



OPERATION & MAINTENANCE MANUAL

Electric Counterbalanced Forklift Trucks

PREFACE

To meet the market demands, electric counterbalanced forklift trucks are newly developed based on our advanced technologies, integrating the advantages of domestic and overseas electric counterbalanced forklift trucks. They are applicable to goods loading/unloading, handling and stacking at stations, ports, goods yards and warehouses involving food, textile and mining industries. If equipped with various attachments, the forklift truck can be applied in a wider range.

Owing to the advanced parts including wide-view lifting system, full hydraulic steering mechanism, automatic booster brake and open type overhead guard and the high-quality motor, battery, imported electric controllers and multi-functional combination instrument, this forklift truck is characterized by excellent performance, convenient operation, wide view, flexible steering, reliable braking, good power performance, low noise, no pollution and beautiful appearance.

This Manual describes the technical parameters, structures of main parts, operating principle and information on operation, service and maintenance of our electric counterbalanced forklift trucks. It is recommended that the operator and equipment management personnel carefully read this Manual before operation.

Strictly observe the provisions and precautions in this manual to ensure long-term optimal working conditions and maximum efficiency of your forklift truck.

The content herein is subject to change without notice in accordance with the improvement of parts and equipment.

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I. Driving, Operation and Routine Maintenance

The driver and management shall perform safe and standard operation in accordance with the **Operation & Service Manual** and **Operator's Manual**. Safety must be foremost in their minds at all times.

1. Transportation

Observe the following precautions for forklift truck transportation by containers or vehicles:

- (1) Apply the parking brake;
- (2) Fix the front and rear parts of the mast and counterweight with steel wires. Wedge the front and rear wheels firmly with wedge blocks;
- (3) Lift the forklift truck from the point stated on the "Lifting Label".
- (4) The fork and battery are removable parts. Refer to the "Main Parameters" for the weights and dimensions.

2. Storage

- (1) Lower the mast to the lowest position;
- (2) Apply the electric lock, set all control levers at neutral position and pull out the power plug;
- (3) Apply the hand brake;
- (4) Wedge the front and rear wheels with wedge blocks;
- (5) Leave the wheels off the ground if the forklift truck will be not used for a long time;
- (6) Apply additional charge to the battery once every month.

3. Preparations before use

- (1) Check whether the instruments operate normally;
- (2) Check the tyre pressure;
- (3) Check whether all handles and pedals operate and reset freely and normally;
- (4) Check whether the battery voltage is within the working range and whether the specific gravity and level of the electrolyte are proper;
- (5) Check the connectors and plugs of the electrical system for good contact;
- (6) Check for leakage of hydraulic oil and brake fluid; check their quantities;
- (7) Check the main fasteners for tightness;
- (8) Check whether the lighting lamps and signal lamps function normally;
- (9) Release the parking brake;
- (10) Test the mast movements including lifting, falling, forward/backward tilting, steering and braking;
- (11) Ensure the pollution degree of hydraulic oil is not higher than class 12.

4. Operation

- (1) Only the trained and certified driver can drive the forklift truck;
- (2) The operator shall wear safety shoes, helmet, clothes and gloves during operation;
- (3) Pay attention to the performance and operating conditions of the mechanical, hydraulic and electrical systems when operating the forklift truck;
- (4) Switch on the power supply, turn on the key switch, move the direction control lever to the desired

position, and rotate the steering wheel to check whether the rear wheels rotate normally; slowly depress the accelerator pedal and keep a proper starting acceleration;

- (5) Observe the voltmeter reading; when the forklift truck is working, if the voltmeter reading is less than 41 V (for the forklift truck with a rated voltage of 80 V, if the voltmeter reading is less than 68 V), immediately stop the forklift truck and charge or replace the battery;
- (6) Never overload the forklift truck. Ensure proper fork spacing and fork position. Set the forks under the goods fully and make the goods on the forks evenly. Unbalanced loading is forbidden;
- (7) Decelerate during steering on wet or slippery road;
- (8) Be careful to drive slowly on wharf or temporary planking;
- (9) No person shall stand under the fork. It's forbidden to lift the fork with a person on it;
- (10) Never lift or lower goods with a high initial speed;
- (11) Never operate the forklift truck or attachments from the positions other than the driver's seat;
- (12) When the mast tilts to the foremost or backmost position or the fork lifts to the highest position, quickly return the handle to the neutral position;
- (13) When the forklift truck travels with load, try to lower the load and tilt the mast backwards. When the mast is lifting, traveling or turn is forbidden;
- (14) During driving, pay attention to the pedestrians, obstacles and hollows on the road and the clearance above the forklift truck;
- (15) Take care when driving up/down a slope. For the slope with a gradient over 1/10, drive forwards to climb up the slope and reverse to climb it down. Steering and handling are forbidden when driving up/down a slope;
- (16) For the high-lift forklift truck with a lift height over 3m, goods falling shall be avoided. Take protective measures when necessary;
- (17) Do not transport unfixed or loose goods. Take care to transport large-size goods;
- (18) When the forklift truck travels with load, emergency brake is forbidden;
- (19) Before leaving the forklift truck, lower the forks on ground, set the gear lever at neutral position, and cut off the power supply. To park the forklift truck on a slope, apply the parking brake, and for long-time stop, wedge the wheels;
- (20) The pressures of safety valves of the multi-way valve and steering gear have been adjusted well before delivery. Do not adjust them at will. If the pressure adjusted is too high, the whole hydraulic system, the hydraulic elements and the motor will be damaged;
- (21) Inflate the tyres in accordance with the "Tyre Pressure" label;
- (22) Operate the forklift truck with attachments but no load as a loaded forklift truck.

5. Charge of battery

- (1) Strictly comply with the battery instructions for the initial charge and additional charge of the battery;
- (2) When the forklift truck is working, if the battery voltage drops to 41 V (for the forklift truck with a rated voltage of 80 V, if the battery voltage drops to 68 V) or the voltage of any cell drops to be less than 1.7 V or the relevant instrument gives an alarm, immediately stop the forklift truck and charge or replace the battery;
- (3) When the battery is charged, frequently check the specific gravity, level and temperature of the electrolyte;

- (4) Charge the battery as soon as possible after the forklift truck is used. The standing time shall not exceed 24 h. Avoid overcharge or undercharge to protect the battery against damage.

Refer to the battery instructions for the charge method and battery operation & maintenance.

6. Service conditions

(1) Ground conditions

The forklift truck shall be used on the flat and solid road surface or ground with good ventilation.

The performance of the forklift truck depends on the ground conditions. The traveling speed shall be adjusted properly. Take special care when operating the forklift truck on a slope or rough road surface.

! Warning

- * **Make sure that the forklift truck running on a muddy road can be stopped in time.**
- * **Bypass rocks and stumps. If impossible, reduce the traveling speed. Take care not to damage the chassis.**

When driving on a road covered with snow or ice, use tyre chains. Never perform sudden acceleration or turn. Control the traveling speed through the accelerator pedal effort.

! Warning

- * **If equipped with tyre chains, the forklift truck gets a larger driving force; however, the anti-sideslipping performance deteriorates. It is necessary to take special care.**

(1) Countermeasures against coldness and hotness

(a) Oil

Use the oil suitable for the ambient temperature.

(b)

- * In cold seasons

The solidifying point of electrolyte under normal charging condition is -35°C.

Always charge the battery under good conditions. The solidified electrolyte will damage the battery case. To avoid solidification, charge the battery to 75% of its capacity at least.

The best method is to keep a specific gravity of 1.260. However, do not exceed this value.

- * In hot seasons

As the water in electrolyte is easy to volatilize, replenish distilled water frequently. Check the electrolyte once every week. Replenish distilled water if insufficient.

In case of high ambient temperature, lower the specific gravity to 1.220±0.01.

As the efficiency of battery is high in hot days, no other maintenance is needed.

! Danger

- * **The gas produced by the battery will explode. Never smoke or use an open flame. Never generate any electric arc or spark around the battery. In case of battery storage or charging in a closed space, ensure good ventilation. The sulfuric acid in the battery will cause burn. Keep it away from your eyes, skin and clothes. In case of contact with sulfuric acid, use clean water for washing immediately. If the sulfuric acid splashes into eyes, go to hospital.**

In hot weather, to obtain good cooling effect, park the forklift truck in a cool place.

7. Safety notes for maintenance

(1) Maintenance place

! Caution

- * Be an appointed place with provision of enough equipment and safety features;
- * With flat ground;
- * With good ventilation;
- * With fire extinguishing apparatus

(2) Notes before maintenance

! Caution

- * No smoking;
- * Wear personal protective equipment (helmet, protective shoes, glasses, gloves and boots) and suitable clothes;
- * Clear away the outflowing oil in time;
- * Clean the dirty oil or dust from the connectors with a brush and a piece of cloth before lubricating them;
- * Turn off the key switch and remove the battery connector except in exceptional circumstances;
- * Lower the forks onto ground before maintaining the forklift truck;
- * Clean the electrical elements with compressed air.

(3) Notes for maintenance

! Caution

- * Never put your feet under the fork. Take care and protect yourself from being stumped by the fork;
- * When the fork is lifted, set cushion blocks or object objects under the inner mast to prevent the sudden falling of the fork and mast. Carefully open or close the front back plate and battery case cover plate and protect your fingers against injury;
- * When the working cannot be finished at a time, make a mark for convenience;
- * Use suitable tools. Never use any makeshift;
- * In case of electric shock, see a doctor immediately;
- * Never use the mast as a ladder;
- * Never put your hands, feet or body between the frame and mast assembly.

(4) Type check and replacement

! Caution

- * The tyre removal and installation shall be performed by the service agency appointed by our company;
- * The compressed air shall be handled by specialized personnel;
- * Wear goggles when using compressed air;
- * When removing a tyre, never loosen the bolt and nut at the connection of rim. The tyre is filled with high-pressure air, the looseness of bolt, nut or rim will result in very dangerous situations.

(5) Use of jack (for tyre replacement)

! Warning

When jacking up the forklift truck with the jack, never go under the forklift truck.

! Caution

- * Before jacking up the forklift truck with the jack, ensure no person or load on the forklift truck;
- * When the forklift truck is lifted off the ground, stop using the jack and set cushion blocks under the forklift truck to avoid falling;
- * Before jacking up the forklift truck with the jack, take measures to prevent sliding of the forklift truck.

(6) Lifting of forklift truck

! Caution

- * The lifting operation shall be carried out by specially trained personnel;
- * The rope shall be fit to the designated lifting position on the forklift truck;
- * All ropes shall have sufficient bearing capacity.

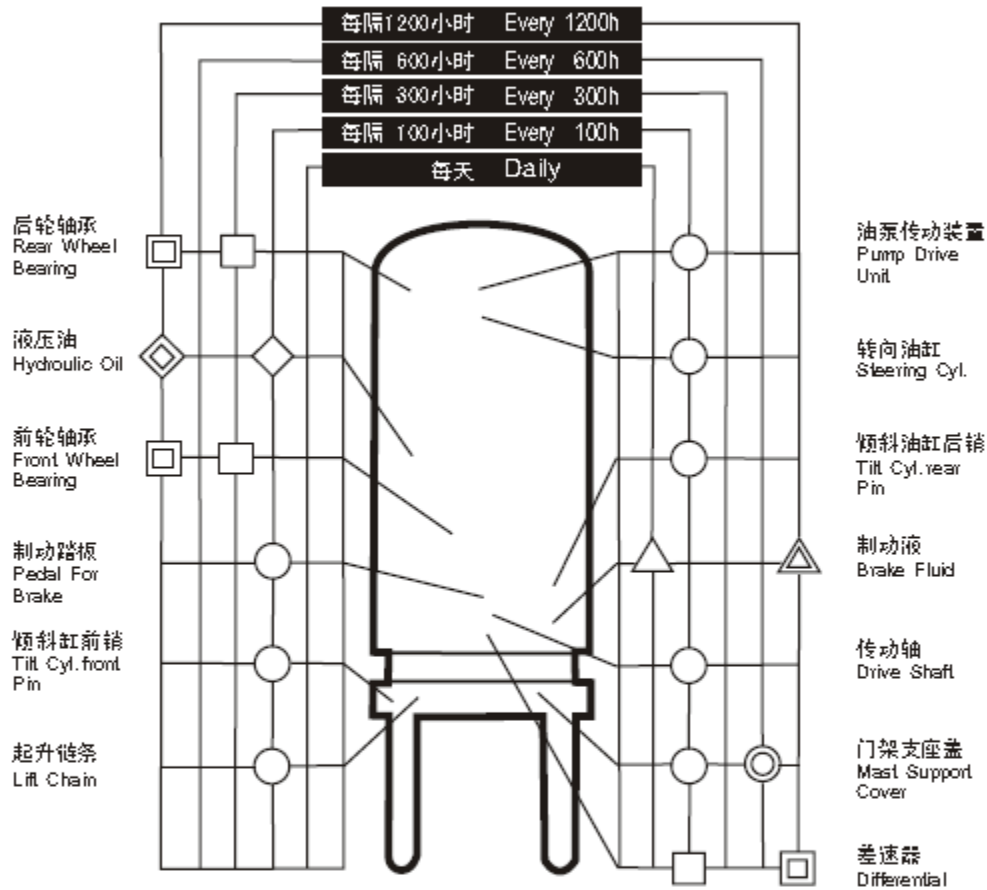
(7) Waste (electrolyte, oil, etc.) discharge requirements

! Caution

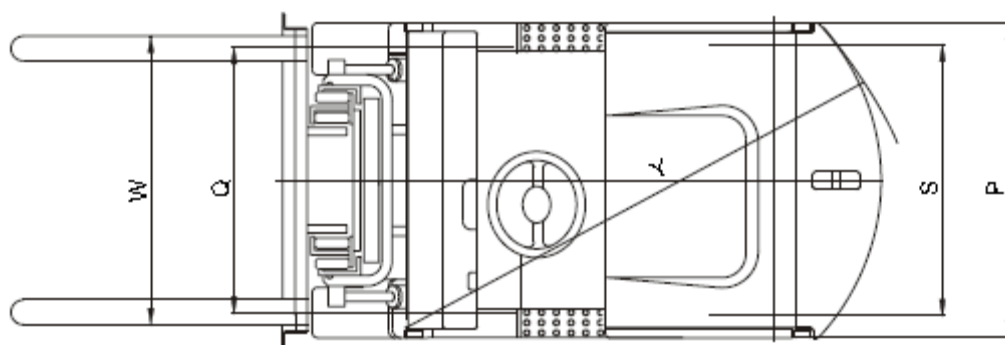
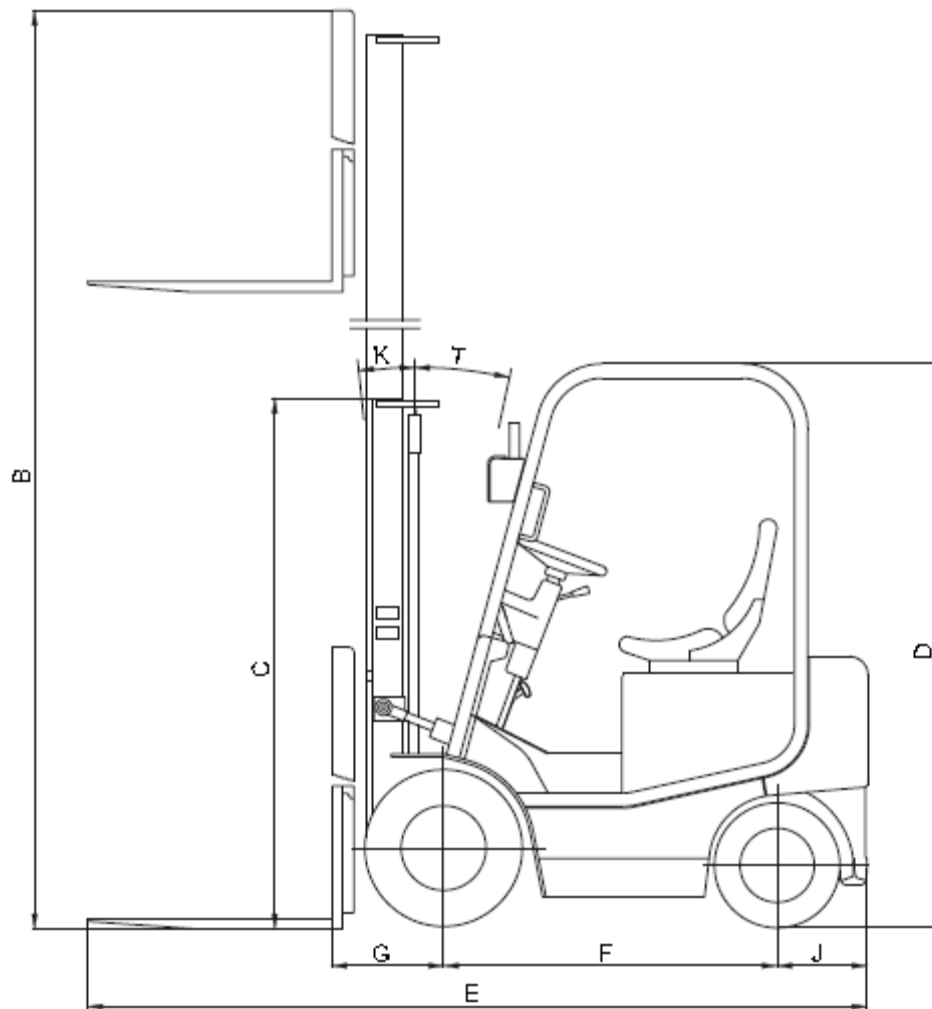
The waste liquid from the forklift truck shall be recycled in accordance with the government's provisions. Never discharge them randomly.

7. Lubrication system diagram

润滑系统提示 LUBRICATION SYSTEM DIAGRAM



II. Main Technical Parameters



Outside View

Main Technical Parameters

Model		Unit	Electric counterbalanced forklift truck					
			CPD10-SA	CPD15-SA	CPD20-SA	CPD25-SA	CPD30-SA	CPD35-SA
Rated load		kg	1000	1500	2000	2500	3000	3500
Load center		mm	500	500	500	500	500	500
Lift height		mm	3000	3000	3000	3000	3000	3000
Fork	Dimension	mm	920×100×35		920×122×40	1070×122×40	1070×125×45	1070×130×50
	Weight	kg	37		41	46		
Mast tilt (forward/back) (F/R)		°	6/12	6/12	6/12	6/12	6/12	6/12
Min. turning radius		mm	1800	1800	2050	2050	2250	2250
Min. ground clearance		mm	100	100	110	110	110	110
Overhead guard height		mm	2130	2130	2130	2130	2140	2140
Front suspension		mm	422	422	485	485	485	485
Max. traveling speed (full load)		km/h	13	13	13	13	15	15
Max. lifting speed (full load)		mm/s	300	270	240	225	280	280
Max. gradeability		%	13	13	10	10	15	15
Overall length (without fork)		mm	2020	2020	2365	2365	2365	2365
Overall width		mm	1070	1070	1150	1150	1270	1270
Overall height with fully lifted fork		mm	4030	4030	4030	4030	4030	4030
Mast height		mm	1995	1995	1995	1995	1995	1995
Front wheel			6.50-10-10-PR		7.00-12-12-PR		28×9-15-12PR	
Rear wheel			5.00-8-8PR		18×7-8-14PR		18×7-8-14PR	
Wheelbase		mm	1250	1250	1450	1450	1680	1680
Wheel track (front/rear)		mm	890/920	890/920	960/950	960/950	1000/950	1000/950
Dead weight		kg	2800	2990	3800	4100	4650	4870
Battery	State of origin		Germany	Germany	Germany	Germany	Germany	Germany
	Voltage	V	48	48	48	48	80	80
	Capacity	Ah	440	440	640	640	500	500
	Overall dimension	mm	975×600×464		1020×800×500		1025×852×987	
	Weight	kg	770		1166			
Motor	Traveling	kW	5	5	6.3	6.3	2×10.0	2×10.0
	Lifting	kW	8.2	8.2	8.6	8.6	24	24
Controller			SEVCON/ZAPI				SME	

III. Structure, Principle, Adjustment and Maintenance (for 1-2.5 t forklift trucks)

1. Transmission system

1.1 General

The transmission system consists of reduction gearbox assembly, differential assembly and driving axle. The driving gear of reduction gearbox is directly connected with the traveling motor. The traveling speed of forklift truck is changed with the motor speed. The traveling direction is changed by changing the rotation direction of the motor.

1.1.1 Reduction gearbox and differential

The reduction gearbox is located between the driving axle and traveling motor. This mechanism has two pairs of gears which reduce the rotation speed from the traveling motor output shaft and increase the torque transmitted from the output shaft and then transmit this torque to the differential. See Fig. 1-1 and Fig. 1-2.

The differential is installed on the half shaft housing at the front axle through the bearing seats at both ends, with the front end connected to the axle housing. The differential housing is of split type. Two half axle gears and four planetary gears are installed in the housing. See Fig. 1-3.

1.1.2 Driving axle

The driving axle consists of axle housing, hub and wheel. It is installed at the front of the frame.

The axle housing is an integral cast structure. The tyre is fixed on the hub with bolts and nuts through the rim. The hub is supported on the axle housing with taper roller bearings. The power is transmitted to the half axle through the differential. The hub is driven by the half axle and then drives the front wheels to rotate. The half axle only bears the torque transmitted to the hub. An oil seal is installed in the hub to prevent the ingress of water and dust and oil leakage. See Fig. 1-4.

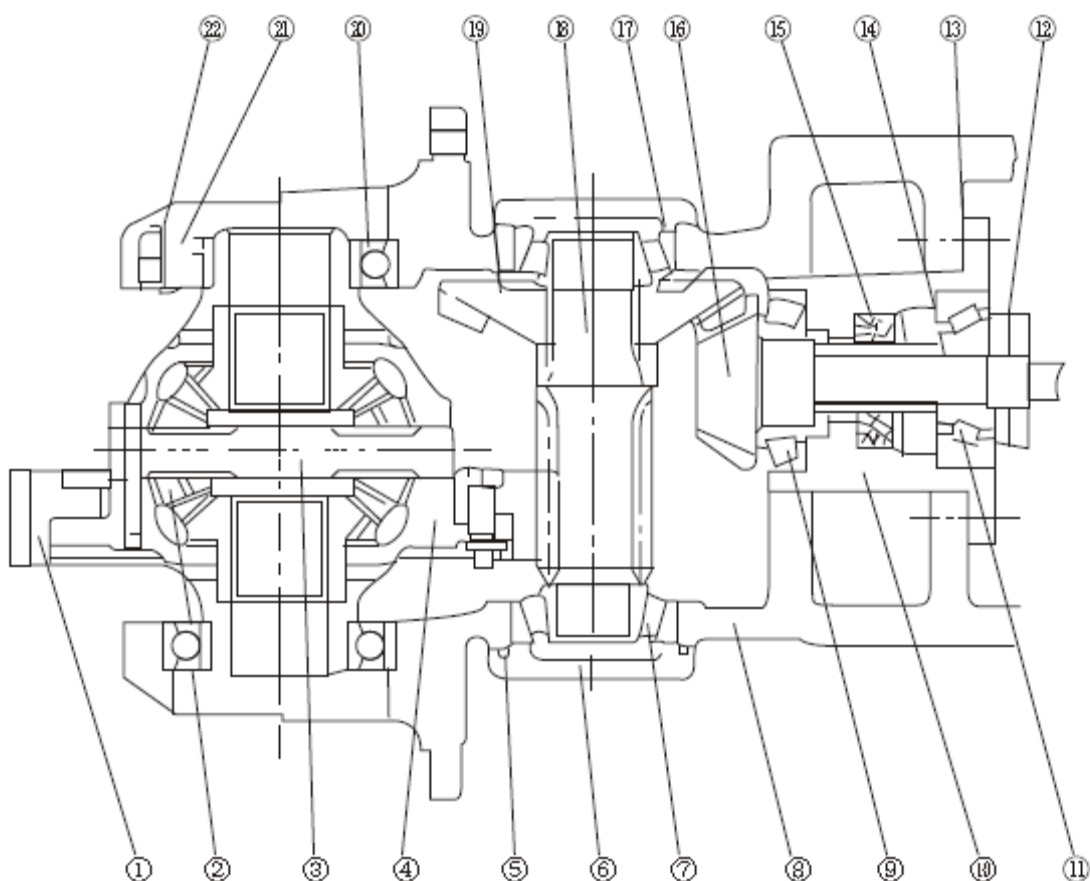
See Table 1-1 for the models of front tyre and rim and the tyre pressure.

Table 1-1

Tonnage	1-1.5t	2-2.5t	3-3.5t
Tyre	6.50-10-10PR	7.00-12-12PR	28×9-15-12PR
Rim	5.00F-10	5.00S-12	7.00T-15
Tyre pressure	0.7MPa	0.7MPa	0.7MPa

Dimensions and Weights of Main Removable Parts

Parameter \ Model		Unit	CPD10-SA/ CPD15-SA	CPD20-SA / CPD25-SA	CPD30-SA / CPD35-SA
Counterweight	Max. overall dimension	mm	1080×910×405	1160×942×491	1160×942×633
	Weight	kg	440/640	780/960	1315/1415
Overhead guard	Max. overall dimension	mm	1680×1366×1070	1680×1144×1650	1680×1144×1650
	Weight	kg	63	75.8	75.8



- | | | | |
|-------------------------|--------------------|------------------------------|-----------------------|
| 1. Gear ring | 7. Bearing | 13. Adjusting gasket | 18. Gear shaft |
| 2. Planetary gear | 8. Reducer housing | 14. Adjusting gasket | 19. Spiral bevel gear |
| 3. Gear shaft | 9. Bearing | 15. Oil seal | 20. Bearing |
| 4. Differential housing | 10. Bearing seat | 16. Driving bevel gear shaft | 21. Bearing seat |
| 5. O-ring | 11. Bearing | 17. Adjusting gasket | 22. Lock washer |
| 6. Cover | 12. Nut | | |

Fig. 1-1 Reducer and Differential (1-1.5t)

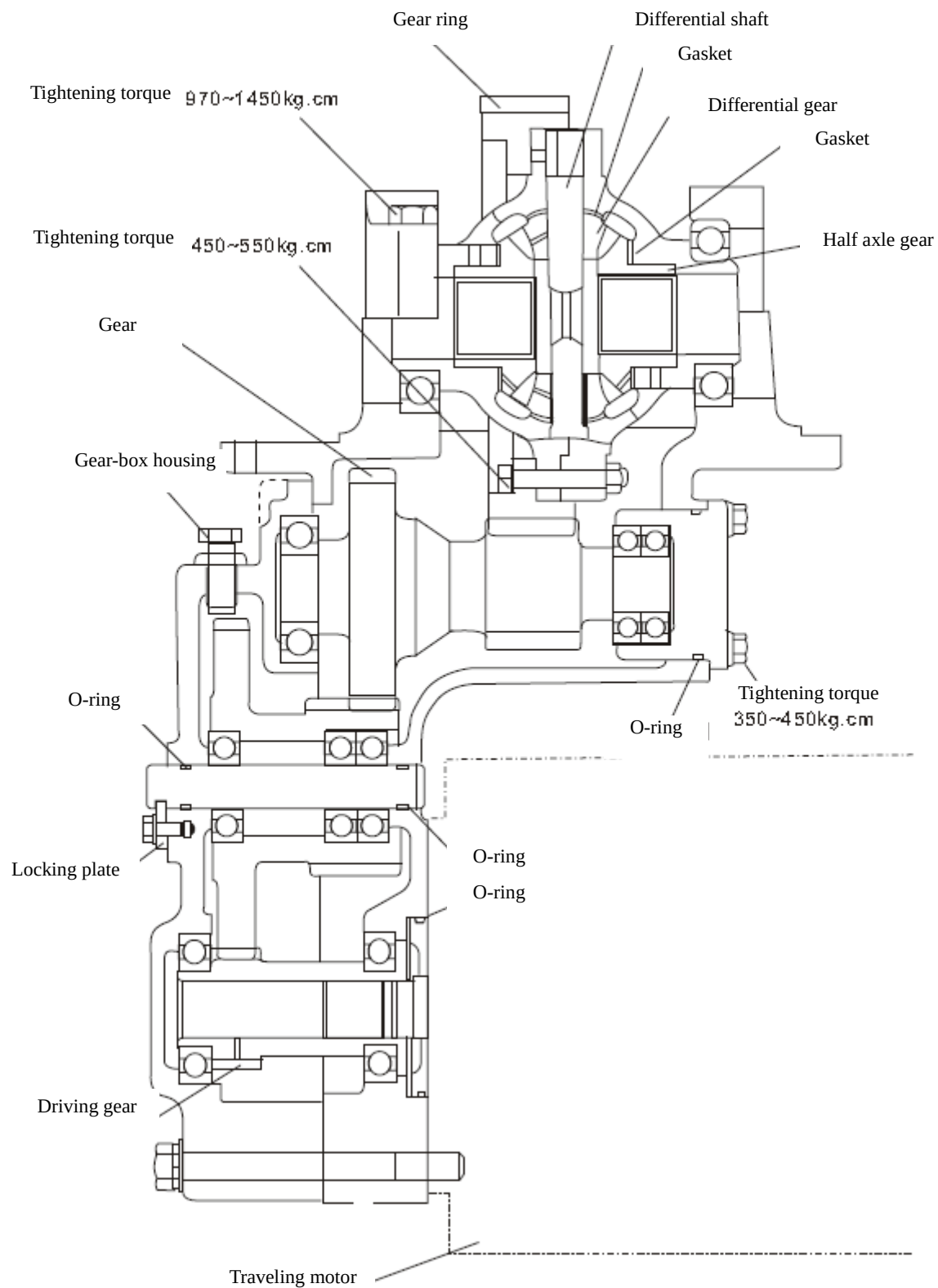


Fig. 1-2 Reducer and Differential (2-2.5t)

