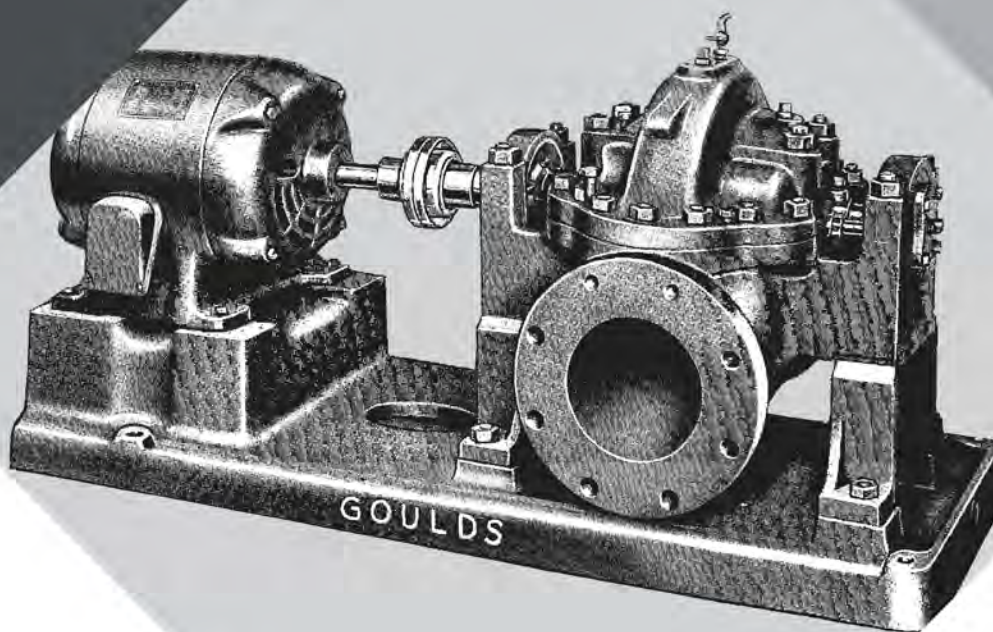


 **GOULDS PUMPS**

Installation, Operation and Maintenance Instructions

3405-3406-3416



ITT

Table of Contents

1 Safety	4
1.1 Important Safety Notice.....	4
1.2 Safety Warnings.....	4
1.3 Safety.....	5
1.4 General precautions.....	6
1.5 ATEX Considerations and Intended Use.....	9
1.6 Parts.....	10
2 Installation	11
2.1 Location.....	11
2.2 Prepare the foundation.....	11
2.3 Piping - general.....	12
2.4 Install suction piping.....	12
2.5 Piping - discharge.....	13
2.6 Connection of piping.....	13
3 Preparation for operation	14
3.1 Pump bearings.....	14
3.2 Driver bearings and coupling.....	15
3.3 Stuffing boxes.....	15
3.4 Connection of water seal piping.....	17
3.5 Connection of piping to quenching gland.....	17
3.6 Connection of bearing cooling water piping.....	20
3.7 Connection of drain piping.....	20
4 Starting pump	21
4.1 Priming.....	21
4.2 Regulation of cooling water flow.....	24
4.3	
Adjustment of stuffing box gland.....	25
4.4 Alignment - final.....	25
4.5 Doweling.....	25
5 Operation	26
5.1 Stuffing box.....	26
5.2 Operating at reduced capacities.....	26
5.3 Operating at reduced head.....	27
5.4 Operating with surge conditions in line.....	27
5.5 Operating under freezing conditions.....	27
6 Trouble check list	28
6.1 No water delivered.....	28
6.2 Not enough water delivered.....	28
6.3	
Not enough pressure.....	28
6.4 Pump works awhile and then quits.....	29
6.5 Pump takes too much power.....	29
6.6 Pump leaks excessively at stuffing box.....	29
6.7 Pump is noisy.....	29

7 Care and maintenance	31
7.1 Lubrication - bearings.....	31
7.2 Repacking stuffing boxes	31
7.3 Sectional view	33
7.4 Dismantling of pump.....	39
7.5 Reassembly of pump.....	40
7.6 Changing rotation of pump in field.....	48
7.7 Overhaul of pump.....	48
7.8 Emergency ball bearing replacement.....	49
7.9 Spare parts.....	50
7.10 Instructions for ordering spare parts.....	51

Foreword

The design, material and workmanship incorporated in the construction of Goulds Model 3405, 3406 and 3416 Double Suction Centrifugal Pumps makes them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, is enhanced and extended by correct application, proper installation, periodic inspection and maintenance. This instruction book was prepared so operators will understand the construction and the correct methods for installing, operating and maintaining these pumps.

Read thoroughly Sections [2 Installation on page 11](#), [3 Preparation for operation on page 14](#), [4 Starting pump on page 21](#) and [5 Operation on page 26](#) and be sure to follow the instructions for installation and operation. Sections [6 Trouble check list on page 28](#) and [7 Care and maintenance on page 31](#) are answers to trouble and maintenance questions. Keep this instruction book handy for reference. Kindly direct any questions or suggestions to the attention of the Engineering Application Div., Goulds Pumps, Inc., Seneca Falls, New York.

Remember, the experience and recommendation of a Goulds representative are always available on any pump application problem.

1 Safety

1.1 Important Safety Notice

To: Our Valued Customers:

User safety is a major focus in the design of our products. Following the precautions outlined in this manual will minimize your risk of injury.

ITT Goulds pumps will provide safe, trouble-free service when properly installed, maintained, and operated.

Safe installation, operation, and maintenance of ITT Goulds Pumps equipment are an essential end user responsibility. This Pump Safety Manual identifies specific safety risks that must be considered at all times during product life. Understanding and adhering to these safety warnings is mandatory to ensure personnel, property, and/or the environment will not be harmed. Adherence to these warnings alone, however, is not sufficient — it is anticipated that the end user will also comply with industry and corporate safety standards. Identifying and eliminating unsafe installation, operating and maintenance practices is the responsibility of all individuals involved in the installation, operation, and maintenance of industrial equipment.

Please take the time to review and understand the safe installation, operation, and maintenance guidelines outlined in this Pump Safety Manual and the Instruction, Operation, and Maintenance (IOM) manual. Current manuals are available at <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/> or by contacting your nearest Goulds Pumps sales representative.

These manuals must be read and understood before installation and start-up.

For additional information, contact your nearest Goulds Pumps sales representative or visit our Web site at <https://www.gouldspumps.com>

1.2 Safety Warnings

Specific to pumping equipment, significant risks bear reinforcement above and beyond normal safety precautions.



WARNING:

A pump is a pressure vessel with rotating parts that can be hazardous. Any pressure vessel can explode, rupture, or discharge its contents if sufficiently over pressurized causing death, personal injury, property damage, and/or damage to the environment. All necessary measures must be taken to ensure over pressurization does not occur.



WARNING:

Operation of any pumping system with a blocked suction and discharge must be avoided in all cases. Operation, even for a brief period under these conditions, can cause superheating of enclosed pumpage and result in a violent explosion. All necessary measures must be taken by the end user to ensure this condition is avoided.



WARNING:

The pump may handle hazardous and/or toxic fluids. Care must be taken to identify the contents of the pump and eliminate the possibility of exposure, particularly if hazardous and/or toxic. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks.

**WARNING:**

Pumping equipment Instruction, Operation, and Maintenance manuals clearly identify accepted methods for disassembling pumping units. These methods must be adhered to. Specifically, applying heat to impellers and/or impeller retaining devices to aid in their removal is strictly forbidden. Trapped liquid can rapidly expand and result in a violent explosion and injury.

ITT Goulds Pumps will not accept responsibility for physical injury, damage, or delays caused by a failure to observe the instructions for installation, operation, and maintenance contained in this Pump Safety Manual or the current IOM available at <http://www.gouldspumps.com/literature>.

1.3 Safety

Definitions

Throughout this manual the words Warning, Caution, Electrical, and ATEX are used to indicate where special operator attention is required.

Observe all Cautions and Warnings highlighted in the Pump Safety Manual and the IOM provided with your equipment.

**WARNING:**

Indicates a hazardous situation which, if not avoided, could result in death or serious injury. Example: Pump shall never be operated without coupling guard installed correctly.

**CAUTION:**

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury. Example: Throttling flow from the suction side may cause cavitation and pump damage.

Electrical Hazard:**WARNING:**

Indicates the possibility of electrical risks if directions are not followed. Example: Lock out driver power to prevent electric shock, accidental start-up, and physical injury.

ATEX:**WARNING:**

When installed in potentially explosive atmospheres, the instructions that follow the Ex symbol must be followed. Personal injury and/or equipment damage may occur if these instructions are not followed. If there is any question regarding these requirements or if the equipment is to be modified, please contact an ITT Goulds Pumps representative before proceeding. Example: Improper impeller adjustment could cause contact between the rotating and stationary parts, resulting in a spark and heat generation.






1.4 General precautions












WARNING:








A pump is a pressure vessel with rotating parts that can be hazardous. Hazardous fluids may be contained by the pump including high temperature, flammable, acidic, caustic, explosive, and other risks. Operators and maintenance personnel must realize this and follow safety measures. Personal injuries will result if procedures outlined in this manual are not followed. ITT Goulds Pumps will not accept responsibility for physical injury, damage or delays caused by a failure to observe the instructions in this manual and the IOM provided with your equipment.

Table 1: General Precautions

WARNING		NEVER APPLY HEAT TO REMOVE IMPELLER. It may explode due to trapped liquid.
WARNING		NEVER use heat to disassemble pump due to risk of explosion from tapped liquid.
WARNING		NEVER operate pump without coupling guard correctly installed.
WARNING		NEVER run pump below recommended minimum flow when dry, or without prime.
WARNING		ALWAYS lock out power to the driver before performing pump maintenance.
WARNING		NEVER operate pump without safety devices installed.
WARNING		NEVER operate pump with discharge valve closed.
WARNING		NEVER operate pump with suction valve closed.
WARNING		DO NOT change service application without approval of an authorized ITT Goulds Pumps representative.
WARNING		<p>Safety Apparel:</p> <ul style="list-style-type: none"> • Insulated work gloves when handling hot bearings or using bearing heater • Heavy work gloves when handling parts with sharp edges, especially impellers • Safety glasses (with side shields) for eye protection • Steel-toed shoes for foot protection when handling parts, heavy tools, etc. • Other personal protective equipment to protect against hazardous/toxic fluids
WARNING		<p>Receiving:</p> <p>Assembled pumping units and their components are heavy. Failure to properly lift and support equipment can result in serious physical injury and/or</p>

		equipment damage. Lift equipment only at specifically identified lifting points or as instructed in the current IOM. Current manuals are available at www.gouldspumps.com/literature_ioms.html or from your local ITT Goulds Pumps sales representative. Note: Lifting devices (eyebolts, slings, spreaders, etc.) must be rated, selected, and used for the entire load being lifted.
WARNING		Alignment: Shaft alignment procedures must be followed to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow coupling manufacturer's coupling installation and operation procedures.
WARNING		Before beginning any alignment procedure, make sure driver power is locked out. Failure to lock out driver power will result in serious physical injury.
CAUTION		Piping: Never draw piping into place by forcing at the flanged connections of the pump. This may impose dangerous strains on the unit and cause misalignment between pump and driver. Pipe strain will adversely effect the operation of the pump resulting in physical injury and damage to the equipment.
WARNING		Flanged Connections: Use only fasteners of the proper size and material.
WARNING		Replace all corroded fasteners.
WARNING		Ensure all fasteners are properly tightened and there are no missing fasteners.
WARNING		Startup and Operation: When installing in a potentially explosive environment, please ensure that the motor is properly certified.
WARNING		Operating pump in reverse rotation may result in contact of metal parts, heat generation, and breach of containment.
WARNING		Lock out driver power to prevent accidental start-up and physical injury.
WARNING		The impeller clearance setting procedure must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation and equipment damage.
WARNING		If using a cartridge mechanical seal, the centering clips must be installed and set screws loosened prior to setting impeller clearance. Failure to do so could result in sparks, heat generation, and mechanical seal damage.
WARNING		The coupling used in an ATEX classified environment must be properly certified and must be constructed from a non-sparking material.
WARNING		Never operate a pump without coupling guard properly installed. Personal injury will occur if pump is run without coupling guard.

1.4 General precautions

WARNING		Make sure to properly lubricate the bearings. Failure to do so may result in excess heat generation, sparks, and / or premature failure.
CAUTION		The mechanical seal used in an ATEX classified environment must be properly certified. Prior to start up, ensure all points of potential leakage of process fluid to the work environment are closed.
CAUTION		Never operate the pump without liquid supplied to mechanical seal. Running a mechanical seal dry, even for a few seconds, can cause seal damage and must be avoided. Physical injury can occur if mechanical seal fails.
WARNING		Never attempt to replace packing until the driver is properly locked out and the coupling spacer is removed.
WARNING		Dynamic seals are not allowed in an ATEX classified environment.
WARNING		DO NOT operate pump below minimum rated flows or with suction and/or discharge valve closed. These conditions may create an explosive hazard due to vaporization of pumpage and can quickly lead to pump failure and physical injury.
WARNING		Ensure pump is isolated from system and pressure is relieved before disassembling pump, removing plugs, opening vent or drain valves, or disconnecting piping.
WARNING		Shutdown, Disassembly, and Reassembly: Pump components can be heavy. Proper methods of lifting must be employed to avoid physical injury and/or equipment damage. Steel toed shoes must be worn at all times.
WARNING		The pump may handle hazardous and/or toxic fluids. Observe proper decontamination procedures. Proper personal protective equipment should be worn. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable environmental regulations.
WARNING		Operator must be aware of pumpage and safety precautions to prevent physical injury.
WARNING		Lock out driver power to prevent accidental startup and physical injury.
CAUTION		Allow all system and pump components to cool before handling them to prevent physical injury.
CAUTION		If pump is a Model NM3171, NM3196, 3198, 3298, V3298, SP3298, 4150, 4550, or 3107, there may be a risk of static electric discharge from plastic parts that are not properly grounded. If pumped fluid is non-conductive, pump should be drained and flushed with a conductive fluid under conditions that will not allow for a spark to be released to the atmosphere.
WARNING		Never apply heat to remove an impeller. The use of heat may cause an explosion due to trapped fluid, resulting in severe physical injury and property damage.
CAUTION		Wear heavy work gloves when handling impellers as sharp edges may cause physical injury.
CAUTION		Wear insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

WARNING		<p>Noise:</p> <p>Sound pressure levels may exceed 80 dbA in operating process plants. Clear visual warnings or other indicators should be available to those entering an area with unsafe noise levels. Personnel should wear appropriate hearing protection when working on or around any equipment, including pumps. Consider limiting personnel's exposure time to noise or, where possible, enclosing equipment to reduce noise. Local law may provide specific guidance regarding exposure of personnel to noise and when noise exposure reduction is required.</p>
WARNING		<p>Temperature:</p> <p>Equipment and piping surfaces may exceed 130°F (54°C) in operating process plants. Clear visual warnings or other indicators should alert personnel to surfaces that may reach a potentially unsafe temperature. Do not touch hot surfaces. Allow pumps operating at a high temperature to cool sufficiently before performing maintenance. If touching a hot surface cannot be avoided, personnel should wear appropriate gloves, clothing, and other protective gear as necessary. Local law may provide specific guidance regarding exposure of personnel to unsafe temperatures.</p>
WARNING		<p>This product contains Carbon Black a chemical known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov</p>



1.5 ATEX Considerations and Intended Use

Special care must be taken in potentially explosive environments to ensure that the equipment is properly maintained. This includes but is not limited to:

Description of ATEX

The ATEX directives are a specification enforced in Europe for electrical and non-electrical equipment installed in Europe. ATEX deals with the control of potentially explosive atmospheres and the standards of equipment and protective systems used within these atmospheres. The relevance of the ATEX requirements is not limited to Europe. You can apply these guidelines to equipment installed in any potentially explosive atmosphere.

