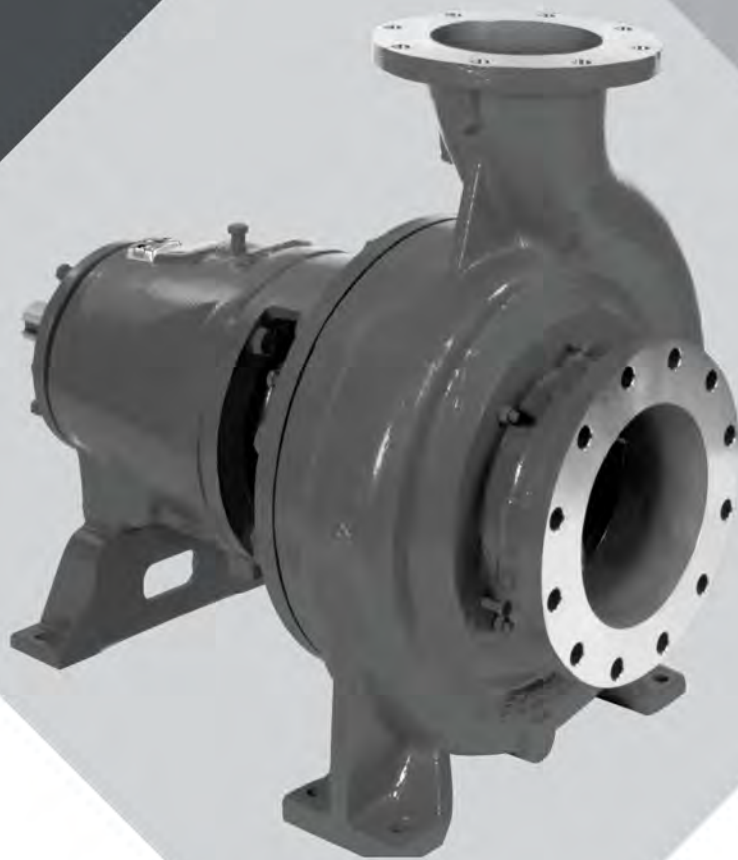




Installation, Operation and Maintenance Instructions

3175



ITT

ENGINEERED FOR LIFE

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 www.gouldspumps.com/literature_ioms.html 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 www.gouldspumps.com.

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 www.gouldspumps.com/literature.

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 this 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

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.









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.



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.

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: <ul style="list-style-type: none"> ♦ Insulated work gloves when handling hot bearings or using bearing heater ♦ Heavy work gloves when handling parts with sharp edges, especially impellers ♦ Safety glasses (with side shields) for eye protection ♦ Steel-toed shoes for foot protection when handling parts, heavy tools, etc. ♦ Other personal protective equipment to protect against hazardous/toxic fluids
WARNING		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.

General Precautions		
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.

General Precautions		
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.

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:

1. Monitoring the pump frame 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 www.gouldspumps.com/literature_ioms.html 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:



The CE and the Ex designate the ATEX compliance. The code directly below these symbols 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 1)

Table 1		
Code	Max permissible surface temperature °F (°C)	Max permissible liquid temperature °F (°C)
T1	842 (450)	700 (372)
T2	572 (300)	530 (277)
T3	392 (200)	350 (177)
T4	275 (135)	235 (113)
T5	212 (100)	Option not available
T6	185 (85)	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.

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.

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Product Description

Description of Units

Reference is made to several different types of pumps in the following text. To enable the reader to associate these terms to his particular unit, photographs of typical units with an identifying description are shown below.

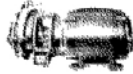


Figure 1: Close Coupled

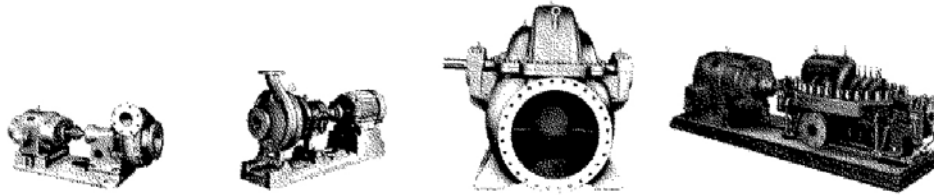


Figure 2: Horizontal



Figure 3: Vertical

Installation

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 start-up.
- 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 ° 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)..

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

Install Close-Coupled and Vertical Pumps

1. Close Coupled
 - a) A "close-coupled" pump may be mounted horizontally or in a vertical position provided motor is above pump.
 - b) 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 holddown bolt holes in the motor feet and pump/ adapter feet. Depending upon the motor frame, the pump or adapter feet may be higher or lower than the motor feet.
 - c) 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.
2. Vertical

- a) 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.
- b) Check all bolts and nuts on the entire unit to make sure they are securely tightened.
- c) Connect float and controls as shown in sectional view at [Parts List](#) (page 50).
3. Installation must be done with care to avoid damage and insure proper operation. It is recommended that a man be stationed inside the pit, whenever possible, to assist in the initial installation.
4. 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.
5. 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.
6. Place motor on motor support and tighten bolts (with lock washers) snugly.
7. Check for alignment by laying a straight edge across coupling hubs at four points 90° apart. See image below. When the straight edge rests evenly at all four points, the coupling is aligned.

NOTICE: Alignment of the coupling is of extreme importance for trouble-free mechanical operation.

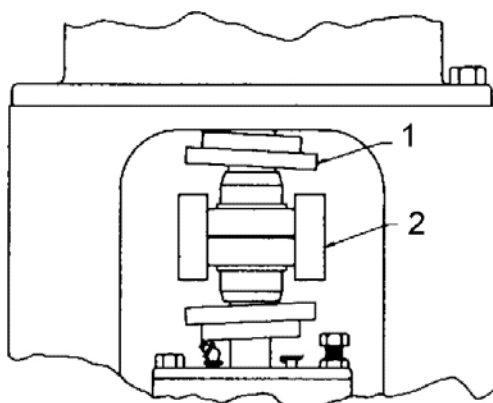


Figure 4: Coupling Alignment

1. Coupling cover

2. Straight edge

8. 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.

Install 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.

- a) Place a washer between the bolt head and sleeve to hold bolts. See image below.

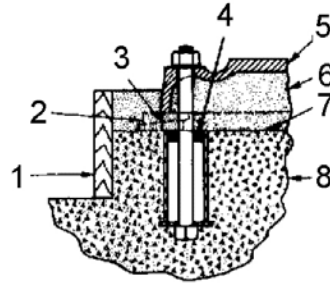


Figure 5: Concrete Foundation

- | | |
|--|--|
| 1. Dam | 5. Bedplate |
| 2. Wedges | 6. Grout |
| 3. Leave 3/4" to 1-1/2" under bedplate for grout | 7. Leave top of foundation rough and wet before grouting |
| 4. Waste | 8. Concrete foundation |

The I. D. of the sleeve should be 2 1/2 - 3 times the bolt diameter.

- b) 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 1/4" after allowance has been made for grouting, bedplate thickness, and nut thickness.
3. Put the unit in place on wedges. The wedges should be placed at four points as shown in the image below. Some long installations may require additional wedges near the middle of the bedplate.

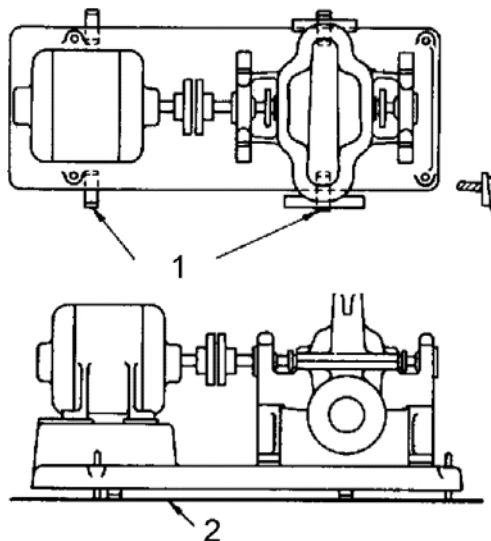


Figure 6: Wedge placement

- | | |
|-----------|---------------|
| 1. Wedges | 2. Foundation |
|-----------|---------------|
4. Disconnect coupling between pump and driver.

NOTICE: "Spider-Insert" couplings, as shown in the image below, need not be disconnected.

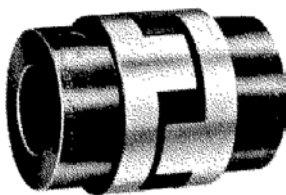


Figure 7: Spider-Insert Couplings

5. By adjustment of wedges, bring the bedplate to an approximate level and provide the proper distance above the foundation for grouting 10.05mm to 38.1mm | 3/4" 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 above pump shaft or if it is, that there is 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.

7. Build wood dam around foundation as shown in [Figure 1](#) (page 6), 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.

General Alignment Procedures

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 conditions. The final alignment procedure is outlined in [Final Alignment](#) (page 27) 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 preassembled).
2. Flexible Spacer Coupling - Furnished as standard on all "back pull-out" units. Contains a removable spacer piece located between coupling hubs.

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

Parallel Alignment

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

2. 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:

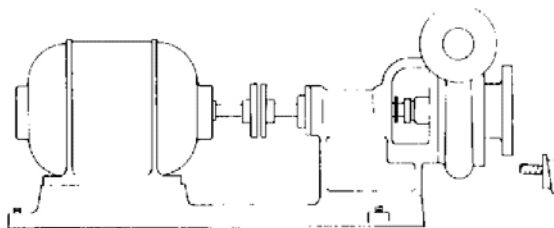


Figure 8: Frame Mounted Units

Pumpage Temperature	Set
Above Ambient	Motor
Temperature	Shaft
Ambient	0.102mm - 0.152mm 0.004" - 0.006" Low
38°C 100°F	0.051mm - 0.102mm 0.002" - 0.004" Low
93°C 200°F	0.000mm - 0.051mm 0.000" - 0.002" Low
149°C 300°F	0.000mm - 0.051mm 0.000" - 0.002" High

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

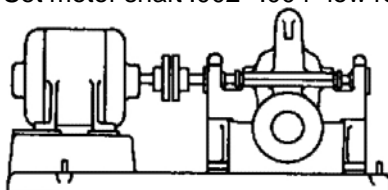


Figure 9: Pedestal Mounted Units

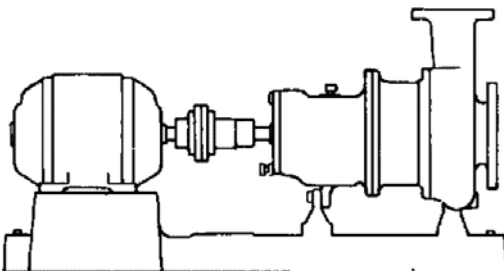


Figure 10: Casing Mounted Units

Pumpage Temperature	Set
Above Ambient	Motor
Temperature	Shaft
Ambient	0.051mm - 0.102mm 0.002" - 0.004" Low
38°C 100°F	0.000mm - 0.051mm 0.000" - 0.002" High
93°C 200°F	0.102mm - 0.152mm 0.004" - 0.006" High
149°C 300°F	0.203mm - 0.254mm 0.008" - 0.010" High

204°C 400°F	0.305mm - 0.356mm 0.012" - 0.014" High
260°C 500°F	0.406mm - 0.457mm 0.016" - 0.018" High

3. To check the parallel alignment:
 - a) Flexible Couplings: Place a straight edge across both coupling hubs at four points 90° apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See image below.
 - b) "Spider-Insert" Couplings: Place a straight edge across both coupling hubs at four points 90° apart. The unit will be in parallel alignment when the straight edge rests evenly on both halves. See image below.

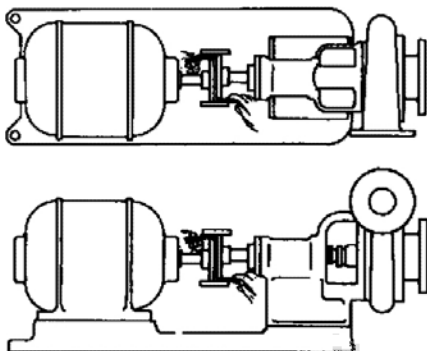
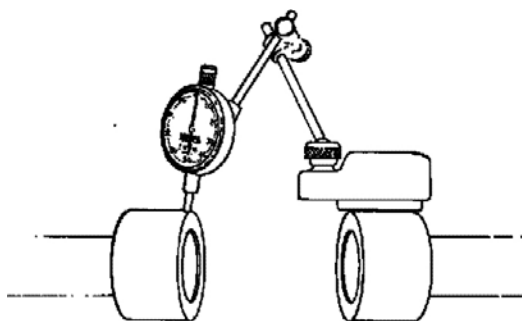


Figure 11: Parallel Alignment with Straight edge

- a) Flexible Spacer Couplings: Place a dial indicator on one hub and rotate that hub 360° while taking readings on the outside diameter of the other hub. When indicator does not deflect more than 0.051mm | 0.002" total, parallel alignment is achieved. See image below.

