

**HELI**

**OPERATION & SERVICE  
MANUAL**

**Three Wheel Lithium Battery  
Powered Trucks (Front Drive)**

**1.5-2t**

## **FOREWORD**

AC type three wheel lithium battery powered forklift truck with front drive is designed on the base of advantages of some trucks made by domestic and foreign manufacturers and developed in introduced technology from abroad to meet the market needs. These trucks are all suited for handling and stacking packed goods in stations, ports, goods yards, warehouses, food processing factory, light and textile industries and other factories. Because the AC type three wheel forklift truck with front drive has small turning radius so it is more suitable for narrow working space such as supermarket and enterprise with high requirement on land usage rate. With some of attachments fitted, the trucks can be applied more and more.

These trucks feature a wide-visible lifting system, integrated electric steering axle, torque feedback device, drive axle with automatic brake, continuous speed control, overhead guard with opened port, high quality motor, lithium battery, MOSFET electric controller and liquid crystal combined meter with large screen so they have a lot of advantages such as good performance, easy operation, wide visibility of operator, flexible steering, reliable braking, powerful and smooth power, low noise, no contamination to environment and beautiful contour.

This manual states the trucks' specifications, operation, maintenance, service, main assemblies' constructions and working principles so as to help operators to use the trucks correctly and attain the highest functions. It is necessary to read over the manual before they operate the trucks or service personnel serve these trucks. The rules and notices in the manual should be abided seriously by relative personals to enable trucks in optimized working state for long period and bring highest efficiency.

Because of the limit of space and editing, the figures, drawings, parts and such diagram illustration used in the manual do not have actual proportion. So size or mass can not be gained from diagram accurately.

This manual content might not correspond with the actual condition because of the improving of our products. Our products are subject to improvements and changes without notice.

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## **I. Safety Rules for Operation and Daily Maintenance of Forklift Truck**

It is important that driver and manager for forklift trucks remember the principle of the “first safety” and ensure the safety operation as the description in 《OPERATION AND SERVICE MANUAL》 & 《OPERATION MANUAL》 .

### **1. Delivery of Forklift Truck**

It must be pay attention to the following items when you deliver forklift trucks with container or trucks.

- (1) Apply the parking brake. For electric truck, the truck shall be power disconnected.
- (2) Fix the mast and the balance weight with steel wire. Wedge up all wheels.
- (3) Sling points should be always at the positions specified in sling index plate when hoisting up the forklift truck.

### **2. Storage of Forklift Truck**

- (1) Drain off fuel completely. Don't drain off the cooling water containing antifreeze and rustproof agent.
- (2) Apply antirust to the surface of the parts not painted. Apply lubrication oil to the lift chain.
- (3) Lowering the mast to the lowest position.
- (4) Apply the parking brake.
- (5) Wedged up the wheels.

### **3. Precautions Before Operation**

- (1) Don't check fuel leakage and lever or instruments at the place where there is open flame. Never fill the fuel tank with the truck running.
- (2) Check the tire inflation pressure.
- (3) The forward-reverse lever should be in neutral.
- (4) Check all the levers and pedals.
- (5) Complete the provisions before starting.
- (6) Release the parking lever.

(7) Make trying operation of the mast for lifting, lowering and Fwd/Bwd tilting and the truck for steering and braking.

#### **4. Operation of Forklift Truck**

(1) Only trained and authorized operator shall be permitted to operate the truck.

(2) Wear all the safety guards, such as shoes, helmet, clothing and gloves while operating the truck.

(3) Check all the control and warning devices before starting the truck. If any damages or defects are found, operate it after repairing.

(4) At the rated loading center, either overload or overload operation is strictly prohibited. The center of cargo should be in line with the frame center, not out of the line. The fork should insert completely under the cargo and make the cargo placed on it evenly. Do not raise an object with one fork end.

(5) The starting, turning, driving, braking and stopping operation of the truck should be done smoothly. When steering on the humid or low friction road, the truck should be decelerated.

(6) Travel with loads as low as possible and tilted backward.

(7) Be careful when traveling on a slope. When climbing grades with a slope of more than 10%, the truck should forward travel, and when descending so grades, backward travel. Never turning on a slope. Avoid loading and unloading operation when descending.

(8) Pay attention to pedestrian, obstacle and bumpy road when driving. Pay attention to the clearance over forklift truck.

(9) Never allow any persons to stand on the forks or the truck to carry persons.

(10) Never permit anyone to stand or walk under upraised forks.

(11) Don't operate truck and attachment of it at any position out of the drive seat.

(12) On the high lift forklift truck, when the lift high more than 3m, it is noted that the goods on it should not fall down or the protection measures must be taken if

necessary.

(13) Tilt the mast of the high lift forklift truck as backward as possible while the truck working. Use minimum forward tilt angle and Min. reverse tilt when loading and unloading.

(14) Be careful and slowly driving over a dockboard or bridge-plate.

(15) Shut down the truck and don't stay on the truck when checking battery or fuel lever.

(16) The unloaded forklift truck with attachments should be operated as a loaded truck.

(17) Don't handle unfixed stacked goods. Be careful to bulky goods to be handled.

(18) If leaving the truck, lower the forks on the ground and let the shift lever to neutral, shut down the engine or cut down electric supply. If parking on a slope is unavoidable, apply the parking brake and block the wheels.

(19) Don't adjust the control valve and relief valve at will to prevent the damage of hydraulic system and its components because of excessive pressure passing them.

(20) Inflate a tyre according to it's stated air pressure. Never over inflate a tyre.

(21) According to the measure method specified in JB/T 3300, the max. noise at the outboard of the truck should be not more than 80dB(A).

(22) Be familiar with and pay attention to the functions of the decals on the forklift trucks.

## **5. Application environment**

1) Environment temperature: -25 ℃ ~ +40 ℃;

2) Relative humidity: <90%;

3) Altitude: <1200m.

## **6. Daily Maintenance of Forklift Trucks**

(1) Inspection before startup

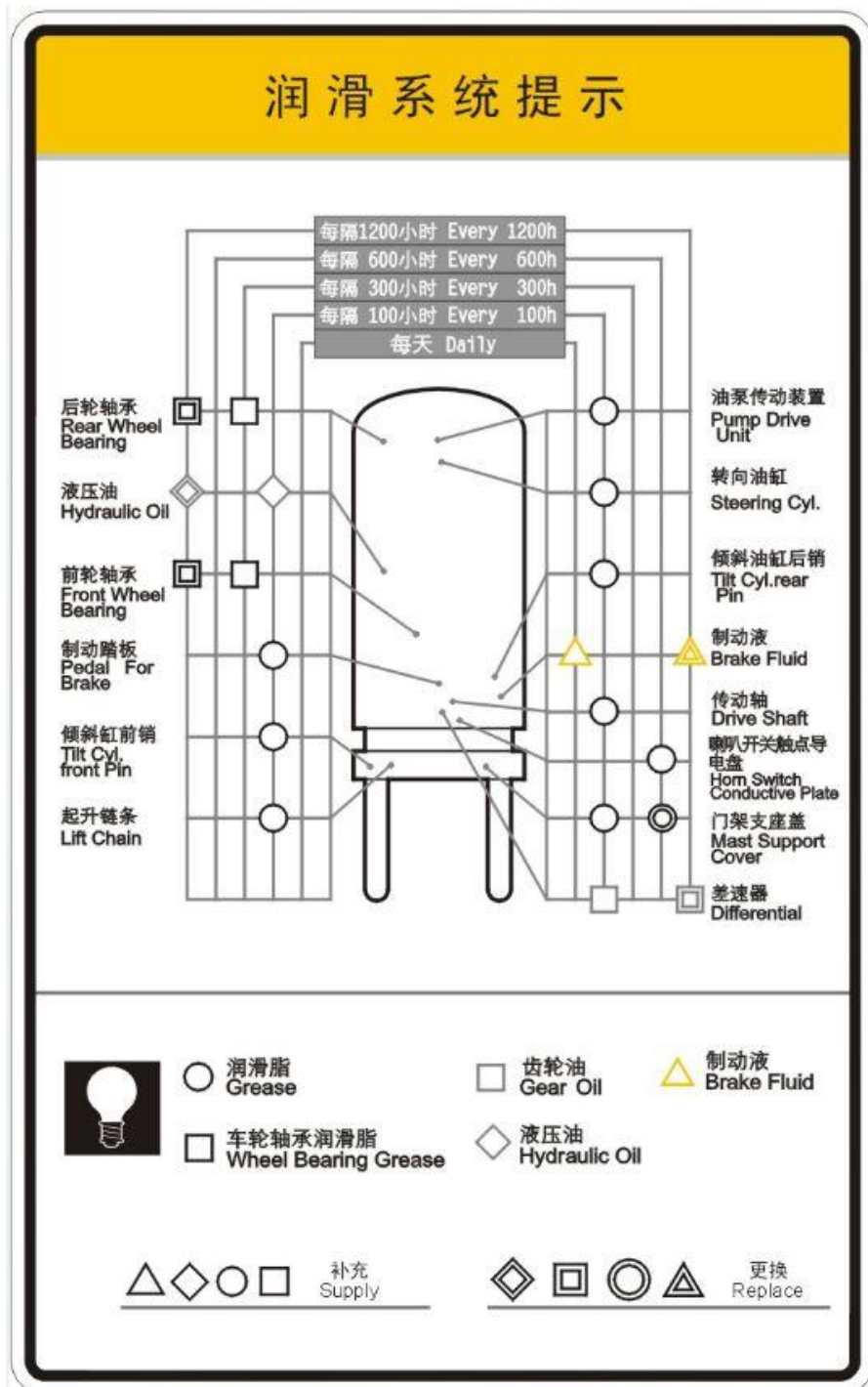
a) Hydraulic oil volume: oil level should stay in the middle of oil meter scale;

- b) Check piping, joints, pumps and valves for leaks or damages;
- c) Check parking brake. The unladen truck can park on the 15% grade ramp, when the parking lever is pulled to the bottom;
- d) Check instruments, lighting, switches and wiring to see if they work normally or not.

(2) Oil used for forklift trucks

Name	Recommended brand	Brand and temperature of using		
Hydraulic oil	Chang cheng	Sticky grade	L-HM32 wearable hydraulic oil	L-HV32 low temp. wearable hydraulic oil
		Temp. of using (°C)	≥-5	≥-20 (cold region)
Lubricating grease	Chang cheng	3# lithium base grease (-20°C ~ +120°C)		
Gear oil of heavy-laden truck	Hai pai	Sticky grade	85W/90GL-5	80W/90GL-5
		Temp. of using (°C)	-15~+49	-25~+49

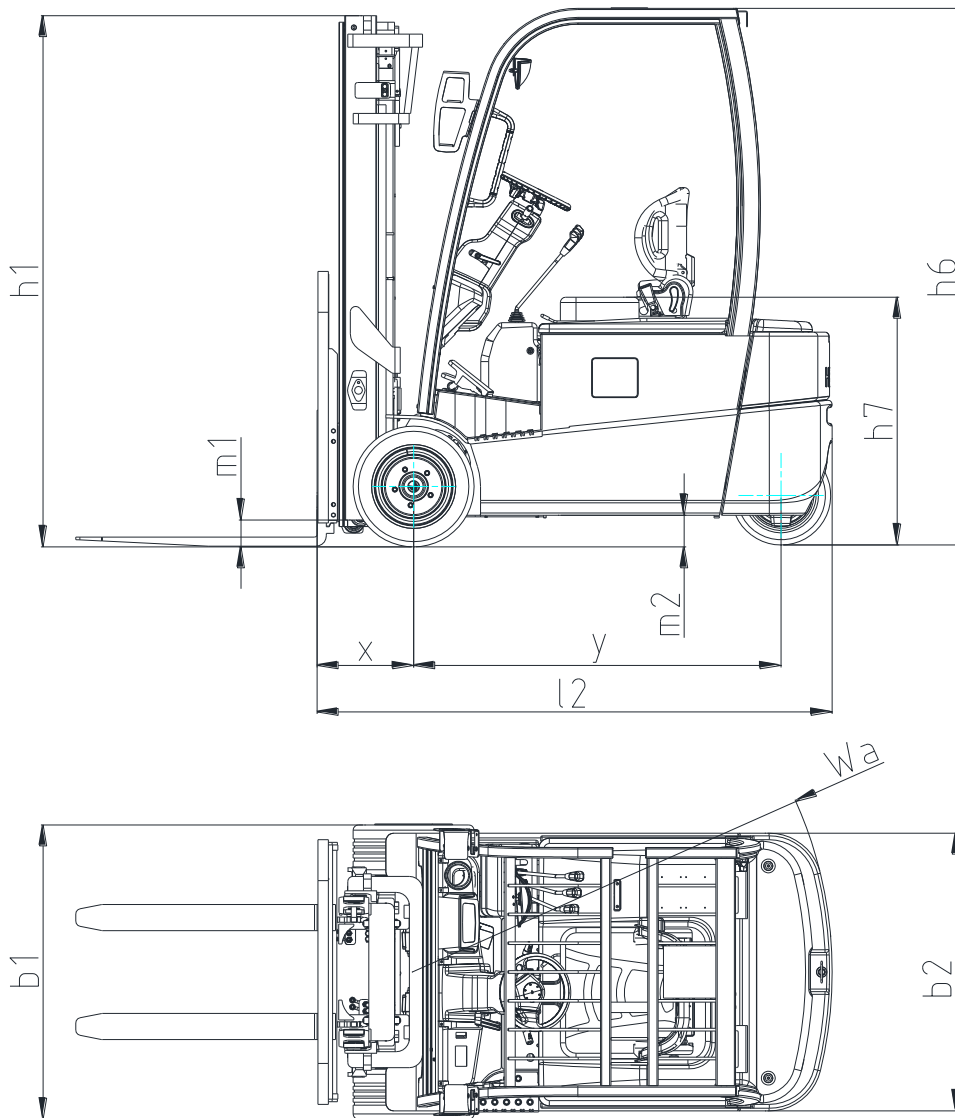
(3)Lubrication chart



Note: for the truck without brake liquid, it is not necessary to refer to the chart for relative operation.



## II. Main Specifications of Forklift Truck



External view of forklift trucks

### Main specifications

Model	Unit	CPD15	CPD16	CPD18	CPD20
Configuration No.		SQ-GB2Li			
Rated capacity	kg	1500	1600	1800	2000
Load center	mm	500			
Power		Lithium battery			
Driving mode		Sit-on type			
Lifting height	mm	3300			
Free lift	mm	90			
Mast tilting angle (front/rear)	deg.	5/7			
Fork size	mm	35×100×920			40×122×920
Wheel base y	mm	1292		1400	
Front/rear tread	mm	910/180		920/180	
Overall length (without fork)	mm	1852	1852	1962	1967
Overall width b1	mm	1060		1120	
Overall height (mast/overhead guard) h1/h6	mm	2175/2040			
Seat height h7	mm	940			
Underground clearance m1/m2	mm	85 (at mast) / 100 (in the middle of truck body)		90 (at mast) / 100 (in the middle of truck body)	
Minimum steering radius Wa	mm	1487	1487	1595	1595
Travelling speed (unloaded/loaded)	km/h	16/16			
Lifting speed (unloaded/loaded)	mm/s	600/380	600/430		600/400
Lower speed (unloaded/loaded)	mm/s	400/500			
Gradeability (unloaded/loaded)	%	30/20			
Service weight	kg	2990	3250	3350	3600
Axle load (unloaded)(front/rear)	kg	1420/1570	1490/1760	1620/1730	1640/1960
Axle load (loaded)(front/rear)	kg	3930/550	4170/680	4450/700	4850/750
Overall gear ratio		26.7			
front/rear tyre		18×7-8 (front wheel) 140/55-9 (rear wheel)		200/50-10 (front wheel) 140/55-9 (rear wheel)	
Travelling motor (S2-60min)	kW	5.4×2			
Oil pump motor (S3-15%)	kW	11			
Lithium battery	V/Ah	48/404 48/320 48/400		48/404 48/542 48/400 48/500 48/600	
Control type		MOSFET/AC			
Working pressure of hydraulic system	MPa	17.5			

Dimensions and weight of main dismountable parts

item \ model		Unit	CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
			GB2Li			
Counterweight	Max. overall size	mm	410×1060×775		425×1060×775	455×1060×775
	Weight	kg	750		945	1068
Assistant counterweight	Max. overall size	mm	980×190×522	980×190×522	980×190×630	980×190×630
	Weight	kg	471	658	516	791
Overhead guard	Max. overall size	mm	1238×1030×1541	1292×1030×1541		1400×1030×1541
	Weight	kg	65	75		90
Mast (lifting height 3300mm)	Max. overall size	mm	1267×1010×2075		1267×1086×2075	
	Weight	kg	577		604	

### III. Construction, Principle, Adjustment and Maintenance of Forklift Trucks

#### 1. Transmission system

##### 1.1 General description

The transmission system of the three wheeled forklift truck includes transmission system we call traditionally and brake system. Front wheel dual driving motor structure makes the right and left wheel of three wheeled truck has drive axle, redactor, brake and driving motor independently to improve working efficiency. Transmission unit is assembled inside of drive axle housing while brake is assembled on motor shaft. The structure is compact.

Truck travelling speed is increased with the increase of motor speed; travelling direction is changed with motor rotation direction; The sensor installed on rear wheel sends information to drive motor controller on right and left front wheel, after receiving different information, right and left front wheel give out different speed and thus steering of the truck is realized. The steering of the three wheeled truck is realized through electric differential. The system has no bevel gear which thus not only improves working efficiency but also reduce bevel gear noise.

##### 1.1.1 Front wheel assembly

Front wheel is made up of solid tyre and rim. Refer to the following for front wheel and rim model:

Tyre parameters		Model			
		CPD15SQ	CPD16SQ	CPD18SQ	CPD20SQ
Model	Super elasticity	18×7-8	18×7-8	200/50-10	200/50-10
	Rim	4.33R	4.33R	6.50F	6.50F

##### 1.2 Disassembling of transmission system

Disassemble the front wheel assembly and travelling motor first before disassemble transmission box. Then parts inside of the transmission box can be repaired or

maintenance.

### 1.2.1 Removal of the wheels

Drain off the gear oil inside of the transmission box before disassembling. Loose 6 drive nut and remove drive wheel. Then loose the 7 bolts on frame hexagon socket bolts and remove transmission box connected with travelling motor from frame. Refer to figure 1-1.

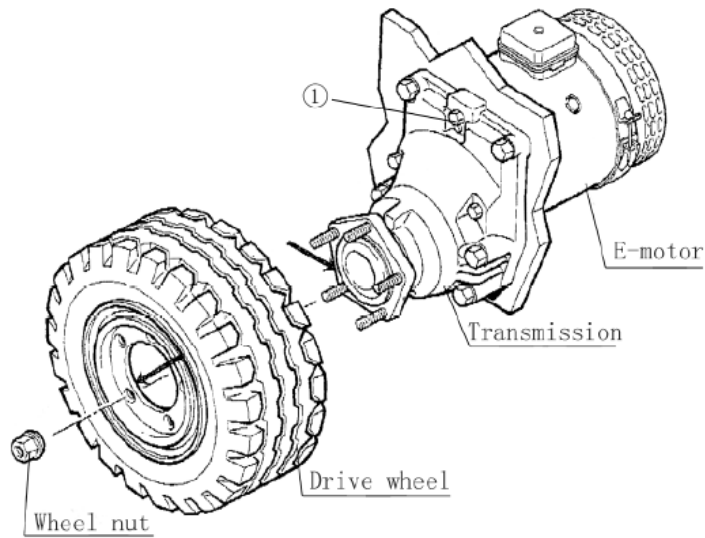


Figure 1-1

### 1.2.2 Removal of travelling motor

Refer to figure 1-2 to remove the bolts fixing travelling motor (one is M8 x50, and two are M8 x75).

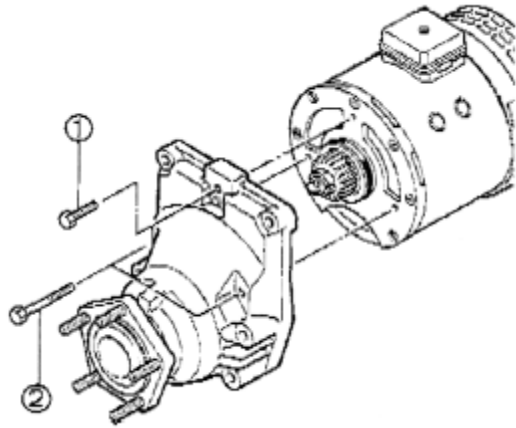


Figure 1-2

NOTE: Take care when removing motor from transmission box.

Take care not to damage the sealing surface for the O-ring in the housing! If only the motor is removed, the released transmission opening is to be sealed in order to avoid that dirt can get inside the transmission.

### 1.2.3 Disassembling and assembling of transmission box

It is not necessary to disassemble this part normally. If has to, please contact HELI sales company.

