EKKO
MATERIAL HANDLING EQUIPMENT
MOVING AHEAD

# Electric Counterbalance Forklift Truck Series

EK18G-LI / EK18G-212LI / EK20G-LI / EK25G-LI /
EK25G-212LI / EK30G-LI / EK35G-LI

# Operation and Maintenance Manual



# Foreword

The EKKO counterbalance electric forklift trucks are new series of products developed by our company to meet the market demand, based on the advantages of electric forklift trucks at home and aboard and in combination with our existing products and mature technologies. They are characterized by environmental protection, maintenance-free, long service life, high efficiency and energy saving, high safety, etc. They are especially suitable for loading and unloading, handling and stacking of goods in stations, ports, freight yards, warehouses as well as food, textile and general logistics industries. If equipped with various attachments, it can be used more widely.

**This product is not suitable for working in dusty, charged dusty, high-temperature and highly corrosive environments! All components shall be cleaned and maintained regularly for working in a less dusty (non-conductive) environment!**

Due to the new PI concept and ergonomic design, this product is equipped with low-noise and high-efficiency integral drive axle, large-angle steering axle, wide-view lifting system and structure body without tail frame and other advanced components. It is also equipped with high-quality motor, battery, MOSFET electronic control and color large-screen LCD combination instrument, hydraulic operation valve and full LED lamp and other advanced components. Therefore, it has the advantages of superior performance, convenient operation, wide visual field, flexible steering, reliable braking, good dynamic performance, low noise, no pollution and aesthetic appearance.

This Manual mainly introduces the technical parameters, structure, working principle, operation, maintenance and other aspects of this series of products. It can help the operator to use the electric forklift truck correctly and give full play to its efficiency. The operator and equipment management personnel shall read it carefully before operating the forklift truck.

Please strictly abide by the regulations and precautions in this Manual in use, so that your forklift will be in the best working condition.

This Manual describes standard and optional vehicles, and the real object shall prevail for non-standard vehicles. In case of any technical questions, please consult the manufacturer.

Due to the continuous improvement of technology or components, the relevant contents in this manual will be changed without notice. Please understand.

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# I. Driving, Operation and Safety Procedures of Forklift Truck

## 1. Basic Principles

Forklift truck drivers and management personnel must keep in mind the concept of "safety first", and carry out safe and standard operation according to the *Operation and Maintenance Manual* and *Driver's Manual* of the forklift truck.

## 2. Transportation of Forklift truck

Pay attention to the following matters when forklift trucks are transported by automobiles:

(1) Apply the parking brake;

(2) The front and back of the mast and counterweight shall be fixed with steel wire, and the corresponding positions of the front and rear tires shall be wedged;

(3) The lifting shall be carried out according to the position indicated on the "lifting signs" of the forklift.

(4) Charge the forklift to 40% ~ 60% and press the emergency power-off switch.

## 3. Storage of Forklift truck

(1) The mast is lowered to the lowest position;

(2) Turn off the key and start the parking brake;

(3) The front and rear tires shall be wedged;

(4) The painted surface shall be applied with antirust oil, and hoisting chains shall be applied with lubricating oil;

(5) Charge the forklift to 40% ~ 60% or above, and press the emergency power-off switch.

## 4. Preparation before Use

(1) Do not check oil leakage, oil level and electrical instruments in places with open fire, and do not refuel when the vehicle is working;

(2) Check the tire pressure; (this step is not required when a solid tire is equipped)

(3) Check the sound, light and alarm devices: various lights, buzzers and horns (including rear handle buttons);

(4) The drive and reverse gear handle shall be in the middle position (neutral position);

(5) Check the state of each handle and pedal;

(6) Make preparations before startup;

(7) Release the parking brake;

(8) Perform test lifting, lowering, forward & backward tilting, turning and braking of the door frame;

**5. Operation of Forklift truck**

(1) The truck can only be driven by drivers who have been trained and have a driver's license;

(2) Operators shall wear shoes, hats, clothing and gloves for safety protection during operation;

(3) Check all control and alarm devices before driving, and operate after repair if any damage or defect is found;

(4) During handling, the load shall not exceed the specified value, and the forks shall be inserted under the pallet, and the pallet shall be evenly placed on the fork. It is not allowed to use a single fork to pick up objects;

(5) Start, turn, drive, brake and stop smoothly, and slow down when steering on a wet or slick road;

(6) When driving with goods, keep the goods as low as possible and tilt the mast backward;

(7) Be careful when driving on a ramp. When driving on a ramp with a gradient of more than 10%, drive forward when going uphill and reverse when going downhill. Do not turn when going uphill or downhill. Do not load or unload when the forklift track is going downhill.

(8) Pay attention to pedestrians, obstacles and potholes when driving, and pay attention to the upper clearance of the forklift;

(9) No one is allowed to stand on the fork, and the truck shall not carry persons other than the driver;

(10) No one is allowed to stand or walk under the fork;

(11) Do not operate the vehicle and attachments from a position other than the driver's seat;

(12) For a high-lift forklift truck with a lift more than 3 m, attention shall be paid to the goods falling, and protective measures shall be taken when necessary;

(13) For high-lift forklift trucks, try to make the mast tilt backward, and it shall tilt forward within the minimum range during the loading and unloading operations;

(14) Be careful and drive slowly when driving on a wharf or temporary planking;

(15) When checking the battery or fuel tank level, the driver shall not be on the vehicle and shall stop the vehicle stably;

(16) When the forklift truck with attachments is operated without goods, it shall be operated as a loaded forklift truck;

(17) Do not handle unfixed or loosely stacked goods, and carefully handle large-sized goods;

(18) When leaving the vehicle, lower the fork to the ground, put the gear lever to the neutral position, turn off the vehicle and disconnect the power supply. When parking on a ramp, pull the parking brake device, and wedge the wheels when the parking will be long;

(19) The pressure of multi-way valves and safety valves of the forklift truck has been adjusted before the truck leaves the factory, so users shall not adjust it at will in use, so as to avoid damage of the whole hydraulic system and hydraulic components caused by excessive high pressure adjusted;

(20) If pneumatic tires are equipped, the tire inflation pressure shall be the pressure value specified on the "Tire Pressure" plate;

(21) The maximum noise value outside the forklift truck shall not be more than 80 dB(A), and the test method is stated in JB/T3300;

(22) Be familiar with and master the contents of various signs on the forklift.

## 6. Routine Maintenance of Forklift Truck

(1) Key points of starting

a) Amount of hydraulic oil: The oil level shall be in the middle of the scale of the oil level gauge;

b) Check whether there is leakage or damage on the pipes, joints, pumps and valves;

c) Check the service brake:

The idle stroke of brake pedal shall be 20~30 mm;

The gap between the front base plate and the pedal shall be greater than 20 mm.

d) Check the parking brake function: When the parking brake is started, the forklift shall be stopped on the slope with specified gradient (no load);

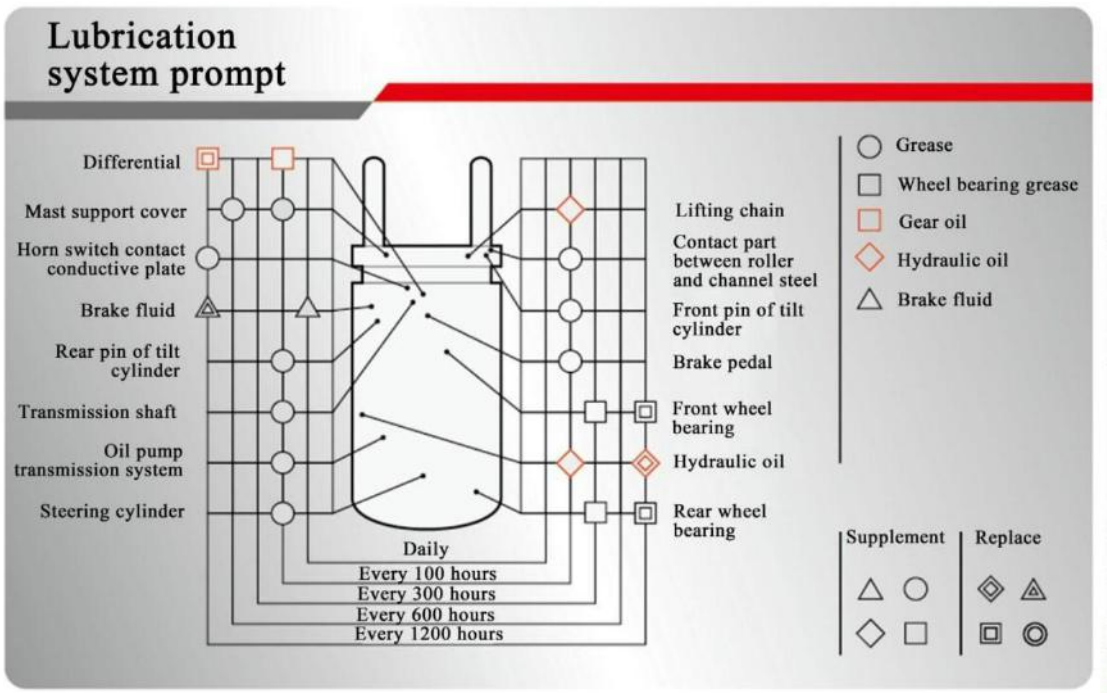
e) Instruments and lighting fixtures, etc.: Check whether the instruments, lighting, connectors, switches and electrical circuits work normally.

(2) Oil and grease for forklift truck

| Name | Grade, code and service temperature | | | Filling volume (L) |
|---|---|---|---|---|
| Hydraulic oil | Viscosity grade | hydraulic oil 40# | Anti-freezing hydraulic oil YYY-LPL-HS32 | 1.5-2t (E):33<br>2-2.5t: 42<br>3-3.8t: 45 |
| | Operating condition | Normal temperature environment | Cold storage environment | |
| Brake fluid | 4604 synthetic brake fluid GB12891 HZY4 | | | / |
| Grease | 3# general purpose lithium grease (-20°C~+120°C)<br>Or 2# L-XDCBB2 low-temperature grease (-40°C~+120°C) | | | / |
| Heavy-duty vehicle Gear oil GL-5 | Viscosity grade | 85W/90 | CLY-LP75W-90 | 1.5-2t (E): 5<br>2-2.5t: 6<br>3-3.5t: 7 |
| | Operating condition | Normal temperature environment | Cold storage environment | |

**Note: The oil filling amount is the amount used for standard mast.**

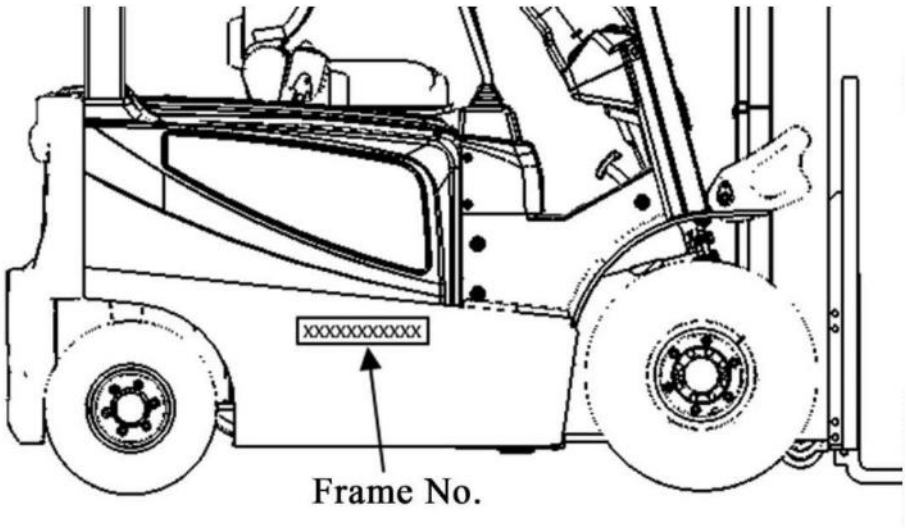
(3) Lubrication system diagram



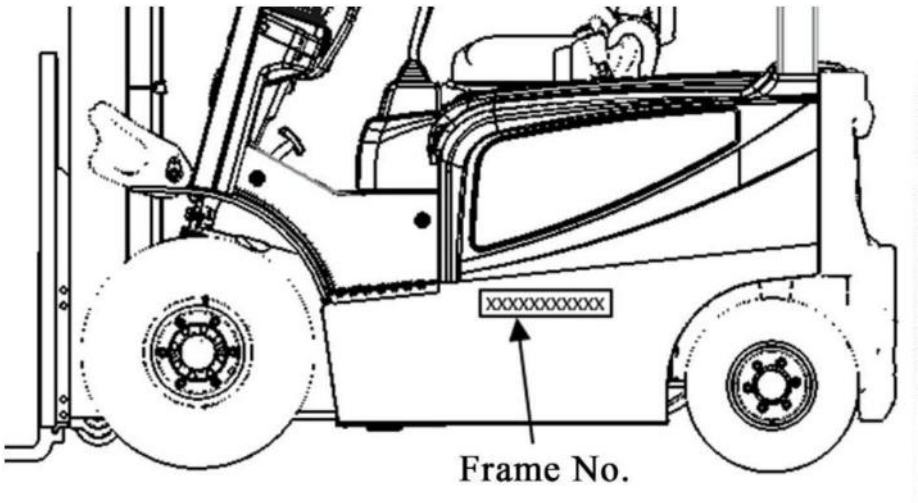

## 7. Description of Frame Number Printing Position

When the vehicle is delivered, a unique frame number (the same as the product number) is marked on the vehicle body, and permanently stamped on the frame with a steel seal. According to the number, the production, sales, maintenance and other information of the vehicle can be traced. The frame number of the battery lifting model

is located in the middle-upper area on the right wall plate of vehicle body, and the frame number of the battery side taking (side pulling and side shoveling) model is located in the middle-upper area on the left wall plate of vehicle body, as shown in the following figure.




Printing Position of Vehicle No. with Lifting Battery

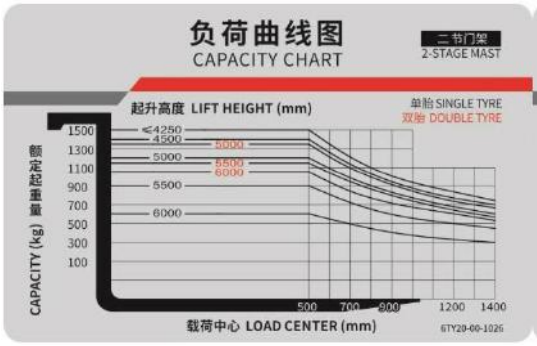



Printing Position of Vehicle Number with Side Battery

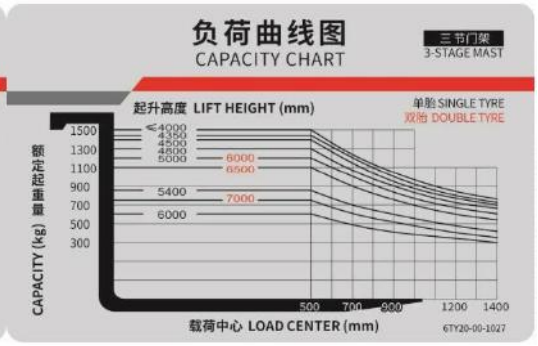
## 8. Load Curve

It is strictly prohibited to overload the forklift, otherwise serious accidents such as structural parts damage and vehicle rollover may occur. If the vehicle is equipped with attachments, such as side shifters and buckets, the actual capacity is lower than the corresponding rated load. The actual capacity and rated load charts are shown below.

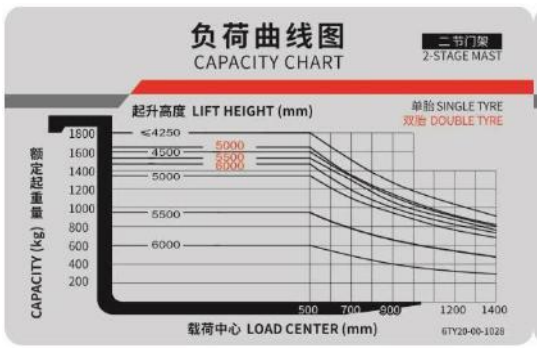
(2) Rated load chart of forklift



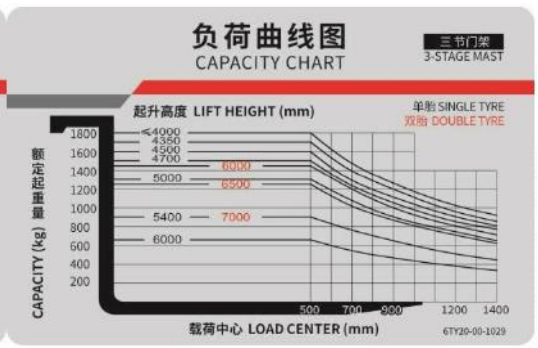

1 .5t Two-stage Mast



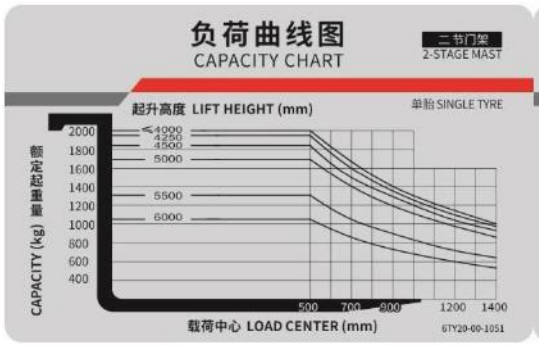

1.5t Three-stage Mast



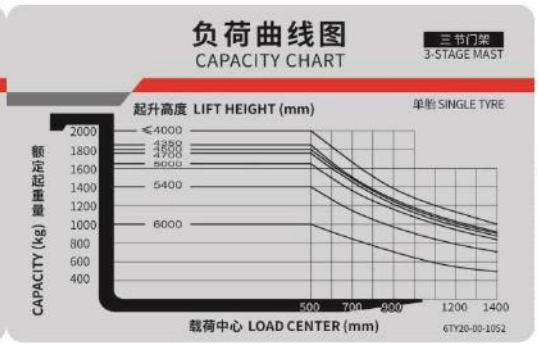

1.8t Two-stage Mast



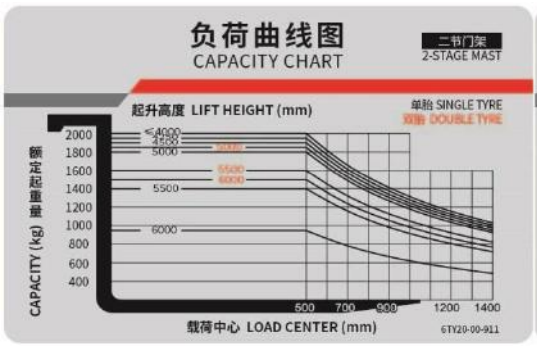

1.8t Three-stage Mast



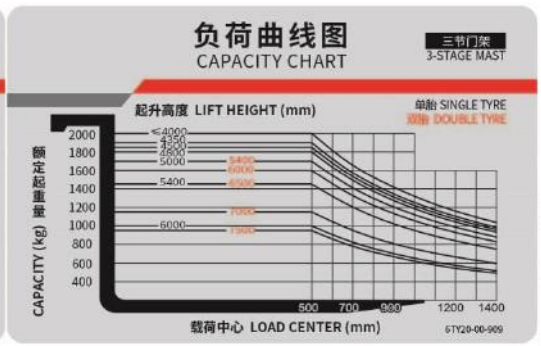

Small 2t Two-stage Mast



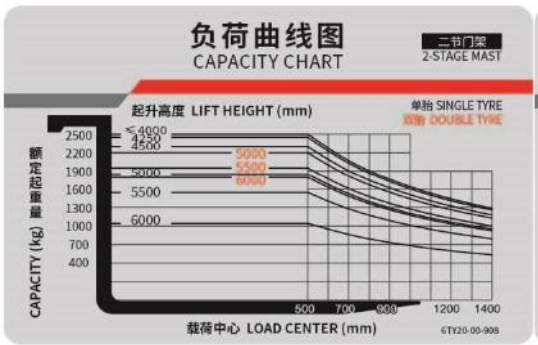

Small 2t Three-stage Mast



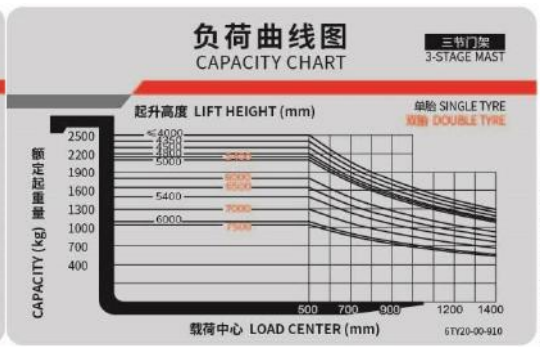

2t Two-stage Mast



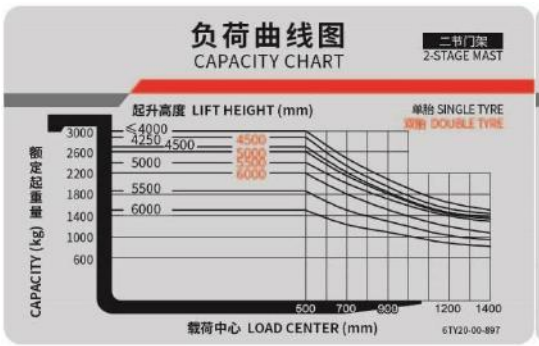

2t Three-stage Mast




2.5t Two-stage Mast



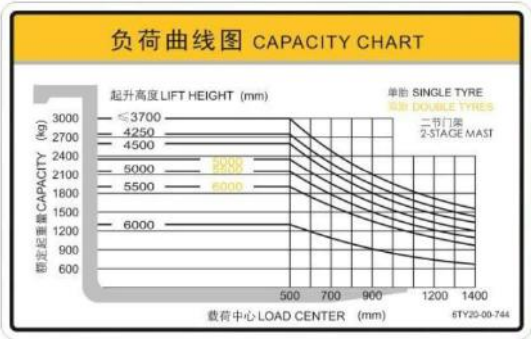

2.5t Three-stage Mast



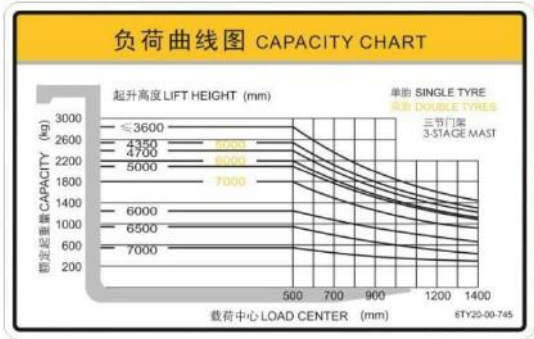

3t (M type) Two-stage Mast



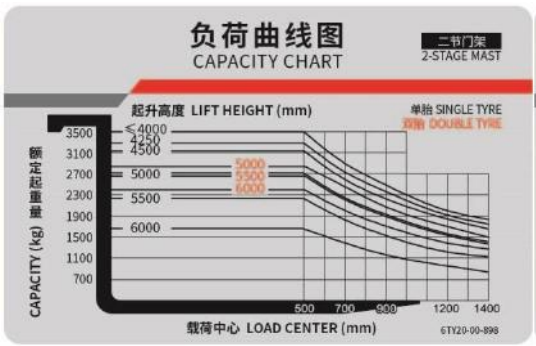

3t (M-type) Three-stage Mast



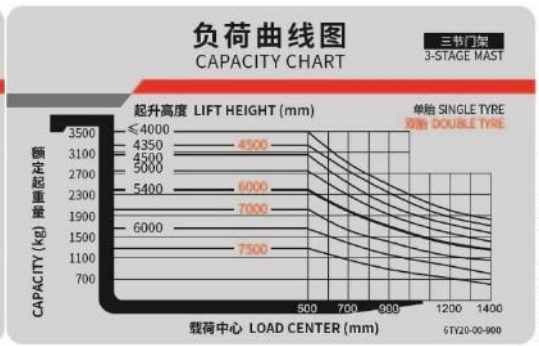

3t (S-type) Two-stage Mast



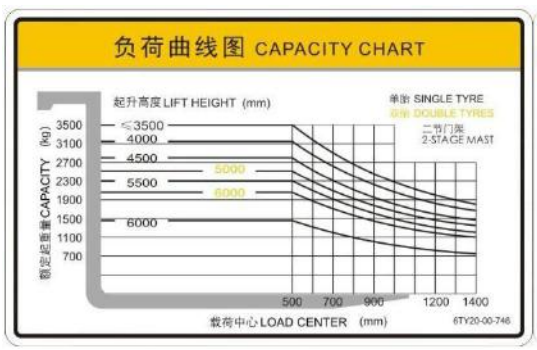

3t (S-type) Three-stage Mast



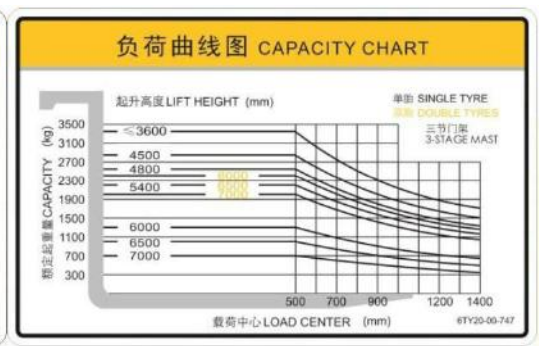

3.5t (M-type) Two-stage Mast



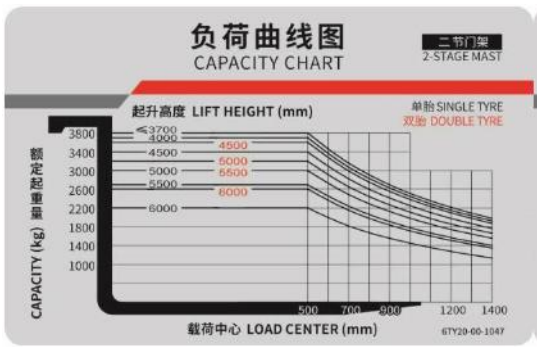

3.5t (M-type) Three-stage Mast



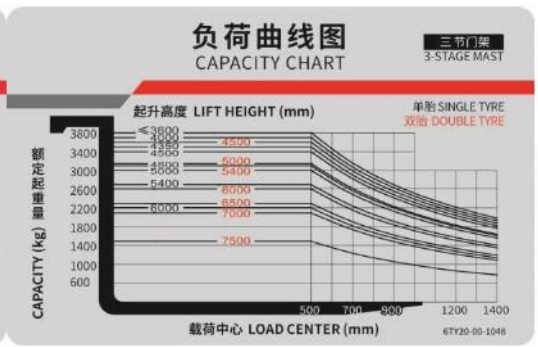

3.5t (S-type) Two-stage Mast




3.5t (S-type) Three-stage Mast

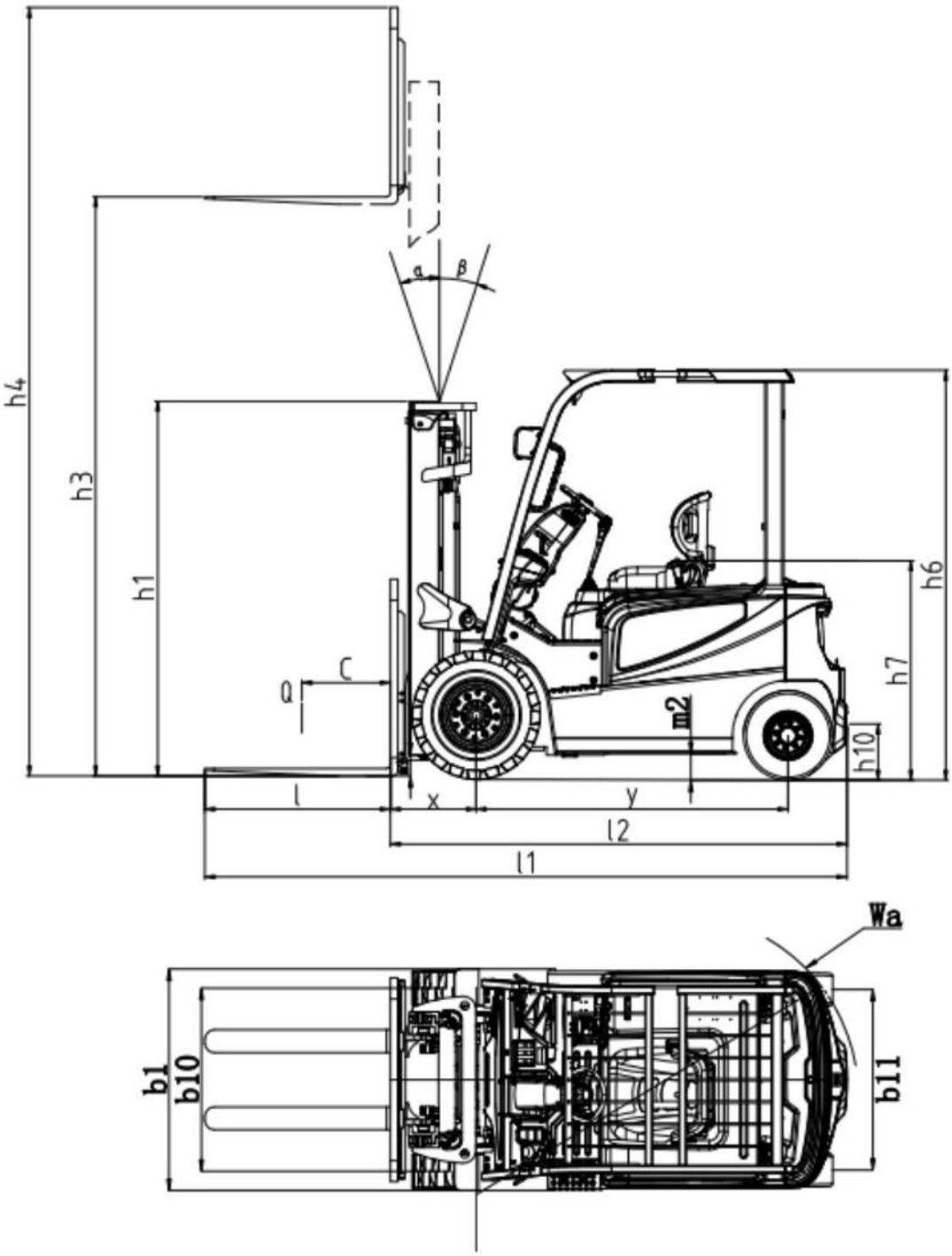



3.8t Two-stage Mast




3.8t Three-stage Mast

## II. Main Technical Parameters of Forklift Truck




Outline Drawing of the Vehicle

## List of Main Technical Parameters

| Model | | | | EK18 | | EK18 | EK20 |
|---|---|---|---|---|---|---|---|
| Configuration No. | | | A3H4-M/A5H4-M | | A5H4-S | | A5XH4-S |
| Rated lifting capacity | Q | kg | 1500 | 1800 | 1500 | 1800 | 2000 |
| Load center distance | c | mm | 500 | | | | |
| Power type | | | Battery | | | | |
| Driving mode | | | Seat type | | | | |
| Tire type | | | Pneumatic tire | | | | |
| Front wheel size | | | 6.50-10-10PR | | | | 6.50-10-12PR |
| Rear wheel size | | | 16x6-8-10PR | | | | |
| Wheel base | y | mm | 1475 | | | | |
| Inclination angle of mast, forward/backward | α/β | ° | 6/8 | | | | |
| Lift height (standard) | h3 | mm | 3000 | | | | |
| Body length (excluding fork) | l2 | mm | 2200 | | | | 2205 |
| Body width | b1 | mm | 1120 | | | | |
| Height of overhead guard | h6 | mm | 2140 | | | | |
| Travel speed (full load/no load) | | km/h | 14.5/15 | | 12/13 | | 14.5/15 |
| Lifting speed (full load/no load) | | m/s | 0.290/0.440 | | 0.270/0.400 | | 0.280/0.440 |
| Max. gradeability, full load/no load | | % | 17/27 | 15/26 | 15/23 | 15/22 | 15/25 |
| Power of drive motor (S2-60 minutes) | | kW | 8 | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lifting motor power (S3-15%) | | kW | 10.6 | | | | |
| Battery voltage/rated capacity | | V/Ah | 48/480 | | 48/400 | | 48/420 |
| Battery weight | | kg | 760 | | 700 | | 705 |
| Total weight (with/without battery) | | kg | 3125/2345 | 3175/2395 | 3050/2345 | 3100/2395 | 3300/2585 |

