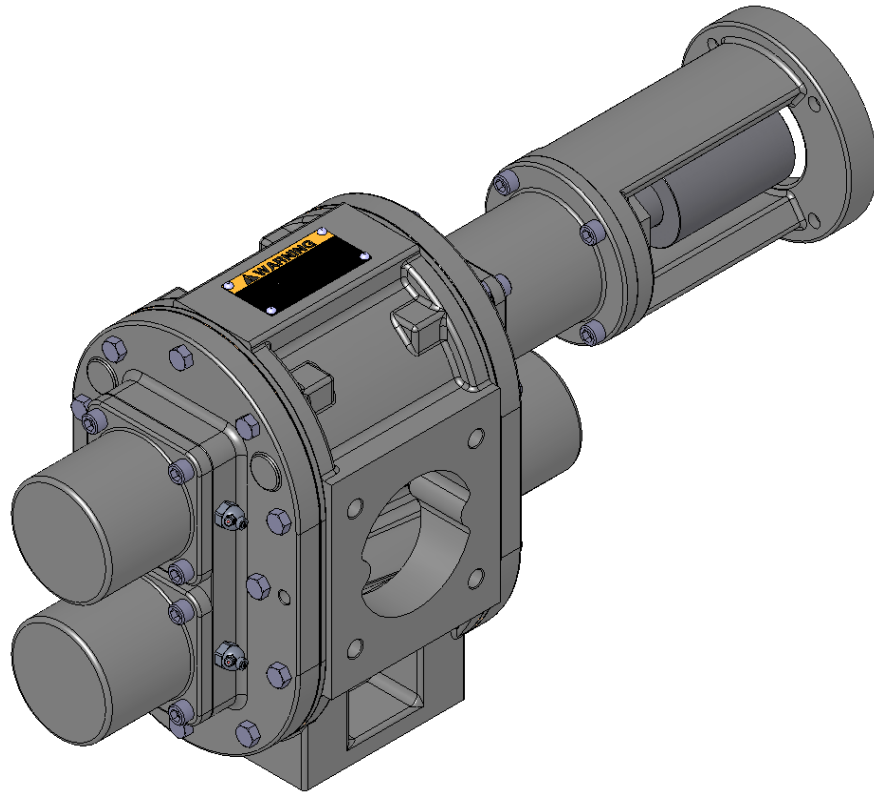




# 4456H TYPE 1 OWNERS MANUAL

G12-545

09/25/09



## **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.

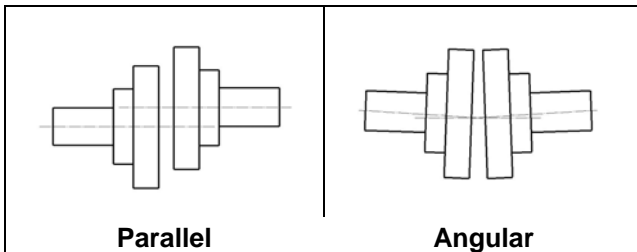
## Separate Pump and Drive Assemblies

### 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

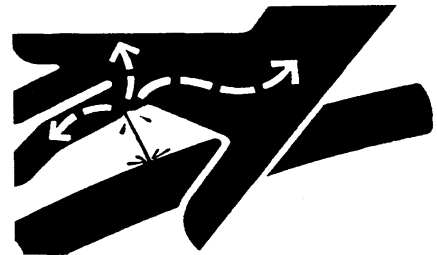
1. Mount the unit on a rigid, heavy base to provide support and absorb shock. Bases should be designed for high rigidity, not just strength.
2. The pump feet were not designed for mounting to concrete and do not have enough contact area to prevent concrete from failing. When mounting to cement or concrete, 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.

## ! 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



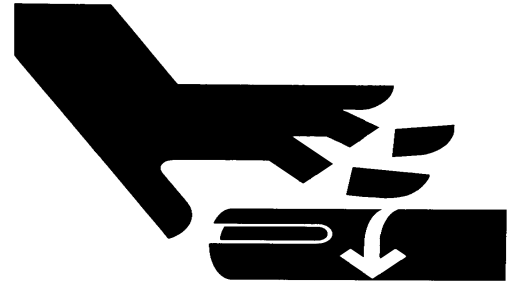
**Injection Hazard: Do not try to stop a leak with your hand! Avoid any close contact with hydraulic fluid jets. Escaping fluid can penetrate skin, causing serious injury. In case of accident, see a doctor immediately for removal of fluid.**