Figure 12: Parallel Alignment with Dial Indicator



Angular Alignment

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

- a) Flexible Couplings: The normal "gap" (distance between coupling halves) is approximately 3.175mm | 1/8". However, the coupling manufacturer's instructions should be followed. Insert a "feeler" or taper gauge at 90° intervals on the circumference of the hubs. When the "gap" is identical within 0.051mm | .002", the unit is in angular alignment. See image below.

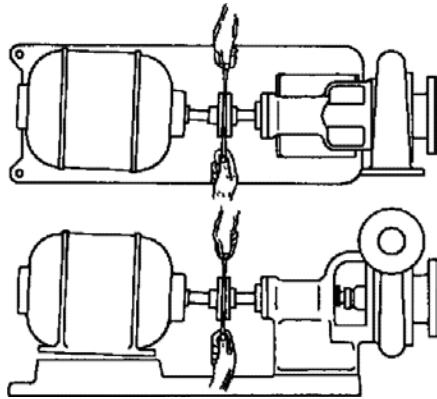


Figure 13: Angular Alignment with Flexible Couplings

- b) Spider Couplings: The normal "gap" (distance between hub and insert) is approximately 1.588mm | 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 image below.

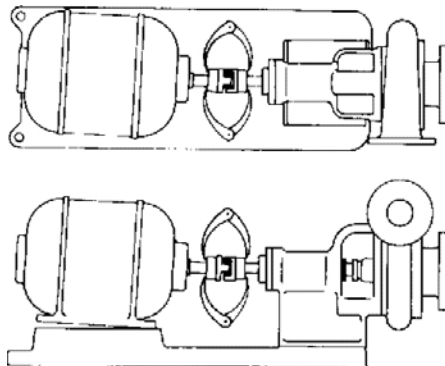


Figure 14: Angular Alignment with Calipers

- c) Flexible Spacer Couplings: Place a dial indicator on one shaft hub and rotate that hub 360°. Take readings from the face of the other hub. Alignment is achieved when indicator does not deflect more than .002". See image below.

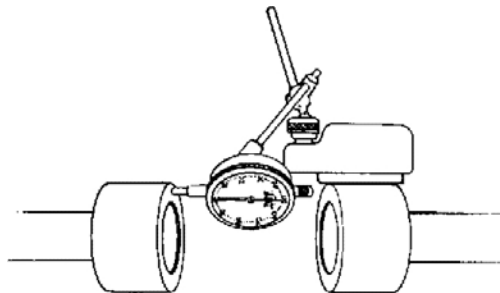


Figure 15: Angular Alignment with Dial Indicator

General Piping

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. See [Final Alignment](#) (page 27).

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 image below. During operation, valves "1" and "3" would be closed, "2" and "4" open. Prior to dismantling, close valves "2" and "4", open "1" and "3". Introducing water at valve "3" will allow water to flush pump and drain at valve "1".

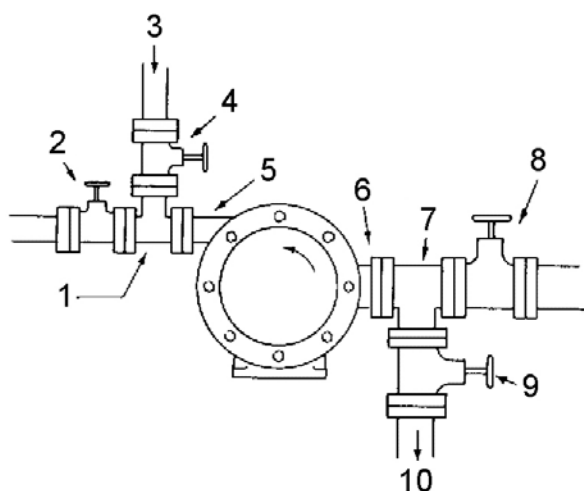


Figure 16: Piping

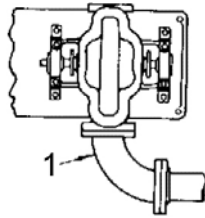
- | | |
|----------------|--------------|
| 1. Tee | 6. Suction |
| 2. Valve "A" | 7. Tee |
| 3. Flush water | 8. Valve "2" |
| 4. Valve "3" | 9. Valve "1" |
| 5. Discharge | 10. To waste |

General Suction Piping

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

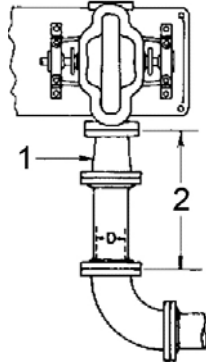
1. Use of elbows close to the pump suction flange should be avoided. Where used, elbows should be long radius.

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 used 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.



1. Elbow must be vertical when next to pump

Figure 17: Wrong



1. Eccentric reducer - with top horizontal

2. Must be at least 2D

Figure 18: Recommended

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.

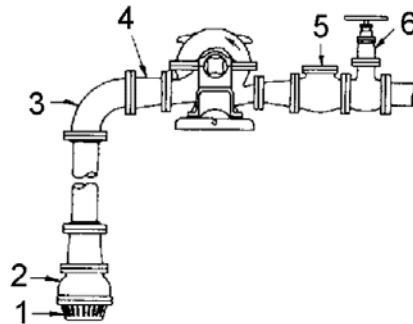


Figure 19: Correct Piping

1. Strainer

2. Foot valve (if used)

3. Long radius elbow

4. Eccentric reducer

5. Check valve

6. Gate valve

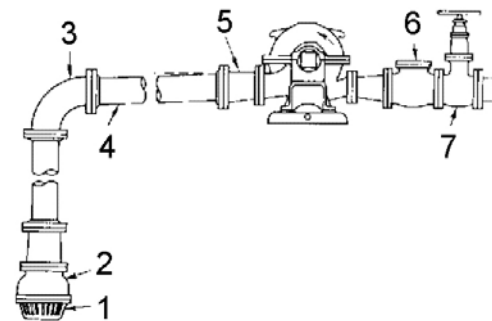


Figure 20: Correct Piping

- | | |
|--|----------------------|
| 1. Strainer | 5. Eccentric reducer |
| 2. Foot valve (if used) | 6. Check valve |
| 3. Long radius elbow | 7. Gate valve |
| 4. Suction pipe slopes upwards from source of supply | |

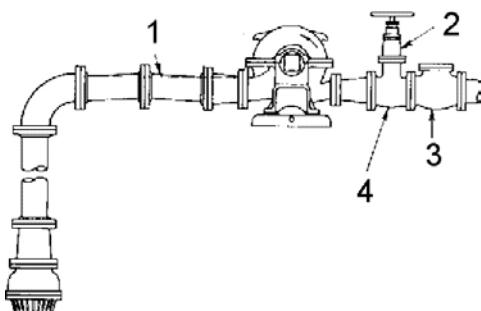


Figure 21: Incorrect Piping

1. Air pocket because eccentric reducer is not used and because suction pipe does not slope gradually upward from supply
2. Gate valve
3. Check valve
4. Gate valve should not be between check valve and pump
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, see recommended piping arrangement shown in the image below.

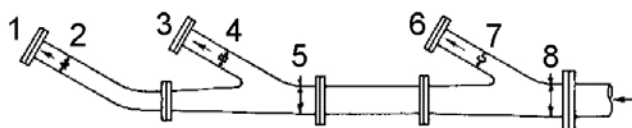


Figure 22: Recommended Piping Arrangement (when separate suction lines are not possible)

- | | |
|-------------|---------------------------------|
| 1. Pump | 5. Area = "A" + "B" (min) |
| 2. Area "A" | 6. Pump |
| 3. Pump | 7. Area "C" |
| 4. Area "B" | 8. Area = "A" + "B" + "C" (min) |

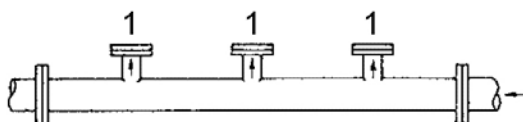


Figure 23: Incorrect Piping Arrangement

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 image below and should not be subjected to rapid changes in direction of the flow pattern.

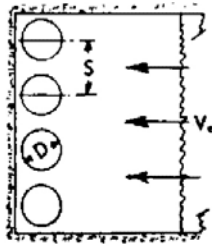


Figure 24: Recommended Pipe Arrangement

$V_e = 1\text{fps or less}$

$S = 1\text{-}1/2 \text{ to } 2D$

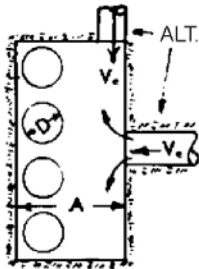


Figure 25: Not Recommended

$V_e = 2\text{fps and up}$
If $A = \text{less than } 8D$

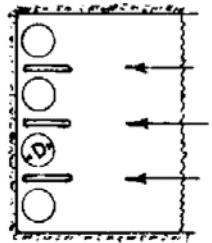


Figure 26: Recommended

Add wall thickness to centerline distance round or ogive wall ends. Gap at rear of wall appx. $D/3$

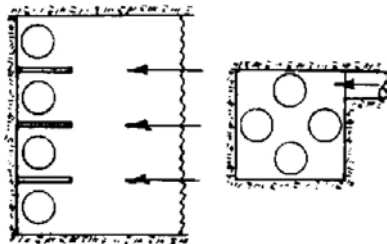


Figure 27: Neither Recommended

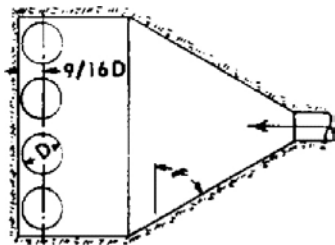


Figure 28: Recommended

Min $O^\circ = 45^\circ$

Preferred $O^\circ = 75^\circ$

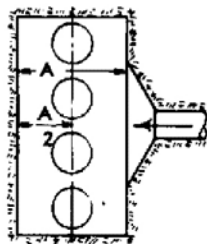


Figure 29: Not Recommended

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 a 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 5](#) (page 13).
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 closing of the line for pump inspection and maintenance.
2. Keep suction pipe free from air pockets.

Discharge Piping

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. Increasesers, 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.

Connection of Piping

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

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

Rotation

NOTICE: Serious damage may result if pump is run in wrong direction.

1. Before coupling is connected, the motor should be wired and the direction of rotation checked.
2. The direction of rotation is marked on the pump. Make sure driver rotates in the same direction.

Connection of Coupling

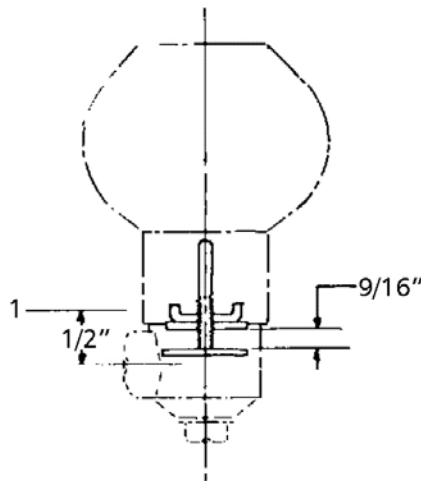
1. Connect coupling. Follow the manufacturer's instructions.
"Spider-Insert" type couplings are pre-assembled.
2. If a coupling guard is furnished with the unit, make sure it is securely fastened.

Commissioning, Startup, Operation, and Shutdown

Pump Bearings

Oil Lubrication

Oil lubricated pumps are not lubricated at the factory. A high quality turbine type 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. The oiler was adjusted to maintain proper oil level before leaving the factory. The adjustment should be checked in case this setting was disturbed. See image below. Check the assembly dimension print for proper location.



1 - Oil level

Figure 30: Oiler

Instructions

1. Remove adjustment assembly from oiler
2. Adjust bars to 9/16"
3. Lock in position
4. Replace adjustment assembly in oiler

Under normal operating conditions, an oil of 300 SSU viscosity at 38°C | 100°F. (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 an oil level remains in the bottle. Several fillings of bottle 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 of sodium lithium base, NGLI #2 consistency. Do not use graphite. Further greasing instructions are included in [Lubricate the Pump](#) (page 32).

Vertical Pump Bearings

The bearing above the pump support plate is a ball bearing and is grease lubricated. Follow the 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. See [Lubricate the Pump](#) (page 32) 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.