**List of Main Technical Parameters**

| Model | | | EK20 | EK25 | EK20 | EK25 |
|---|---|---|---|---|---|---|
| Configuration No. | | | A3H4-M/A5H4-M | | A5H4-S | |
| Rated lifting capacity | Q | kg | 2000 | 2500 | 2000 | 2500 |
| Load center distance | c | mm | 500 | | | |
| Power type | | | Battery | | | |
| Driving mode | | | Seat type | | | |
| Tire type | | | Pneumatic tire | | | |
| Front wheel size | | | 7.00-12-14PR | | | |
| Rear wheel size | | | 18×7-8-14PR | | | |
| Wheel base | y | mm | 1660 | | | |
| Inclination angle of mast, forward/backward | α/β | ° | 6/10 | | | |
| Lift height (standard) | h3 | mm | 3000 | | | |
| Body length (excluding fork) | l2 | mm | 2434 | | | |
| Body width | b1 | mm | 1180 | | | |
| Height of overhead guard | h6 | mm | 2170 | | | |
| Travel speed (full load/no load) | | km/h | 14.5/15 | | 12/13 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lifting speed (full load/no load) | | m/s | 0.290/0.440 | | 0.260/0.400 | |
| Max. gradeability, full load/no load | | % | 17/26 | 15/25 | 15/25 | 15/25 |
| Power of drive motor (S2-60 min) | | kW | 11 | | | |
| Lifting motor power (S3-15%) | | kW | 12 | | | |
| Battery voltage/rated capacity | | V/Ah | 48/600 | | 48/500 | |
| Battery weight | | kg | 930 | | 840 | |
| Total weight (with/without battery) | | kg | 4030/3100 | 4190/3260 | 3940/3100 | 4100/3260 |

## List of Main Technical Parameters

| Model | | | EK30 | EK35 | EK30 | EK35 | EK38 |
|---|---|---|---|---|---|---|---|
| Configuration No. | | | A3H4-M/A5H4-M | | A5H4-S | | A5H4-S |
| Rated lifting capacity | Q | kg | 3000 | 3500 | 3000 | 3500 | 3800 |
| Load center distance | c | mm | 500 | | | | |
| Power type | | | Battery | | | | |
| Driving mode | | | Seat type | | | | |
| Tire type | | | Pneumatic tire of front wheel Solid tire of rear wheel | | Pneumatic tire of front wheel Solid tire of rear wheel | | Pneumatic tire of front wheel Solid tire of rear wheel |
| Front wheel size | | | 28×9-15-14PR | | | | 28×12.5-15-24PR |
| Rear wheel size | | | 18×7-8 | | | | 200/50-10 |
| Wheel base | y | mm | 1750 | | | | 1780 |
| Inclination angle of mast, forward/backward | α/β | ° | 6/10 | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Lift height (standard) | h3 | mm | 3000 | | | | |
| Body length (excluding fork) | l2 | mm | 2567 | 2572 | 2567 | 2572 | 2612 |
| Body width | b1 | mm | 1260 | | | | 1392 |
| Height of overhead guard | h6 | mm | 2180 | | | | 2185 |
| Travel speed (full load/no load) | | km/h | 14.5/15 | | 12/13 | | 14.5/15 |
| Lifting speed (full load/no load) | | m/s | 0.290/0.440 | | 0.260/0.400 | | 0.260/0.400 |
| Max. gradeability, full load/no load | | % | 17/26 | 15/23 | 15/25 | 15/22 | 15/20 |
| Power of drive motor (S2-60 min) | | kW | 15 | | | | |
| Lifting motor power (S3-15%) | | kW | 16 | | | | |
| Battery voltage/rated capacity | | V/Ah | 80/480 | | 80/400 | | 80/480 |
| Battery weight | | kg | 1310 | | 1200 | | 1310 |
| Total weight (with/without battery) | | kg | 4995/3685 | 5310/4000 | 4900/3700 | 5110/3910 | 5610/4300 |

# III. Structure, Principle, Adjustment and Maintenance

## 1. Transmission System

### 1.1 Overview

The transmission system of the electric forklift truck consists of a drive axle (Fig. 1-2) and a reducer (Fig. 1-3). The drive axle is used to support and bear the mast and frame. The reducer is used to increase the input torque and reduce the speed of the motor to meet the use requirements of the vehicle under different working conditions. The driving gear of the reducer is directly connected with the traveling motor. It transmits power to the gears at all levels in the reducer, to the axle shaft through the axle shaft gear of the differential, and then to the hub. The drive axle tire is connected with the hub to realize the power transmission. The traveling speed of the electric forklift increases with the increase of motor speed, and the change of traveling direction is realized by changing the rotation direction of the motor. In addition to the reduction gears at all levels in the reducer, there is an important component -- differential.

### 1.2 Differential assembly

The differential assembly is located at the end of the transmission system, so that the left and right wheels can run at different speeds when the vehicle is turning or running on a curve. The differential assembly is installed on the reducer housing through bearings at both ends. The 1.5-3.8t differential is of left and right split structure (as shown in Fig. 1-1), with two axle shaft gears and four planetary gears.

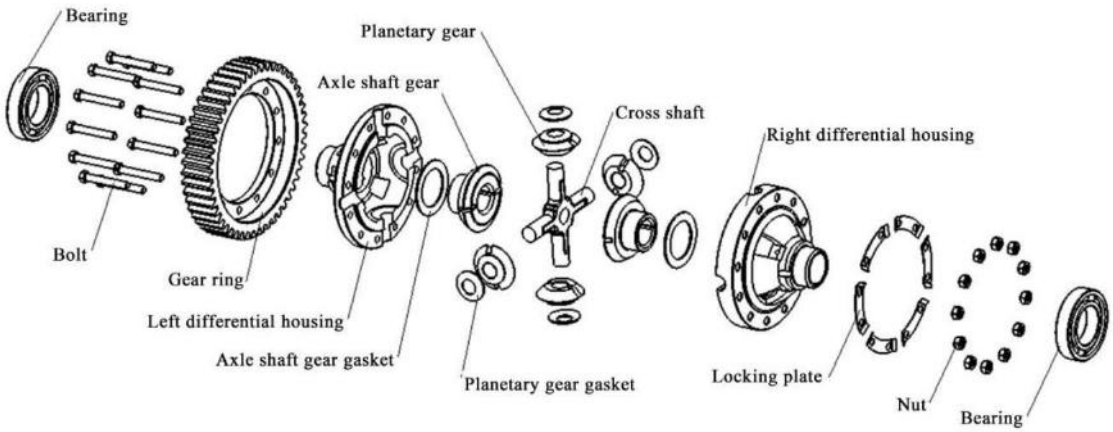



Fig. 1-1 Differential Assembly (1.5-3.8t)

1.3 Drive axle assembly

The drive axle assembly is composed of axle housing, axle shaft, hub, brake and wheel, and is installed in the front of the frame.

The 1.5-3.8t axle housing is of an integral casting structure. The hub is supported on the axle housing by a conical roller bearing, and is connected to the tire with bolts and nuts. The power is transmitted from the reducer to the axle shaft via the differential. The axle shaft drives the hub to rotate the front wheels and only bears the torque transmitted to the hub. Oil seals are installed inside the hub and on the axle shaft to prevent lubricant from entering the brake or the drive axle from oil leakage. See Fig. 1-2.

Refer to Table 1-1 for models and tire pressures of front wheel tires and rims.

Table 1-1

| Forklift tonnage | 1.5t | 1.8t | 2t(E) | 2t | 2.5t | 3t | 3.5t | 3.8t |
|---|---|---|---|---|---|---|---|---|
| Tire | 1.5-1.8t: 6.5-10-10PR<br>2t: 6.5-10-12PR | | | 7.00-12-14PR | | 28×9-15-14PR | | 28×12.5-15-24PR |
| Rim | 5.00F-10 | | | 5.00Sx12DT | | 7.0T-15 | | 9.75-15 |
| Tire pressure | 1.5-1.8t: 790kPa<br>2t: 1000kPa | | | 1000kPa | | 970kPa | | 1000kPa |

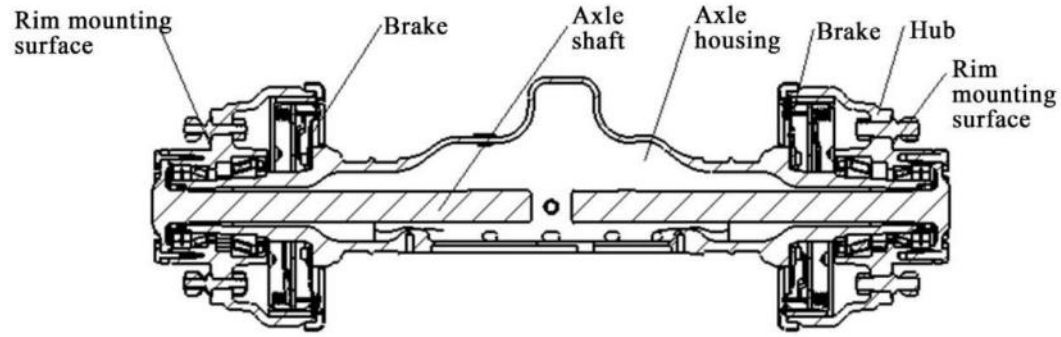



Fig. 1-2 Drive Axle Assembly (1.5-3.8t)

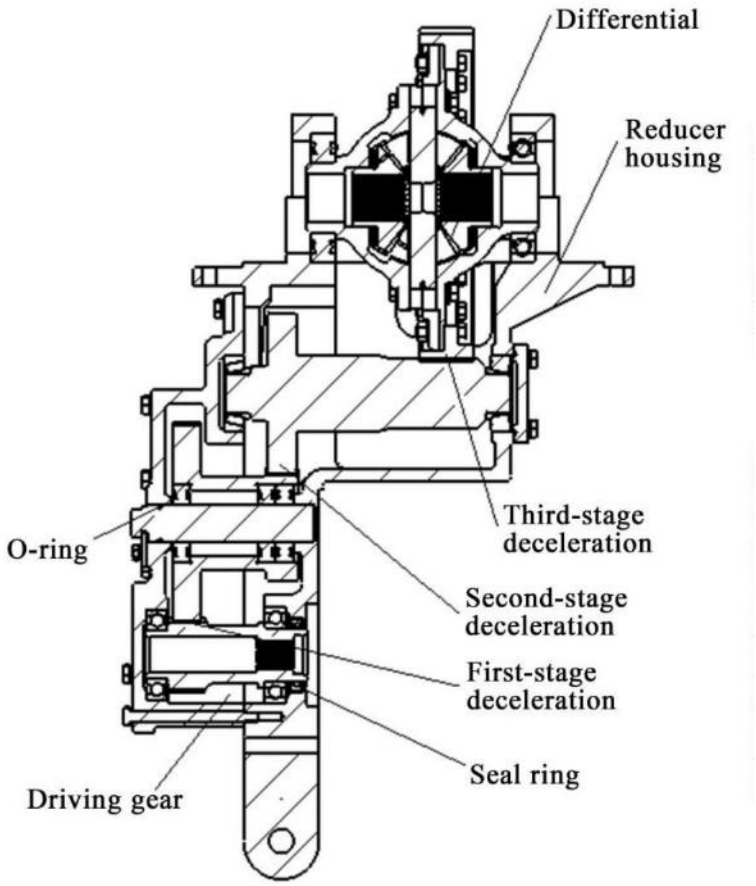



Fig. 1-3 Reducer and Differential (1.5-3.8t)

## 1.4 Installation of hub

(1) Fill the hub with 100cc grease and install it on the axle housing. See Fig. 1-4.

(2) Tighten the inner lock nut with a torque of about 1kg.m and then return it for 1/8 turn.

(3) Hang the spring scale on the bolt to measure the initial torque of the hub, and slowly lock the nut when the specified value is reached. The initial torque: 5-15 kg.m.

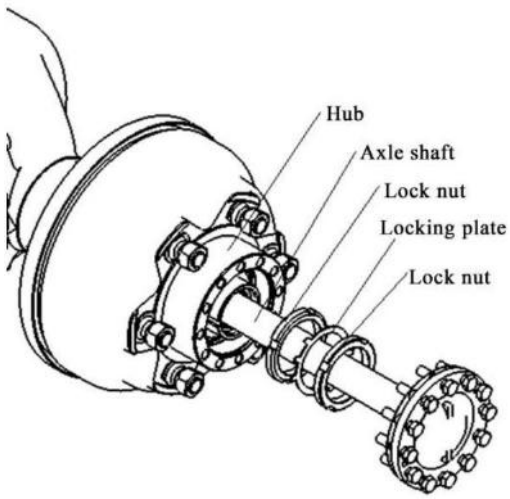



Fig. 1-4 Filling Grease

(4) Install the lock plate and lock nut, and pull up the lock plate.

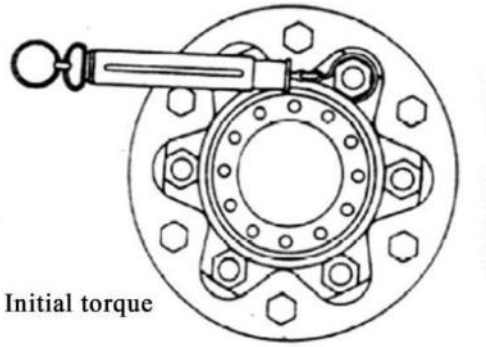


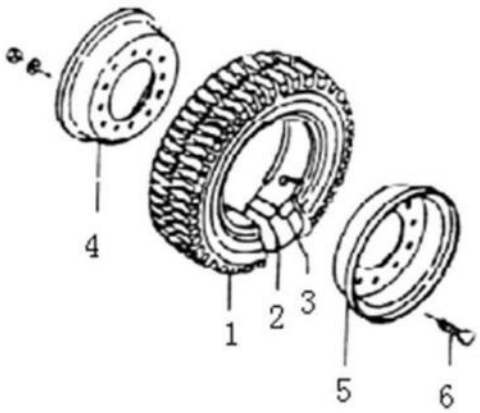

Fig. 1-5 Measurement of Initial Torque

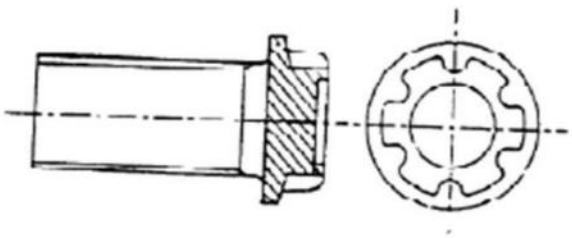
(5) Tire assembly

Install the connecting rod and cap on the tire, and assemble the rim. Pay attention to the following conditions:

Note: a) The air valve rod is at the rim gap and faces outward;

b) The rim bolt head shall be installed towards the outside of the vehicle.



Structure of rim bolt

Fig. 1-6 Wheel Assembly

(1) Tire (2) Valve stem (3) Cap (4) Inner wheel (5) Outer wheel (6) Rim bolt

## 2. Brake System

### 2.1 Overview

The service brake system is a hydraulic booster brake, which is mainly composed of brake pedal, brake master cylinder, slave cylinder, brake fluid reservoir, pipeline and wheel brake. It is of an internal expansion oil pressure type for front two-wheel brake.

Parking brake system acts on the left and right wheel brakes through the mechanical pull lock by pulling the brake handle, and the vehicle is in the parking brake

state.

### 2.1.1 Service brake system

The service brake system is mainly composed of brake pedal, master cylinder, slave cylinder, brake fluid reservoir, pipeline and brake. The principle of service brake is shown in Fig. 2-1.1, and the structure of brake pedal is shown in Fig. 2-1.2. The brake pedal is installed on the bracket assembly through the pin shaft. The pedal force applied to the pedal is converted to the brake master cylinder, through the connection between the pedal and the push rod of the brake master cylinder. The brake master cylinder outputs the oil pressure, which is then transmitted to the oil circuit connection port of the left and right brakes through the brake steel pipe. The brake pedal and the mounting bracket are returned in time by tension springs.

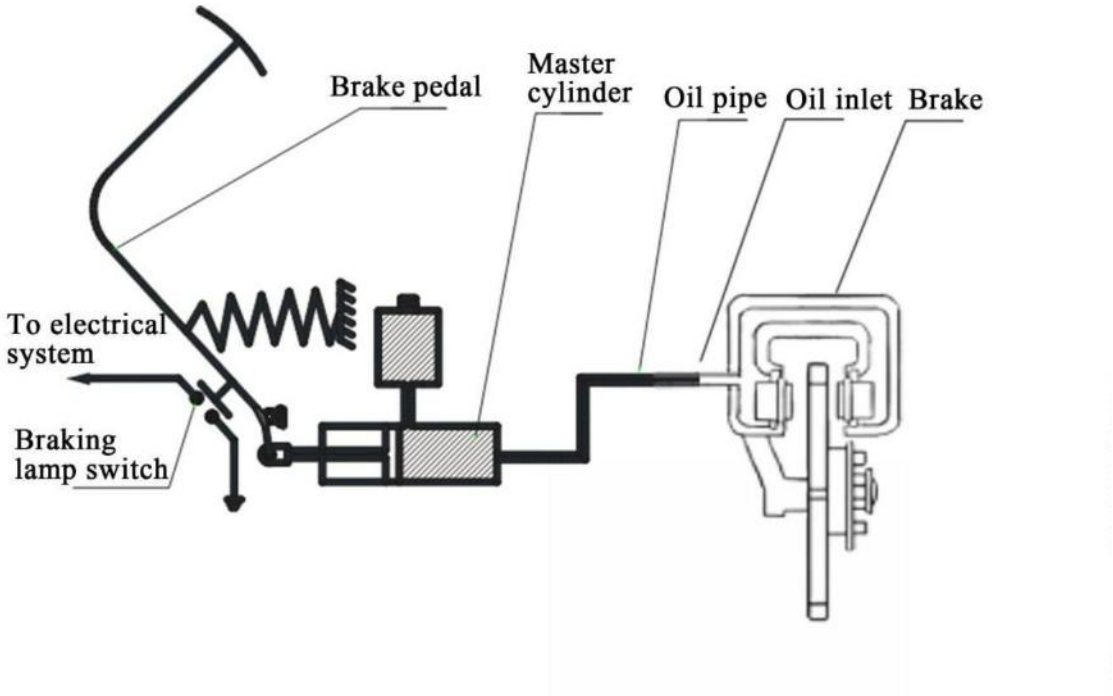



Fig. 2-1.1 Schematic Diagram of Service Brake

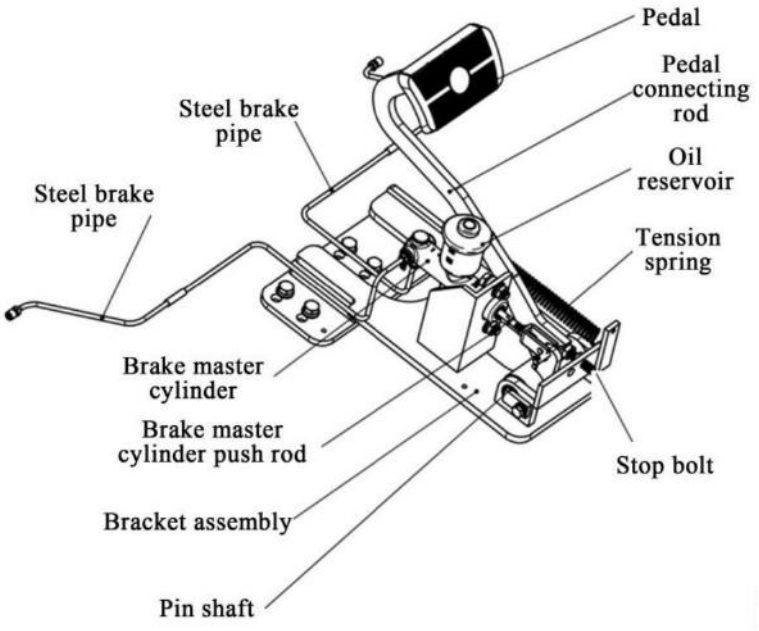
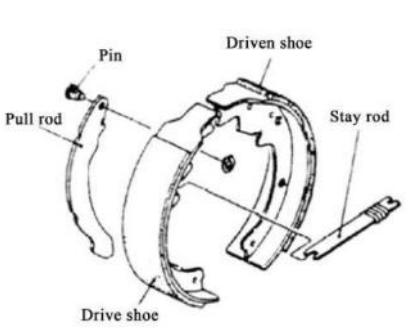



Fig. 2-1.2 Service Brake System

2.1.2 Parking brake system

The parking brake device is assembled in the wheel brake and is composed of a pull rod and a stay rod. The pull rod is installed on the main brake shoe side by a pin, and the action of the pull rod is transmitted to the auxiliary brake shoe side through a stay rod, as shown in Fig. 2-2.1.

The parking brake operating device of this product is a mechanical ratchet manual brake handle, which can provide different braking forces required for parking on a slope and level ground, as shown in Fig. 2-2.2. The adjustment method of braking force: turn the regulator clockwise to increase the braking force; turn the regulator counterclockwise to decrease. The operating pull force during parking brake is 20~30kg.



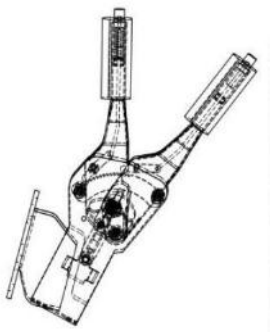
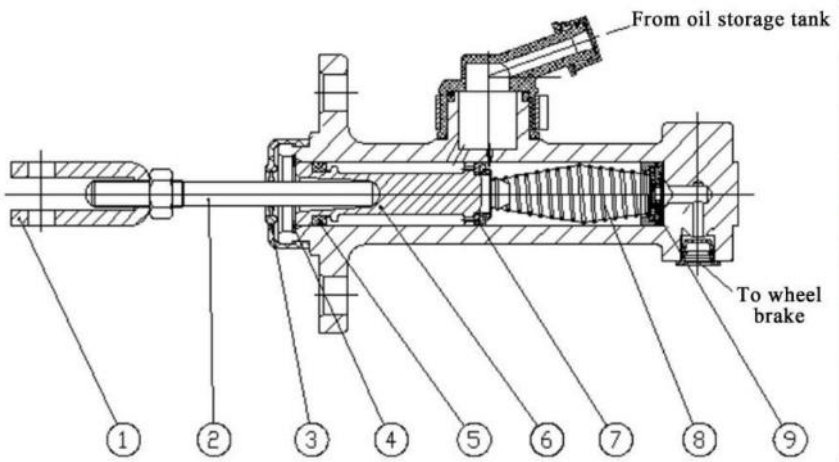



Fig. 2-2.1 Parking Brake Device Fig. 2-2.2 Parking Brake Handle

### 2.1.3 Brake master cylinder

The master cylinder includes a valve seat, a one-way valve, a return spring, a cup, a piston and an auxiliary cup. The end is fixed with a lock washer and a locking wire; the outside is protected with a rubber dust cover; the master cylinder piston is operated through a push rod by operating a brake pedal. When the brake pedal is depressed, the push rod pushes the piston forward, and the brake fluid in the pump body flows back to the oil storage tank through the oil return port until the main rubber cup blocks the oil return port. When the main rubber cup is pushed over the oil return port, the brake fluid in the front chamber of the master cylinder is compressed and makes the one-way valve open, so that the fluid flows to the slave cylinders through the brake pipeline. In this way, each slave cylinder piston extends outward, making the brake shoe friction plate contact with the brake drum, thus achieving the effect of deceleration or braking. At this time, the rear chamber of the piston is filled by the brake fluid from the oil return port. When the brake pedal is released, the piston is pressed back to its original position by the return spring, and the brake fluid in each slave cylinder is also compressed by the brake shoe return spring, so that the brake fluid returns to the master cylinder (piston front chamber) through the one-way valve. When the piston returns to its original position, the brake fluid in the master cylinder flows back to the oil tank through the oil return port. The pressure of the one-way valve is adjusted to be proportional to the residual pressure in the brake pipe and the slave cylinder, so that the brake fluid in the slave cylinder flows back to the oil tank through the oil return port. The pressure of the one-way valve is adjusted to be proportional to the residual pressure in the brake pipe and the brake slave cylinder, so that the slave cylinder cup can be placed correctly to prevent oil leakage and eliminate possible air resistance during emergency braking.




| | |
|---|---|
| 1 | Connecting rod |
| 2 | Push rod |
| 3 | Dust cover |
| 4 | Elastic collar |
| 5 | Auxiliary cup |
| 6 | Piston |
| 7 | Main rubber cup |
| 8 | Spring |
| 9 | One-way valve |

Fig. 2-3 Brake Master Cylinder

2.1.4 Brake

The brake is a double-shoe brake, which is installed on both sides of the box axle assembly.

