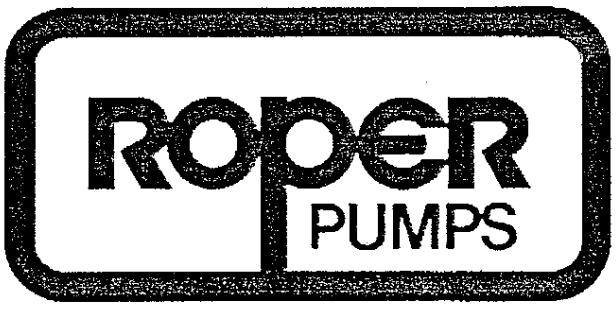
INSTALLATION AND OPERATION MANUAL FOR ROPER Z11, Z17, Z22 PUMPS



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PART NO. G12-240

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NOTE: BOLDFACE TOPICS CONTAIN IMPORTANT SAFETY INFORMATION

1. INTRODUCTION

! IMPORTANT

THIS MANUAL MUST ACCOMPANY THE PUMP UPON ALL TRANSFERRALS. MAKE SURE THE OPERATOR OF THE EQUIPMENT HAS READ AND UNDERSTANDS THIS MANUAL BEFORE OPERATING THE PUMP OR ANY RELATED EQUIPMENT.

When properly selected, installed, operated, and maintained, Roper pumps will provide long, dependable service. Remember, faulty selection and installation form the basis of more pump troubles than all other causes combined. No amount of maintenance can compensate for selection and installation mistakes. Read and understand this manual carefully before installing or operating this pump.

This pump is satisfactory for its rated conditions. Its operation beyond these conditions may subject it to stresses and strains that it is not designed to withstand.

Install ample coupling or belt guards for the protection of the personnel.

This manual will cover standard pumps and most spec. number pumps. Appearance may vary among pumps and construction may vary on spec. number pumps. Specification numbers are assigned to pumps with other than standard features. Roper produces specific manuals for most standard line pump models. Contact Roper to find out if the pump model you have has a specific manual and to request a copy.

If there is any question concerning the ratings, instructions, or compatibility of the pump with the pumped liquid, consult a Roper distributor or:

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! IMPORTANT

Read the following before starting the pump! Failure to heed these warnings may result in an accident causing physical damage, serious personal injury, or death!

- Read and understand all tags and installation and operating instructions.
- **WARNING!** Install proper guard(s). **NEVER** operate pump without guard(s) in place. Even with proper guard(s) installed, always use caution near rotating parts including the drive system for the pump.
- Know the operating conditions.
- Open all lines before starting pump.
- **WARNING! DO NOT** operate this equipment in excess of its rated capacity, pressure, speed, and temperature or other than according to the instructions contained in this manual.

- WARNING! Install and properly set devices into the system to prevent the chance of too much pressure, high temperature, and driver overload. The pump is not provided with these devices.
- WARNING! Proper measures and safeguards must be taken to avoid spillage and overflow from overfilling or putting too much pressure on any component of the system. This includes the receiver and lines.
- *These instructions cannot possibly cover every situation concerning the operation, inspection, adjustment, and test of the equipment furnished. Roper Pump Company must presume that the crew using this pump has ample knowledge and training to apply sound safety and operational practices that may not be mentioned.*

2. SAFETY PRECAUTIONS

WHEN LIQUID BEING PUMPED IS HAZARDOUS OR VOLATILE, ALWAYS TAKE FULL PRECAUTIONS. THIS INCLUDES THE RUN-IN PERIOD AND DURING DISASSEMBLY AND ASSEMBLY OF PUMP.

Controls, guards, walkways, machine arrangement, crew training, etc., are all necessary factors in the creation of a safe, practical installation and are generally not a part of our services. *It is the responsibility of the contractor, installer, owner, and user to add to the materials furnished by Roper to result in a safe installation and to comply with OSHA, state and local laws, and the ANSI Safety Code.*

There are many kinds of devices for pumps and systems such that if one component in a system is stopped, other equipment feeding or following it also can be automatically stopped. Serious thought should be given to the installation of these types of devices in every pump system.

- DO NOT attempt to install, operate, or perform maintenance on this equipment without first reading and understanding the material in this manual. Also, read and understand all tags and any other documentation accompanying the pump.
- DO NOT operate this equipment in excess of its rated capacity, pressure, speed, or temperature or other than according to the instructions contained in this manual.
- DO NOT continue to operate this equipment if there is a failure of any part of the equipment or system. Correct the failure before operating the equipment.
- DO NOT bypass safety controls or guards. Their purpose is to protect and they must be in proper working order.
- DO NOT operate equipment without proper guards in place.
- DO NOT walk, stand, sit, or lean on guards.
- DO NOT work on a pump while it is operating.
- DO NOT place hands, feet, head, or any other part of your body in any pump opening while the pump can be operated.
- DO NOT poke or prod material in the pump.

- **DO NOT** work on this equipment if there is the slightest chance of it becoming energized by accident. Lock out the energy source to the driver and disconnect the coupling before performing maintenance to the equipment.
- **DO NOT** wear loose or dangling clothing or jewelry near the equipment. It could become caught and possibly cause serious injury or death.
- **DO NOT** use metallic or hard faced striking tools when the need for tapping parts into position arises. Hard faced striking tools may damage parts or they may fracture or chip and send particles flying that could cause possible injury.
- **DO NOT** allow spills to remain in the work area. Clean up spills immediately. Oils, greases, and other fluids used in the equipment may create hazards if not cleaned up immediately after a spill.
- **DO NOT** spin bearings with compressed air. This is highly dangerous and can cause the bearing to fragment with explosive force possibly causing serious injury or death.
- **DO NOT** attempt to install, use, or repair this equipment while under the influence of any substance that may impair physical or mental abilities. This includes, but is not limited to, alcohol and prescription and nonprescription drugs.
- **DO NOT** dispose of fluoroelastomers by burning. Toxic vapors are released by this compound upon combustion.

- **DO** completely read and understand the information contained in this manual. The operator of the equipment must be familiar with these instructions.
- **DO** always keep safety in mind.
- **DO** know the operating conditions of the equipment.
- **DO** take proper measures and precautions to avoid spillage and overflow from overfilling or putting too much pressure on any component of the system.
- **DO** identify all possible hazards and decide what controls are needed. Remember, only you understand your product and system characteristics fully. *The ultimate responsibility for the application and safety is with you.*
- **DO** install and properly set devices into the system to prevent the chance of dry operation, overpressure, excessive temperature, and driver overload.
- **DO** provide guards for all exposed rotating parts, including parts of the drive system, to prevent possible injury.
- **DO** be careful when working near an operating pump. Contacting or getting caught in rotating parts could cause serious or fatal injury.
- **DO** keep equipment in good working order, especially safety devices and guards.
- **DO** be aware of your location relative to the equipment.
- **DO** wear proper clothing near the equipment. Safety glasses or goggles, and safety shoes are recommended. They will help reduce the chance of injury.
- **DO** use soft faced striking tools when the need for tapping parts into position arises. Rubber or plastic faced striking tools are recommended.

- DO practice good housekeeping. Clean up spills immediately. Keep the work area clean to avoid hazards. Always be sure of your footing around the equipment to avoid a possible fall and injury.
- DO use proper tools. Avoid *cheater* bars as they are a source for serious injury should they slip or break.

3. NAMEPLATE DATA

Roper identifies each pump manufactured by a metal nameplate attached to the pump. This nameplate describes how the pump was 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.

PUMP NUMBER: _____

SPEC NUMBER: _____

SERIAL NUMBER: _____

TYPE: _____

PUMP NOMENCLATURE

Example: Z22PS4ABH SPEC XXX TYPE 1 SERIAL ZZZ

1. The FIGURE number consists of a nine digit number.
   - The first digit (Z in the example) indicates the Z series gear pump.
   - The second and third digits (22) indicates the appropriate 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 fourth digit (P) indicates the type of faceplate on pump.

     P - Plain

     R - RV style relief valve

     E - EV style relief valve

- The fifth digit (S) indicates seal type.

  S - Single mechanical seal

  D - Double mechanical seal

  C - Cartridge seal

- The sixth digit (4) indicates port arrangement on case.

  3 - Right angle ports

  4 - Straight through ports

- The seventh digit (A) indicates style of port on case.

  F - Roper flange

  T - Threaded ports on case

  A - ANSI flange

- The eighth digit (B) indicates the head arrangement of the pump.

  N - No outboard ball bearing

  B - Outboard ball bearing

  O - Outboard ball bearing auxiliaries mounting provisions

- The ninth digit (H) indicates the final unit.

  G - Gearbox built on

  J - Direct hydraulic drive built on

  H - Bare pump without accessories

  M - Mounted pump and accessories

NOTE: The preceding description of the figure number is to assist in identifying your Roper "Z" 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 a Roper distributor or Roper Pump Company.

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 a Roper distributor or Roper Pump Company.

3. The TYPE number is a number used by Roper 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, Serial, and Type numbers so proper identification of the pump can be assured.

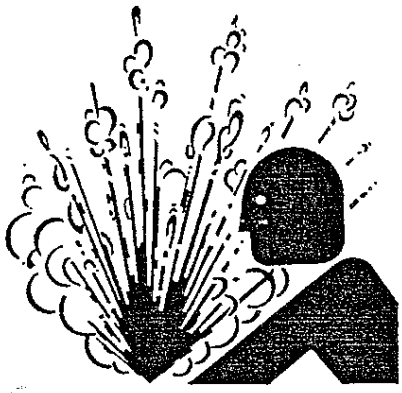
4. PREOPERATION CHECKS

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

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. The driver rotation test must be done with the driver and pump disconnected. When a relief valve is used, make sure it is positioned and adjusted as discussed in Section 10. 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 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 refer to the section on Checking Pump Performance. 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 conform to specifications.



WARNING! Do not overpressurize pump or system.

! WARNING

If there is no pressure relief device in the system, NEVER block the discharge line. High pressure will occur, resulting in possible damage or breakage to the pump or system parts and possible injury to personnel. Even with a pressure relief device in the system, do not operate the pump for more than one minute with the discharge line blocked. 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.

5. PREPARATION OF FOUNDATION

Locate the pump so that it is as low and as close to the fluid source as practical and so that piping to and from the pump will be as short and simple as practical. The pump and its driver must be accessible for inspection and maintenance. Accessibility to the unit and adequate clearance should be a major thought in any installation. The driver must be suitable for the environment (for example; open, splash proof, totally enclosed, or explosion proof electric motor). If the driver is not suitable, choose a different location or obtain another driver.

For best pump-driver unit life, mount each unit on a strong, fabricated, structural steel baseplate with a proper foundation. A good foundation is of major importance to the total installation. A thick, heavy concrete foundation is best since it is heavy enough to support the baseplate rigidly and absorb strain and shock. Locate anchor bolts for the baseplate in the foundation. Use a pipe sleeve, two to three times as large as the anchor bolts, around the anchor bolts to allow some lateral bolt movement during final positioning of the unit.

Place the unit, with the pump and driver mounted on the baseplate, on the foundation and disconnect the coupling (flexible coupling, belts and sheaves, etc.). **DO NOT** reconnect the coupling until all alignment operations are complete. Support the baseplate on rectangular metal blocks and shims or on metal wedges having a small taper. Place the support pieces close to the anchor bolts and directly under the part of the baseplate carrying the greatest weight. Space the support pieces close enough to give uniform support. Allow a gap of about 3/4 inch to 1-1/2 inches between the foundation and baseplate for grouting. Refer to Fig. 1.

Adjust the metal supports or wedges until the shafts of the pump and driver are level. At this time, check the faces of the inlet and discharge connections of the pump for horizontal or vertical position using a level. Correct the positions, if necessary, by adjusting the supports or wedges under the baseplate as required.

For maximum rigidity and lower noise levels, grout the baseplate to the foundation. Use a good grade of nonshrink grout. When all alignments are correct (refer to section on Aligning Driver and Pump), tighten the anchor bolts evenly but not too firmly. Then grout the unit to the foundation. Completely fill the baseplate with grout. It is desirable to grout the leveling pieces, shims, or wedges in place. Fill the spaces between the anchor bolts and sleeves with grout, also. Allow the grout to dry according to the manufacturer's instructions. **DO NOT** fully tighten the anchor bolts until the grout has hardened.

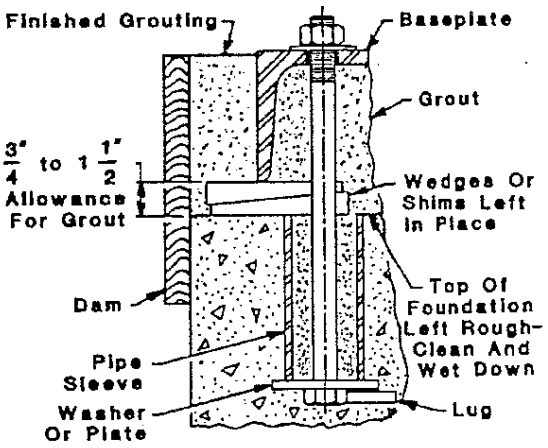


Fig. 1: Typical Baseplate Anchoring

After the grout has hardened and the anchor bolts have been properly tightened, check the unit for parallel and angular misalignment, and if necessary, take corrective measures. After the piping to the unit has been connected, check the alignment again.

NOTE: Attempts to correct alignment in one direction may alter the alignment in the other direction. Therefore, it is necessary to check alignment in all directions after making any adjustments.

Schedule semiannual inspections and checks of the foundation anchor bolts as part of a preventive maintenance program. If loose foundation bolts are found, tighten them and check the unit alignment.

Normal mounting for this pump is horizontal with the pump above the baseplate, properly grouted to a concrete foundation placed in or on solid earth. Mountings other than described above (such as vertical mounting, wall mounting, ceiling mounting, etc.) may require special components and precautions. Extra pump supports, special drivers, extra anchor bolts may be necessary in unusual mountings. If your

application requires other than normal mounting, as described above, you are urged to consult Roper Pump Company for assistance in determining any special needs that may be required.

6. ALIGNING DRIVER AND PUMP

Driver and pump units built at Roper are factory aligned before shipment. **Still, the flexible coupling or belts and sheaves must be accurately realigned during and after installation.** Refer to the flexible coupling or belt and sheave manufacturer's recommendations and instructions for the requirements for proper alignment. Also refer to the section on Preparation of Foundation for additional information.

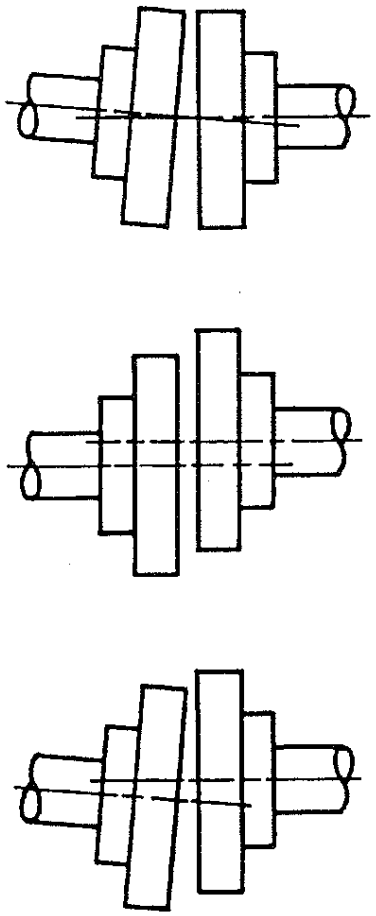


Fig. 2: Misalignments: Top, Angular; Center, Parallel; Bottom, Both.

FLEXIBLE COUPLING

DO NOT use a flexible coupling to compensate for misalignment of the driver and pump shafts. The purpose of the flexible coupling is to compensate for temperature changes and to permit end movement of the shafts without interference with each other while transmitting power from the driver to the pump.

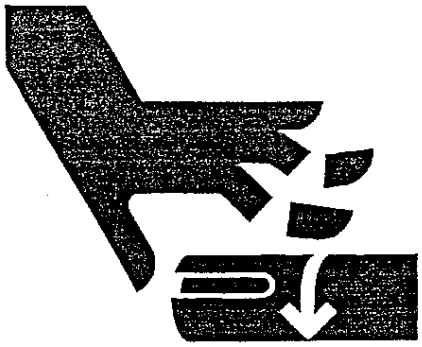
The faces of the coupling halves should be spaced far enough apart so that they cannot strike each other when the driver rotor is moved hard over toward the pump. Allowance should be made for wear of the thrust bearings. The necessary tools for *approximate* checking of the alignment of a flexible coupling are a straight edge and a taper gauge or a set of feeler gauges.

There are two forms of misalignment between the driver shaft and the pump shaft. The first is angular misalignment, where the axes of the shafts are concentric but not parallel. The other is parallel misalignment, where the axes of the shafts are parallel but not concentric. Refer to Fig. 2.

Make the check for angular alignment by inserting the taper gauge or feeler gauges between the coupling faces and comparing the distance between the faces at four points spaced at 90° intervals around the coupling. The unit will be in angular alignment when the measurements show that the coupling faces are the same distance apart at all points.

