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CITIC HEAVY INDUSTRIES

Instruction Manual for Gyratory Crusher

（PXZ-1500II）

Luoyang Mining Machinery Engineering Design Institute Co., Ltd.

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Instruction Manual for PXZ-1500II Gyratory Crusher

Foreword

The instruction manual aims at providing technical guidance for beginners and a technical reference for the experienced operating personnel. Carefully read this manual and keep for future reference. The diagrams and instructions in this manual can guide the operating personnel to carry out appropriate inspection, installation, operation and maintenance on the crusher and its ancillary equipment.

The manual only contains basic operating techniques, which will help technical personnel to understand the crusher and its operation; in place of formal training. Personnel can gradually improve their skills and master more operating techniques. Some revised information may not be included in this manual as the design of the product is updated and upgraded. If conflict arises during actual operation, we will update and add required information or make some appropriate modification in the following edition.

CITIC HIC reserves the rights to terminate the production of this model, modify its specification or design without prior notice, and does not undertake any consequent responsibility or liability. This manual is valid on the completion date of its publication.

If you have any question about the crusher or the manual, please contact CITIC HIC or the local agency to obtain the latest applicable information.

This manual is an overall guidance and general instruction about the technical specification. For all the necessary technical instructions for the actual crusher, please refer to the installation drawings and technical data provided with the specific models.

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Section 1　Safe Operation of Equipment

1.1　Introduction

The gyratory crusher of CITIC Heavy Machinery company is mainly used in mines, quarries, metallurgy and other fields. During its process of design and manufacturing, we take full account of the influence the equipment has on human health and safety. Although some accidents can occur during the course of checking the operating parts and clearing the blocked material, yet most accidents in the crushing and screening plant occur during the course of maintenance. Therefore, this section focuses on the safety notices during the implementation of the above-mentioned work.

To avoid potential security risks , it is necessary to ensure ：

1．Carefully read and strictly observe the suggestions in this manual.

2．Regularly train the personnel for maintenance and safety

3．Strictly observe the general and national safe operation rules.

4．Hang warning signs in hazardous areas.

5．Provide appropriate Protective Personnel Equipment (PPE’s) and tools.

6．The operator and administrative staff have the responsibility to develop effective safe operational conditions and to ensure the relevant personnel observe these rules.

1.2　Safety Rules

The operator and administrative staff have the responsibility to develop effective safe operational conditions, which should conform to the operation management practices of workers as well as any applicable laws, rules or regulations. Each staff member must know about the operation of this machine, the special requirements of the workplace, precautions and potential hazards. Everyone must comprehend and follow these requirements to ensure safety during the operation and maintenance of the equipment.

1.3　Safety Responsibility

The company must provide their employees with a non-hazardous working environment to avoid causing illness, personal injury or death. It must observe the policies and regulations of Labour and Security Department and meanwhile make its employees aware of their rights and obligations. The company must take all necessary measures in making and strengthening rules to ensure compliance with laws and regulations. In addition, the company and its employees must know the relevant government rules and regulations related to the operation and maintenance of this equipment, and strictly implement and observe them.

1.4 Safety Awareness

The operator's serious attitude towards his work is the key to safe operation and also the safeguard against accidents. The safety of the operator and others depend on correct operation of the crusher and complete comprehension of its operating conditions. Most accidents are caused by failure to strictly observe the basic rules or notices of safe equipment operation. Preventive measures must be taken to stop accidents.

1.5 Special Safety Notices

This manual and other documents contain important safety instructions. Prior to the operation of the equipment, all operators and maintenance personnel must carefully read and understand these instructions. In order to arouse greater attention, the instructions directly related to personal safety and the instructions on how to avoid equipment failure, are all highlighted terms and warning symbols in the manual.

1.6 Safety Marks

A series of effective measures are taken during the design and production of the equipment to ensure the operation and maintenance is in a safe and effective mode. Clear safety signs are fixed in a prominent position on the equipment. Once these signs are damaged, lost or can't be distinguished, they must be changed immediately.

During the shut-down period of the equipment, it is necessary to turn off and affix DANGER tags onto the electric/mechanical energy sources and control devices to warn personnel that the equipment is not to be operated.

When working on any part of the crusher, the maintenance supervisor or qualified person must lock the electric/mechanical energy sources and control devices with personnel padlocks and all other technicians to fix their personnel danger tags to the padlock or locked cabinet.

1.7 General Safety Notices

The following safety notices are only used as a guide for there is a chance that during the operation, other situations and changes that are not contained in this manual may arise. The purpose of this content is to make the staff aware of general hazardous conditions when working in or around the crusher.

1.7.1 Personal Safety

1．Read and know each warnings, cautions and instruction in the instruction manual and safety tags fixed onto the equipment.

2．Immediately report all accidents to your supervisor; for all personal injuries immediately contact the emergency services or the medical centre for treatment.

3． Telephone books with emergency number next to all site phones and tell everyone at site the

phone and book locations.

4．Do not operate the equipment or work around it if you have been drinking alcohol, taking sedatives and or other drugs that will reduce your vigilance or will affect your judgment.

5．When getting on or down from the device or walking on the device, please use handrails, ladders, fence and other security devices. Safety harness must be used during high level work in hazardous area operation.

6．Prevent the hair, neckties, scarves, sleeves, trouser legs and other loose clothing from being hooked by the moving parts or the control device.

7．Safety glasses must be worn to prevent flying foreign particles, stones, debris or dust from entering your eyes or as required in the operation specifications. For greater safety, always wear safety glasses to protect your eyes.

8．Wear gloves to prevent hands or fingers from cut, scratch, burn and corrosion damage.

9．Always wear safety helmets and protective shoes in outside designated work areas and as required in the local or national legislations. In the area around and below material transfer point, for example, between the belt conveyor or the feeder and the crusher, there is the risk of falling material. Ensure there are appropriate protective equipment and warning signs.

10．Before starting work on the machine, rings, watches, mobile phones, necklaces and bracelet should be removed.

11．Ear protection equipment should be used in the area with a high noise level.

12．In the working environment with harmful gases, protective masks should be worn. Such as, in the air containing dust particles, the toxic fumes when cutting resin backing manganese plate, when contacting the molten metal, chemicals, solvents or other substances harmful to health.

Remember, working in the environment containing dust particles may increase the risk of catching pneumoconiosis.

13．To reduce labor intensity, please use lifting and moving devices to assist in work; do not run the risk of working with insufficient manpower.

1.7.2 Safe Work Area

1．Keep the work site clean and tidy; Clear the spillage rubble whenever necessary; Avoid the accumulation of gravels or other material in the area such as in the passages, on the platforms, on the ladders, under the conveyors in order not to hinder the normal work.

2．Only inducted and authorized personnel are permitted in the work area.

3．Keep the surface of the equipment clean and free from grease, oil and any other contaminants.

4．Keep the handrails, fences, ladders and platforms clean, dry from grease, oil and any

contaminants.

5．Remove all parts and tools that are not being used from the work areas.

6．Locate safety equipment within the work areas. Ensure all personnel know where the safety equipment is stored and are trained in its use.

7．Check the start alarm and warning device at the working site daily to ensure each device can function properly before starting or operating the equipment.

8．Do not stand under the equipment being lifted or suspended. Safety hooks or hooks with safety latches should be used to lift equipment. When necessary, use a crowbar. When lifting or moving equipment, there must be someone authorized and competently trained to supervise.

9．Be aware of weight limit and space dimensions in and around the work site.

10．The walkways are exclusively for the staff. Overweight objects, should not be stacked in the walkways.

11．Be aware of possible unknown consequences when your sight is limited.

12. Prior to any maintenance or inspection on the crusher, be sure to turn off/disconnect all electrical/mechanical energy sources and control devices. The implementation of the work should not proceed prior to the removal of protective equipment.

13．When cutting or welding, some appropriate protective measures shall be taken . The operating personal should avoid inhaling the smoke, which is a health hazard. These operations should be carried out in well-ventilated outdoors, or a special device for supplying fresh air or exhaust device should be used and comply with the local national safety standards.

1.8 Safety Notice for Crusher

All the operation and maintenance personnel of the crusher should be aware of the following safety notice:

1．Be sure to use the special lifting equipment we provide to install and remove the consumable parts to ensure operator safety.

2．In the case of using a feed hopper or feeder, a platform should be built around the feed opening of the crusher to facilitate the operator's observation of feeding.

Warning! There must be security guard rails and kickboards around the platform and the top of the crusher.

3．It is the mines responsibility to provide a visual warning sign showing the danger of the dump hopper, a visual or audible alarm for the dumping of the truck, a visual alarm for the start of the crusher and safety fences where applicable.

4．Using a primary gyratory crusher, it will inevitably occur that a large size rock may block the feed inlet. The efficient and safe way to remove or dislodge the blockage is to use a hydraulic hammer, crane or the hydraulic arm with grab. The layout and the installation of these devices should be taken into account during the engineering design and planning phase.

Warning!! Blasting procedure is not recommended. The user assumes all responsibility for any damage caused as a result of blasting. CITIC Heavy Machinery bears no responsibility for the consequential personal injury or the damage to the crusher.

5.

Danger!!! If personnel must enter the crushing area for maintenance, first cut off the power supply, lock off the electrical/mechanical control devices, and energy sources. Attach DANGER tags onto the controls that may start the crusher and also onto other energy sources. It is very important to ensure the strength and suitability of the fixed point for the safety harnesses connection.

6.

Be aware! The side plate or hungry boards of the dump hopper must have sufficient height to prevent the rock spilling over the edge, resulting in injury.

7．The rotation direction of the pinion shaft must be correct to ensure the self-tightening for the nuts of the head .

8．The drive motor of the crusher must be interlocked so that it cannot be started until the lubrication system is operating. The oil from the crusher returns normally if the oil temperature is not too high. The oil pump cannot be stopped until the crusher is completely at a standstill. If for any reason the oil pump fails; the crusher motor must be stopped immediately by means of the safety interlocks.

9．After the trial run, all bolts should be re-tightened.

10．Do not stand in the crusher when removing the mantle liner or main shaft.

Warning!! Do NOT blast to remove the mantle or concaves.

11．Note: that hard abrasive material will wear the liners prematurely.

Be aware! That the clearance between the mantle and the concave will lessen and

may cause damage to the main shaft head and the lower shell casting.

12. Daily check the clearance between the mantle and concave liners.

Be aware! The liners of the crusher, especially the concaves, mantle, rim liners and spider arm liners are made from high manganese steel. Gas cutting, welding and grinding manganese steel will produce toxic fumes and dust. Gas masks and other protective equipment is strongly recommended.

13. Be sure to take measures to protect the main drive of the crusher against serious damage with a suitable drive guard. If the user provides the drive guard, its design should conform to all state and local regulations. (Fixed protective cover should be installed on the driving device of the crusher. In the case of V-belt drive, the design of the protective cover must facilitate checking the tension of the matched belts and must comply with local safety regulations.)

14. The crusher is characterized by severe noise. The noise of other auxiliary equipment installed in and around the crusher; such as chutes, transfer stations and screening machines is even higher than the crusher itself. Wear ear protection when working near and around the operating crusher. There should be a warning sign that reminds all the staff to wear ear protection.

Be aware! All the operators must wear ear protection.

1.9 General Safety Notice for the Crushing Plant

Warning!! When working on most crushing and screening equipment, it is required to wear helmets, safety glasses and ear protection. Helmets and safety glasses provide protection to prevent harm. When the noise level exceeds 82dba, ear protection must be worn. When the dust content exceeds the acceptable limit, respiratory protective equipment must be worn.

1. In a crushing plant, the working environment has high dust content, high noise levels and extreme weather conditions.

Note: The operating room should be equipped to provide protection for the operators.

Note: The facilities, such as the platform and the remote observation equipment in the control room or operating room near the crusher, should be equipped for the visual

check of the materials entering the primary crushed zone of the crusher.

2．In the case that the feeder or crusher is equipped with a dump hopper, there is always the danger of the truck's falling into the hopper.

Note: Be sure to install a reversing block, its width should be equal to or wider than the width of the access road and its height should be not less than 50% the diameter of the rear wheel for the largest truck. Meanwhile, the rest of the hopper should have additional security devices (such as guard rails)

3．Ensure there is sufficient lifting capacity of the hoisting device for proper maintenance of all the crusher components.

4．The crushing plant has a dusty environment. If the dust content in the atmosphere exceeds the acceptable level, dust removal or dust suppression measures must be taken. It is the user's responsibility to attach a warning sign of dangerous dust environment, and to take measures to control dust, such as spraying water, the installation of ventilation with a dust collector, or providing protective masks for the staff working near the crusher as required.

5．Don't change, damage or remove fixed warning signs on the crusher.

6．Before fixing mobile crushing stations ensure that the ground is adequately solid and level. Make sure that all supporting tools, tags and barriers are in place. Please follow the manufacturer's suggestions for tool requirements, tagging and barriers relating too mobile equipment.

7．Prior to transferring self-propelled crusher station, check if the brake, lighting and turn signals are working correctly and ensure the supporting feet are raised to a sufficient height from the ground. Check if there are any loose parts to prevent them falling during the transportation.

Warning!! Do not climb onto the crusher while it is in motion.

8. Check if the equipment is in good condition before the operation of each shift. Make sure there is no damage. It must be repaired or replaced if there is damage.

Note: Repair or replace damaged parts before starting or running the equipment. Only replacement parts from the original manufacturer can be used.

9．Starting or running of the equipment

Caution! Before the starting and running of the equipment, inspect the equipment and

working area. Ensure there are no people, animals, tools, parts or anything unsecured remaining on the equipment. Make sure all the safety protective equipment is correctly installed and in good working order.

10．Before the equipment starts, be sure to inform all the staff members and visitors at site that the crusher is ready to start.

Note: Use proper warning devices, such as audible alarm and/or flashing light to attract the attention of staff members and visitors at site to the situation that the equipment is about to start.

11．Start the crusher according to the procedure recommended by the manufacturer.

A person without qualification is not allowed to start and operate any equipment if it is not under the supervision of a trained and qualified operator.

Note: The machine must be always under the supervision of a qualified. If the operator must leave, the person is to be replaced with another qualified operator.

12．Pay attention to any abnormal indications, visible defects, unusual smells and noises during the start-up and operation of the equipment. If any unsafe condition is noted, immediately shut down the crusher as per the specified stop sequence.

13．User must be careful when making inspection, maintenance, lubrication or adjustment.

Warning! Only under the direction of qualified supervisor can this work be done. Stop the machine, shut off all energy sources and lock the safety switch before executing any work under normal conditions.

14．User must be very careful when making inspection, maintenance, lubrication or adjustment, and at the same time follow the safety procedures recommended by the manufacturer.

15．The equipment must be supplied with sufficient lighting and power connection to facilitate maintenance.

16．Control: the customer is obliged to ensure the following conditions are met: be able to start the crusher at any time with the control unit supplied for it. When the crusher stops due to power supply fluctuation or major variation of pressure, temperature, speed and power the safety interlocks do not allow the crusher to restart automatically.

17．The design, manufacture and assembly of all the control units supplied by the customer must be capable of resisting any electrocution risk.

18．Maintenance of the equipment: many parts of the crusher need access to perform maintenance. The manufacturer doesn't supply the access to the following units, such as main drive assembly, spider bearing assembly, hydraulic cylinder assembly for the main shaft positioning system (located under the crusher) and lubrication system. Therefore the customer is obliged to provide and maintain a safe working area and it is the responsibility of the customer to design and install these access platforms..

19．It is prohibited to use an unsafe crane with insufficient lifting capacity and breach safe operating regulations. The crane is used to assemble and disassemble parts of the crusher, including the function of delicately lifting and lowering each part of the crusher.

Important Note: the crane must be used within its rated working capacity. The safe rating includes the weight of hook, pulley, beam and any other rigging, such as wire rope, suspension cable. The weight of safe lifting can only be calculated by deducting the weight of these accessories.

20．When lifting or lowering the parts with the crane, no-one should be in the work zone under or near the suspended component.

1.10 Electric Safety

1. Only trained and qualified personnel are permitted to work on the electrical parts of the equipment and the ancillary plant.

2. The circuit is considered to be connected unless it is proved to be cut-off by testing procedures.

3．Disconnection of all mechanical and electrical energy sources are to be completed and checked by authorised personnel prior to any inspection, maintenance, lubrication or adjustment of the equipment being performed. Personnel DANGER tags to be attached / fixed to all energy sources.

4. Repair or replace any broken, cut-off, split or damaged wire, cable and connector.

5. Before starting any equipment, check if the grounding, motor and feed cables are properly and securely connected.

6. Be aware of the distribution of all the power cable and underground cable. When working in this area, confirm and check that all energy sources have been disconnected or shut off.

7. Do not perform maintenance on electrical equipment while it is raining. Ensure that the equipment energy source has been disconnected and checked prior to any commencement of work.

8. Be aware when working near live lines or electric energy sources. Advise your supervisor if

the work area is unsafe.

1.11 Safety Against Flammables and Hazardous Material

1. Store flammable, explosive and hazardous material in specifically designed fire proof containers away from designated work areas.

2. Regulations require all used and oily rags be disposed of in a specifically designed fire proof container and kept far away from all work areas.

3. Do not put flammable and explosive articles into the equipment.

Caution! It is prohibited to smoke or use open fire around the equipment oil tank, fuel sources or explosive articles.

4. Suitable fire extinguishers are required in the working areas. All personnel must know where they are located and training in how to identify the correct extinguisher and their use. Fire extinguishers are to be located next to all fuel dumps types and should be checked regularly based on manufacturer's instructions.

5. Shut down all the engines and motors when filling oils or flammable liquids. Follow the recommended instructions when filling oils or flammable liquids.

6. Place the oil storage tank or other containers with explosive articles in an environment with good ventilation, far away from the equipment that might produce spark and ignite flammables.

7. When filling oils or conveying flammable, explosive articles, the equipment must be grounded to stop static electricity causing a spark which can ignite the fuel source.

Warning!! Gas fumes can be fatal.

8. Flammable and explosive material, such as gasoline, kerosene or diesel oil is not allowed to be used as detergent. The cleaning agent must be of a nonflammable environmentally friendly type.

9. The use of epoxy type material shall conform to the requirement of the manufacturer.

Note: Mixing and pouring resin should be performed in the open air or in a place with good ventilation. Avoid unsolidified resin from touching the skin. Wear appropriate safety equipment.

10. Check and replace any lead-acid batteries in the open air or at the well-ventilated place. Smoking or open fire is prohibited around these batteries.

Warning!! There is explosive gas in batteries.

11. Handle the waste material, discharging liquids and hazardous articles by strictly following the national and local environmental, safety, transportation and other correlated rules and regulations. Make sure all the operators are familiar with these rules.

12. Wear appropriate protective clothing and equipment with protective facilities before handling flammable, explosive and hazardous articles and follow the recommended procedures.

1.12 Safety of Pressurized System (Air and Liquid)

1. Ensure that pressure has been fully expelled from any pressurised system or vessel prior to opening.

Caution!! It is prohibited to service parts of any pressurized vessel/system before releasing the pressure within.

2. If high temperatures are involved; it is then necessary to expel the pressure and allow the liquid or air to cool prior to opening

3. Do not enter the pressurized system or the vessel until air quality is checked and it is completely cooled and safe to do so.

4. Do not disconnect the air or hydraulic pipeline or other pressurized units before releasing the pressure from the systems and is safe to do so.

5. The pressurized system is not allowed to operate if hoses, valves and pipe fittings are worn or damaged. Replace the worn and damaged parts before applying any pressure.

6. Do not remove the air cylinder or hydraulic cylinder before releasing the pressure in the pressurized system. Only trained qualified personnel are allowed to disassemble the air cylinder or hydraulic cylinder.

Caution!! The setting of the pressure safety valve must not exceed the recommended value.

5. Comply with the requirement of recommended inspection and maintenance procedure for the pressurized system by the manufacturer and ensure safe working condition all the time.

1.13 Welding Security

1. All the welding or cutting must be done by experienced and qualified welders, who have been properly trained in the use of welding processes and equipment.

2. Take all the necessary precautions to prevent welding sparks and slag from landing on the

belt, hose, oil tank or other parts of the equipment, or landing on other personnel within the working area. Always watch out for the possible fire hazard.

3．Connect the welding earth cable to the weldment as close as possible to avoid damage to the equipment or potential injury to the person.

4．Consult the technical requirement with the manufacture of the welding equipment before executing welding operation.

5．Do not weld on the pressurized container or pipeline.

6. Wear appropriate safety equipment to prevent personnel injury when performing gas cutting or welding operations. The operators shall avoid breathing the fumes. Such operation shall be done outdoors with good ventilation and be specially supplied with fresh air or fume extractor if necessary.

1.14 Operating Procedure at Low Temperature

When cooling down each part of the crusher with dry ice, liquid nitrogen or any other refrigerant, follow proper safety procedures and conform to the local professional specifications and standards.

1.15 Basic Safety Rules

1. Ensure that all personnel are trained in safety procedures and are site inducted. All safety rules and procedures must be observed.

2. All personnel are responsible for the personal safety of themselves and others.

3. Often check tools and safeguards to ensure they are not defective or removed.

4. Train all personnel and make them aware of the possible hazards in the work place and the safe methods in completing tasks.

5. Train all personnel on new unfamiliar tasks.

6. It may be necessary to complete a safety check list to identify possible risks and hazards prior to performing any task to ensure safety for all personnel undertaking the work.

7．Ensure that work areas are cordoned off with appropriate barricades and warning signs to stop entering of unauthorized personnel.

Warn all other personnel of potential danger and hazardous conditions.

8．Review working conditions on a regular basis; note and advise any changes to your supervisor. Watch out for any change in the working condition and process.

9．It is everyone’s responsibility to report any unsafe performance or working condition to your supervisor.

10．Keep working areas and the surrounding environment neat and tidy. Arrange used tools and material in order and store them in their correct locations.

Section 2 General Description

2.1 Introduction of Crushing Technology Research and Development Ability

CITIC-HIC Technological center crushing and screening machine research institute is mainly engaged in research and development design of crushing and screening equipment with more than fifty-year's experience in design, research and development. Several series of products have been developed and applied extensively in engineering technology design and complete supply of crushing and screening equipment in numerous industries. With cooperation and exchange of information with a number of colleges, universities and institutes, CITIC-HIC has formed a strong independent research and development ability and innovation capability. Our research institute has been at the forefront in the design of; 76 different types of e.g. jaw crusher, gyratory crusher, cone crusher, hammer crusher, impact breaker, selective crusher, ring hammer crusher, roller crusher, impact crusher, mobile, semi-mobile, and stationary crushing stations, which can be reconfigured and modified to suit the customer's requirements.

2.1.1 Methods of Design, Research and Development

1) Finite Element Analysis Technology

With foundry analog calculation and analysis software associated with heat treatment, welding values and machinery values. And the combined experience with laboratory measures in research and development of new products CITIC-HIC has the ability to alter and improve certain manufacturing procedures. CITIC-HIC also owns the analog software, including German casting analog software MAGMA, French welding heat treatment analog software SYSWELD, American structural analog software UGS NX and Great Britain's material calculation software JMATPRO. With them, most of mechanical performance of products can be analyzed during the product design phase, which helps improve our product design to be more reasonable with better capability.

The main parts and components of the gyratory crusher have been calculated and analysed during the design phase and have passed the practical examination, which indicates the design is reliable and sound.

For the crusher's shell and main shaft finite analysis and analog analysis are modeled.

Refer to VIEW 2-1, 2-2, and 2-3.

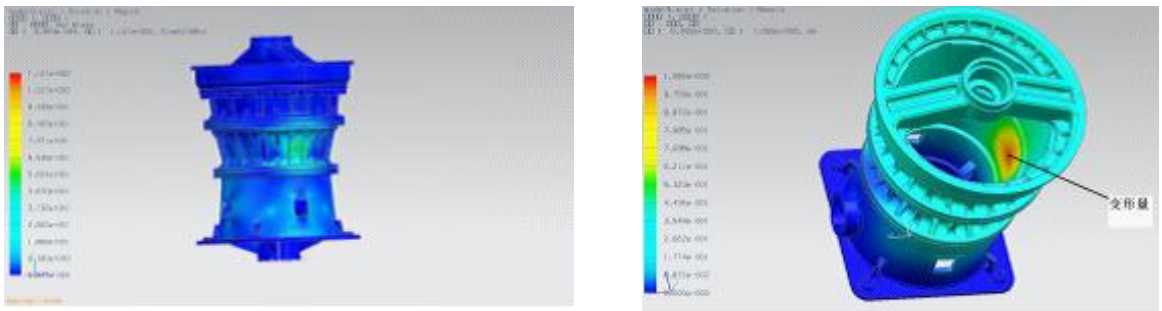


Fig. 2-1 Finite element analysis of gyration crusher's shell

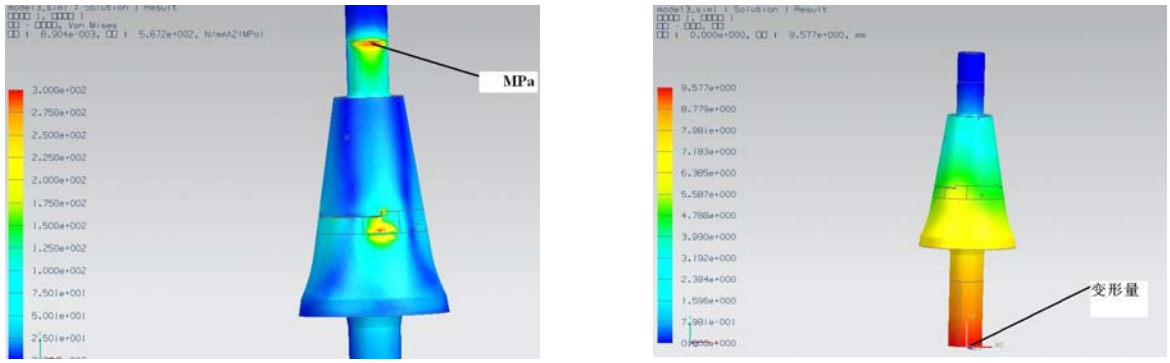


Fig. 2-2 Finite element analysis of main shaft

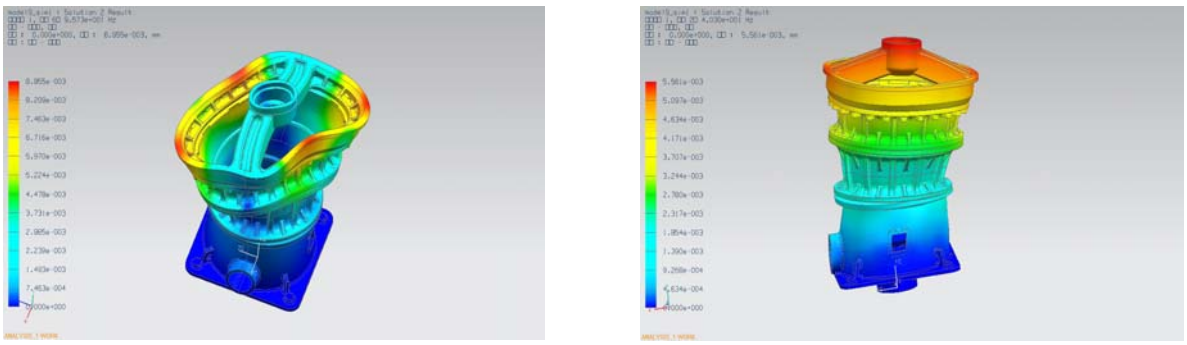


Fig. 2-3 Modal analysis of shell

2) Ability of Design and Laboratory Test

With the latest design platform of CAD/CAM technology and the design production platform of ERP, the whole data shared information-based design platform, was introduced and developed to reduce design cycle dramatically and improve product quality.

With our advanced laboratory, several testing tasks can be performed e.g. analysis of ore and reliability testing of products which provides data support and development protocol for product enhancements.

2.1.2 Product Manufacture Ability

With the process manufacture system based CAPP technology, we can accomplish the standardization of machined pieces, sustain the product manufacture standard further to provide good-quality, high-reliability products for customers. The manufacturing facilities of CITIC-HIC are of the most advanced type in the world with large capacity configuration, for example, casting and smelting department with operating equipment, such as, 18500t hydraulic press, 8400t forging machine with strong capacity, 6.5 x 18m digital control plane type boring and milling machine of high machined precision, and Φ16m digital control double-column vertical carousel machine. So the facilities completely meet with the production requirements of the whole casting, machining process of crushers.

2.2 Transportation

For transportation, the heavy gyratory crusher can be dismantled into several sections, which are then transported as separate packages.

The assembly of parts depends on transport limit conditions and site lifting capacity, generally, including spider ring, middle shell, middle shell, main shaft, bottom shell, bevel gear, eccentric assembly, pinion shaft assembly and external hydraulic lubrication system.

2.3 Use of Drawing and Parts Manual

All the part names and part numbers in the instructions are referred to as an "item". Each crusher is equipped with spare parts list.

After the crusher is shipped, the spare parts list is sent separately, listing all the items, quantity of parts and recommended quantities.

The relevant drawings and parts list are used to order and replace spare parts and consumables.

2.4 Wearing Parts

Wearing parts and replacement parts of gyratory crusher are sold by CITIC HIC. When ordering wearing parts, the following information must be attached:

1．Type, size and serial number of crusher.

2．Description and part number.

3．Quantity of each part

4．Transportation mode, such as by mail, EMS, sea or air

2.5 Recommend Spare Parts

The recommended spare parts for the gyratory crusher can be purchased according to Table 2-1.

Tab.2-1 Recommended spare parts list for the gyratory crusher (PXZ-1500II)

Description	Drawing No.
Spider bushing	G0021-7
Skeleton oil seal	G0021-16
Main shaft sleeve	G0023-6
Main shaft head nut	G0023-3
Main shaft bushing(upper and lower)	G0023-20/G0023-21
Dustproof seal ring	G0023-16
Bottom shell bushing	G0027-35
Eccentric copper bushing	G0024-6(G1)
Mantle Liner (one set)	G0022-1,4,7,11,14,21
Main shaft thrust bearing(spherical friction disk)	G0023-11
Thrust bearing shim(middle friction disk)	G0025-5
Piston wear plate (lower friction disk)	G0025-6
Hydraulic cylinder bushing (Upper·Lower)	G0025-4/G0025-25
Cylinder seal	G0025-2/G0025-3/ G0025-14/ G0025-15/ G0025-19/ G0025-20/G0025-21
Pinion shaft oil seal	Skeleton oil seal JB2600−80
All seal gaskets	Depending on actual condition
Filter element	Depending on actual condition

Note: Another complete main shaft unit can be used as standby to avoid shutdown delays.

2.6 Specification of Gyratory Crusher

PXZ-1500II is a heavy-duty gyratory crusher. The designation of the type is as shown in Figure2-4, which conforms to the standard JB/T1604.

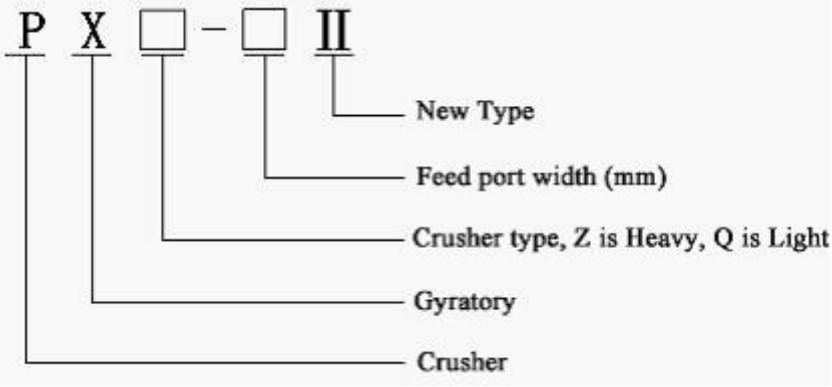


Fig. 2-4 Designation for type of gyratory crusher

Marking example：

New type of heavy gyratory crusher with a 1500mm-wide material inlet:

PXZ-1500II gyratory crusher

2.7 Recommended Feed Size

Vertically adjust the main shaft to compensate for the wear of discharge opening. 80% feed size shall be less than 2/3 of feed opening. This is suitable for primary and secondary gyratory crusher. Such feed size can prevent the blockage at the opening of spider, and make sure of uniform feed at the cavity, so as to make sure of even distribution of pressure within the crushing chamber. If the feed contains a large percentage of fines, it is best practice to remove them by screening prior to feeding to the crusher to avoid excessive wear of manganese steel liner.

2.8 Protection of Crusher Parts During Storage

During long-term storage of crusher parts, special protection shall be taken to prevent damage.

1) Large castings (middle shell, middle shell, bottom shell, ring spider, block ring, dustproof seal ring) shall be properly protected and stored indoor. They shall not be put directly on the ground but on the chock or other support. Apply antirust oil to all the machined surfaces. For further protection, fill crepe paper with oxidation inhibitor treatment in the cavities of the ring spider and bottom shell, pinion bore. In addition, seal all the openings with a glued board cover. Seal all the openings to prevent entry of dirt or water. Then wholly cover it with waterproof tarpaulin and strap it to avoid to exposure to atmosphere and ultraviolet radiation.

2) Small castings (spider bushing, thrust bearing, eccentric bushing) is best to store indoors. Apply antirust oil to all machined surface. Fill crepe paper with oxidation inhibitor treatment into box as necessary. It is important to protect the machined or polished surfaces from corrosion and physical damage.

3) Main shaft assembly shall be applied with antirust oil. If it is stored on transportation saddle, double-saddle shall be used. Apply antirust oil between main shaft and saddle. If it is stored outdoor, cover the whole assembly by waterproof tarpaulin. .

4) Pinion shaft and hydraulic cylinder assembly shall be stored indoor. Fill with antirust oil to pinion shaft assembly. Apply antirust oil to external machined surface. Ensure that there is always antirust oil covering on bearing surface. Turn shaft once a month. In order to avoid damage to air vent, it must face upward during storage. Before storage, remove oil seal of hydraulic cylinder assembly. Seal all the opening of cylinder, and fill with proper antirust oil to cylinder. Cover the opening by glued board and apply antirust oil to exposed external surface. Fill oil along the periphery of piston.

5) Hydraulic control and lubrication system—fill recommended antirust oil to hydraulic control and lubrication system, and the same oil to oil pipes. Cut off the pipe at proper position, for example, manometer. Ensure that a quantity of oil enters the pump to protect from internal corrosion. Block all the pipe openings to protect from air or moisture. If a gear reducer is supplied, fill with antirust oil. If lubrication unit is stored outdoor, cover it by waterproof tarpaulin. After filling pipes with antirust oil, ensure all open ends are sealed.

Do not store parts near high-voltage energy sources e.g. power distribution boards, arc welders or transformers.

6) Seal ring and seal washer shall become hardened without thorough heat insulation and oxidation -inhabitation protection, so that seal loses efficiency. It is recommended to replace these every eight months. As for storage, apply antirust oil as protection, wrap in oiled paper and put in cool and dry place.

7) Circular or column parts—in order to avoid deformation, use brace bar to lift bronze cylinder (except if it is fixed on backing plate). Dustproof seal parts and dustproof collar shall not be vertically but horizontally placed and stored. During storage of column parts, for example, bottom shell bushing or eccentric bushing, these shall be vertically not horizontally placed. Such parts shall be put in cases and stored indoor.

During lifting and storage, please be careful to avoid physical damage of parts. Because climate conditions are varied, please contact local supplier for proper antirust oil. Regularly check stored parts and make sure that they are intact. CITIC-HIC shall not take any responsibility for the damage caused by improper measures.

2.9 Storage of Fully Assembled Crusher

If the crusher is assembled, but trial run period delay is more than 30 days, the following steps shall be followed:

1) Use pump to fill the recommended lubrication into bottom shell cavity, until oil slightly overflows from dustproof ring. Shut off drain line and keep lubrication within the bottom shell. Shut the valve between oil tank and pump to prevent oil from returning to the tank through the drain.

2) Fill lubrication into cavity of spider bearing to prevent condensation.

3) Turn pinion shaft four and half times every two weeks. Prior to delivery the pinion shaft assembly was coated in antirust paint.

4) Apply grease to upper journal of main shaft bushing between spider and lock nut.

5) If lubrication and hydraulic pump are exposed to the atmosphere, cover with waterproof tarpaulin,

2.10 General Properties Description of Gyratory Crusher

CITIC-HIC adopts advanced design methods to manufacture gyratory crushers, with technological properties equal to internationally advanced levels for this type of crusher. Our company has undertaken optimization analysis on the structural integrity, which offers greater availability and reliability. We adopt latest technology and combined mechanical, electrical & hydraulic technics to provide closed-loop control. We can include overall monitoring on the operation of the entire machine, and provide faults diagnosis & alarm function. We adopt man-machine interface technology with visual enhancements to make operation and maintenance simple, to reduce labor strength of operators and maintenance cost.

Through improved design of components, the crusher can perform at an optimum level under harsh operating conditions, and has the function of dustproof and overload protection to make sure of its reliability to reduce maintenance cost and increase economic benefits for the user. Because of the unique cavity design profile and dynamic monitoring and adjustment control, it has the capacity to ensure high-yield and stable quality product.

2.11 Working Principle of Gyratory Crusher

This manual mainly introduces the newly designed PXZ1500II hydraulic gyratory crusher developed by CITIC HIC, making a detailed description for the structural composition, installation, dismantling, method of operation relating to the PXZ-1500II hydraulic gyratory crusher. The structural composition of the PXZ-1500II is shown in Fig.2-5; the main parts list is shown in Table 2-2; the performance parameter is shown in Table 2-3; and the Chinese and English description of the main parts is shown in Table 2-4.

The working principle of the PXZ1500II is as follows: the drive motor supplies power and transfers this power to the bevel gear through the pinion drive shaft; the large bevel gear and the eccentric bushing are keyed to make the eccentric bushing rotate. The main shaft is inserted into the bore of the inner eccentric bush (sleeve), the inner eccentric bush (sleeve) is keyed to the eccentric bush to allow eccentric rotation of the main shaft which is supported by thrust bearings. The rotation of the eccentric bushing causes the main shaft to gyrate. The rotational gyration of the crusher's main shaft causes the mantle to come into close proximity of the concave. This creates a constant crushing zone between the mantle and concave as the main shaft rotates. Once

the material has been crushed to a nominal size smaller than the discharge setting ， it will exit the crusher due to gravity.The working principle of gyratory crusher is to break the material through the continuous rotation of crushing head so the crusher of this type has a higher productivity and a more reliable and steady operation than the jaw breaker.