## 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

---

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

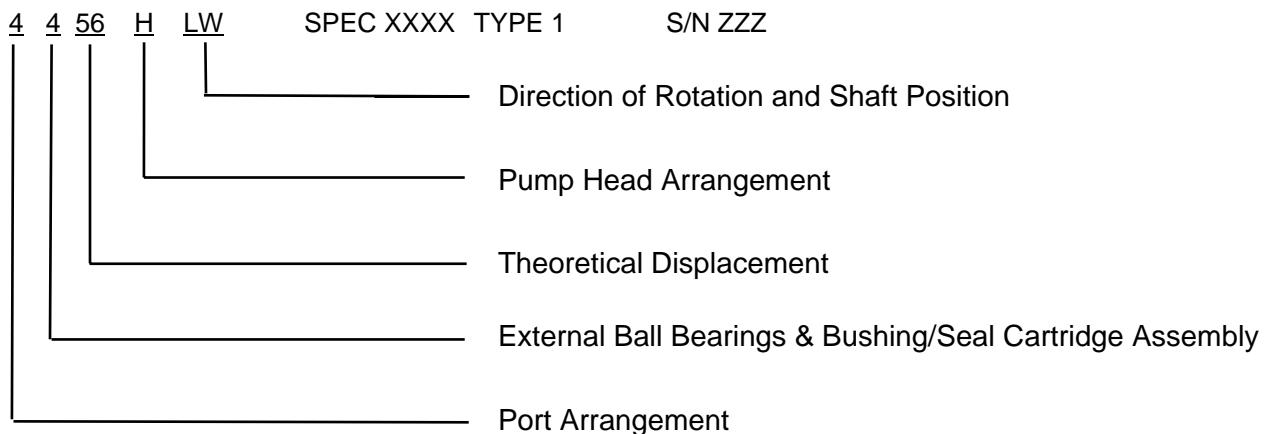
**MODEL** 4456HLW

**SPEC** XXXX    **TYPE** 1

**SERIAL NO.** ZZZ

1. The Model Number consists of an seven digit number.
  - The first digit (4) indicates the port arrangement.  
4 – 4400 Series with straight through ports
  - The second digit (4) indicates external ball bearings, along with bushing/seal cartridge assembly.
  - The third and fourth digits (56) indicate the approximate theoretical displacement in U.S. gallons per 100 revolutions.  
Gallons/100 Rev. [Liters/100 Rev.]  
56 [212]
  - The letter (H) indicates the pump head arrangement.  
H – Pump without outboard bearing to accommodate PTO drive or close coupled hydraulic drive auxiliaries through a rigid coupling.
  - The letter (LW) indicates shaft position.  
No letter (W) – High drive, Clockwise Rotation  
LW – Low drive, Clockwise Rotation  
Z – High Drive, Counter Clockwise Rotation  
LZ – Low Drive, Counter Clockwise Rotation

Example:



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 4400 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.

2. 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.
3. 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.
4. 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

---

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

- 100 psi [862 kPa] Maximum Inlet
- 100 psi [862 kPa] Maximum Discharge
- 99 psi [855 kPa] Maximum Differential

### Speed

- 750 rpm (recommended)
- 1000 rpm Maximum (depending on pumping conditions)

### Temperature

- 250°F [121°C] Maximum

## 3. PREOPERATION CHECKS

---

*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. 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.