The brake consists of 2 groups of brake shoes, brake slave cylinder and slack adjuster.

One end of the brake shoe is in contact with the fixing pin, and the other end is in contact with the clearance adjusting device. The parking brake shoe is pressed by the return spring and the pressure spring pull rod.

In addition, the parking brake mechanism and automatic adjustment device are also assembled on the brake, as shown in Fig. 2-7.

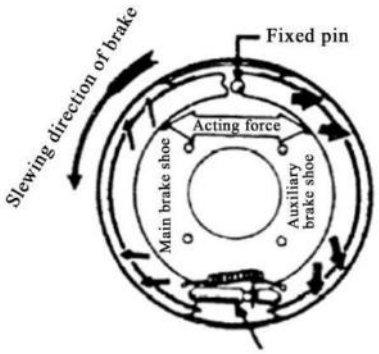
(1) Brake action

The brake slave cylinder applies the same pressure to the main brake shoe and the auxiliary brake shoe to press the brake drum until the upper end of the auxiliary brake shoe presses against the fixing pin, and then the brake shoe moves in the direction of the drum rotation.

After pressing against the fixing pin, the friction between the friction plate and the brake drum increases. As the main brake shoe gives the auxiliary brake shoe a much higher pressure than the brake slave cylinder, a large braking force is generated, as shown in Fig. 2-4.1.

The action of the brake when the vehicle moves backward is opposite to that when

the vehicle moves forward, as shown in Fig. 2-4.2.



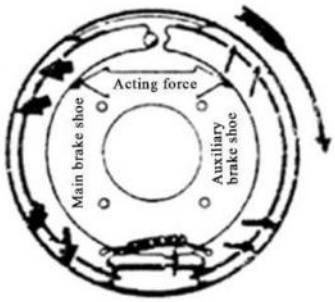




Fig. 2-4.1 Action in Forward Mode Fig. 2-4.2 Action in Backward Mode

(2) Clearance self-adjusting mechanism

The clearance self-adjusting mechanism can keep proper clearance between the friction plate and the brake drum. The structure is shown in Fig. 2-5.

The clearance self-adjusting mechanism only acts during reversing and braking.

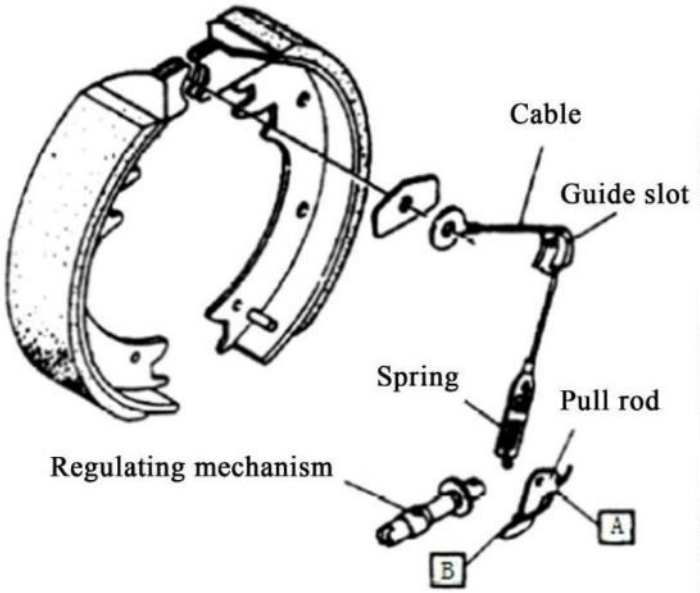



Fig. 2-5 Clearance Self-adjusting Mechanism

▲ Action of clearance self-adjusting mechanism

When the forklift truck moves backward, brake operation is carried out. The auxiliary brake shoe contacts with the main brake shoe and rotates together to make the pull rod turn right around Point A. As shown in Fig. 2-6, Point B is raised. After the brake is released, the pull rod turns left under the action of spring force and Point B is lowered. When the clearance between the friction plate and the brake hub increases, the vertical distance of B point rotation increases, the adjuster is shifted by one tooth, and the adjusting rod becomes longer (see Fig. 2-6), and the clearance decreases accordingly. The clearance adjustment range is shown in the following table:

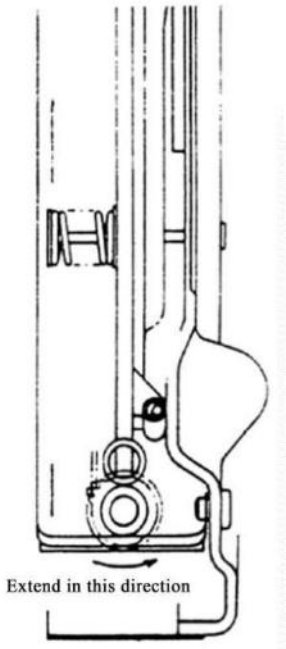



Fig. 2-6 Clearance Self-adjusting Mechanism

Unit: mm

| | 1.5-2.0 (E) | 2-2.5t | 3-3.8t |
|---|---|---|---|
| Clearance | 0.35~0.55 | 0.5~0.55 | 0.25~0.4 |

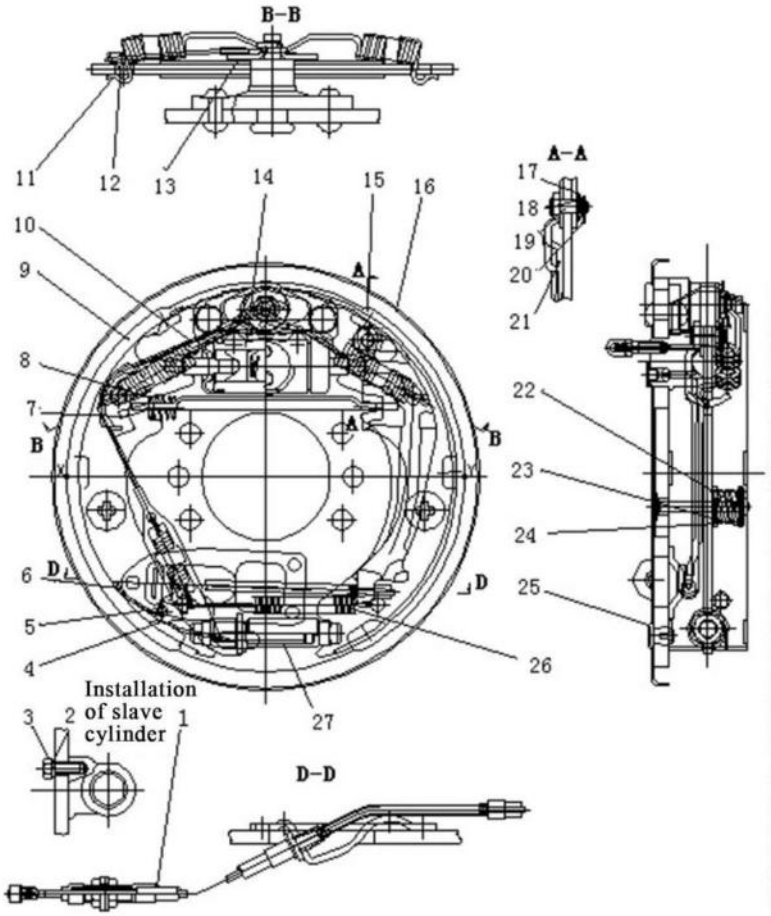



Fig. 2-7 Brake Assembly

| | | | |
|---|---|---|---|
| (1) Brake cable assembly | (2) Washer 8 | (3) Bolt M8x20 | (4) Pawl |
| (5) Pawl pin shaft | (6) Torsion spring | (7) Hand brake push rod | (8) Spring |
| (9) Rear brake shoe with friction plate assembly | (10) Spring wire device | (11) Brake shoe return spring | (12) Guide block |
| (13) Guide plate | (14) Brake slave cylinder assembly | (15) Front brake shoe with friction plate assembly | (16) Base plate assembly |
| (17) Washer 10 | (18) Elastic gasket | (19) Pull rod pin shaft | (20) Rod pin collar |
| (21) Hand brake pull rod | (22) Pressure spring pull rod | (23) Pressure spring seat | (24) Pressure spring |
| (25) Rubber plug | (26) Lower tension spring | (27) Clearance adjuster assembly | |

### 2.1.5 Adjustment of brake pedal

(1) Shorten the push rod on the brake master cylinder;

(2) Adjust the stop bolt, as shown in Fig. 2-8, and adjust the pedal height to about

60~75 mm. After depressing the pedal, the clearance between the pedal and the front bottom plate shall be greater than 20 mm;

(3) Step on the brake pedal and lengthen the push rod until the front end of the push rod contacts the piston of the master cylinder;

(4) Tighten the lock nut of the push rod.

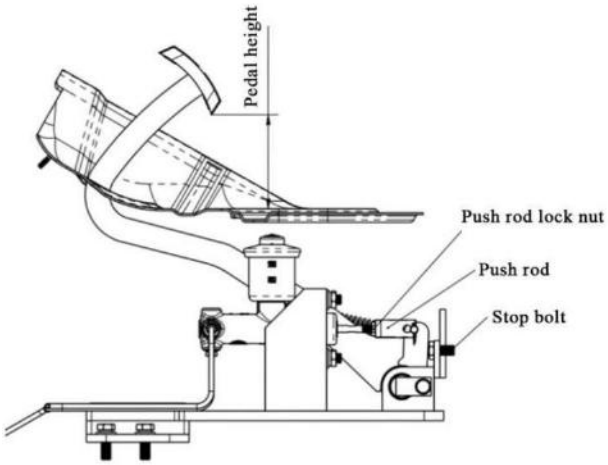



Fig. 2-8 Brake Pedal Adjustment

▲ Adjustment of the brake switch

a) Loosen the lock nut of the brake switch after adjusting the height of the brake pedal;

b) Disconnect the plug to separate the conductor;

c) Turn the switch to make the clearance A = 1 mm;

d) Confirm that the brake lamp is on when the brake pedal is stepped on.

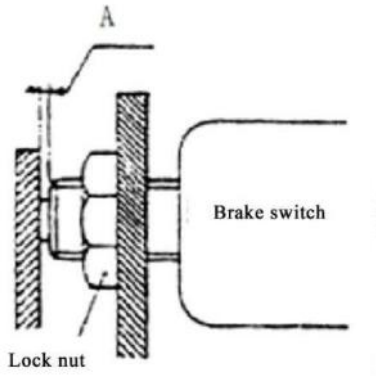



Fig. 2-9 Brake Switch Adjustment

## 2.2 Main points of brake disassembling, assembling and adjustment

This section describes the disassembling, assembling and adjustment of the brake and the adjustment method of the brake pedal when the wheel and hub are disassembled.

This section is applicable to 2.5t brake. Although the structure of regulators is different for other models, the maintenance methods are basically the same.

### 2.2.1 Disassembly of brake

(1) Remove the support pin, adjusting rod, adjusting device and spring on the auxiliary brake shoe.

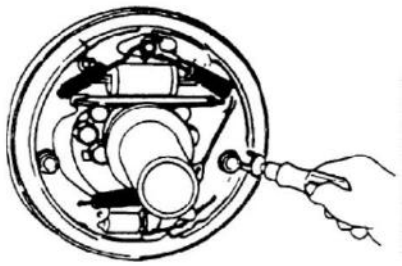


Fig. 2-10

(2) Remove the shoe return spring.

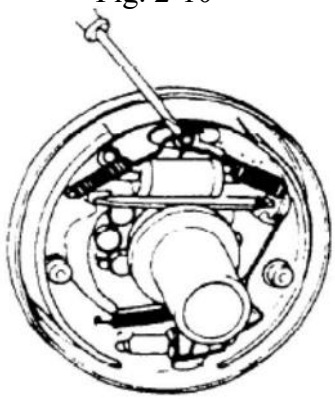


Fig. 2-11

(3) Remove the fixing spring on the main brake shoe.

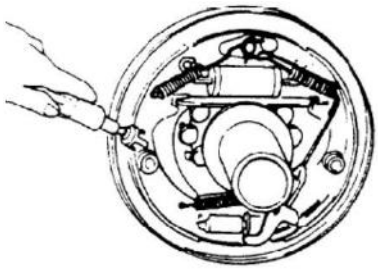


Fig. 2-12

(4) Remove the main brake shoe and auxiliary brake shoe. Remove the adjuster and adjuster spring at the same time.

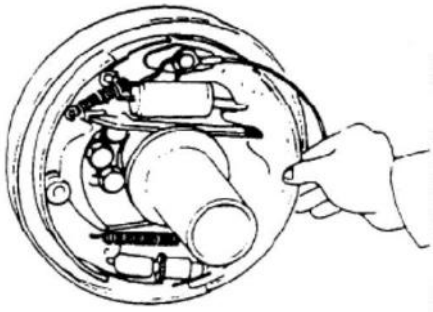


Fig. 2-13

(5) Remove the brake pipe from the brake slave cylinder. Then remove the mounting bolts of the brake slave cylinder and remove the brake slave cylinder from the brake base plate.

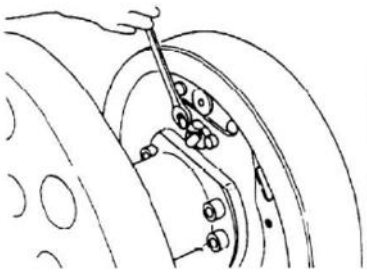


Fig. 2-14

(6) Remove the E- ring for fixing the brake cable on the brake base plate. Then remove the bolts for installing the brake base plate and remove the brake base plate from the drive axle.

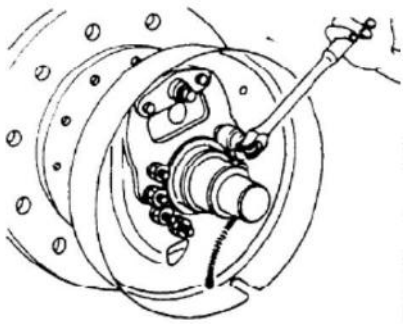


Fig. 2-15

(7) Disassemble the brake slave cylinder: Remove the dust ring. Press one piston at one side to push out the piston on the other side, and then press down the piston with fingers.

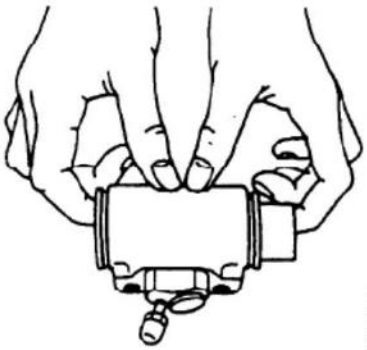


Fig. 2-16

2.2.2 Brake inspection

Inspection of parts and components, repair or replacement of damaged parts and components

(1) Inspect whether there is rust on the inner surface of the slave cylinder and the periphery of the piston. Then measure the clearance between the piston and the cylinder.

Standard size: 0.03-0.10 mm; limit size: 0.15 mm

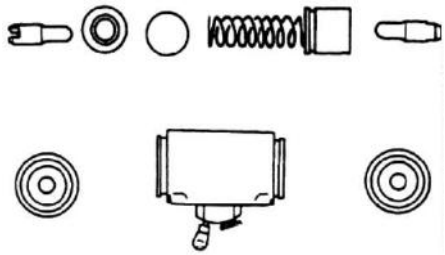


Fig. 2-17

(2) Visually inspect whether the piston cup is damaged or deformed, and replace it if it is abnormal.

(3) Measure the free length of the brake slave cylinder spring, and replace it when it exceeds the reference value.

(4) Measure the thickness of the friction plate and replace it when the wear limit is exceeded.

Unit: mm

| | 1.0-2.0t(E) | 2.0-2.5t | 3.0-3.8t |
|---|---|---|---|
| Standard value | 4.8 | 7.2 | 7.8 |
| Limit value | 2.5 | 3 | 3.3 |

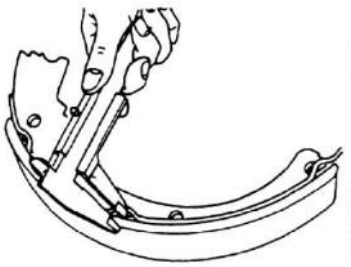


Fig. 2-18

(5) Visually inspect the inner surface of the brake drum. In case of damage or eccentric wear, grind and correct it, and replace it if it exceeds the correction limit.

Unit: mm

| | 1.0-2 t (E) | 2.0-2.5t | 3.0-3.8t |
|---|---|---|---|
| Standard value | Φ254 | Φ310 | Φ314 |
| Limit value | Φ256 | Φ312 | Φ316 |

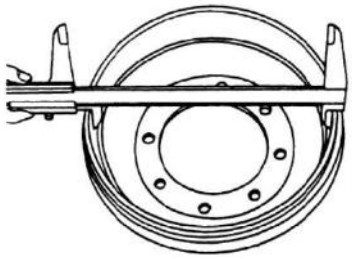


Fig. 2-19

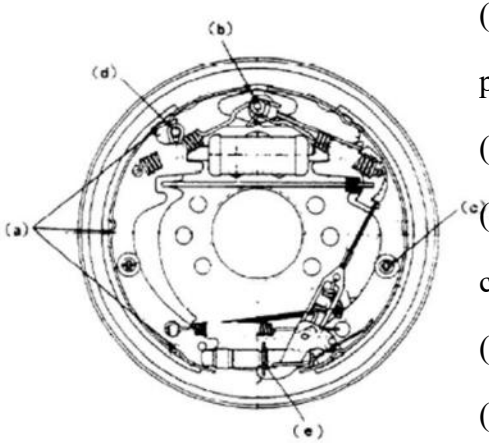
2.2.3 Brake assembly

(1) Apply brake fluid on the cup and piston of the brake slave cylinder, and assemble the spring, piston cup and piston dust ring in sequence.

(2) Install the brake slave cylinder on the brake base plate.

(3) Install the brake base plate on the drive axle.

(4) Apply heat-resistant grease on each part as shown in Fig. 2-20, and be careful not to apply it to the friction plate.




(a) Contact surface between the base plate and brake shoe

(b) Fixed pin

(c) Contact surface between shoe and compression spring seat

(d) Hand brake lever support pin

(e) Adjusting mechanism threads and other rotating parts

Fig. 2-20

(5) The parking brake cable is stuck with an E-ring.

(6) Install the brake shoe with the fixing spring.

(7) Install the pressure spring on the push rod of the hand brake, and then install the push rod on the brake shoe.

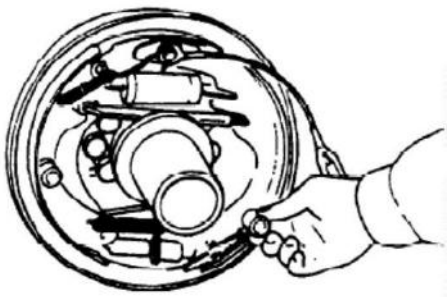


Fig. 2-21

(8) Install the guide plate of brake shoe on the support pin, and then install the return spring of the brake shoe. Install the main brake shoe first and then the auxiliary one.

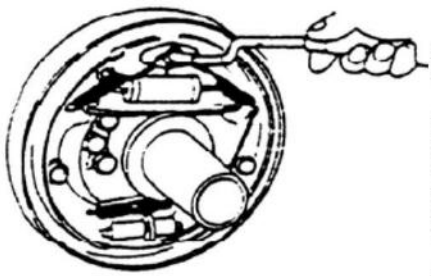


Fig. 2-22

(9) Install the adjuster, adjuster spring, ejector rod and ejector rod return spring. Pay attention to the following points:

a) Thread direction and installation direction of the adjuster;

b) Adjustment direction of the adjuster spring (the contact between adjuster teeth and spring is not allowed);

c) Direction of ejector rod return spring (the spring hook at the end of the support pin fixed on the opposite side of the ejector rod);

d) The lower end of the adjusting lever must be in contact with the adjuster teeth.

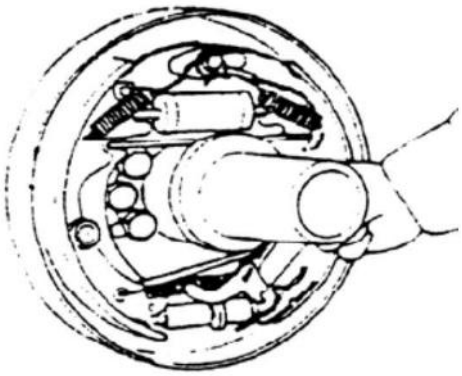


Fig. 2-23

(10) Connect the brake oil pipe to the slave cylinder.

(11) Measure the inner diameter of the brake drum and the outer diameter of the brake shoe, and adjust the adjuster so that the difference between the inner diameter of the brake drum and the outer diameter of the brake shoe friction plate is 1 mm.

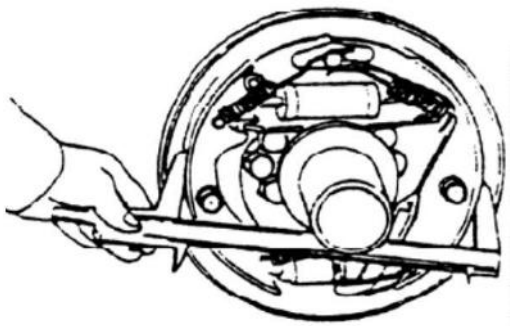


Fig. 2-24

2.2.4 Operation test of clearance self-adjusting device

(1) Firstly, make the diameter of the brake shoe close to the specified installation size, and pull the adjusting lever by hand to rotate the adjuster. When the lever is released, the adjusting lever returns to its original position, and the adjuster gear does not rotate.

Note: Even when the gear of the adjuster returns together with the adjusting lever as it is released, the adjuster can still function well after loading.

(2) If the adjuster cannot act as above mentioned when the adjusting lever is pulled, the following inspection must be carried out:

a) Fix the adjusting lever, ejector rod, ejector rod spring and compression spring seat;

b) Check whether the ejector rod return spring and adjuster spring are damaged, whether the rotation of the adjuster gear and its meshing parts are excessively worn or damaged, and whether the lever is in contact with the gear, and replace damaged parts.

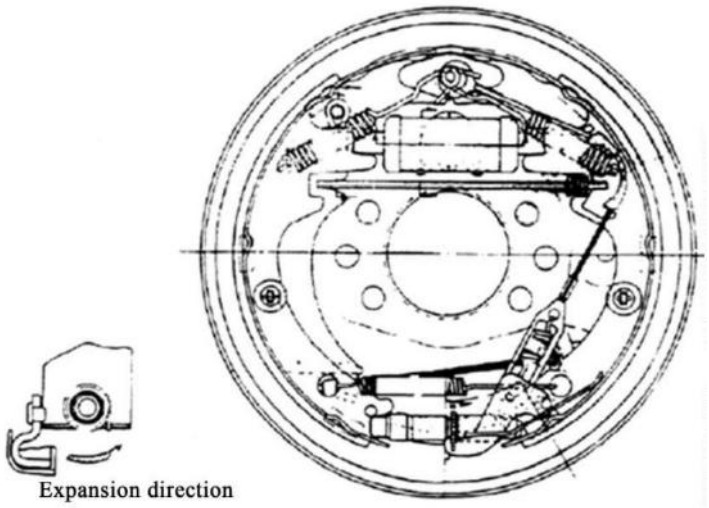



Fig. 2-25

2..3 Fault diagnosis

| Fault | Cause analysis | Troubleshooting |
|---|---|---|
| Brake poor | 1) Oil leakage of brake system | repair |
| | 2) Clearance of brake shoe improperly adjusted | Adjust the adjuster |
| | 3) Brake overheating | Check for slipping |
| | 4) Poor contact between the brake drum and friction plate | Readjust |
| | 5) Impurities attached to friction plates | Readjust |
| | 6) Impurities mixed into brake fluid | Inspect the brake fluid |
| | 7) The brake pedal (inching valve) improperly adjusted | Adjust |
| Brake noise | 1) The friction plate is hardened or impurities are attached to it. | Repair or replace |
| | 2) Base plate is deformed or the bolts are loosened. | Repair or replace |
| | 3) Deformation or incorrect installation of brake shoe | Repair or replace |
| | 4) Wear of friction plate | Replace |
| | 5) Loose wheel bearing | repair |
| Uneven braking | 1) Oil stain on the surface of the friction plate | Repair or replace |
| | 2) Clearance of brake shoe improperly | Adjust the adjuster |

| | | |
|---|---|---|
| | adjusted | |
| | 3) Failure of slave cylinder | Repair or replace |
| | 4) The brake shoe return spring damaged | Replace |
| | 5) Brake drum deflection | Repair or replace |
| Braking failure | 1) Oil leakage of brake system | Repair or replace |
| | 2) Clearance of brake shoe improperly adjusted | Adjust the adjuster |
| | 3) Air in the brake system | Exhaust the air |
| | 4) Incorrect adjustment of brake pedal | Readjust |

## 3. Steering System

### 3.1 Overview

The function of the forklift truck steering system is to change the driving direction of the truck or keep the truck running straight. The performance of the steering system is directly related to the driving safety, working efficiency and driver's labor intensity of the forklift truck. The steering system is classified into mechanical steering system (manual steering system) and power steering system according to the power source used in steering. A mechanical steering system completely relies on the driver's physical ability to control steering and overcome steering resistance torque. In a power steering system, the energy consumed to overcome the steering resistance torque is provided by the prime mover, and the driver operates the system with only a small force to control steering.

Due to the requirements of the working characteristics of the forklift truck, the working site, and the driving passage are narrow, the steering is frequent during operation, and it is often necessary to turn with the minimum radius, so the steering system is required to work reliably and be easy to operate. When the forklift truck is unloaded, the steering axle load accounts for about 60% of the truck weight. To reduce the labor intensity of the driver, this series of forklift trucks produced by our company adopts a full hydraulic power steering system.

### 3.2 Working principle

To turn the forklift truck, the driver applies steering torque on the steering wheel (steering control mechanism) to cause the steering wheel to generate rotational

displacement, which is transmitted to the steering gear through the steering shaft. According to the turning angle of the steering wheel, the steering gear transmits the appropriate volume of pressure oil to the steering cylinder through the pipeline, and the oil cylinder pushes the steering wheel through the steering trapezoidal mechanism to realize steering.

The difference between the full hydraulic steering gear and the hydraulic power steering gear is that the full hydraulic steering gear replaces mechanical components such as the mechanical steering gear and drag link, and the full hydraulic steering gear and the steering cylinder are connected by a high-pressure oil pipe. The load-sensing full hydraulic steering system circuit is equipped with a priority valve, which can ensure that the flow is distributed to the steering system first under any working condition and ensure sufficient oil supply. Only a small amount of flow passes through the steering gear when the steering gear is in the middle position, so as to realize energy saving of the system.

3.3 Composition of steering system

Steering control mechanism

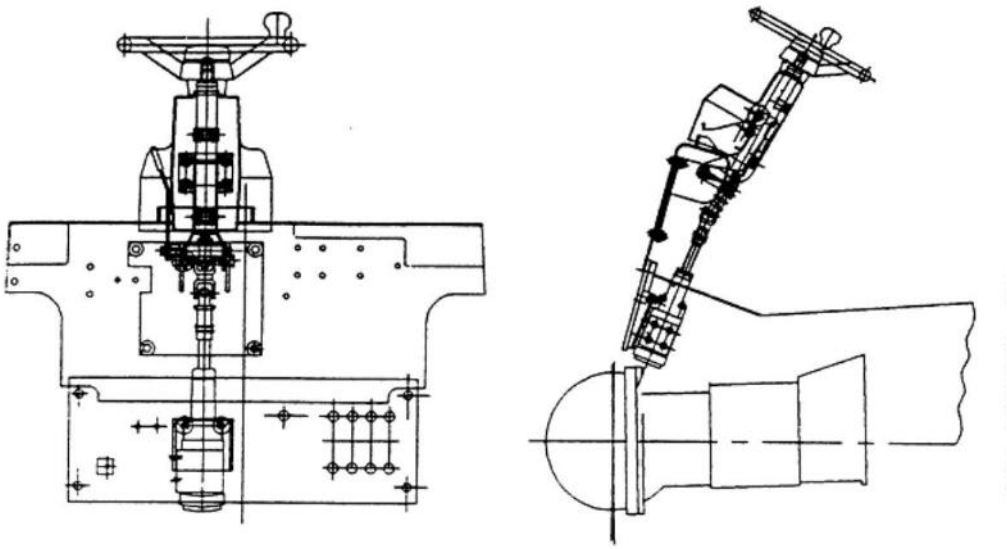


Fig. 3-1 Steering Operation Device

3.4 Steering axle

The 1.5-3.8t steering axle consists of steering axle body, steering cylinder, connecting rod, steering knuckle and other parts and components (as shown in Fig. 3-2).

