

Hydraulic Disc Brake System Operation, Maintenance Instruction



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Foreword

In the manual of PS series hydraulic disc brake system, its structure, principle and application are introduced. Read the manual thoroughly before you operate or repair the disc brake. And install, use and repair it correctly according to the manual.

The operation effects and service-life of the disc brake system are related with design, manufacturing, and also proper operation of customers. We would like to supply customers with high quality products in compliance with the quality assurance system, and also hope that the operators can carefully read the manual to give full play to the quality and the performance of products and successfully achieve the expectant drilling operations.

Because of the continuous improvements on the products, some details in the manual may not be same as in actual. These differences don't affect the understanding of the product's structure, the performance and the application. If having any questions, please contact with us.

As for the continuous improvements on the drilling technology, you will have new requirements on the application. We will be very happy to continuously improve our products and to meet with your special requirements.

Welcome to contact with us.

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1 Description

The PS series hydraulic disc brake system consists of three parts: brake actuation mechanism, hydraulic power unit and control system. These three parts are connected through hydraulic pipeline. The hydraulic power unit is the hydraulic power supply unit, which provides necessary hydraulic power for the actuation mechanism; the control system is the hydraulic power control unit; the actuation mechanism is the braking actuation unit, which consists of braking caliper, caliper frame and friction disc, and the braking calipers include normal open service calipers and normal closed safety calipers.

This series of brake system has the following four functions:

1. **Service Brake** Through operating the handle of the brake valve, adjust the service caliper's normal pressure on the friction disc. So provide adjustable braking torque to the rigs to meet requirements in different working conditions, such as bit feeding, tripping etc.
2. **Emergency Brake** Under emergency condition, press the Red emergency brake button, the service calipers and safety calipers will all applied to realize emergency stop.
3. **Over-winding Protection** When the hook is lifted to a certain height with load the service brake should be actuated but not did, due to the driller's failure in operation and some other reasons, the over winding or colliding prevention valve will give a signal to the service calipers and safety calipers to realize emergency stop for preventing crown block accident.
4. **Parking Brake** When the drilling rig will stop working or the driller wants to leave the driller's station, pulling down the parking brake handle will realize safety calipers braking to prevent the hook from sliding.

In addition, according to customer's requirements **the function of Mistaken Operation Protection** can be added. What is called **Mistaken Operation Protection** is In case that the driller releases parking brake and emergency brake without following requirements of regulations, all braking calipers will come into braking condition to realize safety protection.

2 Main Technical Parameters

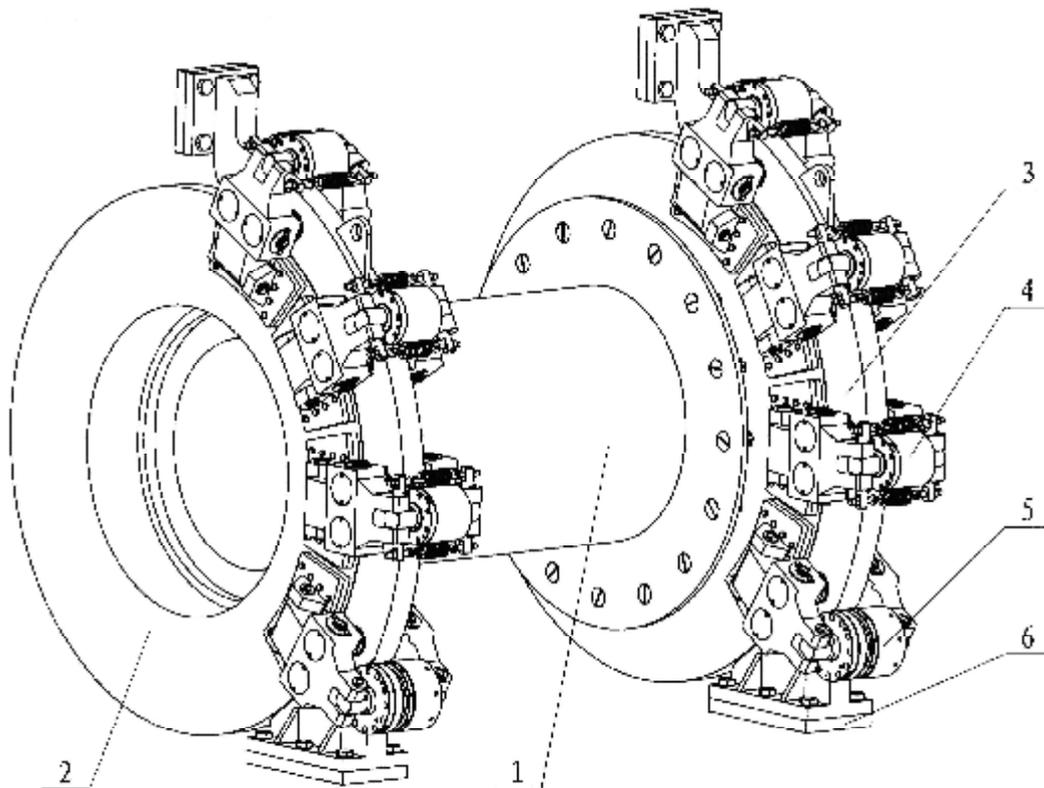
Types	Description	Values of parameters		
		PSZ75	PSZ65	
Service caliper	Max. normal pressure on single side	75 kN	65 kN	
	Effective stroke	30 mm		
	Permitted min. thickness of the brake pad	12 mm		
	Profile dimension (mmxmmxmm)	580x415x420	570x390x400	
	Weight	200 kg	180 kg	
Safety caliper	Max. normal pressure on single side	90 kN	65 kN	
	Max. clearance of the brake pad	1 mm		
	Permitted min. thickness of the brake pad	12 mm		
	Profile dimension (mmxmmxmm)	610x415x420	600x390x400	
	weight	220	200	
Hydraulic system	Rated pressure	8 MPa	6 MPa	
	Working medium	In summer	L-HM46	
		In winter	L-HV32	
	Rated flow of single pump	18 L/min		
	Capacity of oil tank	80 L		
	Power of motor	2.2 kW		
	Capacity of the accumulator	4x6.3 L		
	Power of heater	1 kW		
	Rated flow of cooling water	2 m ³ /h		
	Profile dimension (mmxmmxmm)	1160x960x1220		
	Weight	650 kg		

3 Working Principle and Structural Characteristics

The disc brake system consists of mainly three parts, i.e., brake actuating mechanism, hydraulic power unit and control system.

3.1 Brake Actuating Mechanism

The brake actuating mechanism mainly includes the service calipers, the safety calipers, the friction discs, and the caliper frame, the structure of which is as shown in Figure 1.



1-drum 2.-friction disc 3-caliper frame 4- service caliper 5-safety caliper 6-base

Figure 1 Brake Actuating Mechanism

3.1.1 Service caliper

The service caliper consists of mainly normal open single-action cylinder, disc springs, lever and brake pad, the structure of which is as shown in Figure 2.

The principle is as follows: When oil is supplied into the cylinder, theoretical pushing force F is produced, and $F = P \times A$, where A is the area of the piston. Under the force F , the piston (14) and the cylinder (9) will move toward reverse direction. When the brake pad (1) contacts the friction disc, force F is transmitted through lever (4) to the brake pads, producing normal pressure N and the friction force, i.e., the braking force is produced. Due to the proportional relationship between braking force and oil pressure P , when P reaches a certain value, the friction disc will be braked completely. With the

decreasing of oil pressure P , the braking force also decrease correspondingly. When oil pressure $P=0$, the lever returns to its original position acted by reset spring (10), causing the brake pad to be released from the friction disc, and consequently, the service caliper comes into complete released condition.