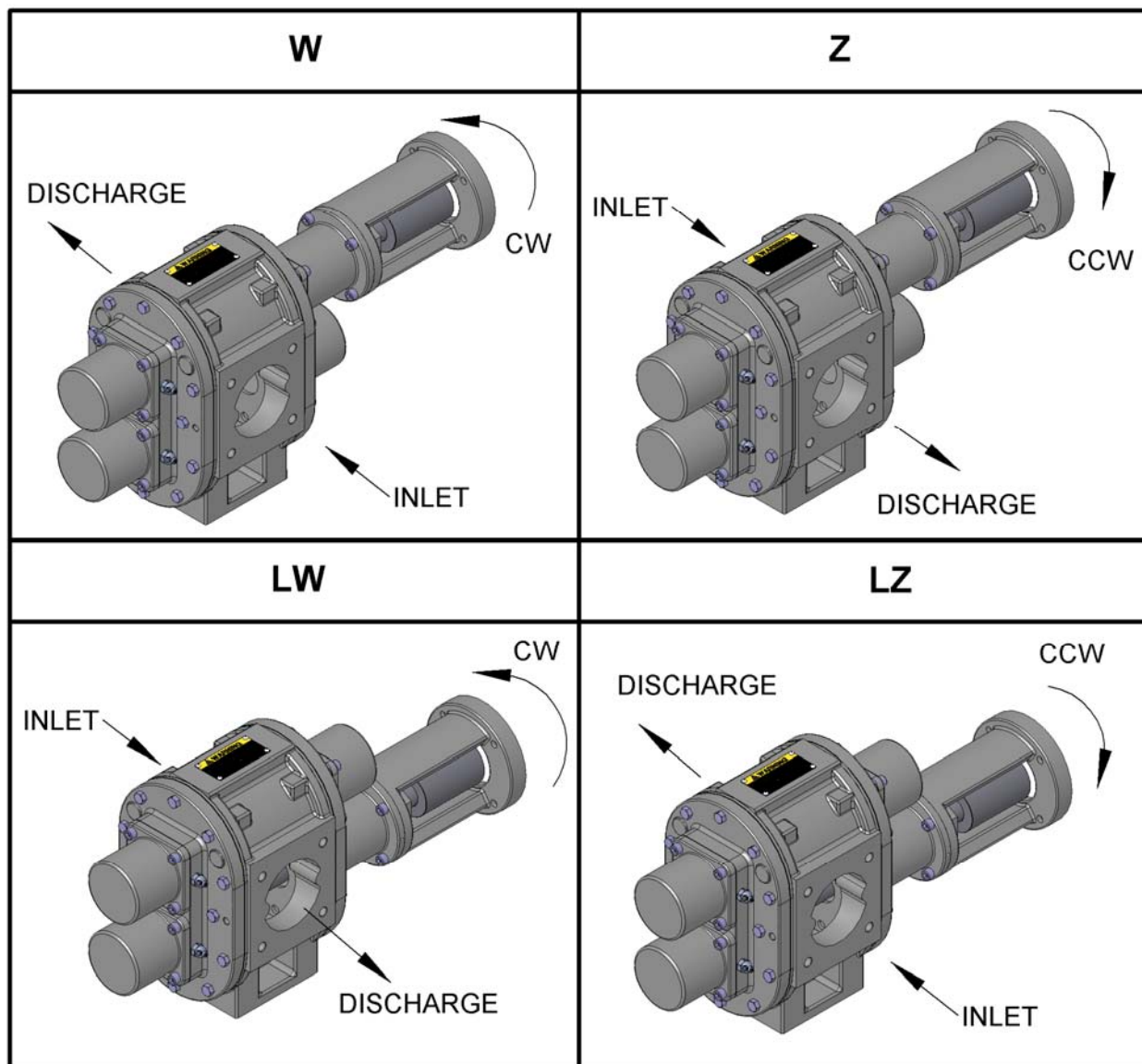
## 4. RECOMMENDED TOOL LIST

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

### Tools for all Pumps:

- (1) Safety Glasses
- (1) 9/16" Combination Wrench
- (1) 3/4" Combination Wrench
- (1) 18" Pipe Wrench
- (1) Pliers
- (1) 3/32", 5/32" & 5/15" Hex Head Wrench (Allen Wrench)

## 5. DIRECTION OF ROTATION



**DIRECTION OF ROTATION FOR HIGH DRIVE & LOW DRIVE PUMP CONFIGURATIONS**  
**Figure 5.1**

## 5. HIGH DRIVE TO LOW DRIVE

---

Prior to operating pump, make sure that the shaft rotation and pipe connections are in accordance with the appropriate illustrations shown in Figure 5.1. 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 and flange gaskets, when provided, can be removed from pump.]

Whenever changing rotation, inspect all parts before reassembly. Replace all worn parts and install new gaskets and seals.

Depending on the pump configuration, some steps may not apply.

1. A.) Close Coupled: Remove motor from bracket (32). Remove ridged coupling (31) and drive key (9) from drive shaft (2). Remove all burrs and sharp edges from drive shaft and keyway.  
B.) PTO Driven: Remove coupling or universal joint and drive key (9) from drive shaft (2). 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 (2) position must be changed. Follow steps 3-11.  
B.) To reverse pump rotation and leave drive shaft (2) in same position; liquid flow through pump will be reversed. Follow step 12.  
C.) To change port and drive shaft location, but keep the same rotation follow steps 13-21.

