SECTION 4 BRAKE SYSTEM

Group 1 Structure and function 4-1
Group 2 Operational checks and troubleshooting 4-8
Group 3 Tests and adjustments 4-12

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

There are two brake systems, the foot brake system and the parking brake system.

The foot brake adopts the brake system of oil type at drive axle.

Oil pressure is generated in maximum 60 kgf/cm^2 through brake oil input path of the left and right drive axle housing, this pressure allows the piston brake to advance and compresses a friction plate and a plate.

So when the transportation travels, it is possible to brake.

The parking brake works by the switch installed on steering column.

2. SPECIFICATION

1) DISK BRAKE

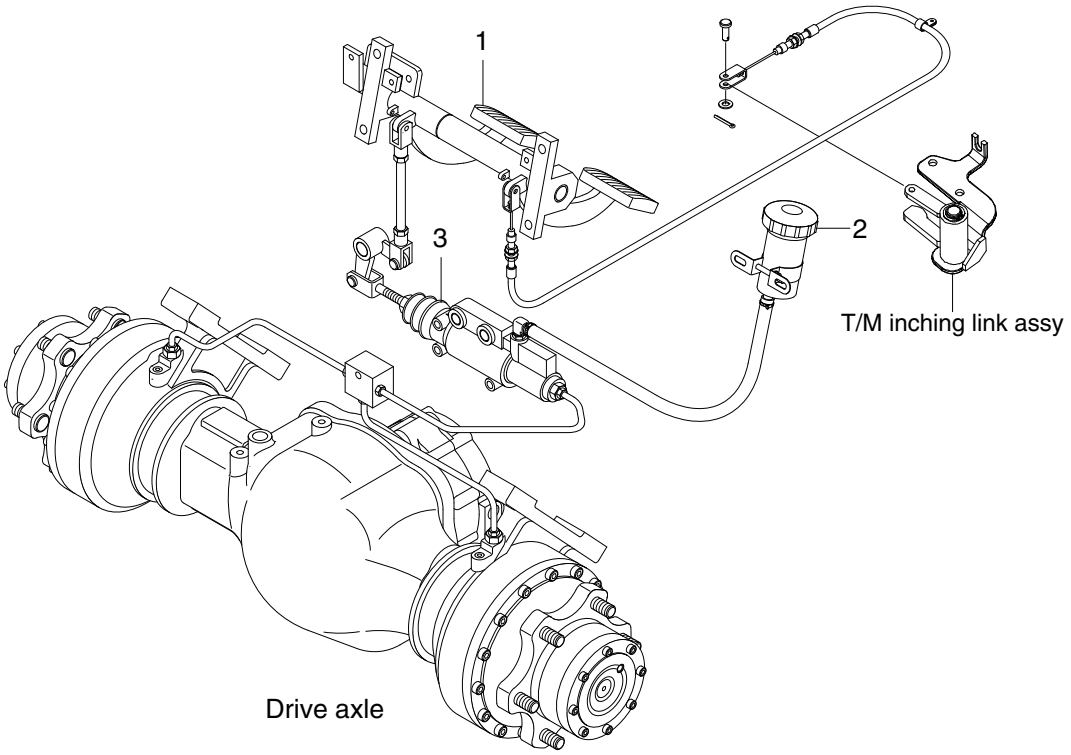
Item		Specification
Type		Wet disk brake
Master cylinder bore diameter		33 mm (1.3 in)
Pedal adjustment	Pedal height	119 mm
	Play	2~4 mm
Brake oil		Azolla ZS32 (ISO VG32 hydraulic oil)

2) PARKING BRAKE

Item	Specification
Type	Wet disk brake (Negative)
Switch location	Steering column
Disc location	Axle carrier assy

3. BRAKE PEDAL AND PIPING

1) STRUCTURE

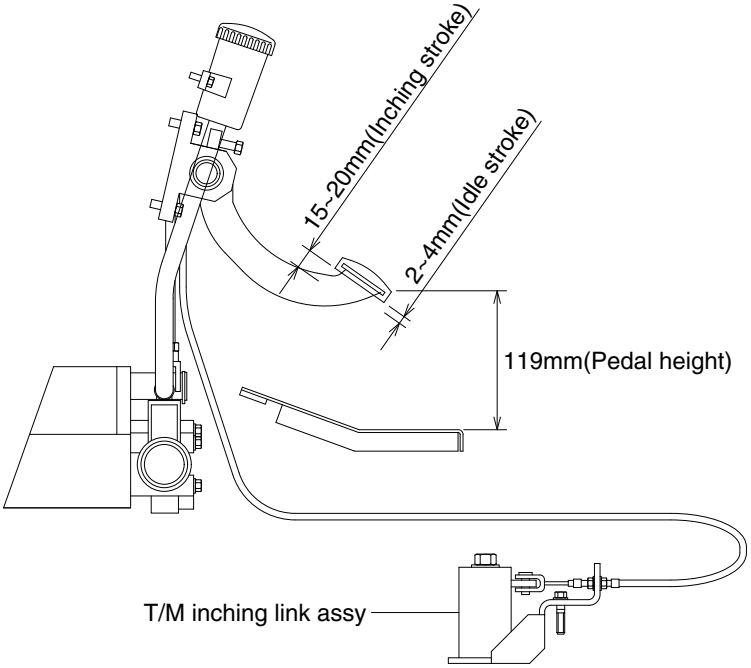


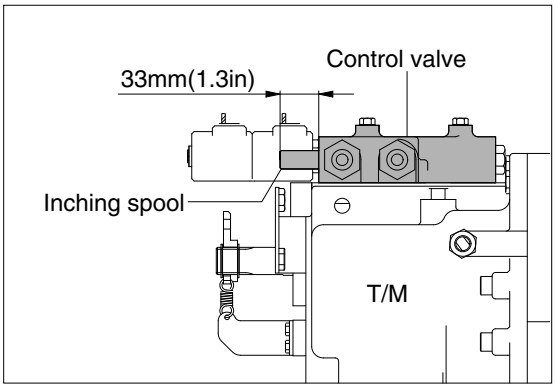
22D9SBS01

1 Brake pedal
2 Reservoir tank assembly
3 Brake master cylinder

4. INCHING PEDAL AND LINKAGE

The brake pedal serves to actuate the hydraulic brakes on the drive axle. At the beginning of the pedal stroke, the inching spool of the transmission control valve is actuated to shift the hydraulic clutch to neutral and turn off the driving force. By treading the pedal further, the brake is applied.





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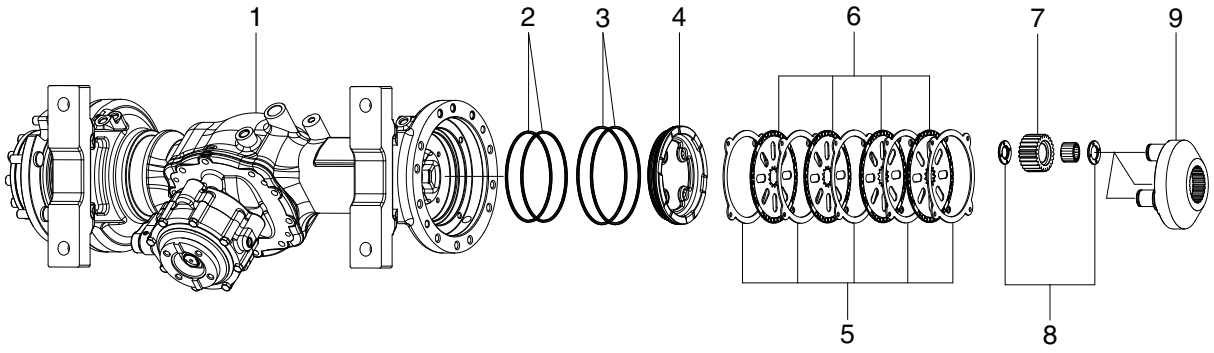
5. WET DISK BRAKE

1) STRUCTURE



22D9SPT20

1	Drive axle housing	4	Piston brake	7	Planet gear
2	Square ring	5	Plate	8	Snap ring
3	Square ring	6	Friction plate	9	Planet shaft

2) OPERATION

Sealed up structure of hydraulic disk brake system secures good brake performance even in the high humid or dusty area.

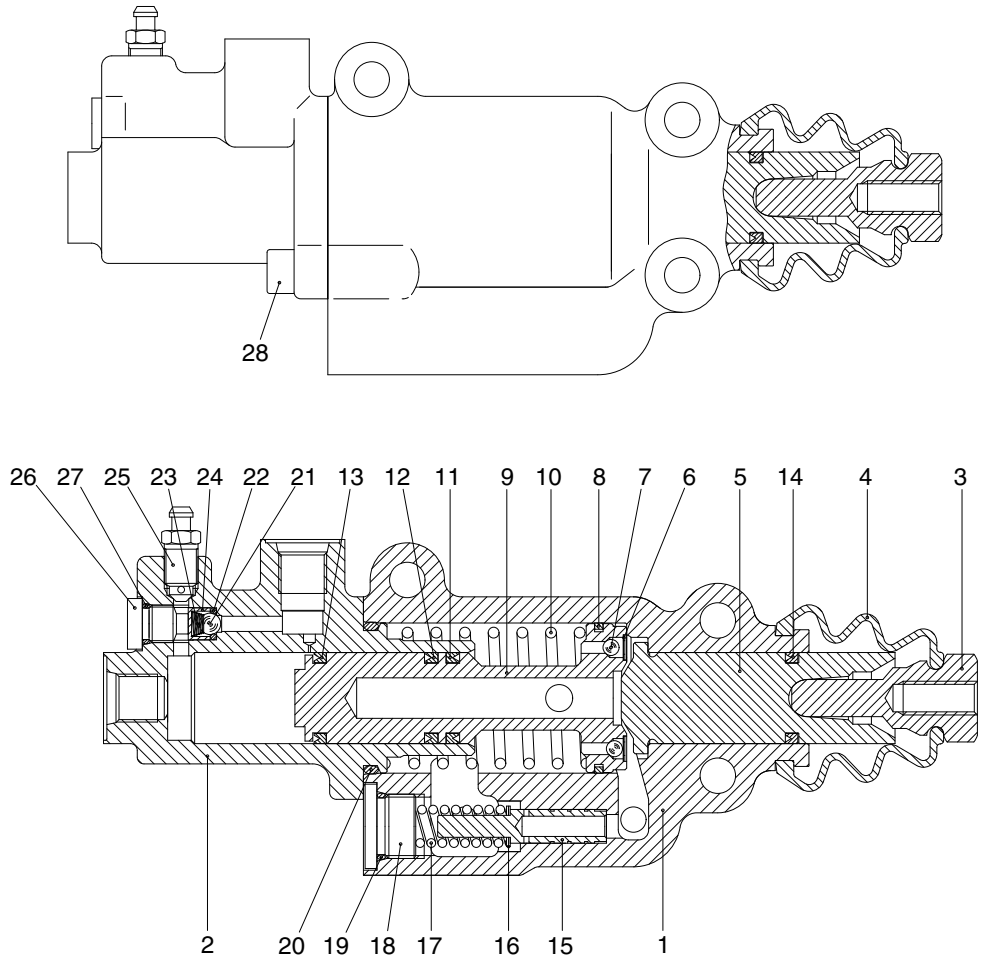
Because it is possible to use the brake semi-permanently, there is no need to replace or change the lining as drum type brake do.

Major components are 6 plates (5), 5 friction plates (6), piston brake (4), and brake housing.

Braking force is applied by restricting the drive force from drive shaft and spline collar.

6. BRAKE VALVE (BOOSTER BRAKE)

1) STRUCTURE

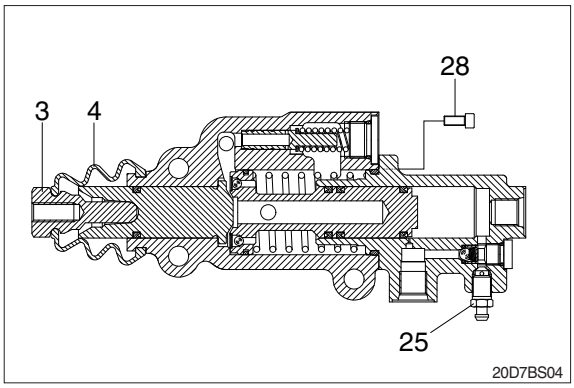


20D7BS03

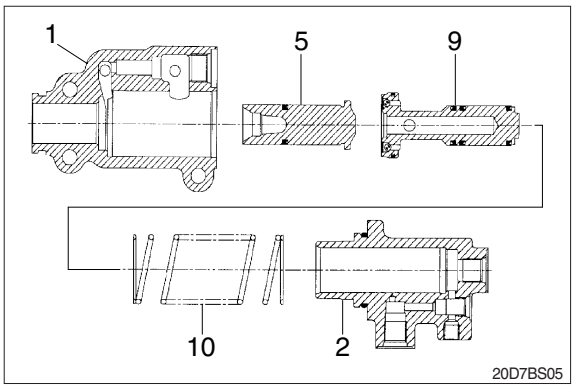
1	Front housing	11	Seal	20	O-ring
2	Rear housing	12	Seal	21	Check ball
3	Push rod	13	Seal	22	O-ring
4	Bellows	14	Seal	23	Check spring
5	Master piston	15	Relief piston	24	Cage
6	Lock washer	16	Shim	25	Air bent
7	Piston ball	17	Relief spring	26	Check plug
8	Piston ring	18	Relief plug	27	O-ring
9	Servo piston	19	O-ring	28	Bolt
10	Servo spring				

2) DISASSEMBLY

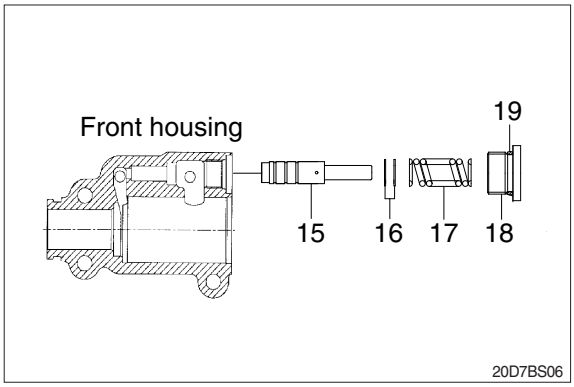
(1) Remove push rod (3), bellows (4), air vent (25) and bolt (28).



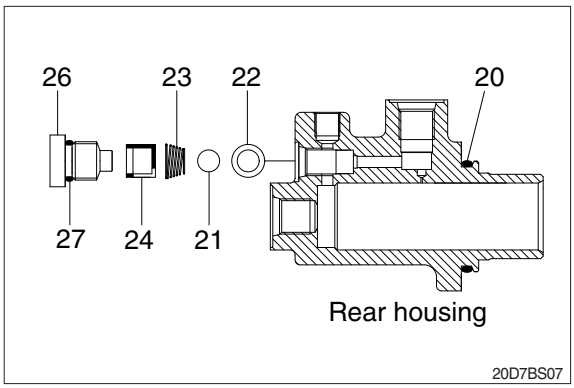
(2) Remove front housing (1), rear housing (2), servo spring (10), servo piston (9) and master piston (5).



(3) Remove relief plug (18) with O-ring (19), relief spring (17), shim (16) and relief piston (15).



(4) Remove O-ring (20), check plug (26) with O-ring (27), cage (24), check spring (23), check ball (21) and O-ring (22).



3) INSPECTION AND ASSEMBLY

(1) Clean all parts thoroughly and lubricate the parts either with mineral or with hydraulic oil, according to their use destination.

(2) All single parts are to be checked for damage and replaced, if required.

(3) Assembly is in opposite order to disassembly.

(4) Seal kit : XKAU-00176

⚠ Use only brake fluid (Azola ZS10) into the compensation reservoirs.

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) GENERAL INFORMATION

Brake system generate small metal wear particles at a fairly steady rate, especially during the break-in period.
If these fine, but hard particles are allowed to circulate in the lubricant, along with external moisture and dirt, internal components will wear at a much faster rate than normal.

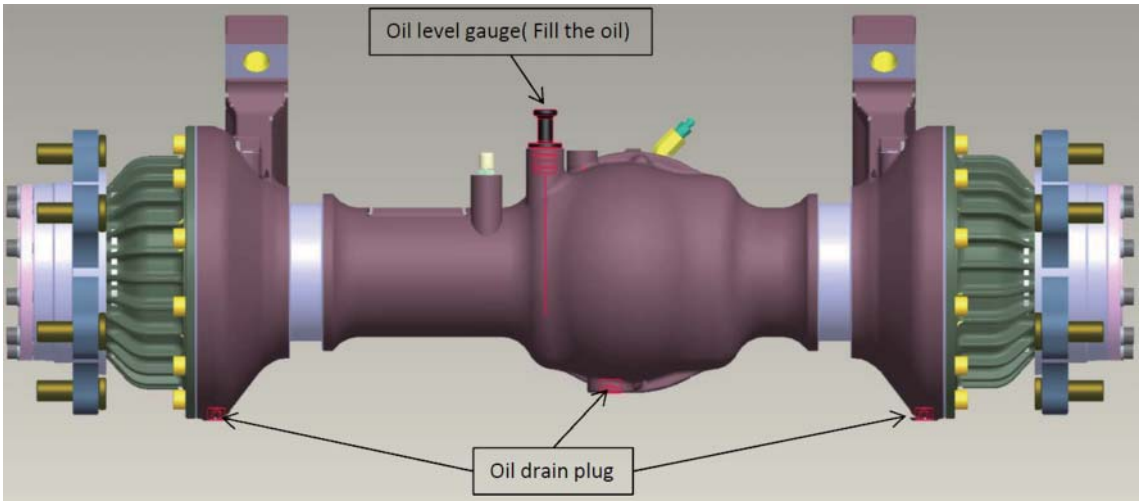
2) BRAKE PIPING

(1) Check pipes, hoses and joints for damage, oil leakage or interference.
(2) Operate brake pedal and check operating force when pedal in depressed. Check also change in operating force, and change in position of pedal when pedal is kept depressed.

3) OIL LEVEL

(1) Check and adjust oil

Axle housing has oil level gauge and drain plug.



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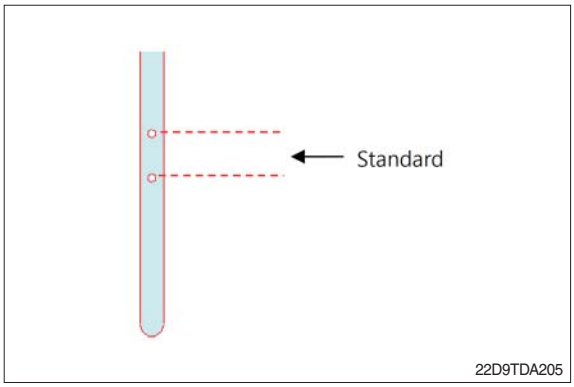
① Make sure the vehicle is on a level surface.
② Pull out oil level gauge from axle, then check the height of oil.
③ If the height of oil of level gauge is higher than the upper limit, take oil out by loosening drain plug and keep the standard refer to (2), page 4-9, if the height of oil is lower than the lowest limit, pour oil in to level gauge and keep the standard.



22D9TDA205

(2) Oil change

⚠ Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only jacks. Jacks can slip and fall over. Serious personal injury can result.

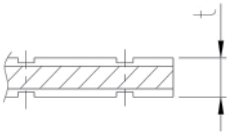
① Make sure the vehicle is on level surface.
② Raise lift of vehicle and drain oil by loosening drain plug.
③ After drain all oil, faster the plug cleaned.
④ Fill oil with checking the height of oil by level gauge at the front of vehicle.

(3) Oil capacity and using oil

① Oil volume is approximately 5.6 liters. Actual volume will vary by axle model and configuration.
② Using Hyundai Genune axle oil (If use incorrect axle oil, the product has noise and burn-out at component).

4) MAINTENANCE

(1) Period of check drive axle : 1,000 hrs
(2) O-ring, oil seal, rubber, gasket : Change all parts at every disassembling, if as necessary.
(3) Check internal leakage of brake system (Brake seal) : Replace as necessary or every 1,000 hrs
(4) Friction plate (disk), reaction (steel) plate : Change the part that exceeds the wear limits.

Item		Part no.	Standard	Limit
Friction plate (Disk)		21DA-10071	t=3.5	t=3.05
		21DA-20940	t=2.2	t=1.80
Plate (Steel plate)		21DA-10051	t=2.5	t=2.35
		21DA-20950	t=1.5	t=1.40

(5) Bearing : If in doubt about the wear or lack of lubrication, replace the bearing and oil
Check the release bearing the see if it rotates unfreely, use matel cleaner and then recheck.
If it is unfreely again, replace the part
(6) Spring : Measure free length of spring, If it has deform ±10% over then free length, replace the part
(7) Gear, shaft : If it is abnormal or change the cross sectional area, you have to change.
(8) Axle oil change

Recommended initial oil change	100 hrs
Check oil level	Every 250 operating hours
Periodic oil change	Evey 1,000 operating hours

2. TROUBLESHOOTING

1) BRAKE SYSTEM

Problem	Cause	Remedy
1. Insufficient braking force	· Hydraulic system leaks oil. · Hydraulic system leaks air. · Disk worn. · Brake valve malfunctioning. · Hydraulic system clogged.	· Repair and add oil. · Bleed air. · Replace. · Repair or replace. · Clean.
2. Brake acting unevenly. (Machine is turned to one side during braking.)	· Tires unequally inflated. · Brake out of adjustment. · Disk surface roughened. · Wheel bearing out of adjustment. · Hydraulic system clogged.	· Adjust tire pressure. · Adjust. · Repair by polishing or replace. · Adjust or replace. · Clean.
3. Brake trailing.	· Pedal has no play. · Piston cup faulty. · Brake valve return port clogged. · Hydraulic system clogged. · Wheel bearing out of adjustment.	· Adjust. · Replace. · Clean. · Clean. · Adjust or replace.
4. Brake chirps	· Brake trailing. · Piston fails to return. · Disk worn. · Disk surface roughened.	· See above. Brake trailing. · Replace. · Replace. · Repair by polishing or replace.
5. Brake squeaks	· Disk surface roughened. · Disk worn. · Excessively large friction between disk plate.	· Repair by polishing or replace. · Replace. · Clean and apply brake grease.
6. Large pedal stroke	· Brake out of adjustment. · Hydraulic line sucking air. · Oil leaks from hydraulic line, or lack of oil. · Disk worn.	· Adjust. · Bleed air. · Check and repair or add oil. · Replace.
7. Pedal dragging.	· Twisted push rod caused by improperly fitted brake valve. · Brake valve seal faulty.	· Adjust. · Replace.

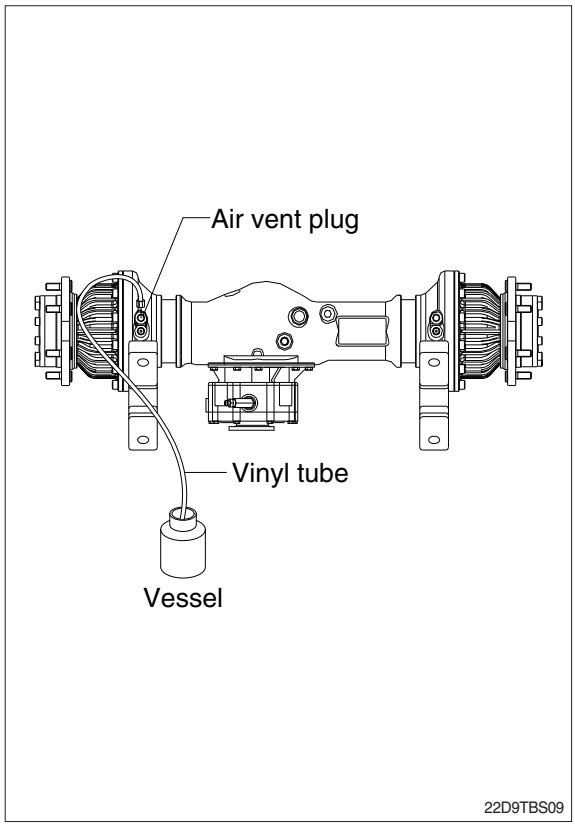
2) BRAKE SYSTEM OF THE DRIVE AXLE

Trouble symptom	Probable cause	Remedy
1. Inoperation of brake		
1) Service brake	· Non-inject or lack of brake oil	· Check oil level, set correct oil volume
	· Damage of brake seal	· Replace piston seal.
	· Wrong assemble brake seal	· After disassembly and adjust or replace part
	· Detect of slide on seal (Axle housing, pistion)	· Replace related part
	· Mix particle of slide on seal	· Wash slide part or replace piston seal
	· Damage of friction plate and plate	· After disassembly and adjust or replace part
	· Defect of material (or oil line)	· After disassembly and replace the part
2) Parking brake	· Damage of parking spring	· After disassembly and replace the part
	· Wrong assembly of parkgin spring	· After disassembly and adjust or replace part
	· Damage of friction plate and plate	· After disassembly and adjust or replace part
2. Impossible release of brake		
1) Service brake	· Failure of return at service brake piston	· After disassembly and adjust or replace part
	· Damage of friction plate and plate	· After disassembly and adjust or replace part
2) Leakage of parking brake	· Damage of brake seal	· After disassembly and replace the part
	· Wrong assemble brake seal	· After disassembly and adjust or replace part
	· Detect of slide on seal (Axle housing, Pistion)	· Replace related part
	· Mix particle of slide on seal	· Wash slide part or replace piston seal
	· Defect of material (or oil line)	· After disassembly and replace the part
3. Deterioration of brake	· Inadequate actuation fluid supply to brake	· Supply standard oil, replace seal of brake system
	· Inadequate pressure to apply brakes	· Check or replace of brake seal and brake oil line
	· Worn or damaged discs	· After disassembly and adjust or replace part
	· Air enter into brake system	· Remove air by air breather
	· Deform parking spring	· After disassembly and replace the part

GROUP 3 TESTS AND ADJUSTMENTS

1. AIR BLEEDING OF BRAKE SYSTEM

1) Air bleeding should be performed by two persons :
   One rides on truck for depressing and releasing brake pedal : the other person is on the ground and removes cap from air vent plug on wheel cylinder.
2) Block the front wheel securely and apply parking brake.
3) Start the engine.
4) Attach a vinyl tube to air vent plug and immerse other end of tube into a vessel filled with hydraulic oil.
5) Loosen air vent plug by turning it 3/4 with a wrench. Depress brake pedal to drain oil mixed with air bubbles from plug hole.
6) Depress brake pedal until no air bubbles come out of air vent plug hole.
7) After completion of air bleeding, securely tighten air vent plug. Install cap on plug.



2. ADJUSTMENT OF PEDAL

1) BRAKE PEDAL

(1) Pedal height from floor plate

Adjust with stopper bolt.

· Pedal height : 119 mm (4.7 in)

(2) Idle stroke

Adjust with rod of master cylinder

· Play : 2~4 mm

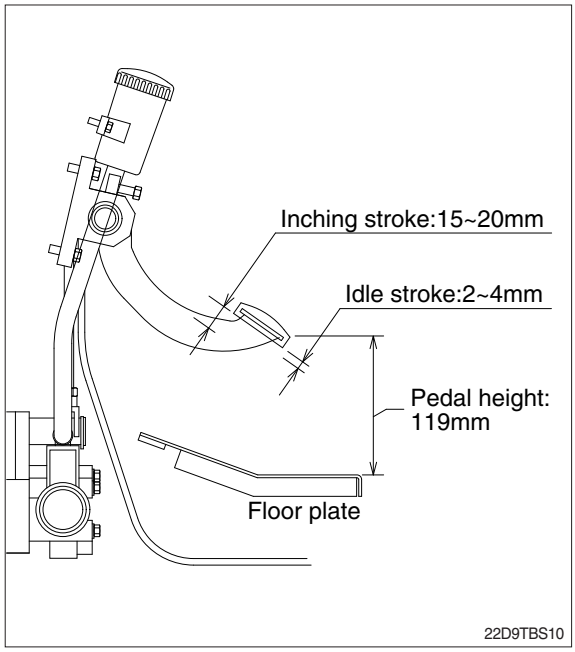
2) INCHING PEDAL

(1) Pedal height from floor plate

Adjust with stopper bolt.

· Pedal height : 119 mm (4.7 in)

(2) Adjust bolt so that brake pedal interconnects with inching pedal at inching pedal stroke 15~20 mm (0.6~0.8 in).

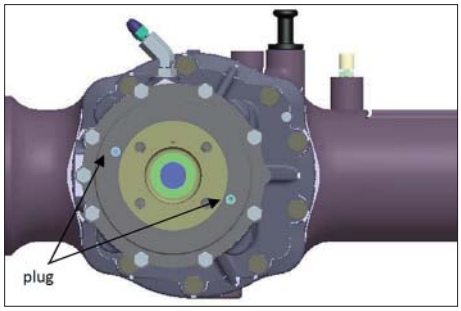


3. PARKING BRAKE RELEASE

In case of malfunction of transmission, it's hard to supply pressure at parking brake.
Using function of parking force release at carrier sub assembly of drive axle, it is possible to tow the truck.

1) DISASSEMBLE PLUG

Must wash surrounding plug before disassembly
Tool : Use 5 mm six-angular lench or bitsocket



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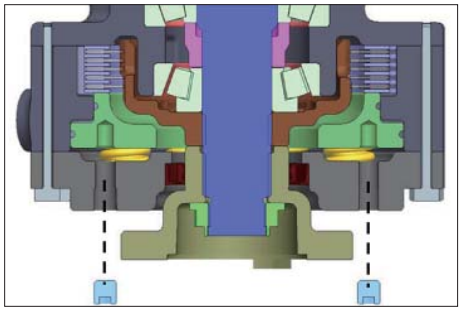
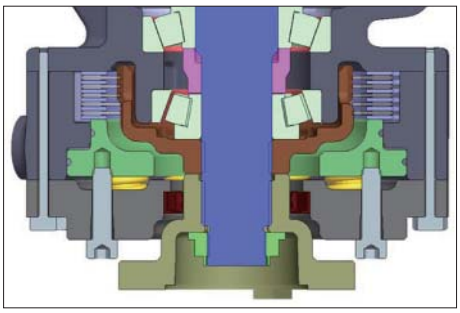
※ Correspond with hole of assembly and tap hole of piston by guide pin.

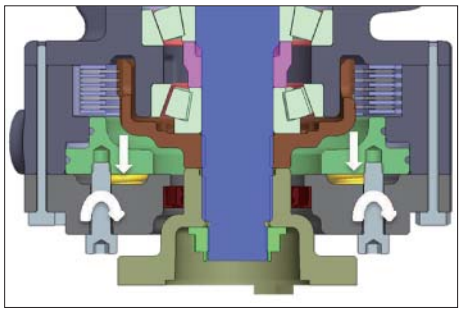

22D9TDA209

2) ASSEMBLE BOLT OF RELEASED PARKING

(1) Assemble bolt for released parking at hole of plug by disassemble.
Bolt spec : M8x1.25P × 30L
Socket-bolt, S109-080304
(2) Assemble bolt by hand to reach axle housing.


22D9TDA210

(3) Tighten two bolt like clockwise rotation.
According to the force of tighten bolt, pull piston and release parking brake.
Tool : Use 6 mm six-angluar lench or bitsocket
(4) Rotate 1.5~2 times by clockwise direction, and then release parking brake.
Do not exceed tightening torque 400 kgf-cm
(5) Check parking to rotate flange shaft by hand.

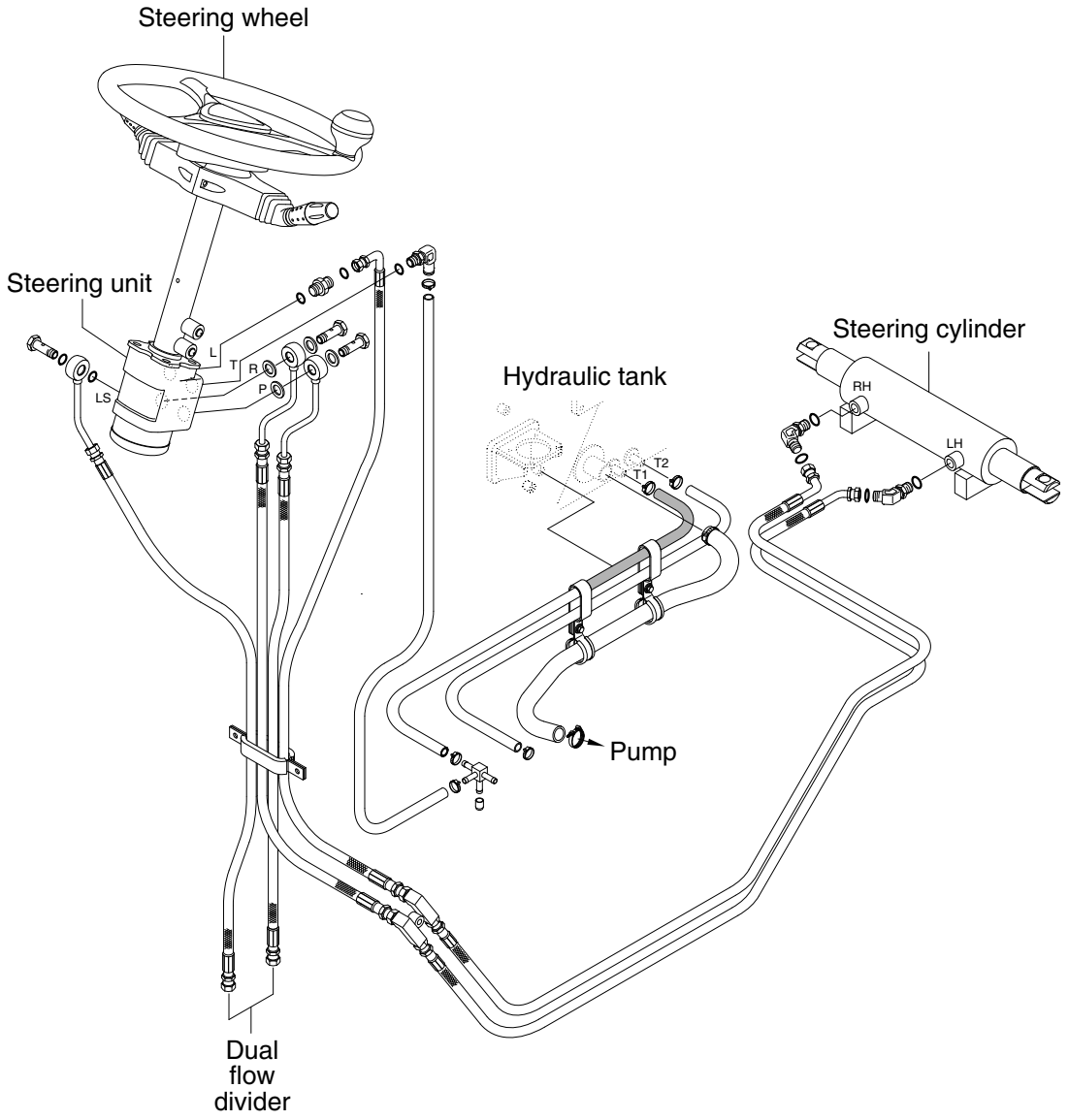

22D9TDA211

SECTION 5 STEERING SYSTEM

Group 1 Structure and function 5-1
Group 2 Operational checks and troubleshooting 5-10
Group 3 Disassembly and assembly 5-12

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE (NON BOOSTER BRAKE)



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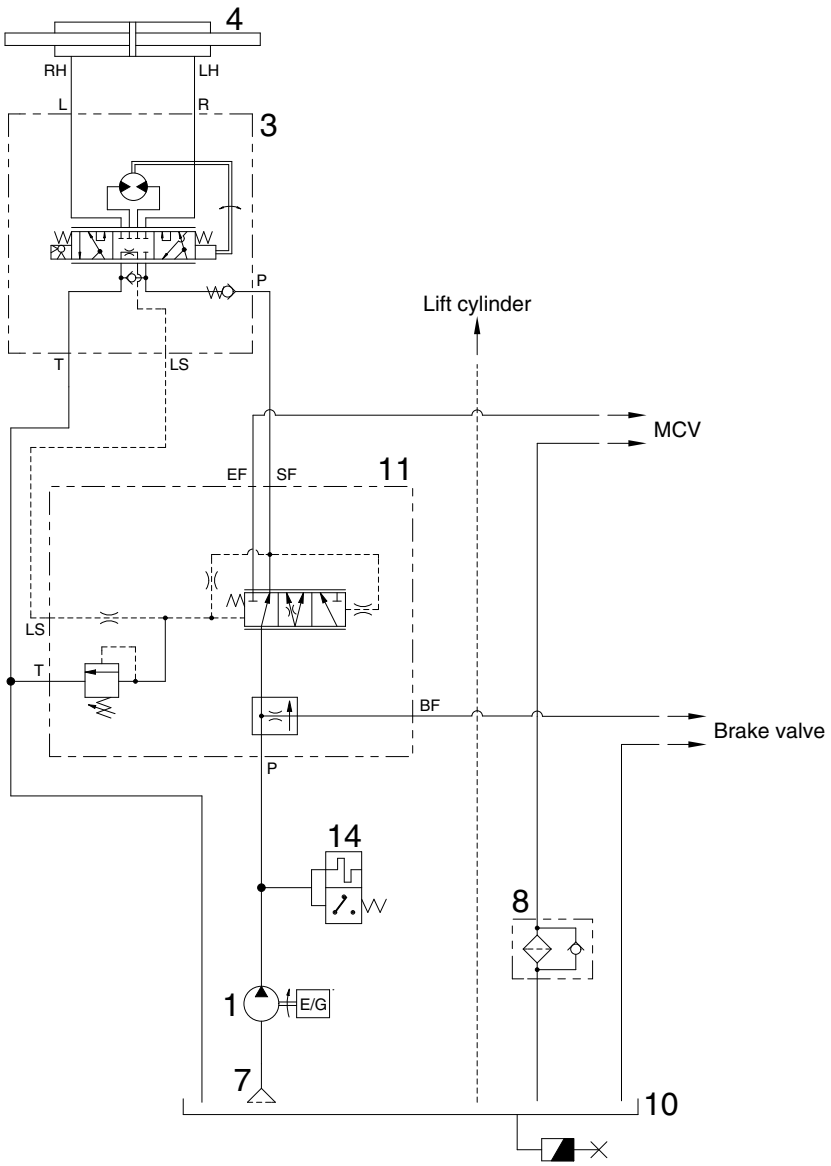
The steering system for this machine is composed of steering wheel assembly, steering unit, steering cylinder, steering axle and pipings. The steering force given to the steering wheel enters the steering unit through the steering column. The required oil flow is sensed by the function of the control section of the unit, and pressurized oil delivered from the hydraulic pump is fed to the steering cylinder. The force produced by the steering cylinder moves the knuckle of steering tires through the intermediate link.

The axle body is unit structure having steering knuckles installed to its both ends by means of kingpins. Hub and wheel are mounted through bearing to spindle of knuckle.

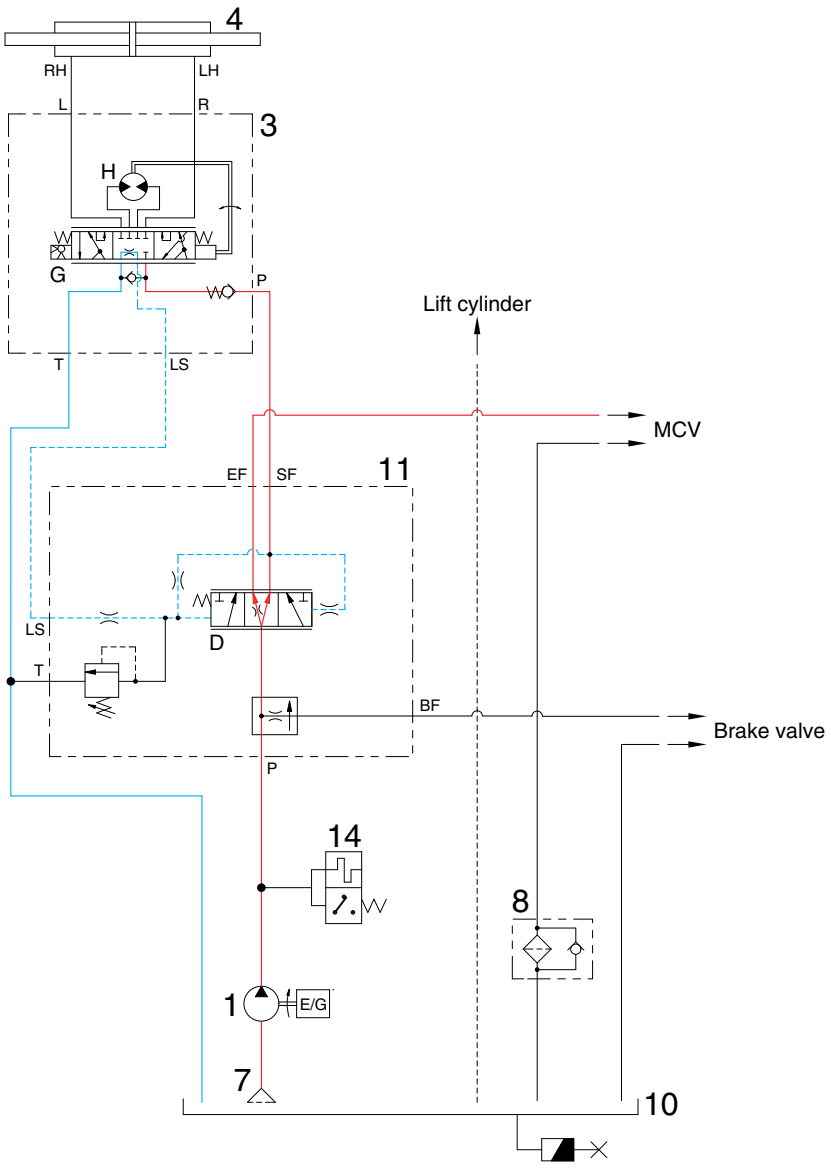
2. HYDRAULIC CIRCUIT



22D9TSS02

1	Hydraulic gear pump	8	Return filter
3	Steering unit (obitrol)	10	Hydraulic tank
4	Steering cylinder	11	Dual flow divider
7	Suction strainer	14	Temperature sensor

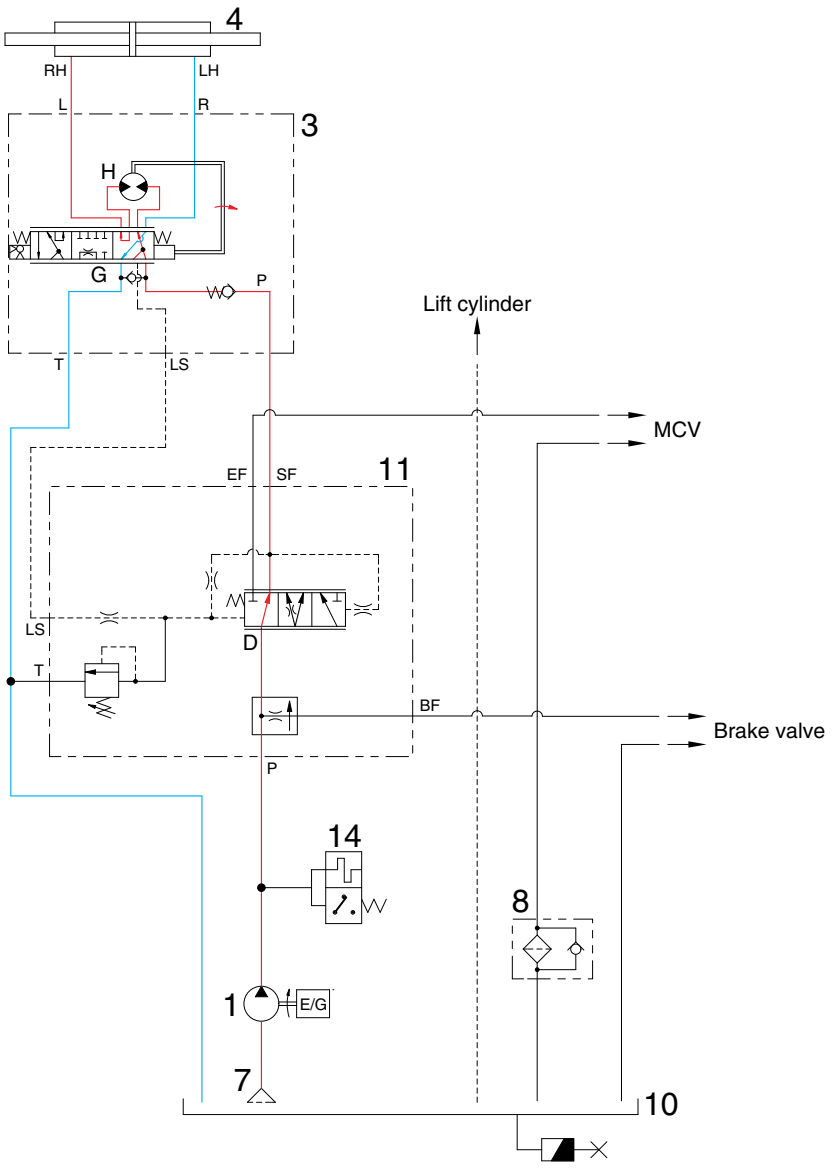
1) NEUTRAL



22D9TSS03

The steering wheel is not being operated so control spool (G) does not move.
The oil from hydraulic gear pump (1) enters dual flow divider (11) and the inlet pressure oil moves the spool (D) to the left.
Oil flow into LS port to the hydraulic tank (10).
So, the pump flow is routed to the main control valve.

