

G2 series 1.5-2t

Three-wheel Stand-on
Battery Forklift Truck

OPERATION & SERVICE MANUAL

FOREWORD

Three-wheel stand-on battery forklift truck 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 three-wheel stand-on battery forklift truck 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 hoisting system, AC electronic steering unit, drive axle with automatic brake, continuous speed control, overhead guard with Radiation grid plate, high quality motor, battery, ZAPI 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 cannot 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 “safety first” 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) Fix the mast and the balance weight with steel wire. Wedge up all wheels.
- (2) 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) Apply antirust to the surface of the parts not painted. Apply lubrication oil to the lift chain.
- (2) Lowing the mast to the lowest position.
- (3) Wedged up the wheels.

3. Precautions before Operation

- (1) Check all the levers and pedals.
- (2) Complete the provisions before starting.
- (3) Step on the service braking pedal.
- (4) Make trying operation of the mast for lifting, lowing 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 travel forward, and travel backward when descending so grades. Never turn 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) 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) .

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

5. Application environment

1) Environment temperature: $-25^{\circ}\text{C} \sim +40^{\circ}\text{C}$;

2) Relative humidity: $<90\%$;

3) Altitude: $<1200\text{m}$.

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;

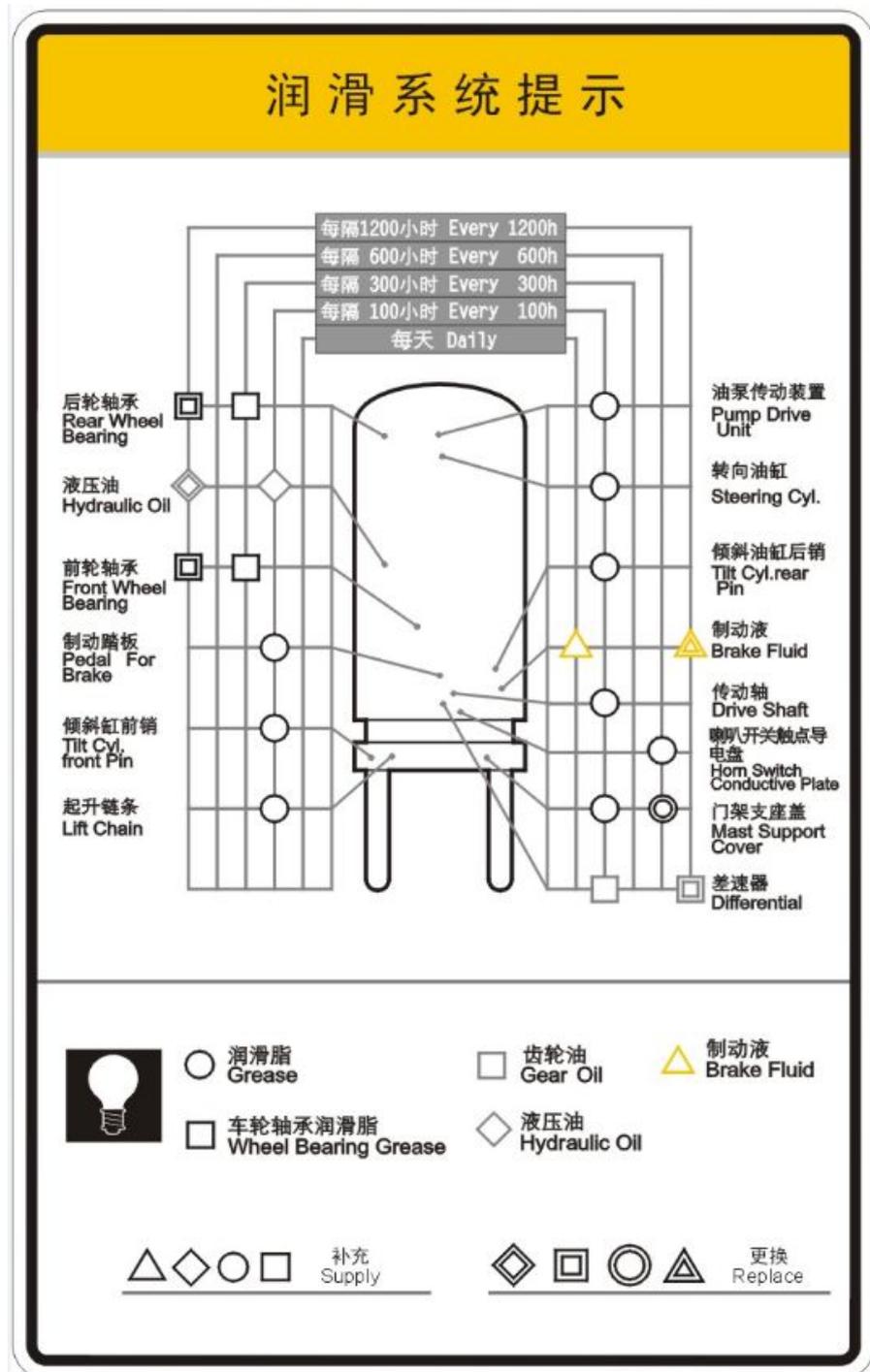
c) Check parking brake. The unladen truck can park on the 15% grade ramp, when the parking lever is pulled to the bottom;

d) Check instruments, lighting, switches and wiring to see if they work normally or not.

(2) Oil used for forklift trucks

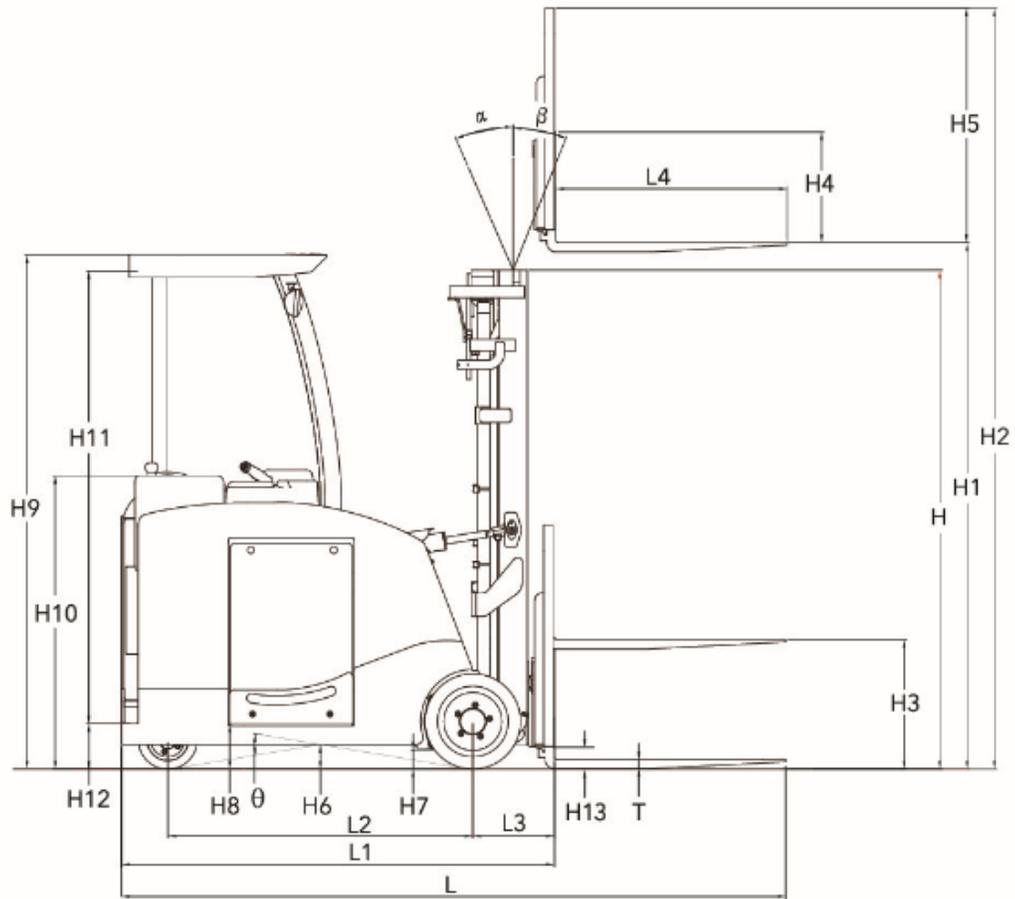
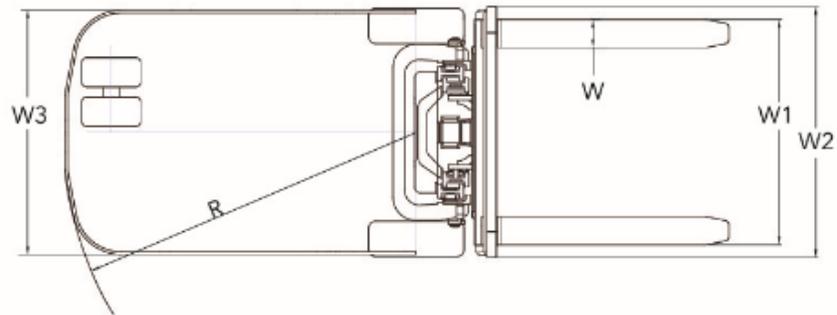
Name	Recommended brand	Brand and temperature of using		
Hydraulic oil	Chang cheng	Sticky grade	L-HM32 wearable hydraulic oil	L-HV32 low temp. wearable hydraulic oil
		Temp. of using (°C)	≥-5	≥-20 (cold region)
Lubricating grease	Chang cheng	3# lithium base grease (-20°C ~+120°C)		
Gear oil of heavy-laden 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, hydraulic steering and horn switch contact plate, it is not necessary to refer to the chart for the supplement or replace of brake liquid and lubricating grease.

II. Main Specifications of Forklift Truck



External view of forklift truck

Main specifications

Model	Unit		CPDSR15		CPDSR15		CPDSR18		CPDSR20	
			GA2		GB2		GA2		GA2	
Rated capacity	lb	kg	3000	1362	3000	1362	3500	1589	4000	1815
Load center	in	m	24/600							
Lifting height	in/mm		185/4700							
Free lifting height	in/mm		45/1145							
Mast tilt angle (fwd/bwd) (α / β)	deg.		$3^{\circ} / 5^{\circ}$							
Fork size (L4*W*T)	in/mm		$42.1 \times 3.9 \times 1.4 / 1070 \times 100 \times 35$							
Wheelbase L2	in/mm		47.4/1205		49.4/1255		49.4/1255		52/1320	
Tread-front	in/mm		36.3/92							
Tread-rear	in/mm		6.7/170.5							
Overall length (without forks) L1	in/mm		67.7/1720		69.7/1770		69.7/1770		72.2/1835	
Overall width W2	in/mm		42.3/1075							
Overall height (mast/overhead guard H)	in/mm		85/2160							
Overall height (overhead guard H9)	in/mm		88/2230							
Stand-on pedal height H12	in/mm		7.4/188							
Under-clearance (mast) H13	in/mm		4/101.5							
Under-clearance (truck body) H7	in/mm		3.25/82.5							
Min. turning radius	in/mm		55.7/1414		57.7/1465		57.7/1465		60.2/1529	
Travelling speed	mph		km/h	7.2	11.6	7.2	11.6	7.2	11.6	7.2
Lifting speed (loaded/unloaded)	ft/ min	m/ s	65/ 110	0.33/ 0.56	65/ 110	0.33/ 0.56	65/ 110	0.33/ 0.56	65/ 110	0.31/ .53
Descending speed	ft/ min	m/ s	98.2	0.45	98.2	0.45	98.2	0.45	98.2	0.45
Gradeability	%		15							

Tyre	front	in	16.25*6-11.5
	rear	in	10*5-6.5
Traction motor		kW	4.5*2
Pump motor		kW	11
Steering motor		kW	0.4

Battery parameters

Model	Parameter						minimum weight	maximum weight
	Max size(in)			Electric part				
	Length	Width	Height	Voltage(V)	Capacity(Ah)	Type	lbs	lbs
CPDSR 15-GA2	38.6	16.5	31	36	750	E125	1980	2250
					930	E155		
					775	5PZS775		
				48	550	5PZB 550H		
CPDSR 15-GB2	38.6	18.5	31	36	875	E125	2300	2600
					1085	E155		
					840	8PZB840		
				48	660	6PZB 660H		
CPDSR 18-GA2	38.6	18.5	31	36	875	E125	2300	2600
					1085	E155		
					840	8PZB840		
				48	660	6PZB 660H		
CPDSR 20-GA2	38.6	21.25	31	36	1000	E125	2590	3050
					1240	E155		
					945	9PZB945		
				48	770	7PZB 770H		

III. Construction, Principle, Adjustment and Maintenance of Forklift Truck

1. Transmission system

1.1 General description

The transmission system of the three wheeled stand-on forklift truck includes transmission system we call traditionally and parking 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.

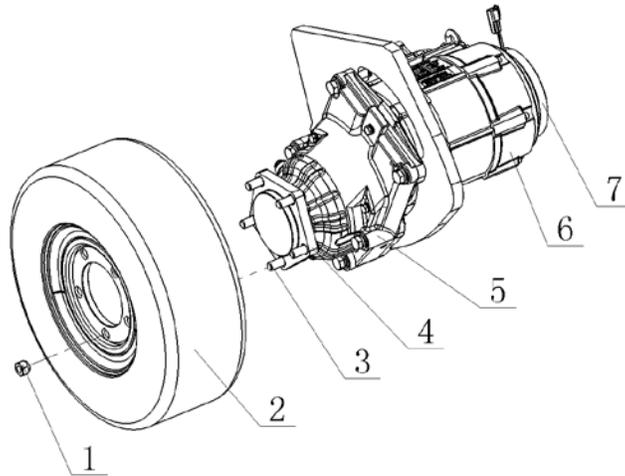
1.2 Disassembling of transmission system

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 (2 are M14 x1.5x 50 bolts and 5 are M14x1.5x100 hexagon socket bolts and remove transmission box

connected with travelling motor from frame. Refer to figure 1-1.



- 1 wheel nut 2 drive wheel 3 hub bolt 4 axle 5 reduction gearbox
6 electrical machinery 7 electromagnetic brake

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 x80) .

NOTE: Take care not to damage the O-ring and driving gear in the housing when removing motor from reduction gearbox! If only the motor is removed, the released transmission opening is to be sealed in order to avoid that dirt can get inside the reduction gearbox.

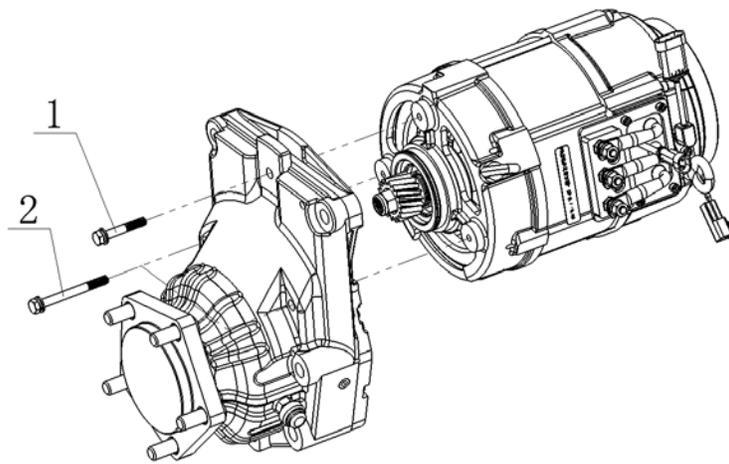


Figure 1-2

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.

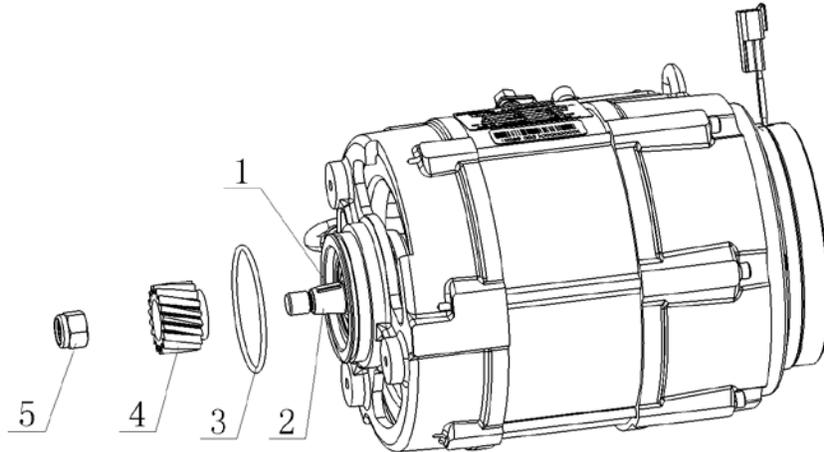


Figure 1-3

The removal steps of the driving gear are as follows, as refer to figure 1-3.

- a. Hold the driving gear (part 4) with an appropriate strap wrench, and remove the locking nut (part 5) with a nut wrench
- b. Pull out the driving gear (part 4) through the pull rod
- c. Remove the semicircular key (part 1) from the motor shaft (part 2)
- d. Remove o-type seal ring (part 3) from motor centering seat

1.2.4 Removal of electromagnetic brake

Electromagnetic braking is achieved through dry friction, the friction surface must remain completely clean, Grease and wear dust are not allowed, the maximum speed is 5000 r/min, the highest ambient temperature is 40°C. The electromagnetic brake must provide direct current and ensure compliance with nominal power supply voltage. All work on electrical connections must be done with power off. Do not change the brake to avoid changing its performance. Do not carry the equipment through the power cord.

Lift the dust shield, screw off three bolt M8x20 (part 1) , pull out the electromagnetic brake (part 2) , as refer to figure 1-4.

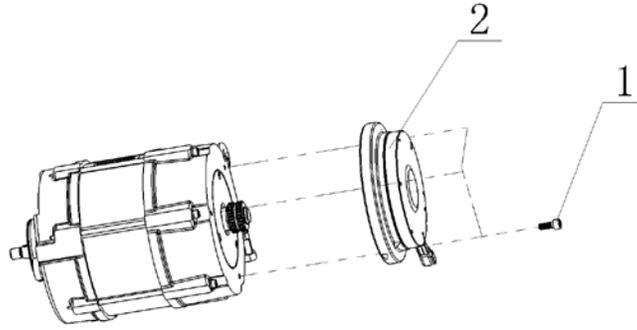


Figure 1- 4

Remove the retainer ring (part 1) from the end of the motor shaft (part 3) , then remove the spline housing (part 2) , as refer to figure 1-5.

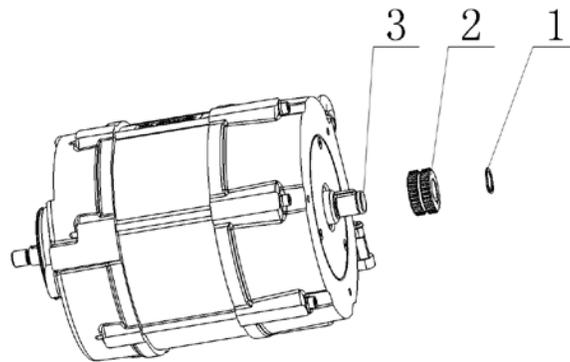


Figure 1- 5

The clearance of the new electromagnetic brake has been adjusted in the factory. Before the electromagnetic brake is re-installed after a period of use, the clearance of the brake needs to be adjusted.

Adjust the clearance by following method.

As refer to figure 1-6, adjust the clearance first by unscrewing the mounting screw (part 5) , then remove the flange (part 4) . Loosen and adjust the adjusting screw (part 6) to obtain the clearance value of $0.3^{+0.1}_{-0.05}$. Tightening torque of mounting screw (part 5) is 5.1 Nm. Install the electromagnetic brake to the motor and confirm that the friction plate of the electromagnetic brake can rotate freely. Perform several motor operations, and then check the air gap value again.