## 1.3 Assembling of transmission system

### 1.3.1 Assembling of travelling motor

Before assembling, clean the contacting face between transmission box and motor with cleanser (for example loctite 706 or alcohol) then make it dry. Check if the contactor is damaged, if there is slight damage, remove it with oil stone. Refer to figure 1-3.

Note: cleansers can not come into contact with the skin ,they must not be swallowed and their vapors must not be inhaled. Always use protective gloves and goggles. If a cleanser has been swallowed inadvertently, call medical help immediately. Pertinent instructions of the manufacturer should be duly noted.

(1) Clean motor shaft (part1) and taper bore of drive pinion (part 2) carefully

(2) Insert woodruff key (part 3) into motor shaft and push drive pinion on.

(3) Screw a new stopping nut (part 4) on and tighten with socket wrench. Tightening torque: 55 Nm (M20 × 1, taper φ 25); 68 Nm (M14 × 1.5, taper φ 20)

(4) Coat O-ring (part 5) slightly with transmission fluid and push it onto centering seat of motor.

(5) Place the motor carefully on the transmission and join the gearings of motor pinion and helical gear carefully.

**Attention: Do not knock with the drive pinion against the helical gear while installing the motor. This can cause knocking noise.**

(6) Turn motor to coincide bore pattern of transmission with bore pattern of motor.

(7) Screw motor to transmission with three hexagon bolts. (parts 1 and 2) (1 × M8 × 50 and 2 × M8 × 75) Tightening torque: 23 Nm.

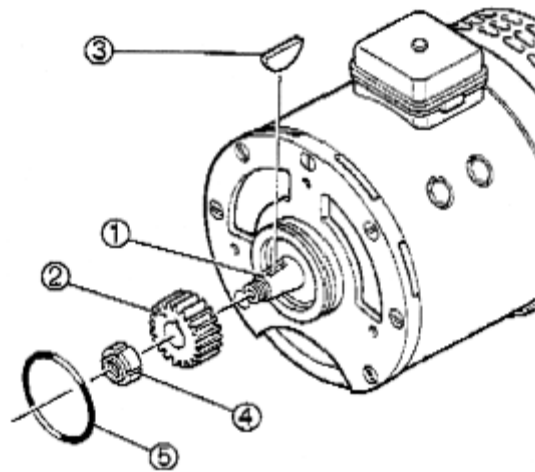


Figure 1-3

### 1.3.2 Mounting the transmission unit to the truck frame

Check the frame surface for damage and irregularities. The maximum admissible irregularity in the area of the transmission contour shall be no more than 0.1 mm. Screw drive unit with 7 hexagon bolts M14 x 1.5 x 70 and shims to frame. The tighten torque is 130~194 Nm. Refer to figure 1-1.

### 1.3.3 Assembling of wheels

The axle is applicable to solid tyre.

(1) Clean mating surfaces on wheel shaft and wheel thoroughly and check if it is damaged.

(2)The bore pattern in the rim should be in line with the bolts of the wheel shaft; then push the wheel on.

(3) Install hub nuts and tighten them. The tightening torque of it is 140Nm.(see Fig.1-4).

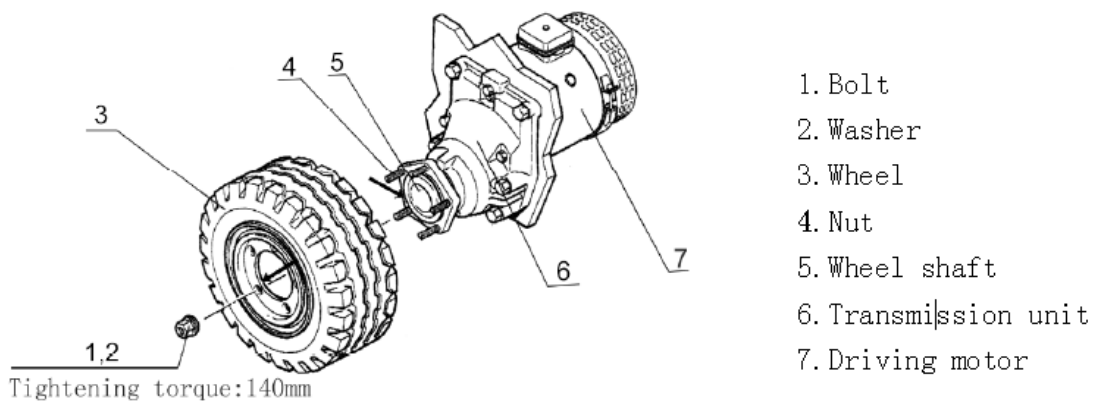


Figure 1-4

#### 1.4 Replenishing with Transmission Fluid

When a truck has been used for 1000 hours or one year, (The accurate time is according to the first reached time.) replace gear oil in differential and main reducer.

(1) Unscrew fluid filling plug (part 3) with sealing ring (part1), and let the gear oil out completely. Before screw fluid filling plug again, remove the dust on the plug. It is necessary to replace the sealing ring if it is damaged.

(2) Unscrew fluid filling plug (part 4) with sealing ring (part 2).

(3) Add gear oil to transmission box. During adding, air is not permitted to enter for bubble may be produced in the transmission box.

(4) Fluid capacity approx. 0.35 liters (standard value).The exact oil amount is determined by funnel.

(5) Gear oil model may be MOBIL ATF200 or ATF210 or ATF220; SHELL



DONAX™ or ATFDEXRONII D-21666 or DONAXTG PLUSD-22543 or DONAXTG D-21126; ESSO TYPESUFFIXA or ATF D-21065 or ATF D-21611 or ATF D-22079.

(6)Screw fluid filling plug (part 1) with the sealing ring (part 2).Tightening torque: 22Nm. Refer to figure 1-5.

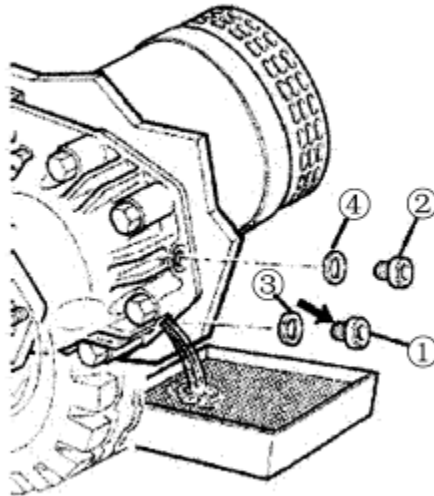


Figure 1-5

## 2. Brake system

### 2.1 General description

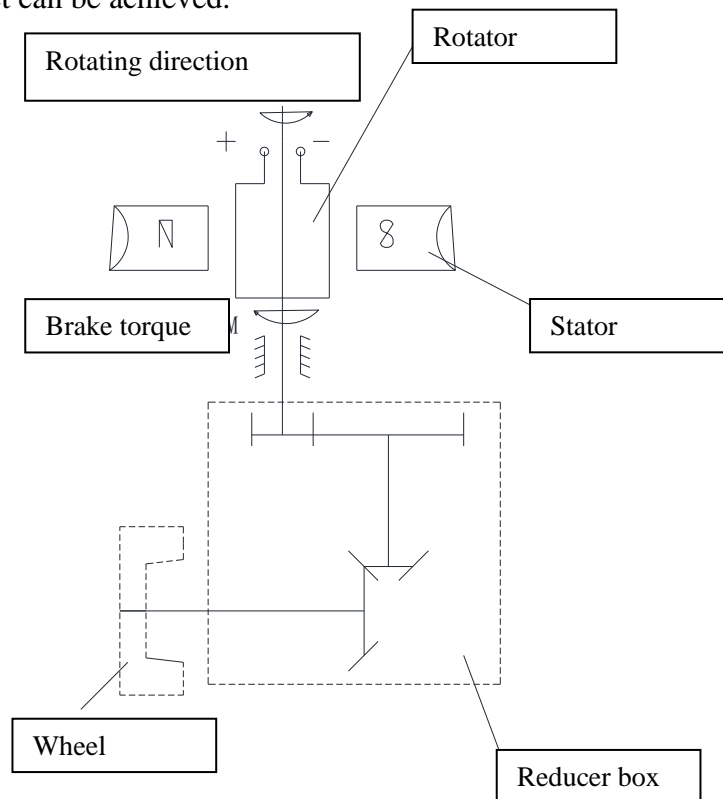
Brake system is made up of service brake and parking brake.

#### 2.1.1 Service brake

The service brake is made up of accelerating pedal, brake pedal, traction controller and traction motor. See the figure below for the service brake principle diagram and the structure of brake pedal.

During travelling, releasing the accelerating pedal slowly or quickly can reduce truck speed quickly and achieve brake effect. Brake effect in normal condition can be realized.

During travelling, Step the brake pedal (2) can achieve brake effect flexibly. Different brake effect can be achieved.





Note:

It is suggest for driver to getting familiar with the brake effect and functioning without load.

### 2.1.2 Parking brake

Electromagnetic parking brake which is installed on traction motor shaft is applied on three wheeled truck.

#### 1) Automatic parking brake

When truck is braked or is stopped, electromagnetic parking brake is applied to lock traction motor output shaft. And thus the truck is stopped with parking brake.

When truck is stopped on a slope, the truck keep stopping through electric method ant then parking brake is started. And thus the truck is stopped with parking brake.

When operating direction switch and stepping on accelerating pedal at the same time, the electromagnetic parking brake is loosed automatically and truck can be operated normally.

#### 2) Power-off parking brake

When key switch is turned off, emergency button is turned off or truck main power is disconnected, electromagnetic parking brake starts automatically. And thus the truck is stopped with parking brake.( It can only be used in case of emergency.)



**Danger:**

**Except under emergency case, it is prohibited to start electromagnetic parking brake through power-off parking brake. When electromagnetic parking brake is applied, do not tow the truck.**

### **3. Steering system**

#### **3.1 General Description**

The function of steering system of forklift is to change the driving direction of the forklift or keep the forklift in straight line driving. The performance of steering system directly concerns with the driving safety, operation efficiency of forklifts and labor intensity of drivers. The steering system is divided into two categories of mechanical steering system (manual steering system) and power steering according to the power source of steering. The mechanical steering system is operated to overcome steering resistance moment fully by relying on the force and skill of driver, while in power steering system, the energy consumed to overcome the steering resistance moment is provided by prime mover and the driver can operate the system to control the turning direction with very small force.

As requested by the working characteristic of the forklifts, the operation site and driving pass are relatively narrow, changing-over is frequent and the minimum radius turnings are often needed, therefore, the steering system is required to be reliable and light in operation. Since the load of steering axle occupies about 60% of the vehicle weight in case of idling, G2-series three-wheel lithium battery powered forklift trucks produced by our Co. adopt fully EPS electric steering system.

#### **3.2 Working Principle**

When the truck is steering, the driver controls the steering wheel, and the TFD (torque feedback device) is connected with the steering spindle. When the steering spindle rotates, the TFD starts to work and turns the rotation angle into an electrical signal. The controller judges the steering force and speed according to the real-time speed. On the one hand, the controller controls the TFD torque feedback device to exert reverse torque on steering wheel to ensure the safety of truck steering at high speed; on the other

hand, the controller provides electrical signal to steering motor to control steer wheels to rotate according to steering wheel operation. It can ensure light and flexible steering at low speed and stable and reliable steering at high speed.

### 3.3 Composition of Steering System

#### (1) Control mechanism of steering

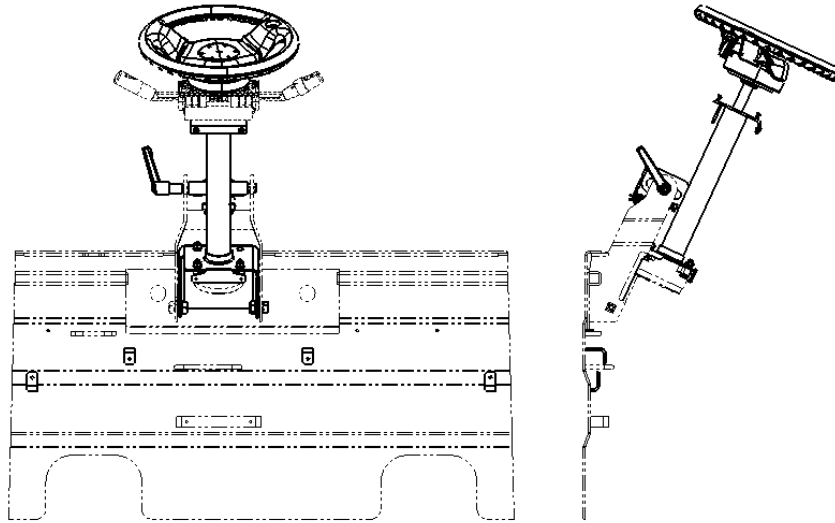


Figure 3-1 Steering unit

The steering control mechanism of the truck is mainly composed of steering wheel, steering column, coupling shaft, torque feedback device and mounting bracket (as shown in Figure 3-1). They are fixed on the dashboard by mounting bracket, the steering wheel, steering column and coupling shaft are connected together, the steering unit is fixed at the lower end of the coupling shaft, and the rotation of steering wheel will drive the rotation of steering unit. The steering wheel can be adjusted to the comfortable position by adjusting the handle.

#### (2) Torque feedback device

The TFD provides input signals to the controller to control the speed and angle output of the steering motor. The device can continuously provide variable torque output, making it easier for operators to adapt to the electric steering system (see electrical system for

details).

### (3) Steering transmission mechanism

The steering motor drives meshing gears and then is transmitted to steer wheel. The steering way is simple, easy and convenient. (Refer to the chapter relating to steering axle for more information).

### 3.4 Integrated electric steering axle

The steering rear axle assembly (as shown in Figure 3-2) is composed of steering motor, mechanical structure (including reductor), steering wheel axle and steer wheels and other parts. The meshing gear pair is driven by the steering motor. When the driver operates the steering wheel, the angle signal is provided to the controller, which gives the control signal to the steering motor. The steering motor outputs a steering torque through the mechanical structure to control the truck steering. The wheel is pried to the rear wheel hub through the wheel rim, and the rear wheel hub is installed on the steering wheel axle through two tapered roller bearings; the inner side of the bearing is equipped with oil seal to keep the grease in the wheel hub and the steering wheel axle cavity.

Steering axle tyre and rim model see table 3-1.

Table 3-1

Ton	1.5t、 1.6t、 1.8t、 2t
Tyre	140/55-9
Rim	4.00 E-9

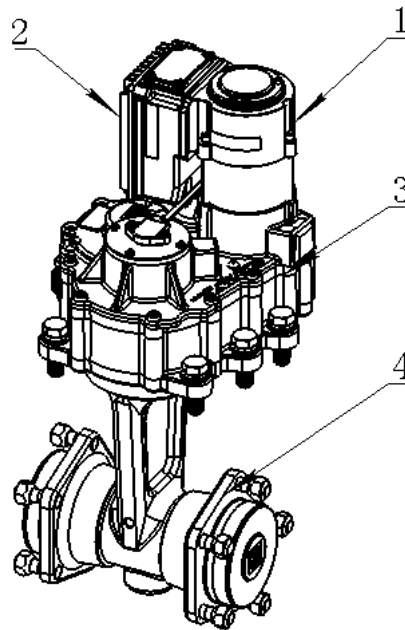


Figure 3-2 Electric steering axle

(1) Steering motor    (2) controller    (3) redactor    (4) hub assembly

### 3.5 Adjustment and Maintenance

#### 3.5.1 Rear wheel bearing pre-load adjustment

(1) As shown in Fig. 3-3, fill up the chamber formed by wheel hubs, wheel hub bearings and wheel hub covers with lubricating grease. Coat the lips of the oil seals with lubricating grease.

(2) Press the hub bearing into the hub and fit the hub on the knuckle shaft.

(3) Fit a flat washer and tighten a castle nut to a torque of 206-235Nm (21-24kgm) and loosen it, and then tighten it again to a torque of 9.8Nm (1kgm).

(4) To ensure firm installation of the hub, slightly knock at it with a wooden hammer and in the meantime, rotate the hub for 3-4turns.

(5) Tighten the castle nut and align one of its notches with a cotter pin hole drilled in the steering knuckle.

(6) Again slightly knock at the hub with a wooden hammer and in this time, rotate



manually the hub for 3-4turns to ensure its smooth rotation with a specified torque of 2.94-7.8Nm (0.3-0.8kgm).

(7) If the torque value necessary to rotate the hub is more than the specified one above-mentioned, screw out the castle nut for 1/6 turn and measure the torque value then.

(8) When the torque value measured is up to the specified one, lock the castle nut with a cotter pin.

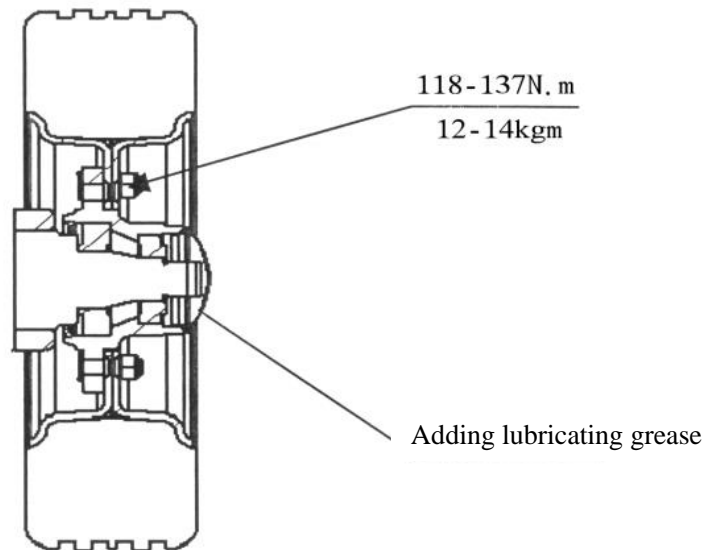


Fig. 3-3 Fill lubricating grease and pre-load adjustment

### 3.5.2 Inspect after reassembling the steering system

(1) Turning the steering wheel right and left, inspect whether the steering power is smooth.

(2) Inspect connection of the electric harness whether is correct by turning the steering hand-wheel ring and left.

(3) Lift up the rear wheels and slowly turn the steering hand-wheel ring and left several times to ensure if the steering is correct.

### 3.5.3 Steering system troubleshooting

Table 3-2

Fault	Reasons	Remedy
No steering	No working of steering motor	Check the harness or replace
	No working of steering controller	Check the harness or replace
Large noise when steering	Large clearance between gears	Adjust
	Over wear of gear	Replace
Rigid steering operation	Uneven rotation of steering wheel	Make the steering wheel to be concentric with steering axle

## **4. Electric system**

### **4.1 General description**

The standard configuration of the electric system include of two controllers. It can succeed in operating the forklift low-noisily, efficiently, smoothly and safety.

The electric system is composed of instrument, traction control system, lifting control system, EPS electric steering control system, lithium battery pack, control switch, lighting and wiring harness etc.

Thereinto, the traction control system is made up of direction switch, acceleration pedal, brake pedal, electromagnetic brake, traction motor and traction controller.

Lifting control system is made up of valve control switch, lifting motor and lifting controller.

EPS electric steering control system is composed of feedback device of steering wheel operation force, steering controller, steering axle and so on.

**Notice: Our Company has the right to improve on the production. Please contact with our company if there is any difference between the product and the manual.**

The circuit diagram of electric system is shown in the following figure.