### 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.
4. Remove four socket head cap screws (30) securing motor bracket (32) to bearing housing (16). Remove bracket (32).
5. Remove lock wire (18a) from packing nut (18) and remove packing rings (17) from bearing housing (16).
6. Remove four socket head cap screws (19) securing bearing housing (16) to endplate (12). Remove bearing housing (16). **Note:** The bearing housing has two 1/2-13 UNC tapped jacking holes. Slightly rotate the housing to keep from damaging the mounting holes in the endplate.
7. Remove four socket head cap screws (19) securing all bearing caps (14) to both endplates (12). Remove bearing caps (14). **Note:** Remove the hex head bolt (24) and washer (25) to release any vacuum created by the fit between the ball bearing (15) and bearing cap (14). This tapped hole can be used as a jacking hole to aid in removal of the bearing cap.
8. Remove o-ring (22).
9. Remove ball bearings (15) from drive shaft (2) and idler shaft (3).
10. Remove spacer ring (28).
11. Remove bushing cartridge assemblies (13) from endplates (12). **Note:** The bushing cartridge assembly has two 10-24 UNC tapped jacking holes to aid in removal. Two small setscrews will need to be removed prior to using longer jacking screws. Jacking screws (29) are provided and are located on the external face of the endplate (12).
12. Pull out drive shaft (2) and idler shaft (3) and switch positions in the case (1).
13. Reassemble in reverse order with drive shaft (2) in new location.

## REVERSE ROTATION, SAME DRIVE SHAFT AND CASE ARRANGEMENT

14. To reverse flow of liquid through pump ports, reverse rotation of drive gear (4) and shaft (2), maintain the original positions of the drive gear/shaft and case (1).

## CHANGE PORT AND DRIVE SHAFT LOCATION, SAME ROTATION

15. To change the port to the opposite side and maintain same pump rotation, change drive gear (4) and shaft (2) from high drive to low drive or vice versa.
16. Remove four socket head cap screws (30) securing motor bracket (32) to bearing housing (16). Remove bracket (32).
17. Remove lock wire (18a) from packing nut (18) and remove packing rings (17) from bearing housing (16).
18. Remove four socket head cap screws (19) securing bearing housing (16) to endplate (12). Remove bearing housing (16). **Note:** The bearing housing has two 1/2-13 UNC tapped jacking holes. Slightly rotate the housing to keep from damaging the mounting holes in the endplate.
19. Remove four socket head cap screws (19) securing all bearing caps (14) to both endplates (12). Remove bearing caps (14). **Note:** Remove the hex head bolt (24) and washer (25) to release any vacuum created by the fit between the ball bearing (15) and bearing cap (14). This tapped hole can be used as a jacking hole to aid in removal of the bearing cap.
20. Remove o-ring (22).
21. Remove ball bearings (15) from drive shaft (2) and idler shaft (3).
22. Remove spacer ring (28).
23. Remove bushing cartridge assemblies (13) from endplates (12). **Note:** The bushing cartridge assembly has two 10-24 UNC tapped jacking holes to aid in removal. Two small setscrews will need to be removed prior to using longer jacking screws. Jacking screws (29) are provided and are located on the external face of the endplate (12).
24. Pull out drive shaft (2) and idler shaft (3) and switch positions in the case (1).
25. Reassemble in reverse order with drive shaft (2) in new location.

## 7. INSTRUCTIONS FOR DRAINING PUMP

---

Refer to Section 10, **PARTS LIST**.

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 cavities in all four bearing housings will not drain.

1. Read and understand all safety instructions and warnings before starting draining procedure.
2. Remove NPT plug (23) from endplate (12) or loosen twelve hex head cap screws (20, 21) securing endplate (12) to allow a gap of 1/32 of an inch [.76 mm] between wearplate (11) and case (1) for draining.
3. Rotate drive shaft (2) 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. After draining has been completed, examine case gaskets (6) making sure gasket is not torn prior to tightening the twelve hex head cap screws (20, 21). If gasket is torn or further disassembly is required, follow steps in Section 8, **INSTRUCTIONS FOR PUMP DISASSEMBLY**, to replace gaskets.



## 8. INSTRUCTIONS FOR PUMP DISASSEMBLY

---

Refer to Section 10, **PARTS LIST**.

Depending on the pump configuration, some steps may not apply.