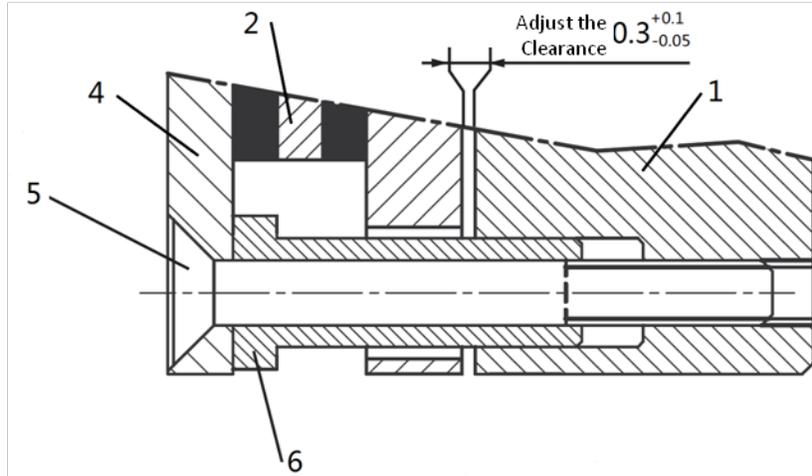
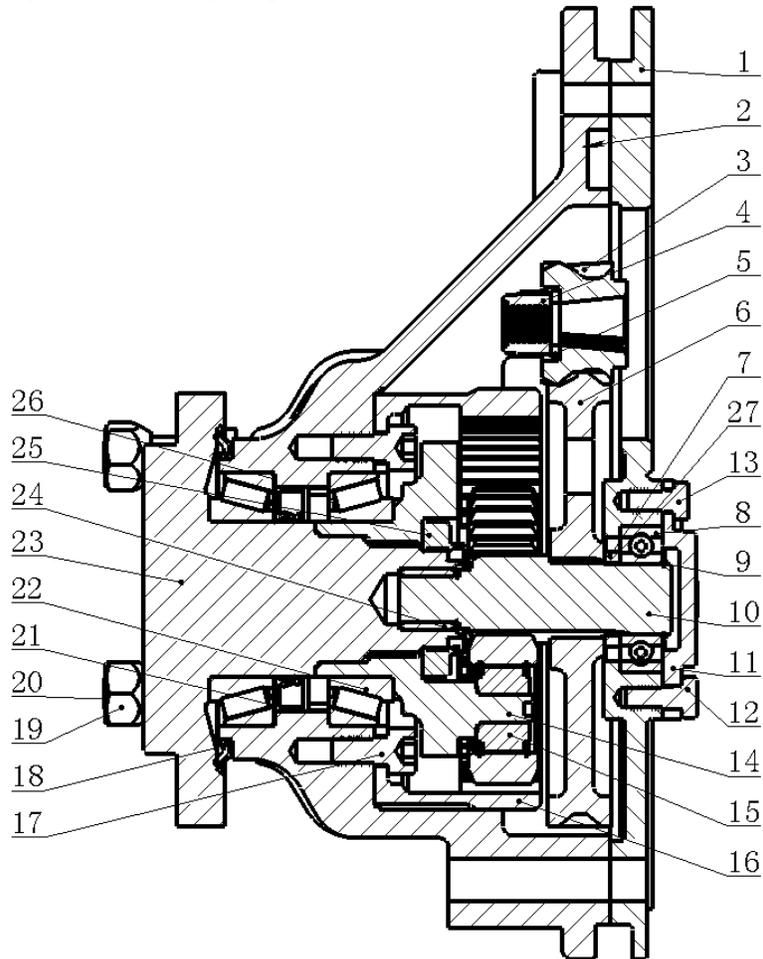


Figure 1-6

- 1 sensor 2 friction plate 3 spline housing 4 flange 5 mounting screw
6 adjusting screw

1.2.5 Disassembly and assembly of gearbox



1 cover 2 Shell body 3 driving gear 4 nut M14 5 washer 6 driven gear 7 shaft sleeve
8 bearing 6205 9 check ring 10 sun gear 11 end cover 12 bolt M8x20 13 bolt M8x16
14 planet rack 15 planet gear assembly 16 gear ring 17 bolt M10x20
18 GAMMA sealing element 19 wheel hub nut 20 wheel hub bolt 21 oil seal
22 bearing 32011 23 output half shaft 24 needle bearing 25 nut M36x15
26 adjusting shim 27 adjusting shim

Figure 1-7

Take care to the following in the reassembly process.

1. Calculate the thickness of the adjusting shim (part 26) to be added, steps are as follows.
 - a. Dimension D (on the shell) , is the distance between the mounting surface of half shaft bearing outer ring output from support and the mounting surface of the outer ring from the supporting planet bracket bearing.
 - b. Dimension E (on the planet bracket) , is the distance between the mounting surface of the outer ring from the supporting planet bracket bearing and the planet bracket mounting face.
 - c. Dimension F (on the output half shaft) , is the distance between the support output shaft bearing outer ring mounting surface to the output shaft step surface.
 - d. Calculate the thickness of the adjustment shim (part 26) , $Z=E+F-D$.
 - e. Select the corresponding type and quantity according to the thickness of the adjusting shim (The thickness of the adjusting shim is 0.1mm, 0.3mm, and 0.5mm) .

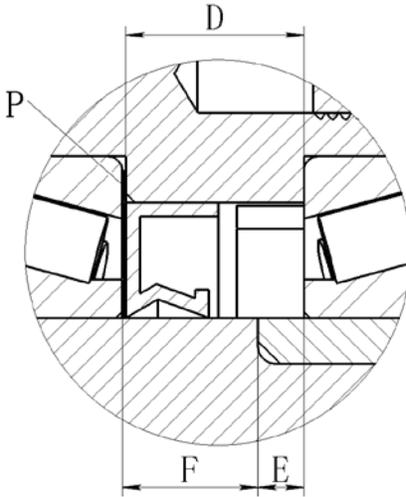


Figure 1-8

For example, the planet bracket dimension $E=5.4\text{mm}$, dimension $F=15.16\text{mm}$ on the output half shaft. Dimensions $D=19.66\text{mm}$, $Z=5.43+15.16-19.66=0.93\text{mm}$.

f. According to experience, 0.1mm needs to be deducted from dimension Z in order to obtain more favorable bearing preload adjustment under operating conditions.

Then, $Z=0.93-0.1=0.83\text{mm}$, then a 0.5mm and a 0.3mm thick adjusting gasket can be selected.

2. After output half shaft (part 23) installed, rotating several output half shaft (part 23), to make the taper roller in a good position in the bearing inner and outer ring, in the process of checking the bearing shall not have any impact, but the output half shaft (part 23) must be able to rotate with the hand, when the total bearing friction torque be measured of $1\text{nm}-5\text{nm}$, bearing preloaded force adjustment is appropriate, then Break the edge of the nut (part 25) with a chisel, the nut (part 25) is embedded into the two gap of output half shaft, in order to lock the nut.

Note: if the bearing friction torque exceeds $1\text{nm}-5\text{nm}$, it needs to be recalibrated to obtain the ideal torque by reducing or increasing the thickness of the adjusting gasket (part 26).

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 1-9.

Note: cleansers cannot 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 (part 2) and taper bore of drive pinion (part 4) carefully
- (2) Insert woodruff key (part 1) into motor shaft and push drive pinion on.
- (3) Screw a new stopping nut (part 5) 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.

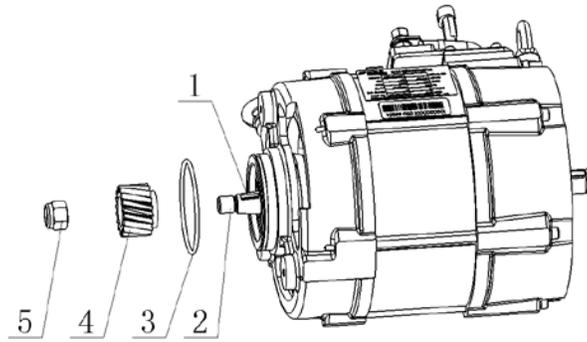


Figure 1-9

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 0.1mm. Screw drive unit with 7 hexagon bolts M14 and shims to frame. 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 figure1-10)

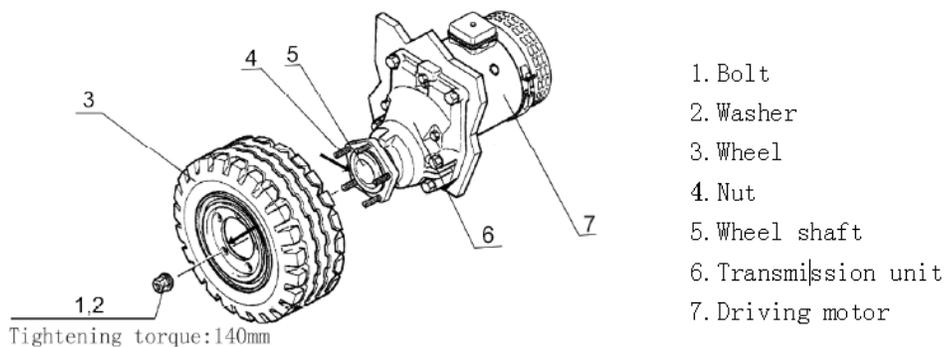


Figure 1-10

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. 0.45 liters (standard value) . The exact oil amount is determined by funnel.

(5) Gear oil model may be MOBIL ATF200 or ATF210 or ATF220; SHELL DONAXTM or ATFDEXRON II 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 1-11.

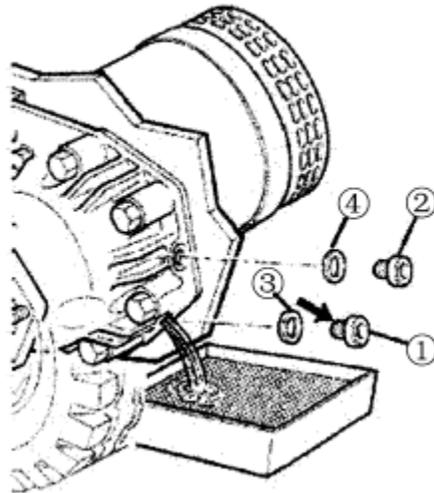


Figure 1-11

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 integrated intelligent handle, brake pedal, traction controller and traction motor.

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

During travelling, release the brake pedal (2) can achieve brake effect flexibly. Emergency 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 stand-on 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.



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 truck weight in case of idling, G-series three-wheeled forklifts produced by our Co. adopt electric power steering system to alleviate the labor intensity of the driver. Power through gear box passed to the rear axle of the wheel hub, and then to the steering axle, the wheel hub and tires.

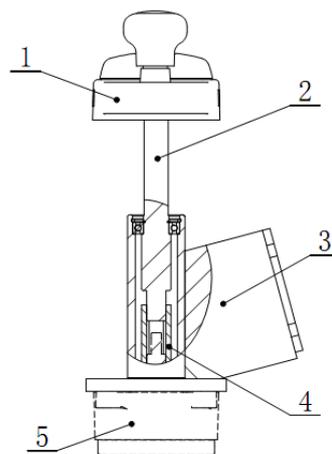
3.2 Working principle

When the truck is steering, the operator applies steering moment on steering wheel (steering operation mechanism) to make steering wheel produce rotation displacement which is transmitted to steering sensor through steering axle. The sensor transmits the signal to steering control unit according to steering wheel's rotation angle, rotation speed. And the steering control unit controls control motor to output corresponding steering speed and moment.

Electric steering device controls power transmitting to steering mechanism from steering motor by electric signal. Thus the truck has higher efficiency because hydraulic oil is not used as transmission medium. Meanwhile, the steering sensor has moment feedback function. The electric steering device will feed moment back according to truck travel speed, steering resistance and steering wheel rotation speed to ensure that the truck is safer and the operation is more comfortable.

3.3 Composition of steering system

3.3.1 Steering operation mechanism



(1) Steering wheel (2) Coupling shaft (3) Steering column (4) connecting sleeve (5) steering sensor

Figure 3-1 Steering unit

The operation mechanism of the truck mainly consists of steering wheel, coupling shaft, connecting sleeve, steering column and steering sensor etc (as shown in figure3-1).

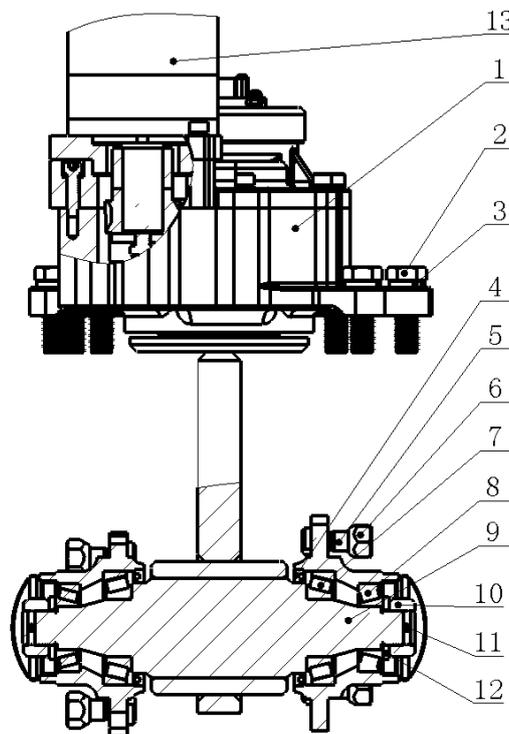
3.3.2 Steering sensor

The steering sensor transmits steering signal to steering control unit according to steering wheel rotation angle and steering speed and meanwhile the steering sensor receives the feedback signal from steering control unit to adjust feedback moment.

3.4 Steering axle

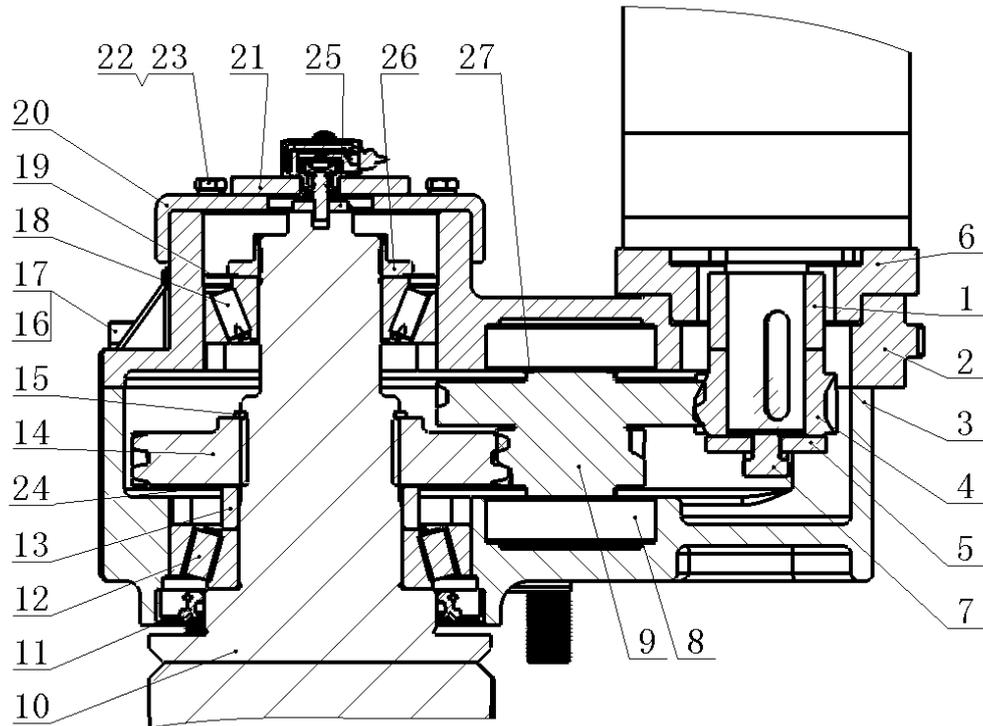
The electric steering bridge is composed of the rear axle of the wheel hub, the

secondary reduction mechanism, the steering motor and etc. The electric steering bridge is fixed to the frame by six bolts M16x1.5x50 and spring pad. The gear box is equipped with grease. Put driving gear on main shaft of steering motor. The driving gear engages with the double gear, the double gear drives the helical gear; the internal spline put on the helical gear is on the spline of the output support shaft of the rear axle assembly of the wheel hub. With the steering motor turning clockwise or counterclockwise, the rear axle assembly of the wheel hub turn left or right. The wheel is pried onto the rear wheel hub by the wheel rim, which is mounted onto the steering wheel shaft by two taper roller bearings. The inner bearing is provided with an oil seal to keep the grease in the hub and shaft cavities of the steering wheel.



1.Gear box, 2.Bolt M16x.5x50, 3.Gasket 16, 4.Framework oil seal, 5.Wheel hub bolt, 6.Wheel hub nut, 7.Bearing 30208, 8.Bearing 30206, 9.Steering wheel axle, 10.Nut M24X2, 11.Pin 5X45, 12.Gasket 24, 13.Steering motor

Figure 3-2 Steering axle



1. shaft sleeve, 2. shell cover, 3. shell, 4. Driving gear, 5. Baffle ring, 6. The motor flange, 7. assembling bolt, 8. Bearing 6305-RS, 9. Duplicate gear, 10. Output support shaft, 11. Skeleton oil seal, 12. Bearing 30212, 13. Driving shaft spacer, 14. Helical gear, 15. Baffle ring 58 16. Bolt M8X30, 17. Gasket 8, 18. bearing 32209. Oil retainer, 20. end cover, 21. Potentiometer plate, 22. bolt M6X20, 23. Gasket 6, 24. Adjusting shim, 25. Fixing plates, 26. Locking nuts, 27. Adjusting gasket

Figure 3- 3 gear box

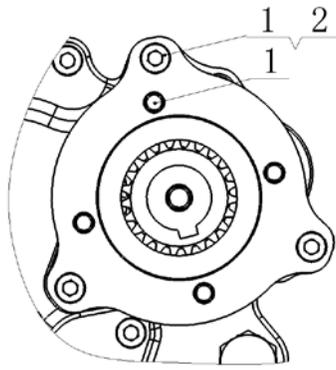


Figure 3-4 Installation of motor

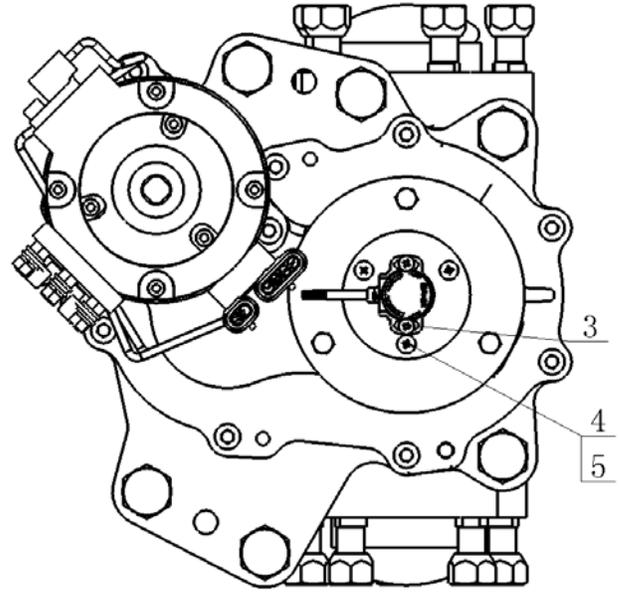


Figure 3- 5 Installation of potentiometer

1. Bolt M8X30, 2. Gasket 8, 3. Bolt M4X25, 4. Bolt M5X16, 5. Gasket 5

Steering motor and motor flange with four bolts M8X30 (plus thread sealant) connected into a whole, when installation should pay attention to the relative position of flange and the steering motor, as refer to figure 3-4 and figure 3-5, then through the three bolts M8X30 add spring washers installed on the reducer shell, needing attention to install the motor pile head relative to the direction of the reducer, as refer to figure 3-6

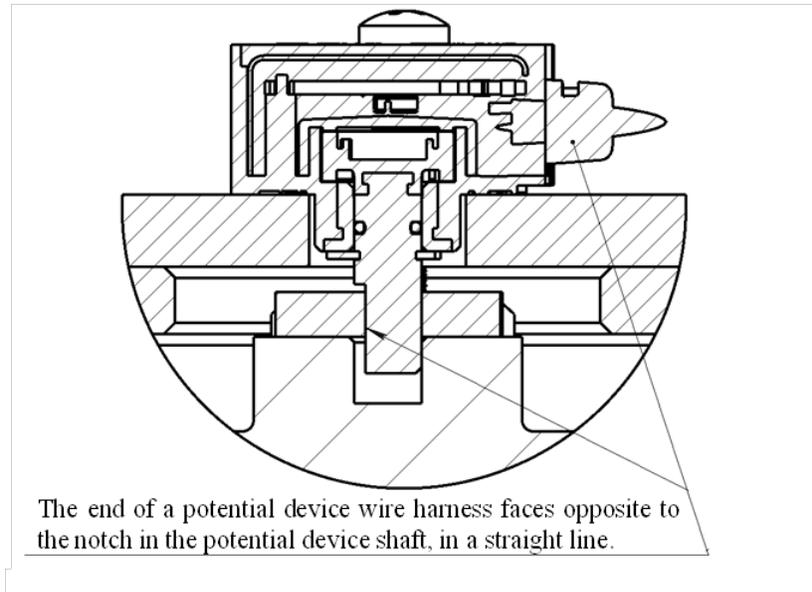


Figure 3- 6 Potential device and fixed plate assembly

3.5 Adjustment steps for preload of the steering wheel bearings

- (1) As refer to figure 3-7, grease is applied to the inner cavity of the hub bearing and the hub cover, and some grease is applied to the lip of the oil seal;
- (2) Fix the bearing outer ring to the wheel hub and install the wheel hub on the steering knuckle shaft;
- (3) Install the flat gasket and tighten the groove nut, the torque is 206~235 N*m (21~24kgm) , loosen the groove nut, and then tighten the groove nut again, the torque is 9.8 N*m (1kgm) ;
- (4) Gently tap the hub with a wooden hammer and rotate it three to four turns to ensure it is not loose;
- (5) Tighten the slotted nut to align the slot with the split pin hole on the knuckle;
- (6) After gently tapping the hub with a wooden hammer, rotate the hub 3~4 turns by hand to ensure a stable rotation, and measure the driving torque of the wheel hub, which is 2.94~7.8N*m (0.3~0.8kgm) ;
- (7) When the driving torque is higher than the specified value, it can be returned 1/6 turns and measured again;
- (8) When the specified value of driving torque is achieved, the castle nut is locked with the split pin.

