GOULDS PUMPS

Installation, Operation and Maintenance Instructions

Model 7200CB, API Type BB5 Double-Casing
Multi-Stage API 610 11th Edition

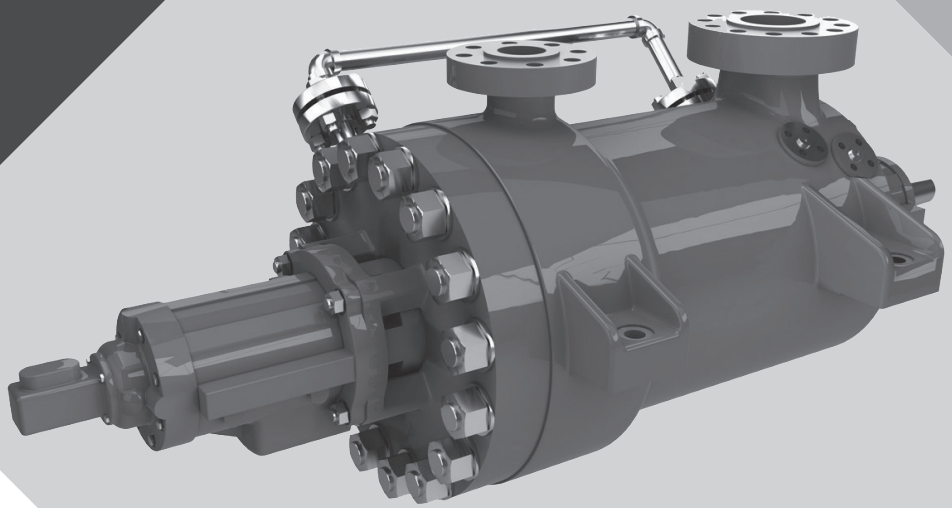

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Table of Contents

Introduction and Safety

Introduction

Purpose of this manual

The purpose of this manual is to provide necessary information for:

- Installation
- Operation
- Maintenance

CAUTION:
Read this manual carefully before installing and using the product. Improper use of the product can cause personal injury and damage to property, and may void the warranty.

NOTICE:
Save this manual for future reference, and keep it readily available at the location of the unit.

Requesting other information

Special versions can be supplied with supplementary instruction leaflets. See the sales contract for any modifications or special version characteristics. For instructions, situations, or events that are not considered in this manual or in the sales documents, please contact the nearest ITT representative.

Always specify the exact product type and identification code when requesting technical information or spare parts.

Safety

WARNING:

- The operator must be aware of safety precautions to prevent physical injury.
- Any pressure-containing device can explode, rupture, or discharge its contents if it is over-pressurized. Take all necessary measures to avoid over-pressurization.
- Operating, installing, or maintaining the unit in any way that is not covered in this manual could cause death, serious personal injury, or damage to the equipment. This includes any modification to the equipment or use of parts not provided by ITT. If there is a question regarding the intended use of the equipment, please contact an ITT representative before proceeding.
- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Do not change the service application without the approval of an authorized ITT representative.

CAUTION:
You must observe the instructions contained in this manual. Failure to do so could result in physical injury, damage, or delays.

Safety terminology and symbols

About safety messages

It is extremely important that you read, understand, and follow the safety messages and regulations carefully before handling the product. They are published to help prevent these hazards:

- Personal accidents and health problems
- Damage to the product
- Product malfunction

Hazard levels

Hazard level	Indication
 **DANGER:**	A hazardous situation which, if not avoided, will result in death or serious injury
 **WARNING:**	A hazardous situation which, if not avoided, could result in death or serious injury
 **CAUTION:**	A hazardous situation which, if not avoided, could result in minor or moderate injury
NOTICE:	• A potential situation which, if not avoided, could result in undesirable conditions • A practice not related to personal injury

Hazard categories

Hazard categories can either fall under hazard levels or let specific symbols replace the ordinary hazard level symbols.

Electrical hazards are indicated by the following specific symbol:

Electrical Hazard:

These are examples of other categories that can occur. They fall under the ordinary hazard levels and may use complementing symbols:

- Crush hazard
- Cutting hazard
- Arc flash hazard

The Ex symbol

The Ex symbol indicates safety regulations for Ex-approved products when used in atmospheres that are potentially explosive or flammable.

Environmental safety

The work area

Always keep the station clean to avoid and/or discover emissions.

Waste and emissions regulations

Observe these safety regulations regarding waste and emissions:

- Appropriately dispose of all waste.
- Handle and dispose of the processed liquid in compliance with applicable environmental regulations.
- Clean up all spills in accordance with safety and environmental procedures.
- Report all environmental emissions to the appropriate authorities.

WARNING:
Do NOT send the product to the ITT manufacturer if it has been contaminated by any nuclear radiation. Inform ITT so that accurate actions can take place.

Electrical installation

For electrical installation recycling requirements, consult your local electric utility.

Recycling guidelines

Always follow local laws and regulations regarding recycling.

User safety

General safety rules

These safety rules apply:

- Always keep the work area clean.
- Pay attention to the risks presented by gas and vapors in the work area.
- Avoid all electrical dangers. Pay attention to the risks of electric shock or arc flash hazards.
- Always bear in mind the risk of drowning, electrical accidents, and burn injuries.

Safety equipment

Use safety equipment according to the company regulations. Use this safety equipment within the work area:

- Helmet
- Safety goggles, preferably with side shields
- Protective shoes
- Protective gloves
- Gas mask
- Hearing protection
- First-aid kit
- Safety devices

NOTICE:
Never operate a unit unless safety devices are installed. Also see specific information about safety devices in other chapters of this manual.

Electrical connections

Electrical connections must be made by certified electricians in compliance with all international, national, state, and local regulations. For more information about requirements, see sections dealing specifically with electrical connections.

Precautions before work

Observe these safety precautions before you work with the product or are in connection with the product:

- Provide a suitable barrier around the work area, for example, a guard rail.
- Make sure that all safety guards are in place and secure.
- Make sure that you have a clear path of retreat.
- Make sure that the product cannot roll or fall over and injure people or damage property.
- Make sure that the lifting equipment is in good condition.
- Use a lifting harness, a safety line, and a breathing device as required.
- Allow all system and pump components to cool before you handle them.
- Make sure that the product has been thoroughly cleaned.
- Disconnect and lock out power before you service the pump.
- Check the explosion risk before you weld or use electric hand tools.

Precautions during work

Observe these safety precautions when you work with the product or are in connection with the product:

- Never work alone.
- Always wear protective clothing and hand protection.
- Stay clear of suspended loads.
- Always lift the product by its lifting device.
- Beware of the risk of a sudden start if the product is used with an automatic level control.
- Beware of the starting jerk, which can be powerful.
- Rinse the components in water after you disassemble the pump.
- Do not exceed the maximum working pressure of the pump.
- Do not open any vent or drain valve or remove any plugs while the system is pressurized. Make sure that the pump is isolated from the system and that pressure is relieved before you disassemble the pump, remove plugs, or disconnect piping.
- Never operate a pump without a properly installed coupling guard.

Hazardous liquids

The product is designed for use in liquids that can be hazardous to your health. Observe these rules when you work with the product:

- Make sure that all personnel who work with biologically hazardous liquids are vaccinated against diseases to which they may be exposed.
- Observe strict personal cleanliness.

Wash the skin and eyes

1. Follow these procedures for chemicals or hazardous fluids that have come into contact with your eyes or your skin:

Condition	Action
Chemicals or hazardous fluids in eyes	1. Hold your eyelids apart forcibly with your fingers. 2. Rinse the eyes with eyewash or running water for at least 15 minutes. 3. Seek medical attention.
Chemicals or hazardous fluids on skin	1. Remove contaminated clothing. 2. Wash the skin with soap and water for at least 1 minute. 3. Seek medical attention, if necessary.

Ex-approved products

Follow these special handling instructions if you have an Ex-approved unit.

Personnel requirements

These are the personnel requirements for Ex-approved products in potentially explosive atmospheres:

- All work on the product must be carried out by certified electricians and ITT-authorized mechanics. Special rules apply to installations in explosive atmospheres.
- All users must know about the risks of electric current and the chemical and physical characteristics of the gas, the vapor, or both present in hazardous areas.
- Any maintenance for Ex-approved products must conform to international and national standards (for example, IEC/EN 60079-17).

ITT disclaims all responsibility for work done by untrained and unauthorized personnel.

Product and product handling requirements

These are the product and product handling requirements for Ex-approved products in potentially explosive atmospheres:

- Only use the product in accordance with the approved motor data.
- The Ex-approved product must never run dry during normal operation. Dry running during service and inspection is only permitted outside the classified area.
- Before you start work on the product, make sure that the product and the control panel are isolated from the power supply and the control circuit, so they cannot be energized.
- Do not open the product while it is energized or in an explosive gas atmosphere.
- Make sure that thermal contacts are connected to a protection circuit according to the approval classification of the product, and that they are in use.
- Intrinsically safe circuits are normally required for the automatic level-control system by the level regulator if mounted in zone 0.
- The yield stress of fasteners must be in accordance with the approval drawing and the product specification.
- Do not modify the equipment without approval from an authorized ITT representative.
- Only use parts that are provided by an authorized ITT representative.

Description of ATEX

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

Guidelines for compliance

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

Monitoring equipment

For additional safety, use condition-monitoring devices. Condition-monitoring devices include but are not limited to these devices:

- Pressure gauges
- Flow meters
- Level indicators
- Motor load readings
- Temperature detectors
- Bearing monitors
- Leak detectors

- PumpSmart control system

Product warranty

Coverage

ITT undertakes to remedy faults in products from ITT under these conditions:

- The faults are due to defects in design, materials, or workmanship.
- The faults are reported to an ITT representative within the warranty period.
- The product is used only under the conditions described in this manual.
- The monitoring equipment incorporated in the product is correctly connected and in use.
- All service and repair work is done by ITT-authorized personnel.
- Genuine ITT parts are used.
- Only Ex-approved spare parts and accessories authorized by ITT are used in Ex-approved products.

Limitations

The warranty does not cover faults caused by these situations:

- Deficient maintenance
- Improper installation
- Modifications or changes to the product and installation made without consulting ITT
- Incorrectly executed repair work
- Normal wear and tear

ITT assumes no liability for these situations:

- Bodily injuries
- Material damages
- Economic losses

Warranty claim

ITT products are high-quality products with expected reliable operation and long life. However, should the need arise for a warranty claim, then contact your ITT representative.

Transportation and Storage

Inspect the delivery

Inspect the package

1. Inspect the package for damaged or missing items upon delivery.
2. Note any damaged or missing items on the receipt and freight bill.
3. File a claim with the shipping company if anything is out of order.
   If the product has been picked up at a distributor, make a claim directly to the distributor.

Inspect the unit

1. Remove packing materials from the product.
   Dispose of all packing materials in accordance with local regulations.
2. Inspect the product to determine if any parts have been damaged or are missing.
3. If applicable, unfasten the product by removing any screws, bolts, or straps.
   For your personal safety, be careful when you handle nails and straps.
4. Contact your sales representative if anything is out of order.

Transportation guidelines

Pump handling and lifting

Precautions for moving the pump

Use care when moving pumps.

WARNING:
Make sure that the unit cannot roll or fall over and injure people or damage property.

NOTICE:
Use a forklift truck with sufficient capacity to move the pallet with the pump unit on top.

Precautions for lifting the pump

WARNING:
Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.

NOTICE:

- Make sure that the lifting equipment supports the entire assembly and is only used by authorized personnel.
- Do not attach sling ropes to shaft ends.

Lifting the pump

Hoist a bare pump using suitable slings under the bearing housing saddle on each end.

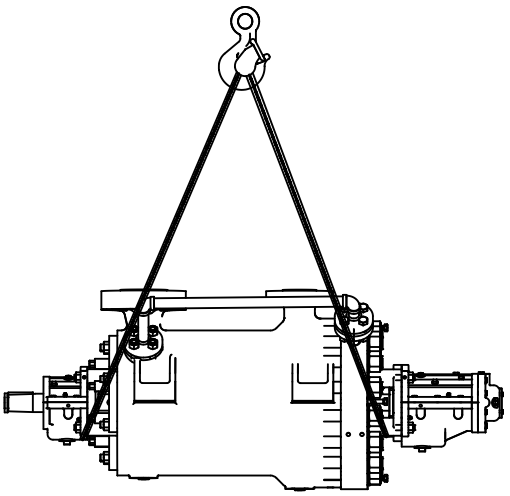


Figure 1: Example of the proper lifting method for a bare pump

Baseplate-mounted units have lifting points for use with proper lifting devices.

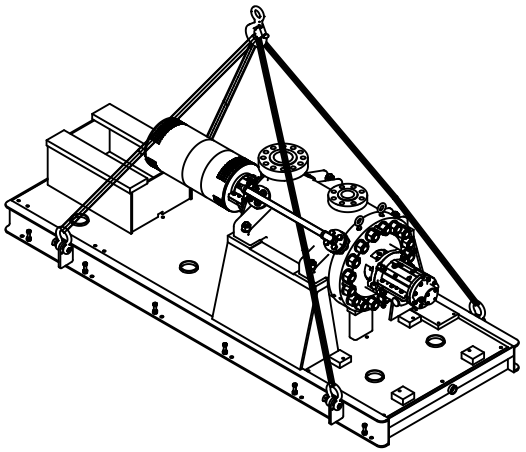


Figure 2: Example of the proper lifting method for baseplate-mounted units without a driver

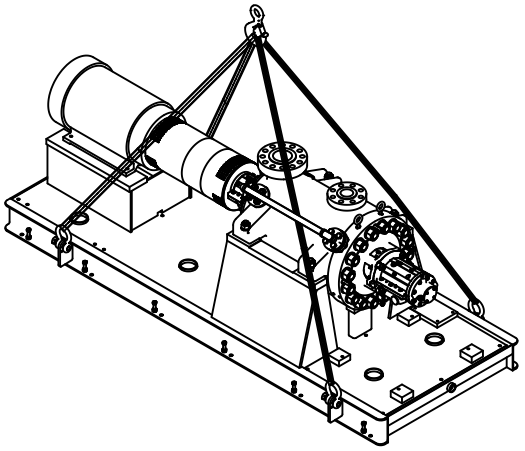


Figure 3: Example of the proper lifting method for baseplate-mounted units with a driver

Storage guidelines

Long-term storage

If the unit is stored for more than 6 months, these requirements apply:

- Store in a covered and dry location.
- Store the unit free from heat, dirt, and vibrations.
- Rotate the shaft by hand several times at least every three months.

Treat bearing and machined surfaces so that they are well preserved. Refer to the drive unit and coupling manufacturers for their long-term storage procedures.

For questions about possible long-term storage treatment services, please contact your local ITT sales representative.

Product Description

General description

Product description

The Model 7200CB is a horizontal centrifugal pump that meets the requirements of API 610 11th Editions (ISO 13709 2nd Edition) and has these characteristics:

- High-pressure
- High-temperature
- Multi-stage
- Between the bearings

Casing

The casing is centerline mounted with top-suction and top-discharge nozzles. The compression gaskets at the three metal-to-metal sealing faces are fully confined.

The flanges are ASME Class 900 raised-face serrated with a 125-250 RMS finish. Other flanges are also available:

- ASME Class 900 ring joint
- ASME Class 1500 raised-face serrated
- ASME Class 1500 ring joint
- ASME Class 2500 raised-face serrated
- ASME Class 2500 ring joint

Impeller

The impeller is fully closed and key driven.

Seal chamber

The seal chamber meets API 682 3rd Edition dimensions for improved performance of mechanical seals. Customer-selected cartridge mechanical seals are standard.

Power end

The power end has these characteristics:

- Carbon steel bearing housings are standard.
- The oil level is viewed through a sight glass.
- Constant-level oilers and labyrinth seals are standard.
- No machining is required in order to convert the standard ring oil lube to either purge or pure mist. Pure mist applications require minor bearing housing modifications.
- Pressure lubrication is required with hydrodynamic thrust bearings.

Bearings

Bearing type	Characteristics
Inboard (radial)	• Consists of a single-row deep-groove ball bearing (standard) • Carries only radial load • Optional sleeve bearings
Outboard (thrust)	• Consists of a pair of single-row angular contact ball bearings mounted back-to-back (standard) • Shouldered and locked to the shaft • Retained in the bearing frame to enable the bearing to carry both radial and thrust loads • Optional hydrodynamic thrust bearing for use with sleeve type journal bearings

Shaft

The heavy duty shaft has these characteristics:

- Designed for cartridge mechanical seals
- Minimal shaft deflection at the seal faces (0.002 in. [0.051 mm]) when run in the worst-case condition (typically minimum flow)
- Lateral modes at least +/- 15% of excitation frequency unless modes are critically damped per API 610.

Baseplate

The fabricated steel baseplate supports the pump, driver, and accessories in accordance with API-610 latest Edition (ISO 13709) requirements.

Direction of rotation

The shaft rotates counterclockwise when viewed from the coupling.

Nameplate information

Important information for ordering

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

When you order spare parts, identify this pump information:

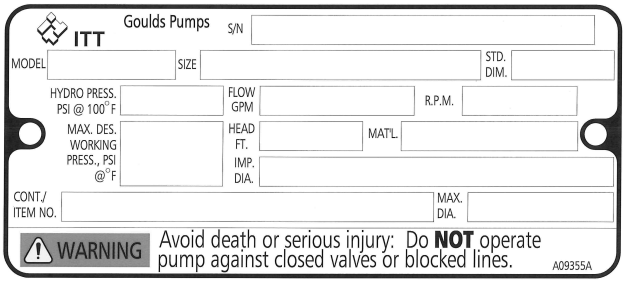
- Model
- Size
- Serial number
- Item numbers of the required parts

Refer to the nameplate on the pump casing for most of the information. See Parts List for item numbers.

Nameplate types

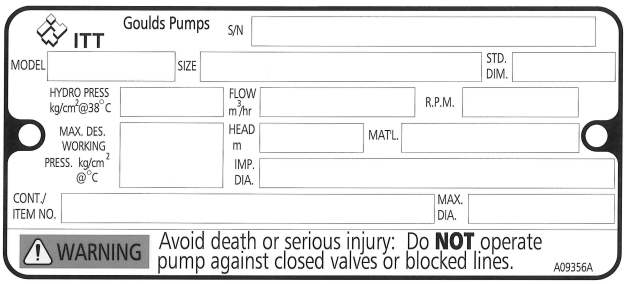
Nameplate	Description
Bearing frame	Provides information about the lubrication system used.
ATEX	If applicable, your pump unit might have an ATEX nameplate affixed to the pump, the baseplate, or the discharge head. The nameplate provides information about the ATEX specifications of this pump.
IECEx	If applicable, your pump unit might have the following IECEx nameplate affixed to the pump and/or baseplate. The nameplate provides information about the IECEx specifications of this pump.

Nameplate on the pump casing using English units



Nameplate field	Explanation
MODEL	Pump model
SIZE	Size of the pump
FLOW	Rated pump flow, in gallons per minute
HEAD	Rated pump head, in feet
RPM	Rated pump speed, in revolutions per minute
HYDRO PRESS	Hydrostatic pressure at 100°F, in pounds per square inch
MAX. DES. WORKING PRESS	Maximum working pressure at temperature °F, in pounds per square inch
S/N	Serial number of the pump
CONT./ITEM NO.	Customer contract or item number
IMP. DIA.	Rated impeller diameter
MAX. DIA.	Maximum impeller diameter
STD. DIM.	Standard ANSI dimensional code
MAT'L	Material of construction

Nameplate on the pump casing using metric units



Nameplate field	Explanation
MODEL	Pump model
SIZE	Size of the pump
FLOW	Rated pump flow, in gallons per minute
HEAD	Rated pump head, in feet
RPM	Rated pump speed, in revolutions per minute
HYDRO PRESS	Hydrostatic pressure at 38°C, in pounds per square inch
MAX. DES. WORKING PRESS	Maximum working pressure at temperature °C, in pounds per square inch
S/N	Serial number of the pump
CONT./ITEM NO.	Customer contract or item number
IMP. DIA.	Rated impeller diameter
MAX. DIA.	Maximum impeller diameter
STD. DIM.	Standard ANSI dimensional code
MAT'L	Material of construction

Nameplate on the bearing frame

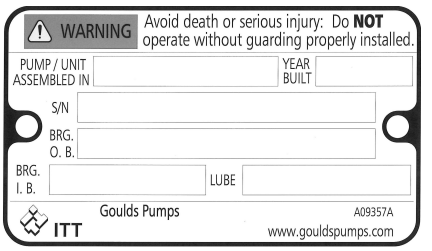


Table 1: Explanation of the nameplate on the bearing frame

Nameplate field	Explanation
BRG. O. B.	Outboard bearing designation
BRG. I. B.	Inboard bearing designation
S/N	Serial number of the pump
LUBE	Lubricant, oil or grease

ATEX nameplate

Nameplate field	Explanation
II	Group 2
2	Category 2
G/D	Pump can be used when gas and dust are present
T4	Temperature class

NOTICE:
Make sure that the code classifications on the pump are compatible with the specific environment in which you plan to install the equipment. If they are not compatible, do not operate the equipment and contact your ITT representative before you proceed.

Installation

Preinstallation

Precautions

WARNING:

- When installing in a potentially explosive environment, make sure that the motor is properly certified.
- You must earth (ground) all electrical equipment. This applies to the pump equipment, the driver, and any monitoring equipment. Test the earth (ground) lead to verify that it is connected correctly.

NOTICE:

Supervision by an authorized ITT representative is recommended to ensure proper installation. Failure to do so may result in equipment damage or decreased performance.

Pump location guidelines

WARNING:

Assembled units and their components are heavy. Failure to properly lift and support this equipment can result in serious physical injury and/or equipment damage. Lift equipment only at the specifically identified lifting points. Lifting devices such as eyebolts, slings, and spreaders must be rated, selected, and used for the entire load being lifted.

Guideline	Explanation/comment
Keep the pump as close to the liquid source as practically possible.	This minimizes the friction loss and keeps the suction piping as short as possible.
Make sure that the space around the pump is sufficient.	This facilitates ventilation, inspection, maintenance, and service.
If you require lifting equipment such as a hoist or tackle, make sure that there is enough space above the pump.	This makes it easier to properly use the lifting equipment and safely remove and relocate the components to a safe location.
Protect the unit from weather and water damage due to rain, flooding, and freezing temperatures.	This is applicable if nothing else is specified.
Do not install and operate the equipment in closed systems unless the system is constructed with properly-sized safety devices and control devices.	Acceptable devices: • Pressure relief valves • Compression tanks • Pressure controls • Temperature controls • Flow controls If the system does not include these devices, consult the engineer or architect in charge before you operate the pump.
Take into consideration the occurrence of unwanted noise and vibration.	
If the pump location is overhead, undertake special precautions to reduce possible noise transmission.	Consider a consultation with a noise specialist.

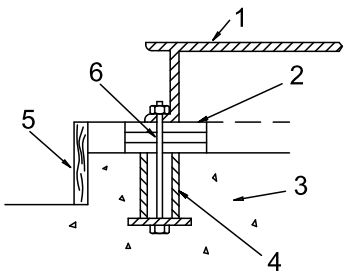
Foundation requirements

Requirements

- The foundation must be able to absorb any type of vibration and form a permanent, rigid support for the unit.
- The location and size of the foundation bolt holes must match those shown on the assembly drawing provided with the pump data package.
- The foundation must weigh between two and three times the weight of the pump.
- Provide a flat, substantial concrete foundation in order to prevent strain and distortion when you tighten the foundation bolts.

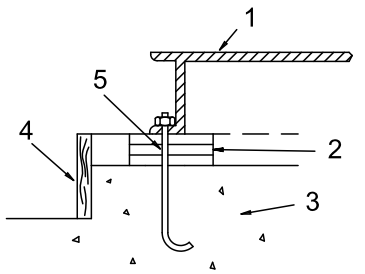
- Sleeve-type and J-type foundation bolts are most commonly used. Both designs allow movement for the final bolt adjustment.

Sleeve-type bolts



1. Baseplate
2. Shims or wedges
3. Foundation
4. Sleeve
5. Dam
6. Bolt

J-type bolts



1. Baseplate
2. Shims or wedges
3. Foundation
4. Dam
5. Bolt

Baseplate-mounting procedures

Prepare the baseplate for mounting

This procedure assumes you have a basic knowledge of baseplate and foundation design and installation methods. Follow industry-standard procedures, such as API RP 686/ PIP REIE 686, or this procedure before you grout the baseplate.

1. Make sure that all baseplate surfaces that will contact grout are free from contamination such as rust, oil, and grime.
2. Thoroughly clean all baseplate surfaces that will come in contact with grout.
   Make sure to use a cleaner that will not leave residue.

NOTICE:
You may need to sandblast the surfaces of a baseplate that come in contact with grout, and then coat those surfaces with a primer that is grout-compatible. Make sure to remove all equipment before sandblasting.

3. Make sure that all machined surfaces are free from burrs, rust, paint, or any other type of contamination.
   If necessary, use a honing stone to remove burrs.

Prepare the foundation for mounting

1. Chip the top of the foundation to a minimum of 1.0 in. (25.0 mm) in order to remove porous or low-strength concrete.
   If you use a pneumatic hammer, make sure that it does not contaminate the surface with oil or other moisture.

   NOTICE:
   Do not chip the foundation using heavy tools such as jackhammers. This can damage the structural integrity of the foundation.

2. Remove water or debris from the foundation bolt holes or sleeves.
3. If the baseplate uses sleeve-type bolts, then fill the sleeves with a non-binding, moldable material. Seal the sleeves in order to prevent the grout from entering.
4. Coat the exposed portion of the anchor bolts with a non-bonding compound such as paste wax in order to prevent the grout from adhering to the anchor bolts.
   Do not use oils or liquid wax.
5. If recommended by the grout manufacturer, coat the foundation surface with a compatible primer.

Install and level the baseplate

NOTICE: Illustrations are for reference only and may not depict the particular pump model.

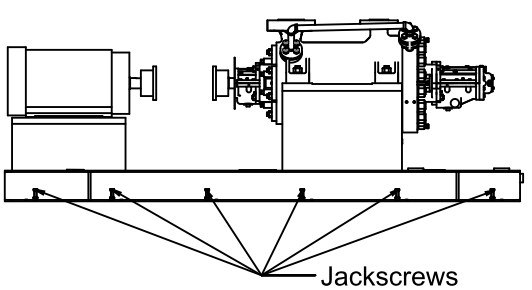


Figure 4: Jackscrew locations, side view

1. Lower the baseplate carefully onto the foundation bolts.
   The baseplate will rest on top of the foundation on the jackscrews provided on the baseplate.
2. Adjust the leveling jackscrews, located adjacent to the foundation bolt holes, until the baseplate rests 1 to 2 in. (25 to 50 mm) above the foundation in order to allow for adequate grouting.
   This provides even support for the baseplate after grouting.
3. Level the baseplate to within 0.002 in./ft. (0.167 mm/m) of the length or width of the baseplate by adjusting the jackscrews.

- The maximum total variation from one end or side of the baseplate to the other is 0.015 in. (0.38 mm).
- Use the equipment mounting surfaces in order to establish the level.

4. Use a non-bonding (anti-seize) compound such as paste wax to coat the portions of the jackscrews that will contact the grout.
   This facilitates removal of the screws after grouting.

NOTICE:
Do not use oils or liquid wax.

5. Thread the nuts onto the foundation bolts and hand-tighten.

Install the pump, driver, and coupling

1. Mount and fasten the pump on the baseplate. Use applicable bolts.
2. Mount the driver on the baseplate. Use applicable bolts and hand tighten.
3. Install the coupling.
   See the installation instructions from the coupling manufacturer.

Pump-to-driver alignment

Precautions

WARNING:
- Follow shaft alignment procedures in order to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling installation and operation procedures from the coupling manufacturer.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.

NOTICE:
Proper alignment is the responsibility of the installer and the user of the unit. Check the alignment of frame-mounted units before you operate the unit. Failure to do so can result in equipment damage or decreased performance.

Alignment methods

Three common alignment methods are used:

- Dial indicator
- Reverse dial indicator
- Laser

Follow the instructions from the equipment manufacturer when you use the reverse dial indicator or laser methods. Detailed instructions for using the dial indicator method are contained in this chapter.

Alignment checks

When to perform alignment checks

You must perform alignment checks under these circumstances:

- The process temperature changes.
- The piping changes.
- The pump has been serviced.

Types of alignment checks

Type of check	When it is used
Initial alignment (cold alignment) check	Prior to operation when the pump and the driver are at ambient temperature.
Final alignment (hot alignment) check	After operation when the pump and the driver are at operating temperature.

Initial alignment (cold alignment) checks

When	Why
Before you grout the baseplate	This ensures that alignment can be accomplished.
After you grout the baseplate	This ensures that no changes have occurred during the grouting process.
After you connect the piping	This ensures that pipe strains have not altered the alignment. If changes have occurred, you must alter the piping to remove pipe strains on the pump flanges.

Final alignment (hot alignment) checks

When	Why
After the first run	This ensures correct alignment when both the pump and the driver are at operating temperature.
Periodically	This follows the plant operating procedures.