Guidelines for compliance

Compliance is fulfilled only when you operate the unit within its intended use. Do not change the conditions of the service without the approval of an ITT representative. When you install or maintain explosion proof products, always comply with the directive and applicable standards (for example, IEC/EN 60079-14).

1. Monitoring the and liquid end temperature.
2. Maintaining proper bearing lubrication.
3. Ensuring that the pump is operated in the intended hydraulic range.

The ATEX conformance is only applicable when the pump unit is operated within its intended use. Operating, installing or maintaining the pump unit in any way that is not covered in the Instruction, Operation, and Maintenance manual (IOM) can cause serious personal injury or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT Goulds Pumps. If there is any question regarding the intended use of the equipment, please contact an ITT Goulds representative before proceeding.

Current IOMs are available at <https://www.gouldspumps.com/en-US/Tools-and-Resources/Literature/IOMs/> or from your local ITT Goulds Pumps Sales representative.

All pumping unit (pump, seal, coupling, motor and pump accessories) certified for use in an ATEX classified environment, are identified by an ATEX tag secured to the pump or the on which it is mounted. A typical tag would look like this:

Figure 1: Typical ATEX pump nameplate

The code classification marked on the equipment must be in accordance with the specified area where the equipment will be installed. If it is not, do not operate the equipment and contact your ITT Goulds Pumps sales representative before proceeding.

1.6 Parts



The use of genuine Goulds parts will provide the safest and most reliable operation of your pump. ITT Goulds Pumps ISO certification and quality control procedures ensure the parts are manufactured to the highest quality and safety levels.

Please contact your local Goulds representative for details on genuine Goulds parts.

2 Installation

2.1 Location

Pumping unit should be placed as close as practical to the source of supply. Always allow sufficient head room to remove the upper half casing of the pump and the rotating element. Floor space allotted to the pumping unit should be sufficient for inspection and maintenance.

2.2 Prepare the foundation

1. The foundation should be substantial in order to absorb any vibration and to form a permanent rigid support for the bedplate. A concrete foundation poured on a solid footing, using a one-three-five mix, of a liberal thickness to support the pumping unit is satisfactory.
2. Foundation Bolts:
 - a) The location and size of the foundation bolts is shown on the outline assembly drawing supplied for the pumping unit.
 - b) Each bolt should be installed with a pipe sleeve around it - to allow for adjustment. The inside sleeve diameter should be $2\frac{1}{2}$ to 3 times the diameter of the bolt. Place a washer between bolt head and sleeve to hold bolt in position. Stuff waste around foundation bolts to prevent concrete from entering between the bolt and pipe sleeve. See [Figure 2: Foundation on page 11](#).
 - c) The foundation bolts should be of sufficient length so that they project through the nut approximately $\frac{1}{4}$ " after allowance has been made for grouting ($\frac{3}{4}$ " to $1\frac{1}{2}$ "), the thickness of the bedplate, and the thickness of the foundation bolt nut. See [Figure 2: Foundation on page 11](#).

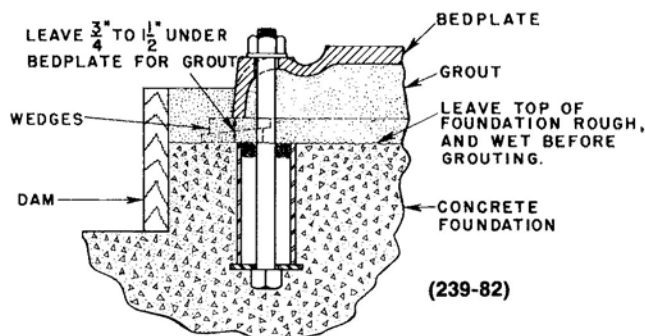


Figure 2: Foundation

3. Preparing Foundation for Mounting:

Prior to setting unit upon the foundation, clean the top surface of concrete.
4. Mounting unit on foundation
 - a) Put the pumping unit in place on the wedges. The wedges should be placed at four points, two below the approximate center of the pump and two below the approximate center of the driver (See). Some installations may require additional wedges near the middle of the bedplate.
 - b) By adjustment of the wedges, bring the unit to an approximate level and provide for the proper distance above the foundation for grouting ($\frac{3}{4}$ " to $1\frac{1}{2}$ "). Plumb the suction and discharge flanges. By further adjustment of the wedges, bring the coupling halves into reasonable alignment. Check by method described in Section , steps 4 through 6.
 - c) After the wedges have been adjusted, tighten foundation bolts evenly but only finger tight.

NOTICE:

Final tightening of foundation bolts is done after grout has set 48 hours.

5. Grouting Unit on Foundation:
 - a) Build wood dam around foundation as shown in [Figure 2: Foundation on page 11](#). Wet top surface of concrete foundation thoroughly.
 - b) Pour grout in hole provided in the top of the bedplate. Use of a non-shrink grout is recommended. The grout should be thin enough to flow out under the bedplate. A mixture of one part Portland cement to three parts sharp sand may also be used. Cement grout should not be so thin that the cement will separate from the sand.
 - c) The grout should be puddled continuously as it is poured to expel the air and completely fill the space under the bedplate, to the level of the grout hole in the top of the bedplate.
 - d) With a trowel, strike along the top of the wood dam to give a neat, finished appearance at this point.
 - e) Allow grout to harden at least 48 hours.

2.3 Piping - general

1. All piping must be supported independently of the pump. The piping should always "lineup" naturally with the pump flanges. Never draw the piping into place by use of force at the flanged suction and discharge connections of the pump.
2. The piping, both suction and discharge, should be as short and direct as possible. Avoid all unnecessary elbows, bends and fittings, as they increase the friction losses in the piping. The size of pipe and fittings should be carefully selected and of sufficient size to keep the friction losses as low as practical.
3. Piping must not be connected to the pump until the grout has thoroughly hardened and the foundation bolts as well as driver and pump hold-down bolts have been tightened. See [Section 2.6 Connection of piping on page 13](#).
4. When handling liquids at elevated temperatures, arrangements must be made for expansion loops or expansion joints so that the linear expansion of the pipe will not cause the pumping unit to be drawn out of alignment.

2.4 Install suction piping

1. General - properly installed suction piping is of extreme importance for trouble-free centrifugal pump operation.
 - a) The suction pipe should be as large or larger than the pump suction.
 - b) Increasers, if used, should be eccentric and preferably at the pump suction flange, sloping side down.
 - c) A centrifugal pump should never be throttled on the suction side for capacity adjustment.
2. Installations With Pump Above Source of Supply - Suction Lift:
 - a) Keep suction pipe free from air pockets.
 - No portion of piping should extend above the pump suction nozzle.
 - b) All joints must be air tight.
 - c) The suction pipe should always be submerged into the source of supply as shown in .

- d) A foot valve should only be used if necessary for priming, or, if the pump is to be used on intermittent service and is required to hold its prime.
 - e) Suction strainers when used should have a net free area of at least three times the suction pipe area.
3. Installations With Pump Below Source of Supply - Suction Head or Flooded Suction:
- a) A gate valve should be installed in the suction line to permit closing the line for pump inspection and maintenance.

2.5 Piping - discharge

- 1. A gate valve and a check valve should be installed in the discharge line. The check valve should be located between the gate valve and pump to permit inspection of the check valve. The gate valve is required for priming, regulation of flow capacity and for inspection and maintenance of the pump.
- 2. Increasesers, if used in discharge line, should be placed between the check valve and the pump.

2.6 Connection of piping

Connect suction and discharge piping. Rotate the pump shaft by hand several complete revolutions to be sure that there is no binding and that all parts are free. Recheck alignment as described in Section . If the connection of the piping causes unit to be out of alignment, correct piping to relieve strain on the pump.

3 Preparation for operation

3.1 Pump bearings

1. Model 3405 pump bearings are grease lubricated and sufficient lubricant is inserted at the factory for 2000 hours of operation.
2. Model 3406 pump bearings are ring oil lubricated, and are not lubricated before leaving the factory.
3. Model 3416 pump bearings are flood oil lubricated and are not lubricated before leaving the factory.

A high quality turbine type oil, with rust and oxidation inhibitors, should be used. For the great majority of operation conditions, oil temperature will run between 50 and 180°F. In this range an oil of 300 SSU viscosity at 100°F. (approximately SAE 20) should be used.

If oil temperature exceeds 180°F. (Models 3405 and 3406) or 250°F. (Model 3416) for extended periods of time, use of cooling water as outlined in [3.5 Connection of piping to quenching gland on page 17](#) and [3.2 Driver bearings and coupling on page 15](#) and/or use of a special high temperature oil should be considered. For extreme conditions, refer to factory or a lubrication expert for a recommendation.

The constant level oilers are found in the box of fittings which accompany the pump. Oiler manufacturer's instructions accompany the oiler. Set as illustrated below.

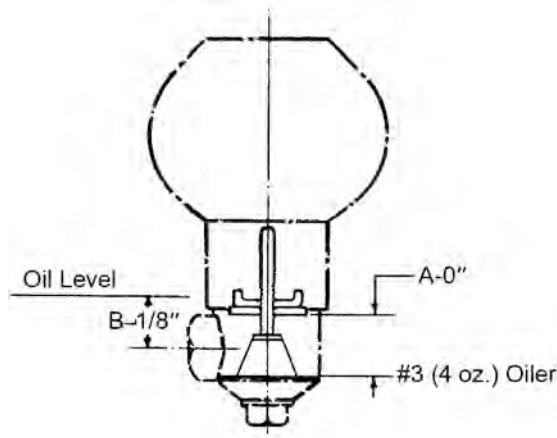


Figure 3: Oiler

On the Model 3406 install the constant level oilers in the bearing housing at each end of the pump. The oiler piping must rest on top of the cap screw which projects from the casing. This screw keeps the oiler piping level. (See [Figure 4: on page 15](#)).

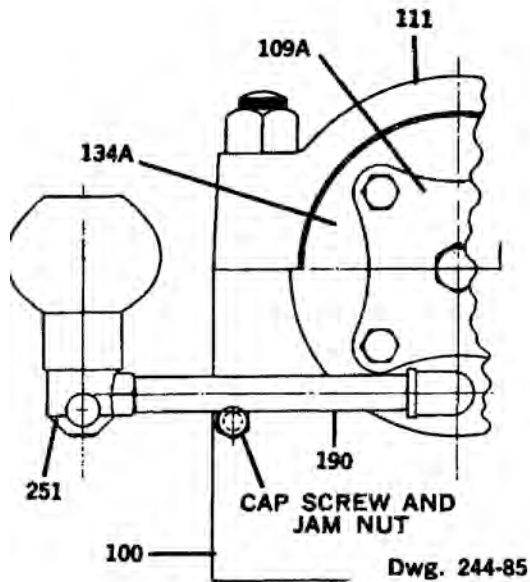


Figure 4:

On the Model 3416 install the constant level oilers in the bearing end covers at each end of the pump, as shown in [Figure 5: on page 15](#). Do not install the oiler in the opening for the optional cooling coils, which are directly below the oiler.

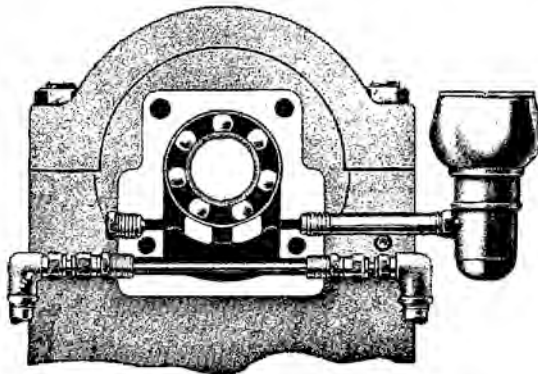


Figure 5:

3.2 Driver bearings and coupling

Check to be sure the driver bearings and coupling are properly lubricated.

3.3 Stuffing boxes

Pumps are furnished with packed type stuffing boxes as standard. However, mechanical seals, either of single or double type, can be furnished on order.

Stuffing Boxes with Packing Rings:

In the box of fittings accompanying the pump will be found the stuffing box packing. The standard packing is John Crane "Super Seal" No. 1 and is a general purpose plastic type packing composed of special long fibre pure asbestos, suitable anti-friction metal particles, fine lubricating graphite, and binder. It contains no volatile oils. The packing is die-formed to facilitate installation. "Super Seal" No. 1 is

recommended for water, ammonia, mild chemicals and all general services, and is good for the maximum temperatures for which the pumps are rated.

It is suggested that the packing rings be allowed to soak in #10 SAE oil for 15 minutes to one hour prior to installation.

