



**3611, 3617, 3622, 3711, 3717, 3722,  
4611, 4617, 4622, 4711, 4717, 4722  
HB, SB, and BH OWNERS MANUAL  
(Use with Supplement Owners Manual  
G12-436 for GHB and BHB Pumps)**

G12-209

04/08/04



## **SAFETY INSTRUCTIONS**

**This is an industrial component. Only a qualified systems integrator should be allowed to design it into a system. The integrator must determine proper plumbing, mounting, driveline and guard components.**

**Improper installation or use could lead to a serious, even fatal, accident. The system integrator must communicate all safe operation procedures to the end user(s).**

**Before operation, fully understand and follow the instructions shown in this manual and any instructions communicated by the system integrator. No one should be allowed to operate or maintain this pump who has not been fully trained to work safely according to the configuration of the pump system and in accordance with all applicable government and industry regulations.**

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## Good Practice

**NOTE:** These are general guidelines and do not cover all possible situations.

It is the responsibility of the system integrator to apply this product properly.

### Plumbing

1. The inlet pipe should be as short and straight as possible to minimize suction pressure losses. Excessive restrictions at the inlet can cause cavitation resulting in poor performance, noise, vibration, or pump damage.
2. Slope the inlet plumbing appropriately to avoid air pockets.
3. Plumbing weight, misalignment with the ports or thermal expansion can exert excessive force on the pump. Plumbing must be properly supported and aligned with expansion joints, if required, to minimize these forces.
4. To prevent over pressure situations, install a relief valve as close to the pump outlet as possible. Install the relief valve before any shut-off valves.

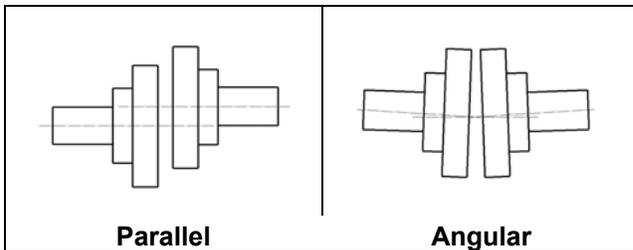
## Separate Pump and Drive Assemblies

### Driveline Guards

1. Assure adequate guards have been installed to prevent personnel contacting moving components.
2. Follow all OSHA, Federal, state and local codes.

### Check Alignment of Pump to Driveline

Excessive misalignment can overload the pump input shaft and cause premature failure. The figures below show parallel and angular misalignments.



### Mounting Base

1. Mount the unit on a rigid, heavy base to provide support and absorb shock. Bases should be designed for high rigidity, not just strength.
2. The pump feet were not designed for mounting to concrete and do not have enough contact area to prevent concrete from failing. When mounting to cement or concrete, use a steel base plate (supplied by others) to distribute the mounting stress over an area large enough to prevent the cement from failing. The base plate should be at least as thick as the pump feet. Grout it in place.

## Roper Pumps' Close Coupled Drives

Hydraulic or Gearmotor units where the drive mounts directly to the pump

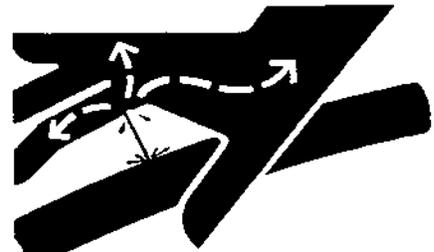
- Driveline is not exposed and does not require guards.
- Alignment between pump and drive line is maintained by the assembly.
- Because the assembly absorbs reaction forces of the driveline, the mounting base does not need to be as robust. The level of rigidity and strength is determined by the piping stresses from the system.

## ! WARNING



**Over-pressure may burst pump or system components. Always include a relief valve in installation. Do not over pressurize pump or block discharge line while running.**

## ! WARNING



**Injection Hazard: Do not try to stop a leak with your hand! Avoid any close contact with hydraulic fluid jets. Escaping fluid can penetrate skin, causing serious injury. In case of accident, see a doctor immediately for removal of fluid.**

## Guarding PTO Drive Shafts

PTO drive systems can be dangerous and when used, additional safety precautions, including guarding, may be required and must be provided by the drive system installer. Roper Pump Company has no responsibility for recommending or providing proper guarding or other safety measures in any particular application.

The installation of proper guards for the power take-off and its associated equipment is the responsibility of the drive system designer and the installer who know the particular product application and the user's exposure to danger. *The ultimate responsibility for the safe application and installation is the user's.*

**! WARNING**



**Operating without guards could result in serious injury or death. Machinery in operation can grab, crush, cut, mangle and dismember. Do not operate without adequate guards in place.**

# 1. NAMEPLATE DATA

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Roper Pump Company identifies each pump manufactured by a metal nameplate attached to the pump. This nameplate describes the pump as built at the factory. Copy the nameplate data from your pump in the area provided below. Use this for ready reference when ordering repair parts or when consulting with a Roper distributor or Roper Pump Company about this pump.

MODEL NUMBER: \_\_\_\_\_  
SPEC NUMBER: \_\_\_\_\_  
TYPE: \_\_\_\_\_  
SERIAL NUMBER: \_\_\_\_\_

## PUMP NOMENCLATURE

MODEL 3722 GHBFORVLX

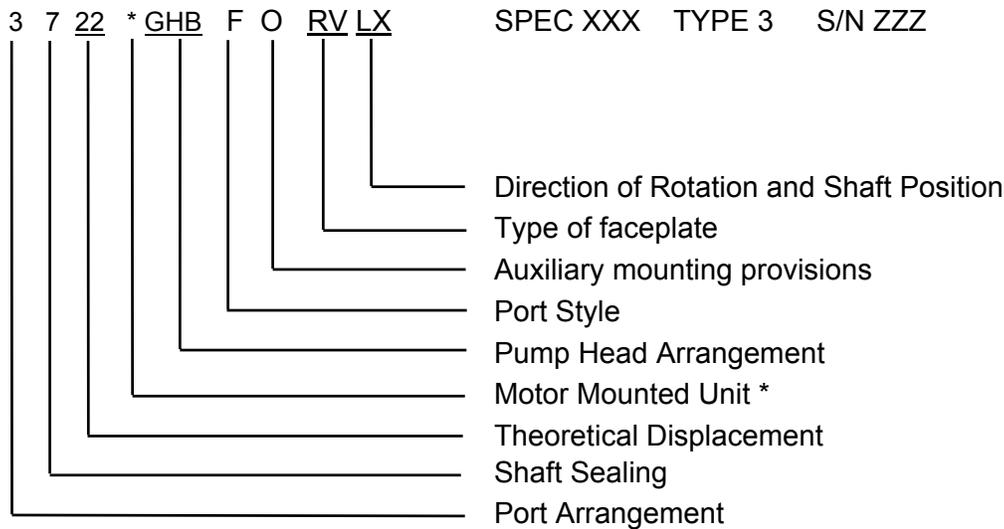
SPEC XXX TYPE 3

SERIAL NO. ZZZ

1. The Model Number consists of an eleven digit number.
  - The first digit (3) indicates the port arrangement.
    - 3 – 3600 Series with right angle ports
    - 4 – 4600 Series with straight through ports
  - The second digit (7) indicates shaft sealing.
    - 6 – Packing
    - 7 – Mechanical Seal
  - The third and fourth digits (22) indicate the approximate theoretical displacement in U.S. gallons per 100 revolutions. Gallons/100 Rev. [Liters/100 Rev.]
    - 11 [41.6]
    - 17 [64.4]
    - 22 [83.3]
  - The letter or group of letters (GHB) indicates the pump head arrangement.
    - HB - Pump with outboard bearing
    - SB - Suspended pump with outboard bearing and auxiliary piping
    - GHB - Pump with outboard bearing and built-on gear reduction unit
    - BHB - Pump with outboard bearing and bracket assembly to accommodate hydraulic drive auxiliaries through a flexible coupling
    - BH - Pump without outboard bearing to accommodate close coupled hydraulic drive auxiliaries through a rigid coupling
  - The letter (F or A) indicates port style
    - No letter – Pump with threaded ports
    - F – Pump with Roper standard flange ports
    - A – Pump with flange facings to accept ANSI flanges
  - On GHB pumps, the letter (O) indicates pump with outboard bearing and auxiliary mounting provisions. (Does not include built-on gear reduction unit).
  - On SB pumps, the letter (O) indicates pump without auxiliary piping.
  - The letters (RV) indicate type of faceplate on pump.
    - See Section 5, **DIRECTION OF ROTATION AND RELIEF VALVES**, for an explanation of the types of valves available.
    - No letters – Plain faceplate
    - RV – RV style relief valve faceplate (Standard RV, Jacketed RV, or Double Setting RV)

- The letter or group of letters (X, LX) indicates direction of rotation and shaft position. The letter (L) indicates low drive unit. If the letter (L) is not used, the shaft will be in a high drive position.
  - No letter or W – Clockwise Rotation (Standard Rotation)
  - X - Counterclockwise Rotation
  - Y - Clockwise Rotation
  - Z - Counterclockwise Rotation
  - LW - Clockwise Rotation
  - LX - Counterclockwise Rotation
  - LY - Clockwise Rotation
  - LZ - Counterclockwise Rotation

Example:



- \* **The letter (M) may be used in this space indicating the pump is mounted with motor. The letter (E) may be used in this space indicating the pump is mounted on a base with or without engine.**

As stated in the explanation of the pump nomenclature, all characters may not appear on every pump nameplate.

**NOTE:** The preceding description of the figure number is to assist in identifying your Roper 3600 series pump only. **DO NOT** attempt to derive any ratings or performance from the figure number. **DO NOT** use the explanation of the figure number to construct your own pump. Not all combinations are possible. For assistance in pump selection, it is recommended that you consult Roper Pump Company or an authorized distributor.

- Occasionally, special pumps or configurations are required which are unique for a particular application. These modifications are clarified by a SPECification number. Identification of any items different than a standard pump can be made by consulting Roper Pump Company or an authorized distributor.
- The TYPE number is a number used by Roper Pump Company for in-house identification of construction and hydraulics. Always include the type number in any references to the pump.
- The SERIAL number is a unique number assigned to each pump built by Roper Pump Company.

In any communication concerning this pump, always be sure to include the Figure, Spec, Type, and Serial numbers so proper identification of the pump can be assured.

## 2. MAXIMUM PUMP RATINGS

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The maximum pressure, speed, and temperature limits for this pump SERIES are shown below.

The maximum rating of a pump with a SPEC number may be different depending on the materials of construction.

Maximum limits for this SERIES:

### Pressure

- 125 psi [862 kPa] Maximum Inlet
- 125 psi [862 kPa] Maximum Discharge

### Speed

- 750 rpm Maximum

### Temperature

- Mechanical Seal Pumps: 212°F [100°C]
- Packed Box Pumps: 250°F [121°C]

## 3. PREOPERATION CHECKS

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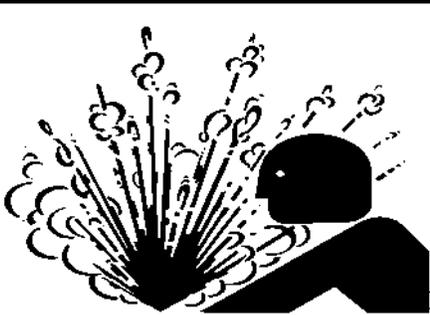
*Read and understand the instructions and recommendations contained in this manual.*

Disconnect the coupling between the driver and pump.

Test the rotation of the driver to make sure it will operate the pump in the desired direction of rotation. Rotation is shown on the pump faceplate if the pump has an integral relief valve. When an integral relief valve is used, make sure it is positioned and adjusted as discussed in Section 5, **DIRECTION OF ROTATION AND RELIEF VALVES**. After the unit is mounted and the piping is connected, the pump should be checked to be sure it operates freely without binding. After operation is proved satisfactory, both pump and driver should be tightly secured and the alignment rechecked before operation.

Before starting, make sure all guards are in place and the inlet and discharge valves are opened.

After starting the unit, check to see that the pump is delivering liquid. If not, stop the driver immediately and correct the problem. After the pump is delivering liquid, check the unit for excessive vibration, localized heating, and excessive shaft seal leakage. Check the pressure or vacuum by installing gauges at both the inlet and discharge sides of the pump to make sure the pressure or vacuum conforms to specifications.

<p><b>! WARNING</b></p> 	<p>If there is no pressure relief device in the system, <b>NEVER</b> block the discharge line. If there is a relief valve in the system, <b>NEVER</b> block the discharge line between the relief valve and pump. High pressure will occur, resulting in possible damage or breakage to the pump or system parts and possible injury to personnel. <b>DO NOT</b> operate the pump for more than one minute with the discharge line blocked downstream of the relief valve. Rapid heating and possible damage will occur. Even an open discharge line does not prevent the possibility of high pressure. Discharge line length, diameter, and arrangement along with fluid viscosity and velocity also can create a high-pressure situation at the pump.</p>
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## 4. RECOMMENDED TOOL LIST

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**NOTE:** Tools not furnished with pump.

### **Tools for all Pumps:**

- (1) Safety Glasses
- (1) 9/16" Combination Wrench
- (1) 3/4" Combination Wrench
- (1) 6" Adjustable Wrench
- (1) CG-45 Snap-On® Tool Bearing Puller
- (1) 6" to 10" Three Square File
- (1) Pliers

### **Additional Tools for HB Pumps:**

- (1) 1/8" Hex Key
- (1) Flat tip Screwdriver, 1/4" wide X 4" long blade

### **Additional Tools for Pumps with an RV Type Relief Valve:**

- (1) 7/16" Combination Wrench
- (1) 18" Pipe Wrench

### **Additional Tools for Pumps with Flanges:**

- (2) 15/16" Combination Wrench

### **Additional Tools for Pumps with Shaft Packing:**

Packing Hook for .34" square packing rings

### **Additional Tools for Pumps with Mechanical Seals:**

- (1) 0400 External Retaining Ring Pliers

### **Additional Tools for BH Pumps:**

- (1) 5/16" Hex Key

## 5. DIRECTION OF ROTATION AND RELIEF VALVES

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There are three types of integral relief valves available. The standard RV, double setting RV, and jacketed RV are all designated by the letters "RV" in the pump nomenclature. The spec number is used to identify which RV relief valve is used.