Permitted indicator values for alignment checks

NOTICE:
The specified permitted reading values are valid only at operating temperature. For cold settings, other values are permitted. You must use the correct tolerances. Failure to do so can result in misalignment and reduced pump reliability.

IMPORTANT

- For electric motors, the motor shaft initial (cold) parallel vertical alignment setting should be 0.002 to 0.004 in. (0.05 to 0.10 mm) lower than the pump shaft.
- For other drivers such as turbines and engines, follow the driver manufacturer's recommendations.

When dial indicators are used to check the final alignment, the pump and drive unit are correctly aligned when these conditions are true:

- The total indicator runout is a maximum of 0.002 in. (0.05 mm) at operating temperature.
- The tolerance of the indicator is 0.0005 in./in. (0.0127 mm/mm) of indicator separation at operating temperature.

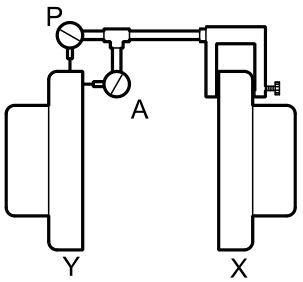
Alignment measurement guidelines

Guideline	Explanation
Rotate the pump coupling half and the driver coupling half together so that the indicator rods have contact with the same points on the driver coupling half.	This prevents incorrect measurement.
Move or shim only the driver in order to make adjustments.	This prevents strain on the piping installations.
Make sure that the hold-down bolts for the driver feet are tight when you take indicator measurements.	This keeps the driver stationary since movement causes incorrect measurement.
Make sure that the hold-down bolts for the driver feet are loose before you make alignment corrections.	This makes it possible to move the driver when you make alignment corrections.
Check the alignment again after any mechanical adjustments.	This corrects any misalignments that an adjustment may have caused.

Attach the dial indicators for alignment

You must have two dial indicators in order to complete this procedure.

1. Attach two dial indicators on the pump coupling half (X):
   a) Attach one indicator (P) so that the indicator rod comes into contact with the perimeter of the driver coupling half (Y).
   This indicator is used to measure parallel misalignment.
   b) Attach the other indicator (A) so that the indicator rod comes into contact with the inner end of the driver coupling half.
   This indicator is used to measure angular misalignment.

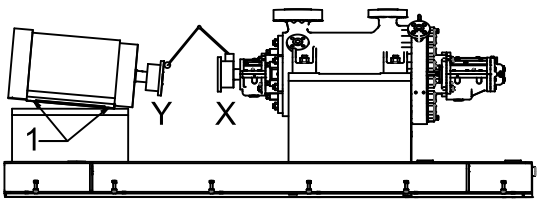


2. Rotate the pump coupling half (X) in order to check that the indicators are in contact with the driver coupling half (Y) but do not bottom out.
3. Adjust the indicators if necessary.

Perform angular alignment for a vertical correction

1. Set the angular alignment indicator to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart at the bottom than at the top. Perform one of these steps: • Add shims in order to raise the feet of the driver at the shaft end. • Remove shims in order to lower the feet of the driver at the other end.
Positive	The coupling halves are closer at the bottom than at the top. Perform one of these steps: • Remove shims in order to lower the feet of the driver at the shaft end. • Add shims in order to raise the feet of the driver at the other end.



1. Shims

Figure 5: Example of incorrect vertical alignment (side view)

4. Repeat the previous steps until the permitted reading value is achieved.

Perform angular alignment for a horizontal correction

1. Set the angular alignment indicator (A) to zero on left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The coupling halves are farther apart on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the left. • Slide the opposite end to the right.
Positive	The coupling halves are closer together on the right side than the left. Perform one of these steps: • Slide the shaft end of the driver to the right. • Slide the opposite end to the left.

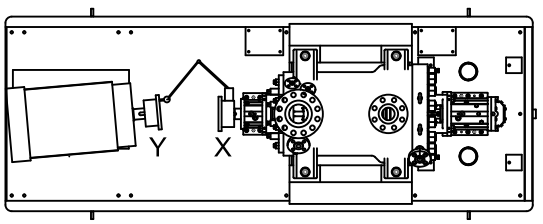


Figure 6: Example of incorrect horizontal alignment (top view)

4. Repeat the previous steps until the permitted reading value is achieved.

Perform parallel alignment for a vertical correction

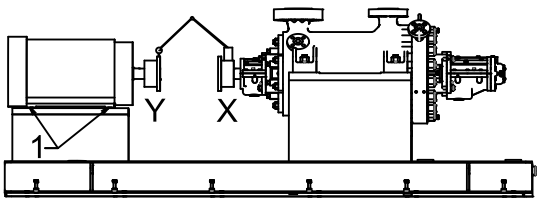
Before you start this procedure, make sure that the dial indicators are correctly set up.

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicator to the bottom-center position (6 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The pump coupling half (X) is lower than the driver coupling half (Y). Remove shims of a thickness equal to half of the indicator reading value under each driver foot.
Positive	The pump coupling half (X) is higher than the driver coupling half (Y). Add shims of a thickness equal to half of the indicator reading value to each driver foot.

NOTICE:



1. Shims

Figure 7: Example of incorrect vertical alignment (side view)

4. Repeat the previous steps until the permitted reading value is achieved.

Perform parallel alignment for a horizontal correction

A unit is in parallel alignment when the parallel indicator (P) does not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart at the operating temperature.

1. Set the parallel alignment indicator (P) to zero on the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicator through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator reading.

When the reading value is...	Then...
Negative	The driver coupling half (Y) is to the left of the pump coupling half (X).

When the reading value is...	Then...
Positive	The driver coupling half (Y) is to the right of the pump coupling half (X).

4. Slide the driver carefully in the appropriate direction.

NOTICE: Make sure to slide the driver evenly. Failure to do so can negatively affect horizontal angular correction.

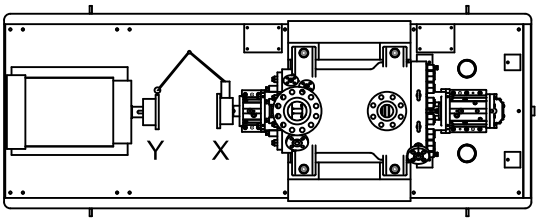


Figure 8: Example of incorrect horizontal alignment (top view)

5. Repeat the previous steps until the permitted reading value is achieved.

Perform complete alignment for a vertical correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart.

1. Set the angular and parallel dial indicators to zero at the top-center position (12 o'clock) of the driver coupling half (Y).
2. Rotate the indicators to the bottom-center position (6 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

Perform complete alignment for a horizontal correction

A unit is in complete alignment when both the angular indicator (A) and the parallel indicator (P) do not vary by more than 0.002 in. (0.05 mm) as measured at four points 90° apart.

1. Set the angular and parallel dial indicators to zero at the left side of the driver coupling half (Y), 90° from the top-center position (9 o'clock).
2. Rotate the indicators through the top-center position to the right side, 180° from the start position (3 o'clock).
3. Record the indicator readings.
4. Make corrections according to the separate instructions for angular and parallel alignment until you obtain the permitted reading values.

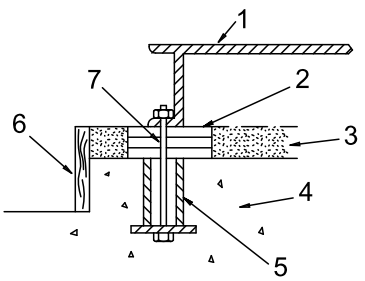
Grout the baseplate

Required equipment:

- Cleaners: Do not use an oil-based cleaner because the grout will not bond to it. See the instructions provided by the grout manufacturer.
- Grout: Non-shrink grout is recommended.

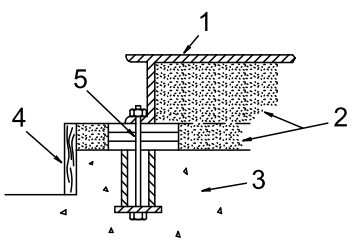
NOTICE: It is assumed that the installer who grouts the baseplate has knowledge of acceptable methods. More detailed procedures are described in various publications, including API Standard 610, 8th Edition, Appendix L; API RP 686, Chapter 5; and other industry standards.

1. Clean all the areas of the baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam.
   When you pour the grout, remove air bubbles from it by using one of these methods:
   - Puddle with a vibrator.
   - Pump the grout into place.
5. Allow the grout to set.



1. Baseplate
2. Shims or wedges
3. Grout
4. Foundation
5. Sleeve
6. Dam
7. Bolt

6. Fill the remainder of the baseplate with grout, and allow the grout to set for at least 48 hours.



1. Baseplate
2. Grout
3. Foundation
4. Dam
5. Bolt

7. Remove the leveling jackscrews after the grout hardens in order to remove any stress points.
8. Tighten the foundation bolts.
9. Recheck the alignment.

Piping checklists

General piping checklist

Precautions

CAUTION:

- Never draw piping into place by using force at the flanged connections of the pump. This can impose dangerous strains on the unit and cause misalignment between the pump and driver. Pipe strain adversely affects the operation of the pump, which results in physical injury and damage to the equipment.
- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.

NOTICE:

Flange loads from the piping system, including those from the 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.

Piping guidelines

Guidelines for piping are given in the Hydraulic Institute Standards available from the Hydraulic Institute at 9 Sylvan Way, Parsippany, NJ 07054-3802. You must review this document before you install the pump.

Checklist

Check	Explanation/comment	Checked
Check that all piping is supported independently of, and lined up naturally with, the pump flange. See Alignment criteria for pump flanges.	This helps to prevent: • Strain on the pump • Misalignment between the pump and the drive unit • Wear on the pump bearings, seal, and shafting	
Keep the piping as short as possible.	This helps to minimize friction losses.	
Check that only necessary fittings are used.	This helps to minimize friction losses.	
Do not connect the piping to the pump until: • The grout for the baseplate or sub-base becomes hard. • The hold-down bolts for the pump are tightened.	—	
Make sure that all the piping joints and fittings are airtight.	This prevents air from entering the piping system or leaks that occur during operation.	
If the pump handles corrosive fluids, make sure that the piping allows you to flush out the liquid before you remove the pump.	—	
If the pump handles liquids at elevated temperatures, make sure that the expansion loops and joints are properly installed.		
Make sure that all piping components, valves and fittings, and pump branches are clean prior to assembly.	—	

Check	Explanation/comment	Checked
Make sure that the isolation and check valves are installed in the discharge line.	Locate the check valve between the isolation valve and the pump. This will permit inspection of the check valve. The isolation valve is required for regulation of flow, and for inspection and maintenance of the pump. The check valve prevents pump or seal damage due to reverse flow through the pump when the driver is turned off.	
Use cushioning devices.	This protects the pump from surges and water hammer if quick-closing valves are installed in the system.	

Alignment criteria for pump flanges

Type	Criteria
Axial	The flange gasket thickness is ±0.03 in. (0.8 mm).
Parallel	Align the flange to be within 0.001 in./in. to 0.03 in./in. (0.025 mm/mm to 0.8 mm/mm) of the flange diameter.
Concentric	You can easily install the flange bolts by hand.

Fastening

WARNING:
- Only use fasteners of the proper size and material.
- Replace all corroded fasteners.
- Make sure that all fasteners are properly tightened and that there are no missing fasteners.

Suction-piping checklist

Performance curve reference

CAUTION:
Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side. This action can result in decreased performance, unexpected heat generation, and equipment damage.

Net positive suction head available ($NPSH_A$) must always exceed NPSH required ($NPSH_R$) as shown on the published performance curve of the pump.

Suction-piping checks

Check	Explanation/comment	Checked
Check that the distance between the inlet flange of the pump and the closest elbow is at least five pipe diameters.	This minimizes the risk of cavitation in the suction inlet of the pump due to turbulence.	
Check that elbows in general do not have sharp bends.	—	
Check that the suction piping is one or two sizes larger than the suction inlet of the pump. Install an eccentric reducer between the pump inlet and the suction piping.	The suction piping must never have a smaller diameter than the suction inlet of the pump.	
Check that the eccentric reducer at the suction flange of the pump has the following properties: • Sloping side down • Horizontal side at the top	—	
If suction strainers or suction bells are used, check that they are at least three times the area of the suction piping.	Suction strainers help to prevent clogging. Mesh holes with a minimum diameter of 1/16 in. (1.6 mm) are recommended.	

Check	Explanation/comment	Checked
If more than one pump operates from the same liquid source, check that separate suction-piping lines are used for each pump.	This recommendation helps you to achieve a higher pump performance.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	

Liquid source below the pump

Check	Explanation/comment	Checked
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the suction piping slopes upwards from the liquid source to the pump inlet.	—	
Check that all joints are air-tight.	—	
If the pump is not self-priming, check that a device for priming the pump is installed.	Use a foot valve with a diameter that is at least equivalent to the diameter of the suction piping.	

Liquid source above the pump

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the suction piping at a distance of at least two times the pipe diameter from the suction inlet.	This permits you to close the line during pump inspection and maintenance. Do not use the isolation valve to throttle the pump. Throttling can cause these problems: • Loss of priming • Excessive temperatures • Damage to the pump • Voiding the warranty	
Make sure that the suction piping is free from air pockets.	This helps to prevent the occurrence of air and cavitation in the pump inlet.	
Check that the piping is level or slopes downward from the liquid source.	—	
Make sure that no part of the suction piping extends below the suction flange of the pump.	—	
Make sure that the suction piping is adequately submerged below the surface of the liquid source.	This prevents air from entering the pump through a suction vortex.	

Discharge piping checklist

Checklist

Check	Explanation/comment	Checked
Check that an isolation valve is installed in the discharge line.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump	
Check that a check valve is installed in the discharge line, between the isolation valve and the pump discharge outlet.	The location between the isolation valve and the pump allows inspection of the check valve. The check valve prevents damage to the pump and seal due to the back flow through the pump, when the drive unit is shut off. It is also used to restrain the liquid flow.	
If increasers are used, check that they are installed between the pump and the check valve.	—	

Check	Explanation/comment	Checked
If quick-closing valves are installed in the system, check that cushioning devices are used.	This protects the pump from surges and water hammer.	

Bypass-piping considerations

When to use a bypass line

Provide a bypass line for systems that require operation at reduced flows for prolonged periods. Connect a bypass line from the discharge side (before any valves) to the source of suction.

When to install a minimum-flow orifice

You can size and install a minimum-flow orifice in a bypass line in order to prevent bypassing excessive flows. Consult your ITT representative for assistance in sizing a minimum-flow orifice.

When a minimum-flow orifice is unavailable

Consider an automatic recirculation control valve or solenoid-operated valve if a constant bypass (minimum-flow orifice) is not possible.

Auxiliary-piping checklist

Precautions

WARNING:

- Cooling systems such as those for bearing lubrication and mechanical-seal systems 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.

NOTICE:

The mechanical seal must have an appropriate seal-flush system. Otherwise, excess heat generation and seal failure can occur.

When to install

You may need to install auxiliary piping for bearing cooling, seal-chamber cover cooling, mechanical seal flush, or other special features supplied with the pump. Consult the pump data sheet for specific auxiliary piping recommendations.

Checklist

Check	Explanation/comment	Checked
Check that the minimum flow for each component is 1 gpm (4 lpm). If the bearing and seal chamber cover cooling are provided, then the auxiliary piping must flow at 2 gpm (8 lpm).	–	
Check that the cooling water pressure does not exceed 100 psig (7.0 kg/cm^2).	–	

Final piping checklist

Check	Explanation/comment	Checked
Check that the shaft rotates smoothly.	Rotate the shaft by hand. Make sure there is no rubbing that can lead to excess heat generation or sparks.	

Check	Explanation/comment	Checked
Re-check the alignment to make sure that pipe strain has not caused any misalignment.	If pipe strain exists, then correct the piping.	

Commissioning, Startup, Operation, and Shutdown

Preparation for startup

WARNING:

- Failure to follow these precautions before you start the unit will lead to serious personal injury and equipment failure.
- Do not operate the pump below the minimum rated flows or with the suction or discharge valves closed. These conditions can create an explosive hazard due to vaporization of pumped fluid and can quickly lead to pump failure and physical injury.
- Never operate the pump without the coupling guard correctly installed.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.

Precautions

NOTICE:

- Verify the driver settings before you start any pump.
- Make sure that the temperature change does not exceed 20°F (11°C) per minute.
- The maximum allowable temperature change for an abnormal transient event such as thermal shock is 250°F (121°C).

You must follow these precautions before you start the pump:

- Flush and clean the system thoroughly to remove dirt or debris in the pipe system in order to prevent premature failure at initial startup.
- Bring variable-speed drivers to the rated speed as quickly as possible.
- If temperatures of the pumped fluid will exceed 200°F (93°C), then warm up the pump prior to operation. Circulate a small amount of fluid through the pump until the casing temperature is within 100°F (38°C) of the fluid temperature.

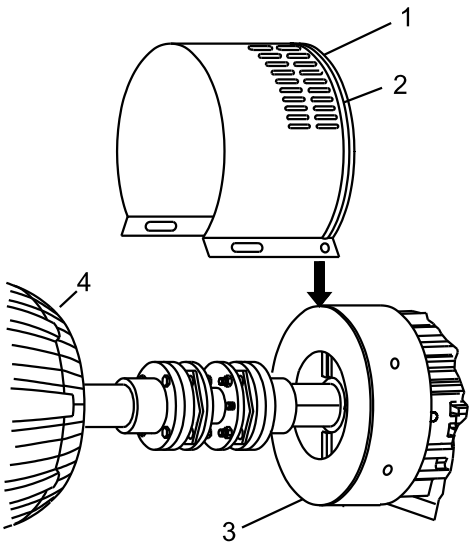
At initial startup, do not adjust the variable-speed drivers or check for speed governor or over-speed trip settings while the variable-speed driver is coupled to the pump. If the settings have not been verified, then uncouple the unit and refer to instructions supplied by the driver manufacturer.

Remove the coupling guard

1. Remove the nut, bolt, and washers from the slotted hole in the center of the coupling guard.
2. Slide the driver half of the coupling guard toward the pump.
3. Remove the nut, bolt, and washers from the driver half of the coupling guard.
4. Remove the driver-side end plate.
5. Remove the driver half of the coupling guard:
   a) Slightly spread the bottom apart.
   b) Lift upwards.
6. Remove the remaining nut, bolt, and washers from the pump half of the coupling guard.

It is not necessary to remove the end plate from the pump side of the bearing housing. You can access the bearing-housing tap bolts without removing this end plate if maintenance of internal pump parts is necessary.

7. Remove the pump half of the coupling guard:
   a) Slightly spread the bottom apart.
   b) Lift upwards.



1. Pump half of the coupling guard
2. Annular groove
3. Deflector fan guard
4. Driver

Check the rotation

WARNING:

- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.

1. Lock out power to the driver.
2. Make sure that the coupling hubs are fastened securely to the shafts.
3. Make sure that the coupling spacer is removed.
   The pump ships with the coupling spacer removed.
4. Unlock power to the driver.
5. Make sure that everyone is clear, and then jog the driver long enough to determine that the direction of rotation corresponds to the arrow on the bearing housing or close-coupled frame.
6. Lock out power to the driver.

Couple the pump and driver

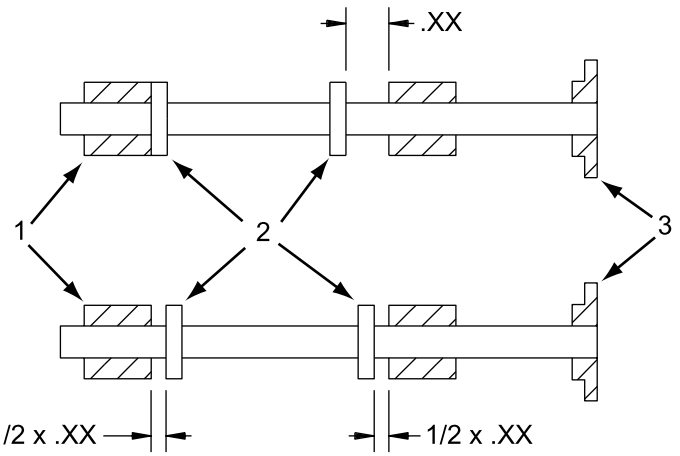
WARNING:

- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- The coupling used in an Ex-classified environment must be properly certified and must be constructed from a non-sparking material.

1. Check the gap between the coupling hubs against the dimensions shown on the elevation drawing or as stamped on the coupling hub. For any necessary adjustment, move the driver not the pump.
   Motors with sleeve bearings may be manufactured with 1/4 or 1/2 in. (6.35 or 12.7 mm) end movement (float) in the motor rotor. For limited end-float arrangement, the gap between the coupling halves must be set in a different manner. If specific directions are not indicated in the motor instructions, then follow this procedure:

   NOTICE:
   If the driver was mounted at the factory, the setting for the coupling is already determined.

   a) Slide the rotor towards the outboard end of the motor as far as it will go and mark the shaft at the motor frame.
   b) Slide the rotor towards the inboard end of the motor as far as it will go and mark the shaft again.
      The distance between the marks should be either 1/2 or 1/4 in. (6.35 or 12.7 mm) if the motor is arranged for limited end-float travel.
   c) Scribe a third mark on the shaft halfway between the scribe marks made in the previous steps.
   d) Clamp the rotor in place.



   1. Sleeve bearing
   2. Thrust collar
   3. Coupling

2. Use the instructions from the coupling manufacturer to lubricate and install the coupling.
3. Check the angular and parallel alignment of the coupling halves. See Pump-to-driver alignment in the Installation chapter.

Coupling guard assembly

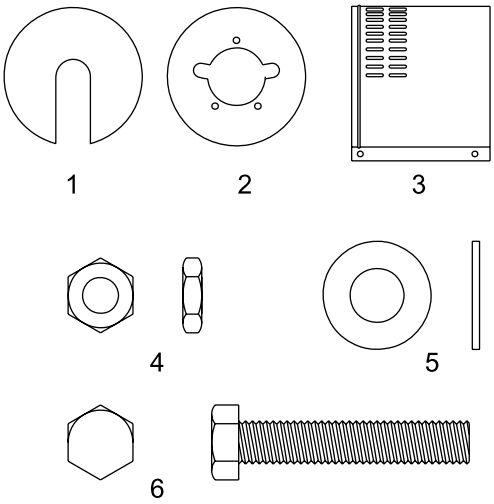
Precautions

WARNING:

- Never operate the pump without the coupling guard correctly installed.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- The coupling used in an Ex-classified environment must be properly certified and must be constructed from a non-sparking material.

Required parts

These parts are required:



1. End plate, drive end
2. End plate, pump end
3. Guard half, 2 required
4. 3/8-16 nut, 3 required
5. 3/8 in. washer
6. 3/8-16 x 2 in. hex head bolt, 3 required

Install the coupling guard

1. Is the end plate (pump end) already installed?
   - If yes: Make any necessary coupling adjustments and then proceed to step 2.
   - If no: Complete these steps:

   a) Remove the spacer portion of the coupling.
   Refer to the instructions from the coupling manufacturer for assistance.

   b) If the coupling hub diameter is larger than the diameter of the opening in the end plate, then remove the coupling hub.

   c) Remove the thrust bearing end-cover screws.

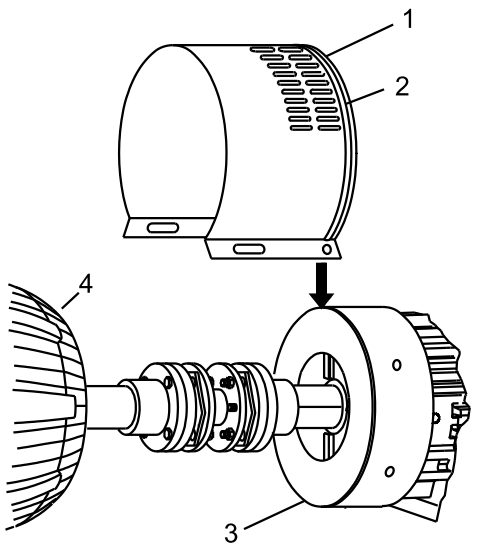
   d) Align the end plate to the thrust bearing end cover so that the holes in the end plate align with the holes in the end cover.

   e) Replace the three thrust bearing end cover screws and torque to the values shown in the Maximum torque values for fasteners table.

   f) Replace the coupling hub (if removed) and the spacer portion of the coupling.
   Refer to the instructions from the coupling manufacturer for assistance.

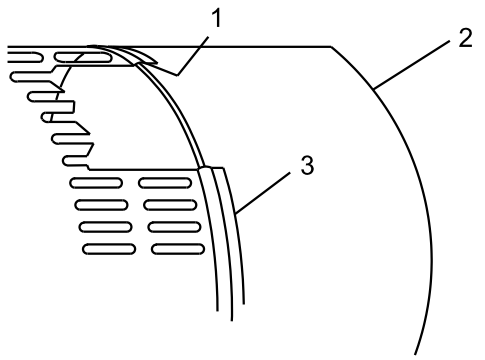
   Complete any coupling adjustments before you proceed with the coupling guard assembly.

2. Slightly spread the opening of the coupling guard half and place it over the pump end plate.



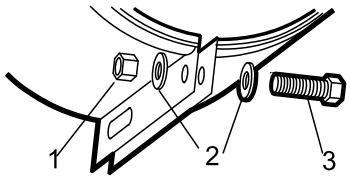
1. Pump half of the coupling guard
2. Annular groove
3. Deflector fan guard
4. Driver

The annular groove in the guard is located around the end plate.
Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.



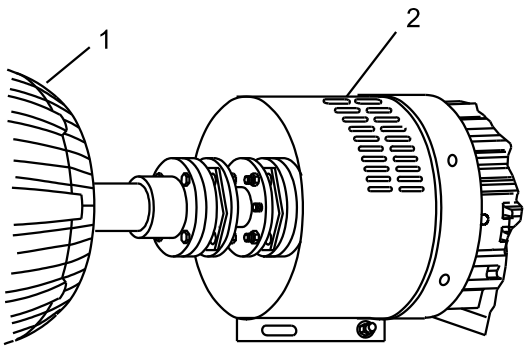
1. Annular groove
2. Deflector fan guard
3. Coupling guard half

3. Place one washer over the bolt and insert the bolt through the round hole at the front end of the guard half.
4. Place a second washer over the exposed end of the bolt.
5. Thread a nut onto the exposed end of the bolt and tighten firmly.
   This figure shows the proper sequence of components:



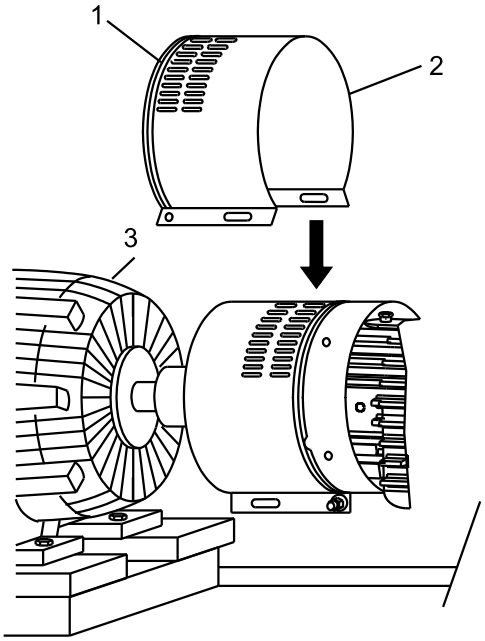
1. Nut
2. Washer
3. Bolt

This figure shows an assembled unit:



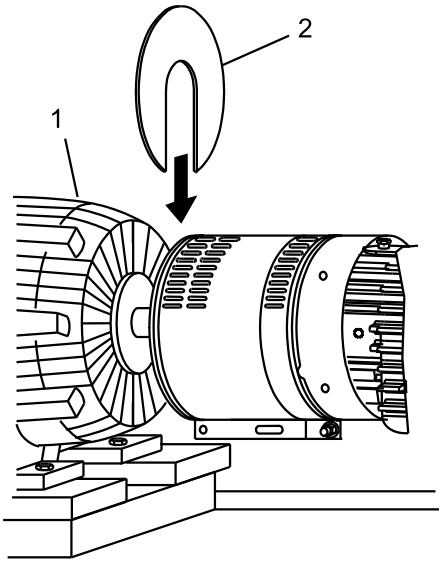
1. Driver
2. Coupling guard half

6. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the driver.



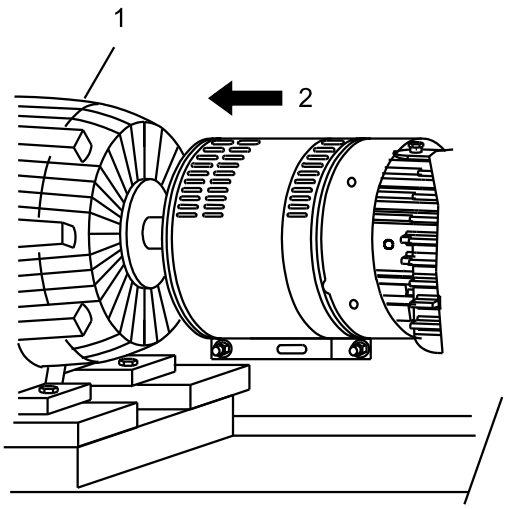
1. Annular groove
2. Coupling guard half
3. Driver

7. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.



