SECTION 4 BRAKE SYSTEM

SECTION 4 BRAKE SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

※ The brakes are operated by a pressure compensated, closed center hydraulic system.
Flow is supplied by a fixed displacement, gear type brake pump.

BRAKE SYSTEM

The fixed displacement brake pump supplies flow to the cut-off valve for service brake circuit and park brake circuits. It flows to three accumulator. The accumulator has a gas precharge and an inlet check valve to maintain a pressurized volume of oil for reserve brake applications.

Oil through the accumulator flows to the brake valves. The brake valve is a closed center design, dual circuit operated by a pedal.

Brake pump flow also goes to the parking brake solenoid valve in cut off valve.

The brake system contains the following components:

- Brake pump
- Parking brake solenoid valve in cut off valve.
- Cut-off valve
- Brake valve
- Accumulators
- Pressure switches

FULL POWER HYDRAULIC BRAKE SYSTEM

ADVANTAGES - The full power hydraulic brake system has several advantages over traditional brake actuation systems. These systems are capable of supplying fluid to a range of very small and large volume service brakes with actuation that is faster than air brake systems. Figure represents a time comparison between a typical air/ hydraulic and full power hydraulic brake actuation system.

Full power systems can supply significantly higher brake pressures with relatively low reactive pedal forces. The reactive pedal force felt by the operator will be proportional to the brake line pressure being generated.

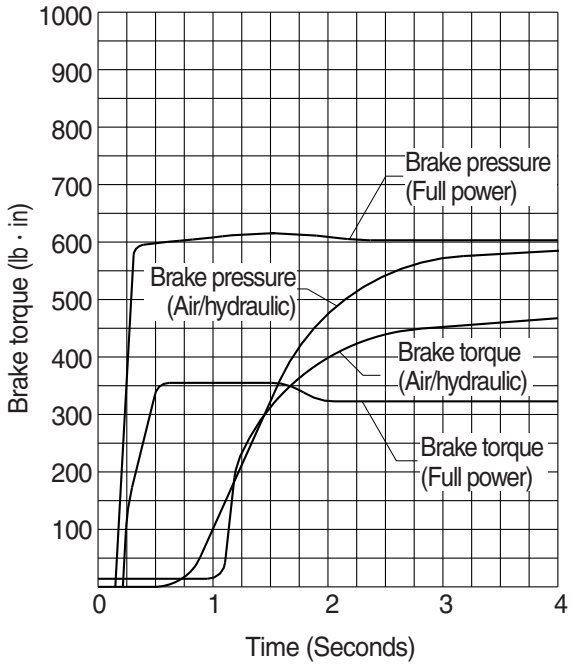
This is referred to as brake pressure modulation.

Another key design feature of full power systems is the ability to control maximum brake line pressure. In addition, because these systems operate with hydraulic oil, filtration can be utilized to provide long component life and low maintenance operation.

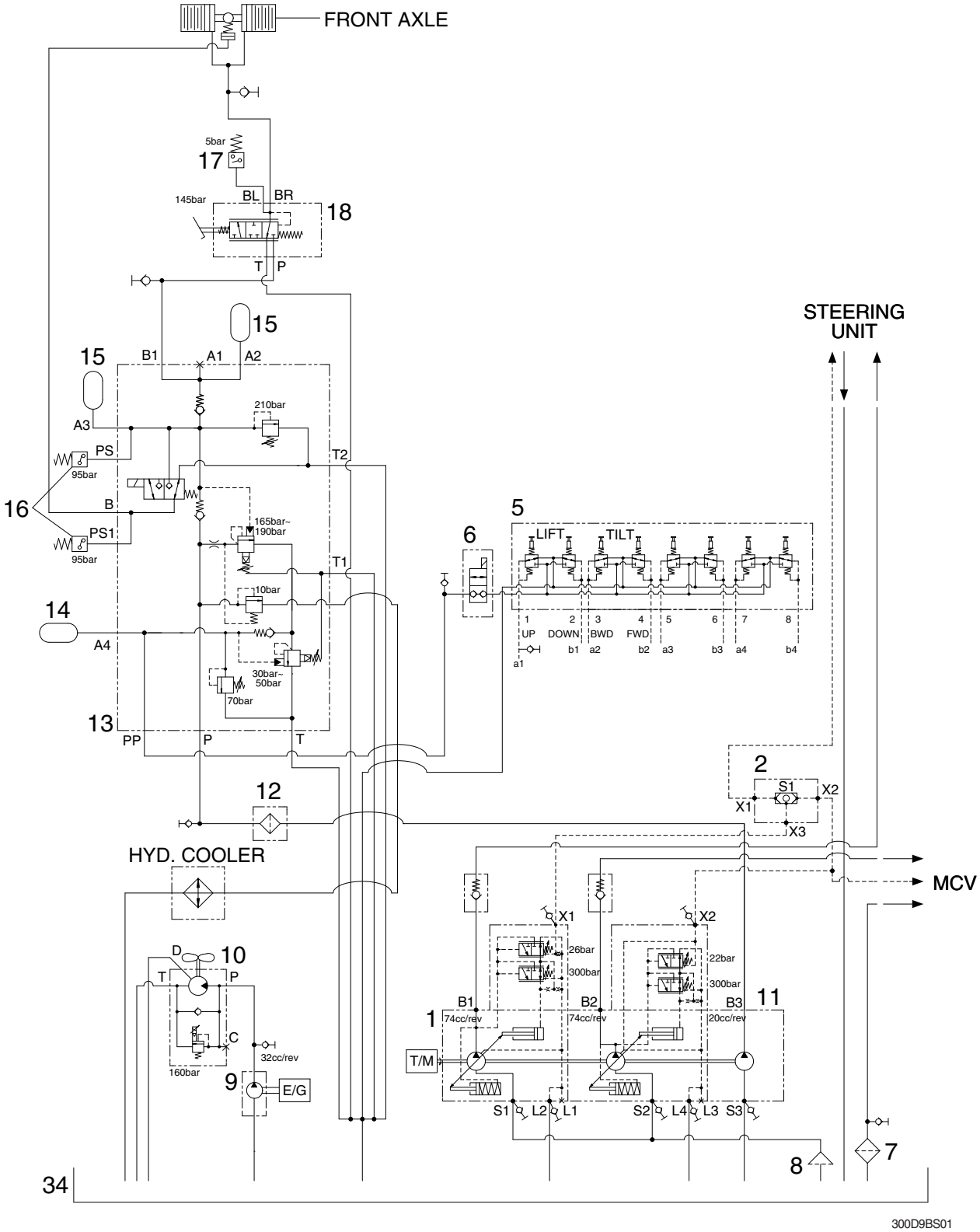
Because these systems are closed center, by using a properly sized accumulator, emergency power-off braking that is identical to power-on braking can be achieved. These systems can be either dedicated, where the brake system pump supplies only the demands of the brake system or non-dedicated, where the pump supplies the demands of the brake system as well as some secondary down stream hydraulic devise.

Another important note is that all seals within these system must be compatible with the fluid medium being used.

Response time
Full power brake actuation VS
Air/Hydraulic brake actuation



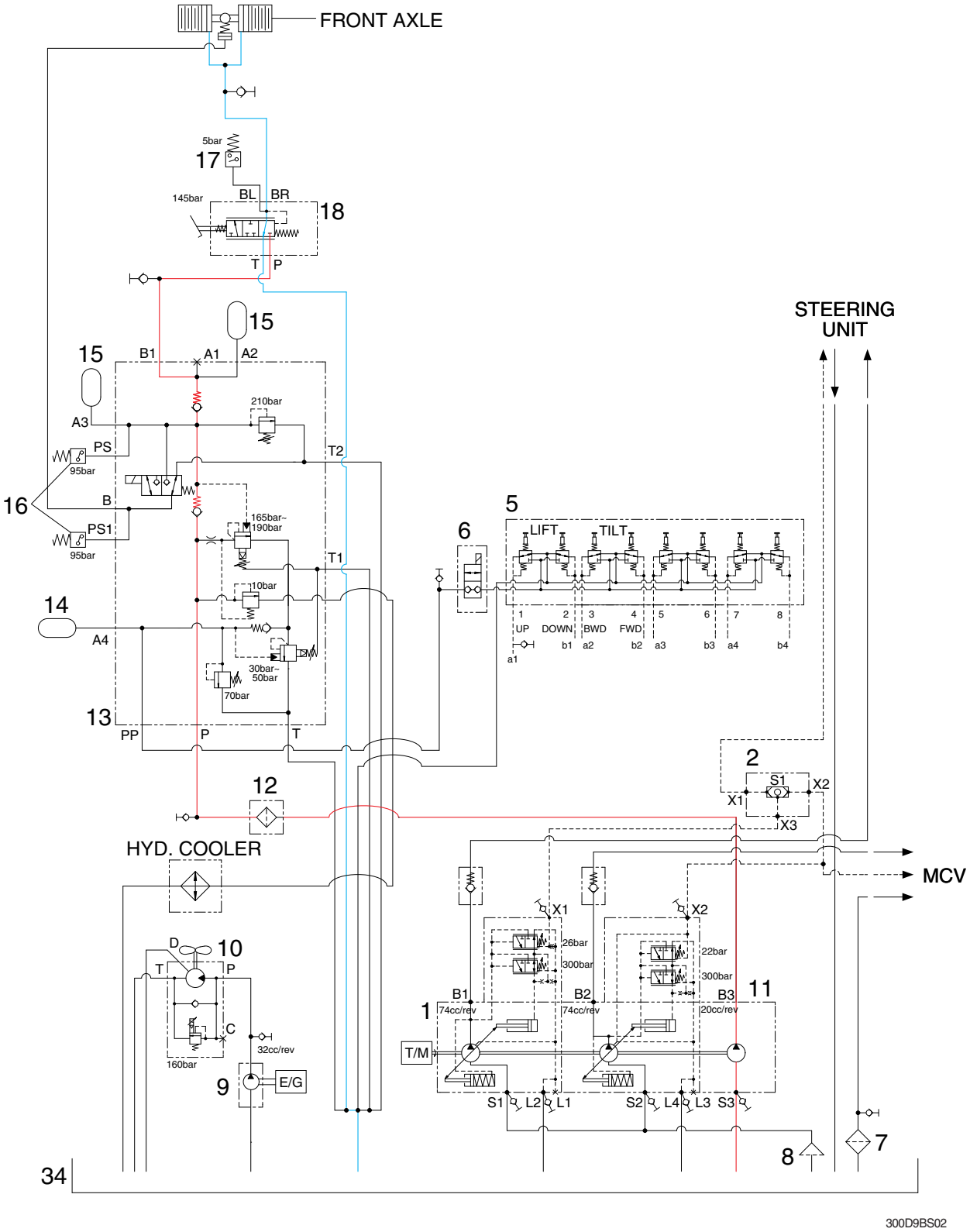
2. HYDRAULIC CIRCUIT



300D9BS01

1	Main pump	9	Fan drive pump	15	Accumulator
2	Shuttle valve	10	Fan drive motor	16	Pressure switch
5	RCV	11	Brake pump	17	Pressure switch
6	OPSS solenoid valve	12	Pressure filter	18	Brake valve
7	Return filter	13	Cut off valve	34	Hydraulic oil tank
8	Strainer	14	Accumulator		

1) SERVICE BRAKE RELEASED



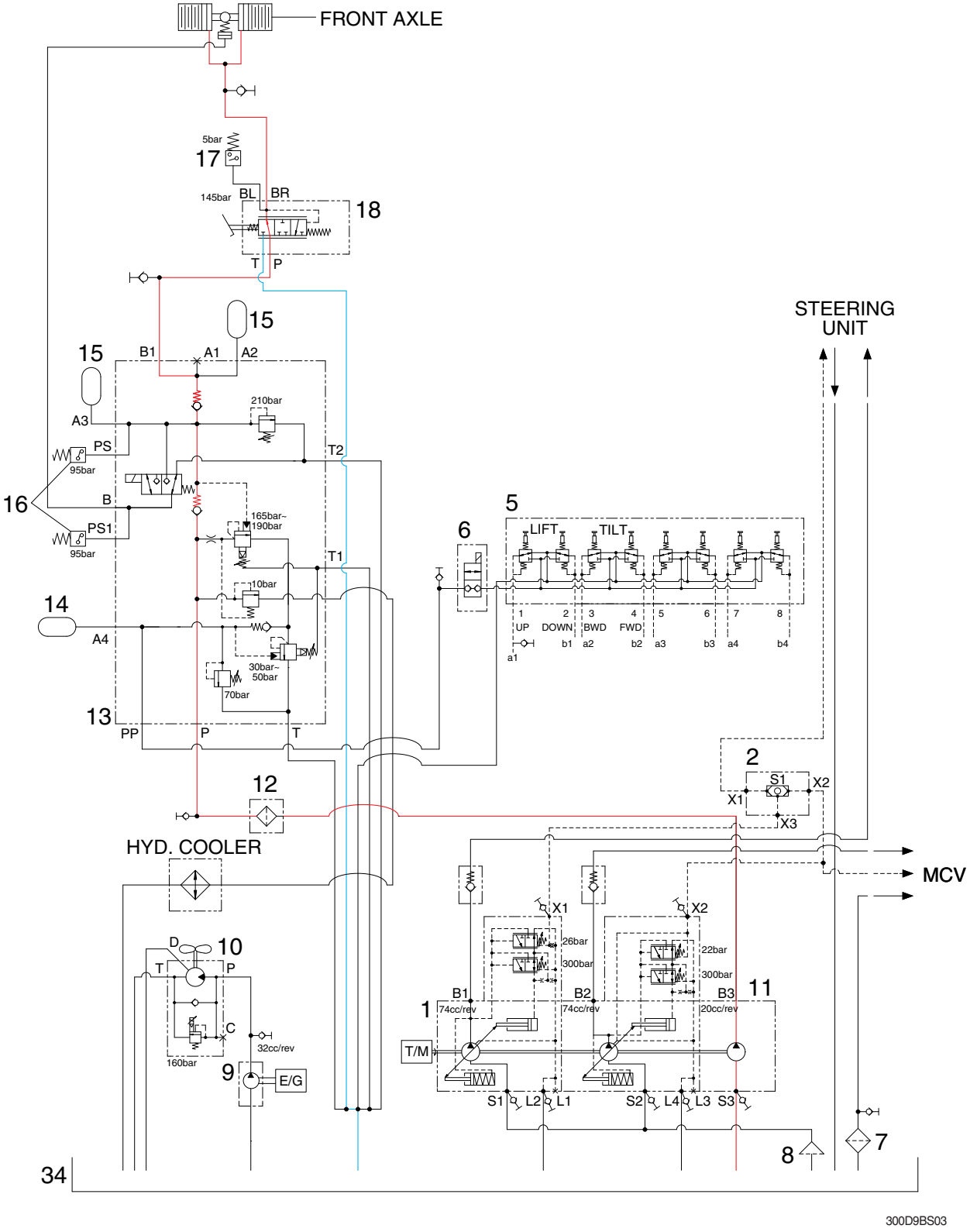
300D9BS02

When the pedal of brake valve (18) is released, the operating force is eliminated by the force of the spring, and the spool is returned.

When the spool removes up, the drain port is opened and the hydraulic oil in the piston of axles return to the tank (34).

Therefore, the service brake is kept released.

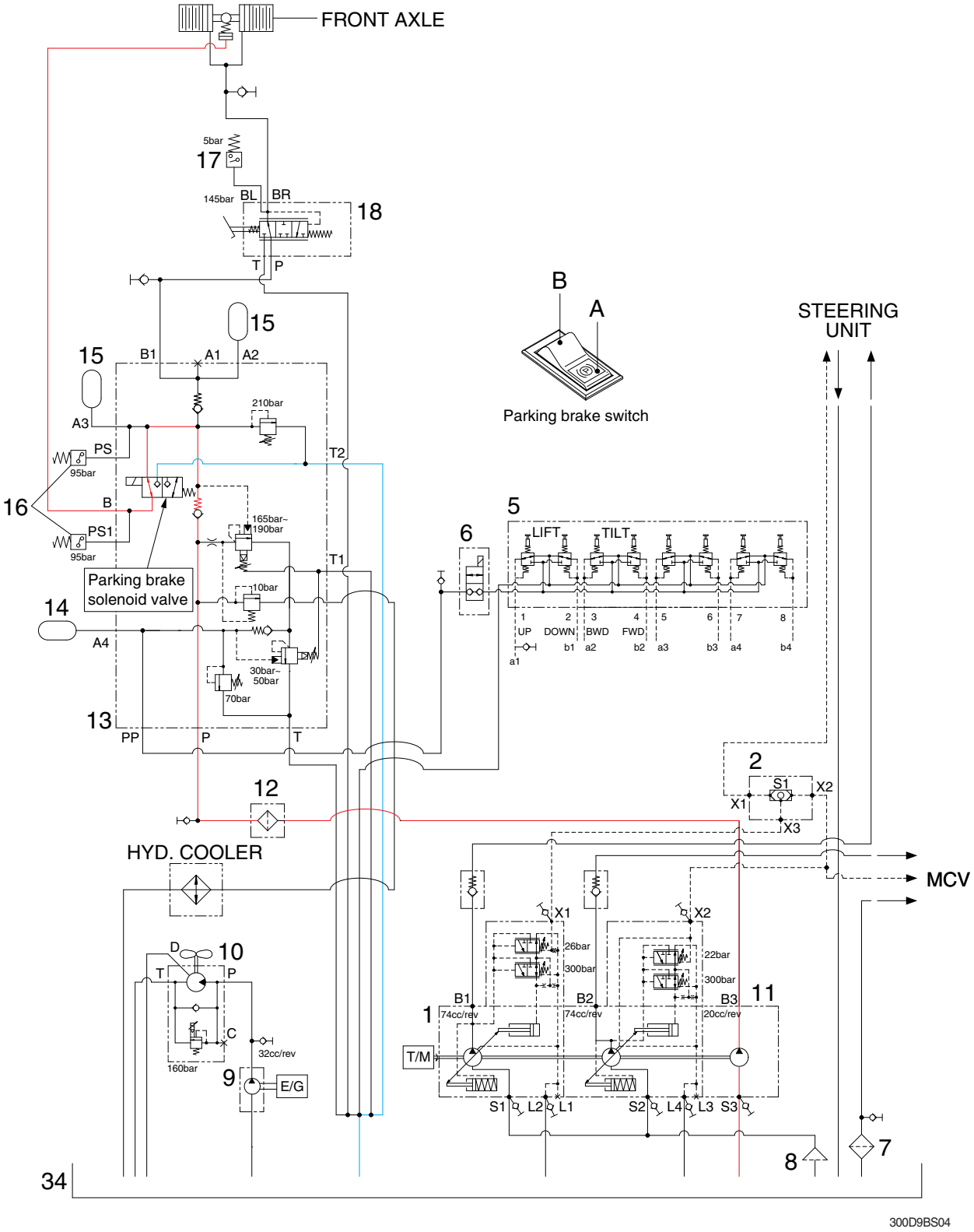
2) SERVICE BRAKE OPERATED



300D9BS03

When the pedal of brake valve (18) is depressed, the operating force overcomes the force of the spring, and is transmitted to the spool. When the spool moves down, the inlet port is opened, and at the same time the hydraulic oil controlled the pressure level by the cut-off valve (13) enters the piston in the front and rear axles. Therefore, the service brake is applied.

3) PARKING BRAKE RELEASED

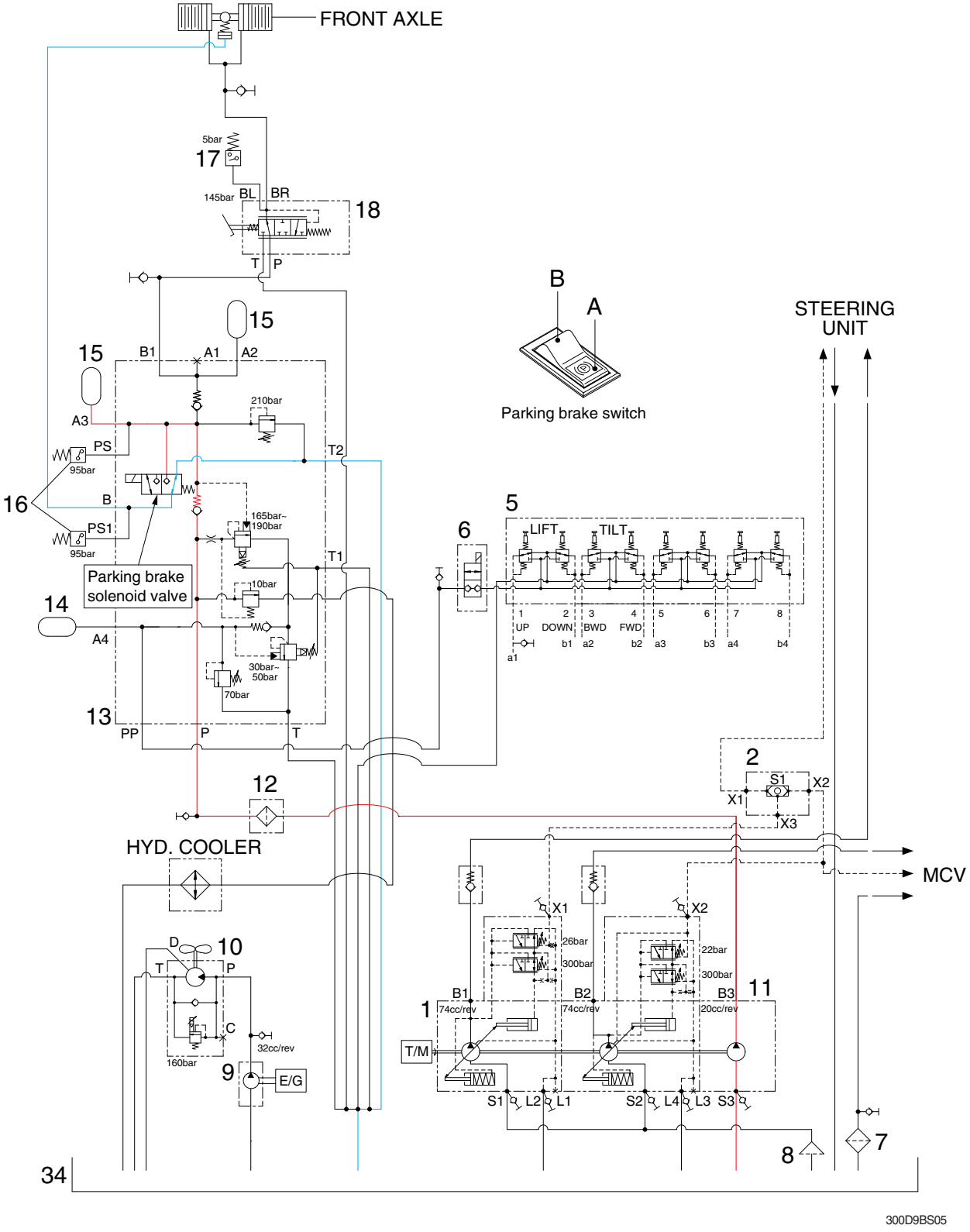


300D9BS04

When the parking brake switch is pressed B position, the solenoid valve is energized and the hydraulic oil controlled the pressure level by the cut-off valve enters the parking brake. It overcomes the force of the spring and pushes the piston rod. This releases the brake.

Therefore, the hydraulic oil pressure is applied to the parking brake piston through the solenoid valve and the parking brake is kept released.

4) PARKING BRAKE OPERATED



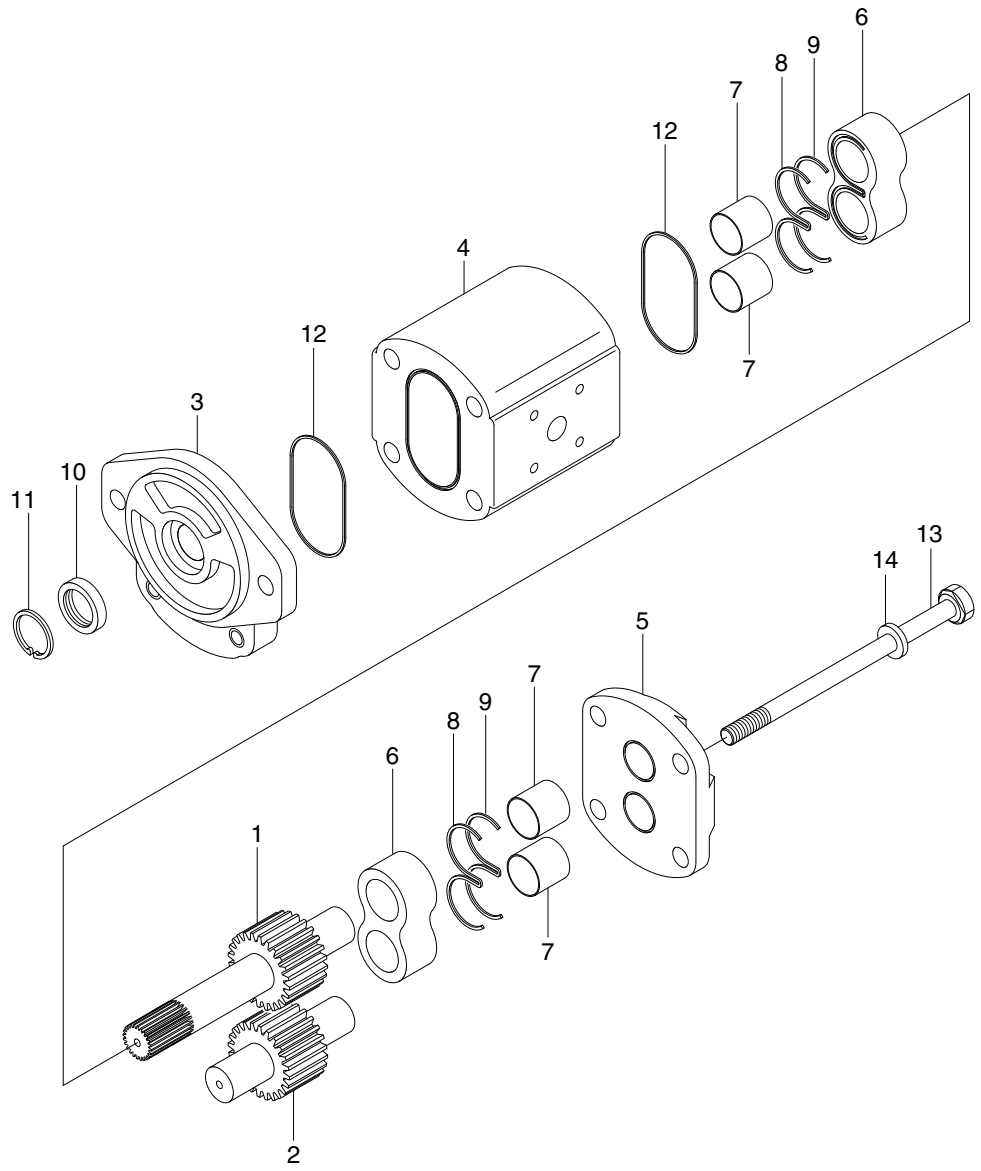
300D9BS05

When the parking brake switch is pressed A position, the solenoid valve is deenergized and the valve open the drain port.

At the same time, the hydraulic oil in the parking brake return to the tank through the solenoid valve. When the piston rod is returned by the force of the spring, the parking brake is applied.

3. AUXILIARY PUMP (BRAKE)

1) STRUCTURE



180D7EBS06

1	Shaft gear	8	Seal
2	Driven gear	9	Back up seal
3	Front cover	10	Retainer seal
4	Gear housing	11	Snap ring
5	Rear cover	12	O-ring
6	Bush block	13	Bolt
7	Bush	14	Spring washer

This gear pump have a maximum delivery pressure of 170 kgf/cm^2.
The pressure loaded type gear pump is designed so that the clearance between the gear and the bushing can be automatically adjusted according to the delivery pressure. Therefore, the oil leakage from the bushing is less than that in the case of the fixed bushing type under a high discharge pressure. Consequently, no significant reduction of the pump delivery occurs, even when the pump is operated under pressure.

2) PRINCIPLE OF OPERATION

(1) Mechanism for delivering oil

The drawing at right shows the operational principle of an external gear pump in which two gears are rotating in mesh.

The oil entering through the suction port is trapped in the space between two gear teeth, and is delivered to the discharge port as the gear rotates.

Except for the oil at the bottom of the gear teeth, the oil trapped between the gear teeth, is prevented from returning to the suction side with the gears in mesh.

Since the gears are constantly delivering oil, the oil delivered to the discharge port is forced out of the port.

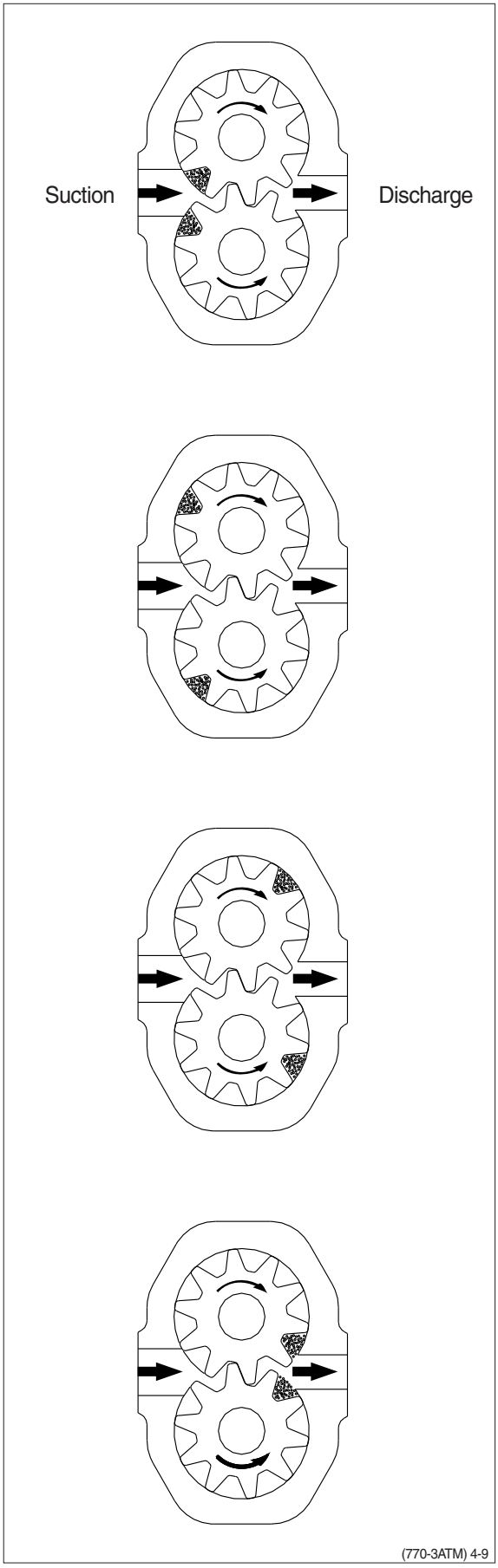
The amount of discharge increases with the speed of rotation of the gear.

If there is no resistance in the oil passage into which the discharged oil flows, the oil merely flows through the passage, producing no increase in pressure.

If however, the oil passage is blocked with something like a hydraulic cylinder, there will be no other place for the oil to flow, so the oil pressure will rise. But the pressure which rises in this way will never go higher, once the hydraulic cylinder piston starts moving because of the oil pressure.

As described earlier, the pump produces the oil flow, but not the oil pressure. We can therefore conclude that pressure is a consequence of load.

In other words, the pressure depends on a counterpart.



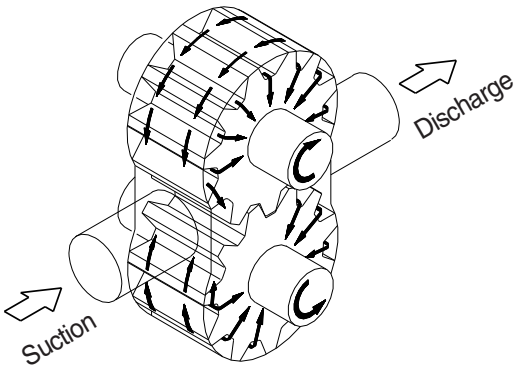
(2) Internal oil leakage

Oil leaks from a place under higher pressure to a place under lower pressure, provided that a gap or a clearance exists in between.

In the gear pump, small clearances are provided between the gear and the case and between the gear and the side plate to allow the oil to leak out and to serve as a lubricant so that the pump will be protected from seizure and binding.

The drawing at right shows how the leaked oil flows in the pump. As such, there is always oil leakage in the pump from the discharge side (under higher pressure) to the suction side. The delivery of the pump is reduced by an amount equal to the pump discharge.

In addition, the delivery of the pump will also decrease as the amount of oil leakage increases because of expanded radial clearance resulting from the wear of pump parts, the lower oil viscosity resulting from increases in the oil temperature, and the initial use of low viscosity oil.



(770-3ATM) 4-10

(3) Forces acting on the gear

The gear, whose outer surface is subjected to oil pressure, receives forces jointing towards its center.

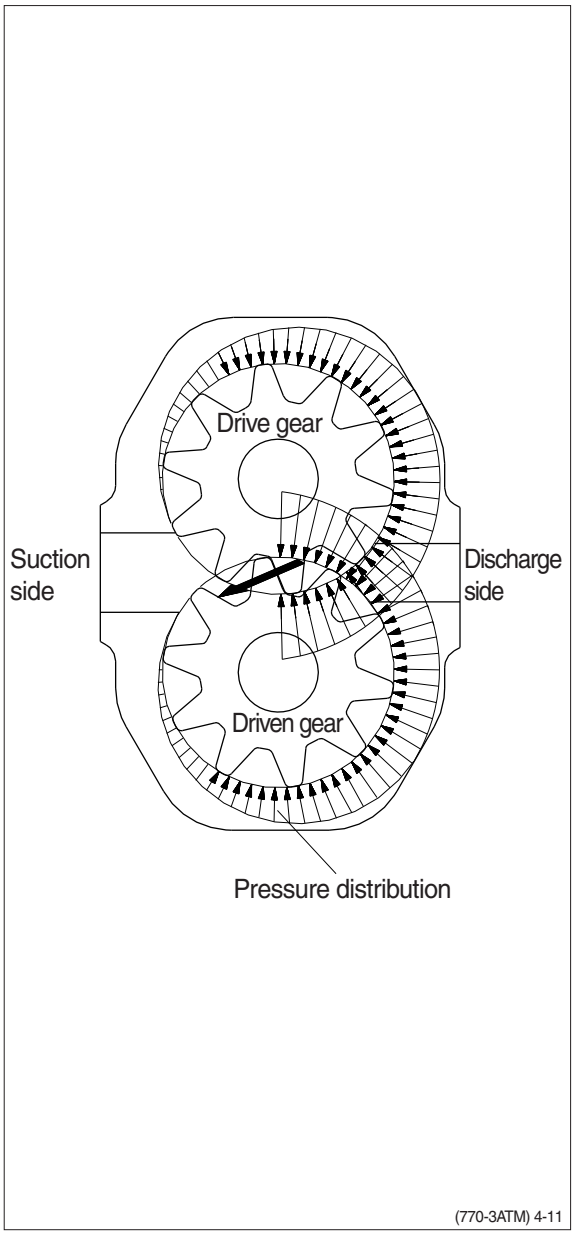
Due to the action of the delivery pressure, the oil pressure in higher on the delivery side of the pump, and due to suction pressure, is lower on the suction side. In the intermediate section, the pressure will gradually lower as the position moves from the delivery side to the suction side.

This phenomenon is shown in the drawing at right.

In addition, the gears in mesh will receive interacting forces.

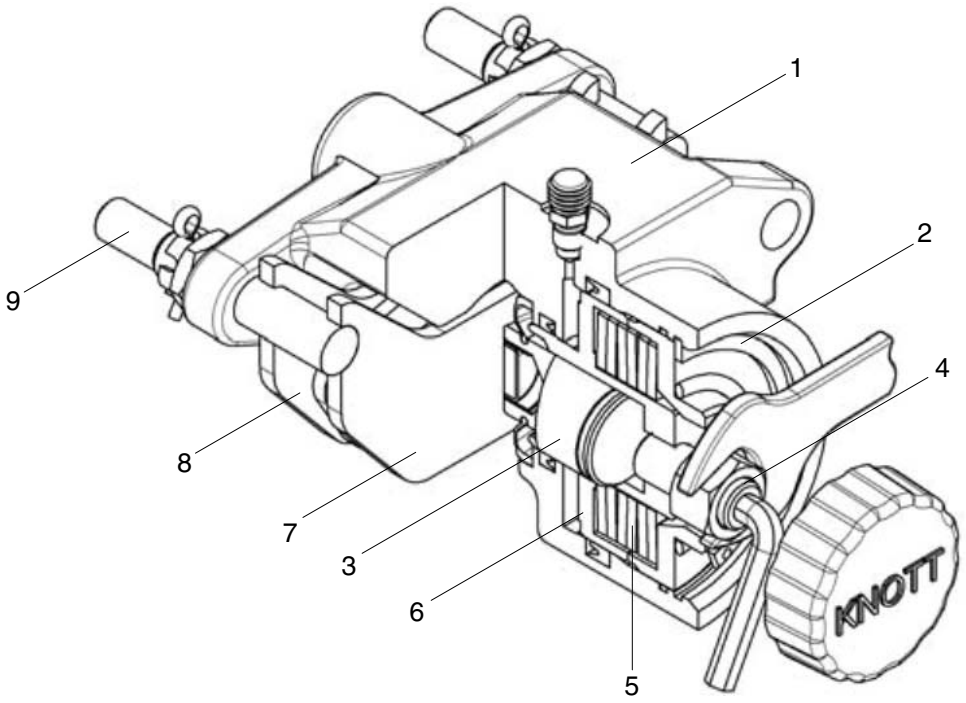
These forces pushing the gears toward the suction side are received by the bearings. Since the gears are pressed toward the suction side by these forces, the radial clearance becomes smaller on the suction side in the case. In some pumps, the clearance may become zero, thus allowing the gear teeth and the case to come into light contact.

For this reason, an excessive increase in the delivery pressure must be avoided, since it will produce a large force which will act on the gears, placing an overload on the bearings, and resulting in a shortened service life of the bearing or interference of the gear with the case.



4. PARKING BRAKE SYSTEM

1) STRUCTURE



100D7BS111

1	Housing	4	Adjust screw	7	Lining pad
2	Pressure ring	5	Bank of cup springs	8	Lining pad
3	Thrust bolt	6	Piston	9	Gliding bolt

2) OPERATION

The two identical brake pads and slide freely on the guide bolt, which is fastened in the housing. The guide bolts are guided in an additional brake anchor plate which in turn is screwed onto the vehicle, i.e. its axle.

On actuation, the brake generates a clamping force at the brake lining pads, which cause a tangential force/braking moment to be generated at the brake disk, the extent of which depends on the coefficients of friction generated by the linings.

The clamping force is generated by the bank of cup springs, during which the piston is moved together with the adjusting screw, the thrust bolt and the brake pad towards the brake disk.

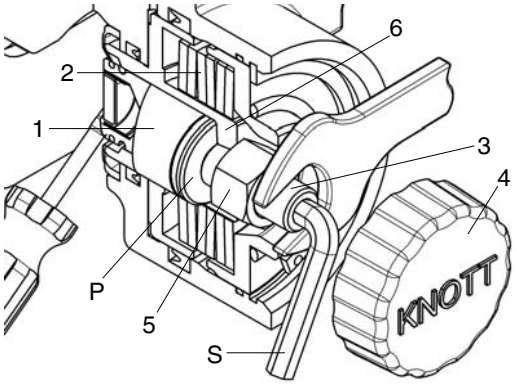
When the brake pad comes into contact with the brake disk, the reaction force shifts the housing onto the guide bolts until the brake pad is also pressed against the brake disk.

The brake is released by complete pre-tensioning of the bank of cup springs. Du-ring this process, through application of the necessary release pressure after overcoming the cup spring force, the piston must move back until it comes to rest against the pressure ring.

The clamping force diminishes with wear of the brake lining and brake disk. The brake must be adjusted at the latest at the times indicated by the adjusting specification followings.

3) MOUNTING AND BASIC SETTING REGULATIONS

Basic brake setting is required after mounting new brake lining plates or brake disks, as well as during all repair stages and in the event of insufficient braking performance.



100D7BS112

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

※ **All mounting and basic setting work must be carried out on the brake when cold.**

(1) Mounting the brake

① Stand the vehicle on an even surface and secure against rolling away.

② Release the screw cap.

③ Release the lock nut (size 24 or 30) and turn the adjusting screw anticlockwise using a size 8 or 10 socket wrench until the pressure bolt comes to rest against the even surface of the piston. In this status, the brake can be mounted onto the brake disk and fastened.

④ Mount the pressure connection again.

Apply the necessary release pressure to the brake until the bank of cup springs is completely pre-tensioned. Following carry out the following page basic setting regulation.

(2) BASIC SETTING REGULATION

① Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

② Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Model	Adjusting screw	Clearance (㎜)		Turns
300D-9	M16 (SW 8)	Min.	0.5	1/4
		Clearance	1.0	1/2
		Max.	1.5	3/4

③ Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

④ Mount the screw cap and tighten as far as possible manually.

⑤ Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

(3) ADJUSTING REGULATIONS

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

① Stand the vehicle on an even surface and secure against rolling away.

② Release the parking brake by using the required release pressure.

③ Release the screw cap and unscrew.

④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

⑤ Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

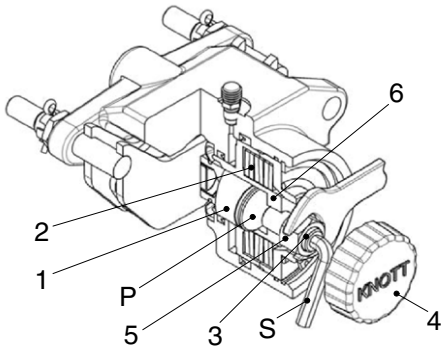
⑥ Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

⑦ Mount the screw cap and tighten as far as possible manually.

※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

4) EMERGENCY RELEASE OF THE PARKING BRAKE

After the failure of the pressure release the parking brake by using following manual procedure.



100D7BS117

1	Thrust bolt	4	Screw cap	P	Even surface
2	Bank of cup springs	5	Lock nut	S	Socket wrench
3	Adjusting screw	6	Piston		

(1) The vehicle has to be secured against rolling away.
(2) Release the screw cap and unscrew
(3) Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter-clockwise until the brake disc is free.

⚠ For the emergency release is an actuation torque of 40 Nm respectively 70 Nm required.

(4) Mount the lock nut and the screw cap and tighten both as far as possible manually. (protection against dirt)

⚠ Now, the vehicle do not have any brake function. The vehicle must be secured against moving away with proper means. Before putting the vehicle into operation again, the brake has to be adjusted again. Refer to previous page. "mounting and basic setting regulations".

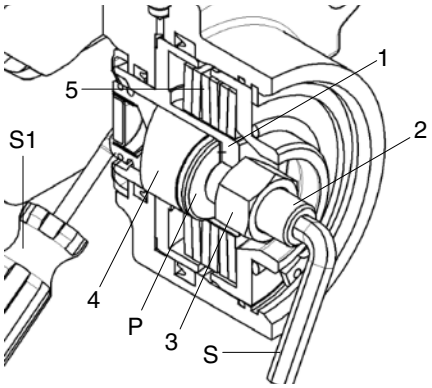
5) MAINTENANCE AND REPAIR WORK

(1) Maintenance and exchange of brake pads

The brake pads themselves are maintenance free. All that is required here is a check for damaged parts, as well as inspection to ensure that the brake disk remains easy running.

The thickness of the brake lining must be subjected to a visual inspection at regular intervals, which depend on vehicle usage, but every six months at the latest. In the event of a minimal residual lining thickness, these intervals must be reduced accordingly in order to avoid major damage to the brake or disk.

Min. residual thickness 1.0 mm per lining pad (6 mm carrier plate thickness).

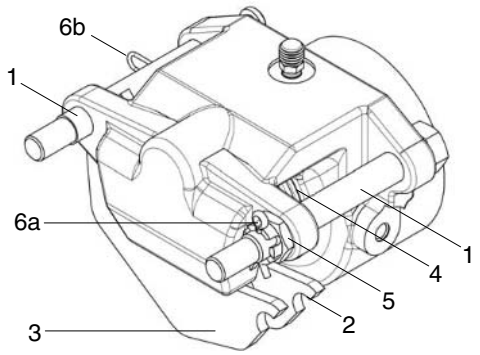


180D7EBS113

1	Piston	5	Bank of cup spring
2	Adjusting screw	S	Socket wrench
3	Lock nut	S1	Screwdriver
4	Thrust bolt	P	Inside of the piston

※ Only original spare lining plates may be used. If any other spare parts are used, no warranty claims will be accepted either for the brakes or their functional characteristics.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the required release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until it lies flush with the inside of the piston.
⑤ Press back the thrust bolt using a suitable screwdriver until it has contact with the piston.



100D7BS114

1	Guide bolt	5	Castellated nut
2	Lining pad	6a	Safety splint
3	Lining pad	6b	Safety clip
4	Permanent magnet		

⑥ Depending on the free space available, release one of the two guide bolts, removing the safety splint, unscrewing the castellated nut and pulling the guide bolt out of the brake anchor plate. Now, the brake lining pads can be removed tangentially to the brake disk.

※ In the event of minimal clearance, i.e. it is not possible for space reasons to exchange the brake lining plate in accordance with these instructions, the brake must be removed completely. To do this, pull both guide bolts out of the brake anchor plate.

⚠ Check the pressure hose. If the pressure hose is to short, it must be unscrewed to remove the brake. Before the pressure hose can be released the brake must be emergency released.

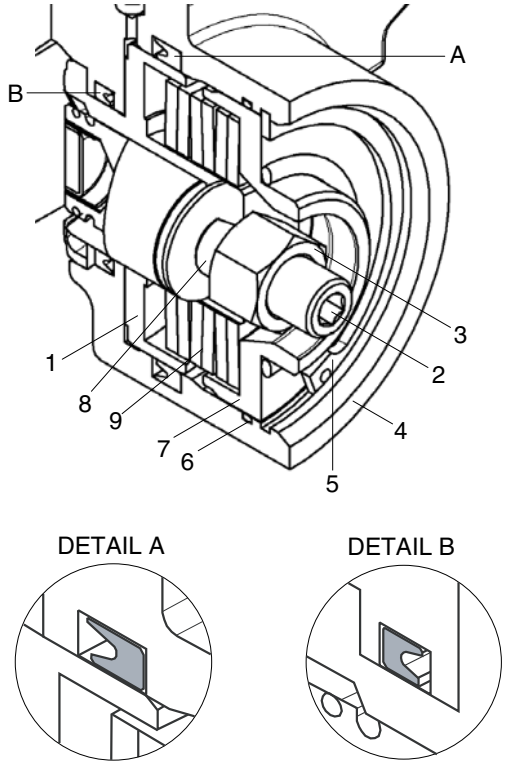
⑦ Exchange the brake pads and insert the guide bolts into the brake anchor plate. If you have removed the complete brake you have to amount the brake on both guide bolt again, now.

⑧ Check both permanent magnets if they still have sufficient magnetic force to hold the brake lining plates. Should this not be the case, the permanent magnets must also be changed by using a suitable screw driver.

⑨ Secure the guide bolt with the castellated nut and the safety splint respective safety clip.

⚠ After mounting new brake lining plates or their repair, the brake must be correctly set in accordance with the instructions "Adjusting regulations".

(2) Changing the seal



100D7BS115

1	Piston	5	Circlip	9	Bank of cup spring
2	Adjusting screw	6	Seal	A	Detail of the seal
3	Lock nut	7	Guide bolt	B	Detail of the seal
4	Housing	8	Thrust bolt		

※ Faulty seals must be exchanged in accordance with the instructions below.

① Stand the vehicle on an even surface and secure against rolling away.
② Release the parking brake by applying the necessary release pressure.
③ Release the screw cap and unscrew.
④ Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually counter clockwise until the adjuster screw is flush with the inner side of the piston.
⑤ Push back the thrust bolt until it has contact with the piston. Following actuate the hand brake valve (No pressure must be in the piston chamber). The bank of cup springs is now completely depressurized.
⑥ Unscrew the pressure hose and remove the brake.
⑦ Release the circlip and remove the pressure ring of the housing.
⑧ Release the bank of cup spings and the piston.

⚠ Pay attention to the mounting direction of the seal rings, otherwise leaks can occur.

⚠ Use for mounting the new seal rings a suitable mounting needle with rounded edge. Be careful.

⑨ Change all seals and mount the parts of the brake in other way round order. By mounting the piston, the sliding and sealing surfaces must be greased lightly using lubricating grease to DIN 51825. The dust protection cap is fitted with a vulcanized-in steel ring which is used to press it through the locating hole. For exchanging, "lever out" the ring using a suitable tool. The new dust protection cap must be pressed in with the aid of a suitable mounting ring and screw clamps or a lever press.

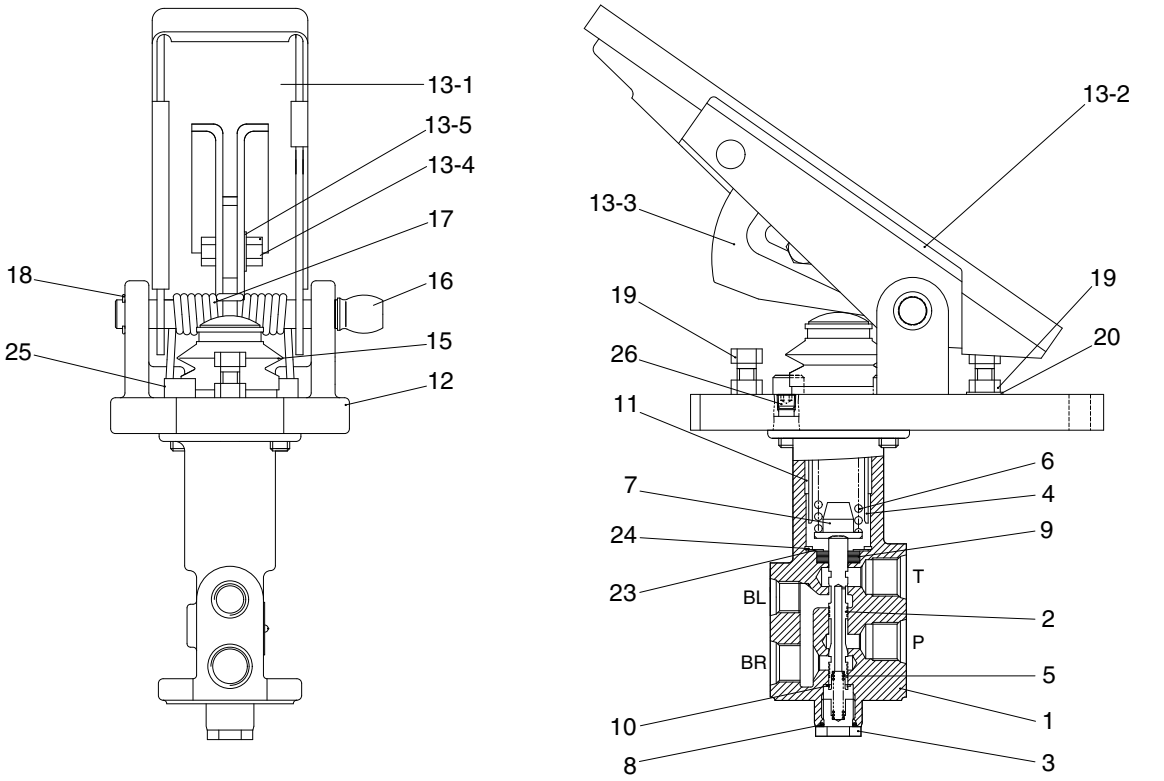
(2) General

Any discovered defects or damage to parts not listed here must naturally be repaired or replaced using original parts.

For any other information not contained in these instructions or for more detailed instructions, please contact Hyundai dealer.

5. BRAKE VALVE

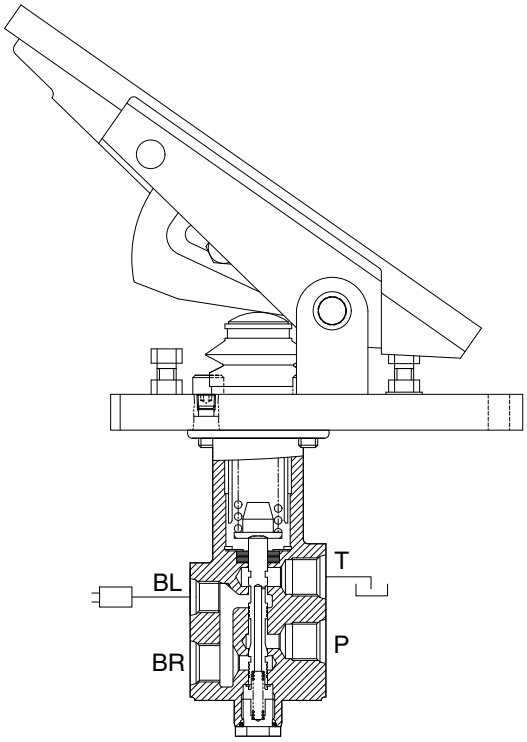
1) STRUCTURE

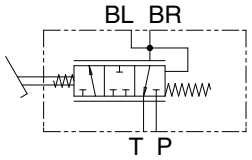


110D7EBS07

1	Body	11	Du bushing	17	Torsion spring
2	Spool	12	Pedal plate	18	Snap ring
3	Plug	13	Pedal assembly	19	Hexagon bolt
4	Holder (piston)	13-1	Pedal	20	Hexagon nut
5	Lower spring	13-2	Rubber	23	Plain washer
6	Main spring	13-3	Lock plate	24	Snap ring
7	Spring retainer	13-4	Hexagon bolt	25	Bolt
8	O-ring	13-5	Plate washer	26	Taper plug
9	Oil seal	15	Bellows		
10	Snap ring	16	Lock pin 1		

2) OPERATION





Hydraulic circuit

Port	Port name	Port size
P	Main pressure port	PF3/8
T	Drain port	PF3/8
BR	Brake cylinder port	PF3/8
BL	Pressure switch port	PF1/4

110D7EBS08

(1) Purpose

The purpose of the brake valve is to sensitively increase and decrease the braking pressure when the brake pedal is actuated.

(2) Ready position

A connection is established between ports (BR) and ports (T) so that the wheel brakes ports (BR) are pressureless via the returns ports (T).

(3) Partial braking

When the brake valve is actuated, an amount of hydraulic pressure is output as a ratio of the foot force applied.

The main spring (6) beneath pedal plate (12) is designed in such a way that the braking pressure changes depending on the angle. In the lower braking pressure range, the machine can be slowed sensitively.

When the braking process is commenced, the spool (2) is mechanically actuated via main spring (6). As spool (2) move downward, they will first close returns (T) via the control edges, thus establishing a connection between accumulator ports (P) and ports (BR) for the wheel brake cylinders. The foot force applied now determines the output braking pressure. The control spool (2) is held in the control position by the force applied (spring assembly above the spool).
After output of the braking pressure, spool (2) is in a partial braking position, causing ports (P) and ports (T) to close and holding the pressure in ports (BR).

(4) Full braking position

When pedal is fully actuated, end position of the brakes is reached and a connection established between accumulator ports (P) and brake cylinder ports (BR). Returns (T) are closed at this point.

When the braking process is ended, a connection is once again established between brake cylinder ports (BR) and return ports (T), closing accumulator ports (P).

(5) Limiting the braking pressure

Pedal restriction bolt (19) on base plate below pedal is used to limit the braking pressure.

(6) Installation requirements

Return lines (T) must be connected directly to the tank.
The connecting lines must be installed is such a way as to permit proper bleeding.

(7) Maintenance of the brake valve

No special maintenance beyond the legal requirements is necessary.

When using high-pressure cleaners on the machine, please make sure that the water jet is not aimed directly at the brake valve (To prevent damaging the bellows).

△ **For safety reasons the whole of the brake valve must be replaced if parts other than those listed above are damaged.**

(8) Repair work

△ When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.

※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

(9) Replacing the pedal cover

Pedal cover (13-2) is simply pulled of by hand. The new pedal cover is pushed over pedal (13-1) and tightened manually. Fasten the bellows with the strap retainers.

(10) Replacing the complete actuating mechanism

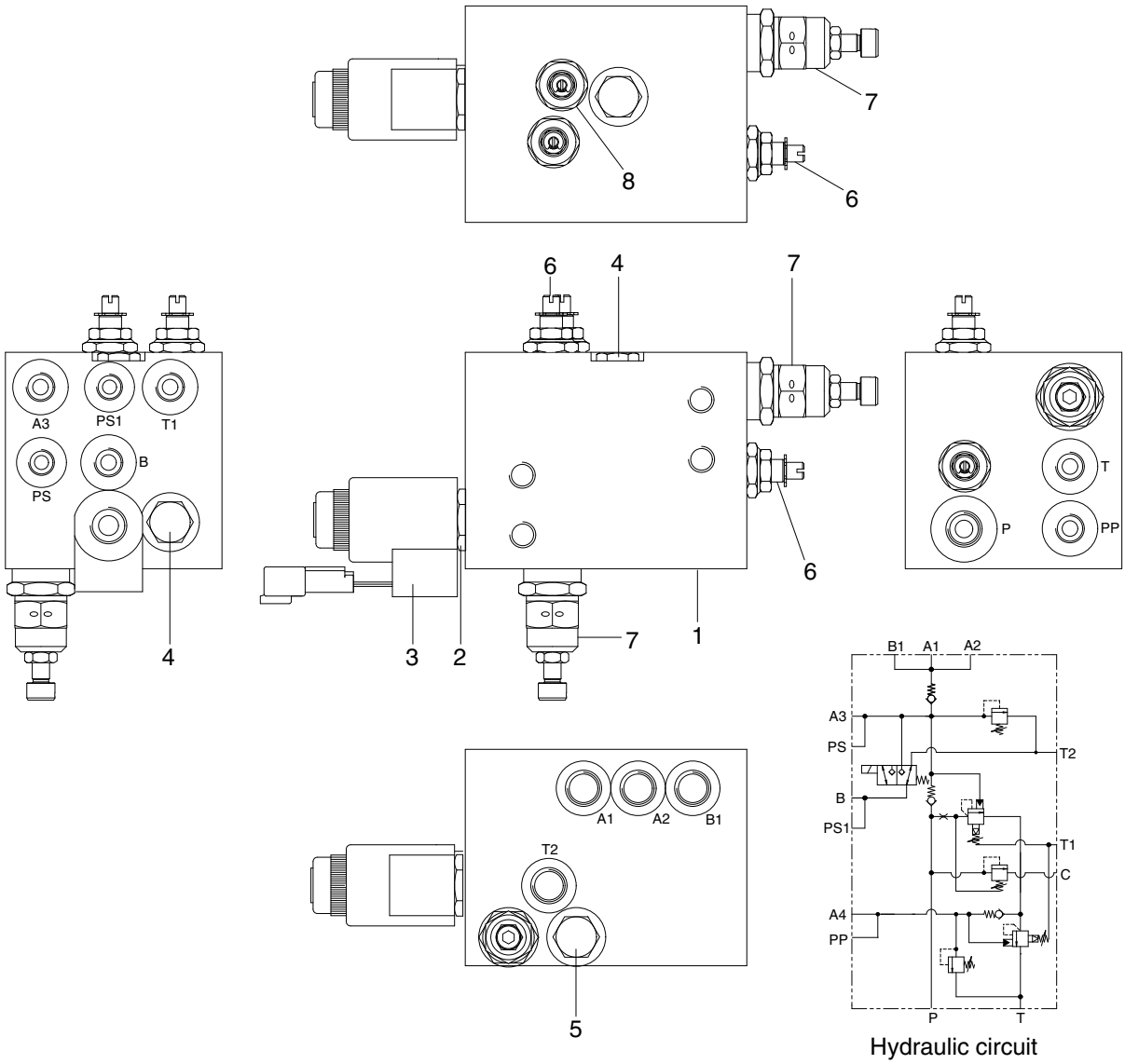
Carefully clamp the unit vertically in a fixture. The actuating mechanism can be removed by taking out the four bolts. Make sure that main spring (6) does not fall out. When installing the new actuating mechanism, make sure that main spring (6) is fitted in the right order.

(11) Replacing the bellows

To change bellows (15) it is advisable to remove pedal (13). For this purpose, loosen retaining ring (18) and knock out pin 1 (16) using a mandrill. When knocking out the bolt, make sure that the mandrill is applied to the side of the bolt without a knurl. Remove pedal (13) and bellows (15). Now fit the new bellows and proceed in reverse order as described above. The upper portion of bellows is fastened to piston (4), its lower portion to pedal plate (12) secure the bellows using clamps.

6. CUT-OFF VALVE

1) STRUCTURE



Hydraulic circuit

180D7EBS35

1	Manifold	5	Check valve
2	Solenoid valve	6	Cut-off valve
3	Coil	7	Relief valve
4	Check valve	8	Logic valve

2) OPERATION

When the pump works, the oil under the pressure flows into P port.

The oil in P port is stored in the accumulator on A3 port.

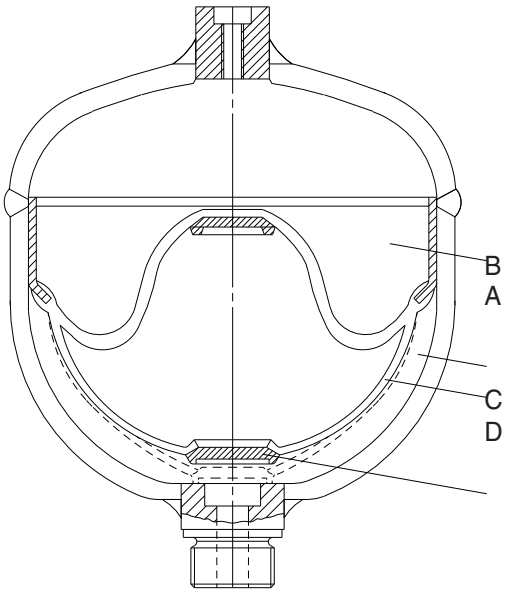
As the pressure on P line rises to 150 bar, the cut off valve (1) starts cut-offing and the oil in the P port is unloaded. The pressure on P line goes down 120 bar by the minute leakage from valve and other factors.

At this pressure, the cut-off valve starts cuting.

This process is repeated in the regular period of 30~40 seconds.

7. BRAKE ACCUMULATOR

1) STRUCTURE



(770-3ATM) 4-22

Item	81L1-0004	31E3-3187
Diameter	121 mm	90 mm
Mounting height	164 mm	140 mm
Nominal volume	0.7 ℓ	0.35 ℓ
Priming pressure	50 kgf/cm^2	15 kgf/cm^2
Operating medium	Oil	Oil
Operating pressure	Max 150 kgf/cm^2	Max 170 kgf/cm^2
Thread	M18 × 1.5	PF1/2
Priming gas	Nitrogen	Nitrogen

A Fluid portion
B Gas portion
C Diaphragm
D Valve disk

2) OPERATION

(1) Purpose

Fluids are practically incompressible and are thus incapable of accumulating pressure energy. In hydropneumatic accumulators, the compressibility of a gas is utilized to accumulate fluid. The compressible medium used in the accumulators is nitrogen.

In braking systems, the purpose of the accumulators is to store the energy supplied by the hydraulic pump. They are also used as an energy reserve when the pump is not working, as a compensator for any losses through leakage, and as oscillation dampers.

(2) Operation

The accumulator consists of a fluid portion (A) and a gas portion (B) with a diaphragm (C) as a gas-tight dividing element. The fluid portion (A) is connected to the hydraulic circuit, causing the diaphragm accumulator to be filled and the gas volume to be compressed as the pressure rises.

When the pressure falls, the compressed gas volume will expand, thus displacing the accumulated pressure fluid into the circuit.

The diaphragm bottom contains a valve disk (D) which, if the diaphragm accumulator is completely empty, closes the hydraulic outlet, thus preventing damage to the diaphragm.

(3) Installation requirements

The accumulators can be fitted in the hydraulic circuit, directly on a component or in blocks on suitable consoles.

They should be fitted in as cool a location as possible.

Installation can be in any position.

(4) Maintenance of the accumulator

No special maintenance beyond the legal requirements is necessary.

The accumulator should be checked annually. It should be replaced if the initial gas pressure has fallen by more than 30% (Please refer to **Performance testing and checking of the accumulator**).

(5) Disposal of the accumulator

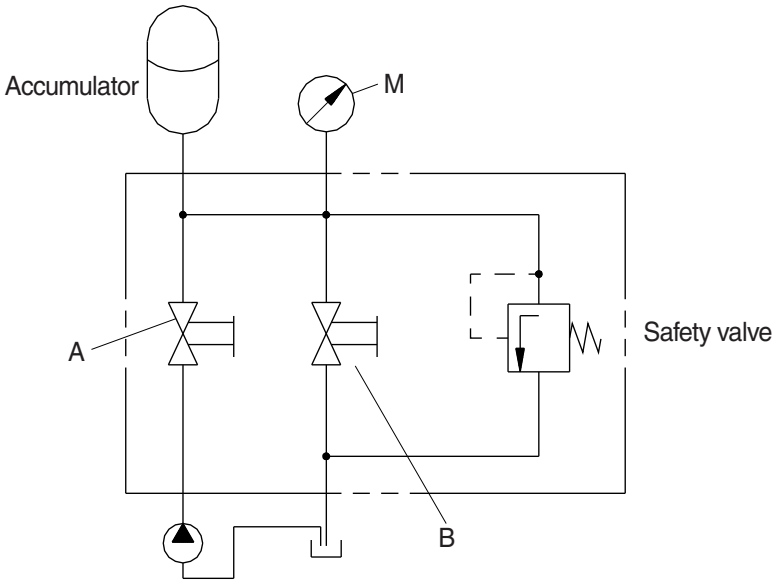
Before the accumulator is scrapped, its gas filling pressure must be reduced. For this purpose, drill a hole through gas chamber (B) using a drill approx. 3mm in diameter. The gas chamber is located on the side opposite the threaded port above the welding seam around the center of the accumulator.

※ Wear safety goggles when doing this job.

(6) Performance testing and checking of the accumulator

The accumulator is gradually pressurized via the test pump; until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from gauge **M**. If the initial gas pressure is more than 30% below the prescribed value, the accumulator needs to be replaced. If the measuring process needs to be repeated, wait for intervals of 3 minutes between the individual tests. Any accumulator whose initial gas pressure is insufficient must be scrapped following the instructions under **Disposal of the accumulator**.

The amount of initial gas pressure can also be checked from the vehicle. Start the vehicle's engine. The pump will now supply oil to the accumulators. Until the initial gas pressure is reached, the hydraulic pressure in the accumulator will rise abruptly. This is apparent from the gauge in the cab. If the initial gas pressure is more than 30% below the prescribed value, that initial pressure lies outside the permissible range for **at least one** of the accumulators fitted in the vehicle. This accumulator can be traced only by using the method described above, i.e. all accumulators have to be individually tested. The accumulator whose initial gas pressure is insufficient must be replaced and scrapped following the instruction under **Disposal of the accumulator.**



(770-3ATM) 4-23

(7) Repair work

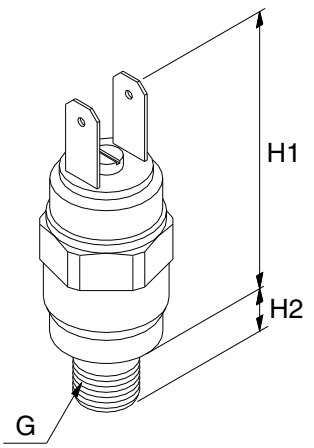
△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine in switched off there will be some residual pressure in the system.**

※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

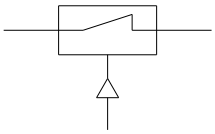
△ **For safety reasons the accumulators need to be replaced as a whole if damaged.**

8. PRESSURE SWITCHES

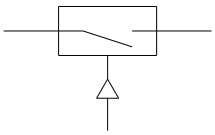
1) STRUCTURE



- Normally closed



- Normally open



7407ABS20

· **Technical data**

Item	Type	Medium	G	H1 mm	H2 mm	Adjusting range kgf/cm²	Adjusting pressure kgf/cm²	Voltage V
Parking	NC	Oil	M12 × 1.5	46	9	50 ~ 150	95 ± 5	Max 42
Charging	NC	Oil	M12 × 1.5	46	9	50 ~ 150	95 ± 5	Max 42
Brake stop	NO	Oil	M12 × 1.5	46	9	1~10	5 ± 1	Max 42

NC : Normally closed NO : Normally open

2) OPERATION

(1) Purpose

The pressure switches are used to visually or audibly warn the driver of the pressure within the system.

(2) Make contact / circuit closer

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on an absorption area within the switch, making an electrical contact as the pressure on that area is increased. The resulting current is used to activate a warning facility, for instance.

(3) Break contact / circuit breaker

The pressure switch can be fitted in the braking system or directly on one of its components.
The system pressure acts on a absorption area within the switch, breaking an electrical contact as the pressure on that area is increased. The current is now broken, e.g. to deactivate a warning facility.

(4) Installation requirements

No special measures need to be taken.

(5) Maintenance of the pressure switch

No special maintenance beyond the legal requirements is necessary.
When using high-pressure cleaners on the vehicle, please make sure that the water jet is not directed at the pressure switch (Corrosion of contacts).

(6) Repair work

△ **When working on the braking system, always make sure that there is absolutely no pressure in the system. Even when the engine is switched off there will be some residual pressure in the system.**

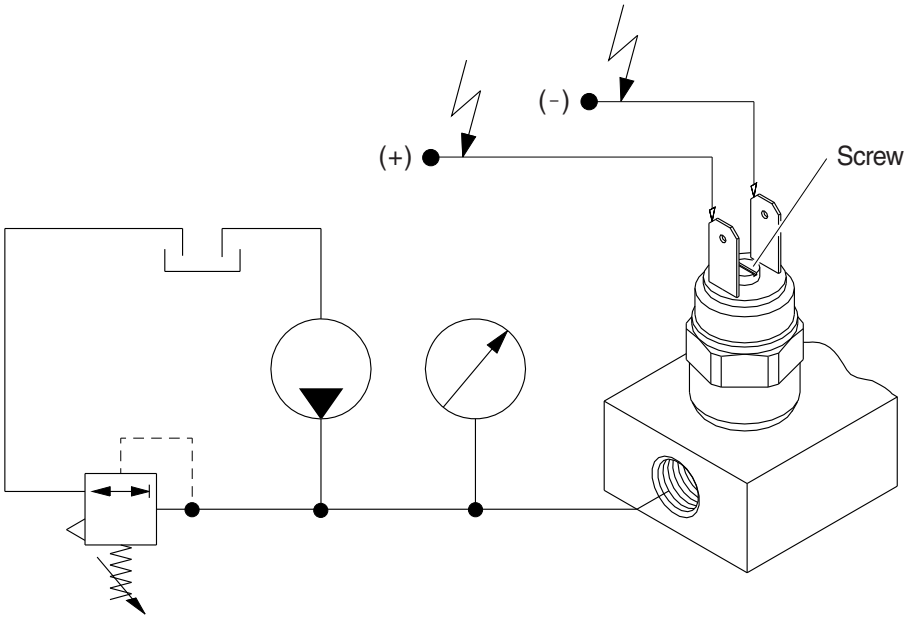
※ When doing repair work, make sure your environment is very clean.
Immediately close all open ports on the components and on pipes using plugs.

※ For safety reasons the pressure switch needs to be replaced as a whole if damaged.

(7) Adjusting and testing pressure switch

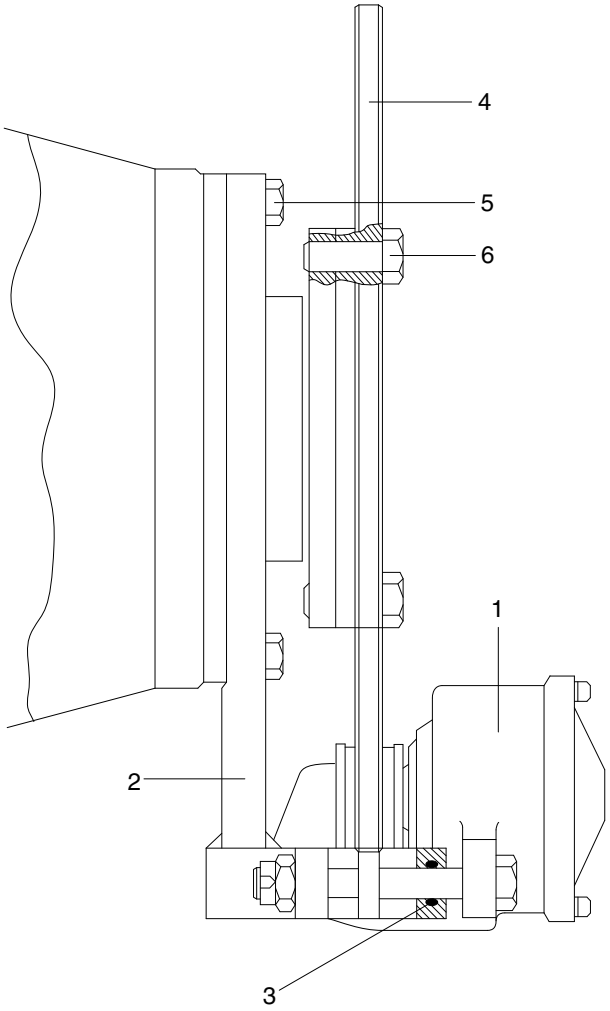
The adjusting screw located between the two contact plugs can be set to the desired value within a certain range. For adjusting range, please refer to the table **Technical data** at page 4-28.

After making the adjustment, the adjusting screw should be secured using wax or a similar material.



(770-3ATM) 4-25

9. PARKING BRAKE



100D7BS109

1	Brake	4	Brake disk
2	Brake carrier	5	Hexagon screw
3	O-ring	6	Hexagon screw

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the mechanic can make a quick check of the system using a minimum amount of diagnostic equipment. If you need additional information, read **structure and function**, Group 1.
A location will be required which is level and has adequate space to complete the checks.

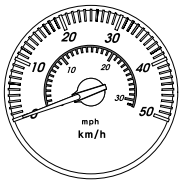
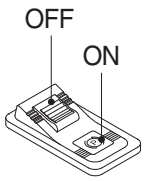
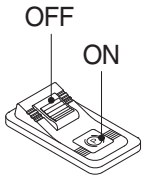
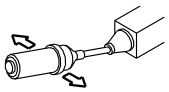
The engine and all other major components must be at operating temperature for some checks.

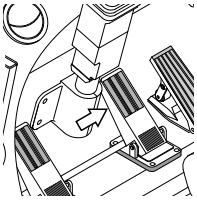
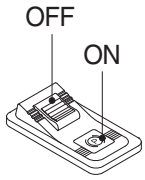
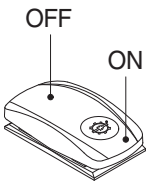
Locate system check in the left column and read completely, following the sequence from left to right.
Read each check completely before performing.

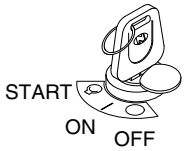
At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be given repair required and group location.
If verification is needed, you will be given next best source of information:

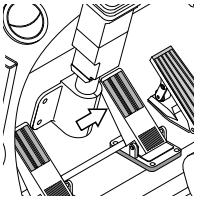
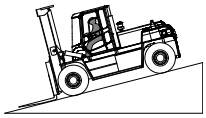
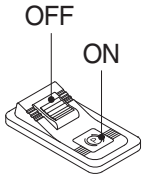
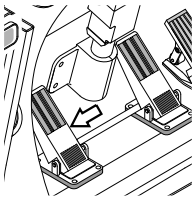
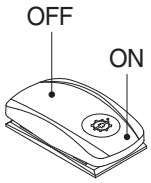
Chapter 2 : Troubleshooting
Group 3 : Tests and adjustments

※ **Hydraulic oil must be at operating temperature for these checks.**

Item	Description	Service action
Parking brake capacity check Seat belt must be worn while doing this check to prevent possible injury when machine stops suddenly.	  Start engine. Fasten seat belt. Release parking brake and put transmission in 2nd gear forward. Drive machine at 8 km/hr and switch parking brake ON. **LOOK/FEEL :** Machine must come to a stop within 2 meters(6 feet) when parking brake is engaged at 8 km/hr. Transmission must shift to neutral.	**OK** Check completed. **NOT OK** Inspect parking brake. Go to group 3.
Parking brake transmission lockout check Engine running.	  Turn parking brake to ON. Place transmission in 1st forward. Slowly increase engine speed to high idle. **LOOK** : Machine must not move.	**OK** Check completed. **NOT OK** Go to transmission control circuit in section 3.