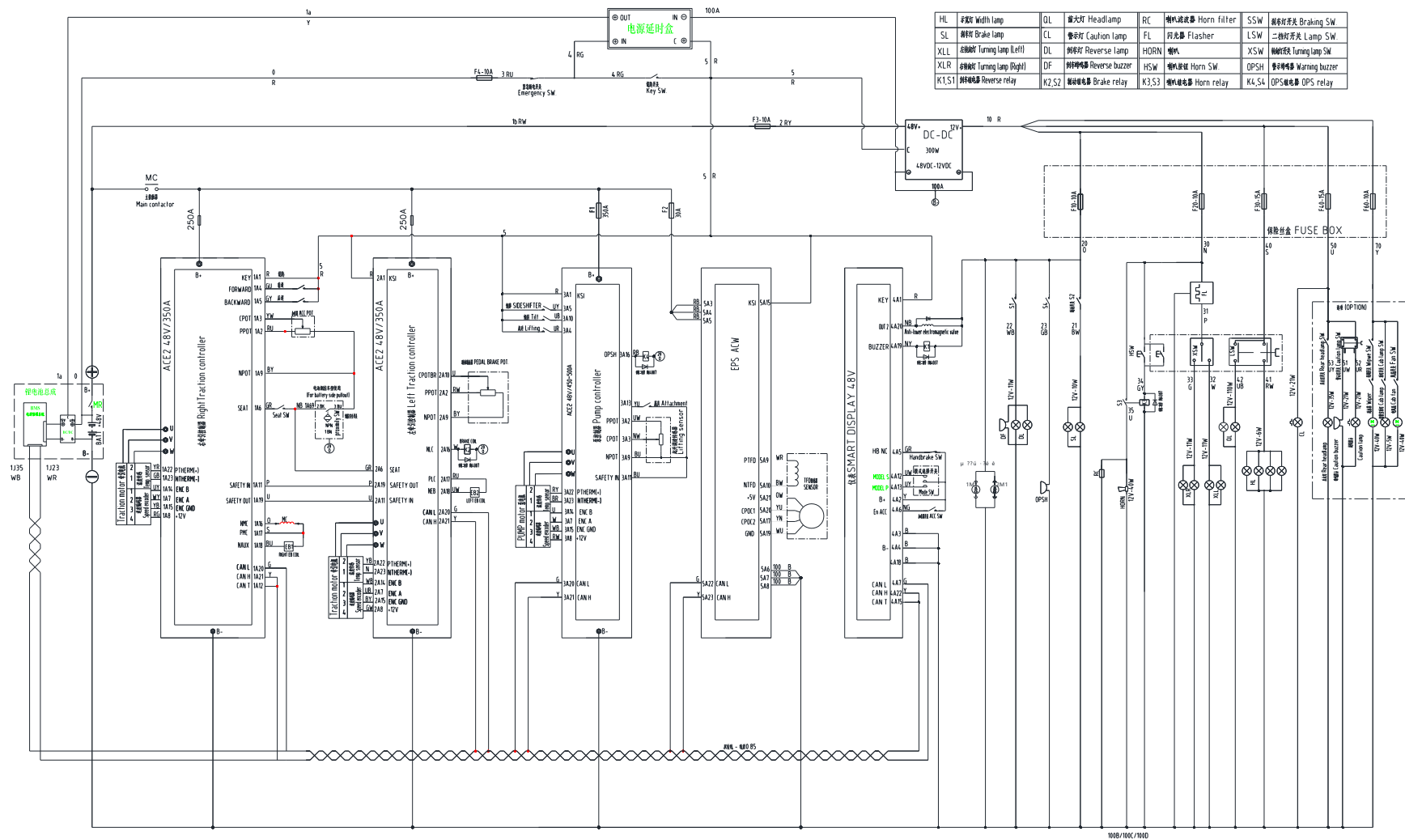


Figure 4-1 Electric system principle diagram (CPD15SQ~20SQ-GB2Li)

## 4.2 Instrument

### (1) Display of the instrument

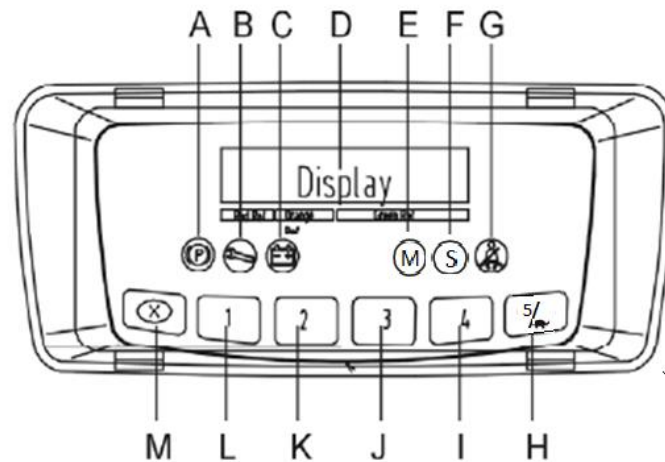


Fig. 4-2 Display of the ZAPI SMART instrument

- (A) Hand brake condition indicator (B) Fault LED (C) Low state of battery LED (D) LCD (E) Moderate traction speed working indicator (F) Low traction speed working indicator (G) Warning lights for seat switch (H) High/moderate/low speed switch/Out button (I) Set down key (J) Set up key (K) Roll down key (L) Roll up key (M) Menu key

### (2) Function and application



SMART DISPLAY is an intelligent dashboard connected to the truck system by CANBUS line. This dashboard provides the diagnostic and set-up of the whole truck system.






Connecting the ZAPI handset or PCWIN tool to SMART DISPLAY, it is possible to read and modify the setting of all the modules present on the CANBUS net. The display implements an interface to the operator through a main page and a number of submenus.


a) Turn on the key switch. When the instrument gets power “HELI AC SYSTEM” is displayed on the LED screen. After system self-testing, battery capacity, truck speed and traction hours will be indicated on the main page.



Fig. 4-3 Display of the ZAPI instrument when power on (fault-free)

b) Battery capacity display: There are 20 grids on the battery capacity indicator. After the truck is powered, the indicator is fully lit (20 grids) if the battery is fully charged. After battery discharge, the battery capacity is reducing, so are the grids of the indicator. When 20 grids of the battery capacity indicator are all off, the fault warning symbol  and battery low symbol  will flash at the same time and the travelling speed slow down, lifting action cut off. Charge the battery in time.

c) Traction travelling mode display: the driver can choose the mode through the  switch except under hand console mode. When  indicator turns on, the truck is travel with medium speed; when  indicator turns on, the truck travels with slow speed; when both  and  are off, the truck travels with high speed.

d) Fault code display : If fault appears,  is often on and refer to Table 4-2 for the fault code (the first line) displayed in the WINDOW , the control module No. (the second line) of CANBUS net where the fault happens and CANBUS net information of ZAPI.

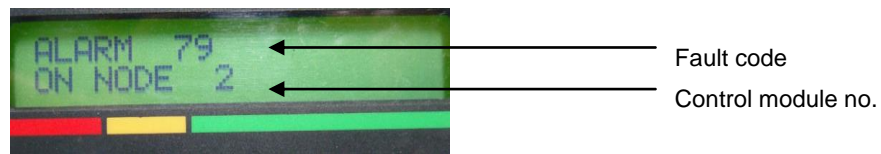


Fig. 4-4 Fault display interface of ZAPI instrument

Table 4-1 ZAPI CANBUS net information

Number associated in CANBUS net	Module
01	SICOS
02	TRACTION
03	TRACTION MASTER
04	TRACTION SLAVE
05	PUMP
06	EPS-AC
09	MHYRIO
16	SMART DISPALY

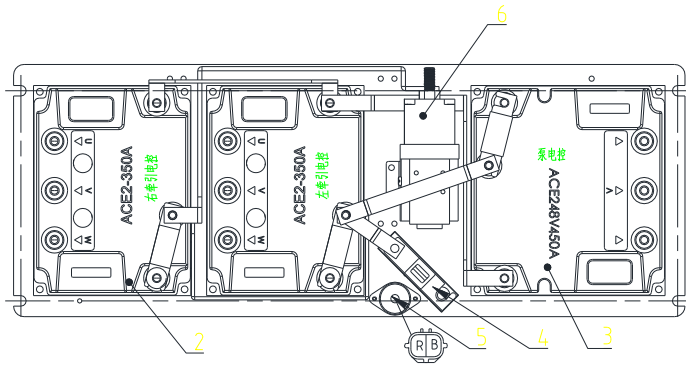
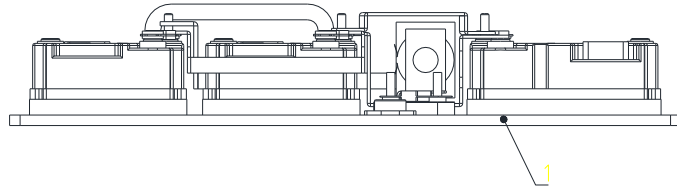
## **4.3 Controller**

### **4.3.1 General description**

The truck adopts the ZAPI ACE2 motor controller imported from Italy, so it has advantages of advanced technology of high frequency MOS tube, superior speed regulating performance, good safety, flexibility and first-class protection etc.

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

### **4.3.2 Control device**



部件	拧紧力矩值(Nm)
接触器	13.4-14.6
熔断器	10-12
控制器	13-15

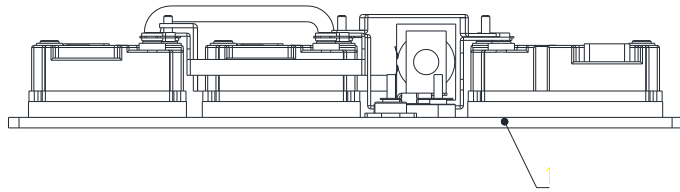
技术要求:

1. 控制器总成各零部件表面应平整, 不得有飞边, 毛刺; 铜排表面吹套黑色热缩套管;
2. 电控装置中的各部件必须安装牢固, 部分部件拧紧力矩见表1, 安装螺钉不得露出安装底板;
3. 请在图示合理且明显位置粘贴相应标贴B+、B-;
4. 控制器总成继电器、警示蜂鸣器等电器元件, 按图示位置布置;
5. 电控总成上所有接线桩头均加装烟斗护套或其它绝缘处理;
6. 软件匹配CPD15SQ-GB2Li;

6	SW200-262	接触器	1	部件				
5	QLB2.041G.701	OPS蜂鸣器	1	部件				
4	FUSE 30A	30A保险丝	1	部件				
3	ACE2 48V/450A	泵控制器	1	成品				
2	ACE2 48V/350A	牵引控制器	2	成品				
1	QLB7.749.101	电控底板	1	铝				
序号	代号	名称	数量	材料	单重	总重	备注	

Figure 4-5 CPD15SQ-GB2Li control device assembly

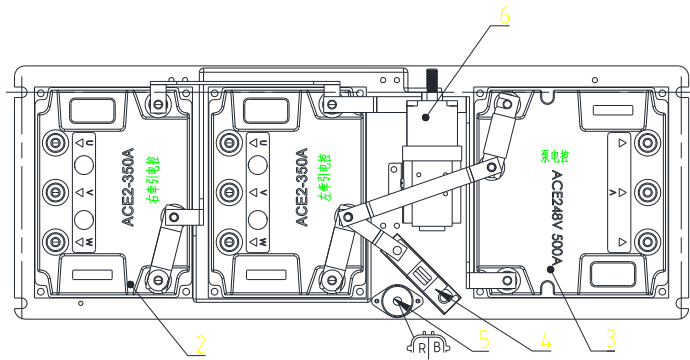




部件	拧紧力矩值(Nm)
接触器	13.4-14.6
熔断器	10-12
控制器	13-15

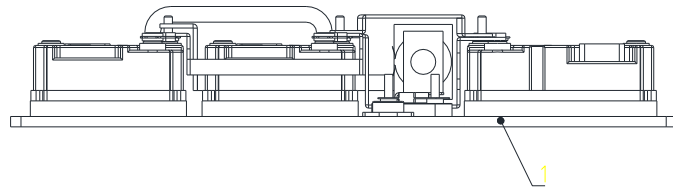
技术要求:

1. 控制器总成各零部件表面应平整, 不得有飞边, 毛刺; 铜排表面吹套黑色热缩套管;
2. 电控装置中的各部件必须安装牢固, 部分部件拧紧力矩见表1, 安装螺钉不得露出安装底板;
3. 请在图示合理且明显位置粘贴相应标贴B+, B-;
4. 控制器总成继电器、警示蜂鸣器等电器元件, 按图示位置布置;
5. 电控总成上所有接线桩头均加装烟斗护套或其它绝缘处理;
6. 软件匹配CPD16SQ-GB2Li车型;



6	SW200-262	接触器	1	部件			
5	QLB2.041G.701	OPS蜂鸣器	1	部件			
4	FUSE 30A	30A保险丝	1	部件			
3	ACE2 48V/500A	泵控制器	1	成品			
2	ACE2 48V/350A	牵引控制器	2	成品			
1	QLB7.749.101	电控底板	1	铝			
序号	代号	名称	数量	材料	单重	总重	备注

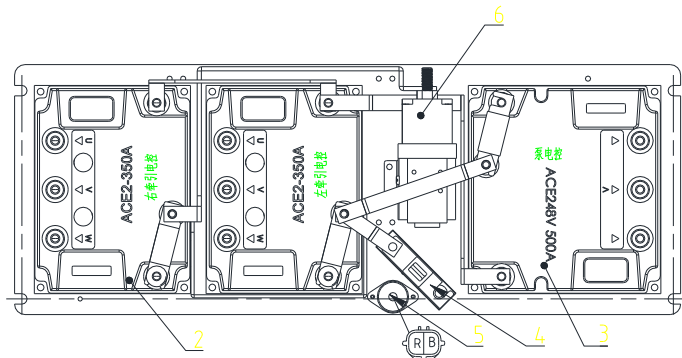
Figure 4-6 CPD16SQ-GB2Li control device assembly



部件	拧紧力矩值(Nm)
接触器	13.4 - 14.6
熔断器	10 - 12
控制器	13 - 15

技术要求:

1. 控制器总成各零部件表面应平整, 不得有飞边, 毛刺; 铜排表面吹套黑色热缩套管;
2. 电控装置中的各部件必须安装牢固, 部分部件拧紧力矩见表1, 安装螺钉不得露出安装底板;
3. 请在图示合理且明显位置粘贴相应标贴B+、B-;
4. 控制器总成继电器、警示蜂鸣器等电器元件, 按图示位置布置;
5. 电控总成上所有接线桩头均加装烟斗护套或其它绝缘处理;
6. 软件匹配CPD18SQ-GB2Li和CPD20SQ-GB2Li车型;



6	SW200-262	接触器	1	部件			
5	QLB2.041G.701	OPS蜂鸣器	1	部件			
4	FUSE 30A	30A保险丝	1	部件			
3	ACE2 48V/500A	泵控制器	1	成品			
2	ACE2 48V/350A	牵引控制器	2	成品			
1	QLB7.749.101	电控底板	1	铝			
序号	代号	名称	数量	材料	单重	总重	备注

Figure 4-7 CPD18~20SQ-GB2Li control device assembly

**Notice: The manufacturer will provide quality warranty for motor controller and the manufacturer will be informed in time for after sales service in case of fault. Please do not open it for maintenance without authorization of manufacturing. The users will be responsible for the personal and property losses caused by maintenance at their own will. ]**

## 4.4 Motor

### 4.4.1 Specifications of motors

Table 4-2 Specifications of motors

Item \ Model	CPD15~16SQ-GB2Li	CPD18~20SQ- GB2Li
Model of traction motor	JXQ-5.4-HL	
Rated power	5.4kW	
Rated voltage	32 V	
Rated current	134.6A	
Rated speed	1777 r/min	
Model of lifting motor	YDB11-4- 6191	YDB11-4- 6193
Rated power	11kW	11kW
Rated voltage	32V	32V
Rated current	307A	307A
Rated speed	1780 r/min	1780 r/min
Model of steering motor	C38215A	
Rated power	0.4 kW	
Rated voltage	48V	
Rated current	50A	
Rated speed	3000 r/min	

The motors are maintenance free three phase AC induction motor.

Note: Disconnect the power when check and maintain the motors to protect form any accidents.

## 4.5 Lithium battery

### 4.5.1 Specifications of battery

Table 4-3 Specifications of battery (standard)

Item	Specifications		Note
Rated voltage/capacity	CPD15~16SQ-GB2Li	48V/404Ah (standard) 48V/320Ah (optional) 48V/400Ah (optional)	
	CPD18~20SQ-GB2Li	48V/404Ah (standard) 48V/542Ah (optional) 48V/400Ah (optional) 48V/500Ah (optional) 48V/600Ah (optional)	
Working voltage range	42V~55V		Actual working voltage
Rated charging current	200A		Charging with consistent current
Charging temperature	0~40°C		Charging at once after it is used completely in 0°C
Discharging temperature	-25°C~50°C		

#### 4.5.2 Use of battery

The correct use and daily maintenance of lead-acid battery have a great influence on the performance and service life of battery, therefore, the users must make maintenance and service by contrast with the actual condition and according to the maintenance instruction provided by manufacturer.

For any questions, please contact the engineers and after sales service of HELI.

##### 1) Battery safety notes

(1) Keep the battery away from dangerous goods or environment, such as conductive dust particles, corrosive chemicals, inflammable and explosive materials, dangerous mechanical equipment, high temperature environment, etc;

(2) Unreasonable use of this series of products may cause smoke, such as external short circuit, overcharge, high ambient temperature, etc. In case of smoke, please cut off the power supply in time, use yellow sand and dry powder fire extinguisher for treatment, and evacuate the crowd and alarm in time in the whole process;

(3) Unreasonable use of this series of products may lead to the bulging of the battery unit, and in serious cases, it may lead to the rupture or crack of the plastic shell. At this time, the battery shall be stopped immediately. Please contact the relevant technical department or after-sales service department of our company in time to obtain the treatment method;

(4) It is forbidden to dismantle, extrude, puncture, use or bake the battery box at high temperature, so as to prevent the battery from being shocked by excessive amplitude, impacted by external force, falling from high place, etc., which may cause personal injury or property loss;

(5) It is forbidden to short-circuit the positive and negative poles of the battery directly, to avoid any metal or other conductive objects other than the battery pole pressing bolt and the conductive belt contacting the positive and negative poles of the battery, which may cause personal injury or property loss;

(6) It is forbidden to expose the battery or put it in the environment above 55 °C for a long time. It is forbidden to try to heat or put the battery into the fire. This operation may cause personal injury or property loss;

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

(8) It is forbidden to dismantle or assemble the battery without permission of the technical personnel designated by the manufacturer, which may cause personal injury or property loss;

(9) Do not immerse the battery in water or other conductive liquid, which may cause personal injury or property loss;

(10) Before using this product, please read the product manual carefully. Children and other untrained personnel are not allowed to use this series of products;

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

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

## 2) Battery usage notes

1) The charging temperature range is: 0 ~ 40 °C, charging under the low temperature environment below 0 °C will cause irreversible damage to the battery, please charge immediately after using under the temperature environment below 0 °C;

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

(3) It is forbidden to store or work for a long time under - 25 °C or above 55 °C;

(4) If the lithium battery is not used for a long time, it should be charged with 40% ~ 60% of the electricity. Store the battery in a dry and cool environment, and charge according to the battery instructions, so as to prevent the battery from being low voltage due to battery's self discharge leads to low electricity which may result in irreversible capacity loss if it is stored for a long time.

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

(6) Non professionals are not allowed to touch, move or disassemble the battery pack and the corresponding high-voltage cable, or other components with high-voltage warning signs;

(7) In case of strong collision during driving, stop the truck in a safe area and check whether the battery pack area is damaged;

(8) In case of battery leakage (liquid or smoke) or damage, please keep away with a safety distance and contact the manufacturer's after-sales service personnel;

(9) In case of electrolyte leakage, please do not touch it; in case of inadvertent contact, wash it with a large amount of water; in case of eye contact, wash it with a large amount of boric acid solution and get medical treatment quickly;

(10) When the truck or battery is on fire, leave the truck quickly to a safe dare. Please use yellow sand and dry powder fire extinguisher for treatment. It is strictly forbidden to use water or incorrect fire extinguisher for fire fighting;

(11) Please use the designated lithium battery charging equipment for charging. It is strictly prohibited to use equipment with poor quality or other types of charging equipment for charging the battery;

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

### 3). Lithium battery maintenance notes

1) When the battery power is less than 20%, it shall be recharged in time, and over discharge of 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 electricity should be kept, please do not fully charge; please fully charge the battery before use;

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

(5) The surface of lithium battery shall be dry and clean, and it is forbidden to wash lithium battery with water;

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

#### 4.5.3 Charger model

Table 4-4 Charger model

No.	Item	Notes
1	D80V-200A-Li quick charger	80V/48V compatible
2	D80V-200A-Li-423 quick charger	80V/48V compatible
3	D48V-200A-Li quick charger	48V
4	D48V-200A-Li-423 quick charger	48V

#### 4.5.4 Charger usage notes

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

(2) Necessary fire-extinguishing devices such as yellow sand and dry powder fire extinguishers shall be equipped around the charger, so that emergency fire-extinguishing can be carried out in case of extreme conditions;

(3) Before charging, make sure that there are no dust, water and other foreign matters in the charging gun and the charging socket. If there are foreign matters, they can be charged only after they are cleaned, otherwise, the charging gun and the charging base



will not be in good contact, resulting in heat or even fire;

(4) Do not modify or dismantle the charging port and charging equipment, which may lead to charging failure and fire;

(5) In order to avoid serious personal injury, the following precautions should be taken when the truck is charging:

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

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

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

(7) After charging, please close the protection cover and door of the truck charging port to prevent foreign matters from entering the charging port during the truck operation, as this will cause damage to the charging port;

(8) In order to avoid damage to the charging equipment, please pay attention to the following:

a) Do not close the door of charging port when the protection cover of charging port is open;

b) Do not pull or twist the charging cable;

c) Do not hit the charging equipment;

d) Do not store or use charging equipment in the environment with temperature higher than 55 °C;

e) It is forbidden to plug in or unplug the charging gun directly when the charging equipment has current output, which may cause electric arcing, property loss and personal injury;

f) Do not place the charging device near the heater or other heat source.

## 4.6 Daily Maintenance

(1) Check the wear condition of the contactor. Change it if necessary. Check the contactor every three months.