### STANDARD RV

This relief valve is externally adjustable by means of an adjusting screw located in the center of the relief valve cap. The range of adjustment is approximately 30 psi [207 kPa] to 125 psi [862 kPa]. The actual capability is dependent on pump speed and liquid viscosity. The settings are for full bypass; that is, all of the fluid is circulating back to the inlet through the relief valve. The end user must set the relief valve for conditions that exactly match the application.

### JACKETED RV

This relief valve operates in exactly the same manner as the standard RV except that the faceplate is jacketed to allow provisions for heating or cooling of the relief valve.

### DOUBLE SETTING RV

This relief valve is externally adjustable by means of an adjusting screw located in the center of the relief valve cap. The adjusting screw is fitted with a two position lever to quickly change the relief valve setting. This is accomplished by moving the lever from one position to the other. The relief valve is set with the lever in the high pressure position so that the relief valve setting can be quickly reduced by approximately 10 to 30 psi [30 to 207 kPa] by moving the lever from the high pressure position to the low pressure position. Actual drop in pressure resulting from moving the lever from the high to the low position is dependent on the application.

### DIRECTION OF ROTATION TAG

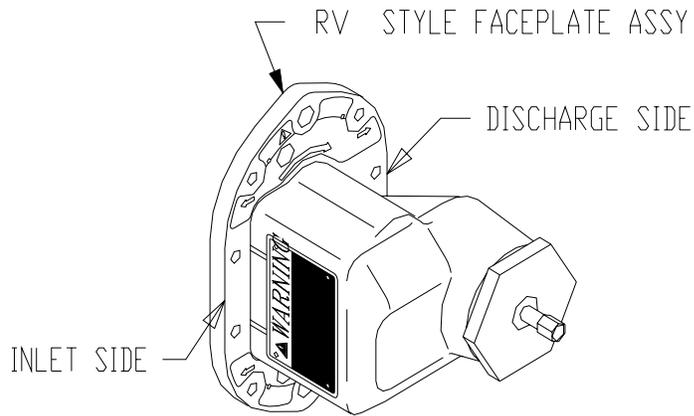
Figure 5.1



TYPICAL DIRECTION OF ROTATION TAG FOUND ON RV STYLE RELIEF VALVES

## RECOGNIZING THE RELIEF VALVE

Figure 5.2



RV STYLE RELIEF VALVE

### PROPER PUMP GEAR ROTATION

Proper gear rotation is shown on the warning tags attached to the relief valve faceplate.

**! WARNING**

### DO NOT REVERSE ROTATION

*Reversing rotation of the pump without reversing the position of the relief valve faceplate will cause the relief valve to be inoperable. Discharge pressure will be holding the valve closed instead of pushing it open. Running the pump against the relief valve can cause very high pressure buildup on the discharge side of the pump and in the system downstream of the pump. High pressure can cause the pump or any other system component to break or leak causing liquid in the system to escape resulting in possible injury or death.*

### PUMP INLET and PUMP DISCHARGE

On the RV style relief valve, either the “pump inlet” or “pump discharge” arrow will always point directly to one side port on the cases that have one side port and one top port. The top port is connected to the side of the pump that is opposite the side port. The “pump inlet” and “pump discharge” arrows will always point directly to the inlet and discharge ports on the pump with straight through port cases.

An integral relief valve should not be used on applications where the discharge must be closed for more than one minute. Prolonged operation of the pump with the discharge closed will cause rapid heating of the liquid circulating through the relief valve, thus resulting in possible damage.

## DIRECTION OF ROTATION FOR THE RV STYLE RELIEF VALVE

The drawings showing **DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE RV STYLE RELIEF VALVE** and position of relief valve with the letter "L" in the designation are for low drive applications (the drive shaft is lower than the side port). All other drawings shown in Figures 5.4 and 5.5 are for high drive applications (the drive shaft is above the side port).

The arrow in the drawing at the end of the drive shaft indicates the direction of rotation needed to achieve proper operation of the pump and relief valve when using the pump and relief valve orientation shown in the drawing. CW indicates clockwise rotations and CCW indicates counterclockwise rotation when viewed from the drive shaft end of the pump.

To determine the correct relief valve position for any of the pump orientations, use the drawings shown in Figures 5.4 and 5.5 titled **DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE RV STYLE RELIEF VALVE**:

1. Find the group of drawings with the proper drive shaft position (high or low drive). Drawings with W, Z, X, or Y rotation are high drive pumps. Drawings with LW, LZ, LX, or LY rotation are low drive pumps. Eliminate all other drawings.
2. In the drawings remaining, find the group of drawings with the proper direction of rotation arrow at the end of the drive shaft. Eliminate all other drawing. CW indicated clockwise rotation and CCW indicates counterclockwise rotation when viewed from the drive shaft end of the pump.
3. In the drawings remaining, find the group of drawings with the proper port positions (straight through or right angle). Eliminate all other drawings.
4. In the remaining drawings, find the drawing with the proper inlet and discharge port locations. This drawing will show the proper relief valve position for the pump configuration chosen. Note the position of the word "INLET" cast on the side of the relief valve faceplate. The word "INLET" must be on the inlet "side" of the pump in order for the relief valve to work properly. The discharge and inlet "sides" of the pump are always directly opposite each other; the top port of the right angle pump is connected to the "side" of the pump via an internal passage.

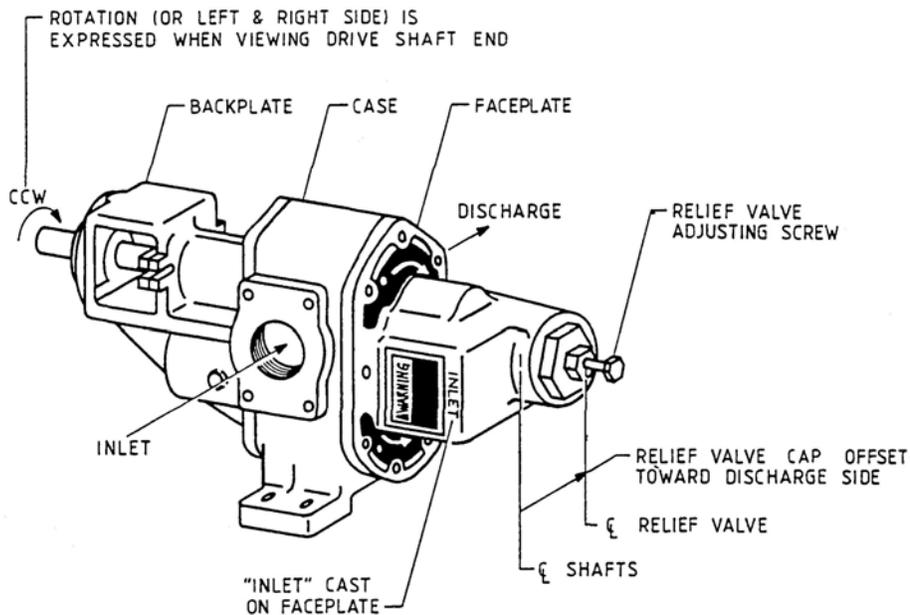


Figure 5.3

# **WARNING**

**DO NOT** operate a pump with a relief valve that is not positioned correctly. The relief valve will be inoperable. This can allow high pressure buildup on the discharge side of the pump and in the system downstream of the pump. High pressure can cause the pump or any other system component to break or leak causing liquid in the system to escape, resulting in possible injury or death.

**NOTE:** The fact that the pump has the correct rotation and pumps liquid in the correct direction does not insure that the relief valve is installed in the correct position, or that it has the correct setting for the application.

**NOTE:** Some older RV style faceplates do not have the word "INLET" cast into the faceplate; however, the position of the relief valve is the same, i.e., relief valve cap and adjusting screw are offset to the discharge side of the pump.

	W		LW	
3X11-3X22				
4X11-4X22				
	Z		LZ	
3X11-3X22				
4X11-4X22				
	X	LX	Y	LY
3X11-3X22				

DIRECTION OF ROTATION FOR 3611 TO 4722 HB PUMP USING RELIEF VALVE

**Figure 5.4**

DIRECTION OF ROTATION FOR 36-3722 SBFORV

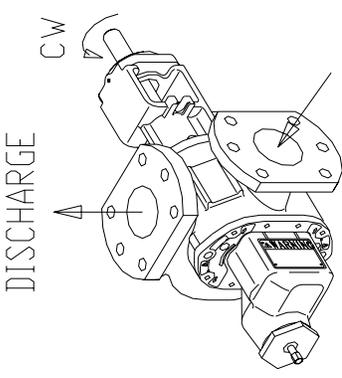
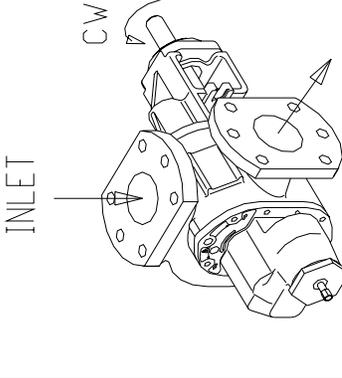
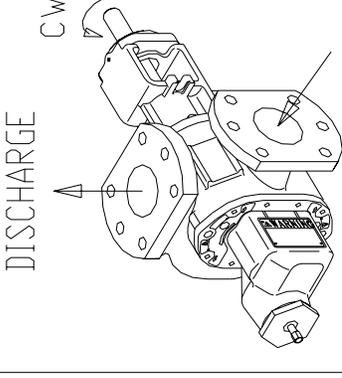
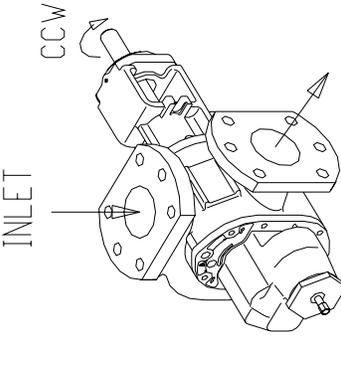
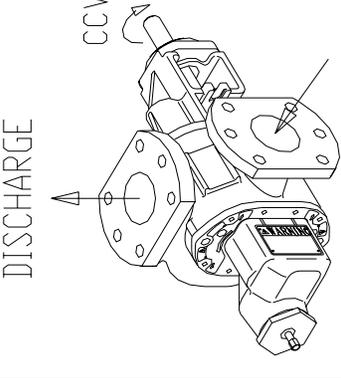
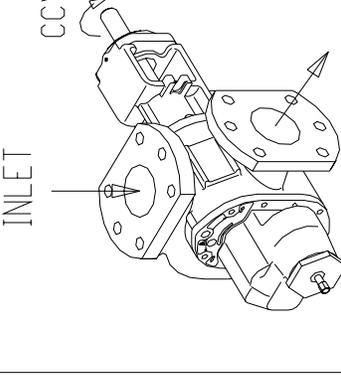
W	LW	Z	LZ
 <p>DISCHARGE CW INLET</p>	 <p>INLET CW DISCHARGE</p>	 <p>DISCHARGE CCW INLET</p>	 <p>INLET CW DISCHARGE</p>
X	LX	Y	LY
 <p>INLET CCW DISCHARGE</p>	 <p>DISCHARGE CW INLET</p>	 <p>INLET CCW DISCHARGE</p>	 <p>DISCHARGE CW INLET</p>

Figure 5.5

## CHANGING THE RV STYLE RELIEF VALVE POSITION

Refer to the sectional drawing shown in Figure 5.6.

# **WARNING**

**DO NOT** remove the relief valve cap (24) without reading the instructions below for disassembling the relief valve. *The relief valve contains a powerful compressed spring (29) that may cause injury or death if released suddenly*

- **WARNING!** Relieve all internal fluid and air pressure inside the pump before disassembly.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Fluid may spill out of the pump when the relief valve faceplate (23B) is removed. Take all necessary precautions to protect yourself, others, and the nearby area from any harm this fluid may do.

You should have already checked the drawings in Figures 5.4 and 5.5 to find the correct way to position your relief valve, based on the pump's direction of shaft rotation and position and the location of the inlet and discharge ports. If you have not checked, do it now to decide whether or not you should change the position of our relief valve.

If the relief valve position needs to be changed, follow the instructions below and refer to Section 14, **PARTS LIST** and the **RV STYLE RELIEF VALVE** drawing shown in Figure 5.6.

1. Turn off pump and lock out energy source to driver.
2. Close inlet and discharge valves.
3. To drain pump, follow procedure in Section 7, **INSTRUCTIONS FOR DRAINING PUMP**.
4. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing faceplate (23B) to case. Remove faceplate.
5. While viewing faceplate (23B) from end with relief valve cap (24), turn faceplate so that orientation of relief valve cap to pump matches **DIRECTION OF ROTATION** drawing previously selected from charts in Figures 5.4 and 5.5.
6. Install two hollow dowel pins (J) on faceplate end of case (19A, B, C, D, E) if they were removed during disassembly. Place appropriate number of case gaskets (20) on end of case. Align faceplate (23B) on hollow dowel pins, maintaining proper orientation as determined above. Secure faceplate to case using two washer head cap screws (K) and eight hex head cap screws (L).

## DISASSEMBLY OF RV STYLE RELIEF VALVE

Refer to the sectional drawing shown in Figure 5.6.

# WARNING

**DO NOT** remove the relief valve cap (24) without reading the instructions without reading the instructions below on disassembling the valve. *The relief valve contains a powerful spring (29) that may cause injury or death if released suddenly.*

- **WARNING!** Relieve all internal fluid and air pressure inside pump before beginning disassembly.
- **WARNING!** Take necessary precautions to prevent pump from rotating while working on relief valve.
- **WARNING!** Fluid may spill out of the pump when the relief valve faceplate (23B) is removed.

Take all necessary precautions to protect yourself, others, and the nearby area from any harm this fluid may do.