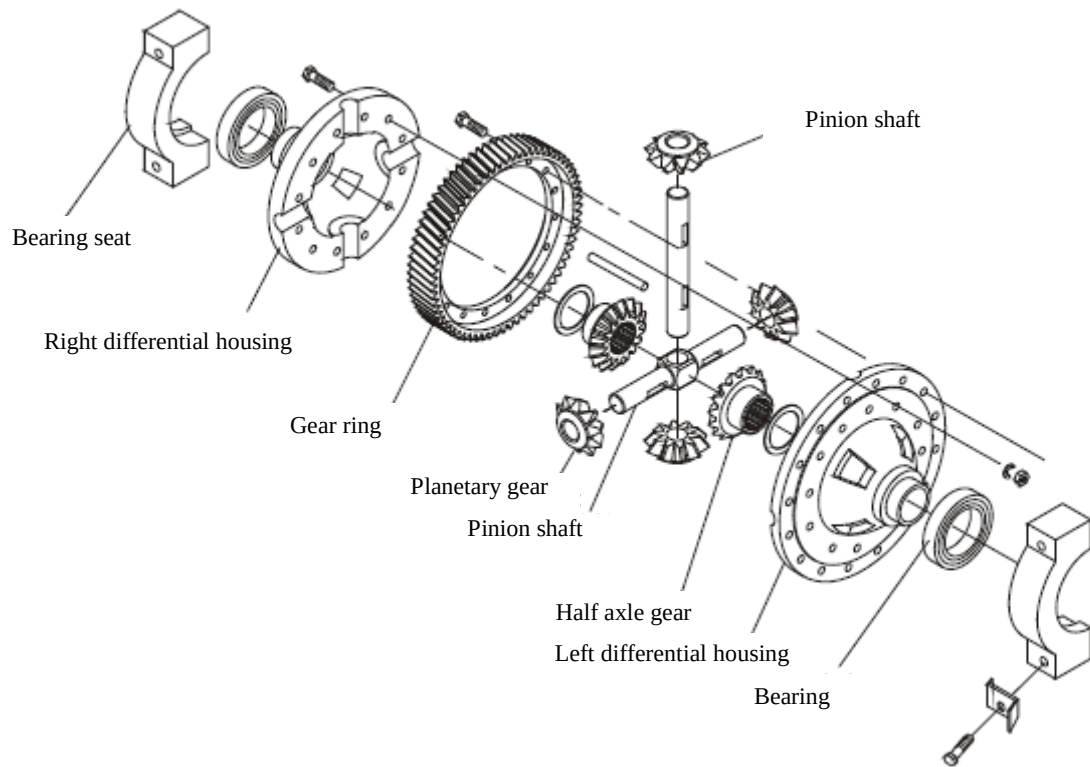


Fig. 1-3 Differential (1-2.5t)

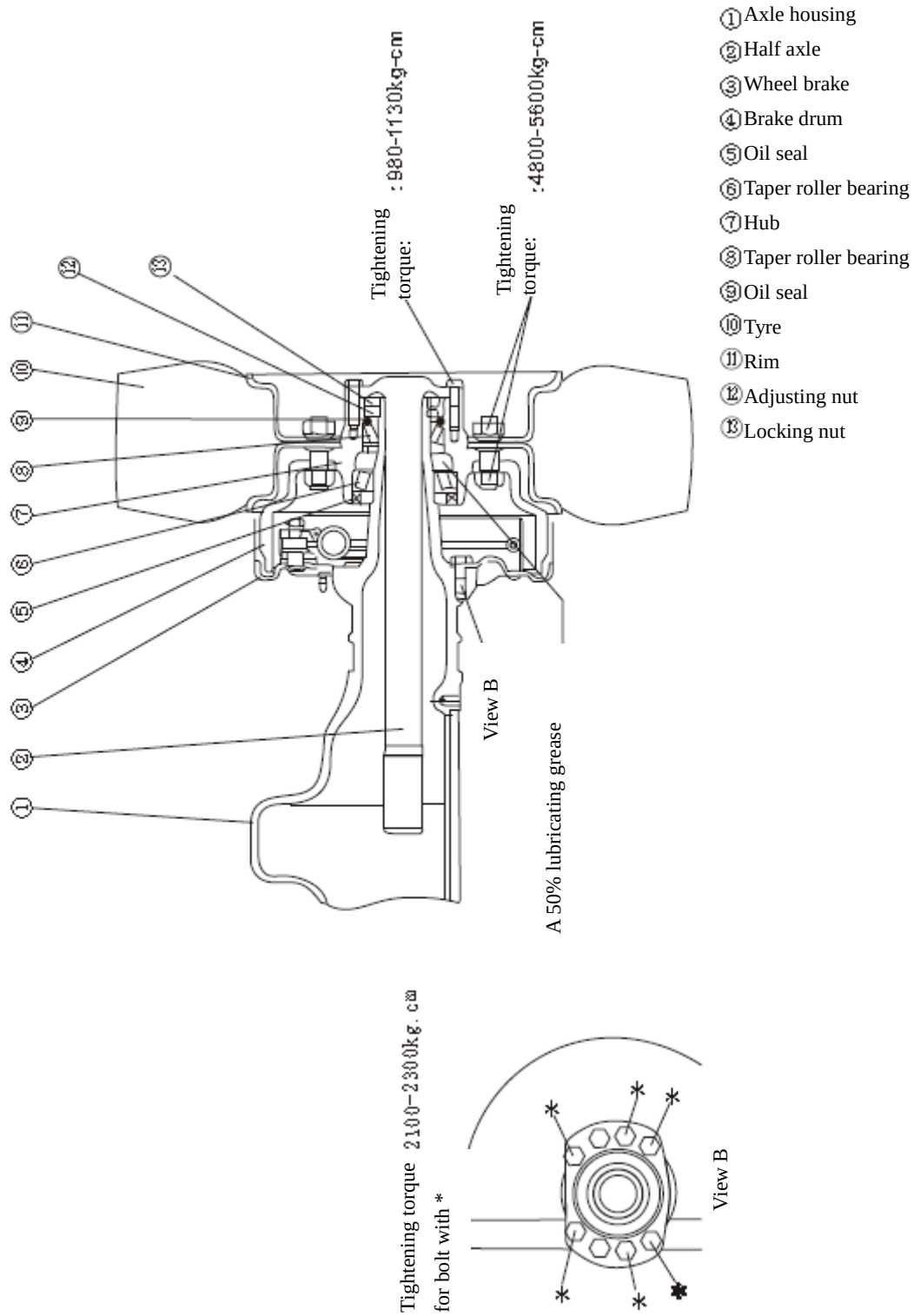


Fig. 1-4 Driving Axle (1-2.5t)

1.1.3 Hub installation

- (1) Add 100cc lubricating grease into the hub. Then, install the hub onto the shaft.
- (2) Tighten the adjusting nut to the torque 1kg.m. Then rotate it back for 1/2 circle.
- (3) Hang a spring balance on the bolt to measure the starting torque of the hub. Lock the nut slowly to the specified value.

Starting torque: 5-15kg.m

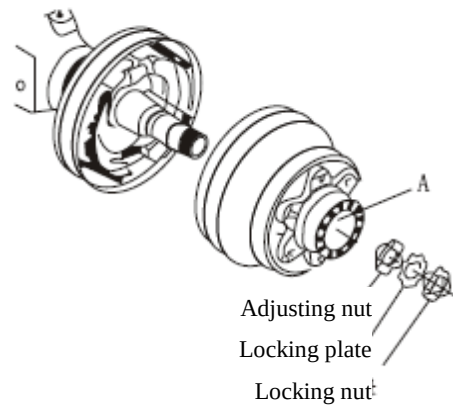


Fig. 1-5 Adding Lubricating Grease

- (4) Install the locking plate and locking nut. Pull up the locking plate to lock the locking nut.

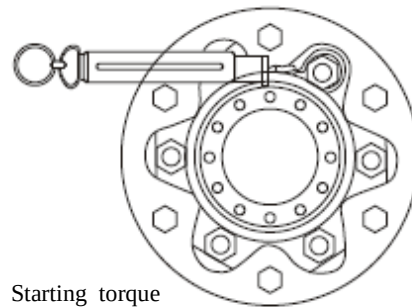


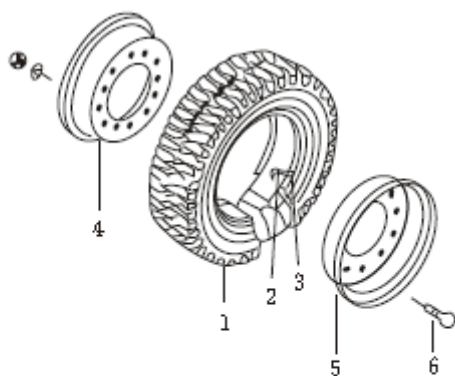
Fig. 1-6 Measuring Starting Torque

- (5) Assemble the tyre.

Install the valve stem and nut cap onto the tyre. Assemble the rim. Pay attention to the following points:

Note:

- (a) The valve stem shall be located at the rim notch outwards.
- (b) The rim bolt head shall be towards the same direction with the valve stem.
- (c) Tighten the rim bolts in the order shown in Fig. 1-8.



1. Tyre 2. Valve stem 3. Nut cap
4. Inner wheel 5. Outer wheel 6. Rim bolt

Fig. 1-7 Wheel Assembly

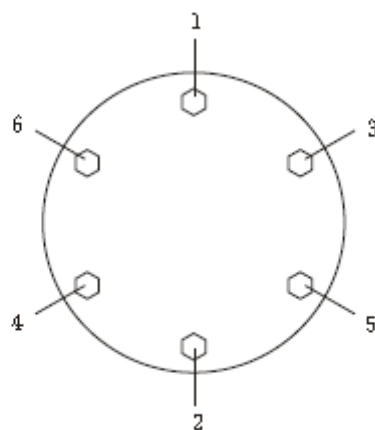


Fig. 1-8

2. Braking system

2.1 General

The braking system consists of internal expanding oil brakes acting on the two front wheels. It is composed of brake pedal, brake master cylinder and wheel brakes.

2.1.1 Brake pedal

See the brake pedal structure in Fig. 2-1. It is installed on the gear-box (for 1-2.5t) or frame (for 3-3.5t) through a support.

The pedal effort is transformed into brake oil pressure through the push rod of brake master cylinder.

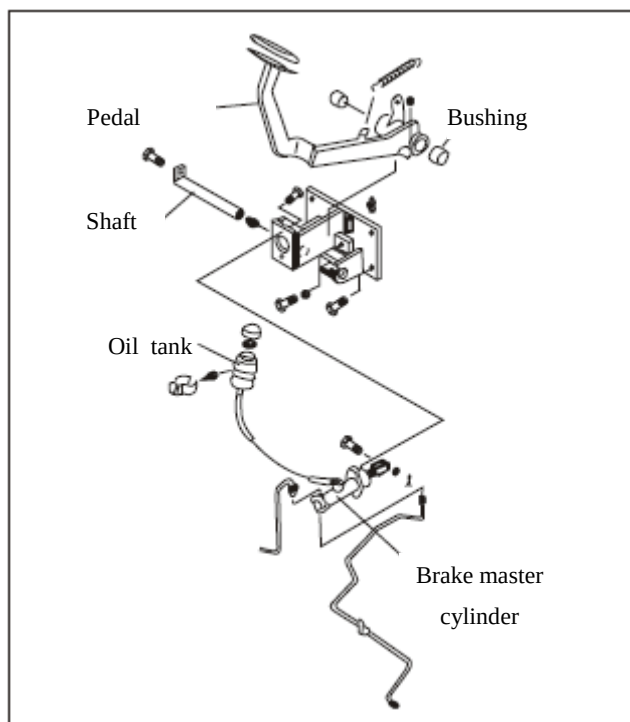


Fig. 2-1 Brake Pedal

2.1.2 Brake master cylinder

The master cylinder includes one valve seat, one one-way valve, one return spring, cup, piston and auxiliary cup. The end is fixed with a stop washer and retaining wires. The exterior is protected by a rubber dust cover. The master cylinder piston operates through the push rod by controlling the brake pedal. When the brake pedal is depressed, the push rod pushes the piston forwards. The brake fluid in the cylinder returns to the oil tank via the oil return port until the main cup blocks the oil return port. After the main cup passes through the oil return port, the brake fluid in the front chamber of master cylinder is compressed and opens the one-way valve. Thus, the brake fluid flows to the wheel cylinder through the brake pipeline. In this way, each wheel cylinder piston extends outwards. This makes the brake shoe lining touch the brake drum. Afterwards, deceleration or braking is achieved. At this time, the rear chamber of piston is filled with the brake fluid from the oil return port and oil inlet. When the brake pedal is released, the piston is pressed backwards by the return spring and the brake fluid in each brake wheel cylinder is pressed by the brake shoe return spring. Then, the brake fluid returns to the master cylinder (front chamber of piston) via the one-way valve and the piston returns to its original position. The brake fluid in the master cylinder returns to the oil tank through the oil return port. The pressure of the one-way valve is adjusted to be in proportion to the rest pressure in the brake pipeline and brake wheel cylinder. This ensures correct position of wheel cylinder cup, so as to prevent oil leakage and vapor lock that may occur during emergency braking.

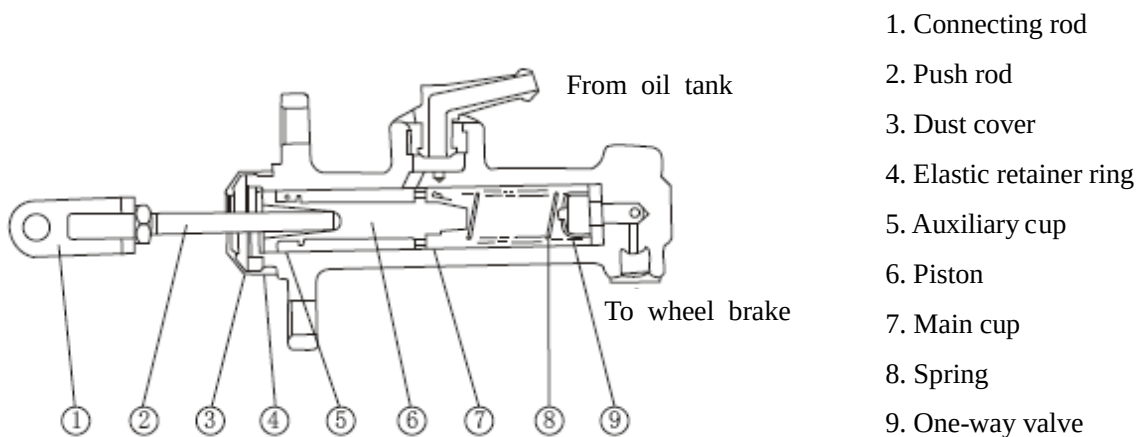


Fig. 2-2 Brake Master Cylinder

2.1.3 Brake

The brake has two shoes. Two brakes are installed at both sides of the driving axle respectively.

The brake consists of two groups of brake shoes, wheel cylinders and adjusters.

One end of the brake shoe is connected with the retainer pin. The other end is connected with the adjuster and presses the parking brake by the return spring and pressure spring pull rod.

The brake is also provided with parking brake mechanism and automatic adjuster. See Fig. 2-8, Fig. 2-9 and Fig. 2-10.

(1) Brake action

The brake wheel cylinder applies a force to the main brake shoe and a same force to the auxiliary brake shoe to press the brake drum until the upper end of the auxiliary brake shoe comes into contact with the retainer pin. Then, the brake shoe moves towards the direction in which the brake drum rotates.

When the retainer pin is supported by the auxiliary brake shoe, the friction force between the friction plate and brake drum increases. As the main brake shoe applies a force to the auxiliary brake shoe which is much larger than the pressure of wheel cylinder, a large braking force can be obtained. See Fig. 2-3.

For the brake action during reversing, the direction is opposite to that during forward traveling. See Fig. 2-4.

(2) Parking brake

The parking brake is installed in the wheel

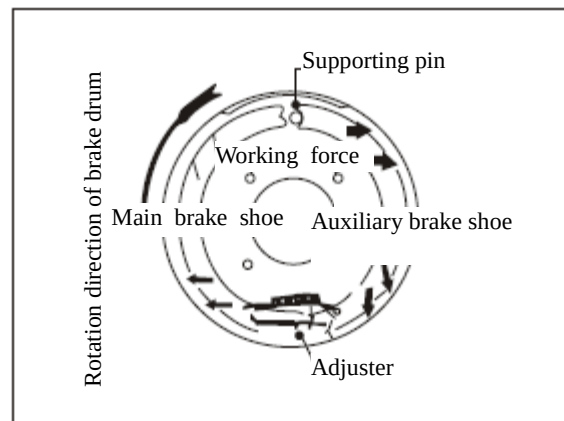


Fig. 2-3 Action During Forward Traveling

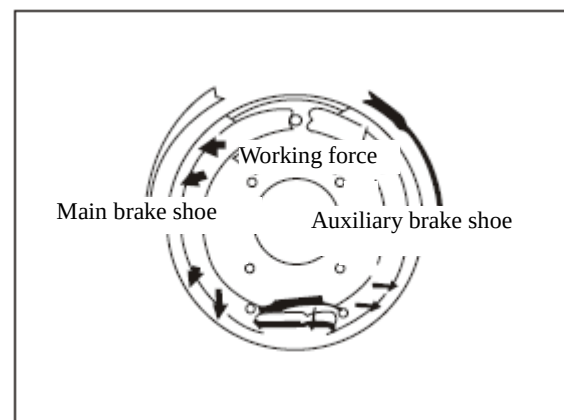


Fig. 2-4 Action During Reversing

brake. It consists of pull rod and push rod.

The pull rod is installed at the main brake shoe side with pins. The action of the pull rod is transmitted to the auxiliary brake shoe side through the push rod. See Fig. 2-5.

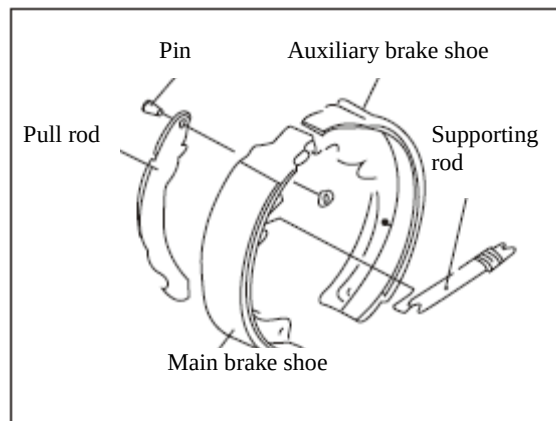


Fig. 2-5 Parking Brake

(3) Automatic clearance adjusting mechanism

The automatic clearance adjusting mechanism can keep a proper clearance between the friction plate and brake drum. See the structure in Fig. 2-6.

It acts only during reversing.

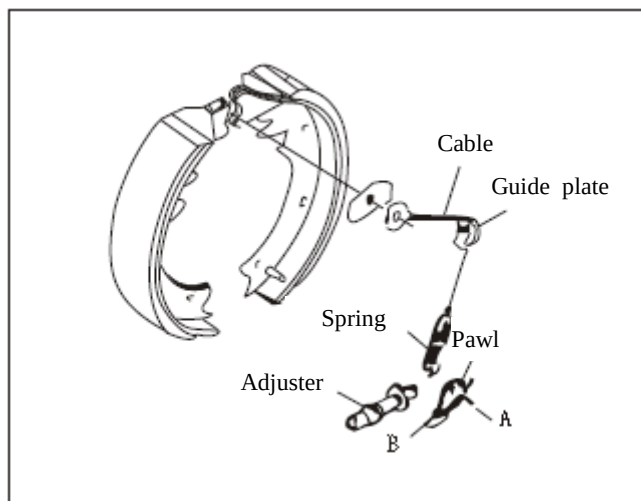


Fig. 2-6

▲ Automatic clearance adjusting mechanism

The automatic clearance adjusting mechanism can act only during reversing. The auxiliary and main brake shoes contact and rotate together. Consequently, the pull rod rotates rightwards around point A. See Fig. 2-6. Accordingly, point B is raised. After brake release, the pull rod rotates leftwards under the action of spring force and point B is lowered. When the clearance between the friction plate and brake drum increases, the vertical distance for pawl rotation at point B increases as well. When the adjuster gear is moved by one tooth, the adjuster rod will elongate (see Fig. 2-7) and the clearance will become small accordingly. The clearance ranges are given in the table below.

Model	1-1.5t	2-2.5t
Clearance	0.35-0.55	0.40-0.45

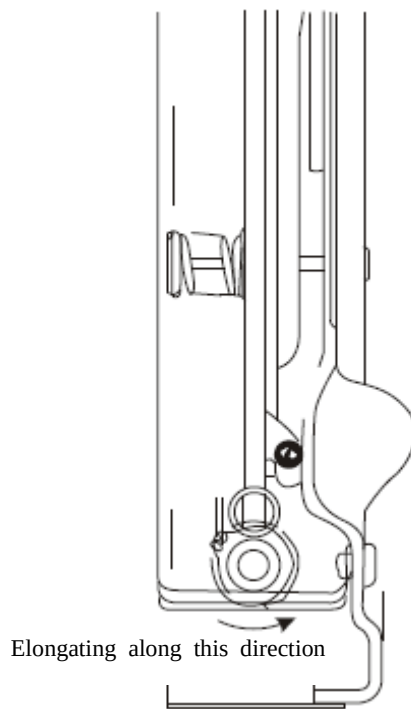
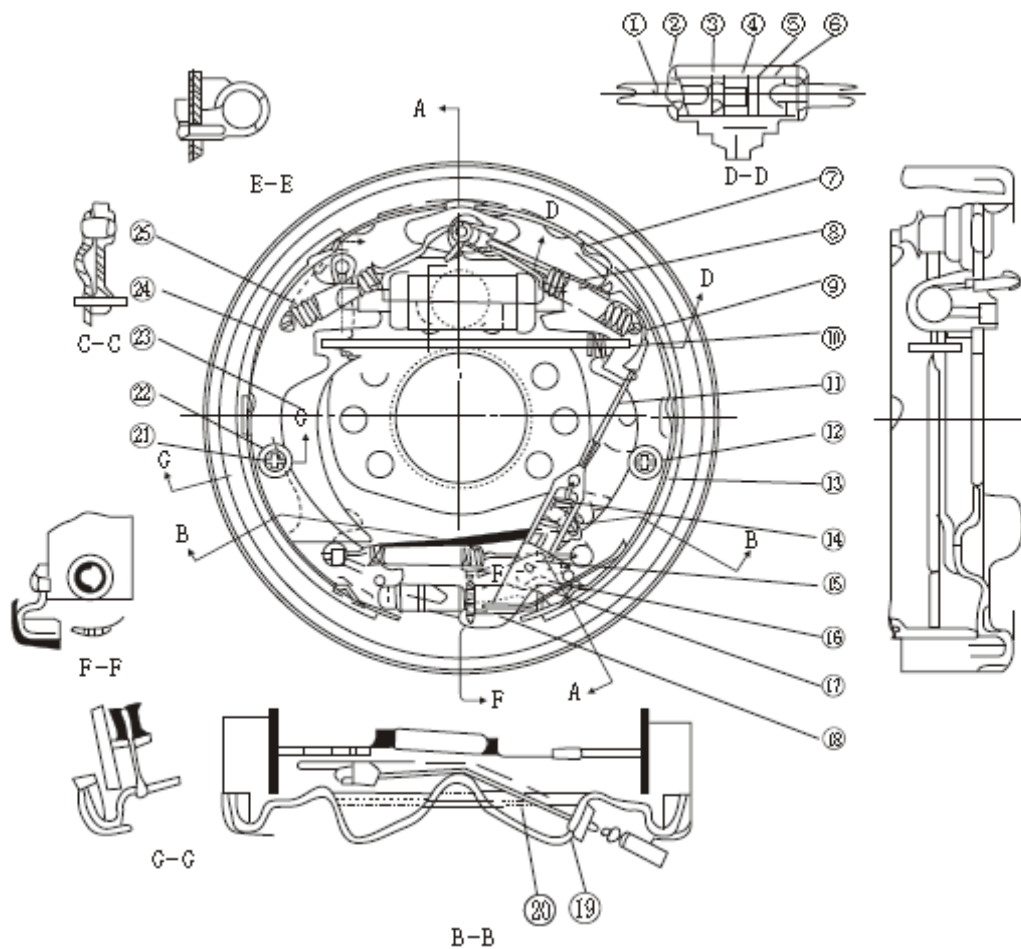
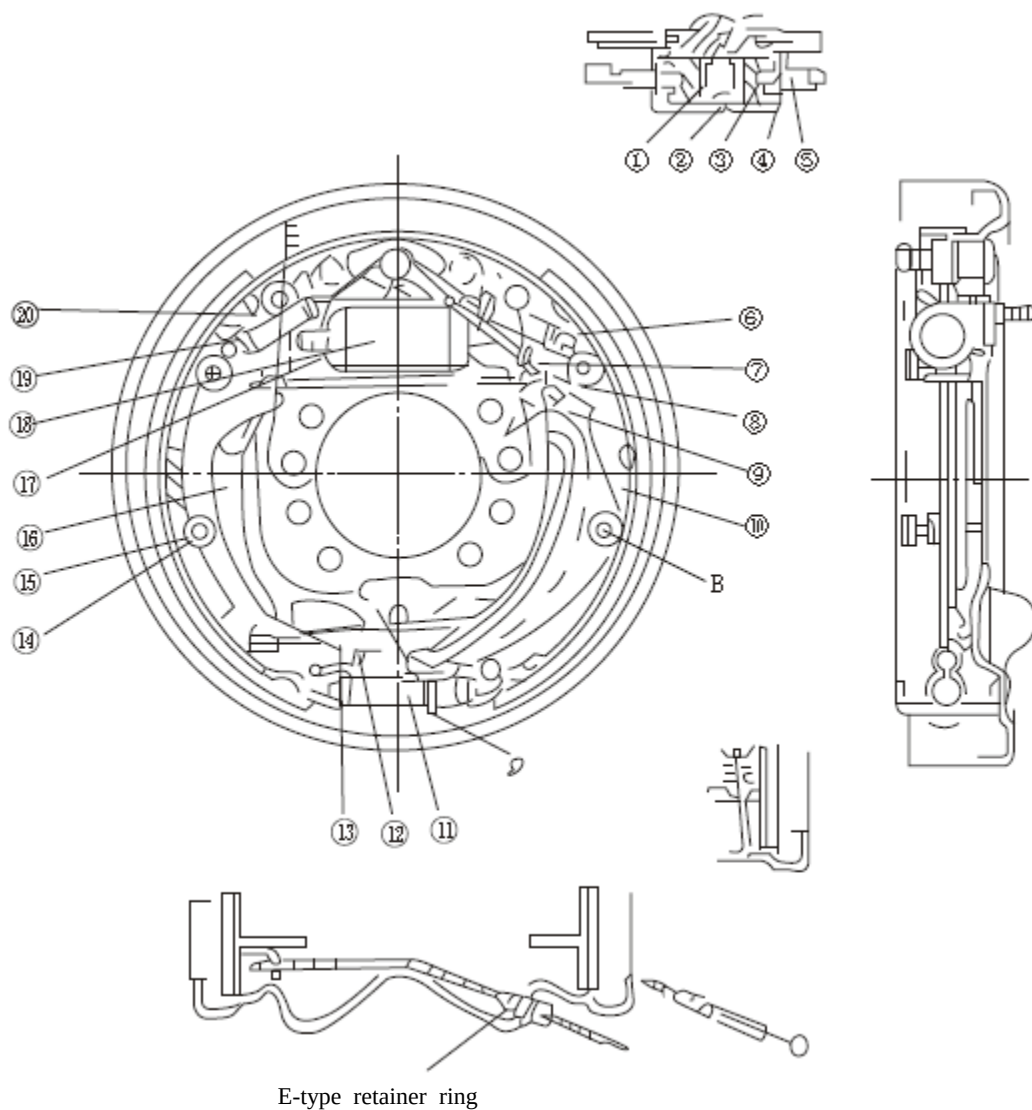


Fig. 2-6 Automatic Clearance Adjusting Mechanism



- | | | | |
|----------------------------------|------------------------------|------------------------------|-------------------------|
| 1. Wheel cylinder piston top rod | 8. Brake shoe return spring | 15. Return spring | 22. Pressure ring seat |
| 2. Protective cover | 9. Spring | 16. Pawl | 23. Hand brake pull rod |
| 3. Piston | 10. Hand brake pull rod | 17. Spring | 24. Main brake shoe |
| 4. Spring | 11. Spring cable | 18. Clearance adjuster | 25. Return spring |
| 5. Cup | 12. Pressure spring pull rod | 19. E-type retainer ring | |
| 6. Wheel cylinder | 13. Pressure spring seat | 20. Parking brake cable | |
| 7. Auxiliary brake shoe | 14. Spring | 21. Pressure spring pull rod | |

Fig. 2-8 Brake (1-1.5t)



- | | | | |
|-------------------|--------------------------|------------------------------|-----------------------------------|
| 1. Spring | 6. Return spring | 11. Clearance adjuster | 16. Hand brake pull rod |
| 2. Cup | 7. Ram | 12. Spring | 17. Hand brake push rod |
| 3. Piston | 8. Return spring | 13. Brake cable assembly | 18. Brake wheel cylinder assembly |
| 4. Cylinder block | 9. Adjusting lever | 14. Pressure spring cover | 19. Return spring |
| 5. Piston top rod | 10. Auxiliary brake shoe | 15. Pressure spring pull rod | 20. Main brake shoe |

Fig. 2-9 Brake (2-2.5t)

2.1.4 Parking brake handle

The parking brake handle is of cam type. The braking force can be adjusted by the adjuster at the end of brake handle.