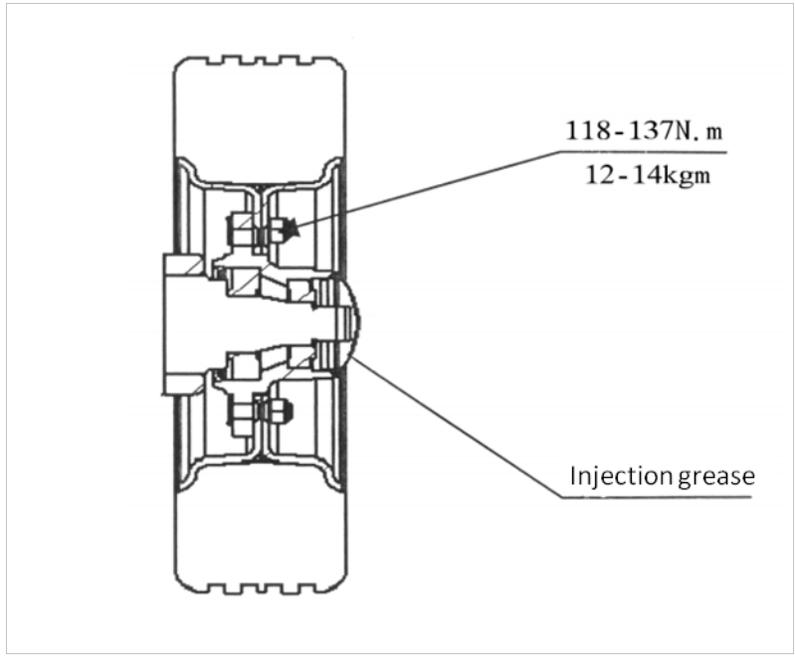


Figure 3-7 Injection grease & preload adjustment

4. Electric system

4.1 General description

The standard configuration of G2 series 1.5-2t is a full AC type control system. 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, steering control system, battery pack, control switch, lighting and wiring harness etc.

The traction control system is made up of lateral electronic rocker, travel switch, foot braking switch, electromagnetic brake, traction control module and AC traction motor.

Lifting control system is made up of lateral electronic rocker, valve control module, lift control module and AC pump motor.

The steering control system is made up of TFD sensor (to send order signal) , steering angle sensor (to feedback steering angle) , steering control module and AC type steering motor 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 figure below.

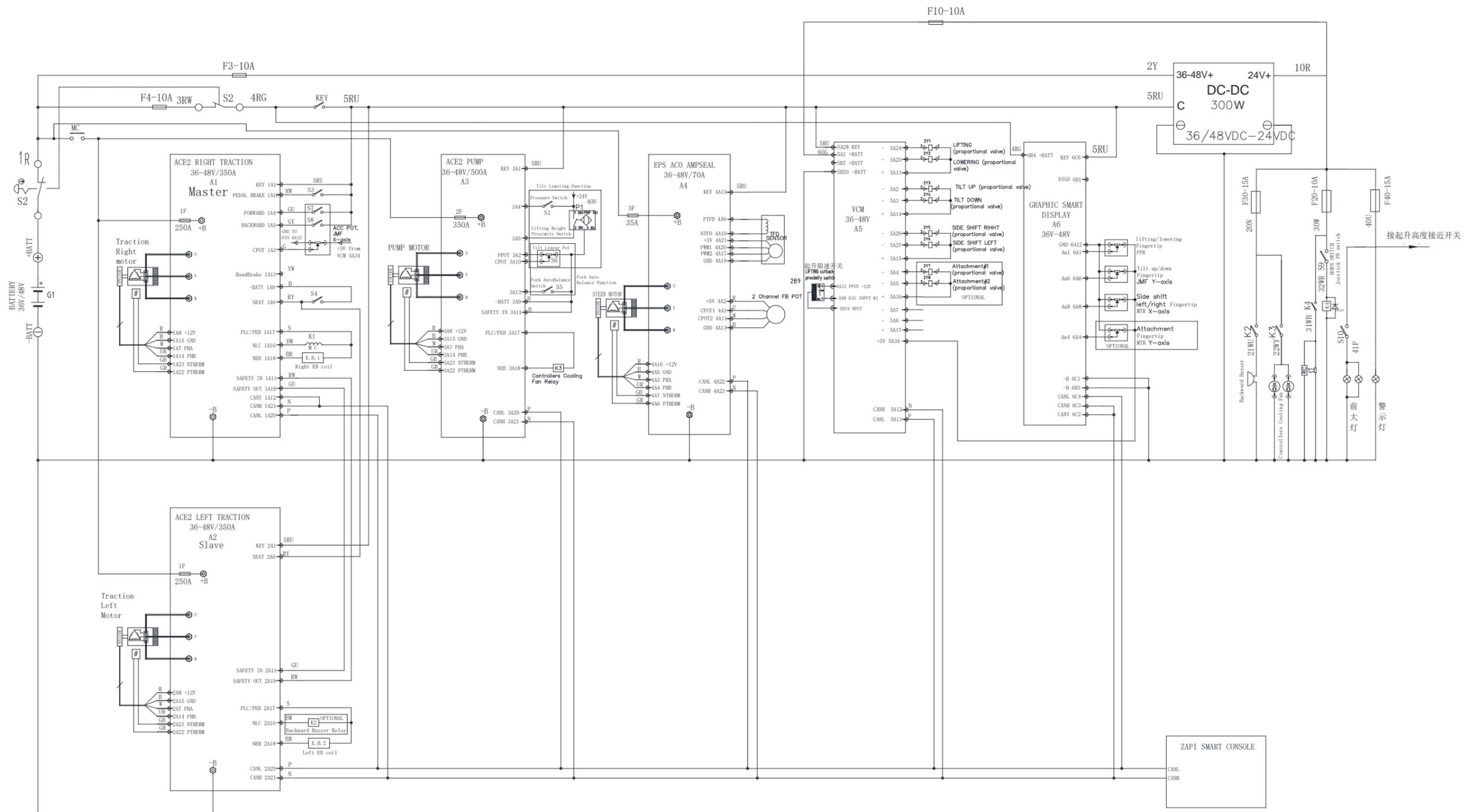


Figure 4-1 Electrical system schematic

4.2 Electrical system specification

4.2.1 CAN BUS technique

The G series CPDSR15-20-GA2 electric three-wheel stand-on type forklift truck uses CAN BUS technology, and each module connected to CAN network (including traction control module/lift control module/steering control module/instrument display module) can act as an access point for external equipment to the CAN BUS. The ZAPI handheld unit (or computer interface controller) can be connected to a module and, through the CAN BUS, to any other module in the network.

The submenu “SET MODEL” is used to select the module that the user wants to connect to. Some data related to each module of the ZAPI bus system is given below:

Relative numbers of CAN BUS network	Module
01	VCM valve controller
03	Main traction controller
04	Auxiliary traction controller
05	lifting controller
6.1	Main steering controller
6.2	Auxiliary steering controller
16	Instrument

4.2.2 Instrument

A) General description

GRAPHIC DISPLAY is a kind of intelligent instrument connected to the truck system through CAN BUS, which can display the truck travelling status, have diagnostic function, and provide the setting of functions such as switching of truck operating mode and height recognition (optional, non-standard) .

B) Panel layout

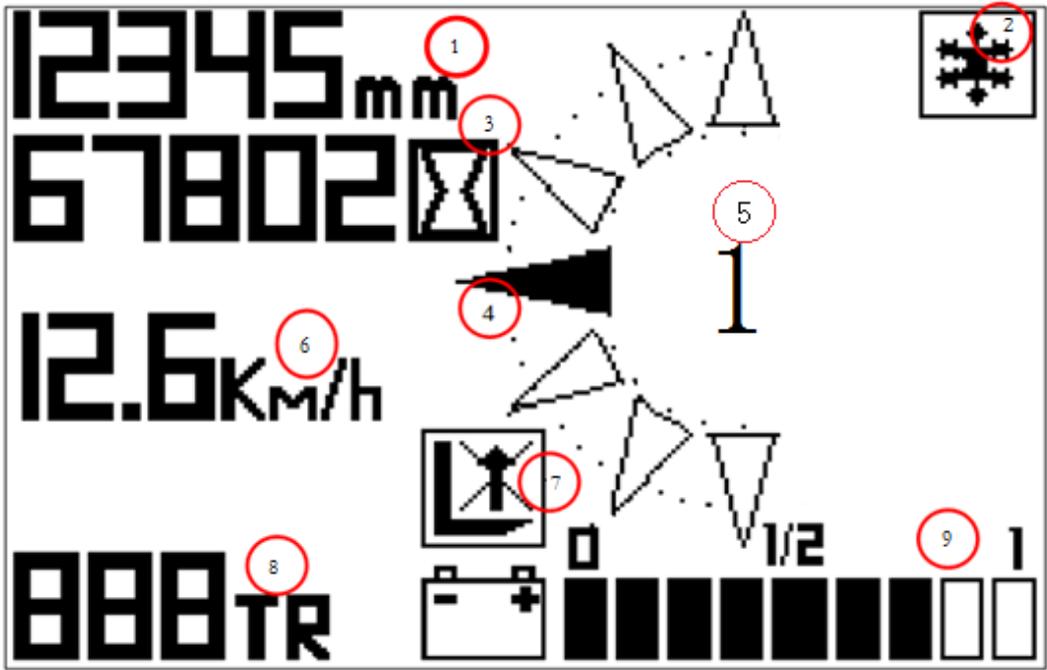


Figure 4-2

(1) Fork height indicator (optional)

Display current fork height, unit mm.

(2) Freezing and heating indication (optional)

When the electric heating function is started in the cold storage, the sign is displayed.

(3) Hourmeter

When the hourglass symbol flickers, it indicates that the clock is ticking and the number indicates the current working time of the truck.

(4) Wheel Angle indicator

Show the current wheel Angle and direction, with 12 arrows (12 arrows for 360° and 6 for 180°) and only one arrow highlighted.

(5) Operating mode indicator

Display the current Operating mode, there are “1-3” and “turtle” modes.

(6) The speed indicator

Display current truck speed, unit Km/h.

(7) Lift lock instruction

Indicate lifting is locked.

(8) Fault code indicator

Display the fault node and fault code.

(9) Battery indicator

Display current battery level.

C) Operating and using instructions of the instrument

(1) Turn on the key switch, when the **instrument** is energized, complete the self-check of the **instrument** system. The main page displays the battery power, truck speed traction hourmeter and wheel angle.

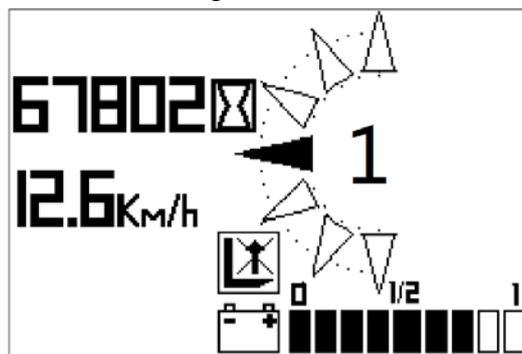


Figure 4-3

(2) Safety switch and brake display: when the travel switch is released, the instrument display graph  is always on, and the truck is in the braking state. At this time, it cannot move forward or backward, but it can turn. After stepping on the travel switch and foot safety switch, the instrument display pattern  is off, the whole truck can travel, and the lifting performance is normal.

Loosen the pedal safety switch, the instrument light  is on, the truck is in the braking state, the operating truck traction system does not work, step down the pedal safety switch, the instrument light  is off, the truck is in the standby state, and the traction operation can be carried out.

(3) Battery capacity display: the figure of battery discharge indicator (BDI) has 9 grids. When the battery capacity of the truck is charged, the indicator is full (9 grids) .With the discharge of the battery, the indicator is correspondingly reduced. When the battery power drops to 15%, there is still 1 grid left. The fault alarm lamp  and undervoltage alarm lamp  will flash simultaneously, in order to protect

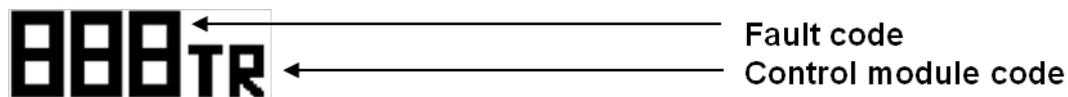
the battery, the truck's driving speed becomes slow and the lifting function is cut off. In the meantime, the battery should be charged in time.



Figure 4-4

(4) Operating timer: After the key switch is turned on and the truck starts working, the timer  will start timing. The user can conduct corresponding maintenance and repair work on the truck according to the time specified in the truck operation and maintenance manual through the accumulated working time of the timer.

(5) Failure code display: If the fault occurs, the instrument pattern  is lighted, the failure code and the control module code of failure occurrence is displayed in the window.



Control module code	Corresponding control module	Control module number
HY	VCM valve control	01
TM	Main traction controller	03
TS	Auxiliary traction controller	04
PU	lift control	05
EM	EPS-AC0	6.0
ES		6.1
DI	Instrument	16

Note: the control module number is the electronic control node number displayed in the handheld unit.

D) Instrument working environment

- ① Working site elevation is not exceeding 1200 meters.
- ② Temperature range of working environment is -25 C~+40 C.

- ③ Maximum relative humidity of working environment is less than 95%

4.2.3 Controller system

CPDSR15-20-GA2 the three-wheel stand-on type electrical counter balanced forklift of this series adopts 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 includes master and slave motor controllers of traction system, lifting controller, valve controller and steering controller, these separately control traction system, lifting system and steering system of the truck.

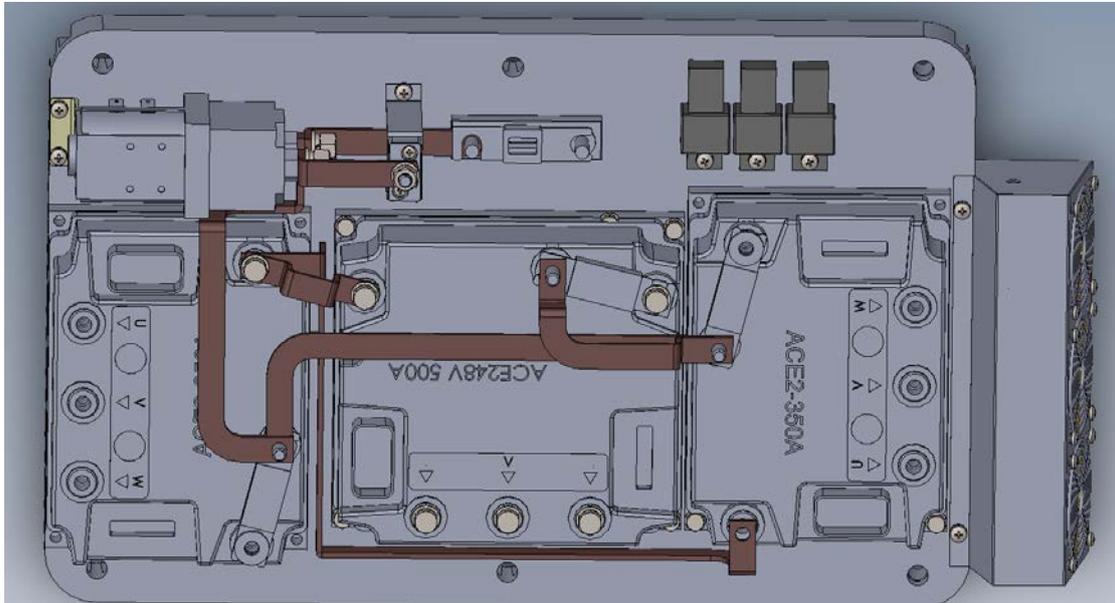


Figure 4-5 Electric controller assembly

A) Traction and pump motor controller

Tractor motor controller type: ZAPI ACE2 48V/350A

Pump motor controller type: ZAPI ACE2 48V/500A

- ACE2 controller which is three phase AC asynchronous motor inverter controls traction motor and pump motor. It has regenerative brake function, CAN bus port and digital control function (based on motor speed feedback).

- Allowable working environment temperature: $-30^{\circ}\text{C} \sim +40^{\circ}\text{C}$, Max. allowable working temperature: 85°C .

- Protection function of the ACE2 traction motor controller:

- a) Battery polarity protection b) Incorrect connection protection
- c) Over heat protection; overload protection; short circuit protection
- d) Controller protection degree: IP65;
- e) Out of control protection f) Battery over discharging protection
- g) Mis-starting protection

● The following functions can be realized through controller’s hand console:

- a) On line inspection and adjusting on traction and lifting control system
- b) On line correction on travelling accelerator and lifting speed adjusting signal
- c) Fault detection and inquiry on traction and lifting control system

B) Steering motor controller

CPDSR15-20-GA2 the three-wheel stand-on type electrical counter balanced forklift of this series adopts EPS-AC0 controller imported from Italy.

Steering motor controller model: ZAPI EPS-AC0 48V/45A

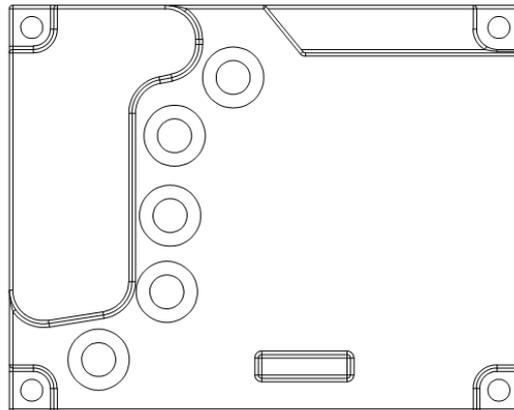


Figure 4-6

- EPS-AC0 controller adopts the high frequency MOS technology, which improves the reliability, and in the meantime, realizes the high-efficiency and low-loss, smooth and mute control.
- EPS-AC0 controller adopts the single chip control system, which has the perfect diagnosis and protection function, and can monitor the internal and external electrical components which affect the work of the steering system online and in real time

- EPS-AC0 controller adopts electric limit protection for the left and right steering limit of 180 degree steering mode
- EPS-AC0 controller can realize the function of automatic alignment of steering wheel, which realizes by the switch of automatic alignment. In the meantime, the steering wheel can be automatic alignment automatically after the electric lock is opened.
- Allowable working ambient temperature range is -30°C ~+40°C, maximum allowable working temperature is 85°C
- The protection function of steering motor controller:
 - a) Battery jar polarity protection;
 - b) Overload and short circuit protection;
 - c) The protection level of the controller is IP54;
- Through the controller's handheld unit (programming device) , the following functions can also be conveniently implemented.
 - a) The steering control system can be tested and adjusted online;
 - b) Can carry out detailed fault detection and inquiry to the steering control system, easy for system maintenance;
 - c) VCM valve controller:

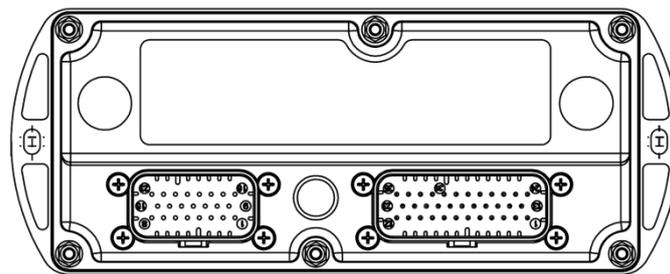


Figure4-7

CPD15-20SQ-GA2R the three-wheel stand-on type electrical counter balanced forklift of this series adopts ZAPI VCM valve controller imported from Italy.

- (1) VCM controller provides multiple digital and analog input ports for connecting to micro switches and potentiometers;
- (2) possess dual microprocessor architecture with two CAN communication ports;
- (3) The machine itself has a very high IP protection level, IP level is 65
- (4) Allowable working temperature range is $-40^{\circ}\text{C} \sim +40^{\circ}\text{C}$;
- (5) Functional characteristics:
 - a) The 16-bit microprocessor is used for primary and security functions and has a memory of 384KB flash memory;
 - b) Up to 11 high level effective digital input ports and 10 analog input ports;
 - c) 2 incremental encoder interfaces
 - d) 2 CAN communication interfaces
 - e) Contains +12V and +5V power output ports
 - f) There are 8 current controlled output ports which can accurately control the hydraulic valve in proportion and the maximum current that the port can pass is 2A.
 - g) .Contains 1 port that can provide up to 4A current output, with PWM control.
 - h) 3 PWM voltage control output ports.

Important Note:

- ◆ Test the truck with wheels raised after the controller being fixed, in that case there will be no danger even the connection is in error.
- ◆ A certain amount of voltage will remain in filter capacitance after the turn off of the electric switch. Cut off the battery and make the remained voltage short circuit by connecting the 10-100ohm resistance to the inverter before checking the inverter.
- ◆ The quality is assured by the producer. When there is a fault, inform the producer of the after-sale service. Do not repair as will unless getting the permission from the producer. Or the user should bear the personal and property damage caused by the unauthorized repair by oneself.

4.2.4 Motor

Specifications of motors: The motors used in each system are free-maintenance three phase AC induction motors.

	Driving motor	Pump motor	Steering motor
Power	4.5KW	11KW	0.4KW
Voltage supplied by battery	36/48V	36/48V	36/48V
Rated current	115A	307A	15A
Speed	4650rpm	1780rpm	2500rpm

Notice: In case of backfire, one must shut off the power when checking and maintaining the motor.

4.2.5 Battery

A) Construction and Specifications of battery

The battery is mainly composed of positive plate, negative plate, separator plate, battery slot cover and electrolyte.