Item	Description	Service action
Service brake pump flow check ※ Hydraulic oil must be at operating temperature for the check. Engine OFF.	 Stop engine. Operate brake pedal approximately 20 times. Start engine and run at low idle. Record number of seconds required for low brake pressure indicator lamp to go out. **LOOK** : Indicator lamp must go out in less than 10 seconds from time engine starts. **NOTE** : Indicator will not come on approximately 1 second after starting engine.	**OK** Check completed. **NOT OK** Check for brake circuit leakage. Go to next page. **IF OK** Install a cap on line connected to inlet of brake valve and repeat pump flow check. If time does not decrease, check for worn brake pump.
Service brake capacity check Engine running.	  Turn inching switch OFF. Apply service brakes, release park brake and put transmission in 2nd forward. Increase engine speed to high idle. **LOOK** : Machine may not move or move at a very slow speed. Repeat check three times to ensure accurate results.	**OK** Check completed. **NOT OK** Check brake pressure in group 3. **IF OK** Inspect brake disk.

Item	Description	Service action
Brake accumulator precharge check ※ The axles and hydraulic oil must be at operating temperature for this check.	 Start and run engine for 30 seconds. Stop engine and turn start switch to ON and wait 5 seconds. **NOTE** : Engine oil pressure lamp will be on due to no engine oil pressure.  Count the number of times the brake pedal can be fully depressed before the low brake pressure warning lamp comes ON. **LOOK** : Warning lamp must come on over 20 times of applications. Start engine and operate at low idle. Observe cluster while applying brake pedal with maximum force. **LOOK/LISTEN** : Brake pressure indicator must not come ON.	**OK** Check completed. **NOT OK** Make sure brake pedal is not binding and keeping brakes partially engaged. Bleed brakes in group 3. Check brake system pressure. **NOT OK** If light comes on with engine running, accumulator has lost it's charge. Inspect and recharge accumulator.
Brake system leakage check	 Start engine and wait 30 seconds. Stop engine. Wait 2 minutes. Turn start switch to ON and wait 5 seconds.  **LOOK** : Brake oil pressure warning lamp must not come on within 2 minutes after stopping engine.	**OK** Check completed. **NOT OK** If brake leakage is indicated with brakes released, check leakage at accumulator inlet check valve and brake valve. If brake leakage is indicated with brakes applied, check for leakage at brake valve and brake pistons. Check individual component leakage.

Item	Description	Service action
Service brake pedal check	 Slowly depress brake pedal. Listen for a hissing noise that indicates oil is flowing to brake pistons. **LISTEN/FEEL** : A hissing noise must be heard when pedal is depressed.	**OK** Check completed. **NOT OK** Inspect for debris under brake pedal. Inspect clutch cut-off linkage.
Service and parking brake system drag checks Engine running	 Position machine on gradual slope. Lower fork approximately 50mm(2 in) from ground. Release parking and service brakes.  **LOOK** : Machine must move or coast. **NOTE** : If machine does not move, check brake pedals to be sure they fully release when feet are removed from pedals.	**OK** Check completed. **NOT OK** Adjust park brake, go to group 3. **NOT OK** Check floor mat interference to pedal or debris build-up. **IF OK** Check for brake pressure when brake is released.
Inching check	 Place inching switch in ON position. Release parking brake. Run engine at half speed in 1st forward.  Depress inching pedal until machine stops with left foot. At this pedal angle, put on right foot on the brake pedal not to release. Release inching pedal. **LOOK** : Machine must move.	**OK** Check completed. **NOT OK** Check inching sensor output voltage.

2. TROUBLESHOOTING

1) SERVICE BRAKE

Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (See section 1)
Step 2. Operational checks (In this group)
Step 3. Troubleshooting
Step 4. Tests and adjustments (See group 3)

Problem	Cause	Remedy
Poor or no brakes	Brake accumulator charge low	Do brake accumulator check.
	Brake pump standby pressure low	Do brake pump standby pressure test.
	Brake pressure low	Do brake valve pressure test.
	Air in system	Bleed brakes.
	Worn brake surface material	Inspect brake surface material.
	Leakage in brake valve	Do brake valve leakage test.
	Leakage in brake piston seal	Check for an over filled differential. Apply brakes and check for leakage from check plug. ※ **It is normal for the oil level to be slightly above the check plug.**
Aggressive brakes	Internal restriction in circuit	Remove lines and components.
	Clutch cut-off switch out of adjustment	Adjust switch.
	Brake valve malfunction	Disassemble and inspect.
	Low oil level	Check oil level.
Brakes drag	Brake pedal not returning properly	Inspect floor mat and pedal.
	Debris holding valve partially open in brake valve	Do brake valve pressure test.
	Warped brake disk	Inspect brake disk.
	Stuck brake piston	Repair.
Brakes lock up	Brake valve malfunction	Clean or replace brake valve.

Problem	Cause	Remedy
Brakes chatter	Air in brake system	Do brake bleed procedure.
	Worn brake surface material	Inspect brake surface material.
	Wrong oil in differential	Drain. Refill.
Hissing noise when brake pedal is held with engine stopped	Leakage in brake valve, or brake piston	Do brake system leakage test.
Brake pressure warning light will not go out or stays on excessively long after start-up	Malfunction in brake low pressure warning switch	Replace switch.
	Brake accumulator pressure too low	Recharge accumulator.
	Low brake pump standby pressure setting.	Do brake pump standby pressure test.
	Leakage in pressure reducing manifold block	Do pressure reducing valve manifold leakage test.
	Leakage in brake system	Do brake system components leakage tests.
	Worn brake pump	Do brake pump flow test.
	Leakage in parking brake solenoid	Do parking brake pressure test.

2) PARKING BRAKE MALFUNCTIONS

Problem	Cause	Remedy
Brake will not hold	Pads not adjusted correctly	Adjust parking brake.
	Malfunctioning parking brake solenoid	Inspect and replace.
	Worn brake disk and / or brake pads	Disassemble, inspect, repair.
	Brake piston hangs up in bore	Remove and inspect. Repair.
Brake disk overheats	Pads out of adjustment	Adjust parking brake.
	Brake not released	Release parking brake. Disassemble, inspect brake. Repair if necessary. Inspect for loosen or broken lines between brake pressure switch and indicator on dash.
Parking brake indicator in monitor does not come on when brake applied	Faulty wiring or switch	Inspect for loose or broken lines between brake pressure switch and indicator on dash. Inspect for a faulty indicator on dash. Replace if necessary.
Brake will not apply	Pads out of adjustment	Adjust parking brake.
	Malfunctioning wiring, switch, or solenoid	Check electric circuit.
	Restriction between brake valve and brake	Remove hose and inspect. Replace.

1. PARKING BRAKE PERFORMANCE

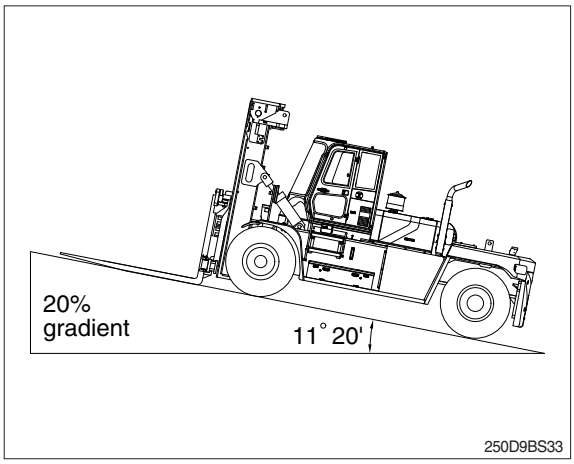
1) MEASUREMENT CONDITION

(1) Tire inflation pressure : Specified pressure

(2) Road surface : Flat, dry, paved surface with 1/5 (11˚20') gradient.

(3) Machine : In operating condition

Item	Standard value
Parking brake performance	Keep machine on 20% (11˚20') gradient



250D9BS33

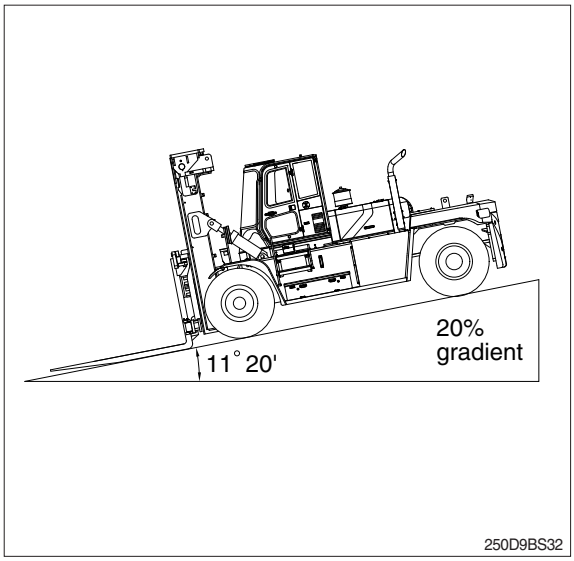
2) MEASURING PROCEDURE

(1) Start the engine and drive the machine straight up a 1/5 gradient with the fork unloaded.

(2) Depress the service brake, place the gear selector lever in neutral, then stop the engine.

(3) Turn the parking brake switch ON, then slowly release the service brake pedal and the machine must be kept stopped.

※ The measurement must be made with the machine facing either up or down the slope.

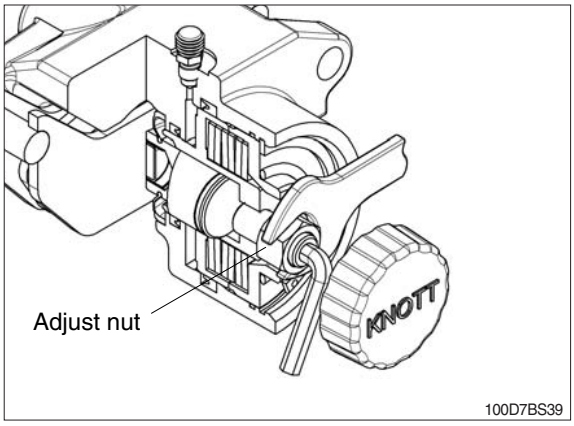


250D9BS32

2. ADJUSTMENT OF BRAKE

1) EXTERNAL BRAKE INSPECTION

· Inspect for wear of brake pad.



100D7BS39

2) BASIC SETTING REGULATION

(1) Turn the adjusting screw manually clockwise until both brake pads make contact with the brake disk. Then it is not longer possible to turn the adjusting screw without exerting a major amount of force.

(2) Turn the adjusting screw anticlockwise in order to set the following rated clearances.

Model	Adjusting screw	Clearance (㎜)		Turns
300D-9	M16 (SW 8)	Min.	0.5	1/4
		Clearance	1.0	1/2
		Max.	1.5	3/4

(3) Hold the adjusting screw in position with a hexagonal socket wrench and lock with lock nut.

(4) Mount the screw cap and tighten as far as possible manually.

(5) Mount the pressure connection in accordance with the instructions of the axle.

※ For bleeding the piston chamber use the socket spanner size 13 for the bleeding valve.

3) ADJUSTING REGULATIONS

During this adjusting process, the parking brake must be released, i.e. the bank of cup springs must be completely pre-tensioned.

(1) Stand the vehicle on an even surface and secure against rolling away.

(2) Release the parking brake by using the required release pressure.

(3) Release the screw cap and unscrew.

(4) Release the lock nut (size 24 or 30) and turn the adjusting screw with socket wrench size 8 or 10 manually clockwise until the two brake pads make contact with the brake disk.

(5) Turn the adjusting screw anti-clockwise and set the clearance specified in the above table.

(6) Hold the adjusting screw in position with the hexagonal socket wrench and lock with the lock nut.

(7) Mount the screw cap and tighten as far as possible manually.

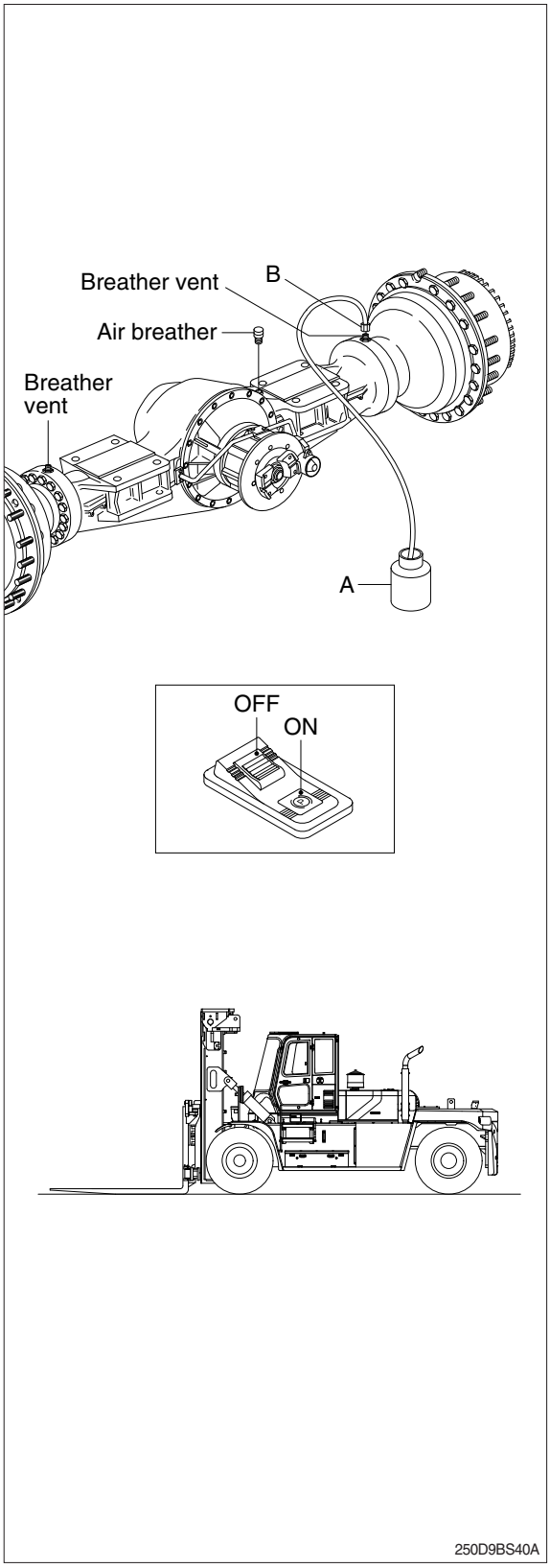
※ Actuate the brake valve several times and check the braking efficiency of the parking brake on a slope.

3. HYDRAULIC BRAKE BLEEDING PROCEDURE

⚠ **Escaping fluid under pressure can penetrate the skin causing serious injury. Avoid the hazard by relieving pressure before disconnecting hydraulic or other lines. Tighten all connections before applying pressure. Search for leaks with a piece of cardboard. Protect hands and body from high pressure fluids.**

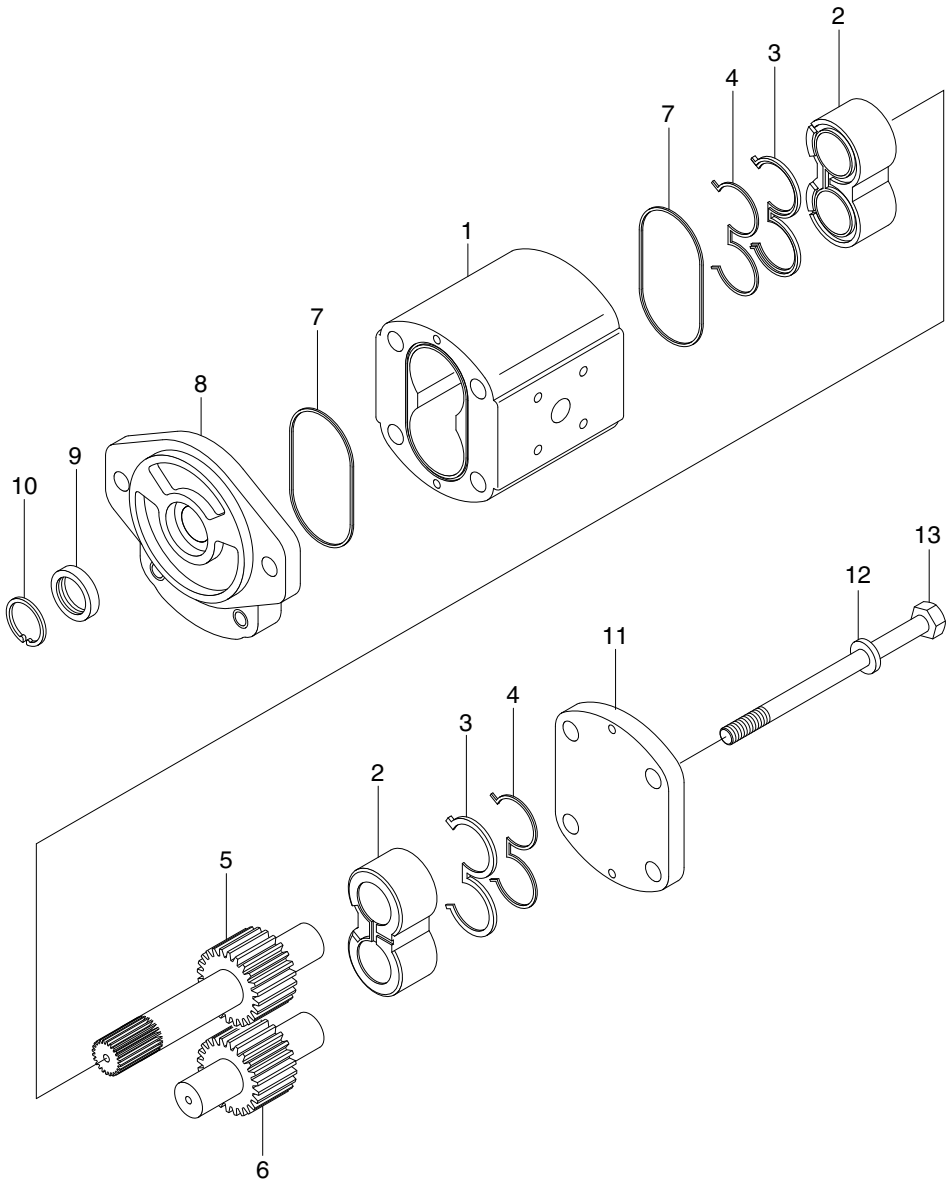
※ If an accident occurs, see a doctor immediately. Any fluid injected into the skin must be surgically removed within a few hours or gangrene may result.
Doctors unfamiliar with this type of injury should reference a knowledgeable medical source.
Two people are required to bleed brake system oil, one to operate brake valve and other to open and close bleed screws.

1) Engage parking brake and block the tire.
2) Put a clear plastic tube on bleed screw (B) to route low to hydraulic reservoir filler tube or container (A).
3) Start engine and run at low idle.
4) Push and hold brake pedal down until brake bleeding procedure is complete.
   ※ If bubbles continue for more than 2 minutes, stop bleeding procedure.
   Check for and correct problem, then continue.
5) Open on bleed screw on differential and axle assembly until hydraulic oil starts to flow. Close bleed screw when oil is free of air. Release brake pedal.
6) Repeat steps 1-5 for each bleed screw.
7) Push either brake pedal and hold down.
8) Check hydraulic oil level.



1. AUXILIARY PUMP (BRAKE)

1) STRUCTURE



180D7EBP00

1	Housing	8	Front cover
2	Bush block	9	Retainer seal
3	Backup seal	10	Snap ring
4	Channel seal	11	Rear cover
5	Shaft gear	12	Washer
6	Driven gear	13	Bolt
7	O-ring		

2) GENERAL INSTRUCTION

(1) Always work in a clean environment.

(2) Wash all components in solvent and blow dry with compressed air before refitting.

(3) Take care not to damage rubber seals.

(4) Avoid damaging precision machined surfaces.

(5) Components should fit into their housings without excessive force. If force is necessary, this normally means that the component does not have the correct dimensional tolerances of is aligned incorrectly.

(6) When hand pressure is insufficient, only use presses or rubber hammer to fit components.

(7) Never strike components with steel hammers.

(8) Steel bush must be fitted only with a suitable press.

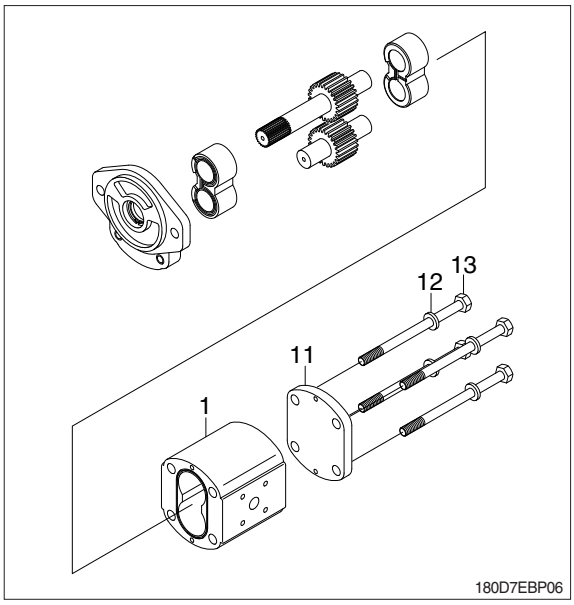
(9) Do not use hammers to fit bearings.

(10) Always respect the direction of rotation when assembling components.

3) DISASSEMBLY

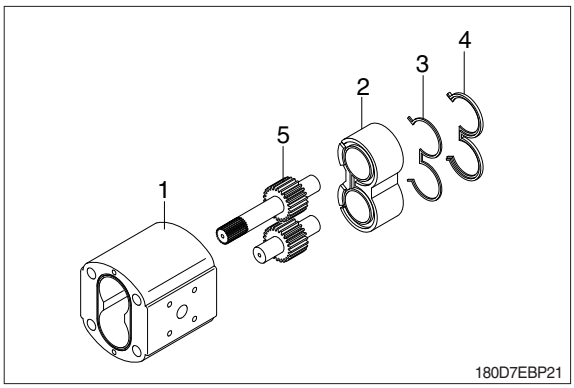
(1) Loosen and remove the bolts (13) with washers (12) from the rear cover (11).

(2) Remove the rear cover (11) from the housing (1).



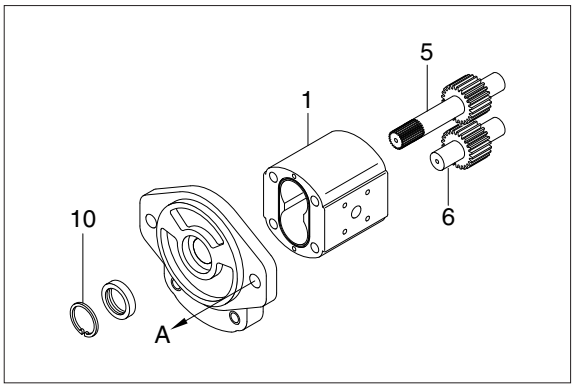
(3) Disassemble the channel seal (4), back up seal (3) and bush block (2), from the housing (1).

※ After removing the bush block (2) from the the housing (1), clean the contacting surface of the bush block (2) with the journal of the shaft gear (5) and the drive gear (1), inspect for excessive wear, scoring or crack.



(4) After removing the snap ring (10), take out the shaft gear (5) and the drive gear (6) from the housing (1).

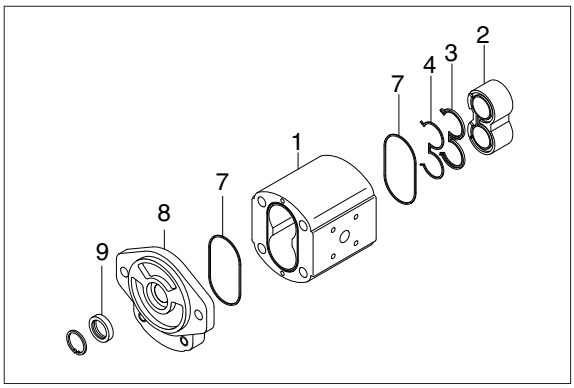
※ For the gear face of the shaft gear (5) and the driven gear (6), inspect for excessive wear, scoring or crack.



180D7EBP51

(5) Remove bush block (2), back up seal (3), channel seal (4) and O-ring (7) from the housing (1).

※ After removing the bush block (2) from the housing (1), inspect whether it is happened scratch or damage for inner surface of the housing (1).



180D7EBP52

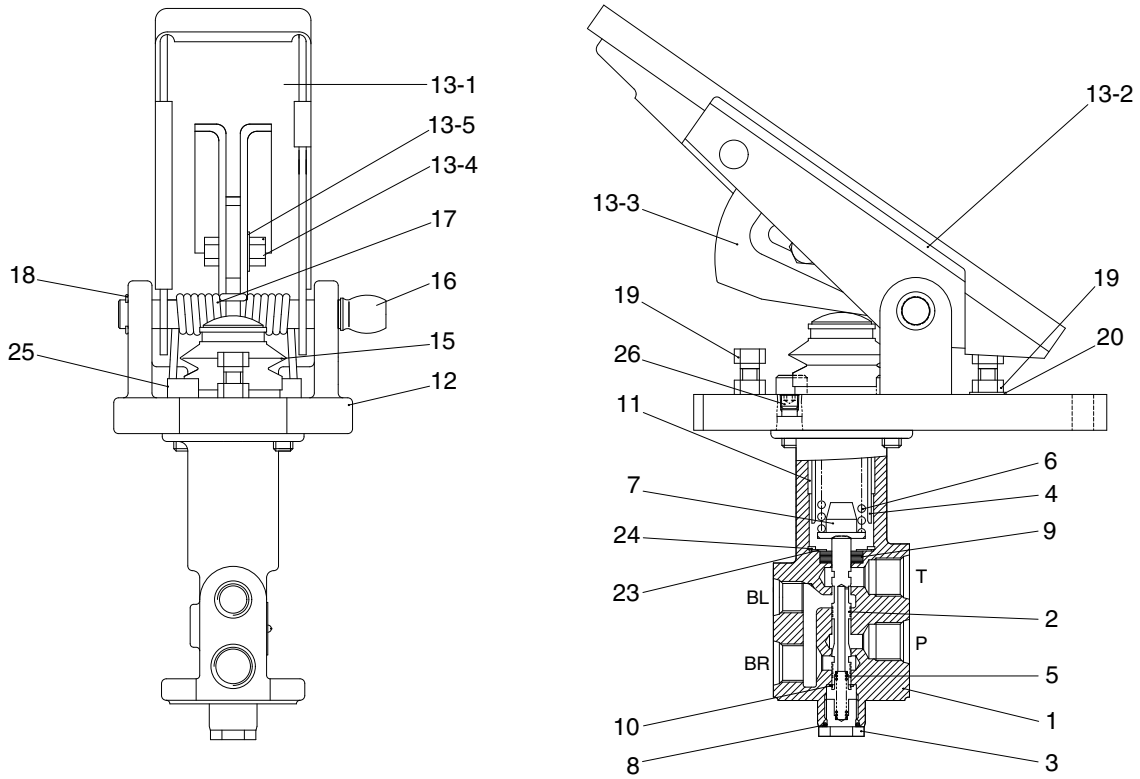
(6) Remove the retainer seal (9) from the front cover (8).

4) ASSEMBLY

Assembly procedure of the pump is the reverse order of the disassembly procedure.

2. BRAKE VALVE

1) STRUCTURE



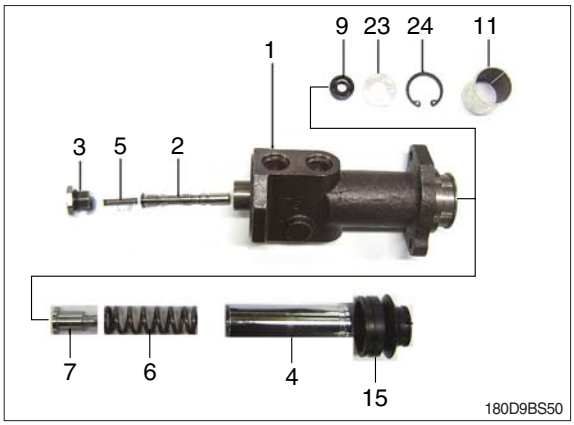
110D7EBS07

1	Body	11	Du bushing	17	Torsion spring
2	Spool	12	Pedal plate	18	Snap ring
3	Plug	13	Pedal assembly	19	Hexagon bolt
4	Holder (piston)	13-1	Pedal	20	Hexagon nut
5	Lower spring	13-2	Rubber	23	Plain washer
6	Main spring	13-3	Lock plate	24	Snap ring
7	Spring retainer	13-4	Hexagon bolt	25	Bolt
8	O-ring	13-5	Plate washer	26	Taper plug
9	Oil seal	15	Bellows		
10	Snap ring	16	Lock pin 1		

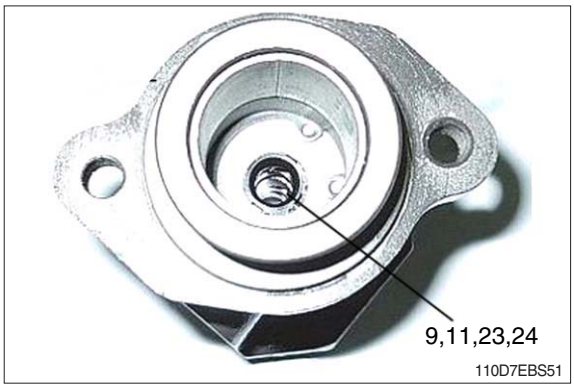
2) REASSEMBLY

(1) Body assembly

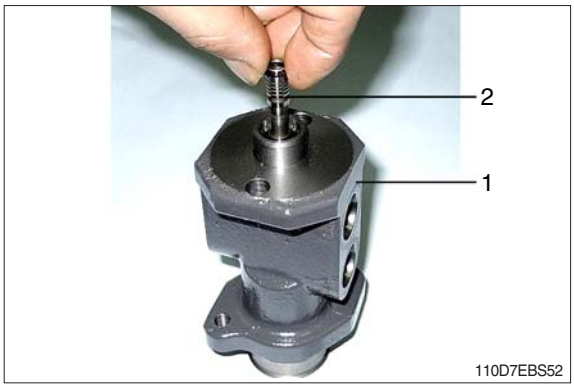
1 Body
2 Spool
3 Plug
4 Holder
5 Spring
6 Main spring
7 Spring retainer
9 Oil seal
11 DU bushing
15 Rubber cover
23 Plain washer
24 Stop ring



① Install oil seal (9), plain washer (23), stop ring (24), DU bushing (11).
- Tool : Jig for dry bearing, snap ring plier.



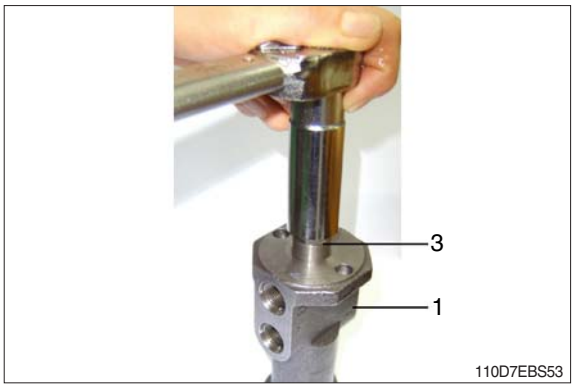
② Install spool (2) into body (1).



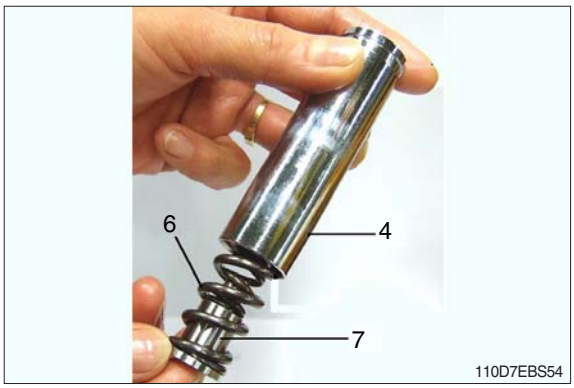
③ Tighten plug (3)
- Tool : 19㎜ spanner
- Tightening torque : 14.0~16.5 kgf · m

⚠ Press-in the DU bushing (11) with a exclusive jig.

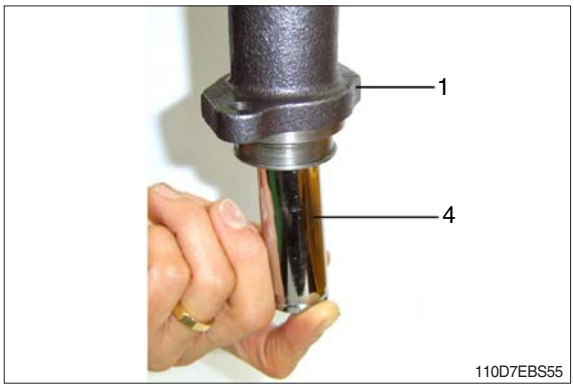
⚠ Be careful of dust and scrap after washing the parts.



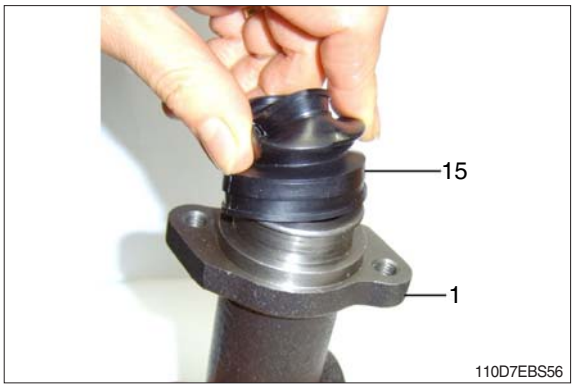
④ Spring retainer (7), main spring (6) and holder (4).



⑤ Insert holder (4) into body (1)

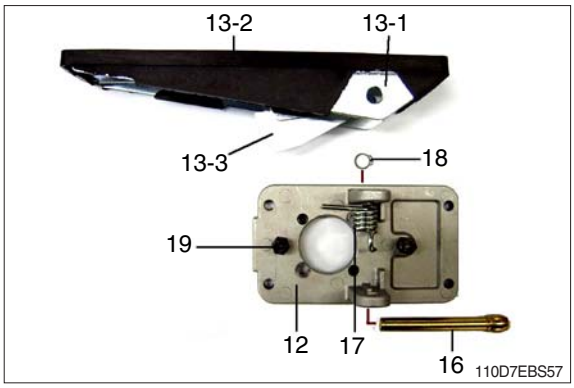


⑥ Rubber cover (15)

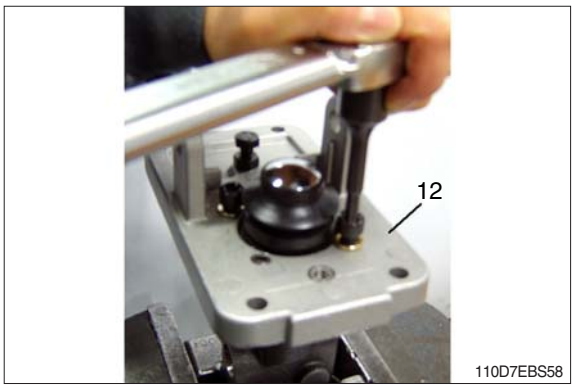


(2) Pedal plate assembly

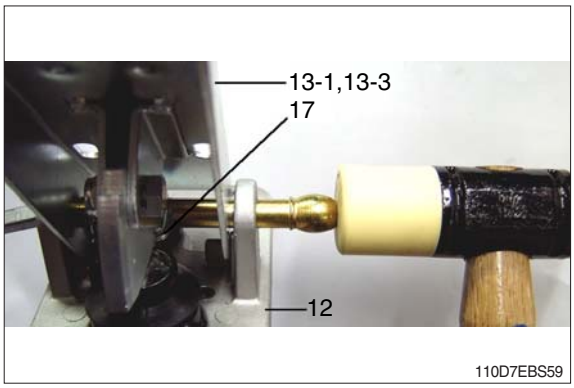
12 Pedal plate
13-1 Pedal
13-2 Pedal cover
13-3 Lock plate
16 Lock pin (pedal)
17 Torsion spring
18 Stop ring
19 Hexagon bolt



① Pedal plate (12) assembly
- Tool : 6 ㎜ torque wrench
- Tightening torque : 2.5~3.0 kgf · m

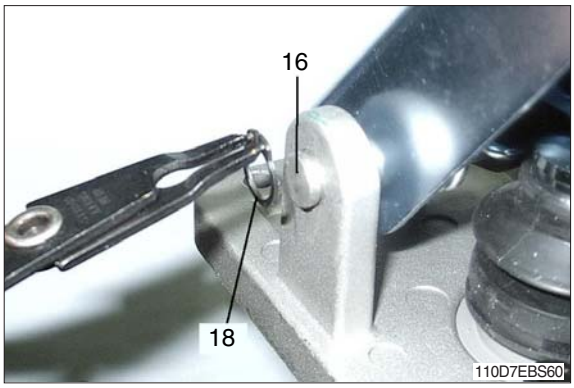


② Pre-assemble pedal assembly (13-1, 13-3) and torsion spring (17) on the pedal plate (12) with a bar of ø12 and then push the bar with a plastic hammer.
- Tool : ø12 bar, plastic hammer.

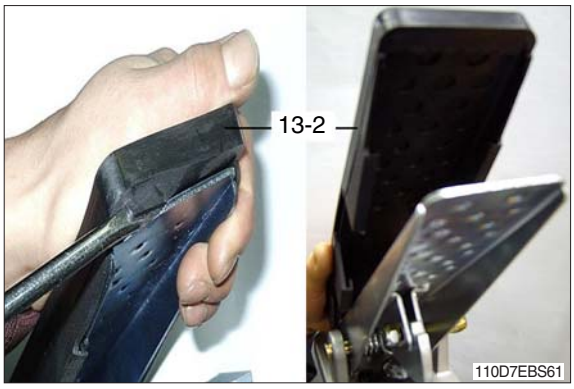


③ Lock pin (pedal) (16), stop ring (18).
- Tool : Snap ring plier for axis.

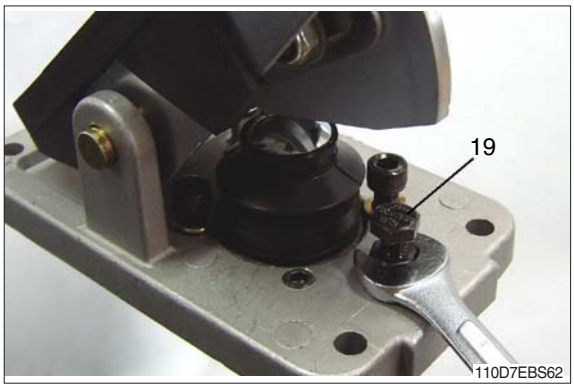
⚠ To prevent pedal plate from being damaged stop ring (18) must be removed before removing lock pin (16).



④ Rubber cover (13-2)



⑤ Hexagon bolt (19)
- Tool : 13 ㎜ spanner
- Tightening torque : 2.0 ㎏f · m

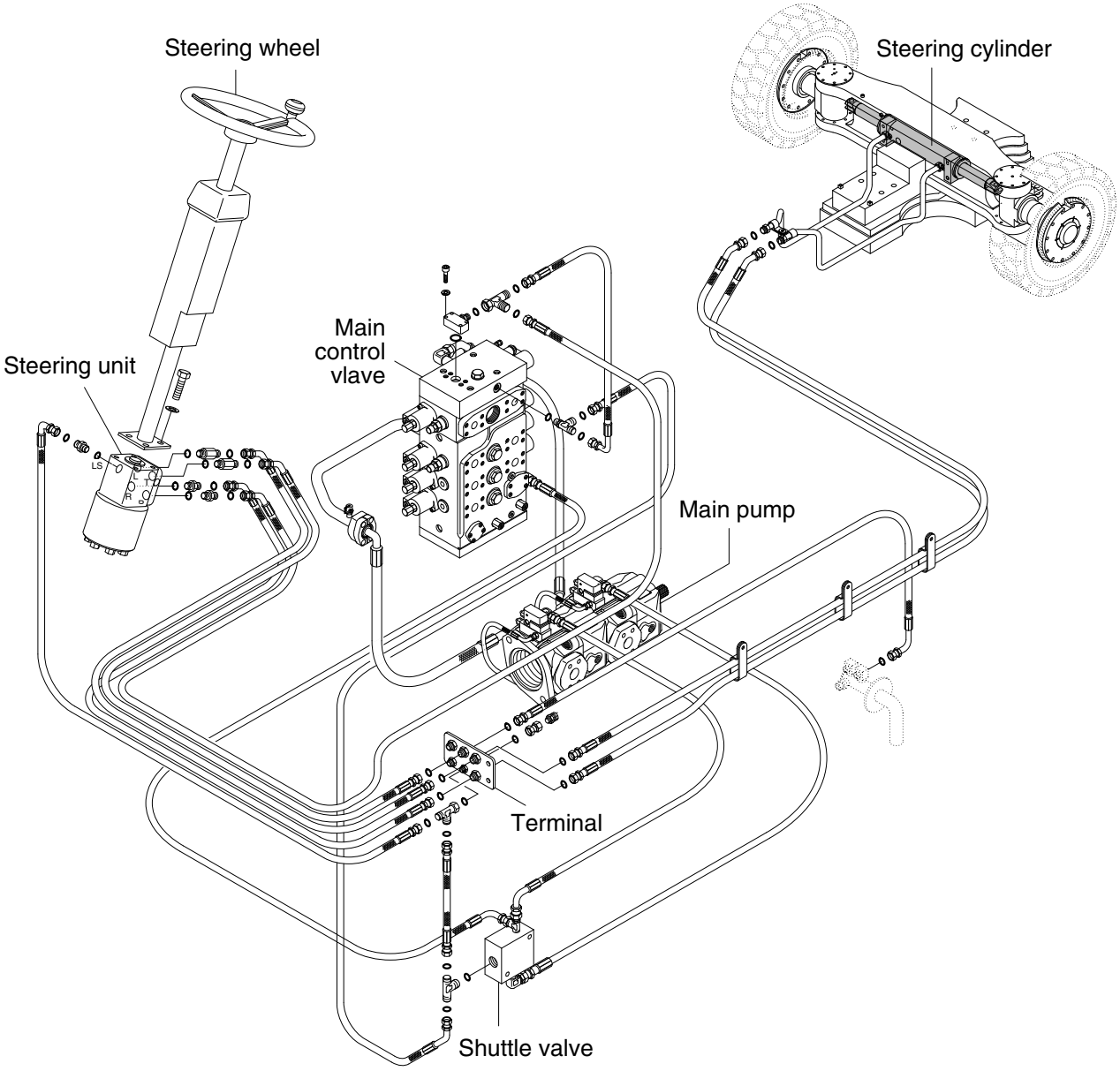


⚠ Never remove the hexagon bolt.
(Pressure setting valve deviation occurs)

SECTION 5 STEERING SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. OUTLINE

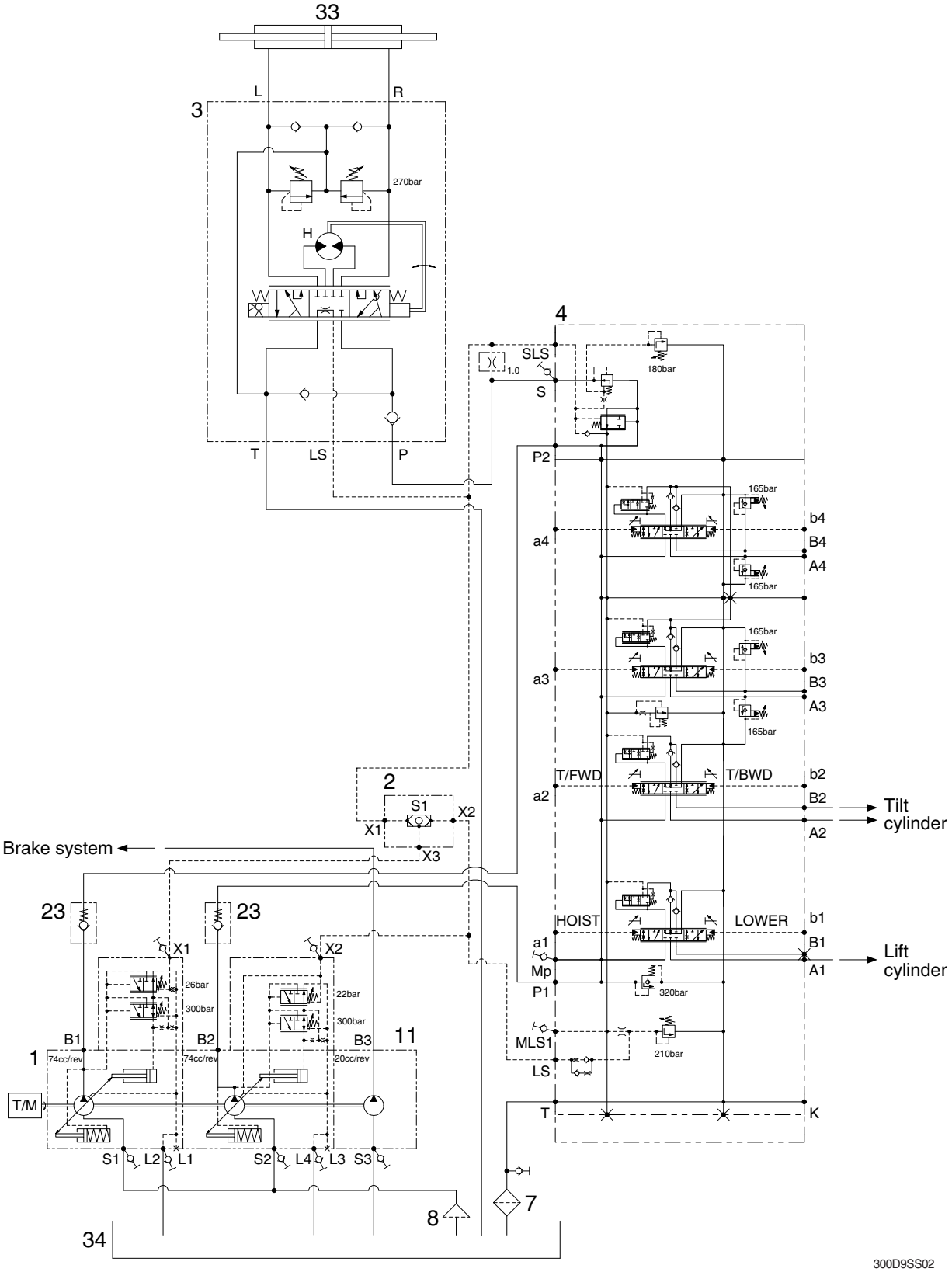


300D9SS01E

The steering system for this machine is composed of steering wheel assembly, steering unit, steering cylinder, steering axle and piping. 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.

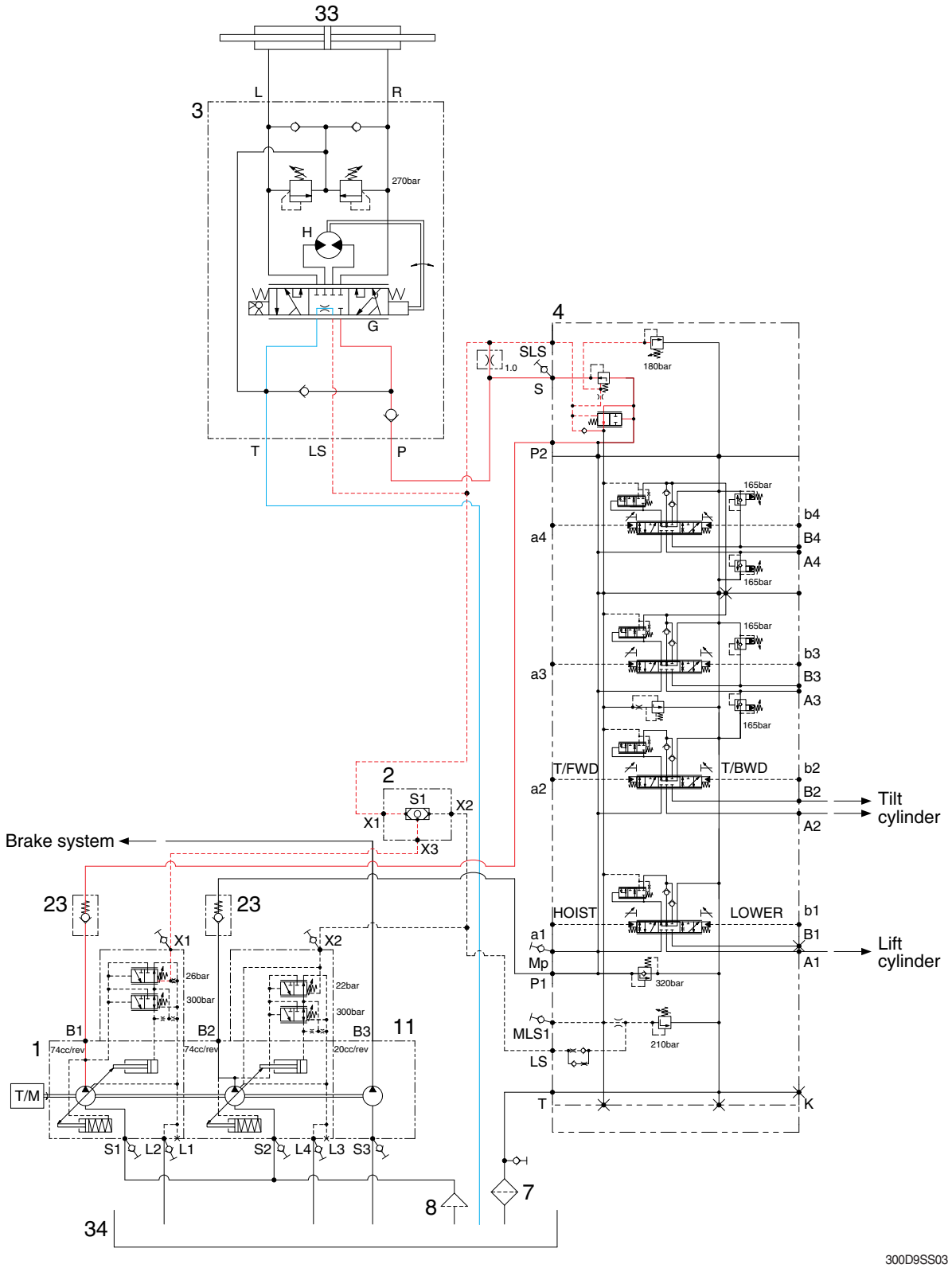
The axle body is unit structure having steering knuckles installed to its both ends by means of king pins. Hub and wheel are mounted through bearing to spindle of knuckle.

2. HYDRAULIC CIRCUIT



1	Main pump	8	Suction strainer
2	Shuttle valve	33	Steering cylinder
3	Steering unit	34	Hydraulic tank
4	Main control valve	35	Shuttle valve
7	Return filter	36	Check valve

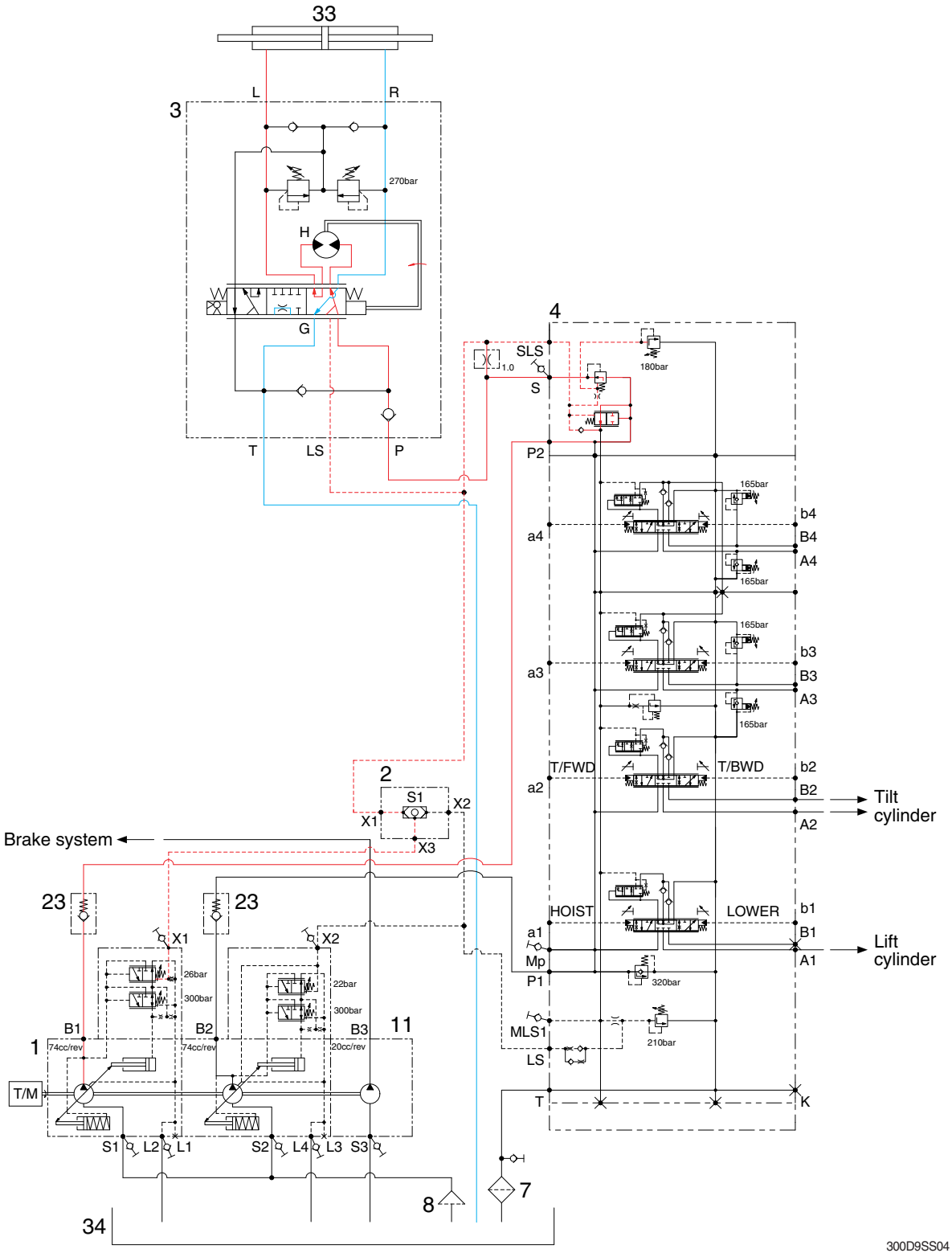
1) NEUTRAL



300D9SS03

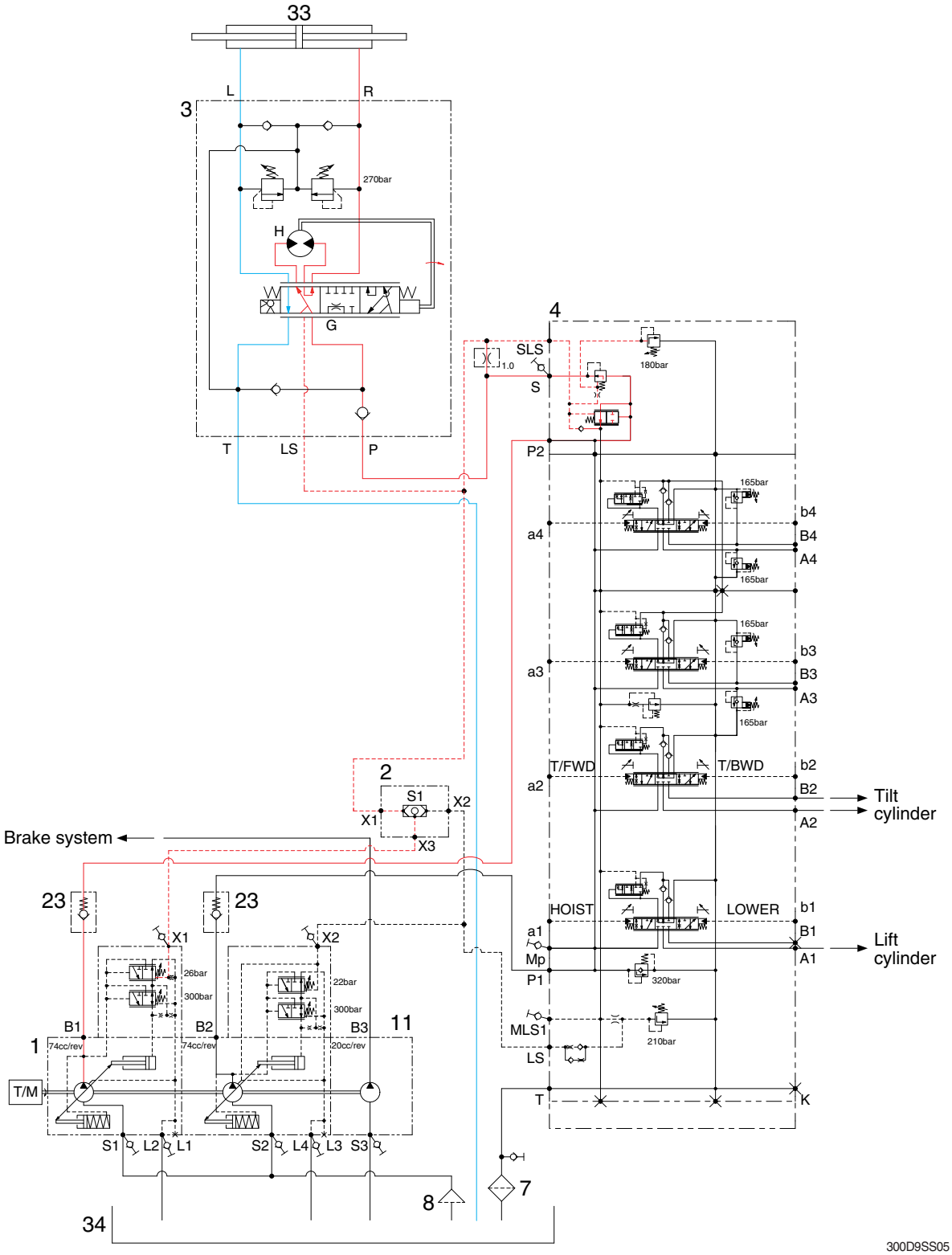
- The steering wheel is not being operated so control spool (G) does not move.
- The oil from the main pump (1) enters port P of steering unit (3) and almost all of pump flow goes to the main control valve.

2) LEFT TURN



- 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 main pump (1) flows into the spool (G) in the steering unit and flows the gerotor (H).
- Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out the left work port (L).
- Oil returned from cylinder returns to hydraulic tank (34).
- When the above operation is completed, the machine turns to the left.

3) RIGHT TURN

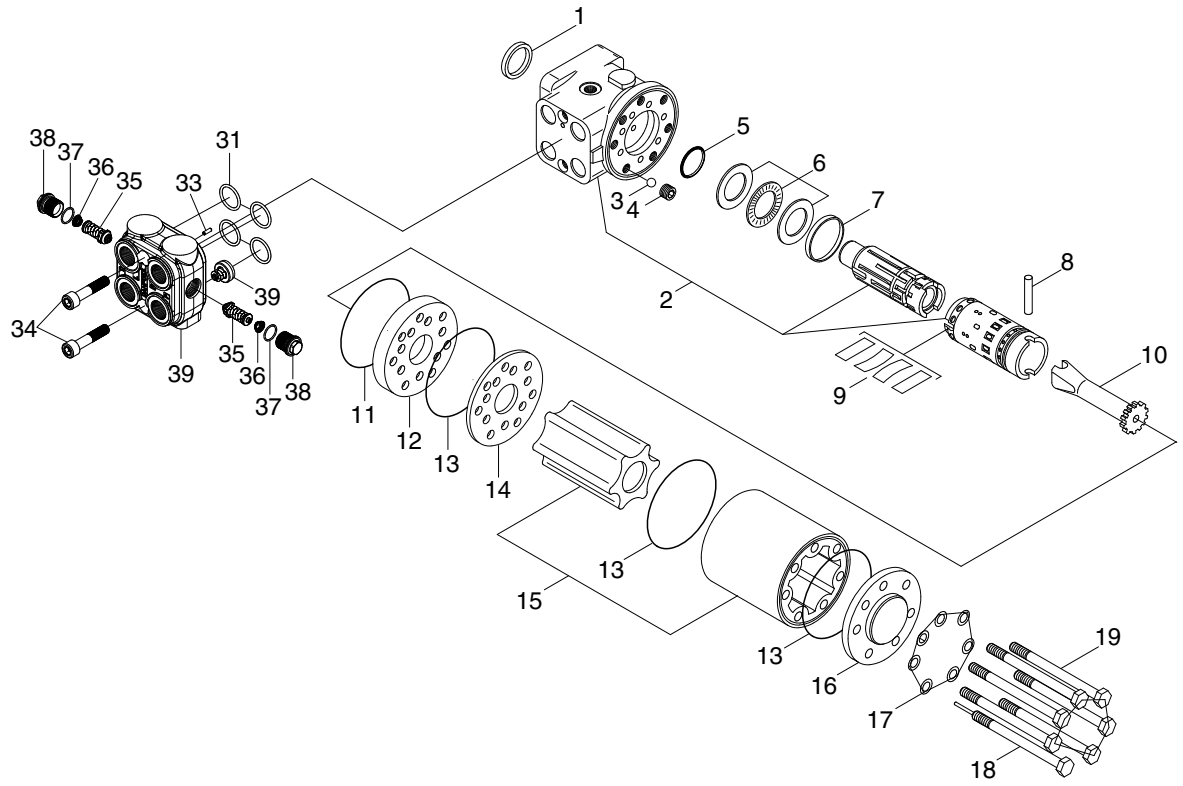


300D9SS05

- 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 main pump (1) flows into the spool (G) in the steering unit and flows the gerotor (H).
- Oil flow from the gerotor (H) flows back into the spool (G) where it is directed out the right work port (R).
- Oil returned from cylinder returns to hydraulic tank (34).
- When the above operation is completed, the machine turns to the right.

3. STEERING UNIT

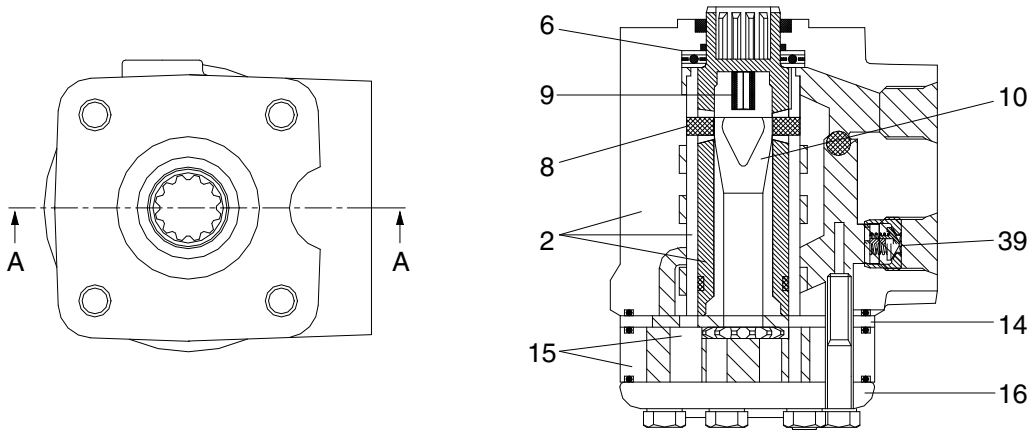
1) STRUCTURE



74095SE05

1	Dust seal ring	10	Cardan shaft	19	Screw
2	Housing, spool, sleeve	11	O-ring	31	Set of O-rings
3	Ball	12	Intermediate plate	33	Rolled pin
4	Thread bushing	13	O-ring	34	Screw
5	Roto glyd ring	14	Distributor plate	35	Shock valve
6	Bearing assembly	15	Gearwheel set	36	Spring
7	Ring	16	End cover	37	O-ring
8	Cross pin	17	Washer	38	Plug
9	Set of spring	18	Screw with pin	39	Housing, check valve

2) OPERATION



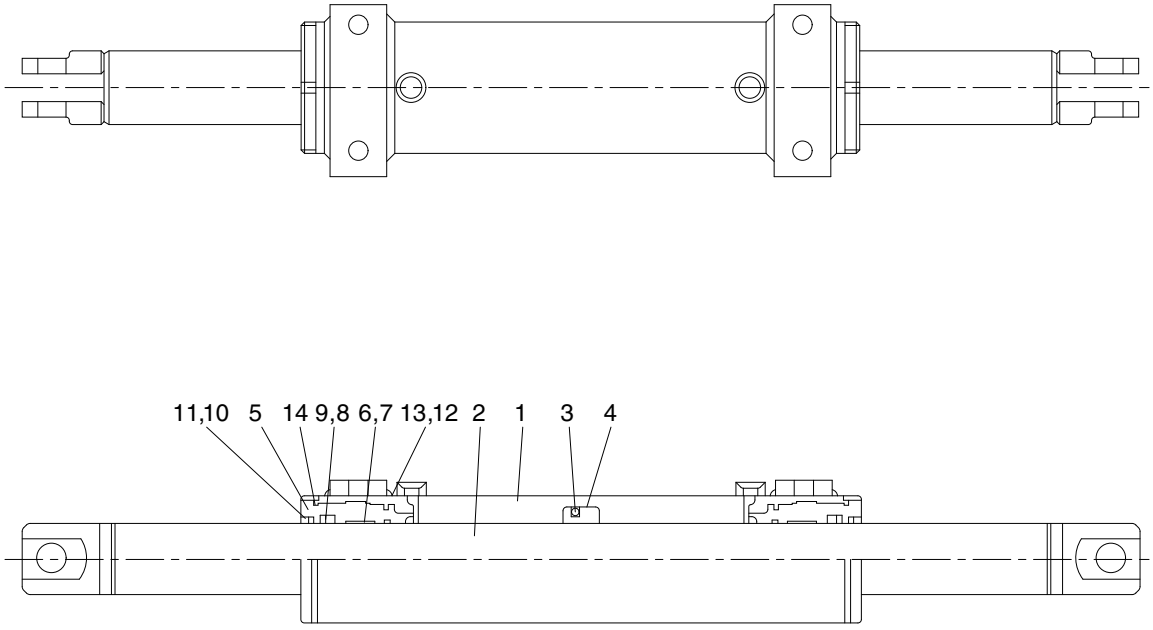
SECTION A - A

7407SE06

The steering unit consists of a rotary valve and a rotary meter.
Via a steering column the steering unit is connected to the steering wheel of the machine.
When the steering wheel is turned, oil is directed from the steering system pump via the rotary valve (spool and sleeve) and rotary meter (gear wheel set) to the cylinder ports L or R, depending on the direction of turn. The rotary meter meters the oil flow to the steering cylinder in proportion to the angular rotation of the steering wheel.
Spool is connected directly to the drive shaft (10) of steering wheel. It is connected to sleeve by cross pin (8) (not in contact with the spool when the steering wheel is at neutral) and neutral position spring (9).
Cardan shaft (10) is meshed at the top with cross pin (8) and forms one unit with sleeve.
At the same time, it is meshed with gear rim of the gerotor set by spline.
There are four ports in valve body. They are connected to the pump circuit, tank circuit, and the head, and left and right steering cylinder. In addition, the pump port and tank port are connected inside the body by the check valve. Therefore, if there is any failure in the pump of engine, oil can be sucked in directly from the tank through the check valve.

4. STEERING CYLINDER

1) STRUCTURE



250D7ESS06

1	Tube assembly	6	Rod bushing	11	Retaining ring
2	Rod assembly	7	Retaining ring	12	O-ring
3	Piston seal	8	U-packing	13	Back up ring
4	Wear ring	9	Back up ring	14	O-ring
5	Rod cover	10	Dust wiper		

2) OPERATION

This machine use to cross connected cylinder for steering operation.
The steering cylinder use a rod cover (5) to remove piston and sealed seals. Dust wiper (10) located on the in side of the rod cover protects cylinder inner parts from dust. The piston is fastened to the rod (2) by weld.

The piston uses a single piston seal (3) to seal between the piston and tube. The rod cover seals against the tube with two O-rings. The rod is sealed against the rod cover with a u-packing (8).

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

1. OPERATIONAL CHECKS

This procedure is designed so the service man can make a quick check of the steering system using a minimum amount of diagnostic equipment. If you need additional information, refer to structure and function in group 1.

A location will be required which is level and has adequate space to complete the checks.

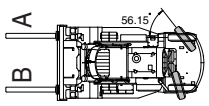
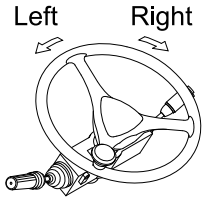
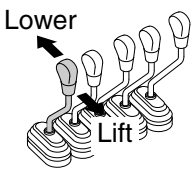
The engine and all other major components must be at operating temperature for some checks.

Locate system check in the left column and read completely, following this sequence from left to right. Read each check completely before performing.

At the end of each check, if no problem is found (OK), that check is complete or an additional check is needed. If problem is indicated (NOT OK), you will be give repair required and group location. If verification is needed, you will be give next best source of information :

- Chapter 2 : Troubleshooting
- Group 3 : Tests and adjustments

※ **Hydraulic oil must be at operating temperature for these checks.**

Item	Description	Service action
Steering unit check	 Run engine at low idle. Turn steering wheel until frames are at maximum right (A) and then left (B) positions. **LOOK** : Frames must move smoothly in both directions. When steering wheel is stopped, tires must stop. **FEEL** : Excessive effort must not be required to turn steering wheel. **NOTE** : It is normal for steering to drift from stops when steering wheel is released.	**OK** Check completed. **NOT OK** Go to next check.
Steering system leakage check Heat hydraulic oil to operating temperature. Run engine at high idle.	 Turn steering wheel rapidly until frames are against stop. Hold approximately 2kg on steering wheel. Count steering wheel revolutions for 1 minute. Repeat test in opposite direction. **LOOK** : Steering wheel should rotate less than 3 rpm. **NOTE** : Use good judgment; Excessive steering wheel rpm does not mean steering will be affected.	**OK** Check completed. **NOT OK** Do steering system leakage test in group 3 to isolate the leakage.
Priority valve (In main pump) low pressure check	Park machine on a hard surface. Hold brake pedal down. Run engine at high idle. Steer machine to the right and left as far as possible. **LOOK** : Machine must turn at least half way to the right and left stops.	**OK** Check completed. **NOT OK** Do priority valve pressure test.
Priority valve (In main pump) high pressure check Run engine at high idle.	 Steer to steering stop and release steering wheel. Lift, tilt hold over relief and observe engine rpm. Turn steering wheel to steering stop and hold, observe engine rpm. **LOOK** : Steering stall engine rpm must be higher than hydraulic stall rpm.	**OK** Check completed. **NOT OK** Priority pressure is set too high. Do priority valve pressure test.

2. TROUBLESHOOTING

※ Diagnose malfunction charts are arranged from most probable and simplest to verify, to least likely, more difficult to verify. Remember the following steps when troubleshooting a problem :

Step 1. Operational check out procedure (See group 3 in section 1)

Step 2. Operational checks (In this group)

Step 3. Troubleshooting

Step 4. Tests and adjustments (See group 3)

Problem	Cause	Remedy
No steering	Low oil level	Add recommended oil.
	Failed steering pump	Remove and inspect return filter for metal pump particles.
	Failed main pump drive	Do main pump flow test.
	Stuck priority valve spool	Remove and inspect priority valve spool.
	Broken priority valve spring	Remove and inspect spring.
	Relief valve in steering valve stuck open.	Do relief cartridge leakage test.
No hydraulic functions steering normal	Stuck open system relief valve	Replace relief valve.
	Locked safety valve	Unlock safety valve.
	Plugged pilot line filter	Inspect and replace.
	Failed hydraulic pump	Remove and inspect the pump.
	Low secondary pressure of RCV	Check the pressure and replace if necessary.

Problem	Cause	Remedy
Slow or hard steering	Too much friction in the mechanical parts of the machine	Lubricate bearings and joints of steering column or repair if necessary. Check steering column installation.
	Cold oil	Warm the hydraulic oil.
	Low priority valve pressure setting	Do priority valve pressure test. Clean or replace cartridge in steering valve.
	Worn hydraulic pump	Do hydraulic pump performance check.
	Sticking priority valve spool	Remove and inspect.
	Broken priority valve spring	Remove and inspect.
Constant steering to maintain straight travel	Air in system	Check for foamy oil.
	Leakage in steering system	Do steering system leakage check.
	Worn steering unit	Do steering system leakage check. Do steering unit neutral leakage test in group 3.
	Leaf spring without spring force or broken	Replace leaf springs.
	Spring in double shock valve broken	Replace shock valve.
	Gear wheel set worn	Replace gear wheel set.
	Cylinder seized or piston seals worn	Replace defects parts.
Slow steering wheel movement will not cause any frame movement	Leakage in steering unit gerotor	Do steering system leakage check.
	Worn steering unit gerotor	Do steering leakage check.
Steering wheel can be turned with frames against steering stop	Leakage in steering system	Do steering system leakage check.
Steering wheel turns with no resistance and causes no frame movement	Broken steering column or splined coupling	Remove and inspect.
	Lack of oil in steering unit	Start engine and check steering operation.
	Leakage in steering system	Do steering system leakage test in group 3.

Problem	Cause	Remedy
Erratic steering	Air in oil	Check for foamy oil.
	Low oil level	Add recommended oil.
	Sticking priority valve spool	Remove and inspect spool.
	Loose cylinder piston	Remove rod to inspect piston.
	Damaged steering unit	Remove and inspect.
Spongy or soft steering	Air in oil	Check for foamy oil.
	Low oil level	Add recommended oil.
Free play at steering wheel	Loose steering wheel nut	Tighten.
	Worn or damaged splines on steering column or unit	Inspect.
Steering unit binding or steering wheel does not immediately return to neutral when released	Binding in steering column or misalignment of column	Inspect.
	High return pressure	Check for a pinched or damaged return line.
	Contamination in steering unit	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
	Large particles of contamination in steering unit	Inspect hydraulic filter for contamination. Repair cause of contamination. Flush hydraulic system.
Steering unit locks up	Worn or damaged steering unit	Repair or replace steering unit.
Abrupt steering wheel oscillation	Improperly timed gerotor gear in steering unit	Time gerotor gear.
Steering wheel turns by itself	Lines connected to wrong port	Reconnect lines.
Vibration in steering system or hoses jump	High priority valve setting	Do priority valve pressure test.
Neutral position of steering wheel cannot be obtained, i.e. there is a tendency towards "motoring"	Steering column and steering unit out of line	Align the steering column with steering unit.
	Too little or no play between steering column and steering unit input shaft	Adjust the play and, if necessary, shorten the splines journal.
	Pinching between inner and outer spools	Contact the nearest service shop.

Problem	Cause	Remedy
"Motoring" effect. The steering wheel can turn on its own.	Leaf springs are stuck or broken and have therefore reduced spring force	Replace leaf springs.
	Inner and outer spools pinch, possibly due to dirt	Clean steering unit or contact the nearest service shop.
	Return pressure in connection with the reaction between differential cylinder and steering unit too high	Reduce return pressure.
	Oil is needed in the tank	Fill with clean oil and bleed the system.
	Steering cylinder worn	Replace or repair cylinder.
	Gear wheel set worn	Replace gear wheel set.
	Spacer across cardan shaft forgotten	Install spacer.

Problem	Cause	Remedy
Backlash	Cardan shaft fork worn or broken	Replace cardan shaft.
	Leaf springs without spring force or broken	Replace leaf springs.
	Worn splines on the steering column	Replace steering column.
"Shimmy" effect. The steered wheels vibrate. (Rough tread on tires gives vibrations)	Air in the steering cylinder	Bleed cylinder. Find and remove the reason for air collection.
	Mechanical connections or wheel bearings worn	Replace worn parts.
	High priority valve setting pressure	Set pressure as regular value.
Steering wheel can be turned slowly in one or both directions without the steered wheels turning.	One or both shock valves are leaky or are missing in steering valve	Clean or replace defective of missing valves.
Steering is too slow and heavy when trying to turn quickly.	Insufficient oil supply to steering unit, pump defective or number of revolutions too low	Replace pump or increase number of revolutions.
	Relief valve setting too low	Adjust valve to correct setting.
	Relief valve sticking owing to dirt	Clean the valve.
	Spool in priority valve sticking owing to dirt.	Clean the valve, check that spool moves easily without spring.
	Too weak spring in priority valve	Replace spring by a stronger.
"Kick back" in steering wheel from system. Kicks from wheels.	Fault in the system	Contact authorized man or shop.