(2) Check the pedals or manual inching switch; measure the voltage drop between the inching switch ends; there is no resistance when the inching switch is closed; there is ringing sound when release. Check every three months.

(3) Check the main circuit, connecting cable among battery, converter and motor. Make sure the well insulation condition of the cables and circuits are tightly connected. Check it every three months.

(4) Check the mechanical moving of the pedal and knob; check if the spring is out of shape; check if the spring of the potentiometer can reach to the max. length or set length. Check it every three months.


(5) Check the mechanical moving of the contactor every three months; if there is any damage or condition affecting the safety, contact with ZAPI dealer.

### **Notice:**

- ◆ After the controller is installed, the wheels of the truck shall be lifted (off the ground) for test, so that even if there is a connection error, there will be no danger.
- ◆ After the battery switch is disconnected, there is a certain voltage remains in the filter capacitor for a period of time. If the inverter needs to be repaired at this time, the battery must be cut off first, and then the 10-100 ohm resistance shall be connected to the positive and negative poles of the inverter to short-circuit the residual voltage on the capacitor.
- ◆ Do not connect the controller to the battery with different nominal voltage shown in the nameplate. If the voltage is high, it will cause power unit failure, and if the voltage is low, the logic card will not work.

- ◆ The manufacturer shall provide quality assurance for the motor controller, and timely inform the manufacturer to provide after-sales service in case of failure; if not authorized and approved by the manufacturer, please do not open the motor controller for maintenance, and the user shall bear the responsibility for personal and property losses caused by the user's unauthorized maintenance.

#### 4.7 Hand brake switch

When the truck is stopped and driver is away from the seat, apply parking brake manually. At this time, only hand brake light  on the meter turns on all the time and truck can not travel.


When restarting the truck, release the parking brake manually, at this time, the brake light  on the meter turns off. The track can travel again.



Figure 4-8 hand brake switch



**Danger:**

**Do not apply parking brake when travelling.**

**Under certain cases, if parking brake is applied suddenly, goods may falling down.**

**Parking brake can be applied only when the truck can not be stopped through braking pedal during travelling.**

#### **4.8 Emergency button**

The emergency power-off switch has the ability to cut off the load current and overload current, which can be used as a safety switch. The emergency power-off switch of the truck has two functions: first, as a safety switch, press the switch in case of emergency to disconnect the battery output, so as to ensure the safety of the whole truck; it is forbidden to operate the button frequently in case of non emergency. Second, it can effectively prevent the battery feeding problem to turn off the emergency power-off switch in the following three cases.

(1) When the forklift is not used for more than 72 hours for a long time, please press the emergency power-off switch when ensuring that the power of lithium battery meets the storage requirements (see the operation and maintenance manual of lithium power battery for details);

(2) In the process of truck transportation, please press the emergency power-off switch when ensuring that the battery capacity meets the transportation requirements (see the operation and maintenance manual of lithium power battery for details);

(3) During maintenance, please press the emergency power-off switch;

**Note: If the emergency power-off switch is not pressed when the truck is not used for a long time, the battery is easy to feed, which affects the normal use of the truck.**

Release the emergency button before working.



Figure 4-9 Emergency button



**Danger:**

**Do not press emergency button when travelling.**

**Under certain cases, if emergency button is pressed suddenly, goods may falling down which may cause personnel injury and goods damage.**

**Emergency button can be applied only when the truck can not be stopped with other methods during travelling.**

**4.9 Troubleshoot**

The failure of the motor controller can be judged by the times of flashing LED, hand-held display information and code displayed by the instrument.

**4.9.1 AC2/ACE2 controller**

(1) Common fault of travelling system (The second line of instrument indicates “ON NODE 2”)

Table 4-5 Common fault of travelling system of AC2/ACE2

Fault Code	Implication	Note	Measures
13	EEPROM KO	EEPROM damaged	The fault is in the internal memory for storing and regulating parameters. When the fault appears, the machine automatically stops. If the fault still exists, when reconnecting it after switching off the electric lock, change the controller. If the fault disappears, the parameters previously stored will be replaced with default value.

17	LOGIC FAILURE #3	Logic card failure 3	Current protection function failure of logic card: change the controller.
18	LOGIC FAILURE #2	Logic card failure 2	Circuit failure of phase voltage feedback hardware on logic card. Change the controller.
19	LOGIC FAILURE #1	Logic card failure 1	The failure produced when the function of low or over voltage acts. In 24V system, the voltage detected by controller exceeds 45V or lower than 9V. In 48V system, the voltage detected by controller exceeds 65V or lower than 11V. Possible causes: (1) Check if there is short circuit in the electric circuit system such as DC-DC and brake coils etc or if the input power supply contact of controller is good. (2) If the battery voltage is excessively low or high. (3) Check B+ and B and see if the power cable on the wiring terminal of contactor etc is tightly fixed. (4) If the voltage calibration parameter of controller is in consistent with actual voltage. (5) There is circuit fault of overvoltage protection hardware on logic card, change the controller.
30	VMN LOW	Low VMN	Cause: The high-end voltage of MOS during startup is 66% smaller than the capacitor voltage or this voltage is smaller than the required value in the operation of motor. Possible causes: (1) Wiring of motor is incorrect or there is circuit problem in motor. Check if three-phase connection of motor is correct, if there is any leakage of electricity on ground and circuit break of motor coil. (2) If actuation of main contactor is rigid and if there is any wearing on contact? (3) Change the controller .
31	VMN HIGH	High VMN	Cause: During startup, the low-end voltage of MOS tube is 10% higher than that of normal battery voltage or the phase voltage is higher than 1/2 of battery voltage. Possible cause: (1) The wiring of motor is incorrect or there exists problem in motor circuit . Check if three-phase connection of motor is correct, if there is any leakage of electricity on the ground and circuit break of motor coil. (2) Change the controller
37	CONTACTOR CLOSED	Adhesion of contactor	When the coil of main contactor is closed, the controller should first check if the contact of main contactor is adhered. Try to discharge the capacitance. If the capacitance voltage is reduced by 20% of the battery voltage, the fault possibly appears. (1) Suggest to check if the contact of contactor is adhered or change the contactor.
38	CONTACTOR OPEN	Contactor open	Logic card drives the coil of main contactor, but the contactor does not close, possible causes: (1) Mechanical fault and locking etc of contactor. (2) Poor contact of contactor. (3) If contactor works normally, change the controller.
53	STBY I HIGH	High standby	The signal output by current sensor detected by

		current	micro-control system exceeds the scope allowed for non-operation current. The trouble has nothing to do with the peripheral parts, so the controller needs to be changed.
60	CAPACITOR CHARGE	Wrong capacitance charge	<p>When the electric lock is switch on, inverter will charge the capacitance through power resistance and check if capacitance is fully charged within the time stipulated, otherwise, the capacitance voltage remains 20% lower than battery voltage, the inverter will give alarm and the main contactor will not close.</p> <p>Possible causes:</p> <p>(1) Peripheral equipment, e.g. DC-DC, motor or other equipment etc interfere with the charging process of controller and these interferences need to be eliminated.</p> <p>(2) The charging resistance is disconnected, there is fault on charging circuit and power module ,so controller needs to be changed.</p>

62	TEMPERAURE	Over-high temperature	<p>In case that total power is allowed, the temperature of controller exceeds 85°C( it relates to the parameter “ MAXIMUM CURRENT”.)</p> <p>Their corresponding relations are as follows: Parameter set alarm temperature</p> <table border="0"> <tr> <td>MAXIMUM CURRENT=50%</td> <td>96°C</td> </tr> <tr> <td>MAXIMUM CURRENT=60%</td> <td>94°C</td> </tr> <tr> <td>MAXIMUM CURRENT=70%</td> <td>92°C</td> </tr> <tr> <td>MAXIMUM CURRENT=80%</td> <td>90°C</td> </tr> <tr> <td>MAXIMUM CURRENT=90%</td> <td>88°C</td> </tr> <tr> <td>MAXIMUM CURRENT=100%</td> <td>86°C</td> </tr> </table> <p>Now, the max. current of controller decreases with the increase of the max. current temperature. When the temperature is 105°C, the current of controller decreases to zero.</p> <p>The fault appears if chopper is in the cold state:</p> <p>(1) Temperature calibration parameter of logic card is incorrect, check parameters.</p> <p>(2) The internal temperature sensor of controller has trouble and change the controller.</p>	MAXIMUM CURRENT=50%	96°C	MAXIMUM CURRENT=60%	94°C	MAXIMUM CURRENT=70%	92°C	MAXIMUM CURRENT=80%	90°C	MAXIMUM CURRENT=90%	88°C	MAXIMUM CURRENT=100%	86°C
MAXIMUM CURRENT=50%	96°C														
MAXIMUM CURRENT=60%	94°C														
MAXIMUM CURRENT=70%	92°C														
MAXIMUM CURRENT=80%	90°C														
MAXIMUM CURRENT=90%	88°C														
MAXIMUM CURRENT=100%	86°C														
65	MOTOR TEMPERAT.	High motor temperature	<p>If temperature digital switch of motor is turned on or analog signal exceeds the cutoff value, the trouble is produced. When the motor temperature reaches 120°C, the controller gives alarm, the vehicle can move at this time. But the max. current and performance are cut down. When the motor temperature reaches 125°C, motor stops working. Now try to lower the temperature of the motor. If the fault still exists when motor is cooled, check the circuit and change the controller if he circuit is OK.</p>												
66	BATTERY LOW	Low capacity of battery	<p>If parameter of “BATTERY CHECK” for battery test is not set as 0 and when charging capacity of battery is lower than 15% and there is no grid on instrument, fault alarm is given and the lifting function is locked, now charge it timely. In case the battery has electricity, check if the</p>												

			value of parameter “ADJUST BATTERY” of controller is consistent with battery voltage.
74	DRIVER SHORTED	Short circuit of driver	When electric lock is close, the microprocessor will detect if driver of main contactor is short-circuited and alarm will be given if yes. Check if there is short circuit on the positive pair A 16 of main contactor coil or negative pole. Change the controller if everything is OK.
75	CONTACTOR DRIVER	Fault of contactor driver	The coil of main contactor can not be normally driven and change the controller if the coil of main contactor has no fault.

78	VACC NOT OK	Accelerator error	<p>Detection time : Standby state</p> <p>The alarm indicates the voltage of accelerator is 1V larger than the min. value set in the signal scope (PROGRAM VACC) of accelerator.</p> <p>Possible causes:</p> <p>(1) The upper and lower voltage limit values of accelerator have not been collected and do it again when entering into PROGRAM VACC.</p> <p>(2) Accelerator error: Accelerator pedal possibly fails to return or internal error of accelerator.</p> <p>(3) The failure of controller</p>
79	INCORRECT START	Incorrect starting sequence	<p>Possible causes for incorrect starting sequence:</p> <p>(1) Direction switch is closed before starting.</p> <p>(2) Incorrect operation sequence.</p> <p>(3) Incorrect wire joining.</p> <p>(4) If the trouble still can not be eliminated, change the controller.</p>
80	FORW+BACK	Forward and backward signals exist at the same time(adhesion of direction switch )	<p>The machine will keep on detecting. But when there are signals requesting operation from two directions at the same time, alarm is given. Possible causes:</p> <p>(1) The wire is damaged.</p> <p>(2) Direction switch fault.</p> <p>(3) Improper operation.</p> <p>(4) Change the controller if the trouble still can not be eliminated.</p>
82	ENCODER ERROR	Encoder error	<p>The controller detects the great difference between two consecutive speed readings of encoder. As the encoder in the system can not change great speed within very short time, so, the encoder may have the trouble (the circuits of one or two encoders are destroyed or broken). Check the mechanical and circuit function of the encoder. The alarm is possibly caused by the electromagnetic noise on the bearing of sensor. If not, change the controller.</p>
220	PROG VACC NOT OK	Programming error of accelerator	<p>If “2.5 POT” is set as “ON”, controller will check the max. and min values of potentiometer recorded during programming. If the min. value of forward is smaller than the max. value of backward or the min. value of backward is bigger than the max. value of forward, the fault will appear. Check if the potentiometer is correct, or make a data acquisition again.</p>
222	WAITING FOR	Waiting for	In CAN communication network, a controller receives a



	NODE	node signal	signal that the other controller can not make normal communication and the controller always is always in the waiting state until CAN communication network is completely normal. Check why the wiring of the modules that fails to communicate is abnormal and see if the software edition or parameter setting is correct.
223	WATCHDOG #1	Watchdog fault 1	During startup, watchdog circuit is activated before software is started. The watchdog signal is invalid in standby or operation state( alarm state) Fault analysis: Hardware circuit of watchdog or output of micro-controller is damaged. The above two cases have nothing to do with external parts, so change the controller.
224	COIL SHORTED EF	Short circuit of auxiliary coil	When the electromagnetic brake connecting to the output terminal of CNA#18IS or auxiliary coil is shorted, the fault signal is produced. Withdraw from the fault state through releasing brake after eliminating the overload condition so that the running request is valid. Fault analysis: Generally, the fault code indicates that the trouble is on the harness or loading coil. So check the connection between controller output and load first. If there is no trouble of external load, the trouble is inside the controller and the controller needs to be changed.
227	WATCHDOG #2	Watchdog fault 2	Cause: During startup, the watchdog circuit is activated before software is started. The watchdog signal is invalid (alarm state)in case of standby or operation state. Fault analysis: The hardware circuit of watchdog or output of micro-controller is damaged. The above two cases has nothing to do with external parts, so change the controller.
228	TILLER OPEN	TILLE off	When tiller input switch is off, about 30S later, the main contactor will be off and warning is given. The warning disappears for next operation.
229	SAFETY INPUT	Safety Input fault	When the safety input switch is off, so is the main contactor, meanwhile the electromagnetic brake or auxiliary output coil is driven. Check if the port of A11 is correctly connected. Change the controller if other parts are correct.
230	COIL SHORTED MC	Coil short circuit of main contactor	CAUSE: When the short circuit coil of main contactor is connected to the output port of CAN#16, the fault signal is produced. After overload is removed, it automatically withdraw from fault state through releasing brake and then the running instruction is valid. Fault analysis: Generally, the fault code indicates that the trouble is on the harness or loading coil. So check the connection between controller output and load first. If there is no trouble of external load, the trouble is inside the controller and the controller needs to be changed.
231	COIL SHORTED HW KO	Fault of coil protection circuit	Short circuit fault of the coil protection circuit used to drive main contactor, electromagnetic brake or auxiliary devices Fault analysis: Change the controller

232	KEYOFF SHORTED	Short circuit of key switch	<p>At start-up stage, if controller detects that there is low logic level signal when key switch is off, there is a fault.</p> <p>Fault analysis: Most possibly is that the voltage is excessively low, suggest to check the followings :</p> <p>(1) If the key switch is based on external load (e.g. the starting of DC-DC converter, the input signal of relay or contactor switch is lower than starting voltage).</p> <p>(2) Check the positive and negative poles of power cable and cell end and the connection between –BATT and +BATT of main contactor and controller. It must be connected with screw and the torsion scope is 13NM~15NM..</p> <p>(3) If no voltage drop has been detected on the power supply line, the fault signal is produced every time when the key switch is on. The fault may be possibly in the hardware of the controller; therefore, the controller needs to be changed.</p>
233	POWER MOS SHORTED	Short circuit of power MOS	<p>Software will check the power bridge before main contactor is closed: It converts into low-end power of MOS and the phase voltage value drops to –BATT (rise to +BATT). If the change of phase voltage value does not conform to the instruction, this fault signal is produced. Change the controller.</p>
235	HANDBRAKE	Fault of handbrake switch	<p>Handbrake input signal is valid when the running instruction is issued.</p> <p>Resolution: Possible causes for the fault :</p> <p>(1) Handbrake switch is damaged or wiring is wrong.</p> <p>(2) Handbrake switch works normally. In TESTER menu, handbrake is always ON. This is a logic fault, so change the controller.</p>
236	CURRENT GAIN	Fault of current gain	<p>The maximum current gain parameter is a factory set value, which indicates that the max. current regulating parameter program has not be used.</p> <p>Resolution: Correctly set program for current gain parameter by ZAPI technical personnel.</p>
237	ANALOG INPUT	Fault of Analog Input	<p>The fault signal is produced when A/D of all analog signals is converted into a fixed value and delay exceeds 400 millisecond. This function is used to check the fault of A/D converter or analog signal conversion.</p> <p>Fault analysis: Change the controller if the fault always exists.</p>
238	WRONG ZERO VOLTAGE	Wrong Zero Voltage	<p>During startup, the feedback value of high end voltage of VMN is not at about 2.5V. The circuit of controller is damaged.</p> <p>Fault analysis : The following checks are suggested:</p> <p>(1) Internal connection of motor.</p> <p>(2) Power cable connection of motor.</p> <p>(3) Drain current between motor and vehicle casing.</p> <p>(4) If the motor connection is good, the problem is inside the controller and changes it.</p>
239	SAFETY	Failure of	Driver short circuit of safety output.

	OUTPUT	safety output	Fault analysis: Check if there is short circuit or Low impedance push-pull output between A19 and -BATT. If it is the circuit trouble of driver of logic card, change the controller.
240	HARDWARE FAULT	Hardware circuit fault	Before driving the coil of main contactor, controller tests MOS driver or the auxiliary output drive is the invalid watchdog circuit signal. If it is not driven, there produces a fault signal. Fault analysis: Change the controller.
241	FLASH CHECKSUM	Flash Memory fault	When key is switched on, the program is a positive value in flash memory and the fault signal is produced in case of negative value. Fault analysis: The problem is on flash memory of microcontroller. The flash memory may be damaged or the program stored destroyed. Try to reset the program of logic card. The fault exists in the microcontroller if the fault still exists, Change the controller.
242	ENCODER LOCKED	Feedback signal fault of encoder	Under normal condition, if the target speed is greater than 10 Hz and the rotation speed of motor higher than 1.5 Hz, the feedback signal of encoder checked by controller should exceed a threshold value. If not, the controller will give alarm. Test the motor encoder and see if motor or wiring is normal and if installation correct. Change the controller if periphery is normal.
243	SENS MOT TEMP KO	Fault of temperature sensor	Phenomenon: The output signal of temperature sensor of motor exceeds the scope. Solution: Check the value of sensor and connection of wires and the fault is inside the controller in case of no problem found.
244	SOFTWARE ERROR	Software error	During software testing, there are many reasons for such fault such as: CAN communication fault and EEPROM READ/WRITE ERROR etc. Check the parameter of "DEBUG MODE", the value must be "OFF".
245	WRONG RAM MEMORY	Dynamic memory fault	Wrong contents are found when testing the main memory: The registration address is "DIRTY" and the fault will restrict the operability of vehicle. Fault analysis: Switch on the key after switching it off and change the controller if the trouble still exists.
246	AUX DRIVER OPEN	Auxiliary output drive fault	Auxiliary coil drive circuit can not drive load. The equipment or drive coil is damaged. Change the controller.
247	DATA ACQUISITION	Data acquisition	The fault will be hinted when calibrating the current gain. No treatment is needed and it will automatically disappear when calibration is finished.
248	NO CAN MESSAGE	NO CAN signal	CAN communication fault between pump and traction. Check CAN wiring, software setting and edition information.
249	CHECK UP NEED	Service time	It is the time for service and maintenance is needed.
250	THERMIC SENS KO	Temperature sensor fault	The output signal of temperature sensor of controller exceeds the range.

			The fault has nothing to do with external parts and change the controller.
251	WRONG SET BATTERY	Wrong set of battery	During startup, the controller tests if the voltage of battery is within the nominal scope. Check if the value of BATTERY VOLTAGE parameter in the menu conforms to that on the voltmeter. If not, make them conform to each other with the function of ADJUST BATTERY. Change the battery.
253	SLIP PROFILE	Slip fault	Wrong selection of SLIP PROFILE PARAMETERS. Check the setting of these values in the hardware setting parameters.
254	AUX DRIVER SHORTED	Auxiliary drive shorted	Short circuit of the driving electric circuit of the electromagnetic brake or auxiliary electric brake. Check if there is short circuit between the A16 and BATT. Circuit fault of the drive unit of the logic card; change the controller.
207	BMS INIT ERROR	Initiation fault of lithium battery BMS	The battery management System BMS inside the lithium battery carries out self check after power on, but does not send 0x2f0 ID to the CAN bus after self check. Check the message sent by BMS through CAN analysis software.
208	NO CAN MSG BMS01	Sudden break off of 0X2F0 ID sent by battery BMS	The battery management System BMS inside the lithium battery is sending 0x2f0 ID normally. The controller can receive the ID normally and work, but the ID is suddenly interrupted. Check the message sent by BMS through CAN analysis software.
211	BMS 01	High battery voltage	Check if the voltage of the battery is correct.
212	BMS 02	Overdischarge Of battery unit	Check if the voltage of the battery unit is correct.
213	BMS 03	Communication interrupt of BMS and controller BMS	Check if the message on CAN is correct through CAN analysis software.
214	BMS 04	Under voltage of battery unit	Check if the voltage of the battery unit is correct.
215	BMS 05	High output current of lithium battery	Check if the output current of lithium battery is below the highest value.
216	BMS 06	High temperature of lithium battery	Check if the temperature of lithium battery is correct.
217	BMS 07	Warning of lithium battery temperature	The temperature of lithium battery reaches the alarm value, but it can continue to work with low intensity, but it needs to stop working immediately and check whether the temperature of lithium battery is correct
218	BMS 08	Charging protection	The battery is charging and any operation is prohibited.