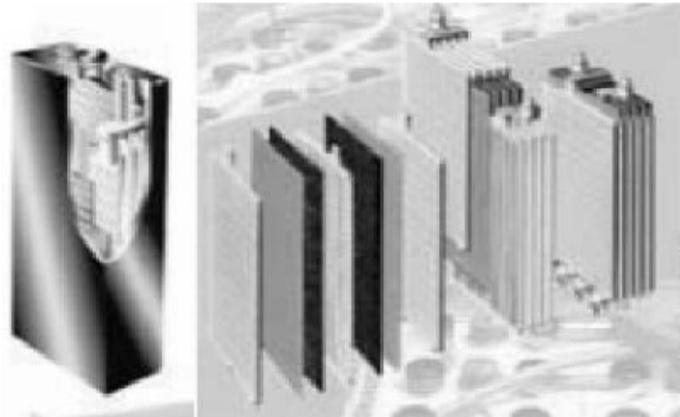


Figure 4-8 Battery construction

Specifications of battery:

Model Item	CPDSR15-GA2	CPDSR15-GB2 CPDSR18-GA2	CPDSR20-GA2
Model	E155	E155	E155
Voltage	36V/48V	36V/48V	36V/48V
Capacity	930Ah/550Ah	1085Ah/660Ah	1240Ah/770Ah
No. of cell	18/24	18/24	18/24

Note: We can supply imported batteries according to customer requirement.

B) 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.

C) Maintenance of battery and matters for attention

Careful observation and regular maintenance of the battery pack will be important to the economic reliability of your forklift. Note that some detailed guidance ensures trouble-free and economical operation.

(1) The surface of battery should be kept clean and dry. Its terminal and wiring parts should be frequently maintained and loosening or poor contact found should be timely eliminated.

(2) No conductive articles are allowed to put on battery to avoid its short circuit.

(3) The first charge of new battery before use is the initial charge and charges in the later use course are the common ones. The charging time of the common charge is different with battery capacity and discharging degree and usually discharging of 70%~100% needs continuous charge of about 8~12 hours.

(4) Open the filling cap during battery charging and close it when charging is finished.

(5) Hydrogen and oxygen gas are separated out during battery charge, therefore, ensure good ventilation condition and prohibit the fire and smoke to prevent explosion.

(6) In use and charging course, the natural evaporation and electrolysis of water content in electrolyte will result in level decrease of electrolyte and increase of density, so distilled water should be frequently added in order to keep height and density of electrolyte normal.

(7) In the course of use, the excessive discharge (i.e. the voltage drop of monomer battery is lower than 1.70V) and excessive charge should be avoided, because, these would seriously affect the service life and performance of battery.

(8) Battery after use should be charged within 24 hours. Failure to charge the battery timely, undercharge, excessive discharge or unused for a long time without additional charging will vulcanize polar plate of battery and result in performance degradation and use difficulty when serious.

(9) In the course of use, equalizing charge should be made to the battery once a month so that all monomers of battery can reach well-balanced and good state when in use.

(10) For battery compartment without liquid leakage hole, check if there is hydrops inside of compartment every month. If there is electrolyte spillage caused by improper adding of distilled water, please clean the hydrops in the compartment with sucker in time.

D) Care and storage

(1) The battery should be stored in a warehouse which is dry, well ventilated and away from direct shinning. The temperature inside should stay between 5-40°C 。

(2) Keep the battery from the heat source at least at a distance of 2m.

(3) The battery should not lie upside down or on the side. It should not bear any mechanical shock or any heavy load.

(4) Keep off any liquid and harmful foreign matter. Be care with the falling of the any metal impurity.

(5) Do not store the battery with electrolyte in. If it is necessary, charge the battery fully. Adjust the lever and density of the electrolyte well. Charge the battery once a month during its storage.

Notice:

(1) During battery charging, the charge should be temporally suspended in the

place where the temperature of electrolyte exceeds 40°C.

(2) In battery charging, the service life of battery will be affected if the temperature of electrolyte is more than 50°C.

(3) Do not charge the battery at low temperature (e.g. cold outdoor) , this would affect the service life of battery.

Notice:

(1) The rated voltage of traction battery is not the safe voltage and there is electric shock injury danger if touched, so take safety precautions.

(2) Traction battery is lead-acid battery and electrolyte is dilute sulphuric acid. So when the battery is tested, fed and adjusted etc, wear safety device to avoid accident.

(3) The shell of charger is of metal conductor, therefore the reliable connection of grounding protection line of charger should be ensured to prevent the electric shock accident.

(4) Pulling out battery connectors should be avoided when charger is not turned off. Special care should be taken as this will make battery undercharged which produces dangerous electric spark.

E) Fault and troubleshooting

The causes that make the battery fault are various, except the quality manufacture and transport storage, mostly due to the improper maintenance. Find out faults and analyze the causation in time, take effective measure as soon as possible to exclude.

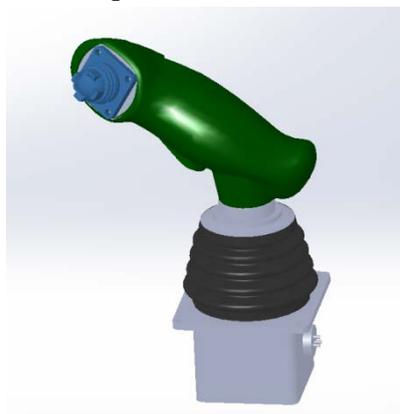
The causes of common fault characteristics and the maintenance methods of battery are shown in the following table.

Fault	Characteristics	Causation	Repair measure
Pole plate sulfide	<ol style="list-style-type: none"> 1) Decrease of the battery capacity. 2) Low density of the electrolytic (below the normal lever) . 3) High battery voltage when beginning or finishing the charging. 4) Air bubble in the early time of charging or beginning. 5) High rising of the electrolytic temperature when charging. 	<ol style="list-style-type: none"> 1) Inefficient first charging. 2) Inefficient charging for a long time. 3) Discharging for many times. 4) No timely charging after discharging. 5) High density of the electrolytic. 6) Low lever of electrolytic. 7) No timely balanced charging. 8) Too low or high discharging current. 9) Impure of the electrolytic. 10) Short inside or electric leakage. 	<ol style="list-style-type: none"> 1) Adopt the measure of balanced charging when the actuality is not severity. 2) Adopt the hydrotherapeutics when the actuality is severity. 3) Do not over discharging. 4) The density of the electrolytic should below the regular lever. 5) The lever of the electrolytic and content of the impurity should be in the prescribed range.
Inside short circuit	<ol style="list-style-type: none"> 1) Low battery voltage or close to zero indeed when charging. 2) Few or no air bubble at the end of the charging. 3) High rising of electrolytic temperature or slow or no rising of electrolytic density. 	<ol style="list-style-type: none"> 1) Curve pole plate; expanded reactive matter; desquamated reactive matter. 2) Much precipitate. 3) Falling of conductor to the battery. 	<ol style="list-style-type: none"> 1) Replace the plate. 2) Clean the precipitate and conductor. 3) Replace the plate.

	<p>4) Low battery voltage under the condition of open circuit or a quick drop to the limit value when discharging.</p> <p>5) Serious self-discharging.</p>		
Shedding off of the reactive matter	<p>1) Decrease of the battery capacity.</p> <p>2) Turbid electrolytic.</p> <p>3) Much precipitate.</p>	<p>1) Being unsuitable to the electrolytic quality standard.</p> <p>2) Frequent discharging and charging or over charging or discharging.</p> <p>3) High electrolytic temperature when charging.</p> <p>4) Outside short circuit when discharging.</p>	<p>1) Clean the precipitate when the actuality is not severity.</p> <p>2) Discard when severity.</p>

4.2.6 Integrated control handle

Integrated control handle is a multifunctional integrated handle, which integrates, lifting/lowering, forward/backward, fore tilting/back tilting, side step to left/ side step to right, go forward/go backward and other functions into an operating handle, which can be set according to the user's requirements.



4.2.7 Proximity switch

The lifting buffer and height indicator switch adopts PNP normally open switch, inductive distance is 3 to 5 mm. When proximity switch switches on, the red tail light lightens. When pass the induction plate, if switch indicator light is not bright, or didn't pass the induction plate, the switch light is normally on, then please check whether the proximity switch is in the induction distance or whether the output signal line and power line connected to the proximity switch are connected inversely first.

4.3 Failure diagnosis

4.3.1 General Description

The traction control system, lifting control system, steering control system and intelligent instrument system on the truck are all continuous monitoring microprocessor controller and they carry out a diagnosis program on main functions.

The diagnosis program is made up of the following 4 points:

- (1) Diagnosis when the key switch is closed: check if the circuit for watch dog, current sensor, capacity charge, phase voltage, contactor drive, can-bus interface and switch operation order are correct; check if the output of accelerator is correct; check if the two microprocessors are synchronized; check if there are inputs of hardware related to safety.
- (2) Check when it is under standby application: circuit of watch dog, phase voltage, drive of contactor, current sensor, CAN-BUS interface.
- (3) Check when working: circuit of watch dog, drive of contactor, current sensor, CAN-BUS interface.
- (4) Continuous check: inverter temperature, motor temperature

There are two ways to show the diagnosis: one is to use digital handheld unit; the other way is that fault code is transmitted by CAN BUS. The fault code and module node are shown on intelligent instrument.

4.3.2 Common fault of traction system (the instrument shows TR nodes)

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	<p>The failure produced when the function of low or over voltage acts. The voltage detected by controller exceeds 65V or lower than 11V. Possible causes:</p> <p>(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.</p> <p>(2) If the battery voltage is excessively low or high.</p> <p>(3) Check B+ and B and see if the power cable on the wiring terminal of contactor etc is tightly fixed.</p> <p>(4) If the voltage calibration parameter of controller is in consistent with actual voltage.</p> <p>(5) There is circuit fault of overvoltage protection hardware on logic card, change the controller.</p>

30	VMN LOW	Low VMN	<p>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.</p> <p>Possible causes:</p> <p>(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.</p> <p>(2) If actuation of main contactor is rigid and if there is any wearing on contact?</p> <p>(3) Change the controller .</p>
31	VMN HIGH	High VMN	<p>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.</p> <p>Possible cause:</p> <p>(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</p>
37	CONTACTOR CLOSED	Adhesion of contactor	<p>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.</p> <p>(1) Suggest to check if the contact of contactor is adhered or change the contactor.</p>

38	CONTACTOR R OPEN	Contactor open	<p>Logic card drives the coil of main contactor, but the contactor does not close, possible causes:</p> <p>(1) Mechanical fault and locking etc of contactor.</p> <p>(2) Poor contact of contactor.</p> <p>(3) If contactor works normally, change the controller.</p>
53	STBY I HIGH	High standby current	<p>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.</p>
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	TEMPERATURE	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:</p>

			<p>Parameter set Alarm temperature</p> <p>MAXIMUM CURRENT=50% 96°C</p> <p>MAXIMUM CURRENT=60% 94°C</p> <p>MAXIMUM CURRENT=70% 92°C</p> <p>MAXIMUM CURRENT=80% 90°C</p> <p>MAXIMUM CURRENT=90% 88°C</p> <p>MAXIMUM CURRENT=100% 86°C</p> <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>
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 truck 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.</p> <p>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	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 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	ENCODER LOCKED	Motor speed encoder locked	<p>If the controller detects that the motor encoder has no output, it shall keep the fault. Check encoder wiring and check the encoder.</p>
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</p>

			<p>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>
224	COIL SHORTED EF	Short circuit of auxiliary coil	<p>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.</p> <p>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.</p>
225	WAITING FOR NODE	Waiting node	Due to the failure of other controllers on CAN BUS, waiting for other controller faults on CAN BUS to be eliminated.
226	VACC OUT RANGE	Accelerator output is out of range	Recapture the accelerator output voltage
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>

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	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 :

			<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	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.
234	BRAKE RUN OUT	Brake pedal output beyond range	Recapture the output voltage of brake pedal.
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</p>

			TESTER menu, handbrake is always ON. This is a logic fault, so 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 truck 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 CHECKSUM	Flash Memory	When key is switched on, the program is a positive value in flash memory and the fault

		fault	<p>signal is produced in case of negative value.</p> <p>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.</p>
242	SAFETY INPUT KO	Safety input fault	<p>As the driving system is double-drive, once any traction controller fails, and the other one fails to work properly too, this fault will appear, and the fault of another traction controller will be repaired.</p>
243	SENS MOT TEMP KO	Fault of temperature sensor	<p>Phenomenon: The output signal of temperature sensor of motor exceeds the scope.</p> <p>Solution: Check the value of sensor and connection of wires and the fault is inside the controller in case of no problem found.</p>
244	SOFTWARE ERROR	Software error	<p>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”.</p>
245	WRONG RAM MEMORY	Dynamic memory fault	<p>Wrong contents are found when testing the main memory: The registration address is “DIRTY” and the fault will restrict the operability of truck.</p> <p>Fault analysis: Switch on the key after switching it off and change the controller if the trouble still exists.</p>
246	AUX DRIVER OPEN	Auxiliary output drive fault	<p>Auxiliary coil drive circuit can not drive load. The equipment or drive coil is damaged. Change the controller.</p>

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 ault of the drive unit of the logic card; change the controller.

4.3.3 Common fault of pump control system (instrument display PU node)

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.

			<p>(4) If the voltage calibration parameter of controller is in consistent with actual voltage.</p> <p>(5) There is circuit fault of overvoltage protection hardware on logic card, change the controller.</p>
30	VMN LOW	Low VMN	<p>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.</p> <p>Possible causes:</p> <p>(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.</p> <p>(2) If actuation of main contactor is rigid and if there is any wearing on contact?</p> <p>(3) Change the controller .</p>
31	VMN HIGH	High VMN	<p>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.</p> <p>Possible cause:</p> <p>(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</p>

37	CONTACTOR CLOSED	Main contactor adhesion	Check whether the main contactor contact is adhered, check the wiring, check the type of contactor, and check the controller.
38	CONTACTOR OPEN	Main contactor disconnecting	Check the wiring, check the contactor type, check the parameters, check 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	<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:</p> <table data-bbox="810 533 1350 936"> <thead> <tr> <th>Parameter set</th> <th>Alarm temperature</th> </tr> </thead> <tbody> <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> </tbody> </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> <ol style="list-style-type: none"> (1) Temperature calibration parameter of logic card is incorrect, check parameters. (2) The internal temperature sensor of controller has trouble and change the controller. 	Parameter set	Alarm temperature	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
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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 truck can move at this time. But the max. current and performance are cut down.</p>														

			<p>When the motor temperature reaches 125°C, motor stops working. Now try to lower the temperature of the motor.</p> <p>If the fault still exists when motor is cooled, check the circuit and change the controller if the circuit is OK.</p>
66	BATTERY LOW	The battery is low	The battery voltage is too low and needs to be charged in time.
74	DRIVER SHORTED	Short circuit of driver	<p>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.</p>
75	CONTACTOR DRIVER	Main contactor drive fault	Check the wiring, check the contactor type, check the contactor line package resistance, check the parameters, check the controller
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>

			(3) The failure of controller
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 back switches are in effect simultaneously	Check the forward and backward switch wiring, check the switch, check the controller.
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) .</p> <p>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>
209	TILT LIN OUT RAN	Tilt line potentiometer output out of range	Check whether the inclined linear potentiometer is connected, check whether the potential is normal, and resample.
210	TILT LIN ACQUIS.	Wrong sampling values for tilting linear	Resample.

		potentiometers	
211	LIFT ACQUISITION	Error lifting potentiometer sampling value	Resample.
212	LIFT OUT RANGE	Lifting potentiometer output out of range	Check the lifting potentiometer connection; check whether the potentiometer is normal. Resample.
213	TILT ACQUISITION	Tilting potentiometer sampling error	Resample.
214	TILT OUT RANGE	Tilting potentiometer output out of range	Check the tilting potentiometer wiring; check whether the potentiometer is normal. Resample.
215	SHIF ACQUISITION	Wrong sampling value of side shift potentiometer	Resample.
216	SHIF OUT RANGE	Side shift potentiometer output out of range	Check the side shift potentiometer wiring; check whether the potentiometer is normal. Resample.
217	ATT ACQUISITION	Wrong sampling value of attachment potentiometer	Resample.
218	ATT OUT RANGE	Attachment potentiometer output beyond the range	Check the attachment potentiometer wiring; check whether the potentiometer is normal. Resample.
219	VCM IN ALARM	VCM valve controller	Failure of VCM valve controller, repair VCM valve controller.

		failure	
220	PROG VACC NOT OK	Lifting potentiometer programming failure	Resample.
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	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	AUX COIL SHORT	Auxiliary coil short circuit	Check whether the wiring of the auxiliary output port is normal; Whether the port

			coil resistance value is correct; Whether the parameters are correct.
226	VACC OUT RANGE	Lifting potentiometer output out of range	Check the lifting potentiometer connection; Check whether the potentiometer is normal. Resampling.
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.
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	MC COIL SHORT	Main contactor coil short circuit	Check whether the output port wiring of the main contactor is normal, whether the port coil resistance value is correct, and whether the parameters 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

			<p>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>
234	BRAKE/QI RUN OUT	Brake pedal output beyond range	The output voltage of brake pedal is collected again
235	HANDBRAKE	Fault of hand brake switch	Stand-on type front drive three-wheel forklift without hand brake switch, so there is no such fault.
236	CURRENT GAIN	Large static current	Replace the controller.

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> <ol style="list-style-type: none"> (1) Internal connection of motor. (2) Power cable connection of motor. (3) Drain current between motor and truck casing. (4) If the motor connection is good, the problem is inside the controller and changes it.
239	SAFETY OUTPUT	Failure of safety output	<p>Driver short circuit of safety output.</p> <p>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.</p>
240	HARDWARE FAULT	Hardware circuit fault	<p>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.</p> <p>Fault analysis: Change the controller.</p>

241	FLASH CHECKSUM	Flash Memory fault	<p>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.</p> <p>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.</p>
242	ENCODER LOCKED	Feedback signal fault of encoder	<p>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.</p>
243	SENS MOT TEMP KO	Fault of temperature sensor	<p>Phenomenon : The output signal of temperature sensor of motor exceeds the scope.</p> <p>Solution: Check the value of sensor and connection of wires and the fault is inside the controller in case of no problem found.</p>
244	SOFTWARE ERROR	Software error	<p>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</p>

			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 truck. Fault analysis: Switch on the key after switching it off and change the controller if the trouble still exists.
246	AUX DRIV.OPEN	Auxiliary coil opening	Check whether the wiring of the auxiliary output port is normal, whether the port coil resistance value is correct, and whether the parameters are correct.
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 DRIV.SHRT.	Auxiliary drive short circuit	Check whether the wiring of the auxiliary output port is normal, whether the port coil resistance value is correct, and whether the parameters are correct.

4.3.4 Common fault for steering system (instrument displays EM ES nodes)

Fault Code	Implication	Note	Measures
8	WATCHDOG	Watchdog circuit malfunction	When started, the Watchdog circuit is activated before the software is started. The Watchdog signal is not valid (alarm status) when it is in standby or running mode. The watchdog hardware circuit or the output part of the microcontroller is broken. Both of these cases are independent of external components, replace the logical card.
13	EEPROM KO	EEPROM memory to write or read any function damage, will alarm; Different values of the hourly records will also alarm; if the hourmeter cannot start in 12 milliseconds, it will	Replace the controller.

		also alarm.	
16	LOGIC FAILURE #4	In standby mode, if the output phase of Vw-Vv of the voltage amplifier exceeds $\pm 0.25V$, will alarm.	Replace the controller.
17	LOGIC FAILURE #3	In standby mode, if the output of the voltage amplifier fluctuates exceeds $\pm 0.25V$, will alarm.	Replace the controller.
18	LOGIC FAILURE #2	When the actual voltage of the W phase and V phase of the motor is inconsistent with the desired voltage, an alarm occurs.	Must Replace the controller.
19	LOGIC FAILURE #1	When the actual voltage of the W phase and U phase of the motor is inconsistent with the desired voltage, an alarm occurs.	1、 Check if the battery is broken 2、 Replace the controller.
32	VMN NOT OK	After the key switch turned on, in standby state, if the output of the motor voltage amplifier exceeds 2.2v ~ 2.8v, will alarm.	

48	MAIN CONT.OPEN	The alarm only occurs when CAN BUS is set to PRESENT. Then, the main contactor of the traction controller closes, and EPS-AC0 waits for information on the CAN bus, which will alarm if the information is less than 1.5 seconds.	On the traction controller, the main contactor is disconnected.
53	STBY I HIGH	If the output of the current amplifier exceeds 2.2V ~2.8V when the key switch is on and in standby mode, will alarm. When the current amplifier output range fluctuates exceeds $\pm 0.15V$, will alarm.	Replace the controller.
60	CAPACITOR CHARGE		
61	HIGH TEMPERATUR E	Controller bottom temperature over 75°C, generate alarm.	Improve the cooling device or replace the controller.
65	MOTOR	When the DIAG	Check whether the temperature

	TEMPERATUR E	MOTOR TEMP set to ON, the temperature sensor in the MOTOR temperature higher than 150 °C, generate alarm.	sensor inside the motor is working normally. If it is working normally, improve its cooling device.
70	HIGH CURRENT	Excessive current	Check if the motor is suitable for EPS-AC0, otherwise change the controller.
71	POWER FAILURE #3	The V - phase current of the motor is 0, and the motor is still running, generate alarm.	Check whether the power fuse is intact; Check whether the battery anode is connected to the controller; Check whether the V connection line of the motor is intact; Otherwise replace the controller.
72	POWER FAILURE #2	The U-phase current of the motor is 0, and the motor is still running, generate alarm	Check whether the power fuse is intact; Check whether the battery anode is connected to the controller; Check whether the U connection of the motor is intact; Otherwise replace the controller.
73	POWER FAILURE #1	The W - phase current of the motor is 0 and the motor is still running	Check whether the power fuse is intact; Check whether the battery anode is connected to the controller; Check whether the U connection of the motor is intact; Otherwise replace the controller.
84	STEER SENSOR KO	Potentiometer voltage discontinuity	Double potentiometer failure (CPOC1 connected to CNA#9 and CPOC2 connected to CNA#8) varied greatly, much more than MAX SP SLOPE, which generated alarm.

