GOULDS PUMPS

Installation, Operation and Maintenance

Model 3910 10th Edition (ISO 13709)

ITT

FOREWORD

This manual provides instructions for the Installation, Operation, and Maintenance of the Goulds Model 3910 Vertical Bearing Frame In-line Process Pump designed to meet the requirements of the 10th Edition (ISO 13709) of API* Standard 610. This manual covers the standard product plus common options that are available. For special options, supplemental instructions are supplied. This manual must be read and understood before installation and maintenance.

The design, materials, and workmanship incorporated in the construction of Goulds pumps make them capable of giving long, trouble-free service. The life and satisfactory service of any mechanical unit, however, are enhanced and extended by correct application, proper installation, periodic inspection, condition monitoring, and careful maintenance. This instruction manual was prepared to assist operators in understanding the construction and the correct methods of installing, operating, and maintaining these pumps.

ITT - Goulds Pumps shall not be liable for physical injury, damage or delays caused by a failure to observe the instructions for installation, operation, and maintenance contained in this manual.

When pumping unit is installed in a potentially explosive atmosphere, the instructions after 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 a Goulds representative before proceeding.

Warranty is valid only when genuine ITT - Goulds Pumps parts are used.

Use of the equipment on a service other than stated in the order will nullify the warranty, unless written approval is obtained in advance from ITT - Goulds Pumps.

Supervision by an authorized ITT - Goulds representative is recommended to assure proper installation.

Additional manuals can be obtained by contacting your local ITT - Goulds representative or by calling 1-(800)-446-8537.

THIS MANUAL EXPLAINS

- **Proper Installation**
- **Start-up Procedures**
- **Operation Procedures**
- **Routine Maintenance**
- **Pump Overhaul**
- **Troubleshooting**
- **Ordering Spare or Repair Parts**

*** American Petroleum Institute**
1220 L Street, Northwest
Washington, D.C. 20005

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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:** • 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.

GENERAL INFORMATION

PUMP DESCRIPTION

The Model 3910 is a vertical bearing frame in-line centrifugal pump that meets the requirements of API Standard 610 10th Edition (ISO 13709).

The model is based on 5 power ends and 27 hydraulic pump sizes.

Casing - The casing is a vertical in-line mounted design. The gasket is fully confined. ANSI Class 300 raised face serrated flanges are standard; ANSI Class 300 flat face serrated and ring joint flanges are available.

Impeller - The impeller is fully enclosed and key driven by the shaft. An impeller nut with locking set screw prevents axial movement.

Seal Chamber Cover - The Model 3910 seal chamber cover meets API 682 2nd Edition dimensions for improved performance of mechanical seals.

Power End - Regreasable bearings are standard. The power end is sealed with labyrinth seals. Pure oil mist lubrication is optional. Some modifications are required to convert from grease to oil mist.

Shaft - The standard shaft is machined and ground to comply with API 610 10th Edition (ISO 13709) criteria.

Bearings - The inboard (radial) bearing carries only radial load; it is free to float axially in the frame. The outboard (thrust) bearing is shouldered and locked to the shaft and retained in the bearing frame to enable it to carry radial and thrust loads. All fits are precision machined to industry standards. The inboard bearing is a single row deep groove ball bearing. The outboard bearing is a duplex angular contact bearing, which uses a pair of single row angular contact ball bearings mounted back-to-back.

Motor Support - The fabricated steel motor support is designed to support the driver and to provide ample access to both the seal piping and the coupling.

Direction of Rotation - Counterclockwise (left hand) as viewed from the driver, looking at the pump shaft.

NAMEPLATE INFORMATION

Every pump has a Goulds nameplate that provides information about the pump. The nameplate is located on the pump casing.

Special tags which provide additional information (mechanical seal data, etc.) and special tagging required by customers are located on the pump casing or on the bearing frame.

The standard nameplate provides information about the pump's size, rating, bearings, serial number, hydrostatic test pressure of pressure containment parts, maximum allowable working pressure at designated temperature and construction / customer's item number. Rating and hydrostatic test pressure are expressed in English units. Note the format of pump size: Discharge x Suction - Nominal Impeller Diameter in inches, for example, 2x3-13 (Fig. 1A).

The standard nameplate is also available in a version which expresses the rating and hydrostatic test pressure in metric units (Fig. 1B).

When ordering spare parts you will need to identify pump model, size, serial number, and the item number of required parts. Pump information can be taken from the Goulds nameplate. Item numbers can be found in this manual.

If applicable, your pump unit may have the ATEX tag affixed to the pump and/or baseplate (Fig. 2). See the Safety section for a description of the symbols and codes.

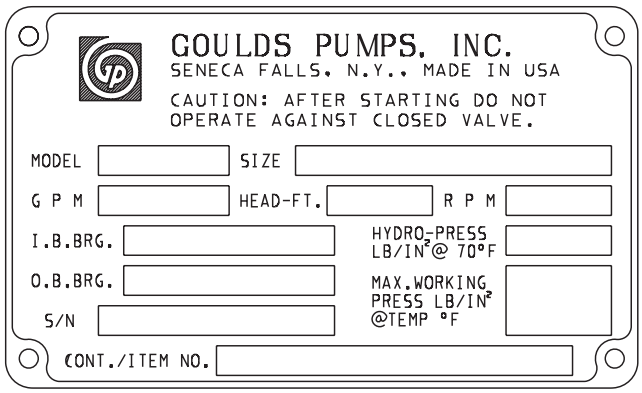

Fig. 1A

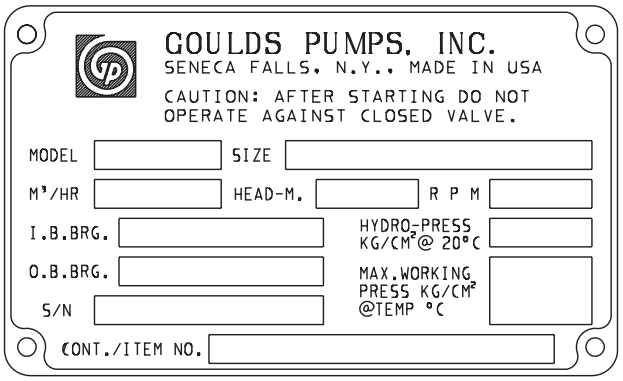

Fig. 1B

Fig. 2

RECEIVING THE PUMP

Inspect the pump as soon as it is received. Carefully check that everything is in good order. Make notes of damaged or missing items on the receipt and freight bill. File any claims with the transportation company as soon as possible.

STORAGE REQUIREMENTS

Short Term (Less than 6 months) Goulds normal packaging procedure is designed to protect the pump during shipping. Upon receipt, store in a covered and dry location.

Long Term (More than 6 months) Preservative treatment of bearings and machined surfaces will be required. Rotate shaft several times every 3 months. Refer to driver and coupling manufacturers for their long term storage procedures. Store in a covered and dry location.

NOTE: Long term storage treatment may be purchased with initial pump order.

HANDLING

⚠ WARNING

Pump and components are heavy. Failure to properly lift and support equipment could result in serious physical injury, or damage to pumps.

Use care when moving pumps. Lifting equipment must be able to adequately support the entire assembly. Hoist bare pump using suitable hooks through the holes in the frame mounted support or suitable slings through the large openings in the casing mounted support (Fig. 3).

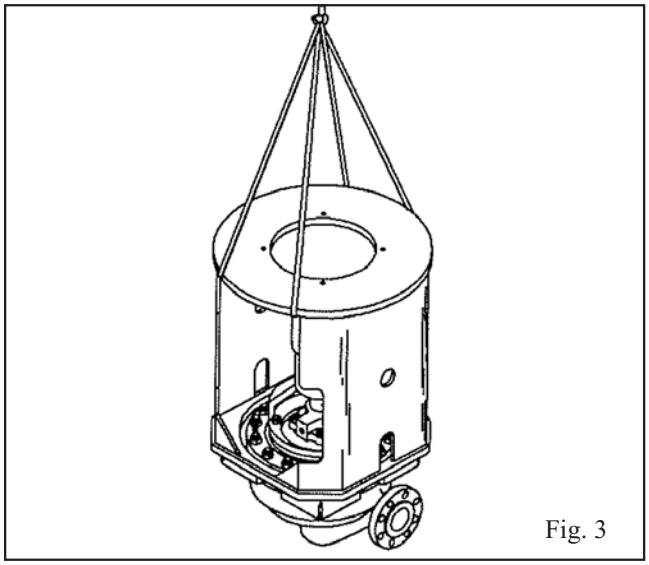

Fig. 3

Units with drivers mounted are moved with slings under the pump casing and driver (Figs. 4 and 5).

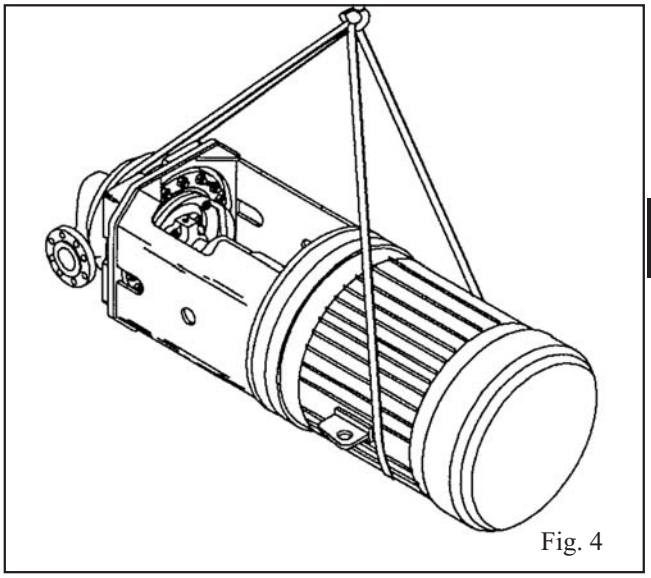

Fig. 4

Or with hooks through the holes in the frame mounted support or with slings through the large openings in the casing mounted support.

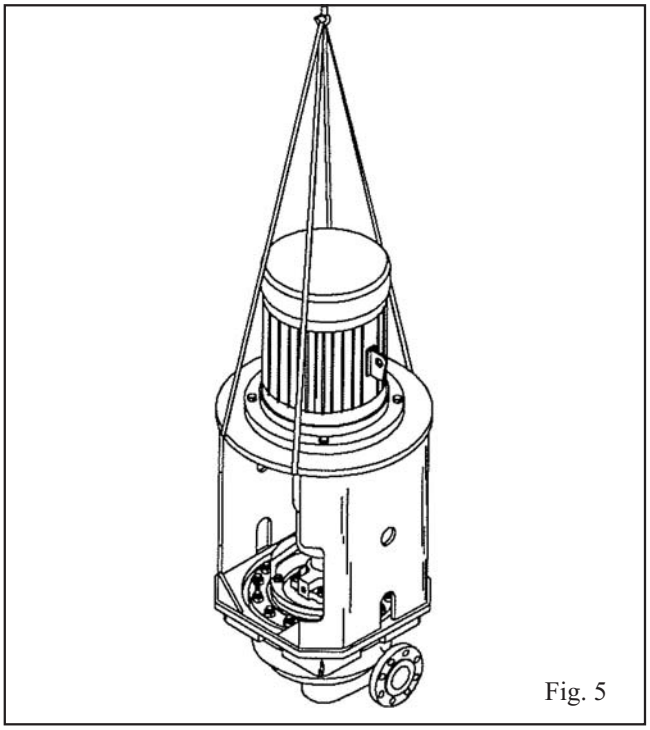

Fig. 5

⚠ WARNING

Units with drivers mounted can be top heavy. Driver weight could cause the assembled unit to overturn and could result in serious physical injury, or damage to pumps.

INSTALLATION

Equipment that will operate in a potentially explosive environment must be installed in accordance with the following instructions.

GENERAL

Procedures for installation described within this section are general in nature. It is assumed that the installer has a basic knowledge of acceptable methods. More detailed procedures are described in various publications, including API Recommended Practice 686/ PIP (Process Industry Practices) REIE 686, "Recommended Practices for Machinery Installation and Installation Design."

SITE/FOUNDATION

A pump should be located near the supply of liquid and have adequate space for operation, maintenance, and inspection. Be sure to allow for crane or hoist service.

Model 3910 in-line pumps are designed to be mounted directly in the piping. The pump casing has a flat base which may be mounted on a concrete foundation which has been poured on a solid footing.

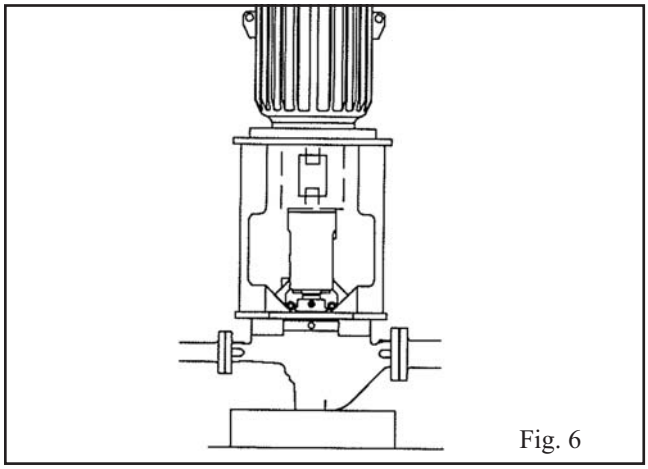

Fig. 6

The foundation must be able to absorb any vibration and to form a permanent, rigid support for the pumping unit (Fig. 6). Goulds recommends this mounting method.

Optional casing supports, which provide additional stability, are also available (Fig. 7).

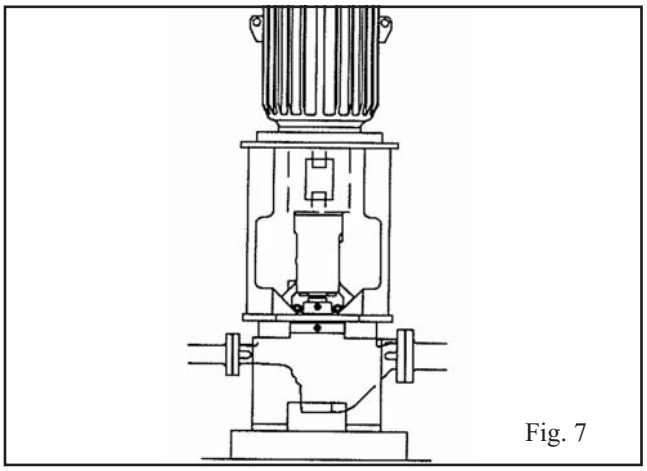

Fig. 7

If it is intended that the piping support the pumping unit, piping supports should be properly designed to accommodate the weight of the pumping unit.

All equipment being installed must be properly grounded to prevent unexpected static electric discharge.

ALIGNMENT AND ALIGNMENT CRITERIA

Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.

GENERAL CONSIDERATIONS

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.

To remove coupling guard, refer to coupling guard installation and disassembly instructions in *Appendix I*.

The times at which alignment is checked and adjusted are:

Initial Alignment (Cold Alignment) is done prior to operation when the pump and the driver are at ambient temperatures.

Final Alignment (Hot Alignment) is done after operation when the pump and driver are at operating temperatures.

- After First Run - To obtain correct alignment when both pump and driver are at operating temperature. Thereafter, alignment should be checked periodically in accordance with plant operating procedures.

NOTE: Alignment check must be made if process temperature changes, piping changes and/or pump service is performed.

Alignment is achieved by adding or removing shims from under the flange of the driver and/or shifting driver horizontally as needed.

NOTE: Proper alignment is the responsibility of the installer and user of the unit.

Accurate alignment of the equipment must be attained. Trouble-free operation can be accomplished by achieving alignment within the levels specified in the following section.

Three common alignment methods are utilized:

- **Reverse Dial Indicator** method is most common.
- **Laser** method is similar to reverse dial indicator method, but uses a laser to obtain the necessary measurements.
- **Dial Indicator** (rim-and-face) method.

Follow alignment equipment manufacturer's procedures when utilizing reverse dial indicator or laser methods. A detailed procedure for alignment using the dial indicator (rim-and-face) method is included as *Appendix II*.

ALIGNMENT CRITERIA

Good alignment is attained when readings as specified in this section have been achieved with pump and driver at operating temperatures (final alignment).

Table 2 shows maximum allowable Total Indicator Reading (T.I.R.) for parallel and angular misalignment.

Table 2
Maximum Allowable
Parallel and Angular Misalignment

	Maximum Allowable Misalignment	
Group	**Parallel**	**Angular**
All	0.05 mm (.002 in.)	0.03 degrees [0.125 mm/cm (.0005 in. /in.) of coupling face diameter]

ALIGNMENT TROUBLESHOOTING

Problem	Probable Cause	Remedy
Cannot obtain horizontal (Side-to-Side) alignment, angular or parallel	Driver flange bolt bound	Loosen motor support hold down bolts and slide motor support and driver until horizontal alignment is achieved.

PIPING

Guidelines for piping are given in the "Hydraulic Institute Standards," available from:

Hydraulic Institute
9 Sylvan Way
Parsippany, NJ 07054

and in API RP 686, and must be reviewed prior to pump installation.

WARNING

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 affect the operation of the pump resulting in physical injury and damage to the equipment.

Flange loads from the piping system, including those from thermal expansion of the piping, must not exceed the limits of the pump. Casing deformation can result in contact with rotating parts which can result in excess heat generation, sparks and premature failure.

1. Piping runs should be as short as possible to minimize friction losses.
2. It is suggested that expansion loops be properly designed and installed in suction and/or discharge lines when handling liquids at elevated tempera- tures, so thermal expansion of piping will not draw pump out of alignment.
3. The piping should be arranged to allow pump flushing prior to removal of the unit on services handling hazardous liquids.
4. Carefully clean all pipe parts, valves and fittings, and pump branches prior to assembly.
5. All piping must be supported independently of, and line up naturally with, the pump flanges. Table 2 shows piping flange alignment criteria.

Table 4
Piping Flange Alignment

Type	Criteria
Axial	Flange gasket thickness ± 0.8 mm (.03 in.).
Parallel	0.001 mm/mm (.001 in./in.) of flange diameter to a maximum of 0.8 mm (.03 in.).
Concentric	Flange bolts should easily install by hand.

In no case should loads on the pump flanges exceed the limits stated in API Standard 610, 10th Edition (ISO 13709).

6. Bottom of casing should be supported by a solid foundation or casing feet should be used.

SUCTION PIPING

CAUTION

$NPSH_A$ must always exceed $NPSH_R$ as shown on Goulds performance curves received with order. (Reference Hydraulic Institute for NPSH and pipe friction values needed to evaluate suction piping).

Properly designed and installed suction piping is a necessity for trouble-free pump operation. Suction piping should be flushed BEFORE connection to the pump.

1. Use of elbows close to the pump suction flange should be avoided. There should be a minimum of two (2) pipe diameters of straight pipe [five (5) pipe diameters is preferred] between the elbow and suction inlet. Where used, elbows should be long radius.
2. Use suction pipe one (1) or two (2) sizes larger than the pump suction, with a reducer at the suction flange. Suction piping should never be of smaller diameter than the pump suction.
3. Reducers, if used, should be eccentric and located at the pump suction flange with sloping side down.

CAUTION

Pump must never be throttled on suction side.

4. A suction screen should be installed prior to initial start-up and when suction system has been opened for work. The screen should be of the cone type with a net area equal to at least three (3) times the cross sectional area of the suction pipe. The mesh of the screen should be sized to prevent particles larger than 1.6 mm (1/16 in.) from entering the pump and should be installed in a spool piece to allow removal for cleaning. The screen should remain in the system until periodic inspection shows system is clean.
5. Separate suction lines are recommended when more than one pump is operating from the same source of supply.

Suction Lift Conditions

1. Suction pipe must be free from air pockets.
2. Suction piping must slope upwards to pump.
3. All joints must be air tight.
4. A means of priming the pump must be provided.

Suction Head/Flooded Suction Conditions

1. An isolation valve should be installed in the suction line at least two (2) pipe diameters from the pump suction to permit closing of the line for pump inspection and maintenance.
2. Keep suction pipe free from air pockets.
3. Piping should be level or slope gradually downward from the source of supply.
4. No portion of the piping should extend below pump suction flange.
5. The size of entrance from supply should be one (1) or two (2) sizes larger than the suction pipe.
6. The suction pipe must be adequately submerged below the liquid surface to prevent vortices and air entrainment at the supply.

DISCHARGE PIPING

Properly designed and installed discharge piping is a necessity for trouble-free pump operation. Discharge piping should be flushed BEFORE connection to the pump.

1. Isolation and check valves should be installed in discharge line. Locate the check valve between isolation valve and pump; this will permit inspection of the check valve. The isolation valve is required for priming, regulation of flow, and for inspection and maintenance of pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.
2. Increasers, if used, should be placed between pump and check valves.
3. Cushioning devices should be used to protect the pump from surges and water hammer if quick-closing valves are installed in system.

BYPASS PIPING

Systems that require operation at reduced flows for prolonged periods should be provided with a bypass line connected from the discharge side (before any valves) to the source of suction.

A minimum flow orifice can be sized and installed in bypass line to preclude bypassing excessive flows. Consult nearest sales office or factory for assistance in sizing orifice.

An automatic recirculation control valve and/or solenoid operated valve should be considered if a constant bypass (i.e. orifice) is not possible.

AUXILIARY PIPING

The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.

Cooling systems such as those for bearing lubrication, mechanical seal systems, etc., where provided, must be operating properly to prevent excess heat generation, sparks, and premature failure.

Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.

Auxiliary piping may be required for seal chamber cover cooling, mechanical seal flush or other special features supplied with the pump. Consult pump data sheet for specific auxiliary piping recommendations.

If seal chamber cover cooling is required, follow guidelines listed below.

1. Flows of 4 l/min. (1 GPM) will generally satisfy cooling requirements.
2. Cooling water pressure should not exceed 7.0 kg/cm^2 (100 psig).

FINAL PIPING CHECK

After connecting the piping to pump:

The* Preventive Maintenance *section must be adhered to in order to keep the applicable ATEX classification of the equipment. Failure to follow these procedures will void the ATEX classification for the equipment.

Check alignment, per alignment criteria outlined previously, to determine if pipe strain has affected alignment. If pipe strain exists, correct piping.

OPERATION

PREPARATION FOR START-UP

When installation in a potentially explosive environment, ensure that the motor is properly certified.

CHECKING ROTATION

CAUTION

Serious damage may result if pump is run in the wrong rotation.

1. Lock out power to driver.

WARNING

Lock out driver power to prevent accidental start-up and physical injury.

2. Make sure coupling hubs are securely fastened to shafts.

WARNING

Do NOT jog a coupled pump.

NOTE: Pump is shipped with coupling spacer removed.

3. Unlock driver power.
4. Make sure everyone is clear. Jog driver just long enough to determine direction of rotation. Rotation must correspond to arrow on bearing frame.
5. Lock out power to driver.

COUPLING PUMP AND DRIVER

WARNING

Lock out driver power to prevent accidental rotation and physical injury.

The coupling used in an ATEX classified environment must be properly certified.

1. Install and lubricate coupling per manufacturer's instructions.

The coupling guard used in an ATEX classified environment must be constructed from a non-sparking material.

2. Install coupling guard. Refer to coupling guard installation instructions in *Appendix I*.

WARNING

Never operate a pump without coupling guard properly installed. Refer to* Appendix I *for coupling guard installation instructions. Personal injury will occur if pump is run without coupling guard.

LUBRICATING BEARINGS

Bearings musts be lubricated properly in order to prevent excess heat generation, sparks and premature failure.

Grease Lubrication
Greased lubricated ball bearings are standard on the Model 3910 units.

The bearings **are** greased at the factory.

See *Preventive Maintenance* section for lubrication recommendations.

Pure Oil Mist Lubrication
Pure oil mist is an optional feature for the Model 3910. Follow oil mist generator manufacturer's instructions. The inlet and outlet connections are located on the side of the bearing frame.

See *Preventive Maintenance* section for lubrication recommendations and connection locations.

WARNING

Operation of the unit without proper lubrication will cause bearing failure and pump seizure.

SHAFT SEALING WITH MECHANICAL SEAL

The mechanical seal used in an ATEX classified environment must be properly certified.

Pumps may be shipped with or without mechanical seal installed. Cartridge type mechanical seals are commonly used for this model. Cartridge seals are preset at the seal manufacturer's facility and require no field settings. Cartridge seals installed by the user require disengagement of the holding clips prior to operation, allowing the seal to slide into place. If the seal has been installed in the pump by Goulds, these clips have already been disengaged. For other types of mechanical seals, refer to the seal manufacturer's instructions for installation and setting.

Connection of Sealing Liquid

The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.

Cooling systems such as those for bearing lubrication, mechanical seal systems, etc., where provided, must be operating properly to prevent excess heat generation, sparks, and premature failure.

Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.

For satisfactory operation, there must be a liquid film between seal faces to lubricate them. Refer to seal manufacturer's drawing for location of taps. Some methods which may be used to flush/cool the seal are:

- Product Flushing - In this arrangement, the pumpage is piped from the casing (and cooled in an external heat exchanger when required) then injected into seal chamber.
- External Flush - A clean, cool compatible liquid is injected from an outside source directly into seal chamber. Flushing liquid must be at a pressure 0.35-1.05 kg/cm^2 (5-15 psi) greater than seal chamber pressure. Injection rate should be 2-8 l/min. (½-2 GPM).
- Other methods may be used which make use of multiple gland connections and/or seal chamber connections. Refer to documentation supplied with the pump, mechanical seal reference drawing, and piping diagrams.

PRIMING PUMP

Pumps must be fully primed at all times during operation.

Never start the pump until it has been properly primed. Several different methods of priming can be used, depending upon type of installation and service involved.

Suction Supply Above Pump
1. Slowly open the suction valve (Fig. 8).

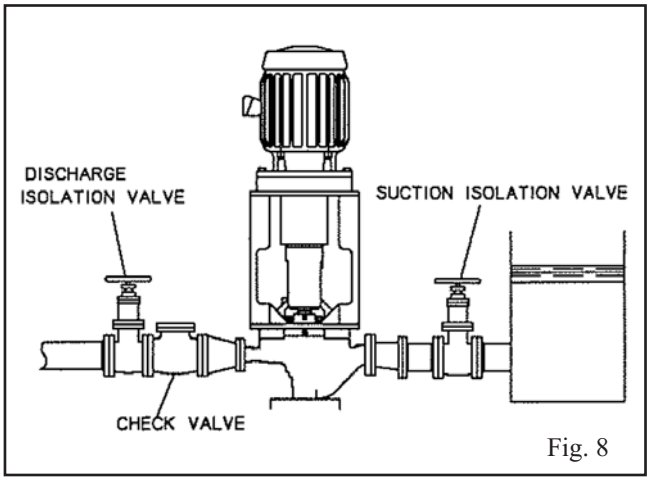

Fig. 8

2. Open air vents on the suction and discharge piping, casing, seal chamber, and seal piping, if provided, until all air is vented and only liquid flows out.
3. Close the vents.

