GARDNER DENVER®

15-600
Version 12
April 2002

TRIPLEX

SINGLE ACTING PUMP

MODELS

PZG – 7”
PZH – 8”
PZJ – 9”
PZK – 10”
PZL – 11”
PXL – 11”

OPERATING AND SERVICE MANUAL

Gardner Denver

MAINTAIN PUMP RELIABILITY AND PERFORMANCE WITH GENUINE GARDNER DENVER PARTS AND SUPPORT SERVICES

Gardner Denver® and OPI® genuine pump parts are manufactured to design tolerances and developed for optimum dependability. Design and material innovations are the result of years of experience with hundreds of different pump applications. Reliability in materials and quality assurance are incorporated in our genuine replacement parts.

Your authorized Gardner Denver and OPI distributor offers all the backup you'll need. A worldwide network of authorized distributors provides the finest product support in the pump industry.
Your local authorized distributor maintains a large inventory of genuine parts and he is backed up for emergency parts by direct access to the Gardner Denver Master Distribution Center (MDC) in Memphis, Tennessee.
Your authorized distributor can support your Gardner Denver and OPI pump needs with these services:

1. Trained parts specialists to assist you in selecting the correct replacement parts.

2. Repair and maintenance kits designed with the necessary parts to simplify servicing your pump.

Authorized distributor service technicians are factory-trained and skilled in pump maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair services.

For the location of your local authorized Gardner Denver and OPI distributor refer to the yellow pages of your phone directory or contact:

Distribution Center:
Gardner Denver
Master Distribution Center
5585 East Shelby Drive
Memphis, TN 38141
Phone: (901) 542-6100
Fax: (901) 542-6159

Factory:
Gardner Denver
1800 Gardner Expressway
Quincy, IL 62301
Phone: (217) 222-5400
Fax: (217) 224-7814

INSTRUCTIONS FOR ORDERING REPAIR PARTS

When ordering parts, specify Pump MODEL and SERIAL NUMBER (see nameplate on unit). The Serial Number is also stamped on top of the cylinder end of the frame (cradle area).

All orders for Parts should be placed with the nearest authorized distributor.

Where NOT specified, quantity of parts required per pump or unit is one (1); where more than one is required per unit, quantity is indicated in parenthesis. **SPECIFY EXACTLY THE NUMBER OF PARTS REQUIRED. DO NOT ORDER BY SETS OR GROUPS.**

To determine the Right Hand and Left Hand side of a pump, stand at the power end and look toward the fluid end. Right Hand and Left Hand are indicated in parenthesis following the part name, i.e. (RH) & (LH), when appropriate.

FOREWORD

Gardner Denver[R] and OPI[R] pumps are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

DANGER
Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.

WARNING
Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.

CAUTION
Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.

NOTICE
Notice is used to notify people of installation, operation or maintenance information which is important but not hazard – related.

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DANGER NOTICES

DANGER

Read and understand the following DANGER NOTICES before moving or operating the pump or any pump package unit equipment.

Reciprocating pumps are machines capable of producing high fluid pressures and flow rates and are designed to be used with proper care and caution by trained, experienced operators. **TO AVOID PERSONAL INJURY, DEATH AND/OR EQUIPMENT DAMAGE, READ AND THOROUGHLY UNDERSTAND THE FOLLOWING DANGER NOTICES PLUS THE ENTIRE OPERATING AND SERVICE MANUAL BEFORE ATTEMPTING TO MOVE OR OPERATE THE PUMP**. Contact a Gardner Denver service representative if you are unable to comply with any of the danger notices or procedures described in these documents.

Closely examine the data plate upon pump delivery to become thoroughly familiar with the operating limits for this pump model. **The pump must <u>never</u> be operated at speeds, pressures or horsepower exceeding the maximum values shown on the data plate or at speeds below the minimum shown. Failure to observe the operating limits shown on the data plate could result in personal injury, death, and/or equipment damage and will void the warranty**. Alterations to the pump, or application of the pump outside the data plate limits, must not be made without Gardner Denver written approval together with a new data plate, as dangerous operating conditions could result.

THE DANGER NOTICE AND DATA PLATES PROVIDED ON THE EQUIPMENT MUST NOT BE REMOVED, PAINTED OVER, HIDDEN OR DEFACED. They must be replaced if they become damaged or unreadable. Provisions should be made to have the following written danger notices plus the pump operating and service manual readily available to operators and maintenance personnel. In addition, copies of all pump system accessory component (e.g. pressure relief valve, pulsation dampener, suction stabilizer, engine, electric motor, etc.) operating and service manuals should be readily available for operator and maintenance personnel use. Read and follow all the precautions and instructions contained in these manuals. If any of these documents are lost or become illegible they must be replaced immediately. The danger notices plus the operating and service manuals should be reread periodically by both operators and maintenance personnel to refresh their memories in safe procedures and practices.

Keep in mind that full operator attention and alertness are required when operating high pressure pumping equipment. Operators should not begin or continue operations when tired, distracted or under the influence of alcohol or any type of prescription or nonprescription drugs.

The timely replacement of expendable parts and any other worn or damaged parts can prevent equipment damage and possible injury. The original parts used in Gardner Denver pumps are designed and tested to exacting standards to provide high quality performance and durability. Your best insurance in maintaining these characteristics is to use genuine Gardner Denver replacement parts.

A broad range of danger notices are covered on these pages, however, they cannot substitute for training, experience and common sense in the safe operation of high pressure pumping equipment.

<u>HAMMER LUG FASTENERS</u>

DANGER

On pumps or pump package units equipped with hammer lug connectors and/or hammer lug valve covers the following precautions must be observed to avoid personal injury, death and/or equipment damage due to contact with the hammer, hammer bar, broken parts from the hammer, hammer bar or lugs or other objects propelled by hammer blows. When tightening or loosening hammer lug connectors and valve covers, operators or maintenance personnel should:

Inspect the hammer, hammer lugs and hammer bar, if one is used, to insure they are all in good condition. Replace any of these parts which are cracked, damaged or badly worn.

- Wear safety shoes and goggles.
- Alert other personnel to move away from the area.
- Check to insure they have safe footing.
- Fully engage the hammer bar, if one is used, to prevent it from disengaging violently from the cover as a blow is struck.
- Wipe their hands and the hammer handle and maintain a firm grip on the handle to avoid losing control of the hammer while swinging and striking.

- Carefully swing the hammer to avoid striking themselves, another person and objects other than the targeted lugs or hammer bar.
- Avoid swinging the hammer above shoulder height.

VALVE SEAT PULLING

DANGER

The following precautions must be observed by operators and maintenance personnel to avoid personal injury, death and/or equipment damage from contact with the puller, hammer, wedge or broken parts from these components when using either a hydraulic or wedge valve seat puller:

Hydraulic Puller

- Wear safety shoes and goggles.
- Chain or tie the jack down as it will jump violently when the valve seat disengages from the valve deck.
- Check to insure the pressure applied by the hydraulic pump does not exceed the hydraulic ram maximum pressure rating.

Wedge Puller

- Grind off any mushroomed material from the wedge before use.
- Follow the DANGER notices listed above in the hammer lug section, but substitute the term wedge for hammer lub an hammer bar.

COVERS AND GUARDS

DANGER

All pump covers must be securely fastened in proper position at all times when the pump is operating to avoid personal injury or death from moving parts. In addition, all moving parts on the entire pump package, including but not limited to, the engine or motors, drive shafts, belts, chains, pulleys, gears, etc., must be equipped with guards or covers, which must also be securely fastened in proper position at all times when the equipment is operating.

Covers and guards are intended to not only protect against personal injury or death, but to also protect the equipment from damage from foreign objects.

EQUIPMENT MOVING AND LIFTING

DANGER

Heavy equipment including pumps, pump package units and components should only be moved or lifted by trained, experienced operators, who are physically and mentally prepared to devote full attention and alertness to the moving and lifting operations. An operator should be fully aware of the use, capabilities, and condition of both the equipment being moved and the equipment being used to move it.

DANGER

Failure to follow safe and proper pump, pump package or component lifting or moving procedures can lead to personal injury, death and/or equipment damage from shifting, falling or other unexpected or uncontrolled equipment movements.

Make sure the hoist, lift truck, ropes, slings, spreader, or other lifting equipment you are using is in good condition and has a rated lifting capacity equal to or greater than the weight being lifted. Lifting devices must be checked frequently for condition and continued conformance to rated load capacity. They should then be tagged with the inspected capacity together with the date of inspection.
Fully assembled pumps and pump package units are heavy and should only be moved using the specified lifting lugs or attachments.

Many individual components have lifting eyes or lugs which must not be used to lift assemblies, as they are designed to bear the weight of the component only.

Before lifting the individual component check to insure the lifting attachment is firmly secured to the component with undamaged, properly torqued fasteners, sound welds, or other secure attachments. Examine the lifting eyes, lugs, slots, holes or other projections to insure they are not cracked, otherwise damaged or badly worn. The repair of existing or addition of new welded lifting eyes, lugs or other projections should only be performed by experienced, qualified welders.

Package units should be lifted with spreaders connected to the lifting attachments normally built into the package unit support skid. Packages too large to lift fully assembled should be separated into smaller

loads. For these smaller loads the lifting devices should be fastened to the lifting attachments normally built into the individual motor, engine, pump or transmission/torque converter, or their separate support skids.

When lifting subassembled components, for example a suction stabilizer attached to suction piping or a discharge pulsation dampener attached to a strainer cross and piping, use special lifting slings designed to safely support the combined weight of the components. If a crane or hoist is being used to lift large components or assemblies, one or more persons should assist the operator from the ground with guide lines attached to the equipment being moved to properly position it and prevent uncontrolled movement.

When you start to lift a pump, package unit, subassemblies or individual components and you observe the equipment is tilting, or appears unbalanced, lower the equipment and adjust the lifting device to eliminate these improper lifting conditions before proceeding to move the equipment.

It is poor practice and dangerous to allow the equipment to pass over or close to your body or limbs. Be prepared to move quickly out of danger if equipment starts to fall, slip or move unexpectedly toward you.

PRESSURIZED PUMP SYSTEMS

DANGER

Fluids under high pressure can possess sufficient energy to cause personal injury, death and/or equipment damage either through direct contact with escaping fluid streams or by contact with loose objects the pressurized fluid propels.

Operating a pump against a blocked or restricted discharge line can produce excessive pressures in the entire discharge system, which can damage or burst discharge system components.

DANGER

Never operate a pump without a properly sized pressure relief valve located in the flowing discharge line immediately adjacent to the pump discharge connection.

The relief valve should be placed in the flowing discharge line and not at the opposite end of the discharge manifold in a dead end connection. The dead end may become clogged with solid material carried in the fluid, which could prevent proper relief valve operation.

DANGER

Never place a shut-off valve or any other component between the pump discharge connection and the pressure relief valve.

Make sure the pressure relief valve is installed so any pressurized relief discharge from the valve is directed away from possible contact with people or equipment. The relief valve must be set to relieve at a pressure equal to or below the maximum pressure values shown on the pump data plate. However, if a component is used in the discharge system with a lower rated pressure capability than that listed on the pump data plate, the pressure relief valve must be set to relief valve must be set to relieve at a pressure equal to or below the rated capability of the lowest rated component.

Before starting the pump every time, check to insure:

- The pressure relief valve is in good operating condition and has been set to the proper relief pressure.
- Any pipe line used to direct pressurized relief flow to another location, such as a collecting tank, is not blocked.
- The discharge system is not blocked and all the discharge line valves are open.

Check all fluid end discharge system components including pipe, connections, elbows, threads, fasteners, hoses, etc., at least once every six months to confirm their structural adequacy. With time, wear, corrosion and fatigue can reduce the strength of all components. Magnetic iron and steel components should be checked with magnetic particle or dye penetrate crack detection equipment. Nonmagnetic materials should be checked for cracks with dye penetrants. All metallic components should also be visually checked during these inspections for signs of corrosion. If a component shows evidence of cracking or loss of material due to corrosion it must be replaced with a new part.

Continually monitor suction and discharge hose assemblies when the pump is operating for leakage, kinking, abrasion, corrosion or any other signs of wear or damage.

Worn or damaged hose assemblies should be replaced immediately. At least every six months examine hose assemblies internally for cut or bulged tube, obstructions and cleanliness. For segment style fittings, be sure that the hose butts up against the nipple shoulder, the band and retaining ring are properly set and tight and the segments are properly spaced. Check for proper gap between nut and socket or hex and socket. Nuts should swivel freely. Check the layline of the hose to be sure that the assembly is not twisted. Cap the ends of the hose with plastic covers to keep them clean until they are tested or reinstalled on the pump unit. Following this visual examination, the hose assembly should be hydrostatically tested, on test stands having adequate guards to protect the operator, per the hose manufacturer's proof test procedure.

Fluid end component inspections should be performed more frequently than every six months if pressures above 2,500 PSI are used in the discharge system or if corrosive, flammable or hot (over 110º F) fluids are being pumped.

Proper stuffing box packing selection is important for safe pump operation. Contact a Gardner Denver service representative for assistance in selecting the proper packing before beginning operation.

Before starting the pump the first time and periodically thereafter check the pump, suction and discharge system fastener torques versus the values listed on page 12 to insure proper tightness. Over and under torquing can damage threaded pipes, connections and fasteners, which may lead to component damage and/or failure. Replace all components found to be damaged or defective. On pumps equipped with stuffing boxes, the gland must be engaged by at least three (3) threads to hold the discharge pressure of the pump.

Block the crankshaft from turning and make certain that all pump drive motor or engine start switches or starter controls are clearly tagged with warnings not to start the pump while repair work is in process.

⚠ DANGER

Do not attempt to service, repair, or adjust the plunger packing or otherwise work on the pump while the unit is operating. Shut off the pump drive motor or engine and relieve the fluid pressure in the pump suction and discharge systems before any work or investigation is performed on the pump or pump systems.

Whenever the pump is operating, continually monitor the entire suction, discharge and pump lubricating systems for leaks. Thoroughly investigate the cause for leakage and do not operate the pump until the cause of the leak has been corrected. Replace any parts which are found to be damaged or defective. When a gasketed joint is disassembled for any reason, discard the used gasket and replace it with a new, genuine Gardner Denver gasket before reassembling the joint.

Due to the high working pressures contained by the fluid cylinder, discharge manifold and discharge piping, welding on these components is not recommended. If welding on the discharge system cannot be avoided, only experienced, qualified welders should be used. In addition, the welded part should be hydrostatically proof tested in the shop with water or hydraulic fluid to one and one half times maximum discharge system working pressure, with no observable fluid leakage, before the part is reinstalled in the pump system.

