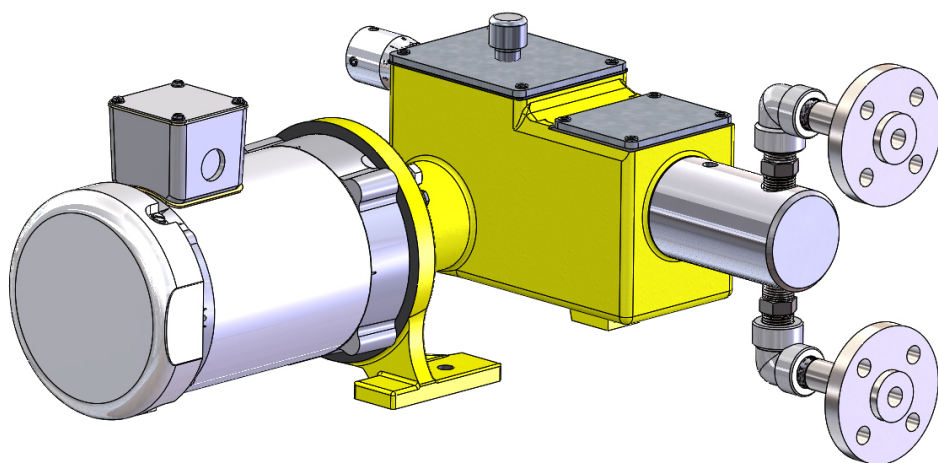




# **MILROYAL® D Drive With Packed Plunger Liquid End**

## **Instruction Manual**

Manual No : 53941

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# **PRECAUTIONS**

The following precautions should be taken when working with metering pumps.  
Please read this section carefully prior to installation.

## **Protective Clothing**



**ALWAYS** wear protective clothing, face shield, safety glasses and gloves when working on or near your metering pump. Additional precautions should be taken depending on the solution being pumped. Refer to **Safety Data Sheets** for the solution being pumped.

## **Hearing Protection**



It is recommended that hearing protection be used if the pump is in an environment where the time-weighted average sound level (TWA) of 85 decibels is exceeded. (as measured on the A scale - slow response)

## **Electrical Safety**



- Remove power and ensure that it remains off while maintaining pump.
- **DO NOT FORGET TO CONNECT THE PUMP TO EARTH/ GROUND.**
- Electric protection of the motor (Thermal protection or by means of fuses) is to correspond to the rated current indicated on the motor data plate.

## **Liquid Compatibility**



Verify if the materials of construction of the wetted components of your pump are recommended for the solution (chemical) to be pumped.

## **Pumps Water “Primed”**



All pumps are tested with water at the factory. If your process solution is not compatible with water, flush the **Pump Head Assembly** with an appropriate solution before introducing the process solution.

## **Plumbing and Electrical Connections**



Always adhere to your local plumbing and electrical codes.

## **Line Depressurization**



To reduce the risk of chemical contact during disassembly or maintenance, the suction and discharge lines should be depressurized before servicing.

## **Over Pressure Protection**



To ensure safe operation of the system it is recommended that some type of safety/pressure-relief valve be installed to protect the piping and other system components from damage due to over- pressure.

## **Lifting**



This manual should be used as a guide only - Follow your company's recommended lifting procedures. It is not intended to replace or take precedence over recommendations, policies and procedures judged as safe due to the local environment than what is contained herein. Use lifting equipment that is rated for the weight of the equipment to be lifted.



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## **1.1 INTRODUCTION**

The MILROYAL® D Controlled Volume Pump is a reciprocating plunger, positive displacement pump designed to deliver accurately measured liquid volumes against a positive differential pressure (or head) between pump suction and discharge. Precision built, the pump performs this function with a repetitive accuracy of plus or minus one percent of mean delivered volume.

Basically, the pump consists of a drive unit, plunger and displacement chamber or liquid end in which the plunger reciprocates. The pump delivers a controlled volume of liquid with each discharge stroke.

Pump capacity is adjustable by changing plunger stroking speed and / or length. Capacity adjustment can be made manually or automatically by signal from remote process control instruments. Selection of capacity control methods is determined by the nature of the application.

## **1.2 UNPACKING**

Pumps are shipped Free on Board (FOB) from the factory and title passes to the customer when carrier signs for receipt of it. The customer, therefore, must file damage claims with the carrier. The shipping crate should be carefully examined upon receipt from carrier to be sure there is no obvious damage to the contents. Open the crate carefully, as there are sometimes accessory items fastened to the inside of the crate which may be lost or damaged. Examine all material inside crate and check against packing list to be sure that all items are accounted for and undamaged.

## **1.3 MOUNTING (Refer to Figure 1)**

Support the pump firmly in a level position on a solid foundation, preferable with the base above floor level to protect it from wash downs and provide easier access for service. This model pump is provided with three tie-down points to accommodate anchor bolts. Table-top operation is possible without need for tie-down with 1/8" or 1/4" plunger diameter liquid end, but tie-down is necessary for 7/16" and 5/8" plunger diameter liquid ends. Up to six units can be easily multiplexed to a single standard motor without special support.

## **1.4 PIPING**

### **1.4.1 General Information**

1. Use piping materials that are resistant to corrosion by the liquid being pumped. Use care in selection of materials to avoid galvanic corrosion at points of connection to the pump liquid end.
2. Use piping sufficiently heavy to withstand maximum pressures.
3. Blow out all lines before making final connections to pump.
4. Provide for pipe expansion when hot fluids are to be pumped. Support piping so that pipe weight is not placed on the pump. Never spring piping to make connections.
5. Piping should be sloped in a manner to prevent trapping of vapor pockets. Vapor present in liquid end will cause inaccurate pump delivery.

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## SECTION 1 - INSTALLATION

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### 1.4.2 Suction Piping

1. If possible use metal or plastic tubing for the suction line because tubing has a smooth inner surface and can be formed into sweep bends, thus decreasing frictional flow losses.
2. Suction piping must be absolutely air tight to insure accurate pumping. After installation, test suction piping with air and soap solution for leaks.
3. A strainer should be used in the suction line to prevent foreign particles from entering the liquid end. Any measures which prevent foreign matter from entering and fouling the ball checks will give increased maintenance free service.
4. It is preferable to have the suction of the pump flooded by having the liquid end located below the level of the fluid in the supply tank.
5. When pumping liquids at temperatures near the boiling point, provide sufficient suction head to prevent “flashing” of the liquid into vapor when it enters the liquid end on the suction stroke.
6. Suction piping need to be one or two sizes larger than the liquid end suction fitting, ensure NPIP (Net Positive Inlet Pressure).
7. Sealed piping, sufficient suction pressure, and properly adjusted packing are absolutely necessary for accurate and stable pump operation.

### 1.4.3 Discharge Piping

1. Install adequate size pump to prevent excessive pressure losses on the discharge stroke of the pump. Maximum pressure at the discharge fitting on the liquid end must be kept at or below the maximum pressure rating as shown on the pump data plate. The peak flow of this type pump during the discharge stroke is approximately three times the average flow rate (because of harmonic motion of the plunger) and discharge piping should be sized accordingly.
2. The pump will not deliver a controlled flow if the discharge pressure is less than the suction pressure. Piping should be arranged to provide at least 5 psi (34.5 kPa) positive pressure differential from the discharge side to the suction side. There are a number of ways to create an artificial discharge pressure, such as the use of a vented riser or a back pressure valve.

## 1.5 SERVICE CONNECTIONS

### 1.5.1 Pump Drive

1. Check the nameplate data on the pump drive (motor) and insure proper power supply is available before making any connections.
2. Preferred motor shaft rotation is marked on the drive side flange of the pump. Although severe immediate damage will not occur if motor rotation is incorrect, preferred rotation should be observed. (See Maintenance Instructions, Assembly of Gear Cage into Pump Housing.) Where possible, correct drive rotation will be established at shipment by the factory.
3. For drives other than constant speed electric motors, refer to complete manufacturer's instructions and service information included with pump.

**1.5.2 Auxiliary (Accessory) Equipment**

1. Service connections for auxiliary or accessory electrical equipment should be determined by reference to wiring diagrams, instruction manuals, and data plate requirements furnished with the equipment.
2. Air operated equipment will normally require two sources of air supply. A standard 60 psig (414 kPa) (80-100 psi (552-690 kPa) at compressor) plant air supply will usually be satisfactory for the power elements. An instrument air signal is required for control instruments.

