HELI

OPERATION & SERVICE MANUAL

H4 series three-wheel battery powered forklift trucks (front drive)

0.8-1.2t

Foreword

The H4 series 0.8-1.2T front-drive three-wheel electric forklift is a brand new series developed by us to meet market demand. It is a green and environmentally friendly product, suitable for stations, ports, logistics and transportation enterprises, machinery manufacturing enterprises, food processing enterprises, military enterprises, and other places. The product has a small turning radius and right-angle stacking aisle width, making it more suitable for operation in areas such as small spaces and high rack warehouses. It can complete operations such as loading and unloading, handling and stacking of goods, and can also be equipped with various attachments.

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, 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 beautiful 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 forklift correctly and give full play to its efficiency. The operator and equipment management personnel shall read it carefully before operating the forklift.

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 trucks, and the real object shall prevail for non-standard trucks. 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. Thank you for your understanding.

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I. Driving, Operation and Safety Procedures of Forklift

1. Basic Principles

Forklift 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 Instructions and Driver's Manual.

2. Transportation of Forklift

Note the following when loading forklifts:

(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) Lift 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

(1) Lower the mast to the lowest position;

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

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

(4） Painted surfaces shall be applied with antirust oil, and lifting chains shall be applied with lubrication 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 truck 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 condition of each handle and pedal;

(6) Make preparations before startup;

(7) Release the parking brake;

(8) Carry out trial operation of mast lifting, forward and backward tilting, steering and braking.

5. Operation of Forklift

(1) Only trained drivers with driving licenses can drive;

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

(3) Check all control and alarm devices before startup, 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 gap of the forklift;

(9) No one is allowed to stand on the fork, and the forklift 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 truck and attachments from a position other than the driver's seat;

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

(13) For high-lift forklifts, 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 truck and shall stop the truck stably;

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

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

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

(19) The pressure of multi-way valves and safety valves of forklift has been adjusted before the truck leaves the factory, so users shall not adjust it at will in use, so as to avoid the 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 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

(1) Key points of starting

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

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

c) Check the stopping brake: it shall be able to stop on a ramp with a 15% slope (with no load);

d) Instruments and lighting fixtures, etc.: Check whether the instruments, lighting, connectors, switches and electrical circuits function well.

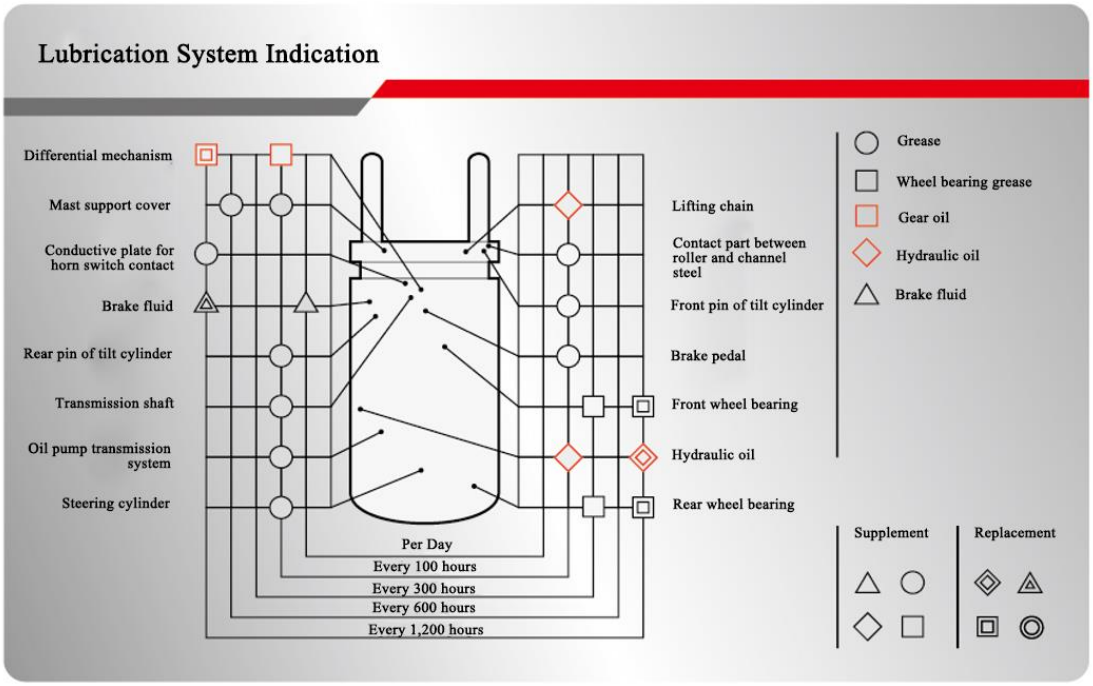
(2) Oil and grease for forklift

<table>
<tr><td>Name</td><td colspan="3">Grade, code and service temperature</td><td>Oil Filling Amount (L)</td></tr>
<tr><td rowspan="2">Hydraulic oil</td><td>Viscosity grade</td><td>HELI customized hydraulic oil 40#</td><td>Anti-freezing hydraulic oil YYY-LPL-HS32</td><td rowspan="2">13</td></tr>
<tr><td>Service environment</td><td>Normal temperature</td><td>Cold storage</td></tr>
<tr><td>Brake fluid</td><td colspan="3">4604 synthetic brake fluid GB12891 HZY4</td><td>/</td></tr>
<tr><td>Grease</td><td colspan="3">3# general purpose lithium grease (-20°C~+120°C)
Or 2# L-XDCBB2 low-temperature grease
(-40°C~+120°C)</td><td>/</td></tr>
<tr><td rowspan="2">Heavy-duty truck
Gear oil GL-5</td><td>Viscosity grade</td><td colspan="2">Mobil ATF200 or ATF210 or ATF220</td><td rowspan="2">0.35 on the left and right sides respectively</td></tr>
<tr><td>Service environment</td><td colspan="2">Normal temperature environment or cold storage environment</td></tr>
</table>

Note: 1. The oil shall be filled in accordance with the amount for the standard mast;

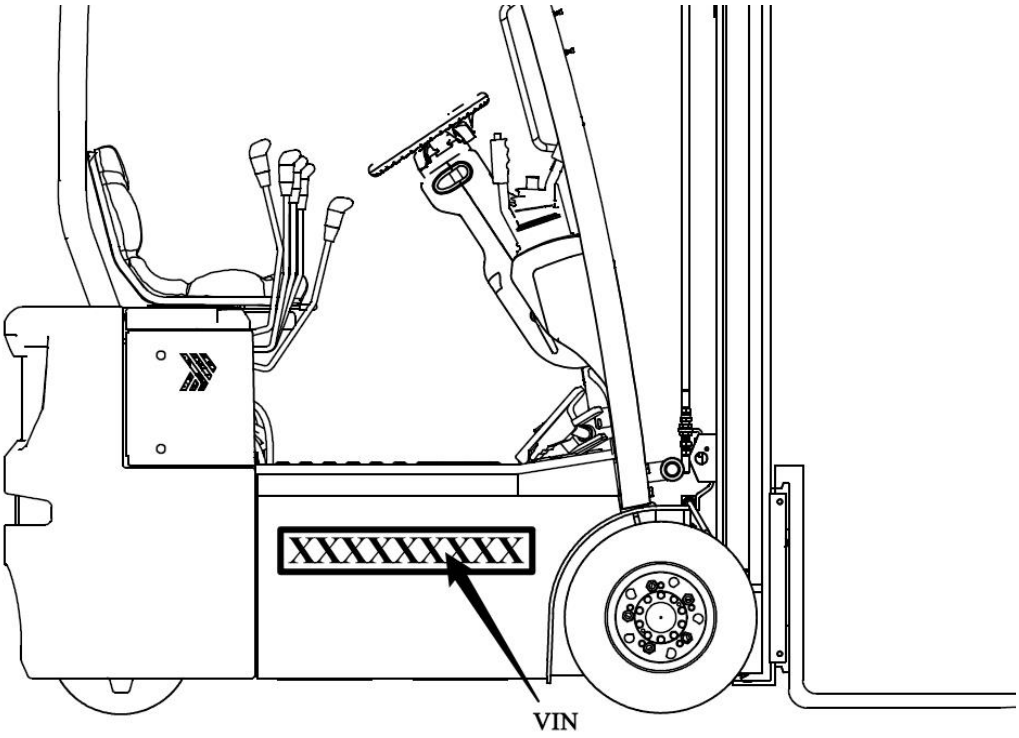
2. NYOGEL782G grease shall be applied to the conductive plate on which the switch contact of the steering wheel horn acts.

(3) Lubrication system diagram



7. Description of Frame Number Position

When the truck is delivered, a unique frame number (the same as the product number) is marked on the truck body, and permanently stamped on the frame with a steel seal. According to the number, the production, sales, maintenance and other information of the truck can be traced. The truck identification number of the battery lifting model is located in the upper middle area on the right side wallboard of the truck body, and its position is shown in the following figure.

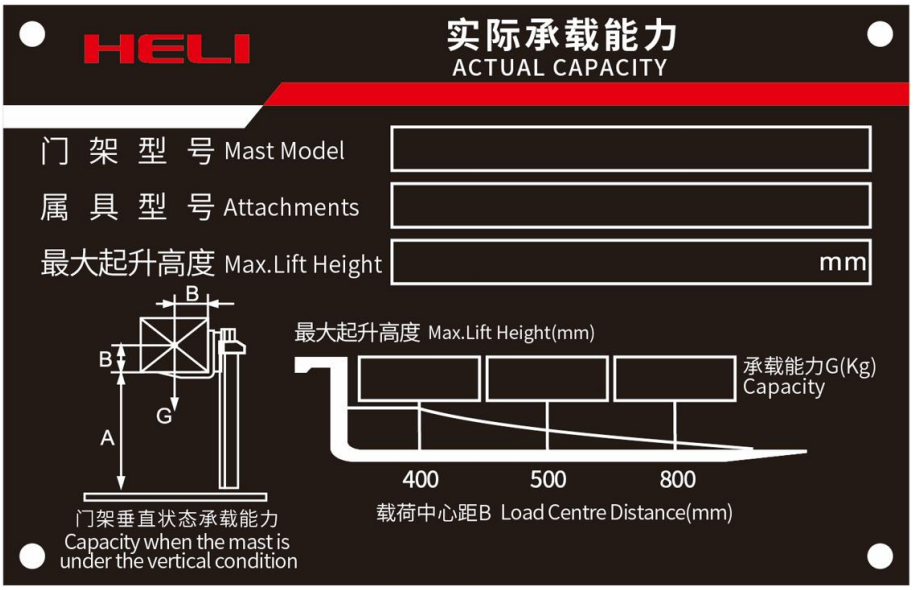


Printing position of truck No. with lifting type battery

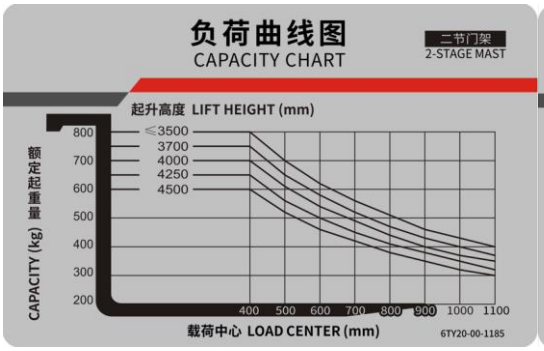
8. Load Curve

Never overload the forklift, otherwise, structural parts damage and serious accidents may occur, such as truck rollover. If the truck is equipped with attachments, such as side shifters and buckets, the actual capacity will be lower than its rated load. The actual capacity and rated capacity charts are shown below.

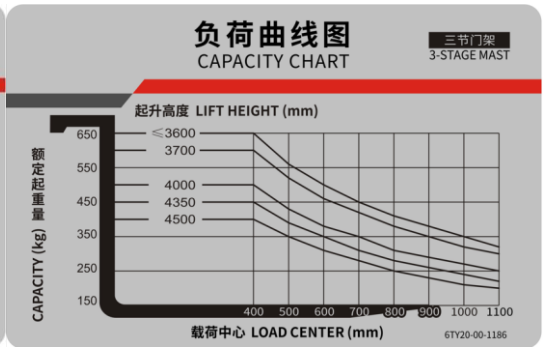
(1) Nameplate of the actual capacity of forklift (example)



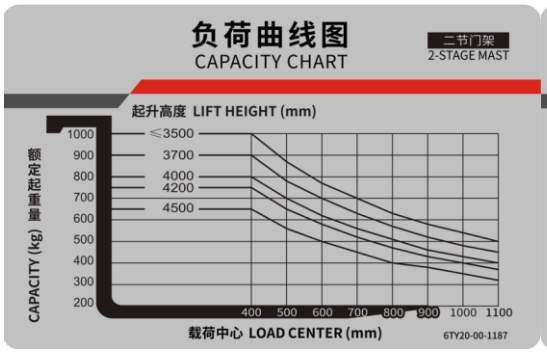
(2) Rated capacity chart of forklift



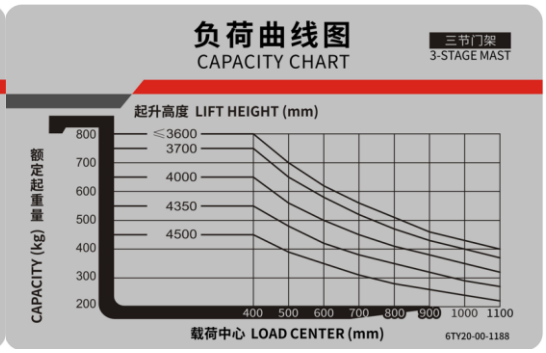
0.8t Two- stage Basic Type Mast



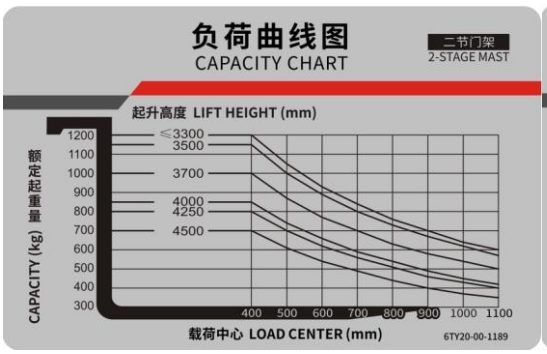
0.8t Three- stage Full Free Mast



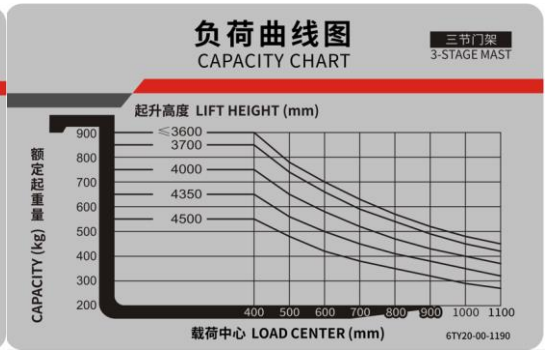
1t Two- stage Basic Type Mast



1t Three- stage Full Free Mast

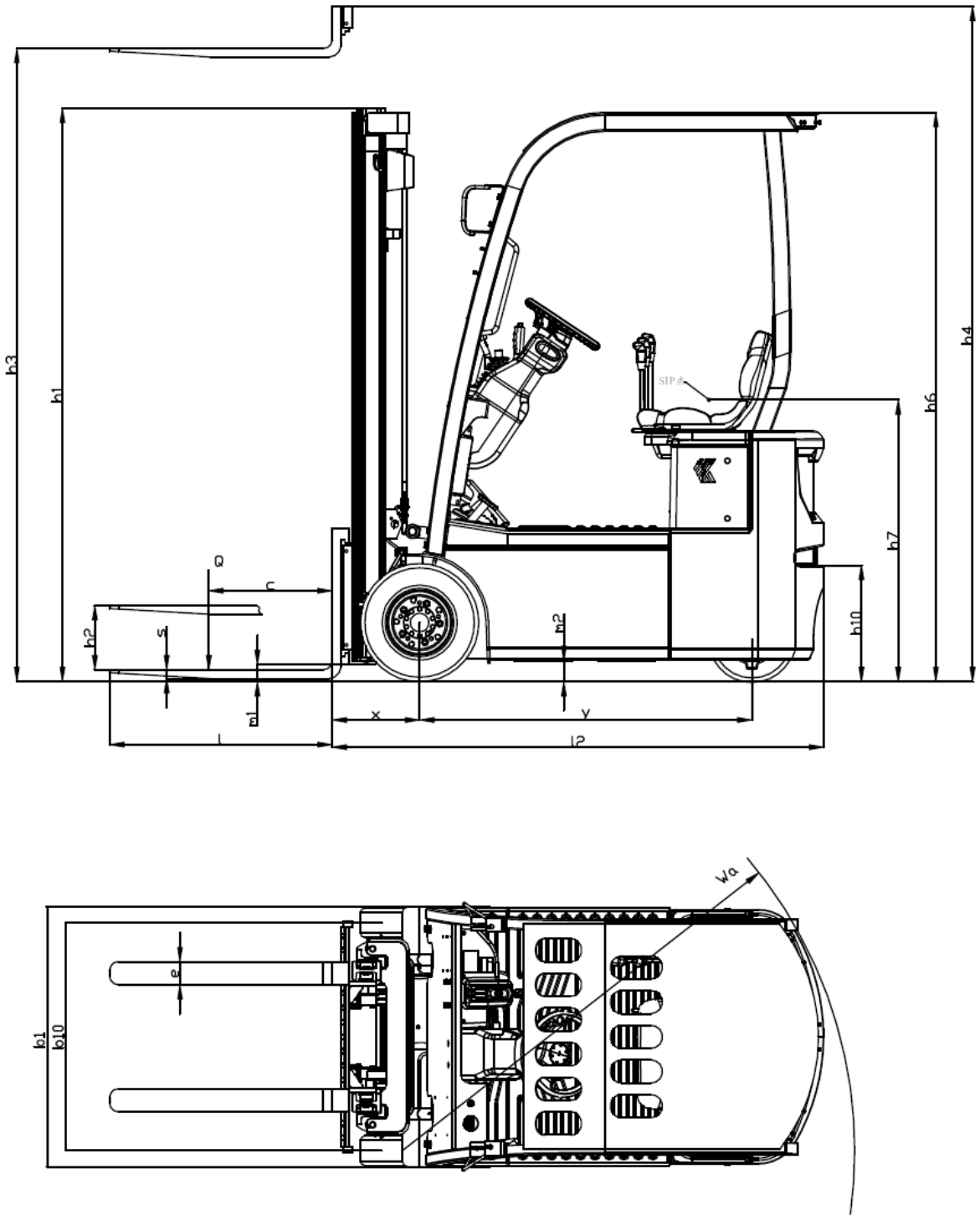


1.2t Two-stage Basic Type Mast



1.2t Three- stage Full Free Mast

II. Main Technical Parameters of Forklift



Outline Drawing of the Truck

List of Main Technical Parameters

Model			CPD08		CPD10		CPD12	
Configuration No.			A1H4	A5H4	A1H4	A5H4	A1H4	A5H4
Rated lifting capacity	Q	kg	800		1000		1200	
Load center distance	c	mm	400					
Power type			Lead-acid battery					
Driving mode			Seat type					
Type of tire			Solid tires					
Front wheel size			4.00-8					
Rear wheel size			3.5-5					
Wheelbase	y	mm	1150					
Inclination angle of mast, forward/backward	α/β	°	5/7					
Lifting height (standard)	h3	mm	3000					
Body length (excluding forks)	l2	mm	2440		2440		2460	
Body width	b1	mm	900					
Height of overhead guard	h6	mm	1960					
Travel speed (full load/no load)		km/h	10/12					
Lifting speed (full load/no load)		m/s	250/380		240/380		230/380	
Max. gradeability, full load/no load		%	14/15		12/15		10/15	
Drive motor power (S2 -60min)		kW	3.0					
Lifting motor power (S3-15%)		kW	4.5					
Battery voltage/rated capacity		V/Ah	24/240		24/360		24/420	
Total weight (with/without battery)		kg	1750/1557		1920/1655		2040/1740	
Operating pressure of the attachments		MPa	14.5					

List of Main Technical Parameters

Model			CPD08		CPD10		CPD12	
Configuration No.			A1LIH4	A5LIH4	A1LIH4	A5LIH4	A1LIH4	A5LIH4
Rated lifting capacity	Q	kg	800		1000		1200	
Load center distance	c	mm	400					
Power type			Lithium battery					
Driving mode			drive type					
Type of tire			Solid tires					
Front wheel size			4.00-8					
Rear wheel size			3.5-5					
Wheelbase	y	mm	1150					
Inclination angle of mast, forward/backward	α/β	°	5/7					
Lifting height (standard)	h3	mm	3000					
Body length (excluding forks)	l2	mm	2440		2460		2480	
Body width	b1	mm	900					
Height of overhead guard	h6	mm	1960					
Travel speed (full load/no load)		km/h	10/12					
Lifting speed (full load/no load)		m/s	250/380		240/380		230/380	
Max. gradeability, full load/no load		%	14/15		12/15		10/15	
Drive motor power (S2 -60min)		kW	3.0					
Lifting motor power (S3-15%)		kW	4.5					
Battery voltage/rated capacity		V/Ah	24/250		24/250		24/280	
Total weight (with/without battery)		kg	1670/1555		1860/1745		1990/1870	
Operating pressure of the attachments		MPa	14.5					

III. Structure, Principle, Adjustment and Maintenance of Forklift

1. Power Train System

1.1 Overview

The transmission system of a forklift consists of a gearbox assembly, a differential assembly, and a drive axle. The driving gear of the reducer is directly connected with the traveling motor by spline. The traveling speed of the forklift increases with the increase of the rotating speed of the motor, and the traveling direction is changed by changing the rotating direction of the motor.

