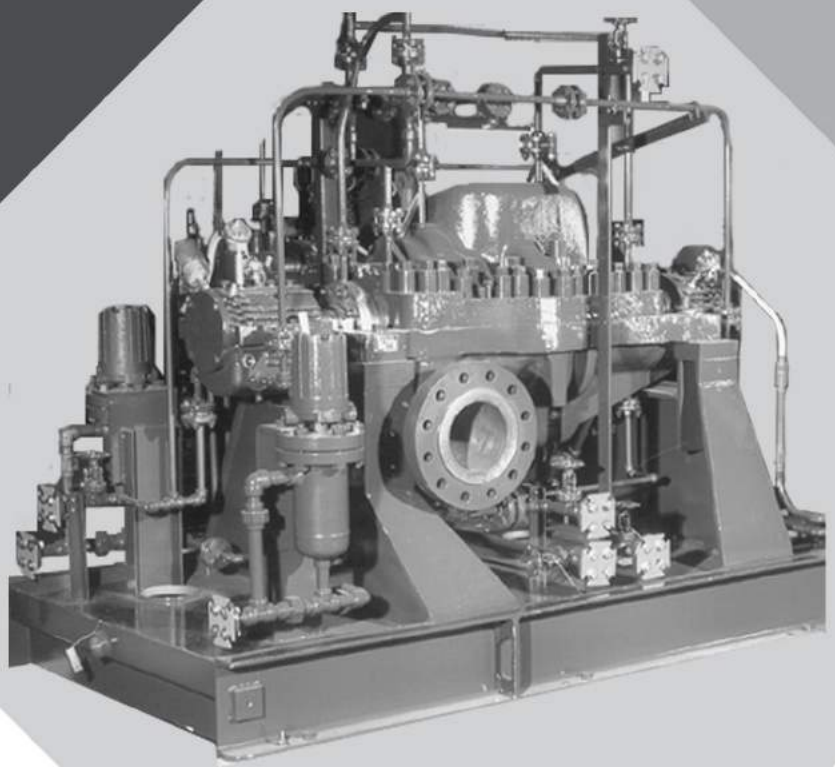
GOULDS PUMPS

Installation, Operation, and Maintenance Manual

Model 3600, API 610 8th, 9th, 10th & 11th Editions (ISO 13709)



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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.
- If the pump/motor is damaged or leaking, do not operate as it may cause an electric shock, fire, explosion, liberation of toxic fumes, physical harm, or environmental damage. Correct/repair the problem prior to putting back in service.
- 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 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 sections 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.

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. Consult with a lifting and rigging specialist before lifting or moving the pump to avoid possible damage to the pump or injury to personnel.

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

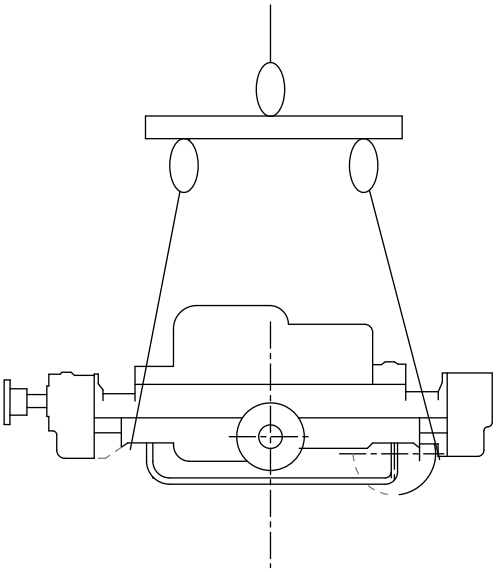


Figure 2: Example of the proper lifting method for a bare pump

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

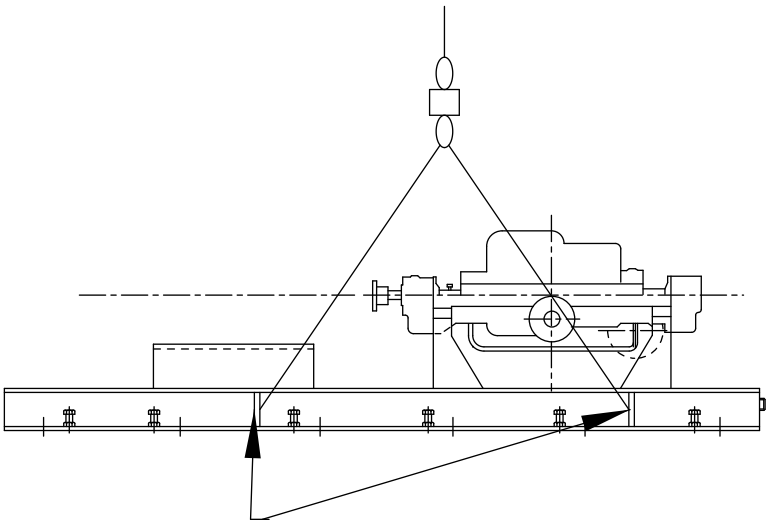


Figure 3: Example of the proper lifting method for baseplate-mounted units without a driver

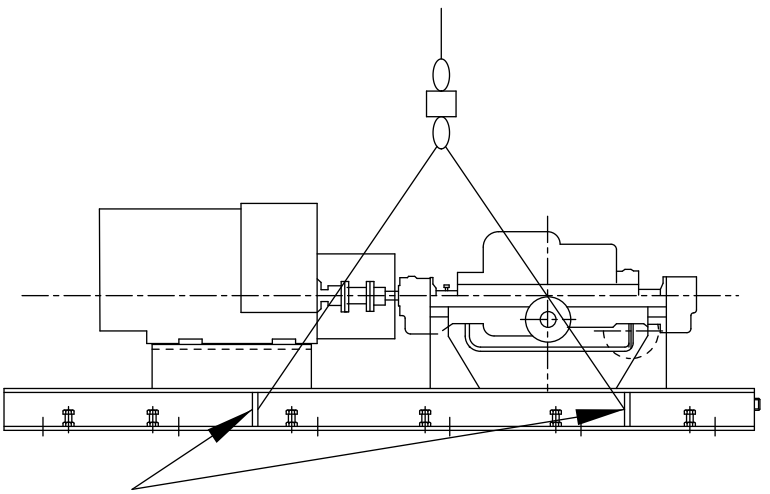


Figure 4: Example of the proper lifting method for baseplate-mounted units with a driver

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.

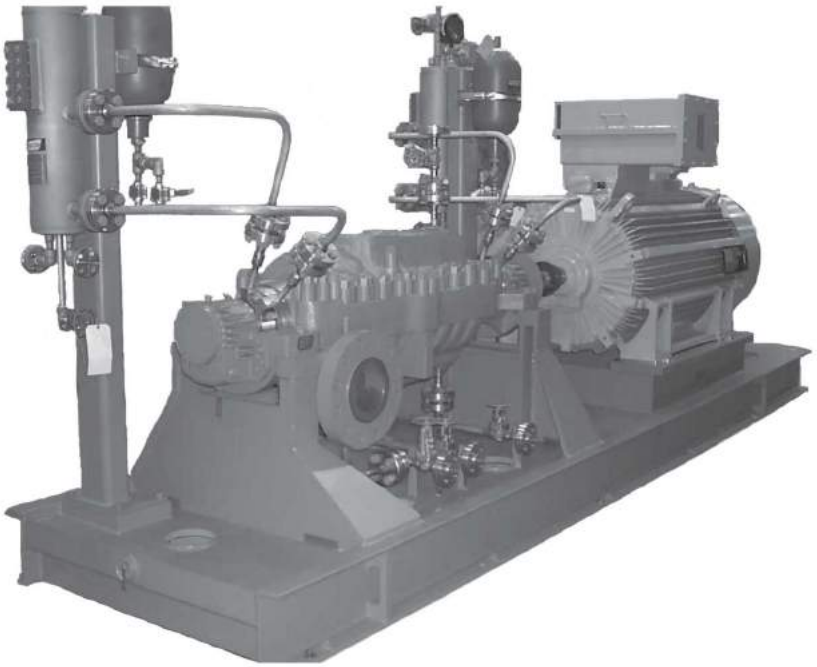
For questions about possible long-term storage treatment services, please contact your local ITT sales representative.

Product Description

General description

Product description

Model 3600 is a high-pressure, multistage, between the bearings, horizontal centrifugal pump that meets the requirements of API 610 11th Edition (ISO 13709).



Casing

The casing is near-centerline mounted with side-suction and side-discharge nozzles.
The standard flanges are ASME Class 900 raised-face serrated with a 125-250 RMS finish.
The following flanges are also available:

- ASME Class 600 raised-face serrated
- ASME Class 600 ring joint
- ASME Class 900 ring joint
- ASME Class 1500 raised-face serrated
- AMSE Class 1500 ring joint

Impeller

The impeller is fully closed and key driven by the shaft.

Seal chamber

The seal chamber meets API 682 3rd Edition dimensions for improved performance of mechanical seals.

Power end

The power end has the following characteristics:

- Ductile iron bearing housings are standard on non-API services.
- Carbon steel bearing housings are standard on API services.
- The oil level is viewed through a sight glass.

- Constant-level oilers and labyrinth seals are standard.
- No machining is required to convert the standard ring oil lube to either purge-oil or pure-oil mist (pure-oil 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 (standard for size 6x8-13 pumps)
Outboard (thrust)	• Consists of a pair of single-row angular contact ball bearings mounted back-to-back (standard) • Shouldered and locked into place, enabling the bearing to carry both radial and axial thrust loads • Optional hydrodynamic thrust bearing (used with sleeve-type journal bearings)

Shaft

The heavy-duty shaft has the following characteristics:

- Designed for cartridge mechanical seals
- Minimal shaft deflection at the seal faces (0.002) when run in the worst-case condition (typically minimum flow)
- Fully compliant with API 10th Edition (ISO 13709)

Baseplate

The fabricated steel baseplate supports the pump, driver, and accessories in accordance with API-610 10th Edition (ISO 13709) requirements.

Direction of rotation

The shaft rotates counterclockwise when viewed from the power end.

Intended applications

Model 3600 is designed to meet the rigorous demands of the petroleum and petrochemical industry.

Nameplate information

Important information for ordering

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
Pump casing Pump	Provides information about the hydraulic characteristics of the pump. The formula for the pump size is: Discharge x Suction - Nominal Maximum Impeller Diameter in inches. (Example: 2x3-8)

Nameplate	Description
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.

Nameplate on the pump casing using English units

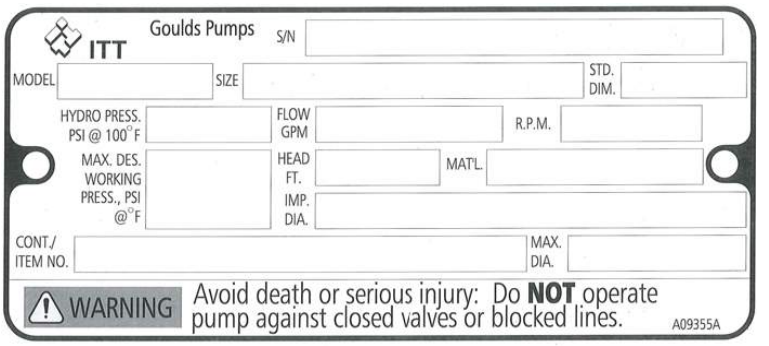


Figure 5: Nameplate on the pump casing using English units

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

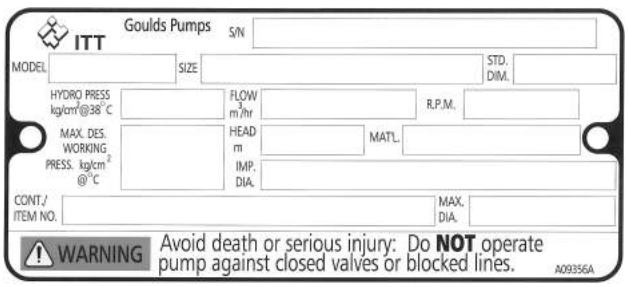


Figure 6: Metric units - nameplate on pump casing

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 Kg/cm^2
MAX. DES. WORKING PRESS	Maximum working pressure at temperature °C in kilograms per square centimeter
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

Nameplate field	Explanation
MAT'L	Material of construction

ATEX nameplate

Figure 7: 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:

- ⟨Ex⟩ When installing in a potentially explosive environment, make sure that the motor is properly certified.
- ⟨Ex⟩ 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.
- Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.

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 hoist rings, shackles, 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.	The best pump location for noise and vibration absorption is on a concrete floor with subsoil underneath.
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 bolts

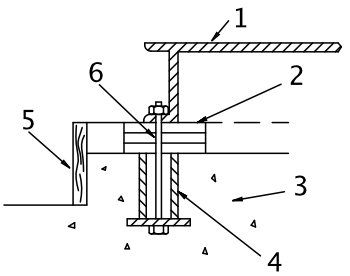


Figure 8: Sleeve type bolts

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

J-type bolts

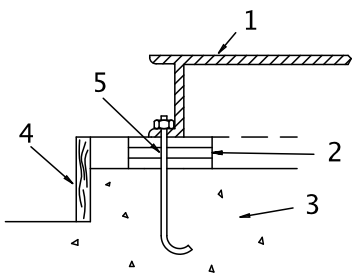


Figure 9: J-type bolts

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

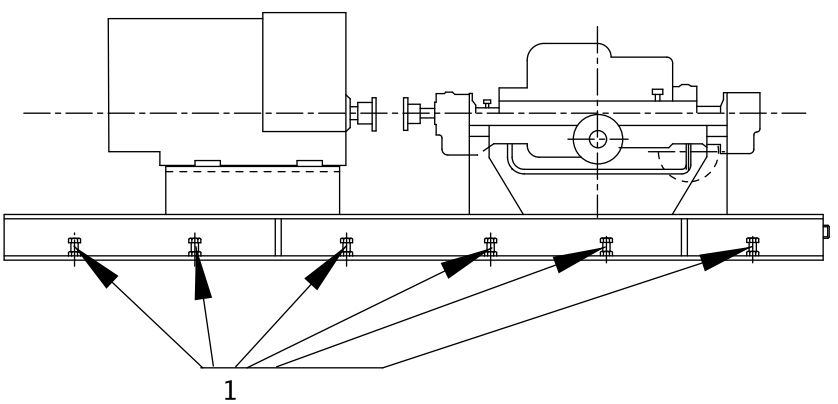
1. Chip the top of the foundation to a minimum of 1.0 in. (25.0 mm) in order to remove porous or low-strength concrete.
   If you use a pneumatic hammer, make sure that it does not contaminate the surface with oil or other moisture.

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.

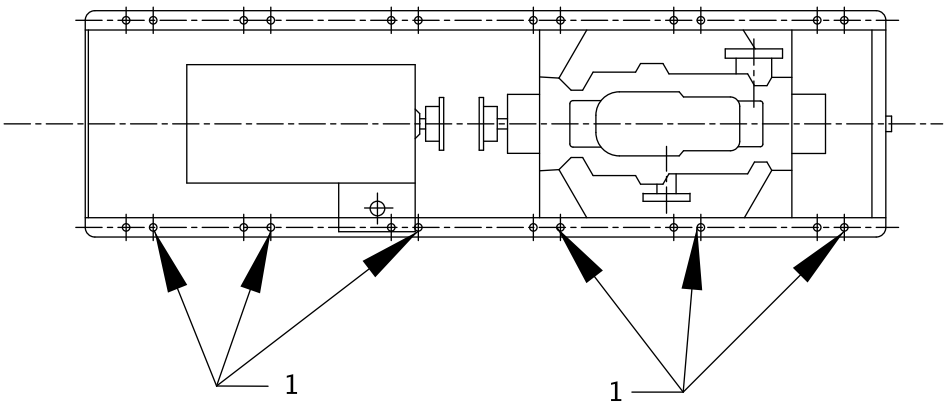
Install and level the baseplate

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



1. Jackscrews

Figure 10: Jackscrew locations, side view



1. Jackscrews

Figure 11: Jackscrew locations, top 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 . 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.
- Ⓔx 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.

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.

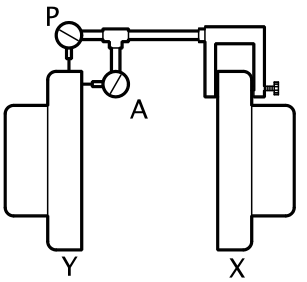


Figure 12: Dial indicator attachment

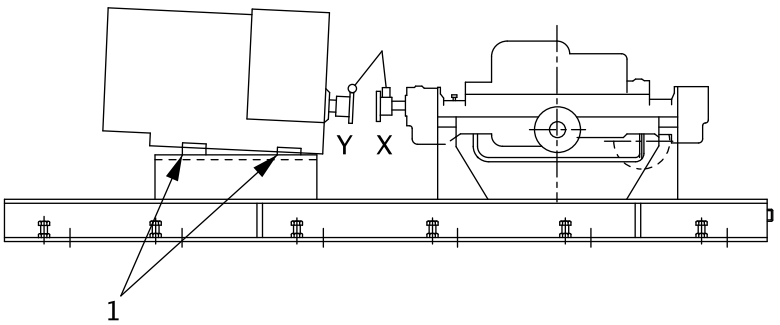
2. Rotate the pump coupling half (X) in order to check that the indicators are in contact with the driver coupling half (Y) but do not bottom out.
3. Adjust the indicators if necessary.

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.

When the reading value is...	Then...



1. Shims

Figure 13: 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.

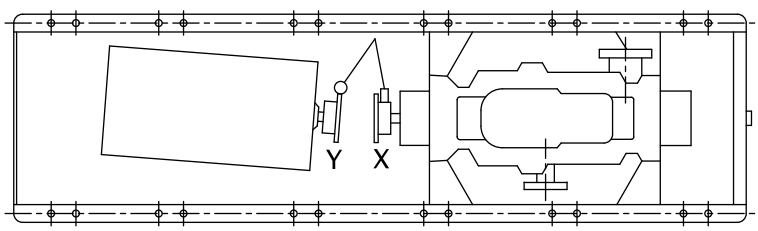


Figure 14: Example of incorrect horizontal alignment (top view)

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

Perform parallel alignment for a vertical correction

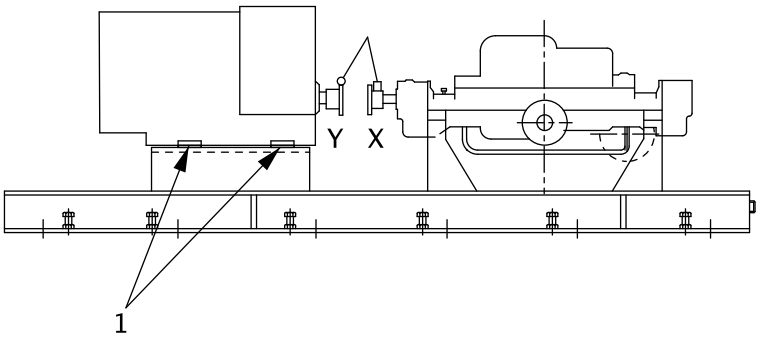
Refer to the alignment table in "Permitted indicator values for alignment checks" (see Table of Contents for location of table) for the proper cold alignment value based on the motor temperature rise and the pump operating temperature.

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.



1. Shims

Figure 15: 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).
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.

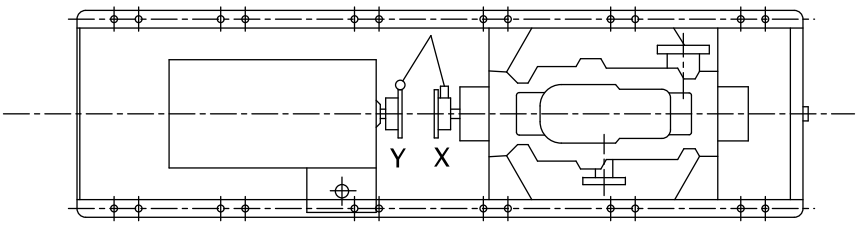


Figure 16: Example of incorrect horizontal alignment (top view)

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, latest edition, Appendix L; API RP 686, Chapter 5; and other industry standards.

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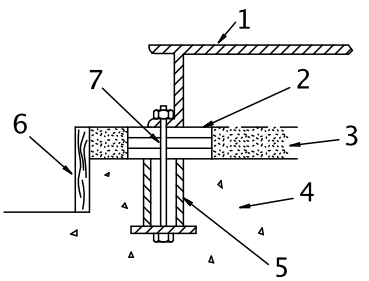
1. Clean all the areas of the baseplate that will come into contact with the grout.
2. Build a dam around the foundation.
3. Thoroughly wet the foundation that will come into contact with the grout.
4. Pour grout through the grout hole into the baseplate up to the level of the dam.
   When you pour the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

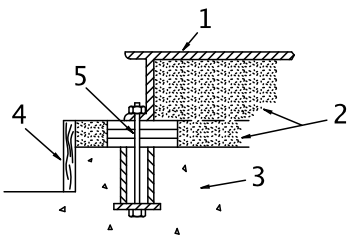
5. Allow the grout to set.



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

Figure 17: Pour grout into baseplate

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

Figure 18: Fill remainder of baseplate with grout

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.

CAUTION:

Ⓔx 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.	This helps to prevent misalignment due to thermal expansion of the piping.	
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. maximum (0.025 mm/mm to 0.8 mm/mm) of the flange diameter.
Concentric	You can easily install the flange bolts by hand.

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	—	
Suggested suction strainers are used. Check that they are at least three times the area of the suction piping. Monitor the pressure drop across the suction strainer. An increased pressure drop across the strainer of 5 psi (34.5 kPa) indicates that the strainer should be removed and cleaned. After a period of time (24 hours minimum) system flushing should be complete and the suction strainer can be removed.	Suction strainers help to prevent debris from entering the pump. Mesh holes with a minimum diameter of 1/16 in. (1.6 mm) are recommended. Liquids with specific gravity less than 0.60 a pressure drop across the suction strainer may be due to ice buildup. Ice buildup can cause turbulence, low pressure areas and pumpage vaporization.	

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 and prevent vapor locking especially with specific gravity of liquid less than 0.60.	
If necessary, make sure that the suction piping includes a drain valve and that it is correctly installed.	—	
Assure adequate insulation is applied for liquids with specific gravity less than 0.60.	To assure sufficient NPSHa.	

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. For specific gravity less than 0.60, minimize distance from pump discharge.	The isolation valve is required for: • Priming • Regulation of flow • Inspection and maintenance of the pump • Reduce risk of pumpage vaporization and vapor locking at low flow rates for low specific gravity liquids.	
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.	—	
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:

- ⟨Ex⟩ 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.
- ⟨Ex⟩ 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:

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

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.	
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

DANGER:
Avoid death or serious injury. Explosion and/or seizure of pump can cause fire and/or burns. Never operate pump past the pressure and temperature limits shown on the nameplate on the pump.