(2) Common fault of pump control system (The second line of instrument indicates “ON NODE 5”)

Table 4-6 Common fault of pump control system

Fault Code	Implication	Note	Measures
13	EEPROM KO	EEPROM damaged	The fault is in the internal memory for storing and regulating parameters. When the fault appears, the machine automatically stops. If the fault still exists, when reconnecting it after switching off the electric lock, change the controller. If the fault disappears, the parameters previously stored will be replaced with default value.
17	LOGIC FAILURE #3	Logic card failure 3	Current protection function failure of logic card: change the controller.
18	LOGIC FAILURE #2	Logic card failure 2	Circuit failure of phase voltage feedback hardware on logic card. Change the controller.
19	LOGIC FAILURE #1	Logic card failure 1	The failure produced when the function of low or over voltage acts. In 24V system, the voltage detected by controller exceeds 45V or lower than 9V. In 48V system, the voltage detected by controller exceeds 65V or lower than 11V. Possible causes: (1) Check if there is short circuit in the electric circuit system such as DC-DC and brake coils etc or if the input power supply contact of controller is good. (2) If the battery voltage is excessively low or high. (3) Check B+ and B and see if the power cable on the wiring terminal of contactor etc is tightly fixed. (4) If the voltage calibration parameter of controller is in consistent with actual voltage. (5) There is circuit fault of overvoltage protection hardware on logic card, change the controller.
30	VMN LOW	Low VMN	Cause: The high-end voltage of MOS during startup is 66% smaller than the capacitor voltage or this voltage is smaller than the required value in the operation of motor. Possible causes: (1) Wiring of motor is incorrect or there is circuit problem in motor. Check if three-phase connection of motor is correct, if there is any leakage of electricity on ground and circuit break of motor coil. (2) If actuation of main contactor is rigid and if there is any wearing on contact? (3) Change the controller .
31	VMN HIGH	High VMN	Cause: During startup, the low-end voltage of MOS tube is 10% higher than that of normal battery voltage or the phase voltage is higher than 1/2 of battery voltage. Possible cause: (1) The wiring of motor is incorrect or there exists problem in motor circuit . Check if three-phase connection of motor is correct, if there is any leakage of electricity on

			the ground and circuit break of motor coil. (2) Change the controller												
53	STBY I HIGH	High standby current	The signal output by current sensor detected by micro-control system exceeds the scope allowed for non-operation current. The trouble has nothing to do with the peripheral parts, so the controller needs to be changed.												
60	CAPACITOR CHARGE	Wrong capacitance charge	When the electric lock is switch on, inverter will charge the capacitance through power resistance and check if capacitance is fully charged within the time stipulated, otherwise, the capacitance voltage remains 20% lower than battery voltage, the inverter will give alarm and the main contactor will not close. Possible causes: (1) Peripheral equipment, e.g. DC-DC, motor or other equipment etc interfere with the charging process of controller and these interferences need to be eliminated. (2) The charging resistance is disconnected, there is fault on charging circuit and power module ,so controller needs to be changed.												
62	TEMPERAURE	Over-high temperature	In case that total power is allowed, the temperature of controller exceeds 85°C( it relates to the parameter “ MAXIMUM CURRENT”.) Their corresponding relations are as follows: Parameter set alarm temperature <table style="margin-left: 20px;"> <tr> <td>MAXIMUM CURRENT=50%</td> <td>96°C</td> </tr> <tr> <td>MAXIMUM CURRENT=60%</td> <td>94°C</td> </tr> <tr> <td>MAXIMUM CURRENT=70%</td> <td>92°C</td> </tr> <tr> <td>MAXIMUM CURRENT=80%</td> <td>90°C</td> </tr> <tr> <td>MAXIMUM CURRENT=90%</td> <td>88°C</td> </tr> <tr> <td>MAXIMUM CURRENT=100%</td> <td>86°C</td> </tr> </table> Now, the max. current of controller decreases with the increase of the max. current temperature. When the temperature is 105°C, the current of controller decreases to zero. The fault appears if chopper is in the cold state: (1) Temperature calibration parameter of logic card is incorrect, check parameters. (2) The internal temperature sensor of controller has trouble and change the controller.	MAXIMUM CURRENT=50%	96°C	MAXIMUM CURRENT=60%	94°C	MAXIMUM CURRENT=70%	92°C	MAXIMUM CURRENT=80%	90°C	MAXIMUM CURRENT=90%	88°C	MAXIMUM CURRENT=100%	86°C
MAXIMUM CURRENT=50%	96°C														
MAXIMUM CURRENT=60%	94°C														
MAXIMUM CURRENT=70%	92°C														
MAXIMUM CURRENT=80%	90°C														
MAXIMUM CURRENT=90%	88°C														
MAXIMUM CURRENT=100%	86°C														
65	MOTOR TEMPERAT.	High motor temperature	If temperature digital switch of motor is turned on or analog signal exceeds the cutoff value, the trouble is produced. When the motor temperature reaches 120°C, the controller gives alarm, the vehicle can move at this time. But the max. current and performance are cut down. When the motor temperature reaches 125°C, motor stops working. Now try to lower the temperature of the motor. If the fault still exists when motor is cooled, check the circuit and change the controller if he circuit is OK.												
74	DRIVER SHORTED	Short circuit of driver	When electric lock is close, the microprocessor will detect if driver of main contactor is short-circuited and alarm will be given if yes. Check if there is short circuit on the												

			positive pair A 16 of main contactor coil or negative pole. Change the controller if everything is OK.
78	VACC NOT OK	Accelerator error	<p>Detection time : Standby state</p> <p>The alarm indicates the voltage of accelerator is 1V larger than the min. value set in the signal scope (PROGRAM VACC) of accelerator.</p> <p>Possible causes:</p> <p>(1) The upper and lower voltage limit values of accelerator have not been collected and do it again when entering into PROGRAM VACC.</p> <p>(2) Accelerator error: Accelerator pedal possibly fails to return or internal error of accelerator.</p> <p>(3) The failure of controller</p>
79	INCORRECT START	Incorrect starting sequence	<p>Possible causes for incorrect starting sequence:</p> <p>(1) Direction switch is closed before starting.</p> <p>(2) Incorrect operation sequence.</p> <p>(3) Incorrect wire joining.</p> <p>(4) If the trouble still can not be eliminated, change the controller.</p>
82	ENCODER ERROR	Encoder error	The controller detects the great difference between two consecutive speed readings of encoder. As the encoder in the system can not change great speed within very short time, so, the encoder may have the trouble (the circuits of one or two encoders are destroyed or broken). Check the mechanical and circuit function of the encoder. The alarm is possibly caused by the electromagnetic noise on the bearing of sensor. If not, change the controller.
221	SEAT MISMATCH	Seat switch signal fault	If the parameter of the "SAFE OUT CONFIG" is 1, the fault may occur. If the traction seat switch signal is different from the pump controller seat switch signal, the fault may occur. Check the seat switch connecting.
222	WAITING FOR NODE	Waiting for node signal	In CAN communication network, a controller receives a signal that the other controller can not make normal communication and the controller always is always in the waiting state until CAN communication network is completely normal. Check why the wiring of the modules that fails to communicate is abnormal and see if the software edition or parameter setting is correct.
223	WATCHDOG #1	Watchdog fault 1	<p>During startup, watchdog circuit is activated before software is started. The watchdog signal is invalid in standby or operation state( alarm state)</p> <p>Fault analysis: Hardware circuit of watchdog or output of micro-controller is damaged. The above two cases have nothing to do with external parts, so change the controller.</p>
227	WATCHDOG #2	Watchdog fault 2	<p>Cause: During startup, the watchdog circuit is activated before software is started. The watchdog signal is invalid (alarm state)in case of standby or operation state.</p> <p>Fault analysis: The hardware circuit of watchdog or output of micro-controller is damaged. The above two cases has nothing to do with external parts, so change the controller.</p>
229	SAFETY	Safety Input	When the safety input switch is off, so is the main

	INPUT	fault	contactor, meanwhile the electromagnetic brake or auxiliary output coil is driven. Check if the port of A11 is correctly connected. Change the controller if other parts are correct.
232	KEYOFF SHORTED	Short circuit of key switch	At start-up stage, if controller detects that there is low logic level signal when key switch is off, there is a fault. Fault analysis: Most possibly is that the voltage is excessively low, suggest to check the followings : (1) If the key switch is based on external load (e.g. the starting of DC-DC converter, the input signal of relay or contactor switch is lower than starting voltage). (2) Check the positive and negative poles of power cable and cell end and the connection between –BATT and +BATT of main contactor and controller. It must be connected with screw and the torsion scope is 13NM~15NM.. (3) If no voltage drop has been detected on the power supply line, the fault signal is produced every time when the key switch is on. The fault may be possibly in the hardware of the controller; therefore, the controller needs to be changed.
233	POWER MOS SHORTED	Short circuit of power MOS	Software will check the power bridge before main contactor is closed: It converts into low-end power of MOS and the phase voltage value drops to –BATT (rise to +BATT). If the change of phase voltage value does not conform to the instruction, this fault signal is produced. Change the controller.
237	ANALOG INPUT	Fault of Analog Input	The fault signal is produced when A/D of all analog signals is converted into a fixed value and delay exceeds 400 millisecond. This function is used to check the fault of A/D converter or analog signal conversion. Fault analysis: Change the controller if the fault always exists.
238	WRONG ZERO VOLTAGE	Wrong Zero Voltage	During startup, the feedback value of high end voltage of VMN is not at about 2.5V. The circuit of controller is damaged. Fault analysis : The following checks are suggested: (1) Internal connection of motor. (2) Power cable connection of motor. (3) Drain current between motor and vehicle casing. (4) If the motor connection is good, the problem is inside the controller and changes it.
239	SAFETY OUTPUT	Failure of safety output	Driver short circuit of safety output. Fault analysis: Check if there is short circuit or Low impedance push-pull output between A19 and -BATT. If it is the circuit trouble of driver of logic card, change the controller.
240	HARDWARE FAULT	Hardware circuit fault	Before driving the coil of main contactor, controller tests MOS driver or the auxiliary output drive is the invalid watchdog circuit signal. If it is not driven, there produces a fault signal. Fault analysis: Change the controller.
241	FLASH	Flash	When key is switched on, the program is a positive value



	CHECKSUM	Memory fault	in flash memory and the fault signal is produced in case of negative value. Fault analysis: The problem is on flash memory of microcontroller. The flash memory may be damaged or the program stored destroyed. Try to reset the program of logic card. The fault exists in the microcontroller if the fault still exists, Change the controller.
242	ENCODER LOCKED	Feedback signal fault of encoder	Under normal condition, if the target speed is greater than 10 Hz and the rotation speed of motor higher than 1.5 Hz, the feedback signal of encoder checked by controller should exceed a threshold value. If not, the controller will give alarm. Test the motor encoder and see if motor or wiring is normal and if installation correct. Change the controller if periphery is normal.
243	SENS MOT TEMP KO	Fault of temperature sensor	Phenomenon: The output signal of temperature sensor of motor exceeds the scope. Solution: Check the value of sensor and connection of wires and the fault is inside the controller in case of no problem found.
244	SOFTWARE ERROR	Software error	During software testing, there are many reasons for such fault such as: CAN communication fault and EEPROM READ/WRITE ERROR etc. Check the parameter of "DEBUG MODE", the value must be "OFF".
245	WRONG RAM MEMORY	Dynamic memory fault	Wrong contents are found when testing the main memory: The registration address is "DIRTY" and the fault will restrict the operability of vehicle. Fault analysis: Switch on the key after switching it off and change the controller if the trouble still exists.
247	DATA ACQUISITION	Data acquisition	The fault will be hinted when calibrating the current gain. No treatment is needed and it will automatically disappear when calibration is finished.
248	NO CAN MESSAGE	NO CAN signal	CAN communication fault between pump and traction. Check CAN wiring, software setting and edition information.
249	CHECK UP NEED	Service time	It is the time for service and maintenance is needed.
250	THERMIC SENS KO	Temperature sensor fault	The output signal of temperature sensor of controller exceeds the range. The fault has nothing to do with external parts and change the controller.
251	WRONG SET BATTERY	Wrong set of battery	During startup, the controller tests if the voltage of battery is within the nominal scope. Check if the value of BATTERY VOLTAGE parameter in the menu conforms to that on the voltmeter. If not, make them conform to each other with the function of ADJUST BATTERY. Change the battery.
253	SLIP PROFILE	Slip fault	Wrong selection of SLIP PROFILE PARAMETERS. Check the setting of these values in the hardware setting parameters.

## 4.9.2 HP-CAN controller

This series of controllers can obtain diagnostic information through the times of LED flashes and fault codes sent to the instrument.

(1) Common fault of control system (The second line of instrument indicates “ON NODE 5”)

Table 4-7 Common fault and remedy of control system

CODE	NOTE	Fault explanation
13	EEPROM KO	EEPROM fault
241	CAN BUS KO	CAN BUS is not connected.
243	KEYOFF	Key switch short circuit
244	WATCHDOG	Self check fault of logic card
76	COIL SHORTED	Coil short circuit
74	DRIVER SHORTED	Driver short circuit
53	STANDBY HIGH CURRENT	The current is high when standby.
30	VMN LOW	The voltage is low.
49	CURRENT ALWAYS EQUAL 0	The current is 0.
33	FULL CONDUCTION KO	It is not completely conducted.
78	VACC NO OK	Fault of speed adjusting sensor
62	THERMIC SENSOR KO	Fault of temperature sensor
66	BATTERY LOW	Insufficient of battery electric quantity
79	INCORRECT START	Protection of starting order
7	CHOPPER NOT CONFIG	Fault of logic data storage unit
242	BATTERY OVERVOLTAGE	overhigh battery electric quantity
246	WAIT MAIN CONTAC	The main contactor is conducted.

(2) Fault explain of HP-CAN controller

a) < BATTERY LOW >

The battery charge is low.

The alarm is signalled only if the BATTERY CHECK option has been selected. All functions except hydrdrive are inhibited.

b) < INCORRECT START >

A running request is present on key startup.

Possible causes:

- Operator error.

- Request microswitch stuck.

c) < STANDBY HIGH CURRENT >

Test carried out in standby, checks that the current is nil. If this is not verified, an alarm is signalled. This alarm shuts down the machine.

Possible causes:

- Current sensor broken and logic failure.

First replace the logic, and if the defect persists, replace the power unit.

d) < CURRENT ALWAYS EQUAL 0 >

Test carried out in running. Checks that the current during running is greater than a minimum value. If not, an alarm is signalled and the machine is shut down.

Possible causes:

- The current sensor is faulty. Replace the power unit.

e) < WATCH-DOG >

The test is made in both running and standby. It is a self-diagnosis test within the logic. If an alarm should occur, replace the logic.

f) < COIL SHORTED >

Cause:

This alarm occurs when there is a short circuit of LC coil connected to driver output of the HP CAN. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling an hydraulic demand.

Troubleshooting:

● The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.

- In case no failures/problems have been found

g) < DRIVER SHORTED >

Cause:

The driver of the main contactor coil is shorted.

Troubleshooting:

- Check if there is a short or a low impedance pull-down between NMC and –BATT.

- The driver circuit is damaged in the controller, which has to be replaced.

h) < VMN LOW >

Cause:

The pump motor output is lower than expected, considering the pwm applied.

Troubleshooting:

- If the problem occurs at start up (the LC does not close at all), check:

- Motor internal connections (ohmic continuity).

- Motor power cables connections.

- If the motor connection are OK, the problem is inside the controller.

- If the problem occurs after closing the LC (the LC closed and then opens back again), check:

- Motor connections.

- If motor windings/cables have leakages towards truck frame.

- If no problem is found on the motors, the problem is inside the controller.

- If the alarm occurs during motor running, check:

- Motor connections.

- If motor windings/cables have leakages towards truck frame.

- That the LC power contact closer properly, with a good contact.

- If no problem are found on the motors, the problem is inside the controller.

i) < DRIVER SHORTED >

Cause:

The driver of the main contactor coil is shorted.

Troubleshooting:

- Check if there is a short or a low impedance pull-down between NMC (CNA#26) and –BATT.

- The driver circuit is damaged in the controller, which has to be replaced.

j) < NO FULL COND. >

The test is carried out in full conduction. If, in this condition, the VMN is found to be greater than  $1/3 V_{BATT}$ , the diagnostic circuit is faulty, causing a safety risk, and thus machine operation is inhibited. If the defect persists, replace the logic.

k) < CAN BUS KO >

Cause:

No Can messages received by the HP CAN microcontroller from other devices (CAN BUS nodes).

Troubleshooting:

This alarm could be caused by a can bus malfunctioning, which blinds communication. Otherwise it is an internal fault of the controller which must be replaced.

(3) Common fault for ZAPI instrument system (The second line of instrument indicates “ON NODE 16”)

Table 4-8 Common fault for instrument system

Fault Code	Implication	Note	Measures
13	EEPROM KO	EEPROM damaged.	Trouble is in the internal memory to store and regulate the parameters. Machine will automatically stops in case of trouble. The controller should be changed if the trouble still exists after reconnection when the electric lock is turned off. If the trouble disappears, the parameters stored before will be replaced with default value.
18	LOGIC	Logic card	Circuit failure of A19 or A20 output port, change the

	FAILURE #2	failure 2	instrument if it has nothing to do with external components.
76	COIL SHORT	Coil short	Drive coil short circuit: Test if there is short circuit on the device connecting with output port of the instrument, otherwise, change the instrument.
102	CAN BUS KO MASTER	CAN communication failure	Instrument no longer receives the data from CAN BUS data wire. In case that the fault code and other alarm signal are displayed together, the fault may possibly be on the CAN interface of the instrument, because the instrument can not receive any message. So, suggest to check the wiring and connection of CAN , or the CAN interface fault of other modules will appear in the CAN network.
103	SERVICE REQUIRED	Maintenance is Needed.	It is the time for maintenance (service).
104	HYDRAULIC OIL		The input of hydraulic oil level is valid during startup. Trouble Diagnosis: Check if the related digital input on instrument (A9) is valid (Refer to TESTER MENU) Check the effective level form(+VB or GND) of the input end (Refer to SET OPTION MENU). (1) If the input is valid, check the relating switch, circuit and oil level. (2) If the input is invalid, there might have an input circuit trouble in the intelligent instrument.

## 5 Hydraulic System

### 5.1 General Description

The hydraulic system consists of oil pump, control valve, priority valve, lift cylinder, tilt cylinder, high & low pressure oil pipe and joint etc. The pump is driven directly by the electromotor. The hydraulic oil flow to control valve through the pump and are distribute to cylinders by the control valve.

#### 5.1.1 Oil pump

The main parts of the gear oil pump for forklift are a pair of external gears mutually meshed and their working principle is as shown in Fig. 5-1.

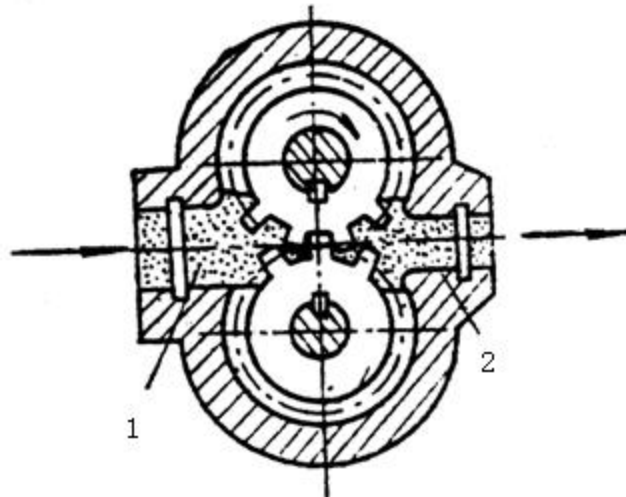


Fig 5-1 Working principle of gear pump  
(1) Oil suction cavity (2) Oil pressing cavity

A pair of meshed involute gear is mounted inside the housing, the two end face seals of gear and gear separate the pump housing into two sealing oil cavities as shown 1 and 2 in the Fig. When the gear of gear pump rotates in the direction shown in the Fig, the volume of space shown by 1 (engaging part for gear disengagement) changes from small to big and forms vacuum. The oil in the oil tank enters into oil suction cavity under the action of atmospheric pressure to fill the intertooth space through the oil suction pipe of pump. While 2 indicates that the volume of space (engaging part for gear entering) changes from big to small and press the oil into pressure oil circuit, i.e.1 is oil suction

cavity, 2 is oil pressing cavity and they are separated by meshing point of two gears. With constant rotation of gear, the suction and discharge outlets of the pump continuously absorb and drain oil.