The gearbox is three-stage with a total speed ratio of 27 to achieve speed and torque transmission, which plays a role in reducing speed and increasing torque, making better use of motor characteristics to meet the service requirements for forklifts.

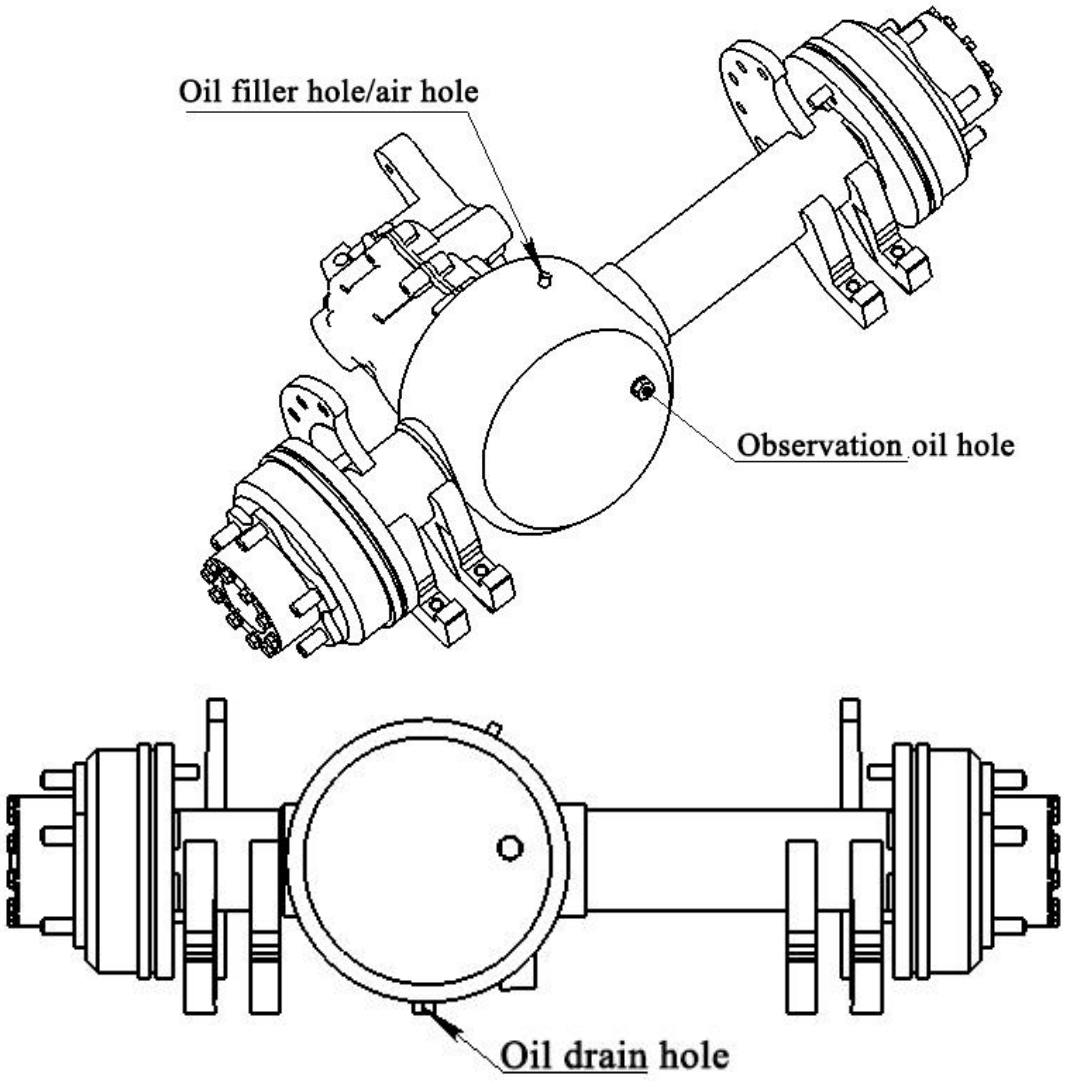
1.2 Addition of gear oil

The service cycle of gear oil is 1,000 hours or one year (whichever comes first), which means that the gear oil needs to be replaced after 1,000 hours or one year of operation of the forklift. At this point, the gear oil in the gearbox shall be drained to add the specified gear oil.

Table 1 Performance Parameters of Mechanical Gearbox

Name	Parameter
Forward gear speed ratio	27
Reverse gear speed ratio	27
Used oil type	85W/90GL-5
Filling amount	Add to the observation oil hole, about 3 L

The model of gear oil is 85W/90 GL-5. The drive axle shall be mounted on the frame or placed horizontally for refueling to the observation oil hole, about 3 L.



2. Braking 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 truck 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.

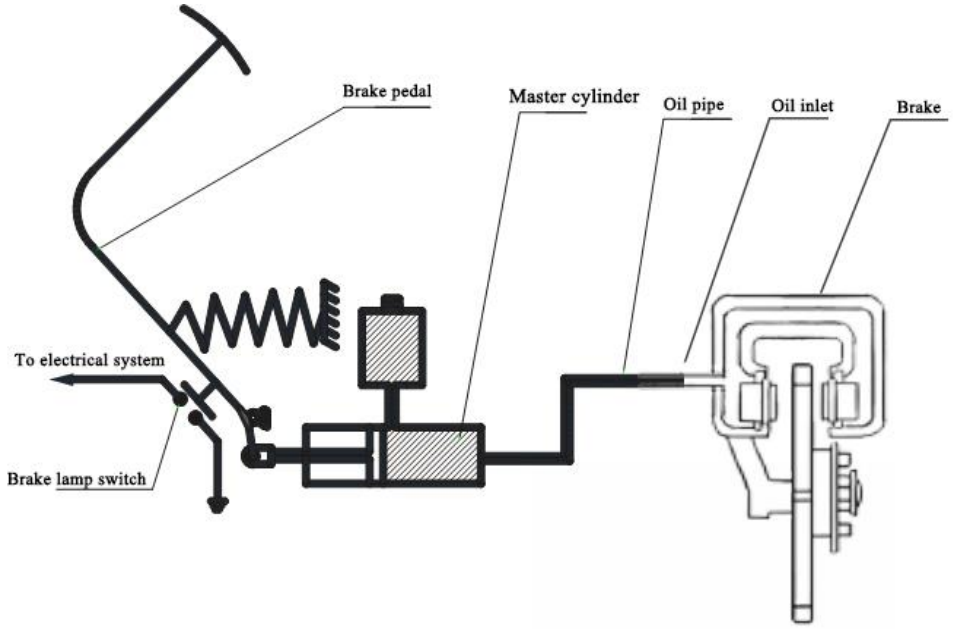


Fig. 2-1.1 Schematic Diagram of Service Brake

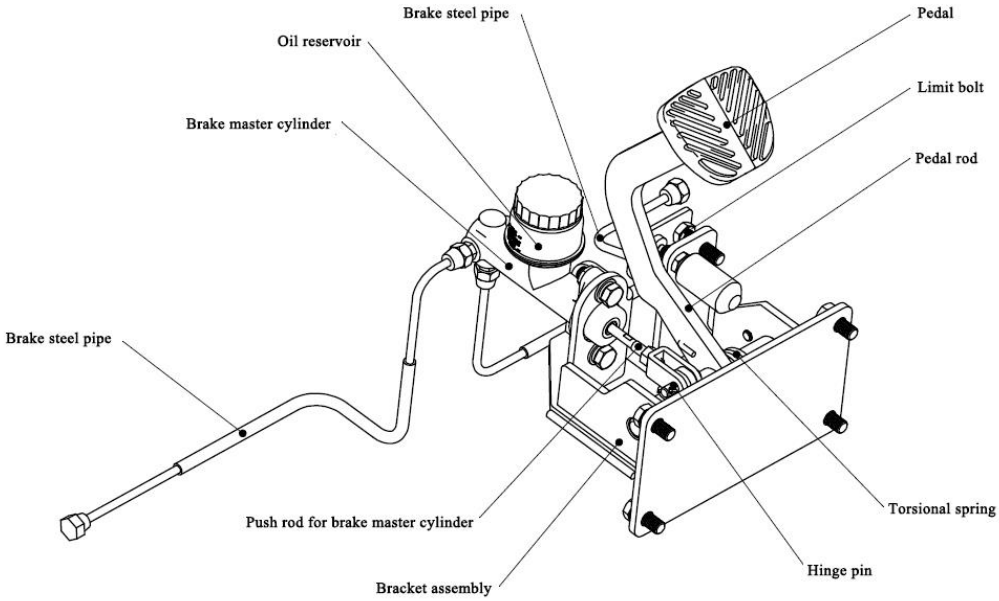


Fig. 2-1.2 Service Brake System

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.

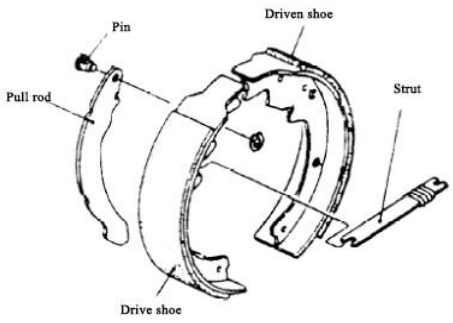


Fig. 2-2.1 Parking Brake Device

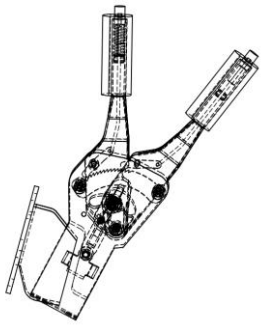
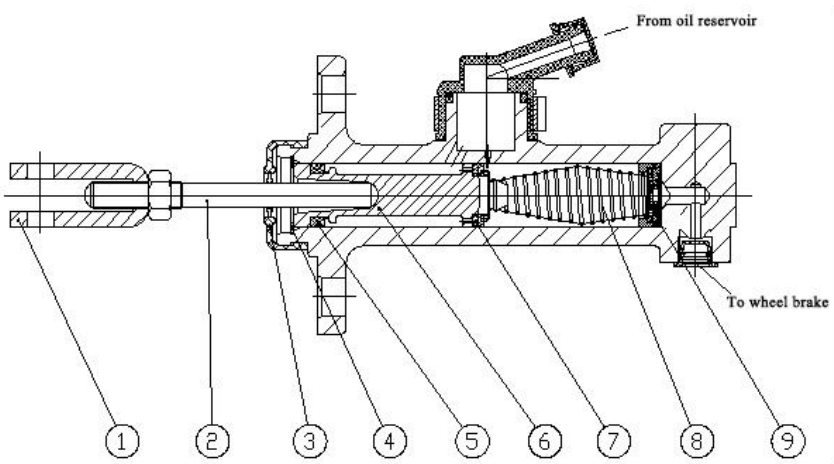


Fig. 2-2.2 Parking Brake Handle

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 rubber 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 truck moves backward is opposite to that when

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

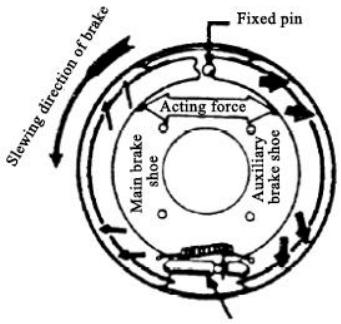


Fig. 2-4.1 Action in Forward Mode

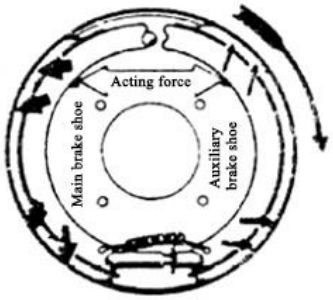


Fig. 2-4.2 Action in Backward Mode

(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.

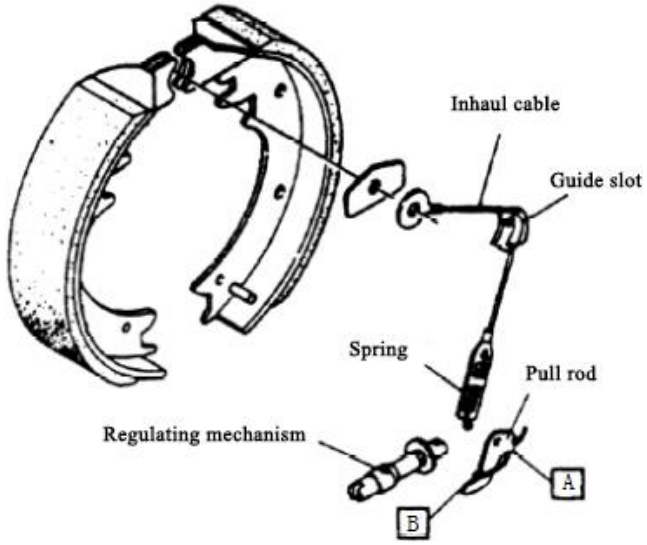


Fig. 2-5 Clearance Self-adjusting Mechanism

▲ Action of clearance self-adjusting mechanism

When the forklift 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:

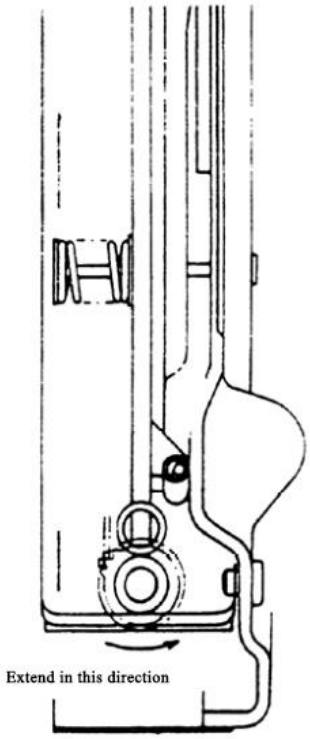


Fig. 2-6 Clearance Self-adjusting Mechanism

Unit: mm

	0.8-1.2t
Clearance	0.15-0.2

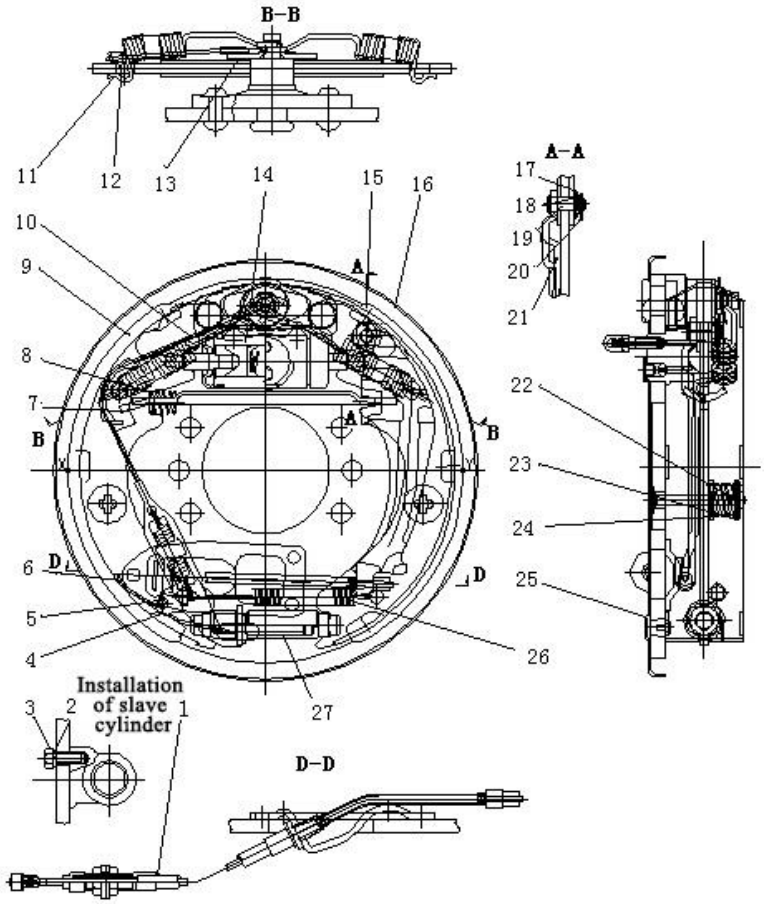


Fig. 2-7 Brake Assembly

(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 Brake pedal adjustment

(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 75~90mm. After depressing the pedal, the clearance between the pedal and the front bottom plate shall be greater than 20 mm;

(3) Depress 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 push rod lock nut.

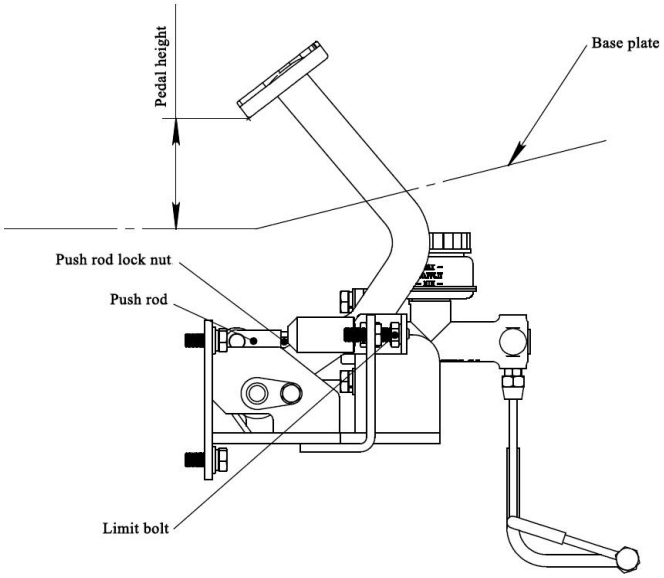


Fig. 2-8 Brake Pedal Adjustment

▲ Adjustment of the brake switch

a) After adjusting the height of the brake pedal, loosen the lock nut of the brake switch;

b) Disconnect the plug to separate the wires;

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

d) Confirm that the brake lamp shall be on when the brake pedal is depressed.

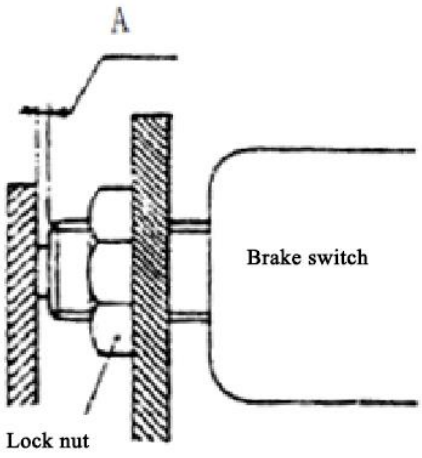


Fig. 2-9 Brake Switch Adjustment

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 0.8t 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 supporting pin, adjusting rod, adjusting device and spring on the auxiliary brake shoe.

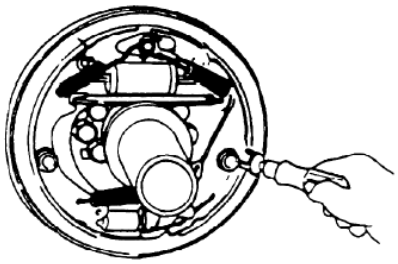


Fig. 2-10

(2) Remove the shoe return spring.

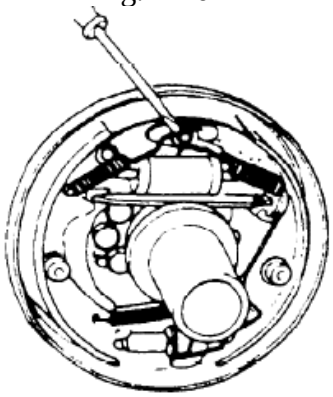


Fig. 2-11

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

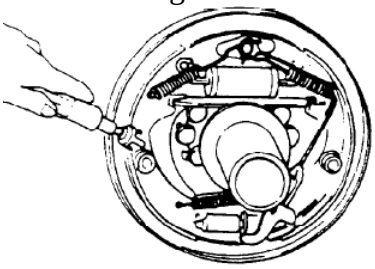


Fig. 2-12

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

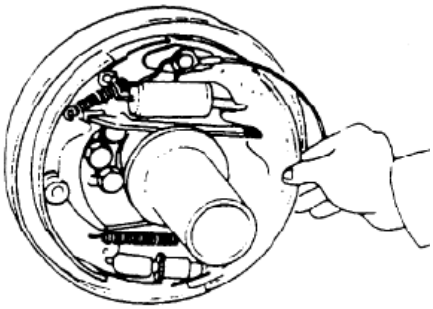


Fig. 2-13

(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.

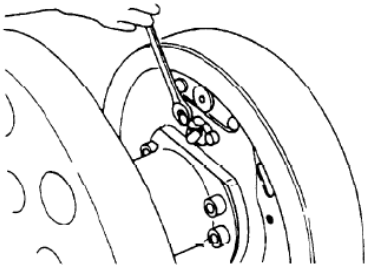


Fig. 2-14

(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.

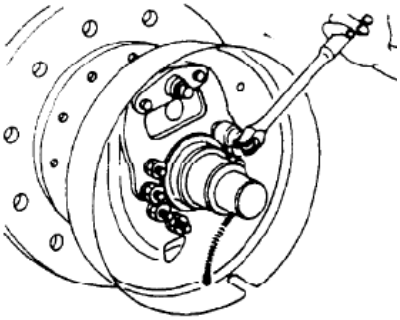


Fig. 2-15

(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.