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.
- Avoid death or serious injury. Leaking fluid can cause fire and/or burns. Operating the pump above maximum rated flow shown on the pump curve leading to an increase in horsepower and vibration along with an increase in NPSHr resulting in mechanical seal and/or shaft failure and/or loss of prime.
- Avoid death or serious injury. Leaking fluid can cause fire and/or burns. Speed of pump must reach 2000 rpm for 2 pole motors and 1000 rpm for 4 pole motors within 10 seconds or an increase in vibration and rotor deflection and decrease in rotor stability leading to mechanical seal and/or shaft failure and/or pump seizure can occur.
- Never operate the pump without the coupling guard correctly installed.
- Ⓔx 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
- Avoid death or serious injury. Explosion and/or seizure of pump can cause fire and/or burns. Assure balance line is installed and either piped to the pump suction or back to the suction vessel to avoid vaporization of pumped fluid.

DANGER:
Avoid death or serious injury. Leaking fluid can cause fire and/or burns. Assure all openings are sealed off prior to filling pump.

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. Accomplish this by flowing fluid from pump inlet to discharge drain (optionally, the casing vent can be included in warm-up circuit but not required). Soak for (2) hours at process 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.

Check the rotation - Frame Mounted

WARNING:

- Operating the pump in reverse rotation can result in the contact of metal parts, heat generation, and breach of containment.
- Ⓔx 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.

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

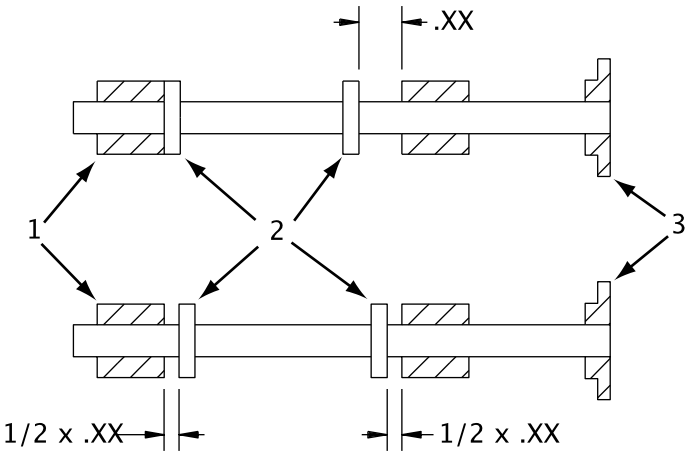
WARNING:

- Ⓔx 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- 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

Figure 19: Driver shaft centering

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

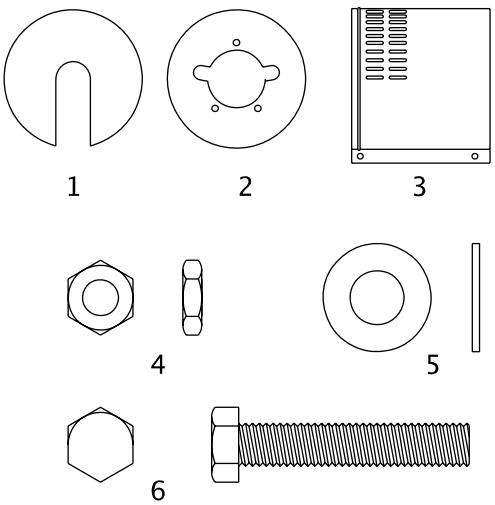
Precautions

WARNING:

- Never operate the pump without the coupling guard correctly installed.
- Avoid death or serious injury. Assure mechanical seal guard is properly installed using supplied fastening hardware.
- Ⓔx 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- 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

Figure 20: Required parts

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.

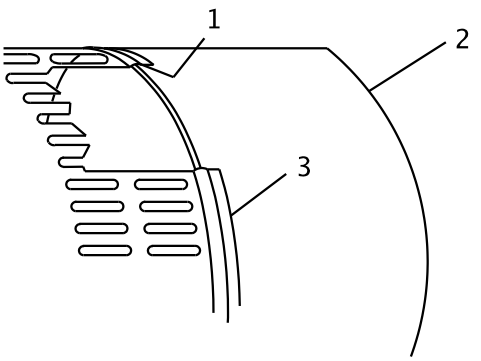
   b) If the coupling hub diameter is larger than the diameter of the opening in the end plate, then remove the coupling hub.

   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.

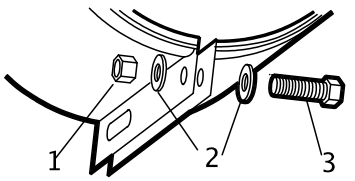
2. Slightly spread the opening of the coupling guard half and place it over the pump end plate. The annular groove in the guard is located around the end plate.
Position the opening (flange) so that it does not interfere with the piping but still allows for access when you install the bolts.



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

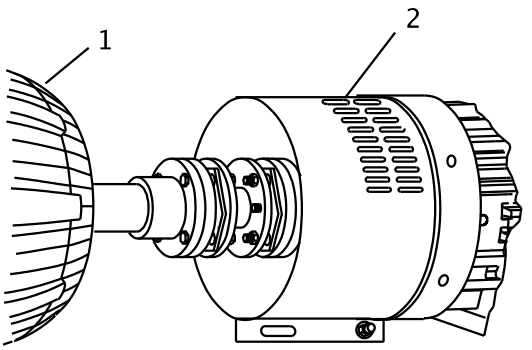
Figure 21: Coupling guard

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

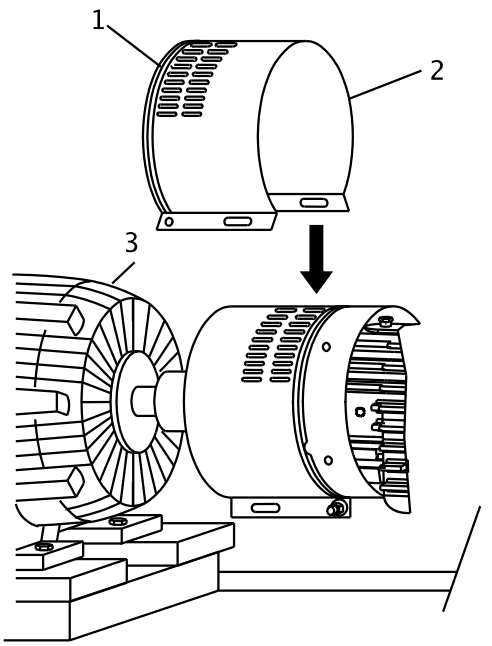
This figure shows an assembled unit:



1. Driver
2. Coupling guard half

Figure 22: Coupling guard

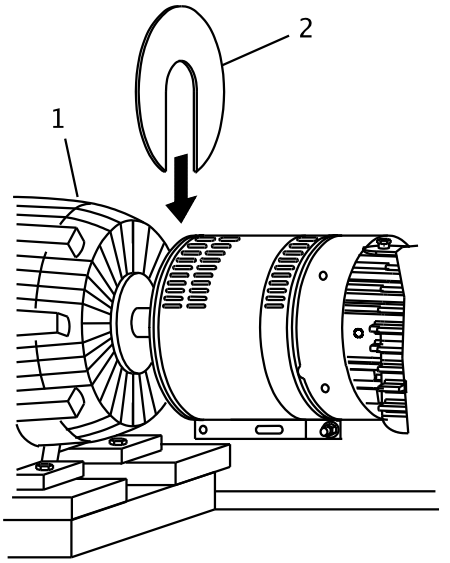
6. Slightly spread the opening of the remaining coupling guard half and place it over the installed coupling guard half so that the annular groove in the remaining coupling guard half faces the driver.



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

Figure 23: Coupling guard

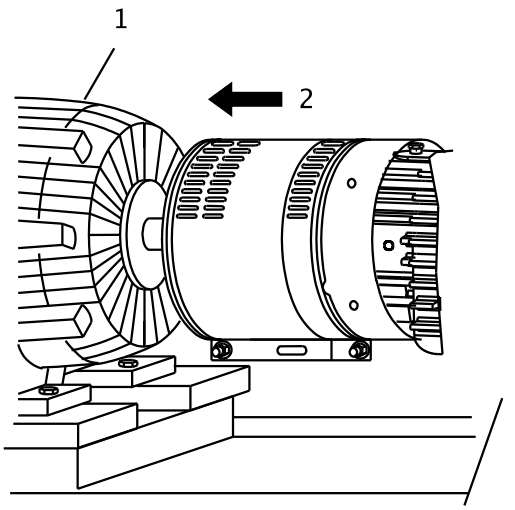
7. Place the end plate over the driver shaft and locate the end plate in the annular groove at the rear of the coupling guard half.



1. Annular groove
2. End plate

Figure 24: End plate and annular groove

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

Figure 25: 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.

NOTICE:

Avoid equipment damage. Refer to driver/coupling/gear manufactures IOM for instructions and recommendations for lubrication.

Pumps are shipped without oil

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

Ring oil lubrication

Ring oil-lubricated bearings are standard.Sleeve/ball bearings are optional. 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 and sleeve/ball bearings

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).

Size	Bearing housing oil volume	
	ounces	milliliters
3x4-8 3x4-9 3x6-9 3x6-10	50 (ball/ball) 50/100 (sleeve/ball)	1480 (ball/ball) 1480/2960 (sleeve/ball)
3x4-12 1/2 4x6-10 4x6-11 4x6-12 6x8-11 6x8-13 6x8-14 8x10-13 10x12-14 1/2 10x12-15 1/2	80 (ball/ball) 120/220 (sleeve/ball)	2365 (ball/ball) 3550/6505 (sleeve/ball)

Oil volume requirements for sleeve/Kingsbury type bearings

The sleeve/Kingsbury 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 (0.23 m^3/hr) for the Kingsbury 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

Brand	Lubricant type		
	Ball/ball	Sleeve/ball	Sleeve/Kingsbury
Exxon	Teresstic EP 68	Teresstic EP 46	Teresstic EP 32
Mobil	DTE Heavy Medium	DTE 746	DTE 732
Sunoco	Sunvis 968	Sunvis 946	Sunvis 932
Royal Purple	SYNFILM ISO VG 68	SYNFILM ISO VG 46	SYNFILM ISO VG 32

Lubricate the bearings with oil

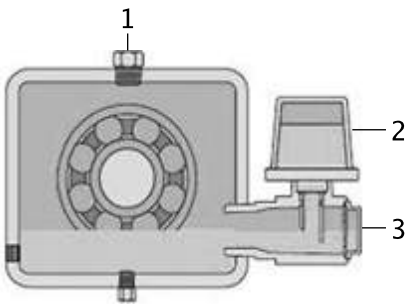
NOTICE:
Do not expose an idle pump to freezing conditions. Drain all liquid that is inside the pump and the cooling coils. Failure to do so can cause liquid to freeze and damage the pump.

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

Figure 26: Checking oil level

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

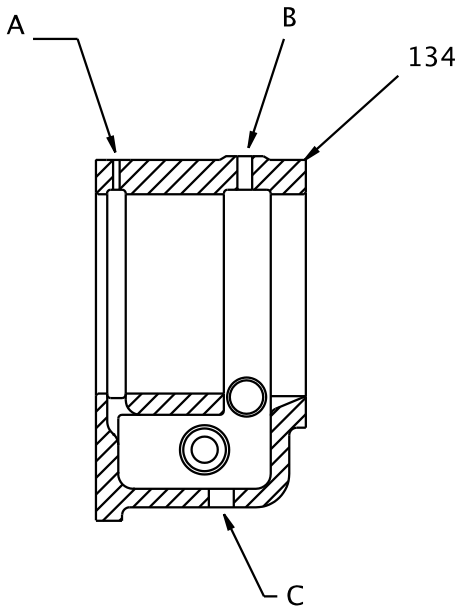
NOTICE:
Do not expose an idle pump to freezing conditions. Drain all liquid that is inside the pump and the cooling coils. Failure to do so can cause liquid to freeze and damage the pump.

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

3. For pure-oil mist, connect the drain lines to the outlet connections.
   This is not required for purge-oil mist.

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:

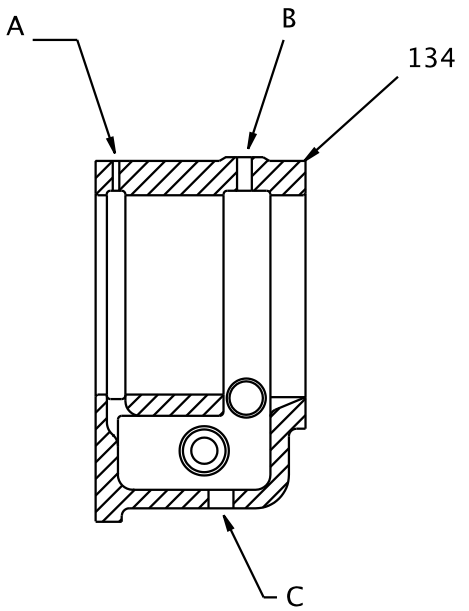
- 1/4 in. NPT connection on the inboard side of the housing
- 1/2 in. NPT connection on the outboard side

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.
3. Refer to "Reassembly" section for proper bearing greasing procedure.

Shaft sealing with a mechanical seal

Precautions

WARNING:
Ⓔx 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:

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

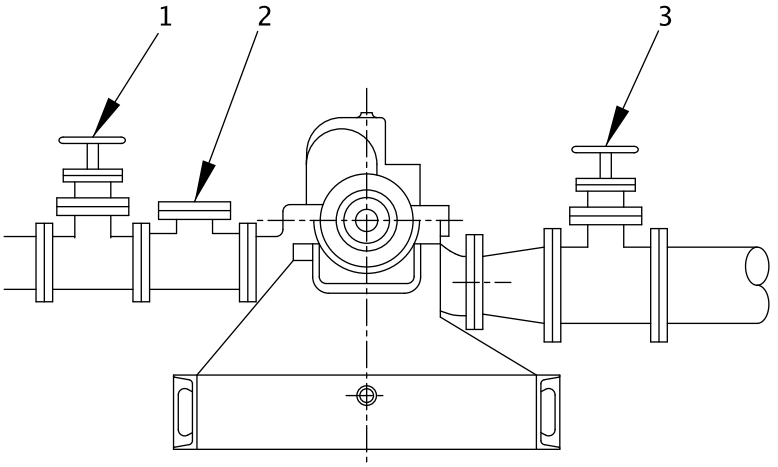
You can use these methods in order to flush or cool the seal:

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.

Pump priming

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

Figure 27: Suction supply above pump

Start the pump

WARNING: Immediately observe the pressure gauges. If discharge pressure is not quickly attained, stop the driver immediately, reprime, and attempt to restart 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.
- On pure or purge-oil mist-lubricated units, remove the viewing port plugs to verify that oil mist flowing properly. Replace the plugs.
- On frame mounted units, ensure that the oil level is correct prior to starting pump. Close coupled pumps do not have oil lubricated bearings.
- Ensure all flush and cooling systems are operating correctly prior to starting pump.

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.
- Do not operate pump past the maximum flow. For maximum flow refer to the pump performance curve.
- 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.
- Do not operate pump below hydraulic or thermal minimum flow. For hydraulic minimum flows refer to technical manual and pump performance curve. To calculate thermal minimum flow, refer to HI Centrifugal Pumps for Design and Application ANSI/HI 1.3-2000.
- 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.

NOTICE:

On ring oil-lubricated pumps, remove oil ring viewing port plugs to verify the following:

- The oil rings are properly positioned in the grooves on the shaft.
- The oil rings are turning.
- The oil rings are throwing oil.

Replace the plugs.

NOTICE:

- Check the bearing temperatures using a pyrometer or other temperature-measuring device. Monitor the bearing temperature frequently during initial operation in order to determine if a bearing problem exists, as well as to establish normal bearing operating temperature.
- For pumps with auxiliary piping, make sure that proper flows have been established and that the equipment is operating properly.
- Establish baseline vibration readings in order to determine normal running conditions. If the unit is running roughly, then consult the factory.
- Monitor all gauges to ensure that the pump is running at or near rating and that the suction screen (when used) is not clogged.

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. If pump becomes plugged shut down and unplug prior to restarting pump.

CAUTION:

- The pump and system must be free of foreign objects. If pump becomes plugged, shut down and unplug prior to restarting pump.
- 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 out the driver to prevent accidental rotation.

Make the final alignment of the pump and driver

WARNING:

- ⟨Ex⟩ 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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- 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.
- ⟨Ex⟩ Alignment procedures must be followed to prevent unintended contact of rotating parts. Follow coupling manufacturer's installation and operation procedures.

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.
   See Remove the coupling guard in the Maintenance chapter.
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.

Use this table to determine whether hot doweling is required.

Stage length	Pump size	Temperature threshold for hot doweling
3	all others	N/A
	6x8-14	370°F (188°C)
	8x10-13	340°F (171°C)
	10x12-14.5	320°F (160°C)
4	all others	N/A
	6x8-11D 6x8-13	360°F (182°C)
	6x8-14	330°F (166°C)
	8x10-13	300°F (149°C)
	10x12-14.5	280°F (138°C)
5	all others	N/A
	4x6-10D 4x6-11D 6x8-11	370°F (188°C)
	6x8-11D 6x8-13	330°F (166°C)
	6x8-14	300°F (149°C)
	8x10-13	270°F (132°C)
	10x12-14.5	250°F (121°C)

Stage length	Pump size	Temperature threshold for hot doweling
6	all others	N/A
	4x6-10	380°F (193°C)
	4x6-10D 4x6-11	360°F (182°C)
	4x6-11D 6x8-11	340°F (171°C)
	6x8-11D 6x8-13	300°F (149°C)
	6x8-14	270°F (132°C)
	8x10-13	240°F (116°C)
	10x12-14.5	225°F (107°C)
7	all others	N/A
	3x4-9	390°F (199°C)
	4x6-10	350°F (177°C)
	4x6-10D 4x6-11	330°F (166°C)
	4x6-11D 6x8-11	310°F (154°C)
	6x8-11D 6x8-13	270°F (132°C)
	6x8-14	250°F (121°C)
8	3x4-8	N/A
	3x4-9	360°F (182°C)
	3x6-9/10	380°F (193°C)
	4x6-10	330°F (166°C)
	4x6-10D 4x6-11	310°F (154°C)
	4x6-11D 6x8-11	280°F (138°C)
	6x8-11D 6x8-13	250°F (121°C)
	6x8-14	230°F (110°C)
9	3x4-8	370°F (188°C)
	3x4-9	340°F (171°C)
	3x6-9/10	360°F (182°C)
	3x4-12.5 4x6-12 4x6-10 4x6-10D 4x6-11	290°F (143°C)
	4x6-11D 6x8-11	260°F (127°C)
	6x8-11D	240°F (116°C)
10	3x4-8	350°F (177°C)
	3x4-9	310°F (154°C)
	3x6-9/10	330°F (166°C)
	3x4-12.5 4x6-12 4x6-10 4x6-10D 4x6-11	270°F (132°C)
	4x6-11D 6x8-11	250°F (121°C)
	6x8-11D	220°F (104°C)

Stage length	Pump size	Temperature threshold for hot doweling
11	3x4-8	330°F (166°C)
	3x4-9 3x6-9/10	300°F (149°C)
	4x6-10	270°F (132°C)
	3x4-12.5 4x6-12 4x6-10D 4x6-11	250°F (121°C)
	4x6-11D	240°F (116°C)
12	3x4-8	310°F (154°C)
	3x4-9 3x6-9/10	280°F (138°C)
	3x4-12.5 4x6-12 4x6-10 4x6-10D 4x6-11	240°F (116°C)
	4x6-11D	220°F (104°C)
13	3x4-8	290°F (143°C)
	3x4-9 3x6-9/10	260°F (127°C)
	3x4-12.5 4x6-12	220°F (104°C)
14	3x4-8	280°F (138°C)
	3x4-9 3x6-9/10	250°F (121°C)
	3x4-12.5 4x6-12	210°F (99°C)

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 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.
- If water-cooled pedestals have been provided, then do not drill through the baseplate pedestal. Doing so can result in leakage of cooling water.

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.

Dowel for hot service

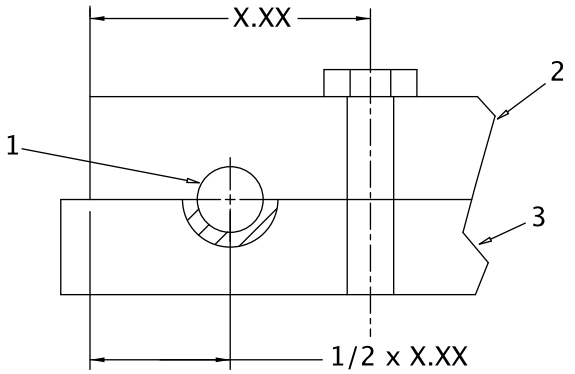
Required tools:

- One 1.00 in. dowel pin
- One 1.00 in. reamer
- Grinder
- 1.00 in. magnetic-based drill

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

1. Remove the hold-down bolts from the pump feet that are furthest from the coupling.
2. Scribe a mark midway between the end of the pump foot and the hold-down bolt hole centerline, parallel with the pump axis.
3. Re-torque the hold-down bolt between the pump foot and the pump pedestal.
4. Mill or grind a spot on the pump pedestal to make it flush with the pump foot.

5. Drill and ream for a 1.00 in. dowel pin, keeping the pin flush with the pump foot.



1. Dowel, 1.00 in. diameter X 1.5 in. long
2. Pump foot
3. Pedestal

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:

⟨Ex⟩ 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:

- ⟨Ex⟩ 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.
- ⟨Ex⟩ The mechanical seal must have an appropriate seal flush system or excess heat generation and seal failure can occur.

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.

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.
  - Electrical connections must be made by certified electricians in compliance with all international, national, state, and local rules.
  - Refer to driver/coupling/gear manufacturers installation and operation manuals (IOM) for specific instructions and recommendations.
- 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.
- A small amount of liquid will be present in certain areas like the seal chamber.