Problem	Cause	Remedy
Heavy kick-back in steering wheel in both directions.	Wrong setting of cardan shaft and gear-wheel set	Correct setting as shown in service manual.
Turning the steering wheel activates the steered wheels opposite.	Hydraulic hoses for the steering cylinders have been switched around	Connect lines to correct ports.
Hard point when starting to turn the steering wheel	Spring force in priority valve too weak	Replace spring by a stronger.
	Clogged orifices in LS side in priority valve	Clean orifices in spool and in connecting plugs for LS.
	Oil is too thick (Cold)	Let motor run until oil is warm.
Too little steering force (Possibly to one side only).	Pump pressure too low	Correct pump pressure.
	Too little steering cylinder	Fit a larger cylinder.
	Piston rod area of the differential cylinder too large compared with piston diameter	Fit cylinder with thinner piston rod or 2 differential cylinders.
Leakage at either input shaft, end cover, gear-wheel set, housing or top part.	Shaft defective	Replace shaft seal.
	Screws loose	Tighten screws.
	Washers or O-rings defective	Replace.

GROUP 3 TESTS AND ADJUSTMENTS

1. HYDRAULIC OIL CLEAN UP PROCEDURE USING PORTABLE FILTER CADDY

※ Service equipment and tool.
- Portable filter caddy
- Two 3658 mm (12ft) × 1" I.D. 100R1 hoses with 3/4 M NPT ends
- Quick disconnect fittings
- Discharge wand
- Various size fittings and hoses

※ Brake system uses oil from hydraulic oil tank.
Flush all lines in the steering system.
Disassemble and clean major components for steering system.
Steering components may fail if steering system is not cleaned after hydraulic oil tank contamination.

1) If hydraulic system is contaminated due to a major component failure, remove and disassemble steering cylinders to clean debris from cylinders.

2) Install a new return filter element. Clean filter housing before installing new element.

※ For a failure that creates a lot of debris, remove access cover from hydraulic oil tank. Drain and clean hydraulic oil tank of fill the specified oil to hydraulic oil tank through upper cover.

3) To minimize oil loss, pull a vacuum in hydraulic oil tank using a vacuum pump. Connect filter caddy suction line to drain port at bottom of hydraulic oil tank using connector. Check to be sure debris has not closed drain port.

4) Put filter caddy discharge line into hydraulic oil tank filter hole so end is as far away from drain port as possible to obtain a through cleaning of oil.

5) Start the filter caddy. Check to be sure oil is flowing through the filters.
   Operate filter caddy approximately 10 minutes so oil in hydraulic oil tank is circulated through filter a minimum of four times.

※ Hydraulic oil tank capacity 387 ℓ (102 U.S. gal).
   Leave filter caddy operating for the next steps.

6) Start the engine and run it at high idle.

※ For the most effective results, cleaning procedure must start with the smallest capacity circuit then proceed to the next largest capacity circuit.

7) Operate all functions, one at a time, through a complete cycle. Also include all auxiliary hydraulic functions.

   Repeat procedure until the total system capacity has circulated through filter caddy seven times, approximately 30 minutes.
   Each function must go through a minimum of three complete cycles for a through cleaning for oil.

※ Filtering time for machines with auxiliary hydraulic functions must be increased because system capacity is larger.

8) Stop the engine. Remove the filter caddy.

9) Install a new return filter element.

10) Check oil level in hydraulic oil tank ; Add oil if necessary.

2. TEST TOOLS

1) CLAMP-ON ELECTRONIC TACHOMETER INSTALLATION

- Service equipment and tools

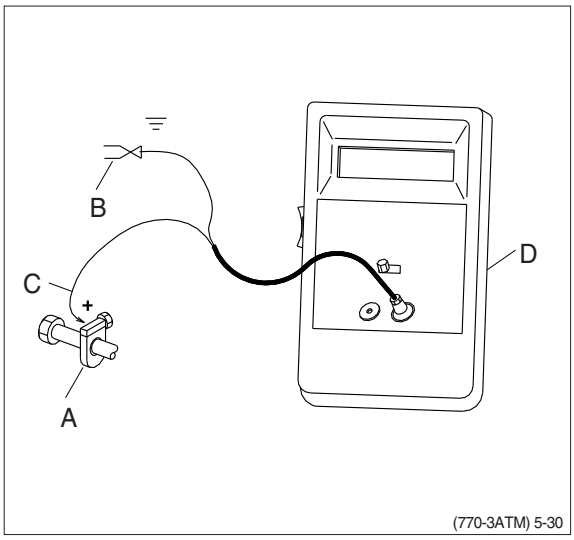
  Tachometer

  A : Clamp on tachometer.
  Remove paint using emery cloth and connect to a straight section of injection line within 100 mm (4 in) of pump. Finger tighten only-do not over tighten.

  B : Black clip (-). Connect to main frame.

  C : Red clip (+). Connect to transducer.

  D : Tachometer readout. Install cable.



(770-3ATM) 5-30

2) DIGITAL THERMOMETER INSTALLATION

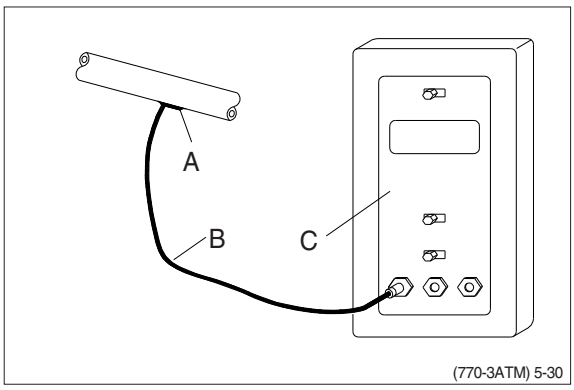
- Service equipment and tools

  Digital thermometer

  A : Temperature probe.
  Fasten to a bare metal line using a tie band. Wrap with shop towel.

  B : Cable.

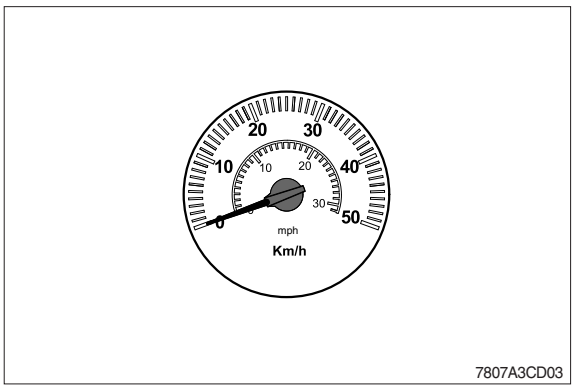
  C : Digital thermometer.



(770-3ATM) 5-30

3) DISPLAY MONITOR TACHOMETER

The display monitor tachometer is accurate enough for test work.



7807A3CD03

3. STEERING UNIT LEAKAGE TEST

· **SPECIFICATION**

Oil temperature 45±5 ˚C (113±9 ˚F)
Engine speed High idle
Maximum leakage 7.5 ℓ /min (2 gpm)

· **GAUGE AND TOOL**

Temperature reader
Measuring container (Approx. 20 ℓ)
Stop watch

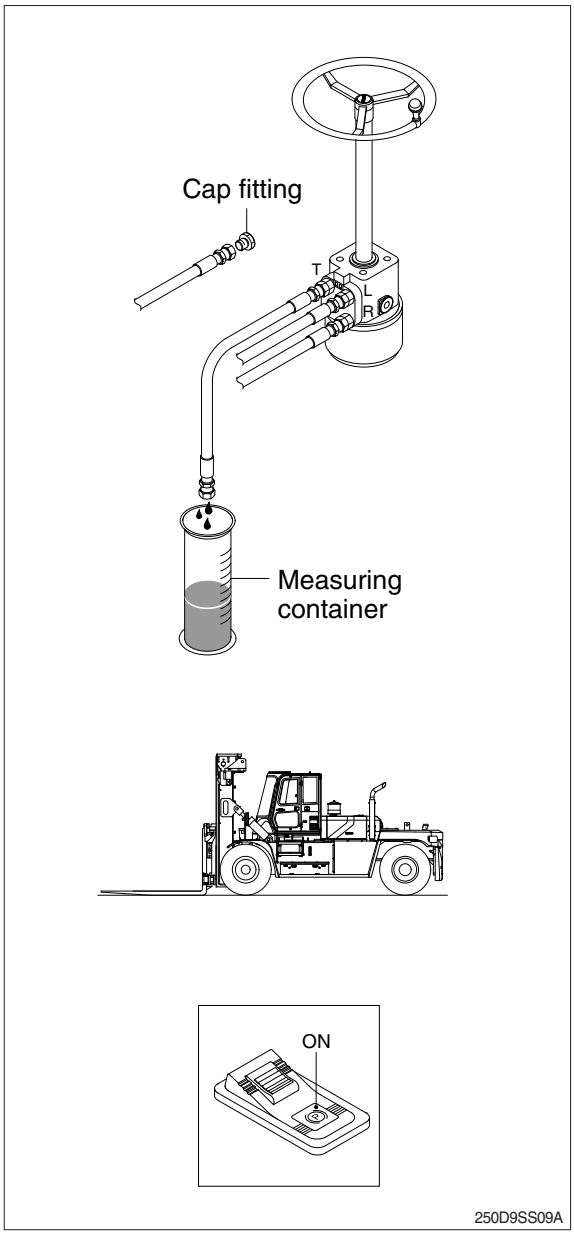
1) Install temperature reader.
(See temperature reader installation procedure in this group).

2) Heat hydraulic oil to specifications.

3) Disconnect return hose from fitting.
Install cap fitting.

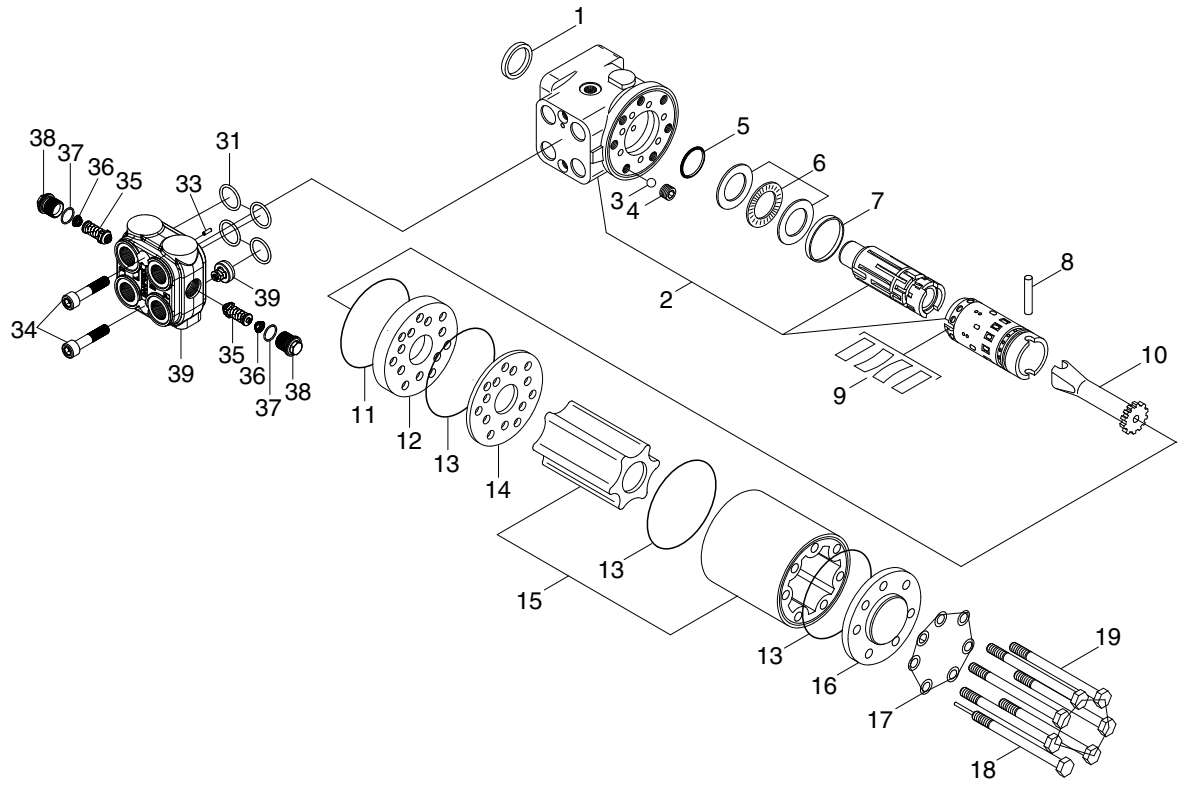
4) Run engine at specifications. Rotate steering wheel completely to the right (or left) approximately 1.2 kgf · m of force.
Measure oil flow from return hose for 1 minute.

5) If leakage is greater than specifications, repair or replace steering unit.



1. STEERING UNIT

1) STRUCTURE

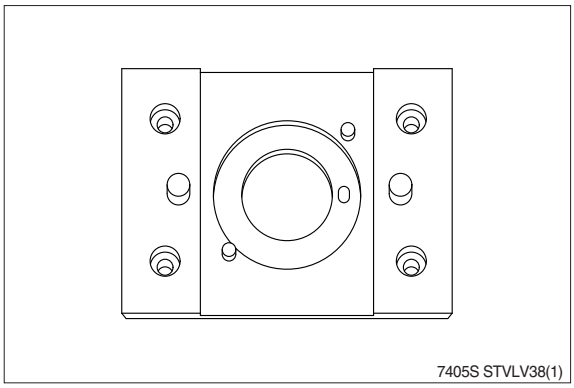


74095SE05

1	Dust seal ring	10	Cardan shaft	19	Screw
2	Housing, spool, sleeve	11	O-ring	31	Set of O-rings
3	Ball	12	Intermediate plate	33	Rolled pin
4	Thread bushing	13	O-ring	34	Screw
5	Roto glyd ring	14	Distributor plate	35	Shock valve
6	Bearing assembly	15	Gearwheel set	36	Spring
7	Ring	16	End cover	37	O-ring
8	Cross pin	17	Washer	38	Plug
9	Set of spring	18	Screw with pin	39	Housing, check valve

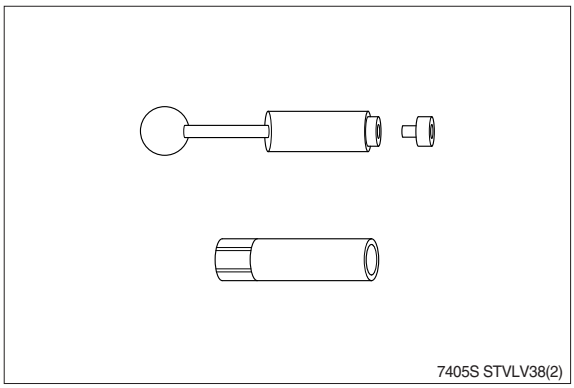
2) TOOLS

(1) Holding tool.



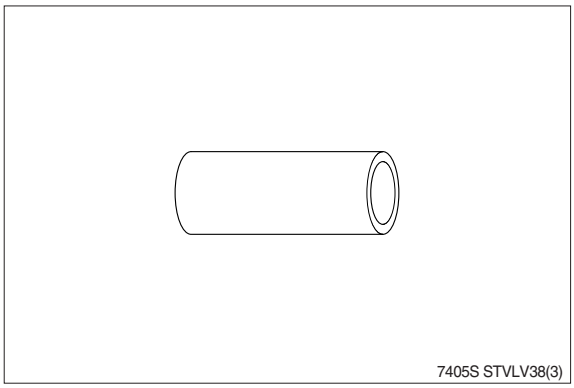
7405S STVLV38(1)

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



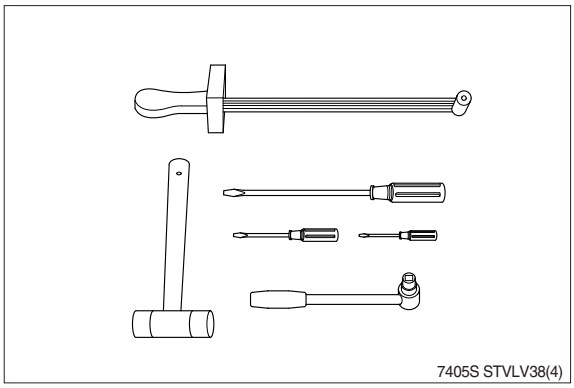
7405S STVLV38(2)

(3) Assembly tool for dust seal.



7405S STVLV38(3)

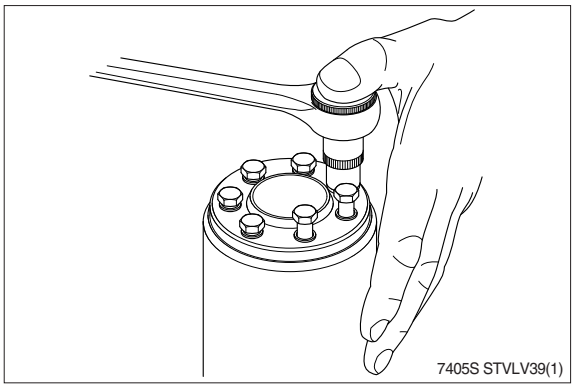
(4) Torque wrench 0~7.1 kgf · m (0~51.6 lb · ft)
13 mm socket spanner
12 mm screwdriver
6 mm screwdriver
2 mm screwdriver
Plastic hammer
Ratchet spanner



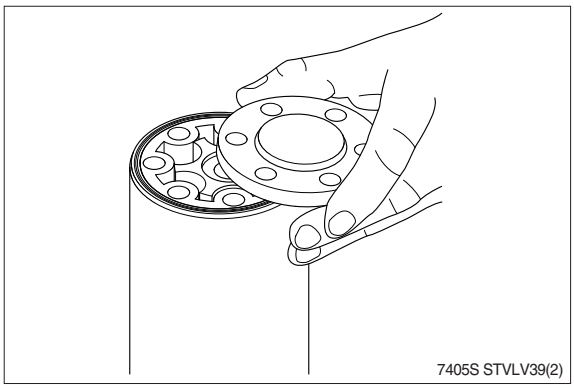
7405S STVLV38(4)

3) DISASSEMBLY

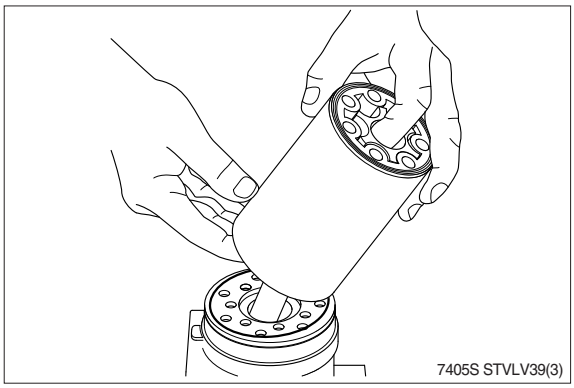
(1) Disassemble steering column from steering unit and place the steering unit in the holding tool. Screw out the screws in the end cover (7-off-one rolled pin).


7405S STVLV39(1)

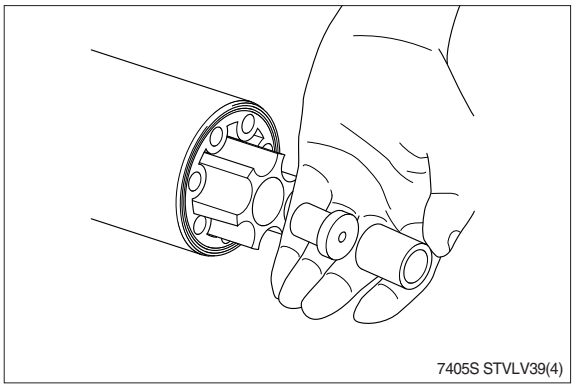
(2) Remove the end cover, sideways.


7405S STVLV39(2)

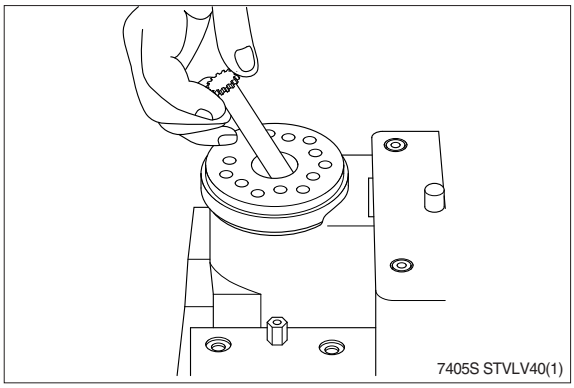
(3) Lift the gearwheel set with spacer bushing (and spacer if fitted) off the unit. Take out the two O-rings.


7405S STVLV39(3)

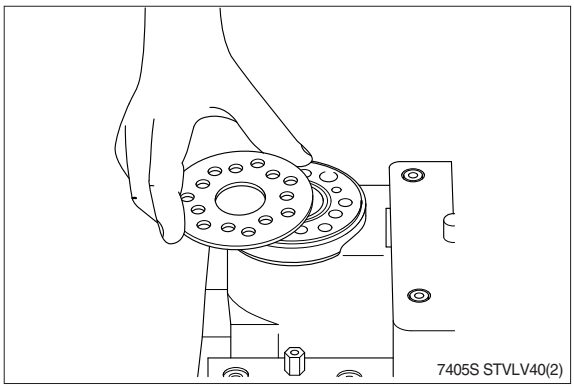
(4) Remove spacer bushing and spacer(if fitted) from the gearwheel.


7405S STVLV39(4)

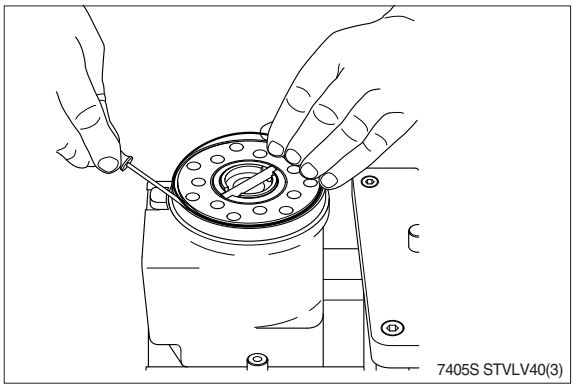
(5) Remove cardan shaft.



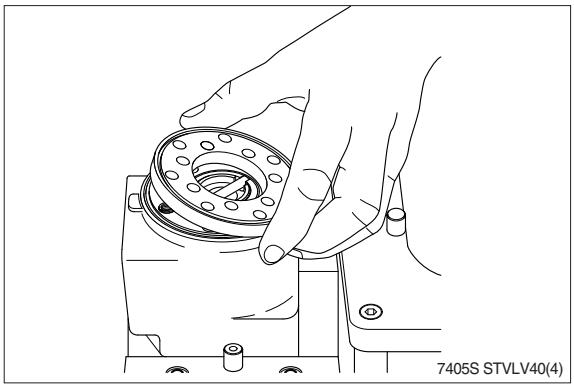
(6) Remove distributor plate.



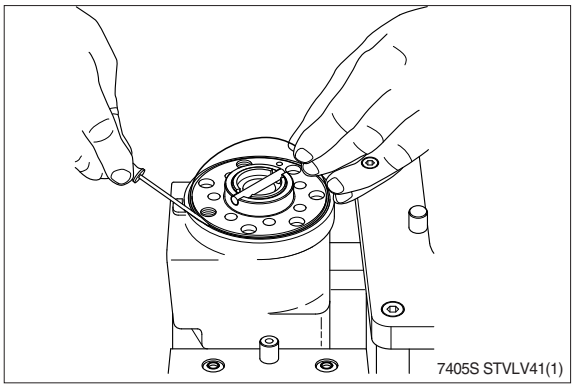
(7) Remove O-ring.



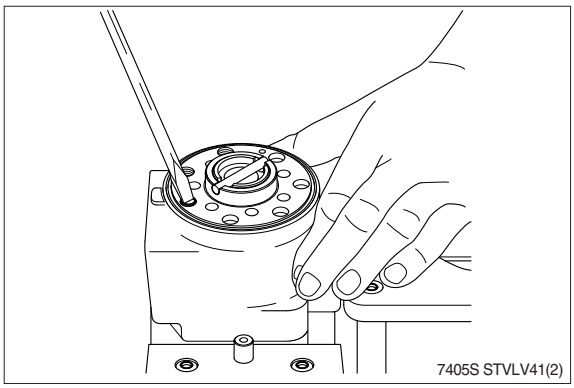
(8) Lift off intermediate plate.



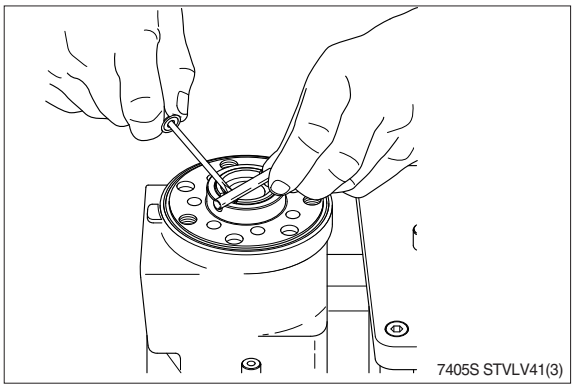
(9) Remove O-ring.



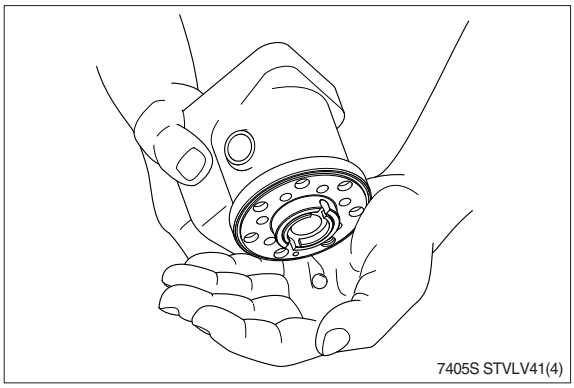
(10) Screw out the threaded bushing.



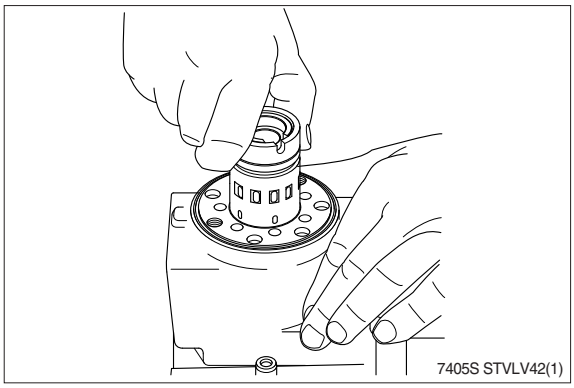
(11) Remove cross pin.



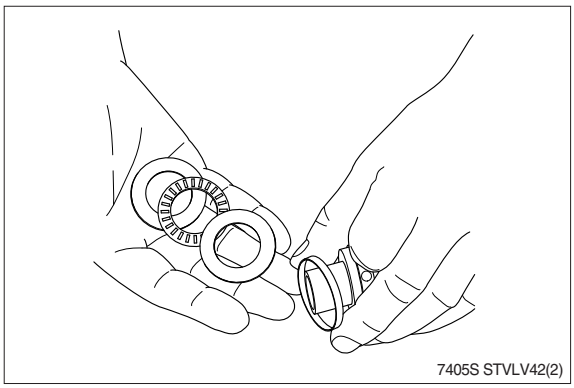
(12) Shake out the ball (ø 8.5 ㎜).



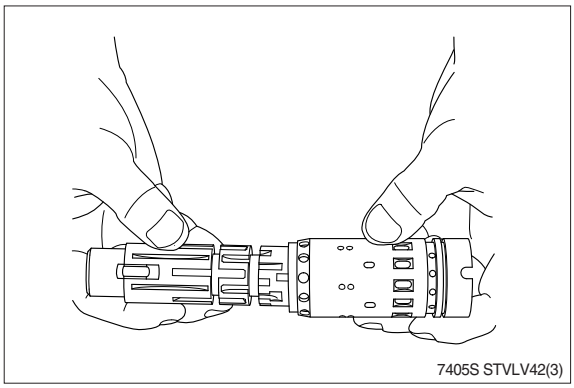
(13) Pull sleeve and spool out of the housing.



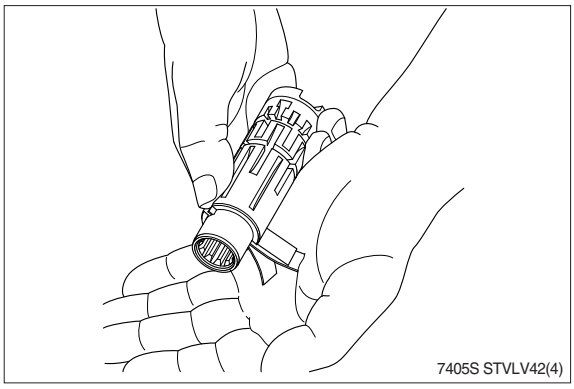
(14) Take ring, bearing races and needle bearing from sleeve and spool. The outer (thin) bearing race can sometimes "stick" in the housing, therefore check that it has come out.



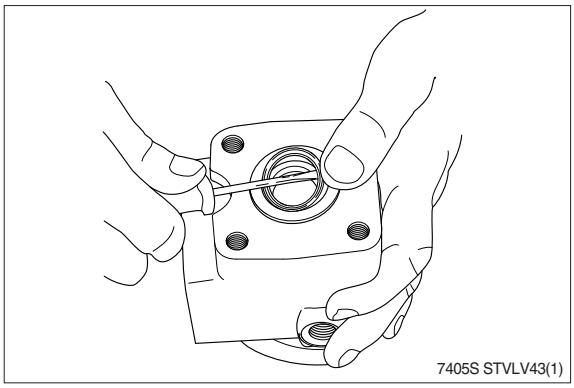
(15) Carefully pull the spool out of the sleeve.



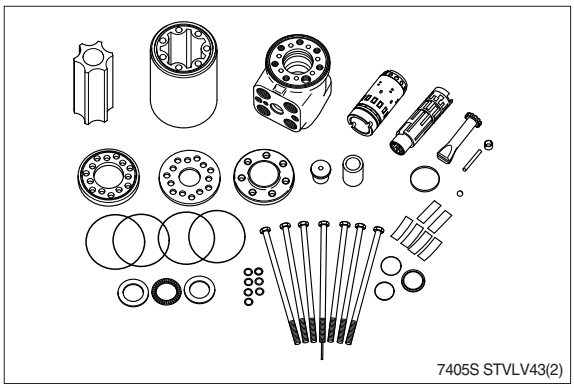
(16) Press the neutral position springs out of their slots in the spool.



(17) Remove dust seal and O-ring.



(18) The steering unit is now completely disassembled.



Cleaning

Clamp all parts carefully in Shellsol K or the like.

Inspection an replacement

Replace all seals and washer. Check all parts carefully and make any replacements necessary.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

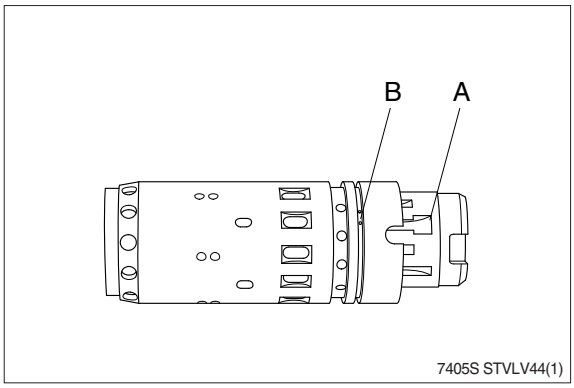
4) ASSEMBLY

(1) Assemble spool and sleeve.

※ The sleeve and spool are correctly assembled when

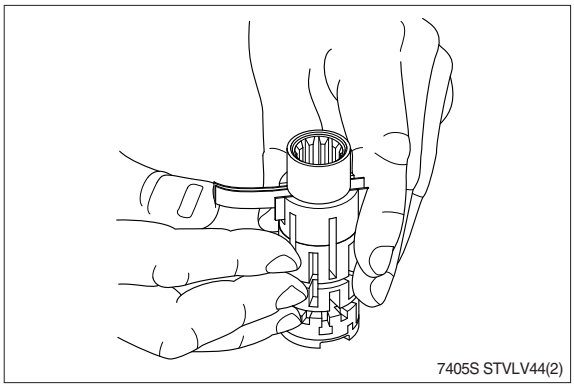
① The slots-in sleeve and spool-for the neutral position springs are opposite each other and

② One of the 3 T-shaped grooves (A) in the spool is opposite one of the sets (B) of small holes in the sleeve.

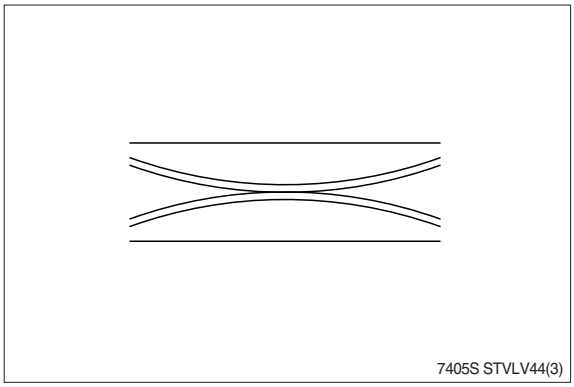


7405S STVLV44(1)

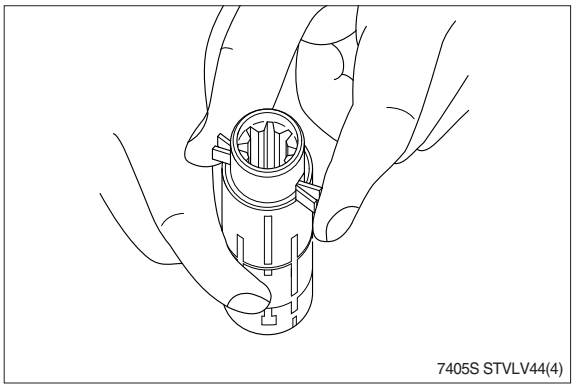
(2) Place the two flat neutral position springs in the slot.


7405S STVLV44(2)

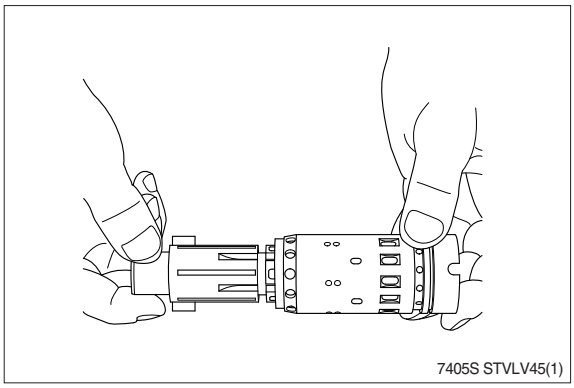
(3) Place the curved springs between the flat ones and press them into place.


7405S STVLV44(3)

(4) Line up the spring set.

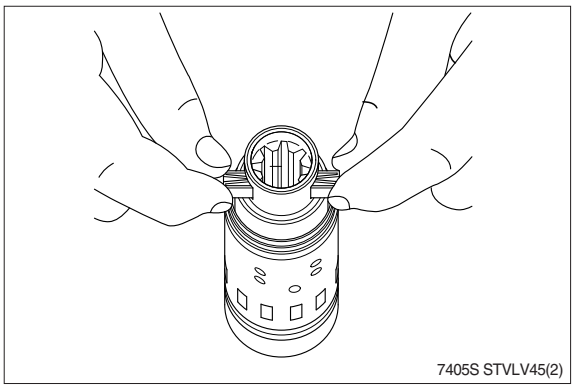

7405S STVLV44(4)

(5) Guide the spool into the sleeve.



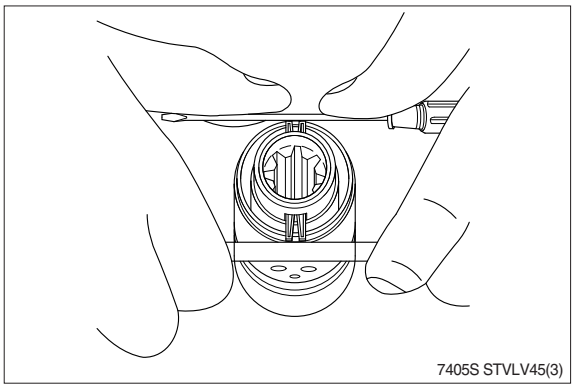
7405S STVLV45(1)

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



7405S STVLV45(2)

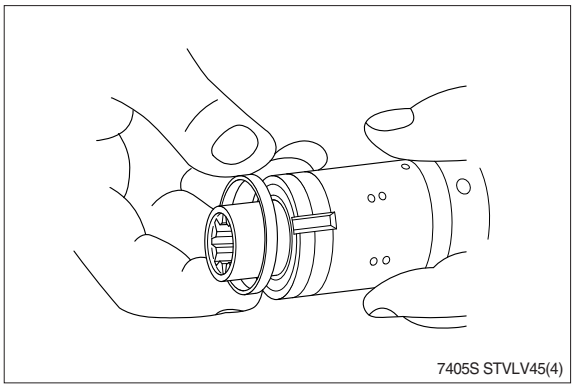
(7) Line up the springs and center them.



7405S STVLV45(3)

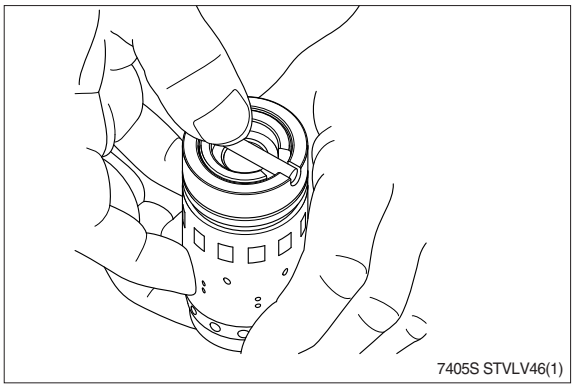
(8) Guide the ring down over the sleeve.

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

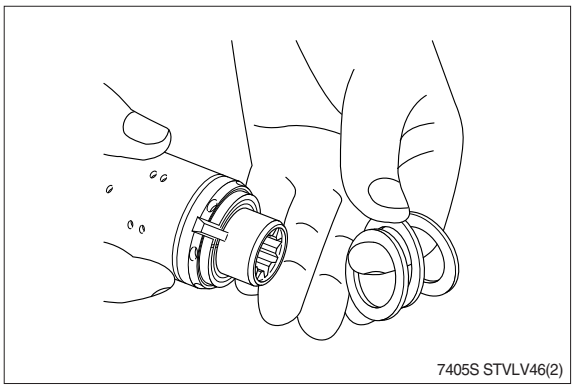


7405S STVLV45(4)

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

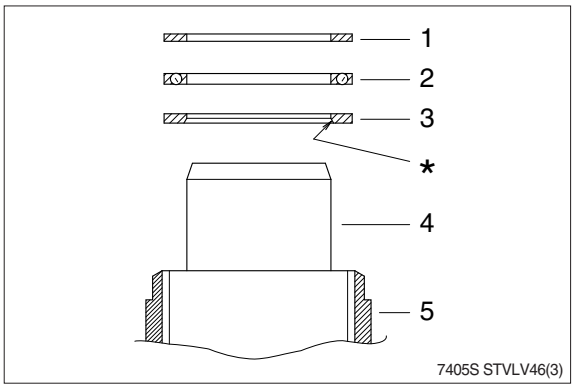


(10) Fit bearing races and needle bearing as shown on below drawing.

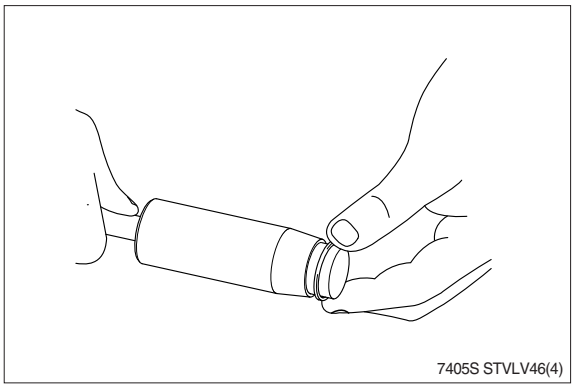


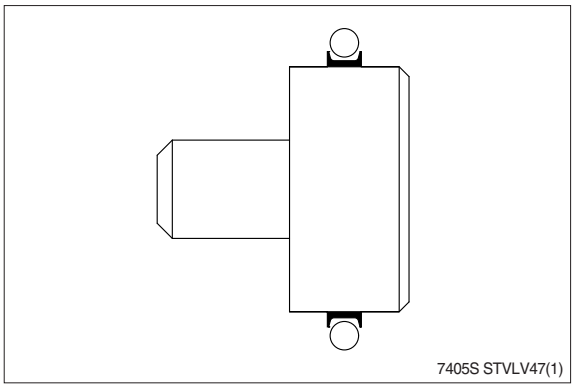
1 Outer bearing race
2 Needle bearing
3 Inner bearing race
4 Spool
5 Sleeve

* Inside chamfer on inner bearing race must face inner spool.

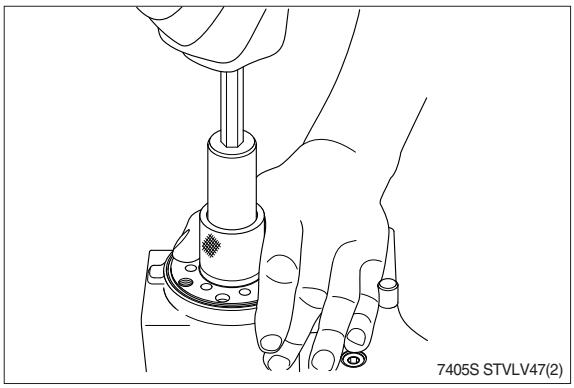


(11) Grease O-ring and kin-ring with hydraulic oil and place them on the tool. See next page.

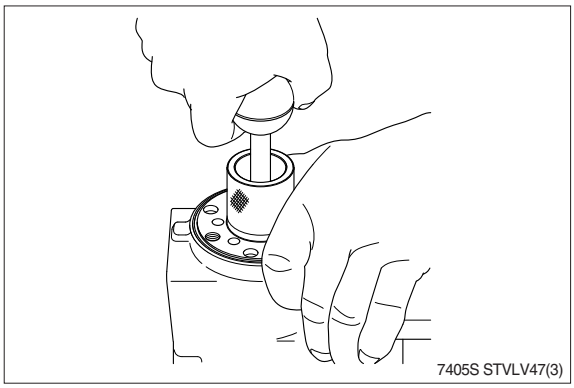



7405S STVLV47(1)

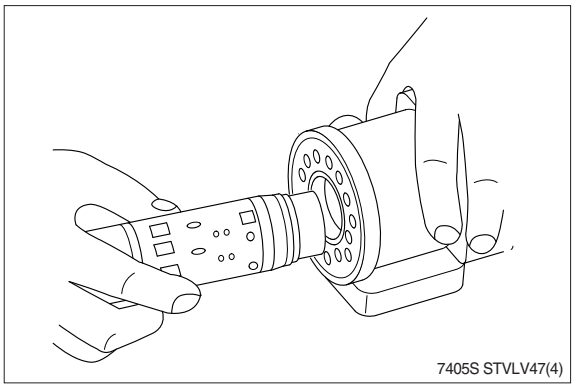
(12) Put the steering unit in the holding tool keeping the bore vertical. Guide the outer part of the assembly tool into the bore. Guide the inner part of the tool right to the bottom.


7405S STVLV47(2)

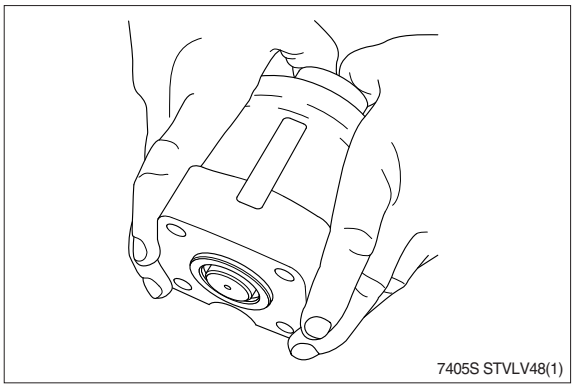
(13) Press and turn the O-ring into position in the housing. Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide in the bore.


7405S STVLV47(3)

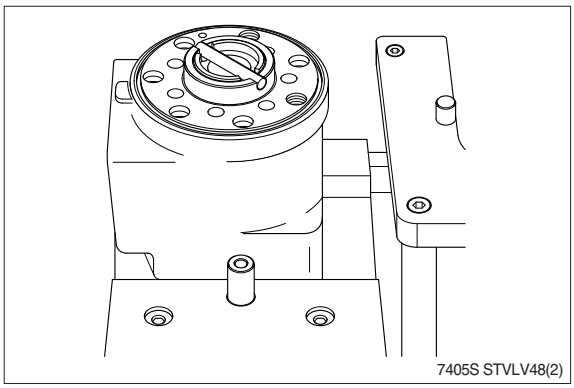
(14) Take the steering unit out of the holding tool and place it horizontally. With a light turning movement, guide the spool and sleeve into the bore.


7405S STVLV47(4)

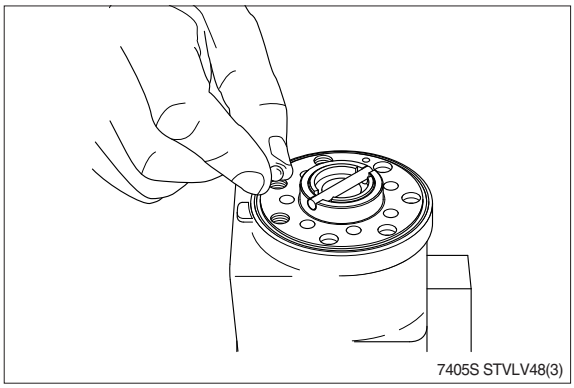
(15) The spool set will push out the assembly tool guide. The O-ring is now in position.


7405S STVLV48(1)

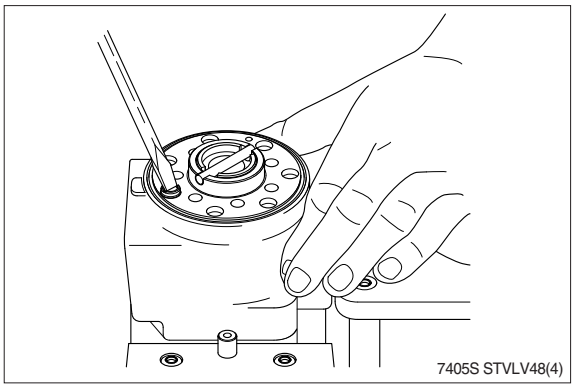
(16) Put the steering unit back into the holding tool keeping the bore vertical. Place the cross pin in the spool/sleeve so that it is parallel to the port flange.


7405S STVLV48(2)

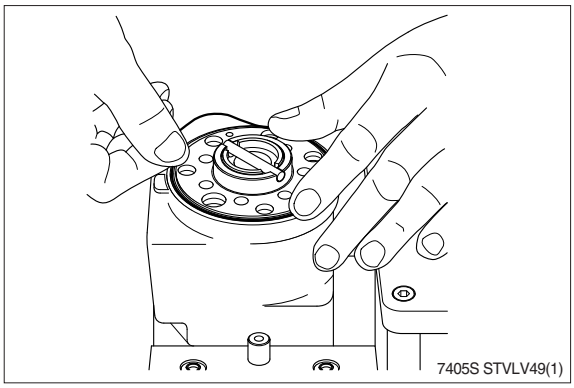
(17) Put the ball into the hole.


7405S STVLV48(3)

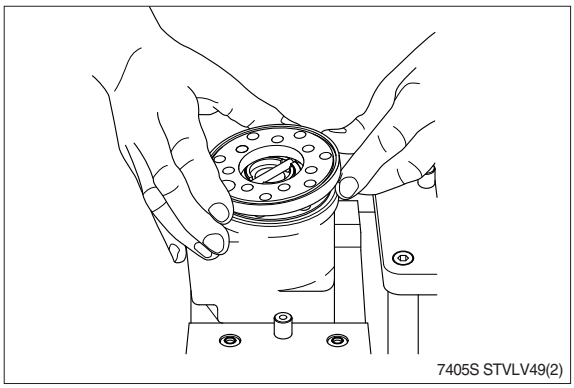
(18) Screw the threaded bushing lightly into the bore. The top of the bushing must lie just below the surface of the housing.


7405S STVLV48(4)

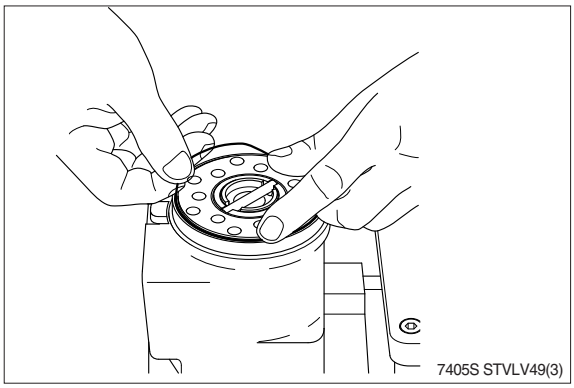
(19) Grease the O-ring with mineral oil approximate viscosity 500 cSt at 20 °C and place it in the groove.



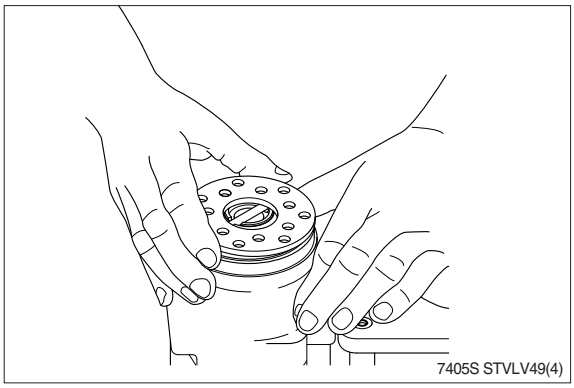
(20) Place the intermediate plate so that the channel holes match the holes in the housing.



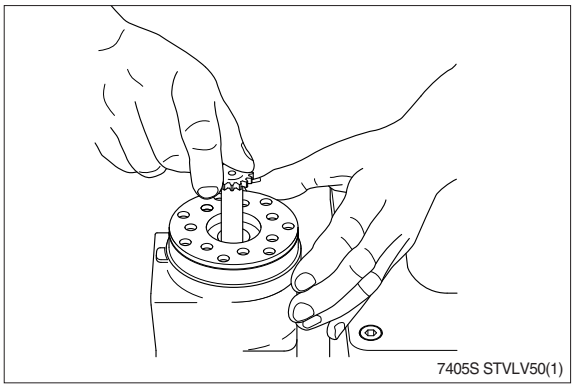
(21) Grease the O-ring with mineral oil approximate viscosity 500 cSt at 20 °C and place it in the groove.



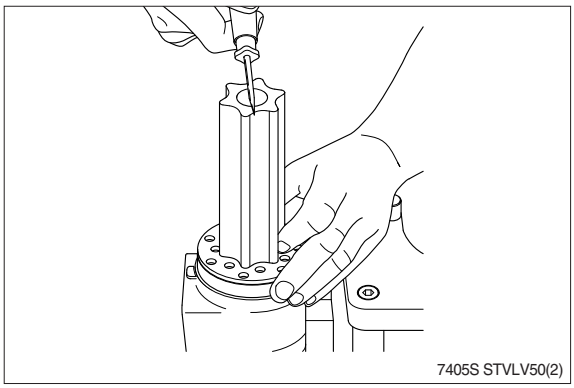
(22) Place the distributor plate so that the channel holes match the holes in the intermediate plate and the housing.



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

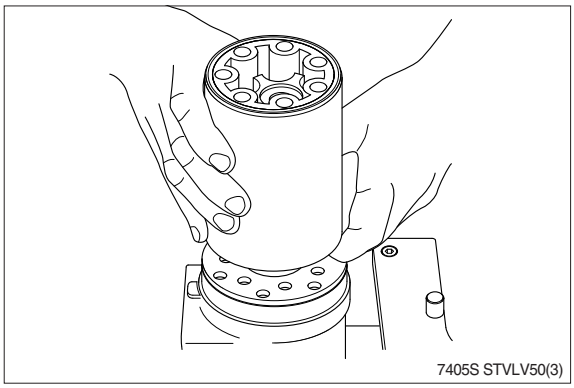

7405S STVLV50(1)

(24) Place the gear wheel (rotor) so that the cross pin from item 33 is positioned in relation to two tooth bases - as the screw driver indicates.

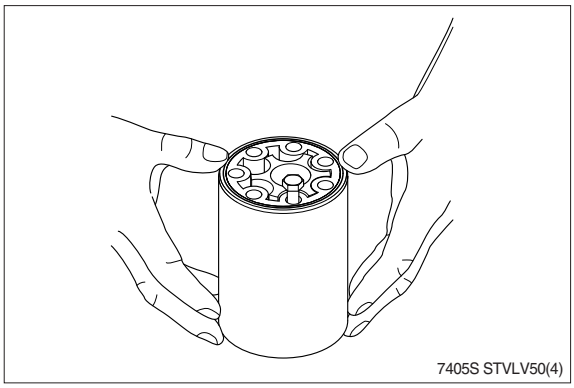

7405S STVLV50(2)

(25) Grease the two O-rings with mineral oil approximate viscosity 500 cSt at 20 ˚C and place them in the two grooves in the gear rim. Fit the gear rim so that the seven through holes match the holes in the distributor plate.

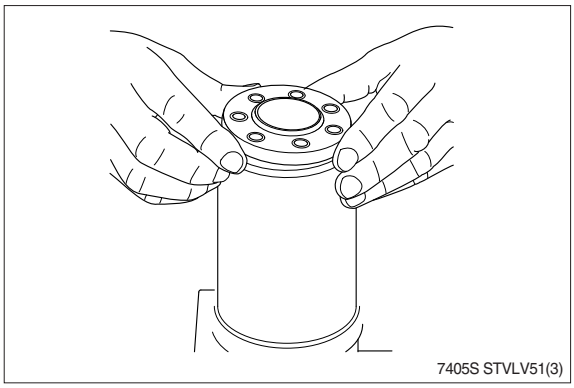
※ Turn the gear rim so that the smaller diameter of the holes face the distributor plate.


7405S STVLV50(3)

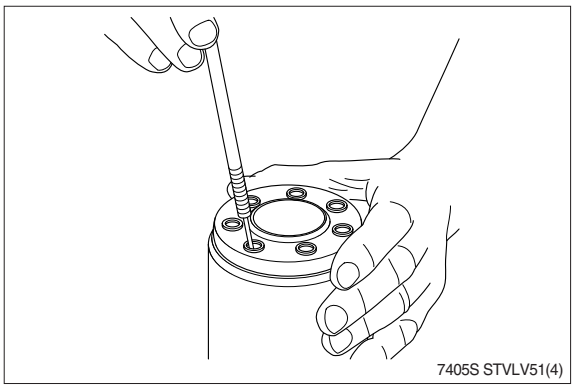
(26) Orientate the holes with a single screw.


7405S STVLV50(4)

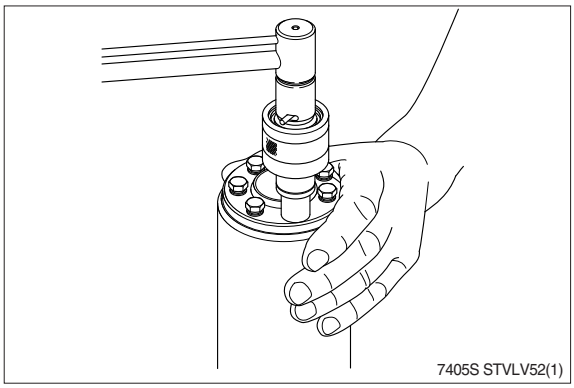
(27) Place the end cover in position.



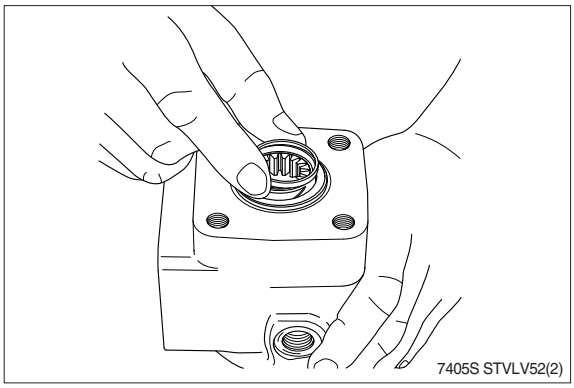
(28) Place the washers over the holes and the rolled pin in the hole shown.



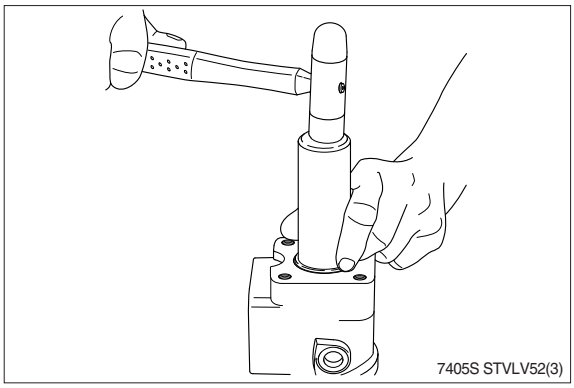
(29) Fit the other six screws. Cross - tighten all the screws and the rolled pin with a torque of $3^{\pm 0.6}$ kgf · m($22^{\pm 4.4}$ lb · ft). Steering unit can now be function tested.



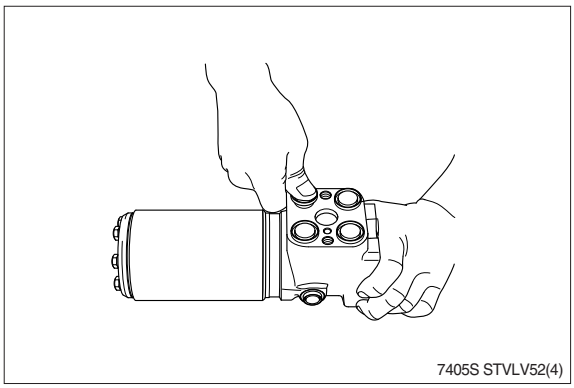
(30) Turn the steering unit 180° and place the dust seal ring in the housing.



(31) Fit the dust seal ring in the housing using special tool and a plastic hammer.

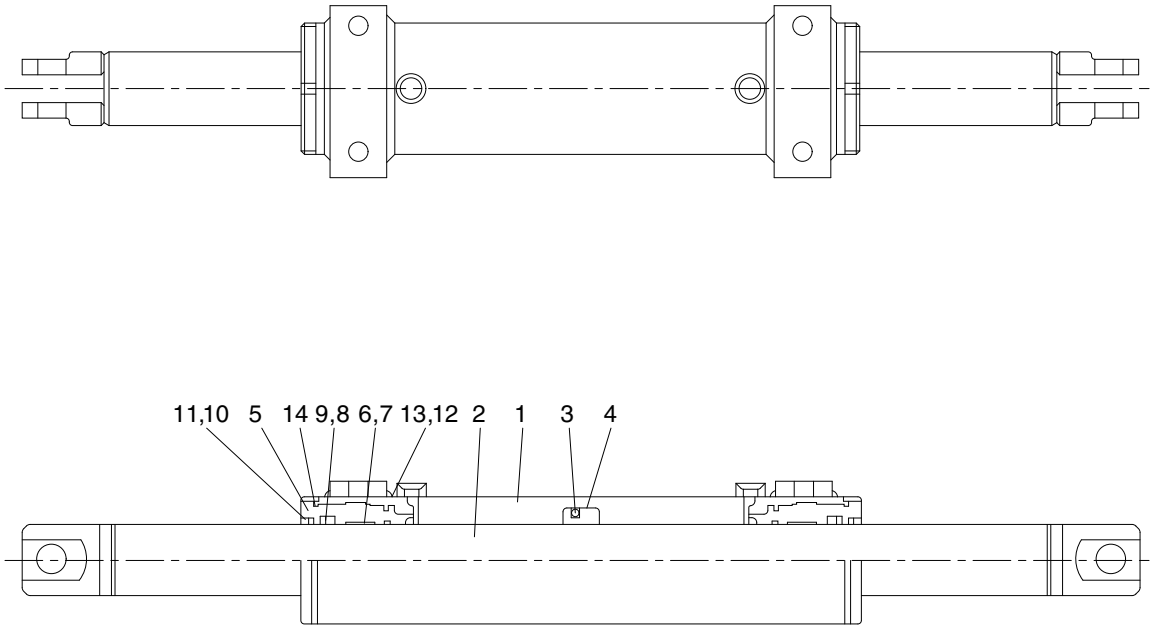


(32) Press the plastic plugs into the connection ports. Do not use a hammer.



2. STEERING CYLINDER

1) STRUCTURE



250D7ESS06

1	Tube assembly	6	Rod bushing	11	Retaining ring
2	Rod assembly	7	Retaining ring	12	O-ring
3	Piston seal	8	U-packing	13	Back up ring
4	Wear ring	9	Back up ring	14	O-ring
5	Rod cover	10	Dust wiper		

2) DISASSEMBLY

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

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

(2) Remove the cover 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 (O-ring, oil seal, dust seal, U-packing, bush). If there are some damage, replace with new parts.

3) CHECK AND INSPECTION

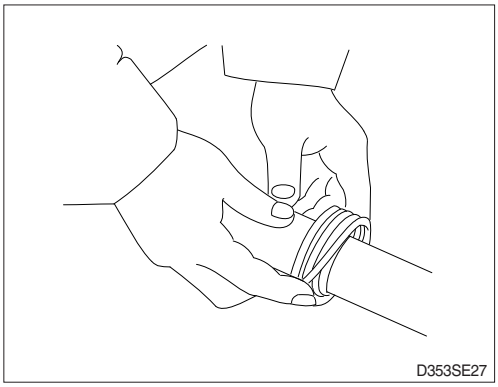
mm (in)

Check item	Criteria		
	Standard size	Repair limit	Remarks
Clearance between piston & cylinder tube	0.05~0.25 (0.002~0.01)	0.4 (0.02)	Replace piston seal
Clearance between cylinder rod & bushing	0.05~0.18 (0.002~0.007)	0.3 (0.01)	Replace bushing
Seals, O-ring	Damage		Replace
Cylinder rod	Dents		Replace
Cylinder tube	Biting		Replace

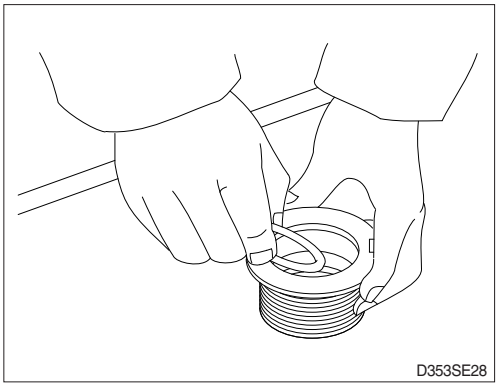
4) ASSEMBLY

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

※ Be careful not to scratch the seal too much during installation or it could not be seated properly.

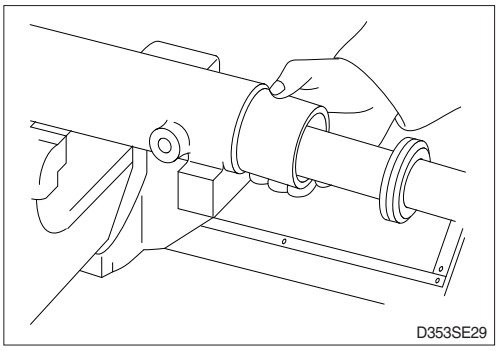

D353SE27

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

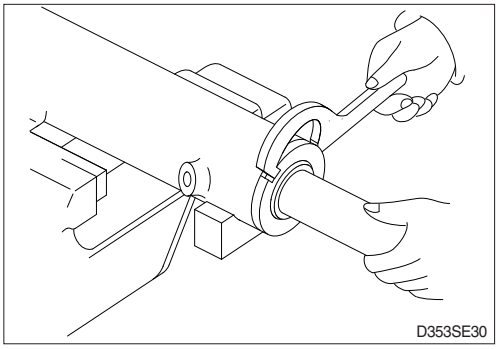

D353SE28

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

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

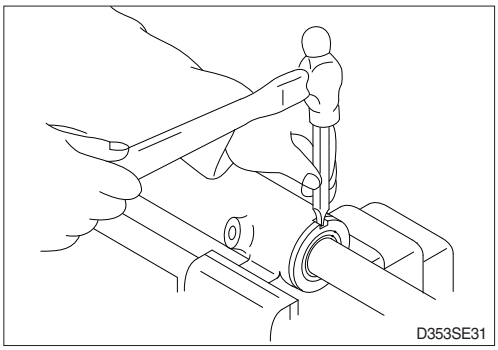


(5) Using a hook spanner, install the gland assembly, and tighten it with torque 60±6 kgf · m (434±43 lbf · ft).



(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 loosen-ing.

※ If it is needed to calk again, never calk on the same place.



(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.

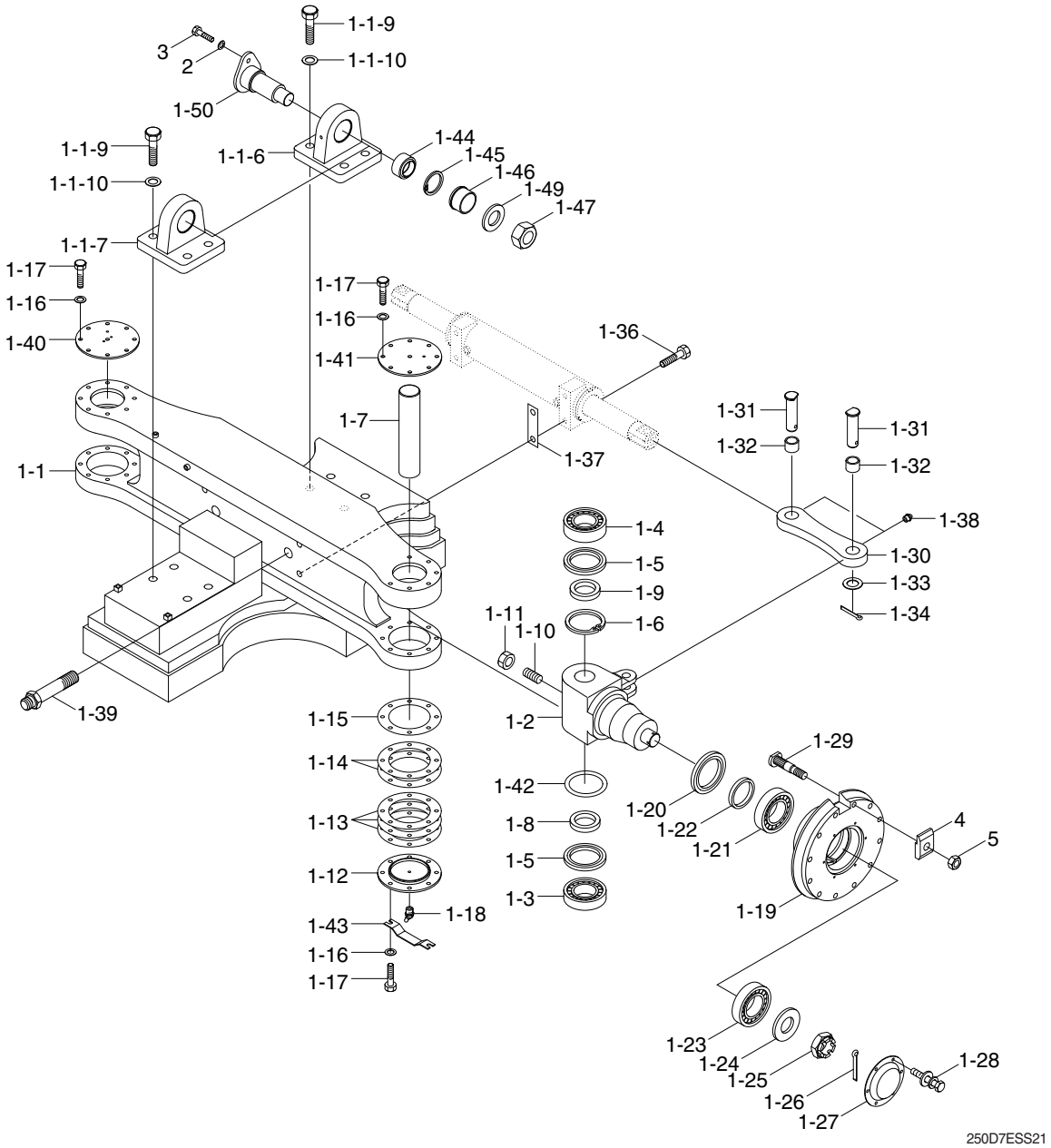
※ Then, repeat the above operation at gradually increasing engine rpm. This releases air from the system and completes preparation for operation.

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

3. STEERING AXLE

1) STRUCTURE

※ Do not remove the stopper bolt unless necessary.

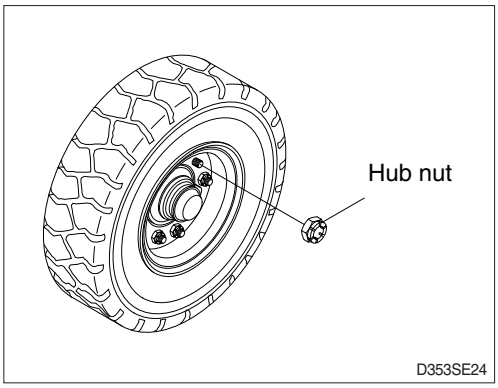


1	Steering axle assembly	1-11	Hexagon nut	1-25	Lock nut	1-40	Cover-RH
1-1	Steering axle	1-12	Cover	1-26	Split pin	1-41	Cover-LH
1-1-6	Plate	1-13	Shim (0.1t)	1-27	Cap	1-42	Spacer
1-1-7	Plate	1-14	Shim (0.2 t)	1-28	Bolt with washer	1-43	Plate
1-1-9	Hexagon bolt	1-15	Shim (0.5 t)	1-29	Hub bolt	1-44	Spherical plain bearing
1-1-10	Hardened washer	1-16	Hardened washer	1-30	Link	1-45	Retaining ring
1-2	Knuckle	1-17	Hexagon bolt	1-31	Link pin	1-46	Bushing
1-3	Taper roller bearing	1-18	Grease nipple	1-32	Bushing	1-47	Hexagon nut
1-5	Oil seal	1-19	Hub	1-33	Plain washer	1-49	Plain washer
1-6	Retaining ring	1-20	Oil seal	1-34	Split pin	1-50	Pin
1-7	King pin	1-21	Taper roller bearing	1-36	Hexagon bolt	2	Plain washer
1-8	Spacer	1-22	Spacer	1-37	Shim (0.2 t)	3	Hexagon bolt
1-9	Spacer	1-23	Taper roller bearing	1-38	Grease nipple	4	Ring clamp
1-10	Hexagon socket setscrew	1-24	Special washer	1-39	Connector	5	Hub nut

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 balance 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 lock nut, washer.

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

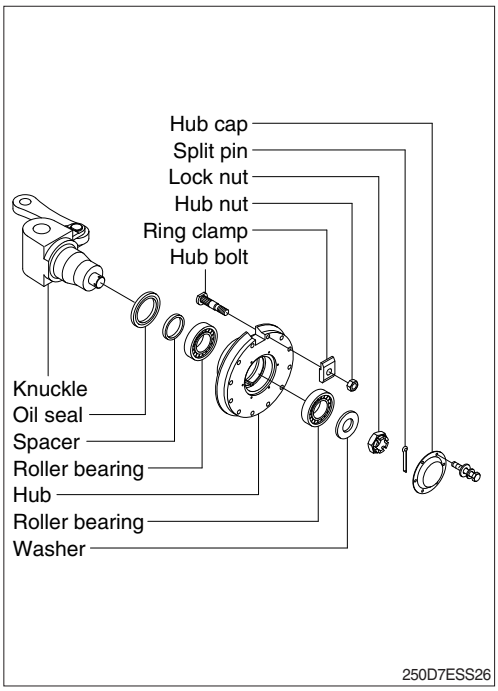
※ Be very careful because just before the hub comes off, tapered roller bearing will fall out.

(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 lock nut in the knuckle to protect the threaded portion.



(8) Loosen set screw (1-10) and nut (1-11).

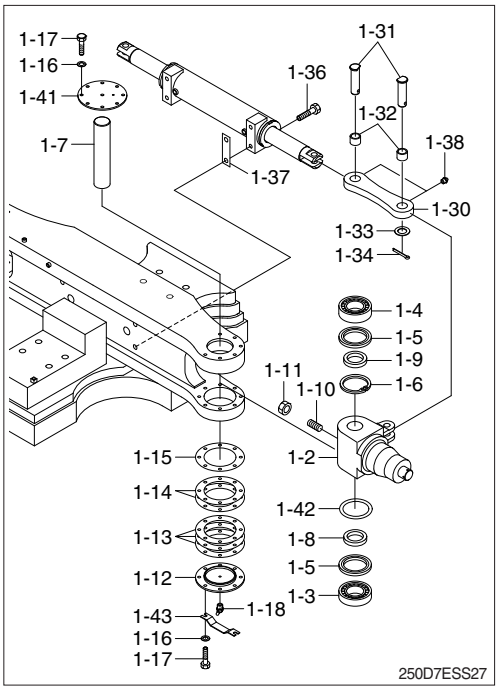
(9) Loosen with washer bolt (1-17) and remove cover (1-12, 1-41), shim (1-13, 1-14, 1-15). Remove grease nipple (1-18).

(10) Push out the king pin (1-7) without damaging the knuckle arm (1-2).

(11) At the same time the king pin is removed, pull out the oil seal (1-5).

(12) If defect is observed in taper roller bearing (1-3), pull it out by using extractor.

(13) Remove spilt pin (1-34), plain washer (1-33) and link pin (1-31).



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 set screw (1-10) of king pin (1-7).

(2) There is a notch in the middle of the king pin (1-7), make sure that this notch is on the set screw side.

(3) Do not hammer to drive in taper roller bearing (1-3) because it will break.
Always use drive-in tool.

※ When assembly knuckle, adjust shims so that there is no clearance.

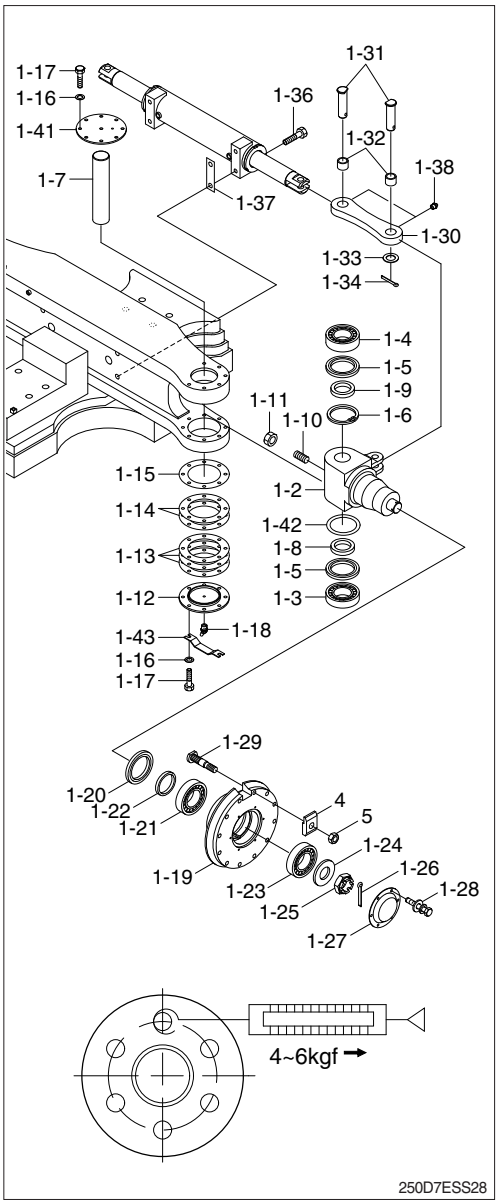
(4) Hub

① Mount oil seal (1-20) and inner race of tapered roller bearing (1-21) on the knuckle.
The bearing should be well greased before assembling.