			Replace the dual potentiometer.
85	STEER HAZARD	Just warn the operator that the steering controller limits the steering Angle and does not slow down the walking speed.	
98	INPUT ERROR #2	The steering wheel's double input signal is wrong	Check the LORD TFD sensor wiring of under the steering wheel.
207	WRONG HW SET	Hardware setting fault	Check that the software is correct. Check that the parameters are correct. Check the controller.
208	OUTPUT MISMATCH	The steering Angle does not match	Check the parameters. Check the motor for normal rotation and no mechanical sticking.
209	W.D. SYNCRO	sync error	If the fault still exists after restart, it may be the electromagnetic protection problem of electric control. Clean the conductor near electric control and reconnect. Replace the controller.
210	WRONG SLAVE VER.	Main and auxiliary chip software are different	After checking the controller's main chip software and auxiliary chip software, write the same version of main and auxiliary chip software as required.
211	TFD FEEDB. ERROR	TFD feedback error fault	Check whether the resistance value of TFD coil is the same as the specification of TFD. Check TFD connection is normal. Check the

			controller parameters. Replace the TFD.
212	WRONG RAM MEM.	RAM unit error failure	If the fault persists after rebooting, the controller needs to be replaced. If the fault goes away, you need to reset the parameters.
213	PARAM RESTORE	Parameter storage failure	After CLEAR EEPROM and rebooting, the fault goes out and the parameters are reset. If there is no CLEAR EEPROM but the fault goes out after rebooting, the controller needs to be replaced.
214	SP JERK	Wrong steering wheel sensor signal	Check that the sensor and controller under the steering wheel are properly wired and that they are not cracked. Replace a sensor.
215	CAN BUS KOM/S	Controller communication error	Check whether the vehicle CAN communication line is correct. Whether is 60 Ω between CANH and CANL. Replace the controller.
216	TFD WRONG RESIST	Wrong TFD coil resistance value	Check whether the resistance value of TFD coil is the same as the TFD specification. Check TFD connection is normal. Check the controller parameters. Replace the TFD.
217	S.P OUTRNG WARN.	Feedback potentiometer output out of range	Check whether the feedback potentiometer is installed correctly and the wiring is correct. Whether the controller parameters are correct. Replace the feedback potentiometer.
218	CONTROLLER MISM.	Error in controller software	Check that the controller type is correct. Whether the software of the controller's internal main and

			auxiliary chip is correct.
219	STEPPER MOTOR MISM	If the D and Q leads of the motor are connected incorrectly, an alarm will be given. Generally, the voltage amplitude of the motor increases, so does its frequency.	The controller must be replaced.
220	MOTOR LOCKED	If the maximum current of the steering motor lasts more than 1 second, an alarm will generate.	The motor locked. 1. Check the phase sequence of steering motor U V W 2. Check the position of steering motor encoder A\B phase 3. Test the motor current and check whether the machine is stuck To make it easier to find faults, set DEBUG OUTPUT to LEVEL 11.
221	M/S PAR CHK MISM	The parameters of the controller's main and auxiliary chips do not match	Check the software and parameters of the main and auxiliary chip of the controller. Rewrite them.
222	FB POT LOCKED	The steering encoder has no feedback	If the motor turns at a certain Angle after starting up, it will stop reporting fault. Check the steering motor encoder wire harness. Check the power supply of the steering controller. If the motor does not rotate after starting the machine, the fault will be

			<p>reported.</p> <p>Check the resistance value of EPS U\ V\ W phase, B+ and B-, and check whether the controller power unit is bad.</p> <p>2. Check whether the winding of the steering motor is disconnected.</p> <p>To make it easier to find faults, set DEBUG OUTPUT to LEVEL 11.</p>
223	FB JERK	Speed feedback encoder error	<p>Check the motor speed encoder connection is correct. Whether the speed encoder output is correct.</p> <p>Replace the steering motor.</p>
225	CURRENT GAIN	This parameter is used to compensate for current amplifier parameters(ADJUSTMENT#3 and ADJUSTMENT#4)	The alarm disappears after troubleshooting
226	STOP TRAC WAR	Traction controller fault	When the traction controller fails, the steering controller prompts this warning.
227	OUTRNG-TURN ST01	The feedback potential output stops	<p>Check whether the feedback potentiometer is installed correctly and the wiring is correct.</p> <p>Whether the controller parameters are correct.</p> <p>Replace the feedback potentiometer.</p> <p>Slowly turn the steering wheel so that the steering wheel is in the middle, then restarting.</p>
228	POSITION	Alarm generates	When used with a alignment switch

	ERROR	when the encoder counts and wheel position do not match	and a FEEDBACK coder, the FEEDBACK sector on the test menu does not match the FEEDBACK ENC. 1. Check the proximity switch power supply; 2. Check the position of steering proximity switch and induction block.
232	ANGLE	Analog input fault	Check whether the feedback potentiometer is installed correctly and the wiring is correct. Whether the controller parameters are correct. Replace the feedback potentiometer. Replace the controller.
235	TFD SHRT/VOLT KO	TFD coil short circuit or voltage fault	Check whether the resistance value of TFD coil is the same as the TFD specification. Check TFD connection is normal. Check the controller parameters. Replace the TFD. Replace the controller.
236	TFD STB I HIGH	TFD coil has high static current	Check whether the resistance value of TFD coil is the same as the TFD specification. Check TFD connection is normal. Check the controller parameters. Replace the controller.
237	SLAVE ALARM OR WAITING MASTER	auxiliary chip fault	When the auxiliary chip fails, the main chip will prompt. Check the failure code of the auxiliary chip by hand and then process accordingly.
238	EPS NOT ALIGNED	The alarm cut off the traction motor and did not align	Check whether the zero approach switch works properly 1. Check the proximity switch power

		forward for the first 6 seconds. During the 6 second delay, the control was not activated, the safety relay was on and the traction was stopped.	supply; 2. Check the position of steering proximity switch and induction block
239	WAITING FOR TRAC	EPS-AC0 requires the pull controller command to turn off the safety switch and enter operation mode until this command is released, and this alarm generates.	
240	LOGIC SUPPLY ERR	Motor low voltage failure	Check whether the three-phase connection of electric control and motor is correct, and whether there is short circuit, circuit break and leakage. Replace the motor. Replace the controller.
241	FB SENSOR LOCKED	The actual position of steering wheel is inconsistent with the command position	Check the motor encoder output is normal. Check the gearbox for excessive resistance. Check the output voltage and current of the controller. Replace the motor. Replace the controller.
242	Q LINE SENSOR KO	Step motor Quadrature line The average voltage is not zero	1. Check the connection of the Q wire of the step motor 2. The resistance value between the cathode and the terminal 2A9 of the

			<p>detection battery is no more than 30 ohms</p> <p>3. Replace the step motor</p>
243	D LINE SENSOR KO	<p>Direct line of stepping motor;</p> <p>The average voltage is not 0</p>	<p>1. Check the connection of D line of step motor.</p> <p>2. Check the resistance value between the cathode and terminal 2 a 9 of the battery, no more than 30 ohms</p> <p>3. Replace the step motor</p>
244	PARAM TRANSFER	<p>Auxiliary chip parameter changes fault</p>	<p>The main chip requires the auxiliary chip to change its parameters in the same way, but the auxiliary chip has not been changed successfully. Reset after changing the main chip parameter several times. Replace the controller.</p>
245	DATA ACQUISITION	<p>An alarm is generated when the motor resistance is measured or when the parameters are adjusted to compensate for the current amplifier gain (the maximum current is set at the factory) .</p>	<p>Turn off then open key switch.</p>
247	CAN BUS KO	<p>The alarm only occurs when CAN BUS is set to PRESENT. Then, EPS-AC0 must</p>	<p>Check CAN BUS communication system and analyze the link of traction controller to steering controller.</p>

		accept the final information from the traction controller, and if the information is less than 1 second, it will alarm.	
248	S.P OUT OF RANGE	Potentiometer failure (CPOC1 connected to CNA#9, CPOC2 connected to CNA#8)	If a single potentiometer, such as CPOC1, is out of range from 0.8v~4.2v, it will alarm. When the dual potentiometer is selected, the two sliding ends and (CPOC1+CPOC2) exceed the range of 4.4v ~ 5.5v, which will alarm. Check the connection of the potentiometer. If a potentiometer is not connected well, an alarm will generate.
249	FB OUT OF RANGE	Feedback potentiometer (CPOT connected to CNB#6) failure	CPOT is out of range from 0.3v to 4.7v and an alarm generate. Check the connection of the feedback potentiometer. If one end of the feedback potentiometer is not connected well, an alarm will be given.
250	INPUT MISMATCH	Main and auxiliary chips end data out of sync	Main and auxiliary chips cannot receive data synchronously and replace the controller.
251	INIT VMN NOT OK	Initial motor voltage error	Check whether the three-phase connection of electric control and motor is correct, and whether there is short circuit, circuit break and leakage. Replace the motor. Replace

			the controller.
252	TWIN POT MISMAT.	Bidirectional potentiometer failure	Check whether the feedback potentiometer is installed correctly and the wiring is correct. Whether the controller parameters are correct. Replace the feedback potentiometer.
253	ANALOG	Analog input fault	Check whether the feedback potentiometer is installed correctly and the wiring is correct. Whether the controller parameters are correct. Replace the feedback potentiometer. Replace the controller.
254	NO SP REFRESH	Wrong steering wheel sensor signal	Check that the sensor and controller under the steering wheel are properly wired and that they are not cracked. Replace a sensor.

4.3.5 Common failures of the instrument (instrument displays DI nodes)

Fault Code	Implication	Fault Code	Implication
08	WATCHDOG	247	CAN BUS KO
13	EEPROM KO	248	HARDWARE FAULT
76	COIL SHORTED	249	SERVICE REQUIRED
82	ENCODER ERROR	250	ANALOG INPUT
242	FREE LFT SENS KO	251	HM SYNC.FAILED
243	SENSOR 0 KO	252	HM SYNC.FAILED
244	CAN BUS KO PUMP	253	LIFT SENS MISM
245	AUX DRIV.OPEN	254	REACH SENS MISM
246	AUX DRIV.SHRT		

Intelligent display related fault analysis

“EEPROM KO”

Fault storing adjustment parameters in the storage area. Instead of banning the vehicle from running, “EEPROM KO” allows the vehicle to continue running at the factory setting value. If the electrical lock is re-opened, the fault “EEPROM KO” still exists and the smart display should be replaced. If the failure disappears, the previously stored parameters will be replaced by factory setting values.

“CANBUS KO”

The intelligent display cannot receive information from the CAN bus chain. The troubleshooting method is as follows:

——If the fault is displayed along with other fault information, the problem may be the CAN interface of the monitor, as the monitor cannot receive any CAN information. It is recommended to check the CAN bus cable and wiring of the monitor.

——If the fault is not shown with other fault information, the problem lies in the CAN interface of other modules in the CAN bus network.

“SEVICE REQUIRED”

Regular maintenance has expired and requires a major overhaul.

“COIL SHORTED”

The load connected to a power output short circuit, generates over current on the relevant driver. The fault elimination method is as follows:

——Check the connection load for burning-out or short circuit

——Check related circuit;

——If the fault still exists even when the load connection is disconnected (no load access) , it is the large current protection circuit of the intelligent display is damaged, replace the intelligent display.

4.3.6 Valve controller common faults (the instrument displays HY nodes)

Main controller codes

Fault Code	Implication	Fault Code	Implication
8	WATCHDOG	226	PUMP IN ALARM
19	LOGIC FAILURE #1	227	NO CAN MSG.14
199	OVERLOAD	228	NO CAN MSG. A
200	WRONG PARAMETER	229	SDO TRAC.
201	WRONG SLAVE VER.	230	INTERLOCK FORK
202	HM MISMATCH	231	CARRIAGE LEVER
203	TILLER MISMATCH	232	TILT LEVER
204	BATTERY LOW	233	SIDE SHIFT LEVER
205	RESET ENCODER	234	WAITINGPCF
206	BATTERY OUT	235	WRONG CONFIG
209	PARAM RESTORE	236	NO CONFIG BACKUP
210	WRONG RAM MEM.	237	NO CONFIG MASTER
211	PUMP INC. START	238	PCF TIMEOUT
212	EEPROM KO	239	REACH SENS OUT R
213	ENCODER LOCKED 1	240	REACH ACQ. SENS.
214	ENCODER LOCKED 2	241	M/S PAR CHK MISM
215	OUT PORT PULL-UP	242	PARAM TRANSFER
217	ANALOG INPUT	243	PRESELECTOR
218	RESET ENCODER KO	244	CHECK UP
219	VALVE ENABLE	245	SEAT
222	LIFT/LOW LEVER	246	NO CAN MSG. C
223	NO CAN MSG. 5	247	NO CAN MSG. 6
224	WAITING FOR NODE	248	NO CAN MSG.10
225	CONTROLLER MISM.	249	CAN BUS DISPLAY

Slave controller code

Fault Code	Implication	Note	Measures
08	WATCHDOG	Watchdog malfunction	
19	LOGIC FAILURE #1	Logical fault 1	
199	OUT1/2 COIL SH.	Coil 1 and 2 short circuit	Check up and down solenoid valve and peripheral wire harness for short circuit phenomenon.
200	OUT3/4 COIL SH.	Coil 3 and 4 short circuit	Check up and down solenoid valve and peripheral wire harness for short circuit phenomenon.
201	OUT5/6 COIL SH.	Coil 5 and 6 short	Check up and down solenoid valve and peripheral wire harness for short circuit phenomenon.
202	OUT7/8 COIL SH.	Coil 7 and 8 short	Check up and down solenoid valve and peripheral wire harness for short circuit phenomenon.
207	WATCH DOG MASTER	Watchdog malfunction	The internal timing problem of the controller, the controller needs to be replaced.
208	EEPROM KO	memory fault	If the fault persists after the restart, the controller needs to be replaced. If the fault goes away, reset the parameters.
209	PARAM RESTORE	Parameter storage failure	After CLEAR EEPROM and rebooting, this failure occurs and the parameters are reset. If there is no CLEAR EEPROM but this failure occurs after rebooting, the controller needs to be replaced.
210	WRONG RAM	RAM unit error	If the fault persists after the restart,

	MEM.	failure	the controller needs to be replaced. If the fault goes away, reset the parameters.
211	PEV DRV.OPEN.	Lift - down solenoid valve coil power source open	Replace the controller
212	PEV DRV.SHORT.	Lift - down solenoid valve coil power short circuit	Check whether there is a short circuit or low resistance between port 3A13 and B+, replace the controller
213	VALVE MISM. OUT	Electromagnetic valve drive out-of-balance fault	The main chip and the auxiliary chip in the controller drive the solenoid valve in different current, check the controller parameters and solenoid valve wiring.
215	OUT PORT PULL-UP	Hardware configuration error	Replace the controller
217	ANALOG INPUT	Controller A\D conversion error	Replace the controller
218	IN.MISM.D	Master/slave controller digital signal mismatch	Replace the controller
219	IN.MISM.A/E	Master and slave controller analog or encoder signal mismatch	Replace the controller
223	NO CAN MSG.C	No CAN communication with traction controller	Check the connection between 3A11\3A12 and 1A20\1A21
224	NO CAN MSG.4	CAN	Switch key switch, the fault does not

		communication timeout	disappear, then replace the controller
225	CONTROLLER MISM	Controller ID storage area code error	Replace the controller
227	NO CAN MSG.14	No CAN communication with pump controller	Check the connection between 3A11\3A12 and 2A20\2A21
231	DRV.SHRT A	Solenoid valve 1-8 drive port short circuit	Replace the controller
232	DRV.OPEN A	Solenoid valve 1-8 drive port open	Replace the controller
233	DRV. SHRT B	NEV1, NEV2, NEV3 Solenoid valve short circuit	Check the solenoid valve connection, check the solenoid resistance, check the controller parameters.
234	DRV. OPEN B	NEV1, NEV2, NEV3 Solenoid valve driving failure	Check the solenoid valve connection, check the solenoid resistance, check the controller parameters. Check the controller.
243	COIL OPEN A	Solenoid valve 1-8 coil open	Check whether the solenoid valve is open or wire harness, connector is loose
244	COIL OPEN B	NEV1, NEV2, NEV3solenoid valve open-circuit fault	Check the solenoid valve connection, check the solenoid resistance, check the controller parameters.

4.3.7 Scheduled maintenance

Check contact wear activity and contact state. Contacts should be checked every three months.

Check the pedals and the switches. Select the appropriate meter (multimeter) to measure the voltage drop at both ends, and make sure there is no resistance between the two contacts of the switch. Clear noises should be heard when the switch is operated. The micro switch should be checked every three months.

Check battery cable, chopper cable, motor cable. Make sure they are insulated from each other and well connected. Large wires should be checked every three months.

Check mechanical operation of the handle. See if spring return is normal; whether the potentiometer can rotate to its maximum or the programmed value of the potentiometer. Check every three months.

Check the mechanical operation of the contactor. Contact movement is normal without friction, there is no stuck phenomenon. Check every three months.

Inspection is carried out by qualified personnel and any parts to be replaced should be original. Be careful not to use non-original accessories. The controller must be installed according to the diagram in the instruction manual. Any changes or special requirements will require consultation with the agent of HELI before doing so. The supplier shall not be responsible for any fault caused by the wiring non-conformity of the specification.

During regular inspection, if technicians find any risk factors or potential safety hazards, they should contact the agent of HELI and explain the situation. The agent will give treatments on the security of the machine operation.

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 Figure 5-1.

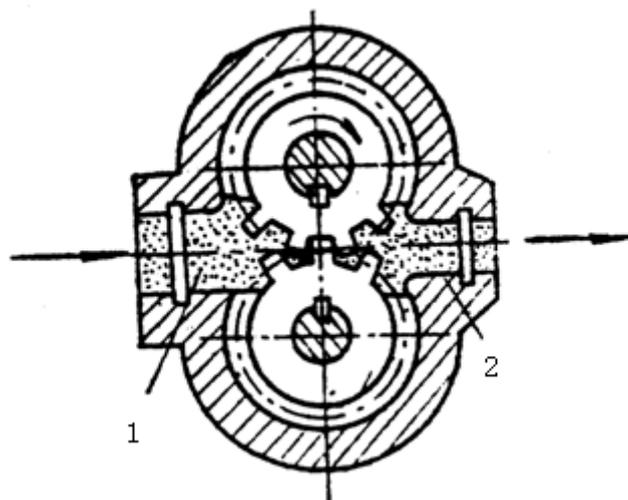


Figure 5-1 Working principle of gear pump
(1) Oil suction cavity (2) Oil pressing cavity

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 Figure. 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 Figure 5-2)

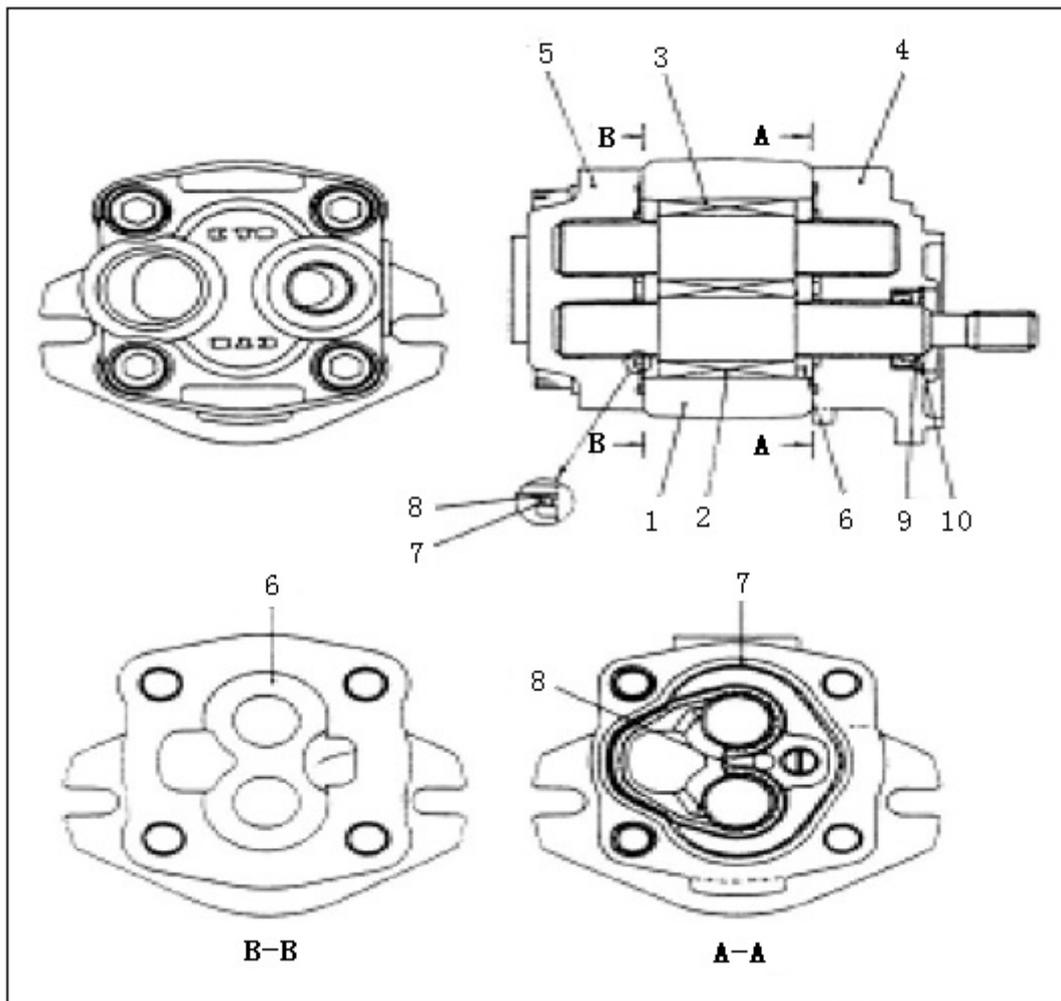


Figure 5-2 Gear pump

- (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 figure 5-3.