NOTICE:

- Avoid injury. Worn pump components can have sharp edges. Wear appropriate gloves while handling these parts.
- 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:

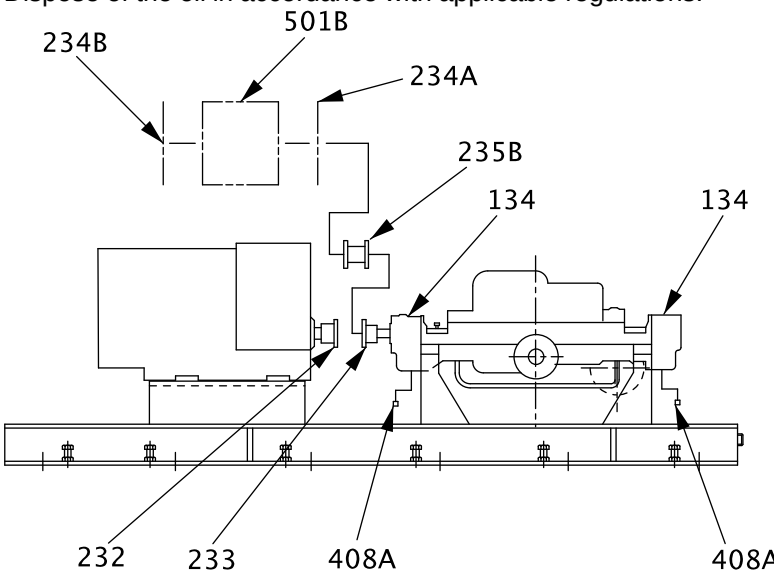
- Brass drift punch
- Cleaning agents and solvents
- Dial indicators
- Drill
- Feeler gauges
- Hex wrenches
- Induction heater
- Lifting sling
- Micrometers (inside and outside)
- Open end wrenches
- Press
- Soft face hammer

- Spanner wrench
- Spanning type puller
- Tap
- Torque wrench with sockets
- Lifting eyebolt (dependent on pump size)

Prepare for disassembly

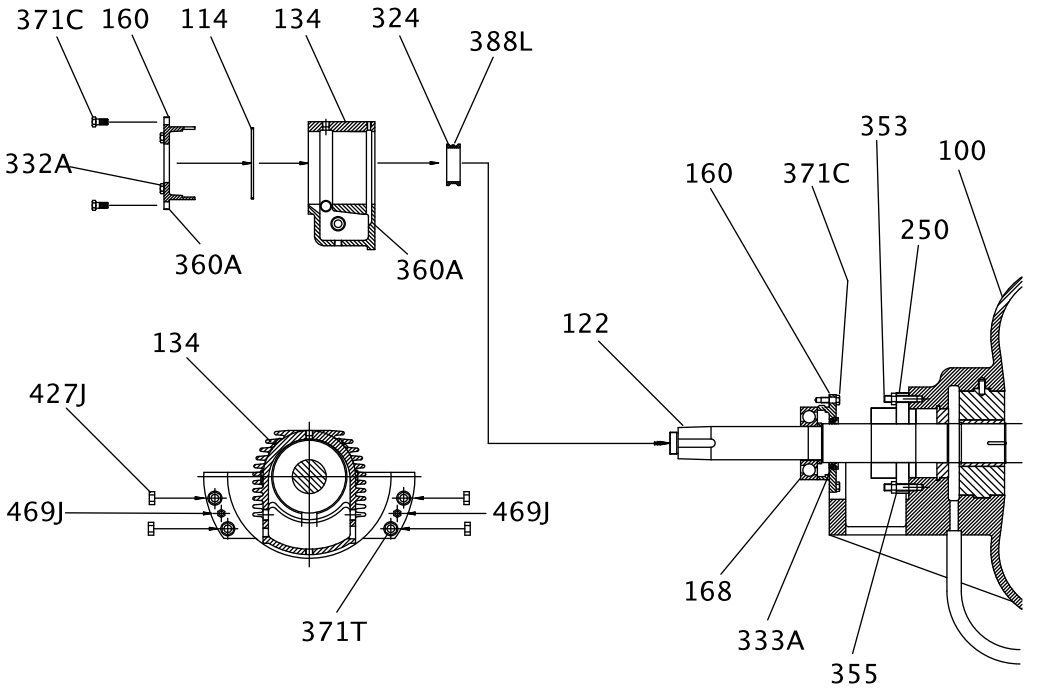
CAUTION:
Allow all system and pump components to cool before you handle them to prevent physical injury.

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.



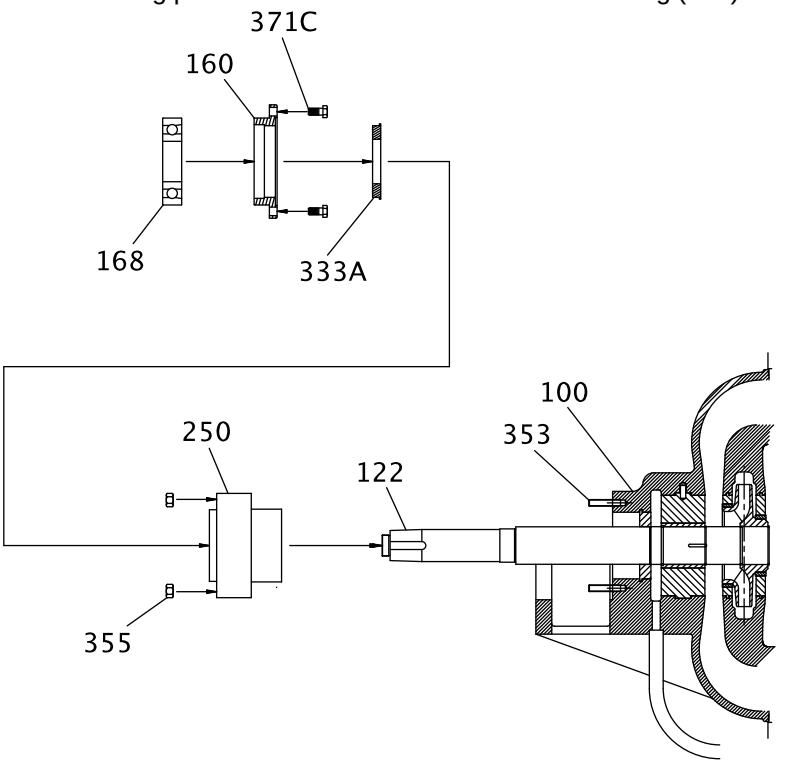
5. Remove the oiler bottle (251) and store it in a safe place.
6. Remove the coupling guard (501B).
   Refer to Remove the coupling guard in the Commissioning, Startup, Operation, and Shutdown chapter.
7. Unbolt and remove the coupling spacer (235B).
   Follow the instructions provided by the coupling manufacturer for assistance.
8. Remove the coupling guard pump endplate (234A).
9. Remove the coupling nut (520) from the tapered shaft end on the pump.
10. Remove the coupling hub (233) from the pump.
    - Scribe the shaft (122) for relocating the coupling hub during reassembly.
    - Use a spanner type puller or puller holes provided in the hub. Refer to the instructions provided by the coupling manufacturer for further assistance.
    - At this point, you can remove the pump from the baseplate.
11. Reposition the setting tabs in order to maintain the position of the mechanical seal.
    Refer to the seal installation drawing provided by the manufacturer.
    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 (160). Loosen the inboard end cover (160) and cover bolts (371C).
   The outboard labyrinth seal (332A) and the bearing housing gasket (360A) will come off with the outboard cover (160).
2. Remove the dowel pins (469J) between the bearing housing flange and the casing flange.
   The connection point of the housing to the casing is referred to as the saddle.
3. Unbolt the bearing housing from the saddle by removing the four nuts (427J).
4. Remove the studs (371T). Rotate the bearing housing in order to remove the inboard end cover bolts (371C).
5. Remove the oil ring (114).
6. Pull the bearing housing (134) off the shaft.
   The gasket (360A) remains on the bearing housing.
7. Loosen the setscrew (388L) on the oil ring sleeve (324) and remove the sleeve.

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



9. Remove the inboard bearing cover (160), the inboard labyrinth seal (333A), and the inner bearing cover bolts (371C).
10. Remove the seal plate nuts (355) and the mechanical seal (250).
    Refer to the instructions provided by the mechanical seal manufacturer.
11. (Optional) Remove the cooling plate bolts (388K and 388G), the cooling plate (490), and the cooling plate gaskets (360U and 360S not shown).
    Removal of the cooling plate is not required in order to remove the head from the case.

Disassemble the thrust end (ball bearing pumps)

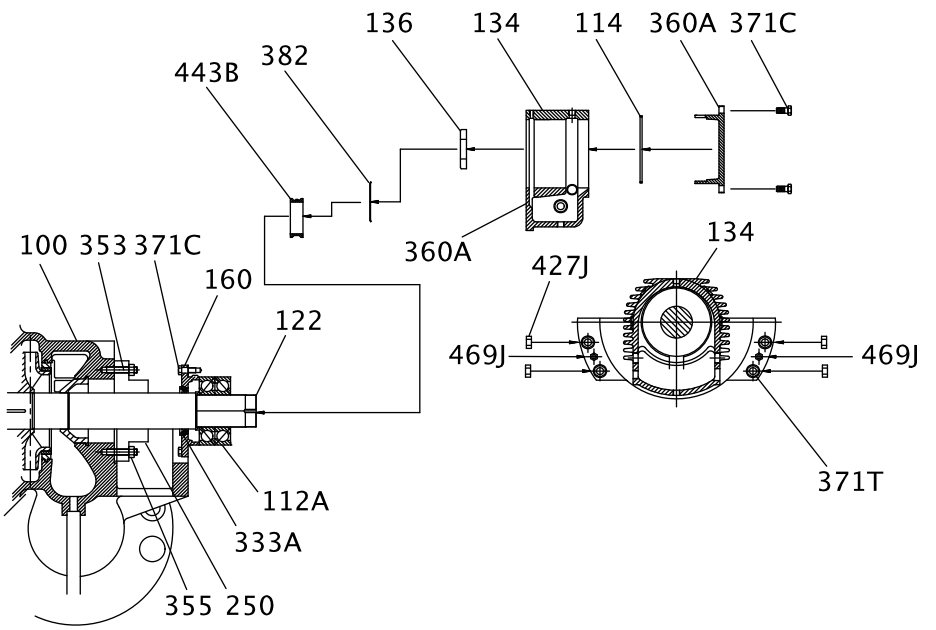


Figure 28: Thrust bearing disassembly

1. Unbolt the cover bolts (371C) and remove the outboard thrust bearing end cover (109A). Loosen the inboard end cover (160) and cover bolts (371C).
   The bearing housing gaskets (360A) will remain on the end covers (109A or 160).
2. Remove the dowel pins (469J) between the bearing housing flange and the head flange.
   The connection point of the housing to the casing is referred to as the saddle.
3. Unbolt the bearing housing from the saddle by removing the four nuts (427J).
4. Remove the studs (371T). Rotate the bearing housing in order to remove the inboard end cover bolts (371C).
5. Remove the oil ring (114).
6. Pull the bearing housing (134) off the shaft.
7. Remove the locknut (136) and the lockwasher (382).
8. Remove the oil ring sleeve (443B), which is held in place by the thrust locknut (136).
9. Use a bearing puller in order to remove the thrust bearing (112A) 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.

All pumps have a bearing spacer (217).

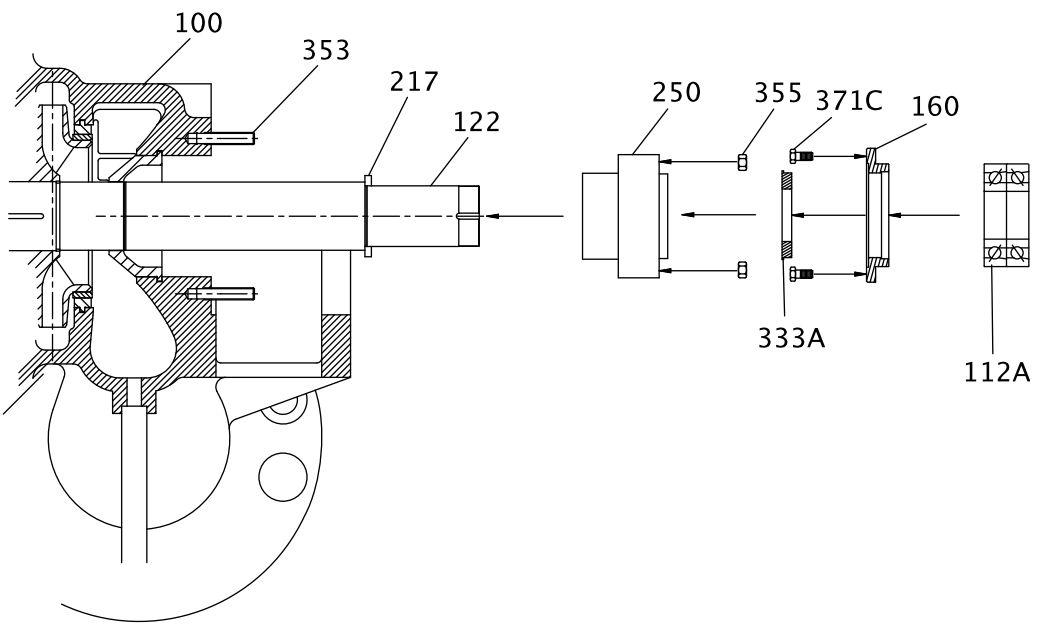


Figure 29: Thrust bearing disassembly

10. Remove the inboard bearing cover (160), the inboard labyrinth seal (333A), and the inner bearing cover bolts (371C).
11. Remove the seal plate nuts (355) and the mechanical seal (250).
    Refer to the instructions provided by the mechanical seal manufacturer.

Disassemble the radial end (sleeve/ball bearing pumps)

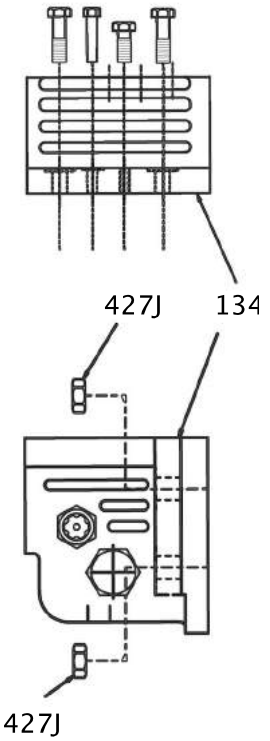


Figure 30: Disassemble the radial end

1. Remove the two dowel pins between the upper and lower halves of the bearing housing (134).
2. Remove the hex screws that connect the upper and lower halves of the bearing housing.
3. Tighten the two jackscrews on the horizontal parting flanges of the bearing housing in order to separate the two halves.
4. Remove the top half of the bearing housing with the upper half of the sleeve bearing (117). Notice that the bearing is pinned to the bearing housing.

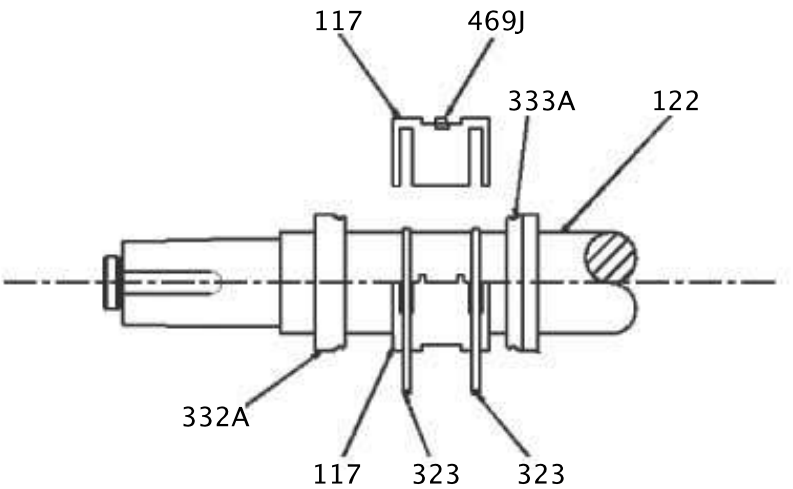


Figure 31: Remove radial sleeve bearing

5. Remove the dowel pins (469J) that hold the lower half of the bearing housing to the casing flange.

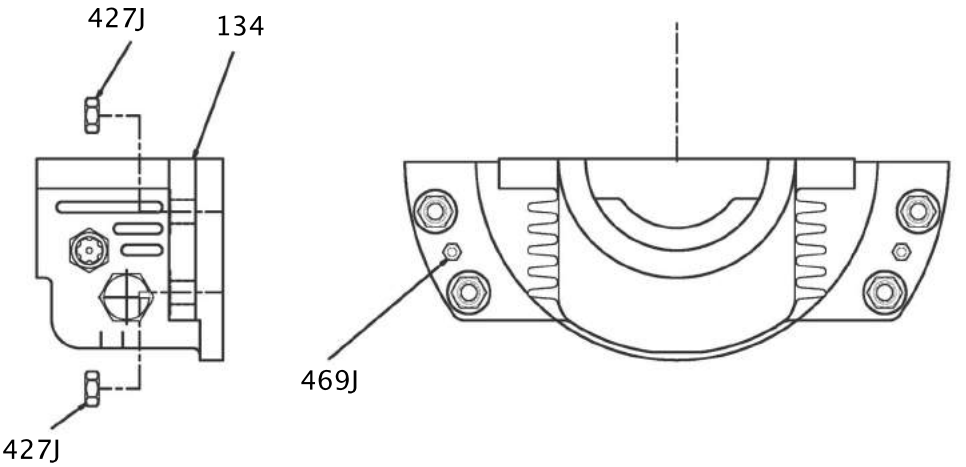


Figure 32: Dowel pin removal

6. Loosen and remove the nuts (427J) that hold the bearing housing in place.
7. Rotate the lower half of the sleeve bearing (117) around the shaft (122) in order to remove the bearing from the lower housing.
8. Remove the lower half of the bearing housing.
9. Remove the outboard labyrinth seal (332A), the two oil rings (323), and the inboard labyrinth seal (333A).

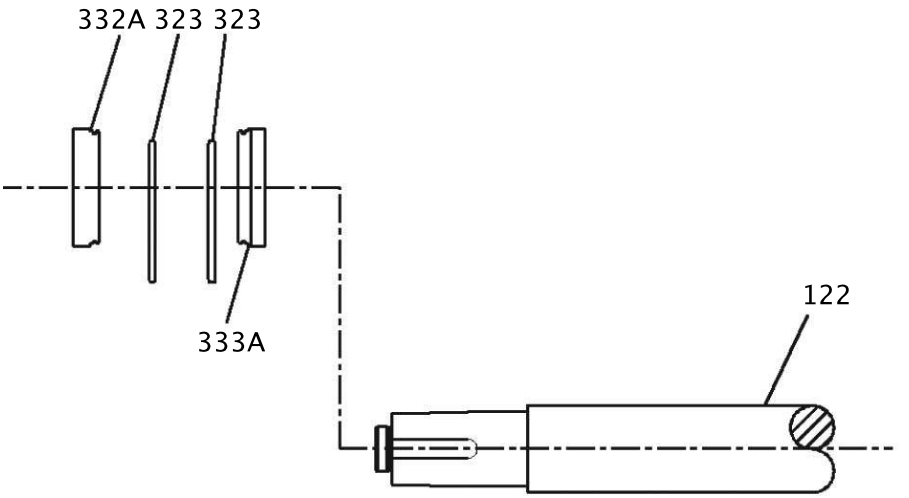


Figure 33: Labyrinth seal removal

Disassemble the thrust end (sleeve/ball bearing pumps)

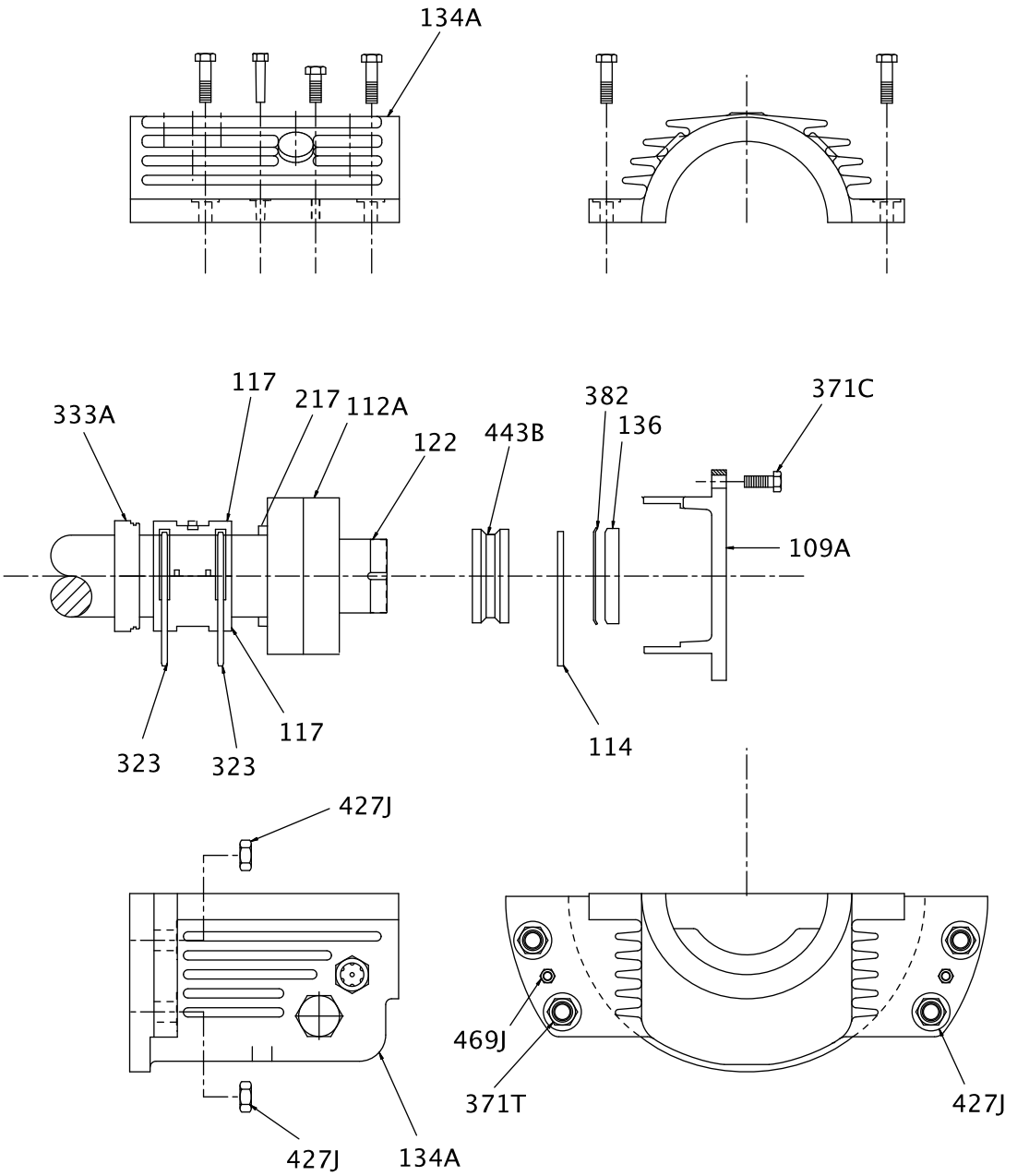


Figure 34: Thrust end disassembly

1. Remove the outboard end cover (109A) by removing the end cover bolts (371C).
2. Remove the upper half of the bearing housing (134A) from the lower half:
   a) Remove the dowel pins between the upper and lower halves of the bearing housing (134A).
   b) Remove the hex head screws that connect the upper and lower halves of the bearing housing (134A).
   c) Tighten the jackscrews in order to separate the housing halves.

d) Remove the top half of the thrust bearing (134A) housing with the upper half of the sleeve bearing (117). Notice that the bearing is pinned to the housing.