Oil pump is to turn the mechanical energy of motor into hydraulic energy, so the oil pump is the actuating unit of hydraulic system of the forklift.

The main pump consists mainly of a pump body, a pair of gears, lining plates and oil seals. This pump uses pressure-balance type bearings and a special lubrication method so as to minimum the clearance of the gear face. (See Fig. 5-2)

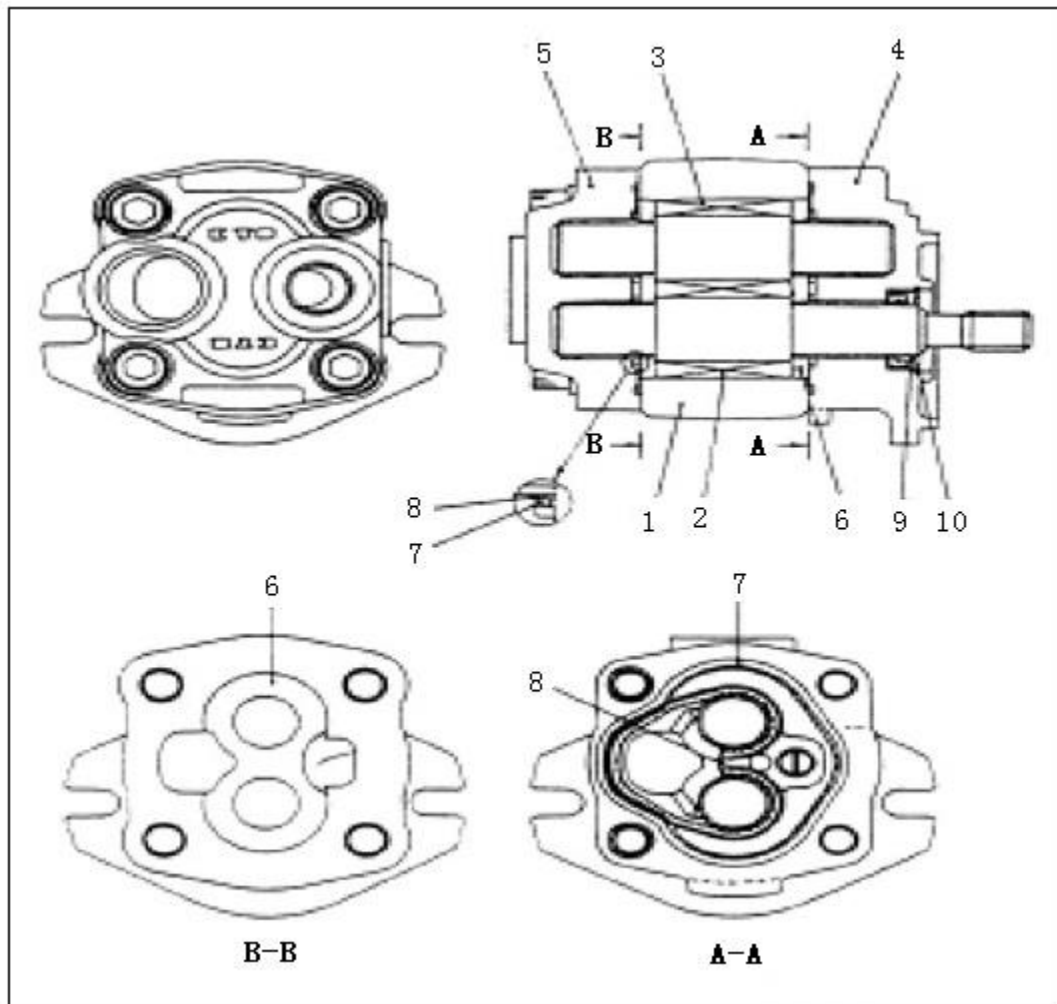


Fig. 5-2 Gear pump

- (1) Pump body (2) Driving gear (3) Driven gear (4) Front cover (5) Rear cover  
 (6) Lining plate (7) Seal ring (8) Ring (9) Oil seal (10) Snap ring



### 5.1.2 Control Valve

The external of the control valve as shown in Fig. 5-3.

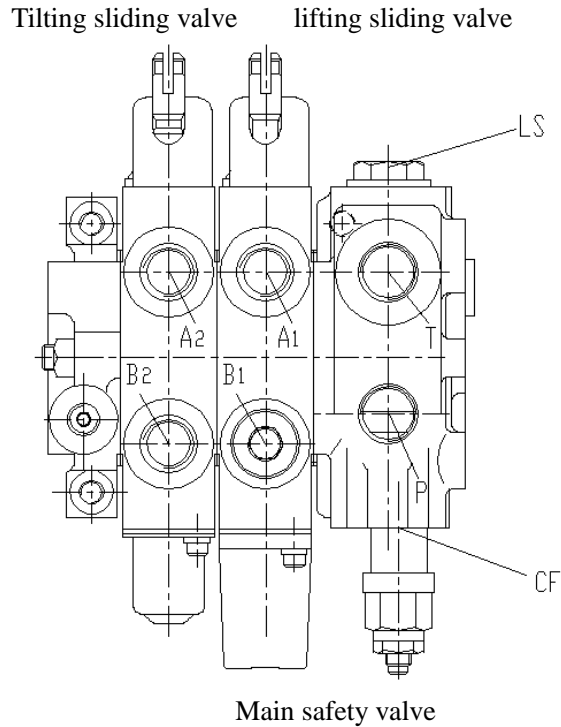


Figure 5-3 Control valve

The control valve adopts two pieces and four body type. The hydraulic oil from working pump distributes the high-pressure oil to the lifting cylinder or tilting cylinder through the control of valve stem. There are safety relief and tilt-locking valves inside the control valve. The safety relief valve is at the top of oil inlet of control valve to control the pressure of the system. The tilt-locking valve is on the tilt valve block and is mainly used to prevent the serious consequence due to wrong operation of control rod when the tilt cylinder has no pressure source. The check valve is mounted between oil inlet and inlet port of lifting valve block and between oil inlets of lifting and tilt valve blocks.

(1) Spool operation (take the tilt spool valve for example)

a) Neutral position (See Fig. 5-4)

The high-pressure oil from lift pump returns to the oil tank through the mid-passage.

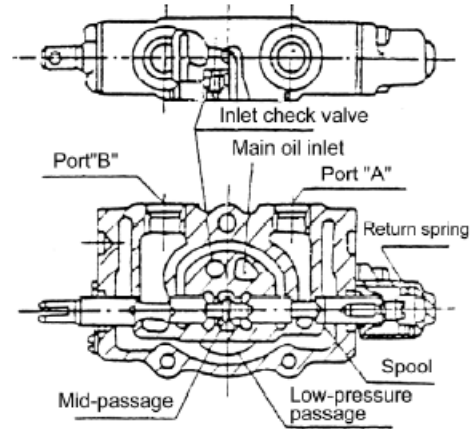


Fig. 5-4 Neutral position

b) Pushing-in of spool (See Fig. 5-5)

In this time, the spool is pushed in to close the mid-passage. This causes the oil from the main oil-inlet to push up the inlet check valve and to flow into the port "B". The return oil from the port "A" flows through the low-pressure passage to the tank and the spool is restored to its neutral position by the return spring.

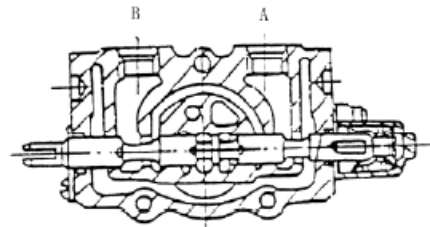


Fig. 5-5 Push in spool

c) Drawing-out of spool (See Fig. 5-6)

With the mid-passage closed, the oil from the main oil-inlet pushes up the check valve and flows into the port "A". The return oil from the port "B" flows through the low-pressure passage to the tank. The spool can be restored to its neutral position by return spring.

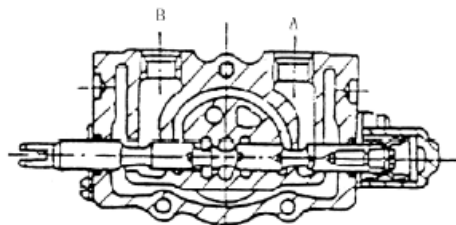


Fig. 5-6 Draw out spool

(2) Motion of safety relief valve

The relief valve is mounted between “HP” nozzle of oil pump and “LP” passage. Oil passing through lifting valve C acts on different areas of diameters “A” and “B”, thus, “K” of check valve and “D” of overflow lift valve are on the valve seat as shown in Fig. 5-7.

When the pressure regulated in “HP” passage of oil pump acts on the spring of pilot valve, the check valve “E” will open. The oil flows into “LP” side through holes around the valve as shown in Fig. 5-8.

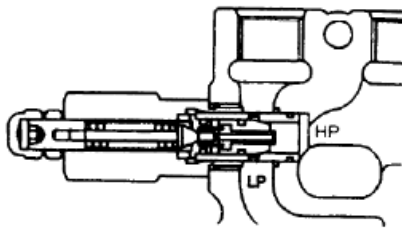


Fig. 5-7

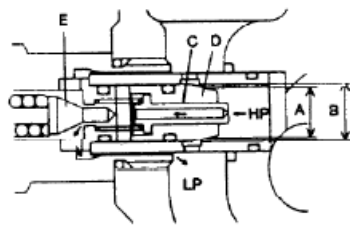


Fig. 5-8

Once the pilot valve “E” opens, the pressure inside valve “C” will drop, valve “E” and valve “C” are on the valve seat. The liquid flowing to the rear of the valve “D” will be closed, so the pressure inside will be decreased. (See Fig. 5-9)

The “HP” passage pressure and inside pressure of oil pump are not even, the valve “D” opens with the action of pressure difference and oil directly flows into the low pressure circuit “LP”. (Refer to Fig. 5-10).

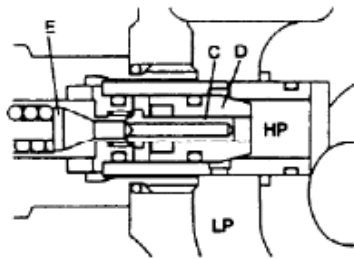


Fig. 5-9

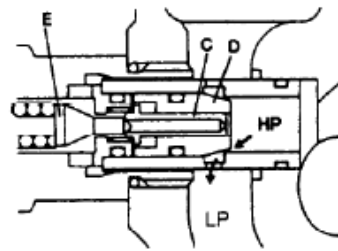


Fig. 5-10

### (3) Action of tilt-lock valve

Tilt spool valve housing contains a tilt-lock valve. The tilt lock valve is intended to prevent vibrations of the mast resulting from the negative pressure in the tilt cylinder and also to avoid danger incurred from mishandling of the spool. When the lift motor isn't running, the mast doesn't be tilted forward by push the tilt lever.

See Fig. 5-11, when the spool is pushed in. See Fig. 5-12, when the lift motor stops.

#### a) The spool is pushed in

The pressure oil flows through the port "B" to tilt cylinder and moves the tilt-lock valve to let the port "A" connect with the low-pressure tank. The tilt cylinder and the mast is tilted forward.

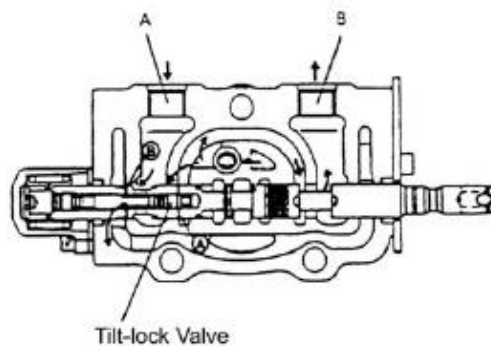


Fig. 5-11

#### b) The spool is pushed in (when the lift motor stops)

When the lift motor stops, no pressure oil flows to the tilt-lock valve. The port "A" can't connect with the low-pressure tank and the mast doesn't be tilted forward.

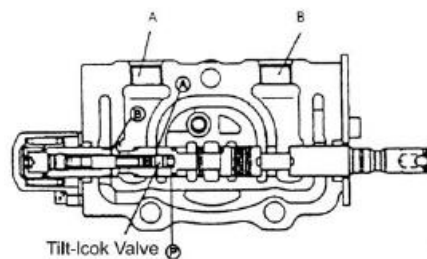


Fig. 5-12

### (4) Operation of the control valve

The control valve is operated with the valve levers. All valve levers are assembled

together with a shaft and the shaft is assembled on the valve joint plate with the bracket.

The valve levers operate the control valve with the joints. (See Fig. 5-13)

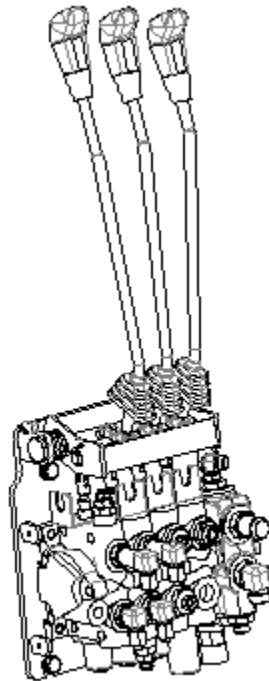
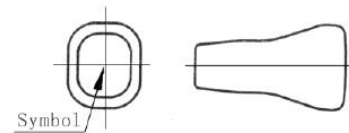


Figure 5-13 Control valve

As you see in Fig. 5-14, the mast lift up when you push the lift lever forward, the mast fall down when you pull the lift lever backward. The mast tilt forward when you push the tilt lever forward, the mast tilt backward when you pull the tilt lever backward.



No.	Symbol	Name
1		Lift or Fall
2		Tilt Forward or Backward

Fig. 5-14 The symbol on the operation lever

(5) Setting pressure of the control valve (See Fig. 5-15)

The pressure of the safety valve shall not be adjusted by non-professional personnel.

The adjustment shall follow following procedures:

a) Screw off the plug of the measuring hole on the inlet of the control valve. Install an oil pressure gauge capable of measuring 25MPa.

b) Operate tilting lever and measure the pressure at the end of the cylinder stroke.

c) If the oil pressure is different with the specified value, loosen the locking nut of the relief valve and turn the adjusting screw left and right until the pressure reaching the specified value. Turn left when the pressure is high and turn right when the pressure is low.

d) Tighten the nut after adjusting.

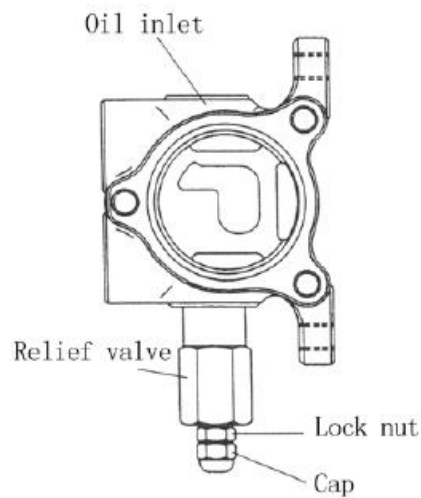
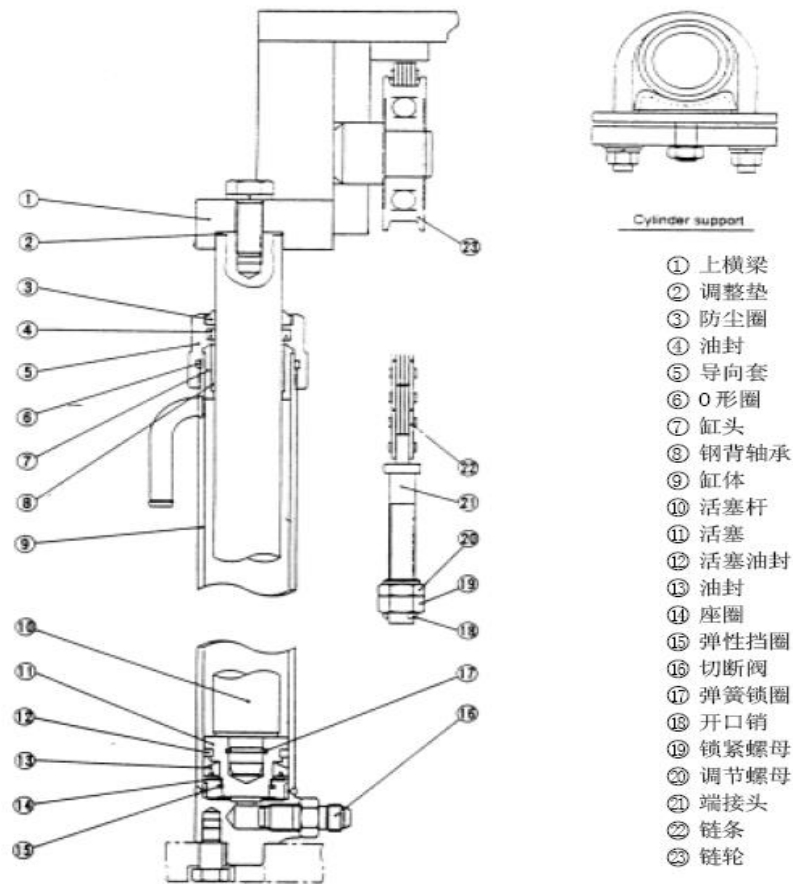


Fig. 5-15

### 5.1.3 Lift cylinder

The lift cylinder is of single-acting piston type. It consists of cylinder body, piston, piston rod, cylinder cap, cut-off valve and oil seals. The cylinder head is equipped with bushing and oil seal and the bushing supports the piston rod and the oil seal keeps dust off. (See Fig. 5-16)

When the hoist valve of control valve is placed at lifting position, hydraulic oil enters into the lower part of piston of hydraulic cylinder from pressure-gradient control valve to selector valve to push rising of piston and lifting of the goods. When the hoist valve of control valve is placed at descending position, the piston rod drops with the action of goods, mast, fork bracket and piston itself, the hydraulic oil is pressed back to oil tank. If the cut-off valve is mounted at the bottom of cylinder (See Fig. 5-17), it can play the role of protection if the mast rises when high-pressure pipe cracks.

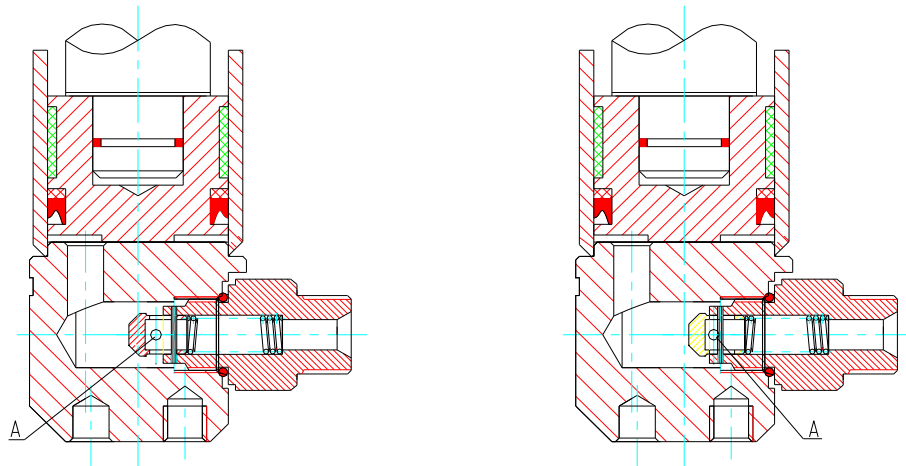


- |                      |                   |                    |                     |
|----------------------|-------------------|--------------------|---------------------|
| 1. upper beam        | 2. Adjusting shim | 3. Dust proof ring | 4. Oil seal         |
| 5. Guide sleeve      | 6. O ring         | 7. Cylinder head   | 8. Bearing          |
| 9. Cylinder body     | 10. Piston rod    | 11. Piston         | 12. Piston oil seal |
| 13. oil seal         | 14. Seat ring     | 15. Snap ring      | 16. Cut-off valve   |
| 17. spring lock ring | 18. Collar pin    | 19. Lock nut       | 20. Adjusting nut   |
| 21. end connector    | 22. chain         | 23. Chain wheel    |                     |

Figure 5-10 lifting cylinder

### 5.1.4 Cut-off valve

The cut-off valve is mounted at the bottom of the cylinder (See Fig. 5-17) to prevent the goods from falling suddenly when the high pressure pipe is broken. The oil from hoist cylinder passes through the hole A on the outer circumference of the spool when returning to oil tank, if flow rate of oil through the hole is less than the setting value of the valve and the pressure difference before and after spool smaller than spring force, the spool will not move at this time and slide valve does not work. If the flow rate through the spool hole exceeds the setting value due to high pressure pipe cracking or other reasons, the pressure difference before and after spool will be larger than the spring force and move the spool to the left. In this way, hole A is closed, only small amount of oil flows out from the small clearance of spool and valve bush and the goods descends slowly.