When installing the packing and the PTFE lantern ring, twist the rings sideways just enough to get them around the shaft sleeves. Do not attempt to pull rings straight out to get them over shaft and shaft sleeve. (See [Figure 6: on page 16.](#))

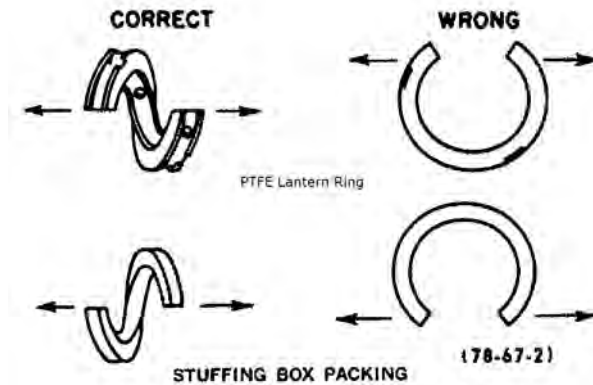


Figure 6:

Insert two rings of packing for Group "S" & "M" pumps and three rings for Group "L" pumps against the stuffing box bushings (125), staggering the joints. See [7.3 Sectional view on page 33](#). The lantern ring (105) should then be inserted in the stuffing box. When it is in its proper position, it will be directly opposite the sealing inlet connection.

After the lantern ring is in place, insert three more rings of packing, staggering the joints. Two extra rings of packing are furnished in each set of packing. The extra ring for each side may be added as required.

Insert gland packing (210) into recess in each gland half and trim off excess flush with face of each gland half.

Now, insert lower half gland (107) into stuffing box. Run ½"-20 SAE nuts (355) about three-fourths the length of the threaded part of bolts (353) and place cupped washers (354) on gland bolts.

Insert round, flattened end of gland bolts into recesses of bearing housing (134 or 166) on Model 3405, or into recesses of bearing housing cover (160) on Model 3406. Threaded portion of gland bolts lays on gland half.

Insert upper half gland into stuffing box. Place cupped washers over the bosses on the gland to hold the gland halves together.

Draw the gland nuts up evenly but not tight.

Stuffing Boxes With Mechanical Seals:

When mechanical seals are furnished they are installed at the factory and no further adjustments are required.

When single mechanical seals are used, the water seal piping must be connected as explained in [3.4 Connection of water seal piping on page 17](#).

When double mechanical seals are used, the water seal piping is omitted and the four holes in stuffing box and casing must be plugged. Cooling liquid from an outside source must be piped to the gland openings at a pressure slightly more than the suction pressure of the pump.

The two gland openings are tapped for 1/8" pipe.

3.4 Connection of water seal piping

Water seal piping is required only when pump is operating under suction lift or when single mechanical seal is used. It is not necessary when pump is operating under suction head or when double mechanical seal is furnished, in which cases the four openings in the stuffing box and casing must be plugged.

On all iron pumps or when the pump is handling hydro-carbons, solvents and similar liquids, a grease lubricator, using a non-solvent grease, should be fitted into the tapped opening in stuffing boxes ([Figure 7: on page 17](#)).

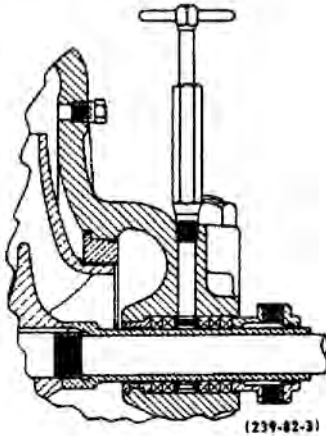


Figure 7:

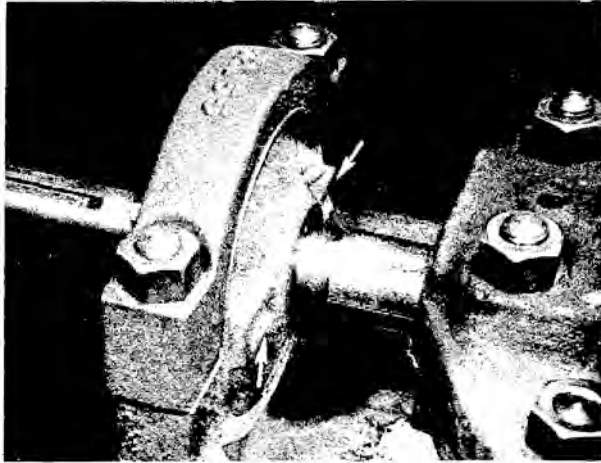
If the liquid contains abrasives or paper stock particles (white water applications) or is gritty, omit the water seal piping and plug the tapped openings in the casing. Pipe a clean water supply with a shut-off valve to each of the openings at the top of stuffing boxes at a pressure slightly higher than the suction pressure on the pump.

The water seal piping, when required, is shipped separately in the box of fittings accompanying the pump. When this piping is used, one end is attached to the tapped opening in the casing and the other end to the tapped opening on the top of the stuffing box with connectors furnished. See [7.3 Sectional view on page 33](#).

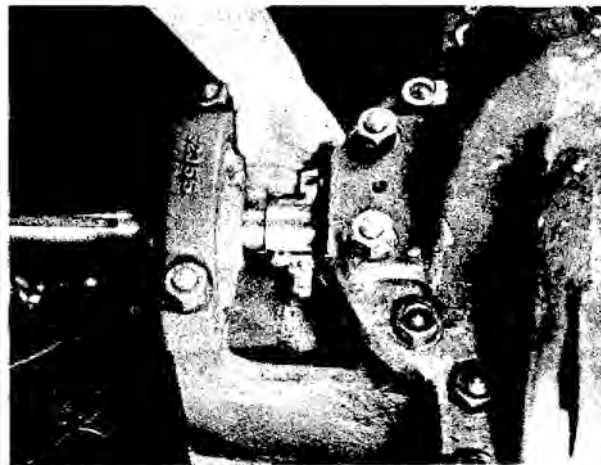
3.5 Connection of piping to quenching gland

The stuffing box gland can be operated with or without quenching water. Quenching is recommended on applications where the liquid pumped is:

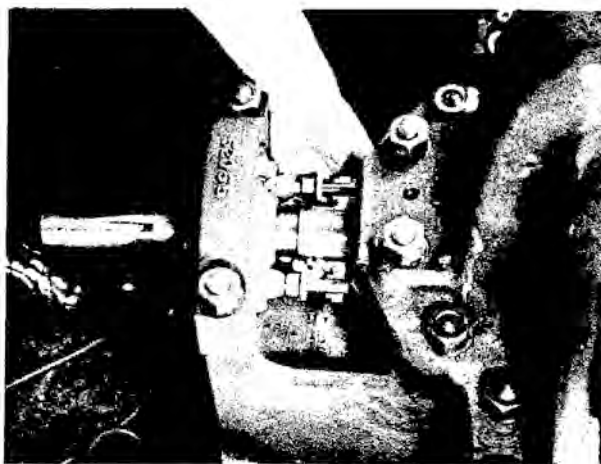
1. Bearing Housing Showing Slots for Gland Bolt Heads.



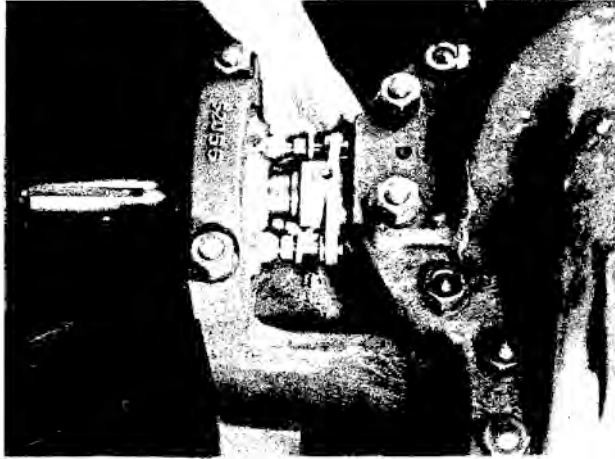
2. First Half of Stuffing Box Gland Installed.



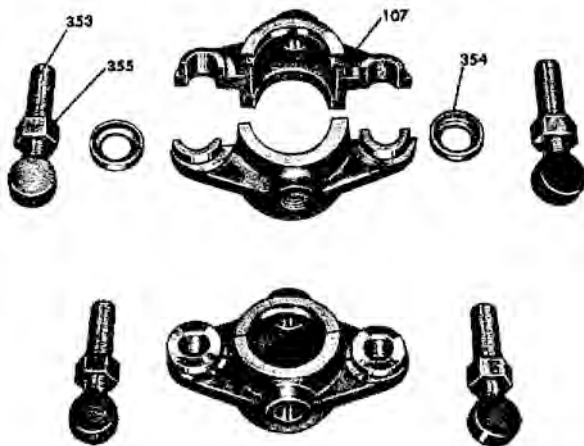
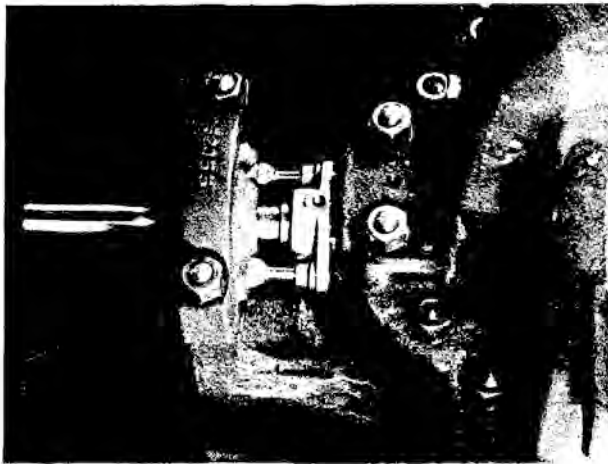
3. Lay Gland Bolts on bottom half of Gland with bolt heads in bearing housing slots. Nuts and special cup washers should be all the way back on the bolts, toward the bolt heads as shown.



4. Install top half of stuffing box gland over gland bolts and bottom half of gland.



5. Slide cup washers over shoulders of gland flanges and tighten nuts evenly to provide proper pressure against stuffing box packing. Gland bolts do not screw into tapped holes in casing. Tapped holes in casing are for mechanical seal gland only when pumps are furnished with seals.



1. Model 3405 - Between 180°F and 250°F when bearing housings are not cooled and between 250°F and 350° F, in addition to bearing housing cooling.
2. Model 3406 - Between 180° and 250°F.
3. Model 3416 - Between 250° and 350°F when bearing housings are not cooled and between 350° and 400°F, in addition to bearing housing cooling.

4. Volatile or toxic, in order to smother the gland leakage, which then can be piped away.

The quenching liquid must be from an outside source and should be piped with a flexible pipe, into the opening in the upper gland half and allowed to drain into chamber or pocket in lower half casing. When used for cooling, the flow should be regulated as shown in [4.2 Regulation of cooling water flow on page 24](#). The openings in the gland halves should be installed in each quenching line.

3.6 Connection of bearing cooling water piping

Water cooled bearing housings are furnished when ordered (Models 3405 and 3416 only). Bearing cooling should be used when the liquid pumped is:

1. Model 3405 between 180° and 250°F when gland quenching is not used and between 250° and 350°F, in addition to gland quenching.
2. Model 3416 between 250° and 350°F when gland quenching is not used and between 350° and 400°F, in addition to gland quenching.

On the Model 3405 - cooling water lines should be connected to the 3/8" pipe tap openings in the bearing housing, as shown in the sectional assembly, [7.3 Sectional view on page 33](#). The inlet line should be at the bottom, and should have a shut-off valve installed to regulate flow. See Regulation of cooling water flow for instructions for regulating cooling water flow.

On the Model 3416 - the cooling coils are installed as follows:

1. Refer to Figure 1, which shows the installed cooling coil.
2. Special fittings and tubing are in the box of fittings sent with the pump.
3. Remove four - 1/4" plugs from bearing end covers (109 and 119) - one plug from each side of each cover. The plugged openings are those below the openings for the constant level oilers.
4. Screw 1/4" pipe x 1/4" O.D. tube compression fittings into each of the four openings.
5. Push each 1/4" O.D. x 9" long copper tube through one fitting until it comes out the fitting on the other side. Center tubing so that equal lengths project from each side. Tighten nuts on compression fittings.
6. Connect the 1/4" pipe x 1/4" O.D. tubing elbow to each end of the copper tube. This provides a 1/4" pipe connection for cooling water piping.
7. Connect cooling water. The inlet line should have a shutoff valve to regulate flow.

3.7 Connection of drain piping

Connect overflow outlets from stuffing boxes (located in casing near pump feet) to drain, and connect overflow from bedplate (located at pump end of bedplate) to drain. All of the above overflow openings are tapped for 3/4" pipe.

4 Starting pump

4.1 Priming

The pump must always be fully primed and the suction pipe full of liquid before pump is started.

If pump is run dry, the rotating parts within the pump may seize to the stationary parts as they depend on the liquid being pumped for lubrication.

Several different methods of priming can be used, depending on the type of installation and service involved.

NOTICE:

If the pump is being used to pump potable or drinking water, the priming line should be protected against back-siphonage by the installation of a check valve and an approved type vacuum breaker.

Suction Supply Above Pump:

When pump is installed as shown in [Figure 8: on page 21](#), pump will prime itself. Open gate valve on suction and close discharge gate valve. Open air vent valves until all air is expelled and water flows through openings. Close air vent valves, start pump, open discharge gate valve, and pump will continue to be primed for any future starting.

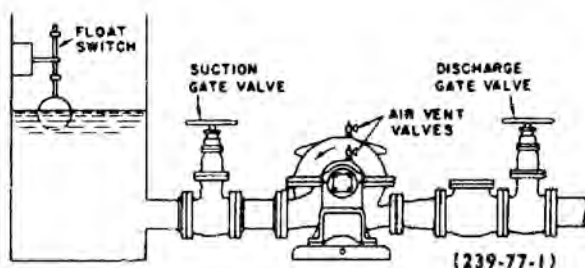


Figure 8:

This method is the simplest and, particularly for automatic operation, the safest. A float switch in the suction reservoir can be arranged to stop pump, should there be failure of liquid supply.