1. brake pad
2. steel backing
3. clevis pin with head I
4. lever
5. support lever
6. semicircle retaining ring
7. clevis pin with head II
8. cover of the cylinder
9. cylinder
10. extension spring
11. back cover
12. parallel pin
13. adjusting nut
14. piston rod

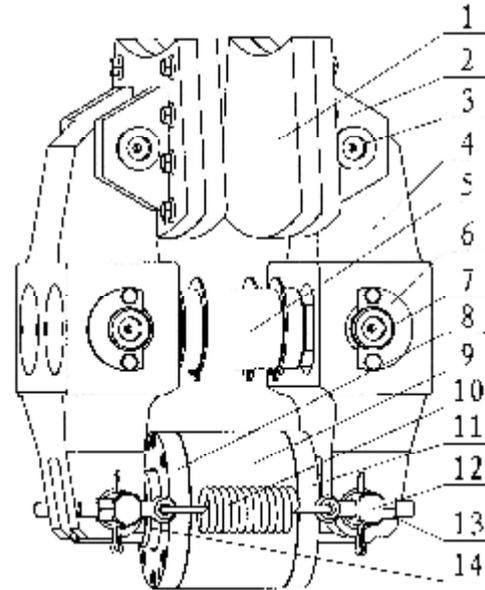


Figure 2 Service caliper

3.1.2 Safety Caliper

The safety caliper consists of normal closed single-acting oil cylinder, disc spring, lever and brake pad, the structure of which is as shown in Figure 3.

1. brake pad
2. caliper body
3. clevis pin with head I
4. lever
5. support lever
6. semicircle retaining ring
7. clevis pin with head II
8. piston
9. cover of the cylinder
10. cylinder
11. tightening nut
12. adjusting nut
13. clevis pin with head III

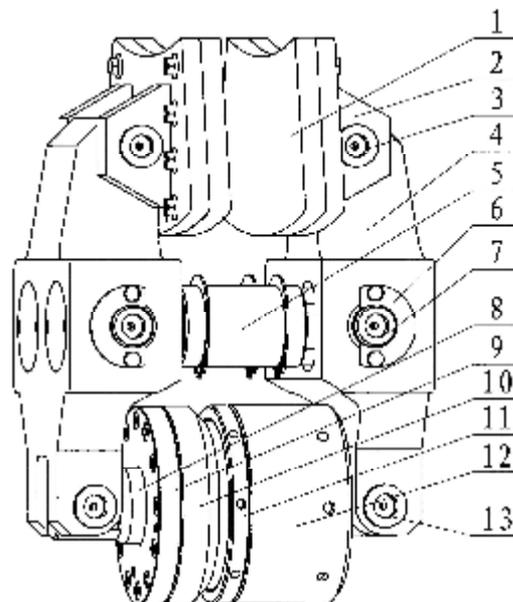


Figure 3 Safety Caliper

The principle of the safety caliper is just opposite to that of the service

caliper. When the normal closed single-acting cylinder's oil pressure is $P=0$, the set-in disc springs transmit the force through the two levers to the brake pad and consequently acts on the friction disc, producing normal pressure N , realizing brake. When the oil pressure of the cylinder P is not equal to 0, which means oil pressure exist, the oil pressure will overcome the disc spring force to compress the disc spring, releasing the brake through the lever.

3.1.3 Friction disc

The friction disc, which forms the brake pair with brake pad, is one of the core components. Usually, each set of product is provided with two friction discs, which are mounted on both ends of the drawworks drum.

According to structures, friction discs are classified into three types: water cooling, air cooling and solid discs.

- I The water-cooling disc has internal cooling water channels, which have water inlet and outlet ports at the inner diameter of the friction disc, with water draining port at the outer diameter for draining the water channels empty to prevent the friction disc from being frozen and broken in cold weather. When in normal operation, the water draining port is sealed with a screw plug. When the braking system is working, cooling circulation water is fed to the friction disc to balance the heat produced by friction if the brake pair.
- I The air-cooling disc internal has natural ventilation channels to discharge heat through natural ventilation channels and surface.
- I The solid disc relies on the surface to discharge heat. Such type of friction disc is mainly used for smaller drilling rigs.

3.1.4 Caliper frame

The caliper frame is the base of the actuating mechanism. The service caliper and the safety caliper are mounted on this base. Usually, two provided caliper frames are mounted on the base of the drawworks, located in front of both ends of the drawworks drum.

3.2 Hydraulic power unit

The hydraulic power unit includes: oil tank assembly, pumps, control block assembly, oil filling assembly and electrical control box. The hydraulic control principle is as shown in Figure 4.

3.2.1 Oil tank Assembly

The oil tank assembly includes: oil tank, oil suction valve, oil draining valve, oil level/ temperature gauges and cooler.

The function of the oil suction valve is as follow: when the oil pump is maintained or repaired, close the valve to separate the oil tank from suction port of the pump. In normal condition, this valve is open.

The oil draining valve is provided for hydraulic oil changing. In normal condition, it is closed.

Oil level/temperature gauge is provided for checking oil level and temperature in the oil tank.

The cooler is of tube-row type, which is used to balance heat produced in

the whole system. Whether the cooler is to be used depends on the working temperature of the system. When cooling is needed, close the bypass shut-off valve to turn on cooling water; when cooling is not needed, open the bypass shut-off valve to turn off cooling water.

3.2.2 Pump Groups

The pump is the heart of the hydraulic system. Two same plunger pumps are provided in the hydraulic system. Each of these two pumps is driven by an explosion-proof motor. One pump is in operation while the other stand by, alternatively in operation.

3.2.3 Control Block Assembly

The control block assembly consists mainly of oil way block, accumulator, shut-off valve, one-way valve, relief valve and high-pressure filter.

The accumulator can reduce pressure impulse in the loop and provide certain reserved energy when the pump can't work normally, and make working calipers braking 5~6 times normally.

The shut-off valve is used to “dump” the pressure in the accumulator. **In normal operation, tighten the shut-off valve securely, or else, the pressure of system can't be established.**

The function of the one-way valve is to separate the oil discharge ports of the two pumps to form three oil loops, which are independent from each other and also connected with each other, and to prevent oil back flowing in the accumulator.

The safety valve is an overflow valve, which functions as a safety valve for protection.

The high-pressure filter is used to filter high-pressure oil to guarantee cleanness of the hydraulic system.

3.2.4 Oil Filling Assembly

The oil filling assembly consists of one hand-operated pump and a filter. Oil is filled into the tank through the hand-operated pump to guarantee cleanness of the oil.