In summary, high pressure fluid streams can possess sufficient energy to cause personal injury, death and/or equipment damage. These results can occur either through direct contact with the fluid stream or by contact with loose objects the fluid stream has propelled, if the pump system is improperly used, or if the fluid is misdirected, or allowed to escape from defective or improperly maintained equipment.

FLAMMABLE, HOT, COLD OR CORROSIVE FLUID PUMPING

⚠ DANGER

Extreme caution must be exercised by trained and experienced operators when flammable, hot, cold or corrosive fluids are being pumped in order to avoid personal injury, death and/or equipment damage due to explosion, fire, burn, extreme cold or chemical attack.

Never operate a pump which is pumping hydrocarbons or other flammable, hot, cold, or corrosive fluids when any part of the pump, suction system or discharge system is leaking. Stop the pump immediately if any leakage, other than a few drops per minute of packing weepage, is observed. Keep all flame, sparks, or hot objects away from any part of the pump, suction system, or discharge system. Shield the pump, suction system and discharge system to prevent any flammable, hot, cold

or corrosive fluid leakage from dripping or spraying on any components, flame, sparks, hot objects or people. Inspect the plungers, packing, gaskets and seals for fluid leakage frequently and replace all worn or leaking parts.

Selection of the proper gaskets, seals and stuffing box packing is even more critical when flammable, hot, cold or corrosive fluids are being pumped than when other, inherently less dangerous fluids are used. Contact a Gardner Denver service representative for assistance in selecting the proper gaskets, seals and packing before beginning operation.

Since some packing weepage into the cradle area is inevitable, the drain at the bottom of the cradle must be connected to a drain line which conducts the fluid leakage to a collection container located in a protected area. The entire drain system and container must be constructed of materials resistant to attack from the pumped fluid or from explosion or fire of the pumped fluid.

Heavy duty cradle covers must be securely fastened in the proper position on the pump at all times when the pump is operating. If the pumped fluid releases harmful, explosive or flammable vapors the covers must be vented to conduct the fumes away from the pump unit to a nonhazardous area.

Before beginning pumping operations or starting the pump power source (whether an engine or electric motor) check the atmosphere all around the pumping site for the presence of flammable or explosive vapors. Do not begin operation and stop ongoing operation if flammable or explosive vapors are detected. Hot surfaces, sparks, electric current or engine exhaust could ignite flammable or explosive vapors. Each engine used as a power source on pumping units where flammable or explosive vapors could form should be equipped with an air inlet shut-off. If flammable or explosive vapors are present in the pumping site atmosphere, an engine could continue to run on these vapors even after the engine fuel line is shut-off if an air inlet shut-off is not used.

In addition, on pumping units used where flammable or explosive vapors could form, all electric motors used as power sources must be of explosion proof construction and all electrical components and wiring must meet the current National Electrical Code for explosive atmospheres.

These precautions must be taken to avoid possible personal injury, death and/or equipment damage from explosion, fire or burns.

HIGH PRESSURE LIQUID JETTING, BLASTING AND CLEANING

DANGER

Extreme caution must be exercised if any type of wand, gun, nozzle or any other pressure and flow directing device is attached to the pump discharge system for use in jetting, blasting, cleaning, etc. This type of equipment must be used with utmost care by trained, experienced operators. High pressure fluid streams can either by direct contact or by propelling loose objects, cause serious personal injury or death to the operators and/or other persons.

Pressure or flow directing devices often receive pressurized flow through flexible hoses, which can burst if they are kinked, cut, abraded or are otherwise worn, damaged or pressured above their rated capacity. Protect the hose and connections from damage by people, objects and vehicles. A broken, cut or otherwise burst hose can release pressurized fluid which may cause personal injury, death and/or equipment damage.

High pressure fluid from hand held or hand directed pressure and flow directing devices may overpower an operator's ability to control or direct the device, which could lead to personal injury, death and/or equipment damage. The operator must brace against the backward thrust of a hand held device. In addition, a safety harness or safety net must be used when working in an area where the operator could be injured in a fall. Stand to the side of any tubing or container being sprayed to avoid back spray and never operate a hand held device above shoulder level.

Never direct the pressurized fluid stream at yourself or any other person, control valves, the pump, pump drive, suction or discharge systems. The pressurized stream can cause serious personal injury or death and can also change valve or control settings which could dangerously increase the delivery pressure to the pressure and flow directing device.

When operating a pressure and flow directing device, use only equipment which automatically shuts off flow when an operator releases hand or foot pressure on the pressurized flow trigger control to prevent injury if the operator is overpowered or becomes disabled.

Check to insure this automatic shut-off equipment is operating properly before every use and **never** circumvent the automatic shut-off for any reason or by any means when operating the equipment.

When operating any type of high pressure liquid jetting, blasting or cleaning devices the operators must always wear protective clothing including, but not limited to, a hard hat with full face visor, heavy duty rain coat and pants, boots with nonskid sole and safety toe, rubber gloves with rough grip surface and ear noise protection.

Full operator attention and alertness are required when operating this equipment to avoid personal injury, death and/or equipment damage. The operators should take frequent rest breaks and cease operations when they become tired or distracted.

Before the equipment is started, the work area must be inspected and properly prepared to avoid personal injury, death and/or damage to equipment. Make sure the work area is checked for hazardous fumes, has adequate ventilation for engine exhaust and sufficient drainage for released fluid. Check the work area for electrical equipment, connections, outlets, fixtures, or lines. If any are present they must be made water tight and the electrical power to these devices must be shut off to avoid electrical shocks from fluid contact. The work area should be clearly marked and roped off to keep unauthorized people and vehicles from entering. Remove all loose parts, tools and equipment from the work area before beginning operation.

All pressure containing devices including wands, nozzles, guns, hoses, connections, etc., should be regularly checked for condition. These components should all be tagged with their tested pressure capabilities together with the date testing was performed. **Always be aware of the pressure level in the system and never connect any equipment to the system which has a rated or tested pressure capability below the system operating pressure**.

The equipment must be shut down and the system pressure released before changing or disconnecting wands, nozzles, guns, hoses, connections or any other pressurized system components.

All pressure containing devices including wands, nozzles, guns, connections, etc., plus all automatic shut-off, pressure and control equipment should be treated with care. Protect them from damage by people, objects and vehicles. **Never** lay them in dirt, mud, ice or other loose material which could plug the fluid opening or interfere with their operation. **Never** use the wand, nozzle, gun, etc. to pry loose material off items being cleaned.

Before starting operation in a cold environment, check to make sure there is no ice in the fluid system and repeat this inspection each time before operation is restarted.

Before purchasing wands, nozzles, guns, connections, and hose, etc., manufacturers of these components should be contacted for detailed information on the design and safety features incorporated in their products. After careful study of various manufacturers products, we recommend that **only** those wands, nozzles, guns, connections and hose, etc., be considered for purchase that you judge to offer the highest quality of design, construction and safety, since these components are among the most critical to the safe operation of high pressure liquid jetting, blasting and cleaning equipment.

After you have selected and purchased these components, follow the manufacturer's instructions completely in their use.

In summary, high pressure jetting, blasting and cleaning are inherently dangerous, as the pressures and flow rates needed to remove scale, clean, etc. are sufficient to cause personal injury, death and/or equipment damage resulting from, but not limited to, any of the conditions described in the above Danger Notices.

SECTION 2
INSTALLATION & OPERATING INSTRUCTIONS

FOR GARDNER DENVER PZ SERIES & PXL SINGLE ACTING POWER PUMPS

Reference to Parts List covering the Model Pump being serviced is recommended in connection with this Instruction Manual.

Repair Parts Lists with Sectional Views are available from any Gardner Denver Sales and Service Office. When ordering parts, always give size and serial number of pump. Always use genuine Gardner Denver parts. For efficient, factory-trained service, consult a Gardner Denver Service Specialist.

START-UP – Pumps are shipped from the factory without oil in the crankcase. The hood should be removed and the power end examined and cleaned if necessary. The pump may have been in storage or in the yard for sometime and as a consequence dirt may have entered the crankcase. Parts may have been robbed from the pump during storage and not replaced. All nuts and screws should be tightened.

Be sure all valves in the discharge line are open. No valve should be installed between the pump and pressure relief valve in discharge line.

To prevent excessive wear on the fluid pistons and packing when starting, remove a suction valve cover plate on each side of the fluid end and prime the pump. Pump should be started slowly, if possible, and should be operated for several hours with practically no discharge pressure. Check oil level as it may be necessary to add a small quantity of oil to compensate for that adhering to the walls of the crankcase the moving parts. The pump may then gradually be brought up to full speed and full working pressure. Watch for undue heating or abnormal noise in the working parts. Check all joints in the suction line to be sure there are no air leaks.

⚠ DANGER

When working on any pump, be certain there is no fluid pressure on either the suction or discharge side. Pressure on the fluid end might move the pump and cause damage or injury to personnel. It is recommended that all suction valve covers be removed to avoid fluid pressure building up against the pistons or plungers.

⚠ DANGER

If the drive is not to be removed, it is recommended that the air line to the clutch be disconnected to prevent accidental starting of the pump.

LOCATION - Pump should be set level and solidly supported. The drive should be accurately aligned. Pump should be placed as close to the slush pit as possible to keep the suction line short and direct. Locate pump as low as possible to maintain a minimum suction lift to the centrifugal charging pump which is used because of the high speed of this type of mud pump.
When the pump skid or master skid is to be bolted or welded to a platform or deck in the field, it is necessary that the following “Final Shimming Procedure” be followed.

Final Shimming Procedure - After the pump skid or master skid has been bolted or welded to a stationary platform or deck, proceed as follows:

a. Remove the cap screws used to secure the pump frame to its skid.

b. At each foot where a space exists between foot and skid, place a dial indicator on the frame foot and skid as shown in FIGURE 1. Set dial to ZERO.

c. Place shims between frame foot and skid where space exists so the dial indicator shows the frame has been raised approximately .005 to .010 inches (.126 to .254 mm).

d. Securely tighten the frame to skid cap screws. If the proper number of shims were used, the dial indicator should return to within +/-.003 inches (.076 mm) of zero. If not, repeat the procedure changing number of shims used.

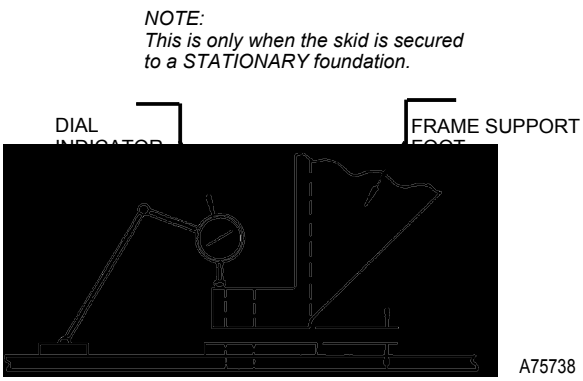


FIGURE 1 – FINAL SHIMMING

SUCTION LINE - Suction pipe or hose to centrifugal charging pump should be a minimum of 12 inches (304.8 mm) diameter and as short as possible. Always use eccentric reducers when reducing suction pipe size. Suction line should slope up toward the charging pump at uniform grade to prevent air pockets being formed. Suction line must be absolutely tight as any air leaking into the line will reduce the capacity of the pump and cause a hydraulic hammer or knock. If it is necessary to have bends in the suction line they should have long radius sweeps and be kept to a minimum in quantity. 10 PSI - 40 PSI suction required. Suction line should be supported near centrifugal charging pump to keep strain from breaking the casing at suction flange.

At least one section of hose in the suction line is desirable to isolate pulsations or vibration. Total suction line should be as short as installation conditions permit. **THIS IS IMPORTANT**.

A suction strainer is recommended for the suction line of every pump. It must be checked frequently and cleaned whenever necessary. A commercial strainer may be installed in suction line ahead of the pump.
It is recommended that a 50 PSI (3.515 kg/cm^2) gauge with a needle valve for protection be installed in the suction line at the discharge of the centrifugal charging pump. This gauge will indicate if pump is charging or if suction valves are not working properly.

RELIEF VALVES - The pump should be protected from excess discharge pressure by a 3 inch (76.2 mm) relief valve. This valve should be installed in a vertical position in a tee mounted directly onto either end of discharge manifold or discharge cross.

DANGER

Never install a shutoff valve in the line between the pressure relief valve and the pump discharge manifold.

If more than one pump is used, a pressure release valve should be furnished for each pump. A hand-operated pressure release valve should be installed in discharge line following the relief valve, with discharge line leading to mud tank. This valve is used to bleed air from discharge line in starting. It is also used to relieve pressure in starting more than one pump in parallel.

SURGE CHAMBER - A surge chamber is essential. One MUST be used for protection to surface equipment and to reduce pulsations when pumping gaseous mud. A nitrogen-charged pressure-bag type surge chamber is recommended. The surge chamber must be kept properly charged, as instructed by the manufacturer.

STARTING A NEW PUMP - It is recommended that the drive be arranged to turn the pump in the direction indicated by arrow shown on the sectional view in this book, on outline prints, and indicated on pump frame. This book provides for crosshead load to be carried on the lower side. This means better lubrication and quiet operation. Lube oil pumps are not automatice reversing.

If the PZ series or the PXL pumps are to be run in reverse direction, refer to “Lube Oil Pump”.
Pumps are shipped from the factory without oil in the crankcase. The hood should be removed and the power end examined and cleaned if necessary. The pump may have been in storage or in the yard for some time, and as a consequence, dirt may have entered the crankcase. Drain all water accumulated in the bottom of the crankcase. Fill crankcase with oil of proper grade to the proper level. Quantity shown on lubrication data plate indicates the approximate oil requirements. All nuts and cap screws should be checked for tightness.
It is recommended that the fluid end of the pump be primed to prevent excessive wear on the fluid pistons and liners when starting. **PRIMING IS IMPORTANT! IT LUBRICATES THE PISTONS IN THE LINERS**.

Pump should be started slowly but not run below half of rated speed. Recheck oil level as it may be necessary to add a small quantity of oil to crankcase and the moving parts. The pump may then be gradually brought up to full speed and full working pressure. Check all joints in the suction line to be sure there are no air leaks.