Suction Supply Below Pump
A foot valve and outside source of liquid may be used to prime the pump. Outside source of liquid can come from a priming pump pressurized discharge line, or other supply (Fig. 9 and 10).

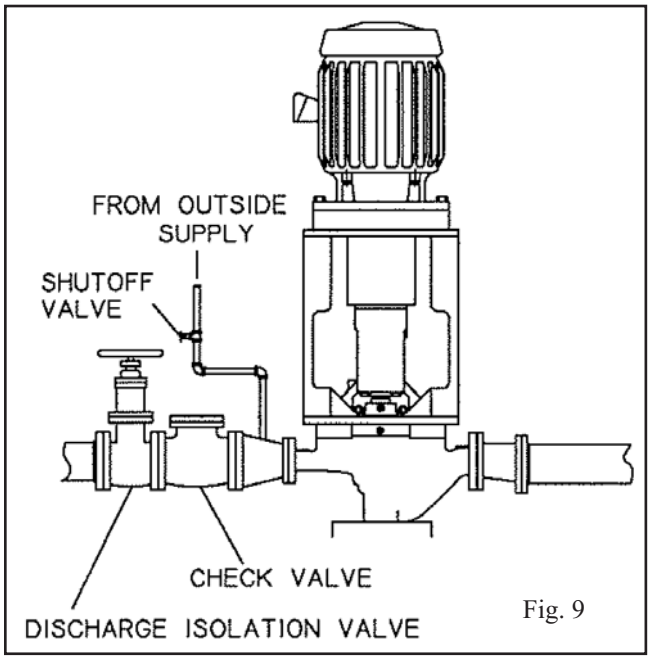

Fig. 9

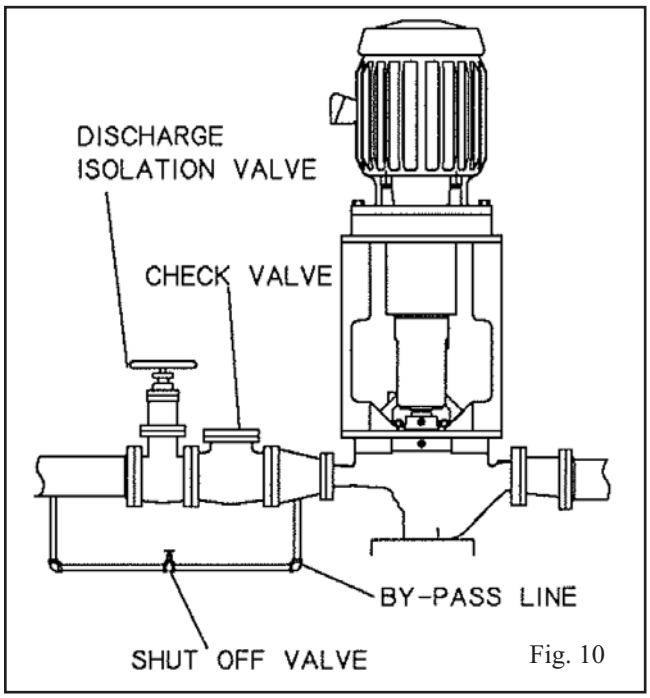

Fig. 10

1. Close discharge valve and open air vents in suction and discharge piping, casing, seal chamber, and seal piping, if provided.
2. Open valve in outside supply line until all air is vented and only liquid flows out.

WARNING

When handling hazardous and/or toxic fluids, proper personal protective equipment is required. If pump is being drained, precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable regulations.

3. Close the vents and then the outside supply line.

Other Methods of Priming Pump

- Priming by ejector.
- Priming by automatic priming pump.

4

START-UP PRECAUTIONS

CAUTION

Ensure that pump and systems are free of foreign objects before operating and that objects cannot enter the pump during operation. Foreign objects in the pumpage or piping system can cause blockage of flow which can result in excess heat generation, sparks, and premature failure.

CAUTION

A build up of gases within the pump, sealing system and or process piping system may result in an explosive environment within the pump or process piping system. Ensure process piping system, pump, and sealing system are properly vented prior to operation.

1. All equipment and personal safety related devices and controls must be installed and operating properly.
2. To prevent premature pump failure at initial start-up due to dirt or debris in the pipe system, ensure the pump can be run continuously at full speed and flow for 2 to 3 hours.
3. Variable speed drivers should be brought to rated speed as quickly as possible.
4. Variable speed drivers should not be adjusted or checked for speed governor or overspeed trip settings while coupled to the pump at initial start-up. If settings have not been verified, uncouple the unit and refer to driver manufacturer's instructions for assistance.

5. Running a new or rebuilt pump at slow speeds may not provide enough flow to adequately flush and cool the wear ring and seal chamber cover bushing.
6. Pumpage temperatures in excess of 93° C (200° F) will require warm-up of pump prior to operation. Circulate a small amount of pumpage through the pump until the casing temperature is within 56° C (100° F) of the pumpage temperature and evenly heated.

NOTE: Warm-up rate should not exceed 1.4° C (2.5° F) per minute.

STARTING PUMP

1. Make sure suction valve and any recirculation or cooling lines are open.
2. Fully close or partially open discharge valve as dictated by system conditions.
3. Start driver.

CAUTION

Immediately observe pressure gauges. If discharge pressure is not quickly attained, stop driver, reprime, and attempt to restart.

4. Slowly open discharge valve until the desired flow is obtained.

CAUTION

Observe pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down and resolve.

OPERATION

GENERAL CONSIDERATIONS

CAUTION

Always vary capacity with regulating valve in the discharge line. NEVER throttle flow from the suction side.

Driver may overload if the pumpage specific gravity (density) is greater than originally assumed, or the rated flow rate is exceeded.

Always operate the pump at or near the rated conditions to prevent damage resulting from cavitation or recirculation.

OPERATIONAL CHECKS

CAUTION

The following are minimum operational checks for the pump only. Consult driver and auxiliary equipment manufacturers' literature for additional information.

1. On grease lubricated units, remove grease relief plugs to verify that grease is present. Replace plugs.
2. On pure oil mist lubricated units, remove viewing port plugs and assure oil mist is flowing properly. Replace plugs.
3. Check bearing temperatures using a pyrometer or other accurate temperature measuring device. Monitor bearing temperature frequently during initial operation to determine if a bearing problem exists as well as to establish normal bearing operating temperature.
4. On units equipped with auxiliary piping, assure that proper flows have been established and that equipment is operating properly.
5. Establish baseline vibration readings to determine normal running conditions. If it is determined that the unit is running rough, consult factory.
6. Monitor all gauges to ensure pump is running at or near rating and that suction screen (when used) is not clogged.

OPERATING AT REDUCED CAPACITY

WARNING

Do NOT operate pump below minimum rated flows or with 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.

CAUTION

Damage occurs from:

1. Increased vibration levels - Affects bearings, seal chambers, and mechanical seals.
2. Increased radial load - Increases stress on shaft and bearings.
3. Heat build up - Vaporization causes rotating parts to score or seize.
4. Cavitation - Increases damage to internal surfaces of pump.

OPERATING UNDER FREEZING CONDITIONS

Exposure to freezing conditions while pump is idle could cause liquid to freeze and damage the pump.

Liquid inside pump should be drained. Liquid inside auxiliary piping, if supplied, should also be drained.

SHUTDOWN

1. Slowly close discharge valve.
2. Shut down and lock out driver to prevent accidental rotation.

WARNING

When handling hazardous and/or toxic fluids, proper personal protective equipment is required. If pump is being drained, precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable regulations.

FINAL ALIGNMENT

Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.

1. Run the unit under actual operating conditions for a sufficient length of time to bring the pump and driver and associated systems to operating temperature.
2. Shut down and lock out driver as described above.

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.

3. Remove coupling guard. Refer to coupling guard installation and disassembly instructions in *Appendix I.*
4. Check alignment while unit is still hot per alignment criteria in the *Installation* section.
5. Reinstall coupling guard. Refer to coupling guard installation and disassembly instructions in *Appendix I.*

PREVENTIVE MAINTENANCE

GENERAL COMMENTS

A routine maintenance program can extend the life of your pump. Well maintained equipment will last longer and require fewer repairs. You should keep maintenance records as this will help pinpoint potential causes of problems.

The* Preventive Maintenance *section must be adhered to in order to keep the applicable ATEX classification of the equipment. Failure to follow these procedures will void the ATEX classification for the equipment.

MAINTENANCE SCHEDULE

ROUTINE MAINTENANCE

- Bearing lubrication
- Seal monitoring
- Vibration analysis
- Discharge pressure monitoring
- Temperature monitoring

ROUTINE INSPECTIONS

- Check for unusual noise, vibration and bearing temperatures.
- Inspect pump and piping for leaks.
- Check seal chamber for leakage.

3 MONTH INSPECTIONS

- Check foundation.
- If pump has been left idle, check mechanical seal. Repair or replace if required.
- Pump should be re-greased at least every 3 months (2000 hours) or more often if there are any adverse atmospheric conditions or other conditions which might contaminate or break down the grease.
- Check shaft alignment and realign if required.

ANNUAL INSPECTIONS

- Check pump capacity, pressure and power. If pump performance does not satisfy your process requirements, and process requirements have not changed, pump should be disassembled, inspected, and worn parts should be replaced. Otherwise, a system inspection should be done.

INSPECTION INTERVALS

- Inspection intervals should be shortened appropriately if the pumpage is abrasive and/or corrosive,

or if the enviornment is classified as potentially explosive.

MAINTENANCE OF BEARINGS

Do not insulate bearing housings as this can result in excess heat generation, sparks, and premature failure.

Service temperature in an ATEX classified environment is limited to the area classification specified on the ATEX tag affixed to the pump (reference* Table 1 *in the* Safety *section for ATEX classifications).

GREASE LUBRICATED BEARINGS

Grease lubricated bearings are pre-lubricated at the factory. Regrease bearings every 2000 operating hours or 3 months, whichever occurs first.

Regrease Procedure

NOTE: When regreasing there is danger of impurities entering the bearing housing. The grease container, the greasing device, and fittings must be clean.

1. Wipe dirt from both grease fittings (Fig. 11).
2. Remove two grease relief plugs from side of frame opposite grease fittings.
3. Fill both grease cavities through grease fittings with recommended grease until fresh grease comes out of the relief holes. Reinstall grease relief plugs until immediately prior to starting pump.

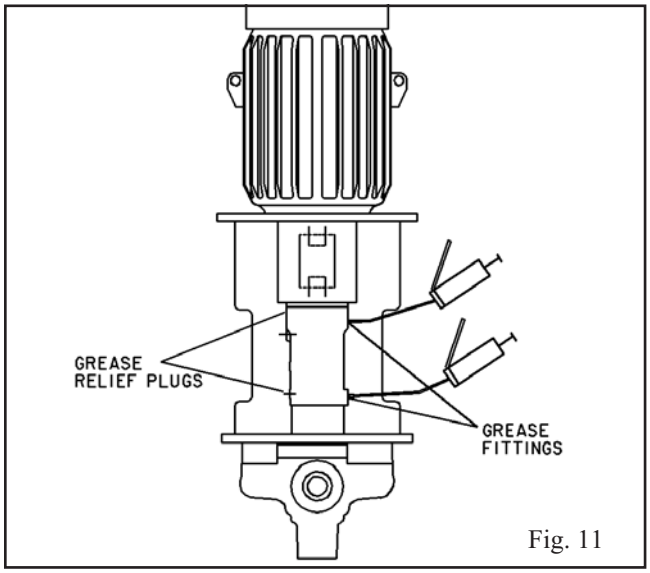

Fig. 11

NOTE: The bearing temperature usually rises after regreasing due to an excess supply of grease. Temperatures will return to normal after pump has run and purged the excess from the bearings, usually two to four hours. Grease relief plugs should be removed during this period, and replaced when temperature has stabilized.

For most operating conditions a lithium based mineral oil grease of NLGI consistency number 2 is recommended. This grease is acceptable for bearing temperatures of -15°C to 110°C (5°F ro 230°F).

Bearing temperatures are generally about 20°F (18°C) higher than bearing housing outer surface temperature.

Some acceptable greases are:

NLGI Consistency	2
Exxon	Unirex N2
Mobil	Mobilux EP2
Sunoco	Multipurpose EP
SKF	LGMT 2

CAUTION

Never mix greases of different consistency (NLGI 1 or 3 with NLGI 2) or different thickener. For example, never mix a lithium base grease with a polyurea base grease.

NOTE: If it is necessary to change grease type or consistency, the pump must be disassembled and the old grease removed from the bearings.

PURE OIL MIST LUBRICATED BEARINGS (OPTIONAL)

WARNING

Pumps are shipped without oil. Oil mist lubricated bearings must be lubricated at the job site.

1. Follow oil mist system supplier's instructions.
2. Connect oil mist supply lines to upper and center tapped connection.

3. Connect drain line to bottom tapped connection (Fig. 12).

Oil mist lubrication is required above pumpage temperature of 232°C (450°F), but may be used at lower temperature.

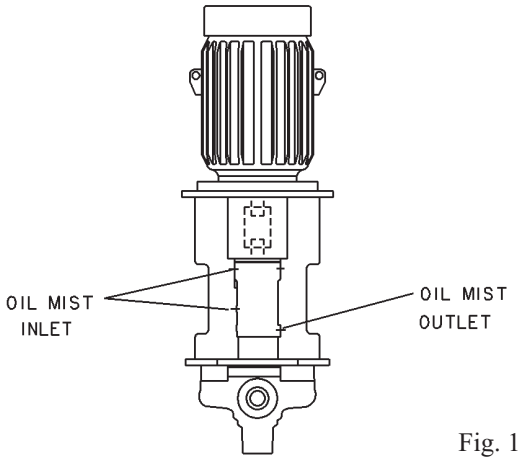

Fig. 12

A high quality turbine oil with rust and oxidation inhibitors should be used. For the majority of operational conditions, bearing temperatures will run between 50°C (120°F) and 82°C (180°F). In this range, an oil of ISO viscosity grade 68 at 40°C (100°F) is recommended. If bearing temperatures exceed 82°C (180°F), use ISO viscosity grade 100.

Some acceptable oils are:

Exxon	Teresstic EP68
Mobil	Mobil DTE 26 300 SSU @ 40°C (100°F)
Sunoco	Sunvis 968
Royal Purpal	SYNFILM ISO VG 68 Synthetic Lube

MAINTENANCE OF SHAFT SEALS

5

The mechanical seal used in an ATEX classified environment must be properly certified.

When mechanical seals are furnished by Goulds, a manufacturer's reference drawing is supplied with the data package. This drawing should be kept for future use when performing maintenance and adjusting the seal. The seal drawing will also specify required flush liquid and attachment points. The seal and all flush piping must be checked and installed as needed prior to starting the pump.

The life of a mechanical seal depends on various factors such as cleanliness of the liquid handled and its lubricating properties. Due to the diversity of operating conditions it is, however, not possible to give definite indications as to its life.

WARNING

NEVER operate the pump without liquid supplied to the 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.

The mechanical seal must have an appropriate seal flush system. Failure to do so will result in excess heat generation and seal failure.

Cooling systems such as those for bearing lubrication, mechanical seal systems, etc., where provided, must be operating properly to prevent excess heat generation, sparks and premature failure.

Sealing systems that are not self purging or self venting, such as plan 23, require manual venting prior to operation. Failure to do so will result in excess heat generation and seal failure.

TROUBLESHOOTING

Problem	Probable Cause	Remedy
No liquid delivered.	Pump not primed.	Check that pump and suction line are full of liquid. Reprime pump.
	Suction line clogged.	Remove obstructions.
	Impeller clogged with foreign material.	Back flush pump to clean impeller.
	Foot valve or suction pipe opening not sufficiently submerged.	Consult factory for proper depth. Use baffle to eliminate vortices.
	Suction lift too high.	Reduce suction lift.
Pump not producing rated flow or head.	Air leak thru gasket.	Replace gasket.
	Air leak thru seal chamber.	Replace or readjust mechanical seal.
	Impeller partly clogged.	Back flush pump to clean impeller.
	Worn wear rings.	Replace defective part as required.
	Insufficient suction head.	Ensure that suction line shutoff valve is fully open and line is unobstructed. Increase suction head.
	Worn or broken impeller.	Inspect and replace if necessary.
	Wrong direction of rotation.	Change rotation to concur with direction indicated by arrow on bearing frame.
Pump starts then stops pumping.	Improperly primed pump.	Reprime pump.
	Air or vapor pockets in suction line.	Rearrange piping to eliminate air pockets.
	Air leak in suction line.	Repair (plug) leak.
Bearings run hot.	Improper alignment.	Re-align pump and driver.
	Improper lubrication.	Check lubricant for suitability and quantity.
	Insufficient cooling liquid.	Check cooling system.
Pump is noisy or vibrates.	Improper pump/driver alignment.	Align shafts.
	Partly clogged impeller causing imbalance.	Backflush pump to clean impeller.
	Broken or bent impeller or shaft.	Replace as required.
	Impeller out of balance.	Balance impeller.
	Foundation not rigid.	Assure uniform contact of pump and/or supports with foundation.
	Worn bearings.	Replace.
	Suction or discharge piping not anchored or properly supported.	Anchor per Hydraulic Institute Standards/ API RP 686 recommendations.
	Pump is cavitating.	Locate and correct system problem.
Excessive leakage from stuffing box.	Worn mechanical seal parts.	Replace mechanical seal.
	Overheating mechanical seal.	Check lubrication and cooling lines.
Motor requires excessive power.	Head lower than rating. Pumps too much liquid.	Consult factory. Install throttle valve. Cut impeller.
	Liquid heavier than expected.	Check specific gravity and viscosity.
	Rotating parts bind.	Check internal wear parts for proper clearances.

DISASSEMBLY & REASSEMBLY

REQUIRED TOOL

- Open end wrenches
- Lifting sling
- Induction bearing heater
- Brass drift punch
- Spanner wrench
- Allen wrenches
- Torque wrench with sockets
- Dial indicator
- Micrometers (inside and outside)
- Cleaning agents
- Feeler gauges
- Drill
- Tap
- Spanning type puller
- Soft face hammer
- Press

DISASSEMBLY

WARNING

Pump components are heavy. Proper methods of lifting and securing must be employed to avoid physical injury and/or equipment damage.

WARNING

The Model 3910 may handle hazardous and/or toxic fluids. Proper personal protection is required. Precautions must be taken to prevent physical injury. Pumpage must be handled and disposed of in conformance with applicable regulations.

NOTE: Before disassembling the pump for overhaul, ensure all replacement parts are available.

WARNING

Lock out power supply to driver to prevent accidental startup and physical injury.

PREPARATION FOR DISASSEMBLY

1. Shut off all valves controlling flow to and from pump.

WARNING

Operator must be aware of pumpage and safety precautions to prevent physical injury.

2. Drain liquid from piping; flush pump if necessary.
3. Disconnect all auxiliary piping, tubing and equipment that will interfere with removal of back pull-out assembly.
4. Remove coupling guard. Refer to coupling guard installation and disassembly instructions in *Appendix I.*
5. Remove coupling spacer. Follow coupling manufacturer's instructions for assistance.

REMOVAL OF BACK PULL-OUT ASSEMBLY

1. Loosen and remove casing stud nuts (425).
2. Separate back pull-out assembly from casing (100) by tightening jacking bolts (418) provided. Tighten jacking bolts evenly using alternating pattern (Fig. 13).

NOTE: Penetrating oil may be used if seal chamber cover to casing joint is excessively corroded.

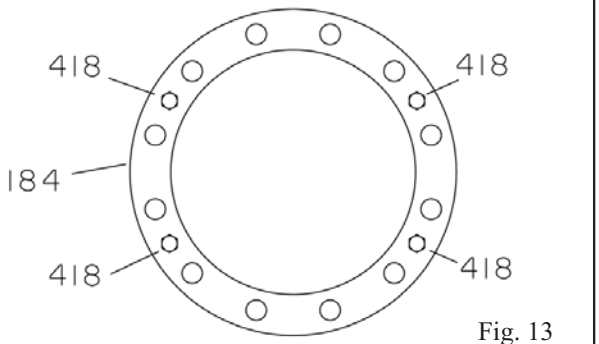

Fig. 13

3. Remove back pull-out assembly using Goulds back pull-out device or other suitable means. Refer to instructions in *Appendix III*.

⚠ WARNING

Pump components are heavy. Proper methods of lifting and securing must be employed to avoid physical injury and/or equipment damage.

4. Remove and discard casing gasket (351). (Replace this with new gasket during reassembly.)
5. Secure to prevent movement during transport. Transport back pull-out assembly to a clean work area for further disassembly.
6. Support and secure back pull-out assembly firmly to workbench.

REMOVAL OF IMPELLER

1. Loosen set screw (198A) in end of impeller nut (304) (Fig. 14).
2. Loosen and remove impeller nut (304).

NOTE: Impeller nut has LEFT HAND threads.

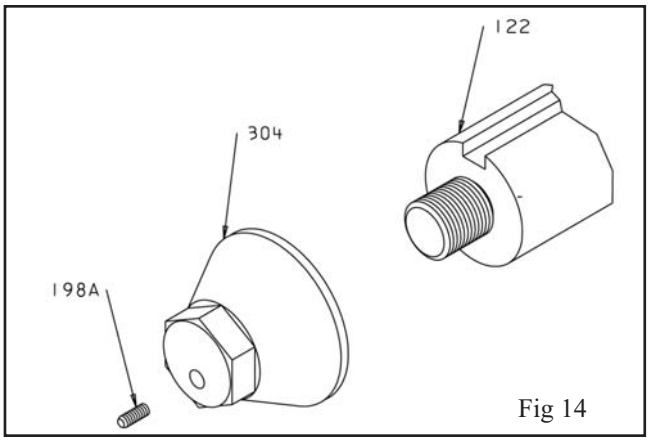

Fig 14

3. Pull impeller (101) from shaft (122). Use a spanning type puller if required.

! CAUTION

When handling the impeller, wear heavy work gloves to prevent cutting hands on sharp edges.

4. Remove impeller key (178).

REMOVAL OF COUPLING HUB

1. Blue and scribe shaft (122) for relocating coupling hub during reassembly (Fig. 15).
2. Remove coupling hub.

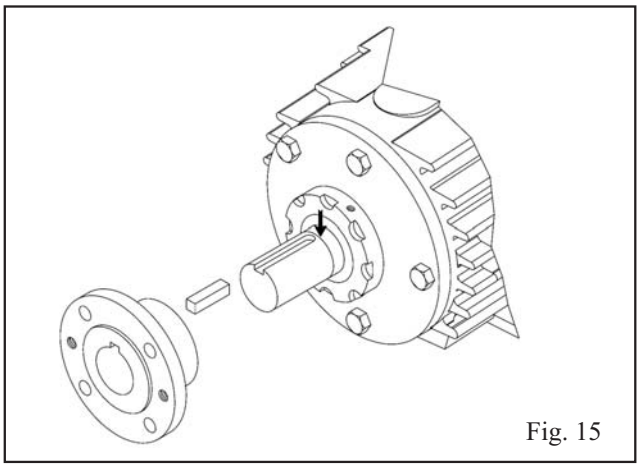
Fig. 15

REMOVAL OF SEAL CHAMBER COVER

1. Loosen and remove gland stud nuts (355)(Fig. 16).
2. Slide cartridge mechanical seal away from seal chamber cover (184).
3. Install eyebolt in tapped hole provided in seal chamber cover (184).
4. Rig lifting sling to eyebolt and to overhead lifting device. Take light strain on sling.

5. Loosen and remove seal chamber cover/bearing frame bolts (370H).
6. Separate seal chamber cover (184) from bearing frame (228) by tapping on cover flange with a hardwood block or a soft face hammer.
7. Guide seal chamber cover (184) over end of shaft (122) once cover releases from bearing frame (228).

CAUTION

Cartridge mechanical seal may be damaged if cover is allowed to come in contact with it.

8. Loosen set screws and remove cartridge mechanical seal from shaft (122).
9. Remove and discard mechanical seal O-ring or gland gasket (360Q). (Replace this with a new O-ring or gasket during reassembly.)

REMOVAL OF OPTIONAL WATER JACKET COVER

1. Suspend seal chamber cover (184) from lifting sling, or firmly support seal chamber cover in a vertical position such that one water jacket connection is on the top and the other is on the bottom.

WARNING

Seal chamber cover must be adequately supported so that it cannot fall. Personal injury and/or damage to equipment could occur.

2. Introduce water slowly into the bottom connection until all air is vented and only water comes out of the top connection.

WARNING

All air must be vented from water jacket. If all air is not vented, it can cause water jacket cover (490) to be propelled from its fit in the seal chamber cover (184). Personal injury and/or damage to equipment could occur.

3. Stop introduction of water into water jacket.
4. Seal top connection with plug or other suitable means.
5. Slowly increase water pressure on inlet (bottom) connection. Water jacket cover (490) should be forced from its fit in the seal chamber cover (184). Be prepared to catch water jacket cover.

CAUTION

Do not exceed 7.0 kg/cm^2 (100 psig) pressure in water jacket.

6. Remove and discard outer and inner water jacket cover O-rings (412S and 497T, respectively) from grooves in water jacket cover (490). (Replace these with new O-rings during reassembly.)