② Install the outer race of the bearing (1-3) in the wheel center and assemble to the knuckle.

③ Put washer (1-24) in place, tighten with nut (1-25) and locked with split pin (1-26). 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 (1-27).
Bearing should be well greased before assembling.



SECTION 6 HYDRAULIC SYSTEM

SECTION 6 HYDRAULIC SYSTEM

GROUP 1 STRUCTURE AND FUNCTION

1. HYDRAULIC SYSTEM OUTLINE

The hydraulic system is a pilot operated, closed center system which is supplied with flow from the variable displacement main hydraulic pump.
The pilot control system is a low pressure, system which is supplied with flow from the auxiliary pump.

The hydraulic system components are :

- Main pump
- Auxiliary pump
- Main control valve
- Lift cylinder
- Tilt cylinders
- Remote control valve
- OPSS solenoid valve
- Cut-off valve

The oil from the B2 main pump via the priority spool built in the main control valve is combined with oil from the B1 main pump by parallel passage and flows the main control valve.

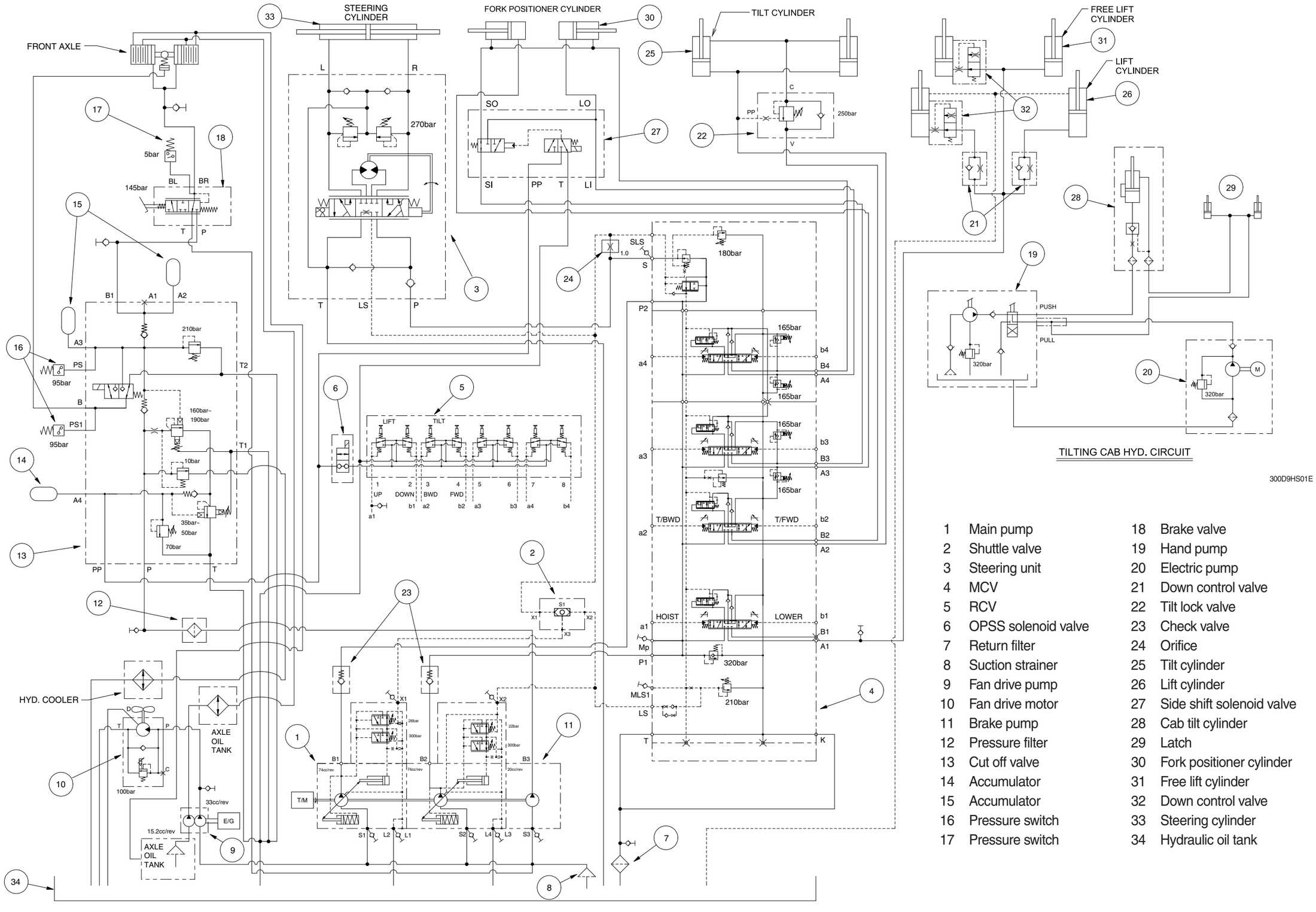
The main control valve is a parallel circuit type, closed center valve which routes flow to the lift, tilt and or auxiliary cylinders when the respective spools are shifted.

Flow from the brake pump is routed to the cut-off valve that charges the pressure in accumulators. After charging the pressure in accumulators for braking, the flow gose to accumulators for RCV. The cut-off valve flow either to the brake valve or to the remote control valve.
The remote control valve routed flow to either end of each spool valve section in the main control valve to control spool stroke.

A accumulator mounted on pilot supply unit supplies a secondary pressure source to operate remote control valve so the boom can be lowered if the engine is off.

The return circuit for the main hydraulic system have return filter inside the hydraulic tank. The return filter uses a filter element and a bypass valve. The bypass valve is located in the upside of filter.

2. HYDRAULIC CIRCUIT



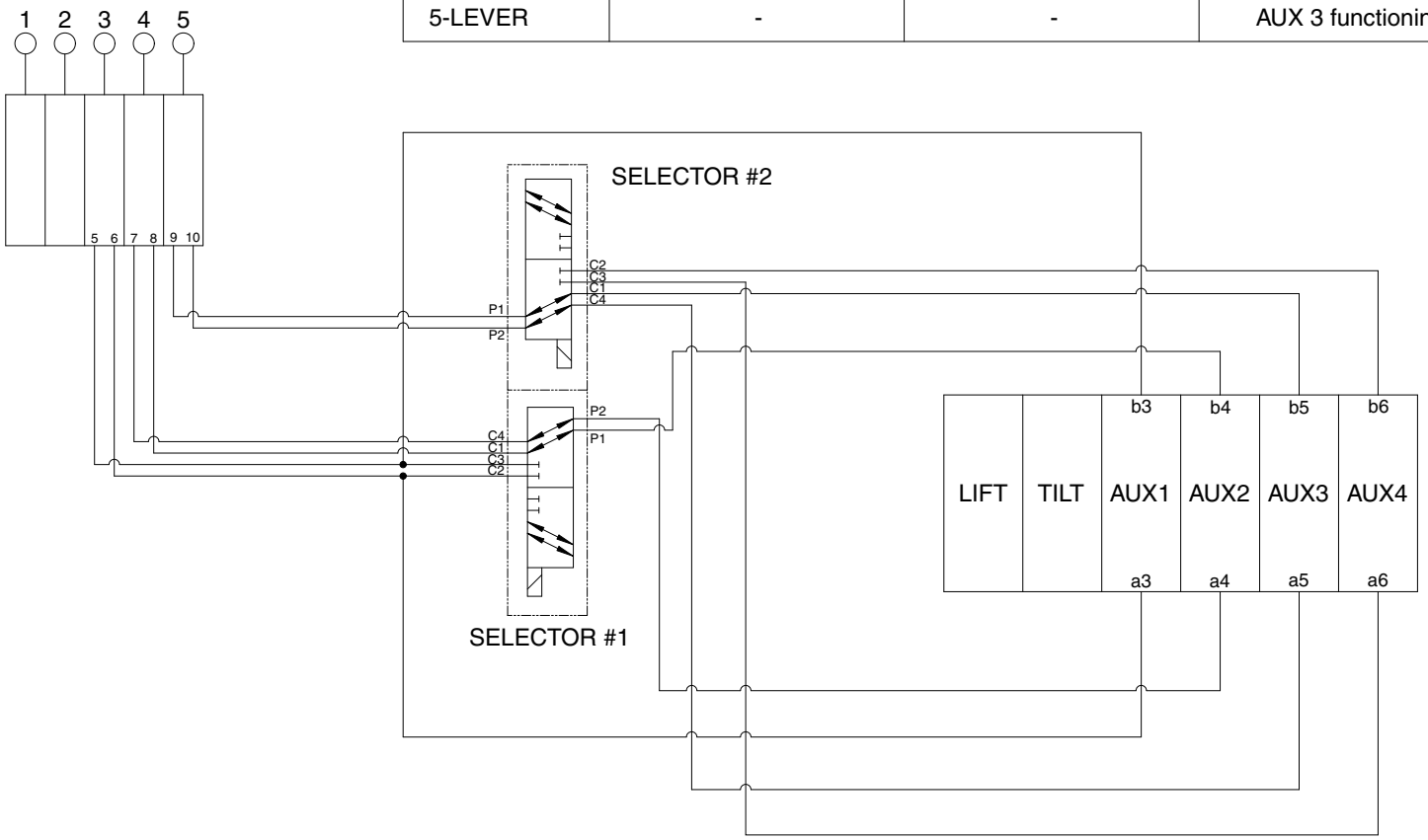
TILTING CAB HYD. CIRCUIT

300D9HS01E

1	Main pump	18	Brake valve
2	Shuttle valve	19	Hand pump
3	Steering unit	20	Electric pump
4	MCV	21	Down control valve
5	RCV	22	Tilt lock valve
6	OPSS solenoid valve	23	Check valve
7	Return filter	24	Orifice
8	Suction strainer	25	Tilt cylinder
9	Fan drive pump	26	Lift cylinder
10	Fan drive motor	27	Side shift solenoid valve
11	Brake pump	28	Cab tilt cylinder
12	Pressure filter	29	Latch
13	Cut off valve	30	Fork positioner cylinder
14	Accumulator	31	Free lift cylinder
15	Accumulator	32	Down control valve
16	Pressure switch	33	Steering cylinder
17	Pressure switch	34	Hydraulic oil tank

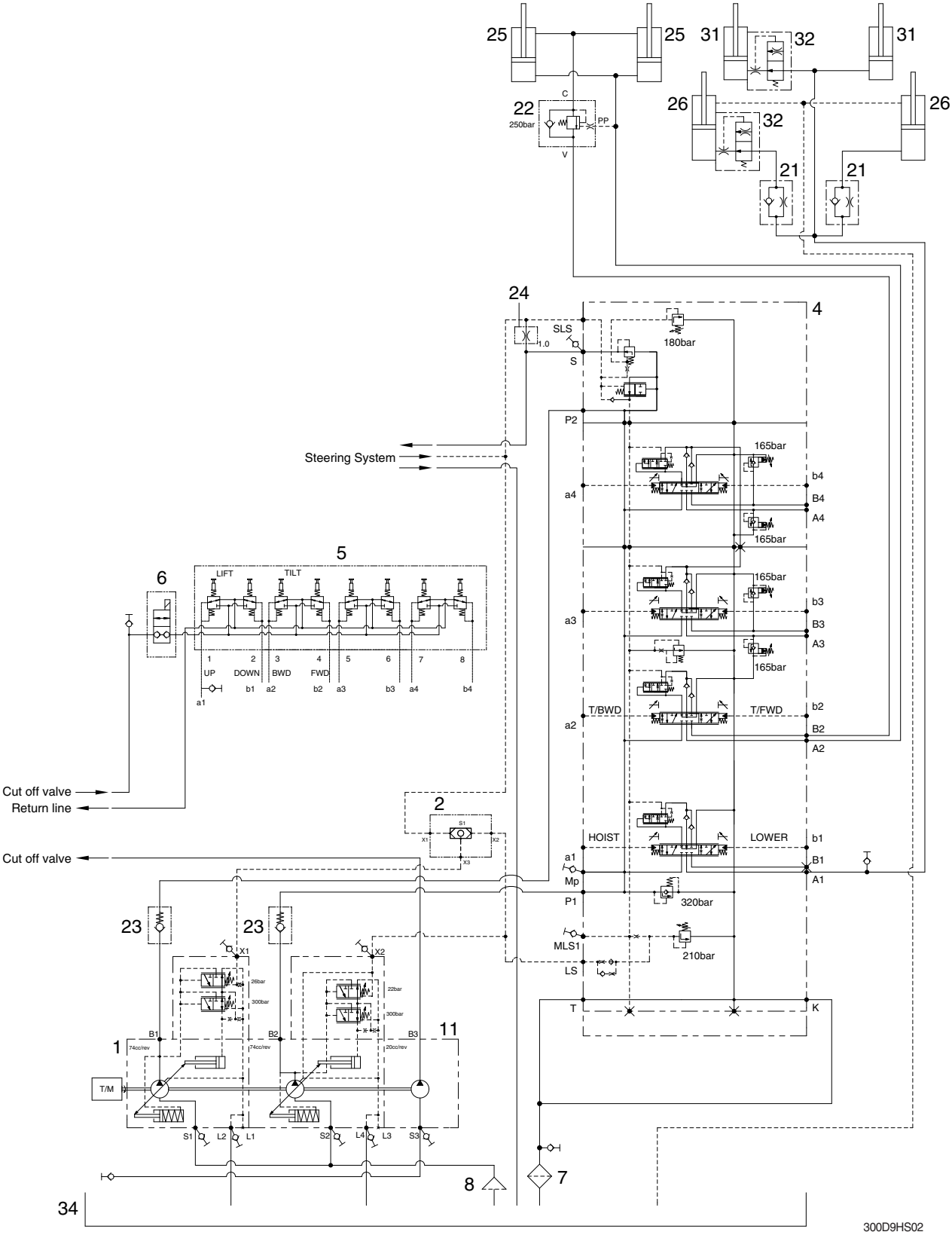
PILOT CIRCUIT (7 function for 5-lever)

	3-LEVER S/W OFF (SELECTOR #1 INACTIVATION)	3-LEVER S/W ON (SELECTOR #1 ACTIVATION)	5-LEVER S/W OFF (SELECTOR #2 INACTIVATION)	5-LEVER S/W ON (SELECTOR #2 ACTIVATION)
3-LEVER	AUX 1 functioning	AUX 1, 2 functioning	-	-
4-LEVER	AUX 2 functioning	Non-functioning	-	-
5-LEVER	-	-	AUX 3 functioning	AUX 4 functionig



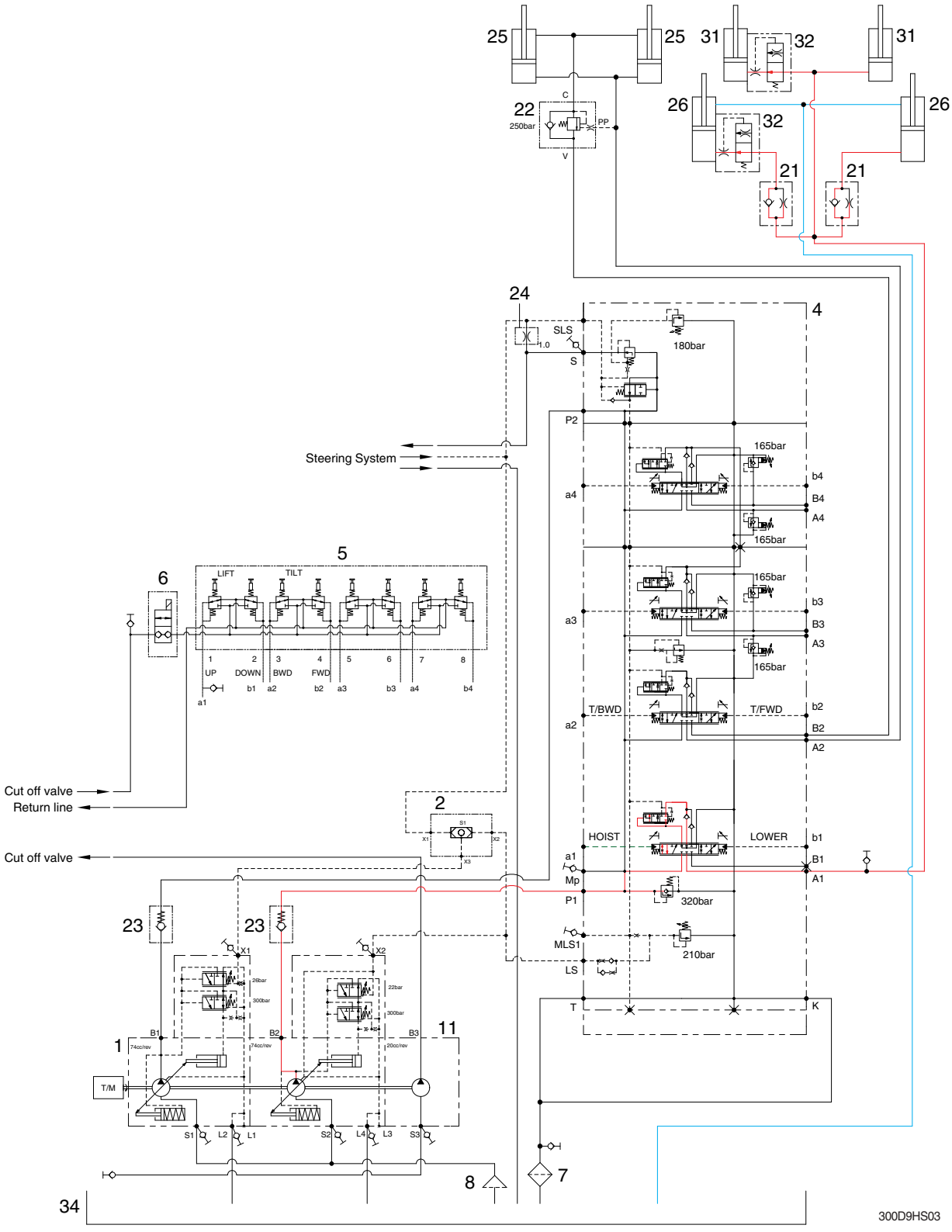
250D7EHS07

3. WORK EQUIPMENT HYDRAULIC CIRCUIT



1	Main pump	8	Strainer	25	Tilt cylinder
2	Shuttle valve	11	Charging pump	26	Lift cylinder
4	Main control valve	21	Down control valve	31	Free lift cylinder
5	Remote control valve	22	Tilt lock valve	32	Down safety valve
6	OPSS solenoid valve	23	Check valve	34	Hydraulic oil tank
7	Return filter	24	Orifice		

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



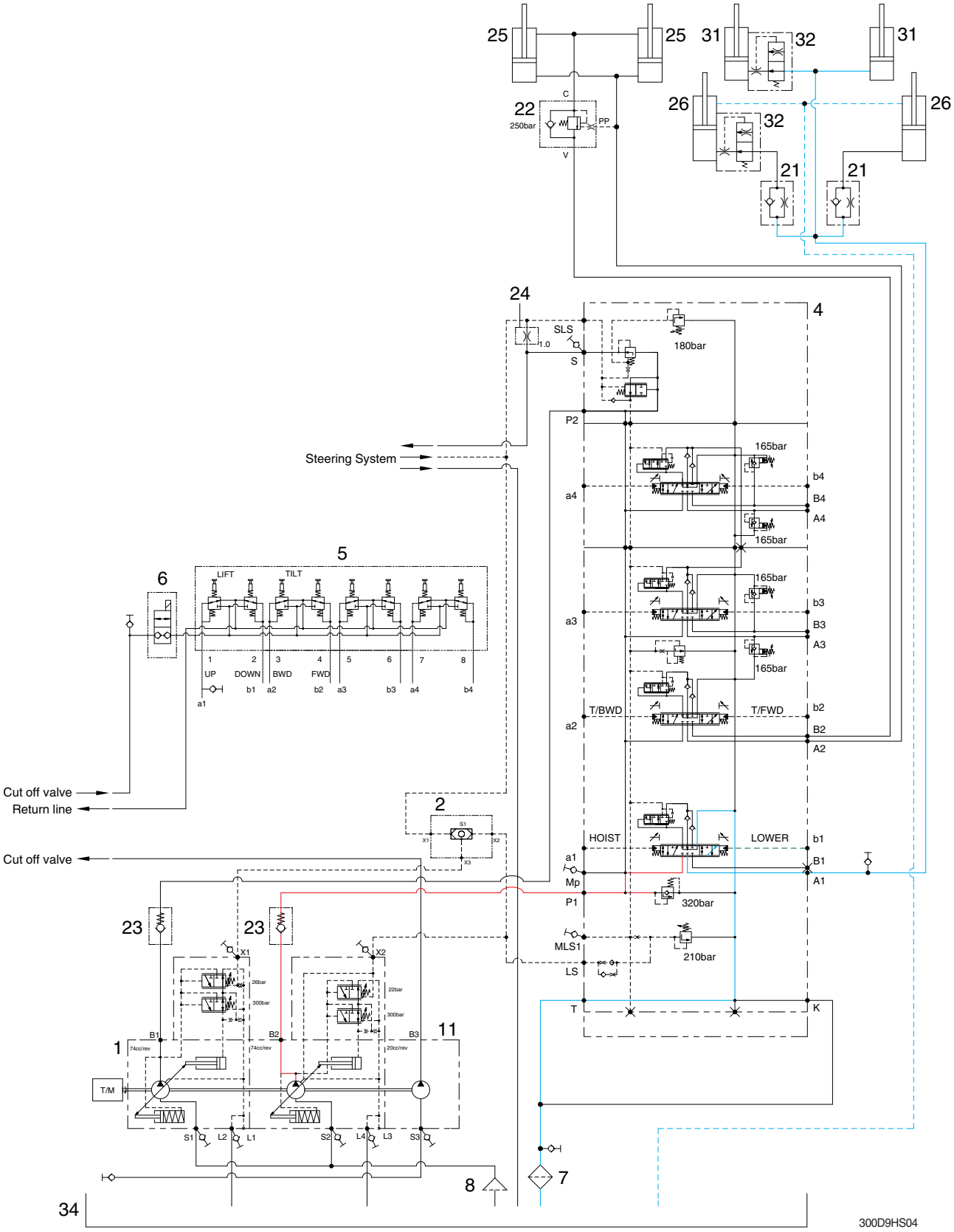
When the lift control lever is pulled back, the spool is moves to lift position by the pilot oil pressure from the remote control valve (5).

The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the large chamber of lift cylinder (26) and free lift cylinder (31) by pushing the load check valve of the spool.

The oil from the small chamber of lift cylinder (26) returns to hydraulic oil tank (34) at the same time.

When this happens, the forks go up.

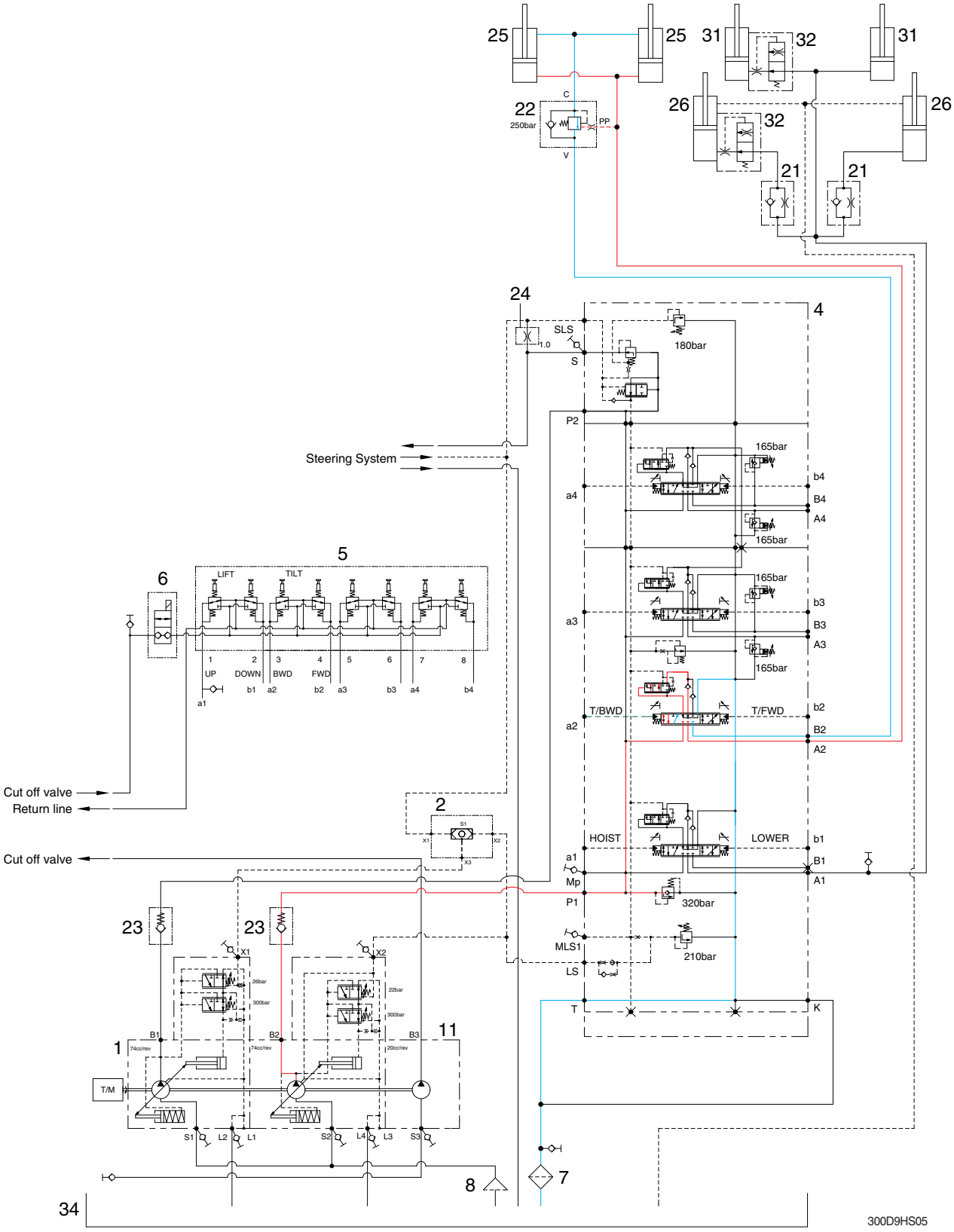
2) WHEN THE LIFT CONTROL LEVER IS IN THE LOWER POSITION



When the lift control is pushed forward, the spool is moved to lower position by the pilot oil pressure from the remote control valve (5).

The work ports (A1, A3) and the small chamber and the large chamber are connected to the return passage, so the lift will be lowered due to its own weight.

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



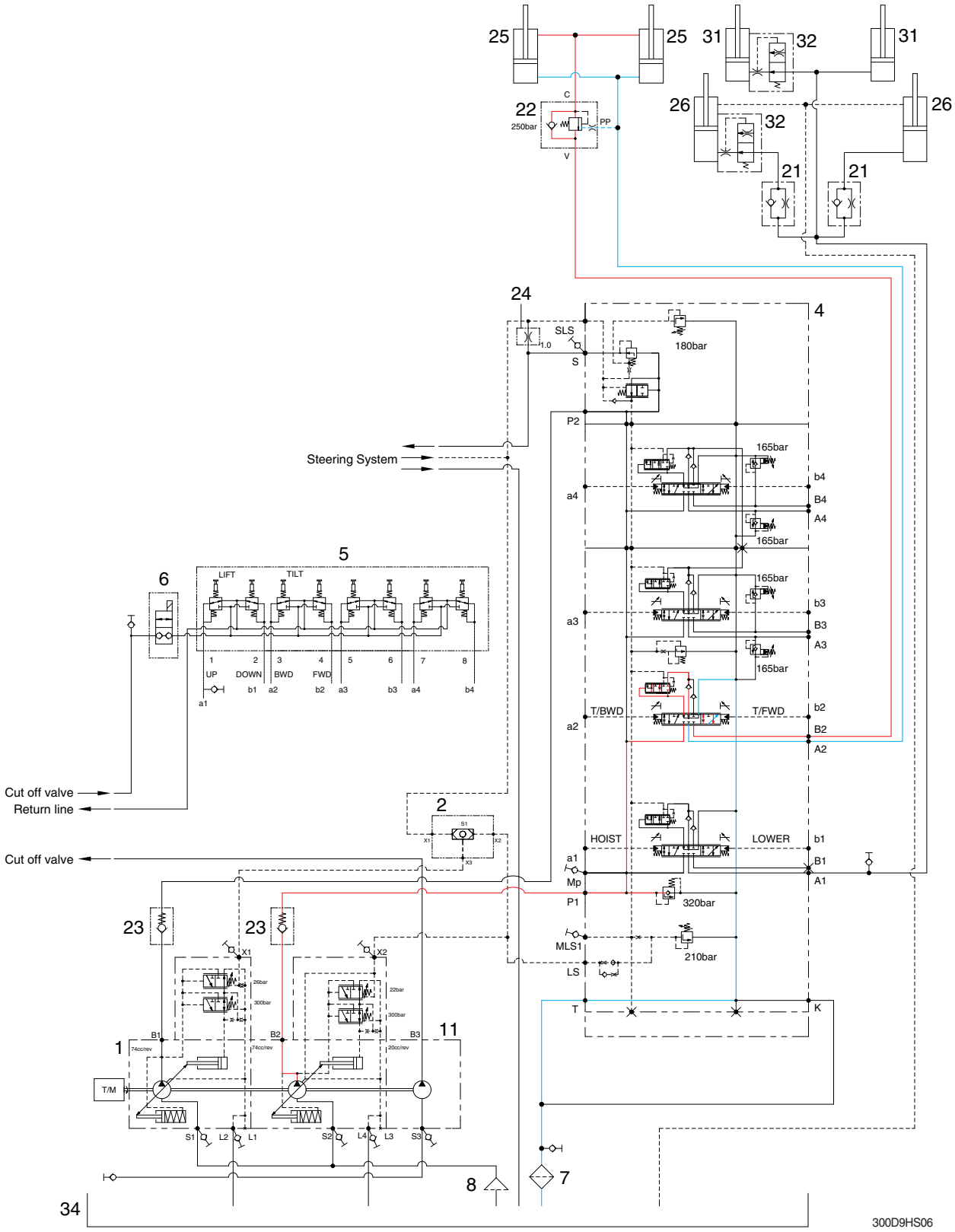
When the tilt control lever is pushed forward, the spool is moved to tilt forward position by the pilot oil pressure from the remote control valve (5).

The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the large chamber of tilt cylinder (25) by pushing the load check valve of the spool.

The oil at the small chamber of tilt cylinder (25) returns to hydraulic tank (34) 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 is moved to tilt backward position by the pilot oil pressure from the remote control valve (5).

The oil from hydraulic main pump (1) flows into main control valve (4) and then goes to the small chamber of tilt cylinder (25) by pushing the load check valve of spool.

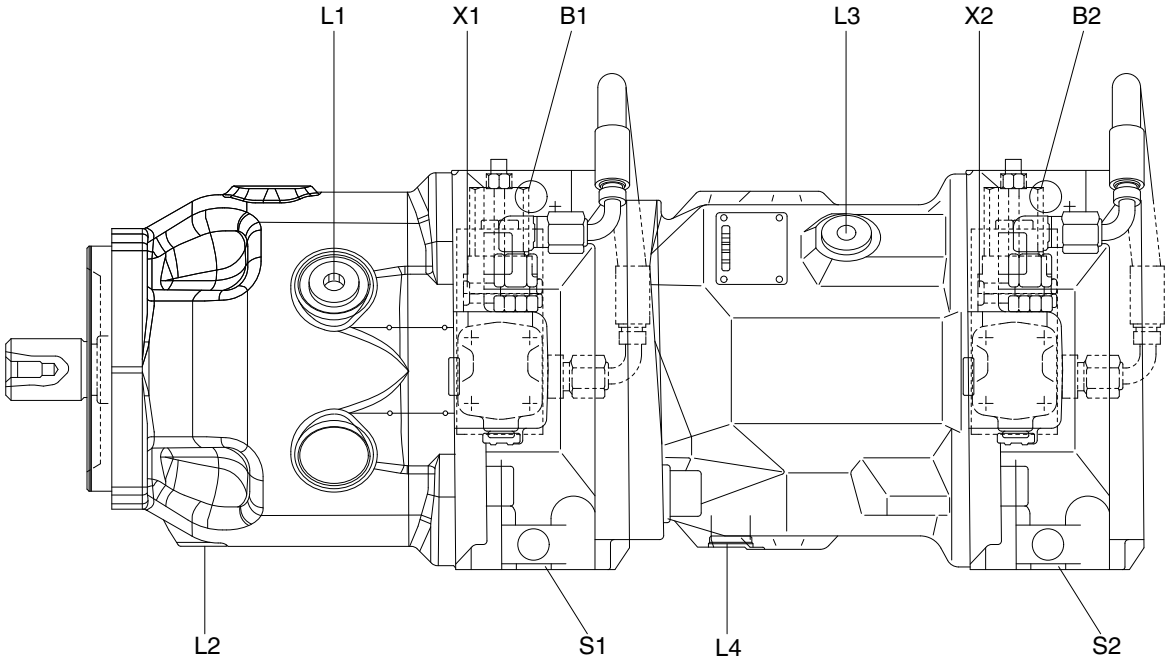
The oil at the large chamber of tilt cylinder (25) returns to hydraulic tank (34) at the same time.

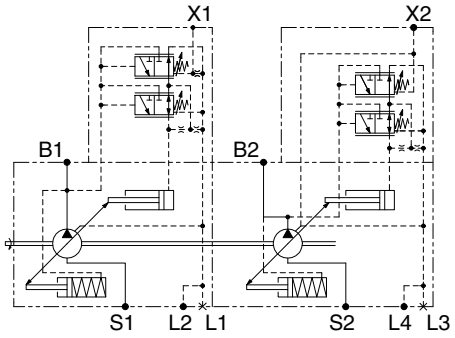
When this happens, the mast tilt backward.

4. MAIN PUMP

1) STRUCTURE (1/2)

This variable displacement piston pump consists of steering pump and working pump.



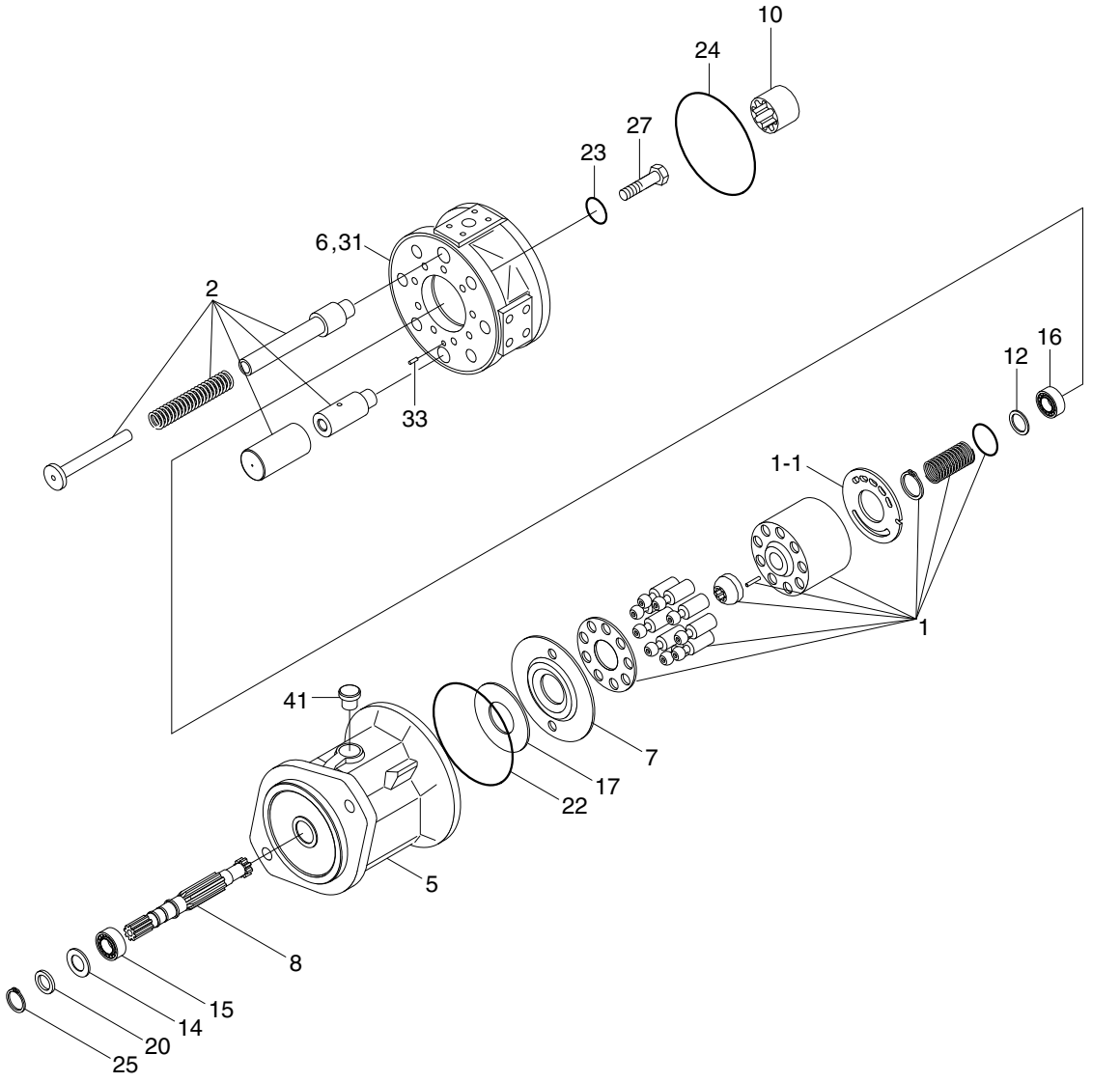


HYDRAULIC CIRCUIT

180D7EMP04

Port	Port name	Size
B1	Pressure port	SAE 1"
B2	Pressure port	SAE 1"
S1	Suction port	SAE 2"
S2	Suction port	SAE 2"
L1, L2	Case drain port	7/8-14UNF-28
L3, L4	Case drain port	7/8-14UNF-28
X1, X2	Pilot pressure port	7/16-20UNF-28

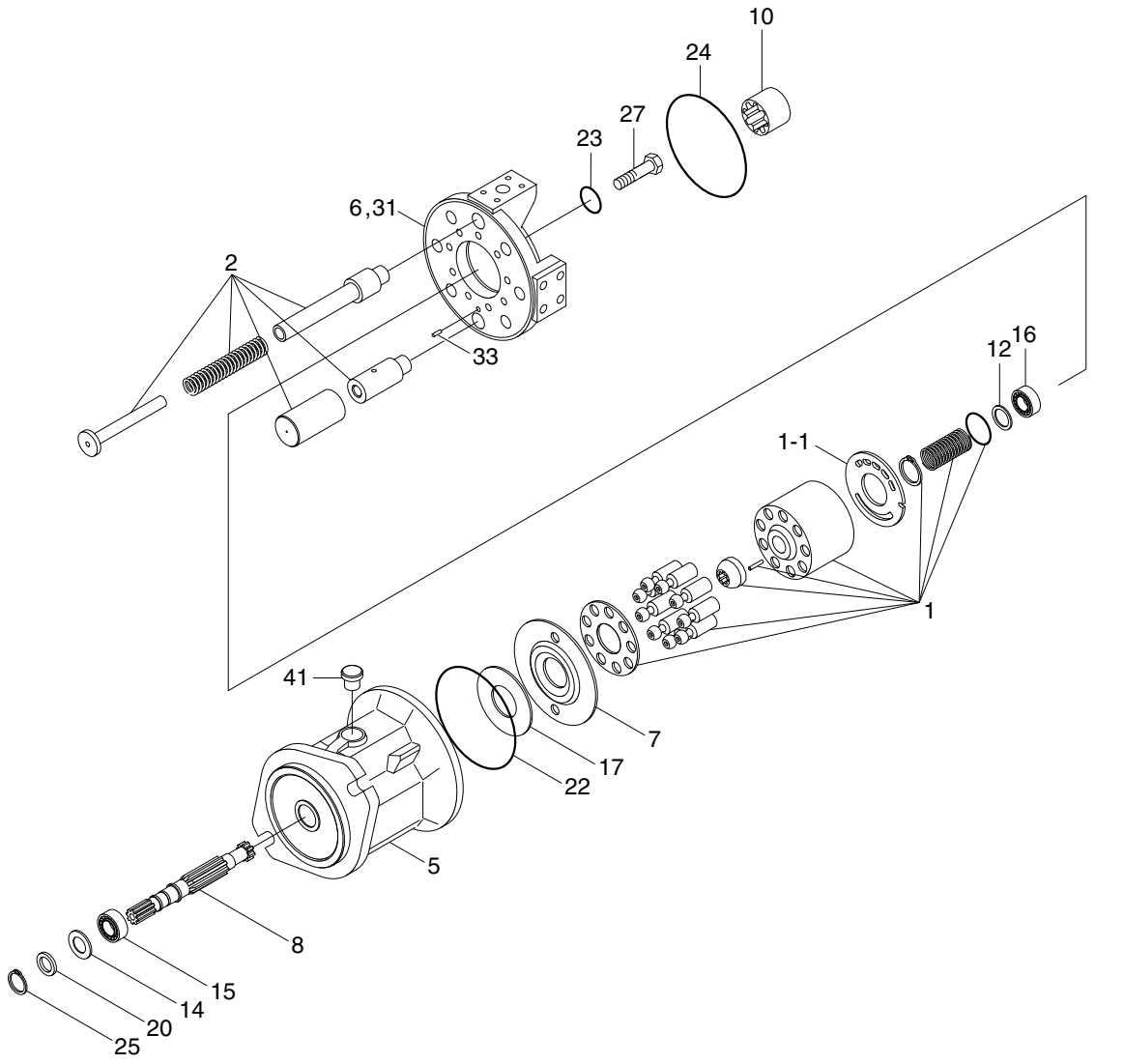
· FRONT PUMP



180D9MP01

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Splined hub	23	O-ring		

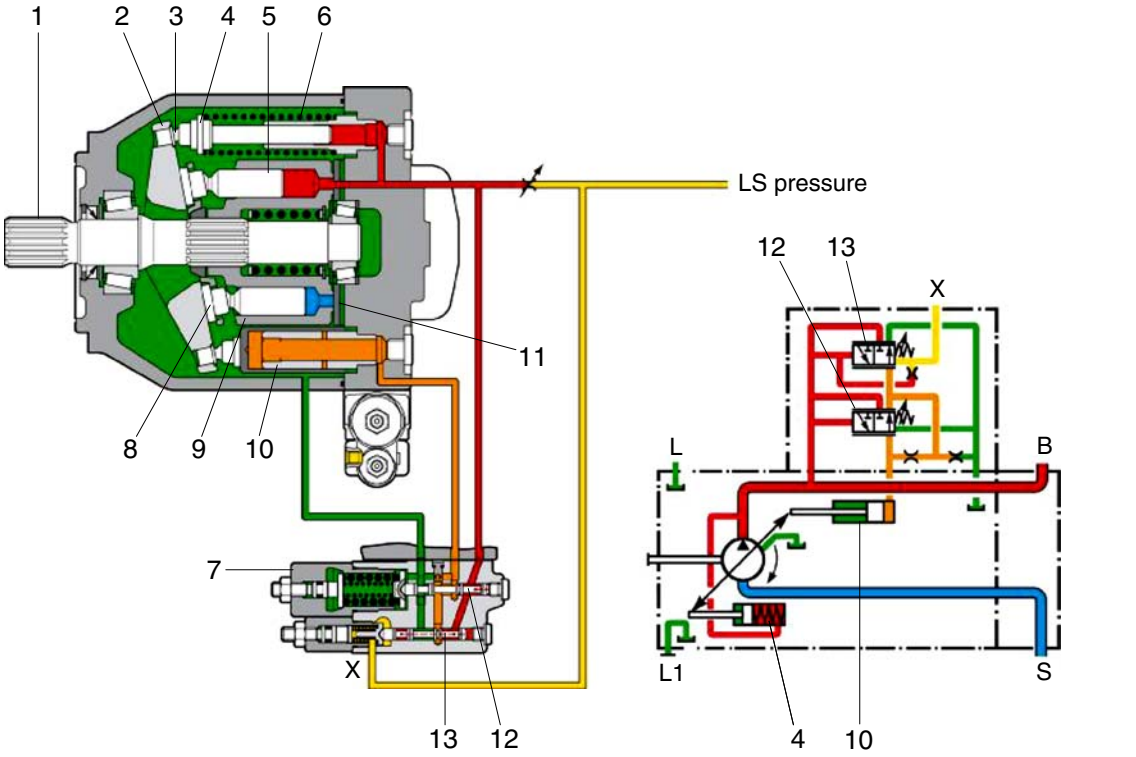
· REAR PUMP



180D9MP02

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Spline hub	23	O-ring		

2) FUNCTION



1	Drive shaft	6	Counter spring	11	Control plate
2	Swash plate	7	Pressure & flow compensator valve	12	Pressure compensator spool
3	Shoe plate	8	Piston shoe	13	Flow compensator spool
4	Counter piston	9	Cylinder		
5	Piston	10	Control piston		

The steering pump and attachment pump are variable displacement piston pump. The steering pump and attachment pump are flow controlled by LS signal. When the steering and attachment are not being used, the pumps are at low pressure standby.

The load sensing pressure that is sensed from steering and attachment hydraulic systems flows to flow compensator spool (13). This spool keeps the pump output at a level that is necessary to fulfill the requirements for the system flow and for the pressure.

The pressure compensator spool (12) also limits maximum system pressure. The pressure compensator spool (12) prevents damage to the steering and attachment hydraulic components from excessive pressure.

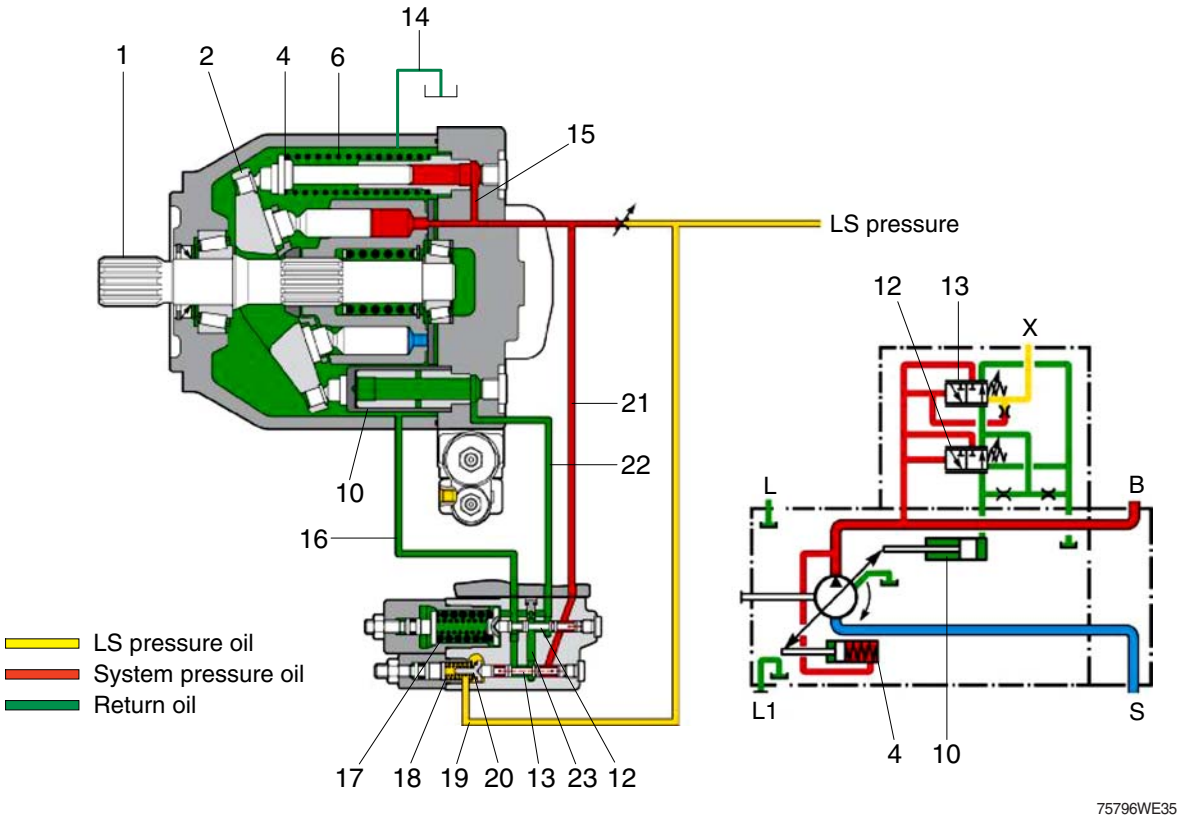
The swivel angle of the pumps is controlled by counter piston (4) and control piston (10). Counter spring (6) cause swash plate (2) to move at maximum displacement or causes swash plate (2) to upstroke.

Control piston (10) has a larger area (diameter) than counter piston (4). Control piston (10) causes swash plate (2) to destroke the pump.
Flow compensator spool (13) and/or pressure compensator spool (12) changes pump output by regulating the pump discharge pressure that is acting on control piston (10).

Control piston (10) diameter is larger than counter piston (4) diameter, the oil pressure that is acting against control piston (10) overcomes the force of counter spring (6). The oil pressure than causes the pump to destoke.

Pressure and flow compensator valve (7) also controls the maximum output of pump pressure.
When steering and attachment pressure rises above pressure compensator setting, pressure compensator spool (12) overrides flow compensator spool (13). This causes the pump to destroke.

(1) Upstroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

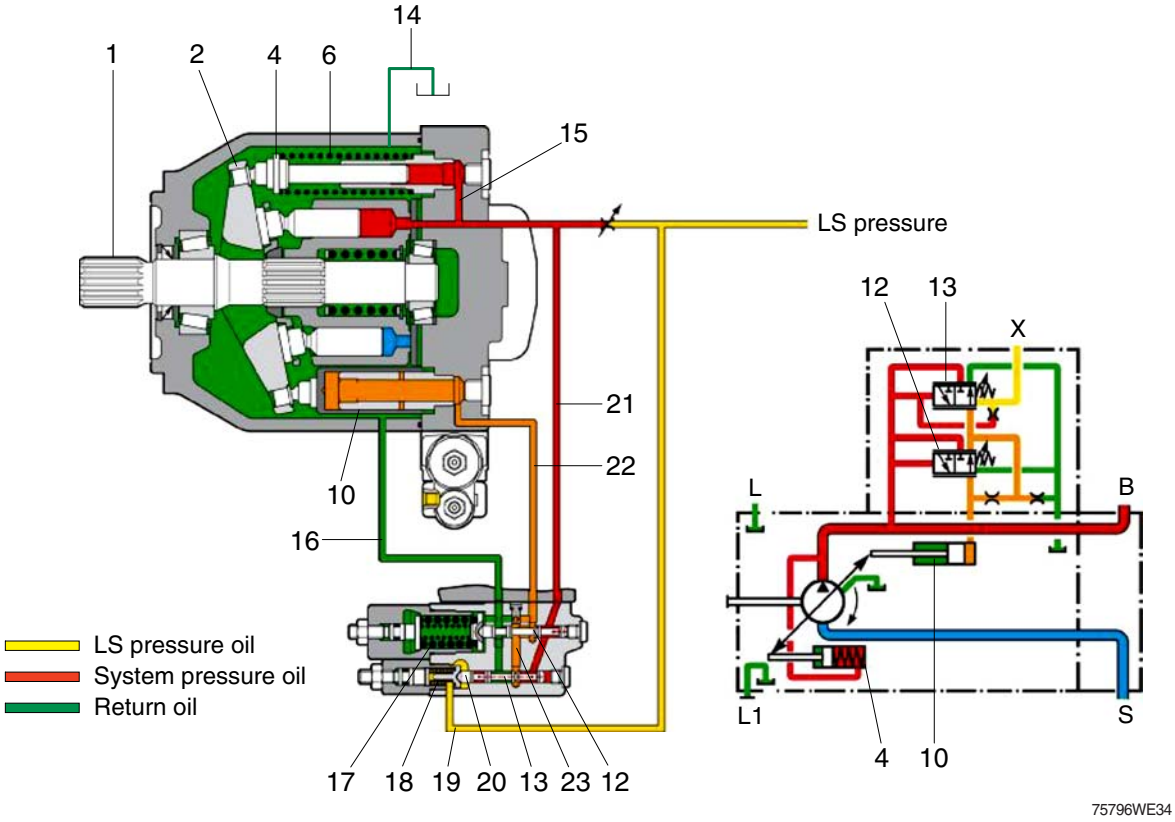
Upstroking of the pump occurs as flow demand from attachment and steering system.
The increased flow demand causes a LS pressure in LS line (19). The LS pressure in LS line (19) combines with the force of spring (18) in cavity (20).
The force of spring (18) causes pump pressure to be higher than the LS pressure (19).
If the combination of LS pressure and of spring force is greater than the pump discharge pressure, this difference pressure causes spool (13) to move right. As spool (13) moves right, the spool (13) blocks the flow of supply oil to control piston (10). Pump swash plate (2) is controlled by pressure and flow as much as hydraulic system requests.

When the oil flow to control piston (10) is blocked, the pilot oil in passage (22) drains to passage (23). The oil then flows past pressure compensator spool (12) and through passage (16) into the housing and via the drain line (14) to tank.

Supply oil flows through passage (15) to counter piston (4). The oil acts against counter piston (4).
The oil combines with the force of counter spring (6). This causes swash plate (2) to upstroke.

This also causes the pump flow to increase. As flow requirements are satisfied, the pump output pressure increase. The pressure increases until the pressure in passage (15) moves flow compensator spool (13) up to be satisfied with system requirement for pressure and flow.
¡¤Pump discharge pressure = force of spring (18) + LS pressure (19)

(2) Destroking



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

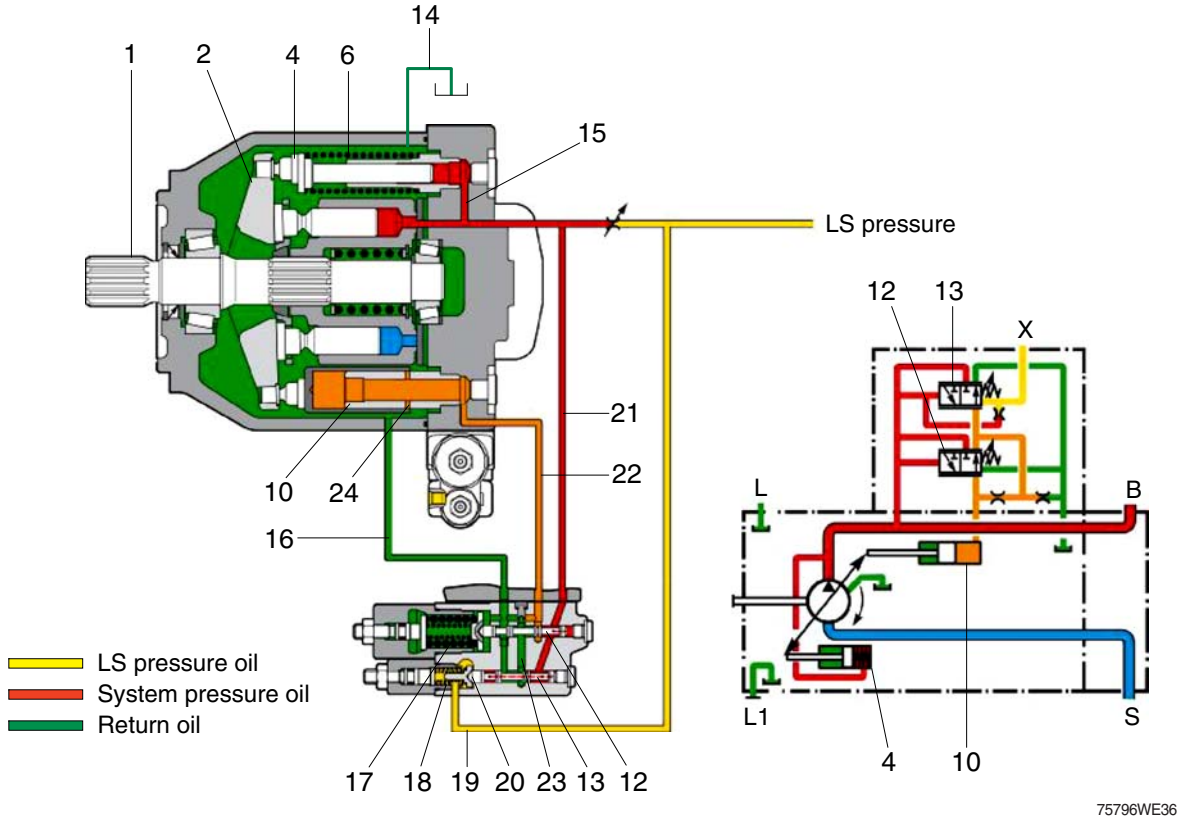
The decreased flow demand causes a LS pressure in line (19). The LS pressure in line (19) combines with the force of spring (18) in cavity (20).
This combination of LS pressure and of spring force is less than the pump pressure in passage (21). This causes flow compensator spool (13) to move left.
Pump oil now flows through passage (15). The oil then flows past flow compensator spool (13), through passage (22), and then to control piston (10).

The pump pressure behind control piston (10) is now greater than the combined force of counter piston(4) and of counter spring (6). The angle of swash plate (2) decreases.
This decreases the pump output and the system pressure.

When the lower flow requirements are met, flow compensator spool (13) moves right up to the balanced position. Swash plate (2) maintains an angle that is sufficient to provide the lower required pressure. If the operator does not turn the steering wheel and does not move lever, then the pump will return to low pressure standby.

※ Control piston ¡æ Changes pump displacement ; influenced by controller.
Counter piston ¡æ Helps to change pump displacement but no possible to control this piston.

(3) Low pressure standby



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring	24	Cross-drilled hole

Low pressure standby constitutes the following condition: a running engine and inactive steering and attachment. There are no flow demands on the pump or pressure demands on the pump. Therefore, there is no LS pressure in line (19).
Before you start the engine, counter spring (6) holds swash plate (2) at the maximum angle. As the pump begins to turn, oil begins to flow and pressure increases in the system.
Because of close centered steering control valve and close centered attachment hydraulic system.

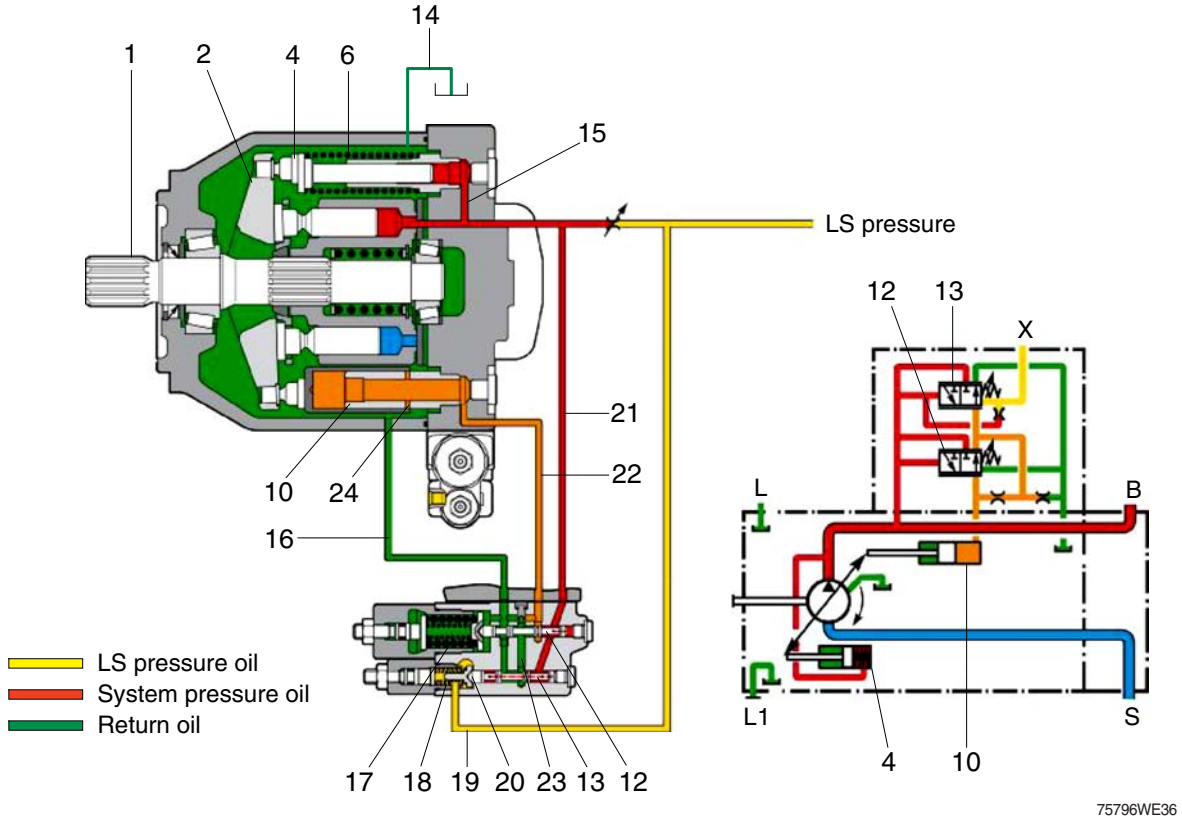
As this pressure increase, the pressure pushes flow compensator spool (13) against spring (18). This causes flow compensator spool (13) to move left. This opens passage (23) in order to allow pressure oil to flow to control piston (10).

The oil acts against control piston (10) in order to overcome the force of counter spring (6). The oil causes control piston (10) to move to the left.
When control piston (10) moves to the left, the piston moves swash plate (2) toward the minimum angle. Control piston (10) continues to move to the left until cross-drilled hole (24) allows the oil to drain to the case.

Cross-drilled hole (24) limits the maximum travel of control piston (10) to the left. The pump supplies a sufficient amount of flow that compensates for system leakage. The pump also supplies a sufficient of flow that compensates for leakage to the pump case. The leakage to the pump case is a result of the cross-drilled hole. The pump maintains low pressure standby. Low pressure standby pressure should not exceed 40 bar (580 psi).

※ Low pressure standby will vary in the same pump as the system leakage or the pump leakage increases. The pump will upstroke slightly in order to compensate for the increasing leakage. Control piston (10) will cover more of the cross-drilled hole.

(4) High pressure stall



1	Drive shaft	13	Flow compensator spool	19	LS line from the metering pump
2	Swash plate	14	Case drain	20	Cavity
4	Counter piston	15	Passage	21	Passage
6	Counter spring	16	Passage	22	Passage
10	Control piston	17	Spring	23	Cavity
12	Pressure compensator spool	18	Spring		

When the hydraulic system stalls under load or when the cylinders reach the end of the stroke, the main system pressure increases. But LS pressure (19) is regulated by LS relief valve on steering system and attachment system. The pressure difference between discharged pump and LS pressure equal to spring (18). It means no flow is necessary. Therefore, discharged pressure push flow compensator spool (13) left . Supply oil now flows past flow compensator spool (13) and through passage (23). The oil flows past flow compensator spool (13) and into passage (22). The oil then flows to control piston (10).

Pump swash plate (2) will be minimum displacement if the operator does not turn the steering wheel and lever, then the pump will return to low pressure standby.

(5) Adjustment of flow control

Flow compensator setting must be carried out following procedures and conditions.

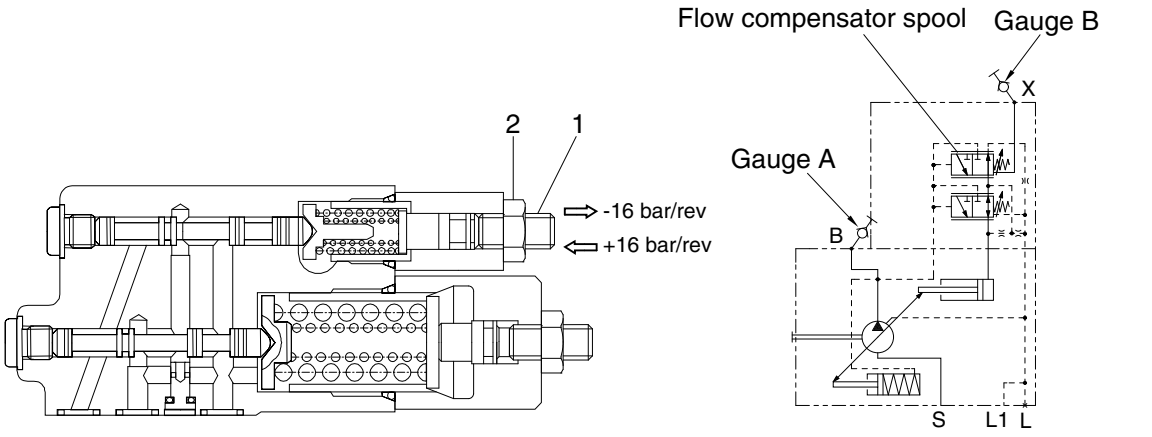
① **Conditions**

- Engine is running (at high or low idle).
- Lever is operated slowly (example : Mast).
- Pressure gauges are installed.

※ Discharge pump flow should be less than max pump flow.

② **Procedures**

- Loosening the hexagon nut (2).
- Adjusting screw (1) of flow controller by tightening or loosing the screw (1).
  · Flow setting : △P = Gauge A - Gauge B
  · Specification : Steering pump (26 bar) / Attachment pump (22 bar)



300D9HS90

(6) Adjustment of pressure control

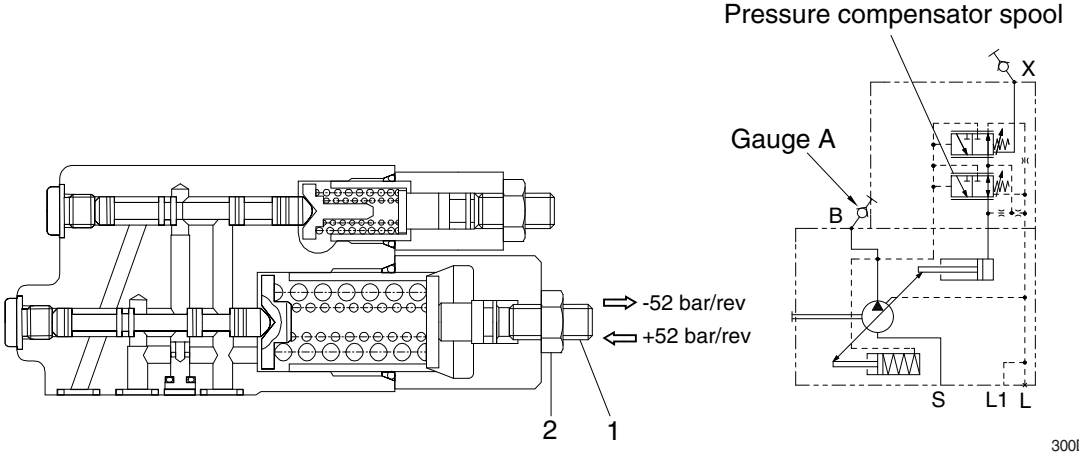
Pressure compensator setting must be carried out following procedures and conditions.

① **Conditions**

- Engine is running.
- System is at relief condition.

② **Procedures**

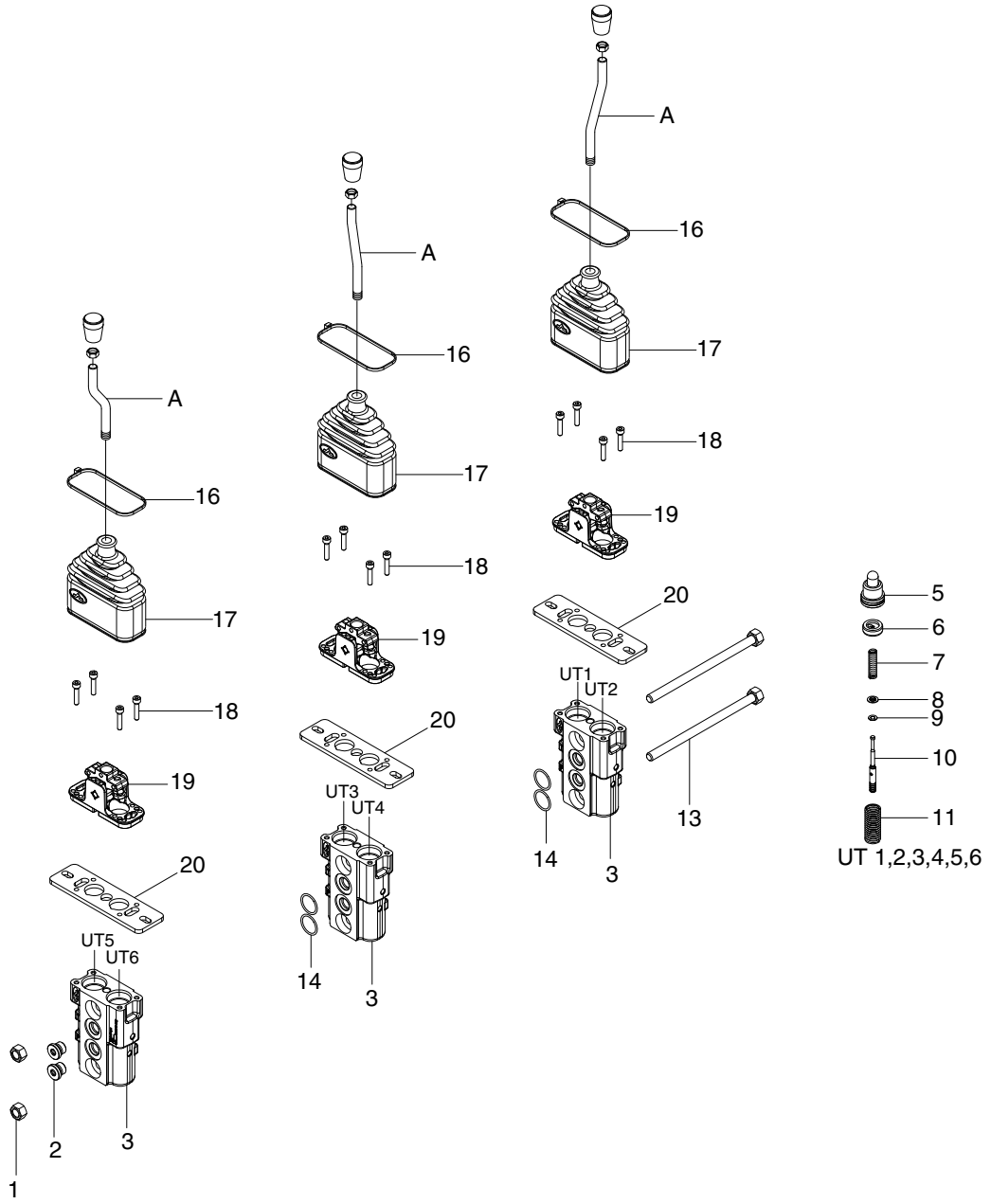
- Loosening the hexagon nut (2).
- Adjusting screw (1) of pressure controller by tightening or loosing the screw (1).
  · Maximum pressure setting = Gauge A
  · Specification : Steering pump (300 bar) / Attachment pump (300 bar)



300D9HS91

5. REMOTE CONTROL VALVE

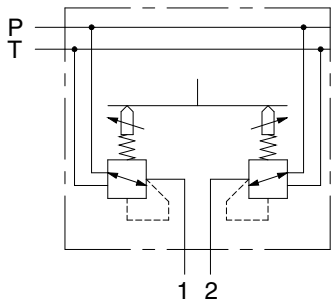
1) STRUCTURE



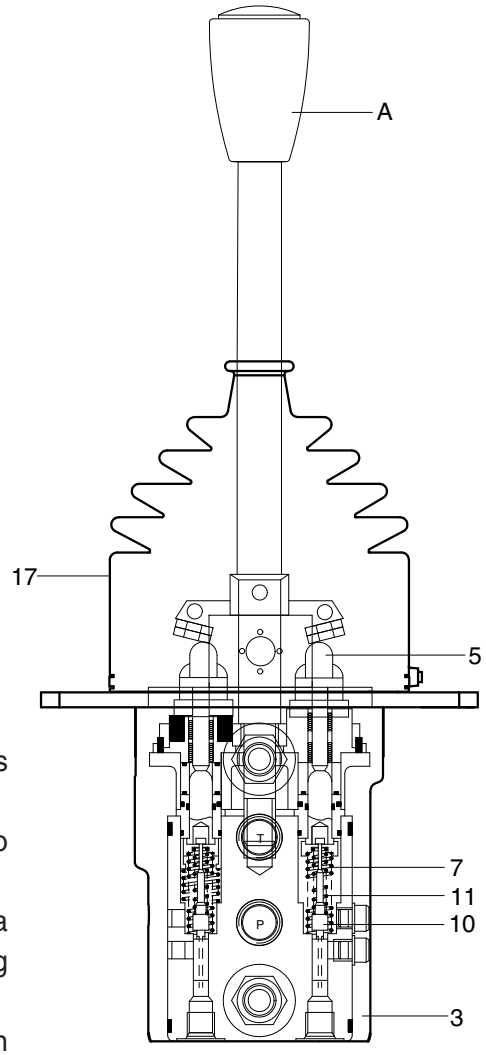
100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellows
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) OPERATION



HYDRAULIC CIRCUIT



100D7RCV01

(1) Hydraulic functional principle

Pilot devices with end position locks operate as direct operated pressure reducing valves.

They basically comprise of control lever (A), two pressure reducing valves, body (3) and locks.

Each pressure reducing valve comprises of a plunger kit (5), a metering spring (7) and a spring (11).

At rest, control lever (A) is held in its neutral position by return springs (11). Ports (1, 2) are connected to tank port T.

When control lever (A) is deflected, plunger kit (5) is pressed against return spring(11) and metering spring (7).

Metering spring (7) initially moves docking rod (10) downwards and closes the connection between the relevant port and tank port T. At the same time the relevant port is connected to port P. The control phase starts as soon as docking rod (10) finds its balance between the force from metering spring (7) and the force, which results from the hydraulic pressure in the relevant port (ports 1, 2).

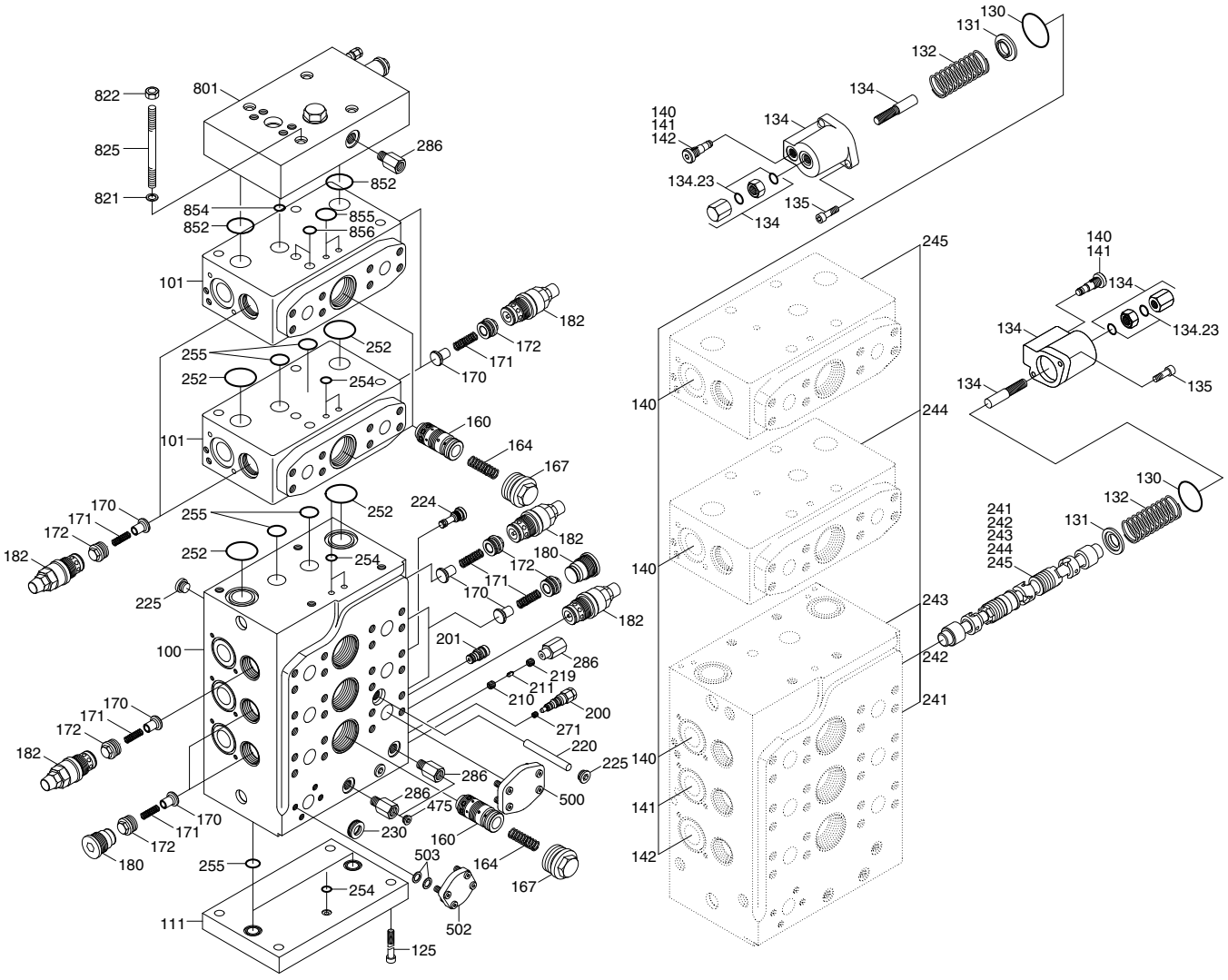
Due to the interaction between docking rod (10) and metering spring (7) the pressure in the relevant port is proportional to the stroke of plunger (5) and hence to the position of control lever (A).