Adjustment of braking force:

Rotate the adjuster clockwise and the braking force increases. Rotate the adjuster anticlockwise and the braking force decreases. See Fig. 2-11.

Pull force: 20-30kg

Note: For 1-2.5t forklift trucks, adjust the braking force by rotating the screw in the adjuster.

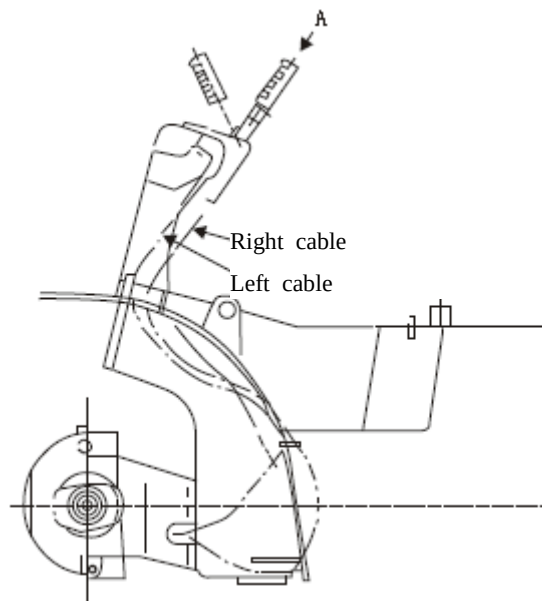


Fig. 2-11 Parking Brake Handle

2.2 Disassembly & assembly and adjustment of brake

This section introduces the disassembly, reassembly and adjustment of brake and the adjustment of brake pedal when the vehicle and hub have been disassembled.

2.2.1 Disassembly of brake

- (1) Remove the retainer pin, adjusting lever, adjuster and spring from the auxiliary brake shoe.

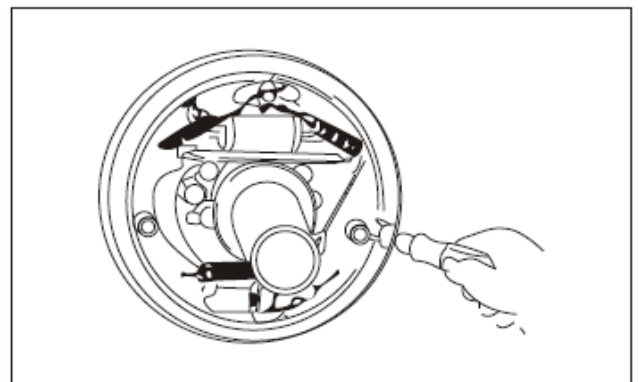


Fig. 2-12

- (2) Remove the return spring of brake shoe.

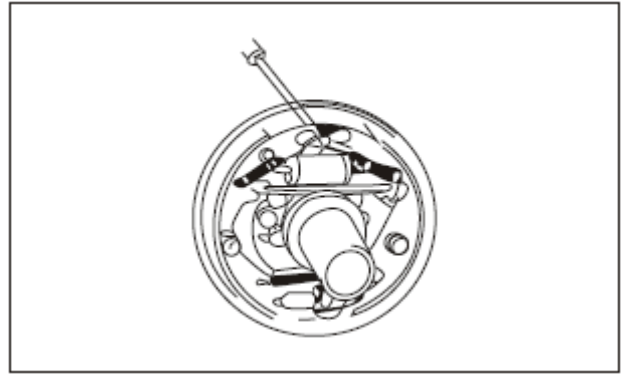


Fig. 2-13

- (3) Remove the retainer spring of main brake shoe.

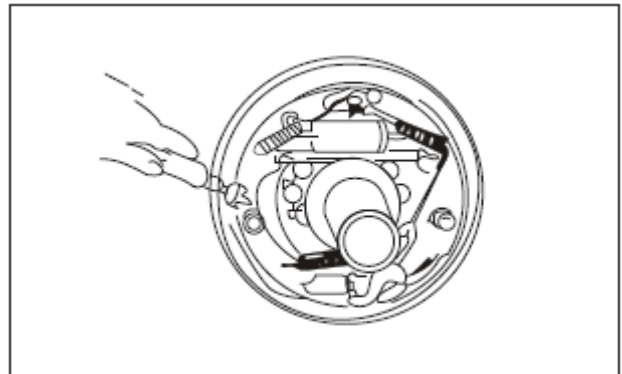


Fig. 2-14

- (4) Remove the main brake shoe and auxiliary brake shoe. Additionally remove the adjuster and adjuster spring.

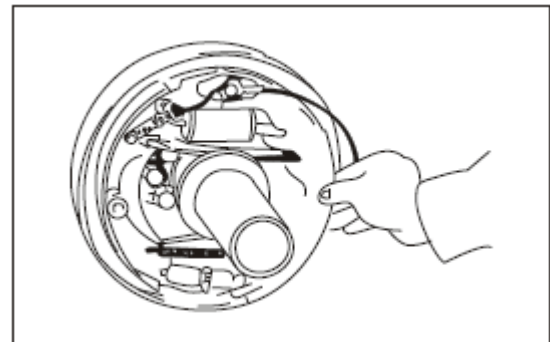


Fig. 2-15

- (5) Remove the brake pipeline from the wheel cylinder.

Then, remove the mounting bolt of wheel cylinder to separate the wheel cylinder from the back plate.

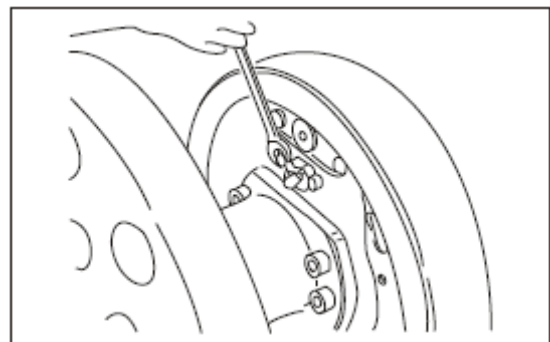


Fig. 2-16

- (6) Remove the E-type retainer ring fixing the brake cable to the back plate. Next, remove the mounting bolt of back plate and take down the back plate from the driving axle.

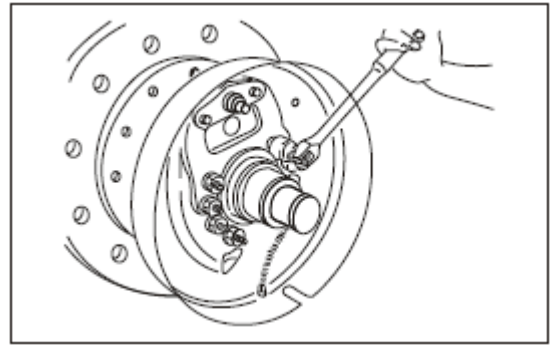


Fig. 2-17

- (7) Disassemble the wheel cylinder: remove the dust-proof ring; press one piston to push out the other piston and then press this piston out by fingers.

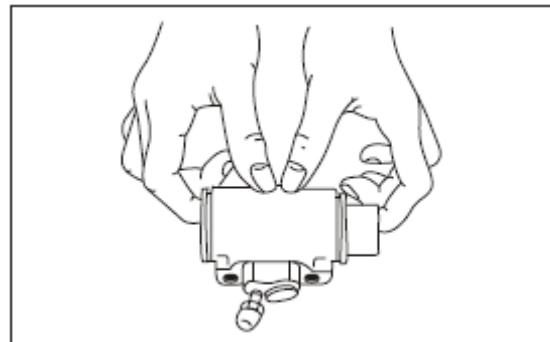


Fig. 2-18

2.2.2 Brake check

Check all parts. Repair or replace the damaged part.

- (1) Check the inner surface of wheel cylinder block and the outer surface of piston for rust.

Measure the clearance between the piston and cylinder block.

Specified value: 0.03-0.10mm

Limit: 0.15mm

- (2) Visually check the piston cup for damage and distortion. If any, replace it.
- (3) Check the free length of the wheel cylinder spring. If unacceptable, replace it.
- (4) Check the thickness of friction plate. In case of excessive wear, replace it.

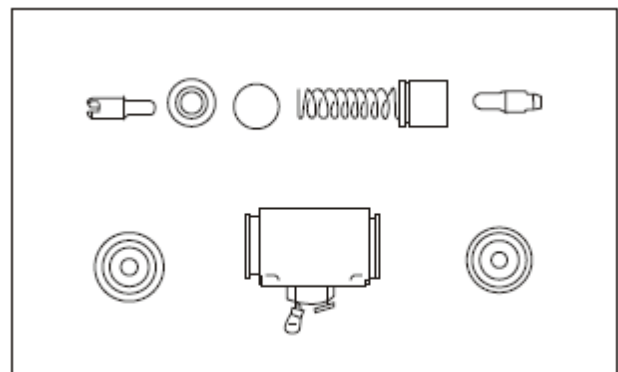


Fig. 2-19

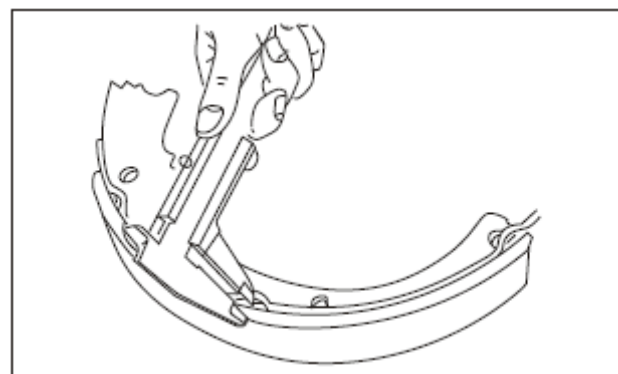


Fig. 2-20

Unit: mm

	1~1.5t	2~2.5t
Standard	4.8	7.2
Limit	2.5	5.0

- (5) Visually check the inner surface of the brake drum. In case of damage or eccentric wear, correct it; in case of excessive wear, replace it.

Unit: mm

	1~1.5t	2~2.5t
Standard	254	310
Limit	256	312

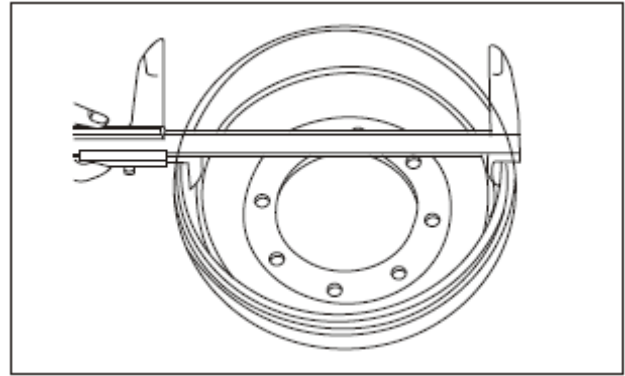


Fig. 2-21

2.2.3 Assembly of brake

- (1) Apply brake fluid to the wheel cylinder cup and piston. Then, assemble the spring, piston cup, piston and dust-proof ring orderly.
- (2) Install the wheel cylinder on the back plate.
- (3) Install the back plate onto the driving axle.
- (4) Add heat-resistant lubricating oil to the lubrication points shown in Fig. 2-22.

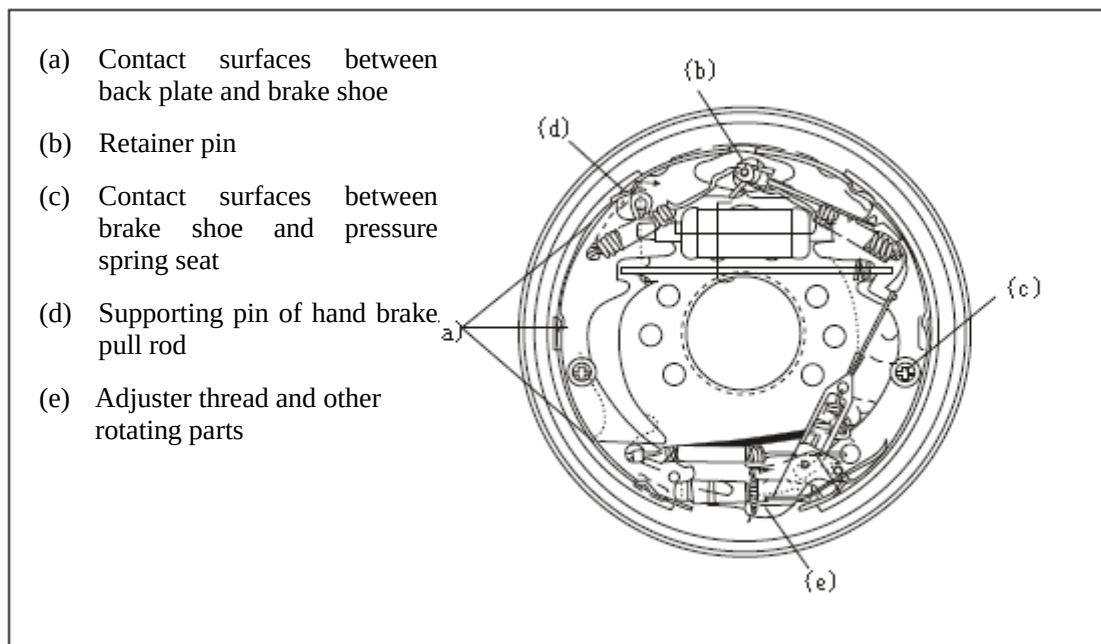


Fig. 2-22

- (5) Clamp the brake cable assembly with the E-type retainer ring.
- (6) Install the brake shoe with the retaining spring.
- (7) Install the pressure spring onto the hand brake push rod, and then install the push rod onto the brake shoe.

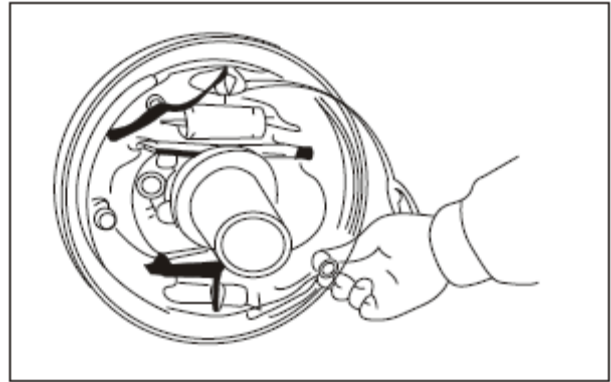


Fig. 2-23

- (8) Install the guide plate of brake shoe onto the supporting pin, and then install the return spring of brake shoe. Install the main brake shoe at first, and then install the auxiliary brake shoe.
- (9) Install the adjuster, adjuster spring, ram and ram return spring.



Fig. 2-24

Pay attention to the following points:

- (a) The thread direction and installation direction of the adjuster
 - (b) The direction of adjuster spring (the adjuster gear cannot touch the spring).
 - (c) The direction of ram return spring (the spring hook at the supporting pin end shall be fixed at the opposite side of ram).
 - (d) The lower end of adjusting lever shall touch the adjuster gear.
- (10) Connect the brake pipe to the wheel cylinder.
 - (11) Measure the inner diameter of brake drum and outer diameter of brake shoe. Operate the adjuster to make the diameter difference be 1mm.

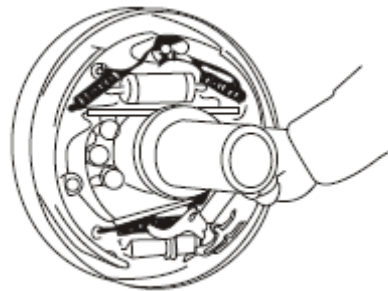


Fig. 2-25

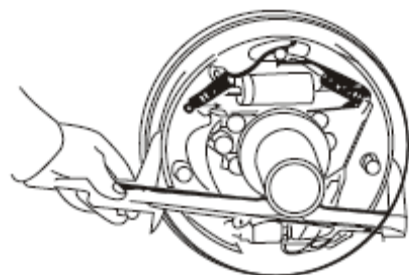


Fig. 2-26

2.2.4 Operation test of automatic clearance adjuster

- (1) Make the diameter of the brake shoe close to the specified installation dimension. Pull the adjusting lever by hands to rotate the adjuster. When it is released, the adjusting lever returns to its original position while the adjuster gear does not rotate.

Notice: Even the adjuster gear and adjusting lever return together after the lever is released, the adjuster can still work normally after installation.

- (2) If the adjuster cannot act as mentioned above when the adjusting lever is pulled, carry out the following check.
 - (a) Check whether the adjusting lever, ram, ram spring and pressure spring seat are installed firmly.
 - (b) Check the ram return spring and adjuster spring for damage. Check the rotation of adjuster gear and check the meshing parts for excessive wear and damage. Check whether the lever touches the gear. Replace the damaged parts.

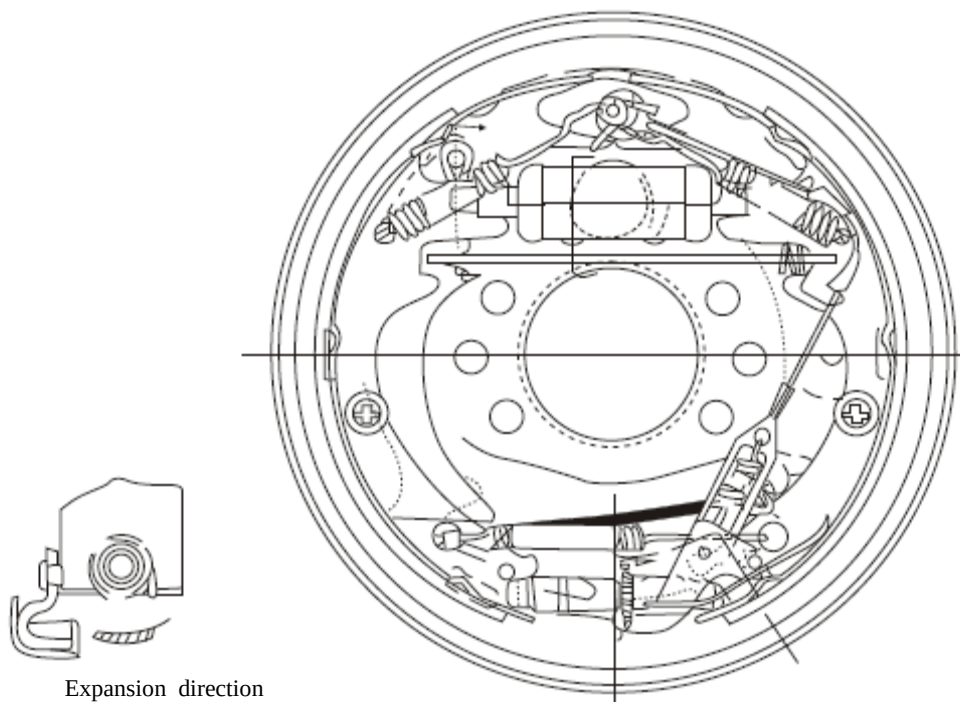


Fig. 2-27

2.2.5 Adjustment of brake pedal

- (1) Shorten the push rod;
- (2) Adjust the catch bolt to adjust the pedal height. See Fig. 2-28.
- (3) Depress the brake pedal to elongate the push rod until the front end of push rod touches the master cylinder piston.
- (4) Tighten the locking nut of push rod.

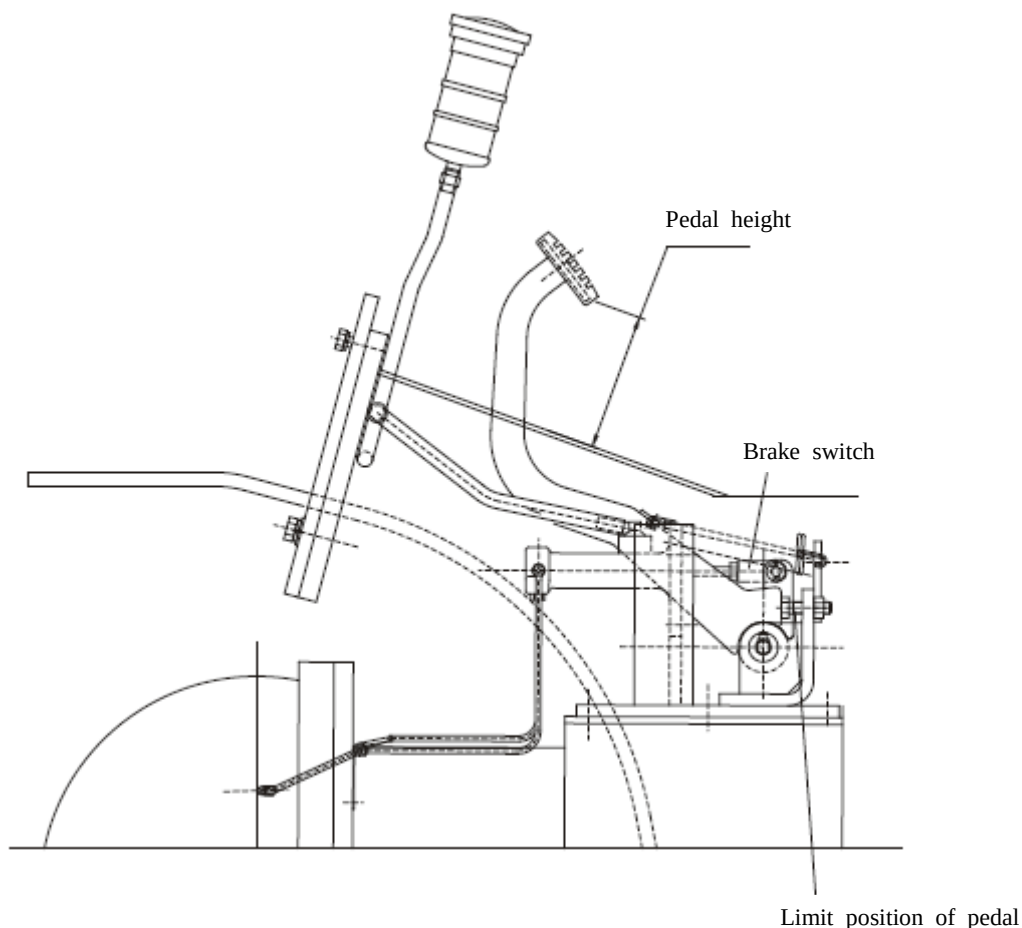
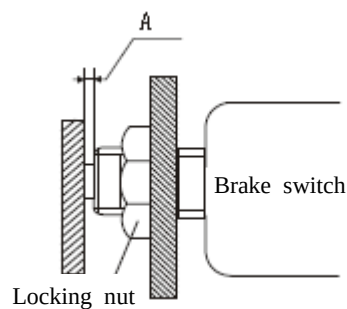


Fig. 2-28

▲ Adjustment of brake switch

- (a) After adjusting the brake pedal height, loosen the locking nut of brake switch.
- (b) Pull out the connector to disconnect the wire.
- (c) Adjust the brake switch to make the clearance $A = 1\text{mm}$.
- (d) Make sure the brake lamp is lit up when depressing the brake pedal.



2.2.6 Malfunction diagnosis

Malfunction	Cause	Solution
Poor braking effect	1 Oil leakage of braking system 2 Improper clearance of brake shoe 3 Overheating of brake 4 Poor contact between brake drum and friction plate 5 Impurities on friction plate 6 Impurities in brake fluid 7 Improperly adjusted brake pedal (inching valve)	Repair Adjust adjuster Check for sliding Adjust again Repair or replace Check brake fluid Adjust
Noise from brake	1 Hardening of friction plate surface or impurities on it 2 Distorted back plate or loose bolt 3 Distorted brake shoe or incorrect installation 4 Worn friction plate 5 Loose wheel bearing	Repair or replace Repair or replace Repair or replace Replace Repair
Uneven braking	1 Oil dirt on friction plate surface 2 Improper clearance of brake shoe 3 Failed wheel cylinder 4 Damaged return spring of brake shoe 5 Deflected brake drum	Repair or replace Adjust adjuster Repair or replace Replace Repair or replace
Weak braking	1 Oil leakage of braking system 2 Improper clearance of brake shoe 3 Air in braking system 4 Improperly adjusted brake pedal	Repair or replace Adjust adjuster Release air Adjust again

2.3 Structure, Principle, Adjustment and Maintenance (for 3-3.5 t forklift trucks)

2.3.1 Transmission system

General

The transmission system for **3-3.5t** forklift trucks includes conventional transmission system and partial braking system. The double-motor structure of front wheels makes the left and right wheels have their own driving axles, gear-boxes, brakes and driving motors respectively. Thus, the working efficiency is improved largely. In addition, both the transmission and brake are installed in the driving axle housing as a whole, which makes the structure compact.

The traveling speed of forklift truck is changed with the motor speed. The traveling direction is changed by changing the rotation direction of the motor. The sensors installed on the rear wheels transmit signals to the controller controlling the driving motors on left and right front wheels and then the motors output different rotation speeds according to the received signals to achieve the steering of forklift truck. The front wheel steering is realized by the motor speed difference. With this system, the differential composed of bevel gears is saved, which not only improves the working efficiency but also eliminates the noise generated by the transmission of bevel gears.

Main characteristics and parameters of reduction gearbox

The **PMS701** reduction gearbox is applicable to 3-3.5t electric forklift trucks with double-motor drive.

This reduction gearbox consists of two parts:

- 1) Reduction gear
- 2) Braking system including brake disc with lubricating oil

This technology (patented) can maximize the working performance of the whole reduction gearbox. The two parts above work separately but use the same lubricating oil (with different levels). During service, the oil of the two parts can compensate each other. In this way, both the brake disc and gear can be lubricated properly, which accordingly improves the following performances:

- A) Service life of braking system
- B) Radiation capacity
- C) System efficiency

Additionally, to replace the brake disc, the gear in the reduction gearbox needs not to be removed.

The user can select positive brake (hydraulic and mechanical brake) or negative brake (hydraulic brake at the time of starting) just by changing the brake lever on the reduction gearbox housing.

Notice:

Generally, the maximum working temperature of the reduction gearbox is 120°C. When this value is exceeded, stop the forklift truck to cool down the reduction gearbox.

The brake disc and reduction gear in the reduction gearbox are connected: service brake (foot, hydraulic); parking brake (hand, mechanical).

Max. load on axle	kg	4400
Max. power on axle	kW	7-8
Max. rotation speed on axle	rpm	5000*
Optional gear ratio		17.5-20.4-24.2-27.3-29.5
Allowable continuous torque on output wheel	Nm	1900
Allowable torque on output wheel	Nm	3000
Tyre size		28×9-15-12PR
Lubricating oil		SAE 80W/API G14**
Lubricating oil volume	L	1.2-1.3***
Change interval of lubricating oil	Ore Hours	1000
Weight	kg	57

* VITON seal rings shall be set at the motor connections in case of high rotation speed (> 3500 rpm).

** Recommended lubricating oil

*** Depending on the installation angle of the reduction gearbox

Brake fluid		DOT4*
Max. braking pressure	bar	85
Max. bearing pressure of seal ring	bar	150
Brake oil volume	cm ³	3.2
Brake oil volume for old brake disc	cm ³	5.6
Stroke of control lever for new brake disc	mm	15
Stroke of control lever for old brake disc	mm	21
Brake torque on wheel	Nm	> 3300
Force on brake lever/torque on tyre		1000 N=1700Nm
Oil for negative brake release		Mineral oil
Min. hand brake release pressure	bar	80
Allowable maximum hand brake pressure	bar	150
Hand brake torque on wheel	Nm	> 2000

* To use mineral oil, replace the sealing device.

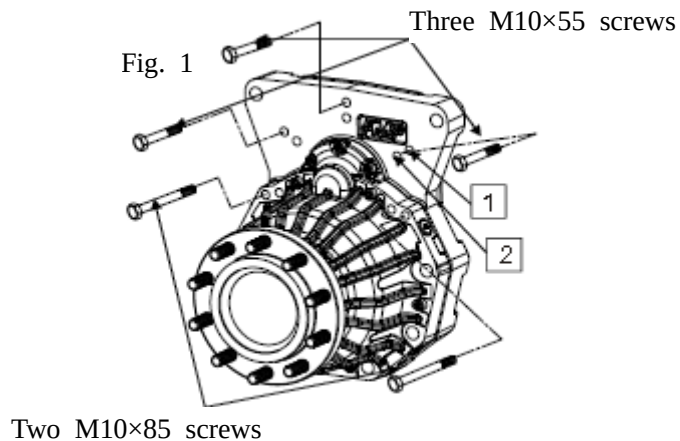
2.3.2 Installation of transmission system

General

The seal rings of the shaft connected with the motor are installed on the motor flange, including a lip-type seal ring and an **O**-ring. The motor flange is connected to the reduction gearbox with five M10 screws (see Fig. 1). Three screws are **60** mm long and two screws are **85** mm long.