Priming With Foot Valve:

With pump installed on suction lift, with foot valve at end of suction line, priming can be done any of the following three ways:

1. From Some Outside Supply (See [Figure 9: on page 22](#)). Close discharge gate valve, open air vent valves and open valve in primary supply line until all air is expelled and water issues from vent openings. Close valve in priming supply line, close air vent valves and start pump; then open discharge gate valve.

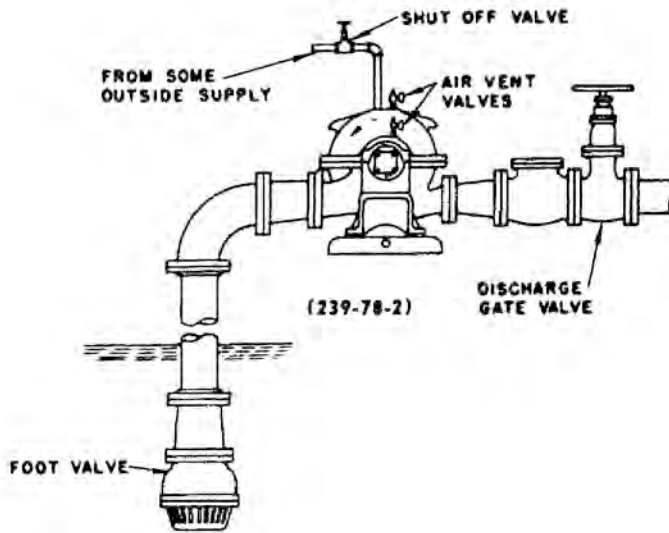


Figure 9:

2. By Separate Hand or Manually Controlled Priming Pump (See [Figure 10: on page 22](#)).

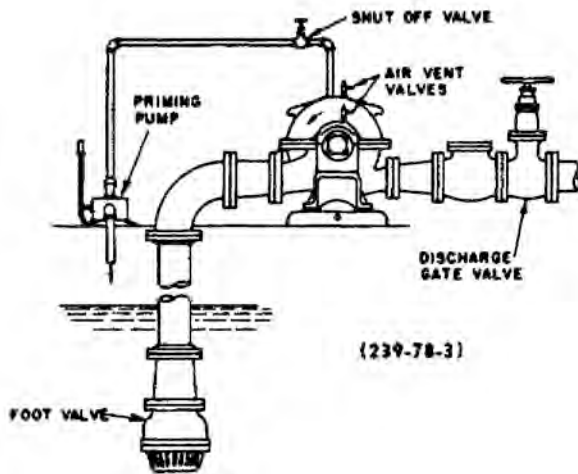


Figure 10:

Close discharge gate valve (keep air vent valves closed) and open valve in line to priming pump. Exhaust air from pump and suction piping until water flows from priming pump. Close valve in priming line, start pump and open discharge gate valve. Or, by reversing connections on priming pump and extending priming pump suction to source of liquid supply, centrifugal pump may be primed by pumping liquid into casing until liquid comes out of the open air vent valves. As in Section 4.1 Priming on page 21 A2 (a). In either of these methods (a) and (b), the pump will remain primed, provided foot valve is tight. Any failure, however, of foot valve when pump is standing idle, will permit the pump to lose its prime. During long idle periods, the pump can also lose its prime through leakage from stuffing boxes.

3. Bypassing Around Discharge Check Valve (See [Figure 11: on page 23](#)).

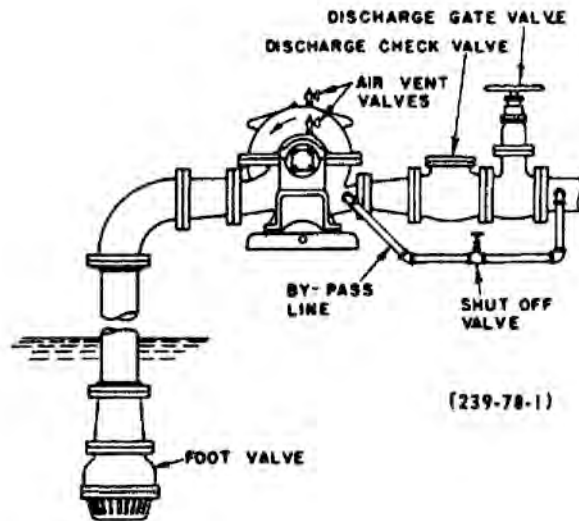


Figure 11:

This method can be used only when there is liquid under some pressure in the discharge line. The original prime must be effected from some outside source. After subsequent idle periods, open air vent valves and open valve in bypass line around discharge check and gate valves until liquid flows from air vent openings. Close air vent valves and bypass valve, start pump and open discharge gate valve.

The valve in bypass can be left open, in which event, during idle periods, loss through foot valve is constantly replenished from discharge line. This system is used for automatic operation where idle periods are of short duration and there is no danger of exhausting all liquid from discharge line, due to a leaky foot valve. If the valve in the bypass is left open, as described above, the foot valve must be capable of withstanding static head pressure of the system.

Priming by Ejector:

On suction lift installations, an ejector, operated by steam, compressed air, or water under pressure, and connected to tapped opening in top of casing can be used to remove air from casing and suction line, thus priming the pump.

Close discharge gate valve, open valve "E" in steam, air or water pressure supply line. Open valve "S" in suction pipe of ejector connected to pump casing. Air will be evacuated and liquid will be drawn up into suction pipe and pump casing. When all air is evacuated, start pump, close valve "S" and valve "E", and open discharge gate valve.

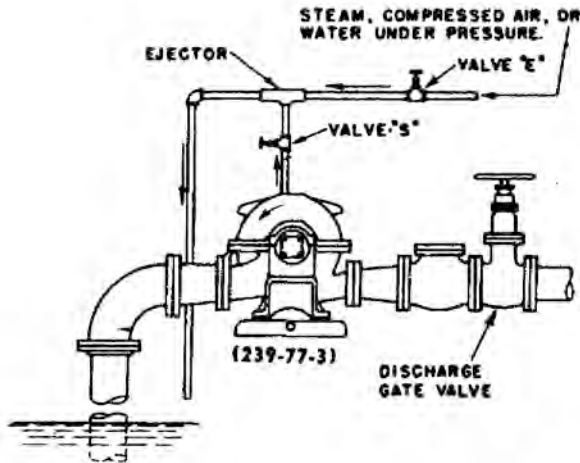


Figure 12:

Priming by Automatic Primer Pump

Where there is a fluctuating suction lift that occasionally might drop below the normal limits of the pump or for installations where there is any quantity of air entrained with the liquid being pumped, the system shown in [Figure 13: on page 24](#) is very well adapted.

A vacuum tank and a vacuum gauge can be installed near the primer pump and the vacuum switch set to automatically start or stop the primer pump according to the vacuum required to keep the system primed.

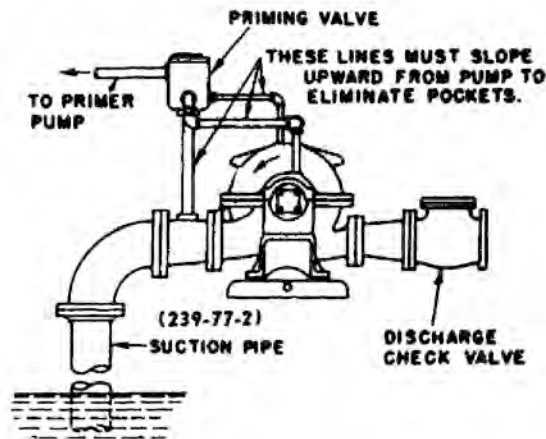


Figure 13:

4.2 Regulation of cooling water flow

The supply of liquid to the water-cooled bearings and quenching glands should be regulated by valves in the supply line. Approximately ½ G.P.M. to each gland and G.P.M. to each bearing cooling coil is sufficient. The cooling lines should be checked periodically to see that they have not become clogged.

4.3 Adjustment of stuffing box gland

With pump running at rated speed, stuffing box glands can be adjusted. Draw gland nuts up evenly and only one-sixth of a turn at a time, allowing sufficient time between adjustments for the packing to adjust itself and the effect on the leakage to be observed. If any sign of heating is evident, shut off the pump and allow the boxes to cool. Several starts may be necessary before the boxes run cool. Do not back off the gland nuts on a hot box as this will usually result in liquid leaking between the outer edge of the packing and the stuffing box bore. It must be borne in mind that it takes newly-installed packing some time to "run in" and that during this period, frequent attention and careful adjustments are necessary. See [5.1 Stuffing box on page 26](#) for final adjustments of gland.

4.4 Alignment - final

Final alignment can only be accomplished after unit has been run under actual operating conditions for a sufficient length of time to bring the unit up to operating temperatures.

After this warm-up period has elapsed, stop the unit and immediately disconnect the coupling and check the alignment.

Follow the alignment procedure as outlined in Alignment - initial, with the exception of Paragraph 6, which allows for "growth" of the parts due to temperature difference between the driver and the pump. However, at the operating temperature, the unit will be in correct horizontal and vertical parallel alignment when a straight edge rests evenly on both halves of coupling rims at four points 90° apart.

As cautioned in 6, changing alignment in one direction may alter the alignment in another. Check through each alignment procedure after making any alignment change.

4.5 Doweling

Doweling is not required in Group "S" and "M" pumps. On these pumps, patented lock washers are furnished which hold the pump and driver feet securely in place.

On Group "L" pumps, the pump and driver should be doweled after installation is complete and the unit is in correct final alignment. Four #6 taper dowel pins are included in the box of fittings accompanying the pump.

These pins have a taper of ¼" to the foot. The diameter at large end is 0.341" (approximately 11/32") and the recommended drill size is 9/32".

Drill through two diagonally opposite feet of the pump and driver into the bedplate. Use a reamer with a taper of ¼" to the foot. Ream out the drilled holes so that dowels extend well into the bedplate but project above the pump and driver feet.

If the operator so desires, the same size pins and method of doweling can be used on Series "S" and "M" pumps in addition to the patented lock washers.

To determine the group of a particular size pump, see interchangeability list, [7.3 Sectional view on page 33](#).

5 Operation

5.1 Stuffing box

1. Stuffing Boxes With Packing Rings - Less Quenching Gland and Grease Lubricator:

Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never draw up packing so that the stuffing box heats, as this will cause damage to both packing and sleeve. Always draw up gland nuts evenly and when pump is running.

After pump has been in operation for some time and the packing has been completely run in, at least 40 to 60 drops per minute of the liquid should be allowed to trickle from the stuffing box at all times for cooling and lubricating the packing and shaft sleeve.

2. Stuffing Boxes With Packing Rings - With Quenching Gland:

The same precautions as described above apply. However, the amount of leakage through the packing cannot be so readily ascertained, due to the quenching liquid. In most cases, the valve on the quenching liquid supply line can be shut off for a short period and the amount of leakage determined as in [5.1 Stuffing box on page 26](#) 1. In no instance should the gland be drawn up tight.

3. Stuffing Boxes With Packing Rings - With Grease Lubricator:

Operation is the same as directed in [5.1 Stuffing box on page 26](#) with the addition that the handle on the lubricator should be given a turn or two about every 100 hours off operation.

4. Stuffing Boxes With Mechanical Seal:

This type of box requires no attention other than to make sure that the circulating lines do not become dogged.

5.2 Operating at reduced capacities

Do not operate a centrifugal pump at greatly reduced capacities or with discharge gate valve closed, because the energy required to drive the pump is converted into heat. If this condition exists over a long period, the temperature of the liquid in the pump may increase until the boiling point is reached. If this occurs, the rotating parts are exposed to vapor with no lubrication and they may score or even seize to the stationary parts; and furthermore, if running clearances have enlarged due to wear, seizure may not take place. Continued operation under these conditions may create an explosive hazard due to the confined vapor under high pressure and temperature.

To guard against possible damage, protective devices are available, such as:

1. Liquid temperature relay or thermostat which will shut off the unit if the liquid temperature in the pump exceeds a predetermined maximum. This device guards against possible damage due to running the pump against a closed valve.
2. Constant open bypass orifice between the pump discharge and any check or regulating valve in the discharge line. The liquid through the orifice is returned to the suction source. The amount of liquid by-passed is a function of input horsepower and the allowable temperature rise. This device also is insurance against damage due to running the pump against a closed discharge valve or very low flow conditions.
3. Bearing temperature relay which will shut the unit down if the bearing temperature exceeds a predetermined maximum.
4. Low suction pressure control which will shut off the unit should the suction pressure drop below a pre-established minimum.

A centrifugal pump should never be throttled for capacity adjustment on the suction side.

5.3 Operating at reduced head

On motor driven pumps, when discharge head or pressure is allowed to drop considerably below the rated point for any length of time, the motor should be watched for heating because the pump capacity increases rapidly with reduced head, as does horsepower consumption. If this condition is likely to persist, arrangements should be made either to manually or automatically throttle the discharge valve to build up head to a safe point.

5.4 Operating with surge conditions in line

If pump is installed with a quick closing valve in discharge line that closes when pump is running, dangerous pressure surges may be built up that can cause damage to the pump or line. In services of this kind, some cushioning arrangement must be provided to protect the pumping equipment.

5.5 Operating under freezing conditions

When exposed to freezing conditions and pump is standing idle, liquid inside the pump should be drained by removing drain plugs in bottom of casing and opening air cocks at top. Cooling water should also be drained from the water-cooled bearing (if water-cooled bearings are used).

6 Trouble check list

6.1 No water delivered

1. Priming - casing and suction pipe not completely filled with liquid.
2. *1Speed too low.
3. Discharge head too high. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss), Check with gauge.
5. Impeller or suction pipe or opening completely plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn or water seal plugged allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.

*1 When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

6.2 Not enough water delivered

1. Priming - casing and suction pipe not completely filled with liquid.
2. *1Speed too low.
3. Discharge head higher than anticipated. Check total head (particularly friction loss).
4. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with gauge.
5. Impeller or suction pipe or opening partially plugged.
6. Wrong direction of rotation.
7. Air pocket in suction line.
8. Stuffing box packing worn - or water seal plugged allowing leakage of air into pump casing.
9. Air leak in suction line.
10. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
11. Foot valve too small.
12. Foot valve not immersed deeply enough (see Figure 8).
13. Mechanical defects: Wearing rings worn. Impeller damaged. Casing gasket defective.

*1 When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

6.3 Not enough pressure

1. *1Speed too low.
2. Air in water.