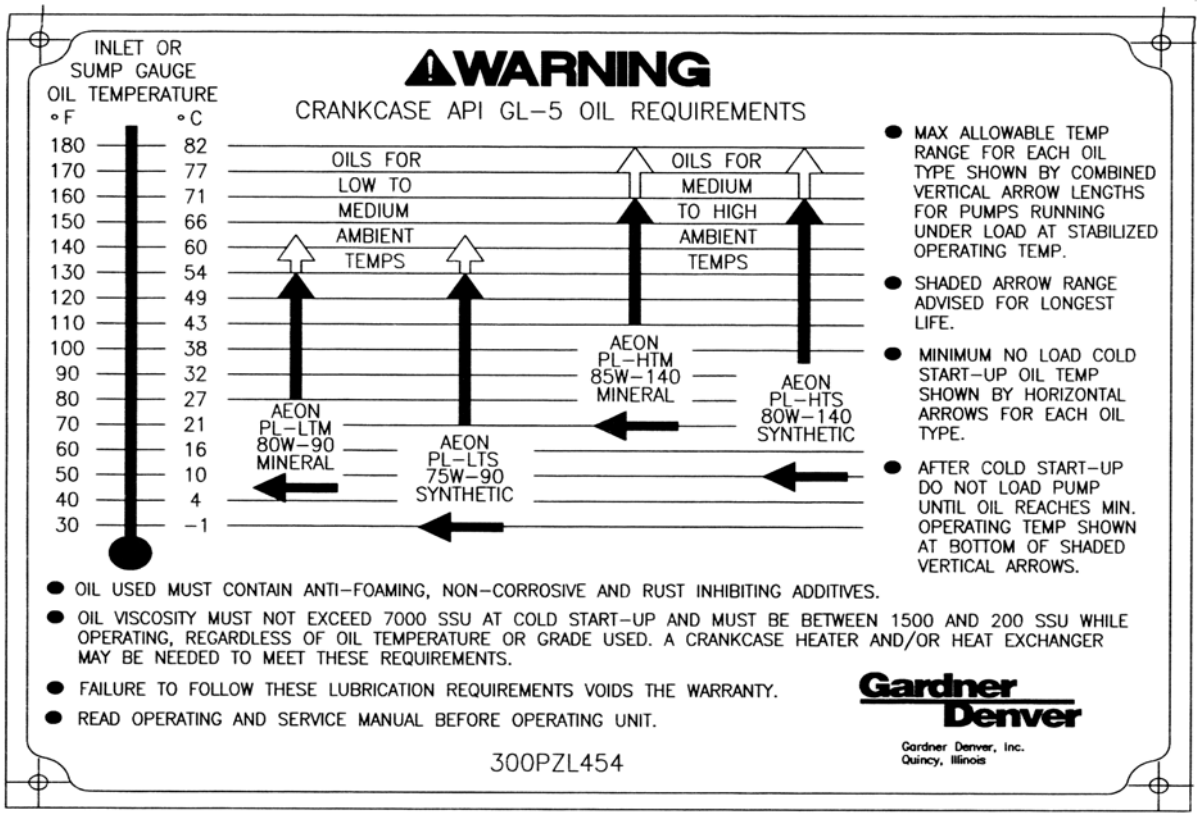


FIGURE 2 – CRANKCASE OIL REQUIREMENTS

LUBRICATION - All power end working parts are lubricated by the oil in the crankcase. Check oil level frequently. Selection of oil is to be taken from the recommendations given in FIGURE 2 and on the pump data plate. Local conditions and practice may also influence the selection. Essential additives are foam and oxidation inhibitors. Oil is to be added as required to maintain oil level near the top of the oil level indicator on the side of the frame.

- Oil viscosity must not exceed 7000 SSU at start-up and must be between 1500 SSU and 200 SSU while operating, regardless of the oil temperature or grade used. A crankcase heater and/or an oil heat exchanger may be needed to meet these requirements.

LUBRICATION SCHEDULE

Frequency	Type	Procedure
Daily	*A.P.I. Type GL-5 Lubricant	Check oil level with pump running.
Daily	50% Water Plus 50% Water Soluble Oil	Check fluid level in piston wash tank.
1000 Hours	*A.P.I. Type GL-5 Lubricant	Change oil and clean inside of frame. Change oil filter element.

FIGURE 3 – LUBRICATION SCHEDULE

- Failure to follow these lubrication requirements will void the warranty.
- Some operating conditions and/or oil brands produce excessive oil foaming, even when the specified GL-5 oils containing antifoaming additives are used. Oil foaming can cause pump damage, as oil bubbles will not lubricate moving parts properly. If significant oil foaming occurs, contact Gardner Denver Marketing or Service, (217) 222-5400, for the current factory recommended defoamant to be added to the lubricating oil.
- Oil must have antiwear, antifoaming, noncorrosive and rust inhibiting additives.

Oil is constantly circulated through a renewable element filter and then through a heat exchanger, when one is used, by means of a rotary pump driven from the main gear. Oil is discharged into an elevated oil feed trough, from which it is conducted to jackshaft and main bearings. Oil also flows from the trough to lubricate the connecting rod bearings.

Operating temperatures of the oil should be kept below 200°F (93.3°C) to reduce oxidation.

OIL CAPACITIES		
Pumps Without Heat Exchanger		
Model	**Cast Frame**	**Fabricated Frame**
PZG	60 Gal. (227.1 Liters)	None
PZH	60 Gal. (227.1 Liters)	85 Gal. (321.8 Liters)
PZJ	70 Gal. (264.9 Liters)	105 Gal. (397.4 Liters)
PZK	85 Gal. (321.8 Liters)	100 Gal. (378.5 Liters)
PZL	85 Gal. (321.8 Liters)	100 Gal. (378.5 Liters)
PXL	85 Gal. (321.8 Liters)	None
Pumps With Heat Exchanger		
Model	**Cast Frame**	**Fabricated Frame**
PZG	41 Gal. (155.2 Liters)	None
PZH	41 Gal. (155.2 Liters)	65 Gal. (321.8 Liters)
PZJ	50 Gal. (189.3 Liters)	85 Gal. (397.4 Liters)
PZK	85 Gal. (321.8 Liters)	None
PZL	85 Gal. (321.8 Liters)	None
PXL	85 Gal. (321.8 Liters)	None

Time between oil changes depends upon local and/or operating conditions. Under normal circumstances, if the crankcase is kept clean, it should not be necessary to change the oil more than once in 1000 hours of operation. Many operators change oil after each well drilled. Oil should be changed if found to be dirty or contaminated with mud or water, as the oil lubricated roller bearings will be damaged by contamination. An oil change is comparatively inexpensive, as the approximate crankcase capacities are shown above.

In order to assure proper lubrication, the PZG, PZH & PZJ pumps should not be run under 10 RPM for more than a few minutes at a time without providing additional lubrication from an extra external oil pump. The PZK, PZL & PXL pumps should not be run under 40 RPM.

The oils normally used in large mud pumps are quite viscous at lower temperatures. When starting cold, the pump should be started slowly and brought up to operating speed slowly. This practice will assure proper lubrication of all working parts before pump is fully loaded.

OIL FILTER - A replaceable element oil filter is located inside the pump crankcase. Filter mounting flange is on oil is changed or every 1000 hours of operation. Filter element is protected from excessive internal oil pressure by a relief valve between it and the oil pump.

Filter element should be replaced each time crankcase oil is changed or every 1,000 hours of operation. The filter element is protected from excessive internal oil pressure by a relief valve between it and the oil pump.

On units equipped with a heat exchanger, oil flows through the oil filter before going through the heat exchanger.

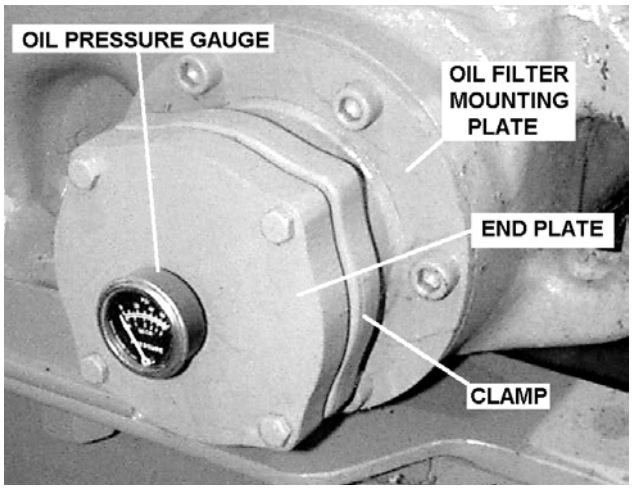


FIGURE 5 – OIL FILTER MOUNTING

HEAT EXCHANGER (Optional Equipment) - For PZ series & PXL pumps a bronze heat exchanger can be provided to keep crankcase oil temperature at 160° F (71.1° C) by means of an automatic water control valve. This valve has a sensing probe in the crankcase oil, and it monitors water to the heat exchanger to maintain oil temperature within close limits.
Water must be drained from the heat exchanger during freezing weather. Ruptured water tubes will admit water into the oil, with resulting damage to working parts of the pump.

Cooling water can be drained from the heat exchanger by removing water connections and blowing compressed air into upper opening. Water will then flow from the lower opening. Air is necessary, as water will not otherwise drain due to small size of tubes, capillary attraction, and the horizontal position of the heat exchanger mounting.
Water should not be admitted to the heat exchanger as long as oil temperatures do not exceed 160° F(71.1° C). A dial thermometer is standard equipment on all PZ series and PXL pumps.

Salt water can be used for cooling. Zinc anode plugs are provided for corrosion protection. These plugs are to be replaced when they have been corroded away.

DIRECTION OF ROTATION - The PZ series & PXL pumps MUST be driven in the direction as shown by arrow on sectional view, outline drawing and on pump frame. The oil pump on PZG, PZH and PZJ models is a nonreversible pump without adjustments described in “Lube Oil Pump”, page 24.

Running the pump in the prescribed direction insures proper lubrication and quiet operation as the load on the crosshead will be carried on the lower side.

CROSSHEAD DRAINS - PZ series & PXL pumps are equipped with two plugged drain openings below and in front of the crossheads. These openings are to drain any possible leakage from the oil stop head packings which collects in a small reservoir built into the frame. This area should be drained daily.

It is recommended that these openings be piped together and a valve installed to simplify the daily draining. Failure to drain this area could result in drilling mud in the power end and possible premature failure.

OPERATION - For normal drilling operation, the pumps are to be run at the ratings listed on pages 12 thru 15. In no case should pressure exceed that shown for each diameter piston - to do so would subject working parts to operating loads in excess of those for which they were designed, resulting in reduced life.

MAINTENANCE SCHEDULE FOR GARDNER DENVER "PZ" SERIES AND "PXL" PUMPS:

Daily:

1. Inspect condition of piston and liners. They should be run until leakage of fluid is visible or becomes excessive.
2. Clean inside frame cradle.
3. Clean and refill piston wash tank after excessive contamination.
4. Check piston wash baffle, make certain nozzles are not clogged.
5. Check pulsation dampener for proper charge.

Weekly:

1. Remove valve covers and gaskets. Replace if cut or warn.
2. Check fluid valves and seats for wear. Replace cut or worn inserts and valves.
3. Inspect urethane bushing in suction and discharge valve guides and replace if worn.
4. Inspect piston locknut. Replace if damaged, corroded, or if nylon locking insert has lost its effectiveness. Nut should be used only three times and then replaced. Do not overtighten nuts.

Every Two Weeks:

1. Remove valve cover locks. Clean threads on locks and rings. Coat threads with moly coat thread compound or heavy-duty lead base thread compound. Replace if they are worn or cracked.

Monthly:

1. Check all fluid cylinder studs and nuts for tightness.
2. Remove and clean discharge cross strainer.
3. Check condition of oil stop head seals and replace if worn or leaking excessively.

Every 1000 Hours:

1. Clean frame oil drain magnet during oil change.
2. Clean frame oil drain plug magnets located in front of crossheads and clean the oil passage.
3. Clean inside frame during regular oil change.

Every 6 Months:

1. Replace oil stop head seals even though leakage is not evident.

Cylinder					Displacement				Maximum Pressure		Piston Load		Pump RPM	Jack-shaft RPM	Input HP
Qty.	Diameter		Stroke		Gal. Per Rev.	Liter Per Rev.	Gal. Per Min.	Liter Per Min.	PSI	kg/cm2	Pounds	kg			
	Inches	mm	Inches	mm											
MODEL PZG – 550 H.P. TRIPLEX MUD PUMP															
3	7	177.8	7	177.8	3.5	13.25	507	1919	1673	117.6	64,380	29,202	145	670	550
3	6 1/2	165.1	7	177.8	3.02	11.43	437	1654	1940	136.4	64,380	29,202	145	670	550
3	6	152.4	7	177.8	2.57	9.73	373	1412	2277	160.1	64,380	29,202	145	670	550
3	5 1/2	139.7	7	177.8	2.16	8.18	313	1185	2710	190.5	64,380	29,202	145	670	550
3	5	127.0	7	177.8	1.79	6.78	259	980	3279	230.5	64,380	29,202	145	670	550
3	4 1/2	114.3	7	177.8	1.45	5.49	210	795	4048	284.6	64,380	29,202	145	670	550
Weight Complete Pump ..... 17,410 lbs. (7897.04 kg) Gear Ratio ..... 4.625 to 1 Length Over Skid ..... 120 Inches (3048.0 mm) Width Over Skid ..... 50 Inches (1270.0 mm															
MODEL PZH – 750 H.P. TRIPLEX MUD PUMP															
3	7	177.8	8	203.2	4.0	15.14	580	2196	1996	140.3	76,817	34,844	145	652	750
3	6 1/2	165.1	8	203.2	3.45	13.06	500	1893	2315	162.8	76,817	34,844	145	652	750
3	6 ¼	158.8	8	203.2	3.19	12.08	462	1749	2504	176.0	76,817	34,844	145	652	750
3	6	152.4	8	203.2	2.94	11.13	426	1613	2717	191.0	76,817	34,844	145	652	750
3	5 1/2	139.7	8	203.2	2.47	9.35	358	1355	3233	227.3	76,817	34,844	145	652	750
3	5	127.0	8	203.2	2.04	7.72	296	1120	3912	275.1	76,817	34,844	145	652	750
3	4 1/2	114.3	8	203.2	1.65	6.25	240	908	4830	339.6	76,817	34,844	145	652	750
3	4	101.6	8	203.2	1.31	4.96	189	715	5000*	351.5*	62,832*	28,510*	145	652	613*
Weight Complete Pump ..... 21,650 lbs. (9820.27 kg) Gear Ratio ..... 4.5 to 1 Gear Ratio ..... 4.5 to 1 Length Over Skid ..... 193.62 Inches (4917.9 mm) Width Over Skid ..... 89 Inches (2260.6 mm															

