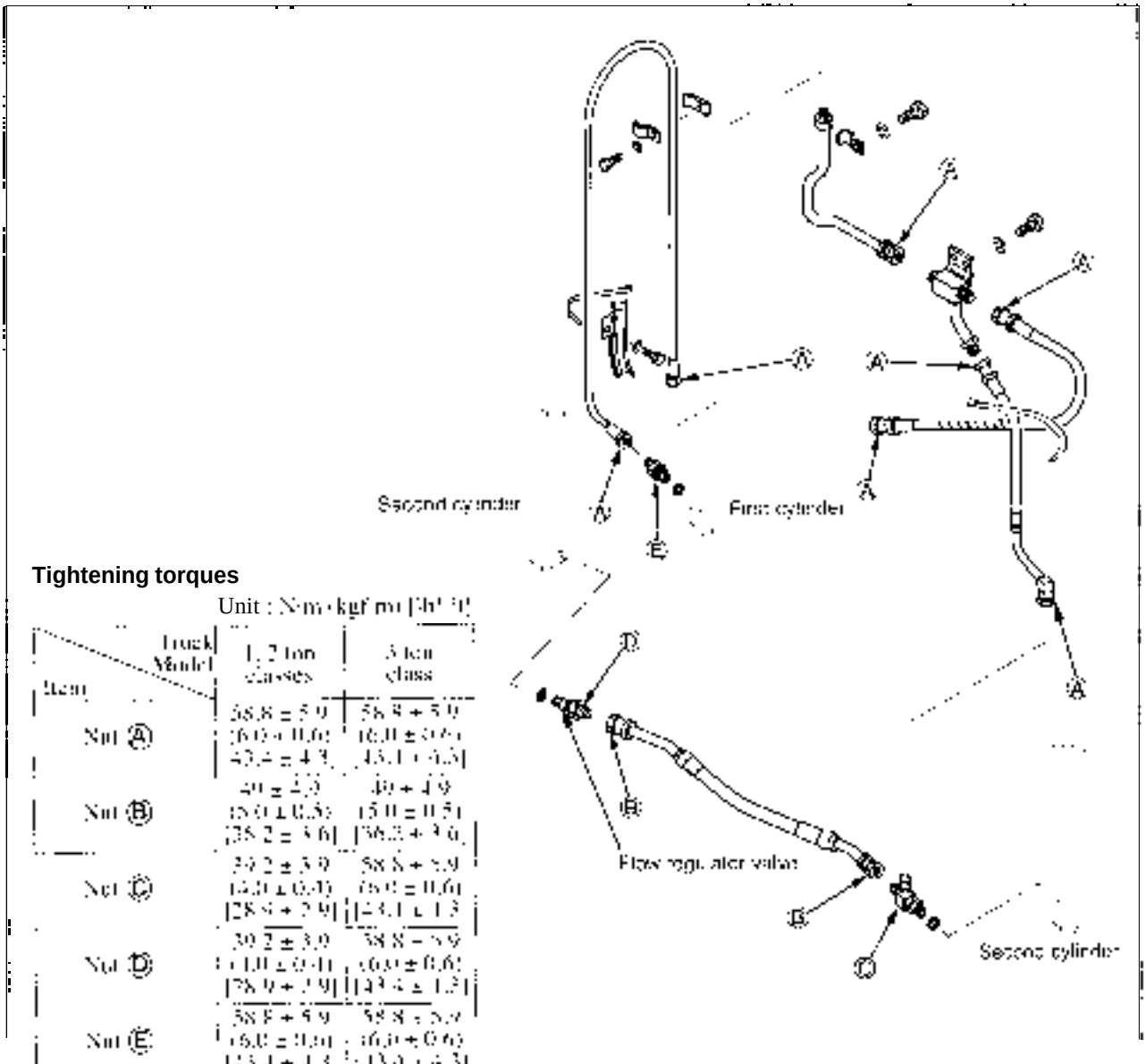
Tightening torques

Unit : N·m (kgf·m) [lbf·ft]

Item \ Truck Model	2 ton classes	3 ton class
Nut Ⓐ	58.8t5.9 (6.0 ± 0.6) [43.4 ± 4.3]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.9]	49.0 ± 4.9 (5.0 ± 0.5) [36.9 ± 3.6]
Nut Ⓒ	39.293.9 (4.0 ɔ 0.4) [28.9 ± 2.91	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
Nut Ⓓ	39.2 ± 3.9 (4.0 ± 0.4) [28.9 ± 2.91	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.31
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 Ⓕ	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 Ⓒ and Ⓔ ➤Ⓕ, 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 Ⓐ	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 Ⓑ	40 ± 4.9 (4.0 ± 0.5) [28.9 ± 3.6]	40 ± 4.9 (4.0 ± 0.5) [28.9 ± 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 Ⓓ	30.2 ± 3.9 (3.0 ± 0.4) [21.7 ± 2.9]	58.8 ± 5.9 (6.0 ± 0.6) [43.4 ± 4.3]
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]

Note: When installing fittings Ⓒ, 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

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:

(I) 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.

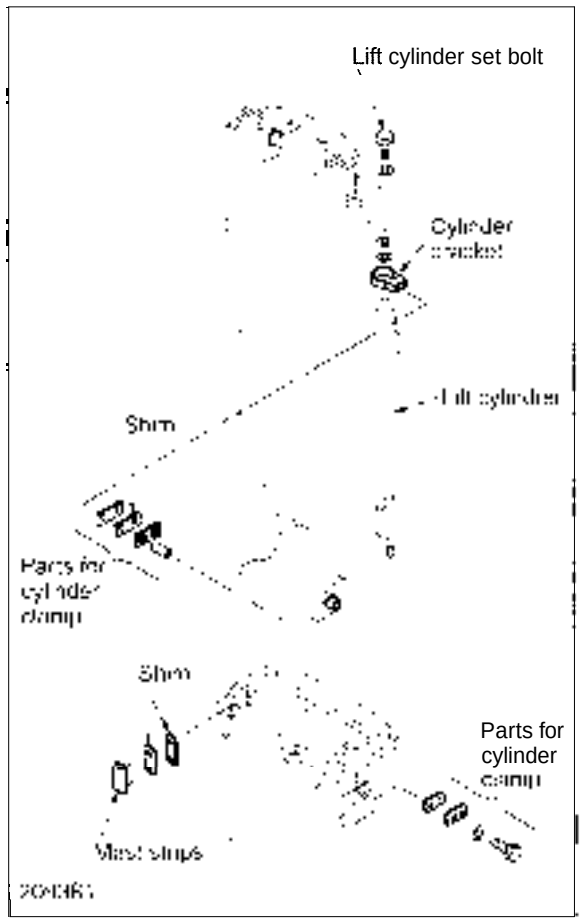
(3) Remove the set bolts at the top of the lift cylinders. Place a sling around the inner mast. Lift the inner mast using a hoist connected to the sling in order to disengage the lift cylinders' piston rods from the inner mast. Remove the hose guard.

(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.

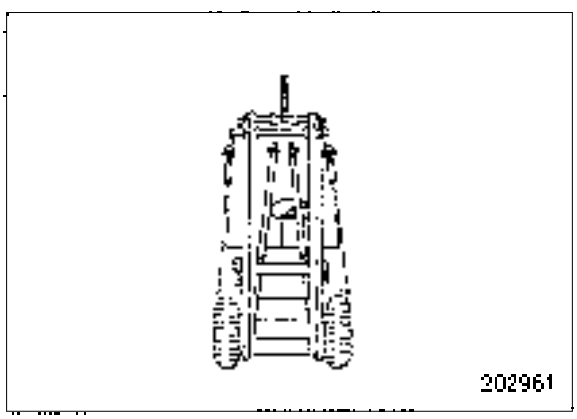
(5) Using the hoist, slowly lower the inner mast until the mast contacts the lift cylinders.

(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.



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.

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 [illegible] to the sling in order to disengage the lift cylinders' piston rods from the inner mast. Remove the hose guard.

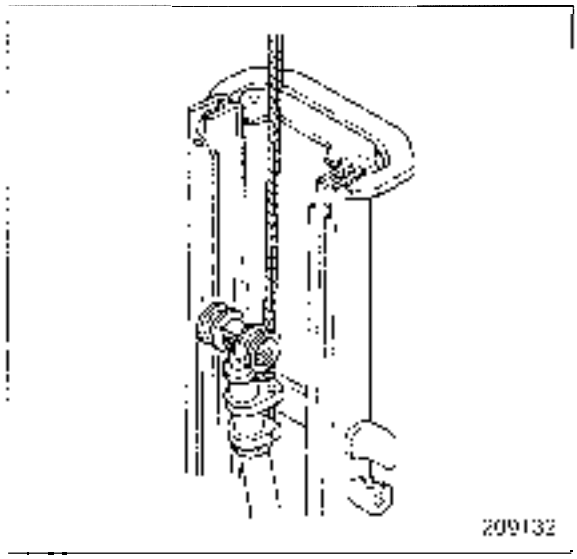
(c) Remove the second lift cylinder clamp bolts, and separate the cylinders from the outer mast. Pull out the lift cylinders from the seats at the bottom of the outer mast. Tilt the cylinders until they rest on the outer mast cross member. Using a rope, fix the cylinders onto the cross member.

(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.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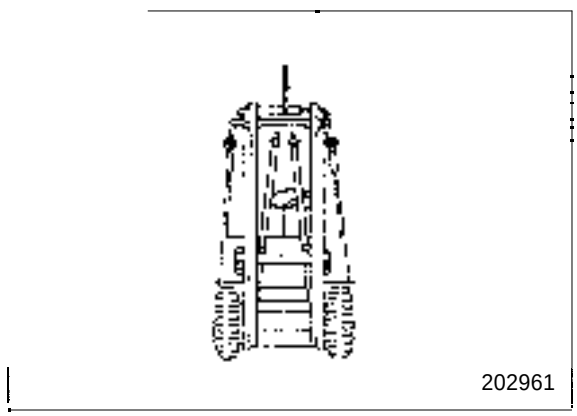
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3. Triplex Mast

(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.

(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.

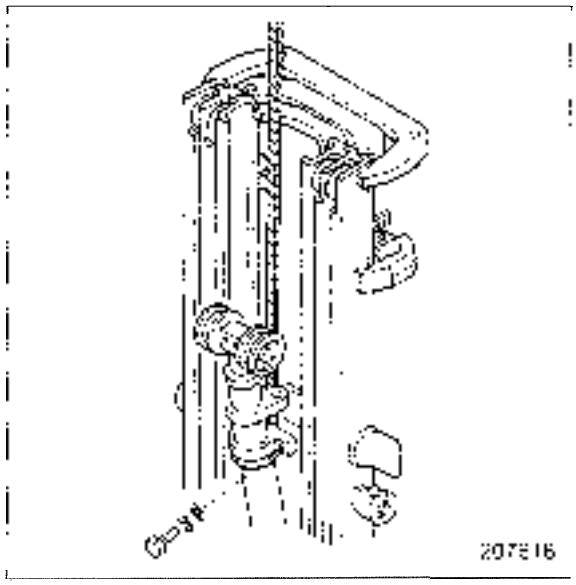
(d) Disconnect the second lift chains at the outer mast ends, and place the loose ends on the floor beyond the inner mast.

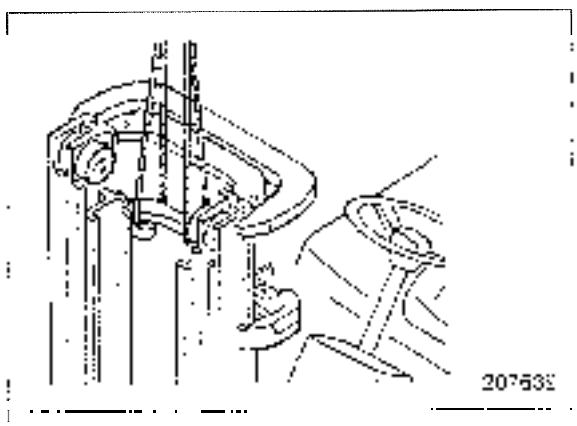
(e) Lower the inner mast to such a height that allows the mast rollers to be removed.

(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.

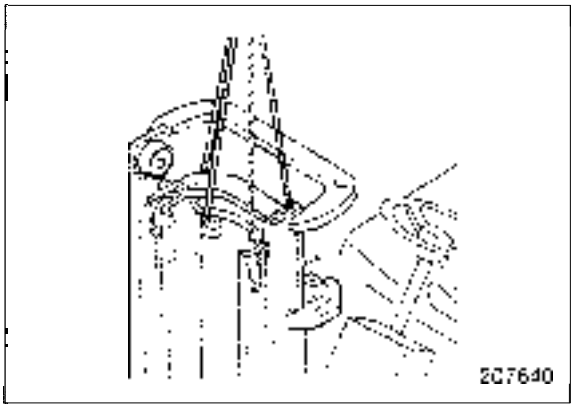
(d) Remove two lift cylinder clamps, dismount the second lift cylinders from the mounting sections at the lower outer mast section. Tilt the cylinders by moving the top sections towards the center of the truck. Using a rope, fix the cylinders onto the cross member.