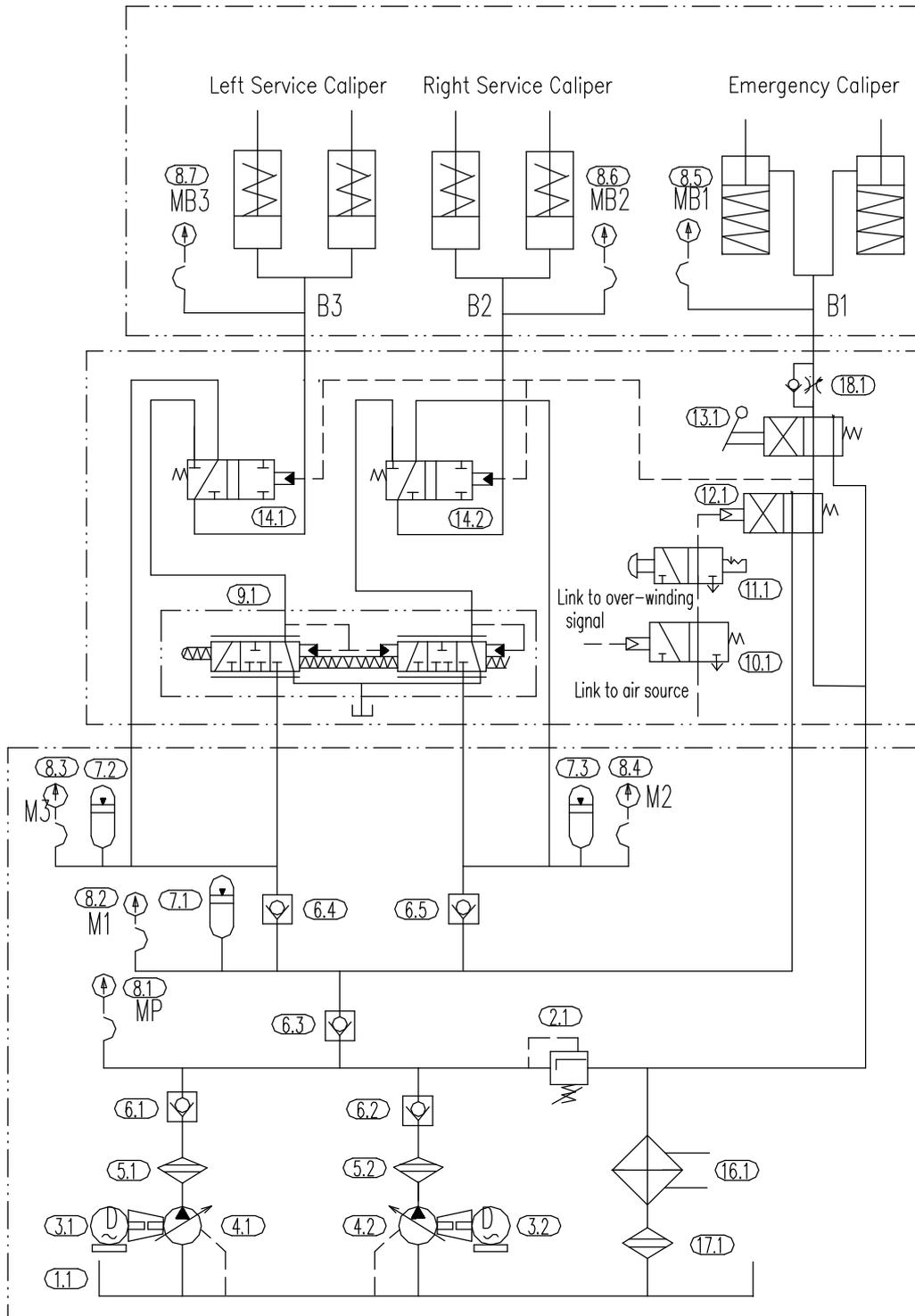
3.2.5 Electrical Control Cabinet

The electrical control cabinet of the hydraulic power unit is used mainly to control the start and stop of the motors and heater in the system. The electrical control cabinet is explosion-insulated. The working principle is shown as in Figures 6 and 7.

3.3 Control system

The control system includes braking valve assembly, parking brake valve assembly, control valve group, pipes and pressure meters.

The hydraulic principle is shown as in Figure 4.



1. oil tank 2. relief valve 3. motor 4. pump 5. fine filter 6. check valve
 7. accumulator 8. pressure meter 9. brake valve 10. pneumatic reversing air valve
 11. emergency brake valve 12. pneumatic reversing valve 13. parking brake
 valve 14. hydraulic reversing valve 16. cooler 17. returning oil filter
 18. one-way throttle valve

Figure 4. Principle of the Hydraulic System

Service Brake: Service brake is realized by means of brake valve (9), which is controlled by the brake handle. The brake valve is a hand-operated proportional relief valve, the output pressure of which changes proportionally with the pulling of the brake handle. When the brake handle is pulled to the Max. angle, the corresponding output pressure of the valve has its largest value, and the service caliper's braking force reaches the largest value; when the brake handle is pushed to its original position, the output pressure of the valve is zero, and the service caliper is released.

Parking Brake : The parking brake valve (13) is a hand-operated reversing valve. When the handle is pulled, the parking brake valve changes direction to relief the pressure in the safety caliper's oil cylinder and thus the spring force makes the safety caliper realize parking brake.

When the parking brake needs to be released, first, pull the handle of brake valve to "brake" position so that the brake valve (9) controls the mis-operation protection valve (15) to change direction. Then, push the handle of the parking brake valve to feed hydraulic oil into safety caliper's cylinder to overcome disc spring's force so that parking brake is released.

attention: To release parking brake, the handle of the service brake must be first pulled and, then the handle of the parking brake is pushed to release the parking brake.

Emergency Brake: Emergency brake is controlled by emergency brake valve (11), which is a manual reversing valve and controls pneumatically operated reversing valve (12). When the emergency brake button is pressed, air supply is cut-off and the valve (12) is reset by the spring to make the safety caliper brake. At the same time, hydraulic operated reversing valve (14) changes direction due to loss of pressure at the controlling end to let hydraulic oil flow directly into the working cylinder to make the service caliper brake, which means that all calipers brake to realize emergency brake.

To release emergency brake, just like releasing parking brake, the brake handle must be first pulled to "braking" position and, then pull out emergency brake button to release emergency brake.

Over-winding Protection: When the drawworks lifts the load up close the crown block, a pneumatic stroke valve mounted near to the crown block (or a over-winding valve mounted on the drawworks) is actuated due to collided by an external force to turn on the air path. Now there are two conditions, i.e., normal air supply turning on and normal air supply being cut off.

- I In normal air supply turning-on, i.e., in normal operation, the controlling end of the air operated reversing valve (12) has air supply on, and now the direction changing of the valve (10) is controlled by air signal output by the over winding valve to cut off air supply to realize emergency brake.
- I In normal cutting off air supply, i.e., in normal operation, the air operated reversing valve (12) has air supply off. the air signal output by

the over winding valve directly controls the valve (12) to reverse direction to realize emergency brake.

Mis-operation Protection : To release parking brake, the braking lever must be first pulled to “braking” position, then the parking handle is pushed to release parking brake to guarantee safety. If the driller operates without following regulations, instead of first pulling the braking lever, but pushing the parking handle first, now, not only the parking brake is not released but also the service caliper is under full braking condition, thus to realize mis-operation protection. Thus the driller is forced to operate according to regulations.

Attention: The weakness of mis-operation protection is: in the normal operation, if the handle is not stired for a longer time, the function of mis-operation protection is started up and emergency brake is realized.

4 Installation

4.1 Install the Friction Disc

4.1.1 The stagger of the working surface of the friction disc related to the rotary drum shaft should be less than 0.3mm.

4.1.2 The friction disc should be cleaned, with the friction surface free of oil and dirt.

4.1.3 For water-cooled friction disc, water inlet and outlet pipes should be connected.

4.2 Install the Brake Calipers and Caliper frames

4.2.1 Fasten the upper and lower transit plates firmly onto the caliper frames.

4.2.2 Install the brake calipers on the caliper frames. On completion of installation, turn them to see whether they rotate flexibly, whether there is blockage or jam, and whether it is difficult to rotate. When the safety calipers are installed, adjusting nut should be rotated so that the distance between two brake pads become maximum for installation of caliper body.

4.2.3 Install the whole actuating mechanism onto the drawworks.

Requirements of Installation:

- (1) The gap between the outer circle of the friction disc and inner circle of the caliper frame should be uniform; no interference with the caliper frame is permitted.
- (2) The caliper frame should be parallel with the friction disc, centered, allowable deviation $\pm 1mm$.
- (3) The brake pads should be enclosed within the friction disc.
- (4) All fit with friction disc, with fitting area $\geq 75\%$.
- (5) After adjustment and alignment, weld the upper and lower transit plates to the designed location on the drawworks base.

4.3 Install the Hydraulic power unit and Control system

Install the hydraulic power unit and control system on the designed location.