1. Annular groove
2. End plate

8. Repeat steps 3 through 5 for the rear end of the coupling guard half, except that you hand tighten the nut.
9. Slide the rear coupling guard half towards the motor so that it completely covers the shafts and coupling.



1. Driver
2. Slide to fit

10. Repeat steps 3 through 5 for the center slots in the coupling guard.
11. Firmly tighten all nuts on the guard assembly.

Bearing lubrication

Precautions

WARNING:
Make sure to properly lubricate the bearings. Failure to do so can result in excess heat generation, sparks, and premature failure.

Pumps are shipped without oil

You must lubricate oil-lubricated bearings at the job site.

Ring oil lubrication

Ring oil-lubricated bearings are standard. Bearing housings are supplied with constant-level oilers and sight glasses. Make sure that oil rings are properly seated in the grooves in the shaft.

Pure or purge oil-mist lubrication

Pure or purge oil mist are optional features. Follow the oil-mist generator manufacturer's instructions. The inlet and outlet connections are located on the top and bottom of the bearing housing, respectively.

Oil volumes

Oil volume requirements for ball/ball

This table shows the required amount of oil for oil-lubricated bearings.

All frames in this table use a Watchdog Oiler, which has a capacity of 4 oz. (118 ml).

Bearing housing oil volume	
ounces	**milliliters**
80	2365

Oil volume requirements for sleeve/hydrodynamic type bearings

The sleeve/hydrodynamic type bearing is a pressurized lubrication system where oil is flowed into the bearing. This system does not have an oil sump. The system requires a flow rate of 0.5 gpm (0.12 m^3/hr) for the sleeve bearing and 1.0 gpm (0.23m^3/hr) for Kingsbury #5 and 2.0 gpm (0.45 m^3/hr) for Kingsbury #6 for the hydrodynamic thrust bearing at 15 psi (100 kPA).

Lubricating-oil requirements

Oil quality requirements

Use a high-quality turbine oil with rust and oxidation inhibitors with rated viscosity shown below at 100°F (38°C).

Oil requirements based on temperature

For the majority of operating conditions, bearing temperatures run between 120°F (49°C) and 180°F (82°C), and you can use an oil of ISO viscosity grade 68 at 100°F (38°C). If temperatures exceed 180°F (82°C), refer to the table for temperature requirements.

Temperature	Oil requirement
Bearing temperatures exceed 180°F (82°C)	Use ISO viscosity grade 100. Bearing temperatures are generally about 20°F (11°C) higher than bearing-housing outer surface temperatures.
Pumped-fluid temperatures are extreme	Refer to the factory or a lubrication expert.

Acceptable oil for lubricating bearings

Acceptable lubricants

Table 2:

Brand	Lubricant type	
	Ball/Ball	Sleeve/Hydrodynamic
Exxon	Teresstic EP 68	Teresstic EP 32
Mobil	DTE 768	DTE 732
Sunoco	Sunvis 968	Sunvis 932
Royal Purple	SYNFILM ISO VG 68	SYNFILM ISO VG 32

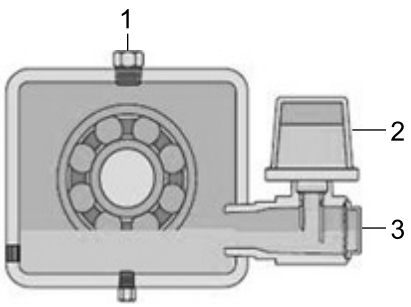
Lubricate the bearings with oil

Ring oil-lubricated pumps are supplied with an oiler that maintains a constant oil level in the bearing housing.

1. Fill the oil reservoir in the bearing frame:
   a) Fill the bearing chamber through the main body of the Watchdog until it reaches the optimum fluid level visible in the bullseye sight.
   b) Fill the watchdog reservoir using a funnel.
   c) Verify o-ring is on the Watchdog oiler spout.
   d) Place your thumb over the reservoir spout. Invert and insert the spout into the internal threaded boss on the main body.
   e) Tighten reservoir. Do not over-tighten.
   f) Verify that proper oil level is maintained per the following diagram.

NOTICE:
Do not fill the oil reservoir of the bearing frame through the plug at the top.

2. Check that the oil level is correct. The correct oil level is centered in the bullseye sight glass, when the pump is not in operation. During operation, bullseye sight gives a false oil level reading. Shown is general schematic. Oil level is below outer race of bearing.



1. Plug
2. Reservoir
3. Main body

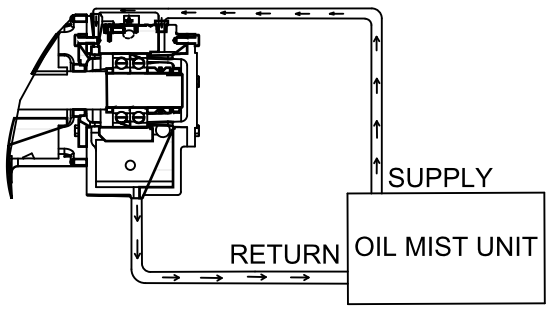
Lubricate the bearings with pure or purge-oil mist (optional)

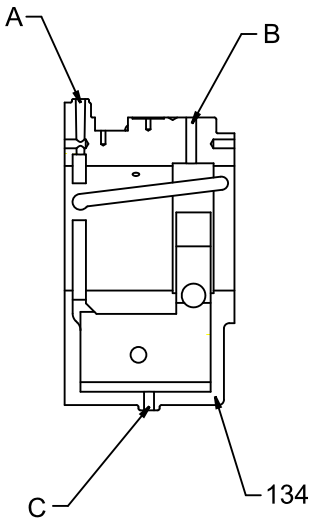
Before lubricating with purge-oil mist, make sure that the bearing frame is properly lubricated. See Lubricate the bearings with oil.
The oil requirements for ring-oil-lubricated bearings also apply to oil-mist-lubricated bearings.

NOTICE:
Oil mist is recommended for use on ball bearing arrangements only. See Convert to oil-mist lubrication.

1. Prepare the oil-mist generator according to the manufacturer's instructions.

2. Connect the oil-mist supply lines to the oil-ring inspection plug connections.
   Note that only one of the two connection ports in the radial bearing housing (134) is used (immediately above the single row radial bearing). You must connect to both connections on the thrust bearing housing, because there are two rows of bearings.





Oil-mist connections

A. Radial and thrust
B. Thrust only
C. Radial and thrust drain

Convert to oil-mist lubrication

NOTICE:
Make sure that pipe threads are clean and apply thread sealant to plugs and fittings.

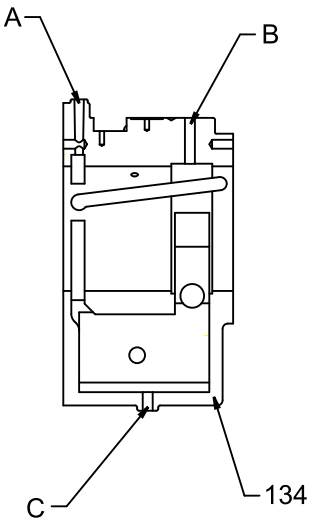
You can convert from ring-oil lubrication to oil-mist lubrication in pumps with ball bearing construction. The radial and thrust end bearing housings (134) have pre-drilled connections for oil misting:

- 1/4 in. NPT connection on the inboard side of the housing
- 1/2 in. NPT connection on the outboard side

Purge-oil mist lubrication provides intermittent oil mist in the bearing housing. This system uses the oil sump in the housing, and requires the oil ring and the constant-level oiler.

Pure-oil mist lubrication provides constant oil mist in the bearing housing. This system does not use the oil sump, oil ring, or constant-level oiler. The drain connections in the bearing housing are used as part of the oil recirculation system.

1. On the radial housing, replace the 1/4 in. NPT plug with an oil-mist fitting provided by the oil-mist system manufacturer.
   The 1/2 in. NPT connections remains plugged because it is not required in the oil-mist system.
2. On the thrust housing, replace the 1/4 in. NPT plug with an oil-mist fitting. Replace the 1/2 in. NPT plug with a 1/2 in. to 1/4 in. bushing and insert an oil-mist fitting provided by the oil-mist system manufacturer.



Oil-mist connections

A. Radial and thrust (1/4 in.)
B. Thrust only (1/2 in.)
C. Radial and thrust drain

NOTICE:
In both housings, the inboard channel beneath the 1/4 in. NPT connection must be 1/4 in. plug-epoxied to prevent rapid oil drainage. Drill a 1/8 in. hole for required but restricted drainage.

Lubricate the bearings after a shutdown period

1. Flush out the bearings and bearing frame with a light oil to remove contaminants.
   During flushing, make sure to rotate the shaft slowly by hand.
2. Flush the bearing housing with the proper lubricating oil to ensure oil quality after cleaning.

Shaft sealing with a mechanical seal

Precautions

WARNING:
The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

NOTICE:

- The mechanical seal must have an appropriate seal-flush system. Otherwise, excess heat generation and seal failure can occur.
- Cooling systems such as those for bearing lubrication and mechanical-seal systems 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.

Shipping

Pumps may be shipped with or without a mechanical seal installed.

Cartridge-type mechanical seals

Cartridge-type mechanical seals are commonly used. Cartridge seals are preset by the seal manufacturer 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 ITT, these clips have already been disengaged.

Other mechanical seal types

For other types of mechanical seals, refer to the instructions provided by the seal manufacturer for installation and setting.

Connection of sealing liquid for mechanical seals

Seal lubrication is required

Seal faces must have liquid film between them for proper lubrication. Locate the taps using the illustrations shipped with the seal.

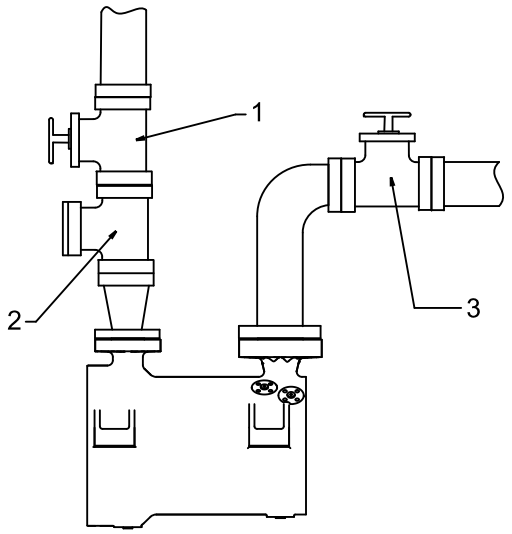
Seal flushing methods

You can use these methods in order to flush or cool the seal:

Method	Description
Product flush	Run the piping so that the pump pushes the pumped fluid from the casing and injects it into the seal gland. If necessary, an external heat exchanger cools the pumped fluid before it enters the seal gland.
External flush	Run the piping so that the pump injects a clean, cool, compatible liquid directly into the seal gland. The pressure of the flushing liquid must be 5 to 15 psi (0.35 to 1.01 kg/cm^2) greater than the seal chamber pressure. The injection rate must be 0.5 to 2 gpm (2 to 8 lpm).
Other	You can use other methods that employ multiple gland or seal chamber connections. Refer to the mechanical seal reference drawing and piping diagrams.

Prime the pump with the suction supply above the pump

1. Slowly open the suction isolation valve.
2. Open the air vents on the suction and discharge piping, the casing, the seal chamber, and the seal piping, if provided, until all air is vented and only the pumped fluid flows out.
3. Close the air vents.



1. Discharge isolation valve
2. Check valve
3. Suction isolation valve

Start the pump

CAUTION:

- Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver, reprime, and attempt to restart the pump.
- Observe the pump for vibration levels, bearing temperature, and excessive noise. If normal levels are exceeded, shut down the pump and resolve the issue.

Before you start the pump, you must perform these tasks:

- Open the suction valve.
- Open any recirculation or cooling lines.

1. Fully close or partially open the discharge valve, depending on system conditions.
2. Start the driver.
3. Slowly open the discharge valve until the pump reaches the desired flow.
4. Immediately check the pressure gauge to ensure that the pump quickly reaches the correct discharge pressure.
5. If the pump fails to reach the correct pressure, perform these steps:
   a) Stop the driver.
   b) Prime the pump again.
   c) Restart the driver.
6. Monitor the pump while it is operating:
   a) Check the pump for bearing temperature, excessive vibration, and noise.
   b) If the pump exceeds normal levels, then shut down the pump immediately and correct the problem.
      A pump can exceed normal levels for several reasons. See Troubleshooting for information about possible solutions to this problem.
7. Repeat steps 5 and 6 until the pump runs properly.

Pump operation precautions

General considerations

CAUTION:

- Vary the capacity with the regulating valve in the discharge line. Never throttle the flow from the suction side since this can result in decreased performance, unexpected heat generation, and equipment damage.
- Do not overload the driver. Driver overload can result in unexpected heat generation and equipment damage. The driver can overload in these circumstances:
  - The specific gravity of the pumped fluid is greater than expected.
  - The pumped fluid exceeds the rated flow rate.
- Make sure to operate the pump at or near the rated conditions. Failure to do so can result in pump damage from cavitation or recirculation.

Operation at reduced capacity

WARNING:
Never operate any pumping system with a blocked suction and discharge. Operation, even for a brief period under these conditions, can cause confined pumped fluid to overheat, which results in a violent explosion. You must take all necessary measures to avoid this condition.

CAUTION:

- Avoid excessive vibration levels. Excessive vibration levels can damage the bearings, stuffing box or seal chamber, and the mechanical seal, which can result in decreased performance.
- Avoid increased radial load. Failure to do so can cause stress on the shaft and bearings.
- Avoid heat build-up. Failure to do so can cause rotating parts to score or seize.
- Avoid cavitation. Failure to do so can cause damage to the internal surfaces of the pump.

Operation under freezing conditions

NOTICE:
Do not expose an idle pump to freezing conditions. Drain all liquid that is inside the pump and the cooling coils. Failure to do so can cause liquid to freeze and damage the pump.

Shut down the pump

WARNING:
The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.

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

Make the final alignment of the pump and driver

WARNING:

- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Follow shaft alignment procedures in order to prevent catastrophic failure of drive components or unintended contact of rotating parts. Follow the coupling installation and operation procedures from the coupling manufacturer.

You must check the final alignment after the pump and driver are at operating temperature. For initial alignment instructions, see the Installation chapter.

1. Run the unit under actual operating conditions for enough time to bring the pump, driver, and associated system to operating temperature.
2. Shut down the pump and the driver.
3. Remove the coupling guard.
4. Check the alignment while the unit is still hot.
   See Pump-to-driver alignment in the Installation chapter.
5. Reinstall the coupling guard.
6. Restart the pump and driver.

Doweling the pump casing

You must dowel the pump casing to the baseplate pedestals in order to maintain the proper pump position. There are two methods for doweling the pump casing, depending on whether the pump is used in a cold application or a hot application. Hot doweling is required above 250°F (121°C). All pumps are equipped for hot doweling.

When the driver is mounted at the factory, the pump is doweled for both cold and hot applications; the driver is not doweled in order to allow for final field alignment. When the driver is mounted in the field, the pump is not doweled. Therefore, these doweling procedures, typically done at the factory, must be done in the field.

NOTICE:
You should dowel only after completing the final alignment.

Dowel for motor installation

1. Center the pump on its pedestal so that the hold-down bolts are centered in the tapped holes of the pump pedestal.
2. Place the motor on the baseplate with the proper shaft separation (DBSE = distance between shaft ends).
3. Tighten the pump hold-down bolts.
4. After you have determined the correct motor location on the motor pedestals, mark the location of the motor on the pedestals with a hole punch through the hold-down bolt holes in the motor feet.
5. Remove the motor, then drill and tap the punched holes on the motor pedestal.

   NOTICE:
   Scribe the motor shims in order to return them to the correct location on the motor pedestal.

6. Set the motor back onto the baseplate with the shims in the correct location. Tighten the hold-down bolts.
7. Loosen the pump and motor hold-down bolts. Confirm that the pump and motor are not bolt-bound in order to make sure that the final drilled holes will be correctly located.

NOTICE:
Do not dowel the pump prior to this procedure because you will not be able to move the pump on its pedestals.

Dowel for cold and hot service

Required tools:

- Two number 7 taper pins
- One number 7 taper pin reamer
- 21/64 in. or "Q" size drill
- Hardwood block or soft-faced hammer

NOTICE:
This procedure must be done only after the pump is properly aligned with the driver on the baseplate.

1. Drill two holes through the pump foot and pump pedestal. Position each hole between the hold-down bolt and the end of the pump foot at the coupling end on both sides.
2. Ream the holes with a number 7 taper pin reamer to the proper fit with the taper dowel pins. Insert the pins deep enough so that only the threaded portions are exposed when the pins are fully seated.
3. Seat the taper pins firmly in the holes with a hardwood block or soft-faced hammer.

If you should ever need to remove the dowel pins, tighten the hex nuts provided on the pins. If the pins are not seated deeply enough, put a spacer under the hex nuts in order to lift the pins free when the hex nuts are tightened.

NOTICE:
Always remove the dowel pins before removing the casing. Failure to do so can result in casing damage.

Additional dowel for hot service

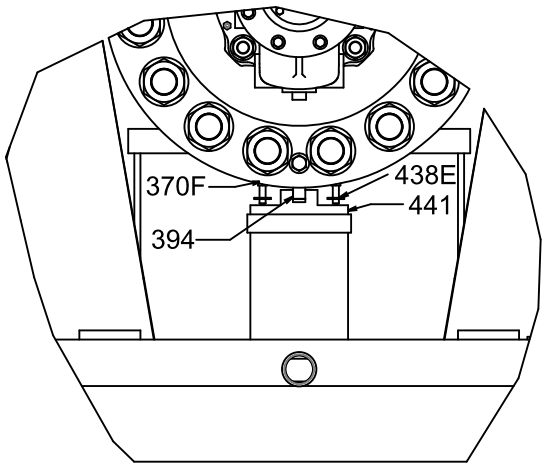
Required tools:

- Supplied hardware stated below
- Impact wrench

NOTICE:
This procedure must be done only after the pump is properly aligned with the driver on the baseplate.

1. Install pin (394) into casing.
2. Place block (441) on pedestal located on baseplate and align with pin (394) in casing.

3. Secure block with lockwasher (438E) and capscrew (370F) to baseplate.



Maintenance

Maintenance schedule

Maintenance inspections

A maintenance schedule includes these types of inspections:

- Routine maintenance
- Routine inspections
- Three-month inspections
- Annual inspections

Shorten the inspection intervals appropriately if the pumped fluid is abrasive or corrosive or if the environment is classified as potentially explosive.

Routine maintenance

Perform these tasks whenever you perform routine maintenance:

- Lubricate the bearings.
- Inspect the seal.

Routine inspections

Perform these tasks whenever you check the pump during routine inspections:

- Check the level and condition of the oil through the sight glass on the bearing frame.
- Check for unusual noise, vibration, and bearing temperatures.
- Check the pump and piping for leaks.
- Analyze the vibration.
- Inspect the discharge pressure.
- Inspect the temperature.
- Check that there is no leakage from the mechanical seal.

Three-month inspections

Perform these tasks every three months:

- Check that the foundation and the hold-down bolts are tight.
- Check the mechanical seal if the pump has been left idle, and replace as required.
- Change the oil every three months (2000 operating hours) at minimum.
  - Change the oil more often if there are adverse atmospheric or other conditions that might contaminate or break down the oil.
- Check the shaft alignment, and realign as required.

Annual inspections

Perform these inspections one time each year:

- Check the pump capacity.
- Check the pump pressure.
- Check the pump power.

If the pump performance does not satisfy your process requirements, and the process requirements have not changed, then perform these steps:

1. Disassemble the pump.
2. Inspect it.
3. Replace worn parts.

Bearing maintenance

Bearing lubrication schedule

Type of lubrication	First lubrication	Lubrication intervals
Ring oil Purge oil	Add oil before you install and start the pump. Change the oil after 200 hours for new bearings.	After the first 200 hours, change the oil every 2000 operating hours or every three months.
Pure oil Forced oil	Follow the recommendations from the manufacturer.	Follow the recommendations from the manufacturer.

Mechanical-seal maintenance

WARNING:
The mechanical seal used in an Ex-classified environment must be properly certified. Prior to startup, make sure that all areas that could leak pumped fluid to the work environment are closed.

CAUTION:
Never operate the pump without liquid supplied to mechanical seal. If you run a mechanical seal dry, even for a few seconds, this can cause seal damage. Physical injury can occur if a mechanical seal fails.

NOTICE:

- 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.
- Cooling systems, such as those for bearing lubrication and mechanical-seal systems, must be operating properly to prevent excess heat generation, sparks, and premature failure.
- The mechanical seal must have an appropriate seal flush system or excess heat generation and seal failure can occur.

Reference drawing

The manufacturer supplies a reference drawing with the data package. Keep this drawing for future use when you perform maintenance and seal adjustments. The seal drawing specifies the required flush fluid and attachment points.

Before you start the pump

Check the seal and all flush piping.

Mechanical seal life

The life of a mechanical seal depends on the cleanliness of the pumped fluid. Due to the diversity of operating conditions, it is not possible to give definite indications as to the life of a mechanical seal.

Disassembly

Disassembly precautions

WARNING:

- This manual clearly identifies accepted methods for disassembling units. These methods must be adhered to. Trapped liquid can rapidly expand and result in a violent explosion and injury. Never apply heat to impellers, propellers, or their retaining devices to aid in their removal unless explicitly stated in this manual.
- Always disconnect and lock out power to the driver before you perform any installation or maintenance tasks. Failure to disconnect and lock out driver power will result in serious physical injury.
- Crush hazard. The unit and the components can be heavy. Use proper lifting methods and wear steel-toed shoes at all times.
- The pump can handle hazardous and toxic fluids. Identify the contents of the pump and observe proper decontamination procedures in order to eliminate the possible exposure to any hazardous or toxic fluids. Wear the proper personal protective equipment. Potential hazards include, but are not limited to, high temperature, flammable, acidic, caustic, explosive, and other risks. You must handle and dispose of pumped fluid in compliance with the applicable environmental regulations.

NOTICE:

Make sure that all replacement parts are available before you disassemble the pump for overhaul.

Tools required

In order to disassemble the pump, you need these tools:

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

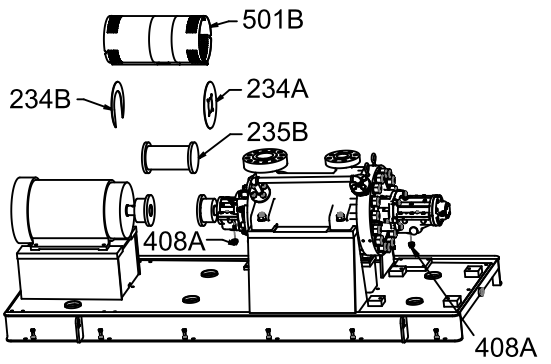
Prepare for disassembly

CAUTION:

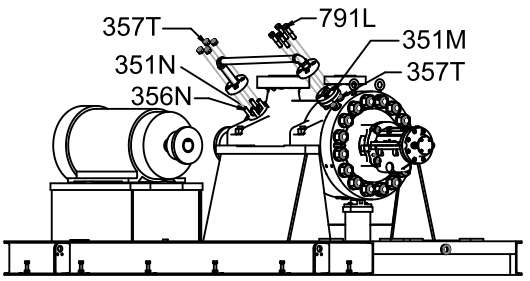
Allow all system and pump components to cool before you handle them to prevent physical injury.

1. Close the isolation valves on the suction and discharge sides of the pump.
2. Drain the liquid from the piping; flush the pump if necessary.
3. Disconnect all auxiliary piping, tubing, and equipment that will interfere with the removal of the head and the rotor.

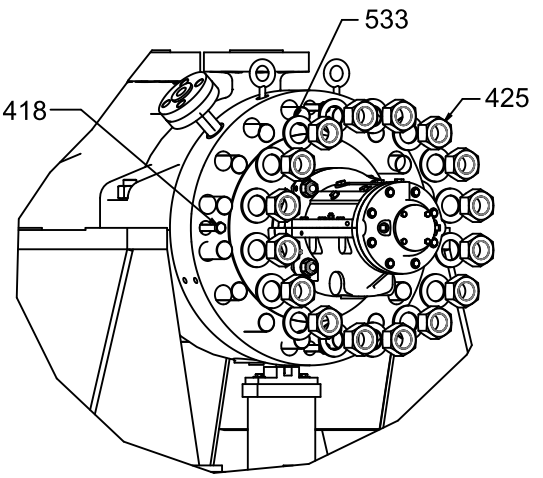
4. Remove the oil drain plugs (408A) from the bottom of the bearing housings (134) and drain the oil.
   Dispose of the oil in accordance with applicable regulations.



5. Remove the oiler bottle (251) and store it in a safe place.
6. Remove the coupling guard (501B) and motor coupling guard endplate (234B).
   Refer to Remove the coupling guard in the Commissioning, Startup, Operation, and Shutdown chapter.
7. Unbolt and remove the coupling spacer (235B).
   Follow the instructions provided by the coupling manufacturer for assistance.
8. Remove the coupling guard pump endplate(234A).
9. Unbolt and remove balance line bolts (791L) and nuts (357T). Remove balance line and gasket (351M).

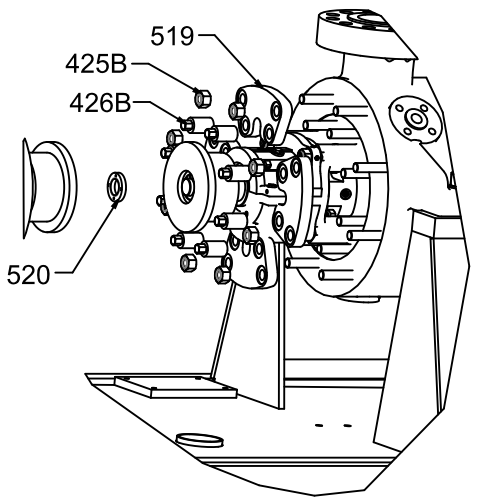


10. Loosen and remove head nuts and washers (425 and 533).

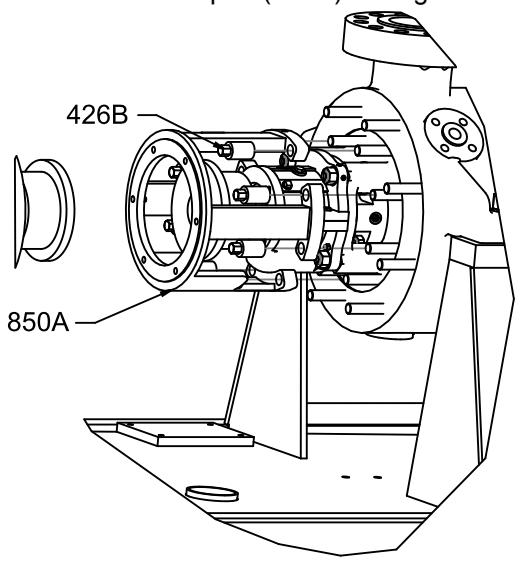


Bundle Removal Using Disassembly Cradle

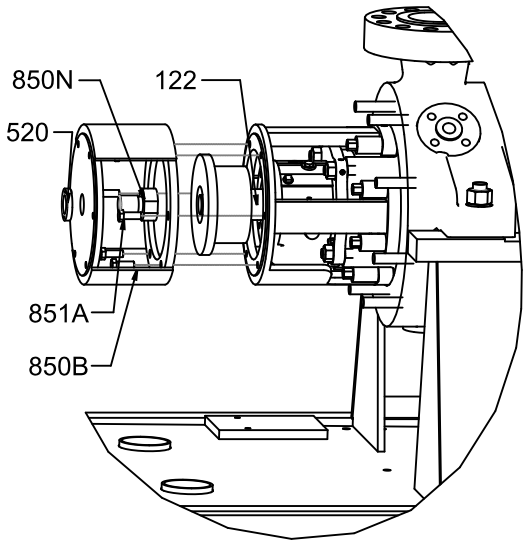
1. Loosen and remove suction cover nuts (425B and 426B).
2. Remove the suction cover locking plates (519).
3. Remove the coupling nut (520).