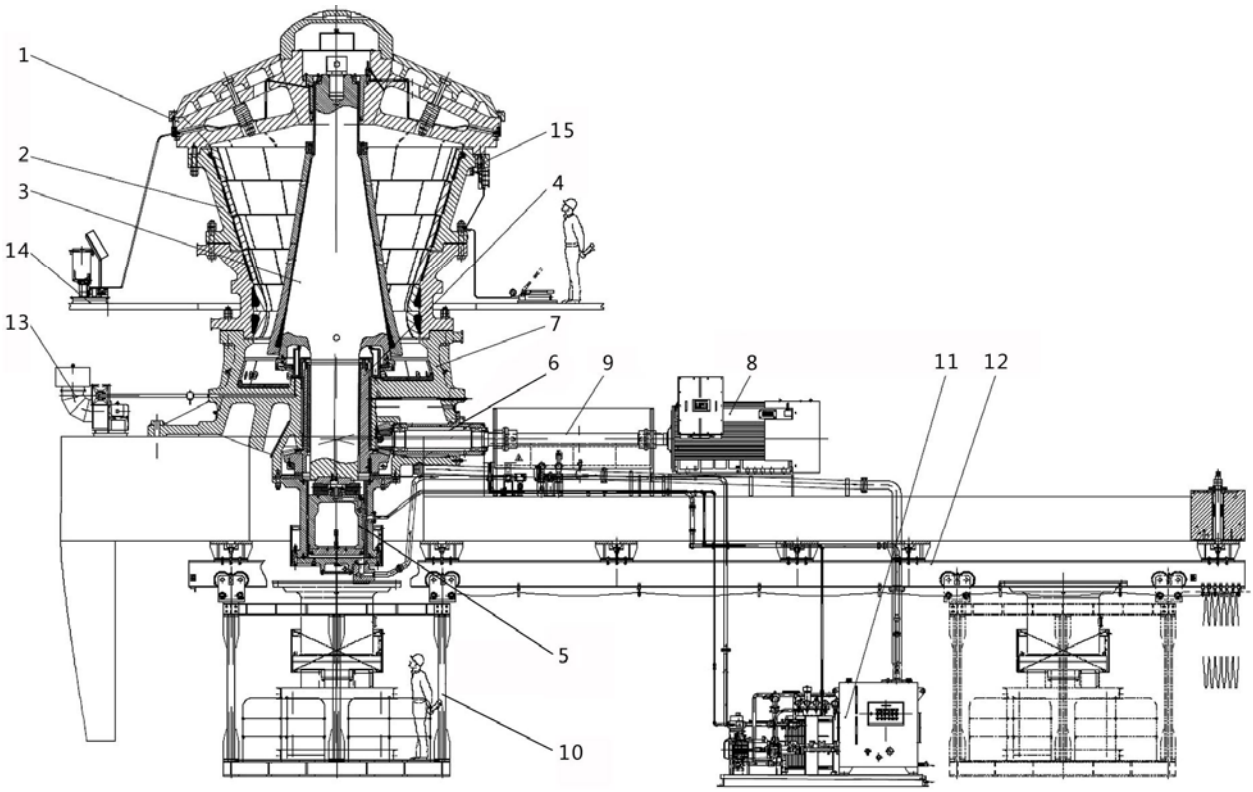


Fig. 2-5 Structure and layout of PXZ-1500II gyratory crusher

Tab. 2-2 Main parts list of PXZ-1500II gyratory crusher

No.	Dwg No.	Name	No.	Dwg No.	Name
1	G0021	Spider assembly	10	G00210	Service pulley assembly
2	G0022	Middle shell assembly	11	E363	Hydraulic lubrication station
3	G0023	Crushing cone assembly	12	G00211	Foundation assembly
4	G0024	Eccentric bushing assembly	13	G00212	Fan unit
5	G0025	Hydraulic cylinder assembly	14	G00213	Grease lubrication station
6	G0026	Drive assembly	15	G00214	Spider disassembly device
7	G0027	Bottom shell assembly	16	DG002	Electrical parts
8	G0028	Motor assembly	17	G00215	Name plate
9	G0029	Drive shaft assembly			

Tab. 2-3 Technical specification of PXZ-1500II

Crusher Spec.	Approximate Weight of standard configuration (kg)									
	Total Weight	Spider unit	Middle shell	Crushing cone	Eccentric bushing unit	Cylinder unit	Drive unit	Bottom shell unit	Drive shaft unit	Motor unit
PXZ-1500II	378143	71703	111298	62409	9870	13082	2703	76253	2239	12978

Crusher Spec.	Standard eccentric distance (mm)	Motor power (kW)	Swing per minute	Pinion shaft				Pitch backlash classification
				Rotary speed (RPM)	D.A of drive end (mm)	Key slot W×D	Extension of drive end	
PXZ-1500II	25～49	630	149	600	Φ220	50×17	343.5	C

Crusher spec.	Feed size (mm)	Close side setting (max) mm	Max. allowable lifting height of main shaft with wear mantle (mm)	Piston oil flow (min) mm	Hydraulic pump			Main shaft thrust bearing			
					Output pressure (max): MPa	Motor power (kW)	Working Pressure (MPa)	New bearing O.D thickness	Allowable wear (mm)	New bearing thickness	Total wear of thrust bearing
PXZ-1500 II	1500	230	210	50	5	11	1.0～1.3	54. 6	10	110	25

Crusher spec.	Tank capacity		Lubrication pump			Oil filter size (μm)	Water cooler		Air radiator			Spider oil tank (L)
	Lube (L)	hydraulic oil (L)	Output (L/min)	Motor power (kW)	Nominal pressure (MPa)		Cooling area	Cooling capacity	Fan power	Speed	Air flow	
PXZ-1500II	3200	1200	250	7.5	1.0	40	Depending on the site condition					36

Tab.2-4 Main Parts List (English)

Bottom shell assembly	**Eccentric bushing assembly**
Bottom shell	Eccentric
Pinion shaft arm liner	Eccentric bushing
Frame Arm liner	Top counterweight
Bottom shell bushing	Top counterweight ring
Bottom shell bushing key	Bottom counterweight
Bottom hub liner	Eccentric bushing key
Side liner	Eccentric gear
Dustproof collar	Eccentric gear key
Dustproof ring washer	Eccentric wearing plate
	Eccentric support plate
Hydraulic cylinder assembly	**Drive assembly （Pinion shaft assembly）**
Hydraulic cylinder	Pinion shaft bushing
Hydraulic cylinder bolt	Pinion
Hydraulic cylinder top bushing	Pinion shaft bearing（pinion end）
Hydraulic cylinder bottom bushing	Pinion shaft bearing（drive end）
Hydraulic cylinder O ring	Labyrinth seal
Hydraulic piston	Pinion shaft
Thrust bearing washer	Pinion shaft key
Piston wearing plate	Pinion shaft key (drive end)
Hydraulic cylinder cover	Pinion shaft block ring
“O”ring	

Position indicator	
Main shaft assembly	**Upper shell and lower shell (middle shell assembly)**
Main shaft	Upper shell
Main shaft bushing	Lower shell
Main shaft locknut	Concave segments
Main shaft bushing lock washer	Concave lock
Main shaft thrust bearing	Epoxy backing
Upper mantle	Support ring
Lower mantle	
Liner (mantle or concave)	
Locknut	
Locknut pin	
Dustproof seal ring	
Top dust proof retaining ring	
Bottom dust proof retaining ring	
Spider assembly	**Other parts**
Spider	Bolt
Spider cap	Nut
Spider bushing	Washer
Spider bushing seal	Spring
Spider vent cover	Screw
Spider edge liner	
Spider arm liner	
Spring	

Section 3 Installation of Gyratory Crusher

3.1 Points for Attention in Erection

3.1.1 Requirement of Foundation

An erection drawing of main parts and components for volume and weight will be supplied with each crusher. A crane is required to be located near the crusher for service and maintenance requirements. Ensure there is enough space under the crusher to remove the hydraulic cylinder, eccentric bushing and pinion shaft when constructing the equipment foundation.

The foundation is always designed by customer, contractor or CITIC-HIC can provide this service if required. CITIC-HIC can arrange the design and working performance of the crusher, alternatively CITIC-HIC can also produce general crusher layout GA drawings with foundation, work space requirements and feeding arrangement.

The following regulations must be observed：

3.1.2 Soil for Crusher Foundation

1) The foundation geotechnical should meet and conform to the requirements of the “Cone Penetrometer Testing” method or other recognised soil property tests.

2) The foundation must be prepared to suit the geotechnical conditions.

3) The foundations are to be designed and built by a qualified CIVIL engineering company. Ensure recommended concrete strength and reinforced steel bar meet ISO standards.

3.1.3 Crusher Feeding Arrangement

The correct feeding arrangement is required to minimize the impact of large rocks directly onto the rim liners and spider cap. This avoidance will improve the service life of mechanical components.

Uneven feeding may make large amount of stones into one side of the crushing cavity, not fill the whole cavity, or the coarse or fine stones may separate into the different parts of the cavity.the following conditions may lead to:

1) The hydraulic regulating system to generate a higher hydraulic impact force, leading to premature excessive wear of the manganese liners and damage of mechanical component .

2) uneven or over-quick wear of local Concave segments may lead to uneven product size and the reduction of the service life of crushing surface.

3) If fully breakage in the 360° cavity is not achieved, the output of the crusher may reduce.it is of great importance to make stones evenly distributed in the cavity with minimum impact.

Besides , it is also important for the dump truck to discharge along the spider from the two sides of material pit to make the material over the spider arm.

3.1.4 Appropriate Feeding Arrangement

NOTE: The correct orientation of the crusher when installed in the dump hopper is to have the spider arms in line with both the dump zones to protect the main shaft and ensuring even distribution of the feed material.

The feed pocket which is above the spider arms should direct the feed rock into a buffer zone which is formed by the rock and fines, so as not to fall directly into the crushing cavity.

The tipped feed rocks must not impact the spider cap and shaft directly.

If large rocks falls directly into the crushing chamber, will cause a high impact load to the crusher liners and components, which will also cause undue heavy impact to the main shaft.

Another advantage of a proper feeding arrangement is improving the wear service life for crusher's mantle and concave liners and spider and bottom shell bushes.

The effect of uneven feed or one sided feed will be to grind an ellipse in the spider bush and bottom shell bushes.

When designing the discharge chute size for the primary crusher, it is recommended to allow for the maximum capacity of the tip trucks. The rock will first drop to the buffer zone; than slide into crushing cavity, so the impact is minimal.

3.1.5 Effect of Large Dump Trucks

In modern crushing plants, the stone discharge angle and the association between the tip discharge point and the large rock impact point by increasing the size of the dump truck and pocket capacity will be changed proportionately. In recent years and because of economical reasons re: opencast pit mining, larger dump trucks are gradually replacing the small tip trucks.

The following are the methods for modifying existing dump hoppers to avoid problems created by larger dump trucks.

1) Moving the dump truck stops back a suitable distance on both sides of the dump hopper will move the discharge impact point further away from the crusher. This is particularly suitable for multi-functional dump trucks.

2) If big and small dump trucks are to be used at the same time; an alternate discharge pattern needs to be applied. The small tip truck will discharge on one side and the bigger dump truck will discharge from the other side. Dump truck stops will need to be located according to truck size and dump points within the dump hopper.

3.1.6 Arrangement of Crusher Discharge Outlet

At the bottom of the crusher, a discharge storage hopper or rock box which can store two truckloads of material at least is required. If the discharge belt stops operating, the storage hopper could evacuate the crushing cavity.

A feeder should be installed between the discharge storage hopper and belt, thus adjusting the discharge rate and eliminate discharge impact on the belt.（or apply the slide chute discharge system based on the actual conditions.）

3.1.7 Air Dust Seal

The crusher has an air inlet pipe which is connecting the pressurised air and oil chamber. The pipe is located at a frame beam of the bottom shell. The positive pressure air in the oil seal chamber helps to expel dust and prevent contamination of the oil. The over pressure air is supplied either from an air-blower or an air compressor.

See fig.3-1 for the installation instruction for the air dust seal device of PXZ-1500II.

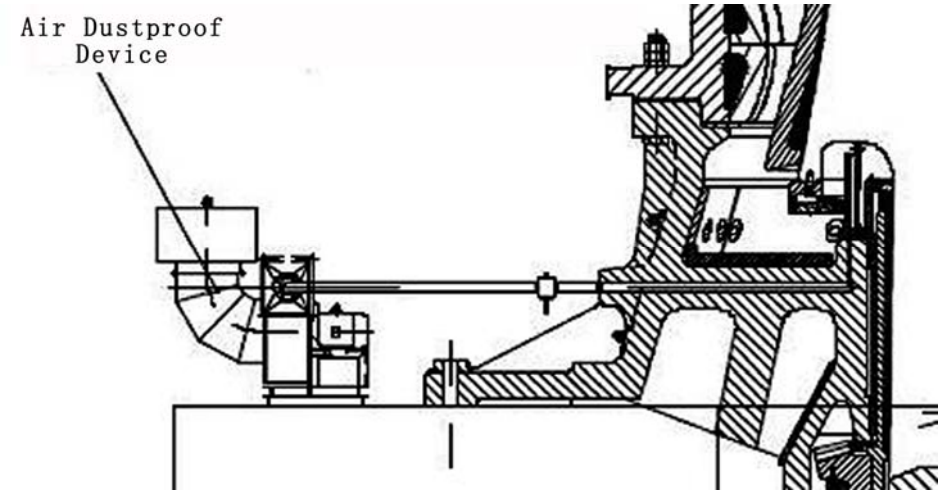


Fig. 3-1 Installation of air dust seal device of PXZ-1500II

3.1.8 Driving Device of Crusher

The pinion shaft of heavy gyratory crusher drives a spiral bevel gear and pinion and is enclosed in a housing which is extending from the bottom shell. The driving force is usually provided by an electric motor.

Please refer to *section 2 - Table 2-4 general technical specification table* : pinion shaft rotational speed and maximum recommend power.

The direct drive comprises a floating shaft (cardan type) which is mounted between the motor and pinion shaft so the pinion shaft can be removed without dismantling the motor.

It is suggested to use a wound rotor induction type motor because of its greater starting torque. If the power supply suits the high initiation starting current, then the squirrel cage induction motor can also be chosen.

3.2 Installation of Crusher

3.2.1 General Instruction

The crusher components will be subject to very high loads during the operation including the bearings. So all care must be taken at the time of assembly, to make sure of the correct centering, and the supply of enough, clean and pollution-free lubricating oil to the operating components. Proper erection procedures and implementing a good maintenance program during the operation will guarantee bearing surfaces remain free of dirt and dust contaminants.

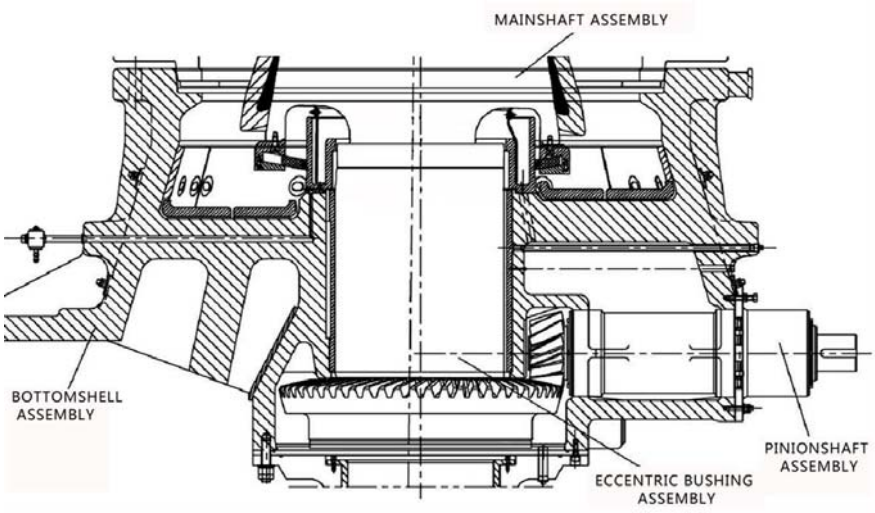


Fig.3-2 Assembly details of bottom shell, main shaft, eccentric bushing and pinion shaft drive for gyratory crusher PXZ-1500II

All pipes require thorough cleaning before assembly and tightening. Completely check the lubricant oil circuit and remove all corrosion or filth before erection. Clean and remove all the preservative oil by pickling. Also finish any slightly damaged machined part in order to get a proper match at the time of assembly.

Sub-assembly drawing 3-2 indicating assembly details of bottom shell, main shaft, eccentric bushing and transmission drive for the gyratory crusher PXZ-1500II.

3.2.2 Installation of the Bottom Shell

1) If the gyratory crusher is mounted on a concrete foundation, it is necessary to grout the lower frame onto the foundation. Stainless steel shim plates should be located in the four corners adjacent to the foundation bolts. The thickness and shim size is based on the actual installation finished height. First level the shims in both directions. Form work is required to retain the grout while being poured. Thus the shim plate surface becomes the machine datum plane.

2) The bottom shell of the crusher must be vertical to the foundation, which is checked according to the position of center line of the internal bore hole and jointing flange.

3) A proper gap shall be kept between the bottom shell mounting flange and the top of the foundation in order to pour the grout. Internal and external form work is required to retain the

grout while being poured.

4) After the grouting has solidified, torque the foundation bolts to the recommended values after all the grout has properly hardened.

5) Follow the recommendations of the concrete manufacturer during the preparation and erection. It is very important to keep the crusher level in two directions. The qualified civil engineer shall supply the requirements and design of the foundation.

6) When Customers are required to supply the correct foundation bolts. A qualified structural engineer's recommendations on bolt Grade is to be specified for this application. Bolts will also have a suitable thread length to accommodate the bottom shell flange, a structural washer, two (2) nuts and the base plate.

3.2.3 Assembling the Eccentric Bushing

Please refer eccentric bushing section for details relating to assembly. The eccentric bushing should be put on the wear-resisting plate and orientated with the eccentric backup plate. Seal the seam between base and eccentric backup plate with the "O" ring supplied.

The following is the erection steps for crusher eccentric bushing:

1) Put the eccentric backup plate on the sliding car and align the oil drain hole to the hole on the hydraulic cylinder flange. Install the wear-resisting plate and backup plate "O" ring on the backup plate and then install the eccentric bushing on the wear-resisting plate.

2) There is a movable trolley for the eccentric bushing, which has a hydraulic lifting device used to remove and replace the eccentric bushing.

3) Lift the eccentric bushing up to the mounting position using either the adjusting screw rod or hydraulic lifting device.

4) Fix the backup plate to the lower shell with the bolts and lock washers.

3.2.4 Assembly the Hydraulic Cylinder

The cylinder assembly should then be bolted to the bottom shell (refer details in cylinder section. For the assembly details of oil cylinder of PXZ-1500II gyratory crusher refer to Fig. 3-3.

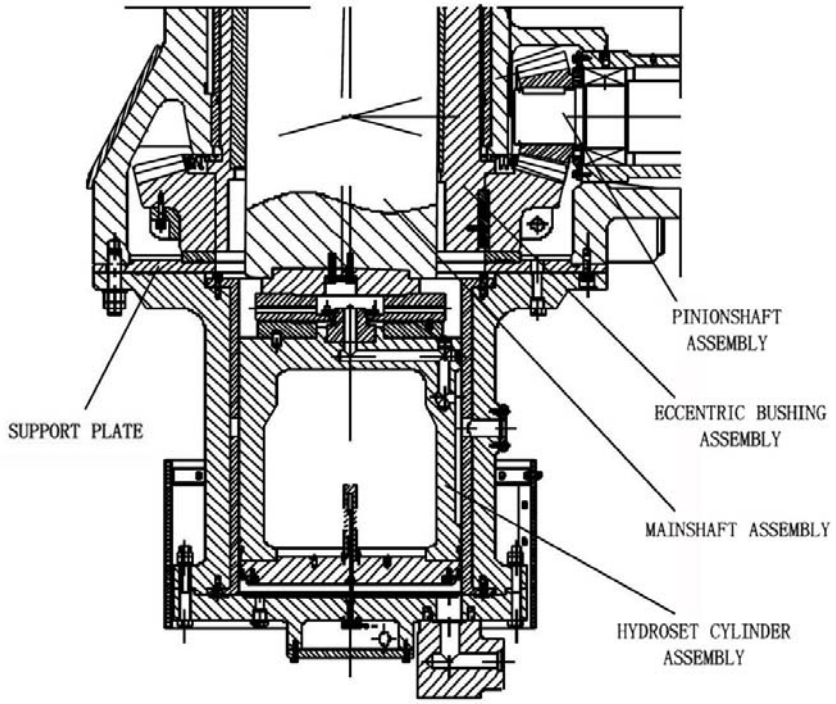


Fig.3-3 PXZ-1500II gyratory crusher cylinder assembly drawing

The following is the erection steps for crusher hydraulic cylinder：

1) Place the cylinder on the sliding trolley, then move the trolley to the underside of the bottom shell and make sure the base plate's oil drain port is being aligned to the frame oil drain hole. Check the erection position of the piston wear plate and thrust bearing washer. Clean the “O” ring groove and the top of cylinder surface. Inserting the “O” ring seal into the ring groove.

2) Lift the cylinder assembly to the installation position with the hydraulic platform or adjusting screw rods, applying a hydraulic jack to assist with fitting the locking nut, then tighten it and make sure there is no oil leakage.

3) Fix the bolt studs, nuts and locknuts, and then tighten securely to prevent seepage.

4) Remove the cover and select the available socket head cap screw and lock washer, install the feed bin level indicator in the crusher (optional by user). It should be connected to the power supply when installing the indicator.

5) Be careful to protect the lubrication and hydraulic oil pipes to avoid impact damage by rocks. The customer will provide the protection guards.

3.2.5 Assembling the Pinion Shaft Drive Assembly

The pinion shaft drive parts have been assembled prior the shipment; therefore this assembly can be directly installed into the bottom shell. For assembly of the bottom shell and pinion shaft drive details for gyratory crusher PXZ-1500II refer to Fig 3-4. When the crusher drive is completely assembled then inspect and adjust gear and pinion for backlash gap and correct

contact and for details of these values refer to section 6 "pinion shaft assembly".

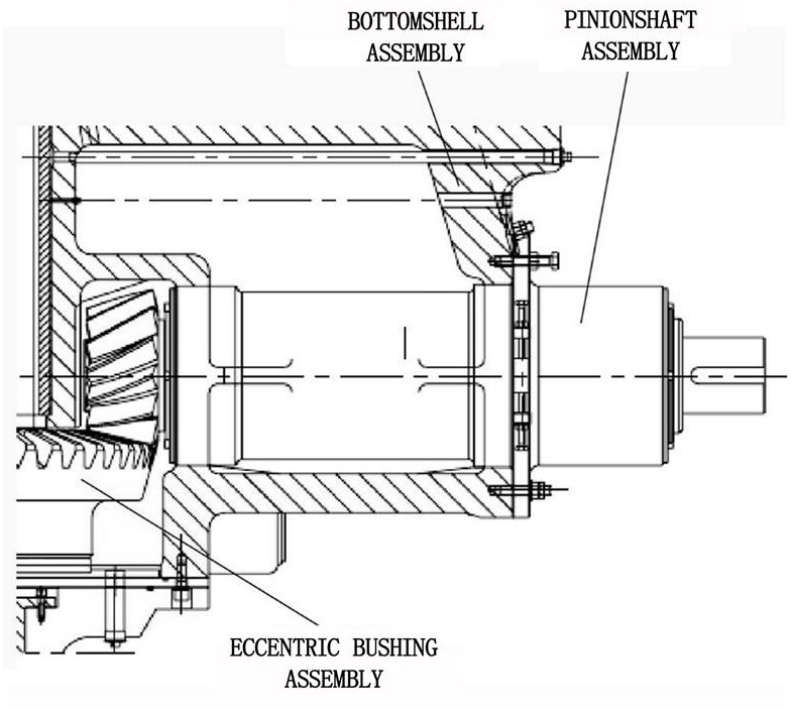


Fig. 3-4 Assembly of the Pinion Shaft and bottom shell for gyratory crusher PXZ-1500II

3.2.6 Assembling the Main Shaft

The main shaft includes shaft, main shaft bushing, main shaft sleeve, mantle, locking nut, thrust bearing, dust ring, retaining ring and lifting lug. Please see the section 7 about details, such as the appropriate installation.

Remove the dust seal components before installing the main shaft. Carefully check and clean the dust seal and its seat retainer, making sure the seal ring can move freely in the seat retainer after installation. The main shaft lifting lug has been installed at the factory. So it is not necessary to remove after installation. It must be checked to make sure the lug has been already fully tightened before lifting and installing the main shaft. It is necessary to fit a suitable shackle between the main shaft lug and crane lifting hook.

3.2.7 Assembly of Middle Shell

Check the taper fit spigot condition between the lower frame and bottom shell. Remove any burrs, marks, rust or dirt on the contact surface. Apply oil on the lower frame taper fit and flange. Do not apply white lead which will cause inconvenience for later dismantling of the middle shell after it sets.

Gyratory crusher PXZ-1500II incorporates a middle shell which is constructed to join the top and bottom shells together via taper fitting spigot flanges; Details please refer to Chapter 8 “Middle shell Assembly".

Ensure the concave liner support ring is in place, it should keep the lower frame level. It is fitted to the machine finished taper fit point. Keep level so that the connecting flanges are parallel when bolting together. The flange joint has a slight interference taper fit. For PXZ-1500II, there should be a 1～4mm gap between the upper and lower flanges on middle shell frame before tightening up.

First tighten up the two wedges which are located 180 degrees apart and ensure the flange gap is equal. Then tighten up the two wedges which are located 90 degrees apart to the preceding two wedges, and make sure there is an equal gap between the upper and lower frame. Then fasten the remaining wedges with the same torque alternately. Go on fastening the wedge with same order and turns to ensure that the gap between flange surfaces is evenly diminished until a 0.10mm feeler gauge cannot be inserted at any point in the flange circumference.

If the gap does not fully close after all the bolts have been torqued may indicate slight misalignment or foreign material between the spigot faces. It would be necessary to separate the two shell frames and check for any material between the spigot faces and alignment.

3.2.8 Installation of the Middle Shell Liner

There is a cavity behind the lower concave liners of middle shell . To save zinc or epoxy resin backing material, this cavity can be filled with cement mortar, which contains 75% sand and 25% cement. The ribs shall be welded crosswise between the liner and the cavity to prevent the cement mortar from falling off. The cement mortar must be solidified and dried naturally. Note that excessive moisture will influence the solidification and strength of epoxy resin.

Warning!! If the molten zinc makes contact with moisture it will cause an explosion and cause human injuries. So it is necessary to fully clean the inside of the shell frames and the back of the concaves to make sure they are dry.

Note: At the time of applying the epoxy resin or zinc backing, oil should be smeared on the backing surface of the shell frames for easy removal. Do not apply oil or mould releasing agent when using zinc backing

At the time of applying epoxy resin backing, do not smear any mould releasing agent or oil-base sealant on the back of the concave liners; otherwise it will cause the liner to loosen and move during crushing. This is because the thickness of the backing is difficult to control. The vertical gap between the bottom concave liner plates shall be approx.10mm up to a maximum of 16mm. Fit and locate a spacer between the joints at approx. half the thickness of the concave.

Prior to pouring the backing ,one way to fix the concave liner of middle shell is to use steel ring

and knock in wedges behind the steel ring; the other way is to fix with sticks or dry sand.

Fill the gap between the liners in order to prevent the hot zinc or epoxy resin flowing out. If zinc is used, Babbit or equivalent sealing battens should be used to seal the joint of the concave and the backing board.

If using the epoxy resin backing, it is best to finish the complete installation of the same row of concaves and backing. Each pouring backing height shall be 3/4 of the liner height in order to avoid having the repeated seam at the same place due to the multiple pouring. It is necessary to be very careful if applying the epoxy resin or zinc. The molten zinc cannot blend with formed solidified zinc. The zinc should be evenly poured along the entire circumference to avoid porosity after the zinc cools. Then proceed to install the next concave row by the same procedure until all concave rows have been installed.

Always apply the special precautionary measures when installing and maintaining the manganese steel liner. Hard and non-abrasive rocks can cause the manganese metal to deform due to the lack of hardening of the manganese.

If allowed to go on working, the deformed metal will make the liner completely expand causing the middle shell to fracture.

In order to prevent this condition arising, the vertical seam width can be increased to 16mm between the concave liner segments. Because there can be a possibility of the liners becoming dislodged, usually 16mm is the maximum gap allowed between the concave liners. If the gap is increased then it may be necessary to trim the two sides of locking liner to make it suit with the available circumferential space.

The deformation/expansion of the concave segments requires continual monitoring during the initial operation period of a new crusher.

As noted the deformation/expansion of the concave segments can cause serious damage to the crusher. The solution is: regularly cut off the edge of perpendicular and horizontal joint with acetylene torch to avoid the middle shell being affected by the expansion of the concave manganese segments. The segments may require regular trimming of the vertical and horizontal edges to ensure deformation expansion does not cause damage to the top, middle or bottom shells or shell separation.

3.2.9 Assembly of the Spider Assembly

The spider is installed after installing the gyratory crusher's middle shell and crushing cone (main shaft assembly). The main components include the spider ring, spider bush and seal, spider cap, spider arm guard and rim liners.

Completely clean the top of main shaft sleeve and shaft as well as spider center bore. Check the taper matching spigot surfaces between the spider rim and middle shell. Remove any burrs,

marks, rust and dirt on the contact surfaces. Smear oil between the two matching spigot surfaces. Do not use white lead which will be harden and lead to inconvenience when separating spider rim from the middle shell.

At the time of lifting the spider rim it should be kept on the horizontal plane and fitted over the main shaft sleeve, then lowered onto the middle shell, aligning the spigots of the middle shell and spider rim. Ensure the spider rim is level when making contact with the middle shell spigot and bolt holes are aligned. The flange junction shall have a slight interference taper fit. There should be a 1 - 4 mm gap between the spider rim and middle shell flanges prior to torqueing to recommended values.

When tightening the bolts, tighten up the two bolts which are separated by 180 degree and ensure the gap between flange faces of spider and middle shell is equal. Then tighten up another two bolts which are located 90 degrees away from the preceding two bolts, and make sure there is an equal gap between the flange faces of middle and bottom shell. Then fasten the remaining bolts to the same torque value alternately. Continue tighten the fixing bolts in the recommended sequence to ensure that the gap between flange surfaces is evenly lessened until the 0.10mm feeler gauge cannot be inserted at any point in the flange circumference.

Check the oil seal of spider bushing, which has been pressed into the counter bore in the bottom of the spider housing. Place the spider bushing in the center bore of the spider and there is a gap between the flange lower surface and spider top surface. Fix the bush-type flange tightly on the spider with fastening bolts and the bolts should be tightened uniformly to avoid the inclination or rotation of spider bushing in center bore.

3.3 Check Before First Operation of the Crusher

After the completion of general assembly for the first time, the following check shall be carried out before starting up, so as to ensure normal start and operation.

Tab.3-1 Check items after the completion of general assembly and before starting up of the crusher

Check parts	Check contents	Check position
Main shaft assembly	Check whether the main shaft bushing is assembled in position	shaft head and bushing on top of the main shaft
	Check whether the clamp nut of the main shaft bushing is locked and the stop circlip bolt is fastened in advance	Top of the shaft bushing of the main shaft
	Check whether the lock nut fixing the bush (liner) of the main shaft is locked, the circlip is assembled in position and the screw is fastened in advance	Top of the shaft bushing of the main shaft
	Check whether the upper support ring and lower support ring on the lower end of the larger end of the main shaft are fastened, the dust ring is assembled in position and ensure that the clearance inside the chamber formed by the dust	Lower part of the larger end of the cone of the main shaft

	ring between the upper and lower support ring is over 2mm.	
	Check whether the grease-proof rubber ring is assembled in position, whether it is assembled as per the reformed dimension and whether it is assembled firmly.	Lower part of the larger end of the cone of the main shaft
	Check whether the spherical friction disk of the main shaft is assembled in position and the fastener fixing the friction disk is fastened	Shaft head on the lower end of the main shaft
Spider assembly	Check whether the bolt of the spider bushing is fastened in advance. Recheck after running for some time.	Liner of the spider ring and the spider arm
	There shall be clearance between the push ring flange and spider hub of the spider oscillating bearing assembly, which shall not be under 0.5mm. The recommended bolt pre-tightening load is 500～686N·m.	Spider taper bushing flange
	When assembling the spider oscillating bearing assembly, make sure that the lubricating oil port of the spider and the oil groove on the external surface of the steel bushing of the spider are center aligned	Taper bushing and lubricating hole of the spider
	Check whether the sealing on the lower end of the support ring of the spider is assembled in position and the position of the lip is correct	Seal groove on the lower end of the taper bushing of the spider
	Take grease lubricating exam, check whether the oil circuit is unblocked and the seal for oil pipe joints is qualified	Grease circuit of the spider
	Check whether the oil level gauge of the spider is working normally	Top of the taper bushing flange of the spider
	Before hooding the spider, ensure that there's no impurity inside the chamber. Meanwhile, cover the internal wall of the taper bushing of the spider with lubricating grease	Internal chamber of the taper bushing of the spider
Middle shell assembly	Ensure that the joint bolts of spider and the middle shell unit, the middle shell unit and the bottom shell are bolted firmly, check whether the pre-tightening load is enough. Recheck after running for some time.	Flange bolts between shells
	Check whether the liner and the middle shell unit is loose	Internal chamber of the middle shell unit
Eccentric bushing assembly	Check whether the lower balance bolt is fastened	Underneath of the large gear flank
	Check whether the upper balance bolt is fastened	Upper part of the eccentric steel bushing
	The eccentric copper bushing has been assembled in place in the eccentric steel bushing, see whether the lower end of copper bushing and the spigot of the eccentric steel bushing gain contact	Eccentric steel bushing, eccentric copper bushing
	Check whether the large gear is assembled in position	Eccentric steel bushing, large gear
	Clean up before assembling, ensure that there's no impurity and foreign matters	

Bottom shell assembly	Recheck whether the bolts of bottom shell ring liner is fastened	Bottom shell ring liner
	Check whether the air intake of the bottom shell is unblocked without any foreign matters	180° position of the drive hole of the bottom shell
	Check whether the copper bushing of the bottom shell is assembled in position	Bottom shell copper bushing
	Check whether the lubricating circuit of the bottom shell is unblocked and the pipeline is clean	Top of the drive hole
	Before assembling the eccentric copper bushing, drive unit and hydraulic cylinder unit, reconfirm all the lubricating chambers and the lubricated surfaces are clean. Impurities and dirts are not allowed, especially inside the copper bushing hole and the gear chamber of the bottom shell.	Lubricating chamber
Drive assembly	Verify whether the assembling position of each part of the drive unit is correct	Every part of the drive unit
	Ensure that the fasteners of drive unit are tightened firmly	Fixing of each part of the drive unit
	Recheck the gear backlash and notify the manufacturer to confirm	Bull gear and pinion
Hydraulic cylinder assembly	Check whether the bolts on the bottom of the cylinder are pre-tightened	Bottom of the oil cylinder
	Check whether the upper and lower liner bushing of the oil cylinder are assembled in position, whether their fastening bolts are assembled in position	Upper and lower copper bushing of the oil cylinder
	Check whether the sealing of the plunger of the cylinder is assembled in position and the position is correct	Oil seal on the plunger
	Check whether the lower friction disc is fixed in position	Upper part of the plunger and lower part of the middle friction disc
	Check whether the middle friction disc is assembled in position, position limiting piece of the middle friction disc and the retaining ring for the axle are assembled in position	Middle friction disc
	Check whether the position of the displacement transducer is correct and the fastener is firm	Middle part of the cylinder bottom
	Check whether the hydraulic and lubricating oil chamber are clean without impurity and foreign matters	Hydraulic oil, lubricating oil chamber
	Check whether the oil circuit is unblocked and clean	Lubricating, hydraulic oil circuit
Coupling assembly	Make sure the installation dimension of the coupling is correct	Coupling on the motor end and coupling on the drive end
	Measure the concentricity of the coupling, confirm correct, while ensuring the couplings on motor end and the drive end are concentric, record and report the manufacturer to confirm	Connecting shaft, coupling on the motor end and coupling on the drive end
Motor assembly	Check whether the installation position of the motor is correct, adjust alignment in position, and reverify the pre-tightening of the bolts connecting the motor and the motor base	Motor installation

Overall assembly	Check whether the shells are assembled in position	Between shells
	Check whether the O ring between the bottom shell and the oil cylinder is assembled in position, ensure no leakage	Between bottom shell and the oil cylinder
	After assembling the main shaft, ensure that the oil-proof rubber ring and dust ring of the main shaft are assembled in position	Lower part of larger end of the main shaft cone
	The main shaft and the taper bushing of the spider has no wear after assembling the main shaft. Measure the clearance between the main shaft and the taper bushing of the spider	Between the taper bushing of the spider and the main shaft bushing
	Check the gear backlash of large and small gear	Large and small gear
	Check whether the lubrication and hydraulic system pipeline are assembled in place, pipes are unblocked without foreign matters (including grease lubrication system)	Hydraulic lubrication circuit system
Preparation before start-up	Take the lubrication test, adjust the pressure and flow rate ratio, check the sealing condition of the lubrication system	Hydraulic lubrication station
	When the lubricating system is turned on, have a function test for the hydraulic system when the main motor stop running, lift and lower the new placed main shaft for more than three times, ensure that the main shaft run to the correct position, raise 200mm each time, and check the condition of the hydraulic system, whether there is abnormal leakage. After completion of three lifting, check whether the main shaft has abnormal position change or wear	
	After completion of the two works before start-up, the lubrication system is running in normal operation, the lubricating oil return is normal, and the lubricating oil has no anomalies such as impurities. Then start the hydraulic system, lift the main shaft to 50mm or higher (not lower than 50mm), if there is no anomalies, the machine can be started.	

Section 4 Bottom Shell Assembly

4.1 Structure and Assembly

The bottom shell, a main part of the crusher, is fixed to the foundation by anchor bolts. The eccentric bushing rotates in the copper bushing located in the main central hub bore of the bottom shell. There are two hub frame arms which join the hub to the inner wall of the bottom shell together with a pinion shaft housing the pinion shaft. These arms are fitted with replaceable manganese steel hub and bottom shell arm liners which protect the casting against impact damage and wear to the bottom shell casting components.

The bottom shell assembly forms the base structure which is mounted onto the foundation and includes the bottom shell, bottom shell guard plate, rib guard plate, pinion shaft guard plate, bottom shell bushing and dustproof cover etc.

Details for the bottom shell assembly of gyratory crusher PXZ-1500II refer to Fig 4-1 and Table 4-1 below.

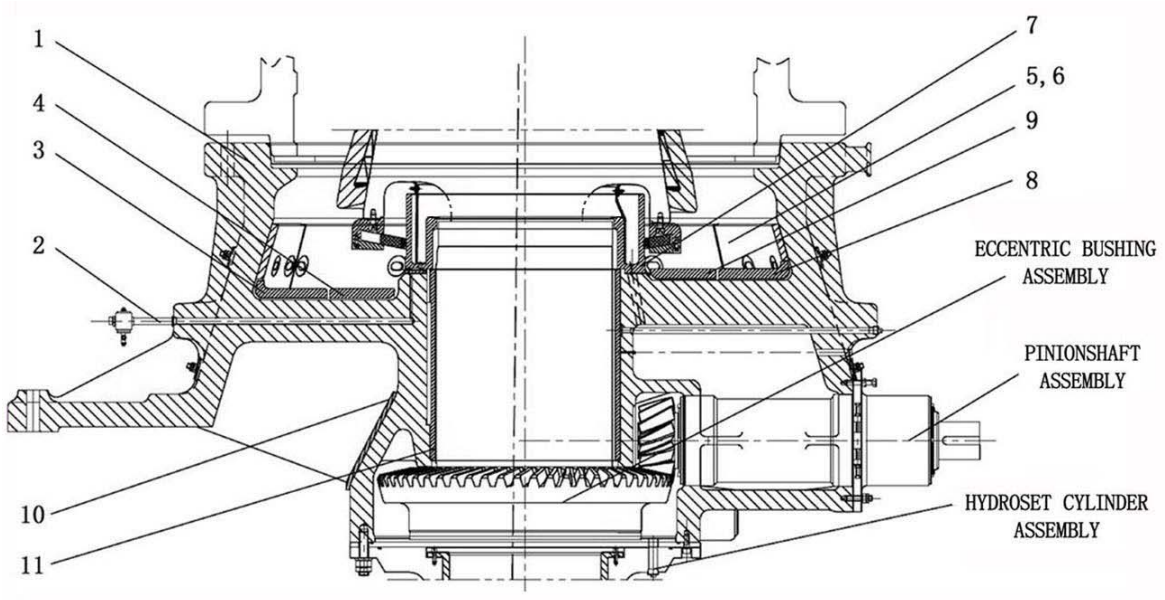


Fig. 4-1 Bottom shell structure of PXZ-1500II gyratory crusher

Tab. 4-1 PXZ-1500II gyratory crusher bottom shell components list

No.	Part No.	Description	No.	Part No.	Description
1	G0027-1P	Bottom shell Assembly	7	G0027-31	Anti-dust ring
2	G0027-8	Air feed pipe	8	G0027-33	Auxiliary shaft liner (Pinion shaft liner) (1#)
3	G0027-9	Arm Liner (1#)	9	G0027-34	Auxiliary shaft liner (Pinion shaft liner) (2#)
4	G0027-10	Arm Liner (2#)	10	G0027-3P	Hub liner
5	G0027-11P	Ring liner (Upper)	11	G0027-35	Bottom shell bushing
6	G0027-19P	Ring liner (Lower)			

Anti-dust ring is a press fit into the bottom shell hub. Anti-dust ring is drilled on its inner side for bolting onto the bottom shell; disassemble the anti-dust ring and the seal pad from the bottom shell. Dismantle the anti-dust ring which is press fitted into the bottom shell by using the jacking

bolts fitted into the pre-drilled and threaded holes. Carefully install the seal pad for reassembling. The larger hole located on seal pad should be aligned to the spill ports of bottom shell and anti-dust ring.