4.4 Connect the Hydraulic Piping

The hydraulic piping consists mainly of high-pressure hoses, quick couplings and pipe clamps.

The connection of hydraulic piping includes connecting hydraulic power unit, drilling control panel and braking actuation mechanism with high-pressure hoses according to design requirements to form a complete hydraulic system. In places, where disconnection and moving are required, quick couplings are provided for easy and quick disconnection and prevention of contamination of hydraulic pipe. The connections of the three major units are shown in Figure 5.

- (1) Before installation, make sure that inner side of pipes is clean, metal pipes are free of rust corrosion, connectors are installed with seals,

- and pipes are connected strictly in accordance with oil ports marks.
- (2) Quick coupling should not be subjected to external force and gravity in working condition. It is forbidden to insert or pull quick coupling with hydraulic pressure. When inserting, cleanliness should be maintained and false connection is forbidden. When pulling, plug the pipeline with the protecting head.
 - (3) Every 1.5 ~2m of the hydraulic pipe, a pipe caliper should be fixed.
 - (4) Piping should be laid in safe areas to avoid damages.

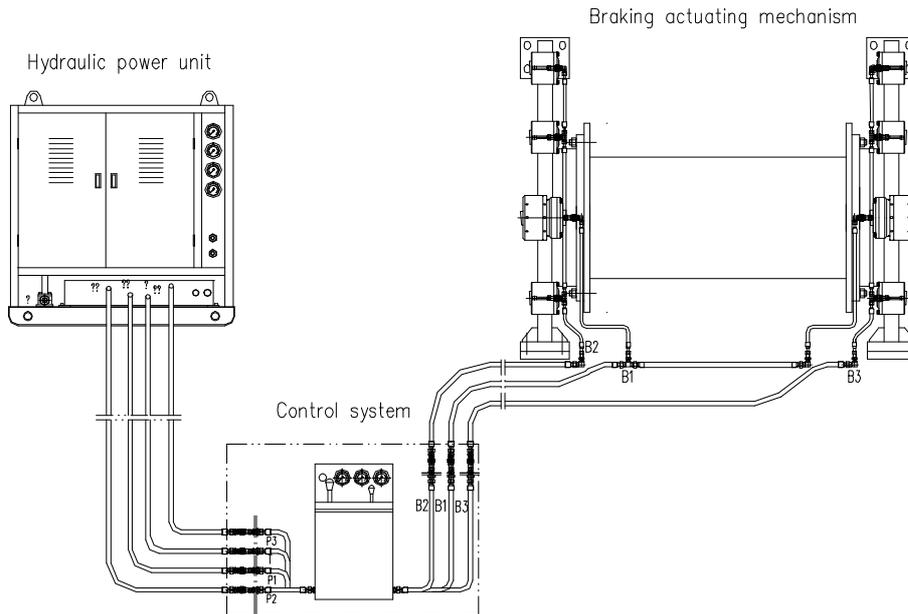


Figure 5. Connection Sketch of Hydraulic Pipes

4.5 Connection of Air Piping

Connection of air piping is to connect of the over winding valve with the ports in the control system.

4.6 Connection of Electrical Circuits

For wiring of the electrical control cabinet of the hydraulic power unit, see Figures 6 and 7.

The plugs and sockets for wiring should comply with relevant technical specifications and safety and explosion prevention codes.

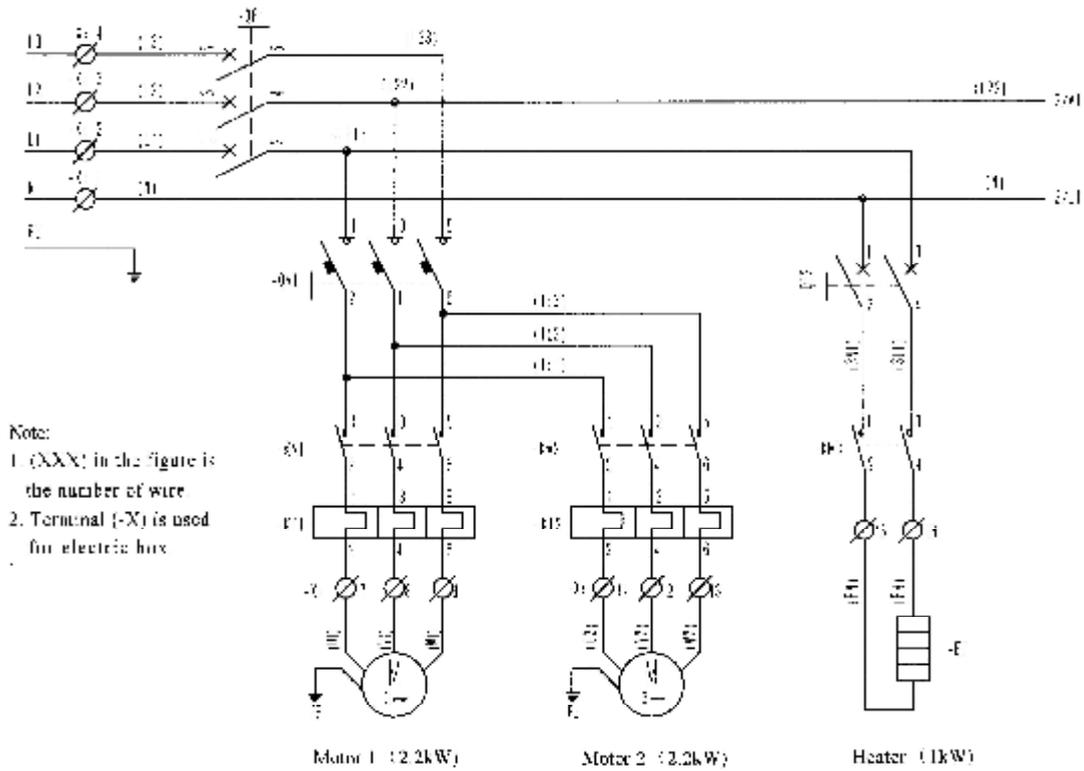


Figure 6 Electric principle of the hydraulic power unit (1)