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. Close inlet and discharge valves.
6. A.) Close Coupled: Remove motor from bracket (32). Remove ridged coupling (31) and drive key (9) from drive shaft (2) Remove all burrs and sharp edges from drive shaft and keyway.  
B.) PTO Driven: Remove coupling or universal joint and drive key (9) from drive shaft (2). Remove all burrs and sharp edges from drive shaft and keyway.
7. Drain inlet and discharge lines. Disconnect lines from pump inlet and discharge.
8. Follow the procedure in Section 7, **INSTRUCTIONS FOR DRAINING PUMP**.
9. If equipped, remove four socket head cap screws (30) securing motor bracket (32) to bearing housing (16). Remove bracket (32).
10. Remove lock wire (18a) from packing nut (18). Then remove packing nut (18) and remove packing rings (17) from bearing housing (16).
11. Remove four socket head cap screws (19) securing bearing housing (16) to endplate (12). Remove bearing housing (16). **Note:** The bearing housing has two 1/2-13 UNC tapped jacking holes. Slightly rotate the housing to keep from damaging the mounting holes in the endplate.
12. Remove four socket head cap screws (19) securing all bearing caps (14) to both endplates (12). Remove bearing caps (14). **Note:** Remove the hex head bolt (24) and washer (25) to release any vacuum created by the fit between the ball bearing (15) and the bearing cap (14). This tapped hole can be used as a jacking hole to aid in removal of the bearing cap.
13. Remove o-ring (22).
14. Remove ball bearings (15) from drive shaft (2) and idler shaft (3).
15. Remove spacer ring (28).
16. Remove bushing cartridge assemblies (13) from endplates (12). **Note:** The bushing cartridge assembly has two 10-24 UNC tapped jacking holes to aid in removal. Two small setscrews will need to be removed prior to using longer jacking screws. Jacking screws (29) are provided and are located on the external face of the endplate (12).
17. Pull out drive shaft (2) and idler shaft (3).
18. Remove twenty-four hex head cap screws (20, 21) securing both endplates (12).
19. Remove case gaskets (6) and wearplates (11).
20. Remove drive gear (4) and idler gear (5) from case (1).

21. Remove four dowel pins (10) from case (1).
22. Disassemble the bushing cartridge assembly (13).
23. Remove retaining ring (13f).
24. Remove lip seal (13e), u-cup seal (13d), and o-ring (13g).
25. Remove choke ring (13b or 13c).
26. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets and seals (6, 13d, 13e, 13g, 17, and 22) be installed each time pump is disassembled and reassembled.

## 9. INSTRUCTIONS FOR PUMP ASSEMBLY

---

Refer to Section 10, **PARTS LIST**.

Refer to Section 5, **DIRECTION OF ROTATION**, to assure proper configuration for pump rotation and port location prior to assembling pump.

Depending on the pump configuration, some steps may not apply.

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 and seals (6, 13d, 13e, 13g, 17, and 22) 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, 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.
3. Install key (8) in drive shaft (2) and slide drive shaft into drive gear (4) bore.
4. Install key (8) in idler shaft (3) and slide idler shaft into idler gear (5) bore.
5. Read and understand Section 5, **DIRECTION OF ROTATION**. Using information from Section 5, determine position of case in relation to coupling end of drive shaft (2). Install drive gear/shaft and idler gear/shaft into proper positions in case (1).
6. Install hollow dowel pins (10) into case (1).
7. Position one case gasket (6) per side on case (1). (Oil or grease may be used to hold gaskets in place.)
8. **Gently** slide wearplate (11) into position over shafts and onto dowel pins (10).
9. Position one case gasket (6) on each wearplate (11). (Oil or grease may be used to hold gaskets in place.)
10. Liberally grease all four shaft surfaces.
11. **Gently** slide endplates (12) into position over shafts and onto dowel pins (10).
12. Install and tighten twelve hex head cap screws (20, 21) in both endplates (12). **Note:** The two hex head cap screws (21) are located at the 12 o'clock and 6 o'clock positions on the endplate (12).
13. Assemble bushing cartridge assembly's (13). Place one o-ring (13g) into groove on the OD. Place one u-cup (13d) into groove in the ID. Press choke ring (13b or 13c) into bore. Press lip seal (13e), with seal facing outward into the bore with the retaining groove. Install retaining ring (13f).
14. Slide bushing cartridge assembly (13) over each of the shaft ends and push into bores and flush with endplate (12) surface.