The bottom shell bushing, made of bronze, is fixed in the inner hole of bottom shell through direct keys .The bottom shell bushing can be installed and removed from above after spider rim, main shaft, anti-dust ring and the eccentric bushing are removed or prior to assembling. The bushing and bottom shell are of interference fit, so it requires cooling for approximately 2 hours in a special vessel using dry ice. The bushing should be installed into the bottom shell as quickly as possible after cooling to the required temperature.

In case of a bearing fault of the bushing , lift it out with the crane and lug supplied. Under normal conditions, the cold-fitted bushing and bottom shell are of interference fit, so it is easy to disassemble. however , if it is seriously worn and difficult to disassemble, the bushing can be disassembled into two halves by using the method of flame cutting and lift respectively. For the flame cutting, the bushing to bu cut must be fixed to ensure the safety of the operator.

There must be a cross bracing rod fitted to the hook on the lug between two ropes, which will avoid the rope tension breaking the top of the bush. The lug is relatively small, so the applied pulling force cannot be excessive.

If the bushing can be removed by lifting ,the following methods can be used :

1) Glued board can be used to seal the bottom section of the bush and it can be shrunk by pouring dry ice powder into the internal cavity and then removed by the crane.

2) A steel plate or beam placed at the bottom of the bush can be pushed out by a jack placed on the bolster below the crusher assisted by the overhead crane.

Internal bore of the bottom shell hub should be checked before assembling a new bush. The internal wall must be comparatively smooth with both a good roundness and no taper. All the burrs and the projections should be removed. The bush marked with "top" should be placed up. If assembled upside down, oil hole of the bush will not align to the oil groove ring on the bottom shell, therefore the lube oil flowing into the eccentric shaft and eccentric bushing will be greatly reduced affecting the lubricating efficiency between the bushing and eccentric.

Put the bushing with assembled keys into the fridge or place very fine dry ice powder into the center bore. For the use of dry ice , cover with thermal insulation blanket or canvas. 2 hours later, it is easy to fit it into the center bore of the bottom shell. The reason for cooling the bushing is :although it and the center bore of bottom shell are of interference fit, yet it may deform when it is dismantled from the clamp after the machining. It is easy to fit in after the cooling, avoiding the emergence of bushing deformation and metal snap-in; however, if it is still difficult to install after the cooling, a jack must be used: put a thick steel bar or I-beam onto the upper part of the lower shell(middle shell) and tighten with bolts. Place a small jack between the the beam and the

board on bottom shell bushing and use it to press the bushing into the bore of bottom shell.

The Frame arm liners and pinion shaft liner housing of the bottom shell should be installed and dismantled using the lifting holes of the liners rather than temporary lugs welded on the liners.

Bottom shell wear liners need to be installed after the frame arm liners and countershaft liners are installed. Bottom shell wear liners are fixed by taper screws. Welded lugs are allowed to be used when bottom shell wear liners are installed. Refer Fig.4-2 for the installation of ring liner.

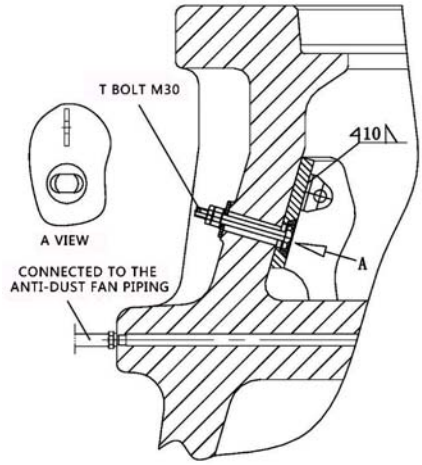


Fig. 4-2 Installation schematic diagram of bottom shell wear liner

The sliding bearing structure between the bottom shell bushing and the eccentric bushing requires lubricating and cooling. The oil volume required for the shell bushing is about 15L/min., For the location of the connection of the lubricating points, refer to the Figure 4-3. The inlets of the lubricating points of PXZ-1500II type gyratory crusher adopt 1-5/12″ UNF pipe thread for the connection and the return ports adopt 5″ NPT pipe thread to connect to the external lubricating pipeline.

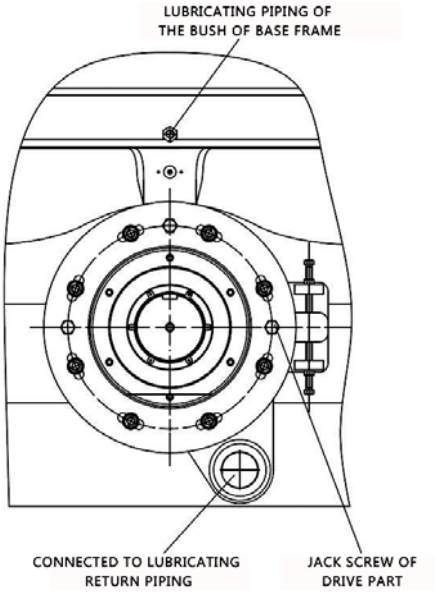


Fig.4-3 Schematic diagram of the inlets for the lubricating points of the bottom shell bushing

4.2 Performance Features

1) The structure of the bottom shell is optimized and designed by means of finite element analysis to provide a more stable, reliable and appropriate structure.

2) The design with a ring groove in the bottom shell hub which matches the eccentric bush, increases the lubricating effect and plays an active role in improving the main shaft speed and increasing the production.

3) The unique design with the anti-dust ring produces a positive effect by preventing the encroachments of dust into the lubricating system and prolonging the life time of the machine.

4) One rib of the bottom shell is designed with an over-pressure air entry to provide compressed air directly into the lubricating system , which brings a better dust-proof effect.

Section 5 Eccentric Bushing Assembly

5.1 The Structure and Assembly of Eccentric Bushing Assembly

5.1.1 Structure and Composition of Eccentric Bushing

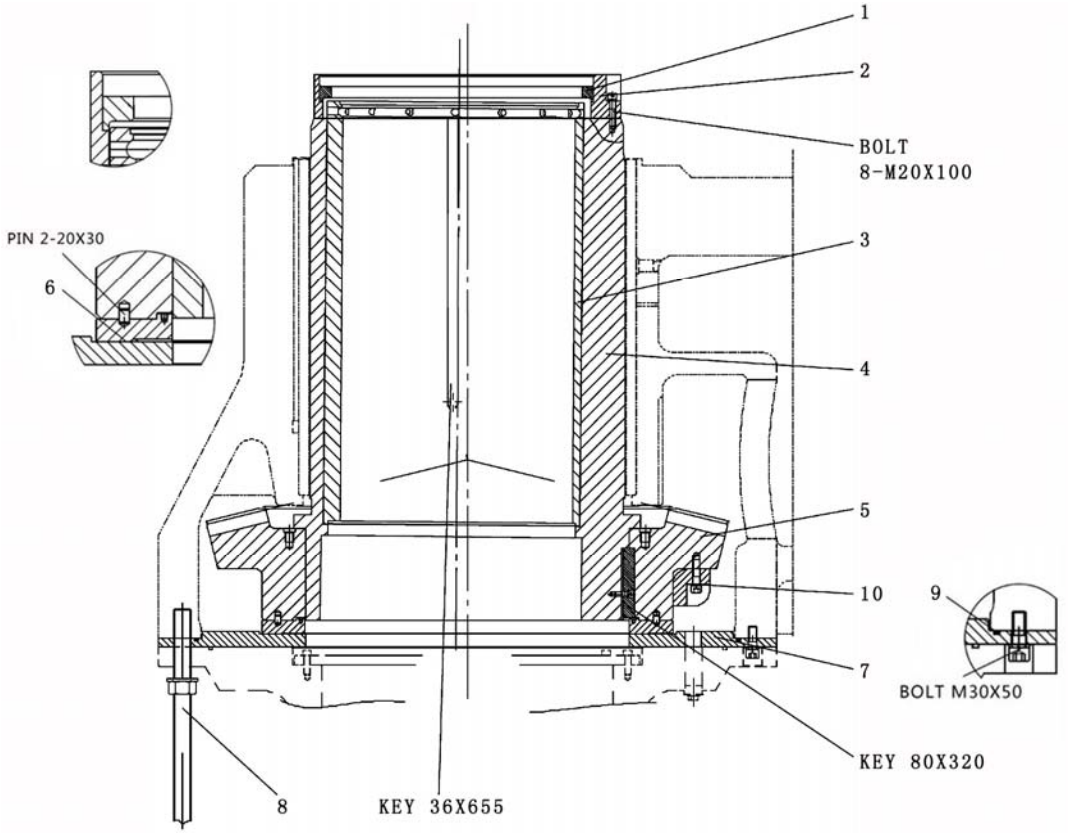


Fig. 5-1 Structure diagram of eccentric bushing of PXZ-1500II gyratory crusher

The eccentric bushing of PXZ-1500II gyratory crusher mainly consists of Eccentric Steel Bushing[G0024-7(G)], Eccentric Copper Bushing[G0024-6(G1)], Bevel gear wheel (G0024-8), Counterweight block (G0024-15), Upper Counterweight (G0024-1) and Key. See Figure 5-1 and Table 5-1 for details. The eccentric steel bushing is located on the wear resistant plate (G0024-10), fixed by the support plate (G0024-11). The bull gear rotates the eccentric steel bushing, and then the eccentric bushing, the lower counterweight, the upper counterweight and the key follows.

Tab. 5-1 Main parts list of eccentric bushing unit of PXZ-1500II

No.	Part No.	Description	No.	Part No.	Description
1	G0024-1(1)	Upper Counterweight	6	G0024-10	Wear resistant plate
2	G0024-2P	Upper Counterweight ring	7	G0024-11	Support plate
3	G0024-6(G1)	Inner Eccentric Bushing	8	G0024-12	Mounting Bolt M56X800
4	G0024-7(G)	Eccentric Steel Bushing	9	G0024-13	O Ring1844X10
5	G0024-8	Large conical gear	10	G0024-15	Counterweight Block

5.1.2 Assembly of Eccentric Bushing

1.Eccentric bushing is located between wear-resisting ring and support plate. When locating the support plate, the oil discharge hole shall be aligned with the cylinder flange hole.

2.The O seal ring of support plate shall be replaced if it's broken after checked. Light grease shall be applied when fixing the O seal ring in the ring groove of support plate.

3)For the Lifting of eccentric bushing assembly, main shaft should be made to enter the bushing hole to guide the eccentric bushing assembly into bottom shell bushing. If a jack is used, the top of the eccentric steel bushing and the bushing should not snap in, or else, lifting the eccentric bushing assembly may need much more force. Once the snap-in occurs, lower the eccentric bushing assembly and waggle on the lifting adjusting screw to make it well fitted with the bushing .

4) The eccentric gear may be easily installed in site once it's located into the bottom shell bush assembly. The teeth can be meshed by slightly rotating the pinion back and forth to ensure the eccentric gear and the pinion gear is fully engaged.

5) The support plate of the eccentric bushing can be fastened at the bottom of the lower shell by the bolts after the eccentric bushing is in it position.

6) Check the backlash and the flank contact ratio of the gear and pinion.

5.2 Parts Assembly

5.2.1 Eccentric Bushing

The eccentric bushing is one of the key parts of the crusher. Its eccentric bore is sized to suit the main shaft and drive the mainshaft to gyrate. Its material and processing technique CITIC adopts both realize the advanced level of the world's similar products to ensure its good performance.

Prior to the disassembly of the eccentric bushing, the upper counterweight should be dismantled. For the disassembly, knock it out of the eccentric shaft with a hammer and wood block. If it can not be knocked out, press it out of the eccentric steel bushing. When replacing it, adopt push fit to assemble it into the inner bore of the eccentric steel bushing. It is fixed on the eccentric bushing with keys. Before the assembly of the bushing, fit the keys to the keyway and push the bronze bushing with keys into the inner bore of the eccentric steel bushing. Before assembly, it is suggested to use fine dry ice to cool the bushing with keys with thermal insulation blanket covered for two hours until the outer surface of the bushing frosts. The bushing must be pressed in not knocked in, or else, its top may deforms and inner diameter may lessen. Another way is to put a jack between the fastening supporting frame and the eccentric shaft to press the bushing in. For the disassembly instruction, please see fig. 5.2.

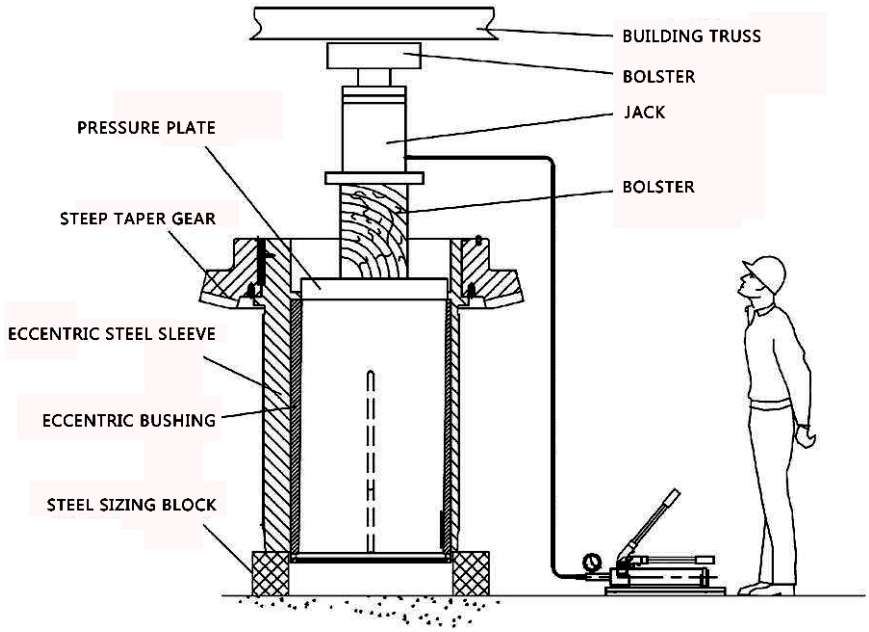


Fig. 5-2 Disassembly instructions for the eccentric bushing of crusher

5.2.2 Bull Gear

The fit between the bevel gear and eccentric bush is a slight interference fit. A hydraulic jack or power pack can be used to press the eccentric gear of the eccentric bush. The gear should be installed close to the eccentric steel sleeve. The eccentric part should be placed upside down when it's being dismantled. The related details about dismantling the gear; refer to the dismantling specification of large-sized parts.

Check whether the gear is broken or excessively worn or not. Excessive wear is likely due to the tooth clearance between the two gears is not correct or discharge gap of the crusher is less than the designed minimum or the oil is contaminated or the pinion is not properly installed. A spacer or shim of proper thickness can be used to adjust the gear and tooth distance of the pinion.

The steps of installing the gear as follows:

1) The key is installed so that eccentric bushing is tightly fitted with the gear. The square key is fixed by a hex screw. The key should be installed after the gear installation.

2) Check whether there are any burrs or marks on the fitting surfaces of the key groove and key groove ends. . Extra material should be removed from them to be aligned with the contact surface of the key.

3) The gear with or without a lower counterweight must be hot installed on the eccentric bushing. The gear should be immersed in the oil heated to 150 deg C. Smoke will rise from the oil as it approaches boiling point. In general, oil temperature is over 150 deg C for most oils.

4) A clearance of 25mm should be kept on the lower part of heated gear edge support (with the tooth up).

5) Three lugs with proper sizes should be installed on the top of eccentric steel sleeve and put in the gear bore after lifting until its shoulder contacts the gear surface.

For dismounting the gear of eccentric bushing see fig.5-3.

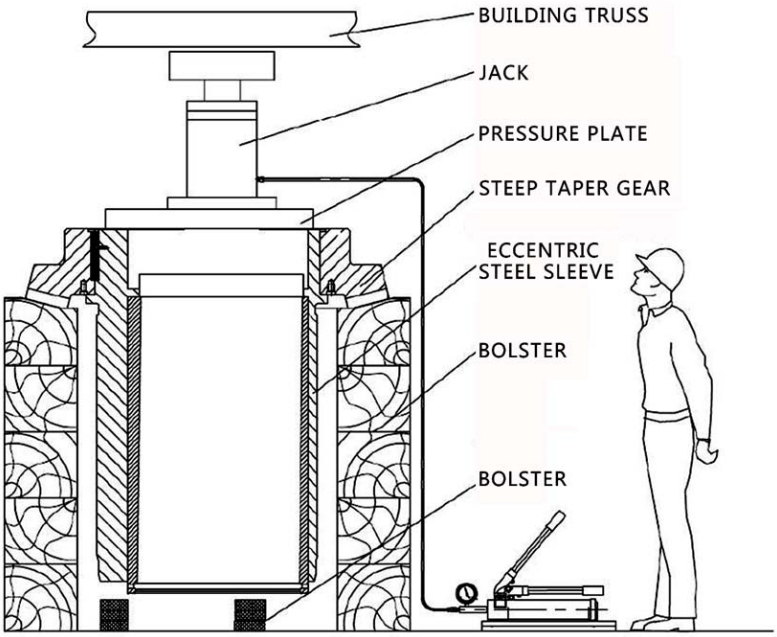


Fig.5-3 Dismounting the bull gear of crusher

5.2.3 Lower Counterweight

Lower counterweight is fixed by 5 hex screws and restricted to move horizontally by a cylinder pin.

A. Dismantle

1. The eccentric bushing should be put on the bolster approx. 400mm above the ground level. Three lugs with proper sizes should be installed on the top of upper counterweight if upper counterweight and the top of eccentric steel sleeve have been dismantled. The bolster must be put below the lower counterweight and also between two blocks. .

2. Dismantle fixed counterweight and hex screw of the gear.

3. The eccentric should be lifted and removed from the lower counterweight. If the lower counterweight remains connected to eccentric bushing part, the gear and lower counterweight should be separated.

B. Assembly

1. A bolster should be placed between two bolts of lower counterweight at approx. 1300mm above ground level.

2. Three lugs of the correct sizes should be installed on the top of upper counterweight if upper counterweight and the top of eccentric steel sleeve have been dismantled. The eccentric should be lifted and put on lower counterweight to ensure that two column pins on lower counter-weight seat have been inserted into the positional holes of the gear.

3. Five hex screws and spacers can be used to fasten the lower counterweight and the gear.

5.2.4 Upper Counterweight

The upper counterweight assembly includes upper counterweight [G0024-1(1)] and upper counterweight ring(G0024-5). See fig.5-4 and Table 5-2 for details. Upper counterweight ring is installed on the bore of upper counterweight by cooling and shrinking to prevent eccentric bush from moving up on eccentric sleeve. If the eccentric bush is seized on to the main shaft, the retainer ring will be pressed out from upper counterweight when main shaft is lifted.

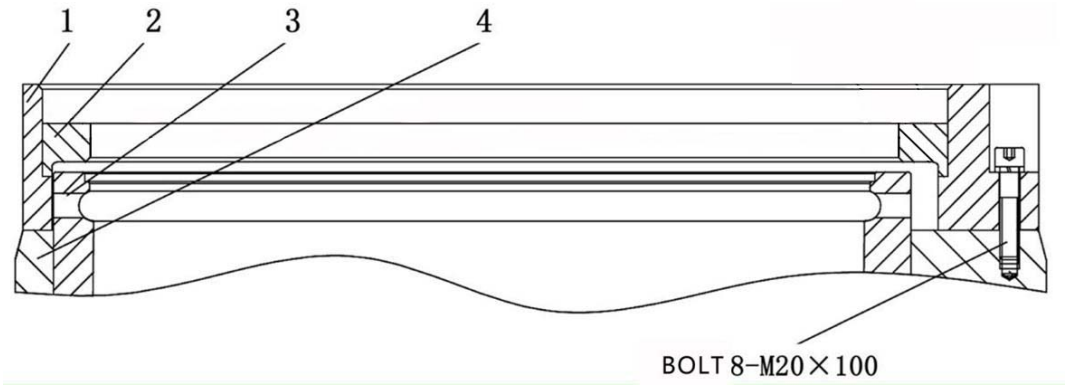


Fig. 5-4 Structure of upper counterweight of PXZ-1500II gyratory crusher

Tab.5-2 Main parts list of upper counterweight of PXZ-1500II gyratory crusher

No.	Part No.	Description
1	G0024-1（1）	Upper counterweight
2	G0024-5	Upper counterweight ring
3	G0024-6（G1）	Eccentric copper bushing
4	G0024-7（G）	Eccentric steel bushing

The upper counterweight of eccentric bushing of PXZ-1500II gyratory crusher is fixed at the top of eccentric bushing by 8 screws.

A.Dismantle：

1. Remove the screws.

2. Three eye bolts of the proper sizes should be installed in the tapped lifting holes of counterweight side and lifted up from the eccentric.

3. Retainer ring will be pressed out from the top of upper counterweight. In general, do not dismantle unless the retainer ring has been severely broken or bent.

B.Assembly：

1. Any burrs should be removed from the bore of the upper counterweight and the external surface of the retainer ring.

2. The retainer ring should be placed in the dry ice and cooled for 2 hours or the counterweight should be heated until 121 deg C.

3. The retaining ring should be pressed into the upper part of the counterweight until it contacts the shaft shoulder of upper counterweight. The narrow edge of the retaining ring

must contact the shaft shoulder of the upper counterweight.

4. The eccentric bushing should be installed before upper counterweight is installed.

5.2.5 Wear Ring

The role of wear ring (G0024-10) on PXZ - 1500II gyratory crusher is to support the bevel gear wheel. It is made of cast bronze material with the characteristics of vibration absorption and wear-resistance, and fixed at the bottom of the gear through straight pins. It is a quick-wear part of the crusher; if the oil groove wears to a certain extent , the performance of the wear ring and the engagement of the gear and pinion will be affected, so the wear extent should be checked regularly ; when the wear of its oil groove is over 25% (2.5mm)of the groove depth (oil groove is 10mm deep), it is necessary to replace it. It is advisable to check every three months . The check of its wear extent can not be conducted until the support plate (G0024-11) is removed.

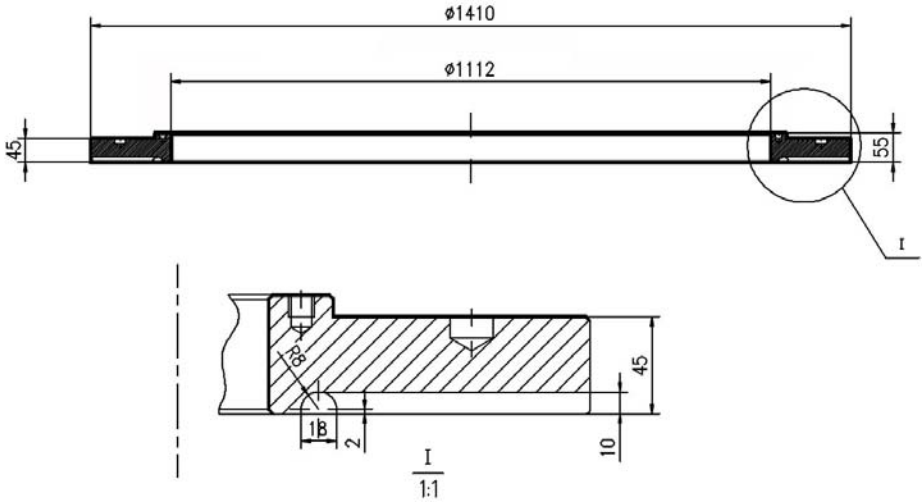


Fig.5-5 Oil groove depth of wear ring

5.3 Performance Features

1. The function of upper counterweight and lower counterweight is designed to better avoid the imbalance caused by eccentric rotation under large eccentric throws and high rotational speed. This upper counterweight improves the overall machine balance compared with only lower a counterweight structure.

2. The eccentric structure of copper sleeve, steel sleeve and the bush is adopted to get larger eccentric distance and reduce the materials at the same time, get greater production under the same speed and reach a higher speed to further improve the production efficiency of the crusher.

3.Overall the rotational out of balance forces are reduced and therefore the operation is more reliable and stable and the maintenance cost can be reduced.

Section 6 Pinion Shaft Assembly

6.1 Structure and Composition of the Pinion Shaft Assembly

The heavy gyratory crusher pinion shaft is fitted with taper roller bearings. The bearings are bath lubricated via the oil hole in the front surface of the shaft sleeve. The driving device rotates the pinion shaft which is supported on the roller bearings and carries the pinion gear. The pinion drives the eccentric bevel gear transferring power to the eccentric and the main shaft.

This pinion shaft assembly is equipped with oil level parts with oil level converter and aspect angle mirror for the use of monitoring appropriate oil level. There are two electrical resistance temperature sensors inside the pinion shaft housing which monitor the bearing temperature of the pinion shaft. There are also two vibration sensors mounted inside and outside of the pinion shaft housing; which monitor the pinion bearing condition. (It is possible to fit these options based on actual needs and site conditions.) See figure 6-1and table 6-1 for sectional structural formation of pinion shaft assembly.

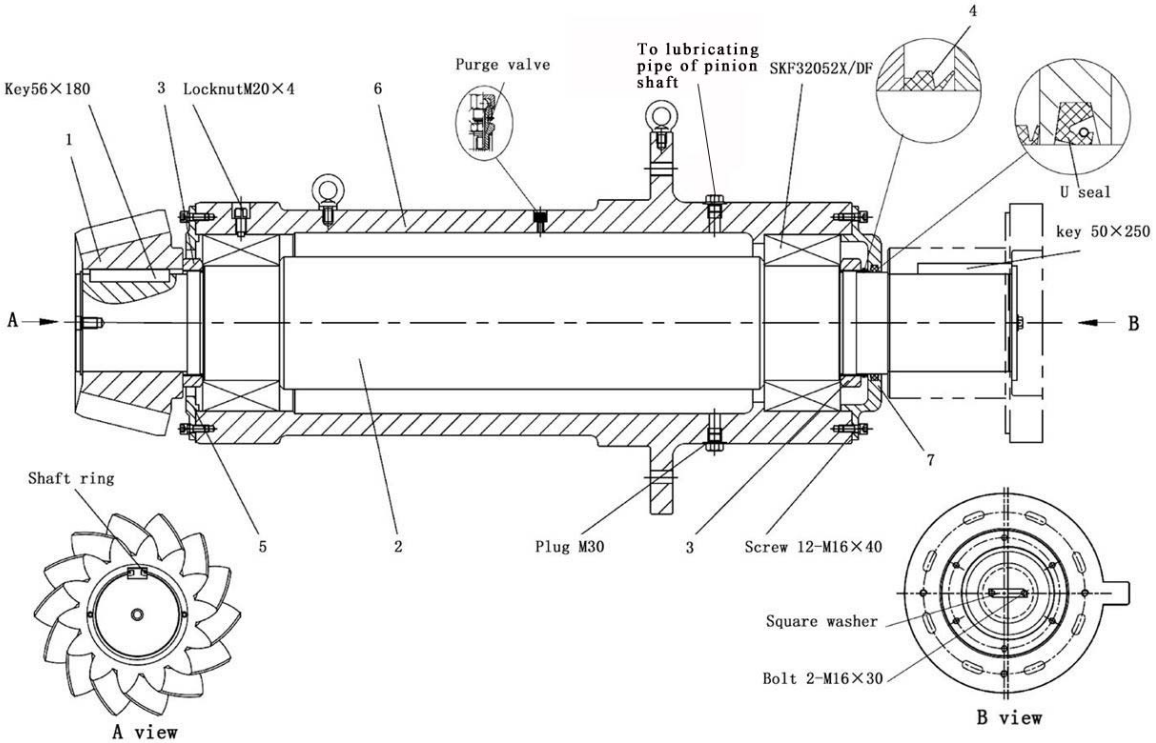


Fig. 6-1 Structure of pinion shaft unit of PXZ-1500II gyratory crusher

Tab. 6-1 Main parts list for transmission unit of PXZ-1500II crusher

No.	Part No.	Name
1	G0026-1	Bevel pinion
2	G0026-2	Pinion shaft
3	G0026-3	Lock nut
4	G0026-4	V Seal ring
5	G0026-5	Transparent cover 1

6	G0026-6	Shaft Sleeve
7	G0026-7	Transparent cover 2
W4713010639	GB/T 1096-2003	Pin 50×180
W4703250004	GB/T 83-1988	Screw M20×40
W4903310122	JB/ZQ 4528-2006	Vent valve 4 （M12X1.5）
W6507010789	SKF 32052X/DF	SKF Bearing 32052X/DF
W6111210023	HG4-339-66	U Seal ring 230X265X16
W4713010643	GB/T 1096-2003	Flat pin 50×250
W4709080070	JB/ZQ 4344-1986	Retainer ring 220
W4703100188	GB/T 70.1-2000	Bolt M16×40
W4701070181	GB/T 5783-2000	Bolt M16×30
W4711320010	JB/ZQ 4347-2006	Washer 35×190
W4709110012	JB/ZQ 4349-2006	Retainer ring 260

6.2 Pinion Shaft Assembly Installation Procedure

When installing the pinion shaft assembly, it is necessary to already have the eccentric bushing assembly and the eccentric gear fitted into the bottom shell hub. When fitting the pion shaft housing assembly into the bottom shell ensures that the assembly is free to rotate. It may be required to fit an adjusting shim between pinion shafts housing bottom shell flange.

Correct installation method of pinion shaft assembly is as follows:

1. Fit the preheated bearing onto the pinion end of the pinion shaft. Press the bearing until it is against the shaft shoulder before it cools. Ensure that the bearing inner race is hard up against the shaft shoulder.

2. Fit the double row steel spherical bearing and the locking circlip onto the pinion gear end of the pinion shaft. Check whether each of the marked faces are in the correct position. Assemble the rest of the inner race of the bearing on the pinion end to the pinion, and then the clamped bearing assembly abuts against the shaft shoulder till it cooled down.

3. Fit the shaft on the bearing of the pinion end and cool down before releasing the clamp force. Coat the two contact surfaces of limit lock nut and the inner race of the bearing with fluid sealant. Assemble the limit lock nut to the pinion shaft, and press the bearing to the shaft shoulder. Note: the limit lock nut is left-hand thread. Wipe off the excess fluid sealant. Fix the limit lock nut by inserting the locking plate into the notch on the limit lock nut (the notch is aligned with the key way on the shaft). Bend the blade of the locking plate into the key way, and fix with a socket head cap screw of the locking plate and a lock washer.

4. Position the pinion shaft housing horizontally and insert the drive end bearing, spacer and fasteners.

5. Assemble the drive end bearing, limit lock nut, locking plate and fasteners, and then coat with fluid sealant as per step 1 and step 3. Note: the oil seal lip of drive end should toward the bearing.

6. After the bearing is cooled down, insert the pinion shaft into the shaft sleeve, until the shaft

shoulder of drive end bearing hold out against the support inside the shaft sleeve. Insert the sealing cover plate of drive end in position, and measure the clearance between the sealing cover plate and the shaft sleeve. Put a gasket of 0.25mm thicker than the clearance into it, and tighten the sealing cover plate and oil seal in position.

7. Place the pinion key into the shaft key way. Assemble the preheated pinion onto the shaft. Fit the circlip onto the shaft. There is an interference fit between the pinion and the shaft of 0.05 to 0.12mm.

8. Fill the void with sufficient grease via the grease nipple located on the sealing plate of drive end until the grease purges to ensure contaminants are removed. Rotate the shaft when greasing up to ensure uniform distribution of the grease.

9. Smear protective oil onto the shaft sleeve to prevent corrosion of the pinion shaft and the bearing surfaces before operating.

6.3 Assembly of the Pinion Shaft Housing to the Crusher Bottom Shell

1. Reassembly of the pinion assembly to the crusher:

1) Use a length pipe to counter balance the end of the pinion shaft housing opposite the pinion end of the shaft. Place a gasket on the mounting flange of the pinion shaft sleeve housing. Caution: the thickness of the gasket must be suitably matched with the pinion and gear. Any variation in the thickness may cause a variation in shape of the gear contact pattern between the pinion and the gear.

2) Screw the lifting lug into the tapped hole on the top of pinion shaft housing.

3) Place the pinion shaft assembly into the bottom shell opening. As it is a close fit a counter balance pipe is required to guide the assembly into the bottom shell opening. When the pinion makes contact with eccentric gear, rotate the shaft to engage the eccentric and pinion teeth completely in order to complete the installation.

4) Torque up all bolts to the recommended values.

5) Adjust the backlash between the pinion and the large gear.

6) Reconnect the hose assembly between the sight glass for oil level and the shaft sleeve of pinion.

7) Unscrew the oil plug, fill up to proper level.

2. Check the backlash and tooth contact if new pinion, gear or eccentric shaft is assembled.

3. Install the drive and drive guard.

6.4 Disassembly the Pinion Shaft Assembly From the Bottom Shell

Note: during the installation, cleaning, maintenance and overhaul of the crusher, the

maintenance personnel r must ensure that all energy sources are disconnected and power is turned off and locked in the off position. Hang warning signs according to relevant regulations. Otherwise, serious injuries or incidents may occur, endangering personal safety.

The procedure of removing the pinion shaft assembly from the crusher should be in accordance with following:

1. Disassemble the drive shaft and coupling between the crusher motor and the crusher. Both of the half couplings of the drive shaft can remain on the drive shaft and the motor shaft. .

2. Disassemble the half couplings, or retain them on the drive shaft.

3. Unscrew the oil drain screw plug on the bottom of the pinion shaft housing and drain the lubricating oil.

4. Disconnect all lubrication hoses. Also disconnect the oil level inspection sight glass if fitted.

5. Unscrew the bolts connecting the pinion shaft housing to the bottom shell.

6. Screw 3 bolts into the tapped holes in mounting flange; tighten the bolts alternately to separate the pinion shaft housing from the bottom shell.

7. Fit an eye bolt into the tapped hole on the top of flange of drive part, then assemble the lifting tool, and tighten them by a small size hoist or a hand-lift hoist block.

8. Keep the pinion shaft housing balanced by a length of pipe or other similar means, and remove the pinion shaft housing from the bottom shell of the crusher.

6.5 Disassembly of the Pinion Shaft Assembly

After removing the pinion shaft from the crusher, place it on skids or blocks and ensure it is stable prior to disassembly and draining the oil. Do not place any machined surface directly on the ground; always ensure the parts are protected.

1. Remove the housing locking screw. Disassemble the U shape seal ring, V shape seal ring and the transparent cover 2 on the input shaft end. Remove the screws and washers used for fixing the transparent cover 1.

2. Invert the pinion shaft. Remove the lock washer and the bearing lock nut on the end of the pinion shaft. 3. Press out the inner bearing of the pinion shaft, together with the pinion, the transparent cover of the pinion end and the outer bearing.

3. Press to remove the inner bearing cone of the pinion shaft, pinion, the transparent cover of the pinion end, and bearing of the pinion end together.

4. Remove the circlip at the front of the pinion. Press to remove the bevel pinion from the shaft.

5. Remove the bearing from the pinion shaft housing.

6. Remove the outer race from the shaft sleeve of the pinion shaft housing.

7. Clean and check all the components. Replace all the damaged and defective components.

See figure 6-2 and 6-3 for the dismantling method of the pinion shaft assembly and its ancillary components and pinion gear.

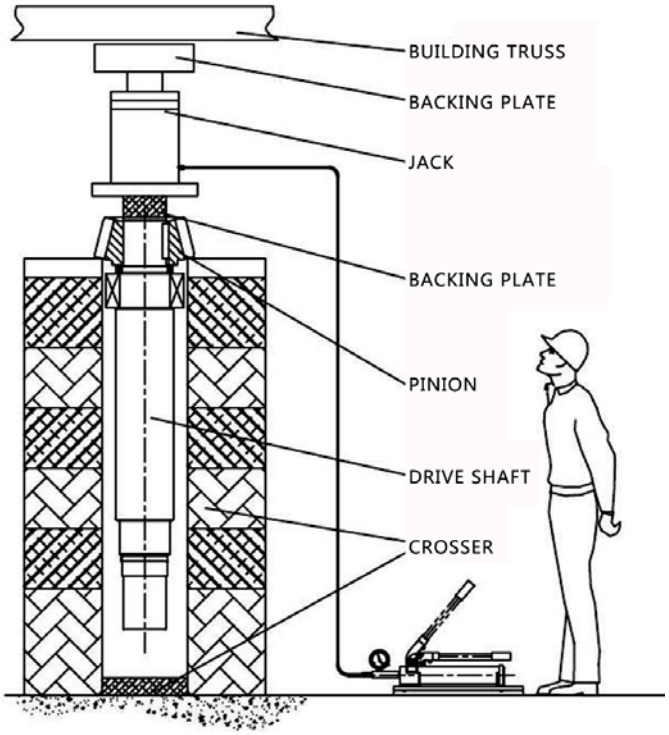


Fig.6-2 Dismantling of pinion shaft and the assembly

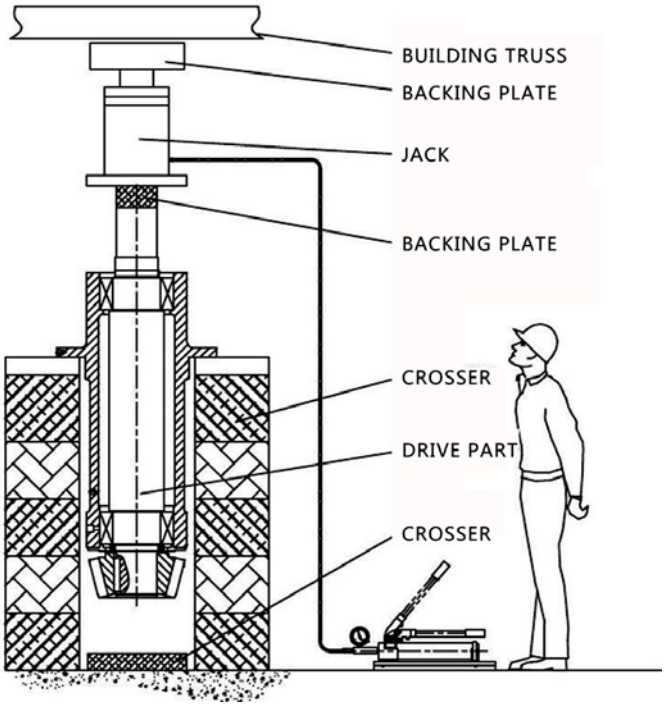


Fig. 6-3 Dismantling the pinion shaft assembly

6.6 Assembling Pinion Shaft Assembly

Before reassembling the drive assembly, ensure all the parts are cleaned and free of debris.

1. Fit the preheated inner race onto the end of the pinion shaft. Press the inner race to abut hard against the shaft shoulder till it has cooled down.
2. Assemble the inner side race and outer race of the pinion side together, and tighten them with the lock nut.
3. Assemble the pinion side bearing and the drive shaft into the housing and locate.
4. Assemble the input end bearing into the main shaft and pinion shaft housing and tighten with locknuts.
5. Assemble the input seal ring and the transparent cover (end cover)and tighten with the screws.
6. Assemble the pinion key in the key way of main shaft. Fit the heated pinion on the drive shaft. Assemble the retaining circlip in the shaft groove as soon as possible. The circlip should abut against the pinion face.
7. Fill in the clearance between the bevel pinion and the transparent cover(end cover) with oil, rotate the bearing appropriately to ensure the oil is uniform. Fill an appropriate amount of grease in the drive shell, and rotate the pinion shaft to prevent corrosion before use.