4. Install extension adapter (850A) and tighten suction cover nuts (426B).

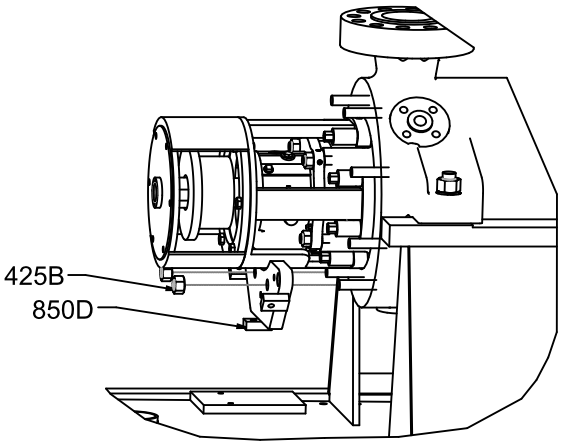


5. Tighten stub shaft extension tie (850N) to pump shaft (122).

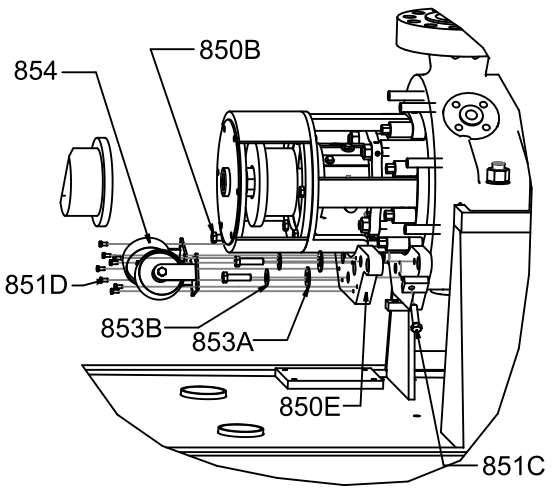


6. Install extension tie (850B) and tighten bolts (851A).
7. Tighten coupling nut (520).

8. Install caster adapter plate (850D) and tighten suction cover nuts (425B).

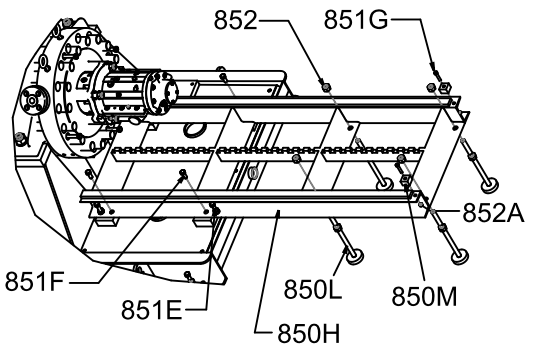


9. Install caster mounting plate (850E) and tighten bolts (850B) with washers (853A and 853B).



10. Install jack screw (851C).
11. Install casters (854) and tighten bolts (851D).

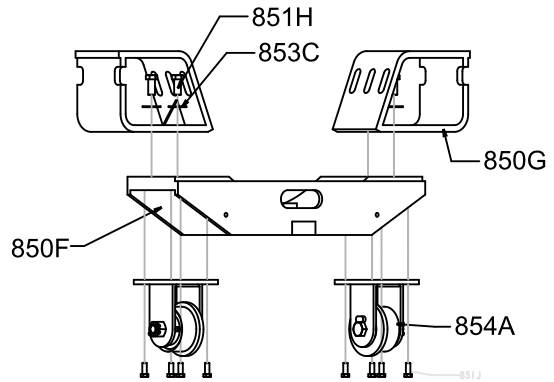
12. Install rail supports (850L) to assembly rail (850H). Using jack screws (851E) and nuts (852), adjust as necessary to level with ground and baseplate. Tighten nuts (852) and bolts (851F).



13. Install rail stop (850M) and tighten bolt (851G) and nut (852A).

Assemble cart for head.

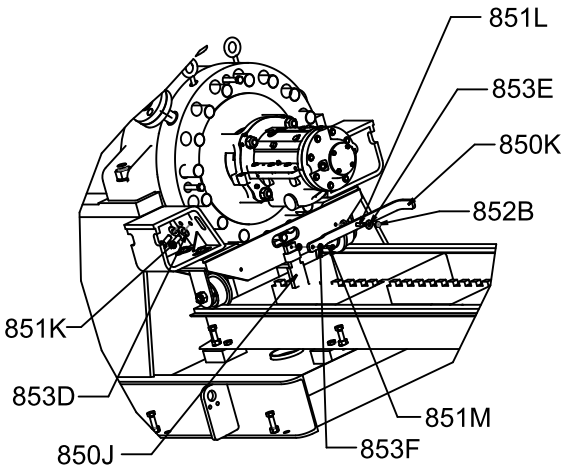
14. Install cart bracket (850G) to cart (850F) and tighten bolts (851H) with washers (853C).



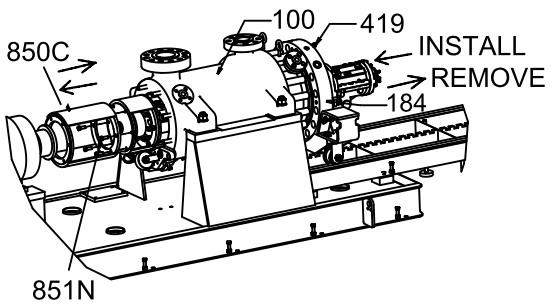
15. Install casters (854A) to cart and tighten bolts (851J).

Assemble cart to head.

16. Install cart to head (184) and tighten bolts (851K) with washers (853D).

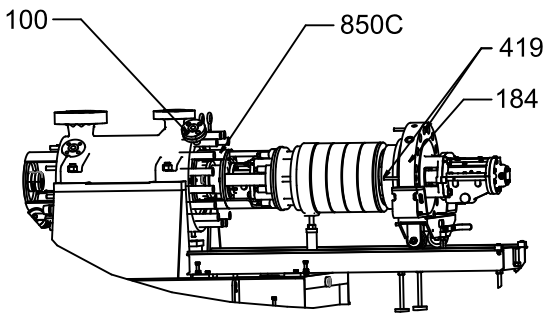


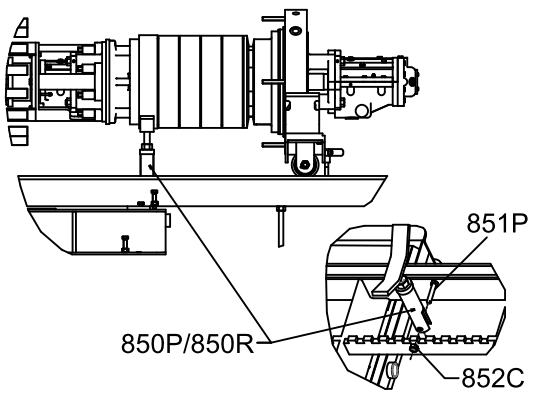
17. Install stop plate (850J) and stop lever (850K) and tighten bolts (851L and 851M) and nut (852B) with washers (853E and 853F).
18. Use the jackscrews (419) in order to loosen the head (184) from the casing (100). Push bundle out of casing (100) until there is enough room to install the extension (850C). Install extension (850C) and tighten bolts (851N).



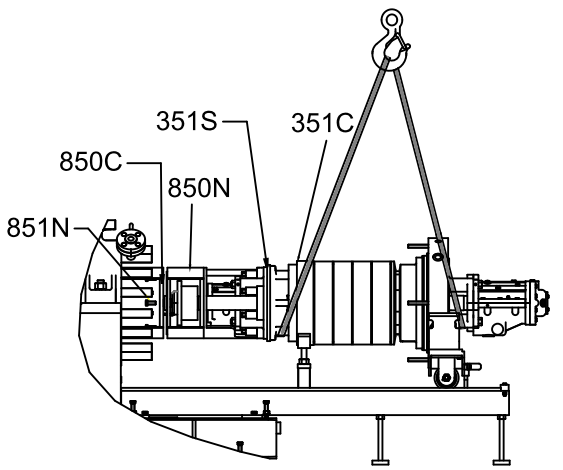
19. Repeat line 18 until bundle is fully through the casing (100).

20. Install jack stands (850P and 850R) and tighten bolt (851P) and nut (852C). Adjust until jack stand fits snuggly under bundle.

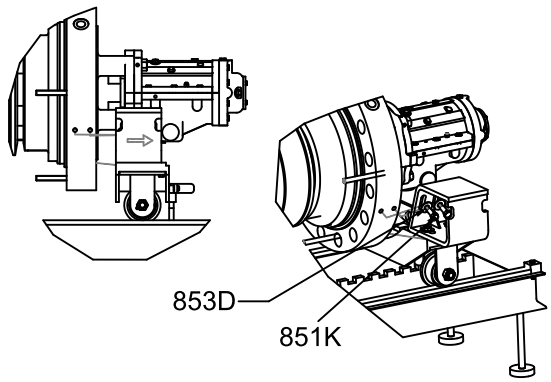




21. Place suitable slings as shown and place some tension on the bundle.



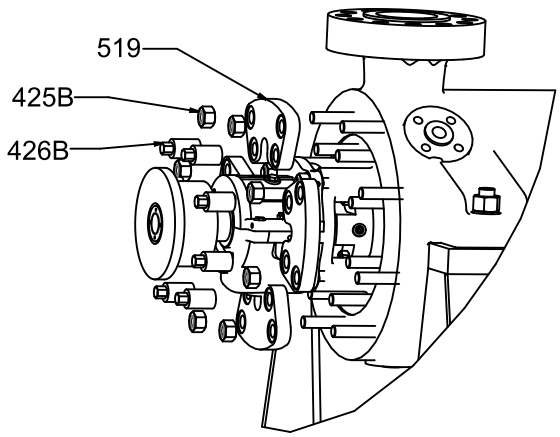
22. Loosen and remove bolts (851N) and remove extension (850C) from extension tie (850N).
23. Remove suction cover gaskets (351C and 351S).
24. Loosen and remove bolts (851K) and washers (853D) and remove cart from head (184).



25. Hoist bundle using suitable slings as shown.

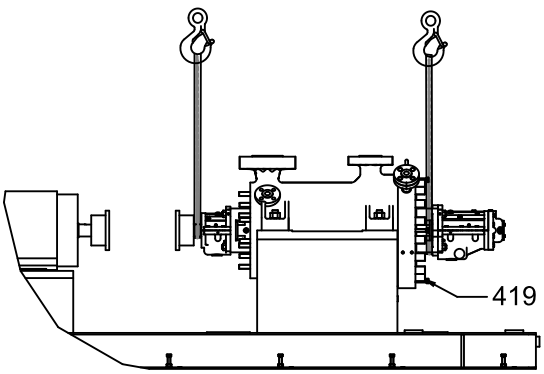
Bundle Removal Using Slings Only

1. For non-cartridge designs, proceed to step 3. Loosen and remove suction cover nuts (425B and 426B).

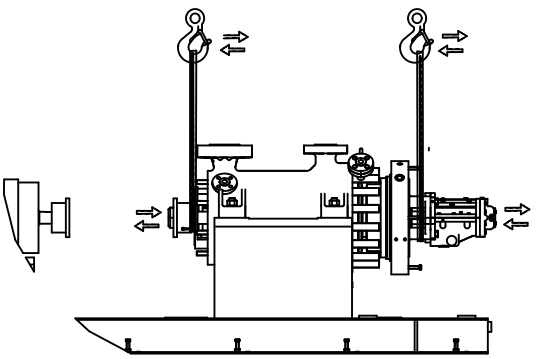


2. Remove the suction cover locking plates (519).
3. For non-cartridge designs only, disassemble the pump coupling hub per "Prepare for Bundle Disassembly" section and disassemble the radial end per the appropriate bearing section.

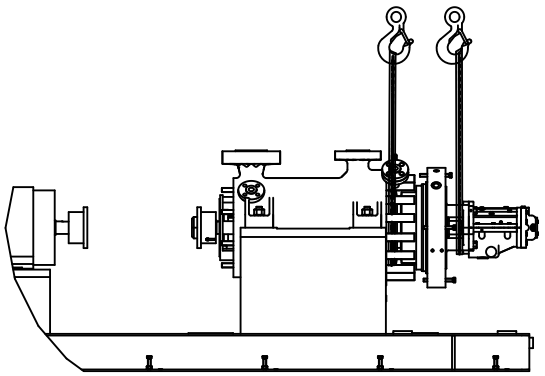
4. Use the jackscrews (419) in order to loosen head (184) from the casing (100).

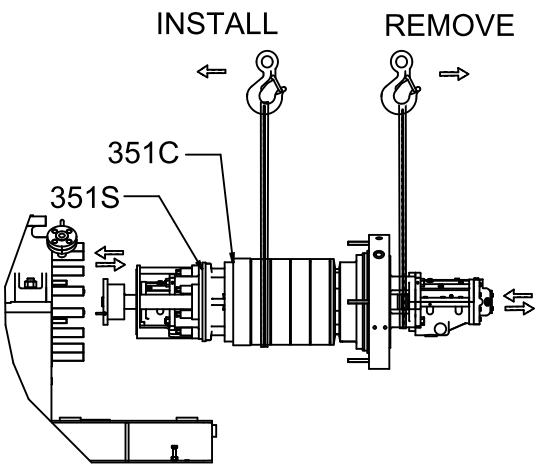


5. Using suitable slings pull bundle out until radial end of shaft / housing is inside casing (100).



6. Reposition the slings around bundle and remove from the casing (100).

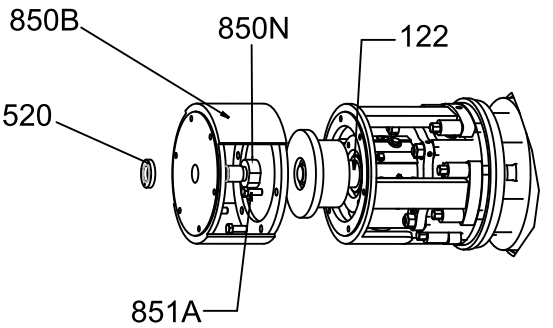




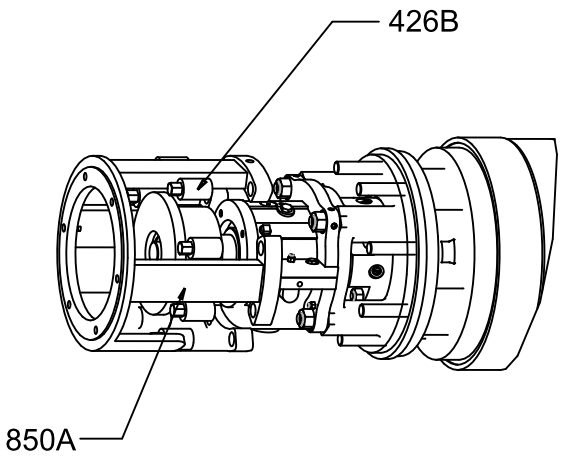
7. Remove suction cover gaskets (351C and 351S).

Prepare for Bundle Disassembly

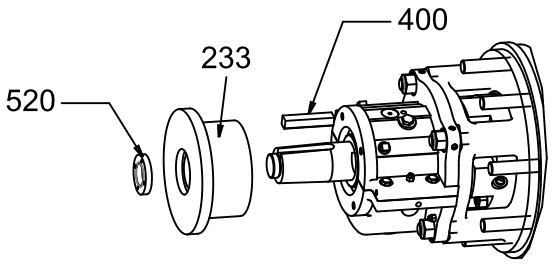
1. If disassembly cradle was not used, proceed to step 4. Remove the coupling nut (520).



2. For disassembly cradle only, loosen and remove bolts (851A) and remove extension tie (850B).
3. For disassembly cradle only, remove stub shaft extension tie (850N).
4. For disassembly cradle only, loosen and remove suction cover nuts (426B) and remove extension adapter (850A).

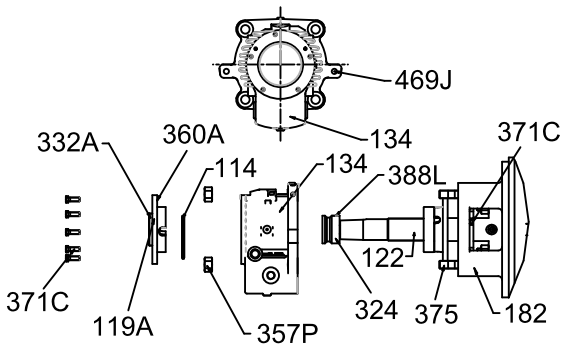


5. For bundle remove with slings only, remove the coupling nut (520).



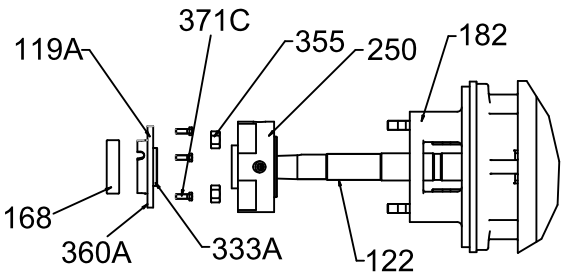
6. Remove the coupling hub (233) and coupling key (400) from the pump.
7. Reposition the setting tabs in order to maintain the position of the mechanical seal. Loosen all set screws on sleeve collar. Refer to the seal installation drawing provided by the manufacture. Position both seals at this time.

Disassemble the radial end (ball bearing pumps)



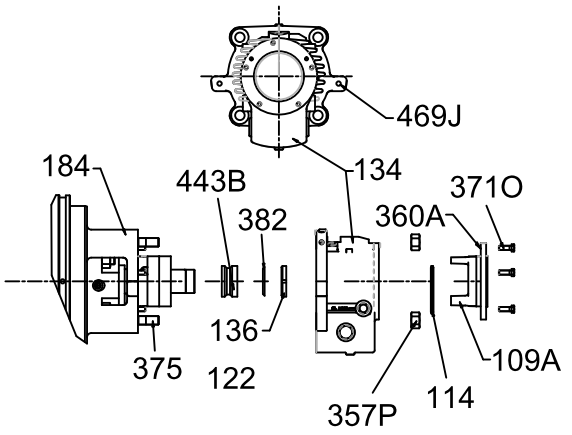
1. Unbolt and remove the cover bolts (371C) and the outboard end cover (119A). Unbolt and remove the inboard cover bolts (371C).
   The outboard labyrinth seal (332A) and the bearing housing gasket (360A) will come off with the outboard cover (119A).
2. Remove the oil ring (114).
3. Remove the dowel pins (469J) between the bearing housing flange and the suction cover flange. Tighten the nut on the dowel pin to back it out of the hole.
   The connection point of the bearing housing (134) to the suction cover (182) is referred to as the saddle.
4. Unbolt the bearing housing (134) from the saddle by removing the nuts (357P).
5. Pull the bearing housing (134) off the bearings.
6. Loosen the setscrew (388L) on the oil ring sleeve (324) and remove the sleeve.

7. Use a bearing puller in order to remove the radial bearing (168) from the shaft.



8. Remove the inboard bearing cover (119A). The inboard labyrinth seal (333A) and the bearing housing gasket (360A) will come off with inboard cover (119A).
9. Remove the gland nuts (355) and the mechanical seal (250).
   Refer to the instructions provided by the mechanical seal manufacturer.

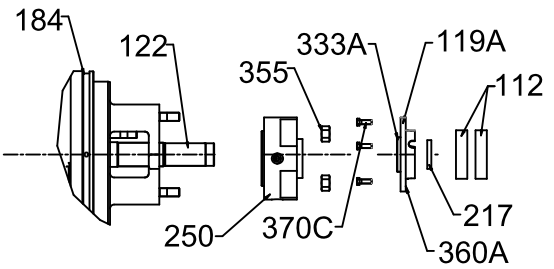
Disassemble the thrust end (ball bearing pumps)



1. Unbolt and remove the cover bolts (371C) and the outboard thrust bearing end cover (109A). Unbolt and remove the inboard cover bolts (371C).
   The bearing housing gaskets (360A) will remain on the end covers (109A).
2. Remove the oil ring (114).
3. Remove the dowel pins (469J) between the bearing housing flange and the head flange.
   Tighten the nut on the dowel pin to back it out of the hole.
   The connection point of the bearing housing (134) to the head (184) is referred to as the saddle.
4. Unbolt the bearing housing (134) from the saddle by removing the nuts (357P).
5. Pull the bearing housing (134) off the bearings.
6. Remove the locknut (136) and the lockwasher (382).
7. Remove the oil ring sleeve (443B), which is held in place by the thrust locknut (136).
8. Use a bearing puller in order to remove the thrust bearing (112) from the shaft (122).

The inner race on this inner duplex bearing remains on the shaft when the bearing is pulled. Remove this inner race by applying heat. Do this away from the pump site.

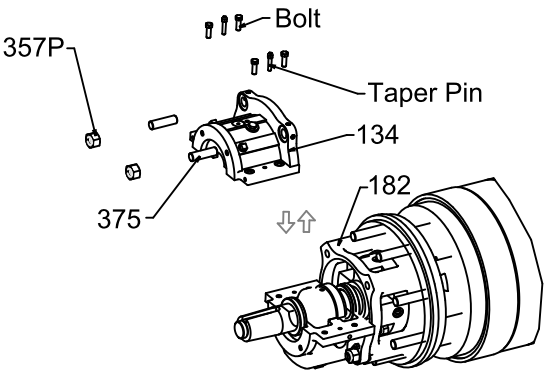
WARNING:
The pump may handle hazardous and/or toxic liquids. Trapped or undrained liquid can cause explosions when heat is applied. Never apply heat at the pump site for this reason. Heat can also distort machined surfaces.



9. Remove bearing spacer (217)
10. Remove the inboard bearing cover (119). The inboard labyrinth seal (333A), and the bearing housing gasket (360A) will come off with the inboard cover (119A).
11. Remove the gland nuts (355) and the mechanical seal (250).
    Refer to the instructions provided by the mechanical seal manufacturer.

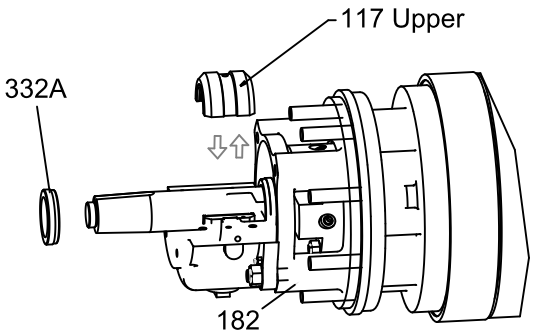
Disassemble the Radial End (Sleeve/Hydrodynamic Bearing Pumps)

1. Unbolt upper half of the bearing housing (134) from the saddle by removing the nuts (357P) and studs (375). The connection point of the bearing housing (134) to the suction cover (182) is referred to as the saddle.

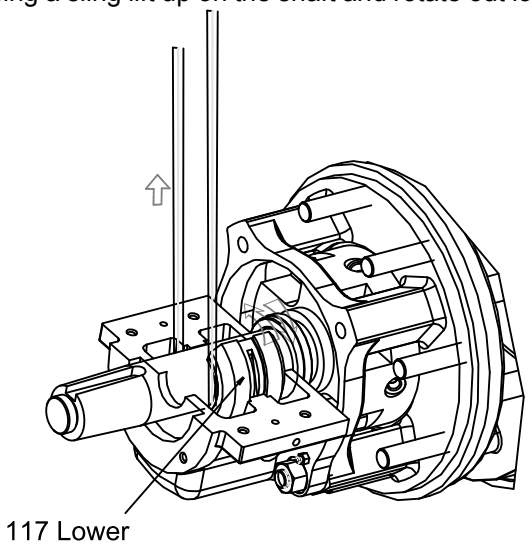


2. Remove the two dowel pins between the upper and lower halves of the bearing housing (134). Tighten the nut on the dowel pin to back it out of the hole.
3. Unbolt upper half of the bearing housing (134) and remove.

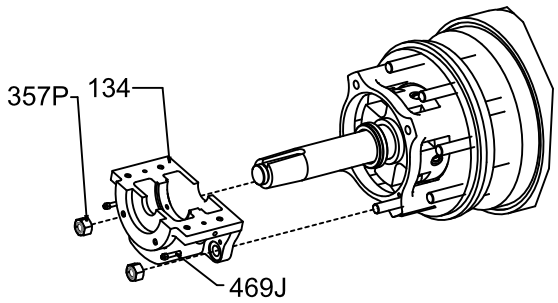
4. Remove upper half of sleeve bearing (117). Notice that the sleeve bearing is pinned to the upper half of the bearing housing.



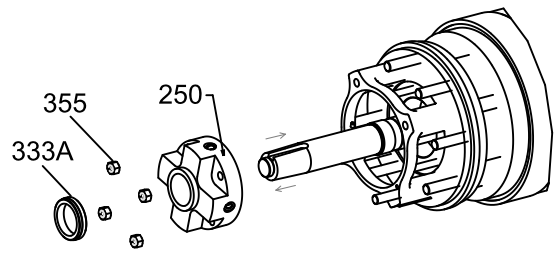
5. Remove the outboard labyrinth seal (332A).
6. Using a sling lift up on the shaft and rotate out lower half of sleeve bearing (117).



7. Remove the dowel pins (469J) between the bearing housing flange and saddle flange. Tighten the nut on the dowel pin to back it out of the hole.



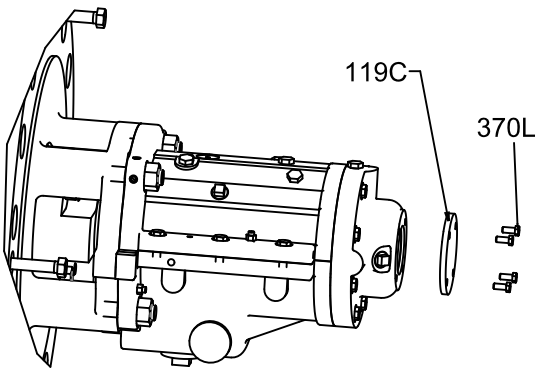
8. Unbolt lower half of the bearing housing (134) from the saddle by removing the nuts (357P).
9. Remove lower half of the bearing housing (134).
10. Remove the inboard labyrinth seal (333A).

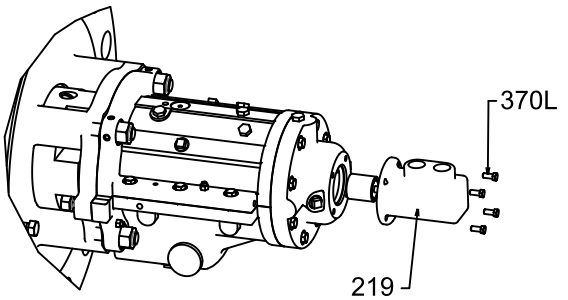


11. Remove gland nuts (355) and the mechanical seal (250).
    Refer to the instructions provided by the mechanical seal manufacturer.

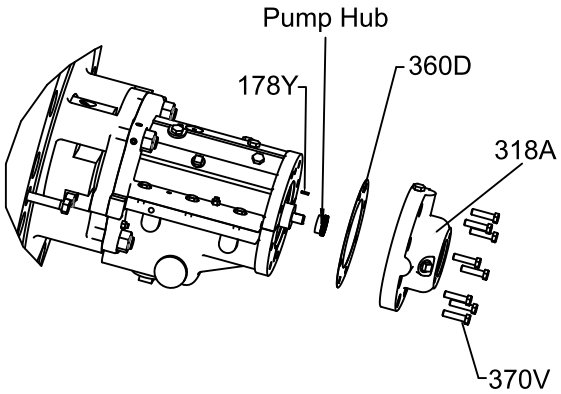
Disassemble the Thrust End (Sleeve/Hydrodynamic Bearing Pumps)

1. Unbolt and remove oil pump / endplate bolts (370L) and remove oil pump (219), if supplied, or endplate (119C) if no oil pump is installed. Coupling sleeve might come off with oil pump.

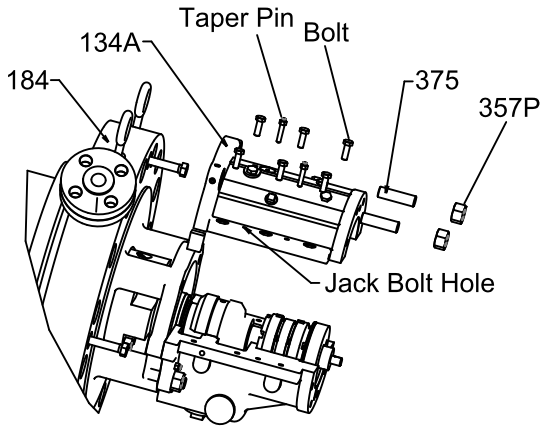




2. Unbolt and remove adapter bolts (370V) and remove oil pump adapter (318A). The oil pump adapter gasket (360D) will come off with the oil pump adapter (318A).

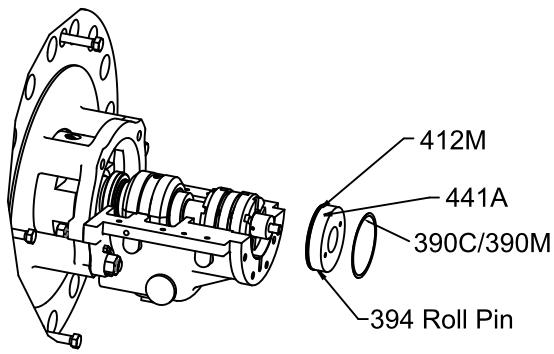


3. For pumps with oil pump only, remove coupling sleeve if it didn't come off in step #1. Loosen set screw on coupling hub and remove coupling hub and coupling key (178Y).
4. Unbolt upper half of the bearing housing (134A) from the saddle by removing the nuts (357P) and studs (375). The connection point of the bearing housing (134A) to the head (184) is referred to as the saddle.