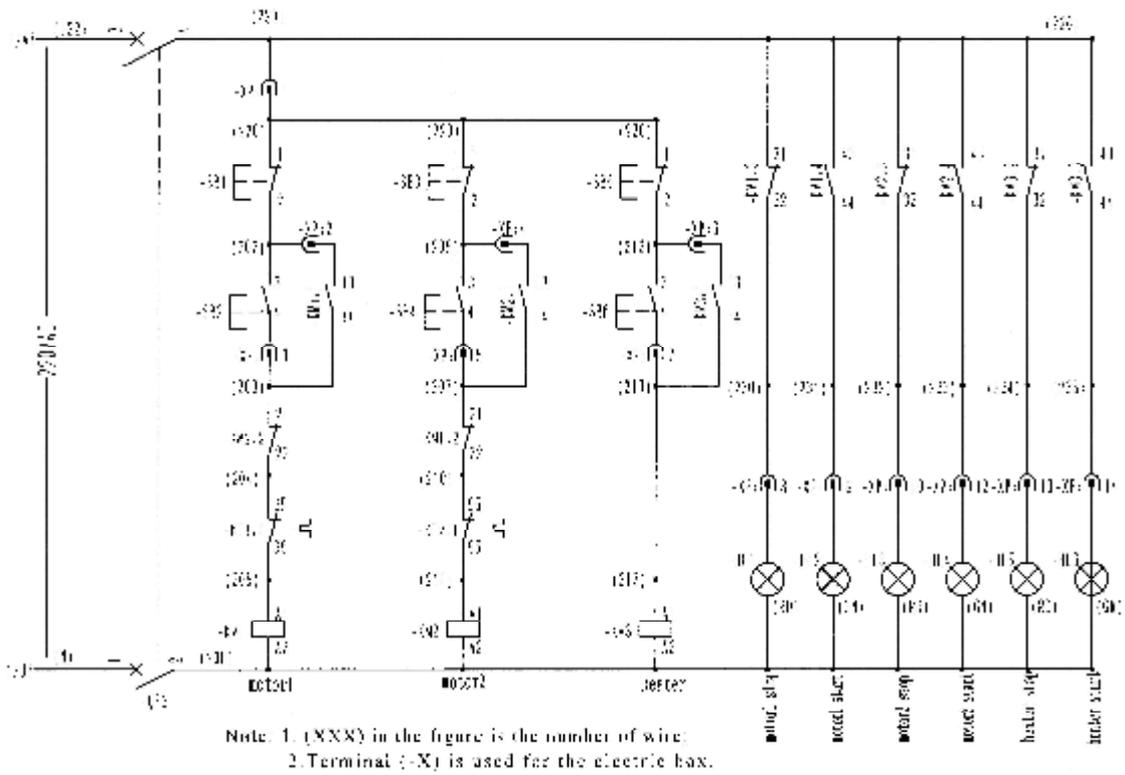


Figure 7 Electric principle of the hydraulic power unit (2)

5 Adjustment and Tests

5.1 Preparation:

- 1) Check connection of pipes; be sure that no errors occur, in particular, wrong connection in P1 (piping and instrument) may cause drill string free fall.
- 2) Check oil level in the oil tank.
- 3) Check pressure of filled Nitrogen in the accumulator, be sure that the pressure is 4Mpa.
- 4) Open shut-off valve at the oil suction port and oil bleeding port of the plunger pumps; close shut-off valve of the accumulator. When cooler's working is not required, the bypass shut-off valve of the cooler should be opened; else, this valve of the cooler should be closed.
- 5) Jog the motors to check for correct rotation direction of the motors (the plunger pump's rotation direction is clockwise, i.e., the direction indicated by the red arrow on the pump).

5.2 Adjustment and Tests:

- 1) Start motor.
- 2) Set rated pressure and maximum pressure of the system.

Setting steps are as follows:

- i. Start one set of pump-motor;
- ii. Loosen the nut of the relief valve and turn it clockwise to a position approximately at 3/4;
- iii. Remove the protecting cap of the pressure adjusting valve of the pump, unscrew lock nut of the pressure adjusting valve. Clockwise turn the adjusting screw with a hex wrench to increase pressure. While doing this, watch the MP pressure meter until to 9.5Mpa. If the pressure stops rising during adjustment, turn the relief valve a little. Alternatively adjust between the relief valve and the pressure adjusting valve on the plunger pump until the MP pressure meter displays 9.5Mpa.
- iv. Adjust the relief valve downward until the MP pressure reaches 9Mpa. Then tighten the screw cap of the relief valve.
- v. Adjust the pressure adjusting screw of the pump again until MP pressure maintains the rated pressure, and tighten the lock nut

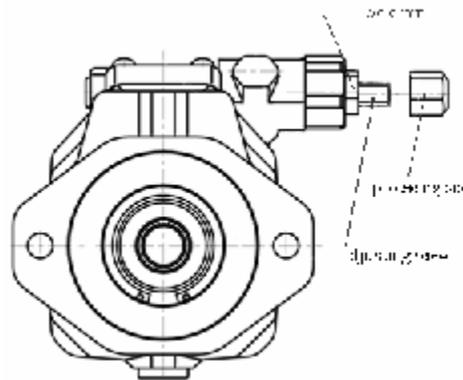


Figure 8 Plunger pump

- vi. Tighten the protection cap.

Note: Before delivery from factory, the maximum pressure had been adjusted to set value, which is not allowed to be changed unless in special cases.

- 3) Watch the pressure gauge of the hydraulic power unit, to see whether it is stabilized at the set value.
- 4) Air Bleeding: Lightly pull the handle of the brake valve to adjust the pressure of the service calipers at the about 1Mpa, unscrew the air bleeding screw a little on the cylinder of the service calipers until no foam is seen in the discharged oil. Bleed air from cylinders of service caliper this way one by one. When there is pressure in the safety calipers, bleed air in the same way as in the case of service caliper.
- 5) Pull down the service brake handle to bring the pressures of the right and left calipers to the maximum value, then pull out emergency button and push the parking handle to “release” position, now the three pressure gauges have the same pressure value, which are the pressure of the system, then stop the motor for 10 minutes. Observe the pressure gauges P1, P2 and P3 of the hydraulic power unit. If the pressure gauge readings remain unchanged, it indicates OK; if the readings drop, it indicates there is leakage in the system; then in-time remedy is required.
- 6) Adjust the Braking Clearance of the Safety Calipers
When there is pressure in the safety calipers, loosen the lock nut, anti-clockwise turn the adjusting nut to make the safety caliper’s brake pads fit completely with the friction disc, then turn the adjusting nut counterclockwise by 1/8 circle (now the clearance between the friction disc and brake pad is about 0.5mm), finally tighten the lock nut.
- 7) Adjust the Braking Clearance of the Service calipers
Adjustment of clearance is realized through adjusting the nuts at the two end of the spring. Clockwise Turn for tightening while counterclockwise turn for loosening. The clearance between the brake pads and the friction discs should be as small as possible. The smaller the clearance, the shorter the responding time for braking.
- 8) Lightly and slowly pull down the “braking handle” to check whether the pressures rise smoothly, whether service calipers move quickly and respond quickly. Repeat the operation several times to guarantee reliable performance.
- 9) Fitting and Running-in of Brake pads

Start the drum and slowly pull the “braking handle” to make the brake pads fit and run in with the friction disc.

- 10) Fitting and running-in of the new brake pads should be repeated until the contact area reaches $\geq 75\%$ of the whole area before being used. During fitting and running in operation, care should be taken to control braking pressure at 3Mpa.
- 11) Check over winding and crown block colliding prevention devices.
- 12) On completion of on-site installation and adjustment, run the oil pumps for 10~30 minutes and repeatedly operate the “braking handle” before putting into normal operation. Now check for correct oil level and oil loops, particularly, the level in the oil tank should be maintained at the middle between highest and lowest levels.
- 13) Only everything is OK, can the machine be used.

6 Operation Regulations

6.1 Preparations before Operation

- 1) Check for correct connection of all pipelines.
- 2) Open the suction valve and the releasing valve of the plunger pump.
- 3) Close returning oil valve of the accumulator group.
- 4) Connect external Power.
- 5) Turn on the Power.

! warning!

It is necessarily to open the suction valve and the releasing valve of the plunger pumps before putting into use. If not, the pumps will be damaged seriously.

6.2 Operation Regulations

- 1) Reset the braking handle, emergency brake button and parking brake handle, Namely, the braking handle in “release” position, emergency brake button and parking brake handle in “brake” position
- 2) Start the motor, now the system is in emergency brake condition.
- 3) Release: First pull the service brake handle to the “brake” position to brake the loads; then push parking brake handle, and pull out emergency brake button to bring them all in “release” position.
- 4) Service brake: Pull “braking handle” to realize service brake. The operation angle range is 0~60°, the bigger the pulling angle, the larger the braking force.

! Cautions !

When lowering drilling strings, particularly, heavy ones, auxiliary brakes should be used in combination. The combined capability of the disc brake and the auxiliary brakes should be used to safely lower the drill strings and casing pipes. In no case free fall of any load, no matter how small it is, is allowed. Continuous deceleration must be maintained during lowering.

During tripping, lightly pull the braking handle to let the brake pad lightly contact the friction disc. Thus, the braking responding time would be shorter, and drilling string not well braked is avoided.

! Warning !