6

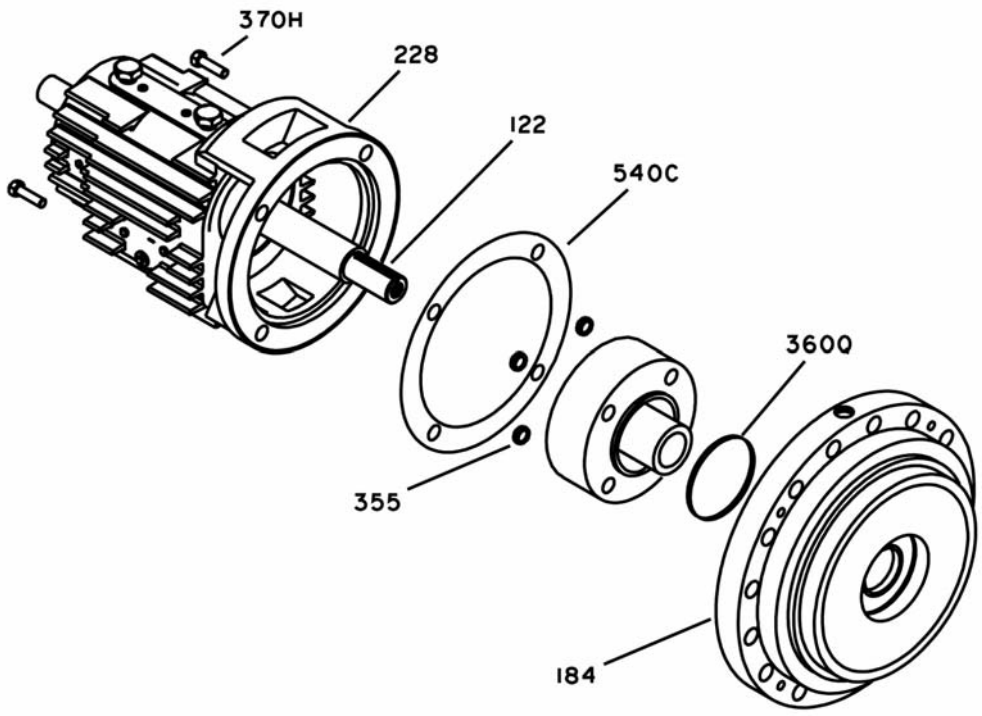

Fig. 16

DISASSEMBLY OF STANDARD GREASE LUBRICATED POWER END

This section covers disassembly of standard ring oil or optional purge oil mist lubricated power end. For power ends with optional features (pure oil mist lubrication, bearing cooling, etc.), refer to the appropriate section.

1. Loosen and remove thrust bearing end cover/bearing frame screws (370N).
2. Pry thrust bearing end cover (109A)/INPRO (123A) with O-ring (412, not shown) out of bearing frame (228). SA thrust bearing end cover is sealed to the bearing frame with a gasket (360A) (Fig. 17).

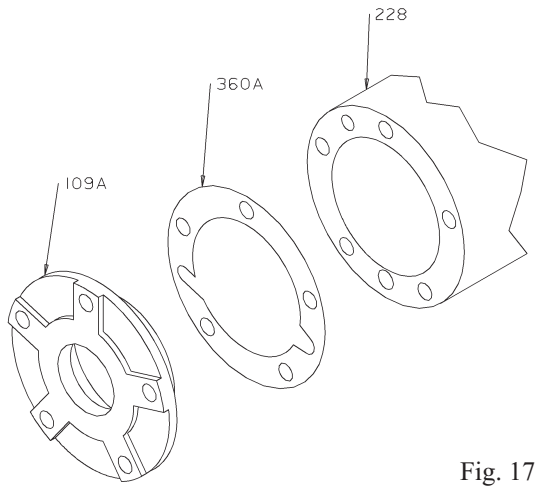

Fig. 17

3. Remove and discard thrust bearing end cover shims (390C). Replace with new shims during reassembly. (Not applicable to pumps with SA bearing frame.)
4. Withdraw shaft/bearing assembly carefully from bearing frame (228).

! CAUTION

Do NOT remove bearings from shaft unless they are to be replaced.

5. Bend locking tang of thrust bearing lockwasher (382) from notch in bearing locknut (136) (Fig. 18).

NOTE: Save bearings for inspection.

6. Loosen and remove thrust bearing locknut (136) and lockwasher (382).
7. Press or pull duplex thrust bearing (112) from shaft (122).
8. Remove grease shelf (253) from shaft (122).
9. Press or pull radial bearing (168) from shaft (122).

NOTE: Save bearing for inspection.

10. Loosen and remove radial bearing end cover / bearing frame screws (370P) (Fig. 19). Omit this step on SA pumps. Radial INPRO Oil Seal (123) is pressed in place and sealed with an O-ring (Fig. 20).
11. Remove radial bearing end cover (119A)/ Radial INPRO (123) with gasket (360) or Radial INPRO (123) (SA pump only) from bearing frame (228) by tapping out of fit in frame.

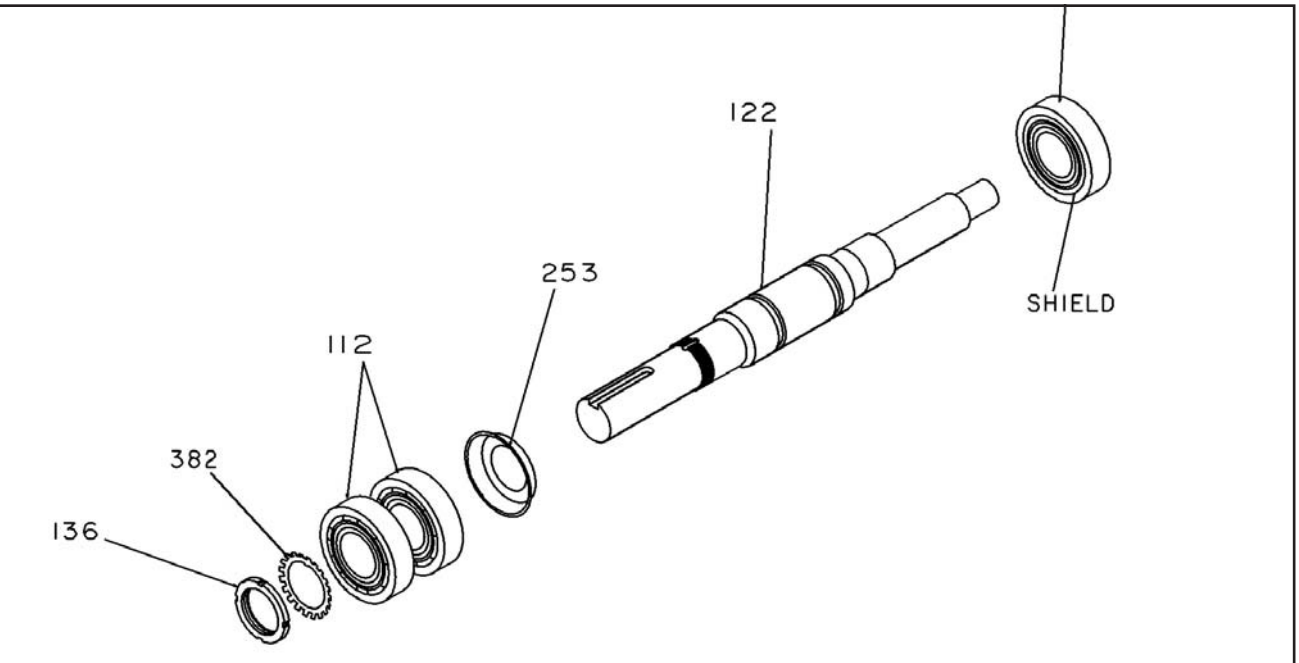

Fig. 18

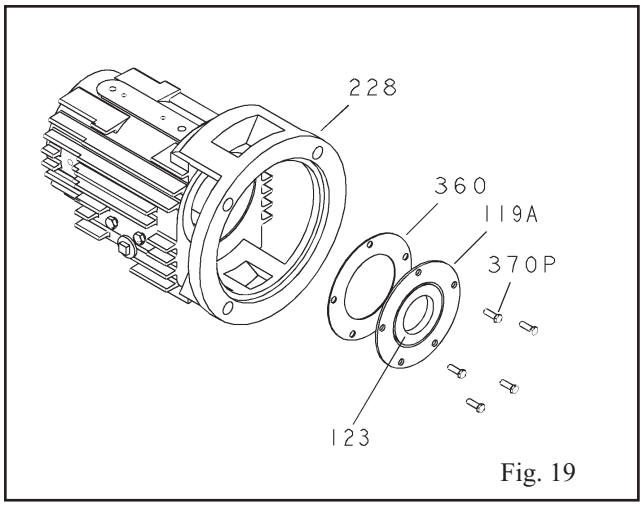

Fig. 19

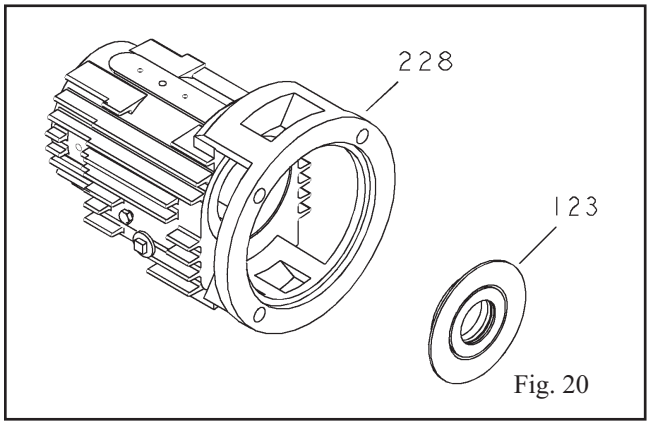

Fig. 20

12. Remove and discard radial bearing end cover gasket (360). (Replace this with a new gasket during reassembly.)
13. Press Radial and Thrust INPRO (123 & 123A) out of radial (N/A on SA pumps) and Thrust End Covers (119A & 109A).

DISASSEMBLY OF OPTIONAL PURE OIL MIST LUBRICATED POWER END

Pure oil mist lubricated power ends are disassembled in the same manner as grease lubricated power ends. Grease shelf (253) is not furnished with pure oil mist lubrication. Disregard any reference to this part.

DISASSEMBLY OF POWER END WITH OPTIONAL RADIAL HEAT FLINGER

The radial heat flinger (123B) replaces the standard radial INPRO (123) and is removed in the same manner except 3 set screws (222) need to be loosened (Fig. 21). Remove and discard frame / seal chamber cover thermal gasket (540C) (Fig. 16). (Replace this with a new gasket during reassembly. Remainder of disassembly is the same as grease lubrication.

DISASSEMBLY OF POWER END WITH OPTIONAL AIR COOLING PACKAGE

1. Loosen radial heat flinger set screw (222) (Fig. 21).
2. Loosen thrust fan set screw (222). SA pumps thrust fan sits on coupling diameter.
3. Slide thrust fan (123E) off shaft (122).
4. Loosen and remove thrust bearing end cover/bearing frame screws (370N).
5. Remove thrust fan guard support (234D).

Remainder of disassembly is the same as steps 2-13 of grease lubrication section.

FINAL DISASSEMBLY

Remove any remaining plugs and fittings.

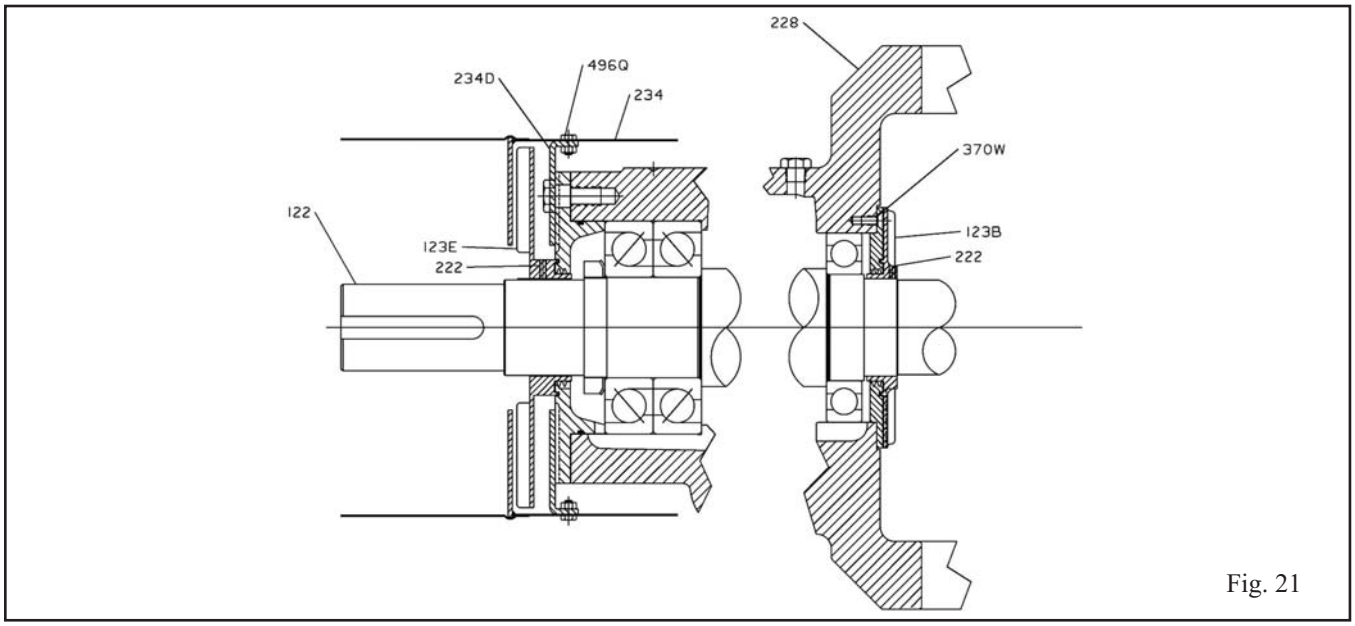

Fig. 21

INSPECTIONS

Model 3910 parts must be inspected to the following criteria before they are reassembled to ensure the pump will run properly. Any part not meeting the required criteria should be replaced.

NOTE: Clean parts to remove oil, grease or dirt. Protect machined surfaces against damage during cleaning.

CASING (100)

The casing should be inspected for excessive wear, corrosion or pitting. Areas most susceptible are indicated by the arrows in Fig. 22. Casing should be repaired or replaced if it exceeds the following criteria:

1. Localized wearing or grooving greater than 3.2 mm (⅛ in.) deep.
2. Pitting greater than 3.2 mm (⅛ in.) deep.
3. Irregularities in case gasket seat surface which could hinder or prevent sealing.

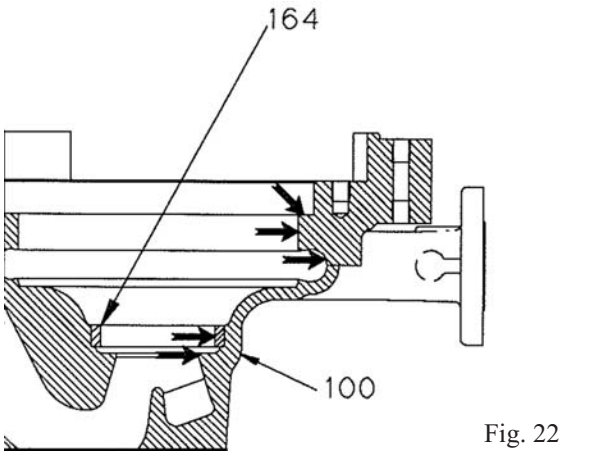

Fig. 22

IMPELLER (101)

1. Inspect impeller vanes for damage. Replace if grooved deeper than 1.6 mm (1/16 in.) or if worn evenly more than 0.8 mm (1/32 in.). (Area "a" in Fig. 23.)
2. Inspect shrouds for damage. Replace if worn or bent more than 0.8 mm (1/32 in.). (Area "b" in Fig. 23.)
3. Inspect leading and trailing edges of the vanes for pitting, and erosion or corrosion damage. Replace as in No. 1. (Area "c" in Fig. 23.)
4. Clean and check impeller bore diameter.
5. Check impeller balance. It should be rebalanced if it exceeds the criteria of ISO 1940 G1.0.

NOTE: Balancing impellers to ISO 1940 G1.0 requires extremely accurate tooling and equipment and should not be attempted unless such tooling and equipment are available.

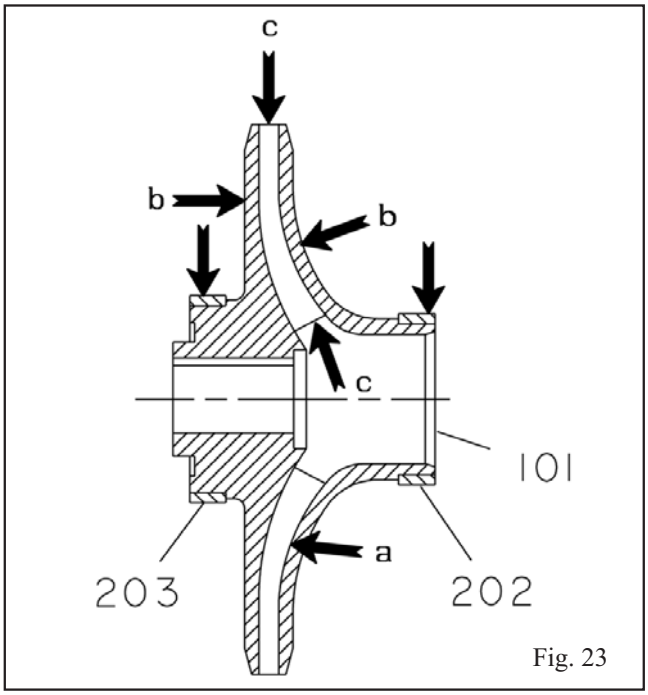

Fig. 23

BALL BEARINGS (112, 168)

1. Ball bearings should be inspected for contamination and damage. The condition of the bearings will provide useful information on operating conditions in the bearing frame (228).
2. Lubricant condition and residue should be noted.
3. Bearing damage should be investigated to determine cause. If cause is not normal wear, it should be corrected before pump is returned to service.

NOTE: It is good practice to replace all ball bearings that have been removed from their shaft fits. Always replace if they are worn, loose or rough and noisy when rotated. Replacement bearings must be of proper size and type.

4. Replacement bearings must be the same as, or equivalent to, those listed in *Table 3*.

Table 4
Model 3910 Bearings

Group	Radial (Inboard)		Thrust (Outboard)
	Grease	Oil Mist	
SA	6210 C3Z	6210 C3	7310 BEGAM
SX	6212 C3Z	6212 C3	7312 BEGAM
MX, LA	6213 C3Z	6213 C3	7312 BEGAM
XLX	6218 C3Z	6218 C3	7317 BEGAM

NOTE: Bearing numbers are based on SKF / MRC designations.

SHAFT (122)

1. Check bearing fits. If any are outside the tolerance shown in Tables 5 or 5A, replace the shaft (Fig. 24).
2. Check shaft surface for damage, especially in areas indicated by arrows in Fig. 24. Replace if damaged beyond reasonable repair.
3. Check shaft straightness. Use "V" blocks or balance rollers to support the shaft on bearing fit areas. Replace shaft if runout exceeds 0.03 mm (.001 in.)

NOTE: Do NOT use shaft centers for runout check as they may have been damaged when removing bearings or impeller.

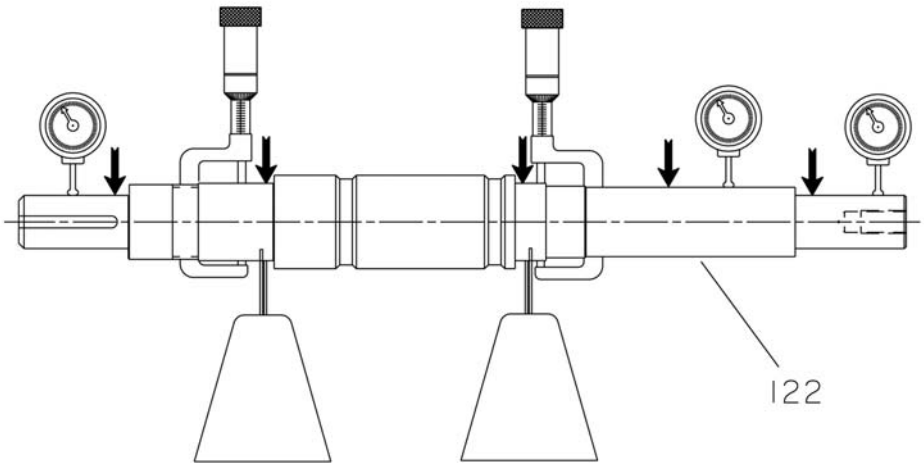

Fig. 24

Table 5
Model 3910 Bearing Fits & Tolerances (SI Units)
According to ISO 286 (ANSI/ABMA Standard 7)

Location	Description	Group and Dimensions (mm)			
		SA	SX	MX, LA	XLX
Radial (Inboard)	Shaft O.D.	50.013 50.002	60.015 60.002	65.015 65.002	90.018 90.003
	Interference	0.002 0.025	0.002 0.030	0.002 0.030	0.003 0.038
	Bearing I.D.	49.988 50.000	59.985 60.000	64.985 65.000	89.980 90.000
	Frame I.D.	90.000 90.022	110.000 110.022	120.000 120.022	160.000 160.025
	Clearance	0.000 0.037	0.000 0.037	0.000 0.037	0.000 0.050
	Bearing O.D.	90.000 89.985	110.000 110.022	120.000 119.985	160.000 159.975
Thrust (Outboard)	Shaft O.D.	50.013 50.002	60.015 60.002	60.015 60.002	85.018 85.003
	Interference	0.002 0.025	0.002 0.030	0.002 0.030	0.003 0.038
	Bearing I.D.	49.998 50.000	59.985 60.000	59.985 60.000	84.980 85.000
	Frame I.D.	110.000 110.022	130.000 130.025	130.000 130.025	180.000 180.025
	Clearance	0.000 0.037	0.000 0.043	0.000 0.043	0.000 0.050
	Bearing O.D.	110.000 109.985	130.000 129.982	130.000 129.982	180.000 179.975

Table 5A
Model 3910 Bearing Fits & Tolerances (USA Units)
According to ISO 286 (ANSI/ABMA Standard 7)

Location	Description	Group and Dimensions (inches)			
		SA	SX	MX, LA	XLX
Radial (Inboard)	Shaft O.D.	1.9690 1.9686	2.3628 2.3623	2.5597 2.5592	3.5440 3.5434
	Interference	0.0001 0.0010	0.0001 0.0012	0.0001 0.0012	0.0001 0.0015
	Bearing I.D.	1.9680 1.9685	2.3616 2.3622	2.5585 2.5591	3.5425 3.5433
	Frame I.D.	3.5433 3.5442	4.3307 4.3316	4.7244 4.7253	6.2992 6.3002
	Clearance	0.0000 0.0015	0.0000 0.0015	0.0000 1.0015	0.0000 0.0020
	Bearing O.D.	3.5483 3.5427	4.3307 4.3301	4.7244 4.7238	6.2992 6.2982
Thrust (Outboard)	Shaft O.D.	1.9691 1.9686	2.3628 2.3623	2.3628 2.3623	3.3472 3.3466
	Interference	0.0001 0.0010	0.0001 0.0012	0.0001 0.0012	0.0001 0.0015
	Bearing I.D.	1.9680 1.9685	2.3616 2.3622	2.3616 2.3622	3.3457 3.3465
	Frame I.D.	4.3307 4.3315	5.1181 5.1191	5.1181 5.1191	7.0866 7.0876
	Clearance	0.0000 0.0015	0.0000 0.0017	0.0000 0.0017	0.0000 0.0020
	Bearing O.D.	4.3307 4.3301	5.1181 5.1174	5.1181 5.1174	7.0866 7.0856

WEAR RINGS (164, 202, 203, 230)

All units are equipped with casing (164), impeller (202 and 203) and seal chamber cover wear rings (230).

When clearances between the rings become excessive, hydraulic performance decreases substantially.

1. Measure all wear ring diameters (Figs. 25, 26, 27).
2. Calculate diametral wear ring clearances. Minimum diametral clearances should be as shown in *Table 6*.
3. Replace wear rings when diametral clearance exceeds two times the minimum clearance as shown in *Table 6* or when the hydraulic performance has decreased to unacceptable levels. Refer to *Renewal of Wear Parts* for replacement instructions for wear rings.

NOTE: For operating temperatures above 260° C (500° F) and for materials with greater galling tendencies (e.g. stainless steel), increase diametral clearance dimensions by 0.13 mm (.005 in.).

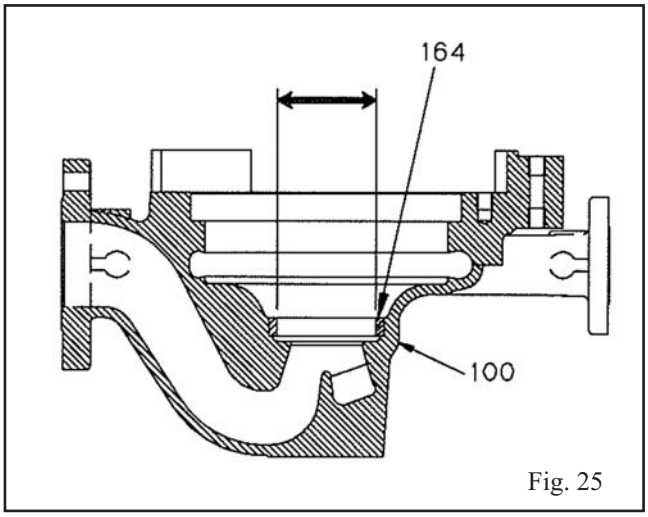

Fig. 25

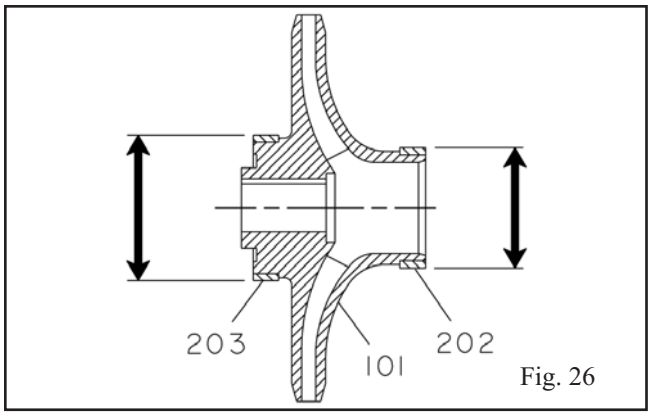

Fig. 26

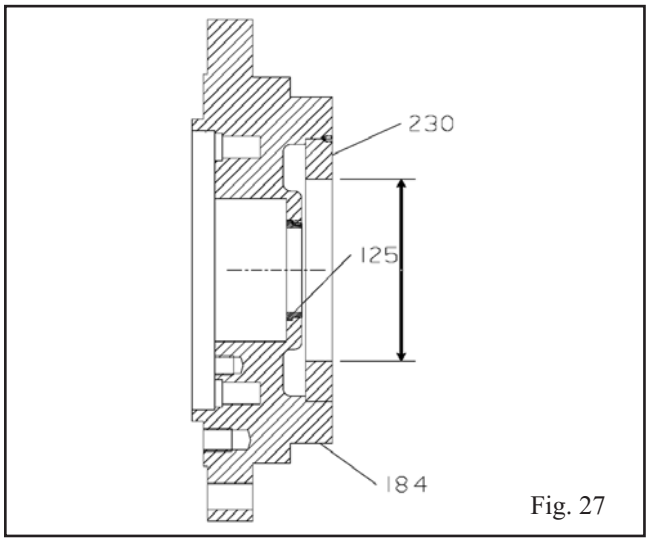

Fig. 27

SEAL CHAMBER COVER (184)

Seal chamber cover is available in two versions: one (optional) has a cooling chamber and water jacket cover (490) and the other (standard) does not. The (optional) cooled version is used when elevated pumpage temperatures are present.

