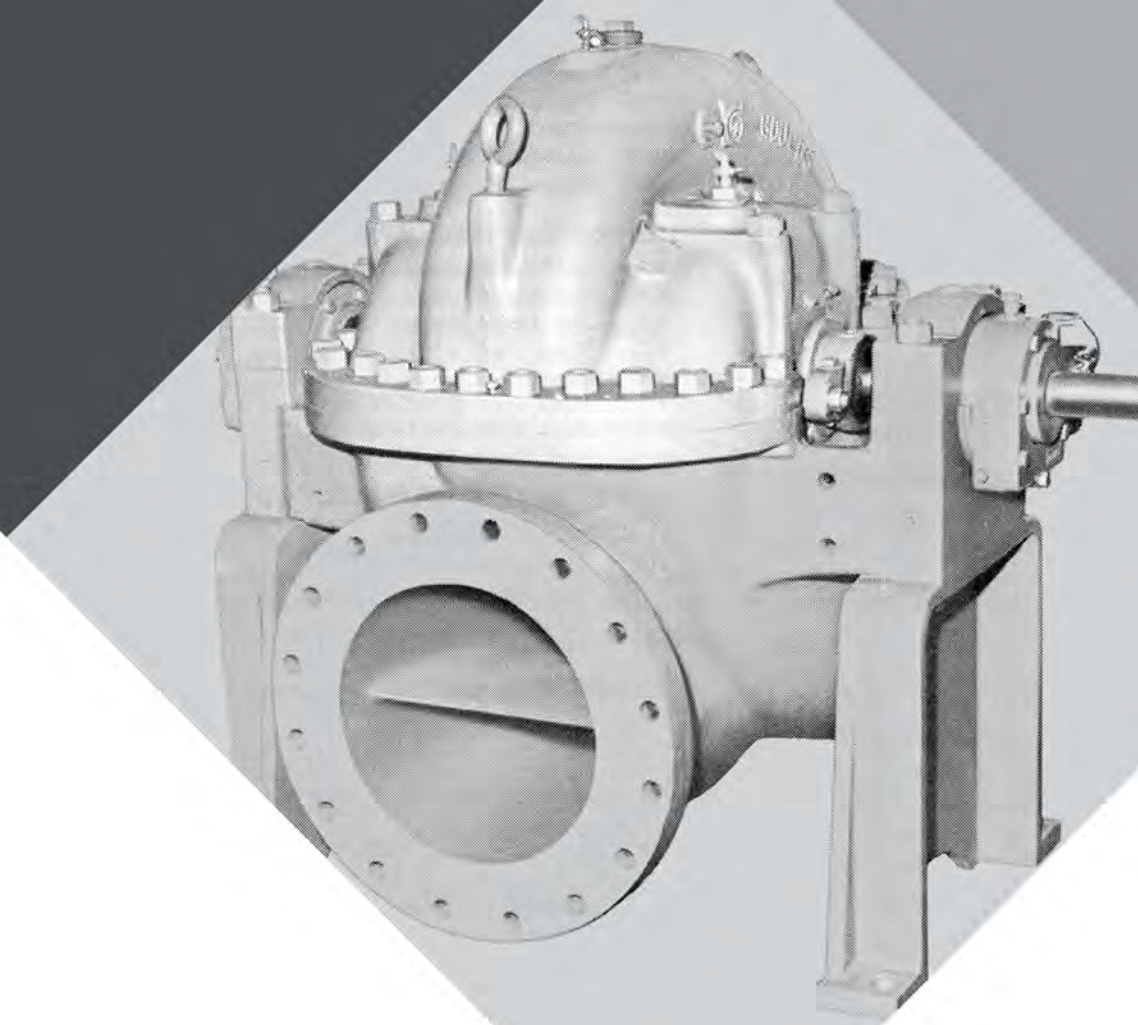
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3415



ITT

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1 Introduction and 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		Safety Apparel: • 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		Receiving: Assembled pumping units and their components are heavy. Failure to properly lift and support equipment can result in serious physical injury and/or

		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.

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		Noise: 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.
WARNING		Temperature: Equipment and piping surfaces may exceed 130ºF (54ºC) 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.
WARNING		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

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 baseplate on which it is mounted. A typical tag would look like this:

Figure 1: Typical ATEX pump nameplate

Table 2: Temperature class definitions

Code	Maximum permissible pumpage temperature in °C | °F	Minimum permissible pumpage temperature in °C | °F
T1	450 | 842	372 | 700
T2	300 | 572	277 | 530
T3	200 | 392	177 | 350
T4	135 | 275	113 | 235
T5	100 | 212	Option not available
T6	85 | 185	Option not available

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.

The CE and the Ex designate the ATEX compliance. The code below reads as follows:

II = Group 2

2 = Category 2

G/D = Gas and Dust present

T4 = Temperature class, can be T1 to T6 (see Table)

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 Storage, uncrating and handling

Storage

Goulds normal domestic storage preparation is suitable for protecting the pump during shipment in covered trucks. It also provides protection during covered storage at the jobsite, and for a short period between installation and startup.

If the pump is to be idle and exposed to the elements for an extended period, either before or after installation, special precautions are required. One approach is to provide special preservatives and wrapping before shipment. However, after installation, the protective wrappings will have been removed. Therefore, application of preservatives after installation is considered good practice. The driver and coupling manufacturers should be contacted for recommendations on preservations and protection procedures.

It is considered good practice to rotate the shaft on pumps which contain ball or roller bearings approximately 30 degrees every few weeks.

Uncrating

Care should be taken when uncrating pumps. If shipment is not delivered in good order and in accordance with the Bill-of-Lading, note the damage or shortage on both receipt and freight bill. Make any claims to the transportation company promptly.

Instruction sheets on various components as well as the Instruction book for the pump are included in the shipment. Do not discard.

Handling

Care should be used in moving pumps. Pumps should not be hoisted by eyebolts. These eyebolts are used for removing upper half casings or back pull out
assemblies for maintenance and inspection. Bedplate mounted units should be slung under bedplate (under pump and driver).

2.2 Location

Pumping unit should be placed as close as practical to the source of supply. Floor space and head room allotted to the unit must be sufficient for inspection and maintenance. Be sure to allow for crane or hoist service. On horizontally split case pumps, always allow sufficient head room to remove the upper half casing.

2.3 Installation - close-coupled and vertical pumps

Close-coupled

A close-coupled pump may be mounted horizontally or in a vertical position provided motor is above pump. The unit should be bolted to a concrete foundation or an adequately supported structure, substantial enough to absorb any vibration and to form a permanent rigid support for the unit. All units have hold-down bolt holes in the motor feet and pump/adapter feet. Depending upon the motor frame, the pump or motor feet may be higher or lower than the motor feet. Shim as required, then bolt all feet securely to support or foundation. Since the pump is mounted on the motor, permanent alignment is built in. No subsequent alignment is necessary.

Vertical

Vertical pumps may be mounted directly on a pit, using either the pump support plate only or in conjunction with a pit or tank cover. The units are shipped completely assembled except for motor, pit cover (if any), and float controls. Check all bolts and nuts on the entire unit to make sure they are securely tightened. Connect float and controls as shown on 10.1 Sectional View and Parts List on page 55.

Installation must be done with care to avoid damage and ensure proper operation. It is recommended that a man be stationed inside the pit, whenever possible, to assist in the initial installation.

Lower the assembled pump (less motor) carefully into the pit. Guide unit carefully so that it does not strike sides of pit. When unit is in place, level the support plate. Shim under support plate as required. Pump must hang perfectly vertical to avoid placing a bending stress on the unit.

The support plate should be bolted to an adequately supported structure, substantial enough to absorb any vibration and to form a permanent, rigid support for the unit.

Place motor on motor support and tighten bolts (with lock washers) snugly.

Alignment of the coupling is of extreme importance for trouble-free mechanical operation. Check for alignment by laying a straight edge across coupling hubs at four points· 90 degrees apart. See Figure 2: Alignment using straight edge on page 11. When the straight edge rests evenly at all four points, the coupling is aligned.

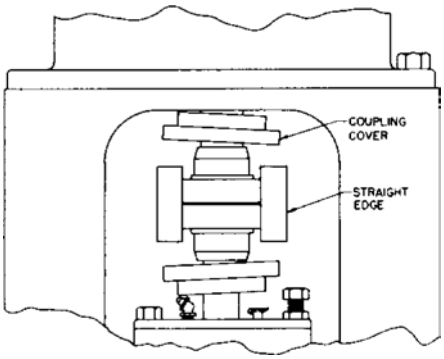

Figure 2: Alignment using straight edge

The machined faces of the motor support and motor will provide angular alignment. However, any foreign material or burrs on the surface will destroy this alignment. Make sure surfaces are clean and smooth.

2.4 Installation - horizontal pumps

Bedplate mounted units are normally mounted on a concrete foundation of liberal thickness poured on a solid footing, using a one-three-five mix. The foundation should be substantial in order to absorb any vibration and to form a permanent, rigid support for the pumping unit.

1. The location and size of foundation bolts are shown on the outline assembly drawing supplied for the unit.
2. When unit is mounted on a concrete foundation, each foundation bolt should be installed with a pipe sleeve around it to allow for adjustment.

   The I.D. of the sleeve should be 2-1/2-3 times the bolt diameter. Place a washer between the bolt head and sleeve to hold bolts. See Figure 3: Concrete foundation on page 12.
3. Stuff waste around bolts to prevent concrete from entering between bolt and sleeve. Bolts should be of sufficient length so that they project through the nuts approximately ¼" after allowance has been made for grouting, bedplate thickness, and nut thickness.

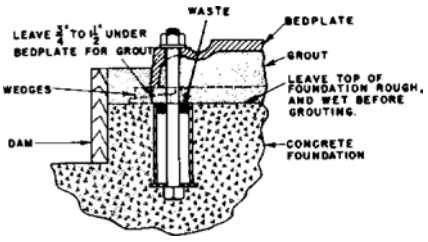

Figure 3: Concrete foundation

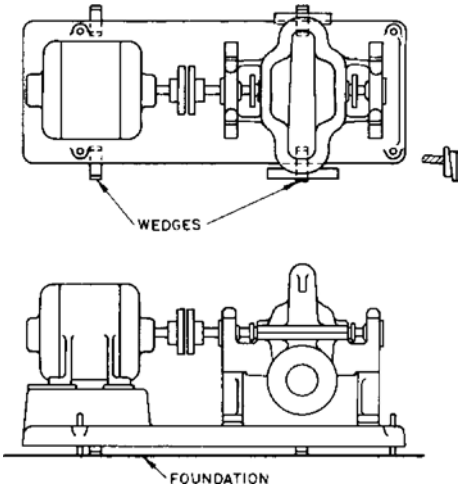

Figure 4: Wedge placement

4. Disconnect coupling between pump and driver.

NOTICE:

Spider-insert couplings, as shown in Figure 5: Spider-insert coupling on page 12, need not be disconnected.

Figure 5: Spider-insert coupling

5. By adjustment of wedges, bring the bedplate to an approximate level and provide the proper distance above the foundation for grouting (¾" to 1-1/2"). Level or plumb the suction and discharge flanges. Bring pump and motor shafts into reasonable alignment making absolutely certain that motor shaft is not a sufficient thickness of shims under the motor feet to allow for adjustment during alignment.
6. Tighten foundation bolts, but only finger tight. Maintain the level of the bedplate.

NOTICE:

Final tightening is done after pump is grouted and grout has set at least 48 hours.

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7. Build wood dam around foundation as shown in Figure 3: Concrete foundation on page 12, and thoroughly wet top surface of foundation. Pour grout in hole provided in top of bedplate. Use of non-shrink grout is recommended. Grout should be thin enough to flow out under the bedplate but not so wet that sand and cement will separate. 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. Strike along top of dam with trowel to give a neat finished appearance. Allow grout to harden at least 48 hours.

8. Tighten foundation bolts.
9. Tighten pump hold-down bolts.

2.5 Alignment procedures

General

Alignment of the pump and driver is of extreme importance for trouble-free mechanical operation. The following are suggested steps to establish the initial alignment of the unit.

NOTICE:
This is an initial alignment. The final alignment is done after the unit has been run under actual operating condition. The final alignment procedure is outlined in 4.5 Alignment - final on page 31 and must be followed. Make sure motor starting switch is locked out to prevent accidental rotation.

Any coupling manufacturer's instruction sheets, sent with the pump, should be studied and used when installing, aligning, or servicing coupling. Note that coupling hubs are not necessarily mounted flush with the shaft ends.

If instructions are not available, the following procedure may be used. The procedure is given for two basic coupling types:

1. Flexible Coupling - Normally furnished on all units except back pull-out. Normally not assembled (except spider-insert type which are pre-assembled).
2. Flexible Spacer Coupling - Furnished as standard on all back pull-out units. Contains a removable spacer piece located between coupling hubs.

NOTICE:
Alignment in one direction may alter alignment in another. Check through each alignment procedure after making any alignment alteration.

Parallel alignment

Unit is in parallel misalignment when the shaft axes are parallel but not concentric. Shift driver as required.

In order to obtain vertical parallel alignment under actual operating conditions, the driver shaft may have to be set higher or lower (using thin shim stock) than the pump shaft due to differences in expansion rates. Pump expansion rates vary with pump design. The following is a suggested cold setting for motor driven units:

Frame mounted units

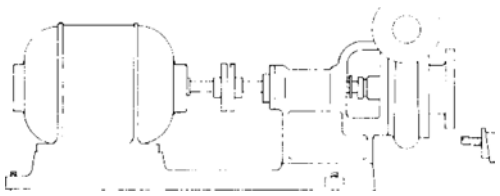


Figure 6: Frame mounted units

Pumpage Temperature Above Ambient Temperature	Set Motor Shaft
Ambient	.004" to .006" Low
100ºF	.002" to .004" Low
200ºF	.000" to .002" Low
300ºF	.000" to .002" High

Pedestal Mounted Units

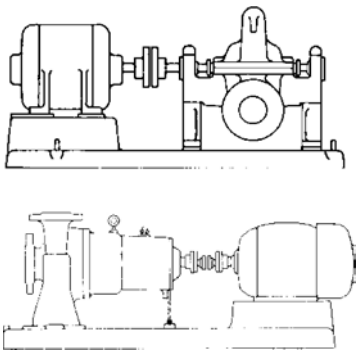


Figure 7: Pedestal mounted units

Set motor shaft .002" - .004" low regardless of pumpage temperature.