3. Impeller diameter may be too small.
4. Mechanical defects: Wearing rings worn. Impeller damaged. Casing gasket defective.
5. Wrong direction of rotation.
6. Be sure pressure gauge is in correct place on discharge nozzle of pump and not on top of casing.

*1 When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

6.4 Pump works awhile and then quits

1. Leaky suction line.
2. Stuffing box packing worn - or water seal plugged allowing leakage of air into pump casing.
3. Air pocket in suction line.
4. Not enough suction head for hot water or volatile liquids. Check carefully as this is a frequent cause of trouble on such service.
5. Air or gases in liquid.
6. Suction lift too high (suction pipe may be too small or long, causing excessive friction loss). Check with switch gauge.
7. Impeller plugged.

6.5 Pump takes too much power

1. *1Speed too high.
2. Head lower than rating, pumps too much water.
3. Liquid heavier than water. Check viscosity and specific gravity.
4. Mechanical defects:
 - Shaft bent.
 - Rotating element binds.
 - Stuffing boxes too tight.
 - Pump and driving unit misaligned.
5. *1Wrong direction of rotation.

*1 When connected to electric motors, check whether motor wiring is correct and receives full voltage. When connected to steam turbines, make sure that turbine receives full steam pressure.

6.6 Pump leaks excessively at stuffing box

1. Packing is worn or not properly lubricated.
2. Packing is incorrectly inserted or not properly run in.
3. Packing is not right kind for liquid handled.
4. Sleeves scored.

6.7 Pump is noisy

1. Hydraulic noise - cavitation, suction lift too high. Check with gauge.
2. Mechanical defects:

6.7 Pump is noisy

- Shaft bent.
- Rotating parts bind, are loose or broken. Bearings worn out.
- Pump and driving unit misaligned.

7 Care and maintenance

7.1 Lubrication - bearings

Grease Lubricated Bearings

1. As specified in Section 3.1 [Pump bearings on page 14](#), Model 3405 pumps with grease lubricated bearings are lubricated at the factory for 2000 hours or three months service. Do not add grease at too frequent intervals. It is suggested that additional or replacement lubricant be added only after 2000 hours operation or three month intervals. While shaft is revolving, insert grease through "Alemite" fittings (193) into bearing housing until grease appears through relief fitting (113), Do not add additional lubricant after grease appears through relief fitting.
2. The grease should be renewed in the Model 3405 housings at least once annually.
 - Following an overhaul operation and when bearing housings contain no lubricant, proceed to grease the bearings as follows: Insert grease through "Alemite" fittings (193) into bearing housing until grease comes out the relief fitting. Turn shaft by hand several revolutions in both directions during the greasing operation. Do not add additional lubricant after grease appears through the relief fitting.
 - Grease may be renewed in housings without removing rotating element as follows: Remove bearing end covers (109-119) and clean old grease from housing and covers using clean cloths soaked in kerosene. Insert grease through "Alemite" fittings until new grease appears through the bearings. Wipe bearing housings clean again to remove all old grease displaced through the bearing. Replace end covers and add grease through the "Alemite" fittings as described previously.
3. The ball bearing grease should be of a sodium or lithium base, NGLI No. 2 consistency. Do not use graphite.
4. The following is the approximate grease capacity for each bearing housing in fluid ounces:
Group "S" - 2 ounces.
Group "M" - 3 ounces.
Group "L" - 4½ ounces.

Oil Lubricated Bearings

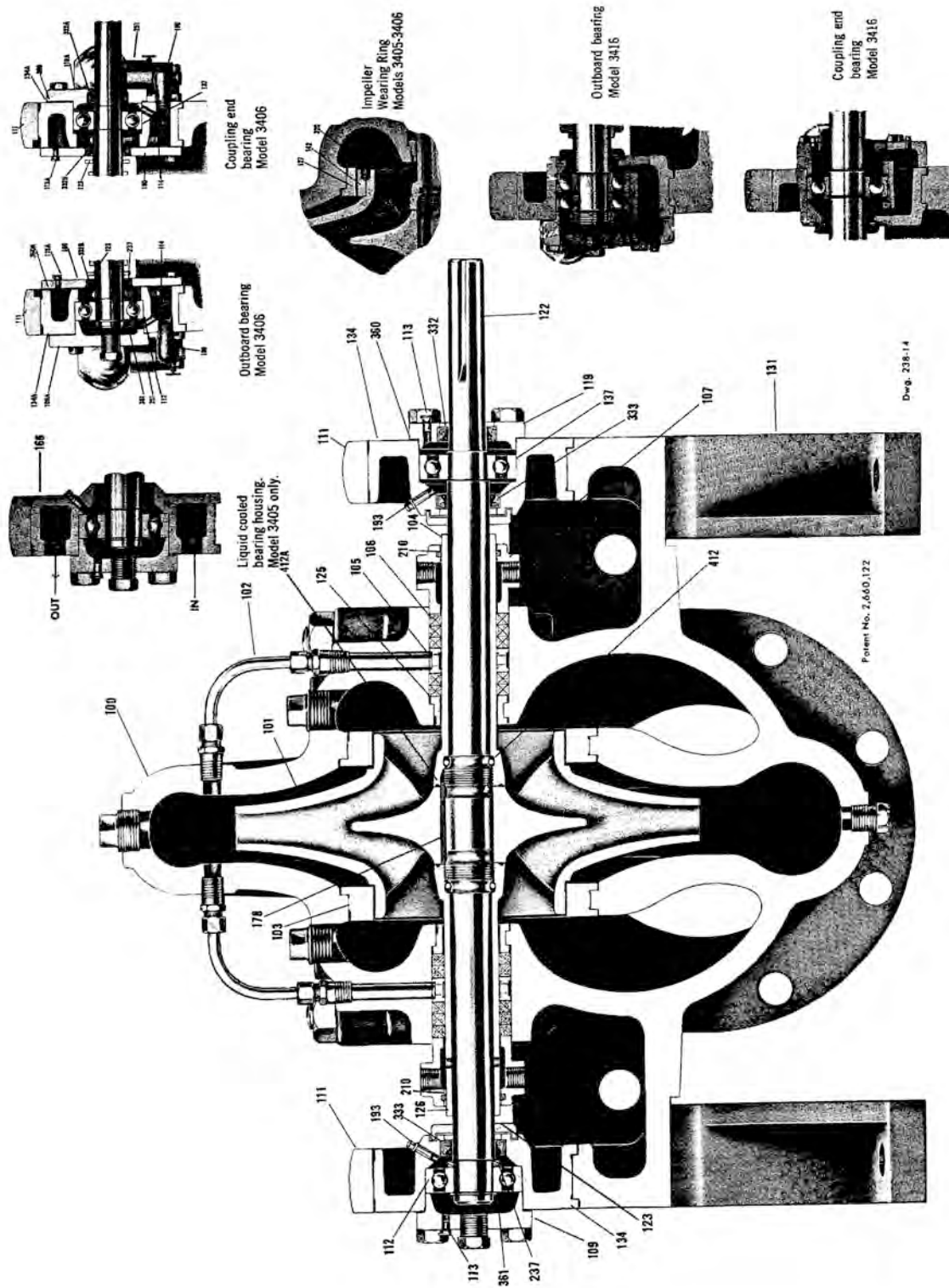
1. On Model 3406 and 3416 pumps, keep oiler bottle filled with correct grade of oil. Oiler will maintain constant oil level in bearing housings.
2. Under normal operating conditions, a good grade of oil will be suitable for 6 months to one year between changes, as long as it is free from contaminants. A small sample of oil should be drained from the bearing frame periodically. Any cloudiness, turbidity, discoloration or presence of solids is evidence of contamination, and the oil should be changed immediately.

7.2 Repacking stuffing boxes

1. To remove stuffing box gland assembly: Back off nuts (355). Slip the cupped washers (354) from bosses on gland, lift the upper gland half out of stuffing box and remove the gland bolts and lower gland half. This now affords unobstructed access to the stuffing box for repacking.
2. Remove the three outer rings of packing with the aid of a packing hook.
3. Remove split lantern ring by inserting a wire hook in the slots in the outer edge of the ring and pulling ring from box.
4. Remove the remaining rings of packing with the aid of a packing hook.
5. Remove all foreign matter from stuffing box.

6. An alternate method of removing the packing and lantern ring is as follows: Remove the upper half casing. See [7.4 Dismantling of pump on page 39](#) 1, 2, 4, 5. Remove the packing and lantern ring from the stuffing box. This method permits the inspection of the shaft sleeve and the stuffing box bushing. If the shaft sleeves are found to be deeply grooved in the packing area, they should be replaced as it is only possible for the packing to do an efficient job when the sleeve surface is relatively smooth.

7.3 Sectional view



Materials of Construction Parts List and Chart of Parts Interchangeability

ITEM No.	Regl. Pump	PART NAME	MATERIAL		INTERCHANGEABILITY BY GROUP AND CASING CLASS													
			ALL IRON	ALL BRZ.	GROUP M	GROUP L												
100	1-Up. 150w.	CASING	1000	1103	AI/316 REL.	ALL 316												
101	1	IMPELLER	1103	1103	316	316												
102	2	WATER SEAL PIPE	BRASS	1103	316	316												
103	2	WEARING RING—CASING	USE GREASE TUBING	1106	1106	316	316											
104	1	SHAFT SURVEY—LOCKING	1106	1106	316	316												
105	2	LANTERN RING	GLASS FUSED TEFLON	1106	1106	316	316											
106	1 5/8	STUFFING BOX PACKING																
107	2	STUFF. BOX BRIT GLAND	1104	1000	316	316												
109	1	BRG. END COVER—THRUST END	1000	1000														
109A	1	BRG. END COVER—THRUST END	1000	1000														
111	2	BEARING CAP	1000	1000														
112	2	BALL BEARING—THRUST END	STEEL															
113	2	GREASE RELIEF FITTING	STEEL															
113A	2	OIL BREATHER FITTING	STEEL															
114	2	OIL RING	BRASS															
119	1	BRG. END COVER—CRG. END	1000	1000														
119A	1	BRG. END COVER CRG. END	1000	1000														
122	1	SHAFT	SAE 4340	AI/303	316	316												
123	2	DEFLECTOR	1000	1000														
125	2	STUFFING BOX BUSHING	1102	1000	316	316												
126	1	SHAFT SLEEVE—WITH SET SCREW	1104	AI/400*	1106	316	316											
X127	2	WEAR RING—CASING	1104	1000	1106	316	316											
131	2	PEDESTAL	1000	1000														
134	2	BEARING HOUSING	1000	1000														
134A	2	BEARING HOUSING	1000	1000														
137	1	BALL BEARING—CRG. END	STEEL															
142	2	WEARING RING—IMPELLER	1103	1000	316	316												
160	2	BRG. HOUSING COVER	1000	1000														
166	2	BRG. HOUSING—LIQUID COOLED	1000	1000														
176	1	IMPELLER KEY	AI/303		316	316												
193	2	GREASE FITTING	STEEL															
210	1 5/8	GLAND PACKING	ALUMITE															
227	1	BALL BEARING COLLAR	1/4" x 1/2" NON-ASBESTOS															
231	2	CONSTANT LEVEL OILER	STEEL															
320	6	SET SCREW (IMP. WRG. RINGS)	303 STAINLESS															
331	4	SHA—BRG. CAP (NOT ILLUS.)	M. NON-ASBESTOS															
332	1	GREASE SEAL—BRG. END COVER																
332A	1	OIL SEAL BRG. END COVER CRG. END																
332B	2	OIL SEAL BRG. HOUSING COVER																
333	2	GREASE SEAL—BRG. HOUSING																
333	1	GASKET—CASING PARTING (NOT ILLUS.)																
333	4	GLAND BOLT (ILLUS. PG. 3)																
333A	4	GLAND BOLT (HOT ILLUS.)																
334	4	GLAND HOLDING WASHER (ILLUS. PG. 3)																
335	4	GLAND BOLT NUT (ILLUS. PG. 3)																
360	2	GASKET—BRG. END COVER	.0145 DUPLEX PAPER															
360A	2	GASKET BRG. HOUSING COVER	MANILA PAPER															
361	1	SNAP RING	STEEL															
412	2	"O" RING SHAFT	BUNA RUBBER															
412A	2	"O" RING (IMPELLER HUB)	TEFLON															

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

NOTE: ALL PARTS S, M AND L EXCEPT NO. 131. PEDISTAL INTERCHANGEABLE WITH GOULDS MODEL 3316 MULTI-STAGE PUMPS.
 *FOR THESE SIZES IMPELLER WEARING RINGS ARE STANDARD.
 *WHITE METAL, GRAPPHITE, LONG FIBRE NON-ASBESTOS.
 *PLAQUE HARDENED.

Construction details

Table 2: Group S

		2x3-11	3x4-8G 3x4-8	3x4-8H	3x4-12 3x4-12G	3x4-14	4x6-8 4x6-8G	4x6-12	4x6-12G
Pump	Weight - bronze fitted bare pump	320	300		390	455	365	470	
	Casing thickness - volute	5/8"	5/8"		11/16"	3/4"	3/4"	11/16"	
	Casing thickness - side walls	1/2"	1/2"		5/8"	5/8"	9/16"		
	Max diameter spherical solids	1/4"	1/2"	3/8"	3/16"		1/2"	5/8"	3/8"
	Casing capacity - gallons	1.5	2		2.6	3.6	3.75	4.25	
Stuffing box	Stuffing box bore	2"							
	Stuffing box packing size	2-5/16"							
	Stuffing box - no. of packing rings	5							
	Width of lantern ring	3/8"							
Shaft	Shaft diameter at impeller	1-3/16"							
	Shaft diameter in shaft sleeve	1-1/16"							
	Shaft diameter at coupling end	15/16"							
	Outside diameter of shaft sleeve	1-3/8"							
General	Ball bearing - both ends	305-S							
	Max total working pressure* ¹	250 PSI							
	Max test pressure	375 PSI							
	Bearing centers	18-3/8"							
	Max shaft HP per 100 RPM	2.57							
Temperature limits	Max liquid temp without cooling or quenching	180°F							
	Max liquid temp with quenching gland	250°F							
	Max liquid temp with bearing cooling (Grease lube)* ²	250°F							
	Max liquid temp with quench gland and bearing cooling (Grease lube)	350°F							

*1 Any part of which may be suction pressure.

*2 Water cooled bearings available for model 3405 only.