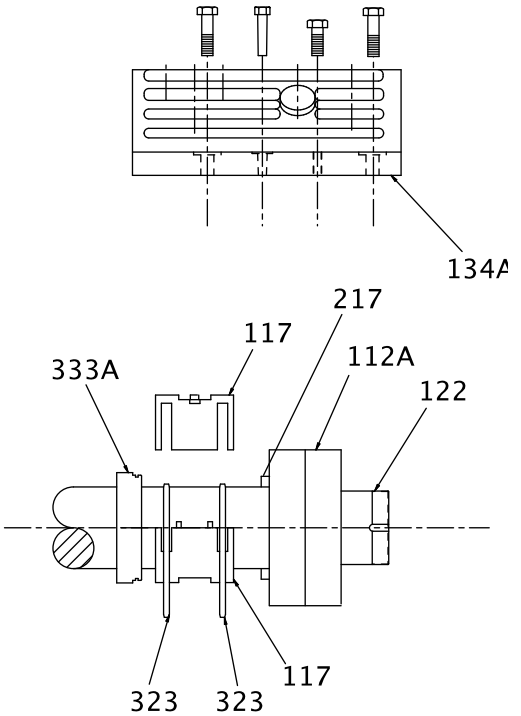


Figure 35: Removal of upper half of thrust bearing and sleeve bearing

3. Remove the outboard oil ring (114).

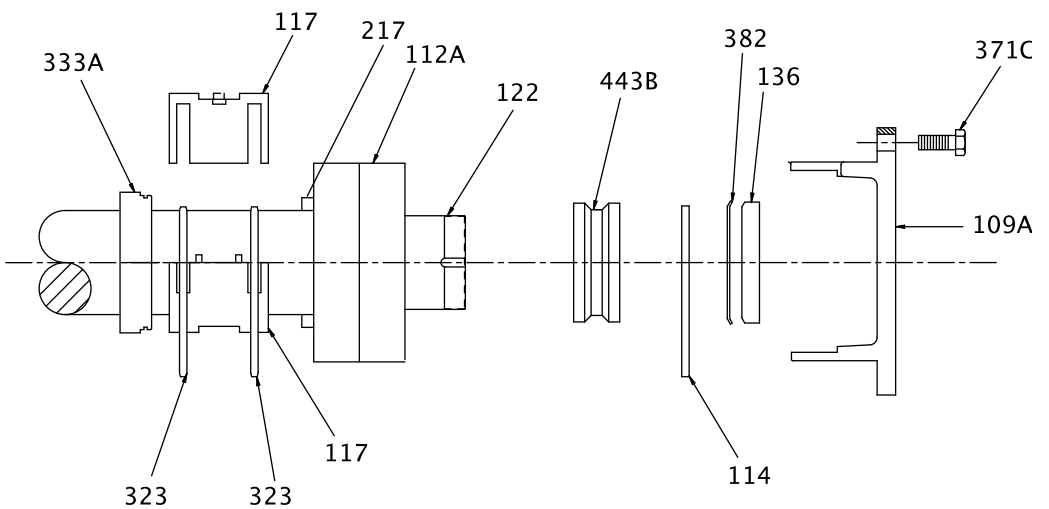


Figure 36: Outboard oil ring removal

4. Remove the dowel pins (469J) that hold the lower half of the bearing housing to the casing flange.

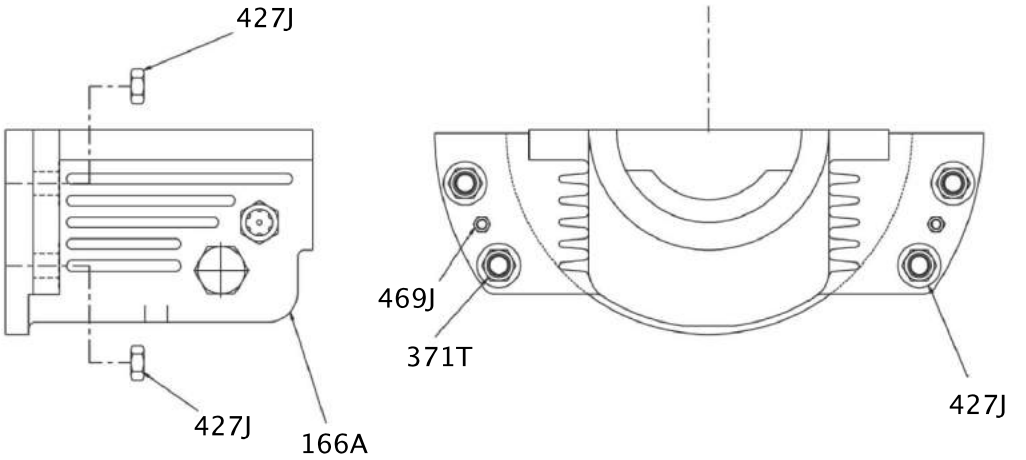


Figure 37: Dowel pin removal

5. Loosen the nuts (427J) that hold the bearing housing in place.
   The bearing housing will rest on the studs.
6. Rotate the lower half of the sleeve bearing (117) around the shaft (122) in order to remove it from the lower bearing housing.
7. Remove the nuts (427J).
8. Remove the lower half of the bearing housing (134A) using a crane. Remove the studs (371T).
9. Remove the thrust locknut (136) and the lockwasher (382) from the shaft.
10. Remove the oil ring sleeve (443B).
11. Use a bearing puller tool in order to remove the thrust bearing (112A) from the shaft.
    The inner race on this inner duplex bearing will likely remain 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.

All pumps have a bearing spacer (217).

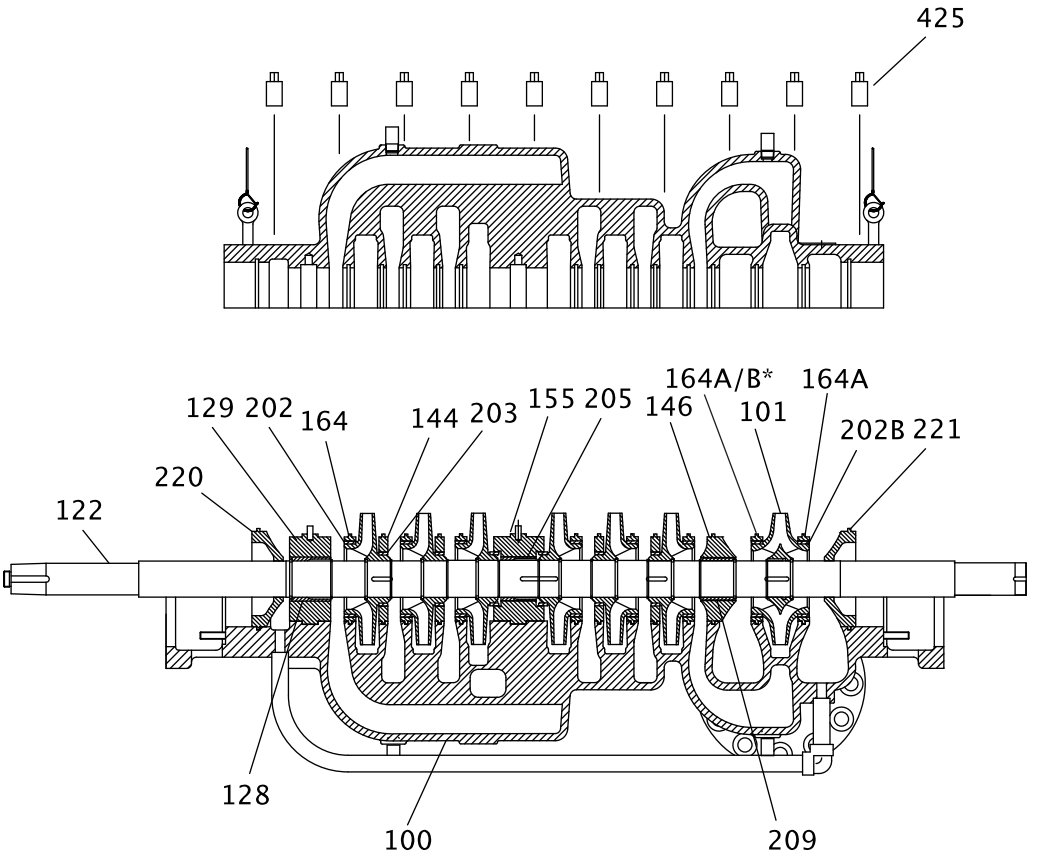
12. Remove the two oil rings (323) located at the sleeve bearing.
13. Remove the labyrinth seals (333A).

Disassembly of the sleeve/Kingsbury bearing arrangement

If your pump is equipped with the rarely-supplied sleeve/Kingsbury bearing arrangement, refer to the topics Disassemble the radial end (sleeve/ball bearing pumps) and Disassemble the thrust end (sleeve/ball bearing pumps) for sleeve bearing disassembly.

Also see the instructions provided by Kingsbury for specific information regarding this tilting-pad hydrodynamic bearing.

Remove the rotating element



* 164A for 4x6-10 and 4x6-11 pumps. 165B for all other pump sizes.

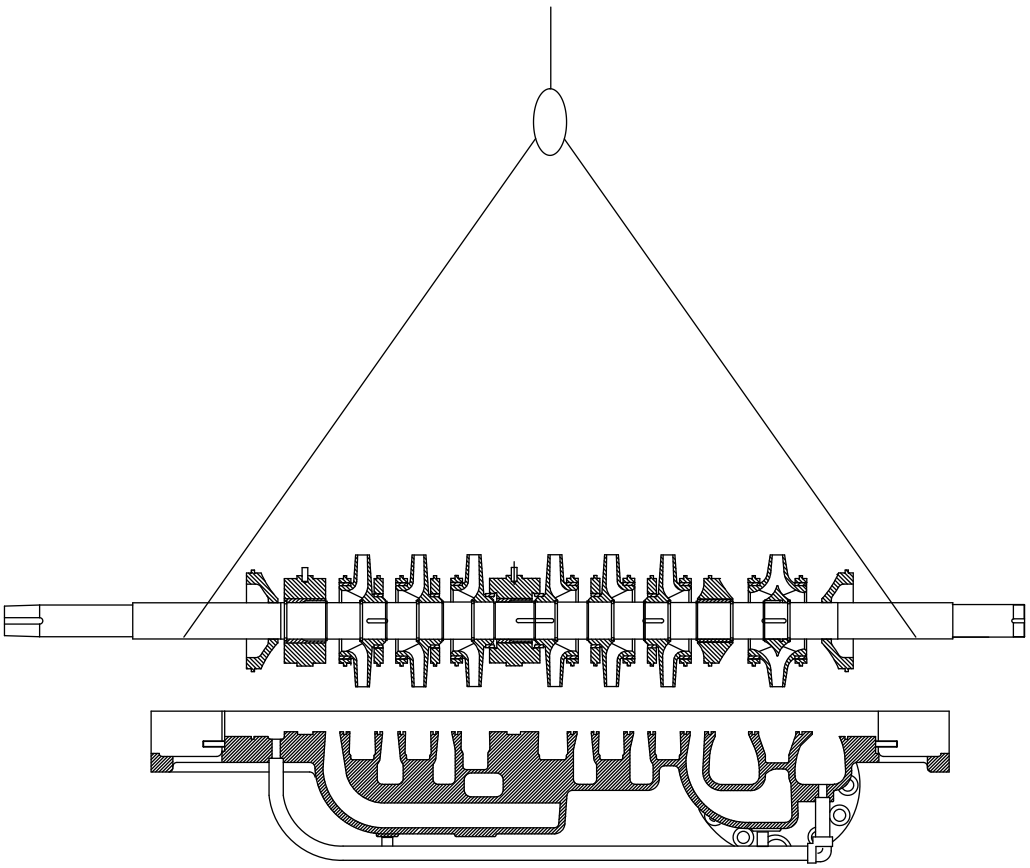
1. Loosen and remove the casing nuts (425) and taper pins.
2. Use the jacking bolts (provided with the pump) to loosen the upper half from the lower half of the casing (100).

WARNING:
Never use heat to disassemble the pump due to the risk of an explosion from trapped liquid.

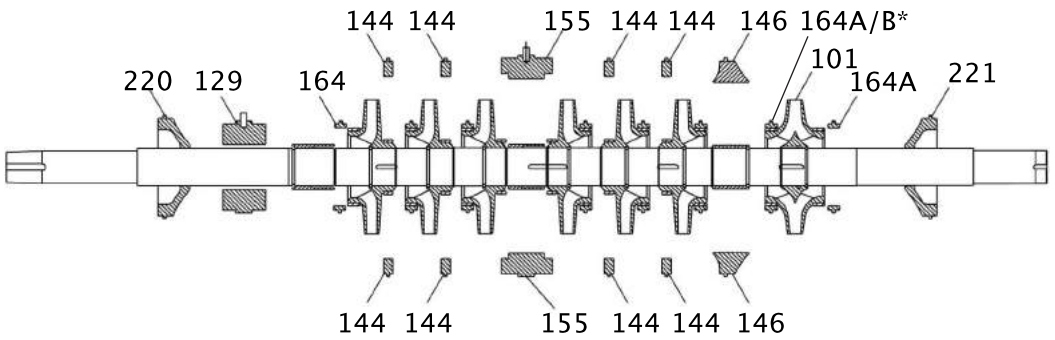
3. Insert eyebolts (not supplied) in the pre-drilled threaded holes in the perimeter of the upper half of the casing. Remove the upper half to the work area.

WARNING:
Use the eyebolts to lift only the upper half of the casing. They will not support the weight of the entire pump.

4. Position one sling between the throttle bushing (129) and the impeller, and another sling between the first-stage impeller (101) and the seal chamber (221). Lift the rotating assembly slightly to remove contact with the wear parts.



5. Remove the socket head capscrews from the center bushing (155).

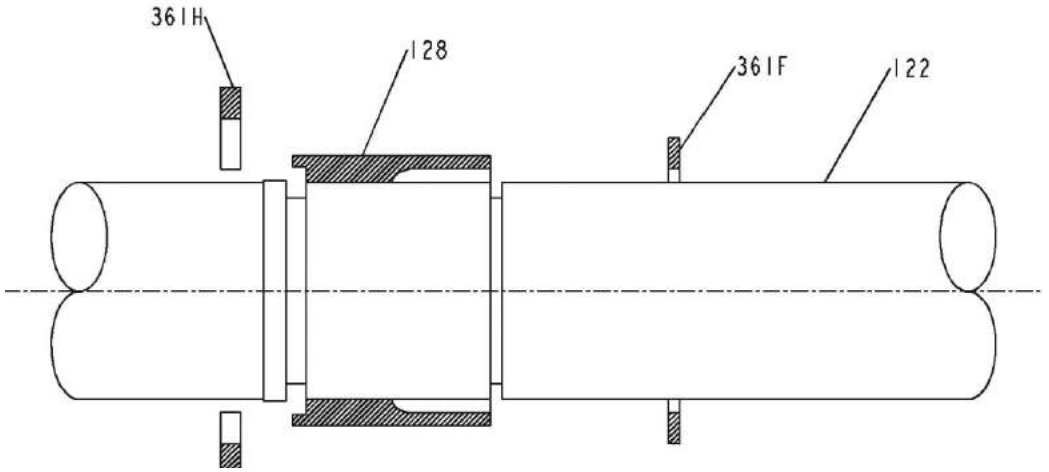


* 164A for 4x6-10 and 4x6-11 pumps. 165B for all other pump sizes.

6. Remove the center bushing (155), all stage rings (144), and the diaphragm (146), if supplied.
   a) Remove the upper half of all components.
   b) Rotate the lower half of all components out of the lower half of the casing.
7. Lift the rotating assembly further to disengage the stationary locks.
8. Remove the seal chambers (220, 221), the throttle bushing (129), the first-stage casing ring (164A), and the series casing ring (164) on the opposite side.
9. Lift the rotating assembly out of the lower half of the casing.
10. Remove the casing studs (356A, 356C, 356K) and the casing gasket (351).

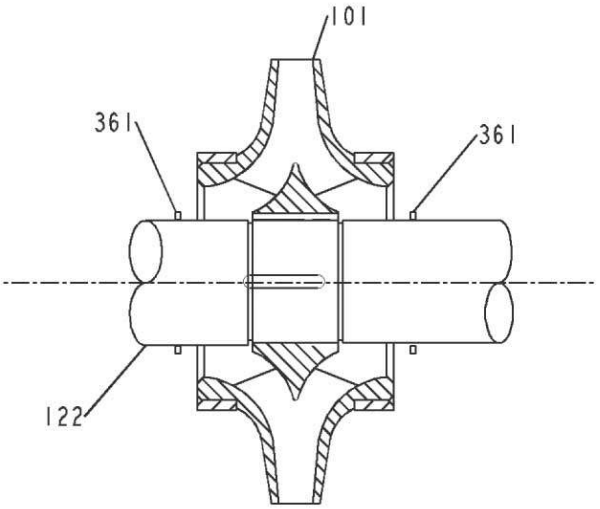
Disassemble the rotating element

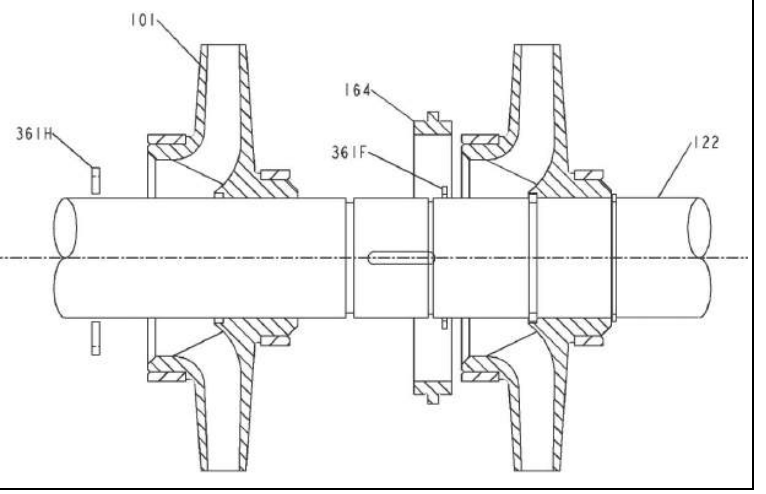
1. Remove throttle bushing sleeve (128):
   a) Remove the snap ring (361F).
   b) Slide the sleeve towards the center of the rotor, exposing the locating ring (361H).
   c) Remove the locating ring (two halves) and the throttle bushing sleeve.



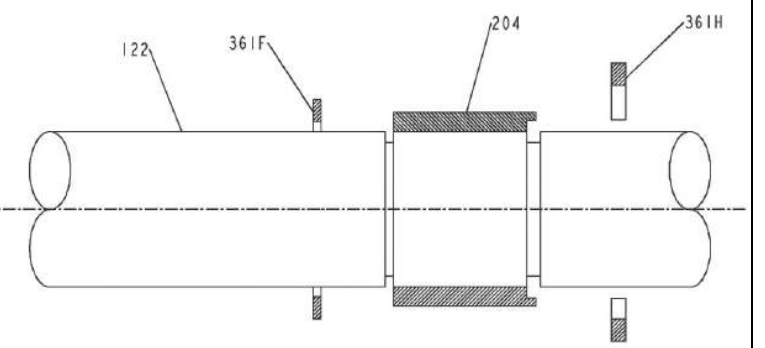
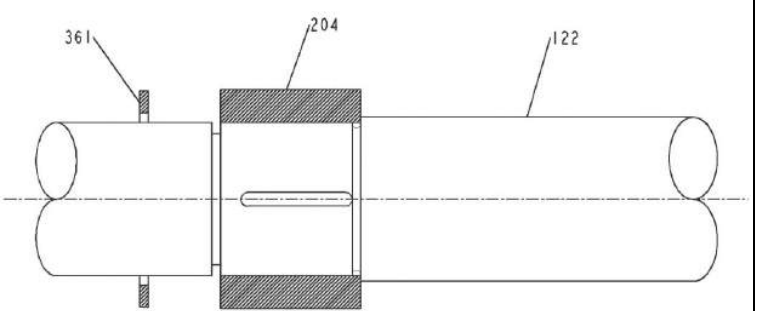
2. Depending on the pump size, do the following to remove the first-stage impeller:

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

If the pump is...	Then...
6x8-13	1. Remove the two snap rings (361) that hold the impeller in place. 2. Heat the impeller to 300°F–400°F (150°C–200°C) and slide the impeller off. 3. Remove the subsequent casing ring (164). 

If the pump is...	Then...
All others	1. Remove the snap ring (361F) from the first-stage impeller (101). 2. Heat the impeller to 300°F–400°F (150°C–200°C) and slide it towards the center of the rotor in order to expose the locating ring (361H). For double-suction, first-stage impellers (except 4x6-10 and 4x6-11), remove the impeller and retrieve the locating ring (361H). 3. Quickly remove the locating ring and the impeller. 4. Remove the subsequent casing ring(s) (164, 164A, 164B). 

3. Depending on the pump, do the following to remove the diaphragm sleeve (204):

If the pump is...	Then...
Double suction	1. Remove the snap ring (361F). 2. Slide the sleeve towards the center of the rotor, exposing the locating ring (361H). 3. Remove the locating ring (two halves) and the diaphragm sleeve. 
6x8-13	The diaphragm sleeve is held in place by a shoulder and a snap ring (361). 1. Remove the snap ring. 2. Remove the sleeve. 

4. Repeat step 2 for the remaining impellers.

NOTICE:
Allow the shaft and impeller to cool to ambient temperature before assembling the next impeller.

5. After all the impellers are removed, remove the center sleeve (205).
   This step does not apply to 6x8-13 pumps.

Preassembly inspections

Replacement guidelines

Casing check and replacement

WARNING:
Avoid death or serious injury. Leaking fluid can cause fire and/or burns. Inspect and assure gasket sealing surfaces are not damaged and repair or replace as necessary.

Inspect the casing for cracks and excessive wear or pitting. Thoroughly clean gasket surfaces and alignment fits in order to remove rust and debris.