This pressure control which is dependent on the position of the control lever and the characteristics of the control spring permits the proportional hydraulic control of the main directional valves and high response valves for hydraulic pumps.

A rubber bellows (17) protects the mechanical components in the housing from contamination.

6. MAIN CONTROL VALVE

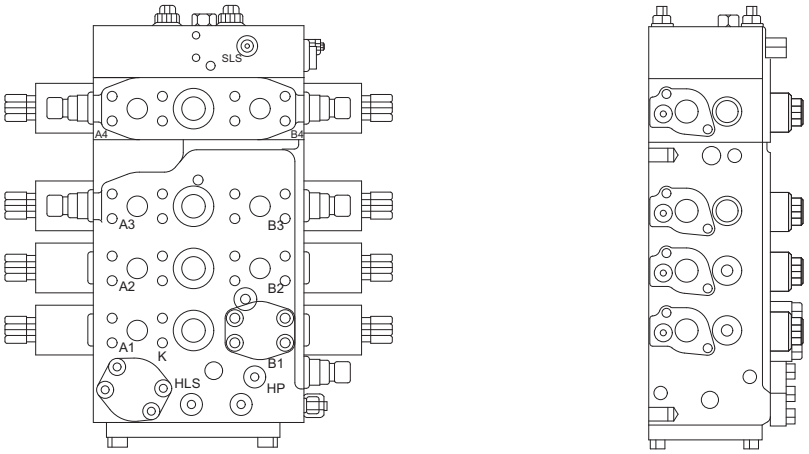
1) STRUCTURE

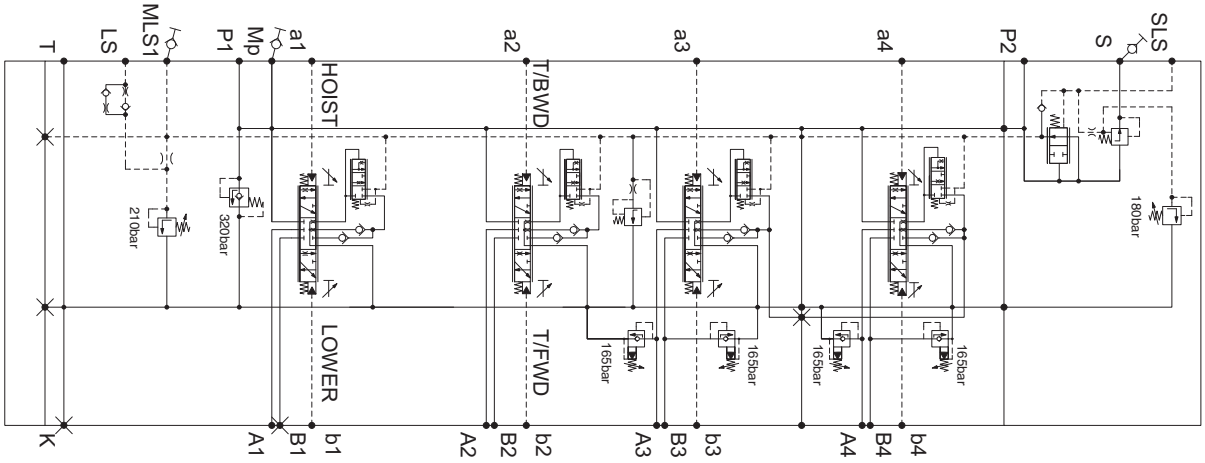


180D7EMCV01

100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

STRUCTURE

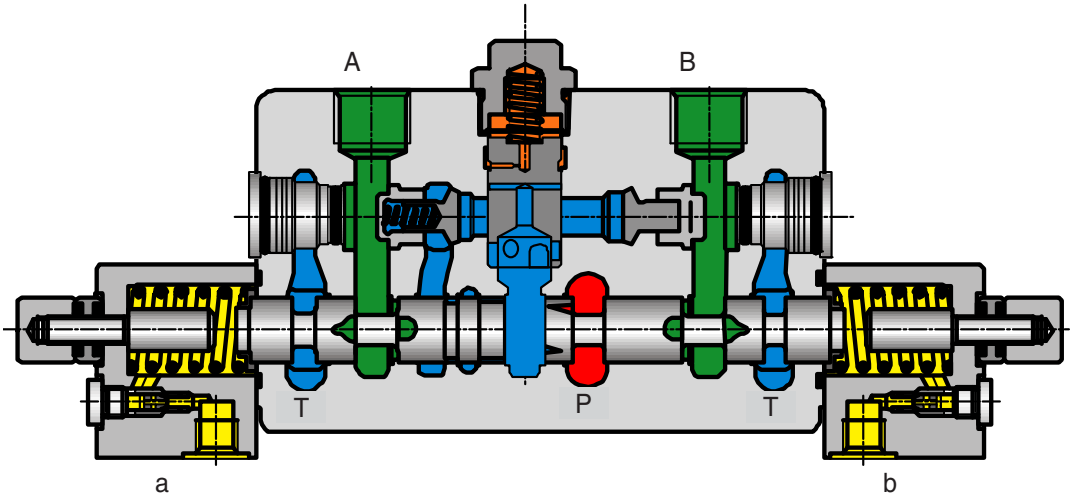




250D9MCV02

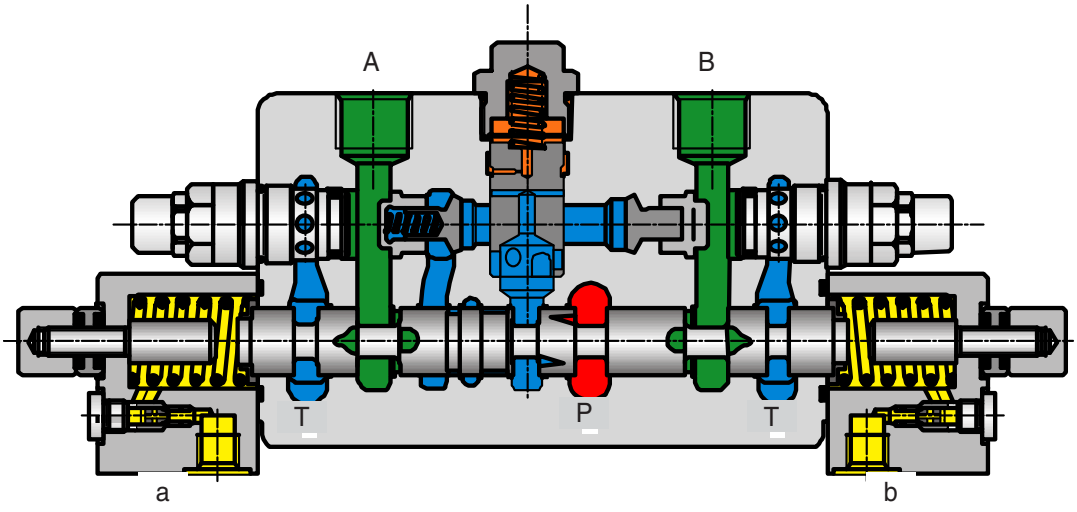
Port	Port name	Size	Port	Port name	Size
P1	From main pump	SAE 6000 psi 1 1/4"	a1, b1	From RCV lift port	9/16" - 18UNF
T	To hydraulic tank	SAE 3000 psi 1 1/4"	a2, b2	From RCV tilt port	9/16" - 18UNF
A1, B1	To lift cylinder port	SAE 6000 psi 1"	a3, b3	From RCV aux port	9/16" - 18UNF
A2, B2	To tilt cylinder port	SAE 6000 psi 1"	a4, b4	From RCV aux port	9/16" - 18UNF
A3, B3	To aux cylinder port	SAE 6000 psi 1"	LS	To shuttle valve	9/16" - 18UNF
A4, B4	To aux cylinder port	SAE 6000 psi 1"	SLS	To steering unit	9/16" - 18UNF
P2	From main pump	SAE 6000 psi 3/4"			
S	To steering unit	SAE 6000 psi 3/4"			

2) LIFT & TILT SECTION



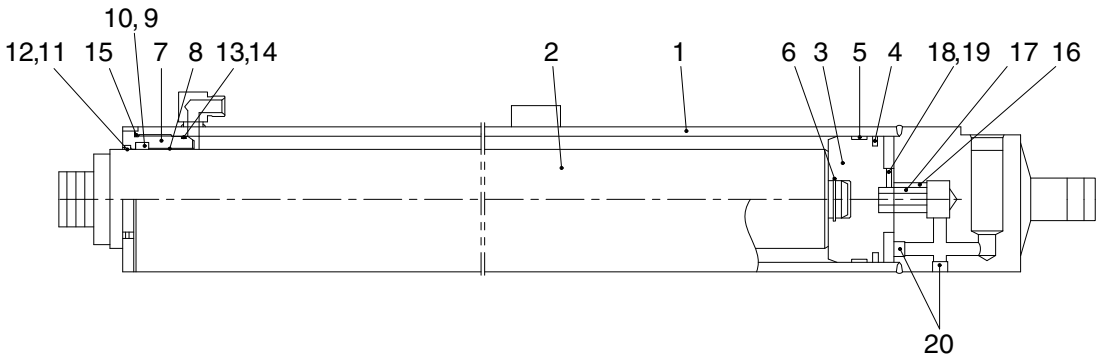
180D7EMCV12

3) AUXILIARY SECTION



180D7EMCV13

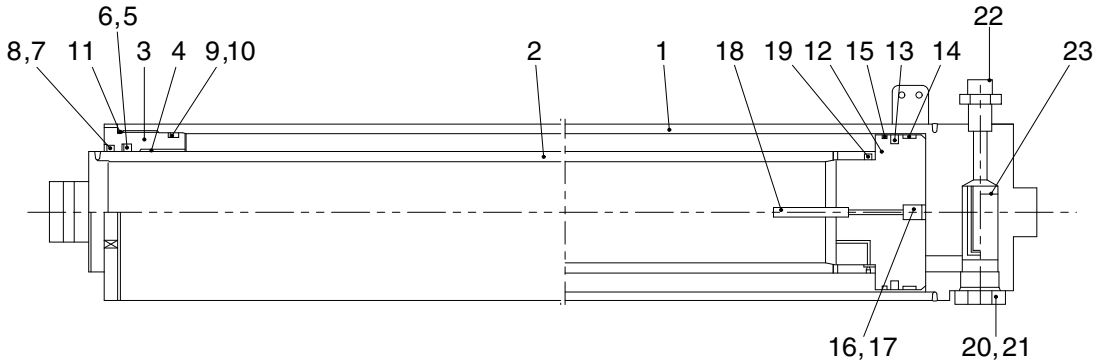
7. LIFT CYLINDER



300D9CY01

1	Tube assembly	8	Rod bushing	16	Cushion ring
2	Rod	9	U-packing	17	Guide
3	Piston	10	Back up ring	18	Set screw
4	Piston seal	12	Retaining ring	19	Set screw
5	Wear ring	13	O-ring	20	Plug
6	Stop ring	14	Back up ring		
7	Rod cover	15	O-ring		

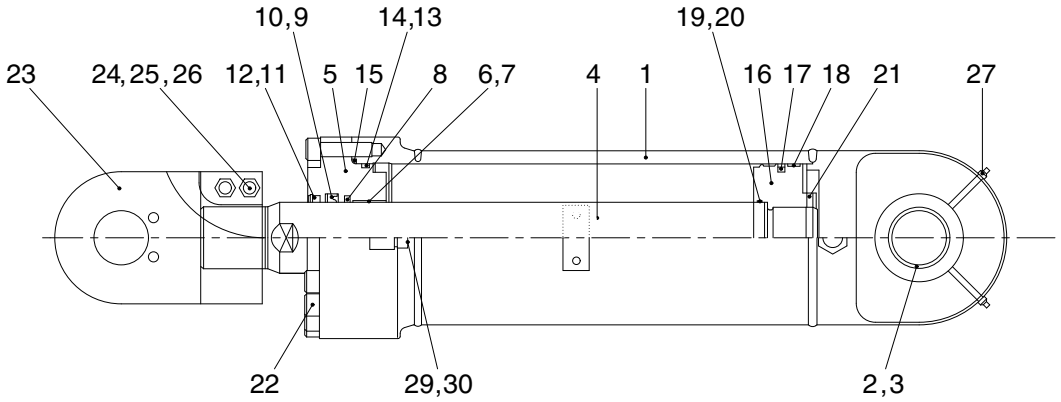
8. FREE LIFT CYLINDER



300D9CY01-1

1	Tube assembly	9	O-ring	17	Retaining ring
2	Rod	10	Back up ring	18	Pipe
3	Rod cover	11	O-ring	19	Set screw
4	Rod bushing	12	Piston	20	Plug
5	U-packing	13	Piston seal	21	O-ring
6	Back up ring	14	Wear ring	22	O-ring
7	Dust wiper	15	Dust ring	23	Down safety valve
8	Retaining ring	16	Check valve		

9. TILT CYLINDER



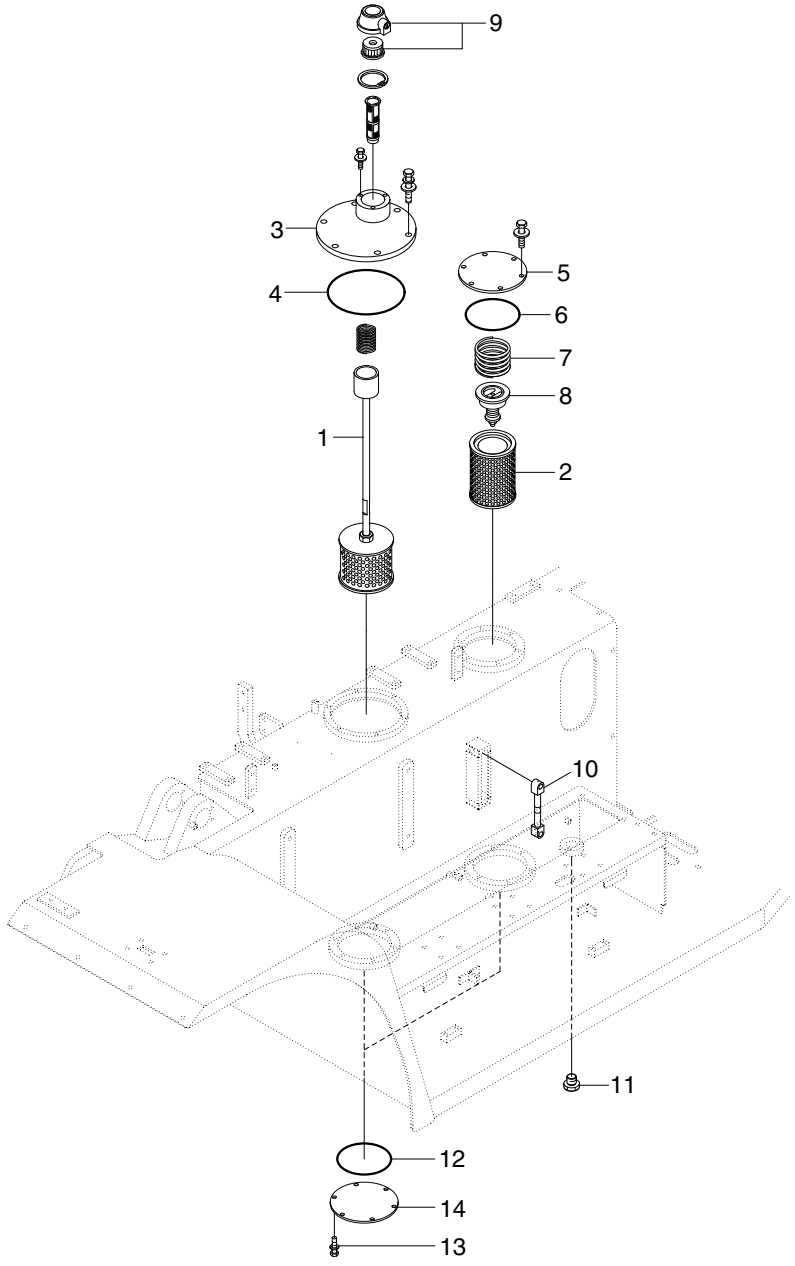
300D9CY11

1	Tube assembly	11	Dust wiper	21	Set screw
2	Spherical bushing	12	Retaining ring	22	Hex socket bolt
3	Retaining ring	13	O-ring	23	Eye
4	Rod	14	Back up ring	24	Hexagon bolt
5	Rod cover	15	O-ring	25	Hexagon nut
6	Rod bushing	16	Piston	26	Spring washer
7	Retaining ring	17	Piston seal	27	Grease nipple
8	Buffer ring	18	Wear ring	29	O-ring
9	U-packing	19	O-ring	30	Dust cap
10	Back up ring	20	Back up ring		

10. HYDRAULIC OIL TANK

1) STRUCTURE

- The oil from the hydraulic tank is sent from the pump through main control valve to the cylinders. In the return circuit, the oil from various parts merges.
- A part of oil is cooled in the oil cooler, passes through the hydraulic filter and returns to the hydraulic tank.



300D9HS13

1	Strainer	6	O-ring	11	Magnetic plug
2	Element	7	Spring	12	O-ring
3	Cover	8	Bypass valve	13	Bolt with washer
4	O-ring	9	Air breather	14	Suction flange
5	Cover	10	Level gauge		

2) AIR BREATHER

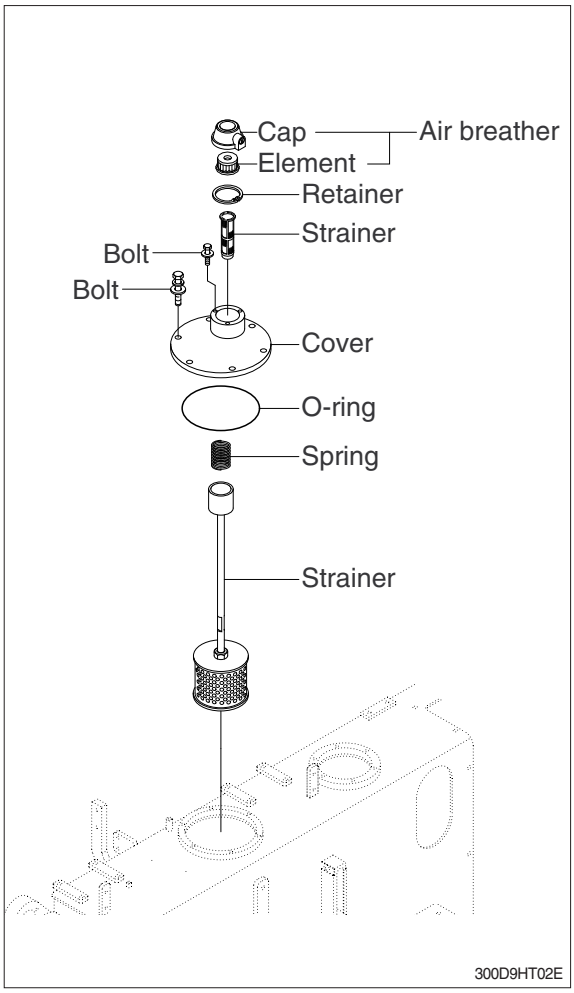
The air breather is equipped with the capacity to perform two functions simultaneously-as an air filter and as a breathing valve.

(1) Preventing negative pressure inside the tank

The tank is a pressurized sealed type, so negative pressure is formed inside the hydraulic tank when the oil level drops during operations. When this happens, the difference in pressure between the tank and the outside atmospheric pressure opens the puppet in the breather, and air from the outside is let into the tank or prevent negative pressure.

(2) Preventing excessive pressure inside the tank

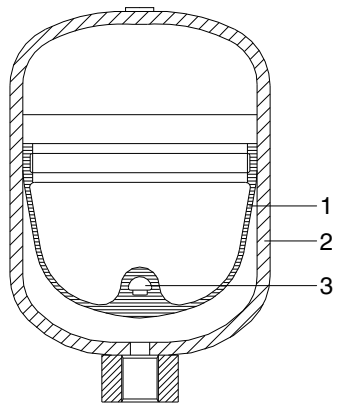
When the hydraulic cylinder is being used, the oil level in the hydraulic system increases and as temperature rises. If the hydraulic pressure rises above the set pressure, breather is actuated to release the hydraulic pressure inside the tank.



10. ACCUMULATOR

The accumulator is installed at the cut off valve. When the mast is left the raised position, and the control levers are operated with the engine stopped the pressure of the compressed nitrogen gas inside the accumulator sends pilot pressure to the control valve to actuate it and allow the boom and bucket to come down under their own weight.

Type of gas	Nitrogen gas (N_2)
Volume of gas	0.35 ℓ (0.1 U.S.gal)
Charging pressure of gas	15 kg/cm^2 (213 psi)
Max actuating pressure	170 kg/cm^2 (2420 psi)



1 Diaphragm
2 Steel pressure vessel
3 Closure button

7803AWE56

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 1 m 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**

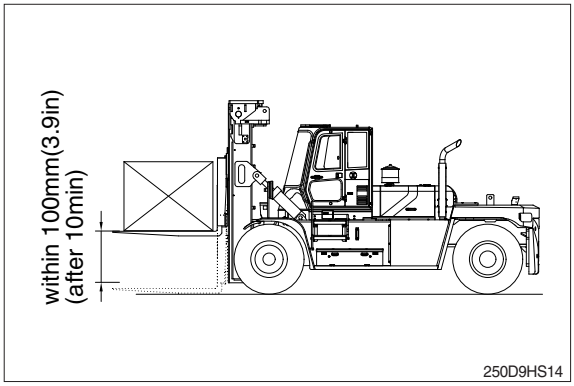
- Down (Downward movement of forks)
  : Within 100 mm (3.9 in)
- Forward (Extension of tilt cylinder)
  : Within 5°

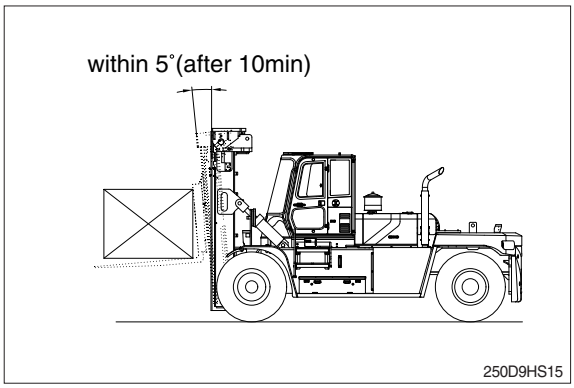
(3) If the hydraulic drift is more than the specified value, replace the control valve or cylinder packing.

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

mm (in)

Standard	Under 0.6 (0.02)

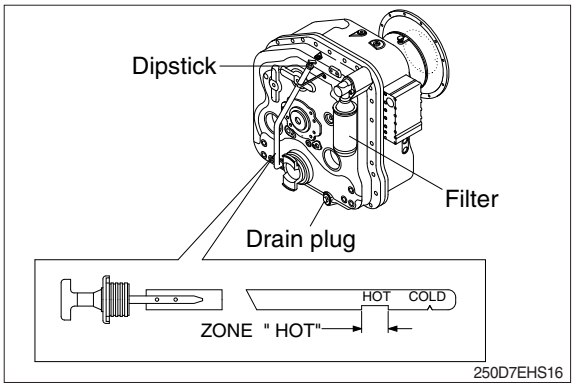




2) HYDRAULIC OIL

(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). Line filter uses paper element, so replace periodically (every 6 months or 1200 hours)



3) CONTROL VALVE

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

Check that oil pressure is 210 kgf/cm^2.
(2990 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.

Problem	Cause	Remedy
Actuator (cylinder or motor) works slowly or does not operate.	· Shortage of oil in oil tank. · Decrease of relief valve pressure. · Spool got stuck. · Shortage of oil flow to the valve.	· Check the oil level in the oil tank. · Install pressure gauge on the circuit, and check the pressure with it by handling the lever. · Check that manual lever moves smoothly. · Check that lever stroke is enough. · Check that oil flow of the pump is within specified rate.
Cylinder lowers considerably under normal circumstance.	· Internal leakage of cylinder happens frequently. · Excessive leakage from spool of the valve. · Spool got stuck. · Leakage in a part of the circuit.	· Fit the stop valve on the pipe between valve and cylinder, observe the internal leakage of cylinder. · Check the oil viscosity is not too low. · Check that manual lever moves smoothly. · Check the circuit. · Observe leakage from pipes.
Pressure does not increase sufficiently.	· Defect of relief valve. · Leakage in a part of the circuit.	· Check the relief valve. · Check the circuit. · Observe leakage from pipes.
Temperature rising of the hydraulic oil.	· Working with higher pressure than rated pressure. · Low viscosity of oil. · Leakage from a part of the circuit. · Oil leakage in the pump. · Insufficient suction of the pump.	· Check the flow pressure. · Check the sort of oil and viscosity. · Check if the circuit is relieved at all times. · Check if the temperature of pump surface higher 30 ˚C than oil temperature. · Check the oil tank volume. · Check if the suction strainer is blocked.
Steering force is heavy.	· Defect of steering relief valve.	· Check the steering relief valve.

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 puppets 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 *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.

★ A good pressure gauge must be installed in the line which is in communication with the main relief. A load must be applied in a manner to reach the set pressure of the main relief unit.
Then, follow these steps:

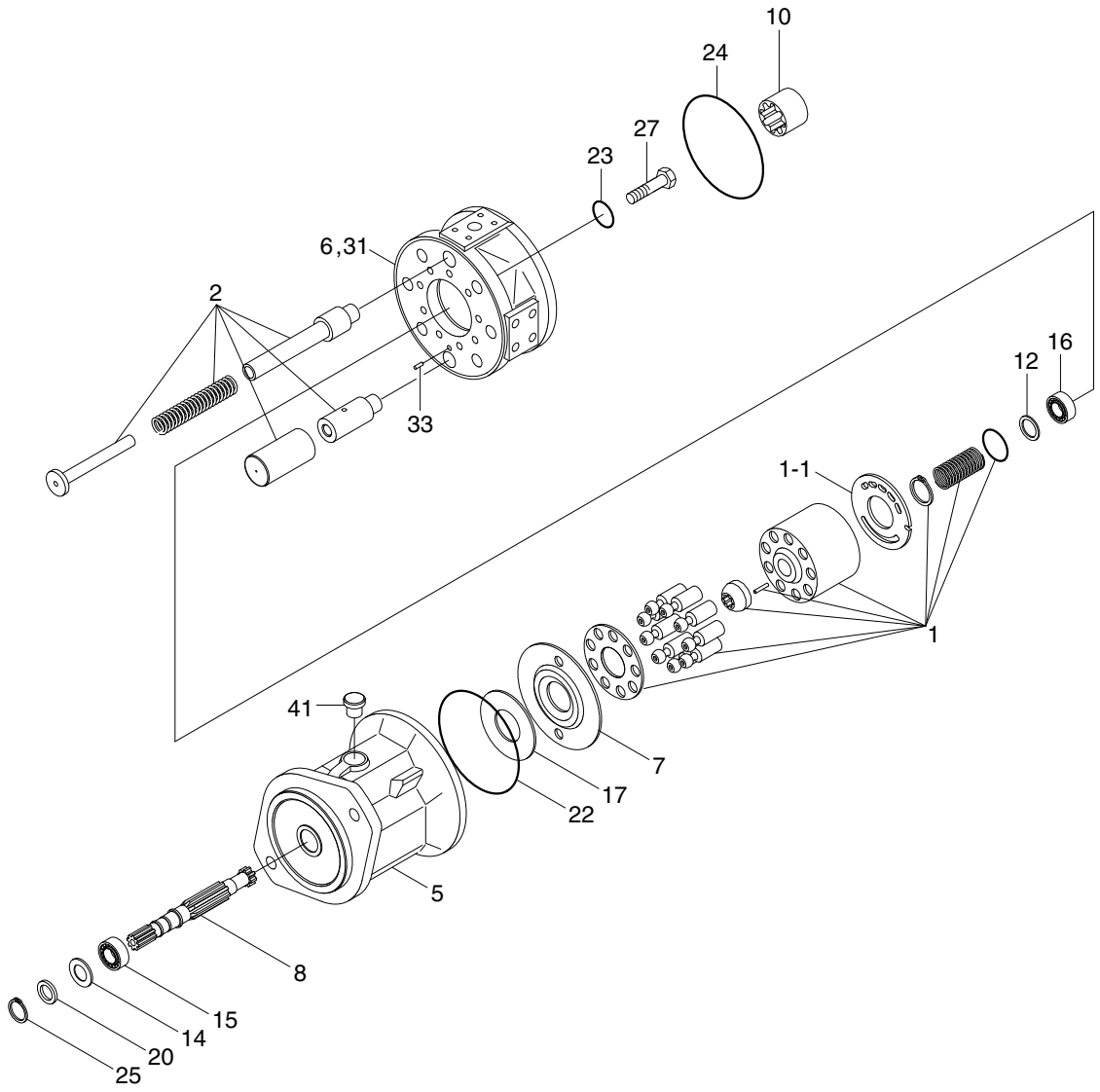
- Loosen lock nut.
- Set adjusting nut to desired pressure setting.
- If desired pressure setting cannot be achieved, add or remove shims as required.
- Tighten lock nut.
- Retest in similar manner as above.

4) 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.

1. MAIN PUMP

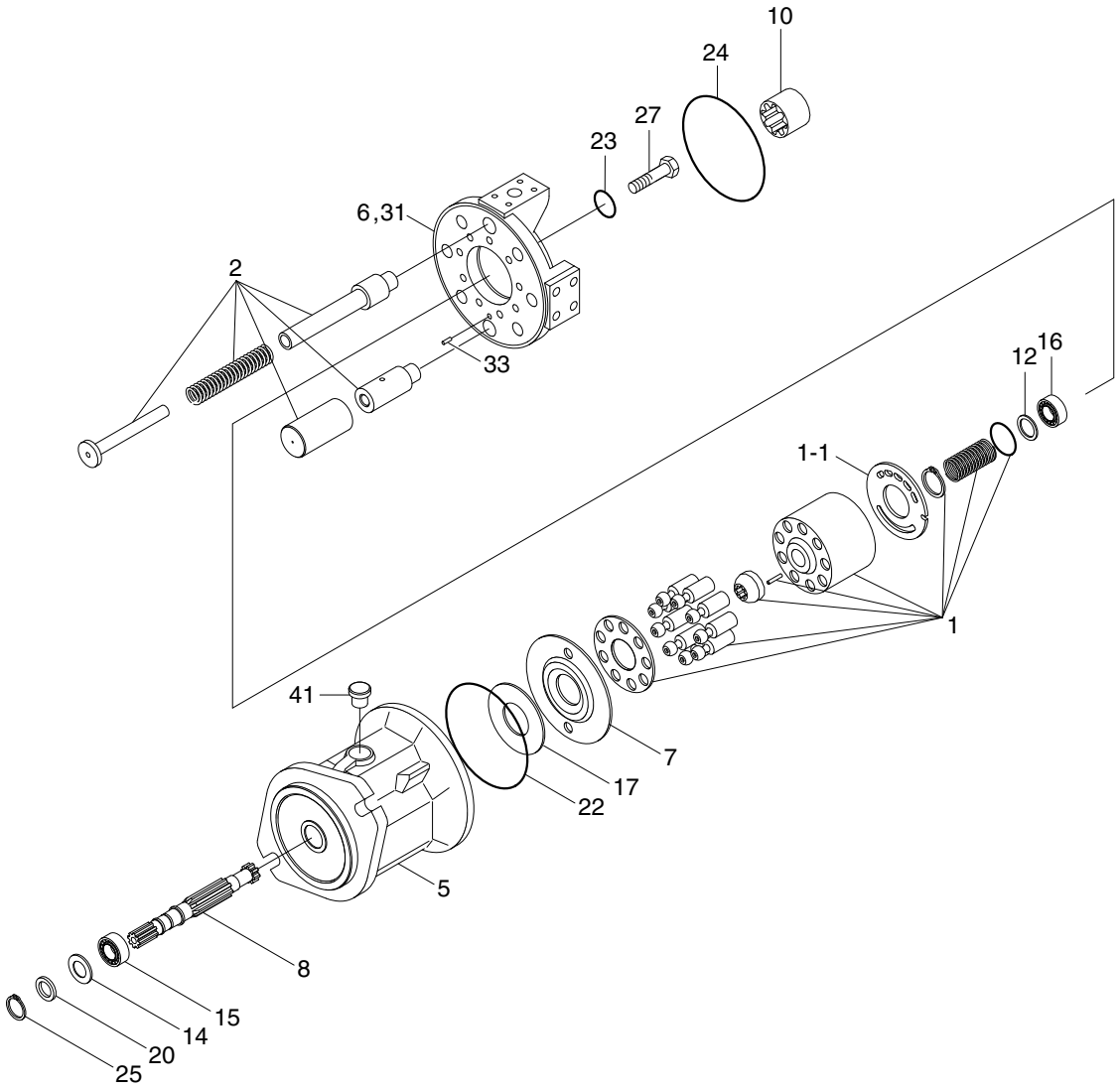
1) STRUCTURE (front)



180D9MP01

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Splined hub	23	O-ring		

STRUCTURE (rear)



180D9MP02

1	High speed rotary	12	Shim	24	O-ring
1-1	Control plate	14	Stop ring	25	Retaining ring
2	Adjusting piece	15	Taper roller bearing	27	Socket screw
5	Pump housing	16	Taper roller bearing	31	Double break-off pin
6	Port plate	17	Bearing liner	33	Cylinder pin
7	Swash plate	20	Shaft seal ring	41	Plug
8	Drive shaft	22	O-ring		
10	Spline hub	23	O-ring		

2) GENERAL REPAIR GUIDE LINES

※ Observe the following guidelines when carrying out repairs on hydraulic pumps.

(1) Close off all openings of the hydraulic unit.

(2) Replace all of the seals.
Use only original spare parts.

(3) Check all sealing and sliding surfaces for wear.

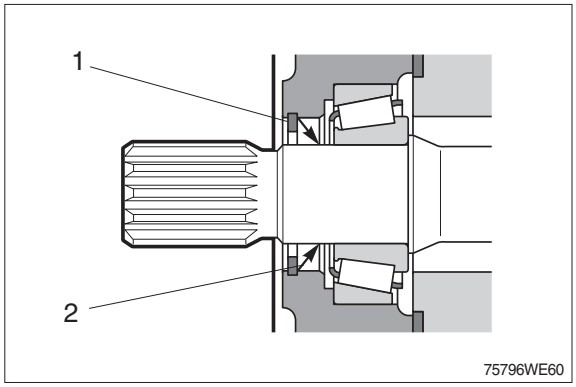
※ Re-work of the sliding surfaces by using, for example abrasive paper, can damage the surface.

(4) Fill the hydraulic pump with hydraulic oil before commissioning.

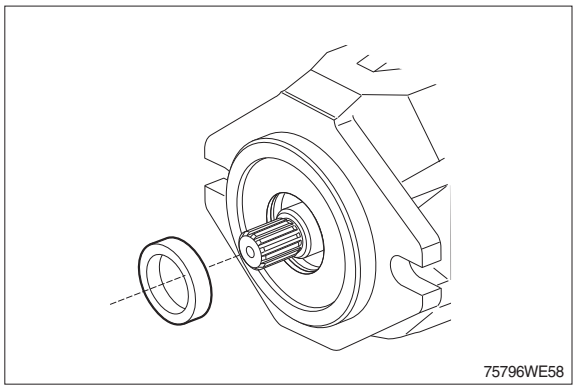
3) SEALING THE DRIVE SHAFT

(1) Protect the drive shaft.
Remove the circlip.
Remove the shaft seal.

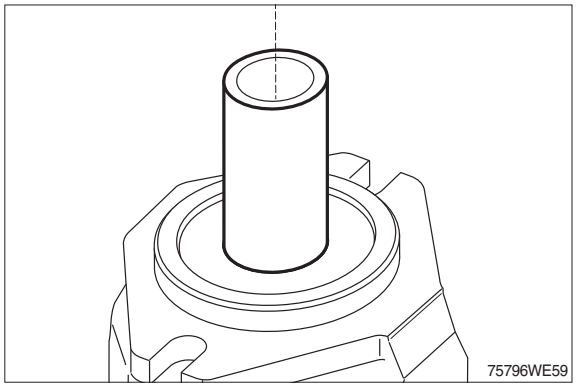
1 Circlip 2 Shaft seal



(2) Change the shaft seal and check its sliding surface (drive shaft) and housing, grease the sealing ring.



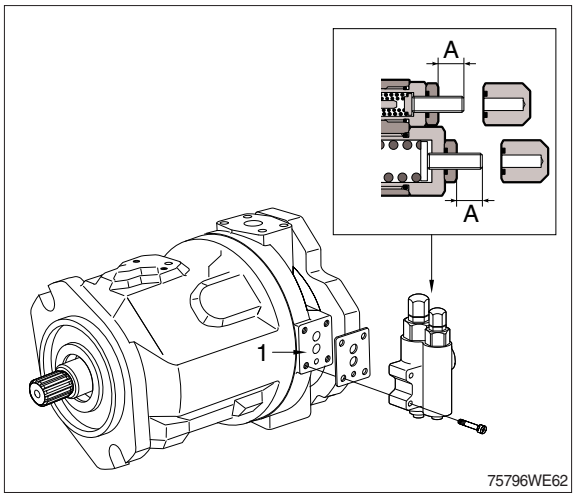
(3) Assemble the sealing ring, fitting tool holds the correct position of the sealing ring in the pump housing.
Assemble the circlip in the correct position.



4) SEALING / CLEANING THE CONTROL VALVE

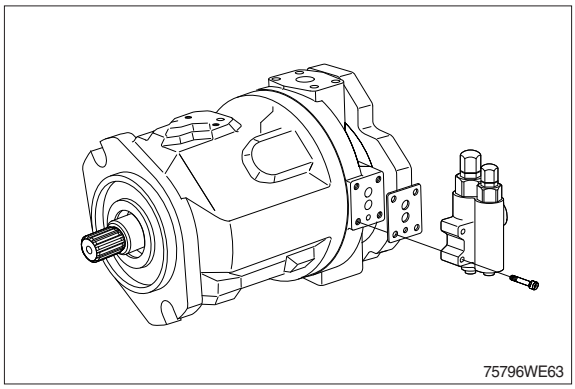
(1) Disassemble the control valve.

※ Measure dimension A and note down. Check sealing surface (1).

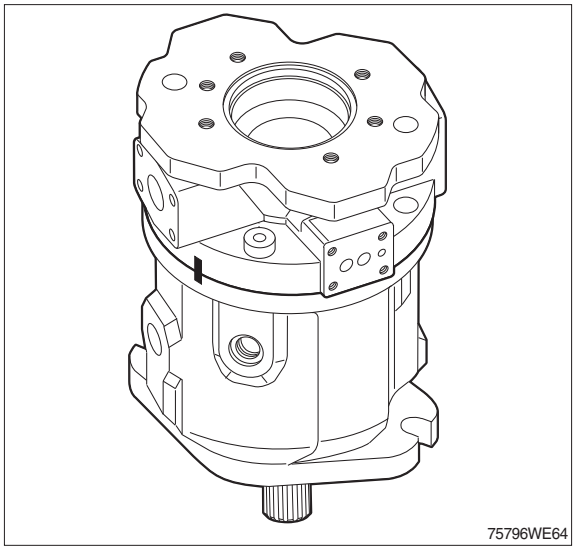


5) DISASSEMBLE THE PUMP

(1) Remove the control valve.

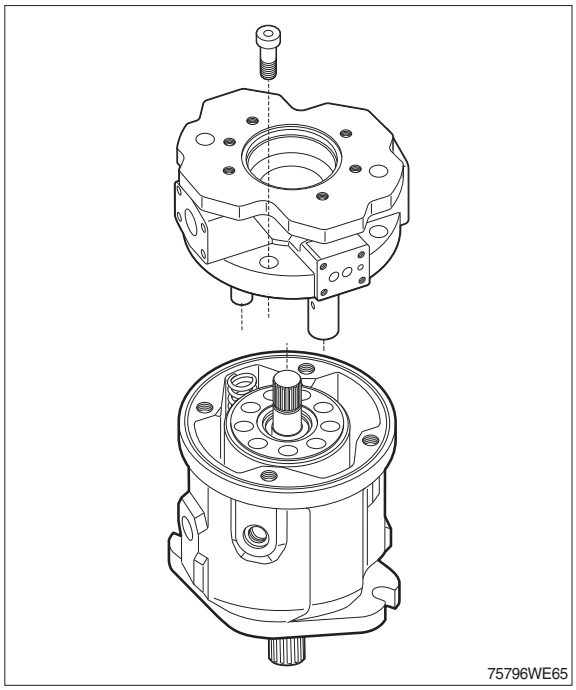


(2) Mark the location of the connection plate on the housing.



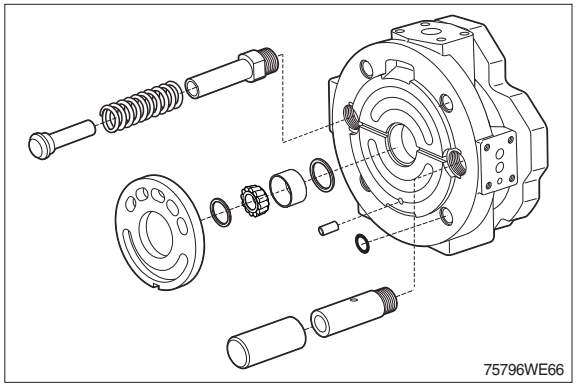
(3) Remove the connection plate fixing bolts and the connection plate.

※ Distributor plate and adjustment piston can drop down.

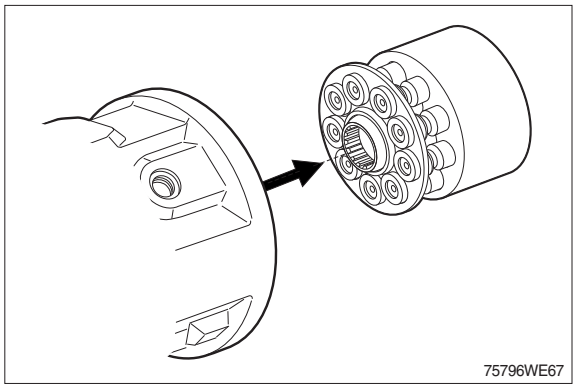


(4) Remove distributor plate.
Take note of the orientation.

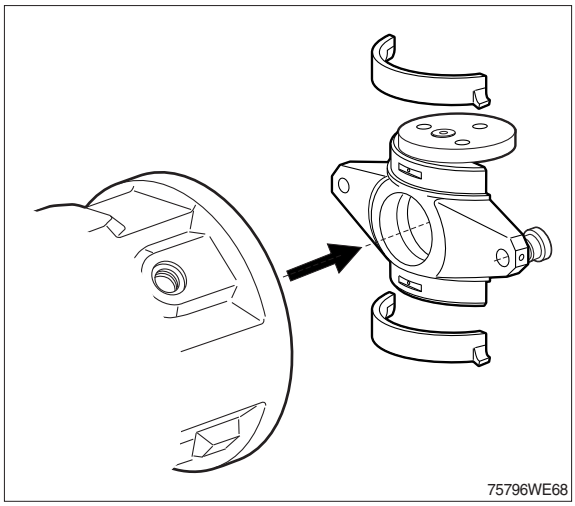
※ Remove bearing with withdrawal tool.
Do not damage the sealing surface.



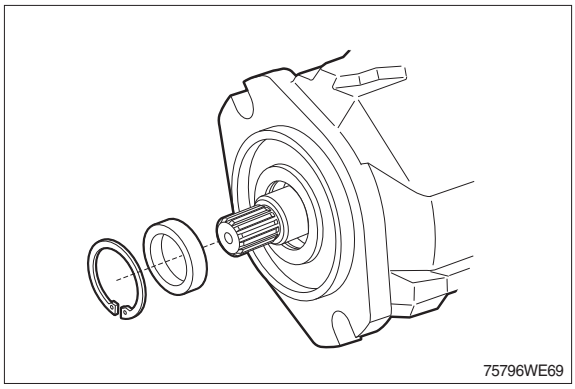
(5) Remove the rotary group in a horizontal position.



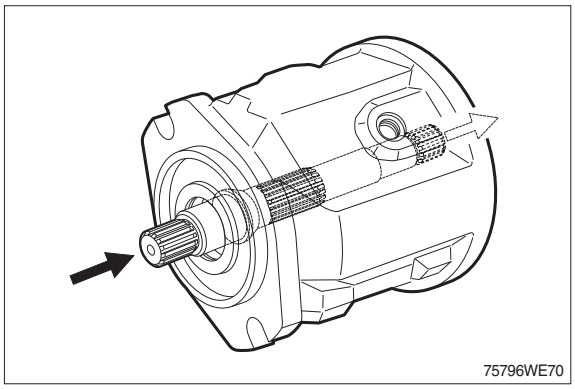
(6) Remove swash plate and bearing shells.



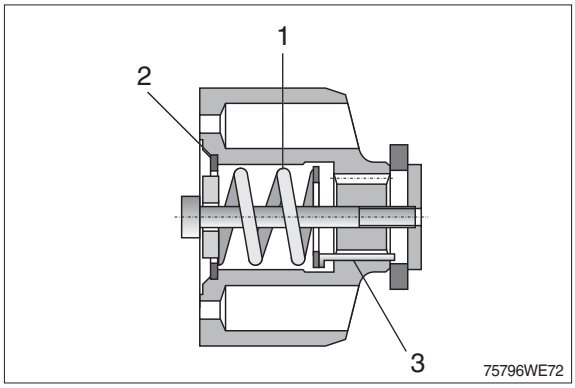
(7) Remove the circlip and the shaft seal.



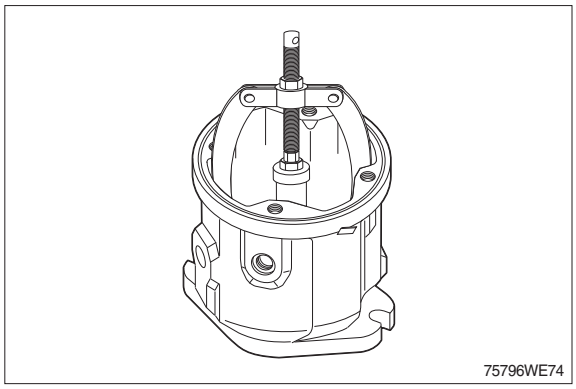
(8) Remove the drive shaft through rear side.



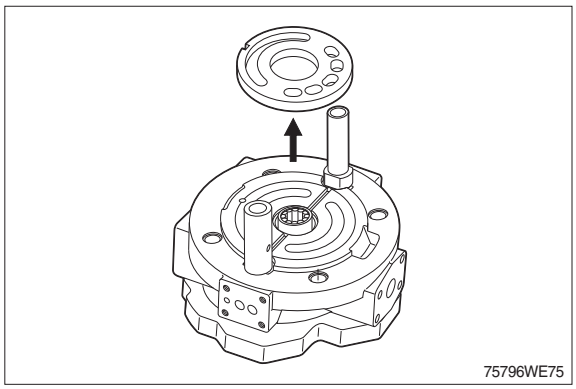
(9) Pre-tension the spring (1) using a suitable device.
Remove circlip (2).
Remove spring (1) and pressure pins (3).



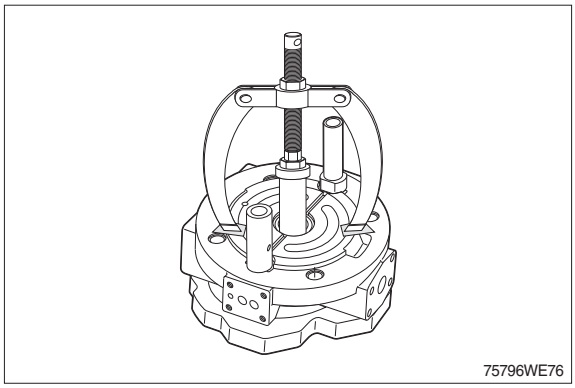
(10) Use bearing puller to remove outer bearing race of front bearing out of housing press seat.



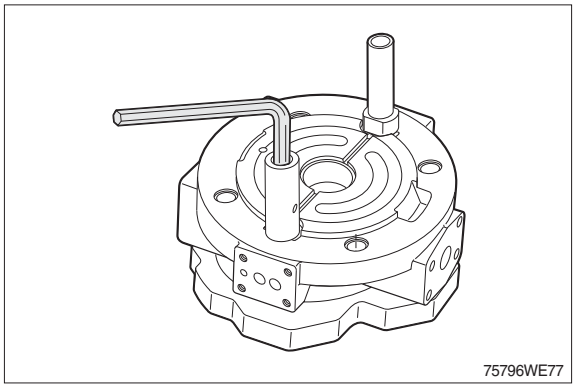
(11) Remove the control plate.



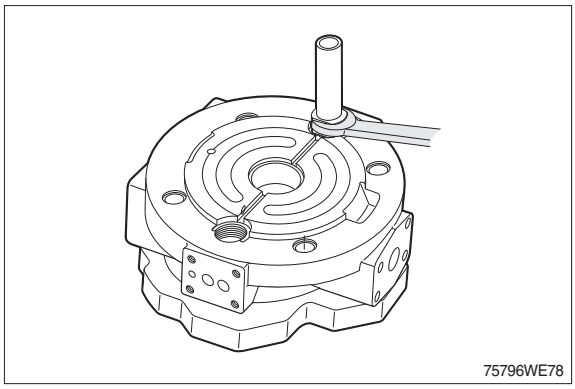
(12) Use bearing puller to remove outer bearing race of rear bearing - press seat.



(13) Disassemble the guide of control piston (Mounting position: pilot valve side).

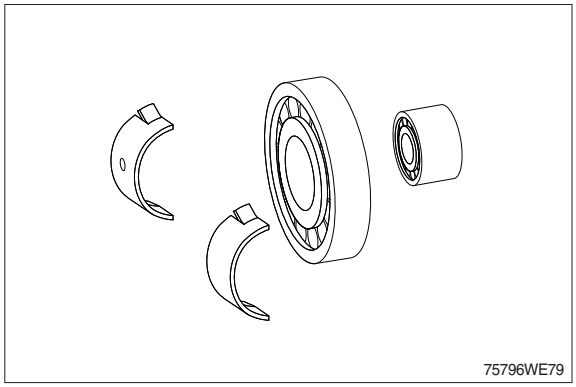


(14) Disassemble the guide of the opposite piston.

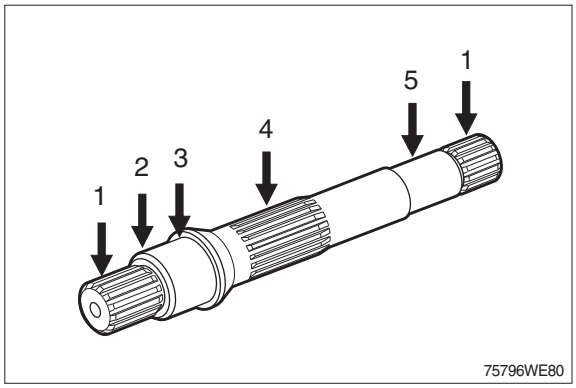


6) INSPECT HINTS

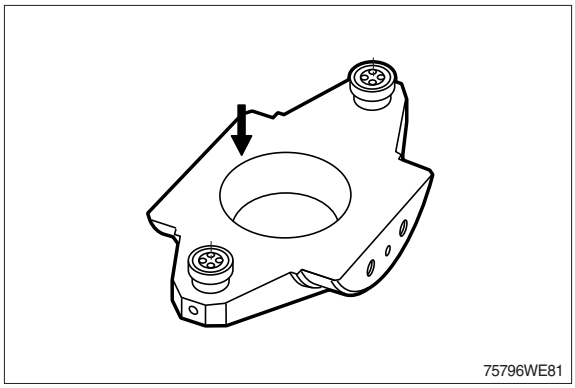
(1) Renew all bearings.



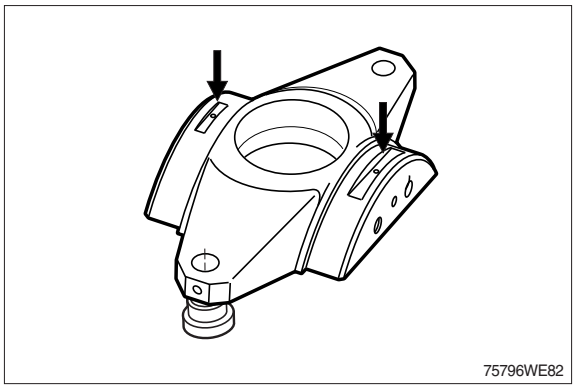
(2) Check :
1 Wear on splines, rust
2 Drive shaft seal wear grooves
3 Bearing seat
4 Splines for cylinder drive
5 Bearing seat



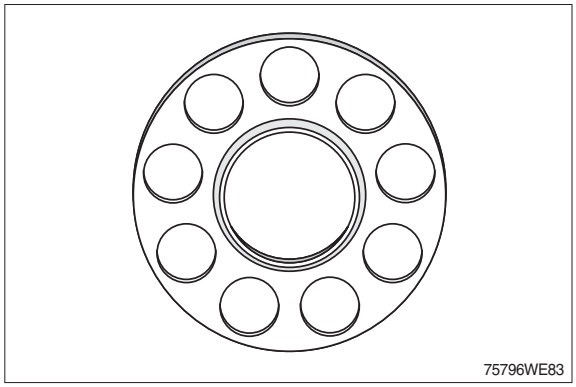
(3) Check :
Sliding surface free of grooves.



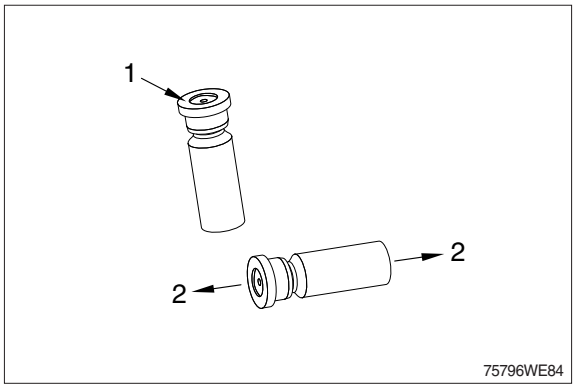
(4) Check
Bearing surfaces.



(5) Check
That the retaining plate is free of grooves and that there is no wear in the slipper pad area.

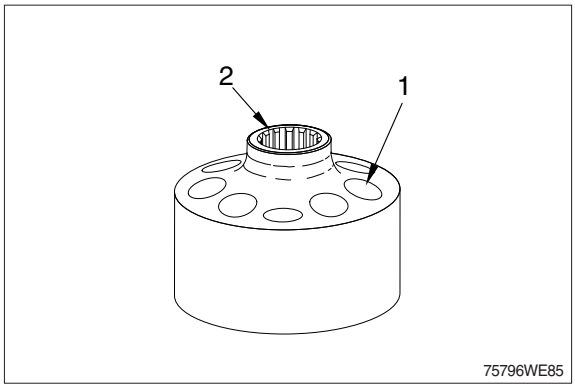


(6) Check
Check to see that there are no scratches or metal deposits on the sliding surface (1) and that there is no axial play (2) (Pistons must only be replaced as a set).

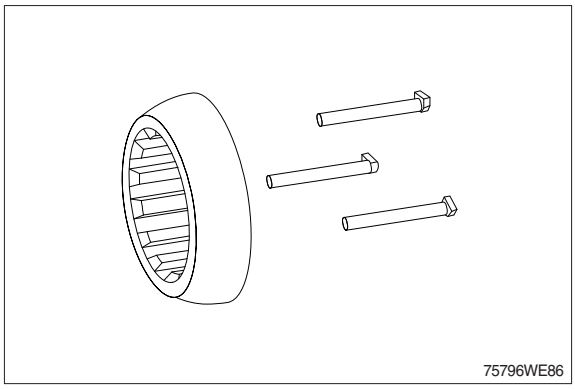


(7) Check

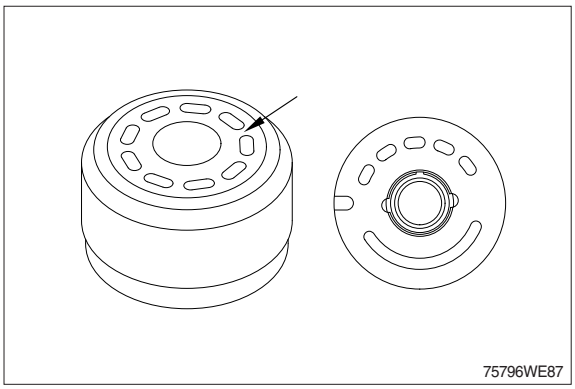
1 Cylinder bores
2 Splines



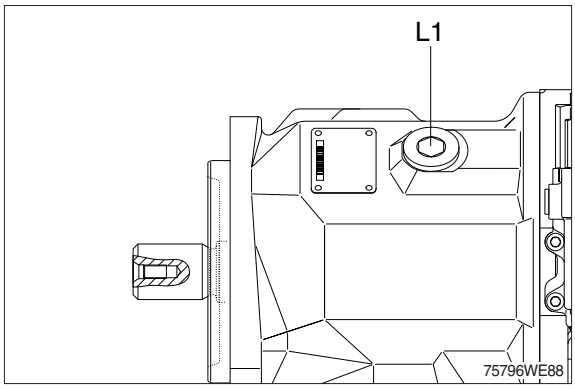
(8) Free of grooves, no signs of wear.



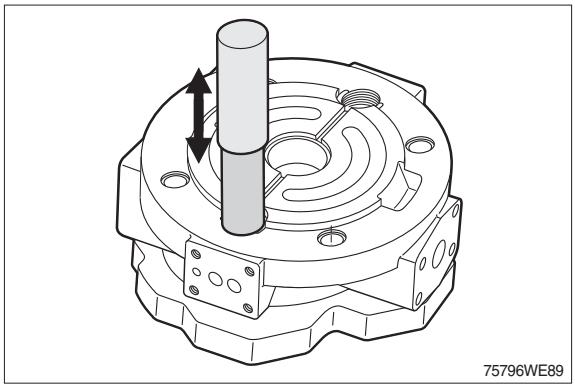
(9) Check
Cylinder sliding surface free of grooves, no wear, no embedded foreign particles. That there are no scratches on the control plate. (Only replace them as a set).



(10) Check
Mounting surface - control plate undamaged.

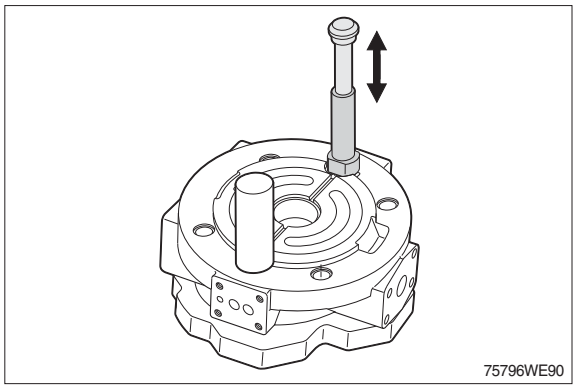


(11) Check
Check running conditions of the control piston.



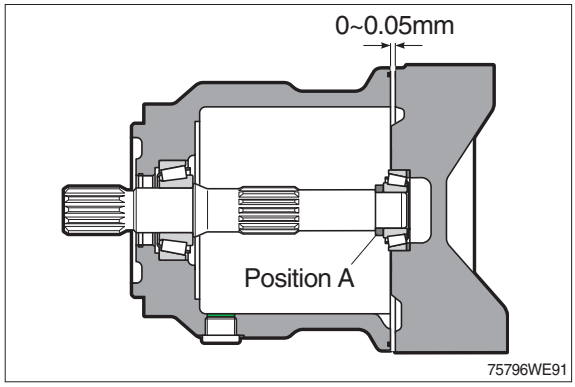
(12) Check

Check running conditions of the opposite piston.



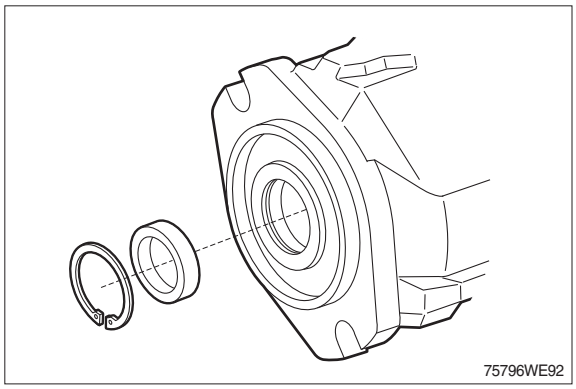
7) ADJUSTMENT OF TAPER ROLLER BEARING SET

(1) Cast iron housing must have initial tension of the bearings: 0~0,05 mm, grind position A if necessary.



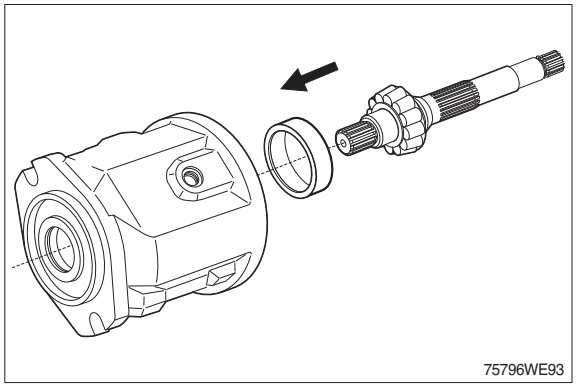
8) PUMP ASSEMBLY

(1) Fit the seal into the housing.
Fit the circlip.

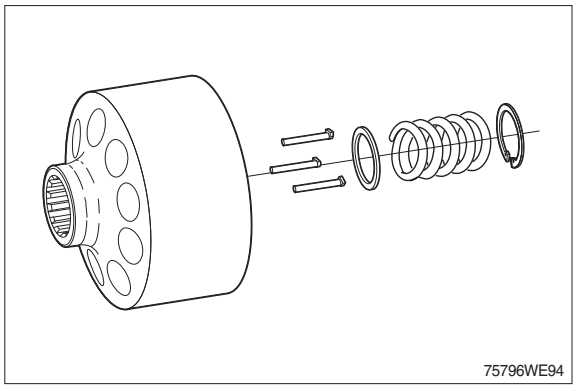


(2) Fit the drive with bearing from rear end.

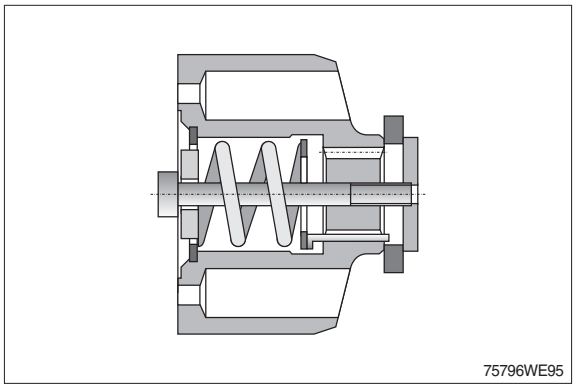
※ Do not touch seal lip with edge of keyway or spline.



(3) Fit pressure pins using an assembly aid.

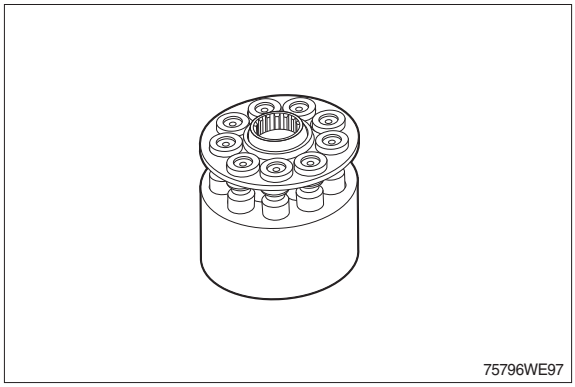


(4) Pre-tension the spring using a suitable device.



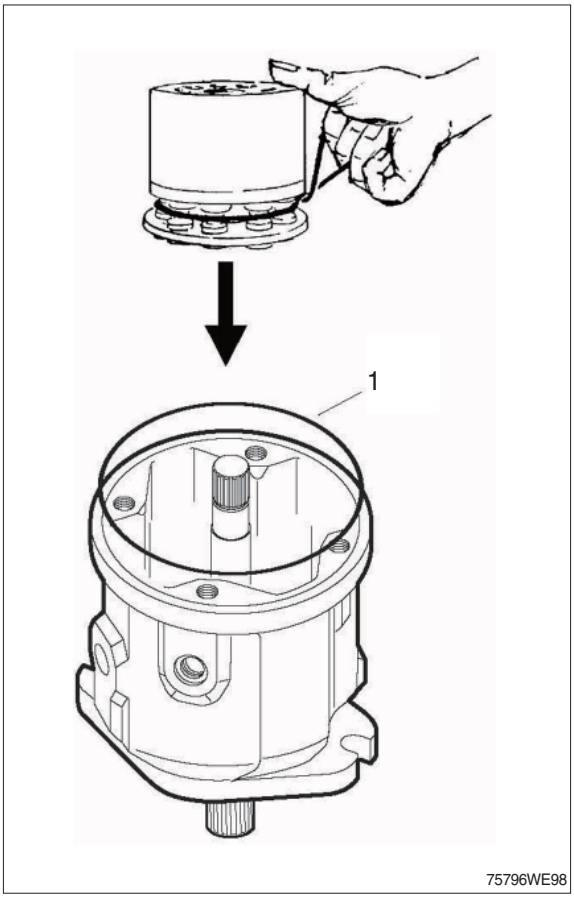
(5) Assemble piston with retaining plate.

※ Oil piston and slipper pad.



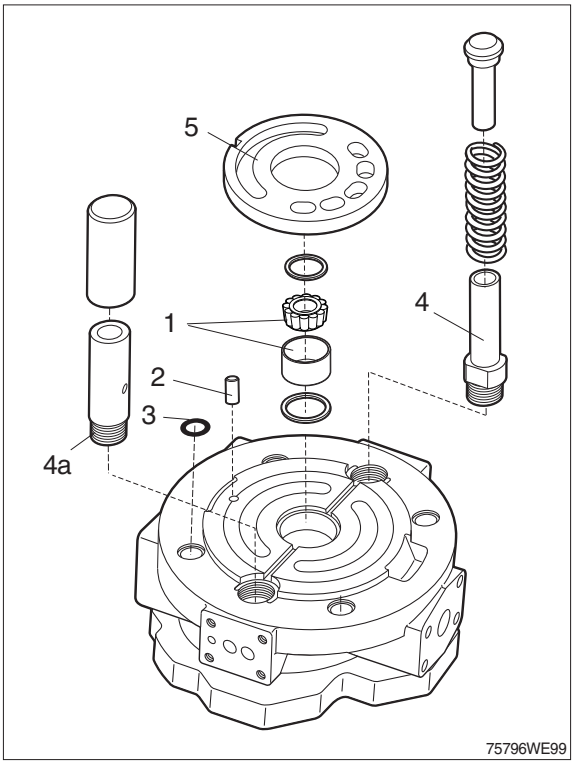
(6) Fit rotary group.

※ Hold the piston by using an O-ring.
Fit O-ring (1).



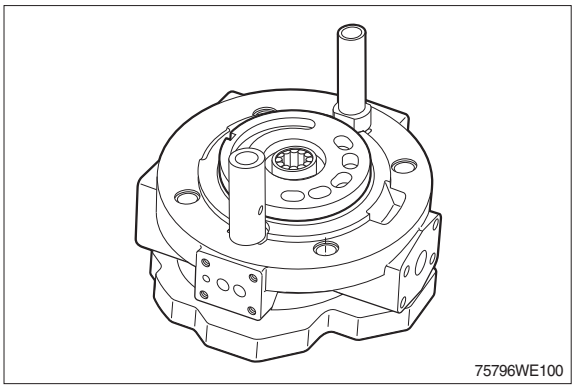
(7) Fit bearing (1) in connection plate.
Fit cyilindrical pin (2).
Fit O-rings (3) 4 pieces.
Fit adjustment spool (4) and guide piston (4a).
Fit distributor plate (5) (direction of rotation dependent)

※ Assembly.
Hold the components in place with grease.

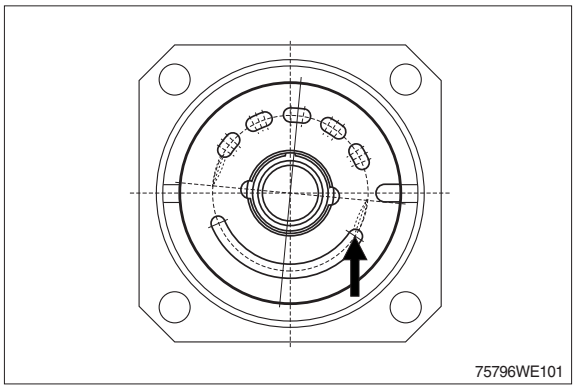


(8) Fit distributor plate.

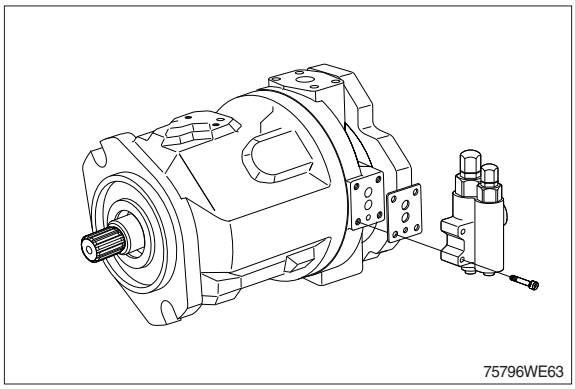
※ Assembly aid : Grease



(9) For clockwise rotation pumps the distributor plate is off-set by 4˚ to the right from the centre position.
(Clockwise and anti-clockwise rotation distributor plates are not identical).

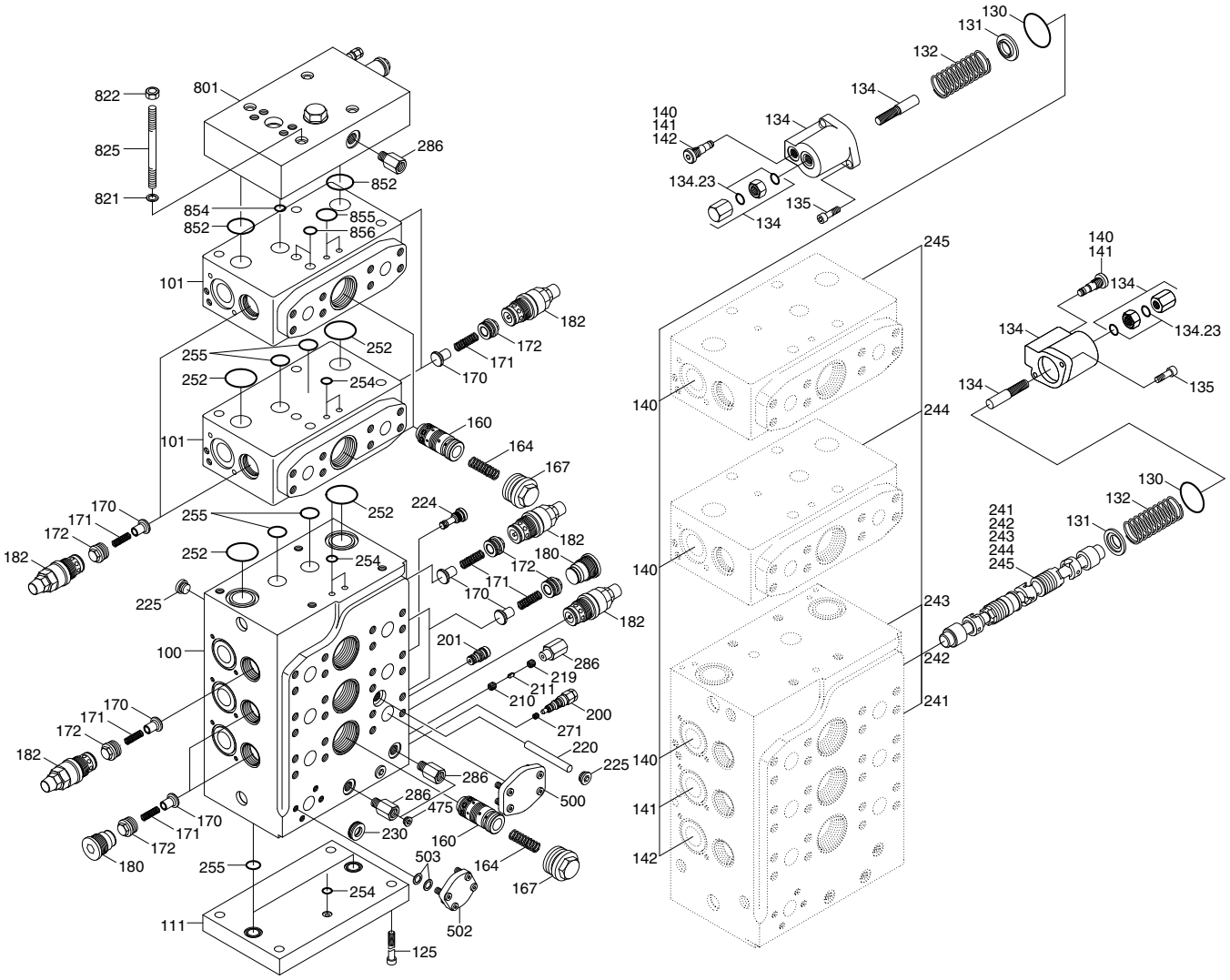


(10) Fit connection plate and control valve.



2. MAIN CONTROL VALVE

1) STRUCTURE



180D7EMCV01

100	Housing	160	Spool	220	Spool	286	Reducing piece
101	Housing	164	Compression spring	224	Locking screw	475	Locking screw
111	Plate	167	Locking screw	225	Locking screw	500	Blank flange
125	Cylinder	170	Cone	230	Connection piece	502	Blank flange
130	O-ring	171	Compression spring	241	Spool	503	Washer
131	Retainer spring	172	Locking screw	242	Spool	801	End block
132	Compression spring	180	Plug	243	Spool	821	Washer
134	Cover	182	Relief valve	244	Spool	822	Hexagonal nut
134.23	O-ring	200	Shuttle valve	245	Spool	825	Stud
135	Bolt	201	Drain orifice	252	O-ring	852	O-ring
140	Locking screw	210	Valve seat	254	O-ring	854	O-ring
141	Throttle check valve	211	Throttle bolt	255	Seal	855	O-ring
142	Throttle check valve	219	Valve seat	271	Orifice	856	Seal

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE12 (1" 1/16-12UNF) & SAE16 (1" 5/16-12UNF) is 4.3 kgf · m (31 lbf · ft) and SAE6 (9/16-18UNF) is 2.5 kgf · m (18 lbf · ft).
(2) Care must be taken not to damage the seals by excess temperature or spatter of welding, when welding near by the valve.
(3) During the installation, care must be taken not to damage spool. It might cause defect of operation such as the spool getting stuck in valve body.
(4) Fit the rubber hosepipe for the machine, which expected vibration.
(5) Until piping, don't remove the blinds from each port.