The steering trapezoid adopts a crank slider mechanism, and the steering knuckle is pushed by the cylinder piston rod through the connecting rod to offset the steering wheel, thus realizing steering. The steering axle is fixed on the tail frame at the rear of the frame by bolts after the installation of damping blocks on the front and rear end plates, so that the axle body can swing around the pin shaft on the end plate, and a certain damping effect can be obtained due to the damping blocks. There is a steering knuckle on the left and right sides of the steering axle respectively. The rear hub is installed on the steering knuckle shaft with two conical roller bearings. The oil seal is installed inside the bearing to keep the grease in the hub and knuckle cavity.

See Table 3-1 for steering axle tire, rim model and tire pressure:

Table 3-1

| Forklift tonnage | 1.5t, 1.8t, 2t(E) | 2t, 2.5t | 3t, 3.5t, 3.8t |
|---|---|---|---|
| Tire | 16×6-8-10PR | 18×7-8-14PR | 3-3.5t: 18×7-8<br>3.8t: 200/50-10 |
| Rim | 4.33R-8 | 4.33R-8 | 3-3.5t: 4.33R-8<br>3.8t: 6.50F-10 |
| Tire pressure | 860kPa | 970kPa | Solid tires |

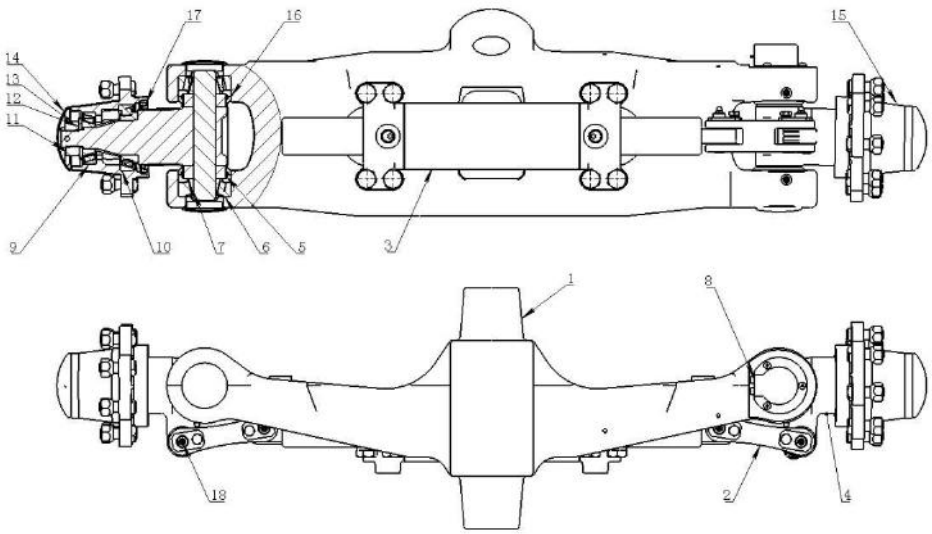



Fig. 3-2 Steering Axle

(1) Steering axle body (2) Connecting rod (3) Steering cylinder (4) Steering knuckle (5) Shaft sleeve (6) conical roller bearing (7) Steering knuckle kingpin (8) Steering potentiometer (9) Conical roller bearing (10) Conical roller bearing (11) Lock nut (12) Washer (13) Lock pin (14) Hub cover (15) Steering hub (16) Oil seal (17) Oil seal (18) Connecting rod pin

(1) Steering cylinder

The steering cylinder is a double-acting piston cylinder. Both ends of the piston rod are connected with the steering knuckle through the connecting rod. The pressure oil from the full hydraulic steering gear moves the piston rod left and right through the steering cylinder to realize left and right steering. The piston seal is a combined part of the support ring and O-ring, the cylinder head and piston rod are axially sealed by U-ring, and the oil cylinder is fixed on the steering axle through the cylinder heads on both sides. (See Fig. 3-3)

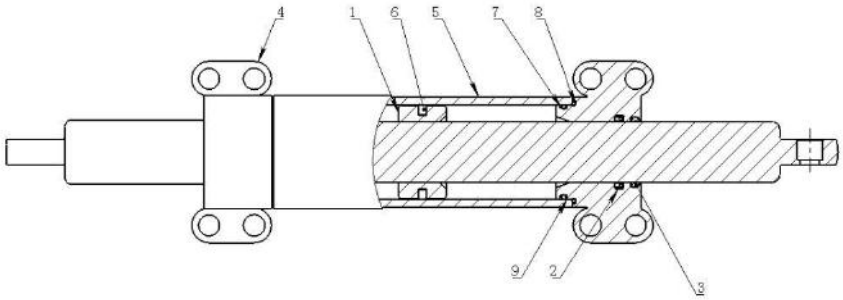



Fig. 3-3 Steering Cylinder

(1) Piston rod (2) U-ring (3) Dust ring (4) Cylinder head (5) Cylinder barrel (6) Combined seal ring (7) O-ring (8) O-ring (9) Stopper

(2) Hub

The hub is installed on the steering knuckle with two tapered roller bearings. The wheel is pried to the hub through the rim. An oil seal is installed on the inner side of the bearing to keep the grease in the hub and steering knuckle cavity. The tightness of the bearing is adjusted with nuts.

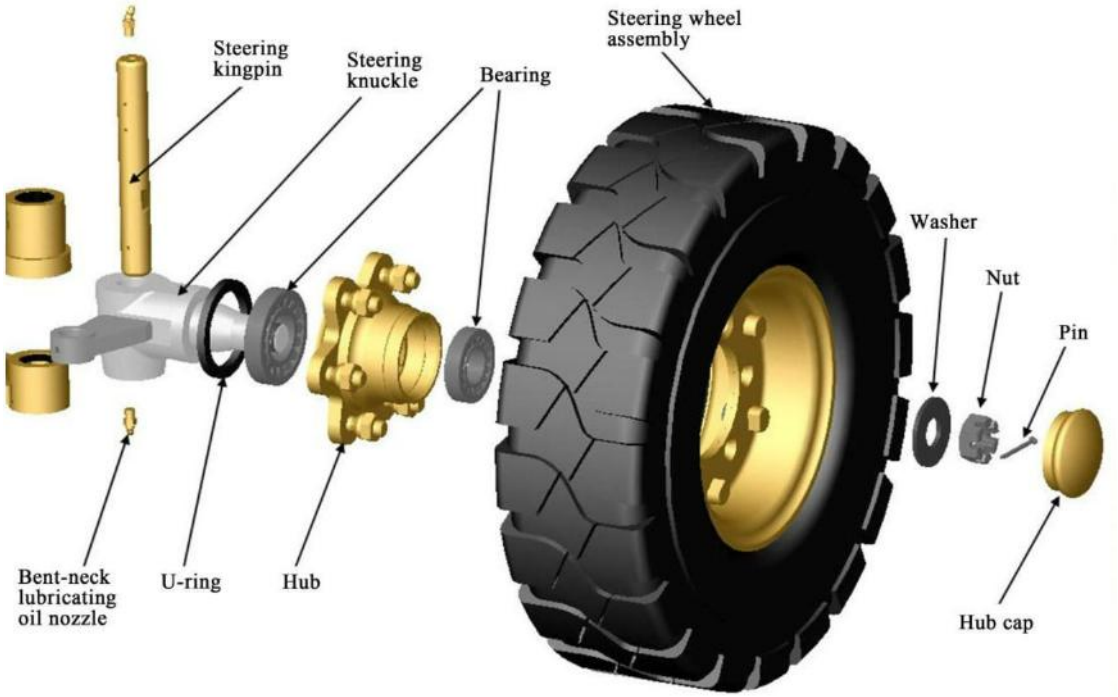



Fig. 3-4 Hub

3.5 Installation, commissioning, and maintenance

3.5.1 Adjustment steps of the pre-tightening load of the steering wheel bearing

(1) As shown in Fig. 3-5, apply grease to the inner cavity of the hub, inner and outer bearings and hub cover, and apply some grease to the lip of the oil seal;

(2) Fix the bearing outer ring around the hub, and install the hub to the steering knuckle shaft;

(3) Install the flat washer and tighten the slotted nut with a torque of 206~235N.m (21~24kgm). Loosen the slotted nut and then tighten it with a torque of 9.8N.m (1kgm);

(4) Gently knock the hub with a wooden hammer and turn the hub by 3 ~ 4 turns to ensure that the hub is not loose.

(5) Tighten the channel nut and align the channel to the cotter pin hole on the steering knuckle;

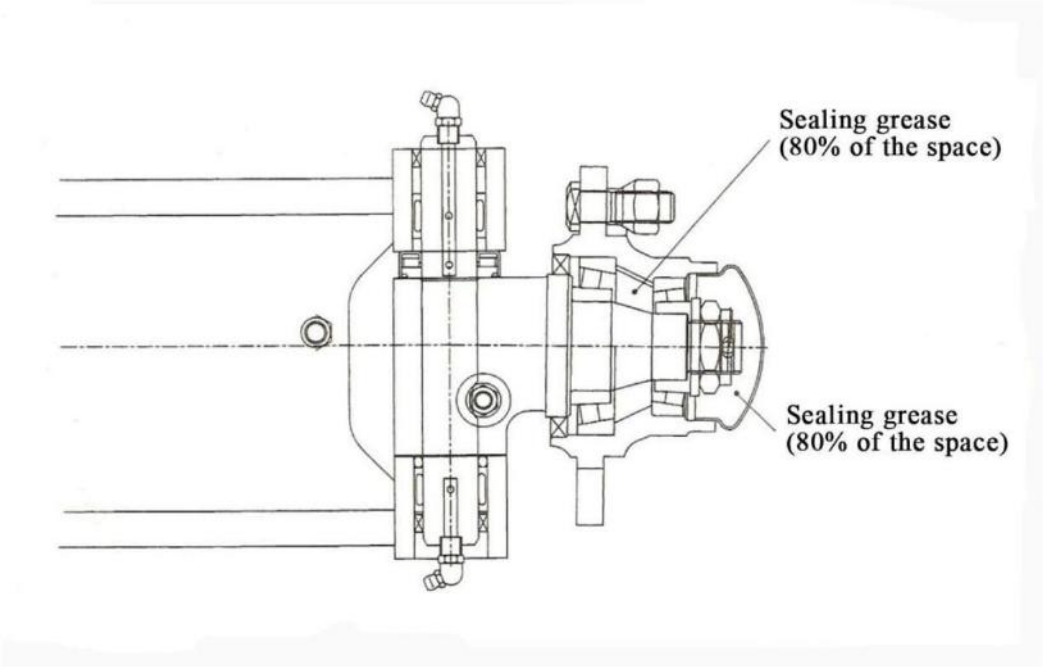



Fig. 3-5 Adding Lubricating Grease and Pre-tightening Load Adjustment

(6) Tap the hub gently with a wooden hammer, rotate the hub by hand for 3~4 turns to ensure stable rotation, and measure the rotating torque of the hub, which is 2.94~7.8N.m (0.3~0.8kgm);

(7) When the rotation torque is more than the specified value, turn the hub in the reverse direction by 1/6 turn and then measure the rotation torque again.

(8) When the specified rotation torque is reached, lock the channel nut with a cotter pin.

During tire replacement, after installing a new tire, apply sealant on the hub bolt, and ensure that the tightening torque of the hub nut is 160N.m for a 1.5-3.8t forklift.

3.5.2 Maintenance of steering system

(1) The steering kingpin shall be checked every 40 hours, and the up-and-down elbow lubricating nozzle of the kingpin shall be replenished with lubricating grease every 300 hours. Rotary joints between the piston rod and the connecting rod of steering cylinder, between the left and right steering knuckle arms and the connecting rod shall be checked every 40 hours, and grease shall be replenished every 300 hours.

(2) The grease of the bearing at the steering hub needs to be replaced every 1200 hours;

(3) Check the working status of the steering system during routine maintenance. During steering, the hand operating force acting on the steering wheel shall be 10-25N; the difference between the left and right steering forces shall not be more than 10N; when the forklift runs in a straight line at the maximum speed, there shall be no obvious snaking phenomenon. If there is any fault, it shall be analyzed and eliminated by referring to Table 3-2 Steering System Fault Analysis Table.

(4) A special lubricating grease shall be applied at the horn switch contact conductive plate of the steering wheel every 1200 hours .

3.6 Main faults and troubleshooting of the steering system

3.6.1 Inspection steps after reassembly of steering system

(1) Turn the steering wheel to the leftmost and rightmost to see if the leftward and rightward force is even and the rotation is smooth;

(2) Check whether the oil pressure pipeline is correctly placed and whether the left and right steering devices are installed oppositely;

(3) Jack up the rear wheel, slowly turn the steering wheel left and right, and repeat several times to remove the air in the hydraulic pipeline and cylinder.

3.6.2 Removal of faults of steering system

Table 3-2 Steering System Fault Analysis Table

| Fault | Cause analysis | Troubleshooting |
|---|---|---|
| Steering wheel rotation failure | The oil pump is damaged or faulty | Replace |
| | The diverter valve is blocked or damaged | Clean or replace |
| | The rubber hose or joint is damaged or the pipeline is blocked | Replace or clean |
| Heavy steering wheel | The pressure of diverter valve is too low | Adjust the pressure |
| | Air in the oil circuit | Exhaust the air |
| | The steering gear fails to reset, and the positioning leaf spring is broken or has insufficient elasticity | Replace the leaf spring |
| | Too much leakage in the steering cylinder | Check the piston seal |
| Forklift snaking or swinging | The steering flow is excessively large | Adjust the flow of diverter valve |
| | Broken or inelastic spring | Replace |
| High working noise | The oil level in oil tank is low | Refuel |
| | The suction pipe or the oil filter is blocked | Clean or replace |
| Oil leakage | The steering cylinder guide sleeve seal is damaged or the pipeline or joint is damaged | Replace |

## 4. Electrical System

### 4.1 Overview

The electrical system of EKKO lead acid counterweight electric forklift truck is equipped with a full AC control system, which can realize the silent, efficient, smooth, unhindered and safe control of the whole vehicle.

It is mainly composed of a color instrument, control system, traction motor, pump motor, battery pack, control switch and lighting device, connecting harness, etc.

**Note: The manufacturer reserves the right to continuously improve the products. Please consult the manufacturer if there is any discrepancy between the product and the instructions.**

The schematic diagram of the electrical system is as follows.

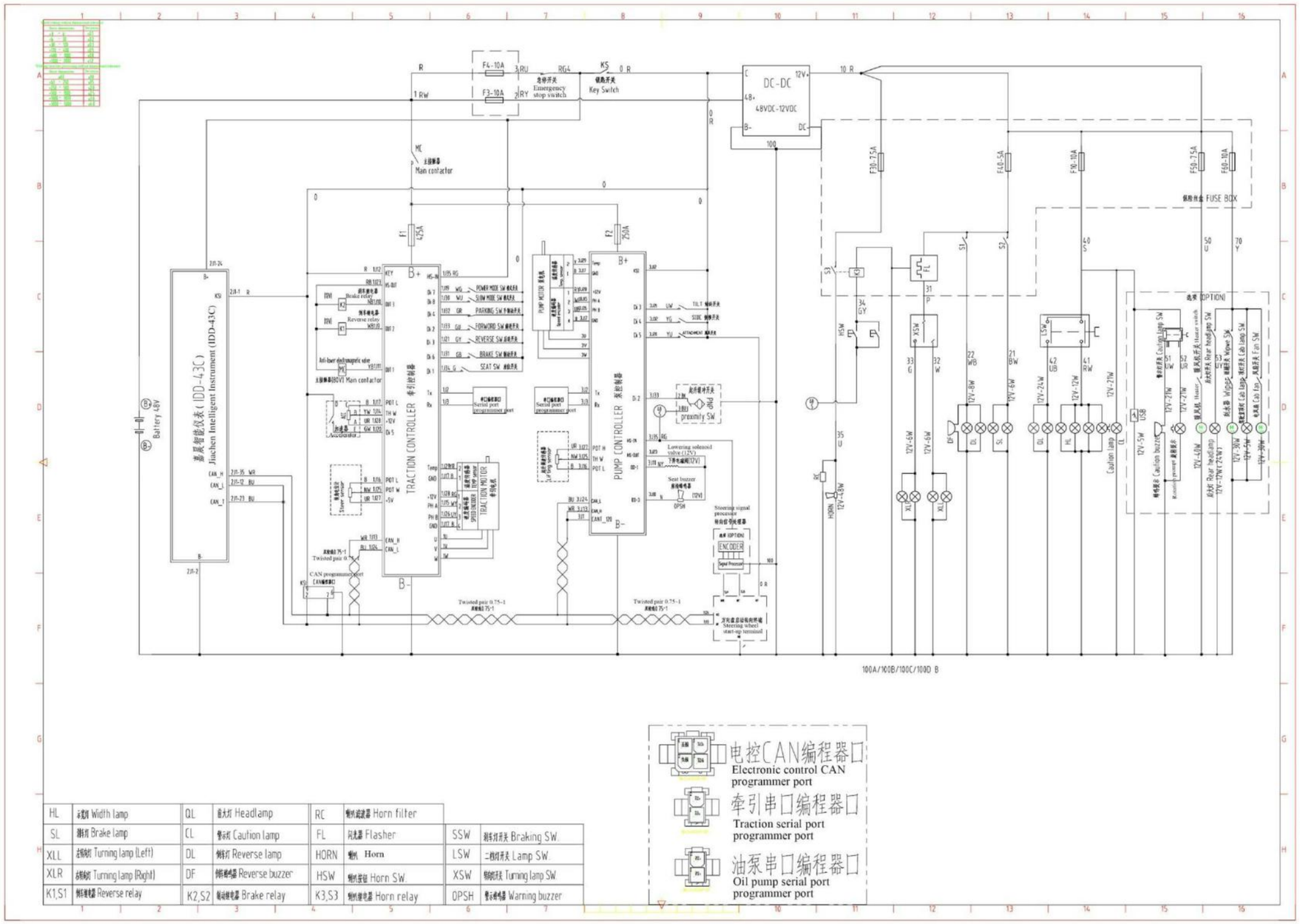
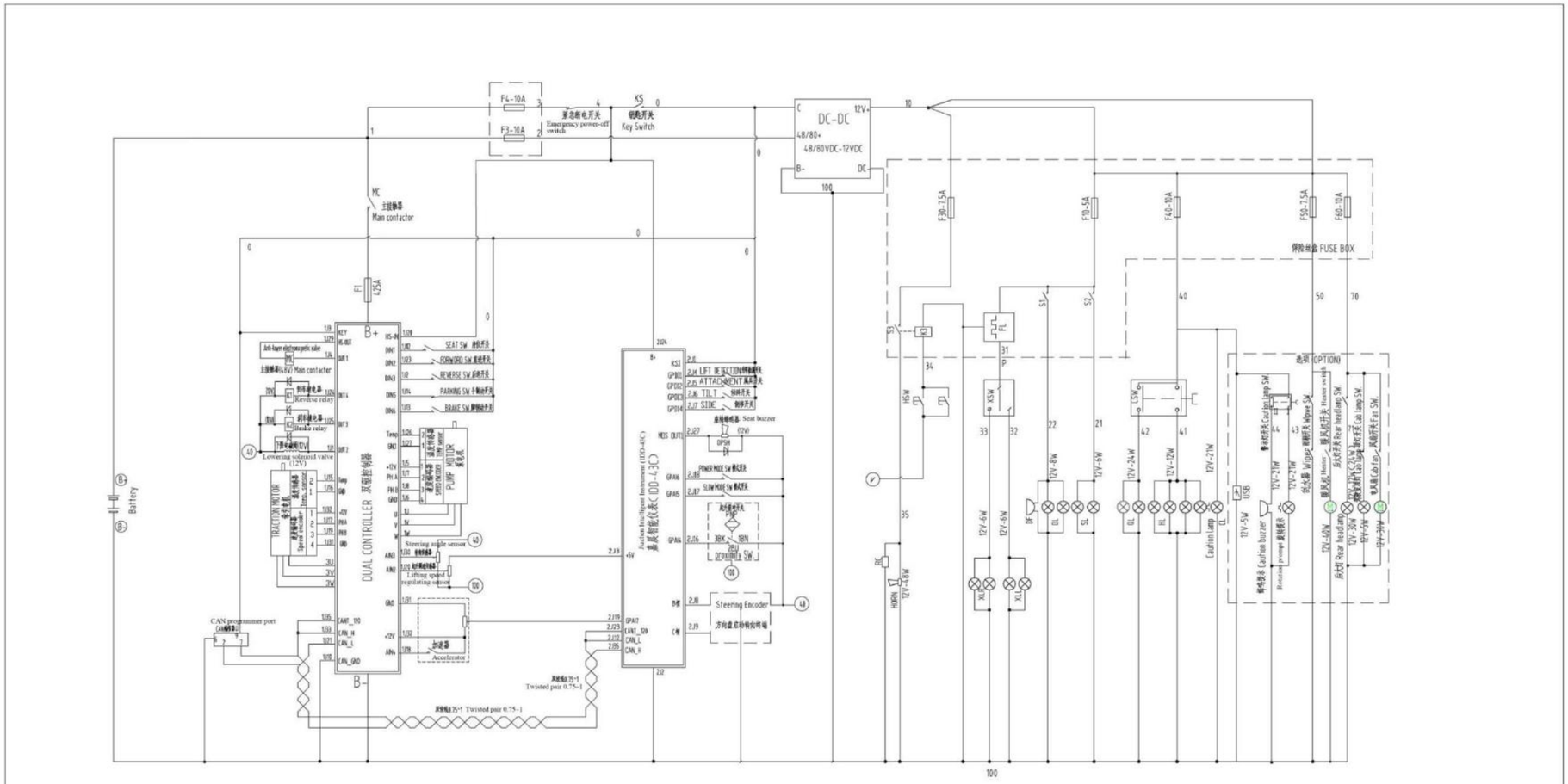



Fig. 4-1 Schematic Diagram of Electrical System (CPD15/18/20/25/30/35-A5H4-M/S & CPD20-A5XH4-S & CPD38-A5H4-S)




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HL | 示宽灯 Width lamp | QL | 前大灯 Headlamp | RC | 喇叭滤波器 Horn filter | | |
| SL | 刹车灯 Brake lamp | CL | 警示灯 Caution lamp | FL | 闪光器 Flasher | SSW | 刹车灯开关 Braking SW. |
| XLL | 左转向灯 Turning lamp (Left) | DL | 倒车灯 Reverse lamp | HORN | 喇叭 Horn | LSW | 二档灯开关 Lamp SW. |
| XLR | 右转向灯 Turning lamp (Right) | DF | 倒车蜂鸣器 Reverse buzzer | HSW | 喇叭按钮 Horn SW. | XSW | 转向灯开关 Turning lamp SW. |
| K1,S1 | 倒车继电器 Reverse relay | K2,S2 | 制动继电器 Brake relay | K3,S3 | 喇叭继电器 Horn relay | OPSH | 警示蜂鸣器 Warning buzzer |

Fig. 4-2 Schematic Diagram of Electrical System (CPD15/18/20/25/30/35-A3H4-M)

## 4.2 Instrument

### 4.2.1 Jiachen intelligent instrument (with Jiachen electronic control)

(1) It is a color screen instrument connected to the vehicle system via CAN bus. It can display the running status of the vehicle and has the diagnosis function.

(2) The instrument can read or modify the settings of all control modules connected to it in the CAN bus network. The node definition is shown in the following table:

| CAN Bus Network Related Numbers | Module |
|---|---|
| 08 | Traction controller |
| 07 | Pump controller |
| 05 | Steering controller |
| 16 | Instrument |

(3) Panel layout and interface display
With Jiachen electronic control:




Fig. 4-3 Jiachen Intelligent Instrument Panel (with Jiachen Electronic Control)




Fig. 4-4 Introduction to Instrument Interface Display Information (Standard Main Interface)

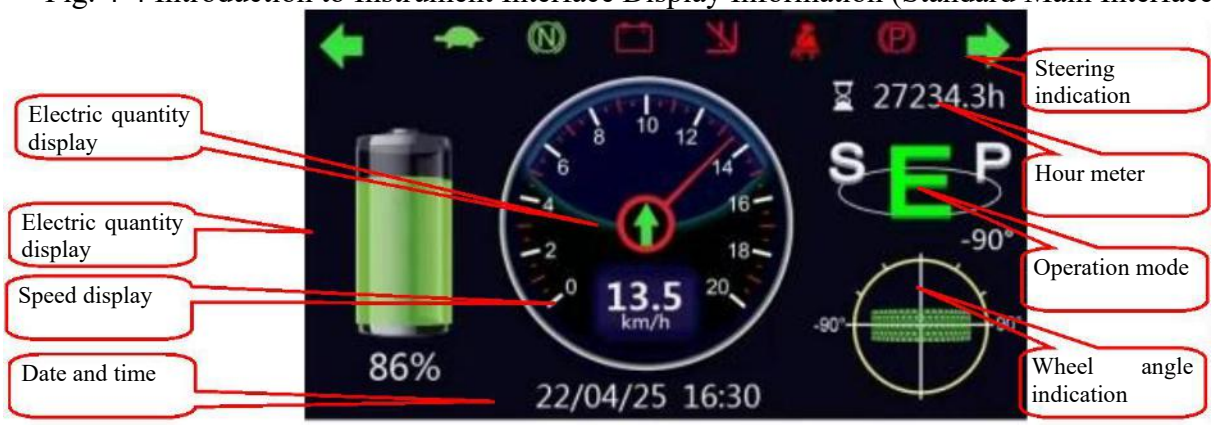



Fig. 4-5 Introduction to Instrument Interface Display Information (Optional Main Interface)




Fig. 4-6 Instrument Interface-Fault Display

With INMOTION electronic control:




Fig. 4-7 Jiachen Intelligent Instrument Panel (with INMOTION Electronic Control)




Fig. 4-8 Introduction to Instrument Interface Display Information

(4) Function and application

1) Hour meter

The figure shows the accumulated working time of the current vehicle. The working timer starts timing after the key switch is turned on and the vehicle starts working.

2) Direction indication

It indicates whether the current vehicle is in the forward gear or reverse gear.

3) Battery capacity indication

It displays the current battery capacity icon, and the current battery capacity is displayed above the battery capacity icon.

4) Operation mode

It displays the current working mode, with three gears: "P", "E" and "S".

5) Steering indication

It indicates the left and right steering of the vehicle.

6) Steering wheel angle indication

It represents the driving direction of the steering wheel.

7) Traveling speed

It displays the current vehicle speed in km/h.

8) Fault code display

It displays the current fault code of the vehicle.

9) LED indicator

When the operation mode is in S mode, the low speed indicator is on;

When the direction switch is in the middle position, the neutral indicator is on;

When the battery level is lower than or equal to 20%, the low battery indicator will be on;

When the battery level is lower than 15%, the lifting lock indicator will be on;

When the driver leaves the seat, the seat indicator is on;

When the parking brake switch is closed, the parking brake indicator is on.

## 4.3 Electronic control

### 4.3.1 Overview

This series of counterweight forklift trucks are equipped with motor controllers of domestic brand Jiachen and imported brand INMOTION. The control system has advanced high-frequency MOS technology, superior speed regulation performance, good safety,

flexibility and first-class protection. In addition, it has the advantages such as cutting-edge AC flux vector control technology to ensure efficient operation, programmable acceleration and deceleration characteristic curves and optimal performance curves.

The controller assembly includes motor controller, contactor, relay set, fuse, OPS warning buzzer, electronic protector and related wiring harness.