1. Ensure all gasket/O-ring sealing surfaces are clean and have no damage that would hinder or prevent sealing (Fig. 28).
2. Ensure all cooling (where applicable), flush and drain passages are clear.
3. Inspect other surfaces for damage. Replace if worn, damaged or corroded more than 3.2 mm (⅛ in.) deep.
4. Measure inside diameter of seal chamber cover bushing (125). If the diametral clearance between it and the impeller hub (101) exceeds 1.20 mm (.047 in.), one or both parts should be replaced. Refer to *Renewal of Wear Parts* for replacement instructions for seal chamber cover bushing.

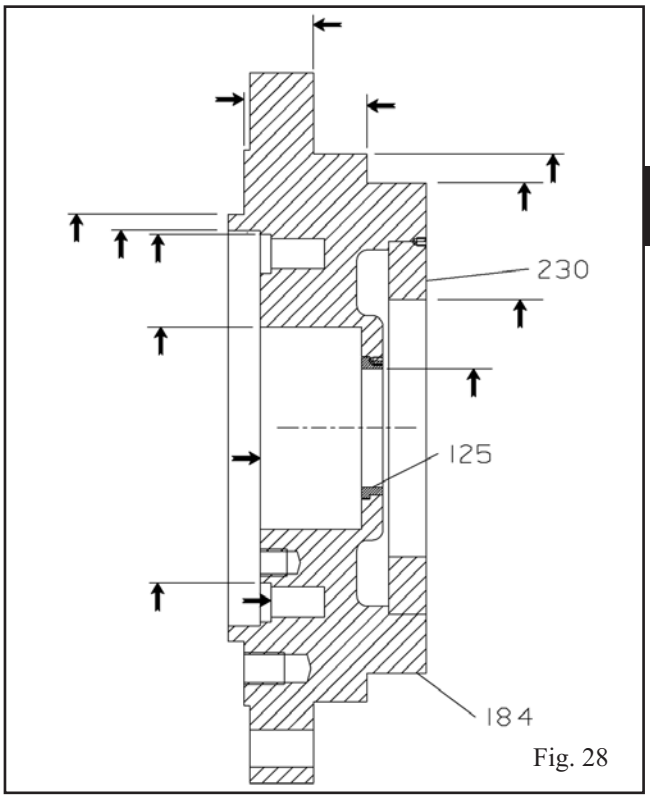

Fig. 28

Table 6
Minimum Running Clearances

Diameter of Impeller Wear Ring		Minimum Diametral Clearance	
mm	in.	mm	in.
<50	<2.000	0.25	0.010
To to 64.99	2.000 to 2.4999	0.28	0.011
65 to 79.99	2.500 to 2.999	0.30	0.012
80 to 89.99	3.000 to 3.499	0.33	0.013
90 to 99.99	3.500 to 3.999	0.35	0.014
100 to 114.99	4.000 to 4.499	0.38	0.015
115 to 124.99	4.500 to 4.999	0.40	0.016
125 to 149.99	5.000 to 5.999	0.43	0.017
150 to 174.99	6.000 to 6.999	0.45	0.018
175 to 199.99	7.000 to 7.999	0.48	0.019
200 to 224.99	8.000 to 8.999	0.50	0.020
225 to 249.99	9.000 to 9.999	0.53	0.021
250 to 274.99	10.000 to 10.999	0.55	0.022
275 to 299.99	10.000 to 11.999	0.58	0.023
300 to 324.99	12.000 to 12.999	0.60	0.024

BEARING FRAME (228)

1. Visually inspect bearing frame for damage and cracks.
2. Check frame inside surfaces for rust, scale or debris. Remove all loose and foreign material (Fig. 29).
3. Make sure all lubrication passages are clear.
4. Check bearing bores. If any are outside the tolerance in *Table 6*, replace the bearing frame.

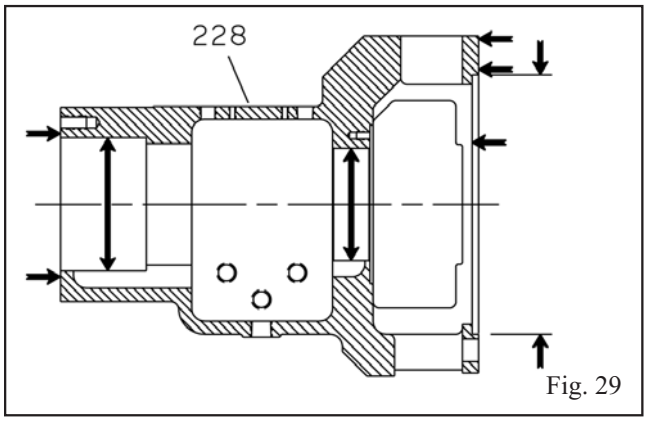

Fig. 29

CARTRIDGE MECHANICAL SEAL

Refer to mechanial seal manufacturer's instructions for assistance.

Cartridge type mechanical seals should be serviced by seal manufacturer.

COUPLING GUARD

1. Inspect guard for corrosion or other defects.
2. Replace guard or repair.

⚠ WARNING

To avoid physical injury, coupling guard must be installed and must be maintained in first-class condition.

GASKETS, O-RINGS, SHIMS, AND SEATS

NOTE: Spiral wound gaskets should not be reused.

1. Replace all gaskets, O-rings and shims at each overhaul / disassembly.
2. Inspect seats. They must be smooth and free of physical defects. Skin cut seats in lathe as necessary, maintaining dimensional relationships with other surfaces. Replace parts if seats are defective beyond reasonable repair.

GENERAL

All other parts should be inspected and repaired or replaced, as appropriate, if inspection indicates continued use would be harmful to satisfactory and safe pump operation.

Inspection must include, but not be limited to, the following:

- Bearing End Covers (109A) and (119A)
- INPROS (123) and (123A)
- Radial Heat Flinger (123B)*
- Thrust Fan (123E)*
- Bearing Locknut (136)
- Impeller Key (178) and Coupling Key
- Impeller Nut (304)
- Bearing Lockwasher (382)
- Water Jacket Cover (490)*
- All Nuts, Bolts and Screws

* If supplied.

RENEWAL OF WEAR PARTS

REPLACEMENT OF SEAL CHAMBER COVER BUSHING

Seal chamber cover bushing (125) is held in place by a press fit and locked by three set screws.

Removal of Bushing (125)

1. Remove set screws.
2. Press bushing (125) out of fit toward bearing frame side of seal chamber cover (184) bore (Fig. 30).

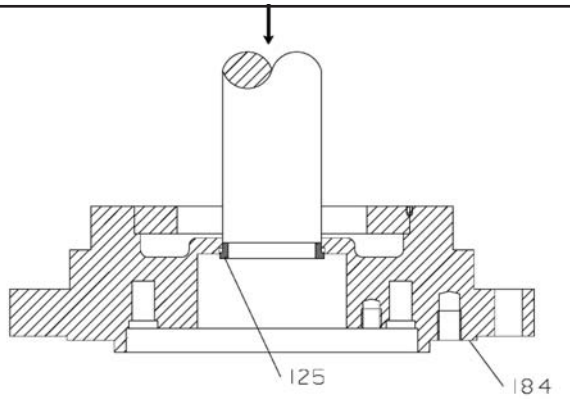

Fig. 30

Installation of Bushing (125)

1. Clean bushing fit in seal chamber cover (184) thoroughly.
2. Chill new bushing (125) using dry ice or other suitable chilling substance, and install bushing into fit of cover (184). Be prepared to tap the bushing in place with a hardwood block or soft faced hammer (Fig. 31).

WARNING

Dry ice and other chilling substances can cause physical injury. Contact supplier for information and advice for proper handling precautions and procedures.

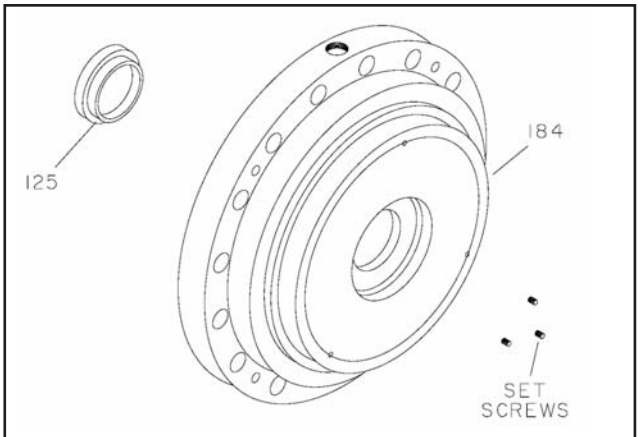

Fig. 31

3. Locate, drill and tap three new set screw holes on impeller side of cover (184) equally spaced between original set screw holes.
4. Install set screws and upset threads.

REPLACEMENT OF WEAR RINGS

Casing (164), impeller (202 and 203) and seal chamber cover wear rings (230) are held in place by a press fit and three set screws (222E and 320).

Removal of Wear Rings (164, 202, 203, 230)

1. Remove set screws (222E and 320).
2. Remove wear rings from casing (100), impeller (101), and seal chamber cover (184) using suitable pry or puller to force rings from fits.

   Rings may also be machined for removal.

CAUTION

Excessive machining can damage ring fits and render parts unusable.

Installation of Wear Rings (164, 202, 203, 230)

1. Clean wear ring seats thoroughly, insuring they are smooth and free of scratches.
2. Heat new impeller wear rings (202 and 203) to 82° - 93° C (180° - 200° F) using a uniform method for heating (e.g. - oven) and place on impeller (101) wear ring seats (Fig. 32).

CAUTION

Use insulated gloves to handle rings. Ringswill be hot and can cause physical injury.

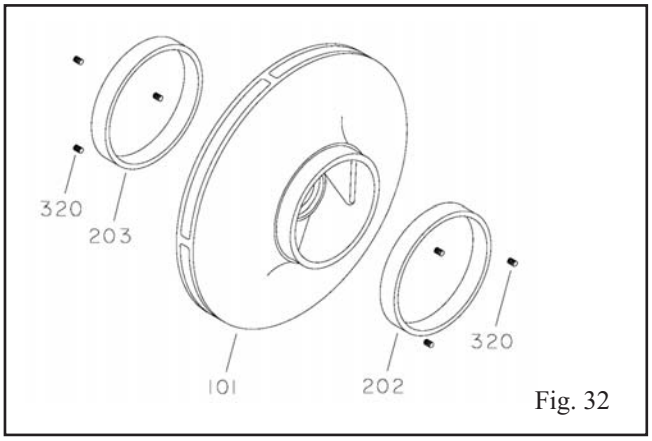

Fig. 32

6

3. Chill new casing wear ring (164) using dry ice or other suitable chilling substance, and install ring into fit of casing (100). Be prepared to tap the ring in place with a hard wood block or soft faced hammer (Fig. 33).

WARNING

Dry ice and other chilling substances can cause physical injury. Contact supplier for information and advice for proper handling precautions and procedures.

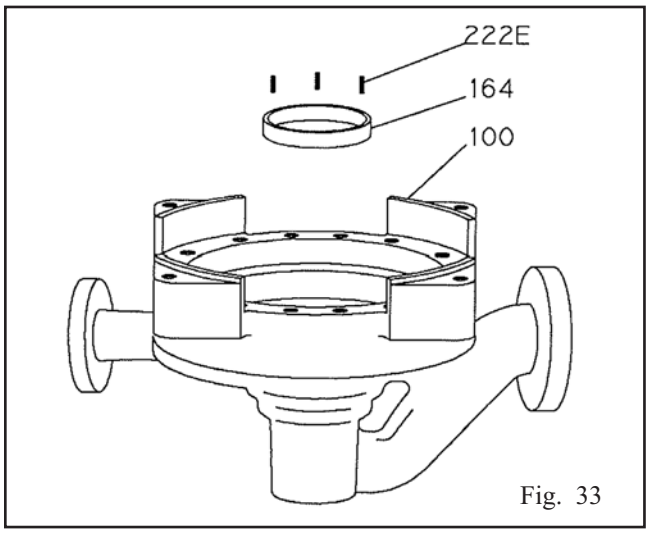

Fig. 33

4. Chill new seal chamber cover wear ring (230), using dry ice or other suitable chilling substance, and install ring into fit of cover (184). Be prepared to tap the ring in place with a hardwood block or soft faced hammer (Fig. 34).

WARNING

Dry ice and other chilling substances can cause physical injury. Contact supplier for information and advice for proper handling precautions and procedures.

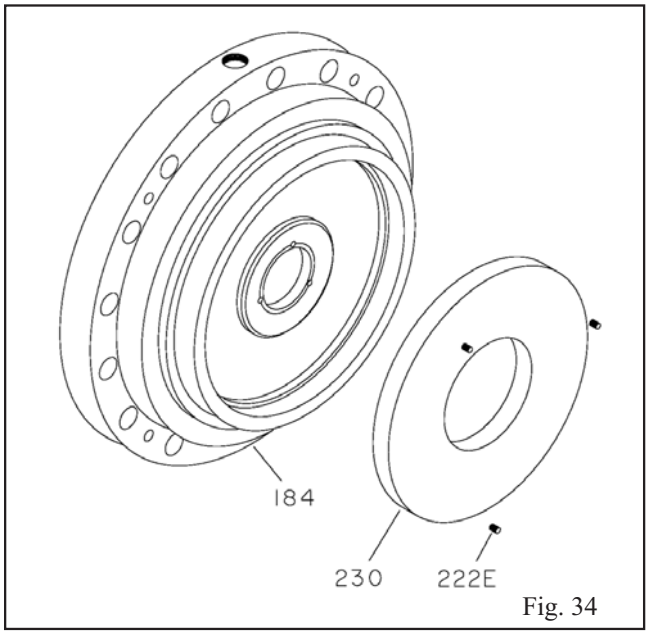

Fig. 34

5. Locate, drill and tap three new set screw holes equally spaced between the original holes in each new ring and ring seat area.
6. Install set screws (222E and 320) and upset threads.

The impeller and wear ring clearance setting procedures 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.

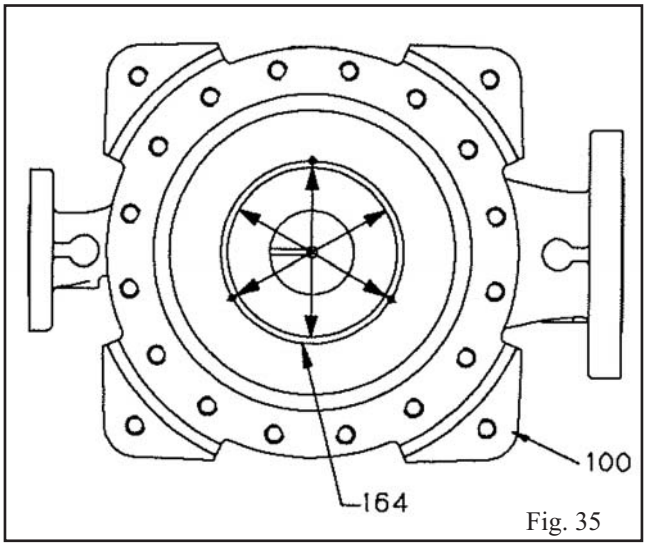

Fig. 35

7. Check casing wear ring (164) runout / distortion by measuring bore at each set screw location with inside micrometers or vernier calipers (Fig. 35). Any distortion in excess of 0.08 mm (.003 in.) should be corrected by machining prior to trimming new impeller wear rings (202 and 203).
8. Measure bore of casing wear ring (164) to establish the required impeller wear ring (202) diameter to provide the recommended running clearances as indicated in *Table 6* and subsequent note.
9. Repeat steps 7 and 8 for the seal chamber wear ring (230).
10. Turn impeller wear rings (202 and 203) to size after mounting on impeller (101).

NOTE A: All replacement impeller wear rings, except those hard faced, are supplied 0.51 mm (.020 in.) to 0.75 mm (.030 in.) oversize.

NOTE B: Spare hard faced impeller wear rings are not supplied oversize but are supplied to pre-established proper running clearances when both impeller and casing wear rings are renewed.

CAUTION

For runout checks, firmly support bearing frame assembly in horizontal position, as shown in Fig. 36.

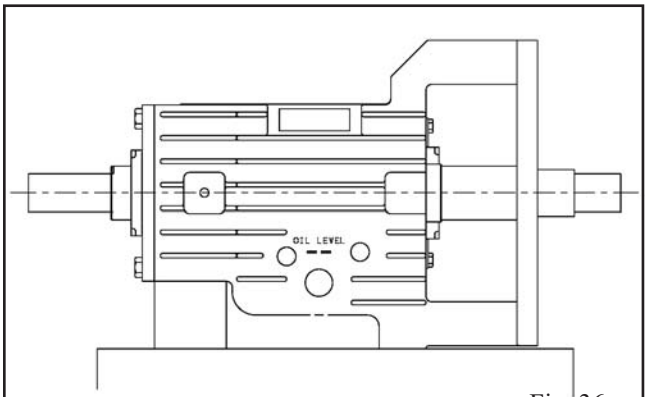

Fig. 36

11. Check impeller wear ring runout in the following manner:

    a. Install impeller key (178) on shaft (122) of assembled bearing frame from which the seal chamber cover (184) has been removed, and on which the runouts have been determined to be within the specifications established in *Reassembly* section. Key should be at top (12 o'clock) position for installation of impeller (101).

    b. Install impeller (101) on shaft (122).

CAUTION

When handling the impeller, wear heavy work gloves to prevent cutting hands on sharp edges.

    c. Secure impeller (101) firmly with impeller nut (304).

NOTE: Impeller nut has LEFT HAND threads.

    d. Mount dial indicator as shown in Fig. 37.

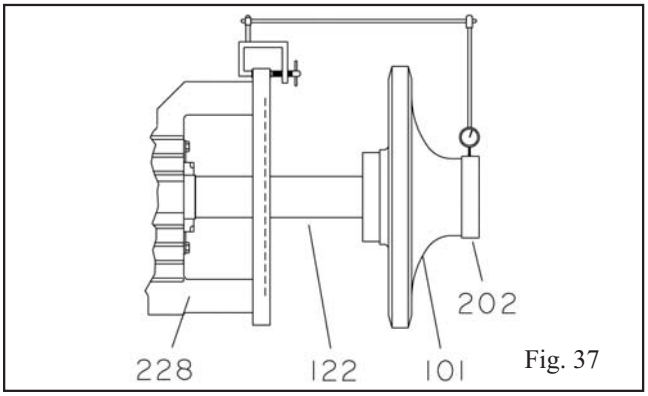

Fig. 37

    e. Rotate shaft (122) so indicator rides along the casing side impeller wear ring (202) surface for 360 degrees.

    f. Repeat steps d and e for seal chamber cover side wear ring (203).

If impeller wear ring (203 and 203) runout is in excess of 0.13 mm (.005 in.):

    a. Check for distortion at set screw areas.

    b. Check shaft (122) runout and all mating surfaces of shaft and impeller (101) hub for perpendicularity.

    c. True up all surfaces found damaged and recheck impeller wear ring (202 and 203) runout.

REASSEMBLY

Refer to *Table 7* for torque values while reassembling pump.

Leakage of process liquid may result in creating an explosive atmosphere. Ensure the materials of the pump casing, impeller, shaft, sleeves, gaskets and seals are compatible with the process liquid.

Leakage of process liquid may result in creating an explosive atmosphere. Follow all pump and seal assembly procedures.

Table 7
Maximum Torque Values for Model 3910 Fasteners
Values in N-m (ft.-lb.)

Item Number	Description	Group/ Size	Construction - API Designation										Non-API Material
			S-1	S-3	S-4	S-5	S-6	S-8 S-8N	S-9	C-6	A-8 A-8N	D-1	Modified A-8
136	Bearing Locknut	SA SX, MX, LA XLX	95 (70) 149 (110) 407 (300)										
304	Impeller Nut	SA, SX MX LA, XLX	145 (107) 178 (131) 287 (212)										
353 and 355	Gland Studs & Nuts	SA All others	118 (87) 235 (173)										
365A and 425	Casing Studs & Nuts	SA, SX MX (11") MX (13") LA (16") XLX (21")	415 (306) 415 (306) 671 (495) 1006 (742) 1426 (1052)										
370H	Screw - Bearing Frame/ Seal Chamber Cover	SA SX MX, LA XLX	41 (30) 80 (59) 142 (105) 346 (256)										
370N	Screw -Thrust Bearing End Cover to Frame	SA, SX MX, LA XLX	41 (30) 41 (30) 80 (59)										
370P and 370W Optional	Screw -Radial Bearing End Cover to Frame	SX MX, LA XLX	9 (7)										
469Q (Optional)	Screw -Thrust Deflector Fan Guard Support	All	9 (7)										
	Pump to Base Bolts	All	955 (705)										

NOTE: The torque values specified in the above table are for dry threads. These values should be reduced for lubricated threads only when lubricants of high stress ability (e.g. - Molycote) are used.

NOTE: Materials listed in the above table are equal to the respective API 610, 10th Edition (ISO 13709) material classes. In some cases, superior materials are substituted.

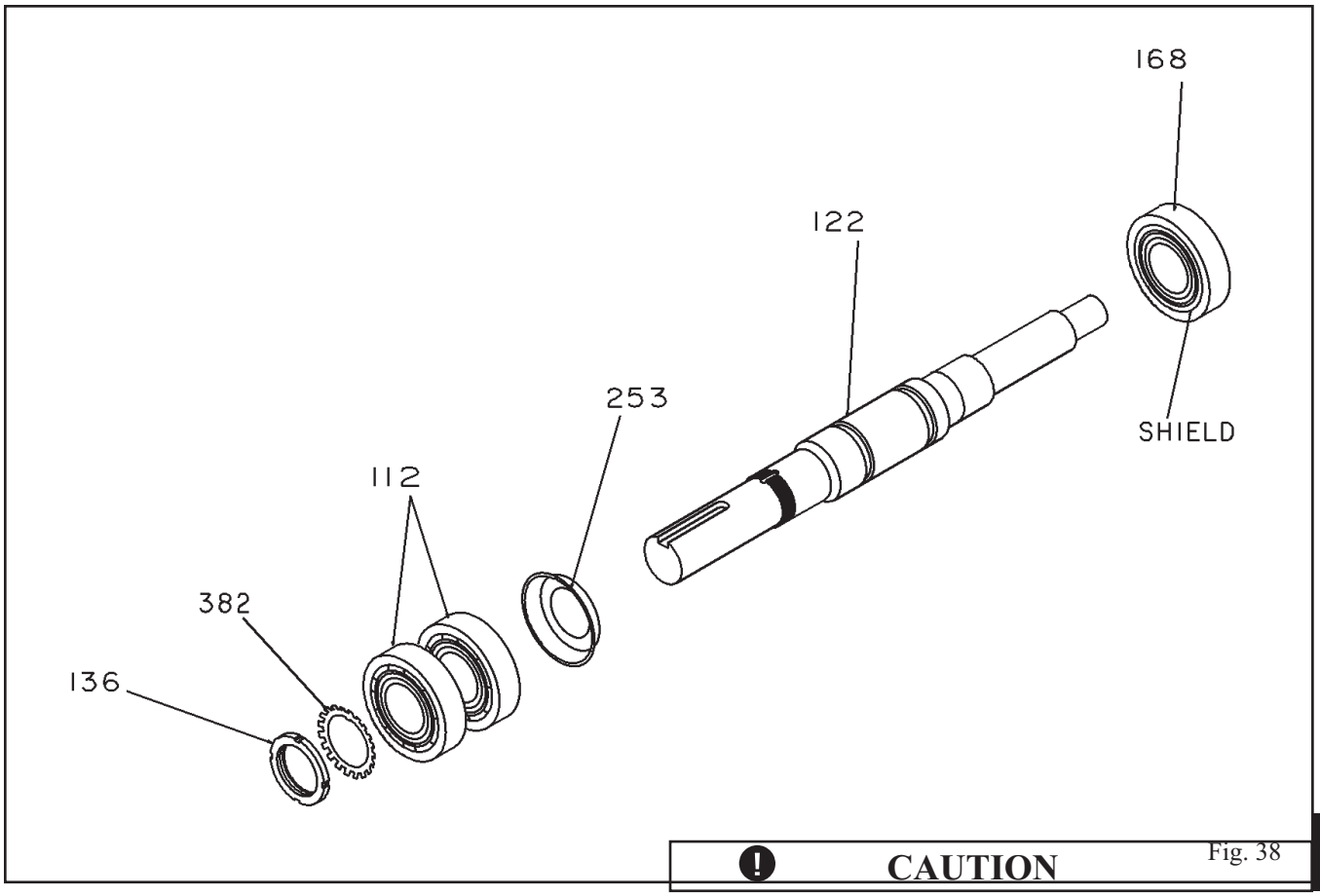

Fig. 38

ASSEMBLY OF STANDARD GREASE LUBRICATED POWER END

This section covers assembly of standard grease lubricated power end. For power ends with optional features (pure oil mist lubrication, bearing cooling, etc.), refer to the appropriate section.

⚠ WARNING

Pump components are heavy. Proper methods of lifting and securing must be employed to avoid physical injury and/or equipment damage.

NOTE: Make sure that all parts and threads are clean and that all directions under* Inspections *have been followed.

Leakage of process liquid may result in creating an explosive atmosphere. Follow all pump and seal assembly procedures.

1. Install radial (inboard) bearing (168) on shaft (122) with shield facing shaft shoulder (Fig. 38).

NOTE: There are several methods used to install bearings. The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

! CAUTION

Use insulated gloves when using a bearing heater. Bearing will get hot and can cause physical injury.

2. Install grease shelf (253) on shaft (122).
3. Install thrust (outboard) bearings (112) on shaft (122).

! CAUTION

The Model 3910 uses duplex bearings mounted back-to-back. Make sure orientation of the bearings is correct.

NOTE: There are several methods used to install bearings. The recommended method is to use an induction heater that heats as well as demagnetizes the bearings.

! CAUTION

Use insulated gloves when using a bearing heater. Bearings will get hot and can cause physical injury.