Cylinder					Displacement				Maximum Pressure		Piston Load		Pump RPM	Jack-shaft RPM	Input HP
Qty.	Diameter		Stroke		Gal. Per Rev.	Liter Per Rev.	Gal. Per Min.	Liter Per Min.	PSI	kg/cm2	Pounds	kg			
	Inches	mm	Inches	mm											
MODEL PZJ – 1,000 H.P. TRIPLEX MUD PUMP															
3	7	177.8	9	228.6	4.5	17.03	585	2215	2639	185.5	101,548	46,061	130	582	1000
3	6 1/2	165.1	9	228.6	3.88	14.69	504	1908	3060	215.1	101,548	46,061	130	582	1000
3	6 ¼	158.8	9	228.6	3.59	13.59	466	1764	3310	232.7	101,548	46,061	130	582	1000
3	6	152.4	9	228.6	3.30	12.53	430	1628	3592	252.5	101,548	46,061	130	582	1000
3	5 1/2	139.7	9	228.6	2.78	10.52	361	1367	4274	300.5	101,548	46,061	130	582	1000
3	5	127.0	9	228.6	2.29	8.70	298	1128	5000*	315.5*	98,175*	44,532*	130	582	967*
3	4 1/2	114.3	9	228.6	1.86	7.04	242	916	5000*	315.5*	79,522*	36,071*	130	582	783*
3	4	101.6	9	228.6	1.46	5.53	191	723	5000*	315.5*	62,832*	28,501*	130	582	619*

Weight Complete Pump ..... 26,500 lbs. (12,020.19 kg)
Gear Ratio ..... 4.48 to 1
Length Over Skid ..... 224.12 Inches (5692.648 mm)
Width Over Skid ..... 96 Inches (2438.0 mm
Width Over Jackshaft ..... 80.20 Inches (2037.08 mm)

MODEL PZK – 1,350 H.P. TRIPLEX MUD PUMP															
3	7	177.8	10	254	5.0	18.93	575	2177	3624	254.8	139,474	63,264	115	504	1350
3	6 1/2	165.1	10	254	4.31	16.31	496	1878	4203	295.5	139,474	63,264	115	504	1350
3	6	152.4	10	254	3.67	13.89	422	1508	4933	346.8	139,474	63,264	115	504	1350
3	5 1/2	139.7	10	254	3.09	11.70	355	1344	5000*	351.5*	118,791*	53,884*	115	504	1150*

Weight Complete Pump ..... 40,500 lbs. (18370.48 kg)
Gear Ratio ..... 4.5 to 1
Gear Ratio ..... 4.38 to 1
Length Over Skid ..... 222.5 Inches (5651.5 mm)
Width Over Skid ..... 96 Inches (2438.4 mm
Width Over Jackshaft ..... 104 Inches (2641.6 mm

Cylinder					Displacement				Maximum Pressure		Piston Load		Pump RPM	Jack-shaft RPM	Input HP
Qty.	Diameter		Stroke		Gal. Per Rev.	Liter Per Rev.	Gal. Per Min.	Liter Per Min.	PSI	kg/cm2	Pounds	kg			
	Inches	mm	Inches	mm											
MODEL PZL – 1,600 H.P. TRIPLEX MUD PUMP															
3	7	177.8	11	279.4	5.50	20.82	632	2392	3905	274.5	150,275	68,164	115	504	1600
3	6 1/2	165.1	11	279.4	4.74	17.94	545	2063	4529	318.4	150,275	68,164	115	504	1600
3	6	152.4	11	279.4	4.04	15.29	465	1760	5000*	351.5*	141,372*	64,126*	115	504	1505*
3	5 1/2	139.7	11	279.4	3.40	12.83	390	1476	5000*	351.5*	118,791*	53,884*	115	504	1265*
Weight Complete Pump ..... 40,500 lbs. (18,370.48 kg) Gear Ratio ..... 4.38 to 1 Length Over Skid ..... 222.5 Inches (5651.5 mm) Width Over Skid ..... 96 Inches (2438.4 mm Width Over Jackshaft ..... 104 Inches (2641.6 mm															
MODEL PZL – 1,600 H.P. TRIPLEX MUD PUMP (HIGH PRESSURE)															
3	7	177.8	11	279.4	5.5	20.82	632	2392	3905	274.5	150,300	68,164	115	504	1600
3	6 1/2	165.1	11	279.4	4.74	17.94	545	2063	4529	318.4	150,300	68,164	115	504	1600
3	6	152.4	11	279.4	4.04	15.29	465	1760	5316	373.7	150,300	68,164	115	504	1600
3	5 1/2	139.7	11	279.4	3.40	12.83	390	1476	6328	444.8	150,300	68,164	115	504	1600
3	5	127.0	11	279.4	2.80	10.60	322	1219	7500*	527.2*	147,262*	66,797*	115	504	1565*
Weight Complete Pump ..... 41,750 lbs. (18,937.47 kg) Gear Ratio ..... 4.38 to 1 Length Over Skid ..... 222.5 Inches (5651.5 mm) Width Over Skid ..... 96 Inches (2438.4 mm Width Over Jackshaft ..... 104 Inches (2641.6 mm															

Cylinder					Displacement				Maximum Pressure		Piston Load		Pump RPM	Jack-shaft RPM	Input HP
Qty.	Diameter		Stroke		Gal. Per Rev.	Liter Per Rev.	Gal. Per Min.	Liter Per Min.	PSI	kg/cm2	Pounds	kg			
	Inches	mm	Inches	mm											
MODEL PXL – 2,000 H.P. TRIPLEX MUD PUMP															
3	7	177.8	11	279.4	5.50	20.82	632	2392	4882	343.2	187,875	85,219	115	504	2000
3	6 1/2	165.1	11	279.4	4.74	17.94	545	2063	5662	298.0	187,875	85,219	115	504	2000
3	6	152.4	11	279.4	4.04	15.29	465	1760	6645	467.1	187,875	85,219	115	504	2000
3	5 1/2	139.7	11	279.4	3.40	12.83	390	1476	7500*	527.2*	178,125*	80,797*	115	504	1895*
3	5	127.0	11	279.4	2.80	10.60	322	1219	7500*	527.2*	147,262*	66,797*	115	504	1565*

Weight Complete Pump ..... 46,250 lbs. (20,978.63 kg)
Gear Ratio ..... 4.38 to 1
Length Over Skid ..... 222.5 Inches (5651.5 mm)
Width Over Skid ..... 96 Inches (2438.4 mm
Width Over Jackshaft ..... 104 Inches (2641.6 mm

Remove hood and crosshead inspection plates for access to working parts. Before working on inside of crankcase, it is necessary to drain the oil. Lube oil pump mounting brackets and piping connections are below the oil level.

Mark all parts during dismantling so they can be returned to their original position during reassembly.

It is highly recommended that pump be removed to a machine shop if major work is to be done on power end.

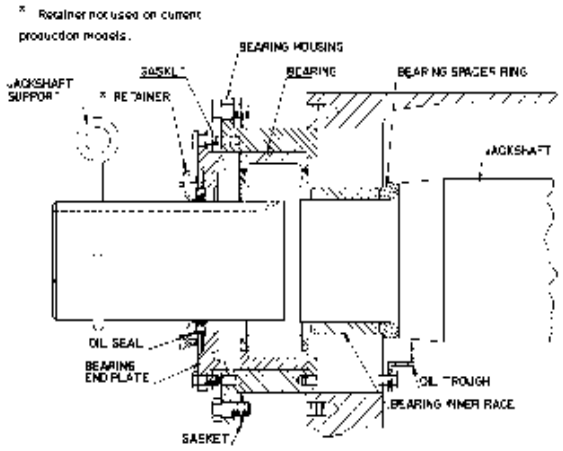


FIGURE 11 – JACKSHAFT BEARING INSTALLATION

JACKSHAFT - To remove the jackshaft, it is necessary to remove all sheaves from the jackshaft. Then remove bearing end plates and bearing housings from both sides of pump. Support each end of jackshaft while removing bearing housings. The jackshaft can be moved horizontally until the pinion teeth clear the teeth of the eccentric gear. The jackshaft can now be removed from either side of the pump.

The jackshaft bearings are of the straight roller type with roller and cage assembly held in the flanged outer race. The inner race is not flanged. The outer race and roller assembly will slide over the inner race which remains on the jackshaft. Both bearings are identical.

The straight roller bearings permit the jackshaft to float endwise. Thrust loads are carried on the spherical main bearings. Main bearings will be covered as a separate item.

The safest way to remove the inner race of the jackshaft bearing from the shaft is by the careful use of heat. Do not overheat to the point where race is discolored. Be careful not to damage the bearing spacer ring between the inner race and the shoulder on the shaft.

If the jackshaft bearing is to be replaced, the outer race and roller assembly can be driven or pressed out of the bearing housing.

The jackshaft bearings should be replaced if any of the rollers or races shows damage or if they are excessively worn. A noisy bearing indicates bearing damage, requiring replacement. Check clearances by inserting feeler gauge between the roller and inner race with bearing assembled on the shaft and in the housing. This check can be made with the bearing temporarily assembled out of the pump, but with inner race on jackshaft. See recommended running clearances on pages 28, 29, or 30.

To mount the new bearings, heat the inner race in oil to about 300º F (148.8º C) and slip it in on the shaft against the bearing spacer ring. Be certain the spacer ring is in place with the chamfered end of the bore over the large fillet on the jackshaft. The inner race and the spacer are to be assembled snugly against the shaft shoulder. The shaft can be reinstalled in the frame.

To mount a new oil seal wear sleeve, heat the sleeve in oil to about 300º F (148.8º C) and slip it on the shaft. See FIGURE 13, page 17.

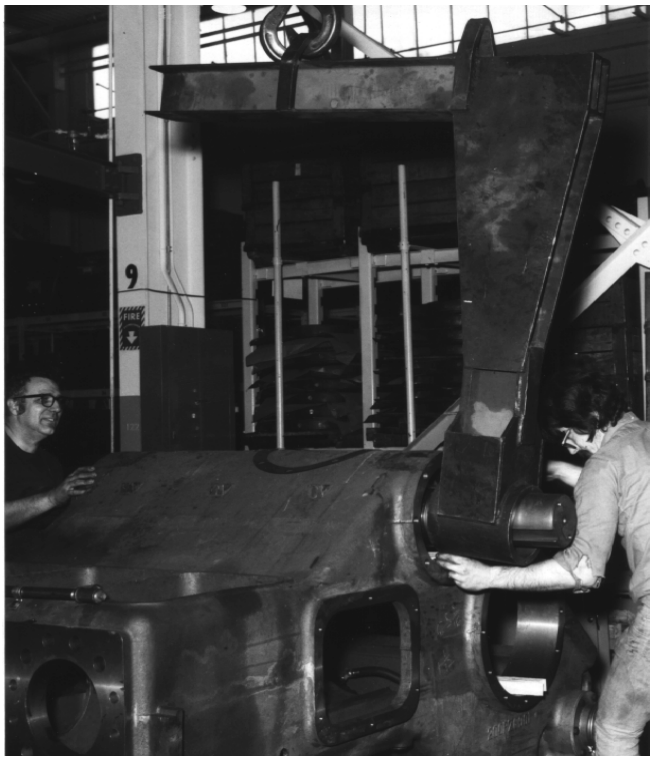
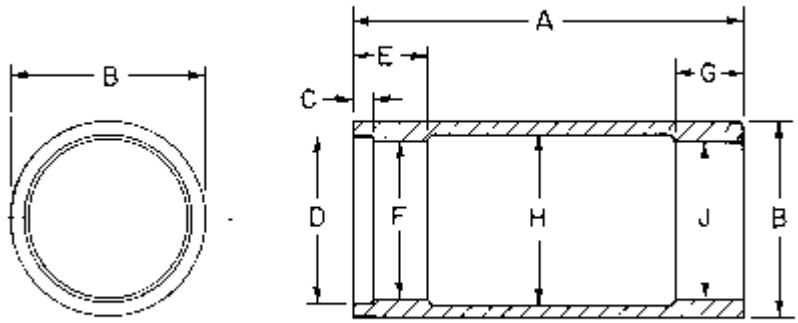


FIGURE 12 – JACKSHAFT REMOVAL/INSTALLATION FIXTURE



TOOL FOR INSTALLATION OF JACKSHAFT WEAR SLEEVE

	PZG Stroke: 7"		PZH Stroke: 8"		PZJ Stroke: 9"		PZK Stroke: 10"		PZL Stroke: 11"		PXL Stroke: 11"	
Dimensions	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm
A	7.0	178	14.0	356	16.0	406	12.0	305	12.0	305	10.0	254
B Diameter	7.0	178	7.75	197.0	8.335	211.71	10.75	273.0	10.75	273.0	11.5	292.1
C	.38	9.6	.50	13.0	.50	13.0	1.75	44.5	1.75	44.5	1.00	25.4
D Diameter	6.25	159.0	6.878 6.880	174.70 174.75	7.378 7.680	187.40 187.45	9.504 9.505	241.40 241.42	9.504 9.505	241.40 241.42	10.007 10.005	254.17 254.12
E	------	------	2.00	51	2.00	51	2.9	74	2.9	74	2.50	63.5
F Diameter	6.004 6.006	152.50 152.55	6.752 6.754	171.50 171.55	7.252 7.254	184.20 184.25	9.252 9.254	235.00 235.05	9.252 9.254	235.00 235.05	9.755 9.753	247.77 247.72
G	------	------	3.00	76.0	3.00	76.0	1.4	36	1.4	36	2.50	63.5
H Diameter	------	------	6.88	175.0	7.38	187.5	10.0	254	10.0	254	10.2	259.08
J Diameter	6.004 6.006	152.50 152.55	6.752 6.754	171.50 171.55	7.252 7.254	184.20 184.25	9.252 9.254	235.00 235.05	9.252 9.254	235.00 235.05	9.755 9.753	247.77 247.72

FIGURE 13 – OIL SEAL WEAR SLEEVE INSTALLATION TOOL

To reassemble the jackshaft in the pump, it is necessary to reverse procedure of removal. The teeth of the pinion can mesh in only one direction, therefore, the jackshaft is not interchangeable end for end in the pump unless gear and eccentric assembly is also reversed. Reversal of the complete gearset is permissible after gear or pinion teeth become badly worn. Since gear is not on centerline of the frame, it is necessary to move the oil pump and filter from original position to the opposite side of the frame and repipe as required.