Make the check for parallel alignment by placing a straight edge across both coupling halves at the top, bottom, and at both sides. The unit will be in parallel alignment when the straight edge rests evenly on the coupling halves at all positions. Allowance may be necessary for temperature changes and for coupling halves that do not have the same outside diameter. Take care to have the straight edge parallel to the axes of the shafts.

Correct angular and parallel misalignment by placing shims under the mounting feet of the equipment. After each change, it is necessary to recheck the alignment of the coupling halves. Adjustment in one direction may disturb adjustments already made in another direction.



WARNING! Do not operate without guards in place.

! WARNING

Make sure there is no chance of the driver becoming energized while aligning driver and pump. Getting caught in rotating parts of the drive system may cause serious personal injury or death. Do not start or operate pump without guards in place.

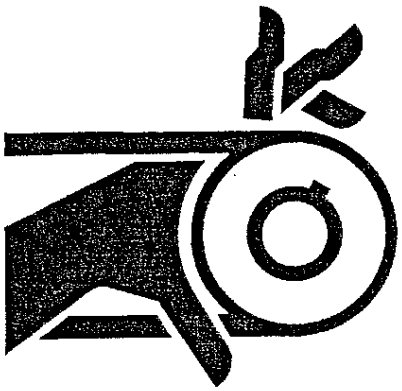
BELTS AND SHEAVES

Some applications involving low discharge pressure and slow speeds may permit the mounting of the driven sheave directly on the pump shaft. However, it is recommended that all belt drive assemblies be designed with a separate jackshaft mounted on pillow blocks to carry the side loads of the sheaves and belts and a flexible coupling connecting the jackshaft to the pump shaft.

The driver and pump shafts must be parallel, and the belts at right angles to these shafts. Misalignment will cause undue belt wear, or turn-over in the grooves. *Approximate* alignment should be checked by placing a long straight edge evenly across the rims of both sheaves. If the faces of the sheaves are not of equal width, the alignment may be checked by resting the straight edge across the rim of the widest sheave and measuring the distance from the straight edge to the nearest belt groove with a scale. Adjust either sheave on the shaft to equalize these dimensions.

The driver should be mounted with adequate provision for belt center distance adjustment. Provide a minus adjustment to permit belt installation without stretching and a plus allowance to provide belt take-up.

DO NOT pry, twist, or force the belts over the sheave grooves. This will damage the belts and greatly reduce the belt life. Shorten the drive by moving the driver enough to permit fitting the belts in the proper grooves. When the belts are in place, increase the center distance until proper belt tension is obtained. Adjust take-up until only a slight bow appears on the slack side of the drive when it is operating. All the belts must be pulling evenly. Belt tension should be reasonable. It is not necessary to have belts excessively tight.



WARNING! Do not operate without guards in place.

! WARNING

With guard removed, visually inspect belts only. Align or adjust belts with energy source to driver locked out to prevent operation. Getting caught in rotating parts of the drive system may cause serious personal injury or death. DO NOT start or operate pump without guards in place.

During the first few days of operation, the belts will seat themselves in the sheave grooves. After that, the drive must be adjusted to take up the slack. Slipping belts will result in lowered capacity. Squealing or smoking belts are sometimes a clue to the slipping of belts but not always.

Keep belts clean and free from oil. Clean oily belts with a cloth dampened with soap and water. Stop drive to clean belts. **DO NOT** attempt to clean belts while the drive is operating. Never install new belts on the same drive with used belts. **DO NOT** use sheaves with chipped or worn grooves. For hazardous locations, check to see if an antistatic belt should be used. When purchasing replacement belts, the same size and type should be ordered as furnished originally.

7. ADDITIONAL IMPORTANT WARNINGS AND INFORMATION

- *This manual cannot possibly cover every situation concerning the use, inspection, adjustment, and test of the pump furnished. Roper must presume that the crew using this pump have ample knowledge and training to apply sound safety and operating practices that may not be mentioned.*
- Roper pumps are general purpose pumps for a wide range of uses; yet, *they are not designed nor intended for use with every known substance.* It is, therefore, not practical to include performance or maximum ratings in this manual. Roper sales brochures contain standard ratings for the type of pump involved. If you do not have ratings or performance properties for your pump, they may be obtained by contacting a Roper distributor or Roper Pump Company.
- Review this manual to figure out the proper union of the pump into the total plant or system operating programs.
- *Roper does not supply, recommend, or approve the systems in which its pumps are or may be used.* Unless designed, built, and used properly, systems may be unsafe or dangerous. You should check and comply with all federal, state, local, and other regulations and recommendations such as: NFPA, UL, OSHA, API, etc.

In particular, you must check the pumped liquid properties and take proper precautions. Among other things, consider the following:

- Decide the results of spillage or leakage (all pumps or systems may fail sometime).

_____ Explode	_____ Toxic
_____ Corrode	_____ Fire
_____ Chemical Burn	_____ High Temperature
_____ High Pressure	_____ Other

- Are you using proper safeguards?

_____ Temperature Controls

_____ Pressure Controls

_____ Leak Detectors

_____ Shutoff Devices

_____ High or Low Pressure Safeguards

_____ Alarm Devices

_____ Overfill or Overflow Detection

_____ Driver Overload Controls

_____ Consider all possible methods and series of failure.

_____ Are any other methods needed to control a hazard?

_____ Regular scheduled inspection for the wear and tear of parts.

- Identify all possible hazards. Decide upon and install the required controls. Only you, the user, understand your product and system properties fully. *The ultimate responsibility for the application and safety is with you.*
- Particularly note the chance of fire and burns from flammable or hot liquid spillage from burst hoses and take proper precautions.

- Properly guard all exposed rotating parts of the drive to the pump.
- Install a pressure relieving device in the system discharge piping to protect the equipment and crew from accident due to too much pressure. Read Section 4 on Preoperation Checks; page 6.
- Spillage or overflow, from overfilling or putting too much pressure on any component of a system incorporating this pump, may result in an accident. Proper measures and precautions must be taken to avoid spillage or overflow from overfilling or putting too much pressure on any component of the system. This includes the receiver and lines.
- Roper continually updates its manuals; therefore, you should periodically request an updated copy or check that you have the latest edition.

Prior to starting pump, read sections on Preparation of Foundation; Aligning Driver and Pump; Installation of Pipes; Threaded Port Connections; and Preoperation Checks. These sections may be found elsewhere in this book.

WARNING! Do not operate without guards in place.

! WARNING

ROTATING PTO DRIVE SHAFTS

- DO be careful when working near a rotating PTO drive shaft. Contacting or getting caught in the drive shaft can cause serious injury or death.
- DO install proper guard for exposed PTO drive shaft after installation.
- DO NOT work on pump or PTO drive shaft while the driver is rotating.

GUARDING PTO DRIVE SHAFTS

The proper installation of the power take-off and its associated equipment and the decision to install proper guards is left entirely up to the designer and the installer. The product applications and the exposure to danger of the operators are beyond control and knowledge of Roper Pump Company.

If a PTO drive shaft is used, provide proper guarding.

A Roper hydraulic drive system may be used to eliminate the exposed PTO drive shaft. If a PTO drive shaft is used, provide proper guarding.

8. INSTALLATION OF PIPES

- DO NOT connect raised face flanges to the ports of a cast iron pump.
- DO use flat faced flanges with cast iron pumps.

Piping must be installed and checked carefully. Allow for any expansion or contraction.

Any external force or moment (torque or twist) applied on the pump ports by the piping will cause stresses in the pump and its foundation. This may cause misalignment that could result in hot bearings, worn couplings, or excessive vibration. Such forces or moments may be caused by improperly aligned piping or by thermal expansion of the piping when pumping hot or cold fluids. The piping should be supported independently. Use flexible piping connectors and insure that they are properly anchored.

If an expansion joint is installed in the piping between the pump and the nearest point of anchor in the piping, a force equal to the area of the expansion joint (which may be considerably larger than the normal pipe size) times the pressure in the pipe will be transmitted directly to the pump. Pipe couplings that do not provide an axially rigid connection have the same effect. This reaction force can be so large that it would be impractical to design suitable components to withstand the force. If an expansion joint or nonrigid coupling is used, install a pipe anchor between it and the pump. If properly installed, this will eliminate the forces mentioned above.

The pump port size does not necessarily establish the correct pipe size. Piping must be sized and arranged to provide ample inlet pressure at the pump and to insure that the discharge pressure will be at least as low as the rated pressure of the pump. If the fluid to be pumped is viscous, or the piping long, or the suction lift or static discharge head somewhat high, piping one or two sizes larger may be required. Friction losses should be carefully calculated (see Hydraulic Institute Pipe Friction Manual or similar authority for friction loss data) and compared to the pump ratings before the installation is made. Where valves are used in the piping system, gate, ball, or butterfly valves are preferable to globe or angle valves. 90° long radius elbows or 45° elbows are preferable to standard short radius elbows.

9. THREADED PORT CONNECTIONS

American National Standard Taper Pipe Threads (NPT) are standard for pipe plugs and threaded ports of the pump. British Standard Pipe Threads (BSP) are available on request for most sizes.

To produce a pressure tight joint, a thread sealant must be used. TFE tape is generally not recommended where cast iron is used as one or more parts of the joint. The use of TFE tape for installing cast iron fittings may cause damage to the pump or fittings.

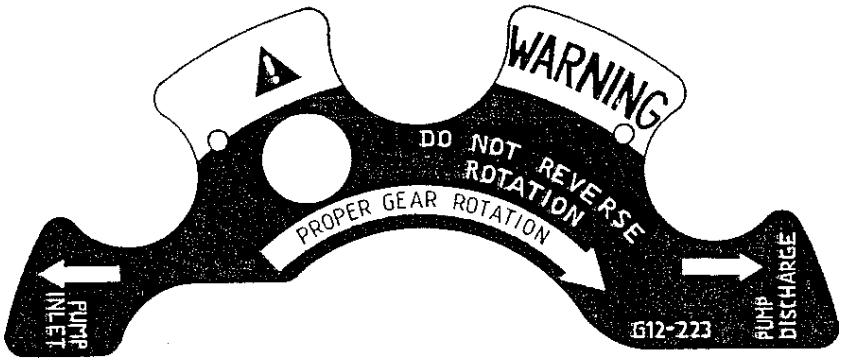
The following is a partial list of sealants that may be used when making up joints on the pump:

- PST Pipe Sealant No. 567 - Loctite Corp.
- Rectorseal No. 5 - The Rectorseal Corp.
- Leak Lock - Highside Chemical, Inc.

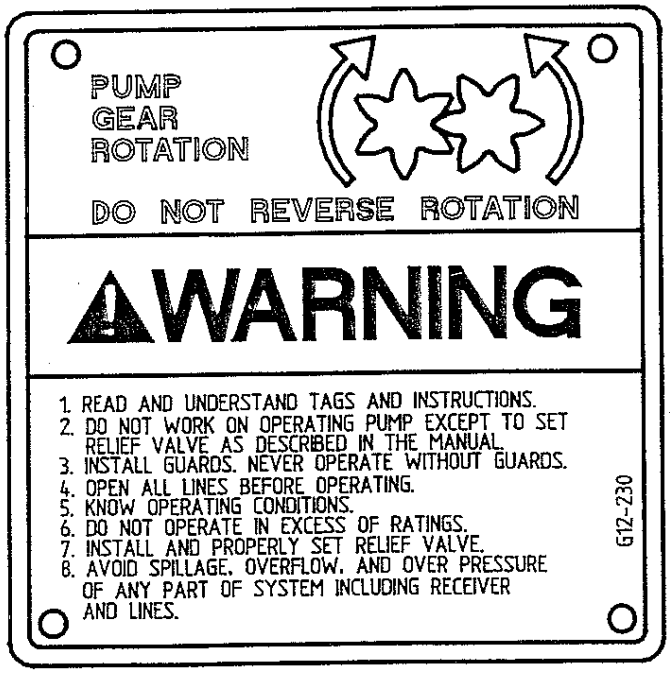
Follow the sealant manufacturer's instructions when making up a joint.

10. DIRECTION OF ROTATION AND RELIEF VALVES

DIRECTION OF ROTATION TAGS

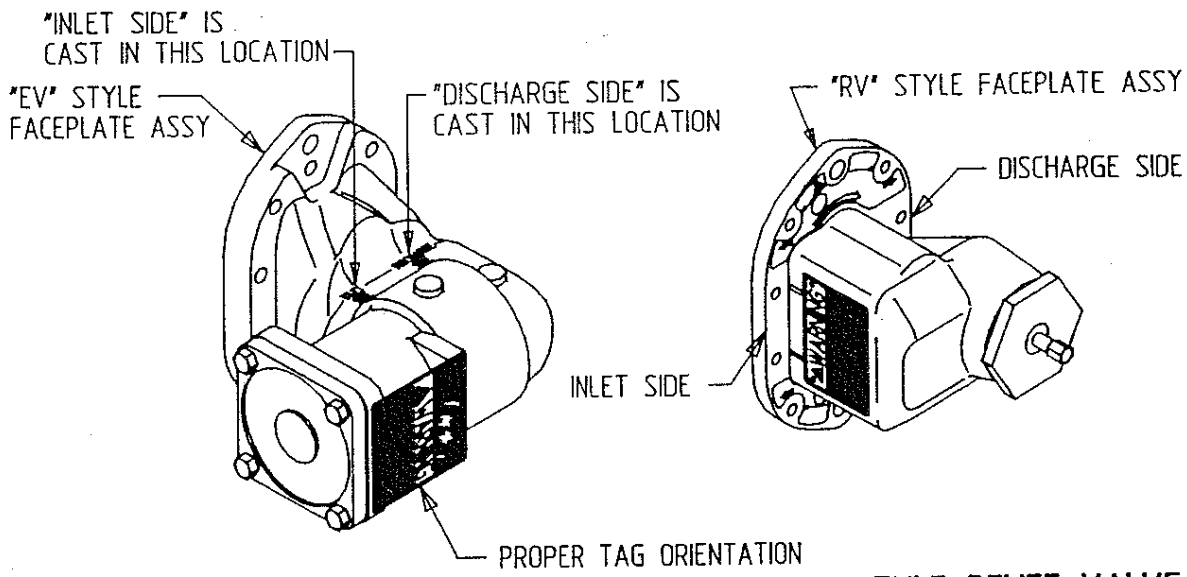


TYPICAL DIRECTION OF ROTATION TAGS FOUND ON RV STYLE RELIEF VALVES



TYPICAL DIRECTION OF ROTATION TAG FOUND ON EV

RECOGNIZING THE RELIEF VALVE TYPES



PROPER GEAR ROTATION or PUMP GEAR ROTATION

Gear rotation is determined when viewing the pump from the faceplate end.

DO NOT REVERSE ROTATION

- **WARNING!** 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

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.

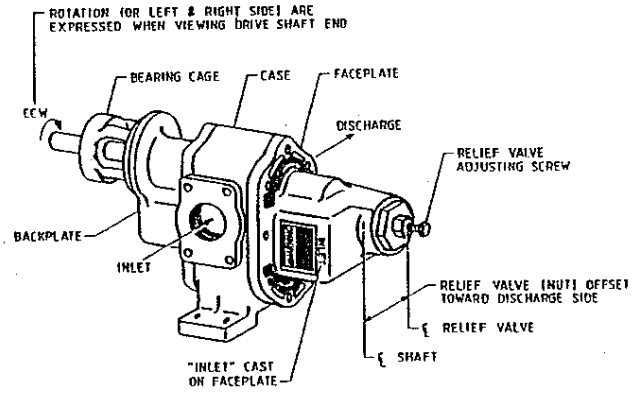
A built-in relief valve should not be used on applications where the discharge must be closed for more than one minute. Prolonged operation of the pump with the discharge closed will cause heating of the liquid circulating through the relief valve, thus resulting in possible damage.

For inlet pressures over 25 psig [172.4 kPa], consult a Roper distributor or Roper Pump Company, Commerce, GA.

DIRECTION OF ROTATION FOR THE RV STYLE RELIEF VALVE

To determine the correct relief valve position for any of the pump orientations shown in the DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE RV STYLE RELIEF VALVE drawings on page 16:

1. Find the group of drawings with the proper drive shaft position (high or low). 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 drawings.
3. In the drawings remaining, find the group of drawings with the proper port positions (straight through or right angle). CW indicates clockwise rotation and CCW indicates counterclockwise rotation when viewed from the drive shaft end of the pump. 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.