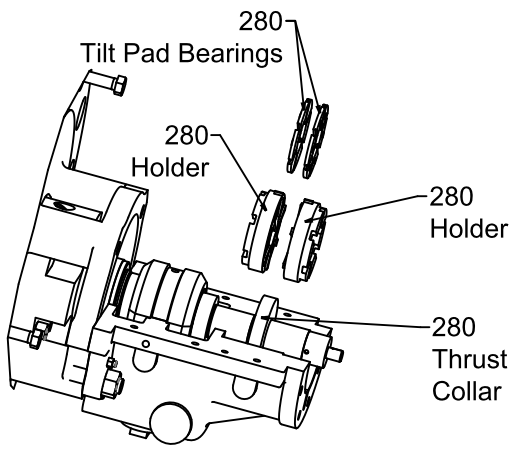


5. Remove the two dowel pins between the upper and lower halves of the bearing housing (134A). Tighten the nut on the dowel pin to back it out of the hole.
6. Unbolt upper half of the bearing housing (134A) and remove. Use jackscrews on the horizontal parting flange as necessary in order to separate the two halves.

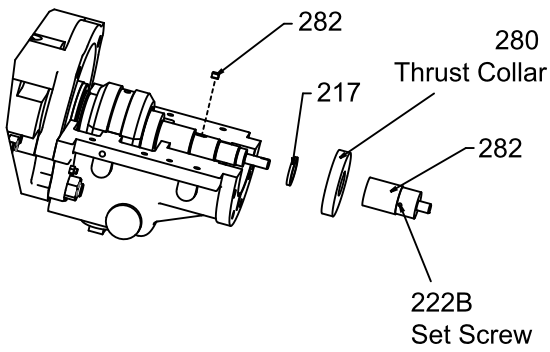
7. Remove shims (390C & 390M).



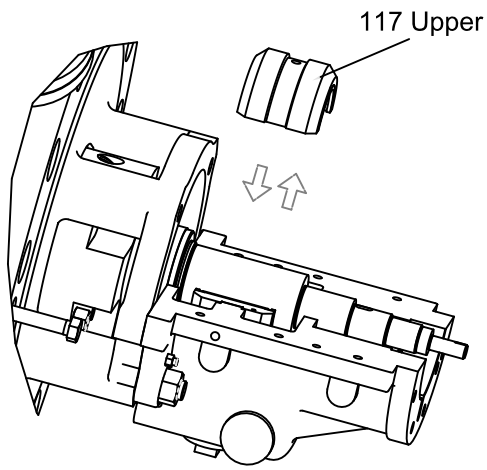
8. Remove filler plate (441A). The o-ring (412M) and roll pin (394) will come off with filler plate (441A).
9. Remove tilt pad bearings and holders (280). The holders are split and will have to be rotated to remove all of the tilt pad bearings.



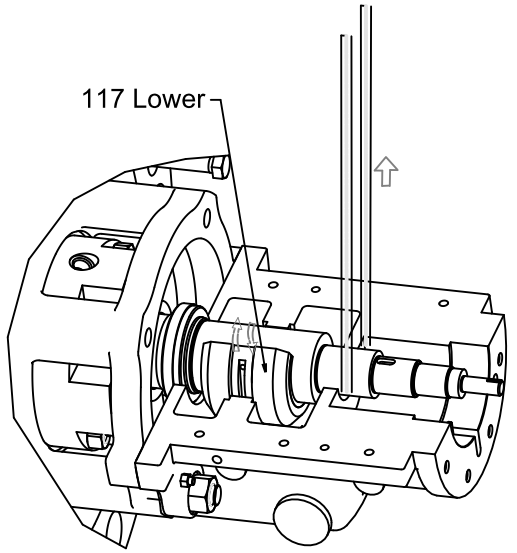
10. Loosen the setscrew (222B) on the thrust collar nut (283) and unthread thrust collar nut. Threads on thrust collar nut are left handed.



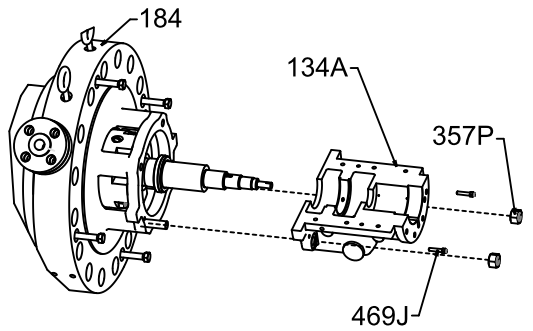
11. Remove thrust collar (280) and thrust collar key (282).
12. Remove bearing spacer (217).
13. Remove upper half of sleeve bearing (117). Notice that the sleeve bearing is pinned to the upper half of the bearing housing.



14. Using a sling lift up on the shaft and rotate out lower half of sleeve bearing (117).

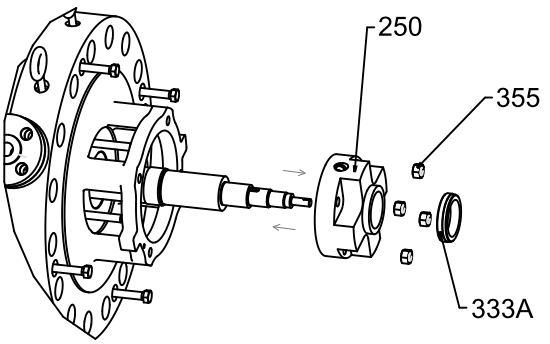


15. Remove the dowel pins (469J) between the bearing housing flange and saddle flange. Tighten the nut on the dowel pin to back it out of the hole.



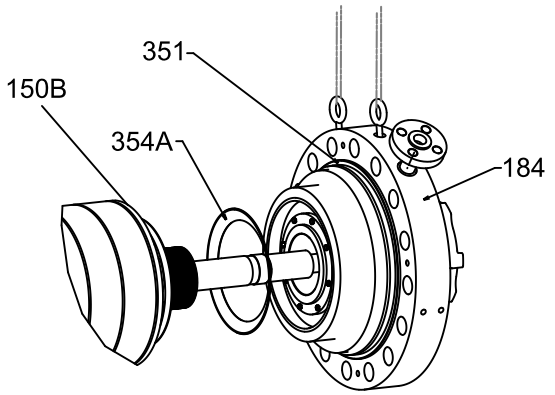
16. Unbolt lower half of the bearing housing (134A) from the saddle by removing the nuts (357P).
17. Remove lower half of the bearing housing (134A).

18. Remove the inboard labyrinth seal (333A).



19. Remove gland nuts (355) and the mechanical seal (250).
    Refer to the instructions provided by the mechanical seal manufacturer.

Disassemble the Bundle

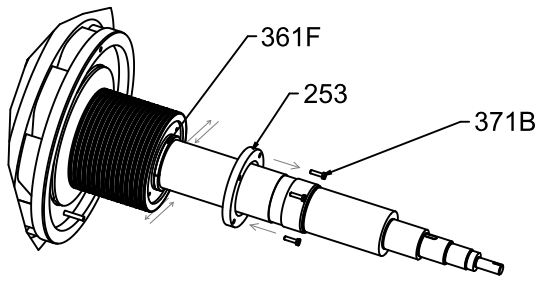


1. Install eyebolts (not supplied) in the pre-drilled threaded holes in the top outside perimeter of the head (184).

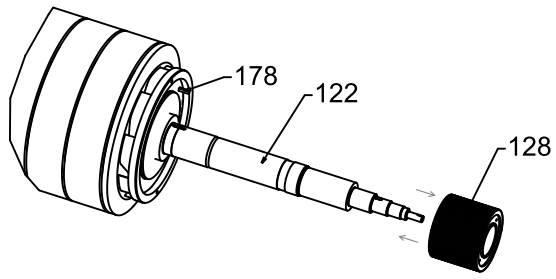
WARNING:
Use the eyebolts to lift only the head. They will not support the weight of the entire bundle.

2. Remove head (184) from the discharge cover (150B). The head gasket (351) and belleville washer (354A) will come off with the head (184). If not remove both these items.

3. Unbolt and remove locating ring retainer bolts (371B) and remove locating ring retainer (253).



4. Remove sleeve locating ring (361F).
5. Remove balance drum sleeve (128) from shaft (122).

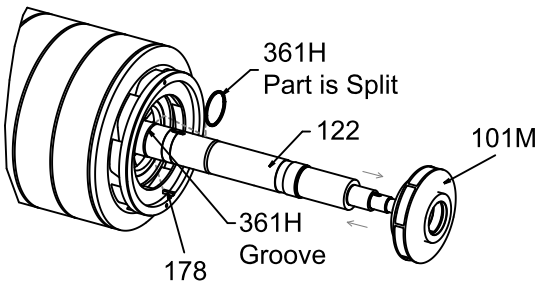


6. Remove sleeve key (178).

CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.

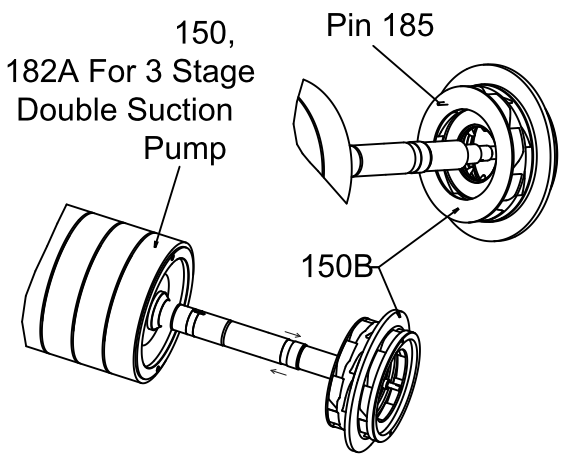
7. Heat the last stage impeller (101M) hub to 300°F-400°F (150°C-200°C). Using the puller holes on the impeller hub remove from shaft (122).

8. Remove impeller locating ring (361H) and impeller key (178).



CAUTION:
Burn hazard. The discharge cover will get hot. Wear insulated gloves when handling the discharge cover.

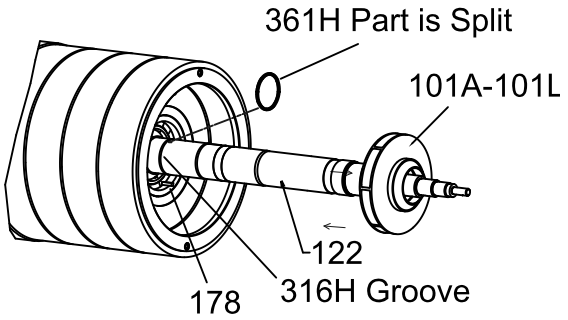
9. Heat the intermediate cover (150) outer diameter to 300°F-400°F (150°C-200°C). For a 3 stage, double suction first stage pump this will be the inboard suction cover (182A). Install eyebolts (not supplied) into the lifting holes and use pry slots to remove discharge cover (150B).



NOTICE:
Allow the shaft and intermediate cover to cool to ambient temperature before proceeding with disassembly.

CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.

10. Heat the next impeller (101A-101L) hub to 300°F-400°F (150°C-200°C). Using a hook in the impeller vanes (vertical disassembly only) remove from shaft (122).

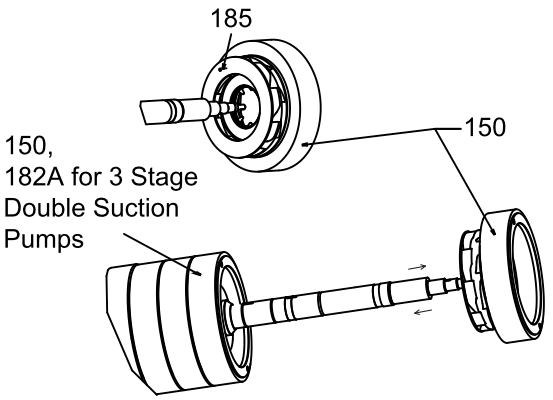


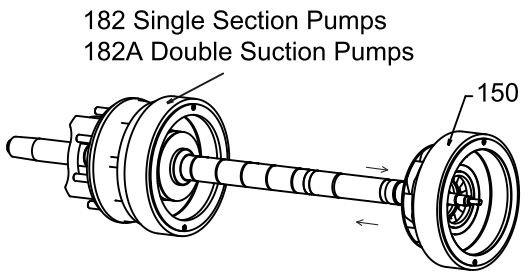
11. Remove impeller locating ring (361H) and impeller key (178).

CAUTION:
Burn hazard. The intermediate cover will get hot. Wear insulated gloves when handling the intermediate cover.

12. Heat the next intermediate cover (150) outer diameter to 300°F-400°F (150°C-200°C). Note the last intermediate cover that is removed, the suction cover (182) for single suction pumps or the inboard suction cover (182A) for double suction pumps will be the part that is

heated. Install eyebolts (not supplied) into the lifting holes and use the pry slots to remove intermediate cover (150).

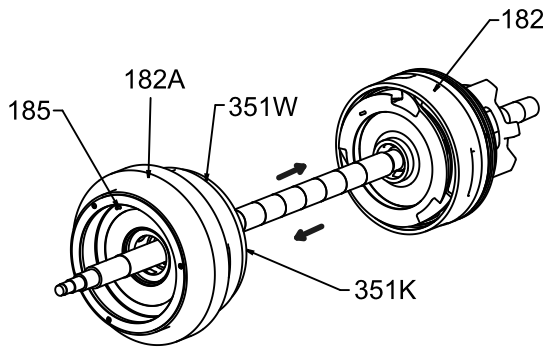




NOTICE:
Allow the shaft and intermediate cover to cool to ambient temperature before proceeding with disassembly.

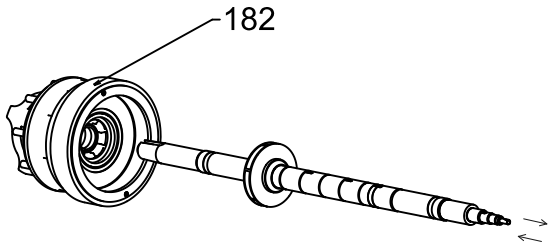
13. Repeat steps 10 through 12 until all impellers, except 1st stage, and intermediate covers are removed.

14. For double suction pumps only, remove inboard suction cover (182A) from suction cover (182). The inboard suction cover gaskets (351K & 351W) will come off with the inboard suction cover (182A).

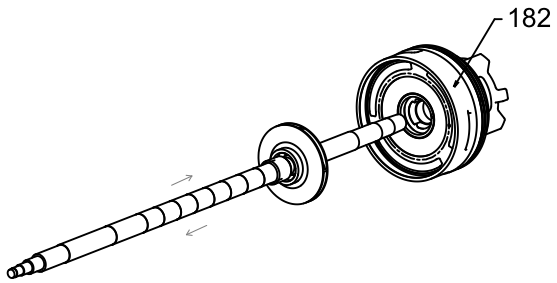


15. Remove remaining shaft assembly from suction cover (182).

Single Suction

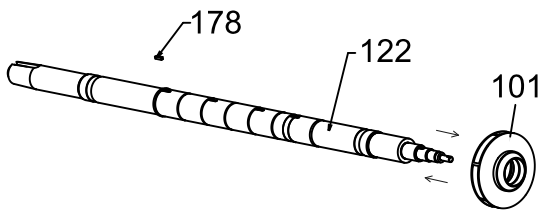


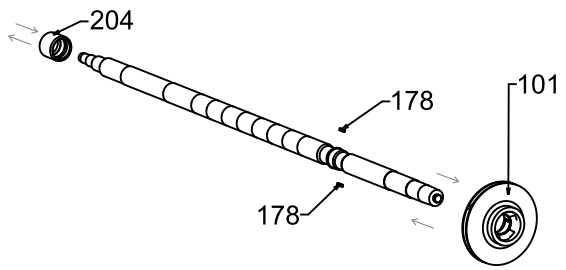
Double Suction



CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.

16. Heat the 1st stage impeller (101) hub to 300°F-400°F (150°C-200°C) and remove from shaft (122). For double suction pumps, the first stage impeller (101) is removed from the opposite end.





17. Remove impeller key (178).

CAUTION:
Burn hazard. The interstage sleeve will get hot. Wear insulated gloves when handling the sleeve.

18. For double suction pumps only, heat the interstage sleeve (204) to 300°F-400°F (150°C-200°C) and remove from shaft (122).
19. For double suction pumps only, remove interstage sleeve key (178).

Preassembly inspections

Replacement guidelines

Casing check and replacement

Inspect the casing, suction covers and head for cracks and excessive wear or pitting. Thoroughly clean gasket surfaces and alignment fits to remove rust and debris.

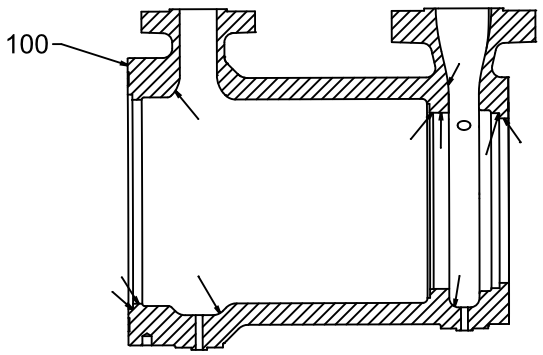
Repair or replace these parts if you notice any of these conditions:

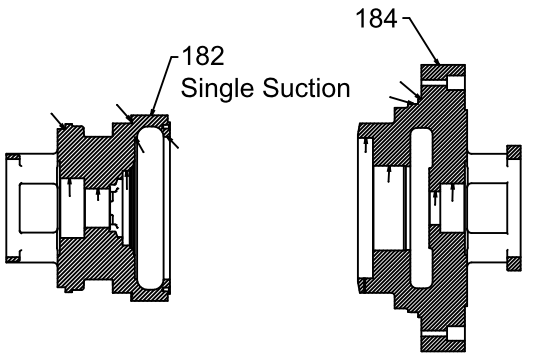
- Localized wear or grooving that is greater than 1/8 in. (3.2 mm) deep
- Pitting that is greater than 1/8 in. (3.2 mm) deep
- Irregularities in the casing-gasket seat surface
- Wear ring clearances that exceed the values in the Minimum running clearances table

NOTICE:
When clearances between the rings become excessive (increase by 50%), hydraulic performance decreases substantially.

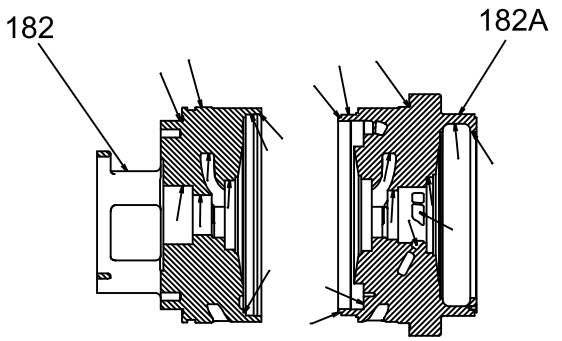
Casing, suction covers and head areas to inspect

The arrows point to the areas to inspect for wear:





Double Suction



Impeller, intermediate and discharge cover replacement

This table shows the criteria for replacment:

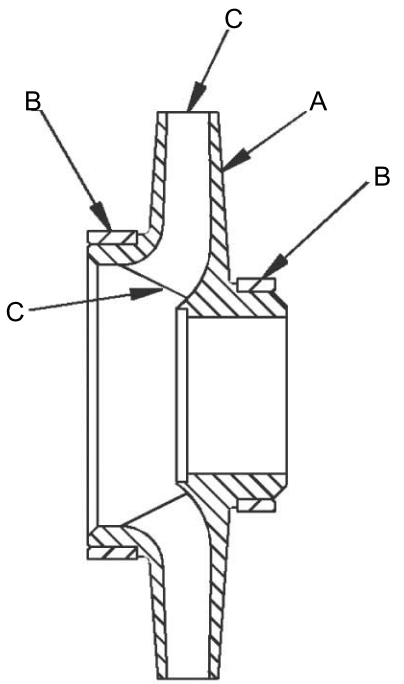
Impeller, intermediate and discharge cover parts	When to replace
Impeller / Diffuser vanes	• When grooved deeper than 1/16 in. (1.6 mm), or • When worn evenly more than 1/32 in. (0.8 mm)
Vane edges	When you see cracks, pitting, or corrosion damage
Keyway and bores	When you see damage
Wear ring surfaces	When the clearance to the casing wear ring has increased by 50% over the values in the Minimum running clearances table

Impeller checks

- Check and clean the impeller bore diameter.
- Check the impeller balance. Rebalance the impeller if it exceeds the ISO G1.0 (4W/N) criteria.

NOTICE:
You must have extremely accurate tooling equipment to balance impellers to the ISO G1.0 criteria. Do not attempt to balance impellers to this criteria unless this type of tooling and equipment is available.

Impeller areas to inspect



A. Shroud
B. Wear ring
C. Vane

Labyrinth seal replacement

Replace the labyrinth-seal O-ring if it has cuts and cracks.

Oil ring replacement

Oil rings must be as round as possible in order to function properly. Replace oil rings if they are worn, distorted, or damaged beyond reasonable repair.

Cartridge mechanical seal replacement

Cartridge-type mechanical seals should be serviced by the seal manufacturer. Refer to the instructions from the mechanical seal manufacturer for assistance.

Coupling guard replacement

Repair or replace the coupling guard if you notice corrosion or other defects.

Gaskets, O-rings, and seats replacement

- Replace all gaskets and O-rings at each overhaul and disassembly.
- Inspect the seats. They must be smooth and free of physical defects.
  In order to repair worn seats, skin cut them in a lathe while you maintain dimensional relationships with other surfaces.
- Replace parts if the seats are defective.

Additional parts

Inspect and either repair or replace all other parts, if inspection indicates continued use would be harmful to satisfactory and safe pump operation.

Inspection must include these items:

- Bearing end covers (109A and 119A)
- Labyrinth seals (332A and 333A)
- Bearing locknut (136)
- Impeller key (178) and coupling key (400)
- Bearing lockwasher (382)
- All nuts, bolts, and screws

Shaft replacement guidelines

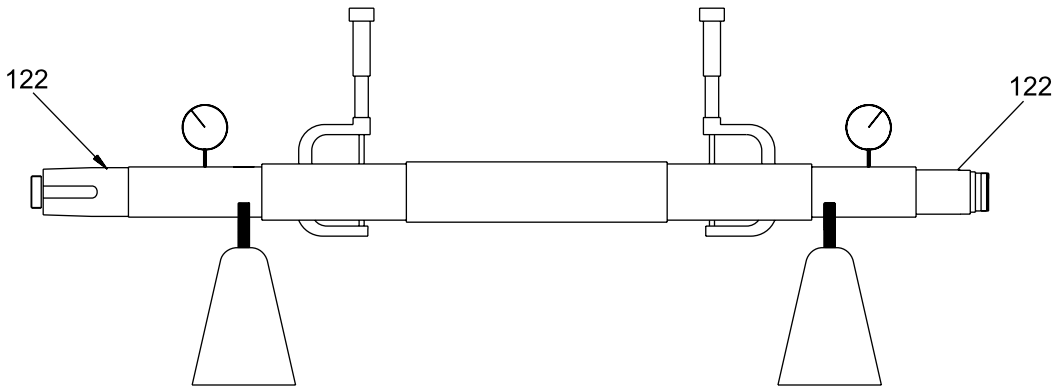
Shaft measurement check

Check the bearing fits of the shaft. If any are outside the tolerances shown in the Bearing fits and tolerances table, then replace the shaft.

Shaft straightness check

Check the shaft straightness. Use "V" blocks or balance rollers to support the shaft on the bearing fit areas. Replace the shaft if runout exceeds the values in the Shaft and rotor runout requirements table.

NOTICE: Do not use shaft centers for the runout check as they may have been damaged during the removal of the bearings or impeller.



Shaft surface check

Check the shaft surface for damage. Replace the shaft if it is damaged beyond reasonable repair.

Rotor

Allowable runouts of the fully assembled rotor are listed in the Shaft and rotor runout requirements table.

Table 3: Shaft and rotor runout requirements

Characteristic	Requirement
Flexibility factor, L^4/D^2	>$1.9x10^9$ mm ($3.0x10^6$ in.)
Allowable shaft runout, TIR	40 µm (0.0015 in.)
Component fit to shaft	Interference
Allowable rotor radial runout, TIR*	60 um (0.0025 in.)

Characteristic	Requirement
*Total indicated runout of impeller hubs and sleeves	

Bearings inspection

Condition of bearings

Do not reuse bearings. The condition of the bearings provides useful information on operating conditions in the bearing frame.

Checklist

Perform these checks when you inspect the bearings:

- Inspect the bearings for contamination and damage.
- Note any lubricant condition and residue.
- Inspect the ball bearings to see if they are loose, rough, or noisy when you rotate them.
- Investigate any bearing damage to determine the cause. If the cause is not normal wear, correct the issue before you return the pump to service.

Replacement bearings

Replacement bearings must be the same as, or equivalent to, those listed in this table.

NOTICE:
Thrust bearings must have machined bronze cages (retainers).

Table 4: Model 7200CB ball bearing fits

Bearing numbers are based on SKF/MRC designations.

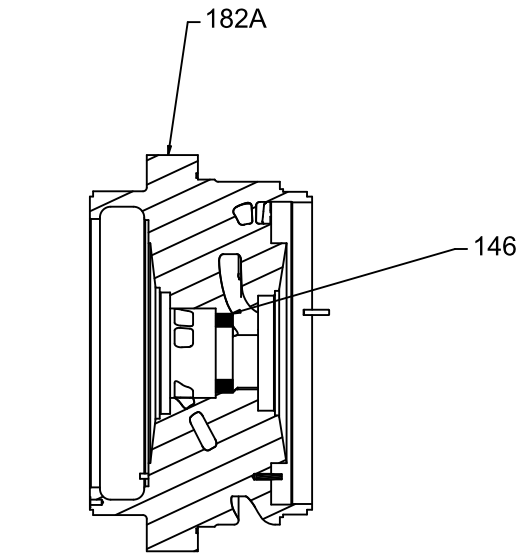
Radial bearing	Thrust bearing	Bearing housing bore in (mm)	Shaft turn in (mm)	
6216	7313/BECBM	5.5118 (140.00) 5.5128 (140.03)	Thrust 2.5597 (65.02) 2.5592 (65.00)	Radial 3.1502 (80.02) 3.1497 (80.00)
6313	7313/BECBM	5.5118 (140.00) 5.5128 (140.03)	2.5597 (65.02) 2.5592 (65.00)	
6314	7314/BECBM	5.9055 (150.00) 5.9065 (150.03)	2.7565 (70.02) 2.7560 (70.00)	

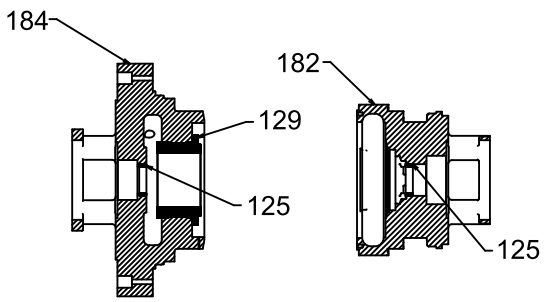
Bearing housings

Perform these checks when you inspect the bearing housings:

- Check that the bearing housings are very clean, with no burrs.
- Remove all loose and foreign material.
- Check the bearing housing bores against the values in the Ball bearing fits table.
- Repair or replace housings as necessary.

Replace the wear bushings





The throat bushing (125), interstage bushing (double suction pumps only) (146) and balance drum (129) are held in place by a press fit and three set screws (222D and 222Z).

1. Remove the bushing:
   a) Remove the set screws.
   b) Press the throat bushing (125) into the seal chamber of the suction cover (182) and head (184) bore. Use jackscrew (not provided) to remove drum (129) from head (184). Press the interstage bushing (double suction pumps only) into cross over area of inboard suction cover (182A).
2. Install new bushing:
   a) Thoroughly clean the bushing and drum fit in the suction cover (182), inboard suction cover (182A) and head (184). Apply an anti-seize compound to the bore.

b) Chill the new throat bushing (125), interstage bushing (146) and drum (129) using dry ice or other suitable chilling substance, and install the bushing into the fit of the suction cover (182) and head (184). The drum into the fit of the head (184). The interstage bushing into the fit of the inboard suction cover (182A).
Be prepared to tap the bushing in place with a hardwood block or soft-faced hammer.

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

c) Locate, drill and tap three new set screw holes equally spaced between the original holes in each new bushing and bushing seat area.
d) Install set screw (222D and 222Z) and upset threads.

Replace the wear rings

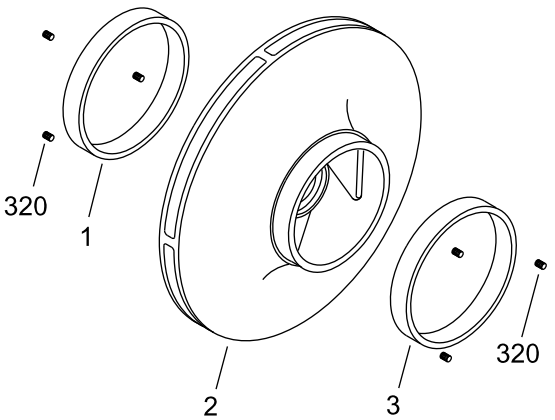
The casing wear rings (164, 164A, 164B, 144) and impeller wear rings (202, 202A, 202B, 203) are held in place by a press fit and three setscrews (222E, 320).

1. Remove the wear rings:
   a) Remove the setscrews.
   b) Remove the wear rings from the suction cover (182), the inboard suction cover (182A), the intermediate cover (150), the discharge cover (150B) and the impeller (101-101M). Use suitable pry or puller tools to force the rings from the fits.
   You can also machine the rings for removal.