Casing Mounted Units

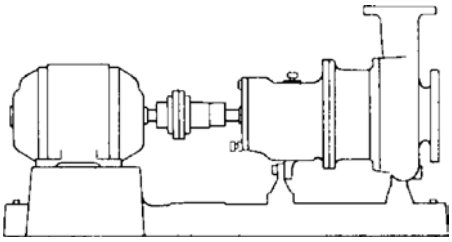


Figure 8: Case mounted units

Pumpage Temperature Above Ambient Temperature	Set Motor Shaft
Ambient	.002" - .004" Low
100ºF	.000" - .002" High
200ºF	.004" - .006" High
300ºF	.008" - .010" High
400ºF	.012" - .014" High
500ºF	.016" - .018" High

To check the parallel alignment:

1. Flexible Couplings

   Place a straight edge across both coupling hubs at four points 90 degrees apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See Figure 9: Parallel alignment check on page 15.

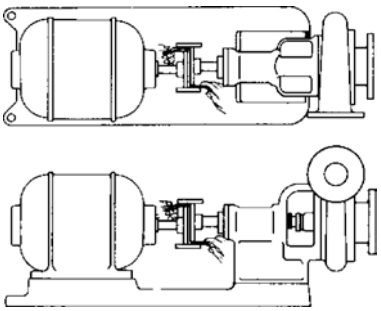


Figure 9: Parallel alignment check

2. Spider-insert couplings

   Place a straight edge across both coupling hubs at four points 90 degrees apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See Figure 9: Parallel alignment check on page 15.

3. Flexible spacer couplings

   Place a dial indicator on one shaft hub and rotate that hub 360 degrees while taking readings on the outside diameter of the other hub. When indicator does not reflect more than .002" total, parallel alignment is achieved. See Figure 10: Dial indicator on page 15.

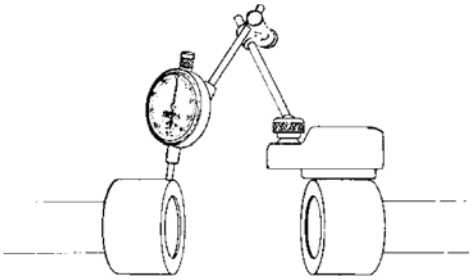


Figure 10: Dial indicator

Angular alignment

Unit is in angular misalignment when the shaft axes arc concentric, but not parallel. Shim unit as required.

1. Flexible Couplings

   The normal gap (distance between coupling halves) is approximately 1/8". However, the coupling manufacturer's instructions should be followed. Insert a feeler or taper gauge at 90 degree intervals on the circumference of the hubs. When the gap is identical within .002", the unit is in angular alignment. See Figure 11: Angular alignment - feeler gauge on page 15.

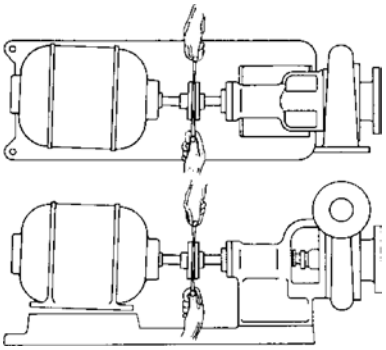


Figure 11: Angular alignment - feeler gauge

2. Spider-Insert Couplings

   The normal gap (distance between hub and insert) is approximately 1/16". However, the coupling manufacturer's instructions should be followed. Check alignment by using calipers at 90° intervals on the circumference on the outer end of hubs. When caliper measurements are identical, the unit is in angular alignment. See Figure 12: Angular alignment - calipers on page 16.

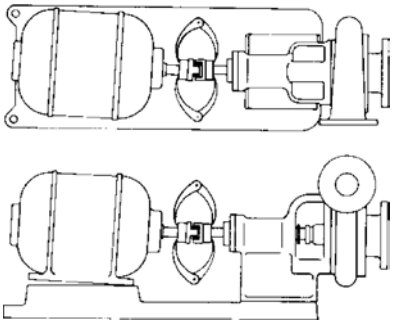


Figure 12: Angular alignment - calipers

3. Flexible Spacer Couplings

   Place a dial indicator on one shaft hub and rotate that hub 360 degrees. Take readings from the face of the other hub. Alignment is achieved when indicator does not deflect more than .002". See Figure 13: Dial indicator on page 16.

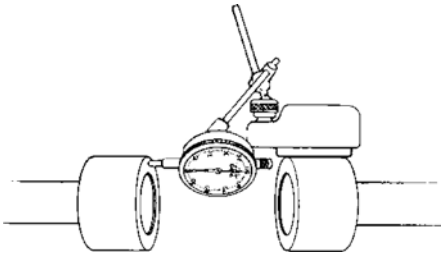


Figure 13: Dial indicator

2.6 Piping - general

1. All piping must be supported independently of the pump. The piping should always line-up 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, as this may impose dangerous strains on the unit and cause misalignment between pump and driver.
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.
4. When handling liquids at elevated temperatures, it is suggested that expansion loops or joints be properly installed in suction and/or discharge lines so that linear expansion of the piping will not draw the pump out of alignment.

   If such expansion loops or joints are not used, the forces and moments, due to thermal expansion of the piping system, that can act upon the pump inlet and discharge flanges must be determined and must not exceed the limits permissible for the specific pump in question.

Such installations require extremely careful and precise attention to hot alignment procedures. Refer to 4.5 Alignment - final on page 31

5. On units handling corrosives, the piping can be arranged so that corrosives can be flushed from pump prior to opening unit for service. See Figure 14: Pump flushing on page 17. During operation, valves l and 3 would be closed, 2 and 4 open. Prior to dismantling, close valves 2 and 4, open l and 3. Introducing water at valve 3 will allow water to flush pump and drain at valve 1.

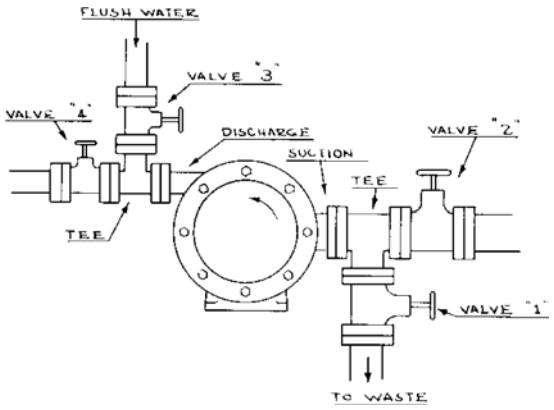


Figure 14: Pump flushing

2.7 Piping - suction

General

Properly installed suction piping is of extreme importance for trouble-free centrifugal pump operation.

1. Use of elbows dose to the pump suction flange should be avoided. Where used, elbows should be long radius.

   On double suction pumps, if an elbow must be used at the pump suction flange, it must be in a vertical position only. If an elbow must be in other than a vertical position, it is permissible only providing there is a minimum of two diameters of straight pipe between the elbow and pump suction flange.

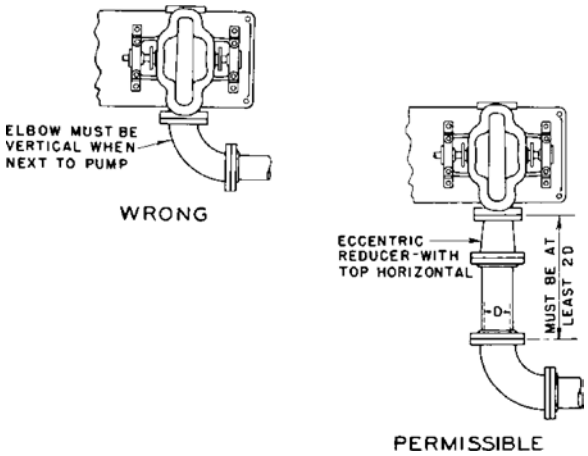


Figure 15:

2. The suction pipe should never be of smaller diameter than the pump suction. Use of suction pipe one or two sizes larger than the pump suction, with a reducer at the pump suction flange, is desirable.

3. Reducers, if used, should be eccentric and preferably at the pump suction flange sloping side down.

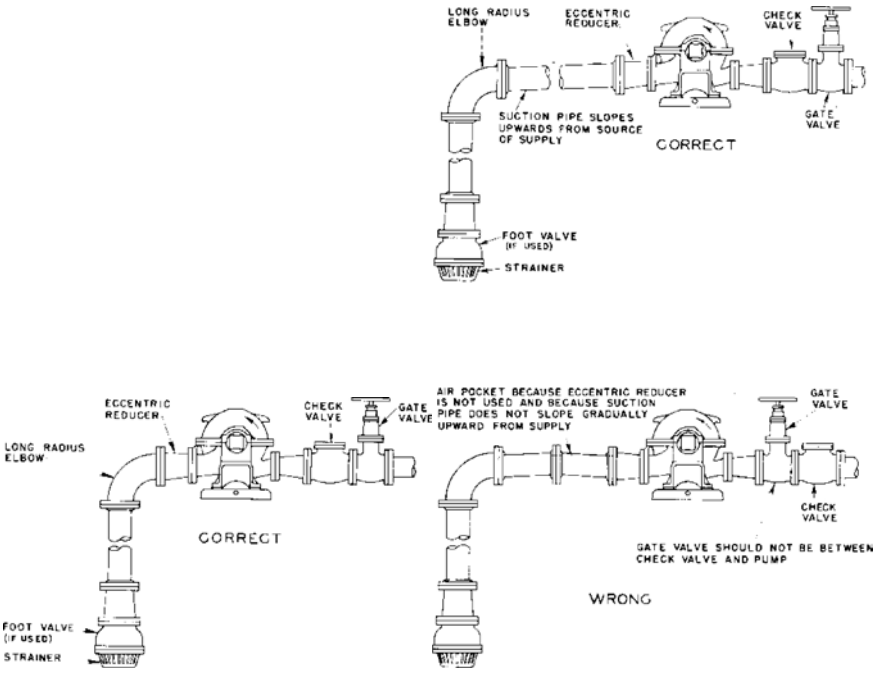


Figure 16:

4. A centrifugal pump should never be throttled on the suction side.
5. Suction strainers, when used. should have a net "free area" of at least three times the suction pipe area.
6. Separate suction lines should be used when more than one pump is operating from the same source of supply. If it is not possible to have separate lines, piping arrangement shown in Figure 17: on page 18 is recommended.

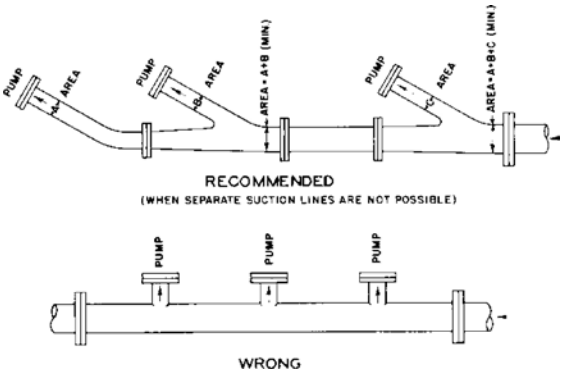


Figure 17:

Suction piping design for large pumps

Large units taking their suction supply from sumps require special attention. A properly designed sump is a must. The larger the unit, the more important these considerations become. A 3000 GPM pump should be considered a large unit.

The following sketches will show the preferred pipe arrangement within the sump. Pipe should be located near the back wall of the sump as shown in Figure 18: on page 19, Figure 19: on page 19, and Fig. 18 and should not be subjected to rapid changes in direction of the flow pattern.

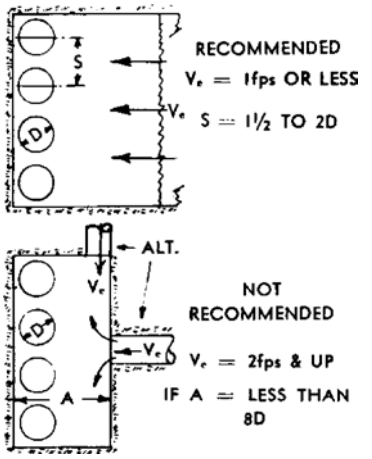


Figure 18:

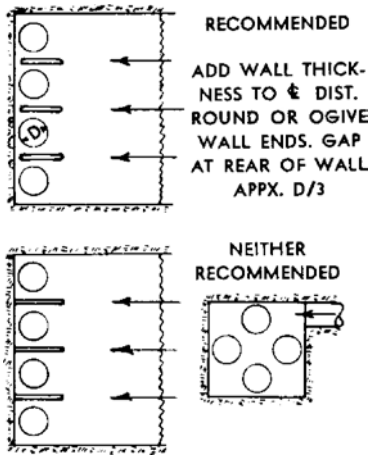


Figure 19:

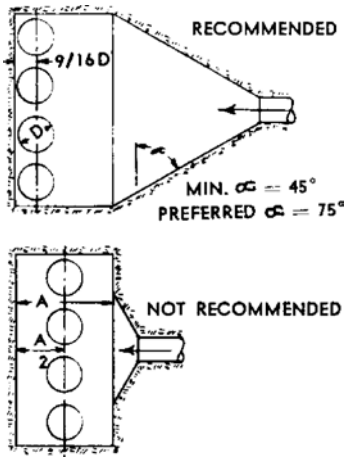


Figure 20:

The velocity of the water approaching the pump suction pipe should be kept to a maximum of one foot per second to avoid air being drawn into the pump. Pump suction inlet velocities and submergence (the height of the water above the pump inlet) are two additional factors that must be considered. These factors vary so greatly with the size and capacities of the individual pumps and systems that past experience, or good reference, should be relied upon in arriving at these values.