15. Place spacer ring (28) over shaft and slide the ring toward the bushing cartridge assembly (13). **Note: See Section 11** for more information on alternative placement of the spacer ring.
16. Apply anti-seize compound to the OD of the four shafts in the ball bearing (15) area.
17. Slide ball bearing (15) until the shoulder of the bearing rest against the shoulder on the shaft and will not slide further. Tighten setscrews locking bearing in place.
18. Apply anti-seize compound to the OD of the ball bearings (15).
19. Place four o-rings (22) over the OD of each bushing cartridge assembly (13).
20. Slide three bearing caps (14) over the ball bearings (15), place the spacer ring (28) in the alignment bore of the bearing cap (14), then align the bearing cap (14) onto the bushing cartridge assembly (13). Taking care not to pinch o-ring (22).
21. Slide the bearing housing (16) over the ball bearing (15), place the spacer ring (28) in the alignment bore of the bearing housing (16) on the drive shaft (2), then align the bearing housing (16) onto the bushing cartridge assembly (13).
22. Secure all bearing caps (14) and bearing housing (16) with four socket head cap screws (19).
23. Install hex head cap screws (24) and washers (25) into bearing caps (14).
24. Install two packing rings (17) in bearing housing (16) bore. Stagger joints on each packing ring 180° apart. Rings must not be tamped or seated.
25. Slide packing nut (18) with over end of drive shaft (2).
26. Screw packing nut (18) into bearing housing (16) finger tight. Tighten  $\frac{1}{2}$  to  $\frac{3}{4}$  of one round then loosen to finger tight. See Section 11, **SHAFT SEALING**.
27. If equipped, attach and secure motor bracket (34) with four socket head cap screws (30).
28. Attach lock wire (18a) to packing nut (18) and bearing housing (16) or motor bracket (32).

## 10. PARTS LIST

---

1. Case Assembly
2. Drive Shaft
3. Idler Shaft
4. Drive Gear
5. Idler Gear
6. Case Gasket
8. Drive & Idler Key
9. Drive Key
10. Hollow Dowel Pin
11. Wearplate
12. Endplate
13. Bushing Cartridge Assembly
  - 13a. Bushing
  - 13b. Choke Ring
  - 13c. Extended Choke Ring
  - 13d. U-Cup Seal
  - 13e. Lip Seal
  - 13f. Retaining Ring
  - 13g. O-Ring
14. Bearing Cap
15. Ball Bearing
16. Bearing Housing
17. Packing Ring
18. Packing Nut
  - 18a. Lock Wire
19. Socket Head Cap Screw
20. Hex Head Cap Screw
21. Hex Head Cap Screw
22. O-Ring
23. NPT Plug
24. Hex Head Cap Screw
25. Washer
28. Spacer Ring
29. Socket Head Cap Screw
30. Socket Head Cap Screw
31. Rigid Coupling
32. Hydraulic Motor Bracket