It is recommended to install the screw at the outer ring screw hole (1).

To further tighten the motor or if the motor to be installed is small, use the inner ring screw hole (2).



Notes for Installation

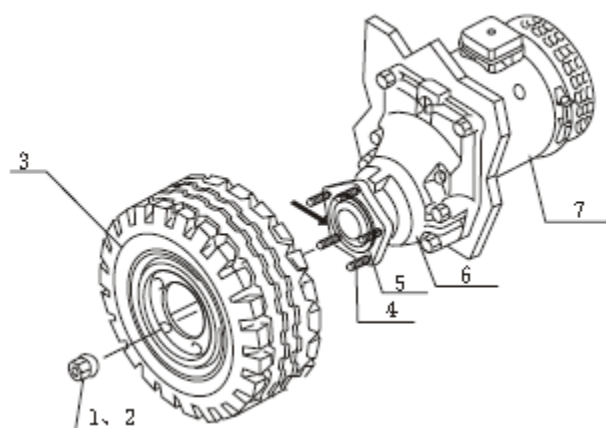
After the reduction gearbox and the motor are connected, only the axial movement can allowed. No tilt shall occur. It is recommended to first lift the motor, then place the reduction gearbox on a fixed plane with the spline at the inlet upwards, and at last align the spline with the motor shaft for installation.

To facilitate the connection, it is recommended to fit pins in the three screw holes and replace them with screws after the reduction gearbox and motor are aligned and arranged well.

Installation of tyre

The wheel shaft on the gear-box is applicable to installation of pneumatic tyre as well as **cushion** tyre.

- a) Ensure the wheel shaft surface and the mounting surface of the tyre are clean and check them for damage.
- b) Align the rim holes with the bolts on the wheel shaft and then push the wheel to make the rim surface coincide with the wheel shaft contact surface.
- c) Install the elastic washers, plain washers and nuts and then tighten them to the torque of **140 Nm**. See the following figure.



1. Hub nut

2. Washer

3. Wheel

4. Hub bolt

5. Wheel shaft

6. Reduction gearbox

7. Driving motor

2.3.3 Maintenance of reduction gearbox

Before using the reduction gearbox, it is necessary to lubricate it. The oil-filling piston, oil level check piston and oil-drain piston will be used (see Fig. 2).

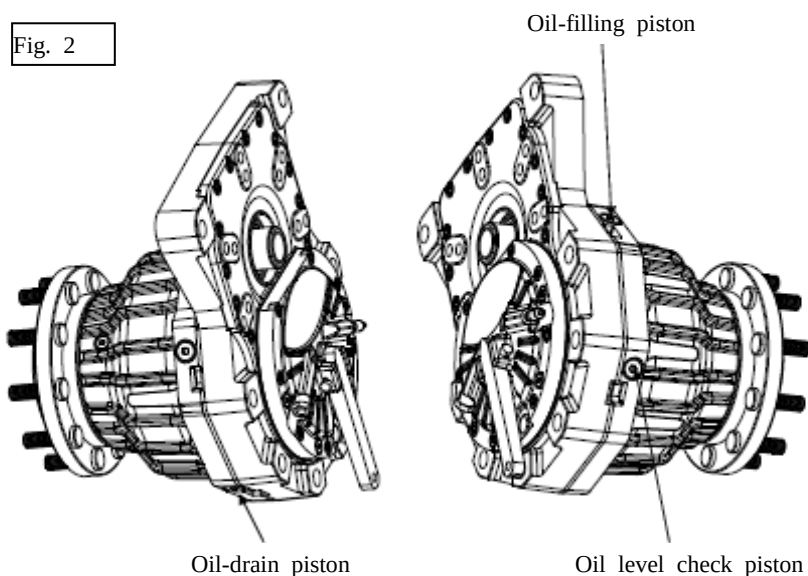
Check whether the lubricating oil is added to the specified level by overflowing, namely adding lubricating oil until the oil overflows from the oil filler.

In any case, the volume of lubricating oil added into the reduction gearbox shall be as follows:

1.2-1.3 L

Change the lubricating oil once every after **1000** working hours.

Recommended lubricating oil (in compliance with **SAE 80W/APIGL4**): **ROTRA JD-F-AGIP**



2.3.4 Removal of transmission system

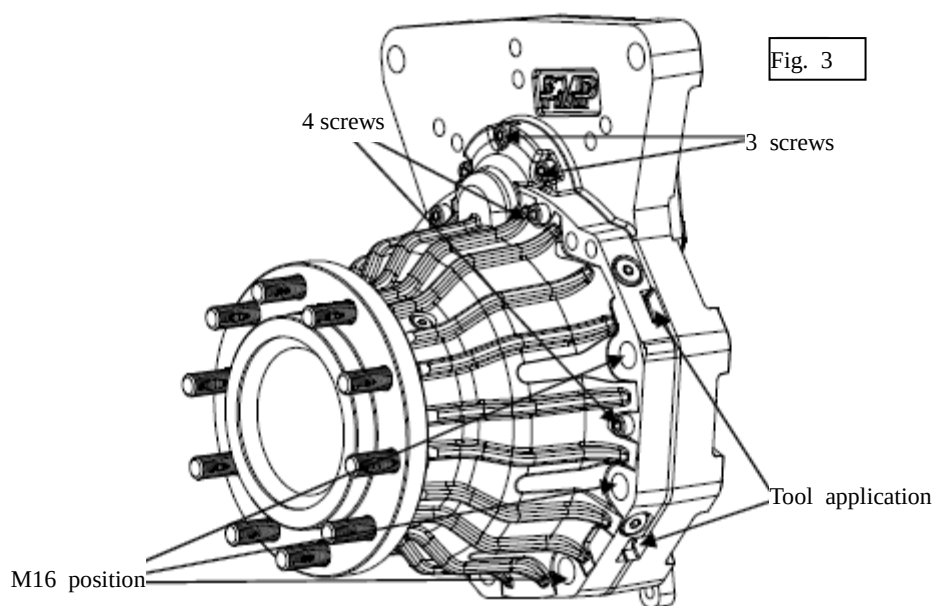
Removal of reduction gearbox

General

To open the gear box, it is unnecessary to remove the reduction gearbox from the forklift truck and drain the oil in the braking system. Only the lubricating oil in the gear box needs to be drained. Therefore, only the piston at the lower part needs to be removed.

Removing the housing

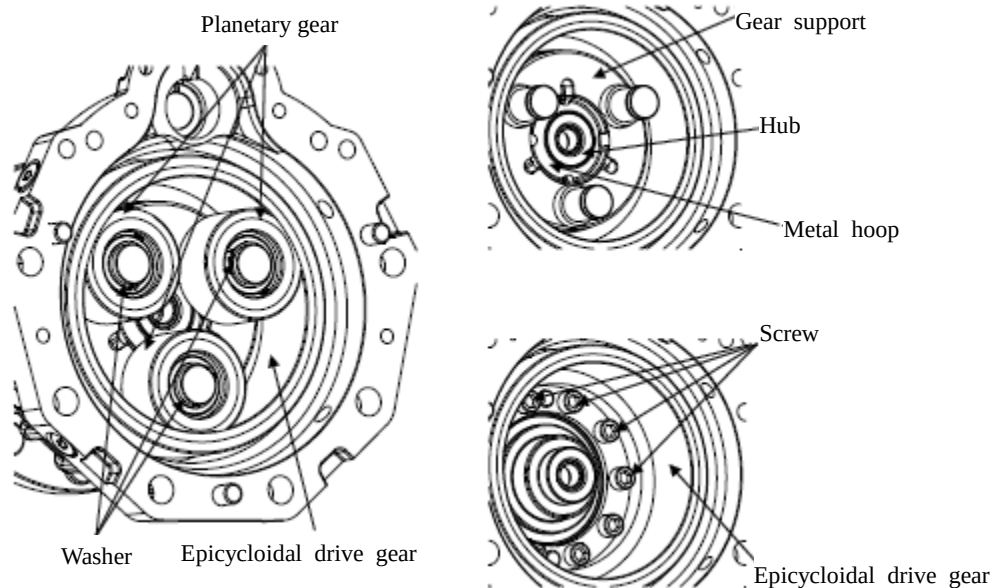
Dismount the **six M16** screws from the gear box at first and then the **three** screws and **four** screws. Afterwards, the gear box can be taken down axially. A tool can be used to pry the gear box at the **four** notches at the edge of the gear box. Take care as the gear box is heavy.



Removing the epicycloidal drive gear and hub

Remove the planetary gears and the bearing installed with them. Take down the washers at first and then use proper tools to remove them. Remove the metal hoop with proper tools. To dismount the hub, install a metal tube into the threaded hole **M40** at the middle of the hub at first and then lightly press this tube. The gear support can be dismounted as well.

Screw off the **ten** screws and then remove the drive gear.



For the following operation, remove the flange of reduction gearbox from the forklift truck. As the flange is still connected to the motor, it is necessary to dismount the two **M16** screws. Place the flange and motor on a plane and then dismount the **five M10** screws connecting the flange and motor to separate them.

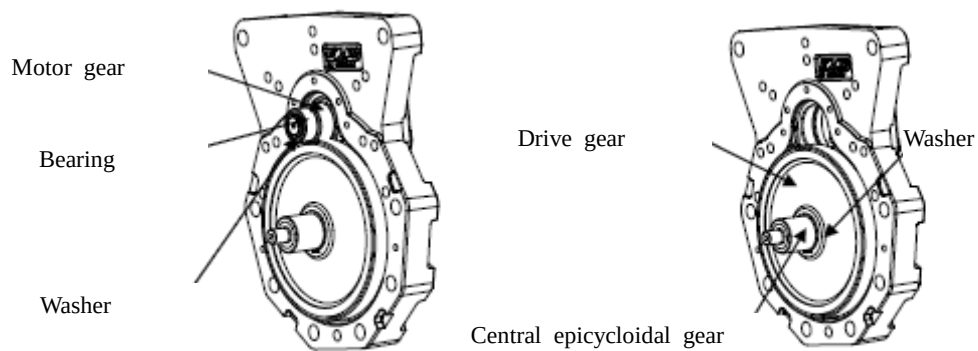
Removing the input shaft

Take down the washers at first, then dismount the bearing and gear with a puller, and at last remove the input shaft with a plastic hammer.

Removing the central epicycloidal gear

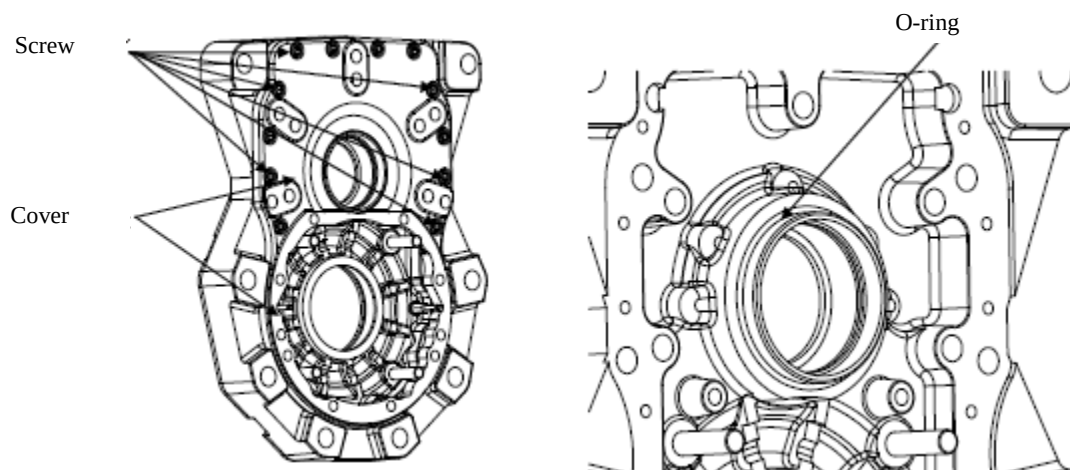
!! Caution: Before this operation, always drain the lubricating oil from the brake box and remove the whole braking system.

Remove the washers. Set a disc on the flange at the braking system side and set a tube on the gear towards the gear box, and then press this tube to dismount the drive gear ring.



Removing the cover

Dismount the **12** screws from the cover and take down the cover axially. Then take down the **O**-ring from the flange seat.



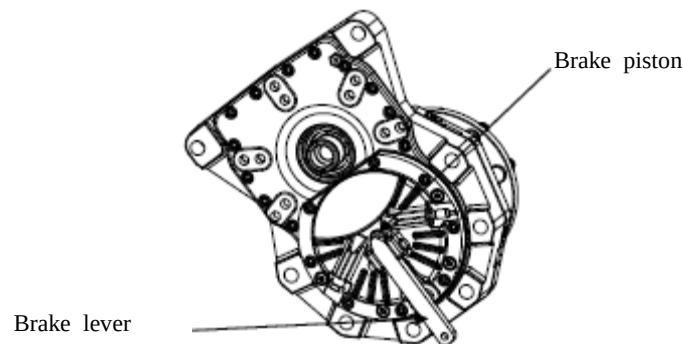
2.3.5 Maintenance of braking system

The lubricating oil for the braking system is the same as that for reduction gearbox. During service, it is necessary to add lubricating oil frequently.

When installing the reduction gearbox, confirm that the connecting wire of the hand brake is tightened and the mechanical lever is free without pressing the brake disc.

For the foot brake, it is recommended to install a brake pump with the maximum working pressure of **85bar** and braking pressure of **50/70 bar**.

Check whether the brake stroke of the brake piston exceeds **3.5 mm** once every **3000** working hours. If yes, replace the brake disc. For **PMS701 cp** reduction gearbox, you can also confirm whether the brake disc needs to be replaced by checking the stroke of brake lever. Remove the connecting wire from the brake lever and set the lever to contact with the piston at first, and then pull the lever forcefully to measure its stroke. If the stroke exceeds **21 mm**, replace the brake disc.



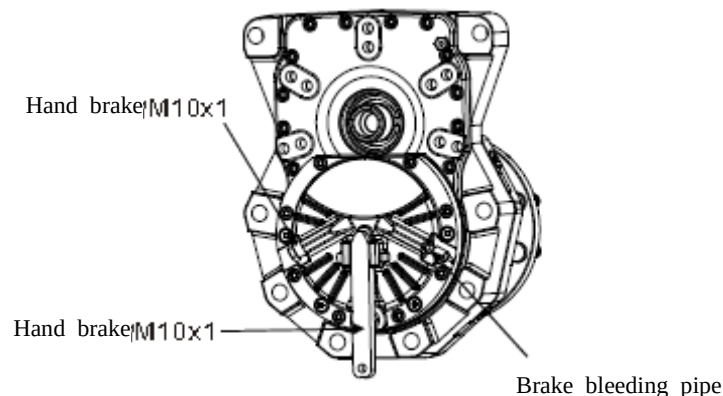
The piston **M10×1** is used to connect the hydraulic system of the brake.

The air bleeder is located at the brake lever side. It is used to discharge the air in the brake. The stroke of the brake lever is about **15-21 mm**, depending on the wear degree of the brake disc.

Mechanically, the maximum bearing pressure of the brake disc is **200bar** and the maximum bearing pressure of the brake piston seal ring shall not exceed **150bar**.

The brake piston seal ring is tested to be applicable to **DOT 4** brake fluid. **Use DOT4 for brake fluid change every year!**

* In case of special requirement, the seal ring applicable to mineral oil can be installed.

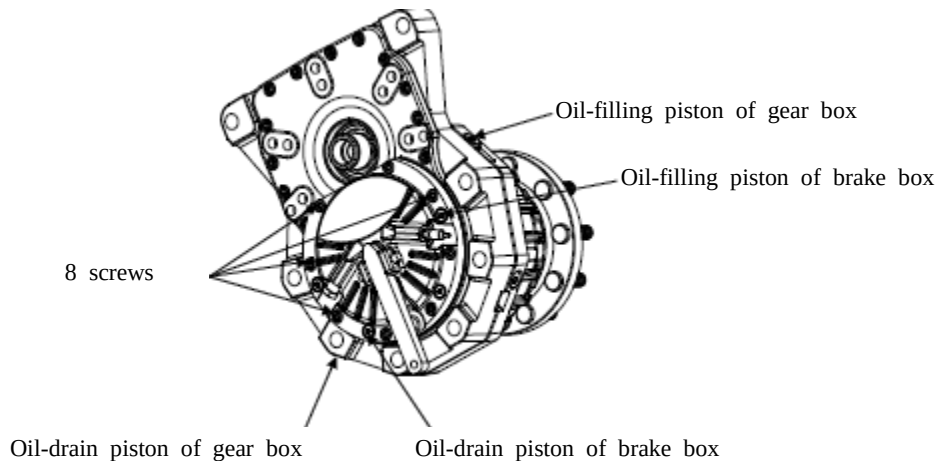


2.3.6 Removal of braking system

General

To remove the braking system, take down the reduction gearbox from the forklift truck at first. After properly lifting and assembling the reduction gearbox oil device, disconnect all the circuits connected with it. Remove the **eight M16** screws. Take down the reduction gearbox and motor from the forklift truck and then put them on a plane.

Screw off the piston and drain a part of oil. Remove the **eight** screws. Find out the two **M10** threaded holes among the **eight** screw holes and screw two short **M8** screws into these two threaded holes to the end. At last, install **M10** screws onto these two screws until the brake box cover is dismounted.



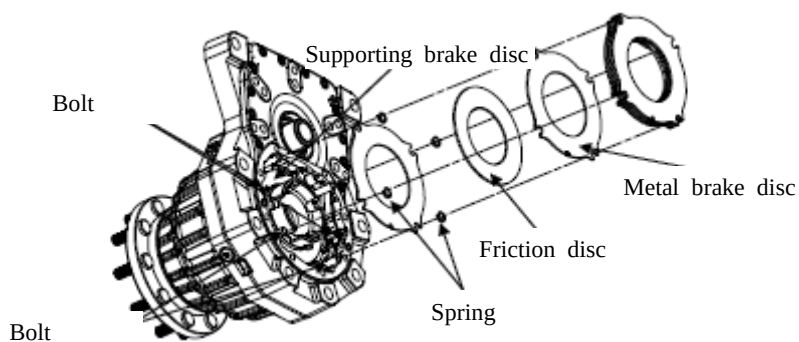
Replacement of brake disc

The whole braking system consists of **6** metal brake discs and **5** friction discs. They are arranged alternately so that the first and the last discs are smooth. **Four** springs are inserted between every two metal brake discs and each spring is fitted on the corresponding bolt.

Take down the two fixed washers from the bolt and then remove the brake disc propeller and the **11** brake discs. Dismount the spring from the bolt. Remove the aluminum supporting brake disc.

Carefully clean the brake box and install the new brake discs in the following order:

1. Insert the supporting metal brake disc;
2. Insert the metal brake disc and friction brake disc and fit the four springs on the bolts;
3. Repeat the two steps above until all brake discs are installed;
4. Install the last metal brake disc and fit two springs on the bolts;
5. Fit the brake disc propeller on the bolt and press it tightly. Install two fixed washers on the bolt.



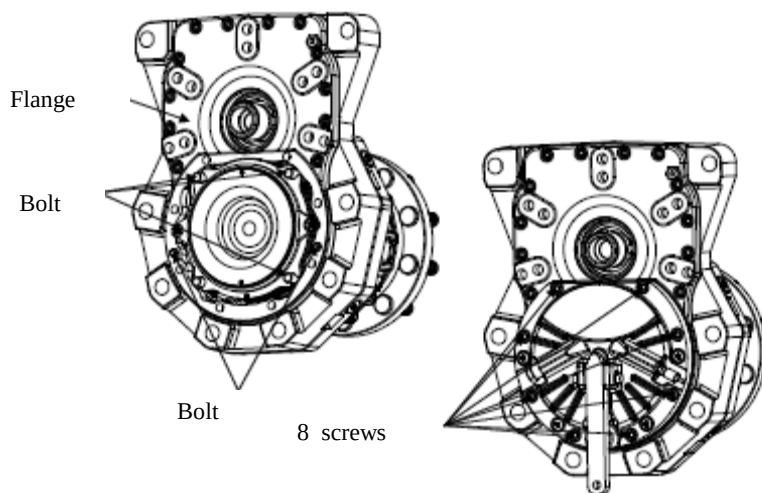
Install the seal ring onto the brake box housing, and then install this assembly onto the housing by taking the two bolts as center. At last, connect it to the brake disc box with four bolts. Additionally, adjust the positions of the two housings with a rubber hammer to make them closed fully.

Then, install the 8 screws to the corresponding positions and tighten them to the following torque:

Screw **M8 cl. 12.9** **40 Nm**

Lubrication

Refer to the method for reduction gearbox. Both the parts (brake and gear) are lubricated by the same lubricating oil.



3. Steering system

3.1 General

The steering system mainly consists of steering wheel, steering shaft, steering gear, steering oil pump and steering axle. The steering shaft is connected with the steering gear through the universal joint. The steering shaft is connected with the steering wheel through the universal joint. The steering column can tilt forwards or backwards properly. See Fig. 3-1. The steering axle is installed on the tail frame, with a steering knuckle at the left and right sides respectively. The steering cylinder piston rod drives the steering knuckle through the connecting rod to make the steering wheels deflect. In this way, steering is realized.

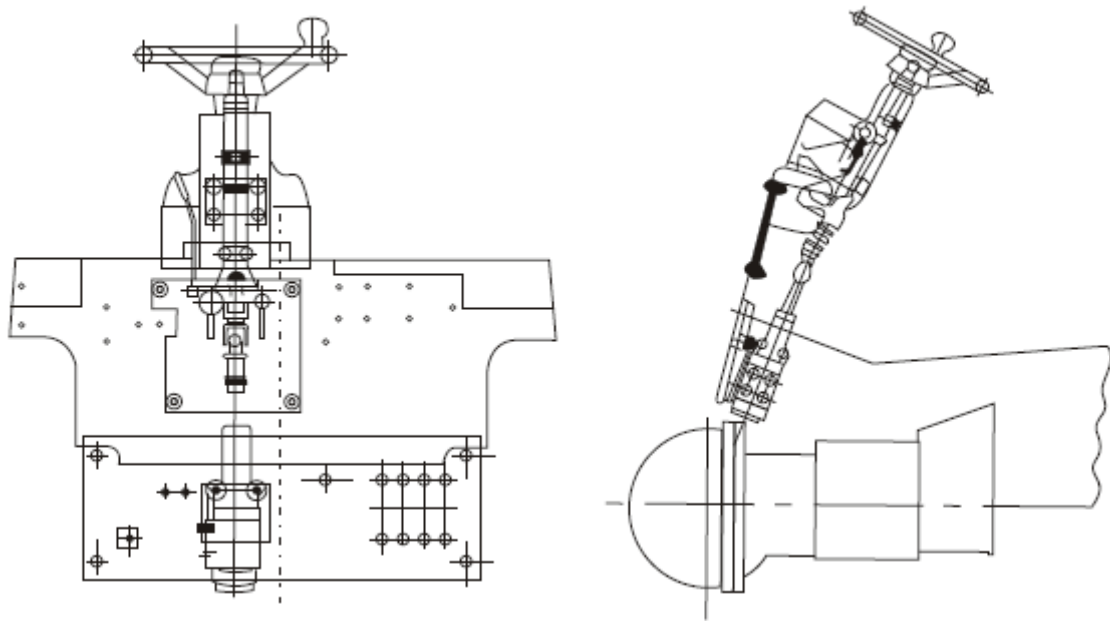


Fig. 3-1

3.1.1 Cycloidal full hydraulic steering gear

The full hydraulic steering gear (Fig. 3-2) can quantitatively deliver the pressure oil from the oil pump to the steering cylinder through pipeline according to the rotation angle of steering wheel. When the oil pump cannot supply oil, steering can be done manually.

This steering gear is composed of one common steering gear and one combination valve. The hole on the upper cover of the combination valve is a safety valve. In addition, there is a bidirectional overload valve in the combination valve. It is used to protect the parts against damage in case of high pressure in the hydraulic system caused by accidental impact on the wheels during traveling. The safety valve and bidirectional overload valve have been adjusted by the manufacturers. Never adjust them at random.

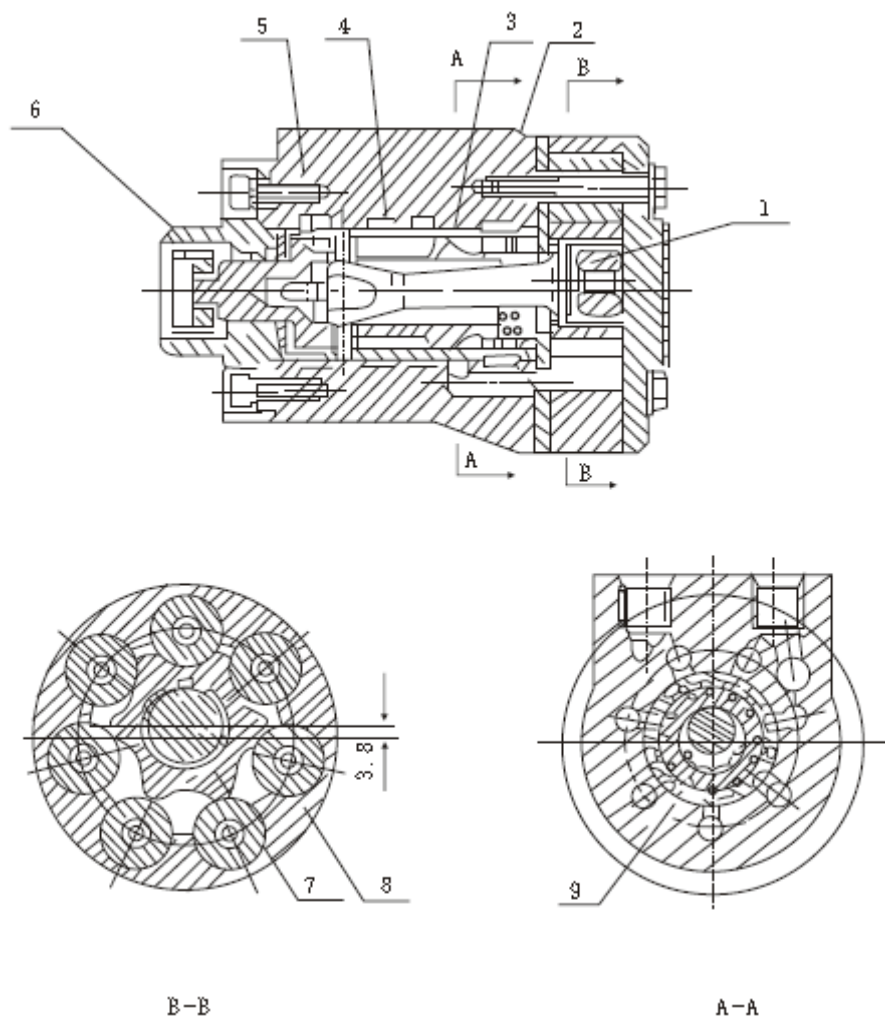


Fig. 3-2 Cycloidal Full Hydraulic Steering Gear

- | | | |
|---------------|----------------------------|-----------------|
| 1. Limit stop | 4. Universal driving shaft | 7. Rotor |
| 2. Valve body | 5. Spring piece | 8. Stator |
| 3. Valve core | 6. Connecting block | 9. Valve sleeve |

3.1.2 Steering axle

The steering axle is a welding structure with box section. See Fig. 3-3. It comprises steering axle body, steering cylinder, connecting rod, steering knuckle and steering wheel. The ackerman steering applies slider-crank mechanism. The cylinder piston rod drives the steering knuckle through the connecting rod to make the steering wheels deflect. In this way, steering is realized. With the front and rear axis pins, the steering axle is fixed to the tail frame with bolts through the bearing seat. The axle can swing around the axis pins. A steering knuckle is set at the left/right side of the steering axle respectively. The rear wheel hub is installed to the steering knuckle shaft through two taper roller bearings. The wheel is fixed on the hub with rim bolts. The bearing inside is provided with an oil seal to keep the lubricating grease in the hub and steering knuckle chamber.

See the table below for the models of tyre and rim and the tyre pressure.