(e) Lower the middle mast and inner mast until mast rollers (outer mast upper roller and middle mast lower roller) can be moved.

(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.



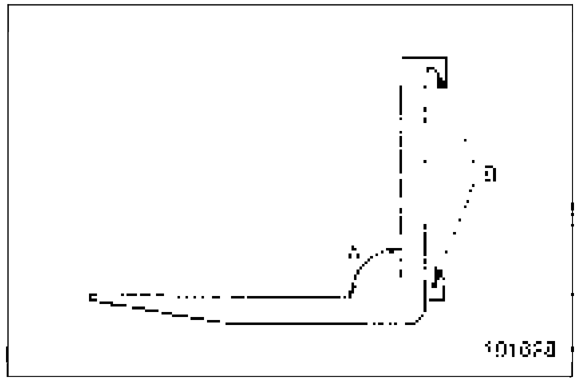
- For reassembling, follow the disassembly sequence in reverse.

Inspection and Adjustment

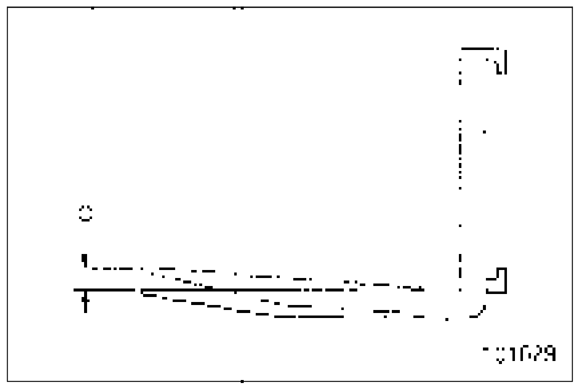
The inspection and adjustment in this chapter can be done without dismounting or disassembling. Conduct inspection whenever a defect is suspected.

1. Forks (all mast models)

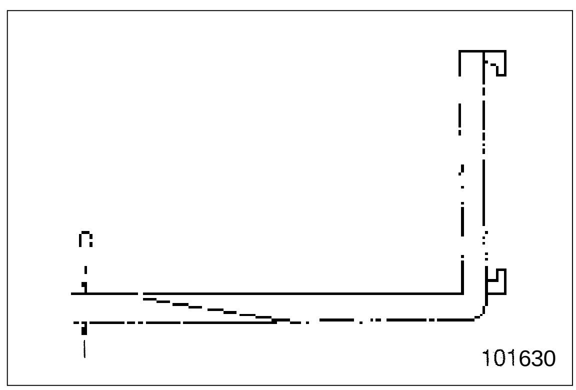
(1) Carefully inspect the forks for cracks. Special attention should be given to the heel section A, all weld areas and mounting brackets B.
Forks with cracks shall be removed from service.
Magnetic particle inspection is generally preferred due to its sensitivity and the ease of interpreting the results.
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.)

Item \ Truck Model		P40001	P45001	PC40001, P40001	P50001	P55001, P60001, P65001, P70001
Fork thickness	A	34 (1.34)	35 (1.38)	37 (1.46)	42 (1.65)	50 (1.97)
	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.

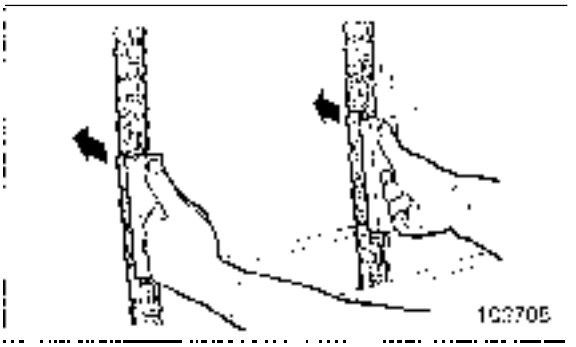
(6) Start the engine, and place the mast vertical again.

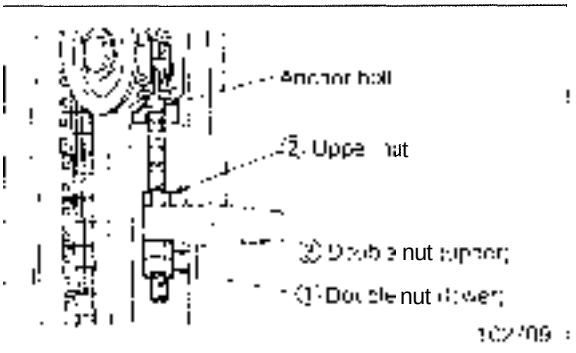
(7) Repeat (2) through (5) of procedure 1, to check the chain tension and adjust it as needed.

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.



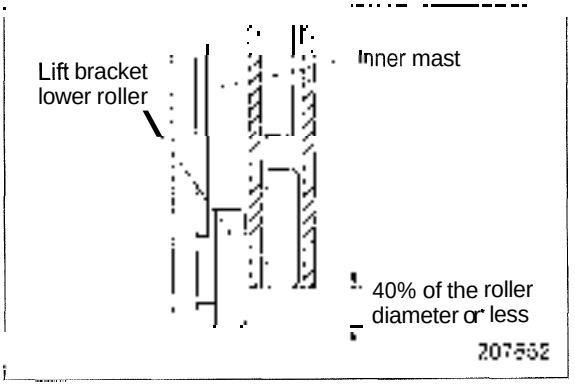


Tightening torque Unit : N·m (kgf·m) [lbf·ft]

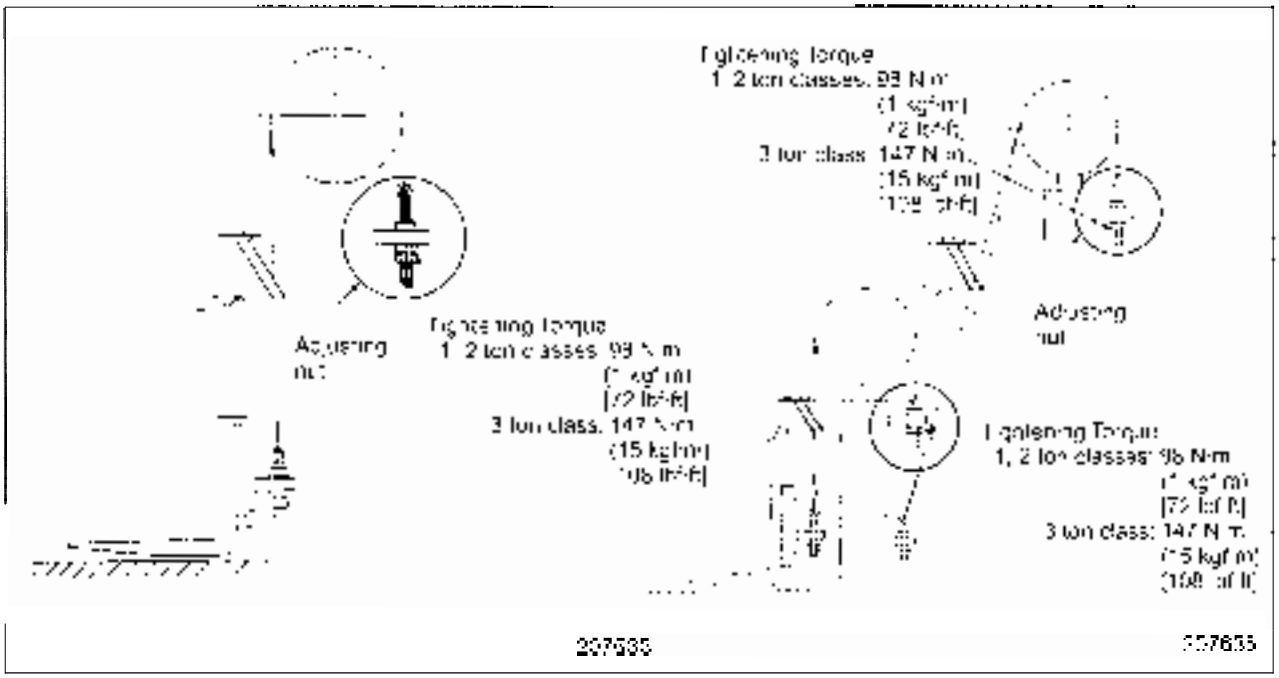
Item \ Truck Model	1, 2 ton classes	3 ton class
Nuts ①, ③	98 (3.86)	147 (5.79) $^{+49\ (193)}_{0}$

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



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.

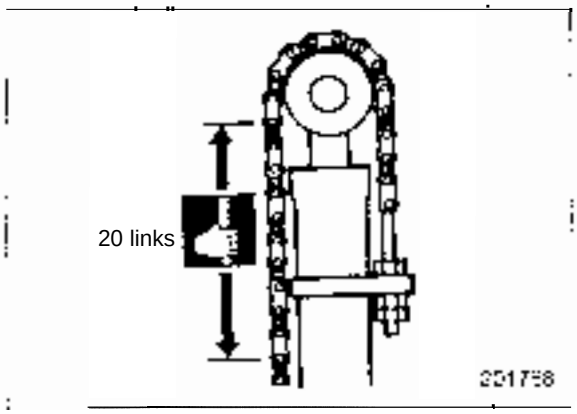
(2) Measure the length of 20 links of chain. When the length exceeds the service limit specified in the table below, replace the chain with new one.

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		393 (15.4)	402 (15.8)	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)

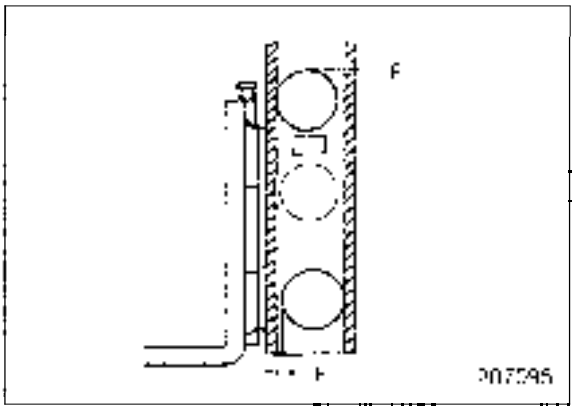


4. Adjusting Clearance between Lift Bracket Roller and Inner Mast (all mast models)

(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

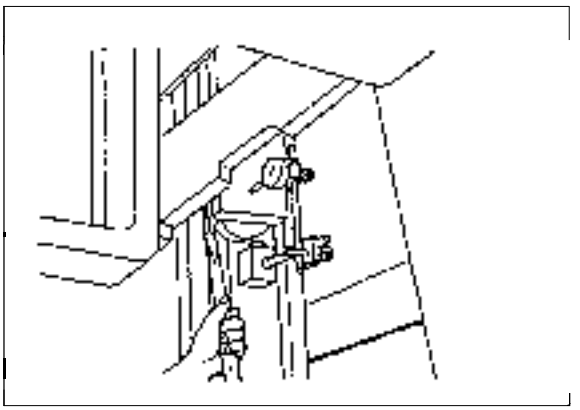
(a) Raise the mast to the top.

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

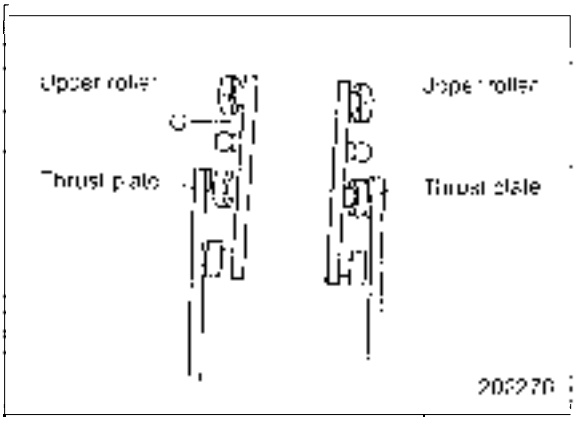
(c) Go over to the opposite side of the mast, and push the lift bracket to one side with a bar. Set the indicator to zero.

(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.



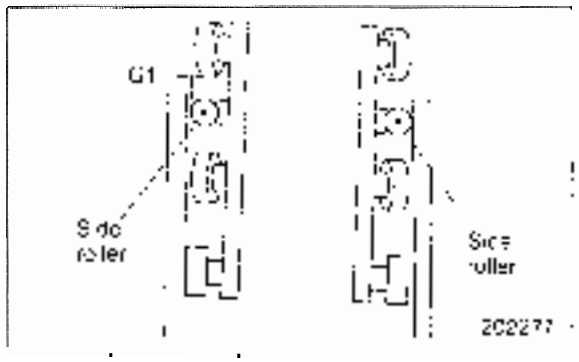
Note: Upper rollers are free from checking and adjusting.