**1.5.3 Drains**

Provide drains convenient to the pump so that any leakage may be easily removed. The pump catchall area is provided with a cast hole which may be drilled and tapped or otherwise altered to receive desired piping for drainage.

## SECTION 2 - OPERATION

### 2.1 PRINCIPLES OF OPERATION

MILROYAL® D Pumps consist of two basic mechanisms; the drive system and the liquid end. The drive mechanism (*Figure 1*) is unique and operates on a patented polar crank principle (*Figure 2*). Essentially, a crank driven by a worm gear reduction system rotates on a plane whose slope is variable.

As the slope of the plane is changed OFF the vertical, a link transmits the resulting reciprocating motion from the crank to the plunger. Stroke length of the pump is increased from zero to maximum by adjusting the slope of the plane from vertical.

As the plunger reciprocates in the liquid end, the pumped liquid is alternately drawn into and discharged from the liquid end. On the suction (rearward) stroke the liquid follows the plunger, unseating the double suction ball checks and seating the discharge ball checks (*Figure 4 or 5*). The discharge ball checks prevent back-flow of liquid into the displacement chamber. On the discharge stroke (plunger moving forward) the plunger exerts pressure on the liquid, causing the discharge ball checks to rise, allowing liquid to flow out of the displacement chamber and seating the suction ball checks. Thus, by repetitive reciprocating plunger strokes, liquid is caused to flow in only one direction from the suction port, through the displacement chamber, and out the discharge port.

### 2.2 OPERATION

#### 2.2.1 Pre-Operational Inspection

After the pump is installed, but before it is started for the first time, a number of checks should be made:

1. Be sure all tie down bolts are tight, piping is installed properly, and the discharge line is open.
2. Check the pump housing and fill to the correct level with the recommended lubricant listed in the table below. The nominal capacity of the MILROYAL® D housing is 1 pint. Fill to the level of the drain plug.

| Liquid End     | Operating Oil Temperature       | Type Oil                        |
|----------------|---------------------------------|---------------------------------|
| Packed Plunger | 15°F to 125°F<br>(-9°C to 52°C) | AGMA No. 7<br>Compounded        |
|                |                                 | Nevastane SL 100,<br>Food Grade |

#### 2.2.2 Capacity Adjustment: Stroke Length

Pump capacity is adjusted by turning the micrometer type stroke adjustment knob clockwise to decrease or counterclockwise to increase the capacity as required. The adjustment scale is marked in percent of full stroke, with calibration lines on the knob at 1.0% intervals. There is a friction plug and setscrew threaded into the side of the boss enclosed by the stroke adjustment knob. Periodic adjustment (tightening) may be required to provide enough friction to keep the stroke adjustment from creeping. The nylon friction plug should be replaced when worn to keep from bearing the steel setscrew against the stroke adjustment screw threads and damaging this part.

### **2.2.3 Capacity Adjustment: Stroke Speed**

Capacity of the MILROYAL® D Pump is directly proportional to the input drive speed. Most pumps are supplied with a constant speed electric motor as the input power source. With a constant speed input power source, the stroking speed is established by the worm and worm gear set installed in the pump housing, and may be changed only by changing this gear set. The use of a variable speed input power source, however, allows continuous variation of stroking speed and, therefore, output flow rate variation over a broader range.

## **2.3 START- UP**

### **2.3.1 General**

All pumps are thoroughly tested under simulated operating conditions before they leave the factory to verify the pump capacity and to check the drive motor for satisfactory operation at maximum rated pressure. With the pump housing filled to the proper oil level and all piping and electrical connections made, the pump is now ready for start-up.

### **2.3.2 Packing**

New packing, installed and shipped from the factory in a complete pump or liquid end, has been “set” and run-in during production quality assurance testing and requires no further breaking in for start-up. During operation, if leakage does occur, the gland nut should be tightened a little at a time (1/6 turn or less) until leakage is minimized or stopped. The packing should be allowed to resettle at least five minutes between adjustments. If it is possible to tolerate a little leakage at the gland, the leaking liquid will help to lubricate and cool the packing and plunger, greatly extending the life of both.

### **2.3.3 Capacity Calibration**

After the initial break-in period and adjustment of the packing, test runs should be made to determine the exact capacity of these controlled volume pump under the specific operating conditions for various stroke length settings. Usually it is necessary to calibrate the pump at only three stroke length settings to determine its characteristics throughout the entire range. The settings normally used are full stroke (100%), 50%, and 20% stroke length.

Two methods of measuring the capacity in a given time limit can be used:

1. Measure the drop in liquid level from calibrated vessel (preferred).
2. Measure the quantity collected from the discharge side of the pump.

It is essential that the suction lines of controlled volume pumps be absolutely free of entrapped air or vapor to prevent gas movement into the liquid end. Milton Roy liquid ends are designed to rapidly discharge any small bubbles which may enter. However, any large amounts of gas in the liquid end is alternately compressed and expanded with each plunger stroke and causes inaccuracies in pumping. In severe case the liquid end may become vapor bound and cease pumping altogether.

## SECTION 3 - MAINTENANCE INSTRUCTIONS-DRIVE SECTION

The MILROYAL® D Pump has been carefully designed, manufactured, assembled, and tested to give reliable service with a minimum amount of maintenance. However, in normal operation, a periodic check of the pump is recommended to visually confirm proper operation of the pump.

### 3.1 LUBRICATION

Fill the gear section of the MILROYAL® D housing with recommended gear lubricant (*see page 8 for oil type*) to the oil level plug hole. The oil should be changed every 2500 hours of operation or every six months, whichever comes first. This can often be scheduled with winter and summer oil change.

### 3.2 SPARE PARTS (Figure 3)

It is recommended that a standard group of spare parts (*shown in Table 4*) be kept on hand at all times to prevent serious delays in repairs. The following list of spare parts represents those which should be kept on hand for each pump drive (see liquid end section for spare parts for liquid end).

Parts orders must include the following information:

1. Quantity required.\*
2. Part number.\*
3. Part description.\*
4. Pump serial number (include in all correspondence regarding the pump).\*\*
5. Full model number.\*\*

\* Found in this manual.

\*\* Found on pump nameplate.

#### EXAMPLE:

Two No. 200 Clevis Pins for model DB2-C-175R, serial number IP-0009 Milton Roy Pump.

### 3.3 RETURNING PUMPS TO THE FACTORY

Pumps will not be accepted for repair without a Return Material Authorization, available from the Factory Repair Department. Pumps returned to the Factory for repairs should be clearly labeled to indicate the liquid being pumped. Process liquid should be flushed from the pump liquid end and oil should be drained from the pump housing before the pump is shipped.

#### Note:

*Federal law prohibits handling of equipment that is not accompanied by an OSHA Safety Data Sheet (SDS). A completed SDS must be packed in the shipping crate with any pump returned to the factory. These safety precautions will aid the troubleshooting and repair procedure and preclude serious injury to repair personnel from hazardous residue in pump liquid end. A Safety Data Sheet must accompany all returns.*

All inquiries or parts orders should be addressed to your local Milton Roy representative or sent to: [www.miltonroy.com](http://www.miltonroy.com).

| Item Number  | Part Name                                            | Qty          |
|--------------|------------------------------------------------------|--------------|
| 160          | Crank Pin                                            | 1            |
| 165          | Crank Pin Shoulder                                   | 1            |
| 142          | Connecting Rod Assembly (Includes Spherical Bearing) | 1            |
| 270          | Friction Plug                                        | 2            |
| 152          | Dowel Pin                                            | 1            |
| 210          | Snap Ring                                            | 2            |
| 40           | Shaft Oil Seal                                       | 4            |
| 112          | Worm Shaft Bearing                                   | 2            |
| 211-0042-006 | Journal Nut Tool                                     | 1            |
| None         | Coupling Insert for 300 Coupling                     | 1            |
| None         | LOCTITE™ Grade 222                                   | 0.10 cc tube |

Table 1. Drive Spare Parts.

## SECTION 3 - MAINTENANCE INSTRUCTIONS-DRIVE SECTION

### 3.4 REPLACING SPARE PARTS (Figure 3)

#### 3.4.1 Removal of Gear Cage

1. Remove pump housing assembly from No. 272 motor mounting adapter.
2. Remove No. 290 shaft cover.
3. Remove No. 25 oil drain plug and drain oil from housing.