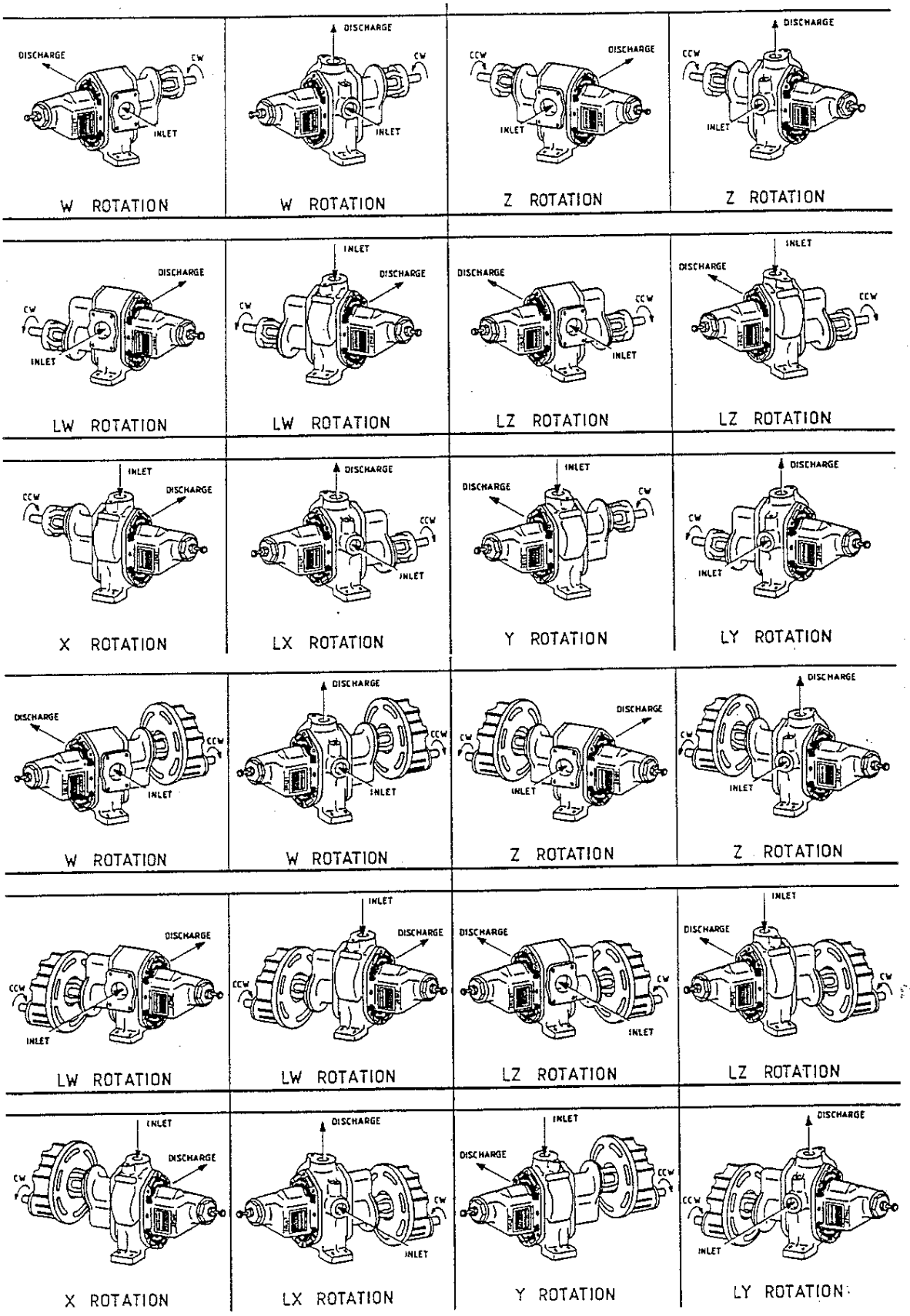
The drawings showing DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE RV STYLE RELIEF VALVE and position of relief valve with the letter "L" in the designation are for low drive applications (the drive shaft is lower than the side port). All other drawings shown on page 16 are for high drive applications (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 (viewed from drive shaft end of pump).

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.

DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE RV STYLE RELIEF VALVE



CHANGING THE RV STYLE RELIEF VALVE POSITION

- **WARNING!** Liquid 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 liquid may do.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Relieve all internal liquid/air pressure inside the pump before disassembly.
- **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 can cause injury or death if released suddenly.

You should have already checked the drawings on page 16 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 your relief valve.

The plain or "RV" style relief valve faceplate assembly can be removed to service pump internals by removing two washer head cap screws (K) and eight washer head cap screws (L).

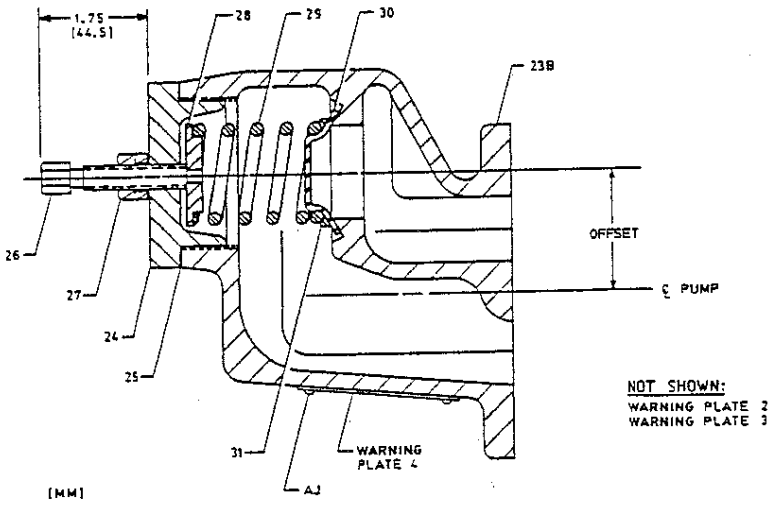
DISASSEMBLY OF RV RELIEF VALVE

- **WARNING!** Liquid 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 liquid may do.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Relieve all internal liquid/air pressure inside the pump before beginning disassembly.
- **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 can cause injury or death if released suddenly.

1. Turn off pump and lock out energy source to driver.
2. Close inlet and discharge valves.
3. Drain pump by removing lower pipe plug (S) from faceplate (23B). When draining pump, use necessary precaution with liquid being pumped to avoid possible injury or death.
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 the faceplate (23B).
6. Remove spring (29), poppet (30), spring washer (31), and spring guide (28).
7. Inspect all parts and replace worn or damaged parts as required. Read section on Replacement Parts.

ASSEMBLY OF RV 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 the 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 the steps below on how TO ADJUST THE RV STYLE RELIEF VALVE.



RV STYLE RELIEF VALVE

TO ADJUST THE RV STYLE RELIEF VALVE

- **WARNING! DO NOT** proceed with the relief valve adjusting procedure without guards in place.
- **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.

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

1. Connect a pressure gauge near the pump in the discharge line between the pump and the point where the discharge line will be closed. (Most pumps have tapped and plugged holes in the case near the outlet or in the discharge flange which may be used for this connection.)
2. Loosen the locknut (27) on the adjusting screw (26).
3. Back the adjusting screw (26) out to the point where the end of the adjusting screw will be 1-3/4 inches (44.5 mm) from the plug cap (24). (See RV style relief valve drawing.)

4. Start pump and close the discharge line slowly. **DO NOT** exceed pressure rating of pump or other equipment between pump and discharge line valve. If this pressure is reached while closing the discharge valve, **DO NOT** close any further. **DO NOT** run pump with 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 the pressure gauge shows the desired pressure setting.
6. Tighten locknut (27).
7. Open discharge line and turn off pump.

Relief valve is now set.

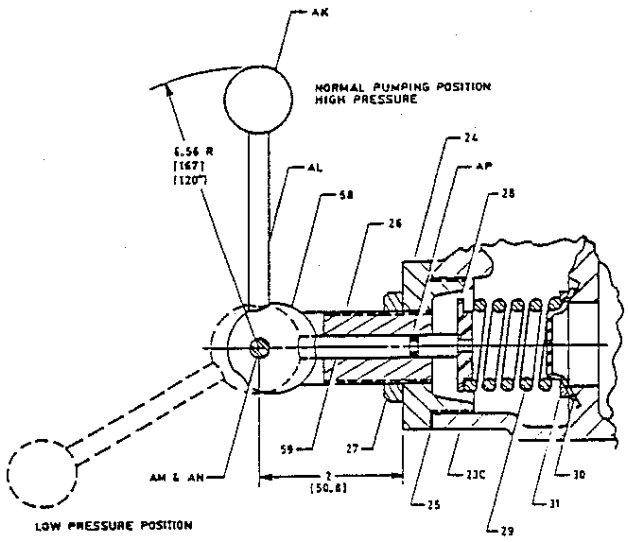
DISASSEMBLY OF DOUBLE SETTING RV STYLE RELIEF VALVE

- **WARNING!** Liquid 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 liquid may do.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Relieve all internal liquid/air pressure inside the pump before beginning disassembly.
- **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 can cause injury or death if released suddenly.

1. Turn off pump and lock out energy source to driver.
2. Close inlet and discharge valves.
3. Drain pump by removing lower pipe plug (S) from faceplate (23B). When draining pump, use necessary precaution with liquid being pumped to avoid possible injury or death.
4. Loosen lock and seal nut (27). Decrease pressure on spring (29) by turning the adjusting screw (26) clockwise until it turns freely.
5. After decreasing the pressure on the spring (29), remove the relief valve cap (24) by unscrewing it from the faceplate (23B).
6. Remove spring (29), spring guide (28), poppet (30), and spring washer (31).
7. Remove the operating piston (59). Replace O-ring (AP) if required.
8. After several pump disassemblies, it is necessary to change the locking seal nut (27). Remove the adjusting screw (26) from the relief valve cap (24). Remove locking seal nut (27) from the 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 the adjusting screw (26) except if parts need replacement.
10. Inspect all parts and replace all worn or damaged parts as required. Read section on Replacement Parts.

ASSEMBLY OF DOUBLE SETTING RV STYLE RELIEF VALVE

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 I. D. of spring (29).
4. Turn the adjusting screw (26) down into the relief valve cap (24) with lever in high pressure position. Move lever to the low pressure position; this should leave the operating piston (59) out past the edge of the 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 the double setting relief valve mechanism by the adjusting screw (26) and ball handle (AK).
6. Hold the adjusting screw (26) and turn the relief valve cap (24) to engage it into the threads of the faceplate (23B).
7. Tighten relief valve cap (24), but **DO NOT** allow adjusting screw (26) to come out of the relief valve cap or engagement of operating piston (59) in spring guide (28) will be lost.
8. Adjust relief valve by following the steps below on how TO ADJUST THE DOUBLE SETTING RV STYLE RELIEF VALVE. Tighten lock and seal nut (27). Check operation of lever.



TO ADJUST THE DOUBLE SETTING RV STYLE RELIEF VALVE

- WARNING! Take necessary precautions to prevent injury or physical damage that could be caused by any loss of the product being pumped while adjusting the relief valve.

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

1. Connect a pressure gauge near the pump in the discharge line between the pump and the point where the discharge line will be closed. (Most pumps have tapped and plugged holes in the case near the outlet or in the discharge flange which may be used for this connection.)
2. Loosen the lock and seal nut (27) on the adjusting screw (26).
3. Back the adjusting screw (26) out to the minimum setting by turning the ball handle (AL) counterclockwise to the point where the hex head cap screw (AN) in the adjusting screw (26) will be 2 inches (50.8 mm) from the relief valve cap (24). (See double setting relief valve drawing.)
4. Move the ball handle (AL) to the normal pumping position as shown on the drawing on page 20.
5. Start pump and close discharge line slowly. **DO NOT** exceed pressure rating of pump or other equipment between pump and discharge line valve. If this pressure is reached while closing the discharge valve, **DO NOT** close any futher. **DO NOT** run pump with closed discharge line for more than one minute at a time.
6. With discharge valve closed and using ball handle (AL), turn adjusting screw (26) clockwise until pressure gauge shows the desired pressure setting.
7. Tighten lock and seal nut (27).
8. The relief valve is now set at the desired high pressure setting.
9. Move the ball handle (AL) to the low pressure setting as shown on page 20 and note the low pressure setting.
10. Open discharge line and turn off pump.

Relief valve is now set.

CONVERSION FROM RV STYLE RELIEF VALVE TO DOUBLE SETTING RV STYLE RELIEF VALVE

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

DIRECTION OF ROTATION FOR EV STYLE RELIEF VALVE

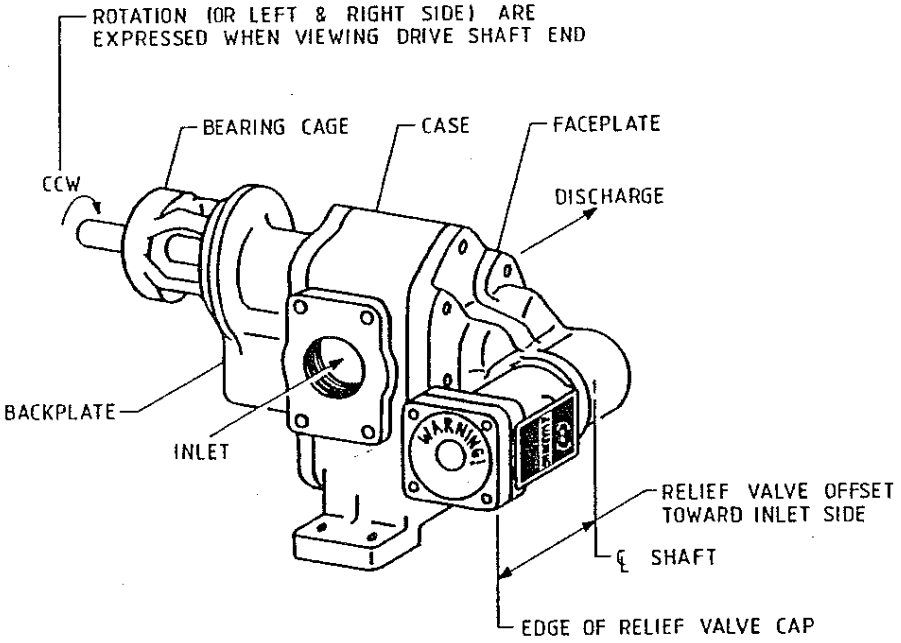
To determine the correct relief valve position for any pump of the pump orientations shown in the DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE EV STYLE RELIEF VALVE drawings on page 23 :

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 drawings.

3. In the drawings remaining, find the group of drawings with the proper port positions (straight through or right angle). CW indicates clockwise rotation and CCW indicates counterclockwise rotation when viewed from the drive shaft end of the pump. 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. The "EV" style relief valve assembly is marked with "INLET SIDE" and "DISCHARGE SIDE." The word "INLET SIDE" must be on the inlet "side" of the pump 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.

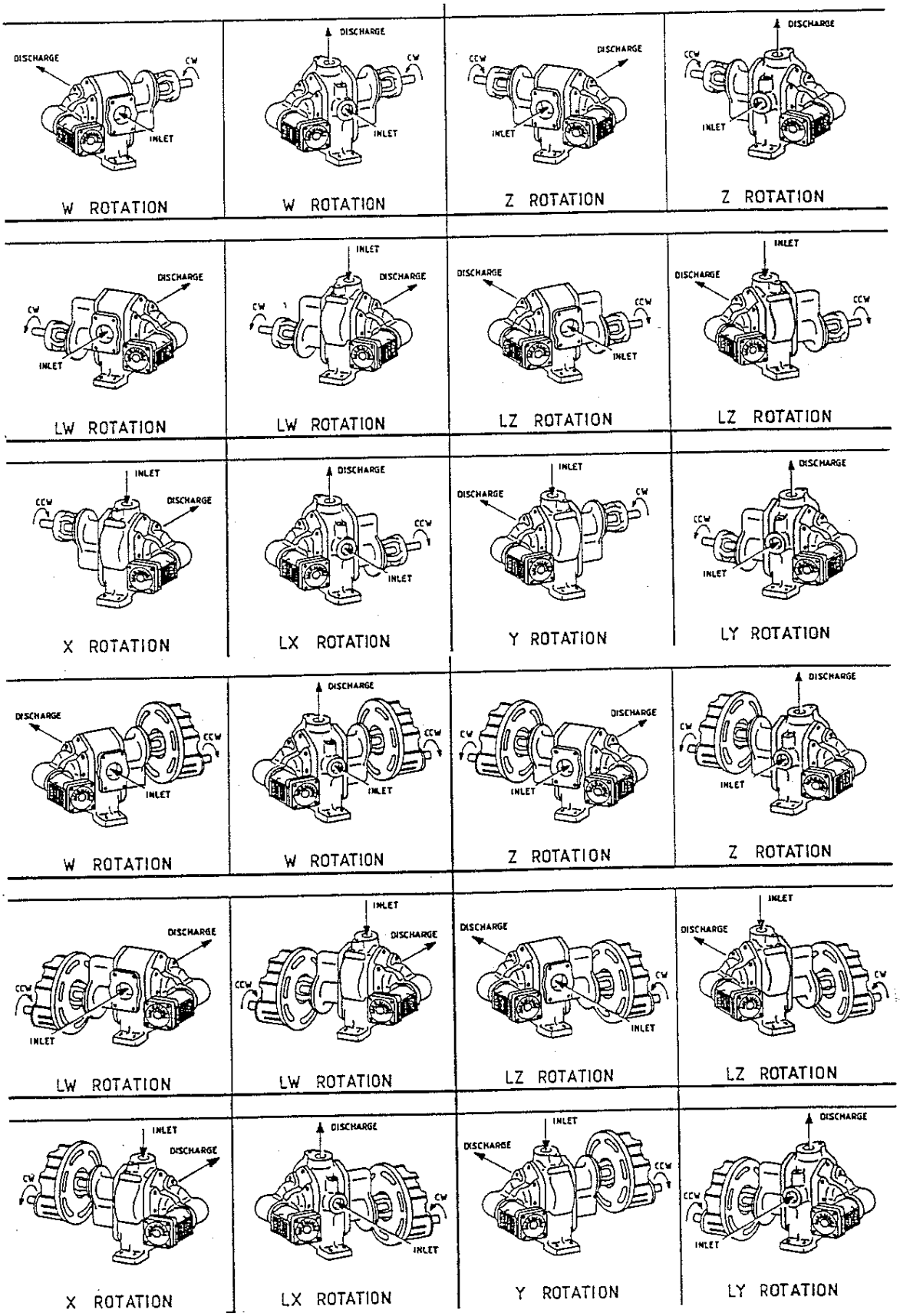


The drawings showing DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE EV STYLE RELIEF VALVE and position of the relief valve with the letter "L" in the designation are for low drive applications (the drive shaft is lower than the side port). All other drawings shown on page 23 are for high drive 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 (viewed from drive shaft end of the pump).