CAUTION:
Excessive machining can damage ring fits and render parts unusable.

2. Install new wear rings:
   a) Thoroughly clean the wear-ring seats, and make sure that they are smooth and free of scratches. For casing rings only, apply an anti-seize compound to the bore.
   b) Heat the new impeller wear rings to 180°F–200°F (132°C–143°C) using a uniform method for heating, such as an oven, and place them on the impeller (101-101M) wear-ring seats.

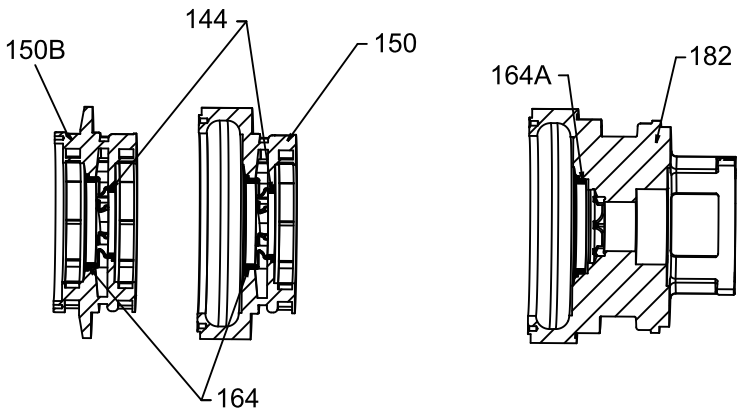
WARNING:
Wear insulated gloves when you handle rings. Rings will be hot and can cause physical injury.

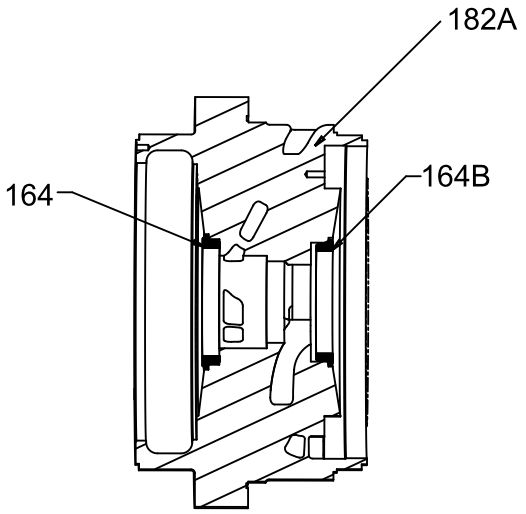


- 1. Wear ring - 202B (double suction), 203 (single suction and series)
- 2. Impeller - 101 through 101M
- 3. Wear ring - 202, 202A (1st stage)

c) Chill the new casing wear ring (164, 164A, 164B, 144) using dry ice or other suitable chilling substance, and install the ring into the fit of the suction cover (182), inboard suction cover (182A), intermediate cover (150) and discharge cover (150B).
Be prepared to tap the ring in place with a hardwood block or soft-faced hammer.

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





d) Locate, drill, and tap three new setscrew holes equally spaced between the original holes in each new ring and ring seat area.
e) Install the setscrews (222E) and upset threads.

3. Check the casing wear rings runout and distortion by measuring the bore at each setscrew location with inside micrometers or vernier calipers.
Machine any distortion in excess of 0.003 in. (0.08 mm) before you trim the new impeller wear rings.
4. Confirm the bore of the casing wear rings.
5. Turn the impeller wear rings to size after you mount it on the impeller.

NOTICE:
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.

All replacement impeller wear rings are supplied 0.020 in. to 0.030 in. (0.508 mm to 0.762 mm) oversize. See the table Minimum running clearances for final running clearances. Machine the impeller rings accordingly.

When the impeller assembly is supplied as a spare part (impeller with wear rings), the wear rings are machined to the required dimension.

Minimum running clearances

Impeller wear rings

Balance drum sleeve (128) and interstage sleeve (204) clearance is 0.010 in (0.25 mm). Impeller wear rims clearance is 0.010 in (0.25 mm) if Goulds standard or per below table if API 610. Note tolerance on clearance is +/-0.002 in (0.05 mm)

Diameter of rotating member at clearance		Minimum diametrical clearance	
in.	mm	in.	mm
3.500 to 3.999	90.00 to 99.99	0.014	0.36
4.000 to 4.499	100.00 to 114.99	0.015	0.38
4.500 to 4.999	115.00 to 124.99	0.016	0.41
5.000 to 5.999	125.00 to 149.99	0.017	0.43
6.000 to 6.999	150.00 to 174.99	0.018	0.46
7.000 to 7.999	175.00 to 199.99	0.019	0.48
8.000 to 8.999	200.00 to 224.99	0.020	0.51
9.000 to 9.999	225.00 to 249.99	0.021	0.53
10.000 to 10.999	250.00 to 274.99	0.022	0.56
11.000 to 11.999	275.00 to 299.99	0.023	0.58
12.000 to 12.999	300.00 to 324.99	0.024	0.61

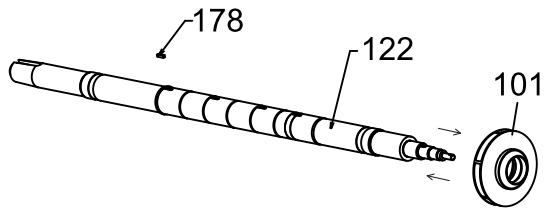
Reassembly

Assemble the Bundle

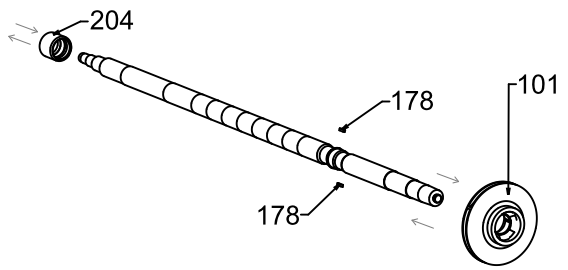
1. Install the impeller wear rings (202, 202A, 202B and 203).
   See Replace the wear rings in the Preassembly inspections section.
2. Install the casing wear rings (164, 164A, 164B and 144).
   See Replace the wear rings in the Preassembly inspections section.
3. Install throat bushing (125), interstage bushing (146) (double suction pumps only) and balance drum (129).
   See Replace the wear bushings in the Preassembly inspections section.

NOTICE:
The 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.

4. Install 1st stage impeller key (178).



CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.

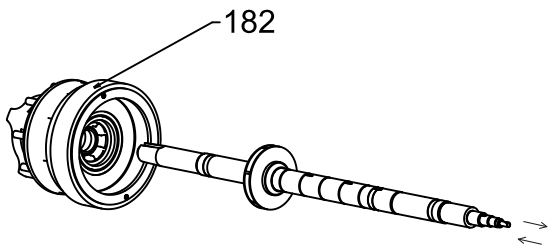


5. Assemble the 1st stage impeller (101) onto the shaft (122) from the thrust end. The impeller is an interference fit. Use an electric induction heater to heat the impeller to 300°F-400°F (150°C-200°C). For double suction pumps, the first stage impeller (101) is assembled from the coupling end.
   Apply an anti-seize compound to the outer diameter of the impeller rings.
6. For double suction pumps only, install interstage sleeve key (178).

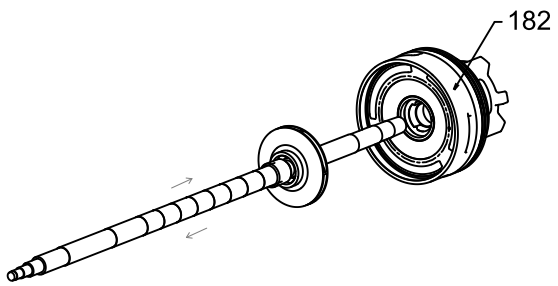
CAUTION:
Burn hazard. The interstage sleeve will get hot. Wear insulated gloves when handling the sleeve.

7. For double suction pumps only, assemble the interstage sleeve (204) onto the shaft (122). The sleeve is an interference fit. Use an electric induction heater to heat the sleeve to 300°F-400°F (150°C-200°C).
   Apply an anti-seize compound to the outer diameter of the interstage sleeve.
8. Assemble shaft assembly into suction cover (182).

Single Suction



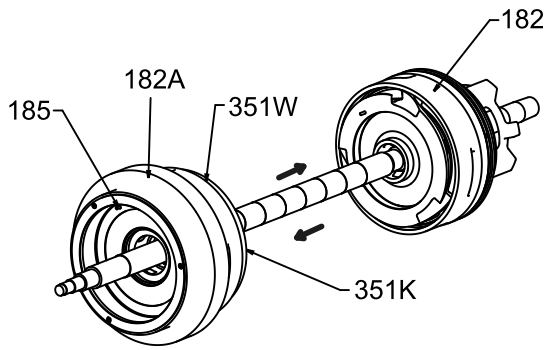
Double Suction



WARNING:
Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advise for proper handling precautions and procedures.

9. For double suction pumps only, install the inboard suction cover gaskets (351K & 351W). Apply high vacuum grease to gasket. Install alignment dowel pin (185) into inboard suction cover (182A). Dowel pin is a press fit. Chill pin using dry ice or other suitable chilling substance. Be prepared to tap the pin in place with a soft faced hammer. Apply an anti-

seize compound to the register fit. Assemble the inboard suction cover (182A) onto the suction cover (182).

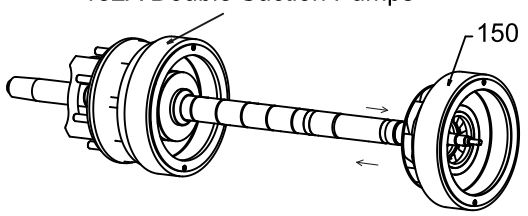


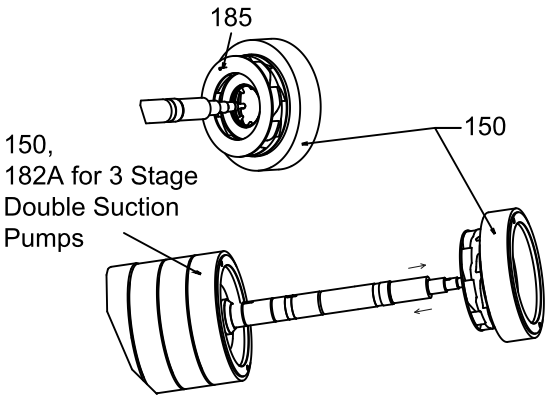
WARNING:
Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advise for proper handling precautions and procedures.

CAUTION:
Burn hazard. The intermediate cover will get hot. Wear insulated gloves when handling the intermediate cover.

10. Install alignment dowel pin (185) into intermediate cover (150). Dowel pin is a press fit. Chill pin using dry ice or other suitable chilling substance. Be prepared to tap the pin in place with a soft faced hammer. Assemble intermediate cover (150) to the suction cover (182) for single suction pumps or to the inboard suction cover (182A) for double suction pumps. Subsequent assemblies will be to the previous intermediate cover (150). Step is not required for 3 stage double suction pumps. The intermediate cover is an interference fit. Heat the outer diameter of the previous cover to 300°F-400°F (150°C-200°C). Install eyebolts (not supplied) into the lifting holes to assemble the intermediate cover (150).

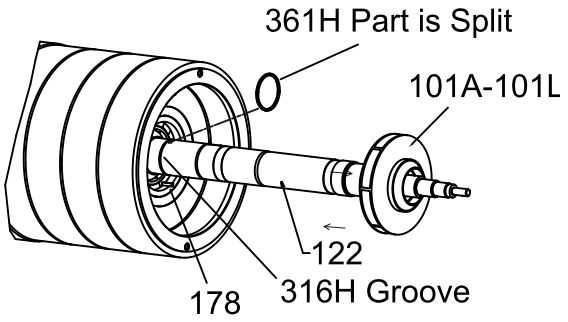
182 Single Section Pumps
182A Double Suction Pumps





11. Check total travel of rotating assembly. This will remain constant within 0.039 in (1 mm). If large variation occurs disassemble and diagnose. Something is not seated properly.
12. Install impeller locating ring (361H) and impeller key (178). Apply high vacuum grease to both locating ring and key or super glue them in place so they don't fall out when assembling the impeller.

CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.



NOTICE:
Allow the shaft and intermediate cover to cool to ambient temperature before proceeding with disassembly.

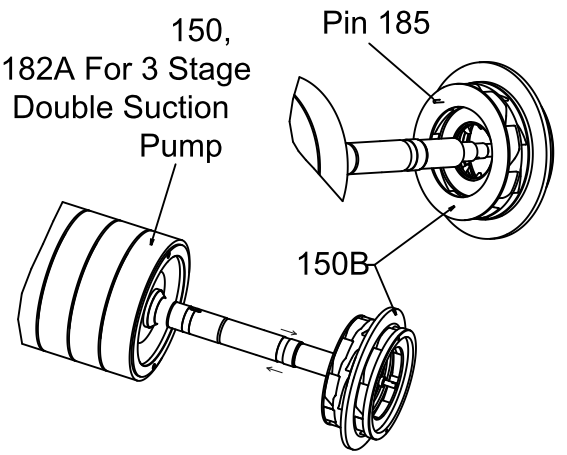
13. Assemble impeller (101A-101L) onto the shaft (122) from the thrust end. The impeller is an interference fit. Use an electric induction heater to heat the impeller to 300°F-400°F (150°C-200°C). Apply an anti-seize compound to the outer diameter of the impeller rings.

14. Repeat steps 10 through 13 until all impellers, except last stage, and intermediate covers are disassembled.

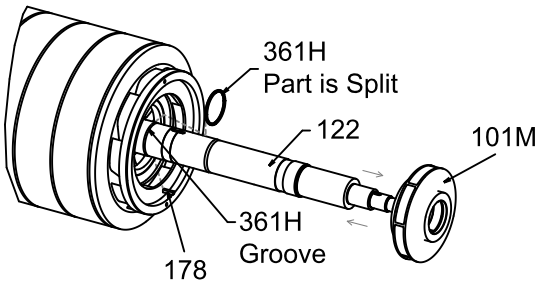
WARNING:
Dry ice and other chilling substances can cause physical injury. Contact the supplier for information and advise for proper handling precautions and procedures.

CAUTION:
Burn hazard. The discharge cover will get hot. Wear insulated gloves when handling the discharge cover.

15. Install alignment dowel pin (185) into discharge cover (150B). Dowel pin is a press fit. Chill pin using dry ice or other suitable chilling substance. Be prepared to tap the pin in place with a soft faced hammer. Assemble discharge cover (150B) to the intermediate cover (150). For 3 stage double suction pump it will be assembled to the inboard suction cover (182A). The discharge cover is an interference fit. Heat the outer diameter of the previous cover to 300°F-400°F (150°C-200°C). Install eyebolts (not supplied) into the lifting holes to assemble the discharge cover (150B).

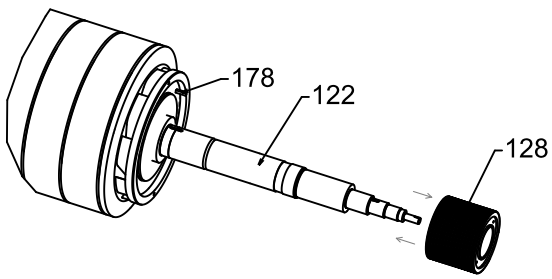


16. Install impeller locating ring (361H) and impeller key (178). Apply high vacuum grease to both locating ring and key or super glue them in place so they don't fall out when assembling the impeller.



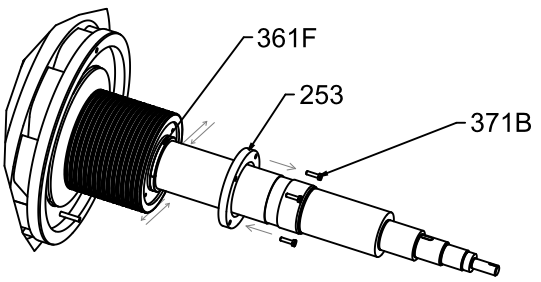
CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.

17. Assemble the last stage impeller (101M) onto the shaft (122) from the thrust end. The impeller is an interference fit. Use an electric induction heater to heat the impeller to 300°F-400°F (150°C-200°C). Use puller holes on the impeller hub to assemble onto shaft. Apply an anti-seize compound to the outer diameter of the impeller rings.
18. Check total travel of rotating assembly. This will remain constant within 0.039 in (1 mm). If large variation occurs disassemble and diagnose. Something is not seated properly.
19. Install sleeve key (178). Apply high vacuum grease to key or super glue it in place so it doesn't fall out when assembling the sleeve.

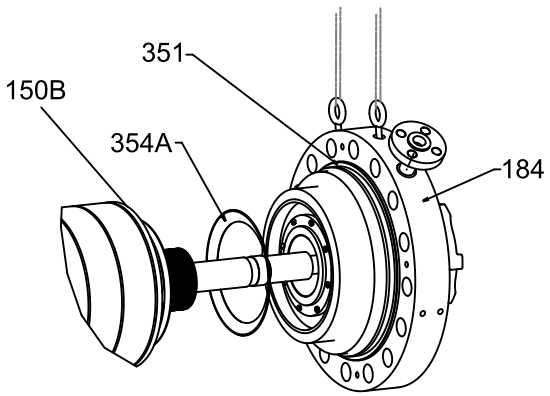


20. Assemble the balance drum sleeve (128) onto the shaft (122) from the thrust end. Apply an anti-seize compound to the outer diameter of the balance drum sleeve.

21. Install sleeve locating ring (361F).



22. Install locating ring retainer (253). Tighten locating ring retainer bolts (371B).
23. Install belleville washer (354A) and the head gasket (351) onto head (184). Apply a liberal amount of high vacuum grease to washer and gasket so it doesn't fall out when assembling the head.



24. Insert eyebolts (not supplied) in the pre-drilled threaded holes in the top outside perimeter of the head (184).

WARNING:
Use the eyebolts to lift only the head. They will not support the weight of the entire bundle.

25. Assemble head (184) onto the discharge cover (150B). Apply an anti-seize compound to the register fit where indicated by the arrow.

Confirm the seal chamber runout

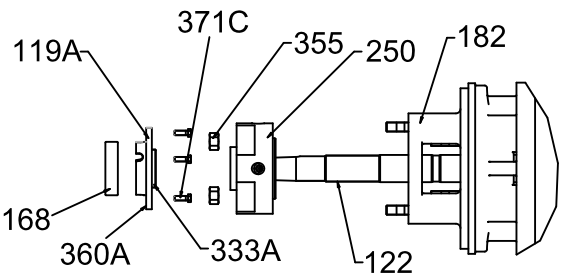
The bearing housings (134 and 134A) are doweled to the head (184) and suction cover (182) during the original build. However, in order to assure the correct running position of the shaft, use this procedure in order to confirm the seal chamber runout before you install the cartridge mechanical seals:

1. Install the bearings (for ball bearings use a flapper wheel to make inside diameter of old bearing a slight clearance fit) on the shaft and bolt the bearing housings (134 and 134A) to the suction cover (182) and head (184).
2. Mount the dial indicator on the shaft (122). Rotate the shaft (122) so that the indicator rides along the seal chamber bore for 360°.
3. If the total indicator reading exceeds 0.005 in. (0.127 mm), determine the cause and make corrections.
   It may be necessary to readjust the housing.
   a) Remove the dowel pins and use the adjusting screws to bring the runout to within 0.002 in. (0.0508 mm).
   b) Redowel the housings in a different location.
4. Check the seal-chamber face runout.
   a) With a dial indicator mounted on the shaft, rotate the shaft so that the indicator rides along the seal-chamber face for 360°.
   b) If the total indicator reading exceeds the allowable runout as this table shows, determine the cause and make corrections.

Seal chamber bore in inches (millimeters)	Maximum allowable total indicator reading in inches (millimeters)
5.118 (130)	0.0025 (0.0635)
5.512 (140)	0.0030 (0.0762)
6.299 (160)	0.0030 (0.0762)
6.693 (170)	0.0035 (0.0889)
7.087 (180)	0.0035 (0.0889)

5. Remove the dowel pins and unbolt the bearing housings. Discard the old ball bearings.

Assemble the radial end (ball bearing pumps)



1. Install the mechanical seal (250) on the shaft. Apply an o-ring lubricant to the inside diameter of the seal sleeve o-ring. Torque gland nuts (355) to the values found in the "Maximum Torque Values for Fasteners" table.
2. Install the inboard labyrinth seal (333A) into the inboard radial end cover (119A):
   a) Clean the end cover with a solvent.
   b) Fit the labyrinth seal (333A) into the bore of the cover (119A). Apply an o-ring lubricant to the outside diameter of the labyrinth seal o-ring.
   c) Tap the seal in with a rubber mallet.

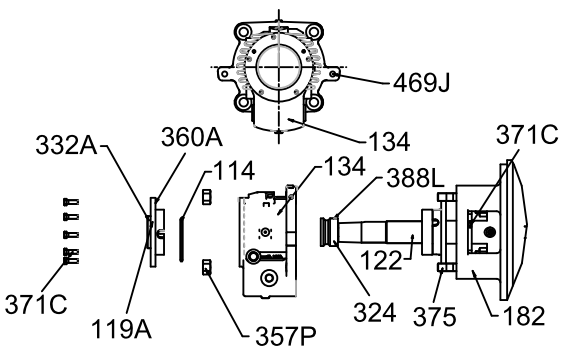
NOTICE:
Make sure that the expulsion port is at the 6 o'clock position and is properly seated.

3. Install the inboard end cover (119A) and the inboard bearing end cover gasket (360A) onto the shaft. Apply an o-ring lubricant to the inside diameter of the labyrinth seal o-ring. Apply high vacuum grease to gasket.
4. Install the radial bearing (168) onto the shaft (122).
   The bearing is interference fit.
   a) Heat the bearings to 250° F (120° C) with an electronic induction heater.
      The induction heater also demagnetizes the bearings.

CAUTION:
Wear insulated gloves when you use a bearing heater. Bearings get hot and can cause physical injury.

NOTICE:
Do not use a torch and do not force.

   b) Install the bearing (168) onto the shaft (122).
5. Install the oil-ring sleeve (324) and tighten the setscrew (388L).



6. Install the bearing housing (134) over the bearing. Apply a lubricant that is to be used in service to the outside diameter of bearing. Finger-tighten the nuts (357P) on the stude (375). Insert dowel pins (469J) then tighten nuts (357P).
   The bearing housing is doweled to the suction cover (182) during the original build to assure the correct running position of the shaft.
   The connection point of the bearing housing (134) to the suction cover (182) is referred to as the saddle.

NOTICE:
The bearing housing flange must fit metal-to-metal (no gap) to the bearing saddle flange.

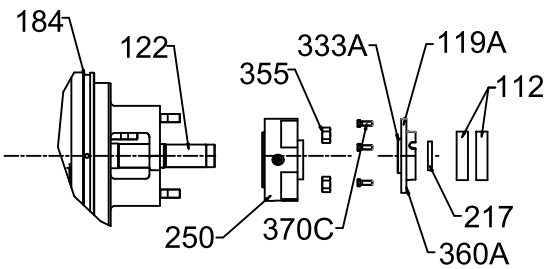
7. Tighten the inboard end cover bolts (371C).
8. Install the oil ring (114).
9. Install the outboard labyrinth seal (332A) into the outboard radial-end cover (119A):

a) Clean the end cover with a solvent.
b) Fit the labyrinth seal (332A) into the bore of the cover (119A). Apply an o-ring lubricant to the outside diameter of the labyrinth seal o-ring.
c) Tap the seal in with a rubber mallet.

NOTICE:
Make sure that the expulsion port is at the 6 o'clock position and is properly seated.

10. Install the outboard end cover (119A) and the outboard bearing end cover gasket (360A) onto the shaft. Apply an o-ring lubricant to inside diameter of the labyrinth seal o-ring. Apply high vacuum grease to gasket.. Tighten the outboard end cover bolts (371C).

Assemble the thrust end (ball bearing pumps)



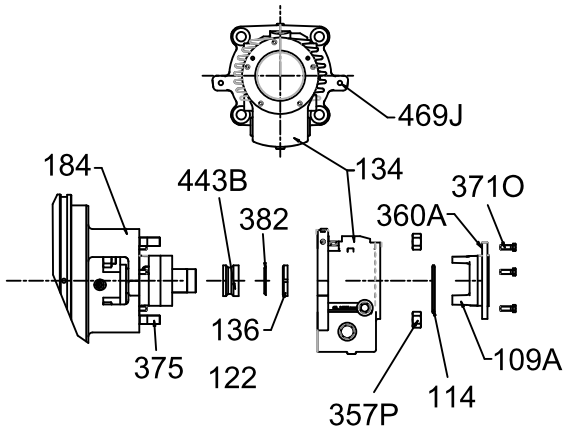
1. Install the mechanical seal (250) on the shaft. Apply an o-ring lubricant to the inside diameter of the seal sleeve o-ring. Torque gland nuts (355) to the values found in the "Maximum Torque Value for Fasteners" table.
2. Install the inboard labyrinth seal (333A) into the inboard end cover (119A):
   a) Clean the end cover with a solvent.
   b) Fit the labyrinth seal (333A) into the bore of the cover (119A). Apply an o-ring lubricant to the outside diameter of the labyrinth seal o-ring.
   c) Tap the seal in with a rubber mallet.

NOTICE:
Make sure that the expulsion port is at the 6 o'clock position and is properly seated.

3. Install the inboard end cover (119A) and the inboard bearing end-cover gasket (360A) onto the shaft. Apply an o-ring lubricant to the inside diameter of the labyrinth seal o-ring. Apply high vacuum grease to gasket.
4. Final centering of the rotating element cannot be performed without the casing (100). This step is outlined in section "Final Assembly Steps."
5. Install the bearing spacer (217).
6. Install the bearings (112A) (use flapper wheel to make inside diameter of old bearing a slight clearance fit) on the shaft.

CAUTION:
Pump cannot be operated in this condition until proper bearings are installed.

7. Install the oil ring sleeve (443B), bearing lockwasher (382) and bearing locknut (138). Tighten the locknut by hand with a spanner wrench until the bearing is snug against the shoulder.



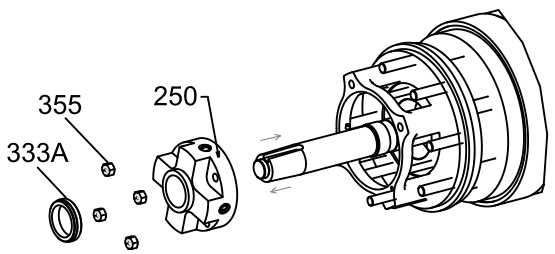
8. Install the bearing housing (134) over the bearings. Apply a lubricant that is to be used in service to the outside diameter of bearings. Finger-tighten the nuts (357P) on the studs (375). Insert the dowel pins (469J); then tighten the nuts (357P).
   The bearing housing is doweled to the head (184) during the original build to assure the correct running position of the shaft.
   The connection point of the bearing housing (134) to the head (184) is referenced to as the saddle.

   NOTICE:
   The bearing housing flange must fit metal-to-metal (no gap) to the bearing saddle flange.

9. Tighten the inboard end-cover bolts (371C).
10. Install the oil ring (114).
11. Install the bearing end cover (109A) and the bearing end cover gasket (360A) with the end cover bolting (371C). Apply high vacuum grease to gasket.
12. When new bearings are installed, you must measure the axial end play:
    a) Move the shaft axially from the coupling end.
    b) Measure the shaft axial movement with a dial indicator mounted on the radial bearing housing.
    c) Add or subtract end cover gaskets (360A) until axial movement is between 0.005 and 0.010 in. (0.127 and 0.254 mm).

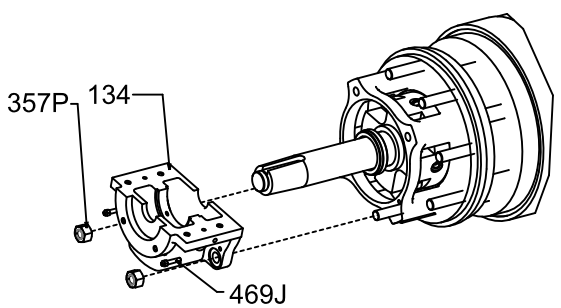
Assemble the Radial End (Sleeve/Hydrodynamic Bearing Pumps)

1. Install the mechanical seal (250) on the shaft. Apply an o-ring lubricant to the inside diameter of the seal sleeve o-ring. Torque gland nuts (355) to the values found in the “Maximum Torque Values for Fasteners” table.