**Note:**

*At this point the entire pump body should be securely held in a comfortable working position, such as in a large vise.*

4. Remove No. 300 coupling from worm shaft.
5. Turn stroke control to 100%. Using journal nut tool, unscrew No. 100 journal nut (right hand thread) from housing.

**Note:**

*The journal nut can be removed more easily by applying a steady force on the wrench rather than by attempting to hammer the wrench to break the nut free.*

6. Unscrew the journal nut and pull it OFF the shaft. Bearing No. 112 should come out with the journal nut.
7. Remove worm shaft from housing.
8. Unscrew and remove crankpin and crankpin shoulder, No. 160 & 165.
9. Remove No. 210 snap rings and push clevis pin No. 200 aside to disengage stroke adjusting screw.
10. Lift gear cage out of housing. The remaining bearing should come out with the cage. The cage cannot be removed unless this bearing is in place in the cage.
11. Remove nut No. 100 and worm gear from the crank. Take care not to lose the key which pins worm gear to crank.
12. Bronze bearing No. 72 must be pressed onto crank if replacement of bearing is required.

#### 3.4.2 Removal of Crosshead (Figures 4 & 5)

1. The above disassembly procedure for removal of Gear Cage must be accomplished prior to removal of Crosshead.
2. Unscrew Plunger Adapter Nut No. 235 until the thread is free of the Crosshead.
3. Pull Crosshead out of its bore from the rear, taking care not to lose Thrust Washer No. 245 if it remains in Crosshead when Nut No. 235 is removed.
4. Use a drift pin to remove No. 152 Dowel Pin joining Crosshead and Connecting Rod Assembly No. 142.

### **CAUTION**

CONNECTING ROD ASSEMBLY MAY BE OF TWO PIECE CONSTRUCTION, HAVING A THREADED SHANK SPHERICAL BEARING SCREWED INTO CONNECTING ROD. IF SO, DO NOT CHANGE THE RELATIONSHIP OF CONNECTING ROD AND SPHERICAL BEARING HOLES BY SCREWING THE BEARING IN OR OUT. IF THE RELATIONSHIP IS CHANGED, DAMAGE TO THE PUMP WILL OCCUR WHEN PUT BACK INTO OPERATION.

#### 3.4.3 Assembly & Installation of Crosshead

1. Support Crosshead in a "V" block of soft material to protect Crosshead outside finish. Insert No. 142 Connecting Rod Assembly into Crosshead slot so the dog-leg of the Connecting Rod points the Spherical Bearing to the open side of the slot.
2. Push No. 152 Dowel Pin into Crosshead (slip fit) and tap pin through hole in the Connecting Rod (force fit). Make sure Dowel Pin ends are not sticking out either side of Crosshead and that connecting rod oscillates freely without binding.
3. Insert assembled Crosshead into Pump Housing, gently working it forward through No. 52 Oil Seal.

## SECTION 3 - MAINTENANCE INSTRUCTIONS-DRIVE SECTION

### 3.4.4 Assembly of Gear cage into Pump Housing

Before assembly, several of the parts may need special preparation.

The Journal Nut threads (on nut and housing), Crankpin and Crankpin Shoulder, Worm Shaft, Crank threads, Crank Nut, and if bearings or oil seals are removed the outside of bearings and seals and inside of mating housing surfaces must be thoroughly cleaned of oil and foreign matter. This will require scraping of parts to remove original film of LOCTITE™ and use of solvent for degreasing.

**CAUTION** DO NOT IMMERSE SEALS IN SOLVENT AS THIS MAY CAUSE SEVERE SWELLING OF SEAL MATERIAL.

The following special tools and equipment are required: MILROYAL® D Journal Nut Tool No. 211-0042-006, and LOCTITE™ Grade 222.

1. Replace Oil Drain Plug No. 25.
2. If bearings and / or oil seals have been removed for replacement:
  - a. Crosshead Oil Seal No. 52 should be installed with sealing lip facing stroke adjustment end of pump. Apply a thin coat of LOCTITE™ Grade 222 to outside of Seal Casing and press in Seal until it is firmly seated in the bottom of its recess.
  - b. The motor-side Shaft Bearing should be pressed into its recess with grade HV LOCTITE™. Seat the Bearing into the recess as far as it will go. The same procedure should be followed for installing the other bearing into the Journal Nut.
- c. After the bearings are installed, lightly coat the outside of Shaft Oil Seals with LOCTITE™ Grade 222 and press into place until flush with bearing recess. Be sure seal lips are facing toward the bearings. When all bearings and shaft seals are installed there should be one seal in the drive side of the Housing, one bearing in the drive side of the Gear Cage, and a bearing and oil seal in the Journal Nut, all LOCTITED™ sealed in place.
3. Insert Crank No. 216 with its pressed-on Bearing No. 72 through bore in Gear Cage, and insert No. 90 Key into key way. Slide Worm Gear onto Crank with side of Worm Gear having stamped identification numbers facing stroke adjustment end of pump. Apply 2 to 3 drops of LOCTITE™ Grade 222 to crank threads and tighten nut No. 100 to 125-130 Inch-pounds (46-48 N). Check to insure free rotation of Crank and Worm Gear.
4. Insert Clevis Pins No. 200 into holes in Gear Cage with tongs pointed inward.
5. Place Gear Cage into housing. Position drive-side bearing into its recess in housing.
6. Insert Shaft and Worm through Cage and Bearing. Apply 3 to 4 drops of LOCTITE™ Grade 222 to a single thread of Journal Nut about mid-way on the Nut, coating the thread for an entire revolution.
7. Slip Journal Nut over Shaft and screw it finger tight into Housing. Make sure both shaft bearings are seated in their recesses. Using Journal Nut Tool, tighten Journal Nut to approximately 30 inch-pounds (11 N) torque.

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## SECTION 3 - MAINTENANCE INSTRUCTIONS-DRIVE SECTION

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8. Adjust stroke adjustment screw to 10% and pull Gear Cage to align No. 200 Clevis Pins with groove in stroke adjustment screw. Slide Clevis Pins into the groove and install No. 220 “E” Rings so concave sides of rings bear against cage.
9. Pin No. 142 Connecting Rod Bearing to No. 216 Crank using No. 160 and No. 165 Crank Pin and Crank Pin Shoulder in the following manner. Determine operating direction of rotation of crank. Place a drop of LOCTITE™ Grade 222 on threaded section of No. 160 Crank Pin. Insert No. 165 Crank Pin Shoulder through leading side hole of crank and No. 160 Crank Pin through following side hole of crank. This allows the solid crank pin to perform the heavy duty cycle portion of the pumping stroke.
10. If applicable, assemble Liquid End and Plunger into Pump Body as outlined in Liquid End Maintenance section.

#### 4.1 SPARE PARTS (Figure 4)

It is recommended that a standard group of spare parts be kept on hand at all times to prevent serious delays in repairs. The following list of spare parts represents those which should be kept on hand for each liquid end (see pump drive section for spare parts for pump drive).

Parts orders must include the following information:

1. Quantity required.\*
2. Part number.\*
3. Part description.\*
4. Pump serial number (include in all correspondence regarding the pump).\*\*
5. Full model number.\*\*

\* Found in this manual.

\*\* Found on pump nameplate.

#### EXAMPLE:

Four No. 384 Clevis Pins for model DB2-C-175R, serial number IP-0009 Milton Roy Pump.

#### NOTE:

*Unless otherwise specified, plunger size and materials of construction of spare parts will be the same as specified on the original pump order.*

#### 4.2 RETURNING PUMPS TO THE FACTORY

Pumps will not be accepted for repair without a Return Material Authorization, available from the Factory Repair Department. Pumps returned to the Factory for repairs should be clearly labeled to indicate the liquid being pumped. Process liquid should be flushed from the pump liquid end and oil should be drained from the pump housing before the pump is shipped.

#### NOTE:

*Federal law prohibits handling of equipment that is not accompanied by an OSHA Safety Data Sheet (SDS). A completed SDS must be packed in the shipping crate with any pump returned to the factory. These safety precautions will aid the troubleshooting and repair procedure and preclude serious injury to repair personnel from hazardous residue in pump liquid end. A Safety Data Sheet must accompany all returns.*

All inquiries or parts orders should be addressed to your local Milton Roy representative or sent to: [www.miltonroy.com](http://www.miltonroy.com).

| Item Number | Part Name          | Qty    |
|-------------|--------------------|--------|
| 383         | Ball Seat          | 4      |
| 385         | Cap Gasket         | 6      |
| 222         | Plunger Assembly   | 1      |
| 245         | Thrust Washer      | 1      |
| 250         | Thrust Washer Ring | 1      |
| 384         | Ball Check         | 1      |
| 425         | Packing            | 2 Sets |

**Table 2. Spare Parts for Liquid Ends with 1/8" and 1/4" Diameter Plunger.**

### **4.3 LUBRICATION**

No lubrication is required. All sliding surfaces which would normally require lubrication are in contact with a self- lubricating fluorocarbon material.