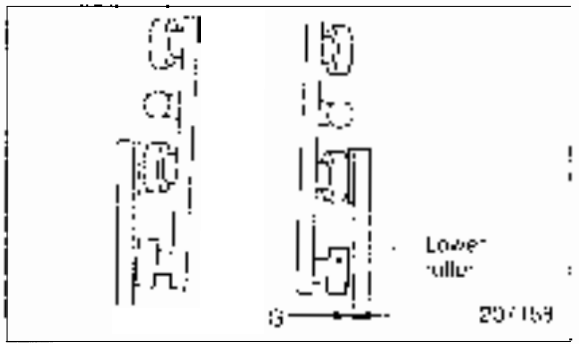
Clearance G	0.1 to 0.5 mm (0.004 to 0.020 in.)

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 GI between the side roller. If clearance GI 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 GI 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.



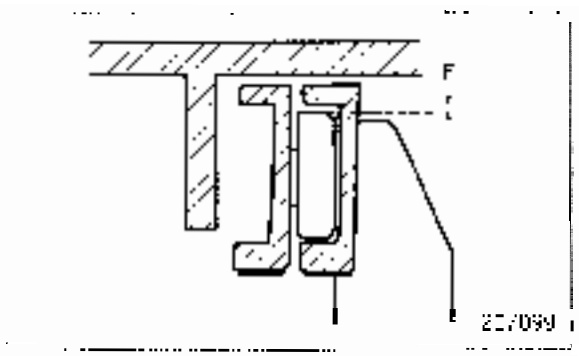
5. Mast Roller Clearance Adjustment (all mast models)

(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



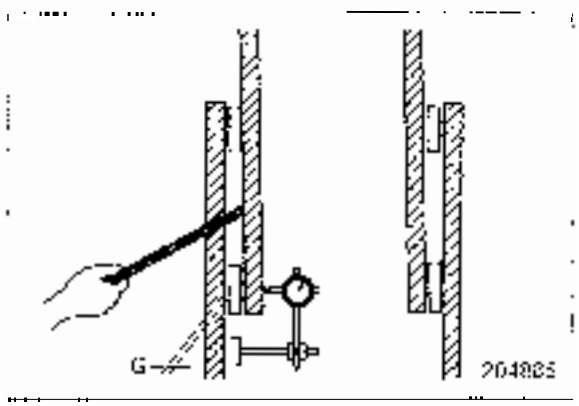
(c) If the clearance F is out of the specification, use oversize rollers. For mast roller replacement and installation procedures, refer to "Installing mast rollers" on page 12-22.

(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.

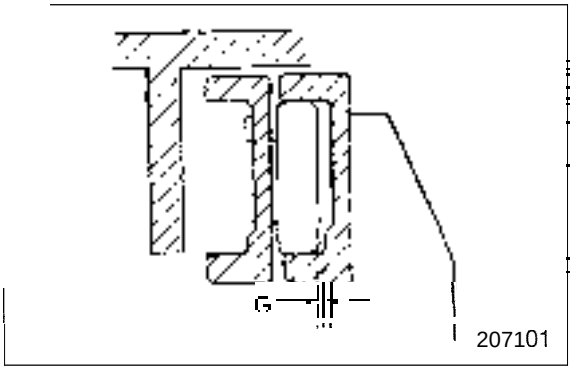


(d) Insert a bar between the outer and inner masts on the indicator side, and push the inner mast to the opposite side.

(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 rnast rollers" on page 12-22

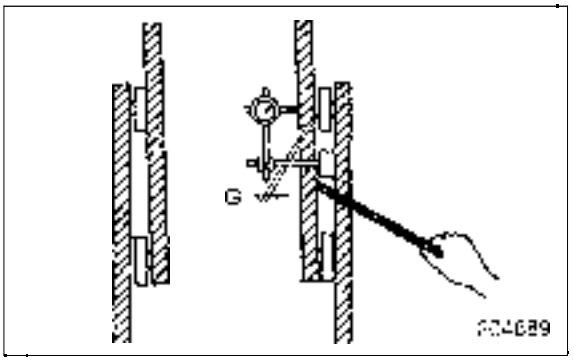


(3) Right-to-left clearance check on outer mast main rollers

(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.

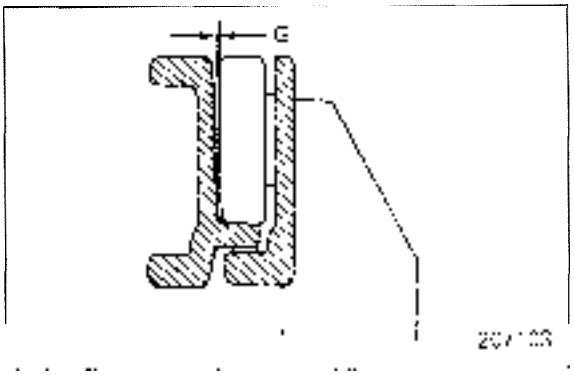


(d) Insert a bar between the outer and inner mast, and push the inner mast to the opposite side.

(e) Read the indicator. This reading is the clearance G between outer mast roller and inner mast.

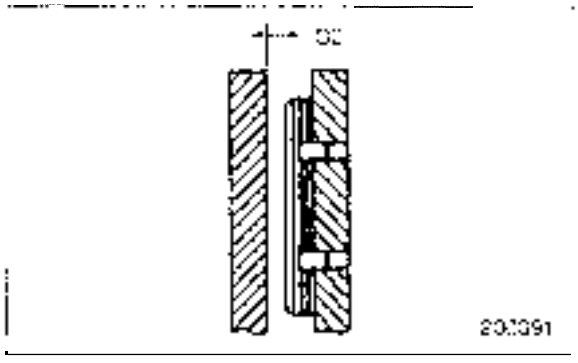
Clearance G	0.1 to 0.5 rnm (0.004 to 0.020 in.)

(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.



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.

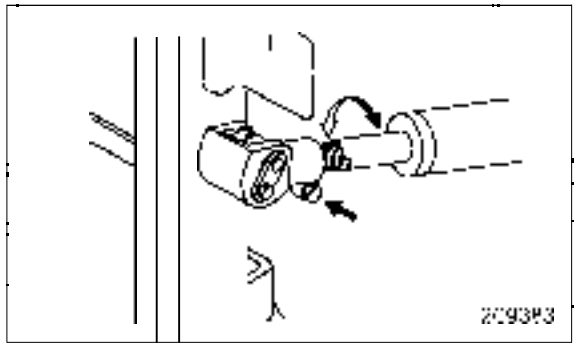
7. Tilt Angle Adjustment (all mast models)

(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°

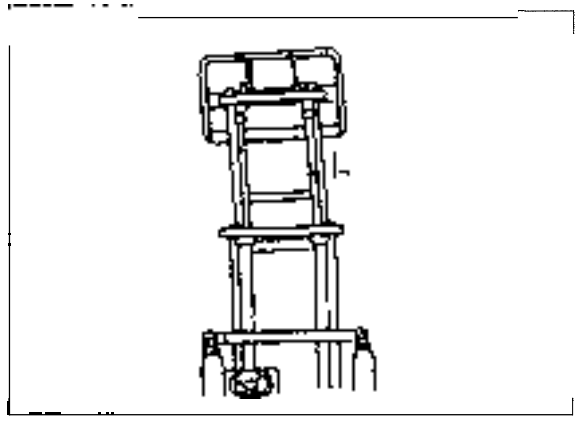
(5) After adjusting the tilt angle, tighten the socket bolts to the specified torque.

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.

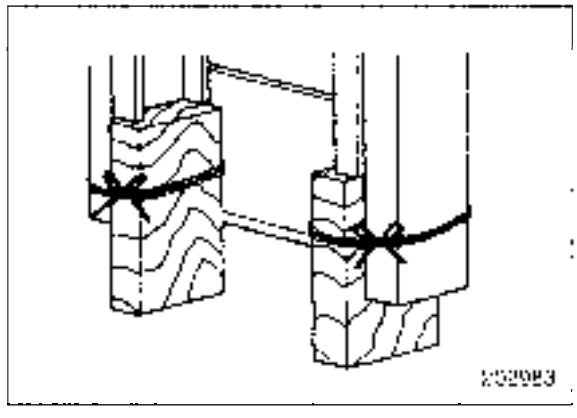
(2) If the top of the inner mast jolts at that moment, make a shim adjustment. Abnormal condition can be detected by a little time lag in stopping between the piston rods, left and right, and shaking of the rod with a longer cylinder stroke.



(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.

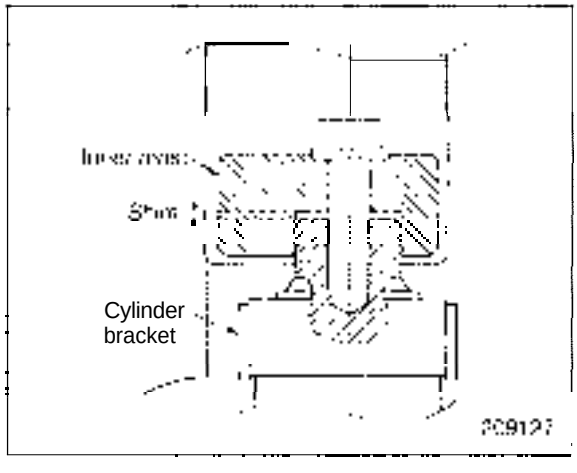
(b) Remove the set bolt at the top of lift cylinder which showed earlier stroke end, retract the piston rod, and insert shims at the top of piston rod end.



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.



Troubleshooting

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	Repair or replace.
	Forks bent	
	Un-even loading	

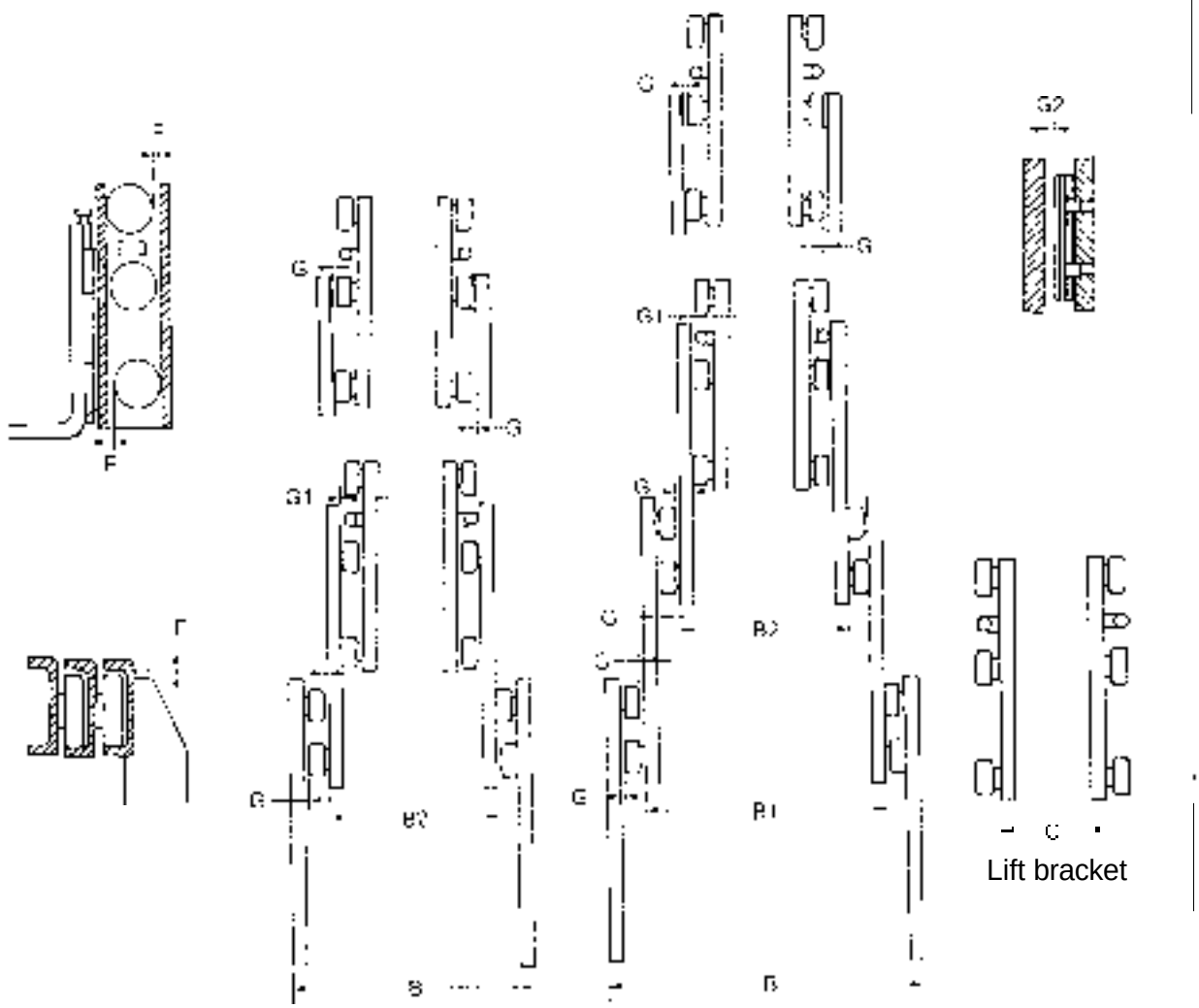
Service Data

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	[illegible]	[illegible]	[illegible]
Rollers	Main roller external diameter			S	[illegible]	[illegible]	[illegible]
				M	[illegible]	[illegible]	[illegible]
				L	[illegible]	[illegible]	[illegible]
				LL	[illegible]	[illegible]	[illegible]
	Side roller external diameter			A	[illegible]	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	[illegible]		
		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	[illegible]		
		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		[illegible]			
Finger bar bend				A	5.0 (0.2) or less		

Item	Truck Model	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Fork thickness	A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	B	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



Simplex mast,
Duplex mast

Triplex mast

Lift bracket

Mast width is slightly wide at the lower portion than at the upper portion.
Measure the clearance at the mast upper position.