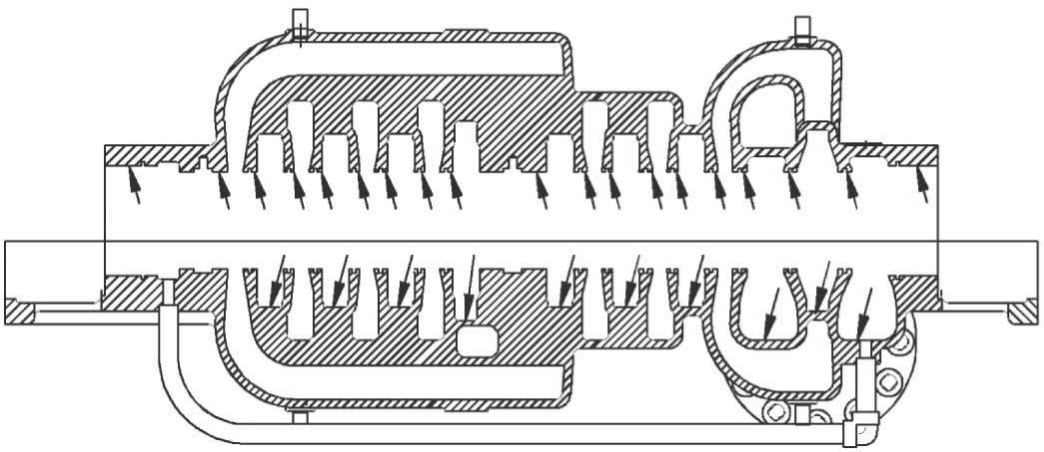
Repair or replace the casing if you notice any of these conditions:

- 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 areas to inspect

The arrows point to the areas to inspect for wear on the casing:



Impeller replacement

This table shows the criteria for replacing the impeller:

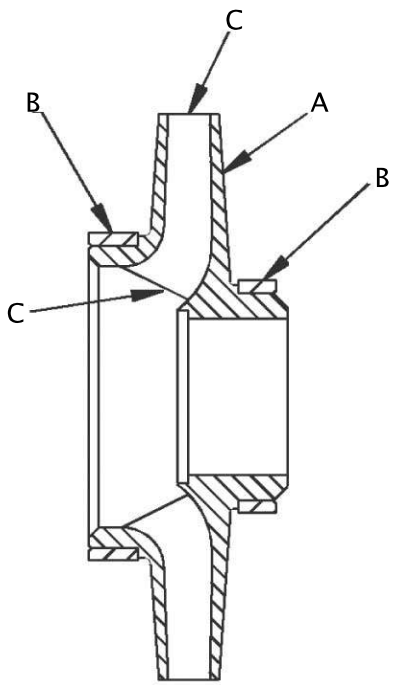
Impeller parts	When to replace
Impeller vanes	• When grooved deeper than 1/16 in. (1.6 mm), or • When worn evenly more than 1/32 in. (0.8 mm)
Pumpout vanes	When worn or bent more than 1/32 in. (0.8 mm)
Vane edges	When you see cracks, pitting, or corrosion damage
Wear ring surfaces	When the clearance 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

Figure 38: Impeller inspection

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

WARNING:
Avoid death or serious injury. Leaking fluid can cause fire and/or burns. Replace any damaged or worn gaskets/o-rings.

- 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 360A)
- Labyrinth seals (332A and 333A)
- Bearing locknut (136)
- Impeller key (178) and coupling key (400)
- Bearing lockwasher (382)
- Water jacket cover (490), if supplied
- 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 inspection

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

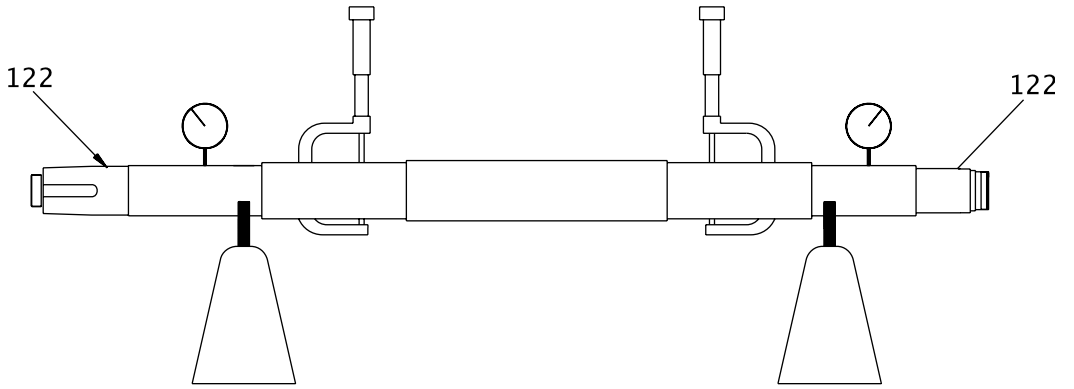


Figure 39: Shaft inspection

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 1: 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.)
*Total indicated runout of impeller hubs and sleeves	

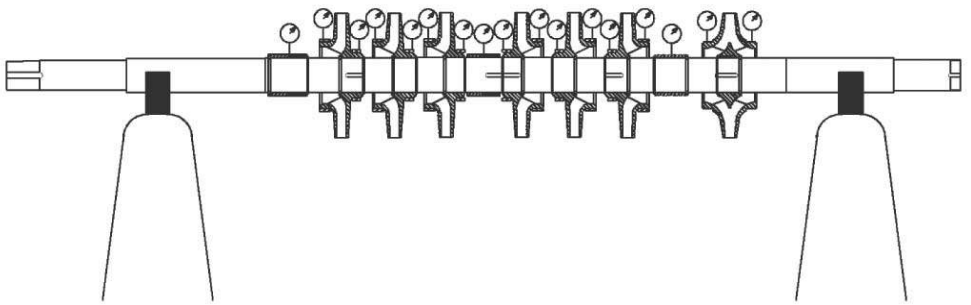


Figure 40: Fully assembled rotor

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 2: Model 3600 ball bearing fits
Bearing numbers are based on SKF/MRC designations.

Pump size	Radial bearing	Thrust bearing	Bearing housing bore	Shaft turn
3x4-8 3x4-9	6311	7311/BECBM	4.7244 4.7253	2.1664 2.1659
3x6-9 3x6-10	6312	7312/BECBM	5.1181 5.1191	2.3631 2.3626
4x6-10 3x4-12.5	6313	7313/BECBM	5.5118 5.5128	2.5597 2.5592
4x6-11 4x6-12 6x8-11	6314	7314/BECBM	5.9055 5.9065	2.7565 2.7560
6x8-13 6x8-14 8x10-13 10x12-14.5	6216	7313/BECBM	5.5118 5.5128	2.5597 thrust 2.5592 thrust 3.1502 radial 3.1497 radial

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.

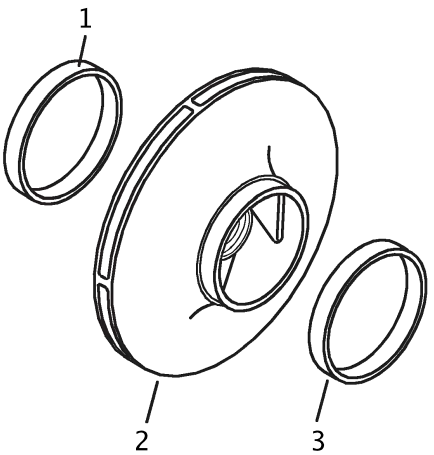
Replace the wear rings

A press fit and three tack welds hold the impeller wear rings (202, 202A, 202B, 203) in place.

1. Remove the impeller wear rings (202, 202A, 202B, 203):
   a) Grind out the tack welds.

b) Remove the wear rings from the impellers (101–101M), using suitable pry or puller tools to force the rings from the fits.
You may also machine the rings in order to remove them.

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



1. Wear ring – 202A (double suction), 202B (double suction for 4x6-10 and 4x6-11 only), 203
2. Impeller – 101 through 101M
3. Wear ring – 202, 202B (first stage)

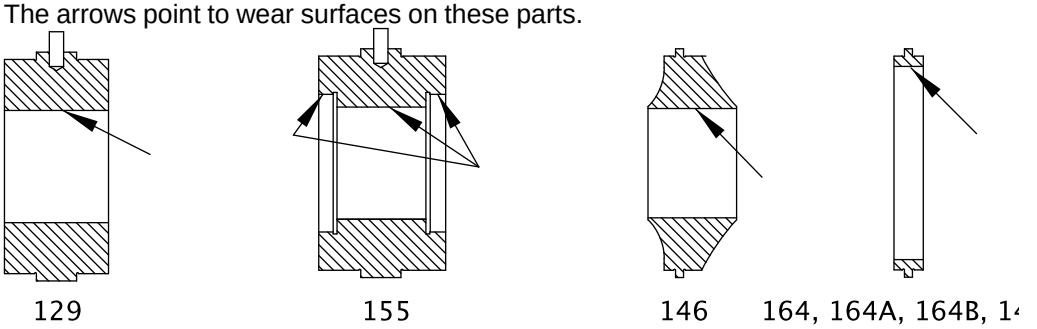
2. Install new wear rings (202, 202A, 202B, 203):
   a) Clean the wear-ring seats thoroughly to make sure that they are smooth and free of scratches.
   b) Heat the new impeller wear rings to 180°F–200°F (82°C–93°C) using a uniform method for heating, such as an oven, and place them on the impeller (101-101M) wear-ring seats.

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

   c) Tack weld each ring in place in three equidistant places.
3. Check the throttle bushing (129), the center bushing (155), the diaphragm (146), the case ring (164, 164A, 164B), and the stage ring (144) runout/distortion by measuring the bore at three locations with inside micrometers or vernier calipers.

Correct any distortion in excess of 0.003 in. (0.076 mm) by machining prior to trimming new impeller wear rings, if supplied.

The arrows point to wear surfaces on these parts.



Part number	Part name
129	Throttle bushing
155	Center bushing
146	Diaphragm
164, 164A, 164B, 144	Case and stage ring

4. Confirm the bore of the throttle bushing (129), the center bushing (155), the diaphragm (146), the casing ring (164, 164A, 164B), and the stage ring (144).
5. Turn the impeller wear rings (202, 202A, 202B, 203) to size after mounting on the impeller (101-101M).

CAUTION:

The impeller and wear-ring clearance setting procedures must be followed. Improperly setting the clearance or not following any of the proper procedures can result in sparks, unexpected heat generation, and equipment damage.

All replacement impeller wear rings are supplied 0.020 in. to 0.030 in. (0.508 mm to 0.762 mm) oversize. See 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

Table 3: Diametrical clearance in inches (millimeters)

This table gives diametrical clearance data for wear parts.

Pump size Goulds standard	Impeller wear ring			Pressure reducing sleeves	Center impeller rings
	API 610	Ring diameter	Goulds standard	Goulds standard	
3x4-12.5	0.010 (0.254)	0.016 (0.406) 0.018 (0.457)	4.25 (107.95) 6.00 (152.40)	0.010 (0.254)	0.030 (0.762)
4x6-12	0.010 (0.254)	0.016 (0.406) 0.018 (0.457) 0.018 (0.457)	4.62 (117.35) 6.00 (152.40) 6.25 (158.75)	0.010 (0.254)	0.030 (0.762)
3x4-8 3x4-9	0.010 (0.254)	0.015 (0.381) 0.016 (0.406) 0.017 (0.432)	4.00 (101.60) 4.87 (123.70) 5.50 (139.70)	0.010 (0.254)	0.030 (0.762)
3x6-9 3x6-10	0.010 (0.254)	0.015 (0.381) 0.017 (0.432) 0.018 (0.457)	4.01 (101.85) 5.22 (132.59) 6.60 (167.64)	0.010 (0.254)	0.030 (0.762)
4x6-10	0.010 (0.254)	0.015 (0.381) 0.017 (0.432) 0.018 (0.457)	4.24 (107.70) 5.97 (151.64) 6.52 (165.61)	0.010 (0.254)	0.030 (0.762)

Pump size Goulds standard	Impeller wear ring			Pressure reducing sleeves	Center impeller rings
	API 610	Ring diameter	Goulds standard	Goulds standard	
4x6-11	0.010 (0.254)	0.016 (0.406) 0.018 (0.457) 0.019 (0.483)	4.61 (117.10) 6.48 (164.59) 7.36 (186.94)	0.010 (0.254)	0.030 (0.762)
6x8-11	0.010 (0.254)	0.016 (0.406) 0.019 (0.483) 0.019 (0.483) 0.019 (0.483) 0.020 (0.508) 0.020 (0.508)	4.61 (117.10) 7.25 (184.15) 7.50 (190.50) 7.75 (196.85) 8.12 (206.25) 8.62 (218.95)	0.010 (0.254)	0.030 (0.762)
6x8-13	0.010 (0.254)	0.017 (0.432) 0.019 (0.483) 0.020 (0.508)	5.74 (145.80) 7.86 (199.64) 8.48 (215.39)	0.010 (0.254)	0.030 (0.762)
6x8-14	0.010 (0.254)	0.016 (0.406) 0.019 (0.483) 0.019 (0.483) 0.019 (0.483) 0.020 (0.508) 0.020 (0.508)	4.99 (126.75) 7.49 (190.25) 7.74 (196.60) 7.99 (202.95) 8.24 (209.30) 8.62 (218.95)	0.010 (0.254)	0.030 (0.762)
8x10-13	0.010 (0.254)	0.016 (0.406) 0.019 (0.483) 0.020 (0.508) 0.020 (0.508)	4.99 (126.75) 7.99 (202.95) 8.24 (209.30) 8.99 (228.35)	0.010 (0.254)	0.030 (0.762)
10x12-14.5	0.010 (0.254)	0.017 (0.432) 0.020 (0.508) 0.020 (0.508) 0.021 (0.533)	5.42 (137.67) 8.69 (220.22) 8.96 (227.58) 9.75 (247.65)	0.010 (0.254)	0.030 (0.762)

Reassembly

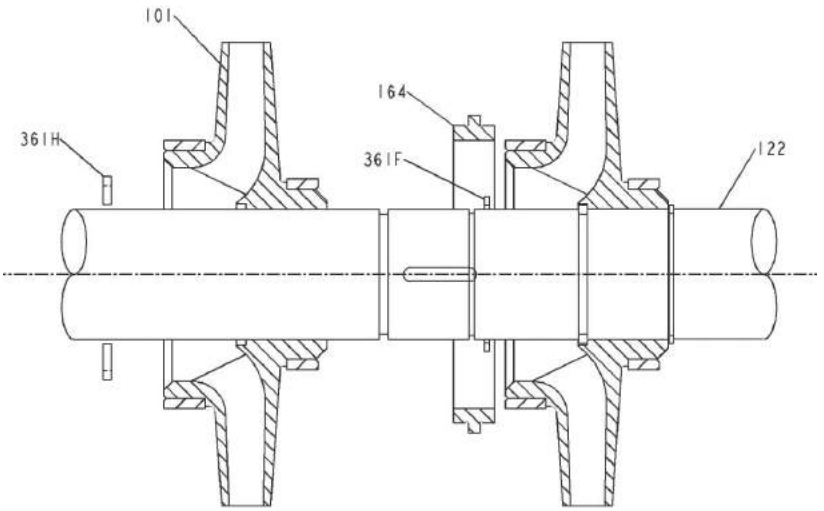
Assemble the rotating element

WARNING:
The pump and the components can be heavy. Make sure to use proper lifting methods, and wear steel-toed shoes at all times. Failure to do so can result in physical injury or equipment damage.

NOTICE:
Make sure that all parts and threads are clean and that you have followed all directions under the Preassembly inspections section.

1. Assemble the center impeller (101M) onto the shaft. The impeller is interference fit.
   a) Use an electric induction heater to preheat the impeller to 300°F–400°F (150°C–200°C).
   b) Slide the impeller past the locating ring groove, put the locating rings (361H) in place, and slide the impeller back so that it is snug against the locating ring.
   c) Install the snap ring (361F).

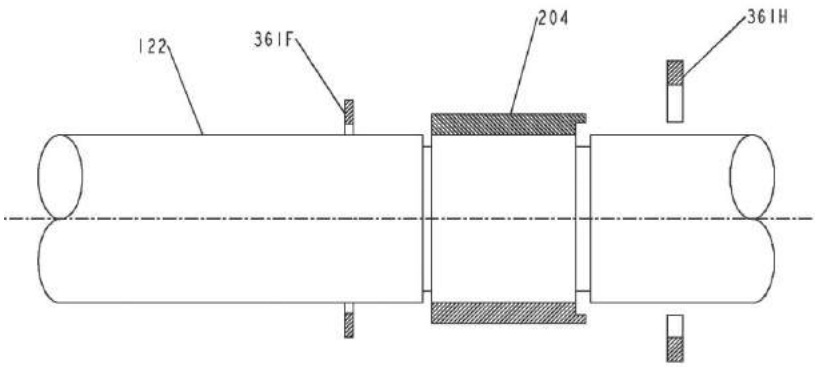
CAUTION:
Burn hazard. The impeller will get hot. Wear insulated gloves when handling the impeller.



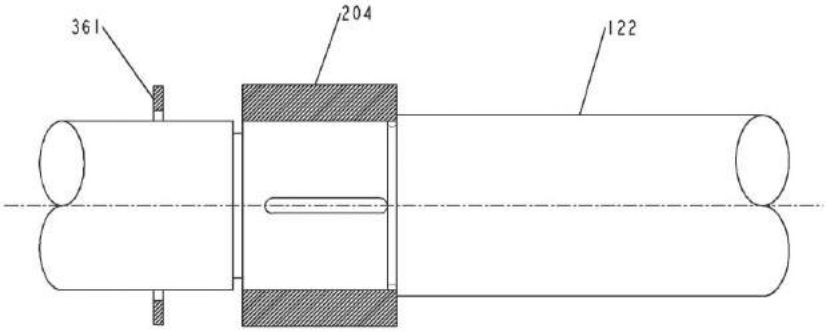
2. Install the center sleeve (205). (Not applicable on 6x8-13 pumps.)
3. Repeat step 1 for all subsequent impellers making sure to install the casing ring (164, 164A, 164B) on each previous impeller.

NOTICE:
Allow the shaft and impeller to cool to ambient temperature before assembling the next impeller.

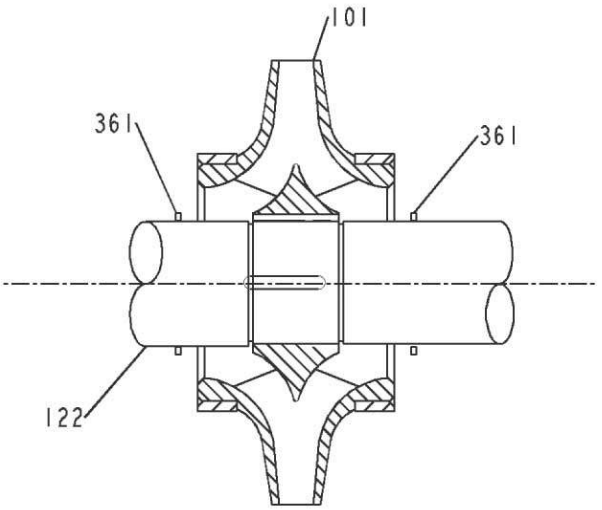
4. On double-suction pumps only, prior to assembling the first-stage impeller (101), assemble the diaphragm sleeve (204):
   a) Slide the diaphragm sleeve onto the shaft past the locating ring groove, put the locating ring (361H) in place, and slide the sleeve back so that it is snug against the locating ring.
   b) Install the snap ring (361F).



5. On 6x8-13 pumps only, assemble the diaphragm sleeve (204) snug against the shaft shoulder and install the snap ring (361).



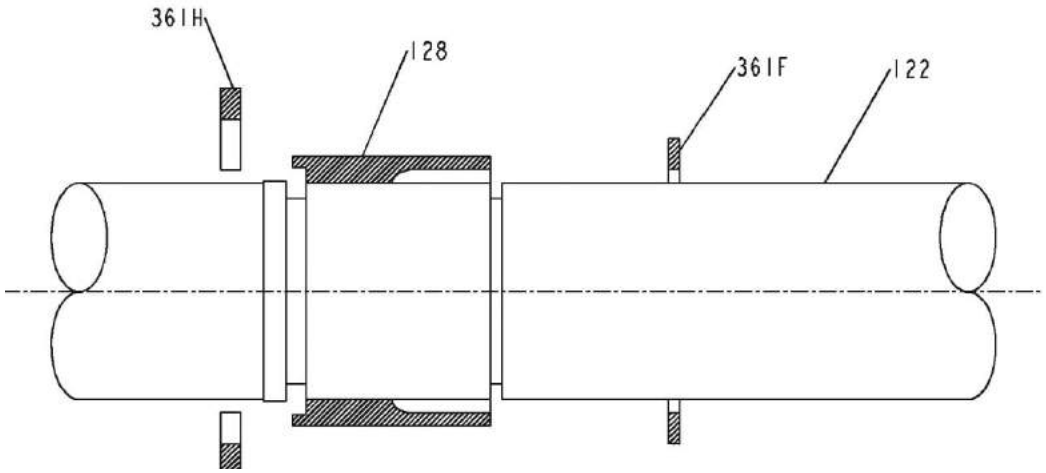
6. Assemble the first-stage impeller (101) as in Step 1.
7. On double-suction pumps only (except 4x6-10 and 4x6-11), install the locating ring (361H), then slide on the first-stage impeller and install the snap ring (361F).
8. On 6x8-13 pumps only, secure the first-stage impeller in place with a snap ring (361) on either side of the hub.



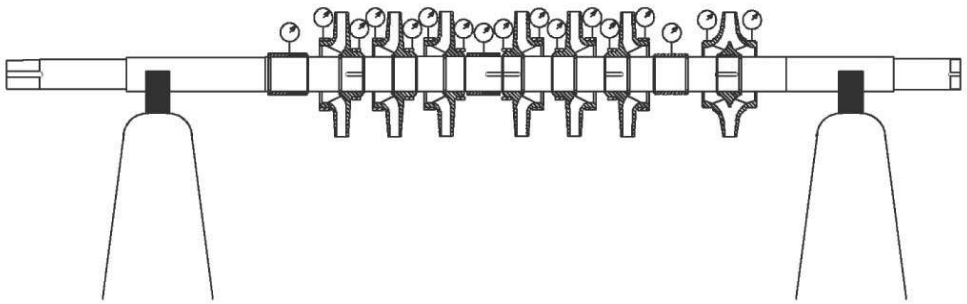
9. Assemble the throttle bushing sleeve (128).
   a) Slide the sleeve onto the shaft past the locating ring groove, put the locating ring (361H) in place, and slide the sleeve back until snug.
   b) Install the snap ring (361F).

CAUTION:

Ⓔx 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.