### **4.4 CHECK VALVE MAINTENANCE**

Suction and discharge cartridge assembly 405 are designed to be self cleaning and should give long, trouble free service. If the check valves do become fouled, a hot detergent solution cleaning will usually remove all but the most stubborn contaminants. Prepare a hot detergent solution and pump it freely through the pump for 10 to 15 minutes. Flush with hot water and return the pump to normal service.

If flushing does not prove adequate, remove the cartridges and inspect for chemical damage. A cotton swab is often helpful in cleaning the seat area. Replace cartridge assembly with Ball Checks, Seats, and Gaskets in the order shown on *Figure 4*. This cartridge design depends on compression of the Cap Gaskets (No. 385) to prohibit leakage from around outside of Ball Seats and exterior thread of No. 381 Caps; therefore, on reassembly tighten Caps down firmly.

### **4.5 PACKING ADJUSTMENT, START- UP AND REPLACEMENT**

New Packing, installed and shipped from the factory in a complete pump or liquid end, has been "set" and run-in during production quality assurance testing and requires no further breaking in for start-up. If, during operation, leakage does occur, Gland Nut No. 430 should be tightened a little at a time (1/6 turn or less) until leakage is minimized or stopped. Wait at least five minutes between adjustments to allow packing to resettle. If it is possible to tolerate a little leakage at the Gland, the leaking liquid will help to lubricate and cool Packing and Plunger, greatly extending the life of both.

#### **4.5.1 Replacing Packing**

1. To replace packing it is necessary to remove liquid end from the pump.
2. Loosen No. 430 Gland Cap.
3. Remove two screws which retain No. 410 Adapter to Pump Housing and pull liquid end straight forward, taking care not to bend plunger. Inspect plunger for scoring or pitting and replace if necessary.
4. With liquid end OFF pump, remove gland cap and packing follower.
5. Remove old packing with a small hook (do not scratch stuffing box) and thoroughly clean stuffing of any foreign material.
6. Install new packing with female portions facing forward so they may react with applied hydraulic pressure and expand against stuffing box walls and plunger to effect a good seal.
7. Replace packing follower and screw gland cap on lightly.
8. Install plunger if it has been removed, making sure the two thrust washers are replaced. If necessary, moisten solid washer with a drop of clean light oil to insure it remains seated in plunger adapter nut during installation.
9. After tightening plunger adapter nut, loosen it 1/8 turn (no more or thrust washer may unseat).
10. Carefully slide entire liquid end over plunger and back onto pump and secure it with the two screws.
11. Tighten gland cap finger tight to center plunger, then tighten plunger adapter nut firmly.
12. Tighten No. 430 gland cap 1/4 turn past finger tight and hold packing under this compression for 10 minutes to allow packing to settle in stuffing box.

13. Loosen gland cap and retighten 1/6 turn (one HEX flat) past finger tight.
14. Start pump at 100% stroke length but without pumping load. It is permissible to run liquid end dry, or pump fluid to atmospheric pressure. Run for about 1/2 hour.
15. At end of this break-in period put pump into full operation against normal pumping load. Adjust capacity to the desired chemical feed.
16. Adjust packing as explained under "Packing Adjustment, Start- Up and Replacement".

### 5.1 SPARE PARTS (Figure 5)

It is recommended that a standard group of spare parts be kept on hand at all times to prevent serious delays in repairs. The following list of spare parts represents those which should be kept on hand for each liquid end (see pump drive section for spare parts for pump drive).

Parts orders must include the following information:

1. Quantity required.\*
2. Part number.\*
3. Part description.\*
4. Pump serial number (include in all correspondence regarding the pump).\*\*
5. Full model number.\*\*

\* Found in this manual.

\*\* Found on pump nameplate.

#### EXAMPLE

Four No. 435 Clevis Pins for model DB2-C-175R, serial number IP-0009 Milton Roy Pump.

#### NOTE:

*Unless otherwise specified, plunger size and materials of construction of spare parts will be the same as specified on the original pump order.*

### 5.2 RETURNING PUMPS TO THE FACTORY

Pumps will not be accepted for repair without a Return Material Authorization, available from the Factory Repair Department. Pumps returned to the Factory for repairs should be clearly labeled to indicate the liquid being pumped. Process liquid should be flushed from the pump liquid end and oil should be drained from the pump housing before the pump is shipped.

#### NOTE:

*Federal law prohibits handling of equipment that is not accompanied by an OSHA Safety Data Sheet (SDS). A completed SDS must be packed in the shipping crate with any pump returned to the factory. These safety precautions will aid the troubleshooting and repair procedure and preclude serious injury to repair personnel from hazardous residue in pump liquid end. A Safety Data Sheet must accompany all returns.*

All inquiries or parts orders should be addressed to your local Milton Roy representative or sent to: [www.miltonroy.com](http://www.miltonroy.com).

| Item Number | Part Name                     | Qty    |
|-------------|-------------------------------|--------|
| 222         | Plunger Assembly              | 1      |
| 250         | Thrust Washer                 | 1      |
| 250         | Thrust Washer Ring            | 1      |
| 9001        | Ball Check Cartridge Assembly | 2      |
| 428         | Gland Bearing Liner           | 2      |
| 425         | Packing                       | 2 Sets |

**Table 3. Spare Parts for Liquid Ends with 7/16" and 5/8" Diameter Plunger.**

### 5.3 LUBRICATION

Once each day lubricate the packing lightly with lubricant recommended on pump data face sheet (front of manual). A grease fitting located on the liquid end is provided for this purpose.

### 5.4 CHECK VALVE MAINTENANCE

The ball check cartridge assemblies, each with double ball checks are designed to give long, trouble-free service. If the check valves do become fouled, cleaning with a hot detergent solution will usually remove all but the most stubborn contaminants. Prepare a hot detergent solution and pump freely through the pump for 10 to 15 minutes. Flush with hot water and return to normal service. If flushing does not prove adequate, remove and disassemble cartridges to inspect for chemical damage. To remove balls and seats from cartridge, perform the following:

1. Using a 5/16" (7.93 mm) diameter pin, push out No. 383 seats and No. 386 ring insert from small end of No. 381 body.
2. Using a 1/16" (1.59 mm) diameter pin, push out No. 385 limit pin from seat.
3. Remove No. 384 ball check and inspect ball and seat for marks, pits and scratches. The important portion of the seat is where ball contacts edge of the hole. This area should be a smooth bright band when viewed under 10X magnification. Any imperfections in either ball or seat is cause for replacement.

4. It is recommended that No. 382 O-ring and No. 386 ring insert be replaced after disassembly.
5. After cleaning all parts, reassemble as shown in *figure 5*. Make sure O-ring end of seat is placed into body first, and that the entire assemblies are screwed into liquid end with arrows on body pointing upward.



### CAUTION

ONE OF THE FOLLOWING WILL RESULT FROM INCORRECT BALL CHECK CARTRIDGE ASSEMBLY: (A) IMMEDIATE SEVERE DAMAGE TO PUMP MECHANISM, (B) NO PUMPING, (C) REVERSE PUMPING ACTION (FROM DISCHARGE LINE INTO SUCTION LINE).

6. Threads on cartridges should be prepared with sparing amount of pipe dope or, preferably, with a thread sealant tape to prevent air or fluid leakage past threads.

### 5.5 PACKING ADJUSTMENT, START-UP AND REPLACEMENT

New packing, installed and shipped from the factory in a complete pump or liquid end has been set and run-in during Production Quality Assurance and requires no further break-in prior to full load start-up.

If, during operation, leakage does occur, gland cap no. 403 should be tightened a little at a time (1/6 turn or less) until leakage is minimized or stopped. Wait at least five minutes between adjustments to allow packing to resettle. If it is possible to tolerate a little leakage at Gland Cap, the leaking liquid will help to lubricate and cool packing and plunger, greatly extending the life of both.

### **5.5.1 Types of Packing**

There are two general types of packing used in this pump, automatic and compression.