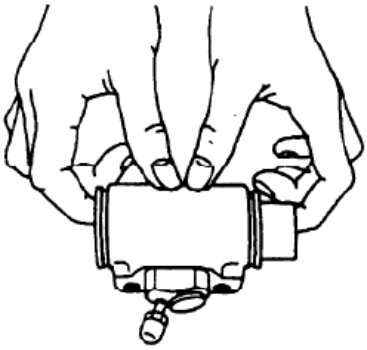


Fig. 2-16

2.2.2 Inspection of brake

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

(1) Check 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

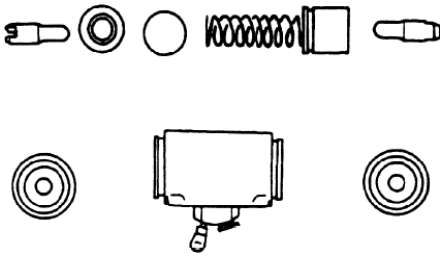


Fig. 2-17

(2) Visually check 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 criterion.

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

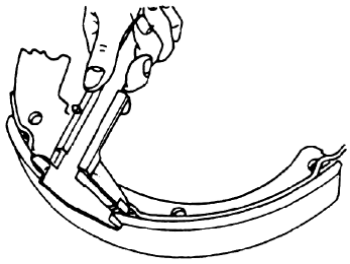


Fig. 2-18

Unit: mm

	0.8-1.2t
Standard value	4.9
Limit value	2

(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.

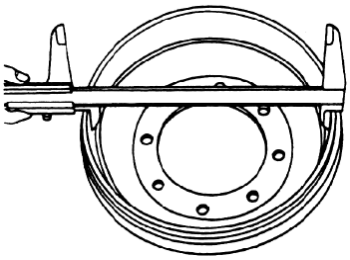


Fig. 2-19

Unit: mm

	0.8-1.2t
Standard value	Φ180
Limit value	Φ182

2.2.3 Assembly of brake

(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 bottom 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.

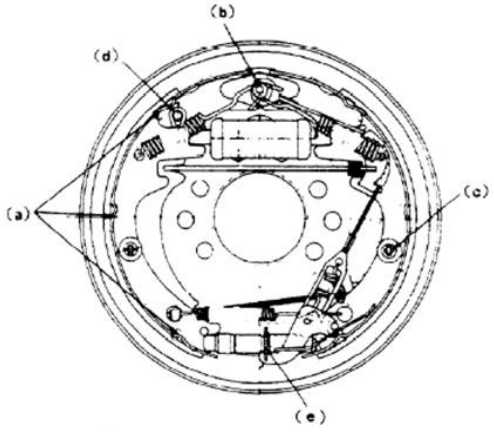


Fig. 2-20

(a) Contact surface between bottom plate and brake shoe

(b) Fixing pin

(c) Contact surface between shoe and pressure spring seat

(d) Hand brake lever support pin

(e) Adjusting mechanism threads and other rotating parts

(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.

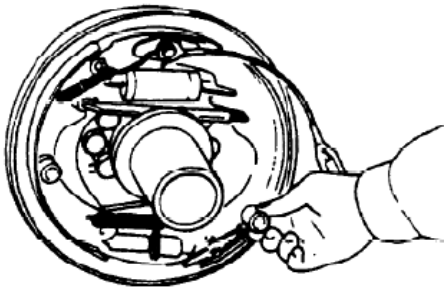


Fig. 2-21

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

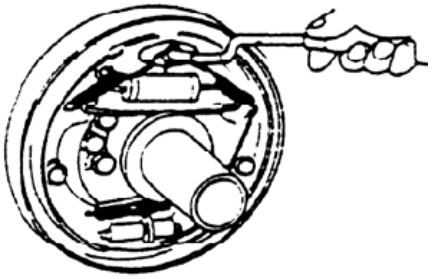


Fig. 2-22

(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) Ejector rod return spring direction (the spring hook at the end of the support pin shall be 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.

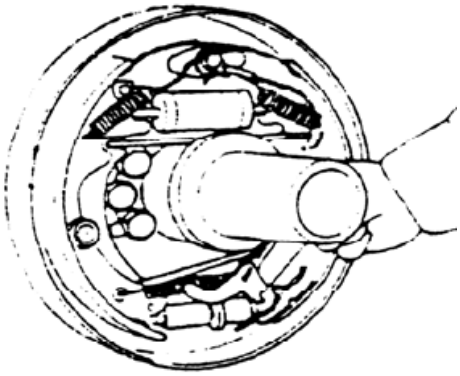


Fig. 2-23

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

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

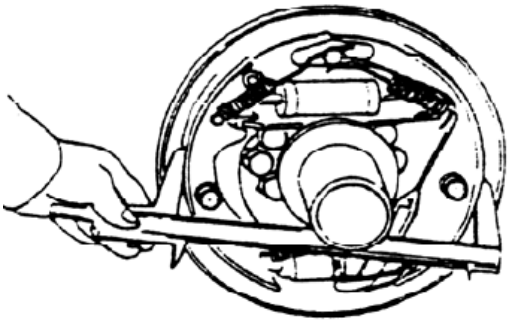


Fig. 2-24

2.2.4 Operation test of automatic clearance adjuster

(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 realize the actions above when the adjusting lever is pulled, the following inspection shall be made:

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

b) Check whether the ejector rod return spring and adjuster spring are damaged, whether the rotation of 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.

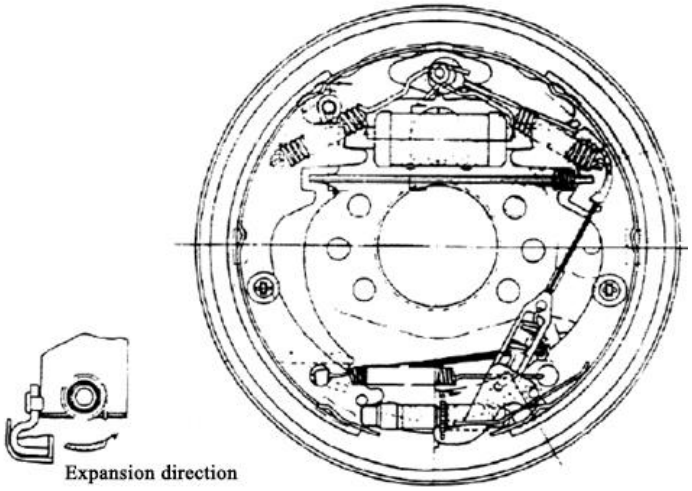


Fig. 2-25

2.2.3 Fault diagnosis

Symptoms	**Cause analysis**	**Troubleshooting method**
Poor braking	1) Oil leakage of brake system	Repair it
	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	Replacement
	5) Loose wheel bearing	Repair it
Uneven braking	1) Oil stain on the surface of the friction plate	Repair or replace
	2) Clearance of brake shoe improperly adjusted	Adjust the adjuster
	3) Failure of slave cylinder	Repair or replace
	4) The brake shoe return spring damaged	Replacement
	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	Deflating
	4) Incorrect adjustment of brake pedal	Readjust

3. Steering System

3.1 General

The function of the forklift 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. 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, 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 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 forklifts produced by our company currently adopts a full hydraulic power steering system.

3.2 Working principles

To turn the forklift, 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

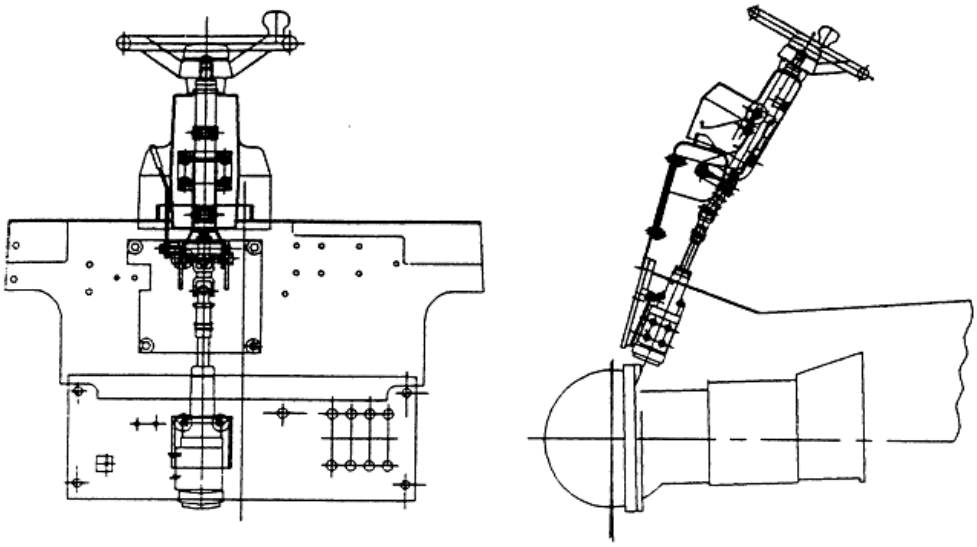


Fig. 3-1 Steering Operation Device

3.4 Steering axle

3.4.1 Overview

The axle is a three-wheel steering axle structure, which is composed of a supporting gear shaft, a slewing bearing, a wheel axle and hub, a cylinder barrel, a piston rod, and other parts. The steering is a gear mechanism, which is driven by the movement of the piston rod to rotate the supporting gear shaft, so that the steering wheel is offset to achieve steering.

3.4.2 Parts catalog

Fig. 3-2 is an exploded view of a three-wheel steering axle assembly, and Table 3-1 is a list of parts corresponding to the exploded view.

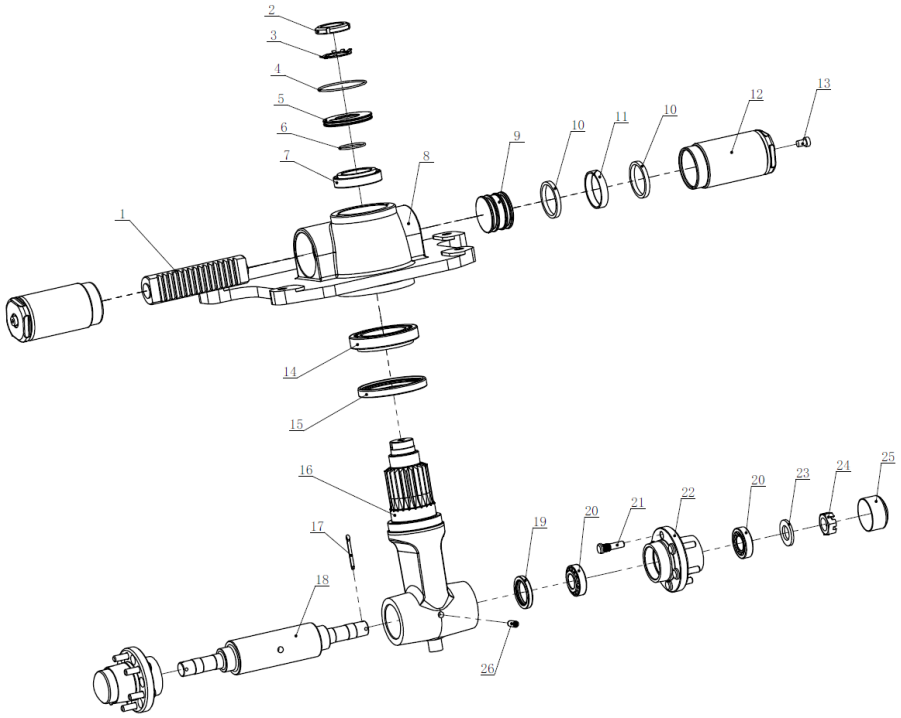


Fig. 3-2 Exploded View of Three-wheel Steering Axle Assembly

Table 1-1 List of Parts Corresponding to the Exploded View

S/N	Material No.	Material description	Quantity
1	A2594-32071	Rack	1
2	B4832-00039	Round nut M39x1.5	1
3	B5512-00039	Thrust washer 39	1
4	Z6003-08202	O-ring, Φ82x2.65	1
5	A2594-32091	Bushing, φ40Xφ82X8.5	1
6	Z6054-04002	O-ring, Φ40x2.65	1
7	Z-32010UBC	Tapered roller bearing, Z-32010UBC	1
8	A2594-32011	Pivoting support	1
9	A2594-32061	Piston	2
10	22439-43711	U-ring	4
11	A2594-32081	Back-up ring, 63x12x2.5	2
12	A2594-30101	Cylinder tube assembly	2
13	P02V4-32100	1/4G cylinder plug	2
14	Z-32015UBC	Tapered roller bearing, Z-32015UBC	1
15	Z6301-09012	Framework oil seal, φ90xφ115x12	1
16	A2594-32021	Supporting gear shaft	1
17	B3010-05045	Cotter pin 5×45	2
18	A2594-32051	Axle	1

19	P94E4-32181	Oil seal, Φ40XΦ55X8	2
20	Z-30205	Bearing 30205	4
21	A2594-32111	Hub bolt, M10X46	12
22	A2594-32101	Hub assembly	2
23	B5313-00024	Flat washer 24	2
24	24234-32311	Slotted nut, M24X2	2
25	GPU-0600ZXL	Hub cover	2
26	B3420-10024	Pin, A10X24	1

3.4.3 Key points of assembly

1. Hub assembly: Press the outer rings of the large and small bearings into the hub fitting holes with special press-fitting tooling to ensure that the outer rings are properly fitted with the hub; install hub bearings and add 3# lithium-based grease to the hub, with an amount of 1/3-1/2 of the inner cavity of the hub; and apply a small amount of 3# lithium-based grease on the working surface of the oil seal and install it into the fitting hole of the hub;

2. Assembly of a supporting gear shaft and its components: Press the wheel shaft into the supporting gear shaft and fix it with the wheel shaft using a dowel pin;

3. Assembly of a slewing bearing and its components: Install a tapered roller bearing at the upper end of the slewing bearing, and install a tapered roller bearing and a framework oil seal at the lower end. Apply a layer of grease to both inner and outer lips of the oil seal, and install a rack into the slewing bearing;

4. Assembly of a supporting gear shaft slewing bearing: Apply 3 # lithium-based grease to the contact part between the gear and the rack, insert the supporting gear shaft into the slewing bearing, adjust the rack to fit the supporting gear shaft, install the bushing and thrust washer, and finally screw the nut into the supporting gear shaft, tighten it first, then completely loosen it, and then tighten it with a torque of 200N·m to ensure flexible rotation of the supporting gear shaft;

5. Assembly of a steering wheel axle hub: install the hub assembly on the steering wheel shaft, install the gasket, lock the slotted nut with the cotter pin, and finally use a special tool to install the hub cover. Adjustment of hub bearing preload: Tighten the

slotted nut first, then loosen it by 1/8-1/6 turns, and then tighten it to ensure that the cotter pin is locked when the start-up force of the hub is 40-80N;

6. Assembly of a cylinder barrel slewing bearing: Place the U-shaped seal ring and back-up ring on the piston, and then install the piston into the cylinder barrel, ensuring that the spherical surface of the piston faces the opening of the cylinder barrel, and then screw the cylinder barrel into the slewing bearing.

3.4.4 Maintenance of steering system

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

(2) Regular maintenance schedule for steering axle:

The regular maintenance schedule for steering axle is based on standard operating hours and operating conditions. If the forklift operates under harsh conditions, please perform maintenance in advance ("☆" indicates maintenance, "★" indicates replacement).

Inspection Item	**Inspection contents**	**Tools**	**Daily (8 hours)**	**Monthly (200 hours)**	**Every 3 months (600 hours)**	**Every 6 months (1200 hours)**	**Annually (2400 hours)**
Tire	Tire pressure	Barometer	☆	☆	☆	☆	☆
	Abnormal wear		☆	☆	☆	☆	☆
	Check any nail, stone or other foreign matter on tire			☆	☆	☆	☆
	Check the hub nuts for looseness	Detection hammer	☆	☆	☆	☆	☆
All bearings	Check the hub bearing for looseness and noise			☆	☆	☆	☆
Slewing bearing assembly	Check for damage			☆	☆	☆	☆
Supporting gear shaft assembly	Check the wheel shaft and supporting gear shaft for any looseness or damage			☆	☆	☆	☆
	Check the wheel shaft and supporting gear shaft for any deformation or damage			☆	☆	☆	☆
	Check for installation	Detection hammer		☆	☆	☆	☆

3.4.5 Inspection steps after reinstallation of steering system

(1) Turn the steering wheel to the left and right limits to see if the leftward and rightward force is even and the rotation is smooth;

(2) Check whether the oil pressure pipeline layout is correct 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;

3.4.6 Removal of faults of steering system

Analysis of Steering System Failure

Symptoms	**Cause analysis**	**Troubleshooting method**
Steering wheel does not turn	The oil pump is damaged or faulty	Replacement
	The diverter valve is blocked or damaged	Clean or replace
	Rubber hose or joint is damaged or pipe is blocked	Replace or clean
Heavy steering	The pressure of diverter valve is too low	Adjust pressure
	Air is in oil circuit	Exhaust air
	The steering gear fails to reset, and the positioning spring plate is broken or lacks elasticity	Replace the spring plate
	Excessive internal leakage of steering cylinder	Check the piston seal
Forklift snaking or swinging	The steering flow is excessively large	Adjust the flow of diverter valve
	Spring is broken or provides no elastic force	Replacement
Working noise is loud	The oil level in oil tank is low	Refuel
	Suction pipe or oil filter is blocked	Clean or replace
Oil leakage	The steering cylinder guide sleeve seal is damaged or the pipeline or joint is damaged	Replacement

4. Electrical System

4.1 Overview

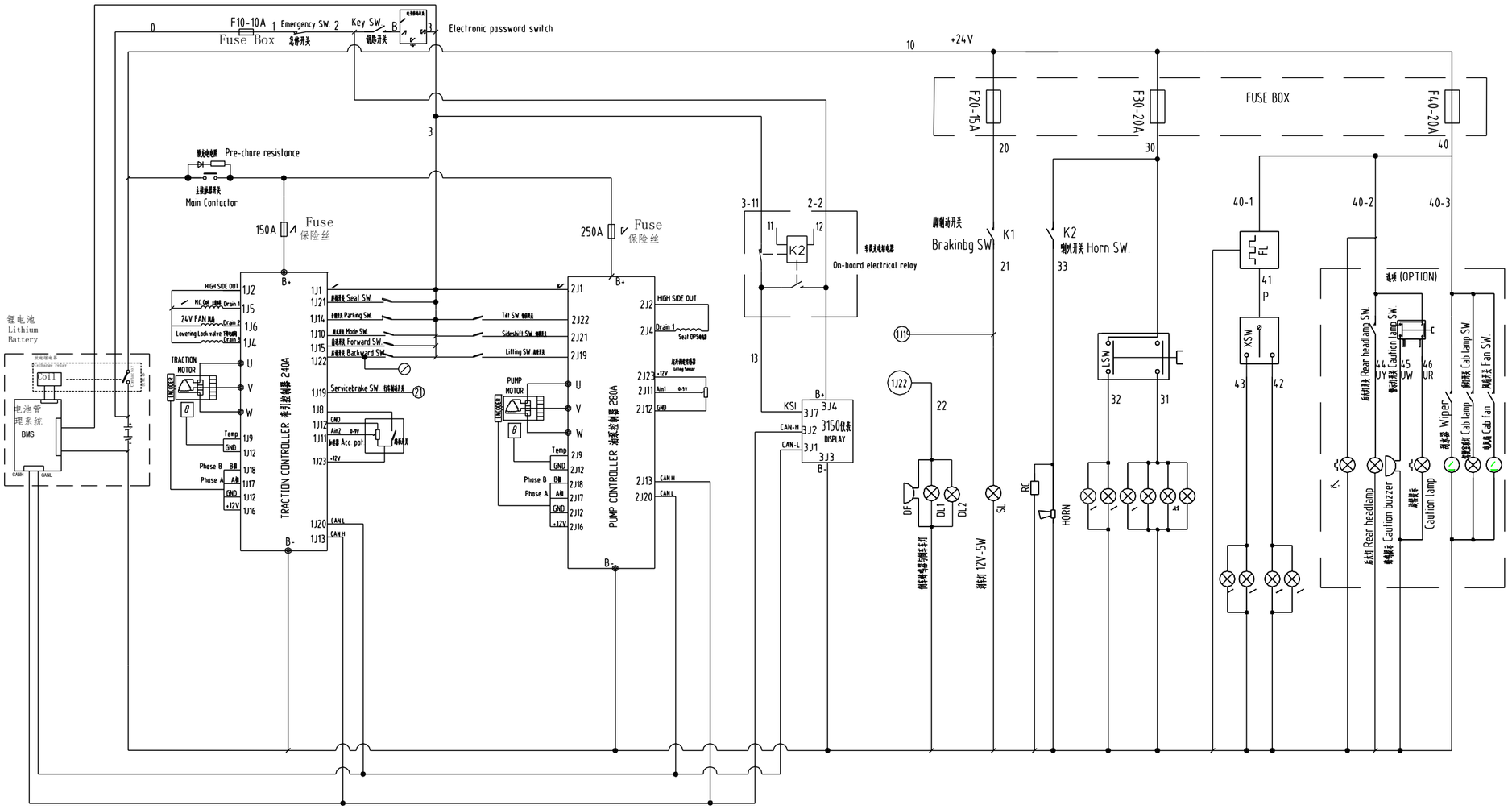
For the H4 series 0.8-1.2T front-drive three-wheel balanced forklift, there are two brands of electrical systems to choose from. Currently, there are two control systems, CURTIS and Zhengzhou Jiachen, both of which are high-performance full AC control systems that can achieve quiet, efficient, smooth, unhindered, and safe control of the entire truck.

The electrical system is mainly composed of intelligent instrument, traction control system, pump control system, battery packs, acousto-optic system, and wiring harness.

🕮Precautions

The manufacturer reserves the right to continuously improve the product. If the actual product is inconsistent with the Manual, please consult the manufacturer.

The schematic diagram of the electrical system is shown in the drawing below.