Required direction of rotation of the pump provides that inner ends or apex of gear and pinion teeth lead. This means that when viewing from the hood opening, the inner ends of the gear teeth point upward toward the jackshaft and the inner ends of the pinion teeth point toward the gear. Gears may be reversed, but direction of rotation of the pump MUST NOT BE REVERSED. See paragraph “Lube Oil Pump” on the following page. Pump should be run in the direction shown on sectional view and indicated by arrow on outline print and frame. Apex of teeth will follow after gearset has been reversed.

After jackshaft is in place with the pinion in mesh with the gear, install the bearing housings with the outer bearing race and roller assemblies in them. Be careful to keep dirt from the bearings during assembly. The housing is to be started on the bearing and in the bore of the frame and lightly driven in. Be sure the gasket is on the housing. Long threaded studs may be used to pull the housing into the frame bore. It is well to work both housings at the same time after they have been well started over the bearing inner race. This will minimize end thrust on the gear teeth.

Before assembling bearing plates into the frame, the bearing oil troughs should be installed. The bearing housing can be rotated in the frame, making it easy to

level oil trough properly. Top of oil trough is to be level. The PZG pump does not have oil trough.
Outer oil seals are to be placed in the bearing end plate after it is bolted to the bearing housing and frame. Coat inside of oil seal liberally with bearing grease. The seal is to be installed with garter spring to inside, toward bearing. Permanently bolt jackshaft bearing housings and their end plates to the frame.

LUBE OIL PUMP – The lube oil pump, part number 46C21, used in the PZG, PZH and PZJ pumps can be reversed in direction when the complete gear sets are reversed after the following procedure is completed.
Remove the oil pump with standard left hand helix drive gear from the pump frame. Remove the drive gear from the oil pump shaft.

Remove the end cap from the oil pump opposite the shaft end, remove the drain plug screw opposite the oil pump discharge port. Install the drain plug screw in the hole provided 180^{o} or opposite from the suction port. Reverse the suction and discharge lines to the lube oil pump and reverse the data tag "IN – ROTATION – OUT". The drain plug screw must be installed in the pump body opposite the oil pump discharge port. Replace the end cap.

Install the optional right hand helix drive gear on the oil pump shaft. Install the oil pump and gear assembly on alternate mounting pad in the pump sump to mesh with reversed eccentric gear.

The lube oil pump, part numbers 46C58 (previous production) and 201PAH188 (current production), used in the PZK, PZL & PXL pumps can be reversed in direction without modification to the pump. The oil flow through the pump will reverse direction when shaft is rotated in reverse.

Viewing the oil pump 46C58 from the shaft end, rotating the shaft clockwise, the right hand pump opening is the inlet. When rotating shaft counterclockwise, the left hand opening is the inlet and the right hand opening becomes the outlet.

When shaft rotation of the 201PAH188 oil pump changes direction, the direction of flow changes without changing inlet and outlet port positions.

When reversing the complete gear sets on PZK, PZL and PXL pumps, the left hand helix pump drive gear must be replaced with an optional right hand helix drive gear. Install the oil pump and drive gear assembly on the alternate sump mounting pad to mesh with the reversed eccentric gear.

CONNECTING RODS – The connecting rods are split into body and cap, and bolted together without shims.

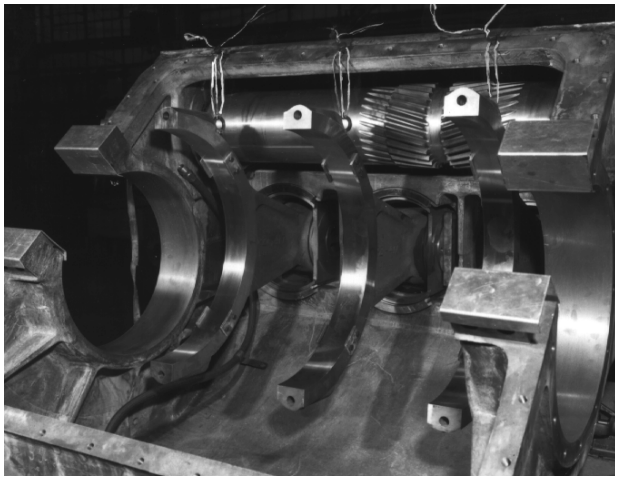


FIGURE 14 – CONNECTING ROD SUPPORT

This construction is used to simplify installation and/or removal of eccentric and gear assembly.

The upper connecting rod bolt is inserted from the cap side to avoid interference with jackshaft. The lower bolt is inserted from body side to make nut easily accessible.

Crosshead pins with bearing inner races can be removed without disturbing the connecting rods on PZG, PZH and PZJ pumps. On the PZK, PZL & PXL pumps, the hood must be removed and the connecting rods loosened from the cap and parted by about one inch (25.4 mm) before the center crosshead pin will clear the outside connecting rod.

Always protect crosshead slide in frame by placing a block of wood under small end of connecting rod. If slide should be accidently damaged, be certain to stone damaged area so no metal projects above slide surface. DO NOT USE EMERY CLOTH.

When caps are removed, the bodies of the connecting rods can be supported by wiring or tying them to cap screws temporarily screwed into hood ledge above them. Do not damage hood gasket surface. See FIGURE 14.

Remove eccentric bearing retainers from the connecting rod body and cap before cap is removed. Replace retainers after connecting rods have been reassembled. Be sure to wire the cap screws securely. Connecting rod bolt nuts are to be tightened to recommended torque shown on pages 31 and 32. The Pal locknuts are to be driven against nut by hand and then tightened 1/3 to 1/2 turn.

ECCENTRIC AND GEAR ASSEMBLY -

⚠ WARNING

Be sure to remove the oil pump drive pinion when removing or replacing the eccentric and gear asembly to avoid bending the oil pump shaft when the gear is removed.

Eccentric and shaft are made in one piece.

Eccentric and gear assembly is to be removed from the frame for the following reasons:

(a) Assembly is to be reversed after gear is worn.

(b) Gear is to be replaced.

(c) One or more eccentric bearings are to be replaced.

(d) Eccentric is to be replaced.

Procedure For Removal:

1. Remove connecting rod caps and support the rods.

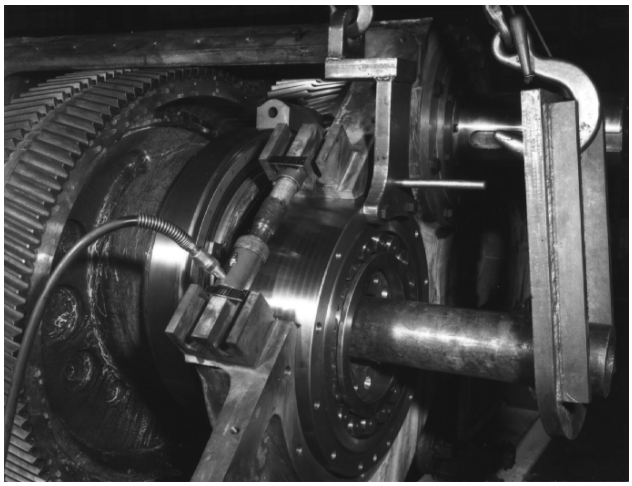


FIGURE 15 – ECCENTRIC GEAR ASSEMBLY SUPPORT

2. Remove large main bearing plates from frame and bearing cartridges.
3. Remove frame clamp studs over main bearings.
4. Remove frame spacer blocks by removing them sideways, as they are keyed to frame. Be sure the

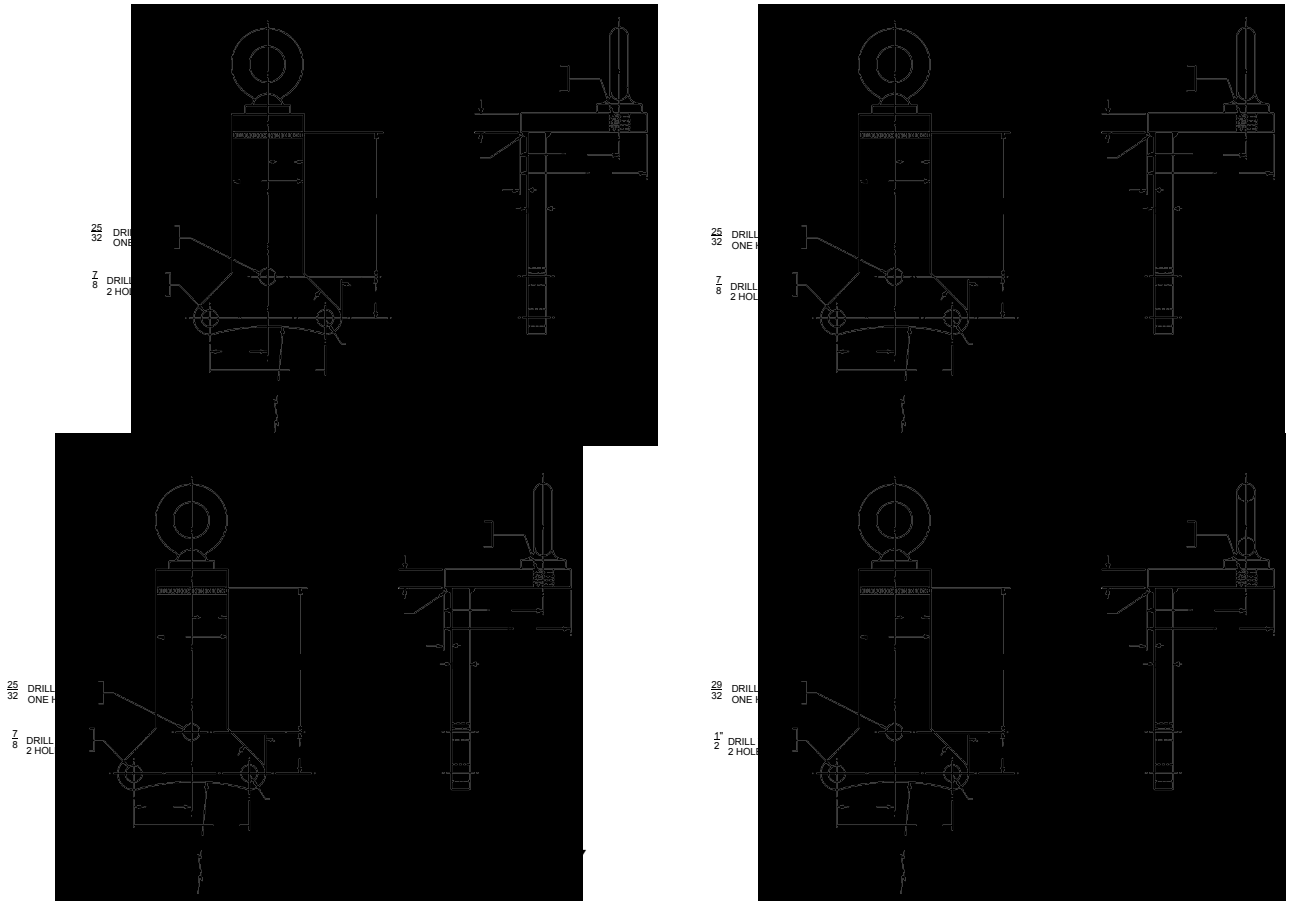


FIGURE 16 – MAIN BEARING CARTRIDGE LIFITING & LOCATING DEVICES
(Dimensions Shown in Inches – See Figure 17, Page 20 for Metric Equivalents)

METRIC EQUIVALENTS			
Inches	mm	Inches	mm
3/8 (.375)	9.525	3	76.2
.38	9.652	3.20	81.28
.68	17.272	4.0	101.6
.69	17.526	4.2	106.68
25/32 (.78125)	19.844	4.44	112.776
7/8 (.875)	22.225	4.5	114.3
.88	22.352	4.56	115.824
29/32 (.90625)	23.019	4.88	123.952
1.0	25.4	5 1/8 (5.125)	130.175
1 1/8 (1.125)	28.575	5 1/2 (5.5)	139.7
1.5	28.1	6.0	152.4
1.75	44.45	6.40	162.56
2.0	50.8	6.5	165.1
2.12	53.848	7.0	177.8
2 3/16 (2.1875)	55.563	7.9	200.66
2.22	56.388	8.0	203.2
2.28	56.912	8.68	220.472
2.44	61.976	9 17/32 (9.84375)	250.031
2 3/4 (2.75)	69.85	11.5	292.1

FIGURE 17 – TABLE OF METRIC EQUIVANENTS FOR DIMENSIONS (INCHES)

spacer blocks are marked to assure reassembly in original position.

5. Loosen main bearing retainer plate screws in ends of eccentric shaft. Do not remove the retainer plate screws. Leave about 1/4" (6 mm) space between eccentric shaft and retainer plates.
6. Spread frame slot approximately 1/64" (.4 mm) by means of hydraulic or screw jacks (FIGURE 15, page 19). **Be sure to protect faces of frame slots against damage from jacks. This is important.**
7. Support eccentric and gear assembly in original position by means of a sling, hoist or blocks (FIGURE 15, page 19).
8. Connect a 10,000 PSI (703.1 kg/cm^2)hydraulic oil pump (BlackHawk P76 or equivalent) to 3/8" pipe tap in end of eccentric shaft after removing protective plug. There is a clearance hole through the retainer plate.
9. Hydraulic pressure will loosen bore of the main bearing on the tapered shaft.
10. With bearing loose on the shaft taper, the retainer plates should be removed. They are heavy, so suitable provisions must be provided to handle them. Lifting devices shown in FIGURE 16, page 19, are useful in disassembly as well as during assembly.
11. Eccentric and gear assembly, with the connecting rod bearings on it, can now be lifted and shifted to remove it from the frame. **Be sure to protect frame slot faces with a sheet material to prevent damage to them and to the tapered eccentric shaft.** THIS IS IMPORTANT.

    It will be necessary to raise or lower and shift the suspended connecting rods to clear the eccentric during removal.

    After eccentric assembly has been removed from the frame, remove outer cam bearings from their inner races. They might slide off and be damaged or injure someone.
12. Set eccentric assembly in a clean place so work can proceed on it.
13. It is essential that every effort be taken to protect all roller bearing from dust and dirt by keeping them wrapped in sheet plastic or clean paper. Be certain to cover the bearings if they are to remain out of the frame for hours, such as overnight.