Automatic type packing is made up of a series of shaped rings which have sealing lips that react with applied hydraulic pressure to form a good fluid seal against both the moving plunger and walls of the stuffing box. This type packing is generally preferred over the compression type because of its lower friction against plunger and somewhat self-adjusting characteristics which allow it to compensate for wear and maintain good sealing.

Automatic packing must never be adjusted so tightly that it loses its capability to properly flex during operation. It is seldom necessary to adjust this type of packing any more than finger tight.

Packings of square or round cross section which must be firmly compressed in the stuffing box are known as compression types. These are available in many materials, and are usually used only when the somewhat limited materials of automatic type are not compatible with the pumped fluid. They depend on mechanical compression in stuffing box by the follower and gland cap for fluid sealing. If compression type packing is too tightly compressed against the moving plunger, frictional force will be reflected back through the drive mechanism as an overload, or develop sufficient localized heat to destroy sealing surfaces of both plunger and packing.

Compression type packing is very dependent on proper break-in to develop a good sealing surface.

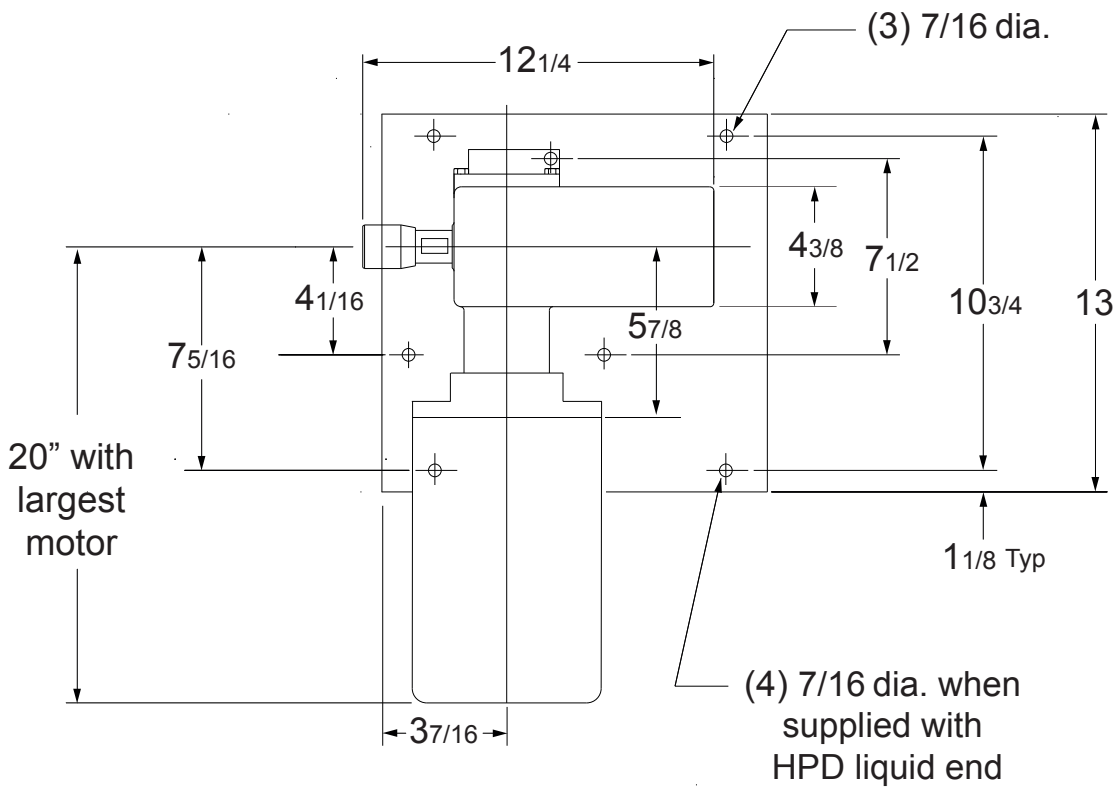
### **5.5.2 Replacing Packing**

1. To properly replace packing, it is necessary to remove liquid end from pump.
2. Loosen No. 430 Gland Cap (do not remove).
3. Remove the two No. 270 screws which attach liquid end to pump housing.
4. Pull liquid end straight OFF pump and plunger, taking care not to damage plunger by bending. Inspect plunger for scoring or pitting and replace if necessary.
5. Remove No. 430 Gland Cap and No. 427 Gland follower. Inspect No. 428 gland bearing liner and replace if worn. Remove rear section of packing with a small hook or corkscrew device, taking care not to scratch wall of stuffing box. Remove No. 419 lantern ring, remaining forward section of packing and No. 418 neck ring. Thoroughly clean lantern ring, neck ring, and stuffing box of all foreign matter.
6. *Refer to figure 5.* It can be seen that the total packing set consists of a neck ring, a lantern ring, a gland follower, and two separate sets of packing material. The forward set of packing (nearest check valves) is intended to seal against pumped fluid. The rear set is intended to seal lubricant in and force lubricant to flow forward at injection. A new packing set should be made up to the following dimensions with a tolerance of +0 to -1 packing ring.
  - a. Length of neck ring and front set of packing (automatic packing to include one male and one female adapter) 1 1/2" (38 mm).
  - b. Total overall length of both front and rear packing sets, neck ring, and lantern ring (including adapters for automatic type packing) 2 3/4" (70 mm).

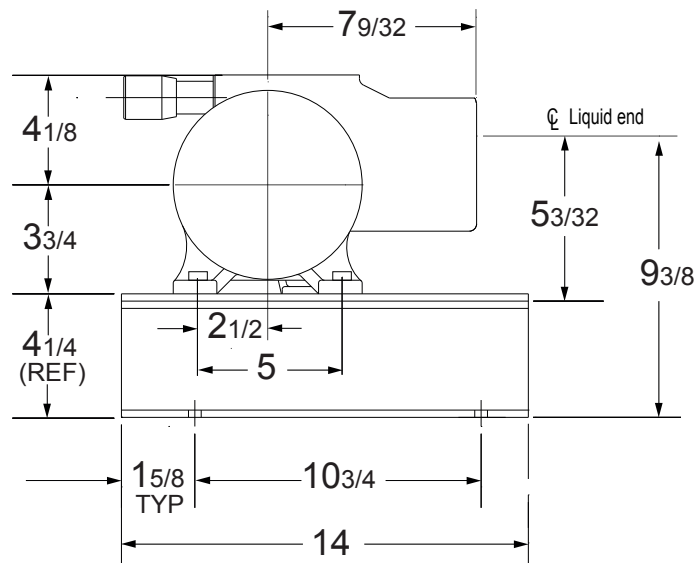
7. To install packing, coat each piece with recommended lubricant and install in order shown in *figure 5*. Place each piece into stuffing box individually, insuring each piece is firmly seated. Automatic packing should be installed with lips facing forward; if rings are split, locate the joints so they are not in line.
  8. Install No. 427 gland follower with it No. 428 liner in place. Install follower with its bore lip facing away from packing.
  9. Screw No. 430 gland cap loosely onto liquid end.
  10. To replace thrust washer, adjust pump stroke length setting to 0%. Unscrew No. 245 floating plunger nut from crosshead and remove plunger assembly. Replace worn rings if necessary.
  11. With plunger installed, carefully slip liquid end back over plunger and onto pump body with grease fitting up and secure with washers and bolts. Observe to flow direction arrows stamped onto No. 9001 ball check cartridge assembly; arrows should both be pointing up.
  12. After new packing is installed and liquid end is mounted on pump, the new packing must be broken in to develop a reliable sealing surface and insure long, trouble free packing life. Tighten gland cap 1/4 turn past finger tight and hold packing under this compression for at least 10 minutes. While under compression, inject a small amount of recommended lubricant into fitting provided.
  13. Loosen gland cap and retighten 1/6 past finger tight.
  14. Start pump at 100% stroke length but without pressure load. It is permissible to operate liquid end dry, or to pump clear fluid to atmospheric pressure. Run for about 1/2 hour.
- NOTE:**  
*Often, compression type packings will expand due to frictional heat generated during initial break-in. If gland cap becomes uncomfortably hot to touch during break-in, gland cap should be loosened slightly (by less than 1/6 turn) to relieve excessive frictional force.*
15. At the end of this break-in period, put pump into full operation against normal operating load.