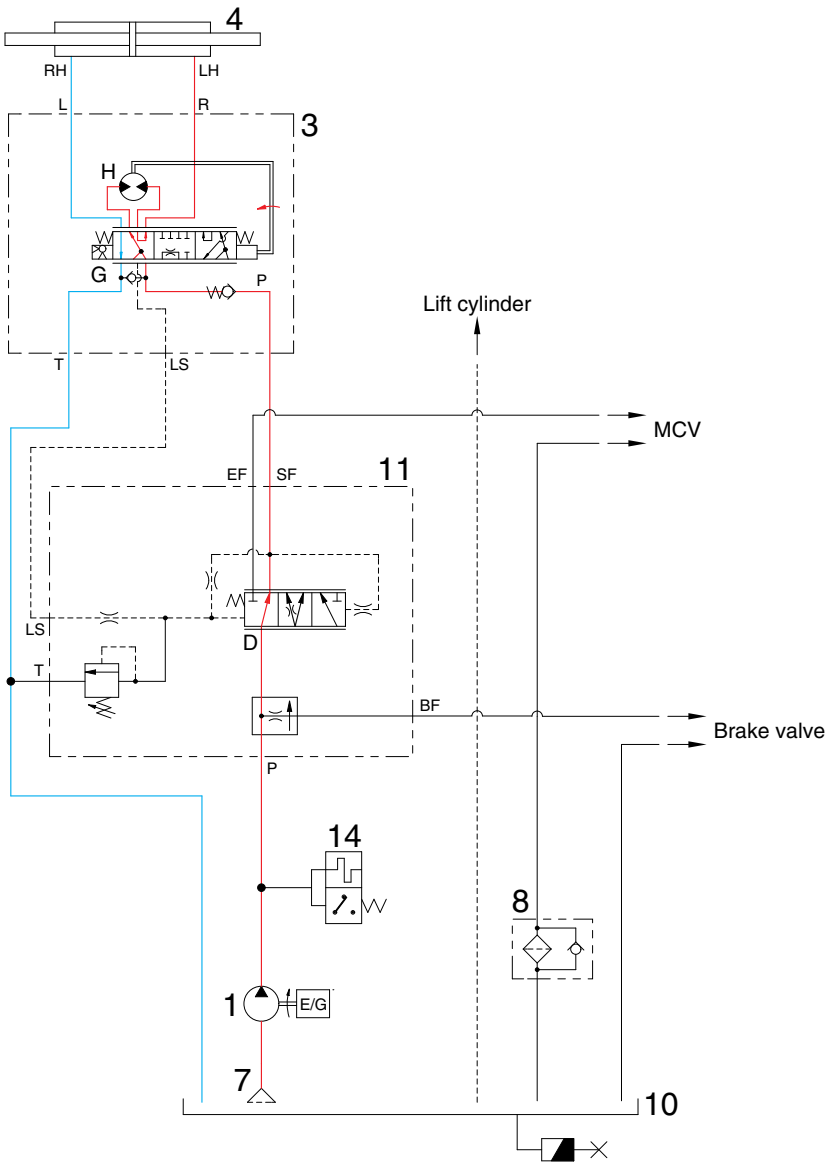
2) LEFT TURN



22D9TSS04

When the steering wheel is turned to the left, the spool (G) within the steering unit (3) connected with steering column turns in left hand direction.
At this time, the oil discharged from the pump flows into the spool (G) within the steering unit (3) through the spool (D) of dual flow divider (11) and flows to the gerotor (H).
Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out of the left work port (L).
Oil returned from cylinder returns to hydraulic tank (10).
When the above operation is completed, the machine turns to the left.

3) RIGHT TURN

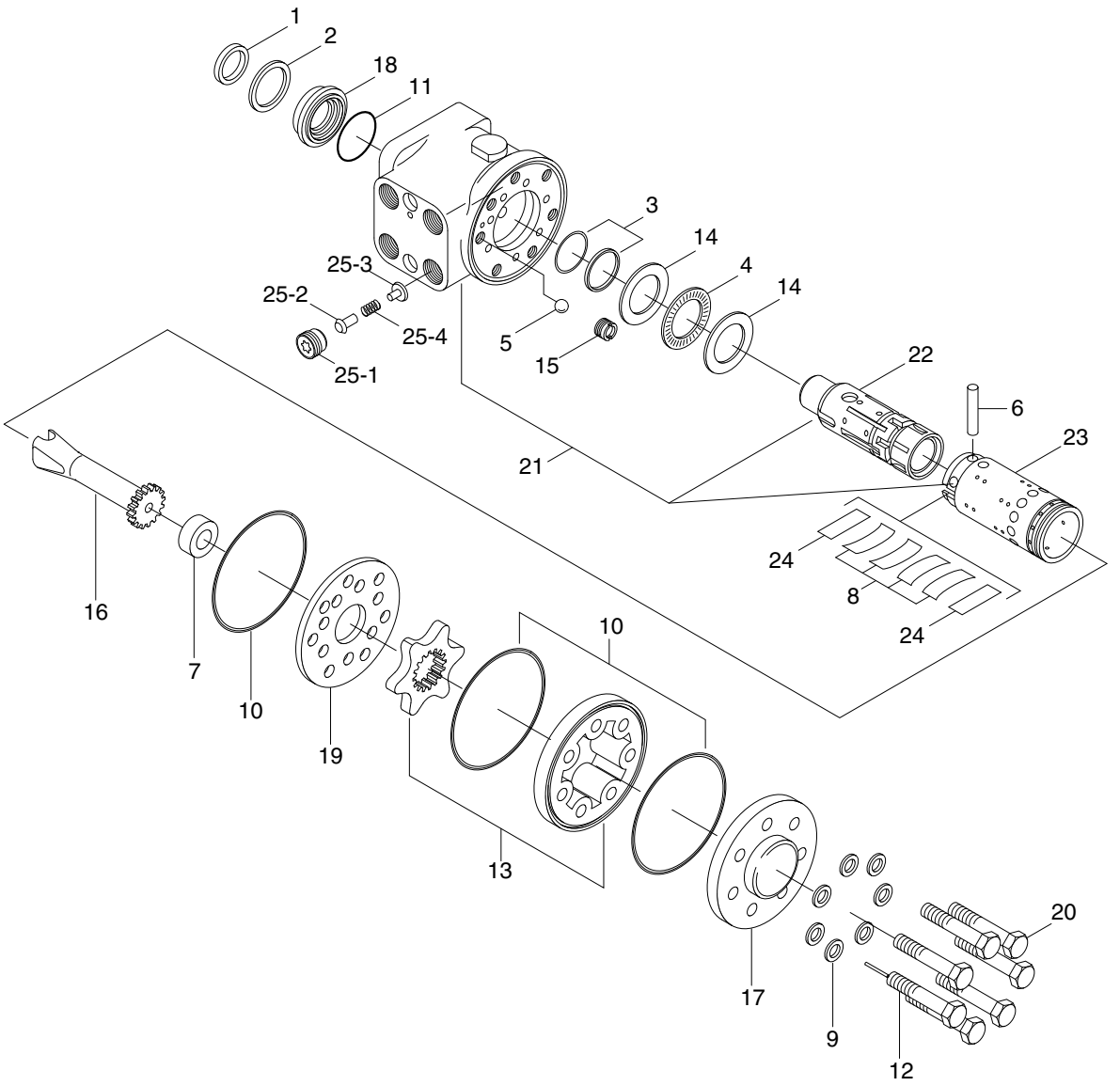


22D9TSS05

When the steering wheel is turned to the right, the spool (G) within the steering unit (3) connected with steering column turns in right hand direction.
At this time, the oil discharged from the pump flows into the spool (G) where it is directed out of the right work port (R).
Oil returned from cylinder returns to hydraulic tank (10).
When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

1) STRUCTURE



20D7SS06

1	Dust seal	11	O-ring	21	Housing
2	Retaining ring	12	Rolled screw	22	Spool
3	Cap seal	13	Gerotor set	23	Sleeve
4	Thrust bearing	14	Bearing race	24	Plate spring
5	Ball	15	Bore screw	25	P-port check valve
6	Pin	16	Drive	25-1	Plug
7	Spacer	17	End cap	25-2	Poppet
8	Center spring	18	Gland bushing	25-3	Spring seat
9	Washer	19	Plate	25-4	Spring
10	O-ring	20	Cap screw		

2) OPERATION

The steering unit is composed of the control valve (rotary valve) and the metering device. The control valve controls the flow of oil from the pump in the interior of the unit depending on the condition of the steering wheel. The metering device is a kind of hydraulic motor composed of a stator and a rotor. It meters the required oil volume, feeds the metered oil to the power cylinder and detects cylinder's motion value, that is, cylinder's motion rate.

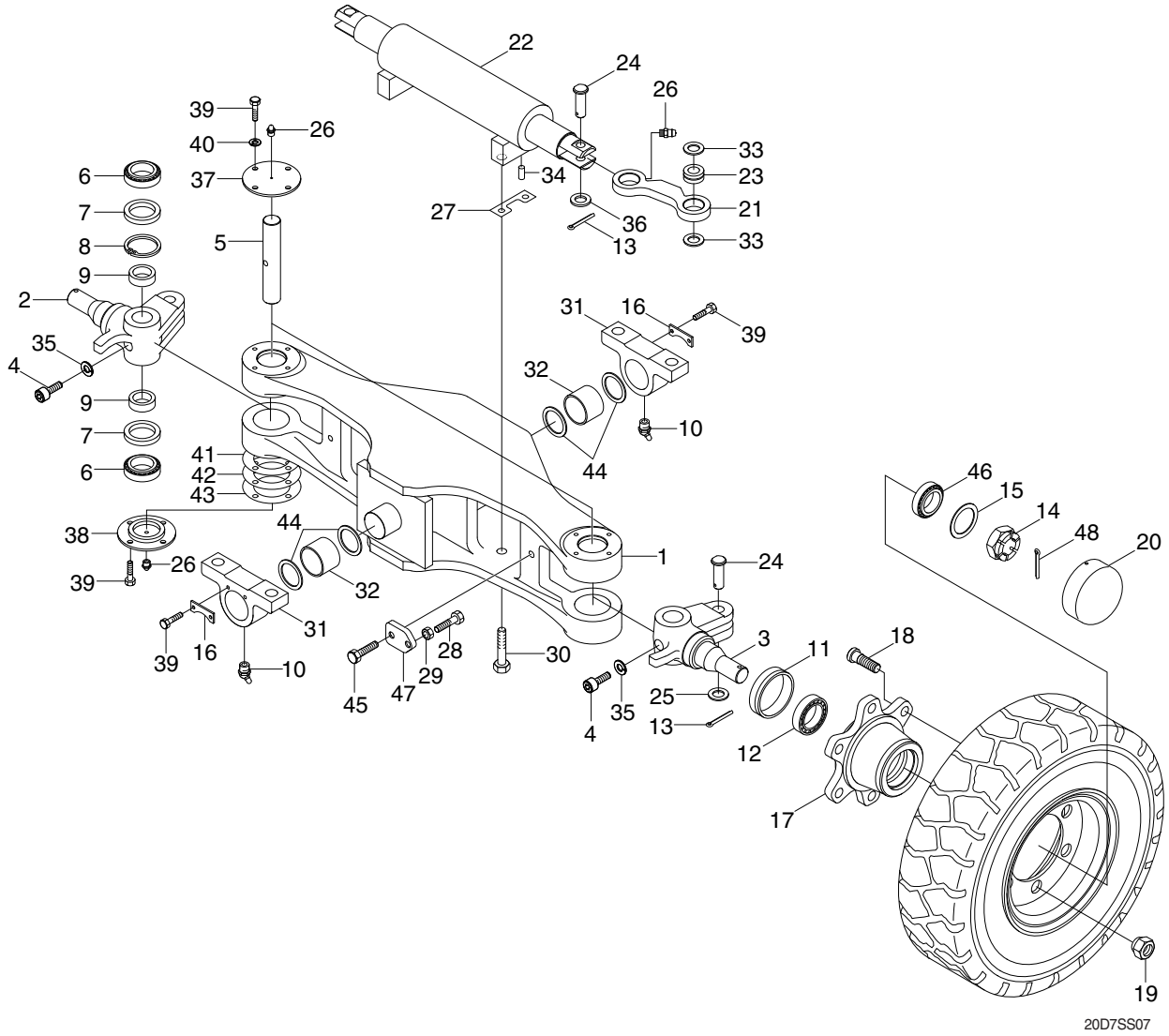
When the steering wheel is turned, the spool turns, the oil path is switched and the oil is fed into the metering device. As a result, the rotor is caused to run by oil pressure, and the sleeve is caused to run through the drive shaft and cross pin. Therefore, when the spool is turned, the spool turns by the same value in such a manner that it follows the motion of the spool. Steering motion can be accomplished when this operation is performed in a continuous state.

⚠ If the hoses of the steering system are incorrectly connected, the steering wheel can turn very rapidly when the engine is started. Keep clear of the steering wheel when starting the engine.

The centering spring for the spool and sleeve is provided to cause the valve to return to the neutral position. It is therefore possible to obtain a constant steering feeling, which is transmitted to the hands of the driver. Return to the center position occurs when the steering wheel is released.

4. STEERING AXLE

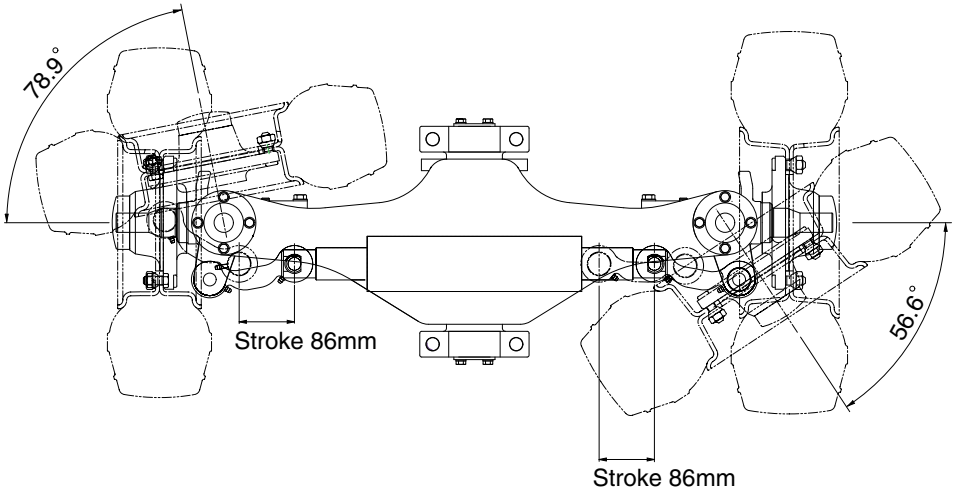
1) STRUCTURE

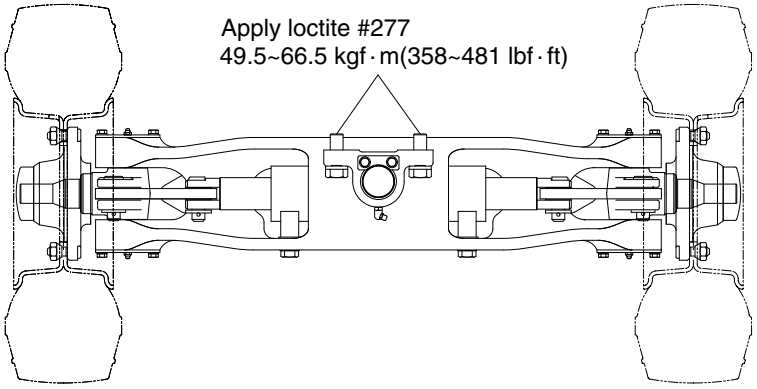


20D7SS07

1	Steering axle	17	Hub	33	Thrust washer
2	Knuckle-RH	18	Hub bolt	34	Pin
3	Knuckle-LH	19	Hub nut	35	Spring washer
4	Special bolt	20	Hub cap	36	Hardened washer
5	King pin	21	Steering link	37	Upper cover
6	Taper roller bearing	22	Steering cylinder	38	Lower cover
7	Oil seal	23	SPH plain bearing	39	Hex bolt
8	Retaining ring	24	Steer link pin	40	Spring wahser
9	Collar	25	Plain washer	41	Shim (0.1)
10	Grease nipple	26	Grease nipple	42	Shim (0.15)
11	Oil seal	27	Lock plate	43	Shim (0.3)
12	Taper roller bearing	28	Bolt	44	Spacer(0.5)
13	Split pin	29	Hex nut	45	Hex bolt
14	Nut	30	Hex bolt	46	Taper roller bearing
15	Washer	31	Trunnion block	47	Plate
16	Plate	32	Bushing	48	Split pin

2) TIGHTENING TORQUE AND SPECIFICATION



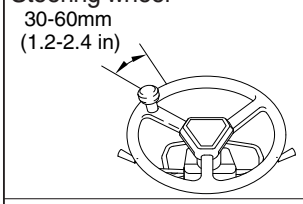


20D7SS08

Type	Unit	Center pin support single shaft
Structure of knuckle	-	Elliott type
Toe-in	degree	0
Camber	degree	0
Caster	degree	0
King pin angle	degree	0
Max steering angle of wheels (Inside/Outside)	degree	78.9 / 56.6
Tread	mm (in)	980 (38.6)

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

<table>
<tr><th>Check item</th><th>Checking procedure</th></tr>
<tr><td>Steering wheel
 
</td><td>· Set rear wheels facing straight forward, then turn steering wheel to left and right. Measure range of steering wheel movement before rear wheel starts to move. Range should be 30~60 mm at rim of steering wheel. If play is too large, adjust at gear box.
Test steering wheel play with engine at idling.</td></tr>
<tr><td>Knuckle</td><td>· Check knuckle visually or use crack detection method. If the knuckle is bent, the tire wear is uneven, so check tire wear.</td></tr>
<tr><td>Steering axle</td><td>· Put camber gauge in contact with hub and measure camber. If camber is not within 0±0.5°; rear axle is bent.
· Ask assistant to drive machine at minimum turning radius.
· Fit bar and a piece of chalk at outside edge of counterweight to mark line of turning radius.
· If minimum turning radius is not within±100 mm (±4 in)of specified value, adjust turning angle stopper bolt.
Min turning radius (Outside)
<table>
<tr><td>22D-9S</td><td>2286 mm (90 in)</td><td>30D-9S</td><td>2413 mm (95 in)</td></tr>
<tr><td>25D-9S</td><td>2342 mm (92 in)</td><td>33D-9S</td><td>2463 mm (97 in)</td></tr>
</table></td></tr>
<tr><td>Hydraulic pressure of power steering</td><td>Remove plug from outlet port of flow divider and install oil pressure gauge.
Turn steering wheel fully and check oil pressure.
※ Oil pressure : 90 kgf/cm² (90 bar)</td></tr>
</table>

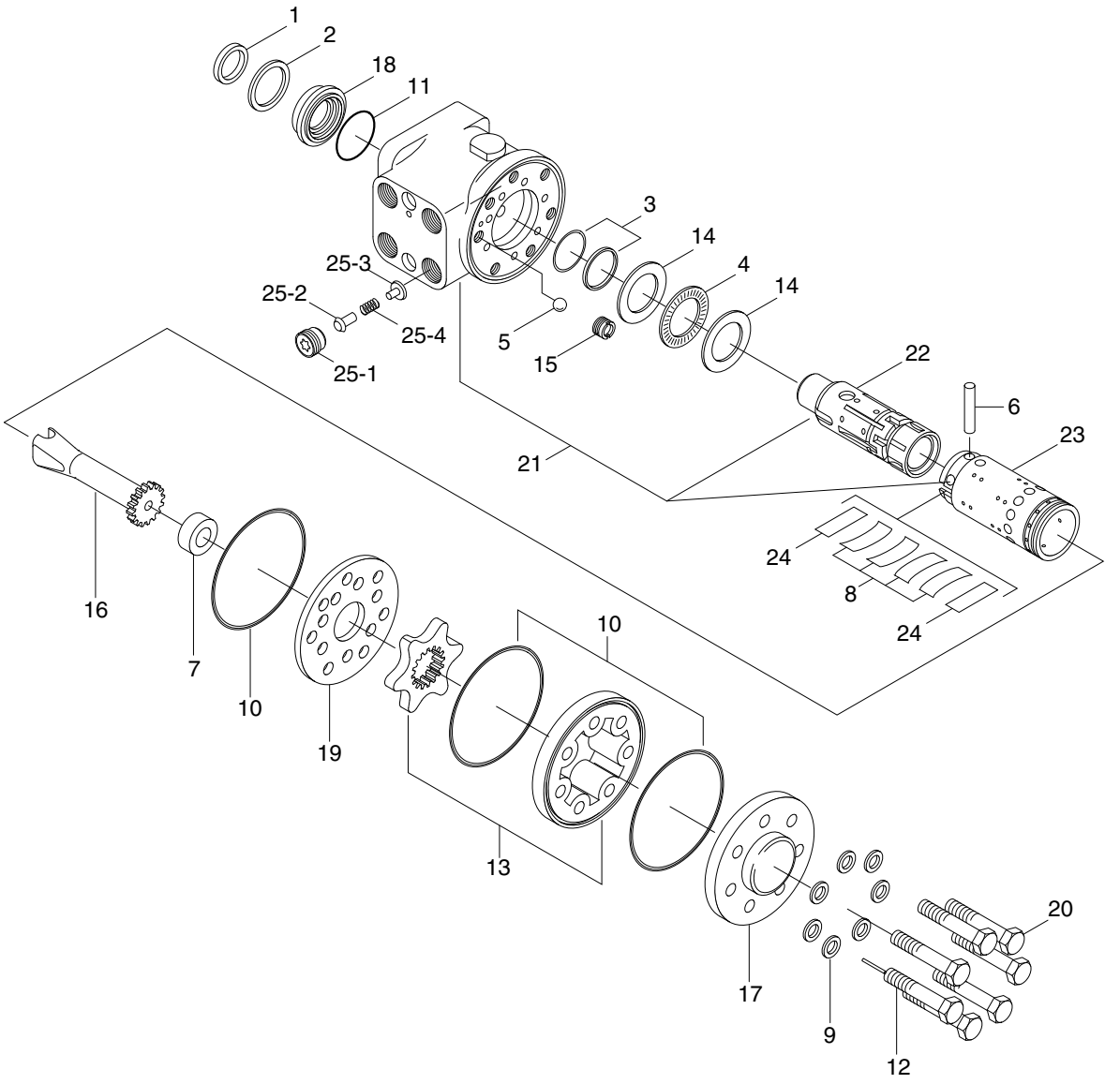
2. TROUBLESHOOTING

Problem	Cause	Remedy
Steering wheel drags.	· Low oil pressure. · Bearing faulty. · Spring spool faulty. · Reaction plunger faulty. · Ball-and-screw assembly faulty. · Sector shaft adjusting screw excessively tight. · Gears poorly meshing. · Flow divider coil spring fatigued.	· Check lockout. Repair. · Clean or replace. · Clean or replace. · Replace. · Clean or replace. · Adjust. · Check and correct meshing. · Replace.
Steering wheel fails to return smoothly.	· Bearing faulty. · Reaction plunger faulty. · Ball-and-screw assy faulty · Gears poorly meshing.	· Clean or replace. · Replace. · Clean or replace. · Check and correct meshing.

Problem	Cause	Remedy
Steering wheel turns unsteadily.	· Lockout loosening. · Metal spring deteriorated.	· Retighten. · Replace.
Steering system makes abnormal sound or vibration.	· Gear backlash out of adjustment. · Lockout loosening. · Air in oil circuit.	· Adjust. · Retighten. · Bleed air.
Abnormal sound heard when steering wheel is turned fully	Valve · Faulty. (Valve fails to open.) Piping · Pipe (from pump to power steering cylinder) dented or clogged.	 · Adjust valve set pressure and check for specified oil pressure. · Repair or replace.
Piping makes abnormal sounds.	Oil pump · Lack of oil. · Oil inlet pipe sucks air. · Insufficient air bleeding.	 · Add oil. · Repair. · Bleed air completely.
Valve or valve unit makes abnormal sounds.	Oil pump · Oil inlet pipe sucks air. Valve · Faulty. (Unbalance oil pressure) Piping · Pipe (from pump to power steering) dented or clogged. · Insufficient air bleeding.	 · Repair or replace. · Adjust valve set pressure and check specified oil pressure. · Repair or replace. · Bleed air completely.
Insufficient or variable oil flow.	· Flow control valve orifice clogged.	· Clean
Insufficient or variable discharge pressure.	Piping · Pipe (from tank to pipe) dented or clogged.	 · Repair or replace.
Steering cylinder head leakage (Piston rod)	· Packing foreign material. · Piston rod damage. · Rod seal damage and distortion. · Chrome gilding damage.	· Replace · Grind surface with oil stone. · Replace · Grind
Steering cylinder head thread (A little bit leak is no problem)	· O-ring damage.	· Replace
Welding leakage	· Cylinder tube damage.	· Tube replace.
Rod	· Tube inside damage. · Piston seal damage and distortion	· Grind surface with oil store. · Replace
Piston rod bushing inner diameter excessive gap	· Bushing wear.	· Replace

1. STEERING UNIT

1) STRUCTURE

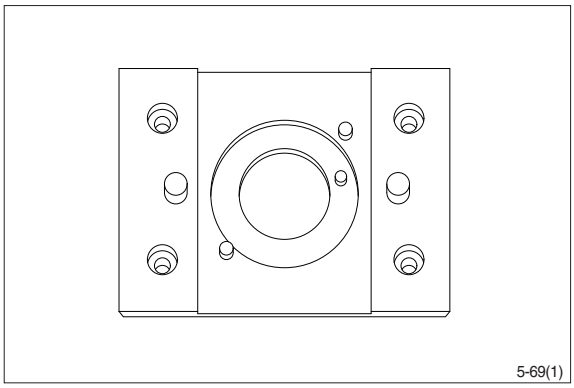


20D7SS06

1	Dust seal	11	O-ring	21	Housing
2	Retaining ring	12	Rolled screw	22	Spool
3	Cap seal	13	Gerotor set	23	Sleeve
4	Thrust bearing	14	Bearing race	24	Plate spring
5	Ball	15	Bore screw	25	P-port check valve.
6	Pin	16	Drive	25-1	Plug
7	Spacer	17	End cap	25-2	Poppet
8	Center spring	18	Gland bushing	25-3	Spring seat
9	Washer	19	Plate	25-4	Spring
10	O-ring	20	Cap screw		

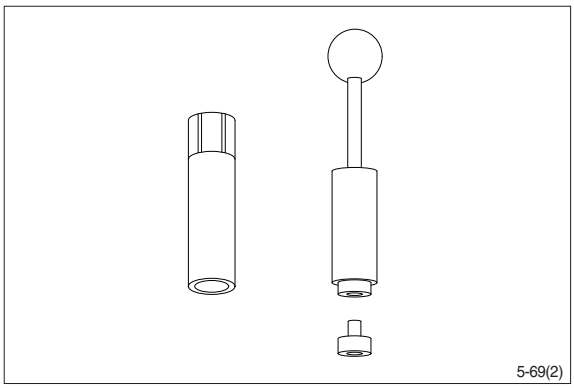
2) TOOLS

(1) Holding tool.



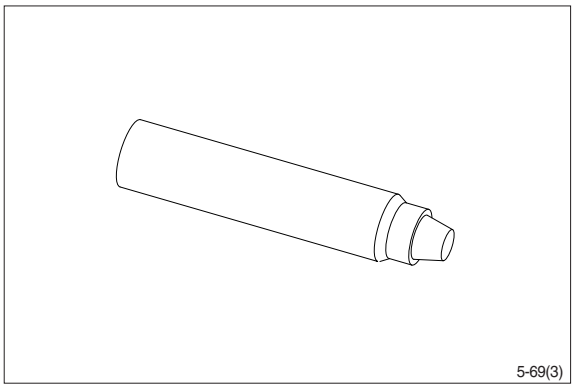
5-69(1)

(2) Assembly tool for O-ring and kin-ring.



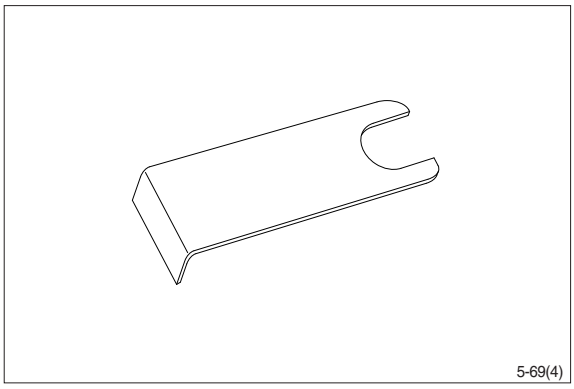
5-69(2)

(3) Assembly tool for lip seal.



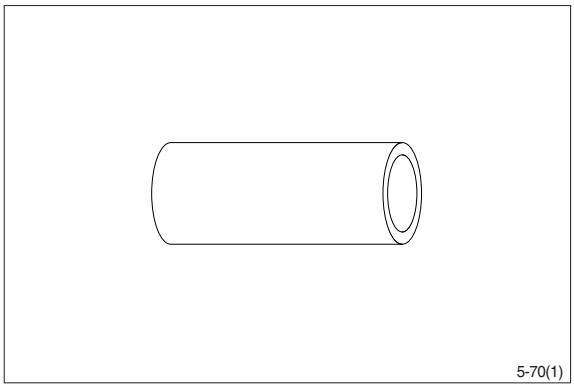
5-69(3)

(4) Assembly tool for cardan shaft.

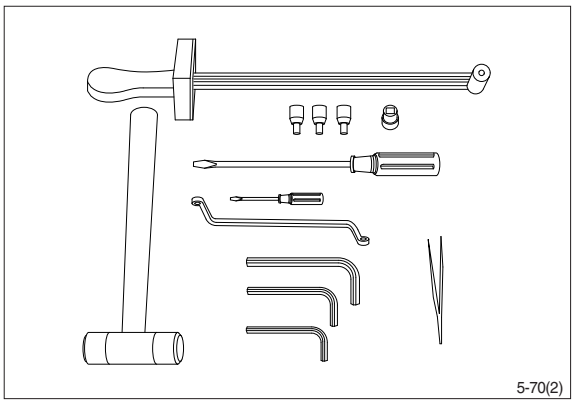


5-69(4)

(5) Assembly tool for dust seal.

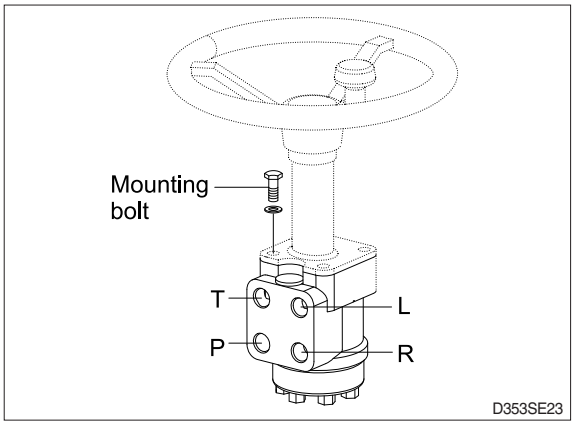


(6) Torque wrench 0~7.1kgf · m
(0~54.4lbf · ft)
13 mm socket spanner
6, 8 mm and 12 mm hexagon sockets
12 mm screwdriver
2 mm screwdriver
13 mm ring spanner
6, 8 and 12 mm hexagon socket spanners
Plastic hammer
Tweezers



3) TIGHTENING TORQUE

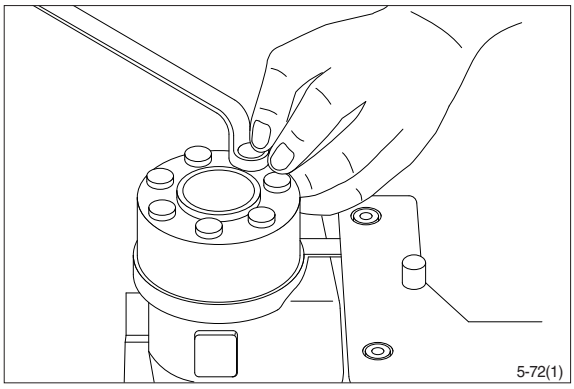
L : Left port
R : Right port
T : Tank
P : Pump



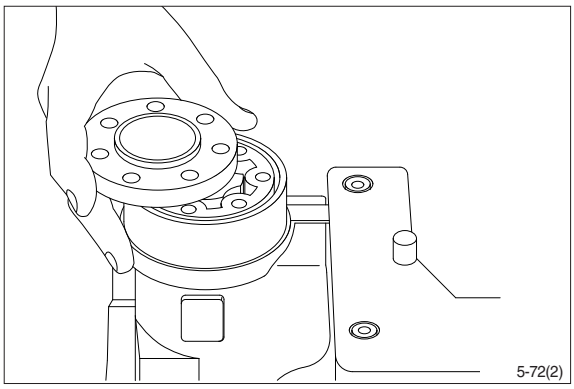
Port	Size	Torque [kgf · m (lbf · ft)]
L	3/4 UNF - 16	13 (94)
R	3/4 UNF - 16	13 (94)
T	3/4 UNF - 16	13 (94)
P	3/4 UNF - 16	13 (94)
Mounting bolt	M10×1.5	5.0±1.0 (36±7.2)

4) DISASSEMBLY

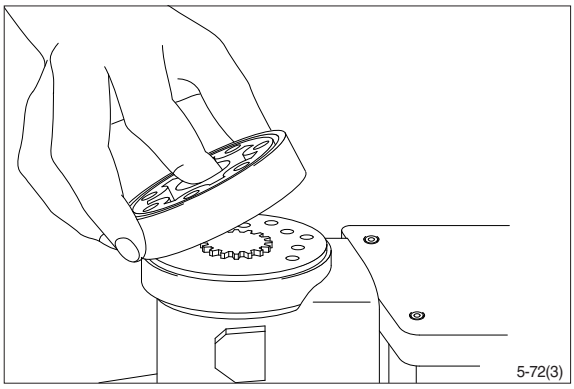
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool.
Screw out the screws in the end cover (6-off plus one special screw).


5-72(1)

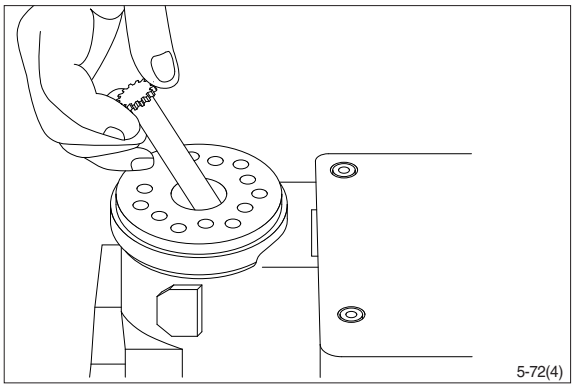
(2) Remove the end cover, sideways.


5-72(2)

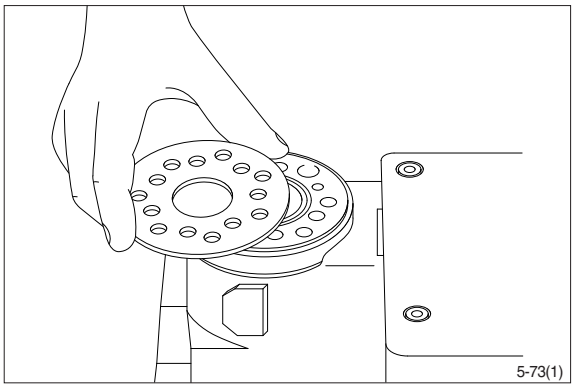
(3) Lift the gearwheel set(With spacer if fitted) off the unit.
Take out the two O-rings.


5-72(3)

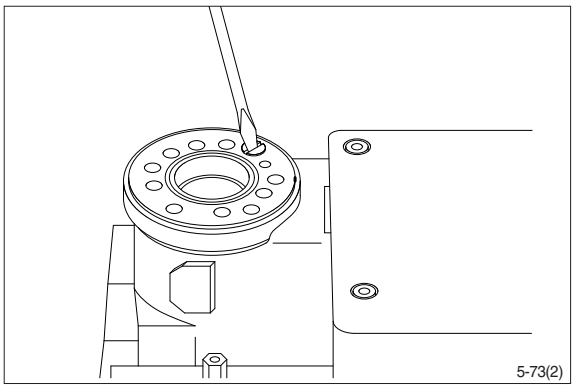
(4) Remove cardan shaft.


5-72(4)

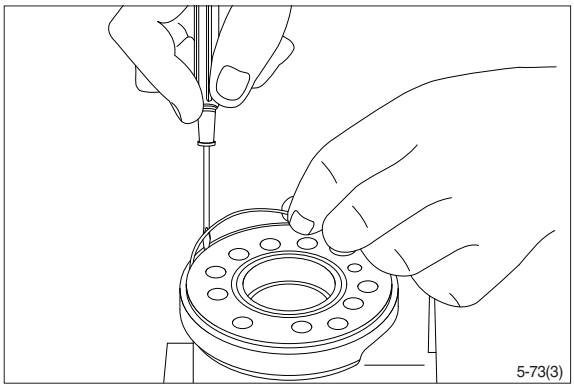
(5) Remove distributor plate.


5-73(1)

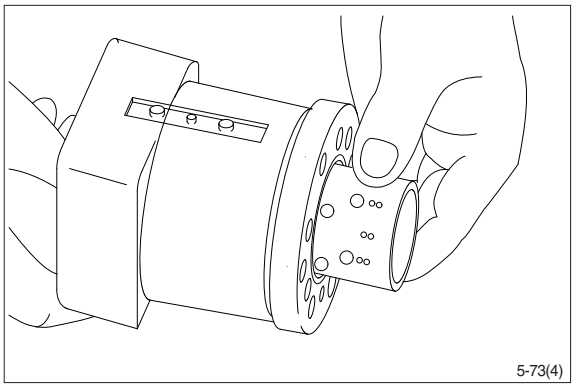
(6) Screw out the threaded bush over the check valve.


5-73(2)

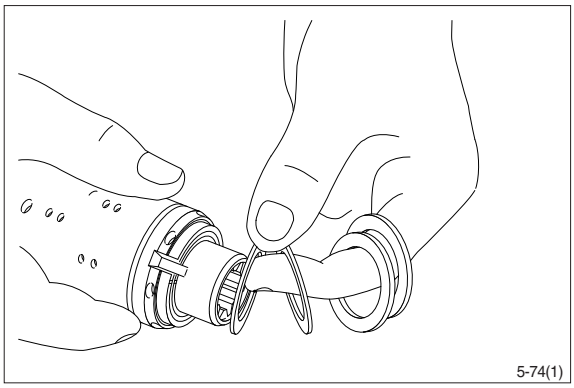
(7) Remove O-ring.


5-73(3)

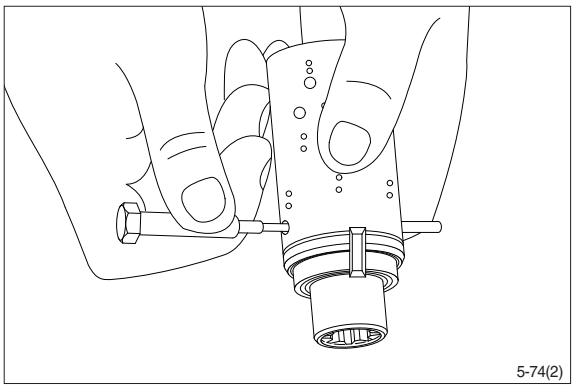
(8) Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and thrust bearing will be pushed out of the housing together.


5-73(4)

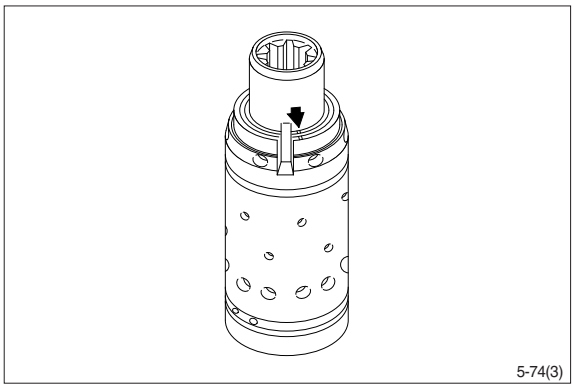
(9) Take ring, bearing races and thrust bearing from sleeve and spool. The outer (Thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.


5-74(1)

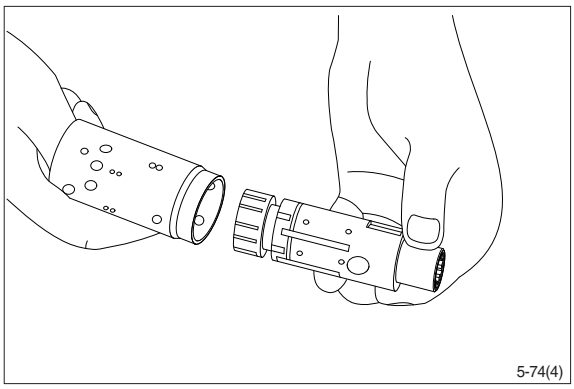
(10) Press out the cross pin. Use the special screw from the end cover.


5-74(2)

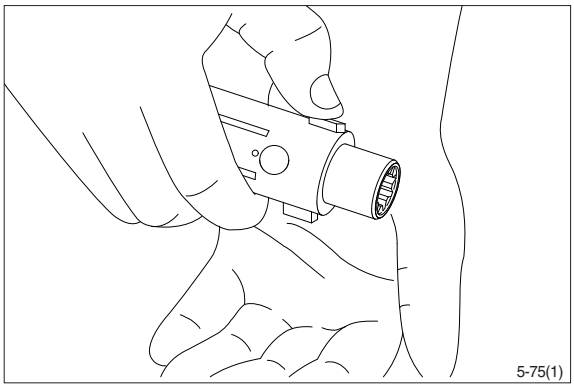
※ A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (See drawing).
If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are disassembled.


5-74(3)

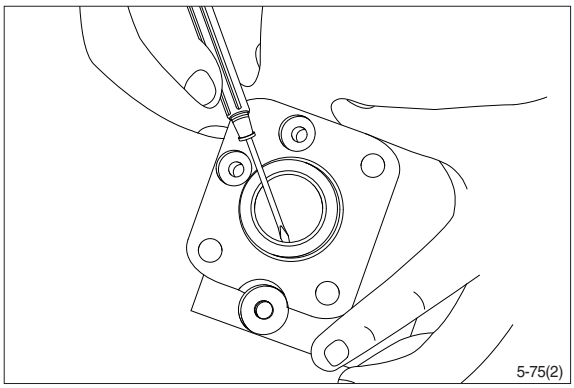
(11) Carefully press the spool out of the sleeve.