Driver Bearing and Coupling

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

Stuffing Box 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 the stuffing box. Stuffing box packing is furnished in the box of fittings which accompanies the pump. When packing the stuffing box, refer to the [Parts List](#) (page 50) 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 image below. Another form of packing ring is the 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.

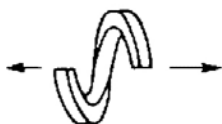


Figure 31: Correct



Figure 32: Incorrect

There are two basic types of lantern rings - PTFE and metal. Two-piece PTFE lantern rings are supplied in most units. Install as shown below. Note: 2 pieces make one ring. Notches must face one another but need not be aligned.

Figure 33: Metal Lantern Ring



Correct



Incorrect



Figure 34: PTFE Lantern Ring

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 image below. Use gland to jack the bushing and ring into the box. Stagger joints in each ring 90°. Make sure center of lantern ring lines up with flush tap in the stuffing box. Any extra rings are spares.

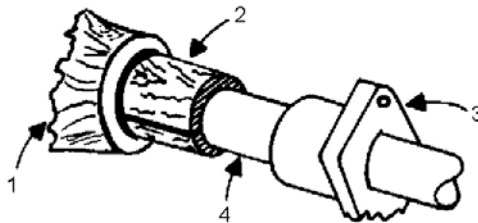


Figure 35: Wooden split bushing

- | | |
|---------------------------|----------|
| 1. Stuffing box | 3. Gland |
| 2. Wooden "split bushing" | 4. Shaft |

Tighten the gland nuts evenly but not tight. Follow adjustment procedure outlined in [Initial Inspection After Starting](#) (page 27).

Remove 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.
See [Disassemble the Pump](#) (page 35).
 - a) Remove packing and lantern ring and inspect sleeves.
 - b) If deeply grooved, sleeves should be replaced.

Mechanical Seals

When mechanical seals are furnished, the description and identification is indicated on the order writeups which are a part of the order acknowledgement, dimension print, and the packing list. Separate seal manufacturers' 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.

Connection of Sealing Liquid or Grease Lubricator (Packed Box)

If the stuffing box pressure is above atmospheric pressure, and the pumpage is dean, 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 and lubricated and air will be drawn into the pump.

Sealing Liquid

Sealing liquid may be supplied by recirculation of pumpage through a line from the casing to the stuffing box. If the 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 recirculating pumpage or outside sealing liquid is not desired. The grease should be insoluble in the pumpage.

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 the 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 (usually 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 [Parts List](#) (page 50). 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

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

Mechanical Seals

Seal materials (carbon, ceramic, PTFE, etc.) are suitable for use at temperatures to 260°C | 500°F. (100°C to 121°C | 212°F to 250°F 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. Onehalf 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 chamber. One-half to two GPM should be circulated. Cooling water, one to three GPM, should be circulated through the stuffing box jacket, if any.

Connection of Drain Piping

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

Connection of Equalizing Piping

Some multi-stage pumps have equalizing piping to equalize pressure on the stuffing boxes (see [Parts List](#) (page 50)). 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.

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 [Impeller Clearance Adjustment](#) (page 33).

Check for Free Turning

1. Rotate shaft by hand to be sure rotating element is free. If element rubs or binds:
 - a) Check alignment.
 - b) Remove pipe loads.
 - c) Check impeller clearance (if external adjustment is possible) as outlined in [Impeller Clearance Adjustment](#) (page 33).
 - d) If unit is equipped with leveling bolts on frame or casing foot, then check to be sure that bolts are not overtightened.

Regulation of Cooling and Flushing Liquids

The supply 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
- Mechanical Seals - ½ to 2 GPM

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

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 100°F. Gradually heat pump before introducing hot liquids.

1. Suction Supply Above Pump

When pump is installed as shown below, pump will prime itself.

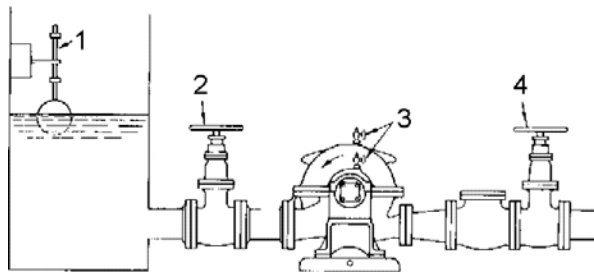


Figure 36: Self priming

- | | |
|-----------------------|-------------------------|
| 1. Float switch | 2. Air vent valves |
| 2. Suction gate valve | 3. Discharge gate valve |

- 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.

2. Prime with Foot Valve

With pump installed on suction lift, with foot valve at end of suction line, priming can be done any of the following three ways: In 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. During long idle periods, the pump can also lose its prime through leakage from stuffing boxes.

- a) 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.

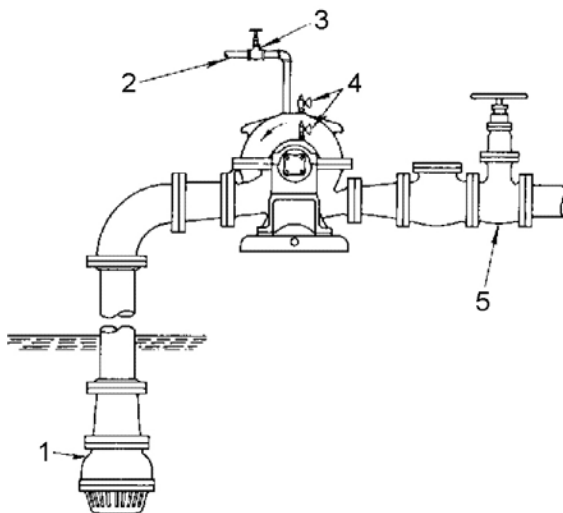


Figure 37: Foot valve

- | | |
|-----------------------------|-------------------------|
| 1. Foot valve | 4. Air vent valves |
| 2. From some outside supply | 5. Discharge gate valve |
| 3. Shut off valve | |

- b) By Separate Hand, or Manually Controlled, Priming Pump: Close discharge gate valve (keep air vent valves dosed) 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.

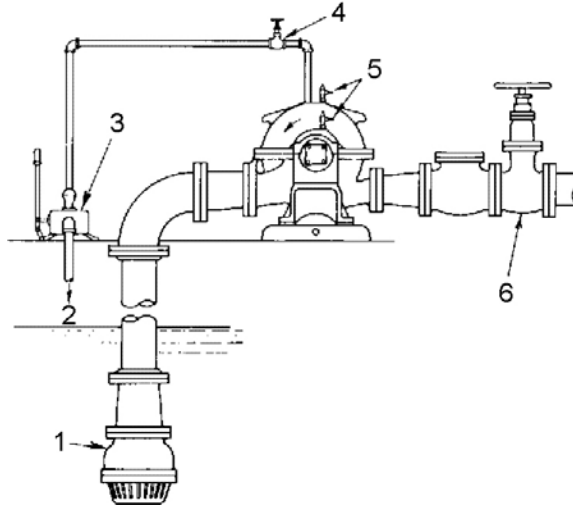


Figure 38: Hand or manually controlled pump

- | | |
|-------------------|--------------------|
| 1. Foot valve | 4. Air vent valves |
| 2. Priming pump | 5. Discharge valve |
| 3. Shut off valve | |

In methods a and b above, the pump will remain primed, provided foot valve is tight. Any failure, however, of foot valve when pump is standing idle, will permit the pump to lose its prime. During long idle periods, the pump can also lose its prime through leakage from stuffing boxes.

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

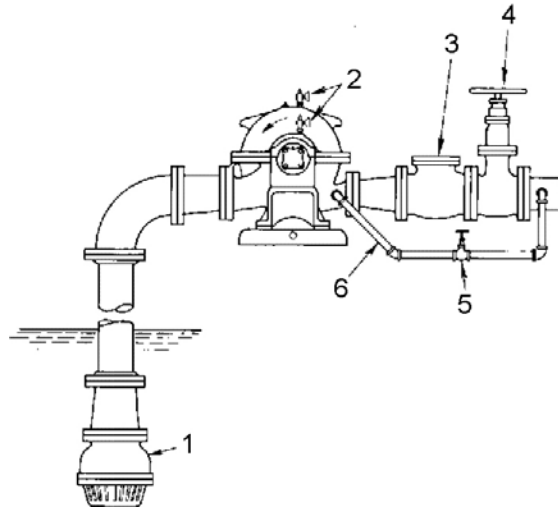


Figure 39: Bypassing

- | | |
|--------------------------|-------------------------|
| 1. Foot valve | 4. Discharge gate valve |
| 2. Air vent valves | 5. Shut off valve |
| 3. Discharge check valve | 6. By-pass line |

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

3. Priming by Ejection

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

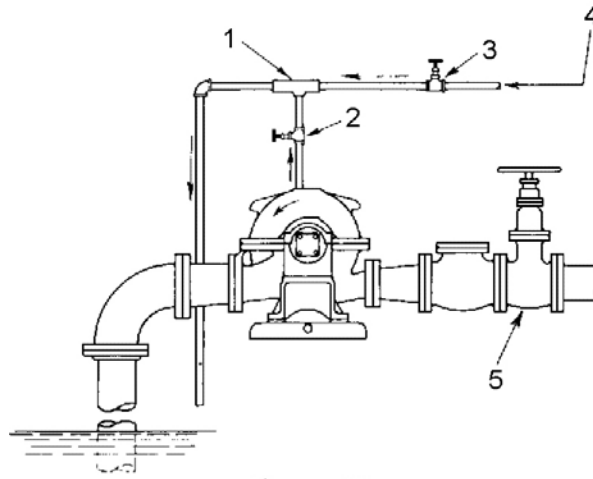


Figure 40: Ejection

1 - Ejector

2 - Valve "S"

3 - Valve "E"

4 - Steam, compressed air, or water under pressure

5 - Discharge gate valve

- b) 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.
4. Priming by Automatic Primer Pump

- a) 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 below is very well adapted.

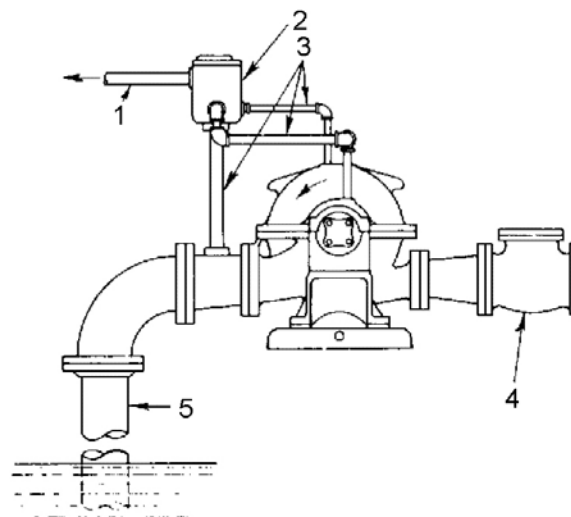


Figure 41: Automatic primer pump

1 - To primer pump

2 - Priming valve

3 - These lines must slope upward from pump to eliminate pockets

4 - Discharge check valve

5 - Suction pipe

- b) 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.

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 cool. Do not back off the gland nuts on a hot box as this will usually result in liquid leaking between the outer edge of the packing and the stuffing box bore. Remember that it takes newly installed packing some time to "run in" and that during this period, frequent attention and careful adjustments are necessary. See [Stuffing Box Operation](#) (page 28).

Mechanical Seal

The mechanical seal was adjusted at the factory. If the seal leaks slightly when 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.

Final Alignment

1. Final adjustment can only be accomplished after the unit has been run under actual operating conditions for a sufficient length of time to bring the unit up to operating temperature.
2. After this warm-up period has elapsed, stop the unit and immediately disconnect the coupling and check the alignment.
 - a) On "Back-Pull Out" end suction units, the frame foot should be loosened to relieve any strain due to thermal expansion.
 - b) On units which have jacking bolts on the foot, loosen the hold-down bolts.
 - c) On units which have a slotted hole on the foot near the bearing frame, loosen the foot-to-bearing frame bolt.
3. Make sure motor switch is "locked out" to prevent accidental rotation. After a minute or two, retighten foot bolts.
4. Repeat each alignment procedure outlined in [General Alignment Procedures](#) (page 7).
5. Reconnect coupling.
6. Check final alignment after approximately one week of operation.

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 in 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.

1. 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 1/4" per foot taper. The dowels should extend well into the bedplate but project above the pump feet.