SERVICE DATA

Maintenance Schedule

Abbreviation..... X: Check, C: Clean, D: Drain, L: Lubricate, R: Replace

	Inspection point	How to check	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Service data
[illegible]ake	Brake drum & shoe clearance	Feeler gauge				X				1 ton: 0.5 to 1.0 mm (0.0197 to 0.0394 in.) 2, 3 ton: 0.1 to 0.35 mm (0.004 to 0.014 in.)
	Brake hose, pipes & joints	Visual		X						
	Brake pedal clearance between pedal and floor when depressed	Scale	X							Powershift T/M: 1.5 to 6.5 mm (0.0591 to 0.2559 in.) Manual T/M: 7 mm (0.2756 in.)
	Parking brake lever operating effort	Spring scale	X							245 to 295 N (24.98 to 30.08 kgf) [55.08 to 66.32 lbf]
	Service brake fluid level	Visual	X							
	Brake [illegible] pedal rod (see Note 2)	Visual/wrench					L			
	Brake master cylinder hoses & rubber parts							R		
	Service brake fluid							R		135 cc (8.238 cu in.)
	Brake wheel cylinder rubber parts							R		
Cooling	Radiator fin (see Note 2)	Visual			*C*	*C*				
	Cooling fan	Visual/feel	X							
	Engine coolant level	Visual	X							
	Radiator [illegible]	Visual/feel			X			X		
	Rubber hose condition	Visual/feel			X			X		
	V belt (fan & alternator) tension (deflection)	Scale		X						Gasoline engine: 11 to 13 mm [illegible]
	Engine coolant (incl. reserve tank)							R		[illegible]
Ele[illegible]a[illegible]	Alternator	Operation/visual			X		X			
	Back lamps	Visual	X							
	Battery electrolyte level (see Note 4)	Visual	X							
	Battery electrolyte specific gravity (see Note 4)	Hydrometer			X	X				1.28 or higher
	Driving interlock system	Operation/visual	X							
	Electrical wires	Visual/feel			X	X				
	Horn	Operation/visual	X							
	Meter panel (instrument) lamps (incl. parking brake and seat belt)	Operation/visual	X							

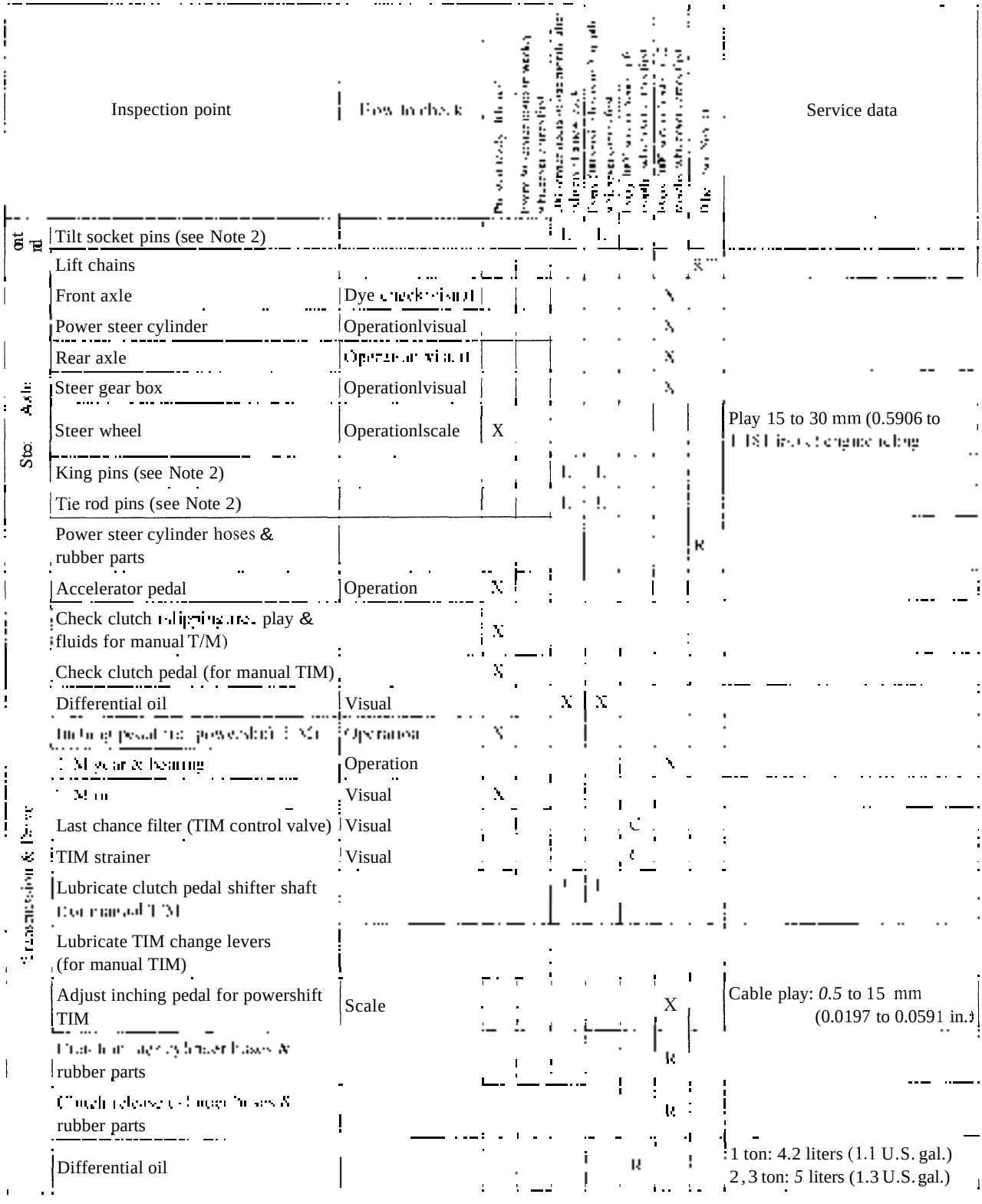
Abbreviation..... X: Check, C: Clean, D: Drain, L: Lubricate, R: Replace

	Inspection point	How to check											Service data
Electrical	Mast interlock system	Operator visual	X										
	Parking brake buzzer	Operation test	X										
	Starter	Operator aural			X			X					
	Stop lamps	Operator visual	X										
	Working & head lamps	Operator visual	X										
Engine	Cylinder head bolt & manifold nut	Wrench			X								
	Engine (exhaust, noise, vibration)	Visual/feel	X										
	Engine oil level	Dip stick	X										
	Idling speed (for Carburetor and diesel engine)	Tachometer	X										Gasoline engine models:700 rpm Diesel-engine models :650 to 700 rpm
	Intake & exhaust valve clearance	**Feeler gauge**			X		X			X			Gasoline engine (hot): 0.38 mm (0.0150 in.) Diesel-engine models (cold): 0.25 mm (0.0098 in.)
	Positive crankcase ventilation valves & hoses	Air blow test					X						
	Engine oil				R		R						
	Engine oil filter				R		R						
Frame & Chassis	Frame assist grip	Visual/wrench	X										
	Loosen bolts & nuts	Wrench			X		X						
	Overhead guard	Deformation	X										
	Seat adjustment	Operation/wrench	X										
	Seat belt	Operation/visual	X										
Fuel	Tar in vaporizer (see Note 3)	Check & drain			D		D						
	Fuel hose, pipes & joints (see Note 3)	Visual		X									
	Fuel level	Meter panel	X										
	Check injection nozzle (for Diesel)									X			
	Injection nozzle (for G, LP & G/L dual engine with electronic control)				X		X						
	Clean gasoline fuel filter (for G & G/L dual engines without electronic control) (see Note 3)												
	LPG fuel filter (see Note 3)						X						
	Change diesel fuel filter (see Note 3)				R			R					

Abbreviation..... X: Check, C: Clean, D: Drain, L: Lubricate, R: Replace

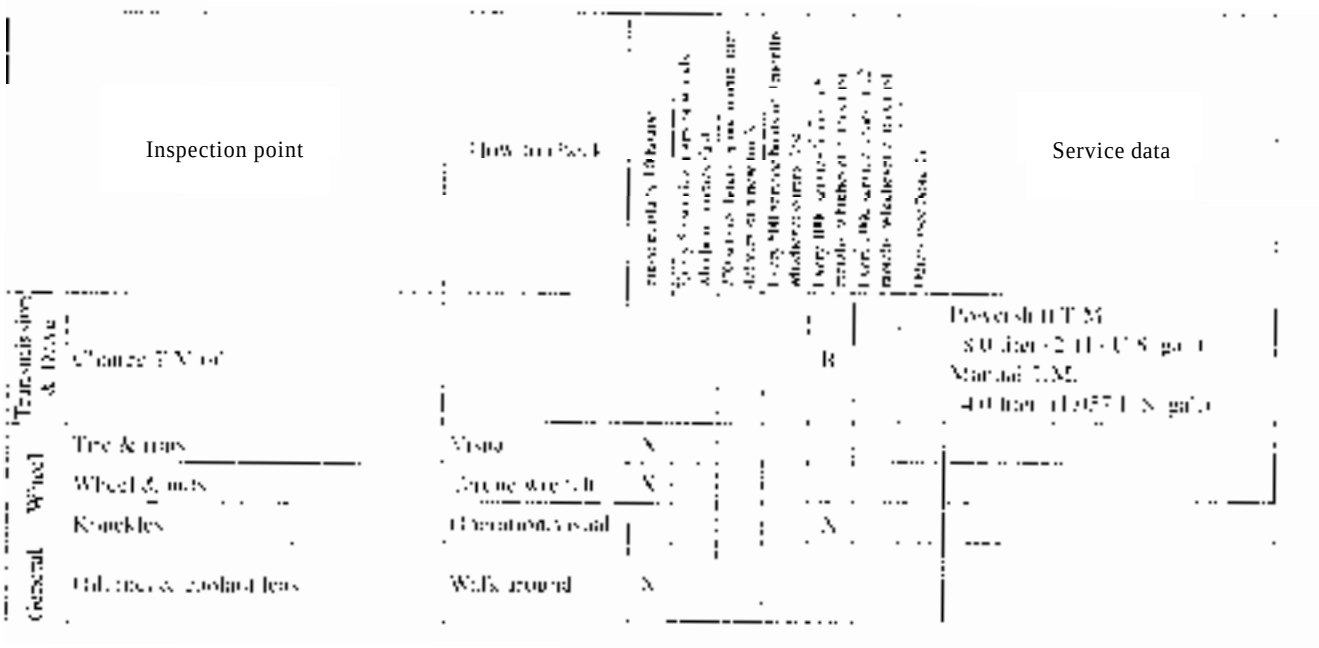
	Inspection point	How to check												Service data
	Fuel hose												R	
	Change gasoline fuel filter (for G & G/L dual engine w/o elec.cont.) (see Note 3)				R			R						
	LPG fuel filter (see Note 3)											R		
	Vaporizer rubber parts											R		
	Control valve	Oil pressure gauge										X		
	Hydraulic hose, pipes & joints	Visual			X									
	Hydraulic oil	Visual	X											
	Hydraulic suction strainer	Visual and smell										X		
	Hydraulic tank strainer	Visual											C	
	Hydraulic hose (high-pressure hose)												R	
	Hydraulic oil											X		1 ton: 28 liter (7.398 U.S. gal.) 2, 3 ton: 39 liter (10.30 U.S. gal.)
	Hydraulic tank return oil filter				R			R						
	Check distributor point, cap & rotor (for G & G/L dual engine w/o elec. cont.)				X		X							
	Check ignition timing (for G & G/L dual engine w/o elec.cont.)				X		X							
	Spark plug gap	Plug gauge			X		X					X		
	Clean distributor inside (for G & G/L dual engine w/o elec.cont.)											C		
	Air cleaner element (see Note 2)	Visual			C									
	Air cleaner element (see Note 2)											R		
	Lift chains	Operation check	X											
	Lift cylinder mounting bolts	Torque wrench	X											
	Load backrest	Operation visual	X											
	Mast & forks	Operation visual	X											
	Mast strip sliding surfaces	Visual	X											
	Tilt cylinder socket bolts	Torque wrench	X											
	Lift chains (see Note 2)			L										
	Mast support (see Note 2)			L										

Abbreviation..... X: Check, C: Clean, D: Drain, L: Lubricate, R: Replace



	Inspection point	How to check	Service data
Front Axle	Tilt socket pins (see Note 2)		
	Lift chains		
	Front axle	Dye check or visual	
	Power steer cylinder	Operation/visual	
	Rear axle	Operation/visual	
	Steer gear box	Operation/visual	
	Steer wheel	Operation/scale	Play 15 to 30 mm (0.5906 to 1.181 in.) at engine idling
	King pins (see Note 2)		
	Tie rod pins (see Note 2)		
	Power steer cylinder hoses & rubber parts		
	Accelerator pedal	Operation	
	Check clutch adjusting nut play & fluids for manual T/M)		
	Check clutch pedal (for manual TIM)		
	Differential oil	Visual	
	Inching pedal for powershift TIM	Operation	
	TIM gear & bearing	Operation	
	TIM oil	Visual	
Transmission & Power	Last chance filter (TIM control valve)	Visual	
	TIM strainer	Visual	
	Lubricate clutch pedal shifter shaft (for manual TIM)		
	Lubricate TIM change levers (for manual TIM)		
	Adjust inching pedal for powershift TIM	Scale	Cable play: *0.5* to 15 mm (0.0197 to 0.0591 in.)
	Clutch booster cylinder hoses & rubber parts		
	Clutch release cylinder hoses & rubber parts		
	Differential oil		1 ton: 4.2 liters (1.1 U.S. gal.) 2, 3 ton: *5* liters (1.3 U.S. gal.)