5-74(4)

(12) Press the neutral position springs out of their slots in the spool.

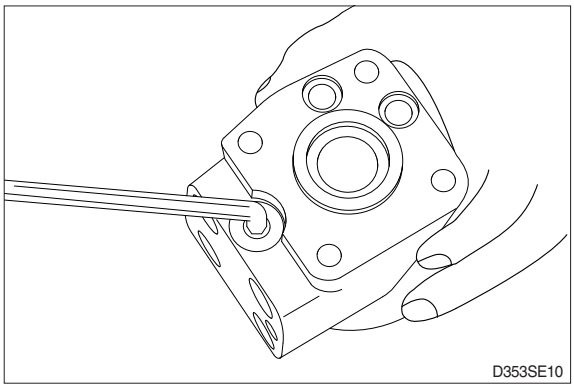


(13) Remove dust seal and O-ring.

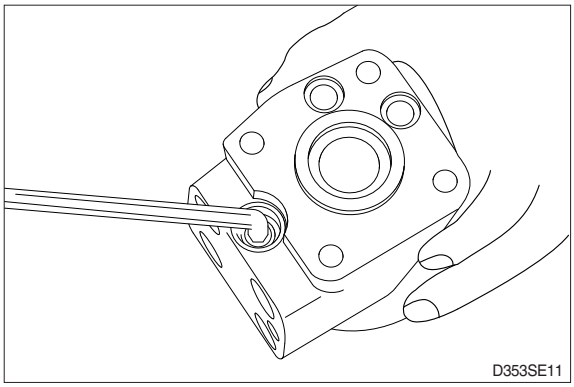


Disassembling the pressure relief valve

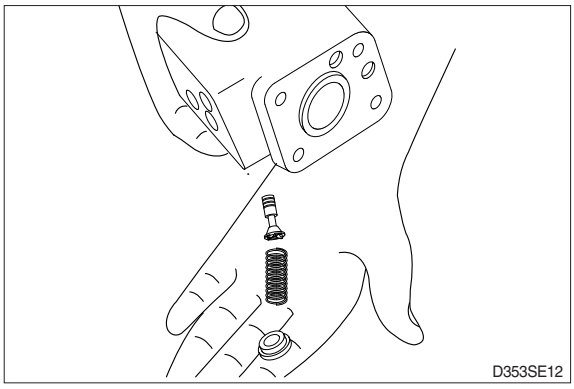
(14) Screw out the plug using an 8 mm hexagon socket spanner.
Remove seal washers.



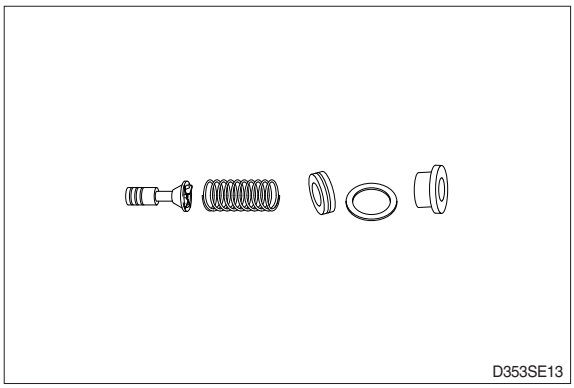
(15) Unscrew the setting screw using an 8 mm hexagon socket spanner.



(16) Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.



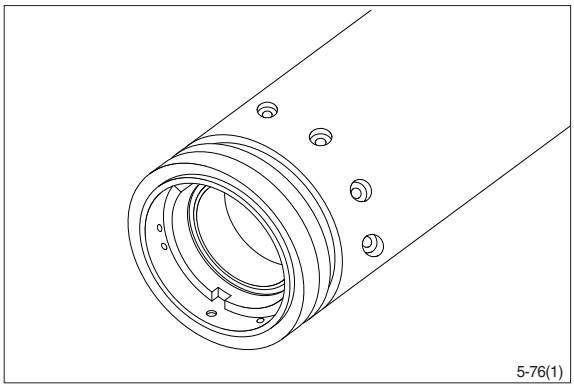
(17) The pressure relief valve is now disassem-bled.



5) ASSEMBLY

(1) Assemble spool and sleeve.

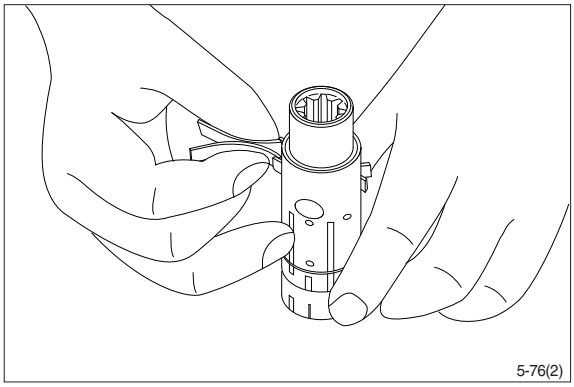
※ When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool / sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.



5-76(1)

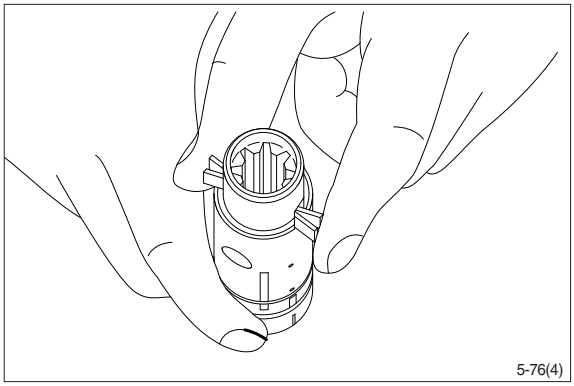
(2) Place the two flat neutral position springs in the slot.

Place the curved springs between the flat ones and press them into place (see assembly pattern).



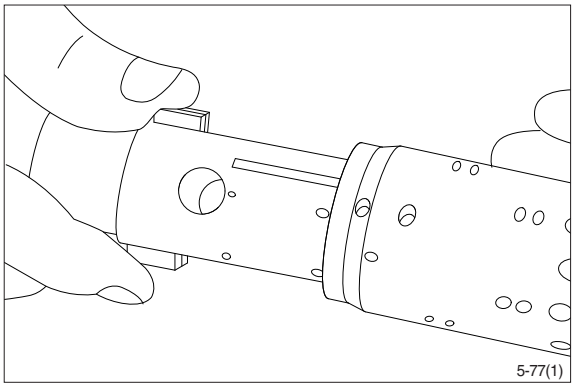
5-76(2)

(3) Line up the spring set.



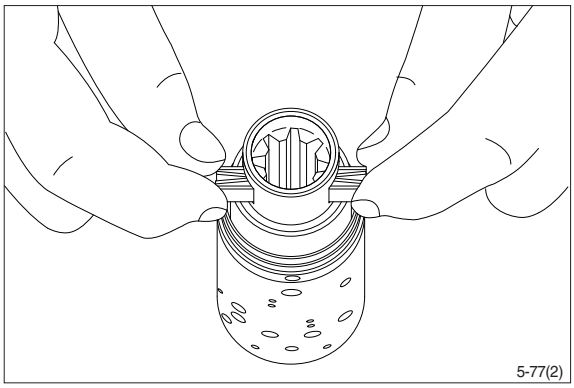
5-76(4)

(4) Guide the spool into the sleeve. Make sure that spool and sleeve are placed correctly in relation to each other.

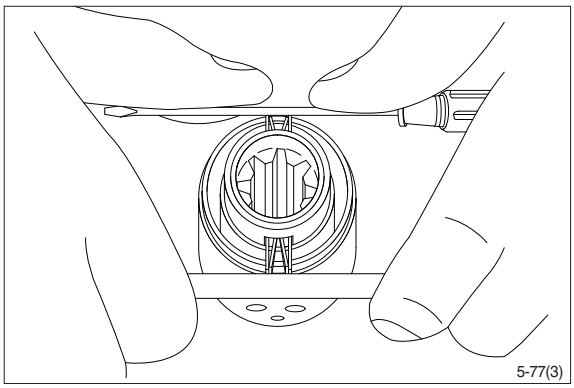


5-77(1)

(5) Press the springs together and push the neutral position springs into place in the sleeve.

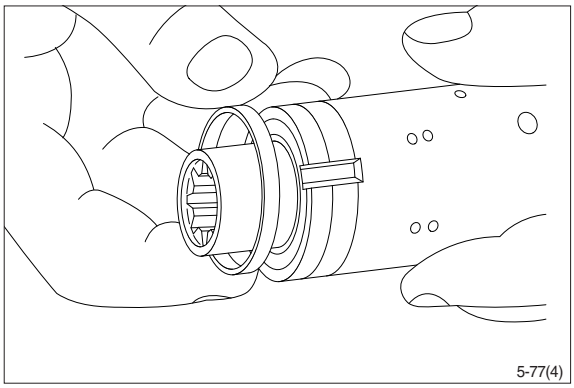

5-77(2)

(6) Line up the springs and center them.

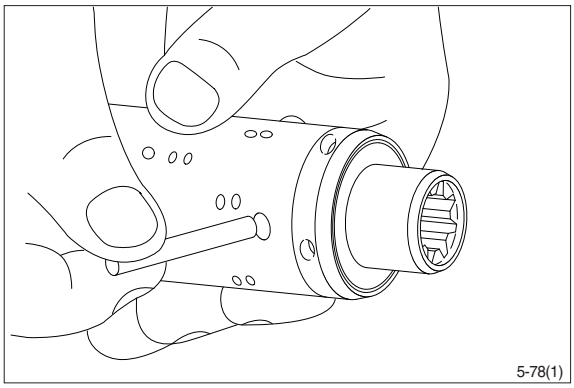

5-77(3)

(7) Guide the ring down over the sleeve.

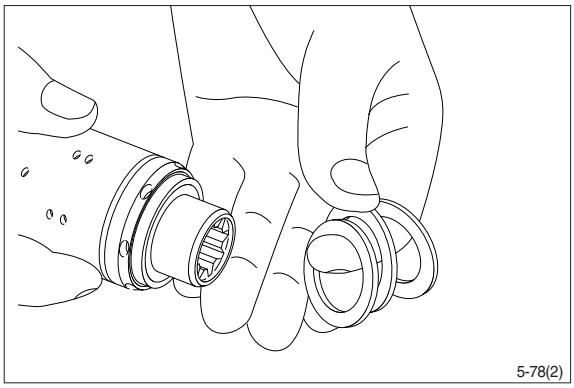
※ The ring should be able to rotate free of the springs.


5-77(4)

(8) Fit the cross pin into the spool / sleeve.

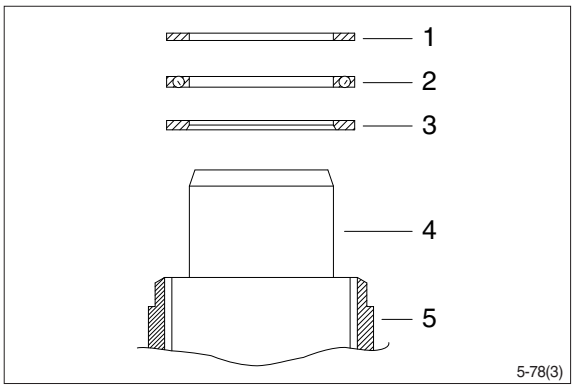

5-78(1)

(9) Fit bearing races and needle bearing as shown on below drawing.



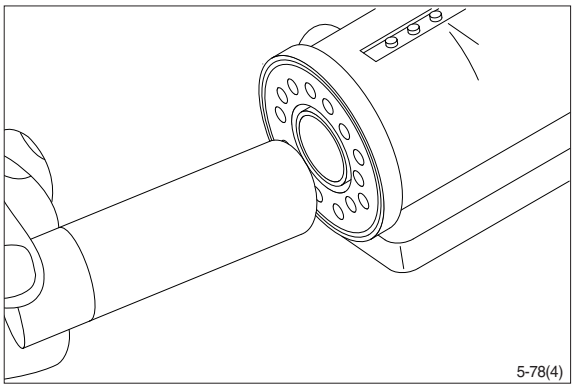
※ **Assembly pattern for standard bearings**

1 Outer bearing race
2 Thrust bearing
3 Inner bearing race
4 Spool
5 Sleeve

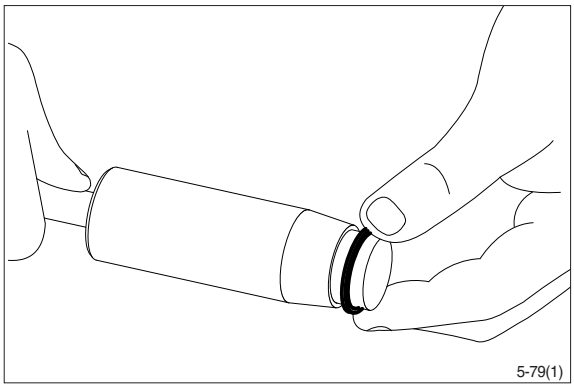


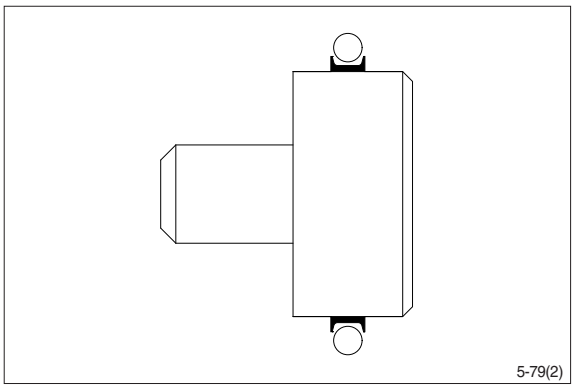
Installation instruction for O-ring

(10) Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.

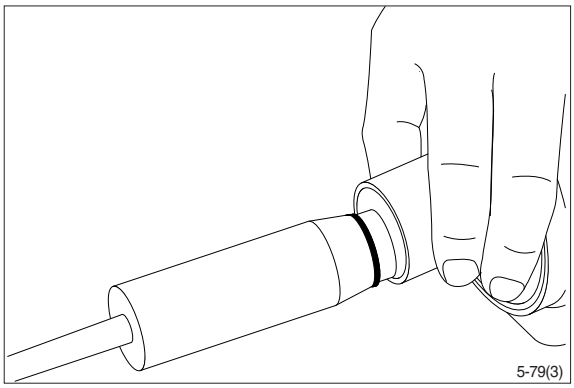


(11) Grease O-ring with hydraulic oil and place them on the tool.

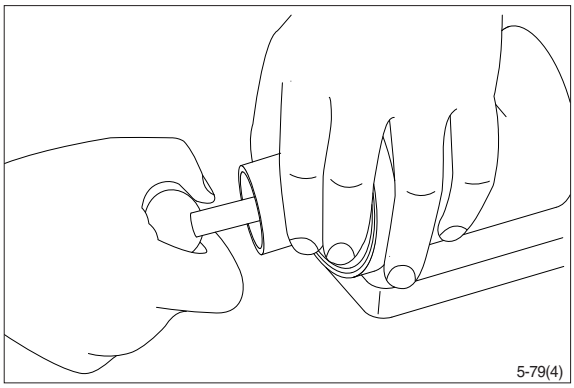

5-79(1)


5-79(2)

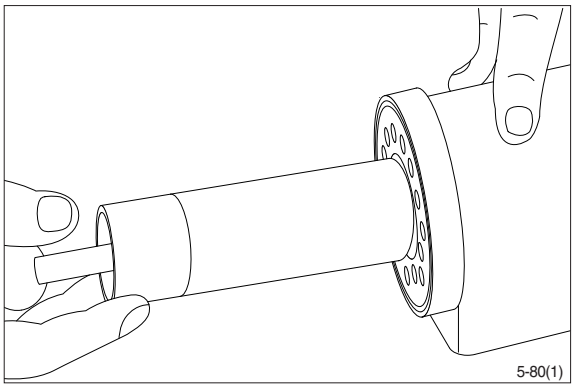
(12) Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.


5-79(3)

(13) Press and turn the O-ring into position in the housing.

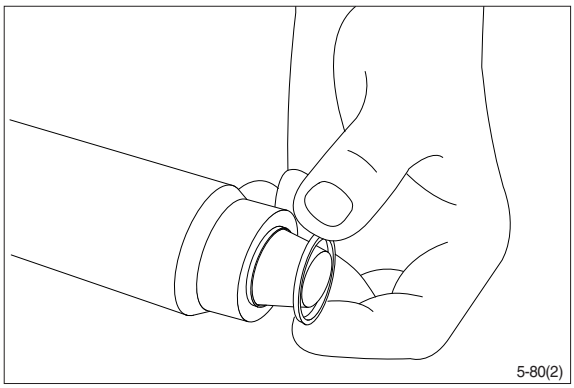

5-79(4)

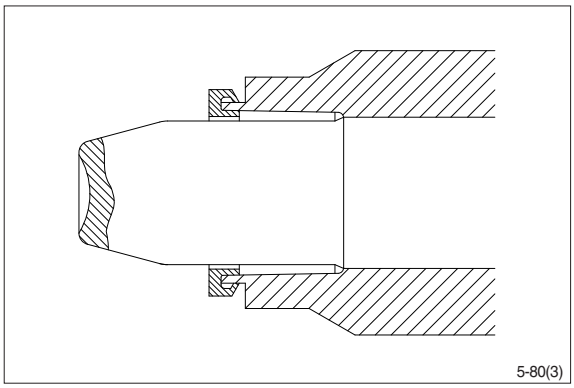
(14) Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.



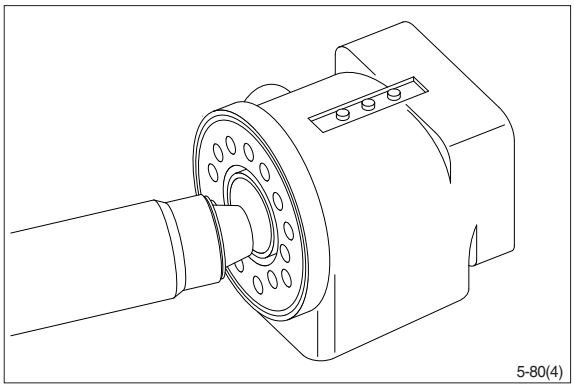
Installation instructions for lip seal

(15) Lubricate the lip seal with hydraulic oil and place it on the assembly tool.

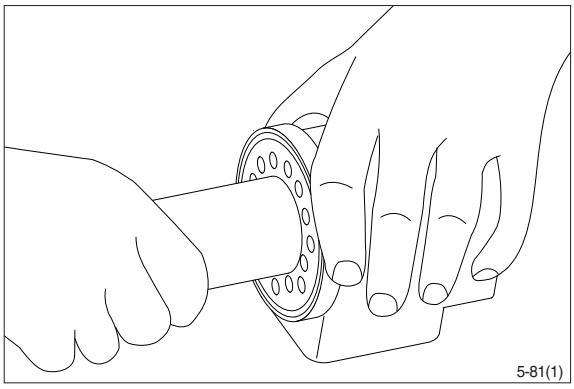




(16) Guide the assembly tool right to the bottom.

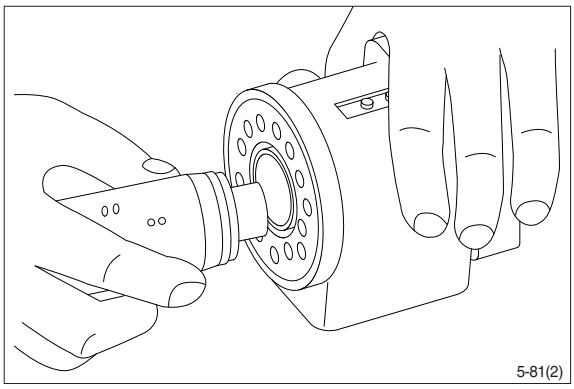


(17) Press and turn the lip seal into place in the housing.

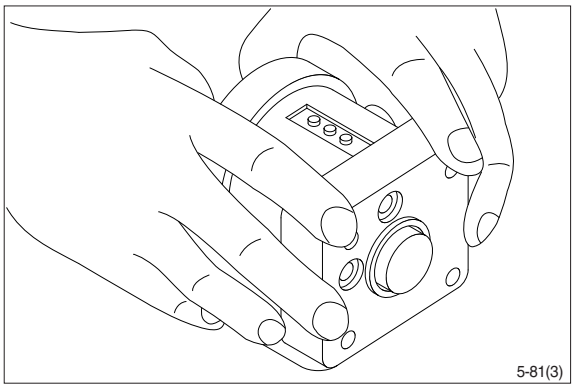


(18) With a light turning movement, guide the spool and sleeve into the bore.

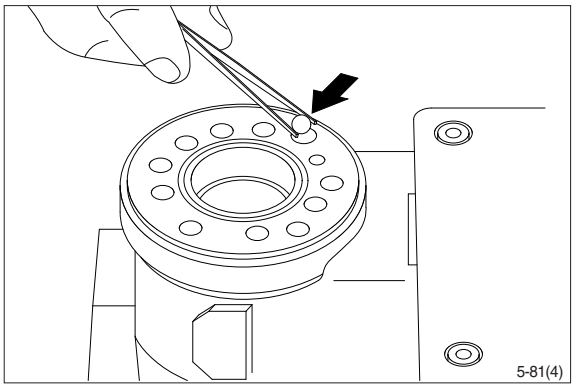
※ Fit the spool set holding the cross pin horizontal.



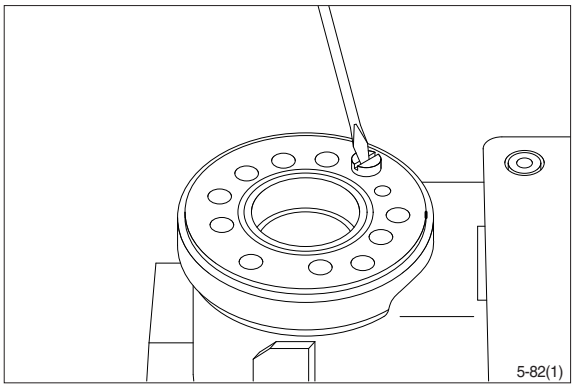
(19) The spool set will push out the assembly tool guide. The O-ring are now in position.



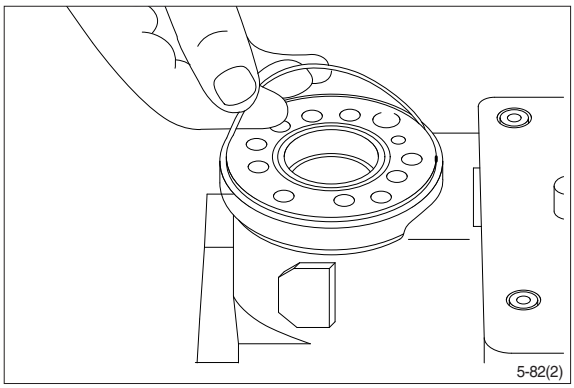
(20) Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.



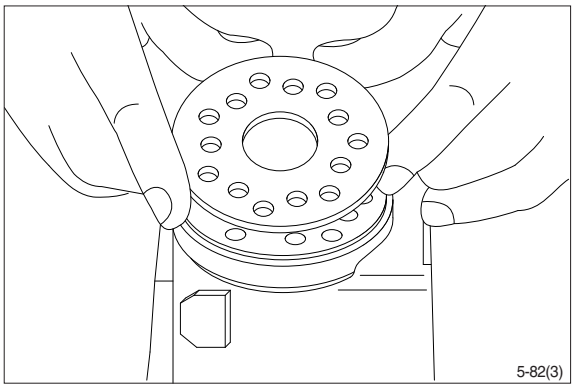
(21) Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.



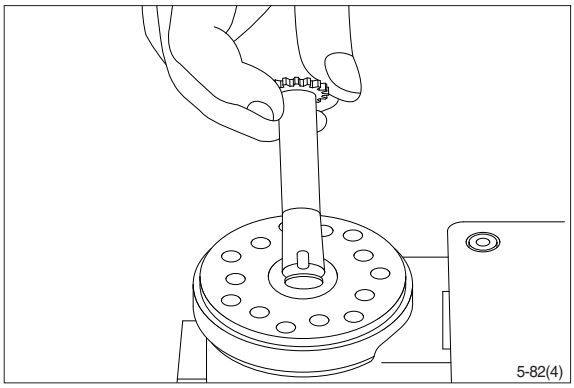
(22) Grease the O-ring with mineral oil approx. viscosity 500 cSt at 20˚C.



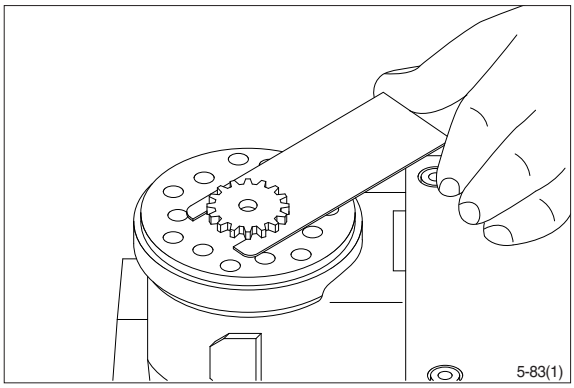
(23) Place the distributor plate so that the channel holes match the holes in the housing.



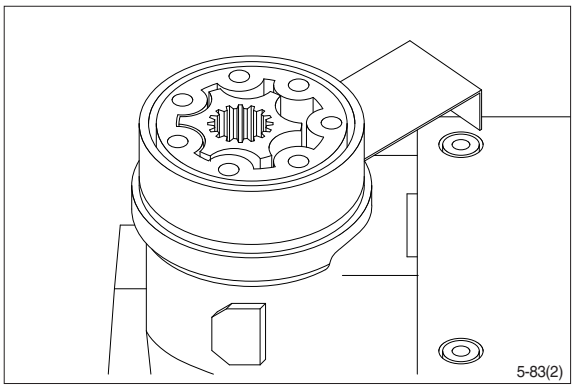
(24) Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.



(25) Place the cardan shaft as shown - so that it is held in position by the mounting fork.



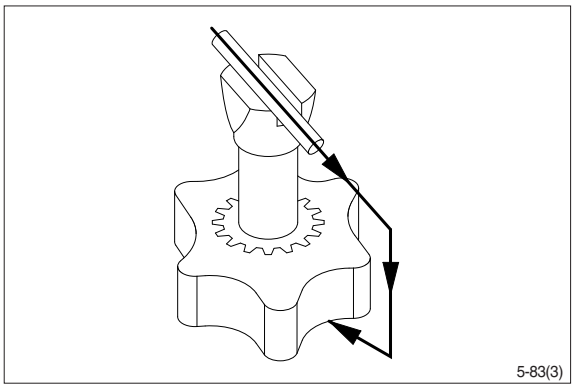
(26) Grease the two O-rings with mineral oil approx. viscosity 500 cSt at 20°C and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.



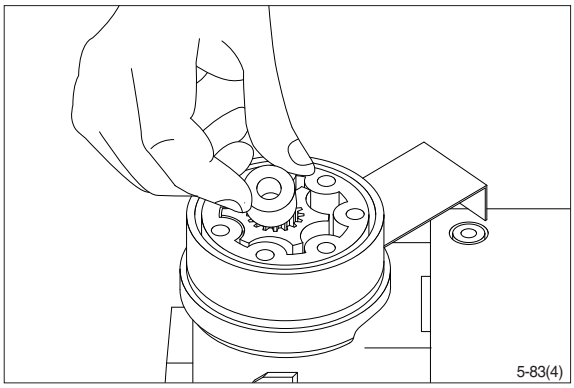
(27) Important

Fit the gearwheel (Rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown.

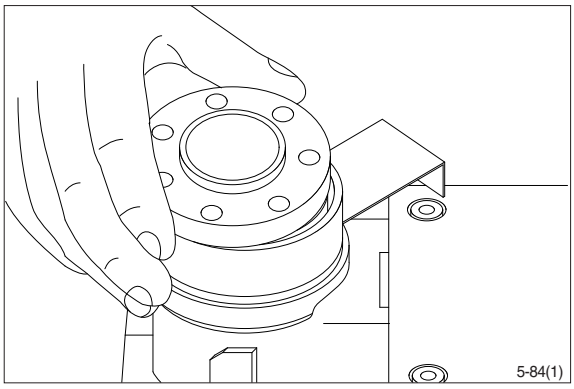
Turn the gear rim so that the seven through holes match the holes in the housing.



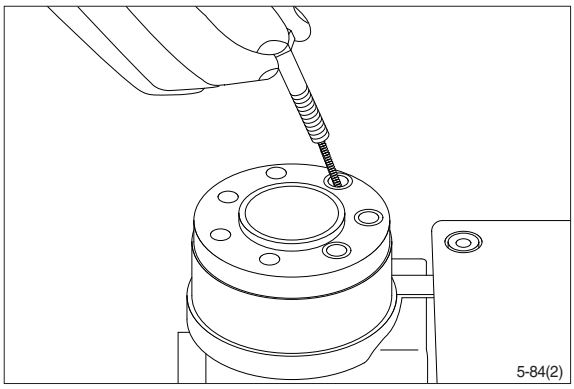
(28) Fit the spacer, if any.



(29) Place the end cover in position.

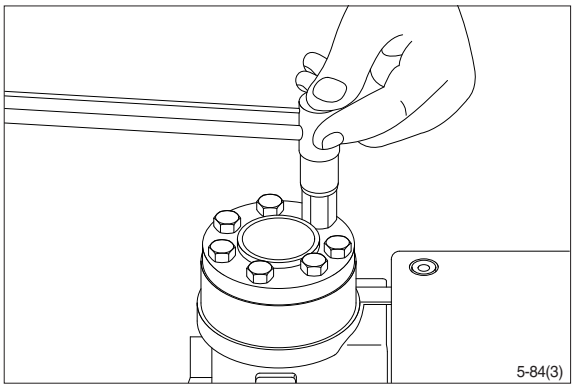

5-84(1)

(30) Fit the special screw with washer and place it in the hole shown.

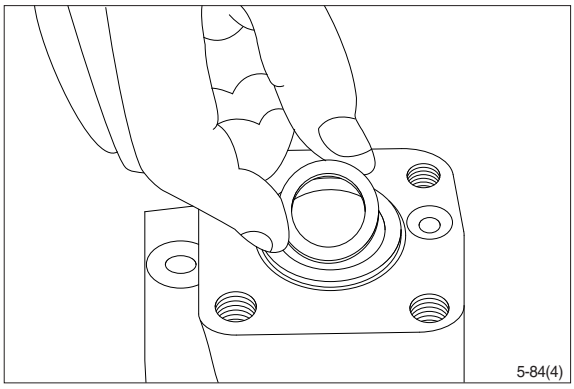

5-84(2)

(31) Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin.

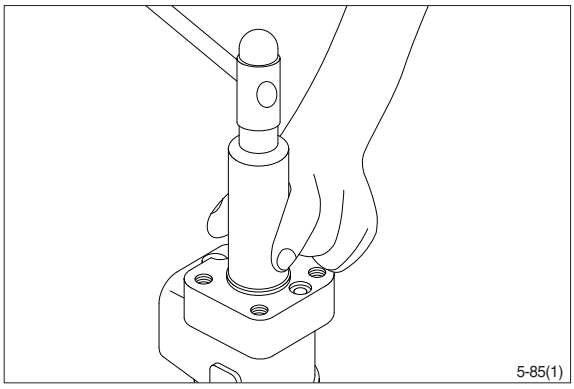
· Tightening torque : 3.0 ± 0.6kgf · m
(21.7 ± 4.3lbf · ft)


5-84(3)

(32) Place the dust seal ring in the housing.

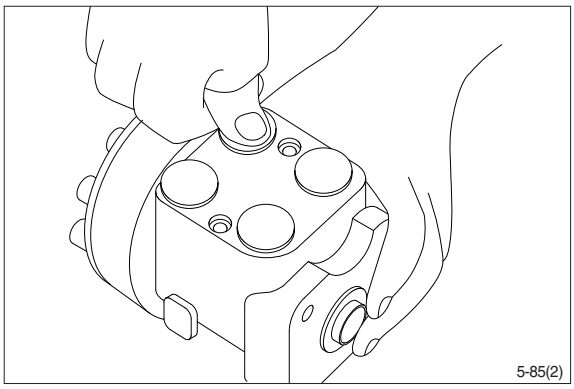

5-84(4)

(33) Fit the dust seal ring in the housing.


5-85(1)

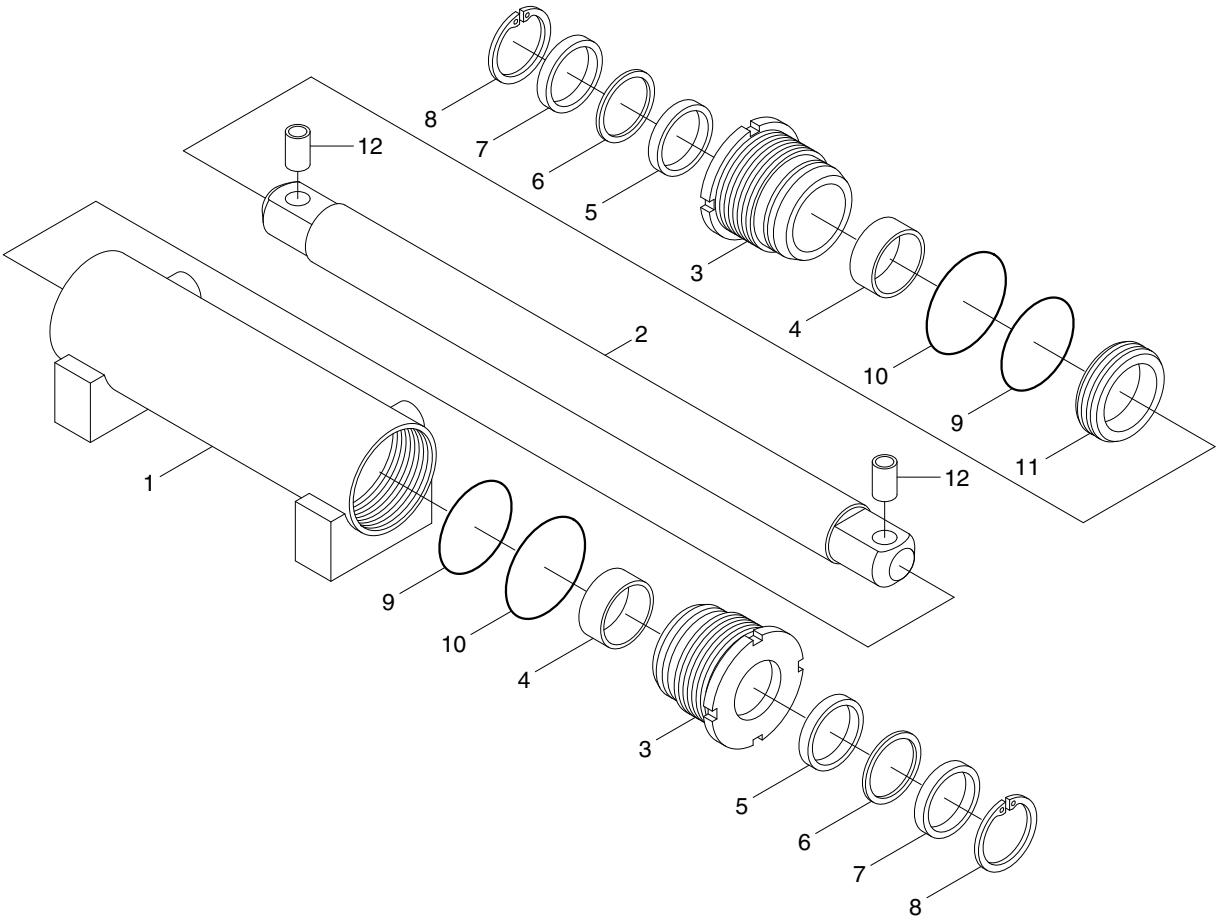
(34) Press the plastic plugs into the connection ports.

※ **Do not use a hammer!**


5-85(2)

2. STEERING CYLINDER

1) STRUCTURE



D255SS11

1	Tube assembly	5	Rod seal	9	O-ring
2	Rod	6	Back up ring	10	O-ring
3	Gland	7	Dust wiper	11	Piston seal
4	DU bushing	8	Snap ring	12	Pin bush

2) DISASSEMBLY

※ Before disassembling steering cylinder, release oil in the cylinder first.

(1) Put wooden blocks against the cylinder tube, then hold in a vice.

(2) Remove the gland by hook a wrench in the notch of cylinder head and turn counter-clockwise.

(3) Remove the cylinder rod and piston from the tube.

(4) Check wear condition of the sealing parts. If there are some damage, replace with new parts.

3) CHECK AND INSPECTION

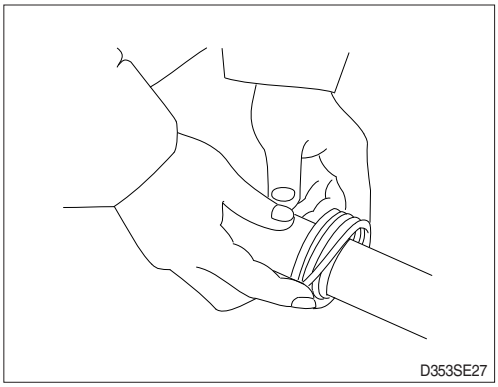
mm (in)

Check item	Criteria		Remedy
	Standard size	Repair limit	
Clearance between piston & cylinder tube	0.064~0.137 (0.0025~0.0054)	0.180 (0.0070)	Replace piston seal
Clearance between cylinder rod & bushing	0.024~0.112 (0.0009~0.0044)	0.120 (0.0049)	Replace bushing
Seals, O-ring	Damage		Replace
Cylinder rod	Dents		Replace
Cylinder tube	Biting		Replace

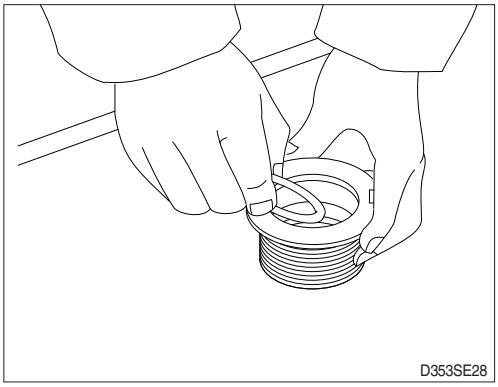
4) ASSEMBLY

(1) Install a new piston seal the groove on the piston.

※ Be careful not to scratch the seal too much during installation or it will not seat properly.

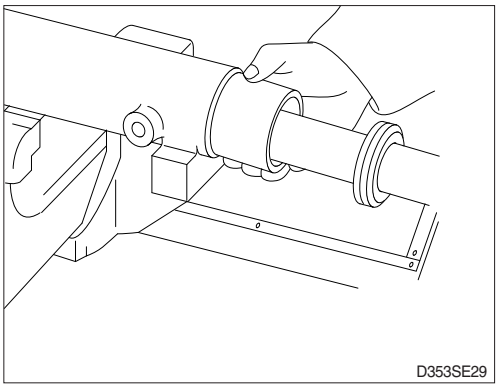

D353SE27

(2) Install the rod seal to the position in the gland applying a slight coat with grease prior to install.

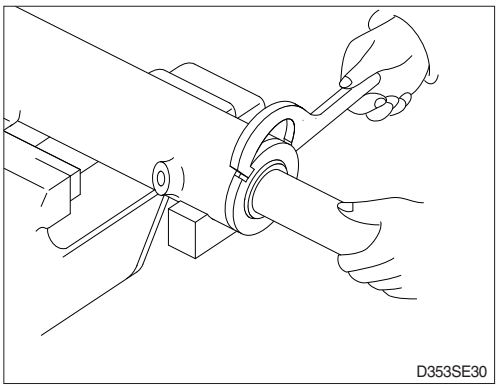

D353SE28

(3) Install the dust wiper to the gland using a special installing tool. Coat the dust wiper with grease slightly before installing.

(4) Set a special tool the cylinder, gland assembly into the cylinder tube.

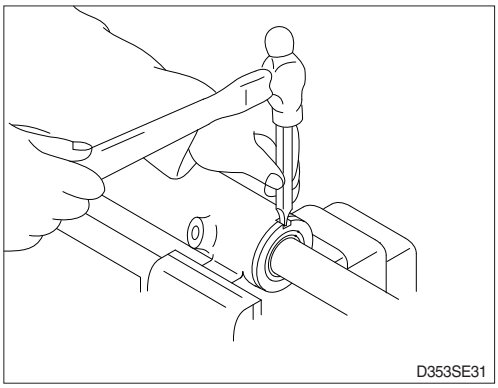

D353SE29

(5) Using a hook spanner, install the gland assembly, and tighten it with torque 60±6 kgf · m (434±43 lbf · ft).


D353SE30

(6) After the gland assembly was installed to the cylinder tube, calk at the tube end into the groove on the gland to prevent screw loosening.

※ If it need calking again, never using previous calking position.


D353SE31

(7) Move the piston rod back and forth several times for the full distance of its stroke. This helps to seat the ring and seals before applying full hydraulic pressure to the cylinder.

(8) Install cylinder into trail axle.

(9) While idling the engine with the rear wheels off the ground, operate the steering wheel left and right alternately.

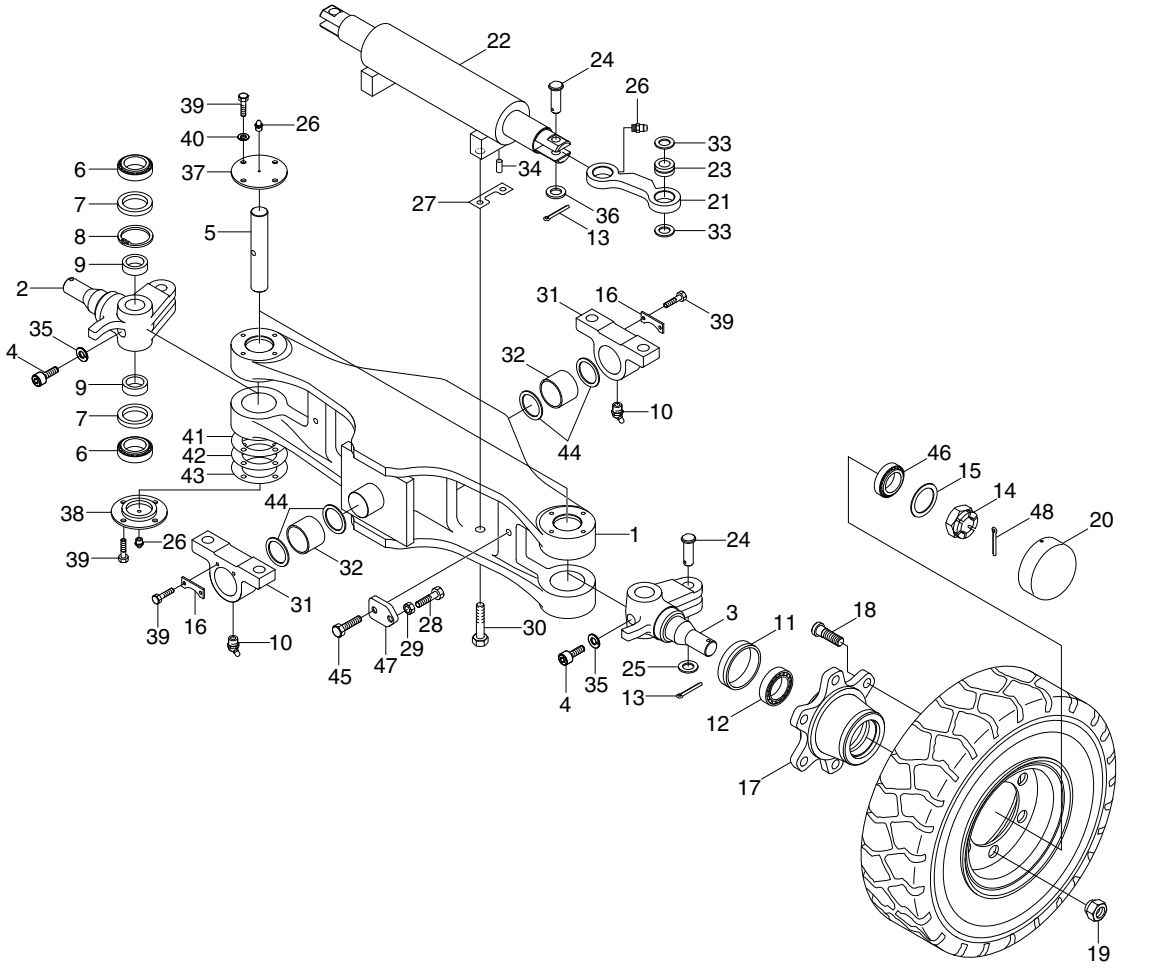
※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

(10) Stop the engine, lower the floating rear wheels, and check pump joints for oil leaks and looseness and retighten, them as required.