4. Place bearing lockwasher (382) on shaft (122). Place tang of lockwasher in keyway of shaft.
5. Thread bearing locknut (136) onto shaft (122). After bearings and shaft have cooled to ambient temperature, tighten locknut to torque value shown in *Table 7*.
6. Bend any tang of bearing lockwasher (382) into a slot of locknut (136).

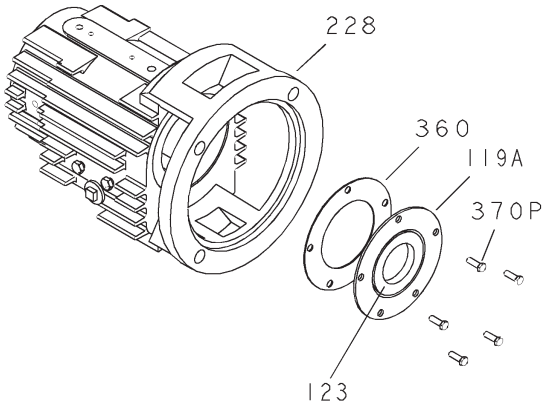

Fig. 39

NOTE: Coat internal surfaces of bearings with lubricant to be used in service.

7. Press radial INPRO (123) into radial end cover (119A). Ensure expulsion port is at 6 o'clock position and is properly seated. Install radial bearing end cover (119A), and new end cover gasket (360) on bearing frame (228) (Fig. 39). For SA pumps, press radial INPRO (123) into bearing frame 228. Ensure expulsion port is at 6 o'clock position and is properly seated (Fig. 40).

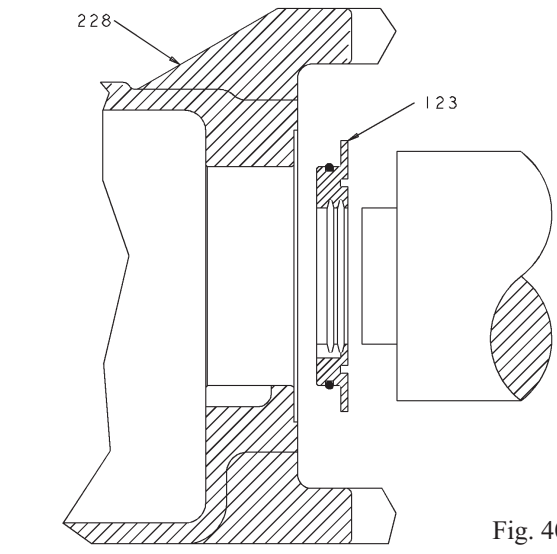

Fig. 40

8. For SX, MX, LA, and XLX pumps, install and tighten radial end cover bolt/bearing frame screws (370P) evenly to the torque values shown in *Table 7*.
9. Coat outer races of bearings (112) and (168) with compatible oil.
10. Coat internal bearing surfaces of bearing frame (228) with compatible oil.
11. Carefully guide shaft/bearing assembly into bearing frame (228) until thrust bearing (112) is seated against shoulder of frame (Fig. 41).

NOTE: Do not force assembly together.

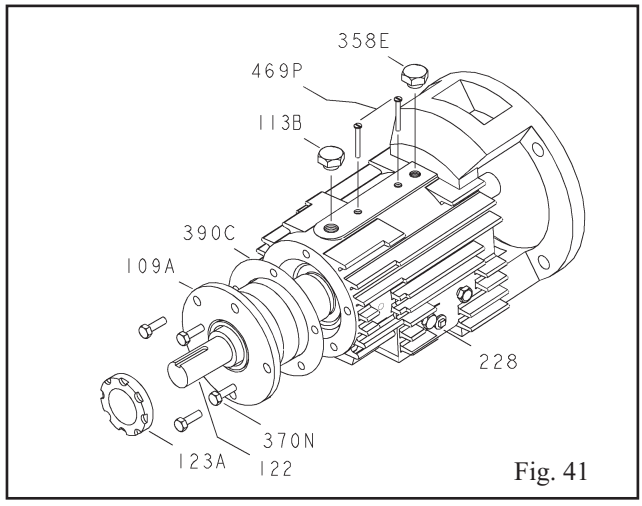

Fig. 41

12. Check shaft (122) for free turning. If rubbing or binding is detected, determine cause and correct.
13. For SX, MX, LA, and XLX pumps, install three (3) thrust bearing end cover shims (390C) on the thrust bearing end cover (109A) and align holes. For SA pumps, install three (3) thrust bearing end cover gaskets (360A) on the bearing end cover (109A). Align the gasket to the end cover so that the openings in the gaskets align with the oil grooves on the end cover (Fig. 42).

! CAUTION

Failure to align gasket with oil grooves will result in bearing failure from lack of lubrication.

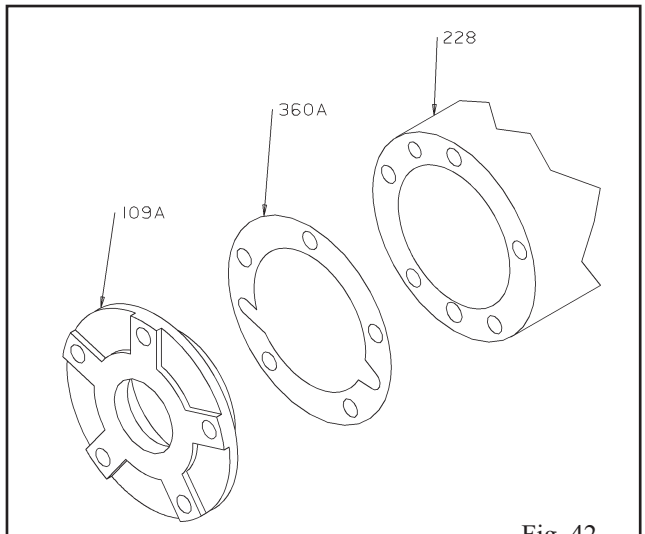

Fig. 42

14. Install thrust bearing end cover (109A) over shaft (122) and onto bearing frame (228). For SA pumps, install thrust cover with the words “Top oil mist” on top.

15. Install and tighten thrust bearing end cover/bearing frame screws (370N) evenly to torque valves shown in *Table 7*.

CAUTION

Do not over tighten thrust bearing end cover/ bearing frame screws.

16. Determine axial end play as follows:

    a. Mount dial indicator as shown in Fig. 43.

    b. Apply axial force to impeller end of shaft (122) and firmly seat thrust bearing (112) against shoulder in bearing frame (228).

    c. Apply axial force in opposite direction and firmly seat thrust bearing (112) against thrust bearing end cover (109A).

    d. Repeat steps b and c several times and record total travel (end play) of rotating element.

    e. Total travel (end play) must fall in the range of 0.025 to 0.125 mm (0.001 to 0.005 inches).

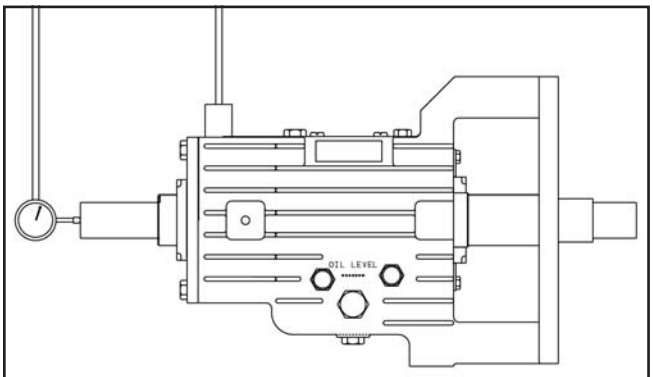

Fig. 43

17. The axial end play is achieved by adding or removing end cover gaskets (360C) for SA pumps or end cover shims (390C) between the thrust bearing end cover (109A) and the bearing frame (228). Add gaskets/shims if no axial end play is present.

18. Repeat steps 13 - 16. Total travel (end play) should fall in the range of 0.025 - 0.125 mm (.001 - .005 in.). If the measured total travel falls outside this range, remove or add the appropriate quantity of individual shims to obtain the proper total travel. For SA pumps, skip steps 19 through 22.

19. Remove thrust bearing end cover (109A).

20. Press INPRO (123A) into thrust bearing end cover (109A). Ensure expulsion port is at 6 o'clock position and is properly seated.

21. Install O-ring (412, not shown) into groove in thrust bearing end cover (109A) (N/A on SA pumps).

22. Lubricate O-ring (412) with a suitable lubricant.

23. Install thrust bearing end cover (109A) with O-ring (412) over shaft (122) and into bore of bearing frame (228). Ensure that O-ring is not damaged while entering bore in frame.

24. Install and tighten thrust bearing end cover/ bearing frame screws (370N) evenly to torque values shown in *Table 7*.

CAUTION

Do not over tighten thrust bearing end cover/ bearing frame screws.

25. Check shaft (122) for free turning. If rubbing or excessive drag is detected, determine cause and correct.

CAUTION

For runout checks, firmly support bearing frame assembly in horizontal position, as shown in Fig. 36.

26. Check shaft (122) impeller fit runout in the following manner:

    a. Mount dial indicator on bearing frame (228) as shown in Fig. 44.

    b. Rotate shaft (122) through maximum arc from one side of keyway to the other. If total indicator reading is greater than 0.050 mm (.002 in.), determine cause and correct.

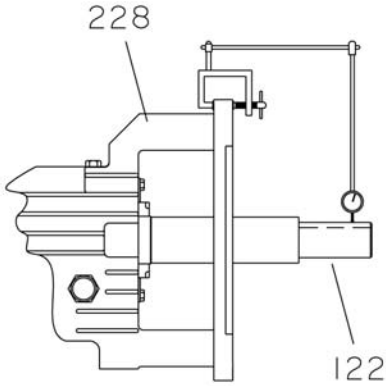

Fig. 44

CAUTION

Avoid turning shaft so that dial indicator contacts keyway. Readings will be incorrect and damage to dial indicator could result.

27. Check shaft (122) seal fit runout in the following manner:

    a. Mount dial indicator as shown in Fig. 45.

    b. Rotate shaft (122) so indicator rides along shaft surface for 360 degrees. If total indicator reading is greater than 0.050 mm (.002 in), determine cause and correct.

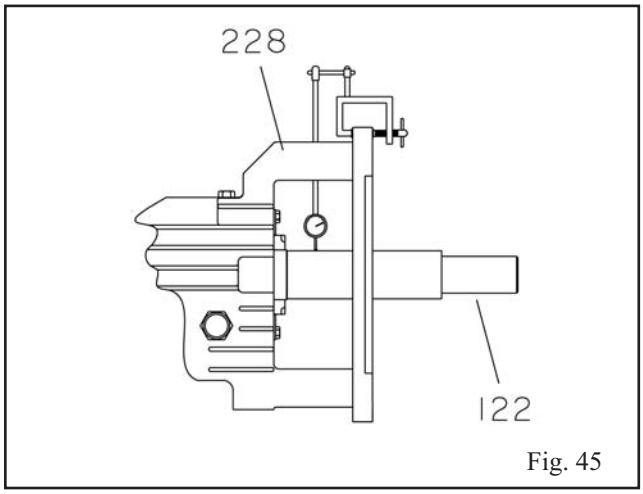

Fig. 45

28. Check bearing frame (228) face runout in the following manner:

    a. Mount dial indicator on shaft (122) as shown in Fig. 46.

    b. Rotate shaft (122) so indicator rides along the bearing frame (228) face for 360 degrees. If total indicator reading is greater than 0.10 mm (.004 in), disassemble and determine cause.

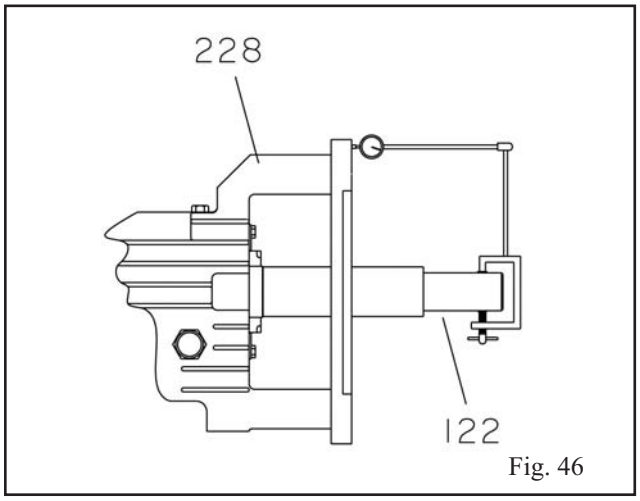

Fig. 46

29. Check bearing frame (228) lock runout in the following manner:

    a. Mount dial indicator on shaft (122) as shown in Fig. 47.

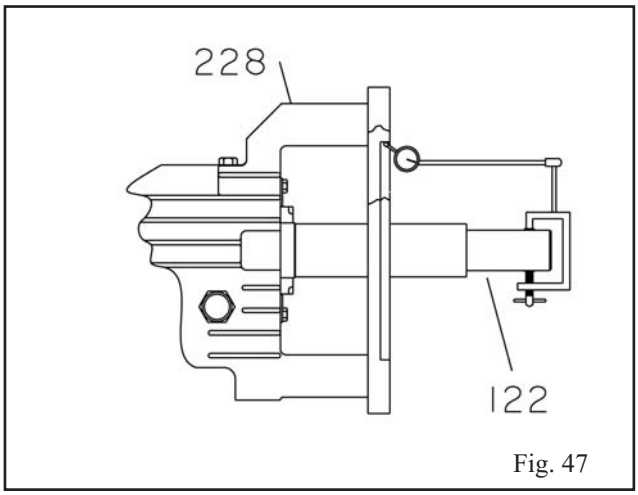

Fig. 47

    b. Rotate shaft (122) so indicator rides along the bearing frame (228) lock for 360 degrees. If total indicator reading is greater than 0.10 mm (.004 in.), disassemble and determine cause.

30. Install and tighten any plugs and/or fittings removed during disassembly.

ASSEMBLY OF OPTIONAL PURE OIL MIST LUBRICATED POWER END

Pure oil mist lubricated power ends are assembled in the same manner as grease lubricated power ends. Grease shelf (253) is not furnished with pure oil mist lubrication. Any reference to this part may be ignored.

ASSEMBLY OF POWER END WITH OPTIONAL RADIAL HEAT FLINGER

The radial heat flinger (123B) replaces the standard radial INPRO (123) and is installed in the same manner except three set screws need to be tightened. Remainder of assembly is the same as ring oil lubrication. During the assembly of the bearing frame (228) and seal chamber cover (184), install bearing frame / seal chamber cover gasket (540C) into recess on bearing frame (228) and align holes (Fig. 57).

ASSEMBLY OF POWER END WITH OPTIONAL AIR COOLING PACKAGE

Assemble power end as described in steps 1-23 of ring oil lubrication section. Note that in step 7, radial heat flinger (123B) replaces the standard radial INPRO (123).

24a. Position thrust fan guard support (234D) on thrust bearing end cover (109A).

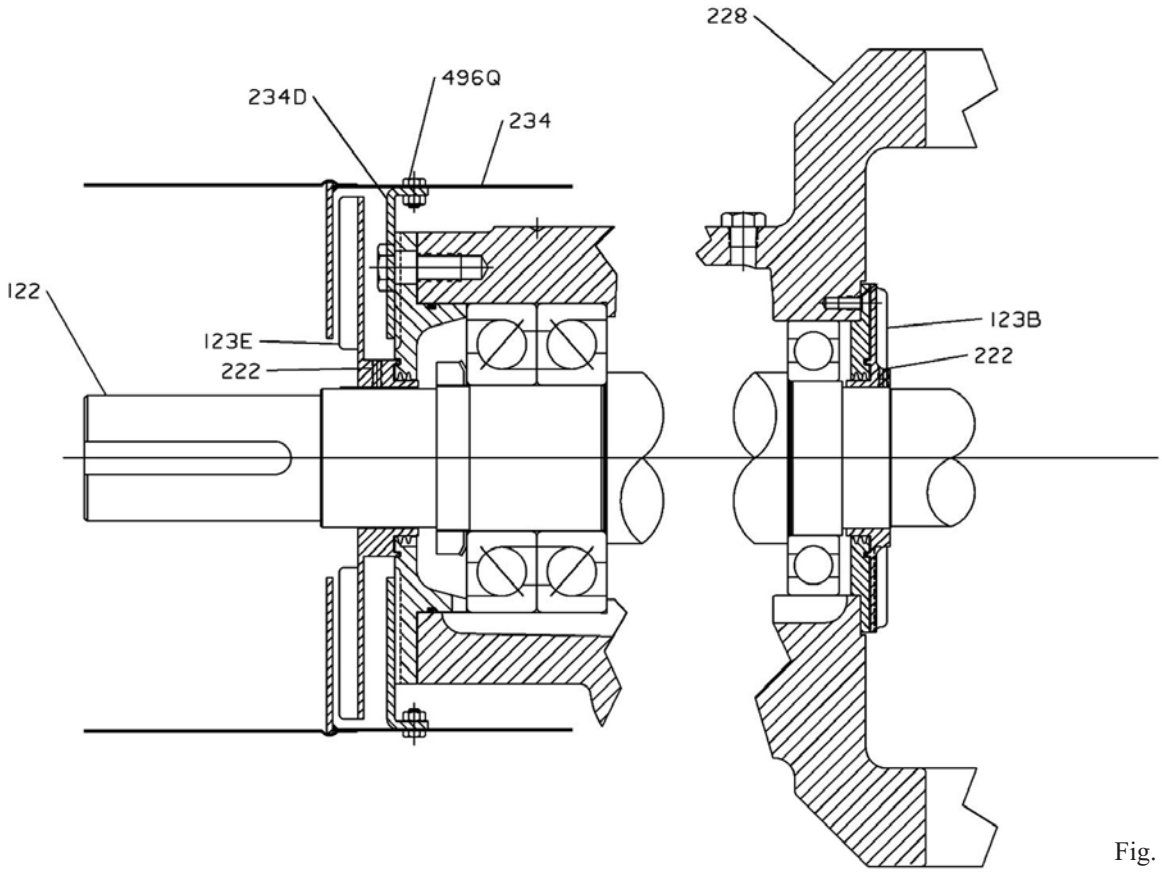

Fig. 48

24b. Install and tighten thrust bearing end cover/ bearing frame screws (370N) evenly to torque values shown in *Table 7*.

! CAUTION

Do not over tighten thrust bearing end cover/ bearing frame screws.

24c. Install thrust fan (123E) over shaft (122).

24d. Position thrust fan (123E) approximately 0.8 mm (.030 in.) from thrust INPRO (123A) and tighten deflector fan set screw (222) firmly. On SA, pumps butt fan against coupling diameter shoulder.

24e. Tighten heat flinger set screws (222) firmly.

Complete assembly of power end as described in steps 25 - 30 of grease oil lubrication section. During the assembly of the bearing frame (228) and seal chamber cover (184), install bearing frame / seal chamber cover gasket (540C) into recess on bearing frame (228) and align holes (Fig. 57).

INSTALLATION OF OPTIONAL WATER JACKET COVER

1. Install outer and inner water jacket cover O-rings (412S and 497T, respectively) into grooves in water jacket cover (490) (Fig. 49).

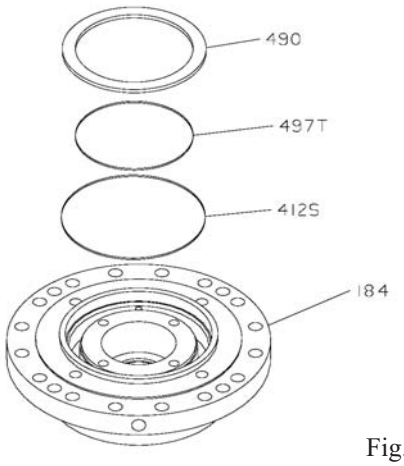

Fig. 49

2. Lubricate sealing surfaces in seal chamber cover (184) and O-rings (412S and 497T) with suitable lubricant.

3. Insert water jacket cover (490) with O-rings (412S and 497T) into fit in seal chamber cover (184). Ensure that water jacket cover enters uniformly and that O-rings are not damaged.

PRELIMINARY INSTALLATION OF SEAL CHAMBER COVER

1. Install eyebolt in tapped hole provided in seal chamber cover (184) (Fig. 50).
2. Rig sling to eyebolt and to overhead lifting device.
3. Lift seal chamber cover (184) and position to align with shaft (122).
4. Install seal chamber cover (184) on bearing frame assembly by guiding cover carefully over shaft (122) and into bearing frame (228) lock.
5. Install seal chamber cover/bearing frame bolts (370H) and tighten evenly using alternating pattern. Torque bolts to values shown in *Table 7*.

CAUTION

For runout checks, firmly support bearing frame assembly in horizontal position, as shown in Fig. 36.

6. Check seal chamber cover (184) face runout in the following manner:

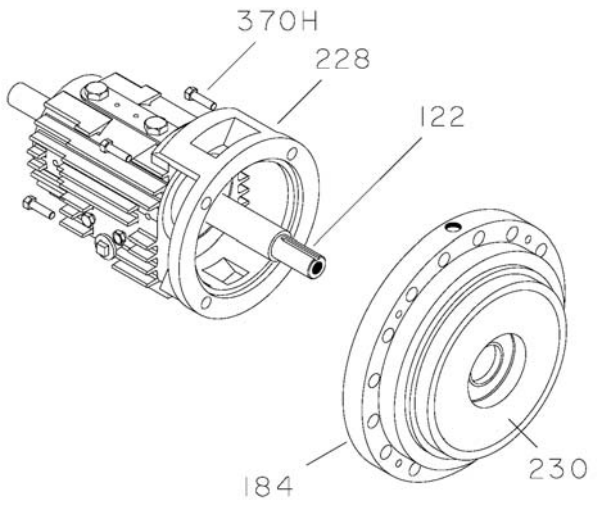

Fig. 50

   a. Mount dial indicator on shaft (122) as shown in Fig. 51.
   b. Rotate shaft (122) so indicator rides along the seal chamber cover (184) gasket face for 360 degrees. If total indicator reading is greater than 0.13 mm (.005 in.), determine cause and correct.

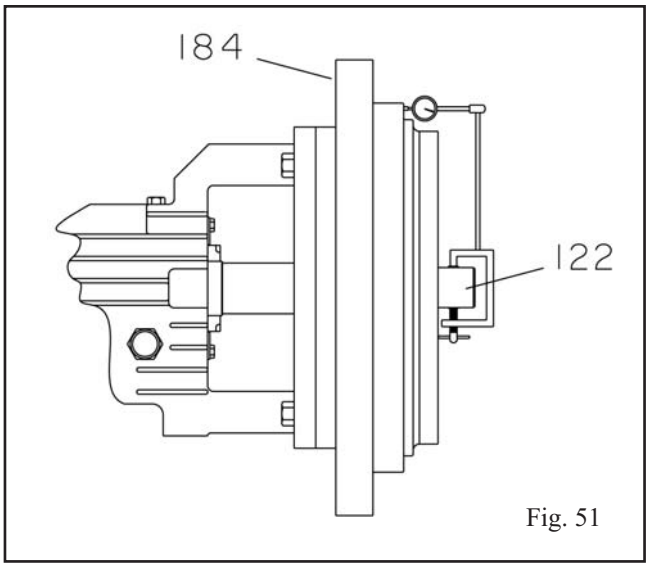

Fig. 51

7. Check seal chamber cover (184) lock runout in the following manner:
   a. Mount dial indicator on shaft (122) as shown in Fig. 52.
   b. Rotate shaft (122) so indicator rides along the seal chamber cover (184) lock for 360 degrees. If total indicator reading is greater than 0.13 mm (.005 in.), determine cause and correct.

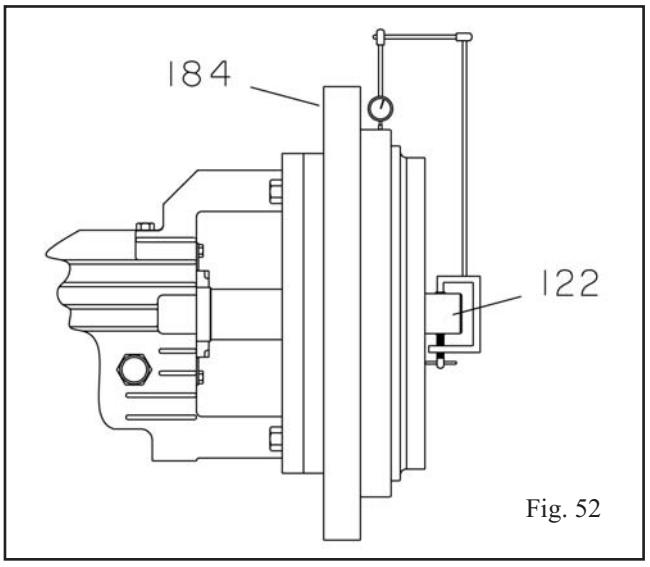

Fig. 52

NOTE: If two dial indicators are available, steps 6 and 7 may be performed simultaneously.

The impeller and wear ring clearance setting procedures 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.

8. Check seal chamber cover wear ring (230) runout in the following manner:

   a. Mount dial indicator on shaft (122) as shown in Fig. 53.

   b. Rotate shaft (122) so indicator rides on seal chamber cover wear ring (230) surface for 360 degrees. If total indicator reading exceeds 0.15 mm (.006 in.), determine cause and correct.

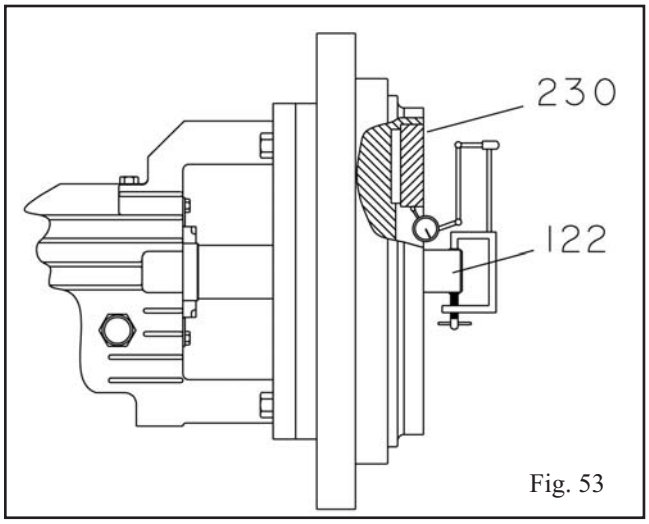

Fig. 53

9. Check seal chamber face runout in the following manner:

   a. Mount dial indicator on shaft (122) as shown in Fig. 54.

   b. Rotate shaft (122) so indicator rides along the seal chamber face for 360 degrees. If total indicator reading is greater than the values shown in *Table 7*, determine cause and correct.