The suction pipe should be sized to obtain a flow velocity of 4 to 7 feet per second. Changes in flow direction should be avoided wherever possible, especially near the pump suction. A reducer at the pump suction flange to smoothly accelerate and stabilize flow into the pump is desirable.

Refer to the nearest Goulds representative for further information.

Installations with pump above source of supply - suction lift

1. Keep suction pipe free from air pockets - See Figure 16: on page 18.
2. Piping should slope upwards from source of supply.
3. No portion of piping should extend above the pump suction nozzle.
4. All joints must be air tight.

Installations with pump below source of supply - suction head or flooded suction

1. A gate valve should be installed in the suction line to permit dosing of the line for pump inspection and maintenance.
2. Keep suction pipe free from air pockets.
3. Piping should be level or slope gradually downward from the source of supply.
4. No portion of the piping should extend below pump suction flange.
5. The size of entrance from supply should be no smaller than the suction pipe.
6. The suction pipe should be adequately submerged below the liquid surface at the source of supply.

2.8 Piping - discharge

1. Gate and check valves 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 and for inspection and maintenance of the pump. The check valve is required to prevent reverse flow through the pump when the driver is turned off.
2. Increasers, if used in discharge line, should be placed between the pump and check valves.
3. If quick-closing valves are installed in the system, cushioning devices should be used to protect the pump from surges and water hammer.

2.9 Connection of piping

Connect suction and discharge piping to the pump. Rotate pump shaft several times by hand to be sure there is no binding and that all parts are free. Recheck alignment.

NOTICE:
On non-metallic pumps, use gaskets which are suitable for the flanges. PTFE envelope style is recommended.

2.10 Rotation

Serious damage may result if pump is run in wrong direction. Before coupling is connected, the motor should be wired and the direction of rotation checked. The direction of rotation is marked on the pump. Make sure driver rotates in the same direction.

2.11 Connection of coupling

Connect coupling. Follow the manufacturers instructions. Spider-Insert type couplings are pre-assembled. If a coupling guard is furnished with the unit, make sure it is securely fastened.

3 Preparation for Operation

3.1 Pump Bearings

Oil lubrication

Oil lubricated pumps are not lubricated at the factory. A high quality turbine oil, with rust and oxidation inhibitors, should be used. Constant level oilers are supplied with most oil lubricated pumps. They are included in the box of fittings which accompanies the pump. Set oiler per dimensions A and B shown in 6.1 Lubrication on page 34. Check the assembly dimension print for proper location.

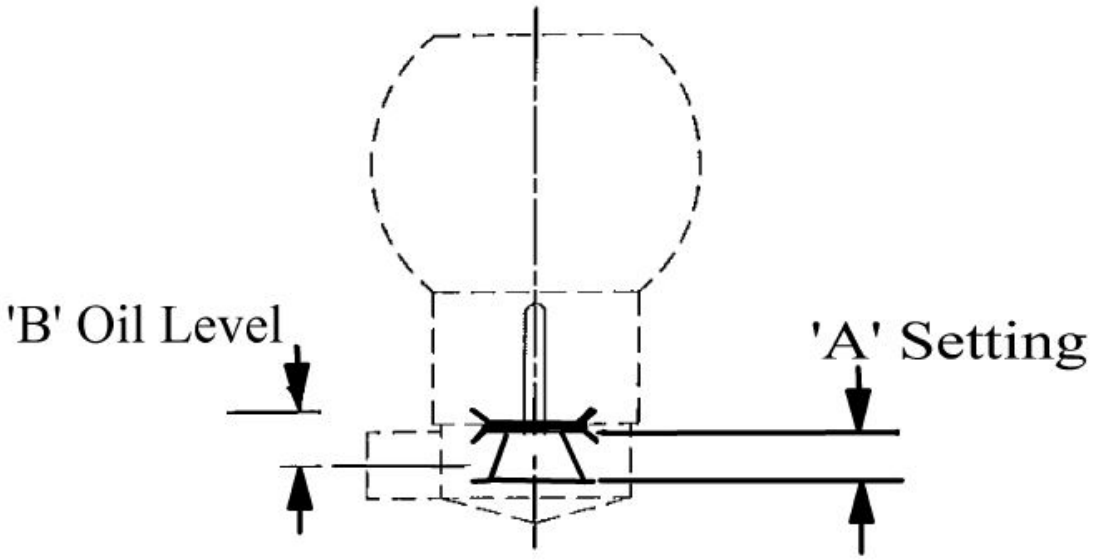


Figure 21:

Under normal operating conditions, an oil of 300 SSU viscosity at 100F)Approximately SAE-20) should be used. For extreme conditions refer to the factory or a lubrication expert for a recommendation.

Fill the bottle with the proper grade of oil and replace in the oiler housing. Oil reservoir in bearing housing is filled when oil level remains in the bottle. Several fillings will be required. Never fill through the oil vent or through the oiler without use of the bottle.

Grease lubrication

Grease lubricated pumps can be identified by the grease fittings located on the bearing housing. Sufficient lubricant is inserted at the factory for 2,000 hours of operation. Do not grease at too frequent intervals.

It is suggested that additional or replacement lubricant be added after 2,000 hours or at three-month intervals.

The lubricant should be renewed in the housings at least once annually. This should be done when the annual overhaul is made.

The grease should be sodium lithium base, NGLI #2 consistency. Do not use graphite. Further greasing instructions are included in 6.1 Lubrication on page 34.

Vertical pump bearings

The bearing above the pump support plate is a ball bearing and is grease lubricated. Follow previous instructions for grease lubrication.

The pump steady bearings (below the pump support plate) are sleeve type and made of various materials depending upon the application of the pump. Refer to 6.1 Lubrication on page 34 for specific details.

Close-coupled pumps

Close-coupled pumps contain no pump bearings. The only bearings in the unit are contained within the motor. Make sure that the motor bearings are properly lubricated. Refer to the motor manufacturer for instructions.

3.1.1 Driver bearings and coupling

Check to be sure that the driver bearings are properly lubricated. Contact the motor manufacturer for lubrication instructions. Refer to coupling instructions supplied separately for coupling lubrication.

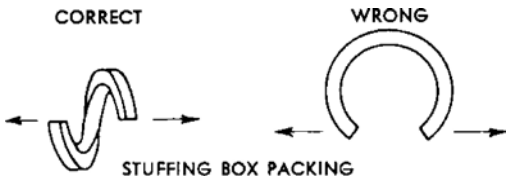
3.1.2 Stuffing boxes

Packing

Before packing the stuffing box, make sure box is clean and contains no foreign material. If unit has a metal lantern ring, assembled with the pump, make sure ring is outside stuffing box.

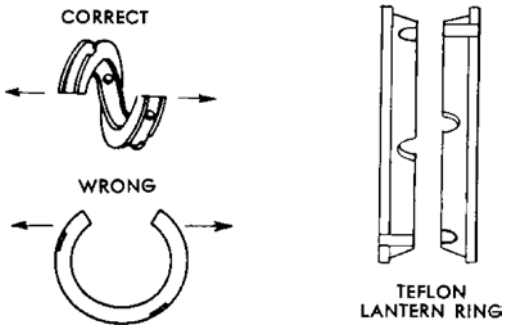
Stuffing box packing is furnished in the box of fittings which accompanies the pump. When packing the stuffing box, refer to 10.1 Sectional View and Parts List on page 55 for the arrangement of packing rings and lantern ring. Depending upon the particular pump and/or application, the lantern ring may be in the middle or bottom of the stuffing box, incorporated in another part or not used at all.

Some packing rings are die-formed and special care must be taken during installation. To install, twist the ring sideways just enough to get it around the shaft or sleeve. Do not attempt to pull rings straight out. See on page 23. Another form of packing ring is tie bulk-type packing which is cut to the proper length. Each piece should be placed around the shaft or sleeve and the ends of the packing should just meet to form a smooth, perfect ring. If necessary, the ends should be trimmed to obtain this fit.

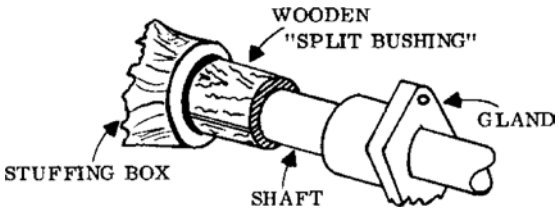


There are two basic types of lantern rings, PTFE and metal. Two-piece PTFE lantern rings are supplied in most units. Install as shown in on page 24.

NOTICE:
Two pieces make one ring. Notches must face one another but need not be aligned.



To pack the stuffing box, install the packing and lantern ring in the proper sequence. Each ring should be installed separately. Firmly seat each ring. Use of a wooden split bushing is recommended. See on page 24. Use gland to jack the bushing and ring into the box. Stagger joints in each ring 90 degrees. Make sure center of lantern ring lines up with flush tap in the stuffing box. Any extra rings are spares.



Tighten the gland nuts evenly but not tight. Follow adjustment procedure outlined in 4.4 Initial inspection after starting on page 30.

Removal of packing

To remove packing from the stuffing box, the following steps should be followed:

1. Remove gland assembly.
2. Remove packing with a packing hook.
3. Remove lantern ring by inserting a wire hook into the ring on the outer edge.
4. Clean the stuffing box.
5. On horizontally split case pumps, an alternate method of removing packing is to remove the upper half casing. Refer to 6.3 Disassembly of pump on page 35. Remove packing and lantern ring and inspect sleeves. If deeply grooved, sleeves should be replaced.

Mechanical seals

When mechanical seals are furnished, the description and identification is indicated on the order write-ups which are a part of the order acknowledgement, dimension print, and the packing list. Separate seal manufacturer's installation drawings are attached to the pump. The seals are installed and adjusted at the factory. The manufacturer's drawings should be filed for future use in maintaining the seal and in adjusting the seal when the pump is disassembled. To properly prepare the seal for operation, various cooling and flushing flows may have to be connected. In some cases, these flows are recirculated from the pump casing; in others, liquid from an outside source may be used. Connect cooling and flushing flows to seal as directed in subsequent steps.

3.1.3 Connection of sealing liquid or grease lubricator (packed box)

If the stuffing box pressure is above atmospheric pressure, and the pumpage is clean, normal gland leakage of 40 to 60 drops per minute is usually sufficient to lubricate and cool the packing and sealing liquid is not required.

Sealing liquid or grease lubricator is required when:

1. Abrasive particles in the pumpage could score the shaft or sleeve.

2. Stuffing box pressure may be below atmospheric pressure due to pump running with suction lift, or when suction source is under vacuum. Under these conditions, the packing will not be cooled

Sealing liquid

Sealing liquid may be supplied by recirculation of pumpage through a line from the casing to the stuffing box. If pumpage is abrasive, an outside source of clean compatible liquid must be used at a pressure of 30 to 50 PSI above suction pressure.

Grease lubricator

The grease lubricator is supplied when the use of a recirculating pumpage or outside sealing liquid is not desired. The grease should be insoluble in the pumpage.

3.1.4 Connection of cooling water piping

Quench gland

Most pumps which contain stuffing box packing have quench glands. Quenching prevents heat transfer along the pump shaft to bearings. Quenching is also most important for smothering vapors and fumes given off at the stuffing box. This is particularly true on applications such as hot water.

The quenching liquid 9Usually water) must be from an outside source. It should be piped, with flexible pipe, into the tapped opening on top of the stuffing box gland. A shut-off valve should be installed.

Bearings

Bearing cooling is available on some units. When it is available, cooling water must be connected to the jacket when pumping hot liquids. See the temperature limits listed under Construction Details. in Sect VIII-D. Valves should be installed in the coolant supply lines to regulate the flow.

Stuffing boxes

Some units are equipped with cooling jackets around the stuffing box as standard. It is optional on various other models. Coolant lines are connected in the same manner as the bearing cooling lines.

Casing pedestals

O, water cooled pedestals are available. Connection of coolant lines is made in the same manner as above some models

Mechanical seals

Seal materials (carbon, ceramic, PTFE, etc.) are suitable for use at temperatures to 500ºF (212º to 250ºF if seal has rubber parts). However, for satisfactory operation, there must be a liquid film between the seal faces to lubricate them. If the liquid flashes to vapor, the faces will run dry and be damaged. To prevent this, the liquid must be cool. In general, this requires that the liquid be cooled so that the vapor pressure is well below the stuffing box pressure. Doubtful cases should be referred to Goulds for a recommendation. Refer to seal manufacturer's drawing for location of taps. Some methods which may be used to cool the seal are:

1. Dead ended seal chamber

   No liquid is circulated through the stuffing box. The isolated or dead ended liquid around the seal is cooled by circulating water in the stuffing box jacket, if any.

2. Cool liquid flushing - external source

   A clean, cool compatible liquid is injected from an outside source directly into the seal chamber. The flushing liquid must be at a pressure 20 to 40 PSI greater than the pressure in the stuffing box. One-half to two GPM should be injected. A control valve and rotometer placed in the inlet

line permits accurate regulation. Cooling water can be circulated through the stuffing box water jacket (if any) in addition to the external flush.

3. Cool liquid flushing - product cooling

   In this arrangement, pumped liquid is piped from the pump casing, cooled in an external heat exchanger, then injected into the seal chamber. A control valve together with a rotometer and/or a dial thermometer should be installed in a line from the exchanger to the seal circulated. Cooling water, one to three GPM, should be circulated through the stuffing box jacket, if any.

3.1.5 Connection of drain pipping

All units contain tapped openings around the stuffing box for drainage. On corrosion resistant units, a drain pan is supplied with a tapped opening. Check the assembly dimension print for size and location.