ECCENTRIC CAM BEARINGS - These bearings are mounted on, and remain with the eccentric and gear assembly during dismantling and reassembly of the power end. The bearings are of the cylindrical roller type, with the rollers retained in the outer race. The inner races are shrunk on the eccentric cams.

The outer races with rollers slide off the end or outer eccentric cam bearing inner races. The center bearing is slipped over the adjacent eccentric cam after its bearing race has been removed.

Inner bearing races can be removed by heating evenly all around with torches. If bearings are to be use again, be careful no to discolor the inner race with excessive heat. "Spit-frying" hot is sufficient. Handle with gloves.

The center bearing inner race is slipped over the adjacent end cam while it is still hot and after the end bearing inner race has been removed.

These bearings are not preloaded and must have running clearance. Check with feeler at bottom and

between inner race and rollers. See 28 thru 30 for recommended running clearances.

Inner races are equipped with an end ring. They must be mounted on the correct end of each inner race. Refer to sectional view showing eccentric and bearings for proper location of inner race end ring. Radius on inside diameter of end ring must face out.

ASSEMBLY OF ECCENTRIC AND GEAR ASSEMBLY IN FRAME - The following procedures should be carefully followed in assembling eccentric and gear assembly in frame.

1. Install a pipe through eccentric and gear assembly and place bearing carrier and bearing assemblies on either end. With lifting devices shown in FIGURE 18, page 22, lift the unit and turn the eccentric so center throw is at the extreme top position (see reference mark in photograph). Carefully guide into position as shown. Be sure teeth of eccentric gear are pointing in proper direction to mesh with teeth of jackshaft.
2. Bar eccentric and gear assembly so reference point on center throw moves away from operator approximately 20º from vertical as shown in FIGURE 19, page 22. Ease the assembly back and down slightly, being careful not to damage teeth of gear or lip of frame.
3. As eccentric moves into position, the connecting rods must be lifted and guided into position as they come in contact with the eccentric. See FIGURE 20, page 22.
4. Bar eccentric so reference point moves back toward operator to approximately 20º his side of vertical as shown in FIGURE 21, page 22.
5. Ease eccentric back and lower into position as connecting rods come to rest on eccentric. Care must be taken as teeth of main gear come in contact with teeth of jackshaft. Refer to FIGURE 22 and FIGURE 23, page 23.
6. With eccentric in position as shown in FIGURE 24, page 23, a porta-power jack can now be used to spread the frame for installation of the bearing carrier and bearing assemblies as described under “Main Bearings”.

MAIN BEARINGS - These bearings are of the double-row spherical type. Inner race has a tapered bore. Main bearings can be replaced without removing eccentric assembly from the pump and without disturbing connecting rods.

Remove bearings with cartridges from the eccentric shaft and frame as outlined in procedure covering removal of eccentric and gear assembly. Be sure to support eccentric securely in its original location. Remove lube oil pump gear to protect oil pump shaft as main gear might move during this operation.

Main bearing is a slip fit in the bearing cartridge or carrier, and can be readily removed. Remove inner retainer ring from end of cartridge if it is necessary to drive the bearing from the cartridge.

Antifriction bearings should not be removed from their protective wrapping until ready to be mounted. **Do not remove protective grease from rollers of new bearings. It will not contaminate crankcase oil.**

Procedure For Mounting

1. When ready to mount, unwrap bearing and stand it upright on a clean flat surface with bore horizontal.
2. Determine and record internal clearance by checking with feeler gauge between upper rollers and inside diameter of outer race. Check both rows of rollers.
3. Wipe outside diameter of bearing clean and apply a thin coat of crankcase oil.
4. Wipe bore of bearing cartridge clean.
5. Push bearing snugly onto taper of shaft by hand only, without cartridge.
6. Check and record bearing overhang with a depth micrometer or with straight edge and feeler blades. This can be done with eccentric out of the frame as shown in FIGURE 25, page 23.
7. Determine thickness of shim pack required for drive-up by subtracting .067” (1.7018 mm) for PZG and PZH, .075” (1.905 mm) for PZJ, or .090” (2.286 mm) for PZK, PZL and PXL from the bearing overhang. For example (Model PZJ): If the overhang is .100” (2.54 mm), the shim pack thickness is .100” (2.54 mm) minus .075” (1.905 mm) equals .025” (.635 mm).
8. Lay bearing on a flat clean surface with small end of bore down.
9. Lower cartridge over bearing, using light blows with a soft mallet if needed. Bearing cartridge is interchangeable end for end.
10. Bolt retainer ring directly against upper end of R.H. bearing cartridge. This will be at large end of bearing bore. Wire cap screws.
11. Bolt retainer to upper end of L.H. cartridge with 1/8” (3.175 mm) spacer between. Wire cap screws. Current models do not use retainer and spacer on L.H. cartridge. R.H. bearing is secured endwise. The L.H. bearing floats endwise within the cartridge to allow for uneven expansion and contraction of eccentric shaft and frame. Bearings are not preloaded.
12. Apply a thin and uniform coating of micronized graphite or light oil to bore of bearing and to tapered portion of eccentric shaft.

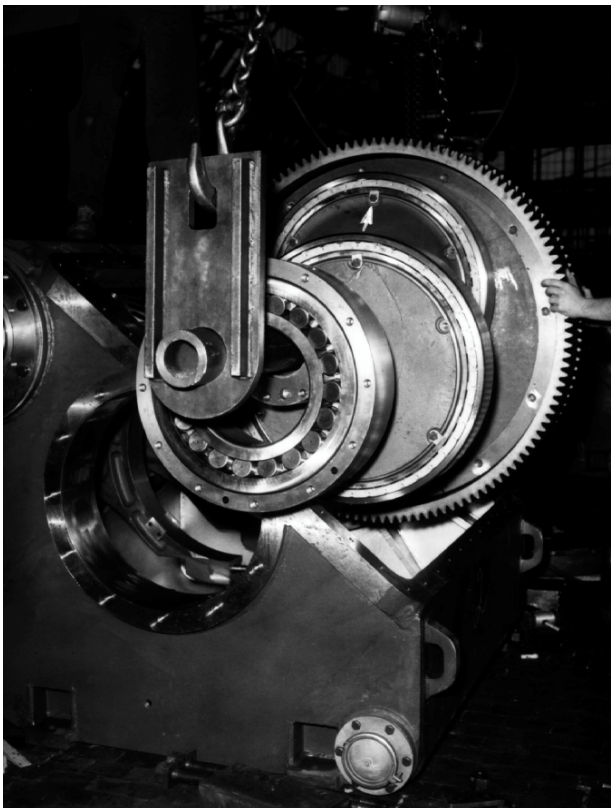


FIGURE 18

FIGURE 19

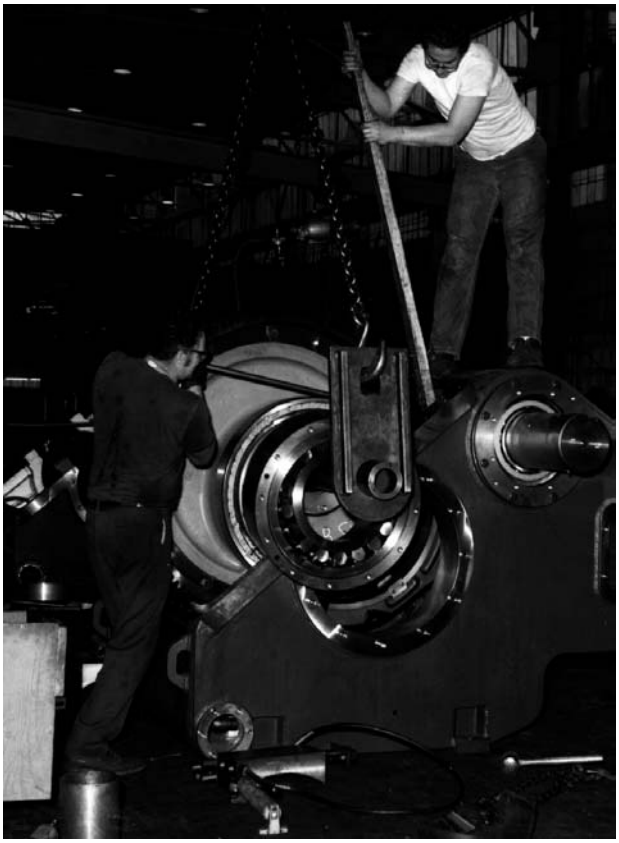


FIGURE 20

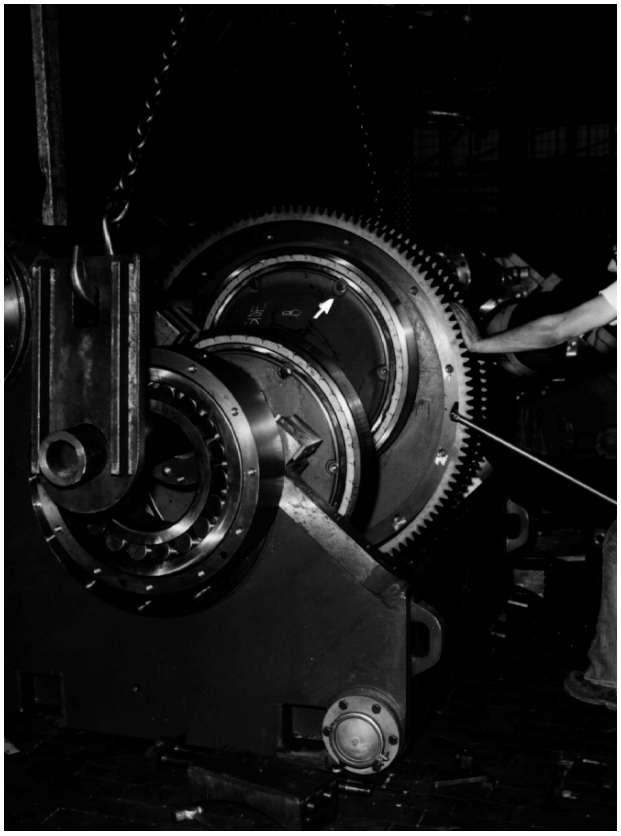


FIGURE 21

FIGURE 22

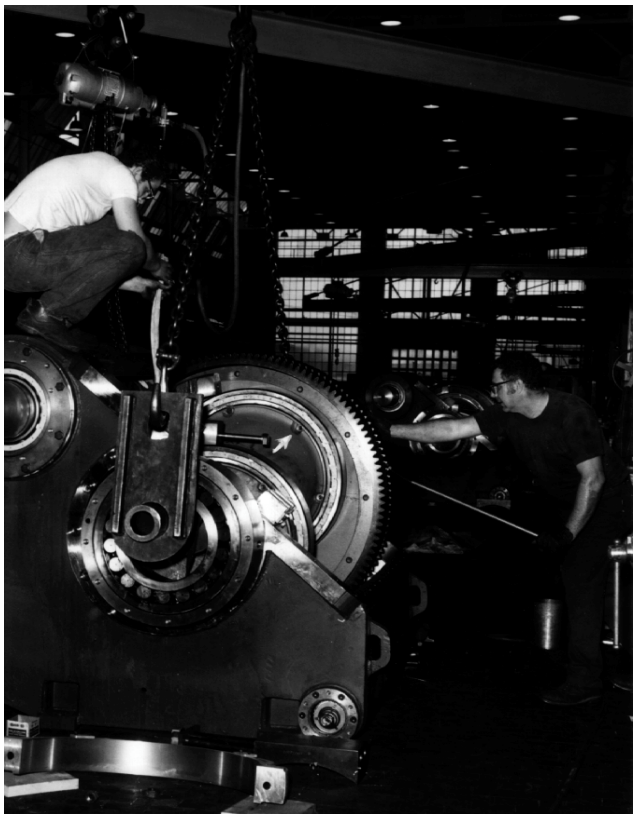


FIGURE 23

FIGURE 24

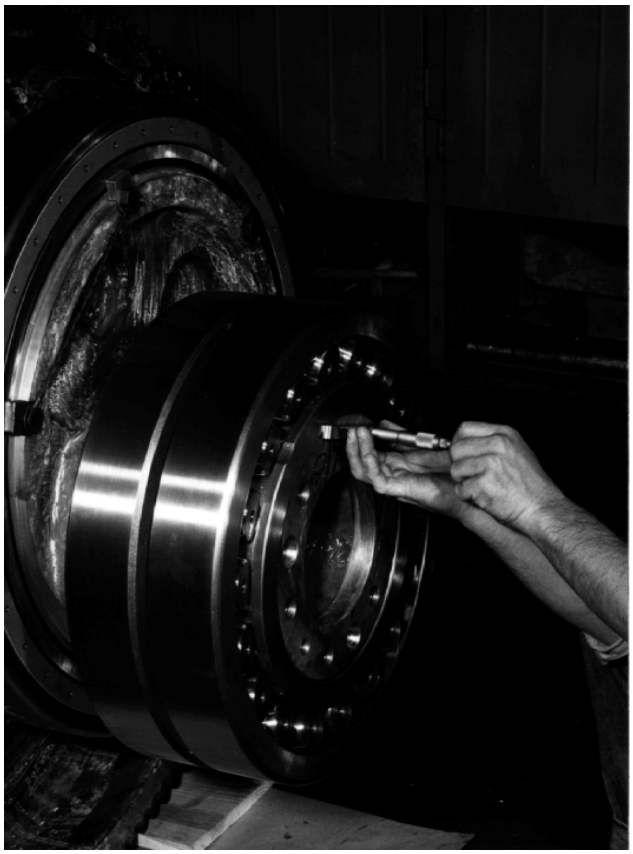


FIGURE 25

13. Mount shim pack on end of journal and assemble bearing retainer plate.

14. Force bearing onto shaft taper by tightening cap screws as evenly as possible.

    Bearing retainer plate must be clamped solidly against shims. It may be necessary to vary thickness of shim pack slightly to keep internal running clearances within the recommended limits.

    If excessive torque on retainer plate screws is required, it may be necessary to resort to hydraulic assistance. See Item 8 on Page 20.

15 Rotate bearing cartridges in frame so holes for bearing end plate cap screws line up. The lifting device shown in FIGURE 15 and FIGURE 16, page 19, will automatically align holes.

    Bearing cartridge must enter bore in frame as bearing is put on shaft. Use a soft mallet on end of cartridge if necessary.