When flow is lower than set value      when flow is higher than set value  
Figure 5-17 working principle of cut-off valve

### 5.1.5 Flow regulator valve

The flow regulator valve, located in the lift cylinder circuit to limit the descending speed of loaded forks, has the construction as shown in Fig. 5-18.

When the lift spool is placed in the “lift” position, the oil from the control valve flows through the oil chambers A and B, oil holes C, D, E and F, and the chamber G to



the lift cylinder without any regulation. When the lift spool is placed in the “down” position, the oil pushes the orifice plate and a pressure difference generates between the chambers A and B, the pressure difference overcomes the force of the spring and moves the valve core right, thus the oil flow being decreased by narrowing of the hole D and C, and reduces the oil flow passing through the orifice plate.

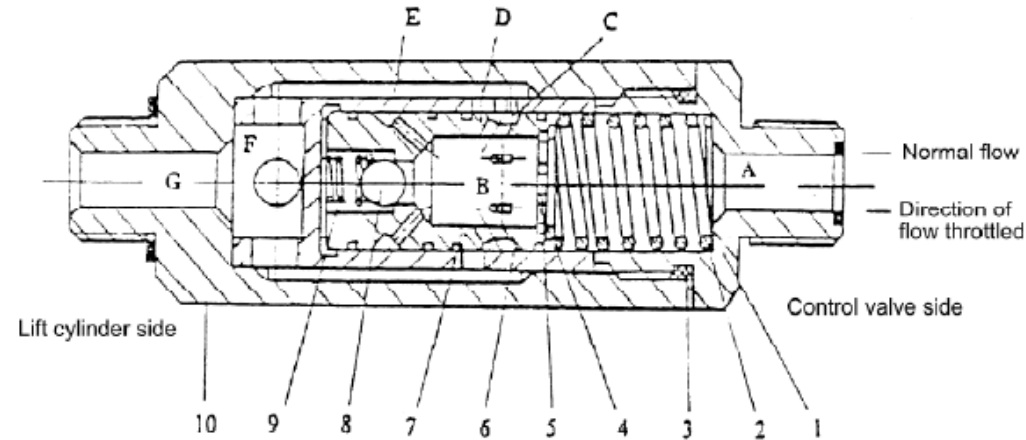


Fig. 5-18 Flow regulator valve

- (1) Nipple (2) Spring (3) Ring seal (4) Snap ring (5) Spool (6) Sleeve  
 (7) Steel ball (8) Spring of the check valve (9) Valve body

### 5.1.6 Tilt cylinder

The tilt cylinder is of double-action and piston type hydraulic cylinder and is mounted at both sides of mast with its piston rod end connecting with mast. The bottom of tilt cylinder is connected through dowel with connecting end of frame and mast and the forward and backward tilting of the mast are fulfilled by the motion of tilt cylinder.

The tilt cylinder consists primarily of piston, piston rod, cylinder body, cylinder base, guide sleeve and seals. The piston, welded to the piston rod, is fitted with two Yx-rings and one wear ring on its circumference. A bushing press-fitted to the inner side of the guide sleeve supports the piston rod. The guide sleeve is with dust seal, snap ring, Yx-ring and O-ring to prevent oil leakage and keep dust off. Fitted with them, the guide sleeve is screwed into the cylinder body. When piston moves, oil enters from one port and exits from the other. The piston rod is furnished with adjusting threads to adjust the

difference between the dip angles. (See Fig. 5-19)

When the tilt lever is pushed forward, the high-pressure oil enters into the cylinder body from the cylinder tail, moving the piston forward and causing the mast assembly to tilt forward until 6 degrees. When the tilt lever is pulled backward, high-pressure oil enters into the cylinder body from the guide sleeve and moves the piston backward, tilting the mast assembly backward.

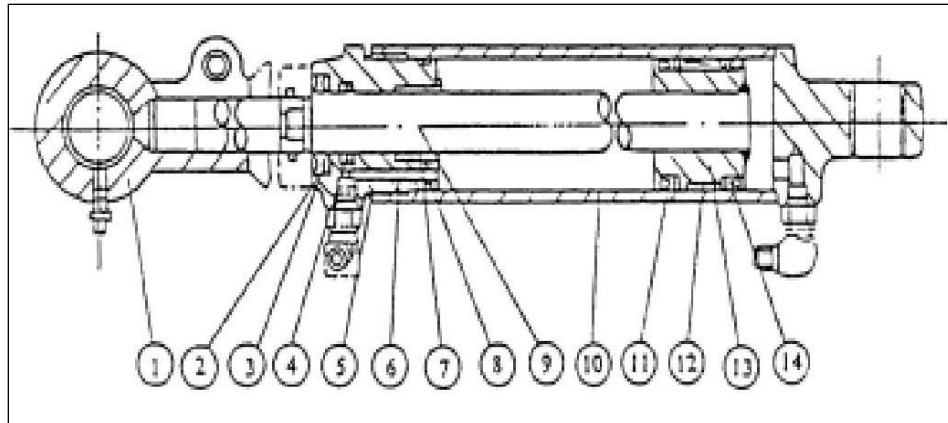


Fig. 5-19 Tilt cylinder

- (1) Ear ring (2) Dust ring (3) Snap ring (4) Yx-ring (5) O-ring (6) Guide sleeve  
(7) Bushing (8) O-ring (9) Piston rod (10) Cylinder body (11) Yx-ring (12) Wearing  
(13) Piston (14) Yx-ring

### 5.1.7 Oil tank

Oil suction filter is fixed in the oil tank while the return oil filter is fixed in the oil returning pipelines to make sure the cleanness of the supplied oil.

### 5.1.8 Hydraulic oil circuit

The hydraulic system principle diagram see Fig. 5-20 and the hydraulic oil circuit see Fig. 5-21.

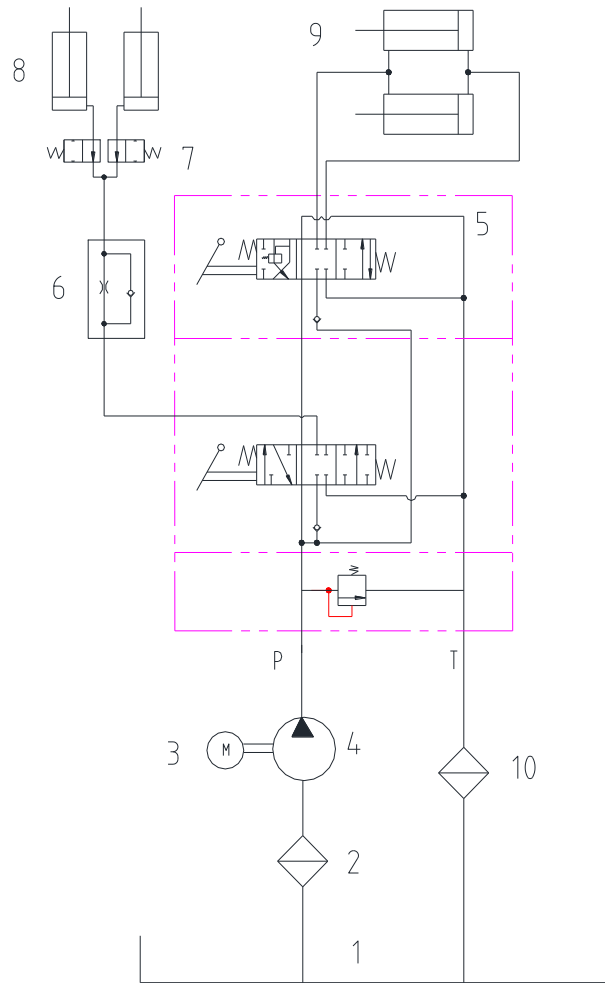


Fig. 5-20 Hydraulic system principle diagram

- (1) Oil tank (2) Oil suction filter (3) Pump motor (4) Gear pump (5) Control valve  
 (6) Flow regulator valve (7) Cut-off valve (8) Lift cylinder (11) Tilt cylinder  
 (12) Return oil filter

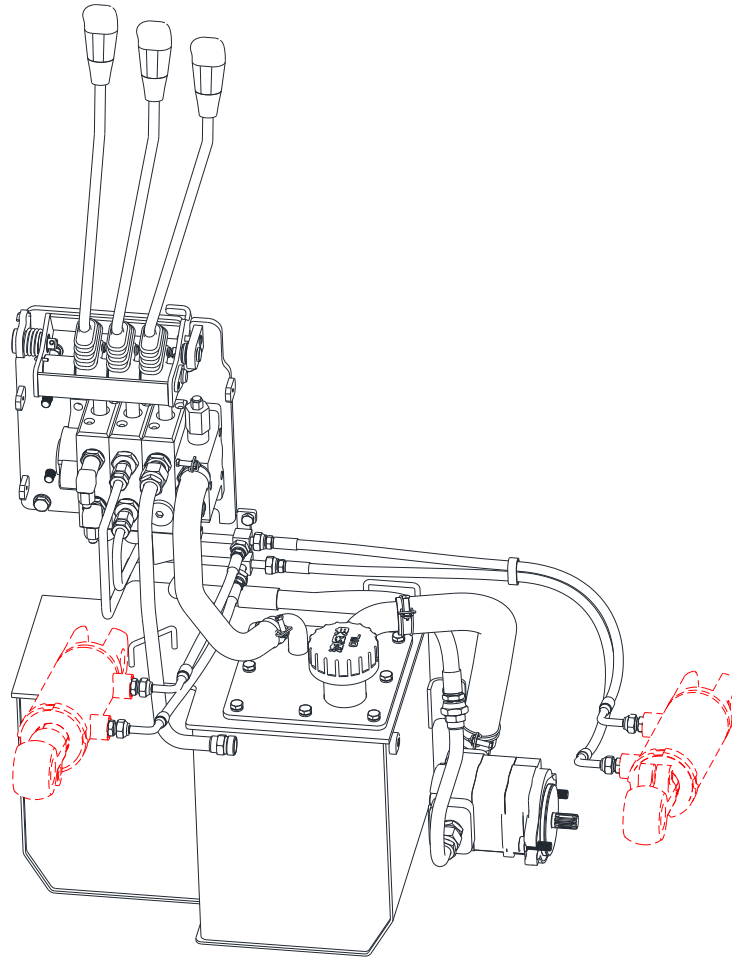


Figure 5-21 Hydraulic pipeline

## **5.2 Maintenance, Fault Analysis and Remedies**

### **5.2.1 Maintenance**

Check if there is any seepage and serious oil leakage on the pipe fittings of hydraulic drive system, hoist cylinder, tilt cylinder, oil pump, before and after each shift. Check if the working oil inside work oil tank is sufficient and check and clean the strainer mesh of oil filter mounted in the work oil tank once every week.

Normally, change the oil in the work oil tank once every 1200-1500 hours of work and mixed use of oils of different brands is not allowed.

### **5.2.2 Maintenance of lift pump**

(1) Disassembly

Before disassembling the pump, put the removed parts on the paper or cloth. Don't damage the parts. (See Fig. 5-23)

- a) Hold the pump cleaned in a vice by lightly clamping the flange section.
- b) Remove bolts 11, pump cover 5, pump body 1.
- c) Remove lining plate 6, drive gear 2, driven gear 3.
- d) Remove the seal ring 7 and ring 8 from front cover or rear cover.

**Notice: Don't remove the seal ring and ring from the front cover and rear cover, if the seal ring and ring needn't be replaced.**

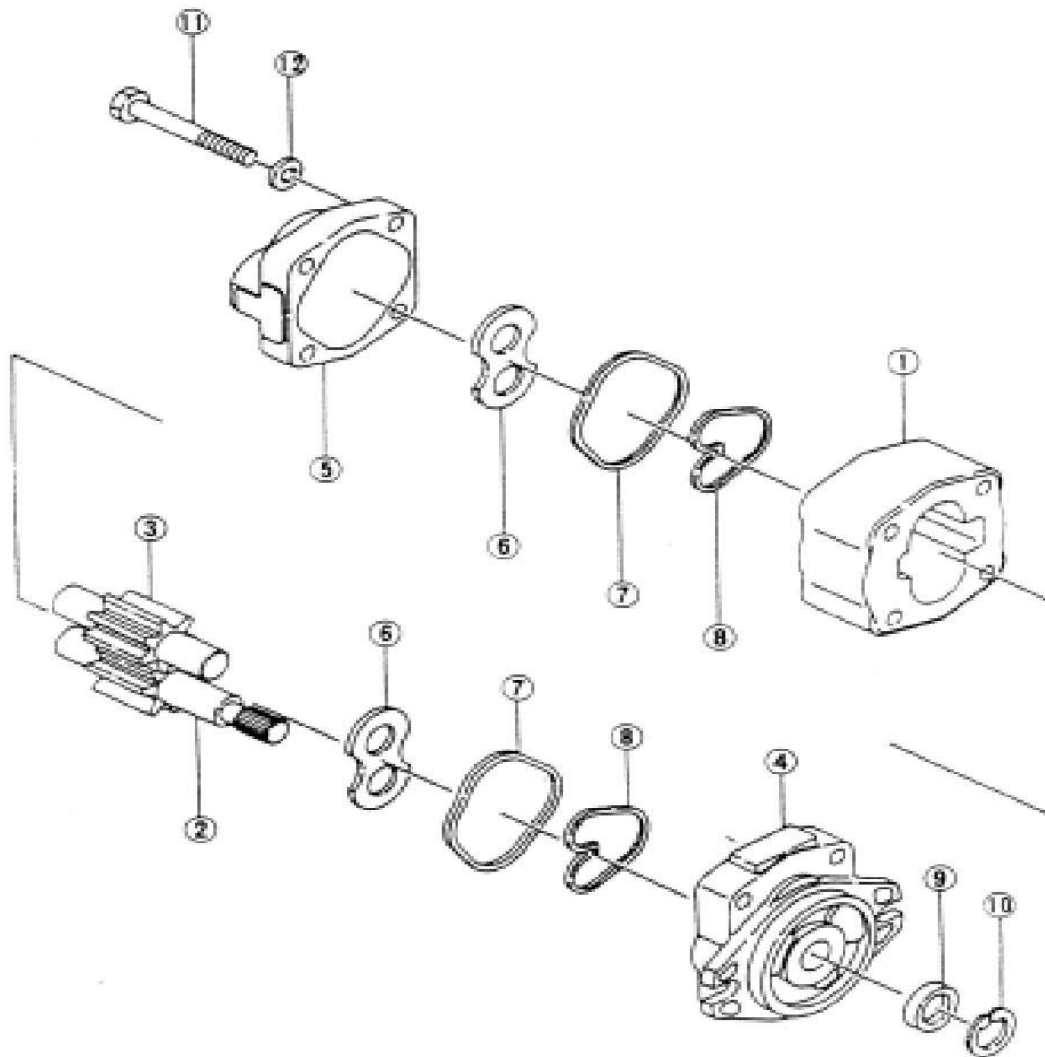


Fig. 5-22 Gear pump

- (1) Pump body (2) Drive gear (3) Driven gear (4) Front cover (5) Rear cover  
(6) Lining plate (7) Seal ring (8) Ring (9) Oil seal (10) Snap ring

(2) Inspection

Check the disassembled parts and wash them with light oil. Don't wash the rubber items with light oil.

a) Body inspection (See Fig. 5-23)

If the contact length between pump body lumen and gear longer than 1/2 long of the perimeter, replace the pump body.

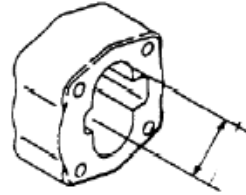


Fig. 5-23

b) Lining plate inspection (See Fig. 5-24)

Inspect the contact surface of the lining plate. If the surface is worn or its thickness is smaller than the specified value, replace the lining plate.

The specified thickness of the lining

c) Front and rear pump cover

If the color changed range of the inner surface of the bushing exceed 150 ° , replace the bushing.

d) Inspect the drive gear and the driven gear from front and rear. If they are worn excessively, replace them. If the dimension "D" is smaller than the specified value, replace them in pairs.

D=20.961mm

plate: 4.94mm.

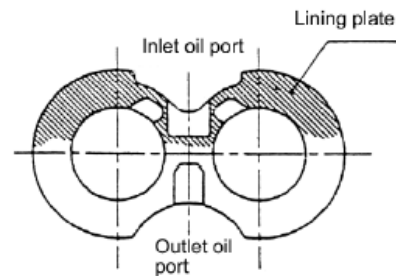


Fig. 5-24

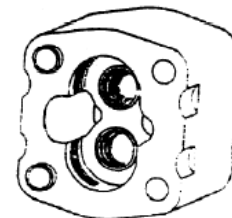


Fig. 5-25

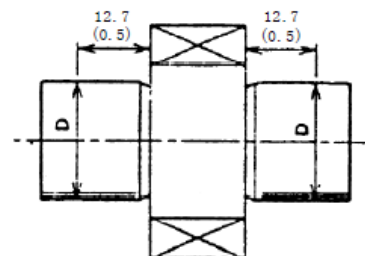


Fig. 5-26

e) Replace seal rings, bushings, seal rings, rings, oil seals and snap rings as required.

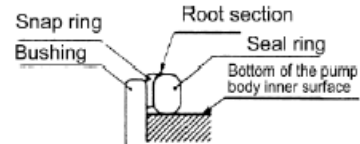


Fig. 5-27

(3) Reassembly

a) Fixed the front cover on the clamping. (See Fig. 5-28)

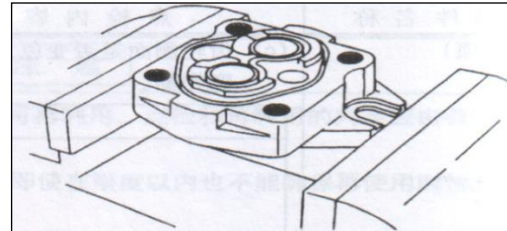


Fig. 5-28

b) Install a new seal ring on the front cover of the pump.

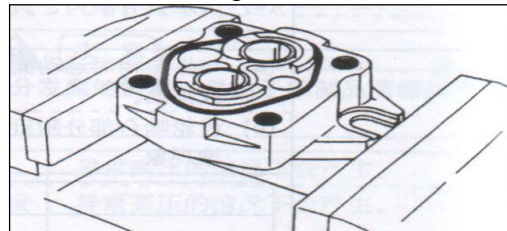


Fig. 5-29

**Notice: Don't twist.**

c) Install a new ring on the front cover of the pump. The direction of the installation see Fig. 5-30.

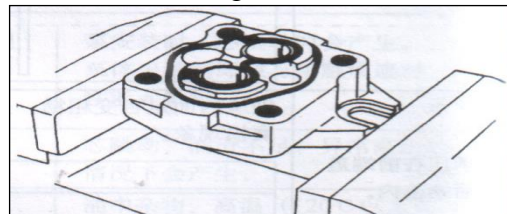


Fig. 5-30

d) Install the pump body on the front cover. Pay attention to the direction of the pump body.

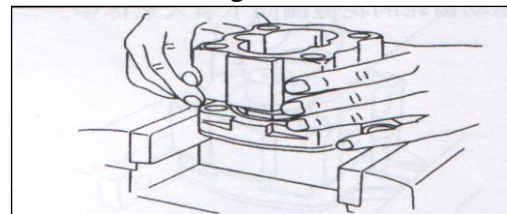


Fig. 5-31

e) Install the lining plate on the groove of the front cover, don't confuse the inlet oil port and the outlet oil port. Pay attention to the direction of the lining plate.

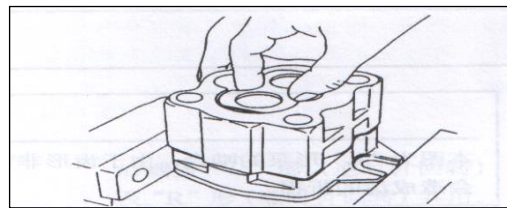


Fig. 5-32

f) Install the drive gear on the pump body with the side of the spline downward.

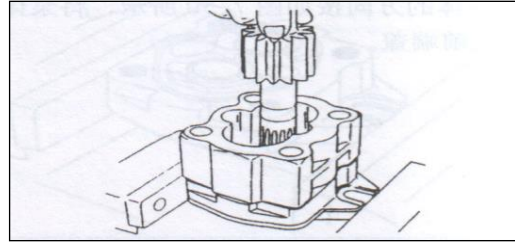


Fig. 5-33

g) Install the driven gear on the pump body as the direction shown in Fig. 5-34.

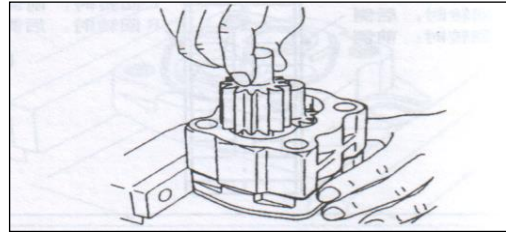


Fig. 5-34

h) Install the lining plate on the side of the gear, don't confuse the inlet oil port and the outlet oil port.