2. Drivers should also be doweled but the driver manufacturer should be contacted for instructions.

Stuffing Box Operation

1. Stuffing boxes with packing rings - less quenching liquid or grease lubricator:
 1. Periodically inspect stuffing box to see that there is sufficient leakage to lubricate the packing and maintain a cool box. Never draw up packing so that the stuffing box heats, as this will cause damage to both packing and sleeve. Draw up gland nuts slowly and evenly and only when pump is running.
 2. 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:
 1. The same precautions as described above apply. However, the amount of leakage through 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 step 1 above.
 2. 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 the packing.
3. Stuffing boxes with packing rings - with grease lubricator:
 1. Operation is the same as directed in step 1 above, with the addition that the handle on the lubricator should be given a turn or two about every 100 hours of operation.
4. Stuffing boxes with mechanical seal:
 1. This type of box requires no attention other than to make sure that the circulating lines do not become clogged.

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 insurance against damage due to running the pump against a closed discharge valve or very low flow conditions.
3. Bearing temperature relay which will shut the unit down if the bearing temperature exceeds a predetermined maximum.

4. Low suction pressure control which will shut off the unit should the suction pressure drop below a pre-established minimum. A centrifugal pump should never be throttled for capacity adjustment on the suction side.

Operating at Reduced Head

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

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.

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.

Maintenance

Bearing Maintenance

Bearing Temperatures

All bearings operate at some 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 49°C to 53°C | 120° F - 130°F. depending upon the individual. Above this temperature, the human hand is worthless in estimating temperature.

Bearing temperatures up to 82°C | 180°F 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 sign al to investigate. The unit should be checked for abnormal hydraulic operation and unnecessary loads, such as coupling misalignment, etc.

Bearing Inspection

- **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.
- **Sleeve Bearing**
Sleeve bearings should be inspected to determine if any deep scratches or gouges (other than oil grooves) are present. The babbitted surfaes 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."

Clean the 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 in as dust-free an atmosphere as possible. All tools, as well as the hands, should be kept clean.

1. If new bearings are to be installed, they should not be unwrapped until ready for installation and should not be cleaned or washed.
2. 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:
 - a) Pour one or two quarts of clean, water-free kerosene into a clean pail.
 - b) Dip the bearings into the kerosene and agitate slowly.
 - c) Repeat until bearing is completely clean.
 - d) Blow dry with clean filtered compressed air.
 - e) 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.
 - f) When the bearing has been blown dry, oil it immediately with a good grade of clean machine oil to prevent corrosion or rust.
3. If there is any question as to the condition of bearings, it is always best to replace them. This may prevent an unplanned shutdown.

Bearing Removal

1. **Ball Bearings**

- a) A puller such as the one shown below 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.

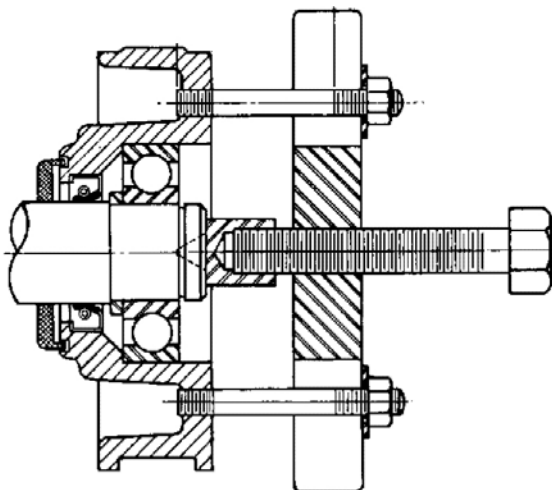


Figure 42: Bearing puller

- b) The puller screw should be tightened steadily to enable the bearing to slide smoothly off the shaft.

On some units, the bearing housings slide off the bearings and the puller such as the one shown below 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.

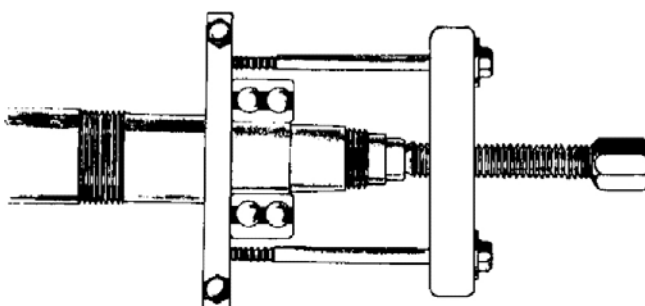


Figure 43: Bearing puller

NOTICE: Do not damage the end of the shaft.

2. Sleeve Bearings
 - a) After the bearing shells have been removed, a bearing puller, such as shown above should be used to remove the ball bearing.
 - b) 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.
3. After the bearings have been removed, they should be wrapped in dean paper or cloth to prevent contamination. Other parts which surround the bearings, such as bearing housings, should be kept clean in the same manner.

Install the Ball Bearings

1. A film of clean machine oil should be applied to the bearing seat on the shaft.
2. 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.

3. Once the bearing is located on the shaft, a driving sleeve, such as the one shown below should be used. The sleeve should contact the inner race of the bearing only. The bearing should be pressed or driven until it contacts shoulder "x".

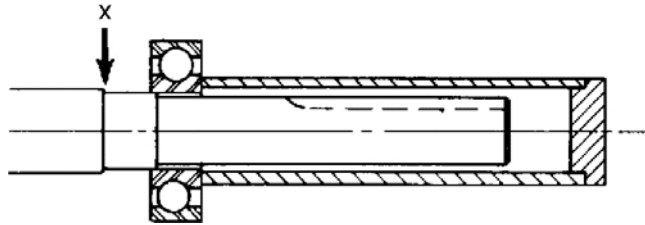


Figure 44: Driving sleeve

4. Duplex thrust bearings must be mounted in the proper position as described in [Reassemble the Pump](#) (page 41).

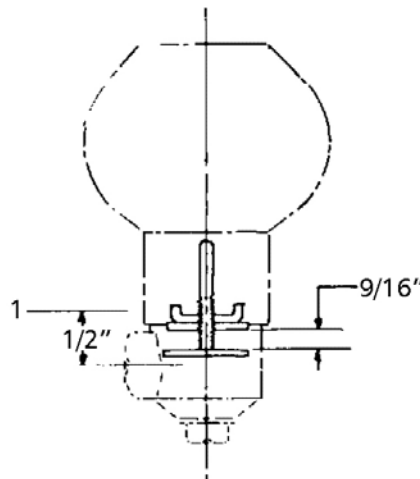
Lubricate the Pump

1. Oil Lubrication

Refer to [Pump Bearings](#) (page 17) for oil specifications. Oil lubricated ball bearings are standard on the Model 3175. The bearings are not lubricated at the factory.

Oil lubricated pumps are supplied with an oiler which maintains a constant oil level in the bearing frame. Refer to [Disassemble the Pump](#) (page 35) for oiler location.

- a) Before installing the oiler on the bearing frame, check the oiler adjustment.



1 - Oil level

Figure 45: Oiler

Instructions

1. Remove adjustment assembly from oiler
 2. Adjust bars to 9/16"
 3. Lock in position
 4. Replace adjustment assembly in oiler
- b) Install oiler on either side near oil level groove marked on frame.

- c) Fill the oiler bottle with oil and replace in the oiler housing. Oil reservoir in bearing frame 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.
For information only: The Model 3175 bearing frame oil capacities are:

Group	Approx. Capacity
S	167 oz 5 Qts.
M	133 oz 4 Qts.
L	100 oz 3 Qts.

2. Grease Lubrication - To lubricate pump: Insert grease through grease fittings while shaft is rotating, until clean grease appears through the relief caps.
Refer to [Pump Bearings](#) (page 17) for grease specifications. Grease lubrication is optional on the Model 3175. These units can be identified by the grease fitting located on the bearing housing. Bearings are lubricated at the factory. Do not grease at too frequent intervals.
To lubricate pump: Insert grease through grease fittings while shaft is rotating, until clean grease appears through the relief caps.
3. Conversion From Oil to Greased Lubrication

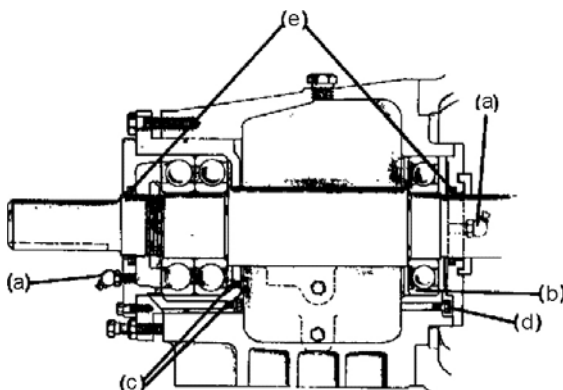


Figure 46: Grease lubricated bearings

- a) For oil lubrication, both bearing end covers (inboard and outboard) are equipped with two 1/8" taps that are plugged. To convert to grease lube, 1/8" Alemite fittings are installed in place of these plugs.
- b) Radial bearings are changed to have a shield on the frame reservoir side of the balls. The following are correct designations:

Frame	MRC Bearing No.
S	313 SF
M	317 MF
L	222 MF

- c) The bearing housing should have three 3.175mm | 1/8" recirculation openings plugged.
- d) Bearing frame should have one recirculation opening at the radial bearing plugged.
- e) Position of oil seals remain unchanged with lips facing away from bearings.

Impeller Clearance Adjustment

If a gradual loss in head and/or capacity occurs, performance can be restored by adjusting the impeller. If performance cannot be restored by adjustment, pump should be disassembled as directed in [Disassemble the Pump](#) (page 35) and the impeller and casing inspected for wear. Either a feeler gauge or a dial indicator can be used to set the impeller clearance.

Feeler Gauge Method

- Loosen adjustment bolts and nuts (371A & 423B).

2. Tighten bolts (370C) evenly, while slowly rotating the shaft, until the impeller just starts to rub on the casing.
3. Loosen each bolt (370C) until a 0.38 mm | .015" feeler gauge can be placed between the bearing housing flange and underside of head of bolts (370C).
4. Be sure that jam nuts on bolts (371A & 423B) are loose. Tighten each bolt (371A & 423B) a flat at a time until bearing housing is tight against bolts (370C). Be sure that all bolts (370C, 371A & 423B) are tight. Tighten jam nuts on bolts (371A & 423B).

A - Feeler Gauge

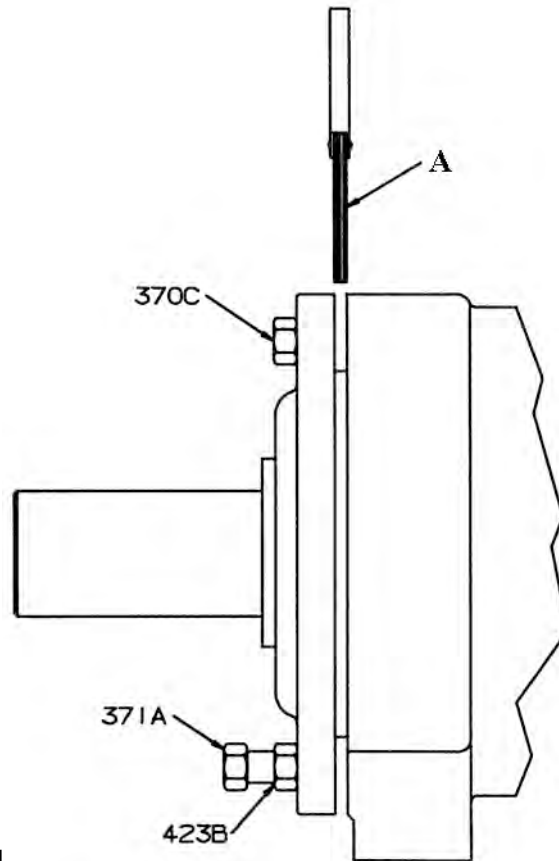


Figure 47: Feeler Gauge Method

Dial-Indicator Method

1. Remove one bolt (370C) and thread a pipe or rod in its place. This is to hold a dial indicator as shown below.
2. Loosen adjustment bolts and nuts (371A & 423B).
3. Tighten each bolt (370C) evenly, while slowly rotating the shaft, until impeller just starts to rub against casing.
4. Clamp a dial indicator so that the button rests against the end of the shaft, or against the front of the face of the coupling, and set indicator at zero.
5. Loosen bolts (370C) about 6 flats.
6. Be sure that jam nuts on the bolts (371A & 423B) are loose. Tighten bolts (371A & 423B) a flat at a time, until the dial indicator shows that the shaft has moved 0.38mm | 0.015".
7. Tighten bolts (370C), then check to be sure all bolts (371A & 423B) are tight. Finally, tighten jam nuts on bolts (371A & 423B).