16. Remove frame slot spreader jacks. Replace frame slot spacers. Be certain block to frame keys are in place. Replace frame slot clamp studs, washer plates and nuts. Tighten nuts to approximately 500 foot-pounds (69.13 kg-m) only at this time. Be sure ends of both bearing cartridges are flush with frame faces.

    The end of L.H. bearing may not be flush with the end of its cartridge as this is the floating bearing. Plus or minus 1/16" (1.5875 mm), or less, is satisfactory.

17. Tighten nuts on frame slot clamp studs a minimum of 1/3 turn total (2 flats). This equals the torque shown in the Torque Tables on pages 31 and 32.

⚠ WARNING

It is important that these studs are tightened as recommended to prevent stud and/or frame breakage.

18. Bolt R.H. bearing end plat in place first.

19. Bolt L.H. bearing end plate in place.

20. Assemble the drive pinion on the shaft of the lube oil pump.

21. Remove all tools and loose parts from the crankcase. Remove the device use to support the weight of the eccentric assembly.

22. Replace lube oil pump. Put the hood back in place. Be sure the gasket is in good condition and in proper location. Bolt down securely. Use grease on frame flange to help keep hood gasket in place.

23. Do not forget to replace or renew the crankcase oil. Now is a good time for an oil change and a new filter element to protect the new bearings just installed.

CROSSHEAD PINS

Procedure For Removal of Outer Crosshead Pins

1. Cut wire and remove retainer plate to crosshead cap screws and use these as jack screws in tapped holes in plate to pull pins. A little persuasion with a drift driven against the crosshead body and close to the large end of pin will help loosen the pin.

Procedure For Removal of Center Crosshead Pin

1. Remove outer crosshead next to large end of center crosshead pin to give room to remove pin from center crosshead. Protect crosshead slide in frame with a block of wood.

2. Rotate pump until center crosshead is at end of its stroke toward fluid cylinder.

3. Remove center crosshead pin as described above for the two outer pins.

PUSH RODS - Push rods can be removed from the crossheads by working through handhole plates in the sides of the frame and also through the oil stop openings after the oil stop head assemblies have been removed.

Be careful not to damage the highly polished surface on which oil seals bear.

Push rods are stainless steel and should be protected when the pump is painted. Paint will damage the oil stop head seals.

⚠ WARNING

Be sure to install the push rods with the flat side and the word TOP to the top side of the crosshead for proper alignment of the push rod, piston rod, piston and liner.

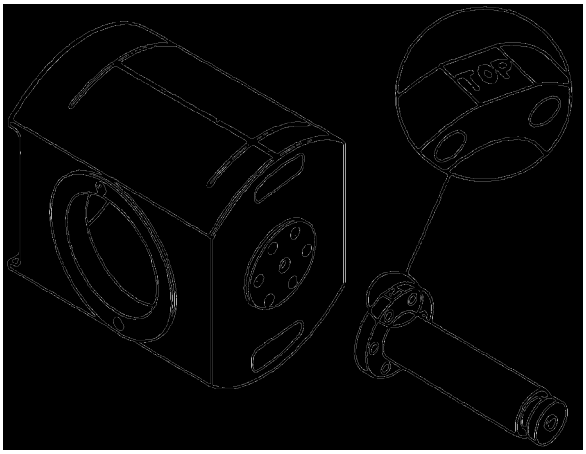


FIGURE 26 – INSTALLATION OF PUSH RODS

CROSSHEADS - Crossheads are one-piece construction and run on replaceable bronze slides bolted in the frame. Crossheads are made of ductile iron.

Procedure For Removal

1. Remove oil stop head assemblies, crosshead pins and push rods as described above.

2. Slide the crossheads through the oil stop openings in the frame and lift them clear. Be careful to protect the shoe surfaces from damage.

CROSSHEAD SLIDES - The crosshead slides are cast of tough bearing bronze. Top and bottom slides are interchangeable and are bolted into the frame. Slides are also interchangeable end for end.

The operating load is carried on the lower shoe and slide when pump is run in prescribed direction.
It is unlikely that upper slides will even require replacement unless damaged by accident.

It is necessary to remove the jackshaft in order to reach the cap screws which hold the upper crosshead slides to the frame on early models. Later models are provided with openings on the outside of the frame to reach and remove these cap screws and nuts.

Lower slides may eventually need to be replaced after long wear or if damaged. It is advisable to remove the crossheads as described above in order to reach the countersunk head cap screws which secure the slides to the frame. The nuts are on the outside and underneath the frame.

Use of shims between the crosshead slides and the frame is not recommended as they may fret through. Use new slides instead of shimming.

Slides can be removed through oil stop head openings in frame, or through crosshead inspection openings.

OIL STOP HEADS - Oil stop heads keep the crankcase oil within the frame. They also keep mud and liner washing fluids from entering the crankcase.
Oil stop packing consists of two identical seals mounted in adaptors. They are not adjustable.

The inner seal lip is pointed inward toward the crankcase to strip oil from the push rod. The outer seal lip points outward toward liner to strip mud and/or water from the push rod. Be certain seals are properly installed.

The seal adaptors, with seals in them, can be slipped off and on the push rods by removing the clamp holding piston rods against the push rods and separating the two flanges. Do not use a screwdriver or drift to separate the push rod and piston rod flanges. Turn the pump slightly.

It is essential that oil stop head seals be replaced at the first indication of leakage. Oil leakage will be indicated by oil collecting on top of the liner washing water in the reservoir. If rig water is used for washing and run to a waste area, it is difficult to check the above method.

If oil leakage is serious it will show up in a lower oil level in the crankcase. In this case oil must be added to the crankcase as required until new oil stop seals can be installed.

Leakage of mud and water into the crankcase will be indicated by a milky appearance of the crankcase oil. Mud will also be seen below oil stop heads on inside of crankcase through crosshead inspection plate openings.

When mud is found in crankcase, oil should be changed. Drain and clean out crankcase before putting in the new oil. Replace seals in oil stop heads before running pump.

It is recommended that oil stop head seals be changed every six months of operation, even though leakage is not evident.

VALVE CHAMBERS - The PZ series and PXL pumps are equipped with individual valve chambers (cylinders).

Valve chambers are secured to frame with high tensile strength studs. It is important that nuts on these studs be checked occasionally for tightness. A loose nut will eventually cause a stud to break under pulsating load. These connecting studs extend through the liner clamp flanges. Liner clamps are clamped by means of above studs against the liner flanges and serve to clamp liners tightly against valve chambers. A square rubber

compound gasket seals end of liner against valve chamber. When replacing a valve chamber it is necessary to remove the discharge manifold. Also remove screws holding suction manifold to the chamber being replaced. Loosen, but do not remove suction manifold screws in the other two chambers. Suction manifold can be dropped enough to clear gaskets. These members are to be securely bolted to the new valve chamber before it is finally tightened against frame connecting flange. Be sure manifold gaskets are in place.

LINER CLAMP AND LINERS - When liner clamps are reinstalled or replaced, it is advisable to check cylinder to frame stud nuts and tighten if necessary. Refer to pages 31 and 32 for proper torques.

Nuts holding liner clamps in place should not be overtightened as distortion of the clamp and liner bore may result. Recommended torque values are shown on pages 31 and 32.

Change size of pistons and liners as volume and/or pressure requirements change. See rating charts on pages 12 thru 15.

Liners are replaced by removing the liner clamp. Liners should be cleaned and oiled after removal to protect against rusting during storage, so they can be used again.

Pump liners are to be clean both inside and out when installed. Also clean the liner clamp bore and lightly oil all surfaces.

Use new gaskets when installing liners and be sure to clean all surfaces against which the gaskets fit. Liners or valve chambers may be cut by leaking gaskets.

PISTONS - Single-acting pistons consist of a steel piston body with insert retained by a washer and snap ring.

Pistons, with piston rods, can be removed or installed through suction valve opening after valve upper guide is removed by turning it 90_. Valve spring must also be removed. 7" pistons on PZG, PZH and PZJ pumps must be removed through frame. In the 7500 PSI high pressure fluid cylinders, 6" diameter is the maximum that can be removed through the suction valve opening. Larger diameters must be removed through the frame.

It is recommended that a piston and rod assembly be kept ready for replacement. This is a practical time-saver.

PISTON ROD - Piston rods are manufactured of high carbon steel. They are electrolytically plated to protect against corrosion. They are provided with a knurled section so rod can be held while tightening piston nut. It is important that piston rod nut be tightened to recommended torque shown on pages 31 and 32.

Piston rod to piston fit is straight. Piston fits against flange on piston rod with on "O" ring gasket to prevent l connecting flanges and pilots. DO NOT use a screwdriver or cold chisel to separate the flanges - turn the pump slightly.

For pumps with threaded piston rod to push rod connection, tighten to torque specified on pages 31 and 32.

PISTON WASHING SYSTEM - The piston washing system is vital to the satisfactory performance and life of pistons and liners. The complete system must be kept in good operating condition. Washing fluid should be maintained in good condition and should be replaced when contaminated to the point where free circulation is impaired. This is of utmost importance and should be impressed upon all operators of the pump.

Water supply lines should be permanently attached to the openings provided in the circulating pump and the tank. Water is then quickly available as a washing fluid or to flush out the lines by operating the proper valves in the piping system.

The piston washing fluid may be varied according to conditions and operator's preference. Water makes a suitable washing fluid under most conditions. Good results can be obtained using water with one-half gallon (1.9 liters) of soluble oil per tank of water within the closed system. A light oil gives good results under some conditions, and can be used under severe freezing conditions.

The more fluid circulated, the better; however, it should be regulated by a valve in discharge line of the centrifugal circulating pump to prevent splashing and being blown about.

MAINTENANCE OF VALVES - In order to keep the pump in its best operating condition, it is necessary to examine the suction and discharge valves occasionally to see that excessive wear or cutting by the slush or mud has not impaired their efficiency. Any worn or damaged parts should be replaced.

This is especially true with regard to the inserts. Standard inserts are made from urethane and are the part of the valve which should be changed most frequently. They are much cheaper than the valves and seats, and if the inserts are renewed as soon as they begin to fail, the more expensive steel parts will last much longer. Routine inspection of valves every two or three days is recommended.

When removing a worn valve seat, use the Gardner-Denver puller powered with a hydraulic jack. Be careful to chain or tie the jack down as it will jump violently when the valve seat lets go. If it becomes necessary to resort to the use of heat or a cutting torch to remove a valve seat, the services of a man experienced in these operations is necessary.

Before putting new seats in the pump, the tapered bore in the valve seat deck of the cylinder must be thoroughly cleaned with a wire brush. Wire brush should be used around the bore rather than up and down. Wipe the bore clean and do not use oil or grease. The bore must be clean and dry or seat may not seat properly. The valve seat tapered surface must be cleaned and dry before assembling in cylinder deck.

Place the new seat in the bore. Use an old valve bumper or a block of hard wood and drive with a sledge to a snug initial fit. The pressure load on the valve in operation will drive the seat home. Never reuse an old seat once it has been removed from a cylinder, as it may not fit solidly in the valve deck.

Replace the valve guide or valve guide bushings if worn. Replace the valve spring if it is worn, corroded, distorted, or below normal tension. Valves are provided with stainless steel springs for maximum operating life. A broken spring will cause rapid wear of valve guides and should be replaced. It will also cause wear on suction valve guide mounting lugs inside the valve chamber (cylinder).

Do not put a used valve assembly on a new seat unless it is in practically a new condition. Be sure to replace a doubtful insert to protect seat and bumper.

It requires experience and judgment to determine if valve parts should be replaced or not. Valves are cheaper than downtime.

When installing valves, wipe all sealing surfaces clean, put the gasket carefully in place in the valve chamber and install cover plate. Be sure gasket is not twisted or extruded. Tighten valve cover lock securely by using a bar and hammer.

The life of the valves will be lengthened if the mud tanks are kept clean. In may cases foreign objects are caught under the valves, thereby holding them open and causing rapid cutting of the seats and valves.

SUCTION STRAINER - A suction strainer is recommended for the suction line of every pump to protect the valves.
The current PZ series and PXL pumps are not equipped with a suction strainer. A commercial strainer, however, may be installed in the suction line ahead of the pump.

The early PZJ pumps were equipped with a perforated metal strainer inside the suction manifold. This strainer can be removed from the end opposite the suction line for inspection and cleaning. Strainer should be checked if the pump starts to run rough, with violent discharge pulsations. One or more cylinders may have their suction obstructed by debris in the strainer.