**Note: The manufacturer shall provide quality assurance for the motor controller. In case of failure, the manufacturer shall be notified in time to provide after-sales service. Please do not open it for maintenance without authorization and approval of the manufacturer. The user shall be liable for personal and property losses caused by his/her unauthorized maintenance.**

## 4.4 Motor

### 4.4.1 Motor specification

Table 4-1 Motor Specification

| Model / Item | EK30GB / EK35GB | EK20GB / EK25GB | EK18GS |
|---|---|---|---|
| Traction motor brand | Wanxin (15KW) | Wanxin (11KW) | Wanxin (8KW) |
| Model of travel motor | JXQ-15-3B | JXQ-11-4B | JXQ-8-3B |
| Rated voltage | 53V | 32V | 32V |
| Rated current | 162A | 248A | 182A |
| Rated speed | 1751r/min | 1883 r/min | 1741r/min |
| AC lifting motor brand | Wanxin (16KW) | Wanxin (12KW) | Wanxin (10.6KW) |
| AC lifting Motor model | JXQD-16-1B | JXQD-12-4B | JXQD-10.6-1B |
| Rated voltage | 53V | 32V | 32V |
| Rated current | 230A | 282A | 252A |
| Rated speed | 2100 r/min | 2144 r/min | 1967 r/min |

4.4.2 Inspection and Maintenance of Motor

(1) Routine inspection of motor

a) Insulation resistance of motor. Limit (not less than 1 MΩ)

b) The motor rotor shall rotate flexibly without friction.

c) Check whether the wiring of the motor is correct and reliable.

(2) Routine maintenance of motor

Pay attention to daily cleaning of motor surface, such as sand or other adhesives on the housing, to avoid affecting the heat dissipation of the motor.

Normally, it shall be checked once every six months, and the main work is as follows:

a) Carry out external inspection and surface cleaning of the motor, and remove dust from the motor.

b) Check, clean and replace the motor bearing, and listen carefully for abnormal noise during operation.

(3) Operating conditions of motor

a) The altitude shall not be more than 1200m;

b) Ambient air temperature range: -25°C ~ +40°C;

c) The relative humidity reaches 100%, and condensation forms on the motor surface.

4.5 Use of Battery and Charger

4.5.1 Battery specifications

| Parameters | Specification | | Notes |
|---|---|---|---|
| Nominal voltage/capacity | EK18GS / EK18GSH | 48V/400Ah (-S standard)<br>48V/420Ah (standard for small 2t)<br>48V/480Ah (-M standard, -S optional)<br>48V/560Ah (optional)<br>48V/600Ah (optional) | 4PzS400<br>4PzS420<br>4PzS480<br>4PzS560<br>4PzS600 |
| | EK20GB / EK25GB | 48V/500Ah (-S standard)<br>48V/600Ah (-M standard, -S optional)<br>48V/700Ah (optional) | 5PzS500<br>5PzS600<br>5PzS700<br>5PzS750 |

| | | | |
|---|---|---|---|
| | | 48V/750Ah (optional) | |
| | EK30GB / EK35GB | 80V/400Ah (-S standard)<br>80V/480Ah (-M standard, -S optional, 3.8t standard)<br>80V/560Ah (optional)<br>80V/600Ah (optional) | 4PzS400<br>4PzS480<br><br>4PzS560<br>4PzS600 |
| Operating voltage range | 48V：41V~52V<br>80V：69V ~ 88V | | Actual operating voltage |

Note: Other models of domestic or imported batteries can be configured according to user requirements.

4.5.2 Use of Battery

The correct use and routine maintenance of the lead-acid battery make a major difference to the performance and service life of the battery. Therefore, the user must carry out maintenance according to the provisions of the operation and maintenance instructions provided by the manufacturer and based on the actual situation.

4.5.3 Maintenance and precautions of battery

(1) The surface of the battery shall be kept clean and dry. Poles, bolts, and wiring parts shall be maintained frequently. Loose or poor contact shall be eliminated in time.

(2) No conductive objects are allowed to be placed on the battery, so as to avoid a short circuit of the battery.

(3) The first charge of the new battery before use is the initial charging, and all subsequent charges during use are normal charges. The charging time of normal charge varies based on the battery capacity and discharge degree, and it usually takes about 8~12 hours to charge continuously for discharge of 70%~100%.

(4) During battery charging, the gas cap of the filling hole shall be opened, and then closed after charging.

(5) When the battery is charged, oxygen-hydrogen gas will be separated out, so good ventilation conditions shall be ensured, and smoking or open flames prohibited are strictly prohibited to prevent explosion.

(6) During the use and charging of the battery, the water in the electrolyte will

naturally evaporate and electrolyze resulting in a lower liquid level and higher density of the electrolyte. Therefore, distilled water shall be added frequently to maintain the normal height and density of the electrolyte.

(7) Over-discharge (i.e., the voltage drop of battery cell is below 1.70V) and over-charge shall be avoided as far as possible during the use of the battery. Because over-discharge and overcharge of the battery will seriously affect the service life and performance of the battery.

(8) After use, the battery shall be charged in time within 24h. If the battery is often not charged in time, undercharged, over-discharged, or not used for a long time and not recharged, the battery plate will be vulcanized, resulting in degradation of battery performance and difficulty in use in serious cases.

(9) During the use of the battery, equalizing charge shall be carried out once a month to make all battery cells in a balanced and consistent state.

4.5.4 Storage and preservation of battery

(1) The battery shall be stored in a dry, clean and well-ventilated warehouse at 5°C~40°C.

(2) Battery must not be exposed to direct sunshine, solarization or rain, and shall be at least 2m from the heat.

(3) Battery must not be placed inversely or horizontally, and must not be thrown, rolled or pressed.

(4) Contact with any poisonous and corrosive articles shall be avoided, and no metal or impurity may fall into the battery.

(5) The battery shall not be stored with electrolyte. If it is required to be stored in case of special circumstances, it shall be fully charged and the electrolyte level and density shall be adjusted. During the storage period, the battery shall be charged once a month by the normal charging method.

**Note: (1) During battery charging, when the electrolyte temperature exceeds 40°C, the charging shall be suspended.**

**(2) During battery charging, when the electrolyte temperature exceeds 50°C, the service life of the battery will be affected.**

**(3) Do not charge the battery at low temperatures (such as cold outdoor), otherwise, the service life of the battery will be affected.**

**Notes: (1) The rated voltage of the traction battery is not safe, so there is a risk of electric shock injury if the battery is touched. Pay attention to your safety.**

**(2) The traction battery is a lead-acid battery, and the electrolyte is dilute sulfuric acid. Therefore, you shall wear protective equipment during battery testing, filling and adjustment to avoid accidents.**

**(3) The charger shell is a metal conductor. In order to prevent electric shock accidents, the grounding protection wire of the charger shall be reliably connected.**

**(4) The battery connector shall not be unplugged when the charger is not turned off, which will cause the battery to be undercharged and thus generate a dangerous electric spark. Therefore, great attention shall be paid.**

4.5.5 Faults and treatment of battery

There are many reasons for battery faults. Except for the influence of manufacturing quality and transportation and storage, most of them are caused by improper maintenance. When faults are found, analyze the causes in time and take effective measures to eliminate them as soon as possible.

Table 4-5 Faults and Treatment Methods of Battery

| Fault | Characteristics | Causes | Remedial and Preventive Measures |
|---|---|---|---|
| Sulphuration of pole plate | 1) Low capacity<br>2) The electrolyte density is lower than the normal value.<br>3) The battery terminal voltage is too high at the beginning and end of charging.<br>4) The electrolyte temperature rises too fast during charging.<br>5) Bubbles are formed prematurely when charging starts. | 1) Insufficient initial charging.<br>2) Long-term undercharge.<br>3) Frequent over discharge.<br>4) After discharging, failure to charge in time and out of service for a long time<br>5) Too high electrolyte density<br>6) Too low electrolyte level Plate exposure.<br>7) Failure to perform equalizing charge in time.<br>8) Discharge current too high or too low.<br>9) Impure electrolyte<br>10) Internal local short circuit or electric leakage. | 1) In mild cases, equalizing charge shall be adopted.<br>2) In severe cases, "hydrotherapy" shall be adopted.<br>3) Do not over discharge.<br>4) The electrolyte density shall not exceed the specified value.<br>5) The electrolyte level and impurity content shall be within the specified range. |
| Internal short circuit | 1) The battery terminal voltage is very low or even close to zero during charging.<br>2) No or very few bubbles exist at the end of charging.<br>3) During charging, the electrolyte temperature rises rapidly, and the density rises slowly or does not rise.<br>4) The open-circuit voltage of the battery is low, and the voltage drops to the final voltage too early during discharge. | 1) Plate bending, and active substance expansion or falling off, resulting in damage to the partition and short circuit.<br>2) Excessive sediment, causing short circuit.<br>3) Conductive foreign matters falling into battery, causing short circuit. | 1) Replace the baffle plate.<br>2) Remove deposits and conductive materials.<br>3) Replace the pole plate. |

| | | | |
|---|---|---|---|
| | 5) Severe self-discharge. | | |
| Active materials on plate falling off. | 1) The battery capacity is reduced.<br>2) The electrolyte is turbid.<br>3) There are too much sediments. | 1) Electrolyte not up to standard.<br>2) Excessive charge and discharge or overcharge and over discharge.<br>3) Electrolyte temperature of battery too high during charging.<br>4) Short circuit in external circuit during discharging. | Remove sediments in mild cases and scrap in severe cases |

4.6 Emergency power-off switch

The emergency power-off switch has the ability to cut off the load current and overload current, and can be used as a safety switch. The emergency power-off switch of the forklift mainly has two main functions: First, it serves as a safety switch, which can be pressed to disconnect the battery output in case of emergency to ensure the safety of the whole vehicle. Frequent operation of this button is prohibited in case of non-emergency, so as not to reduce the service life of the device. Second, disconnecting the emergency power-off switch can effectively prevent the battery feeding problems under the following three conditions.

(1) When the forklift is out of use for more than 72 hours, on the premise of ensuring that the lithium battery meets the storage requirements (see the *Operation and Maintenance Manual of Lithium-ion Power Battery* for details), please press the emergency power-off switch;

(2) During transportation, on the premise of ensuring that the battery capacity meets the transportation requirements (see the *Operation and Maintenance Manual of Lithium-ion Power Battery* for details), please press the emergency power-off switch;

(3) Please press the emergency power-off switch during maintenance of the forklift;

**Note: When the forklift is out of use for a long time, if the emergency power**

**off switch is not pressed, the battery is easy to be fed, affecting the normal use of the forklift.**

4.7 Routine maintenance

(1) Check the wear condition of the contacts. Replace the contacts when they are worn. The contacts shall be checked once every three months.

(2) Check the pedal or handle microswitch, and measure the voltage drop at both ends of the microswitch. There shall be no resistance when the microswitch is on or off, and there shall be clear sound when it is released. Check once every three months.

(3) Check the main circuit: battery-inverter-motor connecting cable. Ensure that the cable is well insulated and the circuit is tightly connected. Check once every three months.

(4) Check the mechanical movement of the pedal or handle. Check whether the spring can deform normally and whether the potentiometer spring can stretch to the maximum level or set level. Check once every three months.

(5) Check the mechanical movement of the contactor. It shall move freely and not stick, and the mechanical action of the contactor shall be checked once every three months. If any condition that may cause damage or endanger safety is found during the inspection, the agent of the controller shall be notified immediately, and the agent shall decide the operation safety of the vehicle.

**Note: When the chopper is installed, the wheels of the vehicle shall be lifted (off the ground) for testing, so that there will be no danger even if there is a connection error.**

**When the electric lock switch is disconnected, there is still a certain voltage in the filter capacitor for a period of time. If the inverter is to be maintained now, the battery must be cut off first, and then a 10-100 ohm resistor is connected to the positive and negative poles of the inverter to short-circuit the residual voltage on the capacitor.**

## 4.8 Fault diagnosis

### 4.8.1 Jiachen Control System

| Fault No. | English fault name | Solution |
|---|---|---|
| 1 | Controller short circuit single overcurrent | 1. Restart the key switch. 2. Battery voltage is low. |
| 2 | Controller short circuit continuous overcurrent | 1. Restart the key switch. 2. Battery voltage is low. |
| 3 | Controller current sensor failure | 1. Restart the key switch |
| 4 | Controller output continuous overcurrent | 1. Restart the key switch |
| 5 | Controller output single overcurrent | 1. Restart the key switch |
| 6 | Controller current gain failure | 1. Restart the key switch |
| 8 | Motor speed higher | 1. Motor speed sensor fails; 2. Wiring harness fails, and the motor speed sensor cable is broken or short-circuited. |
| 13 | Motor is not connected | 1. The motor wire is not connected to the controller 2. Check whether the motor wire is open-circuited 3. Check whether the motor is normal |
| 15 | High battery voltage warning | 1. High battery voltage |
| 16 | Battery voltage higher | 1. High battery voltage |
| 17 | Low battery voltage warning | 1. Low battery voltage 2. Connect the lithium battery model to the charger and turn on the key to operate the vehicle |
| 18 | Battery voltage lower | 1. Low battery voltage |
| 19 | Precharge fault | 1. Check whether the wire harness is broken 2. Low battery voltage 3. Connect the lithium battery model to the charger and turn on the key to operate the vehicle |
| 20 | Battery voltage sampling error | 1. Restart the key switch |
| 21 | Temperature sensor open | 1. Restart the key switch |
| 22 | Temperature sensor short | 1. Restart the key switch |

| | | |
|---|---|---|
| 27 | Motor temperature sensor open | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor cable is broken. |
| 28 | Motor temperature sensor short | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor cable is short-circuited. |
| 29 | Motor over temperature warning | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor cable is broken; 3. Motor temperature is too high. |
| 30 | Motor temperature higher | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor cable is broken; 3. Motor temperature is too high. |
| 31 | Motor low temperature warning | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor connecting wire broken; 3. Motor temperature is low. |
| 32 | Motor temperature lower | 1. Traction motor temperature sensor fails; 2. Wiring harness fails, and the traction motor temperature sensor cable is broken; 3. Motor temperature is too low. |
| 33 | Temperature sensor open | 1. Restart the key switch |
| 34 | Temperature sensor short | 1. Restart the key switch |
| 35 | Controller high temperature warning | 1. Restart the key switch |
| 36 | Controller temperature higher | 1. Restart the key switch |
| 25 | Controller low temperature warning | 1. Restart the key switch |
| 37 | Controller temperature lower | 1. Restart the key switch |
| 42 | Motor encoder loss phase A | 1. Motor speed encoder traction fails; 2. Wiring harness fails, and the motor speed encoder cable is broken. |
| 43 | Motor encoder loss phase B | 1. Motor speed encoder traction fails; 2. Wiring harness fails, and the motor speed encoder cable is broken. |

| | | |
|---|---|---|
| 44 | Drive 1 shorted & overcurrent ,cut off | 1. Check whether the wiring harness of t the main drive output 1 is short-circuited; 2. Drive output 1 coil fails. |
| 45 | Drive 1 shorted & overcurrent ,warning | 1. Check whether the wiring harness of t the main drive output 1 is short-circuited; 2. Drive output 1 coil fails. |
| 46 | Drive 1 coil Opened | 1. Check the wiring harness of main the drive output 1 for open circuit; 2. Drive output 1 coil fails. |
| 47 | Drive 1 overcurrent ,warning | 1. Check whether the wiring harness of t the main drive output 1 is short-circuited; 2. Drive output 1 coil fails. |
| 48 | Drive 2 shorted & overcurrent ,cut off | 1. Check whether the wiring harness of the main drive output 2 is short-circuited; 2. Drive output 2 coil fails. |
| 49 | Drive 2 shorted & overcurrent ,warning | 1. Check whether the wiring harness of the main drive output 2 is short-circuited; 2. Drive output 2 coil fails. |
| 50 | Drive 2 coil Opened | 1. Check the main drive output; 2 harness for open circuit 2. Drive output 2 coil fails. |
| 51 | Drive 2 overcurrent ,warning | 1. Check whether the wiring harness of the main drive output 2 is short-circuited; 2. Drive output 2 coil fails. |
| 52 | Drive 3 shorted & overcurrent ,cut off | 1. Check whether the wiring harness of the main drive output 3 is short-circuited; 2. Drive output 3 coil fails. |
| 53 | Drive 3 shorted & overcurrent ,warning | 1. Check whether the wiring harness of the main drive output 3 is short-circuited; 2. Drive output 3 coil fails. |
| 54 | Drive 3 coil Opened | 1. Check the wiring harness of the main drive output 3 for open circuit; 2. Drive output 3 coil fails. |
| 55 | Drive 3 overcurrent ,warning | 1. Check whether the wiring harness of the main drive output 3 is short-circuited; 2. Drive output 3 coil fails. |
| 56 | Drive input shorted & overcurrent ,cut off | 1. Check whether the wiring harness of the main drive input is short-circuited. |

| | | |
|---|---|---|
| 57 | Drive input opened | 1. Check whether the wiring harness of the main drive input is short-circuited. |
| 58 | Drive input shorted & overcurrent ,warning | 1. Check whether the wiring harness of the main drive input is short-circuited. |
| 59 | Drive input/output overcurrent ,warning | 1. Check whether the wiring harness of the main drive input is short-circuited; 2. Connect the lithium battery model to the charger and turn on the key to operate the vehicle. |
| 60 | CAN communication fault | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 61 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 62 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 63 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 64 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 65 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 66 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 67 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |

| | | |
|---|---|---|
| 68 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 69 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 74 | | 1. Check whether the CAN bus is open-circuited or short-circuited (controller and instrument); 2. Check whether the resistance on the CAN bus is 60Ω. |
| 75 | EEPROM recovery failure | 1. Restart the key switch |
| 76 | | 1. Restart the key switch |
| 77 | Watchdog failure | 1. Restart the key switch |
| 78 | Logic failure | 1. Restart the key switch |
| 79 | | 1. Restart the key switch |
| 80 | | 1. Restart the key switch |
| 81 | Internal power failure | 1. Restart the key switch |
| 82 | | 1. Restart the key switch |
| 83 | | 1. Restart the key switch |
| 84 | | 1. Restart the key switch |
| 86 | | 1. Restart the key switch |
| 87 | | 1. Restart the key switch |
| 88 | Motor encoder open | 1. Check whether the wiring harness of the motor encoder is open-circuited; 2. Motor encoder fails |
| 89 | Motor encoder short | 1. Check whether the wiring harness of the motor encoder is short-circuited; 2. Motor encoder fails. |
| 90 | 12V voltage higher | 1. Check the motor encoder and the wiring harness of the temperature sensor; 2. Motor encoder fails; 3. Motor temperature sensor fails. |
| 91 | 12V voltage gain failure | 1. Check the motor encoder and the wiring harness of the temperature sensor; 2. Motor encoder fails; 3. Motor temperature sensor fails. |
| 93 | Incorrect start Accelerator pedal switch active before key on | 1. Release accelerator pedal |

| | | |
|---|---|---|
| 94 | Forward or reverse switch active before key on | 1. Set the direction switch to neutral. |
| 95 | Forward switch and reverse switch active<br>at the same time | 1. Direction switch fault |
| 96 | Throttle analog value out of range | 1. Accelerator pedal fails or the analog value needs to be recalibrated |
| 97 | Throttle switch failure | 1. Accelerator pedal fault |
| 98 | Brake pedal analog value out of range | 1. Brake pedal fails or the analog value needs to be recalibrated |
| 99 | Brake pedal switch failure | 1. Brake pedal fault |
| 100 | Handbrake closed | 1. Release the hand brake |
| 101 | Handbrake failure | 1. The driver leaves the vehicle without pulling the hand brake. |
| 102 | Angle sensor failure | 1. The steering potentiometer fails or the analog value needs to be recalibrated. |
| 103 | Incorrect start Tilt switch active before<br>key on | 1. Disconnect the tilt switch. |
| 104 | Incorrect start Side switch active before<br>key on | 1. Disconnect the side shift switch. |
| 105 | Incorrect start Attachment switch active before key on | 1. Disconnect the attachment switch. |
| 106 | Lifting pot out of range | 1. The lifting speed regulating sensor fails or the analog value needs to be recalibrated. |
| 107 | Incorrect start Lift switch active before key on | 1. Disconnect the lift switch. |
| 108 | Traction drive limit | 1. The battery capacity is low and the vehicle speed is limited |
| 109 | Pump drive limit | 1. The battery capacity is low and the oil pump is limited |
| 110 | Battery SOC Low | 1. The battery power is low, and the lifting is cut off. |
| 111 | BMS high voltage failure | |
| 112 | BMS high charge current failure | |
| 113 | BMS in charge current mode | |
| 114 | BMS low temperature failure | |

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|---|---|---|
| 115 | BMS high temperature failure | |
| 116 | BMS CAN failure | |
| 117 | BMS ISO failure | |
| 118 | Slave watchdog failure | |
| 119 | CAN line voltage high | |
| 120 | BMS cell high voltage failure | |
| 121 | BMS cell low voltage failure | |
| 122 | BMS cell delta high voltage failure | |
| 123 | BMS cell delta high temperature failure | |
| 124 | BMS low voltage failure | |
| 125 | BMS high Logic failure | |
| 126 | BMS internal CAN failure | |
| 127 | BMS high discharge current failure | |
| 128 | BMS level 1 failure | |
| 129 | BMS level 2 failure | |
| 130 | BMS temperature failure | |
| 131 | BMS indicates Limit Current alarm warning | |
| 132 | BMS indicates cutoff Current warning | |
| 133 | BMS Current Warning | |
| 134 | BMS failure | |
| 135 | BMS voltage protection | |
| 136 | BMS power supply failure | |
| 137 | BMS current sampled opened | |
| 138 | BMS temperature sampled opened | |
| 139 | BMS voltage sampled opened | |
| 140 | BMS Fire failure | |
| 141 | BMS discharge temperature failure | |
| 142 | Motor Blocked Protection | 1. Restart the key switch<br>; 2. Depress the brake pedal to unlock. |

| | | |
|---|---|---|
| 143 | BMS Over Discharge Alarm | |

### 4.8.2 INMOTION

| Fault Code | English fault name | Solution |
|---|---|---|
| 20 | Incorrect start Accelerator pedal switch active before key on | Release accelerator pedal |
| 21 | Incorrect start Forward switch or reverse switch active before key on | Set the direction switch to neutral. |
| 22 | Forward switch and reverse switch active at the same time | Direction switch fault |
| 23 | Throttle analog value out of range | Accelerator pedal fails or the analog value needs to be recalibrated |
| 24 | Throttle analog fault | |
| 31 | Traction controller CAN communication fault | Please check whether CAN line or controller and instrument are disconnected |
| 32 | Battery voltage low | Charging required |
| 34 | CPU fault | Restart the key switch |
| 36 | Incorrect start Tilt switch active before key on | Reset the tilt switch |
| 37 | Incorrect start Side switch active before key on | Reset the side switch |
| 38 | Incorrect start Attachment switch active before key on | Reset the accessory switch |
| 39 | Incorrect start Lift switch active before key on | Reset the lift switch |
| 40 | Lift analog value out of range | Lift analog value is damaged or needs to be recalibrated. |
| 43 | Steer analog value out of range | The angle analog value is damaged or needs to be recalibrated. |
| 44 | Traction controller speed protection | 1、Alarm for high vehicle speed;<br>2、Traction motor speed sensor fault |
| 45 | Traction controller encoder fault | 1、Traction motor speed sensor fault;<br>2、Wire harness fails and the traction motor speed sensor cable is broken |
| 81 | Traction controller temperature is low | Alarm for low controller temperature |
| 82 | Traction controller temperature is high | Alarm for high controller temperature |
| 83 | Traction controller temperature sensor fault | Controller temperature sensor fault |

| | | |
|---|---|---|
| 84 | Traction motor temperature is low | 1、Traction motor temperature too low;<br>2、Traction motor thermistor fault |
| 85 | Traction motor temperature is high | 1、Traction motor temperature too high<br>2、Traction motor thermistor fault |
| 86 | Traction motor temperature sensor fault | 1、Traction motor thermistor fault;<br>2、Wire harness fails and the traction motor temperature sensor cable is broken |
| 87 | Traction motor encoder fault | 1、Traction motor speed sensor fault;<br>2、Wire harness fails and the traction motor speed sensor cable is broken |
| 88 | DC bus voltage of traction controller is high | 1、High battery voltage;<br>2、The ramp is too steep and regenerative braking is too strong |
| 89 | DC bus voltage of traction controller is low | Charging or inspection of the power wiring harness is required |
| 90 | The default value of the traction controller is updated | Refresh the protection after the program and restart the key. |
| 91 | Traction drive limit | The battery capacity is low and the vehicle speed is limited |
| 97 | Open drain of traction output open or short | Check the outlet harness for short circuit and open circuit (e.g., main contactor and reversing relay) |
| 98 | Traction controller over current or short | Check power wiring harness |
| 101 | Traction controller short | 1、Check power wiring harness;<br>2、Contact is enabled without contacting the controller |
| 102 | Traction controller temperature is high cut back | The temperature of the traction controller is too high and cooling is required |
| 103 | Traction motor temperature is high cut back | 1、The temperature of the traction motor is too high and cooling is required.<br>2、Traction motor temperature sensor fault |
| 104 | Traction controller over current | 1、The vehicle is overloaded or mechanically jammed;<br>2、Motor encoder failure |
| 105 | Traction controller precharge failed | Replace precharge resistor |
| 110 | DC bus voltage of traction | Low battery capacity |
| 111 | DC bus voltage of traction controller | High battery voltage |

| | | |
|---|---|---|
| | is high cut | |
| 112 | DC bus voltage of traction controller is high cut back(Hardware monitoring) | High battery voltage |
| 114 | Internal power supply error | Check wiring harness of motor encoder and temperature sensor |
| 121 | Pump controller temperature is low | Alarm for low controller temperature |
| 122 | Pump controller temperature is high | Alarm for high controller temperature |
| 123 | Pump controller temperature sensor fault | Controller temperature sensor fault |
| 124 | Pump motor temperature is low | 1、Oil pump motor temperature is too low;<br>2、Oil pump motor thermistor fault |
| 125 | Pump motor temperature is high | 1、Oil pump motor temperature is too high;<br>2、Oil pump motor thermistor fault |
| 126 | Pump motor temperature sensor fault | 1、Oil pump motor thermistor fault;<br>2. Wire harness fails and the oil pump motor temperature sensor cable is broken |
| 127 | Pump controller encoder fault | 1、Oil pump motor speed sensor fault;<br>2、Wire harness fails and the oil pump motor speed sensor cable is broken |
| 128 | DC bus voltage of pump controller is high | High battery voltage |
| 129 | DC bus voltage of pump controller is low | Charging or inspection of the power wiring harness is required |
| 130 | The default value of the pump controller is updated | Refresh the protection after the program and restart the key. |
| 132 | Pump drive limit | The battery is low and needs to be charged |
| 137 | Open drain of pump output open or short | Check the outlet harness for short circuit and open circuit |
| 138 | Pump controller over current or short | Check power wiring harness |
| 141 | Pump controller short | Check power wiring harness |
| 142 | Pump controller temperature is high cut back | Over temperature alarm of pump controller |
| 143 | Pump motor temperature is high cut back | Pump motor over temperature alarm |
| 144 | Pump controller current calibration error | Restart |

| | | |
|---|---|---|
| 145 | Pump controller precharge failed | Replace precharge resistor |
| 150 | DC bus voltage of pump controller is low cut back | Low battery capacity |
| 151 | DC bus voltage of pump controller is high cut back | High battery voltage |
| 152 | DC bus voltage of pump controller is high cut back(Hardware monitoring) | High battery voltage |
| 153 | Pump controller Internal Supply fault | 1、Restart the key switch;<br>2、Check wiring harness of motor encoder and temperature sensor |
| 154 | Pump controller speed control fault | 1、High pump speed alarm;<br>2、Pump motor speed sensor fault |
| 155 | BMS CAN bus off | BMS CAN 通信故障 |
| 156 | BMS temperature protection | Lithium battery temperature protection |
| 157 | BMS over temperature protection | Lithium battery over temperature protection |
| 158 | BMS single body over discharge | Low battery cell over discharge of lithium battery |
| 159 | BMS over voltage protection | Lithium battery overvoltage protection |
| 161 | Display CAN fault | Check the connection between instrument CAN and electronic control CAN line |
| 163 | BMS over current | Excessive current of lithium battery |
| 164 | Charge protection | Lithium battery charging protection |
| 165 | Seat switch off after a period of time, the direction of the request to reset | Reset direction switch |
| 168 | BMS indicates Limit Current alarm | Current-limiting protection of lithium battery |
| 169 | BMS indicates cutoff Current alarm | Lithium battery current cutoff protection |
| 200 | Proportional valve error | Special proportional valve failure |
| 241 | HPG CONTROLLER CAN BUS KO | Check the Baud rate of CAN communication line and controller (HPG DC pump control failure) |
| 242 | HPG CONTROLLER BATTERY OVER VOLTAGE | High battery voltage (HPG DC pump control failure) |
| 243 | HPG CONTROLLER KEY SHORTED | Key switch adhesion (HPG DC pump control failure) |
| 244 | HPG CONTROLLER WATCHDOG ERROR | Restart the key switch (HPG DC pump control failure) |
| 246 | HPG CONTROLLER WAITING FOR MAIN CONTACTOR | Switch off pump control contactor parameters (HPG DC pump control failure) |