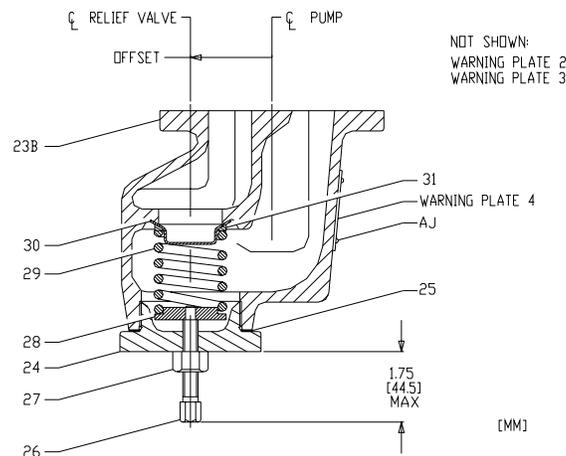
1. Turn off pump and lock out energy source to driver.
2. Close inlet and discharge valves.
3. To drain pump, follow the procedure in Section 7, **INSTRUCTIONS FOR DRAINING PUMP.**
4. Decrease pressure on spring (29) by loosening lock and seal nut (27) and unscrewing adjusting screw (26) until adjusting screw turns freely.
5. After decreasing pressure on spring (29), remove the relief valve cap (24) by unscrewing it from faceplate (23B).
6. Remove spring (29), poppet (30), spring washer (32), and spring guide (28).
7. Inspect all parts and replace worn or damaged parts as required.

## ASSEMBLY OF RV STYLE RELIEF VALVE

1. Install poppet (30) into faceplate (23B).
2. Install spring (29) into faceplate (23B) making sure that spring is centered on poppet (30) and resting on spring washer (31).
3. Place pilot of spring guide (28) into I.D. of spring (29).
4. Screw adjusting screw (26) with lock and seal nut (27) assembled into hole in relief valve cap (24).
5. Place small end of adjusting screw (26) in hole in spring guide (28) and screw relief valve cap (24) into faceplate (23B).
6. Adjust relief valve by following steps shown in how **TO ADJUST THE RV STYLE RELIEF VALVE.**

## RV STYLE RELIEF VALVE

Figure 5.6



### TO ADJUST THE RV STYLE RELIEF VALVE

Refer to the sectional drawing shown in Figure 5.6.

- **WARNING!** Take necessary precautions to prevent personal injury or physical damage that could be caused by any loss of the product being pumped while adjusting the relief valve. **DO NOT** adjust the relief valve without coupling guards in place.

The relief valve must be adjusted under conditions identical to the operating conditions (viscosity, rpm, etc.)

1. Connect a pressure gauge near pump in discharge line between pump and point where discharge line will be closed.
2. Loosen locknut (27) on the adjusting screw (26).
3. Back adjusting screw (26) out to point where end of adjusting screw will be 1-3/4 inches [44.5 mm] from plug cap (24). See **RV STYLE RELIEF VALVE** drawing shown in Figure 5.6.
4. **WARNING! DO NOT** start the pump until all rotating shafts and couplings are properly guarded. After all rotating shafts and couplings are properly guarded, start the pump and close the discharge line slowly. **DO NOT** exceed the pressure rating of pump or other equipment between the pump and the discharge line valve. If this pressure is reached while closing the discharge valve, **DO NOT** close any further. **DO NOT** run the pump with a closed discharge line for more than one minute at a time.
5. With discharge valve closed, turn adjusting screw clockwise in 1/2 turn increments until pressure gauge shows desired pressure setting.
6. Tighten locknut (27).
7. Open discharge line and turn off pump.

## DISASSEMBLY OF DOUBLE SETTING RV STYLE RELIEF VALVE

Refer to the sectional drawing shown in Figure 5.7.

# **WARNING**

**DO NOT** remove the relief valve cap (24) without reading the instructions below on disassembling the valve. *The relief valve contains a powerful spring (29) that may cause injury or death if released suddenly.*

- **WARNING!** Relieve all internal fluid and air pressure inside the pump before beginning disassembly.
  - **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
  - **WARNING!** Fluid may spill out of the pump when the relief valve faceplate (23B) is removed. Take all necessary precautions to protect yourself, others, and the nearby area from any harm this fluid may do.
1. Turn off pump and lock out energy source to driver.
  2. Close inlet and discharge valves.
  3. To drain pump, follow the procedure in Section 7, **INSTRUCTIONS FOR DRAINING PUMP**.
  4. Loosen lock and seal nut (27). Decrease pressure on spring (29) by turning adjusting screw (26) counterclockwise until it turns freely.
  5. After decreasing pressure on spring (29), remove relief valve cap (24) by unscrewing it from faceplate (23B).
  6. Remove spring (29), spring guide (28), poppet (30), and spring washer (31).
  7. Remove operating piston (59). Remove o-ring (AP) if required.
  8. After several pump disassemblies, it is necessary to change locking seal nut (27). Remove adjusting screw (26) from relief valve cap (24). Remove locking seal nut (27) from adjusting screw (26). Keep threads on adjusting screw clean and free from dirt. Also remove any nicks or dents from damaged threads to prevent damage to sealing surfaces of seal nut.
  9. Usually there is no need to disassemble ball handle (AK) and its components from adjusting screw (26) except if parts need replacement.
  10. Inspect all parts and replace all worn or damaged parts as required.

## ASSEMBLY OF DOUBLE SETTING RV STYLE RELIEF VALVE

Refer to the sectional drawing shown in Figure 5.7.

1. Install poppet (30) and spring washer (31) into faceplate (23B).
2. Install spring (29) into faceplate (23B) making sure that spring is centered on poppet (30) and resting on the spring washer (31).
3. Place pilot of spring guide (28) into spring (29).
4. Turn adjusting screw (26) down into relief valve cap (24) with lever in high pressure position. Move lever to low pressure position; this should leave operating piston (59) out past edge of relief valve cap (24). (O-ring friction should hold operating piston temporarily). Place new relief valve cap gasket (25) on relief valve cap (24).
5. Slide tip of operating piston (59) into spring guide (28) while holding double setting relief valve mechanism by adjusting screw (26) and ball handle (AK).
6. Hold adjusting screw (26) and turn relief valve cap (24) to engage it into threads of faceplate (23B).



10. Open discharge line and turn off pump.

Relief valve is now set.

### CONVERTING FROM RV STYLE RELIEF VALVE TO DOUBLE SETTING RV STYLE RELIEF VALVE

1. On standard RV style relief valve, loosen lock and seal nut (27).
2. Turn adjusting screw (26) counterclockwise to decrease pressure on spring (29).
3. Remove relief valve cap (24) and gasket (25) along with lock and seal nut (27) and adjusting screw (26).
4. Install double setting relief valve mechanism in accordance with instructions in **ASSEMBLY OF DOUBLE SETTING RV STYLE RELIEF VALVE**.

### JACKETED PUMPS

Jacketed faceplates and backplate are available on 3600, 3700, 4600, 4700 series pumps. They look similar to the standard nonjacketed ones described in this manual except for the four threaded taps on the jacketed faceplates and backplates. Two of the four taps are piped as inlet and outlet for the heating or cooling medium. It is recommended that steam, when used, be piped into the jacket from a top tap and out through a bottom tap. Liquid, when used, should be piped into the jacket from a bottom tap and out a top tap. In addition to the two taps on both endplates not used for piping, two ¼" NPT taps on the jacketed backplate are provided to facilitate clean out of scale.

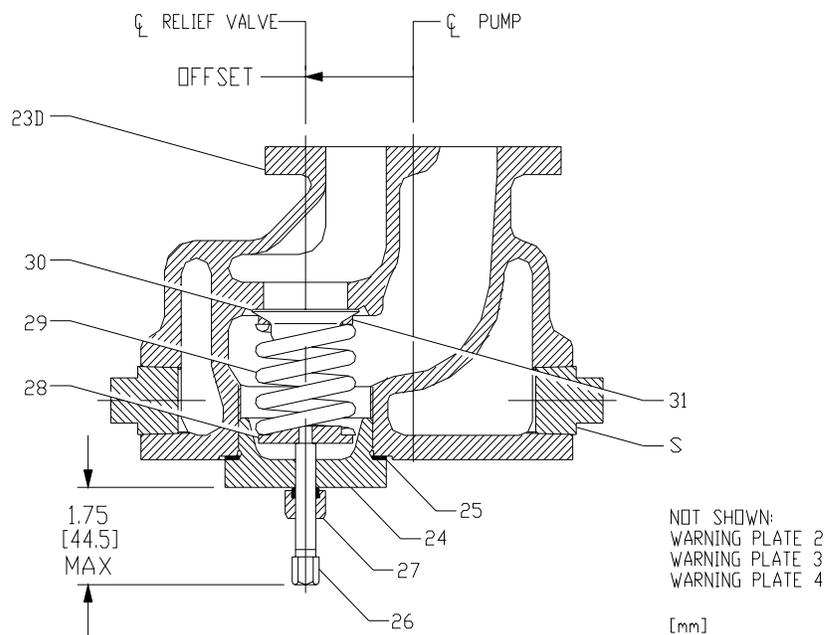
The heating or cooling medium should be steam or a noncorrosive, nonclogging liquid. A steam medium is limited to 350°F [177°C] maximum. A liquid medium is limited to 450°F [232°C] maximum. The jacketing is limited to 125 psi [862 kPa] maximum.

- **WARNING!** Other special parts will be required to operate at temperatures up to 450°F [232°C].

The jacketed RV style relief valve faceplate, similar to nonjacketed, must have the adjusting screw offset toward the discharge side of the pump.

### JACKETED RV STYLE RELIEF VALVE FACEPLATE

Figure 5.8



## 6. HIGH DRIVE TO LOW DRIVE

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Prior to operating pump, make sure that the shaft rotation, pipe connections, and the relief valve position are in accordance with the appropriate illustrations shown in Figures 5.4 and 5.5. In order to change the rotation and/or piping orientation, it may be necessary to remove the piping from the pump or the pump from the mounting. [Fittings (21) and flange gaskets (22), when provided, can be removed from pump.]

Whenever changing rotation, inspect all parts before reassembly. Replace all worn parts and install new gaskets in appropriate numbers as removed.

1. Remove coupling or universal joint and drive key (A) from drive shaft (32). Remove all burrs and sharp edges from drive shaft and keyway.
2. A.) To reverse pump rotation and keep piping arrangement the same, drive shaft (32) position must be changed. Follow steps 3 – 10.  
B.) To reverse pump rotation and leave drive shaft (32) and case (19A, B, C, D, E) in same position; liquid flow through pump will be reversed. Follow steps 11 – 12.  
C.) To change port to opposite side on pumps with a right angle port arrangement and maintain same pump rotation, follow steps 13 – 20.  
D.) To change port to opposite side, maintain same pump rotation and drive shaft (32) in same position; liquid flow through pump will be reversed. Follow steps 21 – 26.

### REVERSE ROTATION, SAME PIPING ARRANGEMENT

3. To reverse pump rotation and keep piping arrangement the same, it is necessary to change from high drive to low drive or low drive to high drive (3600-3700 series with right angle ports: W to LX, X to LW, Z to LY, Y to LZ; 4600-4700 series with straight through ports: W to LZ, Z to LW) or vice versa.
4. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing backplate (6A, B) to case (19A, B, C, D, E) and separate backplate assembly from case assembly. On 3600-4700 "H" and "BH" pumps, drive gear (34) will pull out with backplate assembly. On "HB", "SB", "GHB", and "BHB" pumps, drive gear (34) may remain in case assembly.
5. Switch drive gear (34) and idler gear/shaft (35 and 33) positions in case (19A, B, C, D, E).
6. Position appropriate number of case gaskets (20) on case (19A, B, C, D, E) (oil or grease may be used to hold gaskets in place).
7. Rotate backplate (6A, B) assembly 180°.
8. Slide drive shaft (32) and gear key (B) into shaft hole of drive gear (34).
9. Slide backplate (6A, B) assembly into position and secure.
10. On 3600-4700 series with gear reduction unit, mount oil cup (AB) in top hole in gear case (44) and petcock (AC) in second hole from bottom.

### REVERSE ROTATION, SAME DRIVE SHAFT AND CASE ARRANGEMENT

11. To reverse flow of liquid through pump ports, reverse rotation of drive shaft (32), maintain the original positions of the drive shaft and case (19A, B, C, D, E) (3600-3700 series with right angle ports: W to X, LW to LX, Z to Y, LX to LY; 4600-4700 series with straight through ports: W to Z, LW to LZ) or vice versa.
12. On pumps with relief valve, relief valve faceplate (23B or 23C) must be removed, rotated 180°, and remounted.

## CHANGE PORT AND DRIVE SHAFT LOCATION, SAME ROTATION

13. To change the port to the opposite side and maintain same pump rotation, change drive shaft (32) from high drive to low drive (3600-3700 series with right angle ports: W to LY, Y to LW, Z to LX, X to LZ) or vice versa.
14. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing backplate (6A, B) to case (19A, B, C, D, E) and separate backplate assembly from case assembly. On 3600-4700 "H" and "BH" pumps, drive gear (34) will pull out with backplate assembly. On "HB", "SB", "GHB", and "BHB" pumps, drive gear (34) may remain in case assembly.
15. Remove the faceplate (23A, B, C, D).
16. Rotate case (19A, B, C, D, E) 180°, (front to back).
17. Switch drive gear (34) and idler gear/shaft (35 and 33) positions in case (19A, B, C, D, E).
18. If plain faceplate (23A) is used, remount to case (19A, B, C, D, E) in same position. If a relief valve faceplate (23B, C, D) is used, rotate faceplate 180° and remount to case (19A, B, C, D, E).
19. Rotate backplate (6A, B) assembly 180° and remount on case (19A, B, C, D, E).
20. On pumps with gear reduction unit, mount oil cup (AB) in top hole of gear case (44) and petcock (AC) on next bottom hole.

## SAME ROTATION, CHANGE PORT LOCATION, SAME DRIVE SHAFT LOCATION

21. To change port to opposite side, maintain same pump rotation and drive shaft (32) in same position; the flow of liquid through the pump will be reversed (3600-3700 series with right angle ports: W to Y, LW to LY, Z to Z, LZ to LX) or vice versa.
22. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing backplate (6A, B) to case (19A, B, C, D, E) and separate backplate assembly from case assembly. On 3600-4600 "H" and "BH" pumps, drive gear (34) may remain in case assembly.
23. Remove faceplate (23A, B, C, D).
24. Remove case (19A, B, C, D, E) and rotate 180° (front to back).
25. Remount and secure case (19A, B, C, D, E) to faceplate (23A, B, C, D).
26. Remount backplate (6A, B) assembly to case (19A, B, C, D, E).