4) PRECAUTION FOR OPERATION

(1) Max input pressure range should be less than 300 bar (4350 psi).
(2) Back pressure of tank port should be less than 25 bar (367 psi).
(3) The oil temperature should be between -20 ~ 80 ˚C. And ambient temperature should be from -40 ~ 60 ˚C. because that very high viscosity of oil will be cause defect of spool operation, warm up the machine to avoid it.
(4) 15/12- ISO4406 level of filtration is required in the hydraulic circuit for long life cycle of each components without mechanical trouble.

5) SPECIAL TOOL

(1) 3, 8, 5, 12 mm wrench.
(2) 17, 30, 36 mm spanner.
(3) Torque wrench adjustable from 0.9 ~ 4.3 kgf · m (7 ~ 31 lbf · ft).

6) INSTRUCTION FOR DISASSEMBLY AND REASSEMBLY

Before disassembly, visually inspect for leakage of oil and for part that have damage and clean the valve up. Preparation for assembly put the tag on each part to prevent wrong assembly and clean the parts completely. Inspect the parts if there is any scratch or dent, and check the movement. In assembly process, follow the tightening torque specification.

(1) Operation

Warm-up is very important before operation.

Be careful operating control valve when oil and valve temperature is low, to avoid stick by spool heat shock.

Not doing continual operates of main relief valve and port relief valve, warm valve uniformly by circulating oil to each cylinder.

Not doing neither inching operating nor multiple operation in low temperature to avoid heating locus of control.

(2) Relief valve

Exchanging complete relief valve is recommended. Therefore do not disassemble if there is any defect in the relief valve.

(3) Mounting

Be careful not to affect extreme force to control valve by hydraulic hose.

Tighten up all mounting blots in same torque.

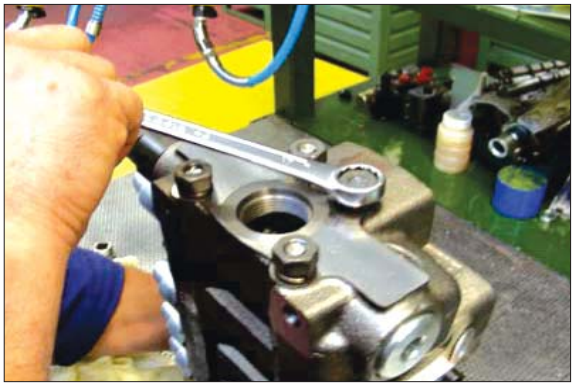
It is possible that seals are damaged by heat weld slag in which case of welding near the control valve.

To prevent contamination entering control valve, do not take off the shipping plug until install hydraulic hose.

6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen tightening two bolts with 17 ㎜ spanner.



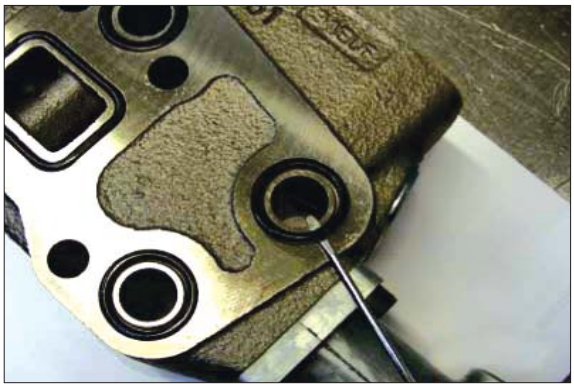
100D7MCV01

Taking out working section one by one.

100D7MCV02

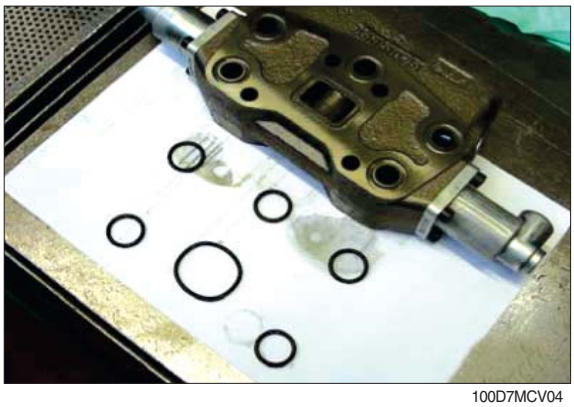
Remove O-rings on the surface of working section properly.

Pay special attention not to give any scratch on the surface.



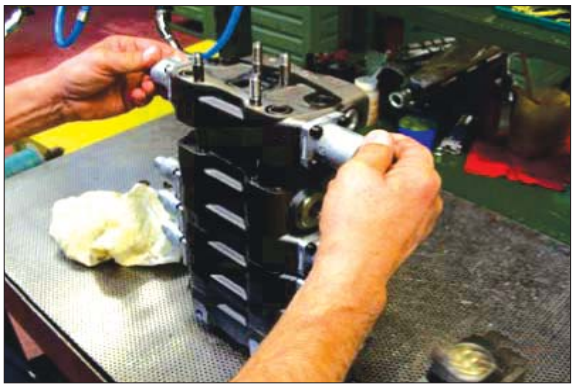
100D7MCV03

Prepare two sizes of O-rings.
And fix the O-rings on the right positions with some grease in order to avoid separation from the surface while moving.



100D7MCV04

Locate new or repaired working section in right position according to the order of functions.



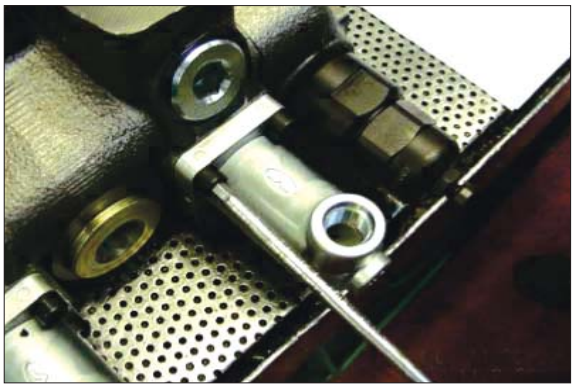
100D7MCV05

Tighten four nuts (M17) in a crisscross pattern with proper assembling torque of 4.3 kgf · m (31 lbf · ft).

100D7MCV06

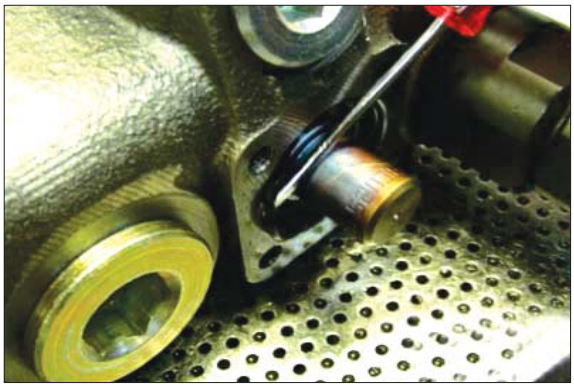
(2) Replacing spool & control kit

Loosen 4 screws holding aluminum kits to the body with 5 mm wrench.



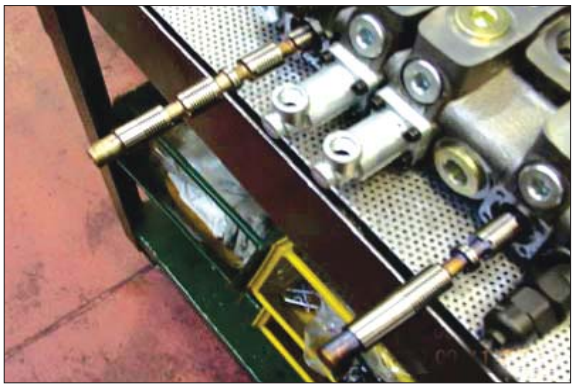
100D7MCV07

Take off all components and O-ring, valve inside, with attention not to give any damage to it.
Don't use anything with sharp edge.



100D7MCV08

Take out the spool, as straight as possible. Even very little force on the spool while disassembling & assembling could make deformation on the spool.



100D7MCV09

Prepare all components before starting reassembling spool control kit.

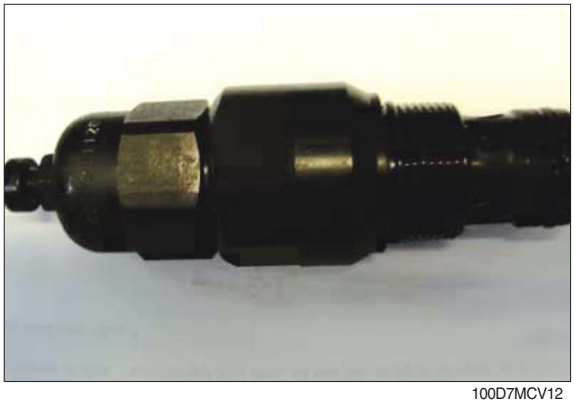
100D7MCV10

Fit aluminum kit to the body with 5 ㎜ wrench by 1.0 kgf · m (7.2 lbf · ft).

100D7MCV11

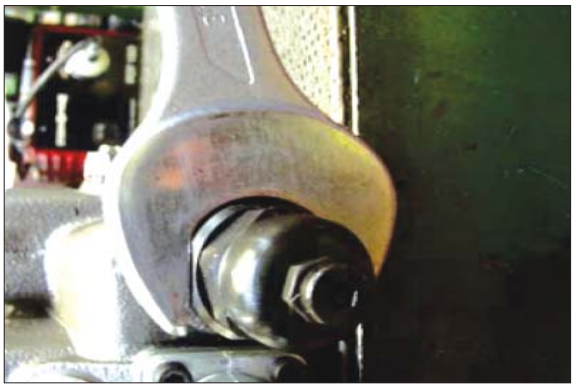
(3) Replacing relief valve

Prepare a new relief valve.



100D7MCV12

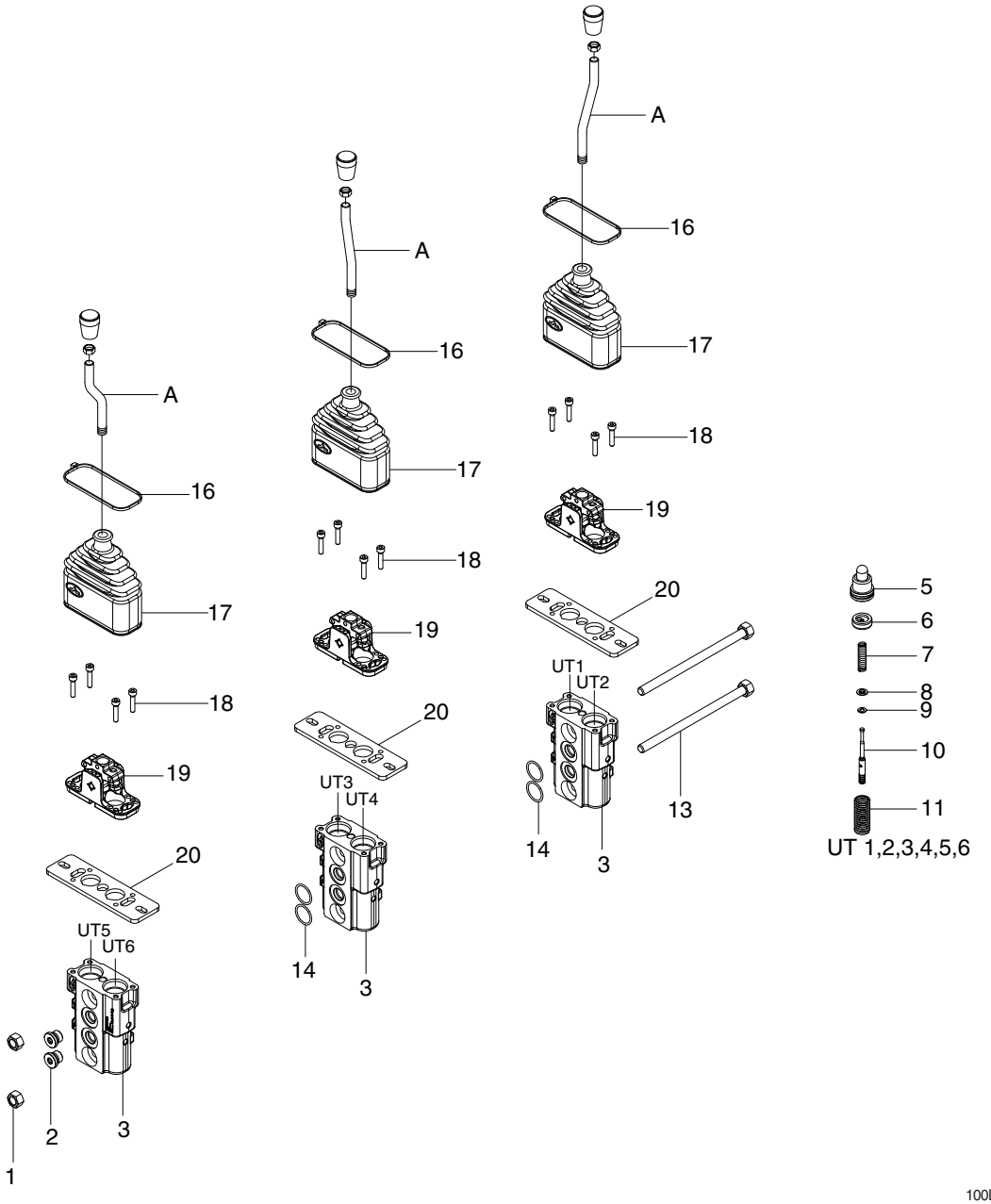
Replace old relief valve with new one.
Relief valve should be fitted with proper tool, 36 mm spanner, with 4.3 kgf · m (31 lbf · ft) torque.



100D7MCV13

3. REMOTE CONTROL VALVE

1) STRUCTURE



100D7RCV00

A	Lever	7	Metering spring	14	O-ring
1	Nut	8	Seeger ring	15	Kit 3
2	Plug	9	Seeger ring	16	Clamp
3	Body	10	Docking rod	17	Rubber bellow
4	Kit 1	11	Spring	18	Screw
5	Plunger kit	12	Kit 2	19	Support kit
6	Spring guide	13	Tie rod with nut	20	Flange

2) GENERAL PRECAUTIONS

(1) In the system, all of the pipes must be carefully cleaned before installation in order to remove dirt, rust, and deposits.
(2) The following cleaning procedures are recommended: Sanding, brushing, pickling, and flushing with a solvent to remove contaminating particles.
(3) The use of Teflon tape, hemp, or other "fillers" for joints is PROHIBITED
(4) Verify that the pipes, fittings and connections are not subjected to mechanical stress.
(5) Make sure that the pipes are not wound and that there are no abrasions on the surface.

3) PRECAUTION FOR DISASSEMBLY AND ASSEMBLY

(1) Valve piping joint should be tightened with the specified torque value. When piping, care should be taken not to apply excess pressure to the valve. If valve is installed with incorrect torque values, it might cause defect of spool operation, noise or vibration.
Recommended tightening torque of SAE 4 (7/16-20UNF) is 1.0 kgf · m (7.2 lbf · ft).
(2) Care must be taken not to damage the seals by excess temperature or spatter of welding, when welding near by the valve.
(3) During the installation, care must be taken not to damage spool. It might cause defect of operation such as the spool getting stuck in valve body.
(4) Fit the rubber hosepipe for the machine, which expected vibration.
(5) Until piping, don't remove the blinds from each port.

4) PRECAUTION FOR OPERATION

(1) Max input pressure range should be less than 30 ~ 100 bar (435 ~ 1450 psi).
(2) Back pressure of tank port should be less than 3 bar (43.5 psi).
(3) The oil temperature should be between -10 ~ 80 ˚C. And ambient temperature should be from -40 ~ 60 ˚C. because that very high viscosity of oil will be cause defect of spool operation, warm up the machine to avoid it.
(4) 15/12- ISO4406 level of filtration is required in the hydraulic circuit for long life cycle of each components without mechanical trouble.

5) SPECIAL TOOL

(1) 3 mm wrench.
(2) 13 mm socket spanner.
(3) Torque wrench adjustable from 1.02 ~ 3.06 kgf · m (7.4 ~ 22.1 lbf · ft).

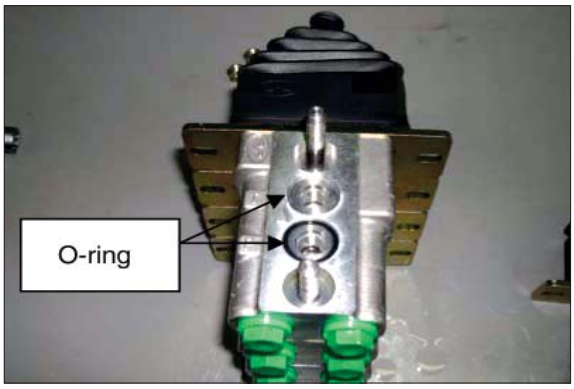
6) DISASSEMBLY & ASSEMBLY

(1) Replacing complete working section

Loosen two tightening bolts with 13 mm spanner.

100D7RCV02

Taking out the damaged section and insert new one. Pay attention 2 O-rings on the internal passage to be in right position.



100D7RCV03

Tight M13 nut with proper torque 3.06 kgf · m (22.1 lbf · ft).

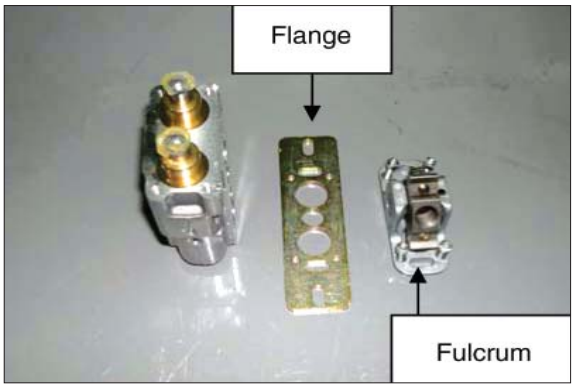
100D7RCV04

(2) Replacing pilot pressure spool

Loosen 4 screws holding upper part to the body with 3 mm wrench holding mounting plate no to spring up by return springs inside.

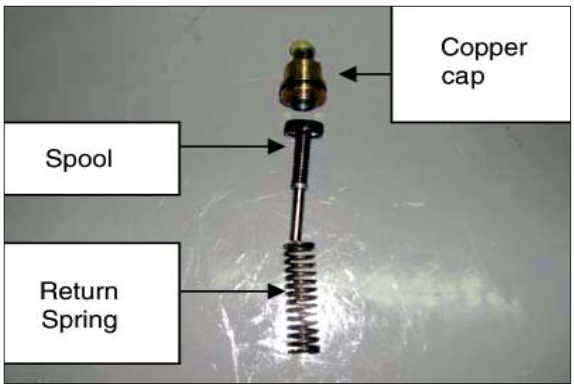
100D7RCV05

Take off the fulcrum and mounting flange very carefully keeping all components in their own positions.



100D7RCV06

Take out the spool, return spring from the body. And replace any component if it is needed.



100D7RCV07

Reassemble the spool in opposite order mentioned above.
Insert spool as straight as possible not to give any damaged on it while inserting it into body.


100D7RCV08

Prepare copper cap in clean.
Apply some clean grease around the O-ring on the copper cap, in order to avoid any damage of O-ring while fitting it into body.


100D7RCV09

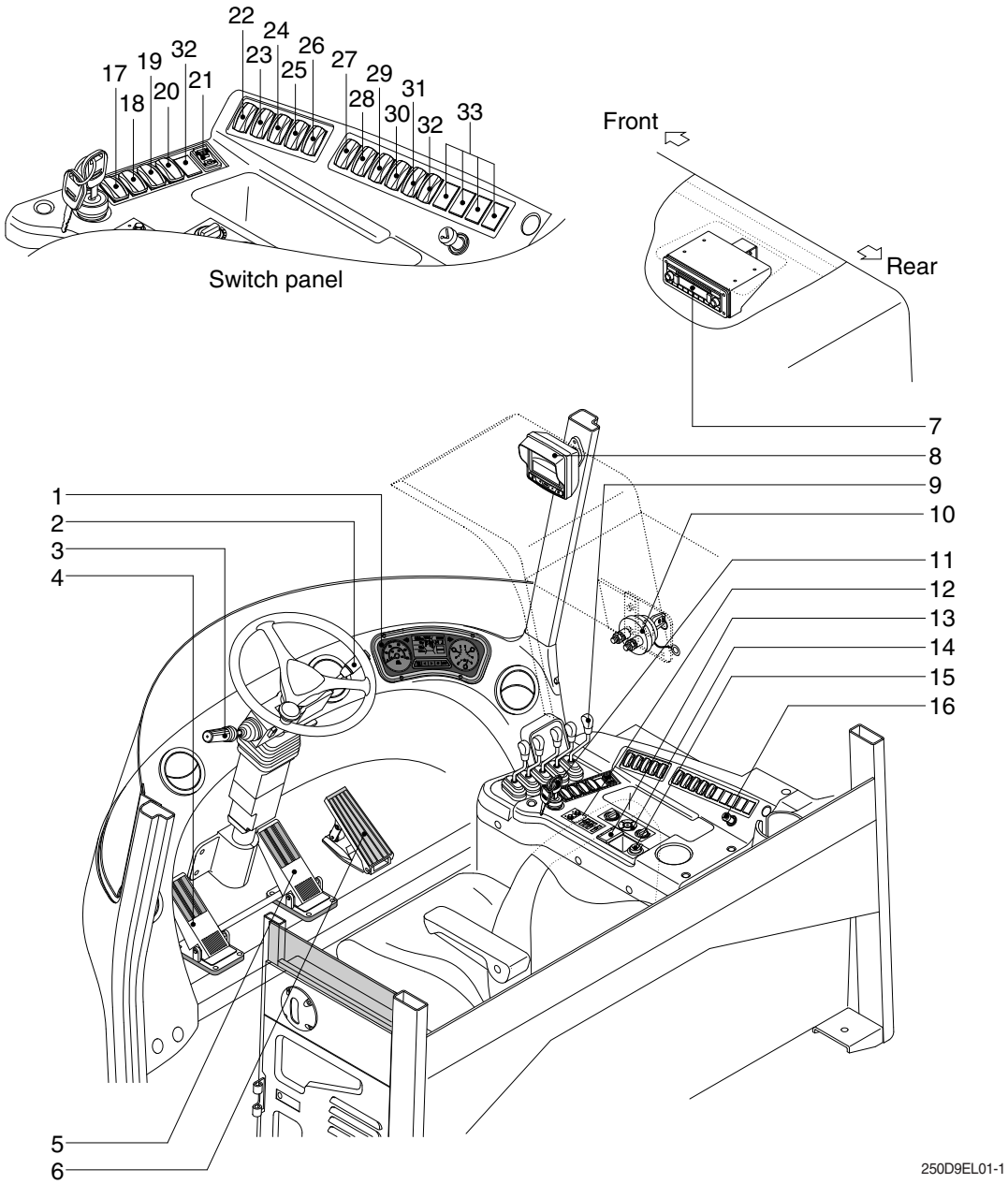
Hold tightly mounting flange and lay fulcrum on the flange and screw in clamp bolts in a crisscross pattern.
Clamp torque is 0.67 kgf · m (4.9 lbf · ft).

100D7RCV10

SECTION 7 ELECTRICAL SYSTEM

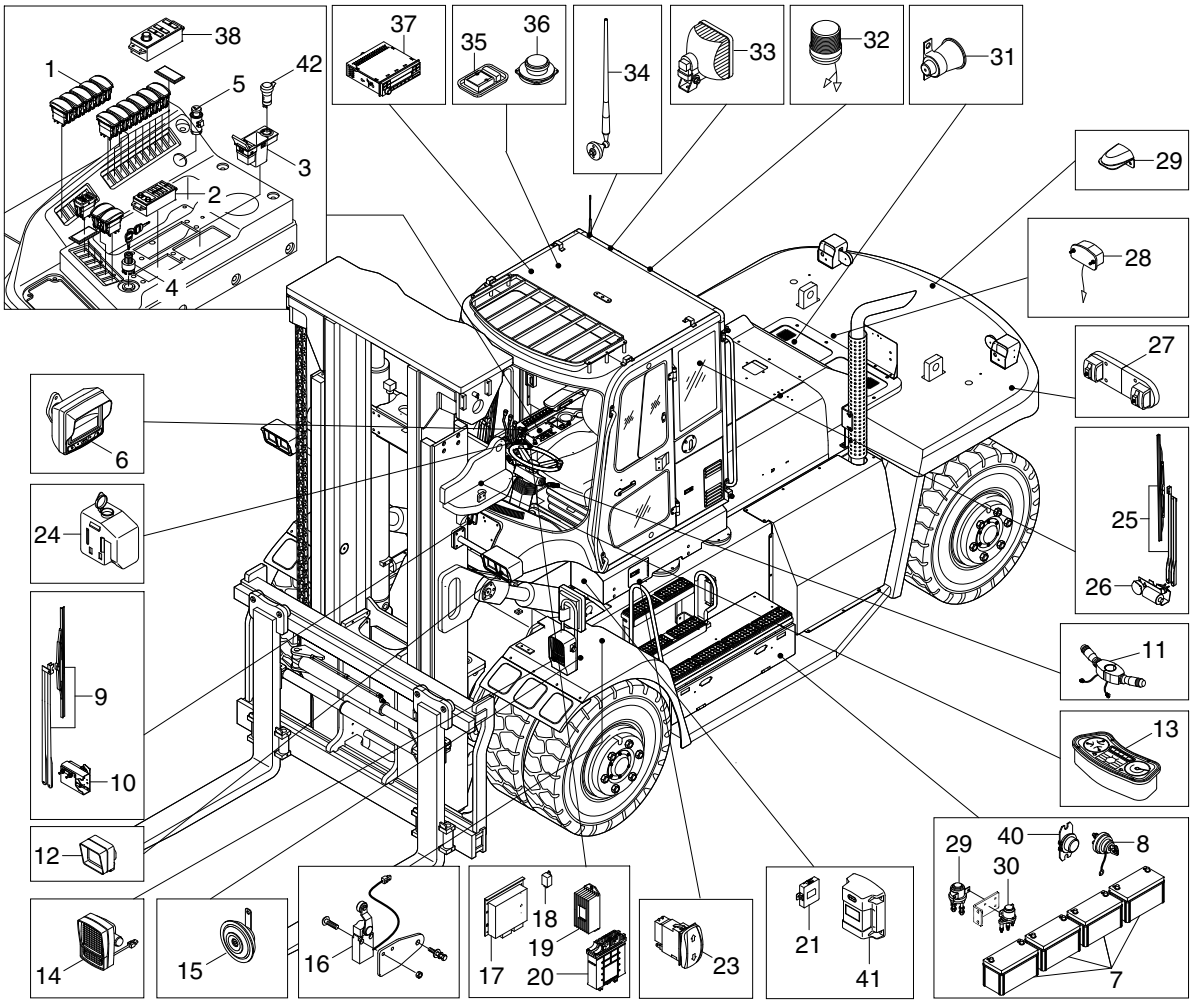
GROUP 1 COMPONENT LOCATION

1. LOCATION 1



1	Cluster	12	Remote controller (opt)	23	Inching switch
2	Multi function switch	13	Handsfree (opt)	24	Fuel warmer switch
3	Gear selector lever	14	Aircon & heater switch	25	Inc/Dec switch
4	Inching pedal	15	USB socket	26	SCR cleaning switch
5	Brake pedal	16	Cigar lighter	27	Engine mode switch
6	Accelerator pedal	17	Main light switch	28	Rear wiper/washer switch
7	Radio and USB player	18	Rear work lamp swich	29	Top wiper/washer switch (opt)
8	Monitor (opt)	19	Hazard switch (opt)	30	Air compressor switch (opt)
9	Remote control lever	20	Beacon lamp switch (opt)	31	Seat heat switch
10	Master switch (opt)	21	Parking brake switch	32	Cooling fan control switch (opt)
11	Starting switch	22	Auto/Manual select switch	33	Cover

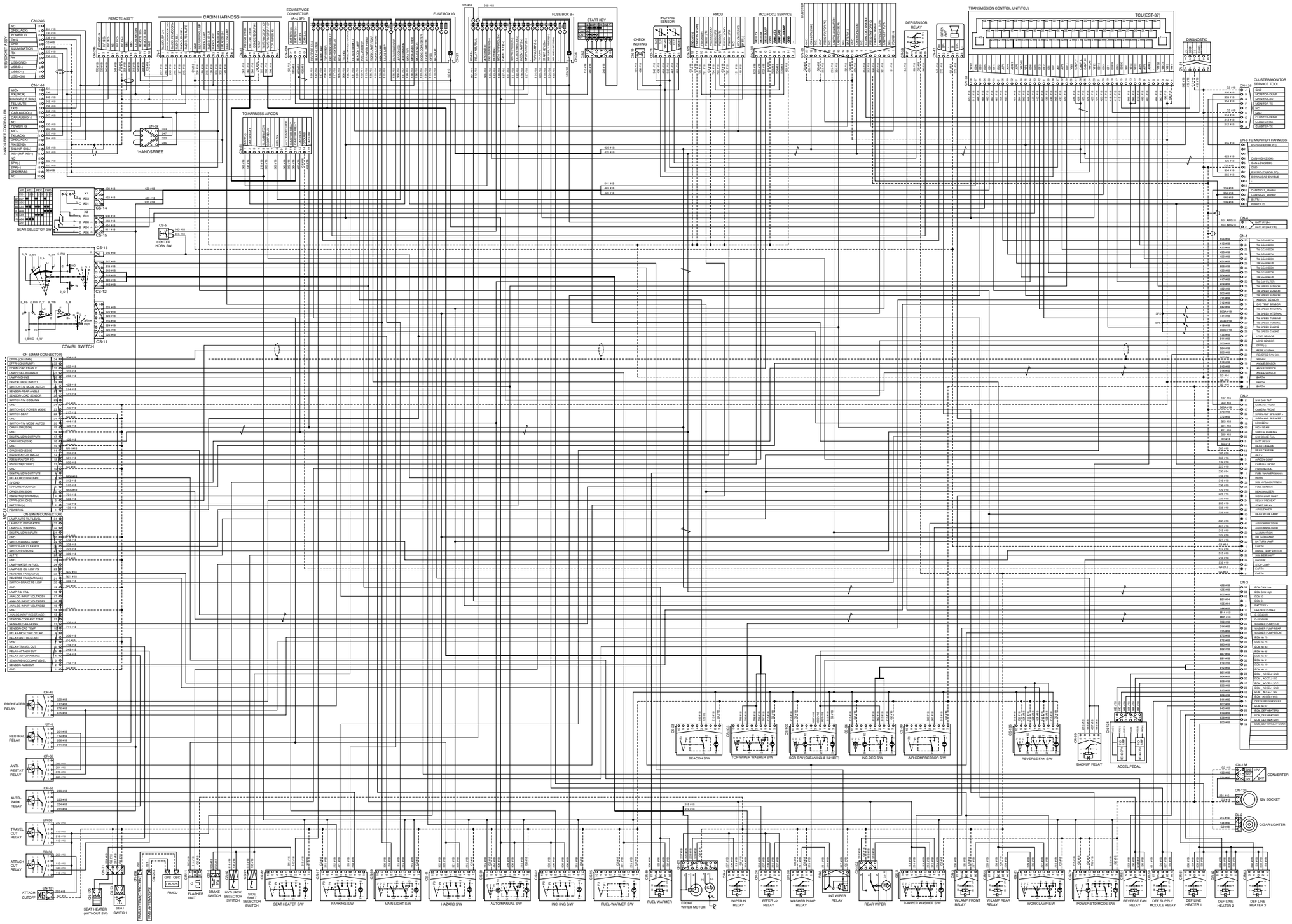
2. LOCATION 2



250D9EL02-2

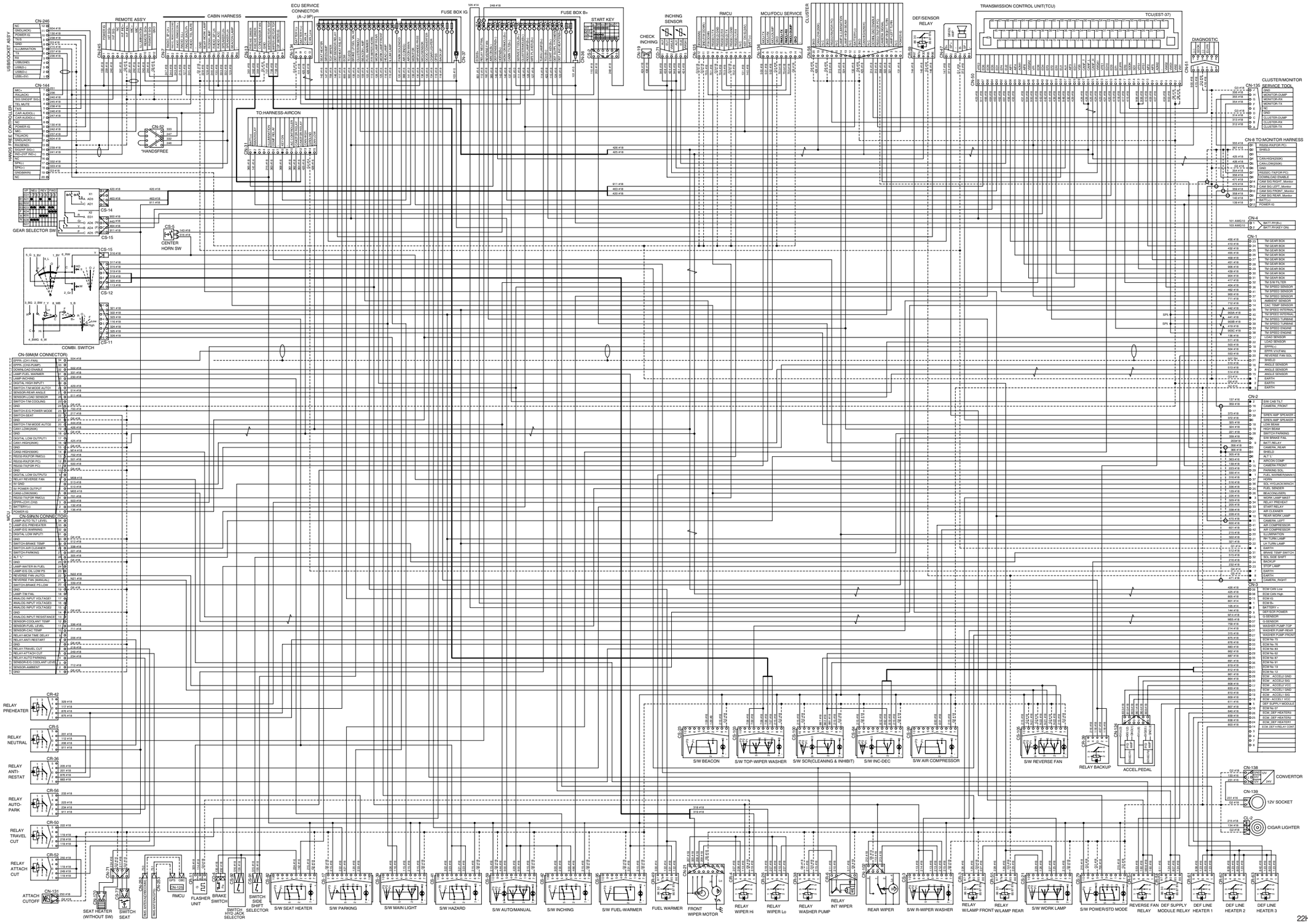
1	Switch panel	15	Horn	29	Start relay
2	Remote controller	16	Tilt limit switch	30	Heater relay
3	USB & socket assembly	17	MCU	31	Travel alarm buzzer
4	Start switch	18	Int wiper relay	32	Beacon lamp
5	Cigar lighter	19	DC-DC converter	33	Work lamp assembly
6	Monitor assembly	20	TCU	34	Antenna
7	Battery	21	Handsfree control relay	35	Room lamp
8	Master switch	23	Cabin tilt switch	36	Speaker assembly
9	Wiper assembly	24	Washer reservoir tank	37	Radio and USB player
10	Wiper motor	25	Rear wiper assembly	38	Aircon/Heater switch
11	Multifunction switch	26	Rear wiper motor	40	Battery relay
12	Front turn lamp	27	Rear combination lamp	41	RMCU
13	Cluster	28	License lamp	42	12V socket
14	Head lamp	29	Rear camera kit		

· ELECTRICAL CIRCUIT (1/4, -#0015)



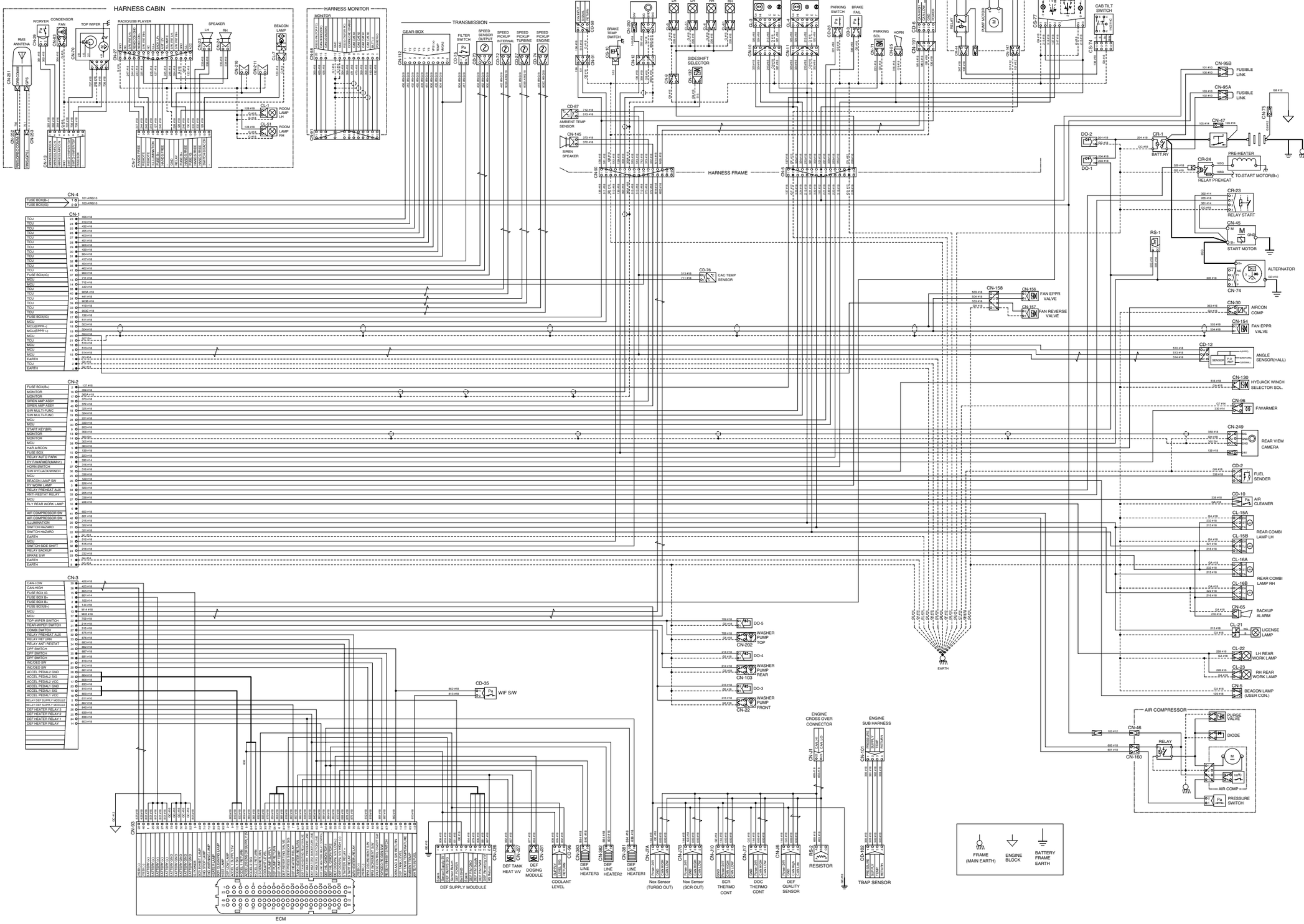
250D9EL03A

· ELECTRICAL CIRCUIT (2/4, #0016-)



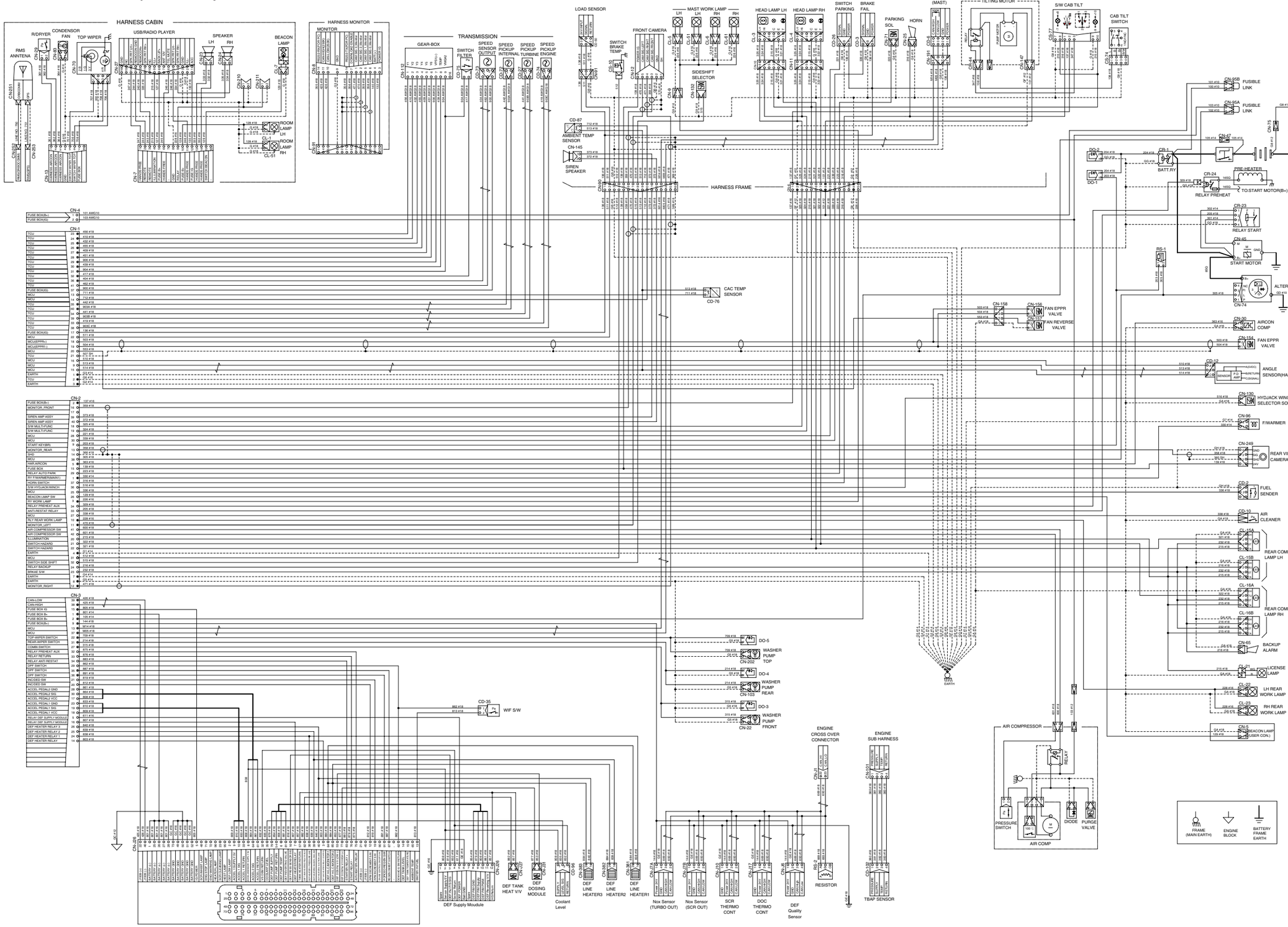
22HV-10006-00 1OF2

· ELECTRICAL CIRCUIT (3/4, -#0015)



250D9EL04A

· ELECTRICAL CIRCUIT (4/4, #0016-)



GROUP 3 CLUSTER

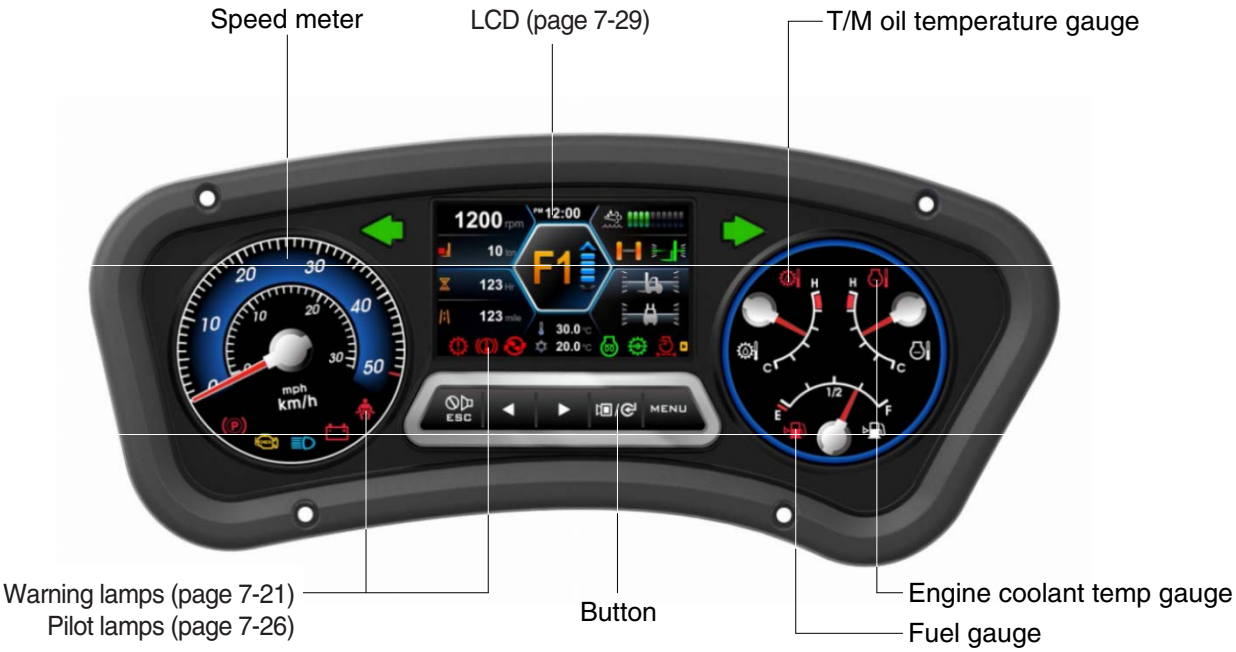
1) STRUCTURE

The cluster consists of gauges, lamps, buttons and LCD as shown below, to warn the operator in case of abnormal truck operation or conditions for the appropriate operation and inspection.

- Gauges : Indicate operating status of the truck.
- Warning lamps : Indicate abnormality of the truck.
- Pilot lamps : Indicate operating status of the truck.
- LCD : Display the truck model, error code and engine speed etc.
- Buttons : Select the truck model, error code and engine speed etc and stop the buzzer sound.

※ **The cluster installed on this truck does not entirely guarantee the condition of the truck. Daily inspection should be performed according to chapter 7. PLANNED MAINTENANCE AND LUBRICATION of the operator's manual.**

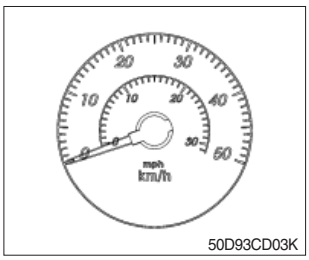
※ **When the cluster provides a warning immediately check the problem, and perform the required action.**



180D9CD03

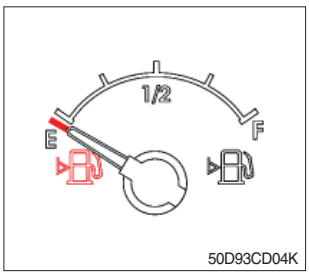
2) GAUGE

(1) Speed meter



① The speed meter displays the speed of truck in mph and km/h.
- 0~50 km/h
- 0~31 mph

(2) Fuel gauge

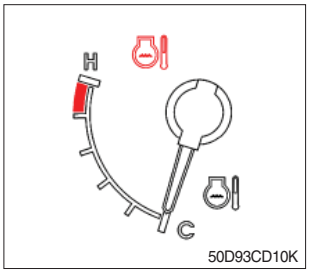


① This gauge indicates the amount of fuel in the fuel tank.

② Fill the fuel when the warning lamp lights ON or the indicator moves E point, refuel as soon as possible to avoid running out of fuel.

※ **If the gauge indicates below E point even though the truck is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(3) Engine coolant temperature gauge



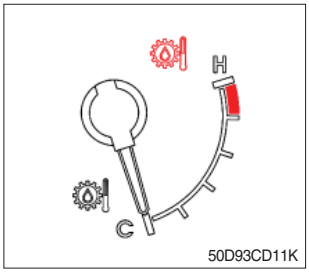
① This indicates the temperature of coolant.
- White range : 40~104 ˚C (104~219 ˚F)
- Red range : Above 104 ˚C (219 ˚F)

② Keep idling engine at low speed until the indicator is in the operating range.

③ If the indicator is in the red range, turn OFF the engine and check the radiator and engine.

※ **If the gauge indicates red range even though the truck is on the normal condition, check the electric device as that can be caused by the poor connection of electricity or sensor.**

(4) Transmission oil temperature gauge

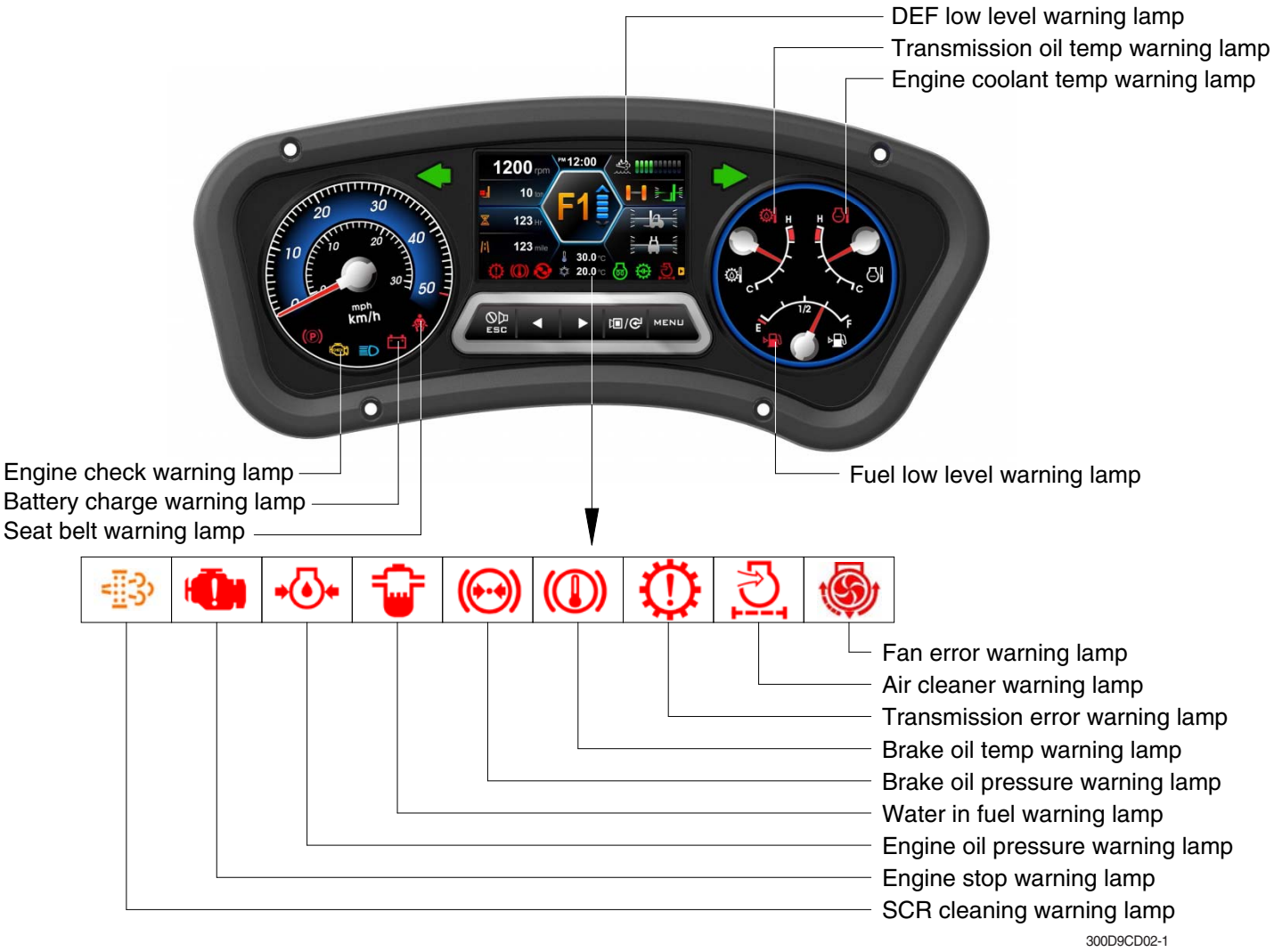


① This range indicates the temperature of transmission oil.
- White range : 40~107 ˚C (104~225 ˚F)
- Red range : Above 107 ˚C (225 ˚F)

② Keep idling engine at low speed until the indicator is in the operating range.

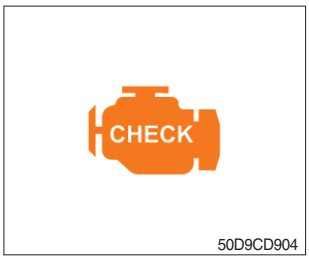
③ If the indicator is in the red range, it means the transmission is overheated. Be careful that the indicator does not move into the red range.

3) WARNING LAMPS



※ **When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).**

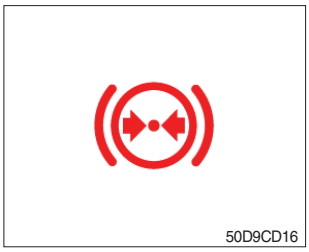
(1) Engine check lamp



① This lamp lights ON during a nonfatal engine system error.

② The engine can still be run, but the fault should be corrected as soon as possible.

(2) Brake oil pressure warning lamp

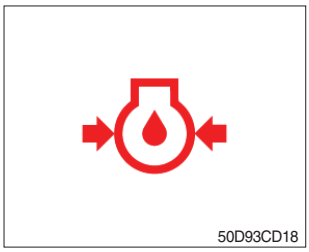


① The lamp lights ON when the oil pressure of service brake drops below the normal range.

② When the lamp is ON, stop the engine and check for its cause.

※ **Do not operate until the problems are corrected.**

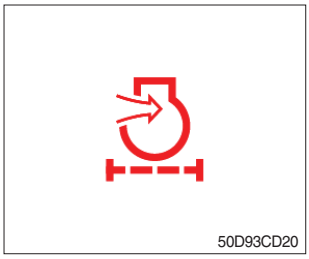
(3) Engine oil pressure warning lamp



① This lamp comes ON for a while after starting the engine because of the low oil pressure.

② If the lamp comes ON during engine operation, shut OFF engine immediately. Check oil level.

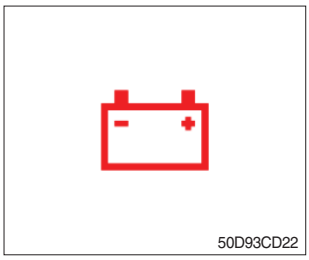
(4) Air cleaner warning lamp



① This lamp operates by the vacuum caused inside when the filter of air cleaner is clogged.

② Check the filter and clean or replace it when the lamp is ON.

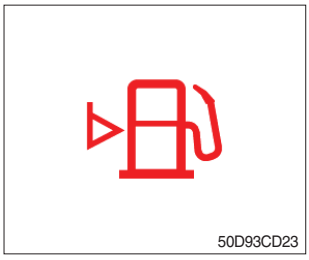
(5) Battery charging warning lamp



① This lamp is ON after key switch is turned ON, it is turned OFF after starting the engine.

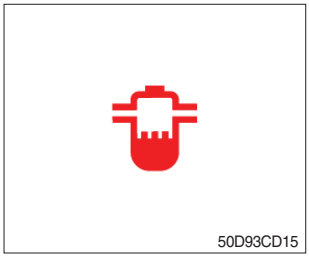
② Check the battery charging circuit when this lamp comes ON during engine operation.

(6) Fuel low level warning lamp



① Fill the fuel immediately when the lamp is turned ON.

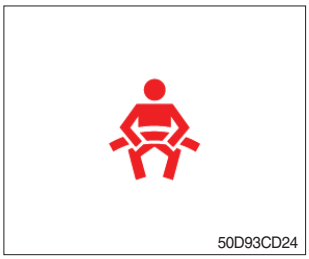
(7) Water in fuel warning lamp



① Light up when water in fuel.

② Stop the engine and please drain the water of the fuel filter (with water separator).

(8) Seat belt warning lamp



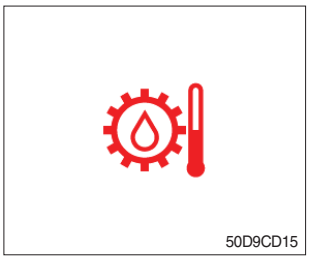
① This lamp lights ON for the first five seconds after starting the engine.

(9) Engine coolant temperature warning lamp

① This lamp is turned ON when the temperature of cooling water is over the normal temperature (104 °C, 209 °F).

② Check the cooling system when the lamp is ON.

(10) Transmission oil temperature warning lamp

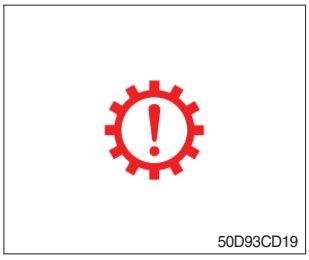


① This lamp informs the operator that transmission oil is above the specified temperature (107 ˚C, 225 ˚F).

- Lamp ON : Abnormal
- Lamp OFF : Normal

※ **When this lamp lights up during operation, stop the engine and check the truck.**

(11) Transmission error warning lamp



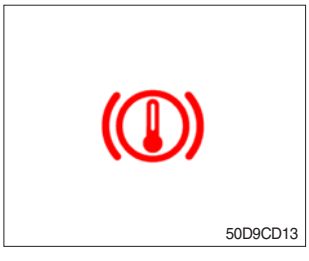
① This lamp lights ON and the information window of the LCD shows the error code when an error occur in the transmission.

② Immediately pull the truck to a convenient stop. Stop the engine. Investigate the cause.

※ **Consult a HYUNDAI dealer to investigate the cause.**

※ **Do not operate until the cause has been corrected.**

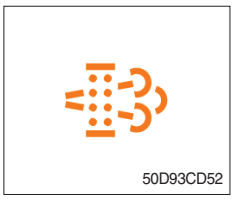
(12) Brake oil temperature warning lamp



① This lamp is turned ON when the brake oil temperature is too high.

② When the lamp is ON, stop the engine and check for its cause.

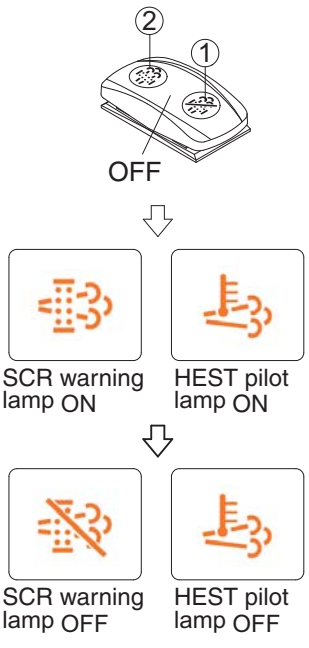
(13) SCR (Selective Catalytic Reduction) CLEANING WARNING LAMP



① This lamp lights ON when the SCR cleaning is needed and lamp flashes when manual SCR cleaning is activeted as table below.

Condition	Warning lamp				Remark
	SCR cleaning lamp	DEF Low Lamp	Engine Check Lamp	Engine Stop Lamp	
SCR needs to be cleaned	On	-	-	-	1. Change to a more challenging duty cycle. 2. Perform manual SCR cleaning.
SCR needs to be cleaned immediately	On	-	On	-	Manual SCR cleaning is required.
Stationary SCR cleaning status	Flash	-	-	-	-
DEF level initial warning	-	On	-	-	DEF level 10% Engine error code 3497
DEF level critical warning	-	Flash	-	-	DEF level 5% Engine error code 3498
DEF level initial warning	-	Flash	On	-	DEF level 2.5% Engine error code 1673, 25% derate
DEF level secondary derate warning	-	Flash	On	-	DEF level 0% Engine error code 3547,3714 50% derate, 30 min.
DEF level final derate warning	-	Flash	On	On	Engine error code 3712 Contact Hyundai service center or dealer.

※ Manual SCR cleaning method



300D9CD143

※ Manual SCR cleaning applies if the truck is in a fireproof area and there is no plan to turn off the truck during the SCR cleaning.

① Stop and park the truck.

② Push the switch to position ② to initiate the manual SCR cleaning.

※ Refer to the page 7-54 for the switch operation.

※ The engine speed may increase during SCR cleaning and it will take approximately 20~60 minutes depending on condition.

③ The SCR cleaning warning lamp flash and HEST pilot lamp will light on during the manual SCR cleaning function is operating.

④ The SCR cleaning warning and/or HEST pilot lamp will light OFF when the SCR cleaning function is completed.

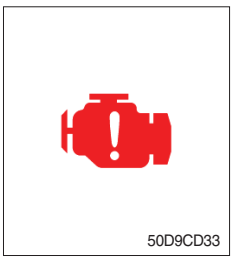
(14) DEF (Diesel Exhaust Fluid) low warning lamp

① This warning lamp indicates, when illuminated or flashing, that the diesel exhaust fluid level is low.

※ **Add the diesel exhaust fluid into DEF tank.**

※ **Refer to the page 7-28 for detail.**

(15) Engine stop warning lamp



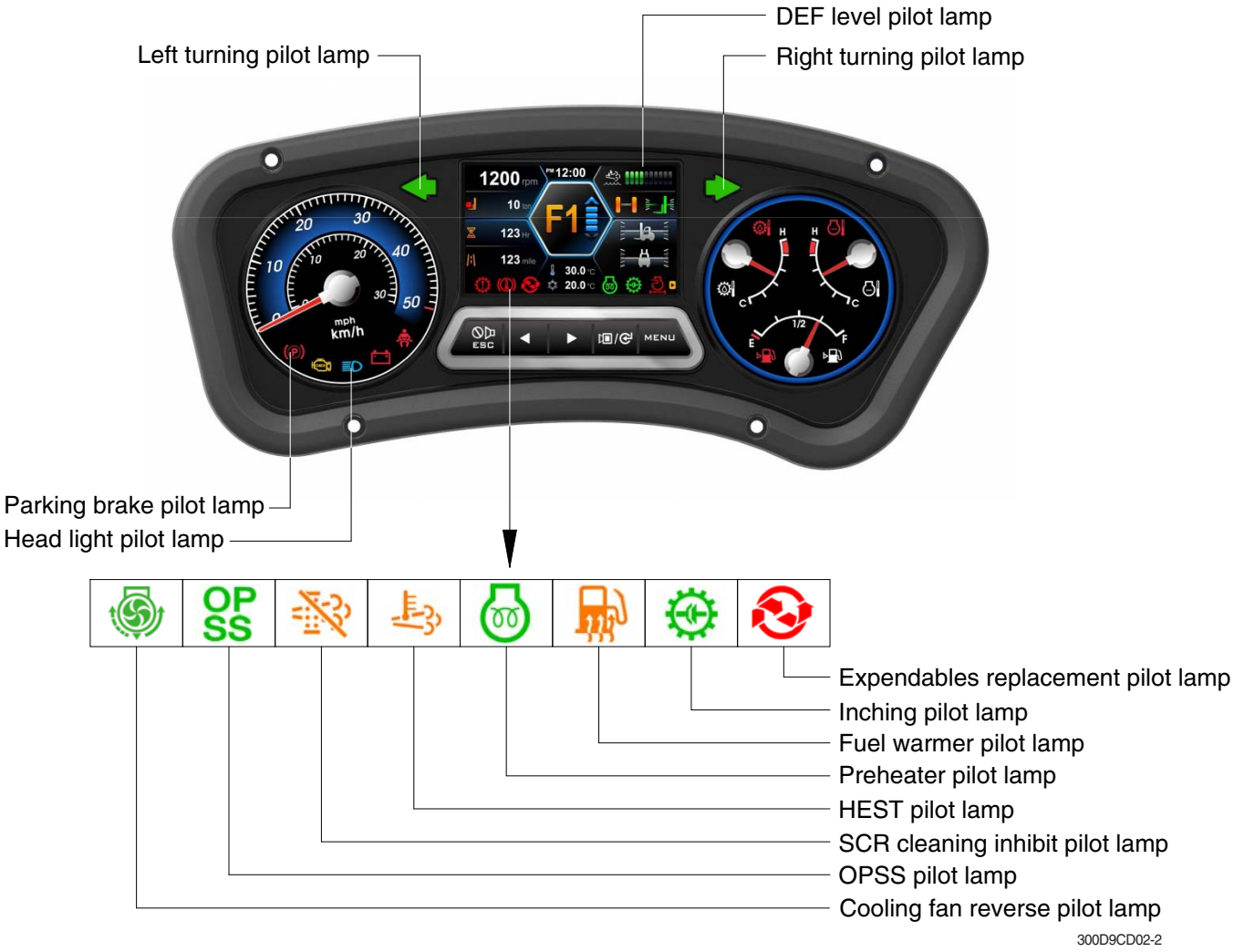
① When this warning lamp lights ON, stop the engine immediately and and check the DEF level and related parts of the engine.

※ **Please contact your Hyundai service center or local dealer.**

(16) Fan error warning lamp

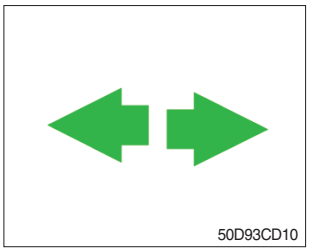
① This lamp is turned ON when the cooling fan error occurs.

4) PILOT LAMPS



※ **When the warning and pilot lamps are illuminated more than display, you can display next lamps by push the button (▶).**

(1) Direction pilot lamp



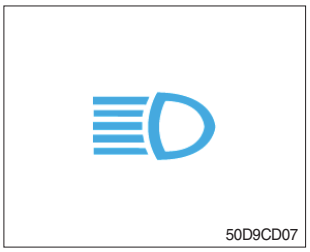
① This lamp flashes when the signal indicator lever is moved.

(2) Parking brake pilot lamp

① When the parking brake is actuated, the lamp lights ON.

※ **Check the lamp is OFF before driving.**

(3) Head light pilot lamp



① This lamp comes ON when the main light switch is operated to 2nd step.

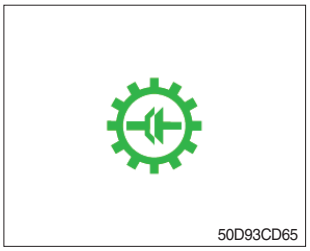
(4) Preheater pilot lamp

① This lamp lights ON when start switch is turned clockwise to the ON position. Light will turn off after approximately 15~45 seconds, depending on engine coolant temperature, indicating that preheating is completed.

② When the lamp goes out the operator should start cranking the engine.

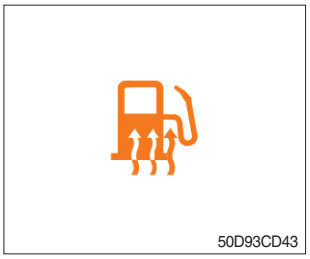
※ **Refer to page 5-13 of the operator's manual.**

(5) Inching pilot lamp



① When the inching switch is pressed, the lamp lights ON.

(6) Fuel warmer pilot lamp



① Illuminates when the hydraulic fluid temperature is below 20 °C (68 °F) or engine coolant temperature is below 10 °C (50 °F).

② If the engine coolant temperature is above 60 °C (140 °F) or hydraulic fluid temperature is above 45 °C (113 °F) the start switch is in the ON position, automatic fuel heating is canceled.

(7) OPSS pilot lamp

① This signal lamp lights ON when the operator leaves the seat.

② Powered travel movement of the truck shall be possible only if the operator is in the normal operating position. Transmission will automatically shift to neutral upon the exiting of the operator.

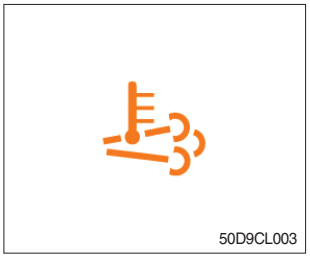
③ The gear selector lever must be cycled through neutral with the operator in the normal operating position to regain powered direction control.

(8) SCR cleaning inhibit pilot lamp

① This pilot lamp lights ON when the SCR cleaning switch is pushed inhibit position, therefore automatic and manual SCR cleaning can not occur. It should inhibited, before caused fire due to the exhaust gas in high temperature.

※ **Refer to the page 7-54 for the SCR cleaning switch.**

(9) HEST (High exhaust system temperature) pilot lamp



① This warning lamp indicates, when illuminated, that exhaust temperatures are high due to SCR cleaning.

② The lamp will also illuminate during a manual SCR cleaning.

③ When this lamp is illuminated, be sure the exhaust pipe outlet is not directed at any surface or material that can melt, burn, or explode.

⚠ **When this lamp is illuminated, the exhaust gas temperature could reach 800 ℃ [1500 ℉], which is hot enough to ignite or melt common materials, and to burn people.**

※ **The lamp does not signify the need for any kind of equipment or engine service; It merely alerts the equipment operator to high exhaust temperatures. It will be common for the lamp to illuminate on and off during normal equipment operation as the engine completes the SCR cleaning.**

(10) DEF (Diesel Exhaust Fluid) level pilot lamp

① This gauge indicates the level of DEF (10 steps).

② Fill the DEF when the level is low.

(11) Expendables replacement pilot lamp

① This lamp lights ON if expendables which must be replaced are exist.

② The lamp will light up only 3 minutes since KEY ON, and then light off.

③ Please check the expendables management list in maintenance menu.

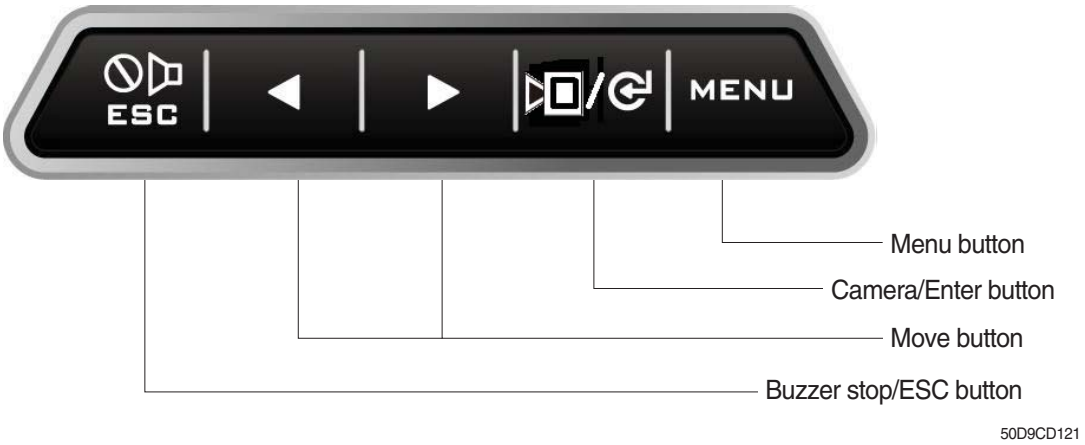
(12) Cooling fan reverse rotation pilot lamp

① This lamp lights ON when the cooling fan is operated to the reverse rotation.

※ **Refer to page 7-55 for the operation of the cooling fan.**

4) CLUSTER BUTTON

Each button has the following function.



50D9CD121

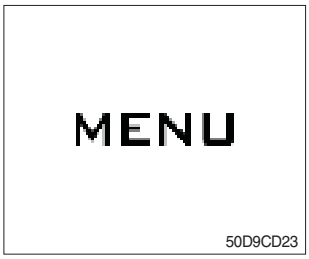
(1) Buzzer stop/ESC button

50D9CD22

① This button is used to stop the buzzer sound.

② If another alarm condition occurs after this button has been pressed, the alarm buzzer will re-sound.

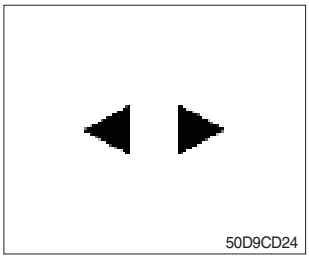
(2) Menu button



50D9CD23

① Move in menu (left, up / right, down).

(3) Move button



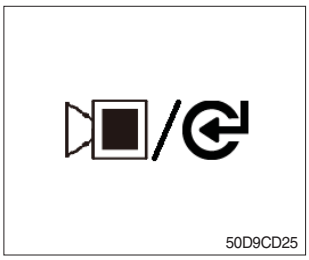
50D9CD24

① Move in menu (left, up / right, down).

② Decrease / Increase input value.

③ When the warning and pilot lamps occur over six, you can display next lamps by push the button (▶).

(4) Enter button



50D9CD25

① Change the camera screen on main

② This button is used to select menu.

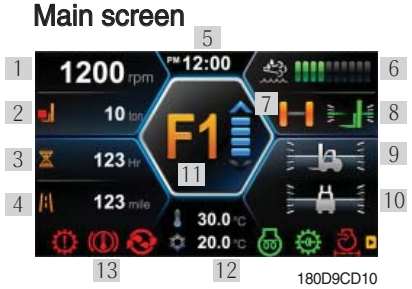
5) LCD

(1) Main screen

※ You can select or set the menu by the button of the cluster.

※ Please refer to the page 7-29 for the selection and change of the menu and input value.

Main screen



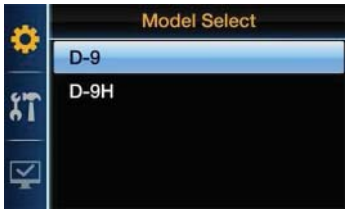
180D9CD10

MENU

Main menu screen

50D9CD11

Sub menu screen



300D9CD12

1	Engine rpm	8	Mast angle (opt)
2	Load indicator (opt)	9	Vehicle angle X (opt)
3	Hour meter	10	Vehicle angle Y (opt)
4	Odometer	11	T/M info (error code, gear, warning)
5	Current time	12	Temperature (outdoor temp., setting temp) (cabin opt)
6	DEF level gauge	13	Warning and pilot lamps
7	Rear wheel angle (opt)		

Communication error

180D9CD13

※ Main screen when occurred communication error between the cluster and TCU/ MCU / ECU

Occurrence of the truck fault

While illuminates the engine, transmission or air conditioner warning lamp, when you press right button (▶) in the cluster button for about 4 seconds, it directly connected to the current failure screen.

(Warning lamp : Engine ( ), Transmission ( ) and Air conditioner ( ).

(2) Camera screen

① Depending on the gear, if the gear is rear position, screen is changed to camera screen.

② If the camera is not mounted or the camera signal is abnormal, the current screen remains.

(3) Main menu

No.	Main menu	Sub menu	Description
1	 Equipment 50D9CD14K	Model select Tilt setting Rear angle setting Weight sensor setting ESL setting Vehicle max speed limit AEB setting (R) MCU/cluster information Cooling fan control Auto idle down	Model select Tilt setting (mast and vehicle angle) Rear angle setting Cross-section, load weight adjust, weight display setting, load indicator buzzer ESL setting Vehicle max speed limit (10~30 km) AEB setting (R)MCU/cluster information Rotation direction, reverse interval and time Auto idle down ON/OFF
2	 Maintenance 50D9CD15K	Failure history Maintenance management Signal statue User password change Alternate torque Opening of communication	Current history, logged history and delete logged fault Replacement, Change interval oils and filters Display information of sensors User password change (5~10 digit) Alternate torque mode Orbcomm, GPS antenna
3	 Display setting 50D9CD16K	LCD adjustment Time setting Unit setting Language setting AS phone number ESL password change Maintenance management	LCD brightness setting Time setting Unit setting (temp, speed, weight, pressure) Language setting (13 languages) Check and change AS phone number ESL password change (5~10 digit) Maintenance information (cycle, elapsed time, change count, alarm info)

(3) Equipment

① Choose the equipment

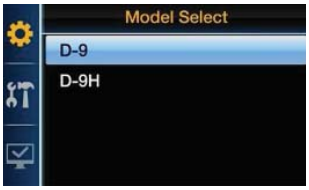
180D9CD20

50D9CD21

- To enter the menu, you must input user password.
- Default password is '00000'
- You should set password by five to ten digit.