6.7 Adjustment of Backlash Between Eccentric Gear and Pinion Gear

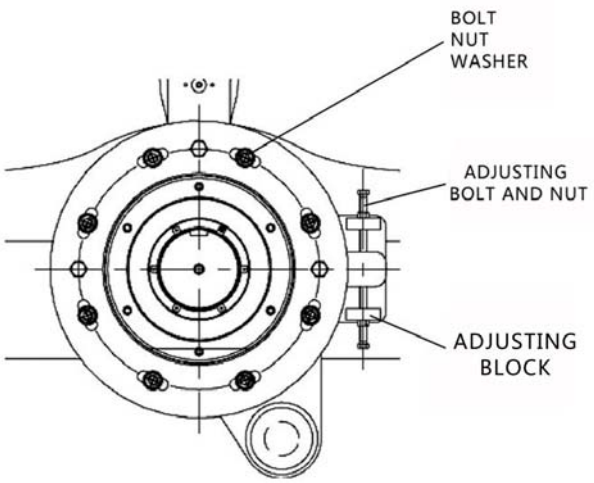


Fig. 6-4 Adjustment of backlash for gear wheel and pinion

The unique structural design for the pinion shaft housing assembly and the bottom shell is beneficial to adjusting the pinion backlash, making it convenient for maintenance in saving adjustment time and cost.

1. The pinion shaft housing (drive casing)is able to rotate around its center, as slotted holes are provided on the flange. First loosen the stud bolts of the flange of the pinion shaft housing. On the horizontal plane, the centerline of the pinion shaft and the centerline of the shaft housing are offset from each other. Rotating the shaft housing clockwise will move the pinion down toward the direction of the eccentric gear reducing backlash. Whereas, rotating it anticlockwise will lift the pinion away from the eccentric gear increasing backlash.

2. The backlash rotation adjustment in either direction can be completed by the use of the jack

bolt on the bush of the bottom shell and the bearing on the joining part of pinion shaft housing flange. A hexagonal nut is provided to lock the jack bolt in the correct position after the backlash adjustment of gear and pinion gears. Re-torque the stud bolts in the pinion housing mounting flange to the nominated values.

6.8 Adjustment of Gear Clearance

A spiral bevel gear is used in the PXZ1500II gyratory crusher. The following instructions are used for the installation and maintenance of these gears.

Because the flank contact position of the spiral bevel gear may be different due to the difference in installation of each gear, the following procedure relates to an ideal installation.

The position of the crusher gears is not fixed in their exact operating position, e.g. the gears may be slightly offset. But if the gear contact offset in a wide range, the gear must be re-positioned.

After reassembling the gears, it is considered as reasonable that if the gear contact position conforms to the gear contact zone under heavy load, the only requirement would be to make micro-adjustments according to the gear adjustment chart. Attention to following items during the installation and maintenance for the gear fit is recommended:

1. Whether the bevel gear and bevel pinion are installed in right position.

2. Check the contact condition for the mating gears.

3. Check whether the gear backlash is within the required range.

4. Check whether all the tap bolts and nuts are locked tightly.

5. Ensure gears are well lubricated before the crusher is operated.

A. Measuring the backlash between the eccentric gear and the pinion gear.

If the crusher has been fully assembled, the clearance between the eccentric pinion shaft assembly and the eccentric bottom shell bush assembly should be eliminated during the gear backlash measuring period. A piece of wood block should be placed into the crushing chamber on the opposite side of the pinion; lift the main shaft by the hydraulic to minimize the clearance, the lifting pressure is about 1MPa. When the pressure reaches 1.1MPa, the eccentric assembly can be pushed toward the pinion gear.

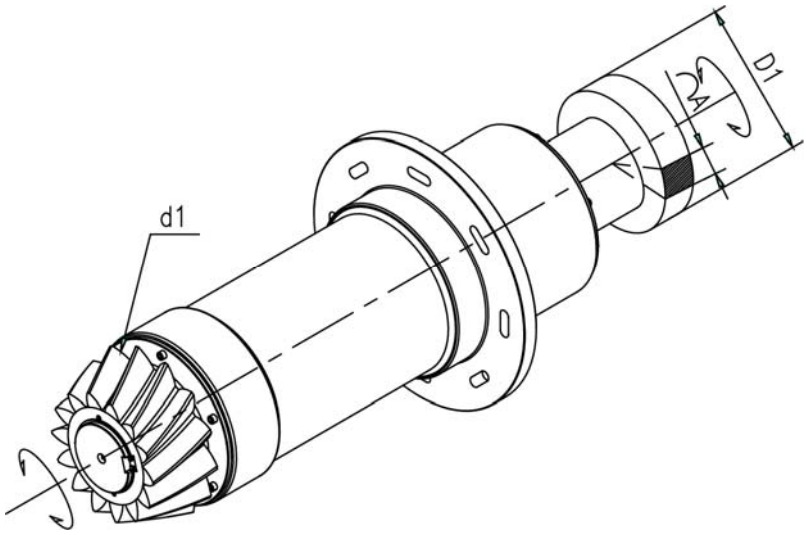


Fig. 6-5 The relationship between outer circle rotation of shaft coupling and the gear backlash of gear and pinion

As shown in Figure 6-5, the relationship between actual gear backlash and coupling clearance is as follows:

Displacement of outer circle of coupling = (actual gear backlash X • diameter of outer circle of coupling) / diameter of pinion pitch circle

Due to the structure of the gyratory crusher, its gear backlash could not be measured directly after its assembly. So, we use indirect measurement method: measure the equal rotation of outer diameter of the couplings on the drive assembly to show the gear backlash indirectly. Specific method is as follows: turn the pinion shaft, measure its rotation arc length A on a certain diameter of the flange surface of the shaft casing. The backlash of pinion pitch circle d can be calculated through the ratio, then required normal backlash is $d_n=d\cos\alpha\cos\beta$,where α is pressure angle; β is spiral angle.

So, the gear backlash of PXZ1500II gyratory crusher:

Specification of crusher	Pinion pitch diameter of d1/mm	Normal backlash/mm	Display clearance of the coupling/mm
60X89 （PXZ-1500II）	447	2.50～2.80	2.20～2.50

B. Inspections on the Contact ratio of Gear and Pinion

Contact inspection requires daubing blue coloring agent onto the surface of gears and the contact points are generally taken. Inspections on the contact ratio of flank of tooth are made according to the contact condition of coloring agent after a rotational check. It is required that the contact ratio for pitting on the flank of tooth along the direction of the tooth width is no less than 50%,and that along the direction of tooth depth is also no less than 50%.

Adjustments on contact ratio of the flank of tooth are made by adding or removing the number of

gaskets between the pinion shaft housing flange and bottom shell. Adjust the contact area of the tooth flank with changes of gasket thickness. Suitable gear contact should accord with the condition shown in Figure 6-6.

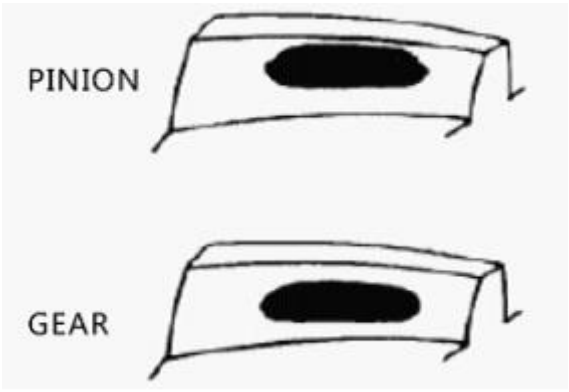


Fig. 6-6 Ideal contact position of the gear and pinion of the crusher

C. Adjustments of Gear to Pinion Backlash

Inspections can be made according to the measurement method of the backlash stated in section A. If the gear backlash value cannot satisfy the design requirements, two jacking bolts on the bottom shell can be used to adjust the pinion shaft housing assembly.There is a certain eccentricity of the center of the crusher bottom shell bore and the center of the drive assembly on the horizontal plane . Loosen the fastening bolts of the drive housing and loosen the adjusting bolts of bottom shell . The pinion shaft assembly can be rotated to raise or lower the pinion to ensure correct backlash adjustment.

For the reassembly of the eccentric bushing and the drive assembly, it is necessary to check whether the backlash of gear and pinion and the contact rate of tooth face meet the required backlash in the table.

D.Wear and repair cycle of gear and pinion

Maximum allowable wear thickness of gear and pinion is 1.5 ~ 1.5 mm; please replace if the value is exceeded. In the first 3 years of its operation , it is recommended to check the wear extent of the gear and pinion every 6-12 months. Three years later, careful check should be conducted at least every 3months; if the value is over the maximum wear value, please replace. The gear manufacturing cycle is 6 - 7 months, so it is necessary to order its spare parts in advance. In normal working conditions excluding extreme failure conditions, the service life of the gear and pinion is at least 7 years. In order to better guarantee the working performance and service life of the gear and pinion, check the the noise of gear transmission at least once a week and ensure the oil of the gear and pinion free of pollution.

6.9 Technical Performance

1. Select and assemble the temperature sensor, vibration sensor and position sensor, conduct real-time monitoring on the temperature, operating condition and lubricating condition of the

bearings using the latest measuring and testing techniques, and make actual adjustments as per the operation conditions, realizing closed-loop control of electromechanical integration, greatly improving the service efficiency of the machine, and reducing the maintenance cost.

2. The unique gear adjustment design allows for easy adjustment of the gear clearance, which makes the adjustment simple and easy to achieve; the higher frequency of adjustment reduces the maintenance period and the cost for operators.

3. Compared with traditional sleeve or plain bearings, the rolling bearing design increases the driving efficiency and rotational speed, lessens the lubricating system load, and makes the assembly easier to service, operate and is more efficient.

4. The spiral bevel gear driving design provides increased torque, reduces noise and friction and is a more stable and reliable transmission.

Section 7 Main Shaft Assembly

7.1 Structure and Composition of Main Shaft Assembly

The main shaft assembly (Crushing cone unit) of PXZ-1500II gyratory crusher generally comprises, the main shaft (G0023-5), the mantle locknut (G0023-8), the main shaft sleeve (G0023-6), the spherical friction disc (G0023-10P), the upper and lower mantle of main shaft (G0023-20 and G0023-21), the dustproof seal ring (G0023-16), upper and lower support ring (G0023-14/17) and etc. See Figure 7-1 and Table 7-1 for details. The main shaft assembly is the action cone of gyratory crusher, which through the eccentric movement of eccentric bushing drives the main shaft to swing in order to crush the material. See Figure 7-2 for the installation instructions for upper mantle of the main shaft.

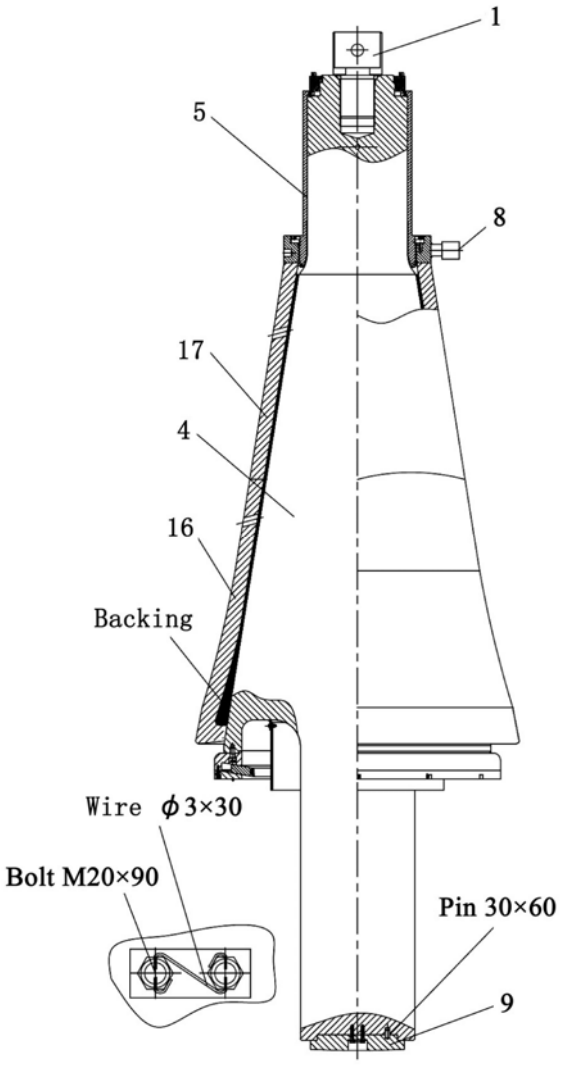


Fig.7-1 Main shaft structure of PXZ-1500II crusher

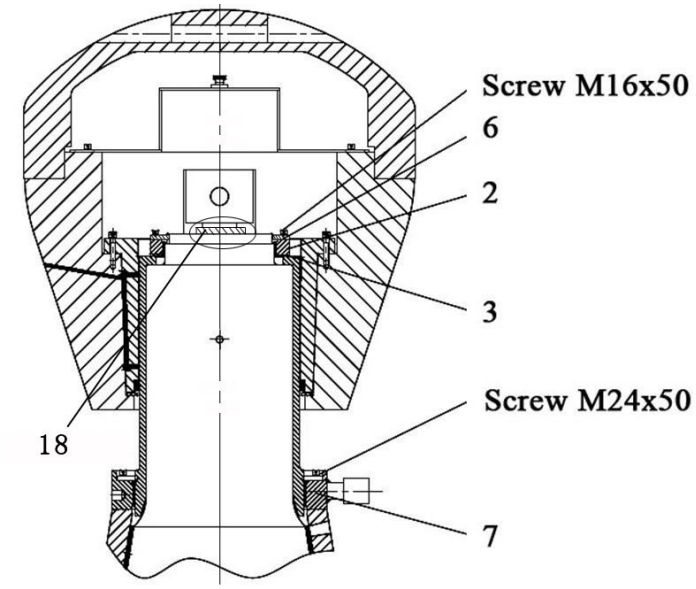


Fig. 7-2 Installation scheme of the upper part of mainshaft

Tab.7-1 Main parts list of main shaft （PXZ-1500II）

No.	Part No.	Name	No.	Part No.	Name
1	G0023-1	Eye bolt	10	G0023-14	Lower support ring
2	G0023-3	Lock nut of sleeve	11	G0023-15	Seal ring 1490×1438×35
3	G0023-4	Retainer ring 1	12	G0023-16	Dust seal ring
4	G0023-5	Main shaft	13	G0023-17	Upper support ring
5	G0023-6	Main shaft sleeve	14	G0023-18	Rubber ring
6	G0023-7	Packing washer 2	15	G0023-19	Support ring
7	G0023-8	Lock nut of mantle	16	G0023-20	Lower mantle of shaft
8	G0023-9	Wustite iron	17	G0023-21	Upper mantle of shaft
9	G0023-10P	Spherical friction disk	18	G0023-36	Eye bolt block

7.2 Points for Attention Prior to the Removal and Installation of the Main Shaft Assembly

The spider assembly must be removed prior to the disassembly of main shaft assembly. Excluding at some small discharging openings, main shaft can be disassembled without the disassembly of top shell and concave segments. for the lifting of mainshaft, the eye bolt installed on its top can be used(eye bolts of main shaft do not have to be removed). A U type shackle with pin is used between eye bolt and crane hook. Since the main shaft fits into the offset eccentric bush, it is not in a true vertical position when originally assembled. Therefore a crusher with small eccentric throw can be directly connected to the crane hook and eye bolt. The main shaft is extracted from the eccentric bush with the main shaft is tilting to the side. Generally if it cannot be drawn out without using force; the eccentric bush will be damaged by the main shaft.

Main shaft needs to be carefully placed into maintenance well or onto a support frame the machined surfaces. If the main shaft is placed horizontally, it is to be lifted in an inclined position after a timber sleeper or rubber belt is placed at the shaft ends or on the thrust bearing. Take care not to damage the thrust bearing at the bottom of main shaft.

7.3 Mantle Lock Nut Removal

The self-locking nut is to ensure that the mantle mantle closely contacts the tapered head of the main shaft. During crushing the self-locking nut turns to ensure its positive fit with the mantle. A feeler gauge is used to check if n the non-contacting seating area is less than 25% of the outer circumference.

Firstly the locking pin needs to be drilled out before the nut is removed from main shaft. The lock nut connects to the mantle by these assembling pins. So the nut turns when the mantle mantle rotates to maintain positive contact. The lock nut has a right-hand thread. Take care that the thread is not damaged during assembly. The nut is welded to the square head removal block and then loosened by a sledge hammer. If the nut is too tight and it does not turn after sledge hammering, use a cutting torch to evenly heat the lock nut and then continue attempting to loosen with the sledge hammer.

After the mantle is installed on the main shaft and zinc or epoxy resin is poured in the back, the thread is checked in the collar bush for the lock nut. Any splashed zinc slag and other foreign matter affecting the nut installation are all cleaned. The nut is assembled on the bush, and then screw it down to make it fit tightly to the bush. The assembling pin is placed in the groove and welded to the lock nut.

7.4 Mantle

The mantle is fitted over the main shaft and moves with it relative to the stationary outer concave to perform the rock crushing. Mantle mantles require a high wear resistant material and can be divided into single or multiple integral styles. Mantles for PXZ-1500II type crusher uses upper, middle and lower detachable style.

Generally the mantle is not disassembled until it cannot be used any more. It is removed by cutting about 6~12 mm away from under the joint between the lock nut and upper mantle. Cutting can be started s from an unused half round hole for the assembly pin. Remove the top torch ring of the upper mantle to relieve the pressure on the lock nut for reuse. After welding suitable lifting lugs to the top of the mantle the crane is used remove it from the main shaft. During the lifting process the area is to be cordoned off to ensure personnel remain at a safe distance to avoid injury from falling backing material.

Assembling the Mantle:

1. Trial install the lock nut on the main shaft to ensure that it turns freely.

2. Remove burrs from the taper part of shaft that makes contact with the backing. Otherwise the burr functions like a key and deepens when the manganese steel mantle elongates. Babbitt can be used to fill any depression in the shaft surface to make it flat,

3. When pouring zinc backing, coat the head with a film of oil. When epoxy resin is used as the

backing, the shaft face is covered with either beeswax or stripping silicon grease. Over lubrication will result in solidified resin.

4. Place the main shaft in the maintenance well or steel frame platform.

5. Place the upper, middle and lower mantle parts onto the taper part of main shaft. Around the circumference three approximately equal places are selected and 6 hard wood wedges are placed between upper and lower mantle to form a gap 9~10 mm in size. After this the lock nut is located just above the thread of the main shaft sleeve the thread is left handed for the lock nut.

6. Wedge the mantle firmly until the mantle top sits hard against the lock nut bottom face.

7. Carefully remove the lock nut and measure the clearance between mantle and main shaft at four equal circumferential points.

8. Four hard wood wedges are to be used to make the mantle extended bottom end align with the taper center at the top of main shaft.

9. Again check the fit of mantle to lock nut.

10. Carefully remove the lock nut and upper mantle and ensure the middle and lower mantle remain fixed. The clearance is checked between middle, lower mantle and main shaft.

11. The seat area of the lower mantle is sealed prior to pouring backing.

12. Reinstall the upper mantle and the lock nut and check the clearance between them (or cutting ring). The area not in contact shall not exceed 25% of the circumference in size.

13. Carefully remove the lock nut and the upper mantle to ensure the lower mantle is fixed.

14. Pour zinc when it is heated to a temperature of 540 deg. C. Lower mantle is to be heated uniformly at a temperature about 920 deg. C. No preheating required, but solidification accelerator can be used if epoxy resin is used for backing.

Note that the zinc alloy container and main shaft must be completely dry without any moisture when zinc alloy is used for backing.

15. Pour a small amount of backing to check if it leaks from the bottom of mantle. Seal again if necessary. Babbitt is used to stop lower mantle top joint in order to make the backing material be equal in height with the mantle. When using epoxy resins, only pour for the second time after approx. one hour from when the first backing was poured.

16. Pour equally into the void between middle, lower mantle and main shaft to complete the mantle pouring process to ensure it solidifies evenly.

17. After the backing is solidified, Babbitt film is coated over the top edge and corner between main shaft and backing. Ensure that Babbitt covers the backing edge so as to form an interlayer between each part of the epoxy/zinc backing. The backings of the three parts of mantle must be

isolated to ensure the separate rotation to make the lock nut self-tighten.

18. Around the circumference three approximate places are selected and 6 hard wood wedges are placed between upper, middle and lower mantle to form a gap of 9~10 mm in size.

19. Fill the void between upper, middle and lower mantle. Zinc or epoxy resin is used to fill each mantle part separately.

20. The mantle is aligned by means of wood sheet and locating wedges. Top mantle face is aligned with the lock nut. Remove the lock nut and place centering shims between mantle and main shaft carefully.

21. Pour the zinc when it is heated to a temperature 540 deg. C. The mantle is to be heated uniformly to a temperature about 920 deg. C. No preheating required but solidification acceleration only if epoxy resin is used for backing.

22. Zinc or epoxy resin is poured to a height where it is 25 mm from the underside of taper start of the main shaft. Do not pour the backing material in the void under the lock nut. Above the height may affect the tightening of lock nut.

23. Allow the backing to set and harden after pouring.

24. The lock nut is coated with an anti-seizing compound in the thread and is assembled on the main shaft. The lock nut is tightened to make it a tight fit with the mantle and make the semi-circle mouse hole align with the semi-circle hole in the half round part of mantle. The half round groove is aligned and the assembling pin is placed. The assembling pin is then welded to the lock nut.

25. Lifting lugs are removed from the mantle after the mantle is assembled on the main shaft.

7.5 Dust Seal Ring

The dust seal ring can move freely within the mounts under the mantle. It is in a slide fit with the dust ring. And it forms the only barrier between crusher and the inner oil path of the crusher.

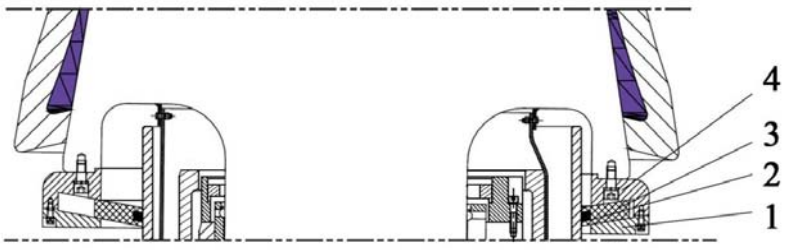


Fig.7-3 The structure of dust seal ring (PXZ-1500II)

The enclosed circular seal mainly consists of four parts, namely the upper support ring, seal ring, joint ring, and lower support ring. The upper support ring is fixed to the main shaft by screws and usually needs no dismantling; the lower support ring is connected to the upper support ring by another series of screws. The dust proof seal ring is retained in the cavity

between the upper and lower support rings (Refer Figure 7-3).

Corresponding parts list marked by number in the Figure can be found in Table 7-2.

Tab.7-2 Main parts list of dust seal ring (PXZ-1500II)

No.	Part No.	Name
1	G0023-14	Lower support ring
2	G0023-15	Seal ring 1490×1438×35
3	G0023-16	Dustproof ring
4	G0023-17	Upper support ring

A.Removing the Dust Seal Ring

1. Lift main shaft from the crusher.

2. Remove the retainer bolt. Four bolts are inserted in the retainer's threaded hole to prop up the upper and lower support rings apart.

3. The retainer and the dust seal ring slide out from the main shaft end. An option to remove the dust seal ring is that the lower retainer and the dustproof seal ring are dismounted before the main shaft is withdrawn.

B.Assemble Dust Seal Ring

1. Place the dust seal ring on the top of lower retainer. The retainer is raised to make the seal ring adhere to the bottom face of upper retainer.

2. The supplied bolts are used to secure the upper and lower retainers.

3. Check the clearance between the lower retainer and the dust seal ring. It should be 0.76 - 2.29 mm with wear allowance of 3.2mm when new. A spacer can be used between the retainers to ensure the minimum clearance if necessary.

4. The seal ring can be moved freely in the retainer after being assembled.

5. Take care lowering the main shaft because the dust seal ring must slide onto the mating face of the stationary dust collar. The construction of the dust seal ring is relatively more fragile and breakable when compared to the weight of shaft.

Note: while installing the main shaft into the crusher, the bore of the dustproof seal ring of the main shaft is needed to pass over the outer face of the bottom shell dust cover. Allow a little clearance between seal ring and outer race of dust cover to make it convenient for the seal ring to slide over the dust cover while the main shaft is swinging on the crane. The seal ring is made of polyurethane material which is easily influenced by temperature and to deformation if forced. If the deformation is too large it will influence the installation of the main shaft and the operation of crusher will be impaired. In that case, it is possible to polish the upper end of outer face of the bottom shell dust collar or make slight lead in taper to increase the sliding clearance through the process of machining the matching surface of the two parts. This can decrease the degree of difficulty when installing the main shaft and therefore guarantee the safe operation of crusher.

7.6 Main Shaft Sleeve

The main shaft sleeve (G0023-6) is installed on the upper main shaft in a hot condition such that it can be replaced easily if damaged, worn or scratched. The standard sleeve is used on the heavy crusher has a thread on the external lower face for the mantle lock nut. An upwards thrust force is exerted from the manganese steel mantle during the crushing operation. A packing washer (G0023-7) is fitted to the top of main shaft and the sleeve lock nut (G0023-3) is then used to retain the main shaft sleeve. (Refer Fig.7-4 and Table 7-3). The diameter of mianshaft neck and the diameter of the bore of the mainshaft sleeve shown in Figure 7-5 are for the reference of the user during the installation and check of mainshaft and its sleeve.

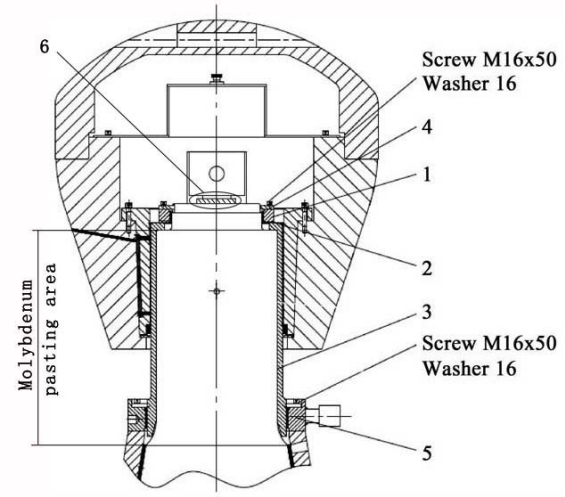


Fig.7-4 Installation scheme of main shaft sleeve of PXZ-1500II Type

Tab.7-3 Main components of main shaft sleeve of PXZ-1500II

No.	Part No.	Name
1	G0023-3	Lock nut of the sleeve
2	G0023-4	Retainer ring 1
3	G0023-6	Shaft sleeve
4	G0023-7	Packing washer 2
5	G0023-8	Lock nut of mantle
6	G0023-36	Eye bolt block

A. Removing the Main Shaft Sleeve

1. The lock tab and the lock nut must be removed. If the nut is not easily dismounted, the cutting ring can be destroyed to relieve the pressure force.

2. A gap 1.5~3 mm in length is cut by gas welding or oxyacetylene torch on one side of the neck. Take care that the main shaft is not cut; or it will cause an increased local stress in the shaft and the shaft will be weakened.

3. Completely separate the gap by using a lever.

4. A wedge is then driven into the gap to widen it and provide a clearance to remove the sleeve. Check the outer face of main shaft and sleeve, remove any concave and convex damage or rust

and clean the part thoroughly.

B. Assembling the Main Shaft Sleeve

1. First, apply molybdenum disulfide adhesive to the outside surface in the matching zone of the main shaft (see Figure 7-5). This adhesive is a solid lubricant, mainly acting as a lubricant to the installation of the mainshaft, and suitable for high-pressure high-temperature condition.

Note: Applying the molybdenum disulfide adhesive with closed operation and local ventilation, it is necessary to wear self-inhalation filter type dust respirator , chemical safety goggles, virus infiltration overalls and latex gloves, etc .

2. The bush is heated to a temperature of 150 deg. C in an oil bath.

3. Slide the sleeve onto the shaft till the upper bush edge is flush with shaft top.

4. Slide the sleeve onto the shaft till the extruding part of top bore contacts the shoulder.

5. The lock nut is installed to make it close to the bushing top. The lock tab is bent closed to the lock nut and tightened with bolts. The tightening torque of M16 bolt is 200 N· m; refer to List A attached to the manual for details.

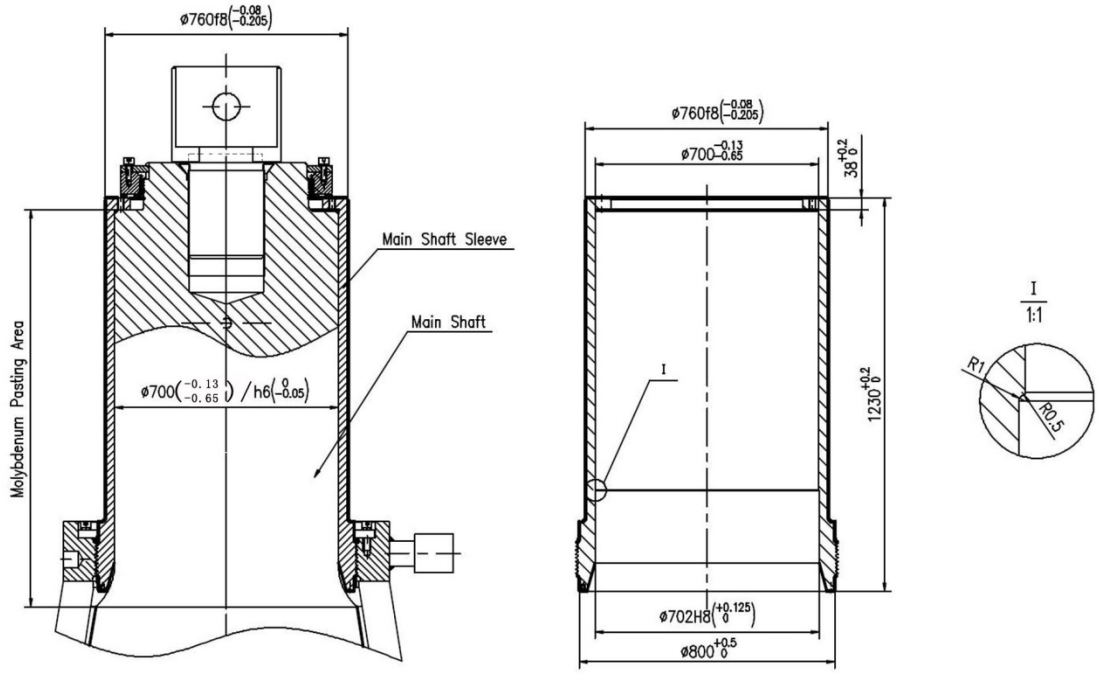


Fig. 7-5 Installation dimension of mainshaft and its sleeve

7.7 Technical Performance

1. The main shaft is a one piece casting integral of main shaft and head centre, eliminating the stress centralization caused by connection and fit, reducing the assembly steps and enhancing the mechanical performance and integrity.

2. The design method of a locking thread in the main shaft sleeve is adopted to avoid the stress

concentration resulting from having a locking thread machined into the main shaft and therefore lessen the risk of shaft breakage due to stress concentration.

3. The main shaft is a component that evidences transition in all major rounded corners to make the stress distribution uniform, therefore minimizing the shaft's breaking risk and therefore offering n integral, reliable, long life structural design.

Section 8 Middle Shell Assembly

8.1 Structure and Composition of Middle Shell Assembly

The middle crusher shell assembly mainly consists of upper shell, lower shell and the concave liners. (See fig. 8-1 and table 8-1). This assembly is mainly used to support the spider ring casting and functions as the support for the concave liner segments forming the fixed outer crushing chamber surface. The crushing of the rock mainly takes place inside the middle shell area of the chamber.

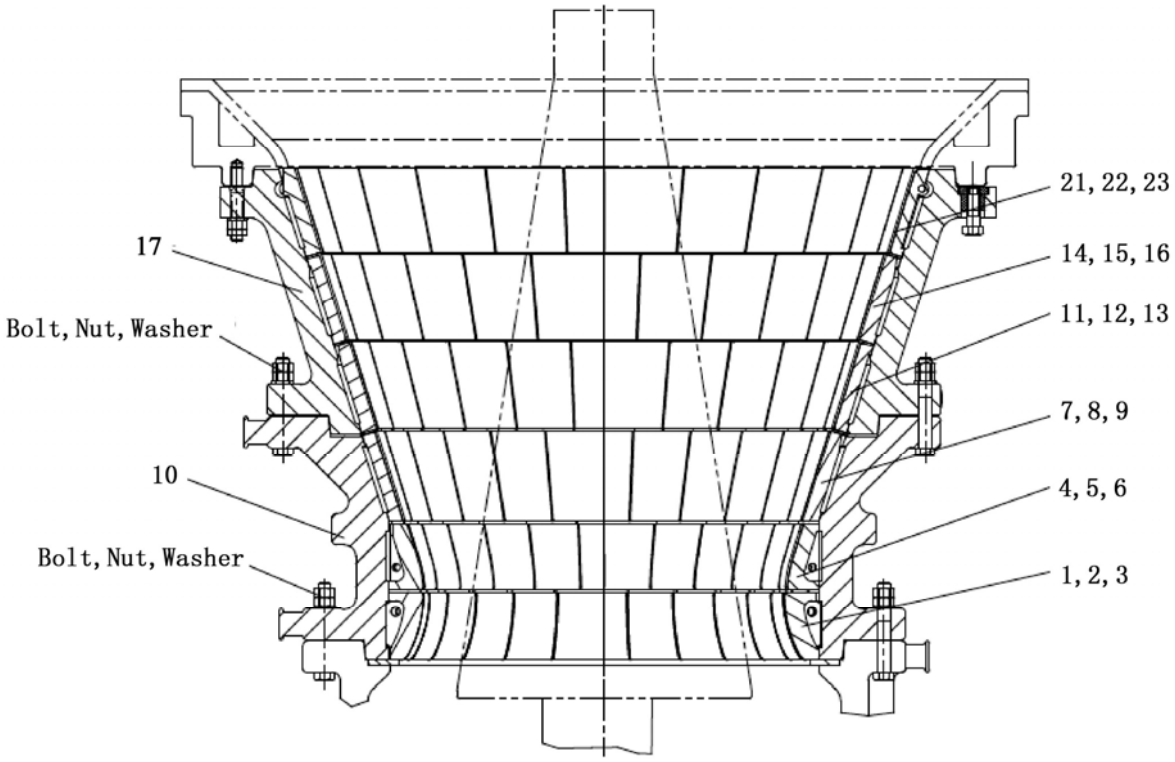


Fig. 8-1 Structure of the middle shell assembly of PXZ-1500II

Tab. 8-1 Main parts for the middle shell assembly of PXZ-1500II

No.	Part No.	Name	No.	Part No.	Name
1	G0022-1	1# Liner	10	G0022-10	Lower shell
2	G0022-2	1# Backing plate	11	G0022-11	4# Liner
3	G0022-3	1# Spacer	12	G0022-12	4# Backing plate
4	G0022-4	2# Liner	13	G0022-13	4# Spacer
5	G0022-5	2# Backing plate	14	G0022-14	5# Liner
6	G0022-6	2# Spacer	15	G0022-15	5# Backing plate
7	G0022-7	3# Liner	16	G0022-16	5# Spacer
8	G0022-8	3# Backing plate	17	G0022-17P	Upper shell
9	G0022-9	3# Spacer	18	G0022/24	Epoxy Resin

8.2 Assembly and Disassembly of the Middle Shell Assembly

The upper and lower shells of the crusher are assembled through conical spigot connecting flange. Check the upper shell and lower shell spigot tapers of their machined flange surfaces

which must be free of rust and incidental damage. Apply a thin film of oil to the horizontal plane of the upper shell and position the lower shell onto the bottom shell. Inspect the clearance of the flanges at intervals of 90 degrees. Tighten all flange bolts uniformly in a diagonal pattern. Check the connection of the shell joint for its tightness by means of a feeler gauge of 0.1mm. If any larger clearance shows that the taper fit of the frames is not completely together. Troubleshoot this by checking the spigot surface contact and correct it. There should not be any foreign material whatsoever between the two conical surfaces that could affect their tight fit.

Certain pressure is needed to separate the taper fit between the upper and lower shells. The operating procedure for this is suggested as follows:

1. Remove all bolts (or wedges) from the connection flanges of upper and lower shells.

2. Position hard steel wedges into four relevant wedge slots on the flange of upper shell.

3. Connect the upper shell to an overhead travelling crane or similar type crane and then knock four wedges uniformly into the joint by means of a sledge hammer. At the same time remove the upper shell by the aid of a steady pulling force by the crane. Be aware that when the shell taper fit is released it will cause the shell to suddenly bounce.

4. After the removal of upper shell, lubricate the machined surfaces at the joint between upper and lower shells to protect them from rusting. Then position upper shell onto a suitable timber bed and properly protect its machined surfaces.

8.3 Assembly and Disassembly of Middle Shell Concave Liner

Considering the impact of the concave liners' direct effect upon the operating cycle of the crusher, CITIC HIC's liners are designed and manufactured from material of premium wearing resistance.

A. Removal Procedure of the Shell Concave Liners

1. Remove all loose rocks and debris around the spider rim liners. At the same time remove any loose rock and debris between the rim liners and concrete dump hopper floor to make safe when removing the ring spider.

2. Removal of the Ring Spider Assembly.

3. Locate the wedge liner in the top-layer liners. It is usually located under the spider arm. It may also be found by its outer section having parallel sides. The side sections of the remaining top-layer standard concave liners are likely to be in the same radius.

4. Prior to the execution of the dismounting procedure, a safe working platform shall be constructed.

5. When removing the manganese steel concaves, it is suggested that a lifting lug be welded to each so as to ensure lifting safety. Weld the lifting lug near the top of the concave liners following the procedure below. (The first welded initial lifting lug is self-contained and supplied

by the maker to the user and is removed after site installation.)

6. Cut both vertical sides of the wedge liner from the zinc or epoxy resin by gas torch cutting.

7. Prior to removing the liners, connect the proper lifting equipment to the lifting lug. Safety regulations for proper operation and lifting procedure shall be followed.

8. When removing the wedge liners, drive a chisel into the pouring channel behind the liner. A large rock breaker hammer or pneumatic jack hammer mounted on the crane is suggested to be used to drive the chisel.

9. Remove the remaining top-layer standard liners in a safe way.

10. There is a wedge liner among each layer of liners and their removal shall be carried out according to the above procedures 4-6.

The welded lifting lug of the crusher concave liners shall be manufactured according to the following figure 8-2.

For the lifting lug size and dimensions refer Fig. 8-2, and table 8-2.

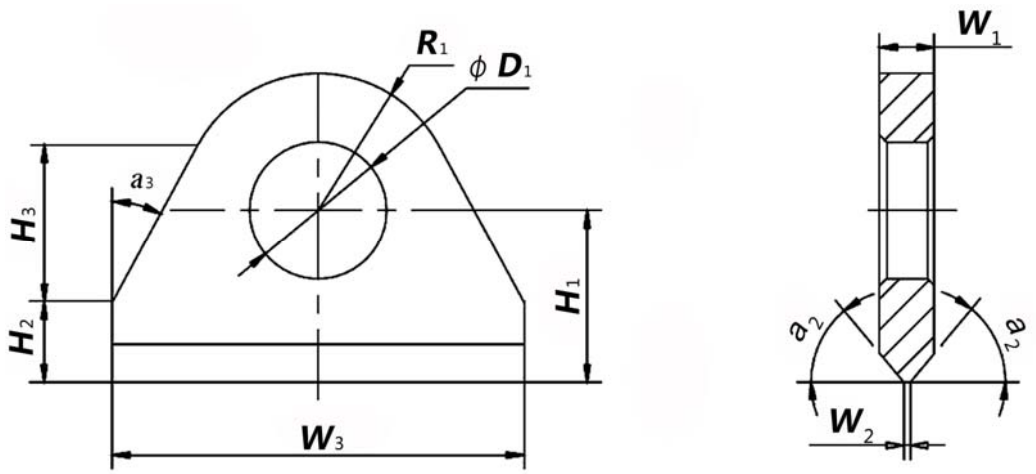


Fig.8-2 Structure of welded lifting lug

Tab.8-2 Liner lifting lug size

Code Number	Size/mm
H_1	50
H_2	23
H_3	46
R_1	40
ϕD_1	40
W_1	16
W_2	2
W_3	120
a_1	29
a_2	50

B. Fitting of the Concave Liners

Please refer section 3 For the Installation of the Concave liners.