Abbreviation..... X: Check, C: Clean, D: Drain, L: Lubricate, R: Replace



Note 1: *: Change in 1 to 2 years

**: Change in 2 years

***: Change in 2 to 4 years

Note 2: In corrosive or abrasive environments, clean, lubricate and change more frequently.

Note 3: When fuel with poor quality is used, check, drain, clean and change more frequently.

Note 4: Not required if battery is full maintenance free battery.

Note 5: Apply soap suds to the piping joints to check for any gas leakage after replacing the LPG tank.

Tightening Torques for Standard Bolts and Nuts

With spring washer 101656

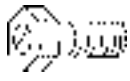
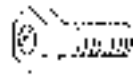
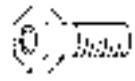
Nominal size		Pitch		(7)			(8)			(10)		
mm	in.	mm	in.	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
6	0.24	1	0.04	8.6	0.88	6.4	10.8	1.1	8.0	14.7	1.5	10.8
8	0.32	1.25	0.05	19.6	2.0	14.5	26.5	2.7	19.5	36.6	3.7	26.8
10	0.39	1.25	0.05	41.2	4.2	30.4	53.0	5.4	29.1	81.4	8.3	60.0
12	0.47	1.25	0.05	74.5	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	2256.2	230.1	1663.3	2931.1	299.2	2164..	4123..	419.6	3035.9
39	1.54	1.5	0.06	2896.0	295.3	2134.9	3763.8	383.8	2776.0	5258.3	536.2	3878.3

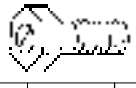
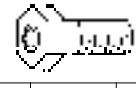
Metric fine thread

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

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
Metric coarse thread	10	0.39	1.5	0.06	33.3	3.4	24.6	43.1	4.4	31.8	67.7	6.9	49.9
	12	0.47	1.75	0.07	58.8	6.0	43.4	76.5	7.8	56.4	115.7	11.8	85.3
	14	0.55	2	0.08	96.4	9.8	70.9	124.5	12.7	91.9	182.4	18.6	134.5
	16	0.63	2	0.08	147.1	15.0	108.5	191.2	19.5	141.0	274.6	28.0	202.5
	18	0.71	2.5	0.10	203.0	20.7	149.7	264.8	27.0	195.3	383.4	39.1	282.8
	20	0.79	2.5	0.10	286.4	29.2	211.2	371.7	37.9	274.1	536.4	54.7	395.6
	22	0.87	2.5	0.10	383.4	39.1	282.8	499.2	50.9	368.2	725.9	74.0	535.2
	24	0.95	3	0.12	492.3	50.2	363.1	640.4	65.3	472.3	924.8	94.3	682.1
	27	1.06	3	0.12	724.7	73.9	534.5	942.2	96.1	695.1	1350.4	137.7	996.0
	30	1.18	3.5	0.14	969.9	98.9	715.3	1259.2	128.4	928.7	1843.7	188.0	1359.8
	33	1.30	3.5	0.14	1326.8	135.3	980.1	1727.0	176.1	1273.7	2477.2	252.6	1827.1
	36	1.42	4	0.16	1670.0	170.9	1235.1	2180.0	222.3	1607.9	3159.9	320.3	2284
	39	1.54	4	0.16	2219.2	226.3	1636.6	2884.1	294.1	2127.2	4158.8	424.0	3037.9
	42	1.65	4.5	0.18	2254.7	280.9	2031.8	3581.4	365.2	2641.3	5137.7	523.9	3789.1

	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	113.8	11.6	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	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	509.6	52.0	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	171.7
	30	1.18	3.5	0.14	1140.8	116.4	841.2	1483.8	151.1	1092.9	2168.3	221.1	1599.2
	33	1.30	3.5	0.14	1563.2	159.4	1153.0	2033.2	207.2	1498.7	2915.5	297.3	2150.4
	36	1.42	4	0.16	1972.1	201.1	1454.6	2564.1	261.5	1891.1	3766.8	384.0	2777.5
	39	1.54	4	0.16	2611.5	266.3	1925.4	3395.1	346.1	2502.6	4983.2	491.1	3573.8
	42	1.65	4.5	0.18	3254.1	331.8	2400.5	4232.3	431.6	3120.7	6021.8	614.4	4388.1

Remarks: 1. The tolerance on the torque is ± 10%

2. The torques are for "dry" condition.

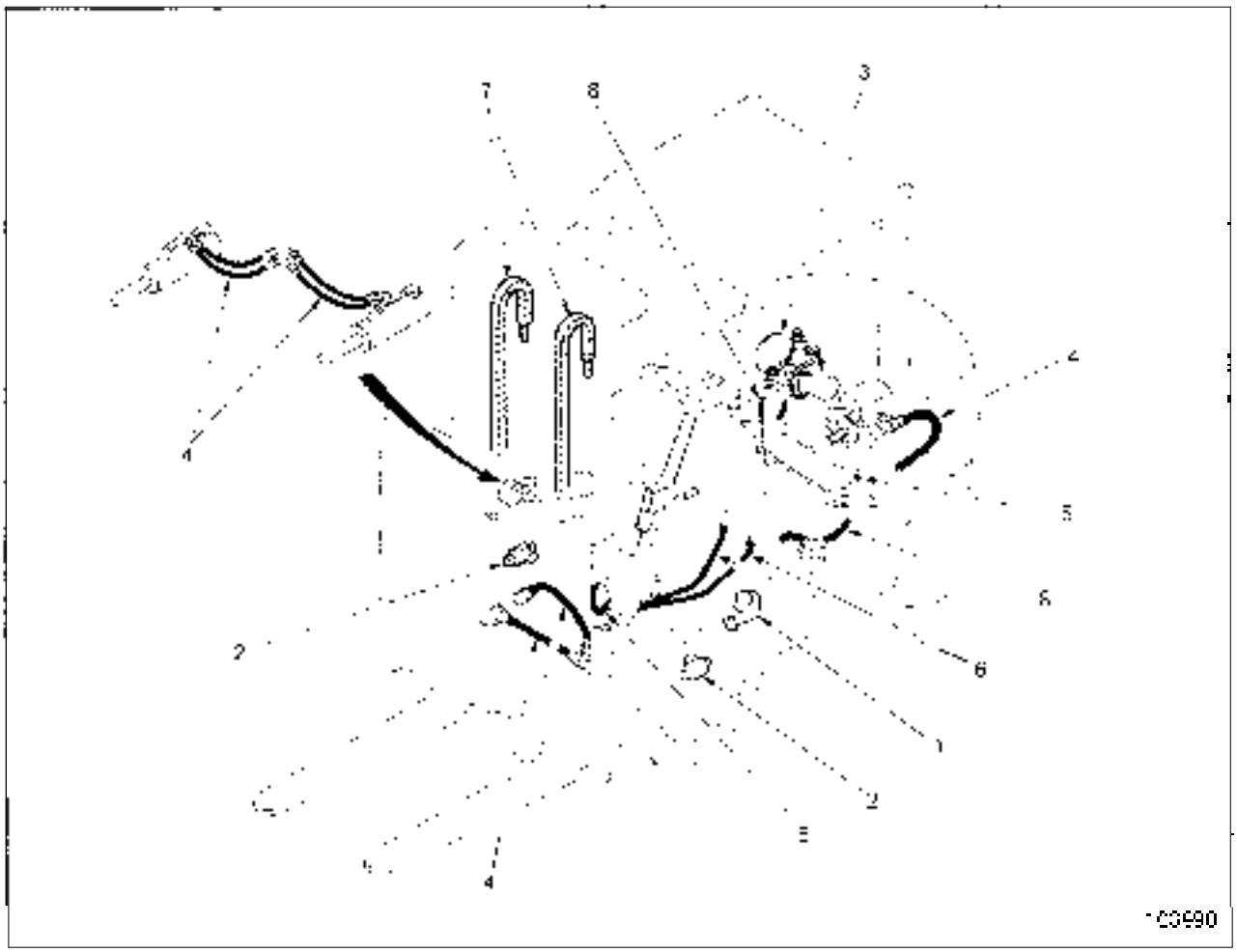
Periodic Replacement Parts

The parts listed below are important for the safe operation of the truck, and are specially designated as the parts to be replaced at specified periods. Each service shop is requested to adhere to the replacement schedule given here on all trucks brought into its care:

	Periodic replacement parts	Service	Period				
			1 month after delivery	Every 3 months (500 hrs)	Every 6 months (1000 hrs)	Every 1 year (2000 hrs)	Every 2 years (4000 hrs)
1	*Rubber parts for brake master cylinder	Replace				○	○
2	*Rubber parts for brake wheel cylinder	Replace				○	○
3	*LPG-gas regulator kit	Replace				○	○
4	*Hydraulic hose	Replace				○	○
5	*Rubber parts for power cylinder	Replace					○
6	*Hoses for power steering	Replace					○
7	*Lift chains	Replace					○
8	*Fuel hoses	Replace					○
9	Engine oil filter element	Replace	○	○	every 3 months (500 hrs)		
10	LPG fuel filter	Clean	○				
		Replace				○	○
11	Hydraulic tank return filter	Replace	○		○	○	○
12	Air clearance element	Clean					
		Replace			○	○	

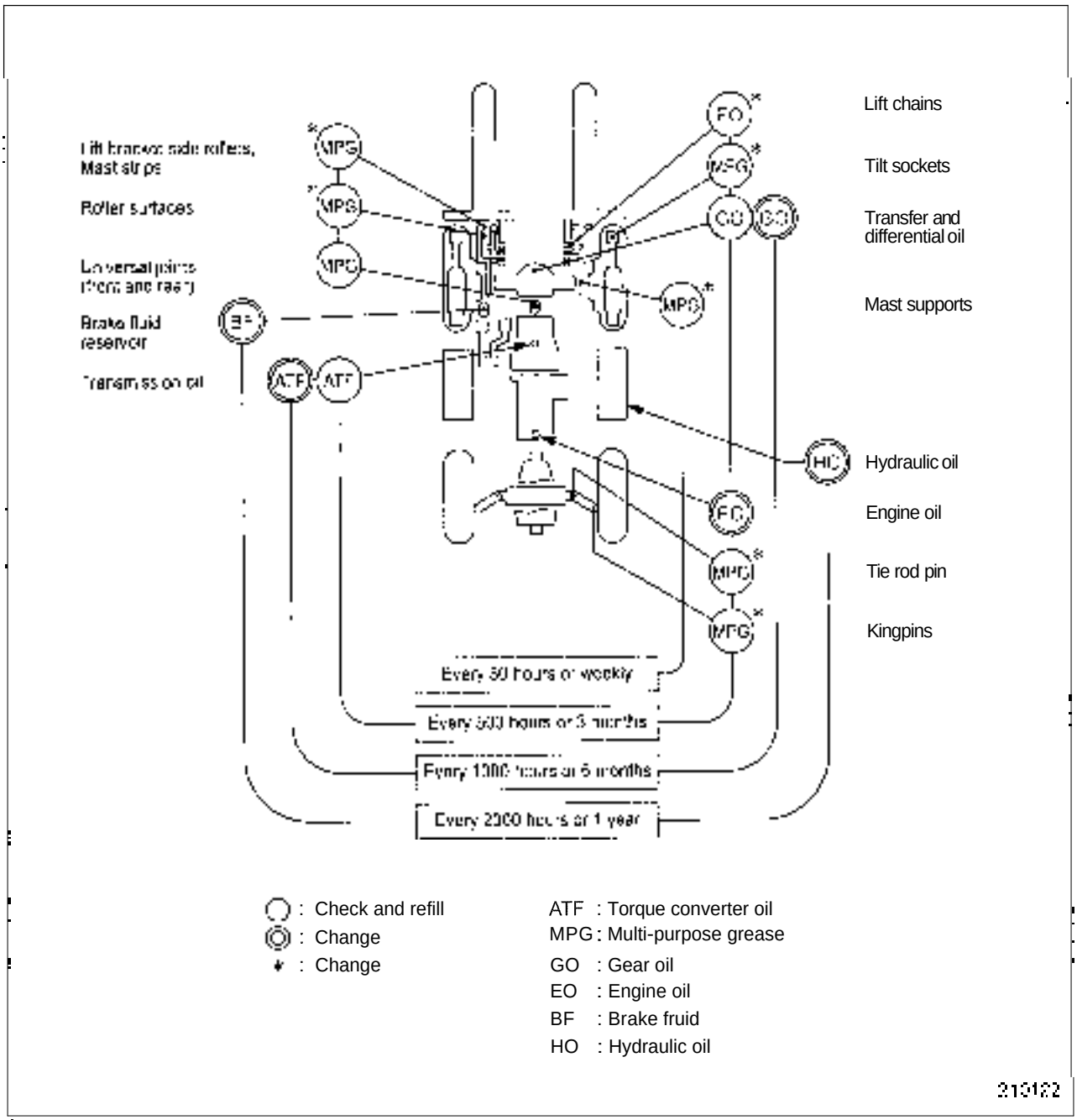
Note: "*" indicates important safety-related parts.