- **WARNING! DO NOT** operate a pump with a relief valve that is not positioned correctly. The relief valve will be inoperable. This can cause 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.

DIRECTION OF ROTATION FOR PUMP CONFIGURATIONS USING THE EV STYLE RELIEF VALVE

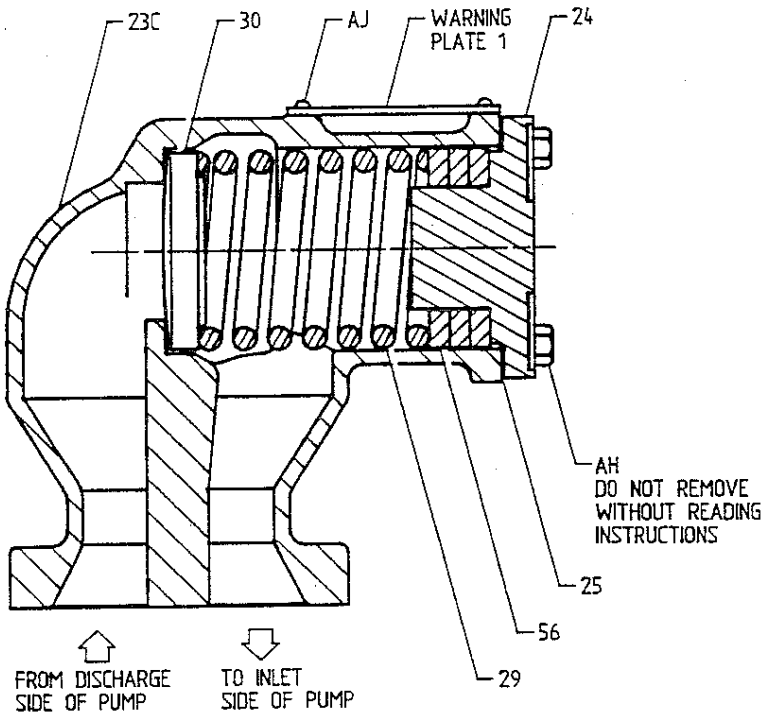


CHANGING EV STYLE RELIEF VALVE POSITIONING

- **WARNING!** Liquid may spill out of the pump when the relief valve faceplate (23C) is removed. Take all necessary precautions to protect yourself, others, and the nearby area from any harm this liquid may do.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Relieve all internal liquid/air pressure inside the pump before beginning disassembly.
- **WARNING! DO NOT** remove the relief valve cap (24) or any of the bolts (AH) that hold it in place without reading the instructions on page 26 for disassembling the valve. The relief valve contains a powerful compressed spring (29) that can cause injury or death if released suddenly.

You should have already checked the drawings on page 23 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 your relief valve.

The "EV" type faceplate assembly may be removed from the pump following the same procedure used on the "RV" or plain faceplates to service the pump internals.



EV STYLE RELIEF VALVE

CHECKING THE PRESSURE SETTING OF THE EV STYLE RELIEF VALVE

There is no external adjustment on the "EV" type relief valve. The pressure setting can only be changed by carefully uncompressing the spring inside by following the instructions below and removing the relief valve cap (24). Metal shims (56) may then be placed between the end of the spring (29) and the relief valve cap (24). With

none of the shims in place, the relief valve will open at approximately 73 psi [503.3 kPa] differential pressure between inlet and discharge. With one shim, the relief valve will open at approximately 87 psi [599.8 kPa] differential. With two shims, the relief valve will open at approximately 101 psi [696.4 kPa] differential. With three shims, the relief valve will open at approximately 116 psi [799.8 kPa] differential. **NEVER** put more than three shims in the relief valve. **NEVER** modify or make shims (56).

Standard "EV" type relief valves are originally built with three shims installed for an opening pressure of approximately 116 psi [799.8 kPa] differential pressure. This is the pressure at which the relief valve begins to open and let liquid flow from the discharge side of the pump back to the inlet side of the pump. At this point, the liquid flowing through the relief valve will be a small percentage of the total pump flow. If the resistance to flow downstream of the pump increases, a higher percentage of total pump flow will go through the relief valve. When the system downstream of the pump is completely blocked, the entire output of the pump will be circulating through the relief valve. The pressure on the discharge side of the pump may be different at this point from the opening pressure of the relief valve. With high flow rates or very viscous (thick) liquids, the discharge pressure of the pump will tend to be higher than the opening pressure of the relief valve when the discharge line from the pump is completely blocked. With low flow rates or low viscosity (thin) liquids, the discharge pressure of a pump with a blocked discharge may actually be less than the opening pressure of the relief valve.

- **WARNING!** You must test the pump, as installed in your system, on the most viscous (thickest) liquid that you will be pumping and at the highest speed at which the pump will run. This is to make sure that when the discharge line is completely blocked, the discharge pressure is not above the rated pressure of the pump or any system components downstream of the pump. To do this test, you need a way to gradually block off the discharge line such as a valve downstream of the pump, and a way to measure the discharge pressure at the pump such as a pressure gauge at the pump's outlet. With the pump running at the highest speed on the most viscous (thickest) liquid that will be pumped, gradually block the discharge line while closely watching the discharge pressure of the pump. **IF AT ANY TIME THE DISCHARGE PRESSURE IS EQUAL TO OR GREATER THAN THE RATED PRESSURE OF THE PUMP OR ANY SYSTEM COMPONENTS DOWNSTREAM, STOP THE PUMP IMMEDIATELY, UNBLOCK THE DISCHARGE LINE,** and follow the instructions on page 26 to set the relief valve to a lower opening pressure. You may leave the relief valve pressure setting as it is if you meet all of the following:

  You are running at fastest speed

  AND

  You are running thickest liquid

  AND

  You can block discharge line

  AND

  Pressure is less than maximum allowable system pressure

  AND

  Pressure is less than maximum allowable pump pressure.

CHANGING THE RELIEF VALVE PRESSURE SETTING AND DISASSEMBLING THE RELIEF VALVE

- **WARNING!** There is a very powerful compressed spring (29) inside the relief valve assembly. Releasing this spring suddenly could result in injury or death. To disassemble the relief valve or to change its pressure setting, you must uncompress the spring in a controlled way by following the steps below. Unscrewing the four bolts (AF) which hold the relief valve cap (24) in place will release this spring.
- **WARNING!** When you remove the relief valve, liquid may spill out. Take all necessary precautions to protect yourself, others, and the nearby area from any harm this liquid may do.
- **WARNING!** Take necessary precautions to prevent the pump from rotating while working on the relief valve.
- **WARNING!** Relieve all internal liquid/air pressure inside the pump before beginning disassembly.

Before beginning, you will need the following fasteners: Two 3/8 inch diameter bolts or cap screws 4 inches [102 mm] long with at least 2 inches [51 mm] of 3/8-16 UNC-2A thread or two steel rods at least 4.5 inches [115 mm] long with 3/8-16 UNC-2A threads along the entire length, and two steel nuts with 3/8-16 UNC-2B threads.

1. Remove two hex head cap screws (AH) that are diagonally across from each other on the relief valve cap (24).
2. Screw the two 4 inch [102 mm] long bolts or the two threaded rods at least 2 inches [51 mm] deep into the two holes that you removed the cap screws (AH) from. If you are using the threaded rods, screw the nuts at least .5 inch [13 mm] onto the opposite end of the rods.
3. Unscrew the two remaining hex head cap screws (AH) two or three turns only. At this point, liquid may leak from the relief valve.

- **WARNING! DO NOT** stand directly in front of the relief valve cap (24) while unscrewing any of these bolts (AH).

4. Continue unscrewing the two hex head cap screws (AH) two or three turns at a time, alternating from one to the other so that the two come out together.
5. When the relief valve cap (24) is resting against the heads of the 4 inch [102 mm] long bolts, or against the nuts on the threaded rod, you may remove the two remaining hex head cap screws (AH).
6. Unscrew the two 4 inch [102 mm] long bolts or the nuts on the threaded rods until there is no more load on the relief valve cap (24) and the setting shims (56) (if any) drop out.
7. Remove the relief valve cap (24), any remaining shims (56), and the spring (29) and poppet (30) if necessary.

8. Decide how many shims (56) you need using the chart below:

Number of Setting Shims between Spring and Relief Valve Cap	Differential Pressure where Relief Valve begins to open
0	73 PSI [503.3 kPa]
1	87 PSI [599.8 kPa]
2	101 PSI [696.4 kPa]
3	116 PSI [799.8 kPa]

- **WARNING! NEVER** use more than three setting shims (56) or any shims that are more than .98 inches [24.9 mm] total thickness. This can keep the relief valve from opening and can cause excessively high pressures in the pump and system resulting in accidents that could cause injury or death.
- **WARNING!** The pressure setting in the table above is the pressure at which the relief valve opens. The pressure in the pump and the system may be substantially different when the discharge line from the pump is completely blocked. You must test any new pressure setting or change in operating conditions to be sure that the pressures involved will not be too high for the pump or your system. An earlier section of these instructions called Checking the Pressure Setting of the EV Style Relief Valve explains how.

9. To reassemble the relief valve, put the poppet (30) and spring (29) back into the relief valve faceplate (23C) as shown in the sectional on page 24. Make sure the pointed end of the poppet (30) goes in first and that the spring (29) fits around the step on the back side of the poppet (30).

10. Put the proper number of setting shims (56) (that you determined in step 8) against the end of the spring (29), then put the gasket (25) and the relief valve cap (24) on. Hold these in place while you screw the two 4 inch [102 mm] long bolts or the two threaded rods with the nuts on them into the relief valve faceplate (23C). The bolts or rods must be in two holes that are diagonally across from each other.
    - **WARNING! DO NOT** use a gasket (25) that is broken, cracked, or torn. Replace it with a new gasket.

11. Alternately tighten the two bolts or nuts, two or three turns at a time, as far as possible.

12. Screw two hex head cap screws (AH) into the two empty holes until barely tight. The cap screws (AH) must screw into the relief valve faceplate (23C) at least .5 inch [13 mm] at this point. If they will not, reverse your steps to disassemble the valve again and check to see that you do not have more than three setting shims (56).

13. Screw the two hex head cap screws (AH) that you just installed in all the way. Alternately tighten them two or three turns at a time.

14. Remove the two 4 inch [102 mm] long bolts or two threaded rods and put the other two hex head cap screws (AH) in their place.

15. Tighten down all four hex head cap screws (AH).

11. HIGH DRIVE TO LOW DRIVE AND LOW DRIVE TO HIGH DRIVE

Prior to operating pump, make sure that the shaft rotation, pipe connections, and the relief valve position is in accordance with the appropriate illustrations shown on page 16 or on page 23. In order to change rotation and/or piping orientation, it may be necessary to remove piping from pump or pump from mounting. (Flanges (21) and flange gaskets (22), when provided, can be removed from pump.) Remove coupling or universal joint and drive key (A) from drive shaft (32A, B). Remove all burrs and sharp edges from drive shaft and keyway.

NOTE: Whenever changing rotation, inspect all parts before reassembly. Replace all worn parts and install new gaskets in appropriate number as removed. Be sure key (B) in drive shaft (32A, B) aligns with keyway in drive gear (34) and idler gear (35) before assembling. Backplate (6) and associated parts include: backplate assembly, mechanical seal (11), drive shaft (32A, B), drive key (A), and gear reduction unit if applicable.

To reverse pump rotation and keep piping arrangement the same, it is necessary to change from high drive to low drive ("Z" series with right angle ports: W to LX, X to LW, Z to LY, Y to LZ; "Z" series with straight through ports: W to LZ, Z to LW) or vice versa. Remove drive key (A), backplate (6) and associated parts from case (19A, B, C, D). (On "Z" series without outboard ball bearing, drive gear (34) will pull out with associated parts.) Remove drive gear (34), idler shaft (33), gear key (B) and idler gear (35). Place drive gear (34) and idler gear (35) in opposite positions in case (19A, B, C, D). Place gear key (B) in keyway of idler shaft (33) and place in I. D. of idler gear (35). Position appropriate number of case gaskets (20) on case (19A, B, C, D) (oil or grease may be used to hold gaskets in place). Rotate backplate (6) and associated parts 180°. Slide drive shaft (32A, B) and gear key (B) into I. D. of drive gear (34). Slide backplate (6) and associated parts into position and secure. On "Z" series with gear reduction assembly, mount oil cup (AB) in top hole in gear case (44) and petcock (AC) on next to bottom hole.

To reverse pump rotation and leave drive shaft (32A, B) and case (19A, B, C, D) in same position, the flow of liquid through pump ports will be reversed ("Z" series with right angle ports: W to X, LW to LX, Z to Y, LZ to LY; "Z" series with straight through ports: W to Z, LW to LZ) or vice versa. Also the RV style relief valve faceplate (23B) or EV style relief valve faceplate (23C) will have to be removed and rotated 180° and then secured.

To change the port to the opposite side and maintain same pump rotation, change drive shaft (32A, B) from high drive to low drive ("Z" series with right angle ports: W to LY, Y to LW, Z to LX, X to LZ) or vice versa. Remove the backplate (6) and associated parts. (On "Z" series without outboard ball bearing, drive gear (34) will pull out with associated parts.) Remove the faceplate (23A, B, C). Remove case (19A, B, C, D) and rotate 180°. Remount and secure case (19A, B, C, D) to faceplate (23A, B, C). If plain faceplate (23A) is used, remount on case (19A, B, C, D) in same position. If RV or EV style relief valve faceplate (23B, C) is used, rotate 180° and remount to case (19A, B, C, D). Rotate backplate (6) and associated parts 180° and remount on case (19A, B, C, D). On "Z" series with gear reduction assembly, mount oil cup (AB) in top hole of gear case (44) and petcock (AC) on next bottom hole.

To change port to opposite side, maintain same pump rotation and drive shaft (32A, B) in same position; the flow of liquid through the pump ports will be reversed (on "Z" series with right angle ports: W to Y, LW to LY, Z to X, LZ to LX) or vice versa. Remove backplate (6) and associated parts. (On "Z" series without outboard ball bearing, drive gear (34) will pull out with associated parts.) Remove faceplate (23A, B, C, D). Remove case (19A, B, C, D) and rotate 180°. Remount and secure case (19A, B, C, D) to faceplate (23A, B, C, D). Remount backplate (6) and associated parts to case (19A, B, C, D).

12. INSTRUCTIONS FOR PUMP DISASSEMBLY

Refer to the sectional drawing in Section 17.

1. Read sections on Safety Precautions and Additional Important Warnings and Information 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. Read section on Replacement Parts.
2. If you do not know which pump or seal arrangement you have, collect nameplate data and refer to Section 3 on pages 4 and 5 to determine what you have. Consult factory if you have any questions.
3. When cleaning or lubricating, use only compatible products with products being pumped and with sealing elastomers. **DO NOT** use petroleum base products with seals with EPR elastomers. Clean and lubricate drive shaft (32A, B) with light oil unless EPR elastomers are used. Use a nonpetroleum based lubricant with EPR elastomers.
4. If unit being disassembled uses a gear reduction unit, a new lip seal (5) will be required. The lip seal (5) will be destroyed during disassembly.
5. Turn off pump and lock out energy source to driver. **DO NOT** proceed further with disassembly of the pump if there is the slightest possibility that the driver may be started.
6. If used, turn off and disconnect flush from mechanical seal.
7. Close inlet and discharge valves.
8. Remove guard and disconnect coupling between the driver and pump.
9. Drain inlet and discharge lines. Disconnect lines from pump inlet and discharge.
10. Drain pump by removing lower pipe plug (S) from faceplate (23A, B, C). The faceplate is furnished with two pipe plugs (S). After removing plug, rotate the drive shaft very slowly by hand in both directions to make certain that the pump has been drained as much as possible.
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). Remove the faceplate (23A, B, C).
12. Remove two dowel pins (J) from case.
13. Remove case gaskets (20).

14A. On pumps without outboard ball bearing, remove outer retaining ring (36B) from drive shaft (32A, B). Remove drive gear (34) and key (B). Remove inner retaining ring (36A).

14B. On pumps with outboard ball bearing and pumps with gear reduction unit, remove drive gear (34) and key (B) from drive shaft (32A, B).

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 (6) to case (19A, B, C, D) and separate parts.
17. Remove case gaskets (20) from opposite side of case (19A, B, C, D).
18. Remove two dowel pins (J) from opposite side of case (19A, B, C, D).
19. Remove drive key (A) from drive shaft (32A, B).

Pump Without Outboard Ball Bearing (See page 43)

20. Remove four socket head cap screws (E) securing seal retainer (9) to backplate (6). Remove seal retainer gasket (10).