Table 3: Group M

		3/4x17	4x6-11	4x6-14	4x6-17	4x6-17G	5x8-12D V	5x8-14D V	6x8-8	6x8-8G	6x8-12	6x8-12G	6x8-14	6x8-14G	6x8-17D V	6x8-17G DV	8x10-12D V	8x10-12 G DV	
Pump	Weight - bronze fitted bare pump	650	640	660	720		680	750	585		725		795		895		905		
	Casing thickness - volute	3/4"	5/8"	1/4"	3/4"		5/8"	11/16"	3/4"		13/16"		7/8"		7/8"		7/8"		
	Casing thickness - side walls	3/8"	5/8"	1/4"	3/4"		5/8"	11/16"	3/8"		11/16"		3/4"		3/4"		3/4"		
	Max diameter spherical solids	5/16"	5/16"	7/16"	7/16"	5/16"	11/16"	11/16"	1"	3/4"	11/16"	5/8"	3/4"	7/16"	3/4"	7/16"	1"	11/16"	
	Casing capacity - gallons	3.9	5.0	5.3	5.4		8.3	8.5	7.6		9.1		9.4		11.6		16.5		
Stuffing box	Stuffing box bore	2-1/2"																	
	Stuffing box depth (to stuffing box bushing)	2/13/16"																	
	Stuffing box packing size	3/8" x 3/8"																	
	Stuffing box - no. of packing rings	5																	
	Width of lantern ring	3/4"																	
Shaft	Shaft diameter at impeller	1-9/16"																	
	Shaft diameter in shaft sleeve	1-7/16"																	
	Shaft diameter at coupling end	1-3/8"																	
	Outside diameter of shaft sleeve	1/3/4"																	
General	Ball bearing - both ends	307-S																	
	Max total working pressure *1	250 PSI																	
	Max test pressure	375 PSI																	
	Bearing centers	22-1/2"																	
	Max shaft HP per 100 RPM	9.7																	
Temperature limits	Max liquid temp without cooling or quenching	180°F																	

		3/4x17	4x6-11	4x6-14	4x6-17	4x6-17G	5x8-12D V	5x8-14D V	6x8-8	6x8-8G	6x8-12	6x8-12G	6x8-14	6x8-14G	6x8-17D V	6x8-17G DV	8x10-12D V	8x10-12 G DV	
	Max liquid temp with quenching gland	250°F																	
	Max liquid temp with bearing cooling (Grease lube)* ²	250°F																	
	Max liquid temp with quench gland and bearing cooling (Grease lube)	350°F																	

*1 Any part of which may be suction pressure.

*2 Water cooled bearings available for model 3405 only.

Table 4: Group L

		6x8-22DV	8x10-14	8x10-14G	8x10-17	8x10-17G	10x12-12	10x12-14	10x12-14G	10x12-17	10x12-17G	12x14-12DV	12x14-14DV
Pump	Weight - bronze fitted bare pump		1285		1330		1300	1385		1555		1600	1620
	Casing thickness - volute	11/16"	7/8"		7/8"		7/8"	7/8"		1"		7/8"	15/16"
	Casing thickness - side walls	1-3/16"	3/4"		3/4"		3/4"	3/4"		3/4"		3/4"	3/4"
	Max diameter spherical solids	13/16"	1"	7/8"	3/4"	7/8"	1-3/4"	1"	1-11/16"	3/4"		1-1/4"	1-3/4"
	Casing capacity - gallons		21.0		19.5		24.9	25.0		29.3		33.0	35.5
Stuffing box	Stuffing box bore	3-1/4"											
	Stuffing box depth (to stuffing box bushing)	3-1/8"											
	Stuffing box packing size	3x8' x 3/8"											
	Stuffing box - no. of packing rings	6											
	Width of lantern ring	7/8"											
Shaft	Shaft diameter at impeller	2-3/16"											
	Shaft diameter in shaft sleeve	2-3/16"											
	Shaft diameter at coupling end	1-15/16"											

		6x8-22DV	8x10-14	8x10-14G	8x10-17	8x10-17G	10x12-12	10x12-14	10x12-14G	10x12-17	10x12-17G	12x14-12DV	12x14-14DV
	Outside diameter of shaft sleeve	2-1/2"											
General	Ball bearing - both ends	310-S											
	Max total working pressure* ¹	250 PSI											
	Max test pressure	375 PSI											
	Bearing centers	28"											
	Max shaft HP per 100 RPM	27.1											
Temperature limits	Max liquid temp without cooling or quenching	180°F											
	Max liquid temp with quenching gland	250°F											
	Max liquid temp with bearing cooling Grease lube)* ²	250°F											
	Max liquid temp with quench gland and bearing cooling (Grease lube)	350°F											

*1 Any part of which may be suction pressure.

*2 Water cooled bearings available for model 3405 only.

Table 5: Typical bronze analysis

No.	Cu. %	Sn. %	Pb. %	Zn. %	P. %	Ni. %
1102	84-86	4-6	4-6	4-6	--	--
1103	87	6	4.5	1.75	.05-.15	0.75
1106	84	8	8	--	.10-.15	--
1109	88	8	.3	4	--	--

Symbol 1000 - cast iron - corresponds to ASTM A278-59T Class 25

Symbol 1003 - cast iron - corresponds to ASTM A278-59T Class 30

Table 6: Replacement snap rings (Part 361) (Waldes type 5102 or equal)

Group	Ring No.	Pliers No.
S	100	2, 22, 4, or 24
M	137	4 or 24
L	196	4, 24, 6, or 26

Table 7: Replacement grease and oil seals (Victor or equal)

Part No.	Groups	Group M	Group L
332	H 60222	K 60454	K 60771

Part No.	Groups	Group M	Group L
332A	H 60222	K 60454	K 60771
332B	K3 64284	K3 63290	K 60810
333	H 60284	K 60478	K 60810

7.4 Dismantling of pump

The basic instructions are for a Model 3405 pump. Where dismantling of the Model 3406 or 3416 pumps differ, the necessary supplementary instructions are included.

1. Drain liquid from pump.
2. Shut off and disconnect any auxiliary piping.
3. Disconnect coupling.
4. Remove gland assembly from stuffing boxes. See [7.2 Repacking stuffing boxes on page 31](#).
5. Jack and remove dowel pins from upper half casing by use of hex nut provided on top of pins. Remove nuts from casing parting studs and loosen upper half casing (100) by screwing two bolts (½"-13 threads) in holes provided in the flange. Lift off upper half casing, being careful not to injure the parting gasket. Use the lugs provided for lifting the upper half casing. Do not use these lugs for lifting entire pump.
6. Remove nuts from bearing cap studs and lift bearing cap (III) from unit.

NOTICE:

These caps must be replaced on the same end of pump from which they were removed.

They should be marked for identification before disassembly. The shims under the bearing caps should be preserved and reused at reassembly. If lost or damaged, they must be replaced by shims 1/64" thick.

7. Carefully lift rotating assembly from unit and place on padded supports which will not injure the shaft sleeves.
8. Note the distance from the end of the shaft to the face of the pump half coupling so that the coupling half can be correctly positioned when reassembled. Pull the coupling half from pump shaft.
9. Remove coupling key.
10. Remove cap screws on each end cover and remove end covers (109 and 119) from bearing housing (134 or 166). Preserve end cover gaskets (360). On the Model 3406 and 3416 the constant level oilers (251) must first be removed from both thrust and coupling end and the oil drained from the bearing housings.
11. Remove snap ring (361) from shaft. Use No. 4 Waldes pliers. The Model 3416 has a shaft nut rather than a snap ring.
12. Remove ball bearings (112 and 137) from shaft seat by the use of a bearing puller. Details of a recommended puller, capable of removing bearings from all three groups of pumps, are shown in Figure 19. Care must be used. Puller bar must be square with shaft so that equal pressure is applied evenly to the circumference of the outer race of the bearing. A steady pressure must be applied to the puller screw.

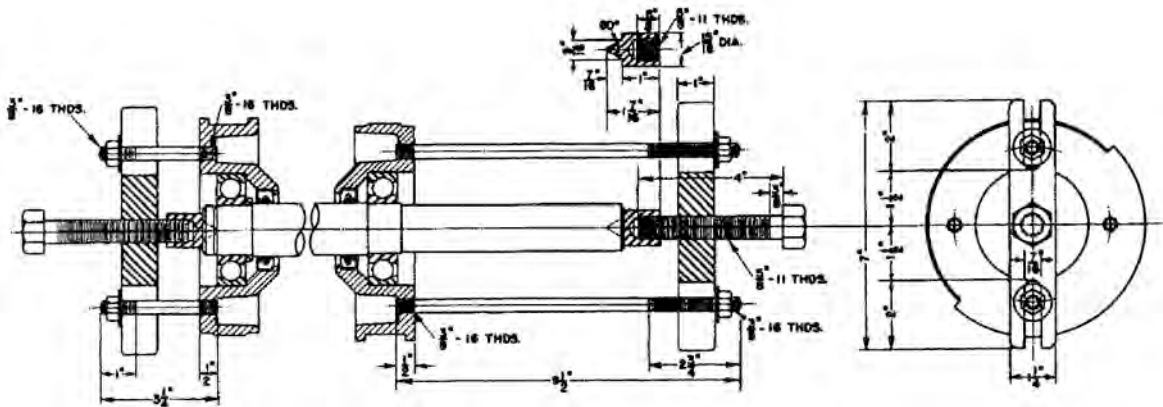


Figure 14:

Never use hammer blows to drive shaft through bearings. Protect bearings from dirt or other contamination.

13. Slide ball bearing collar (237 off of shaft) (122).
14. Slide bearing housings from shaft. Remove deflectors (123) from both ends of shaft. On the Model 3406, remove cap screws from bearing housing covers (160) on both bearing housings and lift out oil rings (114). Preserve bearing housing cover gaskets (360A).
15. Slip casing wearing rings (103 or 127) from impeller and off rotating element.
16. Slide packing, lantern rings (105) and stuffing box bushings (125) off ends of shaft.
17. Smooth the exposed portions of the shaft at the ends of the sleeves with fine emery cloth so that sleeves will not bind while being removed.
18. The shaft sleeve (1266) must be removed first. This is the sleeve with the spanner holes. Loosen set screw in sleeve (if supplied) - previous design did not have set screws. Unscrew sleeve from shaft with a pin spanner or a strap wrench. Shaft to sleeve threads are right hand. Do not use pipe wrench. Never attempt to remove the sleeve (104) which has no spanner holes until impeller and impeller key are removed from shaft.
19. Tap the impeller (101) from shaft with a lead mallet. Tap evenly around the impeller as near as possible to the shaft. Do not drive against the sealing surface on end of hub. Do not let the key "ride up" on the exposed curved portion of the sled runner keyway.

Should the impeller key start to "ride" as the impeller is being removed, the key can be driven back by a drift pin or piece of keystone a size smaller than the impeller key.
20. Remove key from keyway.
21. Unscrew and remove the remaining sleeve from shaft by hand or with a strap wrench. Shaft to sleeve threads are right hand. This completes the disassembly of the pump.

7.5 Reassembly of pump

The following directions are for use when the pump is completely dismantled and it is desired to reassemble. [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#) illustrate the steps described in the following. The basic instructions are for a Model 3405 pump. Where reassembly of the Model 3406 or 3416 pumps differ the necessary supplementary instructions are included.

1. Check shaft to see that it is not bent or otherwise damaged, and that it is also smooth and clean. Inspect "O" Rings (412 and 412A). Replace if damaged. Position "O" Rings (412) inside shaft sleeves as shown in the [7.3 Sectional view on page 33](#).
2. Determine the correct setting of the impeller and sleeves on the shaft in relation to the rotation of the pump. To do this, face the discharge flange of pump. The locking shaft sleeve must be on the right as shown in [Figure 15: on page 41](#) and the impeller must rotate in correct relation to the casing as shown in the end views in [Figure 15: on page 41](#).

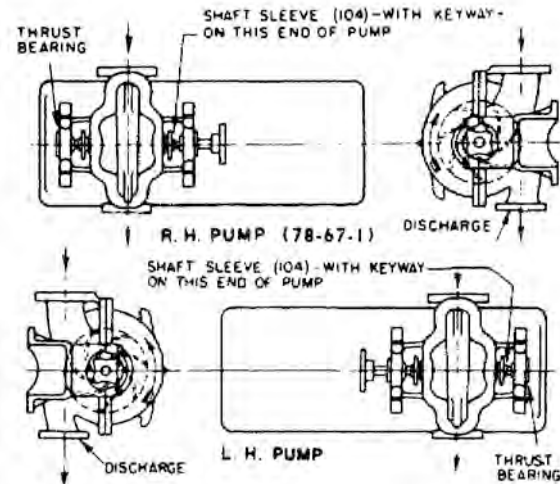


Figure 15:

3. Mark the location of the keyway on the outside of both the impeller hub and the locking sleeve (104) at points "A" and "B" in [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#). These marks will be used later to indicate that the keyways are in line.
4. Assemble the shaft sleeve (104) that has a keyway in the threaded end but does not have spanner wrench holes. Turn sleeve in a clockwise direction on shaft until the dimension from the threaded end of the sleeve to the shaft shoulder at thrust bearing or outboard seat agrees with the dimension on [Figure 17: Right hand pump on page 43](#) for right hand or [Figure 16: Left hand pump on page 42](#) for left hand rotation.

This dimension must be held as near as possible with the keyways in the shaft and sleeve in alignment.

For the Model 3416 substitute the following B dimensions for those shown on [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#).