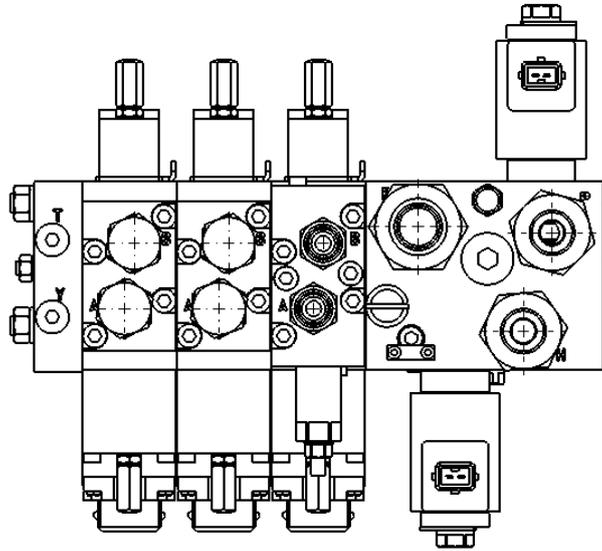


Figure 5-3 Control valve

The control valve adopts four pieces and five body type. The hydraulic oil from working pump distributes the high-pressure oil to the lifting cylinder or tilt cylinder through the control of valve element. There are compensator, safety relief and balance valves inside the control valve. A compensator is provided at the inlet, the lifter valve plate inlet, the inclined valve plate inlet and the fitting inlet. The safety relief valve is at the top of oil inlet of control valve to control the pressure of the system. The balance valve is on the second tilt valve block and is mainly used to prevent the serious consequence due to wrong operation of tilting switch when the tilt cylinder has no pressure source.

(1) Main filling valve block view

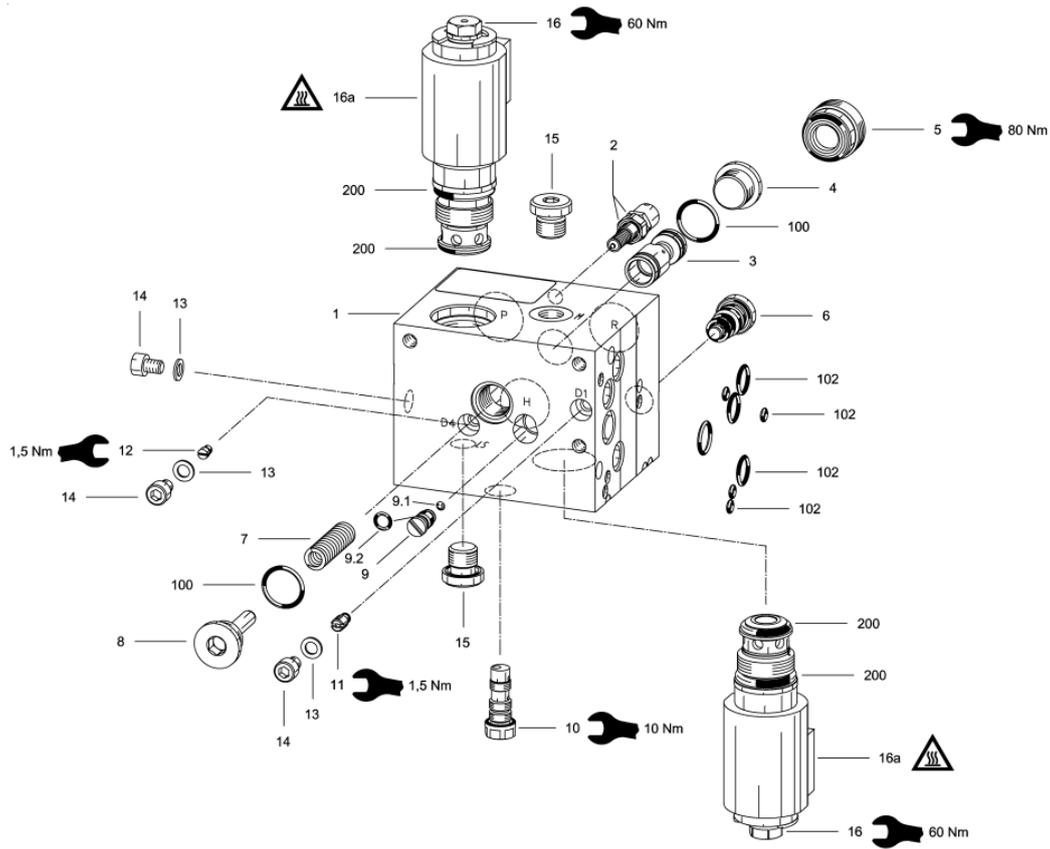


Figure 5-4 Multi-way valve main filling valve block explosion view

The main filling valve block contains the multi-way valve main filling port, inlet pressure compensator, lifting and descending electromagnetic valve. The specific parts and components are shown in figure 5-4 and table 5-1.

Table 5-1 Main filling valve block parts directory

Mark number	Material number	Quantity	Material description	Figure number
1	3408 4676-00	1	Filling and lift valves	8074 016 G
2	6800 9428-03	1	Overflow valve	7700 221 C
3	3036 4965-00	1	pressure compensator	7778 040 C
4	3013 4068-00	1	Inside plug	7661
5	3012 8009-00	1	Nut	7445 000 D
6	7500 0300-00	1	Plug	7625 200 A
7	3008 4579-00	1	Spring	7650 112

8	3014 4788-00	1	Spring plug	7981 260 A
9	6800 4078-00	1	Shuttle valve	7700 041 A
9.1	6190 0105-00	1	Steel ball	\
9.2	6096 4514-00	1	O-ring 6.07x1.78	\
10	6800 8190-00	1	Drop valves	7778 303
11	3014 5049-00	1	Gap filter	7700 794
12	3014 5034-00	1	Empty thread plug	8074 008
13	6095 1102-00	3	Red copper pad	\
14	6005 0195-00	3	Inside hexagonal bolt	\
15	6013 2506-00	2	Plug	\
16	7749 0090-00	2	EMP 31 V 80 solenoid valve	7913 600 E
16a	EMP 3 -AMP...	2	Solenoid valve coil	\
100	6096 9218-00	2	O-ring 17.17x1.78	\
102	6801 1557-00	1	Seal ring	7996 920
200	6800 6606-00	1	Seal ring EMP 31	\

(2) Balancing valve block

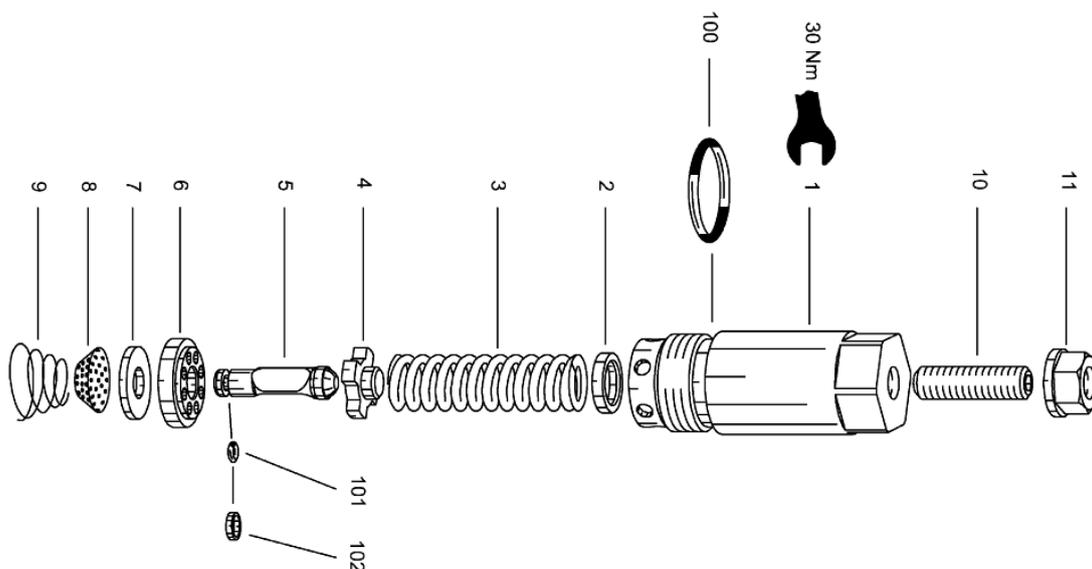


Figure 5-5 Balancing valve block exploded view

The balancing valve is located on the second tilting valve plate, which is mainly

used to keep the cargo in a certain position to prevent serious consequences caused by the improper operation of the tilting oil cylinder in the case of no pressure source. For specific parts and components, please see figure 5-5 and table 5-2.

Table 5-2 Balancing valve parts directory

Mark number	Material number	Quantity	Material description	Figure number
1	3601 5003-00	1	Balance valve housing	7918 211
2	3001 8015-00	1	Lock pad	7918 110
3	3008 4040-00	1	spring	7918 215
4	3001 4042-00	1	spring seat	7918 218
5	6800 8131-01	1	Balancing valve	7918 206 A KPL.
6	3012 5592-00	1	valve seat	7918 248
7	3020 5027-00	1	valve plate	7918 258
8	3047 4022-00	1	filter screen	7918 204
9	3008 4459-00	1	conical spring	7164 010
10	3014 4463-00	1	bolt	7660 040
11	6285 6202-00	1	Seal lock nut	\
100	6096 4472-00	1	O-ring 15.6x1.78	\
101	6096 9827-00	1	O-ring 1.78x1.02	\
102	6097 5219-00	1	Check ring 3.9x5x1.1	7918 207

5.1.3 Lift cylinder

The lift cylinder is of single-acting piston type. It consists of cylinder body, piston, piston rod, cylinder cap, pipeline explosion-proof 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 Figure 5-6)

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 arm carrier and piston itself, the hydraulic oil is pressed back to oil tank. If the pipeline explosion-proof valve is mounted at the bottom of cylinder (See figure 5-7), it can play the role of protection if the mast rises when high-pressure pipe cracks.

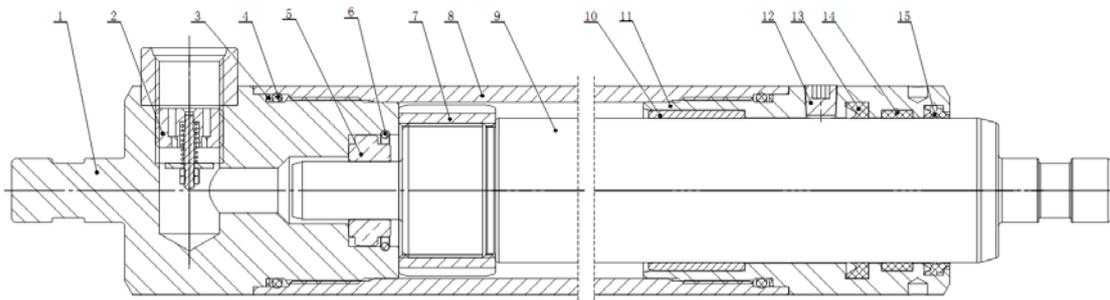


Figure 5-6 Lift cylinder

5.1.4 Pipeline explosion-proof valve

Pipeline explosion-proof valve is used to prevent the damage of people and goods caused by the fall of fork caused by the rupture of high pressure hose. It is installed at the bottom of oil cylinder. The working principle is as follows: in normal operation, both A to B and B to A maintain the path clear. In case of pipe rupture, there is a huge pressure difference between B chamber and A chamber, separation blade 4 seals the through-flow hole of valve body 1, cut off the oil duct between the oil cylinder and the oil channel outside the cylinder to ensure the safety of goods and personnel.

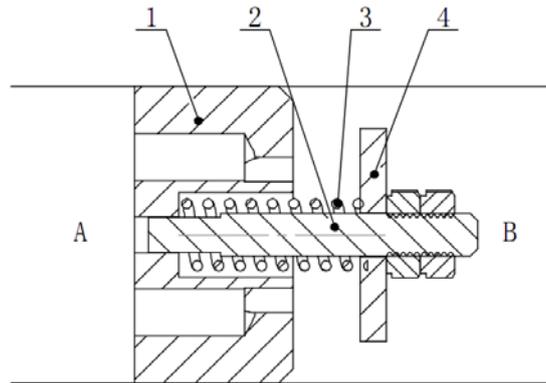


Figure 5-7 Pipe anti-explosion valve structure diagram
 1. valve body 2. guiding shaft 3.spring 4. Separation blade

5.1.5 Flow regulator valve

The speed limit valve is installed in the lifting oil path to limit the descending speed of the fork when it is overloaded, and its mechanism is shown in FIGURE 5-8. It is mainly composed of cylindrical valve body with control spool, valve core spring and freely floating detection throttle disc.

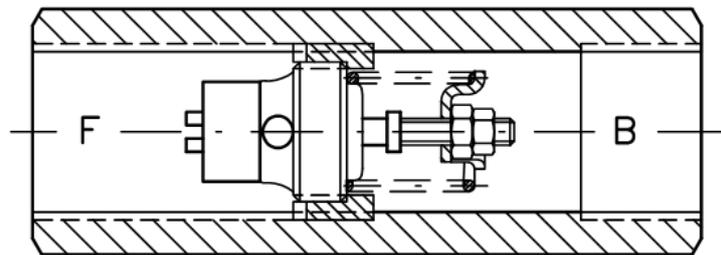


Figure 5-8 Speed Limit Valve

Working principle: working flow direction is B to F, through speed limit flow.

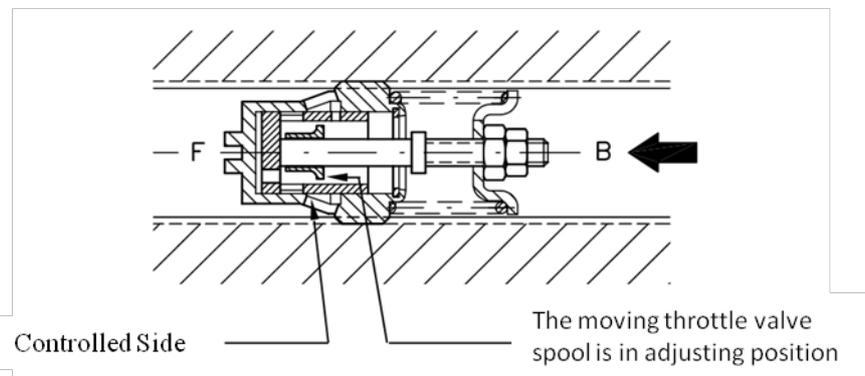


Figure 5-9 Speed limit state of flow

Work flow direction is F to B, flow freely.

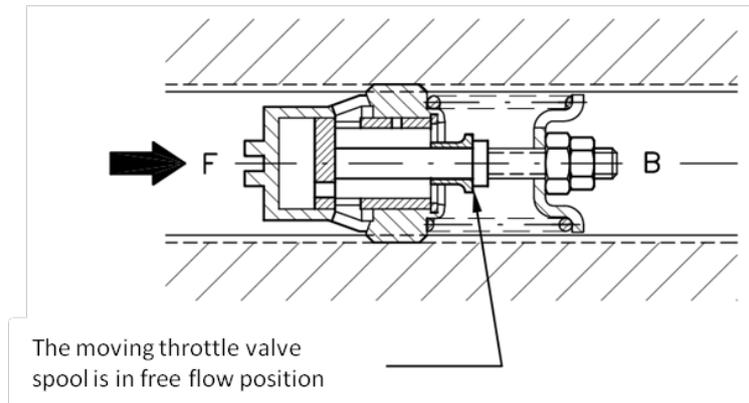


Figure 5-10 Free-flow conditions

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 Figure 5-11)

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.

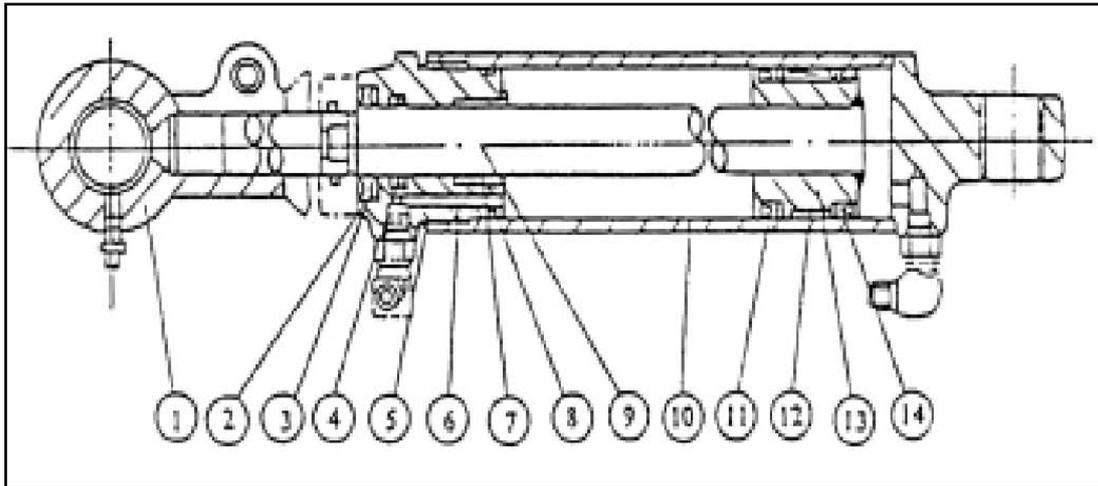


Figure 5-11 Tilt cylinder

- (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 Figure 5-12 and the hydraulic oil circuit see Figure 5-13.

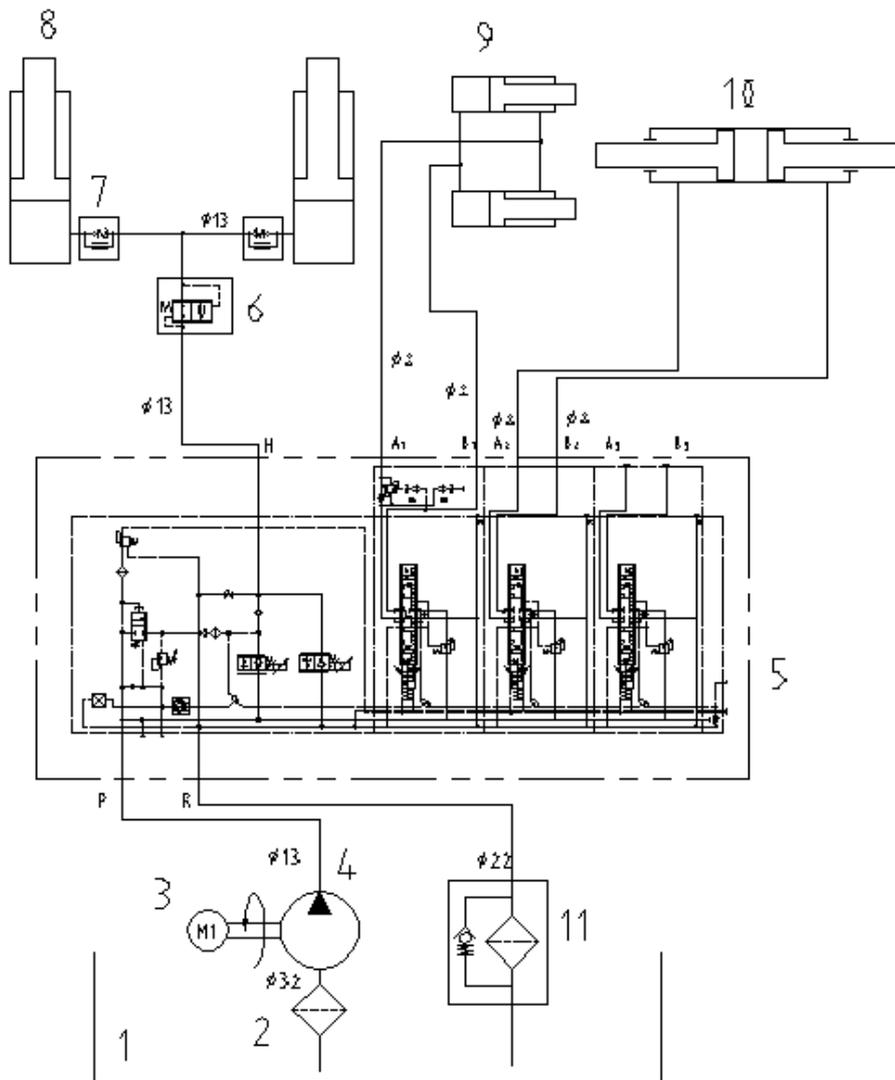


Figure 5-12 Hydraulic system principle

- (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 (9) Tilt cylinder (10) attachment cylinder (11) Return oil filter

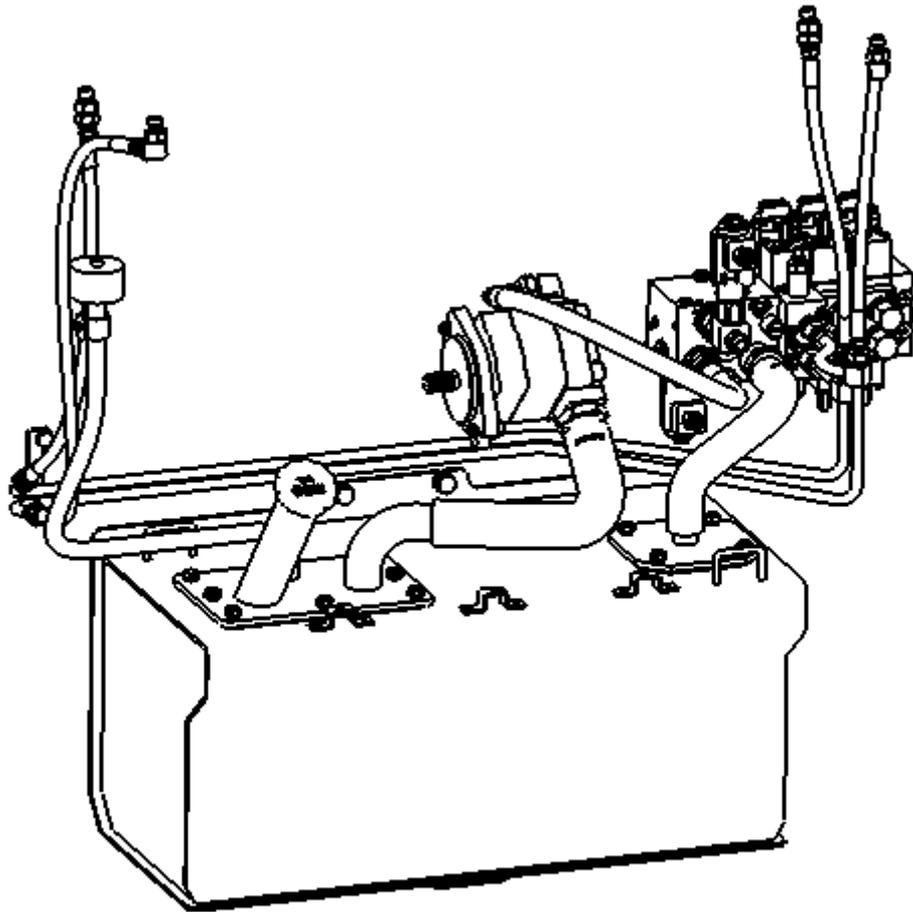


Figure 5-13 Hydraulic piping

5.2 Maintenance, failure analysis and troubleshooting methods

5.2.1 Maintenance

Check before and after work whether there is leakage or serious leakage of hydraulic transmission system's pipe joints, lifting oil cylinder, tilting oil cylinder, oil pump, full hydraulic steering gear and steering oil cylinder; Check whether the oil in the working oil tank is sufficient; Inspect and clean the strainer screen once a week.