SL	刹车灯 Brake lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp Switch	K1	脚制动开关 Brakinbg SW.
DF	倒车蜂鸣器 Reverse buzzer	XSW	转向灯开关 Turning lamp switch	QL1 QL2	前大灯 Headlamp	K2	喇叭开关 Horn SW.
DL1 DL2	倒车灯 Reverse lamp	XL1 XL2	右转向灯 Turning lamp (Right)	HL1	示宽灯 Width lamp (Front)		
RC	喇叭滤波器 Horn filter	XL3 XL4	左转向灯 Turning lamp (Left)	HL2	示宽灯 Width lamp (Rear)		

Fig.: Schematic Diagram of Electrical System (CPD08/10/12SQ-A1LIH4)

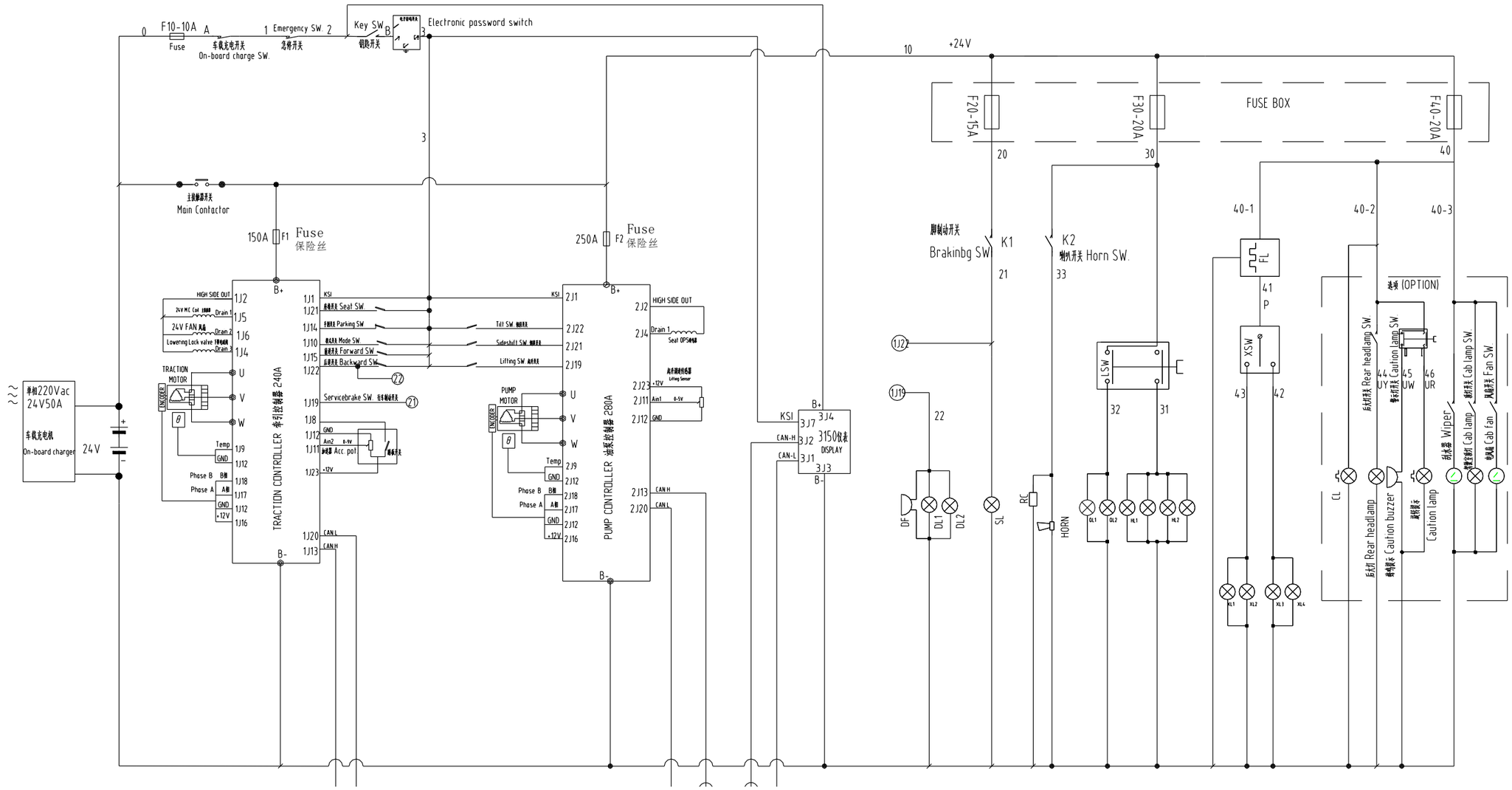
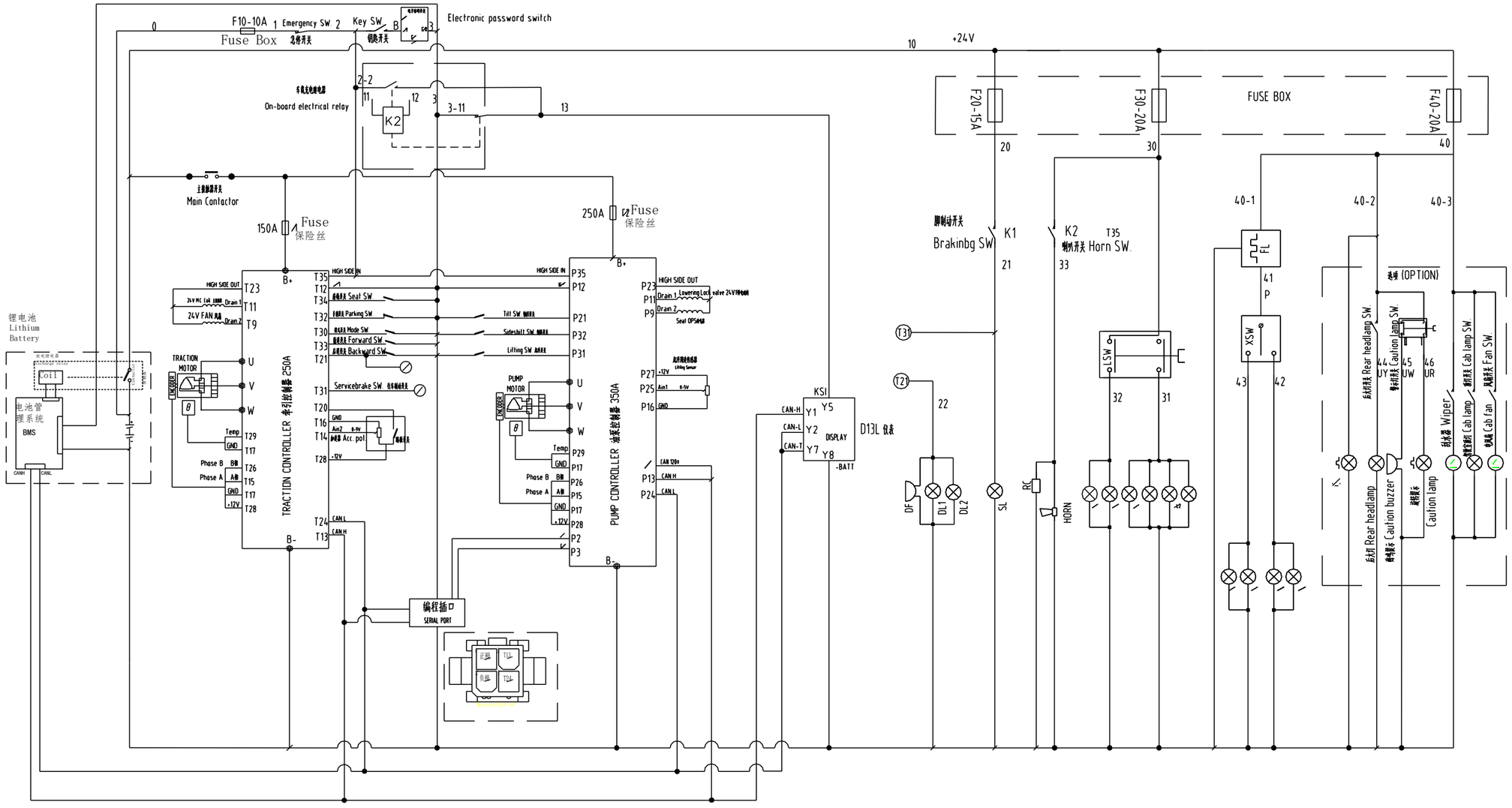
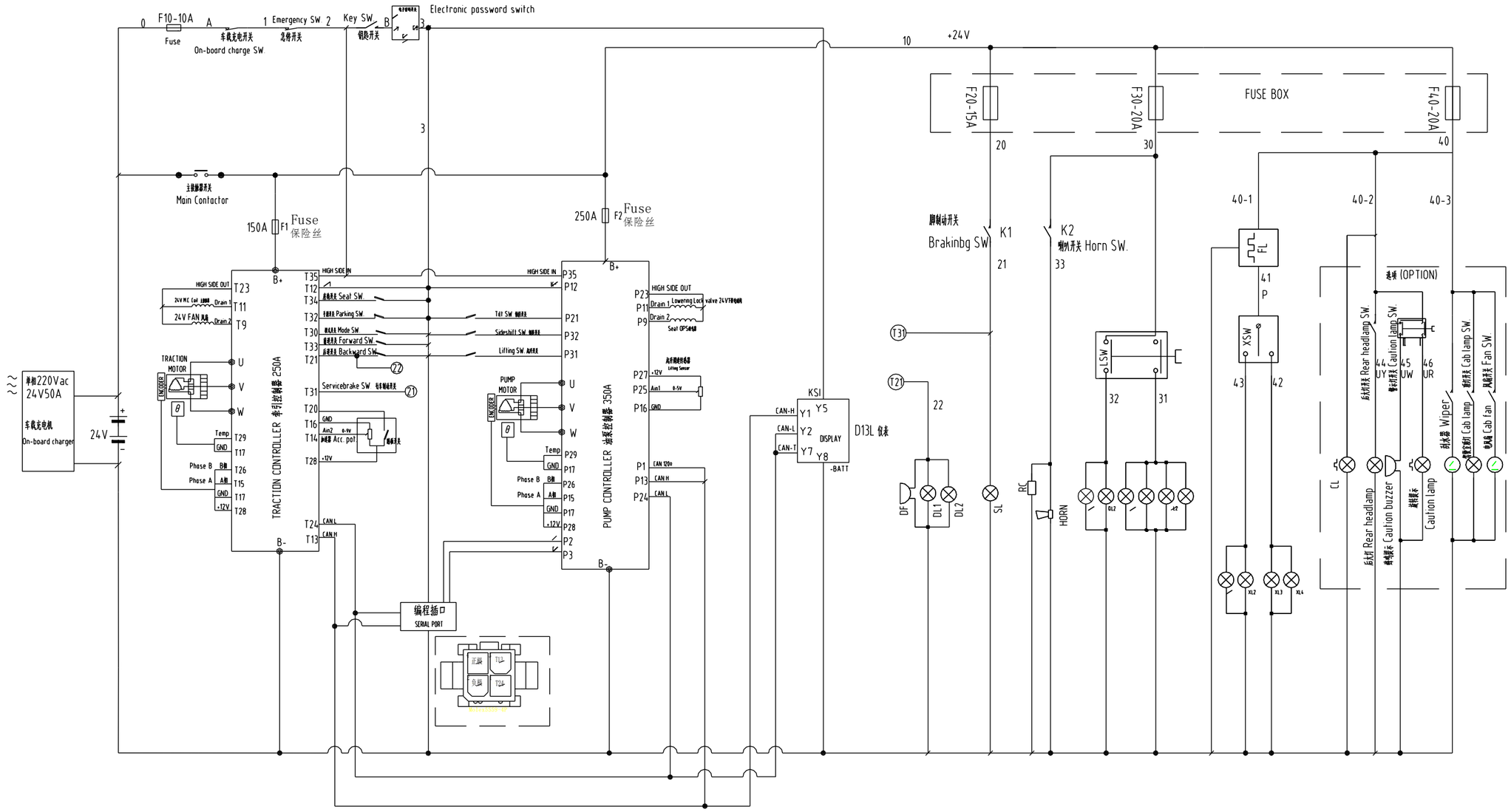


Fig.: Schematic Diagram of Electrical System (CPD08/10/12SQ-A1H4)



SL	刹车灯 Brake lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp Switch	K1	脚制动开关 Brakinbg SW.
DF	倒车蜂鸣器 Reverse buzzer	XSW	转向灯开关 Turning lamp switch	QL1 QL2	前大灯 Headlamp	K2	喇叭开关 Horn SW.
DL1 DL2	倒车灯 Reverse lamp	XL1 XL2	右转向灯 Turning lamp (Right)	HL1	示宽灯 Width lamp (Front)		
RC	喇叭滤波器 Horn filter	XL3 XL4	左转向灯 Turning lamp (Left)	HL2	示宽灯 Width lamp (Rear)		

Fig.: Schematic Diagram of Electrical System (CPD08/10/12SQ-A5LIH4)



SL	刹车灯 Brake lamp	FL	闪光器 Flasher	LSW	二档灯开关 Lamp Switch	K1	脚制动开关 Brakinbg SW.
DF	倒车蜂鸣器 Reverse buzzer	XSW	转向灯开关 Turning lamp switch	QL1 QL2	前大灯 Headlamp	K2	喇叭开关 Horn SW.
DL1 DL2	倒车灯 Reverse lamp	XL1 XL2	右转向灯 Turning lamp (Right)	HL1	示宽灯 Width lamp (Front)		
RC	喇叭滤波器 Horn filter	XL3 XL4	左转向灯 Turning lamp (Left)	HL2	示宽灯 Width lamp (Rear)		

Fig.: Schematic Diagram of Electrical System (CPD08/10/12SQ-A5H4)

4.2 Detailed description of electrical system

4.2.1 CAN Bus technology

This model uses CAN Bus technology, which connects each module (including traction control module, oil pump control module, and instrument display module).

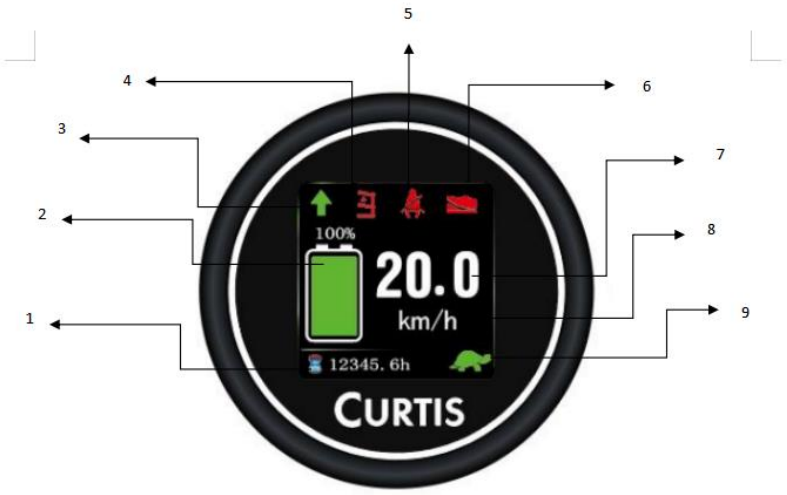
4.2.2 Curtis Instrument 3150

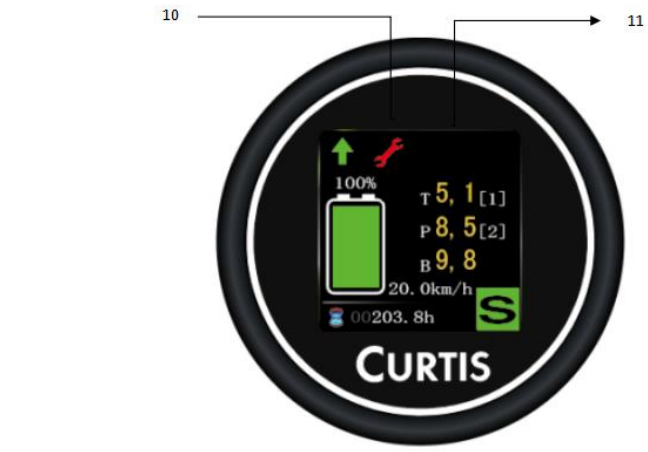
A) General

The Curtis Instrument 3150 is an intelligent instrument connected to the truck system through a CAN Bus. This instrument displays real-time information on truck running status such as battery remaining capacity, hour meter, speed, fault codes, etc.

The Curtis Instrument 3150 has the function of backlighting, suitable for places with insufficient light, and has the function of heating, suitable for cold storage.

B) Instrument display interface





Mode Display



Alarm and operation indications

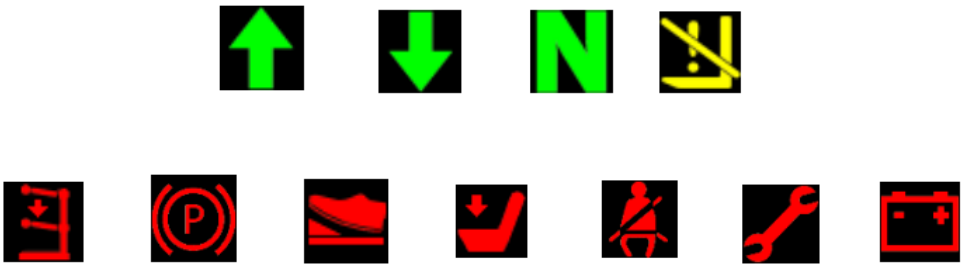


Fig. 4-1 Display Interface of Curtis Instrument 3150

The Curtis 3150 is a 1.54-inch (39.1 mm) bright dot matrix color LCD, encapsulated in a 52 mm package with a resolution of 240 * 240, enabling visualization of key information, and allowing for unique customizable UI for state recognition. As shown in Fig. 4-1:

1 - Remaining battery capacity of hour meter;

2 - Remaining battery capacity;

3 - gear indication;

4 - Lifting indication;

5 - Seat belt switch indication;

6 - Truck fault code;

7 - Speed indication;

8 - Speed unit;

9 - Low gear indication;

10 - Truck fault indication;

11 - Truck fault code.

C) Instructions for operation and use of instrument

(1) Turn on the key switch, and allow the instrument to perform a self inspection. When the self-inspection is completed, under normal circumstances, the first line on the instrument displays the remaining battery capacity and the second line displays the operating timer. The remaining battery capacity is displayed in digital form, and the operating timer starts when the truck is turned on.

(2) When the truck speed is greater than or equal to 1 km/h, the second line displays the speed, which is shown in digital form.

(3) When the truck shows a fault, the second line displays the truck fault, which is displayed in numerical form.

(4) When the truck receives a driving command and the handbrake switch is not released, 2 displays "P" to alarm the driver to release the handbrake.

D) Operating environment of instrument

(1) The operating ambient temperature ranges from -10 ℃ to +85 ℃, and -40 ℃ to +85 ℃ for heating type;

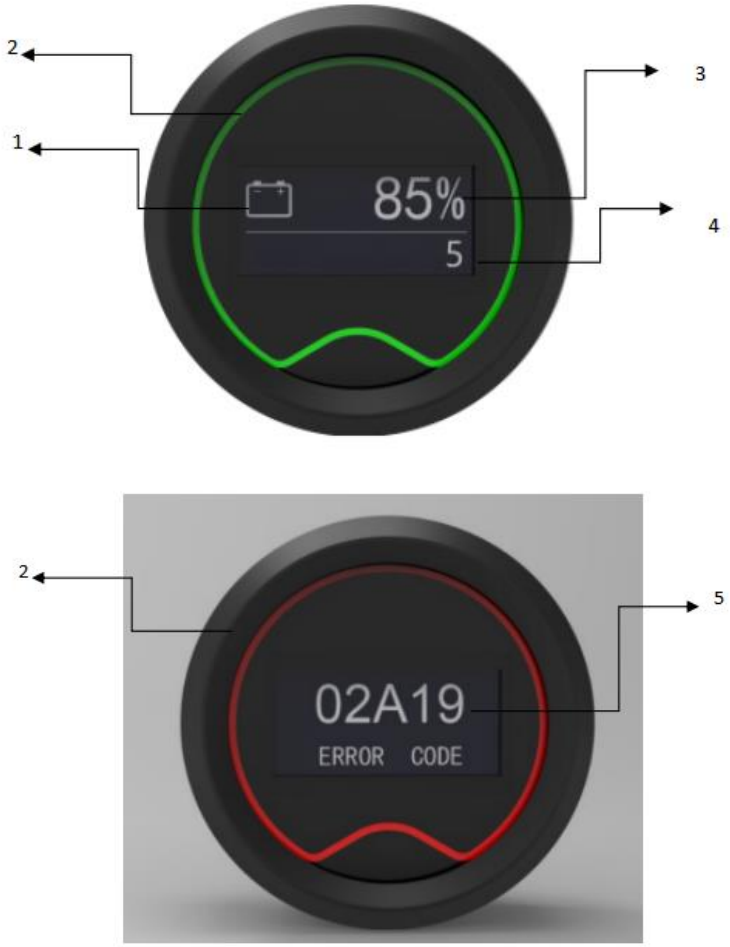
(2) The front protection grade is IP65, and the back protection grade is IP54.

PIN	Signal name	Description
1	CAN Low	CAN low
2	CAN Hi	CAN high
3	B-	Battery negative pole
4	B+	Battery positive pole
5	SCI Tx / SW1	Serial communication, Tx/Switch 1
6	SCI Rx / SW2	Serial communication, Rx/Switch 2
7	KSI	Electric lock
8	Lift Lock Output/SW3	Lifting lock/Switch 3

4.2.3 Zhengzhou Jiachen Instrument D13L

D13L is a truck instrument based on CAN and serial communication. It displays information such as truck speed, electric quantity, hour meter and fault codes by communicating with the truck controller. With the advantages of instant messaging,

real-time display and high visualization, it is widely used in various industrial trucks, low-speed passenger cars, driverless trucks and special trucks.