Tonnage	1-1.5t	2-2.5t	3-3.5t
Tyre	5.00-8-10PR	18×7-8-14PR	18×7-8-14PR
Rim	3.50D-8	4.33R-8	4.33R-8
Tyre pressure	0.7MPa	0.9MPa	0.9MPa

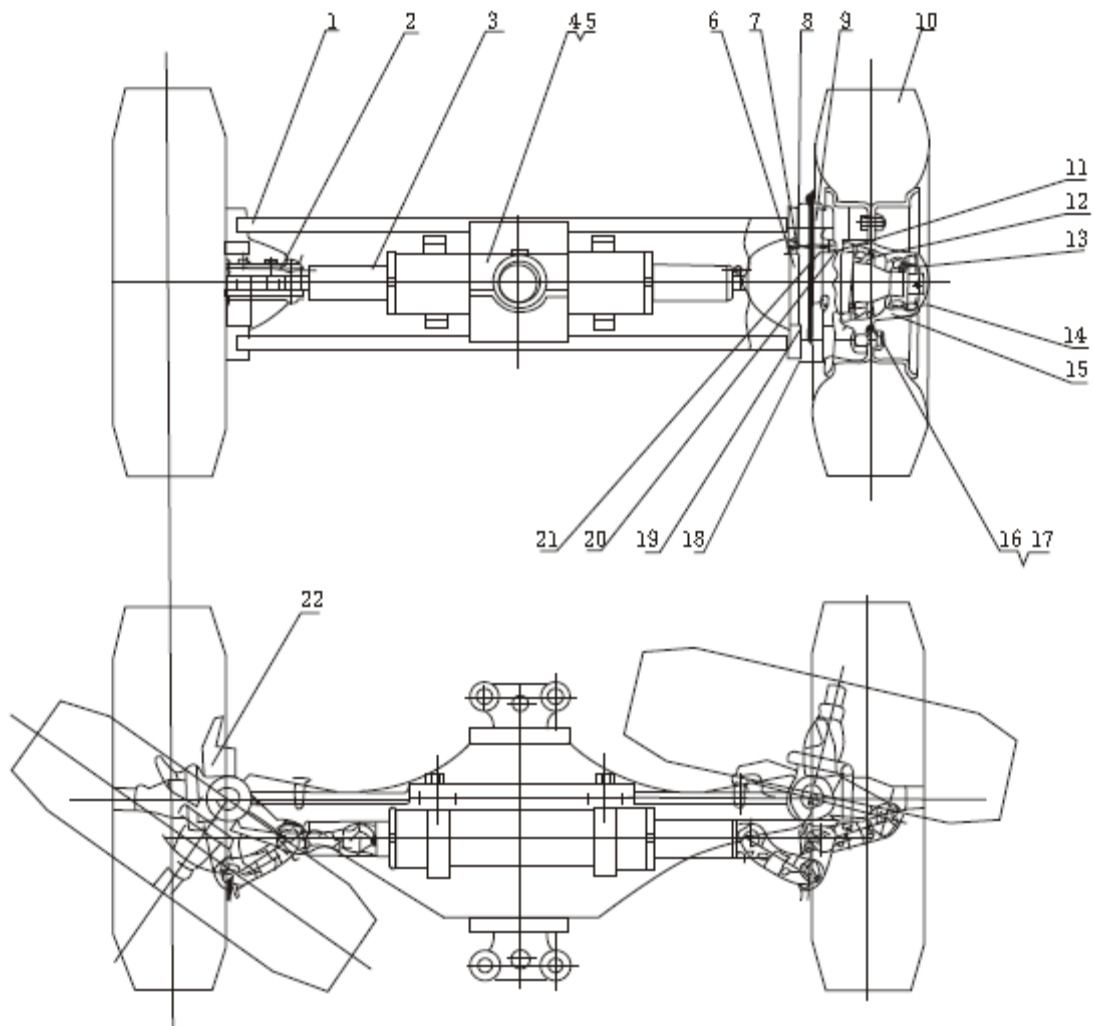


Fig. 3-3 Steering Axle

- | | | |
|------------------------------------|---------------------------------|------------------------------------|
| 1. Steering axle body | 9. King pin of steering knuckle | 17. Hub nut |
| 2. Connecting rod | 10. Tyre | 18. Oil seal |
| 3. Steering cylinder | 11. Oil seal | 19. O-ring |
| 4. Rear axle bearer | 12. Taper roller bearing | 20. Bushing |
| 5. Bushing | 13. Taper roller bearing | 21. Dust cover |
| 6. Right steering knuckle assembly | 14. Hub cover | 22. Left steering knuckle assembly |
| 7. Thrust bearing | 15. Hub | |
| 8. Needle bearing | 16. Hub bolt | |

(1) Steering knuckle

The steering knuckle is installed between the upper and lower parts at both ends of steering axle body by the steering king pin, taper bearing, dust cover and O-ring. The upper and lower ends of the king pin are fixed on the axle body with a retainer pin and a split pin respectively. The bearing is supported by the taper bearing pressed on the axle body.

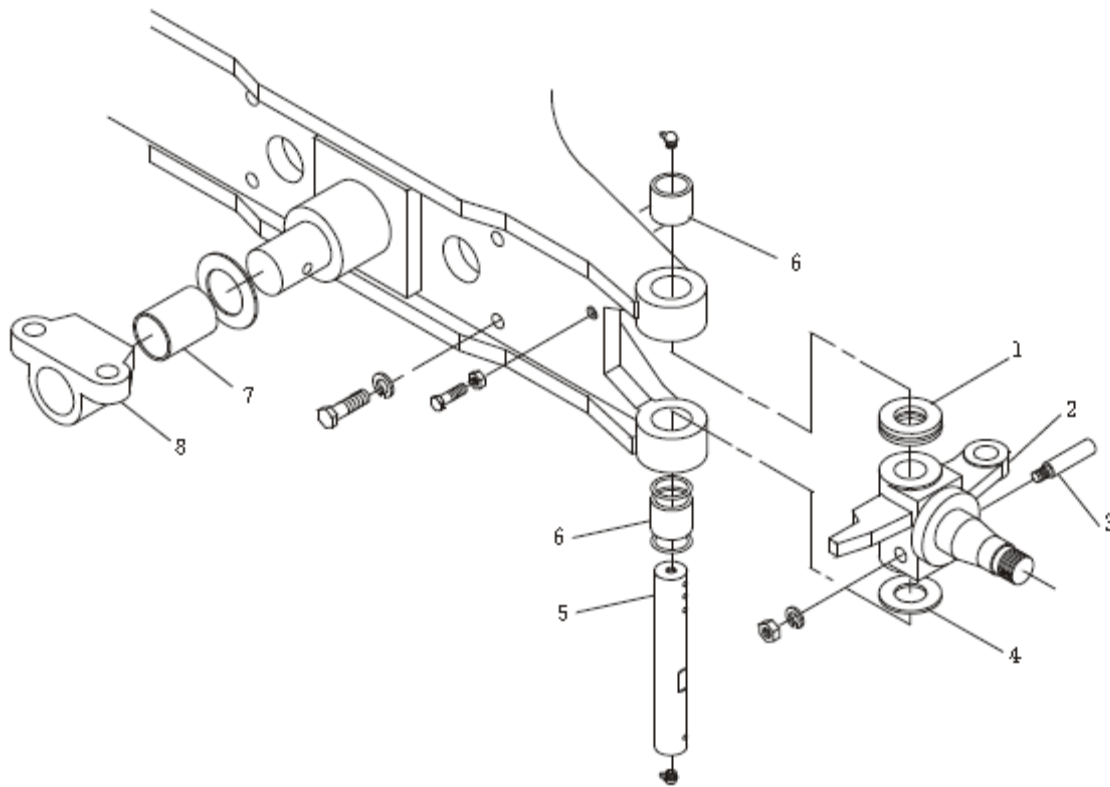
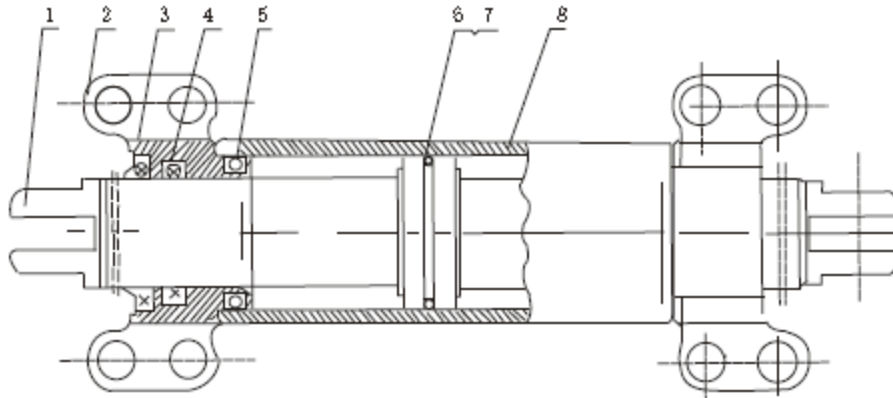


Fig. 3-4 Steering Knuckle

- | | | |
|---------------------|-----------------------------------|---------------------|
| 1. Thrust bearing | 4. Steering knuckle adjusting pad | 7. Bushing |
| 2. Steering knuckle | 5. Steering knuckle king pin | 8. Rear axle bearer |
| 3. Retainer pin | 6. Needle bearing | |

(2) Steering cylinder

The steering cylinder is of double-acting piston type. The two ends of the piston rod are connected with the steering knuckle through the connecting rod. The pressure oil from the full hydraulic steering gear pushes the piston rod to move left/right through the steering cylinder to achieve left/right turn. The piston seal is a combined seal composed of supporting ring and O-ring. A Yx-type seal ring is set between the cylinder head and piston rod. The cylinder is fixed on the steering axle through the cylinder head at both sides. (See Fig. 3-5)



- | | | | |
|------------------------|-------------------|--------------------|------------------------------|
| 1. Piston rod assembly | 2. Cylinder head | 3. Dust ring 50×72 | 4. YX-type seal ring 50×65×9 |
| 5. O-ring 65×3.55 | 6. O-ring 60×3.55 | 7. Supporting ring | 8. Cylinder block |

Fig. 3-5 Steering Cylinder

(3) Hub

The hub is installed on the steering knuckle by two taper roller bearings. The wheel is fitted onto the hub through the rim. The bearing inside is provided with an oil seal to keep the lubricating grease in the hub and steering knuckle chamber. The nut is used to adjust the tightness of bearing.

3.2 Essentials of adjustment and maintenance

3.2.1 Adjustment of pretension load on steering wheel bearing

- (1) Lubricate the hub, inner and outer bearings, internal chamber of hub cover, and oil seal lip. See Fig. 3-6.
- (2) Fix the bearing cup on the hub. Install the hub onto the steering knuckle shaft.
- (3) Install the plain washer and tighten the slotted nut to a torque between 206N.m and 235N.m (21-24kgm). Loosen the slotted nut and then tighten this nut to 9.8N.m (1kgm).
- (4) Beat the hub lightly with a wood hammer to rotate the hub for 3-4 circles. Make sure the hub is not loose.
- (5) Tighten the slotted nut and align the slot with the split pin hole on the steering knuckle.
- (6) Beat the hub lightly again with the wood hammer. Rotate the hub for 3-4 circles by hands to ensure stable rotation. Measure the rotating torque of the hub. It shall be 2.94-7.8N.m (0.3-0.8kgm).
- (7) When the rotating torque exceeds the specified value, rotate the hub back for 1/6 circle. Measure the torque again.
- (8) When the specified torque is reached, lock the slotted nut with the split pin.

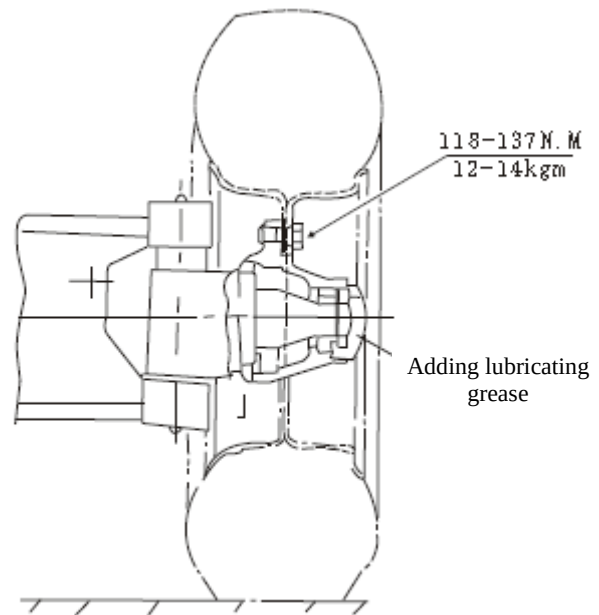


Fig. 3-6 Adjustment of Pretension Load

3.2.2 Check of reassembled steering system

- (1) Turn the steering wheel to left and right limit positions. Check whether the forces are uniform and whether the rotation is balanced;
- (2) Check whether the oil pressure pipeline is installed correctly and whether the left steering and right steering are set reversely;
- (3) Jack up the rear wheels and slowly turn the steering wheel repeatedly to release the air out of the hydraulic pipeline and oil cylinder.

3.2.3 Malfunction diagnosis of steering system

Malfunction	Cause	Solution
Failure to rotate steering wheel	Damaged or failed oil pump	Replace
	Damaged rubber hose or connector or blocked pipeline	Replace or clean
Difficult rotation of steering wheel	Low pressure of safety valve	Adjust pressure
	Air in oil circuit	Release air
	Failed resetting of steering gear, broken or weak retaining spring	Replace spring piece
	Severe internal leakage of steering cylinder	Check piston seal
Crawl or swing of forklift truck	Broken or weak spring	Replace
Loud working noise	Low oil level in oil tank	Add oil
	Blocked suction pipe or oil filter	Clean or replace
Oil leakage	Damaged guide sleeve seal of steering cylinder, pipeline or connector	Replace

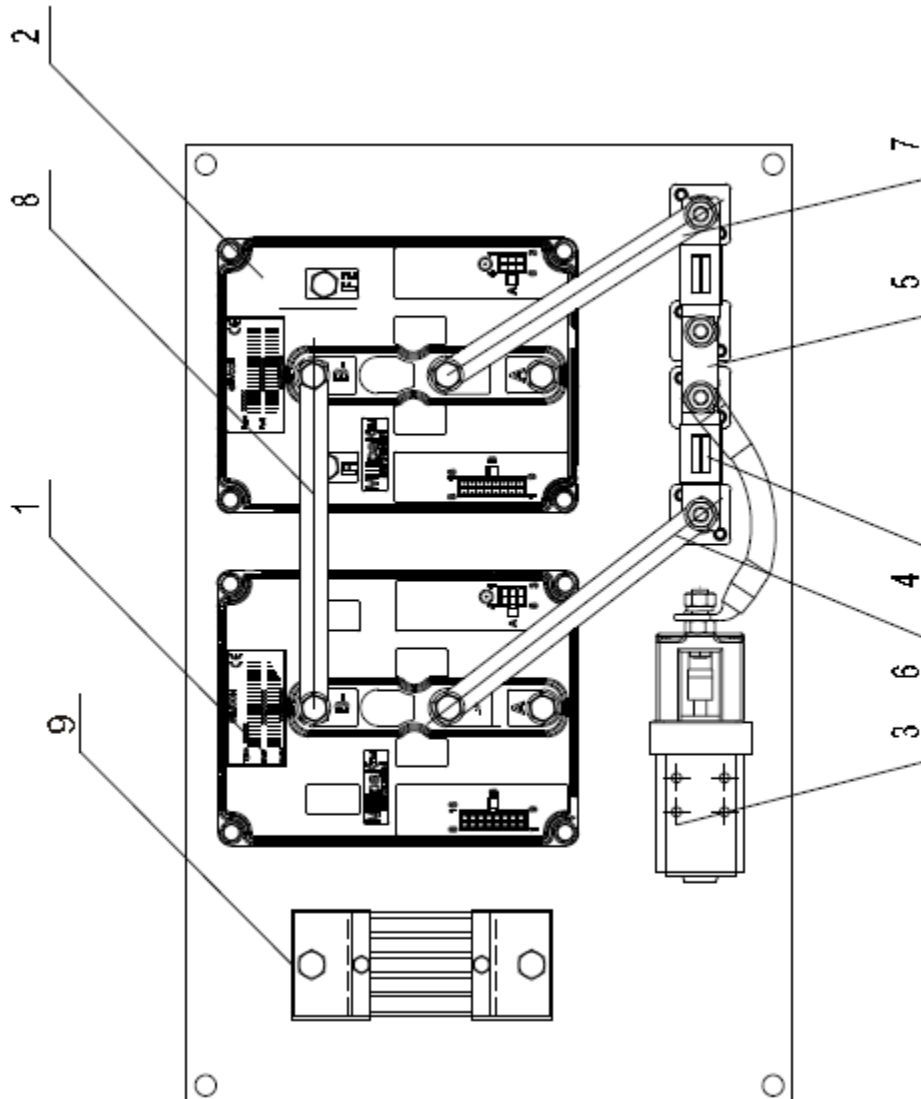
The steering motor of this forklift truck is controlled by the direction control lever. Only when the direction control lever is set at “Forward” or “Reverse” position and the accelerator pedal is depressed, can the motor be started.

To discharge air, start the steering motor and lightly rotate the steering wheel (in case of any abnormality, cut off the power supply immediately, find out the cause and do troubleshooting). The steering wheel shall be rotated easily and freely. The steering wheels will deflect accordingly. Rotate the steering wheel left/right repeatedly and the air in the system can be discharged completely.

4. Electrical system

4.1 SEVCON electric controller (1-2.5t)

The electrical system mainly includes battery, traveling motor, lifting motor, adjustment controller, control switch, combination instrument and lamps.



1. Reverse brake control box 600 A

2. Pump control box 600 A

3. Wire contactor

4. Fuse 425 A

5. Connecting wire

6. Connecting wire

7. Connecting wire

8. Connecting wire

9. Diverter 600 A

4.1.1 Malfunction diagnosis

Malfunction diagnosis of electric controller

When the control system of the forklift truck goes wrong, the malfunction code will appear on the instrument to inform the maintenance personnel. Refer to the section “Malfunction Code” in “Malfunction Diagnosis Table Instructions” attached with the forklift truck for malfunction diagnosis.

Malfunction diagnosis of MOSFET electric controller

In case of misoperation or malfunction, the LED flashes for warning. Below are the flashing times and the corresponding malfunction descriptions.

ON = No fault, normal condition

OFF = Internal controller fault

1 time = Setting out of range

2 times = Incorrect starting sequence

3 times = MOSFET short circuit

4 times = Contactor fault or motor open circuit

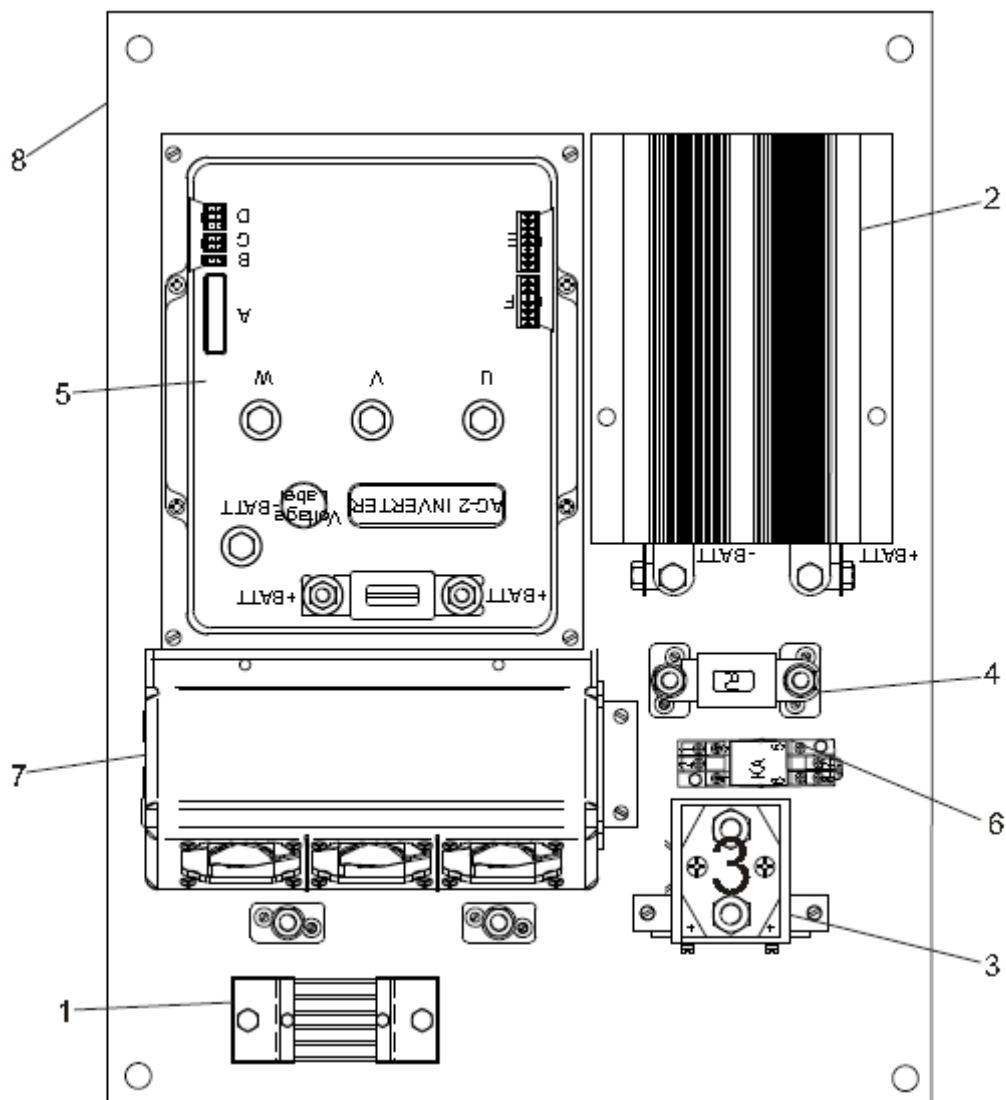
5 times = Not defined

6 times = Accelerator wire off, setting wrong or fault

7 times = Low or high power supply voltage

8 times = High temperature protection

4.2 ZAPI half AC electric controller (1-2.5t)



1. Diverter
4. Fuse
7. Fan

2. Oil pump controller
5. Traveling controller
8. Radiating plate

3. Main contactor
6. Relay

4.2.1 Malfunction diagnosis

Malfunction diagnosis of electric controller

When the control system of the forklift truck goes wrong, the malfunction code will appear on the instrument to inform the maintenance personnel. Refer to the section “Malfunction Code” in “Malfunction Diagnosis Table Instructions” attached with the forklift truck for malfunction diagnosis.

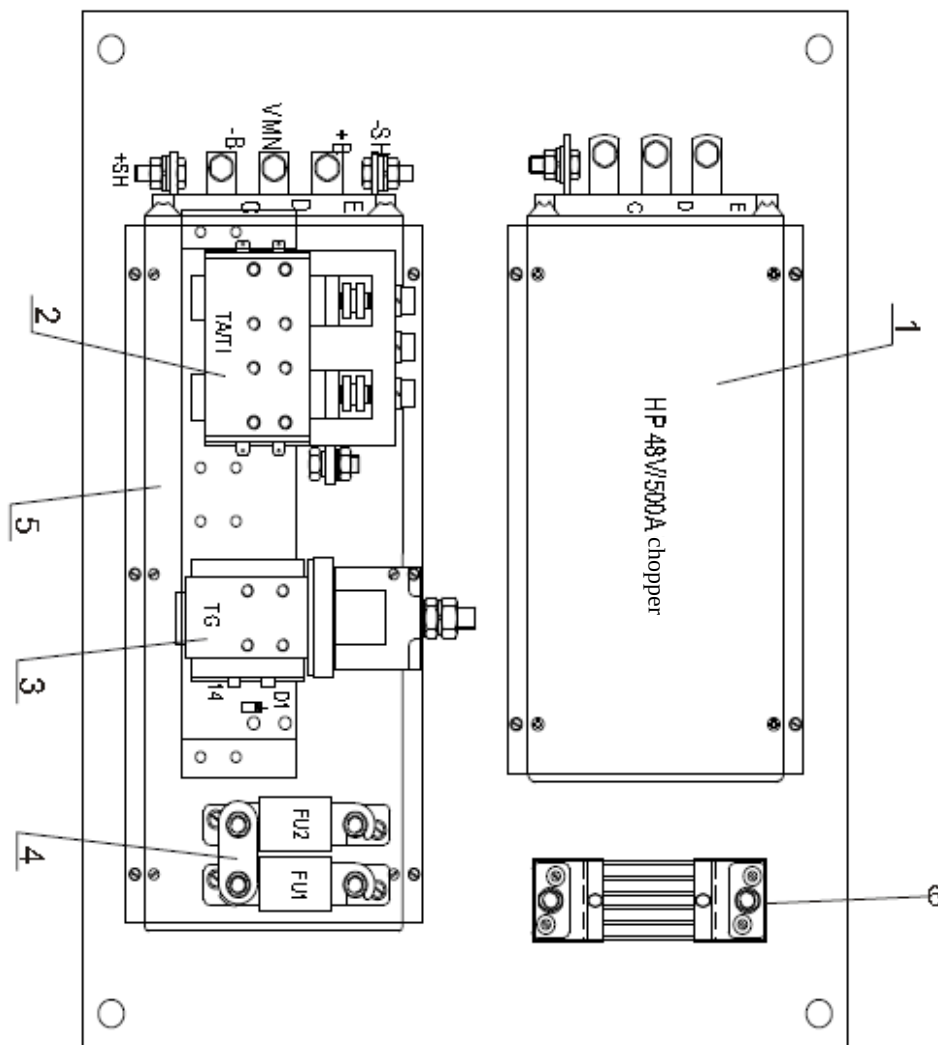
The table below lists the flashing times of LED and the corresponding messages displayed on the handheld display and instrument.

Flashing Times	Indication by Handheld Display	Indication by Instrument	Notes
1 time	WATCH DOG	AI08	The automatic diagnosis by watch dog will be performed under both operation and standby modes In case of any failure, replace the logic card.
Logic card failure	EEPROM KO	AI13	The memory saving adjusting parameters is damaged. In this case, the machine will stop automatically. This failure can be corrected by switching off the electric lock and then switching it on. If this method does not work, replace the logic card; if the failure is corrected, the data saved before will be deleted and substituted by factory settings automatically.
	LOGIC FAILURE #1	AI19	Failure of low/high voltage protection Possible causes: 1. Actual low/high voltage appears. 2. The high voltage protection hardware of logic card fails. Replace the logic card.
	LOGIC FAILURE #2	AI18	Failure of phase voltage feedback function of logic card Replace the logic card.
	LOGIC FAILURE #3	AI17	Failure of current protection function of logic card Replace the logic card.
	CHECK UP NEEDED	AI99	Alarm for overdue check of machine Check the machine.
	INCORRECT START	AI79	Incorrect starting sequence Possible causes: 1. Damaged operating switch 2. Incorrect starting sequence 3. Incorrect wire connection 4. If the above causes are excluded, replace the logic card.
	FORW + BACK	AI80	The machine will perform detection all along. When operation request signals in two directions are detected simultaneously, an alarm will be given. Possible causes: 1. Damaged wire 2. Failed inching switch 3. Improper operation 4. If the above causes are excluded, replace the logic card.
	HAND BRAKE	AI71	The vehicle cannot be started as the handle switch is turned on. Possible causes: 1. Damaged wire 2. Failed inching switch 3. Improper operation 4. If the above causes are excluded, replace the logic card.
3 times Capacitor charge error	CAPACITOR CHARGE	AI60	When the electric lock is switched on, the inverter charges the capacitor through the power resistor and check whether the capacitor is fully charged within the specified time. If not, the inverter will give an alarm and the main contactor will not close.

Flashing Times	Indication by Handheld Display	Indication by Instrument	Notes
Low/high phase voltage or VMN voltage			Possible causes and solutions: 1. Check whether the charging resistor is disconnected. If yes, replace the resistor. 2. Malfunction of charging circuit 3. Malfunction of power module battery
			This item will be checked during initialization and standby. Possible causes: 1. Incorrect motor connection; incorrect motor power supply connection; check whether the 3-phase power supply connection is correct and check the motor for earth leakage. 2. The inverted is damaged and needs to be replaced.
4 times Incorrect accelerator signal range			Check time: standby state The accelerator voltage is 1 V , exceeding the minimum set value within the accelerator signal range (Program vacc). Possible causes: 1. Improperly adjusted potentiometer 2. Damaged potentiometer
Failure of accelerator connection			In case of incorrect wire connection, an alarm will be given.
5 times High standby current			Check time: standby state If the current under standby state is not 0, an alarm will be given and the vehicle will stop automatically. Possible causes: 1. Damaged current sensor 2. Damaged logic plate. Replace the logic plate. If the failure still exists, replace the power unit.
6 times Short circuit of contactor coil			When the electric lock is switched on, the microprocessor will check the main contactor drive. If it works abnormally, an alarm will be given. In this case, replace the logic card. High current in main contactor coil will result in LED warning and opening of main contactor. Check the external circuit for short circuit or measure the resistance of the main contactor. If they are normal, replace the logic card.
Short circuit of main contactor drive			When the electric lock is switched on, the microprocessor will check the main contactor drive for short circuit. In case of short circuit, an alarm will be given and the logic card shall be replaced.
			At the end of initial diagnosis, pull the logic card, namely closing the main contactor, to check the drain voltage of the drive. If the voltage is high, an alarm will be given.
Open circuit of contactor			The logic card drives the main contactor coil but the contactor fails to close. Possible causes: 1. Disconnected or poorly connected coil cable 2. Contactor's contact working abnormally
Malfunction of electric brake drive			The microprocessor checks the electric brake drive. If the output state of the drive is inconsistent with the input signal of the microprocessor, an alarm will be given and the logic card shall be replaced.
Failure of hour meter output			Incorrect Hm (standard model) output Causes: damaged output transistor; damaged logic card
7 times Temperature			The inverter temperature exceeds 75°C and the maximum current of the inverter reduces with the increase of

Flashing Times	Indication by Handheld Display	Indication by Instrument	Notes
protection			temperature. When the temperature reaches 100°C , the inverter stops working. If the malfunction appears when the inverter is under cold state: 1. Check the connection of the temperature sensor 2. Malfunction of temperature sensor 3. Malfunction of logic card
			The system will check the signals of the temperature sensor all along. If any signal exceeds the range, an alarm will be given. In this case, check the sensor connection.
All along			Low battery. When the electric quantity of the battery is less than 10% of the capacity, this failure will occur. The maximum current drops to 50% .