Not using the auxiliary brake to control load lowering may cause control failure, resulting in property losses, injuries or even death! During tripping the connection between the

auxiliary brake and the winch should be maintained from the beginning to the end.

- 5) Parking brake: Pull the parking brake handle to the “brake” position to realize parking brake.

To switch to service brake, parking brake must be released first, that is, pull service brake handle to the “brake” position to brake the load, then push parking brake handle to “release” position, then carry out service brake.

! Cautions !

Parking brake involves only safety calipers. To guarantee the high-rigidity disc spring in the safety caliper’s oil cylinder to have enough spring force, replace the disc spring group at least once every 12 months.

- 6) Emergency brake: Press the emergency brake button to realize emergency brake.

To switch to service brake, emergency brake must be released first, that is, first pull the service brake handle to “brake” position to brake the load, then pull out the emergency brake button, next, carry out service brake.

Note: When the driller leaves the drilling console, parking brake. Slip must be applied for suspending heavy load. Suspending heavy load for long time by disc brake is strictly forbidden.

! Cautions !

During tripping, particularly in fast tripping, operation of parking brake handle and emergency brake button is strictly forbidden. Otherwise, severe damages would cause to equipment.

7 Maintenance

Due to application of hydraulic system, the disc brake is much more complicated than the traditional band brake. In particular, some dirt sensitive high-performance components, such as pumps, valves and hydraulic cylinder, need more careful maintenance than the band brake.

The key point of maintenance of the disc brake is laid on the hydraulic loop and braking caliper's oil cylinders. What are mentioned below and listed in the maintenance plan need routine maintenance.

7.1 Oil Level

Frequent checks of oil level and in-time oil refilling are necessary. When the oil level in the system is below the lowest level, negative factors such as temperature rising and non-soluble air accumulation would occur. Air pockets may cause pump failure; exposed electrical heater may cause local temperature rising, resulting in decomposition and deterioration of oil, consequently leading system failure.

Lowered oil level indicates oil penetration and leakage. To remove them, in-time check and maintenance are necessary.

7.2 Oil Temperature

The maximum temperature of hydraulic oil is 60°C. Higher temperature would accelerate aging of oil and reduce service life of seals and hoses. Oil temperature of the oil tank must be frequently checked and monitored. Temperature rising may indicate contamination and formation of colloidal matter, or damage of the plunger pump. Sudden oil temperature rising is a alarming signal, and immediate shut down and check is absolutely necessary.

7.3 Pressure Gauge

Observe readings on the pressure gauge of the hydraulic power unit, particularly, pressure gauge of the system. The pressure gauge should stabilize at the set values. Calibrate the pressure gauges regularly.

7.4 Oil Filter

The returning oil filter is provided with a visual blockage indicator, whose point in green zone indicates normal filtering element; in yellow zone, light blockage; in red zone, heavy blockage, which needs cleaning the filter enclosure and changing filter element. Check at least once a day when the working temperature reaches normal value; or check at the shift relief.

The high-pressure oil filter is provided with a visual blockage indicator, when the red rod plug of which is pushed out, it means blockage occur. In that case, oil filter enclosure must be cleaned and filtering element changed. Check at least once a day when the working temperature reaches normal value; or check at the shift relief by the operator of the next shift. However, the red rod

plug may be pushed out due to larger flow resistance during the course of temperature rising. So be careful to make distinction between normal temperature rising and abnormal temperature rising.

The air filter is used only for filtering air, which flows in or out of the oil tank. Every 1~3 months, the filtering element should be cleaned or changed.

7.5 Accumulators

Filled air pressure of the accumulator must be checked frequently. First, stop the motor, relieve the hydraulic pressure in the accumulator, then, remove the external and internal protection cap, connect Nitrogen filling tool, and turn the knob lightly to measure pressure. If the pressure is lower than 4Mpa, connect the coupling to the Nitrogen bottle, take off the knob for Nitrogen filling.

When relieve pressure, open all shut-off valves to discharge oil pressure in the accumulators. **In normal operation, tighten the shut-off valve securely, or else, the pressure of system can't be established.**

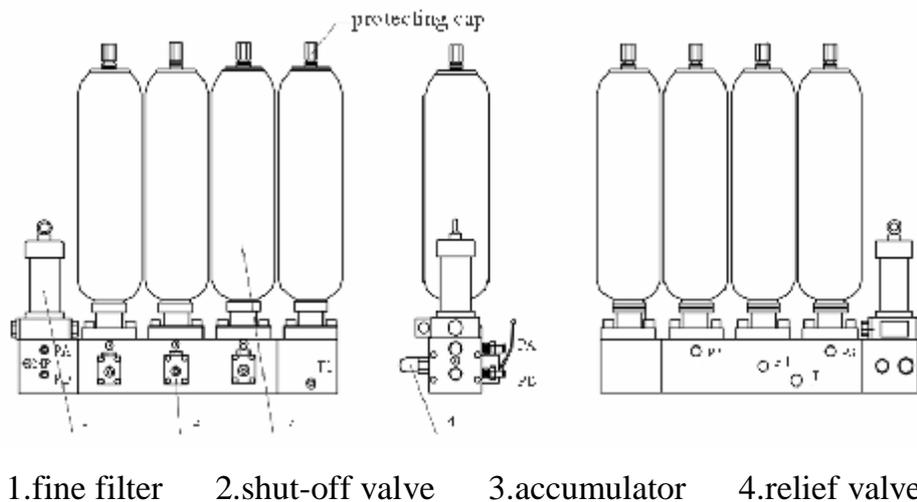


Figure 9 the accumulator group

7.6 Pump Groups

Check the pump groups frequently to guarantee that the two pump groups are always in good condition.

7.7 The System Preventing Colliding With the Crown Block

The over winding valve, which is not used in a long time, should be checked frequently to guarantee its reliability. Particularly in winter, the compressed air may contain moisture, which may freeze in the air pipe due to cold weather, and frozen ice may cause blockage in the air pipes, which may result in failure of the colliding prevention function. Give one trial operation of the colliding preventing system every day to guarantee normal work.

7.8 Service calipers

At the shift relief, check the thickness of the brake pads and the sealing performance of the oil cylinder. With the wearing of the brake pads (wearing on one side 1~1.5mm), pulling force of the tension spring should be adjusted so that the brake pads can return back when released and the clearance is not too big. When the brake pad is worn to only 12mm thick, it must be replaced.

7.9 Safety Calipers

Check the released brake clearance frequently (at least once a week), the thickness of the brake pads and the sealing performance of the oil cylinder. If the clearance between the friction disc and the brake pad is >1mm, the braking clearance must be adjusted to about 0.5mm. After application of emergency brake operation, the released brake clearance also should be checked. When the thickness of the brake pad is worn to only 12mm, it must be replaced.

! Cautions !

Adjust the braking clearance of the safety calipers in time, otherwise failure of emergency brake and parking brake may be caused.

! Cautions !

To guarantee the reliability of the safety caliper, replace the disc spring group once every 12 months at least.

7.10 Quick Coupling and Hydraulic Pipe

Check twice a day all quick couplings to guarantee good connection. Particularly, after shift of piping or accidental colliding on the piping, strictly check to see whether severe damages are caused, or false connection on the quick coupling exists, to guarantee no damage to the hydraulic pipes and quick coupling in good condition.

7.11 Structural Elements

Checks and maintenance for structural elements are concentrated mainly on braking caliper's levers, pin shafts, oil cylinders, caliper frames, friction discs, couplings and tightening elements. Items to be checked include damages, deformation, cracks and other problems, which may exist.