| | | |
|---|---|---|
| 180 | BMS indicates brake Current alarm | Vehicle feedback protection of lithium battery |
| 181 | BMS CAN Error | BMS CAN communication error |
| 201 | Steer controller short | Check power wiring harness |
| 202 | Steer controller temperature is high cut back | The temperature of the steer controller is too high and cooling is required |
| 203 | Steer motor temperature is high cut back | 1. Steer motor temperature is too high and needs to be cooled; 2. Steering motor temperature sensor fails. |
| 205 | Steer controller precharge failed | Replace precharge resistor |
| 206 | DC bus voltage of Steer controller is low cut back | Low battery voltage |
| 207 | DC bus voltage of Steer controller is high cut back | High battery voltage |
| 210 | Steer motor encoder fault | 1. Steering motor speed sensor fails; 2. Wiring harness fails, and the steering motor speed sensor cable is broken. |
| 211 | Steer motor temperature sensor fault | 1. Steering motor thermistor fails; 2. Wiring harness fails, and the steering motor temperature sensor cable is broken. |
| 212 | Steer controller temperature sensor fault | Controller temperature sensor fault |
| 214 | Steer controller Internal power supply error | Check the steer motor encoder and temperature sensor harness |
| 217 | Open drain of Steer output open or short | Check the outlet harness for short circuit and open circuit |
| 218 | Steer motor temperature is low | 1、Steering motor temperature is too low;<br>2、Thermistor fault of steer motor |
| 219 | Steer motor temperature is high | 1、Steer motor temperature is too high;<br>2、Thermistor fault of steer motor |
| 220 | Steer controller temperature is low | Alarm for low controller temperature |
| 221 | Steer controller temperature is high | Alarm for high controller temperature |
| 222 | DC bus voltage of Steer controller is high | High battery voltage |
| 223 | DC bus voltage of Steer controller is low | Charging or inspection of the power wiring harness is required |
| 234 | Steer Controller Internal power supply error | Check the steer motor encoder and temperature sensor harness |

| | | |
|---|---|---|
| 51 | Slave traction controller short | 1、Check power wiring harness;<br>2、Contact is enabled without contacting the controller |
| 52 | DC bus voltage of Slave traction controller is low cut back | Low battery voltage |
| 54 | Slave traction controller over current | 1、The vehicle is overloaded or mechanically jammed;<br>2、Motor encoder failure |
| 55 | DC bus voltage of Slave traction controller is high cut back | High battery voltage |
| 56 | DC bus voltage of Slave traction controller is high cut back(Hardware monitoring) | High battery voltage |
| 57 | Slave traction controller precharge failed | Replace precharge resistor |
| 58 | Slave traction motor temperature is high cut back | 1、The temperature of the slave traction motor is too high and cooling is required.<br>2、Slave traction motor temperature sensor fault |
| 59 | Slave traction controller temperature is high cut back | The temperature of the slave traction controller is too high and cooling is required |
| 60 | Slave traction controller temperature sensor fault | Slave controller temperature sensor fault |
| 61 | Slave traction motor controller fault | Slave traction motor speed sensor AB is opposite. |
| 63 | Slave traction motor temperature sensor fault | 1、Thermistor fault of the slave traction motor;<br>2、Wire harness fails and the slave traction motor temperature sensor cable is broken |
| 64 | Open drain of Slave traction output open or short | Check the outlet harness for short circuit and open circuit |
| 65 | Internal power supply error | Check wiring harness of motor encoder and temperature sensor |
| 67 | Slave traction motor encoder fault | 1、Slave traction motor speed sensor fault<br>2、Wire harness fails and the slave traction motor speed sensor cable is broken |
| 170 | DC bus voltage of Slave traction controller is low | Charging or inspection of the power wiring harness is required |
| 171 | DC bus voltage of Slave traction controller is high | 1、High battery voltage;<br>2、The ramp is too steep and regenerative braking is too strong |

| | | |
|---|---|---|
| 172 | The default value of the Slave traction controller is updated | Refresh the protection after the program and restart the key. |
| 173 | Slave traction motor temperature is low | 1、Slave traction motor temperature is too low;<br>2、Thermistor fault of the slave traction motor |
| 174 | Slave traction motor temperature is high | 1、Temperature of the slave traction motor is too high;<br>2、Thermistor fault of the slave traction motor |
| 251 | Authentication Failed | Use correct authentication information. |
| 252 | Disable Function Level 1 | Release Disable Function Level 1. |
| 253 | Disable Function Level 2 | Release Disable Function Level 2. |
| 254 | IDT CAN communication fault | Check the CAN communication line between the control system and the IDT module. |

## 5. Hydraulic System

### 5.1 Overview

The hydraulic system consists of oil pump, multi-way valve, priority valve, lifting cylinder, tilt cylinder, high and low pressure oil pipes, joints and other parts. The lifting motor drives the oil pump, which marks the conversion of mechanical energy into hydraulic energy. The pump provides oil for the system, which is distributed to each oil cylinder through the multi-way valve.

#### 5.1.1 Oil pump

A pair of external gears mutually engaged serves as the main parts of the gear oil pump used in the forklift. The working principle is shown in Fig. 5-1.

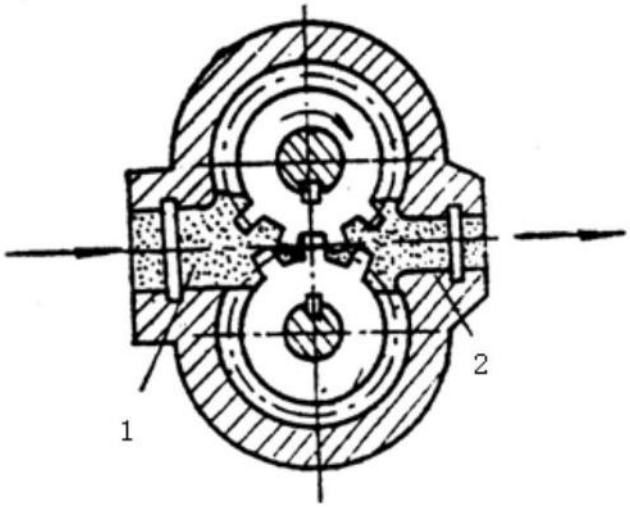



Fig. 5-1 Working Principle of Gear Pump
(1) Oil suction cavity (2) Oil pressing cavity

A pair of meshing involute gears is installed inside the housing, and both ends of the gears are sealed. The gears divide the pump housing into two sealing oil cavities, i.e., the spaces marked 1 and 2 in the figure. When the gear of the gear pump rotates in the direction shown in the figure, the volume of the space (where the gear teeth are disengaged) indicated by the number 1 increases, forming a vacuum. Under the action of atmospheric pressure, the oil in the oil tank enters the oil suction cavity through the oil suction pipe of the pump and fills the space between the teeth. However, the volume of the space (gear meshing position) indicated by the number 2 decreases, and the oil is hydraulically fed into the pressure oil circuit. That is, 1 is the oil suction cavity, 2 is the

oil pressure cavity, and they are separated by the meshing points of two gears. When the gear rotates continuously, the oil suction and discharge port of the pump continuously sucks and discharges oil.

The oil pump converts the mechanical energy of motor into hydraulic energy, so the oil pump is the power mechanism of forklift hydraulic system.

The main pump consists of pump body, a pair of gears, liner plate and oil seal. The pressure balance bearing and special lubrication method are used to minimize the gear backlash. The pressure balance method is to press the liner plate against the side of the gear due to the oil discharge guide between the liner plate and the pump body, as shown in Fig. 5-2.

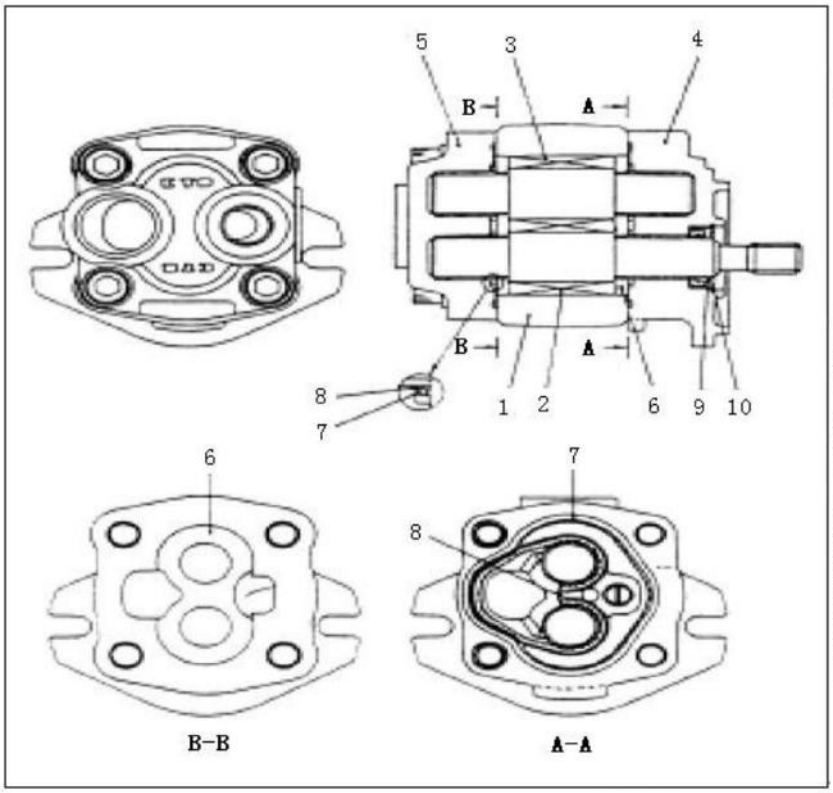



Fig. 5-2 Outline Drawing of Gear Pump Structure

(1) Pump body (2) Drive gear (3) Driven gear (4) Front end cover (5) Rear end cover (6) Lining plate (7) Seal ring (8) Retainer ring (9) Oil seal (10) Elastic retainer ring

### 5.1.2 Multi-way valve

The appearance of the multi-way valve is shown in Fig. 5-3.

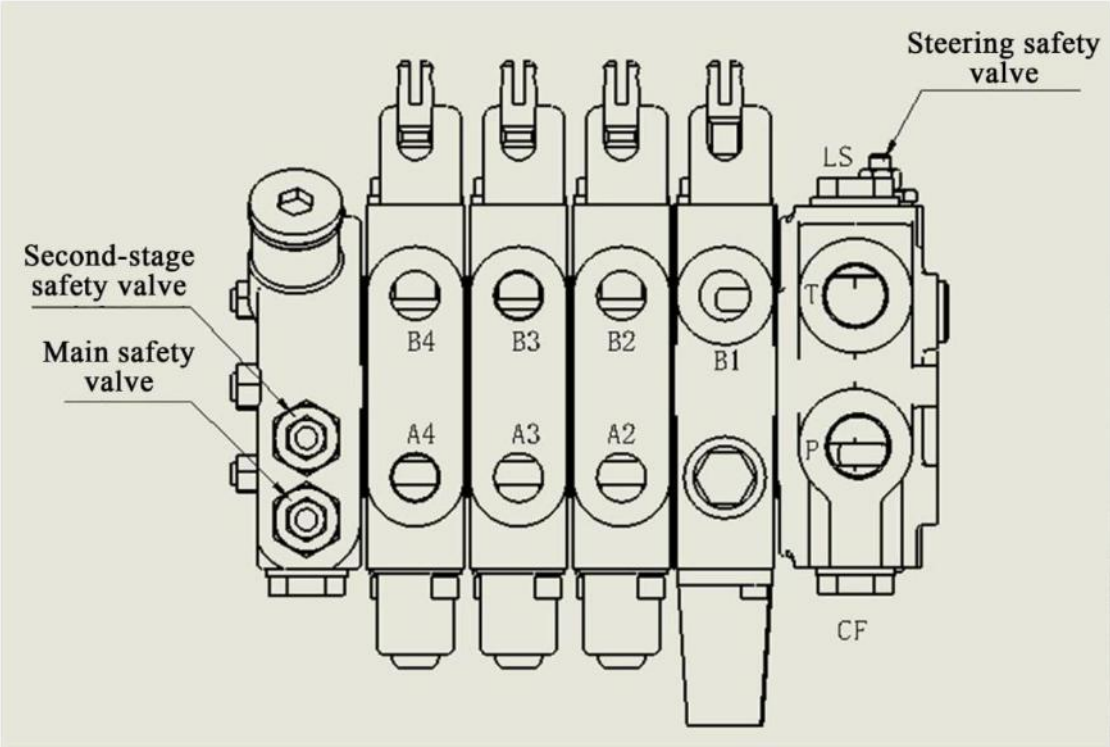



Fig. 5-3 Outline Drawing of Multi-way Valve

The multi-way valve is of two-piece four-body type, and the hydraulic oil from the working oil pump is controlled by the valve stem of the multi-way valve, and the high-pressure oil is distributed to the lift cylinder or the tilt cylinder. Safety valve and self-locking valve are installed inside the multi-way valve. The safety valve is arranged on the upper side of the oil inlet of the multi-way valve to control the system pressure; and the self-locking valve is arranged on the tilting valve plate, which is mainly used to prevent serious consequences caused by incorrect operation of the operating rod when the tilt cylinder has no pressure source. Check valves are installed between the oil inlet and the oil suction of the lifting valve plate and between the oil inlet of the lifting valve plate and the oil inlet of the tilting valve plate.

(1) Operation of multi-way valve

The multi-way valves are operated with the operating rod, all of which are installed on a connecting shaft. The shaft is fixed on the right valve connecting plate of the frame through the support, and the operating rod operates the multi-way valve through the connecting rod. as shown in Fig. 5-4.

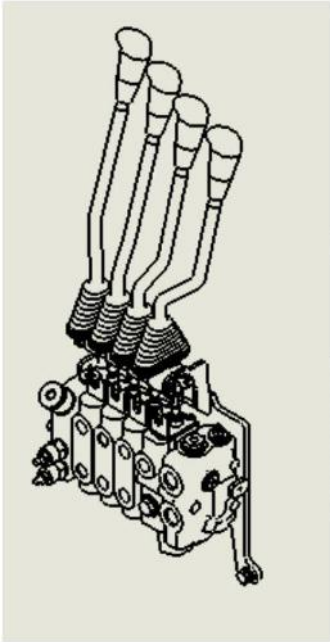
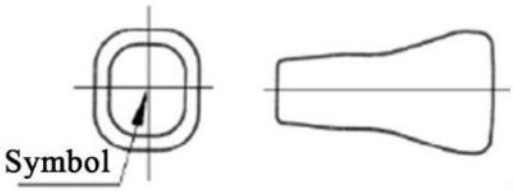


Fig. 5-4 Control Device of Multi-way Valve




| S/N | Symbol | Name |
|---|---|---|
| 1 | | Lifting |
| 2 | | Tilting |

Fig. 5-5 Multi-way Valve Control Handle Identification

Push forward and pull back the lifting handle according to the arrow direction shown in Fig. 5-5, and the mast will rise and fall respectively. Push forward and pull back the tilting handle, and the mast will tilt forward and backward respectively.

(2) Adjustment of multi-way valve pressure

Pressure adjustment method of safety valve (Fig. 5-6)

The pressure of the safety valve shall not be adjusted at will. If it must be adjusted, please follow the steps below.

a) Unscrew the plug of the measuring hole at the inlet of the multi-way valve and install an oil pressure gauge that can measure at 25MPa.

b) Operate the tilting handle, and measure the pressure when the cylinder stroke reaches the bottom.

c) When the oil pressure is different from the specified value, loosen the lock nut of overflow valve, and turn the adjusting screw left and right to the specified value. Turn left when the pressure is high, and turn right when the pressure is low.

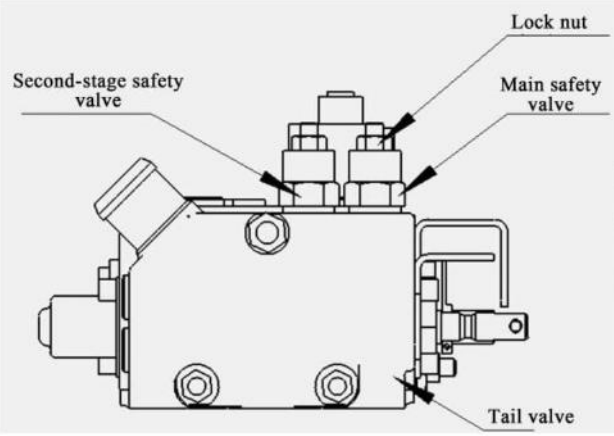


Fig. 5-6

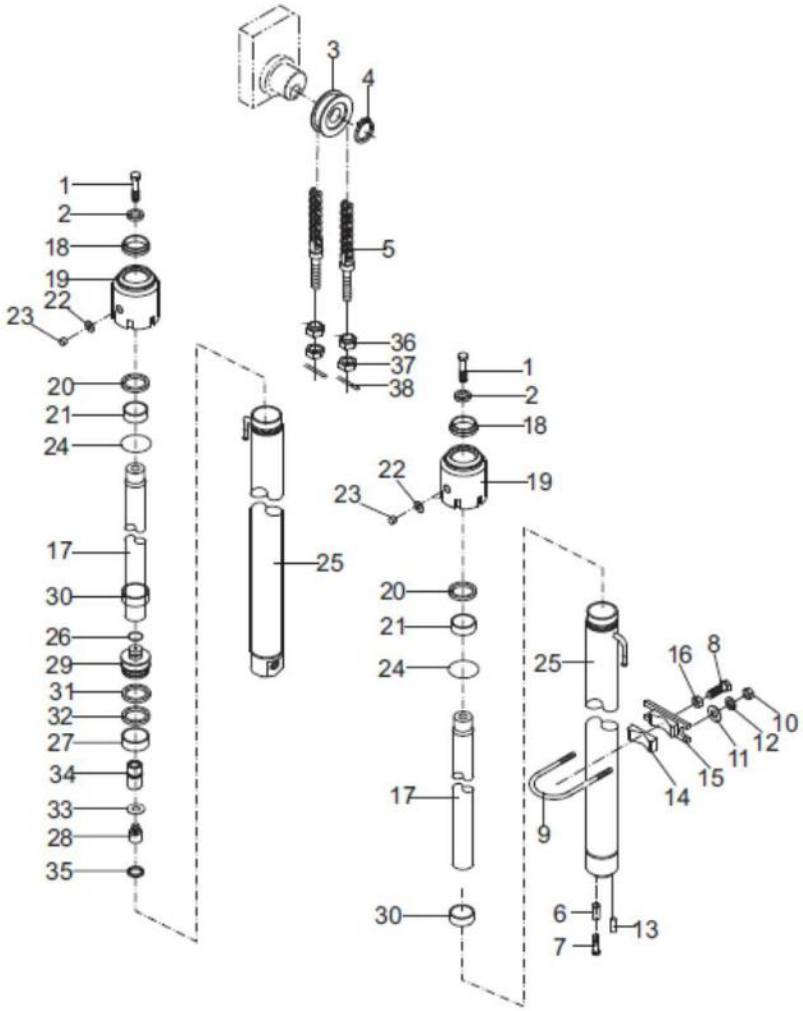
d) Tighten the nut after adjustment.

5.1.3 Lifting cylinder

The lifting cylinder is a single-acting piston type hydraulic cylinder. It consists of cylinder block, piston and piston rod, cylinder head, cut-off valve, seal, etc. (Fig. 5-7). The cylinder head is equipped with the steel-backed bearing and oil seal to support the piston rod and prevent dust from entering.

When the lifting slide valve of the multi-way reversing valve is placed in the rising position, the hydraulic oil enters reversing valve from the priority valve and then enters the lower part of the oil cylinder piston, pushing the piston rod upward and thus lifting the goods. When the lifting slide valve of the multi-way reversing valve is placed in the lowering position, the piston rod is lowered under the action of the mass of the goods,

mast, fork arm carrier and piston, and the hydraulic oil is pressed back to the oil tank. A cut-off valve is installed at the bottom of the cylinder (Fig. 5-8). If the mast rises, the high-pressure pipe can be broken for safety protection.



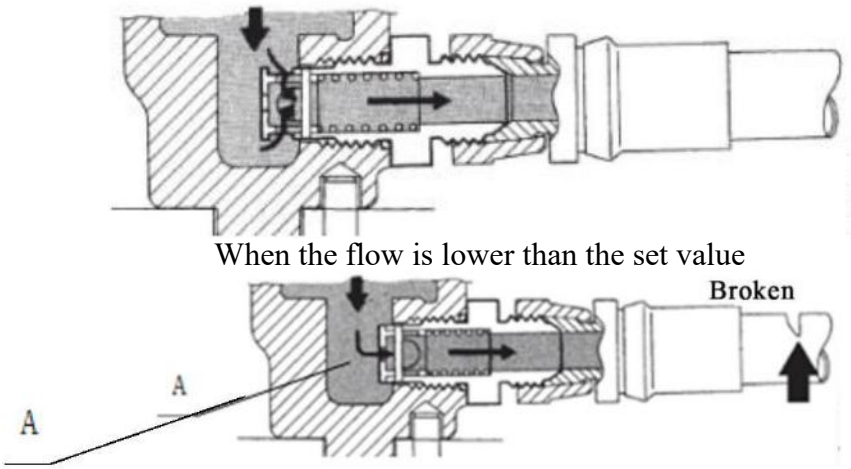

1. Bolt M16×1.5×40 2. Washer 16 3. Sprocket 4. Retainer ring 40 5. Chain assembly 6. Spacer sleeve 7. Bolt M12×1.25×25 8. Bolt M12×1.25×50 9. U-bolt 10. Nut M10×1.25 11. Washer 10 12. Washer 10 13. Pin B10×26 14. Adjusting block 15. Cylinder support block 16. Nut M12×1.25 17. Piston rod 18. Dust ring 40×52×7/10 19. Guide sleeve 20. Seal ring 40×50×6 21. Steel-backed bearing 4030 22. Gasket 23. Screw M5×6 24. O-ring d49.7×2.4 25. Cylinder block 26. Round wire snap ring 27. Support ring 50×10×2.5 28. Valve assembly 29. Piston 30. Adjusting sleeve φ48×40.5 31. Stopper 50×40×3 32. Seal ring for hole 50×40×6 33. Gasket 34. Sleeve 35. Round wire snap ring for hole 36. Spherical nut 37. Nut M14×1.5 38. Pin 3.2×30

Fig. 5-7 Lifting Cylinder

### 5.1.4 Cut-off valve

The cut-off valve is installed at the bottom of the lifting cylinder (see Fig. 5-8). When the high-pressure pipe suddenly breaks, it can prevent the goods from descending sharply. When the oil from the lifting cylinder returns to the oil tank, it will

pass through the hole Aon the outer circumference of the valve element. If the flow rate of oil through the hole is lower than the set value for the valve and the pressure difference between the front and rear of the valve element is lower than the spring force, the valve element will not move and the slide valve will not act. If the flow rate through the valve element hole exceeds the set value when the high-pressure pipe breaks or for other reasons, the pressure difference between the front and rear of the valve element will be greater than the spring force to make the valve element move to the left. In this way, the hole A is closed, and only a small amount of oil flows out of the gap between the valve element and the valve bush, so the goods are lowered gradually.




When the flow is lower than the set value

When the flow is higher than the set value

Fig. 5-8 Working Principle of Cut-off Valve

5.1.5 Speed limit valve

The speed limit valve is installed in the lifting oil circuit to limit the lowering speed of the fork under heavy load. Its mechanism is shown in Fig. 5-9. When the slide valve of multi-way valve is in the "lifting" position, the high-pressure oil from the multi-way valve flows into the lifting cylinder through chambers A and B, holes C, D, E and F and chamber G without throttling. When the slide valve of multi-way valve is in the "lowering" position, the oil from the lifting cylinder flows through chamber G, oil holes F, E, D, C and chambers B and A and through the whole valve. At this time, a pressure difference is generated between chamber A and chamber B, and the ball valve (Item 8) is opened. When the pressure difference exceeds the spring force of spring 2,

the valve element 7 moves to the right, and the oil flow decreases as holes D and C become smaller. It thus reduces the flow through the orifice.

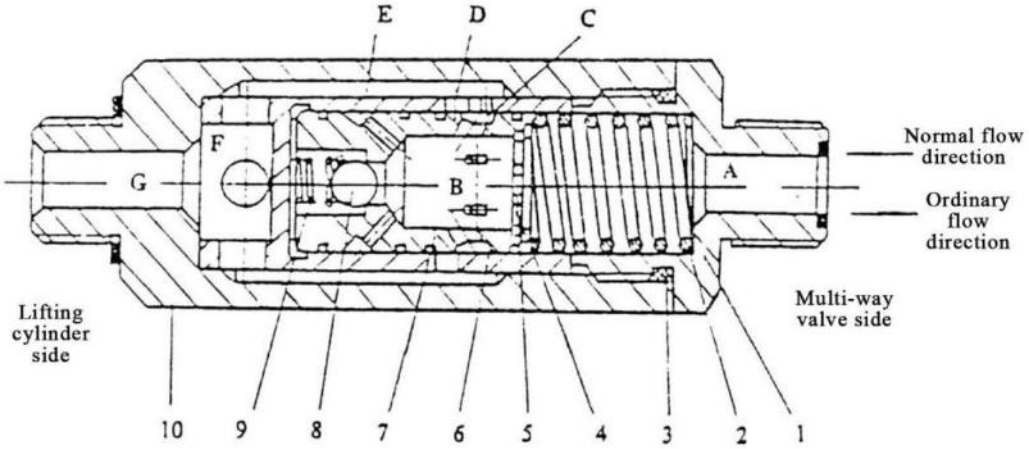



Fig. 5-9 Speed Limit Valve

(1) Speed limit valve connector (2) Spring (3) Seal (4) Collar
(5) Throttle plate (6) Valve element (7) Valve bush (8) Steel ball
(9) One-way valve spring (10) Valve body

5.1.6 Tilt cylinder

The tilt cylinder is a double-acting piston type hydraulic cylinder, and installed on both sides of the mast. Its piston rod end is connected with the mast, and the bottom of the tilt cylinder is connected with the mast with pins. The forward tilting and backward tilting of mast are done by the action of the tilt cylinder.

The tilt cylinder is mainly composed of piston, piston rod, cylinder block, cylinder bottom, guide sleeve and seal. The piston and the piston rod are of a welded structure. The outer edge of the piston is equipped with a support ring and two Yx sealing rings. The inner hole of the guide sleeve is equipped with a shaft sleeve and a Yx sealing ring, a stopper and a dust ring. The shaft sleeve supports the piston rod. The sealing ring, the stopper and the dust ring can prevent oil leakage and dust, and are screwed onto the cylinder block together with the O-ring. When the piston moves, the oil is fed from one port and discharged from the other, and the piston rod is provided with an adjusting thread to adjust the difference between the inclination angles. (See Fig. 5-10)

When the slide valve is pushed forward, the high-pressure oil enters from the bottom of the cylinder, thus pushing the piston forward to make the mast tilt forward;

when the slide valve is pulled back, the high-pressure oil enters from the front of the cylinder block, pushing the piston backward until the mast tilts backward and reaches a proper position.

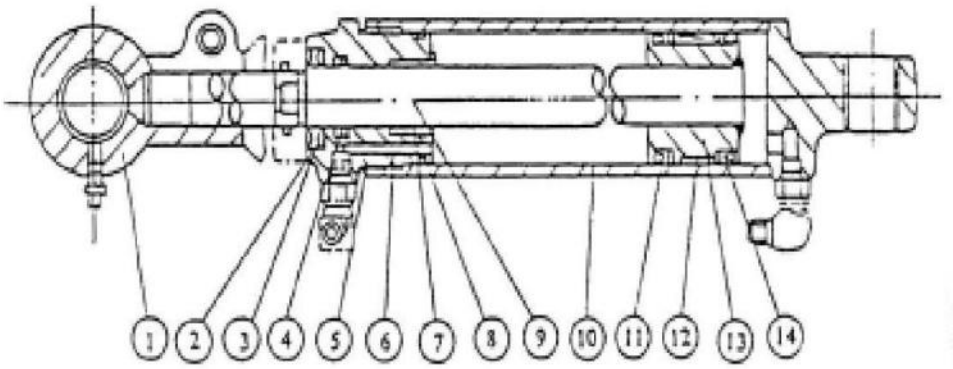



Fig. 5-10 Tilt Cylinder
(1) Lug (2) Dust ring (3) Baffle ring (4) Yx seal ring (5) O-ring
(6) Guide sleeve (7) Bearing (8) O-ring (9) Piston rod (10) Cylinder block
(11) Yx seal ring (12) Support ring (13) Piston (14) Yx seal ring

5.1.7 Hydraulic oil tank

The hydraulic oil tank is equipped with an oil suction filter, an oil return filter and a respirator to ensure the cleanliness of oil in the hydraulic system.