## SECTION 6 - TROUBLESHOOTING

|                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pump mechanism will not operate                       | <ul style="list-style-type: none"> <li>• Incorrect or inoperative electrical circuit to motor. Check and repair / reset power supply, fuses, thermal overload protectors, wiring.</li> </ul>                                                                                                                                                                                                                                                                                               |
|                                                       | <ul style="list-style-type: none"> <li>• Incorrect or inoperative electrical circuit to motor. Correct controlling devices such as liquid level, speed control, etc.</li> </ul>                                                                                                                                                                                                                                                                                                            |
|                                                       | <ul style="list-style-type: none"> <li>• Discharge line blocked. Remove blockage (open valve, thaw discharge lines).</li> </ul>                                                                                                                                                                                                                                                                                                                                                            |
|                                                       | <ul style="list-style-type: none"> <li>• Discharge line blocked. Check maximum pressure rating of pump from data plate.</li> </ul>                                                                                                                                                                                                                                                                                                                                                         |
| Pump does not deliver rated flow                      | <ul style="list-style-type: none"> <li>• Fluid vapor in liquid end. Eliminate suction line leaks, tighten line fittings, increase available suction head by increasing suction line size; decrease suction line length; heat fluid to decrease its viscosity or cool fluid farther away from its boiling point.</li> </ul>                                                                                                                                                                 |
|                                                       | <ul style="list-style-type: none"> <li>• Suction or discharge check valves fouled. Clean per liquid end maintenance instructions or replace.</li> </ul>                                                                                                                                                                                                                                                                                                                                    |
|                                                       | <ul style="list-style-type: none"> <li>• Capacity adjustment improperly set or pump not operating at proper speed. Adjust capacity and insure electrical requirements of motor are available .</li> </ul>                                                                                                                                                                                                                                                                                  |
|                                                       | <ul style="list-style-type: none"> <li>• Packing leaking excessively. Adjust or replace per liquid end maintenance instructions.</li> </ul>                                                                                                                                                                                                                                                                                                                                                |
| Motor and pump body hot                               | <ul style="list-style-type: none"> <li>• Normal operating temperature of both motor and pump body is frequently uncomfortable to the touch. However, neither should exceed 200°F (93°C).</li> </ul>                                                                                                                                                                                                                                                                                        |
|                                                       | <ul style="list-style-type: none"> <li>• Power supply does not match electrical requirement of motor. Insure proper matching of power supply and motor.</li> </ul>                                                                                                                                                                                                                                                                                                                         |
|                                                       | <ul style="list-style-type: none"> <li>• Pump being operated at greater than rated performance. Reduce pressure or stroke speed. If this is not practical, contact factory.</li> </ul>                                                                                                                                                                                                                                                                                                     |
|                                                       | <ul style="list-style-type: none"> <li>• Pump improperly lubricated. Drain oil and refill with proper amount of recommended lubricant.</li> </ul>                                                                                                                                                                                                                                                                                                                                          |
| Noisy operation                                       | <ul style="list-style-type: none"> <li>• Check valves may emit a clicking sound in normal operation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                            |
|                                                       | <ul style="list-style-type: none"> <li>• In pump housing- Insure proper lubrication, replace worn bearings, clevis pins, or gears.</li> </ul>                                                                                                                                                                                                                                                                                                                                              |
| Pump is not at zero stroke when adjustment reads zero | <ul style="list-style-type: none"> <li>• Stroke adjustment knob is set incorrectly (a normal pump may not be able to obtain absolute zero stroke at any setting). Minimum obtainable stroke should not exceed 0.015" (0.381 mm). Adjust pump to minimum stroke obtainable, loosen knob set- screw, reset to zero indication, and retighten knob wet- screw. Adjust pump to minimum stroke obtainable, loosen knob setscrew reset to zero indication, re- tighten knob setscrew.</li> </ul> |
| Leaking oil                                           | <ul style="list-style-type: none"> <li>• Worn crosshead oil seal. Replace seal, inspect crosshead for scoring, replace if necessary.</li> </ul>                                                                                                                                                                                                                                                                                                                                            |
|                                                       | <ul style="list-style-type: none"> <li>• Worm shaft seals. Clean and inspect oil seal bushings, replace seals, bushings, and O-rings as necessary.</li> </ul>                                                                                                                                                                                                                                                                                                                              |
| Stroke knob "creeps" OFF setting                      | <ul style="list-style-type: none"> <li>• Loose friction plug. Tighten friction plug setscrew, replace plug if necessary.</li> </ul>                                                                                                                                                                                                                                                                                                                                                        |



Top View



Side View

Figure 1. Pump dimensions.

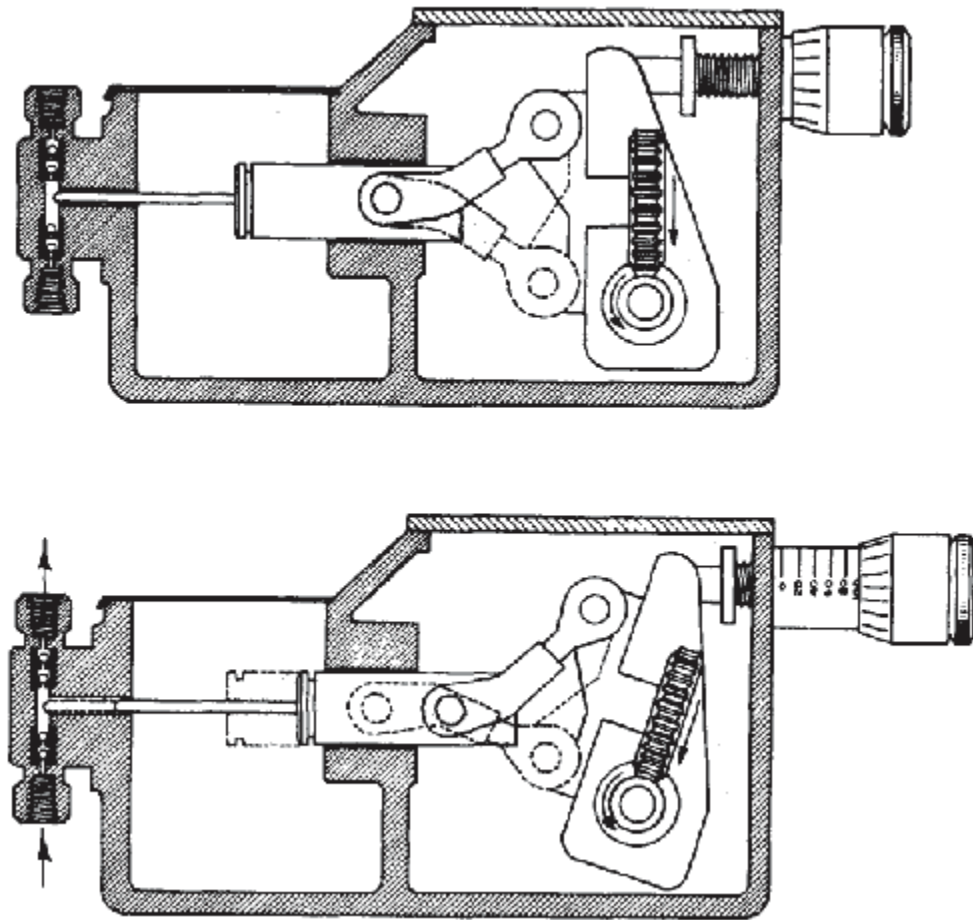
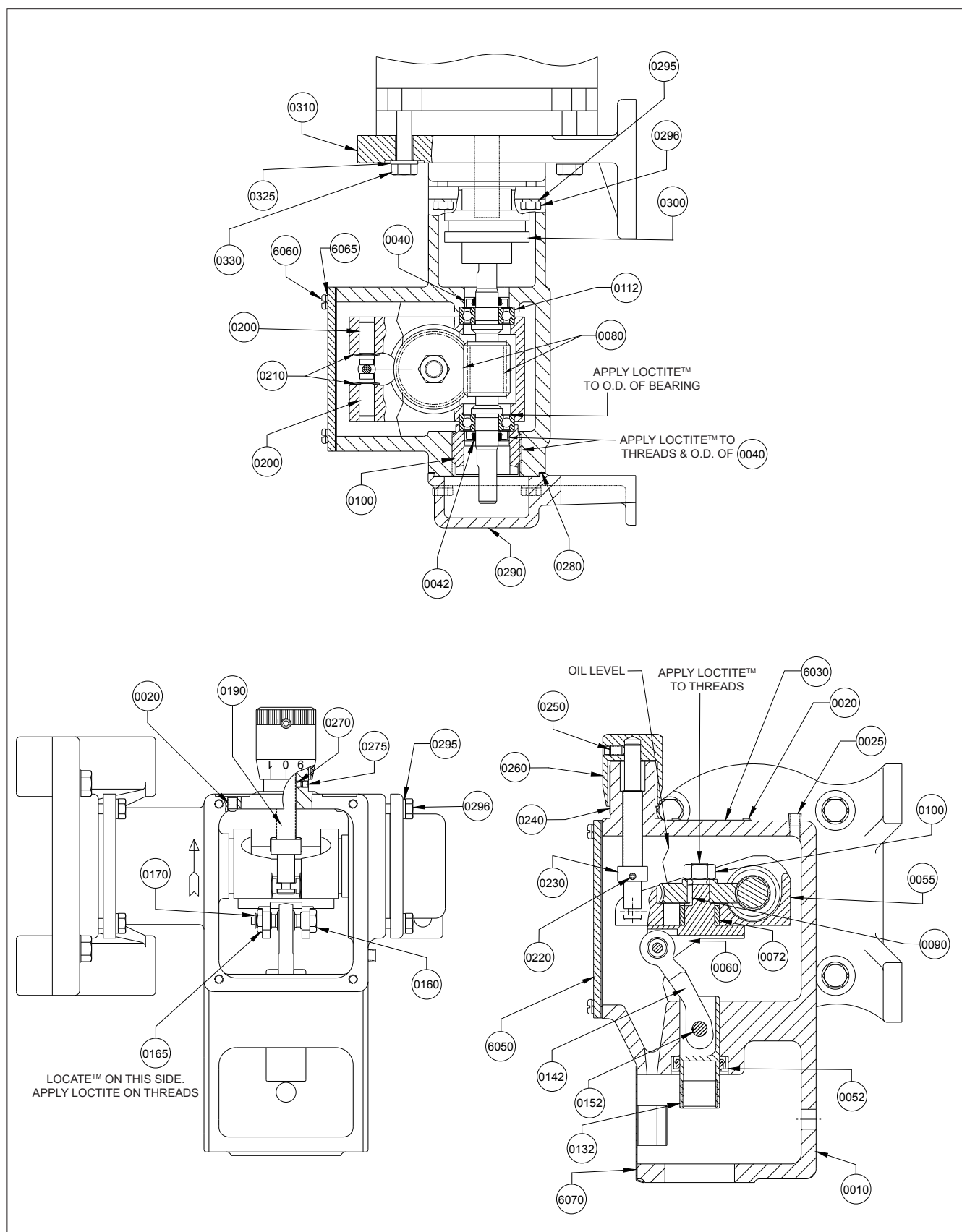