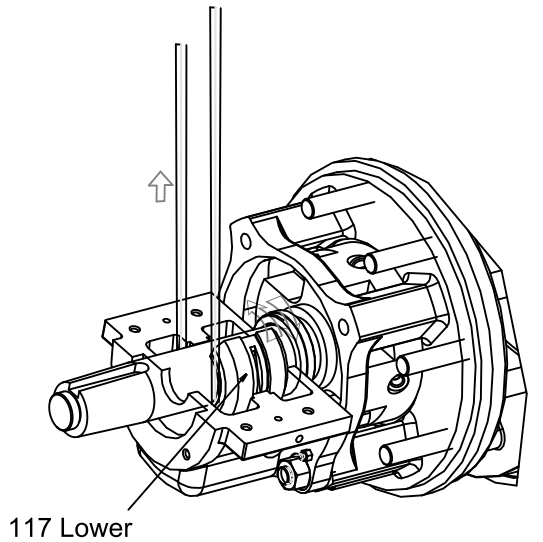


2. Install the inboard labyrinth seal (333A) onto shaft (122). Apply an o-ring lubricant to the inside and outside diameter of the labyrinth seal o-rings.
3. Install lower half of the bearing housing (134). Finger tighten the nuts (357P) on the studs (375). Insert the dowel pins (469J) then tighten the nuts (357P).
   The bearing housing is doweled to the suction cover (182) during the original build to assure the correct running position of the shaft.
   The connection point of the bearing housing to the suction cover (182) is referred to as the saddle.

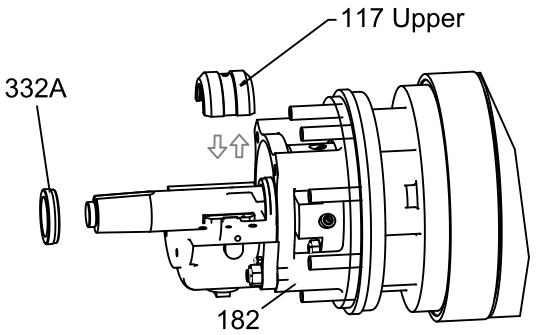
NOTICE:
The bearing housing flange must fit metal to metal (no gap) to the saddle.



4. Using a sling lift up on the shaft and rotate in lower half of sleeve bearing (117). Apply a lubricant that is to be used in service to the inside diameter of sleeve.



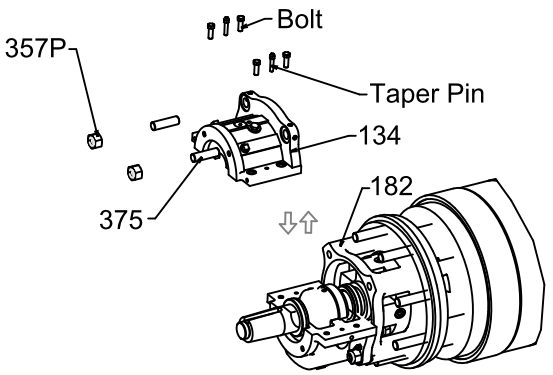
5. Install upper half of sleeve bearing (117). Apply a lubricant that is to be used in service to the inside diameter of sleeve. Ensure pin is at the 12 o'clock position.



6. Slide labyrinth seal (333A) into bearing housing (134).
7. Install the outboard labyrinth seal (332A) onto shaft and slide into bearing housing (134). Apply an o-ring lubricant to the inside and outside diameter of the labyrinth seal o-rings.

NOTICE:
Make sure that the expulsion port of the labyrinth seal is at the 6 o'clock position and is properly seated in the bearing housing.

8. Install the upper half of the bearing housing (134). Align sleeve dowel pin to the 12 o'clock position. Install taper pins and tighten bolts to clamp both halves of the bearing housing together.

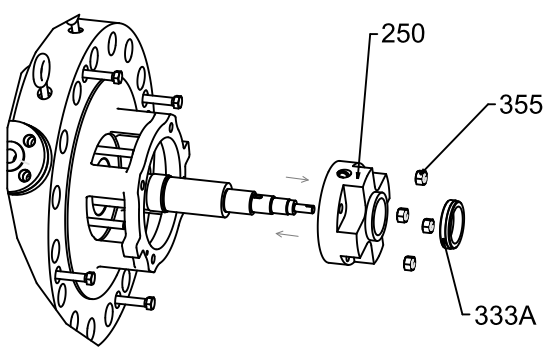


9. Install studs (375) and tighten nuts (357P) on the studs (375).

NOTICE:
The bearing housing flange must fit metal to metal (no gap) to the saddle.

Assemble the Thrust End (Sleeve/Hydrodynamic Bearing Pumps)

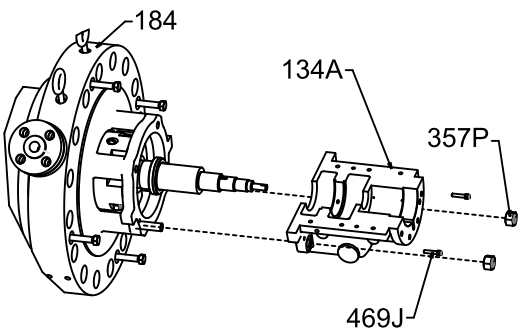
1. Install the mechanical seal (250) on the shaft. Apply an o-ring lubricant to the inside diameter of the seal sleeve o-ring. Torque gland nuts (355) to the values found in the "Maximum Torque Values for Fasteners" table.



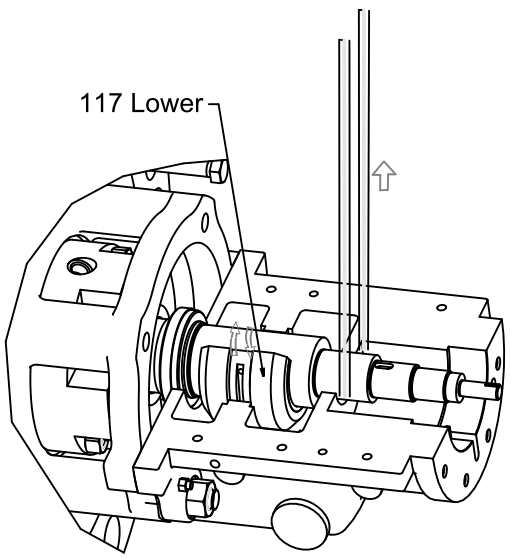
2. Install the inboard labyrinth seal (333A) onto shaft (122). Apply an o-ring lubricant to the inside and outside diameter of the labyrinth seal o-rings.
3. Install lower half of the bearing housing (134A). Finger tighten the nuts (357P) on the studs (375). Insert the dowel pins (469J) then tighten the nuts (357P).
   The bearing housing is doweled to the head (184) during the original build to assure the correct running position of the shaft.

The connection point of the bearing housing (134A) to the head (184) is referred to as the saddle.

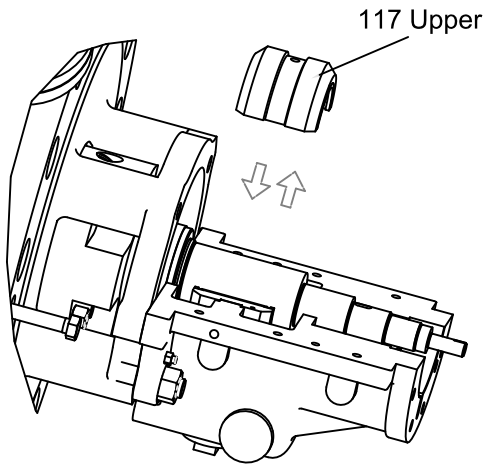
NOTICE:
The bearing housing flange must fit metal to metal (no gap) to the saddle.



4. Using a sling lift up on the shaft and rotate in lower half of sleeve bearing (117). Apply a lubricant that is to be used in service to the inside diameter of sleeve.



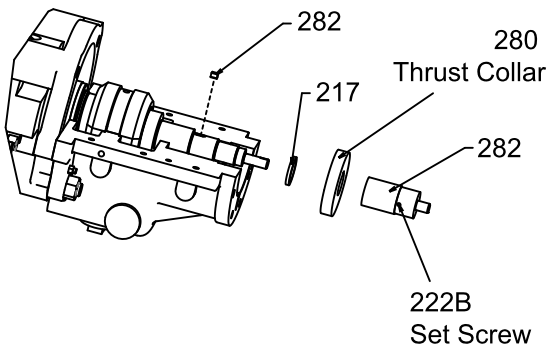
5. Install upper half of sleeve bearing (117). Apply a lubricant that is to be used in service to the inside diameter of sleeve. Ensure pin is at the 12 o'clock position.



6. Slide labyrinth seal (333A) into bearing housing (134A).

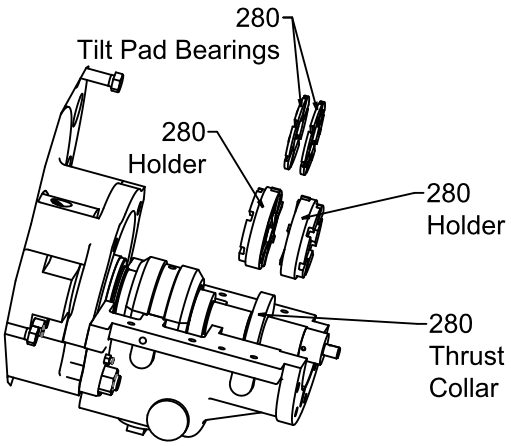
NOTICE:
Make sure that the expulsion port of the labyrinth seal is at the 6 o'clock position and is properly seated in the bearing housing.

7. Final centering of the rotating element can not be performed without the casing (100). This step is outlined in section "Final Assembly Steps."
8. Install bearing spacer (217).

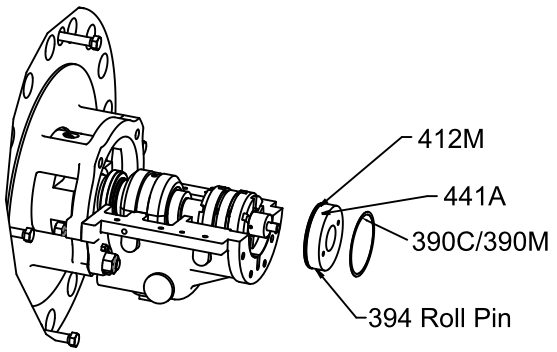


9. Install thrust collar key (282) and thrust collar (280).
10. Install thrust collar nut (283). Apply an anti-seize compound to the shaft threads. Use a spanner wrench to tighten thrust collar nut against thrust collar. Threads on thrust collar nut are left handed. Tighten set screw (222B).

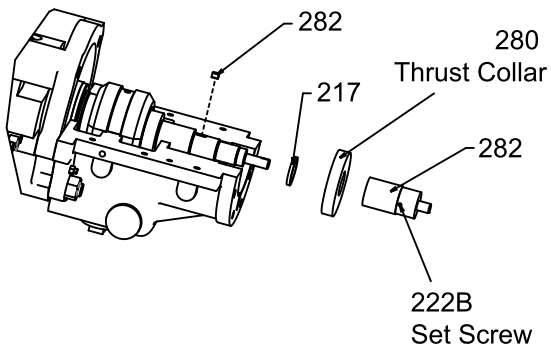
11. Install tilt pad bearings and holders (280). The holders are split and will have to be rotated to install all of the tilt pad bearings. Apply a lubricant that is to be used in service to the face of each of the tilt pad bearings. Ensure holders keys are at the 12 o'clock position.



12. Install o-ring (412M) and roll pin (394) onto filler plate (441A). Install filler plate (441A). Apply an o-ring lubricant to the outside diameter of the filler plate o-ring. Ensure dowel pin is at the 6 o'clock position.



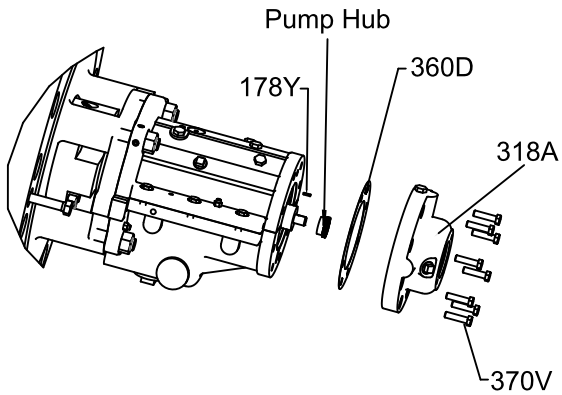
13. Install the upper half of the bearing housing (134A). Align sleeve dowel pin and tilt pad bearing holder keys to the 12 o'clock position. Install taper pins and tighten bolts to clamp both halves of the bearing housing together.



14. Install studs (375) and tighten nuts (357P) on the studs (375).

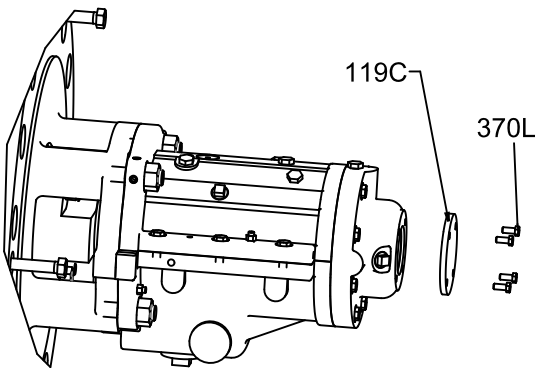
NOTICE:
The bearing housing flange must fit metal to metal (no gap) to the saddle.

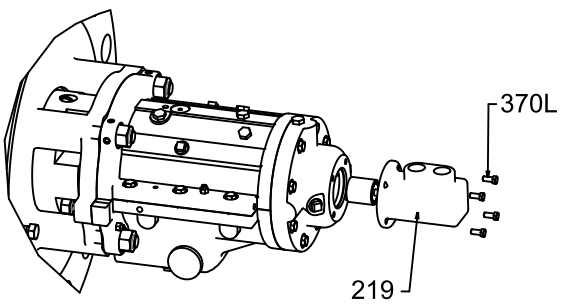
15. For pumps with oil pumps, install pump coupling key (178Y) and coupling onto the shaft (122). Tighten set screw.
16. Install shims (390C & 390M). Apply high vacuum grease to shims.
17. Install oil pump adapter gasket (360D) to oil pump adapter (318A). Apply high vacuum grease to gasket.



18. Install oil pump adapter (318A) and tighten bolts (370V).
19. When new bearings are installed, you must measure the axial end play:
    a) Move the shaft axially from the coupling end.
    b) Measure the shaft axial movement with a dial indicator mounted on the radial bearing housing.

c) Add or subtract shims (390C & 390M) until axial movement is between 0.010 and 0.015 inches (0.254 and 0.381 mm).

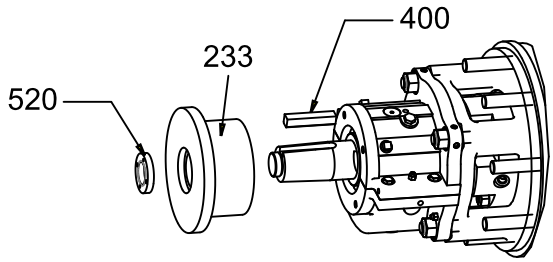




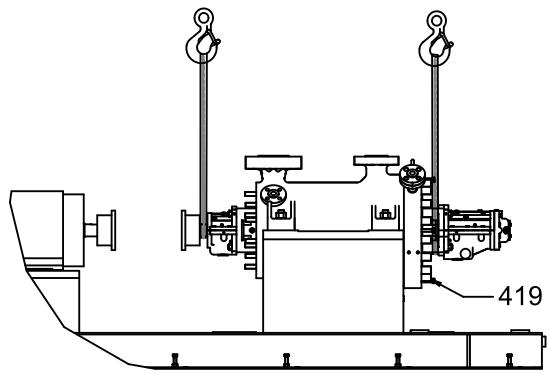
20. For pumps with oil pump only, if not already installed, install coupling key and coupling onto oil pump shaft. Tighten set screw. Install coupling sleeve (ensure snap ring is in place) over oil pump coupling hub.
21. Install oil pump (219), if supplied, or endplate (119C). If an oil pump is being installed, ensure coupling sleeve engages coupling hub on pump. Tighten bolts (370L).

Prepare for Bundle Reassembly

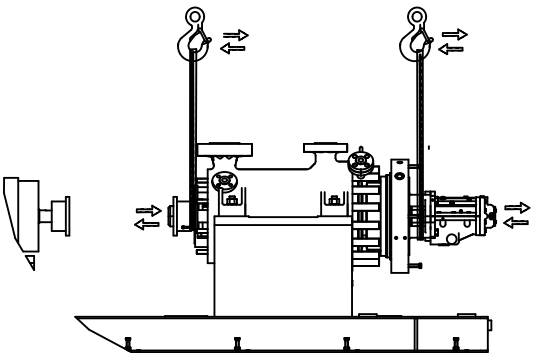
1. Install the coupling key (400) and the coupling hub (233).



2. For bundle remove with slings only, install the coupling nut (520) onto shaft (122) and tighten set screw (388Y).
3. For disassembly cradle only, install extension adapter (850A) and tighten suction cover nuts (426B).



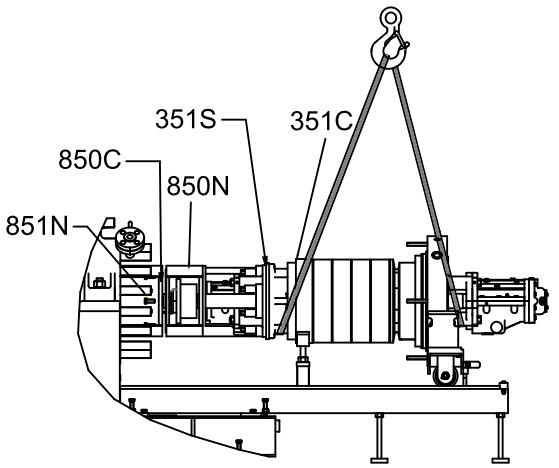
4. For disassembly cradle only, install stub shaft extension tie (850N) onto shaft (122).



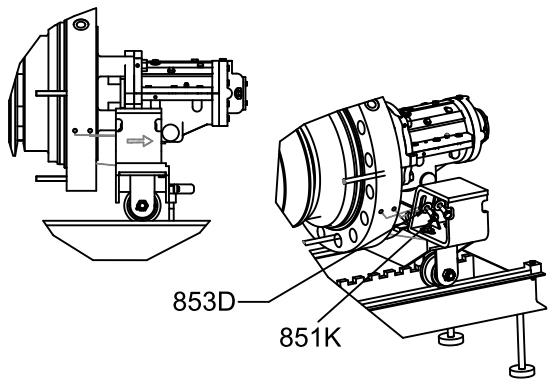
5. For disassembly cradle only, install extension tie (850B) and tighten bolts (851A).
6. For disassembly cradle only, install the coupling nut (520) onto the shaft (122).

Bundle Assembly Using Disassembly Cradle

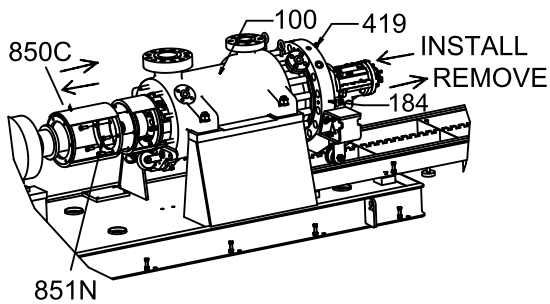
1. Install suction cover gaskets (351C and 351S). Apply high vacuum grease to gaskets. Apply an anti-seize compound to suction cover (182 and 182A (double suction pumps only)) register fits. Remove jack screws (419) if still installed.
2. Hoist bundle using suitable slings as shown.



3. Install cart to head and tighten bolts (851K) with washers (853D).

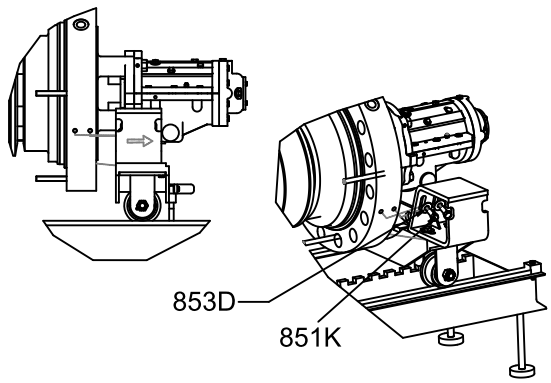


4. Reattach extension (850C) to extension tie (850N) and tighten bolts (851N).
5. Push bundle into casing (100) until there is enough room to remove the extension (850C). Loosen and remove bolts (851N) and remove extension (850C).

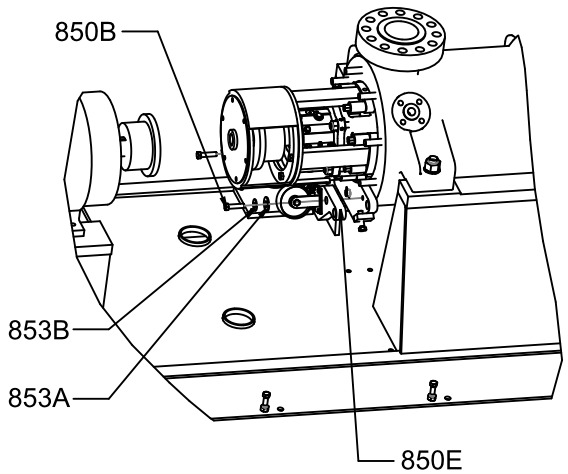


6. Repeat line 5 until bundle is fully installed into the casing (100).

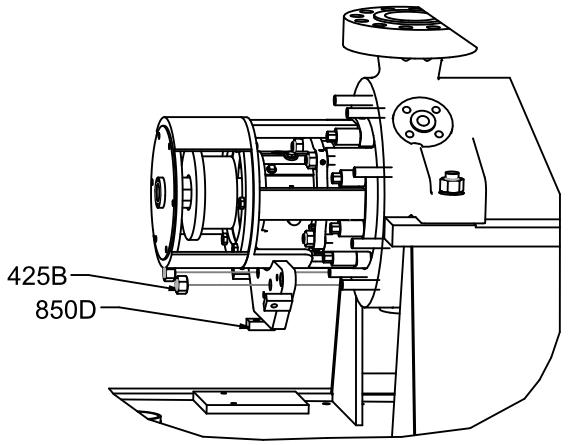
7. Loosen and remove bolts (851K) and washer (853D) and remove cart.



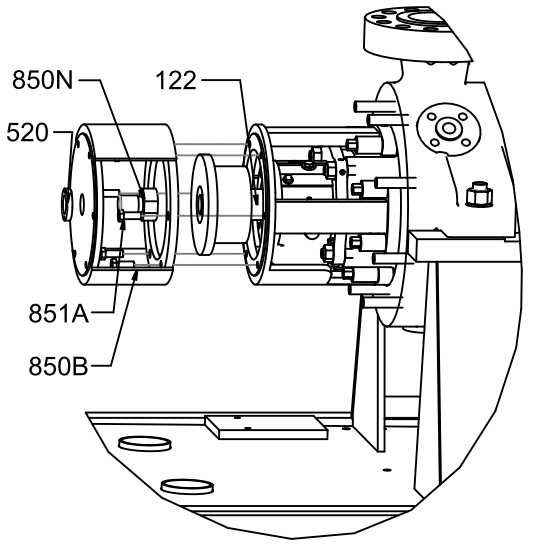
8. Loosen and remove bolts (850B) and washers (853A and 853B). Remove caster mounting plate (850E).



9. Loosen and remove suction cover nuts (425B). Remove caster adapter plate (850D)..

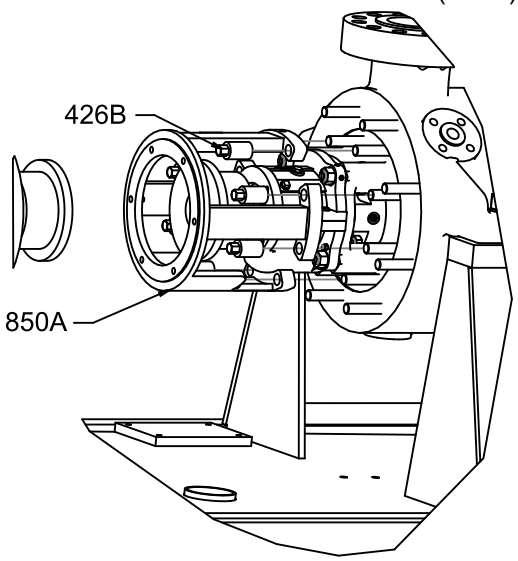


10. Loosen and remove coupling nut (520).

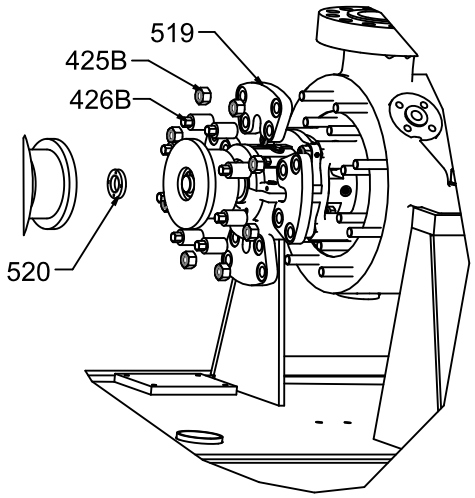


11. Loosen and remove bolts (851A). Remove extension tie (850B).
12. Loosen and remove stub shaft extension tie (850N) from pump shaft (122)..

13. Loosen and remove suction cover nuts (426B). Remove extension adapter (850A).

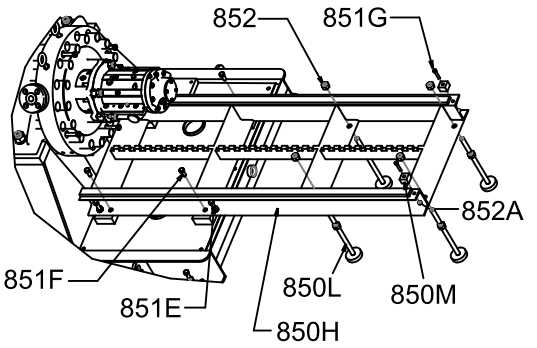


14. Install the coupling nut (520) onto shaft (122) and tighten set screw (388Y).



15. Install the suction cover locking plates (519).
16. Torque suction cover nuts (425B and 426B) to the values found in the “Maximum Torque Values for Fasteners” table. Apply anti-seize compound to suction cover studs (356F).

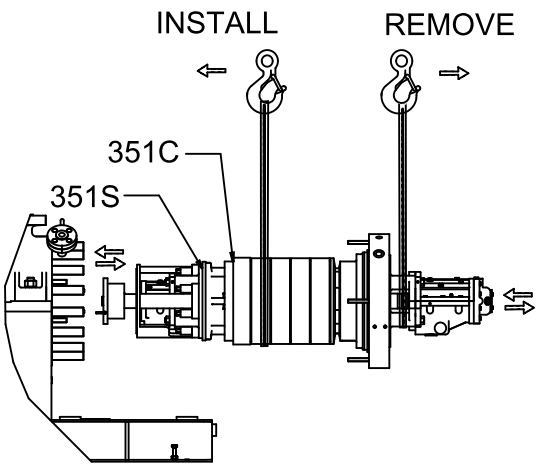
17. Optional for space constraints. Loosen and remove bolts (851F) and nuts (852). Remove assembly rail (850H) and rail supports (850L).

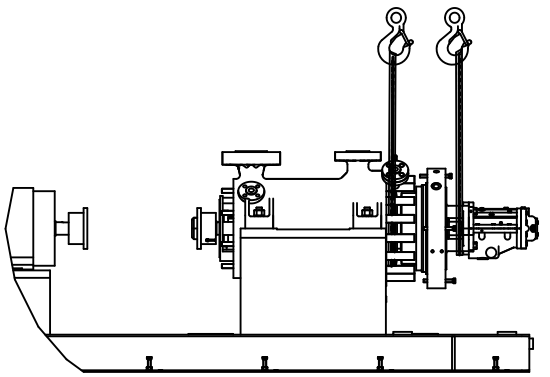


Bundle Assembly Using Slings Only

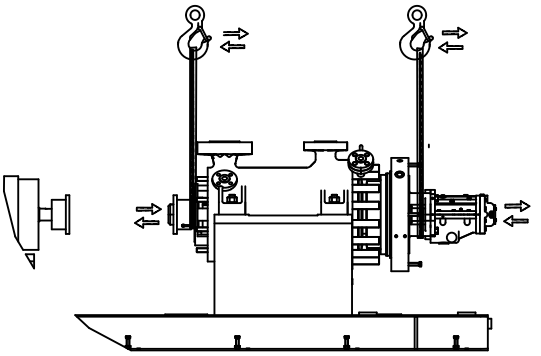
1. Install suction cover gaskets (351C and 351S). Apply high vacuum grease to gaskets. Apply an anti-seize compound to suction cover (182 and 182A (double suction pumps only)) register fits. Remove jack screws (419) if still installed.