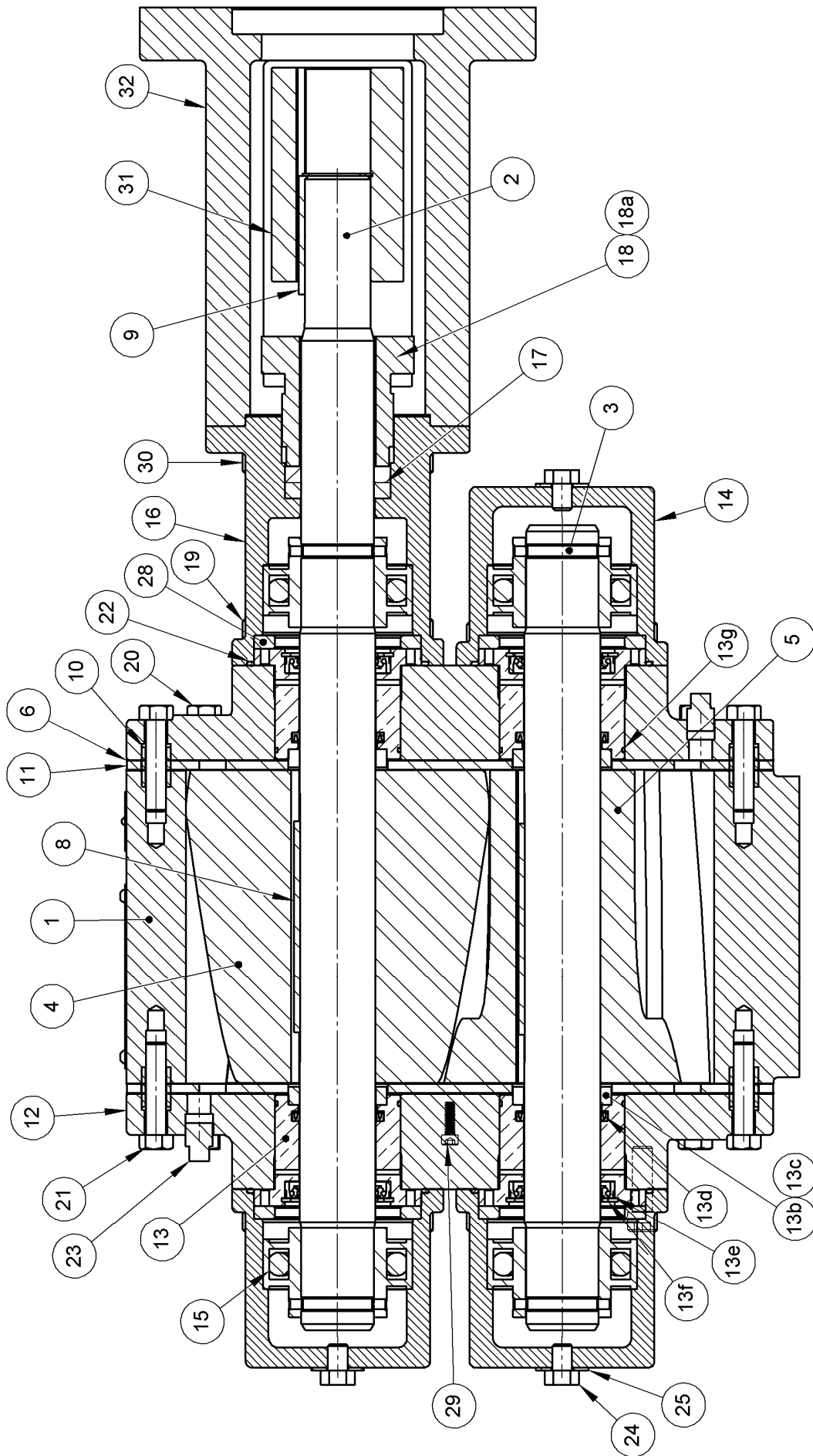


Figure 10.1

# 11. SHAFT SEALING

---

Internal seals within each bushing cartridge assembly (13) seal the shafts. Each cartridge contains a U-Cup (13d) seal and a high-pressure Lip seal (13e).

## Spacer Ring Placement:

Depending on the extent of a rebuild, the spacer ring (28) can be placed on either side of the flange on the bushing cartridge assembly (13). This will relocate the bushing cartridge assembly to allow the U-cup and Lip seal to seal on a new area of the shaft. From the factory the spacer ring will be located on the outer face of the bushing cartridge assembly (face closest to the ball bearing). See Fig 10.1 for reference.

Note: It is recommended when relocating the spacer ring (28) between the endplate (12) and bushing cartridge assembly (13) the bushing cartridge assembly is replaced with a special bushing cartridge assembly that has a extended choke ring (13c). Please, consult with the distributor or factory for questions.

## EMERGENCY BACK-UP, SHAFT PACKING

The pump is designed to not use the compression packing unless there is a failure within drive shaft bushing cartridges internal seals.

The emergency packing gland should remain loose until needed, in the event of an internal seal failure, stop the pump, remove the lock wire, tighten packing gland, and schedule the pump for maintenance.

Note: The packing gland can be tightened or loosened by a pipe wrench if there is no motor bracket. If there is a motor bracket, the packing gland can be tightened or loosened by using a phillips screwdriver or similar tool that will fit into the thru holes on the hex head end of the packing gland.

## STANDARD COMPRESSION PACKING

The 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.

## CARE OF PACKING

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.

The packing gland nut should be 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 nut should then be backed off until finger-tight.

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 nut. The gland nut 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.

## **12. LUBRICATION**

---

Pumps are fitted with lube fittings to all four bushing cartridge assemblies. Lubricate the bushings on a regular basis with any good quality bearing grease that is compatible with the product being pumped.

## **13. INDEX**

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