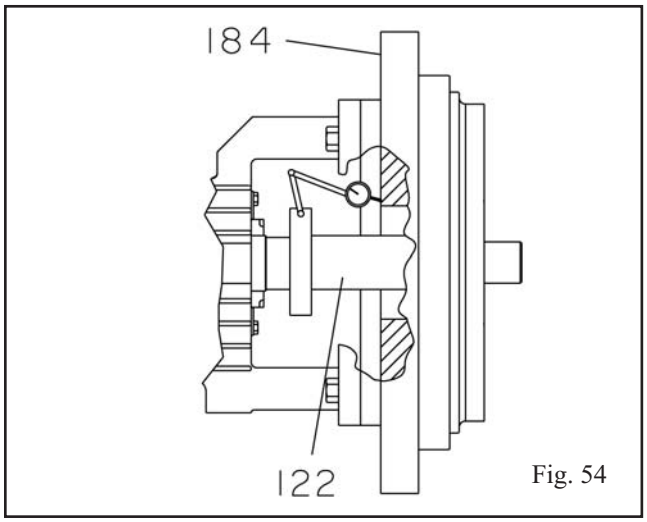

Fig. 54

Table 8
Maximum Allowable Seal Chamber Face Runout

Group	Maximum Allowable Total Indicator Reading
SA	0.045 mm (0.0018 in.)
SX	0.05 mm. (.002 in.)
MX, LA	0.06 mm. (.0024 in.)
XLX	0.07 mm. (.0028 in.)

10. Check seal chamber lock (register) runout in the following manner:

    a. Mount dial indicator on shaft (122) or shaft sleeve (126) as shown in Fig. 55.

    b. Rotate shaft (122) so indicator rides along the seal chamber lock (register) for 360 degrees. If total indicator reading is greater than 0.125 mm (.005 in.), determine cause and correct.

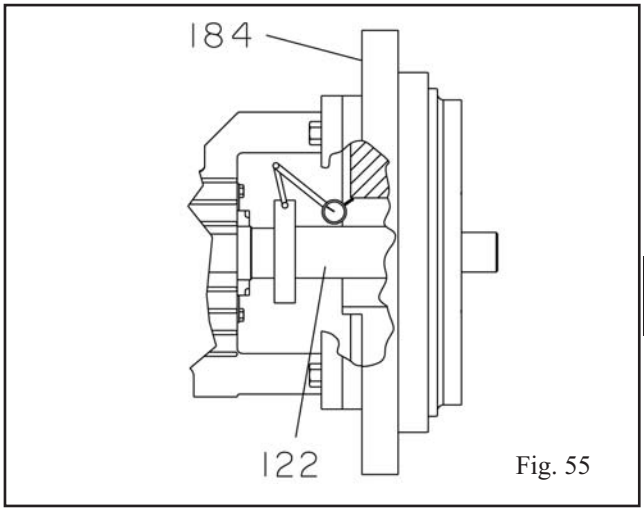

Fig. 55

11. Install impeller key (178) in keyway of shaft (122). Key should be at top (12 o'clock) position for installation of impeller (101).

12. Install impeller (101) on shaft (122).

CAUTION

When handling impeller, wear heavy work gloves to prevent cutting hands on sharp edges.

NOTE: Anti-galling compound should be applied to the impeller bore to aid in assembly and disassembly.

13. Install impeller nut (304) and tighten firmly.

NOTE: Impeller nut has LEFT HAND threads.

CAUTION

The impeller and wear ring clearance setting procedures 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.

6

14. Check impeller (101) impeller wear ring (202) runout in the following manner:

    a. Mount dial indicator as shown in Fig. 63.

    b. Rotate shaft (122) so indicator rides along wear ring (202) surface for 360 degrees. If total indicator reading is greater than 0.13 mm (.005 in.), determine cause and correct.

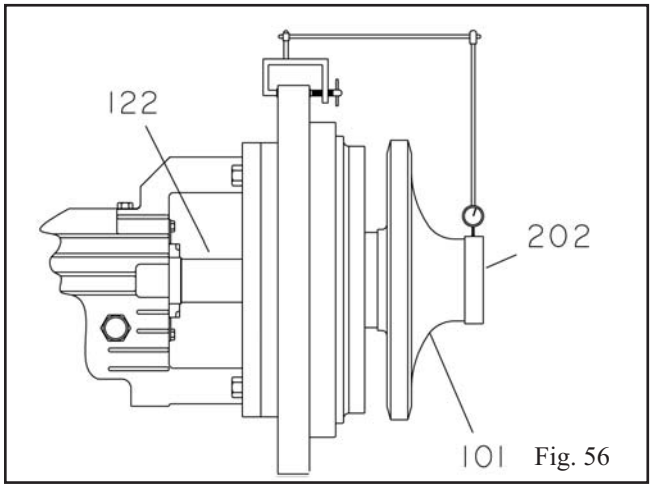

Fig. 56

INSTALLATION OF CARTRIDGE TYPE MECHANICAL SEAL AND SEAL CHAMBER COVER

NOTE: Refer to mechanical seal manufacturer's drawings and instructions for assistance during installation of mechanical seal.

1. Loosen and remove impeller nut (304).

NOTE: Impeller nut has LEFT HAND threads.

2. Remove impeller (101), impeller key (178), and seal chamber cover (184) as described in disassembly.
3. Lubricate all O-rings with suitable lubricant, unless seal manufacturer's instructions indicate otherwise.
4. Slide cartridge seal assembly (rotary, stationary, gland, gland gasket and sleeve) onto shaft (122) (Fig. 57).

NOTE: Ensure that mechanical seal gland piping connections are properly oriented.

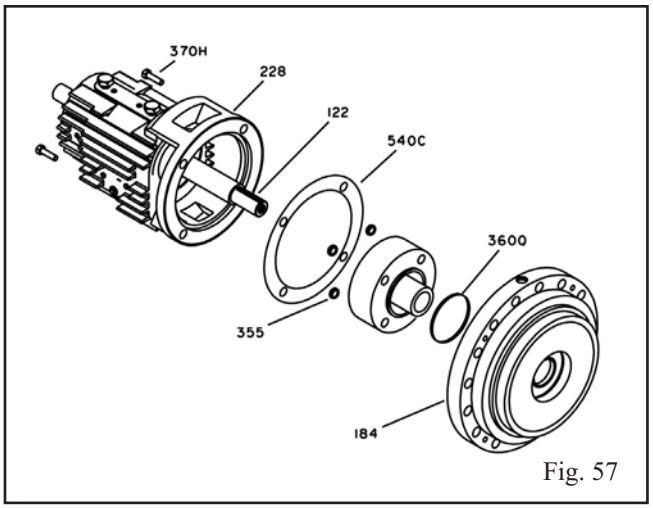

Fig. 57

5. Rig sling to eyebolt and to overhead lifting device.
6. Lift seal chamber cover (184) and position to align with shaft (122).
7. Install seal chamber cover (184) on power end by guiding cover carefully over cartridge seal rotary and ensuring that gland studs (353) smoothly enter holes in cartridge seal gland and that cover pilots into bearing frame (228) lock.

! CAUTION

Mechanical seal parts may be damaged if they or adjacent parts are handled improperly.

8. Install seal chamber cover/bearing frame bolts (370H) and tighten using alternating pattern. Torque bolts to values shown in *Table 7*.
9. Install gland stud nuts (355) and tighten evenly to torque values shown in *Table 7*.
10. Tighten set screws in locking collar.
11. Disengage spacer ring or clips.
12. Check for free turning. If rubbing or excessive drag is detected, determine cause and correct.

INSTALLATION OF IMPELLER

NOTE: It is desirable to repeat runout checks on seal chamber cover face, lock and wear ring surfaces as previously described in "Preliminary Installation of Seal Chamber Cover".

1. Install impeller key (178) in keyway of shaft (122). Key should be at top (12 o'clock) position for installation of impeller (101).

! CAUTION

When handling impeller, wear heavy work gloves to prevent cutting hands on sharp edges.

2. Install impeller (101) on shaft (122).

NOTE: Anti-galling compound should be applied to the impeller bore to aid in assembly and disassembly.

3. Install impeller nut (304) and tighten to torque values shown in *Table 7*.

NOTE: Impeller nut has LEFT HAND threads.

4. Tighten the set screw (198A) in the end of the impeller nut (304).

5. Check for free turning. If rubbing or excessive drag is detected, determine cause and correct.

NOTE: It is desirable to repeat runout check on impeller wear ring surface as previously described in "Replacement of Wear Rings."

INSTALLATION OF COUPLING HUB

Install key and pump half coupling hub on shaft (122) until hub is flush with the scribe mark determined during disassembly (Fig. 58). Refer to coupling manufacturer's instructions for assistance.

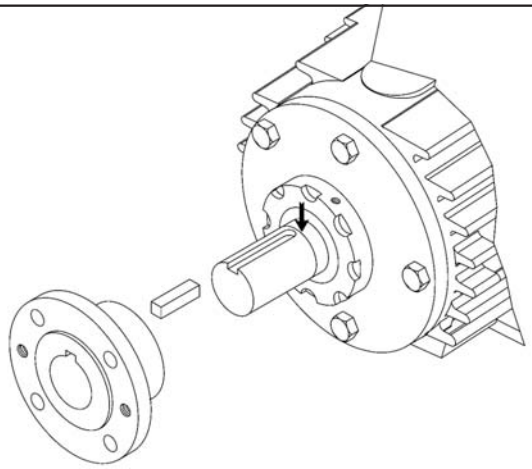

Fig. 58

INSTALLATION OF BACK PULL-OUT ASSEMBLY IN CASING

1. Install new casing gasket (351) on gasket surface of casing (100).

NOTE: Anti-galling compound may be applied to the casing fits to aid in assembly and disassembly.

2. Replace back pull-out assembly in casing (100) using Goulds back pull-out device or other suitable means. Refer to instructions in *Appendix III.*

3. Lower back pull-out assembly into proper position in casing (100) by loosening jacking bolts (418) evenly.

NOTE: Ensure that casing gasket is not damaged.

4. Install casing stud nuts (425).

5. Inspect gap between seal chamber cover (184) and casing (100) and adjust casing stud nuts (425) as necessary to make gap uniform.

6. Tighten casing stud nuts (425) uniformly, using alternating pattern, until seal chamber cover (184) is in metal-to-metal contact with the casing (100). Tighten each nut to torque value shown in *Table 7*.

7. Check for free turning. If rubbing or excessive drag is detected, determine cause and correct.

ADDITIONAL ASSEMBLY

1. Replace coupling spacer, coupling guard and auxiliary piping, tubing, and equipment that were removed during preparation for disassembly.

2. Lubricate bearings as described in the *Preventive Maintenance* section.

POST ASSEMBLY CHECKS

All checks and procedures listed under* Safety, Installation, Operation *and* Preventive Maintenance *sections must be followed.

Rotate shaft by hand to ensure it rotates smoothly and there is no rubbing which could lead to excess heat generation and or sparks.

ASSEMBLY TROUBLESHOOTING

Symptom	Probable Cause	Remedy
Excessive shaft end play.	Bearing internal clearance too great.	Replace bearings with correct type.
	Excessive thrust bearing end cover shim pack thickness.	Remove individual shims to obtain proper thickness.
	Thrust bearing end cover loose.	Tighten screws.
Excessive shaft runout.	Shaft bent.	Replace.
Excessive bearing frame flange runout.	Shaft bent.	Replace.
	Bearing frame flange distorted.	Replace.
Excessive seal chamber cover runout.	Seal chamber cover not properly seated on frame.	Replace or remachine.
	Corrosion or wear.	Replace or remachine.
Excessive impeller wear ring runout.	Bent shaft.	Replace.
	Improper machining of wear ring.	Replace or remachine.

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PARTS LIST WITH STANDARD MATERIALS OF CONSTRUCTION

Materials shown are typical. Refer to order documentation for actual materials furnished.

Item	Part Name	Qty per Pump	Construction - API Designation				
			S-4	S-6	S-8	C-6	A-8
100	Casing	1	1212			1234	1296
101	Impeller	1	1212	1222	1265	1222	1265
109A	Thrust Bearing End Cover	1	1212				
112	Ball Bearing, Thrust	1 pair	Steel				
119A	Radial Bearing End Cover	1	2210				
122	Shaft	1	2238		2256	2244	2256
123	Deflector, Radial	1	1618				
123A.	Deflector, Thrust	1	1618				
123B	Deflector, Fan, Radial	1	1425				
123C	Deflector, Fan Thrust	1	1425				
125	Throat Bushing, Seal Chamber	1	1001	2244	2256	2244	2256
136	Locknut, bearing	1	Steel				
164	Wear Ring, Casing	1	1001	1232	1265	1232	1265
168	Ball Bearing, Radial	1	Steel				
178	Key, Impeller	1	2229			2224	2229
184	Seal Chamber Cover	1	1212			1234	1296
198A	Set Screw, Impeller Nut	1	2229				
202	Wear Ring, Impeller	1	1001	1299	1071	1299	1071
203	Wear Ring, Impeller	1	1001	1299	1071	1299	1071
222	Set Screw, deflector	2	2229				
222E	Set Screw, stationary wear rings	6	2229				
228	Bearing Frame	1	1212				
230	Wear Ring, Seal Chamber Cover	1	1001	1232	1265	1232	1265
234	Deflector Fan Guard	1	3201				
234D	Support, Deflector Fan Guard	1	3201				
240	Motor Support (Casing Mount)	1	3201				
253	Grease Shelf	1	3201				
304	Impeller Nut	1	2210	2229			
320	Set Screw, Impeller Wear Ring	6	2229				
340	Motor Support (Frame Mount)	1	3201				
351	Gasket, Casing	1	Spiral Wound 316 Stainless Steel				
353	Stud, Gland	4	2239				
355	Nut, Gland Stud	4	2285				
356A	Stud, Casing	Var.	2239				
360	Gasket, Radial Bearing End Cover	1	Vellumoid				
360A	Gastket, Thrust Bearing End Cover	3	Vellumoid				
370H	Screw, Bearing Frame/ Seal Chamber Cover	4	2210				
370N	Screw, Thrust Bearing End Cover	5	2210				
370P	Screw, Radial Bearing End Cover	5	2210				
382	Lockwasher, Bearing	1	Steel				
390C	Shim Pack, Thrust Bearing End Cover	1	304SS				
408A	Plug, Oil Drain	1	Steel with magnetic insert				
412	O-ring, Thrust Bearing End Cover	1	Buna N				
418	Bolt, Jacking	4	2210				
425	Nut, Casing Stud	Var.	2239				
469P	Retainer, Oil Ring	2	2285				
497F	O-ring, Thrust Deflector	1	Buna N				
497H	O-ring, Radial Deflector	1	Buna N				
497S	O-ring, Radial End Cover	1	Buna N				
540C	Gasket, Frame/Seal Chamber Cover	1	Aramid Fiber				

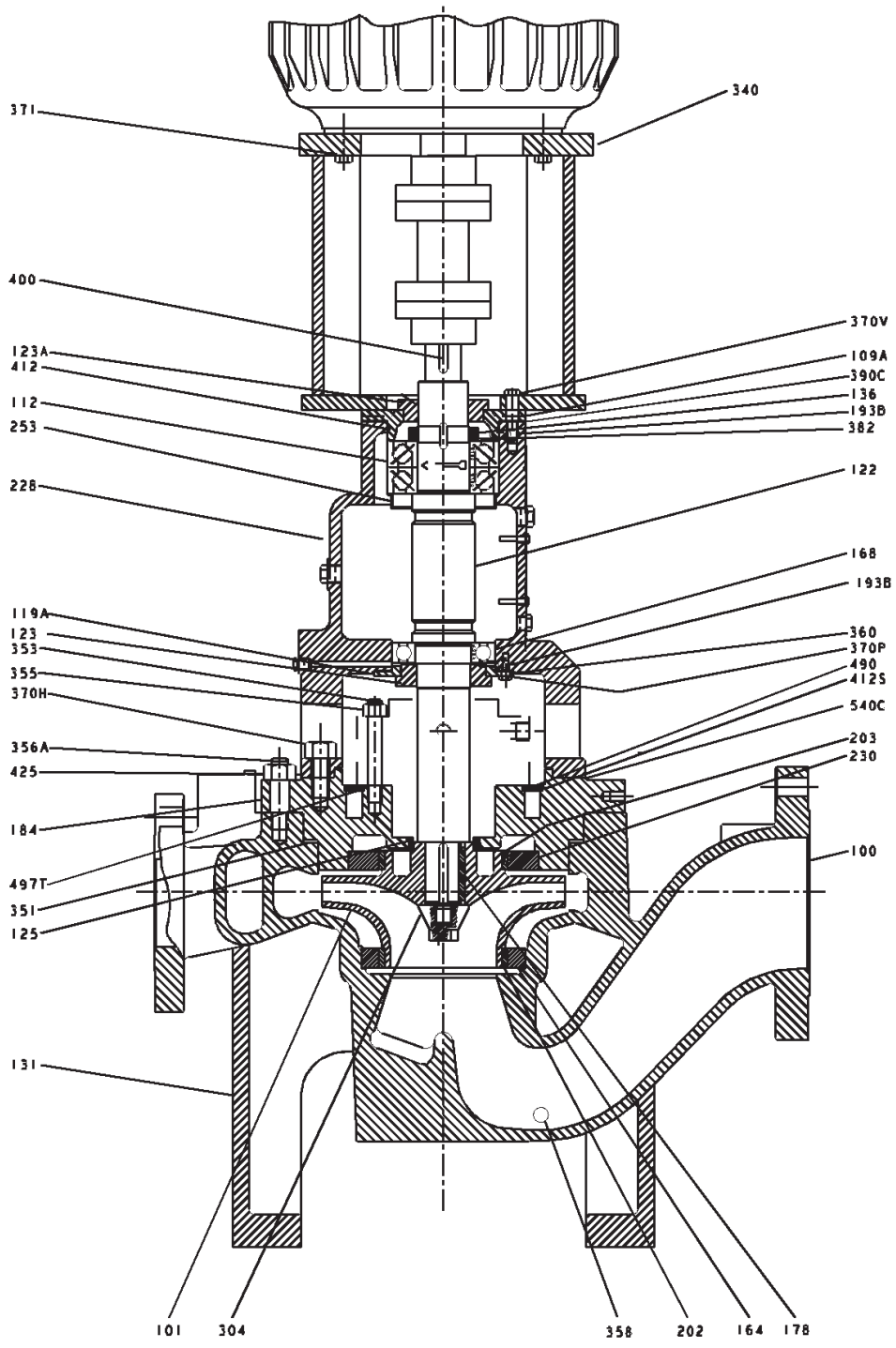
Materials Cross Reference Chart

Material	Goulds Pumps Material Code	ASTM Material Designation	Other
Cast Iron	1000	A48 Class 25	
Cast Iron	1001	A48 Class 20	
Nitronic 60	1071	A743 Gr. CF10SMnN	
Carbon Steel	1212	A216 WCB	
12% Chrome Steel	1222	A743 Gr. CA6NM	
12% Chrome Steel	1232	A743 Gr. CA15	
12% Chrome Steel	1234	A487 Gr. CA6MN Class A	
316L Stainless Steel	1265	A743 Gr. CF3M	
316L Stainless Steel	1296	A351 Gr. CF3M	
12% Chrome Steel	1299	A743 Gr. CA15	
Aluminum	1425	SC64D	UNS A03190
Bismuth Bronze	1618	B505 CDA 89320	
Steel	2210	A108 Gr. 1211	UNS G12110
316 Stainless Steel	2229	A276 Type 316	
4140 Steel	2238	A434 Gr. 4140 Class BD	
410 Stainless Steel	2244	A276 Type 410	UNS S41000
316L Stainless Steel	2256	A276 Type 316L	UNS S31603
Steel	3201	A283 Grade D	
316L Stainless Steel	3223	A240 Type 316L	

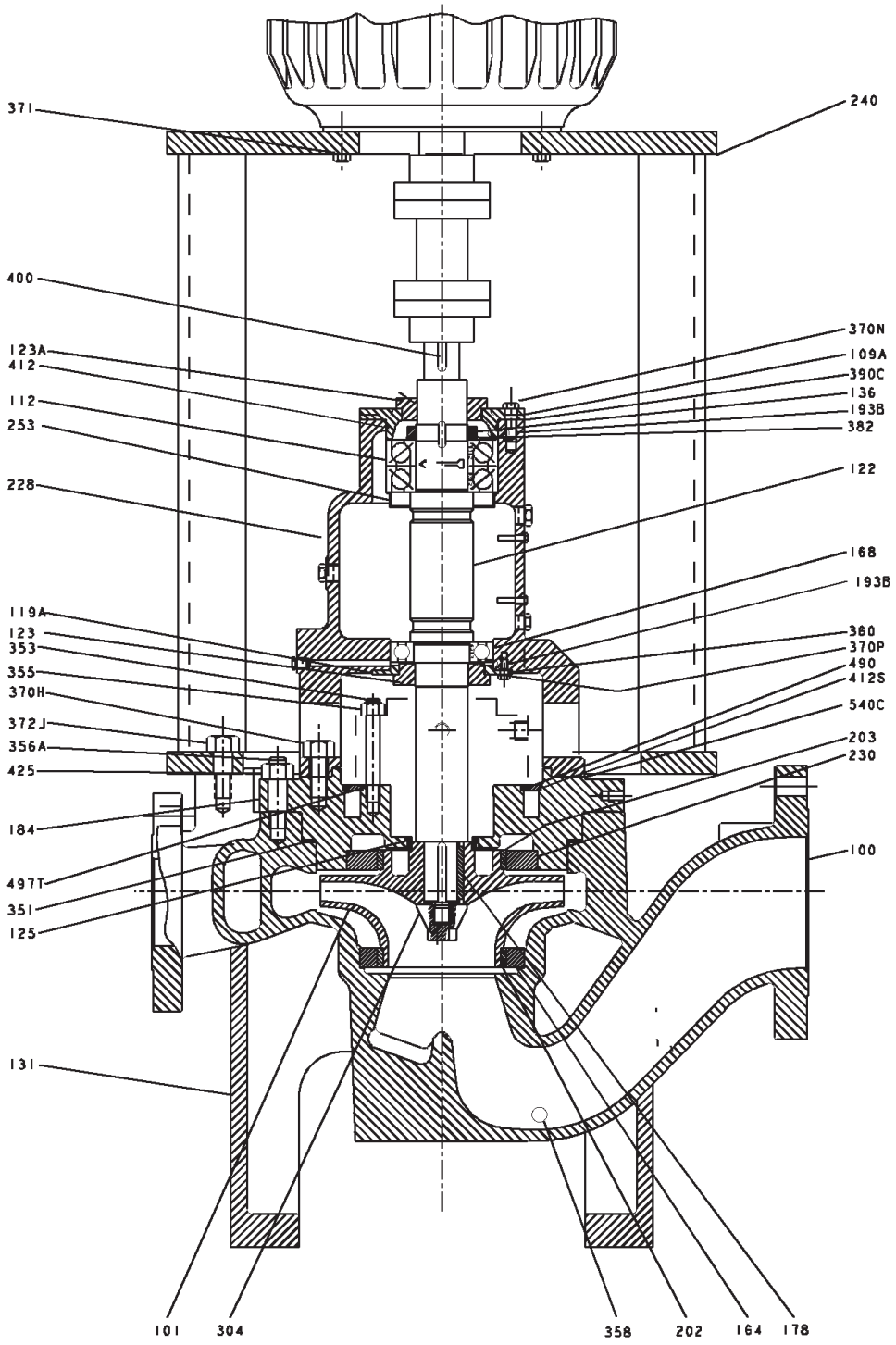
FASTENERS/PLUGS

Material	Goulds Pumps Material Code	ASTM
Carbon Steel	2210	A307 Grade B
316SS	2229	F593 Alloy Group 2
4140 Steel	2239	A193 Grade B7
4140 Steel	2285	A194 Grade 2 H

MODEL 3910 SA, SX, MX, AND LA PUMPS WITH FRAME MOUNTED MOTOR SUPPORT



MODEL 3910 SA, SX, MX, AND LA PUMPS WITH CASING MOUNTED MOTOR SUPPORT



6

SPARE PARTS

When ordering spare parts, always state Goulds serial number, and indicate part name and item number from relevant sectional drawing. It is imperative for service reliability to have a sufficient stock of readily available spares.

RECOMMENDED SPARE PARTS

It is suggested that the following spare parts be stocked, where applicable:

- Thrust Bearing (Duplex Pair) (112)
- Throat Bushing - Seal Chamber Cover (125)
- Bearing Locknut (136)
- Casing Wear Ring (164)
- Radial Bearing (168)
- Impeller Wear Ring - Casing Side (202)
- Impeller Wear Ring - Cover Side (203)
- Set Screws (222E and 320)
- Seal Chamber Cover Wear Ring (230)
- Impeller Nut (304)
- Casing Gasket (351)
- Radial Bearing End Cover Gasket (360)
- Thrust Bearing End Cover Gaskets (360A)
- Bearing Lockwasher (382)
- Cartridge Mechanical Seal (383)
- Thrust Bearing End Cover Shims (390C)
- Thrust Bearing End Cover O-ring (412)
- Water Jacket Cover O-rings (412S and 497T)
- Frame/Seal Chamber Cover Gasket (540C)

For critical services, the following parts should also be stocked, where applicable:

- Impeller (101) with Impeller Rings (202 and 203)
- Thrust Bearing End Cover (109A)
- Radial Bearing End Cover (119A)
- Shaft (122)
- Radial INPRO (123)
- Thrust INPRO (123A)
- Heat Flinger (123B)
- Thrust Fan (123E)
- Impeller Key (178)

An alternative approach is to stock a complete back pull-out assembly. This is a group of assembled parts which includes all but the casing and coupling.

APPENDIX I-A

INSTALLATION AND DISASSEMBLY INSTRUCTIONS FOR GOULDS ANSI B15.1 COUPLING GUARDS (CASING MOUNT MOTOR SUPPORT ONLY)

The coupling guard used in an ATEX classified environment must be constructed from a non-sparking material.

All Power Ends Except Those Mounted with Optional Air Cooling Package

WARNING

Before installation or disassembly of the coupling guard is performed, the driver must be de-energized, the driver controller / starter put in a locked-out position and a caution tag placed at the controller / starter indicating the disconnect. Replace coupling guard before resuming normal operation of the pump. ITT Industries - Goulds Pumps assumes no liability for avoiding this practice.

Simplicity of design allows complete assembly of the coupling guard, including the end plate (pump end), in about fifteen minutes. If the end plate is already in place, assembly can be accomplished in about five minutes. Fig. I-A-1 shows the coupling guard components.