3.1.6 Connection of equalizing piping

Some multi-stage pumps have equalizing piping to equalize pressure on the stuffing boxes (see Sectional view 10.1 Sectional View and Parts List on page 55). This piping is in the box of fittings which accompanies the pump. The ends of the piping must be connected to the openings in each stuffing box.

3.1.7 Impeller adjustment

Some end suction pumps, in addition to vertical pumps, have means of adjusting impeller clearance within the casing. The clearance was set at the factory, but in transit, the clearance may have been lost. Proper clearance must be attained before a pump is operated or serious damage may occur. Check and reset impeller clearance by method described in 6.2 Impeller clearance adjustment on page 35.

4 Starting Pump

4.1 Checking for free turning

Rotate shaft by hand to be sure rotating element is free. If element rubs or binds:

1. Check alignment.
2. Pipe loads should be removed.
3. Check impeller clearance (if external adjustment is possible) as outlined in Sect 6.2 Impeller clearance adjustment on page 35.
4. If unit is equipped with leveling bolts on frame or casing foot, check to be sure that bolts are not overtightened.

4.2 Regulation of cooling and flushing liquids

The supplu of liquid to any cooling jackets, quench glands, or mechanical seals should be regulated by valves in the supply line. Approximate flow rates are as follows:

Quench glands	½ to 1 GPM
Cooling jackets	1 to 3 GPM
Mecnanical Seals	½ to 2 GPM

The cooling lines should be checked periodically to see that they have not become clogged.

4.3 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 since they depend upon the liquid being pumped for lubrication.

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

Vertical sump pumps, when submerged, need not be primed since the pump is filled with liquid.

NOTICE:
On glass-lined pumps, the thermal shock limit of the glass varies with the conditions of operation. Do not introduce liquid to pump if temperature difference between liquid and pump is over 100ºF. Gradually heat pump before introducing hot liquids.

Suction supply above pump

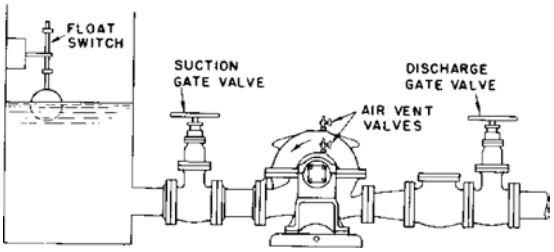


Figure 22: Suction supply above pump

When pump is installed as shown in Figure 22: Suction supply above pump on page 27, 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 and open discharge gate valve. Pump will continue to be primed for any future starting.

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 three following ways:

1. Outside supply

   Close discharge gate valve, open air vent valves and open valve in priming supply line until all air is expelled and water issues from vent openings. Close air vent valves, close valve in priming supply line, and start pump; then open discharge gate valve.

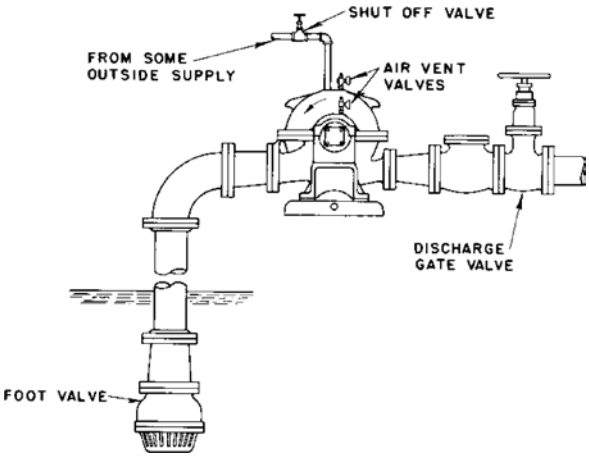


Figure 23: Priming with foot valve

2. By separate hand, or manually controlled, priming pump

   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. With priming pump running, close valve in priming line, start pump and open discharge gate valve.

   An alternate method is to reverse connections on priming pump and extending priming pump suction to source of liquid supply. The pump may be primed by pumping liquid into casing until liquid comes out of the open air vent valves.

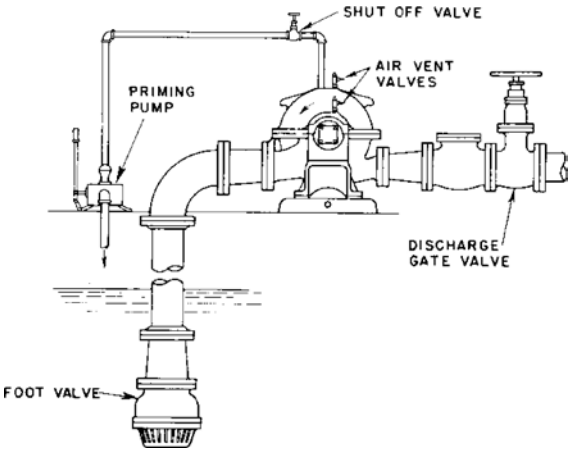


Figure 24: Priming with foot valve

In either of these methods (1) and (2), 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 through leakage from stuffing boxes.

3. Bypassing around discharge check valve

   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 valves in bypass line around discharge check and gate valves until liquid flows from vent openings. Close air vent valves and bypass valve, start pump and open discharge gate valve.

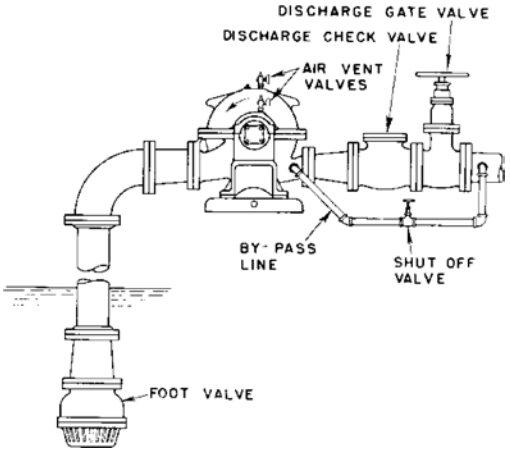


Figure 25:

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 leaky foot valve. The foot valve must be capable of withstanding static head pressure of the system.

Priming by ejection

On suction lift installation, an ejector, operated by steam, compressed air, or under water 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. See Figure 26: on page 30.

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.

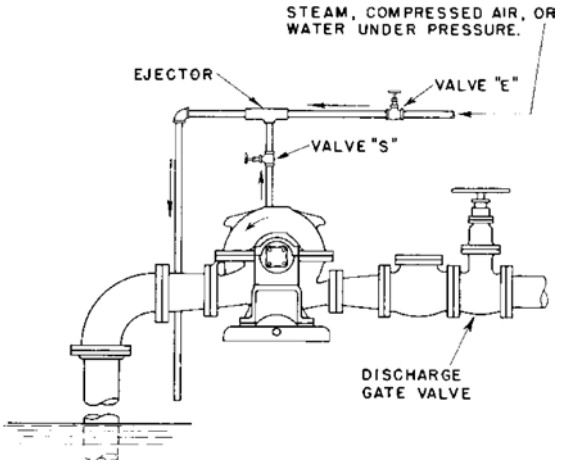


Figure 26:

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 in the pumpage, the system shown in Figure 27: on page 30 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.

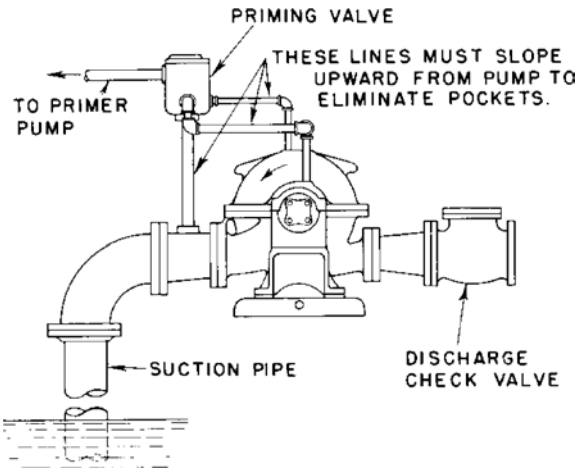


Figure 27:

4.4 Initial inspection after starting

Packed box

With pump running at rated speed, the stuffing box gland can be adjusted. Draw gland nuts up evenly and only 1/6 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 down the pump and allow the box to cool. Several starts may be necessary before the box runs coo. 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. Remember that it takes newly installed packing some time to run in and that

during this period, frequent attention and careful adjustments are necessary. Refer to 5.1 Stuffing box on page 32

Mechanical seal

The mechanical seal was adjusted at the factory. If the seal leaks slightly when the pump is first started, a few hours run-in will allow seal to adjust itself. Never run seal dry. Make sure cooling flow lines, if any, are operating properly.

4.5 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. on Back-pull-out suction end units, the frame foot should be loosened to relieve any strain due to thermal expansion. on units which have jacking bolts on the foot, loosen the hold-down bolts. On units which have a slotted hole on the foot near the bearing frame, loosen the foot-to-bearing frame bolt. Make sure motor switch is locked out to prevent accidental rotation. after a minute or two, retighten foot bolts.

Repeat each alignment procedure outlined in 2.5 Alignment procedures on page 13

Reconnect coupling.

Check final alignment after approximately one week of operation.

4.6 Doweling

Some units do not require doweling since lock washers are furnished which hold the pump and driver feet securely in place.

On other units, the pump and driver feet should be doweled after installation is completed, and the unit is correct final alignment. Taper dowel pins, included in the box of fittings, are furnished for these units.

NOTICE:
On all multi-stage units, dowel pins (if supplied) should be used on the coupling end of pump only. Do not dowel feet on outboard end of pump.

On units to be doweled (except those noted above), drill through two diagonally opposite feet of the pump into the bedplate. Use a reamer with a ¼" per foot taper. The dowels should extend well into the bedplate but project above the pump feet. Drivers should also be doweled but the driver manufacturer should be contacted for instructions.

5 Operation

5.1 Stuffing box

1. Stuffing boxes with packing rings, less quenching liquid or grease lubricator:

   Periodically inspect the 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. Draw up gland nuts slowly and evenly and only 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 liquid:

   The same precautions as described above apply. However, the amount of leakage though the packing cannot be easily determined, 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 1.. In no instance should the gland be drawn up tight. Never throttle the clean liquid supply into the stuffing box as a substitute for proper adjustment of packing; a steady flow from the seal cage into the pump is required to prevent entrance of pumpage into packing.

3. Stuffing boxes with packing rings, with grease lubricator:

   Operation is the same as directed in 1., with the addition that the handle on the lubricator should be given a turn or two every 100 hours of 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 clogged.

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. 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.

WARNING:
If running clearances have enlarged due to wear, seizure may not take place and 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 by-pass 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 bypassed is a function of input horsepower and the allowable temperature rise. This device also is assurance 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 minimum.
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 capacity increases with reduced head, as does horsepower consumption. If this condition is likely to persist, arrangements should be made to either manually or automatically throttle the discharge valve to build up head to a safe point.

5.4 Operating with surge conditions in line

If a 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.

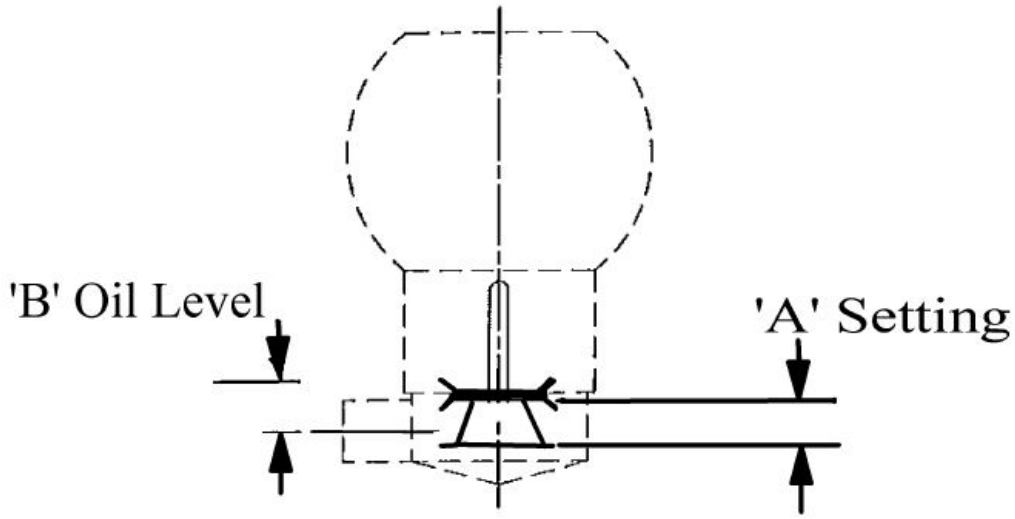
5.5 Operating under freezing conditions

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. Liquid inside cooling jackets or glands should also be drained.

6 Maintenance

6.1 Lubrication

1. *Oil lubrication* (refer to 3.1 Pump Bearings on page 22 for oil specs. Ring oil lubricated ball bearings are standard on all Model 3415 units. The bearings are not lubricated at the factory.
    1. Remove adjustment assembly from oiler.
    2. Adjust bars to Dim. A.
    3. Lock in position.
    4. Replace adjustment assembly in oiler.



Group	Oiler Size	A	B
S	#3 (4 oz.)	19/32"	½"
M	#5 (8 oz.)	9/16"	½"

See construction details for size-group designation.

Figure 28:

Oil lubricated pumps are supplied with oilers which maintain a constant oil level in the bearing housing. See Figure 29: Pump on page 35 for oiler location.

1. Before installing the oiler on the bearing housing, check the oiler adjustment.
2. Install oilers.
3. Fill each oiler bottle with oil and replace the oiler housing. Oil reservoir in bearing housing is filled when oil remains visible in the bottle. Several fillings of the bottle will be required. Never fill through the oil vent or the oiler without use of the bottle.

Sleeve bearings with a ball thrust are optional on the Model 3415. They also utilize constant level oilers and use the same setting dimensions given above.