- I Check tightening elements, if necessary, tighten in time.
- I Key points for check and maintenance for the friction discs include:
 - 1) **Wearing** The allowable maximum wearing of the friction disc is 10mm (unilateral allowable is 5 mm) . Check and measure the thickness of the working surface of the friction disc regularly.
 - 2) **Thermal Fatigue Cracks** The enormous heat produced by rolling friction during braking of the friction disc causes expansion of the disc face, which will contract when cooled down. Such alternative

expansion and contraction may result in fatigue cracks in the friction disc. With extension of service time, when small stress cracks have expanded into bigger ones, enough attention should be given and remedy measures taken. For example, use a grinding tool to grind off a little along the cracks to check the depth of the cracks, carry out repairing weld and finally grind flat with a sand wheel.

- 3) **Oil Dirt** The working surface of the friction disc should be free of oil whether stuck or splashed thereto to avoid reduction of friction coefficient, consequently braking force, leading to drilling string not well braked accident. However, lubricant on the wire rope sometimes may be splashed to the working surface of the friction disc due to rotating of the drum. For this frequent check and cleaning is necessary.
- 4) **Circulation water** When the drilling rig is in use, the circulation water in the water-cooling disc should be existed, and the water line should be unblocked, so that there is enough circulation water to take off the heat which is produced by braking.

! caution !

If there is no circulation water in the water-cooling disc in use, the disc life will be decreased, and the cracks will be produced more easily.

In cold areas, in winter, if the drilling rig is no in use, cooling water in the friction disc must be drained thoroughly or to feed circulation water to the friction disc to avoid breakage caused by uneven contraction due to frozen.

- I Check welded elements, particularly, the caliper frames and caliper bodies, to see whether there are cracks and corrosion problems in the welds thereof. If necessary, repair or change any of them. These elements and component should be checked at least once every half a year.
- I Check moving parts to see whether there is sticking, particularly, in places like the pin shaft of the lever. Deposit of braking dust may cause poor lubrication. So feed lubrication grease once a month to guarantee good lubrication.

Maintenance Plan

No.	Items to be checked	requirements	frequency
1	Oil level	Between the lowest level and the highest level. Fill the L-HM46 or LHV32 hydraulic oil through the manual operated pump	Every shift
2	Temperature	Oil temperature $\leq 60^{\circ}\text{C}$	
3	Pressure of the system	PSZ75, 8 MPa; PSZ65, PSX50, 6MPa	
4	Oil filter	The point of the blockage indicator in green zone.	
5	Sound and temperature of the pumps	Neither abnormal noise nor high temperature	
6	System for preventing colliding with the crown	Trigger the colliding prevention valve and guarantee correct braking position	
7	Oil cylinder sealing performance	No leakage	Every day
8	Clearance in the brake pad	Service caliper: adjust the tension spring force Safety caliper: $\leq 0.5\text{mm}$	
9	Thickness of the brake pad	Minimum thickness 12mm	
10	Pipes and connectors	Sealing in good condition, no leakage, no damage	
11	Quick couplings	No leakage, no damage, no false connection	
12	Sticking of pin shafts	No load, push, pull and rotate pin shafts to see whether free movement without sticking	Every week
13	Filled Nitrogen pressure in accumulators	4Mpa	
14	Oil sample	Check and remove dirt	
15	Oil feeding to all parts	Feed lubrication oil from oil feeding ports	1 month
16	Fixing bolts	Check and tighten all fixing bolts and screws	3 months
17	Dismantle and clean levers and pin shafts	Check braking dust, change damaged parts	6 months
18	Wearing and cracks of friction disc	Allowable maximum worn thickness 10mm, thermal fatigue cracks should not affect strength and cause water leakage, otherwise change any	
19	Filtering element	Change	
20	Welds in caliper frames	Check welds for cracks	
21	Structure check	Check all structural elements in braking system	
22	Cleaning of hydraulic system	Clean oil tank and all hydraulic pipe loops	
23	disc spring	Change all disc springs	12 months

8 Trouble Shooting

The following chart shows some potential malfunction and possible cause.

Troubles	Possible causes
Pressure in the system is not proper.	Pressure setting unit of the pump is not set correctly, or failure;
	Setting of the system safety valve is not correct, or failure
	Shut-off valve of the accumulator is not closed tightly.
	Too low oil level in the oil tank
	Hydraulic oil contaminated, dirty oil
	Shut-off valves in the oil suction of the pump and the returning oil pipe are not open.
Oil temperature too high	Pressure setting of the safety valve is too low, or valve failure leading bypass flow
	Too low oil level in oil tank
	Hydraulic oil contaminated, dirty oil
Loud noise and vibration	Too low oil level in oil tank
	Loose coupling in oil suction and returning oil pipes cause air bleeding in the system
	Misalignment between motor and pump
	Loose bolts in the motor base plate
Slow response of hydraulic operation	Too low hydraulic oil pressure
	Too low system pressure
	Blockage of hydraulic oil filter
	Leakage or low pressure of the accumulator
	Blockage in control valve, or defects thereof
	Hydraulic oil leakage
Pin shaft sticking	Poor lubrication
	Deposit of braking dust in pin shaft or shaft holes
	Over wearing or corrosion
	Damaged parts
Slow releasing of main braking calipers	High returning oil resistance
	Weak rigidity of resetting spring

9 Disassembly, Assembly and Replacement of Key Components

! Cautions !

- 1 Before giving maintenance to any parts of hydraulic system, pressure of the accumulator must be first released. Otherwise, injury or even death may happen!**
- 1 Special attention should be given to maintain clean condition of working place because contaminants are the first reason to cause the hydraulic system failure. Before loosening any screw, clean the surrounding areas. Cover all openings, which link to the system inside, with clean covers to prevent contaminants from coming into the system. During operation, care should also be taken to avoid contamination of the hydraulic system.**

9.1 Filter Element of the Returning Oil filter

Unscrew the upper cover of the returning oil filter counterclockwise. Then remove the whole filter, remove the upper cover and take out the old filter element. Clean the inside of the filter with kerosene, and then dry it. Replace the filter element, screw the upper cover and reassemble the whole filter.

9.2 Filter Element of the Filter in Piping

Unscrew down the lower part counterclockwise, and replace it.

9.3 The Filter Element of the High Pressure Oil Filter

Remove the high pressure oil filter, open the upper cover with a wrench, clean the inside with kerosene, and dry it. Replace the element, put the upper cover, and reassemble the whole filter.

! Cautions !

It is strictly forbidden to reuse the used filter element!

9.4 Oil Pump

When one of the pumps is being replaced, the other one can work normally without releasing accumulator's pressure. Close the shut-off valve in the suction and returning pipes to prevent oil flowing out of the oil tank. Remove oil discharging pipe and coupling, as well as oil suction pipe and coupling. Remove the two screws, which connect the motor and the pump, to take out the pump. Check the shaft coupling to see whether it is in good condition. If it can be reused, remove the shaft coupling from the pump and mount it onto the new pump; if it can not be reused, both the shaft coupling on the motor and that on the pump should all be changed, then install the new pump and connect oil suction pipe, coupling, oil discharge pipe and coupling. Align the inner discharge returning oil pipe connection port with the inner discharge returning oil port of the pump, open the shut-off valve, feed oil into the pump shell, and then connect the

pipe line. Open the shut-off valve of oil suction pipeline, and check to see no error occurs, then commission the pump.

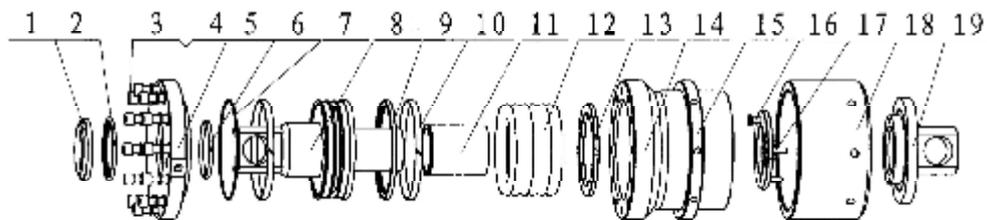
! Cautions !