## 7. INSTRUCTIONS FOR DRAINING PUMP

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Refer to Section 14, **PARTS LIST**.

# **WARNING**

- **WARNING!** Relieve all internal fluid and air pressure inside the pump before attempting to drain the pump.
- **WARNING!** Take necessary precautions to prevent the pump from becoming energized while draining the pump.
- **WARNING!** Take necessary precautions to prevent injury or physical damage that could be caused by any loss of the product being pumped while draining the pump.

The extent to which a pump can be drained is dependent upon the product being pumped. Low viscosity products such as solvents will drain quickly and easily. High viscosity products such as molasses and tar will drain very slowly. Also, the draining of high viscosity products will be less complete.

Regardless of the product pumped, the areas at the blind end of the bearing bores and the mechanical seal chamber will not drain.

1. Read and understand all safety instructions and warnings before starting draining procedure.
2. There are two pipe plugs (S) in the faceplate (23A, B, C.). Remove one that is in lowest position.
3. Rotate drive shaft very slowly by hand. Each time that flow from drain increases, stop turning shaft until flow stops; then resume until flow increases again. Be sure to rotate shaft several complete revolutions in each direction until all flow from drain has stopped.
4. Reinstall and tighten pipe plug(s).

## 8. INSTRUCTIONS FOR PUMP DISASSEMBLY

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Refer to Section 14, **PARTS LIST**.

1. Read and understand all safety instructions and warnings before starting to disassemble pump. While disassembling pump, always inspect disassembled parts and adjacent parts to see if further disassembly is needed. Replace worn or damaged parts as required.
2. If you do not know which pump arrangement you have, collect nameplate data and refer to Section 1, **NAMEPLATE DATA**, to determine what you have. Consult a Roper distributor or Roper Pump Company if you have any questions.
3. When cleaning or lubricating, use only cleaning solutions and lubricants that are compatible with products being pumped and with sealing elastomers. **DO NOT** use petroleum base products with seals with EPR elastomers. Use a nonpetroleum base lubricant with EPR elastomers.
4. Turn off pump and lock out energy source to driver. **DO NOT** proceed further with disassembly of pump if there is the slightest possibility that driver may be started.
5. If used, turn off and disconnect flush from mechanical seal.
6. Close inlet and discharge valves.
7. Remove guard and disconnect coupling between driver and pump.
8. Drain inlet and discharge lines. Disconnect lines from pump inlet and discharge.
9. Follow the procedure in Section 7, **INSTRUCTIONS FOR DRAINING PUMP**.
10. A.) For 3600/4600 “HB” and “SBFO” pumps, follow steps 11 – 20.  
B.) For 3700/4700 “HB” and “SBFO” pumps, follow steps 11 – 20.  
C.) For 3700/4700 “BH” pumps, go to Section 12, **INSTRUCTIONS FOR DISASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE**. After disassembling hydraulic drive, return to this section and follow steps 11 – 20.
11. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing faceplate (23A, B, C,) to case (19A, B, C, D, E). Remove faceplate (23A, B, C,).
12. Remove two dowel pins (J) from case.
13. Remove case gaskets (20).
14. A.) On “BH” pumps, remove faceplate end retaining ring (36B) from drive shaft (32). Remove drive gear (34) and key (B). Remove backplate end retaining ring (36A).  
B.) On “HB” and “SBF” pumps, remove drive gear (34) and key (B) from drive shaft (32).
15. Remove idler gear (35) and key (B) from idler shaft (33). Remove idler shaft.
16. Remove two washer head cap screws (K) and eight hex head cap screws (L) securing backplate (6A, B) to case (19A, B, C, D, E) and separate parts.

17. Remove case gaskets (20) from opposite side of case (19A, B, C, D, E).
18. Remove two dowel pins (J) from opposite side of case (19A, B, C, D, E).
19. Remove drive key (A) from drive shaft (32).
20. A.) For 3600/4600 “BH” pumps, follow steps 21 – 24.  
 B.) For 3600/4600 “HB” and 3622 “SBFO” pumps, follow steps 25 – 30.  
 C.) For 3700/4700 “BH” pumps, follow steps 52 – 55.  
 D.) For 3700/4700 “HB” and “SBFO” pumps, follow steps 56 – 61.

#### **3600/4600 “BH” Pumps (See Figure 14.1)**

21. Remove two locknuts (F) from studs (AG) securing packing gland (14) in place. Remove packing gland clip (13) and packing gland (14).
22. Remove packing rings (16) and packing washer (18). Remove lantern ring (17) if used. Packing hooks are commercially available to assist in removal of packing rings.
23. Remove drive shaft (32). Clean drive shaft and adjacent parts. Examine drive shaft. Replace drive shaft if excessively worn or scored.
24. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (20, 22, 25) be installed each time pump is disassembled and reassembled.

#### **3600/4600 “HB” AND 3622 “SBFO” Pumps (See Figure 14.2)**

25. Remove retaining ring (3) from backplate (6A, B).
26. Loosen setscrews in ball bearing (2). Remove ball bearing.
27. Remove two locknuts (F) from square head bolts (G) securing packing gland (14) in place. Remove packing gland clip (13), packing gland (14), spring clip (15), and two square head bolts (G).
28. Remove packing rings (16) and packing washer (18). Remove lantern ring (17) if used. Packing hooks are commercially available to assist in removal of packing.
29. Remove drive shaft (32). Clean drive shaft and adjacent parts. Examine drive shaft. Replace drive shaft (32) if excessively worn or scored.
30. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (20, 22, 25) be installed each time pump is disassembled and reassembled.

#### **3700/4700 “BH” Pumps (See Figure 14.1)**

31. Remove two hex head cap screws (E) securing seal retainer (9) to backplate (6A, B). Remove seal retainer (9).
32. Remove drive shaft (32) along with mechanical seal (11) and retaining ring (12) from backplate (6A, B).
33. When removing following types of single seals (John Crane® Type 21, Type 8-1, Type 9; Pac-Seal® Type 21; Sealol® Type 43), clean and lubricate drive shaft (32) prior to removing mechanical seal making sure that drive shaft is smooth and free from all burrs. Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). Inspect sealing surfaces of stationary seal face and inspect rotation element. Replace as required. Remove retaining ring (12) from drive shaft (32) if applicable.
34. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (20, 22, 25) be installed each time the pump is disassembled and reassembled.

### 3700/4700 “HB” and 3722 “SBFO” Pumps (See Figure 14.2)

35. Remove retaining ring (3) from backplate (6A, B).
36. Loosen setscrews in ball bearing (2). Remove ball bearing.
37. Remove two locknuts (F) from square head bolts (G) securing seal retainer (9) to backplate (6A, B). Remove seal retainer (9).
38. Remove drive shaft (32) along with mechanical seal (11) and retaining ring (12) from backplate (6a, b).
39. When removing following type of single seals (John Crane® Type 21, Type 8-1, Type 9; Pac-Seal® Type 21; Sealol® Type 43), clean and lubricate drive shaft (32) prior to removing mechanical seal making sure that drive shaft is smooth and free fro all burrs. Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). Inspect sealing surfaces of stationary seal face and inspect rotation element. Replace as required. Remove retaining ring (12) from drive shaft (32), if applicable.
40. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (20, 22, 25) be installed each time pump is disassembled and reassembled.

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Pac-Seal® is a registered trademark of Pac-Seal Inc.  
Sealol® is a registered trademark of EG & G Sealol.

## 9. BEARING REMOVAL AND INSTALLATION

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### BEARING REMOVAL

Pump bearings are available in bronze, iron, carbon, and glass/graphite impregnated PTFE. Any of these bearings may be removed using a Snap-On® tool puller, part number CG45. This tool may be purchased through your local tool dealer or through Roper Pump Company. If you do not have this bearing puller, any of the bearings may be removed by using a hacksaw blade to cut through the bearing in two places 180° apart. This procedure will usually loosen the bearing enough to be pulled out. If this procedure is used, take care to prevent damage to the bore into which the bearing is pressed.

Carbon bearings may also be removed by carefully chipping the bearing out with a chisel. Take care not to scar the endplate bores during the bearing removal process.



After removing the bearings, always check the endplate bores for nicks and burrs caused by the removal process. The bores must be clean, smooth, and free of burrs before attempting to install new bearings.

## BEARING INSTALLATION

1. Remove all burrs and raised edges from bores for bearings.
2. Place faceplate or backplate on a press base with milled face upward. Support endplate so that milled face is perpendicular (square) with press ram.
3. Position endplate so that one bearing bore is located directly under press ram.
4. A.) If iron or bronze bearings are to be installed, lubricate endplate bores with a light oil that is compatible with product to be pumped.  
B.) If carbon bearings are to be installed, lubricate bearings by submerging them in cold water prior to installation.  
C.) If glass/graphite filled PTFE bearings are to be installed, no lubricant should be used.
5. Place end of new bearing at entrance of bore in endplate, taking care to align grooves in bearing with the grooves in face of endplate.
6. Press bearing into endplate bore. *When carbon bearings are being installed, it is important to press them in with one slow uninterrupted stroke to prevent cracking.* It is best to use a stepped arbor with a few thousandths of an inch clearance between arbor and bore of bearing. Be sure to press bearings in until they are flush to .005 of an inch [.127 mm] below milled face of endplate.
7. Repeat procedure for second bearing.
8. Using a three square file, file shallow grooves in ends of bearings to connect grooves inside bearings with groove on milled face of endplate. If your bearings or endplates do not have grooves, omit this step.

## 10. DIMENSIONAL DATA FOR INTERNAL PARTS

Nominal dimensions are given below. With the exception of gasket thickness and lateral clearance, your actual measurements should vary from these numbers by no more than .002". Use properly calibrated measuring equipment when measuring parts.

ITEM	PUMP SIZE		
	11	17	22
Bore for Bearings	1.4375	1.4375	1.4375
Shaft O.D.	1.0620	1.0620	1.0620
Case Bores	3.8490	3.8490	3.8490
Gear O.D.	3.8410	3.8410	3.8410
Gear O.D. to Case Bore Diametral Clearance	.0080	.0080	.0080
Bronze Bearing O.D.	1.4385	1.4385	1.4385
Bronze Bearing Press Fit	.0010 min.	.0010 min.	.0010 min.
Bronze Bearing I.D. (Free)	1.0680	1.0680	1.0680
Bronze Bearing I.D. (Installed)	1.0670	1.0670	1.0670
Shaft to Bronze Bearing Diametral Clearance	.005	.005	.005
Iron Bearing O.D.	1.4385	1.4385	1.4385
Iron Bearing Press Fit	.0010 min.	.0010 min.	.0010 min.
Iron Bearing I.D. (Free)	1.0675	1.0675	1.0675
Iron Bearing I.D. (Installed)	1.0665	1.0665	1.0665
Shaft to Iron Bearing Diametral Clearance	.0045	.0045	.0045
Carbon Bearing O.D.	1.4400	1.4400	1.4400
Carbon Bearing Press Fit	.0025 min.	.0025 min.	.0025 min.
Carbon Bearing I.D. (Free)	1.0710	1.0710	1.0710
Carbon Bearing I.D. (Installed)	1.0690	1.0690	1.0690
Shaft to Carbon Bearing Diametral Clearance	.0067	.0067	.0067
Case Width	2.994	4.494	5.994
Gasket Thickness (One)	.012	.012	.012
Compressed Gasket Thickness (Two)	.016	.016	.016
Gear Face Width	3.001	4.501	6.001
Lateral Clearance (Two Compressed Gaskets)	.009	.009	.009

# 11. INSTRUCTIONS FOR PUMP ASSEMBLY

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Refer to Section 14, **PARTS LIST**.

Refer to Section 5, **DIRECTION OF ROTATION AND RELIEF VALVES**, to assure proper configuration for pump rotation, port location, and relief valve position prior to assembling pump.

1. Read and understand all safety instructions and warnings before assembling pump. Visually inspect all parts during assembly. Replace all worn or damaged parts. Although they may appear reusable, it is recommended that new gaskets (20, 22, 25, if applicable, 38, 48, 50) and lip seals (5, 39) be installed when pump is being reassembled.
  - **WARNING!** Only use genuine Roper gaskets. Gasket thickness determines proper clearances. Always check quantity of gaskets removed and replace with exact quantity. Proper material must be used based on application.
2. When cleaning or lubricating, only use products that are compatible with product being pumped and elastomers within pump. **DO NOT** use petroleum base products with seals with EPR elastomers. Clean and lubricate parts with light oil unless EPR elastomers are used. Use a nonpetroleum base lubricant with EPR elastomers.
3. Mechanical seals are precision pieces of equipment. Use extreme care not to damage seal faces or elastomers during assembly.
4. Install two hollow dowel pins (J) on each side of case (19A, B, C, D, E). Place appropriate number of case gaskets (20) on faceplate side of case. Align faceplate (23A, B, C,) on hollow dowel pins (J). Secure faceplate to case using two washer head cap screws (K) and eight hex head cap screws (L).
5. Place idler gear (35) into case bore. Install key (B) in keyway on idler shaft (33). Slide idler shaft into I.D. of idler gear.
6. A.) For 3600/4600 “BH” pumps with shaft packing, follow steps 7 – 16.  
B.) For 3600/4600 “HB” and 3622 “SBFO” pumps with shaft packing, follow steps 17 – 26.  
C.) For 3700/4700 “BH” pumps with a standard mechanical seal, follow steps 27 – 35.  
D.) For 3700/4700 “BH” pumps with a positive drive mechanical seal, follow steps 36 – 50.  
E.) For 3700/4700 “HB” and 3722 “SBFO” pumps with a standard mechanical seal, follow steps 51 – 59.  
F.) For 3700/4700 “HB” and 3722 “SBFO” pumps with a positive drive mechanical seal, follow steps 60 – 74.