Location of Periodic Replacement Parts



Lubrication Instructions

Lubrication Chart



Fuel and Lubricant Specifications

Fuel or lubricant		Specification	Recommendation for ambient temperature °C (°F) 1-30 -20 -10 0 10 20 30
Fuel			Consult your local Cat lift truck dealer
Engine oils	Gasoline-engine model	API service classification SJ or above	SAE 10W-30
	Diesel-engine model	API service classification CF or above	
Transfer and differential oil		GL-4 or GL-5	SAE 80 SAE 90
Powershift transmission oil		Dexron II	Consult your local Cat lift truck dealer
Hydraulic oil		ISO VG32	
Brake fluid		FMVSS – DOT 3 or DOT 4 (SAE J1703)	
Grease	Wheel bearings	NLGI No.2 grade multi-purpose type (lithium base), Consistency: 271	
	Chassis	NLGI No.1 grade multi-purpose type (calcium base), Consistency: 320 or NLGI No.1 grade multi-purpose type (lithium base), Consistency: 315	

Antifreeze solution (Long Lift Coolant)	Ambient temperature, °C (°F)	−39 (−38.2)	−30 (−22)	−25 (−13)	−20 (−4)	-15 (5)	-10 (14)
	Concentration, %	55	50	45	40	35	30

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 lubrication 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)		
Engine lubrication system (including oil filter capacity)	Diesel-engine models	8.5 (2.2)	10 (2.6)	
	Gasoline-engine models	3.8 (1.0)		
Transmission oil		10 (2.6)		
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)

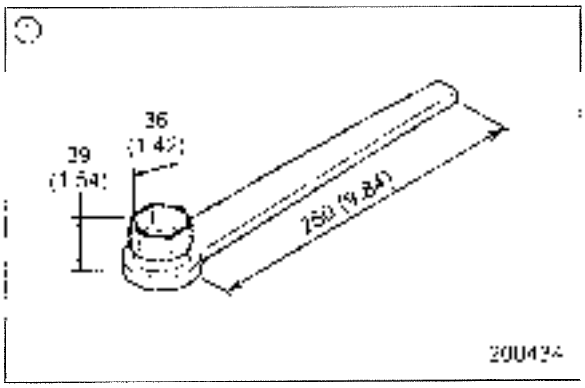
Truck Models		1-ton class	2-ton class	3-ton class
Capacity		970 (2140)	1590 (3510)	2200 (4850)
Engine service weight	Gasoline-engine model	140 (300)		
	Diesel-engine model	180 (400)	260 (570)	
Power train Engine, transmission (excl. reduction gear and differential)	Gasoline-engine model	280 (620)	290 (640)	
	Diesel-engine model	350 (770)	395 (870)	
Overhead guard		60 (130)		
Rear axle		90 (200)	130 (290)	
Duplex mast [3 m (118 in.)]	Outer mast	160 (350)	220 (485)	245 (540)
	Inner mast	130 (290)	150 (330)	165 (360)
	Lift bracket (incl. backrest)	90 (200)	130 (290)	165 (360)
	Forks (two)	80 (180)	130 (290)	165 (360)
	Lift cylinder and related parts	55 (120)	65 (140)	105 (230)

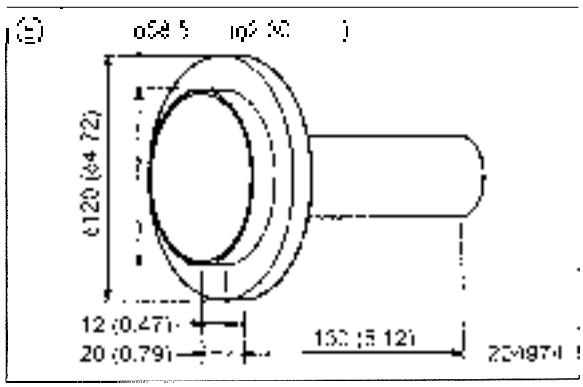
Special Service Tools

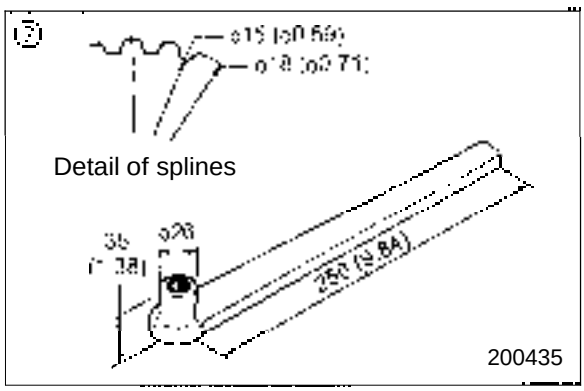
Special Service Tools

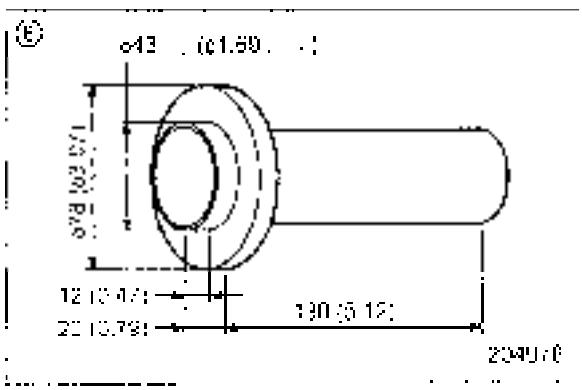
No.	Part number	Part name	[illegible]	[illegible]	2 ton class	3 ton class
1	91268 - 00100	Wrench	Removal and installation of pulley (To be used with 91268 - 00200)	○	○	○
[illegible]	91268 - 00200 91868 - 00100	Wrench Wrench	Removal and installation of pulley	○	○	○
[illegible]	91268 - 00701	Socket wrench	Removal and installation of rear wheel nut and weight bolt	○	○	○
[illegible]	91268 - 05100	Bolt	Removal of pump body	○	○	○
[illegible]	[illegible]	Installer	Installation of pump body oil seal	○	○	○
[illegible]	[illegible]	Installer	Installation and tightening of transmission output shaft oil seal	○	○	○
[illegible]	[illegible] [illegible] [illegible] [illegible]	Puller Plate Bolt Puller	Removal of bearing (To be used with plate, bolt and puller) (Commercially available, BANZAI)	○ ○ ○	○ ○ ○	○ ○ ○
[illegible]	[illegible]	Installer	Installation of ball bearing	○	○	○
[illegible]	[illegible]	Piston tool	Removal and installation of clutch return spring	○	○	○
10	91268 - 00500	Ring puller	Removal and installation of snap ring	○	○	○
11	[illegible]	Gauge kit	Measurement of transmission hydraulic pressure	○	○	○
[illegible]	[illegible]	Connector	Measurement of hydraulic pressure (To be used with 64309 - 17701 Gauge kit)	○	○	○
[illegible]	[illegible]	Socket wrench	Removal and installation of front wheel hub nut	○		
[illegible]	[illegible]	Socket wrench	Removal and installation of front wheel hub nut		○	○
[illegible]	[illegible] [illegible] [illegible]	Bevel pinion puller Puller seat Wheel hub puller	Removal of front wheel hub Removal of front wheel hub Removal of front wheel hub	○ ○	 ○	 ○
[illegible]	91468 - 00300 64309 - 12300	Installer Installer	Installation of front axle wheel bearing inner race	 ○	○	○
17	91268 - 05400	Installer	Installation of oil seal into carrier cover input flange differential carrier	○	○	○
[illegible]	91268 - 05600	Installer	Installation of bevel pinion taper roller bearing into	○	○	○
[illegible]	91268 - 05700	Installer	Installation of bevel pinion taper roller bearing into carrier cover	○	○	○
20	91268 - 05800	Installer	Installation of bevel pinion taper roller bearing	○	○	○
21	91268 - 05900	Installer	Installation of drive gear ball bearing into carrier cover	○	○	○

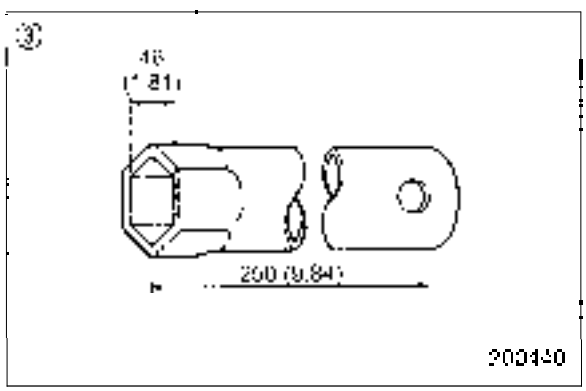
Key No.	Part number	Part name	Used for	Truck model: 1 ton class	2 ton class	3 ton class
22	91268 - 01500	Installer	Installation of rear axle inner bearing inner race	○		
23	64309 - 40400	Installer	Installation of rear axle inner bearing inner race	–	○	○
24	91268 - 01400	Installer	Installation of rear axle outer bearing inner race	○		
25	91468 - 00400	Installer	Installation of rear axle outer bearing outer race		○	○
26	91468 - 00500	Installer	Press-fitting of rear axle pivot bushing		○	○
27	91468 - 00100	Installer	Installation of bell crank bearing and king pin bearing	○	○	○
28	91468 - 00200	Installer	Removal of bell crank bearing and king pin bearing	○	○	○
29	91268 - 01200	Installer	Removal and installation of king pin bearing (To be used with 91468 - 00100 and 91468 - 00200 Installers)	○	○	○
30	64309 - 15411	Spring remover	Removal of return spring	○	○	○
31	64309 - 15412	Spring retainer	Removal and installation of brake shoe	○	○	○
32	64309 - 15413	Spring hook	Installation of return spring (Tools No. 35, 36 and 37 are included in 64309 - 15400 Tool Set)	○	○	○
34	91268 - 10600	Steering wheel puller	Removal of steering wheel	○	○	○
34	91268 - 01800	Pitman arm puller	Removal of pitman arm	○	○	○
35	91268 - 13400	Socket	Removal and installation of power cylinder guide	○	○	○
36	91268 - 13600	Rod cap	Insertion of power cylinder guide	○	○	○
37	91268 - 03300	Plate	Assembly of steering gear control valve	○	○	○
38	91268 - 06200	Connector	Measurement of power steering relief pressure (To be used with 64309 - 17701 Gauge kit)	○	○	○
39	91268 - 01600	Installer	Installation of tilt Cylinder tube busing	○	○	○
40	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			○
41	64309 - 16300	Pipe	Measurement of control valve main relief pressure and overload relief pressure (To be used with 64309 - 17701 Gauge kit)	○	○	○
	F4540 - 06300	Connector		○	○	○