3. TRAIL AXLE

1) STRUCTURE

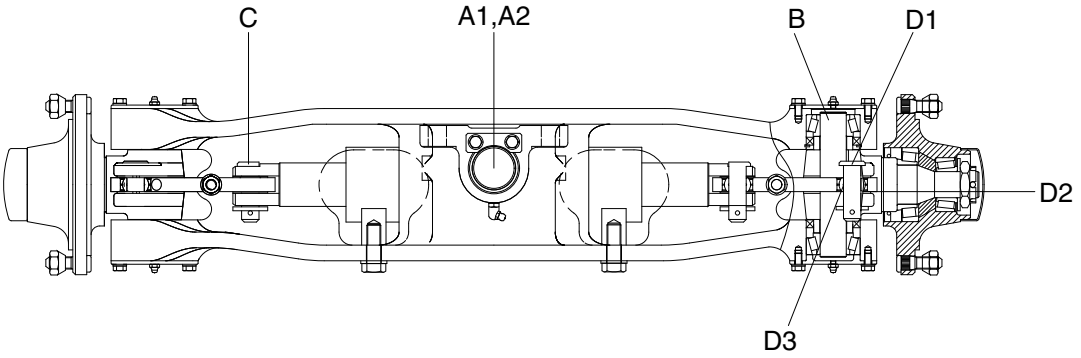
※ Do not remove the stopper bolt unless necessary.



20D7SS07

1	Steering axle	17	Hub	33	Thrust washer
2	Knuckle-RH	18	Hub bolt	34	Pin
3	Knuckle-LH	19	Hub nut	35	Spring washer
4	Special bolt	20	Hub cap	36	Hardened washer
5	King pin	21	Steering link	37	Upper cover
6	Taper roller bearing	22	Steering cylinder	38	Lower cover
7	Oil seal	23	SPH plain bearing	39	Hex bolt
8	Retaining ring	24	Steer link pin	40	Spring wahser
9	Collar	25	Plain washer	41	Shim (0.1)
10	Grease nipple	26	Grease nipple	42	Shim (0.15)
11	Oil seal	27	Lock plate	43	Shim (0.3)
12	Taper roller bearing	28	Bolt	45	Hex bolt
13	Split pin	29	Hex nut	46	Taper roller bearing
14	Nut	30	Hex bolt	47	Plate
15	Washer	31	Trunnion block	48	Split pin
16	Plate	32	Bushing		

2) CHECK AND INSPECTION



20D7SS10

unit : mm (in)

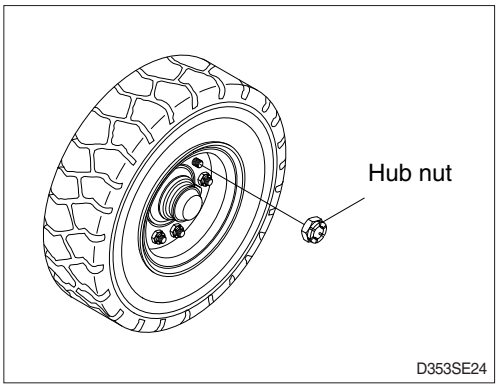
No.	Check item			Criteria		Remarks
				Standard size	Repair limit	
A	Shaft	A1	OD of shaft	55 (2.2)	54.5 (2.1)	Replace
		A2	ID of bushing	55 (2.2)	55.5 (2.2)	
B	OD of king pin			35 (1.4)	34.5 (1.4)	
C	OD of steering cylinder pin			20 (0.8)	19.5 (0.8)	
D	Knuckle	D1	OD of pin	20 (0.8)	19.5 (0.8)	
		D2	Vertical play	-	-	Adjust with shims
		D3	ID of bushing	20 (0.8)	20.5 (0.8)	Replace

· OD : Outer diameter
· ID : Inner diameter

3) DISASSEMBLY

※ Servicing work on the knuckle part can be carried out without removing the axle assy from chassis. The work can be done by jacking up the counter weight part of the truck.

(1) Loosen the hub nut and take off the steering wheel tire.



(2) Remove Hub cap.

(3) Pull out split pin and remove slotted nut.

(4) Using the puller, take off the hub together with the roller bearing.

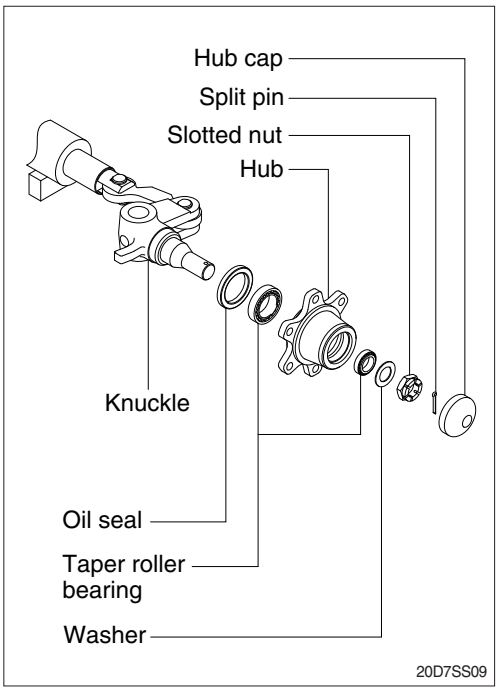
※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(5) After hub is removed take off the inner race of roller bearing.

(6) Pull out oil seal.

※ Don't use same oil seal twice.

(7) Repeat the same procedure for the other side. Moreover, when disassembling is completed, part the slotted nut in the knuckle to protect the threaded portion.



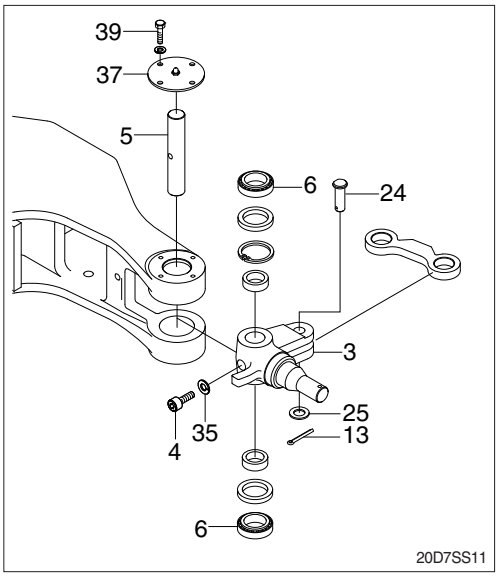
(8) Loosen special bolt (4) and spring washer (35).

(9) Remove hexagon bolt (39) and upper cover (37).

(10) Push out the king pin (5) without damaging the knuckle arm (3).

(11) If defect is observed in bearing (6), pull it out by using extractor.

(12) Remove spilt pin (13), plain washer (25) and link pin (24).



4) ASSEMBLY

※ In reassembling, have all parts washed, grease applied to lubricating parts, and all expendable items such as oil seal and spring washers replaced by new ones.

Perform the disassembly in reverse order.

(1) Tighten the special bolt (4) and washer (35) of king pin (5).

(2) There is a notch in the middle of the king pin (5), make sure that this notch is on the special bolt side.

(3) Do not hammer to drive in bearing (6) because it will break.
Always use drive-in tool.
Be sure that the fixed ring of the bearing is placed in position facing the knuckle (3).

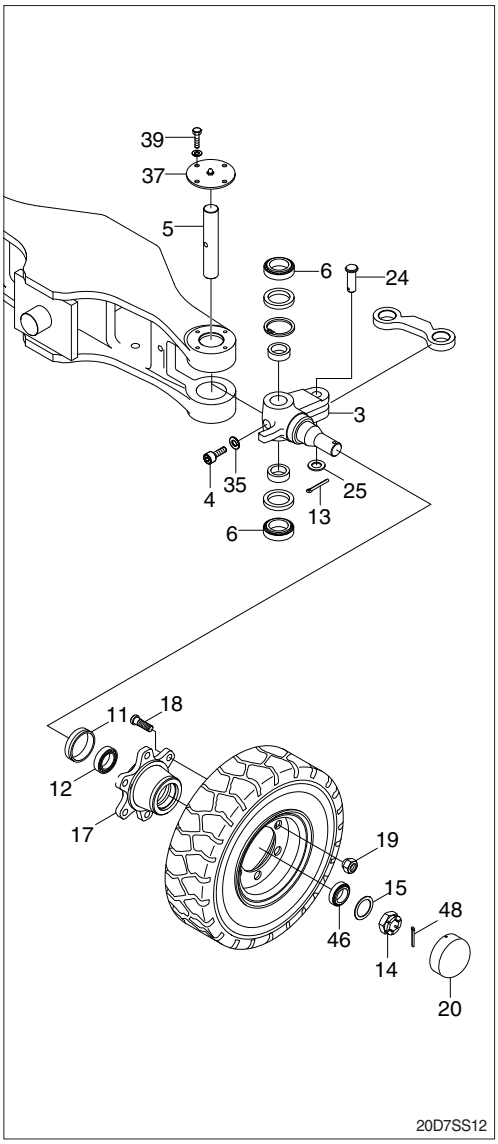
(4) Hub

① Mount oil seal (11) and inner race of tapered roller bearing (12) on the knuckle. The bearing should be well greased before assembling.

② Install the outer race of the bearing (46) in the wheel center and assemble to the knuckle.

③ Tighten nut (14) and lock with split pin (48). In locking with split pin, locate the hole for the split pin by turning the nut back 1/6 of a turn.
Adjust the preload of bearing.

④ Mount the hub cap (20).
Bearing should be well greased before assembling.

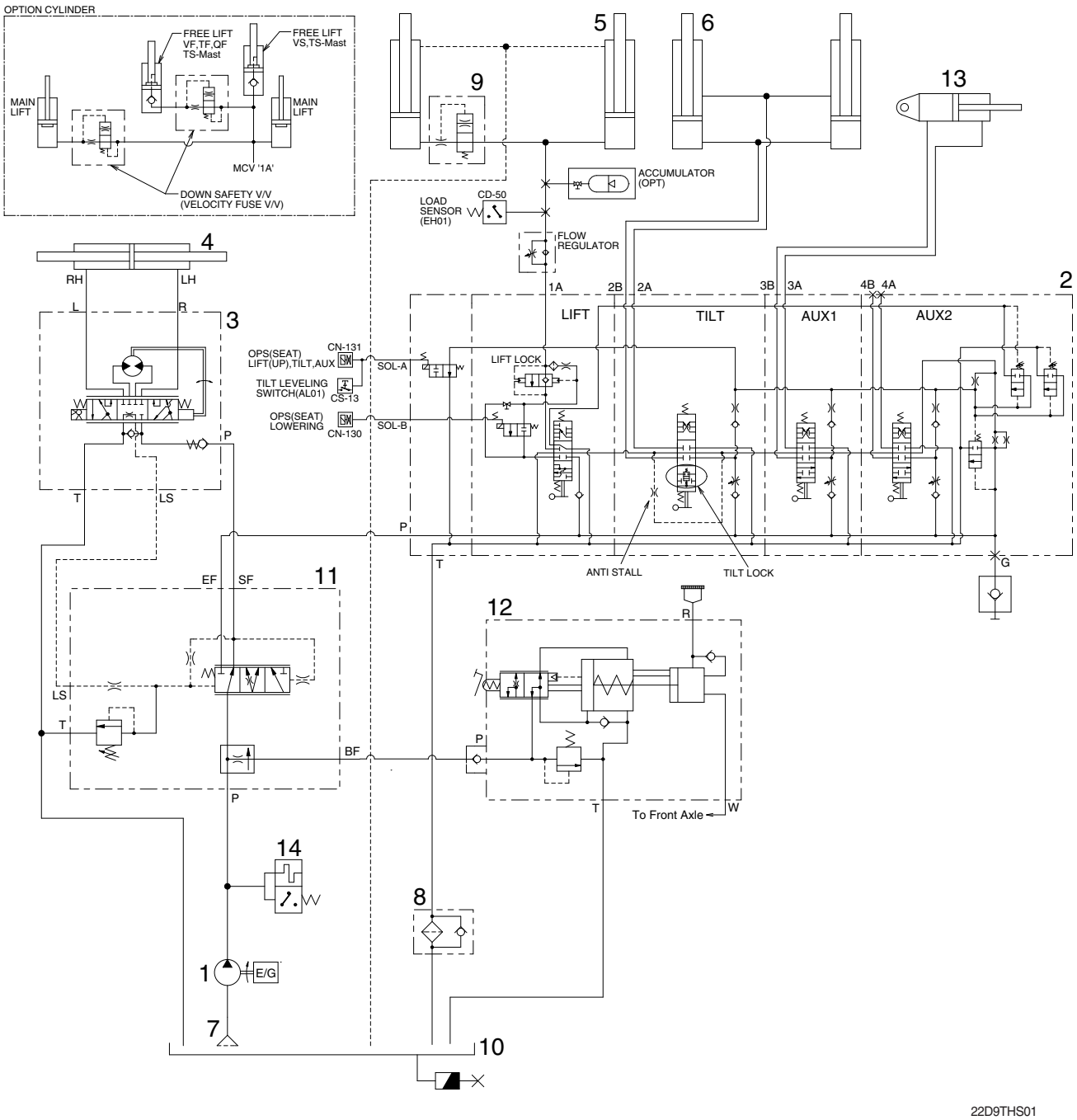


SECTION 6 HYDRAULIC SYSTEM

Group 1 Structure and function 6-1
Group 2 Operational checks and troubleshooting 6-17
Group 3 Disassembly and assembly 6-21

GROUP 1 STRUCTURE AND FUNCTION

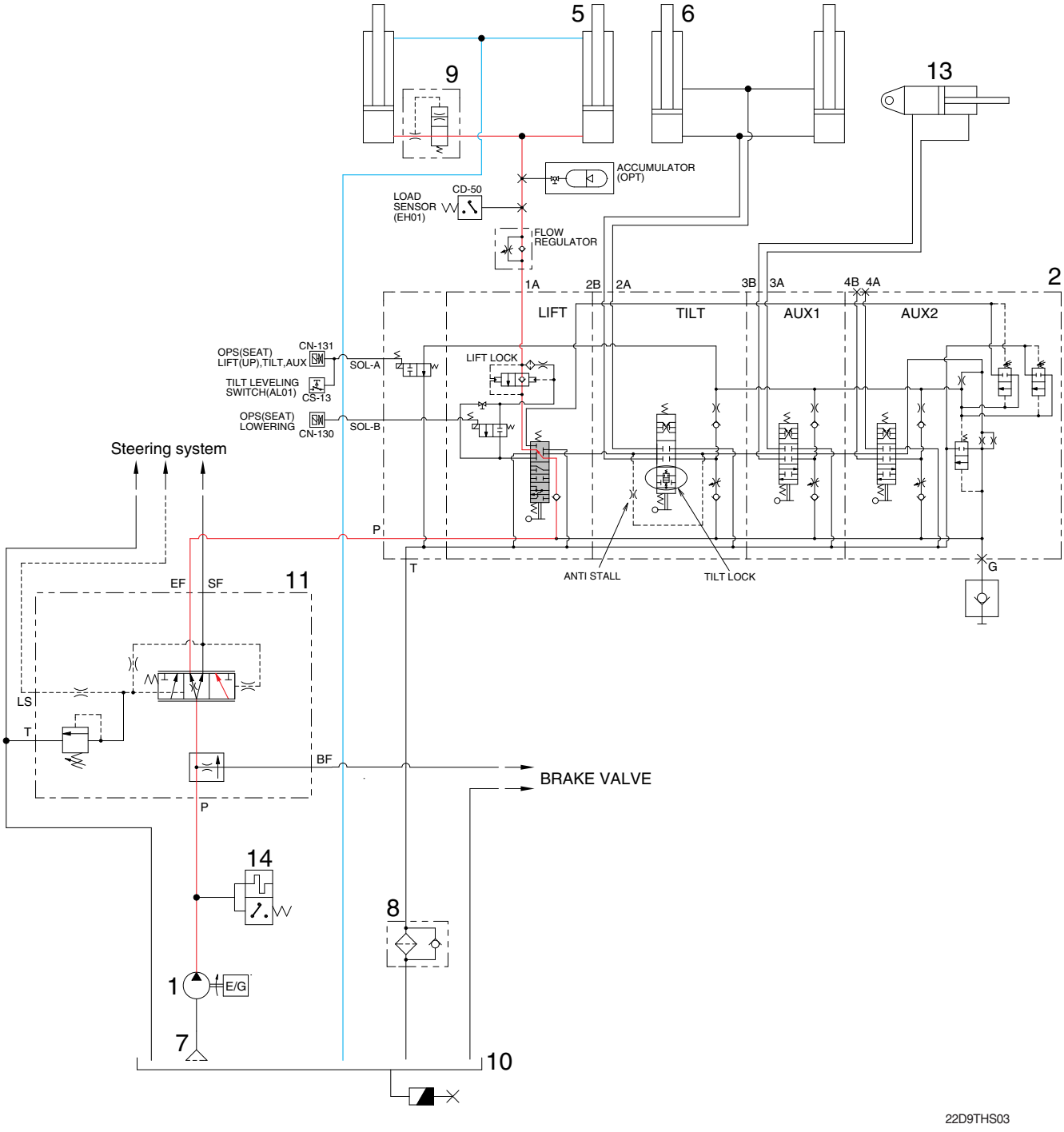
1. HYDRAULIC CIRCUIT



22D9THS01

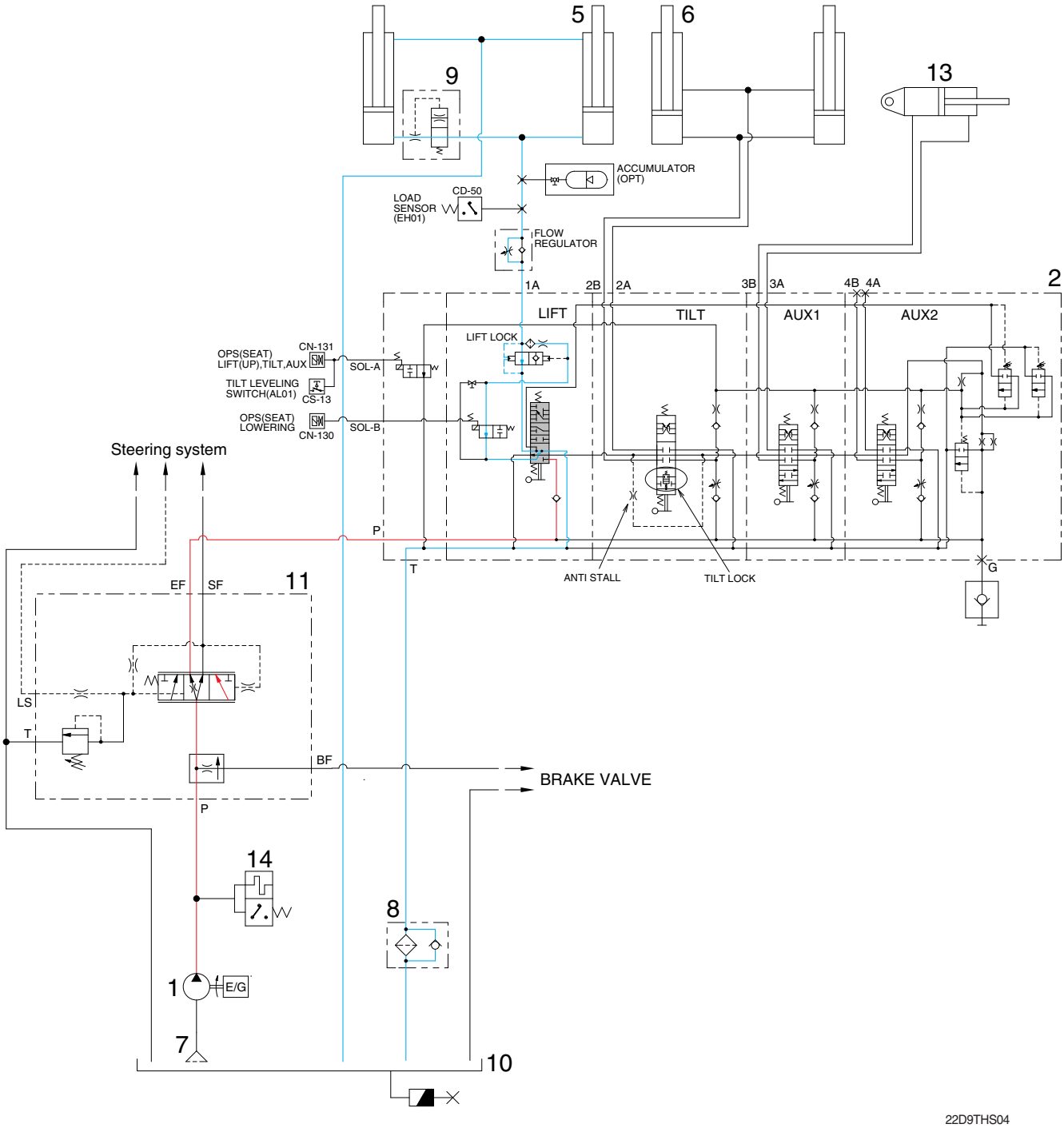
1	Hydraulic gear pump	8	Return filter
2	Main control valve	9	Down safety valve
3	Steering unit	10	Hydraulic tank
4	Steering cylinder	11	Dual flow divider
5	Lift cylinder	12	Brake valve
6	Tilt cylinder	13	Side shift cylinder
7	Suction strainer	14	Temperature sensor

1) WHEN THE LIFT CONTROL LEVER IS IN THE LIFT POSITION



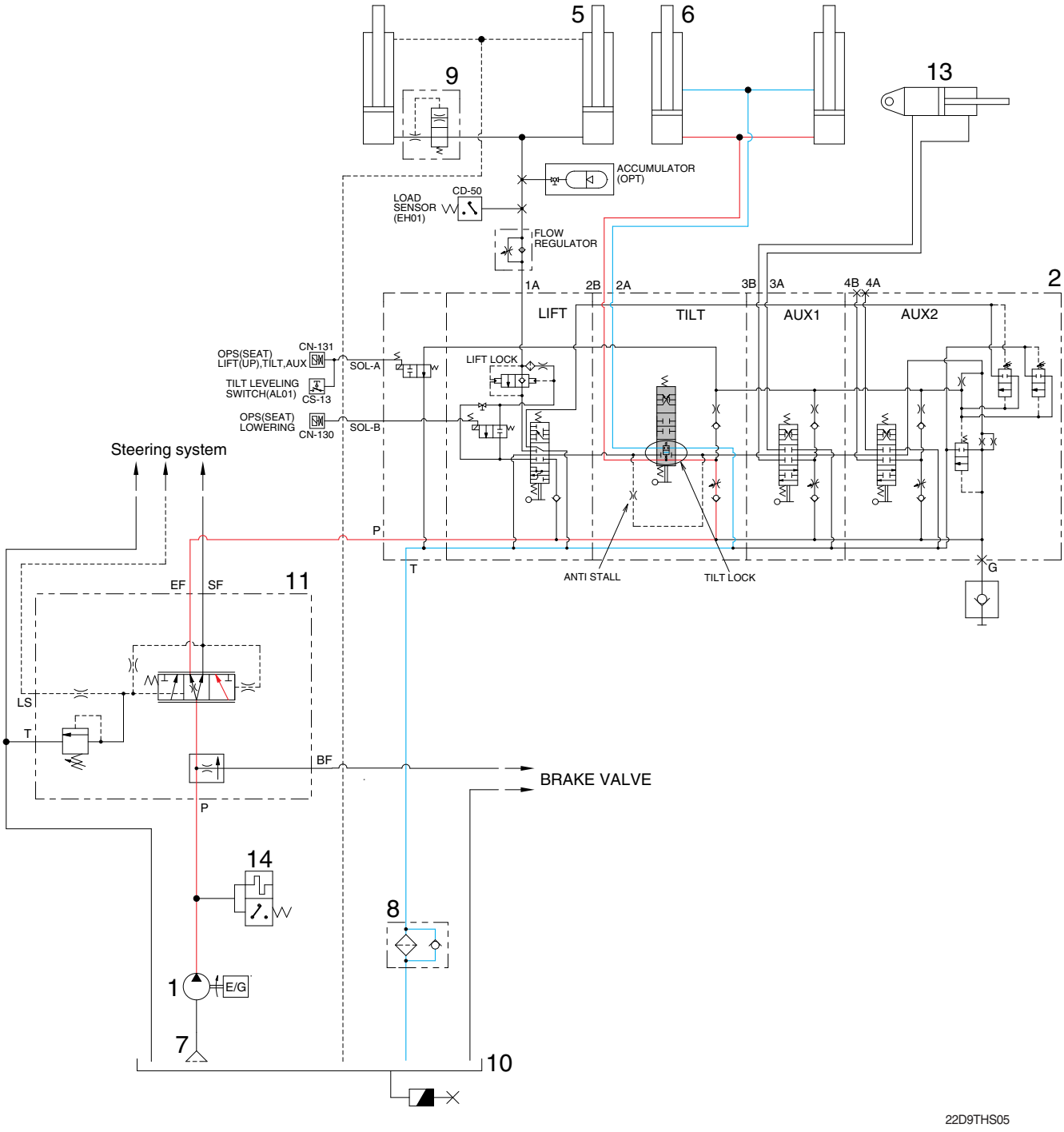
When the lift control lever is pulled back, the spool on the first block moves to lift position.
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of lift cylinder (5) by pushing the load check valve of the spool.
The oil from the small chamber of lift cylinder (5) returns to hydraulic oil tank (10) at the same time.
When this happens, the fork goes up.

2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION



When the lift control lever is pushed forward, the spool on the first block moves to lower position. The work port (1A) and the small and the large chamber of lift cylinder are connected to the return passage, so the fork will be lowered due to its own weight.

3) WHEN THE TILT CONTROL LEVER IS IN THE FORWARD POSITION



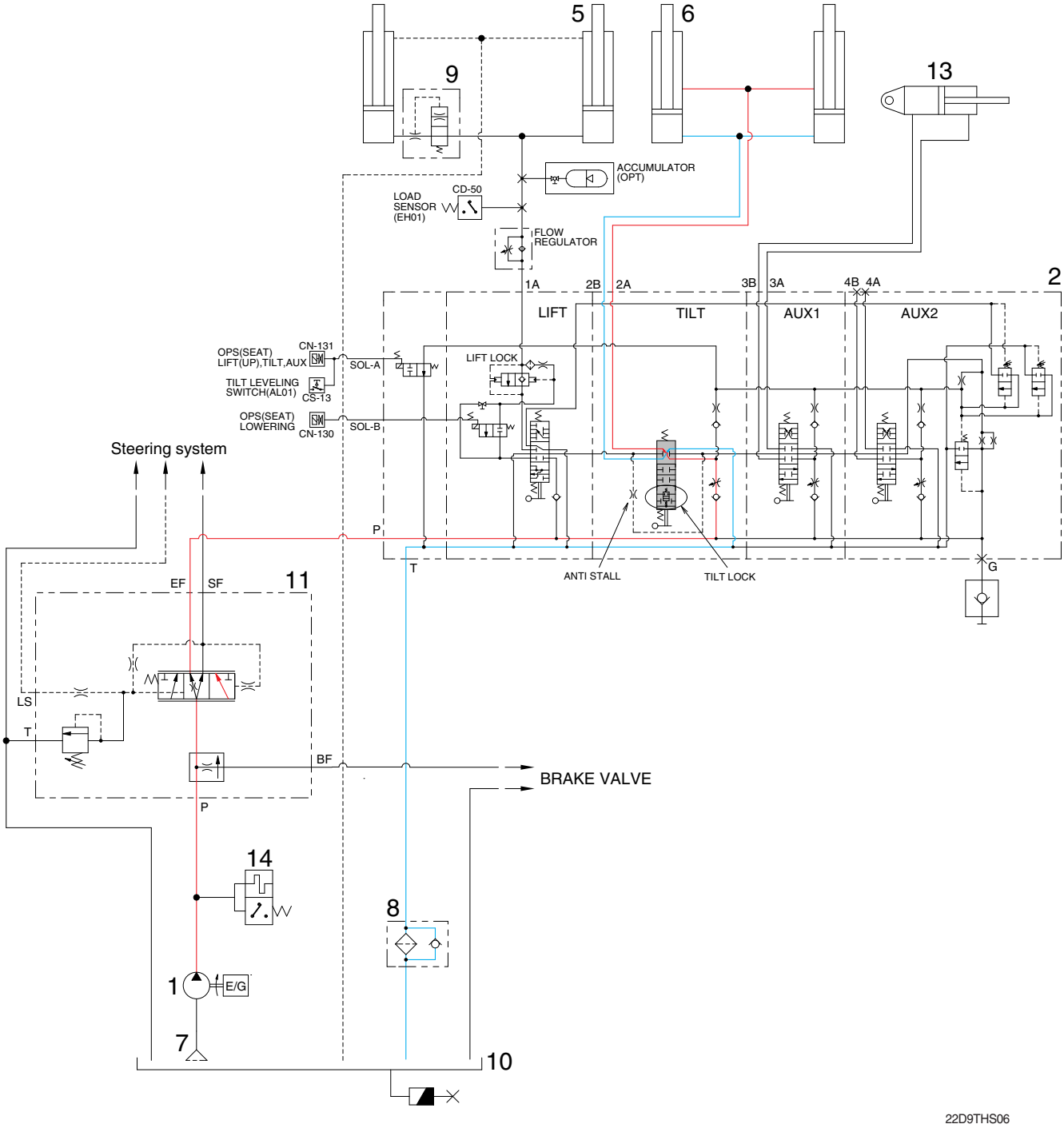
When the tilt control lever is pushed forward, the spool on the second block is moved to tilt forward position.

The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the large chamber of tilt cylinder (6) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder (6) returns to hydraulic tank (10) at the same time.

When this happens, the mast tilt forward.

4) WHEN THE TILT CONTROL LEVER IS IN THE BACKWARD POSITION



When the tilt control lever is pulled back, the spool on the second block is moved to tilt backward position.

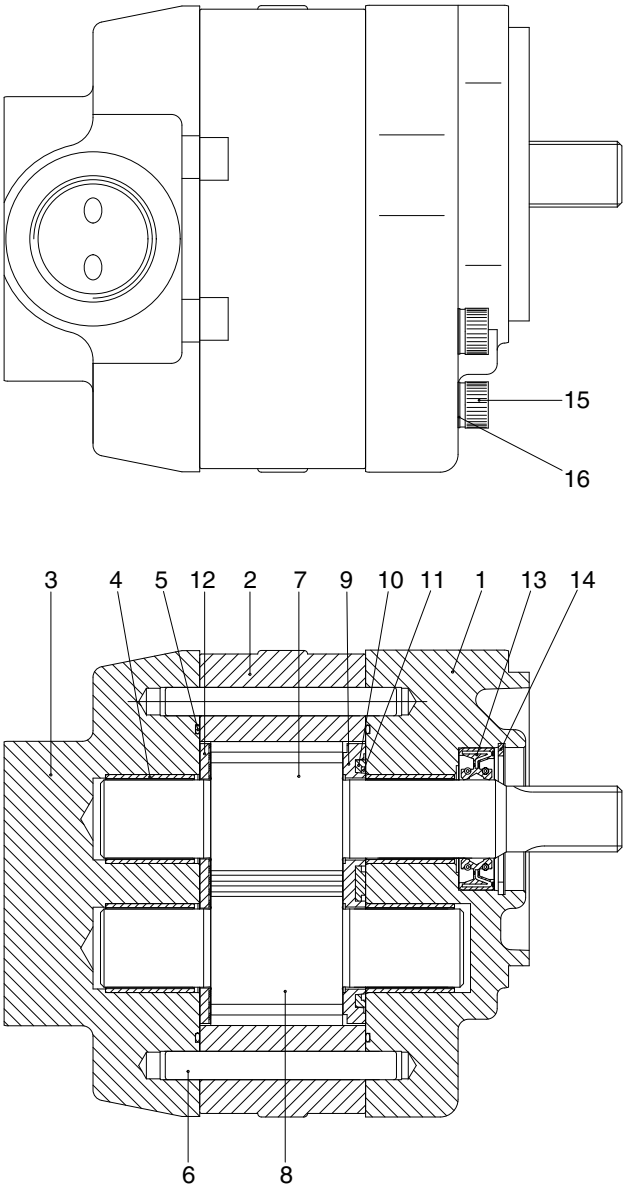
The oil from hydraulic gear pump (1) flows into main control valve (2) and then goes to the small chamber of tilt cylinder (6) by pushing the load check valve of the spool.

The oil at the large chamber of tilt cylinder (6) returns to hydraulic tank (10) at the same time.

When this happens, the mast tilts backward.

2. HYDRAULIC GEAR PUMP

1) STRUCTURE



20D7HS14

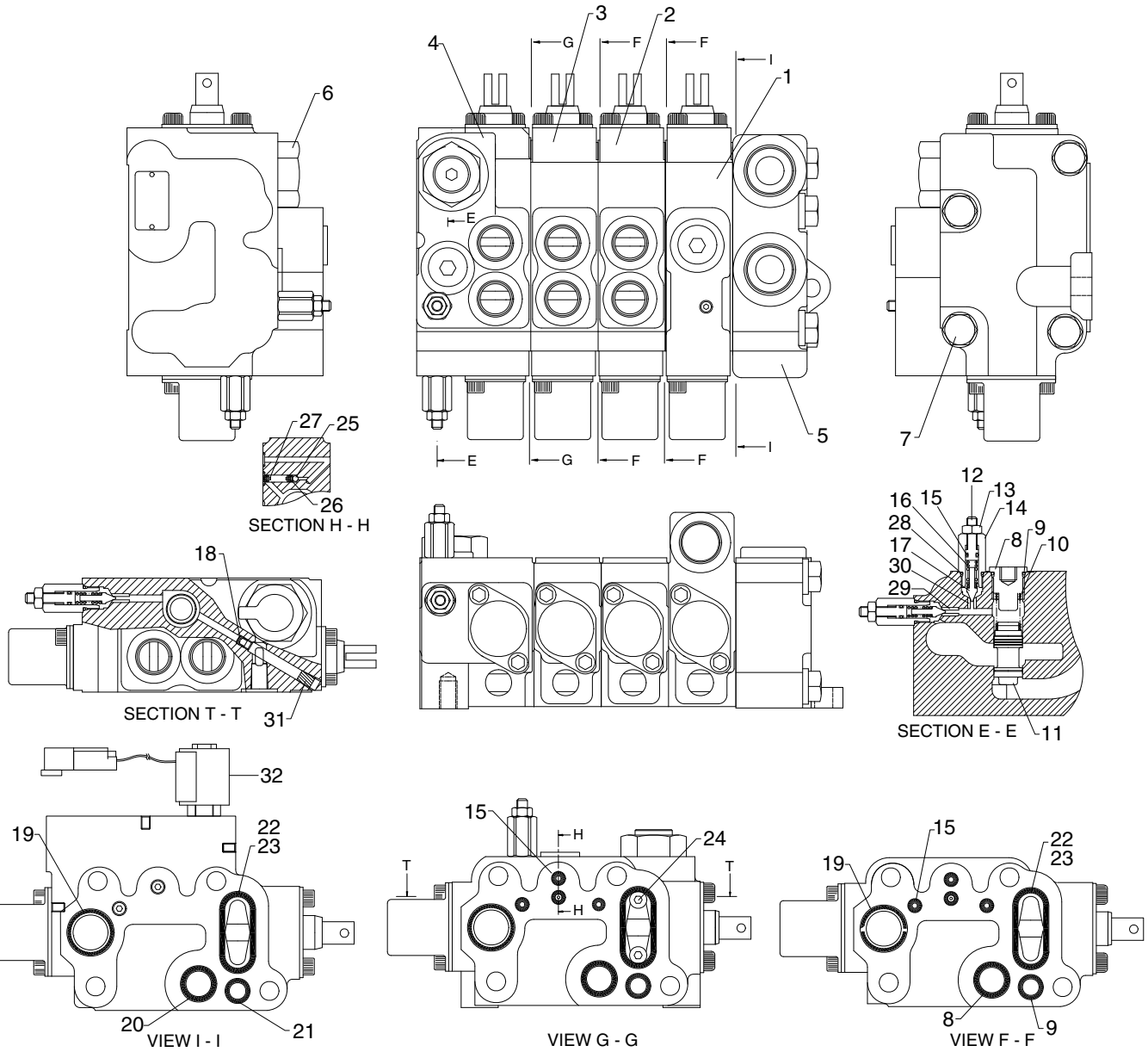
1	Housing	7	Drive gear	13	Oil seal
2	Body	8	Idle gear	14	Snap ring
3	Rear cover	9	Side plate	15	Bolt
4	Bushing	10	O-ring	16	Washer
5	O-ring	11	Back up ring		
6	Pin	12	Side plate		

2) OPERATION

This pump comprises of a rear cover, a body and a housing bolted together. The gear journals are supported by bushings (4) to give high volumetric and mechanical efficiencies.

3. MAIN CONTROL VALVE

1) STRUCTURE (4- Spool)



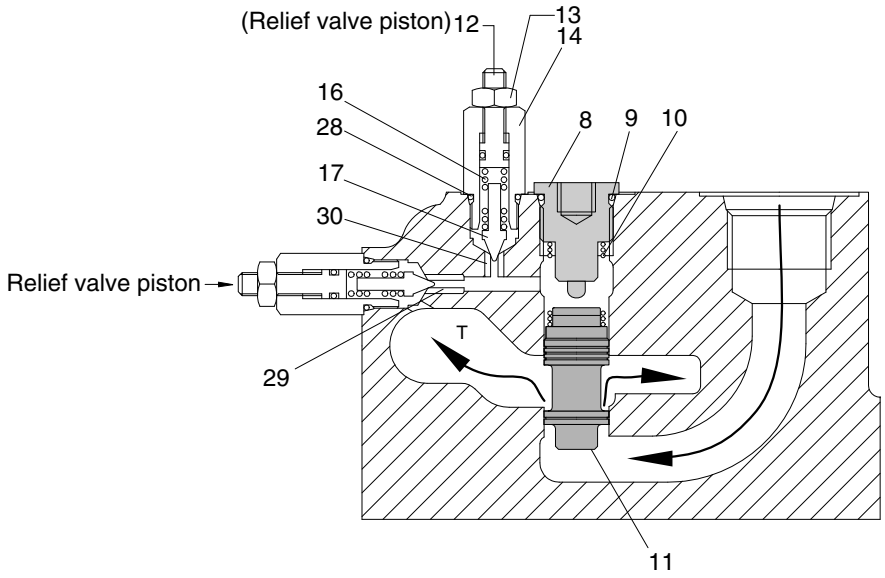
Port name	Size
Inlet port	1-1/16-12UN
Outlet port	1-1/16-12UN

20DEHS07

1	Lift block assy	12	Relief piston	22	O-ring
2	Tilt block assy	13	Nut	23	O-ring, retainer
3	Aux1 block assy	14	Relief plug	24	Plug
4	Work block assy	15	O-ring	25	Steel ball
5	PT block	16	Relief spring	26	Load sensor spring
6	Gauge plug assy	17	Pilot poppet	27	Load sensor spring
7	Long bolt	18	Plug	28	O-ring
8	Plug	19	O-ring	29	System relief seat
9	O-ring	20	O-ring	30	Secondary relief seat
10	Spring	21	O-ring	32	Solenoid valve assy
11	Spool				

2) INLET SECTION OPERATION

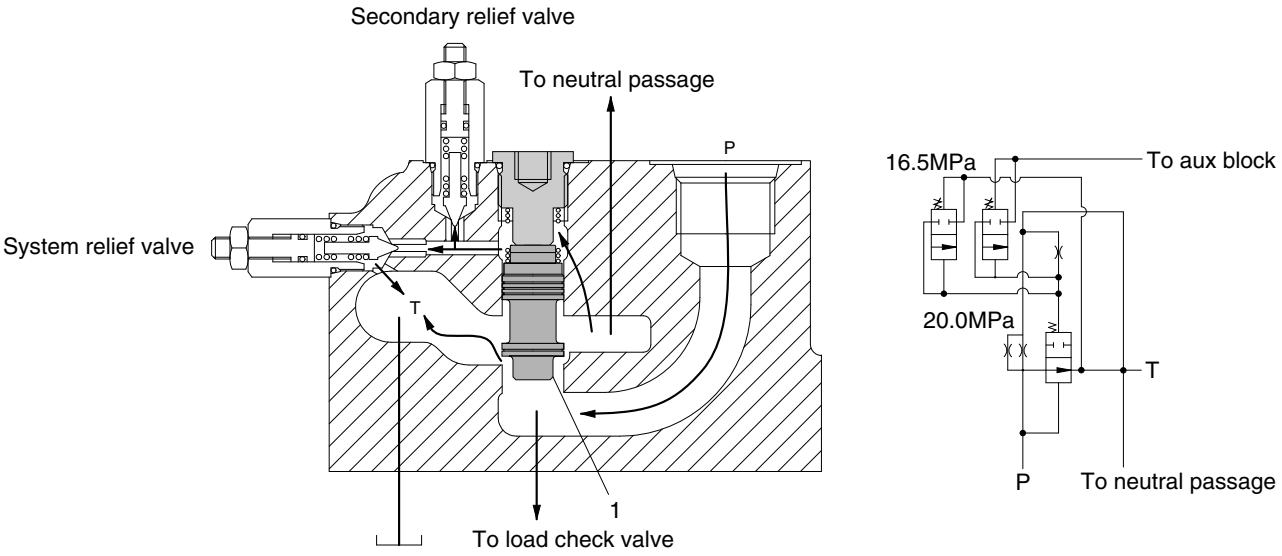
(1) Structure and description



20D7HS08

8	Plug	14	Relief plug
9	O-ring	16	Relief spring
10	Spring	17	Pilot poppet
11	Spool	28	O-ring
12	Relief piston	29	System relief seat
13	Nut	30	Secondary relief seat

(2) Operation

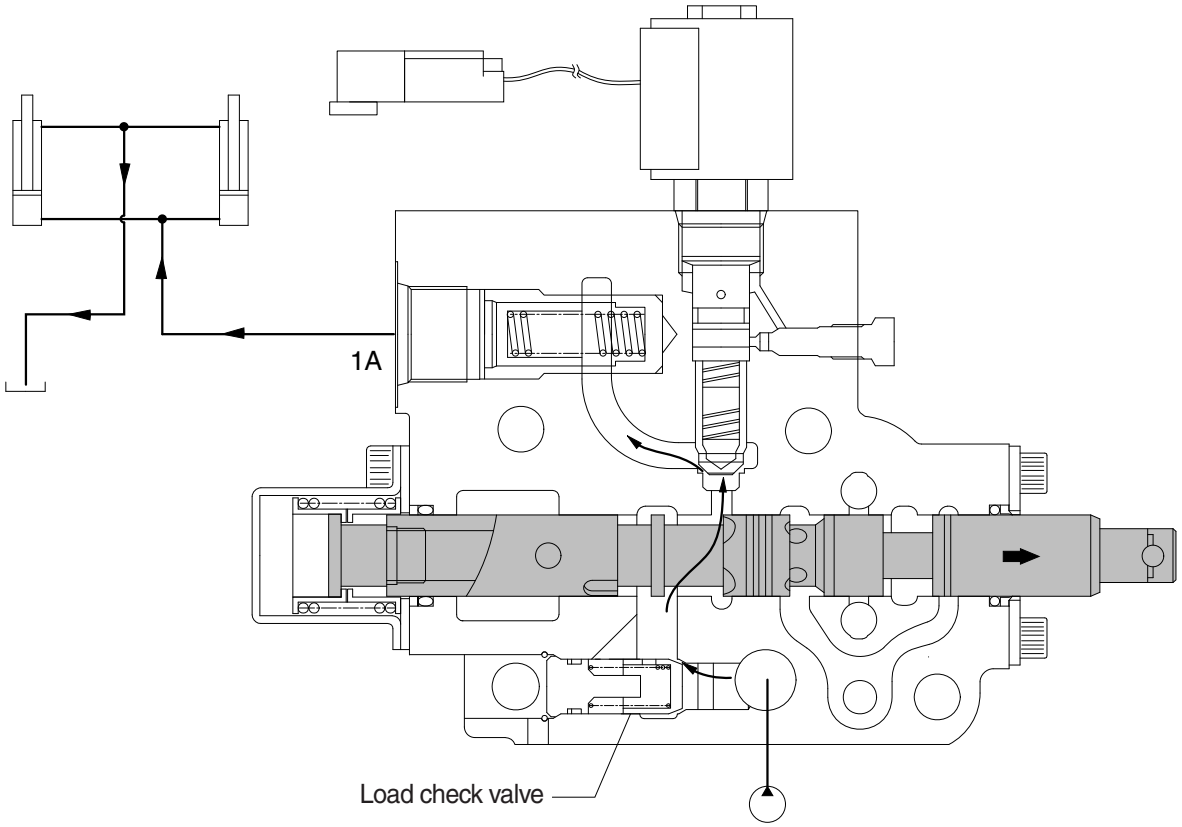


20D7HS15

Oil flows from P (pump) port to reservoir (T) by pushing hydrostat spool (1).
Before the center bypass line closed, hydrostat spool is keep opening, so pump port (P) and tank port (T) are always connected in operation to minimize heat generation.