## 3600/4600 “BH” Pumps (See Figure 14.1)

7. Install backplate end retaining ring (36A) on drive shaft (32). Install key (B) on drive shaft. Slide drive gear (34) onto drive shaft. Install faceplate end retaining ring (36B) on drive shaft to secure drive gear.
8. Place appropriate number of case gaskets (20) on backplate side of case (19A, B, C, D, E). Slide drive gear (34) assembled with drive shaft (32), and backplate (6a, B) into case bore. Align backplate (6A, B) on hollow dowel pins (J). Secure backplate (6A, B) to case (19A, B, C, D, E) using two washer head cap screws (K) and eight hex head cap screws (L).
9. Install packing washer (18) over drive shaft (32) and into packing bore of backplate (6A, B).
10. Install packing rings (16) and lantern ring (17), if used, in backplate bore. Stagger joints on each packing ring 180° apart. Seat each ring before adding next ring. Rings must not be tamped or seated too tightly.
11. Check drive shaft (32) for free movement after each ring is installed.
12. When packing box is sufficiently full to allow entry of packing gland (14) about ¼ of an inch [6 mm], reassemble packing gland.
13. Install studs (AG) into backplate (6A, B). Insert packing gland (14) into packing box about ¼ of an inch [6 mm]. Slide packing gland clip (13) over studs (AG). Using two locknuts (F), secure packing gland (14) in

place. Draw locknuts up evenly on packing gland to assure proper seating of packing (16), then loosen locknuts (F) about ½ turn. **DO NOT** cock packing gland. This could cause binding or heating of drive shaft.

14. Install drive key (A).
15. For 3600/4600 “BH” hydraulic drive assembly, go to Section 13, **INSTRUCTIONS FOR ASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE**.
16. Read and understand all safety instructions and warnings before installing and operating pump.

#### **3600/4600 “HB” and 3622 “SBFO” Pumps (See Figure 14.2)**

17. Place drive gear (34) into case bore. Install key (B) in keyway of drive shaft (32). Slide drive shaft into bore of drive gear.
18. Place appropriate number of case gaskets (20) on backplate side of case (19A, B, C, D, E). Align backplate (6A, B) on dowel pins (J). Secure backplate to case using two washer head cap screws (K) and eight hex head cap screws (L).
19. Install packing washer (18) over drive shaft (32) into packing bore of backplate.
20. Install packing ring (16) and lantern ring (17), if used, in packing bore of backplate. Stagger joints on each packing ring 180° apart. Seat each ring before adding next ring. Rings must not be tamped or seated too tightly.
21. Check drive shaft (32) for free movement after each ring is installed.
22. When packing box is sufficiently full to allow entry of packing gland (14) about ¼ of inch [6 mm], reassemble packing gland.
23. Place one square head bolt (G) through each slot in backplate (6A, B) and through each hole in packing gland (14). Install packing gland (14) into packing box about ¼ of an inch [6 mm]. Slide packing gland clip (130) over square head bolts (G). Using two locknuts (F), secure packing gland (14) in place. Install spring clip (15) across square head bolts (G). Draw locknuts up evenly on packing gland to assure proper seating of packing (16), then loosen locknuts about ½ turn. **DO NOT** cock packing gland. This could cause binding or heating of drive shaft.
24. Install ball bearing (2) on drive shaft (32) and into backplate (6A, B) as shown in the sectional drawing on page 68. The bearings are prelubricated and do not require lubrication at time of initial installation. A small amount of grease will be required during regular maintenance. Align setscrews in inner race of ball bearing with wide groove in shaft. Tighten setscrews in ball bearing (2) to secure bearing to drive shaft (32). Install retaining ring (3) into backplate (6A, B) to secure ball bearing (2) to backplate.
25. Install drive key (A).
26. Read and understand all safety instructions and warnings before installing and operating pump.

#### **3700/4700 “BH” Pumps (Standard Mechanical Seal) (See Figure 14.1)**

27. Install faceplate end retaining ring (36b) on drive shaft (32). Install key (B) in keyway on drive shaft. Slide drive gear (34) onto drive shaft. Install backplate end retaining ring (36A) on drive shaft to secure drive gear.
28. Place appropriate number of gaskets (20) on backplate side of case (19A, B, C, D, E). Slide drive gear (34) assembled with drive shaft (32), and backplate (6A, B) into case bore. Align backplate (6A, B) on hollow dowel pins (J). Secure backplate (6A, B) to case (19A, B, C, D, E) using two washer head cap screws (K) and eight hex head cap screws (L).
29. Install retaining ring (12) on drive shaft (32).
30. Carefully remove all burrs and sharp edges from shaft over which rotating element of seal will slide.
31. Lubricate drive shaft and mechanical seal bore with a compatible lubricant. Install mechanical seal (11) on drive shaft and position seal back against retaining ring (12). Care must be taken not to nick o-ring. Be sure lapped (polished) faces of stationary seal face and rotating element are together.
32. Install seal retainer (9). Secure seal retainer in place using two hex head cap screws (E).
33. Install drive key (A).

34. For 3700/4700 “BH” hydraulic drive assembly, go to Section 13, **INSTRUCTIONS FOR ASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE**.

35. Read and understand all safety instructions and warnings before installing and operating pump.

### **3700/4700 “BH” Pumps (Positive Drive Mechanical Seal) (See Figure 15.1)**

36. Install retaining ring (12) on drive shaft (32) to locate mechanical seal.

37. Carefully remove all burrs and sharp edges on shaft over which rotating element of seal will slide.

38. Apply a compatible lubricant to seal I.D. and to O.D. of drive shaft (32).

39. Slide rotating element of mechanical seal (11) onto drive shaft (32) before removing three or four clips that are taped to rotating element. Push rotating element back against retaining ring (12), tighten setscrews in seal, and remove clips that are taped to seal.

40. Slide faceplate end of drive shaft, with rotating element attached, into backplate (6A, B).

41. Install backplate end retaining ring (36A) on drive shaft (32). Install key (B) in keyway on drive shaft. Slide drive gear (34) onto drive shaft. Install faceplate end retaining ring (36B) to secure drive gear.

42. Place appropriate number of gaskets (20) on backplate side of case (19A, B, C, D, E). Slide drive gear (34), assembled with drive shaft (32), and backplate (6A, B) into case bore. Align backplate (6A, B) on hollow dowel pins (J). Secure backplate (6A, B) to case (19A, B, C, D, E) using two washer head cap screws (K) and eight hex head cap screws (L).

43. Lubricate o-ring on stationary seal face and seal chamber bore with a compatible lubricant. Slide stationary seal face over keyway end of drive shaft (32) and down to seal chamber. Be sure lapped (polished) face is toward rotating member of seal. Push stationary seal face into seal chamber.

44. Install antirotation pin (T) in locator ring (60).

45. Position locator ring (60) with antirotation pin (T) toward seal face. Align antirotation pin (T) with slot in back of stationary seal face and push into counterbore of backplate (6A, B).

46. Install seal retainer (9). Secure seal retainer in place using two hex head cap screws (E).

47. Install drive key (A).

48. For 3700/4700 “BH” hydraulic drive assembly, go to Section 13, **INSTRUCTIONS FOR ASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE**.

49. Ball bearing (2) and retaining ring (3) are not used in this configuration.

50. Read and understand all safety instructions and warnings before installing and operating pump.

### **3700/4700 “HB” and 3722 “SBFO” Pumps (Standard Mechanical Seal) (See Figure 14.2)**

51. Place drive gear (34) into case bore. Install key (B) in keyway of drive shaft (32). Slide drive shaft into bore of drive gear.

52. Place appropriate number of case gaskets (20) on backplate side of case (19A, B, C, D, E). Align backplate (6A, B) on dowel pins (J). Secure backplate to case using two washer head cap screws (K) and eight hex head cap screws (L).

53. Install retaining ring (12) on drive shaft (32).

54. Carefully remove all burrs and sharp edges from shaft over which rotating element of seal will slide.

55. Lubricate drive shaft and mechanical seal bore with a compatible lubricant. Install mechanical seal (11) on drive shaft and position seal back against retaining ring (12). Care must be taken not to nick o-ring. Be sure lapped (polished) faces of stationary seal face and rotating elements are together.

56. Install ball bearing (2) on drive shaft (32) and into backplate (6A, B). The bearings are prelubricated and do not require lubrication at time of initial installation. A small amount of grease will be required during regular maintenance. Tighten setscrews in ball bearings (2) to secure bearing on drive shaft (32). Install retaining ring (3) into backplate (6A, B) to secure ball bearing (2) to backplate (6A, B).

57. Place one square head bolt (G) through each slot in backplate (6A, B) and through each hole in seal retainer (9). Secure seal retainer against backplate using two locknuts (F).
58. Install drive key (A).
59. Read and understand all safety instructions and warnings before installing and operating pump.

**3700/4700 “HB” and 3722 “SBFO” Pumps (Positive Drive Mechanical Seal) (See Figure 15.1)**

60. Place drive gear (34) into case bore.
61. Install retaining ring (12) on drive shaft (32) to locate mechanical seal.
62. Carefully remove all burrs and sharp edges on shaft over which rotating element of seal will slide.
63. Apply a compatible lubricant to seal I.D. and to O.D. of drive shaft (32).
64. Slide rotating element of mechanical seal (11) onto drive shaft (32) before removing three or four clips that are taped to rotating element. Push rotating element back against retaining ring (12), tighten setscrews in seal, and remove clips that are taped to seal.
65. Slide faceplate end of drive shaft (32) with rotating element of mechanical seal attached, into backplate (6A, B) through bore for ball bearing (2).
66. Place appropriate number of case gaskets (20) on backplate side of case (19A, B, C, D, E). Install key (B) in keyway of drive shaft (32). Slide drive shaft into bore of drive gear while aligning backplate (6A, B) on dowel pins (J). Secure backplate (6A, B) to case (19A, B, C, D, E) using two washer head cap screw (K) and eight hex head cap screws (L).
67. Lubricate o-ring on stationary seal face and seal chamber bore with a compatible lubricant. Slide stationary seal face over keyway end of drive shaft (32) and down to seal chamber. Be sure lapped (polished) face is toward rotating member of seal. Push stationary seal face into seal chamber.
68. Slide ball bearing (2) over drive shaft (32). Align setscrews in ball bearing (2) with groove in drive shaft and tighten setscrews. The bearings are prelubricated and do not require lubrication at time of initial installation. A small amount of grease will be required during regular maintenance.
69. Install retaining ring (3) into backplate (6A, B) to secure ball bearing (2) to backplate (6A, B).
70. Install antirotation pin (T) in locator ring (60).
71. Position locator ring (60) with antirotation pin (T) toward seal face. Align antirotation pin (T) with slot in back of stationary seal face and push into counterbore of backplate (6A, B).
72. Place one square head bolt (G) through each slot in backplate (6A, B) and through each hole in seal retainer (9). Secure seal retainer against backplate using two locknuts (F).
73. Install drive key (A).
74. Read and understand all safety instructions and warnings before installing and operating pump.

## 12. INSTRUCTIONS FOR DISASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE

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Refer to Section 14, **PARTS LIST**.

1. Read and understand all safety instructions and warnings before starting to disassemble hydraulic drive components from pump. While disassembling, always inspect disassembled parts and adjacent parts to see if further disassembly is needed. Replace worn or damaged parts as required.
2. Turn off pump and lock out energy source to hydraulic motor. **DO NOT** proceed further with disassembly of the pump if there is the slightest possibility that the hydraulic motor may be started.
3. Close inlet and discharge valves.
4. If pump is to be disassembled:
  - A.) Refer to Section 14, pump sectional drawing for “**BHFRV**”.
  - B.) If used, turn off and disconnect flush for packing or mechanical seal.
  - C.) To drain pump, follow the procedures in Section 7, **INSTRUCTIONS FOR DRAINING PUMP**.
  - D.) Disconnect lines from pump inlet and discharge.
5. Remove two cap screws securing hydraulic motor to bracket (61).
6. Slide hydraulic motor out of bracket. The rigid coupling (62) is a slip fit on both shafts; therefore, it may remain on pump shaft or motor shaft.
7. Remove four socket head cap screws (64) securing bracket (61) to backplate (6A, B). Remove bracket.
8. For further disassembly of the pump, refer to Section 8, **INSTRUCTIONS FOR PUMP DISASSEMBLY**, steps 1 – 20. Also, refer to steps 21 – 24 for pumps with packing, or steps 31 – 34 for pumps with mechanical seals.

## 13. INSTRUCTIONS FOR ASSEMBLY OF A TYPE “BH” HYDRAULIC DRIVE

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1. Refer to Section 14, **PARTS LIST**, for 3600-4700 “**BHFRV**” for pump assembly. If pump requires assembly, refer to Section 11, **INSTRUCTIONS FOR PUMP ASSEMBLY**, steps 1 – 6. Also, refer to steps 7 – 16 for pumps with packing or steps 27 – 50 for pumps with mechanical seals.
2. Refer to Section 14, sectional drawing for **TYPE “BH” HYDRAULIC DRIVE COUPLING ASSEMBLY** (Figure 14.3) for assembly of bracket and coupling.
3. Install retaining ring (63) in rigid coupling (62).
4. Install key (Z) in pump shaft keyway. Slide rigid coupling (62) onto shaft until end of the shaft is against retaining ring (63).
5. Place bracket (61) onto pilot of backplate (6A, B). Secure bracket with four socket head cap screws (64).
6. Slide rigid coupling (62) back until outboard end of coupling is even with outboard end of bracket (61).
7. Install key in hydraulic motor shaft. Line up shaft key and rigid coupling keyway and slide units together. Rotate hydraulic motor to align motor mounting holes and secure motor with two or four cap screws as required.
8. Read and understand all safety instructions and warnings before installing and operating pump.