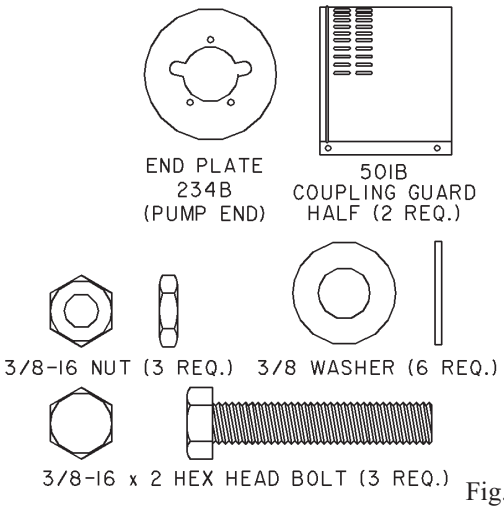


Fig. I-A-1

INSTALLATION

NOTE: If end plate (pump end) is already installed, make any necessary coupling adjustments and then proceed to Step 7.

1. Remove spacer portion of coupling. Refer to coupling manufacturer's instructions for assistance.
2. If the coupling hub diameter is larger than the diameter of the opening in the end plate (234B), remove the coupling hub.
3. Remove three thrust bearing end cover/bearing frame screws (370N) as indicated in Fig. I-A-2.

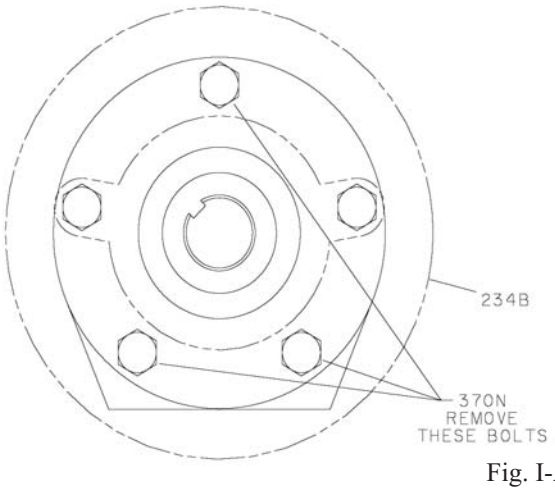


Fig. I-A-2

8

4. Align the end plate (234B) to the thrust bearing end cover (109A) so that the two slots in the end plate align with the bolts remaining in the end cover, and the three holes in the end plate align with the holes in the end cover.
5. Replace the three thrust bearing end cover / bearing frame bolts (370N) and torque to values shown in Table 8.
6. Replace coupling hub (if removed) and spacer portion of coupling. Refer to coupling manufacturer's instructions for assistance.

NOTE: Coupling adjustments should be completed before proceeding with coupling guard assembly.

7. Spread opening of coupling guard half (501B) slightly and place over pump end plate (234B) as shown in Fig. I-A-3.

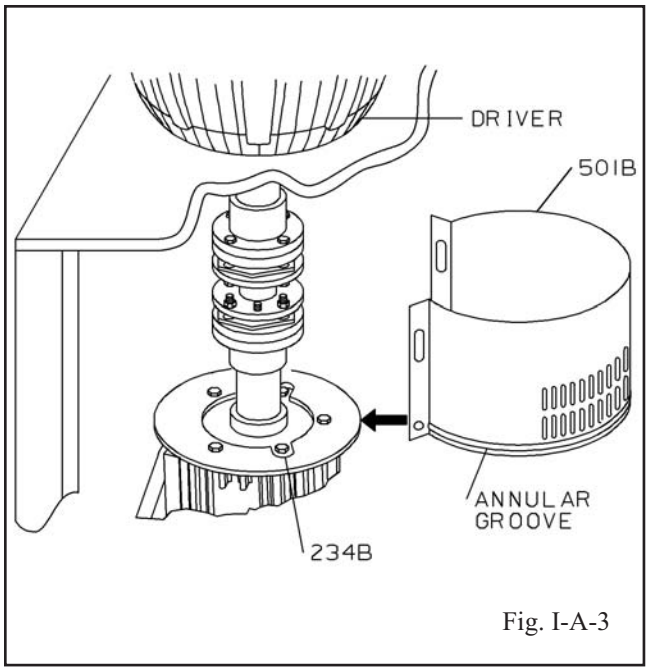


Fig. I-A-3

The annular groove in the guard is located around the end plate as indicated in Fig. I-A-4.

NOTE: Locate opening (flange) so that it will not interfere with piping but will allow access for installing bolts (Step 8).

8. Place one washer over bolt and insert bolt through round hole at front end of guard half (501B).
9. Place a second washer over exposed end of bolt.
10. Thread nut onto exposed end of bolt and tighten firmly.

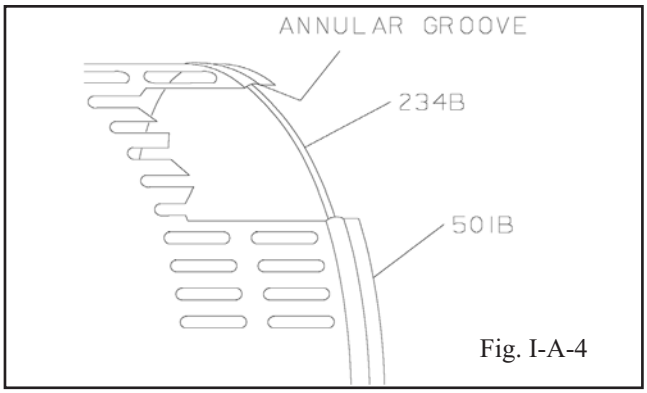


Fig. I-A-4

The proper sequence of components is shown in Fig. I-A-5; an assembled unit is shown in Fig. I-A-6.

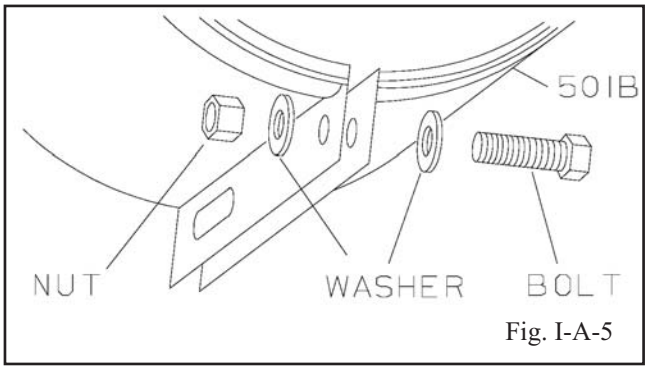


Fig. I-A-5

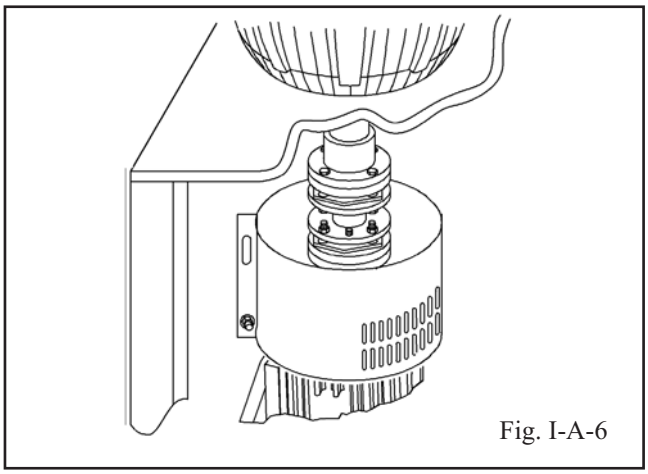


Fig. I-A-6

11. Spread opening of remaining coupling guard half (501B) slightly and place over installed coupling guard half so that annular groove in remaining coupling guard half faces the driver as indicated in Fig. I-A-7.

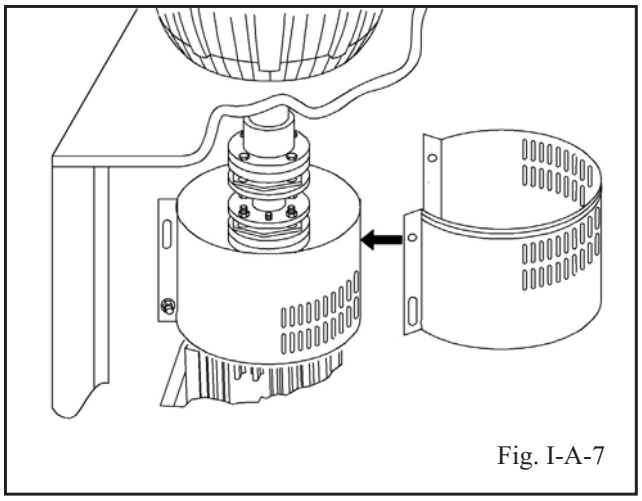


Fig. I-A-7

12. Repeat steps 8-10 for rear end of coupling guard half (501B), except that nut should be finger tightened only.
13. Adjust length of coupling guard to completely cover shafts and coupling as shown in Fig. I-A-8 by sliding rear coupling guard half (501B) towards motor.
14. Repeat steps 8-10 for center slots in coupling guard.
15. Tighten all nuts on the guard assembly firmly.

DISASSEMBLY

The coupling guard must be removed for certain maintenance and adjustments to the pump, such as adjustment of the coupling. The coupling guard should be replaced after maintenance is completed.

WARNING

Before assembly or disassembly of the coupling guard is performed, the driver must be de-energized, the driver controller / starter put in a locked-out position and a caution tag placed at the controller / starter indicating the disconnect. Replace coupling guard before resuming normal operation of the pump. ITT Industries - Goulds Pumps assumes no liability for avoiding this practice.

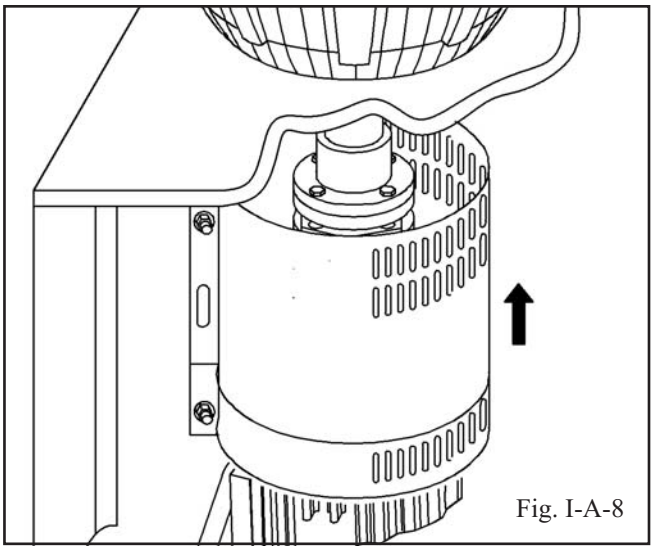


Fig. I-A-8

WARNING

DO NOT resume normal pump operation with the coupling guard removed.

1. Remove nut, bolt, and washers from center slotted hole in the coupling guard assembly.
2. Slide driver end coupling guard half (501B) towards pump (Fig. I-A-8).
3. Remove nut, bolt, and washers from driver coupling guard half (501B).
4. Spread opening of driver coupling guard half (501B) slightly and lift over remaining coupling guard half (Fig. I-A-7).
5. Remove nut, bolt, and washers from remaining coupling guard half (501B).
6. Spread bottom of coupling guard half slightly and lift off pump end plate (234B) (Fig. I-A-3).

This completes disassembly of the coupling guard.

NOTE: It is not necessary to remove the end plate (pump end) from the pump bearing frame. Before removing other components, refer to* Disassembly *section of this manual.

APPENDIX I-B

INSTALLATION AND DISASSEMBLY INSTRUCTIONS FOR GOULDS ANSI B15.1 COUPLING GUARDS (CASING MOUNT MOTOR SUPPORT ONLY)

The coupling guard used in an ATEX classified environment must be constructed from a non-sparking material.

Power Ends with Optional Air Cooling Package

WARNING

Before installation or disassembly of the coupling guard is performed, the driver must be de-energized, the driver controller/starter put in a locked-out position and a caution tag placed at the controller/starter indicating the disconnect. Replace coupling guard before resuming normal operation of the pump. ITT Industries - Goulds Pumps assumes no liability for avoiding this practice.

Simplicity of design allows complete assembly of the coupling guard, including the thrust end deflector fan guard support, in about twenty minutes. If the guard support is already in place, assembly can be accomplished in about ten minutes. Fig. I-B-1 shows the coupling guard components.

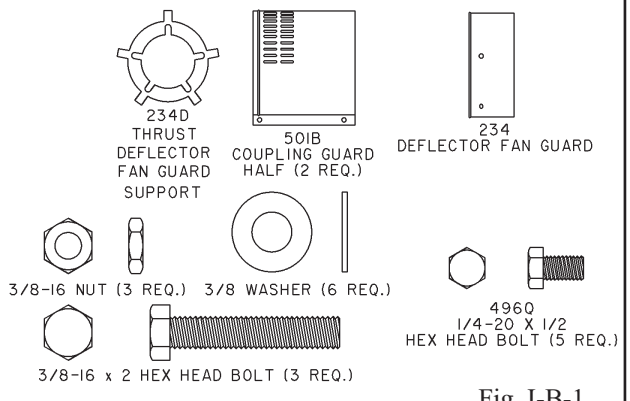


Fig. I-B-1

INSTALLATION

NOTE: If deflector fan guard support is already installed, make any necessary coupling adjustments and then proceed to step 11.

1. Remove spacer portion of coupling. Refer to coupling manufacturer's instruction for assistance.
2. If the coupling hub diameter is larger than the diameter of the opening in the deflector fan guard support (234D), remove the coupling hub.
3. Loosen thrust deflector fan set screw (222)(Fig. I-B-2).

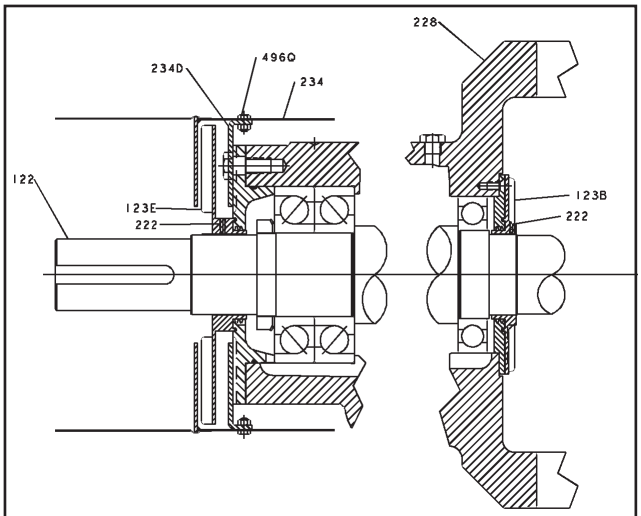


Fig. I-B-2

4. Slide thrust deflector fan (123E) off shaft (122).
5. Remove thrust bearing end cover/bearing frame screws (370N) (Fig. I-B-3).

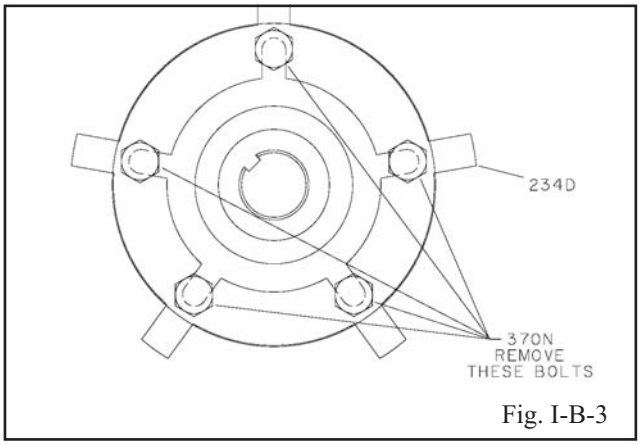


Fig. I-B-3

8

6. Align the thrust deflector fan guard support (234D) to the thrust bearing end cover (109A) so that the slots in the support align with the holes in the end cover.
7. Replace the thrust bearing end cover/bearing frame screws (370N) and torque to values shown in Table 8.

CAUTION

Do not over tighten thrust bearing end cover/ bearing frame screws.

8. Install thrust deflector fan (123E) over shaft (Fig. I-B-2).
9. Position thrust deflector fan (123E) approximately 0.8 mm (.030 in.) from thrust bearing end cover (109A) and tighten deflector set screw (222) firmly.
10. Slide thrust deflector fan guard (234) over guard support (234D) and align holes in guard with tapped holes in guard support (Fig. I-B-4).
11. Install thrust deflector fan guard/support screws (469Q) and tighten to value shown in Table 8.
12. Replace coupling hub (if removed) and spacer portion of coupling. Refer to coupling manufacturer's instructions for assistance.

NOTE: Coupling adjustments should be completed before proceeding with coupling guard assembly.

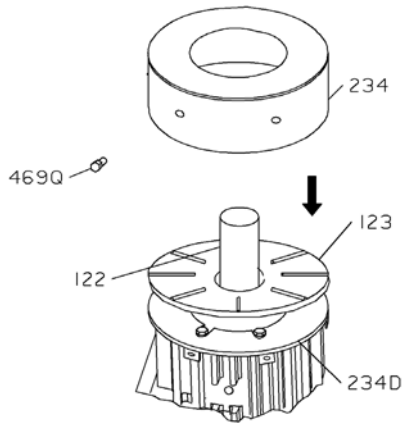


Fig. I-B-4

13. Spread opening of coupling guard half (501B) slightly and place over thrust deflector fan guard (234) so that annular groove in guard half locates around guard support extension (Fig. I-B-5 and I-B-6).

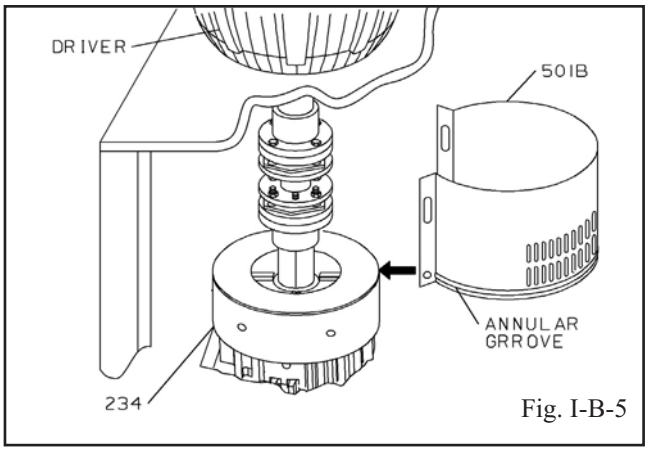


Fig. I-B-5

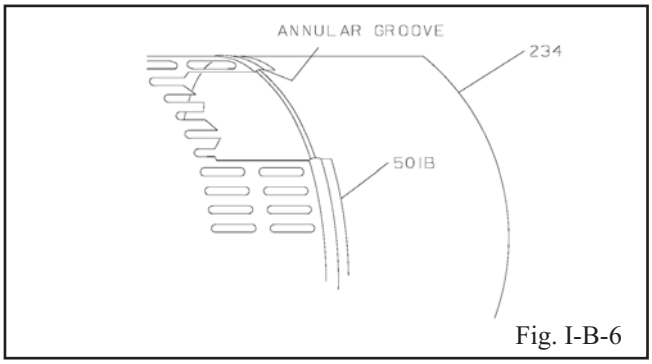


Fig. I-B-6

NOTE: Locate opening (flange) so that it will not interfere with piping but will allow access for installing bolts (Step 14).

14. Place one washer over bolt and insert bolt through round hole at front end of guard half (501B).
15. Place a second washer over exposed end of bolt and tighten firmly.
16. Thread nut onto exposed end of bolt and tighten firmly.

The proper sequence of components is shown in Fig. I-B-7; an assembled unit is shown in Fig. I-B-8.

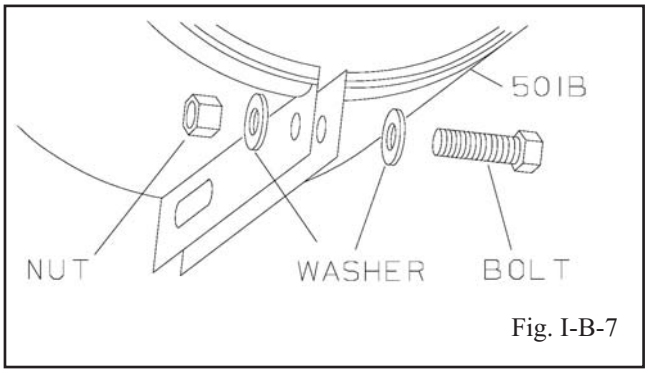


Fig. I-B-7

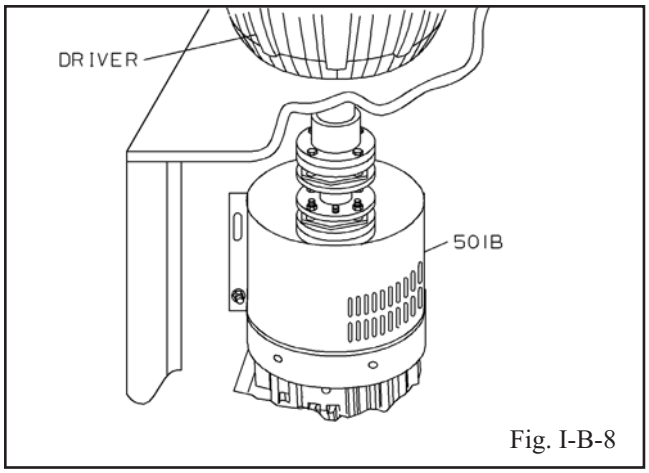


Fig. I-B-8

17. Spread opening of remaining coupling guard half (501B) slightly and place over installed coupling guard half so that annular groove in remaining coupling guard half faces the driver (Fig. I-B-9).
18. Repeat steps 14-16 for rear end of coupling guard half (501B), except that nut should be finger tightened only.
19. Adjust length of coupling guard to completely cover shafts and coupling as shown in Fig. I-B-10 by sliding rear coupling guard half (501B) towards motor.
20. Repeat steps 14-16 for center slots in coupling guards.
21. Tighten all nuts on the guard assembly firmly.

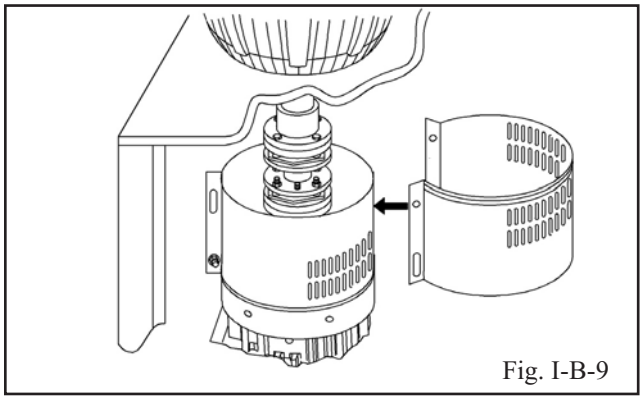


Fig. I-B-9

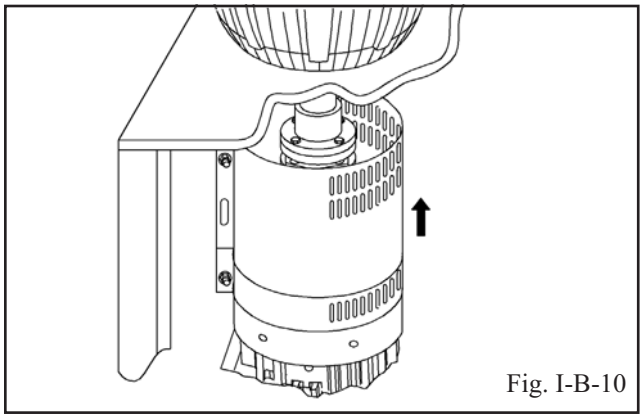


Fig. I-B-10

DISASSEMBLY

The coupling guard must be removed for certain maintenance and adjustments to the pump, such as adjustment of the coupling. The coupling guard should be replaced after maintenance is completed.

WARNING

Before assembly or disassembly of the coupling guard is performed, the driver must be de-energized, the driver controller / starter put in a locked-out position and a caution tag placed at the controller / starter indicating the disconnect. Replace coupling guard before resuming normal operation of the pump. ITT Industries - Goulds Pumps assumes no liability for avoiding this practice.

WARNING

DO NOT resume normal pump operation with the coupling guard removed.

1. Remove nut, bolt and washers from center slotted hole in the coupling guard assembly.
2. Slide driver end coupling guard half (501B) towards pump (Fig. I-B-10).
3. Remove nut, bolt and washers from driver coupling guard half (501B).
4. Spread opening of driver coupling guard half (501B) slightly and lift over remaining coupling guard half (Fig. I-B-9).
5. Remove nut, bolt and washers from remaining coupling guard half (501B).
6. Spread bottom of coupling guard half slightly and lift off pump end plate (234B) (Fig. I-B-5).

This completes disassembly of the coupling guard.

NOTE: It is not necessary to remove the thrust deflector fan guard from the pump bearing frame. Before removing other components, refer to* Disassembly *section of this manual.

APPENDIX II

DIAL INDICATOR (RIM-AND-FACE) ALIGNMENT PROCEDURE

Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.

Appendix II details the procedure to be followed when using the dial indicator (rim-and-face) method of aligning pump and motor shafts.

Other alignment methods (reverse dial indicator, laser) are acceptable. Maximum allowable misalignment criteria for these methods is shown in the Alignment Procedure.

Good alignment is achieved when the dial indicator readings as specified in this alignment procedure are equal to 0.05 mm (.002 in.) Total Indicator Reading (T.I.R.) or less when the pump and driver are at operating temperature (Final Alignment).

SET UP

1. Mount two dial indicators on the pump coupling half X so they contact the driver coupling half Y (Fig. II-A).

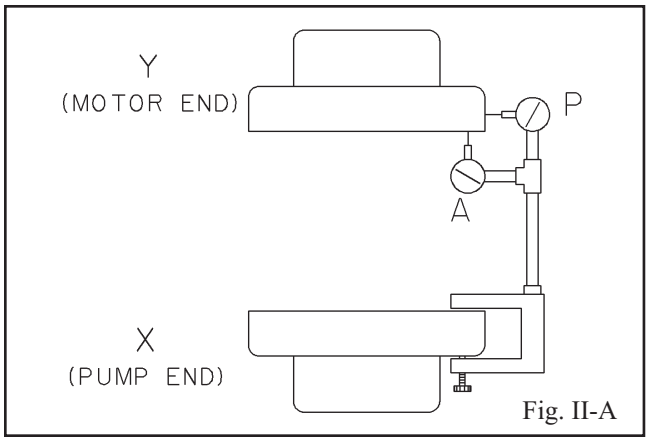


Fig. II-A

2. Check setting of indicators by rotating coupling half X to ensure indicators stay in contact with coupling half Y but do not bottom out. Adjust indicators accordingly.