2. Using suitable slings around the bundle as shown insert into the casing (100).

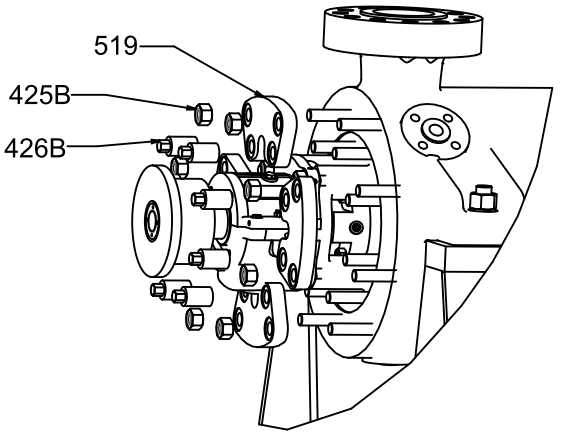




3. Reposition the slings around the radial end of shaft / housing and insert the rest of the way into the casing.



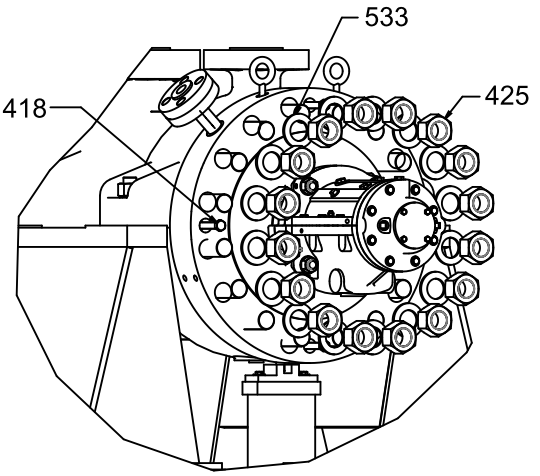
4. For non-cartridge designs, proceed to step 6. Install the suction cover locking plates (519).



5. Torque suction cover nuts (425B and 426B) to the values found in the “Maximum Torque Values for Fasteners” table. Apply anti-seize compound to suction cover studs (356F).
6. For non-cartridge designs only, reassemble the pump coupling hub and key per "Prepare for Bundle Reassembly" and reassemble the radial end per the appropriate bearing section.

Final Assembly Steps

1. Install head washers (533) and torque head nuts (425) to the values found in the “Maximum



Torque Values for Fasteners” table.

a) Apply anti-seize compound on casing studs (356A) and to the face of the head where the washers make contact.
b) Install a nut on every other stud.
c) Tighten the nuts evenly to bring the faces of the head and casing together to a metal to metal fit.
d) Mark each of these nuts as Group A.
e) Install the remaining half of the nuts (Group B).
f) Apply a torque of approximately 150 ft-lb (203 N-m) to the Group B nuts.
g) Match mark the Group B nuts to the head.
h) Further tighten the Group B nuts by turning each nut clockwise 17° to 19° past the mark on the head.

i) Loosen the Group A nuts.
j) Repeat steps F through H for the Group A nuts.
k) Torque Group B nuts to value found in the table.
l) Torque Group A nuts to value found in the table.

2. The rotating element must be centered inside the bundle.
   a) Disassemble thrust bearing housing as necessary to remove bearing spacer (217). See appropriate thrust bearing housing disassembly section.
   b) Push the rotating element towards the coupling end until it stops.
   c) Measure the distance from the thrust bearing shoulder on the shaft (122) to the bearing housing saddle face on the head (184).
   d) Pull the rotating element towards the thrust end until it stops.
   e) Again, measure the distance from the thrust bearing shoulder on the shaft (122) to the bearing housing saddle face on the head (184).
      The difference between the two measurements is the total travel of the rotating element.
   f) Calculate the average of these dimensions.
   g) For ball bearing pumps only, measure the shoulder depth on the inboard cover (119A) and subtract the calculated average dimension.
      For hydrodynamic pumps only, measure the thrust bearing shoulder depth on the thrust bearing housing (134A) and the over all length of one of the tilt pad bearings including the holder (280). Add these two dimensions and subtract the calculated average dimension.
      The result is the bearing spacer (217) thickness required to properly center the rotating element.
   h) Remachine the spacer as necessary making sure that both faces are parallel within 0.001 in (0.025 mm).
3. Reassemble thrust bearing housing as necessary. See appropriate thrust bearing housing assembly section. For ball bearing pumps only, the only exception to this is the installation of new thrust bearings. See step 4.
4. For ball bearing pumps only, assemble a new set of thrust bearings (112A) in a back to back arrangement onto the shaft (122). The bearings are an interference fit.
   a) Install bearing spacer (217) onto the shaft (122).

CAUTION:
Burn hazard. The bearings will get hot. Wear insulated gloves when handling the impeller.

   b) Heat the bearings to 250°F (120°C) with an electronic induction heater.
      The induction heater also demagnetizes the bearings.

NOTICE:
Do not use a torch and do not force.

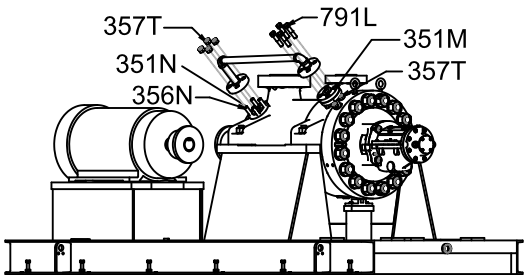
   c) Install the bearings (112A), the oil ring sleeve (443B), and the bearing locknut (138) onto the shaft.
   d) While the bearings are hot, tighten the locknut by hand with a spanner wrench until the bearing is snug against the shoulder.
   e) Allow the bearing assembly to cool slowly to room temperature.
      Do not rapidly cool the bearings with compressed air or other means.
   f) When the bearing assembly is fully cooled, remove the locknut (138), install the lockwasher (382), and install the locknut.

g) Hand tighten the locknut (138) with a spanner wrench. Do not over tighten the bearing. Tap the of the spanner wrench with light strikes from a dead blow hammer while you note the location of the next available lockwasher (382) tab that aligns with the slots in the locknut.
The turning resistance of the nut increase as it tightens. Plan the alignment of the lockwasher tab with the locknut fully tightened. If the locknut is still turning with light strikes with the hammer, then continue to tighten the locknut until the next available tab is aligned with a slot. Do not use heavy strikes with the hammer. If it is not possible to reach the next tab, then loosen the locknut to align with the previous tab.

h) Check the condition of the outer races by rotating the bearings by hand in opposite directions:
   - The outer races generally cannot be counter rotated by hand, but if they do move, the resistance must be high.
   - If the outer races are loose, the bearing is not properly seated and must be retightened.

i) When you have achieved the proper bearing assembly, set the lockwasher tab in the slot in the locknut.

5. Tighten set screws on the mechanical seal sleeve collar. Disengage the setting tabs and ensure they are retightened clear of any rotating part. Refer to the seal installation drawing provided by the manufacture. Complete tasks on both seals at this time.
6. Install the balance line and gaskets (351M). Torque bolts (791L) and nuts (357T) to the values found in the “Maximum Torque Values for Fasteners” table.



Post-assembly checks

Perform these checks after you assemble the pump, then continue with pump startup:

- Rotate the shaft by hand in order to make sure that it rotates easily and smoothly and that there is no rubbing.
- Open the isolation valves and check the pump for leaks.

Assembly references

Maximum torque values for fasteners

Fastener size (diameter in inches) – threads per inch	2210 material ft-lb (Nm)		2229 material ft-lb (Nm)		2239 material ft-lb (Nm)	
	Lub.	Unlub.	Lub.	Unlub.	Lub.	Unlub.
1/4 –20	3 (4)	3 (4)	5 (7)	6 (8)	7 (8)	10 (14)
5/16 –18	5 (7)	7 (9)	9 (12)	12 (16)	15 (20)	20 (27)

Fastener size (diameter in inches) – threads per inch	2210 material ft-lb (Nm)		2229 material ft-lb (Nm)		2239 material ft-lb (Nm)	
	Lub.	Unlub.	Lub.	Unlub.	Lub.	Unlub.
3/8 –16	8 (9)	12 (16)	17 (23)	22 (30)	27 (37)	36 (49)
7/16 –14	13 (18)	20 (27)	26 (39)	35 (47)	43 (58)	57 (77)
1/2 –13	20 (27)	30 (41)	40 (54)	54 (73)	65 (88)	87 (118)
9/16 –12	29 (39)	43 (58)	58 (79)	78 (106)	94 (127)	125 (169)
5/8 –11	39 (53)	59 (80)	80 (108)	107 (145)	130 (176)	173 (235)
3/4 –10	70 (95)	105 (142)	99 (134)	132 (179)	230 (312)	307 (416)
7/8 –9	113 (152)	170 (230)	159 (216)	212 (287)	371 (503)	495 (671)
1 –8	170 (230)	255 (346)	239 (324)	318 (431)	557 (755)	742 (1006)
1-1/8 –8	N/A	N/A	N/A	N/A	817 (1108)	1089 (1476)
1-1/4 –8	N/A	N/A	N/A	N/A	1148 (1556)	1531 (2076)
1-5/8 –8	N/A	N/A	N/A	N/A	2657 (3602)	3543 (4804)
1-3/8 –8	N/A	N/A	N/A	N/A	1558 (2112)	2077 (2816)
1-1/2 –8	N/A	N/A	N/A	N/A	2056 (2788)	2742 (3718)
1-3/4 –8	N/A	N/A	N/A	N/A	3344 (4534)	4459 (6046)
1-7/8 –8	N/A	N/A	N/A	N/A	4152 (5629)	5535 (7504
2 –8	N/A	N/A	N/A	N/A	5090 (6901)	6787 (9202)
2-1/8 –8	N/A	N/A	N/A	N/A	6150 (8338)	8200 (11118)
2-1/4 –8	N/A	N/A	N/A	N/A	7359 (6901)	9812 (13303)
2-3/8 –8	N/A	N/A	N/A	N/A	8706 (9977)	11608 (15738)
2-1/2–8	N/A	N/A	N/A	N/A	10198 (13827)	13598 (18436)

Spare parts

Critical service spare parts

For critical services, stock these parts, where applicable:

- Intermediate cover (150) and discharge cover (150B)
- Inbound suction cover (182A)
- Impellers (101 through 101M)
- Thrust bearing end cover, outboard (ball bearing construction only) (109A)
- Shaft (122)
- Radial bearing end cover, inboard (ball bearing construction only) (119A)
- Impeller key (178)
- Bearing spacer (217)
- Locating rings (361H and 361F)

An alternative approach is to stock a complete bundle or rotating element. A bundle is a group of assembled parts that includes everything but the casing. Rotating element is a group of assembled parts that include all rotating components except the bearings (and parts), mechanical seals and couplings.

Recommended spare parts

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

Stock these spare parts, where applicable:

- Cartridge mechanical seal (250)
- Thrust bearing (duplex pair) (112A) (ball bearing construction only)
- Oil ring (114) (ball bearing construction only)
- Balance drum sleeve (128)
- Balance drum (129)
- Sleeve bearings, two (117) (hydrodynamic bearing construction only)

- Tilt pad bearings (280) (hydrodynamic bearing construction only)
- Bearing locknut (136) (ball bearing construction only)
- Impeller wear rings [202, 202A, 202B (double suction pumps only)]
- Casing wear rings [164, 164A, 164B (double suction pumps only), 144]
- Radial bearing (168) (ball bearing construction only)
- Labyrinth seal, outboard (332A)
- Labyrinth seal, inboard (333A)
- Head / suction cover gasket [351, 351C, 351S, 351K&W (double suction pumps only)]
- Bearing lockwasher (382)
- Bearing end-cover gasket (360A)
- Bellville washer (354A)
- Throat bushing (125)

Troubleshooting

Operation troubleshooting

Symptom	Cause	Remedy
The pump is not delivering liquid.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line is clogged.	Remove the obstructions.
	The impeller is clogged.	Back-flush the pump in order to clean the impeller.
	The shaft is rotating in the wrong direction.	Change the rotation. The rotation must match the arrow on the bearing housing or pump casing.
	The foot valve or suction pipe opening is not submerged enough.	Consult an ITT representative for the proper submersion depth. Use a baffle in order to eliminate vortices.
	The suction lift is too high.	Shorten the suction pipe.
The pump is not producing the rated flow or head.	The gasket or O-ring has an air leak.	Replace the gasket or O-ring.
	The stuffing box has an air leak.	Replace or readjust the mechanical seal.
	The impeller is partly clogged.	Back-flush the pump in order to clean the impeller.
	The clearance between the impeller and the pump casing is excessive.	Adjust the impeller clearance.
	The suction head is not sufficient.	Make sure that the suction-line shutoff valve is fully open and that the line is unobstructed.
	The impeller is worn or broken.	Inspect and replace the impeller if necessary.
The pump starts and then stops pumping.	The pump is not primed.	Re-prime the pump and check that the pump and suction line are full of liquid.
	The suction line has air or vapor pockets.	Rearrange the piping in order to eliminate air pockets.
	The suction line has an air leak.	Repair the leak.
The bearings are running hot.	The pump and driver are not aligned properly.	Realign the pump and driver.
	There is not sufficient lubrication.	Check the lubricant for suitability and level.
	The lubrication was not cooled properly.	Check the cooling system.
The pump is noisy or vibrates.	The pump and driver are not aligned properly.	Realign the pump and driver.
	The impeller is partly clogged.	Back-flush the pump in order to clean the impeller.
	The impeller or shaft is broken or bent.	Replace the impeller or shaft as necessary.
	The foundation is not rigid.	Tighten the hold-down bolts of the pump and motor. Make sure the baseplate is properly grouted without voids or air pockets.
	The bearings are worn.	Replace the bearings.
	The suction or discharge piping is not anchored or properly supported.	Anchor the suction or discharge piping as necessary according to recommendations in the Hydraulic Institute Standards Manual.
	The pump is cavitating.	Locate and correct the system problem.
The stuffing box is leaking excessively.	The packing gland is not adjusted properly.	Tighten the gland nuts.
	The stuffing box is not packed properly.	Check the packing and repack the box.
	The mechanical seal parts are worn.	Replace the worn parts.
	The mechanical seal is overheating.	Check the lubrication and cooling lines.
	The shaft sleeve is scored.	Machine or replace the shaft sleeve as necessary.
The motor requires excessive power.	The discharge head has dropped below the rated point and is pumping too much liquid.	Install a throttle valve. If this does not help, then trim the impeller diameter. If this does not help, then contact your ITT representative.
	The liquid is heavier than expected.	Check the specific gravity and viscosity.
	The stuffing-box packing is too tight.	Readjust the packing. If the packing is worn, then replace the packing.
	Rotating parts are rubbing against each other.	Check the parts that are wearing for proper clearances.
	The impeller clearance is too tight.	Adjust the impeller clearance.

Alignment troubleshooting

Symptom	Cause	Remedy
Horizontal (side-to-side) alignment cannot be obtained (angular or parallel).	The driver feet are bolt-bound.	Loosen the pump's hold-down bolts, and slide the pump and driver until you achieve horizontal alignment.
	The baseplate is not leveled properly and is probably twisted.	1. Determine which corners of the baseplate are high or low. 2. Remove or add shims at the appropriate corners. 3. Realign the pump and driver.

Parts Listings and Cross-Sectional Drawings

Parts list

Table 5: Materials of Construction, Liquid End Components

Goulds Material Class		S-6	S-8N	C-6	A-8N	D-1	D-2
API 610 (ISO 13709) Material Class		S-6	S-8	C-6	A-8	D-1	D-2
Item	Component	Material					
100	Casing Barrel	1212		1234	1296	1402	1401
101	Impellers	1222	1265	1222	1265	1362	1361
122	Shaft	2238[1]	2351	2252	2351	2435	3280
125	Throat Bushing	2245	2445	2245	2445	6187	6171
128	Balance Drum Sleeve	2445				6186	6170
129	Balance Drum	2222	1265	2222	1265	6187	6171
144	Casing Wear Ring - Hub	2222	1265	2222	1265	6187	6171
146	Interstage Bushing	2222	1265	2222	1265	6187	6171
150	Intermediate Cover	1222	1265	1222	1265	1362	1361
150B	Discharge Cover	1222	1265	1222	1265	1362	1361
164, 164A, 164B	Casing Wear Ring - Suction	2222	1265	2222	1265	6187	6171
178	Key - Impeller / Sleeve	2244	2229	2244	2229	2435	3280
182	Suction Cover	1212		1234	1296	1402	1401
182A	Double Suction Cover	1212		1234	1296	1402	1401
184	Head	1212		1234	1296	1402	1401
185	Dowel Pin - Intermediate Cover	2244	2229	2244	2229	2435	3280
202, 202A, 202B	Impeller Wear Ring - Suction	2255[2]	1071	2255[2]	1071	6186	6170
203	Impeller Wear Ring - Hub	2255[2]	1071	2255[2]	1071	6186	6170
204	Interstage Sleeve	2445				6186	6170
253	Retainer - Locating Ring	2244	2229	2244	2229	2435	3280
351, 351S	Gasket - Head / Suction Cover	Spiral Wound 316ss				Spiral Wound Duplex	
351C	Gasket - Suction Cover IB	Grafoil					
351K, 351W	Gasket - Double Suction Cover	Grafoil					
353	Stud Gland	2239					
354A	Bellvill Washer - Bundle	3211				3270	3266
355	Nut - Gland	2285					
356A	Stud - Head	2239					
356F	Stud - Suction Cover	2239					

Goulds Material Class		S-6	S-8N	C-6	A-8N	D-1	D-2
API 610 (ISO 13709) Material Class		S-6	S-8	C-6	A-8	D-1	D-2
Item	Component	Material					
361F, 361H	Locating Ring - Sleeve / Impeller	2244	2229	2244	2229	3270	3266
371B	Cap Screw - Loc. Ring Retainer	2229				2435	3280
371E	Cap Screw - Balance Drum	2229				2435	3280
425	Nut - Head	2285					
425B	Nut - Suction Cover	2285					
426B	Cap Nut - Suction Cover	2239					
519	Locking Plate - Suction Cover	3207					
533	Washer - Head	Hardened Steel					

1. Standard shaft material for S6 material clas is ASTM A434 Grade 4140 Class BC (4140). API requirements that material be upgraded to A479 Type 410 on boiler feed service or when the operating temperature exceeds 350°F (180°C).
2. Impeller wear rings are optional (Impeller with integral rings is standard).

Table 6: Materials of Construction, Power Frame Components

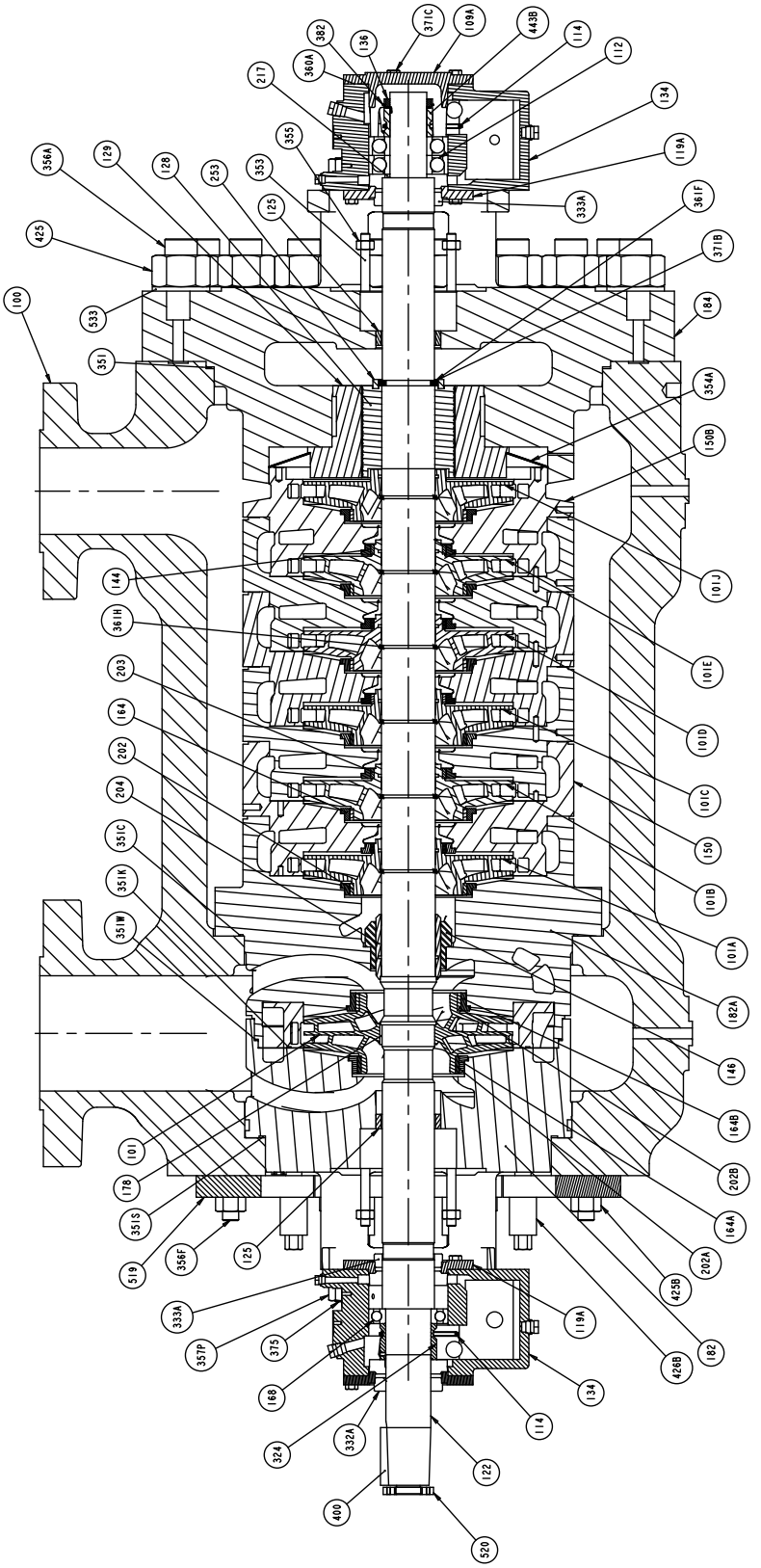
Item	Component	Material
109A	Bearing End Cover - Thrust	1212
112	Ball Bearing - Thrust	Steel
114	Oil Ring	1618
117	Sleeve Bearing	Steel / Babbitt
119A	Bearing End Cover - Radial	2210
119C	Cover - Oil Pump	2210
134, 134A	Bearing Housing	1212
136	Locknut - Thrust Bearing	Steel
168	Ball Bearing - Radial	Steel
178Y	Key - Coupling IMO Pump	2213
217	Bearing Spacer	2210
219	Oil Pump	Steel
280	Tilt Pad Thrust Bearing	Steel / Babbitt
282	Key - Thrust Collar	2213
283	Thrust Collar Nut	2210
318A	Oil Pump Adapter	1212
324	Oil Ring Sleeve - Radial Bearing	2210
332A	Inpro VBXX-D - Outboard	Bronze / Viton
333A	Inrpo VBXX-D - Inboard	Bronze / Viton
357P	Nut - Bearing Housing to Casing	2341
360A	Gasket - Bearing End Cover	Vellumoid
360D	Gasket - Oil Pump Adapter	Vellumoid
370L	Cap Screw - Oil Pump to Adapter	2210
370V	Cap Screw - Adapter to Bearing Housing	2210
371C	Cap Screw - Cover to Bearing Housing	2210
375	Stud - Bearing Housing to Casing	2210
382	Lockwasher - Thrust Bearing	Steel
390C, 390M	Shim - Oil Pump Adapter	304ss
400	Key - Coupling	2213
412M	O-Ring - Filler Plate	Viton
441A	Filler Plate	2210
443B	Oil Ring Sleeve - Thrust Bearing	2210
520	Nut - Coupling	2210

Table 7: Material Description

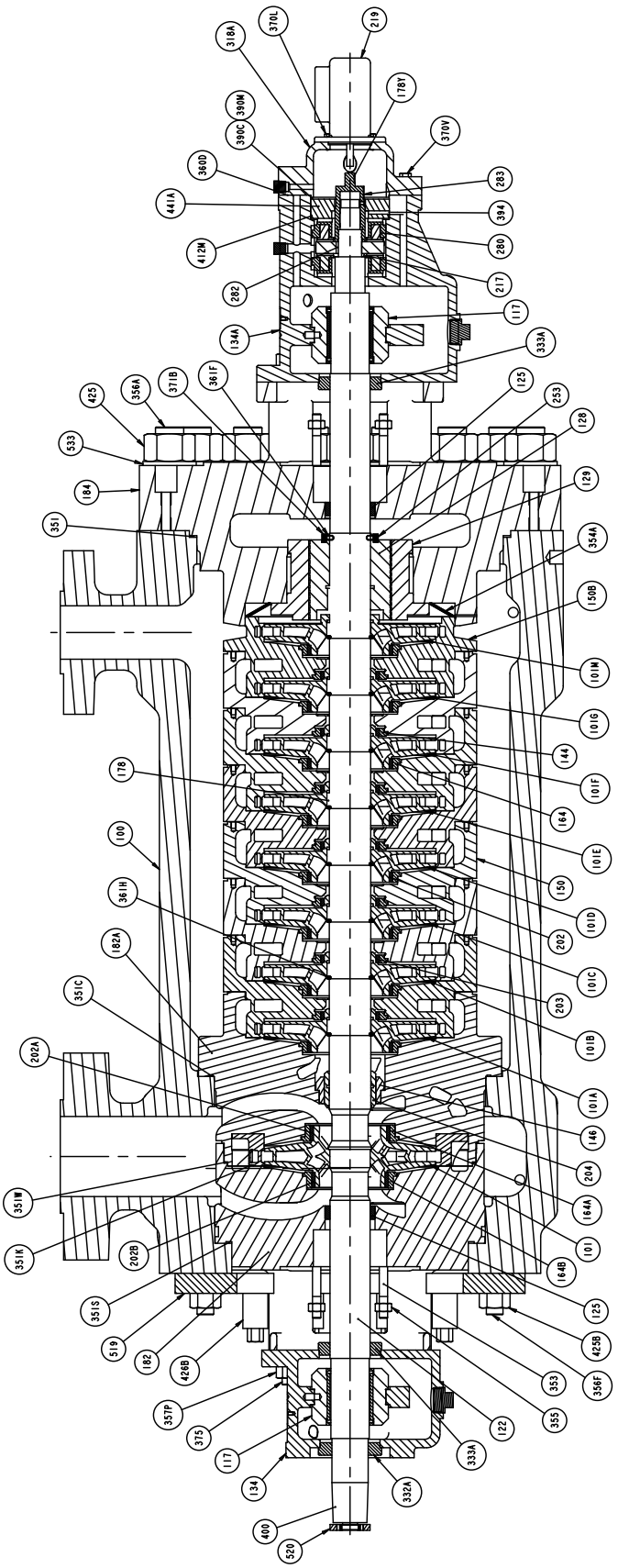
Material	Description	Form	ASTM	UNS
1071	Nitronic	Casting	A743 Grade CF10SMnNA216	----
1212	Carbon Steel	Casting	A216 Grade WCB	J03002
1222	12% Chrome	Casting	A743 Grade CA6NM Class A	J91540
1234	12% Chrome	Casting	A487 Grade CA6NM Class A	J91540
1265	316LSS	Casting	A743 Grade CF3M	J92800
1361	Super Duplex SS	Casting	A890 Grade 5A	J93404
1362	Duplex SS	Casting	A890 Grade 3A	J93371
1296	316LSS	Casting	A351 Grade CF3M	J92800
1401	Super Duplex SS	Casting	A995 Grade 5A	J93404
1402	Duplex SS	Casting	A995 Grade 3A	J93371
1618	Bismuth Bronze	Casting	B505 C89320	C89320
2210	Carbon Steel	Wrought	A108 Grade 1213	G12130
2210	Carbon Steel	Fastner	A307 Grade B	----
2213	Carbon Steel	Wrought	A108 Grade 1020	G01200
2222	420SS Hardened	Wrought	A276 Type 420	S42000
2229	316SS	Wrought	A276 Type 316	S31600
2229	316SS	Fastner	F593 Alloy Group 2	S311600
2238	Alloy Steel	Wrought	A434 Grade 4140 Class BC	G41400
2239	Alloy Steel	Fastner	A193 Grade B7	G41400
2245	410SS Hardened	Wrought	A276 Type 410	S41000
2255	17-4PH	Wrought	A564 type 630 Cond. H1150D	S17400
2285	Alloy Steel	Fastner	A194 Grade 2H	K04002
2341	Carbon Steel	Fastner	A563 Grade A	K05802
2351	Nitronic 50	Wrought	A276 Type XM-19	S20910
2435	Duplex SS	Wrought	A276 Type S31803	S31803
2445	Nitronic 60	Wrought	A276 Type S21800	S21800
3207	Carbon Steel	Wrought	A516 Grade 70	K02700
3211	316SS	Wrought	A240 Type 316	S31600
3266	Super Duplex SS	Wrought	A240 Type S32750	S32750
3270	Duplex SS	Wrought	A240 Type S31803	S31803
3280	Super Duplex SS	Wrought	A479 Type S32750	S32750
6170	Duplex SS Hardface Stellite 6	Coating	n/a	n/a
6171	Duplex SS Hardface Stellite 12	Coating	n/a	n/a
6186	Super Duplex SS Hard-face Stellite 6	Coating	n/a	n/a
6187	Super Duplex SS Hard-face Stellite 12	Coating	n/a	n/a

Cross-sectional diagrams

Model 7200CB - ball/ball



Model 7200CB - sleeve/hydrodynamic



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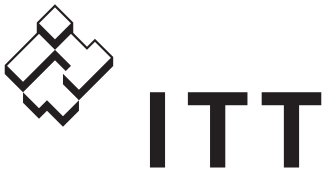

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The original instruction is in English. All non-English instructions are translations of the original instruction.

Form