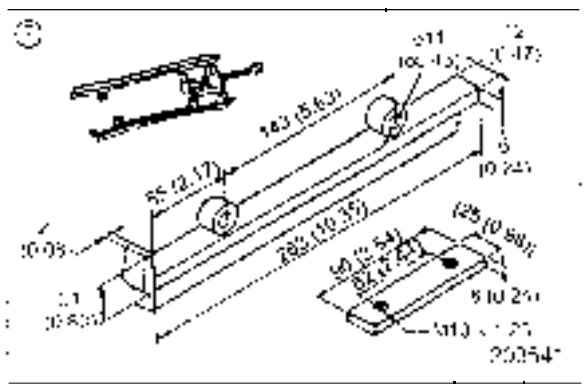


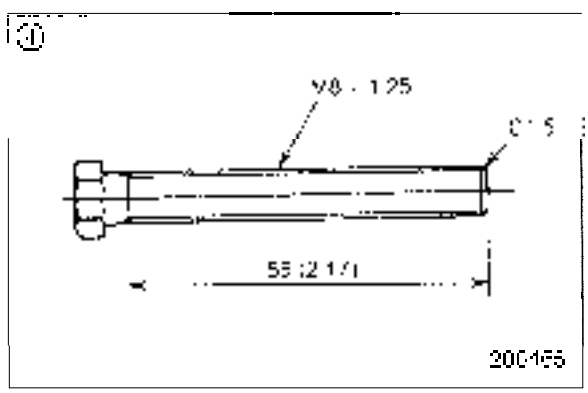


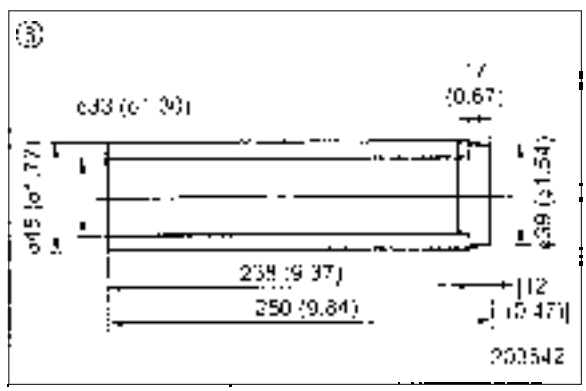












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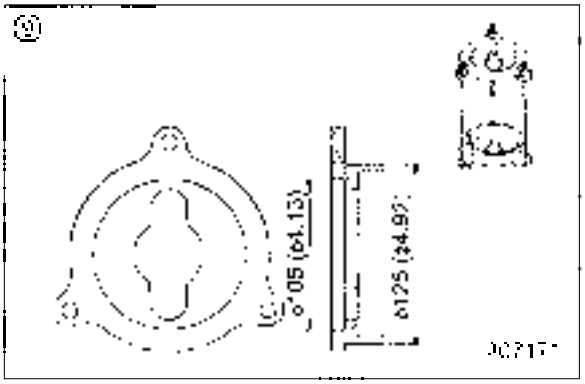

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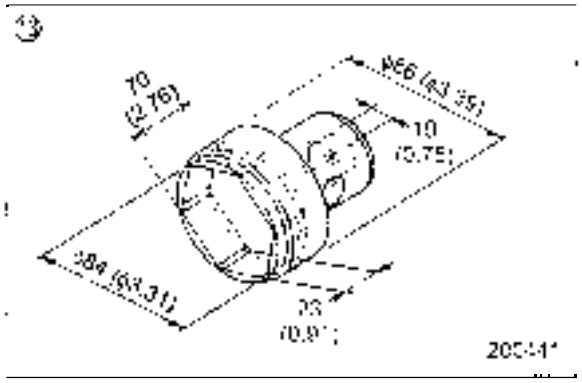

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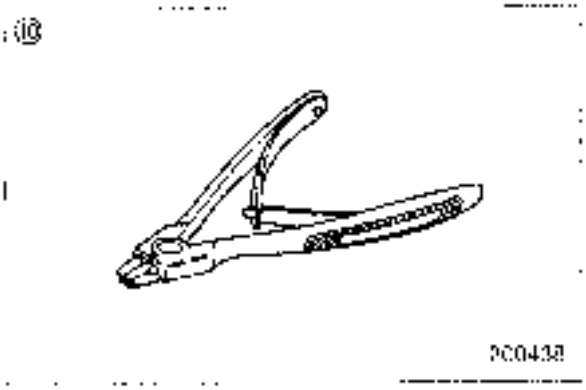

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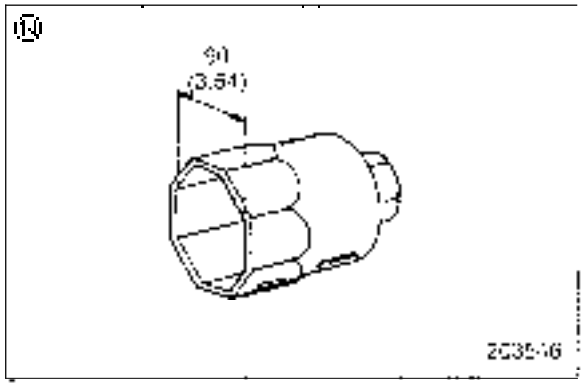

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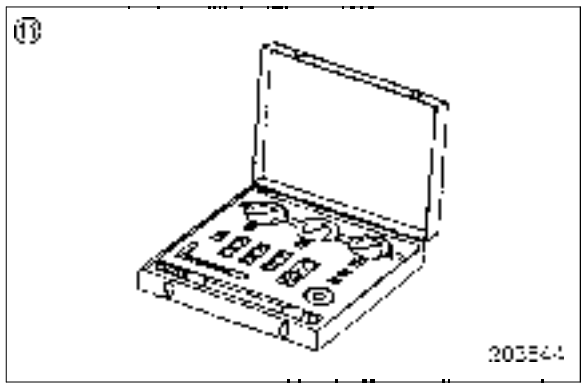

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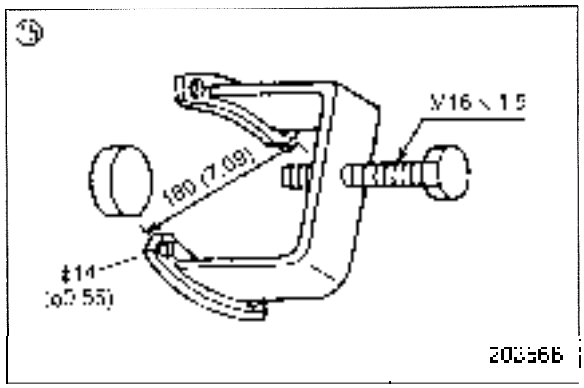

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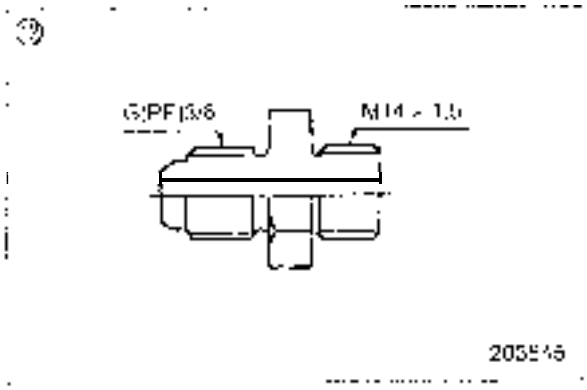

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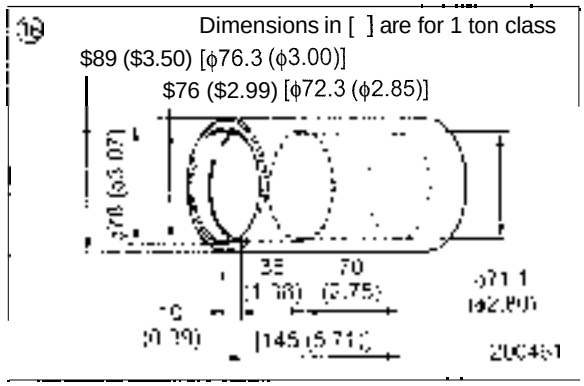