3) LIFT SECTION OPERATION

(1) Lift position



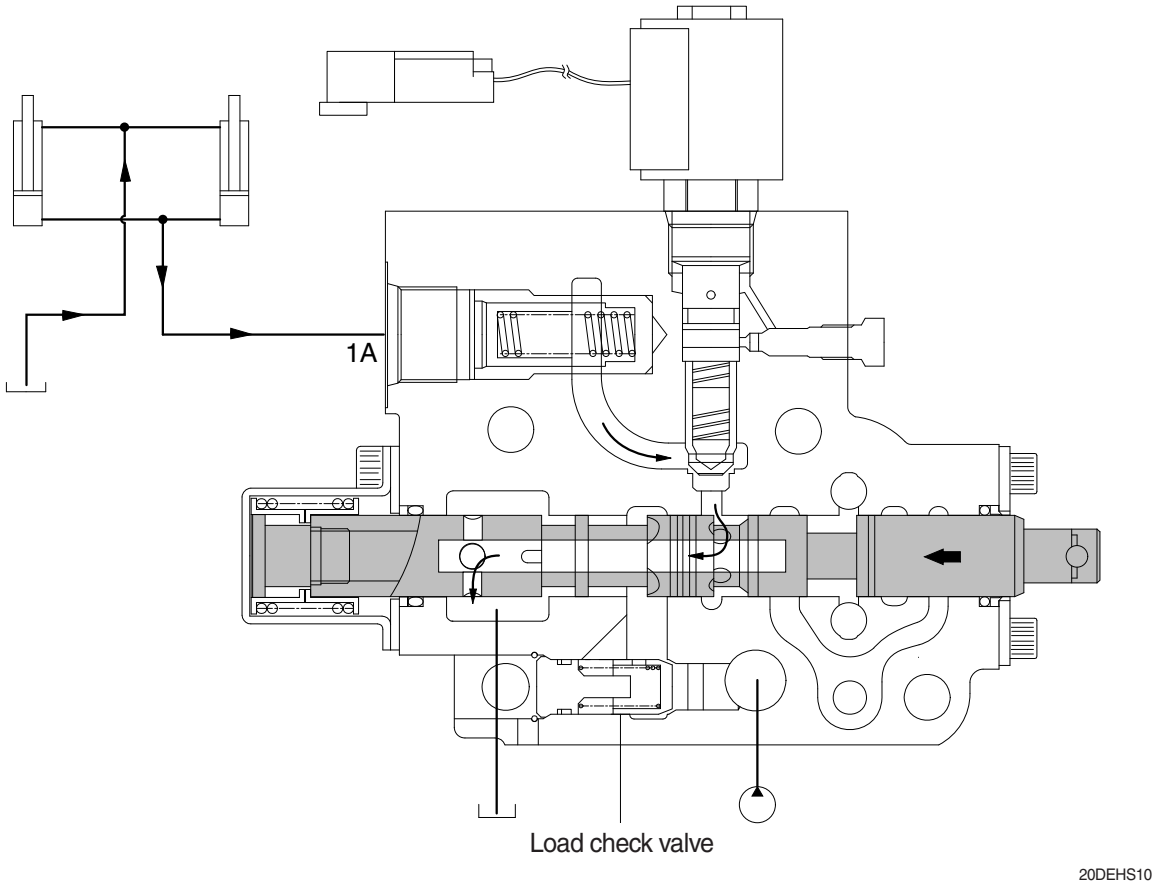
When the lift control lever is pulled back, the spool moves to the right and the neutral passage is closed.

The oil supplied from the pump pushes up the load check valve and flow into lift cylinder port (1A).

The pump pressure reaches proportionally the load of cylinder and fine control finished by shut off of the neutral passage.

The return oil from cylinder flows into the tank.

(2) Lower position

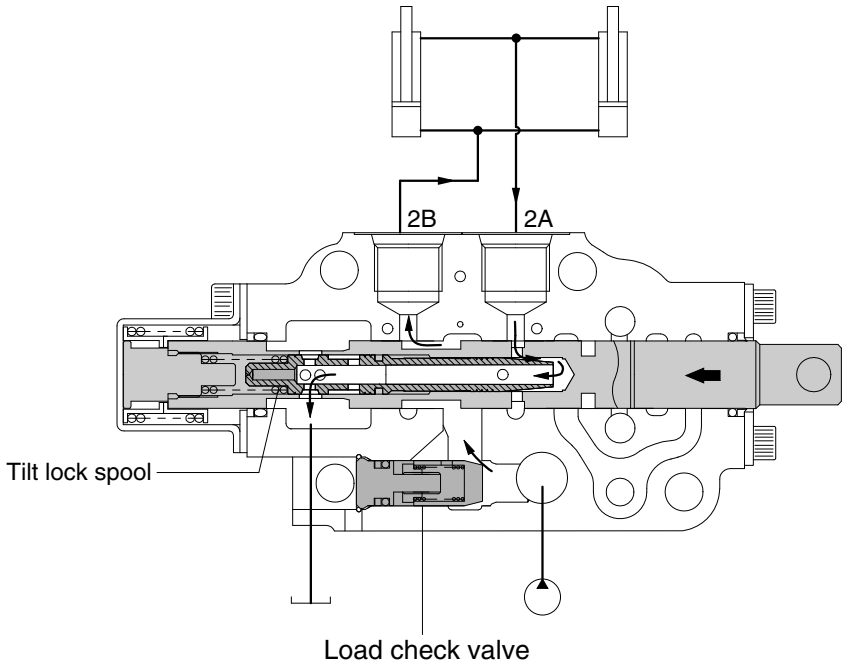


20DEHS10

When the lift control lever is pushed forward, the spool moves to the left and the neutral passage is closed.
The spool moves to the lift lower position, opening up the neutral passage to tank and (1A) → T.
In lift lower position the fork drops due to its own weight.

4) TILT SECTION OPERATION

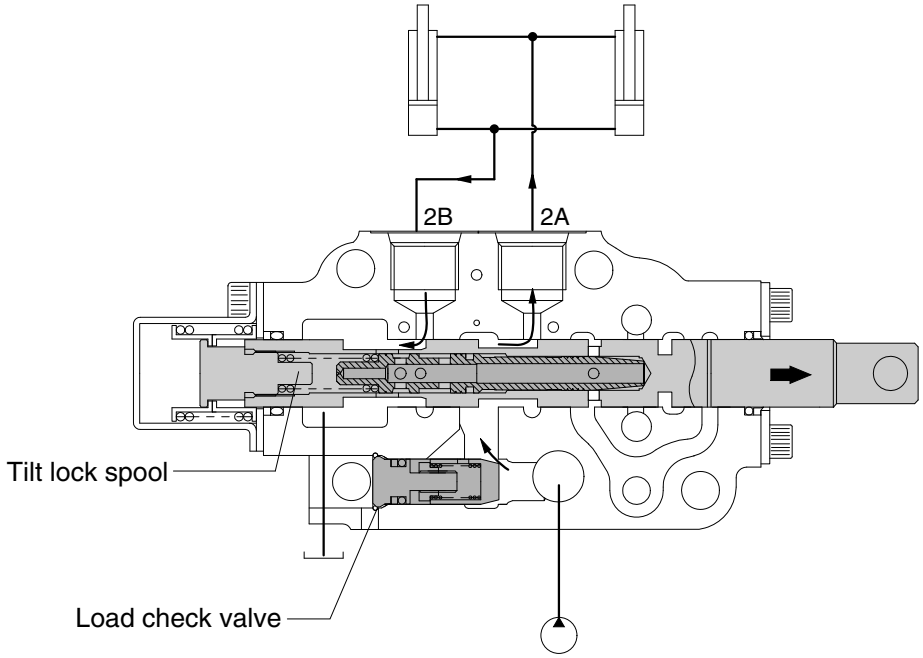
(1) Tilt forward position



20D7HS11

When the tilt control lever is pushed forward, the spool moves to the left and the neutral passage is closed.
The oil supplied from the pump pushes up the load check valve and flow into tilt cylinder port (2B).
The pump pressure reaches proportionally the load of cylinders and fine control finished by closing the neutral passage.
The return oil from cylinder port (2A) flows into the tank through the hole of the tilt lock spool.

(2) Tilt backward position



20D7HS12

When the tilt control lever is pulled back, the spool moves to the right and the neutral passage is closed.
The oil supplied from the pump pushes up the load check valve and flows into tilt cylinder port (2A).
The pump pressure reaches proportionally the load of cylinder and fine control finished by shut off of the neutral passage.
The return oil from cylinder port (2B) flows into the tank via the low pressure passage.

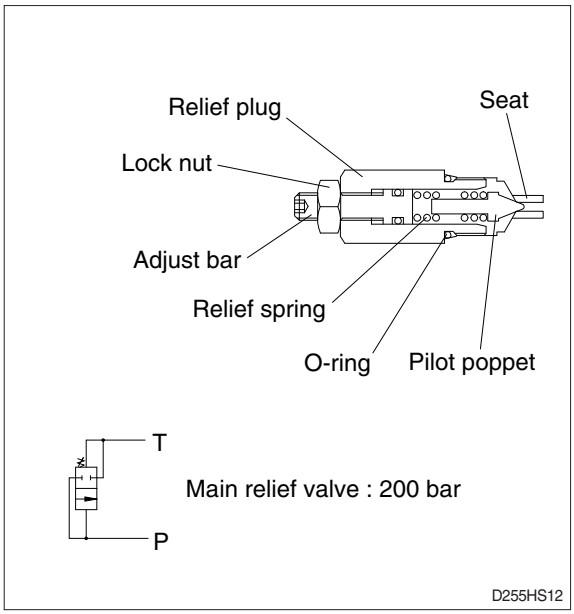
5) MAIN RELIEF VALVE

(1) Pressure setting

A good pressure gauge must be installed in the line which is in communication with the work port relief. A load must be applied in a manner to reach the set pressure of the relief unit.

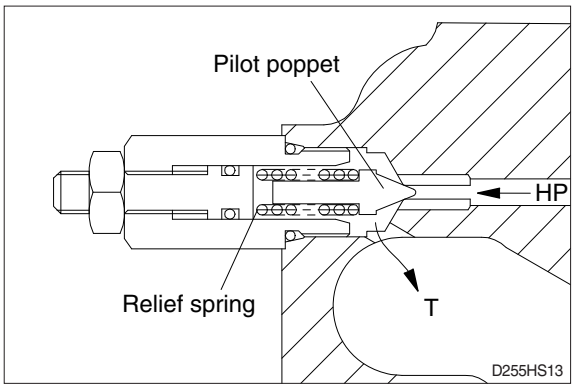
Procedure

① Loosen lock nut.
② Set adjusting bar to desired pressure setting.
③ Tighten lock nut.
④ Retest in similar manner as above.

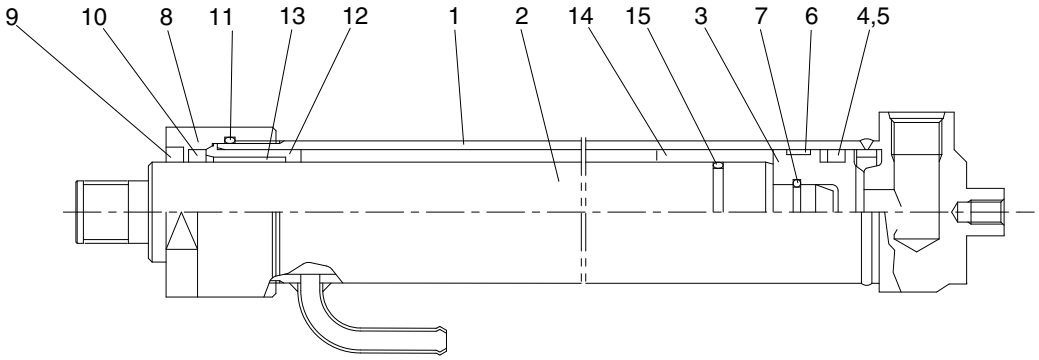


(2) Operation

Pressurized oil over the relief pressure pushes pilot poppet and flows to tank passage, therefore the system pressure keeps under the adjusted relief pressure.



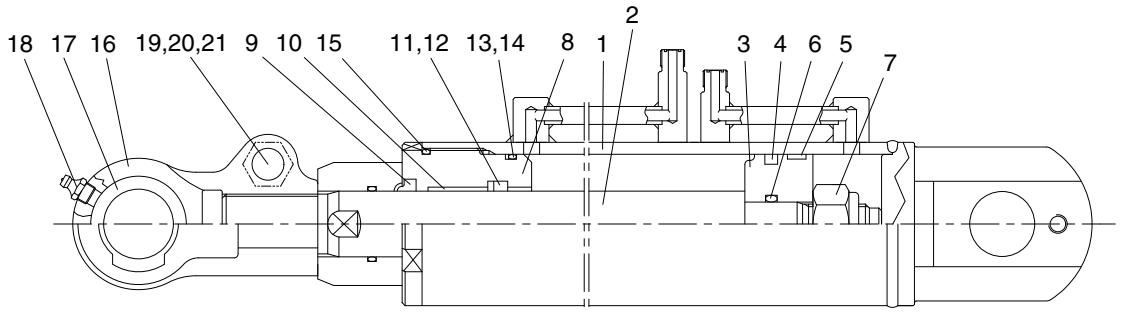
4. LIFT CYLINDER



D255HS18

1	Tube assembly	6	Wear ring	11	O-ring
2	Rod	7	Retaining ring	12	Guide
3	Piston	8	Gland	13	DU bushing
4	Piston seal	9	Dust wiper	14	Spacer
5	Back up ring	10	Rod seal	15	O-ring

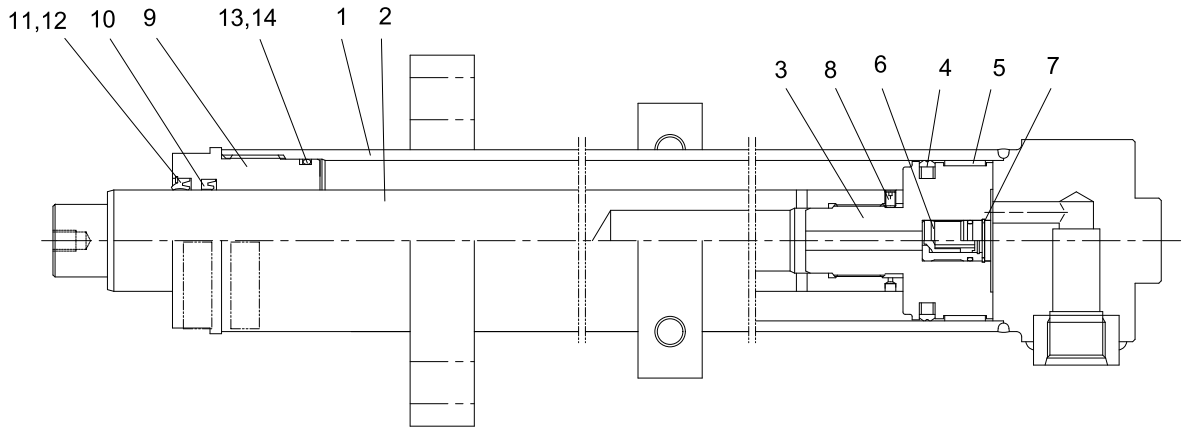
5. TILT CYLINDER



D255HS19

1	Tube assembly	8	Gland	15	O-ring
2	Rod	9	Dust wiper	16	Rod eye
3	Piston	10	Du bushing	17	Spherical bearing
4	Piston seal	11	Rod seal	18	Grease nipple
5	Wear ring	12	Back up ring	19	Hexagon bolt
6	O-ring	13	O-ring	20	Spring washer
7	Hexagon nut	14	Back up ring	21	Hexagon nut

6. FREE LIFT CYLINDER



D255HS20

1	Tube assembly	6	Check valve	11	Dust wiper
2	Rod	7	Back up ring	12	Snap ring
3	Piston	8	Set screw	13	O-ring
4	Piston seal	9	Gland	14	Back up ring
5	Wear ring	10	Rod seal		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

1) CHECK ITEM

(1) Check visually for deformation, cracks or damage of rod.

(2) Set mast vertical and raise 1m from ground. Wait for 10 minutes and measure hydraulic drift (amount forks move down and amount mast tilts forward).

· Check condition

- Hydraulic oil : Normal operating temp
- Mast substantially vertical.
- Rated capacity load.

· Hydraulic drift

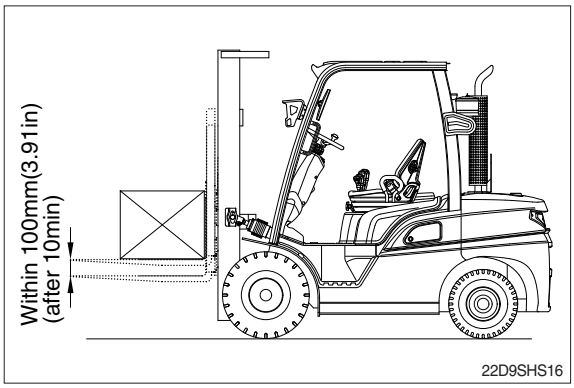
- Down (Downward movement of forks)
: Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
: Within 5°

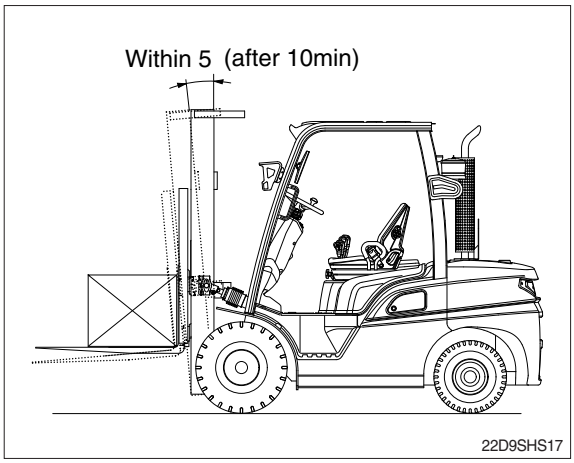
(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

Check that clearance between tilt cylinder bushing and mounting pin is within standard range.

mm (in)

Standard	Under 0.6 (0.02)

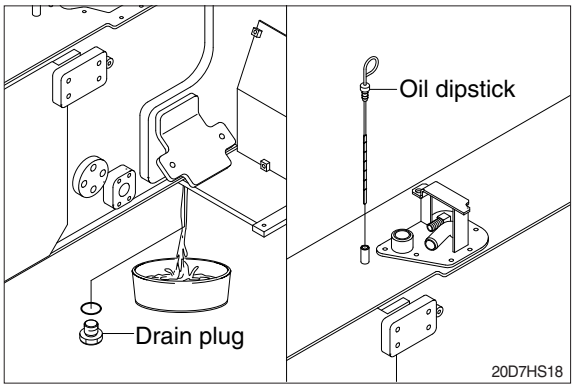




2) HYDRAULIC OIL

(1) Using dipstick, measure oil level, and oil if necessary.

(2) When changing hydraulic oil, clean suction strainer (screwed into outlet port pipe) and line filter (screwed into inlet pipe).



3) CONTROL VALVE

(1) Raise forks to maximum height and measure oil pressure.

Check that oil pressure is 200 kgf/cm^2.

(2845 psi)

2. TROUBLESHOOTING

1) SYSTEM

Problem	Cause	Remedy
Large fork lowering speed.	· Seal inside control valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Replace spool or valve body. · Replace. · Replace packing.
Large spontaneous tilt of mast.	· Tilting backward : Check valve defective. · Tilting forward : tilt lock valve defective. · Oil leaks from joint or hose. · Seal inside cylinder defective.	· Clean or replace. · Clean or replace. · Replace. · Replace seal.
Slow fork lifting or slow mast tilting.	· Lack of hydraulic oil. · Hydraulic oil mixed with air. · Oil leaks from joint or hose. · Excessive restriction of oil flow on pump suction side. · Relief valve fails to keep specified pressure. · Poor sealing inside cylinder. · High hydraulic oil viscosity. · Mast fails to move smoothly. · Oil leaks from lift control valve spool. · Oil leaks from tilt control valve spool.	· Add oil. · Bleed air. · Replace. · Clean filter. · Adjust relief valve. · Replace packing. · Change to SAE10W, class CF engine oil. · Adjust roll to rail clearance. · Replace spool or valve body. · Replace spool or valve body.
Hydraulic system makes abnormal sounds.	· Excessive restriction of oil flow pump suction side. · Gear or bearing in hydraulic pump defective.	· Clean filter. · Replace gear or bearing.
Control valve lever is locked	· Foreign matter jammed between spool and valve body. · Valve body defective.	· Clean. · Tighten body mounting bolts uniformly.
High oil temperature.	· Lack of hydraulic oil. · High oil viscosity. · Oil filter clogged.	· Add oil. · Change to SAE10W, class CF engine oil. · Clean filter.

2) HYDRAULIC GEAR PUMP

Problem	Cause	Remedy
Pump does not develop full pressure.	· System relief valve set too low or leaking. · Oil viscosity too low. · Pump is worn out.	· Check system relief valve for proper setting. · Change to proper viscosity oil. · Repair or replace pump.
Pump will not pump oil.	· Reservoir low or empty. · Suction strainer clogged.	· Fill reservoir to proper level. · Clean suction strainer.
Noisy pump caused by cavitation.	· Oil too thick. · Oil filter plugged. · Suction line plugged or too small.	· Change to proper viscosity. · Clean filters. · Clean line and check for proper size.
Oil heating.	· Oil supply low. · Contaminated oil. · Setting of relief valve too high or too low. · Oil viscosity too low.	· Fill reservoir to proper level. · Drain reservoir and refill with clean oil. · Set to correct pressure. · Drain reservoir and fill with proper viscosity.
Foaming oil.	· Low oil level. · Air leaking into suction line. · Wrong kind of oil.	· Fill reservoir to proper level. · Tighten fittings, check condition of line. · Drain reservoir, fill with non-foaming oil.
Shaft seal leakage.	· Worn shaft seal. · Worn shaft in seal area.	· Replace shaft seal. · Replace drive shaft and seal.

3) MAIN RELIEF VALVE

Problem	Cause	Remedy
Can't get pressure	· Poppet stuck open or contamination under seat.	· Check for foreign matter between poppets and their mating parts. Parts must slide freely.
Erratic pressure	· Pilot poppet seat damaged.	· Replace the relief valve. · Clean and remove surface marks for free movement.
Pressure setting not correct	· Normal wear. Lock nut & adjust screw loose.	· See page 6-14 for How to set pressure on work main relief.
Leaks	· Damaged seats. · Worn O-rings. · Parts sticking due to contamination.	· Replace the relief valve. · Install seal and spring kit. · Disassemble and clean.

4) LIFT CYLINDER

Problem	Cause	Remedy
Oil leaks out from gland through rod.	· Foreign matters on packing. · Unallowable score on rod. · Unusual distortion of dust seal. · Chrome plating is striped.	· Replace packing. · Smooth rod surface with an oil stone. · Replace dust seal. · Replace rod.
Oil leaks out from cylinder gland thread.	· O-ring damaged.	· Replace O-ring.
Rod spontaneously retract.	· Scores on inner surface of tube. · Unallowable score on the inner surface of tube. · Foreign matters in piston seal.	· Smooth rod surface with an oil stone. · Replace cylinder tube. · Replace piston seal.
Wear (clearance between cylinder tube and wear ring)	· Excessive clearance between cylinder tube and wear ring.	· Replace wear ring.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. HYDRAULIC GEAR PUMP

※ **Tools required**

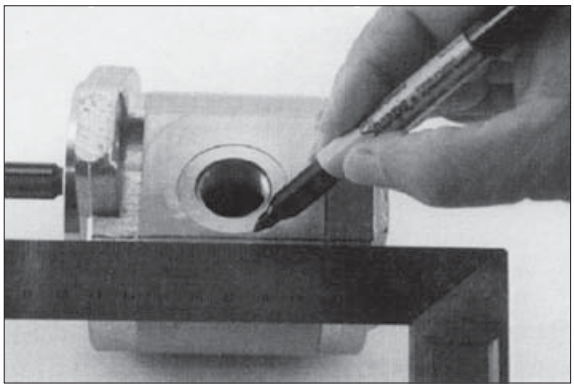
- Metric socket set
- Internal snap ring pliers
- Shaft seal sleeve
- Torque wrench

(1) It is very important to work in a clean work area when repairing hydraulic products. Plug ports and wash exterior of pump with a proper cleaning solvent before continuing.

(2) Remove port plugs and drain oil from pump.

(3) Use a permanent marker pen to mark a line across the mounting flange, gear housing and end cover. This will assure proper reassembly and rotation of pump.

(4) Remove key from drive shaft if applicable.

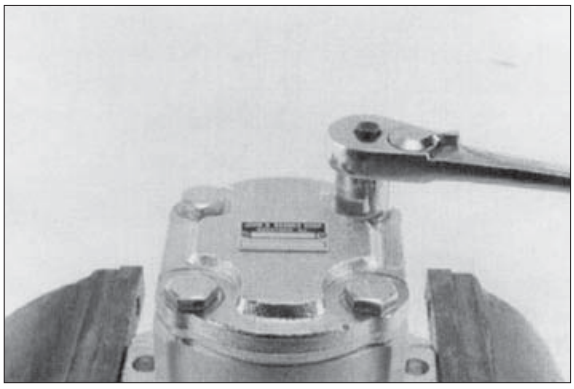


PUMP 01

(5) Clamp mounting flange in a protected jaw vise with pump shaft facing down.

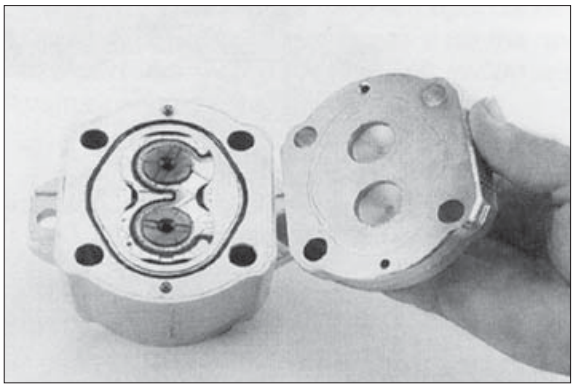
(6) Loosen the four metric hexagon head bolts.

(7) Remove pump from vise and place on clean work bench, remove the four hexagon head bolts and spacers applicable.



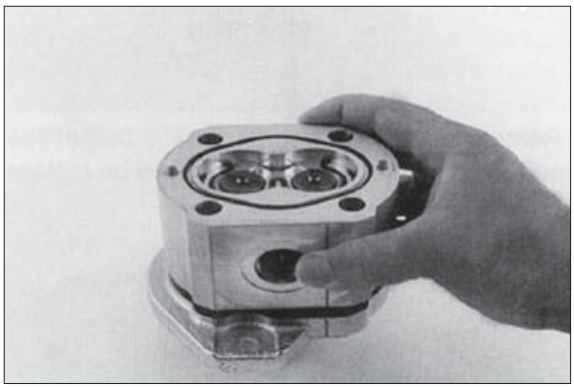
PUMP 02

(8) Lift and remove end cover.



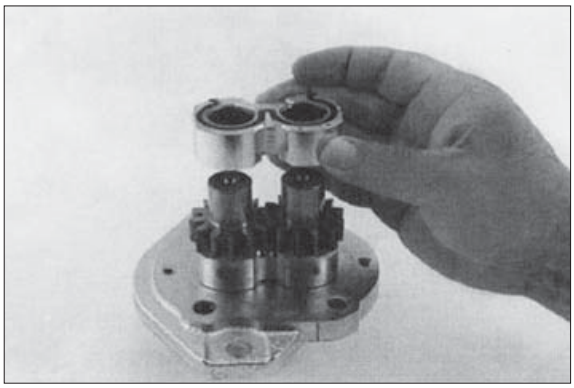
PUMP 03

(9) Carefully remove gear housing and place on work bench. Make sure the rear bearing block remains on the drive and idler shafts.



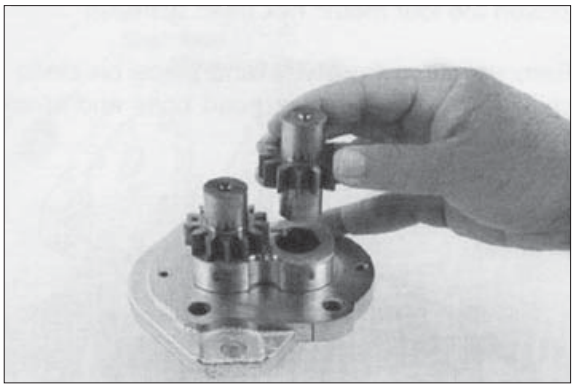
PUMP 04

(10) Remove rear bearing block from drive and idler shafts.



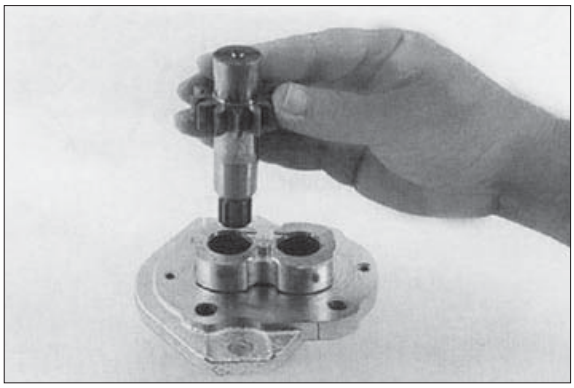
PUMP 05

(11) Remove idler shaft from bearing block.



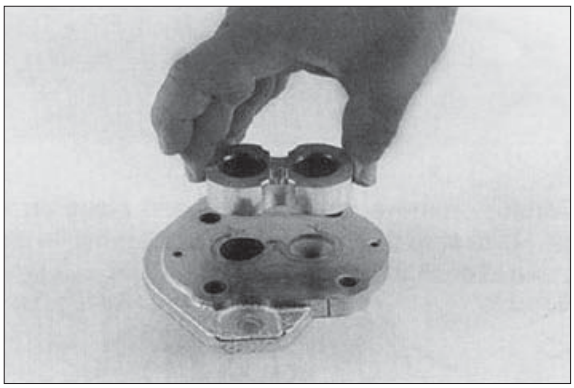
PUMP 06

(12) Remove drive shaft from mounting flange. There is no need to protect the shaft seal as it will be replaced as a new item.



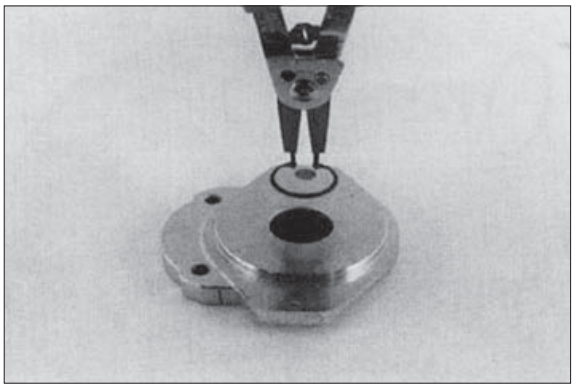
PUMP 07

(13) Remove the front bearing block.



PUMP 08

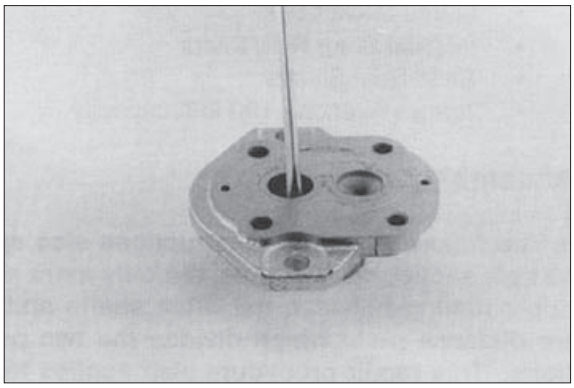
(14) Turn mounting flange over, with shaft seal up, and remove the retaining ring with proper snap ring pliers.



PUMP 09

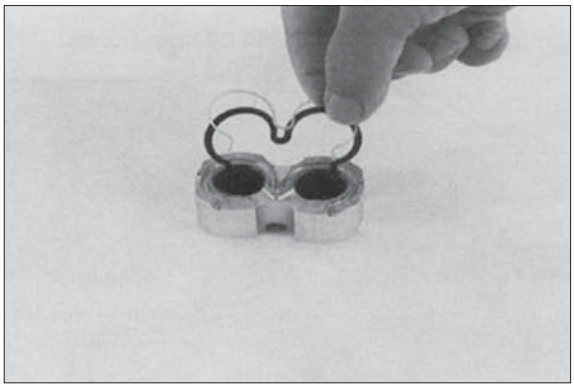
(15) Remove the oil seal from mounting flange, be careful not to mar or scratch the seal bore.

(16) Remove the dowel pins from the gear housing. Do not lose pins.



PUMP 10

(17) Remove seals from both bearing blocks and discard.



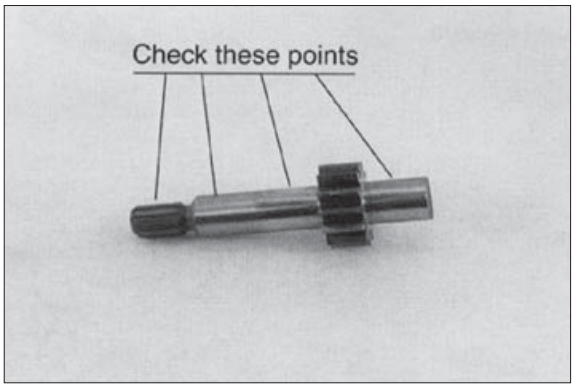
PUMP 11

2) INSPECT PARTS FOR WEAR

(1) Clean and dry all parts thoroughly prior to inspection. It is not necessary to inspect the seals as they will be replaced as new items.

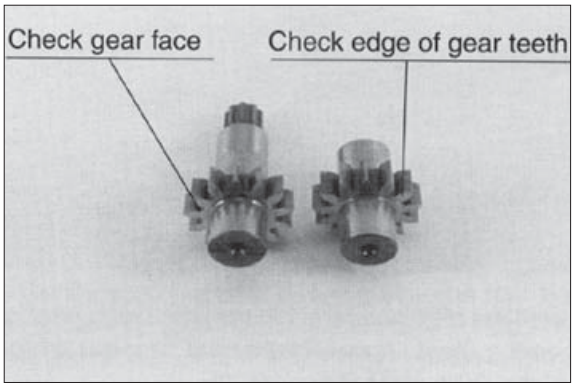
(2) Check drive shaft spline for twisted or broken teeth, check keyed drive shaft for broken or chipped keyway. No marks or grooves on shaft in seal area, some discoloration of shaft is allowable.

(3) Inspect both the drive gear shaft and idler gear shafts at the bearing points and seal area for rough surfaces and excessive wear.



PUMP 12

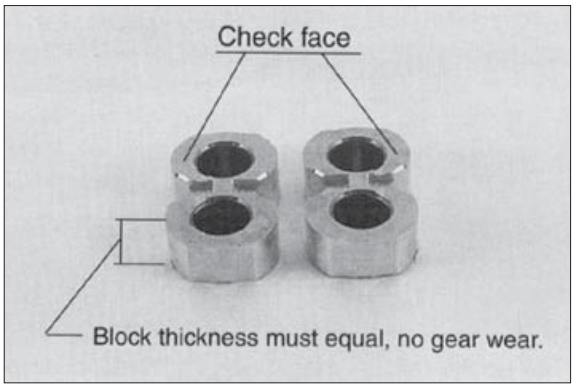
(4) Inspect gear face for scoring or excessive wear. If the face edge of gear teeth are sharp, they will mill into the bearing blocks. If wear has occurred, the parts are unusable.



PUMP 13

(5) Inspect bearing blocks for excessive wear or scoring on the surfaces which are in contact with the gears. Also inspect the bearings for excessive wear or scoring.

(6) Inspect the area inside the gear housing. It is normal for the surface inside the gear housing to show a clean "wipe" on the inside surface on the intake side. There should not be excessive wear or deep scratches and gouges.



PUMP 14

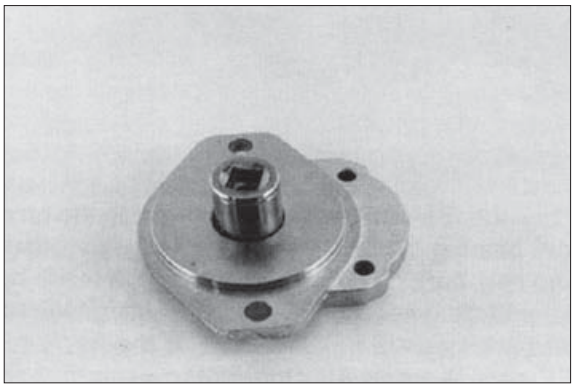
※ **General information**
It is important that the relationship of the mounting flange, bearing blocks and gear housing is correct. Failure to properly assemble this pump will result with little or no flow at rated pressure.

※ **This pump is not bi-rotational.**

3) ASSEMBLY

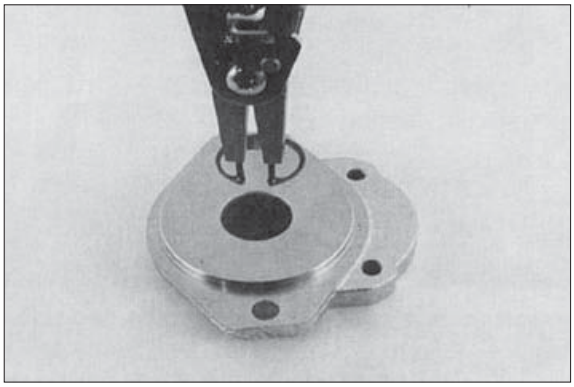
※ New seals should be installed upon reassembly of pump.

(1) Install new shaft seal in mounting flange with part number side facing outboard. Press the seal into the seal bore until the seal reaches the bottom of the bore. Uniform pressure must be used to prevent misalignment or damage to the seal.



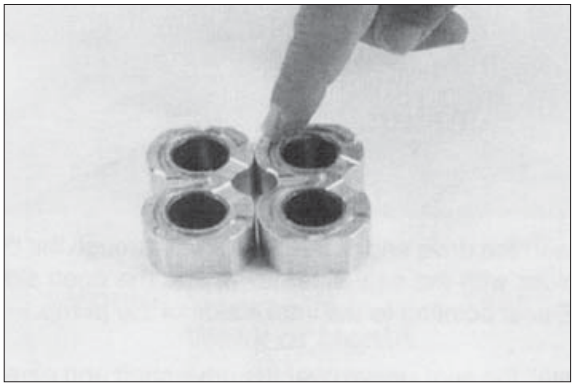
PUMP 15

(2) Install retaining ring in groove in seal bore of mounting flange.



PUMP 16

(3) Place front and back bearing blocks on a clean surface with the E-seal grooves facing up. Apply a light coating of petroleum jelly in the grooves. Also coat the E-seal and backup with the petroleum jelly, this will help keep the seals in place during assembly.

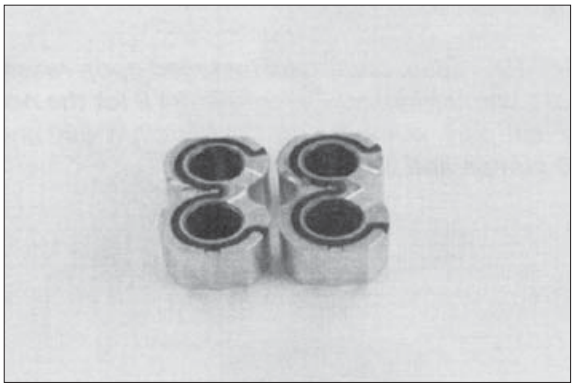


PUMP 17

(4) Place the E-seals, flat side outward, into the grooves in both bearing blocks. Follow by carefully placing the backup ring, flat side outward, in the groove made by the E-seal and the groove in the bearing block.

(5) Place mounting flange, with shaft seal side down, on a clean flat surface.

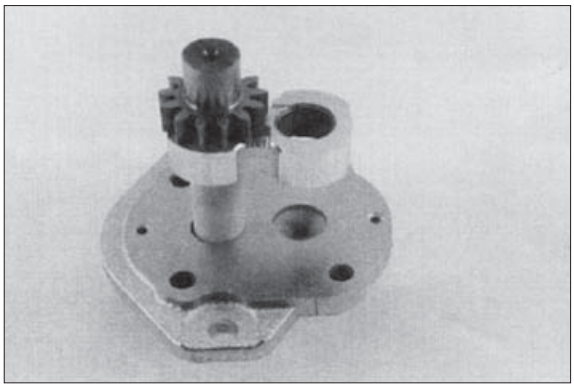
(6) Apply a light coating of petroleum jelly to the exposed face of the front bearing block.



PUMP 18

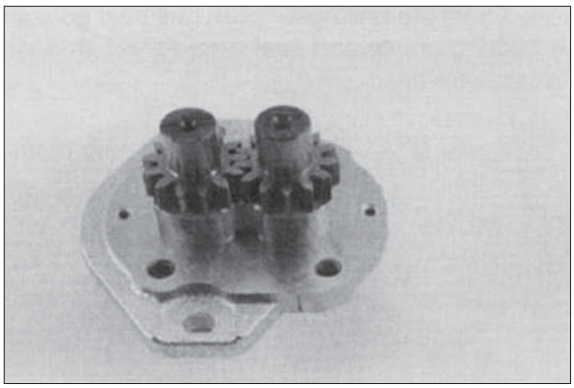
(7) Insert the drive end of the drive shaft through the bearing block with the seal side down, and the open side of the E-seal pointing to the intake side of the pump.

(8) Install the seal sleeve over the drive shaft and carefully slide the drive shaft through the shaft seal. Remove the seal sleeve from shaft.