21A. When disassembling pump that uses a John Crane® Type 8-1,Type 9 or Sealol® 680 mechanical seal which requires an antirotation pin (T) in the seal retainer (9), use extreme care not to lose pin. The pin has a clearance fit.

21B. When disassembling pump that uses a John Crane® Double Type 8-1 or Double Type 9 mechanical seal which requires an antirotation pin (T) in the seal retainer (9) and backplate (6), use extreme care not to lose pins. The pins have a clearance fit.

22. Remove drive shaft (32A, B) from backplate (6).

23A. When removing the following type of single seals (John Crane® Type 21, Type 8-1, Type 9 or Sealol® 680), clean and lubricate drive shaft (32A) prior to removing mechanical seal (11). Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). Remove retaining ring (12) from drive shaft (32A). (Dura® RO, RO-TT or Chesterton® 880 seals are not available for these units.)

23B. When removing the following type of double seals (John Crane® Type 21, Type 8-1, or Type 9), clean and lubricate drive shaft (32B) prior to removing mechanical seal (11). Remove mechanical seal (11). After mechanical seal has been removed, remove stationary seat in bore of backplate (6).

24. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (10, 20, 22, 25) be installed each time pump is disassembled and reassembled.

Pump With Outboard Ball Bearing (See page 44)

25. Remove retaining ring (3) from bearing cage (1).

26. Loosen setscrews in ball bearing (2). Remove ball bearing.

27. Remove four hex head cap screws (C) securing bearing cage (1) to backplate (6).

28. Remove four socket head cap screws (E) securing seal retainer (9) to backplate (6). Remove seal retainer gasket (10).

29A. When disassembling pump that uses a John Crane® Type 8-1, Type 9; Sealol® 680; or a Chesterton® 880 mechanical seal which requires an antirotation pin (T) in the seal retainer (9), use extreme care not to lose pin. The pin has a clearance fit.

When a Dura® RO-TT mechanical seal is used, the antirotation pin is a permanent part of the seat. **DO NOT** remove pin from the seat.

29B. When disassembling pump that uses a John Crane® Double Type 8-1 or Type 9 mechanical seal which requires an antirotation pin (T) in the seal retainer (9) and the backplate (6), use extreme care not to lose pins. The pins have a clearance fit.

When a Dura® Double RO-TT mechanaical seal is used, the antirotation pins are a permanent part of the stationary seats. **DO NOT** remove these pins from the seats.

30. Remove drive shaft (32A, B) from backplate (6).

31A. When removing the following types of single seals (John Crane® Type 21, Type 8-1, Type 9; Sealol® 680; Chesterton® 880; Dura® RO or RO-TT), clean and lubricate drive shaft (32A, B) prior to removing mechanical seal (11). Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). Remove retaining ring (12) from drive shaft (32A).

31B. When removing the following types of double seals (John Crane® Type 21, Type 8-1, Type 9; Dura® RO or RO-TT), clean and lubricate drive shaft (32B) prior to removing mechanical seal (11). Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). After mechanical seal (11) has been removed, remove stationary seat in bore of backplate (6).

31C. When removing the following type of cartridge seals (John Crane® Type 88; Chesterton® 123 or 241), clean and lubricate drive shaft (32B) prior to removing mechanical seal (11). Loosen setscrew on mechanical seal. Remove mechanical seal (11). If John Crane® Type 88 seal is used, remove spacer (13) from seal retainer. Remove seal retainer gasket (10).

32. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (10, 20, 22, 25) be installed each time pump is disassembled and reassembled.

Pump With Gear Reduction Unit **(See pages 45 and 46)**

33. Drain the oil from the gear reduction unit.

34. Remove drive key (A). Remove four hex head cap screws (U) and slide seal retainer (37) assembled with lip seal (39) off the end of the pinion shaft (42).

35. Remove seal retainer gasket (38) between seal retainer (37) and gear case (44).

36. Remove pinion shaft (42) assembly with ball bearing (41) and retaining ring (40).

37. Remove six hex head cap screws (W), twelve flat washers (X), and six lockwashers (Y).

38. Remove gear case (44). Remove gear case gasket (48).

39. Remove needle bearing (43). This bearing is installed with a press fit.

40. Remove retaining ring (45).

41. Remove drive gear (46). A gear puller may be necessary in removing the gear, as a close fit is maintained between the gear and shaft.

42. Remove drive gear key (Z).

43. Remove four socket head cap screws (AD) securing cover (49) to bearing cage (1). Remove cover gasket (50).

44. Remove spacer (47).

45. Remove retaining ring (3) securing ball bearing (2) in place.

46. Remove four hex head cap screws (C) securing bearing cage (1) to backplate (6).

47. Remove bearing cage (1). A puller will be required to pull the bearing cage (1), lip seal (5), and bearing (2) as one unit. This procedure will destroy the lip seal (5).

48. Remove ball bearing (2).

49. Remove lip seal (5) from bearing cage (1) and discard.

50. Remove retaining ring (4) from drive shaft (32A, B).

51. Remove four socket head cap screws (E) securing seal retainer (9) to backplate (6). Remove seal retainer gasket (10).

52A. When disassembling pump that uses a John Crane® Type 8-1, Type 9; Sealol® 680; or Chesterton® 880 mechanical seal which requires an antirotation pin (T) in the seal retainer (9), use extreme care not to lose pin. The pin has a clearance fit. When a Dura® RO-TT mechanical seal is used, the antirotation pin is a permanent part of the seat. **DO NOT** remove pin from the seat.

52B. .When disassembling pump that uses a John Crane® Double Type 8-1 or Type 9 mechanical seal which requires an antirotation pin (T) in the seal retainer (9) and the backplate (6), use extreme care not to lose pins. These pins have a clearance fit. When a Dura® Double RO-TT is used, the antirotation pins are a permanent part of the stationary seat. **DO NOT** remove these pins.

53. Remove drive shaft (32A, B) from the backplate (6).

54A. When removing the following types of single seals (John Crane® Type 21, Type 8-1, Type 9; Sealol® 680; Chesterton® 880; Dura® RO or RO-TT), clean and lubricate drive shaft (32A, B) prior to removing mechanical seal (11). Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). Remove retaining ring (12) from drive shaft (32A, B).

54B. When removing the following types of double seals (John Crane® Type 21, Type 8-1, Type 9; Dura® RO or RO-TT), clean and lubricate drive shaft (32B) prior to removing mechanical seal (11). Loosen setscrews (if present) on mechanical seal. Remove mechanical seal (11). After mechanical seal (11) has been removed, remove stationary seat in bore of backplate (6).

54C. When removing the following types of cartridge seals (John Crane® Type 88; Chesterton® 123 or 241), clean and lubricate drive shaft (32B) prior to removing mechanical seal (11). Loosen setscrew on mechanical seal. Remove mechanical seal (11). If John Crane® Type 88 seal is used, remove spacer (13) from seal retainer. Remove seal retainer gasket (10).

55. Visually inspect all parts. Replace all worn or damaged parts before reassembling pump. It is recommended that new gaskets (10, 20, 22, 38, 48, 50) and new lip seals (5, 39) be installed each time the pump is disassembled and reassembled.

13. INSTRUCTIONS FOR PUMP ASSEMBLY

Refer to Section 10 for Direction of Rotation to assure proper configuration for pump rotation, port location, and relief valve position prior to assembling pump.

1. Read instructions on Replacement Parts, Threaded Port Connections, Shaft Sealing, and Safety Precautions 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 (10, 20, 22, 25, 38, 48, 50) and lip seals (5, 39) be installed when the pump is being reassembled.

   - **WARNING!** Only use genuine Roper gaskets. (1) Gasket thickness determines proper clearances. Always check quantity of gaskets removed and replace with exact quantity. (2) 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 a precision piece 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). 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. On pumps with outboard ball bearing and pumps with gear reduction unit only, place drive gear (34) into case bore.

7. Install drive shaft (32A, B) into bore of backplate (6).

Pump Without Outboard Ball Bearing (See page 43)

8. When assembling pump that uses a John Crane® Single Type 21, Type 8-1 or Type 9 mechanical seal, install retaining ring (12) in groove nearest the coupling end of drive shaft (32A).

   When assembling pump that uses a Sealol® 680 Single mechanical seal, install retaining ring (12) in second groove from the coupling end of the driver shaft (32A).

9. When assembling pump that is using a John Crane® Double Type 8-1 or Type 9 mechanical seal, make sure that the antirotation pin (T) which has a clearance fit is installed properly into backplate bore. Lubricate the bore in the backplate (6) for the inboard stationary seat and carefully push the seat and its sealing ring to the bottom of the backplate (6) bore making sure that the pin is properly aligned in the stationary seat and the backplate (6).

10. Lubricate drive shaft (32A, B) and mechanical seal bore. Install the rotating member of the mechanical seal (11) on drive shaft (32A, B) pushing the seal back against the retaining ring (12) if applicable. Reaching through the appropriate access holes in the top and sides of the backplate, tighten the setscrews in the rotating member of the John Crane® Single Type 8-1, Type 9 or Sealol® 680 mechanical seal. It may be necessary to slightly push or pull drive shaft (32A, B) to align setscrew with appropriate hole located on side or top of backplate. **DO NOT** tighten setscrew on John Crane® Double Type 8-1 or Type 9 mechanical seals at this time.

11. Install inner retaining ring (36A) on drive shaft (32A, B). Install key (B) on drive shaft. Slide drive gear (34) onto drive shaft. Install outer retaining ring (36B) on drive shaft to secure drive gear.

12. Place appropriate number of case gaskets (20) on backplate side of case (19A, B, C, D). Slide drive gear (34) assembled with drive shaft (32A, B), backplate (6), and mechanical seal (11) into case bore. Align backplate (6) on hollow dowel pins (J). Secure backplate (6) to case (19A, B, C, D) using two washer head cap screws (K) and eight hex head cap screws (L).

13A. When assembling pump that uses a John Crane® Single Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of seal retainer (9).

When assembling pump that uses a John Crane® Single Type 8-1, Type 9 or Sealol® 680 mechanical seal, place the antirotation pin (T) in the pin hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the pin is aligned properly in the stationary seat and the seal retainer (9).

13B. When assembling pump that uses a John Crane® Double Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9).

When assembling a pump that uses a John Crane® Double Type 8-1 or Type 9 mechanical seal, place the antirotation pin (T) in the hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the pin is aligned properly in the stationary seat and the seal retainer (9).

14. Place seal retainer gasket (10) on pilot of seal retainer (9). Slide seal retainer (9) over drive shaft (32A, B). Secure seal retainer (9) to backplate (6) using four socket head cap screws (E). Reaching through the appropriate access holes in the top and sides of the backplate, tighten the setscrews in the rotating member of any double seals. Install and tighten pipe plugs (H) in any of the three holes that are not used for external piping to the seal chamber in the backplate (6).

15. Install drive key (A).

16. Read sections on Additional Important Warnings and Information, Threaded Port Connections, Installation of Pipes, Preoperation Checks, Shaft Sealing, and Aligning Driver and Pump before installing and operating pump.

Pump With Outboard Ball Bearing (See page 44)

17. When assembling pump that uses a John Crane® Single Type 21, Type 8-1, Type 9; Dura® RO or RO-TT mechanical seal, install retaining ring (12) in groove nearest the coupling end of the drive shaft (32A).

When assembling pump that uses a Sealol® 680 single mechanical seal, install retaining ring (12) in second groove from the coupling end of the drive shaft (32A).

When assembling pump that uses a Chesterton ® 880 single mechanical seal, no retaining ring is needed. Measure from the drive end of drive shaft (32B) 9.94 ± .03 inches (252 ± .8 mm) on the Z11 pump or 9.19 ± .03 (233 ± .8 mm) on the Z17 and Z22 pumps and scribe line on drive shaft for setting proper operating length of mechanical seal (11).

18. When assembling pump that uses a John Crane® Double Type 8-1 or Type 9 mechanical seal, make sure that the antirotation pin (T) which has a clearance fit is installed properly into backplate bore. Lubricate the bore in the backplate (6) for the inboard stationary seat and carefully push the seat and its sealing ring to the bottom of the backplate (6) bore making sure that the pin is properly aligned in the stationary seat and the backplate (6).

    When assembling pump that uses a Dura® Double RO or RO-TT mechanical seal, lubricate the bore in the backplate (6) for the inboard stationary seat and carefully push the seat and its sealing ring to the bottom of the backplate (6) bore making sure that the antirotation pin (T) which is a permanent part of the stationary seat is aligned properly in pin hole of backplate bore.

19. When assembling pump that uses a John Crane® Type 88; Chesterton® 123 or 241 cartridge seal, all the following steps apply except for steps 21A and 21B.

20. Lubricate drive shaft (32A, B) and mechanical seal bore. Install rotating member of the mechanical seal (11) on drive shaft (32A, B) pushing the seal back against the retaining ring (12) if applicable. Reaching through the appropriate access holes in the top and sides of the backplate, tighten the setscrews in the rotating member of the John Crane® Single Type 8-1, Type 9; Dura® Single RO, RO-TT; or Sealol® 680 mechanical seal. It may be necessary to slightly push or pull drive shaft (32A, B) to align setscrew with the appropriate hole located on the top or sides of the backplate (6). **DO NOT** tighten the setscrews on John Crane® Double Type 8-1, Type 9, or Dura® Double RO, RO-TT mechanical seal at this time. On Chesterton® 880 single mechanical seal, install mechanical seal (11) so back of seal will align properly with scribed line on drive shaft (32B). Tighten setscrew. If a John Crane® Type 88 cartridge seal is used, install spacer (13) prior to installing mechanical seal. (See Various Sealing Arrangements on page 52 and 53.) **DO NOT** install the socket head cap screws (E) at this time.

21A. When assembling pump that uses a John Crane® Single Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into bore of seal retainer (9).

    When assembling pump that uses a John Crane® Single Type 8-1, Type 9, Sealol® 680 or a Chesterton® 880 mechanical seal, place the antirotation pin (T) in the hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the pin is aligned properly in the stationary seat and the seal retainer (9).

    When assembling pump that uses a Dura® RO or RO-TT mechanical seal, lubricate the seal retainer (9) bore and carefully push the stationary seat and its sealing ring to the bottom of the bore. Make sure that the antirotation pin which is a permanent part of the seal is aligned properly in the seal retainer (9).

21B. When assembling pump that uses a John Crane® Double Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9).

    When assembling pump that uses a John Crane® Double Type 8-1 or Double Type 9 mechanical seal, place the antirotation pin (T) in the hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the antirotation pin is aligned properly in the stationary seat and the seal retainer (9).

When assembling pump that uses a Dura® Double RO or RO-TT mechanical seal, lubricate the seal retainer (9) bore and carefully push the stationary seat and its sealing ring to the bottom of the bore making sure that the antirotation pin which is a permanent part of the seal is aligned properly in the seal retainer (9).

22. Place seal retainer gasket (10) on pilot of seal retainer (9). Slide seal retainer (9) over drive shaft (32A, B). **DO NOT** install socket head cap screws (E) at this time.

23. Install ball bearing (2) on drive shaft (32A, B) and into bearing cage (1) as shown in the sectional drawing on page 43. 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 the setscrews in the inner race of the ball bearing with the wide groove in the shaft. Tighten setscrews in ball bearing (2) to secure bearing to drive shaft (32A, B). Install retaining ring (3) into bearing cage (1) to secure ball bearing (2) to the bearing cage.

24. Secure seal retainer (9) to backplate (6) using four socket head cap screws. Reaching through the appropriate access holes in the top and sides of the backplate (6), tighten the setscrews in the rotating member of any double seals. Install and tighten pipe plugs (H) in any of the three holes that are not used for external piping to the seal chamber in the backplate (6).

25. Place the appropriate number of case gaskets (2) on backplate side of case (19A, B, C, D). Install gear key (B) in keyway on drive shaft (32A, B). Slide drive shaft (32A, B) assembled with backplate (6) and bearing cage (1) into I. D. of drive gear (34). Align backplate (6) on hollow dowel pins (J). Secure backplate (6) to case (19A, B, C, D) using two washer head cap screws (K) and eight hex head cap screws (L).

26. Install drive key (A).

27. Read sections on Additional Important Warnings and Information, Threaded Port Connections, Installation of Pipes, Preoperation Checks, Shaft Sealing, and Aligning Driver and Pump before installing and operating pump.

Pump With Gear Reduction Unit (See pages 45 and 46)

28. When assembling pump that uses a John Crane® Single Type 21, Type 8-1, Type 9; Dura® RO or RO-TT mechanical seal, install retaining ring (12) in the third groove from the coupling end of drive shaft (32A).

    When assembling pump that uses a Sealol® 680 single mechanical seal, install retaining ring (12) in fourth groove from the coupling end of drive shaft (32A).

    When assembling pump that uses a Chesterton® 880 single mechanical seal, no retaining ring is needed. Measure from the drive end of the drive shaft (32B) 7.84 ± .03 inches (199 ± .8 mm) and scribe line on shaft for setting proper operating length of mechanical seal (11).