Under normal circumstances, the oil in the working oil tank should be replaced every 1200 ~ 1500 hours after operation. Various grades of oil should not be mixed.

5.2.2 Maintenance of lift pump

1) Dismantlement

Clean thoroughly before decomposition. The removed parts should be placed on

clean paper or cloth. Be careful not to stain or damage the parts, as shown in figure 5-14.

- a) Clamp the pump flange on the clamp table.
- b) Remove the connecting bolt 11, pump cover ⑤ and pump case ①.
- c) Remove the lining board⑥, drive gear②, driven gear③.
- d) Remove the sealing ring⑦ and baffle ring⑧ from the front and back cover.

Note: If the sealing ring is not to change, do not remove it from the front end.

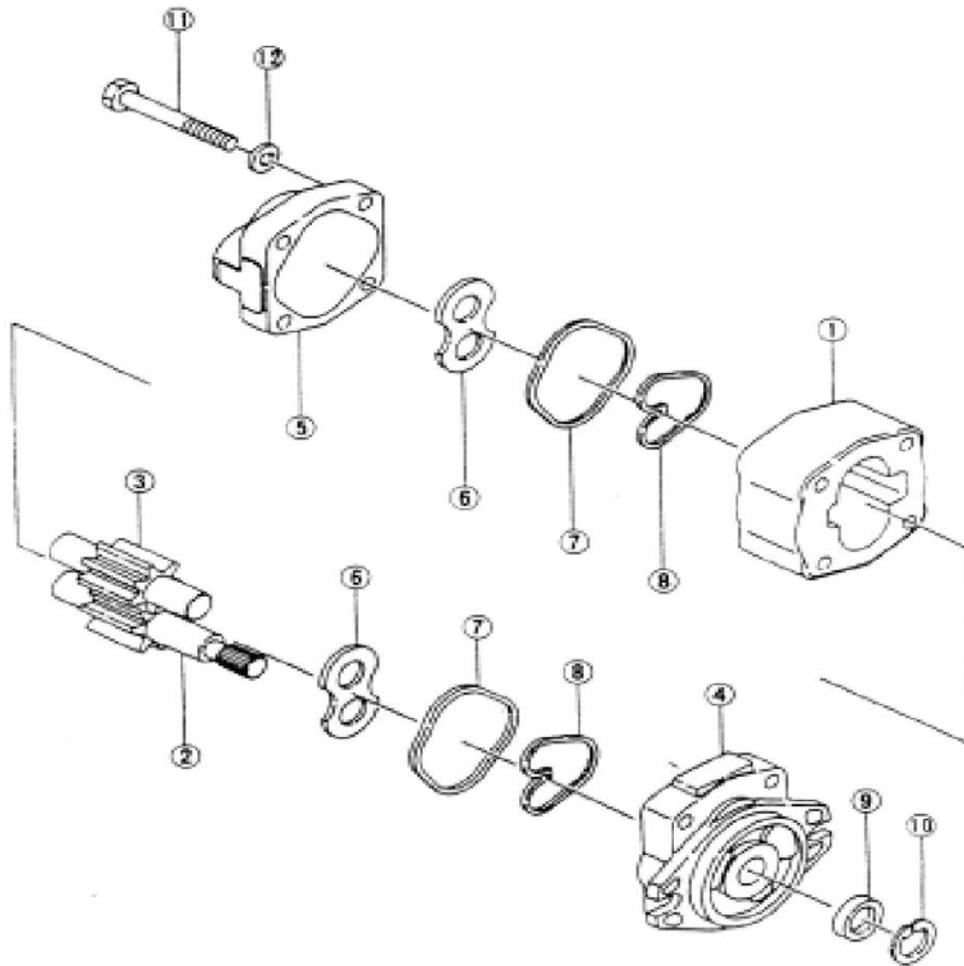


Figure 5-14 Gear pump

- (1) pump body (2) drive gear (3) driven gear (4) front end housing
- (5) rear end cover (6) Lining board (7) sealing ring (8) baffle ring (9) oil seal
- (10) snap ring

2) Inspection

Inspect the decomposed parts and clean them with gasoline (except rubber parts).

a) Pump body check

If the pump body cavity and gear contact length is greater than 1/2 of the circumference, replace the pump body.

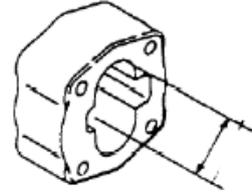


Figure 5-15

b) Lining board check

Check the contact surface of the lining board. If the surface is damaged or the thickness of the lining board is less than the specified thickness, replace the lining board.

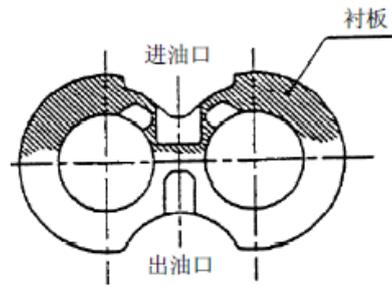


Figure 5-16

Thickness specification for lining board: 4.94mm。

c) Front and rear pump cover

If the inner surface bushing changes color (brown) of more than 150 °, replace it.

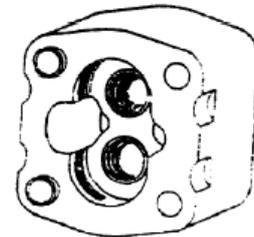


Figure 5-17

d) Check drive and passive gear from front and rear.

Replace in pairs if wear and tear excessive. If size D is less than specified, change in pairs.

$$D=20.961\text{mm}$$

e) Replace the sealing ring, bushing seal, retainer ring, oil seal and spring retaining ring as required.

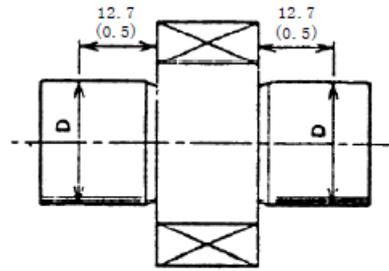


Figure 5-18

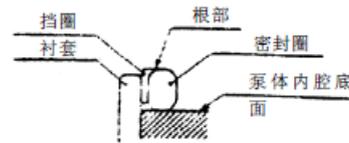


Figure 5-19 bushing seal

3) Assembling

a) Fasten the front end cover on the clamp table as shown in figure 5-20.

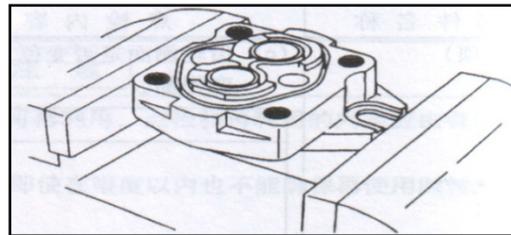


Figure 5-20

b) Install a new sealing ring on the pump front end cover.

Note: do not twist.

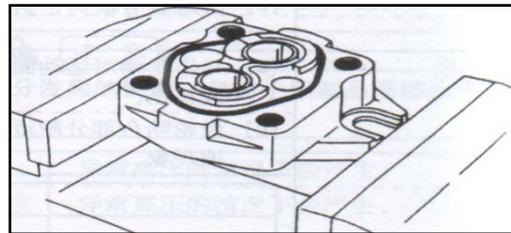


Figure 5-21

c) Install a new retainer ring on the front end cover of the pump. Refer to figure 5-22 for installation direction.



Figure 5-22

d) Load the pump body into the front end cover. Pay attention to pump direction.

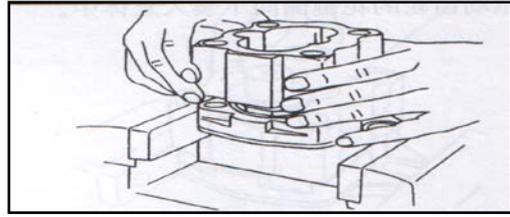


Figure 5-23

e) Install the lining board on the groove part of the front cover. Be careful not to mistake the oil suction port and oil discharge port. Pay attention to the direction of the lining board.

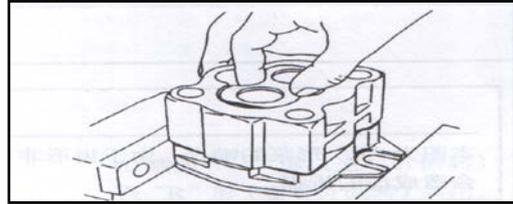


Figure 5-24

f) The spline of the driving gear is laterally loaded into the pump body.

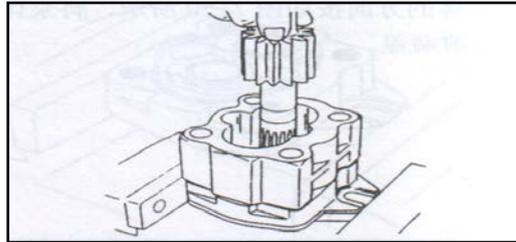


Figure 5-25

g) The driven gear is loaded into the pump body in the direction shown in Figure 5-26.

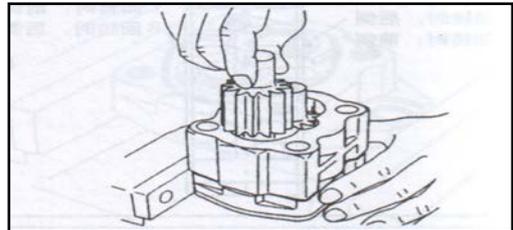


Figure 5-26

h) The rear lining plate is loaded into the pump body, and the gear side is equipped with the lining plate to align the groove with the gear point. Be careful not to mistake the oil intake side and the oil discharge side.

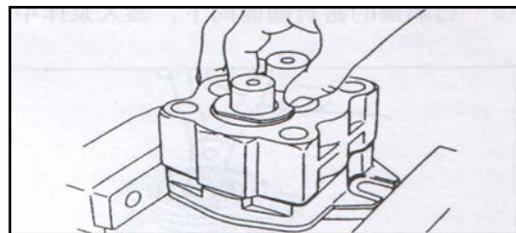


Figure 5-27

i) Put the sealing ring and ring into the groove of the rear cover. In the meantime, apply grease to the sealing ring.

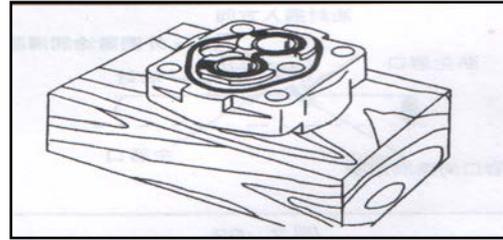


Figure 5-28

j) The seal ring of the back cover is downward and loaded into the pump body. Do not mistake the oil suction port and oil discharge port.

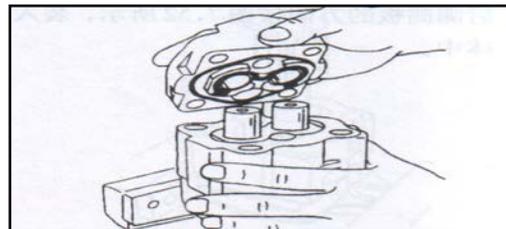


Figure 5-29

k) Install the connecting bolts, tighten it to the required torque 9 ~ 10kg.m.

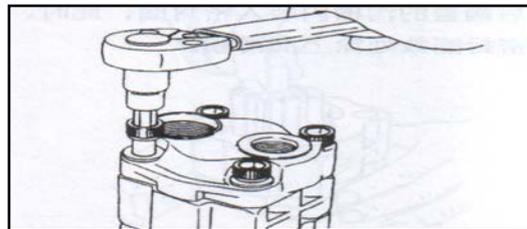


Figure 5-30

l) Remove the pump from the clamping table and apply grease to the outer ring and lip of the oil seal, use mold install it to the front end cover.

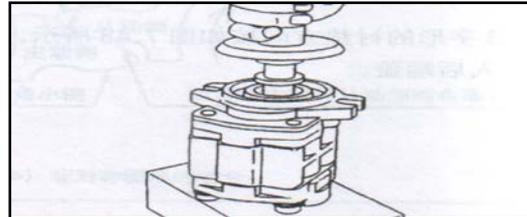


Figure 5-31

m) Install the elastic ring with the caliper to fix the oil seal.

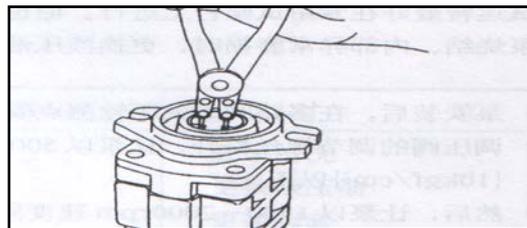


Figure 5-32

4) Test run

Test run is that make the oil pump running-in, check whether the operation is normal. It is best to conduct the oil pump test on the test bench, but the following steps can also be performed on the forklift (if the oil pump is broken down and

repaired because the pump is severely worn or stuck by the hydraulic oil, the hydraulic oil and filter should be replaced before the test run on the forklift) .

a) Install the pump onto the forklift truck and install the pressure gauge into the pressure test port on the multi-way valve.

b) Loosen the adjusting screw of the overflow valve to make the pump run for about 10 minutes at 500 ~ 1000rpm. Make sure the oil pressure is below 10kg/cm^2 .

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

d) Keep the pump running speed at 1500 ~ 2000rpm, increase the pressure by $20 \sim 30\text{kg/cm}^2$ each time, and run for 5 minutes until it reaches 210kg/cm^2 . Then make each oil path work for 5 minutes and replace the oil filter. When increasing the oil pressure, check the oil temperature, pump surface temperature and running sound. If the oil temperature or pump surface temperature rise too much, reduce the load to lower the oil temperature, and then continue the test.

e) After the test, the overflow pressure was set at 210kg/cm^2 and the flow was measured. Oil is measured by lifting speed.

5.2.3 Problems analysis and troubleshooting methods

Fault	fault cause	Troubleshooting methods
Lifting inability or cannot lift	1) Oil pump gear and pump body wear excessive and clearance excessive.	Replace wear parts or pumps.
	2) The piston seal of lifting cylinder is worn down, the clearance is too large and the internal leakage is too much.	Replace the piston seal ring.
	3) The safety valve spring in the multi-way reversing valve fails.	Replace the spring.
	4) Multi-way reversing valve control stem and body wear, excessive oil leakage.	The clearance between the cutting bar and the hole after chrome plating is 0.01 ~ 0.02.
	5) Oil leakage between Multi-way reversing valve body.	Replace the sealing ring and tighten the screws in sequence.
	6) The hydraulic pipeline leaks oil.	Check the sealing gasket for damage to the connecting nut and tighten the pipe joint.
	7) Hydraulic oil temperature is too high (at 80 °C or less) , oil is too thin, insufficient flow.	Change out of order hydraulic oil, park to reduce oil temperature check the cause of excessive oil temperature.
	8) Overburden.	Lifting according to specification.

<p>The piston rod of the hoist cylinder slides down too much</p>	<p>1) Leakage in the piston Yx seal ring of the lifting cylinder. 2) Multi-way reversing valve A type of slide valve internal leakage. 3) Oil leakage in the lifting section.</p>	<p>Replace the Yx type sealing ring. Replace the "O" type sealing ring in the valve. Replace the "O" seal ring in the hinge joint and tighten the joint bolts.</p>
<p>Oil pump underpressure</p>	<p>1) Oil leakage is caused by wear of the sealing ring at the fastener. 2) Hydraulic oil mixed with air bubble, oil suction pipeline has air leakage, hydraulic oil is not enough. 3) The sealing ring inside the pump cover groove is damaged. 4) Bearing sleeve end face wear. 5) Oil pump gear wear. 6) The oil pump is not rotating in the right direction.</p>	<p>Replace the sealing ring. Remove air and replenish hydraulic oil. Change Change Change oil pump Correct</p>
<p>The tilting oil cylinder has large self-tilt</p>	<p>1) Multi-way directional valve leakage. 2) The O - type seal ring of tilt cylinder piston rod is damaged and leakage occurs. 3) The YX ring and O ring in the guide sleeve are damaged, and then oil leaking.</p>	<p>Replace the "O" seal ring, repair the stem and re-distribute the stem and hole clearance to 0.01 ~ 0.02. Change Change</p>

<p>Steering heavy</p>	<p>1) Oil pump supply is insufficient, slow turn steering wheel is lighter, quick turn steering wheel sink.</p> <p>2) There is air in the steering system, foam in the oil, a random noise, the steering wheel turning, and the oil cylinder sometimes moving and sometimes not moving.</p> <p>3) Valve body steel ball one-way valve failure, wheels are heavy whenever steering fast and slow, and steering without pressure.</p> <p>4) The relief valve pressure is lower than the working pressure or the relief valve is stuck by something, steering is light while load is light or empty, increase load then steering sink.</p> <p>5) Oil viscosity is too high.</p>	<p>Select the appropriate pump or check if it is normal.</p> <p>Remove air from the system and check the suction line.</p> <p>Check if the ball is present and if there is something stuck the ball.</p> <p>Adjust the pressure of the overflow valve or clean the overflow valve.</p> <p>Use the recommended viscosity oil.</p>
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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 tilt cylinder and it can tilt forward and backward under the action of tilt 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.

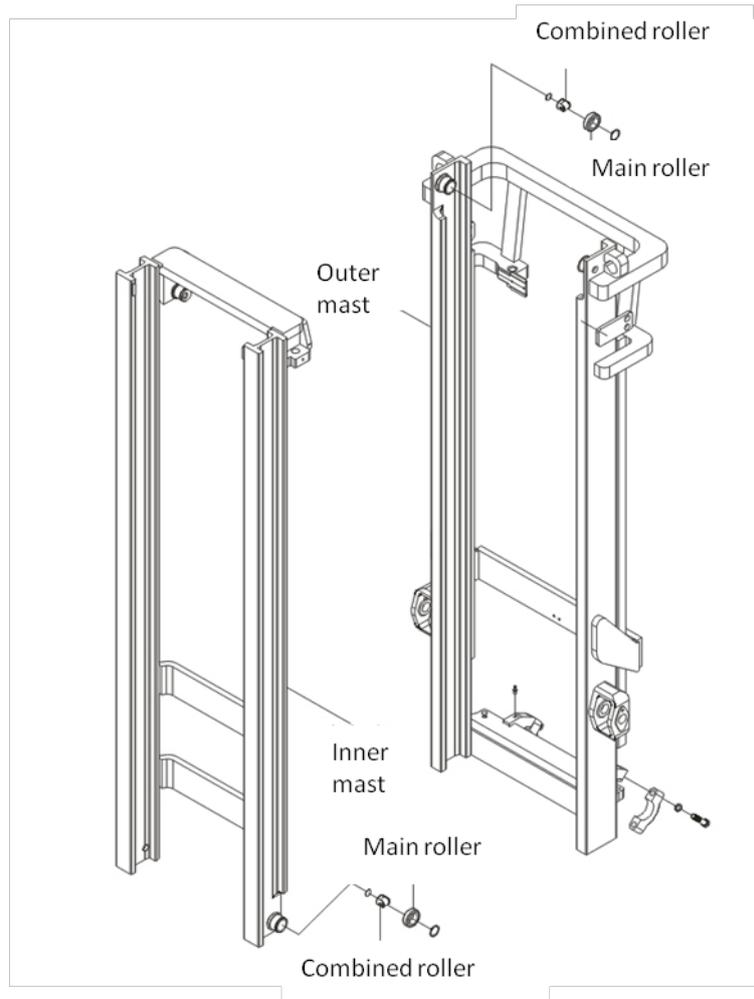


Figure 6-1 Inner mast and outer mast

6.3 Fork arm carrier

The fork arm carrier 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 fork bracket 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.