4.3 ZAPI DC electric controller (1-2.5t)



1. Chopper
4. Fuse

2. Oil pump controller
5. Traveling controller

3. Main contactor
6. Diverter

4.3.1 Malfunction diagnosis

Malfunction diagnosis of electric controller

When the control system of the forklift truck goes wrong, the malfunction code will appear on the instrument to inform the maintenance personnel. Refer to the section “Malfunction Code” in “Malfunction Diagnosis Table Instructions” attached with the forklift truck for malfunction diagnosis.

Malfunction diagnosis of MOSFET electric controller

In case of misoperation or malfunction, the LED flashes for warning. Below are the flashing times and the corresponding malfunction descriptions.

2 times = Incorrect starting sequence

4 times = Accelerator failure

5 times = Damaged current sensor or logic card

6 times = Overload of contactor drive output

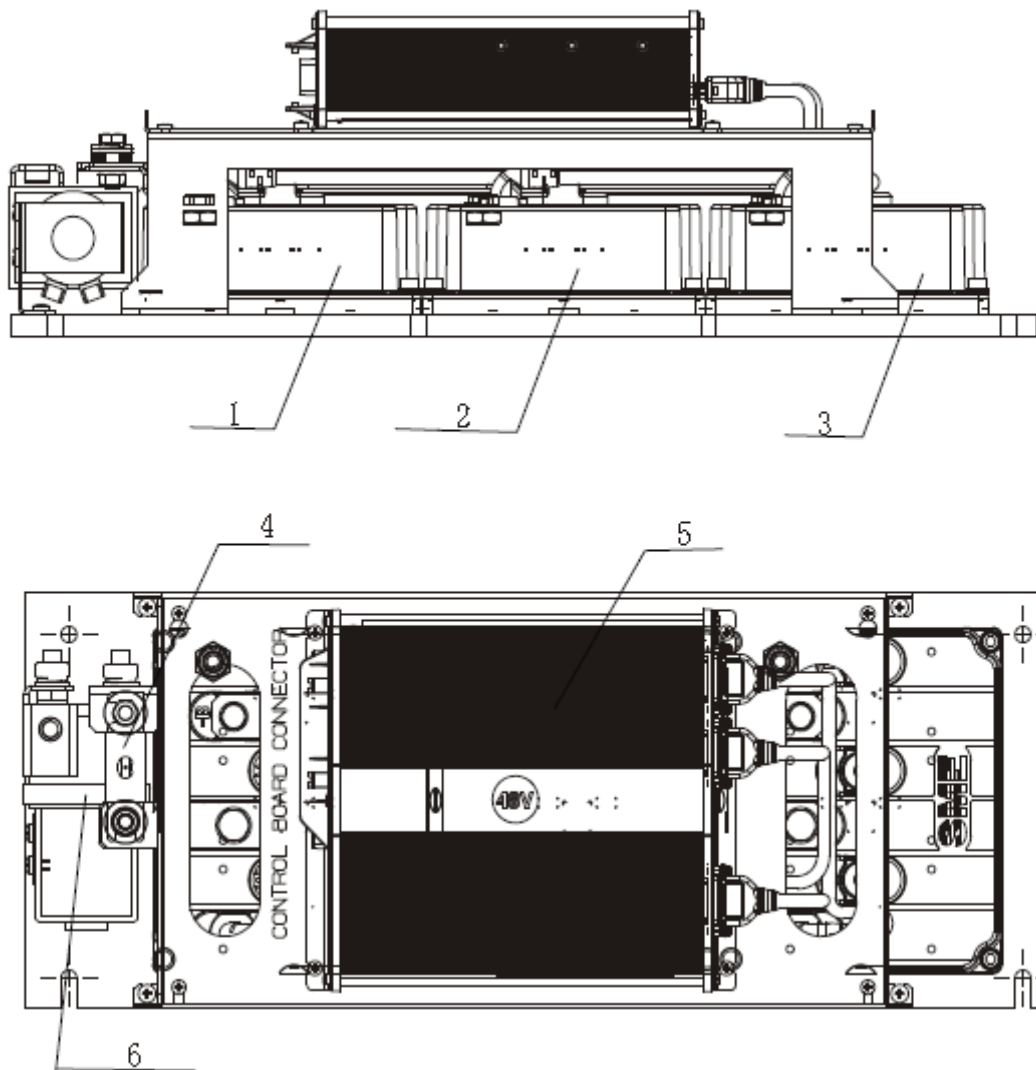
7 times = Temperature protection of chopper

8 times = Failed closure of regenerative contactor

9 times = Failed opening of regenerative contactor

32 times = Over-discharge of battery

4.4 SME electric controller (3-3.5t)



1. Left motor

2. Lifting motor

3. Right motor

4. Fuse box

5. Controller

6. Main contactor

4.4.1 Malfunction diagnosis

Malfunction diagnosis of electric controller

When the control system of the forklift truck goes wrong, the malfunction code will appear on the instrument to inform the maintenance personnel. Refer to the section “Malfunction Code” in “Malfunction Diagnosis Table Instructions” attached with the forklift truck for malfunction diagnosis.

F0: High battery voltage

F1: Low battery voltage

91, F9: Damaged or loose angle potentiometer

FL: Constantly closed pump controller input switch

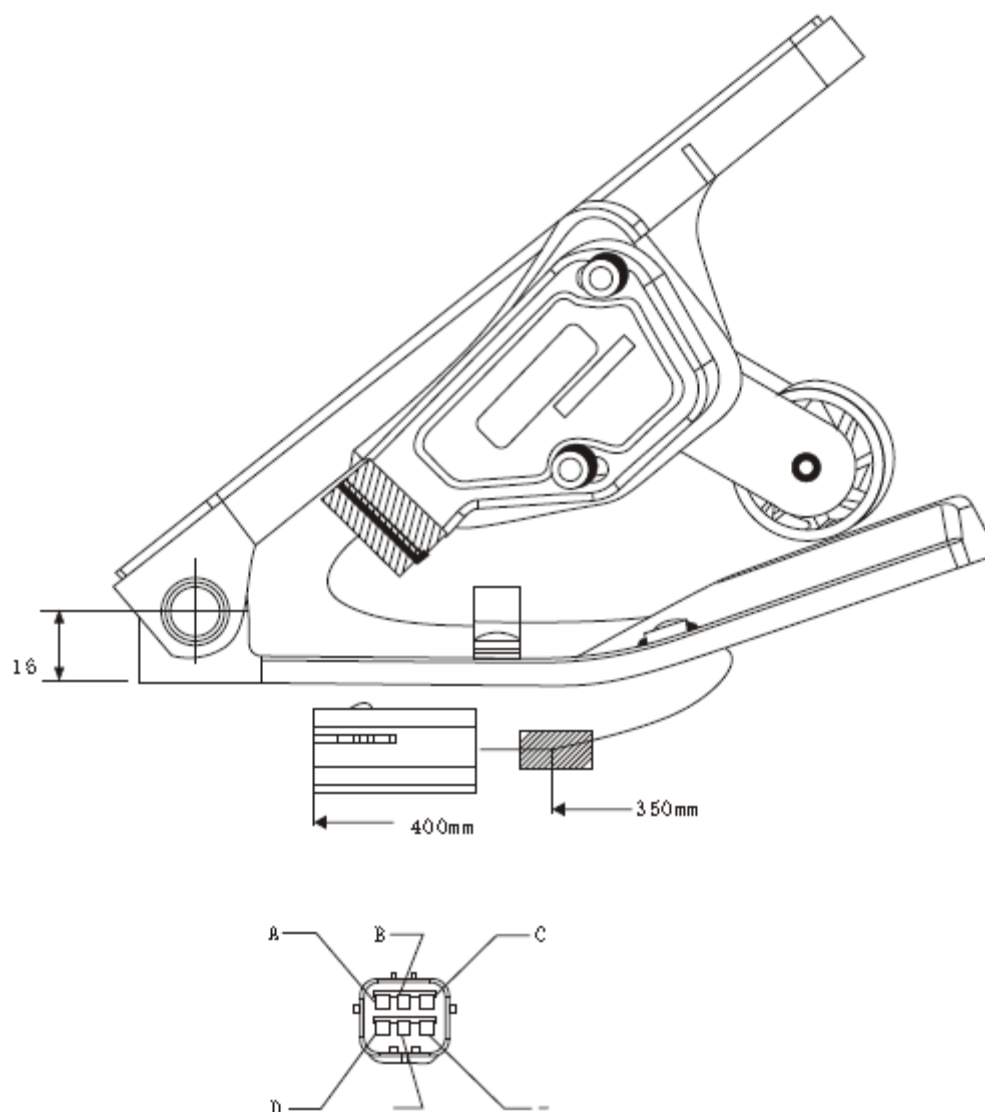
E4, E5, E6: High motor temperature

EE: Open seat switch or incorrect starting sequence

EL: Low battery

17: Failure of main contactor

4.5 Accelerator



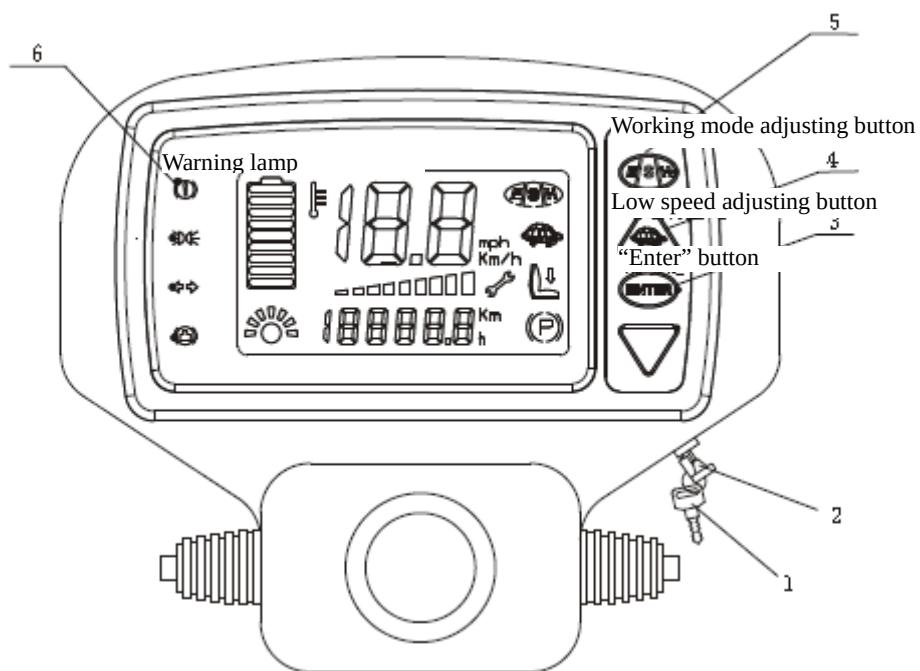
Terminal	Function	Wire Color
A	Power supply input	Red
B	Accelerator output	Green
C	Negative pole	Black
D	Starting switch (-)	Yellow
-	Starting switch (+)	Blue

Fig. 4-1 Accelerator

4.6 Instrument

With the microcomputer technology, the combination instrument has such advantages as real-time sampling, display and control, which allows more flexible and comfortable operation. The instrument is specially provided with low battery voltage warning and protection function which provides better protection for the battery and vehicle.

(1) Symbol explanation



1. Electric lock

2. Light switch

3. "Enter" button

4. Low speed adjusting button

5. Working mode adjusting button

6. Warning lamp

4.7 Battery Operation

(1) Charging the battery

Charge the battery with a proper charger and operate it strictly according to the stipulations in the **Operation & Maintenance Manual** for the charger.

- a) Pull the parking brake lever backward in place to make the parking brake work.

! Caution

* **Keep the battery electrolyte at the specified level, or else it may cause overheating or burnout of the battery.**

* **If the battery electrolyte is insufficient, the service life of the battery will be shortened.**

- b) Add pure water or distilled water.
c) Over-charging is absolutely prohibited.
d) The charging place shall have good ventilation.

! Caution

* **Charge the battery at a place where is well ventilated and away from moisture.**

- e) Open the battery cover.

! Caution

* **Hydrogen will be produced during the charging process; therefore, open the battery cover.**

- f) Check the terminal, cable and plug.

! Caution

* **Check the plug and cable for damage before charging.**

Don't charge the battery when:

- The plug electrode is damaged.
- The terminal and cable are rusted.

These situations may result in accidents such as electric sparks, burns and explosions.

- g) Charge the battery after turning off the key switch.
h) Check the specific gravity.

Measure the specific gravities of the electrolyte of all cells before charging to see if there is any abnormality within the battery and prevent accidents.

- i) Hold the plug or handle other than the cable when connecting or pulling out the plug.

! Caution

* **Don't pull the cable.**

* **When the cable or plug is damaged, contact with the Sales Department of our Company for replacement.**

- j) Stop charging.

! Caution

* Stop charging in strict accordance with the stipulations in the *Operation & Maintenance*

Manual for the charger.

- * Never pull the charger plug during the charging process, or else it may cause dangerous sparks.

(2) Replacing the battery

After the forklift truck continues working for an operation cycle and the battery energy is used up, replace the battery with a fully charged battery pack in time and then charge the dismantled battery.

! Caution

- * **There are two drainage holes at the bottom of battery box; pull out the hole plugs to drain the waste fluid in the battery box.**
- * **Drain the waste fluid at the specified place or to a container; the waste fluid shall be disposed as specified and cannot be discarded randomly.**

! Caution

- * **When replacing the battery, make sure that the battery matches with the forklift truck (for the 1-1.5 t forklift, the battery shall has a voltage of 48 V and a capacity no less than 400 Ah; for the 2-2.5 t forklift, the battery shall has a voltage of 48 V and a capacity no less than 620 Ah). Using unsuitable batteries will reduce the working time of the forklift truck. Using the battery with a low capacity will cause the forklift truck to overturn when traveling due to a light weight.**
- * **The replacement shall be performed on a flat platform.**

Replace the battery in the following steps:

! Caution

- * **When using another forklift truck as the lifting equipment for battery replacement, apply a suitable spreader (attachment).**
- * **The lifting of battery shall be performed by a professional.**
 - a) Pull out the battery plug and open the upper battery cover.
 - b) Remove the right shield and the locking plate.

Lock the upper battery cover securely with a gas spring or other means to prevent the upper battery cover from falling off to hurt people or the forklift truck body.
 - c) When lifting the battery box out of the forklift truck, take care not to damage the steering wheel or other components.
 - d) After installing a fully charged battery pack, connect the battery plug securely.
 - e) Hook the axis pins on the battery box with the locking plates at both sides of the battery.
 - f) Close the upper battery cover.

! Caution

- * **Take care not to squeeze your fingers when closing the upper battery cover.**
- * **Take care not to damage the forklift truck body due to the swing of the battery box when lifting the battery box.**

(2) Operation instructions

1. Voltage meter: displaying the current battery voltage value.
2. Light switch.

3. Electronic lock.
4. Battery voltage indicator lamp: Lighting on when the electronic lock is closed to indicate the forklift truck is electrified and can work.
5. Under-voltage indicator lamp: when this lamp lights on, it indicates the battery is in under-voltage condition; meanwhile, the control power supply (negative pole) of the lifting switch is disconnected and the lifting operation cannot be performed, thus achieving the protection function. The under-voltage value of the 48 V battery is set as 40 V in consideration of the general operation condition of the electric counterbalanced forklift truck; in other words, when the forklift truck works, if the battery voltage is lower than 40 V, the under-voltage protection relay will work after the value of 40 V is displayed for several seconds.
6. Right turn indicator lamp.
7. Hand brake indicator lamp.
8. Width indicator lamp.
9. Traveling indicator lamp.
10. Reversing indicator lamp.
11. Headlamp indicator lamp.
12. Left turn indicator lamp.
13. Electric controller hour meter.
14. Electric controller fault code display: when the electric controller has a fault, this instrument will display a certain code and provide fault diagnosis information for the service personnel.

Harness diagram

1. Overhead guard harness (left) Fig. 4-2
2. Overhead guard harness (right) Fig. 4-3

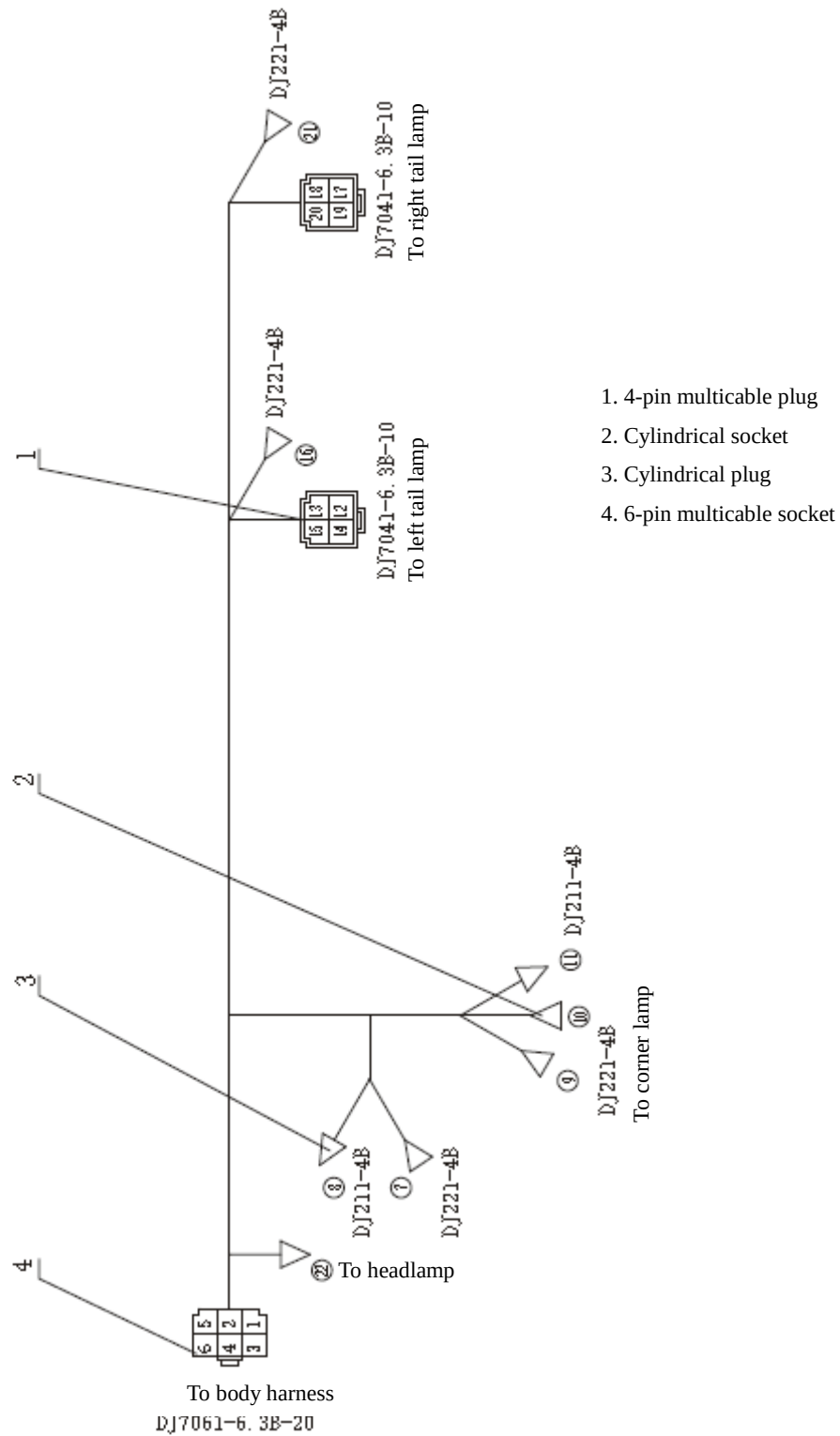


Fig. 4-2 Overhead Guard Harness (Left)

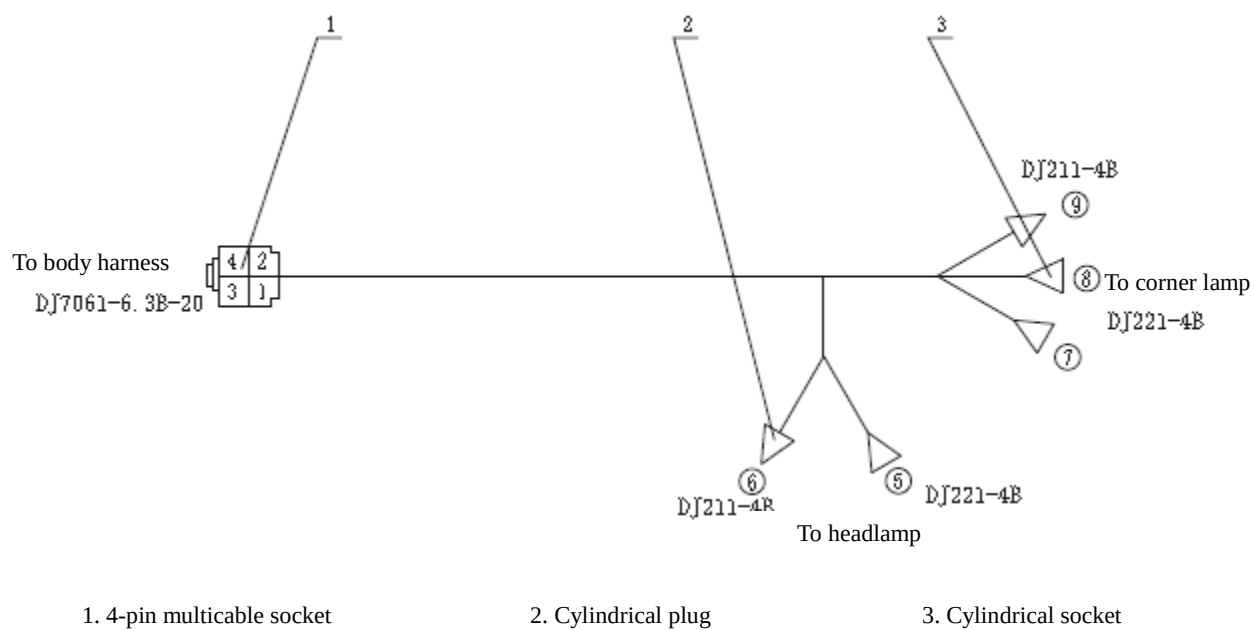


Fig. 4-3 Overhead Guard Harness (Right)

5. Hydraulic system

5.1 General

The hydraulic system consists of main oil pump, multi-way valve, lifting cylinder, tilting cylinder and pipeline. See Fig. 5-1.

The hydraulic oil is supplied by the oil pump directly connected with the motor and then distributed to each cylinder by the multi-way valve.

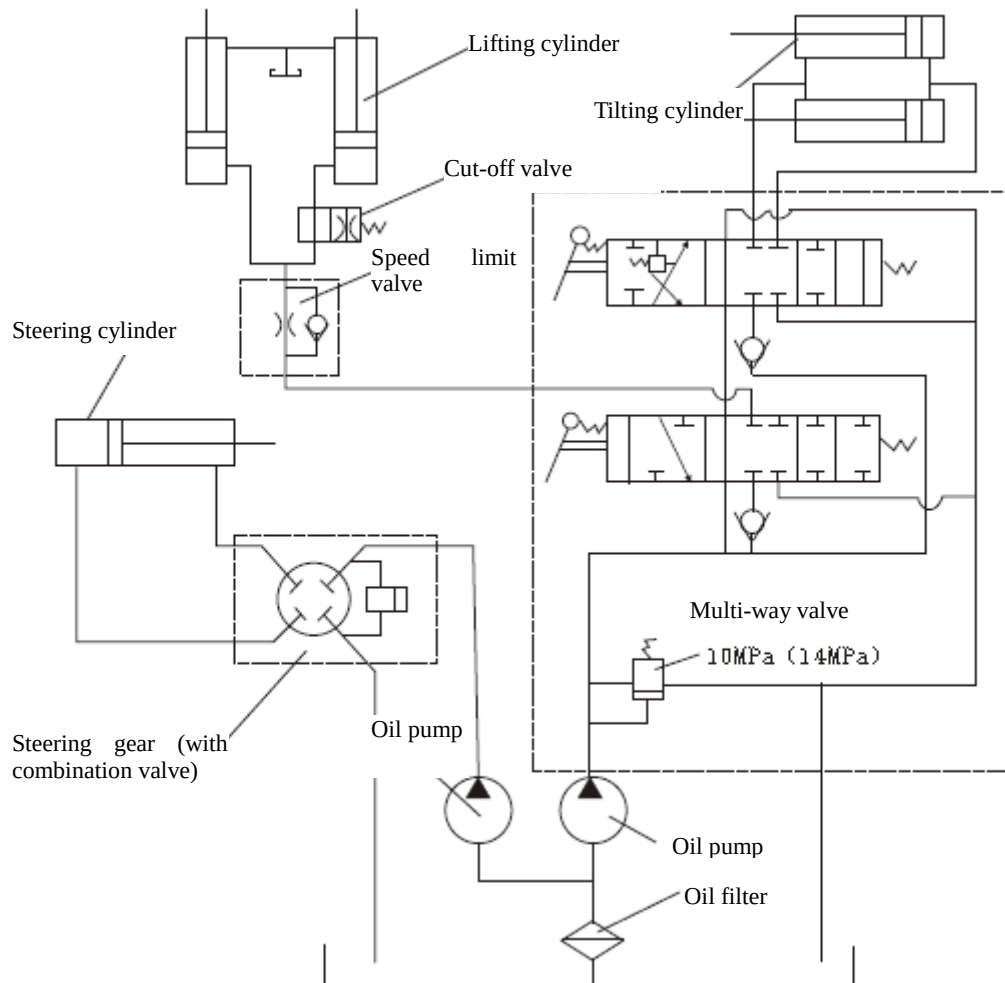


Fig. 5-1 Hydraulic System

5.1.1 Oil pump

The oil pump is a gear pump. One oil pump is used for both lifting and steering.

Oil pump models:

CBD-F316LH4 for 1-1.5t

CBD-F320LH4 for 2-2.5t

CBD-F320 LS11 for 3-3.5t

5.1.2 Multi-way valve

The two-throw multi-way valve consists of 4 valve bodies. The multi-way valve stem controls the hydraulic oil from the oil pump and then distributes the high-pressure oil to the lifting cylinder or tilting cylinder. One safety valve and one self-locking valve are set in the multi-way valve. The safety valve is located at the upper side of the oil inlet. It is used to control the system pressure. The self-locking valve is located on the inclined valve plate. It is used to prevent the tilting cylinder from operating the control lever accidentally when there is no pressure source and accordingly avoid accidents. A one-way valve is set between the oil inlet and the oil suction port of lifting valve plate and between the oil inlet of lifting valve plate and the oil inlet of tilting valve plate respectively.

See Fig. 5-2 for the multi-way valve.

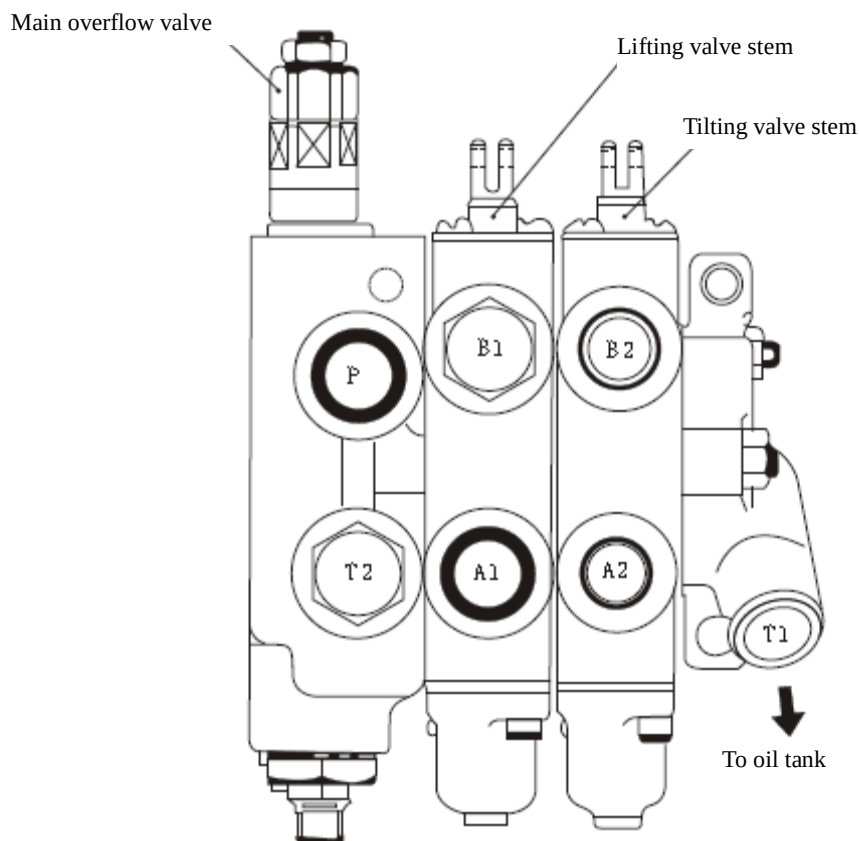


Fig. 5-2 Multi-way Valve

(1) Operation of slide valve (take the tilting slide valve as the example)

(a) Neutral position (Fig. 5-3)

The high-pressure oil from the oil pump returns to the oil tank via the neutral position.