- I When connect the pipe and couplings, O-rings and compound washers must be assembled on specification, otherwise leakage may occur.**
- I When install shaft coupling of the pump, hammering with a hammer is strictly forbidden. The correct way is to push it in with slight force after the shaft has been aligned with shaft hole, and key with key groove. Otherwise, damage to the pump may occur.**
- I Before start-up the pump, please fill the pump shell with oil, open the shut-off valves in the oil suction pipe and returning oil pipe, otherwise the pump may be damaged.**

9.5 The Disc Spring and Sealing Rings of the Safety Caliper

The service life of the disc spring is one year. After one year in service, the disc spring must be changed. The disc spring should be changed in group, only changing some pieces is not allowed. In reassembling, assembling sequence must be strictly followed, changes of the installation sequence and position of pieces of disc spring are not allowed. Leakage of oil cylinder indicates worn off of sealing rings. Worn off sealing ring must be replaced.

- 1) With hydraulic oil being supplied to the system, adjust the adjusting nut to make the braking calipers open to the maximum extent, release the oil pressure in the oil cylinder, pull out quick coupling, remove pin shafts at both ends of the oil cylinder, remove the oil cylinder as a whole, and clean its external part thoroughly with kerosene.
- 2) Disassemble all parts of the oil cylinder as shown in Figure 10:



1. dust-proof ring 2. sealing washer 3. bolt 4. washer 5. cover 6 guide band
 7. O-ring 8. C2 sealing ring 9. OK sealing ring 10. guide band 11. elastic guide sleeve 12. disc spring 13. space washer 14. oil cylinder 15. lock nut 16. bolt
 17. washer 18. adjusting nut 19. back cover of cylinder

Figure 10 Safety Caliper Disassembling Sequence

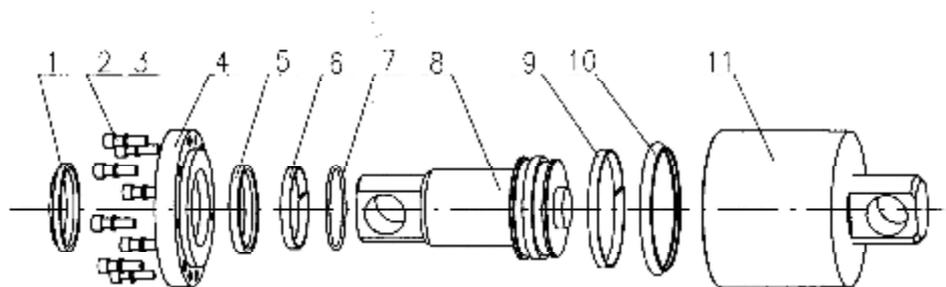
- 3) Clean thoroughly every piece of disc spring with kerosene, dry them, and apply sufficient grease evenly on every piece of disc spring. After the cleaned oil cylinder, oil cylinder cover, piston and elastic guide

sleeve dried, assemble them.

- 4) Install new dust-proof ring, sealing ring and guide band in the oil cylinder cover.
- 5) Install new guide band and sealing rings on the piston.
- 6) Install the new disc spring group strictly in accordance with specified assembling sequence and relation; the piece of disc spring should be assembled with its larger opening downward, the second with its larger opening upward, the third one downward, the fourth one upward, the fifth one downward, the sixth one upward and the seventh one downward, finally, put the spring guide sleeve.
- 7) When assemble the piston, pay attention to the guide band. First feed some hydraulic oil, with one person pressing the piston, another person lightly hammering the piston with a copper bar to hammer it to position.
- 8) Install the hydraulic cylinder. Tighten the bolts symmetrically.
- 9) Install the hydraulic cylinder assembly in its original position. Connect pipes correctly, and adjust the brake clearance. During assembling, cleanness should be maintained, seals protected from damage and scratches.

9.6 Sealing Rings of the Service calipers

- 1) Release oil pressure in the hydraulic cylinder, and after the piston moves back to position, pull out the quick coupling, remove the adjusting nut, tension rod, tension spring, split pin/retaining ring for the shaft, then take off the pin shaft, remove the oil cylinder as a whole.
- 2) Clean the cylinder assembly with kerosene.
- 3) Disassemble all parts of the hydraulic cylinder according to Figure 11.



- | | | | | |
|--------------------|-----------------|-----------|-------------------|------------------|
| 1. dust-proof ring | 2. bolt | 3. washer | 4. cylinder cover | 5. sealing ring |
| 6. guide band | 7. sealing ring | 8. piston | 9. guide band | 10. sealing ring |
| 11. cylinder | | | | |

Figure 11 Disassembling Sequence of the Service calipers cylinder

- 4) First remove the air bleeding screw of the oil cylinder, remove bolts, cylinder cover and pull out the piston.
- 5) Remove the old guide band, sealing ring and dust-proof ring in the cylinder cover, remove the guide band and sealing ring in the piston.

- 6) Wash piston and dry it.
- 7) Put piston rings and sealing rings onto the piston rod.
- 8) Install new dust-proof ring, sealing ring and guide band in the cylinder cover, and put new sealing rings on the piston.
- 9) Apply hydraulic oil on the internal surface of the cylinder, put piston into the cylinder, install cylinder cover, then evenly and symmetrically tighten the bolts.
- 10) Install the oil cylinder assembly on its original place, connect oil piping and adjust clearance.

9.7 Brake Pads

When brake pads fail in function due to wearing or other causes, they should be replaced. Otherwise, drilling string will not be well braked and drill string free fall.

Preparation for changing brake pads:

- 1 **Safety calipers** With pressure being provided, adjust the adjusting nut to make the brake pads have maximum clearance, then release pressure in the oil cylinder;
- 1 **Service calipers** With pressure being released, adjust the tension spring tight to bring the piston into original position.

After unscrew the 8 bolts, which connect the brake pads, the old brake pads can be removed. Remove all old brake pads in sequence, which need to be changed. When removing brake pads, the brake pads of the top or bottom braking calipers should be removed first, removing the brake pads one by one along the circumference. Replace new brake pads in the reversed order one by one in sequence.

Note: After new brake pads being replaced, the braking clearance should be readjusted.

10 Damageable Parts

Damageable Parts List

No	Description	Where to Use	Remarks
1	Brake disc		
2	Brake pad PSZ75A-2-01	Braking calipers	
3	Disc spring PSZ75A-2-06.03	Safety caliper cylinder	
4	Guide band FM 3020		L=255mm
5	Dust-proof ring A5 8008		
6	Sealing ring OK 0150		
7	Sealing ring BA 8007		
8	Sealing ring C2 F015		
9	O-ring 145×3.55		
10	Guide band FM 3020	Service caliper cylinder	L=255mm
11	Guide band FM 3020		L=380mm
12	Dust-proof ring A5 8008		
13	Sealing ring BA 8007		
14	Sealing ring C2 C025		
15	O-ring 118×2.65		
16	O-ring 30×3.1	Hydraulic power unit	
17	O-ring 24×2.4		
18	O-ring 22×2.4		
19	O-ring 18×2.4		
20	O-ring 7×1.9		
21	Compound sealing ring 22		
22	Compound sealing ring 27		
23	Compound sealing ring 30		
24	Compound sealing ring 10	Hydraulic-operated reversing valve	
25	Compound sealing ring 12	Emergency brake valve	
26	Compound sealing ring 14	Oil-way block	
27	Compound sealing ring 18		
28	Compound sealing ring 16	Braking valve	
29	O-ring 16×2.4	Hydraulic pipeline	
30	O-ring 11×1.9		

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