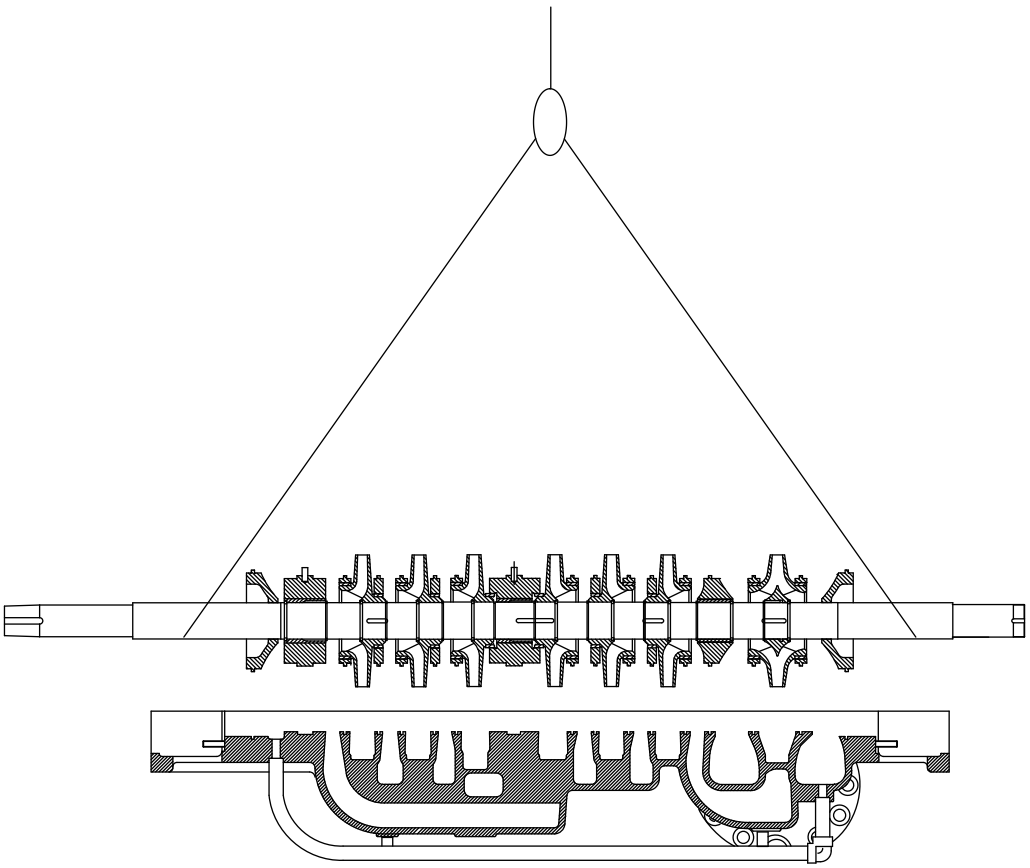
10. Measure the total indicated runout (TIR) on the impeller wear rings, center sleeve, throttle sleeve, diaphragm sleeve, and bearing fits. The shaft is the datum point; measure the runout of wear rings and impeller nuts to the shaft with a dial indicator.
    API limits are listed in the Shaft and rotor runout requirements table.



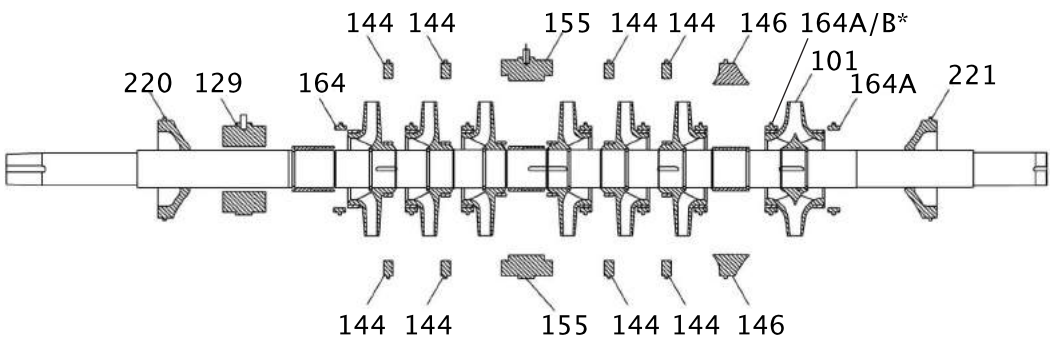
Install the rotating element

1. Fit the casing gasket (351) around all the hydraulics, bores, and through holes using the upper half as a template.
   Pay particular attention to the area around the seal chamber face. This is a critical area for proper sealing. Make sure that the gasket extends all the way to the face but does not protrude past this face. Use a file to make the face clean and flush.
   Sheet-gasket thickness is 1/32 in. (0.8 mm) for pump sizes 3x4-8B, 3x6-9/10, 4x6-10, and 4x6-11. For all other pumps, the thickness is 1/64 in. (0.4 mm). Applicable gasket materials are Garlock Style 3000 or Flexitallic SF 3500.
2. Assemble all casing studs (356A, 356C, 356K).

3. Position one sling between the throttle bushing sleeve (128) and the impeller and a second sling in front of the first stage impeller (101). Lower the rotating assembly into the lower half of the casing to the point where the stationary-groove locks engage.



4. Assemble the first-stage impeller casing ring (164A), the final-series casing ring (164), the throttle bushing (129), and both seal chambers (220, 221).



* 164A for 4x6-10 and 4x6-11 pumps. 165B for all other pump sizes.

5. Lower the rotating assembly, making sure all stationary parts fit into the groove locks.
6. While maintaining tension on the rotating assembly, slide the lower half of all stage rings (144), the center bushing (155), and the diaphragm (146), if applicable, into the lower half of the casing.
7. Assemble the upper half of each component and tighten the socket head capscrews.
8. You must center the rotating element inside the casing whenever the bearings are replaced:
   a) Push the rotating element towards the coupling end until it stops.
   b) Measure the distance from the thrust bearing shoulder on the shaft to the bearing housing face on the casing.

c) Pull the rotating element towards the thrust end until it stops.
d) Again, measure the distance from the thrust bearing shoulder on the shaft to the bearing housing face on the casing.
The difference between the two measurements is the total travel of the rotating element.
e) Calculate the average of these dimensions.
f) Measure the shoulder depth on the inboard cover (160) and subtract the calculated average dimension.The result is the spacer (217) thickness required to properly center the rotating element.
g) Remachine the spacer as necessary making sure that both faces are parallel within 0.001 in. (0.025 mm).

Confirm the seal chamber runout

The bearing housings are doweled to the casing (100) during the original build. However, to assure the correct running position of the shaft, use the following procedure to confirm the seal chamber runout before installing the cartridge mechanical seals:

1. Install the old bearings on the shaft and bolt the bearing housings to the casing.
2. Mount the dial indicator on the shaft (122). Rotate the shaft (122) so that the indicator rides along the seal chamber bore for 180°.
3. If the total indicator reading exceeds 0.005 in. (0.127 mm), determine the cause and make corrections. The bottom reading must be 0.0025 in. (0.0635 mm) or less.
For further instructions see Align the rotor.
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 180°.
   b) If the total indicator reading exceeds the allowable runout as shown in the following table, determine the cause and make corrections.

Size	Maximum allowable total indicator reading in inches (millimeters)
Remaining sizes	0.0030 (0.0762)
10x12-14.5	0.0033 (0.0838)
6x8-13	0.0035 (0.0889)

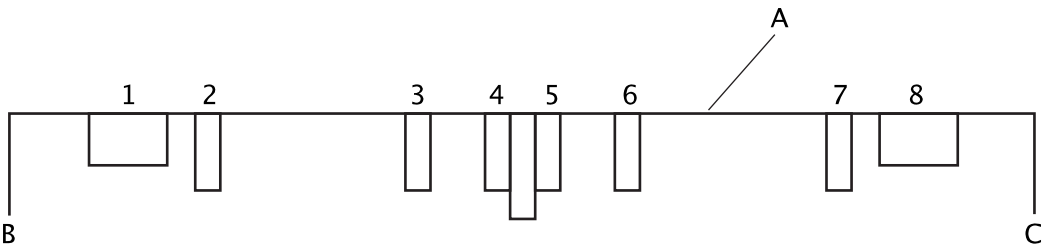
5. Remove the dowel pins and unbolt the bearing housings. Discard the old bearings.

Qualify the casing bores

Three casing bores are used as datums during the centering procedure: the two seal chamber bores and the center case bushing bore. If these bores are not in alignment or are of different sizes, then compensation is required in order to accommodate the deviation(s). Qualification of these three bores must occur before you align the rotor.

1. Measure the ring bores with a plug gauge and correct any conditions that are out of tolerance.

2. Measure the depth of the ring bores noted in the figure and record the measurements in the table row "Actual depth."



1. Inboard seal chamber
2. Last ring bore
3. First ring, inboard side
4. Inboard center bushing bore
5. Outboard center bushing bore
6. Last ring, outboard side
7. First ring bore
8. Outboard seal chamber

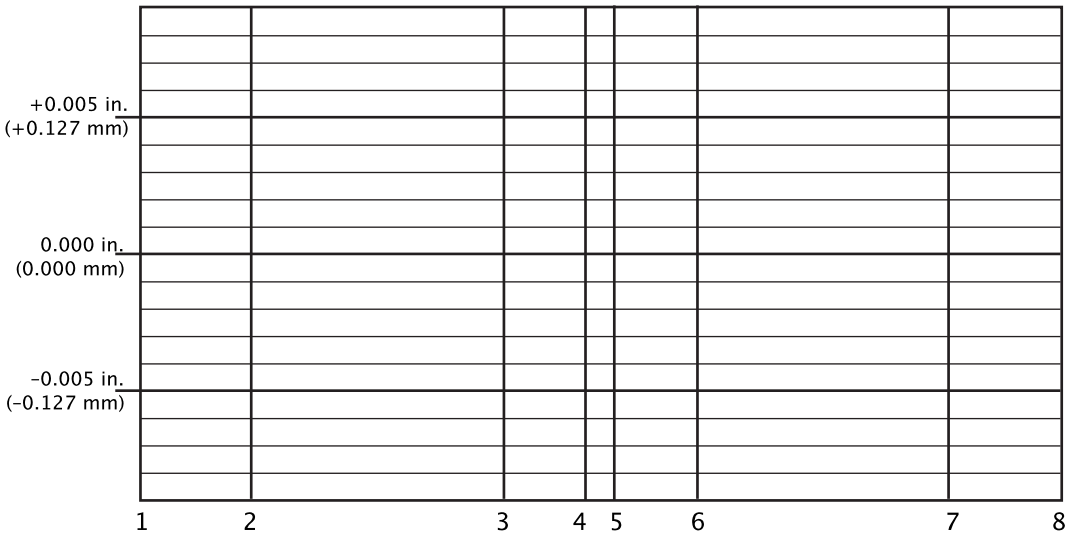
A. Lower half casing flange
B. Inboard end
C. Outboard end

Location	1	2	3	4	5	6	7	8
Design depth								
Actual depth								
Difference								

Pump size	Design depth in inches		
1 and 8	7	2 through 6	
3x4-8B	3.139	3.115	3.115
3x4-9	3.145	3.145	3.145
3x6-9/10	3.139	3.615	3.115
3x4-12.5	3.145	3.370	3.370
4x6-12	3.145	3.370	3.370
4x6-10	3.139	3.584	3.302
4x6-10D	3.139	3.302	3.302
4x6-11	3.139	3.552	3.990
4x6-11D	3.139	3.990	3.990
4x6-11A	3.145	3.995	3.995
6x8-11	3.145	4.427	4.427
6x8-13	3.745	4.745	4.745
6x8-14	3.145	4.620	4.620
8x10-13	3.145	4.870	4.870
10x12-14.5	3.342	5.275	5.275

3. For each bore, subtract the actual depth from the design depth and record the difference in the table.

4. Plot the "Difference" points on the chart.



5. Draw a straight line from point 1 to point 8.
   This is the seal chamber centerline.
6. Draw a trend line through points 2 through 7 and investigate any deviations greater than 0.002 in. (0.051 mm).
   This is the casing ring centerline.
7. Adjust the nominal 0.005 in. (0.127 mm) thickness of the center case shim by the difference between the seal chamber centerline and the ring bore centerline at points 4 and 5.
   - If the seal chamber centerline is above the ring bore centerline, then increase the shim thickness.
   - If the seal chamber centerline is below the ring bore centerline, then decrease the shim thickness.
8. Check and confirm that the separation between the seal chamber center and the rotor center is 0.005 in. (0.127 mm) or less.
   If the separation is greater than 0.005 in. (0.127 mm), then contact your ITT representative for assistance.

Align the rotor

Before you align the rotor, you must qualify the casing bores. See Qualify the casing bores. The purpose of this procedure is to align the center of the bearing housing bores with the center of the casing bore. This ensures that the rotor is straight through all the bores during operation.

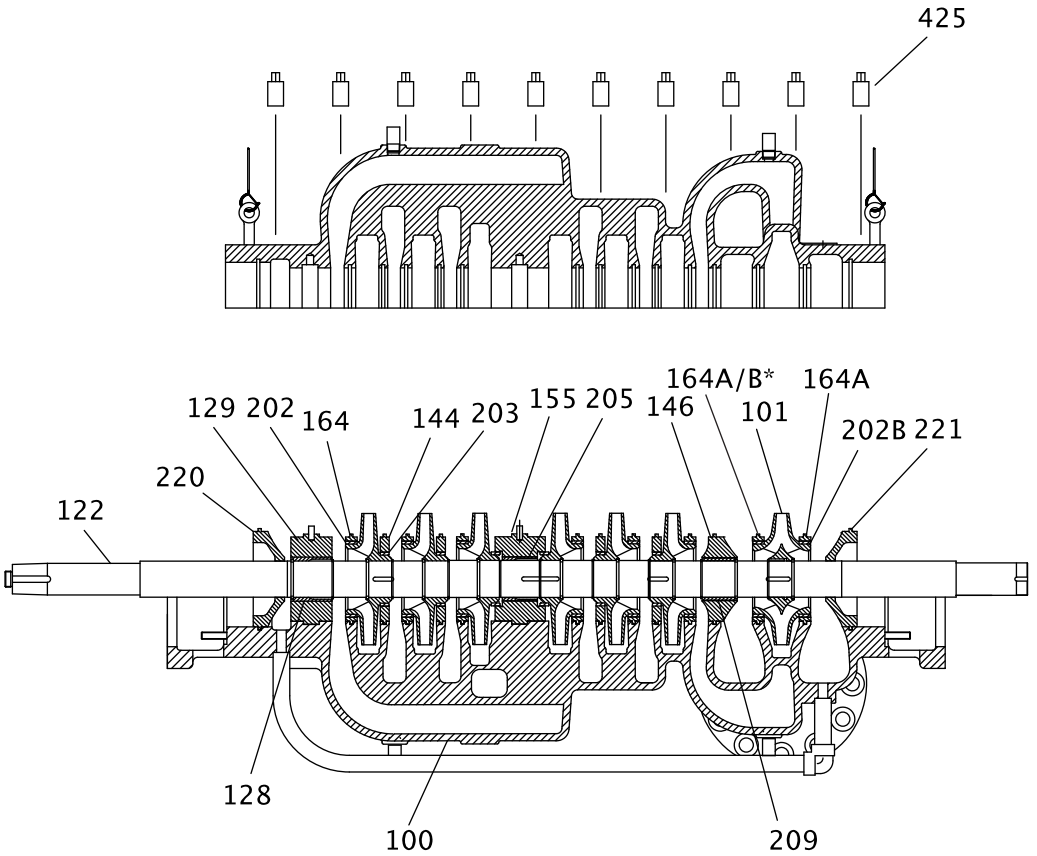
1. Temporarily place two one-inch square shims in the bottom of each center case bushing bore. The thickness of the shim must be determined during the casing bore qualification procedure. These shims remove the sag, or bend, from the rotor by compensating for the misalignment between the center bushing clearance and the casing bore.
2. Place the rotor in the lower half of the casing. Make sure that the dowel in the center case bushing is at the 12 o'clock position.
3. Mount the tool bearings on the shaft.
   Tool bearings are used for rotor alignment purposes only. The bore diameter of the inner race has been increased so that it is a slip fit onto the shaft.
4. Mount the bearing housings. Hand-tighten the mounting nuts to allow for adjustment.
5. Install two dial indicators on the shaft, one in each seal chamber bore.
6. Set each indicator to zero on the same side of the casing. Adjust the bearing housings vertically and horizontally to achieve a TIR less than 0.0015 in. (0.0381 mm).
   Make sure that the indicator is reading on a machined surface and not on a hand-filed surface, which is sometimes necessary near the parting flange.

7. Keep the bearing housing level from side to side during the bearing housing adjustment in order to ensure the correct oil level setting.
8. Double-check the centering of the rotor with a feeler gauge between the casing rings and impeller rings and confirm the clearance around the circumference.
   For standard clearance use a 0.003 in. (0.076 mm) feeler gauge. For API clearance use a 0.006 in. (0.152 mm) feeler gauge. Make minor adjustments to the bearing housings accordingly.
9. Recheck the shaft-to-seal chamber bore TIR after this adjustment.
   Side-to-side readings must be 0.005 in. (0.127 mm) or less. The bottom reading must be 0.0025 in. (0.0635 mm) or less.
10. Tighten the mounting screws on the bearing housing.
    Confirm that the shaft-to-seal chamber TIR has not changed. Adjust the bearing housings until the TIR criteria is met with the mounting screws firmly tightened.
11. Mount a magnetic base dial indicator on the thrust end of the shaft and indicate the housing face of the thrust bearing.
    Readings must be within 0.003 in. (0.076 mm) TIR. If this value is exceeded, inspect the bearing housing and the casing face, and correct any condition that is out of tolerance.
12. Drill pilot holes, taper-ream holes for the dowel pins, and install the dowels.
13. Remove the temporary shims from under the center case bushing either by removing the bushing or by removing the rotor.

Assemble the casing

1. Lower the upper half of the casing, using taper pins to correctly align to the lower half.

NOTICE:
Apply an anti-seize compound to the studs and to the face of the casing where the nuts make contact.



* 164A for 4x6-10 and 4x6-11 pumps. 165B for all other pump sizes.

2. Torque the casing nuts (425) to the values found in the Maximum torque values for fasteners table in Assembly references.
   Start at the center of the casing and work from side to side towards each end.
3. Mount the cartridge mechanical seals (250) on the shaft.

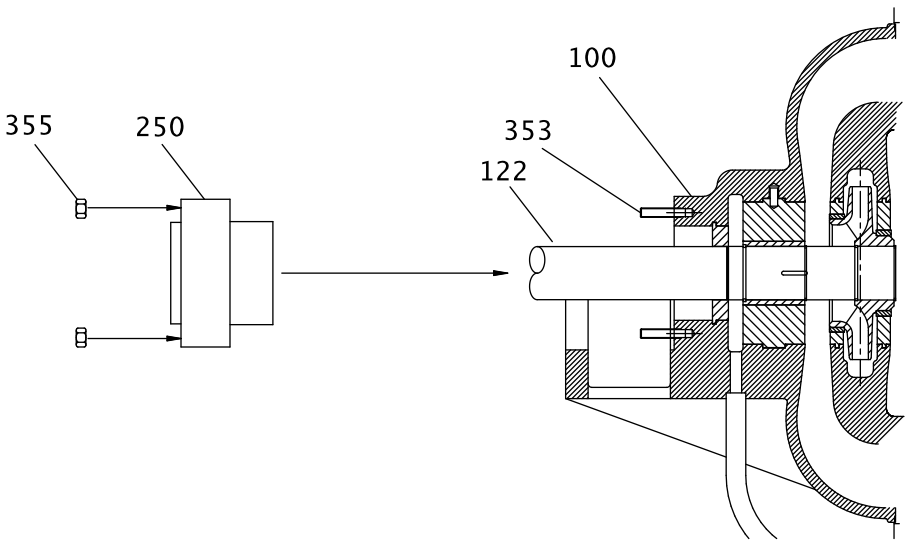


Figure 41: Mount the cartridge mechanical seal on the radial end

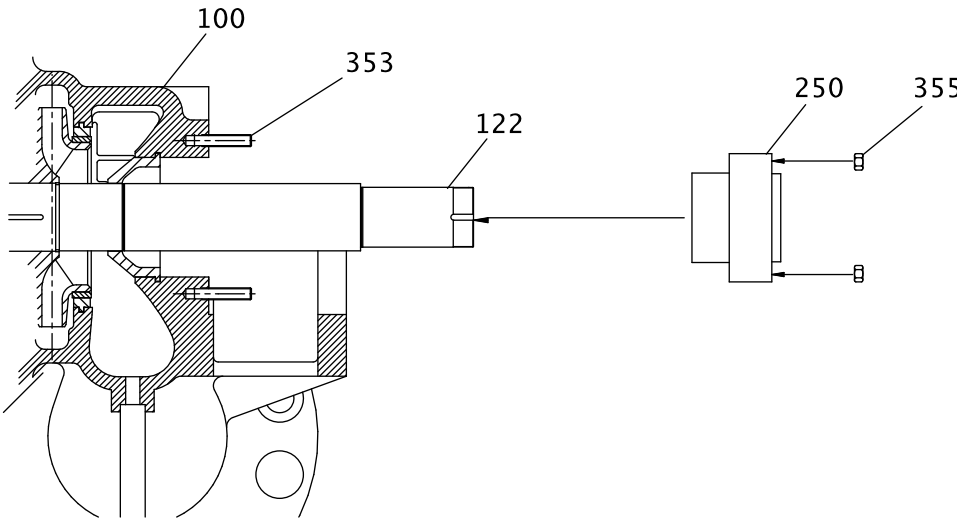


Figure 42: Mount the cartridge mechanical seal on the thrust end

Assemble the thrust end (ball bearing pumps)

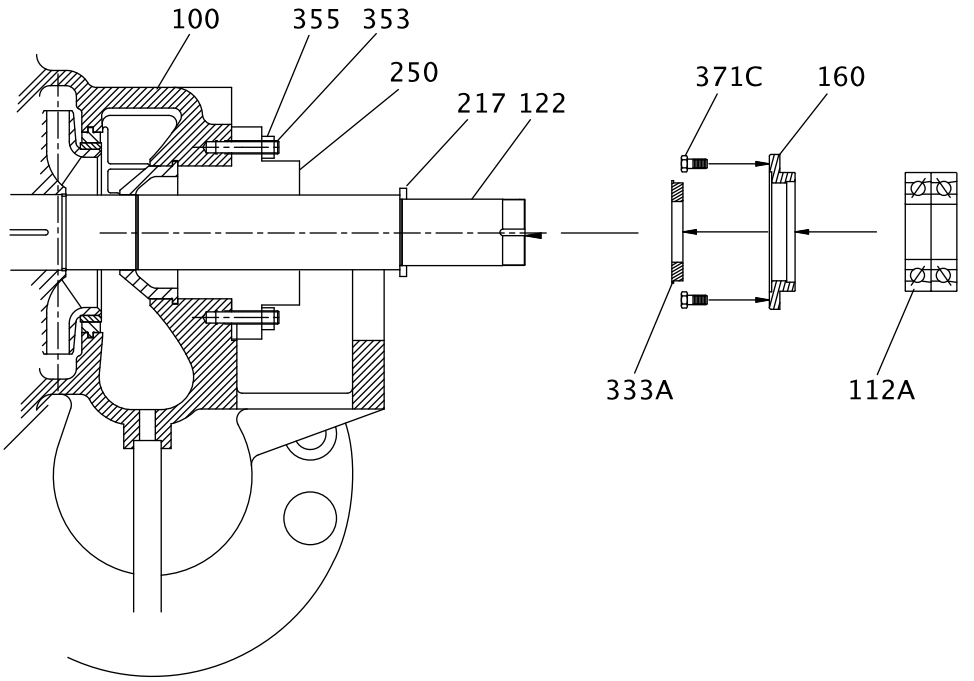


Figure 43: Thrust end assembly

1. Assemble the inboard labyrinth seal (333A) into the inboard thrust end cover (160):
   a) Clean the end cover with a solvent.
   b) Fit the labyrinth seal (333A) into the bore of the cover (160).
   c) Tap the seal in with a hammer.