5.1.8 Hydraulic system oil circuit

The schematic diagram of the hydraulic system is shown in Fig. 5-11. The hydraulic pipeline is shown in Fig. 5-12.

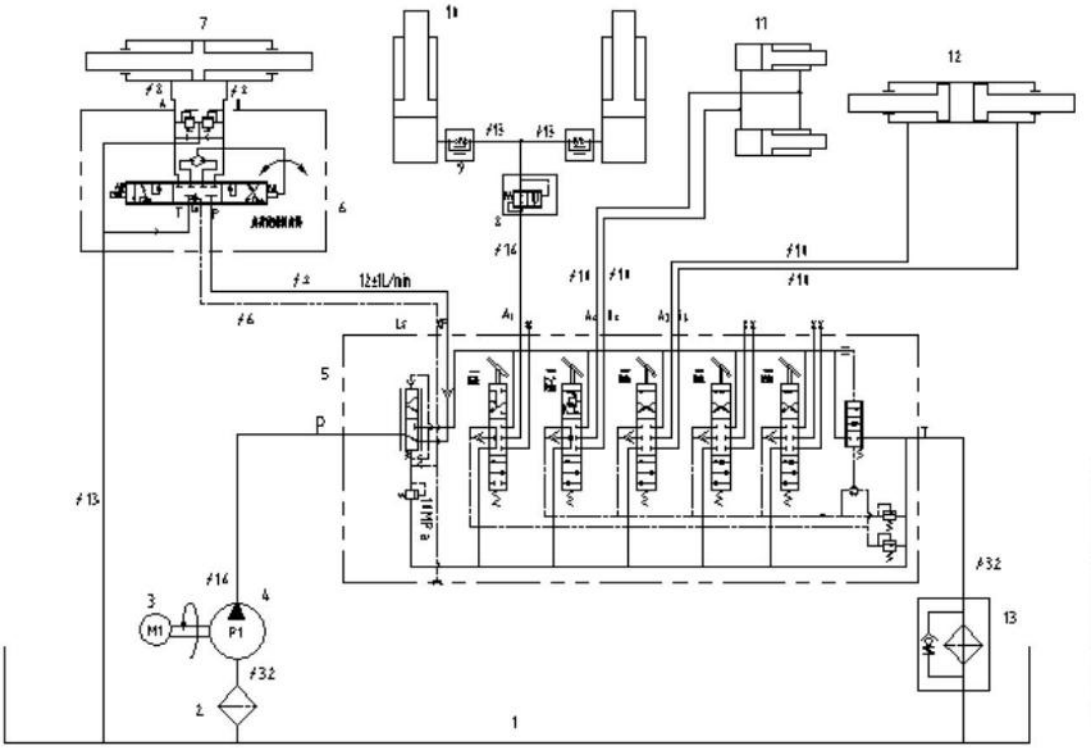



Fig. 5-11 Schematic Diagram of Hydraulic System

(1) Hydraulic oil tank (2) Oil suction filter (3) Pump motor (4) Gear pump (5) Multi-way valve (6) Steering gear (7) Steering cylinder (8) Speed limit valve (9) Cut-off valve (10) Lift cylinder (11) Tilt cylinder (12) Attachment cylinder (13) Oil return filter

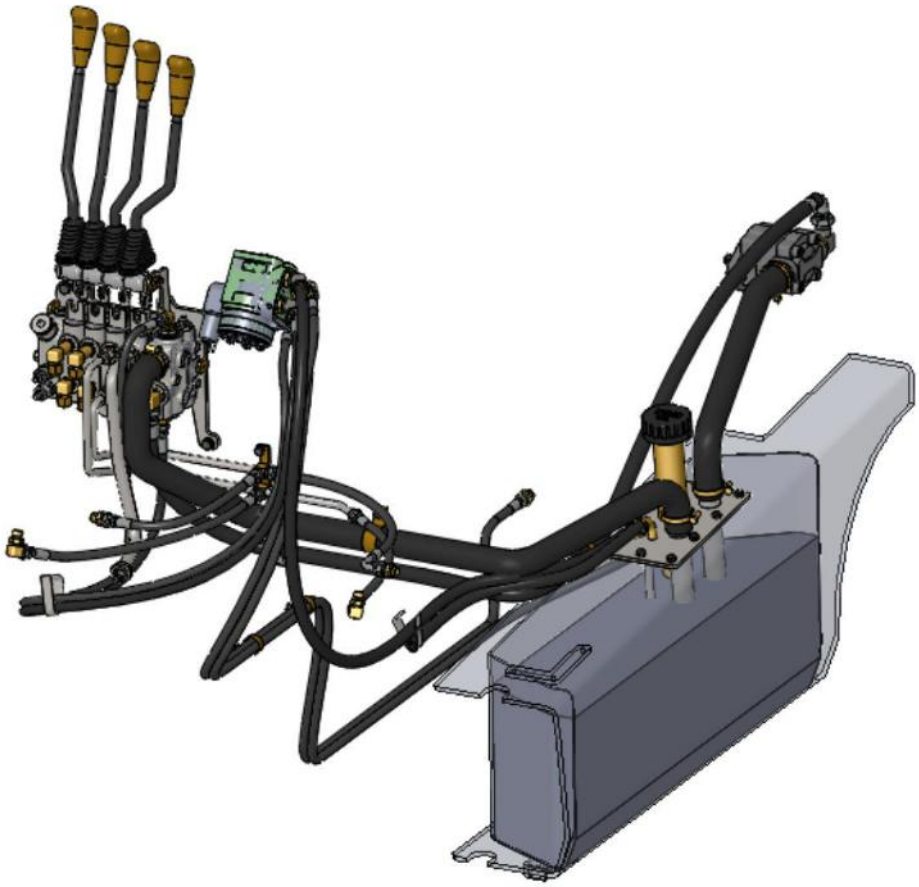


Fig. 5-12 Hydraulic Pipeline

## 5.2 Maintenance, fault analysis and troubleshooting

### 5.2.1 Maintenance

Check the pipe joint, lifting cylinder, tilt cylinder, oil pump, full hydraulic steering gear and steering cylinder of the hydraulic transmission system for leakage or serious oil leakage before and after the shift. Check whether the working oil in the working oil tank is sufficient. Check and clean the filter screen installed in the working oil tank once a week. The oil return filter should be replaced for the first time after 300 hours of use (or one and a half months), and then replaced every 1,200 hours (or 6 months). The filter must be replaced when replacing the hydraulic oil.

Under normal circumstances, the oil in the working oil tank shall be replaced every 1,200-1,500 hours of operation. Oils of various grades shall not be mixed.

5.2.2 Failure analysis and troubleshooting:

| Fault | Fault cause | Troubleshooting |
|---|---|---|
| Insufficient force of lifting or failure of lifting | 1) Excessive wear and clearance between oil pump gear and pump body.<br>2) The piston seal of the lifting cylinder is worn, the clearance is too large, and there is too much internal leakage.<br>3) The safety valve spring in the multi-way reversing valve fails.<br>4) Excessive wear and oil leakage of multi-way reversing valve control valve stem and valve body.<br>5) Oil leakage between multi-way reversing valves.<br>6) Oil leakage from hydraulic pipeline.<br>7) The hydraulic oil temperature is too high (≤80°C), the oil is too thin, and the flow is insufficient.<br>8) Too much load. | Replace the worn parts or oil pump.<br>Replace with a new piston seal ring.<br>Replace with a new spring.<br>After the valve stem is coated with chrome, the clearance between the valve stem and the hole is 0.01~0.02.<br>Replace the sealing ring and tighten the screws in sequence.<br>Check the sealing gasket and connecting nut for damage, and tighten the pipe joint.<br>Replace the unqualified hydraulic oil and shut down to reduce the oil temperature and find the cause of excessive oil temperature.<br>Lift according to the specified lifting capacity. |
| The piston rod of the lifting cylinder slides down largely | 1) There is leakage in the Yx seal ring of the lifting cylinder.<br>2) Internal leakage of A-type slide valve of multi-way reversing valve.<br>3) The oil circuit of the lifting part leaks. | Replace the Yx seal ring.<br>Replace the O-ring in the slide valve.<br>Replace the O-ring in the hinged joint and tighten the joint bolt. |
| Insufficient oil pump pressure | 1) Oil leakage caused by wear of sealing ring at fasteners.<br>2) The hydraulic oil is mixed with air for foaming, the oil suction pipeline leaks air, and the hydraulic oil is insufficient.<br>3) The seal ring in the pump cover groove is damaged.<br>4) The end face of the bearing sleeve is worn.<br>5) The oil pump gear is worn.<br>6) Incorrect rotating direction of oil pump. | Replace the seal ring.<br>Exhaust the air and refill the hydraulic oil.<br>Replace it.<br>Replace it.<br>Replace the oil pump.<br>Correct. |
| Large self-tilting amount of tilt cylinder | 1) Internal leakage of multi-way reversing valve.<br>2) The O-ring of the tilt cylinder piston rod is damaged with internal leakage.<br>3) The YX seal ring and O-ring in | Replace the O-ring, repair the valve stem and re-adjust the fit clearance between the valve stem and the hole to 0.01-0.02.<br>Replace it. |

| | | |
|---|---|---|
| | the guide sleeve are damaged with oil leakage. | Replace it. |
| Steering Heavy | 1) The oil supply of the oil pump is insufficient, and it feels light during slow steering and heavy during fast steering.<br>2) There is air in the steering system, foam in the oil, and irregular noise. The oil cylinder does not move sometimes when the steering wheel rotates.<br>3) The one-way valve of the steel ball in the valve body fails; it feels heavy during fast and slow steering, and the steering is weak.<br>4) If the overflow valve pressure is lower than the working pressure or the overflow valve is stuck by dirt, it feels light when steering with light or no load, and heavy when load is increased.<br>5) Excessively high oil viscosity. | Select an appropriate oil pump or check whether the oil pump is normal<br>Remove the air from system, and check the suction line<br>Check whether the steel ball exists and whether it is stuck by dirt<br>Adjust the overflow valve pressure or clean the overflow valve<br>Use the oil of recommended viscosity |

# 6. Lifting System

## 6.1 Overview of Basic Lifting System

The basic lifting system is a two-stage roller-type vertical ascending and descending system, which is composed of inner and outer masts, and two rear lifting cylinders

Cylinder and a fork arm carrier.

### 6.1.1 Inner and outer masts

The inner and outer masts are welded parts, and mainly supported on the axle housing. The bottom of the outer mast is connected with the axle housing through a support shaft, and the middle part is connected with the frame through a tilt cylinder, which can tilt forward and backward under the action of the tilt cylinder. The outer mast channel steel is of C type, and the main and side rollers are installed at the upper part. The inner mast channel steel is of Jb type, and the main and side rollers are installed at the bottom. Through the rolling of main and side rollers, the inner mast always maintains the established relative position with the outer mast in the process of movement.

The upper main rollers and side rollers of inner and outer masts are maintained at a high position, so attention should be paid to your safety.

The inner and outer masts and attachments are shown in Fig. 6-1.

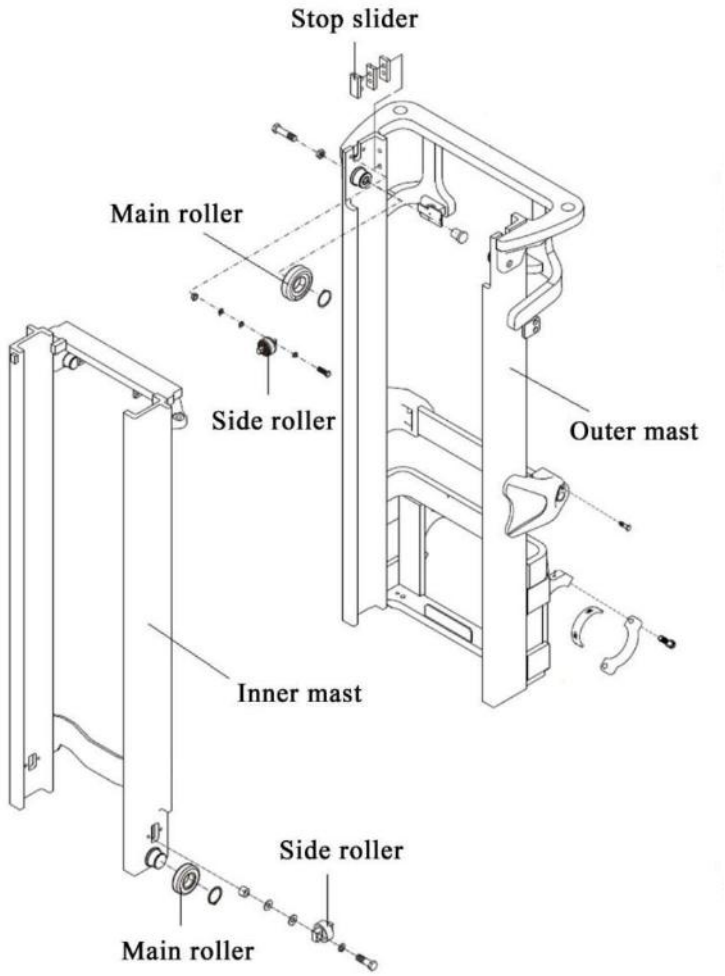



Fig. 6-1 Inner and Outer Masts and Attachments

### 6.1.2 Fork arm carrier

The fork arm carrier rolls in the inner mast through the main roller that is installed on the main roller shaft and clamped by the elastic collar, and the middle and lower rollers are composite rollers. The main roller shaft is welded on the fork arm carrier, and the side roller of the column plate is fixed on the fork arm carrier by bolts, as shown in Fig. 6-2. The longitudinal load is borne by the main roller. When the fork rises to the top, the upper roller is exposed from the mast top. The transverse load is borne by the composite roller and the side roller at the lower end.

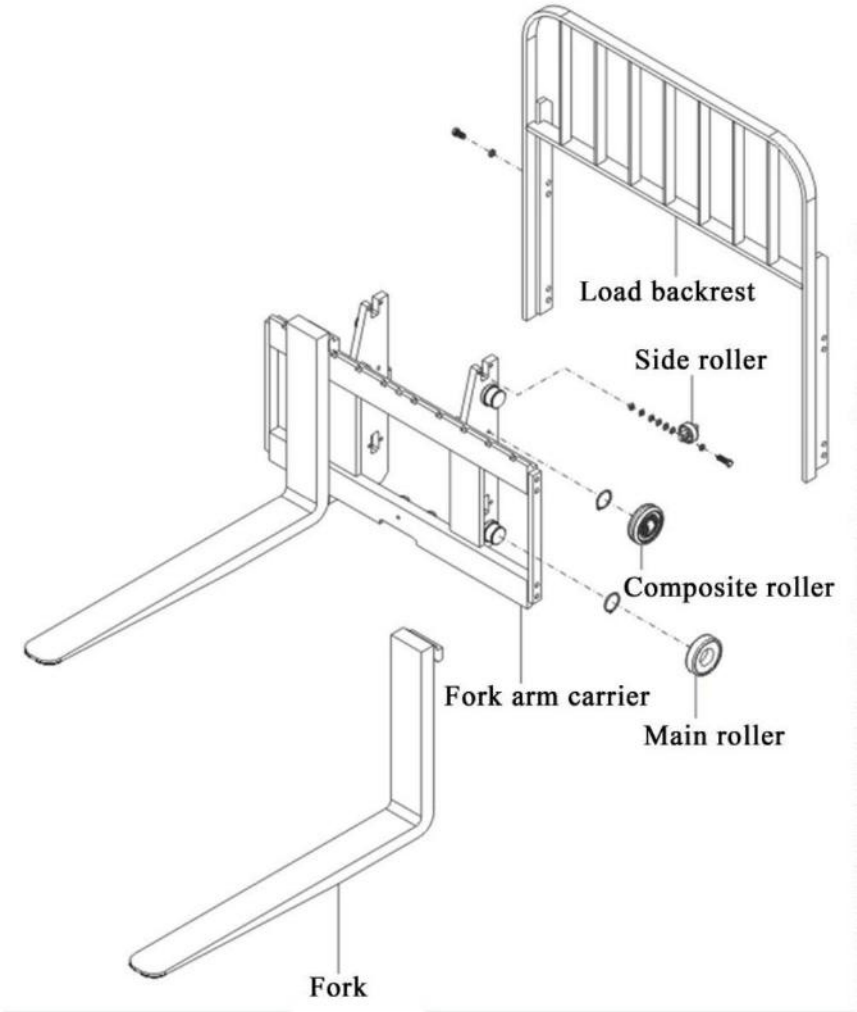



Fig. 6-2 Layout of Fork Arm Carrier

### 6.1.3 Roller Adjustment Method

Main rollers (6 pcs.) are respectively installed at the upper end of the outer mast (2 pcs.), the lower end of the inner mast (2 pcs.) and both sides of the fork arm carrier column plate (2 pcs.). Composite rollers (4 pcs.) are respectively installed on the middle and both sides of the lower end of the fork arm carrier.

Side rollers (6 pcs.) are installed at the upper end of the outer mast (2 pcs.), the lower end of the inner mast (2 pcs.) and the fork arm carrier (2 pcs.) respectively.

Except that the middle and lower composite rollers of the fork arm carrier column plate bear both front and rear loads and lateral loads, the rest main roller only bears front and rear loads, and the side roller bears left and right lateral loads. The main roller

is used in conjunction with the side roller to make the inner mast and the fork arm carrier move freely, as shown in Fig. 6-3.

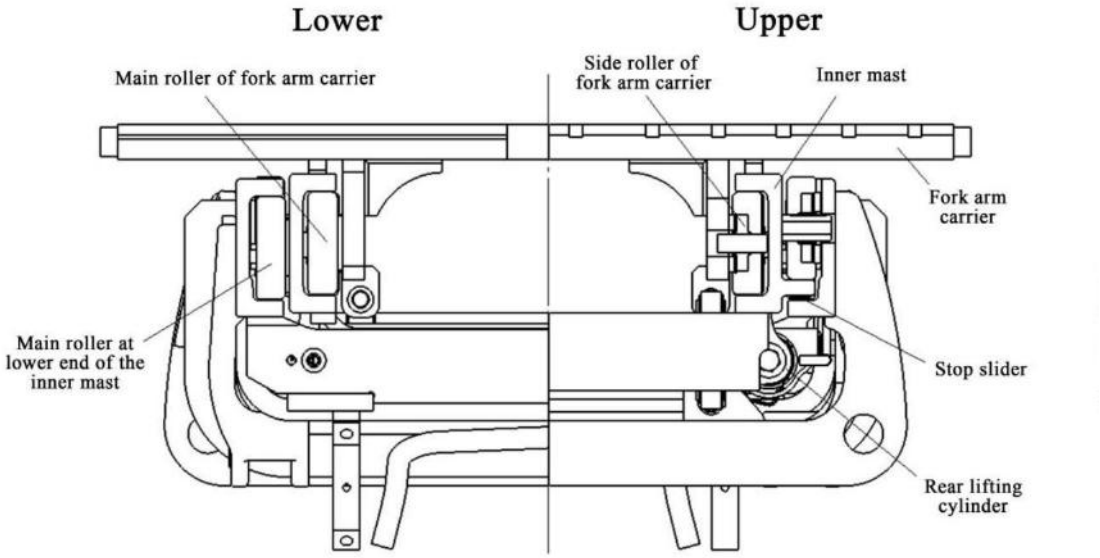



Fig. 6-3 Layout of Rollers

Note: (a) Adjust the side roller clearance to 0~0.5mm;

(b)Grease is applied on the surface of the main roller and the contact surface of mast.

6.1.4 Maintenance

**a Adjustment of lifting cylinder**

When the lifting cylinder, inner or outer mast is removed and replaced, the stroke of the lifting cylinder needs to be readjusted. The adjustment method is shown in Fig. 6-4 below:

(1) Install the head of the piston rod into the upper cross beam of inner mast without adjusting pad.

(2) Slowly lift the mast to the maximum cylinder stroke, and observe whether two cylinder stroke terminals are synchronized. If they are not stopped at the same time, it indicates that the left and right cylinder strokes are not synchronized. Increase or decrease the number of gaskets at the top of the piston rod to synchronize the stroke. Add adjusting gaskets with thicknesses of 0.2 mm and 0.5 mm between the head of

piston rod and the upper cross beam of inner mast.

(3) Then slowly lower the inner mast and observe whether the two cylinder stroke terminals are synchronized. Refer to the adjustment method of lifting synchronization;

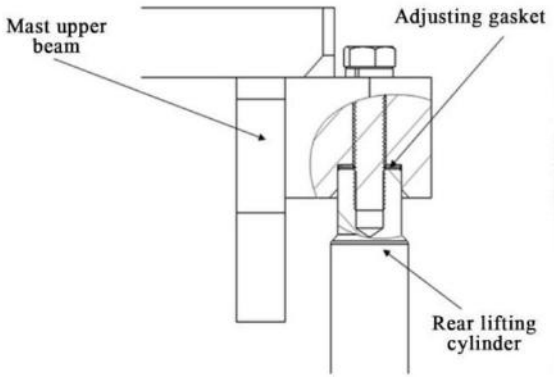



Fig. 6-4 Installation of Rear Lifting Cylinder

(4) Adjust the tension of the chain.

The adjustment of the lifting cylinder also belongs to high-position maintenance, so attention should be paid to your safety.

**b Height adjustment of fork arm carrier**

(1) Park the car on flat ground and make the mast vertical.

(2) Make the fork bottom surface touch the ground, and adjust the adjusting nut of the upper end joint of the chain in such way that there is a distance A between the main roller and the lower end surface of mast channel steel, as shown in Fig. 6-5.

| Type of Forklift | A (mm) |
|---|---|
| 1 ~ 2.0t(E) | 36-41 |
| 2 ~ 2.5t | 24-29 |
| 3 ~ 3.8t | 19-24 |

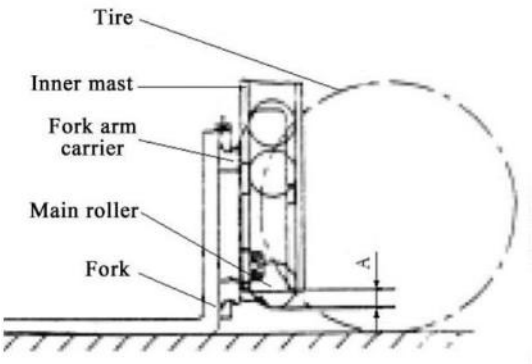



Fig. 6-5

(3) Make the fork fall to the ground and tilt back in place, adjust the upper end joint of the chain, and adjust the nut to make the tension of the two chains the same.

**c Replacement of fork arm carrier roller**

(1) Put a pallet on the fork and park the car on flat ground.

(2) Make the forks and pallets fall to the ground.

(3) Remove the upper end joint of the chain and remove the chain from the sprocket, as shown in Fig. 6-6.

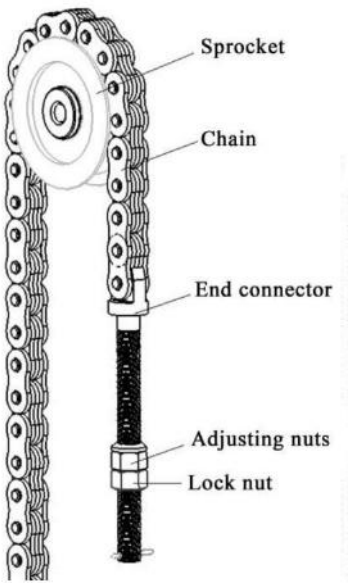


Fig. 6-6

(4) Lift the inner mast.

(5) After confirming that the fork arm carrier has been disengaged from the inner door frame, remove the fork arm carrier.

(6) Replacement of main roller:

a) Remove all spring collars, remove the main roller with a drawing tool, and keep the adjusting pad.

b) Confirm that the new roller is the same as the replaced roller, replace the original roller with a new one, and clamp the elastic collar in place at the same time.

**d Replacement of mast roller**

(1) Remove the fork arm carrier from the inner mast in the same way as described in c Replacement of fork arm carrier roller.

(2) Drive the forklift truck to flat ground, and pad the front wheels by 250~300 mm.

(3) Pull up the hand brake and pad the rear wheels with wedges.

(4) Remove the fixing bolts of the lifting cylinder and inner mast. Lift the inner mast, and be careful not to lose the adjusting pad at the head of the piston rod.

(5) Remove the connecting bolts between the lifting cylinder and the bottom of the outer mast. Remove the lifting cylinder and the oil pipe between the two cylinders. Do not loosen the oil pipe joint.

(6) Lower the inner mast and remove the main roller at the bottom of the inner mast.

(7) The main roller on the upper part of the outer mast will also be exposed from the top of the inner mast, so that the main roller can be removed.

(8) Replacement of main roller:

a) Remove the upper main roller with a drawing tool, and do not lose the adjusting pad.

b) Install the new roller with the adjusting pad removed in Step (a).

(9) Lift the inner mast until all rollers enter the mast.

(10)Install the lifting cylinder and fork arm carrier in the reverse order of removal.

Note: This Manual is a general manual, and the specific structural details of structural parts and composite rollers shall be subject to the actual products. In case of any technical questions, please consult the manufacturer.

## 6.2 Overview of Two-Stage Full Free Lifting System

The two-stage full free lifting system is a two-stage roller-type vertical ascending and descending system, which is composed of inner and outer masts, two rear lifting cylinders, a front lifting cylinder and a fork arm carrier.

### 6.2.1 Inner and outer masts

The inner and outer masts are welded parts, and mainly supported on the axle housing. The mast assembly is connected with the axle and frame in the same way as the two-stage basic type. The bottom of the outer mast is connected with the axle housing through a support shaft, and the middle part of the outer mast is connected with the frame through a tilt cylinder, which can tilt forward and backward under the action of the tilt cylinder. The outer mast channel steel is of C type, and the main and side rollers are installed at the upper part. The inner mast channel steel is of Jb type, and the main and side rollers are installed at the bottom. Through the rolling of main and side rollers, the inner mast always maintains the established relative position with the outer mast in the process of movement.

The maintenance of the upper main roller and side roller of the inner and outer masts belongs to high-level maintenance, and attention shall be paid to safety, as shown in Fig. 6-7.

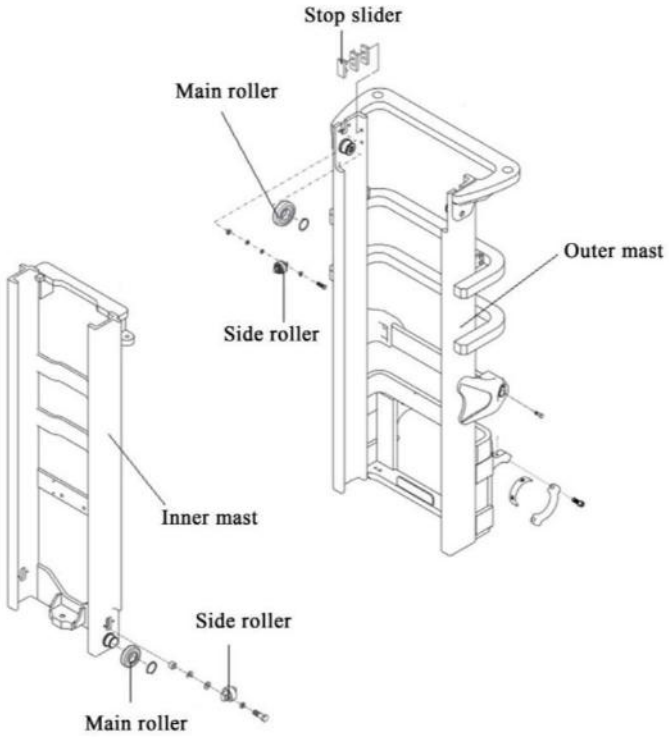



Fig. 6-7 Inner and Outer Masts and Attachments

6.2.2 Fork arm carrier

The fork arm carrier rolls in the inner mast through the main roller that is installed on the main roller shaft and clamped by the elastic collar, and the middle and lower rollers are composite rollers. The main roller shaft is welded on the fork arm carrier, and the side roller of the column plate is fixed on the fork arm carrier by bolts. The longitudinal load is borne by the main roller. When the fork rises to the top, the upper roller is exposed from the mast top. The transverse load is borne by the composite roller and the side roller at the lower end, as shown in Fig. 6-8.