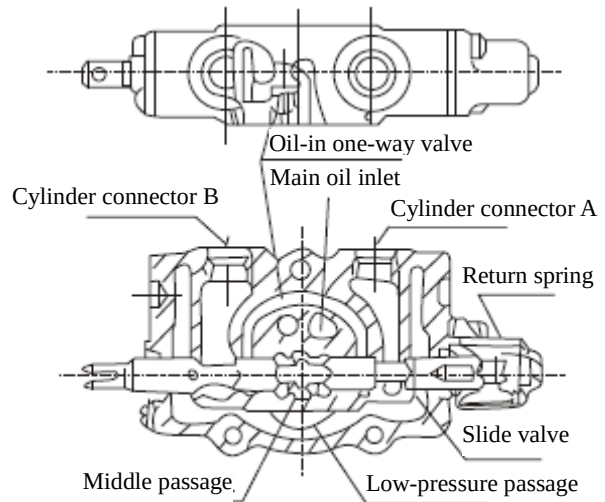


Fig. 5-3

(b) Pushing into the slide valve (Fig. 5-4)

The middle passage is closed. The oil from the oil inlet opens the one-way valve and flows to oil cylinder connector B. The oil from oil cylinder connector A flows into the oil tank via the low-pressure passage. With the assistance of return spring, the slide valve can return to the neutral position.

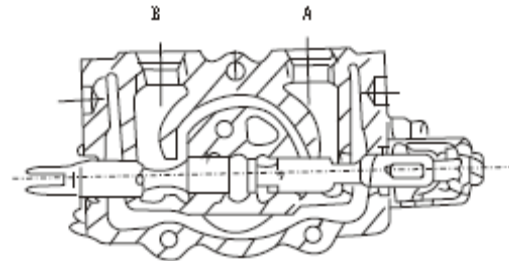


Fig. 5-4

(c) Pulling out the slide valve (Fig. 5-5)

The neutral position is closed. The oil from the oil inlet opens the one-way valve and flows to oil cylinder connector A. The oil from oil cylinder connector B flows into the oil tank via the low-pressure passage. With the assistance of return spring, the slide valve can return to the neutral position.

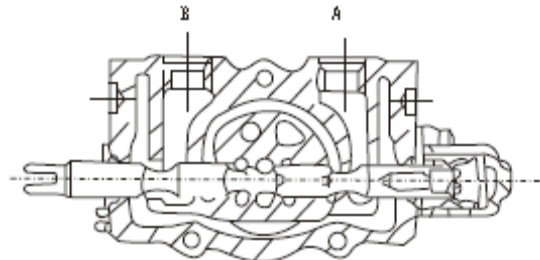


Fig. 5-5

(2) Operation of safety overflow valve

An overflow valve is installed between the HP connector of oil pump and the low-pressure (LP) passage. The oil passing through the lifting valve C acts on different areas with diameters A and B respectively. Thus, both the one-way valve K and overflow lifting valve D are set on the valve seat. See Fig. 5-6.

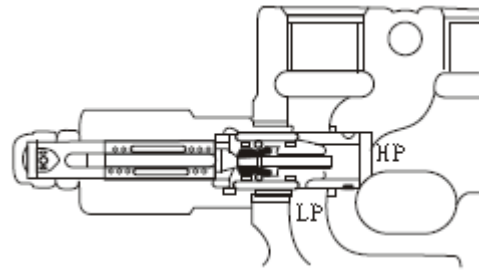


Fig. 5-6

The set pressure in HP passage of oil pump acts on the guide valve spring. Then, the one-way valve F will be opened and the oil flows to the low-pressure (LP) side through the through-holes around the valve. See Fig. 5-7.

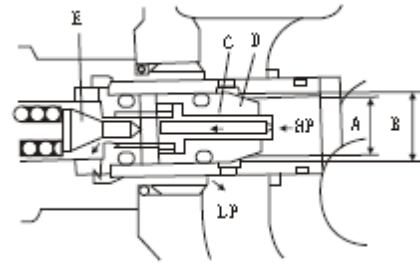


Fig. 5-7

Once the guide valve E is opened, the pressure inside the valve C will drop and the valves E and C will be set on the valve seats. As the oil flow that has passed through the valve D is blocked, the inside pressure will drop. See Fig. 5-8.

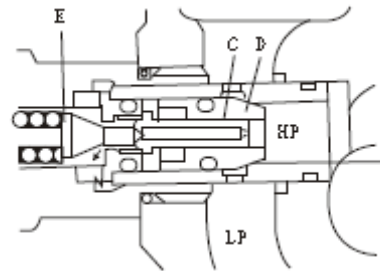


Fig. 5-8

When the pressure at HP passage side and the inside pressure are unbalanced, the valve D will be opened under the effect of pressure difference and the oil directly flows into the low-pressure (LP) passage. See Fig. 5-9.

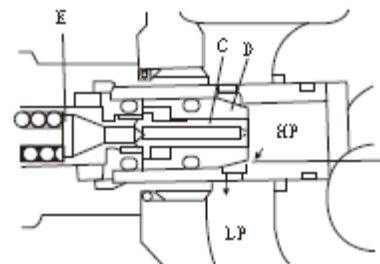


Fig. 5-9

(3) Operation of tilting self-locking valve

The tilting cylinder valve plate is provided with a tilting self-locking valve. It is mainly used to prevent the sudden falling of mast in case of negative pressure in the cylinder and prevent dangers in case of misoperation of tilting valve stem. With this tilting self-locking valve, after engine stop, even the control lever is pushed forcefully, the mast will not be tilted.

The oil flow direction when the valve core is pulled out is the same as that indicated in Fig. 5-5. In this case, the mast tilts backwards. Below are the states when the valve core is pushed in.

- (a) When the valve core is pushed in (pump working)

The oil from the main pump flows into the tilting cylinder through the connector B and the oil returning from the oil tank acts on the piston through the oil port A. The oil returns to the oil tank through the holes A and B on the valve core and the low-pressure passage.

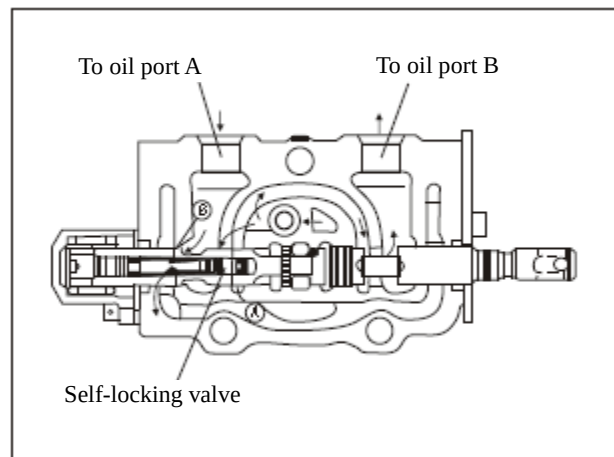


Fig. 5-10

- (b) When the valve core is pushed in (pump not working)

When the valve core is pushed in with the pump not working, no oil will flow into the cylinder connector B. In this case, the pressure at position P will not increase. Therefore, the piston will not move and the oil at cylinder connector A cannot return to the oil tank, and consequently the cylinder does not operate.

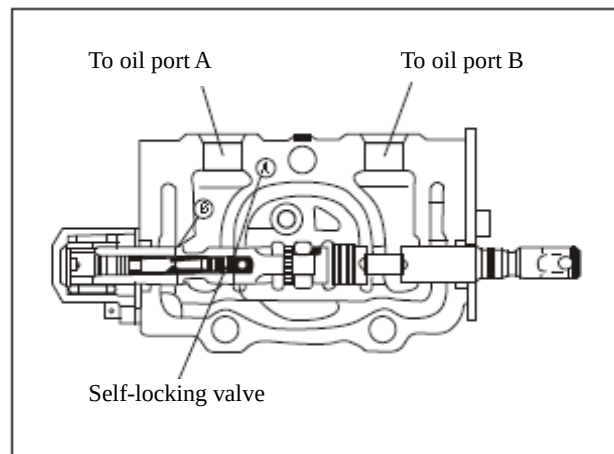


Fig. 5-11

(4) Control of multi-way valve

The multi-way valve is controlled by control levers. All control levers are installed on one connecting shaft. The shaft is fixed on the instrument stand through a support. The control levers control the slide valve through the connecting rod.

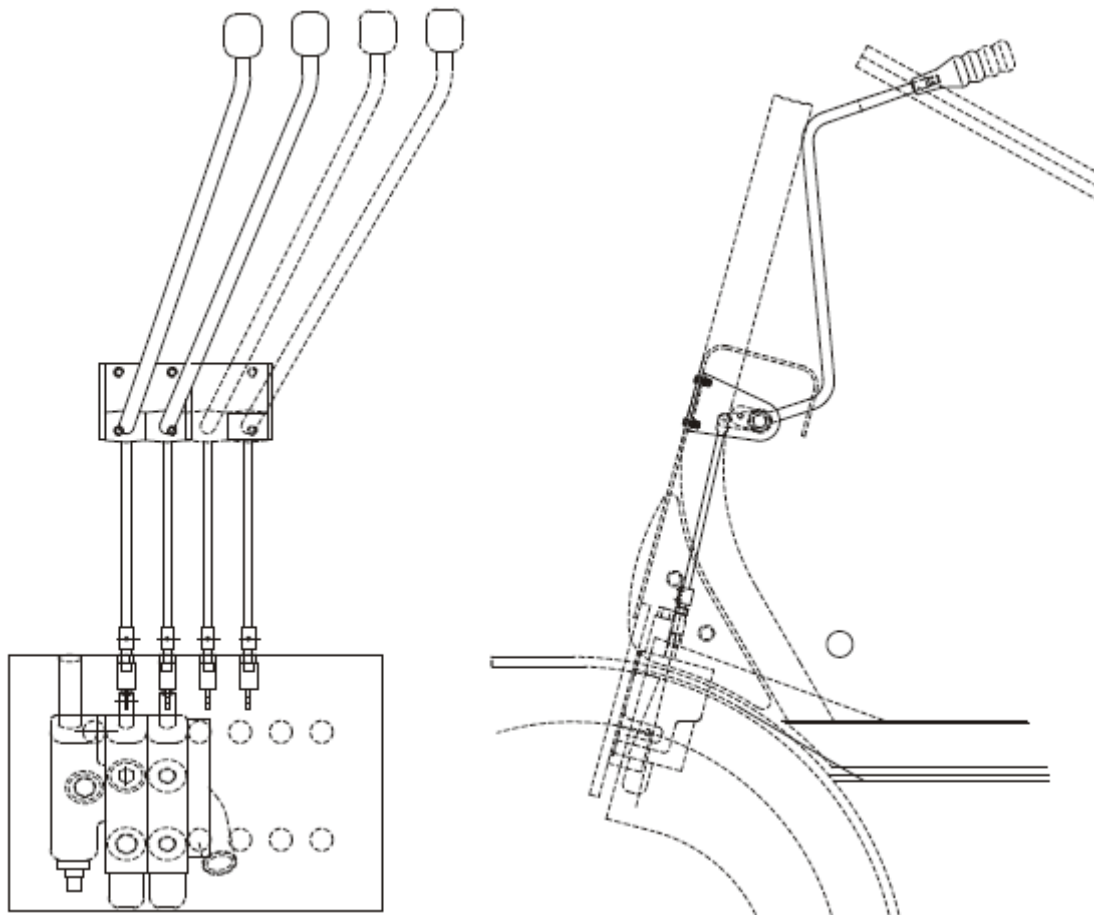


Fig. 5-12 Control of Multi-way Valve

(5) Pressure adjustment of multi-way valve

	1-1.5t	2-2.5t	3-3.5t
Set pressure of safety valve	14.5 MPa	17.5 MPa	17.5 MPa
Set pressure of steering gear	4.5 MPa	6.3 MPa	6.3 MPa

5.1.3 Lifting cylinder

The lifting cylinder is a single-acting piston type cylinder. It consists of cylinder block, piston rod, piston and cylinder head. For this series of forklift trucks, two lifting cylinders are installed behind the outer mast. The bottom of the lifting cylinder is fixed to the lifting cylinder seat of outer mast by pins and bolts. The top of the lifting cylinder (namely the piston rod top) is connected with the upper cross beam of inner mast.

The piston is fixed on the piston rod with elastic steel wires. The piston outer ring is provided with an oil seal and a supporting ring.

A cut-off valve is installed at the cylinder bottom. It can provide protection in case of sudden mast lifting or sudden burst of high-pressure hose.

The cylinder head is equipped with a steel-backed bearing and an oil seal to support the piston and prevent dust.

See Fig. 5-13 for the lifting cylinder structure.

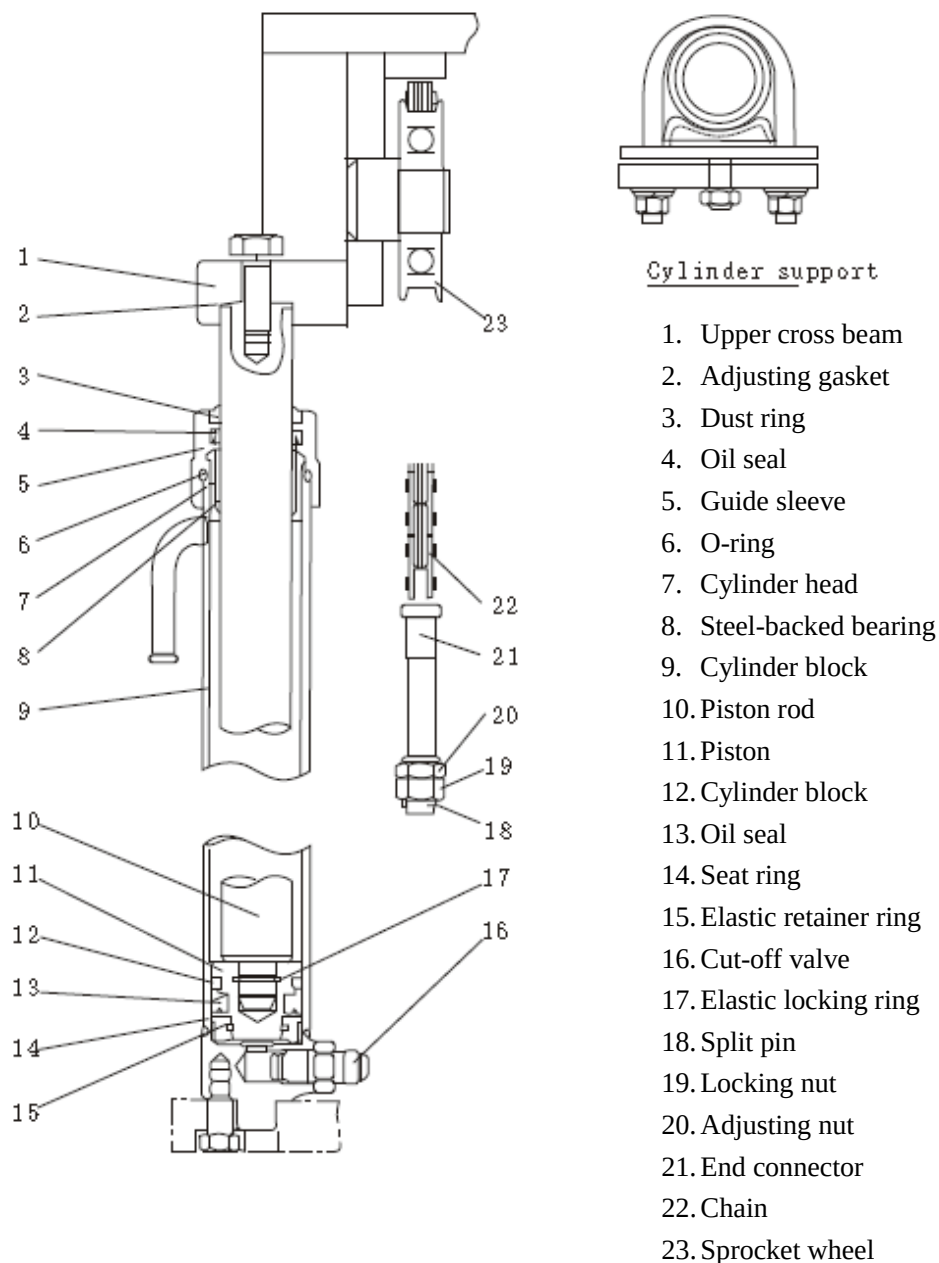


Fig. 5-13 Lifting Cylinder

■ Operation of cut-off valve

A cut-off valve is installed at the cylinder bottom. See Fig. 5-14. It is used to prevent the goods from falling quickly in case of sudden burst of high-pressure hose. The oil from the lifting cylinder passes through the cut-off valve slide valve. The oil holes around the slide valve produce a pressure difference between the two chambers. When this pressure difference is smaller than the spring force, the slide valve does not act. If the high-pressure hose bursts, a large pressure difference will be produced. Consequently, the slide valve will move to block the surrounding oil holes and only a little of oil will flow through the hole at the slide valve end. In this case, the forks will fall slowly.

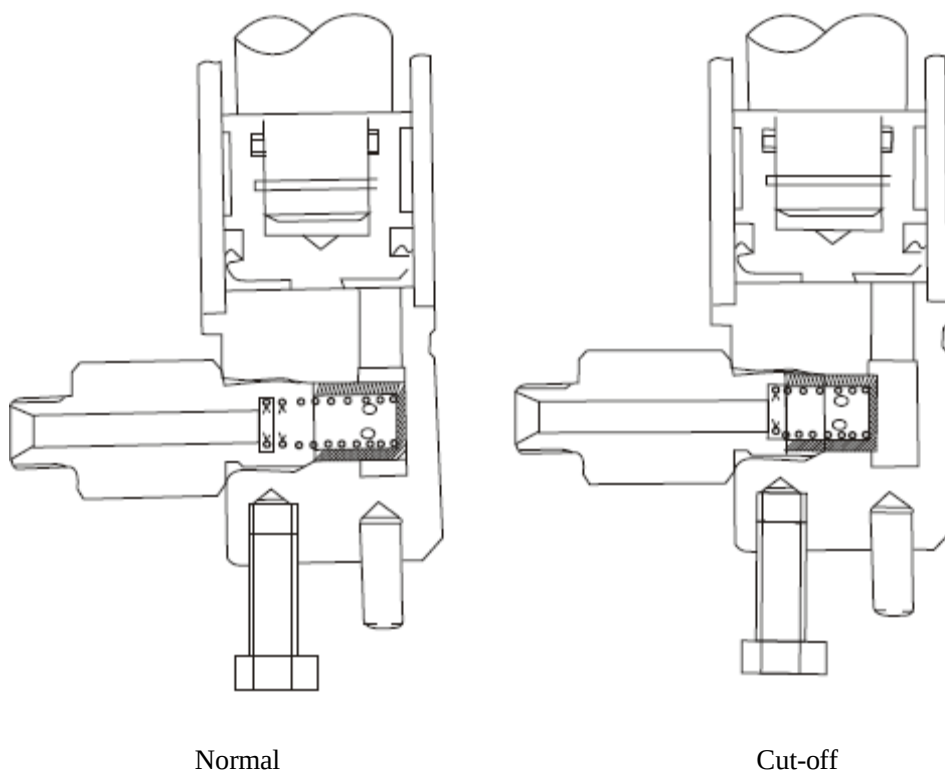


Fig. 5-14

5.1.4 Speed limit valve

The speed limit valve controls the fork falling speed and provides protection under emergencies such as high-pressure pipe burst. See Fig. 5-15.

■ Operation of speed limit valve (Fig. 5-16)

The oil returning from the lifting cylinder flows into valve chamber G and then returns to the multi-way valve through F, E, D, C, B and A.

When lots of oil passes through the valve core hole C, the pressure difference generated here pushes the valve core ④ to move right.

Then, the passage between holes D and C narrows, reducing the returning oil as well as the fork falling speed.

To lift the fork, the high-pressure oil from the multi-way valve flows into the lifting cylinder through A, B, C, D, E, F and G.

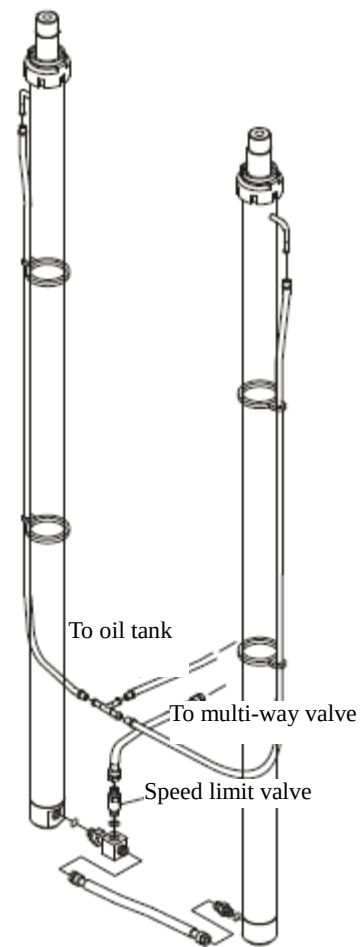


Fig. 5-15

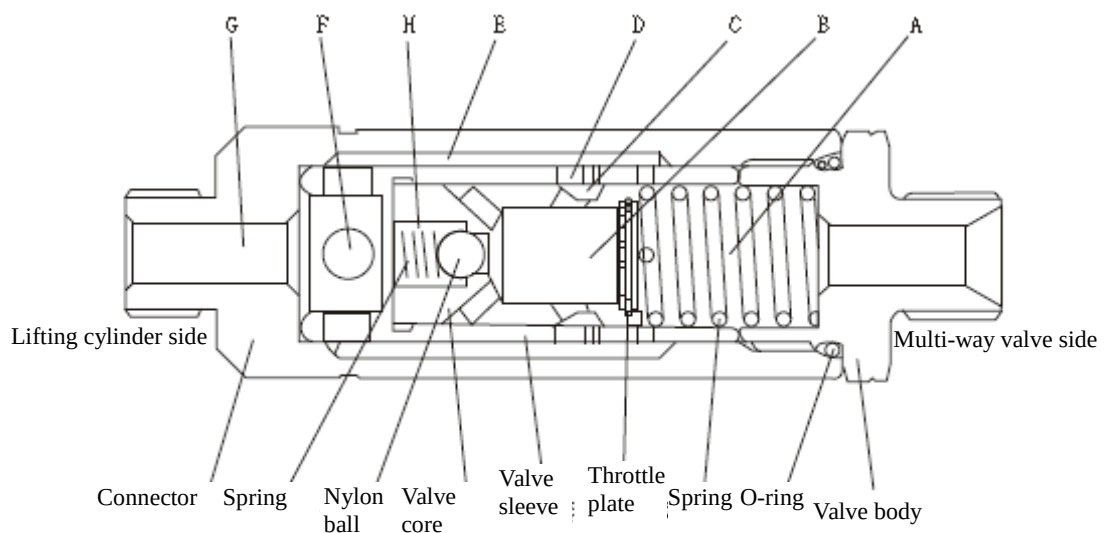


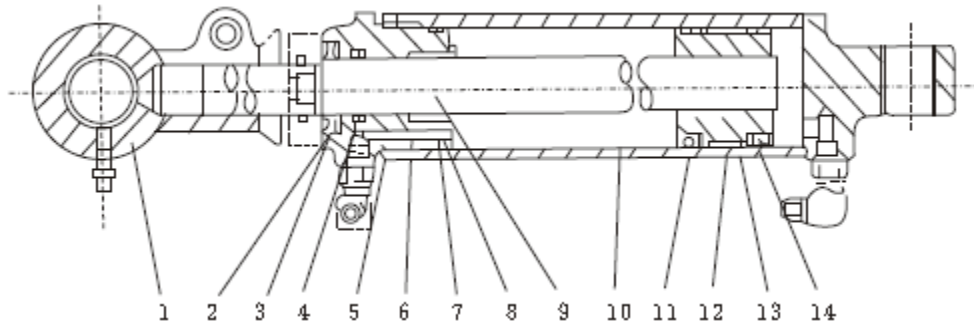
Fig. 5-16 Speed Limit Valve

5.1.5 Tilting cylinder

The tilting cylinder is a double-acting cylinder. Its piston rod end is connected with the mast through an eye ring. The tilting cylinder bottom is connected with the frame with pins. One tilting cylinder is installed at the left/right side of the forklift truck respectively.

The tilting cylinder assembly consists of piston, piston rod, cylinder block, cylinder bottom, guide sleeve and seal. The piston and piston rod are of welding structure. The piston outer ring is provided with a supporting ring and two Yx-type seal rings. The inner hole of guide sleeve is equipped with a shaft sleeve, a Yx-type seal ring, a retainer ring and a dust ring. The shaft sleeve supports the piston rod. The seal ring, retainer ring and dust ring can prevent oil leakage and dust ingress. They are fitted onto the cylinder block together with the O-ring. See Fig. 5-17.

When the tilting cylinder slide valve is pushed forwards, the high-pressure oil enters the cylinder from the bottom and pushes the piston forwards to tilt the mast forwards. When the slide valve is pulled backwards, the high-pressure oil enters the cylinder from the front end of cylinder block and pushes the piston backwards to tilt the mast backwards.



- | | | | |
|----------------------|-----------------|-----------------------|-----------------------|
| 1. Eye ring | 5. O-ring | 9. Piston rod | 13. Piston |
| 2. Dust ring | 6. Guide sleeve | 10. Cylinder block | 14. Yx-type seal ring |
| 3. Retainer ring | 7. Shaft sleeve | 11. Yx-type seal ring | |
| 4. Yx-type seal ring | 8. O-ring | 12. Supporting ring | |

Fig. 5-17 Tilting Cylinder

5.1.6 Hydraulic oil tank

For 1-2.5t forklift trucks, the hydraulic oil tank is installed on right box body of frame. An oil suction filter is set in the tank to ensure oil cleanliness.

5.1.7 Hydraulic pipeline

See Fig. 5-18 for the hydraulic pipeline.

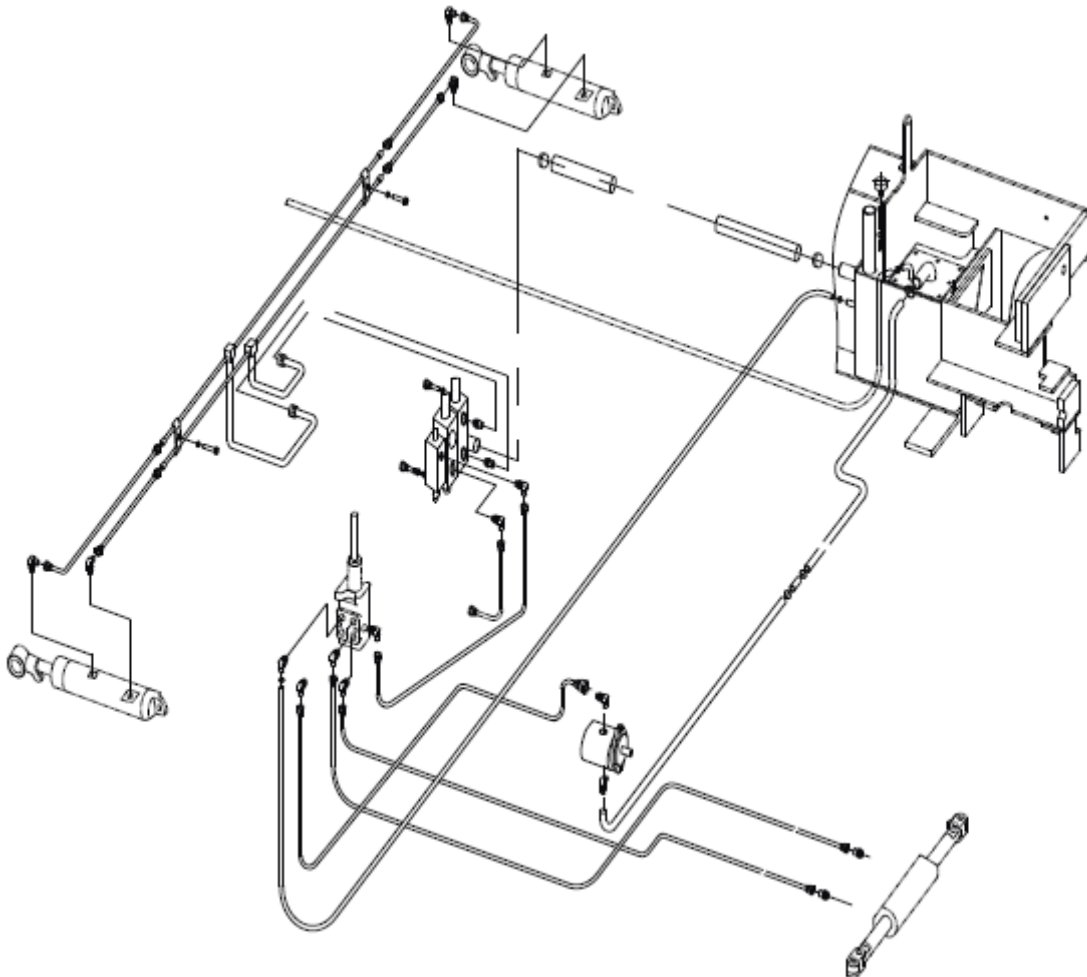


Fig. 5-18 Hydraulic Pipeline

5.2 Maintenance and adjustment

5.2.1 Maintenance of gear pump

(1) Disassembly (Fig. 5-26)

Before disassembly, clean the pump thoroughly. Place the removed parts on a piece of clean paper or cloth. Do not spot or operate any part.