2. Grease lubrication (refer to 3.1 Pump Bearings on page 22) Grease lubricated ball bearings are optional on the Model 3415. These units can be identified by the grease fittings located on the

bearing housing end covers. Grease lubricated bearings are lubricated at the factory. Do not grease at too frequent intervals. To grease bearings:

1. Remove relief plugs on bearing end covers. See Figure 32: Grease lubricated ball bearings on page 37
2. Insert grease through fittings, while shaft is rotating, until grease appears through the relief plug holes.
3. Operate unit for approximately ½ hour with relief holes open to prevent over greasing. After ½ hour, replace relief plugs.

6.2 Impeller clearance adjustment

There is no external impeller adjustment on the Model 3415.

6.3 Disassembly of pump

To prepare the pump for disassembly, proceed as follows:

(a) Shut off all valves controlling flow to and from pump.

(b) Drain liquid from pump. Casing drain plugs are located on bottom of casing.

(c) Disconnect all auxiliary tubing and piping.

(d) Disconnect coupling.

(e) If the unit is oil lubricated, remove oil drain plugs from bottom of bearing housings and drain oil. Replace plugs after draining.

(f) Remove glands from casing. If unit has packed stuffing boxes, unbolt and remove gland halves. If equipped with mechanical seals, slide glands toward bearings. Protect lapped stationary seat faces from damage.

The numbers located on the following figures refer to the procedural steps. For example, number 1 on Figure 29: Pump on page 35 refers to Step 1.

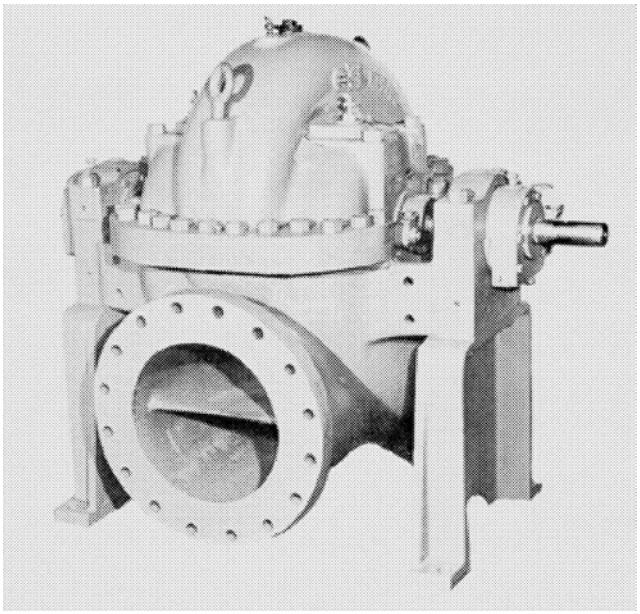


Figure 29: Pump

1. Remove the casing parting nuts. Remove dowel pins (1A). Loosen top half casing by inserting four ½"-13 NC bolts into parting flange. Remove top half casing using the eye bolts. Do not use eye bolts to lift enter pump. Exercise care to prevent the gasket from tearing.
2. Remove bearing caps. Match-mark each bearing cap. They must be replaced on the same end and in the same position on pump during reassembly.
3. Place sling in position (see Figure 30: Rotating element on page 36) and take weight off element. Make sure all stationary parts of rotating element are removed. It is desirable to rotate casing wearing rings, stuffing box bushings and bearing housings 180 degrees to disengage tongue and groove locks.

NOTICE:

- On units with ball bearings, remove element and place on padded supports.
- On units with sleeve bearings, see Figure 33: Ring oil lubricated bearings on page 38.

   1. Unbolt and remove bearing end cover on outboard end of pump. Preserve gasket.
   2. Loosen set screws in dust covers and slide covers away from bearings.
   3. Remove top half bearing adapters and bearing shells. Match-mark shells and adapters as they must be replace on the same end and in the same position during reassembly.
   4. Rotate lower bearing shells and adapters to top of shaft and remove. Oil rings must be lifted slightly to allow removal of bearing shells and adapter. Remove element and place on padded supports.
4. Mark coupling position on shaft and remove coupling and key.
5. Slide casing wearing rings off element.
6. Loosen set screw and remove dust cover (or deflector) from coupling end of shaft.
7. The standard bearings are ring oil lubricated ball bearings. However, grease lubrication and sleeve bearings are optional. Specific bearing disassembly procedures for each type are given below. Select the appropriate procedure and follow it carefully.

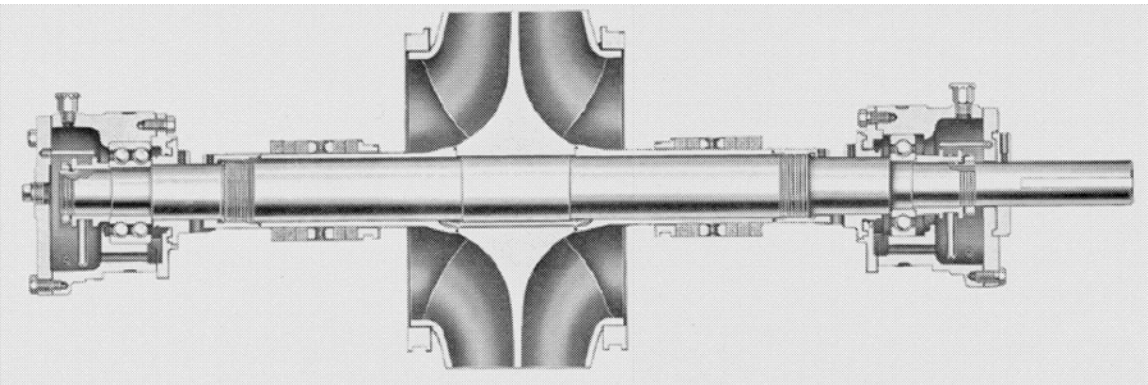


Figure 30: Rotating element

A. Ring oil lubricated ball bearings **B. Grease lubricated ball bearings**

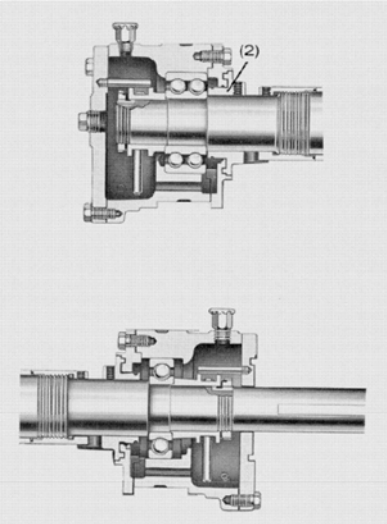


Figure 31: Ring oil lubricated ball bearings

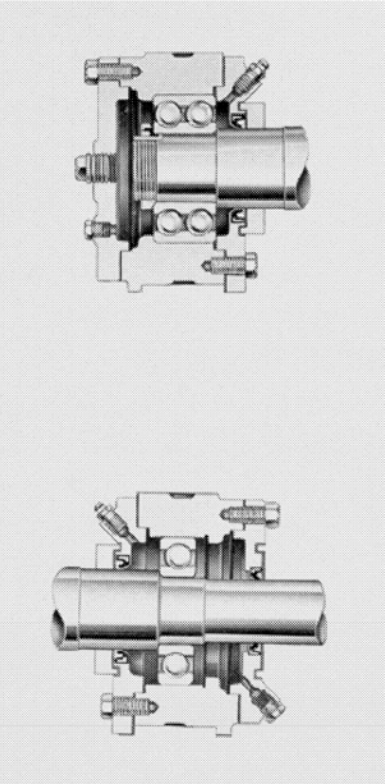


Figure 32: Grease lubricated ball bearings

(a-1) Remove bearing end covers and oil rings from each end of shaft.	(b-1) Remove bearing end covers. Preserve gaskets.
(a-2) Loosen set screws in oil throwers and slide them toward shaft sleeves.	(b-2) Slide deflectors toward shaft sleeves.
(a-3) Unbolt inboard bearing end covers and slide them toward shaft sleeves.	(b-3) Unbolt inboard bearing end covers and slide toward shaft sleeves.
(a-4) Slide bearing housings off shaft. Preserve gaskets.	(b-4) Slide bearing housings off shaft. Preserve gaskets.
(a-5) Straighten tangs in lock washers and remove both bearing lock nuts and washers. Slide oil ring sleeves off shaft.	(b-5) Straighten tang in lock washer and remove outboard end bearing lock nut and washer.
(a-6) Remove ball bearings using a bearing puller as shown in 7.4 Bearing removal on page 48, Figure 43: Bearing puller for units with bearing housings that slide off bearings on page 48. Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through beatings. Protect bearings from contamination.	(b-6) Remove ball bearings using a bearing puller as shown in 7.4 Bearing removal on page 48, Figure 43: Bearing puller for units with bearing housings that slide off bearings on page 48. Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through beatings. Protect bearings from contamination.
(a-7) Remove ball bearings using a bearing puller as shown in 7.4 Bearing removal on page 48, Figure 43: Bearing puller for units with bearing housings that slide off bearings on page 48. Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through beatings. Protect bearings from contamination.	(b-7) Go to Step 8.

C. Ring oil lubricated bearings

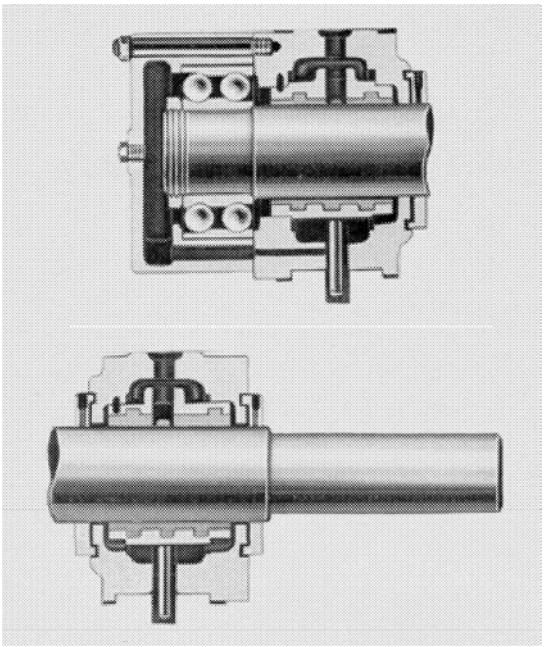


Figure 33: Ring oil lubricated bearings

The first fours steps in the disassembly procedure of sleeve bearings are outlined in Step 3.

(c-5) Lift oil rings off shaft.

(c-6) Straighten tang in lock washer and remove outboard end bearing lock nut and washer.

(c-7) Remove ball bearing using a bearing puller as shown in 7.4 Bearing removal on page 48. Care must be used to prevent damage to bearing. Never use a hammer to drive shaft through bearings. Protect bearings from contamination.

(c-8) Go to Step 8.

8. Slide inboard bearing end covers, oil throwers, dust covers, and deflectors (if any) off shaft. Protect grease seals on grease lubricated pumps.
9. If unit has mechanical seals, slide glands, with stationary seat in place, off shaft. Use care to prevent damage to lapped seal faces. Rotary portion of seal and stuffing box bushing can be left on sleeve until sleeve is removed. If unit has packed stuffing boxes, remove packing, lantern rings and stuffing box bushings.
10. Loosen set screws in shaft sleeve nuts. Using a spanner or strap wrench, remove sleeve nuts. One nut has right hand threads, the other left hand threads. Nuts tighten against pump rotation. Preserve O-rings.
11. Smooth shaft with fine emery cloth so sleeves will not bind upon removal.
12. Carefully slide sleeves off shaft. If pump has mechanical seals, then rotary portion of the seal and the stuffing box bushings will be attached to the sleeve and can be removed later, if required. Protect O-rings located in the end of the sleeve nearest the impeller.
13. Lightly scribe a line on the shaft near the impeller hub. This will determine the proper position of the impeller on the shaft. Drive or press impeller off shaft. Do not damage impeller hub surface which is sealed be sleeve O-ring. Remove key.

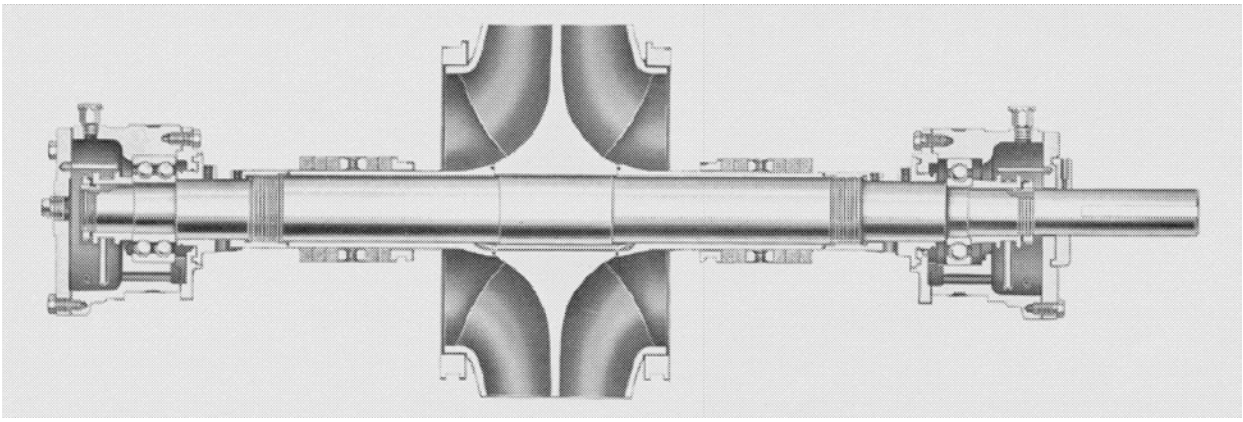


Figure 34: Bearing housing removal

6.4 Pressure temperature capability

The maximum pressure rating of the pump, including the connection of the pump and pipe flanges, can be determined from the chart and table shown below. The maximum working pressure is dependent upon both the casing limits and the mating flanges.