29. When assembling pump that uses a John Crane® Double Type 8-1 or Type 9 mechanical seal, make sure that the antirotation pin (T) which has a clearance fit is installed properly into backplate bore. Lubricate the bore in the backplate (6) for the inboard stationary seat and carefully push the seat and its sealing ring to the bottom of the backplate (6) bore making sure that the pin is properly aligned in the stationary seat and the backplate (6).

    When assembling pump that uses a Dura® Double RO or RO-TT mechanical seal, lubricate the bore in the backplate (6) for the inboard stationary seat and carefully push the seat and its sealing ring to the bottom of the backplate (6)

bore making sure that the antirotation pin (T) which is a permanent part of the stationary seat is aligned properly in pin hole of backplate bore.

30. When assembling pump that uses a John Crane® Type 88; Chesterton® 123 or 241 cartridge seal, all of the following steps apply except for steps 32A and 32B.

31. Lubricate drive shaft (32A, B) and mechanical seal bore. Install the rotating member of the mechanical seal (11) on drive shaft (32A, B) pushing the seal back against the retaining ring (12) if applicable. Reaching through the appropriate access holes in the top and sides of the backplate, tighten the setscrews in the rotating member of the John Crane® Single Type 8-1, Type 9; Dura® Single RO, RO-TT; or Sealol® 680 mechanical seal. It may be necessary to slightly push or pull drive shaft (32A, B) to align setscrew with the appropriate hole located on the top or sides of the backplate (6). **DO NOT** tighten the setscrews on the John Crane® Double Type 8-1, Type 9; or Dura® Double RO, RO-TT mechanical seal at this time.On Chesterton® 880 single mechanical seal, install mechanical seal (11) so back of seal will align properly with scribed line on drive shaft (32B). Tighten setscrew. If a John Crane® Type 88 cartridge seal is used, install spacer (13) prior to installing mechanical seal. (See Various Sealing Arrangements on page 52 and 53). **DO NOT** install socket head cap screws (E) at this time.

32A. When assembling pump that uses a John Crane® Single Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into bore of seal retainer (9).

When assembling pump that uses a John Crane® Single Type 8-1, Type 9, Sealol® 680 or a Chesterton® 880 mechanical seal, place the antirotation pin (T) in the hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the antirotation pin is aligned properly in the stationary seat and the seal retainer (9).

When assembling pump that uses a Dura® RO or RO-TT mechanical seal, lubricate the seal retainer (9) bore and carefully push the stationary seat and its sealing ring to the bottom of the bore. Make sure that the antirotation pin which is a permanent part of the seal is aligned properly in the seal retainer (9).

32B. When assembling pump that uses a John Crane® Double Type 21 mechanical seal, lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9).

When assembling pump that uses a John Crane® Double Type 8-1 or Double Type 9 mechanical seal, place the antirotation pin (T) in the hole of the seal retainer (9). Lubricate the seal retainer bore. Carefully push the stationary seat and its sealing ring into the bore of the seal retainer (9) making sure that the antirotation pin is aligned properly in the stationary seat and the seal retainer (9).

When assembling pump that uses a Dura® Double RO or RO-TT mechanical seal, lubricate the seal retainer (9) bore and carefully push the stationary seat and its sealing ring to the bottom of the bore making sure that the antirotation pin which is a permanent part of the seal is aligned properly in the seal retainer (9).

33. Place seal retainer gasket (10) on pilot of seal retainer (9). Slide seal retainer (9) over drive shaft (32A, B). **DO NOT** install the socket head cap screws (E) at this time.

33. Place seal retainer gasket (10) on pilot of seal retainer (9). Slide seal retainer (9) over drive shaft (32A, B). **DO NOT** install the socket head cap screws (E) at this time.
34. Secure bearing cage (1) to backplate (6) using four hex head cap screws (C)
35. Install lip seal (5) in bearing cage (5).
36. Install retaining ring (4) on drive shaft (32A, B).
37. Install ball bearing (2) on drive shaft (32A, B) and into bearing cage (1) using retaining ring (3) to secure ball bearing (2) in place as shown in the sectional drawing on page 45. The fit between the drive shaft and ball bearing may be a light press fit. **DO NOT** damage seal parts while pressing ball bearing on drive shaft.
38. Secure seal retainer (9) using four socket head cap screws (E). Reaching through the appropriate access holes in the top and sides of the backplate (6), tighten the setscrews in the rotating member of any double seals. Install and tighten pipe plugs (H) in any of the three holes that are not used for external piping to the seal chamber in the backplate (6).
39. Place appropriate number of case gaskets (2) on backplate side of case (19A, B, C, D). Install gear key (B) in keyway on drive shaft (32A, B). Slide drive shaft (32A, B) assembled with backplate (6) and bearing cage (1) into I. D. of drive gear (34). Align backplate (6) on hollow dowel pins (J). Secure backplate (6) to case (19A, B, C, D) using two washer head cap screws (K) and eight hex head cap screws (L).
40. Install spacer (47).
41. Install key (Z) in keyway of drive shaft (32A, B). Place drive gear (46) on drive shaft (32A, B) securing in place using retaining ring (45).
42. Install cover gasket (50) and cover (49) on bearing cage (1) using four socket head cap screws (AD).
43. Install gear case (44) and gear case gasket (48) using six hex head cap screws (W), twelve flat washers (X), and six lockwashers (Y).
44. Install needle bearing (43). The needle bearing is a press fit in the bore.
45. Press ball bearing (41) onto pinion shaft (42) and install retaining ring (40).
46. Install pinion shaft assembly by sliding the small end of the pinion shaft into the needle bearing (43) at the same time the gears are meshed together.
47. Slide the bearing retainer (37) assembled with lip seal (39) and bearing retainer gasket (38) into place. Secure bearing retainer (37) to gear case (44) using four hex head cap screws (U) and four lockwashers (V).
48. Install drive key (A).
49. Read sections on Additional Important Warnings and Information, Threaded Port Connections, Installation of Pipes, Preoperation Checks, Shaft Sealing, and Aligning Driver and Pump before installing and operating pump.

14. INSTRUCTIONS FOR HYDRAULIC DRIVE DISASSEMBLY

Refer to the sectional drawing in Section 17, page 47.

1. Read sections on Safety Precautions and Additional Important Warnings and Information 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. Read section on Replacement Parts.
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. If used, turn off and disconnect flush from mechanical seal.
4. Close inlet and discharge valves.
5. Remove six socket head cap screws (AE) and six lockwashers (AF) securing bracket (51) and bracket (52) together. Slide apart.
6. Remove cap screws securing hydraulic motor to bracket (52).
7. Rotate bracket (52) until hole for loosening setscrew lines up with set screw in coupling half (54). Loosen setscrew and remove coupling half.
8. Remove coupling spider (55).
9. Rotate drive shaft of pump (32A, B) until setscrew in coupling half (53) lines up with hole for loosening setscrew. Loosen setscrew. Remove retaining ring (45) from drive shaft and remove coupling half.
10. Remove drive key (Z).
11. Remove four socket head cap screws (AD) securing bracket (51) to bearing cage (1). Remove bracket.
12. For further disassembly of pump, refer to disassembly of pump with gear reduction unit in Section 12.

    For disassembly of pump with single mechanical seal, refer to steps 10 - 19, 54A.

    For disassembly of pump with double mechanical seal, refer to steps 10 - 19, 54B.

    For disassembly of pump with cartridge seal, refer to steps 10 - 19, 54C.

15. INSTRUCTIONS FOR HYDRAULIC DRIVE ASSEMBLY

1. Refer to Section 13 for pump assembly using steps 1 - 7. For installing single mechanical seal, refer to steps 28, 31, 32A, 33, 34. For installing double mechanical seals, refer to steps 29, 31, 32B, 33, 34. For installing cartridge seal, refer to steps 30, 31, 33, 34.
2. Refer to the sectional drawing in Section 17, page 47.
3. Secure bracket (51) to bearing cage (1) using four socket head cap screws (AD).
4. Install key (Z) in shaft keyway, place coupling half (53) on drive shaft (32A, B). Install retaining ring (45). Rotate drive shaft (32A, B) until setscrew lines up with hole in bracket (52), then tighten setscrew.
5. Install coupling spider (55).
6. Place bracket (52) onto pilot of hydraulic motor. **DO NOT** secure bracket into place at this time.
7. Place coupling half (54) onto shaft of hydraulic motor to dimension shown. Rotate bracket (52) until hole in bracket lines up with setscrew on coupling half. Tighten setscrew.
8. Rotate bracket on motor to line up motor mounting holes with bracket holes. Secure bracket (52) to hydraulic motor using appropriate fasteners.
9. Secure bracket (52) to bracket (51) using six socket head cap screws (AE) and six lockwashers (AF).
10. Read sections on Additional Important Warnings and Information, Threaded Port Connections, Installation of Pipes, Preoperation Checks, and Shaft Sealing before installing and operating pump.

16. GEAR REDUCTION UNIT

Refer to the appropriate sectional drawing in Section 17.

TO ADJUST GEAR REDUCTION UNIT TO PROPER HEIGHT

1. With no oil in gear reduction unit, loosen six hex head cap screws (W).
2. Rotate gear case (44) until coupling halves are accurately aligned. Tighten the six hex head cap screws (W). Assemble the coupling halves. Tighten setscrews in coupling.
3. Refill with oil to level of petcock (AC) using Gulf® Senate 375, Mobil® 600W Cylinder Oil, or AGMA No. 7 compounded oil.

LUBRICATION INSTRUCTIONS FOR INITIAL START-UP

The oil cup (AB) is shipped separate to prevent breakage. Before placing the gear reduction unit in operation, install the oil cup (AB) and check the oil level in unit. The oil level should be maintained even with petcock (AC) at all times.

SERVICING INSTRUCTIONS

The oil should be clean and free from sludge at all times and should be changed at regular intervals. A drain plug (AA) has been provided near the bottom of the gear case (44) for this purpose. The oil (Gulf® Senate 375, Mobil® 600W Cylinder Oil, or AGMA No. 7 compounded oil) should be changed every 1000 hours or every

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four months, whichever comes first. Where operating conditions are severe, such as rapid rise and fall of temperature which caused condensation inside the gear case housing (44) with the resulting formation sludge, or the atmosphere is moist or dusty, it may be necessary to change the oil every one or two months or sooner. The oil cup (AB) at the front of gear case (44) is for filling the unit with oil and also serves as a breather. **DO NOT** allow the oil cup (AB) to become clogged. This could cause high vapor pressure inside the gear case (44).

CHANGING RATIO OF GEAR REDUCTION UNIT

Refer to appropriate sectional drawing on page 46 showing internal construction of the gear reduction assembly. The internal construction for all ratios are identical, except for the drive gear (46) and pinion shaft (42), which determines the gear ratio of that particular unit. The drive gear (46) and pinion shaft (42) are interchangeable in pairs only. See page 42 for ratios available. It is recommended that new gaskets (38, 48) and new lip seal (39) be installed each time unit is disassembled and reassembled.

1. Turn off pump and lock out energy source to driver. **DO NOT** proceed further with disassembly of gear reduction unit if there is the slightest possibility that the driver may be started.
2. Drain oil from the gear reduction unit.
3. If the unit is assembled on a baseplate, direct connected to a motor, it will be necessary to remove the flexible coupling as follows:
   A. Loosen setscrew on motor half of coupling.
   B. Slide motor coupling half towards the motor to clear the pump coupling half. (In case the coupling cannot be removed in this manner, it will be necessary to remove either the motor or pump in order to remove the pump coupling half.)
4. Loosen six hex head cap screws (W) and rotate gear case (44) in the slots provided until pump coupling half is clear of motor coupling half.
5. Remove pump coupling half.
6. Remove drive key (A). Remove four hex head cap screws (U) and four lockwashers (V). Slide seal retainer (37) assembled with lip seal (39) off the end of the pinion shaft (42).
7. Remove seal retainer gasket (38) between seal retainer (37) and gear case (44).
8. Remove pinion shaft (42) assembly with ball bearing (41) and retaining ring (40).
9. Remove six hex head cap screws (W), twelve flat washers (X) and six lockwashers.
10. Remove gear case (44). Remove gear case gasket (48).
11. Remove retaining ring (45).
12. Remove drive gear (46). A gear puller may be necessary in removing the gear, as a close fit is maintained between the gear and shaft.
13. Refer to the gear ratio and pump capacities chart on page 42 to select the desired gear ratio.
14. Slide drive gear (46) on drive shaft (32A, B) securing in place using retaining ring (45). Make sure key (Z) and spacer (47) are in place. The number of teeth or part number is stamped on the drive gear (46). On standard units, the last two numbers of the part number represent the number of teeth on the gear.

15. Install gear case (44) and gear case gasket (48) using six hex head cap screws (W), twelve flat washers (X), and six lockwashers (Y).
16. Press ball bearing (41) onto pinion shaft (42) and install retaining ring (40).
17. Install pinion shaft assembly by sliding the small end of the pinion shaft into the needle bearing (43) at the same time the gears are meshed together.
18. Slide the bearing retainer (37) assembled with lip seal (39) and bearing retainer gasket (38) into place. Secure bearing retainer (37) to gear case (44) using four hex head cap screws (U) and four lockwashers (V).
19. Install drive key (A).
20. Install pump coupling half and tighten setscrews on the drive key (A).
21. Rotate the gear case (44) until coupling halves are accurately aligned. Tighten the six hex head cap screws (W). Assemble coupling and tighten the setscrew in the motor coupling half.
22. Refill with oil to the level of petcock (AC) using Gulf® Senate 375, Mobil® 600W Cylinder Oil, or AGMA No. 7 compounded oil.

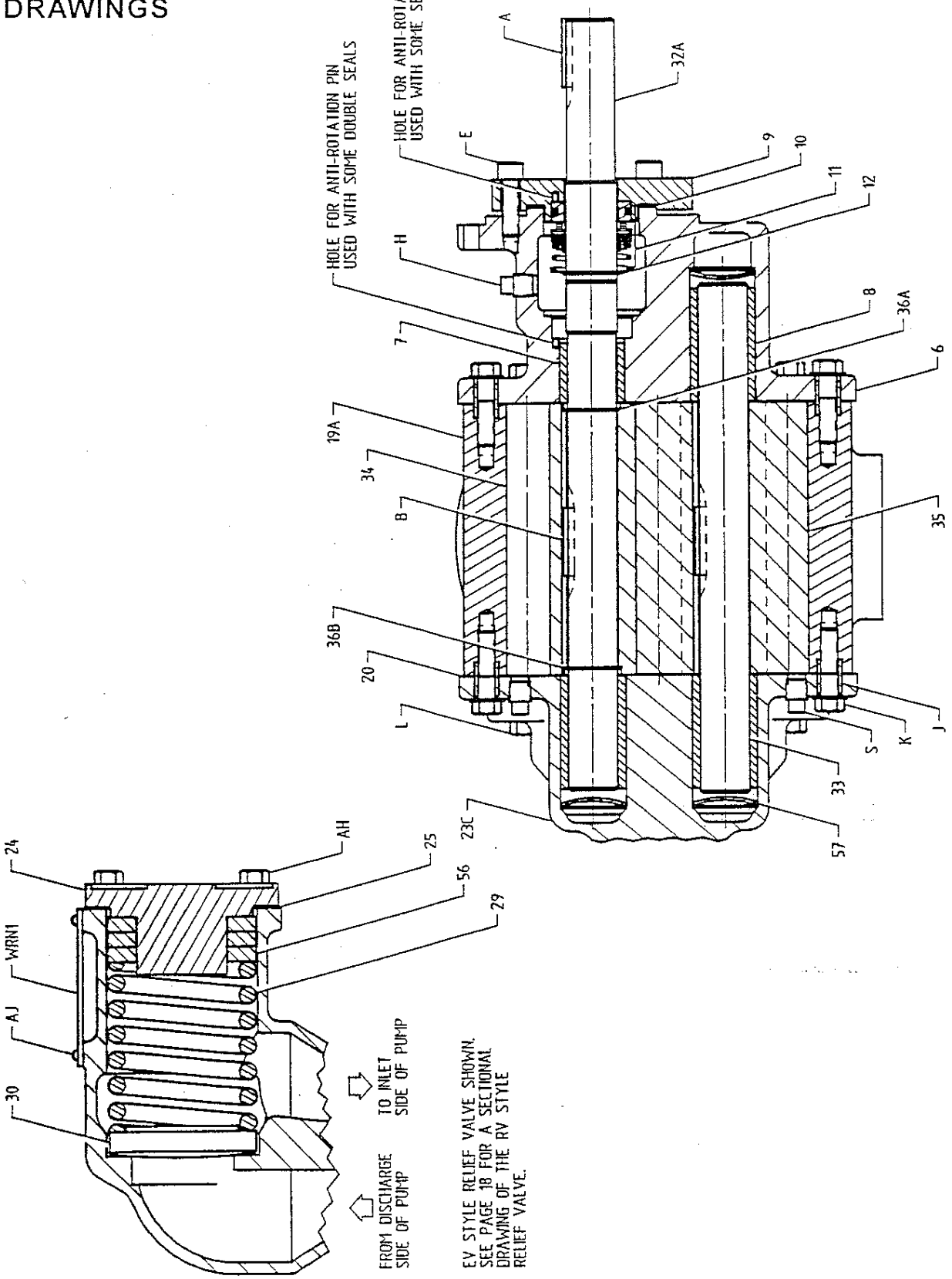
GEAR REDUCTION DATA

The Roper gear reduction unit is totally enclosed and running in oil. The reduction gears are hardened steel to insure long life. Antifriction bearings are used throughout. Gear reducers are rated to transmit up to the horsepowers (kW) shown below. Three interchangeable gear ratios are available.