- (a) Clamp the flange of pump on the vice bench.
- (b) Remove the connecting bolt 11, pump cover 5 and pump box 1.
- (c) Remove the liner plate 6, driving gear 2 and driven gear 3.
- (d) Remove the seal ring 7 and retainer ring 8 from the front and rear end covers.

Notice: If the seal ring will not be replaced, do not remove it from the front end.

(2) Check

Check the disassembled parts. Clean them with gasoline (except the rubber parts).

(a) Pump body

If the contact length between the internal chamber of pump body and the gear exceeds $1/2$ of the circumference, replace the pump body.

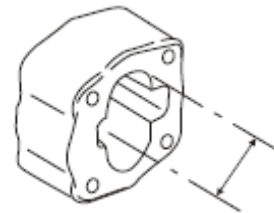


Fig. 5-20

(b) Liner plate

Check the contact surface of the liner plate. If the surface is damaged or the liner plate thickness is less than the specified value, replace the liner plate.

Specified liner plate thickness: 4.94 mm

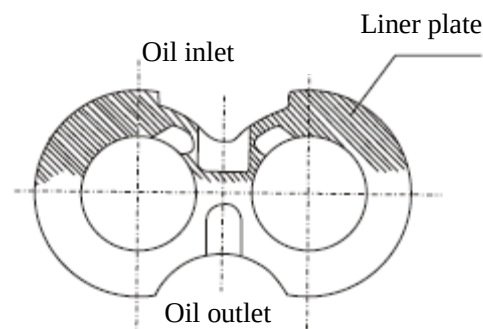


Fig. 5-21

(c) Front and rear pump covers

If the inner surface bushing discolors (brown) for more than 150°, replace it.

- (d) Check the driving and driven gears from front and rear. In case of excessive wear, replace a pair. If the size D is smaller than the specified value, replace them in pairs.

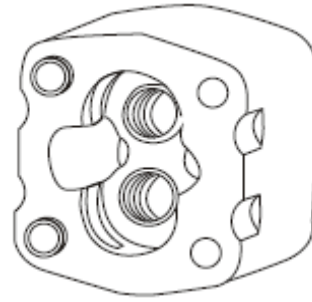


Fig. 5-22

- (e) Replace the seal ring, bushing seal, retainer ring, oil seal and elastic retainer ring as required.

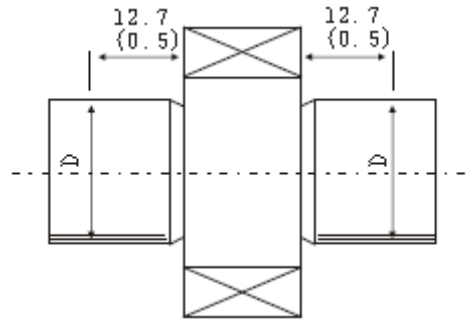


Fig. 5-23

(3) Assembly

- (a) Install a new seal ring and a new retainer ring on the front end cover of the pump.
- (b) Install the liner plate in the groove of front end cover. Do not confuse the oil suction port and oil drain port.
- (c) Install the driving and driven gears on the front end cover.
- (d) Install the liner plate at the side of gear, with the groove aligned with the gear point. Do not confuse the oil suction port side and oil drain port side.
- (e) Install a new seal ring and a new retainer ring in the groove of rear end cover. (see Fig. 5-24)
- (f) Install the rear end cover on the pump body. Do not confuse the oil suction port and oil drain port.
- (g) After all parts are installed, tighten the connecting bolts to the specified torque of 9-10kg.m.

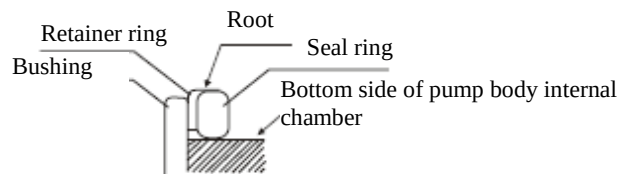


Fig. 5-24 Bushing Seal

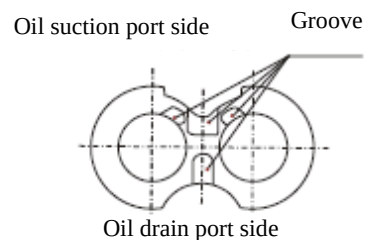
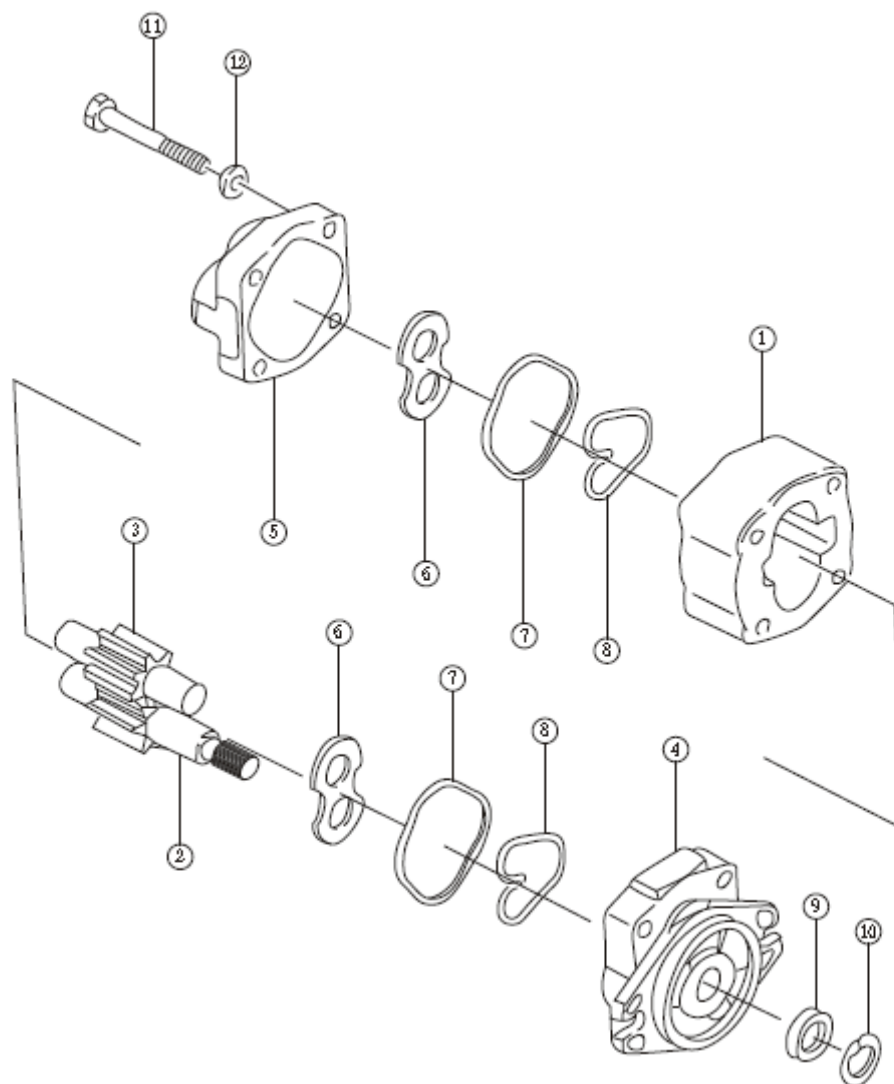


Fig. 5-25 Liner Plate



- | | |
|--------------------|---------------------------|
| 1. Pump body | 7. Seal ring |
| 2. Driving gear | 8. Retainer ring |
| 3. Driven gear | 9. Oil seal |
| 4. Front end cover | 10. Elastic retainer ring |
| 5. Rear end cover | 11. Bolt |
| 6. Liner plate | 12. Washer |

Fig. 5-26 Gear Pump

(4) Test run

Perform a test run for running-in of oil pump. Check whether the running is normal. It would be the best to test the oil pump on a bench. However, you can also test it on the forklift truck according to the following procedures:

(If the oil pump is disassembled and repaired for its excessive wear or seizure caused by hydraulic oil, change the hydraulic oil and replace the filter before the test run on forklift truck.)

- (a) Install the pump onto the forklift truck. Install a pressure gauge at the upper pressure detection port of the multi-way valve.
- (b) Loosen the adjusting screw of the overflow valve to run the pump at a speed of 500-1000rpm for about 10min. Keep the oil pressure lower than 10kg/cm^2 .
- (c) Increase the pump speed to 1500-2000rpm and keep the pump running at this speed for about 10min.
- (d) Keep the pump speed of 1500-2000rpm and increase the pressure by $20\text{-}30\text{kg/cm}^2$ at a time. Run the pump for 5min until the pressure reaches 175kg/cm^2 . Put each oil circuit into operation for 5min. Then, replace the oil return filter.

When increasing the oil pressure, check the oil temperature, pump surface temperature and operation sound. In case of too high oil temperature or pump surface temperature, reduce load to lower the oil temperature and then continue the test.

- (e) After test, keep the overflow pressure at 175kg/cm^2 . Measure the flow by using the lifting speed.

Note: Although the models of the steering oil pump and lifting oil pump are different, the maintenance methods for these two pumps are basically identical. Thus, the descriptions on the maintenance method for steering oil pump are not given here.

5.2.2 Malfunction diagnosis

If the hydraulic system malfunctions, find out the cause and do troubleshooting based on the following table.

(1) Multi-way valve

Malfunction	Cause	Solution
Failure to increase the lifting oil circuit pressure	Seized slide valve	Disassemble and clean
	Blocked oil hole	Disassemble and clean
Vibration Slow increase of pressure	Seized slide valve	Disassemble and clean
	Insufficient air bleeding	Bleed sufficiently
Steering oil circuit pressure exceeding the specified value	Seized slide valve	Disassemble and clean
	Blocked oil hole	Disassemble and clean
Failure to reach the specified oil volume	Improperly adjusted overflow valve	Adjust
Noise	Improperly adjusted overflow valve	Adjust
	Worn sliding surface	Replace overflow valve
Oil leakage (external)	Aged or damaged O-ring	Replace O-ring
Low set pressure	Damaged spring	Replace spring
	Damaged valve seat surface	Adjust or replace overflow valve
Oil leakage (internal)	Damaged valve seat surface	Repair valve seat surface
High set pressure	Seized valve	Disassemble and clean

(2) Oil pump

Malfunction	Cause	Solution
Less oil output	Low oil level in tank	Add oil to specified level
	Blocked oil pipe or oil filter	Clean or replace as required
Low pump pressure	● Damaged liner plate ● Damaged bearing ● Defective seal ring, bushing seal or retainer ring	Replace
	Improperly adjusted overflow valve	Adjust the pressure of overflow valve to specified value with a pressure gauge.
	Air in system	● Re-tighten the oil pipe at oil suction side ● Add oil ● Replace pump oil seal
Noise during operation	Damaged oil suction pipe or blocked oil filter	Check pipe or repair oil filter
	Looseness and air leakage at oil suction side	Tighten
	High oil viscosity	Change oil (suitable for the pump operating temperature)
	Air bubble in oil	Find out cause and take measures
Oil leakage of pump	Damaged pump oil seal or seal ring	Replace
	Damaged pump	Replace

6. Lifting system

6.1 General

The lifting system is of two-stage contact roller type. It performs vertical lifting. The lifting system is composed of inner mast, outer master and fork carriage.

6.1.1 Inner and outer masts (see Fig. 6-1)

The inner and outer masts are welding parts. The bottom of outer mast is installed on the driving axle with bearings.

The middle of outer mast is connected with the frame through the tilting cylinder. Under the effect of tilting cylinder, the outer mast can tilt forwards/backwards.

The channel steel for outer mast is of C type. The main contact roller and side contact roller are installed at the upper part.

The channel steel for inner mast is of C type. The main contact roller and side contact roller are installed at the lower part.

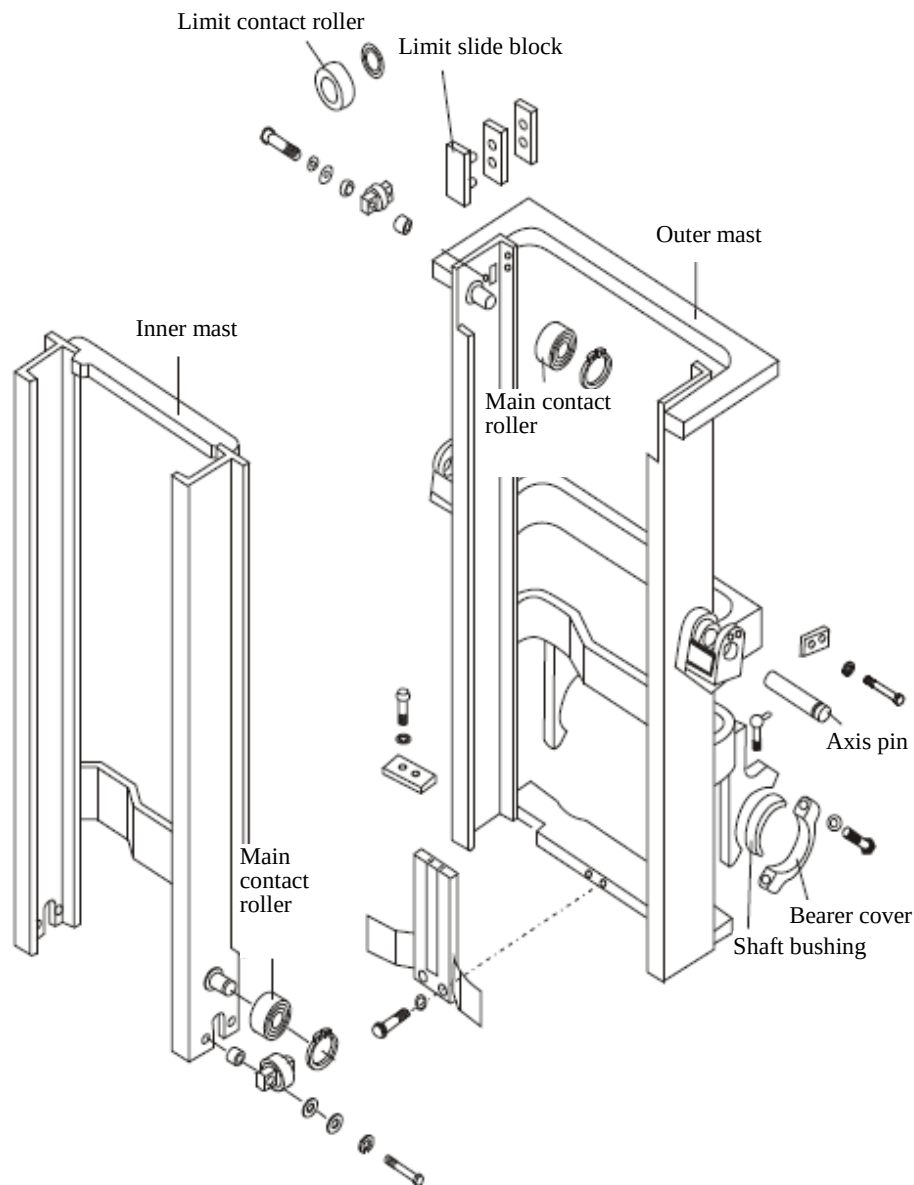


Fig. 6-1 Inner and Outer Masts

6.1.2 Fork carriage

The fork carriage rolls in the inner mast through the main contact roller. The main contact roller is installed on the main contact roller shaft and clamped by an elastic retainer ring. The main contact roller shaft is welded on the fork carriage. The side contact rollers are fixed on the fork carriage with bolts. They roll along the wing of inner mast. They can be adjusted with adjusting gaskets. To avoid rolling clearance, two fixed side contact rollers are used. They roll along the outer side of inner mast wing. The longitudinal load is borne by the main contact roller. When the fork is lifted fully, the contact roller appears at the top of mast. The transverse load is borne by the side contact rollers. The load backrest is an important safety part used to protect the operator against the sliding goods from the forks. If the load backrest is loose, removed or refitted, it will be very dangerous.

Fork lock pin

The fork lock pin locks the forks in a specific position. To adjust the fork spacing, pull up the fork lock pin and turn it for 1/4 circle, and then shift the forks to the desired position. The fork spacing shall be adjusted according to the goods to be handled.

Notice

Since the gravity center of the goods shall be in line with the machine center, both forks shall be adjusted symmetrically. Lock the fork lock pin in place to fasten the forks after the adjustment.

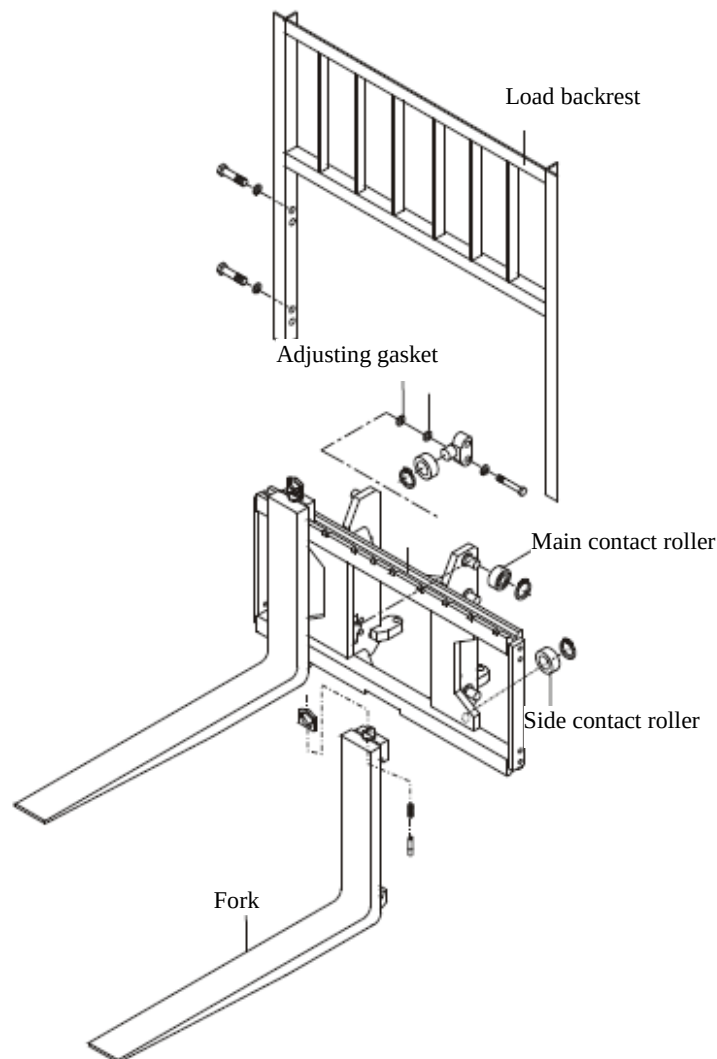
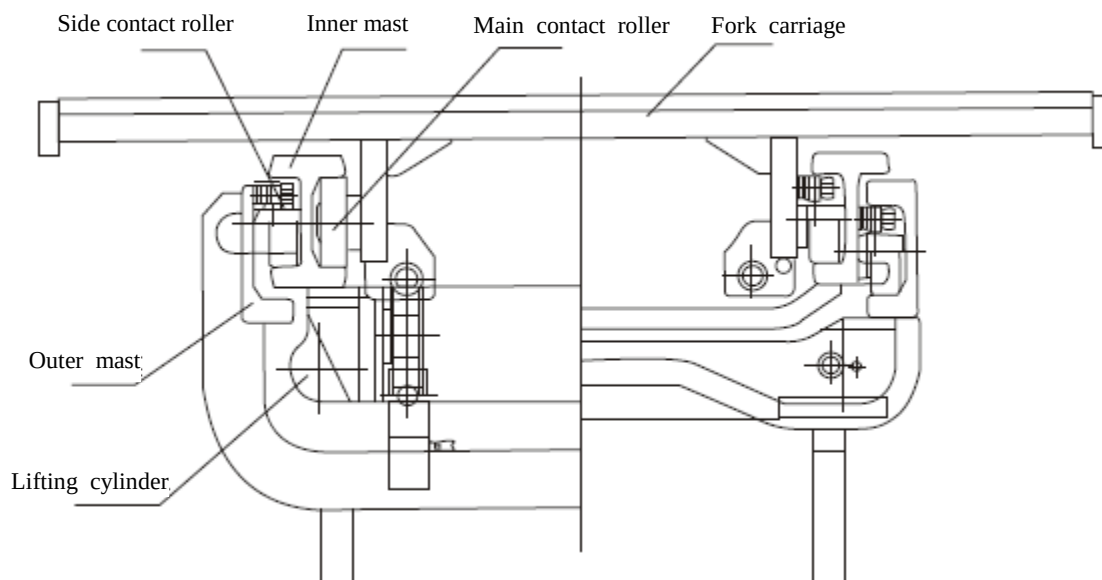


Fig. 6-2 Fork Carriage

6.1.3 Contact roller position (Fig. 6-3)

There are two types of contact rollers: main contact roller and side contact rollers. They are installed on the outer mast, inner mast and fork carriage respectively. The main contact roller bears the front and rear load and the side contact rollers bear the side loads to ensure free motion of inner mast and fork carriage.



Note:

- (a) Adjust the side contact roller clearance to 0.5mm.
- (b) Coat the surface of main contact roller and the contact surface of mast with grease.

Fig. 6-3 Contact Roller Position

6.2 Maintenance and adjustment

6.2.1 Lifting cylinder adjustment

When replacing the lifting cylinder, inner mast or outer mast, adjust the stroke of lifting cylinder in accordance with the following method:

- (1) Install the piston rod head into the upper cross beam of inner mast without any adjusting gasket.
- (2) Lift the mast slowly to the maximum stroke of the cylinder. Check whether the two cylinders synchronize.
- (3) Set adjusting gaskets between the piston rod head of the cylinder that stops first and the upper cross beam of inner mast. The adjusting gasket thicknesses are 0.2mm and 0.5mm.
- (4) Adjust the chain tension.

Upper cross beam of inner mast

Adjusting gasket

Lifting cylinder

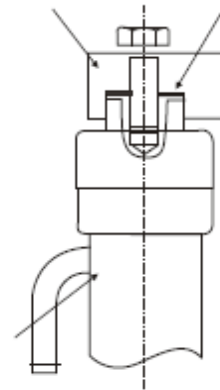


Fig. 6-4

6.2.2 Fork carriage height adjustment

- (1) Park the forklift truck on level ground and make the mast vertical.
- (2) Make the fork bottoms touch the ground. Adjust the adjusting nut at the upper end connector of chain until a distance A between the main contact roller and fork carriage is produced.

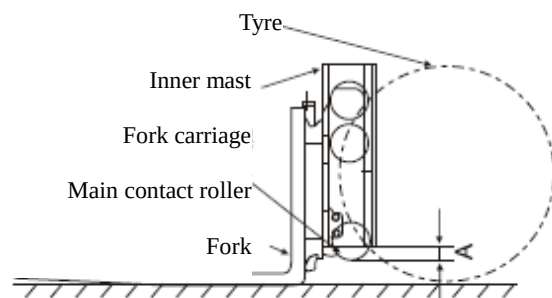


Fig. 6-5

Forklift truck type	A	mm
1~1.5t	36-41	
2~2.5t	24-29	
3t	19-24	

- (3) Lower the forks to ground and tilt the mast to the backmost position. Adjust the adjusting nut at the upper end connector of chain to make the two chains have the same tension.

6.2.3 Replacement of fork carriage contact roller

- (1) Pick up a pallet and park the forklift truck on level ground.
- (2) Lower the forks and pallet to ground.
- (3) Remove the upper end connectors of the chains and take down the chains from the sprocket wheel.
- (4) Lift the inner mast (① in Fig. 6-7).
- (5) Reverse the forklift truck after confirming the fork carriage is separated from the outer mast (② in Fig. 6-7).
- (6) Replace the main contact roller.
 - (a) Remove all elastic retainer rings. Take down the main contact roller with a pulling tool. Retain the adjusting gaskets.
 - (b) Make sure the new contact roller is the same as the contact roller to be replaced. Install the new contact roller into the fork carriage and clamp it with elastic retainer rings.

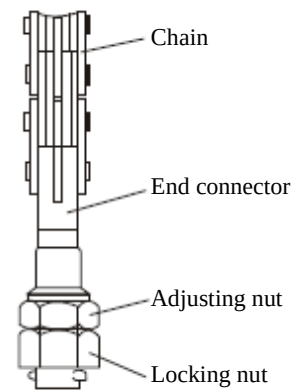


Fig. 6-6

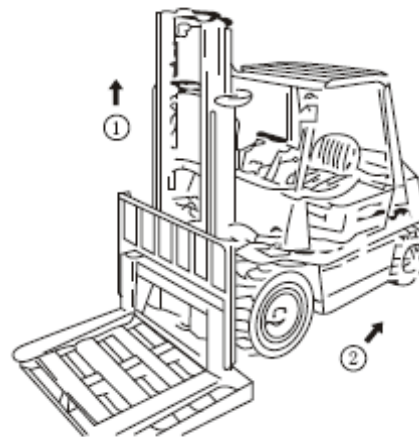


Fig. 6-7

6.2.4 Replacement of mast contact roller

- (1) Remove the fork carriage from the inner mast with the same method for replacement of fork carriage contact roller in 6.2.3.
- (2) Drive the forklift truck onto level ground and put blocks under the front wheels to raise them for 250-300mm.
- (3) Apply hand brake and wedge the rear wheels with wedge blocks.
- (4) Remove the bolts fixing the lifting cylinder and inner mast. Lift the inner mast. Do not lose the adjusting gaskets set at the piston rod head.

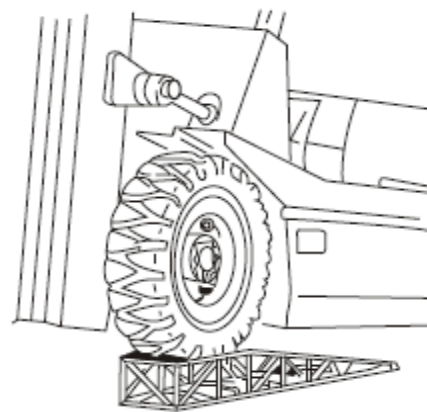


Fig. 6-8

- (5) Remove the connecting bolts between the lifting cylinder and outer mast bottom. Remove the lifting cylinders and the oil pipe between them. Do not loosen the oil pipe connector.
- (6) Lower the inner mast. Remove the main contact roller at the bottom of inner mast. In addition, the main contact roller at the upper part of outer mast can also appear from the inner mast top.
- (7) Replace the main contact roller.
 - (a) Remove the main contact roller at the upper part with a pulling tool. Do not lose the adjusting gaskets.
 - (b) Install the new contact roller and the adjusting gaskets removed in step (a).
- (8) Lift the inner mast to make all contact rollers enter the mast.
- (9) Install the lifting cylinders and fork carriage in the reverse order of disassembly.

7. Maintenance of electric counterbalanced forklift trucks

To keep the forklift truck always under good working condition, careful operation and timely adjustment are necessary. Therefore, the following measures shall be taken.

- (1) Replace the differential, change the gear oil in reducer and retighten all fasteners after the first 100 working hours.
- (2) Readjust the clearances of driving and driven gears in reducer after the first 200 working hours.
- (3) Maintain the motor, electric controllers and battery in accordance with their instructions respectively.
- (4) Check all connectors once every month.
- (5) Protect the forklift truck against water. Never flush the forklift truck with a water gun or use the forklift truck outdoors in rainy days.
- (6) Frequently clean away the dirt from the photoelectric coupler of lifting switch.
- (7) Keep the battery surface clean and dry. Frequently clean away the dirt.
- (8) After normal use, maintain the forklift truck regularly according to the following table.
- (9) The routine external cleaning of the forklift truck does not require special techniques, but other works shall be carried out by specialized personnel.

No.	Item	Maintenance	Interval	Remark
1	Steering wheel bearing	Change grease	1000h	
2	Driving wheel bearing	Change grease	1000h	
3	Steering linkage	Change grease	1000h	
4	Moving parts of hand brake	Add grease	200h	
5	Axis pin of foot brake	Add grease	200h	
6	Driving axle	Change gear oil	2400h	
7	Brake oil	Add	At any time	
8	Axis pin of tilting cylinder	Add lubricating oil	400h	
9	King pin of steering knuckle	Change grease	1000h	
10	Hydraulic oil tank and filter screen	Clean	1000h	
11	Hydraulic oil	Change	1000h	
12	Lifting chain	Replace	4800h	Replace once damage is found
13	High-pressure hose	Replace	4800h	Replace once damage is found
14	Lifting motor switch	Clean (photoelectric coupler)	200h	
15	Traveling motor brush	Check	1000h	
16	Lifting motor brush	Check	1000h	
17	Steering motor brush	Check	1000h	



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