Notes: 1) The instrument has a black background; 2) When the truck is running normally, the instrument aperture turns green, and the interface displays the main interface; 3) When a controller of the truck fails, the instrument aperture turns red and the interface displays the current fault code;

1 - Battery icon;

2 - Truck status indicator;

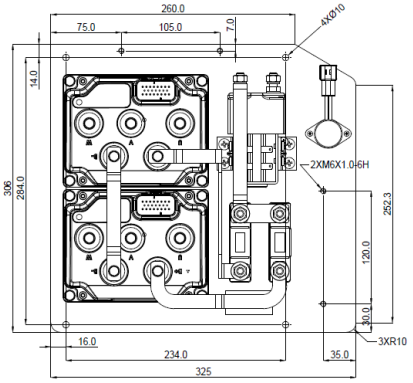
3 - Remaining battery capacity;

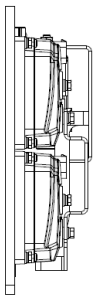
4 - Hour meter;

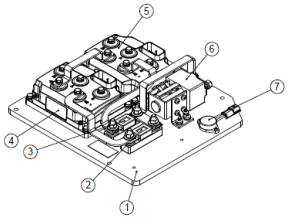
5 - Truck fault code;

4.2.4 Control system

A) Electronic control assembly of 0.8-1.2T front-drive three-wheel electric forklift (including traction motor controller and pump motor controller)



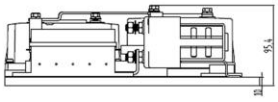




7	FMQ-2714	OPS buzzer	1	Finished product	
6	SW180B-140	Main contactor (24V)		Finished product	
5	F2-A-240-001	Traction controller	1	Finished product	
4	F2-A-24-280-001	Fuel pump controller	1	Finished product	
3	FUSE-200	Fuse 200A	1	Finished product	
2	FUSE-150	Fuse 150A	1	Finished product	
1	A2592-41201	Electronic control bottom plate	1	Finished product	
S/N	Code	Name	Qua-ntity	Material	Remarks

技术要求：
1、连接铜排表面应平整，不得有飞边，毛刺，以免扰人，铜排涂敷为5X3；
2、中间控制器安装前要清理散热面之表，涂抹适量导热硅脂，以增散热；
3、电源及用电接点等到接线柱上，中间电U、V、W、B+、B-螺子（M6）紧固力矩为10.2±1.1Nm，其余布件按GB/AC 41031-1995执行；
4、电源及线上连接示意位置上"B+"、"B-"标志；
5、在电源及线束与外部接上电池包有配合的标志，警示语和标志，易于查看；
6、OPS蜂鸣器插件只线红白色，设计为，B线处黑色，接负极。

Fig. 4-2 Electronic Control Assembly (CURTIS)



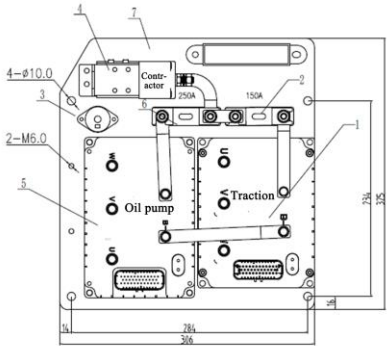
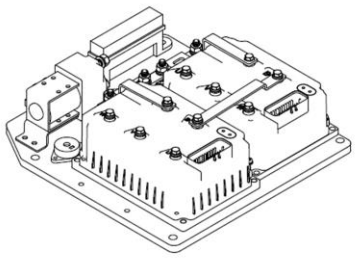




Table 1	
Comp-onents	Tightening Torque (Nm)
Contr-actor	13.4-14.6
Fuse	10-12
Contr-oller	13-15



Technical requirements

1. The electronic control device is connected with copper bars, the surface of which shall be flat without any flash or burrs, and shall be covered with black heat shrink tubing, with the connecting parts exposed only;
2. Before installing the controller on the large base plate, the bottom surface must be cleaned and coated with thermal conductive silicone grease to facilitate heat dissipation;
3. The wiring nut shall be tightened according to the standard torque without any looseness to ensure reliable connection and secured with a suitable clamp;
4. Please attach corresponding markings (U, V, W, B+, B-) in a reasonable and visible position on the diagram;
5. The low-voltage conductors used in vehicles shall meet the requirements of JB/T 8139-1999, and the monochrome wires are listed in the table below. [Double letters indicate bicolor wires.]
6. The software versioning of the controller shall be clearly identified to ensure clear, durable and easy to view.
7. The +B and - B terminal heads of the driver, as well as the terminal heads of the contactor and fuse, need to be covered with black rubber caps.

7	375-306	Electronic control bottom plate	1	Finished product	
6	250A	Fuel pump fuse	1	Finished product	
5	ACMIT 24C350	Fuel pump controller	1	Finished product	
4	SW200-5R3	Contractor	1	Finished product	
3	FMQ-24V	Buzzer	1	Finished product	
2	150A	Traction fuse	1	Finished product	
1	ACMIT 24C350	Traction controller	1	Finished product	
S/N	Code	Name	Qua-ntity	Material	Remarks

Fig. 4-3 Electronic Control Assembly (Zhengzhou Jiachen)

Model of traction controller: Curtis AC F2-A-280-001. Model of oil pump controller: Curtis AC F2-A-24-280-001. The specification of the traction controller is 24V/280A, and that of the oil pump controller is 24V/280A.

(1) F2-A controller is a three-phase AC asynchronous motor inverter, which controls traction motor and pump motor, and has regenerative braking function, CAN BUS interface and digital control of microprocessor (based on motor speed feedback).

(2) The allowable operating ambient temperature ranges from -40°C to +50°C, and the allowable operating controller module temperature ranges from -40°C to +95°C.

(3) Protection functions of F2-A motor controller:

a) Battery polarity protection;

b) Connection error protection;

c) Temperature overheating protection; overload and short circuit protection;

d) Protection grade of controller: IP65;

e) Out-of-control protection;

f) Battery over-discharge protection;

Accidental startup protection.

(4) The following functions can also be conveniently realized through the handheld unit (programmer) of the controller:

a) Online detection and online adjustment of the traction and lifting control system;

b) On-line correction of traveling accelerator and lifting speed regulation signals, with better matching;

c) Detailed failure detection and inquiry for the traction and lifting control system to facilitate system maintenance.

Model of Zhengzhou Jiachen traction controller: ACM11224C250. Model of oil pump controller: ACM1124C350. The specification of the traction controller is 24V/250A, and that of the oil pump controller is 24V/350A.

(1) ACM controller is a three-phase AC asynchronous motor inverter, which controls traction motor and pump motor, and has regenerative braking function, CAN

BUS interface and digital control of microprocessor (based on motor speed feedback).

(2) The allowable operating ambient temperature ranges from -40°C to +50°C, and the allowable operating controller module temperature ranges from -40°C to +95°C.

(3) Protection functions of ACM motor controller:

a) Battery polarity protection; b) Connection error protection;

c) Temperature overheating protection; overload and short circuit protection; d) Protection grade of controller: IP65;

e) Out-of-control protection; f) Battery over-discharge protection;

Accidental startup protection.

(4) The following functions can also be conveniently realized through the handheld unit (programmer) of the controller:

a) Online detection and online adjustment of the traction and lifting control system;

b) On-line correction of traveling accelerator and lifting speed regulation signals, with better matching;

c) Detailed failure detection and inquiry for the traction and lifting control system to facilitate system maintenance.

 Important precautions

A) After the controller is installed, the wheels of the truck shall be lifted (off the ground) for testing, so that there will be no danger even if there is connection error.

B) When the key switch is off, there is still a certain voltage left in the filter capacitor for a period of time. If the inverter needs to be repaired at this point, the battery packs must be disconnected first, and then a 10-100 ohm resistor must be connected to the positive and negative poles of the inverter to remove any residual electricity from the capacitor.

C) Do not connect the controller to any battery pack with a voltage different from

the nominal voltage shown on the nameplate, in order to prevent damage to the controller.

D) When the motor controller malfunctions, the manufacturer shall be notified immediately to provide after-sales service; please do not open it for repair without the authorization and permission of the manufacturer. Any personal and property losses caused by the user's unauthorized repair shall be borne by the user.

4.2.5 Motor

The motors used in the traction and steering systems are maintenance-free three-phase AC induction motors, with the following parameters:

	Traction motor	Oil pump motor
Power	3.0KW	4.5KW
Rated voltage	16.5V	16.5V
Rated current	142A	213A
Rated speed	1736rpm	1739rpm

Important precautions

During the inspection and maintenance of the motor, the power must be cut off to avoid accidents.

4.2.6 Battery

A) Construction and specifications of batteries

A battery mainly consists of a positive plate, a negative plate, a partition, a compartment cover, and electrolyte.

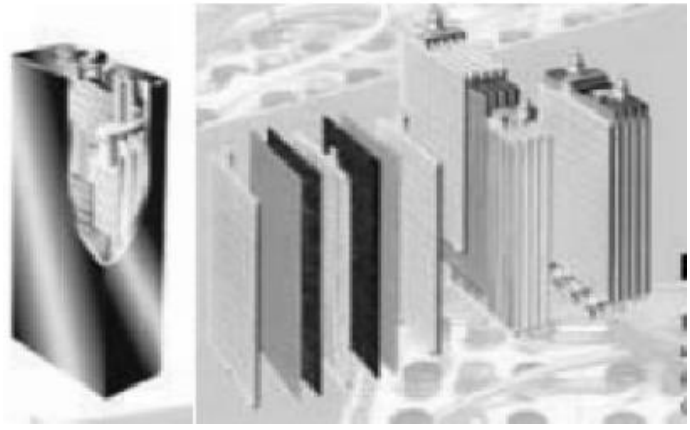


Fig. 4-4 Battery Structure

Selection of battery and lead-acid on-board charger

Battery, charger					
Voltage/Capacity	24V/240	24V/300	24V/360	24V/420	24V480
CPD08SQ	●	○	-	-	-
CPD10SQ	-	-	●	○	○
COD12SQ	-	-	-	●	○
Weight (kg)	193	230	264	301	333
On-board charger	E24V35A-13C22		E24V50A-13C22		
Note: ● Standard ○ Optional - Non-configurable					

Note: Imported brand battery packs may be configured as required by the user.

B) 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 the actual situation.

c) Maintenance and precautions of battery



The battery packs need to be carefully observed and regularly maintained, which is very important for your forklift in terms of economy and reliability. Some detailed guidance ensures trouble-free and economical operation.

(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 to avoid 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 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 pole 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.

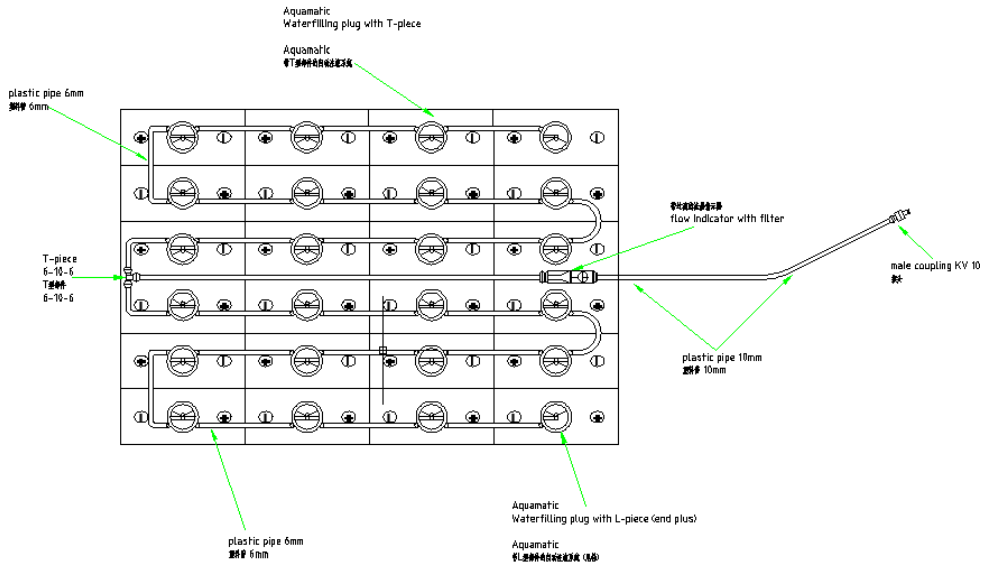
(10) For the battery pack without leakage hole, check whether there is accumulated liquid in the tank every month. If the electrolyte in the cell overflows into the tank due to improper replenishment of distilled water (deionized water) during daily maintenance, please clean the accumulated liquid in the tank with a suction pipe in time.

(11) Battery with automatic water replenishment

1) Schematic Diagram of Automatic Water Replenishment

Automatic water replenishment is carried out when the battery charging is about to end. The special water in the water storage barrel is pumped out through the automatic

liquid filling plug, and each battery cell is filled with water through the water filling pipe and the flow indicator with filtration.



2) Precautions for use

a. Automatic water replenishment shall be carried out when charging is about to end, and automatic water replenishment is strictly prohibited before charging;

b. The correct water pressure shall be ensured by the automatic water replenishment device;

c. The water storage device and water pipeline shall be kept clean and free of dirt;

d. Only specified battery water can be used for battery water replenishment;

e. It is strictly prohibited to flush the filling plug with tap water;

f. Observe the temperature to prevent the automatic water replenishing system from freezing.

D) 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.

🕮Precautions

(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.

🕮Important precautions

(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.

E) 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.

Common fault features, causes and maintenance methods of the battery are shown in the following table:

Fault	Characteristics	Cause	Remedial and Preventive Measures
Sulfuration of pole plate	① Low capacity ② The electrolyte density is lower than the normal value. ③ The battery terminal voltage is too high at the beginning and end of charging. ④ The electrolyte temperature rises too fast during charging. ⑤ Bubbles are formed prematurely when charging starts.	1. Insufficient initial charging. 2. Long-term undercharge. 3. Frequent overdischarge. 4. After discharging, failure to charge in time and out of service for a long time. 5. Electrolyte density is too high. 6. Electrolyte level is too low, causing the plate to be exposed. 7. Failure to perform equalizing charge in time. 8. Discharge current too high or too low. 9. Impure electrolyte. 10. Internal local short circuit or electric leakage.	1) In mild cases, equalizing charge shall be adopted. 2) In severe cases, "hydrotherapy" shall be adopted. 3) Do not overdischarge. 4) The electrolyte density shall not exceed the specified value. 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. ② No or very few bubbles exist at the end of charging. ③ During charging, the electrolyte temperature rises rapidly, and the density rises slowly or does not rise. ④ The open-circuit voltage of the battery is low, and the voltage drops to the final voltage too early during discharge. ⑤ Severe self-discharge.	1. Plate bending, and active substance expansion or falling off, resulting in damage to the partition and short circuit. 2. Excessive sediment, causing short circuit. 3. Conductive foreign matters falling into battery, causing short circuit.	1) Replace the partition. 2) Remove deposits and conductive materials. 3) Replace the pole plate.
Active substances on the pole plate are falling off.	① The battery capacity is reduced. ② The electrolyte is turbid. ③ There are too much sediments.	1. Electrolyte not up to standard. 2. Excessive charge and discharge or overcharge and overdischarge. 3. Electrolyte temperature of battery too high during charging. 4. Short circuit in external circuit during discharging.	Remove sediment in mild cases; and scrap in severe cases.

4.2.7 Lithium battery

Selection of lithium batteries and on-board chargers for various truck models

Lithium Batteries and Chargers										
Brand of lithium battery	Heding				EIKTO			Eneroc		
Voltage/Capacity	250	280	300	404	270	300	350	250	302	346
CPD08SQ	●	○	○	-	○	○	-	○	○	-
CPD10SQ	●	○	○	-	○	○	-	○	○	-
COD12SQ	○	●	○	○	○	○	○	○	○	○
Weight (kg)	115	121	125	142	120	120	120	100	105	120
Low temperature heating of lithium battery pack	●									

On-board charger	E24V50ALI-13C22
Note: ● Standard ○ Optional - Non-configurable	

The correct use and daily maintenance of the lithium battery makes a major difference to the performance and service life of the lithium battery. Therefore, the user must carry out operation and maintenance according to the scope specified by this Manual. In order to avoid unnecessary personal injury and property loss, please read this Manual before using the electric forklift, and carry out normal use and operation according to the procedures or methods specified in this Manual.

In case of any doubt or uncertainty, please contact the relevant technical department or after-sales service department of our Company.

1) Safety precautions for lithium battery

(1) Keep the battery away from dangerous articles or dangerous environment, such as conductive dust particles, corrosive chemicals, flammable and explosive articles, dangerous mechanical equipment, high-temperature environment, etc.;

(2) Unreasonable use of this series of products, such as external short circuit, overcharge and excessive ambient temperature, may lead to smoking. In case of smoking, please cut off the power supply in time, use yellow sand and dry powder fire extinguishers for treatment, and evacuate the crowd and call the police in time during the whole process;

(3) Unreasonable use of this series of products may cause the battery cell to bulge, or even cause the shell to break or crack. In this case, please stop using the battery immediately and contact the relevant technical department or after-sales service department of our company without delay to obtain the handling method;

(4) It is forbidden to disassemble, squeeze, puncture, put or bake the battery and battery box at high temperature, so as to prevent the battery from being subjected to excessive vibration, external impact, falling from high altitude, etc. This operation may cause personal injury or property loss;

(5) It is prohibited to directly short-circuit the positive and negative terminals of

the battery. Any metal or electrically conductive object other than the battery post compression bolts and conductive tape shall be kept from making contact with the positive and negative terminals of the battery, which may result in personal injury or property damage;

(6) It is forbidden to expose the battery or keep it in an environment above 55 °C for a long time. It is forbidden to try to heat the battery, which may cause personal injury or property loss;

(7) It is forbidden to charge the battery without installing a reasonable charging protection device (lithium-ion battery protection circuit board, battery management system, etc.) or using charging equipment not approved by the battery manufacturer (charger, DC power supply, etc.), which may cause personal injury or property loss;

(8) It is forbidden to disassemble and assemble the battery without permission by technicians designated by the manufacturer, as this operation may lead to personal injury or property loss;

(9) The battery shall not be immersed in water or other conductive liquids, which may cause personal injury or property loss;

(10) Before using this product, carefully read the product manual, and children and other untrained personnel are prohibited from using this series of products;

(11) It is forbidden to use this series of products in series or in parallel with other models or types of batteries, as this operation may cause personal injury or property loss;

(12) It is forbidden to connect the whole power supply system containing lithium-ion battery protection circuit board or battery management system in series or in parallel. This operation may lead to personal injury or property loss. If necessary, please contact the relevant technical department of the manufacturer for correct technical support.

2) Precautions for use of lithium battery:

(1) The charging temperature range is 0 ~ 40 °C. Charging under low temperature

below 0 ℃ will cause irreversible damage to the battery. In low-temperature environment below 0 °C, please charge immediately after the truck is used;

(2) The discharge temperature range is :-25~50℃. The discharge capacity at low temperature (-25~0°C) may be lower than that at normal temperature, which is normal. The battery can be used at an ambient temperature of 40~50°C. However, if the ambient temperature of the battery is too high, especially when the battery is in a high temperature environment for a long time, it will accelerate the aging of the internal materials of the battery and shorten the service life of the battery. Therefore, it is not recommended to use the battery at this temperature for a long time;

(3) It is strictly prohibited to store below -25°C or above 55°C and operate for a long time;

(4) If the lithium battery is not used for a long time, 40%~60% of its capacity shall be charged, and it shall be stored in a dry and cool environment, and recharged according to the battery instructions to avoid excessive storage time and irreversible capacity loss caused by low capacity of the battery due to self-discharge;

(5) The self-discharge of lithium battery is affected by ambient temperature and humidity. High temperature and humid environment will accelerate the self-discharge of the battery. It is recommended to store the battery in a dry environment at -10°C ~ 45°C;

(6) Non-professionals are prohibited to touch, move and disassemble the batteries and the corresponding HV cables, or other components with high-voltage warning labels;

(7) If the truck suffers a heavy impact while traveling, please park the truck in a safe place and check whether the battery pack is damaged;

(8) If the battery is found to be leaked (liquid or smoke) or damaged, please keep a safe distance and contact the manufacturer's after-sales service personnel;

(9) Do not contact the leaked electrolyte; in case of contact due to carelessness, wash immediately with water; in case of eye contact, wash with the boric acid solution

and seek medical advice immediately;

(10) When the truck or battery catches fire, quickly leave the truck to a safe distance, and use yellow sand and dry powder fire extinguishers for treatment. It is strictly prohibited to put out the fire with water or incorrect fire extinguishers;

(11) Please use the designated lithium battery charging equipment to charge the battery. It is strictly prohibited to use inferior or other types of charging equipment to charge the battery;

(12) During transportation, please ensure that the battery is disconnected from the truck and charging equipment, and there is no any form of charging and discharging behavior.

3) Precautions for lithium battery maintenance

(1) When the battery capacity is lower than 20%, recharge it in time, and over-discharge of the battery is strictly prohibited;

(2) The battery shall be charged immediately after use, and shall be fully charged, but overcharge is strictly prohibited;

(3) When the truck needs to be stored for a long time, 40%~60% of the power should be stored. Do not fully charge the truck. Please fully charge the battery before use;

(4) Please regularly check the lithium battery charging socket to ensure that the bracket is not loose, the socket cover plate is well sealed, and the internal terminals of the socket are not rusted and free of dust, rain and other foreign matters;

(5) The surface of the lithium battery shall be kept dry and clean. It is strictly prohibited to wash the lithium battery with water;

(6) The battery shall be fully charged and discharged at least once a month;

4.2.8 Charger

1) Model

S/N	Item	Remarks

1	E24V35A-13C22 On-board charger for batteries E24V50A-13C22 On-board charger for batteries E24V50ALI-13C22 On-board charger for lithium batteries	

2) Precautions for use of charger

(1) Please charge in a safe environment and keep away from dust, fire source, corrosion and other environments;

(2) The charger shall be equipped with necessary fire extinguishing devices (yellow sand and dry powder fire extinguishers) around, so as to carry out emergency fire extinguishing in extreme cases;

(3) Before charging, make sure that the charging plug and the charging socket are free of dust, water and other foreign matters. If there is any foreign matter, clean it before charging. Otherwise, the poor contact of the charging plug and the charging socket will lead to heating and even fire;

(4) Do not modify or remove the charging interface and charging equipment, which may result in failure to charge or fire;

(5) Besides, in order to avoid major personal injury, the following prevention awareness should be possessed when charging the car:

a) Do not touch the metal terminal in the charging port or charging plug;

b) When there is lightning, do not charge the truck or touch the truck. Lightning strike may cause damage to the charging equipment and personal injury.