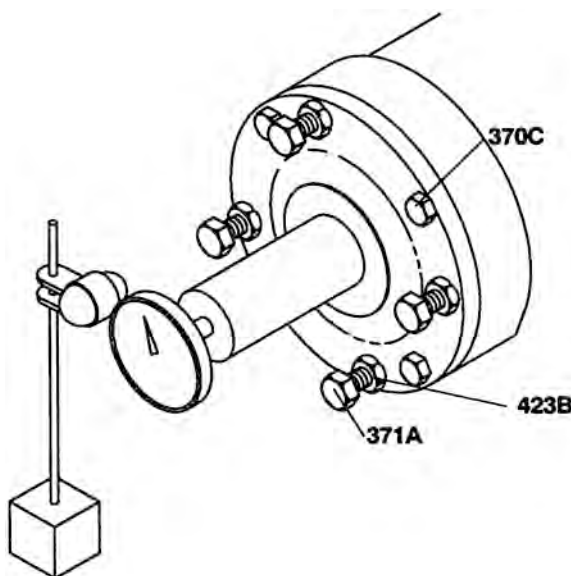


Figure 48: Dial Indicator Method

When either of the above methods, the rotating element and impeller have been moved 0.20mm to 0.38mm | 0.008" to 0.015" away from the casing, thus giving the required clearance between these two parts. Rotate shaft several times to check for free turning.

Disassemble the Pump

The back pull-out feature of this pump allows the complete back pull-out assembly (bearing frame and rotating element) to be removed without disturbing suction or discharge piping or driver.

The [Parts List](#) (page 50) contains a complete sectional view of the pump and parts list with the proper identification numbers. Refer to this section as required during maintenance procedures and when ordering spare or repair parts.

To prepare pump for disassembly, proceed as follows:

1. Lock out power supply to motor.
2. Shut off all valves controlling flow to and from the pump.
3. Drain liquid from pump. Remove casing drain plug (if supplied) which is located on bottom of casing at lowest point.
4. Remove all auxiliary tubing and piping.
5. Flush the pump to remove corrosive or toxic pumpage if required.
6. Disconnect coupling and remove coupling spacer (refer to coupling instructions).
7. Drain oil (remove drain plug) and remove bottle oiler.
8. If unit has stuffing box packing, remove the gland stud nuts. The gland is in two halves and can be removed.

The numbers located on the following figures refer to the procedure steps. For example, number 1 on Figure 5A refers to Step 1.

1. Place chain or sling from crane or hoist through eye bolt.

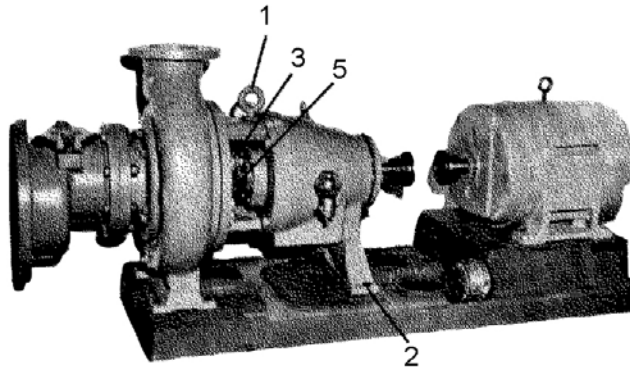


Figure 49: Disassembly

2. Remove frame foot hold-down bolts.
3. Remove bolts which hold frame adapter to casing.
4. Adjust sling tension to support back pull-out assembly.
5. Slide the back pull-out assembly from the casing. The Model 3175 has jacking bolts to assist disassembly. Screw the jacking bolts into the tapped holes in the frame adapter. Tighten bolts evenly, a flat at a time, to jack back pull-out assembly from casing. If working space is available to the side of the bedplate, the "pull-out assembly" can be turned perpendicular to the bedplate. Replace one pedestal hold-down bolt in bedplate and support the bearing frame flange with blocks. Complete disassembly of the "pull-out" assembly" can be accomplished on the job site. If preferred, it can be removed to an available work area.
6. Remove casing gasket.

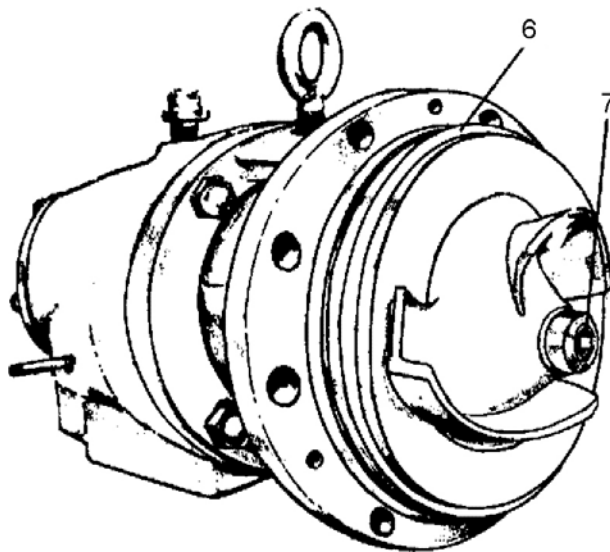


Figure 50: Pull-out assembly

7. Remove the impeller screw with 3/4" Allen wrench. Prevent the shaft from rotating by using a wrench on coupling "flats". Do not lose or damage the impeller screw O-ring.

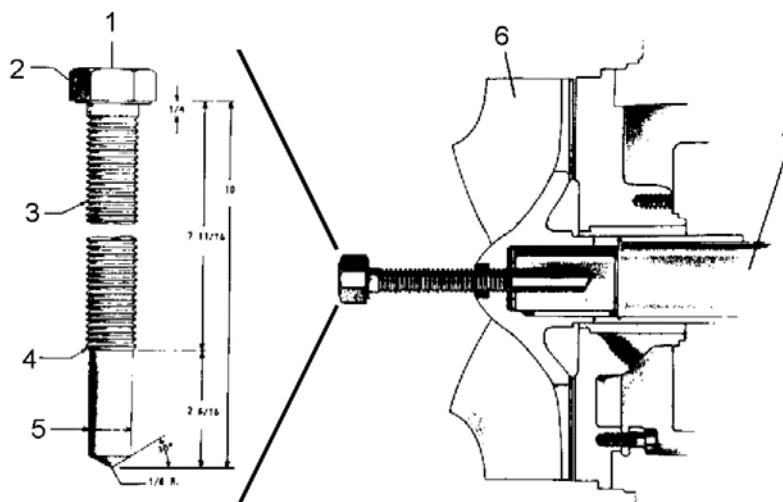


Figure 51: Impeller Puller Stud

- | | |
|--|----------------------------|
| 1. Impeller puller stud - Mach. from std 1" H.H.M bolt | 5. $13/16 \pm 0$ to $1/32$ |
| 2. 1-1/2 width across flats | 6. Impeller |
| 3. 1"11/12 R.H. threads | 7. Shaft |
| 4. 1/16 x 45° chamfer | |

Thread the impeller puller stud into the end of the impeller. This stud pushes against the shaft and pulls the impeller as the stud is turned clockwise.

8. Remove impeller key from the shaft.
Do not lose or damage the shaft sleeve O-ring which seals between the impeller and sleeve.
9. If unit has mechanical seal, remove gland stud nuts. The gland is a solid ring and cannot be removed after unbolting. Carefully slide the gland off the gland studs and move back on shaft and shaft sleeve. Avoid contact with exposed lapped seal faces and keep them clean.

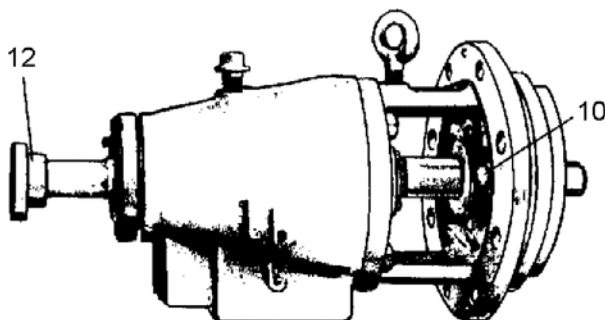


Figure 52: Removal of gland stud nuts and gland

10. Remove the adapter to stuffing box bolts. Pull the stuffing box cover from the frame adapter. (On some units, specifically the 18 and 22 inch units, tapped holes are provided in the frame adapter for the use of jacking bolts to assist disassembly of the stuffing box cover). Do not allow the stuffing box cover to strike the shaft, shaft sleeve, or any mechanical seal part.
11.
 - a) If the pump has a packed stuffing box, remove packing and lantern ring from the stuffing box cover.
 - b) If the pump has a mechanical seal, the rotary portion of seal will slide off with the sleeve. Do not damage seal faces.
12. Scribe shaft at coupling hub for proper positioning of hub during reassembly and remove hub.
To disassemble remainder of the liquid end; casing, suction sideplate, and suction piece (if supplied), proceed as follows:

13. Disconnect suction and discharge flanges.
14. Remove casing hold-down bolts and move casing toward driver. If preferred, casing can be removed from bedplate for further disassembly.
15. Remove suction sideplate nuts.

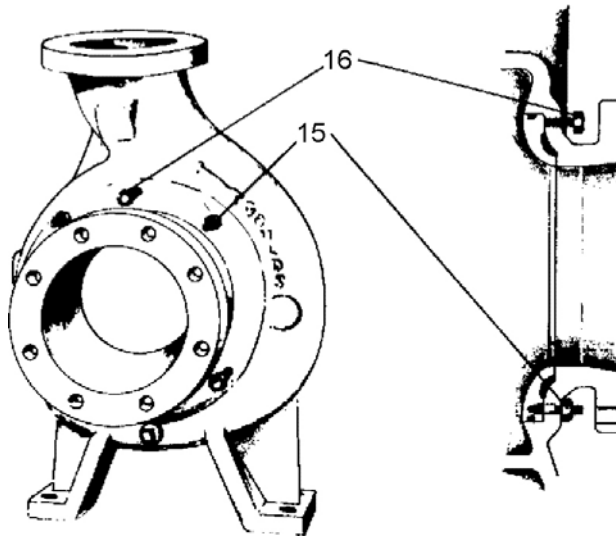


Figure 53: Liquid end disassembly

16. Remove the suction sideplate by tightening the jacking screws evenly. Be sure not to damage the sideplate O-ring. Remove the sideplate-to-casing gasket. To complete disassembly of the power end, proceed as follows:
17. Remove the bolts which hold the frame adapter to the bearing frame. Remove the frame adapter.
18. Remove the deflector from the shaft.
19. Remove the bolts which hold the inboard bearing end cover to the frame. Remove the end cover. Do not damage the oil seal.
20. Tap the oil seal from the inboard bearing end cover if replacement of seal is required. Refer to [Inspection and Overhaul](#) (page 39) for replacement sizes.
21. Remove bearing housing bolts (2). Impeller adjustment bolts with jam nuts (1) can be used to assist in the removal of the shaft and bearing assembly from the bearing frame.

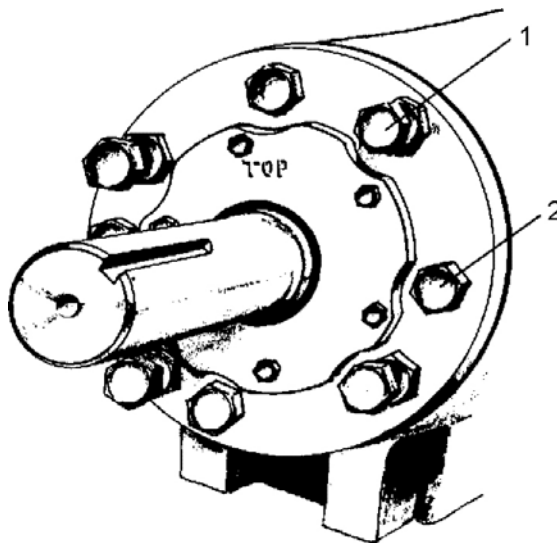


Figure 54: Bearing housing bolt removal

22. Slide the complete shaft assembly from back end of bearing frame. This includes the shaft, both bearings (radial and thrust), and bearing housing. Do not lose or damage bearing housing O-ring.