8.4 Technical Characteristics

1. The optimized chamber design provides a superior crushing action. Any unnecessary wear on the crushing liners caused by unreasonable chamber structure has been avoided.

2. The concave liners are made from high wear resistant material so as to maximize the wear resistance effect of the liners and increase their service life.

3. The optimized design of the liners structure provides a uniform wearing profile of the liners and therefore improves the quality of the crushed product, by achieving a uniform product gradation over the liner life.

Section 9 Spider Ring Assembly

9.1 Structure and Composition of the Spider Ring Assembly

The spider ring assembly of the gyratory crusher is to provide upper main shaft support and distribution of the feed material into the crushing chamber and there is a specific taper fit between the spider and middle shell. The spider ring unit mainly includes the spider (G0021-18), spider bushing[G0021-7(2) or G0021-7(3)], spider lubrication assembly (G00213), spider cap [G0021-5(1)], spider arm liners (G0021-4) and spider ring rim liners (G0021-13). See Figure 9-1 and table 9-1 for the specific structure.

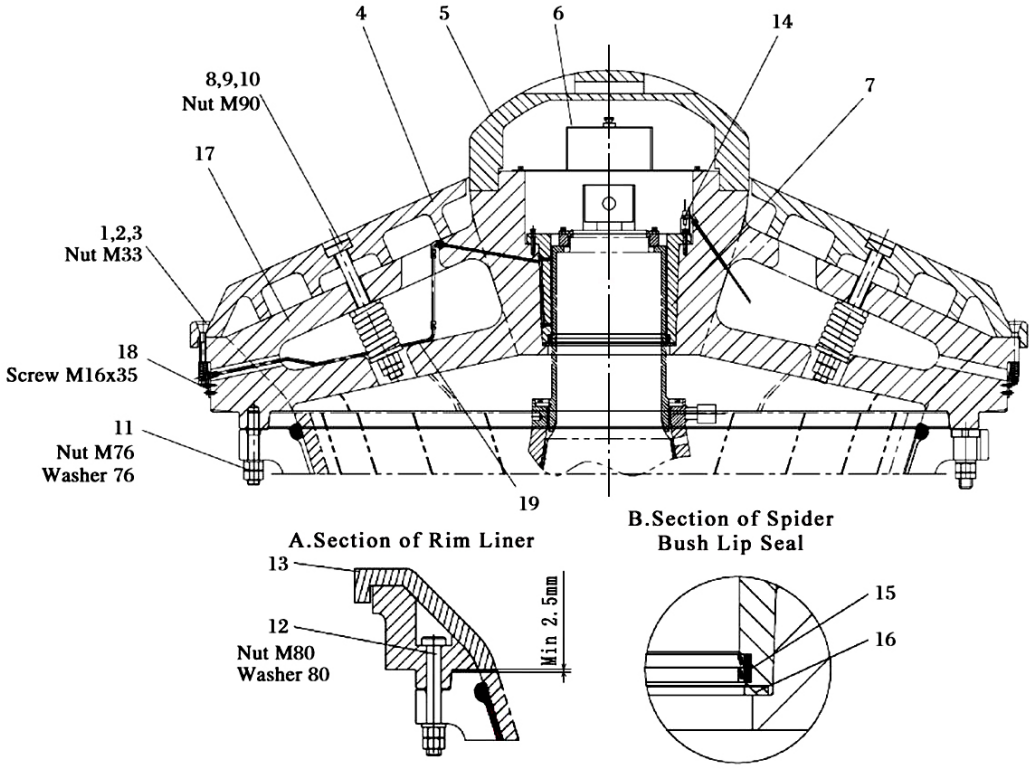


Fig.9-1 Structure of the spider ring assembly (PXZ-1500II)

Tab. 9-1 Main parts of the spider ring assembly (PXZ-1500II)

No.	Part No.	Name	No.	Part No.	Name
1	G0021-1	Square screw	10	G0021-10	Washer 90
2	G0021-2	Washer	11	G0021-11	Stud M76X480(wear part)
3	G0021-3	Spring	12	G0021-12	Connecting Bolt
4	G0021-4	Spider Arm Liner	13	G0021-13	Spider Ring Liner
5	G0021-5(1)	Spider Cap	14	G0021-14P	Oil Level Sensor
6	G0021-6P	Dustproof cover	15	G0021-16	Dust Seal Ring
7	G0021-7(2) /G0021-7(3)	Spider Bushing	16	G0021-17	Ring Gasket
8	G0021-8	Rib Liner Bolt	17	G0021-18	Spider
9	G0021-9	Locking Spring	18	G0021-19	Support Plate

9.2 Spider Ring Unit Mounted to the Shell

1. Inspect the taper fit surface between the ring spider and middle shell and remove all burrs, scratches, dust and dirty material. Apply low- viscosity oil to the horizontal joint surface of the spider ring. White lead must not be used because it will harden to make later dismounting difficult.

2. Check the jacking bolt casing and ensure the jack bolt is in a retracted position. In the case of a hydraulic frame separator, make sure that the piston is retracted.

3. Lift the ring spider assembly horizontally then lower it centrally over the main shaft and position it into the taper fit spigot surface of the middle shell. When properly seated it should remain as level as possible to ensure the connecting flanges are parallel. At intervals of 90 degrees inspect the clearance between the flanges, the clearance shall be within 1.0 - 4.0 mm. Check the contact condition of the taper fitting surfaces, the contact area shall not be lower than 70%. If the spider bush sealing ring is in place, set it around the main shaft carefully so that it will not become damaged or jammed. Note: The clearance between the bottom surface of the spider bushing and top surface of the highest liner of middle shell shall be within 2.5mm to 4 mm (See fig.1) to leave enough falling space for placing the spider taper into the taper fitting surface of middle shell. If the taper does not fit well, the stud M76 in figure 1(No. 11) is easy to break and will affect the movement path of mainshaft, resulting in damage to more related parts.

4. Tighten two bolts at intervals of 180 degrees to ensure a uniform clearance between middle shell and ring spider. Then mount two additional bolts diagonally or in other words at 90 degrees apart from the preceding ones and then ensure the same equal clearance gap is maintained. The mounting torque values all bolts shall be as same as that of the previous four bolts. Tighten the bolts in turn until a feeler gauge of 0.1mm is unable to be inserted at any circumferential flange gap position after fully tightening all the flange bolts.

5. Mount the main shaft scraper ring (backing ring) in the spider hub.

6. Mount the spider bushing seal in the spider hub.

7. After several hours of the operation of the crusher, the bolts connecting the middle shell and spider may loosen. Therefore and after a period of operation check and re-torque the bolts. During the operation of the crusher, check for any movement between middle shell and spider by means of a feeler gauge of 0.1mm. In case of any interaction, the feeler gauge can be inserted into the clearance between the spider and middle shell. The vibration can also be felt by touching the joint. Any movement indicates a poor taper fit, therefore again re-torque the ring spider connecting bolts.

9.3 Spider Air Ventilation Unit

The spider air ventilation unit provides ventilation of the oil storage tank unit of the spider

bearing which exhausts any dust. This unit includes the vent valve, cover board, cover seal ring and fasteners. The spider bush cannot be repaired until these assemblies are dismounted.

9.4 Spider Bushing

The PXZ-1500II gyratory crusher adopts hour-glass type spider bushing with the casting material of ductile cast iron. The spider bushing and spider bore are of taper fitting. The spider bushing bore matches with the main shaft sleeve. See the Fig. 9-2 for its section view, and see Fig. 9-3 for the structural dimension of spider bore.

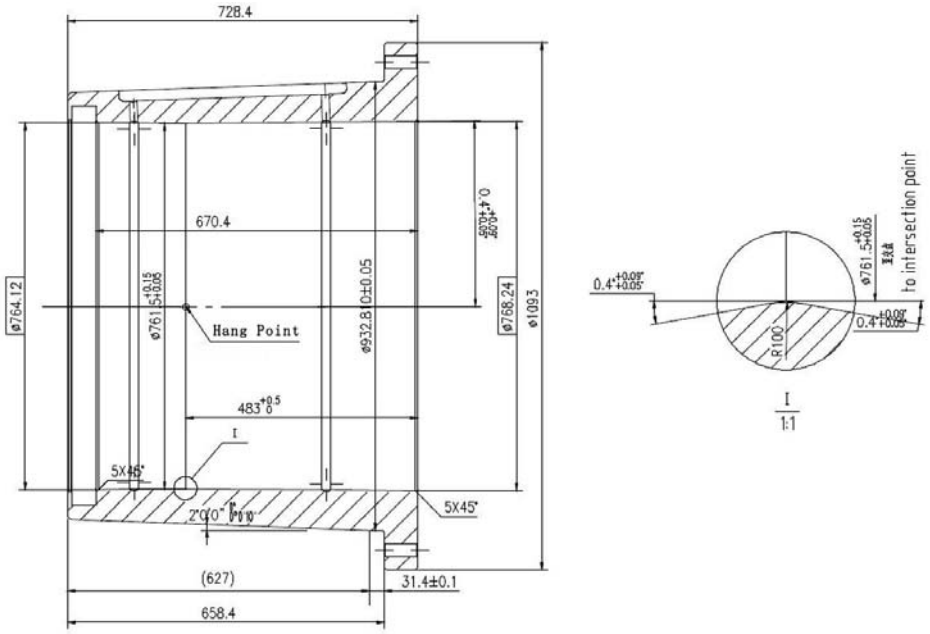


Fig.9-2 Section view of hour -glass type spider bushing

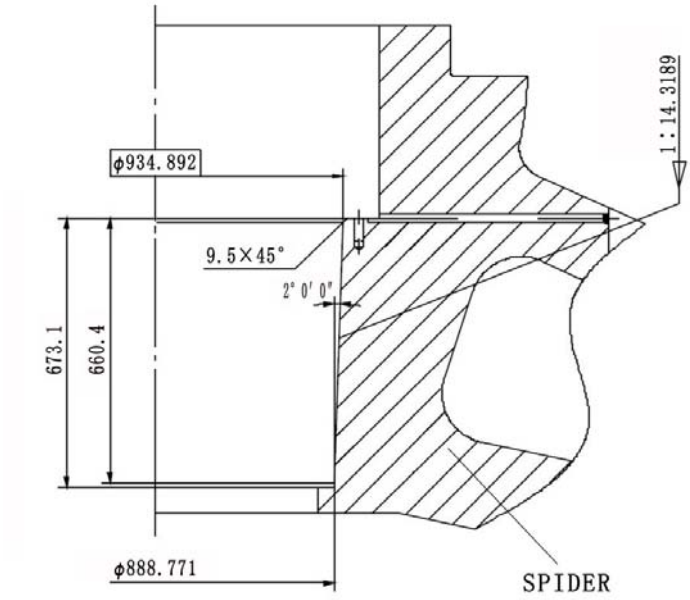


Fig. 9-3 Section dimension of spider bore

A. Removal of the spider bushing

During assembling of the crusher, the spider bushing can be removed from the upper shell. First remove the spider bushing bolts and washers. Screw the threaded jacking screw into the tapped holes in the spider bushing flange so as to evenly withdraw the bushing. Prior to the removal of

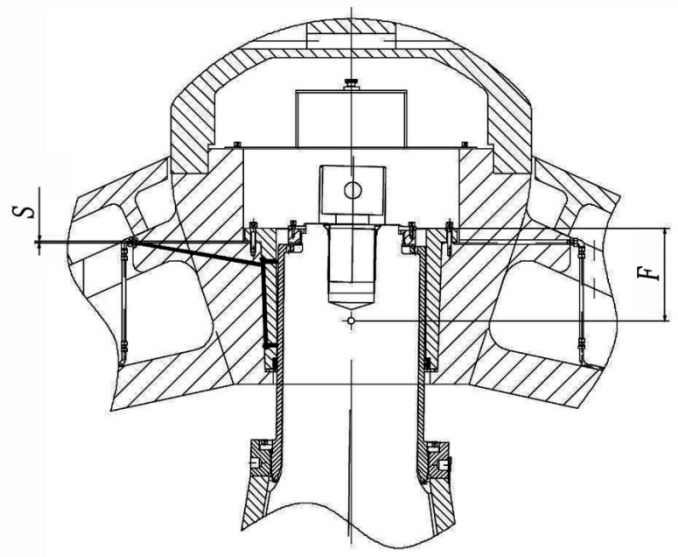


Fig. 9-4 Height value F from flange upper face of spider bushing to the hang point of main shaft, and mounting clearance S of spider bushing flange

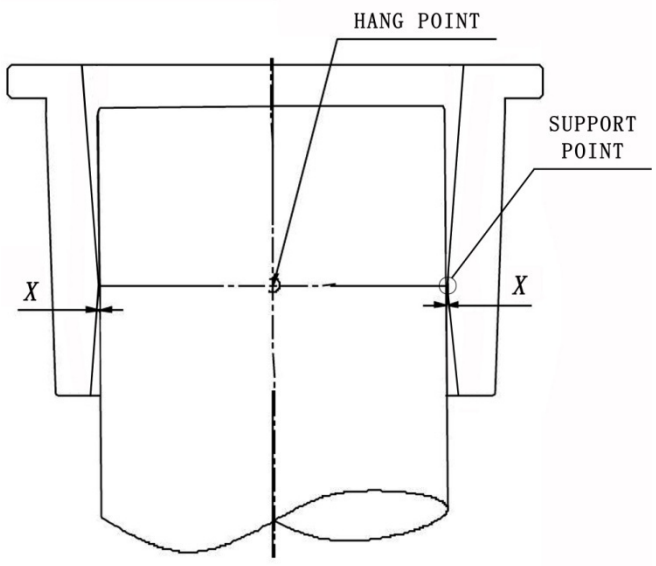


Fig. 9-5 Clearance X between spider bushing and main shaft

the bushing from the crusher, firstly check for the clearance between the spider bushing and the main shaft sleeve at the pivot point (The pivot point refers to the point of the smallest diameter of the hour-glass type spider bushing). The measurement method is in subsection C of this section. If this clearance is equal to or greater than the specified value X (see fig. 9-5 and table

9-2), both bushings or one of them must be replaced. Check the surfaces and dimensions of the bushing. In case of any wear or serious surface marks, it should be discarded. Similarly check the main shaft sleeve and replace it if necessary.

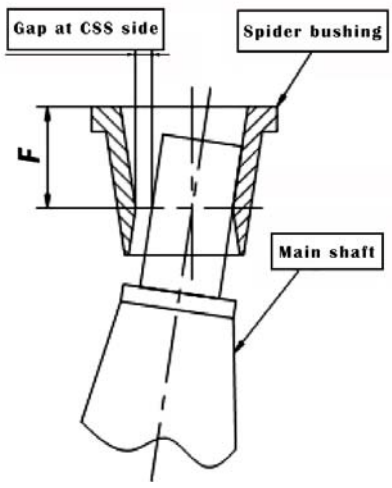
Tab.9-2 Mounting clearance of spider bushing

Crusher Specification	F Value/mm	X Value/mm	X Allowable Max. Value/mm	S Value/mm
60X89 (PXZ-1500II)	483	0.815～0.9275	2.0	1.0～3.0

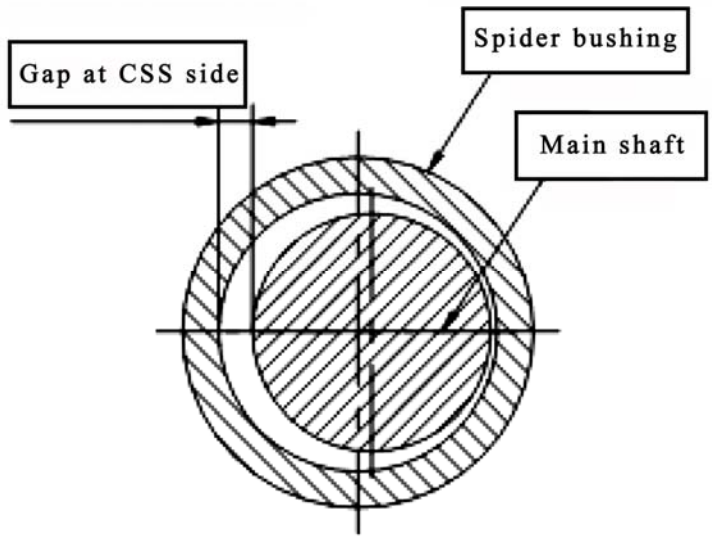
B. The mounting method of spider bushing

In the case of fitting a new bushing, the inside and outside surfaces of the spider hub shall be inspected prior to installation. Check wether the new bushing can rotate inside the spider hub or not to ensure they are a light press fit. If the new bushing rotates inside the spider hub, the spider hub will be enlarged after long-term operation of crusher; If the diameter of the spider hub is greater than that of the bushing, the spider hub will be also enlarged after long-term operation of crusher, under this condition the crusher shall not be installed and operated. This problem can be solved by ordering an oversize spider bushing to match the spider or remachining the spider hub. It is suggested that the latter be preferred because the standard bushing can be used for future replacement. After locating the bushing into the spider hub, there will be a clearance of about 1.0～3.0 mm between the bottom surface of the bushing flange and the spider top surface. Use spider bushing bolts (M24) to fasten the flange and spider. Tighten the bolts uniformly to prevent the bushing from moving up in the spider hub. The recommended maximum tightening torque is 686N·m. The tightening condition of these bolts shall be inspected regularly, to prevent the bushing from loosening.

C. Measuring method for the clearance between spider bushing and mainshaft sleeve



（a）side view



（b）top view

Fig. 9-6　Sketch for position of gap between spider bushing and main shaft

1) Measuring tools ： ①A group of thickness gauge with different size as following 1.5mm, 2mm, 2.5mm, 3mm, 3.5mm and 4mm (the measuring tool is as indicated in the attached drawing).②　Roundness gauge.

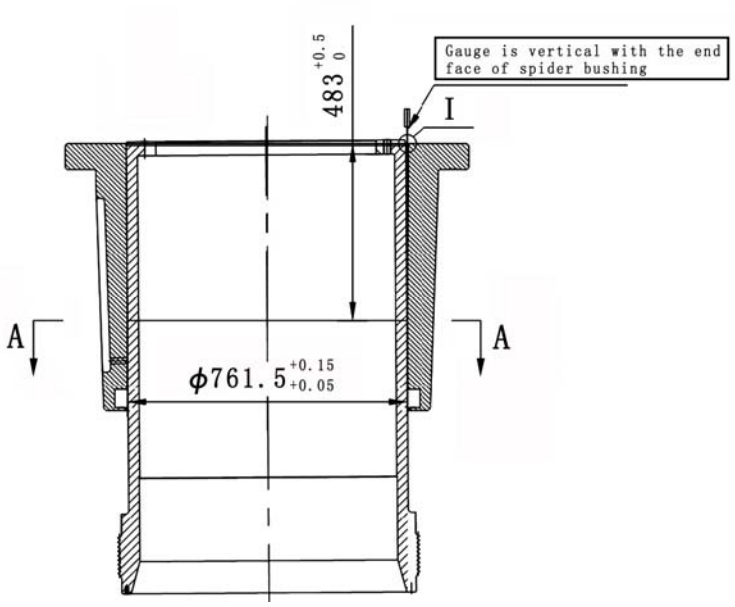


Fig. 9-7　Sketch of gauge to measure the gap

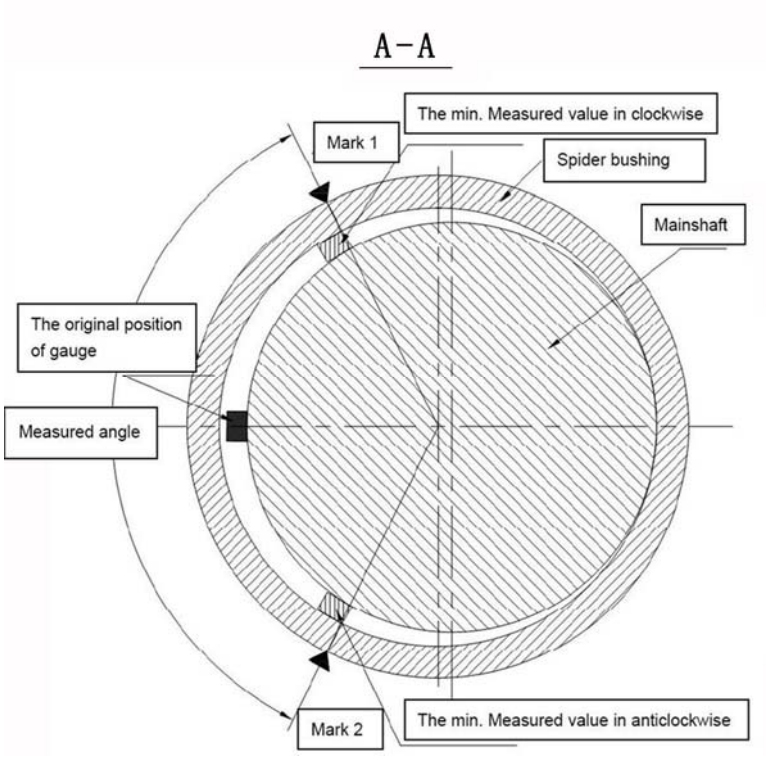


Fig.9-8 Sketch of gauge measurement method

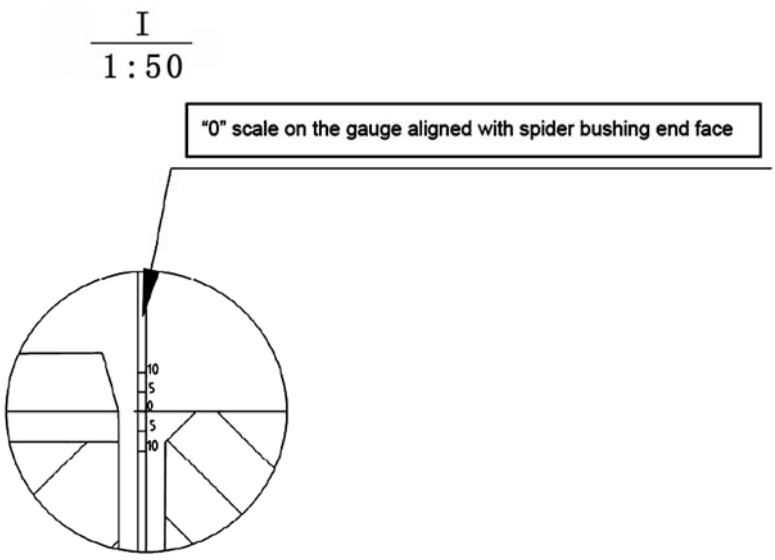


Fig.9-9 Partial enlarged drawing

2) Measuring methods:

①To check if the assembly between main shaft and spider bushing is right or not.

②Before measure the gap of spider, shall confirm the main shaft is located at the right operation position (Here the right position is referring to when the cylinder plug lifting height is around 50mm above, then operate crusher in a normal condition. Finally after stop the operation of crusher, the position of main shaft is the right operation position) see figure 9-6.

③Before measurement, cannot move the main shaft after crusher stop operation, shall keep the original heeling condition of it.

④To measure the gap between spider bushing and main shaft at CSS side. Shall using a group of thickness gauge with different sizes to the gap between spider bushing and main shaft until get the max. gap with the most thickness gauge.

⑤Turn the gauge in item 2.4 in clockwise at the direction of inner circle of spider bushing until the gauge cannot be moved. Then do the marking 1 on the spider bushing, which is corresponding to the location of this gauge as indicated in A-A view. Please refer to figure9-7 and 9-8.

⑥Turn the gauge in item 2.4 in anticlockwise at the direction of inner circle of spider bushing until the gauge cannot be moved. Then do the marking 1 on the spider bushing, which is corresponding to the location of this gauge as indicated in A-A view. Please refer to figure 9-7 and 9-8.

⑦Take the central point of spider bushing as the center, the angle after connecting mark 1 and mark 2 is as indicated in A-A view. Please refer to figure 9-8.

Note：

1. Since when the width of gauge is 10mm, there will be a tolerance with 0.04mm due to the width of gauge itself.
2. When the spider bushing horizontal plane keep aligning with the location belowed of gauge is the position of min. gap between spider bushing and main shaft (as indicated in figure 9-9).
3. For the position of measured height, please refer to the upper sketches.

9.5 Spider Bushing Sealing

The seals of the gyratory crusher spider bushing are pressed into a closed cell below the spider bushing. A double oil seal is fitted with its lip facing downward or the seal facing upward. When replacing the seal ring, dismount the spider bushing and then take the seal ring out of the spider bushing.

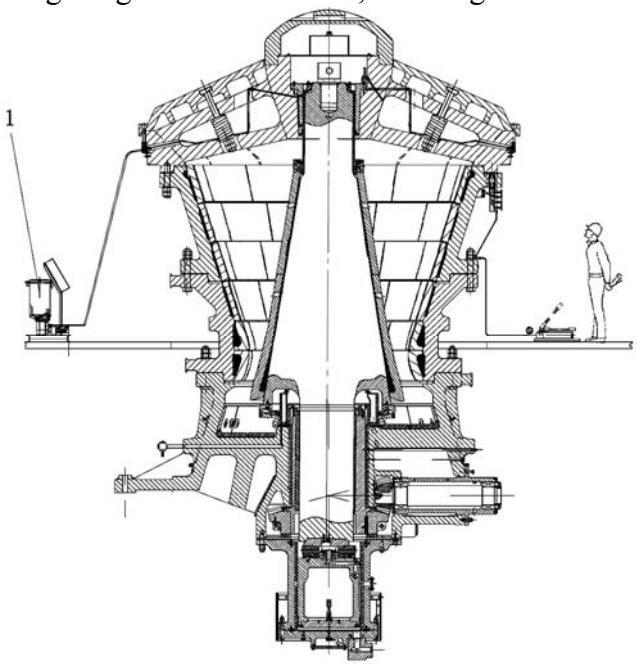
9.6 Spider Lubrication System

The standard configuration of the crusher includes an automatic spider lubrication system. This system includes a spider lubrication cylinder type atomizing pump, spider lubrication drive unit, spider lubrication local/remote switch, oil level sensor, oil transportation hose and other parts. Refer to Figure 9-10(a) , Figure 9-10(b) and Table 9-3 for grease lubrication piping layout . A good lubrication can be achieved by means of this grease lubrication system, so as to reduce the wear and corrosion caused by inadequate lubrication. Besides, the high-level automation of this lubrication system reduces the cost of maintenance and operation.

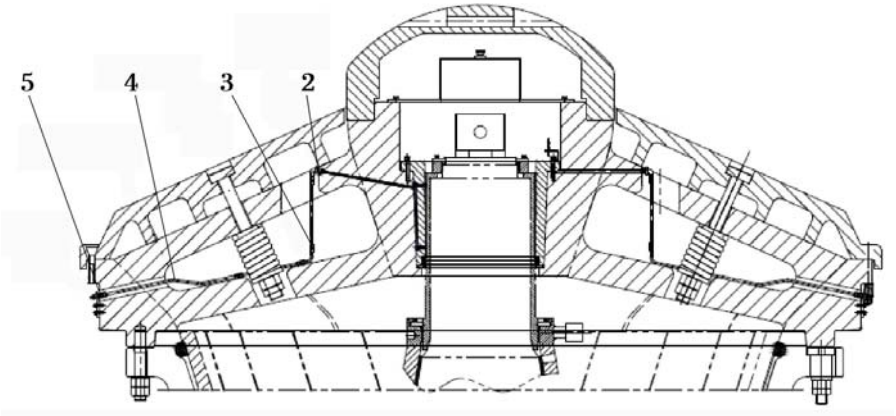
The standard configuration of the crusher includes an automatic lubrication system for the spider, which consists of a barrel pump, a driving unit, local/remote control switch, oil level sensor and

oil hose. The system can display the signals such as the setting of opening time, the alarm of high and low oil levels , the operation of pump motor, the operation of oil-feed pump motor and failure, and can be controlled locally and remotely. It is mainly used for the lubrication of spider bushing of the gyratory crusher with the mode of intermittent oiling. The initial setting is that the grease is added 5min every hour. The opening time of the grease pump is controlled by a control program and the opening of grease pump is interlocked with the temperature sensor on the spider; once the temperature sensor is above a certain temperature,the grease pump starts and feeds. If the grease pump can not start normally, the crusher stops.

The piping layout and structure of the grease lubrication for PXZ - 1500 type gyratory crusher are shown in figure 9-10 (a), figure 9-10 (b), and table 9-3, and its main parameters are in table 9-4. automatic lubrication of the spider can be well achieved through this system, thus minimizing wear and erosion phenomena caused by insufficient lubrication. Besides, the lubrication system is of a high degree of automation, reducing maintenance and operating costs.



(a) Overall Section



(b) Partial Section

Fig.9-10　Spider Grease Lubrication System（PXZ-1500II）

Tab. 9-3　Accessories list of grease lubrication pipeline （PXZ-1500II）

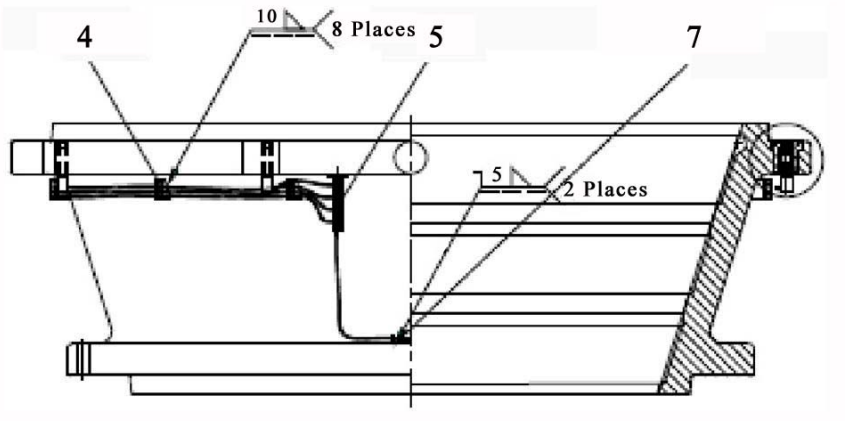
No.	Part No.	Name
1	G00213/1	Grease Lubrication Station
2	G00213/2	Pipe Joint F-WE-L18X3R1/2K
3	G00213/3	Pipe Joint W-GV-L18X3
4	G00213/4	Cooling pipe φ18X3X6200
5	G00213/5	Pipe Joint W-WV-L18X3

Table 9-4 Parameters of grease lubrication system

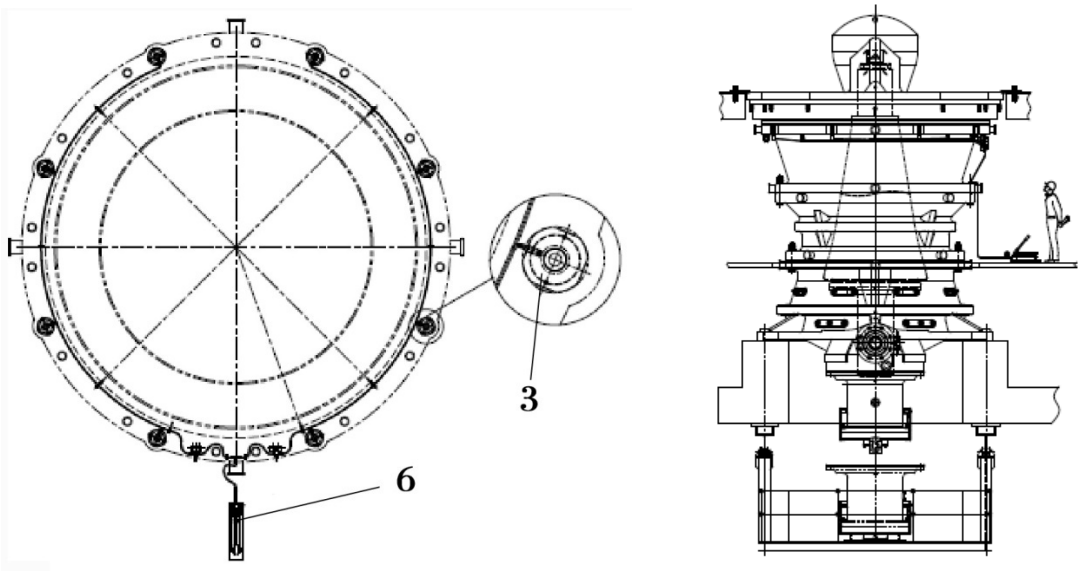
No.	Name		Value
1	Type of **grease lubrication unit**		BM-B
2	Voltage		400VAC 60HZ
3	Max.working pressure		40MPa
4	Flow		37mL/min
5	Oil level switch		mechanical leve switch
6	Motor	Type	SCR
		Power	0.37kW
		Protection class	IP55
		Temperature rise class	B class
		Insulation class	F class
7	Grease range		000#～2#NLGL

9.7　Spider Hydraulic Jacking Unit

Spider hydraulic lifting unit is used to assist in dismounting the spider by using the push force of the hydraulic cylinder to separate the fit conical surfaces of the spider and middle shell. See Figure 9-11 (a), 11(b),11 (c) and Table 9-5 for spider hydraulic jack-up structure and layout type.



(a) Partial view



(b) Top view **(c) Overall layout**

Fig. 9-11 Hydraulic jacking device for the spider unit (PXZ-1500II)

Tab. 9-5 Parts list of hydraulic jacking device for crusher（PXZ-1500II）

No.	Part No.	Name
1	G00214-1P	Locking nut
2	G00214-4	Rubber ring
3	G00214/3	Hydraulic oil cylinder unit
4	G00214-5P	Pipe clamp
5	G00214-8P	Bottom shell of Oil Circuit Block
6	G00214-9P	Bottom shell of manual pump
7	G00214-10P	Frame of oil pipe

Refer Table 9-6 for major parts of jacking cylinder (G00214/3).

Tab.9-6 Parts list of hydraulic cylinder

No.	Name	Model	Qty.	Remarks
1	Manual Pump	P-80	1	
2	Pressure Gauge	G2535L	1	
3	Pressure Gauge Fitting	GA-3	1	
4	Oil Circuit Block	AM-41	2	
5	Tee Joint	FZ1612	2	
6	Male Joint	CH604	10	
7	Rapid Joint	C604	16	
8	Cylinder	RC-108	8	With A-152G saddle and joint
9	Main pipeline assembly		1	Connect main pipeline and oil circuit block piping
10	Auxiliary pipeline assembly		2	Connect oil circuit block and each cylinder piping
11	1# Hose Assembly		2	Connect cylinder and oil circuit block
12	2# Hose Assembly		2	Connect cylinder and oil circuit block
13	3# Hose Assembly		2	Connect cylinder and oil circuit block

9.8 Technical Characteristics

1. The ring spider unit is manufactured as an integral casting and its construction is optimized by means of such technical method as FEA, which provides a higher strength, lower stress on components and therefore a longer service life.

2. The automatic lubrication system of the spider meets the lubrication requirement of the spider bush and main shaft sleeve and therefore increases the service life of both parts and reduces the maintenance cost.

3. The ventilation unit of the spider provides a clean lubricating operating environment under the worst working conditions, therefore avoids possible wear generation caused by foreign particle ingress, and therefore increases the operating up time and reduces the cost of maintenance.

4. The application of such units as the oil level sensor intensifies the functional control of the lubrication system, making the lubrication system more stable and reliable.

Section 10 Hydraulic Assembly

10.1 Structure and Composition of the Hydraulic Assembly

The Hydroset oil cylinder of the PXZ-1500II gyratory crusher includes interconnecting oil cylinder, middle and lower thrust bearings, plunger , position transducer and other associated parts. See Fig. 10-1 for the details and see table 10-1 for the main parts list.

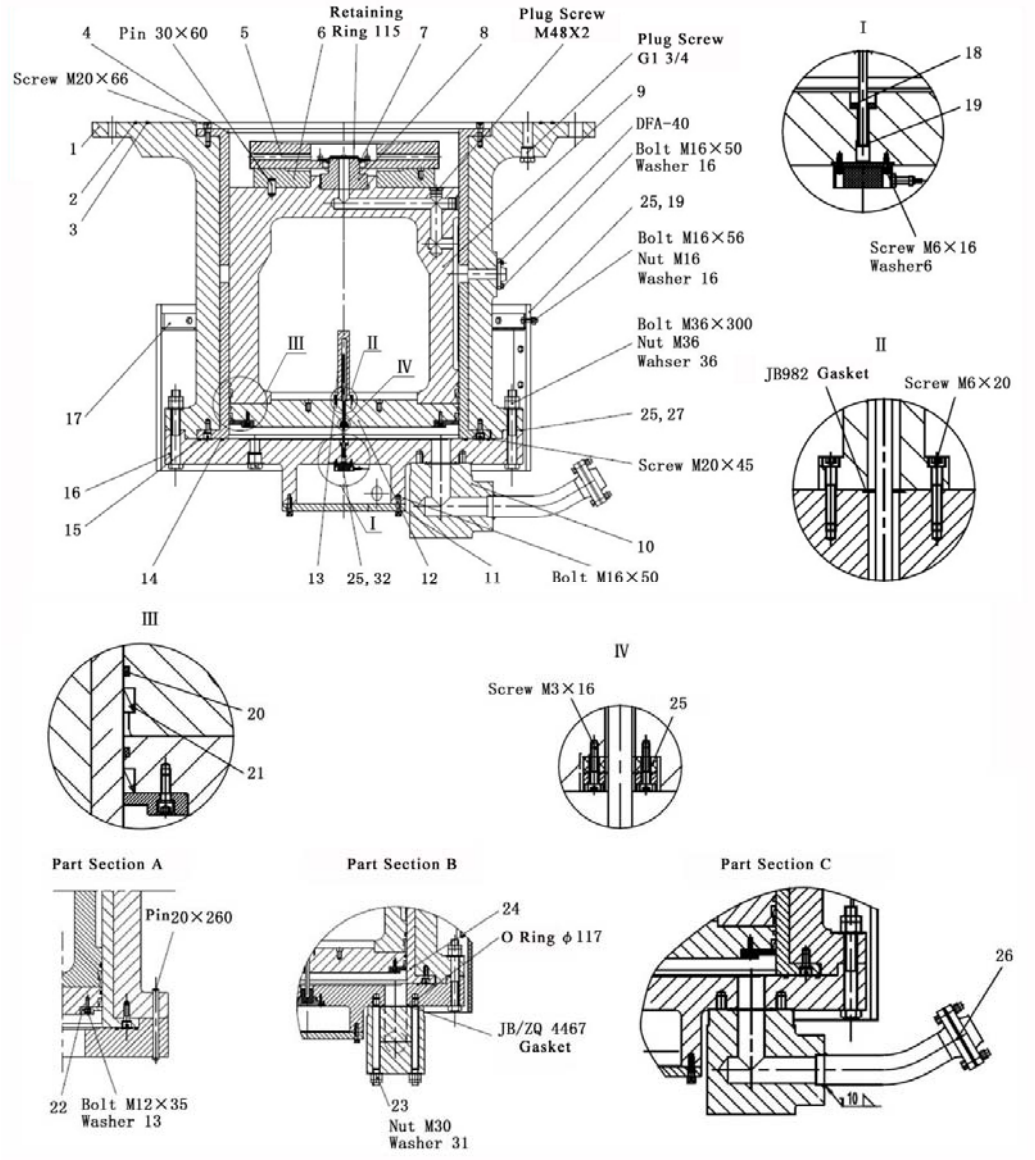


Fig. 10-1 Hydraulic unit structure of PXZ 1500II gyratory crusher

Tab.10-1 Main parts list of the hydraulic cylinder.