(6) After charging, do not disconnect the charging equipment with wet hands or standing in water, because this may cause electric shock and personal injury;

(7) After charging, please close the protective cover of the charging port of the truck and the hatch to avoid foreign matters entering the charging port during the operation of the truck, because this may cause damage to the charging port;

(8) To avoid damage to the charging equipment, please pay attention to the following items:

a) Don't close the charging interface hatch when the charging interface cap is opened;

b) Do not roughly pull or twist the charging cable;

c) Don't let the charging equipment be subject to impact;

d) Don't store or use charging equipment in any environment above 55°C;

e) It is forbidden to directly plug or unplug the charging plug when the charging equipment still outputs the charging current, which may cause electric arc, property loss and personal injury;

f) Do not place the charging equipment near the heater or other heat sources.

3) Operation steps of the main power supply

a) Stop the forklift steadily, turn off the power, and open the truck hood;

b) Take out the charging plug, and properly connect it to the mains power socket;

c) Close the mains power socket input switch and automatically start charging;

d) After charging, disconnect the socket power, pull out the charging plug, rewind the power cord and put it back in its storage location;

e) Close the truck hood and the charging is complete;

4) Charging precautions

a) Ensure that the forklift power is turned off before charging;

b) Keep the surface of the charging interface clean and free of particles, dust, or other debris inside the interface;

c) In case of emergency, please immediately disconnect the mains power socket and input power;

5) Daily inspection

During power-on operation, visually check the operation of the charger to confirm that there are no abnormalities, usually in the following aspects:

a) The operating performance meets the standard process specifications;

b) The surrounding environment meets the standard specifications (see the service environment schedule);

c) Check the charger for any debris, water stains, or dust, and if any, wipe it clean with a dry cloth;

d) No abnormal noise, vibration, or odor;

e) Check whether the fan works normally;

f) No abnormalities such as overheating or discoloration;

g) Check if the input voltage is in the normal operating range;

h) Check if the connectors of each wire are tight.

j) Check if the insulation of any input or output cables is damaged or if any copper wires are exposed, and if any, immediately replace it with a new wiring harness.

6) Maintenance of regular inspection items

Clean the sediment at the fan outlet of the charger every 30 days (depending on the environmental conditions) to ensure that the air outlet window is unobstructed, maintain air flow, and facilitate overall heat dissipation.

Regularly check if the input and output terminals of the charger are properly plugged in, and only when they are properly plugged in can normal charging be ensured.

4.2.9 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 truck. 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.

4.3 Fault diagnosis

1) General

The traction control system, pump control system, and intelligent instrument system used in the whole truck are continuously monitoring microprocessor controllers, and a diagnostic program is executed for the main functions. This diagnostic program consists of four parts:

A) Diagnosis when the key switch is closed to check: if the operation sequence of the watchdog circuit, current sensor, capacitor charging, phase voltage, contactor drive, CAN Bus interface, and switches is correct; if the output of the accelerator is correct; if the two microprocessors are synchronized; and that all security-related hardware inputs are available.

B) Detection during standby: watchdog circuit, phase voltage, contactor drive, current sensor, and CAN Bus interface.

C) Detection during operation: watchdog circuit, contactor drive, current sensor, and CAN Bus interface.

D) Continuous detection: inverter temperature and motor temperature.

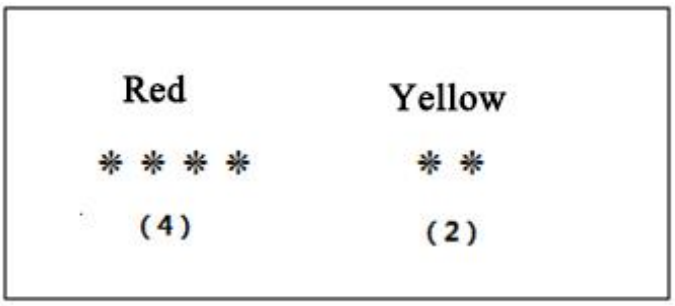
There are two ways of diagnosis: one is to use a digital handheld unit, which provides detailed fault information; the other is to transmit the fault code by CAN-Bus,

and the fault code and module node will be displayed on the intelligent instrument.

2) Fault diagnosis

A) Fault diagnosis of traction and pump control system (F2A controller)

The fault information of F2A controller can be obtained by: (1) using a handheld programmer, or (2) observing the flashing of the LED on the controller. The handheld programmer will display all fault information including current and historical information, and display the name of the fault. One of the LEDs on the controller will turn red or yellow. This displays all current fault information. The number of times the red light flashes represent the first digit of the fault code, and the yellow light flashes represent the second digit of the fault code.



For example, if the red light flashes 4 times and the yellow light flashes 2 times, the fault code is 42. For relevant fault codes and causes, please refer to the list of fault codes in this Manual. In addition, the LEDs on the controller display different controller status information.

LED Information and Display	
Display	Information
LED not working	The controller is not powered on, the battery is dead, or other major failure
Yellow light flashing	Normal operation
Yellow indicator normally ON	The program being downloaded
Red and yellow lights flashing alternately	Fault reported. Please refer to the list of faults
Red light stays on	The controller hardware is faulty, or no software is installed on the controller

B) List of fault codes for traction and pump control system (F2A controller)

Fault code	Fault name	Possible cause	Trigger and Clear Conditions
1-2	Controller Overcurrent Fault types: 1 = U-phase overcurrent; 2 = W-phase overcurrent; 3 = V-phase overcurrent; 4 = controller current > 135% current limit	1. Short circuit in the external connection of the U, V, and W phases of the motor; 2. Motor encoder signal disturbed; 3. Misadjustment of motor parameters; 4. Controller failure	Trigger: The phase current exceeds the upper limit of current detection. Clear: Reset the controller
1-3	Current Sensor Failed	Leakage of U, V, and W phases of the motor stator	Trigger: The current sensor has invalid offset readings. Clear: Reset the controller
		Controller is damaged	
1-4	Precharge Failed	The load connected to the controller B+ terminal suppresses the internal capacitor charging of the controller	Trigger: Controller capacitor charging failed. Clear: On-off interlock or reset controller
		Check the voltage of the pre-charging capacitor	
1-5	Controller Severe Undertemp	The controller temperature is lower than -40℃	Trigger: The radiator temperature is lower than -40°C. Clear: The radiator temperature is higher than -40°C, and then reset the controller
		Controller is damaged	
1-6	Controller Severe Overtemp	The controller temperature is higher than 95°C	Trigger: The radiator temperature is lower than +95°C. Clear: The radiator temperature is lower than +95°C, and then reset the controller
		Truck overload	
		Incorrect installation of controller, poor heat dissipation	
1-7	Sever Undervoltage	Wrong selection of controller voltage parameters	Trigger: Main contactor is closed; Upon the FET bridge circuit works: either due to the low voltage shutdown current output exceeding 64 ms, or reaching the low voltage shutdown voltage value of the controller. Clear: Controller current output > 0% exceeds 100 ms, or capacitor voltage >
		Excessive starting current	
		Excessive internal resistance of battery	
		Poor battery connection	
		The battery fuse is burnt out or the main contactor is not closed	

			low-voltage shutdown voltage value
1-8	Sever Overvoltage	Wrong setting of controller voltage parameters	Trigger: When the FET bridge circuit is working, the capacitor voltage exceeds the setting of severe high voltage. Clear: The capacitor voltage is lower than the setting of severe high voltage, and reset the controller
		The internal resistance of the battery is high, resulting in overvoltage during regenerative braking	
		No battery connection during regenerative braking	
1-8	Controller KSI Terminal Severe KSI Overvoltage Fault type: 1	1. The battery voltage to the controller KSI (pin 1) terminal exceeds the setting of severe high-voltage; 2. Check the voltage displayed by Programmer\System Monitor Menu\\Controller\Keyswitch Voltage	Trigger: KSI voltage exceeds the setting of severe high voltage. Clear: The capacitor voltage is lower than the setting of severe high voltage, and reset the controller
1-9	Speed Limit Supervision	It's detected that the motor speed exceeds the setting under Max Speed Supervision	Trigger: The motor speed exceeds the setting, and the duration also exceeds the setting. Clear: Reset the controller
		Wrong settings under Max Speed Supervision	
1-10	Travel Control Supervision	When the truck is stopped, it is detected that the output frequency and phase current of the controller exceed the parameter settings under Travel Control Supervision	Trigger: The motor frequency and phase current exceed the parameter settings under Travel Control Supervision in a stopped state Clear: Reset the controller
		Wrong setting of parameters under Travel Control Supervision	
2-2	Controller Overtemp Cutback	Controller operates in extreme environments	Trigger: The radiator temperature is lower than +85°C. Clear: The radiator temperature is lower than +85°C, and then reset the controller
		Truck overload	
		Poor installation and heat dissipation of controller	
2-3	Undervoltage Cutback	Batteries needs to be charged	Trigger: Upon the FET bridge circuit works, the capacitor voltage is lower than the limit UndervoltageCut back. Clear: The capacitor voltage is higher
		Wrong setting of controller voltage parameters	
		Excessive external load leads to a decrease in battery	

		voltage	than the limit UndervoltageCut back
		Excessive internal resistance of battery	
		No motor connection during motor driving	
		The main contactor is disconnected and the fuse is burnt out	
2-4	Overvoltage Cutback	Overhigh voltage during regenerative braking	Trigger: Upon the FET bridge circuit works, the capacitor voltage is higher than the limit OvervoltageCutb ack. Clear: The capacitor voltage is higher than the limit OvervoltageCutb ack
		Wrong setting of controller voltage parameters	
		Excessive internal resistance of battery	
		No battery connection during regenerative braking	
2-5	Ext 5V Supply Failure	5V external load is too low (pin 16)	Trigger: 1. 5V output exceeds 5V ± 10%; 2. 5V current is limited by parameter setting. Clear: Reset the controller or VCL
2-6	Ext 12V Supply Failure	12V external load is too low (pin 23)	Trigger: 1. 12V output exceeds 12V ± 15%; 2. 12V current is limited by parameter setting. Clear: Reset the controller or VCL
2-8	Motor Temp Hot Cutback	The motor temperature is higher than or equal to the setting under Temperature Hot, resulting in controller output current limiting	Trigger: The motor temperature is higher than or equal to the setting under Temperature Hot. Clear: Reduce the temperature to a normal value
		Wrong setting of motor temperature and sensor parameters	
2-9	Motor Temp Sensor Failed	Motor temperature sensor disconnected, short circuit	Trigger: The voltage value converted by motor temperature sensor input (pin 9) is out of range. Clear: Return the input voltage of the motor temperature sensor to the normal range
		Wrong setting of temperature sensor parameters	
		Wrong connection of sensor polarity (pin 9 and pin 12)	
3-1	Main Driver Failed	Driver load open-circuit or short-circuit	Trigger: When Main Enable = On, the drive of main contactor
		The connector pin or contactor	

		coil is dirty, resulting in poor connection	is open-circuited or short-circuited. Clear: reset the controller after repair
		Wrong crimping or wiring of connector	
3-2	EM Brake Driver Failed	Driver load open-circuit or short-circuit	Trigger: When EM Brake Type > 0, the drive of electromagnetic brake (pin 4) is open-circuited or short-circuited. Clear: reset the controller after repair
		The connector pin or contactor coil is dirty, resulting in poor connection	
		Wrong crimping or wiring of connector	
3-5	Lower Fault	Equivalent Driver 1* Fault	
3-6	Encoder Fault	Motor encoder fault	Trigger: The motor encoder signal detection fails. Clear: Reset the controller, or if the parameter LOS Upon Encoder Fault = On, reset the interlock switch to clear the fault and enter the LOS fault mode (9-3 fault)
		Wrong wiring	
3-7	Motor Open	Open circuit of motor phase	Trigger: Open circuit of U, V and W phases of the motor is detected. Clear: Switch KSI
		Loose wiring	
3-8	Main Contactor Welded	Main contactor contact adhesion, normally open	Trigger: When the main contactor is released after being closed, the capacitor voltage does not drop. Clear: Reset the controller
		Open circuit in the V or U phase of the motor	
		There is an external voltage directly connected to the controller B+ terminal	
3-9	Main Contactor Did Not Close	Main contactor not closed	Trigger: When the main contactor is controlled to close, the capacitor voltage does not charge up to the battery voltage. Clear: reset the controller
		Oxidation of contactor contacts	
		The controller B+ terminal is externally connected to a large load, resulting in ineffective charging of the capacitor	
		Fuse burned	
		Wrong setting of main contactor parameters	
4-2	Throttle Input	The accelerator input voltage exceeds the setting range of Analog Low and Analog High,	Trigger: The accelerator input voltage exceeds the setting range of Analog Low and

		and the corresponding analog input is defined as an accelerator input	Analog High. Clear: Return the accelerator input voltage to the normal range, and reset the controller
4-6	NV Memory Failure	Memory data read/write failure	Trigger: The controller fails to read and write EEPROM data. Clear: Download correct software and corresponding parameter settings, and reset the controller
		Controller internal fault	
4-7	HPD Sequencing	Wrong sequence of key switch, interlock, direction switch, and accelerator input operation	Trigger: The emergency reverse operation has been completed, but the accelerator input, direction switch and interlock have not returned to their original position. Clear: If EMR Interlock is set to ON, the accelerator, direction switch, and interlock inputs need to be cleared; or if EMR Interlock is set to OFF, the accelerator and direction switch inputs need to be cleared
		Wrong wiring or crimping at key switch, interlock, direction switch, and accelerator input terminals	
		Key switch, interlock, direction switch and accelerator input are affected with moisture	
4-9	Parameter Change Fault	Upon the interlock is closed, modify parameters related to safety, i.e. parameters marked with PCF	Trigger: Adjust the parameters that require the switch KSI. Clear: Reset the controller
4-10	EMR Switch Redundancy	One or both of the two emergency reverse switches do not work, resulting in an invalid state	Trigger: The emergency reverse switches are not synchronized when it is normally on and normally off. Clear: Correct the ON-OFF state, and reset the controller
6-8	VCL Run Time Error	Operation troubles of VCL program	Trigger: VCL runtime error detected. Clear: Modify VCL, and reset the controller
7-2	CAN communication timeout	The time for two adjacent PDOs to receive information exceeds the set PDO timeout time	Trigger: The time for two adjacent PDOs to receive information exceeds the set PDO timeout. Clear: Receive CAN NMT information, or reset the controller
7-3	Stall Detected	Motor stalling	Trigger: No change in motor

		Speed sensor fault Wrong crimping or wiring Abnormal power supply of motor encoder	encoder signal detected. Clear: Reset the controller, or if the parameter LOS Upon Encoder Fault = On, reset the interlock switch to clear the fault and enter the LOS fault mode (9-3 fault) to allow limiting motor output
7-7	Supervision fault	Controller internal fault	Trigger: Internal failure in the controller Clear: Reset the controller
7-9	Input check monitoring fault	Controller internal fault	Trigger: The controller is damaged. Clear: Reset the controller
8-2	PDO Mapping Error	Too many data bits are allocated during PDO mapping, or the target is incompatible	Trigger: Incorrect PDO mapping detected. Clear: Reset the controller
8-3	Internal Hardware Failed	Detected internal failure in the controller	Trigger: Internal fault detected in the controller. Clear: Reset the controller
8-7	Motor Characterization Error	Motor matching failed in matching motor	Trigger: Motor matching failed in matching motor. Clear: Reset the controller
8-8	Encoder pulse signal error	The encoder step settings are different from the actual steps	Trigger: Wrong encoder step setting detected. Clear: Confirm that the encoder step settings are consistent with the actual steps, and reset the controller
8-9	Parameter Out of Range	Parameter values out of range detected	Trigger: Parameter values out of range detected. Clear: Rewrite parameters to normal range
9-1	Firmware Failed	CRC or OS mismatch Incompatible OS used	Trigger: The downloaded software does not match the controller hardware. Clear: Download the software that matches
9-2	EM Brake Failed	The truck is still moving when the electromagnetic brake is locked	Trigger: After electromagnetic brake is set and delayed, truck operation is detected. Clear: 1. Activate accelerator (EM Brake Type = 2); and 2. Activate interlock (EM Brake Type = 1)

9-3	Encoder LOS	Encoder fault 3-6 or 7-3, entering LOS mode	Trigger: Encoder faults 3-6 or 7-3, if parameter LOS Upon Encoder Fault = On, after resetting the interlock switch, enter LOS fault mode (fault 9-3), allowing for limiting the motor output. Clear: Switch KSI, or if LOS has been triggered, clear after confirming the encoder is normal, Motor RPM=0, Throttle Command=0
		Motor encoder failure	
		Wrong crimping or wiring	
		Truck stalled	
9-4	Emer Rev Timeout	Emergency reverse trigger and end, as the emergency reverse time has expired	Trigger: Trigger emergency reverse and run at full expiration. Clear: Turn off emergency reverse input
		Emergency reverse input stuck	
99	Parameter Mismatch	Incorrect motor feedback selection for different motor technology applications	Trigger: 1. The dual-drive function is enabled in torque mode; 2. Encoder is selected for SPMSM motor feedback; 3. Sine-cosine is selected for AC induction motor feedback. Clear: Adjust the parameters to appropriate values, and reset the controller
		Dual drive function enabled in torque mode	
		Dual drive function is enabled for application of single controller	
9-10	Interlock Braking Supervision	The motor speed exceeds the set parameter during interlock braking	Trigger: During interlock braking, the motor speed exceeds the parameter set under Interlock Braking Supervision. Clear: Reset the controller
9-11	Emergency reverse fault was detected	The motor speed exceeds the set parameter during emergency reverse	Trigger: During emergency reverse, the motor speed exceeds the parameter set under Emergency Reverse Supervision. Clear: Reset the controller
10-1	Driver 1 Fault	Driver load open circuit or short circuit	Trigger: Driver 1 is open-circuited or short-circuited, or the drive overcurrent exceeds the parameter set under Driver 1 Overcurrent. Clear: Reset the controller after repairing the short circuit or open circuit
		The connector pin or contactor coil is dirty	
		Wrong crimping or wiring of connector	
		Drive overcurrent, exceeding the set parameter	

10-2	Driver 2 Fault	Driver load open circuit or short circuit The connector pin or contactor coil is dirty Wrong crimping or wiring of connector Drive overcurrent, exceeding the set parameter	Trigger: Driver 2 is open-circuited or short-circuited, or the drive overcurrent exceeds the parameter set under Driver 2 Overcurrent. Clear: Reset the controller after repairing the short circuit or open circuit
10-3	Driver 3 Fault	Driver load open circuit or short circuit The connector pin or contactor coil is dirty Wrong crimping or wiring of connector Drive overcurrent, exceeding the set parameter	Trigger: open-circuited or short-circuited, or the drive overcurrent exceeds the setting parameter value set under Driver 3 Overcurrent Clear: Reset the controller after repairing the short circuit or open circuit
10-4	Driver 4 Fault	Driver load open circuit or short circuit The connector pin or contactor coil is dirty Wrong crimping or wiring of connector Drive overcurrent, exceeding the set parameter	Trigger: Driver 4 is open-circuited or short-circuited, or the drive overcurrent exceeds the parameter set under Driver 4 Overcurrent. Clear: Reset the controller after repairing the short circuit or open circuit
10-5	Driver 5 Fault	Driver load open circuit or short circuit The connector pin or contactor coil is dirty Wrong crimping or wiring of connector Drive overcurrent, exceeding the set parameter	Trigger: Driver 5 is open-circuited or short-circuited, or the drive overcurrent exceeds the parameter set under Driver 5 Overcurrent. Clear: Reset the controller after repairing the short circuit or open circuit
10-8	Driver Assignment Fault	One drive is used for 2 or more functions	Trigger: Driver allocation conflicts Clear: Reset the controller after resolving driver allocation conflicts
11-1	Analog 1 Out of Range	Input voltage of analog 1 is higher than the set value Input voltage of analog 1 is lower than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range,

			and reset the controller
11-2	Analog 2 Out of Range	Input voltage of analog 2 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
		Input voltage of analog 2 is lower than the set value	
11-3	Analog 3 Out of Range	Input voltage of analog 3 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
		Input voltage of analog 3 is lower than the set value	
11-4	Analog 4 Out of Range	Input voltage of analog 4 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
		Input voltage of analog 4 is lower than the set value	
11-5	Analog 5 Out of Range	Input voltage of analog 5 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
		Input voltage of analog 5 is lower than the set value	
11-6	Analog 6 Out of Range	Input voltage of analog 6 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
		Input voltage of analog 6 is lower than the set value	
11-7	Analog 7 Out of Range	Input voltage of analog 7 is higher than the set value	Trigger: 1. The input voltage is higher than the threshold of

		Input voltage of analog 7 is lower than the set value	parameter setting; 2. The input voltage is lower than the threshold of parameter setting. Clear: Return the input voltage to the parameter setting range, and reset the controller
11-8	Analog 8 Out of Range	Input voltage of analog 8 is higher than the set value Input voltage of analog 8 is lower than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
11-11	Analog 18 Out of Range	Input voltage of analog 14 is higher than the set value Input voltage of analog 14 is lower than the set value	Trigger: 1. The input voltage is higher than the threshold of parameter setting; 2. The input voltage is lower than the threshold of parameter setting; Clear: Return the input voltage to the parameter setting range, and reset the controller
11-12	Analog Assignment Fault Type: 9 Analog serial number caused this fault	1. One analog used for two or more functions; 2. One analog input out of range; 3. View Programmer / Controller Setup / IO Assignments / Controls	Trigger: One analog is used for two or more functions or input out of range. Clear: Reset the controller after resolving drive allocation conflicts
12-1	Branding Error	There is a brand mismatch between software and hardware Contact local Curtis Technical Support to handle the fault	Trigger: The software and hardware are incompatible. Clear: As available, branded software shall be loaded, or branded controllers shall be used and the correct files and CIT tools shall be configured
12-3	Hardware Compatibility Error	OS incompatible with controller, downloaded software incompatible with controller hardware	Trigger: Incorrect OS Clear: Download a matching OS
12-5	Lift Input Fault	Any fault diagnosis associated with the lifting input source will trigger the fault. For example, if the lifting input	Trigger: Any fault diagnosis associated with the lifting input source will trigger this fault Clear: Resolve any allocation

		source is an analog input, all faults related to that analog input will be collected to that fault and reported	conflicts or input out of range, then reset the controller
12-6	Lower Input Fault	Any fault diagnosis associated with the descending input source will trigger the fault. For example, if the descending input source is an analog input, all faults related to that analog input will be collected to that fault and reported	Trigger: Any fault diagnosis associated with the descending input source will trigger this fault. Clear: Resolve any allocation conflicts or input out of range, then reset the controller

C) List of fault codes for overcharged lithium batteries and vehicle chargers

Fault information is displayed through the vehicle's instrument panel

Lithium battery fails		
Lithium battery fault address	Fault message	Meaning of fault
2F5	02	Total voltage overcharge protection stop
	03	Over-temperature protection stop
	04	Interlocking protection stop
	05	Low-temperature charging protection stop
	06	Excessively low voltage of battery stop charging
	07	Charging stops due to excessive charging current
	08	Loss of communication with charging
		Master and slave modules are lost.
		Abnormal collection of monomer voltage or monomer temperature
		Charging relay fault
	09	Charging stops due to over-temperature of charging base
	0A	Abnormal CC2 battery
	0B	Charging stop due to excessive cell pressure difference
	0C	Charging stop due to excessive cell temperature difference
	0D	Charging seat temperature fault

Vehicle charger fails		
Vehicle charger fault address	Fault Code	Meaning of fault
2F6	01	Charger hardware fail
	02	Charger over-temperature protection
	04	Error in input voltage setting
	08	No battery voltage
	0F	Communication timeout

4.4 Regular maintenance

Check the wear and contact status of the contactor contacts. The contacts shall be inspected every three months.