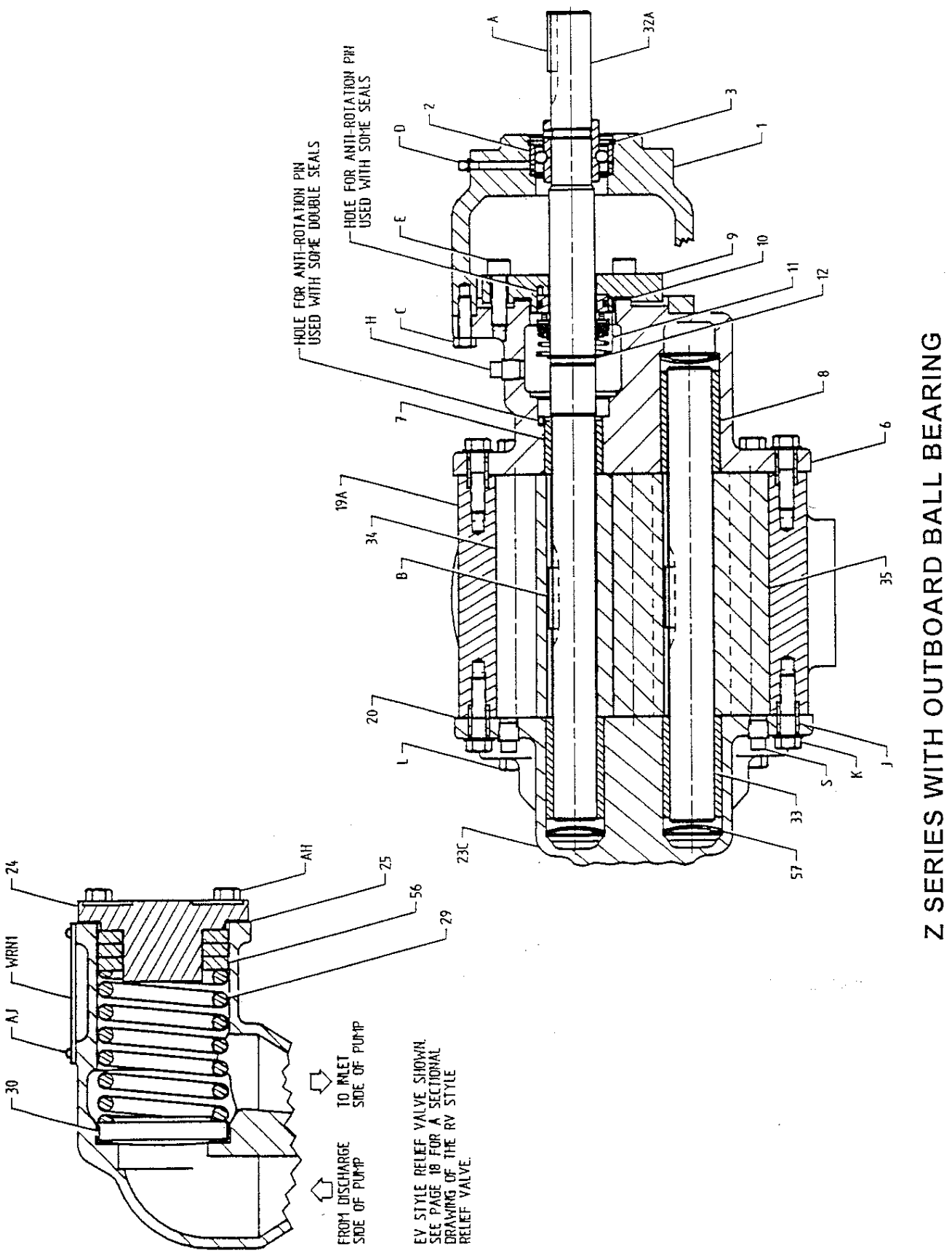
MOTOR RPM	GEAR RATIO	PUMP RPM	TEETH (DRIVER)	TEETH (PINION)	MAX HP [kW]
1150	4.60:1	250	69	15	5.5 [4.1]
	3.94:1	290	67	17	6.5 [4.8]
	3.20:1	360	64	20	8.0 [6.0]
1750	4.60:1	380	69	15	8.5 [6.3]
	3.94:1	445	67	17	10 [7.5]
	3.20:1	545	64	20	10 [7.5]
* 3450	4.60:1	750	69	15	10 [7.5]

* 3450 rpm motors are used in handling low viscosity lubricating liquids.

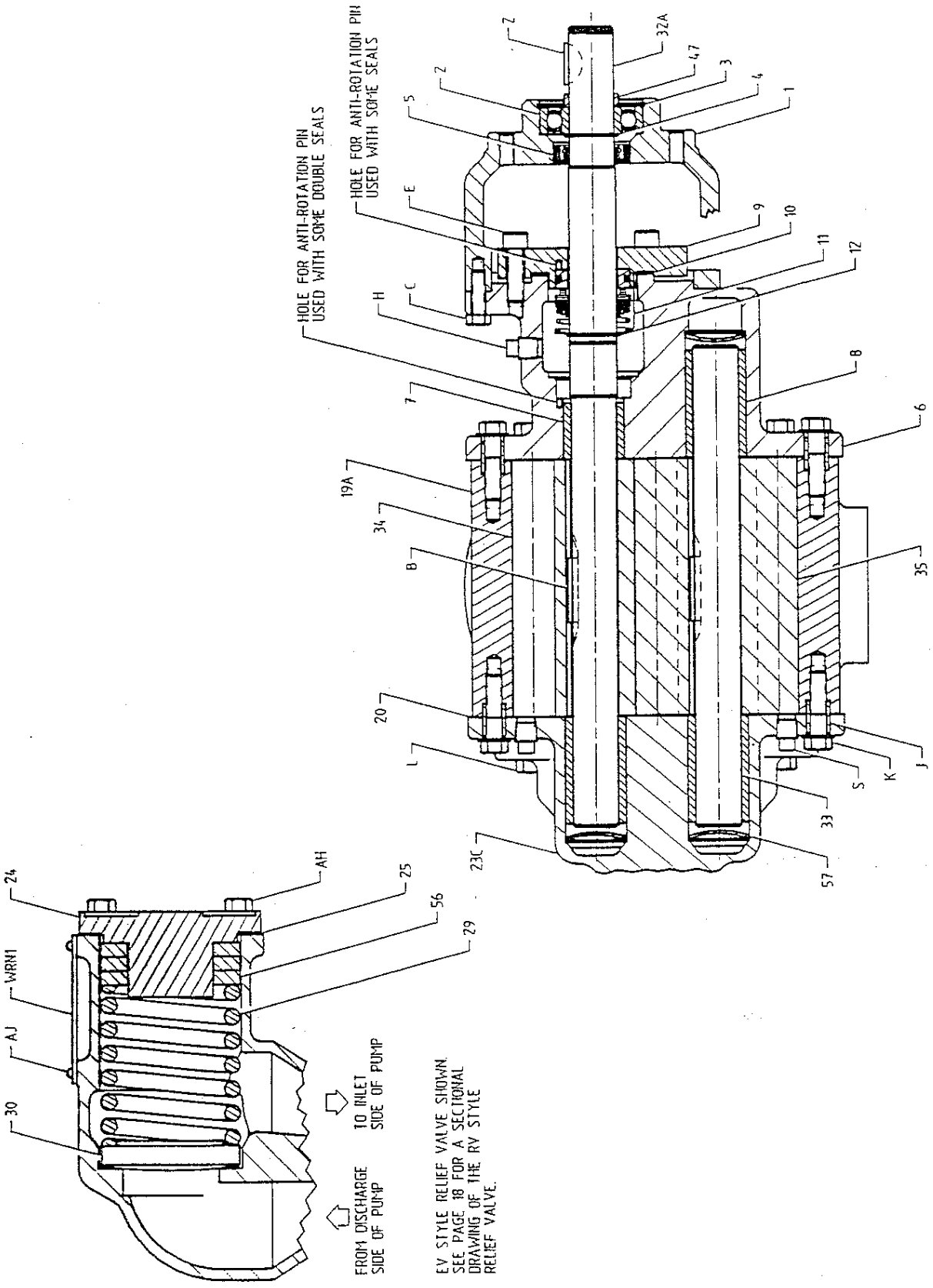
17. PUMP SECTIONAL DRAWINGS



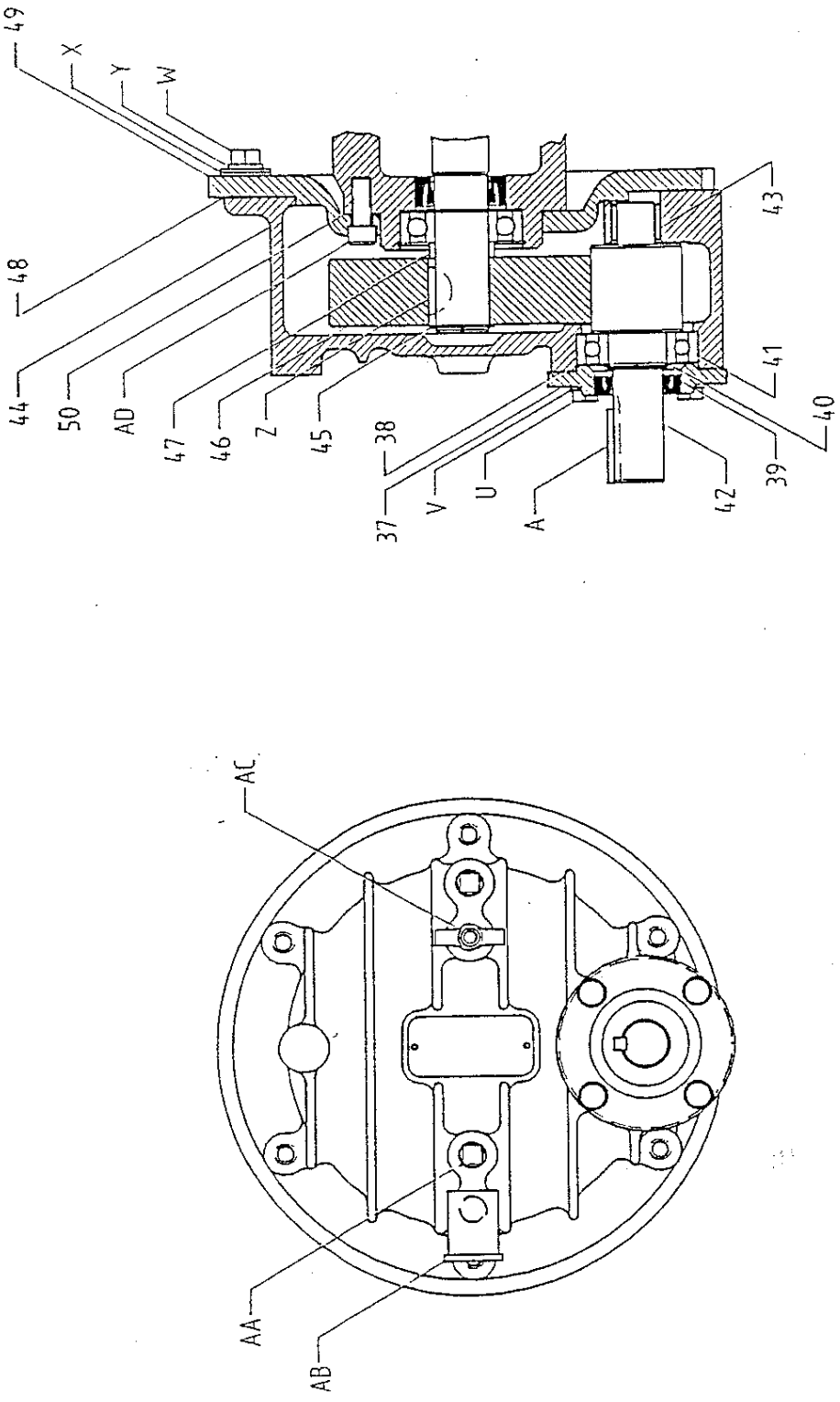
Z SERIES WITHOUT OUTBOARD BALL BEARING



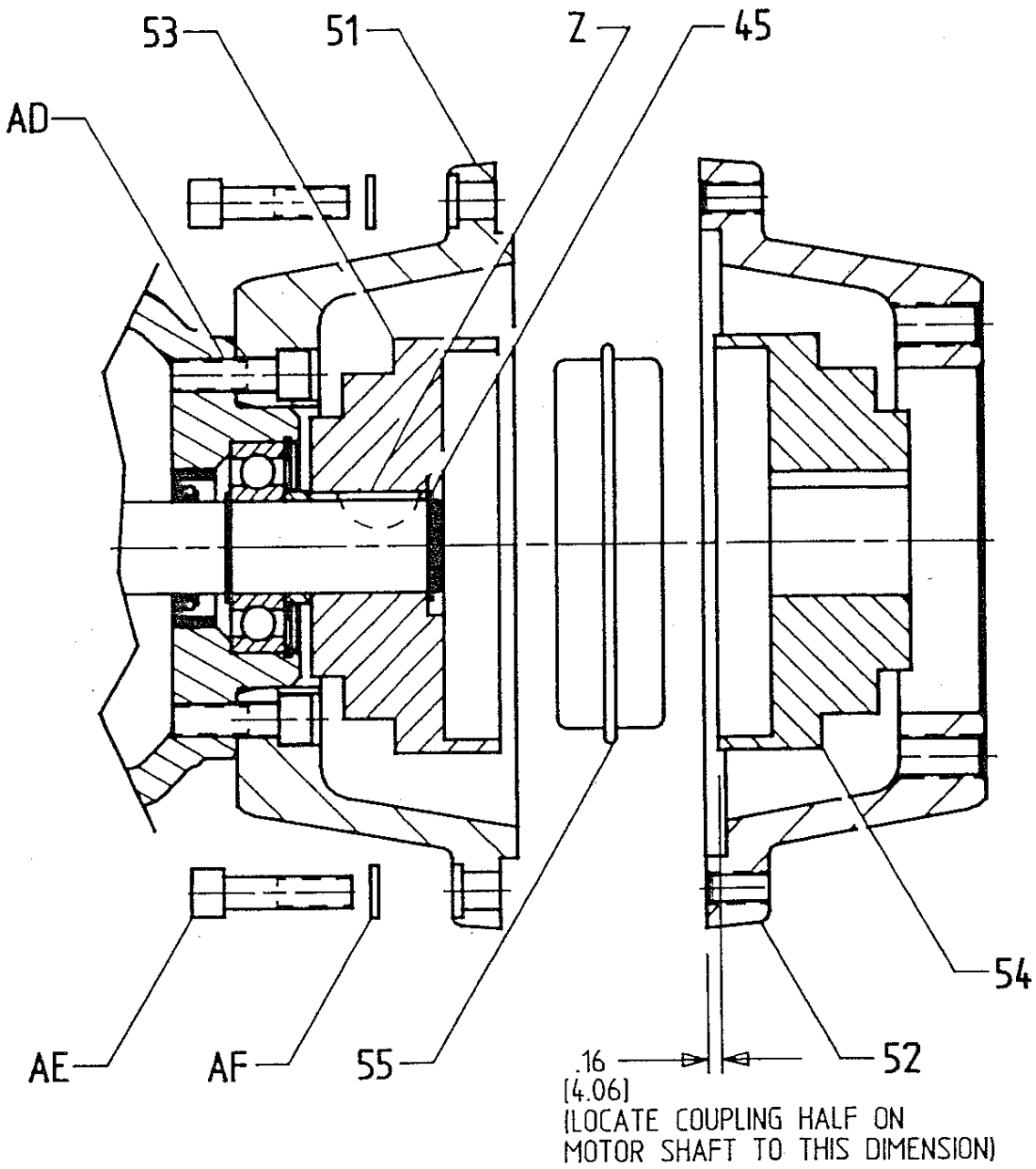
Z SERIES WITH OUTBOARD BALL BEARING



Z SERIES WITH MOUNTING FOR GEAR REDUCTION UNIT



GEAR REDUCTION ASSEMBLY



[MM]

HYDRAULIC DRIVE COUPLING ASSEMBLY

18. PARTS LIST

1. Bearing Cage
2. Ball Bearing
3. Retaining Ring, Bearing Cage
4. Retaining Ring, Ball Bearing
5. Lip Seal (GHB)
6. Backplate
7. Bearing, Short
8. Bearing, Long
9. Seal Retainer
10. Seal Retainer Gasket
11. Mechanical Seal
12. Retaining Ring, Mechanical Seal
13. Spacer, Crane® Type 88 only
19. Case
    - A. ANSI Flanged - Straight Through
    - B. Screwed Case - Right Angle
    - C. Flanged Case - Right Angle
    - D. Flanged Case - Straight Through
20. Case Gasket
21. Flange
22. Flange Gasket
23. Faceplate
    - A. Plain
    - B. RV Style Relief Valve
    - C. EV 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
    - A. With Retaining Ring Groove
    - B. Without Retaining Ring Groove
33. Idler Shaft
34. Drive Gear
35. Idler Gear
36. Retaining Ring, Gear (unit w/o outboard bearing)
    - A. Outer
    - B. Inner
56. Shim, EV Style Relief Valve only
57. Expansion Washer
58. Cam, Double Setting Relief Valve Only
59. Operating Piston, Double Setting Relief Valve Only

WRN1	Warning Plate, EV Style Relief Valve
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
- C. Hex Head Cap Screw, Bearing Cage to Backplate
- D. Lube Fitting
- E. Socket Head Cap Screw, Seal Retainer to Backplate
- 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
- N. Nut, Flange
- P. Pipe Plug, Case
- R. Pipe Plug, Flange
- S. Pipe Plug, Faceplate

T. Antirotation Pin
AH. Hex Head Cap Screw, EV Relief Valve only
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

Gear Reduction Assembly Only

37. Bearing Retainer
38. Bearing Retainer Gasket
39. Lip Seal
40. Retaining Ring, Ball Bearing
41. Ball Bearing
42. Pinion Gear and Shaft
43. Needle Bearing
44. Gear Case
45. Retaining Ring, Drive Gear
46. Drive Gear
47. Spacer
48. Gear Case Gasket
49. Cover
50. Cover Gasket

U. Hex Head Cap Screw, Bearing Retainer to Gear Case
V. Lockwasher, Bearing Retainer
W. Hex Head Cap Screw, Cover to Gear Case
X. Flat Washer, Gear Case
Y. Lockwasher, Gear Case
Z. Key, Drive Gear
AA. Pipe Plug, Gear Case
AB. Oil Cup, Gear Case
AC. Petcock, Gear Case
AD. Socket Head Cap Screw, Cover to Bearing Cage

Hydraulic Drive Coupling Assembly Only

51. Bracket Half, Pump
52. Bracket Half, Motor
53. Coupling Half, Pump
54. Coupling Half, Motor
55. Spider Coupling

AE. Socket Head Cap Screw, Bracket to Bracket

19. SHAFT SEALING

MECHANICAL SEALS

Various types of mechanical seals are available to fit most pumps. (See Various Sealing Arrangements.) Due to the many 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 Roper if you are considering a seal change in your pump.