Figure 2. Polar Crank Mechanism.



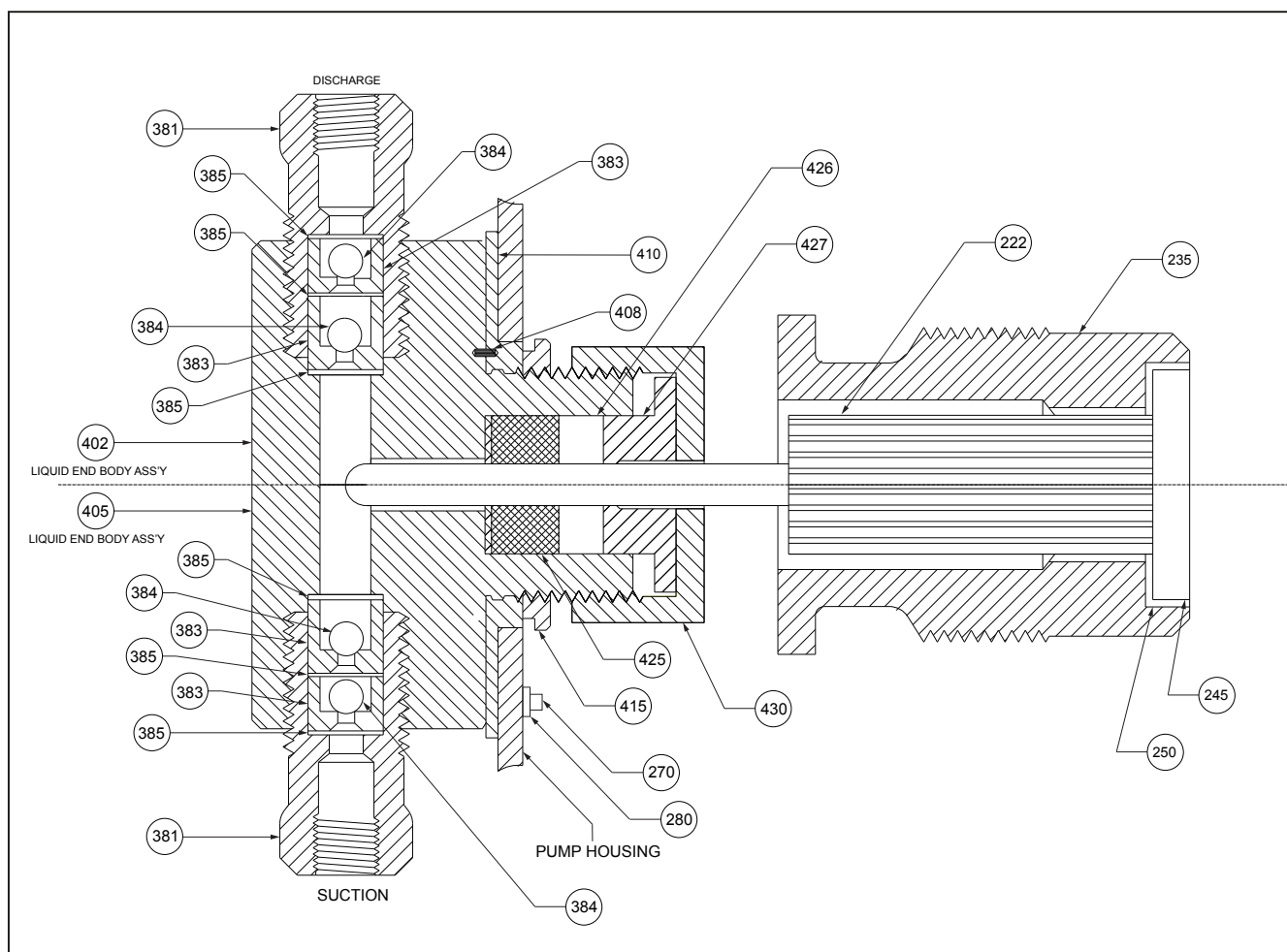
**Figure 3. Basic Drive Assembly Drawing (102-2906-0001).**

| Drawing Location Reference | Quantity Required | Description                              |
|----------------------------|-------------------|------------------------------------------|
| 20                         | A/R               | Loctite™ #242                            |
| 220                        | 1                 | Stop Collar Set Screw #8-32 NC           |
| 275                        | 1                 | Friction Plug Set Screw 1/4-20 NC        |
| 250                        | 2                 | Knob Set Screw #8-32 NC                  |
| 190                        | 1                 | Stroke Adjusting Screw                   |
| 260                        | 1                 | Knob Stroke Adjustment                   |
| 240                        | 1                 | Stroke Scale                             |
| 270                        | 1                 | Friction Plug                            |
| 230                        | 1                 | Stroke Stop Collar                       |
| 300                        | 1                 | Coupling (mounting to pump)              |
| 330                        | 4                 | Motor Screw 3/8-16 NC                    |
| 295                        | 4                 | Shaft Cover Lock Washer 1/4              |
| 325                        | 4                 | Motor Lock Washer 3/8                    |
| 290                        | 1                 | Shaft Cover                              |
| 272                        | 1                 | Motor Mountin Adapter (NEMA 56 C Flange) |
| 80                         | 1                 | Gear Set (specify gear ratio)            |
| 170                        | 1                 | Crank Pin Retaining Ring                 |
| 72                         | 1                 | Crank Bronze Bearing                     |
| 112                        | 2                 | Worm Shaft Bearing                       |
| 52                         | 1                 | Crosshead Oil Seal                       |
| 40                         | 2                 | Shaft Oil Seal                           |
| 100                        | 1                 | Crank Nut 7/16-14 NC 2                   |
| 296                        | 4                 | Motor Adapter Screw 1/4 20 NC            |
| 6060                       | 4                 | Drive Cover Screw #10-24 NC              |
| 20                         | 4                 | Nameplate Drive Screw                    |
| 90                         | 1                 | Crank Key 1/8 Sq                         |
| 210                        | 2                 | Clevis Pin Samp Ring                     |
| 6065                       | 4                 | Drive Cover Lock Washer #10              |
| 295                        | 4                 | Motor Adapter Lock Washer 1/4            |
| 25                         | 2                 | Plug                                     |
| 152                        | 1                 | Dowell Pin                               |
| 55                         | 1                 | Gear Cage                                |
| 6070                       | 1                 | Catchall Cover Assembly                  |
| 6050                       | 1                 | Drive Cover                              |