The table below references the combination of pump size, material and mating pipe flanges to the pressure temperature chart. To determine the maximum working pressure:

1. Select the proper code designation for the pump size, material and mating pipe flanges from the table.
2. Follow the coded curve on the chart to the desired pumping temperature.
3. The pressure value shown at that temperature is the maximum working pressure of the pump and mating pipe flange combination.

Pump Size	Pump Casing Material	Minimum Acceptable Standard* Mating Flanges		Code
		Discharge	Suction	
6 x 10-22 10 x 12-22 12 x 14-18	Cast Iron or Bronze	250 PSI Flat Face Cast Iron or 300 PSI Flat Face Bronze or Steel	125 PSI Cast Iron	A
14 x 16-18	Bronze	150 PSI Flat Face Steel	150 PSI Flat Face Bronze or Steel	B
14 x 16-22	Cast Iron	150 PSI Flat Face Steel		C
16 x 18-18 16 x 18-22H 18 x 20-22	Bronze or Cast Iron	125 PSI Cast Iron		D
8 x 10-22 10 x 12-22 12 x 14-18 14 x 16-18 14 x 16-22 16 x 18-18 16 x 18-22H 18 x 20-22	316SS	150 PSI Flat Face Steel	150 PSI Flat Face Steel	E

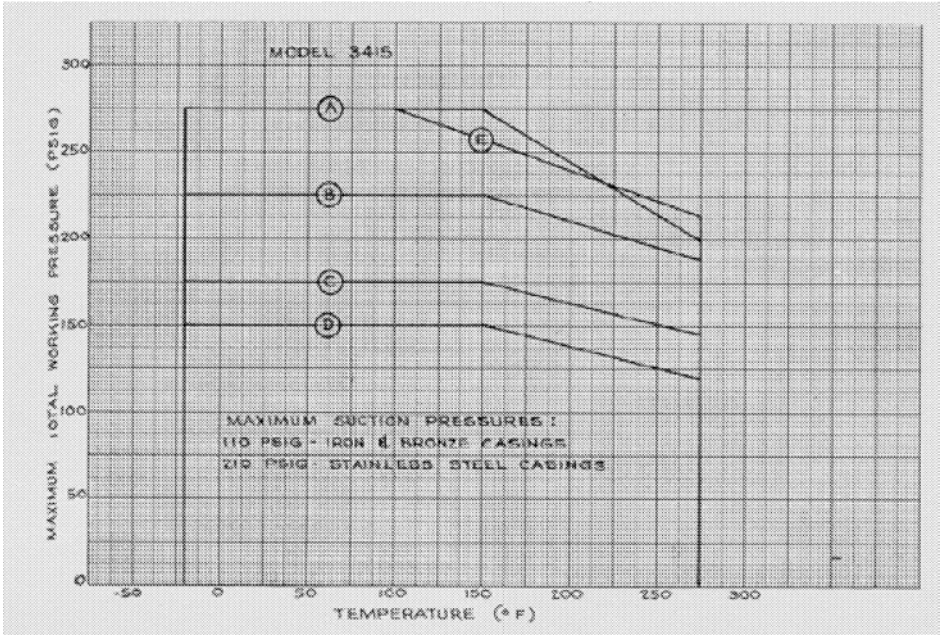


Figure 35:

NOTICE:
For pressure requirements above those shown, optional casing material, flanges and bolting are available. Contact the nearest Goulds representative for details.

6.5 Inspection and Overhaul

1. **O-rings:** Inspect O-rings and replace if damaged. Position them in sleeves and sleeve nuts.
2. **Wearing rings:** The original clearance between the impeller and the casing wearing rings is shown in Table 3: Impeller and Wearing Ring Clearance on page 41. Clearance between casing wearing rings and optional impeller wearing rings is also shown. When hydraulic performance is reduced substantially, the casing rings should be replaced.

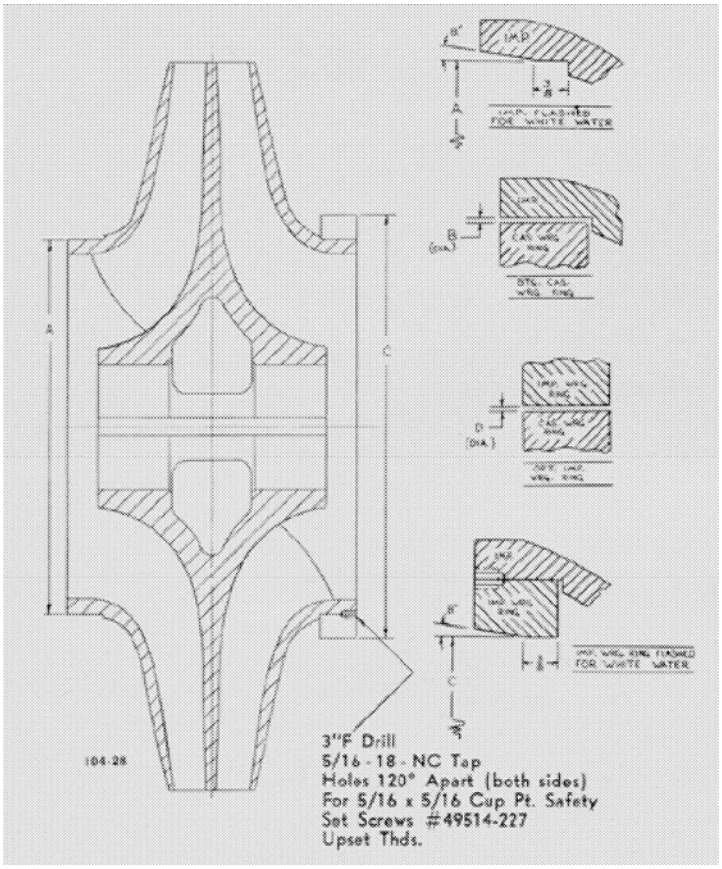


Figure 36:

3. **Impeller wearing rings:** if the unit has impeller wearing rings and it is necessary to replace the rings:
    1. Remove old rings by removing the three set screws and pulling ring off hub.
    2. Clean hub and press on new ring.
    3. Drill and tap three holes 120 degrees apart with an "I" drill and a 5/16"-18NC cap in each ring. Use 5/15" x 5/15" cup point safety set screws. Tighten screws and lightly "upset" threads. See Table 3: Impeller and Wearing Ring Clearance on page 41.
    4. Replacement impeller rings are supplied .020-.030" oversize and must turned to size after mounting on impeller. See Table 3: Impeller and Wearing Ring Clearance on page 41 for dimensions.

Table 3: Impeller and Wearing Ring Clearance

Material	Dimension	Pump Size							
		8x10-22	12x14-18	14x16-18	16x18-18	10x12-22	14x16-22	16x18-22H	18x20-22
		Dimensions below in inches							
Iron and Bronze	A	8.989	10.753	12.236	13.986	10.238	12.986	14.234	15.359
		8.987	10.751	12.233	19.983	10.236	12.983	14.231	15.356
	B	.020	.022	.023	.023	.022	.023	.023	.023
		.024	.026	.029	.029	.026	.029	.029	.029
	C	9.854	12.477	13.102	14.852	11.102	14.477	15.602	16.477
		9.852	12.474	13.099	14.849	11.100	14.474	15.599	16.474

Material	Dimension	Pump Size							
		8x10-22	12x14-18	14x16-18	16x18-18	10x12-22	14x16-22	16x18-22H	18x20-22
		Dimensions below in inches							
	D	.021 .025	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029
Steel	A	8.989 8.987	10.753 10.751	12.236 12.233	13.982 13.979	10.238 10.236	12.982 12.979	14.234 14.231	15.355 15.352
	B	.020 .024	.022 .026	.023 .029	.023 .029	.022 .026	.023 .029	.023 .029	.023 .029
	C	9.854 9.852	12.477 12.474	13.102 13.099	14.852 14.849	11.102 11.100	14.477 14.474	15.602 15.599	16.477 16.474
	D	.021 .02	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029	.023 .029

4. **Gasket:** Inspect flange gasket. If torn or otherwise damaged, cut a new gasket of 1/64". Use the upper half casing as a template. Strike the sheet with a ball peen hammer. This will cut the gasket against the edge of the casing. The gasket must cover the entire surface of the flange, especially around the wearing ring locks, or internal leakage from high to ow pressure zones in the pup will occur.
5. **Shaft:** Check shaft for runout to see that it is not bent, Straighten if required. Bearing sets must be in perfect condition. Replace if necessary. Check always for burrs or foreign matter.
6. **Impeller:** Check impeller and replace if there is:
    1. Excessive erosion, especially on the inlet vanes.
    2. Excessive wear on wearing surfaces. If the impeller diameter has to be cut, it should be dynamically balanced. Imbalance can be corrected by grinding on the outside of the shrouds near the periphery.
7. **Shaft sleeve:** The sleeve surface in the stuffing box area must be smooth and free of grooves. If grooved, replace. O-ring groove in end of sleeve must be in good condition.

    The original diametric clearance between the shaft sleeve and the stuffing box bushing is .030-.034". If this clearance has increased to more than .050-.060" the sleeve, and the stuffing box should be replaced.
8. **Bearings:** Replace ball bearings if worn, loose, rough, or noisy when rotated. Refer to7.2 Bearing inspection on page 47.
9. **General:** All parts should be clean before assembly. This is especially important at O-ring grooves, threads and bearing areas.

6.6 Reassembly

1. Determine the correct positioning of impeller on shaft. Facing the coupling end of shaft, determine proper rotation of unit (clockwise or counter-clockwise). Figure 37: on page 43 shows proper relationship between rotation and impeller vane curvature for counterclockwise rotation.
2. Slide impeller on shaft with key in place. Drive or press shaft into impeller. Do not damage end of shaft. Line up impeller hub with scribe mark made on shaft during disassembly.
3. Place O-rings in grooves in end of shaft sleeves. Slide sleeves on shaft.

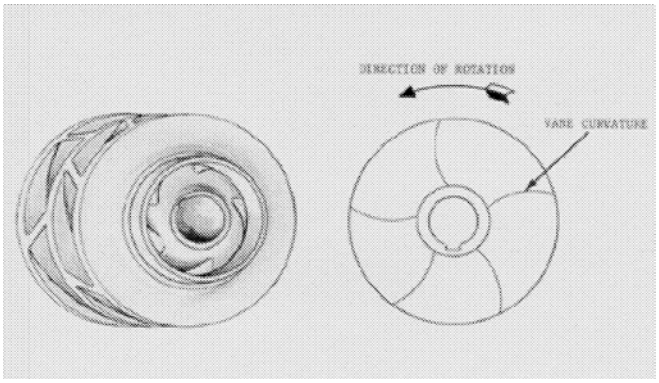


Figure 37:

4. Place O-rings under outer end of sleeves. Tighten shaft sleeve nuts against sleeves using a spanner or strap wrench. Tighten setscrews in sleeve nuts.
5. Slide stuffing box bushings over sleeves. Position as shown in Figure 38: on page 43 so that continuous "lock" is facing towards packing. If unit is equipped with mechanical seals, carefully slide the rotary portion on the sleeve and fasten securely. Check seal manufacturer's drawing for proper position. Carefully slide mechanical seal glands, with stationary seats and gaskets in place, on shaft. If unit has packing, slide the lantern rings on sleeves.
6. This step contains instructions for the installation of bearings. Select the appropriate procedure as you did previously in the Disassembly instructions and follow it carefully.

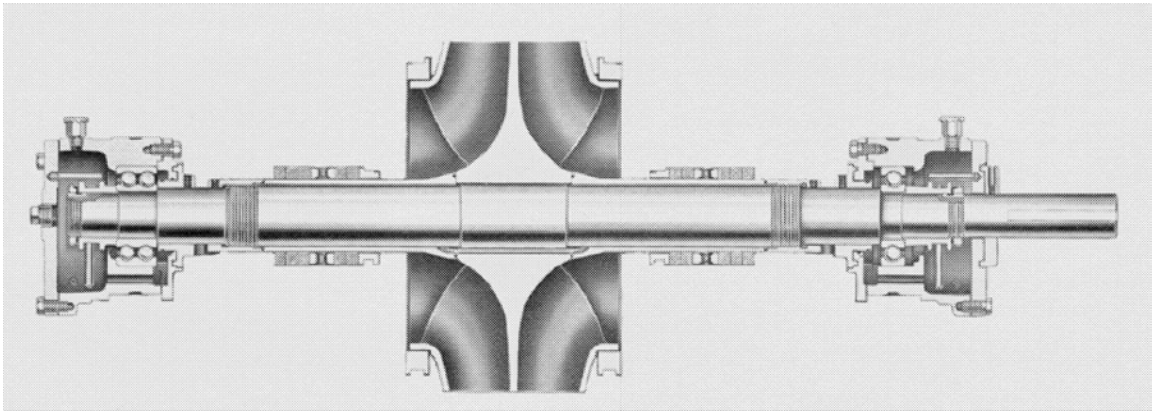


Figure 38:

A. Ring oil lubricated ball bearings **B. Grease oil lubricated ball bearings**

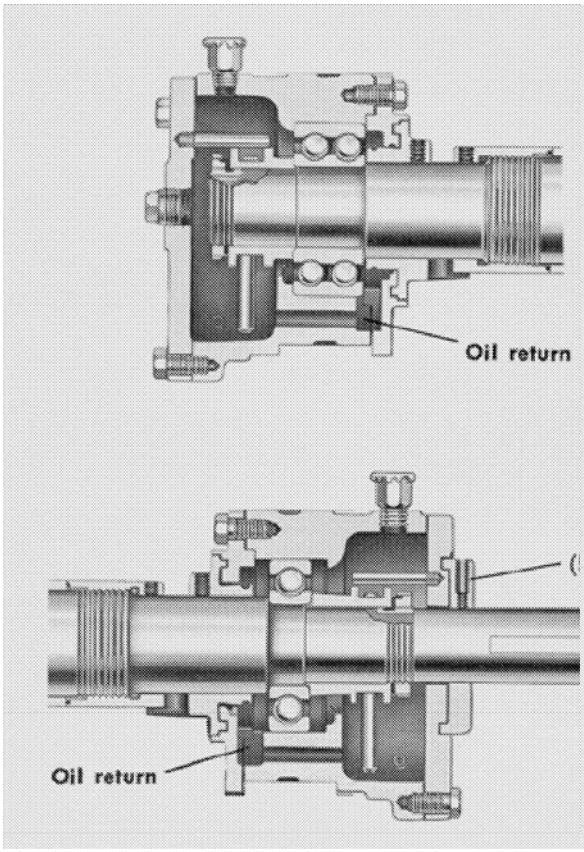


Figure 39: Ring oil lubricated ball bearings

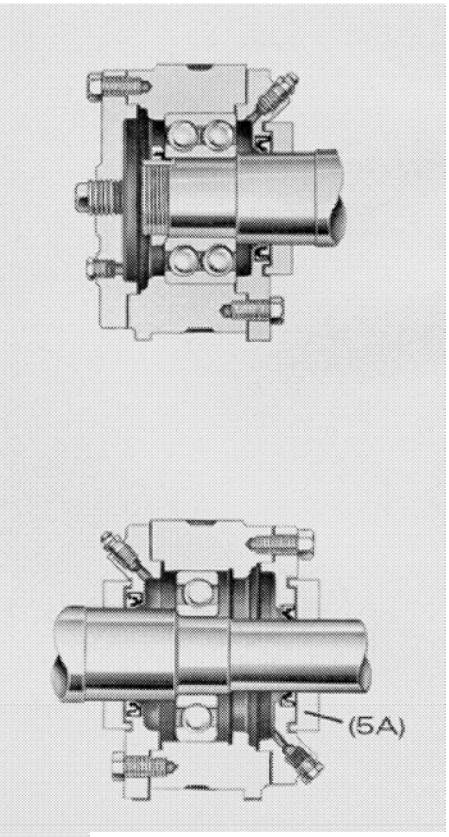


Figure 40: Grease oil lubricated ball bearings

(a-1) Slide oil throwers and inboard bearing end covers on shaft.

(a-2) Install the bearings. Coupling end bearing is single row and the outboard bearing is double row. Although different, they are installed in the same manner. Apply a film of oil to the bearing seat on the shaft. Start the bearing square on the shaft. After starting, use a driving sleeve, such as the one shown in 7.5 Ball bearing installation on page 48, to firmly seat the bearing.

(a-3) Slide oil ring sleeve on shaft against bearings. Place lock washer and bearing lock nuts on shaft and firmly tighten. Bend tangs on washers into slots in lock nuts.

(a-4) Slide bearing housings over bearings and bolt inboard bearing end covers to bearing housings. Line up oil return grooves.

(a-5) Place oil rings in groove on oil ring sleeves and bolt bearing end covers to bearing housings. Place dust cover (5A) on coupling end of shaft.

(a-6) Go to step 7.

(b-1) Slide deflectors and inboard bearing end covers on shaft. Do not damage grease seals.

(b-2) Install the bearings. Coupling end bearing is single row and the outboard bearing is double row. Although different, they are installed in the same manner. Apply a film of oil to the bearing seat on the shaft. Start the bearing square on the shaft. After starting, use a driving sleeve, such as the one shown in 7.5 Ball bearing installation on page 48, to firmly seat the bearing.

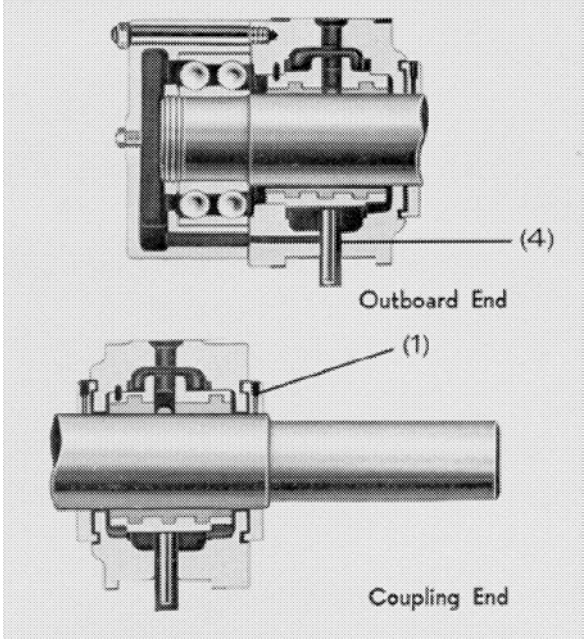
(b-3) Place loch washer and bearing lock nut on outboard end of shaft and firmly tighten. Bend tang on washer into slot in lock nut.

(b-4) Slide bearing housings over bearings and bolt inboard bearing end covers to bearing housings.

(b-5) Bolt outside bearing end covers to bearing housings. Do not damage grease seal on coupling end cover. Slide dust cover (5A) on coupling end of shaft.

(b-6) Go to step 7.

C. Ring oil lubricated sleeve bearings



(c-1) Slide dust covers on shaft.

(c-2) Install ball bearing on outboard end of shaft. Apply a film of oil to the bearing square seat on shaft. After starting, use a driving sleeve, such as shown in 7.5 Ball bearing installation on page 48, to firmly seat the bearing.

(c-3) Place lock washer and bearing lock nut on outboard end of shaft and firmly tighten. Bend tang on lock washer into slot in lock nut.

(c-4) Place oil rings on shaft.

(c-5) Go to step 7.

(c-6) After rotating element is lowered into the casing, lift oil rings slightly and place the lower half bearings shells and adapter on the shaft. Rotate the shells and adapters 180 degrees under the shaft and into position. Following the procedure, place top half shells and adapters in position on top of shaft. Make sure match-marks line up.

(c-7) Bolt bearing end cover with gasket in place to bearing adapter on outboard end of shaft.

(c-8) Go to Step 10.

Figure 41: Ring oil lubricated sleeve bearings

7. Install pump half coupling on shaft. Heat the hub in an oven or hot oil bath until the hub reaches 300ºF. Slide the hub on the shaft until it is positioned in the same location as it was originally. It should line up with the mark scribed on the shaft during assembly. Use caution when handling hot coupling hub. Use of gloves is recommended.
8. Clean all seats in both lower and upper half casing.
9. Slide the casing wearing rings onto the impeller. Make sure that the continuous lock on the upper half of the rings is facing toward the center of the impeller.
10. Carefully lower the rotating element into the lower half casing. If pump has sleeve bearings, follow procedures 6 through 8 in step 6C. Make sure that double locks on wearing rings, bearing housings, and stuffing box bushings are facing up. The unit should settle easily into place. After the element has been properly seated, rotate the rings, bearing housings, and stuffing box bushings 180 degrees so that double locks are located in lower half housing. Check to be sure impeller is centered in casing. If it is nut, loosen sleeve nuts and shift sleeves and impeller as required. Check for free turning by rotating the shaft by hand.

11. Replace the bearing caps and tighten the nuts evenly. Make sure that the caps are replaced on the same end from which they were removed and the match-marks line up. Check for free turning.
12. Place the parting gasket in position on the lower half casing. Make sure edge of gasket is flush with stuffing box bores and tight against the wearing rings and stuffing box bushings.
13. Carefully lower the upper half casing which should settle into place without resistance. Replace dowel pins. Check for free turning. If no binding is apparent, tighten parting nuts alternating on each side of pump starting from the center. Check for free turning after all nuts are tight.
14. Slide oil throwers, dust covers and deflectors, if any, to within 1/32" of the bearing end covers or adapters and tighten set screws.
15. If unit has packing, repack stuffing boxes and replace gland assemblies as outlines in 3.1.2 Stuffing boxes on page 23. If unit has mechanical seals, bolt glands to stuffing box and firmly tighten.
16. Follow alignment procedures as outlines in 2.5 Alignment procedures on page 13. Connect coupling.
17. Lubricate pump bearings as described in 6.1 Lubrication on page 34 for starting and operating procedures.
18. Connect all auxiliary piping.
19. Follow directions in Starting Pump, for starting and operating procedures.

6.7 Emergency ball bearing replacement

If the outboard end ball bearing needs replacement and it is not desirable to overhaul the entire pump, the bearing can be replaced as follows.

NOTICE:
Coupling end bearing cannot be replaced in this manner unless:

- Pump or driver is removed from bedplate or
- Spacer coupling is used

1. Remove oiler and drain oil from housing.
2. Remove bearing cap and outboard bearing end cover. Loosen oil thrower and inboard bearing end cover.
3. Remove oil ring, rotate bearing housing 180 degrees and slide housing off shaft.
4. Remove bearing as outlined in Section C, Step7.
5. Clean bearing housing and end covers. Install new bearing as outlined in 6.6 Reassembly on page 42, step 6. Replace bearing housing end cover.
6. Replace bearing cap and tighten nuts evenly.
7. Lubricate bearing as outlined in 6.1 Lubrication on page 34 and 6.2 Impeller clearance adjustment on page 35.

7 Care and Maintenance of Bearings

7.1 Bearing Temperatures

All bearings operate at same temperature above that of the surrounding atmosphere, unless cooled. Heat is generated within the bearing due to rolling friction, churning of oil and the drag of the race.

Do not use the human hand as a thermometer. A temperature which feels hot varies from 120ºF to 130ºF depending upon the individual. Above this temperature, the human hand is worthless in estimating temperature.

Bearing temperatures up to 180ºF are normal. Determine the temperature accurately by placing a contact type thermometer against the bearing housing. It should be recorded in a convenient location for reference. The stability of the temperature, rather than the number of degrees, is the best indication of normal operation. A sudden increase in temperature is an indication of danger and a signal to investigate. The unit should be checked for abnormal hydraulic operation and unnecessary loads, such as coupling misalignment, etc.

7.2 Bearing inspection

1. Ball and roller bearings

   Ball and roller bearings can be checked for visible wear by slowly turning the races and watching for pits or worn areas on the balls, rollers or raceways. The bearings can also be inspected by holding the inner race and spinning the outer race. If any rasping noises are emitted or the bearing catches, it should be replaced. If any wear on the races is apparent, replacement is suggested.

2. Sleeve bearings

   Sleeve bearings should be inspected to determine if any deep scratches or gouges (other than oil grooves) are present. The babbitted surfaces should also be free of high or low spots. Unless these surfaces are completely smooth, they should be replaced if they cannot be scraped in.

7.3 Cleaning of bearings

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

If new bearings are to be installed, they should not be unwrapped until ready for installation and should not be cleaned or washed.

If old bearings are dirty, they should be replaced. Washing the bearings does not guarantee cleanliness and is risky at best. If new bearings are not readily available, and immediate reassembly is necessary, dirty bearings can be cleaned as follows:

Pour one or two quarts of clean water-free kerosene into a clean pail. Dip the bearings into the kerosine and agitate slowly. Repeat until bearing is completely clean. Blow dry with clean filtered compressed air. With ball bearings, hold the two races together, but allow the inner race to rotate a few turns now and then to dislodge the kerosene from the retainer pockets. When the bearing has been blown dry, oil it immediately with a good grade of clean machine oil to prevent corrosion or rust.

If there is any question as to the condition of bearings, it is always best to replace them. This may prevent an unplanned shutdown.

7.4 Bearing removal

1. Ball bearings

   A puller such as the one shown in Figure 42: Bearing puller on page 48 should be used. The puller bar must be square with the end of the shaft at all times in order to keep even pressure on the outer circumference of the bearing. The puller screw should be tightened steadily to enable the bearing to slide smoothly off the shaft. Do not damage the end of the shaft.

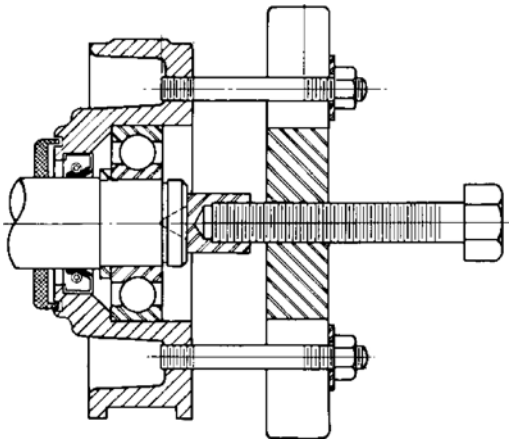


Figure 42: Bearing puller

On some units, the bearing housings slide off the bearings and the puller such as the one shown in Figure 43: Bearing puller for units with bearing housings that slide off bearings on page 48 should be used. This type of puller pulls directly against the bearing itself. The puller bar must be square with the end of the shaft at all times and the puller screw should be tightened steadily to enable the bearings to slide smoothly off the shaft. Do not dame the end of the shaft.

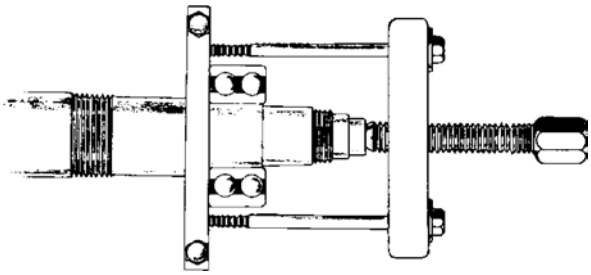


Figure 43: Bearing puller for units with bearing housings that slide off bearings

2. Sleeve bearings

   After the bearing shells have been removed, a bearing puller, such as shown in Figure 43: Bearing puller for units with bearing housings that slide off bearings on page 48, should be used to remove the ball bearing. The puller bar must be square with the end of the shaft at all times and the puller screw should be tightened steadily to enable the bearing to slide smoothly off the shaft. Do not damage the end of the shaft.