Check the pedal and thumb switch. Select a suitable measuring instrument (multimeter) to measure the voltage drop at both ends, and ensure that there is no resistance between the two contacts of the switch. A clear sound shall be heard when the switch acts. Micro switches shall be checked every three months.

Check the battery cables, chopper cables, and motor cables. Make sure that they are insulated from each other and securely connected. The master cable shall be checked every three months.

Check the mechanical operation of the pedal and thumb switch. Check if the spring returns normally; and if the potentiometer can be rotated to its maximum value or the programming value of the potentiometer. Check once every three months.

Check the mechanical operation of the contactor. Check if the contact moves normally without friction or jamming. Check once every three months.

The inspection shall be carried out by qualified personnel, and any parts that need to be replaced shall be original. Do not use non-original parts. The controller must be installed according to the diagram of instructions in this Manual. Any changes or special requirements need to be consulted with a joint agent before implementation. The supplier is not responsible for any faults caused by any discrepancies between the wiring and the instructions.

During the regular inspection, if technicians find any factors that may cause

danger or potential safety hazards, they should promptly contact the agent of HELI and explain the situation. The agent will provide solutions for the safety of machine operation.

5. Hydraulic System

5.1 Overview

The hydraulic system consists of oil pump, multi-way 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 serve as the main parts of the gear oil pump used in the forklift. The working principle is shown in Fig. 5-1.

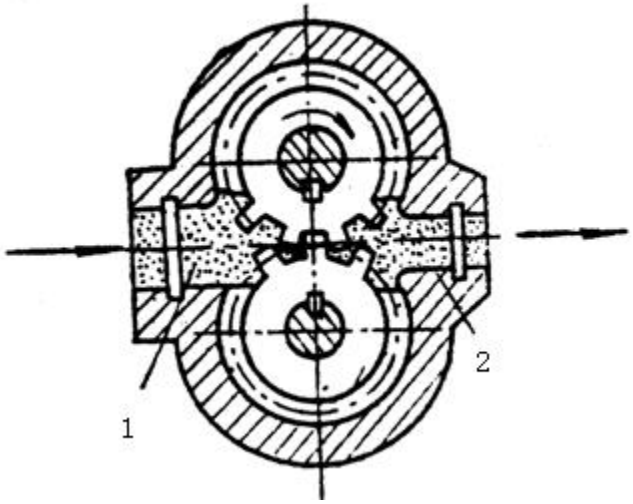


Fig. 5-1 Working Principle of Gear Pump
(1) Oil suction chamber (2) Oil pressing chamber

A pair of meshing involute gears are 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.

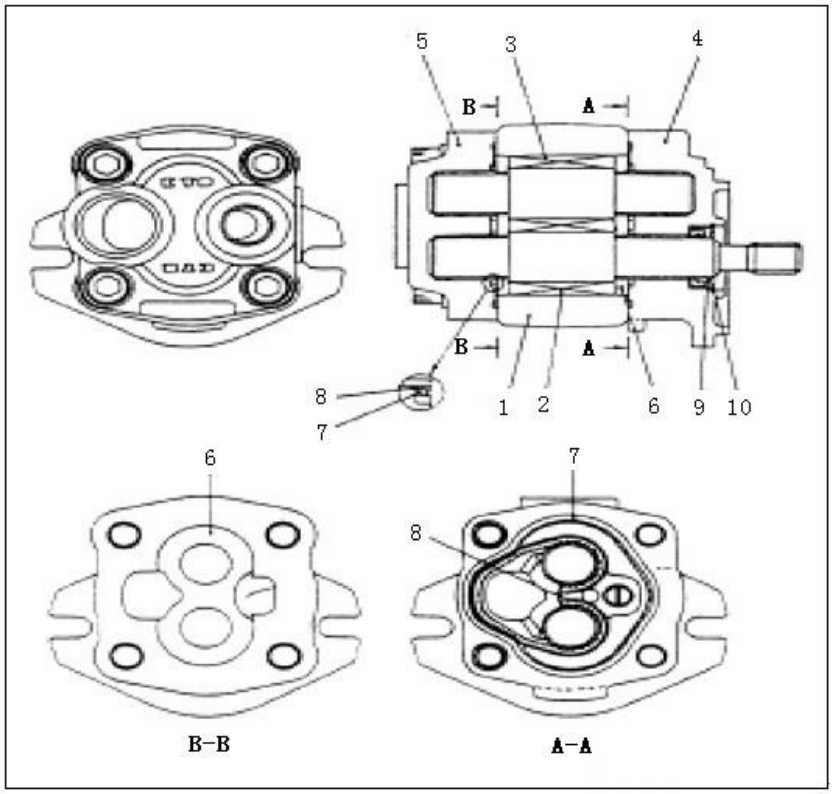


Fig. 5-2 Outline Drawing of Gear Pump Structure
(1) Pump body (2) Drive gear (3) Driven gear (4) Front end cover (5) Rear end cover (6) Lining plate (7) Seal ring (8) Retainer ring (9) Oil seal (10) Elastic retainer ring

5.1.2 Multi-way valve

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

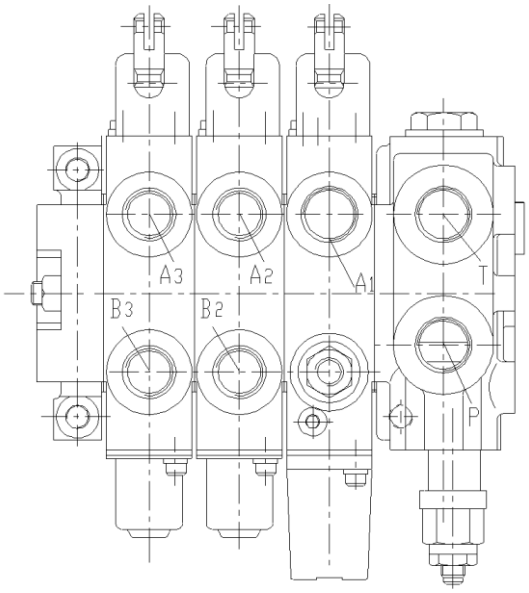


Fig. 5-3 Outline Drawing of Multi-way Valve

The multi-way valve is of piece 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 lifting cylinder or the tilt cylinder. Safety valve and self-locking valve are installed inside the multi-way valve. The safety valve is arranged on below 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 by operating rod, all of which are installed on a connecting shaft which is fixed on the counterweight through the support, and the operating rod operates the multi-way valve through the connecting rod. As shown in Fig. 5-4.

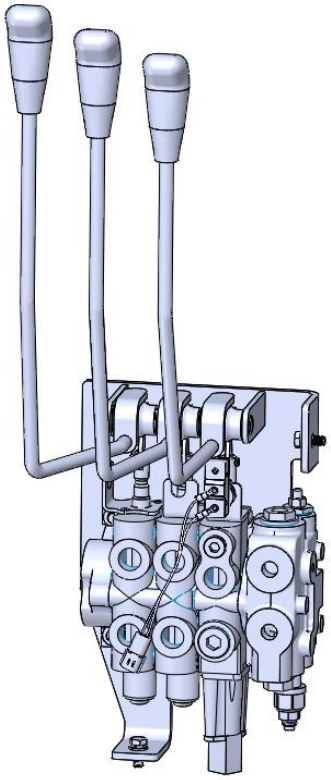


Fig. 5-4 Control Device of Multi-way Valve

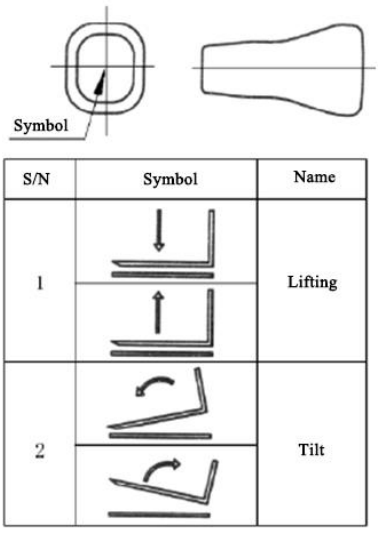


Fig. 5-5 Multi-way Valve Control Handle Identification

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 relief 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.

d) Tighten the nut after adjustment.

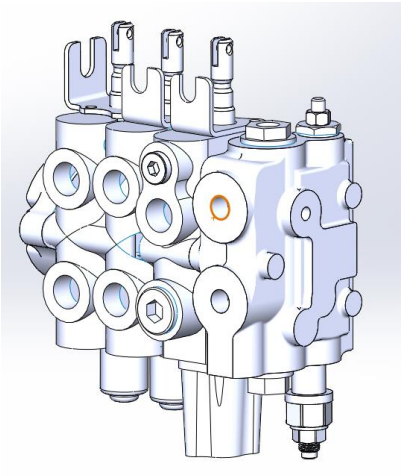
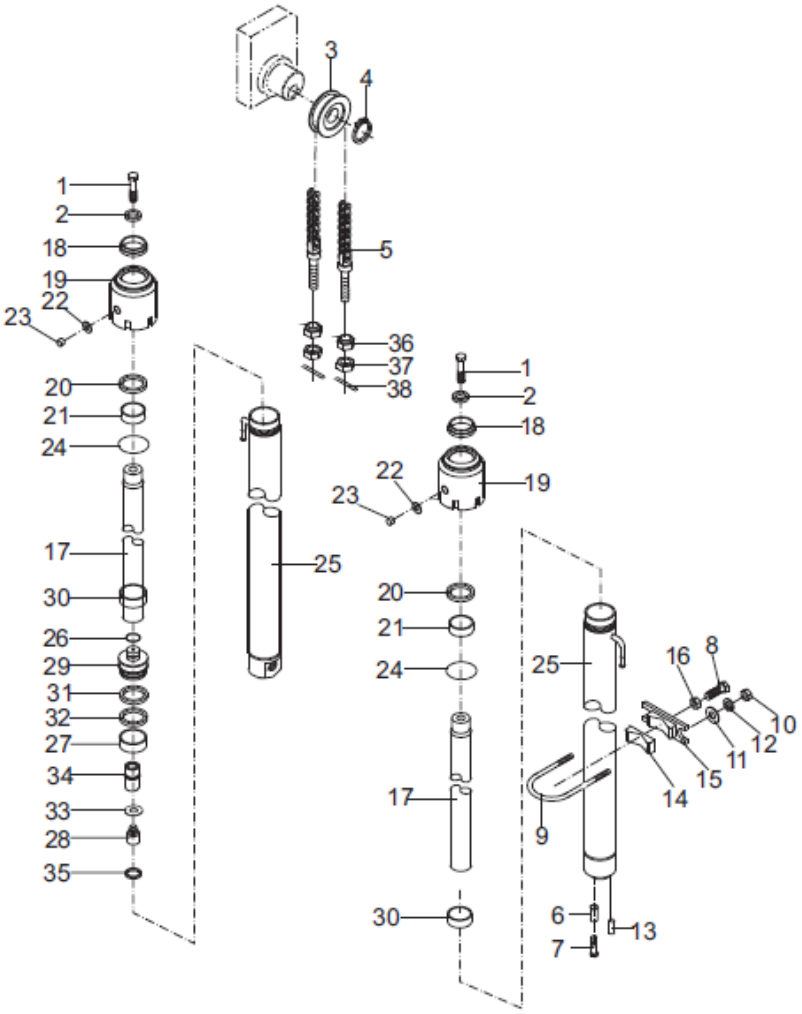


Fig. 5-6

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.



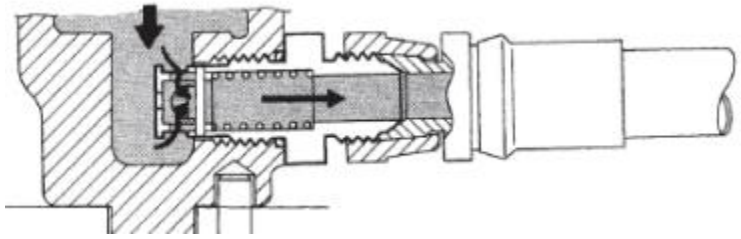
1. Bolt M16×1.5×40 2. Washer 16 3. Sprocket 4. Retainer ring 40
5. Chain assembly 6. Spacer bush 7. Bolt M12×1.25×25 8. Bolt M12×1.25×50
9. U-shaped bolt 10. Nut M10×1.25 11. Washer 10 12. Washer 10 13. Pin B10×26
14. Adjusting block 15. Cylinder support block 16. Nut M12×1.25 17. Piston rod 18. Dustband 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-shaped seal ring d49.7×2.4 25. Cylinder block 26. Steel wire retainer ring 27. Supporting ring 50×10×2.5 28. Valve assembly
29. Piston 30. Adjusting sleeve φ48×40.5 31. Baffle 50×40×3 32. Seal ring for hole 50×40×6
33. Gasket 34. Sleeve 35. Steel wire retainer ring for hole 36. Spherical nut 37. Nut M14×1.5 38. Pin 3.2×30

Fig. 5-7 Lifting Cylinder

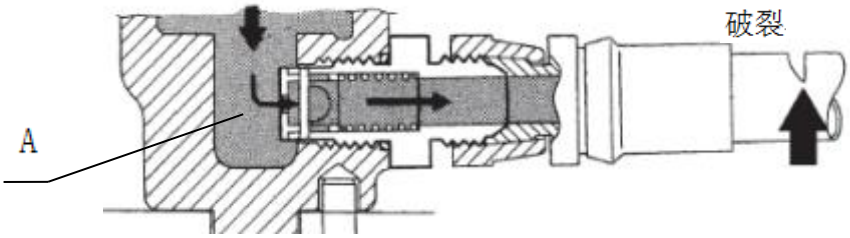
5.1.4 Cut-off valve

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 A on 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.

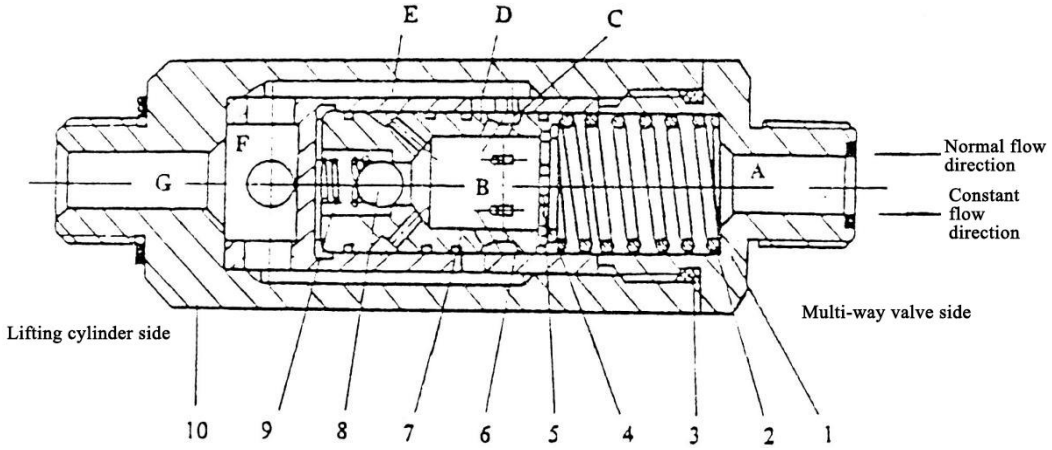


Fig. 5-9 Speed Limit Valve

(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 seal rings. The inner hole of the guide sleeve is equipped with a shaft sleeve and a Yx seal ring, a stopper and a dust ring. The shaft sleeve supports the piston rod. The seal 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.

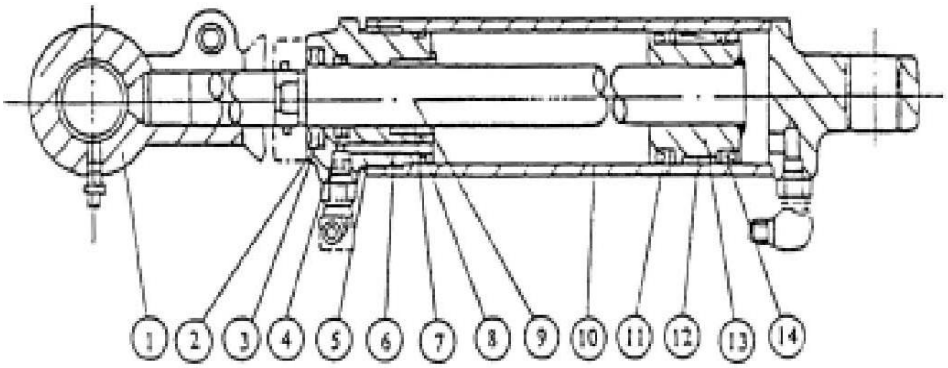


Fig. 5-10 Tilt Cylinder
(1) Lug (2) Dust ring (3) Baffle ring (4) Yx seal ring (5) O-ring
(6) Guide sleeve (7) Bearing (8) O-ring (9) Piston rod (10) Cylinder block
(11) Yx seal ring (12) Support ring (13) Piston (14) Yx seal ring

5.1.7 Hydraulic oil tank

The hydraulic oil tank is equipped with an oil 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.

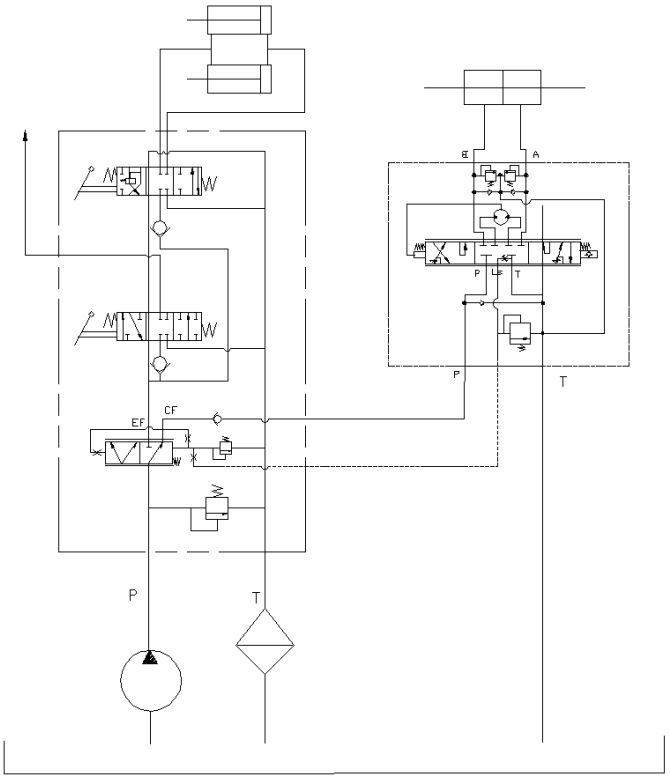


Fig. 5-11 Schematic Diagram of Hydraulic System

(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) Lifting cylinder (11) Tilt cylinder (12) Attachment cylinder (13) Oil return filter

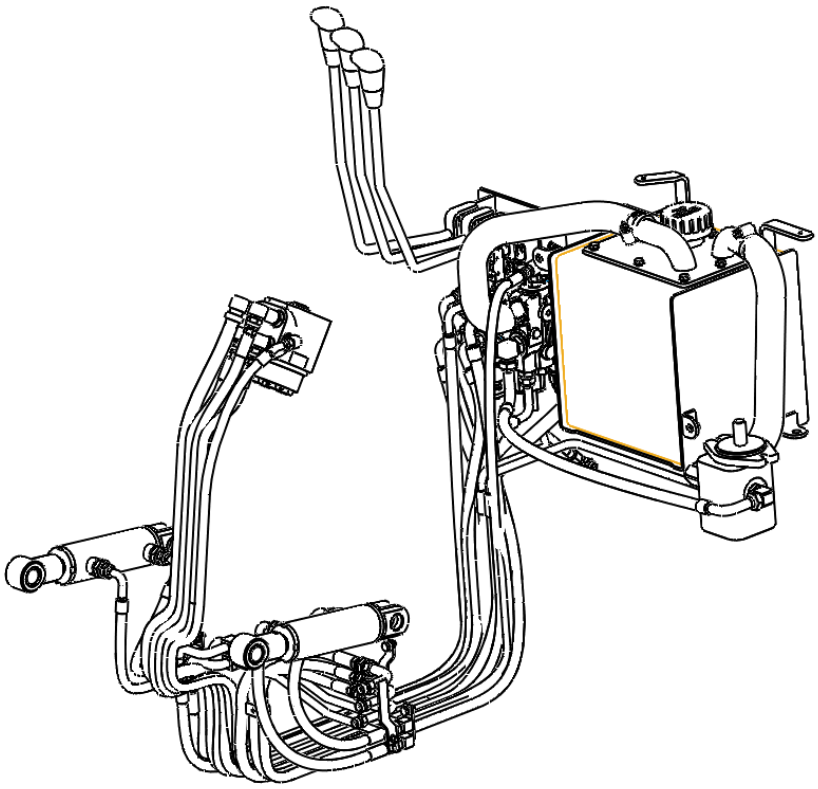


Fig. 5-12 Hydraulic Pipeline

5.2 Maintenance, fault analysis and troubleshooting

5.2.1 Maintenance and Upkeep

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 1200 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 1200-1,500 hours of operation. Oils of various grades shall not be mixed.