## 14. PARTS LIST

---

2. Ball Bearing
3. Retaining Ring, Bearing Cage
6. Backplate
  - A. Standard
  - B. Jacketed
7. Bearing, Short
8. Bearing, Long
9. Seal Retainer
11. Mechanical Seal
12. Retaining Ring, Mechanical Seal
13. Packing Gland Clip
14. Packing Gland
15. Spring Clip
16. Packing Ring
17. Lantern Ring (Not Shown)
18. Packing Washer
19. Case
  - A. ANSI Flanged – Straight Through
  - B. Threaded Port Case – Right Angle
  - C. Flanged Case – Right Angle
  - D. Flanged Case – Straight Through
  - E. Flanged Case - Footless (22 SB only)
20. Case Gasket
21. Flange
22. Flange Gasket
23. Faceplate
  - A. Plain
  - B. RV Style Relief Valve
  - C. Jacketed RV Style Relief Valve
24. Relief Valve Cap
25. Relief Valve Cap, Gasket
26. Adjusting Screw
27. Nut, Lock and Seal
28. Spring Guide
29. Spring

- 30. Poppet
- 31. Adapter
- 32. Drive Shaft
- 33. Idler Shaft
- 34. Drive Gear
- 35. Idler Gear
- 36. Retaining Ring, Gear (H)
  - A. Backplate End
  - B. Faceplate End
- 57. Expansion Washer
- 58. Cam, Double Setting Relief Valve only
- 59. Operating Piston, Double Setting Relief Valve only
- 60. Locator Ring
- WRN2 Warning Plate, RV Style Relief Valve
- WRN3 Warning Plate, RV Style Relief Valve
- WRN4 Warning Plate, RV Style Relief Valve
- A. Drive Key
- B. Key, Gear
- D. Lube Fitting
- E. Hex Head Cap Screw, Seal Retainer to Backplate
- F. Locknut
- G. Square Head Bolt
- H. Pipe Plug, Backplate
- J. Dowel Pin
- K. Washer Head Cap Screw, Endplates to Case
- L. Hex Head Cap Screw, Endplates to Case
- M. Hex Head Cap Screw, Flange Nut, Flange
- S. Pipe Plug, Faceplate
- T. Antirotation Pin
- AG. Stud
- AJ. Drive Screw
- AK. Ball Handle, Double Setting Relief Valve only

AL. Stud, Double Setting Relief Valve only

AM. Self Locking Nut, Double Setting Relief Valve only

AN. Hex Head Cap Screw, Double Setting Relief Valve only

AP. O-Ring, Double Setting Relief Valve only

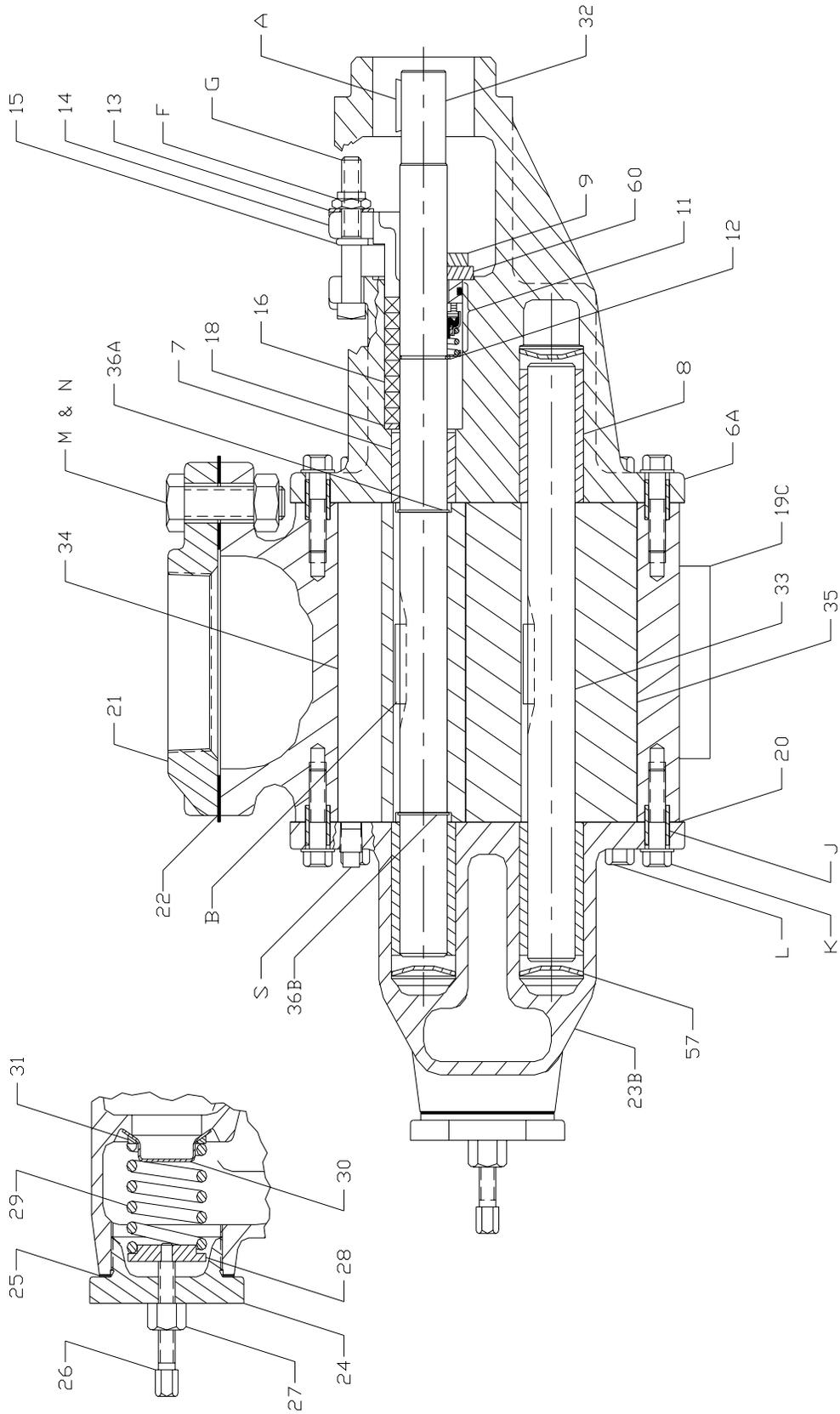
**Type BH Hydraulic Drive Bracket Assembly only**

61. Bracket

62. Rigid Coupling

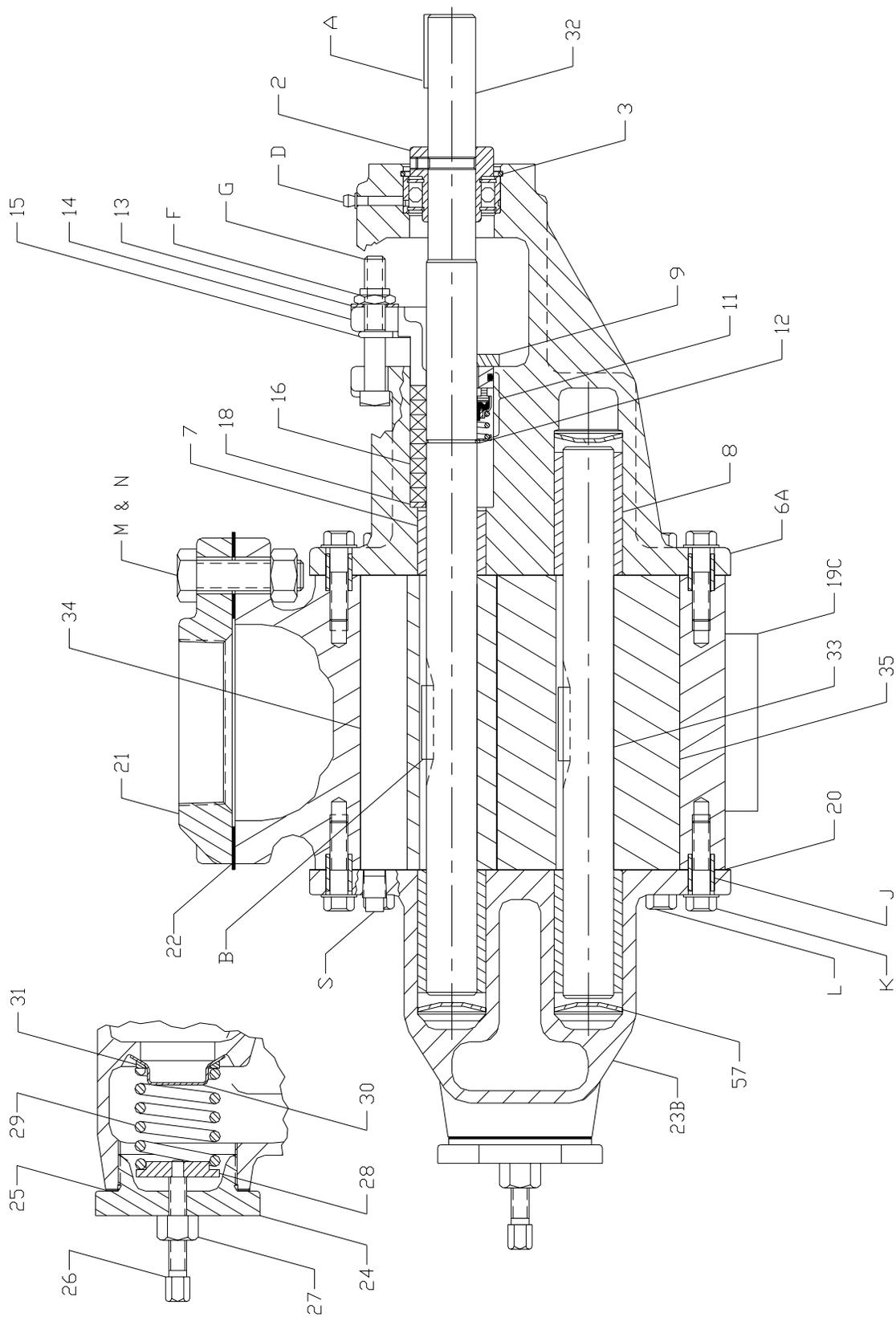
63. Retaining Ring

64. Socket Head Cap Screw



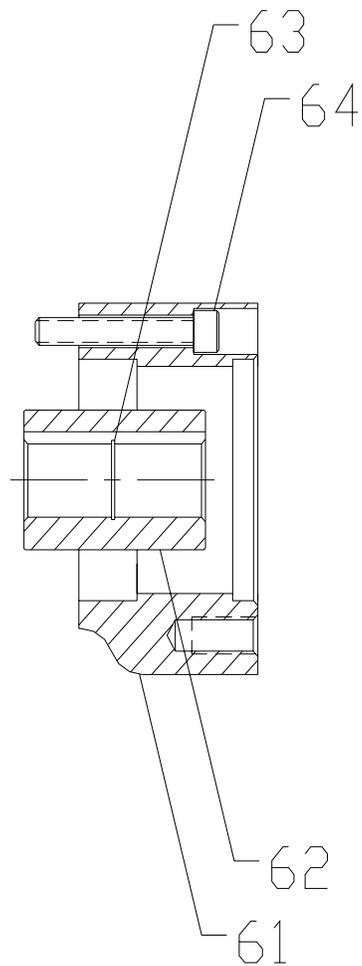
3611-4722 BH,F,RV

Figure 14.1



3611-4722 HB,F,RV

Figure 14.2



**3611-4722 MBH,F,RV**  
**HYDRAULIC DRIVE COUPLING ASSEMBLY**  
**Figure 14.3**

## 15. SHAFT SEALING

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### STANDARD COMPRESSION PACKING

One type of shaft sealing used in these pumps is formed ring packing with or without a lantern ring. When using a packed box pump, use formed packing rings. **DO NOT** use a one piece spiral wrap of packing. Packing rings are available in a wide selection of materials for various applications and temperatures. Previous experience with the pumped fluid is the best guide in selecting the proper packing ring material for your particular application.

Some backplates are furnished with tapped holes on the stuffing box to provide access to the lantern ring or packing set for either flushing or grease lubrication. An external flush or lubrication of the packing may be necessary for proper operation and to help prolong the life of the packing and shaft.

A flush is recommended when the fluid to be pumped is abrasive or the pump operates with negative inlet pressure (suction lift). Clean water is often used to flush the packing. On applications where clean water is not available or where it is incompatible with the fluid being pumped, other clean, nonhazardous liquids may be used for flushing the packing. The flush should be supplied to the stuffing box at a rate of  $\frac{1}{4}$  to  $\frac{1}{2}$  gallons per hour (1 to 2 liters per hour). The pressure of the flushing liquid should exceed the sum of the inlet pressure and half of the differential pressure by 10 to 15 psi [70 to 100 kPa].

If the packing is to be grease lubricated, a good grade of bearing grease should generally be used. Should bearing grease be unacceptable or incompatible with the fluid being pumped, another paste type lubricant may be used. Lubrication of the packing must be performed with the pump stopped. Before daily start-up, if applicable, is a good time.

To lubricate the packing, stop the pump. Carefully clean the stuffing box pipe plugs of any contaminants. After removing the pipe plugs from the stuffing box, install a lubrication fitting into one of the tapped holes. Lubricant now may be injected into the stuffing box through the lube fitting. Inject clean, fresh unused lubricant until it is seen coming out of the other tapped hole. Clean up any excess lubricant and remove the lube fitting. Replace the pipe plugs. This procedure should be performed daily, prior to start-up if the pump is purchased with provisions for grease lubrication. In certain applications, more frequent lubrication of the packing may be necessary. Experience will provide a guide as to how frequently the packing should be lubricated. Applying lubricant often will extend the life of the packing and shaft.

### CARE OF PACKING



## WARNING

**DO NOT** work on or adjust packing while the pump is running.

If truck mounted, **DISENGAGE** the PTO or hydraulic drive and shut off the engine.

If motor driven, **TURN OFF** motor and lock out the energy source.

**CLOSE VALVES** on the inlet and discharge while working on the pump.

Packing hooks are commercially available to help in removing packing rings from the stuffing box. It is generally not recommended to reuse old packing rings. When installing packing, use formed packing rings.

**DO NOT** use a one piece spiral wrap of packing. Before installing packing, carefully clean the stuffing box and shaft.

Packing rings should be installed one ring at a time, with the joints of adjacent rings staggered approximately 180°. Each ring should be seated firmly before the next ring is installed. **DO NOT** forget to install the lantern ring, if applicable. Three rings of packing, followed by the lantern ring, should allow the lantern ring to be approximately aligned with the flush/lube holes in the stuffing box.