   After the bearings have been removed, they should be wrapped in clean paper or cloth to prevent contamination. Other parts which surround the bearings, such as bearing housings, should be kept clean in the same manner.

7.5 Ball bearing installation

A film of clean machine oil should be applied to the bearing seat on the shaft. The bearing should be started on the shaft by tapping the inner race with a hammer or mallet. Do not use a lead mall. The

bearing must be kept square at all times. Once the bearing is located on the shaft, a driving sleeve, such as the one shown in Figure 44: on page 49 should be used. The sleeve should contact the inner race of the bearing only. The bearing should be pressed or driven until it contacts the shoulder "x".

Duplex thrust bearings must be mounted in the proper position as described in 6.6 Reassembly on page 42.

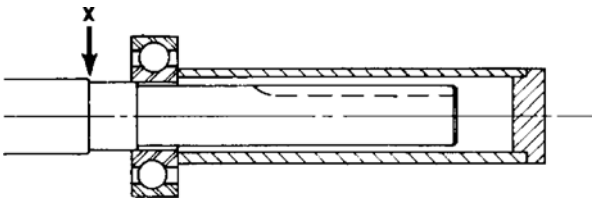


Figure 44:

8 Trouble Checklist

8.1 Trouble Check list

No liquid delivered

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

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

Not enough water delivered

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

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

Not enough pressure

1. Speed too low.*
2. Air or gases in liquid.

3. Impeller diameter may be too small.
4. Mechanical defects:
    - Impeller clearance too great
    - Impeller damage
5. Wrong direction of rotation or impeller installed backwards.
6. Be sure pressure gauge is in correct place on discharge nozzle or discharge pipe.

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

Pump works a while and then quits

1. Leaky suction line.
2. Stuffing box packing worn, or liquid seal plugged, allowing leakage of air into pump casing.
3. Air pocket in suction line.
4. Not enough suction head for hot 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 vacuum or compound gauge.
7. Impeller plugged.
8. Obstruction in suction or discharge line.
9. Casing gaskets damaged.

Pump takes too much power

1. Speed too high.*
2. Head lower than rating, pumps too much water.
3. Liquid heavier than anticipated. Check viscosity and specific gravity.
4. Mechanical defects:
    - Shaft bent.
    - Rotating element binds.
    - Stuffing box too tight.
    - Impeller clearance too great.
5. Wrong direction of rotation or impeller installed backwards.

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

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 correct for liquid handled.
4. Shaft sleeve scored.
5. Insufficient packing.
6. Damaged mechanical seal.

Pump is noisy or vibrates

1. Hydraulic noise, cavitation, suction lift too high. Check with vacuum or compound gauge.

2. Mechanical defects:
    - Shaft bent.
    - Rotating parts bind, are loose or broken.
    - Bearings worn out.
    - Coupling misaligned.

High bearing temperature

Refer to 7.1 Bearing Temperatures on page 47

1. Pump and driver misalignment.
2. Pump capacity too low.
3. Improper lubrication.
4. Excessive vibration.
5. Bent shaft.
6. Rotating element binds.

9 Ordering of Spare Parts

9.1 Spare parts

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

The most desirable parts to have on hand are the following:

1. Horizontally split case pumps
    1. Rotating element: this is a group of assembled parts, including bearings, bearing housings, shaft, impeller(s), wearing rings, stuffing box bushings, and all rotating parts except the coupling.
    2. Stuffing box packing (if any): one set for each stuffing box.
    3. Stuffing box gland packing (if any): one set for each gland.
    4. Mechanical seals (if any): one seal for each stuffing box.
2. Frame mounted end suction pumps
    1. Support head: this is a group of assembled parts which includes all parts except the casing, suction cover and coupling. The impeller is not mounted on the shaft.
    2. Stuffing box packing (if any): one set
    3. Stuffing box gland packing (if any): one set
    4. Mechanical seal (if any): one.
3. Back pull-out end suction pumps
    1. Back pull-out assembly: this is a group of assembled parts which includes all parts except the casing and coupling.
    2. Stuffing box packing (if any): one set
    3. Stuffing box gland packing (if any): one set
    4. Mechanical seal (if any): one.

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

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 replaced as needed.

Following is a list of these suggested parts:

1. Stuffing box packing (if any): one set for each stuffing box.
2. Stuffing box gland packing (if any): one set.
3. Mechanical seal (if any).
4. Shaft sleeve (if any).
5. Ball bearings: one of each.
6. Shaft nut (if any).
7. Bearing locknut and washer (if any).
8. Wearing rings (if any).
9. Shaft - one required.
10. Impeller key (if any).
11. Stuffing box bushings (if any).

If it is not convenient or desirable to carry the spare parts listed above, the following list is suggested as a minimum for servicing the pump under ordinary conditions of wear:

1. Stuffing box packing (if any) - one set for each stuffing box.
2. Stuffing box gland packing (if any) - one set.
3. Shaft sleeve - if any.
4. Ball bearings - one of each.
5. Shaft nut (if any).
6. Bearing locknut and washer (if any).

9.2 Instructions for ordering spare parts

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

1. Give model number, size of the pump and serial number. These can be obtained from the name-plate.
2. Write plainly the names, part numbers and materials of the parts required. These names and numbers should agree with those on the Sectional view in 10.1 Sectional View and Parts List on page 55.
3. Give the number of parts required.
4. Give complete shipping instructions.

10 Parts Listings and Cross-Sectional Drawings

10.1 Sectional View and Parts List

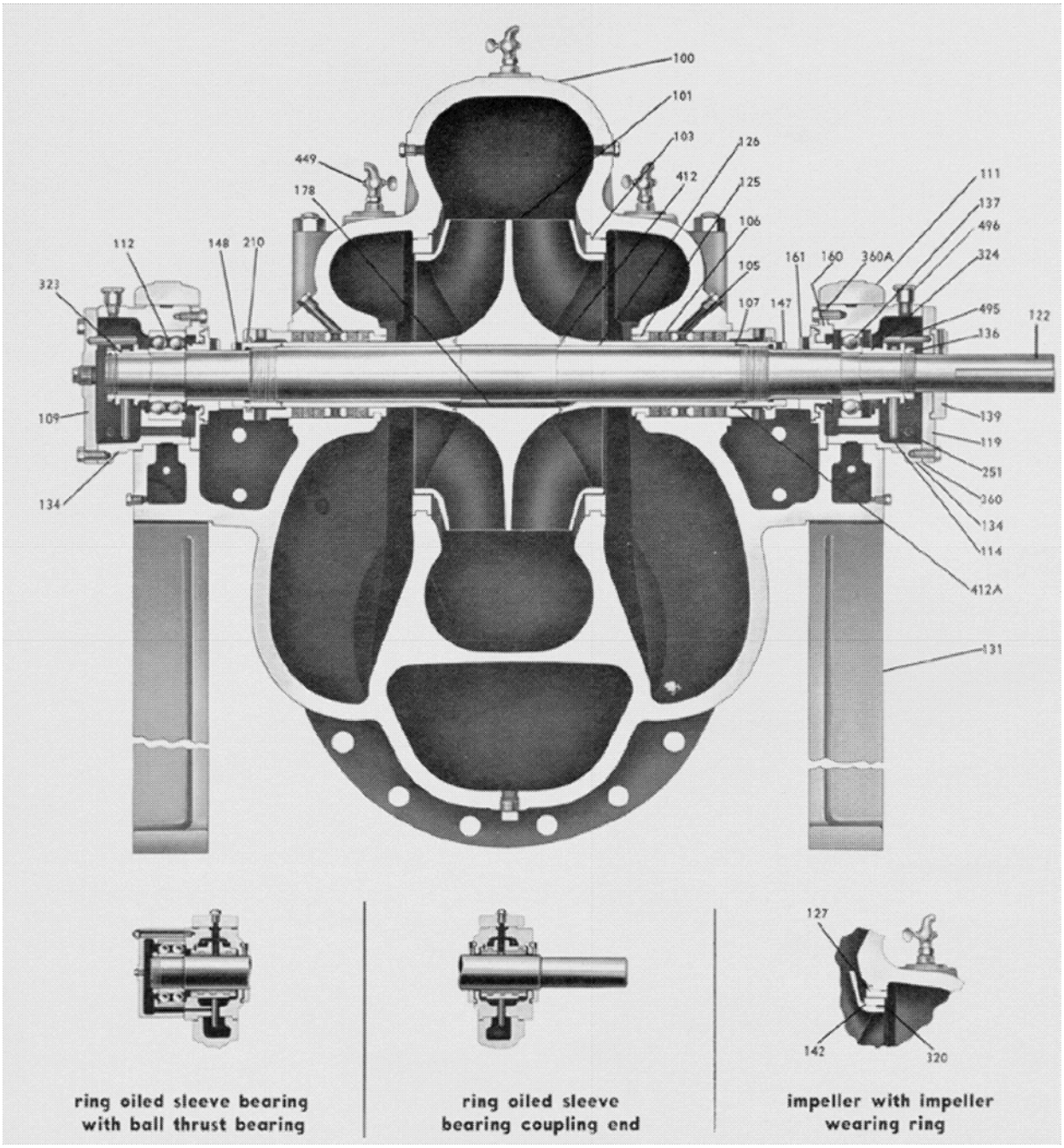


Figure 45:

Parts list and materials of construction

Item No.	Reg per pump	Part Name	Material				
			B.F.	A.L.	A.E.	316 SS	Al/316 R.E.
100	1 upper 1 lower	Casing	1003	1003	1103	316	1003
101	1	Impeller	1103	1000	1103	316	316
103	2	Wearing ring, casing	1106	1000	1106	316	316
105	2	Lantern ring	1102	1000	1102	316	316
106	1 set	Stuffing box packing	Non-Asbestos				
107	2	Stuffing box split gland	1106	1000	1106	316	316
109	1	Bearing end cover, thrust end	1000				
111	2	Bearing cap	1000				
112	1	Ball bearing, thrust end	Steel				
114	2	Oil ring	Brass				
119	2	Bearing end cover, coupling end	1000				
122	1	Shaft	SAE 4340	SAE 4340	316		
125	2	Shaft box bushing	1102	1000	1102	316	
126	2	Shaft sleeve	1106	1000	1106	316	
127	2	Wearing ring, casing (with imp wearing ring)	1106	1000	1106	316	
131	2	Pedestal	1000				
134	2	Bearing housing	1000				
136	2	Bearing locknut and lockwasher	Steel				
137	1	Ball bearing, coupling end	Steel				
139	1	Dust cover	1000				
142	2	Wearing ring, impeller	1103	1000	1103	316	
147	1	Shaft sleeve nut, left hand	1106	1000	1106	316	
148	1	Shaft sleeve nut, right hand	1106	1000	1106	316	
160	2	Bearing end cover, inboard	1000				
161	2	Oil thrower	1000				
178	1	Impeller key	AISI 303				
210	2	Gland packing	Lubricated non-Asbestos				
229	4	Swing bolt, (not shown)	Steel		AISI 303		
251	2	Constant level oiler (not shown)	White metal and glass				
320	6	Set screw, impeller wearing ring	316				
323	1	Oil ring sleeve, thrust end	1000				
324	1	Oil ring sleeve, coupling end	1000				
351	2	Gasket, parting flange (not shown)	non-Asbestos				
355	4	Swing bolt nut, (not shown)	316				
360	2	Gasket, bearing end cover	.0045 paper				
360A	2	Gasket, bearing housing cover, inboard	.0045 paper				
412	2	O-ring, impeller hub	Buna rubber				
412A	2	O-ring, sleeve nut	Buna rubber				
449	2	Air cock	Brass	Steel	Brass	316	Steel
495	2	Retainer pin, oil ring	Steel				
496	2	Breather	Steel				

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

Symbol

1000 - Cast iron - corresponds to ASTM A278 Class 25

1003 - Cast iron - corresponds to ASTM A278 Class 30

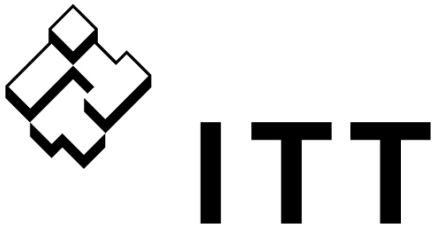
316 - corresponds to AISI Type 316 (wrought) or ASTM A296 CF-8M (Cast)

Construction details

		Group S				Group M			
		8x10-22	12x14-18	14x16-18	16x18-18	10x12-22	14x16-22	16x18-22H	18x20-22
Pump	Weight - bronze fitted bore pump	2700	2420	3300	3450	3400	4600	4900	5400
	Min casing thickness, cast iron and bronze	13/16"	¾"	13/16"	1/8"	7/8"	1-1/8"	1-3/8"	1-3/16"
	Casing capacity - gallons	35	50	70	100	45	90	110	135
Stuffing box	Stuffing box depth (to stuffing box bushing)	5"				?			
	Stuffing box packing (size)	4-5/8"							
	Stuffing box, number of packing rings	5				5			
	Width of lantern ring	1-1/4				1-1/4			
Shaft	Shaft dia. at impeller	3-1/4"				3-3/4"			
	Shaft dia. in shaft sleeve	3-1/4"				3-3/4"			
	Shaft dia. coupling end	2-1/4"				2-3/4"			
	Outside dia. of shaft sleeve	3-3/4"				4-3/8"			
General	Ball bearing, coupling end	MRC-3125				MRC-3155			
	Ball bearing, thrust end	MRC-5312				MRC-5315			
	Max total working pressure	Refer to pressure temperature chart							
	Max test pressure	150% of working pressure at 100ºF							
	Bearing centers	39"				44"			
	Max shaft HP per 100 RPM	46.5				89.0			
Temp limits	Max liquid temp without quenching	180ºF							
	Max liquid temp with quenching	275ºF							

11 Local ITT Contacts

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



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