SECTION 4
DIMENSIONS & RUNNING CLEARANCES

RECOMMENDED RUNNING CLEARANCES	PZG				PZH			
	Inches		mm		Inches		mm	
	Min	Max	Min	Max	Min	Max	Min	Max
(AFTER ASSEMBLY)								
Crosshead to slide	.020	.037	.508	.940	.020	.037	.508	.940
Main Bearing	.001	.004	.025	.102	.003	.006	.076	.152
Jackshaft Bearing	.001	.006	.025	.152	.002	.006	.051	.152
Crosshead Pin Bearing	.001	.006	.025	.152	.001	.005	.025	.127
Connecting Rod to Eccentric Bearing	.001	.011	.025	.279	.002	.010	.051	.254
Oil Pump Pinion to Main Gear – Backlash	.010	.015	.254	.381	.010	.015	.254	.381
Jackshaft to Main Gear - Backlash	.010	.015	.254	.381	.010	.020	.254	.508
MANUFACTURING FITS								
Jackshaft Bearing OD in Housing	.0013 Tight	.0017 Loose	.0330 Tight	.0432 Loose	.0007 Tight	.0031 Loose	.0178 Tight	.0787 Loose
Jackshaft Bearing on Shaft	.0017 Tight	.0037 Tight	.0432 Tight	.0940 Tight	.0020 Tight	.0043 Tight	.0508 Tight	.1092 Tight
Connecting Rod to Eccentric Bearing:								
OD in Connecting Rod	.004 Tight	.000	.102 Tight	.000	.0034 Tight	.0000	.0889 Tight	.0000
ID on Eccentric	.0072 Tight	.0110 Tight	.1829 Tight	.2794 Tight	.0080 Tight	.0115 Tight	.2032 Tight	.2921 Tight
Crosshead Pin Bearing:								
OD in Connecting Rod	.0027 Tight	.0000	.0686 Tight	.0000	.0022 Tight	.0000	.0559 Tight	.0000
ID in Crosshead Pin	.0005 Tight	.0025 Tight	.0127 Tight	.0635 Tight	.0005 Tight	.0025 Tight	.0127 Tight	.0635 Tight
Main Bearing OD in Cartridge	.0002 Loose	.0036 Loose	.0051 Loose	.0914 Loose	.0002 Loose	.0036 Loose	.0051 Loose	.0914 Loose
Main Bearing on Shaft	Tapered Bore Axial Takeup .067 Average		Tapered Bore Axial Takeup 1.702 Average		Tapered Bore Axial Takeup .067 Average		Tapered Bore Axial Takeup 1.702 Average	

RECOMMENDED RUNNING CLEARANCES	PZJ				PZK			
	Inches		mm		Inches		mm	
	Min	Max	Min	Max	Min	Max	Min	Max
(AFTER ASSEMBLY)								
Crosshead to slide	.020	.037	.508	.940	.025	.042	.635	1.067
Main Bearing	.005	.008	.127	.203	.003	.008	.076	.203
Jackshaft Bearing	.002	.004	.051	.102	.002	.008	.051	.203
Crosshead Pin Bearing	.002	.005	.025	.127	.001	.007	.025	.178
Connecting Rod to Eccentric Bearing	.002	.008	.025	.203	.002	.011	.051	.279
Oil Pump Pinion to Main Gear – Backlash	.010	.015	.254	.381	.010	.015	.254	.381
Jackshaft to Main Gear - Backlash	.010	.020	.254	.508	.010	.020	.254	.508
MANUFACTURING FITS								
Jackshaft Bearing OD in Housing	.0007 Tight	.0031 Loose	.0178 Tight	.787 Loose	.0014 Tight	.0025 Loose	.0356 Tight	.0635 Loose
Jackshaft Bearing on Shaft	.0020 Tight	.0043 Tight	.0508 Tight	.1092 Tight	.0020 Tight	.0044 Tight	.0508 Tight	.1118 Tight
Connecting Rod to Eccentric Bearing:								
OD in Connecting Rod	.004 Tight	.000	.102 Tight	.000	.004 Tight	.000	.102 Tight	.000
ID on Eccentric	.009 Tight	.013 Tight	.229 Tight	.330 Tight	.011 Tight	.015 Tight	.2794 Tight	.381 Tight
Crosshead Pin Bearing:								
OD in Connecting Rod	.0027 Tight	.0000	.0686 Tight	.0000	.0018 Tight	.0040	.0457 Tight	.1016
ID in Crosshead Pin	.0005 Tight	.0025 Tight	.0127 Tight	.0635 Tight	.0010 Tight	.0032 Tight	.0254 Tight	.0813 Tight
Main Bearing OD in Cartridge	.0002 Loose	.0036 Loose	.0051 Loose	.0914 Loose	.0002 Loose	.0036 Loose	.0051 Loose	.1321 Loose
Main Bearing on Shaft	Tapered Bore Axial Takeup .074 Average		Tapered Bore Axial Takeup 1.880 Average		Tapered Bore Axial Takeup .090 Average		Tapered Bore Axial Takeup 2.286 Average	

RECOMMENDED RUNNING CLEARANCES	PXL			
	Inches		mm	
	Min	Max	Min	Max
(AFTER ASSEMBLY)				
Crosshead to slide	.025	.042	.635	1.067
Main Bearing	.003	.008	.076	.203
Jackshaft Bearing	.002	.008	.051	.203
Crosshead Pin Bearing	.000	.006	.000	.152
Connecting Rod to Eccentric Bearing	.000	.010	.000	.254
Oil Pump Pinion to Main Gear – Backlash	.010	.015	.254	.381
Jackshaft to Main Gear - Backlash	.010	.020	.254	.508
MANUFACTURING FITS				
Jackshaft Bearing OD in Housing	.0014 Tight	.0025 Loose	.0356 Tight	.0635 Loose
Jackshaft Bearing on Shaft	.0020 Tight	.0044 Tight	.0508 Tight	.1118 Tight
Connecting Rod to Eccentric Bearing: OD in Connecting Rod	.004 Tight	.000	.102 Tight	.000
ID on Eccentric	.0110 Tight	.0150 Tight	.2794 Tight	.381 Tight
Crosshead Pin Bearing: OD in Connecting Rod	.0018 Tight	.0040	.0457 Tight	.1016
ID in Crosshead Pin	.0010 Tight	.0032 Tight	.0254 Tight	.0813 Tight
Main Bearing OD in Cartridge	.0002 Loose	.0036 Loose	.0051 Loose	.1321 Loose
Main Bearing on Shaft	Tapered Bore Axial Takeup .090 Average		Tapered Bore Axial Takeup 2.286 Average	

RECOMMENDED TORQUES – "PZ MODELS" (DRY)	
Cylinder To Frame Stud Nut:	
PZG, PZH & PZJ (1-1/4” Studs)	1800 Ft.Lbs. (248.87 kg-m)
PZG, PZH & PZJ (7/8” Studs)	600 Ft. Lbs. (82.98 kg-m)
PZK & PZL (1-1/4” Studs)	1800 Ft. Lbs. (248.87 kg-m)
Discharge Manifold Stud Nut:	
PZG, PZH & PZJ (1” Studs)	600 Ft. Lbs. (82.96 kg-m)
PZK & PZL (LP) (1” Studs)	600 Ft. Lbs. (82.96 kg-m)
PZK & PZL (HP) (1-1/4” Studs)	1150 Ft. Lbs. (159.0 kg-m)
Connecting Rod Bolt	600 Ft. Lbs. (82.96 kg-m)
Piston Rod Nut	1100 Ft. Lbs. (152.09 kg-m)
Frame Spacer Clamp Studs:	
PZG & PZH	600 Ft. Lbs. (82.96 kg-m)
PZJ, PZK & PZL	1600 Ft. Lbs. (221.22 kg-m)
Liner Clamp to Frame Stud Nut:	
PZG, PZH & PZJ (1-1/4” Studs)	750 Ft. Lbs. (103.7 kg-m)
PZK & PZL (LP) (1-1/4” Studs)	750 Ft. Lbs. (103.7 kg-m)
PZK & PZL (HP) (1-1/4” Studs)	1400 Ft. Lbs. (193 kg-m)
Piston Rod to Extension Rod (Threaded Style)	1000 Ft. Lbs. (138.26 kg-m)
2-Piece PZK & PZL (HP) Piston Rod Stud (Coupling Style)	1000 Ft. Lbs. (138.26 kg-m)
Piston Rod to Extension Rod Coupling Screw or Nut (Coupling Style)	75 Ft. Lbs. (10.37 kg-m)
Crosshead Pin Retaining Plate Screw	370 Ft. Lbs. (51.17 kg-m)
Crosshead Extension to Crosshead Screw	220 Ft. Lbs. (30.43 kg-m)
Valve Cover Lock Ring to Cylinder Screw:	
PZG, PZH & PZJ (1” Studs)	900 Ft. Lbs. (124.4 kg-m)
PZK & PZL (LP) (1” Studs)	900 Ft. Lbs. (124.4 kg-m)
PZK & PZL (HP) (1-1/4” Studs)	1600 Ft. Lbs. (221.2 kg-m)
Eccentric Bearing Cover Plate Screw	
PZG, PZH & PZJ	260 Ft. Lbs (35.9 kg-m)
PZK & PZL	400 Ft. Lbs (55.3 kg-m)

RECOMMENDED TORQUES -"PXL " (DRY)	
CylinderTo Frame Stud Nut (1-1/4" Studs)	1800 Ft.Lbs. (248.87 kg-m)
Discharge Manifold Stud Nut (1-1/4" Studs)	1150 Ft. Lbs. (159.0 kg-m)
ConnectingRodBolt	700 Ft.Lbs.(96.78kg-m)
Piston Rod Nut.	1100 Ft. Lbs. (152.09 kg-m)
Frame Spacer Clamp Studs	1600 Ft.Lbs.(221.22kg-m)
Liner Clamp to Frame Stud Nut (1-1/4" Studs)	1400 Ft. Lbs. (193 kg-m)
2-Piece (HP) Piston Rod Stud (Coupling Style)	1000 Ft. Lbs. (138.26 kg-m)
Piston Rod to Extension Rod Coupling Screw or Nut (Coupling Style)	75 Ft. Lbs. (10.37 kg-m)
Crosshead Pin Retaining Plate Screw	370 Ft.Lbs.(51.17kg-m)
Crosshead Extension to Crosshead Screw.	220 Ft. Lbs. (30.43 kg-m)
Valve Cover Lock Ring to Cylinder Screw (1-1/4" Studs)	1600 Ft. Lbs. (221.2 kg-m)
Eccentric Bearing Cover Plate Screw	400 Ft. Lbs(55.3kg-m)

GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver (the "Company") warrants to each original retail purchaser ("Purchaser") of its new products, assemblies or parts from the Company or its authorized distributors that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment, been subject to negligence, accident, or improper storage, improper installation, operation or application. (Examples: over-pressure, sand-outs, cavitation, corrosion, erosion or degradation).
3. Any product which has not been operated or maintained in accordance with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted directly to the manufacturer.

WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part or assembly which in the Company's judgment proved to have unsatisfactory material or workmanship within the applicable Warranty Period as follows.

Except for the products or components listed below, and subject to the limitations and restrictions set forth in the "Disclaimer" section set forth below, the Warranty Period for all products is 1,250 hours of operation or three (3) months after start-up, not to exceed 120 days after delivery to Purchaser, whichever occurs first. The exceptions are as follows:

1. Power end is warranted for twelve (12) months from date of start-up or eighteen (18) months from date of delivery to the Purchaser, whichever occurs first.
2. Forged steel fluid cylinders are warranted for materials and workmanship for 6 months from the date of installation or 18 months from the date of delivery to the purchaser, which ever occurs first.
3. Repairs are warranted for 90 days from the date of delivery, for the workmanship and materials of the new parts installed.
4. Weld repaired fluid ends and weld repaired components are not warranted.
5. Expendable fluid end parts, including, but not limited to, valves, valve parts, packing, liners and pistons, are not covered by this warranty due to variable abrasive nature of material pumped.

PRESERVATION ASSEMBLIES DESTINED FOR STORAGE

In order for warranty acceptance any pump assembly not immediately installed or destined to be in storage or in transit for extended periods of time must be prepared for storage as defined in the Company's Long Term Storage Procedure. This includes but is not limited to:

- Drain and thoroughly clean inside power end crankcase.
- Spray rust inhibiting oil on all bearing, machined and inside surfaces of the power end.
- Induce clean gear oil into any circulating pump, filter, heat exchanger and piping.
- Remove valves, seats and plungers from the fluid end. Thoroughly clean and dry these parts and all internal surfaces. Coat all cylinder bores, valve covers and reusable expendable parts with rust preventative.
- Flush all water, and contaminants from pump, tanks, hoses and spray nozzles. Spray all components with a rust inhibiting oil.
- Rotate pump every 30 days to insure bearings are oiled.
- At the expense of the Purchaser, any product properly preserved must be inspected by an authorized agent of the Company, prior to the Company, granting any extended warranty beyond that stated in this warranty.

LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel, for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule. Labor costs in excess of the Company rate schedules caused by, but not limited to, location or inaccessibility of the equipment, or labor provided by unauthorized service personnel is not provided for by this warranty.

PRODUCT WARRANTY

All costs of transportation of product or parts claimed not to be as warranted and, of repaired or replacement parts to or from such service facility shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to one of its facilities as designated by the Company, transportation prepaid by the Purchaser, to establish a claim under this warranty.

Replacement parts provided under the terms of this warranty are warranted for the remainder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components.

The Company may request a root cause analysis be performed in-order to identify if a request for warranty claim meets the requirements of this warranty.

DISCLAIMER

Except as to title, the foregoing warranty is the sole and exclusive warranty of the Company. The Company hereby extends other manufactures' warranty or guaranties, if any given to Company by such manufacturer, but only to the extent the Company is able to enforce such warranty or guaranties. The Company has not authorized any party to make any representation or warranty other than as expressly set forthherein. SELLER HEREBY DISCLAIMS AND EXCLUDES ANY OTHER EXPRESS, IMPLIED OR STATUTORY WARRANTIES, ARISING BY OPERATION OF LAW OR OTHERWISE, INCLUDING, WITHOUT LIMITATION, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. COMPANY MAKES NO WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER (EXPRESS, IMPLIED OR STATUTORY), OF LAW OR OTHERWISE, ON ANY EQUIPMENT, COMPONENT PARTS OR ACCESSORIES SOLD HEREUNDER WHICH, ARE NOT MANUFACTURED BY COMPANY.

NOTWITHSTANDING ANYTHING HEREIN TO THE CONTRARY, THE FOREGOING WARRANTY SHALL BE THE SOLE AND EXCLUSIVE REMEDY AVAILABLE TO THE PURCHASER. UNDER NO CIRCUMSTANCES, WHETHER IN CONTRACT, TORT OR OTHERWISE, SHALL THE COMPANY'S TOTAL LIABILITY ARISING IN CONNECTION WITH ANY PURCHASE ORDER EXCEED THE AMOUNT OF ANY SALES OR OTHER PROCEEDS RECEIVED PURSUANT THERETO. IN ADDITION, UNDER NO CIRCUMSTANCES, WHETHER IN CONTRACT, TORT OR OTHERWISE, SHALL THE COMPANY BE LIABLE FOR LIQUIDATED, SPECIAL, INDIRECT, INCIDENTAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES, EXPENSES OR COSTS, INCLUDING, WITHOUT LIMITATION, LOST PROFITS OR FACILITY DOWNTIME, HOWEVER CAUSED AND EVEN IF THE POTENTIAL OF SUCH DAMAGES WAS DISCLOSED AND/OR KNOWN.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented within 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which the cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

WARRANTY REQUESTS

Products to be returned for warranty analysis shall be approved for return in writing by the Company prior to shipment. All requests for product return shall be submitted by email. Facsimile or letter to:

Warranty Department
c/o Gardner Denver Petroleum Pumps
4747 South 83rd East Avenue
Tulsa, Oklahoma 74145

Email: CCR.QAR@gardnerdenver.com
Facsimile: (918) 664-6225

Gardner Denver

Specifications subject to change without notice.

 Litho in U.S.A.

http://www.gardnerdenver.com

For additional information contact your local representative or

Gardner Denver Compressor and Pump Division,
1800 Gardner Expressway, Quincy, Illinois 62301
Customer Service Department Telephone:
(800) 682-9868 FAX: (217) 224-7814

Sales and Service in all major cities.

For parts information, contact Gardner Denver,
Master Distribution Center, Memphis, TN
Telephone: (800) 245-4946 FAX: (901) 542-6159