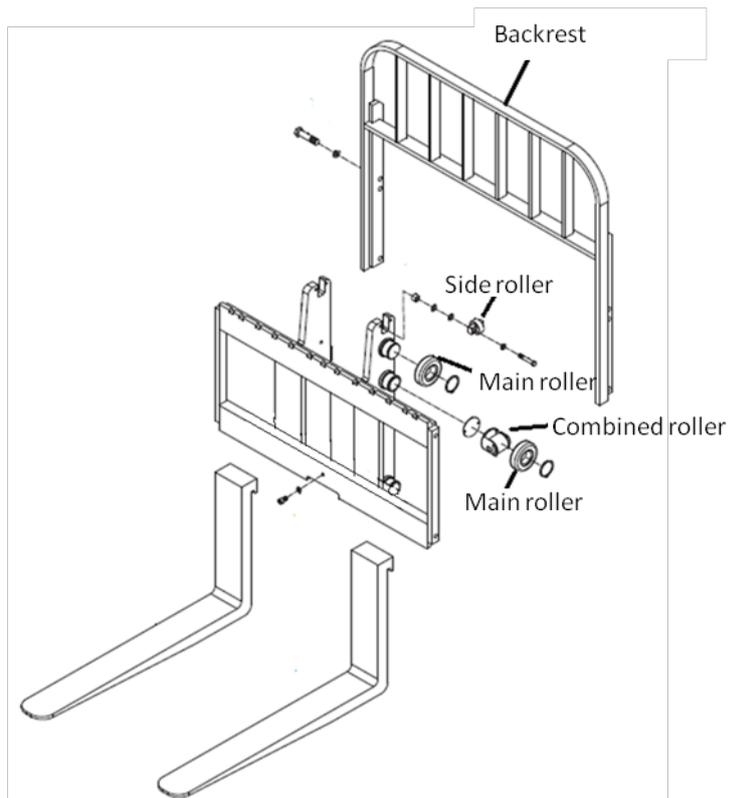


Figure 6-2 Fork arm carrier

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 arm carrier (4) respectively.

The using of main roller and combined roller makes inner mast and Fork arm carrier move smoothly.

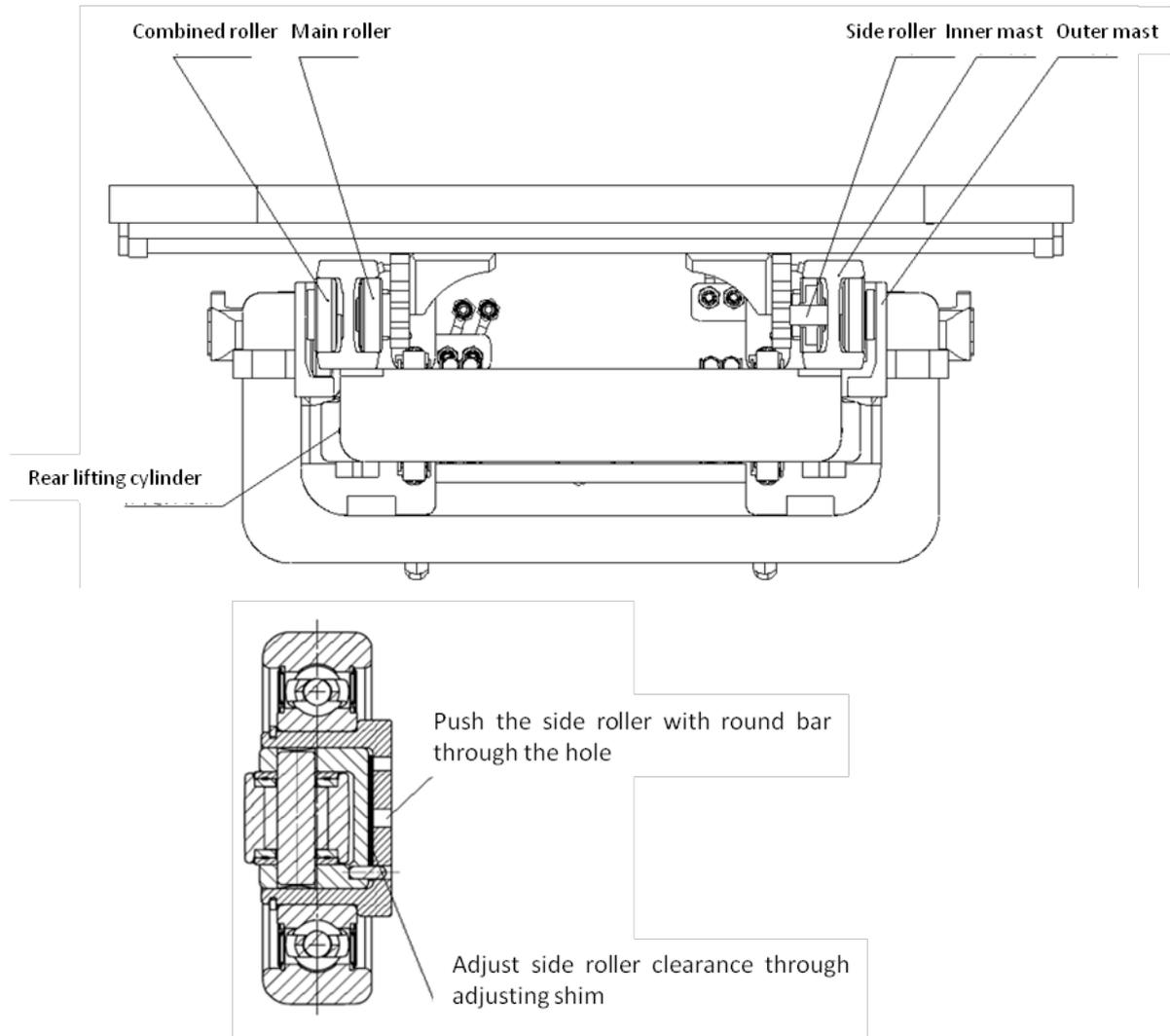


Figure 6-3 roller layout

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.

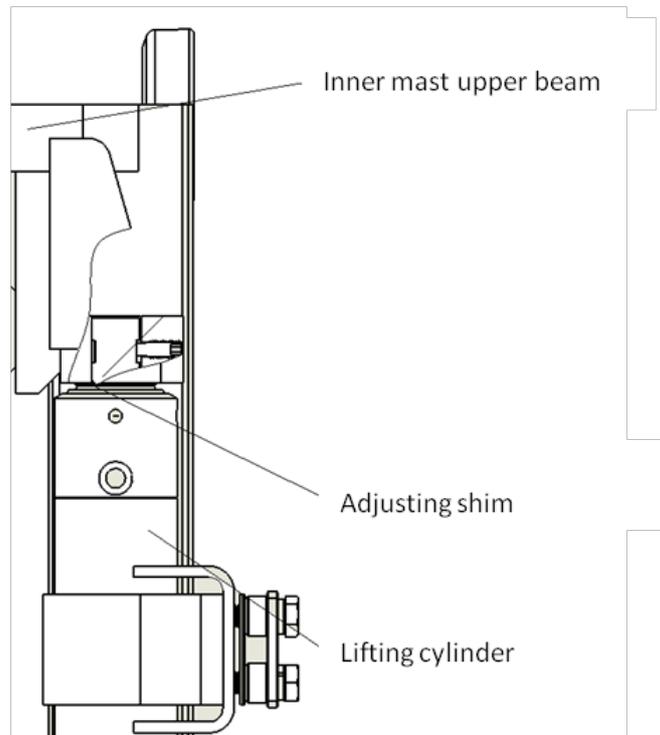


Figure 6-4

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.

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

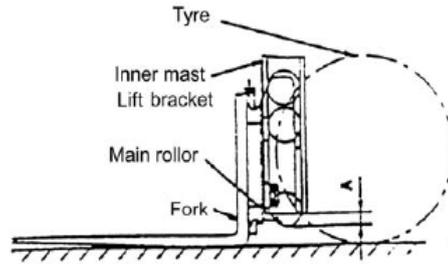


Figure 6-5 Adjust lift bracket's height

(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.

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 Figure 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.

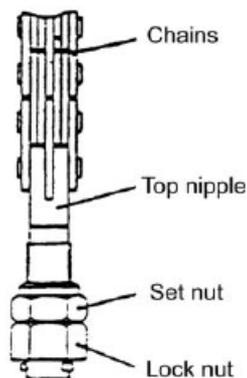


Figure 6-6

6.5.4 Replacing rollers of masts

- (1) Take apart the fork arm carrier 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.

6.6 Overview of three-stage full free lifting system

The lifting system is three-stage full-free roller vertical lifting and contracting, which is composed of three masts(inner, middle and outer) , one front lifting cylinder, two rear lifting cylinders and integral side shifter.

6.6.1 Inner, middle and outer masts

Inner, middle and outer masts are weld assembly, as shown in figure 6-8. The total weight is mainly supported on the frame. The middle of the outer mast is

connected with the frame by tilt cylinder, and can be tilted forward and backward under the action of tilt cylinder. The channel steel of the outer mast is of type C, and a pair of compound roller is installed on the upper part. The channel steel of the middle mast is H type, and the upper part and the lower part installed a pair of compound roller each; The channel steel of the inner mast is H type, and a pair of compound roller is mounted on the lower part, the middle and inner mast keeps the relative position of the middle mast and the outer mast, the inner mast and the middle mast all the time by rolling through the main and side roller.

The maintenance of the upper main roller and side roller of the outer and middle mast belongs to high level maintenance, Pay attention to safety.

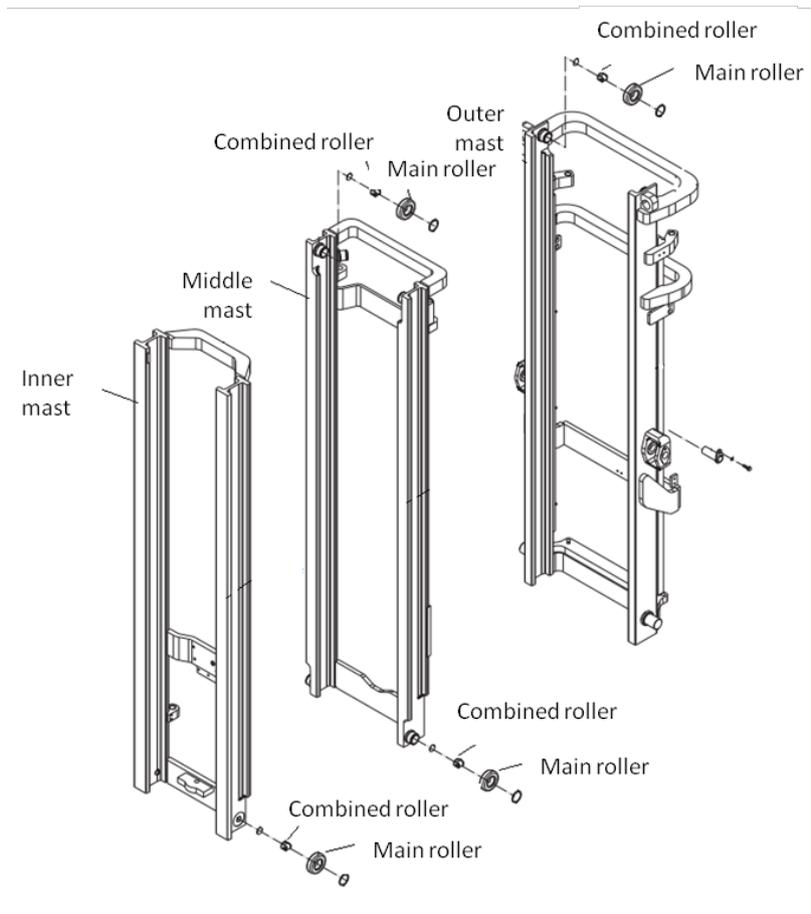


Figure 6-8 Inner, middle and outer masts

6.6.2 Integral side shifter

Integral side shifter (as shown in figure 6-9) is mainly composed of side rear frame, side front frame and side oil cylinder. The side shifter is installed with two sets of compound rollers, one set of main rollers and one set of independent side rollers, so that the side shifter moves up and down smoothly in the channel steel track of inner portal frame and bears longitudinal and transverse loads, can adjust the gap between the side roller and the channel steel web by increasing or decreasing the gasket; when the fork is raised to the maximum height, the top side roller and the main roller go out from the top of the inner mast and support the longitudinal and transverse loads by the middle and bottom compound roller.

The upper and lower sliding block is installed between the side front frame and the side rear frame, the side shift cylinder is welded on the side shift rear frame. When the side shift cylinder works, the side shift cylinder plunger rod should be on the side of the side shift front frame, and the side move of the side shift front frame relative to the side shift rear frame is completed. The maximum distance of side shift is 100mm each. After the side shifter is installed, the forklift has the advantages of accurate stacking, safety, reducing the times of loading and unloading and improving the efficiency of loading and unloading at work. It is not suitable to carry out side movement during operation, nor is it allowed to carry out side movement under the condition of maximum lifting height.

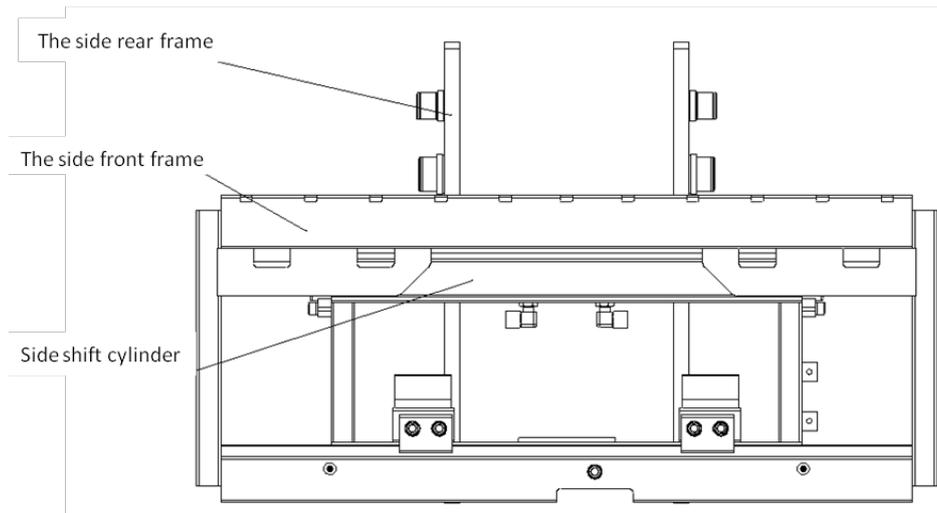


Figure6-9 Integral side shifter structure

6.6.3 Roller arrangement and adjustment method

There are a total of 14 main roller wheels, which are respectively installed on the upper end (2) of the outer mast, the upper end (2) of the middle mast, the lower end (2) of the middle mast, the lower end (2) of the inner mast, and the two sides (6) of the fork frame stanchion. 14 composite roller wheels are installed respectively with the upper end (2) of the outer mast, the upper end (2) of the middle mast, the lower end (2) of the middle mast, the lower end (2) of the inner mast, and the fork arm carrier (6) .

The main roller and compound roller are used together to make the inner mast and fork arm carrier move freely.

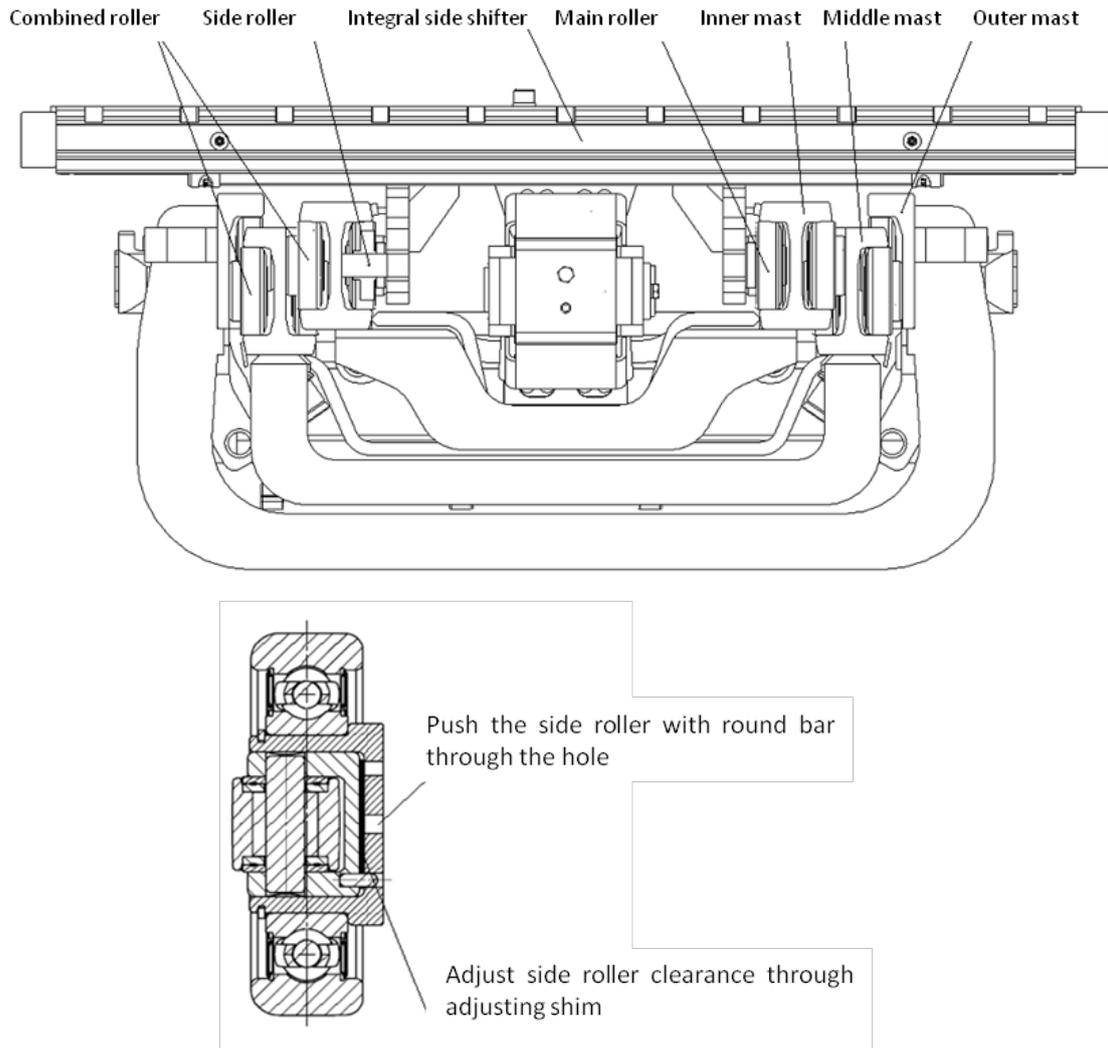


Figure 6-10 Roller arrangement and adjustment

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

(b) Add grease to main roller surface and mast contact surface

6.6.4 Maintenance

6.6.4.1 Rear lift cylinder adjustment

Same like basic lifting system.

6.6.4.2 Fork arm carrier height adjustment

Same like basic lifting system.

6.6.4.3 Change the roller of fork arm carrier

Same like basic lifting system.

6.6.4.4 Change the roller of mast

- (1) Remove the fork arm carrier/integral side shifter from the inner mast in the same way as described in the 6.6.4.3 change fork arm carrier roller.
- (2) Drive the forklift to the level ground and pad the front wheel to 250 ~ 300mm.
- (3) Press the hand brake switch to chock the rear wheel with wedge.
- (4) Lift the inner mast, remove the end connector on the lifting cylinder head and remove the chain from the sprocket.
- (5) Lower the inner mast until the lower part of the inner mast and the main roller of the middle mast are fully exposed.
- (6) Replace the main roller:
 - a) Remove upper main roller with tool and do not lose adjusting pad.
 - b) Install the new roller with the adjusting pad removed in step (a) .
- (7) Remove the fixed bolts of the lifting cylinder and the cylinder support of the middle mast after removal, lift the inner and middle masts together, and take care not to lose the adjusting pad of the piston rod head.
- (8) Remove the connection bolts between the lifting cylinder and the bottom of the beam under the outer mast and the pipe connecting the cylinder bottom.
- (9) Lower the inner and middle mast until the roller completely leaks out from the lower part of the middle mast and the upper part of the outer mast.
- (10) Replace the main roller:
 - a) Remove upper main roller with tool and do not lose adjusting pad.
 - b) Install the new roller with the adjusting pad removed in step (a) .
- (11) Lift the inner and middle mast until all the roller enter the corresponding mast.
- (12) Install lifting cylinder and fork rack according to opposite steps of disassembly.

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