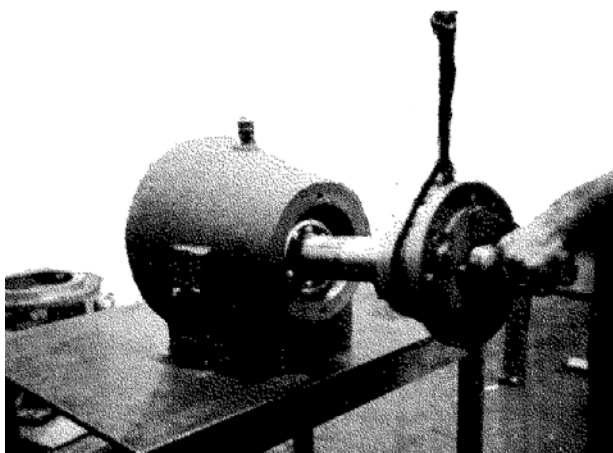


Figure 55: Shaft removal

23. Remove the inboard bearing using a bearing puller as shown in [Bearing Removal](#) (page 30). Care must be taken to prevent damage to bearing. Never use a hammer to drive shaft through bearing. Protect bearing from contamination.
24. Remove the bolts which hold the bearing end cover to the bearing housing. Remove the bearing end cover. Be sure shaft is free of burrs so the oil seal will not be damaged.

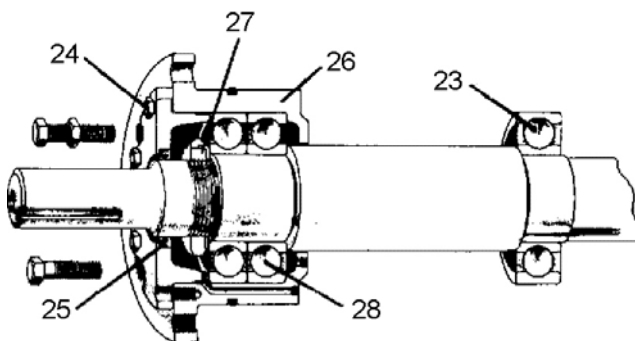


Figure 56: Bolt removal

25. Tap the oil seal from the coupling end bearing end cover if replacement of seal is required. Refer to [Inspection and Overhaul](#) (page 39) for replacement sizes.
26. Slide the bearing housing off shaft.
27. Straighten "tang" in lock washer and remove bearing lock nut and washer.
28. Remove coupling end bearing using a bearing puller as shown in [Bearing Removal](#) (page 30). Care must be taken to prevent damage to bearings. Never use a hammer to drive shaft through bearing. Protect bearing from contamination.

Inspection and Overhaul

Impeller

Replace if impeller shows excessive erosion (especially on ejector vanes on back side of impeller), corrosion, extreme wear or vane breakage. O-ring groove and impeller hub must be in good condition. Impeller has a push fit on shaft 0.000mm to 0.038mm | 0.000" to 0.0015" loose. Check impeller balance.

Sideplate

To maintain maximum efficiency, the clearance between sideplate and impeller should be 0.038mm | 0.015". Overall travel in casing is between 1.499mm and 2.159mm | 0.059" and 0.085". Sideplates should be inspected for erosion, pitting or excessive wear. Replacement is required when distance between impeller and suction sideplate cannot be held to 0.038mm | 0.015" with the axial impeller adjustment.

Shaft

Check for runout to see that the shaft is not bent. Bearing seats and oil seal areas must be in perfect condition and free of scratches and grooves. O.D. and finish in these areas must be within bearing manufacturer's specifications. Check that the keyway is free of corrosion. Replace shaft if necessary.

Shaft Sleeve

The shaft sleeve is a push fit and is bored: "S" - 0.000mm to 0.051mm | 0.000" to 0.002"; "M" & "L" - 0.025mm to 0.076mm | 0.001" to 0.003" larger than the shaft and should tap easily on the shaft. If the sleeve does not tap on easily, the bore and shaft should be inspected to see that they are free from foreign matter or burrs. The fit of the key in the keyway should also be checked to see that it is not causing binding. The key should have a sliding fit on the sides and should have clearance at the top. Sleeve surface in stuffing box must be smooth and free of grooves. If grooved, replace. O-ring groove must be in good condition. The original diametric clearance between shaft sleeve and stuffing box bushing is 0.635mm to 0.813mm | 0.025" to 0.032". If this clearance has increased to more than 1.27mm | 0.050", the shaft sleeve, and at times, the stuffing box bushing should be replaced.

Mechanical Seal

Lapped seal faces, gaskets, and shaft sealing members must be in perfect condition or excessive leakage may result. Replace worn or damaged parts.

Ball Bearings

Replace if worn, loose, rough or noisy when rotated. If dirty, refer to [Clean the Bearings](#) (page 30). Replacement bearings must be proper size and type as specified in the Construction Details in [Parts List](#) (page 50). New bearings should not be unwrapped until ready for use.

Oil Seals

Inspect and replace if torn or otherwise damaged. The sizes are:

Table 1: Coupling end

Group	Vendor	Vendor Part No.
S	Crane	237-325-16
M	Chicago Rawhide	31177
L	Crane	412-525-16

Table 2: Inboard

Group	Vendor	Vendor Part No.
S	Crane	250-325-12
M	Chicago Rawhide	33041
L	Garlock	53 X 2687

Seals are held by a press fit. Lips on seals should face out (away from bearings). One side of bored hole for oil seal is chamfered so that seal will start easily when pressed in.

General

All parts should be dean before assembly. This is especially important at O-ring grooves, threads, lock fits, gasket surfaces, and bearing areas. Any burrs should be removed with crocus cloth.

Reassemble the Pump

This procedure covers reassembly of the pump after complete disassembly. Be sure all directions in [Inspection and Overhaul](#) (page 39) have been followed.

1. Oil bearing seat on coupling end of shaft. Slide coupling end bearing (duplex, mounted back- to-back) on shaft as far as possible by hand. Place pipe or driving sleeve (such as the one shown in [Install the Ball Bearings](#) (page 31)) over shaft, making sure it rests against inner race only. Make sure bearing is "square" on shaft. Tap or press evenly until bearing is seated firmly against the shaft shoulder. Do not mar the shaft, especially where it contacts oil seal. The duplex bearings supplied by the factory as standard are manufactured by MRC. If equivalent bearings of other manufacturer's are used, the arrangement will vary, The duplex bearing arrangement depends on the type of construction used by the manufacturer. Refer to the manufacturer's instructions packed with the bearings for duplex mounting arrangement.
2. Insert the bearing lock washer, pressing tang into shaft keyway until it is firmly against the bearing.
3. Oil shaft threads lightly and snug the bearing locknut against the lock washer. Tighten firmly with a spanner wrench. Seat tang securely into slot in locknut with drift pin. If necessary, tighten locknut slightly to match tang with slot. Do not loosen locknut to position.

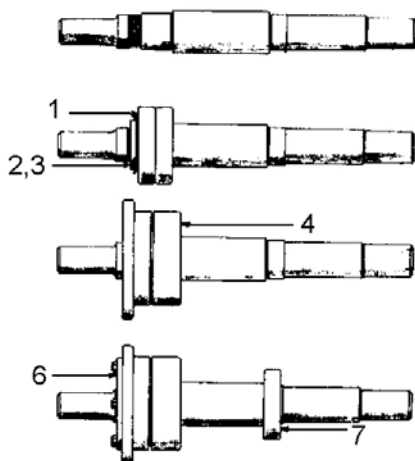
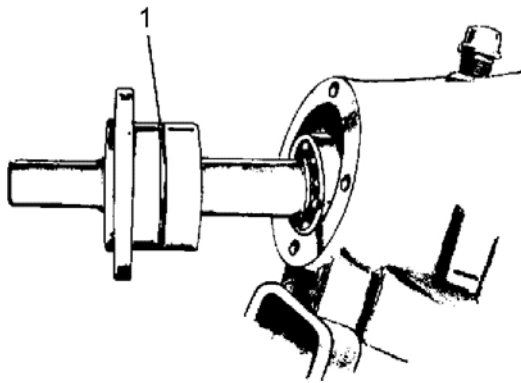


Figure 57: Pump reassembly

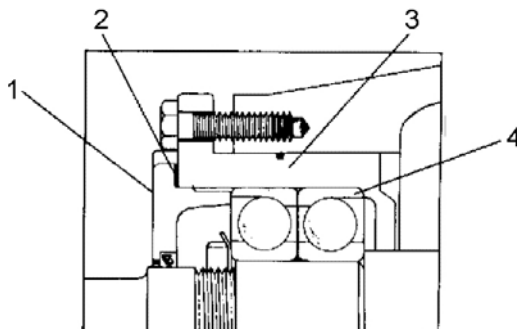
4. Slide bearing housing with O-ring in place, over impeller end of shaft and over outboard bearing.
5. Tap outboard oil seal in place on bearing end cover (coupling end).
6. Place bearing end cover and 0.152mm | 0.006" white manila gasket over coupling end of shaft and fit into bearing housing. If oil seal is dry, oil lightly before sliding over shaft. Be sure to position "TOP" (cast on cover) in line with "TOP" on housing. Bolt end cover firmly to housing.
7. Oil inboard bearing seat on shaft. Slide inboard ball bearing on shaft as far as possible by hand. Place pipe or sleeve (such as the one shown in [Install the Ball Bearings](#) (page 31)) over shaft, making sure bearing is "square" on shaft. Tap or press sleeve evenly until bearing is seated firmly against shaft shoulder. Do not mar shaft, especially where it contacts the oil seal or in stuffing box area.
8. Place a small amount of O-ring lubricant on inside of bearing frame at bearing housing and inboard bearing seats, on O-ring, and on inboard oil seal. Slide shaft assembly into the bearing frame as far as possible. When the bearing housing is properly installed (oil return hole at the bottom), the word "TOP" located on the flange of the bearing housing will line up with the top of bearing frame. Be sure bearing housing O-ring (1) is in place in groove on housing. Insert bearing housing bolts into bearing housing and screw about 12.7mm | 1/2" into frame to hold shaft during further assembly.



1. O-ring

Figure 58: Bearing housing O-ring

9. Tap oil seal into the bearing end cover (inboard).
10. Slide gasket and inboard bearing end cover over shaft and bolt to bearing frame.
11. Slide deflector on shaft with flat side in until it rests against the bearing frame.
12. Bearing end play may be determined at this point as follows: Clamp dial indicator to the pump so that the button rests against the end of the shaft. Push the shaft back and forth as far as possible. Total end play must be at least 0.025 | 0.001" and not more than 0.203mm | 0.008". If end play is less than 0.025mm | 0.001" add coupling end bearing end cover gaskets made from 0.152mm | 0.006" thick manila paper. If end play is greater than 0.203mm | 0.008" remove gaskets. Because of machining tolerances, duplex thrust bearings may vary in width by up to 0.762mm | 0.030". A correctly assembled pump may require as few as one, or as many as three 0.152mm | 0.006" thick gaskets. Refer to image below.



1. Bearing end cover

2. Gaskets - 0.006" thick

3. Bearing housing

4. Duplex thrust bearing

Figure 59: Bearing end play

13. Install and position coupling hub at scribe mark on shaft.
14. Bolt bearing frame to frame adapter.

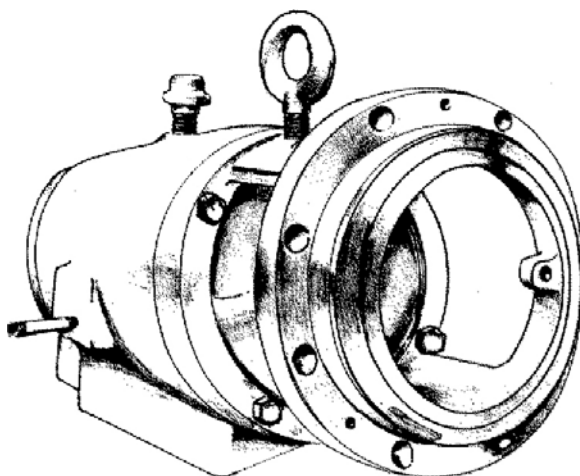


Figure 60: Bearing frame to bearing adapter

15. To install shaft sleeve and stuffing box cover:
 - a) On units with a packed stuffing box, slide shaft sleeve with O-ring in place on the shaft. Tap stuffing box bushing into place by using a sleeve. Check sleeve O.D. and bushing I.D. so it meets requirements of [Inspection and Overhaul](#) (page 39). Lift stuffing box cover into position at impeller end of shaft. Guide stuffing box cover over shaft and sleeve to prevent contact to these surfaces. Bolt the stuffing box cover to the frame adapter.
 - b) On units with a mechanical seal, refer to the order acknowledgement and seal drawing (supplied with the pump) to determine seal type and mounting dimensions.
16. The following instructions refer to pumps equipped with mechanical seals.
 - a) Before mounting any seals, wipe the seal faces carefully with a clean, soft cloth and oil lightly with clean oil.
 - b) Assemble gland, stationary seat, gland and seat gaskets. Carefully slide assembly on sleeve.
 - c) Lightly oil the rotary portion of the seal and slide on sleeve. Position rotary at proper distance from end of sleeve. Correct dimension is shown on the seal drawing. See [Set the Mechanical Seals](#) (page 45) for methods of positioning the rotary.
 - d) Slide the stuffing box cover over shaft. Bolt the stuffing box cover to the frame adapter.