**Table 4. Basic Drive Assembly Drawing Location Reference Chart.**

| Drawing Location Reference | Quantity Required | Description             |
|----------------------------|-------------------|-------------------------|
| 10                         | 1                 | Housing                 |
| 6030                       | 1                 | Nameplate               |
| 100                        | 1                 | Journal Nut             |
| 280                        | 1                 | Cover Gasket            |
| 142                        | 1                 | Connecting Rod Assembly |
| 165                        | 1                 | Crank Pin Shoulder      |
| 160                        | 1                 | Crank Pin               |
| 200                        | 2                 | Clevis Pin              |
| 132                        | 1                 | Cross head              |

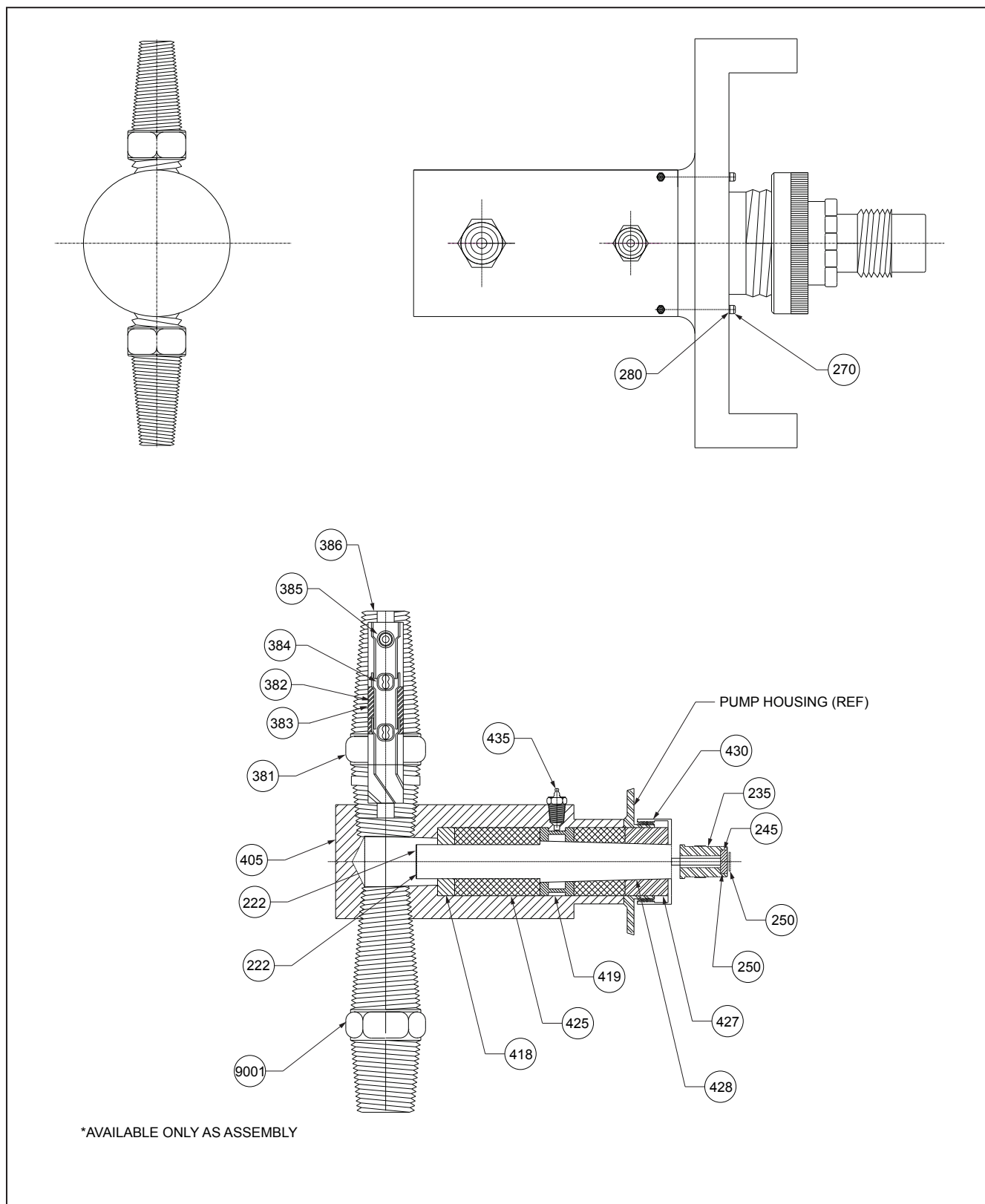
**Table 4. Basic Drive Assembly Drawing Location Reference Chart Contd.**



**Figure 4. 1/8" and 1/4" Liquid Ends Assembly Drawing (102-290-600-015).**

| Drawing Location Reference | Quantity Required | Description                               |
|----------------------------|-------------------|-------------------------------------------|
| 222                        | 1                 | Plunger Assembly                          |
| 235                        | 1                 | Floating Plunger Nut                      |
| 245                        | 1                 | Thrust Washer                             |
| 250                        | 1                 | Thrust Washer Ring                        |
| 402                        | 1                 | Liquid End Body Assembly Consist of:      |
| 405                        | 1                 | Discharge cartridge Assembly Consist of:  |
| 381                        | 1                 | Cap                                       |
| 383                        | 2                 | Ball Seat                                 |
| 385                        | 3                 | Cap Gasket                                |
| 384                        | 2                 | Ball Check                                |
| 405                        | 1                 | Suction Cartridge Assembly consisting of: |
| 381                        | 1                 | Cap                                       |
| 383                        | 2                 | Ball Seat                                 |
| 385                        | 3                 | Cap Gasket                                |
| 384                        | 2                 | Ball Check                                |
| 405                        | 1                 | Liquid End Body                           |
| 426                        | 1                 | Packing                                   |
| 427                        | 1                 | Packing Follower                          |
| 430                        | 1                 | Gland Cap                                 |
| 415                        | 1                 | Liquid End Nut                            |
| 410                        | 1                 | Adapter Liquid End Mounting               |
| 408                        | 1                 | Key Pin                                   |
| 270                        | 2                 | Cap Screw 1/4-20                          |
| 280                        | 2                 | Lock Washer 1/4                           |
| 384                        | A/R               | Loctite™                                  |

**Table 5. 1/8" and 1/4" Liquid Ends Assembly Drawing Location Reference Chart.**



**Figure 5. 7/16" and 5/8" Liquid Ends Assembly Drawing (102-290-600-012).**

| Drawing Location Reference | Description                                  |
|----------------------------|----------------------------------------------|
| 222                        | Plunger Assembly Consisting of:              |
| 222                        | Plunger                                      |
| 250                        | Thrust Washer (Ring)                         |
| 245                        | Plunger Adapter                              |
| 235                        | Nut, Floating Plunger                        |
| 9001                       | Ball Check Cartridge Assembly Consisting of: |
| 381                        | Body                                         |
| 383                        | Seat                                         |
| 382                        | O-Ring                                       |
| 385                        | Limit Pin                                    |
| 384                        | Ball Check                                   |
| 386                        | Ring Insert                                  |
| 419                        | Lantern Ring                                 |
| 418                        | Neck Ring                                    |
| 430                        | Gland Cap                                    |
| 250                        | Thrust Washer (Solid)                        |
| 405                        | Liquid End                                   |
| 428                        | Liner, Gland Bearing                         |
| 427                        | Gland Follower                               |
| 280                        | Washer                                       |
| 270                        | Liquid End Bolts                             |
| 435                        | Grease Fitting                               |
| 425                        | Packing                                      |

**Table 6. 7/16" and 5/8" Liquid Ends Assembly Drawing Location Reference Chart.**