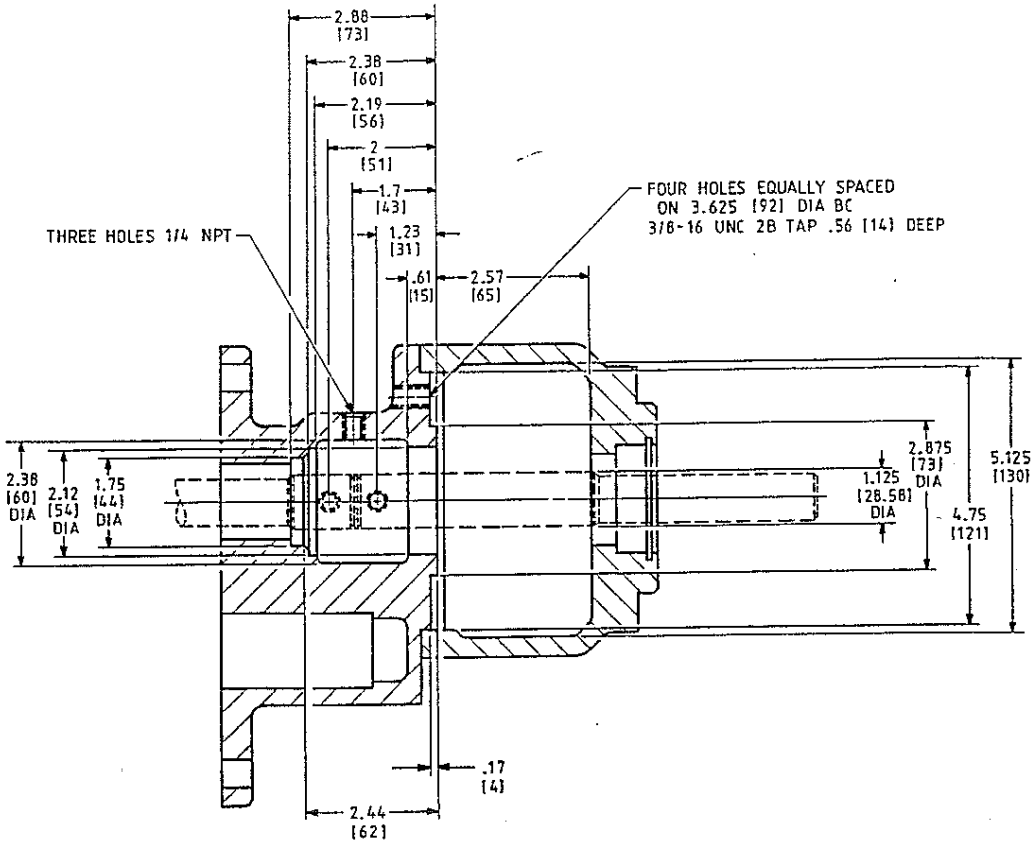
For removal or installation of mechanical seals, refer to disassembly and assembly procedures for pump.

When converting from a standard type seal such as John Crane® Type 21, Type 8-1, Type 9, or Sealol® 680 to a cartridge type seal, a different drive shaft will be required and the seal retainer will be discarded.

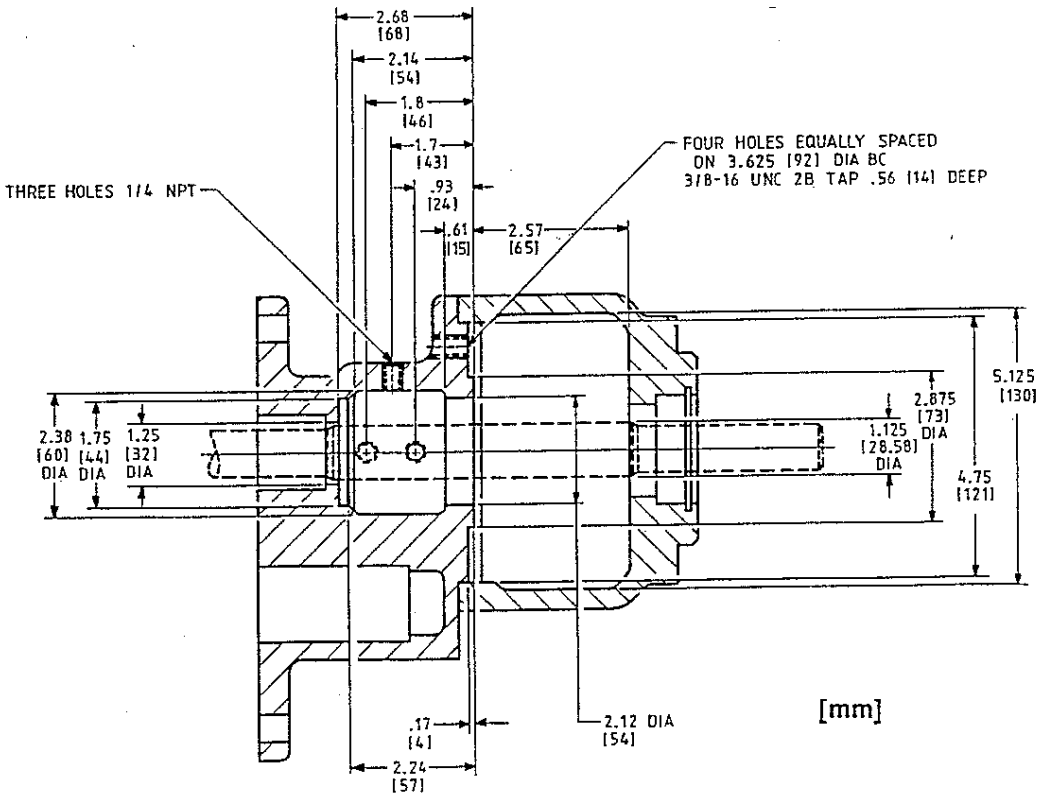
When converting from a standard type seal to a double type seal, the seal retainer and the drive shaft must be changed.

When converting from a standard type seal to a Dura® seal, the backplate, seal retainer, and drive shaft must be changed.

SEAL CHAMBER DIMENSIONALS



STANDARD, DOUBLE & CARTRIDGE MECHANICAL SEAL

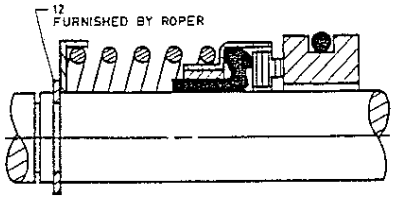


DOUBLE DURA® SEAL ONLY

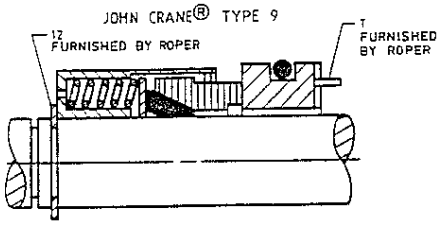
VARIOUS SEALING ARRANGEMENTS

SINGLE MECHANICAL SEAL:

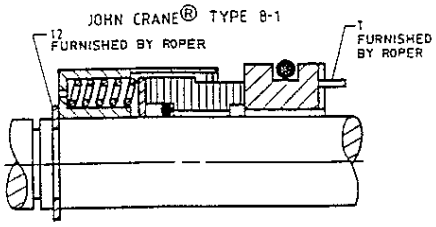
JOHN CRANE® TYPE 21



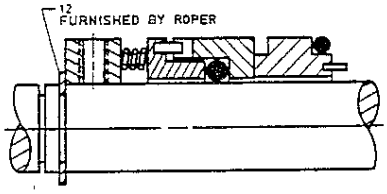
JOHN CRANE® TYPE 9



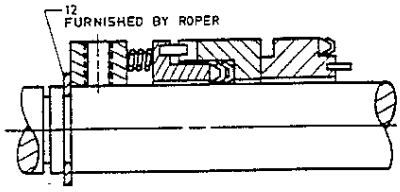
JOHN CRANE® TYPE 8-1



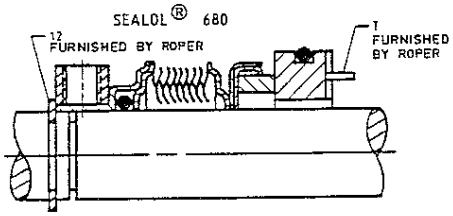
DURA® RO



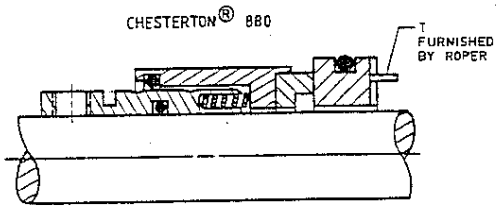
DURA® RO-TT



SEALOL® 680

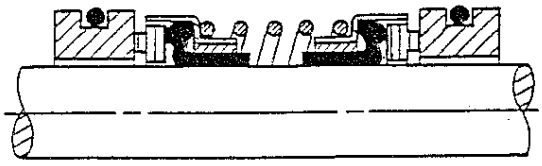


CHESTERTON® 880

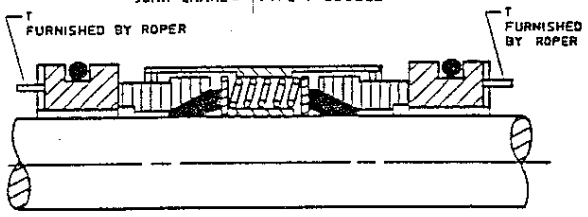


DOUBLE MECHANICAL SEAL:

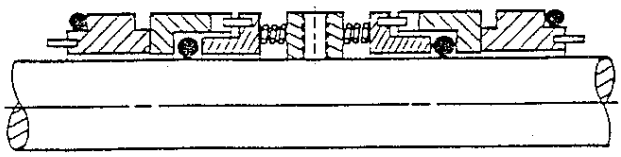
JOHN CRANE® TYPE 21 DOUBLE



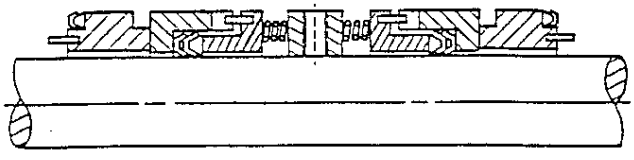
JOHN CRANE® TYPE 9 DOUBLE



DURA® RO DOUBLE

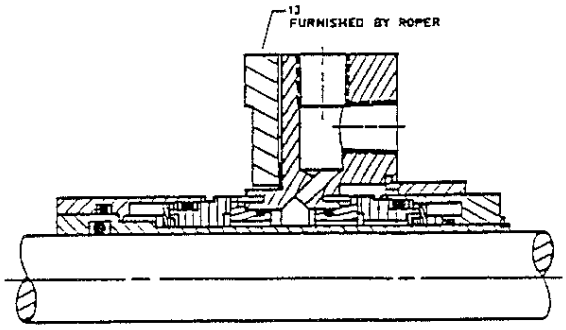


DURA® RO-TT DOUBLE

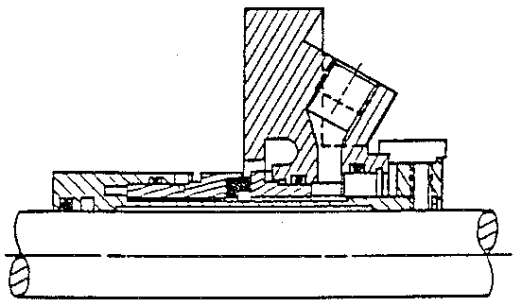


CARTRIDGE MECHANICAL SEAL:

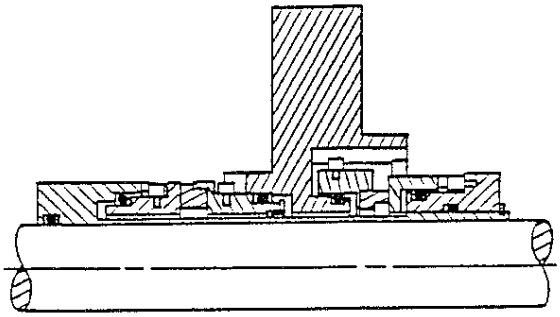
JOHN CRANE® TYPE 88



CHESTERTON® 123



CHESTERTON® 241



20. CHECKING PUMP PERFORMANCE

A summary of the causes of common malfunctions.

PROBLEM	POSSIBLE CAUSES
NO LIQUID DELIVERED	Pump rotating in wrong direction.
	Pump not primed.
	Inlet lift too high. Check this with gauge at pump inlet.
	Clogged inlet line.
	Inlet pipe not submerged.
	Air leaks in inlet line.
	Faulty pressure relief device in system.
	Pump worn.
RAPID WEAR	Excessive pressure.
	Nonlubricating liquid.
	Pump runs dry.
	Incompatibility of liquid and pump materials.
	Pipe strain on pump. See Installation of Pipes.
	Excessive abrasives in liquid.
EXCESSIVE NOISE	Starved pump.
	Air leaks in inlet line.
	Air or gases in liquid.
	Pump speed too high.
	Relief valve chatter. Check pressure setting.
	Improper mounting. Check alignment thoroughly. See Aligning Driver and Pump and Preparation of Foundation.
PUMP TAKES TOO MUCH POWER	Speed too high.
	Liquid more viscous than previously anticipated.
	Operating pressure higher than specified. Check this with gauge at pump discharge.
	Discharge line obstructed.
	Mechanical defect, such as bent shaft.
	Pipe strain on pump. See Installation of Pipes.
	Pressure relief device not operating properly.
	Air leaks in inlet line.

PROBLEM	POSSIBLE CAUSES
INSUFFICIENT LIQUID DELIVERED	Air leaks through mechanical seal.
	Speed too slow.
	Excessive lift at inlet. Check this with gauge at pump inlet.
	Viscosity of liquid too high for size and length of inlet pipe.
	Foot valve, if used, too small, stuck, or not working properly.
	Foot valve or end of inlet pipe not immersed deeply enough in liquid.
	Excessive clearance in pump caused by wear or corrosion.
	Faulty pressure relief device.

21. REPLACEMENT PARTS

Repair parts can be ordered from your nearest Roper distributor. For the location of a distributor near you, contact Roper Pump Company. DO NOT order repair parts by their key number. Order by Roper part number only and include the nameplate data for aid in identification. Repair parts list depicting Roper part numbers are available for most pumps.

Roper Pump Company assumes no responsibility for parts other than those supplied by Roper. The use of substitutes may result in poor performance or in an accident causing physical damage or injury to personnel.

- WARNING! Only use genuine Roper gaskets. (1) Gasket thickness determines proper clearances. Always check quantity of gaskets removed and replace with exact quantity. (2) Proper material must be used based on application

SERVICE NOTES

SERVICE NOTES

Additional copies of the installation and operation manual may be obtained by contacting a Roper distributor or:

Roper Pump Company
P.O. Box 269
Commerce, Georgia 30529 U.S.A.

Telephone: (706) 335-5551
TeleFAX: (706) 335-5505

Your Roper Distributor is:

PART NO. G12-240
ISSUED DATE: 6/1/94

PRINT DATE: 5-6-97