The packing gland nuts should first be evenly tightened with a wrench to seat the packing firmly in the stuffing box and against the shaft. **DO NOT** over-tighten the packing. The gland nuts should then be backed off until finger-tight. Connect the flush or lubricate the packing if either method is used. After the pump is started, note the amount of leakage from the stuffing box. If the packing leakage exceeds ten drops per minute, stop the pump and adjust the gland nuts. The gland nuts should be adjusted evenly in 1/6 to 1/3 turn (1 to 2 flats on the nut) increments. Start the pump and allow it to operate for several minutes. Again, visually examine the stuffing box for excessive leakage. Repeat the above procedure until the stuffing box leakage is between five to ten drops per minute.

**DO NOT** over-tighten the packing. Slight leakage is a necessary requirement for proper packing operation. Leakage of five to ten drops per minute when the pump is operating is desirable, as it will preserve the packing and avoid scoring of the shaft. Over-tight packing may score shafts, increase torque requirements of the pump, damage couplings and drivers, and generate excessive heat.

The pump should be stopped and the packing gland adjusted whenever leakage exceeds ten drops per minute. The condition of the packing should be checked at regular intervals, the frequency depending on the type of service. Experience will dictate how frequently the inspections should be made.

## **MECHANICAL SEALS**

Various types of mechanical seals are available to fit most pumps. (See **VARIOUS SEALING ARRANGEMENTS** shown in Figure 15.3.) Due to the various seal types and styles available, the seal manufacturer's instructions for installation and setting should be followed when available.

**NOTE:** Not all seals will fit or function in all pumps. Modification to the pump backplate, drive shaft, and/or retainer may be required. Consult with a Roper distributor or Roper Pump Company if you are considering a seal change in your pump.

For removal or installation of mechanical seals, refer to disassembly and assembly procedures for pumps.

## **CONVERSION FROM PACKED BOX TO MECHANICAL SEAL OR MECHANICAL SEAL TO PACKED BOX**

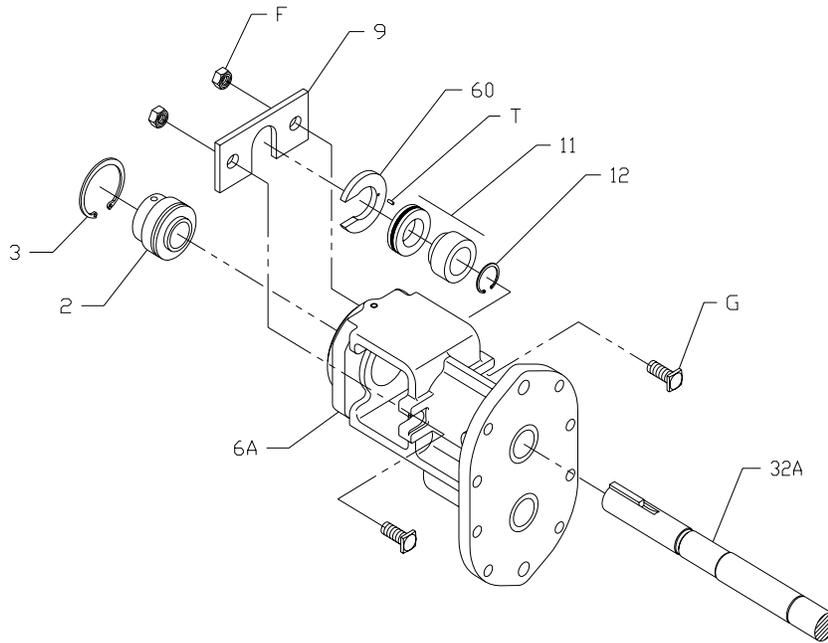
Conversion kits are available to convert from a packed box pump to a mechanical seal pump or visa versa. Contact your Roper distributor or Roper Pump Company for availability of conversion kits.

## **INSTALLATION OF A POSITIVE DRIVE SEAL (JOHN CRANE® TYPE 8-1 AND TYPE 9)**

Refer to the exploded parts drawing shown in Figure 15.1 and to the appropriate seal chamber dimensional drawing shown in Figure 15.2.

1. Machine a counterbore at entrance to seal chamber of backplate (6A, B) as shown in dimensional drawing in Figure 15.2.
2. With drive shaft (32) out of pump, install retaining ring (12) on drive shaft to locate mechanical seal.
3. Carefully remove all burrs and sharp edges on the shaft over which rotating element of seal will slide.
4. Apply a lubricant to seal I.D. and to drive shaft O.D. that is compatible with product being pumped and elastomers within pump. **DO NOT** use petroleum base products with seals with EPR elastomers. Clean and lubricate parts with light oil unless EPR elastomers are used. Use a nonpetroleum base lubricant with EPR elastomers.
5. Slide rotating element of mechanical seal onto drive shaft before removing three or four clips that are taped to rotating element. Push it back to retaining ring (12), tighten setscrews in seal, and remove clips that are taped to seal.
6. Slide faceplate end of drive shaft, with mechanical seal attached, into backplate (6A, B) through bore for outboard ball bearing (2).
7. Use a compatible lubricant to lubricate o-ring on stationary seal face and seal chamber bore.
8. Slide stationary seal face over keyway end of drive shaft (32) and down to seal chamber. Be sure lapped (polished) face is toward rotating member of seal.
9. Install outboard ball bearing (2) to position drive shaft (32) as shown in appropriate sectional drawing on page 64 and 65.

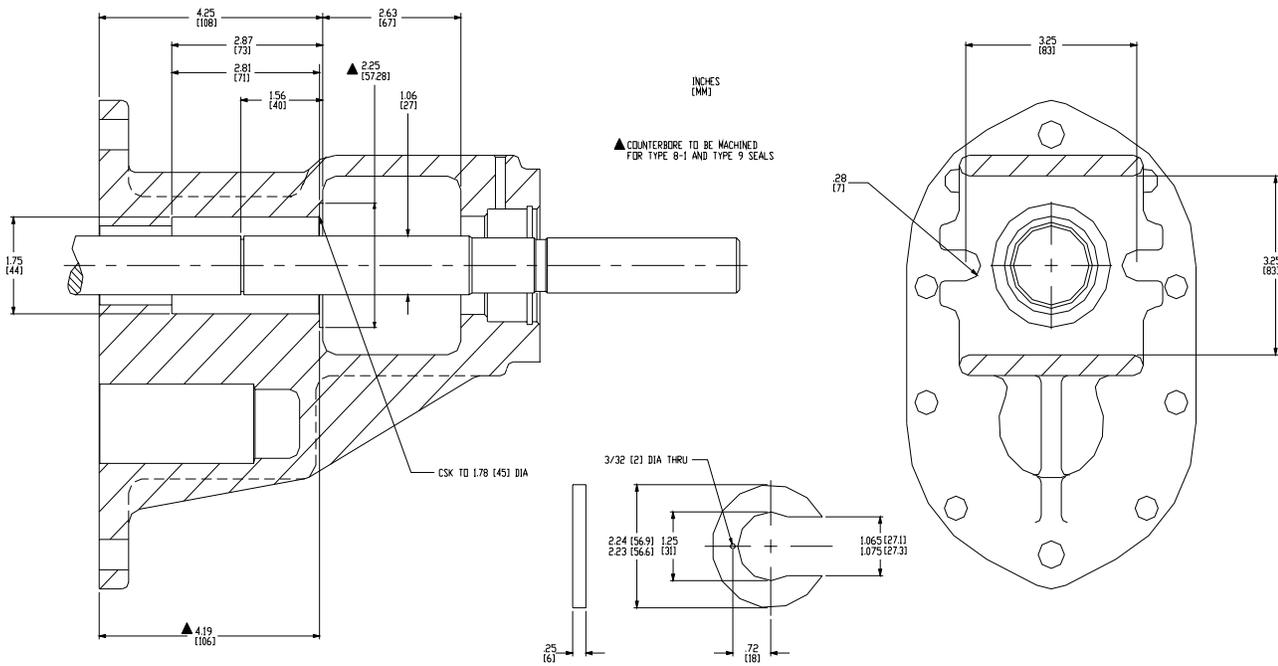
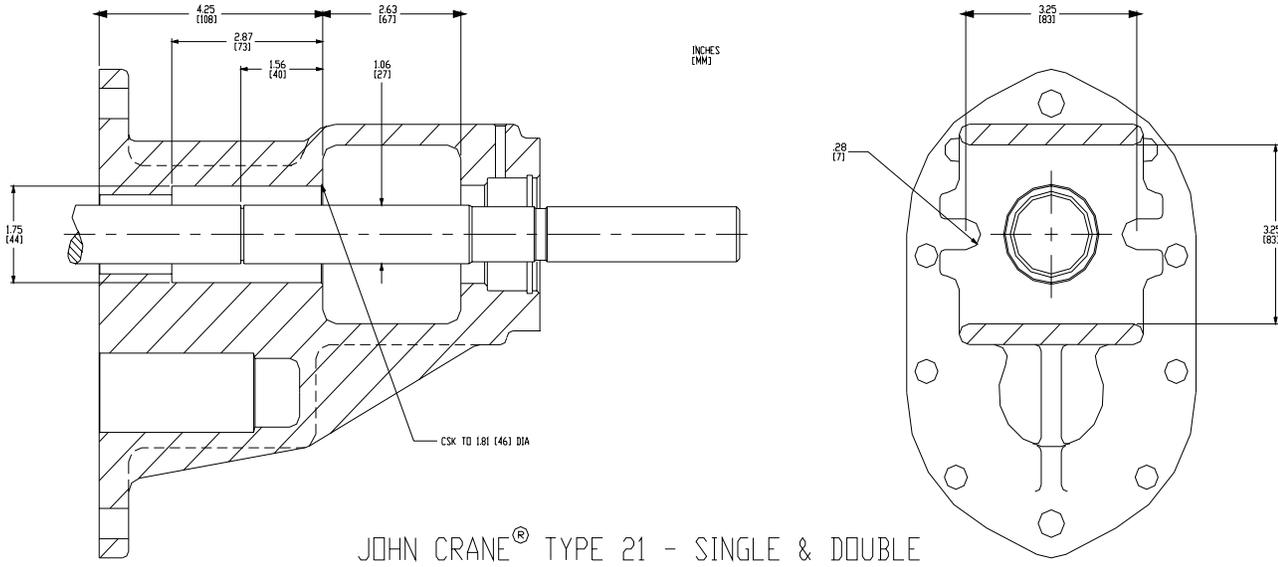
10. Push stationary seal face into seal chamber.
11. Position locator ring (60) in counterbore of backplate (6A, B). Make sure antirotation pin (T) engages in slot in back of stationary seal face.
12. Place one square head bolt (G) through each slot in backplate (6A, B) and through each hole in seal retainer (9). Secure seal retainer against backplate using two locknuts (F).
13. Assemble backplate assembly to remainder of pump following correct steps in **INSTRUCTIONS FOR PUMP ASSEMBLY**, Section 11.



**Figure 15.1**

# SEAL CHAMBER DIMENSIONALS

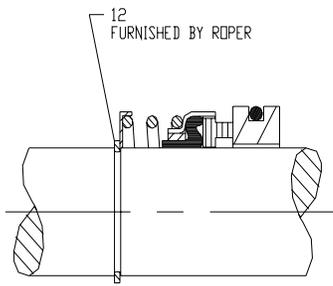
## Figure 15.2



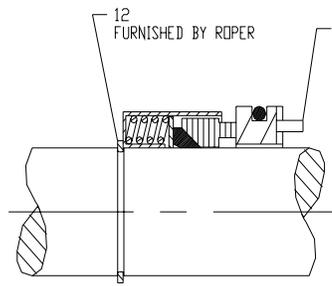
# VARIOUS SEALING ARRANGEMENTS

Figure 15.3

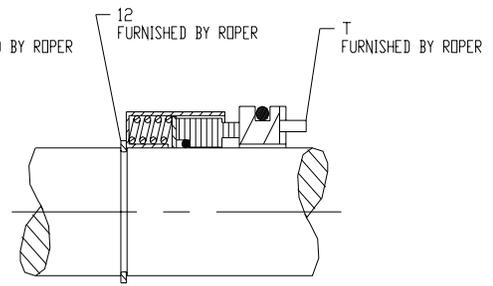
## SINGLE MECHANICAL SEALS



JOHN CRANE® TYPE 21

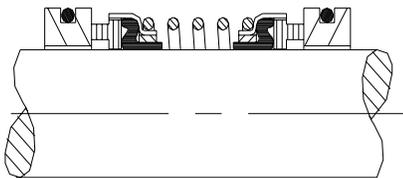


JOHN CRANE® TYPE 9

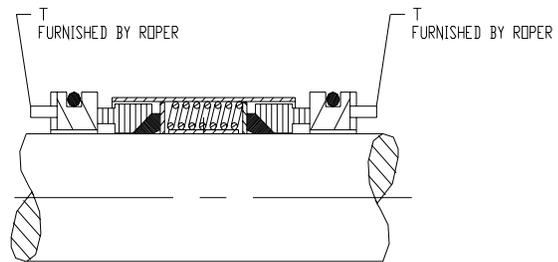


JOHN CRANE® TYPE 8-1

## DOUBLE MECHANICAL SEALS



JOHN CRANE® TYPE 21 DOUBLE



JOHN CRANE® TYPE 9 DOUBLE

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## TERMS & CONDITIONS AND LIMITED WARRANTY

This agreement (this "Agreement"), consisting of these Terms and Conditions, and the associated Order Acknowledgement is binding upon Roper Pump Company, hereinafter "SELLER," and the customer, hereinafter "BUYER." By placing an order for a product with the Seller, the Buyer agrees to these Terms and Conditions of sale and acknowledges that the person placing the order has the authority to enter into the Order Acknowledgement on Buyer's behalf.

**LEGAL EFFECT:** Except as expressly otherwise agreed to in writing by an authorized representative of Seller, the following terms and conditions shall apply to and form a part of any Order Acknowledgement. Seller may suspend its performance of any Order Acknowledgement if Buyer defaults in the performance of its duties under the Order Acknowledgement or under any other agreement between the Buyer and Seller.