5.2.2 Fault analysis and troubleshooting

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

	3) The seal ring in the pump cover groove is damaged. 4) The end face of the bearing sleeve is worn. 5) The oil pump gear is worn. 6) Incorrect rotating direction of oil pump.	Replace. Replace the oil pump. Correct.
Large self-tilting amount of tilt cylinder	1) Internal leakage of multi-way reversing valve. 2) The O-ring of the tilt cylinder piston rod is damaged with internal leakage. 3) The YX seal ring and O-ring in the guide sleeve are damaged with oil leakage.	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. Replace. Replace.
Hard steering	1) The oil supply of the oil pump is insufficient, and it feels light during slow steering and heavy during fast steering. 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. 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. 4) If the relief valve pressure is lower than the working pressure or the relief valve is stuck by dirt, it feels light when steering with light or no load, and heavy when load is increased. 5) Excessively high oil viscosity.	Select an appropriate oil pump or check whether the oil pump is normal Remove the air from system, and check the suction pipeline Check whether the steel ball exists and whether it is stuck by dirt Adjust the relief valve pressure or clean the relief valve Use the oil of recommended viscosity

6. Lifting System

The forklift lifting system is equipped with a two-stage basic rolling telescopic mast as standard, and a three-stage fully free rolling telescopic mast is optional.

6.1 Three-stage fully-free rolling telescopic mast

6.1.1 Inner mast, middle mast, and outer mast

The three-stage fully-free rolling telescopic mast is composed of an inner mast, a middle mast, an outer mast, and a fork arm carrier. The "I" shaped inner mast, the "I" shaped middle mast, and the "I" shaped outer mast (see Fig. 6-1) are of inclined structures. The tilt cylinder support of the crossbeam in the outer mast is connected to the truck support through a tilt cylinder and fixed with a pin shaft. The two supports at the lower end of the outer mast are connected to the front drive axle support and fixed with a pin shaft. The three-stage mast is a rolling telescopic type, which bears longitudinal and transverse loads through composite rollers and makes the inner mast and middle mast move up and down smoothly.

Section of channel steel for inner, middle and outer masts:

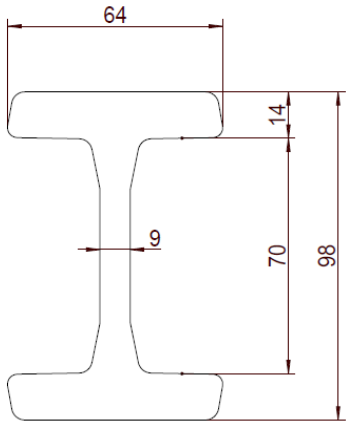


Fig. 6-1 Section Type of Mast

The inner, middle and outer masts are all welded parts, with the outer and middle ones arranged in a front staggered manner, and the middle and inner ones arranged in a front staggered manner. The upper end of the outer mast is equipped with composite rollers, the upper and lower ends of the middle mast are equipped with composite

rollers, and the lower end of the inner mast is equipped with composite rollers. All three types of mast are designed to withstand both radial and lateral forces by adjusting the gap between the composite rollers.

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

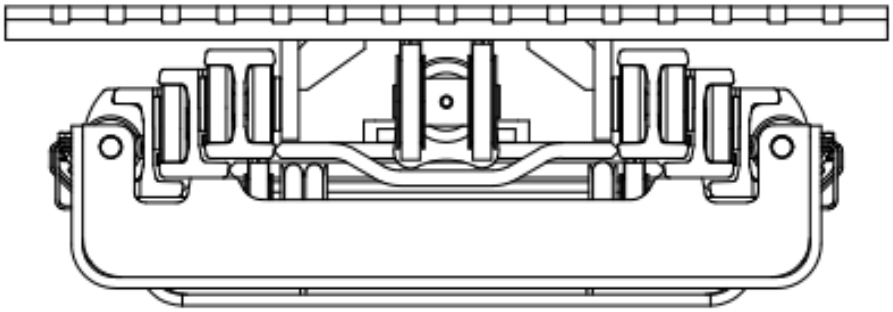


Fig. 6-2 Overall Layout of Channel Steel for Three-stage Mast

6.1.2 Fork arm carrier (for three-stage mast)

The fork arm carrier is mainly a welded structure composed of column plates, upper and lower crossbeams, reinforcement plates, ribbed slabs, side plates, composite roller shafts, chaining plates, limit blocks, and other parts, equipped with two sets of composite rollers, which move smoothly up and down in the inner mast channel rail groove and bear longitudinal and transverse loads. The gap between the side rollers and the channel steel web can be adjusted by adjusting screws, and the longitudinal and transverse loads are borne by two sets of composite rollers.

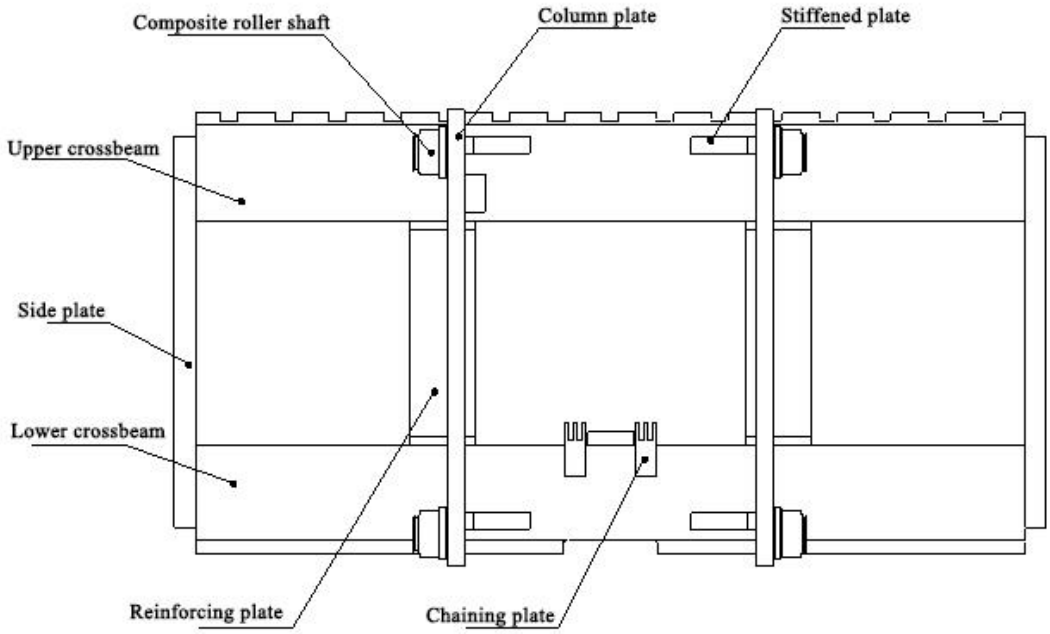


Fig. 6-3 Structural Diagram of Fork Arm Carrier (for three-stage mast)

6.1.3 Installation and adjustment of rollers

A composite roller is mainly composed of main roller set 1, bracket component 2, shaft retaining ring 3, dust-proof gasket 4, shaft head 5, adjusting screw 6, locking plate 7, positioning pin 8, and other parts.

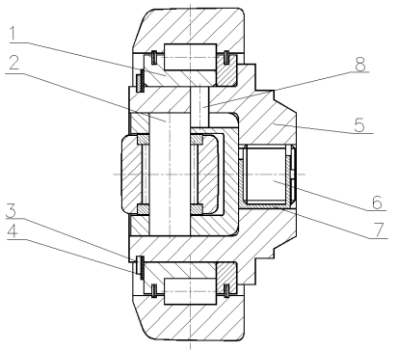


Fig. 6-4 Structure of Composite Rollers

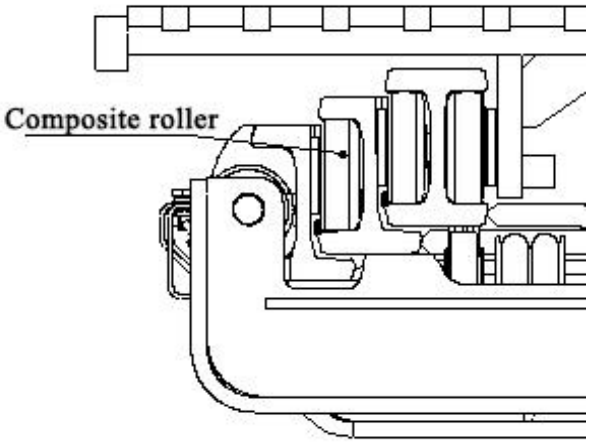


Fig. 6-5 Installation Diagram of Composite Rollers

Note: (a) Adjust the side roller gap to 0.5 mm with an adjusting screw;

(b) Apply grease on the surface of the roller and the contact surface of the mast;

(c) After adjusting the gap between side rollers, the locking plate shall be bent and pressed into the rear groove of the adjusting screw;

(d) There are notches on the side of the bracket components, which must be installed in the same position as the positioning pins.

6.1.4 Synchronous adjustment of (rear) lifting cylinder

When the rear lifting cylinder, inner mast, middle mast, and outer mast are removed and replaced, the synchronization of the lifting cylinder needs to be readjusted. The adjustment method is as follows:

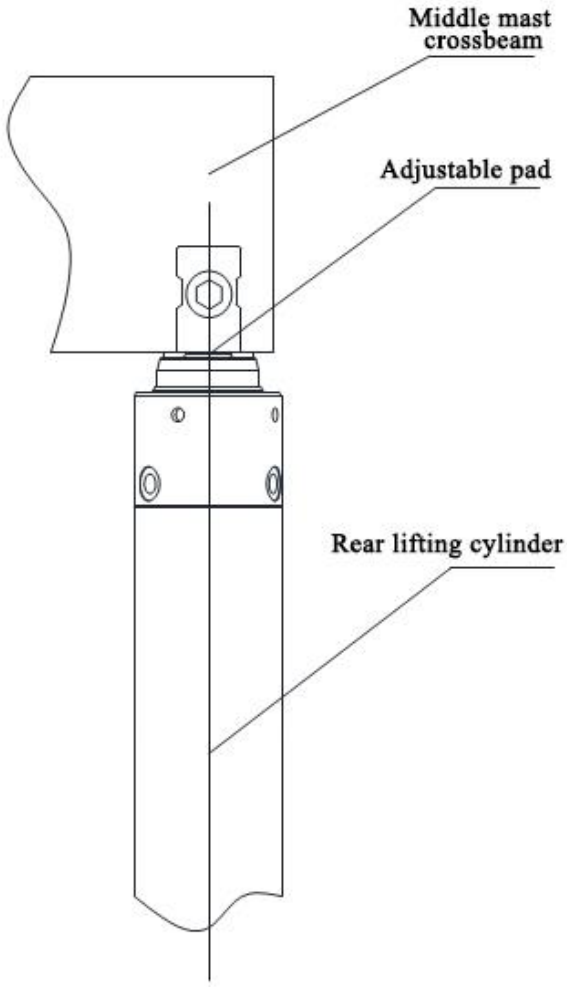


Fig. 6-6 Installation of Rear Lifting Cylinder

(1) Install the plunger rod head with an adjusting pad into the middle mast beam.

(2) Slowly lift the mast to the maximum stroke of the cylinder and check whether the two cylinders are synchronous. Movement stopping asynchronously indicates that the left and right cylinders have different strokes. In this case, an adjustable pad shall be added between the lower end of the plunger rod head and the middle mast crossbeam to ensure synchronization. The thickness of the adjustable pad shall be 0.5 mm and 1 mm.

6.1.5 Tension adjustment of chains

1. Place the fork arm carrier vertically, so that the forks come into contact with the ground, and adjust the adjusting nut at the upper end joint of the front cylinder lifting chain to ensure that the distance between the center of the lower roller of the fork arm carrier (inside the inner mast) and the lower edge of the inner mast is 15-20 mm;

2. Lower the forks to the ground and tilt backward in place, adjust the upper end

joint of the chain, and adjust the nut to make the tension of the two chains the same.

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

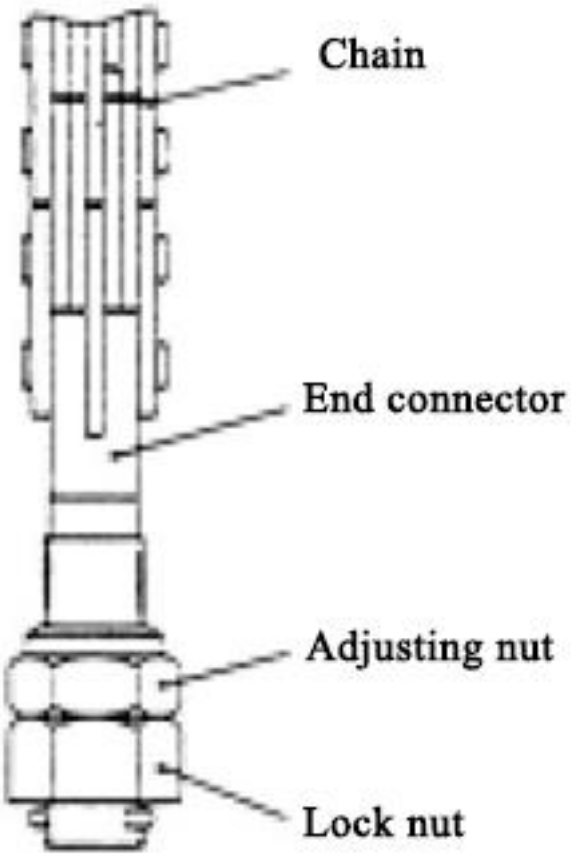


Fig. 6-7 Installation Diagram of Chains

6.2 Basic rolling telescopic mast

6.2.1 Inner and outer masts

The basic rolling telescopic mast is composed of an inner mast, an outer mast, and a fork arm carrier. The "I" shaped inner mast, and the "I" shaped outer mast (see Fig. 6-8) are of inclined structures. The tilt cylinder support of the crossbeam in the outer mast is connected to the truck support through a tilt cylinder and fixed with a pin shaft. The two supports at the lower end of the outer mast are connected to the front drive axle support and fixed with a pin shaft. The basic mast is a rolling telescopic type, which bears longitudinal and transverse loads through composite rollers and makes the inner mast move up and down smoothly.

Section of channel steel for inner and outer masts:

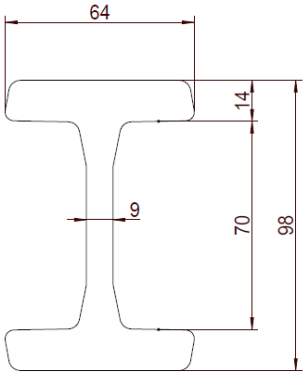


Fig. 6-8 Installation Diagram of Chains

Both the inner and outer masts are welded components, with the outer and inner masts arranged in a staggered manner. The upper end of the outer mast is equipped with composite rollers, and the lower end of the inner mast is equipped with composite rollers. All three types of mast are designed to withstand both radial and lateral forces by adjusting the gap between the composite rollers.

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

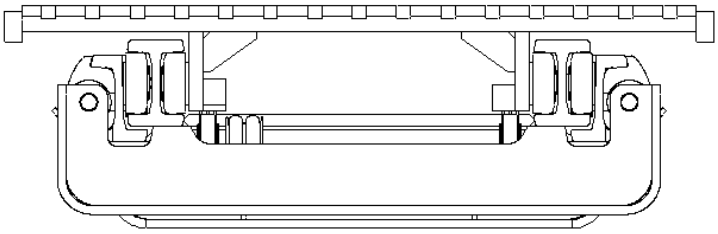


Fig. 6-9 Overall Layout of Channel Steel for Basic Mast

6.2.2 Fork arm carrier (for basic mast)

The fork arm carrier is mainly a welded structure composed of column plates, upper and lower crossbeams, reinforcement plates, ribbed slabs, side plates, composite roller shafts, chaining plates, limit blocks, and other parts, equipped with two sets of composite rollers, which move smoothly up and down in the inner mast channel rail groove and bear longitudinal and transverse loads. The gap between the side rollers and the channel steel web can be adjusted by adjusting screws, and the

longitudinal and transverse loads are borne by two sets of composite rollers.

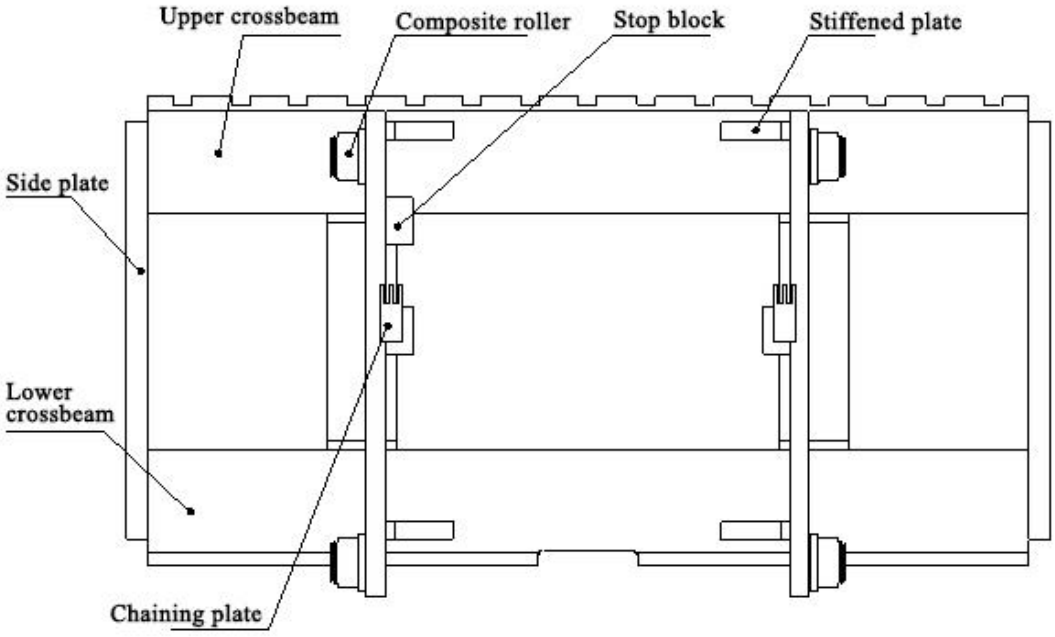


Fig. 6-10 Structural Diagram of Fork Arm Carrier (for two-stage mast)

6.2.3 Position and adjustment of rollers

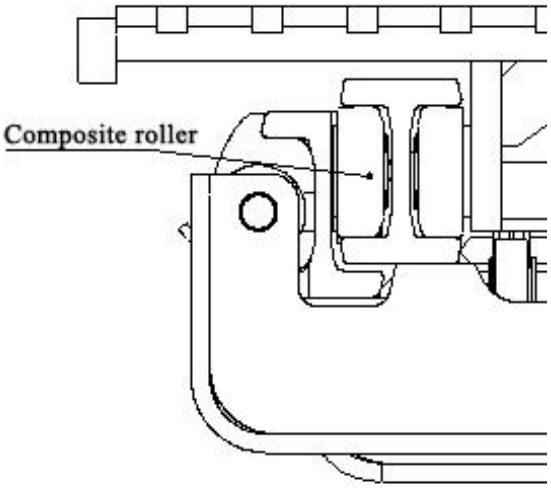


Fig. 6-11 Installation Diagram of Composite Rollers

Precautions for the structure and adjustment of these composite rollers are the same as those for the composite rollers of a three-stage fully free rolling telescopic mast.

6.2.4 Adjustment of lifting cylinder

When the lifting cylinder, inner mast and outer mast is removed and replaced, the stroke of the lifting cylinder needs to be readjusted. This adjustment is the same as that of the lifting cylinder of a three-stage fully free rolling telescopic mast.

6.2.5 Tension adjustment of chains

The installation and tension adjustment of chains are the same as those of a three-stage fully free rolling telescopic mast.

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