PUMP 19

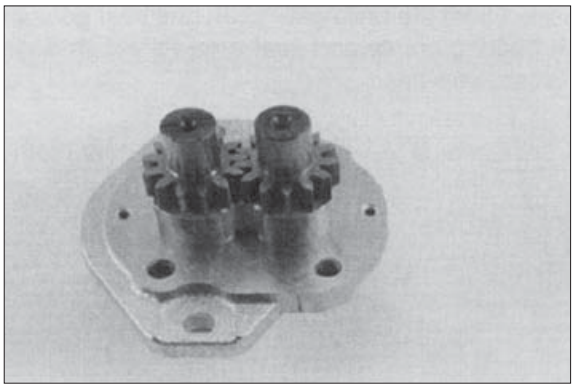
(9) Install the idler gear shaft in the remaining position in the bearing block. Apply a light coat of clean oil to the face of the drive and idler gears.



PUMP 20

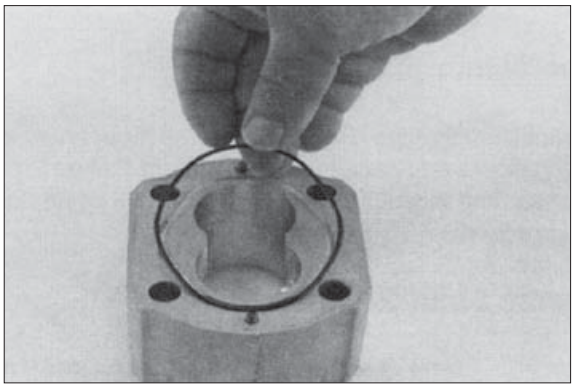
(10) Pick up the rear bearing block, with seal side up and with open end of the E-seal facing the intake side of the pump, place over the drive and idler gear shafts.

(11) Install two dowel pins in the holes in the mounting flange or two long dowel pins through gear housing if pump is a multiple section pump.



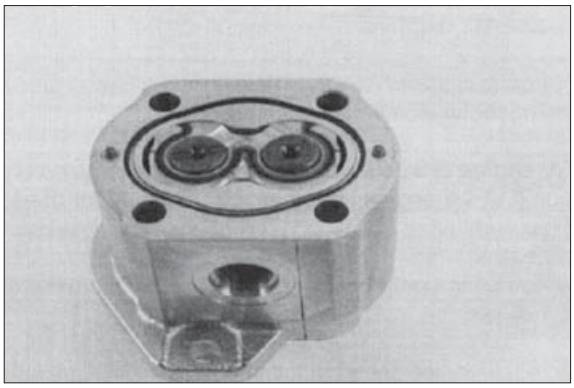
PUMP 20

(12) To install the O-rings in the gear housing, apply a light coating of petroleum jelly in the grooves on both sides of the gear housing.
Also coat the new O-ring and install them in the grooves.



PUMP 22

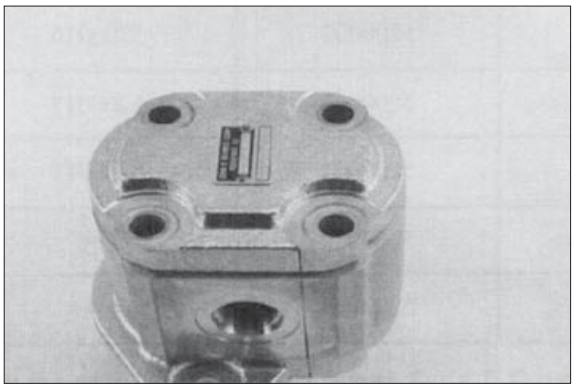
(13) Gently slide the gear housing over the rear bearing block assembly, slide housing down until the housing engages the dowel pins. Press firmly in place with hands, do not force or use any tool.
Check to make sure the intake port in the housing in on the same side as the open end of the E-seal and that the marked lines on the mounting flange and gear housing are in alignment.



PUMP 23

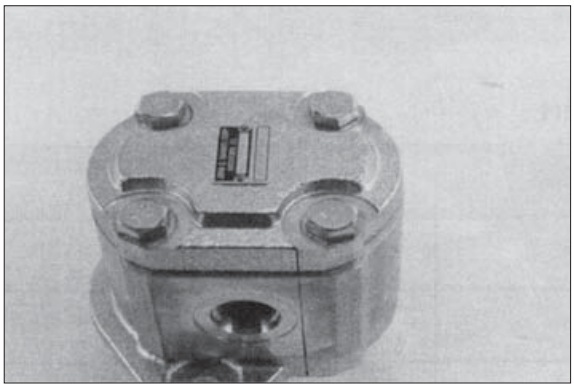
(14) The surface of the rear bearing block should be slightly below the face of the gear housing. If the bearing block sits higher then the rear face of the gear housing then the E-seal or O-ring have shifted out of the groove. If this is the case, remove the gear housing and check for proper seal installation.

(15) Install the two remaining dowel pins in the rear of the gear housing and place the end cover over the back of the pump.



PUMP 24

(16) Install the four spacers and hexagon head bolts through the bolt holes in the end cover, hand tighten.



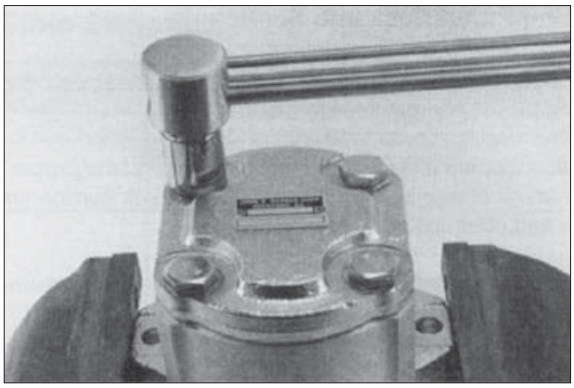
PUMP 25

(17) Place mounting flange of the pump back in the protected jawed vise and alternately torque the bolts.

· Tighten torque : 3.0~4.0 kgf · m
(22~29 lbf · ft)

(18) Remove pump from vise.

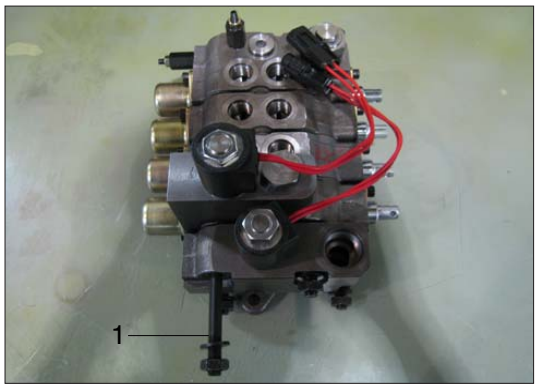
(19) Place a small amount of clean oil in the inlet of the pump and rotate the drive shaft away from the inlet one revolution. If the drive shaft binds, disassemble the pump and check for assembly problems, then reassemble the pump.



PUMP 26

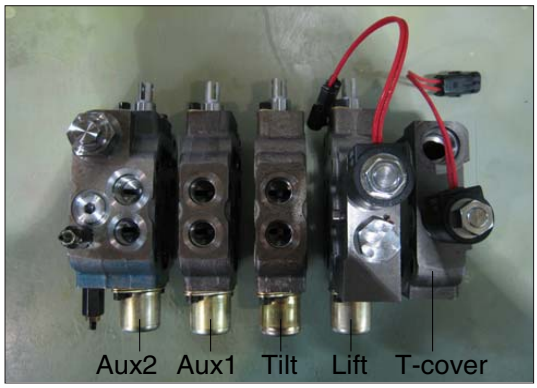
2. MAIN CONTROL VALVE

1) Remove bolt (1) to separate the valve section.
   · Bolt torque (1) : $10.0^{+0.6}_{0}$ kgf · m



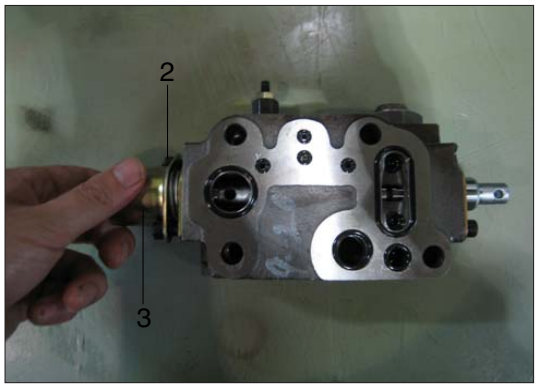
20D7MCV01

2) Divide the valve body.



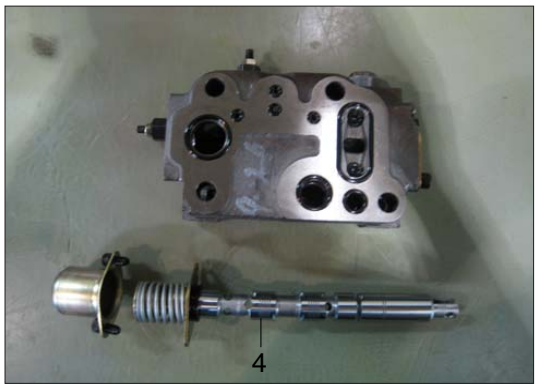
20D7MCV02

3) Remove dust cap (3) and bolt (2) from the valve body.
   · Bolt torque (2) : 1.2 kgf · m



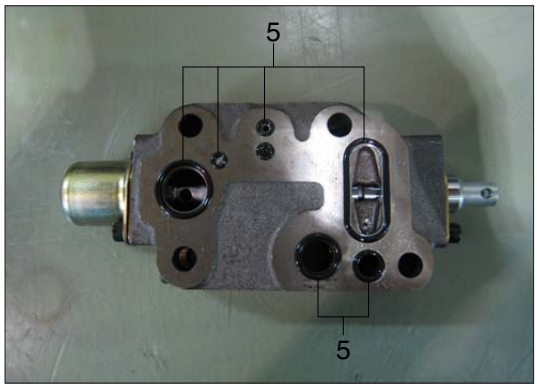
20D7MCV03

4) Remove attachment spool (4) from the valve body.



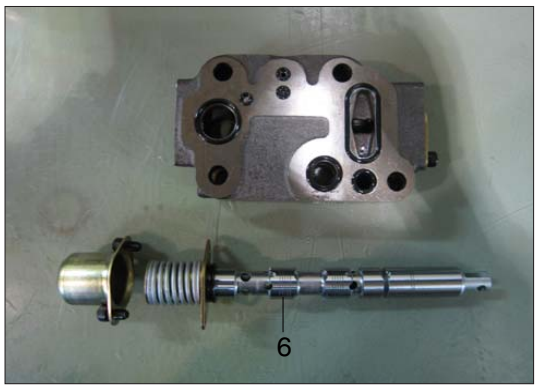
20D7MCV04

5) Remove O-ring seals (5) from the valve body.



20D7MCV05

6) Remove tilt spool (6) from the valve body.

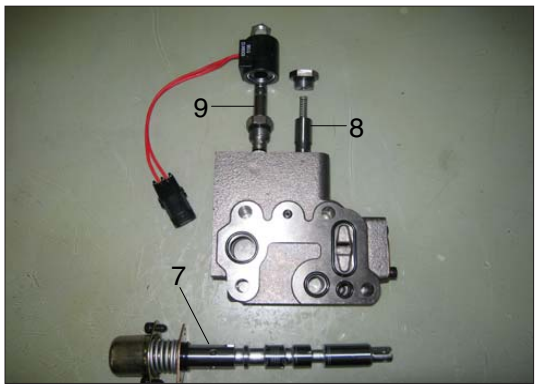


20D7MCV06

7) Remove lift spool (7) from the valve body.

8) Remove lock poppet (8) from the valve body.

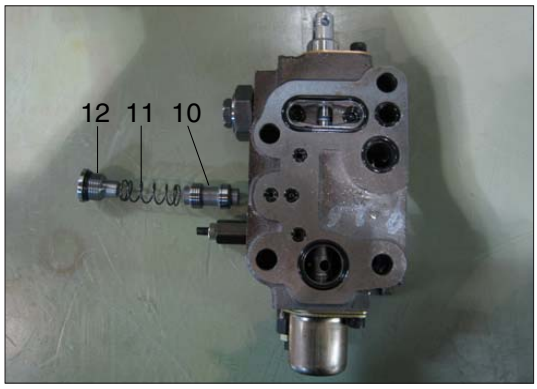
9) Remove normal close solenoid valve (9, Opt) from the valve body.



20D7MCV07

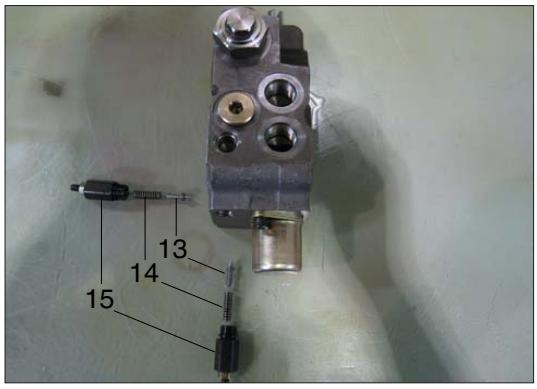
10) Remove plug (12) and spring (11).

11) Remove hydrostat (10).



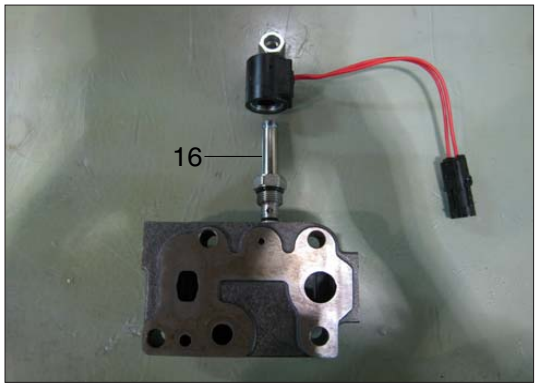
20D7MCV08

12) Remove relief plugs (15), springs (14) and poppets (13).
 · Relief plugs torque (15) : 2.5 kgf · m



20D7MCV09

13) Remove normal open solenoid valve (16, Opt) from the valve body.

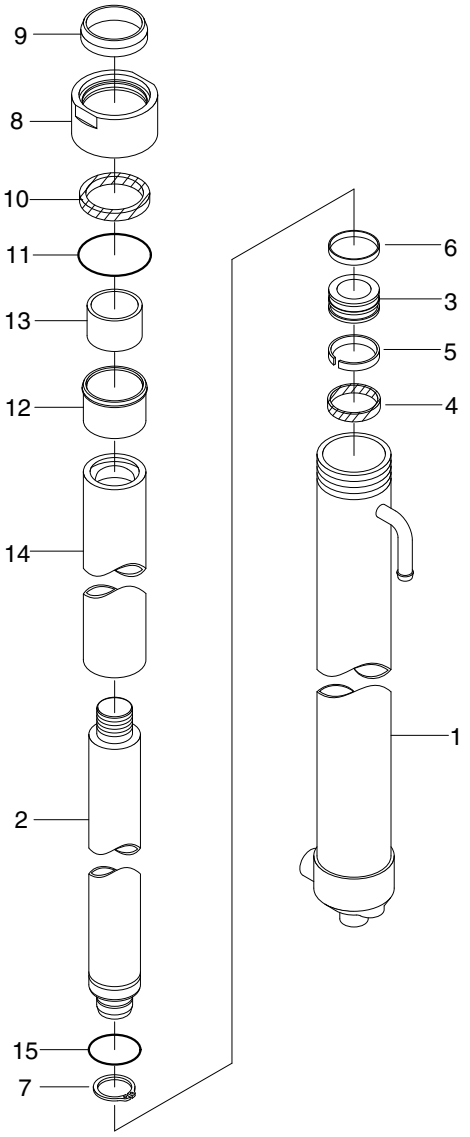


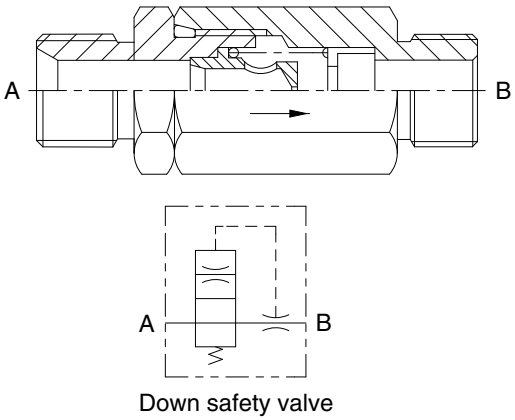
20D7MCV10

14) Assembly procedure of the main control valve is the reverse order of the removal procedure.

3. LIFT CYLINDER

1) STRUCTURE





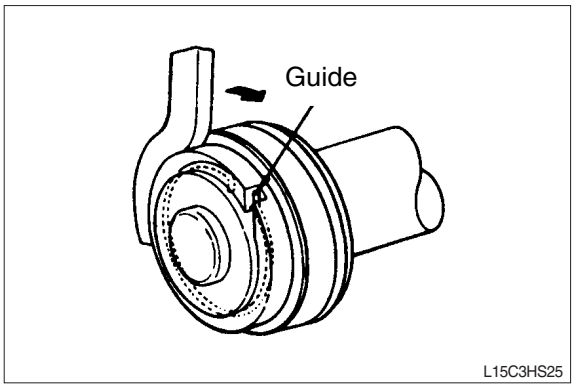
Down safety valve

20D7HS19

1	Tube assy	6	Wear ring	11	O-ring
2	Rod assy	7	Retaining ring	12	Guide
3	Piston	8	Gland	13	Du bushing
4	Piston seal	9	Dust wiper	14	Spacer
5	Back up ring	10	Rod seal	15	O-ring

2) DISASSEMBLY

(1) Hold the cylinder tube in a vice, loosen the cylinder head and remove it.
Remove the spacer from the cylinder tube and knock out the bushing. Hook a wrench in the hole in the retainer at the piston end and turn. Lever up the edge of the guide, then turn the guide in again and the guide can be removed.



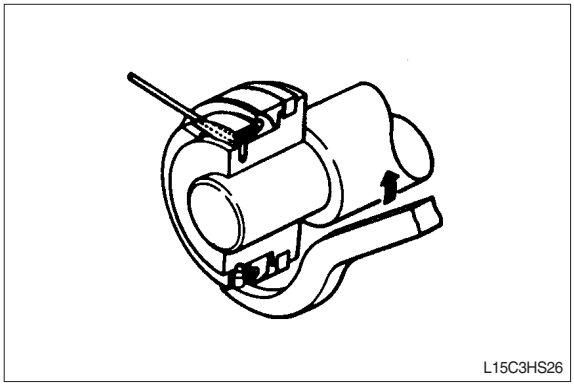
3) CHECK AND INSPECTION

mm (in)

Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between piston ring & tube	0.05~0.030 (0.002~0.012)	0.5 (0.020)	Replace piston ring

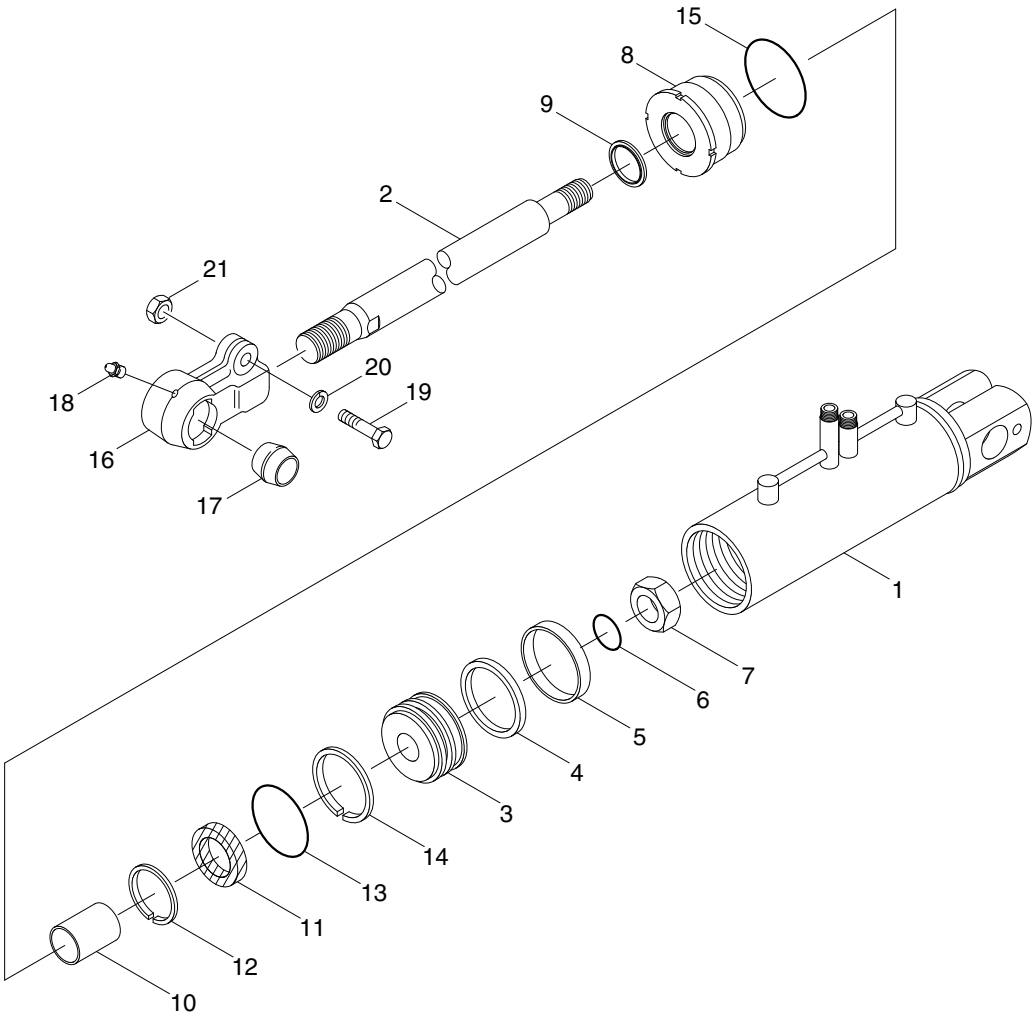
4) ASSEMBLY

(1) Soak the piston ring in hydraulic oil at a temperature of 40 to 50°C, expand the inside diameter and assemble on the piston. Install a piston seal.
Bend the edge of the guide and rotate it to install the guide completely.



4. TILT CYLINDER

1) STRUCTURE

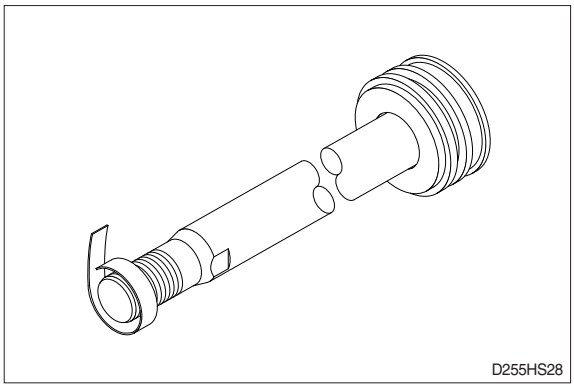


D255HS27

1	Tube assy	8	Rod cover	15	O-ring
2	Rod	9	Dust wiper	16	Eye
3	Piston	10	DU bushing	17	Spherical bearing
4	Piston seal	11	Rod seal	18	Grease nipple
5	Wear ring	12	Back up ring	19	Hexagon bolt
6	O-ring	13	O-ring	20	Spring washer
7	Nylon nut	14	Back up ring	21	Hexagon nut

2) DISASSEMBLY

(1) Hold the parallel parts of the cylinder tube bottom in a vice and mark the rod head end to show how much it is screwed in, then remove the rod head. Next, hook a wrench into the notch at the cylinder head and remove the cylinder head from cylinder tube.
When doing this, wind tape round the threaded part of the rod and be careful not to damage the dust seal and rod seal inside cylinder head.



3) CHECK AND INSPECTION

mm (in)

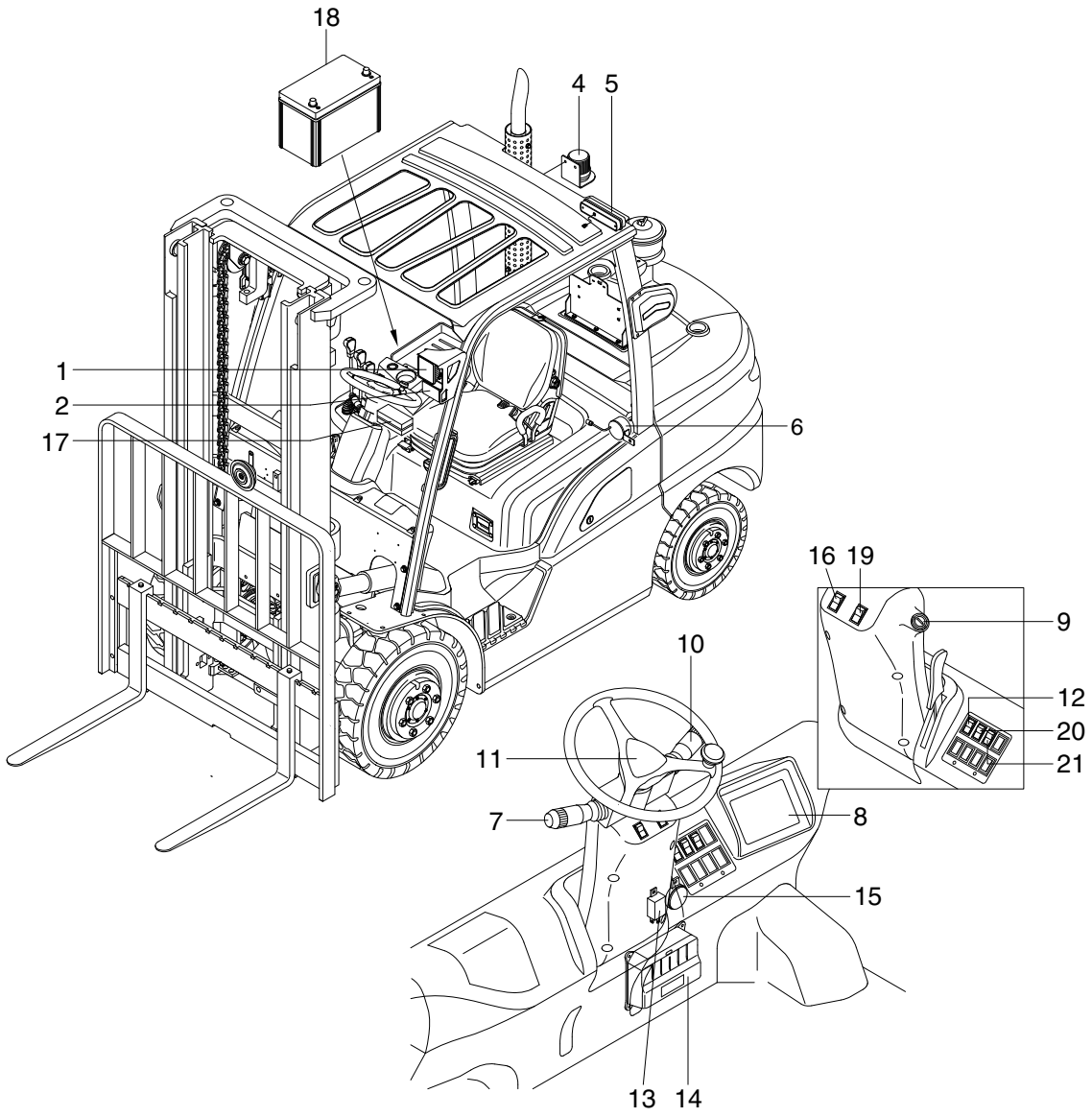
Check item	Standard size	Repair limit	Remedy
Clearance between cylinder rod & bushing	0.072~0.288 (0.003~0.011)	0.5 (0.020)	Replace bushing
Clearance between rod head bushing & pin	0.10~0.35 (0.004~0.014)	0.6 (0.024)	Replace bushing

SECTION 7 ELECTRICAL SYSTEM

Group 1 Component location 7-1
Group 2 Electrical circuit 7-2
Group 3 Component specification 7-15
Group 4 Connector destination 7-16
Group 5 Troubleshooting 7-19

SECTION 7 ELECTRICAL SYSTEM

GROUP 1 COMPONENT LOCATION

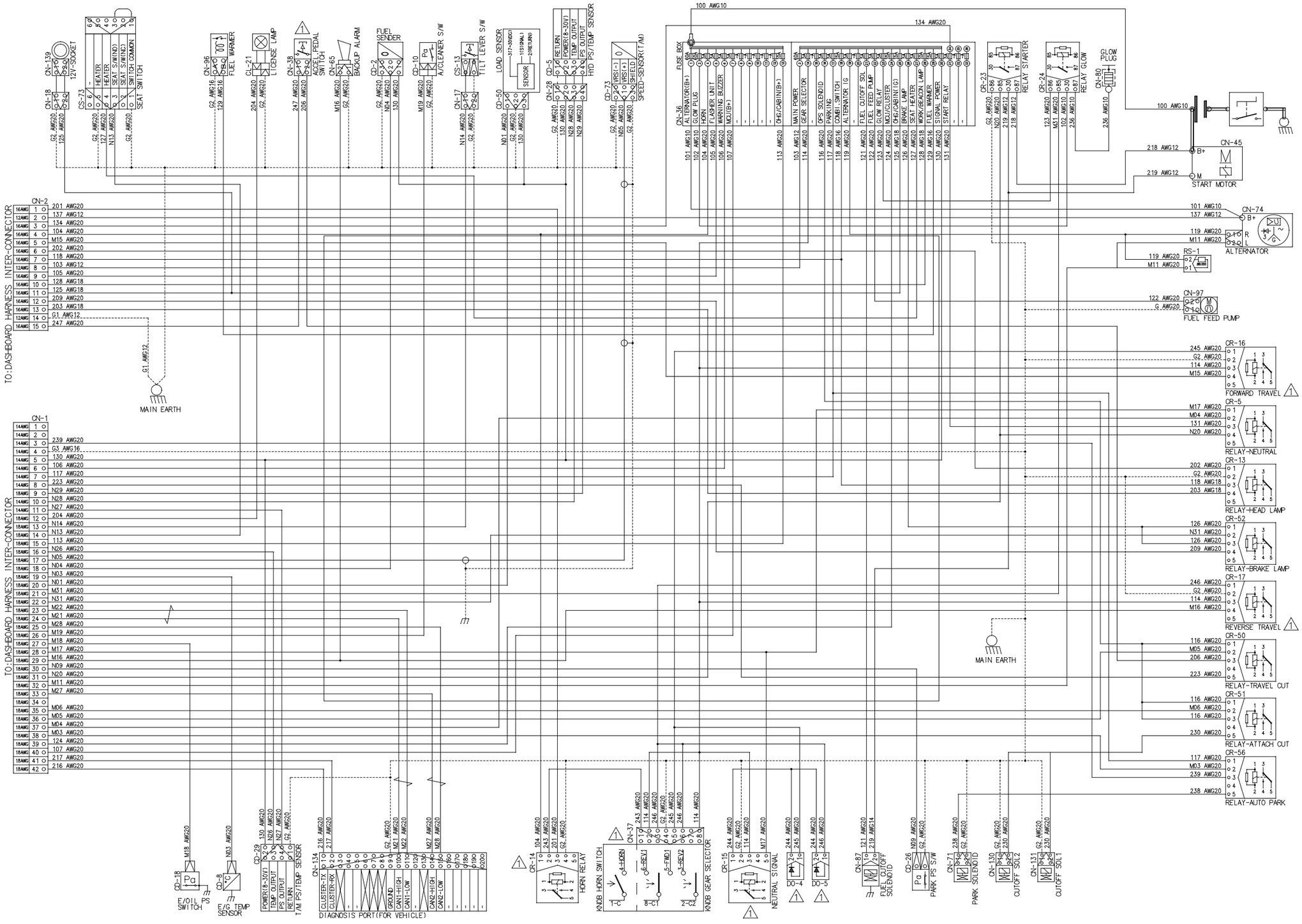


22D9TEL01

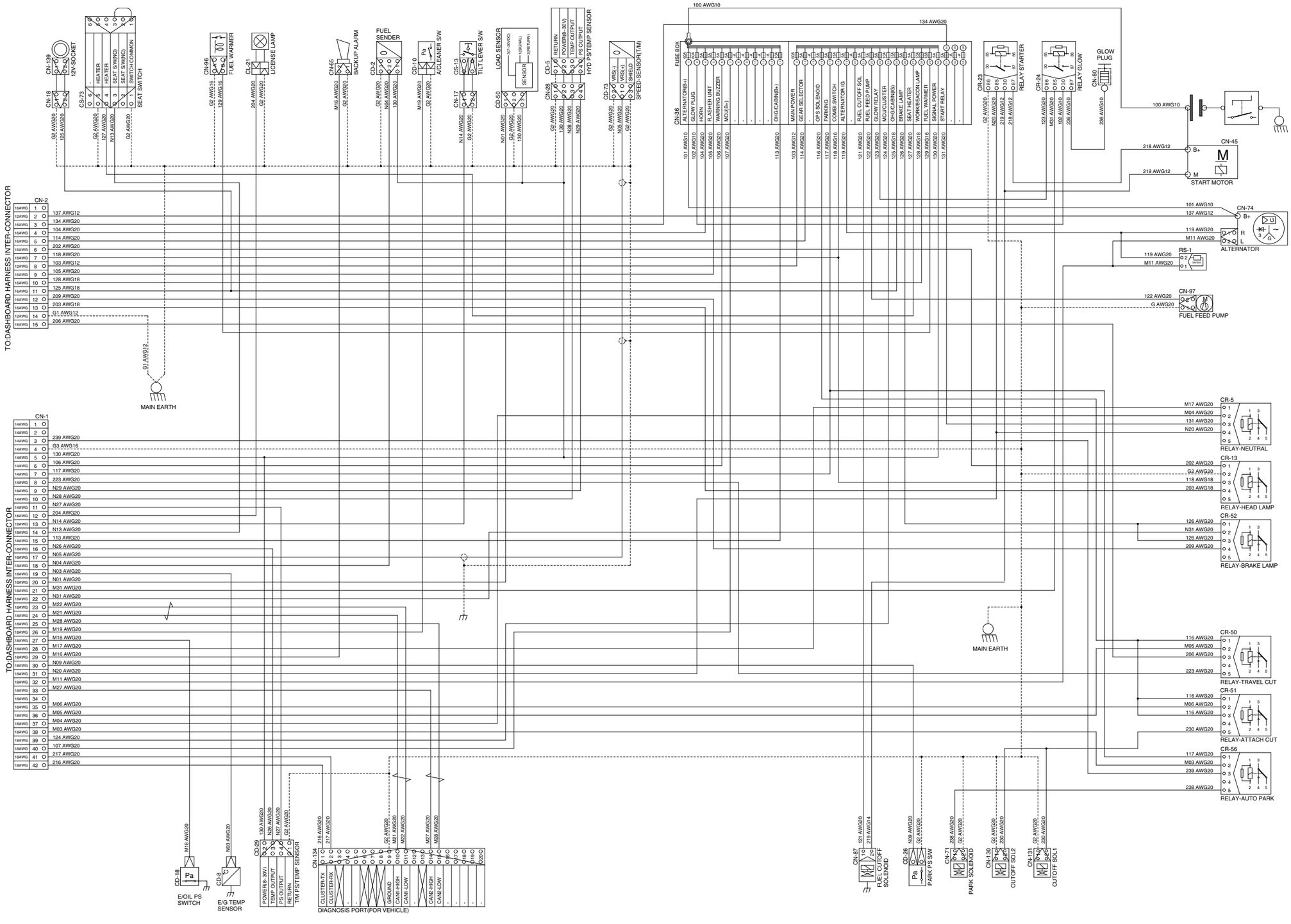
1	Head lamp	9	Start switch	15	Buzzer
2	Turn signal lamp	10	Head lamp switch	16	Hazard lamp switch (opt)
3	Horn assembly		Illumination lamp	17	Fuse box
4	Beacon lamp (opt)		Turn signal switch	18	Battery
5	Combination lamp	11	Horn button	19	Parking switch
6	Back buzzer	12	Work lamp switch (opt)	20	Beacon switch (opt)
7	Forward-reverse lever	13	Flasher unit	21	Wiper switch (opt)
8	Cluster	14	MCU		

GROUP 2 ELECTRICAL CIRCUIT

· ELECTRICAL CIRCUIT (1/4)

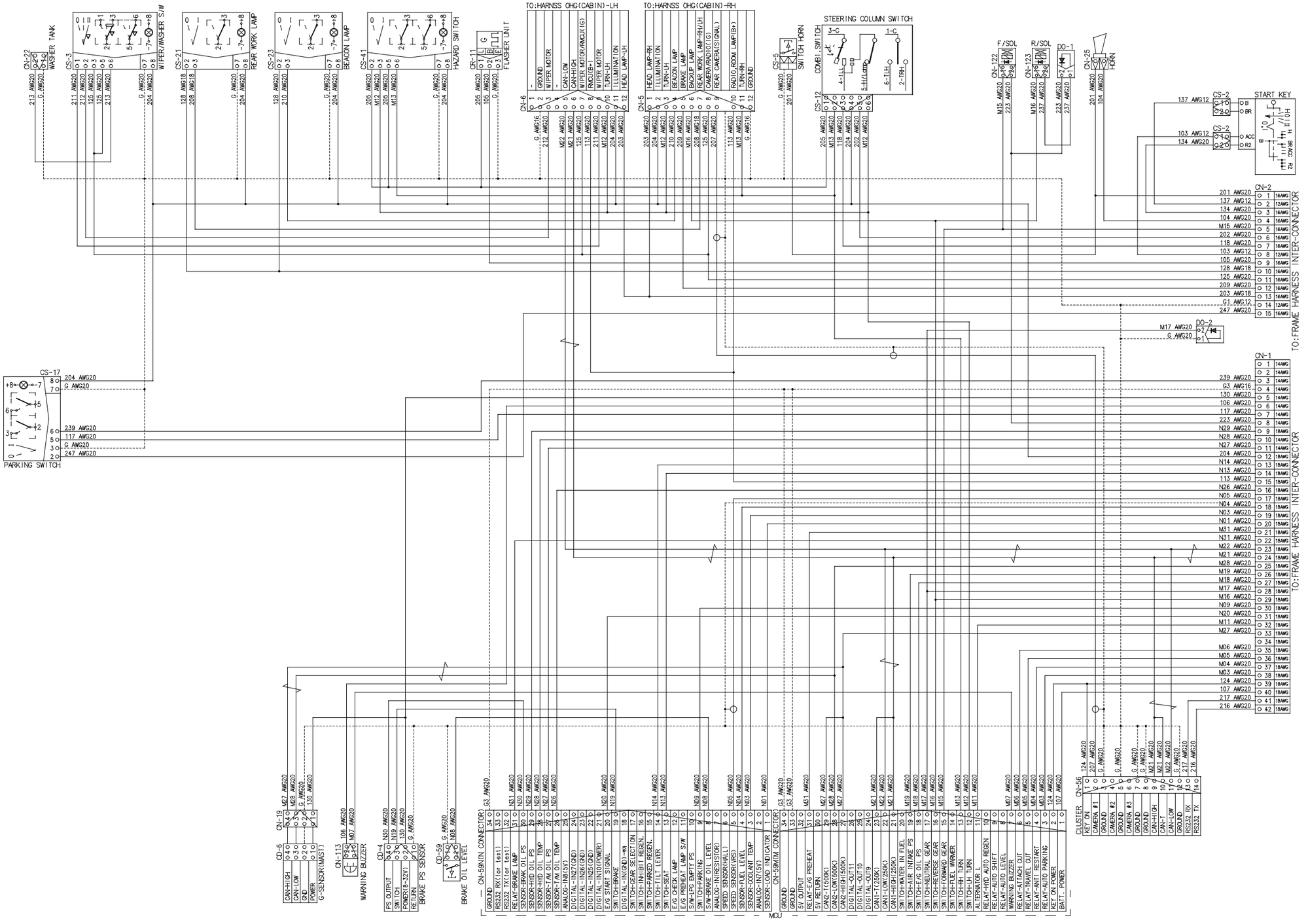


· ELECTRICAL CIRCUIT (2/4)



22D9SEL02-2

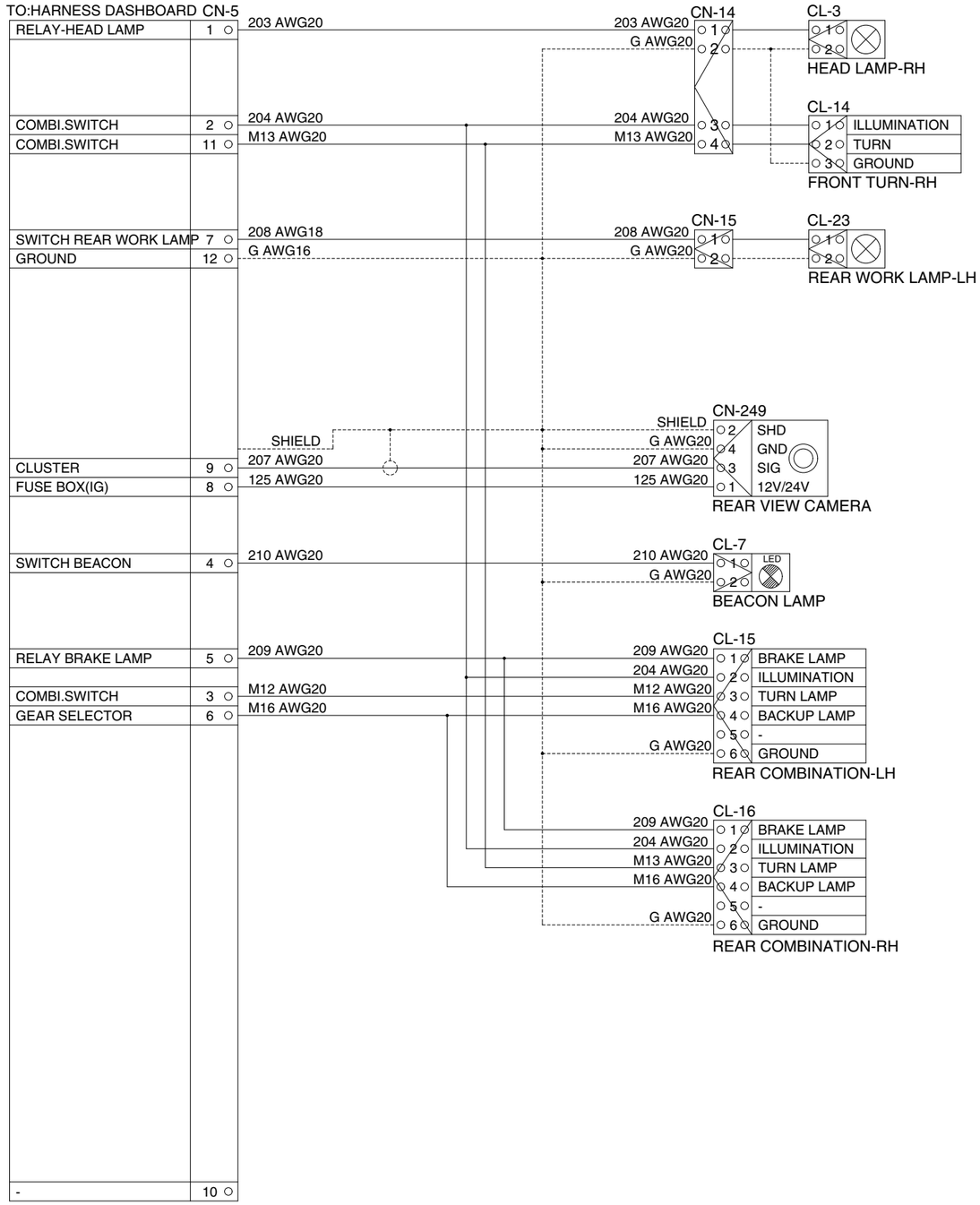
· ELECTRICAL CIRCUIT (3/4)



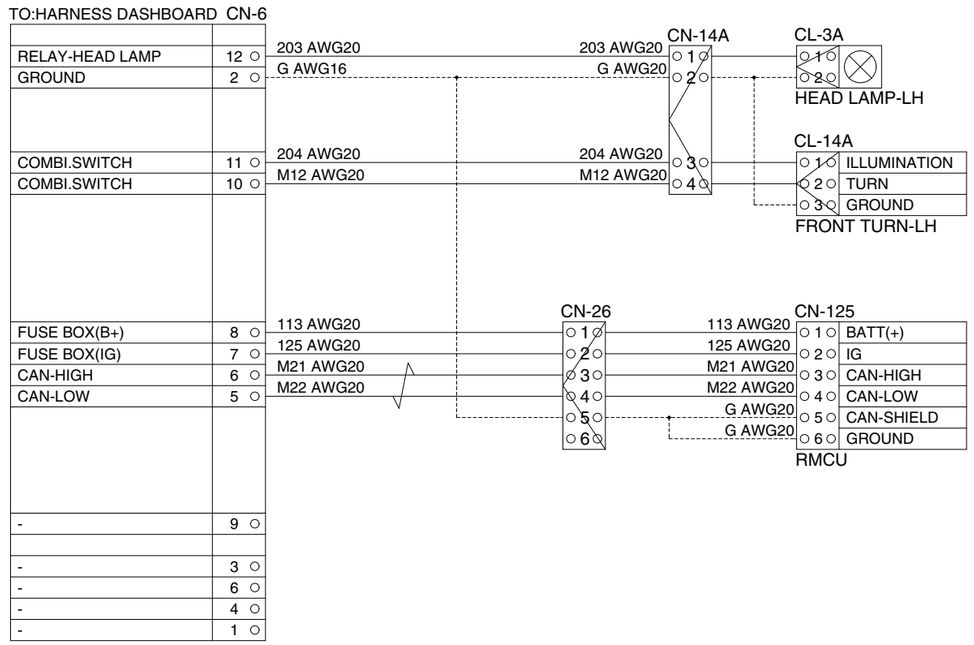
22D9SEL03

· ELECTRICAL CIRCUIT (4/4)

*ELEC.DIAGRAM OF HARNESS OHG-RH



*ELEC.DIAGRAM OF HARNESS OHG-LH



22D9SEL04

1. POWER CIRCUIT

The negative terminal of the battery is grounded to the machine chassis.
When the start switch is in the off position, the current flows from the positive battery terminal.