NOTICE: Be careful not to damage seal on units with double seals. Make sure inboard stationary seat is properly positioned.

17. Place stuffing box cover-to-casing gasket against shoulder of stuffing box cover. Small amounts of O-ring lube may be used on both sides of gasket to seal and secure gasket in place.

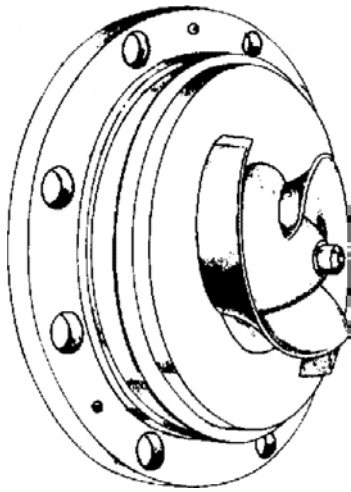


Figure 61: Stuffing box cover-to-casing gasket

18. Lubricate shaft keyway and insert impeller key in shaft and shaft sleeve. Lubricate shaft and slide impeller on shaft as far as possible. Pull impeller on shaft the remainder of distance with impeller screw. Be sure impeller screw O-ring is in place and in good condition. Prevent shaft from rotating by using a spanner or strap wrench.
19. Place O-ring in outer groove of suction sideplate. Install the sideplate-to-casing gasket. Tighten the four sideplate-to-casing studs in tapped holes in sideplate. Place suction sideplate in casing, making sure not to damage the sideplate O-ring. Liberal amounts of O-ring lube may be used to assist in sliding in place. Install and tighten four nuts on sideplate-to-casing studs.
20. Tighten casing hold down bolts.
21. Connect suction and discharge flanges. Care should be taken to prevent excessive pump flange loading.

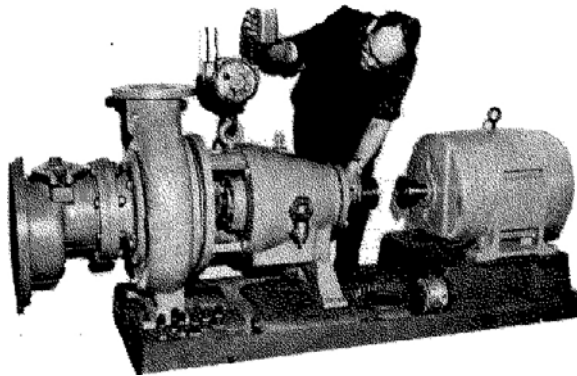


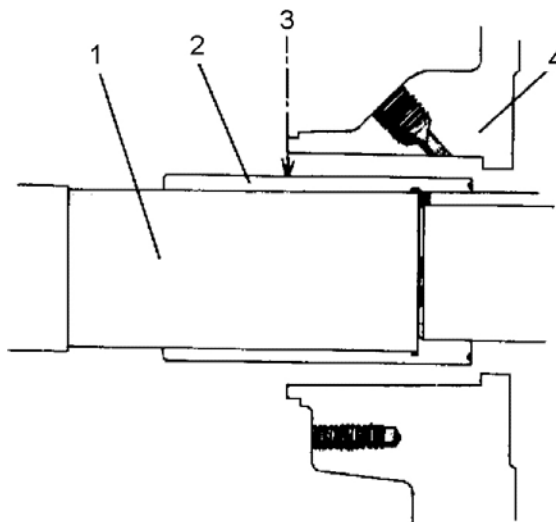
Figure 62: O-ring and suction sideplate-to-casing gasket

22. Slide the completely assembled "back-pull-out" unit into the casing. Tighten the frame adapter-to-casing bolts evenly to assure that gap between adapter and casing is even. Check with a feeler gauge at 4 points 90° apart around the adapter.
23. Install pedestal hold-down bolts. Frame pedestal is not to be flush with bedplate. Clearance of 1/4" is normal. Install shims under pedestal before tightening.
24. Set impeller clearance as outlined in [Impeller Clearance Adjustment](#) (page 33). Clearance between impeller and sideplate should be set at 0.381mm | 0.015" to maintain optimum efficiency. Overall travel must be 1.499mm to 2.159mm | 0.059" to 0.085" dependent on tolerances. If not, check casing gasket to be sure it is 1.588mm | 1/16" thick.
25. If unit requires stuffing box packing, refer to [Stuffing Box Packing](#) (page 18) and pack as directed. Refer also to [Stuffing Box](#) (page 45) for alternate methods of packing.
26. Replace auxiliary piping.
27. Follow procedures outlined in this manual for preparation and operation of the unit.

NOTICE: Pay particular attention to instructions concerning alignment and lubrication.

Set the Mechanical Seals

1. With the bearing frame-shaft assembly completed, carefully slide the gland-stationary seat assembly, with gaskets in place on the shaft. Install shaft sleeve.
2. Carefully slide the stuffing box cover over the sleeve and bolt to the bearing frame.
3. The following method may be employed to determine the correct positioning of the rotary portion of the mechanical seal:
 - a) Scribe the shaft sleeve at the face of the stuffing box.



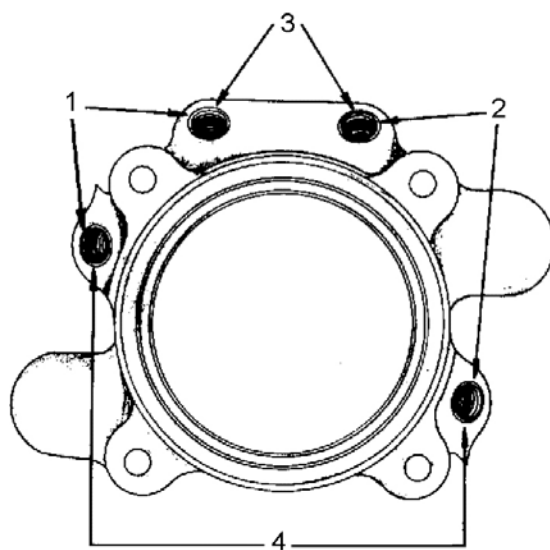
1. Shaft
2. Sleeve
3. Scribe
4. Stuffing box

Figure 63: Shaft sleeve

- b) Unbolt and remove the stuffing box cover. Remove sleeve. Lightly lubricate the rotary portion of the seal and slide onto the sleeve.
- c) Compress the rotary to the correct "working length". Refer to the seal manufacturer's drawing for correct dimensions. Tighten set screws.

Stuffing Box

The standard stuffing box cover has four pipe taps for sealing or flushing liquid to the packing or mechanical seal. Two are used for in and out connections to the throat of the stuffing box for paper stock services with the lantern ring positioned next to the stuffing box throat bushing. Two are alternately used for evaporator or chemical services as in and out connections. The image below shows a stuffing box and location of holes, and the holes used for evaporator service and paper stock service.



- 1. Out
- 2. In
- 3. For paper stock service
- 4. For process and evaporator service

Figure 64: Stuffing box

Troubleshooting

Troubleshooting Checklist

1. No liquid delivered
 1. Pump not primed - casing and suction pipe not completely filled with liquid.
 2. Speed too low.¹
 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.
2. Not enough liquid delivered
 1. Pump not primed - casing and suction pipe not completely filled with liquid.
 2. Speed too low.²
 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
3. Not enough pressure
 1. Speed too low.³
 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.

¹ 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.

² 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.

³ 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.

4. 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.
5. Pump takes too much power
 1. Speed too high.
 2. Head lower than rating, pumps too much liquid.
 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.
6. Pump leaks excessively at stuffing box
 1. Packing is worn or not properly lubricated.
 2. Packing is incorrectly inserted or not properly run in.
 3. Packing is not correct for liquid handled.
 4. Shaft sleeve scored.
 5. Insufficient packing.
 6. Damaged mechanical seal.
7. 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
8. High bearing temperature
See [Bearing Temperatures](#) (page 30)
 1. Pump and driver misalignment.
 2. Pump capacity too low.
 3. Improper lubrication.
 4. Excessive vibration.
 5. Bent shaft.
 6. Rotating element binds.

Parts Listings and Cross-Sectionals

Spare Parts

To ensure against possible long 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 the coupling.
 2. Stuffing box packing (if any) - one set.
 3. Stuffing box gland packing (if any) - one set.
 4. Mechanical seal (if any) - one.

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

Following is a list of these suggested parts:

1. Stuffing box packing (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).

Instructions for Ordering Spare Parts

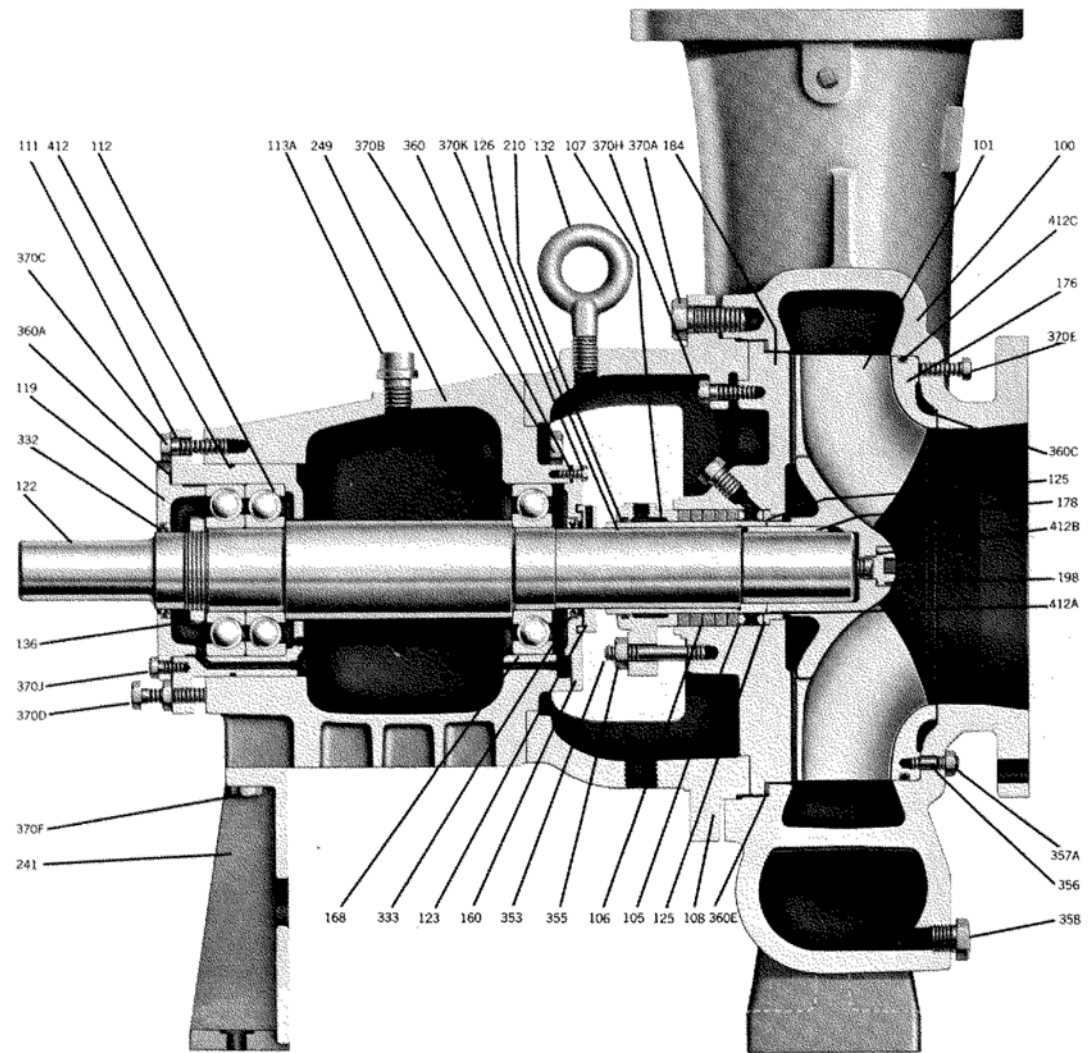
Repair orders will be handled with the minimum of delay if the following directions are followed:

1. Give Model No., size of the pump and serial number. These can all be obtained from the nameplate.
2. Write plainly the names, part numbers and materials of the parts required. These names and numbers should agree with those on the [Parts List](#) (page 50).
3. Give the number of parts required.
4. Give complete shipping instructions.