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

2. Assemble the inboard end cover (160) and the inboard bearing end-cover gasket (360A) onto the shaft.
3. Assemble the thrust bearings (112A) in a back-to-back arrangement onto the shaft (122): The bearings are interference fit.

a) Preheat the bearings to 250°F (120°C) with an induction-type bearing heater.
Be sure to also demagnetize the bearings after heating.

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 bearings (112A), the oil ring sleeve (443B), and the bearing locknut (136) onto the shaft.
c) While the bearings are hot, tighten the locknut by hand with a spanner wrench until the bearing is snug against the shaft shoulder.
d) Allow the bearing assembly to cool slowly to room temperature.
Do not rapidly cool the bearings with compressed air or other means.
e) When the bearing assembly is fully cooled, remove the locknut, install the lockwasher (382), and install the locknut.
f) Hand-tighten the locknut with a spanner wrench. Do not over-tighten the bearing. Tap the end of the spanner wrench with light strikes from a dead blow hammer while you note the location of the next available lockwasher tab that aligns with the slots in the locknut.
The turning resistance of the nut increases 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.
g) 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.

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

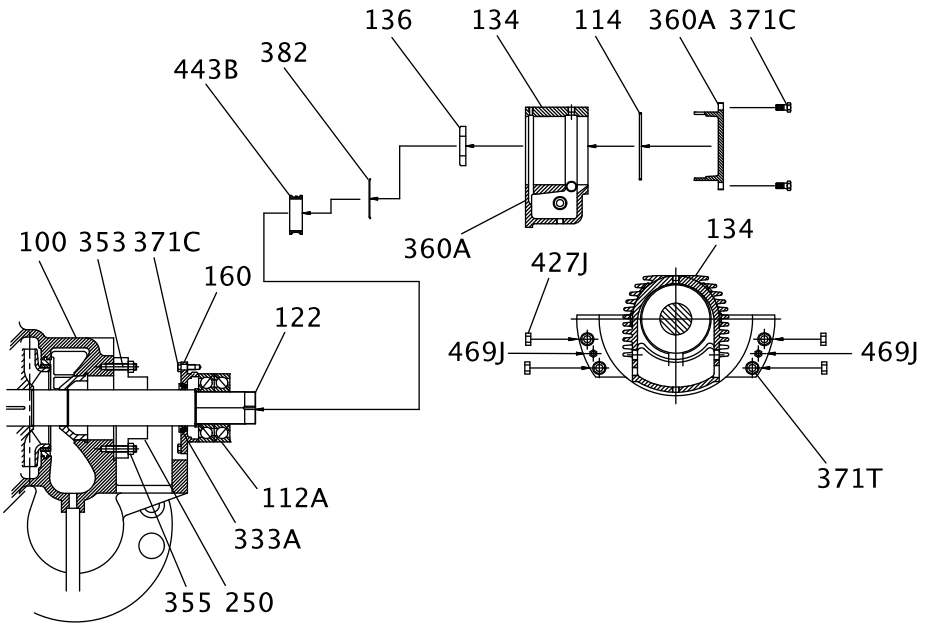


Figure 44: Thrust bearing assembly

Figure 45: Thrust bearing assembly

4. Install the bearing housing (134) over the bearings. Finger-tighten the nuts (427J) on the studs (371T). Insert the dowel pins (469J); then tighten the nuts (427J).
   The bearing housing is doweled to the casing (100) during the original build to assure the correct running position of the shaft.

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

5. Tighten the inboard end-cover capscrews (317C).
6. Install the oil ring (114).
7. Install the bearing end cover (109A) and the bearing end-cover gasket (360A) with the end-cover capscrews (371C).
8. When new bearings are installed, you must measure the axial end play:
   a) Bolt the end cover to the thrust housing.
   b) Move the shaft axially from the coupling end.

Assemble the radial end (ball bearing pumps)

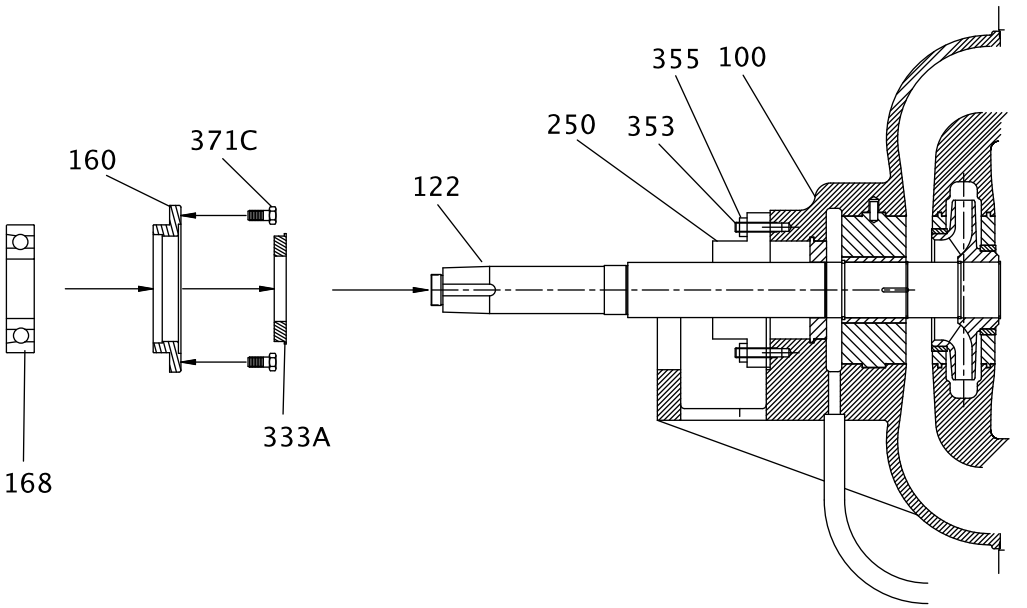


Figure 46: Inboard labyrinth seal assembly

1. Assemble the inboard labyrinth seal (333A) into the inboard radial-end cover (160):
   a) Clean the end cover with a solvent.
   b) Fit the labyrinth seal (333A) into the bore of the cover (160).
   c) Tap the seal in with a hammer.

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

2. Assemble the inboard end cover (160) and the inboard bearing end-cover gasket (360A) onto the shaft.
3. Assemble the radial bearing (168) onto the shaft (122).
   The bearings are interference fit.
   a) Preheat the bearings 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) Coat the internal surface of the bearings with the lubricant that is to be used in service.
   c) Assemble the radial-end bearing (168) onto the shaft (122).
      All pumps have a bearing spacer (217). Refer to Install the rotating element.

4. Install the oil-ring sleeve (324) and tighten the setscrew (388L).

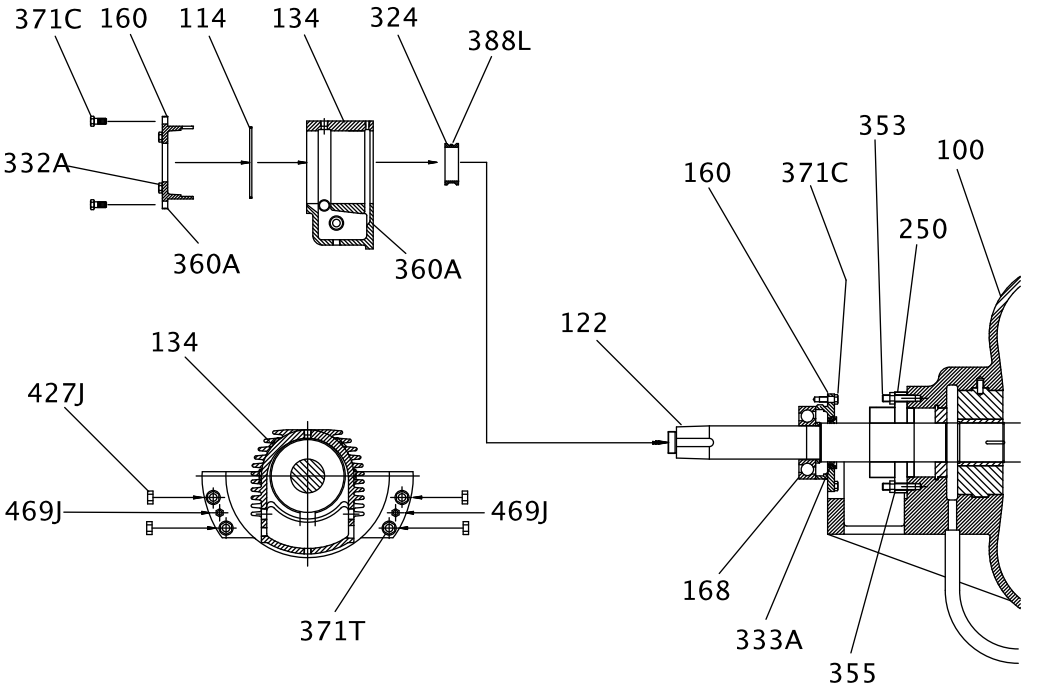


Figure 47: Radial end assembly

Figure 48: Radial end assembly

5. Install the bearing housing (134).
   The bearing housing is doweled to the casing (100) during the original build to assure the correct running position of the shaft.

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

6. Install the oil ring (114).
7. Install the end-cover gasket on the outboard side (360A).
8. Assemble the outboard labyrinth seal (332A) into the outboard radial-end cover (160):
   a) Clean the end cover with a solvent.
   b) Fit the labyrinth seal (332A) into the bore of the cover (160).
   c) Tap the seal in with a hammer.

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

9. Install the end cover (160). Tighten all end-cover capscrews (371C).

Assemble the thrust end (sleeve/ball bearing pumps)

1. Install the inboard labyrinth seal (333A).

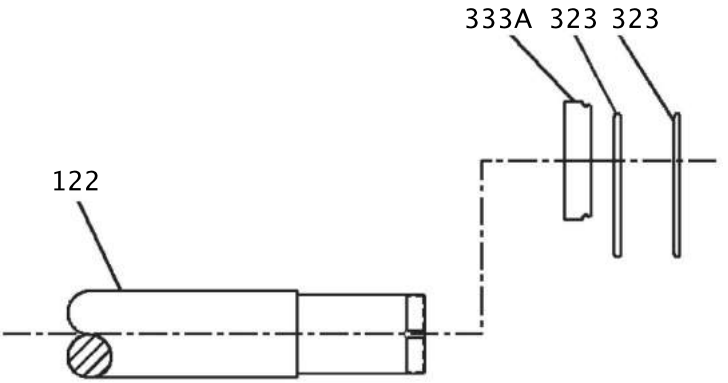


Figure 49: Oil ring installation

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

2. Place the inboard oil rings (114) on the shaft.
3. Assemble the thrust bearings (112A) in a back-to-back arrangement onto the shaft (122): The bearings are interference fit.
   a) Preheat the bearings to 250°F (120°C) with an induction-type bearing heater. Be sure to also demagnetize the bearings after heating.

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 bearings (112A), the oil ring sleeve (443B), and the bearing locknut (136) onto the shaft.
   c) While the bearings are hot, tighten the locknut by hand with a spanner wrench until the bearing is snug against the shaft shoulder.
   d) Allow the bearing assembly to cool slowly to room temperature. Do not rapidly cool the bearings with compressed air or other means.
   e) When the bearing assembly is fully cooled, remove the locknut, install the lockwasher (382), and install the locknut.
   f) Hand-tighten the locknut with a spanner wrench. Do not over-tighten the bearing. Tap the end of the spanner wrench with light strikes from a dead blow hammer while you note the location of the next available lockwasher tab that aligns with the slots in the locknut.
   The turning resistance of the nut increases 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.

g) 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.

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

4. Lift the lower half of the bearing housing (134A) into place, positioning the two inboard oil rings (323) in the bearing housing grooves.
5. Place the installed inboard labyrinth seal (333A) in the lower housing.
6. Finger tighten the lower housing to the head-bearing flange with the head-to-bearing housing studs (371T) and nuts (427J).
7. Install the sleeve bearing (117):
   a) Place the lower half of the sleeve bearing (117) onto the shaft (122) and slide it around the shaft into the lower bearing housing, moving the oil rings accordingly. Position the inboard oil rings (323) in the grooves on the sleeve bearings.
   b) Install the dowel pins in the pre-drilled dowel pin holes between the housing flange and the head-bearing flange.
   c) Tighten the nuts (427J) on the bearing housing to the head studs (371T).
   d) Place the upper half of the sleeve bearing (117) on the shaft, moving the oil rings aside. When the bearing top half is in place, move the oil rings back into the bearing housing and sleeve grooves.
8. Install the upper half of the bearing housing (134A).
9. Place the outboard oil ring (114) on the oil-ring sleeve (443B).
10. Adjust the end play with the gasket (361A) and the thrust end cover (109A).
    When new bearings are installed, you must measure the axial end play:
    a) Bolt the end cover to the thrust housing.
    b) Move the shaft axially from the coupling end.
    c) Measure the shaft axial movement with a dial indicator mounted on the radial bearing housing.

    This table shows the clearance requirements between the thrust bearing end cover and the bearing:

Bearing type	Clearance in inches (millimeters)
Ball/ball	0.005–0.010 (0.127–0.254)
Sleeve/ball	0.005–0.010 (0.127–0.254)
Sleeve/Kingsbury	0.010–0.013 (0.254–0.330)

11. Install the thrust bearing outboard-end cover (109A) , with the gasket (361A). Tighten the end cover to the housing with the capscrews (371C).

Assemble the radial end (sleeve/ball bearing pumps)

1. Install the inboard labyrinth seal (333A).
2. Place the oil rings (323) on the shaft.
3. Place the outboard labyrinth seal (333A) in the lower half of the bearing housing (134), which is not yet attached.
4. Lift the lower half of the housing into place, positioning the inner oil rings (323) in the bearing housing grooves.
5. Place the installed inboard labyrinth seal (333A) in the lower housing.

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

6. Hand-tighten the lower housing to the case bearing flange with the case-to-bearing housing studs (371T) and nuts (427J).
7. Install the sleeve bearing (117):
   a) Place the lower half of the sleeve bearing (117) onto the shaft (122) and slide it around the shaft into the lower bearing housing, moving the oil rings accordingly. Position the inboard oil rings (323) in the grooves on the sleeve bearings.
   b) Install the dowel pins (469J) in the pre-drilled dowel pin holes between the housing flange and the case bearing flange.

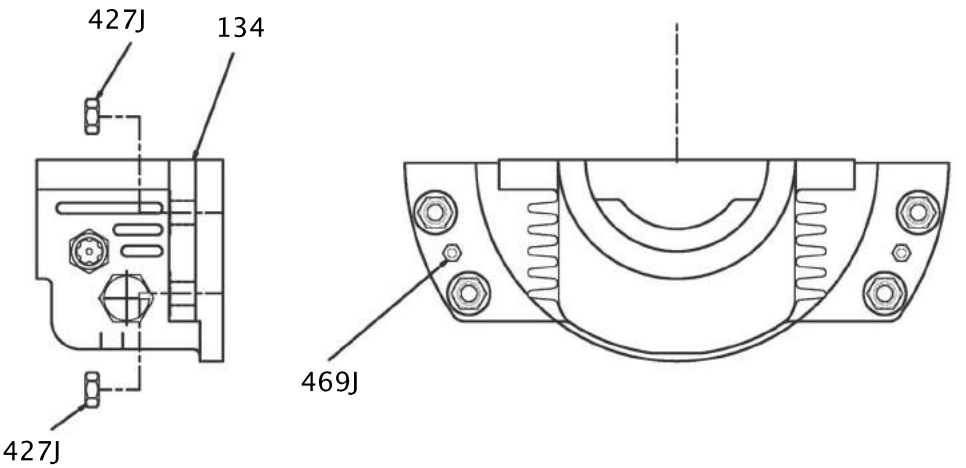


Figure 50: Radial bearing housing installation

   c) Tighten the nuts (427J) on the bearing housing to the case studs (371T).
   d) Place the upper half of the sleeve bearing (117) on the shaft, moving the oil rings aside. When the bearing top half is in place, move the oil rings back into the bearing housing and sleeve grooves.
8. Install the outboard labyrinth seal (332A).

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

9. Install the upper half of the bearing housing (134).
10. Position the dowel pins between the upper and lower halves of the bearing housing. Tighten the bearing-housing hex screws.

Assembly of the sleeve/Kingsbury bearing arrangement

If your pump is equipped with the rarely-supplied sleeve/Kingsbury bearing arrangement, refer to the topics Assemble the radial end (sleeve/ball bearing pumps) and Assemble the thrust end (sleeve/ball bearing pumps) for sleeve bearing reassembly.

Also see the instructions provided by Kingsbury for specific information regarding this tilting-pad hydrodynamic bearing.

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

Lubricated values are 2/3 of the unlubricated values.

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)
1-1/4 –8	N/A	N/A	N/A	N/A	1148 (1556)	1531 (2076)
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)
2-1/8 –8	N/A	N/A	N/A	N/A	6150 (8338)	8200 (11118)
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:

- Impellers (101 through 101M)
- Thrust bearing end cover, outboard (ball and sleeve bearing construction only) (109A)
- Shaft (122)
- Radial bearing end cover, inboard (ball bearing construction only) (160)
- Impeller key (178)
- Bearing spacer (217)
- Snap ring (361F)
- Locating ring (361H)

An alternative approach is to stock a complete rotating element. This is a group of assembled parts that includes all rotating components except the bearings (and parts), mechanical seals, and coupling.

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
- Thrust bearing (duplex pair) (112A)
- Oil rings (114, 323)
- Sleeve bearings, two (117) (sleeve bearing construction only)
- Throttle bushing, sleeve (128)
- Throttle bushing (129)
- Bearing locknut (136)
- Stage ring (144)
- Center bushing (155)
- Casing wear rings (164, 164A, 164B)
- Radial bearing (168) (ball bearing construction only)
- Impeller wear rings (202, 202A, 202B, 203)
- Center sleeve (205)
- Labyrinth seal, outboard (332A)
- Labyrinth seal, inboard (333A)
- Casing gasket (351)
- Bearing lockwasher (382)
- Bearing end-cover gasket (360A)

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 mechanical seal 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.
Vertical (top-to-bottom) alignment cannot be obtained (angular or parallel).	The baseplate is not leveled properly and is probably bowed.	1. Determine if the center of the baseplate should be raised or lowered. 2. Level screws equally at the center of the baseplate. 3. Realign the pump and driver.

Parts Listings and Cross-Sections

Parts list

Table 4: Parts list with materials of construction for sleeve/ball bearing arrangement

The materials in this table are typical. Refer to the order documentation for the actual materials furnished.

Item S-6	Part name S-8N	Quantity per pump	Construction - API designation				
			A-8N	D-1			
100	Casing	1	Carbon steel		12% chrome	316L SS	Duplex[2]
101/101M	Impeller	Varies	12% chrome	316L SS	12% chrome	316L SS	Duplex[2]
109A	Thrust bearing end cover, outboard	1	Carbon steel				
112A	Ball bearing, thrust	1 pair	Steel				
114	Oil ring, thrust bearing	1	Brass				
117	Sleeve bearing	2	Babbitted tin / steel				
122	Shaft	1	17-4PH	Nitronic 50	17-4PH	Nitronic 50	Duplex
128	Throttle bushing sleeve	1	Nitronic 60				H.F. duplex[1]
129	Throttle bushing	1	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
134	Housing, bearing - radial	1	Carbon steel				
134A	Housing, bearing - thrust	1	Carbon steel				
136/382	Bearing locknut and lockwasher	1	Steel				
144	Stage ring	Varies	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
155	Center bushing	1	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
164/164A/164B	Wear rings, casing	Varies	410 SS hardened	316L SS	410 SS	316L SS	H.F. duplex[1]
178	Key, impeller	Varies	316 SS	316 SS	410 SS	316 SS	Duplex
202, 202A, 202B, 203	Wear rings, impeller	Varies	17-4PH	Nitronic 60	17-4PH	Nitronic 60	H.F. duplex[1]
205	Center sleeve	1	Nitronic 60				H.F. duplex[1]
217	Bearing spacer	1	Carbon steel				
323	Oil ring sleeve	4	Brass				
332A	Labyrinth seal, outboard	1	Bronze				
333A	Labyrinth seal, inboard	2	Bronze				
351	Gasket, casing	1	Garlock 3000				
353	Stud, gland	8	4140				
355	Nut, gland stud	8	4140				
356A, 356C, 356K, 425	Stud and nut, casing	Varies	4140				
360A	Gasket, bearing end cover	6	Vellumoid				
361F	Snap ring	Varies	316 SS				
361H	Locating ring	Varies	316 SS				Duplex
371T/427J	Stud and nut, bearing housing to casing	8	Carbon steel				
371C	Capscrew, bearing housing end cover	4	Carbon steel				
400	Coupling key	1	Carbon steel				
443B	Thrust collar	1	Carbon steel				
520	Shaft nut	1	Carbon steel				

[1]Hardface with Colmonoy #6

[2]ASTM A890 Grade 3A Duplex material will be supplied unless otherwise specified.