1) OPERATING FLOW

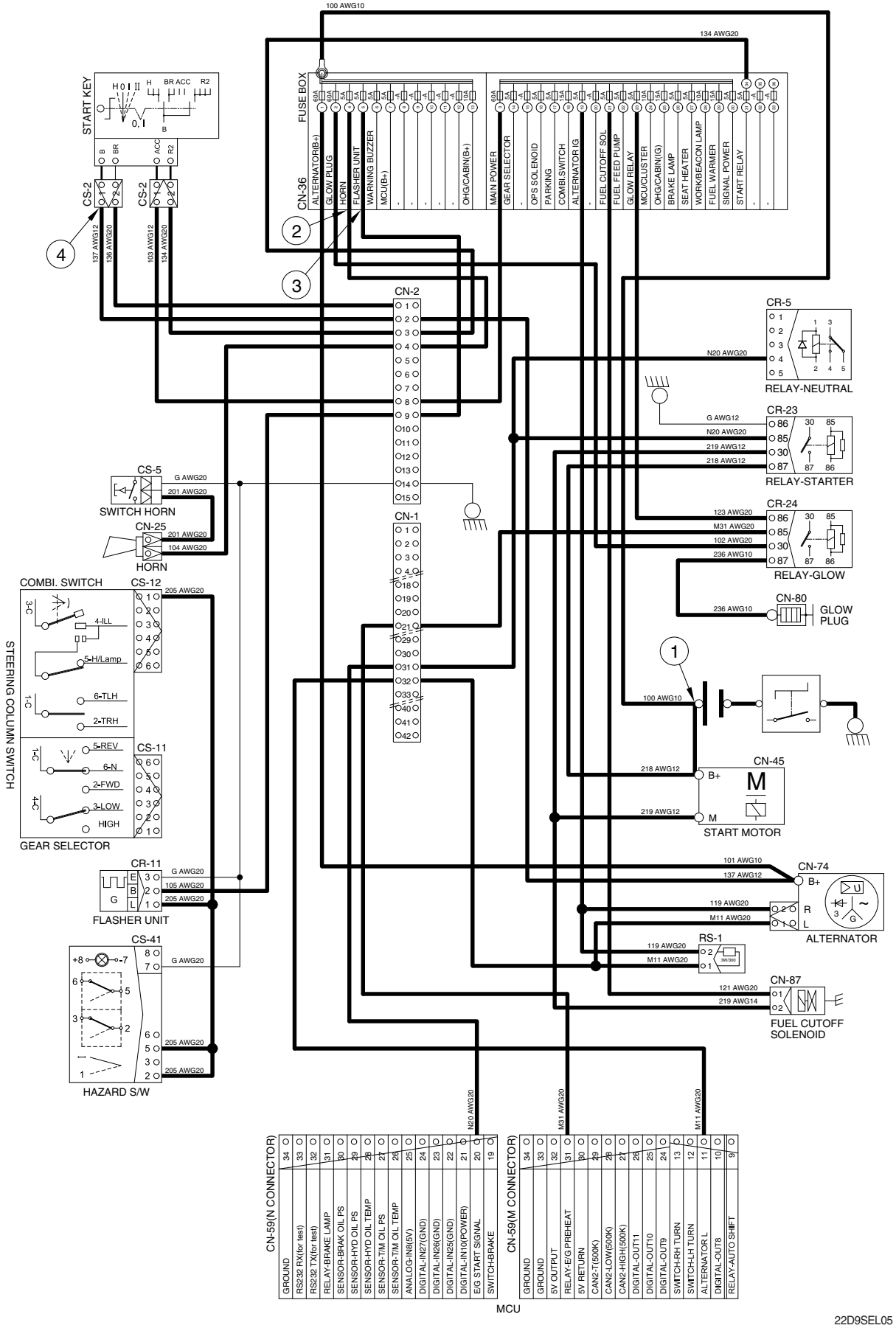
Battery(+) → Start motor [CN-45 (B+)]
- → Glow relay [CR-24] → Glow plug
- → Start relay [CR-23]
- → Fuse box [CN-36 (1)] → Alternator [CN-74 (B+)] → I/conn [CN-2 (2)]
  - → I/conn [CS-2 (1)] → Start switch OFF
  - → Fuse box [No.4] → I/conn [CN-2 (4) → Horn [CN-25]
  - → Fuse box [No.5] → I/conn [CN-2 (9)] → Flasher unit [CR-11 (2) → (1)]
    - → Hazard switch [CS-41 (4, 5)]
    - → Combi switch [CS-12 (1)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
OFF	OFF	① - GND (Battery(+)) ② - GND (Fuse No.3) ③ - GND (Fuse No.4) ④ - GND (Start key)	12V

※ GND : Ground

POWER CIRCUIT



2. STARTING CIRCUIT

1) OPERATING FLOW

Battery (+) terminal → Start motor [CN-45 (B+)]
→ Fuse box [CN-36 (1)] → Alternator [CN-74 (B+)] → I/conn [CN-2 (2)] → Start switch [CS-2 (1)]
→ Start relay [CR-23]

※ **The engine can be started only when the gearshift is in neutral position.**

(1) When start key switch is in ON position

Start switch ON [CS-2 (2)] → I/conn[CN-2 (8)] → Fuse box [No.3] → Main power

(2) When start key switch is START position

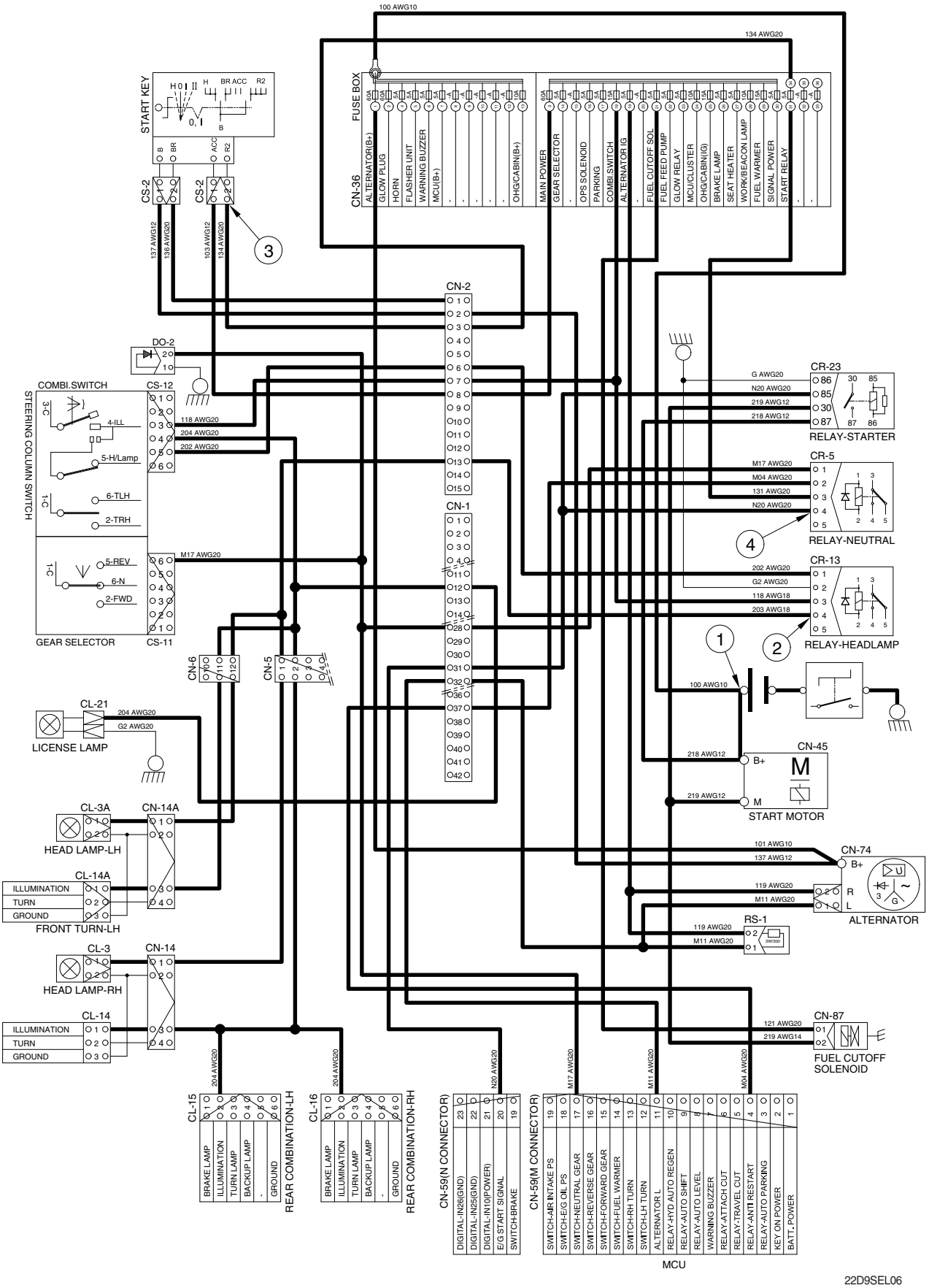
Start switch START [CS-2 (2)] → I/conn [CN-2 (3)] → Fuse box [No. 34 →31]
→ Neutral relay [CR-5(3) → (4)] → Start relay [CR-23]
→ I/conn [CN-1 (31)] → ECU [CN-59 (20)]

2) CHECK POINT

Engine	Key switch	Check point	Voltage
Running	ON	① - GND (Battery B+) ② - GND (Start key) ③ - GND (Neutral relay)	12V

※ GND : Ground

STARTING CIRCUIT



3. CHARGING CIRCUIT

When the starter is activated and the engine is started, the operator release the start switch to the ON position. Charging current generated by operating alternator flows into the battery.
The current also flows from alternator to each electrical component through the fuse box.

1) OPERATING FLOW

(1) Warning flow
Alternator [CN-74 (L)] → I/conn [CN-1 (32)] → MCU [CN-59 (11)]

(2) Charging flow
Alternator [CN-74 (B+)] → Fuse box [CN-36 (1)] → Starter [CN-45 (B+)] → Battery (+) terminal → Charging

2) CHECK POINT

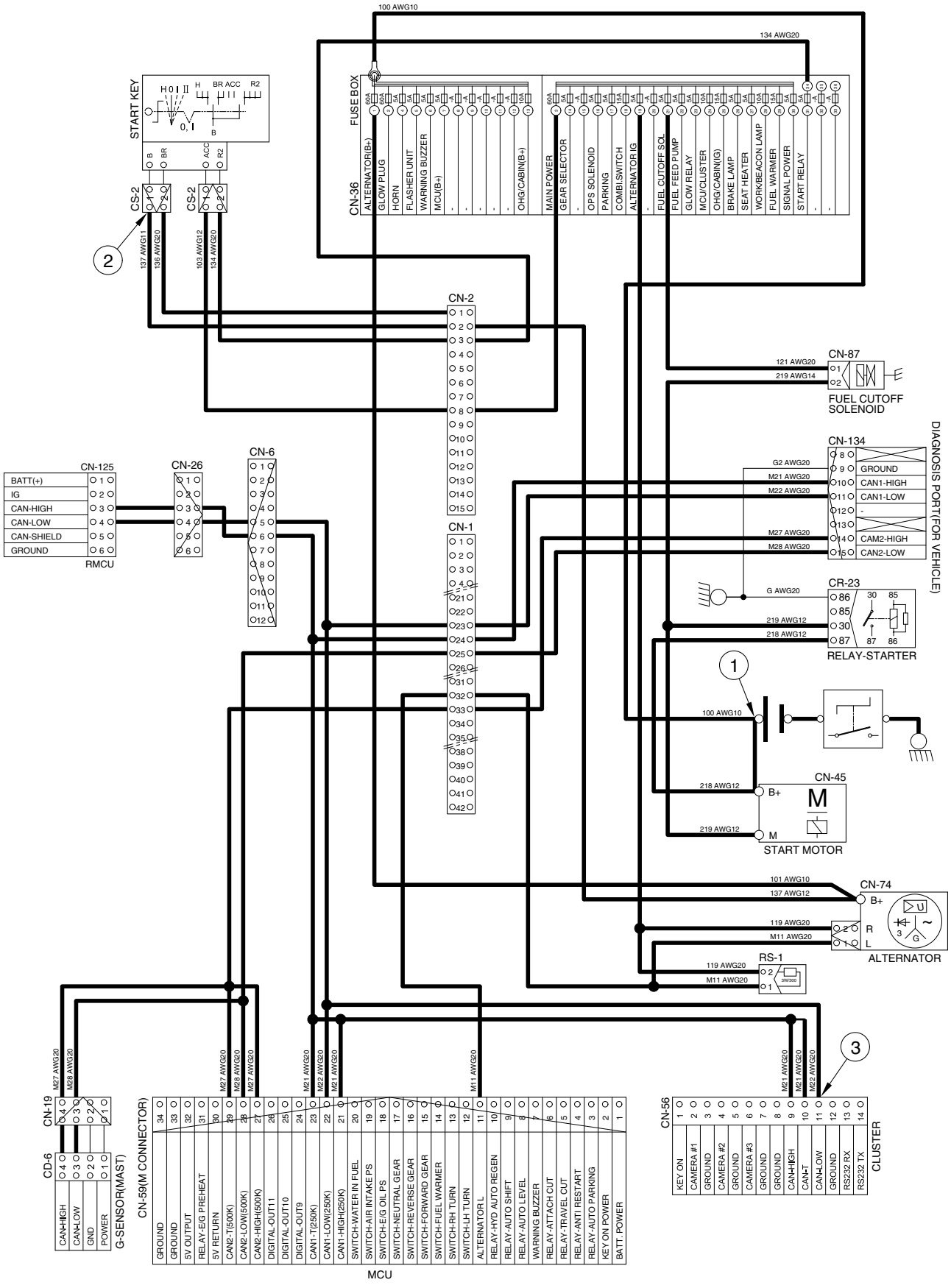
Engine	Key switch	Check point	Voltage
ON	ON	① - GND (Alternator B+) ② - GND (Start switch) ③ - GND (Cluster)	12V

※ GND : Ground

※ Cautions

1. When using an arc welder, always disconnect the ground lead from the battery to prevent alternator or battery damage.
2. Attach the welding ground clamp as close to the weld area as possible to prevent welding current from damaging the bearings of the alternator.
3. Do not disconnect the battery when the engine is running. The voltage surge can damage the diode and resistors in the electrical system.
4. Do not disconnect an electric wire before the engine is stopped and the switches are OFF.

CHARGING CIRCUIT



4. PREHEATING CIRCUIT

Combustion chamber glow plugs are used in order to give satisfactory starting of low ambient temperatures.

1) OPERATING FLOW

Battery (+) terminal → Fuse box [CN-36 (1)] → Alternator [CN-74 (B+)] → I/conn [CN-2 (2)]
→ I/conn [CS-2(1)] → Start switch
→ Glow relay [CR-24]

※ When you turn the start switch to the ON position, the glow relay makes the glow plugs operated and the glow lamp of the cluster turned ON.

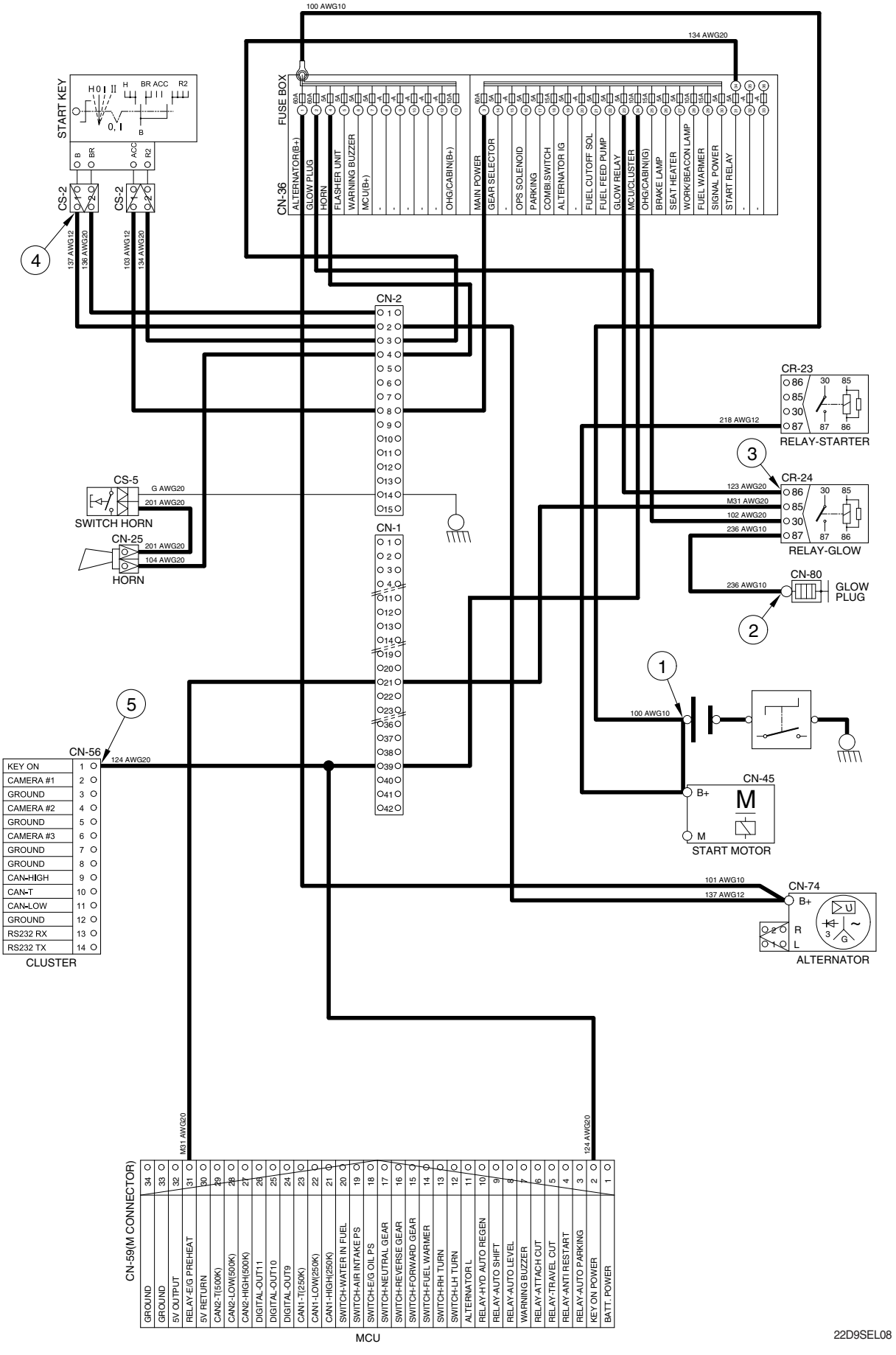
Start switch ON [CS-2 (2)] → I/conn [CN-2 (8)] → Fuse box [CN-36 (3)]
→ Glow relay ON [CR-24] → Glow plug operating
→ Cluster [CN-56 (1)] → Key ON
→ MCU [CN-59 (2)] → Key ON power

2) CHECK POINT

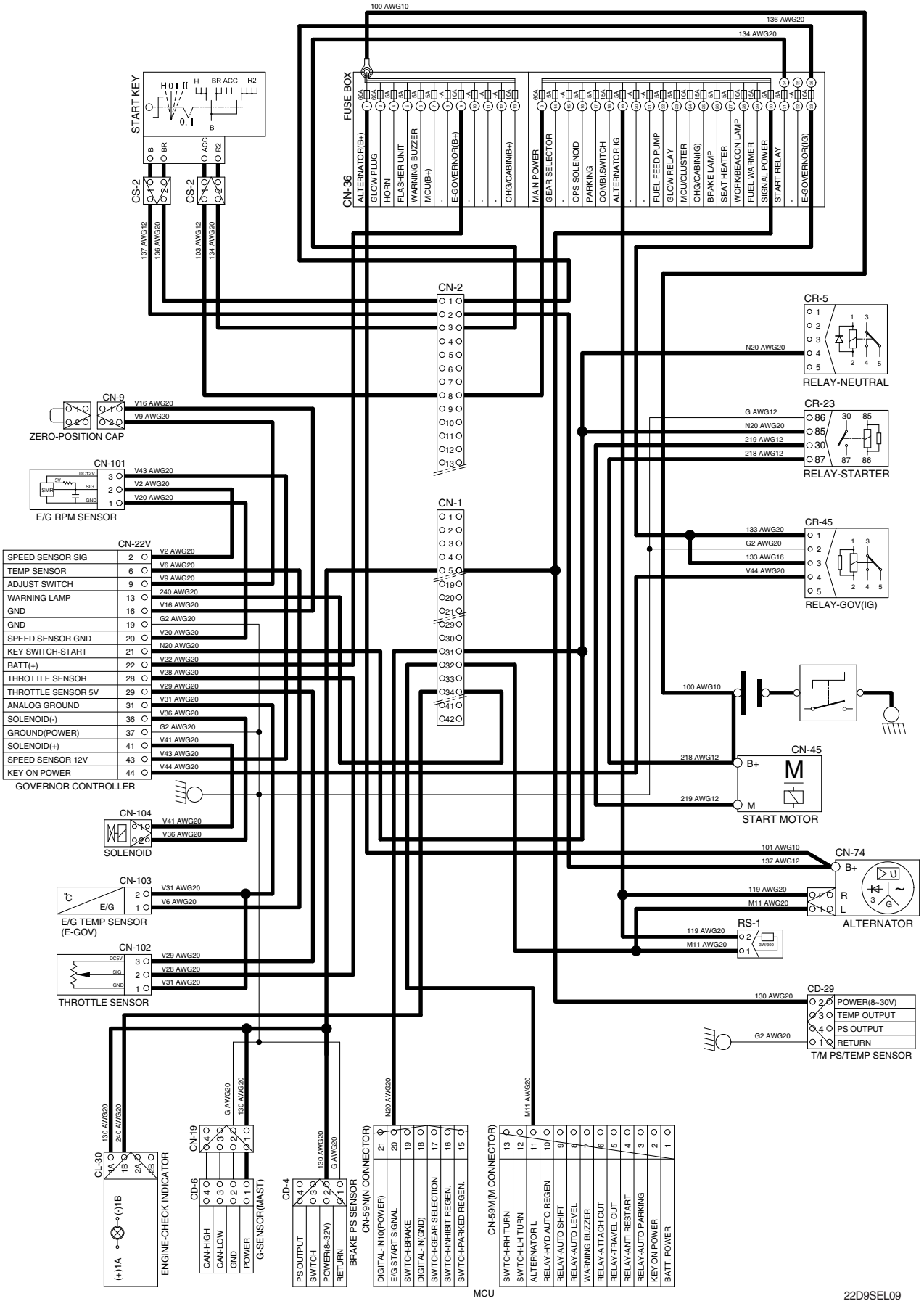
Engine	Key switch	Check point	Voltage
Stop	HEAT	① - GND (Battery B+) ② - GND (Glow plug) ③ - GND (Glow relay) ④ - GND (Start switch) ⑤ - GND (Cluster)	12V

※ GND : Ground

PREHEATING CIRCUIT



GOVERNOR CONTROLLER CIRCUIT



GROUP 3 COMPONENT SPECIFICATION

No	Part name	Qty	Specification	Remark
1	Battery	1	12V-CMF100 RC : 190 min CCA : 850A	
2	Working lamp	1	12V, 55W	
3	License lamp	1	12V, 10W	
4	Rear combination lamp (LED)	2	12V, 1.6W (T/S) 12V, 1.1W (Back) 12V, 0.2W (Tail) 12V, 1.1W (Stop)	
5	Head lamp	2	12V, 55W	
6	Flasher lamp	2	12V (Posi : 0.5W, T/Signal : 2.2W)	
7	Beacon lamp (opt)	1	12V, Max. 1.210A	
8	Beacon lamp - LED (opt)	1	12V, Max. 0.800A	
9	Camera (opt)		12V, Max. 1.32W	
10	Flasher unit	1	12V, 85±10C/M, (23W+23W)×2+3W×2	
11	Backup alarm	1	12V, 90±5dB, 60±10C/M	
12	Horn	1	12V, MAX 3.5A, 105~120dB	
13	Fuel level sender	1	Reed switch - Magnet type Float indicate: E / 4/8 / F Resistance [Ω]: 700 / 350 / 50 Allowance [Ω]: $^{0}_{+5}$% / ±5% / $^{0}_{-5}$%	
14	Cluster	1	12V, 15W	
15	12V scoket	1	12V, 120W	
16	G-sensor	1	12V, 5W	
17	Master switch		180A	
18	Gear selector switch	1	12V, (Resistive load max 12V/3.5A)	
19	Combination switch	1	12V, Direction : Resistive load max 12V/3.5A Multi switch : Resistive load max 12V/2A	
20	Parking brake switch	1	12V, 20A	
21	Hazard switch	1	12V, 20A	
22	Start switch	1	DC 12V	
23	Rear work lamp switch (opt)	1	12V, 20A	
24	Beacon lamp switch (opt)	1	12V, 20A	
25	Front wiper/washer switch (opt)	1	12V, 20A	
26	Relay (4P)	2	12V, 20A	
27	Relay (5P)	2	12V, 20A	

GROUP 4 CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	AMP	42	I/conn (Dashboard harness-frame harness)	936421	936429
CN-2	AMP	15	I/conn (Dashboard harness-frame harness)	2-85262-1	369301-1
CN-5	KET	12	I/conn (Dashboard harness-OHG harness-RH)	-	MG640348
CN-6	KET	12	I/conn (Dashboard harness-OHG harness-LH)	-	MG640348
CN-9	DEUTSCH	2	Zero position	-	DT04-2P
CN-17	KET	2	Tilt lever switch	MG610320	-
CN-18	AMP	2	12V socket	174352-2	-
CN-19	AMP	4	G-sensor	174257-2	-
CN-22V	AMP	44	Engine governor controller	1376886-1	-
CN-25	AMP	1	Horn	171809-2	-
CN-28	KET	4	Hydraulic oil PS/temp sensor	MG610331	-
CN-45	AMP	1	Start motor M	171809-2	-
CN-56	AMP	14	Cluster	776273-2	-
CN-59M	AMP	34	Machine control unit	4-1437290-0	-
CN-59N	AMP	34	Machine control unit	4-1437290-1	-
CN-62	YAZAKI	6	Glow unit	7123-2262	-
CN-65	KET	2	Back buzzer	-	MG640322
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-74	KET	2	Alternator	MG610043	-
CN-87	SUMITOMO	2	Fuel stop solenoid (MECHANIC)	6195-0003	-
CN-96	PACKARD	2	Fuel warmer	15300027	-
CN-97	YAZAKI	2	Fuel feed pump	7123-6423-30	-
CN-101	YAZAKI	3	Engine rpm sensor	7283-8732-40	-
CN-102	SUMITOMO	3	Throttle sensor	6098-0142	-
CN-103	SUMITOMO	2	Engine temp sensor (For engine governor)	6189-0552	-
CN-104	SUMITOMO	2	Solenoid	6189-0249	-
CN-113	KET	2	OPSS buzzer	MG610320	-
CN-122	DEUTSCH	2	Forward solenoid	DT06-2S	-
CN-123	DEUTSCH	2	Reverse solenoid	DT06-2S	-
CN-130	PACKARD	2	Cut off solenoid 2 (Tilt, lift)	12015792	-
CN-131	PACKARD	2	Cut off solenoid 1 (Lift, down)	12015792	-
CN-134	KET	20	Diagnosis port (Vehicle)	MG652863	-
CN-139	KET	2	12V socket	MG610043	-
CN-140	KET	3	MCU update	MG610327	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Switch					
CS-2	KET	2	Start switch	MG610281	MG620282
CS-3	CARLING	10	Wiper/washer switch	21HN-56300	-
CS-5	KET	-	Horn switch	-	MG640329
CS-11	DEUTSCH	6	Gear selector	DT06-6S	-
CS-12	DEUTSCH	6	Combination switch	DT06-6S-P012	-
CS-13	KET	1	Tilt lever switch	ST730018-3	ST750036-3
CS-17	CARLING	10	Parking switch	21HN-56300	-
CS-21	CARLING	10	Work lamp switch	21HN-56300	-
CS-23	CARLING	10	Beacon lamp switch	21HN-56300	-
CS-41	DAEDONG	10	Harzard switch	21HN-56300	-
CS-73	DEUTSCH	6	Seat switch	DT06-6S	-
Lamp					
CL-3	KET	2	Head lamp-RH	ST730018-3	ST750036-3
CL-3A	KET	2	Head lamp-LH	ST730018-3	ST750036-3
CL-7	DEUTSCH	1	Beacon lamp	DT06-2S	DT04-2P
CL-14	AMP	3	Front turn lamp-RH	936187-3	-
CL-14A	AMP	3	Front turn lamp-LH	936187-3	-
CL-15	DAEDONG	6	Combination lamp-LH	110-6PR	-
CL-16	DAEDONG	6	Combination lamp-RH	110-6PR	-
CL-21	KET	2	License lamp	ST730018-3	ST750036-3
CL-23	DAEDONG	2	Working lamp	110-2PR	-
CL-30	-	4	Engine check	21HN-56320	-
Relay					
CR-5	OMRON	5	Neutral relay	21HN-55510	-
CR-11	KET	3	Flasher unit relay	312_GIHUNG_3P	-
CR-13	OMRON	5	Head lamp relay	21HN-55510	-
CR-23	AMP	4	Starter relay	21HN-55520	-
CR-24	AMP	4	Glow relay	21HN-55520	-
CR-45	OMRON	5	Engine governor (1G)	21HN-55510	-
CR-50	OMRON	5	Travel cut relay	21HN-55510	-
CR-51	OMRON	5	Attach cut relay	21HN-55510	-
CR-52	OMRON	5	Brake lamp relay	21HN-55510	-
CR-56	OMRON	5	Auto park relay	21HN-55510	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
Sensor and pressure switch					
CD-2	KET	3	Fuel level sensor	MG610327	-
CD-4	DEUTSCH	4	Brake oil pressure sensor	DT06-4S	-
CD-6	DEUTSCH	4	G-sensor (Mast agnle)	DT06-4S	-
CD-8	AMP	1	Temp sender (For MCU)	171809-2	-
CD-10	KET	1	Air cleaner switch	ST730057-2	-
CD-18	AMP	1	Engine oil pressure sensor	171809-2	-
CD-26	AMP	1	Parking pressure switch	171809-2	-
CD-29	DEUTSCH	4	T/M oil PS/temp sensor	DT06-4S	-
CD-50	DEUTSCH	3	Load sensor	DTM06-3S	-
CD-59	KET	2	Brake oil level	MG610320	-
CD-73	AMP	3	Speed sensor	85205-1	-
Diode					
DO-01	QPL	-	Diode	21E-50550	-
DO-02	QPL	-	Diode	21E-50550	-

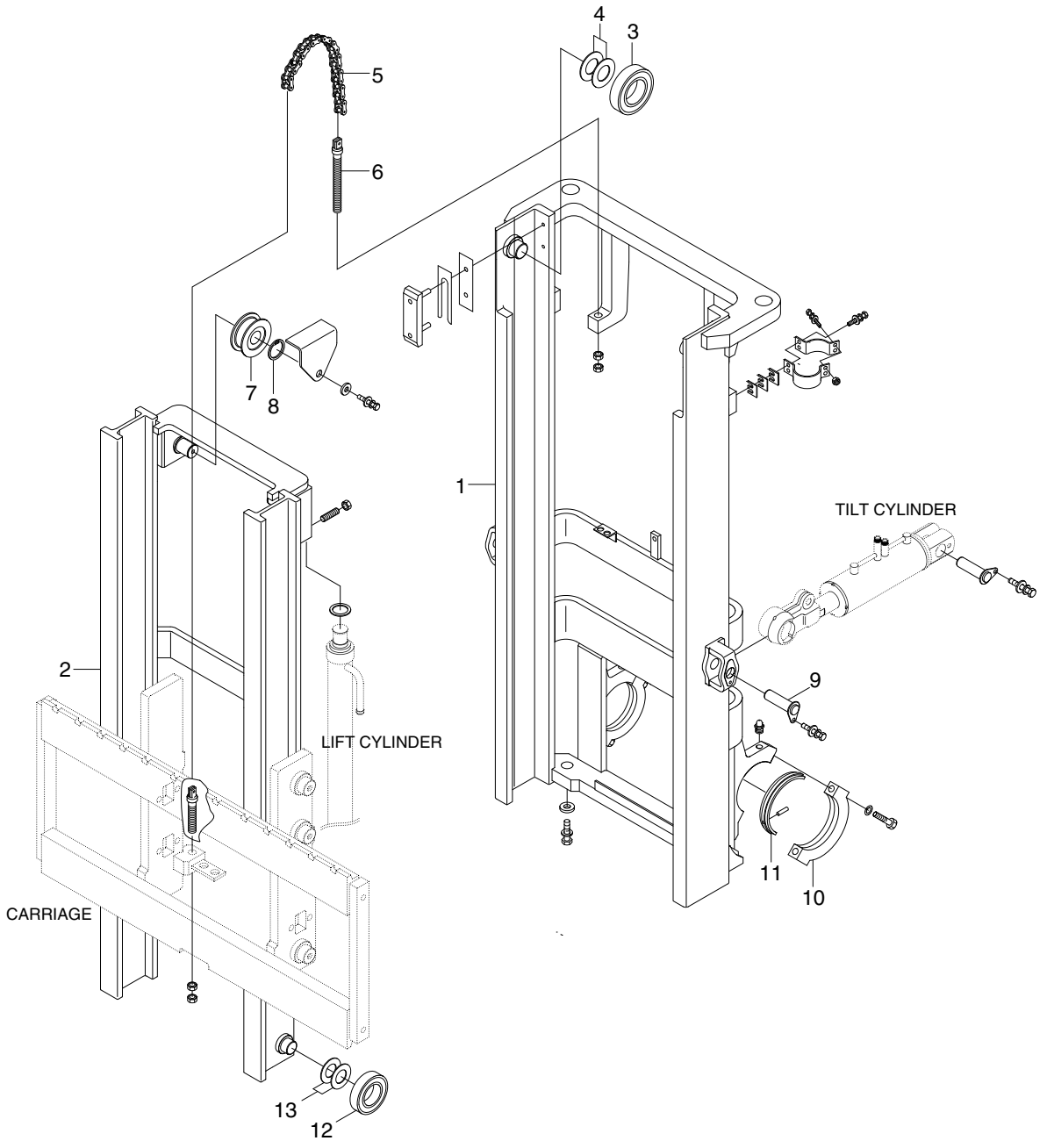
Trouble symptom	Probable cause	Remedy
Lamps dimming even at maximum engine speed.	· Faulty wiring.	· Check for loose terminal and disconnected wire.
Lamps flicker during engine operation.	· Improper belt tension.	· Adjust belt tension.
Charge lamp does not light during normal engine operation.	· Charge lamp defective. · Faulty wiring.	· Replace. · Check and repair.
Alternator makes abnormal sounds.	· Alternator defective.	· Replace
Starting motor fails to run.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Starting motor pinion repeats going in and out.	· Insufficient battery voltage.	· Recharge battery.
Excessively low starting motor speed.	· Insufficient battery voltage. · Starting motor defective.	· Recharge battery. · Replace
Starting motor comes to a stop before engine starts up.	· Faulty wiring. · Insufficient battery voltage.	· Check and repair. · Recharge battery.
Heater signal does not become red.	· Faulty wiring. · Glow plug damaged.	· Check and repair. · Replace
Engine oil pressure caution lamp does not light when engine is stopped (with starting switch left in"ON" position).	· Caution lamp defective. · Caution lamp switch defective.	· Replace · Replace

SECTION 8 MAST

Group 1 Structure 8-1
Group 2 Operational Checks and Troubleshooting 8-5
Group 3 Adjustment 8-8
Group 4 Removal and Installation 8-11

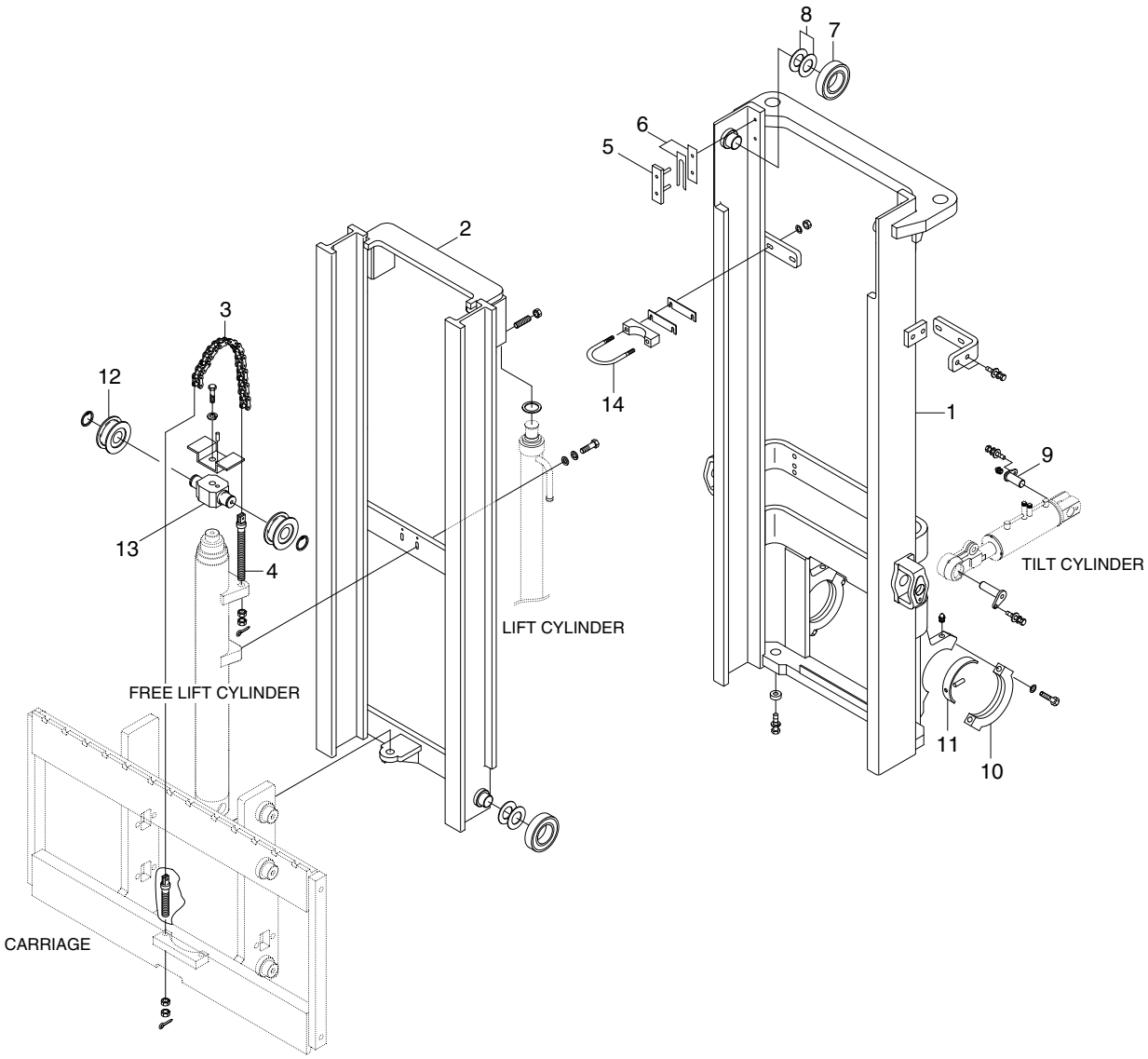
GROUP 1 STRUCTURE

1. 2 STAGE MAST (V MAST)



1	Outer mast	6	Anchor bolt	11	Bushing
2	Inner mast	7	Chain wheel bearing	12	Roller
3	Roller	8	Retaining ring	13	Shim (0.5, 1.0t)
4	Shim (0.5, 1.0t)	9	Tilt cylinder pin		
5	Chain	10	Trunnion cap		

2. 2 STAGE MAST (VF MAST)