Parts List

Construction Details																			
		Group S				Group M						Group L							
		3x6-14 3x8-14	4x6-14 4x8-14 4x10-14	4x6-18 4x8-18 4x10-18	6x8-14 6x10-14 6x12-14	6x8-18 6x10-18 6x12-18	6x8-22 6x10-22 6x12-22	8x10-14 8x12-14 8x14-14	8x10-18 8x12-18 8x14-18	8x14-18H	8x10-22 8x12-22 8x14-22	10x12-18 10x14-18 10x16-18	10x12-22 10x14-22 10x16-22	12x14-18 12x16-18 12x18-18	12x14-22 12x16-22 12x18-22	14x14-18 14x16-18 14x20-18	14x14-22 14x16-22 14x20-22	18x18-22	
General	Net Wgt.—Brz. Fitted Bare Pump With Section Piece	850	925	1050	1100	1525	1700	1550	1600	1725	1800	1900	2050	2000	2350	2125	2800	4500	
	Min. Casing Thickness—C.I.—Brz.*	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	
	Min. Casing Thickness—Steel*	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	
Max. Dia. Solids		1 $\frac{1}{2}$	2	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2	1 $\frac{1}{2}$	3 $\frac{3}{4}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$	1 $\frac{1}{2}$	2 $\frac{1}{4}$	3	1 $\frac{1}{4}$	
Pressure Limits	Max. Working Pressure—PSIG Max. Test Pressure—PSIG	See Pressure-Temperature Chart on page 8A 150% of maximum working pressure at 100° F.																	
Temp. Limits	Max. Liquid Temp. Oil Lub. Without Cooling	250°F.						250°F.						250°F.					
	Max. Liquid Temp.—Oil Lub. With Frame Cooling Max. Liquid Temp.—Grease Lub.	350°F. for C.I., 450°F. for Steel 250°F.						350°F. for C.I., 450°F. for Steel 250°F.						350°F. for C.I., 450°F. for Steel 250°F.					
H.P. Limits	H.P. Per 100 RPM	9.52						23.8						63.5					
Shaft Dia.	At Impeller	1 $\frac{1}{4}$						2 $\frac{3}{4}$						3 $\frac{3}{4}$					
	Under Shaft Sleeve At Coupling Between Bearings	2 $\frac{1}{2}$ 1 $\frac{1}{4}$ 3 $\frac{1}{2}$						3 $\frac{3}{4}$ 2 $\frac{3}{4}$ 4						4 $\frac{1}{4}$ 3 $\frac{3}{4}$ 4 $\frac{1}{2}$					
Sleeve O.D.	Thru Stuffing Box	3						3 $\frac{3}{4}$						4 $\frac{1}{4}$					
Bearings	Coupling End Inboard (Pump End) Bearing Span Shaft Overhang	MRC 7313 DB or Equal MRC 313 S or Equal 12 $\frac{1}{2}$						MRC 7317 DB or Equal MRC 317 M or Equal 11 $\frac{1}{4}$						MRC 7222 P.D.B. or Equal MRC 222 M or Equal 11 $\frac{1}{4}$					
		10 $\frac{3}{4}$	11 $\frac{1}{4}$	11 $\frac{1}{4}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$	12 $\frac{1}{4}$	11 $\frac{3}{4}$	12 $\frac{1}{2}$	11 $\frac{1}{2}$	12 $\frac{1}{2}$	11 $\frac{1}{2}$	12 $\frac{1}{4}$	12 $\frac{1}{4}$	13 $\frac{1}{4}$	12 $\frac{1}{2}$	13 $\frac{1}{2}$	
Stuffing Box	Bore	4						4 $\frac{3}{4}$						5 $\frac{1}{4}$					
	Depth—To Stuffing Box Bushing	3 $\frac{1}{4}$						3 $\frac{1}{4}$						3 $\frac{1}{4}$					
	Packing Size	$\frac{1}{4}$ x $\frac{1}{2}$						$\frac{1}{2}$ x $\frac{1}{2}$						$\frac{1}{4}$ x $\frac{1}{2}$					
	Number Packing Rings	5						5						5					
	Width of Lantern Ring Distance From End of Stuff. Box to Nearest Obstruction	1 3 $\frac{1}{4}$						1 3 $\frac{1}{4}$						1 3 $\frac{1}{4}$					

*Includes $\frac{1}{8}$ Corrosion Allowance



Materials of Construction

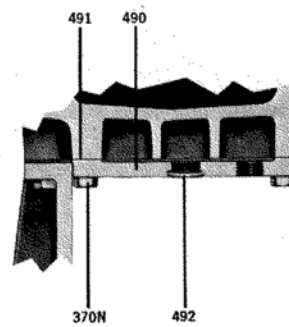
Material	Cu %	Sn %	Pb %	Zn %	Ni %	P %
1102	84-86	4-6	4-6	4-6	—	—
1103	87	6	4.5	1.75	0.75	—
1106	84	8	8	—	—	0.10-15

1000—Cast Iron—Conforms to ASTM A-278 Class 25

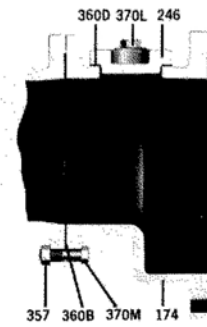
1003—Cast Iron—Conforms to ASTM A-278 Class 30

303—Designates AISI Type 303 Stainless Steel

316—Designates AISI Type 316 Stainless Steel (Wrought) or
ASTM A-296 Grade CF-8M and ACl-CF-8M (Cast)



Optional-Bearing Cooling



Optional-Suction Piece

Figure 65: Sectional View and Parts List

Figure 66:

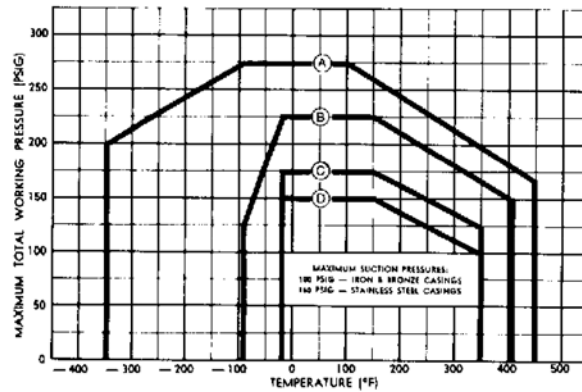
Parts List and Interchangeability Chart																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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Pump Size	Curve	Pump Casing Material	Acceptable Minimum Standard ANSI* Mating Flanges and Fittings	
			Discharge	Suction
3 x 6-14 4 x 6-14 4 x 6-18 6 x 8-14 6 x 8-18 6 x 8-22 8 x 10-14 8 x 10-18 8 x 10-18H 8 x 10-22 10 x 12-18 10 x 12-22	A	316 Stainless Steel	150 Psi Flat Face Steel	150 Psi Flat Face Steel
	B	Bronze (1103)	150 PSI Flat Face Bronze or Steel	150 PSI Flat Face Bronze or Steel
	C	Cast Iron (1003)	125 PSI Cast Iron	125 PSI Cast Iron
12 x 14-18 12 x 14-22	A	316 Stainless Steel	150 Psi Flat Face Steel	150 PSI Flat Face Steel
	B	Bronze (1103)	150 PSI Flat Face Bronze or Steel	150 PSI Flat Face Steel
	C	Cast Iron (1003)	125 PSI Cast Iron	125 PSI Cast Iron
14 x 14-18 14 x 14-22 18 x 18-22	A	316 Stainless Steel	150 Psi Flat Face Steel	150 PSI Flat Face Steel
	B	Bronze (1103)	150 PSI Flat Face Steel	150 PSI Flat Face Steel
	D	Cast Iron (1003)	125 PSI Cast Iron	125 PSI Cast Iron

For Other Materials, Refer to Factory

*American National Standards Institute, Formerly USASI and ASA.

Figure 67: Pressure Temperature Capability



Pump Selection Chart

Table 3: Index and Selection

	Model Number and Pump Type	Describe d in Bulletin	No. of Sizes and Ranges	Max. Capacity G.P.M.	Max Head Feet	Max Temp. °F	Max Working Pressure	Type of Impeller	Class of Construction
Process	3196-STD AVS Chemical	725.1	18 1" - 4"	1600	750	500	375	Open	A, B, C, F
	3196-XL 3196-HT	725.1 XL	5 6" & 8"	2450	230	500 700	375	Open	A, B, C, F A, B, C
	3706 Small glassed	725.2	1 1"	100	115	350	150	Open	D
	3708 Glassed	725.2	4 1" - 3"	700	150	350	150	Semi-Open	D
	3107 PTFE	725.3	1 1"	70	110	300	150	Open	E
	3198 AVS PTFE	725.3	2 1 ½" & 3"	800	410	300	225	Open	E
	2520 Liquid Ring	725.6	1 1 ½"	60	85	212	75	Strgt. Blade	1 & B
	3604 Close-Coupled Small Al-loy	725.7	1 ¾"	16	28	220	75	Semi-Open	B
	3199 Single Stage, Direct Con.	725.8	3 1" - 1 ½"	220	150	350	150	Open	A, B, C
	3716 Cer-Vit		1 1 ½"	140	140	350	100	Open	Cer. - Vit
High Temp. Process	3735-HPI Center-line mounted	724.2	21 1" - 6"	1900	900	800	600	Encl.	C
	3736 HPI Foot mounted	724.2	21 1" - 6"	1900	900	500	600	Encl.	C
Stock	3135 Diagonally split casing	723.1	12 3" - 8"	4000	300	200	150	Open	A, B, C
	3175 Back pull out	723.4	17 3" - 18"	12500	320	450	275	Open	A, B, C

	Model Number and Pump Type	Describe d in Bulletin	No. of Sizes and Ranges	Max. Capacity G.P.M.	Max Head Feet	Max Temp. °F	Max Working Pressure	Type of Impeller	Class of Construc tion
General Service	3655 Single Stg, Close Coupled	710.1	25 1 ¼" - 8"	3800	400	250	150	Encl.	A
	3755 Single stage, di- rect Con.	715.1	25 1 ¼" - 8"	3800	400	350	150	Encl.	A
	3345 Two Stg, Direct Con.	718.2	1 1"	120	500	350	250	Encl.	A
	3320 Two Stg, Close- Coupled	713.1	1 1"	120	500	250	250	Encl.	A
	3189 Single Stg, Di- rect Con.	720.4	2 6" & 8"	3200	155	350	150	Open	A
Multi Stage	3316 Two stage	722.6	10 1" - 8"	3000	1000	400	500	Encl.	A & B in all sizes. C in most sizes
	3330 Me- dium Pressure	722.1	21 3" - 8"	2100	1000	350	370	Encl.	A & B
	3360-65 High Pressure	722.4	11 3" - 8"	2600	3400	350	1200	Encl.	A & B
Double Suction	3405	721.6	39 2" - 12"	6400	550	350	250	Encl.	A & B in all sizes. C in 4" - 12"
	3404 Vertically Mtd.	721.15	39 2" - 12"	6400	525	350	250	Encl.	A & B in all sizes. C in 4" - 12"
	3415DV	721.7	8 8" - 18"	15000	550	275	275	Encl.	A, B, C
	3420-23 Horiz. & Bottom Suction	721.8	7 16" - 36"	75000	400	275	200	Encl.	A, B, C
	3450-60 Horiz. & Bottom Suction	721.2	3 14" - 16"	16000	200	250	250	Encl.	A
Vertical	3171 Vertical Centrifu- gal	726.1	21 1" - 8"	3180	290	450	150	Open	A & C
	VIT Verti- cal Tur- bine	3A.1	18 4" - 36"	20000	3000	250	-	Open	1, 3, 5, 8

Table 4: Materials of Construction

The table at the right shows a code for construction materials. They are listed in the last column of the Index and Selection chart above. Materials listed include both normal inventory alloys and some others built only to order. For specific information on delivery consult your Goulds sales engineer.

Class		Materials of Construction
A	1	All iron (ASTM A278)
	2	Bronze fitted
	3	All bronze. See bulletin for spec.
	4	Ductile iron (ASTM A395)
B	5	Ni-Resist (Type 2) (ASTM A436)
C	6	Carbon steel (ASTM A216 Grade WCA & WCB)
	7	11-13% chrome stainless (ACI CA15)
	8	S16 stainless (ACI CF8M)
	9	Gould A LOV 20 (ACI CN 7 MCU)
	10	Other special sand cast machinable alloys such as low, medium and high carbon steels, ACI C 8C (347) 317 ELC, monel, nickel.
	11	ISO B and C
D	12	All iron, glassed
E	13	Ductile iron, molded-in-place PTFE
F	14	Titanium

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