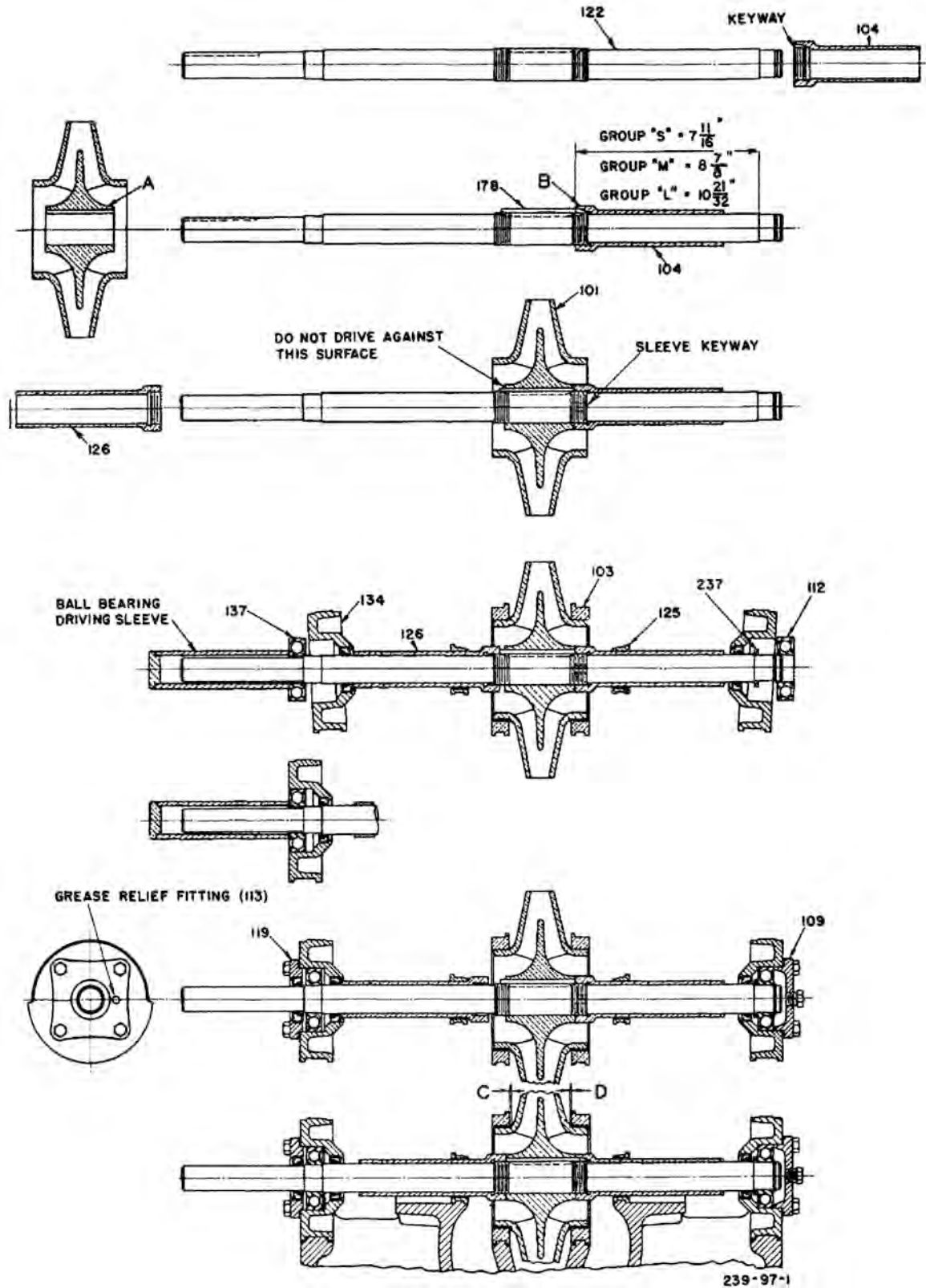


Figure 16: Left hand pump

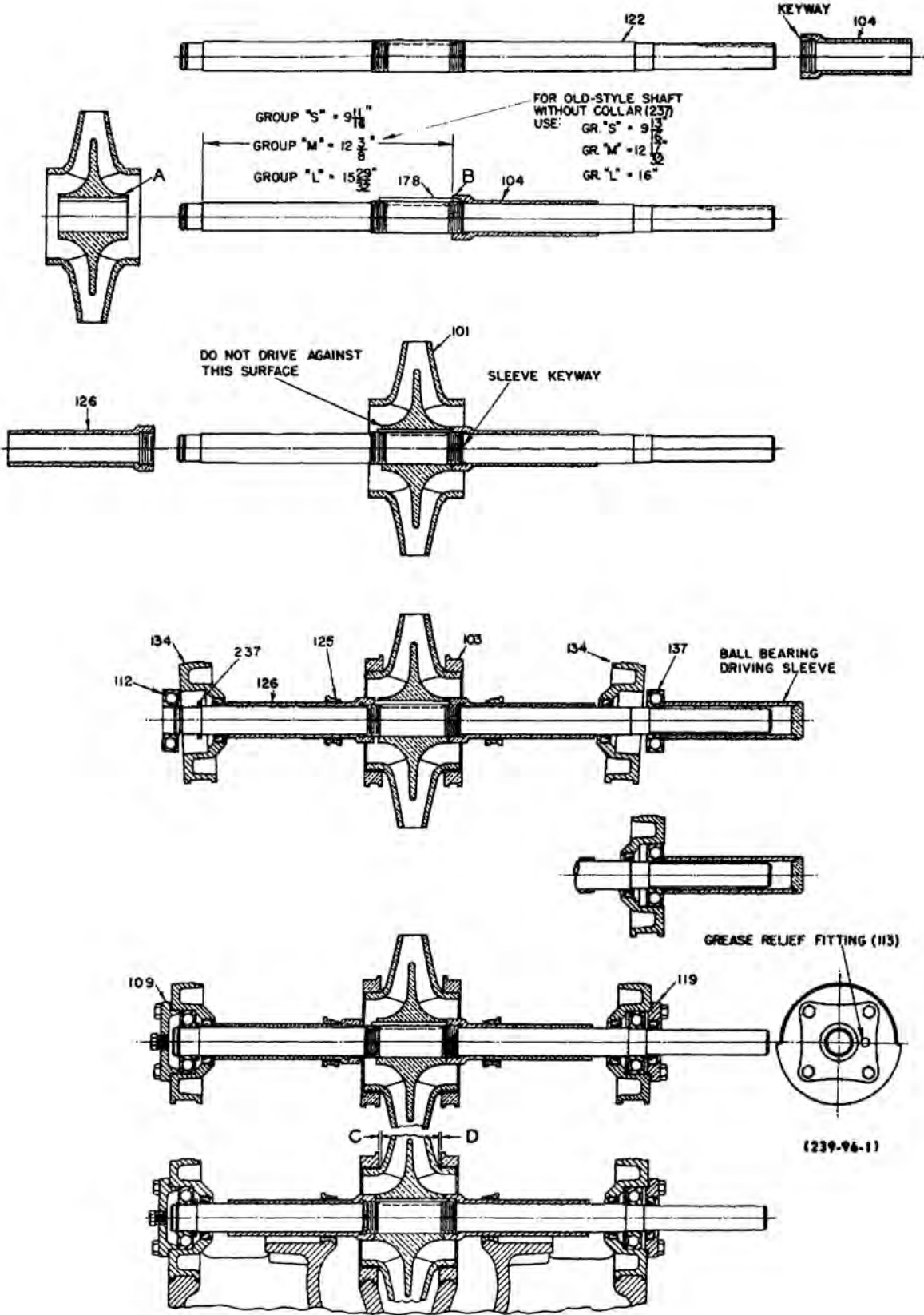


Figure 17: Right hand pump

Group	Left hand pump Figure 16: Left hand pump on page 42	Right hand pump Figure 17: Right hand pump on page 43
S	7-13/16"	9-13/16"
M	9-1/32"	12-17/32"
L	10-3/4"	16"

5. If it is necessary to replace the impeller wearing rings on pumps so equipped, proceed as follows:
- Remove old rings. Rings are held by press fit and also by 3 set screws in edge of impeller and ring.
 - Clean wearing ring seats and press on new rings.
 - Drill 3 holes ("F" drill, 11/16" deep, 120° apart), so that holes are half in impeller and half in ring. Tap holes (5/16"-18 tap, 3/8" deep). Screw set screws in hole, and lightly upset first thread to keep screw from backing out.
 - The impeller wearing rings are supplied 0.020-0.030 inch oversize on the O.D. They should be turned to size after they are mounted on the impeller. Turning to size after mounting is the procedure used in the factory, and has the following advantages:
 - Eliminates possibility of runout.
 - Eliminates distortion and expansion due to the press fit.
 - Permits the user to compensate for wear of the casing wearing rings, so that the casing wearing rings need not be replaced to restore original clearances.
 - Permits the user to select a special clearance for unusual operating conditions.

The table of original clearances in section [7.7 Overhaul of pump on page 48](#) may be used as a guide in setting the final dimension of the impeller rings. If rings are 300 series stainless steel, or if extremely viscous liquids are being handled, the suggested clearance should be increased 0.005 inch.

6. Insert impeller key (178) in shaft keyway. Turn sleeve (104) about a quarter turn, either way, so that key cannot enter keyway in this sleeve until after impeller is checked for correct setting in casing.
7. If the impeller diameter has been cut in the field, the impeller should be statically balanced and, if possible, dynamically balanced. Balancing can be effected by grinding on the outside of the shrouds near the periphery.
8. Place "O" Ring (412A) in groove in end of shaft sleeve (126). Screw shaft sleeve on shaft up to key.

NOTICE:

Model 3405 pumps were previously supplied without "O"-rings (412A) in the ends of the shaft sleeves. On these pumps, coat the large ends of the shaft sleeves and the ends of the impeller hub with plastic thread compound, gas oil a varnish, or white lead. Old and new style sleeves are interchangeable. "O"-rings (412) must be used between shaft sleeve and shaft whether "O"- rings (412A) are used or not. (This applies to step 10 below also.)

-
9. Slide impeller on shaft and tap in place against the sleeve with a lead mall. Tap evenly around the impeller near the wearing ring surface. Do not tap against the sealing surface on end of hub.
10. Place O-ring (412A) in groove in end of shaft sleeve (126). Screw shaft sleeve on shaft up to key.
11. Slip wearing rings (103 or 127) on impeller, being sure that the single lock on the upper half of ring is toward the center of the impeller.
12. Place stuffing box bushings (125) on shaft and slide over shaft sleeves toward impeller. The single lock on the upper half of bushings must be toward the outside, away from impeller.
13. If grease or oil seals (322, 333, 332A, or 332B) are being replaced, make sure that the seals are installed so that the lips of the grease seals face outward, away from the bearings, and the lips of the oil seals face inward, toward the bearings.
14. Make sure that all parts that are assembled inside the bearing housings, including the shaft, snap ring, bearing end covers, bearings and oil rings, are entirely free from dust and dirt.

This is extremely important, as the life of a ball bearing can be drastically reduced if contaminated with even a small amount of dirt. All bearing assembly operations should be done in as dust-free an atmosphere as possible. All tools, as well as the hands, should be kept clean.

If new ball bearings are being used, they should not be unwrapped until ready for installation and should not be cleaned or washed unless the protective

wrapper has been broken and dirt allowed to enter the bearing.

If old bearings, or new ones that have been allowed to become dirty, are being used, clean thoroughly before installing as follows: Use a clean pail or receptacle. Pour into it one or two quarts of clean, water-free kerosene. Dip the bearing into the kerosene and spin slowly. Repeat until all traces of grease have been removed. Now blow dry with clean filtered compressed air, holding the two races together so that they do not rotate but allowing the inner race to rotate a few turns now and then to dislodge the kerosene from the retainer pockets. If the bearing is very dirty, it is advisable to rinse it in a second bath of clean kerosene. When the bearing has been blown dry, oil it immediately with a good grade of clean machine oil; especially the race grooves and balls to prevent corrosion or rust.

15. Place deflectors (123) on shaft. On the Model 3406 - Wipe a small amount of grease on oil seal lips (332B) and slide bearing housing covers (160) carefully over shaft and replace oil rings (114) on shaft against bearing housing covers (160).
16. Wipe a small amount of grease on the grease seal lips in bearing housing (134 or 166). Place bearing housings on shaft and slide them along until they contact the shaft sleeves. Care must be taken not to injure the lips of the grease seals during this operation. A thin piece of shim stock, wrapped inside the grease seal before sliding over the shaft will protect the seal lips and can readily be removed after the seal is past the shaft shoulder.
17. Slide ball bearing collar (237) over thrust end of shaft (122) and push up against shaft shoulder.
18. The thrust and coupling end ball bearings are the same and can be installed on either end of shaft. Both bearings are installed in a like manner as follows: Apply a film of oil to the bearing seat on the shaft. Start bearing "square" and drive on about 1/8", keeping bearing square at all times. Use a driving sleeve as shown in [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#). Note that the outside diameter of this sleeve should never be larger than the outside diameter of the inner race of bearing. Next slip the bearing housing over the ball bearing toward the end of the shaft to eliminate any possibility of binding between the outside of the bearing and the bearing housing bore. Now continue to drive the bearing solidly against the shaft shoulder.

On the Model 3416 coupling end bearing is single row. Thrust bearing is a duplex bearing (two angular contact bearings, specially matched) and must be mounted in "back-to-back" position. This is done on the bearing originally sent with the pump by having the stamped faces of the outer rings against each other.

Both bearings are installed in same manner as the 3405.

Model 3416 uses the following bearings:

	Group S	Group M	Group L
Coupling end	305S	307S	310S
Thrust end	7304PD-DB	7306PD-DB	7308PD-DB

19. Place snap ring (361) in groove in shaft on thrust bearing end. Be sure that groove is clean and that snap ring seats in bottom of groove. Snap ring is flat on one side, tapered on other side. Flat side of ring must be against bearing.

In the Model 3406 slide oil rings (114) toward bearing to the proper position in the bearing housings. Bolt the bearing housing covers to the bearing housing, making sure that the oil breather fitting (113A) in the bearing cover is up when the double locks of the bearing housing are in the lowermost position. This fitting is used as a pressure release for the bearing housing. It must be in the vertical position or the bearing will not be properly oiled. (Thrust end bearing end cover is not installed until Step No. 22.)

20. Oil shaft extension and slide coupling end bearing end cover (119) with gasket (360) in place, being careful not to injure grease seal (332). Turn end cover so that the small oil cup is in line horizontally with center of shaft when the double lock of the bearing housing are in the lowermost position (see [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#). This oil cup is used as a pressure relief for the bearing housing. It must be in the horizontal position to facilitate the correct filling of the grease chamber. (Note that the location of this relief fitting is shown at the top in the sectional assembly, Section [7.3 Sectional view on page 33](#), only to show construction details.) Bolt the bearing end cover securely in place.

On the Model 3406 - Turn end cover so that oil drain notch is at the bottom when the double locks of the bearing housing are in the lowermost position. This notch permits oil to drain from between the bearing and the end cover, maintaining proper oil circulation.