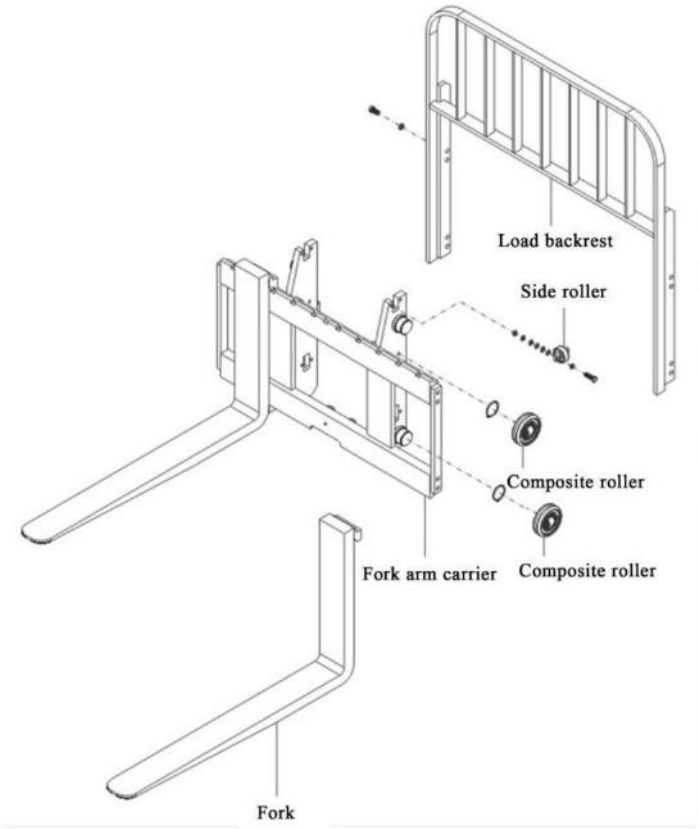



Fig. 6-8 Layout of Fork Arm Carrier

### 6.2.3 Roller Adjustment Method

Main rollers (6 pcs.) are respectively installed at the upper end of the outer mast (2 pcs.), the lower end of the inner mast (2 pcs.) and both sides of the fork arm carrier column plate (2 pcs.). Composite rollers (4 pcs.) are respectively installed on the middle and both sides of the lower end of the fork arm carrier. Side rollers (6 pcs.) are installed at the upper end of the outer mast (2 pcs.), the lower end of the inner mast (2 pcs.) and the fork arm carrier (2 pcs.) respectively.

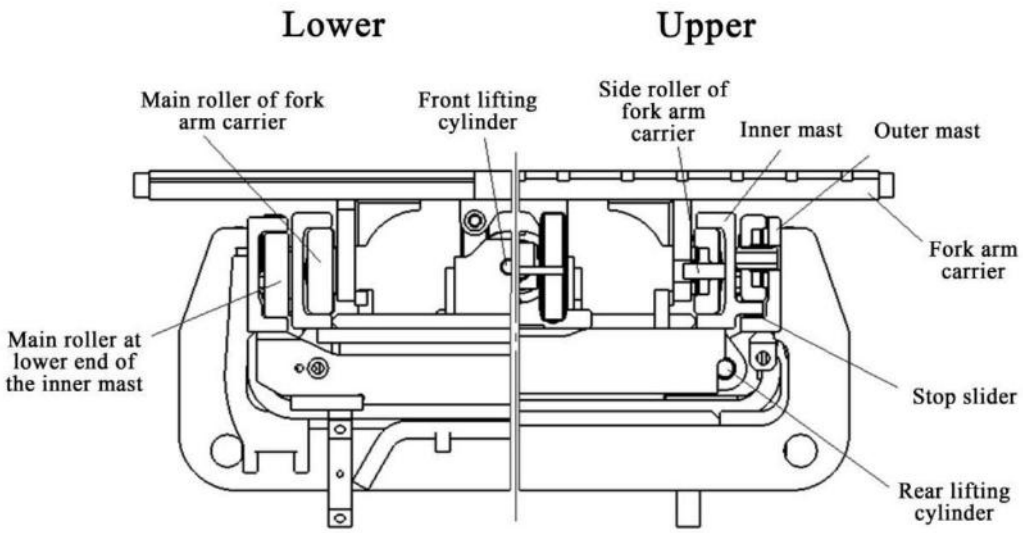



Fig. 6-9 Layout of Rollers

Except that the middle composite rollers of the fork arm carrier column plate bear both front and rear loads and lateral loads, the rest main roller only bears front and rear loads, and the side roller bears left and right lateral loads. The main roller is used in conjunction with the side roller to make the inner mast and the fork arm carrier move freely, as shown in Fig. 6-9.

Note: (a) Adjust the side roller clearance to 0~0.5mm;

(b) Grease is applied on the surface of the main roller and the contact surface of mast.

6.2.4 Maintenance

**a Adjustment of lifting cylinder**

When the lifting cylinder, inner mast or outer mast is removed and replaced, the stroke of the rear lifting cylinder needs to be readjusted (note: It is not required for the front lifting cylinder). The adjustment method is shown in Fig. 6-10 below:

(1) Install the head of the piston rod into the upper cross beam of inner mast without adjusting pad.

(2) Slowly lift the mast to the maximum cylinder stroke, and observe whether two

cylinder stroke terminals are synchronized. If they are not stopped at the same time, it indicates that the left and right cylinder strokes are not synchronized. Increase or decrease the number of gaskets at the top of the piston rod to synchronize the stroke. Add adjusting gaskets with thicknesses of 0.2 mm and 0.5 mm between the head of piston rod and the upper cross beam of inner mast.

(3) Then slowly lower the inner mast and observe whether the two cylinder stroke terminals are synchronized. Refer to the adjustment method of lifting synchronization.

(4) Adjust the tension of the chain.

The adjustment of the lifting cylinder also belongs to high-position maintenance, so attention should be paid to your safety.

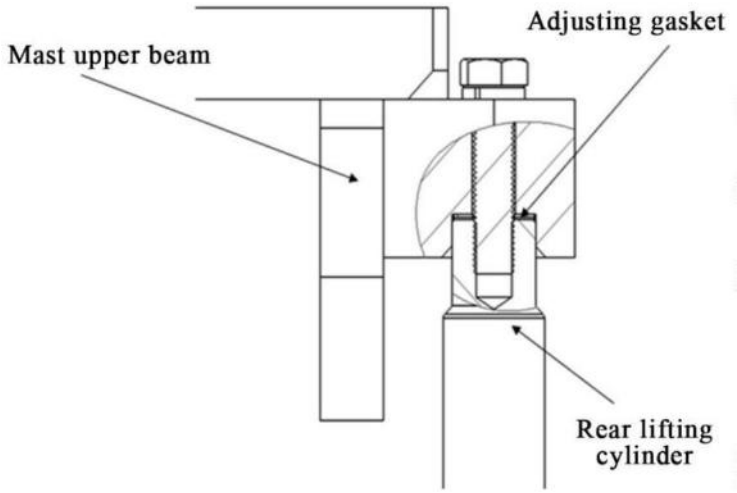



Fig. 6-10 Installation of Rear Lifting Cylinder

(5) When the front cylinder needs to be replaced, it is necessary to remove the fork arm carrier in the same way as c. Remove the fork arm carrier as a whole before removing and replacing the front lifting cylinder, as shown in the figure below.

**b Height adjustment of fork arm carrier**

(1) Park the car on flat ground and make the mast vertical.

(2) Make the fork bottom surface touch the ground, and adjust the adjusting nut of the upper end joint of the chain in such way that there is a distance A between the main roller and the lower end surface of mast channel steel, as shown in Fig. 6-11.

| Type of Forklift | A (mm) |
|---|---|
| 1 ~ 2.0t(E) | 36-41 |
| 2 ~ 2.5t | 24-29 |
| 3 ~ 3.8t | 19-24 |

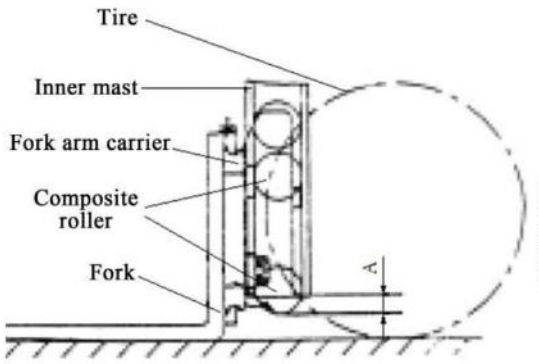



Fig. 6-11

(3) Make the fork fall to the ground and tilt back in place, adjust the upper end joint of the chain, and adjust the nut to make the tension of the two chains the same.

**c Replacement of fork arm carrier roller**

(1) Put a pallet on the fork and park the car on flat ground.

(2) Make the forks and pallets fall to the ground.

(3) Remove the upper end joint of the chain and remove the chain from the sprocket, as shown in Fig. 6-12.

(4) Lift the inner mast.

(5) After confirming that the fork arm carrier has been disengaged from the inner door frame, remove the fork arm carrier.

(6) Replacement of main roller:

a) Remove all spring collars, remove the main roller with a drawing tool, and keep the adjusting pad.

b) Confirm that the new roller is the same as the replaced roller, replace the original roller with a new one, and clamp the elastic collar in place at the same time.

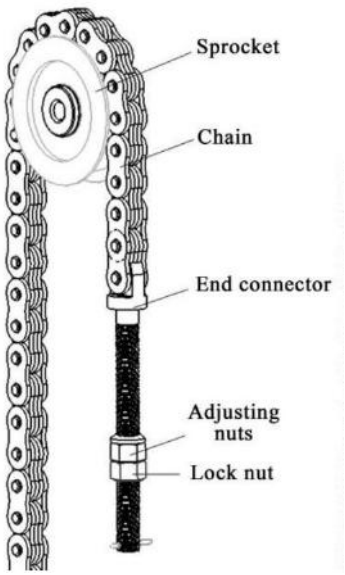



Fig. 6-12

**d Replacement of mast roller**

(1) Remove the fork arm carrier from the inner mast in the same way as described in c Replacement of fork arm carrier roller.

(2) Drive the forklift truck to flat ground, and pad the front wheels by 250~300 mm.

(3) Pull up the hand brake and pad the rear wheels with wedges.

(4) Remove the fixing bolts of the lifting cylinder and inner mast.

Lift the inner mast, and be careful not to lose the adjusting pad at the head of the piston rod.

(5) Remove the connecting bolts between the lifting cylinder and the bottom of the outer mast. Remove the lifting cylinder and the oil pipe between the two cylinders. Do not loosen the oil pipe joint.

(6) Lower the inner mast and remove the main roller at the bottom of the inner mast.

(7) The main roller on the upper part of the outer mast will also be exposed from the top of the inner mast, so that the main roller can be removed.

(8) Replacement of main roller:

a) Remove the upper main roller with a drawing tool, and do not lose the adjusting pad.

b) Install the new roller with the adjusting pad removed in Step (a).

(9) Lift the inner mast until all rollers enter the mast.

(10)Install the lifting cylinder and fork arm carrier in the reverse order of removal.

Note: This Manual is a general manual, and the specific structural details of structural parts and composite rollers shall be subject to the actual products. In case of any technical questions, please consult the manufacturer.

6.3 Three-Stage Full Free Lifting System

The three-stage full free lifting system is a three-stage roller vertical ascending and descending system, which is composed of inner, middle and outer masts, two rear lifting cylinders, a front lifting cylinder and a fork arm carrier.

### 6.3.1 Inner, Middle and Outer Mast

The inner, middle and outer mast are welded parts, and mainly supported on the axle housing. The bottom of the outer mast is connected with the axle housing through a support shaft, and the middle part is connected with the frame through a tilt cylinder, which can tilt forward and backward under the action of the tilt cylinder. The outer mast channel steel is of C type, and the main and side rollers are installed at the upper part. The middle mast channel steel is of Jb type, and a pair of main and side rollers are installed at the upper and lower parts respectively. The inner mast channel steel is of Jb type, and a pair of main and side rollers are installed at the bottom. Through the rolling of main and side rollers, the inner mast always maintains the established relative position with the outer mast in the process of movement. as shown in Fig. 6-13.

The upper main rollers and side rollers of the inner, middle and outer masts are maintained at a high position, so attention should be paid to your safety.

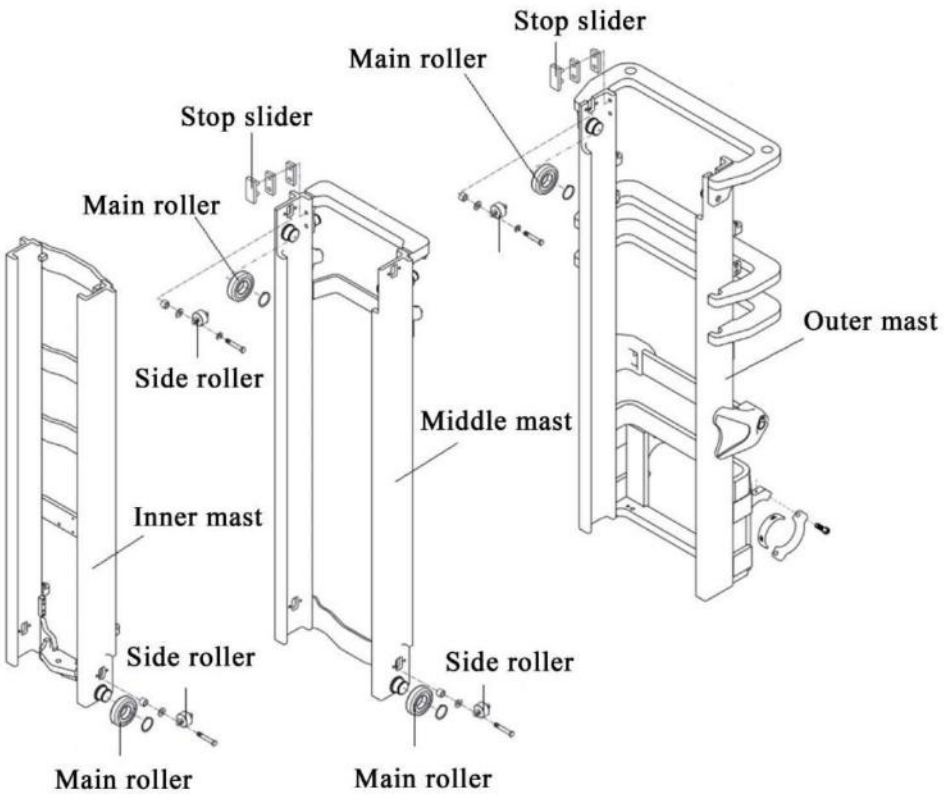



Fig. 6-13 Inner, Middle and Outer Masts and Attachments

6.3.2 Fork arm carrier

The fork arm carrier rolls in the inner door frame through the main roller that is installed on the main roller shaft and clamped by the elastic collar, and the intermediate roller is a composite roller. The main roller shaft is welded on the fork arm carrier, and the roller on the column plate side is fixed on the fork arm carrier by bolts. The longitudinal load is borne by the main roller. When the fork rises to the top, the upper roller is exposed from the mast top. The transverse load is borne by the composite roller and the side roller at the lower end, as shown in Fig. 6-14.

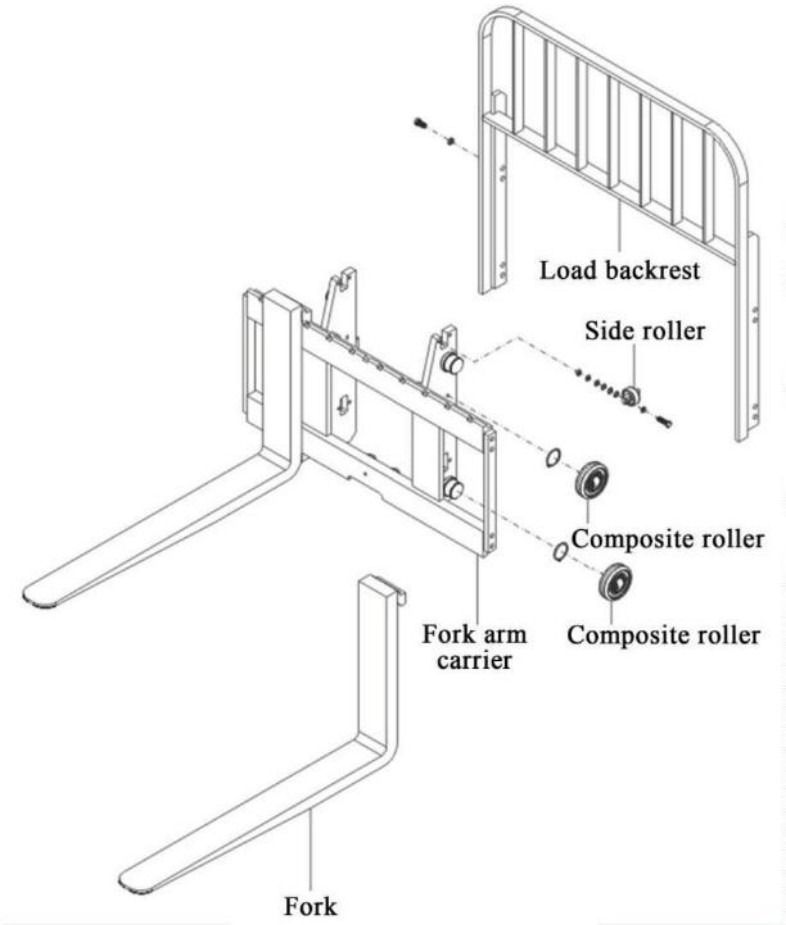



Fig. 6-14 Layout of Fork Arm Carrier

6.3.3 Roller Adjustment Method

Main rollers (10 pcs.) are respectively installed at the upper end of the outer mast (2 pcs.), the upper end of the middle mast (2 pcs.), the lower end of the middle mast (2 pcs.), the lower end of the inner mast (2 pcs.) and both sides of the fork arm carrier column plate (2 pcs.). Composite rollers (4 pcs.) are respectively installed on the middle

and both sides of the lower end of the fork arm carrier.

Side rollers (10 pcs.) are respectively installed at the upper end of the outer mast (2 pcs.), the upper end of the middle mast (2 pcs.), the lower end of the middle mast (2 pcs.), the lower end of the inner mast (2 pcs.) and the fork arm carrier (2 pcs.), as shown in Fig. 6-15.

Except that the middle composite rollers of the fork arm carrier column plate (Fig.6-16) bear both front and rear loads and lateral loads, the rest main roller only bears front and rear loads, and the side roller bears left and right lateral loads. The main roller is used in conjunction with the side roller to make the inner mast and the fork arm carrier move freely.

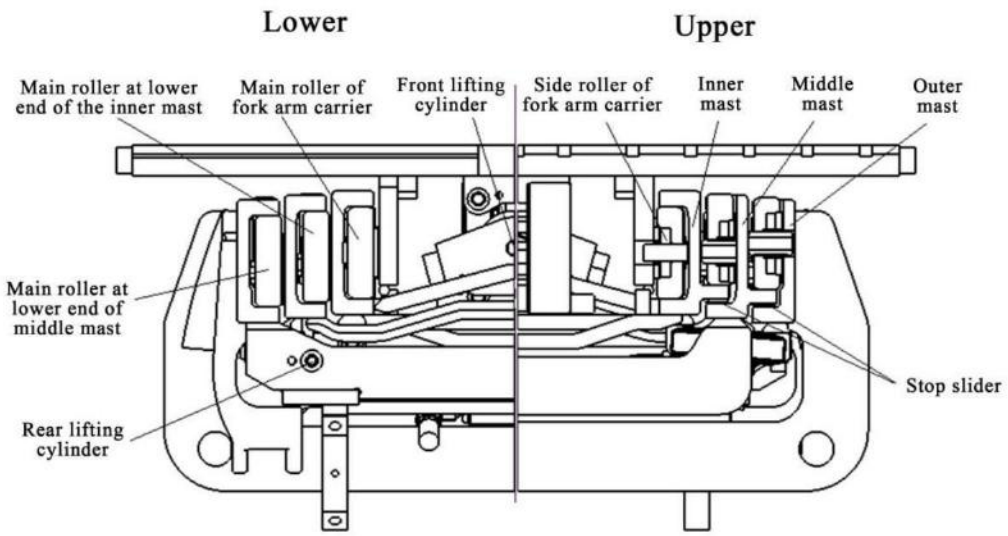



Fig. 6-15 Roller Layout

Note: (a) Adjust the side roller clearance to 0~0.5mm;

(b)Grease is applied on the surface of the main roller and the contact surface of mast.

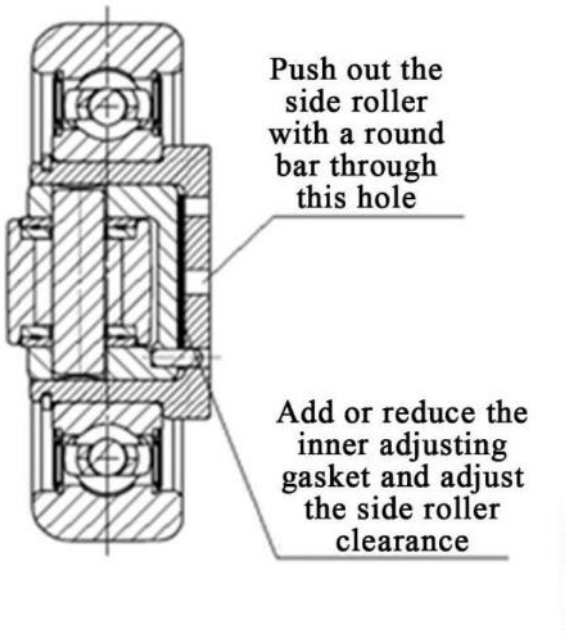



Fig. 6-16 Composite Roller

6.3.4 Maintenance

**a Adjustment of lifting cylinder**

When the lifting cylinder, inner mast or outer mast is removed and replaced, the stroke of the rear lifting cylinder needs to be readjusted (note: It is not required for the front lifting cylinder). The adjustment method is shown in Fig. 6-17 below:

(1) Install the piston rod head into the middle mast cylinder support without adjusting pad.

(2) Slowly lift the mast to the maximum cylinder stroke, and observe whether two cylinder stroke terminals are synchronized. If they are not stopped at the same time, it indicates that the left and right cylinder strokes are not synchronized. Increase or decrease the number of gaskets at the top of the piston rod to synchronize the stroke. Add adjusting gaskets with thicknesses of 0.2 mm and 0.5 mm between the head of piston rod and the middle mast cylinder support.

(3) Then slowly lower the inner mast and observe whether the two cylinder stroke terminals are synchronized. Refer to the adjustment method of lifting synchronization.

(4) Adjust the tension of the chain.

The adjustment of the lifting cylinder also belongs to high-position maintenance,

so attention should be paid to your safety.

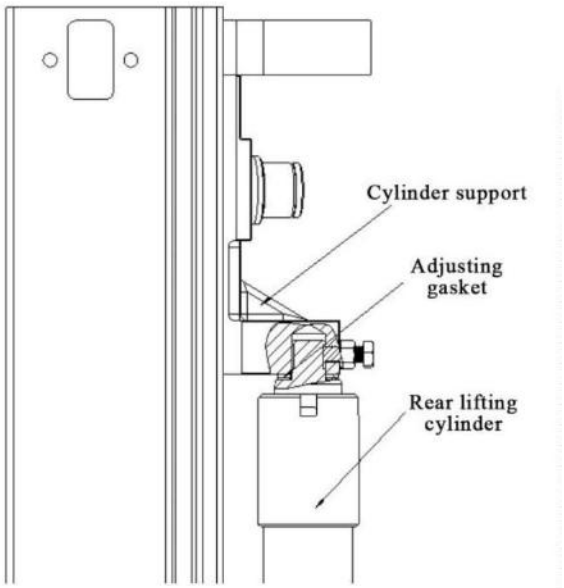



Fig. 6-17 Synchronous Adjustment of Rear Lifting Cylinder

(5) When the front cylinder needs to be replaced, it is necessary to remove the fork arm carrier in the same way as c. Remove the fork arm carrier as a whole before removing and replacing the front lifting cylinder.

**b Height adjustment of fork arm carrier**

(1) Park the car on flat ground and make the mast vertical.

(2) Make the fork bottom surface touch the ground, and adjust the adjusting nut of the upper end joint of the chain in such way that there is a distance A between the main roller and the lower end surface of mast channel steel, as shown in Fig. 6-18.

| Type of Forklift | A (mm) |
|---|---|
| 1 ~ 2.0t(E) | 36-41 |
| 2 ~ 2.5t | 24-29 |
| 3 ~ 3.8t | 19-24 |

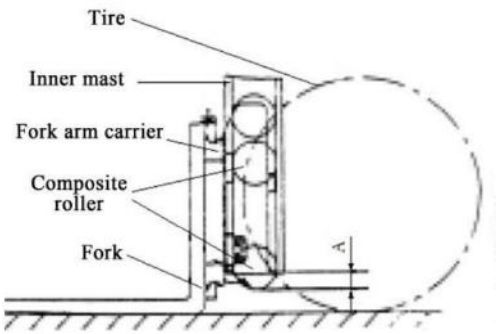



Fig. 6-18

(3) Make the fork fall to the ground and tilt back in place, adjust the upper end joint of the chain, and adjust the nut to make the tension of the two chains the same.

**c Replacement of fork arm carrier roller**

(1) Put a pallet on the fork and park the car on flat ground.

(2) Make the forks and pallets fall to the ground.

(3) Remove the upper end joint of the chain and remove the chain from the sprocket, as shown in Fig. 6-19.

(4) Lift the inner mast.

(5) After confirming that the fork arm carrier has been disengaged from the inner door frame, remove the fork arm carrier.

(6) Replacement of main roller:

a) Remove all spring collars, remove the main roller with a drawing tool, and keep the adjusting pad.

b) Confirm that the new roller is the same as the replaced roller, replace the original roller with a new one, and clamp the elastic collar in place at the same time.

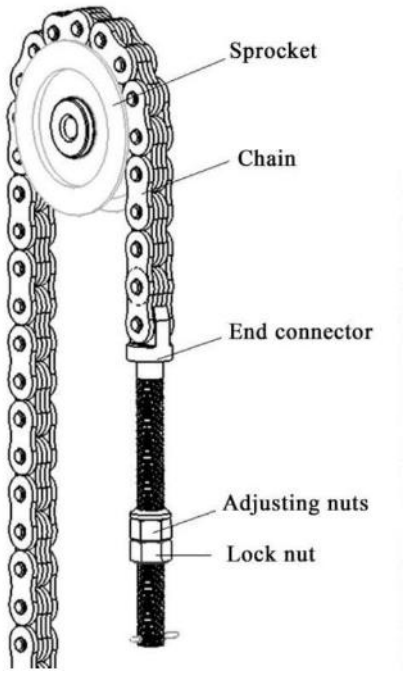



Fig. 6-19

**d Replacement of mast roller**

(1) Remove the fork arm carrier from the inner mast in the same way as described in c Replacement of fork arm carrier roller.

(2) Drive the forklift truck to flat ground, and pad the front wheels by 250~300 mm.

(3) Pull up the hand brake and pad the rear wheels with wedges.

(4) Remove the upper end joint of the chain on the rear cylinder head and remove the chain from the sprocket.

(5) Lower the inner mast until the rollers at the lower part of inner mast and the upper part of middle mast are exposed.

(6) Replacement of main roller:

a) Remove the upper main roller with a drawing tool, and do not lose the adjusting pad.

b) Install the new roller with the adjusting pad removed in Step (a).

(7) Remove the fixing bolts of the lifting cylinder and the middle mast. Lift the inner and middle masts together, and be careful not to lose the adjusting pad at the head of piston rod.

(8) Remove the connecting bolts between the lifting cylinder and the bottom of the outer mast. Remove the lifting cylinder and the oil pipe between the two cylinders, and do not loosen the oil pipe joint.

(9) Lower the inner and middle masts until the rollers at the lower part of middle mast and the upper part of outer mast are exposed.

(10)Replace the main roller, the same as (6).

(11)Lift the inner and middle masts into the corresponding masts.

(12)Install the lifting cylinder and fork arm carrier according to the reverse procedure of removal.

**Note: This Manual is a general manual, and the specific structural details of structural parts and composite rollers shall be subject to the actual products. In case of any technical questions, please consult the manufacturer.**

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