Table 5: Parts list with materials of construction for ball bearing arrangement

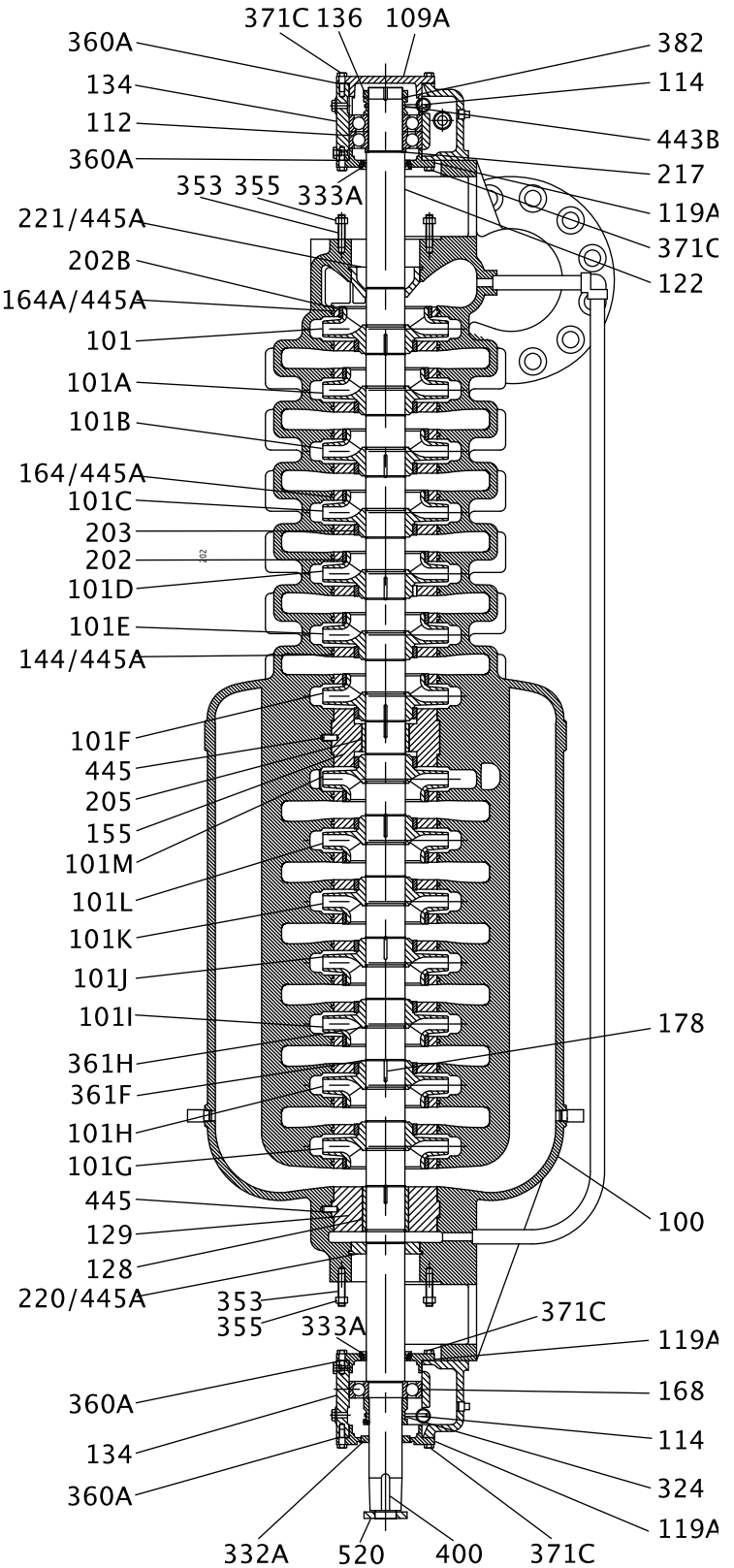
The materials in this table are typical. Refer to the order documentation for the actual materials furnished.

Item S-6	Part name S-8N	Quantity per pump	Construction - API designation				
			A-8N	D-1			
100	Casing	1	Carbon steel		12% chrome	316L SS	Duplex[2]
101/101M	Impeller	Varies	12% chrome	316L SS	12% chrome	316L SS	Duplex[2]
109A	Thrust bearing end cover, outboard	1	Carbon steel				
112A	Ball bearing, thrust	1	Steel				
114	Oil ring	2	Brass				
117	Sleeve bearing	2	Babbitted tin / steel				
122	Shaft	1	17-4PH	Nitronic 50	17-4PH	Nitronic 50	Duplex
128	Throttle bushing sleeve	1	Nitronic 60				H.F. duplex[1]
129	Throttle bushing	1	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
134	Housing, bearing - radial and thrust	2	Carbon steel				
136/382	Bearing locknut and lockwasher	1	Steel				
144	Stage ring	Varies	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
155	Center bushing	1	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
160	Bearing end cover, radial (inboard and outboard) and thrust (inboard)	3	Carbon steel				
164/164A/164B	Wear rings, casing	Varies	410 SS hardened	316L SS	410 SS hardened	316L SS	H.F. duplex[1]
168	Bearing, radial	1	Steel				
178	Key, impeller	Varies	316 SS	316 SS	410 SS	316 SS	Duplex
202, 202A, 202B, 203	Wear rings, impeller	Varies	17-4PH	Nitronic 60	17-4PH	Nitronic 60	H.F. duplex[1]
205	Center sleeve	1	Nitronic 60				H.F. duplex[1]
217	Bearing spacer	1	Carbon steel				
324	Oil ring sleeve, radial end	4	Carbon steel				
332A	Labyrinth seal, radial outboard	1	Bronze				
333A	Labyrinth seal, radial and thrust inboard	2	Bronze				
351	Gasket, casing	1	Garlock 3000				
353	Stud, gland	8	4140				
355	Nut, gland stud	8	4140				
356A, 356C, 356K, 425	Stud and nut, casing	Varies	4140				
360A	Gasket, bearing end cover - radial and thrust	9	Vellumoid				
361F	Snap ring	Varies	316 SS				
361H	Locating ring	Varies	316 SS				Duplex
371C	Capscrew, bearing housing end cover	16	Carbon steel				
371T/427J	Stud and nut, bearing housing to casing/head	8	Carbon steel				
400	Coupling key	1	Carbon steel				
443B	Oil ring sleeve, thrust end	1	Carbon steel				
520	Shaft nut	1	Carbon steel				

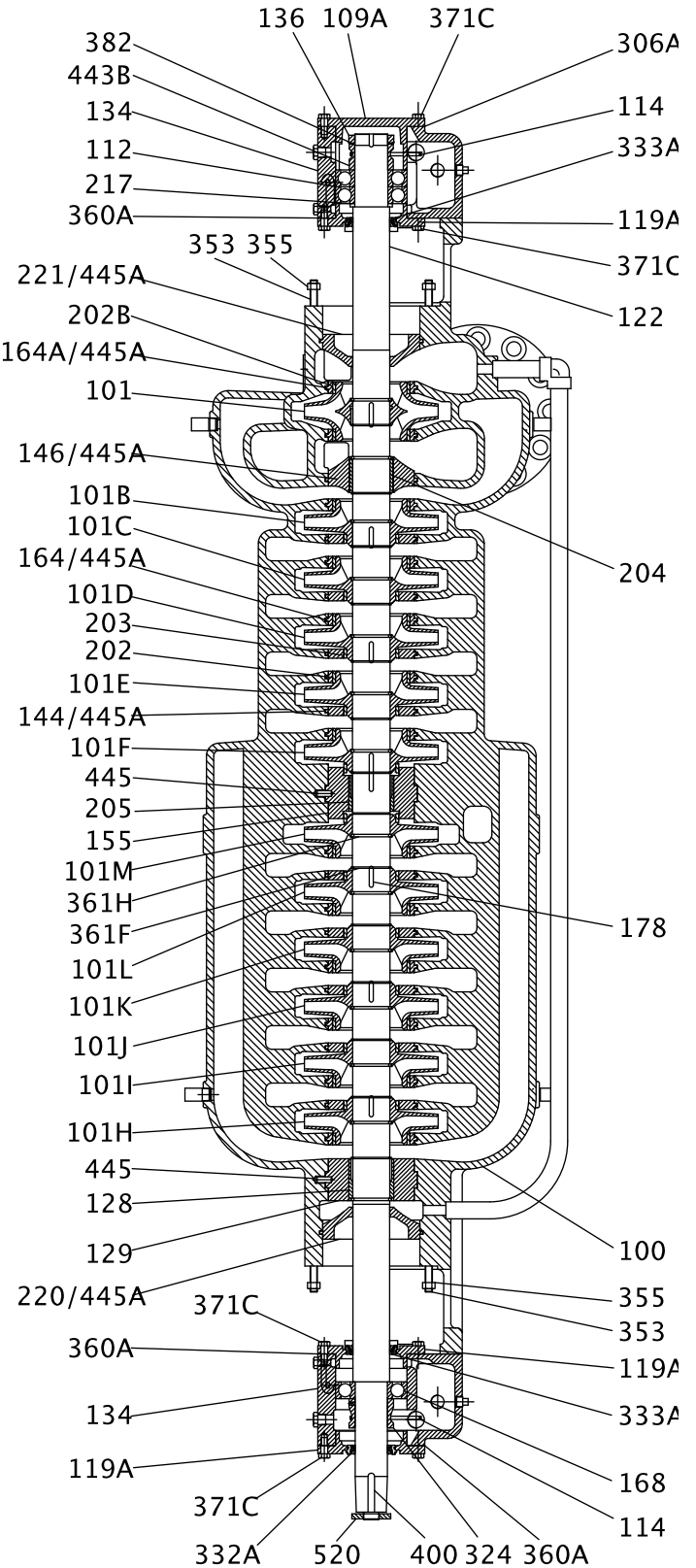
[1]Hardface with Colmonoy #6
[2]ASTM A890 Grade 3A Duplex material will be supplied unless otherwise specified.

Cross-sectional diagrams

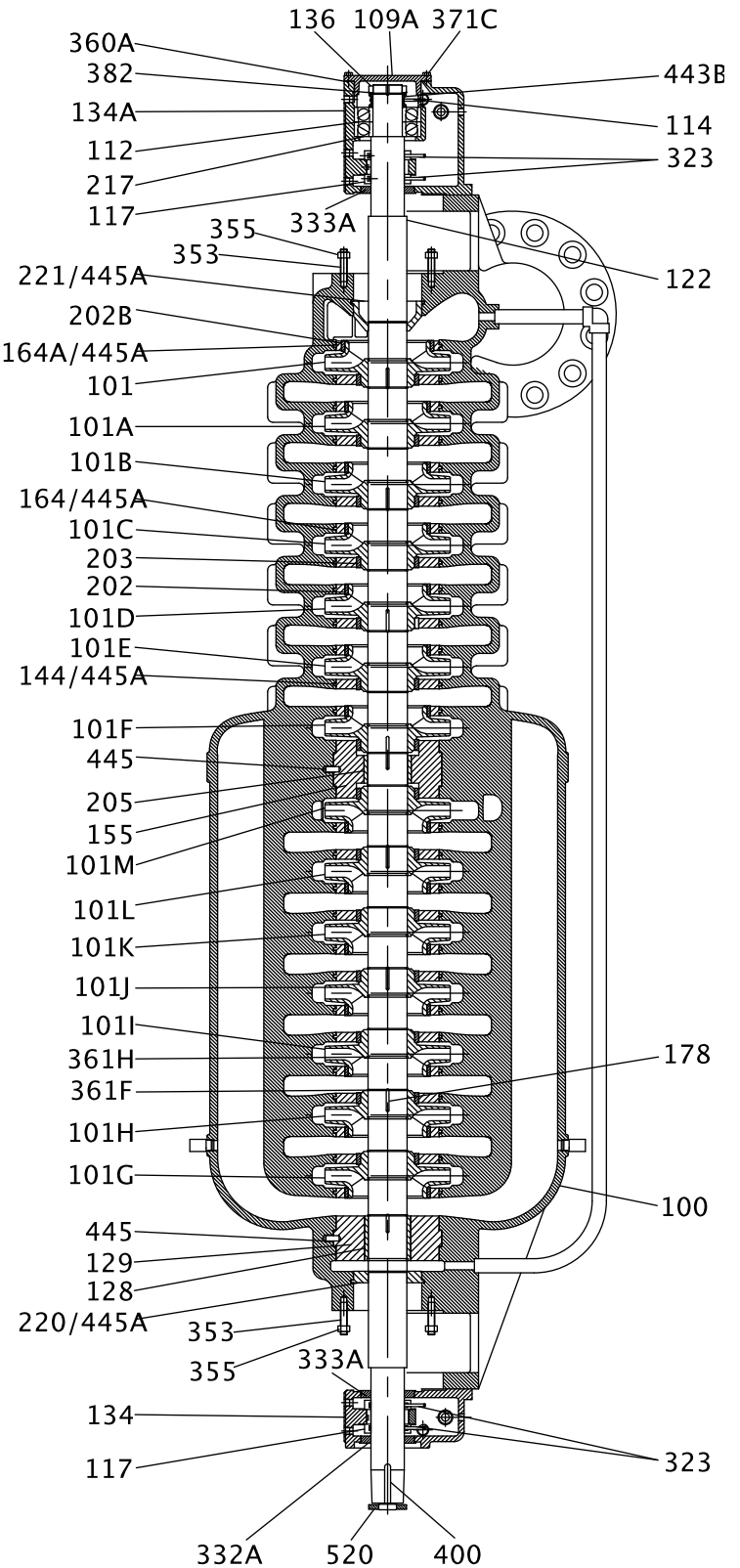
Model 3600 single suction – ball/ball



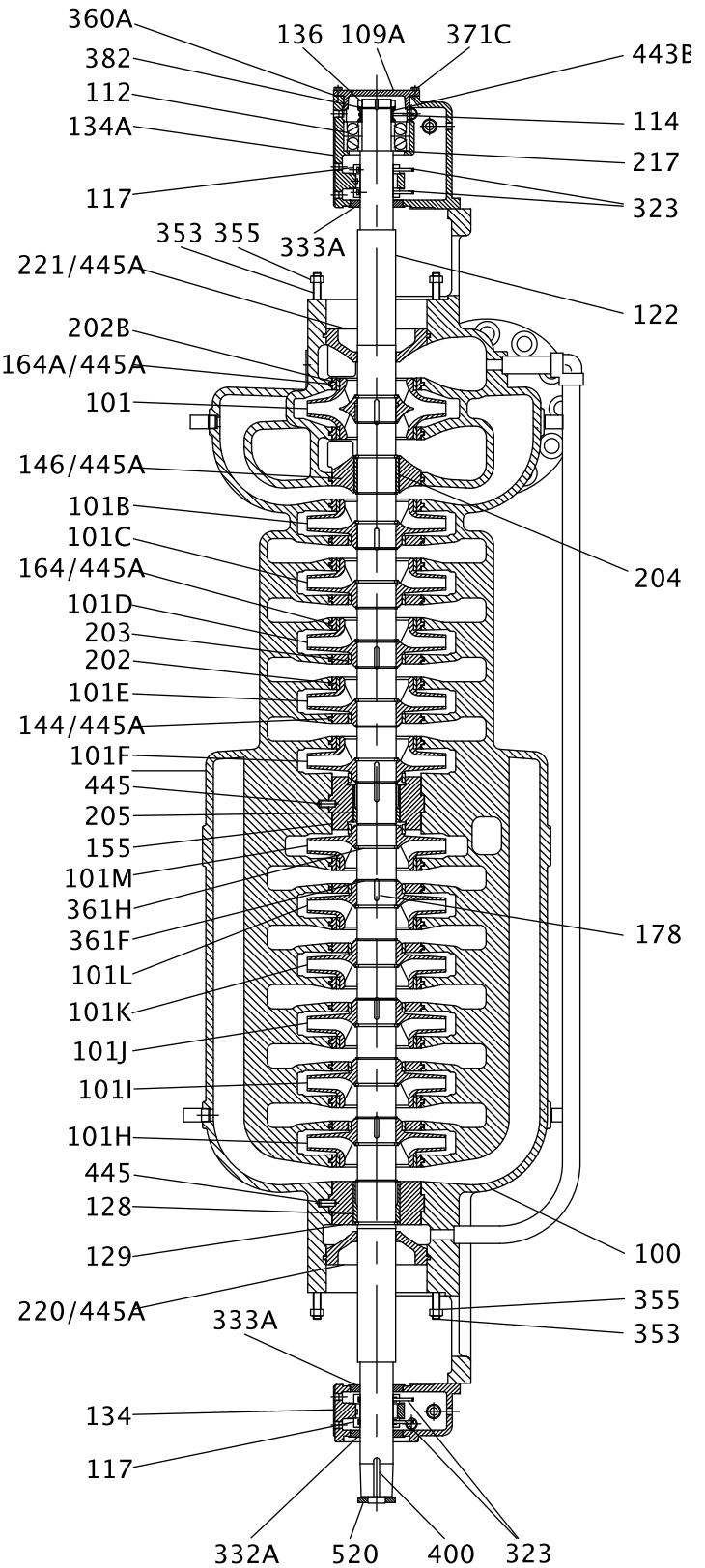
Model 3600 double suction – ball/ball



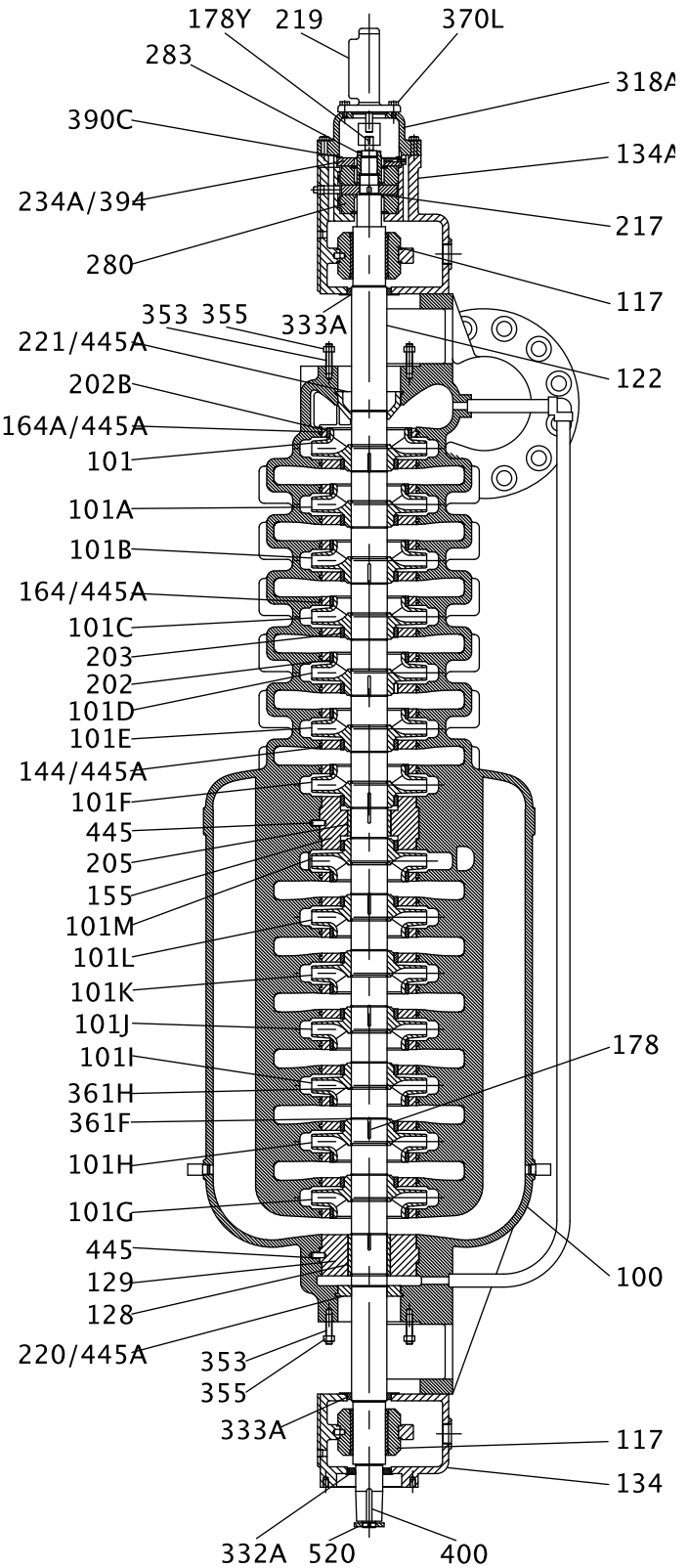
Model 3600 single suction – sleeve/ball



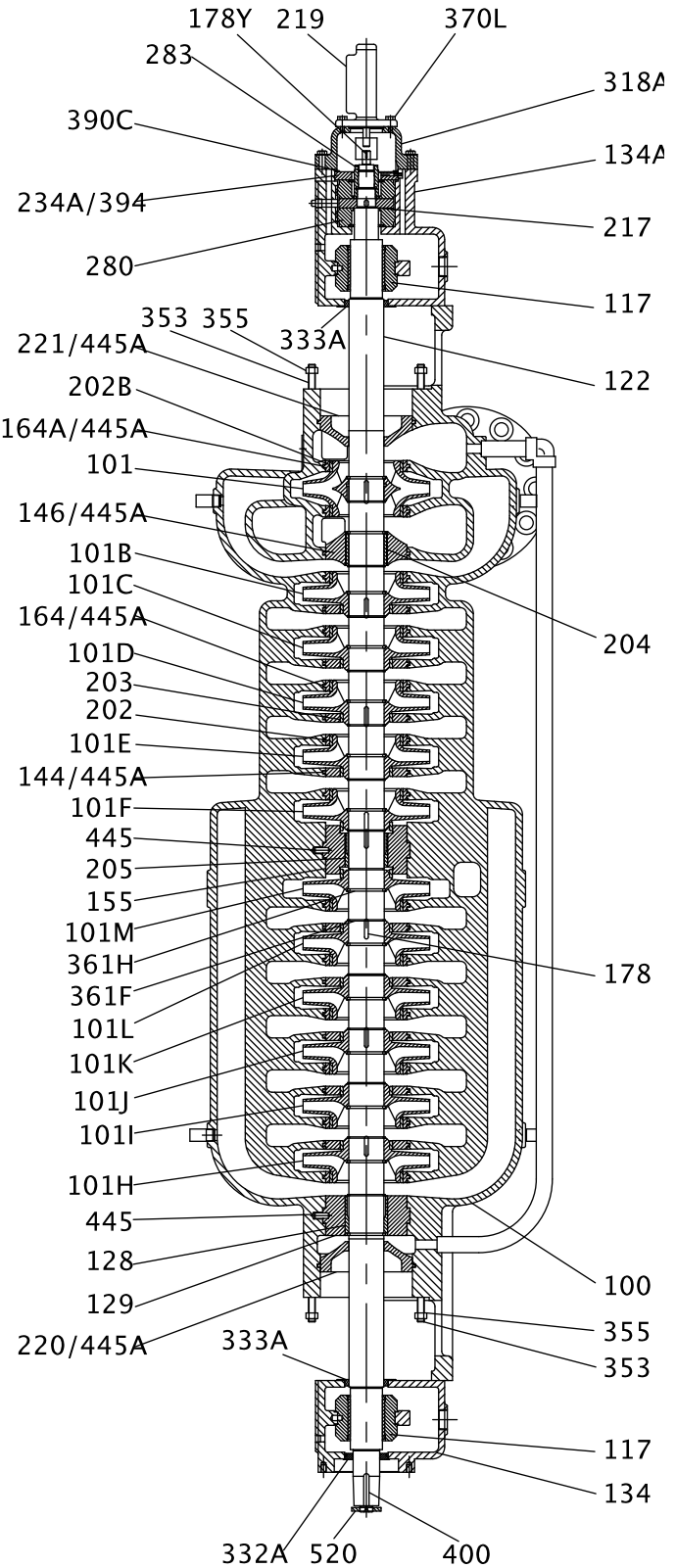
Model 3600 double suction – sleeve/ball



Model 3600 single suction – sleeve/Kingsbury



Model 3600 double suction – sleeve/Kingsbury



Other Relevant Documentation or Manuals

For additional documentation

For any other relevant documentation or manuals, contact your ITT representative.

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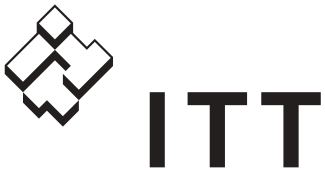

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The original instruction is in English. All non-English instructions are translations of the original instruction.

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