No.	Part No.	Name	No.	Part No.	Name
1	G0025-1	Cylinder sleeve	16	G0025-16	Cylinder bottom
2	G0025-2	O ring φ1750	17	G0025-17P	Protection frame
3	G0025-3	O ring φ1650	18	G0025-18	Insulation pad
4	G0025-4	Upper bushing of cylinder	19	G0025-19	Seal ring
5	G0025-5(1)	Middle friction disk	20	G0025-20	O ring φ955
6	G0025-6	Lower friction disk	21	G0025-21	Y2 seal ring
7	G0025-7(1)	Clamp ring	22	G0025-22	sealing clamp plate
8	G0025-8	Nut	23	G0025-23	Double head stud
9	G0025-9	Plunger	24	G0025-24	O ringφ117
10	G0025-10	Oil circuit block	25	G0025-25	Lower bushing of cylinder
11	G0025-11	Base plate	26	G0025-26P	oil pipeline
12	G0025-12	Plunger plate	27	G0025/19	Protection hood
13	G0025-13	Protection sleeve	28	G0025/26	Industrial paper φ1460/φ1296 δ=0.5
14	G0025-14	O ring φ1018	29	G0025/46	Magnetic ring BTL-P-1013-4R
15	G0025-15	O ring φ1208	30	JB/T982-1977	Sealing gasket 22

10.2 Installing and Removal of the Hydraulic Cylinder

The hydraulic cylinder is fitted to the bottom shell hub and supports the main shaft assembly as well as bearing the axial crushing forces. There are three friction disks on the upper part of oil cylinder. The thrust bearing (upper friction disk) of spherical surface is fixed onto the bottom end of main shaft ; the piston wear plate(lower friction disk) is fixed on the plunger; the thrust bearing gasket(middle friction disk) is of concave spherical surface with flat undersurface. During operation of the crusher, there is relative movement between the concave spherical surface and flat undersurface of the intermediate friction disc and the upper and lower friction disc. The discharge opening of the crusher can be adjusted by changing the volume of the hydraulic oil into the hydraulic cylinder.

Service equipment provided with crusher includes tools used to remove and assembly the hydraulic cylinder. These tools include rolling wheel, sliding track and pushcart; these tools can also be supplied by the OEM.

If the hydraulic cylinder assembly requires repairing the complete assembly should be removed from crusher. Raise the main shaft and support it on the bottom shell frame arms by using timber supports. The weight of main shaft will not be totally on the hydraulic cylinder. Disconnect the connecting lubrication and hydraulic lines, remove the bottom shell oil drain plug which is in bottom of the hydraulic cylinder flange, and drain lubricant out of crusher. Remove the bin sensor and wiring if supplied.

During hydraulic cylinder removal, the eccentric assembly would normally remain in place, unless it also needs to be repaired. The eccentric support plate which is fixed by socket head cap screws can support the when the hydraulic cylinder is removed. Place a jack and some suitable square timbers under the hydraulic cylinder, to assist in its easy removal. Extend the jack until it

can totally support the hydraulic cylinders weight. Insert the threaded guide rods into the tapped stud holes in the support plate by removing two of the studs. Unscrew the guide rod nuts a distance equal to the maximum jack shaft extension. Then lower the hydraulic cylinder down to nuts until supported by the jack. Repeat the above steps until the hydraulic cylinder can be fully removed. Place hydraulic assembly on the removal trolley and then pull out from under the crusher.

When the hydraulic cylinder is removed from crusher, the thrust bearing shim and wear plate of plunger can then be removed from top of the plunger. A lifting lug should be screwed into the hole located in the plunger centre, and it can be then lifted from the hydraulic cylinder.

Check the "Y" type seal (G0025-21) of the plunger plunger to see whether it is damaged or not, if damaged, replace it. A pressure test of 7.5MPa should be performed and maintained for 15min, without any hydraulic oil leaking during the test.

A. Bushing disassembling

Remove the retaining screws from the upper bushing (G0025-4), then screw the extracting bolts into the tapped holes of the upper bushing from the cylinder. The lower bushing (G0025-25) can only be removed from the bottom of the cylinder by screw extracting bolts into the tapped holes of the lower bushing and extracting the lower bushing from the cylinder.

B. Bushing assembling

The upper and lower bushings (G0025-4/25) and cylinder sleeve (G0025-1) are a light-pressure fit. Prior to assembly, the inner wall of the bushing and cylinder must be clean. Use dry ice to cool the bushing, this large bushing may be slightly elliptic, but this will not affect the installation after the dry ice has cooled. Install the cooled bushing into cylinder sleeve, for this large diameter bushing, when installing you can use guide rods.

C. Installation of cylinder bottom seal

The plunger plate (G0025-12) and sealing clamp plate (G0025-22) are removed together. Remove the clamp plate used to fix "Y"-type seal and take out the "Y" type seal ring (G0025-21); put new Y-type seal ring into the plunger plate (G0025-12), then install the sealing clamp plate (G0025-22), using bolts to fix the sealing clamp plate (G0025-22) in place.

D. Installation of cylinder bottom

Prior to installation, make sure that the cylinder bottom is clean. Insert the "O" ring-type seal ring (G0025-14/15) at the cylinder bottom (G0025-16). Position the dowel pin φ20×260 in the cylinder sleeve (G0025-1). Use three threaded rods to lift the cylinder bottom (G0025-16) to contact the cylinder sleeve (G0025-1), and then tighten the connecting bolts alternatively. After the installation of cylinder bottom, install the BTL displacement transducer into the cylinder bottom.

See fig. 10-2 for the installation instruction for cylinder bottom of PXZ-1500II.

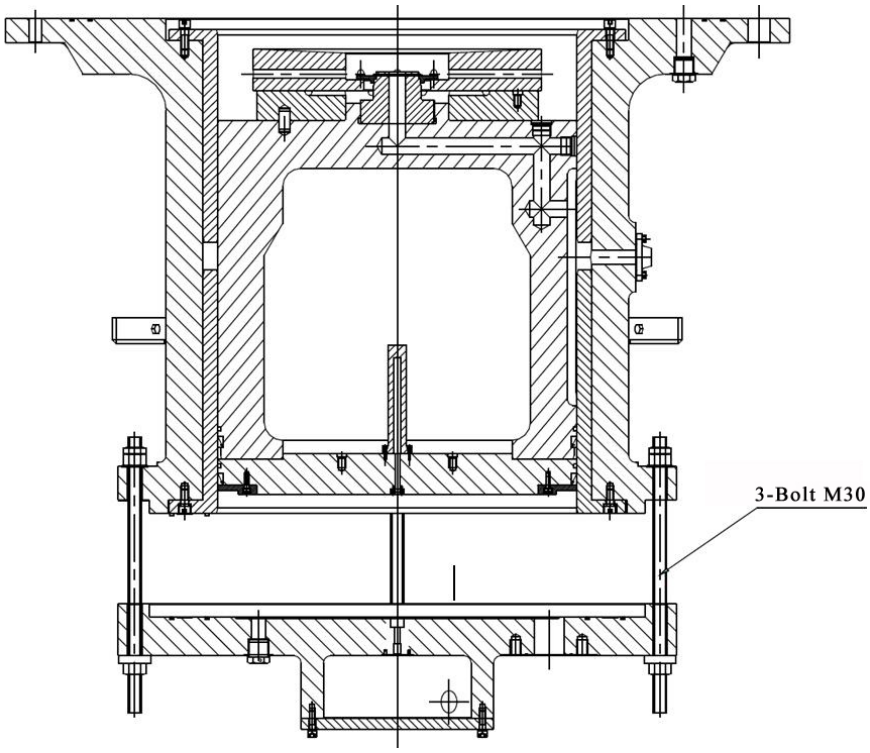


Fig. 10-2 Installation of cylinder bottom of PXZ-1500II

E. Removal of the middle friction disk and lower friction disk

First remove the elastic collar 115 and take out the clamp ring [G0025-7(1)]. Insert a threaded rod into the middle friction disk[G0025-5（1）] and take out middle friction disk. Then screw an M20 eye bolt into the lower friction disk (G0025-6) and remove. If the plunger (G0025-9) is not to be replaced, it is not necessary to remove the nut (G0025-8).

F. Installation of middle friction disk and lower friction disk

The Lower friction disk (G0025-6) is a wear part and needs to be replaced regularly. Prior to installation of a new lower friction disk (G0025-6), install the dowel pin into the plunger (G0025-9) and the nut (G0025-8) on the plunger. Install the lower friction disk (G0025-6) on the upper surface of plunger, install the middle friction disk (G0025-5) onto the lower friction disk and then install the clamp ring (G0025-7) and elastic collar 115(Products of German standards DIN 471 can be chosen).

See fig.10-3 for the mounting of middle and lower friction disk. See table 10-1 for the main parts list.

In order to leave enough space for middle friction disc, an axial clearance of 7.5mm and a longitudinal clearance of 20mm should be left between the bottom surface of clamp ring and the counterbore in middle friction disc to effectively prevent mainshaft during movement form driving the middle friction disc to impact the clamp ring , thus avoiding the damage and drop of

the clamp ring. The specific installation dimension is shown in figure 10-4.

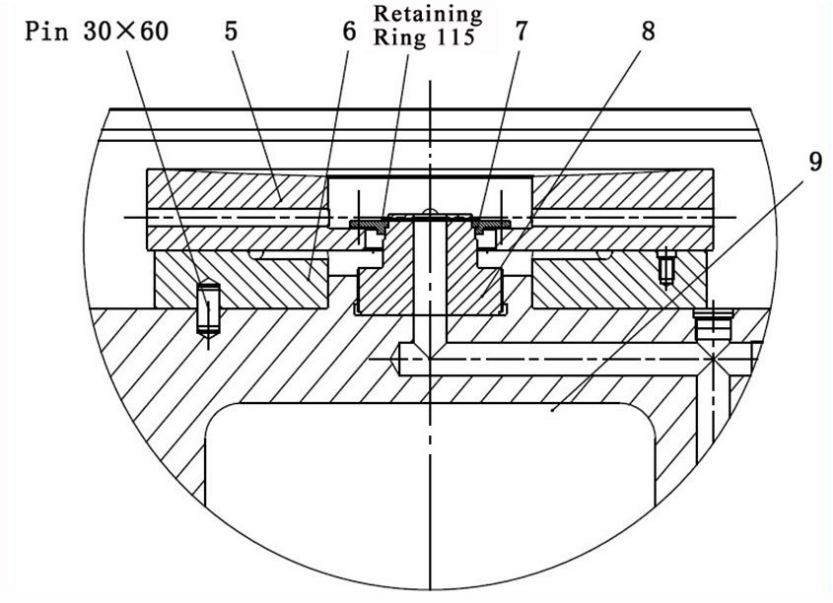


Fig.10-3 Assembly drawing for middle and lower friction disk of cylinder unit of PXZ-1500II

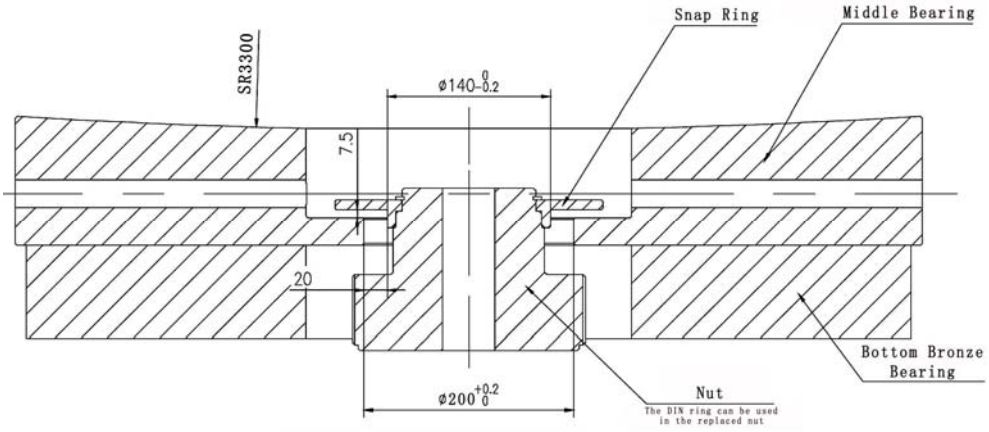


Fig.10-4 Position relation of middle friction disc and end clamp ring

10.3 Technical Performances

1. With the help of modern measuring and testing techniques, the relative height of the cylinder plunger can be controlled with a displacement transducer, thus providing the accurate control of the discharge outlet gap on the basis of its worn condition.

2. Real-time monitoring for hydraulic pressure can be provided with an oil pressure sensor. In case of an overload caused by tramp iron, closed loop gap adjustment control is achieved to avoid damage to the machine caused by the above-mentioned phenomena.

3. The user can provide the accurate control of the crushed stock in the discharge bin as required by allocating a bin level control system; the crusher's productivity capacity can then be

accurately controlled based on the material stock .

4. The thrust bearing support structure of the main shaft makes it more convenient for the adjustment of the discharge outlet, whilst providing overload protection against excessive tramp iron, thus making the entire crushing process more easily controlled.

Section 11 Other Parts

11.1 Fan and Motor

11.1.1 Fan Unit

The fan is used to provide positive air pressure for the internal lubrication system of the crusher and to protect the lubrication system against dust entry damage. So trying to prevent foreign material entering into the lubricant can assist in dust-proofing and prolonging the overall service life.

See Figure 11-1 and Figure 11-2 for the installation and structure of the fan unit.

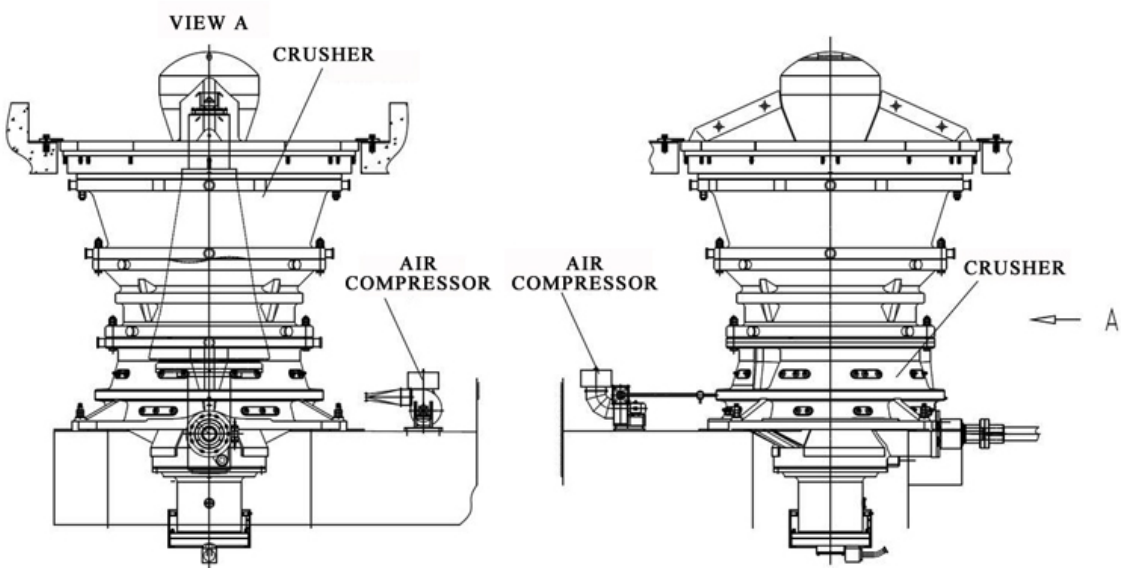


Fig.11-1 Installation for the Fan Assembly of Gyratory Crusher (PXZ-1500II)

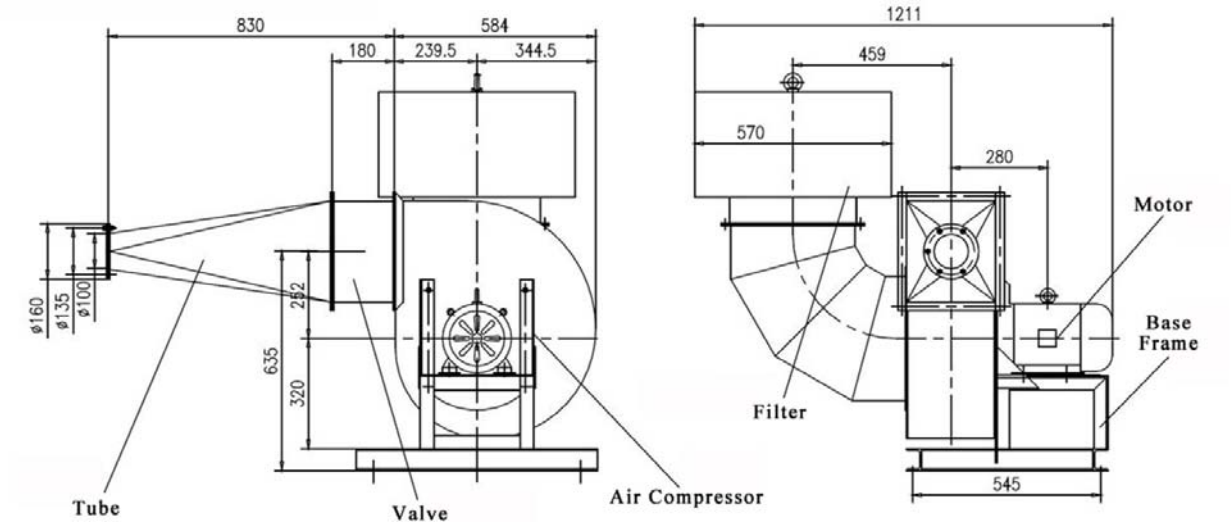


Fig. 11-2 Structure of the Fan Assembly of Gyratory Crusher (PXZ-1500II)

11.1.2 Motor Unit

The motor unit includes the electric motor and its fixing and support device (motor base), which connects to the drive unit through a drive shaft or other drive mode and therefore drives the crusher pinion shaft, achieving the dynamic operation of the gyratory crusher. See figure 11-3 and table 11-1 for the installation position and structure of the crusher motor.

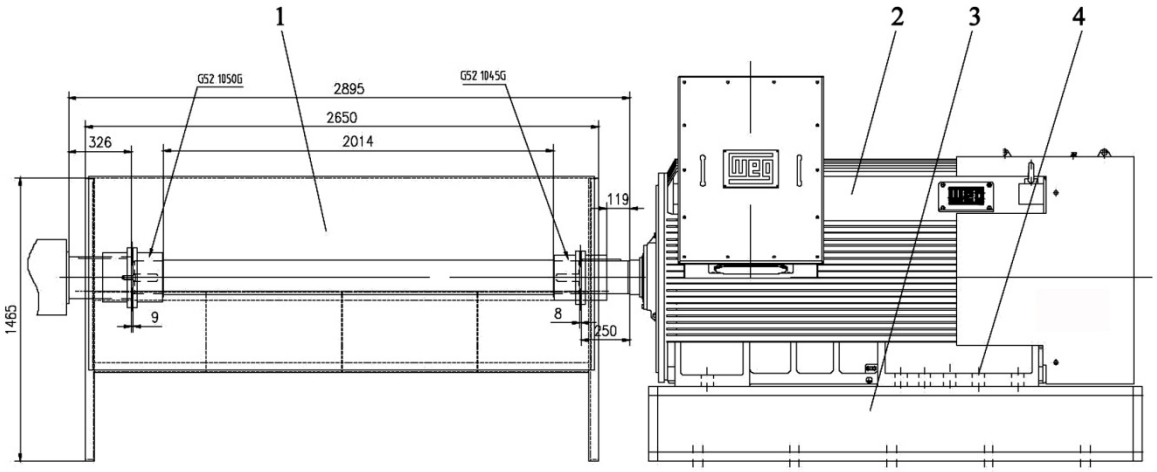


Fig.11-3 Installation drawing for motor unit （PXZ-1500II）

Tab.11-1 Parts list of motor unit （PXZ-1500II）

No.	Part No.	Name
1	G0028-1P	Protection hood
2	G0028/2	Motor HGF 560L 630KW 12P 4000V 60HZ
3	G0028-2P	Motor base
4	GB/T 5782-2000	Bolt M36×150
5	GB/T 6170-2000	Nut M36
6	GB/T 6172.1-2000	Nut M36

Main motor is used to drive the the crusher, which is quipped with a heater and platinum thermal resistance that detects the temperature of the motor. The temperature of the motor can be interlocked with the active shutdown of the crusher. Main parameters and performance of the crusher are shown in table 11-2, table 11-3, table 11-4.

Tab.11-2 Crusher motor identification

NO.	Name	Parameter	NO.	Name	Parameter
1	Frame	560L	19	Insulation class	F
2	Output	630kW	20	Temperature rise	75 °C
3	Frequency	60Hz	21	Locked rotor time	12 s
4	Poles	12	22	Service factor	1.15
5	Rated speed	596 rpm	23	Duty	S1
6	Slip	0.67 %	24	Ambient temperature	45 °C
7	Rated voltage	4000 V	25	Altitude	1000 m
8	Connection	Y	26	Protection Degree	IP55W
9	Rated current	136.7 A	27	Cooling	TEFC (IC411)
10	Rotor voltage	Not applicable	28	Mounting	B3R(E)

11	Rotor current	Not applicable	29	Vibration	A 2.8 mm/s rms
12	Locked rotor current	1094 A	30	Approx. weight	8600 kg
13	LRC (p.u.)	8	31	Moment of inertia	226 kgm2
14	kVA/kW	12.03	32	Noise level	85 dB(A)
15	No load current:	85.3 A	33	Direction of rotation	BOTH
16	Rated torque	10095 Nm	34	Starting method	DIRECT
17	Locked rotor torque	220 %	35	Coupling	DIRECT
18	Breakdown torque	330 %			

Tab.11-3 Crusher motor main parameters

Output	50%	75%	100%
Efficiency(%)	94.2	94.5	95
Power factor	0.5	0.62	0.7

Tab.11-4 Crusher motor notes/accessories

- SPACE HEATER : 110-127/200-240 V,300 W - GROUNDING LUG TRIPLE (STAT CR/ACCESS/FRAME) - 3CT+CAPACITOR+LIGHTNG ARRESTER - OVERSIZED STEEL TERMINAL BOX - ELECTRICALLY INSUL NDE BEARING - PAINTING PLAN : 212P - FINAL COLOR : MUNSELL N 6.5 - TEMPERATURE DETECTOR : PT100 2 PER PHASE 3 WIRES, - TEMPERATURE DETECTOR : PT100 1 PER BEARING 3 WIRES, - STRAY LOAD LOSSES 0.50% OF INPUT POWER. - NOISE LEVEL WITH TOLERANCE OF +3DB(A)	- TORQUE AND CURRENT VS SPEED CURVE AT CM: 11919/2013 - PERFORMANCE VS OUTPUT CURVE AT CM: 12236/2013 - THERMAL LIMIT CURVE AT CM: 12237/2013 - TEMPERATURE RISE BY RESISTANCE METHOD: 75K @ SF 1.00; 100K @ SF 1.15 - MOTOR SUITABLE FOR 2 COLD STARTS OR 1 HOT STARTS ON THE FIRST HOUR - HEATING TIME CONSTANT: 177 MINUTES - COOLING TIME CONSTANT: 507 MINUTES

11.2 Drive Shaft Assembly (Coupling Unit)

The drive shaft assembly connects the motor to the crusher counter shaft in a direct-drive mode. It includes a connecting shaft, two couplings and accessories. The transition of the intermediate coupling shaft makes it very convenient for the maintenance of the machine. When repairing the drive unit or the motor unit, it is only necessary to remove the shaft coupling assembly instead of the entire motor unit to access the pinion shaft for removal. This reduces the maintenance downtime and cost; meanwhile, the direct-drive shaft has a higher efficiency, and occupies less space. (Direct drive can also be changed for belt drive according to the need of the user.) See figure 11-4 for the installation position and structure of coupling assembly.

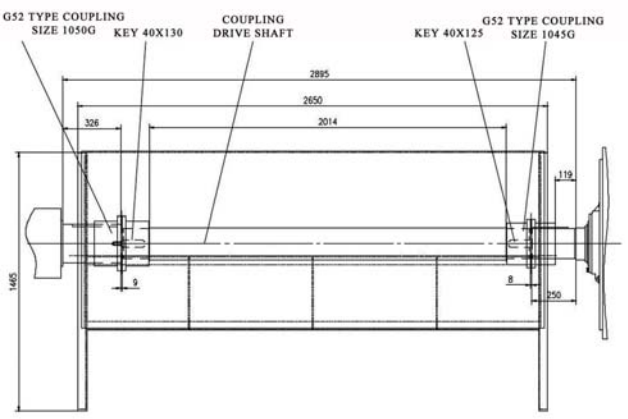
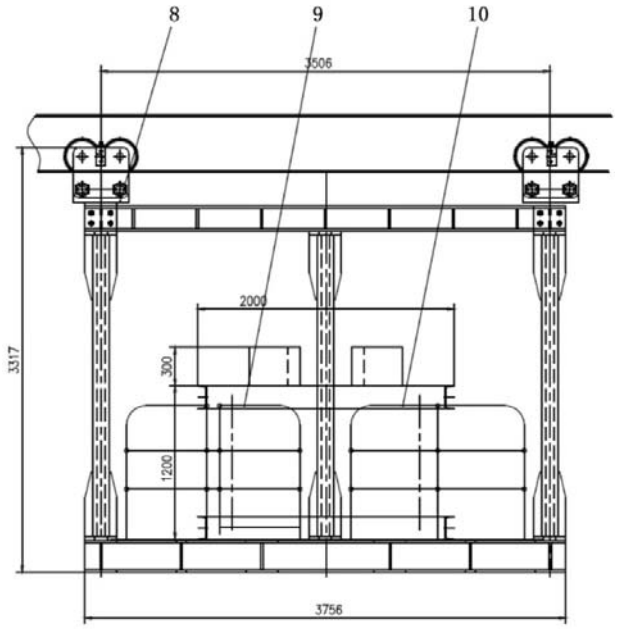


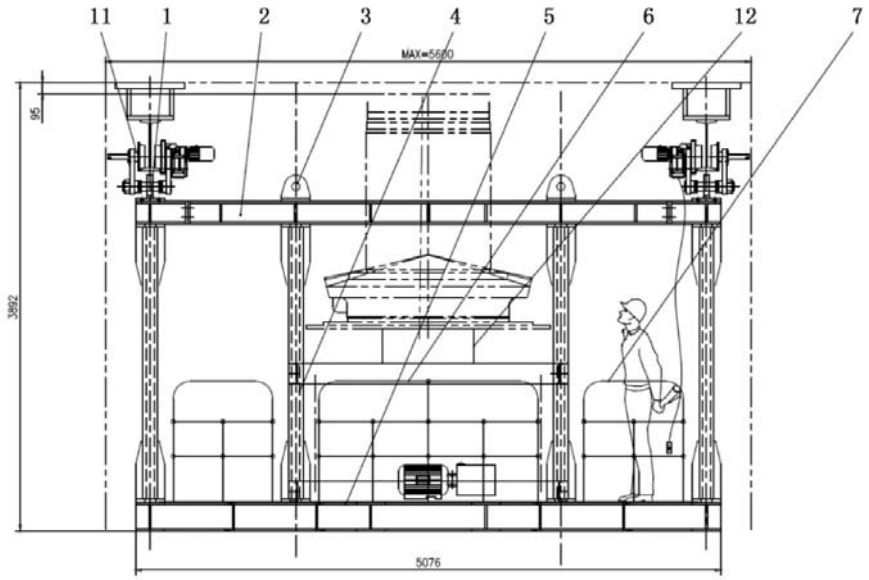
Fig. 11-4　Layout of the drive shaft assembly for gyratory crusher（PXZ-1500II）

11.3　Service Tools

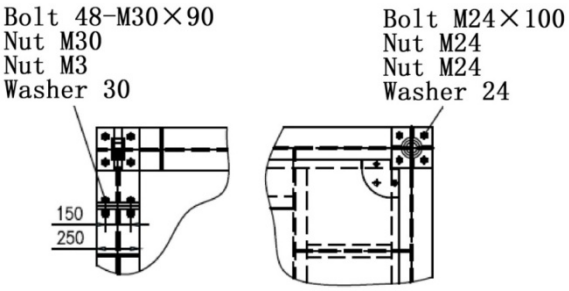
Special service Tools are used for the installation of the crusher and the maintenance of the oil cylinder and eccentric bushing. The design of the service tools will depend on actual site conditions. They can also be designed and installed by the users themselves with the guidance of the crusher maker. See figure 11-5 and table 11-5 for the installation position and the structure of the service tools.



(a) Front View



(b)Side View



(c)The connection of middle shell, intermediate spider and connecting column

Fig. 11-5 Installation scheme for service tools (PXZ-1500II)

Tab.11-5 Main parts list of service tools (PXZ-1500II)

No.	Part No.	Name
1	G00210-1P	Upper frame
2	G00210-2P	Intermediate spider
3	G00210-3P	Lifting rack
4	G00210-4P	Connecting column
5	G00210-5P	Under frame
6	G00210-17P	Guard rail 1
7	G00210-20P	Guard rail 2
8	G00210-22P	Overhead rail rack
9	G00210-23P	Guard rail 3
10	G00210-28P	Guard rail 4
11	G00210/1	Electric drive vehicle
12	G00210/17	Hydraulic lifting platform

Section 12 Hydraulic & Lubricating System

12.1 Introduction

The hydraulic station is a key part of the gyratory crusher. It includes two sections, namely, the hydraulic section and the lubricating section, both of which have a spare oil pump. The oil filter is equipped with double cartridge for backup which can be online alternated to ensure the crusher's continuous operation.

The hydraulic section provides hydraulic support for the main shaft during the crushing operation; By means of vertical adjustment of the main shaft, it can make up for the liner wear and control the product size; When tramp enters the crusher, it is able to do hydraulic concession protection; In case of material buildup following sudden shutdown, it can be manually controlled to lift or lower the main shaft so as to clean up the buildup material in the crushing cavity, eliminating the need of manual excavation. Huge chunks of material in the crushing cavity may sometimes make the main shaft bounce upward. With compensation energy accumulator and one way throttle valve, the hydraulic station can prevent the main shaft from disengage from the plunger piston support when bouncing upward, and avoid damage to crusher parts because of the main shaft's fast downward bounce. The product size adjustment function is realized by the distance sensor mounted on the hydraulic cylinder at the bottom of the main shaft, which feeds back and controls the hydraulic pumps and valves to automatically lift or lower the crusher main shaft and to precisely adjust and control its working position.

The lubrication system provides oil lubrication for the horizontal drive shaft, bevel gear drive, rotating section of the eccentric bushing and the spherical friction disc, performing lubrication and cooling functions.

12.2 Safe Operation Instruction

Operating environment of lubricating station shall be: indoor, dry ,clean, without harmful gas, without explosive gas, without active gas damaging metal or insulation and without conducting dust. The elevation shall not be over than 1000m. The environmental temperature shall be 5-40℃. The relative humidity shall not be over than 50%. No open flame.

. It is forbidden to trample on, climb or pull all the oil pipeline.

. It is not allowed to loose the handle, handwheel or lock screw of all the components.

. When examining and repairing, the oil pressure must be relived. Cut-off the general supply.

. It is forbidden to start the motor of the oil pump if the oil temperature being lower than 16℃.

. It is only allowed to use petrol, diesel oil and lint-free cotton to clean the inner side of the cylinder and component. It is not allowed to adopt cotton yarn.

. The operator must observe the national safety and accidents precautionary measures.

. After continuous operating, part of this driving device (housing, pipeline, etc) may heat up.

WARING: Scorching hot (please wear safe glove.)

. No open flames or fire around driving device!

. During machining operating, there shall be no loosen on threaded joint of the pipeline or flange joint!

WARING: Splashed oil shall pose danger!

. The switch positions of the instruments, such as pressure switch, valve, throttle valve for monitoring and controlling, are not allowed to changed at will.

. Any action to damage the driving device shall be forbidden.

. If the oil-way system needs to change filtering core or to dismantle for repairing, the pressure of the oil-way must be relived at first and all the power supply switches must be turned-off. Take the active measures to ensure that the machine cannot be started during maintaining.

WARING: When the plant producing, the monitoring personal must be in place.

. All the operation, maintaining and repairing on this equipment only can be carried out by the trained personals.

. The electric working on the driving device only can be done by the specified trained personals. Some electric components cannot be opened after energizing, especially for electric terminal box.

WARNING：Risk of electric shock

·The valve on the master machine's connection pipe must be closed when some hydraulic adjustments are conducted, and ensure the main motor off.

· It is not allowed to make any modification to the driving system, especially forbidden to casually add or reduce some components.

· Only spare parts from the original manufacturer are allowed to be used when repairing. It is not allowed to use spare parts from other manufacturers without written permission from the manufacturer of the driving unit.

· Before doing the work concerning with the driving system, ensure there will be nobody switch on the driving unit and other auxiliary device.

· The security inspector can't withdraw until the driving system is stopped or active safe measures are taken.

· All the power for the electrical components must be cut off before disassembling.

· When making maintenance and before disassembling some part in the driving unit, prepare by well suspended or supported.

· After finishing the normal maintenance and check of the driving system and before power-on, ensure the security inspector is at his place.

· When there is need to drain oil dirt, follow the related environmental protection regulations.

· When using some agent or other harmful substance, follow the operation instructions supplied by the manufacturer.

· The driving system can't be started until the running parameters are correct and coincident with the technical specification.

· When the piping breaking is suddenly happened and the high pressure oil is released,

serious injury may be caused to personnels.

· If the seriously polluted hydraulic oil is used, the maintenance downtime may be too long and its costs may be too high.

· The installing field of driving system must be properly inspected and managed to ensure it is clean and sanitary as well as in good order.

· The oil temperature of used mineral oil must not exceed the maximum permissible 80℃ during continuous operation.

· The oil pressure at the lubricating oil supply pipeline is not lower than 1.5bar.

12.3 Oil System Operation Principle

The operating principle of the system(see Fig. 12.1-12.2)，The serial numbers of component names in Fig. 12.1-12.2(see Table 5)

In the hydraulic system, the motor (item 28) drives the pump spindle so that the oil pump make oil absorption from the oil tank. The oil flows through the suction filter, the pump body, the pressure oil filter to the check valve, the overflow valve, and then through the three-position four-way electromagnetic directional control valve, the pilot-controlled check valve, the valve to the energy accumulator, the iron protection valve group, the pressure transducer, the temperature sensor, the displacement controller and the support cylinder at the bottom of the moving cone.The automatic control of power on and off is achieved by the electro-magnet and the motor based on the monitoring value of the sensor.

In the lubricating system, the motor (item 12) drives the pump spindle so that the oil pump make oil absorption from the oil tank. The lubricating oil flows through the butterfly valve of oil suction, the pump body, the safety valve, the check valve, the duplex filter, the ball valve, the cooler, the pressure transducer, the temperature sensor, the flow divider valve, the throttle valve, and then it is divided into three ways, flowing to the crusher's horizontal driving shaft, the interior of the eccentric sleeve and the friction pair's lubricating oil chamber of the exterior of the eccentric sleeve, respectively. Each branch way has a flow controller to monitor the flow. The lubricating oil which has flowed into the interior and the exterior of the crusher's eccentric sleeve flows through the spherical friction disc and the bevel gear pair at the bottom of the spindle, finally into the main return pipe by dead-weight through the oil-out at the crusher's bottom（The horizontal part of the main return pipe slopes down.）The lubricating oil in the branch return pipe from the oil-out at the bottom of crusher's horizontal driving shaft then flows into the main return pipe, and finally back to the lubricating oil tank.