② Model select

180D9CD22



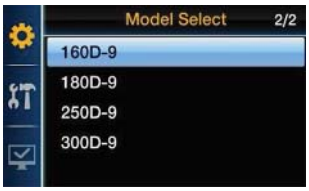
300D9CD12

50D9CD23

- Select the Model

※ **Turn the lift truck ON after turn it OFF when changing D-9 to D-9H or D-9H to D-9.**

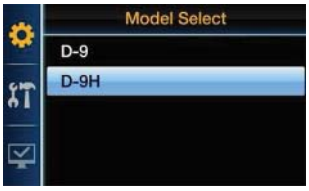
※ **The initial model is selected at the factory, so don't change the different model.**



300D9CD300

300D9CD301

50D9CD25



300D9CD302

300D9CD303

300D9CD304

300D9CD305

③ Tilt setting

180D9CD26 50D9CD27 180D9CD28

- Set the offset about mast angle sensors and vehicle angle sensors.

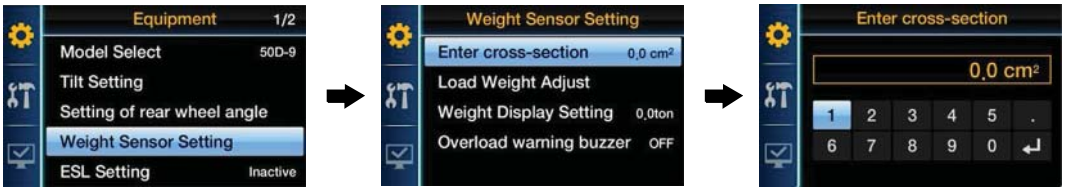
④ Setting for rear wheel angle

180D9CD29 180D9CD30-1 180D9CD31 180D9CD32 180D9CD33 180D9CD34-1

- The user revises a forklift truck steering angle.
- Display set to approve a condition.
  - Right set rear wheel calibration.
  - Center set rear wheel calibration.
  - Left set rear wheel calibration.

⑤ Weight sensor setting

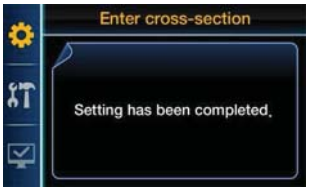
a. Cross-section



180D9CD35-1 180D9CD36-1 180D9CD37

- Enter the designated cross-section (cm^2).

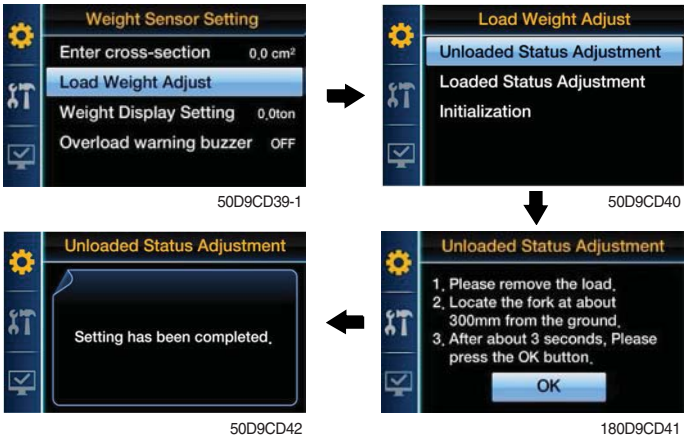
Mast spec	300D-9
V-Mast	402.12
TS-Mast	508.94



180D9CD38

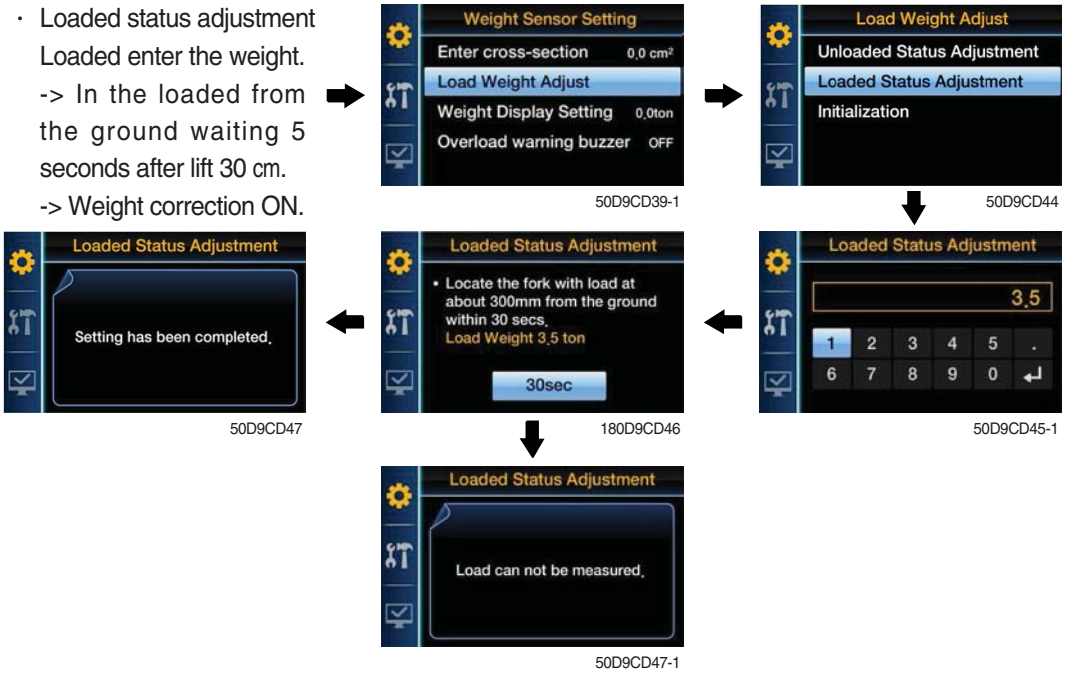
b. Load weight adjust

- Unloaded status adjustment
  In the unloaded from the ground waiting 5 seconds after lift 30 ㎝, and tare ON.



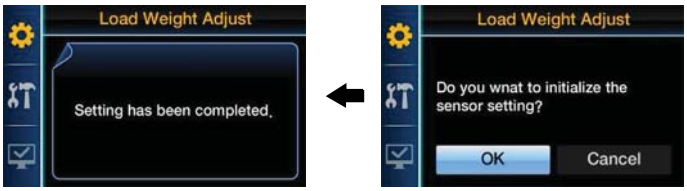
50D9CD39-1 50D9CD40 180D9CD41 50D9CD42

- Loaded status adjustment
  Loaded enter the weight.
  -> In the loaded from the ground waiting 5 seconds after lift 30 ㎝.
  -> Weight correction ON.



50D9CD39-1 50D9CD44 50D9CD45-1 180D9CD46 50D9CD47 50D9CD47-1

180D9CD35-1 50D9CD39-1 50D9CD49



50D9CD51-1 50D9CD50-1

· Initialization
It is initialized loaded status and unloaded status.

c. Weight display setting

180D9CD35-1 50D9CD53-1 50D9CD54

50D9CD55

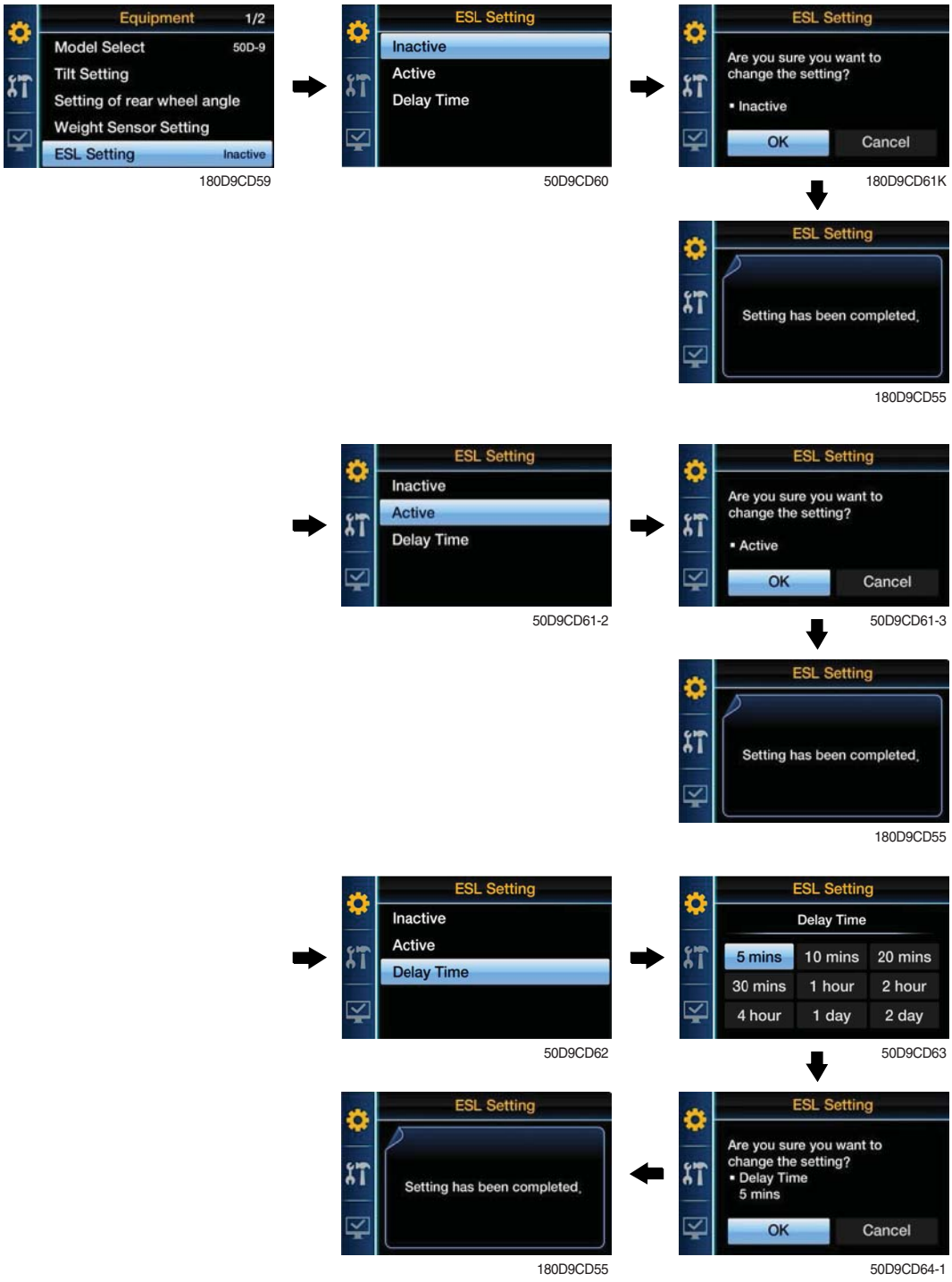
· Select the number of points of weight value display.

d. Overload warning buzzer

180D9CD35-1 50D9CD57-1 50D9CD58-1

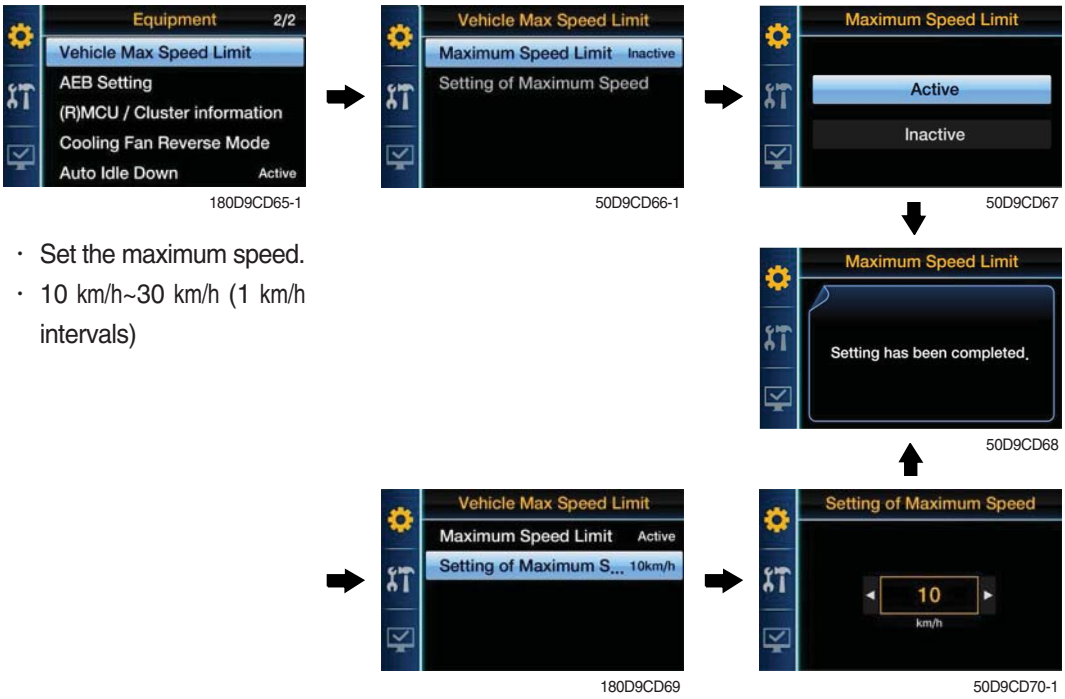
· Choose using buzzer when over weight.

⑥ ESL setting



- Set ON/OFF function for using limitation of ignition and time for starting.
- Set time 5 minutes for starting :
  In 5 minutes you can restart without password, but after 5 minutes, you should input password for starting.

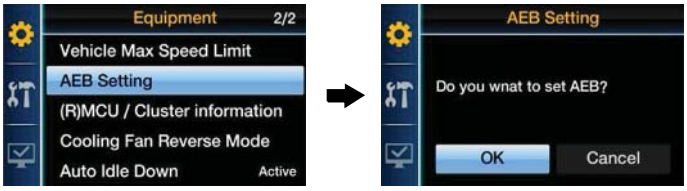
⑦ Vehicle max speed limit



180D9CD65-1 50D9CD66-1 50D9CD67 50D9CD68 180D9CD69 50D9CD70-1

- Set the maximum speed.
- 10 km/h~30 km/h (1 km/h intervals)

⑧ AEB setting



180D9CD71-1 180D9CD72

- Press OK button, then calibration will be started, for cancel, press Menu/ECS/Enter button.
- When it is finished (OK sign at gear box), Press Menu/ECS/Enter button.
- Start the engine : AEB start
- KEY ON : Brake pedal sensor calibration

⑨ (R) MCU / Cluster information

180D9CD73-1 50D9CD74-1

- Software version check for MCU/Cluster/RMCU.

⑩ Cooling fan reverse mode

180D9CD101-1 180D9CD103-1

- Manual : The fan only rotate in reverse direction while you hold down the manual button.
- Automatic : The fan rotate in reverse direction at pre-set interval.
  - Interval : 30 minutes ~ 5 hours
  - Time : 30 seconds ~ 5 minutes

※ **Refer to the page 7-55 for the cooling fan control switch.**

(4) Maintenance

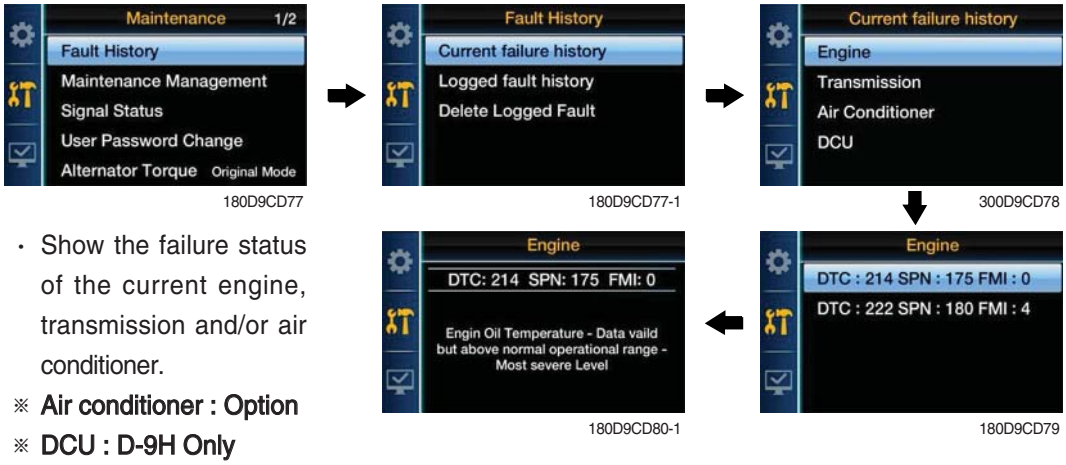
① Choose the maintenance

180D9CD75-1 180D9CD76

- To enter the Menu, you must input user password.
- Default password is '00000'
- You should set password by five to ten digit.

② Failure history

a. Current failure history



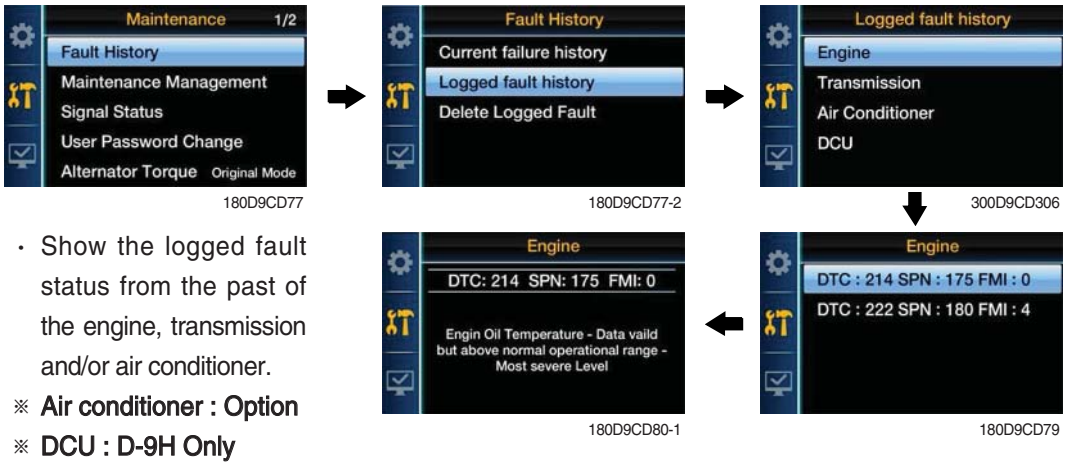
180D9CD77 180D9CD77-1 300D9CD78 180D9CD79 180D9CD80-1

- Show the failure status of the current engine, transmission and/or air conditioner.

※ **Air conditioner : Option**

※ **DCU : D-9H Only**

b. Logged fault history



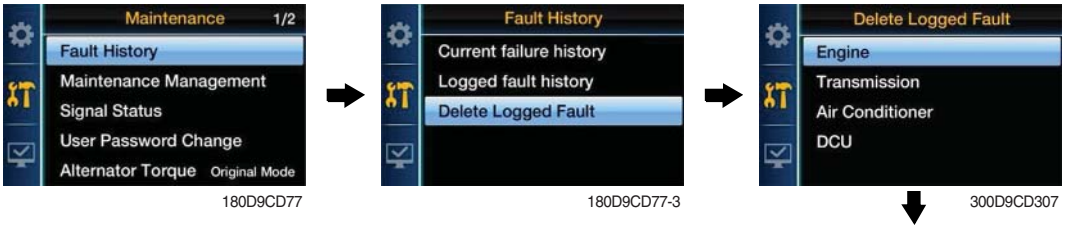
180D9CD77 180D9CD77-2 300D9CD306 180D9CD79 180D9CD80-1

- Show the logged fault status from the past of the engine, transmission and/or air conditioner.

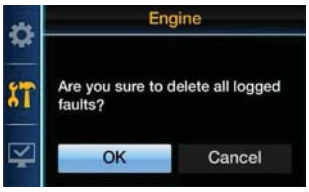
※ **Air conditioner : Option**

※ **DCU : D-9H Only**

c. Delete logged fault



180D9CD77 180D9CD77-3 300D9CD307



180D9CD79-1

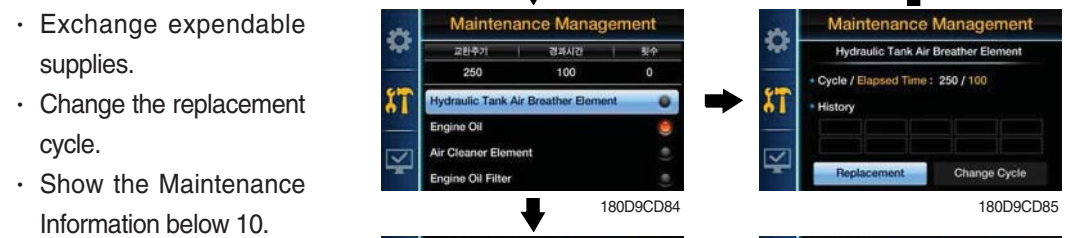
- Initialize of the past logged fault history.

※ **Air conditioner : Option**

※ **DCU : D-9H Only**

③ Maintenance management

180D9CD81 180D9CD82 180D9CD83



180D9CD84 180D9CD85

180D9CD86 180D9CD87 180D9CD88-1

- Exchange expendable supplies.
- Change the replacement cycle.
- Show the Maintenance Information below 10. (Delete the old item, when Information have more than 10)

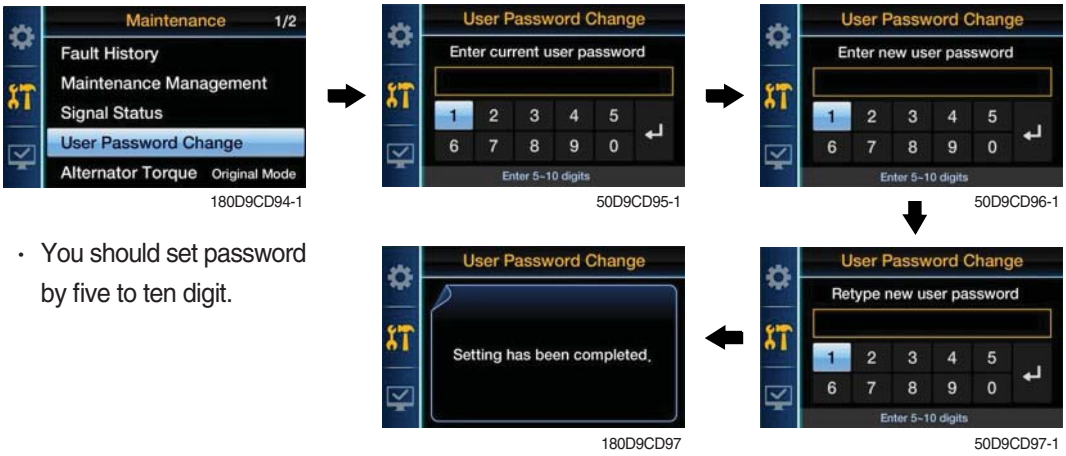
④ Signal status

180D9CD89-1 50D9CD90 180D9CD91

- Display information of each sensors.

50D9CD92 180D9CD93

⑤ User password change



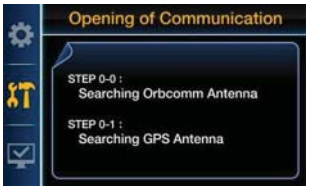
180D9CD94-1 50D9CD95-1 50D9CD96-1

- You should set password by five to ten digit.

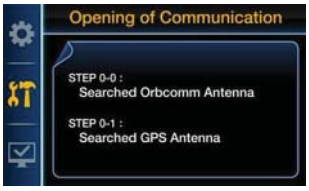
180D9CD97 50D9CD97-1

⑥ Opening of communication

180D9CD98-1



180D9CD99



180D9CD100

- When successfully opened RMCU communication, except for the RMCU comm.

180D9CD101

180D9CD102-1

180D9CD102

180D9CD105-1

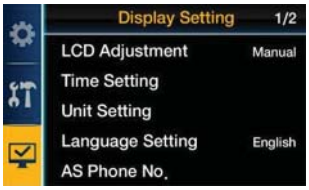
180D9CD104-1

180D9CD106

180D9CD107

(5) Display setting

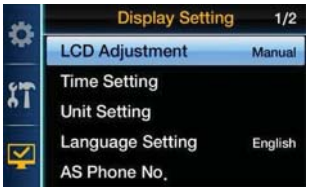
① Choose the display setting



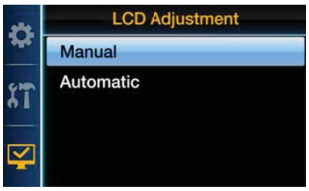
180D9CD108

- No password is required.

② LCD adjustment

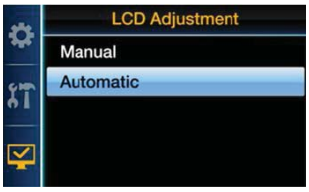


180D9CD109



50D9CD110

180D9CD111



50D9CD112

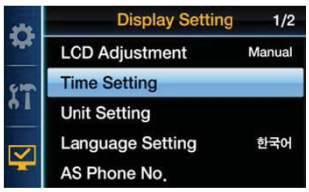
180D9CD113

180D9CD114

180D9CD115

- Manual : Manual setting for LCD brightness.
- Automatic : Automatic control of LCD brightness as set level of Day/Night.
- Setting day time : Set the time for daylight.
  (If you set the time for daylight, the rest time will be night.)

③ Time setting



50D9CD116

180D9CD117

- Set the time (Year, Month, Day, Hour, Minute, AM/PM).

④ Unit setting

180D9CD118 50D9CD118-1 50D9CD119

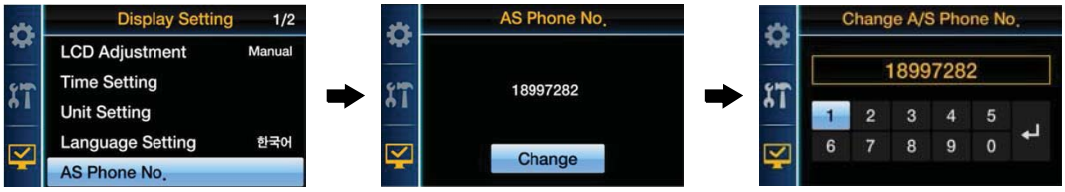
- Change units of temperature / speed / wight / pressure.

⑤ Language setting

180D9CD120 180D9CD121 180D9CD122 50D9CD123

- Set the language used by your device.
  (13 Multiple language)

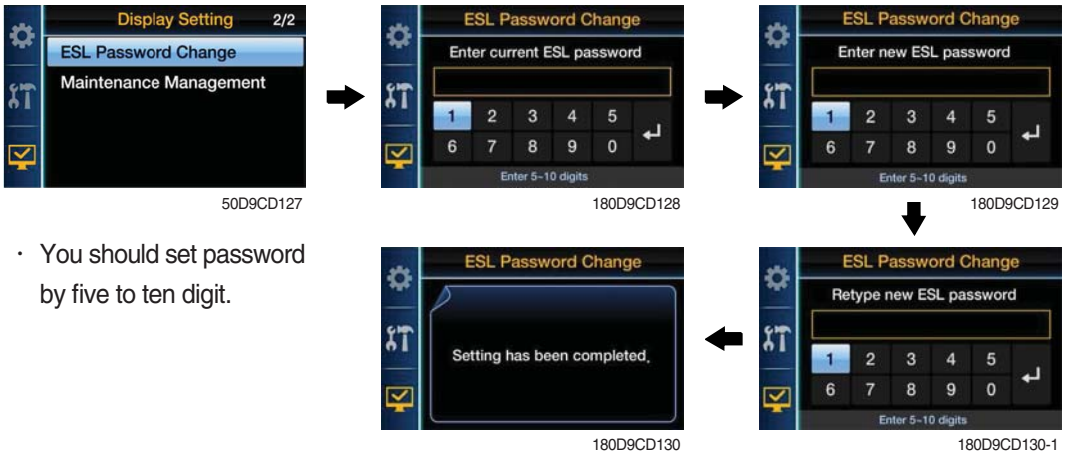
⑥ A/S phone number



50D9CD124 50D9CD125 180D9CD126

- Check and change of contact information for customer service.

⑦ ESL password change



50D9CD127 180D9CD128 180D9CD129 180D9CD130 180D9CD130-1

- You should set password
  by five to ten digit.

⑧ Maintenance management

50D9CD131 50D9CD132-1 50D9CD133-1

· Show the maintenance information (replacement cycle, elapsed time, change count, alarm information).

GROUP 4 TRANSMISSION MESSAGE DISPLAY

1) FUNCTION

The display can be used with the gear selector (DW-3). It indicates speed and driving direction. When driving in the automatic mode, a bar indicator gives additionally also information about the selected driving range; The automatic range is symbolized by arrows above and below the bar indicator. In case of possible errors in the system, a wrench appears on the display, combined with indication of the error number. Also sporadically occurring errors can be indicated.

180D93ACD33

※ If it happens error codes, consult with Hyundai service center to repair the fault.

2) DISPLAY DURING AEB-MODE

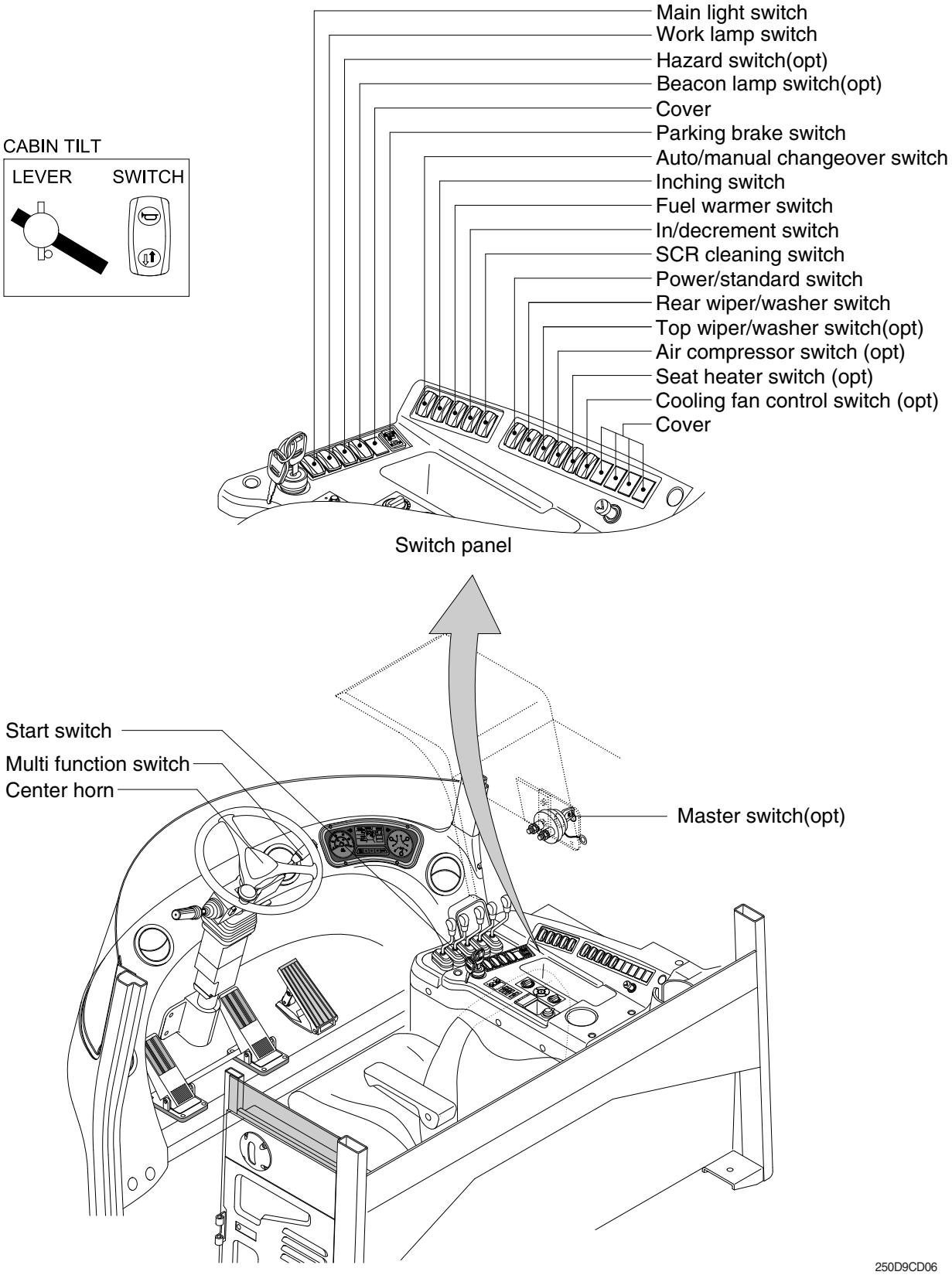
Symbol	Meaning	Remarks
K1.....K3 KV, KR	Calibrating clutch K1...K3, KV or KR resp.	
_and Kx	Wait for start, initialization of clutch Kx, x : 1, 2, 3, V, R	
≡and Kx	Fast fill time determination of clutch Kx	
=and Kx	Compensating pressure determination of clutch Kx	
OK	Calibration for all clutches finished	Transmission stays in neutral, you have to restart the TCU(ignition off/on) after removing AEB-Starter
STOP	AEB canceled(activation stopped)	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
STOP and Kx	AEB stopped, clutch Kx can't be calibrated	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
Spanner and Kx	Kx couldn't be calibrated, AEB finished	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
△E	Engine speed too low → raise enging speed	
▽E	Engine speed too high → lower enging speed	
△T	Transmission oil temperature too low → heat up transmission	
▽T	Transmission oil temperature too high → cool down transmission	
FT	Transmission temperature not in defined range during calibration	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
FB	Operating mode not NORMAL or transmission temperature sensor defective or storing of Calibrated values to EEPROM-has failed.	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
FO	Output speed_not_zero	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
FN	Shift lever not in Neutral position	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
FP	Park brake_not_applied	Transmission stays in neutral, you have to restart the TCU(ignition off/on)
STOP	AEB-Starter was used incorrect or is defective. Wrong device or wrong cable used.	Transmission stays in neutral, you have to restart the TCU(ignition off/on)

3) INITIALIZING THE INCHING SENSOR

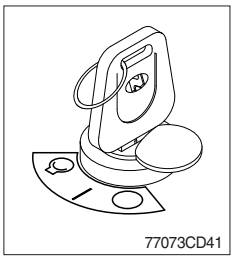
(1) Start engine after parking the machine on flat floor and blocking wheels.
(2) Release parking brake and keep neutral gear shift.
(3) Adjust the inching sensor linkage so that the regular voltage is supplied to inching sensor when operating the pedal.
※ Regular voltage ; Before pedal operation (1±0.1V), After pedal operation (3.5±0.1V).
(4) Stop the engine and then just KEY ON. (Release parking brake, keep neutral gear)
(5) Connect the AEB STARTER to the T/M controller.
(6) Push AEB STARTER over 3 seconds.
(7) If display shows "▼IP", Step on the pedal fully.
(8) If display shows "▲IP", release "OK"
(9) After the successful completion, it displays "OK".
(10) In case of abnormal running, it may display "STOP" with the appropriate error code.
(11) After troubleshooting, start the machine again to repeat above.
※ Above works are to be done with the parking brake released, so machine's wheels must be blocked for safety.

4) DISPLAY DURING INCHPEDAL CALIBRATION

Symbol	Meaning	Remarks
▼IP	Push down the pedal slowly until endposition is reached and hold this position	
▲IP	Release the pedal slowly until endposition is reached	
IP blinkt	A problem occurred, release the pedal slowly until endposition is reached	If the expected endposition could not be reached, release the pedal and try again
OK	Finished inchpedal calibration successful	
FN and Stop	Shift lever not in Neutral position	Calibrations is aborted
FS and Stop	Sensor supply voltage AU1 is out of the specified range	Calibrations is aborted
FO and Stop	Outputspeed_not_zero	Calibrations is aborted
SL and Stop	Sensor voltage below specified range	Calibrations is aborted
SU and Stop	Sensor voltage below specified range	Calibrations is aborted
IL and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
IU and Stop	Sensor position for released pedal out of specified range	Calibrations is aborted
TO and Stop	Time-out calibration, pedal not moved after calibration start	Calibrations is aborted
DL and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
DU and Stop	Angle between pedal positions released and pressed to small	Calibrations is aborted
FI and Stop	Sensor signal 1 and 2 don't match together	Calibrations is aborted

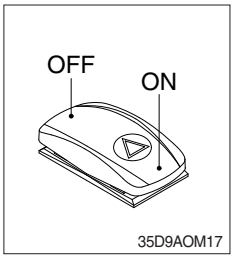

CABIN TILT
LEVER
SWITCH
Main light switch
Work lamp switch
Hazard switch(opt)
Beacon lamp switch(opt)
Cover
Parking brake switch
Auto/manual changeover switch
Inching switch
Fuel warmer switch
In/decrement switch
SCR cleaning switch
Power/standard switch
Rear wiper/washer switch
Top wiper/washer switch(opt)
Air compressor switch (opt)
Seat heater switch (opt)
Cooling fan control switch (opt)
Cover
Switch panel
Start switch
Multi function switch
Center horn
Master switch(opt)
250D9CD06

1) START SWITCH



(1) There are three positions, OFF, ON and START.
- ◯ (OFF) : None of electrical circuits activate.
- | (ON) : All the systems of truck operate.
- ⏻ (START) : Use when starting the engine.
  Release key immediately after starting.

2) HAZARD SWITCH (OPTION)



(1) Use for parking, or loading truck.

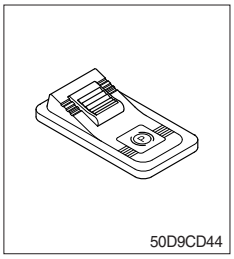
※ **If the switch is left ON for a long time, the battery may be discharged.**

3) INCHING SWITCH

(1) If this switch is pressed, inching operation is applied to inching pedal.

(2) Also, inching lamp on the cluster is illuminated.

4) PARKING BRAKE SWITCH

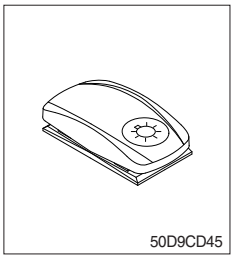


(1) This switch is used to parking brake lock or release.

(2) If this switch is pressed, the parking brake is applied and the warning lamp on the cluster will comes ON.

※ **When operating the gear selector lever, be sure to release the parking brake. If the truck is operated with the parking brake engaged, the brake will overheat and may cause the brake system to go out of order.**

5) MAIN LIGHT SWITCH



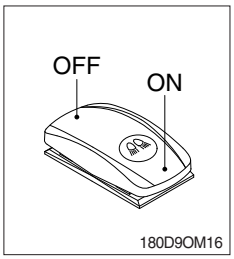
(1) This switch is used to operate the head light by one steps.

① First step : Clearance lamp and cluster illumination lamp comes ON. Also, all of the pilot lamps of switches come

② ON.

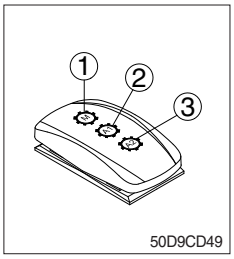
Second step : Head lamp comes ON.

6) WORK LAMP SWITCH



(1) This switch is used to operate the work lamps by two steps.
① First step : Front work lamp comes ON.
② Second step : Rear work lamp comes ON.

7) AUTO/MANUAL CHANGEOVER SWITCH



(1) Manual mode (①)

Press the top of the switch for the manual mode of the autoshift function. The operator selects the desired speed and the desired direction in the manual mode with the gear selector lever.

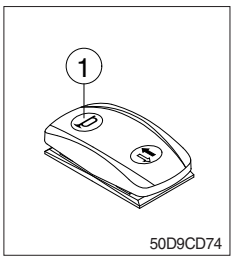
(2) Automatic 1st mode (②)

Place the switch in the middle position for the autoshift function changing from 1st to 3rd gear shift mode.

(3) Automatic 2nd mode (③)

Press the bottom of the switch fully for the autoshift function changing from 2nd to 3rd gear shift mode.

8) CABIN TILT SWITCH



(1) Horn ( )

By pressing position ①, the horn sounds and by releasing, the horn stops.

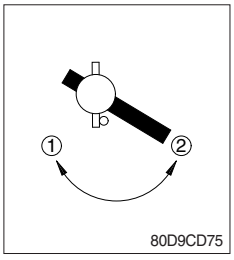
⚠ Sound the horn to warn near by personnel, before tilting the cabin.

(2) Tilting of the cabin (,)

Press the cabin tilt switch in order to tilt the cabin to right side or return to original location.

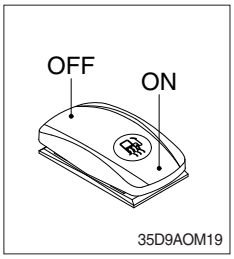
※ Refer to page 7-17 of the operator's manual for the tilting method of the cabin.

9) HAND PUMP LEVER



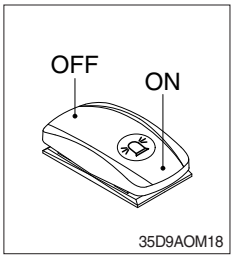
(1) This lever is used when tilting the cabin.
(2) Turn the hand pump lever to counterclockwise direction (①), the cabin shall be tilted to right side by the cabin tilt switch.
(3) Turn the hand pump lever to clockwise direction (②), the cabin shall be returned to original location by the cabin tilt switch.

10) FUEL WARMER SWITCH



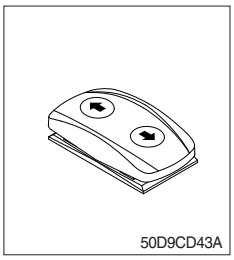
(1) This switch is used to heat the fuel of pre-heater.

11) BEACON LAMP SWITCH (OPTION)



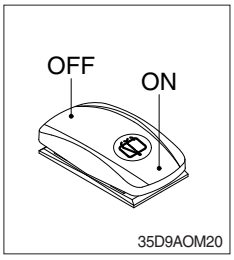
(1) This switch turn ON the strobe light.
① ON : Beacon lamp ON
② OFF : Beacon lamp OFF

12) INC/DECREMENT SWITCH



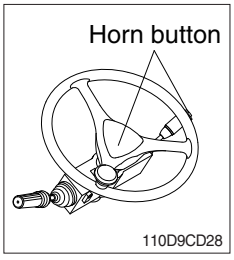
(1) When engine running, the low rpm of engine increase or decrease by 25 rpm by operating this switch.
(2) Engine low rpm returns to normal value when engine restarted.

13) TOP WIPER AND WASHER SWITCH (OPTION)



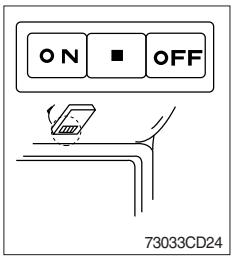
(1) This switch is used to operate the wiper and washer on the top of the cab.
(2) The washer liquid is sprayed and the wiper is operated only while pressing this switch.

14) HORN BUTTON



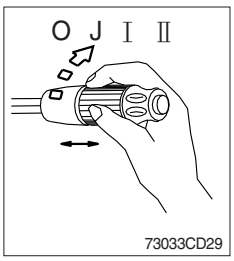
(1) If you press the button on the top of the multifunction switch and the center of the steering wheel, the horn will sound.

15) CAB LAMP SWITCH



(1) This switch turns ON the cab room lamp.

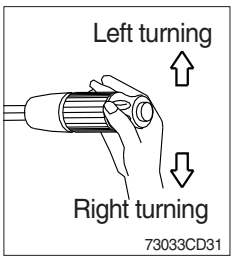
16) MULTI FUNCTION SWITCH



(1) Front wiper and washer switch

① When the switch is in J position, the wiper moves intermittently.
② When placed in Ⅰ or Ⅱ position, the wiper moves continuously.
③ If you push the grip of the lever, washer liquid will be sprayed and the wiper will be activated 2-3 times.

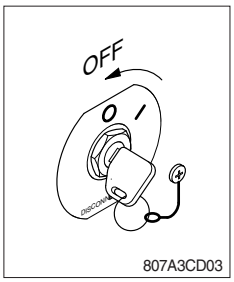
※ **Check the quantity of washer liquid in the tank. If the level of the washer liquid is LOW, add the washer liquid (In cold, winter days) or water. The capacity of the tank is 1 liter.**



(2) Turning switch

① This switch is used to warn or signal the turning direction of the truck to other vehicles or equipment.
② Push the lever up for turning left, pull the lever down for turning right.

17) MASTER SWITCH (OPTION)

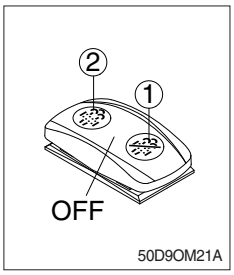


(1) This switch is used to shut off the entire electrical system.
When the machine is not operated for a long time, turn OFF the master switch for the safety purpose.

(2) I : The battery remains connected to the electrical system.
O : The battery is disconnected to the electrical system.

※ **Never turn the master switch to O (OFF) with the engine running. Engine and electrical system damage could result.**

18) SCR (Selective Catalytic Reduction) CLEANING SWITCH



(1) This switch is used to select the cleaning function of the SCR.

(2) Inhibit position (①)

① The inhibit position disallows any automatic or manual SCR cleaning.

② This may be used by operator to prevent SCR cleaning when the machine is operating in a hazardous environment is concerned about high temperature.

③ It is strongly recommended that the this position is only activated when high temperatures may cause a hazardous condition.

(3) OFF position

This position will initate a automatic SCR cleaning when needed.

(4) Manual SCR cleaning position (②)

① This position will only initate a manual SCR cleaning and the SCR cleaning lamp is illuminated.

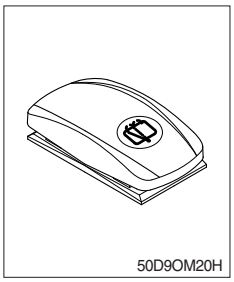
② HEST lamp will be illuminated during the entire SCR cleaning.

※ Refer to the page 7-24 for details.

※ This switch can be move to the manual SCR cleaning position (②) only when the safety button is pulled to backward.

※ Also, this switch return to the OFF position when released the manual SCR cleaning position (②).

19) REAR WIPER/WASHER SWITCH



(1) This switch is used to operate the wiper and washer on the rear of the cab.

(2) The washer liquid is sprayed and the wiper is operated only while pressing this switch.

20) ENGINE MODE SWITCH

(1) This switch offers two selectable operating mode.
The operator can adjust the machine's performance with this selection switch.

(2) Function

① STANDARD MODE : This mode provides maximum fuel efficiency for general loading.

② POWER MODE : This mode provides maximum power output for heavy loading or hill climb.

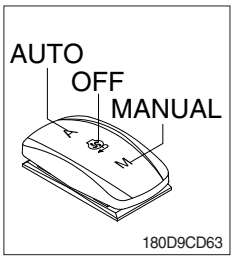
21) AIR COMPRESSOR SWITCH (option)

(1) This switch is used to activate the air compressor.

22) SEAT HEAT SWITCH

(1) This switch is used to heat the seat.

23) COOLING FAN CONTROL SWITCH (option)



(1) This switch use to control the cooling fan.

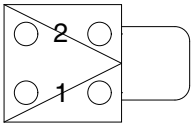
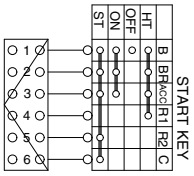
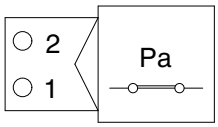
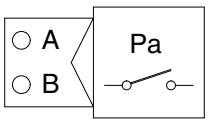
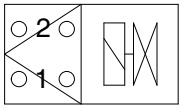
(2) This switch has three positions.

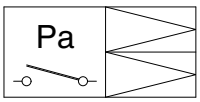
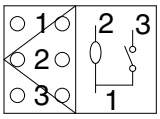
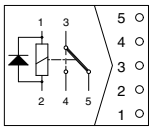
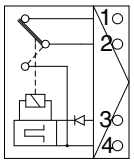
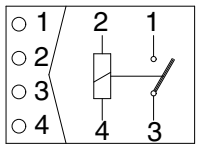
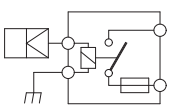
- AUTO : The fan automatically work in reverse according to set up interval and time of the cooling fan reverse mode.
  ※ **Refer to page 7-38 to set of the cluster.**
- OFF : Only forward rotation is possible.
- MANUAL : The fan rotates reverse only while pressing this position.

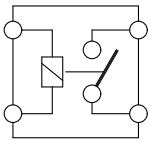
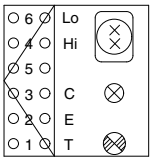
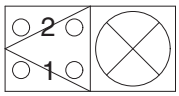
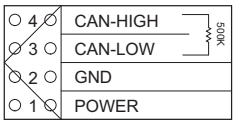
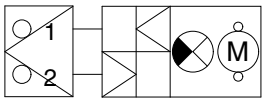
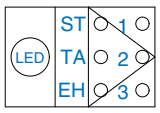
(3) If release the switch, return to the OFF position.

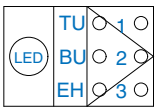
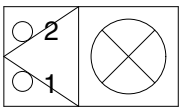
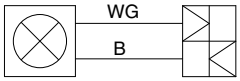
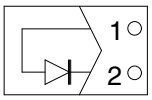
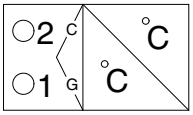
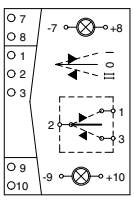
※ **The reverse rotation pilot lamp lights up on the area of the warning and pilot lamp of the LCD when the cooling fan is operated to the reverse rotation.**

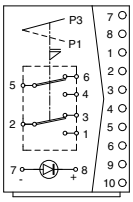
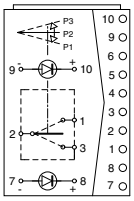
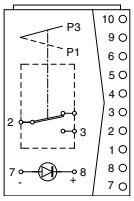
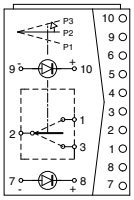
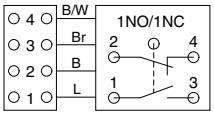
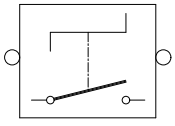
GROUP 6 ELECTRICAL COMPONENT SPECIFICATION

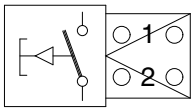
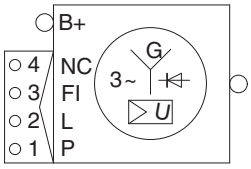
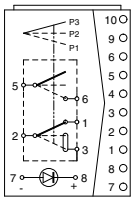
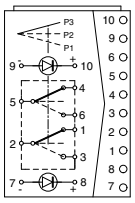
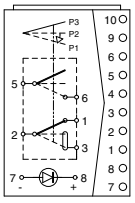
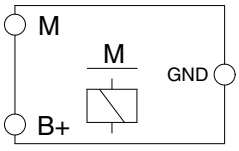
Part name	Symbol	Specifications	Check
Battery		12V × 100Ah (4EA)	※ When checking the battery charging indicator, Green : Normal condition Black : Discharge condition Transparency : Change
Fusible link	 CN-95A CN-95B	CN-95A : 24V 30A CN-95B : 24V 30A	※ Check disconnection Normal : 0 Ω (Connect ring terminal and check resistance between terminal 1 and 2)
Start key	 CS-2	DC 24V	※ Check contact OFF : ∞ Ω (For each terminal) ON : 0 Ω (For terminal 1-2, 1-3) ∞ Ω (For terminal 1-5) START : 0 Ω (For terminal 1-2, 1-3 and 1-5)
Pressure switch	 CD-3 CD-4 CD-26	N.C type	※ Check contact Normal : 0 Ω (CLOSE)
Pressure switch	 CD-29 CD-75 CD-35	N.O type	※ Check contact Normal : ∞ Ω (OPEN)
Solenoid valve (fan EPPR valve)	 CN-71 CN-131 CN-154 CN-156 CN-157	24V 300A	※ Check resistance About 24 Ω

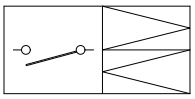
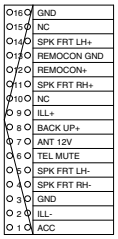
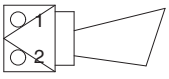
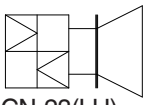
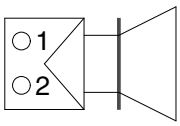
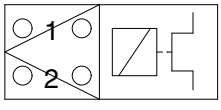
Part name	Symbol	Specifications	Check
Air cleaner pressure switch	 CD-10	Pressure : 635mmH2O (N.O type)	※ Check contact Normal : ∞ Ω
Fuel sender	 CD-2	Reed switch : Magnetic type	※ Check resistance Full : About 50 Ω Low level : About 700 Ω
Relay (5pin)	 CR-4 CR-5 CR-26 CR-36 CR-38 CR-39 CR-42 CR-50 CR-52 CR-54 CR-56 CR-61 CR-62 CR-63	24V 3-4 : 15A (85˚C) 3-5 : 10A (85˚C)	※ Check resistance Normal : 0 Ω (For terminal 3-4) : ∞ Ω (For terminal 3-5)
Int wiper relay	 CR-6	24V 5A Operating time : 2.5±1 sec	※ Check resistance Normal : 0 Ω (For terminal 1-2) : ∞ Ω (For terminal 2-4)
Start relay	 CR-23	24V 300A Exciting current : 2.3A	※ Check resistance Normal : 10 Ω (For terminal 2-4) : ∞ Ω (For terminal 1-3)
Preheat relay	 CR-24	24V 200A Exciting current : 2.3A	※ Check resistance Normal : 10 Ω (For terminal coil) : ∞ Ω (Between ring term)

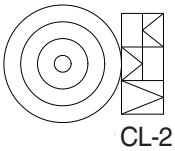
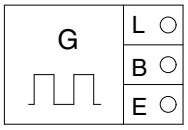
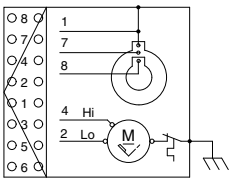
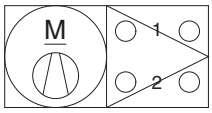
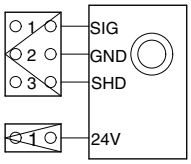
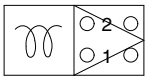
Part name	Symbol	Specifications	Check
Battery relay	 CR-1	24V 100A/1000A Rated ampare : 100A (continue) 1000A (30 second) Exciting current : 0.5A	※ Check resistance Normal : 10 Ω (Between coil) : ∞ Ω (Terminal ring term)
Head lamp	 CL-3 CL-4	24V, H4 75/70W	※ Check resistance Abnormal : ∞ Ω (6-2, 4-2, 3-2, 1-2)
Rear work lamp	 CL-22 CL-23	24V 65W H3 bulb	※ Check disconnection Normal : A few Ω
G-sensor	 CD-6	24V, 5W	-
Beacon lamp	 CL-7	24V 15W (Strobe type)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω
Rear combination lamp	 CL-15A CL-16A	24V 1W (tail) 24V 21W (stop)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω

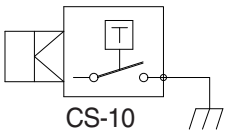
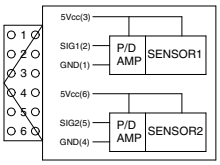
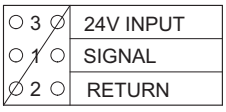
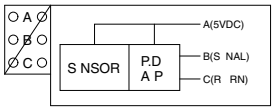
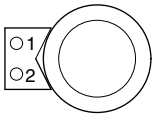
Part name	Symbol	Specifications	Check
Rear combination lamp	 CL-15B CL-16B	24V 21W (backup) 24V 21W (turn)	※ Check disconnection Normal : A few Ω Abnormal : ∞ Ω
Room lamp	 CL-1 CL-51	24V 10W	※ Check resistance Normal : A few Ω Abnormal : ∞ Ω
License lamp	 CL-21	24V 10W (1EA)	※ Check resistance Normal : A few Ω Abnormal : ∞ Ω
Diode	 DO-1 DO-2 DO-3 DO-4 DO-5	Diode spec : 1N5406	-
Temperature sensor (Ambient, CAC)	 CD-76 CD-87	-	-
Switch (Cabin tilt)	 CS-77	24V 8A	※ Check contact Ⅰ : 0 Ω (For terminal 2-1) ∞ Ω (For terminal 2-3) Ⅱ : 0 Ω (For terminal 2-3) ∞ Ω (For terminal 2-1) 0 : ∞ Ω (For terminal 2-1, 2-3)

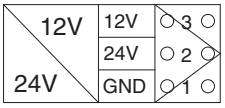
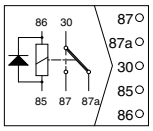
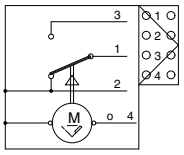
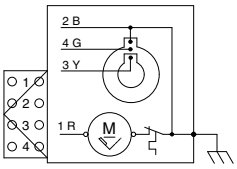
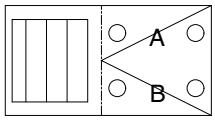
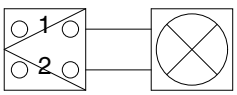
Part name	Symbol	Specifications	Check
Switch (Locking type)	 CS-17 CS-41 CS-42 CS-79 CS-82	24V 8A	※ Check contact P3 : ∞ Ω (For terminal 5-6, 2-3) : 0 Ω (For terminal 5-4, 2-1) P1 : ∞ Ω (5-4, 2-1) 0 Ω (5-6, 2-3)
Switch (Non-locking type)	 CS-64	24V 8A	※ Check contact P2 :∞ Ω (For terminal 2-1, 2-3) P3 : 0 Ω (2-1) P1 : 0 Ω (2-3)
Switch	 CS-23 CS-95 CS-99	24V 8A	※ Check contact P3 :∞ Ω (For terminal 2-3) P1 : 0 Ω (For terminal 2-3)
Switch	 CS-100	24V 8A	※ Check contact P2 :∞ Ω (For terminal 2-1, 2-3) P3 : 0 Ω (For terminal 2-1) P1 : 0 Ω (For terminal 2-3)
Canbin tilt switch	 CS-74	24V 8A	※ Check contact S/W open : ∞ Ω (For terminal NO-COM) : 0 Ω (For terminal NC-COM) S/W closed : 0 Ω (For terminal NO-COM) : ∞ Ω (For terminal NC-COM)
Master switch		6~36V Continuous Capacity : 180Amp Push in capacity : 1000Amp	※ Check contact OFF : ∞ Ω

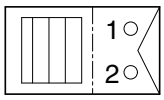
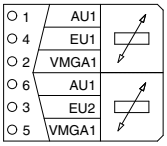
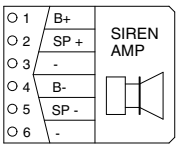
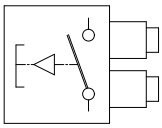
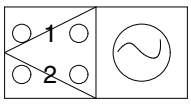
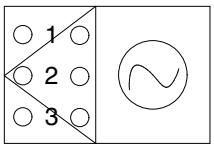
Part name	Symbol	Specifications	Check
Seat switch	 CS-73	24V 8A	※ Check contact OFF : ∞ Ω
Alternator	 CN-74	24V 70A	※ Check voltage Normal : 24~28V
Switch	 CS-21	24V 8A	※ Check contact P3 :∞ Ω (For terminal 5-6, 2-3) P2 : ∞ Ω (For terminal 5-6, 2-1) 0 Ω (For terminal 2-3) P1 : 0 Ω (For terminal 5-6, 2-3)
Switch	 CS-105	24V 8A	※ Check contact P3 : ∞ Ω (For terminal 5-6, 2-3) P1 : 0 Ω (For terminal 5-6, 2-3) ∞ Ω (For terminal 5-4, 2-1)
Switch	 CS-3 CS-39 CS-59 CS-103	24V 8A	※ Check contact P3 :∞ Ω (For terminal 5-6, 2-3) P2 : ∞ Ω (For terminal 5-6, 2-1) 0 Ω (For terminal 2-3) P1 : 0 Ω (For terminal 5-6, 2-3)
Start motor	 CN-45	DENSO 24V 7.8kW	※ Operating or not

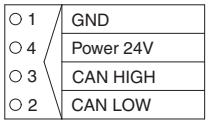
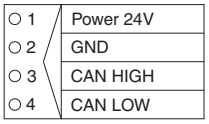
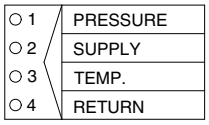
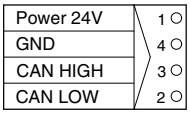
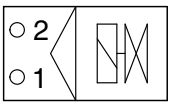
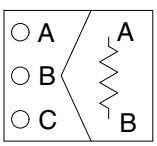
Part name	Symbol	Specifications	Check
Switch (side shift selector, hyd jack selector)	 CS-91 CS-92	N.O type	※ Check contact Normal : ∞ Ω
Radio & USB player	 CN-27	DC27.8V 200W × 2	※ Check resistance Power ON : 4 Ω + 4 Ω (For terminal 1-6, 4-8)
Horn	 CN-25 CN-65	20~28V 100~115dB (A) (at 25V 2m) Max. 1.5A (at 24V)	※ Check operation Supply power(24V) to each terminal and connect ground.
Speaker	 CN-23(LH) CN-24(RH)	4 Ω 20W	※ Check resistance Normal : 50 Ω
Siren speaker	 CN-145	24V	-
Air conditioner compressor	 CN-30	24V 79W	※ Check contact Normal : 13.4 Ω

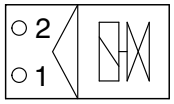
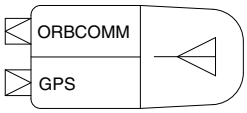
Part name	Symbol	Specifications	Check
Cigar lighter		24V 5A	-
Flasher unit	 CR-11	24V 85~190 C/M 50dB	-
Front wiper motor	 CN-21	24V 1A 2-speed Auto parking	-
Washer pump	 CN-22 CN-83 CN-103 CN-202	24V 2.5A	※ Check contact Normal : 26.4 Ω (For terminal 1-2)
Camera	 CN-249 CN-250	24V 2.5W Signaling : NTSC Angle of view : 145˚C	-
Fuel warmer	 CN-96	24V 15A	※ Check resistance Abnormal : ∞ Ω

Part name	Symbol	Specifications	Check
Coolant level sensor	 CD-96	4.75~5.25V 12.5mA	-
Brake temp switch	 CS-10	N.O type	※ Check resistance Normal : ∞ Ω
Accelerator pedal	 CN-124	5V, hall sensor	※ Check voltage 0.5~3.9V (2-1)
Load sensor	 CD-50	24V, hall sensor	※ Check voltage 0.5~4.5 VDC (1-2)
Angle sensor	 CD-12	5V, hall sensor	※ Check voltage 0.4~4.5 VDC (B-C)
12V-socket	 CN-139	12V 120W Rated ampere : 10A	※ Check resistance Normal : A few Ω (1-2)

Part name	Symbol	Specifications	Check
DC/DC converter	 CN-138	24V 10A Output voltage : 13±1VDC	※ Check resistance Normal : A few Ω (1-2, 1-3)
Relay (5 pin)	 CR-3 CR-49 CR-55 CR-58 CR-59	24V 30-87 : 20A 30-87a : 15A	※ Check resistance Normal : A few Ω (86-85) 0 Ω (30-87a) ∞ Ω (30-87)
Rear wiper motor	 CN-102	24V 1A 1-Speed Auto parking	-
Top wiper motor	 CN-70	24V 1.5A 1-speed Auto parking	-
Seat heaterr	 CN-170	24V	-
Mast work lamp	 CL-5 CL-6 CL-51 CL-61	24V 65W H3	-

Part name	Symbol	Specifications	Check
DEF Line heater	 CN-381 CN-382 CN-383	-	-
Inching sensor	 CD-71	-	-
Siren amp	 CN-47	24V	-
Center horn switch	 CS-5	24V	-
Transmission speed pick up sensor (Internal, Turbine, Engine)	 CD-27 CD-74 CD-72	-	-
Transmission speed sensor (output)	 CD-73	-	-

Part name	Symbol	Specifications	Check
Engine sensor (SCR, DOC)	 CN-J10 CN-J17	-	-
DEF quality sensor	 CN-J6	-	-
TBAP sensor	 CD-102	-	-
NOx sensor (turbo out, SCR out)	 CN-J7A CN-J7B	-	-
Solenoid (DEF tank heater valve, DEF dosing module)	 CN-J27 CN-J31	-	-
Resistor	 RS-2	-	-

Part name	Symbol	Specifications	Check
Solenoid (side shift selector, hyd jack/winch selector)	 CN-130 CN-132	24V 1.2A	※ Check LED lamp ※ Check resistance About 24 Ω
RMS antenna	 CN-251	3.0~5.0V 20mA	-

GROUP 7 CONNECTORS

1. CONNECTOR DESTINATION

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-1	AMP	42	I/conn (Engine harness-Main harness)	936421	936429
CN-2	AMP	42	I/conn (Main harness-Engine harness)	936421	936429
CN-3	AMP	42	I/conn (Engine harness-Main harness)	936421	936429
CN-4	KET	2	I/conn (Engine harness-Main harness)	MG642928	MG652934-5
CN-5	DEUTSCH	2	Beacon	DT06-2S	DT04-2P
CN-6	AMP	15	I/conn (Main harness-Engine harness)	2-85262-1	368301-1
CN-7	AMP	16	I/conn (Main harness-Cabin harness)	368047-1	368050-1
CN-8	KET	14	I/conn (Main harness-Monitor harness)	MG610350	MG640352
CN-9	DEUTSCH	2	I/conn (Frame harness-Master W/Lamp harness)	DT06-2S	DT04-2P
CN-10	DEUTSCH	6	I/conn (Frame harness-Fender harness)	-	DT04-6P
CN-11	DEUTSCH	6	I/conn (Fender harness-Frame harness)	-	DT04-6P
CN-12	DEUTSCH	4	Front camera	DT06-4S	DT04-4P
CN-12	AMP	3	Rear camera	174357-2	174359-2
CN-12	AMP	1	Rear camera	174877-2	174879-2
CN-13	AMP	8	I/conn (Main harness-Cabin harness)	174982-2	-
CN-14	KET	6	Cabin harness	MG610049	MG620048
CN-15	KET	6	Aircon harness	MG610049	
CN-16	DEUTSCH	2	Mast work lamp harness	DT06-2S	DT04-2P
CN-19	KET	2	Inching check	MG610320	MG640322
CN-20	KET	2	Engine harness	MG610331	MG640333
CN-21	DEUTSCH	8	Front wiper	D106-8S	-
CN-22	KET	2	Front washer pump	MG610320	-
CN-23	KET	2	Speaker LH	MG610070	
CN-24	KET	2	Speaker RH	MG610070	
CN-25	Molex	2	Horn	35825-0211	
CN-26	KET	1	Tilt alarm	ST730018-3	ST750036-3
CN-27	KUM	16	USB & MP3	PK145-16017	-
CN-28	AMP	8	T/M display	929504-3	-
CN-29	KET	2	Receiver dryer	MG640795	-
CN-30	KET	2	Compressor	MG610043	-
CN-31	AMP	2	Aircon harness	176146-2	-
CN-32	AMP	2	Aircon harness	-	174354-2
CN-33	AMP	6	Aircon harness	-	174264-2
CN-36	QPL	-	Fuse box (B+)	21HN-55010	-
CN-37	QPL	-	Fuse box (IG)	21HN-55010	-
CN-45	Ring term	-	Start motor (M)	S820-31200	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-45	Ring term	-	Start motor (B+)	S820-20500	-
CN-46	KET	1	Engine harness-Air compressor	MG640944-5	MG650943-5
CN-47	-	1	Master switch (B+)	S820-312000	-
CN-47	KET	1	Master switch	MG640944-5	MG650943-5
CN-47	AMP	4	Speaker	174257-2	174259-2
CN-50	AMP	68	Transmission control unit	963598-1	-
CN-51	AMP	6	TCU service tool	480704-0	926682-3
CN-52	KET	4	Handsfree controller	MG610331	-
CN-55	KET	14	OPSS unit	MG610350	-
CN-56	AMP	20	Cluster	174047-2	-
CN-57	AMP	20	Cluster	175967-2	-
CN-58	KET	14	Monitor	MG610250	
CN-59M	AMP	34	MCU	4-1437290-0	-
CN-59N	AMP	34	MCU	4-1437290-1	-
CN-60	KET	2	Fusible link	-	MG620558
CN-65	DEUTSCH	2	Back-up buzzer	DT06-2S	-
CN-71	DEUTSCH	2	Parking solenoid	DT06-2S	-
CN-71	DEUTSCH	4	Seat switch	-	DT04-4P
CN-74	PACKARD	4	Alternator	12186568	-
CN-75	KET	1	Battery terminal(-)	MG640944-5	-
CN-83	KUM	2	Condenser fan	PB625-02027	-
CN-90	AMP	16	I/conn (Engine harness-Frame harness)	368047-1	-
CN-91	DEUTSCH	3	Fender-RH	-	DT04-3P
CN-92	DEUTSCH	4	ECU connector(J3)	DT06-4S-EP06	-
CN-93	DELPHI	96	ECU connector(J2)	13964577	-
CN-94	FRAMTIME	24	Alternate droop (breakout connector)	F25400	-
CN-95A/B	QPL/KET	2	Fusible link	21N4-01310	MG600558
CN-96	PACKARD	2	Fuel warmer	15300027	-
CN-97	PACKARD	2	Fuel warmer(main filter)	15300027	-
CN-98	DEUTSCH	3	I/conn	DT063S-EP06	-
CN-101	FRAMTIME	4	TBAP sensor	-	54200415
CN-102	AMP	4	Rear wiper motor	180900	-
CN-103	KET	2	Rear washer pump	MG610320	-
CN-112	ZF	16	Gear box	21L7-60290	-
CN-124	AMP	6	Accelerator pedal	174162-2	-
CN-125	DEUTSCH	12	RMCU	DT06-12S	DT04-12P
CN-130	DEUTSCH	2	Hydrojack/ winch select solenoid	DT06-2S	-
CN-131	DEUTSCH	2	Attach cut off	DT06-2S	-
CN-132	DEUTSCH	2	Side shift select solenoid	DT06-2S	-
CN-133	AMP	2	Cabin down solenoid	-	174354-2

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CN-134	DEUTSCH	9	ECU service tool	-	HD10-9-1939P
CN-135	DEUTSCH	9	Cluster/Monitor service tool	-	HD10-9-96P
CN-136	DEUTSCH	9	MCU/RMCU service tool	-	HD10-9-96P
CN-138	KET	3	DC/DC converter	MG610045	-
CN-139	KET	2	12V socket	MG610043	-
CN-144	KET	20	Handsfree controller	MG610240	-
CN-145	KET	2	Siren speaker	MG610049	-
CN-147	KET	2	Cabin tilt pump motor	MG640188-4	-
CN-154	DEUTSCH	2	Fan motor EPPR valve	DT06-2S	-
CN-156	DEUTSCH	2	Fan EPPR valve	DT06-2S	-
CN-157	AMP	2	Fan reverse valve	85202-5	-
CN-158	AMP	4	I/conn (Engine harness-Cooling fan harness)	174257-2	174259-2
CN-160	DEUTSCH	2	Engine harness-Air compressor	DT06-2S	-
CN-169	KET	4	Program dump	DT06-4S-EP06	DT04-4P-E005
CN-191	KET	4	G-sensor	174257-2	174259-2
CN-202	KET	2	Top washer pump	MG610043	-
CN-245	AMP	12	Remote assy	368542	-
CN-246	AMP	12	USB & Socket assy	174045-2	-
CN-249	AMP	3	Rear camera	174357-2	174359-2
CN-249	AMP	1	Rear camera	174877-2	174879-2
CN-381	AMP	2	DEF line heater 1	936059-1	-
CN-382	AMP	2	DEF line heater 2	936059-1	-
CN-383	AMP	2	DEF line heater 3	936059-1	-
CN-J6	ITT CANNON	4	DEF quality sensor	121583-0000	-
CN-J7A	AMP	4	DOC NOx sensor	2-1418390-1	-
CN-J7B	AMP	4	SCR NOx sensor	1-1418390-1	-
CN-J10	AMP	4	SCR thermistor	3-1418390-1	-
CN-J17	AMP	4	DOC thermistor	4-1418390-1	-
CN-J26	AMP	12	DEF supply module	2-1703639-1	-
CN-J27	DEUTSCH	2	Coolant valve	DT06-2S	-
CN-J31	AMP	2	DEF dosing module	936059-1	-
Switch					
CS-2	KET	6	Start key	MG610335	-
CS-3	CARLING	10	Rear wiper washer switch	21HN-56300	-
CS-5	KET	2	Center horn switch	-	MG640322
CS-5A	KET	2	Center horn switch	MG610320	-
CS-5B	-	1	Center horn switch	-	S820-105000
CS-10	KET	1	Brake temperature switch	ST720018-3	-
CS-11	KET	8	Multifunction switch	MG610339	-
CS-12	KET	6	Multifunction switch	MG610335	-

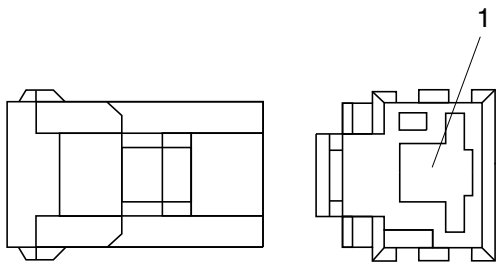
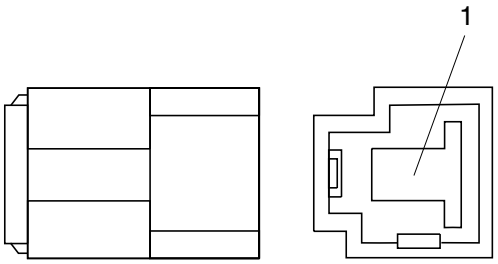
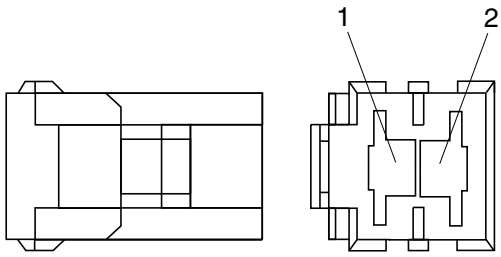
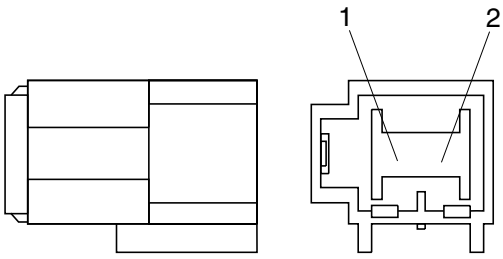
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CS-14	PACKARD	4	Gear selector switch	-	12010974
CS-15	KET	1	Multi function switch	ST730018-3	-
CS-15	KET	4	Gear selector switch	12015797	-
CS-17	CARLING	10	Parking switch	21HN-56300	-
CS-18	DAEDONG	10	Cruise switch	250-10PRG	-
CS-19	DAEDONG	10	Cruise set/resume switch	250-10PRG	-
CS-21	CARLING	10	Work lamp switch	21HN-56300	-
CS-23	CARLING	10	Beacon switch	21HN-56300	-
CS-34	DAEDONG	10	Diagnostic switch	250-10PRG	-
CS-39	CARLING	10	Main light switch	21HN-56300	-
CS-41	CARLING	10	Hazard switch	21HN-56300	-
CS-42	CARLING	10	Inching switch	21HN-56300	-
CS-54	DAEDONG	10	Aircon switch	250-10PRG	-
CS-59	CARLING	10	Auto/manual switch	21HN-56300	-
CS-64	CARLING	10	Inc/dec switch	21HN-56300	-
CS-72	DEUTSCH	4	Tilt switch	-	DT04-4P
CS-74	DEUTSCH	4	Tilt switch	-	DT04-4P
CS-77	CARLING	10	Tilt operation	21HN-56300	-
CS-78	KET	2	Cabin tilt	MG610320	-
CS-79	CARLING	10	Power/Standard switch	21HN-56300	-
CS-80	DAEDONG	10	Air compressor switch	250-10PRG	-
CS-82	CARLING	10	Seal heat switch	21HN-56300	-
CS-91	KET	1	Side shift selector switch	ST30036-3	ST730018-3
CS-92	KET	1	Hyd. jack selector switch	ST30036-3	ST730018-3
CS-95	CARLING	10	Fuel warmer switch	21HN-56300	-
CS-99	CARLING	10	Air compressor switch	21HN-56300	-
CS-100	CARLING	10	DEF regen inhibit switch	21HN-56300	-
CS-103	CARLING	10	Top wiper switch	21HN-56300	-
CS-105	CARLING	10	Cooling fan switch	21HN-56300	-
Lamp					
CL-1	KET	2	Room lamp	-	MG610392
CL-2	KET	1	Cigar lighter	ST730018-3	ST175036-3
CL-2	AMP	1	Cigar lighter	172128-1	-
CL-3	DEUTSCH	6	Head lamp LH	DT06-6S	-
CL-4	DEUTSCH	6	Head lamp RH	DT06-6S	-
CL-5	DEUTSCH	2	Mast lamp-LH	DT06-2S	-
CL-6	DEUTSCH	2	Mast lamp-RH	DT06-2S	-
CL-7	-	6	Beacon lamp	S822-014000	S822-114000
CL-15	KLM	6	Rear combi LH	PB625-06027	-
CL-15A	AMP	3	Illuminate/ stop lamp	282087-1	-

Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CL-15B	AMP	3	Turn/ back up lamp	282087-2	-
CL-16	KLM	6	Rear combi RH	PB625-06027	-
CL-16A	AMP	3	Illuminate/ stop lamp	282087-1	-
CL-16B	AMP	3	Turn/ back up lamp	282087-2	-
CL-21	KET	1	License lamp	ST730018-3	ST750036-3
CL-22	DEUTSCH	2	Rear work lamp - RH	DT06-2S	-
CL-23	DEUTSCH	2	Rear work lamp - LH	DT06-2S	-
CL-24	-	1	Flasher lamp LH	S822-014000	S822-114000
CL-30	KET	2	Room lamp	MG610392	-
CL-40	SWF	2	SCR cleaning lamp	913328	-
CL-41	SWF	2	SCR cleaning inhibit lamp	913328	-
CL-42	SWF	2	E/G stop lamp	913328	-
CL-43	SWF	2	HEST lamp	913328	-
CL-50	SWF	2	DEF low temp	913328	-
CL-51	DEUTSCH	2	Mast lamp-LH	DT06-2S	-
CL-61	DEUTSCH	2	Mast lamp-RH	DT06-2S	-
Relay					
CR-1	RING TERMINAL	-	Battery relay	S820-104000 S820-308000	-
CR-3	HELLA	5	Front w/lamp relay	8JA003526-001	-
CR-4	AMP	5	Wiper HI relay	VCFM-1002	-
CR-5	AMP	5	Netural relay	VCFM-1002	-
CR-6	KET	4	Internal wiper relay	MG610047	-
CR-11	HELLA	5	Flasher unit relay	8JA003526-001	-
CR-12	AMP	5	Fan motor relay	VCFM-1002	-
CR-23	KET	4	Starter relay	MG610047	-
CR-24	RING TERMINAL	-	Preheat relay	-	-
	KET	1	Preheat relay	ST730018-3	-
CR-26	AMP	5	Wiper low speed relay	VCFM-1002	-
CR-36	AMP	5	Anti-restart relay	VCFM-1002	-
CR-38	AMP	5	Washer pump relay	VCFM-1002	-
CR-39	AMP	5	Backup relay	VCFM-1002	-
CR-42	AMP	5	Preheat relay	VCFM-1002	-
CR-44	TYCO	2	Cabin tilt relay	174352-2	-
CR-45	HELLA	5	ECM relay	8JA003526-001	-
CR-46	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-47	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-49	HELLA	5	Fuel warmer relay	8JA003526-001	-
CR-50	AMP	5	Travel cut relay	VCFM-1002	-
CR-52	AMP	5	Attach cut relay	VCFM-1002	-

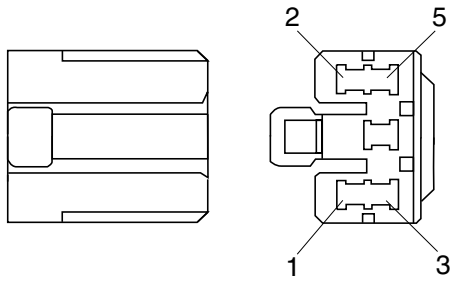
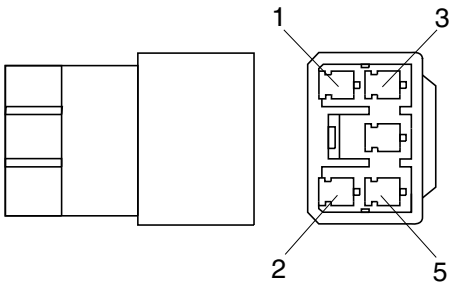
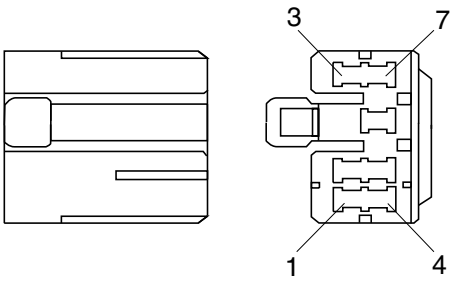
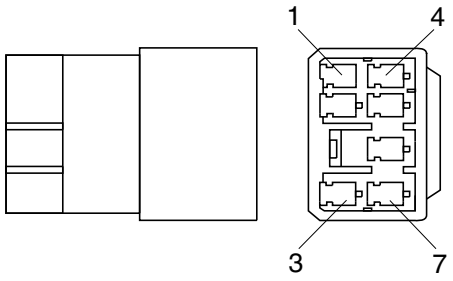
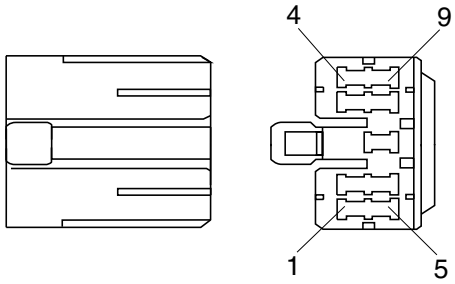
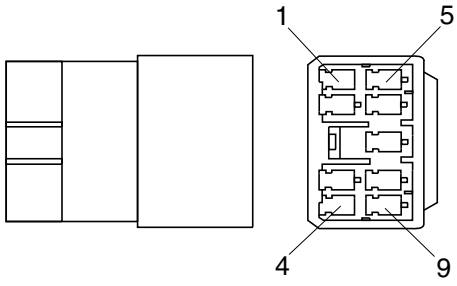
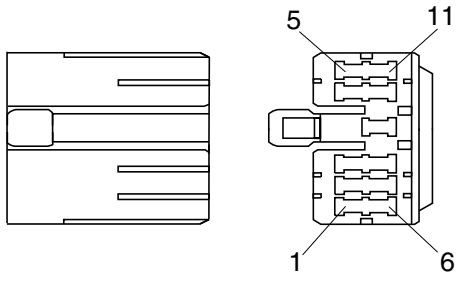
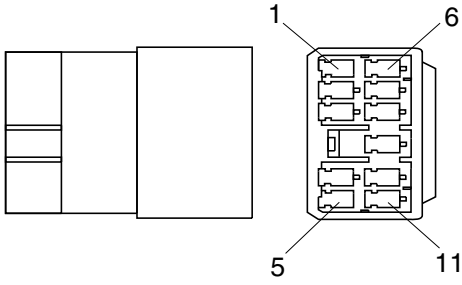
Connector number	Type	No. of pin	Destination	Connector part No.	
				Female	Male
CR-53	AMP	5	Cruise control relay	VCFM-1002	-
CR-54	AMP	5	Brake switch relay	VCFM-1002	-
CR-55	HELLA	5	Rear w/lamp relay	8JA003526-001	-
CR-56	AMP	5	Auto park relay	VCFM-1002	-
CR-58	HELLA	5	DEF supply module relay	8JA003526-001	-
CR-59	HELLA	5	DEF sensor relay	8JA003526-001	-
CR-61	AMP	5	DEF line heater 1 relay	VCFM-1002	-
CR-62	AMP	5	DEF line heater 2 relay	VCFM-1002	-
CR-63	AMP	5	DEF line heater 3 relay	VCFM-1002	-
Sensor and pressure switch					
CD-2	KET	3	Fuel sender	MG610045	-
CD-3	DEUTSCH	2	Brake fail switch	-	DT04-2P
CD-4	AMP	1	Brake switch	171809-2	-
CD-8	AMP	2	Temp sender	827551-3	-
CD-10	KET	1	Air cleaner switch	ST730057-2	-
CD-12	DEUTSCH	3	Angle sensor	DT06-3S	DT04-3P
CD-18	AMP	1	Engine oil pressure switch	S819-010122	-
CD-26	DEUTSCH	2	Parking pressure switch	-	DT04-2P
CD-27	AMP	2	Turbine speed pick-up	963040-2	-
CD-29	ZF	2	Temp sender	21FF-10170	-
CD-35	DEUTSCH	2	Water in fuel switch	DT06-2S	-
CD-50	DEUTSCH	3	Load sensor	DTM06-3S	-
CD-55	KET	2	RCV pressure switch	MG640795	-
CD-71	AMP	6	Inching sensor	1-967616-1	-
CD-72	AMP	2	Internal speed pick-up	963040-3	-
CD-73	AMP	3	Output speed sensor	282087-1	-
CD-74	AMP	2	Engine speed pick-up	963040-3	-
CD-75	AMP	2	Filter switch	282080-1	-
CD-76	AMP	2	Air temp. sensor	963040-3	-
CD-84	AMP	3	Tank doser sensor	3-141844-1	-
CD-87	AMP	2	Ambient temp. sensor	968339-3	-
CD-88	AMP	4	Quality sensor	776524-1	-
CD-96	PACKARD	3	Coolant level sensor	12110293	-
CD-102	SUMITOMO	4	TBAP sensor	6098-0144	-
Diode					
DO-01	AMP/QPL	-	Diode	174352-2	21EA-50550
DO-02	AMP/QPL	-	Diode	174352-2	21EA-50550
DO-03	AMP/QPL	-	Diode	174352-2	21EA-50550
DO-04	AMP/QPL	-	Diode	174352-2	21EA-50550
DO-05	AMP/QPL	-	Diode	174352-2	21EA-50550

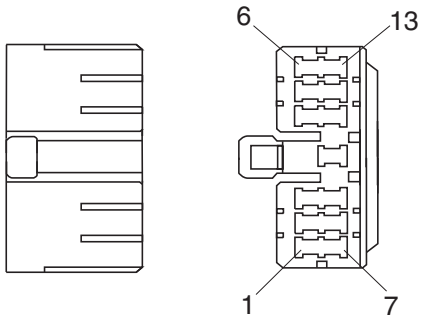
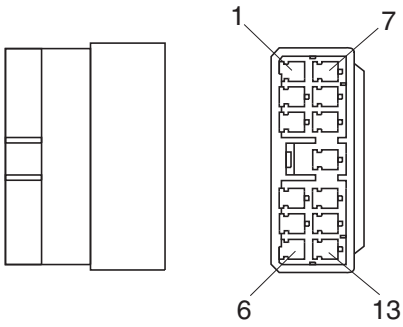
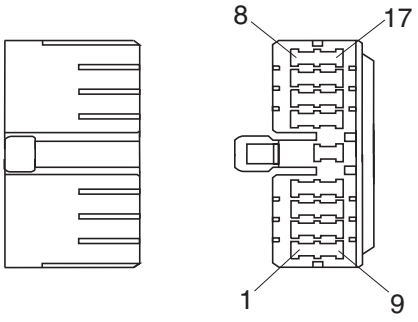
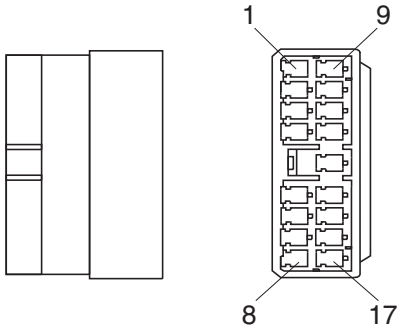
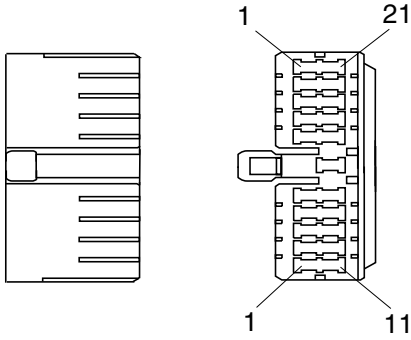
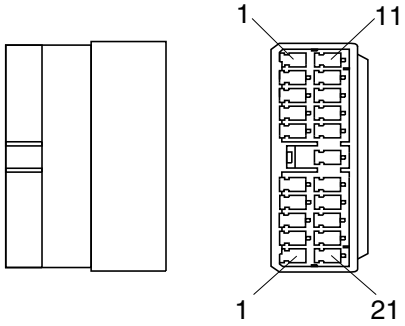
2. CONNECTION TABLE FOR CONNECTORS

1) 58-L TYPE CONNECTOR

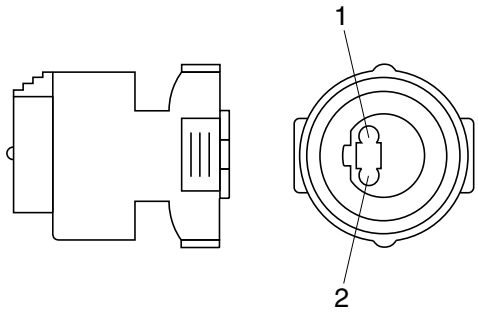
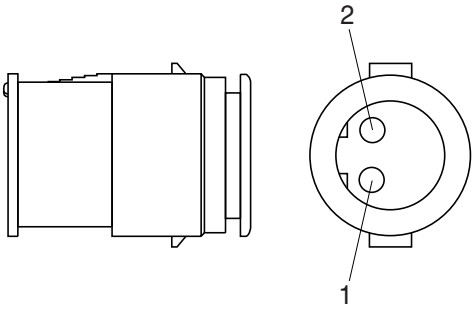
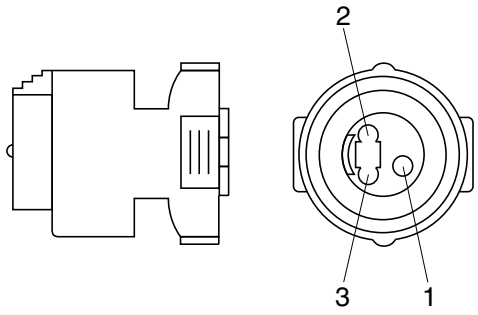
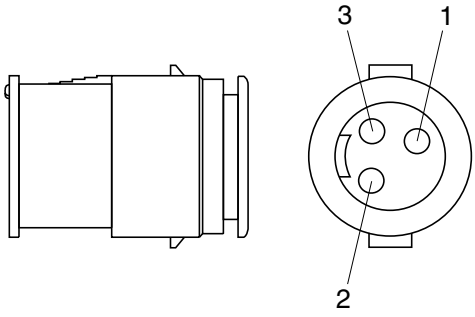
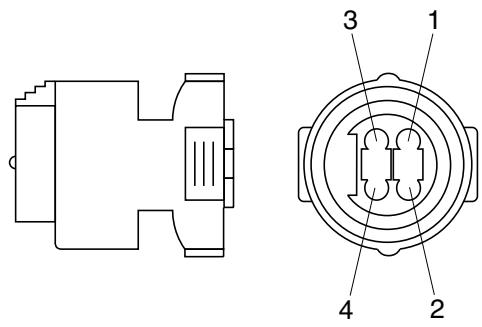
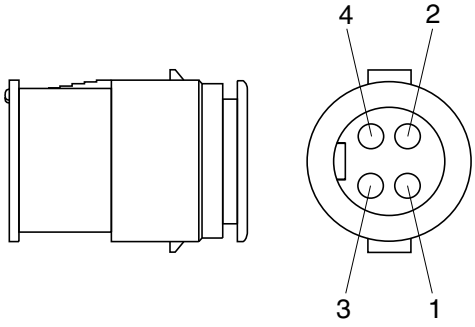
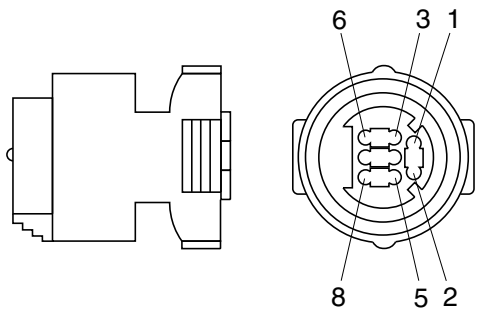
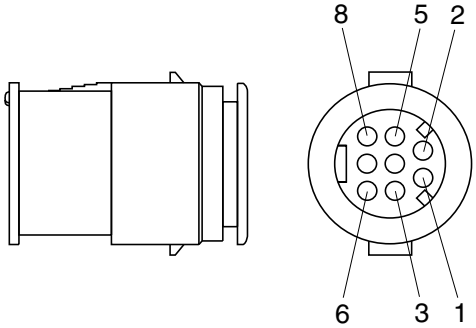
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S813-030100	 S813-130100
2	 S813-030200	 S813-130200

2) PA TYPE CONNECTOR

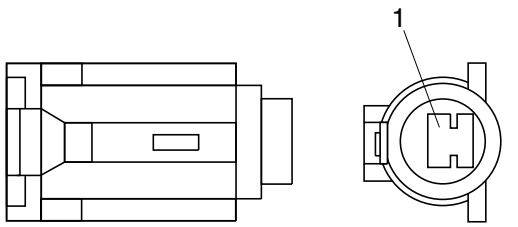
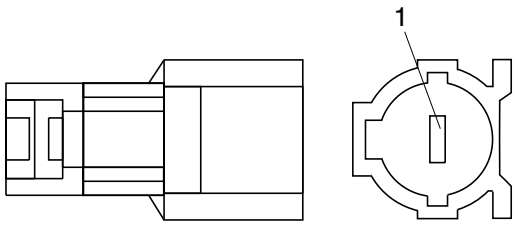
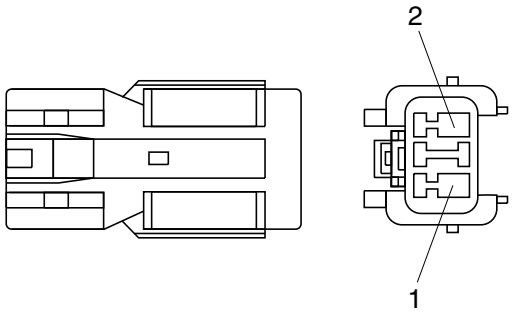
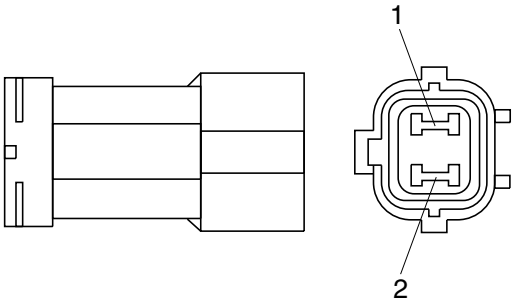
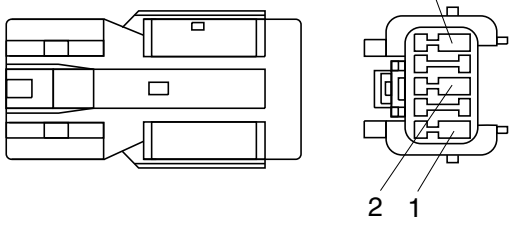
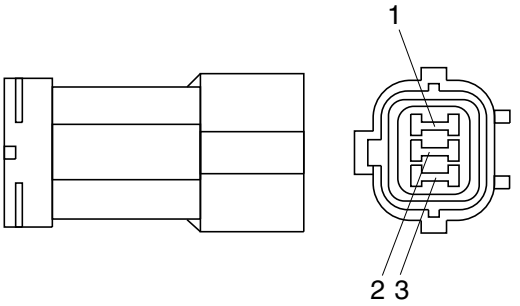
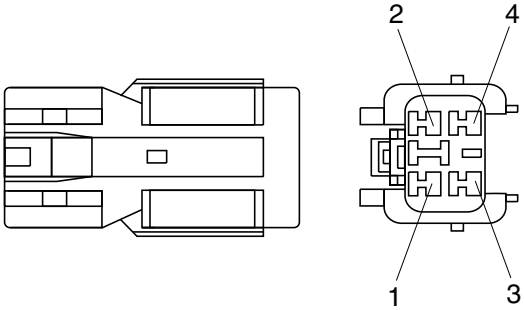
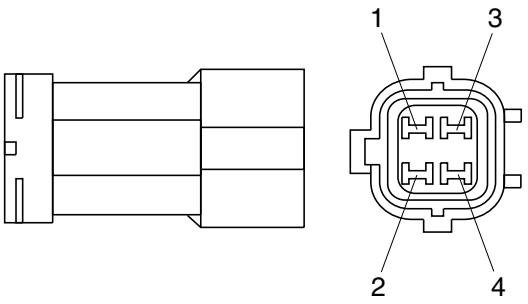
No. of pin	Receptacle connector (Female)	Plug connector (Male)
5	 S811-005002	 S811-105002
7	 S811-007002	 S811-107002
9	 S811-009002	 S811-109002
11	 S811-011002	 S811-111002

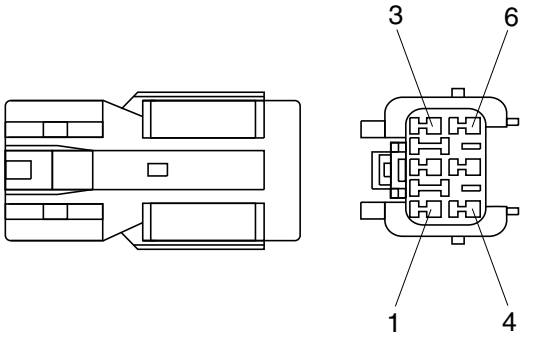
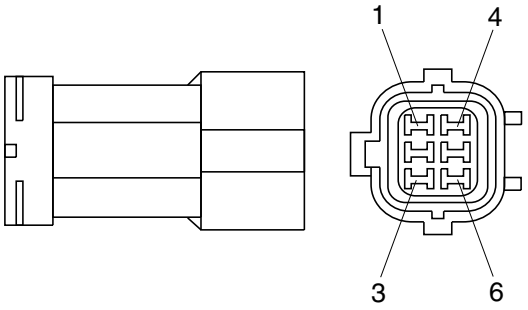
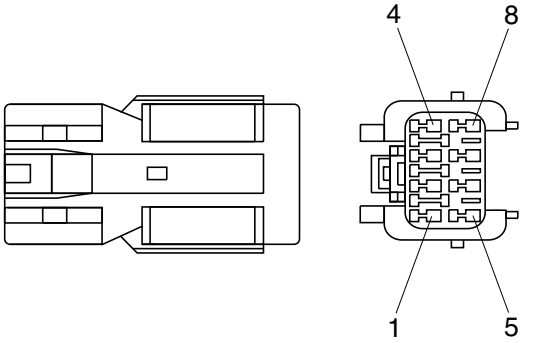
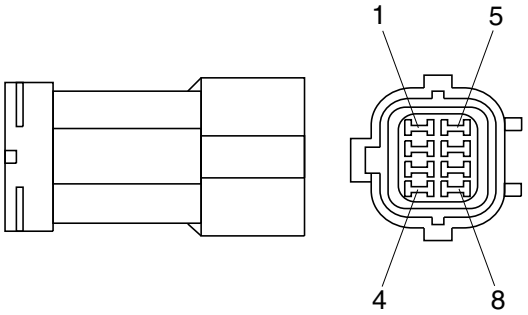
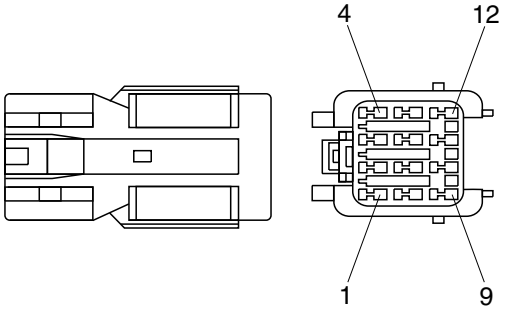
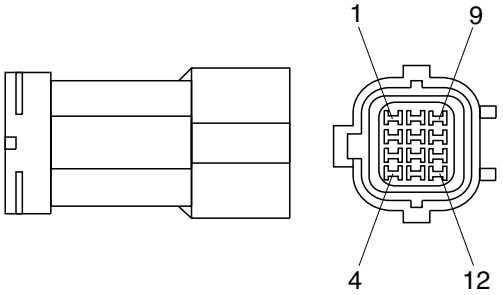
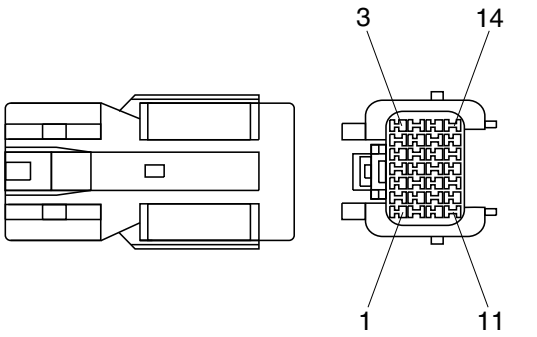
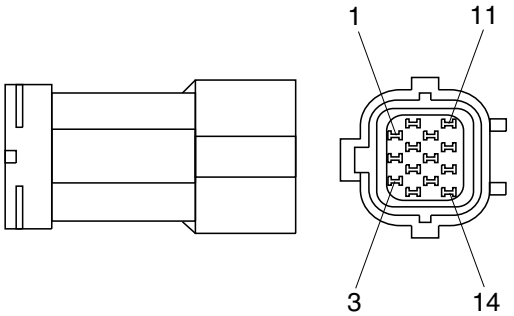
No. of pin	Receptacle connector (Female)	Plug connector (Male)
13	 S811-013002	 S811-113002
17	 S811-017002	 S811-117002
21	 S811-021002	 S811-121002

3) J TYPE CONNECTOR

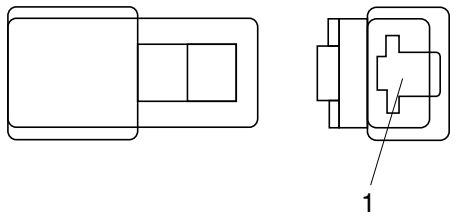
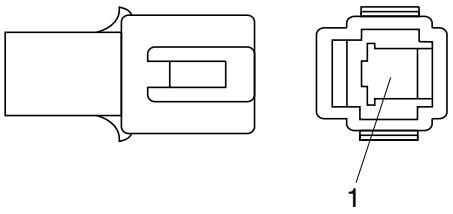
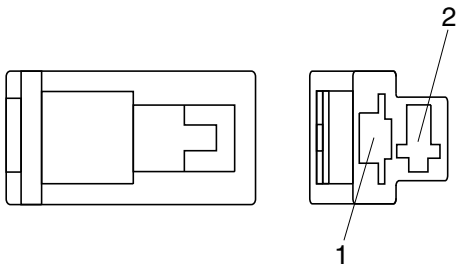
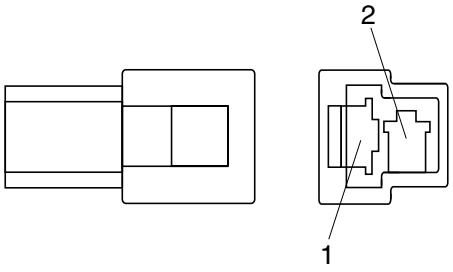
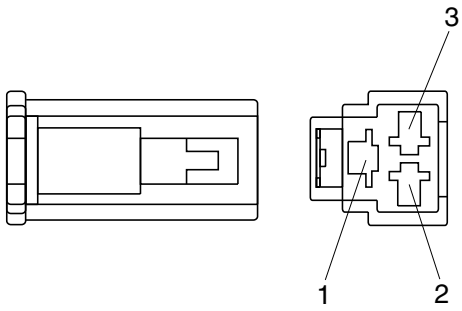
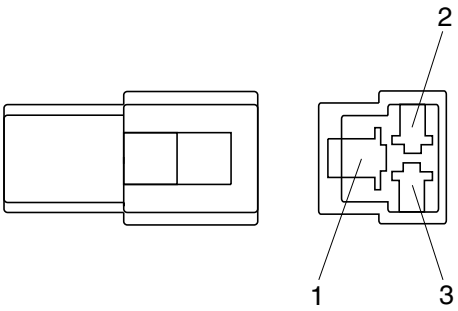
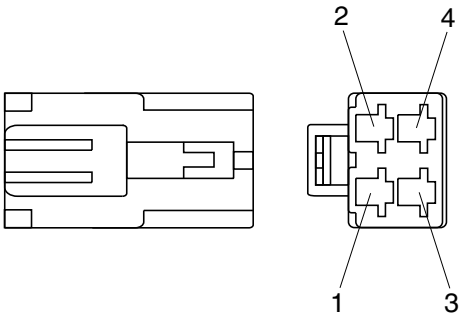
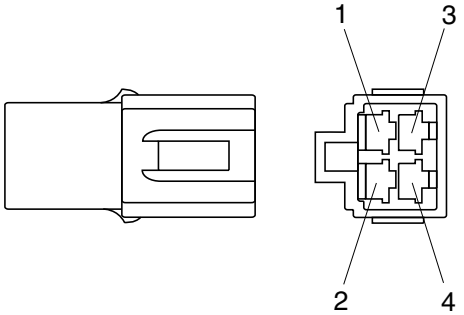
No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 S816-002001	 S816-102001
3	 S816-003001	 S816-103001
4	 S816-004001	 S816-104001
8	 S816-008001	 S816-108001

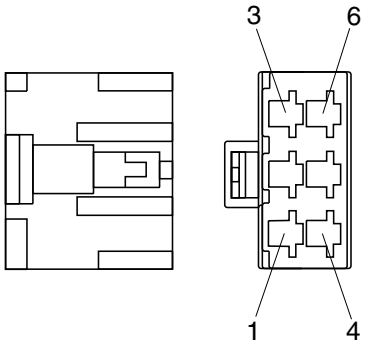
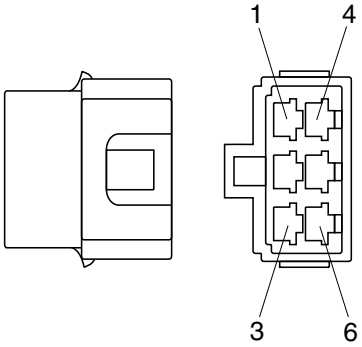
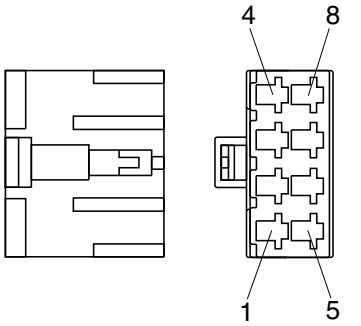
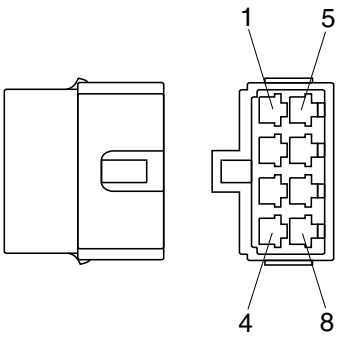
4) SWP TYPE CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S814-001000	 S814-101000
2	 S814-002000	 S814-102000
3	 S814-003000	 S814-103000
4	 S814-004000	 S814-104000

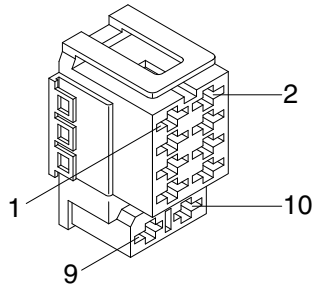
No. of pin	Receptacle connector (Female)	Plug connector (Male)
6	 S814-006000	 S814-106000
8	 S814-008000	 S814-108000
12	 S814-012000	 S814-112000
14	 S814-014000	 S814-114000

5) CN TYPE CONNECTOR

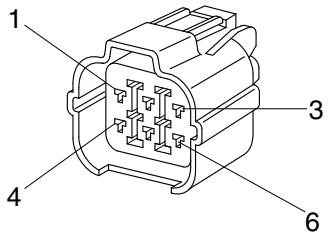
No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 S810-001202	 S810-101202
2	 S810-002202	 S810-102202
3	 S810-003202	 S810-103202
4	 S810-004202	 S810-104202

No. of pin	Receptacle connector (Female)	Plug connector (Male)
6	 S810-006202	 S810-106202
8	 S810-008202	 S810-108202

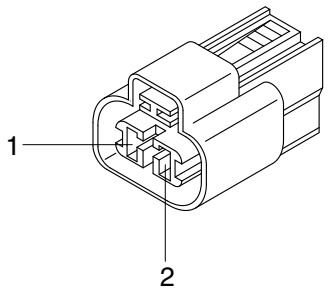
6) ITT SWF CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
10	 SWF593757	

7) HW090 SEALED CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
6	 6189-0133	

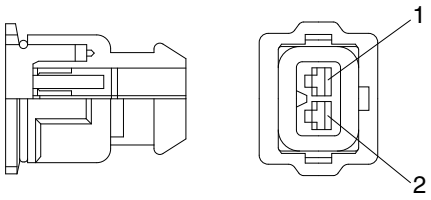
8) MWP02F-B CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 PH805-02028	

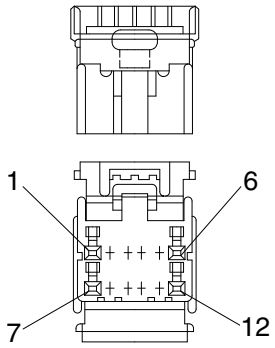
9) AMP ECONOSEAL CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
36	344111-1	344108-1

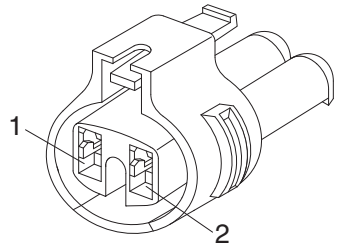
10) AMP TIMER CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
2	 85202-1	

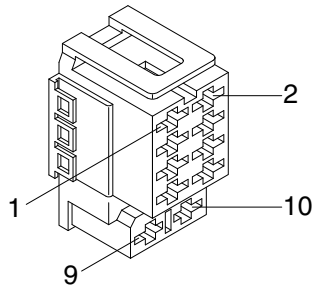
11) AMP 040 MULTILOCK CONNECTOR

No. of pin	Receptacle connector(Female)	Plug connector(Male)
12	 174045-2	

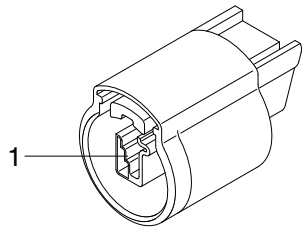
12) KET 090 WP CONNECTORS

No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 MG640795	

13) ITT SWF CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
10	 SWF593757	

14) MWP NMWP CONNECTOR

No. of pin	Receptacle connector (Female)	Plug connector (Male)
1	 NMWP01F-B	

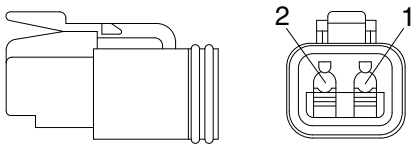
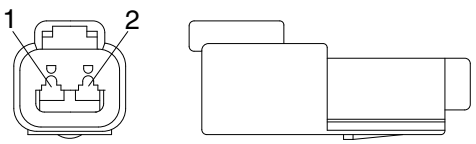
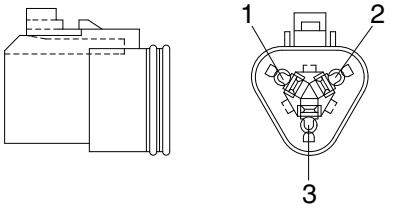
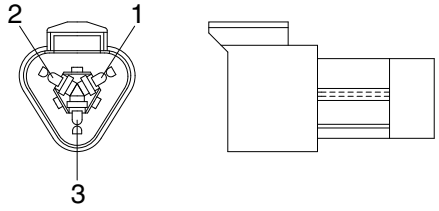
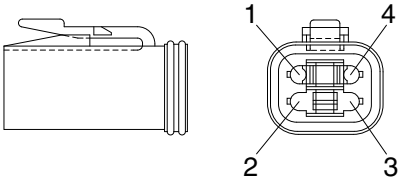
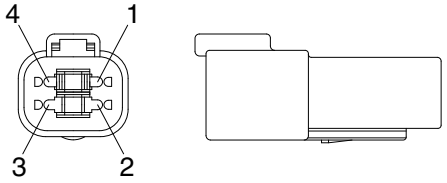
15) DEUTSCH DT CONNECTORS

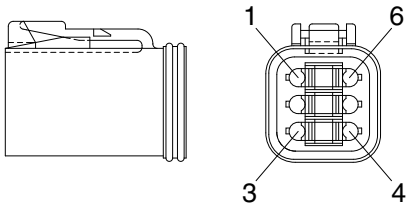
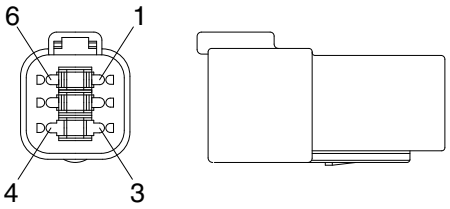
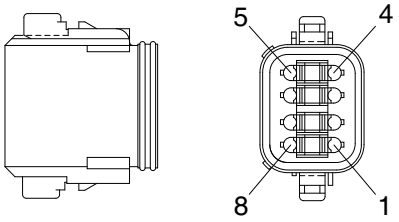
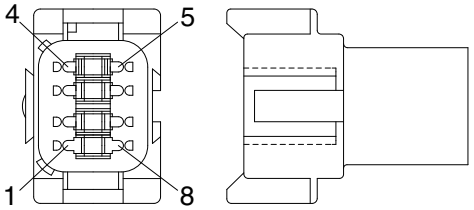
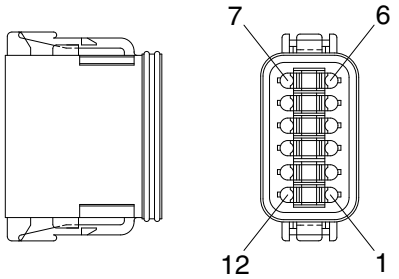
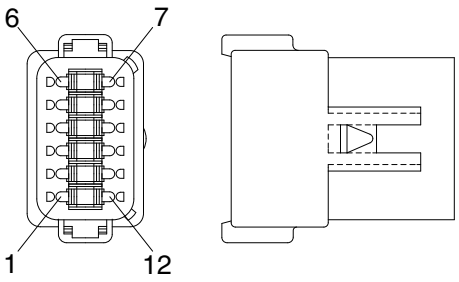
DT 06 - 3S - ★★★★

- ★★★★ : Modifications (See below)
- 3S : Number of contacts (P : Pin, S : Socket)
- 06 : Receptacle, 04 : Plug
- DT : Deutsch connectors

※ Modification

E003 : Standard end cap - gray
E004 : Color of connector to be black
E005 : Combination - E004 & E003
EP04 : End cap
EP06 : Combination P012 & EP04
P012 : Front seal enhancement - connectors color to be black for 2, 3, 4 & 6pin

No. of pin	Receptacle connector (Female)	Plug connector (Male)
2	 DT06-2S	 DT04-2P
3	 DT06-3S	 DT04-3P
4	 DT06-4S	 DT04-4P

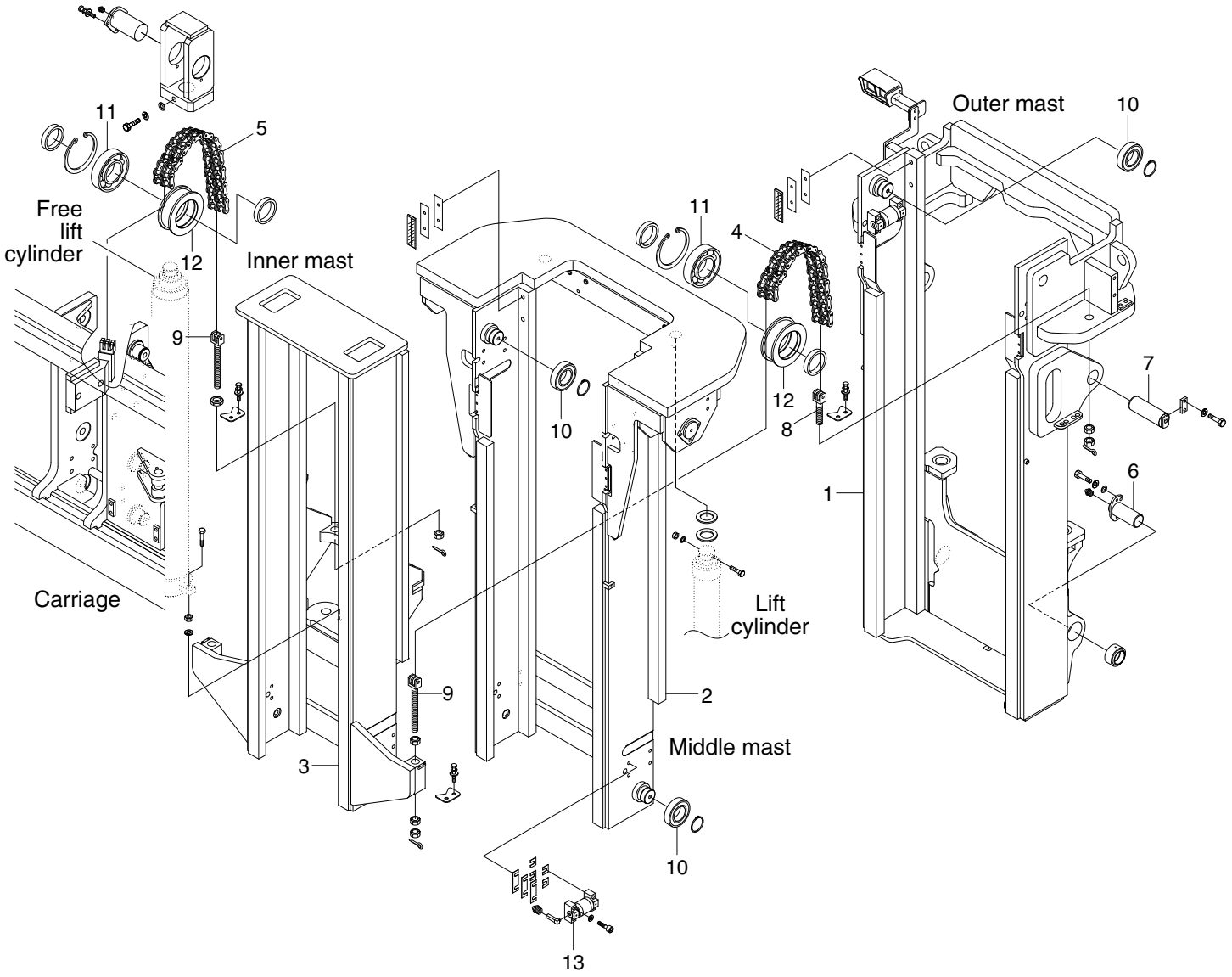
No. of pin	Receptacle connector(Female)	Plug connector(Male)
6	 DT06-6S	 DT04-6P
8	 DT06-8S	 DT04-8P
12	 DT06-12S	 DT04-12P

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 oper.	· 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

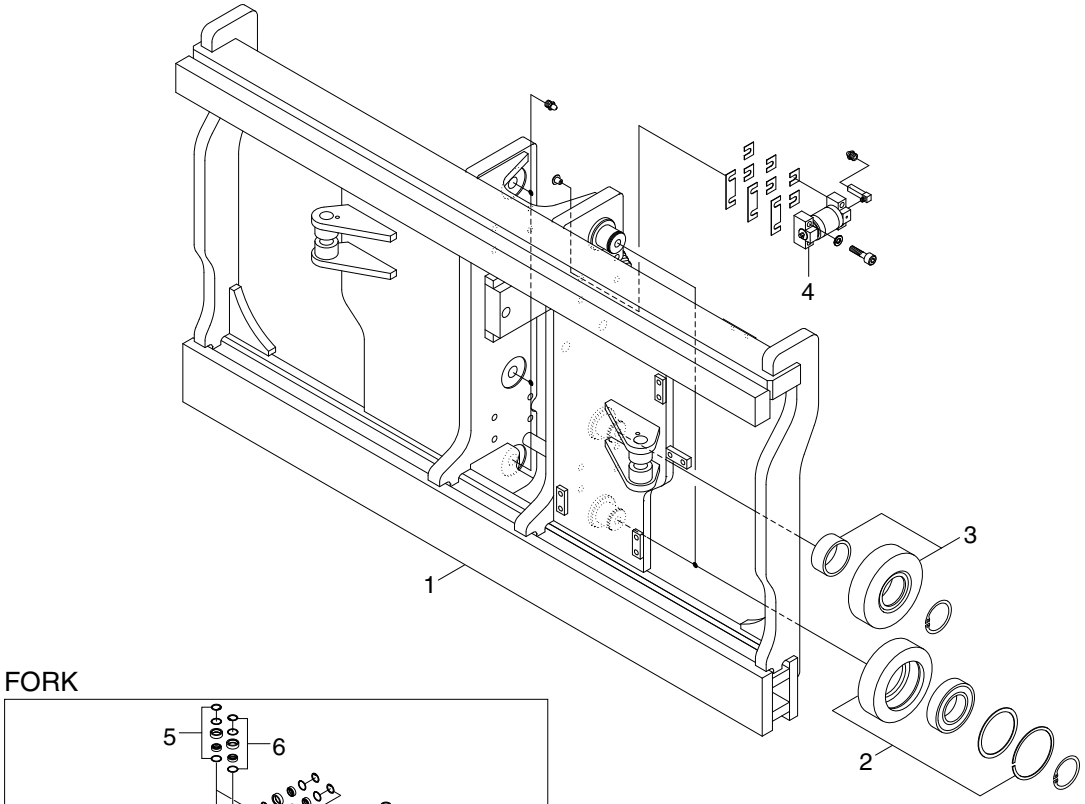
1. 3 STAGE MAST (TF MAST)



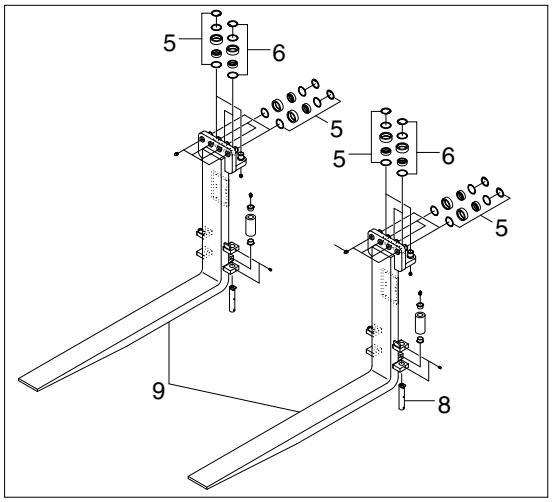
300D9MS01E

1	Outer mast	6	Mast mounting pin	11	Roller bearing
2	Middle mast	7	Tilt cylinder pin	12	Chain sheave bearing
3	Inner mast	8	Anchor bolt	13	Side roller bearing
4	Lift chain	9	Anchor bolt		
5	Free lift cylinder	10	Roller bearing		

2. CARRIAGE AND FORK



FORK



300D9MS02E

1	Carriage	6	Roller
2	Load roller bearing	7	Roller
3	Load roller bearing	8	Pin
4	Side roller	9	Fork
5	Roller		

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

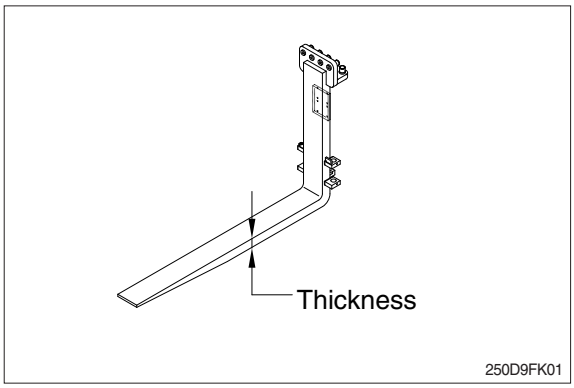
1. OPERATIONAL CHECKS

1) FORKS

(1) Measure thickness of root of forks and check that it is more than specified value.
EX : ℓ =2450 mm (96 in)

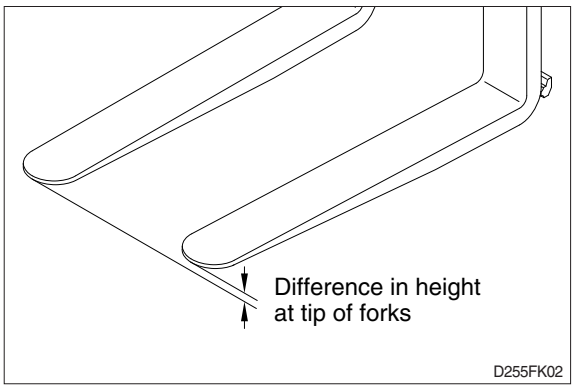
mm (in)

STD Fork assy	Standard	Wear limit
65HV-71200	110 (4.3)	100 (3.9)



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

Fork length (mm)	Height difference (mm)
below 1500	3
equal or above 1500	6



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

2) FORKS

Problem	Cause	Remedy
Abrasion	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	If the measured value is below the wear limit, replace fork.
Distortion	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 : 15 ㎜ · Difference in fork tip width : 35 ㎜	If the measured value exceeds the allowance, replace fork.
Fatigue	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.	Repair fork by expert. In case of excessive distortion, replace fork.

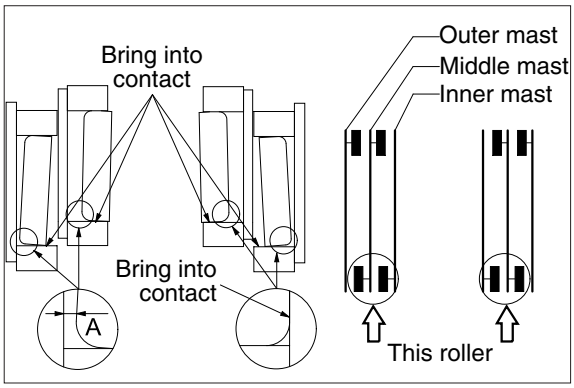
1. MAST LOAD ROLLER (TF MAST)

1) INNER/OUTER MAST ROLLER CLEARANCE ADJUSTMENT

(1) Measure the clearance with the mast overlap at near 480 mm (19 in).

(2) Shift the inner mast to one side to bring the roller into contact with the outer mast and 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 roller clearance equally to the left and right roller.

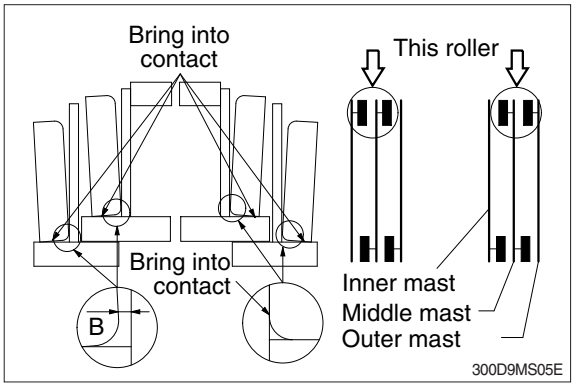
(4) After the adjustment, check that the inner mast moves smoothly in the middle mast and the middle mast moves smoothly in the outer mast.

2) MIDDLE/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 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 middle and outer 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.

(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.

※ When assembling the load roller bearings, it must be sure to observe the followings.

1) The outer race of the load roller bearings should be assembled to inward for 2.5 mm radius round part and outward for 7 mm radius round part.

2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.

3) If it is not, the inner race of the load roller bearing could be separated.
Remove the foreign materials in the grease oil passage of the roller brackets before assembling.

3) CARRIAGE LOAD ROLLER

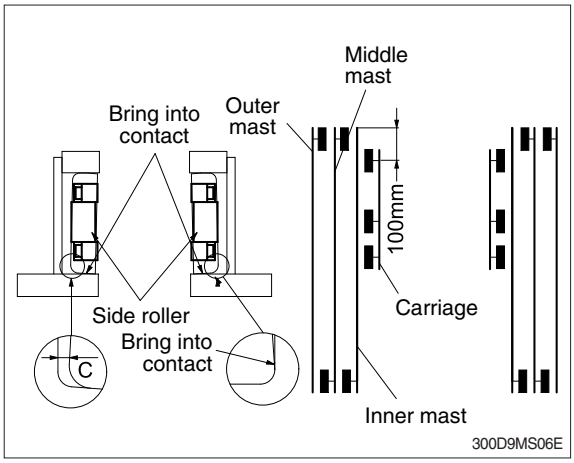
(1) Measure the clearance when the center of the carriage upper roller is 100 mm from the top of the inner mast.

(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 adjust screw.

· Standard clearance C = 0~0.6 mm

(3) Distribute the roller clearance equally to the left and right roller.

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



4) MAST BACK UP LINER

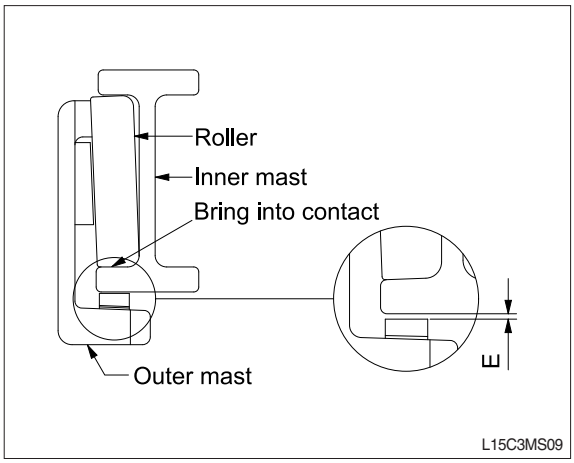
(1) Measure the clearance with the middle mast at the bottom position.

(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.



※ When assembling the load roller bearings, it must be sure to observe the followings.

1) The outer race of the load roller bearings should be assembled to inward for 2.5 mm radius round part and outward for 7 mm radius round part.

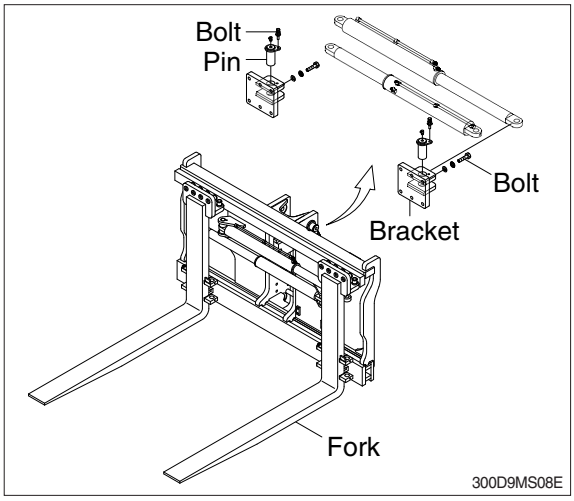
2) When assembling and disassembling the load roller bearings, the jig fixture should be used so that it can be pressed to inner race of the roller bearings.
If it is not, the inner race of the load roller bearing could be seperated.

3) Remove the foreign materials in the grease oil passage of the roller brackets before assembling.

GROUP 4 REMOVAL AND INSTALLATION

1. FORKS

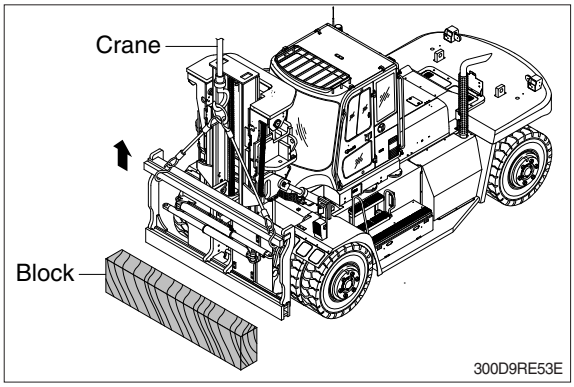
(1) Lower the fork carriage until the forks are approximately 25 mm (1 in) from the floor.
(2) Release fork anchor pins and slide one fork at a time toward the center of the carriage where a notch has been cut in the bottom plate for easy fork removal.
(3) Remove only one fork at a time.
※ On larger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



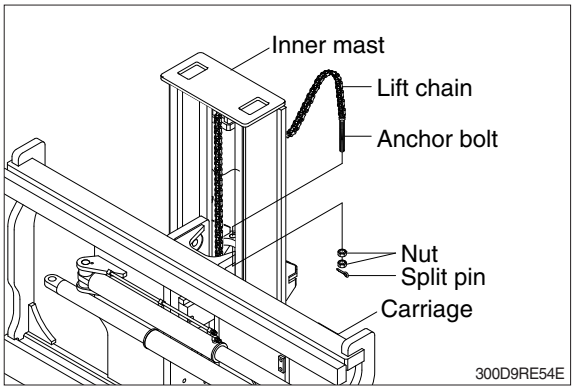
2. CARRIAGE ASSEMBLY

1) CARRIAGE

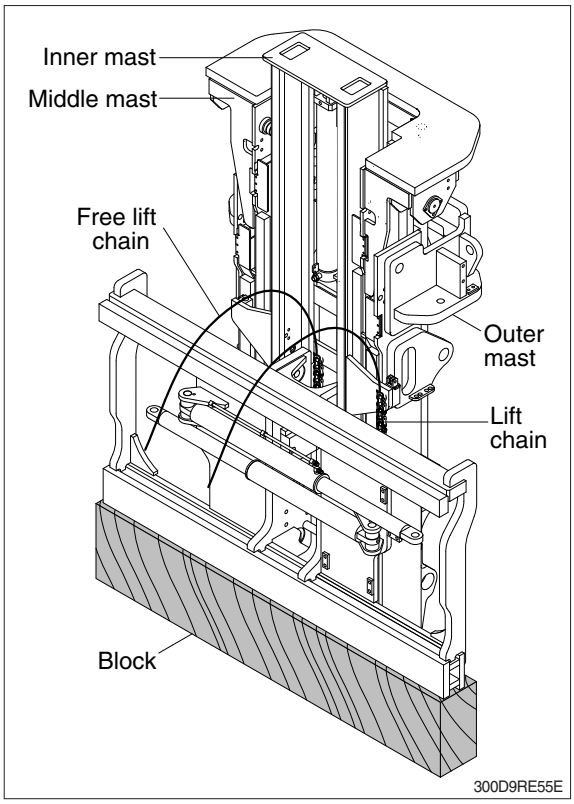
(1) With the mast vertical, raise the carriage high enough to place blocks under the load forks. This is done to create slack in the load chains when the carriage is lowered. Lower the carriage all the way down to the floor. Make sure the carriage is level, this will prevent any binding when the mast 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) Disconnect connector from the work lamp assy.

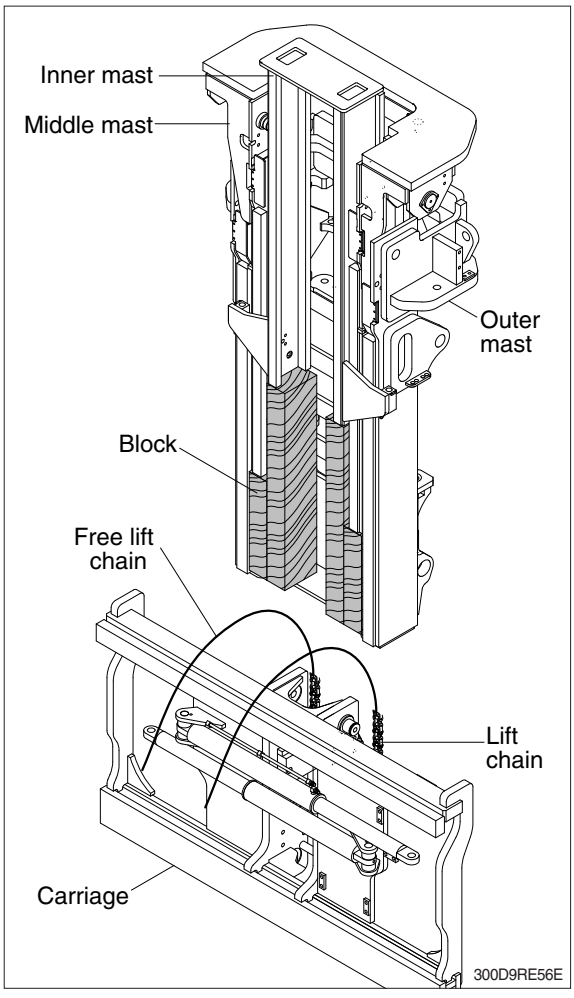


(5) Slowly raise inner mast upright until mast clears top of fork carriage. Move carriage to work area and lower mast.

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

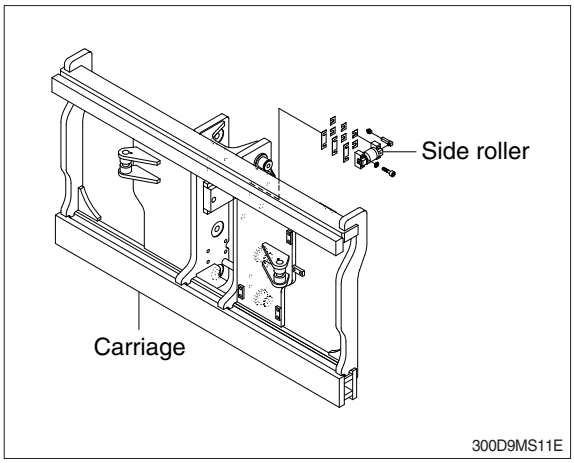
※ Inspect all parts for wear or damage. Replace all worn or damaged parts.

※ Reverse the above steps to reinstall.



2) SIDE ROLLER

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

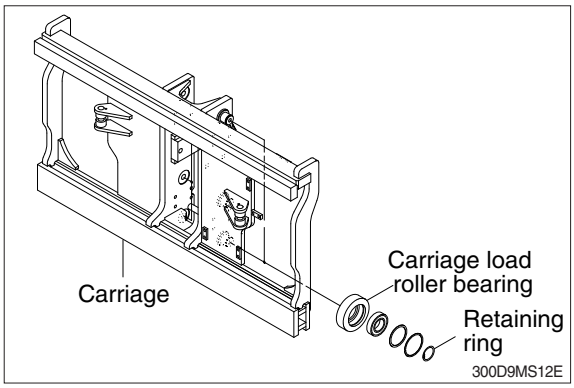


※ **Adjustment**

- 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 along 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 BEARING

(1) Remove carriage as outlined in the carriage removal paragraph.
(2) Using the plier, remove retaining rings from load roller bearing bracket.
(3) Using a plier, remove load roller bearings from load roller bearing bracket.
(4) Reverse the above procedure to assemble. Refer to MAST ROLLER ADJUSTMENT paragraph.



4. MAST LOAD ROLLER

1) 3 STAGE MAST (TF MAST)

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

(2) Loosen and remove hexagon nuts and screws securing lift cylinders to inner mast.

(3) Loosen and remove hexagon bolts and nuts securing lift cylinders to outer 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) with ropes to the outer mast.

(6) Using the overhead hoist, lower inner mast until top and bottom rollers are exposed.

(7) Using a plier, remove load rollers from load roller bracket. Remove side rollers.

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

(9) Reverse the above procedure to assemble.

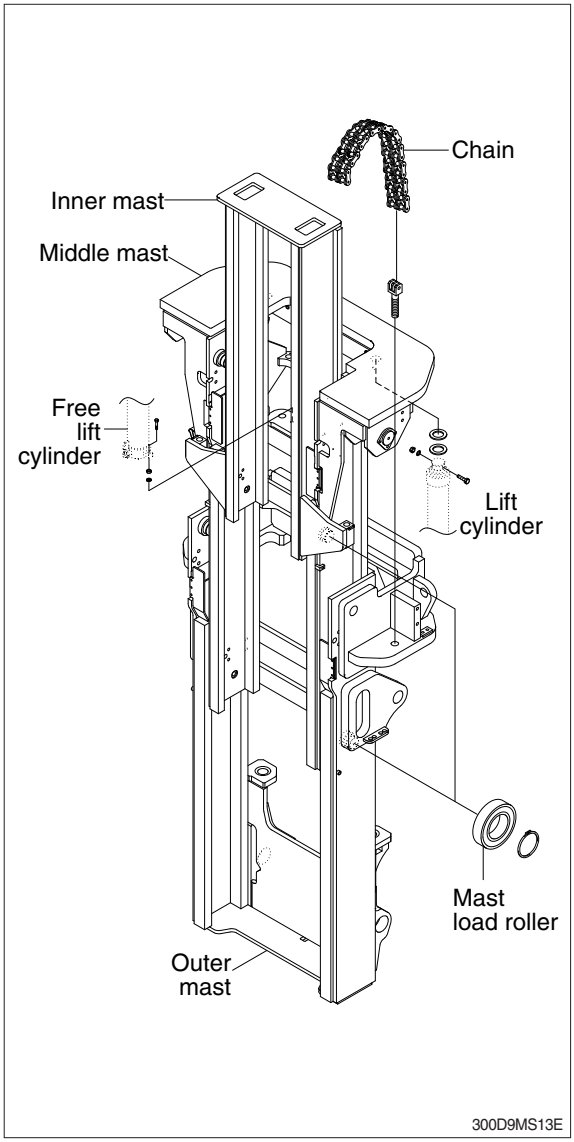
(10) Refer to MAST ROLLER ADJUSTMENT paragraph.

(11) After completing all necessary steps for load rollers removal, use an overhead hoist to remove sling or chain around upper crossmember of the inner mast section.

(12) Lift inner mast upright straight up and out of outer mast section.

Replace and reverse above procedure to install.

Make all necessary measurements and adjustments.



2) ELEVATING THE INNER AND MIDDLE MAST

(1) 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.

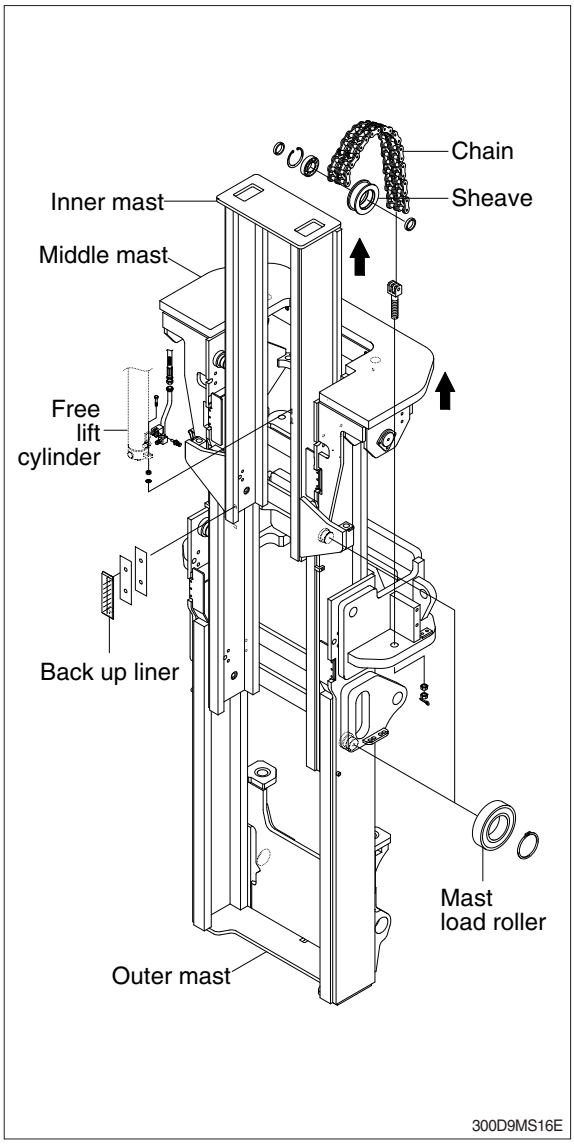
③ While supporting free lift cylinder assembly, remove bolts and washers securing cylinder to mast crossmember.

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.



5. CHAIN

1) CHAIN SHEAVE (TF 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.

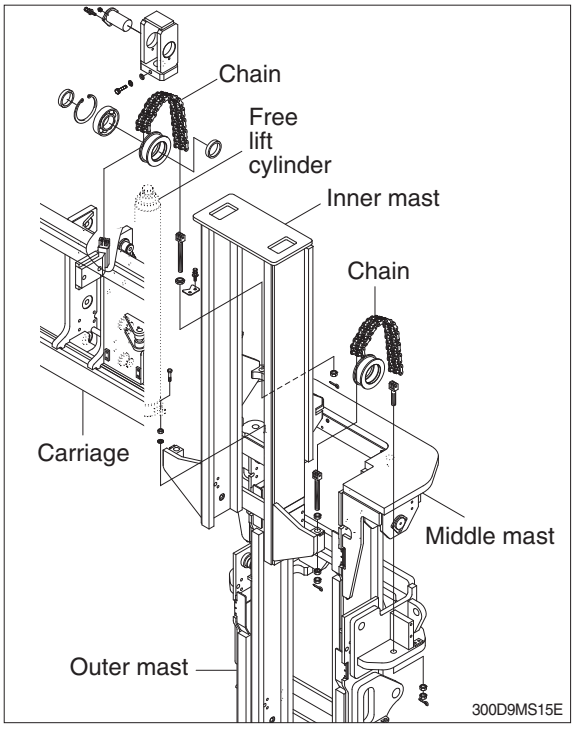
(2) Remove the split pin securing the chain anchor pins and discard. While supporting the chains, remove the chain anchor pins and drape the chain over the carriage.

(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. Use new split pins in chain anchor pins.



2) 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.

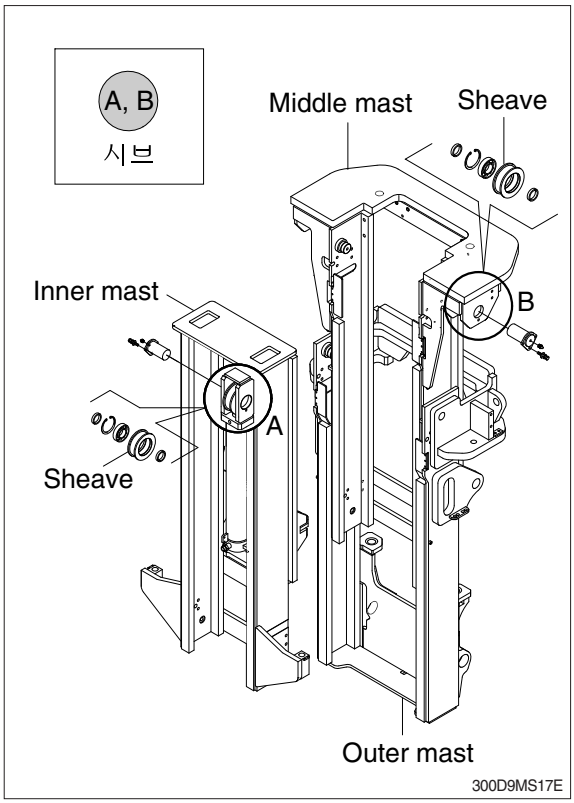
After a sling to the chain wheel bearing support assembly. Using an overhead hoist, lift support assembly straight up and off of free lift cylinder. Move assembly to work area.

(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.



3) 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 150 mm (6") from the floor.

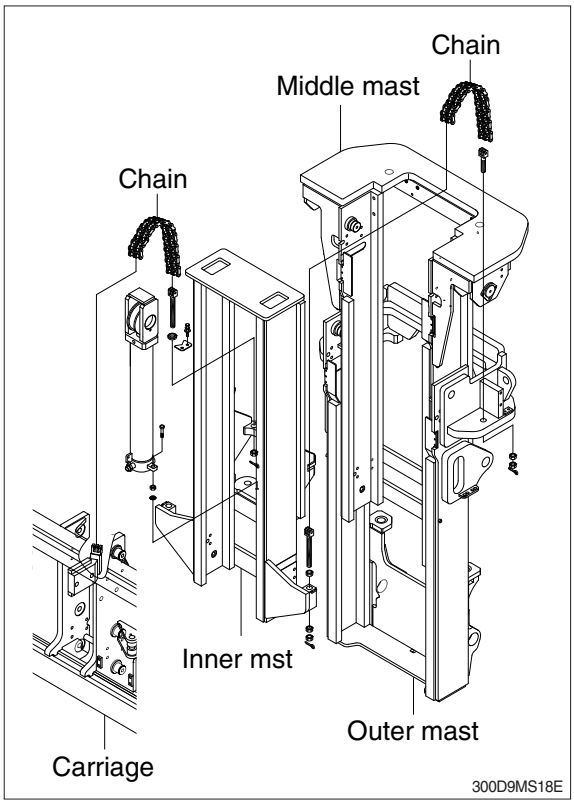
(3) Using a sling or chain around inner mast section attached to an overhead hoist, slowly raise inner mast until there is enough slack in the chains to remove them. Block inner mast section.

(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.



4) CARRIAGE CHAIN

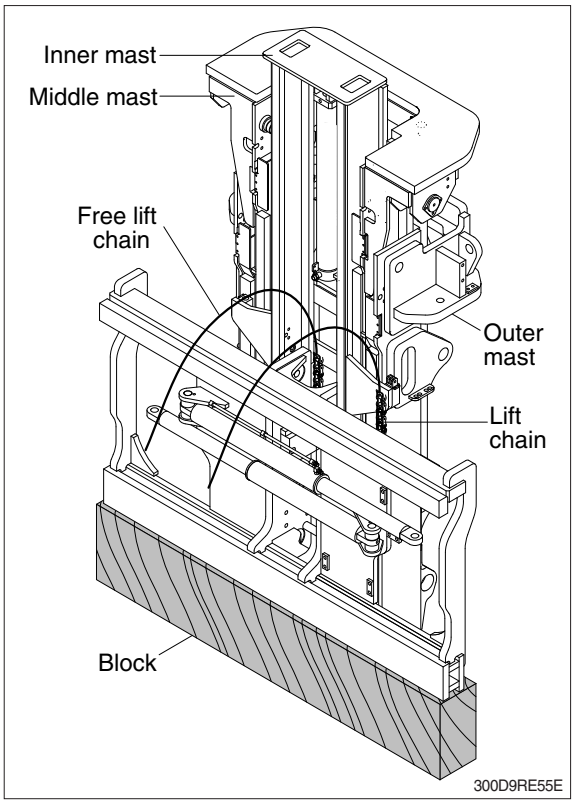
(1) Place a sling around carriage front plate and attach to an overhead hoist. Lift and secure carriage high enough so that split and chain anchor pins on carriage can be easily be removed. Remove chain anchor pins from carriage and drape chains out over carriage.

(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.



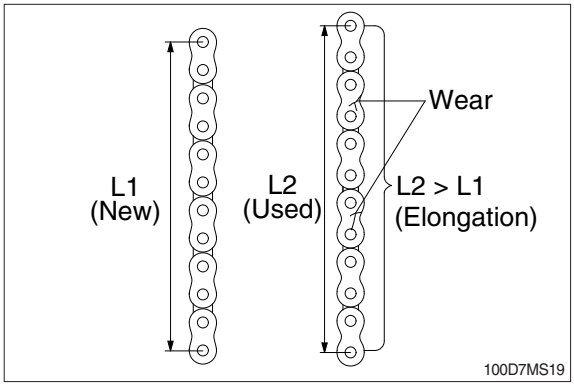
5) LOAD CHAIN INSPECTION AND MAINTENANCE

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 sheaves, the joints very gradually wear. The stretch a chain develops 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 3%, 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 out 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 phenomenon 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 sheaves

An inspection of the chain system includes a close examination of chain anchors and sheaves. 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. Sheaves 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 mm), 3/4 (19.05 mm), 1 (25.4 mm), 1-1/2 (38.1 mm), 2 (50.8 mm), use side A of scale.
- If pitch is 5/8 (15.875 mm), 1-1/4 (31.75 mm) or 2 (50.8 mm), 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.

6) 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 sheaves. 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.