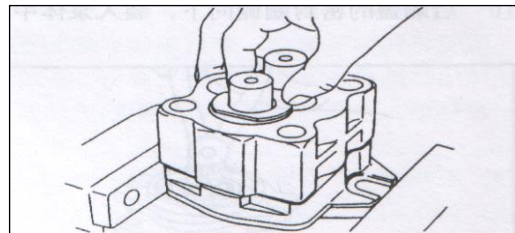


Fig. 5-35

i) Install a new seal ring and a new ring on the groove of the rear cover. Apply lubricating grease on the seal ring.

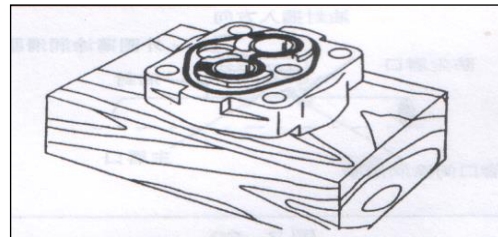


Fig. 5-36

j) Install the rear cover on the pump body with its seal ring downward, don't confuse the inlet oil port and the outlet oil port.

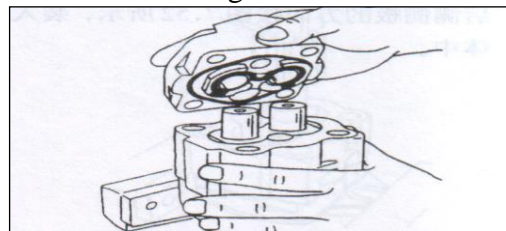


Fig. 5-37



k) Tighten up the connecting bolts with a specified torque of 9 to 10kg.m after all.

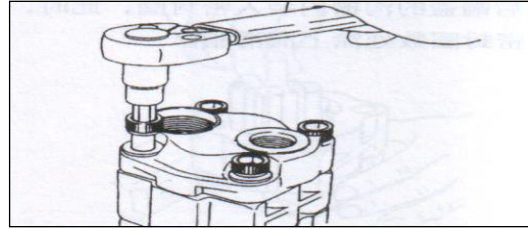


Fig. 5-38

l) Take down the pump from the clamping. Apply lubricating grease on the outside circle and lip of the oil seal, install it on the front cover with mould.

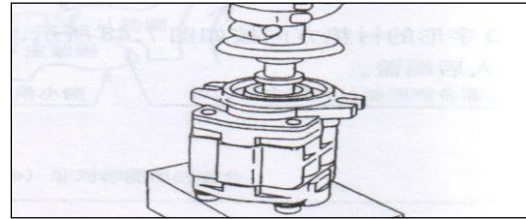


Fig. 5-39

m) Install the snap ring with callipers, fixed the oil seal.

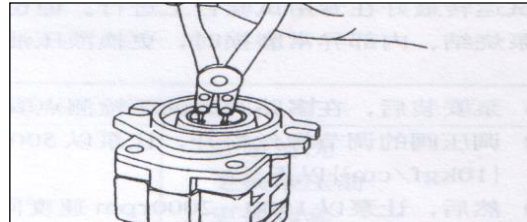


Fig. 5-40

#### (4) Test run

The test run is a running-in period for the oil pump and a inspection whether the running of the pump is normal. Test the oil pump on the test station. And also the test can be done on the forklift truck according to the following procedures:

(If the oil pump needs maintenance because of serious wear or its being stuck caused by the hydraulic oil, change the hydraulic oil or filter before carrying out the test run on the forklift truck.)

a) Install the pump onto the truck and the pressure gauge onto the pressure test end of the control valve.

b) Loose the adjusting screw of the relief valve and make the pump running at a speed of 500~1000rpm for 10 minutes. Make sure the oil pressure be lower than 10kg/cm<sup>2</sup>.

c) Increase the pump speed to 1500~2000rpm for 10 minutes.

d) Make the pump running at a speed of 1500~2000rpm for 5 minutes and increase the pressure to 210kg/ cm<sup>2</sup> by 20~30kg/cm<sup>2</sup> each time. Then make each oil circuit works for 5 minutes and then change the oil filter.

Inspect the temperature of the oil, the temperature of the surface of the pump and the running noise when increasing the oil pressure. If the oil temperature or the temperature of the pump's surface increases to a over high degree, reduce the load and lower the oil temperature. And then go on carrying on the trail.

e) Make the relieving pressure at 210kg/ cm<sup>2</sup> after the test and measure the flow. Measure the oil lever through the lifting speed.

### 5.2.3 Troubleshooting

Trouble	Cause	Trouble shooting
Insufficient lifting capacity or unable to lift	<ol style="list-style-type: none"> <li>1) Excessive wearing between the oil pump gear and pump body and wider-than-normal gap.</li> <li>2) Wearing and wider-than-normal gap of the piston sealing part in the lifting cylinder, excessive inner leakage.</li> <li>3) Failure of safety valve spring of control valve.</li> <li>4) Excessive oil leakage due to wearing between the control valve rod of control valve and valve body.</li> <li>5) Oil leakage among valve bodies of the control valve .</li> <li>6) Oil leakage in hydraulic pipe.</li> <li>7) Higher-than-normal temperature of hydraulic oil (should be <math>\leq 80^{\circ}\text{C}</math>), excessive oil dilution and insufficient flow.</li> <li>8) Excessive load.</li> </ol>	<ol style="list-style-type: none"> <li>1) Replace the wearable parts or oil pump.</li> <li>2) Replace with new piston sealing ring.</li> <li>3) Replace with new spring.</li> <li>4) Chromium plating the valve rod to couple with the hole with the gap at 0.01~0.02.</li> <li>5) Change the sealing ring, screw tight the screw in sequence.</li> <li>6) Check to see whether there is damage to the sealing ring or connecting nut and screw tight the pipe joint.</li> <li>7) Replace the unqualified hydraulic oil, stop operation to lower oil temperature and try to find the cause of over high oil temperature.</li> <li>8) Lift load according to requirements.</li> </ol>
Insufficient pressure of oil pump	<ol style="list-style-type: none"> <li>1) Oil leakage due to wearing of ring seal at fasteners.</li> <li>2) Hydraulic oil is contaminated with air to form foam, air leakage at oil suction pipe-work, insufficient hydraulic oil.</li> <li>3) Damaged ring seal inside the pump cover groove.</li> <li>4) Wearing of the end face of bearing sleeve.</li> <li>5) Oil pump gear wears.</li> <li>6) Wrong rotation direction of oil pump.</li> </ol>	<ol style="list-style-type: none"> <li>1) Replace the ring seal.</li> <li>2) Discharge air and add hydraulic oil.</li> <li>3) Replace.</li> <li>4) Replace.</li> <li>5) Replace the oil pump.</li> <li>6) Correct.</li> </ol>
Excessive self tilting of the tilting cylinder	<ol style="list-style-type: none"> <li>1) Inner leakage of control valve.</li> <li>2) Inner leakage due to the damaged O-ring seal of piston rod of the tilting cylinder.</li> <li>3) Oil leakage due to the damaged YX-ring seal and O-ring seal in the pilot sleeve.</li> </ol>	<ol style="list-style-type: none"> <li>1) Replace O-ring seal, repair valve rod and reassign the coupling gap between valve rod and hole to 0.01~0.02.</li> <li>2) Replace.</li> <li>3) Replace.</li> </ol>

## 6. Lifting system

### 6.1 Normal type lifting system general description

Normal type lifting system is of two stage roller type with vertical up and down moving. It is made up of inner mast, outer mast, two rear lifting cylinder and fork bracket.

### 6.2 Inner mast and outer mast

Inner mast and outer mast are welded parts. Refer to figure 6.1. The weight is beared by frame. The middle part of the outer mast is connected with frame through tilting cylinder and it can tilt forward and backward under the action of tilting cylinder. The steel channel of outer mast is of C type. There is one pair of combined roller on top of the end. The steel channel of inner mast is of H type and there is one pair of combined roller at the lower end. The inner mast keeps a fixed relative position between inner mast and outer mast during moving through main roller and side roller.

The maintenance of the roller and the side rollers on the inner and outer masts is very important. Please be careful.

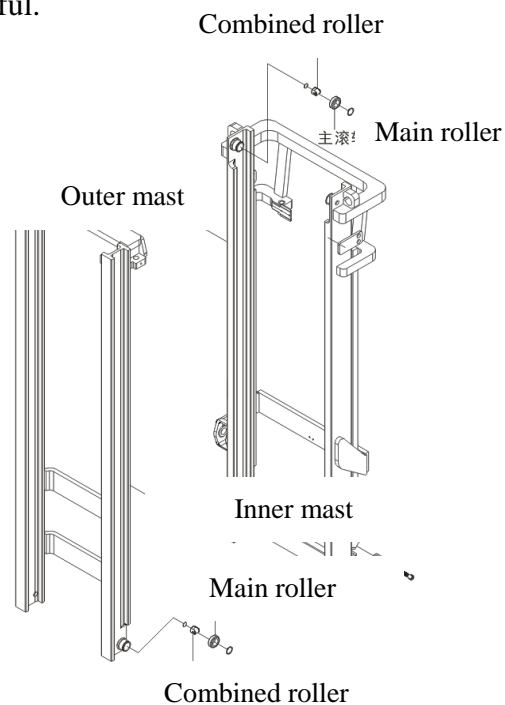


Figure 6-1 inner mast and outer mast

### 6.3 Fork bracket

The fork bracket runs inside of the inner mast through main roller. The main roller is installed on main roller shaft with snap ring. The main roller is welded on fork bracket. The side roller of upright plate is fixed on forkbracket with bolt. The longitudinal load is beared by main roller. When the fork is lifted to the highest position, the upper roller comes out form the mast upper end. The transverse load is beared by side roller.

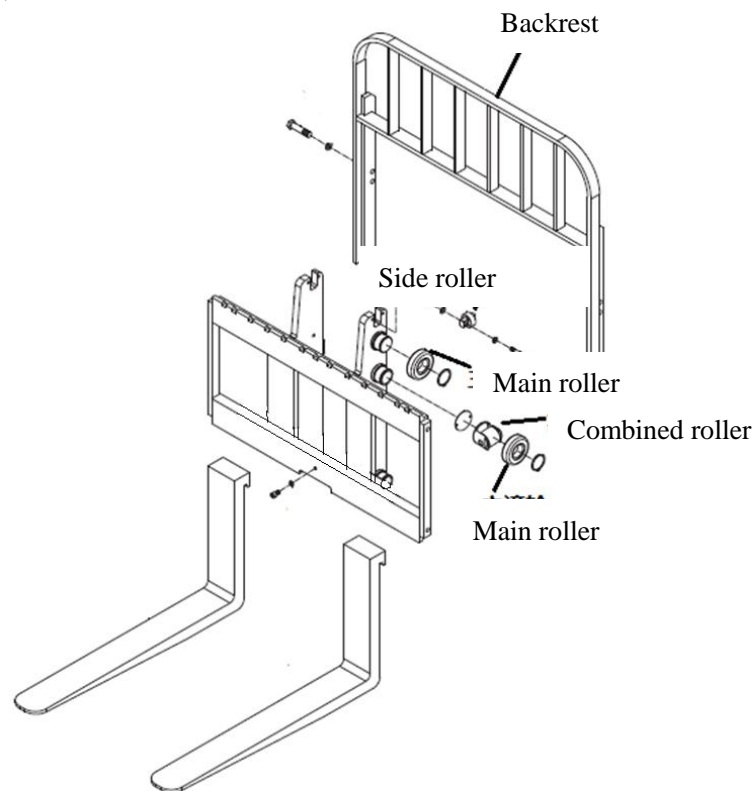


Figure 6-2 Fork brakcet

### 6.4 Roller adjusting method

There are 10 main rollers which are installed on outer mast upper end (2), inner mast lower end (2) and two sides of forkbracket upright plate (6) respectively.

There are 8 combined rollers which are installed on outer mast upper end (2), inner mast lower end (2) and fork bracket (4) respectively.

The using of main roller and combined roller makes inner mast and fork bracket move smoothly.

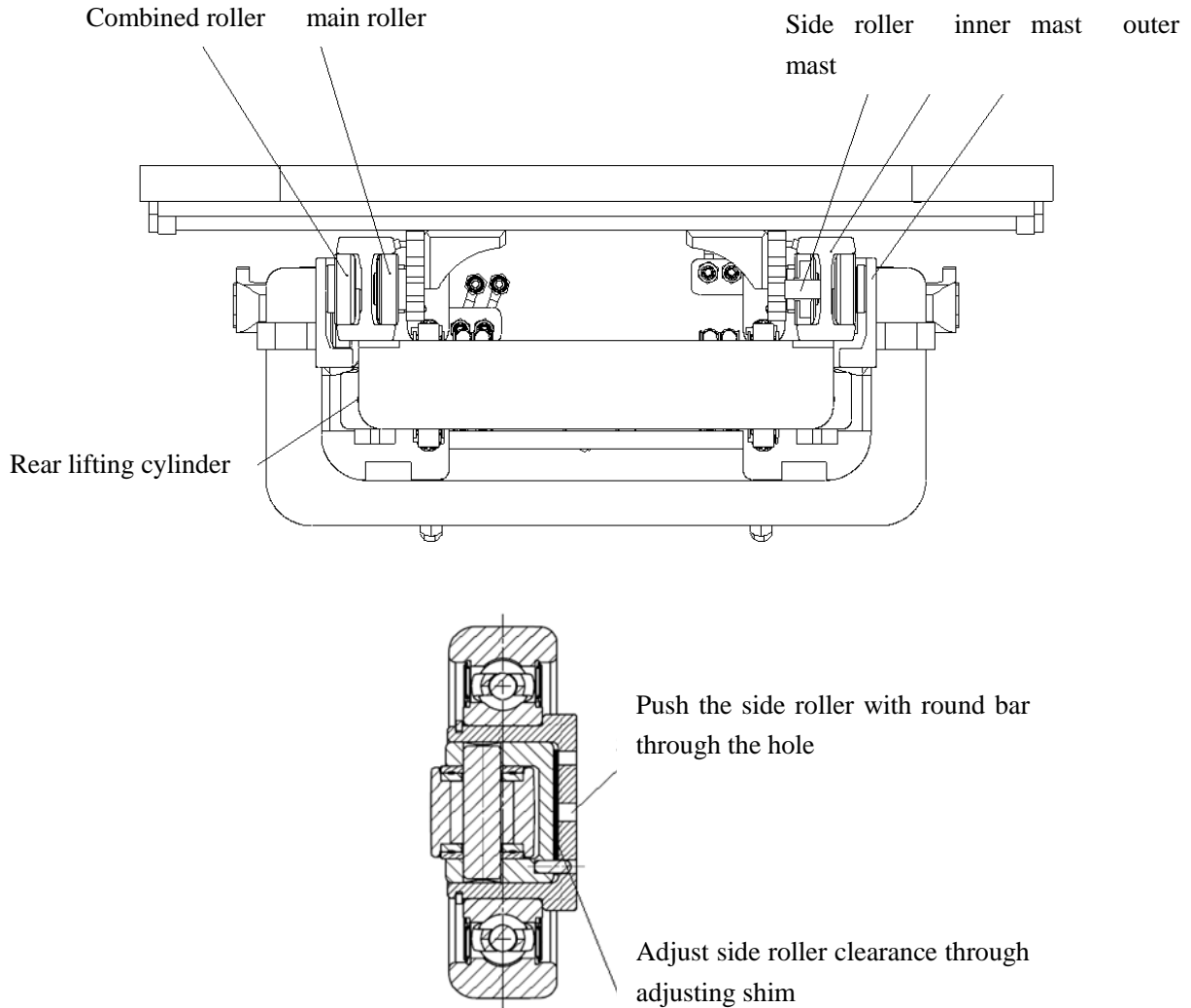


Figure 6-3 roller layout

Note: (a) side roller clearance is between 0 and 0.5mm.

(b) Apply grease on main roller surface and mast contacting surface.

## 6.5 Repair

### 6.5.1 Lifting cylinder adjusting

When dismantling or changing lifting cylinder, inner mast or outermast, rear lifting cylinder needs readjust. (refer to figure 6-5). Adjusting method is followed:

- (1) Install piston rod head into inner mast top beam without adjusting shim.
- (2) Lift the mast slowly to cylinder max. stroke. Check if two cylinders are synchronous. If the two cylinders do not stop at the same time, it means the cylinder strokes are not the same. Adjust the stroke to be the same through adjusting shim (0.2mm

and 0.5mm).

(3) Lower the inner mast slowly and check if two cylinders stroke are synchronous.

Refer to the method above to adjust.

(4) Adjust chain tensioning.

Lifting cylinder adjusting is very important, please take care.

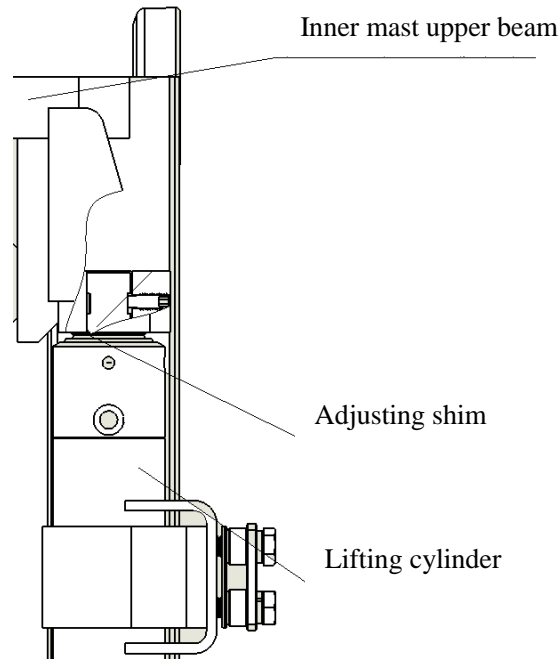


Figure 6-4

### 6.5.2 Adjust lift bracket's height

(1) The truck should be stopped on horizontal ground. And ensure the masts erect.

(2) Lower the forks on the ground, adjust the set nut of tie-in on the upper of chains to make the distance A between main rollers and the lift bracket.

(3) Make the mast assembly tilt backward when forks descended to the ground, adjust the pulling force of lift chains and let the tightness of lift chains be equal.

Truck type	A mm
1-1.8t	36-41
2-2.5t	24-29
3-3.5t	19-24

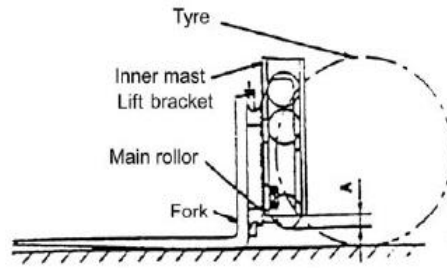


Fig. 6-5 Adjust lift bracket's height

### 6.5.3 Replacing rollers of the lift bracket

- (1) Place a salver on the forks and make the forklift stop on the horizontal ground.
- (2) Make the forks and salver descend to the ground.
- (3) Take down tie-in on top of the chains. And take out chains from sheave. (See Fig. 6-7)
- (4) Make the inner mast rise.
- (5) The forklift can be reversed when the lift bracket disengaged from the outer mast.
- (6) Replacing main rollers
  - (a) Take apart all of snap ring from the lift bracket and take out main rollers.
  - (b) Fit the new main roller (the same type as the old one) on the lift bracket and fastened with snap ring.

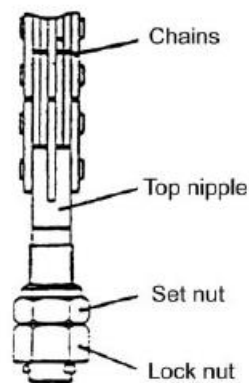


Fig. 6-6



#### **6.5.4 Replacing rollers of masts**

- (1) Take apart the fork bracket from the inner mast, then replace the main roller follows the way as 6.5.3.
- (2) Park the truck on the horizontal ground and lift up the front-wheel 250~300mm from the ground.
- (3) Pull parking brake level fully, and use a wedge to make back-wheel stationary.
- (4) Take apart bolts which fastened lift cylinders and the inner mast. Hang up the inner mast without losing shims of the piston rod heads carefully.
- (5) Take apart bolts which jointed lift cylinders and the bottom of outer mast and take apart the oil-pipe between two lift cylinders without losing the nipple.
- (6) Let down the inner mast and dismantle inner mast lower end main roller.
- (7) Main rollers on the upper outer mast will be showed on the top of the inner mast, then main roller can be removed.
- (8) Replacing main rollers
  - a) Take apart the upper main rollers without losing shims.
  - b) Fit the new main roller and shims together on the outer mast.
- (9) Hang up the inner masts and let all rollers in the inner mast.
- (10) Assembly the lift cylinder and the lift bracket as disassembly contrarily.

# OPERATION & SERVICE MANUAL

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