On the Model 3416 turn the end cover so that the small oil cup is up when the double locks at the bearing housing are in the lowermost position.

Be sure gasket (360) is in place. Bolt bearing end cover to bearing housing.

Install oil pipe (190) and constant level oiler (251) on the coupling end only. Be sure the oiler rests on cap screw, which projects from casing as shown in [Figure 4: on page 15](#).

21. Assemble the pump half coupling on Group "S" pumps as follows: Put oil or white lead on shaft extension and in the coupling bore. Insert pump half coupling key in shaft. Place the complete pump half coupling over end of shaft and align key with keyway. Place a solid object, such as a portion of a 2" diameter bar, against the end of the shaft opposite the coupling end and drive coupling half on shaft with a lead mallet.

NOTICE:

If a bearing puller, similar to that shown in Figure 19 on page 46, is available, it can be used on thrust bearing end to hold shaft when driving on coupling half. When using the puller for this purpose, draw the puller screw up only finger tight so as not to injure snap ring. Locate the coupling half in the same location on shaft as it was when removed. Never drive the coupling on shaft with the bearing end cover (109) in place as this may injure the ball bearing.

-
22. Assemble the pump half coupling on Groups "M" and "L" pumps as follows: Screw a 1/2" stud, approximately 1/4" longer than the length of the coupling hub, into the end of the shaft. Insert the coupling key in shaft. Put oil or white lead on shaft and in the coupling bore. Place the complete pump half coupling in position over the stud and align the key and keyway.

Place washers over the stud against the coupling hub and pull coupling on with a nut placed on the stud. Locate the coupling in the same location on the shaft as it was when removed.

23. Bolt the thrust end bearing end cover (109 or 190A) to the bearing housing. Be sure gasket (360) is in place. On Model 3405 pumps, be sure grease relief fitting is in a horizontal position as indicated in [7.5 Reassembly of pump on page 40 Step 20](#). On Model 3406 pumps, be sure oil drain notch is at bottom as indicated in [7.5 Reassembly of pump on page 40 Step 20A](#). Install oil pipe (190) and constant level oiler (251) on thrust end. Be sure oiler piping rests on cap screw which projects from casing as shown in [Figure 4: on page 15](#).

24. Smooth up and clean casing wearing ring, stuffing box bushing and bearing housing seats in upper and lower half casing. The casing and bearing caps are precision bored so that hand scraping and fitting of the casing wearing rings, stuffing box bushings or bearing housings are not required.

Inspect parting gasket and if torn or otherwise damaged, cut a new gasket of 1/64" sheet asbestos (Johns-Manville service sheet #60 or equivalent). The gasket should be removed while assembling rotating element.

To cut a new gasket, lay the gasket sheet on the upper half casing parting flange, which will serve as a template. Strike the sheet with a ball peen hammer. This will cut the gasket against the edges of the casting, and around the parting stud holes. The gasket must cover the entire surface of the

parting flange, especially around the casing wearing ring locks, or internal leakage from high to low pressure zones in the pump may occur.

Lower carefully the entire rotating element into the lower half casing. Be sure that the wearing ring, stuffing box bushing and bearing housing "locks" line up with the recesses in the lower half casing. The single "lock" on each of these parts must be on top so that when the upper half casing and the bearing caps, having only one recess each, are bolted in place, these parts are locked against rotation.

With "locks" properly aligned, the rotating element should settle easily into place. If there is interference, the impeller may have to be tapped along the shaft until it lines up correctly. The sleeves may have to be backed off to do this.

After the element has been properly seated in the lower half casing, tap impeller along shaft until the shoulders on the impeller are in the center of the space between the two casing wearing rings (103). In other words, dimension "C" and "D" [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#) will be equal.

Now tighten shaft sleeve (104) against impeller until the marks which were made previously line up, indicating that the keyways are in line. Check again the distance between the wearing rings and the impeller shoulders. If rubbing occurs, turn the shaft sleeve (104) one complete turn ahead or back as required.

With the locating marks together, tap the key (178) from the opposite end of impeller into the shaft sleeve (104) until the end of the key is flush with the end of the impeller (on end opposite sleeve 104).

Tighten the shaft sleeve (126) securely against the impeller with a spanner or a strap wrench. Tighten set screw in sleeve (126) (if supplied - previous design did not have set screw). Be sure fiber insert is under set screw so that set screw will not burr shaft.

Check the rotating elements for free turning by rotating slowly in one direction and then the other. The casing wearing rings and the stuffing box bushings should be seated in the lower half casing, and should remain stationary when the shaft is rotated. If they ride on the impeller or sleeves, it may indicate that the bearing housings, wearing rings or bushing surfaces in the lower half casing have not been properly cleaned of scale or other foreign matter, or that there is too much eccentricity in the element, due to a bent shaft or other causes. If any of the above are evident, correct the cause and continue to assemble as follows.

25. Replace shims (1/64" thick) over bearing cap studs.
26. Assemble bearing caps (111) and tighten the nuts evenly, being sure that the bearing caps are replaced on the same end from which they were removed.
27. Check again for free turning of the rotating element.
28. Place the parting gasket in position over the studs on the lower half casing with the edges flush with the stuffing box bores and tight against the wearing rings and stuffing box bushings.
29. Be sure that the "locks" on the stuffing box bushing and wearing rings are in their correct position with the single "lock" on top.

Lower carefully the upper half casing, which should settle into position without resistance and then slip the dowel pins in place.

Check the rotating element for free turning and, if no binding is apparent, tighten casing parting nuts alternately on each side of the pump starting from the center. The shaft should turn freely after all nuts are tightened.

30. Repack stuffing boxes and replace gland assemblies as outlined in [3.3 Stuffing boxes on page 15](#).
31. Check coupling alignment as outlined in Alignment - initial. If the direction of rotation has been changed, see [7.6 Changing rotation of pump in field on page 48](#).
32. Connect coupling as outlined in Connection of coupling.
33. Grease or oil pump bearings as outlined in [7.1 Lubrication - bearings on page 31](#).
34. Connect auxiliary piping, if used.

35. Follow directions in [3 Preparation for operation on page 14](#) for initial operating condition and for starting pump.

7.6 Changing rotation of pump in field

The rotation of these pumps can be changed without using additional parts. The following steps should be followed:

1. Disassemble pump as outlined in [7.4 Dismantling of pump on page 39](#).
2. Loosen dowel pins, if used, in pump feet and remove hold down bolts. Lift lower half casing from bed plate.
3. Turn lower half casing 180° so that suction and discharge flanges are reversed from previous position or turn bedplate 180° and leave pump casing in original position. See [Figure 17: Right hand pump on page 43](#), showing right and left hand pump.
4. Replace lower half casing in this new position on bedplate and bolt in place. Do not dowel.
5. Reassemble pump as outlined in [7.5 Reassembly of pump on page 40](#).
6. Be sure that pump bearings are greased. See [Section 7.1 Lubrication - bearings on page 31](#).
7. Check alignment as outlined in [Alignment - initial](#).
8. Connect coupling as shown in [Connection of coupling](#).
9. Follow directions in [4 Starting pump on page 21](#), for initial operating conditions and for starting pump.

7.7 Overhaul of pump

The pump should be opened and the interior inspected for wear and excessive clearances approximately once each year. The period, however, may vary, depending on operating conditions and severity of service. See [7.4 Dismantling of pump on page 39](#) for disassembly and [Section 7.5 Reassembly of pump on page 40](#), for reassembly of pump.

The following items should be checked:

1. Wearing Ring Clearance:

The original diametric clearance between the wearing rings and the impeller is .010" to .014".

The following is suggested as guide for allowable wear of wearing rings before replacement for 6" pump and smaller:

- Pumps of 50 feet or less T.D.H. (total dynamic head) - .030" to .035" total diametric clearance.
- Pumps of between 51 and 100 feet T.D.H. - .025" to .030" total diametric clearance.
- Pumps of more than 100 feet T.D.H. - .020" to .025" total diametric clearance.

For 8" pumps or larger, the following is suggested:

- Pumps of 50 feet or less T.D.H. - .045" to V
- Pumps of between 51 and 100 feet T.D.H. - .035" to .040" total diametric clearance.
- Pumps of more than 100 feet T.D.H. - .025" to .030" total diametric clearance.

2. Fit of Impeller on Shaft:

These parts are machined for a push fit. (The shaft is made .000" to .0015" smaller than the impeller hub bore) and the impeller should tap easily on the shaft. If the impeller does not tap on readily, the bore and shaft should be inspected to see that they are free from foreign matter or burrs. The fit of the key in the keyways should also be checked to see that it is not causing binding. The key should have a sliding fit on the sides and should have .004" to .016" clearance at the top.

3. Clearance Between Shaft Sleeve (104 or 126) and Stuffing Box Bushing (125):

The original diametric clearance is .008" to .012". If this clearance has increased to more than .030", the shaft sleeve, and at times, the stuffing box bushing should be replaced.

4. Condition of Shaft Sleeves:

If the outer surface of the shaft sleeve at the packing area is deeply grooved, the sleeve should be replaced.

5. Condition of Shaft:

Check shaft for straightness. If bent, it should be straightened. If otherwise damaged, it should be replaced.

6. Condition of Impeller:

Check the impeller and replace if any of the following conditions exist:

1. Excessive erosion, especially on the inlet of vanes.
2. Excessive wear on wearing ring surface.

7. Condition of Ball Bearings:

If the bearings are worn or damaged so that they have become loose or are noisy or rough when rotated they should be replaced.

7.8 Emergency ball bearing replacement

If the thrust end ball bearing (112) has become worn and needs replacing and it is not desirable to overhaul the entire pump, the bearing can be replaced as follows:

NOTICE:

This cannot be done on the coupling end unless the pump or the driver is removed from the bedplate.

1. On Model 3406 pumps, remove oil pipe (190) and constant level oiler from thrust end bearing housing (134A). Drain oil from housing.
2. Remove thrust bearing end cover (109 or 109A).
3. Remove snap ring (361).
4. Remove bearing cap (111).
5. Rotate bearing housing (134, 134A, or 166) 180° so that the two locks are on the top.
6. Remove ball bearing as directed in [7.4 Dismantling of pump on page 39](#) Steps 12 through 14.
7. Thoroughly flush bearing housing, bearing end cover, snap ring, ball bearing collar, and end of shaft with clean kerosene. The slightest trace of dirt or grit may drastically reduce the life of a ball bearing. Examine the ball bearing collar. If the edges of the collar are rounded over, or if the collar is otherwise damaged, replace the collar.

Examine the shoulder on the shaft against which the ball bearing collar bears. Shoulder must be square, and not rounded over.

8. Assemble new ball bearing as follows:

1. Wipe a small amount of grease on the grease seal lips in the bearing housing.
2. Place bearing housing on shaft, with the double locks up, and slide it along to approximately its correct location.
3. Slide ball bearing collar (237) over shaft end and push up to shaft shoulder.
4. Apply a film of oil to the bearing seat on the shaft. Start bearing "square" and tap on shaft up to the shaft shoulder. Use a driving sleeve as shown in [Figure 16: Left hand pump on page 42](#) and [Figure 17: Right hand pump on page 43](#).

5. Place snap ring (361) in shaft groove. Be sure that the groove is clean and that the snap ring seats properly.
6. Bolt bearing end cover (109 or 109A) to bearing housing. Be sure gasket (360) is in place. Position end cover as directed in [7.5 Reassembly of pump on page 40](#) Step 20 so that grease relief fitting or oil drain notch is in correct location.
7. Align locks on bearing end cover with the grooves in lower half casing and rotate bearing end cover 180° so that the locks are at the bottom.
8. Assemble bearing cap (111) being sure that the 1/64" shims are in place, and that the prick punch marks on the cap and the casing are on the same side. Now tighten the nuts evenly.
9. Refill with grease or oil as outlined in [7.1 Lubrication - bearings on page 31](#).

7.9 Spare parts

To ensure against possible long and costly "down time" periods, especially on critical services, it is advisable to have spare parts on hand.

1. The most desirable parts to have on hand are the following:
 1. "Rotating element." This is a group of assembled parts, including bearing housings, bearings, bearing end covers, grease seals, wearing rings, stuffing box bushings and all rotating parts, except coupling.
 2. Stuffing box packing (106) - one set for two stuffing boxes.
 3. Stuffing box gland packing (210) - one set for four gland halves.
 4. Stuffing box gland halves (107) - four required.

With these parts on hand, pump can be easily and quickly reconditioned by replacing the worn parts.

2. An alternate, though not as desirable as that stated above, is to have on hand parts that are most likely to wear and which can be used as needed.

Following is a list of these suggested parts:

1. Stuffing box packing (106) - one set for two stuffing boxes.
 2. Stuffing box gland packing (210) one set for four gland halves.
 3. Shaft sleeve (104 and 126) - one each.
 4. Ball bearings (112 and 137) - two required (both bearings being the same).
 5. Snap ring (361) - one required.
 6. Wearing rings (103) - two required; or (127 and 142 - two of each).
 7. Shaft (122) - one required.
 8. Impeller key (178) - one required.
 9. Stuffing box bushings (125) - two required.
 10. Stuffing box gland halves (107) - four required.
 11. Ball bearing collar (237) - one required.
3. If it is not convenient or desirable to carry the spare parts listed in items 1 or 2, the following list is suggested as a minimum for servicing the pump under ordinary conditions of wear:
 1. Stuffing box packing (106) - one set for two stuffing boxes.
 2. Stuffing box gland packing (210) - one set for four gland halves.
 3. Shaft sleeves (104 and 126) - one each.
 4. Ball bearings (112 and 137) - two required (both bearings being the same).
 5. Snap rings (361) - one required.

6. Ball bearing collar (237) - one required.

7.10 Instructions for ordering spare parts

Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give the Model No., size of the pump and serial number. These can all be obtained from the name plate.
2. Write plainly the names, part numbers and material of the parts required. These names and numbers should agree with those on the sectional assembly ([7.3 Sectional view on page 33](#)).
3. Give the number of parts required.
4. Give complete shipping instructions.

**Visit our website for the latest version of
this document and more information:**
www.gouldspumps.com



ITT - Goulds Pumps Vertical Products Operation
3951 Capitol Avenue
City of Industry, CA 90601-1734
USA

Form IOM.3405-3406-3416.en-US.2022-04