**ACCEPTANCE:** The sale of goods and services is expressly conditional on Buyer's acceptance of Seller's terms and conditions as stated herein. Provided that Seller's terms and conditions have not been previously accepted by Buyer, Buyer's receipt of goods or services shipped under this Agreement constitutes acceptance of these terms and conditions. No additional, different or conflicting provisions proposed by Buyer are acceptable to Seller and are hereby specifically rejected, Seller being unwilling to sell goods on any terms conflicting with, limiting or modifying the terms hereof. Buyer shall not sell, transfer or otherwise provide any goods to another for resale without the prior, written authorization of Seller. Seller reserves the right to sell and to authorize other entities to sell such goods through all means and channels of distribution and in competition with Buyer. Buyer acknowledges that it has no authority to bind or contract in the name or for the account of Seller, to create any liability against Seller or to exert any direction or control over Seller's personnel.

**CHANGES:** This Agreement and the associated Order Acknowledgement constitutes the entire agreement between Seller and Buyer with respect to the subject matter thereof, and supersedes all prior oral or written agreements. This Agreement and the associated Order Acknowledgement may not be amended or modified, except by a further written agreement signed by an authorized representative of Seller. Seller reserves the right to make reasonable changes to an Order Acknowledgement, including changes as to packaging, testing, specifications, designs and delivery schedules. The terms and conditions of any purchase order or other instrument issued by Buyer or its agent in connection with this Agreement and the associated Order Acknowledgement or any goods sold thereunder that is in addition to or inconsistent with the terms and conditions of this Agreement or the associated Order Acknowledgement are null and void and shall not be binding on Seller. Buyer's changes made after formation of this Agreement that affect the schedule or requirements for services or otherwise affect the scope of this Agreement shall be submitted in writing by Buyer and shall become binding only if approved in writing by Seller's cognizant representative. All charges and delays resulting from such changes shall be solely determined by Seller and shall be binding upon Buyer.

**TERMINATION, SUSPENSION, AND CANCELED ORDERS:** Provided that Seller receives adequate written notice from Buyer, Buyer may terminate or suspend performance at Buyer's convenience subject to all reasonable charges, which charges shall be solely determined by Seller. Buyer cannot cancel or alter Orders without the Seller's written consent. If Seller grants such consent, Buyer will reimburse Seller for all of Seller's losses and expense caused by such cancellation or alteration, including without limitation all of Seller's additional costs caused by changes in design or specifications, or by product revisions, and all incidental and consequential damages incurred by Seller as a result of such cancellation or alteration. No goods may be returned to Seller except with Seller's written consent. Title in a returned good will pass when Seller takes possession of the returned goods.

**CREDIT:** The amount of credit offered by Seller to Buyer is contingent upon Seller's opinion of Buyer's capacity, ability, and willingness to promptly pay for goods and services received under the terms of this Agreement. Provided that, in Seller's opinion, there is a material adverse change in Buyer's financial condition and/or Buyer has not, within the agreed time, fully paid for goods and services previously supplied under this and/or another Agreement(s) with Seller, Seller reserves the right to revoke Buyer's credit and/or suspend performance on this and/or other orders for goods and services.

**PAYMENTS:** Standard terms for customers who qualify for credit net 30. A monthly service charge of 1.5% may be charged on amounts owed by Buyer to Seller that have not been paid within by the due date, subject to the maximum amount permitted by law.

**TAXES.** Buyer assumes exclusive liability for any and all taxes, tariffs, fees, duties, withholdings or like charges, whether domestic or foreign, now imposed or hereafter becoming effective ("Taxes") related to the goods and its purchases from Seller, including without limitation, federal, provincial, state and local taxes, value-added taxes, goods and services taxes, stamp, documentary, excise or property taxes, duties and other governmental charges.

**TITLE AND LIEN RIGHTS:** The equipment will remain personal property, regardless of how it is installed or affixed to any realty or structure. After delivery to Buyer, Seller will have all such rights, including security interests and liens, in the equipment as lawfully may be conferred upon Seller by contract under any applicable provision of law.

Buyer agrees to cooperate fully with Seller in the filing of any financing statements, including Uniform Commercial Code (UCC) filings or other documents necessary to perfect such interests and liens. If Buyer defaults in its obligations under the Order Acknowledgement before the price (including any notes given therefore) of the equipment has been fully paid in cash, Seller may take any and all actions permitted by law to protect its interests including, where permissible, repossession of such equipment.

**SHIPMENTS:** All sales are Ex-Works Factory (as such term is defined by the International Chamber of Commerce as of the date hereof). Shipping contracts made by Seller shall be to Buyer's account. All claims for loss or damage after risk of loss has passed to Buyer shall be filed by Buyer with the carrier. Buyer shall be liable to Seller for the full price of the goods, irrespective of loss or damage in transit. Seller shall not be required to provide freight cost receipts to Buyer at the time of invoice. Buyer shall bear all risk and expense for delivery of goods, including without limitation, shipping, loading, unloading, storage, freight, and insurance. Goods may be shipped to Buyer in whole or in part. Title to goods shall pass to Buyer when delivered to the carrier or the Buyer, whichever occurs first, even if the goods are shipped freight prepaid. Among other things, a signed delivery receipt or bill of lading will constitute proof of delivery. The choice of carrier is made solely at the discretion of Seller, and Seller makes no representation as to the acceptability of a particular carrier. Except when Seller expressly agrees in writing, Seller does not guarantee shipment or delivery by a certain date or time, although Seller will strive to deliver goods by the date that it may communicate to Buyer. Seller shall not be liable to Buyer, or any other person, for any loss or damage of any kind which results from delay in shipment, delivery, or failure to give notice of delay, whether or not such delay was caused by Seller or otherwise. Seller reserves the right to backorder any goods and to ship from backorder in such order as Seller determines.

**LIMITED WARRANTY:** Seller warrants, to its original Buyer, that goods manufactured by Seller are free from defects in material and workmanship for 12 months from date of shipment (except for specified products with warranties that supercede this limited warranty. Please consult factory for these products). The Buyer hereby acknowledges and agrees, though free from defects in material and workmanship at the time of shipment, that the useful life of goods manufactured by Seller will vary depending upon the Buyer's frequency of use, application, and other factors, with regard to such goods. In that respect, notwithstanding any other provision to the contrary in the Agreement, these Terms and Conditions, or the Order Acknowledgement, the Seller specifically does not warrant the useful life of any product. If a failure to conform to specifications or a defect in materials or workmanship is discovered within this period, Seller must promptly be notified in writing within thirty (30) days, which notification, in any event must be received no later than 12 months from the date of shipment. Within a reasonable time after such notification, Seller will correct any failure to conform to specifications or any defect in materials or workmanship, or in lieu of such repair, and at its sole option, shall replace the equipment. **THE ABOVE ARE THE BUYER'S EXCLUSIVE REMEDIES FOR BREACH OF WARRANTY.** Seller does not warrant: (a) defects caused by failure to provide suitable installation environment for the product, (b) damage caused by use of the product for purposes other than those for which it was purchased, (c) damage caused by disasters such as fire, flood, wind, and lightning, (d) damage caused by unauthorized attachments, or modification, (e) any other abuse or misuse by the Buyer, including improper installation; or (f) goods which have been damaged or altered by Buyer or its customers. Each good sold by Seller to Buyer shall be deemed to be without defect and in conformity with its specifications and the terms of this Agreement and the associated Order Acknowledgement even though reasonable variances may exist. As a result, Seller cannot and does not guarantee that goods sold hereunder, whether in whole or in part, will exactly match in specification or otherwise, and Buyer acknowledges that reasonable variance is permissible. Additionally, Seller shall have no liability if a good does not conform to any applicable state, county or local ordinance, as the conformity of a good to each state, county and local ordinance is the sole responsibility of the Buyer. Seller reserves the right to change its goods and the components of its goods without prior notice to Buyer, although in circumstances where an order from Buyer has been accepted by Seller, Seller will use commercially reasonable efforts to ensure that such change will not affect performance of the good in a materially adverse manner.

**EXCEPT AS SET FORTH ABOVE AND TO THE MAXIMUM EXTENT PERMITTED BY LAW, SELLER MAKES NO OTHER WARRANTIES FOR A PRODUCT OR UNDER THIS AGREEMENT OR ANY ORDER ACKNOWLEDGEMENT AND HEREBY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR USE, AND INCLUDING THE WARRANTY OF MERCHANTABILITY. IN NO CASE SHALL SELLER BE LIABLE FOR ANY SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES BASED UPON ANY LEGAL THEORY, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, LOSS OF SAVINGS OR REVENUE, LOSS OF USE OF THE PRODUCT OR ANY ASSOCIATED EQUIPMENT, COST OF CAPITAL, COST OF ANY SUBSTITUTE EQUIPMENT, FACILITIES OR SERVICES, DOWNTIME, THE CLAIMS OF THIRD PARTIES INCLUDING CUSTOMERS, INJURY TO PROPERTY AND, UNLESS PRECLUDED UNDER APPLICABLE STATE LAW, BODILY AND PERSONAL INJURY.**

**INDEMNITY; LIABILITY LIMITATION:** Buyer hereby agrees to indemnify, reimburse in full, defend and hold harmless Seller, its subsidiaries, affiliates, officers, directors, personnel and agents from and against any and all liability, claims, suits, actions, losses, costs or expenses including (without limitation) reasonable attorneys' fees relating to or arising out of any claim or demand (a) for any Taxes or related penalties and interest, (b) due to

Buyer's breach of the Order Acknowledgement; (c) that Buyer's customers or a third party may make against Seller based upon or arising from damage due to the acts and/or omissions of Buyer or due to the installation of the goods; (d) for infringement or misappropriation of a third party's intellectual property rights based upon Seller's incorporation of any designs, formulas or specifications in any goods where such designs, formulas or specifications have been specifically ordered or requested by Buyer. To the maximum extent allowable under applicable law and excluding those liabilities that by law Seller cannot limit or disclaim, (i) Seller's aggregate liability arising from or relating to this Order Acknowledgement or goods, regardless of the cause of action asserted, is limited to the amount paid by Buyer to Seller for the applicable goods and (ii) Seller shall not be liable for any special, incidental, consequential, indirect, or punitive damages, including without limitation, lost revenues, loss of use of the goods, loss resulting from improper storage, processing, padding/cushion, delay in delivery or shipment or errors in shipment or labeling, loss of data, or the cost of any substitute goods or related equipment, even if Seller has been advised of the possibility of such damages.

**EXPORT RESTRICTIONS:** Buyer shall not export or re-export goods in violation of any applicable laws or regulations of the United States or the country in which Buyer obtained them.

**CONFIDENTIAL INFORMATION.** During the term of this Agreement and the associated Order Acknowledgement and for the longer of (a) three (3) years following its termination and (b) for such Confidential Information of Seller that is a Trade Secret of Seller as defined by applicable law, for the life of such Seller Trade Secret, Buyer agrees to receive and hold Confidential Information of Seller in trust and in strictest confidence and shall not use, reproduce, distribute, disclose or otherwise disseminate any Confidential Information except as necessary to perform its obligations hereunder. Disclosures of the Confidential Information may be made only to Buyer's employees and agents who have a specific need to know and are subject to confidentiality restrictions at least as restrictive as those contained herein. "Confidential Information" means confidential information relating to the business, products and services of Seller which is or has been disclosed to Buyer, and which has value to Seller and is not generally known to Seller's competitors, including (without limitation), information regarding the specifications provided to Buyer by Seller and Seller's product plans, designs, costs, prices, finances, marketing plans, business opportunities, personnel, R&D activities and know-how.

**CONTROLLING LAW:** This Agreement and the associated Order Acknowledgement entered into hereunder shall be governed and construed in accordance with the laws of the State of Georgia and of the United States of America without reference to any conflicts of law principles; the parties submit themselves to the jurisdiction of the federal and state courts located in Jackson County, Georgia, which shall have exclusive jurisdiction of any disputes arising hereunder, and the parties waive any objection to venue therein. The United Nations Convention on Contracts for the International Sale of Goods, the Uniform Law on the Formation of Contracts for the International Sale of Goods, and any applicable international discovery and service of process conventions shall not be applicable. In the event legal action is undertaken by Seller to collect any amounts due to Seller by Buyer hereunder and if Seller prevails in such action, then Buyer shall reimburse Seller for its reasonable attorney fees and costs incurred in conjunction with such action, which amount shall not exceed the maximum amount allowed by law of the forum in which such action is brought.

**ASSIGNMENT:** Neither this Agreement nor any associated Order Acknowledgement may be assigned by the Buyer, or its contents publicized by the Buyer, without the written consent of Seller. Seller shall have the right to assign, transfer or sublicense all or any part of this Agreement or any associated Order Acknowledgement to another at any time and without the consent of Buyer.

**MISCELLANEOUS:** The various provisions of this Agreement and any associated Order Acknowledgement are severable, and any determination of invalidity or unenforceability of any one provision hereof shall no bearing on the continuing force and effect of the remaining provisions hereof. This Agreement and any associated Order Acknowledgement and the terms and conditions contained herein constitute the entire understanding of the parties with respect to the purchase and sale of the goods, and any prior agreements, with respect thereto, whether written or oral, are superseded hereby. This Agreement and any associated Order Acknowledgement shall be binding on the parties and their respective successors and any permitted assigns.

**ELECTRONIC DATA INTERCHANGE.** The parties may execute a Order Acknowledgement by transmitting and receiving the data contained in the Order Acknowledgement electronically rather than in paper form. To provide the legal validity and enforceability of such Order Acknowledgement, the parties further agree that the data transmitted herein will be considered "in writing" and to have been "signed." The parties agree not to contest the validity or enforceability of a Order Acknowledgement because of the electronic origination, transmission, storage or handling of such Order Acknowledgement. Any computer printout of the data contained in the Order Acknowledgement will be considered an "original" when maintained in the ordinary course of business and will be admissible as between the parties to the same extent and under the same conditions as other business records maintained in documentary form. The parties agree to properly use those security procedures which are reasonably sufficient to ensure that a transmission of the data contained in a Order Acknowledgement is authorized and to protect its business records and data from improper sources.