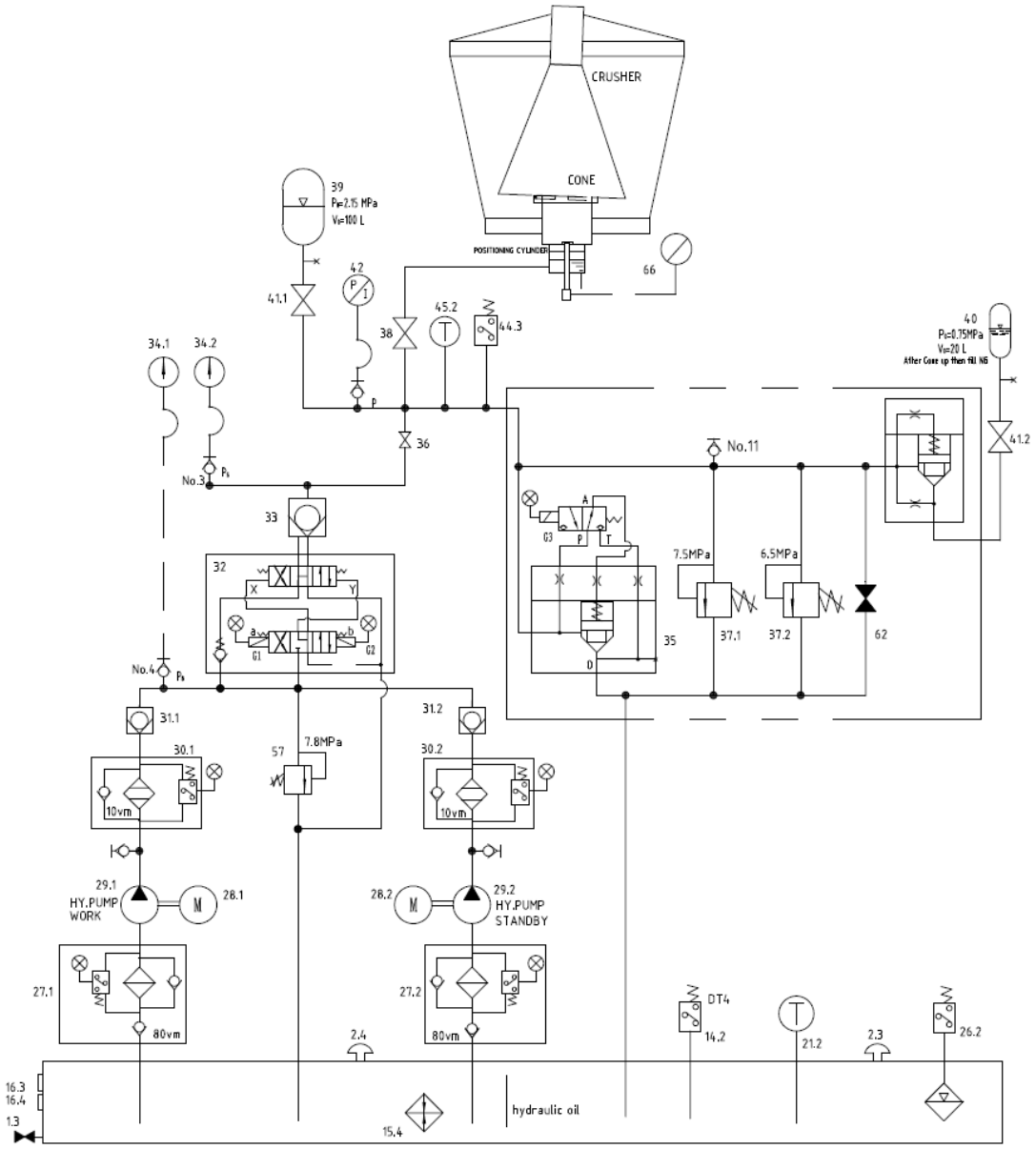


Fig.12-1 Hydraulic System Schematic Diagram of PXZ-1500II

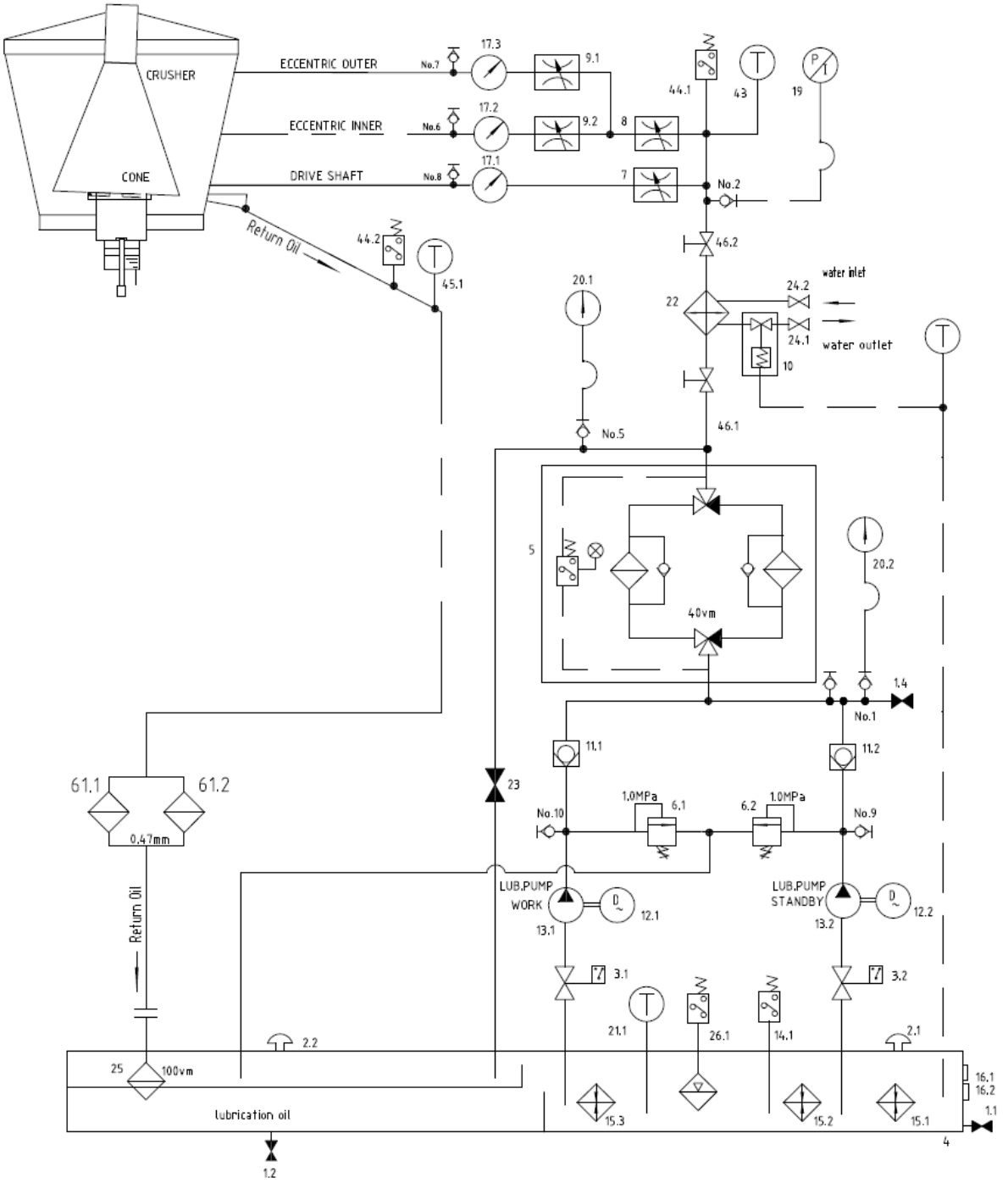


Fig.12-2 Hydraulic System Schematic Diagram of PXZ-1500II

Tab.12-1 Data for performance of hydraulic section (PXZ-1500II)

No-load oil pressure	～0.98MPa
100L accumulator's nitrogen pre-charge pressure	2.15MPa (adjustable)
Normal Working oil pressure	1.0～2.4MPa (adjustable)
Tramp Iron-removal protection oil pressure	2.4～5 (adjustable)
Iron-removal protection Electromagnetic unloading oil pressure	5.0MPa
Iron-removal protection Hydraulic unloading oil pressure	6.5MPa

Max. Nominal oil pressure	7.5MPa
20L accumulator's nitrogen pre-charge pressure	0.75MPa
Nominal flow	44 l/min
Motor power	11kW×2 (11kW for standby)
filtering precision	10μm
Working oil temperature	20～55℃
Electric heater power	1.2kW×1
Hydraulic oil	ISO VG46#
Oil tank capacity	1200 L

Tab.12-2 Data for performance of lubricating part(PXZ-1500II)

Nominal pressure	10bar
Pump Nominal flow	250 l/min
Drive shaft lubrication flow	15 l/min
Eccentric bushing inner lubrication flow (L/min)	135 l/min
Eccentric bushing outer lubrication flow (L/min)	100 l/min
Motor power	7.5 kW×2 (7.5 kW as standby)
Filtering precision	40μm
Cooling water flow	350 l/min
Electric heater power	1.2kW×3
Lubrication viscosity range	ISO VG 150# 4EP
Oil tank capacity	3200L

Tab. 12-3 Data for cooling water

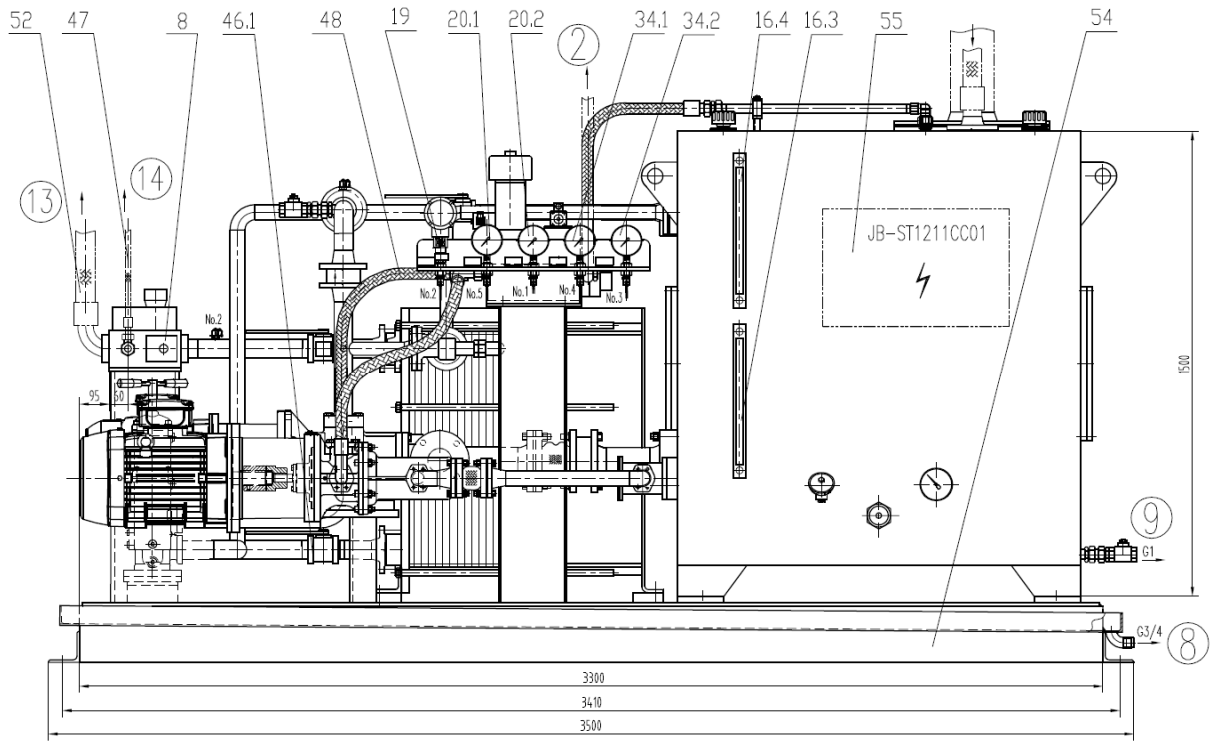
Cooling water temperature	≤ 28 ℃
Cooling water pressure	0.2~0.6 MPa
CI－density in cooling water	< 800ppm
Suspended solid in cooling water	≤ 10mg/L
Cooling water PH value	7～9.2
Methyl orange alkalinity in cooling water	≤ 500mg/L
Ca2＋ in cooling water	30～200mg/L
Fe2+ in cooling water	< 0.5mg/L
CI $^{-}$ in cooling water	≤ 1000mg/L
Free oxygen in cooling water	0.5～1.0mg/L

12.4 Hydraulic & Lubricating Section Structure

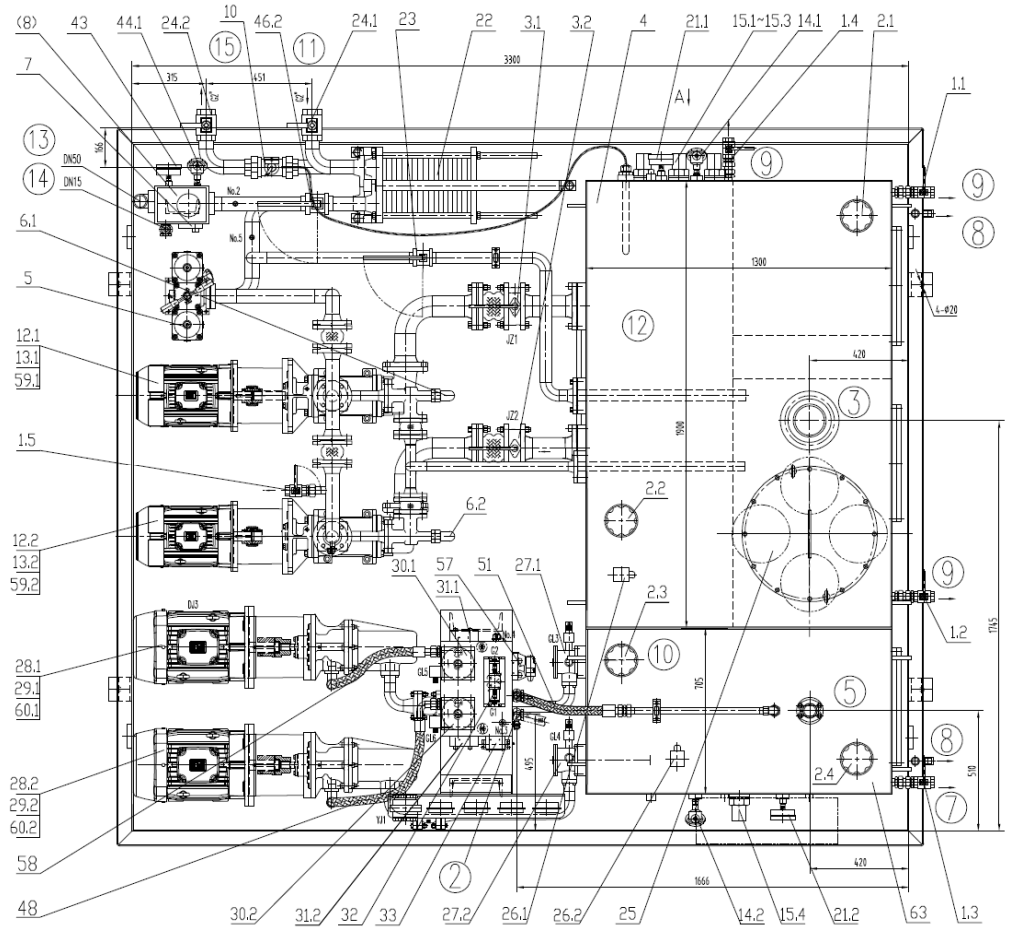
The hydraulic station consists of a hydraulic system and a lubrication system. The two systems share a single base frame, making it compact in structure and easy to maintain.

- The hydraulic pump and the lubrication pump are compactly arranged but independent to each other. The hydraulic system and the lubrication system use hydraulic oil and lubrication oil respectively.
- Both the hydraulic system and the lubrication system are equipped with spare pump to ensure the crusher’s continuous operation in the event of oil pump failure. The oil filter has double cartridge for backup which can be online alternated.

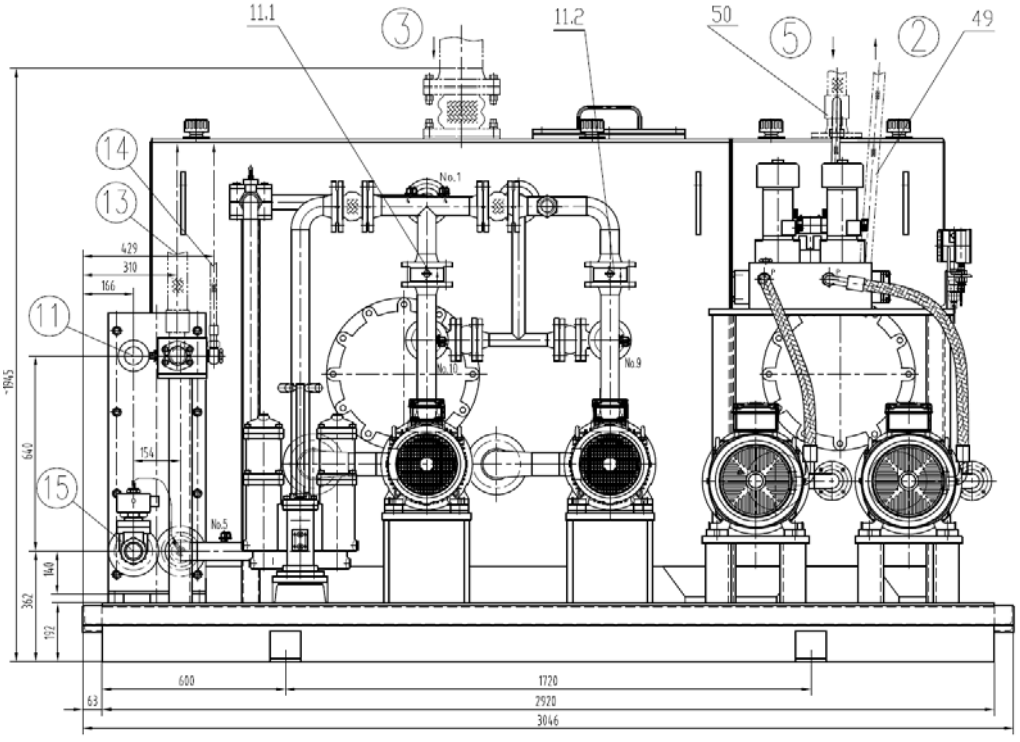
- The hydraulic system is mainly composed of oil tank, pump device, filter, group valve, instrumentation, monitoring element, energy accumulator, piping, valve and oil cylinder, etc.
- The lubrication system is mainly composed of oil tank, pump device, non-return valve, safety valve, filter, cooler, temperature-sensing valve, instrumentation, monitoring element, valve and piping, etc.
- Energy accumulator group in the hydraulic system consists of tramp release concession protection accumulator, tramp release load discharging control valve group, bounce protection accumulator and one way throttle valve. It is installed near the oil cylinder of the main shaft to shorten the pressure pipe and thus make the accumulator protection more flexible and reliable during crushing operation.
- Oil outlet of the lubrication system is divided into three routes, providing oil for horizontal drive shaft, the inside and outside of the eccentric bushing respectively. Flow detector is installed on the inlet of every lubrication point to continuously monitor the online condition of oil supply.
- In addition to the general electrical cabinet, the oil station is equipped with a local control cabinet with control buttons.



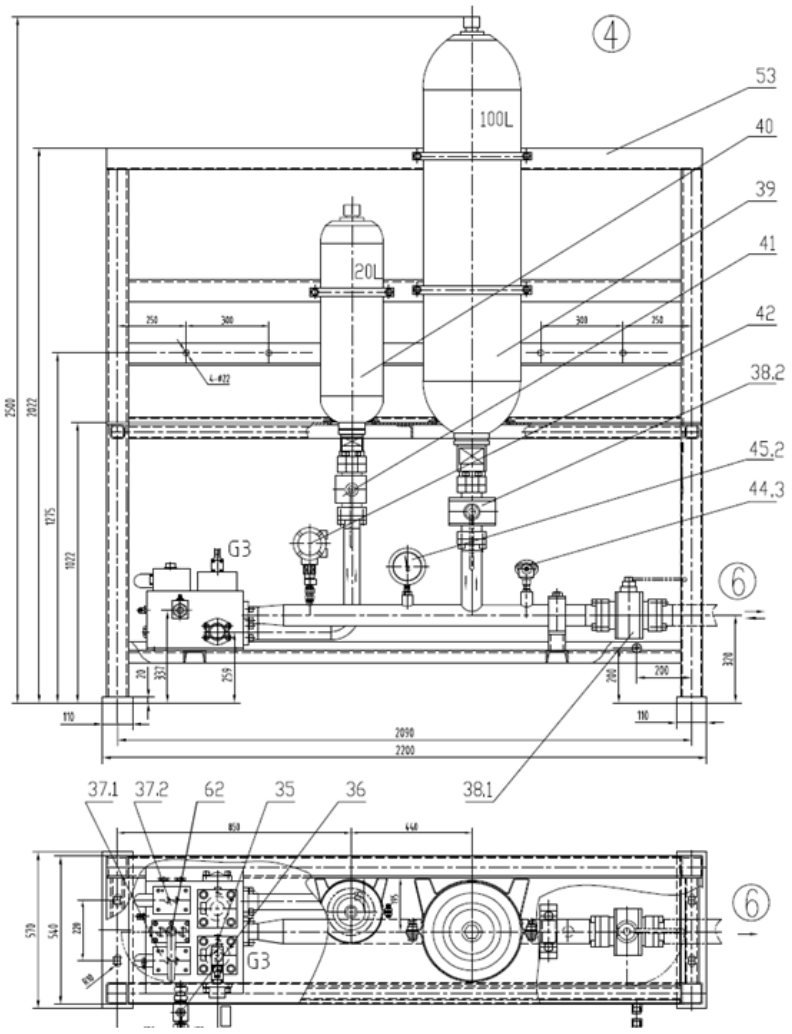
(a)Front View



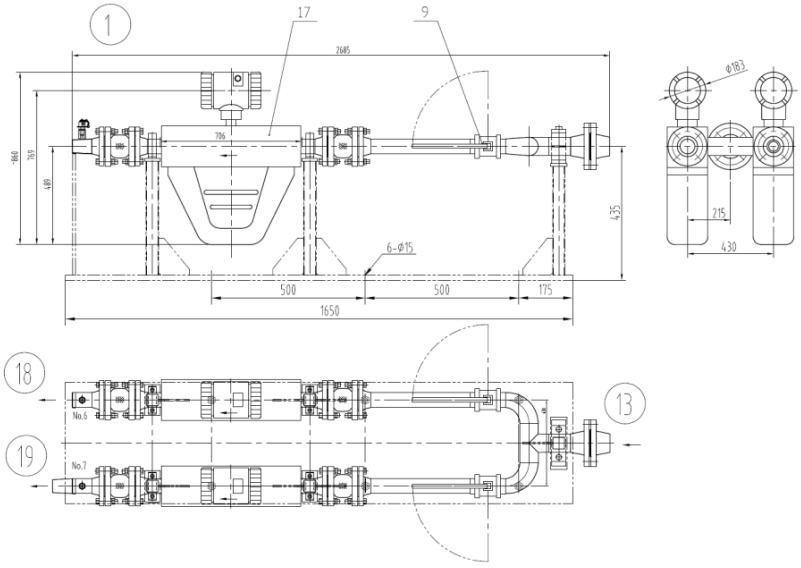
(b) Top View



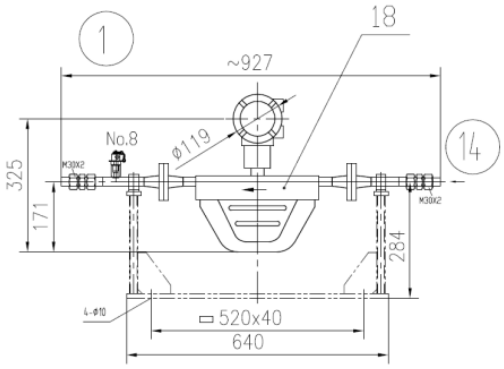
(c) Side View



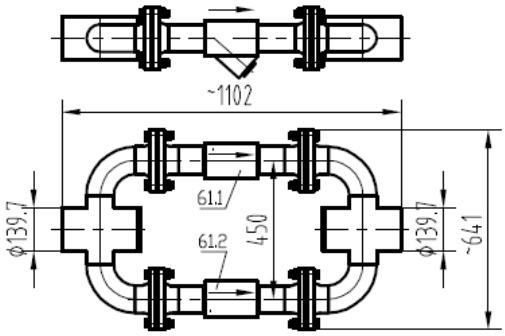
(d) Accumulator unit



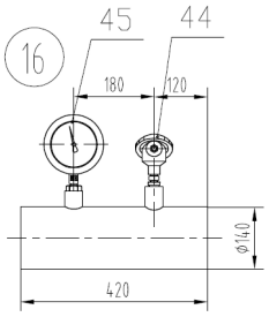
(e) Flow sensor I



(f) Flow sensor II



(h) Temperature for return oil



(g) Rough filtration device for return oil

图注 NOTE：

① 流量检测装置
FLOW SENSOR
② 接蓄能保护部上P口
CONNECT WITH ACCUMULATOR PROTECTOR PORT "P"
③ 润滑回油口
LUBRICATING RETURN PORT
④ 蓄能保护部
ACCUMULATOR PROTECTOR
⑤ 接蓄能器阀组回油口O
CONNECT WITH OF ACCUMULATOR RETURN PORT "O"
OF ACCUMULATOR VALVE SETS
⑥ 接动锥油缸
CONNECT WITH POSITION CYLINDER
⑦ 放油口
OIL DRAIN OF HY.TANK UNDERSIDE
⑧ 放污油口
SUMP OIL DRAIN
⑨ 放油口
OIL DRAIN OF LUB.TANK UNDERSIDE
⑩ 液压油箱
HYDRAULIC SYSTEM TANK
⑪ 冷却器进水管
WATER INLET OF COOLER
⑫ 润滑油箱
LUBRICATING TANK
⑬ 偏心套润滑供油总管
MAIN LUB. OIL FOR ECCENTRIC SLEEVE
⑭ 传动轴润滑供油
LUBE FEED FOR DRIVING SHAFT
⑮ 冷却器出水管
WATER OUTLET OF COOLER
⑯ 回油测温
TEMPERATURE METERAGES FOR RETURN OIL
⑰ 冷却器
COOLER
⑱ 回油粗过滤装置
FILTER FOR RETURN OIL

Fig. 12-3 Hydraulic Station

Tab. 12-4 Hydraulic station interface dimension list

TAG (T.P)	DESCRIPTION	CONNECTION DETAIL
②	OIL INLET "P" OF ACCUMULATOR SETS	PIPE φ28X3(M36X2)
③	LUBRICATING OIL RETURN PORT	DN125 ANSI#150
⑤	OIL RETURN "O" OF ACCUMULATOR SETS	PIPE φ60X4(SAE2"-3)
⑥	OIL INLET OF POSITION CYLINDER	PIPE φ76X7.5(SAE2 1/2"-3)
⑦	OIL DRAIN OF HY.TANK UNDERSIDE	G1"
⑧	SUMP OIL DRAIN	G3/4"
⑨	OIL DRAIN OF LUB.TANK UNDERSIDE	G1"
⑪	WATER INLET OF COOLER	PIPE φ60X4(G2",ANSI#150)
⑬	MAIN LUB. OIL FOR ECCENTRIC SLEEVE	PIPE φ60X4(DN50 ANSI#150)
⑭	LUB. OIL INLET FOR DRIVING SHAFT	PIPE φ22X3(M30X2)
⑮	WATER OUTLET OF COOLER	PIPE φ60X4(G2",ANSI#150)
⑱	LUB. OIL FOR FRAME-ECCENTRIC SLEEVE	PIPE φ42X3.5(DN32 ANSI#150)
⑲	LUB. OIL FOR SHAFT-ECCENTRIC SLEEVE	PIPE φ48X3.5(DN40 ANSI#150)

Tab. 12-5 Hydraulic station Parts No.

33	W6503050108	CHECK VALVE	1						66	W6503290051	FILTER ELEMENTS 01NL.250.10VG	2				
32	W6503170052	DIRECTION VALVE 4WEH16	1						65	W6503290053	FILTER ELEMENTS 01TS.425.80G	2				
31	W6503050030	CHECK VALVE	2					31.1~31.2	64	W6503290052	FILTER ELEMENTS 01NL.400.40G	2				30.1..1
30	W6505010093	OIL FILTER MNU.10VG	2					30.1~30.2	62	W6503310016	BALL VALVE KHP25	1				
29	W6501130050	HP SCREW PUMP G60VC-137	2					29.1~29.2	61	W6505010095	FILTER IG G3(0.47mm)	2				61.1~61.2
28	W6515010061	MOTOR W21-160M-11KW-4	2					28.1~28.2	60	E363-49P	COUPLING & BELLHOUSING (S09T4)	2				60.1~60.2
27	W6505010089	OIL FILTER TSW.80G	2					27.1~27.2	59	E363-47P	COUPLING & BELLHOUSING (S08T9)	2				59.1~59.2
26	W6506230029	OIL LEVEL SWITCH SLWC-7	2					26.1~26.2	58	W6513190900	HOSE 2SN25X1100	1				
25	W4510110003	MAGNETIC FILTER GLQ	4					25.1~25.4	57	W6503350044	RELIEF VALVE DB20/100	1				
24	W6503310068	BALL VALVE G2	2					24.1~24.2	56	W6520010013	GAS-FILLING & MONITORING DEVICE	1				
23	W6503310111	BALL VALVE KHM3S-40	1						55	DG001-AJ1	ELECTRIC CONNECTING BOX	1				
22	W6505030031	COOLER M6-FG14.7	1						54	E363-22PH	BASE	1				
21	W6506130055	THERMOMETER A52	2					21.1~21.2	53	E363-80H	SUPPORT	1				
20	W6506270156	PRESSURE GUAGE SPG100-16	2					20.1~20.2	52	W6513190535	HOSE PTE350X1000	1				
19	W6505150015	PRESSURE TRANSDUCER 30ST62	1						51	W6513190536	HOSE PTE220X1000	1				
18	W6505150016	FLOW SENSOR F050S	1						50	W6513190534	HOSE PHD250X1200	1				
17	W6505150035	FLOW SENSOR F200S	2					17.1~17.2	49	W6513190539	HOSE PHD225X1200	1				
16	W6506290015	LEVEL GUAGE SNA450	4					16.1~16.4	48	W6513190900	HOSE 2SN25X1100	1				
15	W6505130044	ELECTRIC HEATER EHP-1200	4					15.1~15.4	47	W6513190537	HOSE PTE216X1000	1				
14	W6506130040	TEMPERATURE TRANSMITTER TM1016-2	2					14.1~14.2	46	W6503310107	BALL VALVE KHM3S-50	2				46.1~46.2
13	W6501130049	LP SCREW PUMP G3DHC-218	2					13.1~13.2	45	W6506130057	THERMOMETER R52	2				45.1~45.2
12	W6515010107	MOTOR W21-132M-7.5KW-4	2					12.1~12.2	44	W6506130056	TEMPERATURE TRANSMITTER TM1016-1	3				44.1~44.3
11	W6503210032	CHECK VALVE DC DN50	2					11.1~11.2	43	W6506130063	THERMOMETER A52	1				
10	W6503230015	TEMPERATURE REGULATOR 204T	1						42	W6506190136	PRESSURE TRANSDUCER 30ST6A	1				
9	W6503310166	BALL VALVE KH-G11/2"	2					9.1~9.2	41	W6503310058	BALL VALVE SKH DN50	2				
8	W6503210036	SHUT-OFF THROTTLE VALVE DV-16	1					.	40	W6505130037	ACCUMULATOR SB330-20	1				
6	W6503010024	RELIEF VALVE FVJF-6	2					6.1~6.2	39	W6505130036	ACCUMULATOR SB330-100	1				
5	W6505010088	OIL FILTER DU.40G	1					.	38	W6503310115	BALL VALVE SKH DN65	1				38.1~38.2
4	E363-1P	LUB. OIL RESERVOIR	1					.	37	W6503350042	RELIEF VALVE DB020/100	2				37.1~37.2
3	W6503110028	BUTTERFLY VALVE DN80	2					3.1~3.2	36	W6503310112	HP BALL VALVE 28L	1				
2	W6505010012	AIR FILTER SMB80	4					2.1~2.4	35	W6503030013	DIRECTION SEAT VALVE WSE06	1				
1	W6503310094	BALL VALVE G1	5					1.1~1.4	34	W6506270154	PRESSURE GUAGE SPG100-100	2				34.1~34.2

12.5 Control Function of Hydraulic Part

Pressure relay, temperature relay and displacement controller are continuously powered on during the crushing operation, while the electromagnet and the motor are powered on and off on operation demand.

Accumulator Function Description:

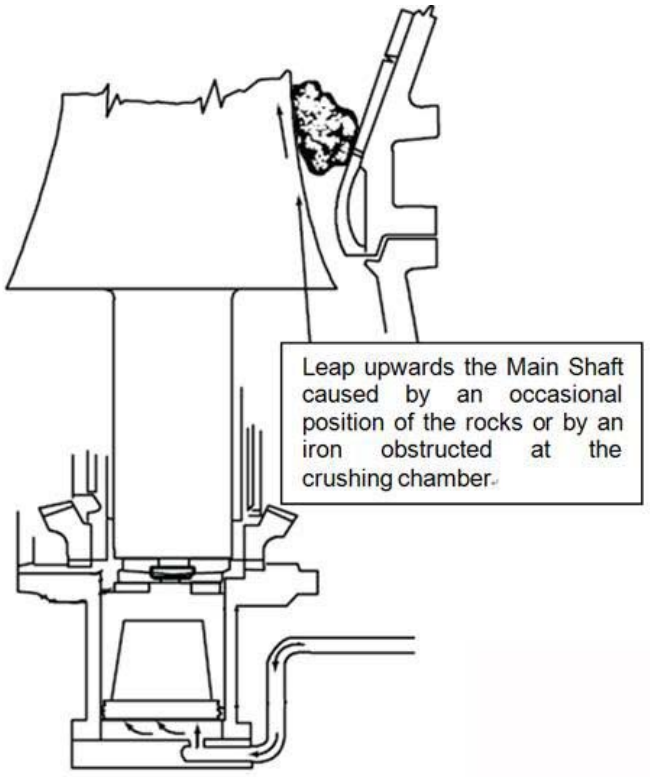


Fig. 12-4

The 20L accumulator and one-way throttle valve serve as bounce protection. The small accumulator was filled with nitrogen by a pressure of around 0.75MPa, which is less than the pressure that the weight of main shaft applied on the oil inside the cylinder and greater than the pressure that the supporting spherical bronze bearing at the bottom of main shaft applied on the oil inside the cylinder. The normal operating pressure of nitrogen is 0.75 - 5MPa, with a maximum pressure of 7.5MPa. Woring principle: When the crusher works with heavy duty, oversized material inside the crushing cavity may sometimes cause the main shaft bounce upwards. The nitrogen inside the small accumulator will expand and the supporting part of plunger piston will move upwards together with the main shaft, avoiding separation of main shaft and the supporting part of plunger piston. Thus, it can be avoided that the main shaft falls back too fast after bounce and damages the crusher components with impact.

The 100L accumulator and unloading protection valve group serve as overload protection and tramp metal release protection. The big accumulator was filled with nitrogen by a pressure of around 2.15MPa, which is adjustable depending on the ore hardness so that the crushing force can be adjusted. The normal operating pressure of nitrogen is 2.15 - 5MPa, with a maximum pressure of 7.5MPa. Woring principle: When the oil pressure inside the oil cylinder exceeds the preset upper limit (2.4MPa, adjustable, which occurs when the oil starts to fill the big accumulator) of the pressure sensor (1210CC-PIT-5055), an acousto-optic alarm will be emitted to stop the crusher's upstream feeding and the accumulator will be switched into the mode of tramp metal release protection. When the oil pressure inside the oil cylinder exceeds the preset upper limit (5MPa, which is the maximum operating pressure of the big accumulator) of the pressure sensor (1210CC-PIT-5055) and maintains that pressure for a period of time (5 - 10s), the

electromagnet (1210CC-FV-5055) will be energized and start unloading. (The pressure oil inside the main shaft oil cylinder starts unloading and will be rapidly released back into the oil tank through cartridge valve. The main shaft of the crusher will be lowered.) During this period, if the oil pressure inside the oil cylinder returns to normal value (P<2.4MPa), the alarm will be automatically disabled. If the oil pressure inside the oil cylinder continues to be above the preset upper limit (2.4MPa) of the pressure sensor (1210CC-PIT-5055) for 60s (adjustable), the electromagnet (1210CC-FV-5055) will be energized and start unloading.

PXZ1500II –1210CN ITM:

The 100L accumulator and unloading protection valve group serve as overload protection and tramp metal release protection. The big accumulator was filled with nitrogen by a pressure of around 2.15MPa, which is adjustable depending on the ore hardness so that the crushing force can be adjusted. The normal operating pressure of nitrogen is 2.15 - 5MPa, with a maximum pressure of 7.5MPa. Woring principle: When the oil pressure inside the oil cylinder exceeds the preset upper limit (2.4MPa, adjustable, which occurs when the oil starts to fill the big accumulator) of the pressure sensor (1210CN-PIT-605), an acousto-optic alarm will be emitted to stop the crusher's upstream feeding and the accumulator will be switched into the mode of tramp metal release protection. When the oil pressure inside the oil cylinder exceeds the preset upper limit (5MPa, which is the maximum operating pressure of the big accumulator) of the pressure sensor (1210CN-PIT-605) and maintains that pressure for a period of time (5 - 10s), the electromagnet (1210CN-FV-605) will be energized and start unloading. (The pressure oil inside the main shaft oil cylinder starts unloading and will be rapidly released back into the oil tank through cartridge valve. The main shaft of the crusher will be lowered.) During this period, if the oil pressure inside the oil cylinder returns to normal value (P<2.4MPa), the alarm will be automatically disabled. If the oil pressure inside the oil cylinder continues to be above the preset upper limit (2.4MPa) of the pressure sensor (1210CN-PIT-605) for 60s (adjustable), the electromagnet (1210CN-FV-605) will be energized and start unloading.

12.5.1 Monitoring of Operation

A displacement sensor (outputting analog value) is installed on the supporting cylinder at the bottom of the main shaft. The crusher operates according to the values measured by the displacement sensor and pressure sensor. The pressure sensor monitors the instantaneous oil pressure in the main shaft oil cylinder during crushing and sends it through Profibus PA to the PLC, thus realizing remote continuous monitoring and operation.

12.5.2 Adjustment of the Discharge Gap

The displacement sensor installed on the oil cylinder at the bottom of the main shaft is able to feed back and control the hydraulic pump and valves to feed oil to or discharge oil from the oil cylinder. Then the crusher will be automatically lifted or lowered so as to precisely adjust the

product size.

Adjustment before the crusher starts: The oil pump motor is energised. Then electromagnet G1 is energised. When the main shaft rises to the preset position of the displacement sensor, the sensor will send a signal to cut off the power of the oil pump motor and electromagnet G1. The automatic adjustment of the discharge gap is completed. When the oil pump motor and the electromagnet G2 are powered on, the main shaft will be lowered.

Adjustment during the crusher operation: If the pressure sensor detects the oil pressure less than 2.4 MPa, the displacement sensor will automatically start/stop the oil pump motor and electromagnet G1 according to the measured displacement value to supply oil to the cylinder and adjust the discharge gap. *(start 1 oil pump motor, energize the electromagnet G1 and lift the main shaft. When the main shaft rises to the preset position of the displacement sensor, the sensor will send a signal to cut off the power of G1 and to delay the power-off of the oil pump motor.

12.5.3 Crushing and Tramp Iron-Removal Protection

During the crushing operation, there are three kinds of overload protection.

First overload protection: When the oil pressure exceeds the preset high limit of P1 (2.4 MPa, adjustable), an acoustic-optic alarm signal will be sent out (to stop the crusher upstream feeding and to put the accumulator into tramp release protection status) and the displacement sensor will record the height. If the alarm lasts for no less than 60s (adjustable), G3 will be energized to release the load (The pressure oil in the main shaft oil cylinder will be quickly released to the oil tank through the cartridge valve block and the main shaft will be lowered). When the oil pressure resumes to normal level (<2.4 MPa), the alarm will be automatically dismissed.

Second overload protection: When the oil pressure exceeds the preset high limit P2 (50bar) of the pressure sensor and maintain the high pressure for a given period (5-10s), the electromagnet G3 will be energized to release load.

Third overload protection: When the pressure controller sends signal or the electromagnet G3 is slow in responding or the electric signal doesn’t work, and the oil pressure in the cylinder exceeds the preset value and keeps rising (6.5-7.5MPa), the overflow valve (item 37) will be automatically opened. The pressure oil in the main shaft oil cylinder will be released to the oil tank and the protection is realized.

Main motor protection:

1）If overcurrent signal is detected in the main motor, G3 will be energized to release load. 2）Five seconds (adjustable, to be determined according to the allowable overcurrent time of the main motor) after G3 is energized, if overcurrent signal can still be detected in the main motor, the main motor will be immediately powered off. 3）If the oil cylinder piston lowered to the

low limit position after G3 is energized, the displacement sensor will send out signal and G3 will be powered off and stops load releasing.

12.5.4 Clean the Crushing Cavity

If there are too much accumulated material in the crushing cavity after the crusher is stopped, then energise the oil pump motor and the electromagnet G1. Wait until the oil pressure rises to a stable value and then energise the electromagnets G1 and G2 respectively to lift and lowere the main shaft repeatedly to help clear the accumulated materials from the crushing cavity.

12.5.5 Monitor the Oil Temperature in the Cylinder

A temperature sensor is installed on the cylinder pressure oil pipe to continuously monitor the hydraulic oil temperature during the crushing operation. When the oil temperature rises to the set value (58℃ recommended), the sensor will send out “High oil temperature in cylinder” signal.

12.5.6 Temperature Controlling

When the oil temperature in the oil tank is lower than the preset value (15℃ recommended), the electro-contact thermometer will indicate “low oil temperature” and the oil pump cannot be started (only when the oil temperature is higher than the low limit value can the oil pump be started), and the electrical heater will be automatically energised to heat the oil; When the oil temperature reaches the high limit value of the electro-contact thermometer (28 ℃ recommended), the electrical heater will be stopped automatically (electrical heaters can be manually or automatically started or stopped within the above-mentioned oil temperature range).

12.5.7 Control of the Oil Level of the Oil Tank

An oil liquid level detection switch is fitted at the oil tank. When the liquid level in the oil tank decrease to the low limit, the audible-visual alarm signal of “low liquid level” will be sent out; When the oil level decreases below the low limit, the audible-visual alarm signal of “lack of oil” will be sent out and the oil pump motor cannot be started; When the oil level is above the high limit in the oil tank, the signal of “high oil level” will be indicated.

12.5.8 Pressure Differential Control

Oil filters are fitted at both the inlet port and the outlet port of the oil pump. A pressure differential sensor is fitted on the oil filter. When the pressure difference is over the preset value, the sensor will send an audible-visual alarm signal. A contamination indicator is installed on the filter at the outlet port of the oil pump. If the filter is clean, the optical indicator will display green scale. With the deterioration of the pipe contamination, the indicator will display increasingly more red scale.

12.6 Control Function of Lubrication Part

During the operation of the crusher, the lubrication oil supply system shall be always in normal

working condition. There are controlling points for pressure, temperature, flow, pressure difference and liquid level at the oil lubricating system. The main machine cannot be started unless the lubrication oil supply system works normally.

There are in total two oil pumps in the lubrication system, one on duty and another standby. The two pumps are interchangeable. A micro limit switch is installed on the butterfly valve (item 3) at the oil inlet of the pump (item 13). The lubrication oil pump motor can only be started when the butterfly valve limit switch is opened. This butterfly valve must be fully opened on a permanent basis (to prevent the oil pump from being damaged). It can only be closed when the lubrication pump (item 13) need to be removed.

12.6.1 Oil Pressure Control

A pressure switch is provided at the outlet port in the oil supply system to continuously monitor the oil pressure. If the oil pressure decreases to the low limit value of pressure switch, the standby oil pump motor will be started. At the same time, the working oil pump will stop and record the time and the sensor will send an audible-visual alarm signal of “working oil pump failure”; When the oil pressure becomes normal, the alarm signal will be automatically cancelled. If the oil pressure keeps decreasing or does not resume to the normal value, (adjustable within 30 sec.) the alarming signal of “low oil pressure” will be sent. When the oil pressure rises to or exceeds the preset high limit, the audible-visual signal of “high oil pressure” will be sent. The signals of “high oil pressure” and “low oil pressure” can both be interlinked to the main motor (to be determined by the main machine designer or on-site maintenance personnel).

12.6.2 Oil Flow Control

A flow switch is fitted to each inlet lubrication point of the crusher to continuously monitor the lubrication oil flow. If any one of the flow switches detects flow cut-off signal (less than 25% of the whole flow here), the flow switch will send audible-visual alarm signal of “small oil flow” and the main motor will be automatically stopped.