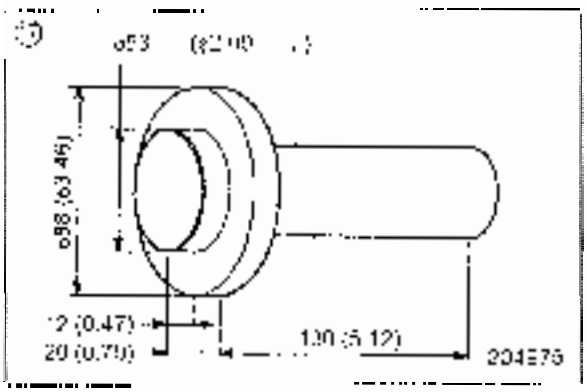

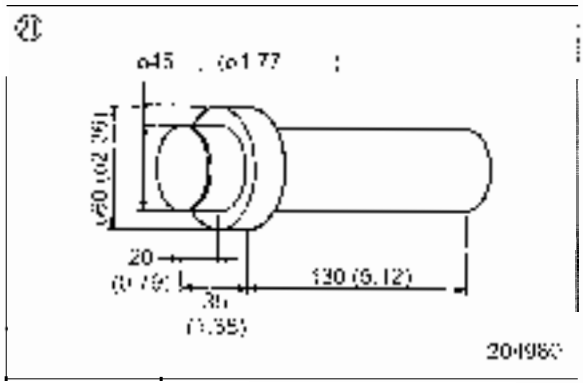

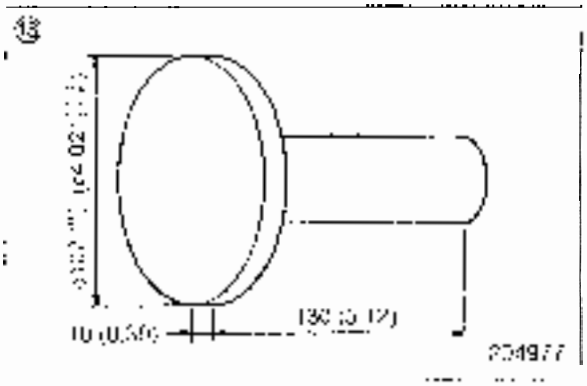

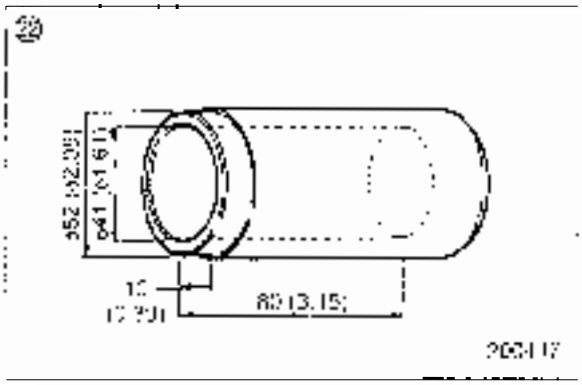

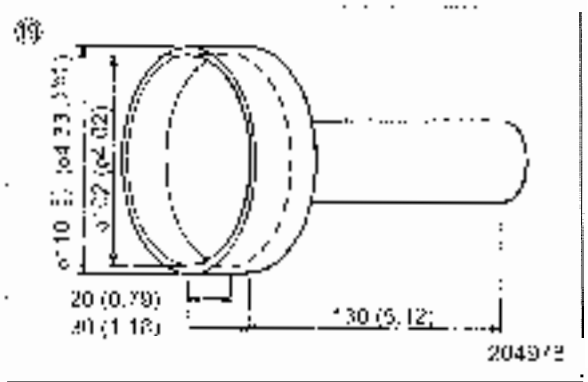

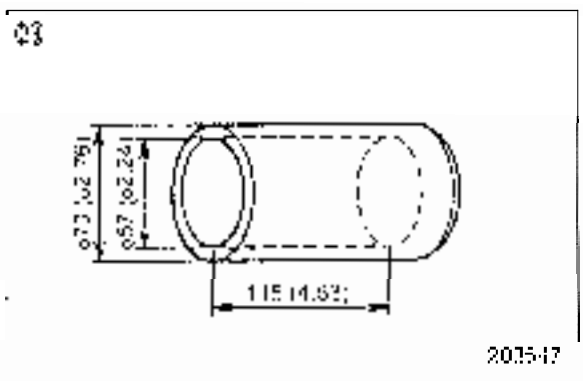

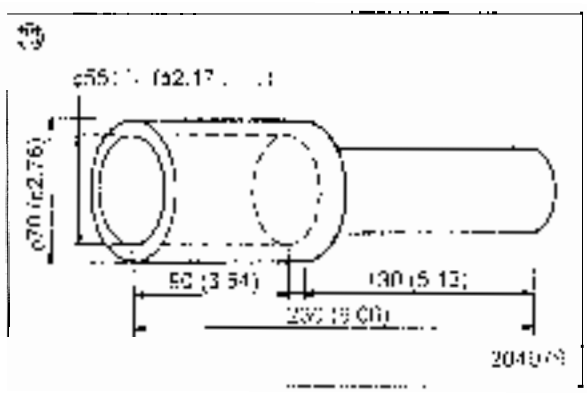

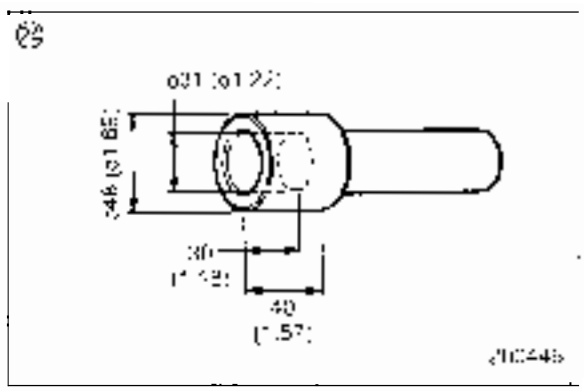

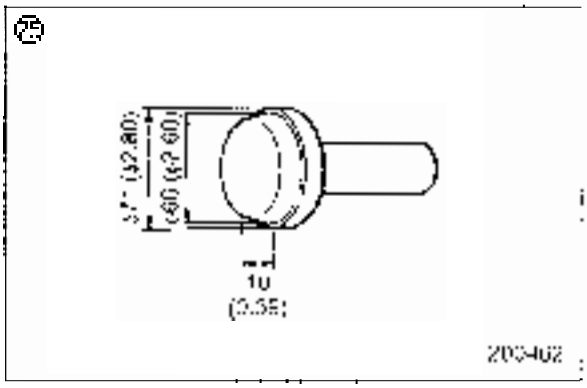

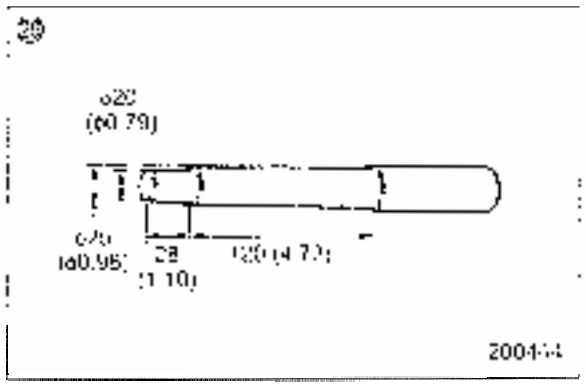

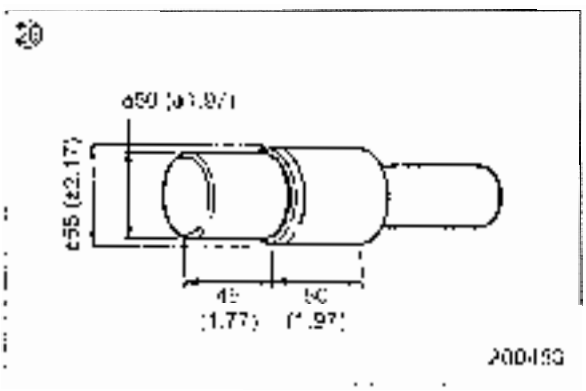

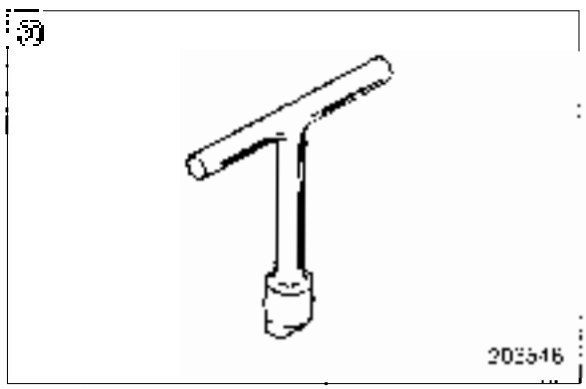

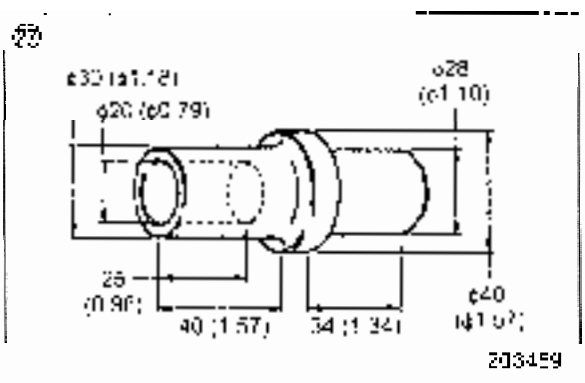

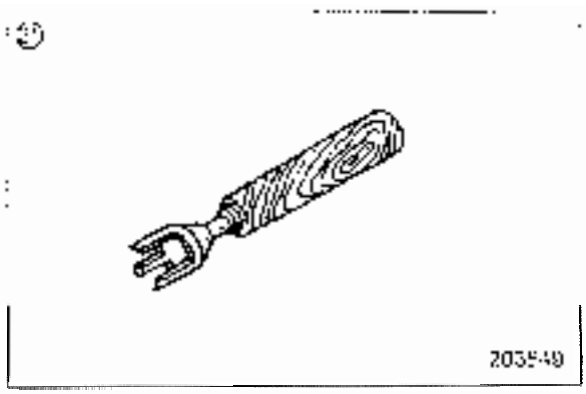

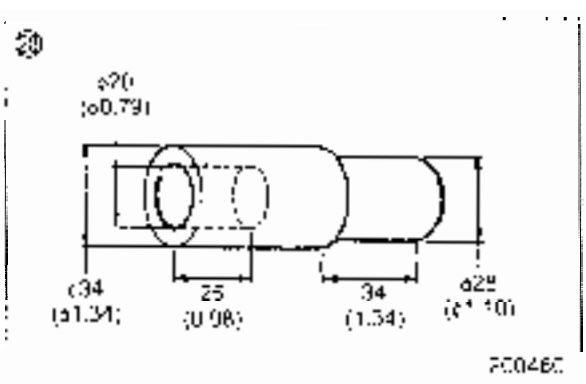

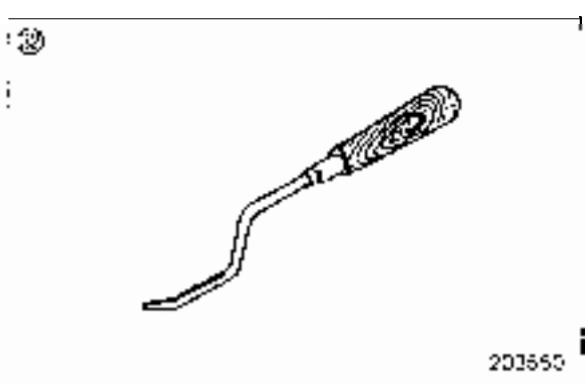

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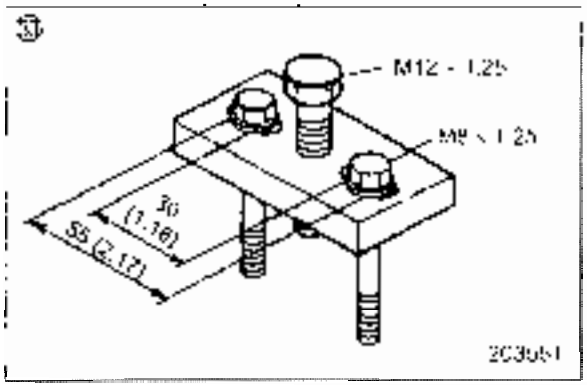

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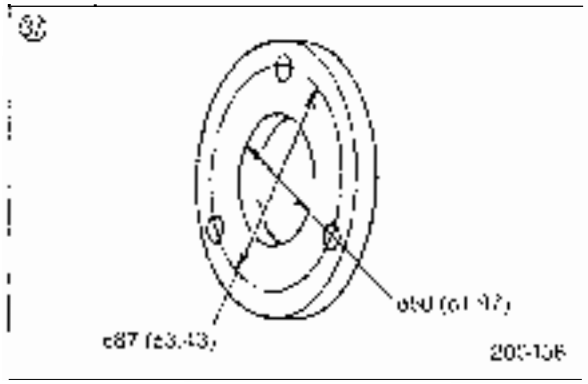

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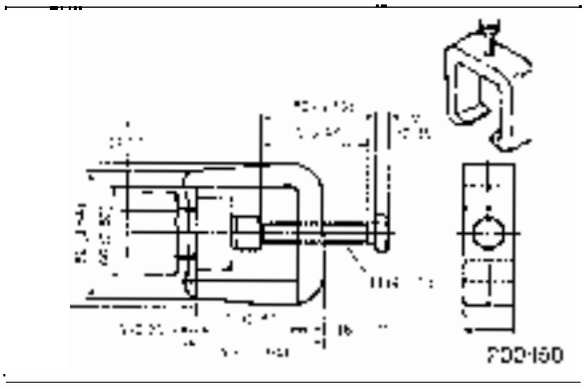

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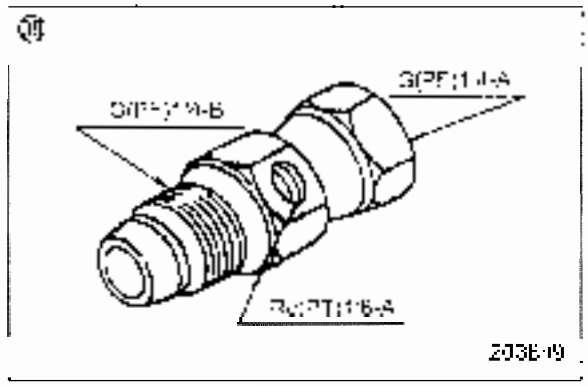

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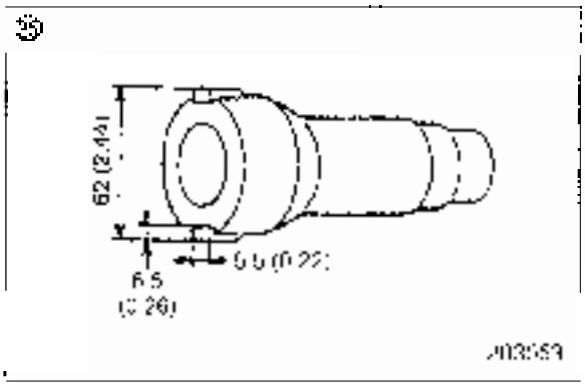

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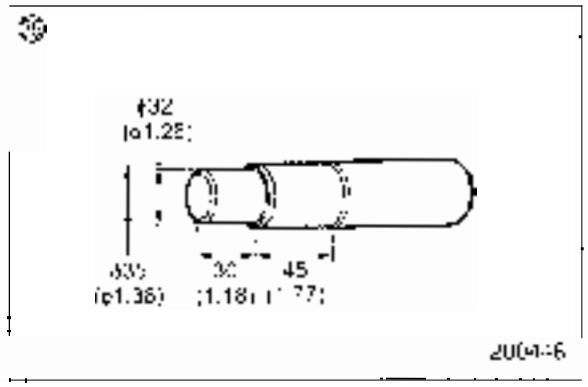

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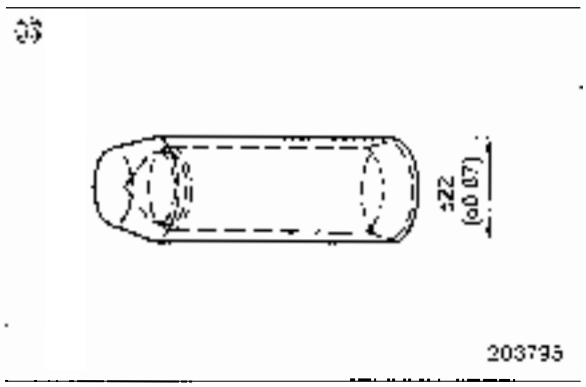

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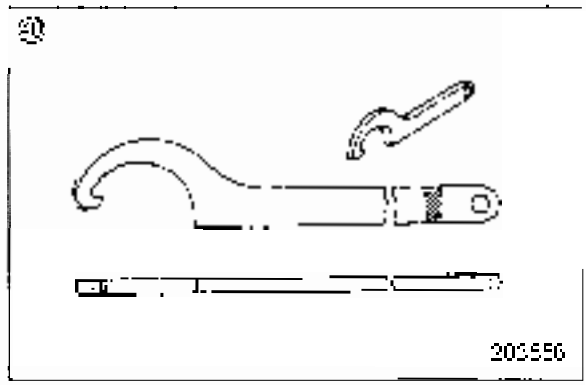

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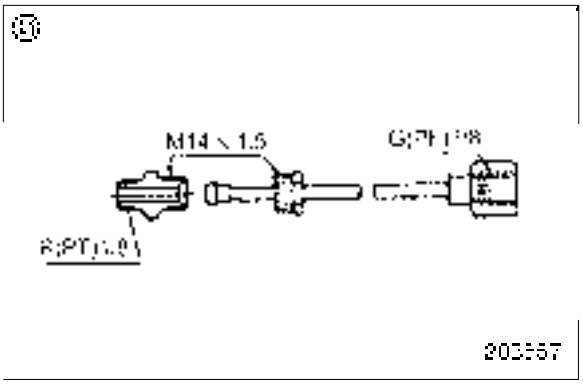

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- ☐ Option Bulletin
- ☐ Part List/Manual
- ☐ Special Instructions
- ☐ Service Manual
- ☐ Service Data Manual
- ☐ Electronic Manual
- ☐ Other

Publication # _____ Engine Model # _____

Truck model # _____ Issue date # _____

Truck serial # _____ Page # _____

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Cat Lift Trucks

Service Manual

P30001-P70001 Lift Trucks

99719-89120

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