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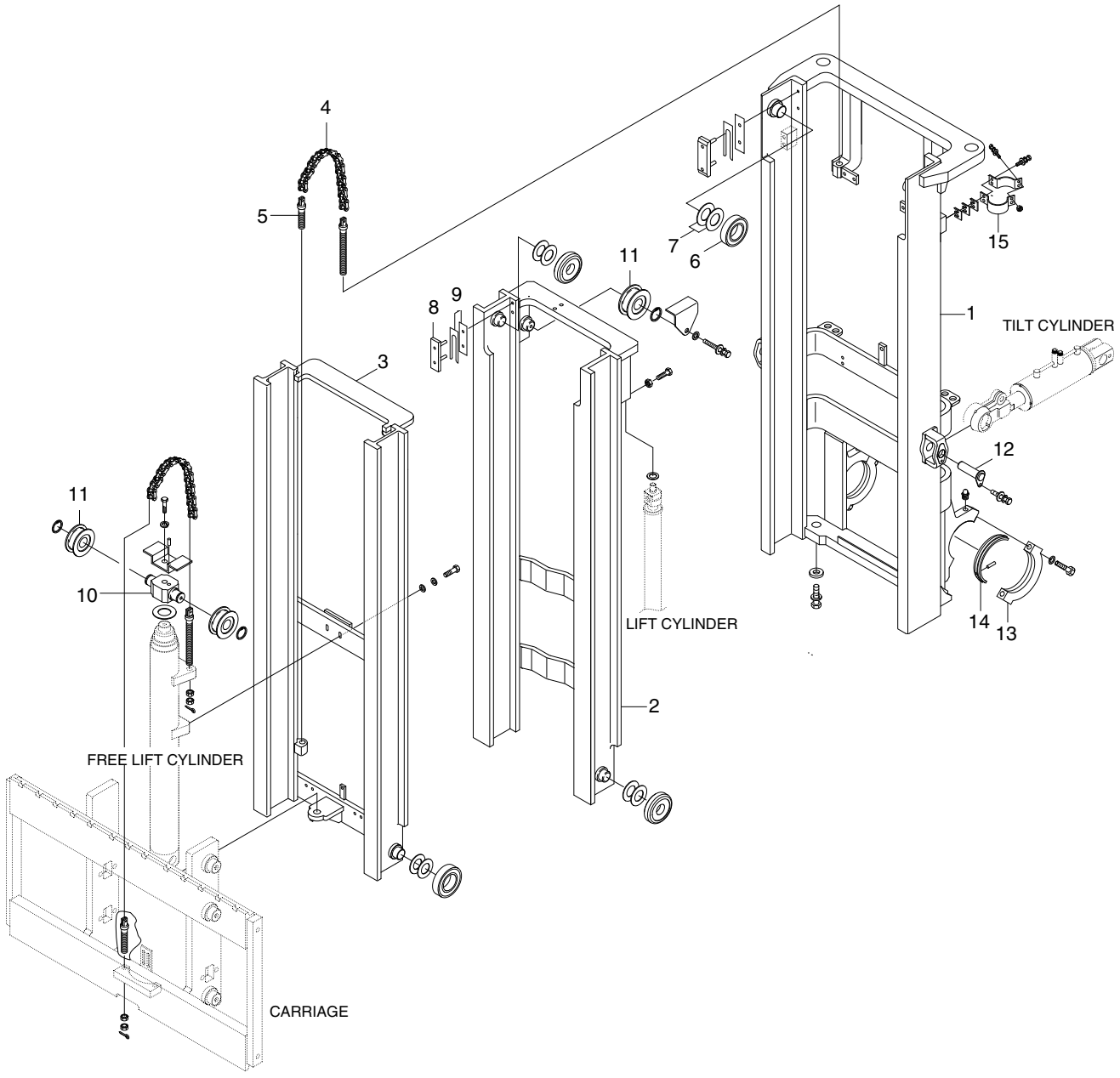
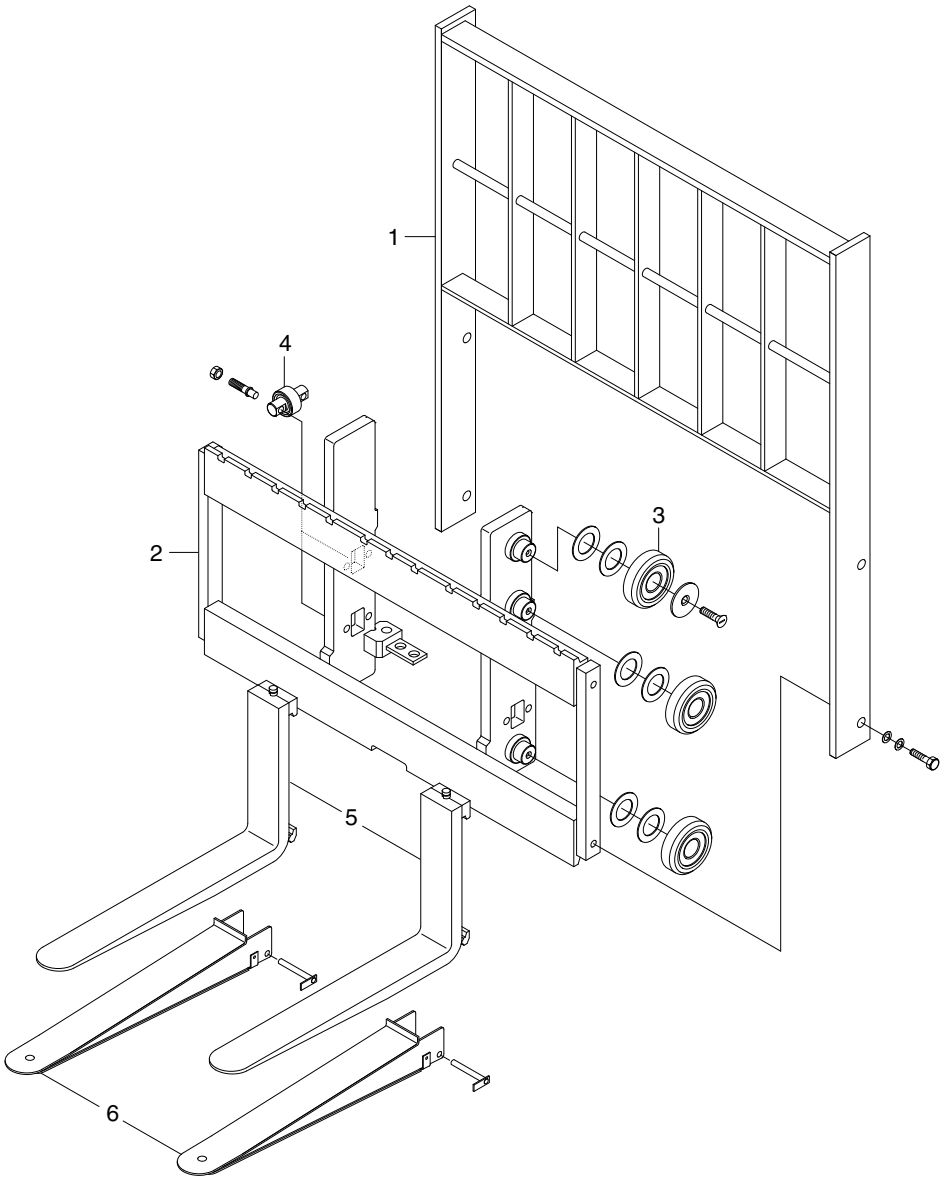
1	Outer mast	6	Shim (0.5, 1.0t)	11	Bushing
2	Inner mast	7	Roller	12	Sheave
3	Chain	8	Shim (0.5, 1.0t)	13	Sheave bracket
4	Anchor bolt	9	Tilt cylinder pin	14	U-bolt
5	Back up liner	10	Support cap		

3. 3 STAGE MAST (TF MAST)



1	Outer mast	6	Roller	11	Sheave
2	Middle mast	7	Shim (0.5, 1.0t)	12	Tilt cylinder pin
3	Inner mast	8	Back up liner	13	Support cap
4	Chain	9	Shim (0.5, 1.0t)	14	Bushing
5	Anchor bolt	10	Sheave bracket	15	Clamp

4. CARRIAGE, BACKREST AND FORK



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1	Backrest	3	Load roller	5	Fork assembly
2	Carriage	4	Side roller	6	Extension fork

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

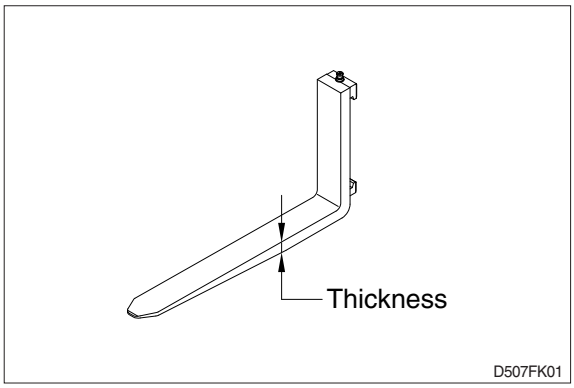
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
EX : ℓ = 1050 mm (41.3 in)

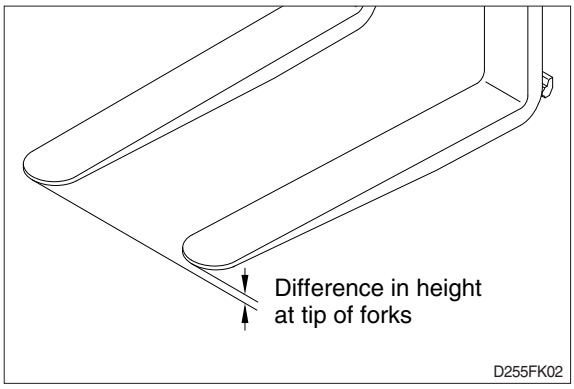
mm (in)

STD Fork assy	Applicable model	Standard	Limit
64HN-21030	22/25D-9S	45 (1.8)	40 (1.6)
64HN-31020	30/33D-9S	45 (1.8)	40 (1.6)



(2) Set forks in middle and measure out of parallel and difference in height at top of forks.

Model	Fork length (mm)	Height difference (mm)
22/25/30/ 33D-9S	equal or below 1500	3
	above 1500	4



(3) Most force is concentrated at root of fork and at hook, so use crack detection method to check cracks.

2. MAST

1) Check for cracks at mast stay, tilt cylinder bracket, guide bar, fork carriage and roller shaft weld. Check visually or use crack detection method. Repair any abnormality.
2) Set mast vertical, raise forks about 10cm from ground and check front-to-rear clearance and left-to-right clearance between inner mast and fork carriage, and between outer mast and inner mast. Use these figures to judge if there is any play at roller or rail.
   · Front-to-rear clearance : Within 2.0 mm (0.08 in)
   · Left-to-right clearance : Within 2.5 mm (0.10 in)
3) Check that there is an oil groove in bushing at mast support.
4) Set mast vertical, raise forks about 10cm from ground, and push center of lift chain with finger to check for difference in tension.
   If there is any difference in tension, adjust chain stopper bolt.
5) Check visually for abnormalities at thread of chain anchor bolt, and at contact surface between chain wheel and chain.
   Rotate chain wheel by hand and check for any play of bearing.

2. TROUBLESHOOTING

1) MAST

Problem	Cause	Remedy
Forks fail to lower.	· Deformed mast or carriage.	· Disassemble, repair or replace.
Fork fails to elevate	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Slow lifting speed and insufficient handling capacity.	· Faulty hydraulic equipment. · Deformed mast assembly.	· See troubleshooting hydraulic pump and cylinders in section 6, hydraulic system. · Disassemble mast and replace damaged parts or replace complete mast assembly.
Mast fails to lift smoothly.	· Deformed masts or carriage. · Faulty hydraulic equipment. · Damaged load and side rollers. · Unequal chain tension between LH & RH sides. · LH & RH mast inclination angles are unequal. (Mast assembly is twisted when tilted)	· Disassembly, repair or replace. · See Troubleshooting Hydraulic Cylinders, pump and control valve in section 6, hydraulic system. · Replace. · Adjust chains. · Adjust tilt cylinder rods.
Abnormal noise is produced when mast is lifted and lowered.	· Broken load roller bearings. · Broken side roller bearings. · Deformed masts. · Bent lift cylinder rod. · Deformed carriage. · Broken sheave bearing.	· Replace. · Replace. · Disassemble, repair or replace. · Replace. · Replace. · Replace.
Abnormal noise is produced during tilting operation.	· Insufficient lubrication of anchor pin, or worn bushing and pin. · Bent tilt cylinder rod.	· Lubricate or replace. · Replace.

2) FORKS

<table>
<tr><th>Problem</th><th>Cause</th><th>Remedy</th></tr>
<tr><td>Abrasion</td><td>Long-time operations causes the fork to wear and reduces the thickness of the fork.
Inspection for thickness is needed.
· Wear limit : Must be 90% of fork thickness</td><td>If the measured value is below the wear limit, replace fork.</td></tr>
<tr><td>Distortion</td><td>Forks are bent out of shape by a number of reasons such as overloading, glancing blows against walls and objects, and picking up load unevenly.
· Difference in fork tip height
<table><tr><th>Fork length (mm)</th><th>Height difference (mm)</th></tr><tr><td>equal or below 1500</td><td>3</td></tr><tr><td>above 1500</td><td>4</td></tr></table></td><td>If the measured value exceeds the allowance, replace fork.</td></tr>
<tr><td>Fatigue</td><td>Fatigue failure may result from the fatigue crack even though the stress to fork is below the static strength of the fork. Therefore, a daily inspection should be done.
· Crack on the fork heel.
· Crack on the fork weldments.</td><td>Repair fork by expert.
In case of excessive distortion, replace fork.</td></tr>
</table>

1. MAST LOAD ROLLER (V, VF MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

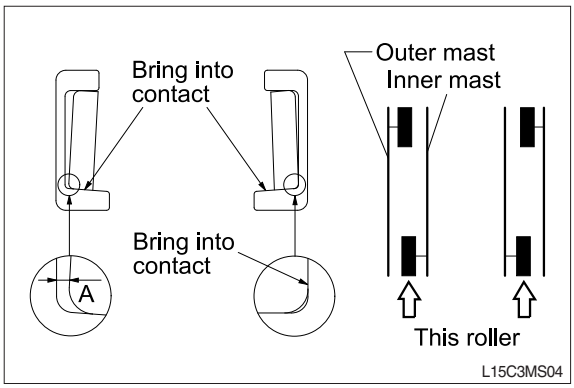
(1) Measure the clearance with the mast overlap at near 480 mm.

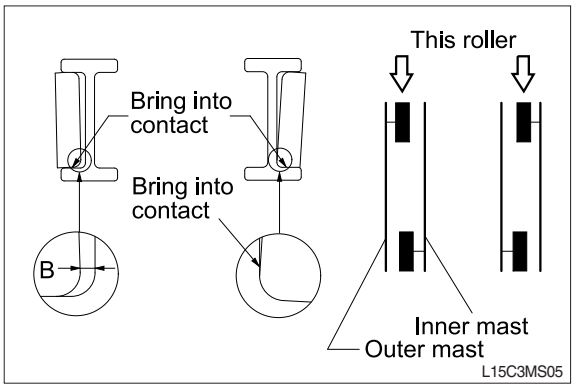
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner/outer mast roller shim.

- Standard clearance A, B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

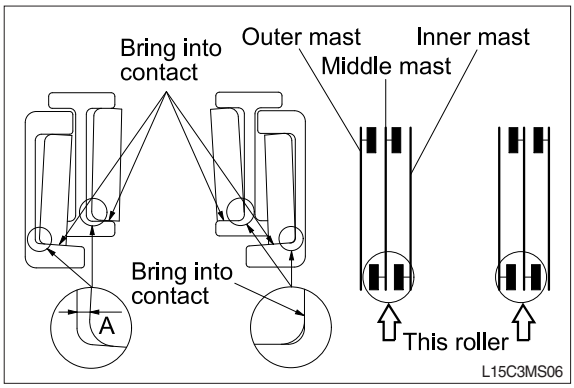
(4) After the adjustment, check that the inner mast moves smoothly in the outer mast.





2. MAST LOAD ROLLER (TF MAST)

1) INNER AND MIDDLE MAST ROLLER CLEARANCE ADJUSTMENT



(1) Measure the clearance with the mast overlap at near 480 mm.

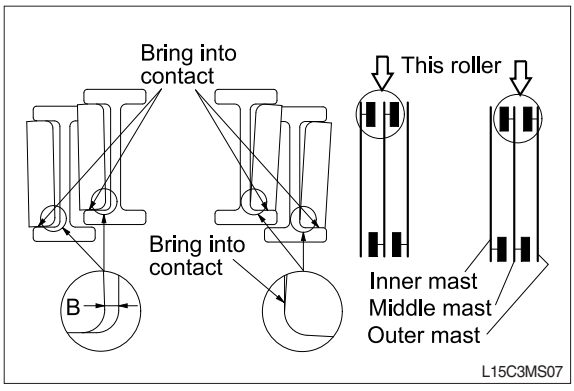
(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the inner and middle mast roller shim, respectively.

- Standard clearance A = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

2) OUTER AND MIDDLE MAST UPPER ROLLER CLEARANCE ADJUSTMENT.



(1) Measure the clearance with the mast overlap at near 480 mm.

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and the middle mast, and adjust the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the outer and middle mast roller shim, respectively.

- Standard clearance B = 0~0.6 mm
- Shim thickness 0.5, 1.0 mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Mast load roller and back up liner, removal and Installation.

(4) After the adjustment, check that the inner mast moves smoothly in the middle mast, and the middle mast moves smoothly in the outer mast.

3) CARRIAGE LOAD ROLLER

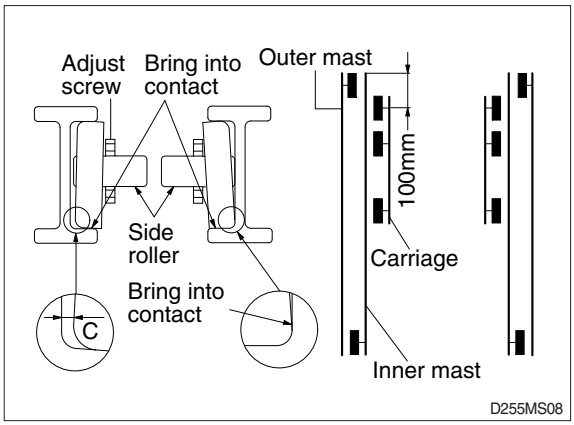
(1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.

(2) Measure the clearance at upper, middle and lower rollers after loosen the adjust screws from the side rollers. Shift the carriage to one side to bring the roller into contact with the inner mast, and measure the clearance between the roller side face and mast at the closest position on the opposite side to the following value by inserting the carriage roller shim.

- Standard clearance C = 0~0.6mm
- Shim thickness 0.5, 1.0mm

(3) Distribute the shim thickness equally to the left and right roller. Refer to Carriage assembly.

(4) After the adjustment, the carriage should move smoothly along the overall mast length.



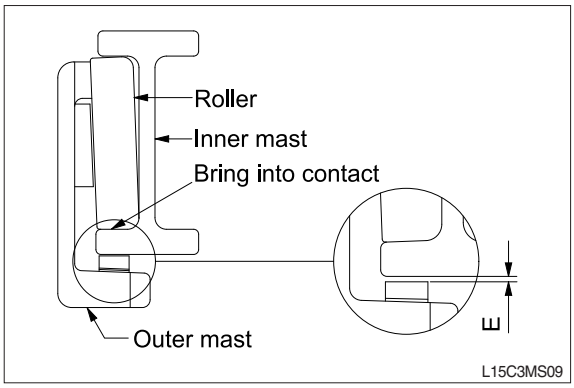
4) MAST BACK UP LINER

(1) Measure the clearance with the middle mast at the bottom position.

(2) With the middle mast in contact with the outer mast roller, adjust the clearance between the mast back up liner and middle mast to the following value by inserting the back up liner shim.

- Standard clearance E = 0.2 ~ 0.6 mm
- Shim thickness 0.5, 1.0 mm

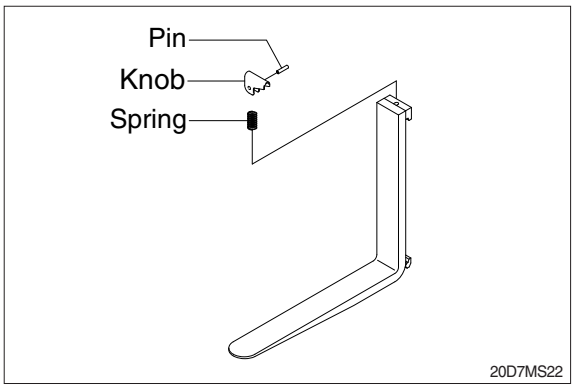
(3) After the adjustment, the mast should move smoothly.



GROUP 4 REMOVAL AND INSTALLATION

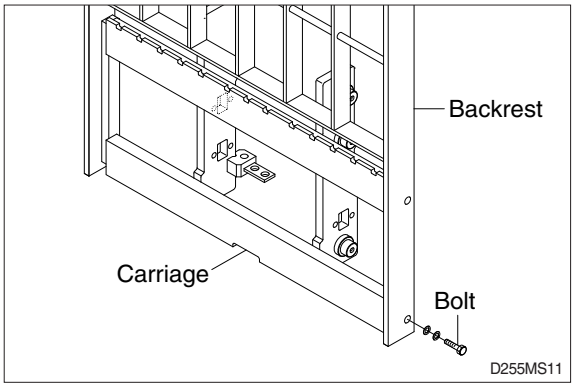
1. FORKS

1) Lower the fork carriage until the forks are approximately 25 mm (1 inch) from the floor.
2) Turn the knob up and slide forks, one by one, toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
3) Remove the fork one by one. On larger forks it may be necessary to use a block of wood.
4) Reverse the above procedure to install load forks.



2. BACKREST

1) Remove bolts securing backrest to fork carriage. Disassemble the backrest from the carriage.
2) Position backrest on carriage and lower in place. Install and tighten bolts.



3. CARRIAGE ASSEMBLY

1) CARRIAGE

(1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast is raised.
(2) While supporting lift chains, remove the split pin and slide out chain anchor pins from the chain anchors of stationary upright.
(3) Pull the chains out of the sheaves and drape them over the front of the carriage.
(4) Slowly raise elevating upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

⚠ Make sure carriage remains on floor and does not bind while mast is being raised.

(5) Inspect all parts for wear or damage. Replace all worn or damaged pars.
(6) Reverse the above steps to reinstall.

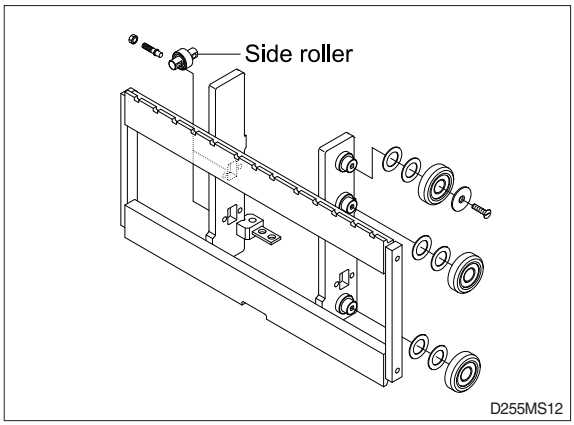
⚠ Replace the split pin of chain anchor with new one.

2) SIDE ROLLER

(1) Remove carriage as outlined in the carriage assembly and removal paragraph.
(2) Loosen and remove nuts, adjust screws and side rollers from carriage side pate.
(3) Thoroughly clean, inspect and replace all worn or damaged parts.
(4) Reverse the above procedure to assembly.

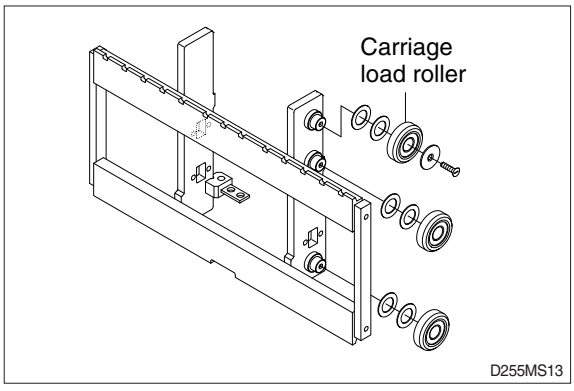
※ **Adjustment**

- Once carriage is properly installed, loosen nuts and adjust screws, (if not already done) allowing carriage to be centered in the inner mast.
- Adjust side roller by tightening screw until side roller just makes contact with mast.
  Back off approximately 1/10 turn on screw and tighten nut to lock screw in place.
- Run carriage up and down for the inner mast to be sure the carriage has free movement and does not stick. Also, make sure chains are properly adjusted.
  Refer to chain adjustment paragraph.
  Make adjustment when necessary and recheck operation of carriage.



3) CARRIAGE LOAD ROLLER

(1) Remove carriage as outlined in the carriage assembly removal paragraph.
(2) Loosen and remove flat head bolts and plain washers from top load roller bracket.
(3) Using a pryer, remove load rollers from load roller bracket.
(4) Reverse the above procedure to assemble.
  Refer to MAST ROLLER ADJUSTMENT paragraph.



4) MAST LOAD ROLLER AND BACK UP LINER

(1) 2 stage mast (V mast)

① Remove the carriage assembly and move them to one side.

② Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.

③ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.

④ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.

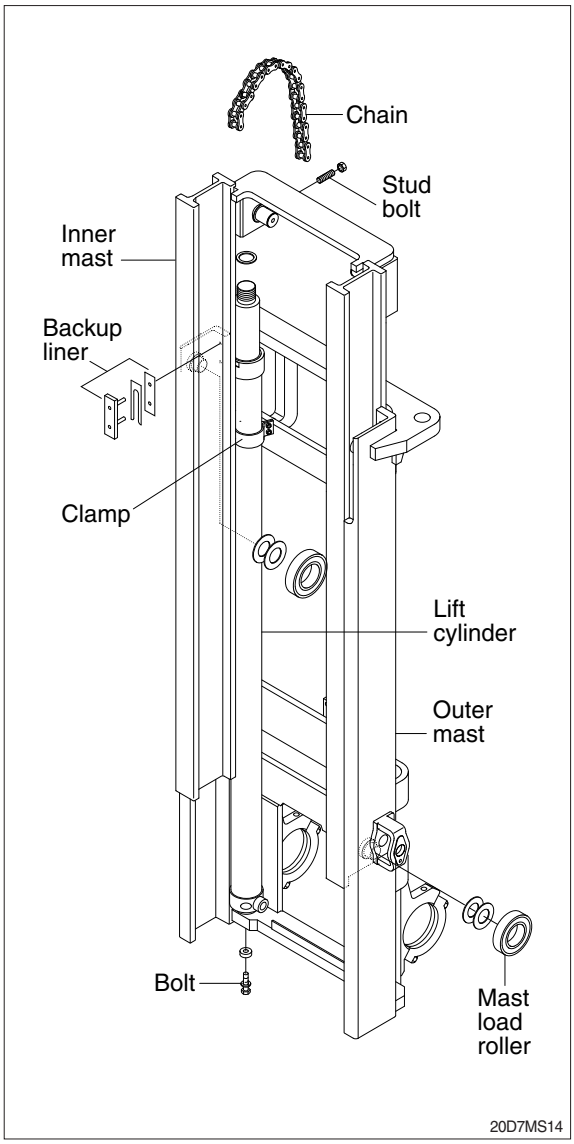
⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.

⑥ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.

⑦ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.

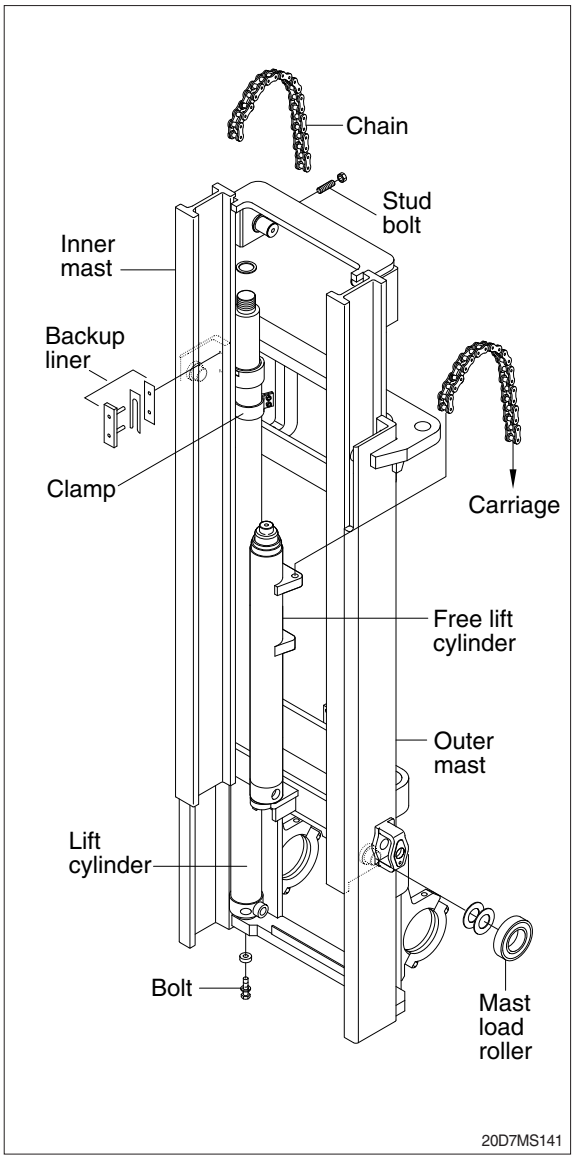
⑧ Thoroughly clean, inspect and replace all worn or damaged parts.

⑨ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 2 stage mast (TF mast)

① Remove free lift chain connected between carriage and free lift cylinder.
② Remove the carriage assembly and move them to one side.
③ Loosen and remove hexagon bolts and washers securing lift cylinders to inner mast.
④ Loosen and remove hexagon bolts and nuts securing lift cylinders to inner mast.
⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist, slowly raise the inner mast high enough to clear lift cylinder.
⑥ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and them with ropes to the outer mast.
⑦ Using the overhead hoist, lower inner mast until top and bottom rollers and back up liners are exposed.
⑧ Using a pryer, remove load rollers from load roller bracket. Remove back up liners and shims.
⑨ Thoroughly clean, inspect and replace all worn or damaged parts.
⑩ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



(2) 3 stage mast (TF mast)

① Remove the carriage assembly and move to one side.

② Loosen and remove hexagon bolt securing bottom cylinder from outer mast.

③ Loosen and remove bolts and special washers securing lift cylinders to middle mast.

④ Attach chains or sling to the inner and middle mast section at top crossmember. Using an overhead hoist, slowly raise the uprights high enough to clear lift cylinder.

⑤ After lowering the lift cylinder rods, and disconnecting lift cylinder hose, tilt the lift cylinders LH and RH and tie them with ropes to the outer mast.

⑥ Using the overhead hoist raise inner and middle masts. Place 4 inch block of wood under the free lift cylinder bracket of the inner mast then lower mast sections (this will create slack in the chains).

⑦ Remove retaining rings securing chain sheaves to sheave support brackets. While support chains, remove chain sheaves and let chains hang free. The upper outer and lower middle mast rollers and back up liners are now exposed.

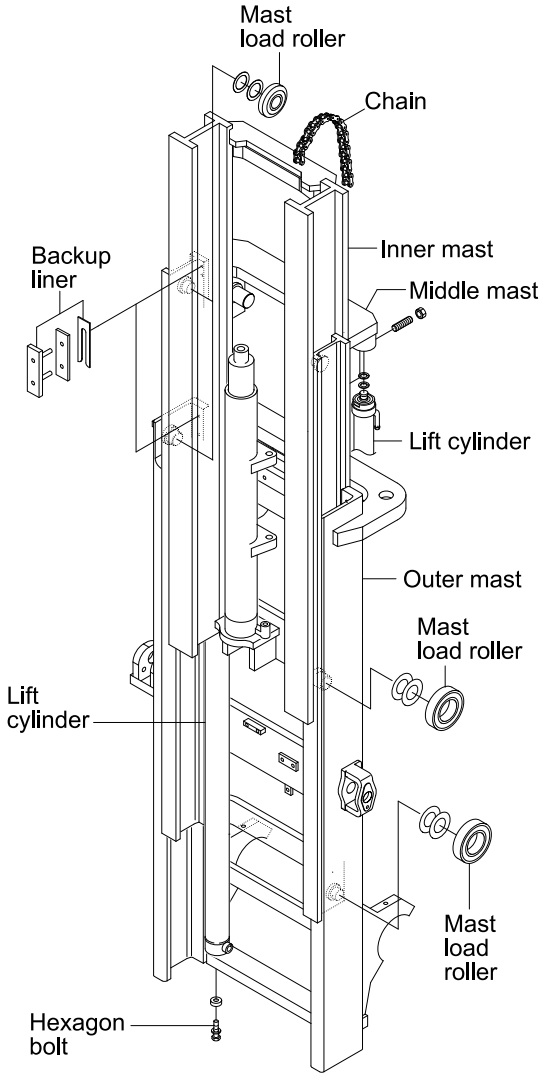
⑧ Using a pryer, remove load rollers from load bracket. Remove back up liners and shims.

⑨ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist, slowly raise the middle mast until top and bottom rollers are exposed.

⑩ Using a player, remove load rollers from load roller bracket.

⑪ Thoroughly clean, inspect and replace all worn or damaged parts.

⑫ Reverse the above procedure to assemble. Refer to MAST LOAD ROLLER ADJUSTMENT paragraph.



5) ELEVATING MAST

(1) Inner mast (V, VF mast)

① After completing all necessary steps for load rollers and back up liner removal use an overhead hoist and sling or chain around upper crossmember of the inner mast section.

② Lift inner mast upright straight up and out of outer mast section.

③ Replace and reverse above procedure to install. Make all necessary measurements and adjustments.

(2) Inner and middle mast (TF mast)

① After completing all necessary steps for load rollers and back up liner removal. Remove rear chains and sheave support if not already done.

② Disconnect free lift cylinder hose. Drain hose into a suitable pan or container and cap hose.

③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.

④ Place a sling around free lift cylinder and attach to an overhead hoist. Slowly raise and move cylinder to one side.

⑤ Attach chains or sling to the inner mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of middle mast section.

⑥ Attach chains or sling to the middle mast section at top crossmember. Using an overhead hoist slowly raise the upright straight up and out of outer mast section.

⑦ Replace upright and reverse above procedure to install. Make all necessary measurements and adjustments.

6) CHAIN

(1) Chain sheave (V, VF mast)

① Place a sling around carriage and attach to an overhead hoist. Lift carriage high enough so that the tension on the chain over sheaves is relieved after the carriage is blocked. Position wooden blocks under the carriage and lower it.

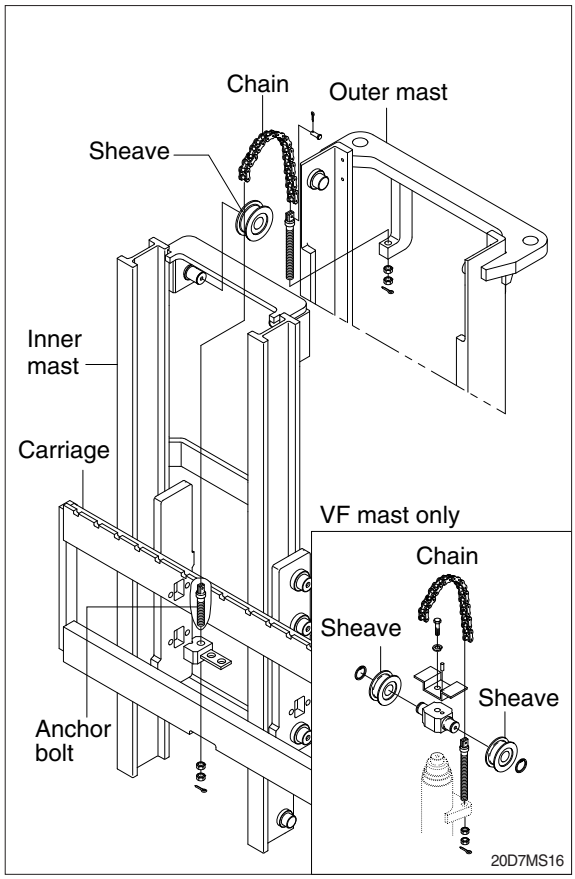
② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chains over the carriage.

③ Remove retaining ring securing sheaves to sheave support. Remove sheaves with bearings.

④ Remove bearing retaining ring from sheave and press bearings from sheaves.

⑤ Thoroughly clean, inspect and replace all worn or damaged parts.

⑥ Reverse the above to assemble and install.



(2) Rear chain sheave (TF mast)

① Raise and securely block carriage and inner mast section.

② Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins from outer mast section.

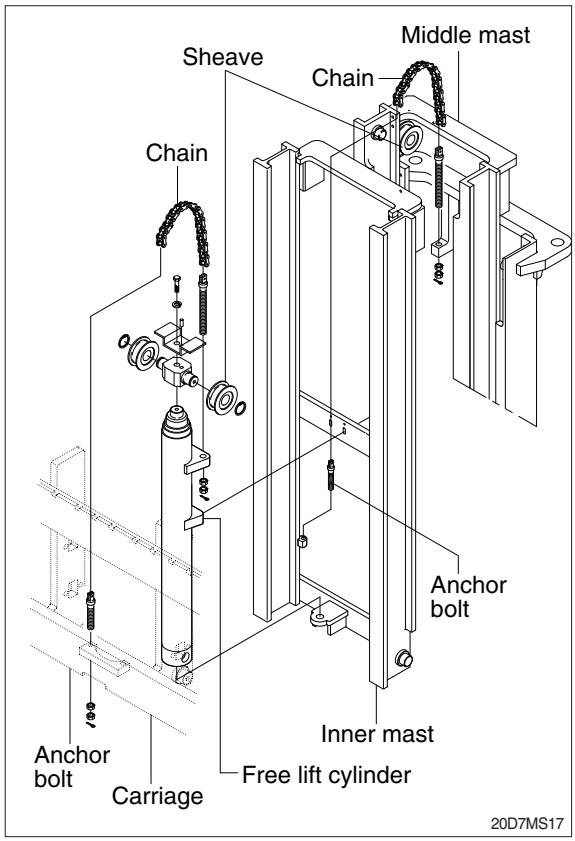
③ Remove chains.

④ Remove retaining ring securing chain sheaves to sheave support. Pry off sheaves with bearings.

⑤ Remove bearing retaining ring from sheave and press bearings from sheaves.

⑥ Thoroughly clean, inspect and replace all worn or damaged parts.

⑦ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins.



(3) Chain wheel bearing support (TF mast)

① Remove the carriage assembly and move to one side.
② After removing bolt to securing chain wheel bearing support assembly to free lift cylinder.
After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.
③ Remove retaining ring securing chain wheel bearing to chain wheel bearing support.
④ Remove bearing retaining ring from chain wheel bearing and press bearings from chain wheel bearings.
⑤ Thoroughly clean, inspect and replace all worn or damaged parts.
⑥ Reverse the above procedure to install.

(4) Rear chain (TF mast)

① Remove the carriage assembly and move to one side. Refer to carriage removal and installation.
② Raise and securely block truck approximately 6 inches from the floor.
③ Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.
④ Remove split pins and chain anchor pins securing chains to chain anchor(part of inner mast).
⑤ While supporting the chains, remove split and chain anchor pins securing chains to chain anchors attached to outer mast section.
⑥ Remove chains.
⑦ Reverse the above to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(5) Carriage chain

① Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.
② Place a wooden block under the carriage and lower the carriage on the block.
③ While supporting the chains, remove split pins and chain anchor pins from chain anchors.
④ Remove chains and wash them with solvent. Refer to this section for Load chain inspection and maintenance.
⑤ Reverse the above procedure to assemble and install. Use new split pins in chain anchor pins. Refer to this section for Load chain lubrication and adjustment.

(6) Load chain inspection and maintenance

After every 200 hours of truck operation, lift chains should be inspected and lubricated inspect for the following chain conditions :

① Wear

As the chain flexes on and off the chain wheel bearings, the joints very gradually wear. The stretch a chain developes in service is due to material being worn off pin outer diameter and pitch hole inner diameter on the inside plate.

Chain wear can be measured using a wear scale or steel tape. When chains have elongated 2%, they should be discarded. When checking chain wear, be sure to measure a segment of chain that operates over a sheave. Do not repair chains by cutting our the worn section and splicing in a new piece. If part of the chain is worn, replace all the chains on the truck.

② Rust and corrosion

Chains used on lift trucks are highly stressed precision components. It is very important that the "as-manufactured" ultimate strength and fatigue strength be maintained throughout the chain service life. Corrosion will cause a major reduction in the load-carrying capacity of lift chain or roller chain because corrosion causes side plate cracking.

③ Cracked plate

The most common cause of plate cracking is fatigue failure. Fatigue is a penomenon that affects most metals and many plastics. After many repeated heavy loads, the plates may crack and the chains will eventually break. Fatigue cracks are almost always found through the pitch holes perpendicular to the pitch line. Contrast this failure mode to the random failures caused by stress-corrosion cracking. If cracks are present, replace all the chain on the truck. Noise in the chain indicates that the plate is on the verge of cracking and will be failed before long.

④ Tight joints

All joints in lift chain should flex freely. Tight joints resist flexure, increase internal friction, thus increasing chain tension required to lift a given load. Increased tension accelerates wear and fatigue problems.

Tight joints in lift chains can be caused by :

- Bent pins or plates.
- Rusty joints.
- Peened plate edges.

Oil rusty chains and replace chains with bent or peened components.

⑤ Protruding or turned pins

Heavily loaded chains operating with lube generate tremendous friction between pins and plates.

In extreme cases, the frictional torque in the joint can actually turn pins in the press-fit outside plates. If chain is allowed to operate in this condition, the pins slowly work out of the chain causing chain failure. Turned pins can be quickly spotted because the flats on the V heads are no longer in line. Chains with turned or protruding pins should be replaced immediately. Do not attempt to repair the chain by driving pins back into the chain.

⑥ Chain side wear

A wear pattern on pin heads and outside plates indicates misalignment. This condition damages chain and sheaves as well as increasing internal friction in the chain system.

⑦ Chain anchors and chain wheel bearings

An inspection of the chain system includes a close examination of chain anchors and chain wheel bearings. Check chain anchors for wear, breakage and misalignment.

Anchors with worn or broken fingers should be replaced. Anchors should be adjusted to eliminate twisting or other misalignment in the chain. When chain is misaligned, load is not distributed uniformly between the plates. Prolonged operation will result in premature fatigue failure. Chain wheel bearings with badly worn flanges and outside diameter should be replaced.

Heavy flange wear indicates chain misalignment.

⑧ Chain wear scale

The chain can be checked for wear or stretching with the use of a chain wear scale. Stretching of a chain is due to the elongation of the pitch holes and wearing of the pin O.D. The greatest amount of stretching occurs at the areas of the chain that flex over the sheaves most frequently. Check the chain at this point with a scale. The wear scale has instructions printed on the sides for use in determining chain stretch and are as follows :

- Determine pitch length of chain using 6 inch scale on one side of wear scale.
- If pitch is 1/2(12.7㎜), 3/4(19.05㎜), 1(25.4㎜), 1-1/2(38.1㎜), 2(50.8㎜), use side A of scale.
- If pitch is 5/8(15.875㎜), 1-1/4(31.75㎜) or 2(50.8㎜), use side B.
- Align point A or B to center of a pin and note position of the opposite A or B point.
- If other point also lines up with a pin, the chain is worn and should be replaced.

If any of the above conditions exists(cracked plates, turned pins, stretching etc), the chains should be replaced in pairs as a complete assembly. Order chains by part number to insure the correct chain length, pitch and material specifications.

(7) Load chain lubrication and adjustment

① Lubrication

The most important consideration in field maintenance of lift chains is lubrication. Hard working, heavily loaded chains cannot be expected to give satisfactory wear life without scheduled periodic re-lubrication. Like all bearing surfaces, the precision manufactured, hardened steel, joint-wearing surfaces require a film of oil between mating parts to prevent rapid wear. Oil must penetrate the chain joint to prevent wear. Applying oil to external surfaces will prevent rust, but oil must flow into the live bearing surfaces for maximum wear life. Frequency of re-lube will vary with operating conditions and environment, the best estimate of lube period is 200 hours. Trucks parked outdoors or trucks in extremely severe service, may require more frequent re-lube to maintain an oil film on all chain surface.

- Wipe off the old oil with a clean cloth and blow out the remaining dirt with compressed air.

⚠ Wear eye protection.

- With a clean brush, apply EP-140 extreme pressure lubricant or heavy motor oil (40W).

② Replacement

Replace chains as a pair. It will be virtually impossible to maintain uniform loading between the strands if a new chain is put into service opposite an old chain. The jonts in the old chain will be greater than that on the new chain, greatly complicating the problem of maintaining equal chain tension. The new chain will wear more slowly causing it to bear the major portion of the load resulting in premature wear and fatigue failure. Don't steam clean or decrease new chains.

The manufacturer's grease is effective in reducing wear and corrosion. If the original factory lube is dried out or wiped off, soak the new chain in heavy engine oil for at 1/2 hour prior to installing on truck. After the old chains have been stripped from the mast, very carefully inspect chain anchors and chain wheel bearing. Broken, cracked or worn anchor must be replaced using the new anchor pin and split pin. Do not paint newly replaced chain after it has been installed.

③ Adjustment

Chain adjustments are important for the following reasons :

- Equal loading of chain.
- Proper sequencing of mast.
- Prevent over-stretching of chains.
- Prevent chains from jumping off sheaves if they are too loose.

④ Adjustment procedure

- With mast in its fully collapsed and vertical position, lower the fork to the floor.
- Adjust the chain length by loosening or tightening nut on the chain anchor.
  After making adjustment on the mast, be sure to tighten the nut.