12.6.3 Control of Temperature

12.6.3.1 Crusher Temperature Control

A temperature sensor is provided for both the oil outlet of the oil station and the oil return point of the crusher to continuously monitor the temperature. When the temperature difference between the two sensors exceeds 20℃, the audible-visual signal of “crusher temperature too high” will be sent; When the temperature difference between the two sensors exceeds 25℃, the main motor will be stopped immediately. When the temperature of the supplied oil exceeds the “alarm” temperature, the motor can go on working, but for several hours only; When the temperature of the supplied oil reaches the maximum oil temperature, the main motor will be stopped (Refer to the technical datasheet for the preset values). When the temperature at the oil return point exceeds 63℃, the main motor will be stopped immediately and the signal of “return

oil temperature too high" will be sent.

12.6.3.2 Oil Temperature of the Oil Supply

Considering the changing environmental conditions, it is unable to calculate accurately the cooling capacity required by the cooler(the technical data sheet indicating the ratings of the cooler).Under the condition of normal operation, the temperature of oil entering the crusher had better be between 32℃ and 42℃.

In order to keep the temperature of the oil supply of the lubrication station constant as possible as well as to enable the oil temperature to reach the operating temperature as soon as possible during the start-up, a temperature control valve with its thermoprobe plugged in the oil tank is mounted in the water delivery pipeline of the cooler. It can turn on or turn off the cooling water pipeline automatically depending on the oil temperature inside the oil tank to keep the temperature at the oil-out port of the cooler close to a constant value.

12.6.3.3 Oil Tank Temperature

A temperature sensor is provided at the oil inlet of the oil tank. When the temperature at the oil inlet is lower than the low limit (15℃), "low oil temperature" will be displayed and the oil pump cannot be started (oil pump can only be started when the oil temperature), and the electrical heater will be automatically energized to heat the oil; When the oil temperature reaches the preset high limit (28℃), the electrical heater will be automatically de-energised (electrical heaters can be manually or automatically started or stopped within the above-mentioned oil temperature range).

12.6.4 Oil Liquid Level Control

An oil liquid level controller is fitted on the oil tank. When the liquid level in the tank lowered to the low limit, the audible-visual alarm signal of "low oil level" will be sent. When the oil level is lower than the minimum low limit, the audible-visual alarm signal of "lack of oil" will be sent and the oil pump motor and the electrical heater cannot be started. When the oil level in the tank increased above the high limit, the signal of "high oil level" will be sent.

12.6.5 Pressure Differential Control

A double cartridge oil filter is provided at the outlet of the oil pump, on which there is a pressure differential switch. When the pressure difference of filtered oil is greater than the preset valve, an audible-visual alarm signal of "filtered oil pressure difference too high" will be sent.

12.7 Commissioning and Operation Specification

The commissioning of the hydraulic system shall begin after the related civil construction, mechanical, electrical, thermal, instrumental and security departments have confirmed that it has met with proper conditions for test running. Make sure and check whether the electrical and thermo instruments wires are connected correctly, the piping arrangement between hydraulic

gyratory crusher and hydraulic station has been done correctly, with acid pickling, phosphorising and flushing. The cleanliness of the pipe shall meet the standard requirement. Take care to protect all the instruments and avoid hitting and damage. All the instruments must not be treaded on.

12.7.1 Preparation for Commissioning

The commissioning of the system mainly refers to the adjustment of the working pressure and preset value of the pressure switch. After the setting value of the pressure control valve and pressure switch have been adjusted and the oil temperature rise above 25℃, the hydraulic system is ready to operate.

Before commissioning, fill the 100L accumulator with nitrogen to achieve the pressure of 2.15 MPa (adjustable depending on the crushing condition) and fill the 20L accumulator with nitrogen to achieve the pressure of 0.75 MPa. See the accumulator manual for detailed nitrogen filling procedures.

Filling of the hydraulic and lubrication oil: To ensure the cleanliness of the ingoing oil (above NAS1638-9), oil must be filled to the tank from the oil inlet on the top of the oil tank by the oil filtration cart (with filtration precision no less than 10μm). Add oil so that the oil level goes above the high limit but does not spill from the tank.

All the oil pump motors rotate in a clockwise fashion (seen from the rear end). When the ambient temperature is lower than 20℃, the electrical heater shall be firstly started to heat up. Wait until the oil temperature rises above 25℃, then the hydraulic system commissioning can begin.

Filter the oil cyclically before commissioning. Shut off the valve (item 38) to the crusher oil cylinder and relieve the hand wheel of pressure control valve (item 57), then start the oil pump motor to circulate the hydraulic oil in the system and have the oil filtered through the filter. During the filtering process, replace the filter element according to the alarm signal from the contamination sensor mounted on the filter and take oil samples regularly to test its cleanness. When the tested oil cleanness reaches the standard requirement, the commissioning work can be started.

12.7.2 Hydraulic System Commissioning

1. Close ball valve (item 38, 41. 1, 41. 2 and 36).

2. Open the hand wheel lock of the pressure regulating valve (item 57) and relieve the adjustment hand wheel of (item 57).

3. Start the motor of (item 28.1), which shall be clockwise seen from the rear end. Run for 5 minutes and there should be no abnormal noise. The pressure gauge (item 34.1) attached to the observation point No.4 shall read 0 (in the dial).

4. Energise electromagnet G1 and slowly adjust the hand wheel of the pressure regulating

valve (item 57) to increase (item 34.2) pressure gauge value to 7.5MPa and (item 34.1) pressure gauge value slightly above 7.5MPa. Run smoothly for 2 minutes.

5. De-energise electromagnet G1 to decrease (item 34.1) pressure value to near zero and maintain (item 34.2) pressure gauge value 7.5MPa.

6. Energise electromagnet G2 to increase (item 34.1) pressure value slightly above 7.5MPa and decrease (item 34.2) pressure value to zero.

7. De-energise electromagnet G2 to decrease (item 34.1) pressure value to about 0.4MPa,maintain (item 34.2) pressure gauge value zero.

8. Open ball valve (item 36) and close ball valve (item 62).

9. Remove the protection cap of pressure regulating valve (item 37.1 and 37.2). Loosen the lock nuts of the adjusting bolts respectively. Counterclockwise turn the adjusting screw of (item 37.1 and 37.2).

10. Energise electromagnet G1 so that (item34.2) pressure gauge value decreases to zero or a very low value. Clockwise turn the adjusting screw of pressure regulating valve (item 37.1) ill it is tightened. Clockwise turn the adjusting screw of pressure regulating valve (item 37.2) ntil the value in pressure gauge (item 34.2) ncreases slowly to 7.5MPa. Stop adjusting, tighten the lock nut and put the protection cap in place.

11. Counterclockwise turn the adjusting screw of the pressure regulating valve (item 37.1) until the hand of the pressure gauge (item34.2) moves from 7.5MPa to 6.5MPa. Stop adjusting, tighten the lock nut and put the protection cap in place.

12. De-energise electromagnet G1. The value of pressure gauge (item34.2) shall maintain 6.5MPa.

13. Energise electromagnet G3. The value of pressure gauge (item34.2) shall decrease to zero. De-energise electromagnet G3.

14. Motor (item28.1) stops.

15. Start motor (item28.2), which rotates clockwise seen from the rear end. Run for 5 minutes and there should be no abnormal noise.

16. Energise electromagnet G1 and the value of pressure gauge (item34.2) shall be 6.5MPa. De-energise electromagnet G1.

17. Repeat the operation in 3.

18. Stop the motor (item28.2).

19. Open ball valve (item 38 and 41). The hydraulic system is now put into normal standby mode.

Primary working pressure of oil: open the valve 36 and 38, with the oil pump running steadily; energise the electromagnet G1 with the indicating value of pressure gauge Ps at the outlet of oil station rising to a certain value until the Po value stops to rise, then the main shaft begins to rise slowly under the working oil pressure, this value will be the relieving oil pressure (mainly dependent on the weight of moving cone).

According to the actual requirements of crushing different ores, the working pressure of the system and the tramp iron-removal protection relief pressure can be adjusted, and the nitrogen pre-filling pressure of accumulator can also be changed correspondingly. The factory tested maximum pressure of this hydraulic station is 7.5 MPa.

12.7.3 Lubrication System Commissioning

1. Open butterfly (item 3.1 and 3.2); Close ball valve (item 1.5);

2. Open ball valve (item 23) and close ball valve (item 46.2).

3. Start the motor (item 12.1), which rotates clockwise seen from the rear end. Run for 5 minutes and there should be no abnormal noise. The value in pressure gauge (item 20.2) attached to observation No.1 shall increase but not exceed 5 bar.

4. Adjust the preset pressure of the safety valve (item 6.1): Open the protection cap at the rear of (item 6.1), loosen the lock nut and counterclockwise turn the adjusting screw with a flat screwdriver for several rounds.

5. Slowly close ball valve (item 23) and observe the pressure change (in the dial) of the gauge (item 20.1) attached to No.5.

6. If the ball valve is fully closed and the pressure value of (item 20.1) it less than 10 bar, then slowly turn the adjusting screw of the safety valve (item 6.1) in a clockwise fashion. Stop adjusting when the pressure value of the gauge (item 20.1) increased slowly to 10 bar.

7. Open ball valve (item 23) and close it slowly. Observe whether the pressure value of (item 20.1) is finally stable at about 10 bar after slow increase. Continue, if necessary, to tune the adjusting screw of the safety valve (item 6.1). After the preset value of the safety valve is configured, tighten the lock nut and put the protection cap in place. Open ball valve (item 23).

8. Stop the motor (item 12.1).

9. Start the motor (item 12.2), which rotates clockwise seen from the rear end. Run for 5 minutes and there should be no abnormal noise.

10. Adjusting the preset pressure of the safety valve (item6.2): Open the protection cap at the rear of (item 6.2), loosen the lock nut and counterclockwise turn the adjusting screw with a flat screwdriver for several rounds.

11. Repeat step 5 to step 7, but the safety valve (item 6.1) shall be change to safety valve (item 6.2).

12. Fully open the throttle valve (item 7), the ball valve (item 9.1) and the ball valve (item 9.2).

13. Open ball valve (item 46.1~2) and close ball valve (item 23).

14. Observe the display value (L/min) of the flow transmitter (item17.1, 17.2 and 18), sum them up and record. Adjust the opening extent of each valve in step 12, making the three flow value 54%, 39% and 7% of the total flow respectively (≈ 250 L/min = 135 + 100 + 15 L/min).

15. Observe the pressure value of (item 19, 20.1 and 20.2)and record.

16. Compare the pressure difference of (item 20.1 and 20.2). If the pressure difference exceeds 2.5 bar or the pressure difference alarm of (item 5) sends out signal, turn the switch handle of (item 5) to the spare filter drum and clean or replace the filter core of (item 5).

17. Adjust the adjusting spring of the temperature valve (item 10) so that it will be opened and the cooling pipe gets through when the oil temperature in the oil tank exceeds 42℃. The lubrication system will be put into normal standby mode.

After both the hydraulic and lubricating systems are working normally, the stimulated interlock test can be performed by the electrical and thermodynamic personnel. After the stimulated interlock test, the main machine can be put into trial run.

12.7.4 Flush the Lubricating Oil Cavity of Crusher

Before the starting of crusher, firstly, circulating filtration shall be conducted to the whole lubricating oil circuit\lubricating oil cavity of crusher for at least 24 hours by starting lubricating oil pump. Open the throttle valve(item 7), the ball valve(item 9.1) and the ball valve(item 9.2) fully, and start the motor of lubricating oil pump, enabling the lubricating oil to enter the inside of crusher and to return to the lubricating oil tank through oil-return pipeline, and the lubricating oil returned from the crusher is filtered via the oil filter of oil-return pipeline（0.47μm）, after 14 hours, remove the filter element for Y-shaped filter of oil-return pipeline, check it, and clean it up, then put a clean fliter element in and continue with circulating filtration, after 10 hours, remove the filter element for Y-shaped filter of oil-return pipeline, recheck it, until no obvious dirt is found in the filter element, remove this filter element for Y-shaped filter of oil-return pipeline(store it properly in case of the crusher maintenance in which the main shaft is detached and circulating filtration for the oil circuit before the restarting of crusher), and install the filter shell of oil-return pipeline appropriately, not until the proper connection of oil-return pipeline can the gyratory crusher be started.

12.8 Daily Maintenance Work

The cleanliness of the oil is essential to the normal operation of the hydraulic system. Therefore, special attention shall be paid to ensuring the cleanliness of the oil from all aspects. During the daily maintenance and troubleshooting, take care to ensure the cleanliness of every port and prevent dirt from going into the oil from the port. Lint-free cotton cloth shall be used to wipe the dusts and stains. Spilled oil must not be returned to the oil tank.

The period of use of the oil is normally one year. Oil samples shall be taken regularly from the manometer joints of every tank cavity for contamination test. Replace the oil if the sample is substandard. Regularly open the draining valve at the bottom of the tank to check if there is water sedimentation. If there are much water sedimentation, check if the viscosity is compliant with the lubrication requirement and find out the water source. Take action to eliminate it.

Because of the change in the chemical composition and proportion of the oil, the interior of the oil tank must be thoroughly cleaned when changing oil. Then fill new oil according to the procedures in section 12.7.1.

The filters shall be removed and cleaned every three months to clean its internal dirt. In operation, if the contamination alarm in the filter sends out signal, clean and replace the filter core as soon as possible. The filter core of the refuel filter shall be replaced depending on its pressure difference indicator. Increase of filter oil pressure difference is a clear proof of filter contamination elevation. Contaminated filter core must be timely removed and cleaned or replaced. Normally after cleaning the filter core, some residue will remain. Intervals between cleaning tend to be shorter and shorter. Therefore, it is advisable to replace the filter core after a couple of cleaning and reuse, depending on the extent of contamination. Discarded filter cores shall be properly disposed of to avoid environmental pollution.

Hydraulic components must be cleaned with gasoline, kerosene and lint-free cotton cloth, chemical fiber, nylon or thick cloth. Cotton yarn is forbidden to use.

The accumulator shall be regularly examined and filled with nitrogen.

Cooler must be taken an internal inspection and cleansing once every 6-12months in accordance with water quality (Generally, soft water should be used). If necessary, the internal seal ring should be replaced. Please note that in any case, for the best cooling , ensure that cooling water quantity shall conform to specified requirements.

Every valve, pressure regulating hand wheel and spanner shall not be arbitrarily tampered with after commissioning.

12.9 Faults and Remedies

Faults		Cause	Remedies
1	No pressure of system	1.1 No output pressure of pump station	1.1Check pressure valve
		1.2 Overflow valve clogged	1.2 Cleanse overflow valve

		1.3 Pilot valve clogged on the electromagnet overflow valve	1.3 Cleanse pilot valve
2	No movement of cylinder; No reversing of reversal valve	2.1 Reversal valve clogged	2.1 Clean reversal valve
		2.2 Electro-magnet de-energized or damaged	2.2Overhaul electric circuit or replace electro-magnet
3	Connection Leaking oil	3.1 No seal	3.1 Install seal
		3.2 Seal damaged	3.2 replace seal
		3.3 Improper connection of thread or flange	3.3 Readjust thread connection or fasten screw
4	No reaction of system; Protection cylinder pressure too low or too high	4.1 Short or open circuit of pressure sensor	4.1 Overhaul electric circuit and well connect wire
		4.2 Connection of pressure sensor damaged	4.2 Replace electric connection
		4.3 Plunger of of pressure sensor clogged	4.3 Cleanse pressure sensor

Section13 Maintenance and Fault Handling

13.1 Start-up preparation

(1) Fill recommended lubricating oil after the thorough cleaning of oil storage tank.

(2)Thoroughly clean the oil tank of the jack-up hydraulic system (MPS), and fill recommended hydraulic oil (see table 12-1, section 12.3, chapter 12).

(3) Discharge the antirust oil in Drive assembly and fill a right amount of oil (see table 12-1,chapter 12, section 12.3).

(4) Fill the recommended grease into the oil trough of the spider.(see table 9-4, chapter 9).

(5)connect the cooling water to the lubricating oil cooler. If the air cooler is used,

Check the connection of the pipeline and the rotation of the fan and discharge the anti-rust oil.

(6)check the electrical connection of the lubrication system and the control system of the jack-up hydraulic system of main shaft.

(7)check the alignment of the driving unit.

Note:Thoroughly flush all lubrication piping before the pump-in of oil into the crusher. Disconnect two oil inlet pipe and flush the system for at least 4 hours. Unproper flushing of lubrication pipeline may cause the dirt into the crusher bearing, easily wearing each friction surface. After flushing, replace the filter element with the spare one.

13.2 Inspection before the starting of the crusher

13.2.1 The starting of lubrication system

Open the manual valves on the oil inlet of the oil pump and filter.

(2)Confirm whether the oil temperature in the tank reaches the appropriate temperature. If the immersion heater is equipped and put into operation , the temperature will reach 32 ℃. Note: the oil temperature should not be too low,otherwise high pressure will arise during the operation of the lubrication system and damage the components of the system.

(3) Start oil pump and check the pipelines for leaks. Tighten any loose connection. Note: the lubrication system should not be started until the pipeline is thoroughly cleaned.

(4) Check the operation condition of the flowmeter on the oil inlet.

(5) check the pressure drop at the inlet and outlet of the filter. Use the clean filter element and the the pressure drop should be 3 ~ 20 kPa under normal working conditions. If no oil flows through by-pass line, the plug on top cap should be used to discharge the air in the filter.

13.2.2 Checking jack-up hydraulic control system of main shaft

(1)open the valve on the oil inlet between the oil tank and control valve.

(2)check whether the "C" port of control valve is connected to MPS oil cylinder, whether free flow arrow of check valve is pointing to the crusher, and whether the air in MPS line is exhausted.

(3) fill recommended oil into MPS oil tank.

(4)The MPS system adopts reserving gear pump, of which the motor can rotate bilaterally. Push the "lifting "button to start the pump , the pump rotates positively , pressurize the control valve assembly , oil flows into the crusher and lift the mainshaft; release the 'lifting" button, the pump stops running and the check valve of its assembly prevents the oil from from flowing back into the tank . Press the "lowering" shaft, the motor rotates inversely, pressurize the control valve assembly, and oil flows back to the tank , thus lowering the mainshaft.

(5)loosen the oil plug at the bottom of the crusher to make MPS control system in "lifting" mode until clean oil flows out form oil drain. cloudy or emulsion oil means that the oil is mixed with air which must be exhausted. For the cleaning of oil return, tighten the drain plug.

(6) set the MPS control system into "lifting mode"and exhaust the air or the oil with entrained air at the system pipeline.

(7) After lifting the mainshaft assembly to the operation position, thoroughly check all the connections of MPS pipeline for leakages. During load running, check the pipeline again. The crushing pressure may cause leakage, which is difficult to find under the the static weight of main shaft.

(8) main shaft is lifted and lowered once every few hours. repeated the exhaust process to ensure all the air into the oil exhausts to the highest point of the system and out of the system. Exhaust the bottom of the crusher before starting the crusher.

13.2.3 Check driving unit

Check the alignment of each coupling of drive assembly, coupling assembly and motor assembly and ensure the driving system is lubricated in accordance with the required mode.

13.3. Start-up of the crusher

13.3.1 Start -up and shut- down sequence

Before starting the crusher, first start the dust removal fan, then the hydraulic lubrication station. When the flow of the lubrication station is steady, the oil return of the return line, all the monitored lubrication parameters, and the fan pressure are all normal, start the jack-up hydraulic system of main shaft. After it, determine the discharge opening of the crusher based on displacement data from the displacement sensor(primary discharge opening is measured by the method of artificial rubber ball and calibrate the displacement data of main shaft after the

measurement); after the correct setting of the discharge opening, observe whether the lubrication parameters, hydraulic parameters and air pressure is normal; if they are all normal, switch on the motor to start the crusher.

The start-up sequence of the crusher: starting the fan -starting the oil pump-start the hydraulic station- jack-up of the main shaft-starting the motor and the crusher

The shut-down sequence of the crusher: stopping the motor-stopping the crusher-lowering the mainshaft through the hydraulic station-stopping the hydraulic station-stopping the oil pump station.

13.3.2 Test run of the crusher

(1)Before the starting or running of the crusher, check whether there are people, animals, tools, parts, or other sundries inside, outside, above, below or around the machine .Ensure all the protection and safety device are properly installed and in good working condition.

(2) make sure the oil level of the tank is 25 mm below the filter screen. Check the flowmeter to confirm whether there is a proper quantity of lubricating oil into two oil feed lines.

(3) check the backlash of gear and pinion and the value should not be lower than the range of design requirements (see section 6.8 in chapter 6).

(4) the oil returns to the oil tank, start the crusher for test run, and the crusher motor energizes instantly. Seen from the front of pinion shaft towards the direction of crusher, the correct direction of rotation of the pinion shaft should be clockwise. Or else, change the motor cable to correct the direction of rotation.

(5) start the crusher for test run. Watch the rotation of main shaft; if the clockwise rotation of main shaft is not over 12rpm, the crusher can be in idle running for a few hours; if it is over 12rpm, a small amount of ore should be put into the crusher to avoid excessive rotation. If there is no ore, one or two tires or similar objects can be used by hang them into the crusher with a rope. No-load test run time should ensure the return oil temperature becomes steady. Note:during the test run of the crusher, tiny bronze scraps may appear on the return screen, which is mainly due to the running-in of crusher bearings for full contact and will gradually be normal after this period.

(6) during the test run, the following noises will appear: a slight friction noise below the main shaft due to the running-in of dust-proof hood and sealing ring, which is a normal phenomenon; uneven noise of gear and pinion caused by the gap between eccentric steel bushing and bronze bushing under no-load condition; the noise of the lubrication pump during heating due to too low oil temperature or oil with entrained air.

13.3.3 Possible problems during test run

During the test run of the crusher , possible problems are:

(1) return oil temperature is too high (more than 58 ℃), which may be caused by insufficient cooling water; if an air cooler is used, that may because of the wrong rotation direction of cooling fan is not correct.

(2) insufficient oil flow or flow indication in the flow regulator may because the valve is installed reversely- its arrow must point to the flow direction.

13.4 Adjusting /checking the discharge opening

Before adjusting the discharge opening of the crusher, first stop the crusher and cut off power supply. Adjustment method of discharge opening: prepare a wooden ball close to the required product size(or other materials of light weight), tie the ball with a thick hemp rope, hang it through the crushing cavity to the crushing point at the widest opening , the ball just pass and determine the discharge opening(OSS). Adjust the hydraulic adjustment system to lift or lower the main shaft to gain proper discharge opening. After the adjustment, check with the ball.

The adjusted discharge opening (OSS) of the crusher is the required opening for the crusher to be delivered. The best staring point of the crushing force is at the mantle on the upper part of the crusher to reduce the sliding damage of the mantle and concave segments.

13.5 Test run

(1) After the initial run or replacing with a new bearing, the crusher should run under low load to provide a running-in period for the new bearing before it bears heavy load.

(2) Run the crusher at half of its production capacity for at least two hours and at most a day.

(3) First feeding adjustment should make the material evenly distributed in the crushing cavity with no segregation of the coarse and fine material

(4) Regularly check the temperature of return oil to ensure the temperature within safe range and check the operation condition of oil cooler. The crusher is equipped with interlock control , so if return oil temperature exceeds safe operating limits, "high oil temperature" alarm and alarm signal will occur and the crusher motor will stop.

(5) Check all connections of all lubrication lines and the line of jack-up control system for leakages and check pinion shaft and spider bushing for leakages.

(6) Check whether there are metal debris on oil return screen. a small amount of bronze and steel scraps during test run is a normal phenomenon.

(7) Check whether the bolts are loose.

(8) Gradually increase the load of crusher, until it runs at full load

(9) Implement final feeding adjustment.

13.6 Notes

Pay attention to the following matters when running the crusher:

(1) The consumed power shall be kept within the range of prescribed maximum power.

(2) The return oil temperature shall be kept within a safe range (shall not exceed 58 ℃).

The pressure of main shaft jacking control system, consumed power and return oil temperature are affected by the discharge opening of the crusher, production capacity and the hardness of crushed materials. If the consumed power is high and stable, but is over the limit, the mantle will be worn so that the discharge opening will be enlarged. Under this condition, the load can be reduced temporarily. However, it is suggested that the worn mantle be replaced. If the power is consumed unsteadily, it may be caused by the uneven distribution of feeding, the segregation of materials, the material clamping and stagnation in crushing cavity, or the air in hydraulic control system.

13.7Daily Maintenance

Due to its harsh working environment, it is necessary to conduct regular maintenance and check on the crusher and keep detailed records to ensure its good performance and operation and avoid serious trouble. The items of check are shown in Table 13-1 and 13-2.

Tab.13-1 Daily maintenance and check

Items of Check	Specific work
Lubrication system	Check the oil volume of the tank; before starting, the oil level should be about 25mm below the screen.
	Check the pressure drop of the filter; if the pressure drop reaches 172kPa, replace the filter element.
	Check oil pump; add the grease if necessary.
Hydraulic system	Check oil volume (if the mantle is at the lowest point, the oil should be full). After setting main shaft, no oil should be added; if main shaft is greatly lowered, the oil will overflow.
	After starting the crusher and feeder, check oil pipes for leaks, for the discharge opening can be maintained if oil leak occurs.
Pinion shaft sleeve	Check oil level after the crusher stops.
Routine check	Check whether the bolts and parts are loose during running; retighten loose ones.
	Check the screen for metal debris, if there is a sudden increase in debris, it indicates that the bearing surface may be overpressure or damaged.
	Check whether there is excessive noise during the running of the crusher.
	Check the return oil temperature every hour until it is within safe range.
	Check oil temperature when shifting and stoping.
	Check the tightness of concave。
	For manganese steel concave, check its clearance daily.

Tab.13-2 Weekly maintenance and check

Check all the items of daily maintenance and check	
Items of check	**Specific work**
Lubrication system	Check the system for dirt or debris, and check the filter; if necessary, replace the filter element. replace the oil if there is suspended contamination or much sediment at the bottom of the tank. Empty the tank, clean and refill it with new oil.
	Check the sedimentation separator on the oil inlet line; if necessary, clean it.
	Check all the connections of oil pipes and crusher for leaks .
	If necessary, lubricate the motor of the oil pump.
	Check the oil pump for abnormal noise or any sign of wear.
Pinion shaft	Check oil level; the level should be constant unless the seal damages or leaks; replace if necessary,
Spider bearing	Check the lubricant in the bearing and the oil level should at the 36mm over the spider bearing.
Accumulator	Check the pressure display of the accumulator; if it is damaged, replace the bladder.
Routine check	Check the clearance between lock nut of main shaft and spider bottom to ensure the wear extent.
	Check the dustproof seal for wear and the tightness of the dustproof seal retainer to prevent the fracture of the bolts.
	Check the mantle and concave for wear and cracks. Check the stretch at the joints of the manganese steel plate, towards the allowable adjustment end of main shaft, and check the bottom two layers for wear.
	The extension of the manganese steel concave exceeding the original clearance of the concave caused by the crushing of hard and ductile materials will lead to the extension of connection bolts of top and middle shell, resulting in the separation of taper fit. In this case, relevant plans should be made that the welding torch should be used to cut vertical and horizontal edges of the concave.

13.8Common Failures and Handling Methods

After the mechanical, hydraulic and electric installation of the crusher, during the commissioning and operation of the equipment, please refer to the table 13-3 for failures and treatments except for special cases which need analyzing and handling in some other ways.

Tab.13-3 Equipment failure handling

Phenomena	Reasons	Solutions
The crusher stops running	The blockage of the material in the crushing cavity	Lower main shaft, clear blocked material; readjust the discharge opening; restart the crusher; check whether the size of the discharge opening to meet the requirements ; check the feeding condition.
	Tramp release	Lower main shaft, clear jammed iron; re-adjust the discharge opening and restart the crusher. If the iron is jammed too tightly and main shaft cannot be lowered, loosen middle shell. If all these methods are in vain, then cut with acetylene.

	Blocked oil pipe (resulting in overload of oil pump)	Clean the pipeline and the screen of oil tank
	Low oil temperature (pump overload caused by an increase in viscosity)	Preheat the oil before starting the crusher
The set discharge opening cannot be maintained.	Oil leakage	Check all the pipes for leaks.
	Leak of check valve in control valve assembly	Check the check valve and replace damaged parts
	Air into the system	Bleed the air in oil pipe
	Failure of oil seal of cylinder unit	Replace new seal or repair the cylinder
Loose or fractured mantle	Partial crushing of too hard material makes the mantle stretch, leading to the shaking of the mantle.	Stop feeding, empty the crushing cavity, check the tightness of the mantle,and replace it if it is loose.
	Improper pouring of epoxy backing;	Too high pouring position of epoxy backing affect self-fastening of main shaft.
Abnormal noise of crusher	Improper backlash leads to high frequency noise between gear and pinion.	Re-adjust the backlash to a proper value, see Chapter 6 " Backlash Adjustment of Gear and Pinion ."
	Excessive load leads to the grinding noise of crusher bottom or the damage of thrust bearing	Excessive load lead to extreme pressure between tooth surfaces and on the surface of thrust bearing; check the screen in oil tank for excessive copper or lead scraps.
	Movement between top and middle shell	Replace the bolts ; if taper fitting surface wears or rusts, build-up welding and machining should be done.
Excessive oil temperature	Air cooler is blocked by dirt,dust or other impurities .	Clean the dust or other impurities on the radiator fin.
	No cooling water or excessive water temperature	Check water source and temperature
	Blocked crushing cavity	Lower main shaft, clean the crushing cavity, check whether the size of discharging opening is smaller than the recommended value and check the feeding condition.
	Bearing failure	Check whether the screen is clogged by cooper or lead scraps and check the bearing.

13.9 Routine inspection, overhaul and maintenance

Disassemble the crusher and check the main parts in the following order. Polishing, maintenance or replacement shall be conducted if necessary.

13.9.1 The inspection of spider assembly

(1) Check the gap between spider bushing and main shaft sleeve before withdrawing the spider and the spider bushing (See Chapter 9, Section 9.4 for the specific measuring methods). The

fulcrum is the pad at the minimum diameter of an hourglass bushing. If the gap between spider bushing and main shaft sleeve at the fulcrum exceeds the maximum value of operation showed in Table 9-2, one of them or both of them shall be replaced.

(2) Check the spider bushing seal for pitting, cracking, or wear. The wear-out seal or damaged seal needs to be replaced.

(3) Check the spider arm liner and the spider edge liner for looseness or wear. If the spider arm liner is over worn, it means the feeding distribution is uneven. In order to ensure even feeding, the feeding arrangement need to be corrected.

(4) Check the taper fitting surface with the top shell and measure the wearing capacity. Remove burrs, scars of collision, corrosion and dirt on the surface. Before installation, oil both taper fitting surfaces or coat them with anti adhesion compounds. White lead is not allowed because the harden white lead can make spider assembly more difficult to demount.

13.9.2 The inspection of middle shell assembly

(1) Check the taper fitting surface between the top shell/middle shell and the spider for corrosion or wear. Make removal if necessary. Measure the wearing capacity of the fitting surface.

(2) Check shell liner for abnormal wear, excessive manganese growth, or other fault phenomenons.

13.9.3 The inspection of bottom shell assembly

Check the wear of the following parts:

(1) Check the taper fitting surface contacted with the middle shell assembly.

(2) Check the center hole and the keyway of the bottom hub.

(3) Check all the liners, arms, hubs and other wear surfaces.

(4) Check if the outer diameter of dustproof cover and its bottom surface which is fitted with the sealing gasket are worn or not. The overwear can cause oil polluted, leading to the wear of the main shaft spherical friction disc or the gear. Meanwhile, check the sealing gasket of bottom dustproof cover. The defect of the sealing gasket can lead to excessive wastage of oil. The incorrect positioning of oil drain can cause the oil to overflow the dustproof cover, so that products will be polluted.

(5) Check the inner bore of bottom shell bushing for defects, such as wear, scratches, burnout, thermal cracking and so on. Remove burrs or protrusions. Before reusing, check the bushing surface for cracking, especially the surface around keyway.

13.9.4 The inspection of eccentric bushing assembly

(1) Check the inner bore of eccentric copper bushing for defects, such as wear, scratch, burnout, thermal cracking and so on. Remove burrs or protrusions. Before reusing, check the copper bushing surface for cracking, especially the surface around keyway.

(2) Check the outer circle of the eccentric steel bushing for defects, such as wear, scratches, burnout, thermal cracking and so on. If the steel bushing is abraded seriously, the inspection is needed to see if there is any cracking. Check and polish the bottom of the gearwheel rotated on eccentric wearing plate. Remove the burrs and cuspidal edges on the teeth of the gearwheel, and check if there is any cracking.

(3) Check the surface of eccentric wearing plate. If there is wear but the surface is still smooth and the oil groove is well, the eccentric wearing plate can be reused. If it is worn seriously and the surface is rough, the replacement is needed.

(4) Check the upper and lower surfaces of eccentric support plate for planeness. The overpressure of hydrosupport cylinder can lead to the bending of the support plate and the cylinder flange. The sealing ring shall be replaced whenever the support plate is replaced.

13.9.5 The inspection of hydrosupport cylinder assembly

(1) Check the step bearing washer for wear or roughness. If it is rough, use the oil stone to grind. Check the planeness of the bottom. The wear limit of the step bearing washer is 10mm. Replace it if the wear is over the limit.

(2) Check the piston wearing plate for wear or burnout, and check its surface for roughness. If the burnout area is small, the piston wearing plate can be polished and reused. If it is seriously burned, replacement is needed. If the surface is worn or not smooth, it need to be replaced. Overwear may be caused by the impurities in the oil or the overpressure of main shaft jacking hydraulic system. The wear limit for the edge thickness of wearing plate is 10mm.

(3) Check the top of the hydrosupport piston for planeness, and check its diameter for wear or scratches. If the top of the hydrosupport piston is not smooth, it needs to be remachined or replaced. If the wear or the scratch is not serious, it can be grinded by hand and reused. If it is possible to scratch the wall of the hydrosupport cylinder, it can not be reused.

(4) Check the top and bottom bushing of the hydrosupport cylinder, especially the vertical groove on the sealing surface. If there is wear or vertical scratch, it can be grinded by hand and reused. It shall be replaced if it is badly worn.

(5) If the oil seal is worn or scratched because of the oil pollution, it shall be replaced.

(6) Check the clamping plate sealing groove for vertical scratch. Check the piston seat at the top of the clamping plate for smoothness. Grind it to be smooth if necessary.

(7) Replace the “O”ring whenever replace the hydrosupport cylinder bottom cover.

(8) Check the surface of hydrosupport cylinder bottom bushing in “O”ring area for burrs or scratches.

(9) Check the top of the upper flange of the cylinder for planeness. Remove the burr or the scar of collision and check the lower flange.

(10) Replace the “O”ring whenever replace the hydrosupport cylinder.

13.9.6 The inspection of main shaft assembly

(1) Check the upper and lower mantles of the main shaft for wear. It shall be replaced if it is badly worn. Cracking or fracture is easy to happen when the mantle is only 25mm thick.

(2) Check the main shaft sleeve for wear. If there is any vertical scratch or groove, replacement is needed.

(3) Check the locknut and the main shaft for the burr, which needs to be removed, if any.

(4) Check the bottom journal of the main shaft for defects, such as grooves, wear, abrasion, thermal cracking and so on. If there is no serious defect, it can be reused after grinding and removing the defect by hand. It needs to be remachined if there are serious defects.

(5) Check the main shaft taper surface. If there is wear or pitting, use grind stone to grind it. The babbit or other similar heat-resisting material can be applied to fill and level up the pit.

(6) Check the main shaft step bearing for wear, burnout or roughness. If the wear or burnout is serious, it shall be replaced. If it is slightly rough, grind it by hand and then check the contact surface of step bearing gasket by bluing. If there is 50% of contact surface, it can still be used.

(7) Check the thickness of dustproof seal ring and the wear of inner bore. If the wear of the inner diameter is over 3.2mm, the replacement is needed. Check if there is any cracking which may caused by the material accumulation under the main shaft assembly. Check the dust proof retaining ring to make sure there is no cuspidal edge on its lower edge. Check the fixed bolts for looseness.

Appendix A Bolts Torque List For PXZ-1500II Gyratory Crusher

Parts	Part No *	Name	Bolt specification	Recommended torque (N·m)
Spider Assembly (G0021)	1	Fastening bolt of spider arm liner	M33 (35#)	1000
	9	Fastening bolt of dustproof cover	M12 (Grade 8.8)	80
	12	Fastening bolt of spider bushing	M24 (Grade 8.8)	700
	14	Bolt of spider arm liner	M90 (35CrMoA)	24500
	20	Joint bolt of spider and middle shell assembly	M76 (35#)	10000
	23	Joint bolt of spider and middle shell assembly	M80 (35#)	12000
Middle Shell Assembly (G0022)	21	Joint bolt of upper and lower shell	M80 (35#)	12000
Main Shaft Assembly (G0023)	2	Fastening bolt of retainer ring 1	M16 (Grade 8.8)	200
	9	Fastening bolt of retainer ring 2	M24 (Grade 8.8)	686
	17	Fastening bolt of spherical friction disk	M20 (Grade 8.8)	400
	2	Fastening bolt of lower support ring	M16 (Grade 8.8)	200
	30	Fastening bolt of upper support ring	M30 (Grade 8.8)	1200
	28	Fastening bolt of rubber ring	M12 (Grade 8.8)	80
Eccentric bushing Assembly (G0024)	5	Fastening bolt of upper counterweight	M20 (Grade 8.8)	400
	10	Fastening screw of gear and pin	M20 (Grade 8.8)	400
	14	Fastening bolt of support plate	M30 (Grade 8.8)	1200
	16	Mounting bolts	M56 (35#)	5100
	21	Fastening screw of counterweight block	M24 (Grade 8.8)	686
Cylinder Assembly (G0025)	4	Fastening screw of cylinder upper bushing	M20 (Grade 8.8)	400
	17	Fastening screw of bottom plate	M16 (Grade 8.8)	200
	20	Fastening screw of protection hood	M16 (Grade 8.8)	200
	22	Fastening bolt of cylinder body and cylinder bottom	M36 (Grade 8.8)	1700
	27	Fastening screw of cylinder lower bushing	M20 (Grade 8.8)	400
	39	Fastening screw of displacement sensor	M6 (Grade 8.8)	10
	45	Fastening screw of magnet ring	M3 (Grade 8.8)	1.3
	50	Fastening screw of seal plate	M12 (Grade 8.8)	80
	52	Fastening bolt of oil circuit block	M30 (35#)	880
Drive Assembly (G0026)	13	Fastening screw of transparent cover 2	M16 (Grade 8.8)	200
Bottom Shell Assembly (G0027)	11	Fastening screw of slinger	M10 (Grade 8.8)	40
	15	Adjusting bolt of bottom shell and drive assembly	M30 (Grade 8.8)	1200
	17	Fastening bolt of bottom shell and drive assembly	M30 (Grade 8.8)	1200
	21	Locking stud of bottom shell and oil	M56 (Grade 8.8)	5900

		cylinder		
	26	Fitting bolt of bottom shell liner	M30 (Grade 8.8)	1200
	29	Fitting bolt of dustproof cover	M24 (Grade 8.8)	686
Motor Assembly (G0028)	4	Fitting bolt of motor base	M36 (Grade 8.8)	1760
Electric Pulley (G00210)	12	Joint bolt of frame body	M30 (Grade 10.9)	1900
	16	Fastening bolt of electric pulley	M24 Grade (8.8)	686
Base Assembly (G00211)	1	Anchor bolt 1	M80 (45#)	15000
	6	Stud M36X960	M36 (35#)	1470
	10	Anchor bolt 2	M80 (45#)	15000
	16	Bolt M24X100	M24 (Grade 8.8)	686
	20	Anchor bolt M16X250	M16 (Grade 3.6)	59
	24	Anchor bolt M12X160	M12 (Grade 3.6)	24
	30	Anchor bolt 3	M80 (45#)	15000

Note :

For Part number (*) please refer to the sub-supplier's drawing for the parts of PXZ-1500II crusher.