MEASUREMENT

To ensure accuracy of indicator readings:

1. Always rotate both coupling halves together so indicators contact the same point on coupling half Y. This will eliminate any measurement problems due to runout on coupling half Y.
2. Take indicator measurements with driver hold-down bolts tightened. Loosen hold-down bolts prior to making alignment corrections.
3. Take care not to damage indicators when moving driver during alignment corrections.

ANGULAR ALIGNMENT

A unit is in angular alignment when indicator A (angular indicator) does not vary by more than 0.05 mm (.002 in.) as measured at four points 90° apart at operating temperature.

Axial Correction

1. Zero indicator A on suction / discharge centerline (12 o'clock) towards the suction (Fig. II-B).
2. Rotate indicators/coupling halves 180° (6 o'clock). Observe needle and record reading.

3a. **Negative Reading -** The coupling halves are farther apart at the second (6 o'clock) position than at the intial (12 o'clock) position. Correct by adding shims in line with the (12 o'clock) position, or by removing shims in line with the (6 o'clock) position (Fig. II-B).

3b. **Positive Reading -** The coupling halves are farther apart at the intial (12 o'clock) position than at the second (6 o'clock) position. Correct by adding shims in line with the (6 o'clock) position, or by removing shims in line with the (12 o'clock) position (Fig. II-B).

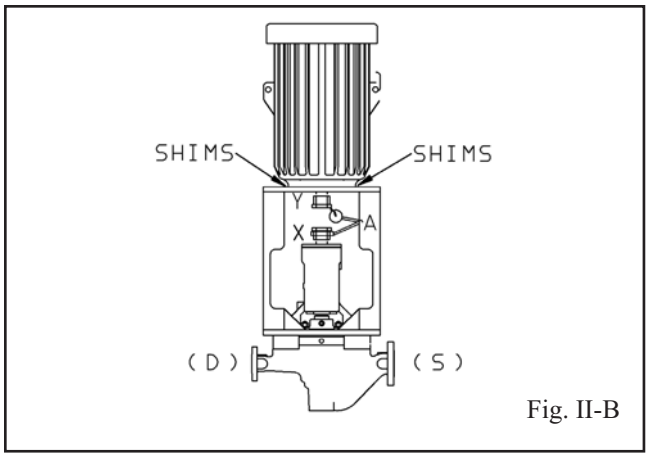


Fig. II-B

4. Repeat steps 1 through 3 until indicator A reads 0.05 mm (.002 in.) or less.

Transverse Correction

1. Zero indicator A on transverse centerline, 90° clockwise from suction centerline (3 o'clock, Fig. II-C).
2. Rotate indicators/coupling halves 180°.

3a. **Negative Reading** - The coupling halves are farther apart at the second (9 o'clock) position than at the initial (3 o'clock) position. Correct by adding shims in line with the (3 o'clock) position, or by removing shims in line with the (9 o'clock) position (Fig. II-C).

3b. **Positive Reading** - The coupling halves are farther apart at the initial (3 o'clock) position than at the second (9 o'clock) position. Correct by adding shims in line with the (9 o'clock) position, or by removing shims in line with the (3 o'clock) position (Fig. II-C).

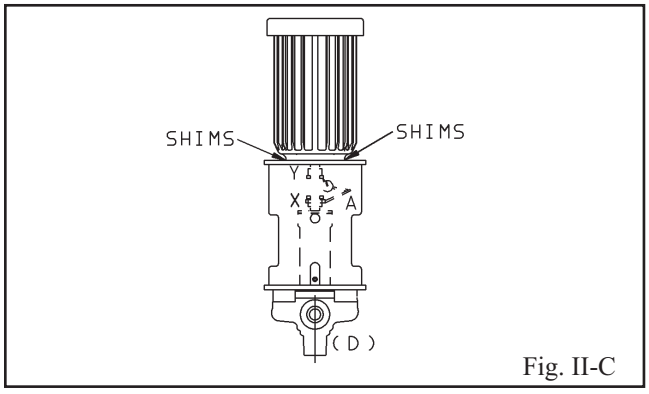


Fig. II-C

NOTE: Drive trains of over 450 pounds are supplied with adjustment provisions fastened to the motor support which may be used to make all horizontal alignment corrections.

4. Repeat steps 1 through 3 until indicator A reads 0.05 mm (.002 in.) or less.

5. Re-check both axial and transverse readings to ensure adjustment of one did not disturb the other. Correct as necessary.

PARALLEL ALIGNMENT

A unit is in parallel alignment when indicator P (parallel indicator) does not vary by more than 0.05 mm (.002 in.) as measured at four points 90° apart at operating temperature, or when the shaft centerlines are within the recommended cold setting criteria as shown in *Table II-1*.

Table II-1
Cold Setting of Parallel Vertical Alignment

Driver Type	Set Driver Shaft
Electric Motor	0.05 - 0.10 mm LOW (.002 - .004 in. LOW)

Axial Correction

1. Zero indicator P on suction/discharge centerline (12 o'clock) towards the suction (Fig. II-D).
2. Rotate indicator/coupling halves 180° (6 o'clock). Observe needle and record reading.

3a. **Negative Reading** - Coupling half X is farther from the suction than coupling half Y. Correct by moving driver away from the suction a distance equal to one-half that of the total reading (Fig. II-D).

3b. **Positive Reading** - Coupling half X is closer to the suction than coupling half Y. Correct by moving driver towards the suction a distance equal to one-half that of the total reading (Fig. II-D).

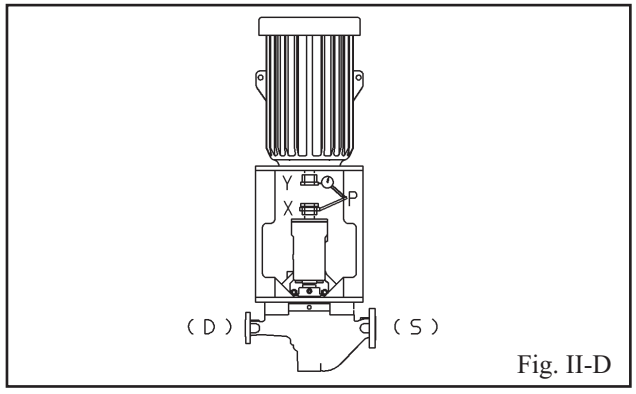


Fig. II-D

NOTE: Equal amounts of shims must be added to or removed from entire driver face, or the vertical angular alignment will be affected.

4. Repeat steps 1 through 3 until indicator P reads 0.05 mm (.002 in.) or less when hot, or per *Table II-1* when cold.

Transverse Correction

1. Zero indicator P on transverse centerline, 90° clockwise from top suction centerline (3 o'clock, Fig. II-E).
2. Rotate indicator/coupling hubs 180° (9 o'clock). Observe needle and record reading.

3a. **Negative Reading** - Coupling half X is farther away from the initial (3 o'clock) position than coupling half Y. Correct by moving driver away from the initial (3 o'clock) position towards the second (9 o'clock) position a distance equal to one-half that of the total reading (Fig. II-E).

3b. **Positive Reading** - Coupling half X is closer to the initial (3 o'clock) position than coupling half Y. Correct by moving driver towards the initial (3 o'clock) position away from the second (9 o'clock) position a distance equal to one-half that of the total reading (Fig. II-E).

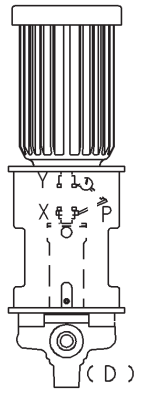


Fig. II-E

NOTE: Failure to slide driver evenly will affect horizontal angular alignment.

4. Repeat steps 1 through 3 until indicator P reads 0.05 mm (.002 in.) or less.
5. Re-check both axial and transverse readings to ensure adjustment of one did not disturb the other. Correct as necessary.

COMPLETE ALIGNMENT

A unit is in complete alignment when both indicators A (angular) and P (parallel) do not vary by more than 0.05 mm (.002 in.) as measured at four points 90° apart when pump and driver are at operating temperature.

1. Zero indicators A and P on suction/discharge centerline (12 o'clock).
2. Rotate indicator towards the suction / coupling hubs 180° (6 o'clock). Observe the needles and record the readings.
3. Make corrections as outlined previously.
4. Zero indicators A and P on transverse centerline, 90° clockwise from suction centerline (3 o'clock).
5. Rotate indicators/coupling hubs 180° (9 o'clock). Observe the needles and record the readings.
6. Make corrections as outlined previously.
7. Recheck both axial and transverse readings to ensure adjustment of one did not disturb the other.
8. Correct as necessary.

NOTE: With experience, the installer will understand the interaction between angular and parallel alignments and will make corrections appropriately.

APPENDIX III

REMOVAL AND INSTALLATION OF BACK PULL-OUT ASSEMBLY USING GOULDS BACK PULL-OUT REMOVAL DEVICE

WARNING

Before removal of the back pull-out assembly, the driver must be de-energized, the driver controller/ starter put in a locked-out position and a caution tag placed at the starter indicating the disconnect.

WARNING

Pump components are heavy. Proper methods of lifting must be employed to avoid physical injury and/or equipment damage.

Goulds back pull-out removal device provides the safest known method for installation and removal of the back pull-out assembly and was developed to meet safety requirements. Other methods for removal and installation of the back pull-out do not incorporate these safety features, and are not recommended. ITT Industries - Goulds Pumps assumes no liability for avoiding this practice.

Simplicity of design allows complete removal of the Model 3910 back pull-out assembly safely and quickly. Components of the standard Goulds back pull-out removal device are shown in Fig. III-A, and are:

Back pull-out removal device frame

- ½ in. - 13 eye nut (1)
- ½ in. bolt (1)
- ½ in. washers (2)
- ¾ - 10 bolts (2)
- ¾ - 10 nuts (2)
- ¾ in. washers (4)
- ½ in. hex cap screws (4)
- ½ in. coupling nuts (2)
- ½ in. jam nuts (2)
- ½ in. eyebolt (1)

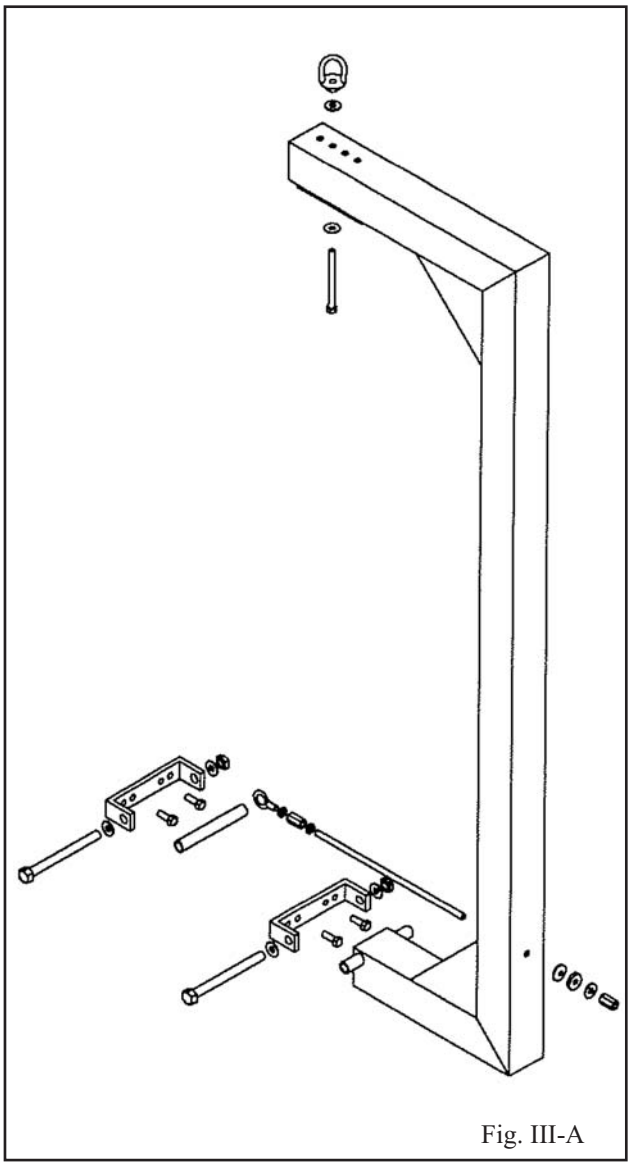


Fig. III-A

- Spherical washer (1)
- ¾ in. sleeve (1)
- Bearing frame brackets (2)
- ½ in. threaded rod (2 parts)

8

The optional, adjustable removal device (Fig III-B) replaces the standard one-piece removal device with a two-piece, adjustable unit which can accommodate less headroom (with smaller drivers), and greater length (for longer drivers).

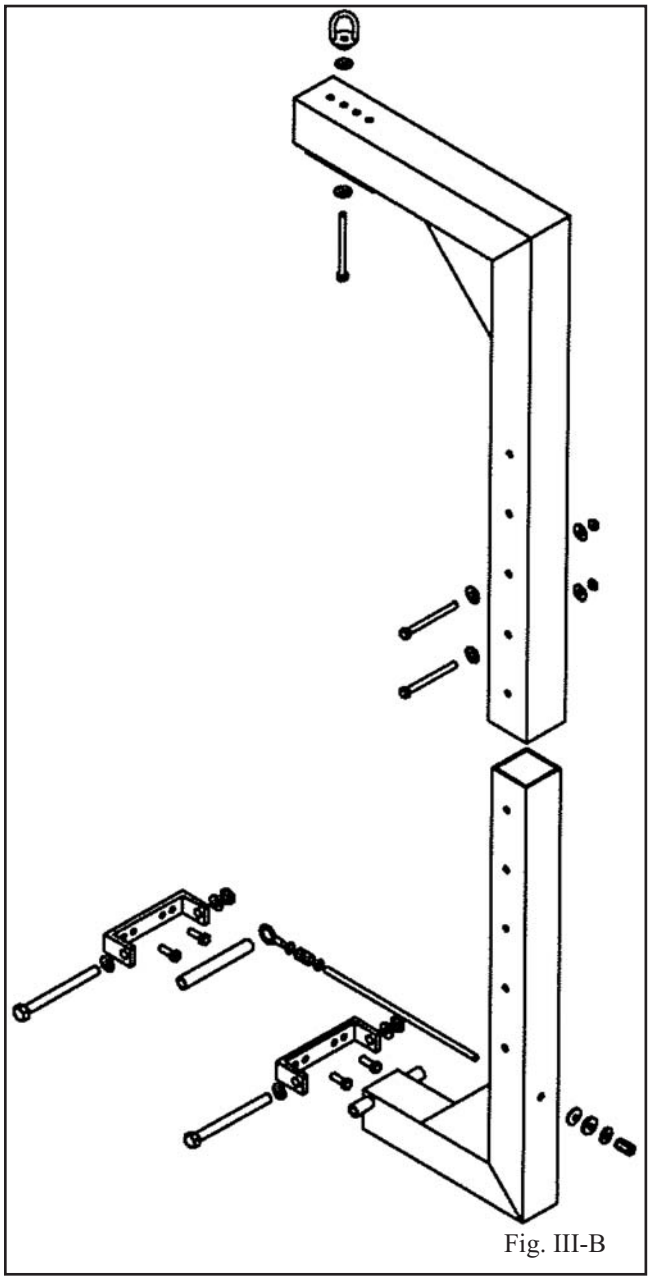


Fig. III-B

Additonal parts are:

- Back pull-out removal device (upper and lower halves) - replaces standard frame.
- ½ in. bolt (2)
- ½ in. washers (4)
- ½ in. nuts (2)

PREPARATION FOR REMOVAL OF BACK PULL-OUT ASSEMBLY

1. Valves must be closed and liquid drained from pumps, as indicated in *Disassembly* section.
2. Auxilliary piping, tubing and equipment that could interfere with removal of the back pull-out must be removed, as indicated in *Disassembly* section.
3. Coupling guard must be removed, as described in Appendix I.
4. Coupling spacer must be removed, as described in Appendix I.
5. Seal chamber cover / casing stud nuts (425) must be removed, and jacking bolts (418) tightened to separate back pull-out from casing (100), as indicated in *Disassembly* section.

ASSEMBLY OF GOULDS BACK PULL-OUT REMOVAL DEVICE

Standard

1. Thread ½ in. hex jam nut on eyebolt until approximately 1 in. (25mm) of threads remain between the nut and the end of the eyebolt.
2. Thread one ½ in. coupling nut on eyebolt and tighten against jam nut.
3. Thread ½ in. hex nut on threaded rod until approximately 1 in. (25mm) of threads have been revealed between the nut and end of the threaded rod.
4. Thread rod into coupling nut until jam nut contacts coupling nut.
5. Tighten jam nut against coupling nut.
6. Insert sleeve through eye of eyebolt.
7. Place one bracket around sleeve so that large holes in bracket align with holes in sleeve.
8. Insert one ¾ in. bolt through washer, brackets and sleeve.
9. Place ¾ in. washer and nut on exposed, threaded end of bolt and tighten nut against washer.
10. Place second bracket around sleeve in lower leg of removal device so that large holes in bracket align with holes in sleeve.
11. Insert second ¾ in. bolt through washer, bracket and sleeve.
12. Place ¾ in. washer and nut on exposed, threaded end of bolt and tighten nut against washer.

13. Place ½ in. bolt through washer and appropriate hole in upper leg of removal device.

NOTE: Generally, the second hole from the open end of the upper portion of the removal device gives best results. Other holes have been provided for individual adjustments.

14. Place ½ in. washer onto exposed, threaded end of bolt, thread on ½ in. eye nut and tighten against washer.

Optional (Adjustable)

1. Follow steps 1-14 as described under Standard.
2. Measure distance between lower mounting bracket location on bearing frame (228) and top of driver.
3. Insert lower half of removal device into upper half until measured distance between bracket and upper leg is equal to the distance measured in Step 2.
4. Extend length of removal device by pulling lower half from upper half until next set of adjusting holes in upper and lower halves align.
5. Insert two ½ in. bolts through washers and adjusting holes in upper and lower halves of removal device.
6. Place ½ in. washer and nuts on exposed, threaded ends of two bolts and tighten nuts against washers.

REMOVAL OF BACK PULL-OUT ASSEMBLY

1. Remove grease fittings or oil mist connections (193) from bearing frame (228).
2. Fasten upper (first) bracket assembly to upper machined boss on bearing frame (228) with two ½ in. bolts (Fig. III-C).
3. Rig sling to eye nut installed in upper leg of removal device and to overhead lifting device.
4. Lift removal device and bracket assembly with overhead lifting device and position lower bracket on lower machined boss of bearing frame (228) so that holes in bracket align with threaded holes in frame.
5. Fasten lower (second) bracket to lower machined boss on bearing frame (228) with two ½ in. bolts.
6. Guide threaded rod through mating hole in upright portion of removal device while raising upper leg.

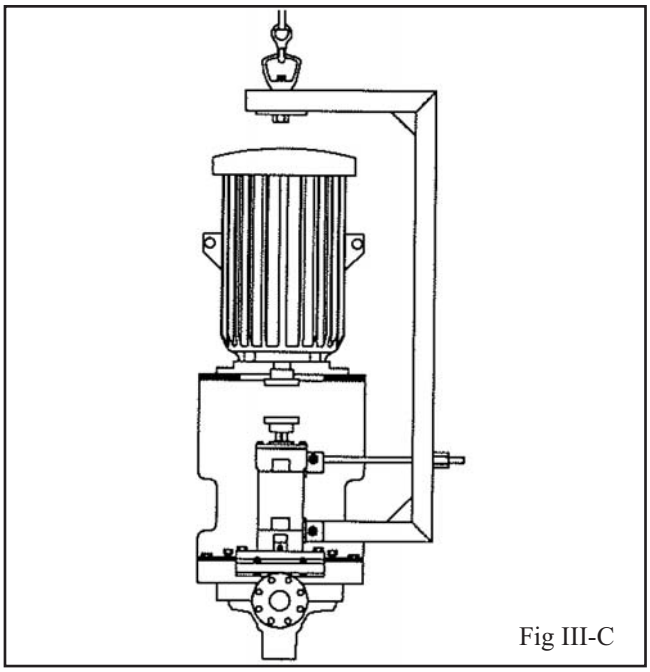


Fig III-C

7. Place spherical washer (two pieces), ½ in. flat washer and second ½ in. coupling nut on exposed end of threaded rod and tighten nut against washer.

NOTE: At this point, upright of removal device should be vertical and parallel with centerline of shaft. If not, determine cause and correct.

8. Lift back pull-out assembly/removal device assembly vertically until seal chamber cover/ stuffing box cover (184) clears casing studs (356A) (Fig III-D).

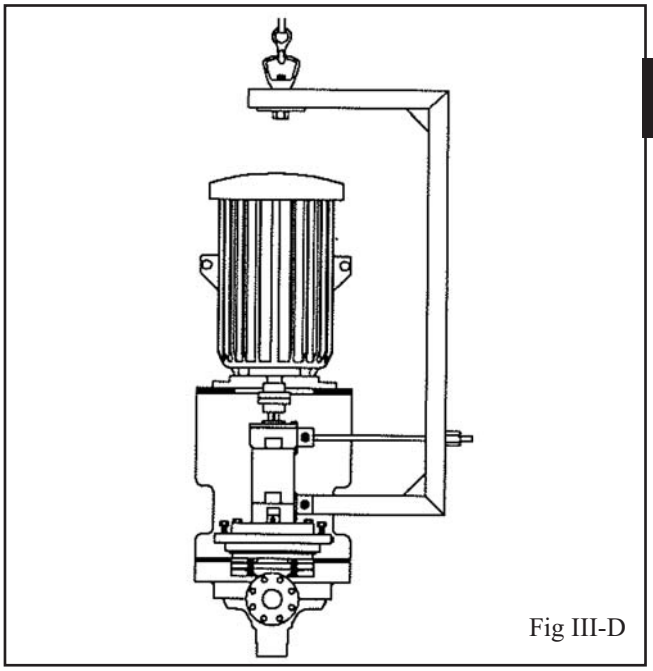


Fig III-D

CAUTION

Do not allow coupling halves or other components to make contact, as damage to coupling and/or other components could result.

9. Tighten coupling nut on threaded rod to tilt top of back pull-out assembly towards upright of removal device (Fig III-E).

10. Repeat steps 8 and 9 until seal chamber cover/ stuffing box cover (184) aligns with cutout in motor support (240) and coupling clears top flange of motor support.

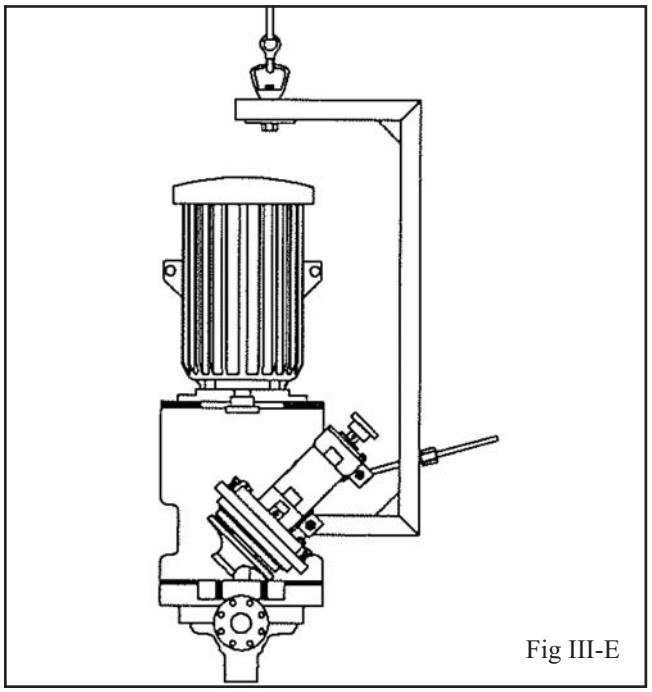


Fig III-E

11. Move bearing frame assembly/removal device assembly horizontally until clear of motor support (240) (Fig III-F).

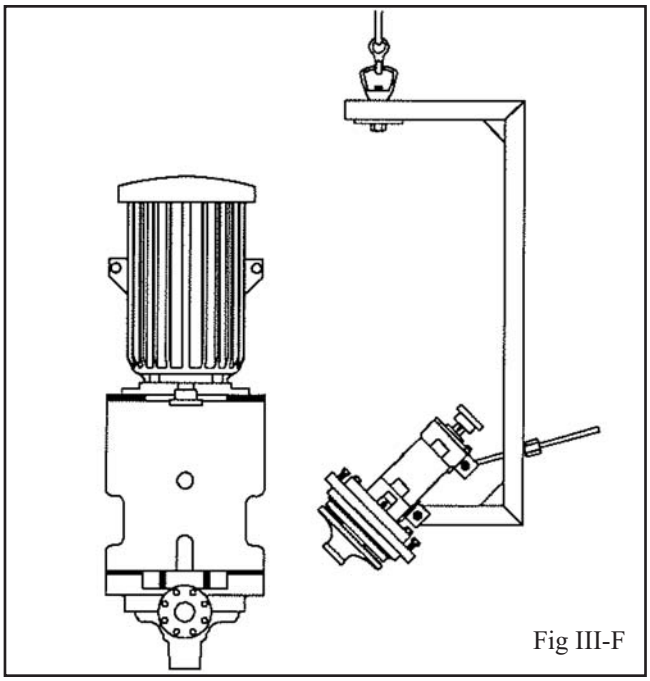


Fig III-F

NOTE: In some cases, it may be necessary to loosen the coupling guard end plate from the thrust bearing end cover to gain sufficient clearance. Follow coupling guard installation and disassembly instructions in **Appendix I.**

NOTE: With experience, maintenance personnel will understand the interactions between vertical and rotational movements of the bearing frame assembly/removal device assembly and will make adjustments appropriately.

12. Follow the remaining instructions in Disassembly.

INSTALLATION OF BACK PULL-OUT ASSEMBLY

Reverse steps in Removal of Back Pull-Out Assembly, previously described in this appendix.

HOW TO ORDER PARTS

When ordering parts, call
1-800-446-8537
or your local ITT Industries - Goulds Representative

EMERGENCY SERVICE

Emergency parts service is available
24 hours / day 365 days / year . . .
Call 1-800-446-8537

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