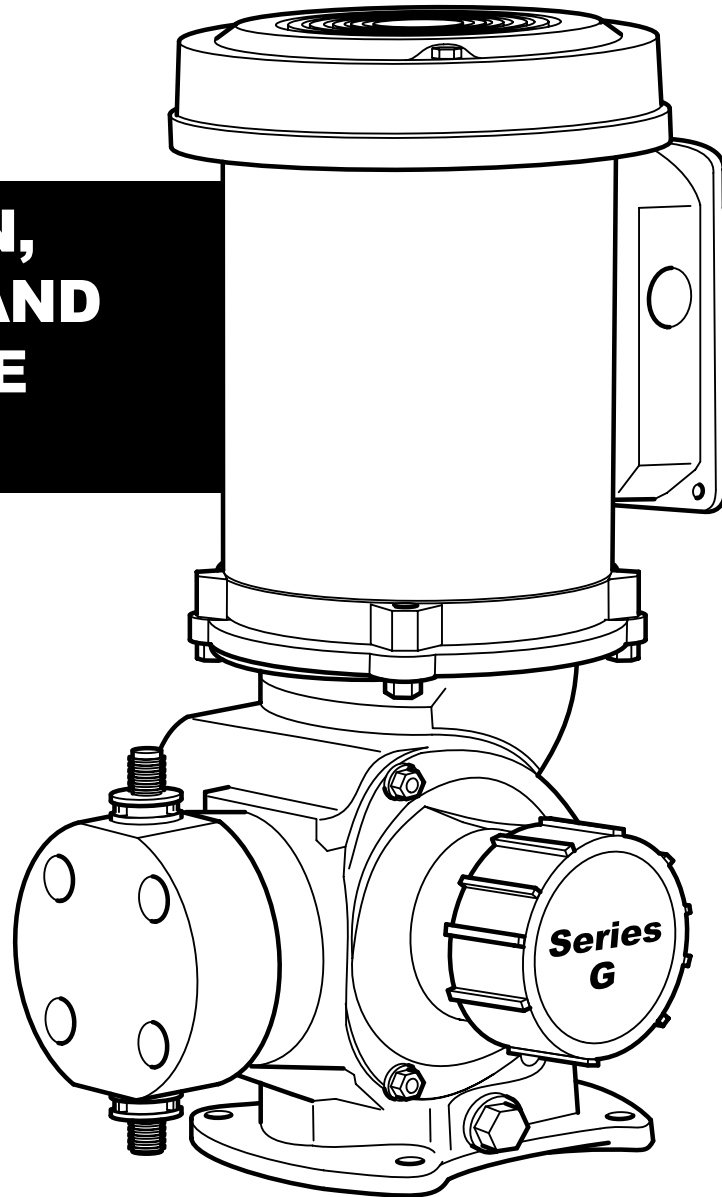




# Series G Model D

## METERING PUMP

### INSTALLATION, OPERATION, AND MAINTENANCE MANUAL



Please record the following data for file reference

Tag Number(s): \_\_\_\_\_

Model Number: \_\_\_\_\_

Serial Number: \_\_\_\_\_

Installation Date: \_\_\_\_\_

Installation Location: \_\_\_\_\_

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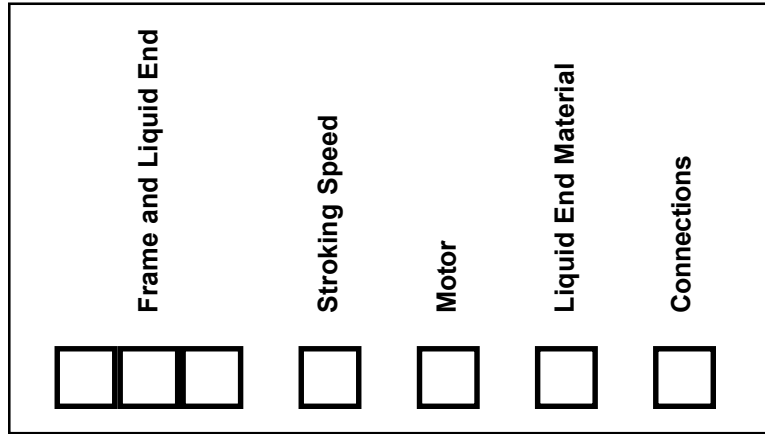
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# MACROY D PUMP MODEL NUMBER AND OPTIONS



## Frame and Liquid End (D Frame)

Code	Description
SD2	Max 0.7 GPH / 175 PSI
SD4	Max 12.0 GPH / 150 PSI
SD7	Max 50 GPH / 100 PSI
SD8	Max 115 GPH / 75 PSI

## Stroking Speed

Code	Description
1	43 SPM
2	86 SPM
6	120 SPM
3	173 SPM

## Motor

Code	Description
X	NEMA 56C Flange Less Motor
8	115/230 VAC, 60 Hz, 1 PH, 1800 RPM
9	115/230 VAC, 50 Hz, 1 PH, 1500 RPM
J	230/460 VAC, 60 Hz, 3 PH, 1800 RPM
L	220/380 VAC, 50 Hz, 3 PH, 1500 RPM
P	DC Variable Speed Drive

## Liquid End Material

Code	Description
2	PVDF
7	316ss
8	PVC
P	Polymer Service
L	Slurry Applications
N	H <sub>2</sub> SO <sub>4</sub> Applications

## Connections

Code	Description
P	NPT
T	Tubing
B	Outgassing Liquid Applications (NPT)
C	Outgassing Liquid Applications (Tubing)

## SECTION 1 DESCRIPTION

### 1.1 GENERAL INFORMATION

The Series G Model D is a reciprocating, chemical dosing pump capable of producing flows up to 115 gallons per hour (430 liters per hour) at pressures up to 175 psi (12 Bar). These pumps feature a mechanically actuated diaphragm liquid end, which eliminates the need for flow-restricting contour plates, and a stroke adjustment mechanism based on the variable eccentric principle instead of the traditional lost-motion design. It is designed for industrial service and offers an accuracy of  $\pm 2\%$  of full rated flow between 10% and 100% of its flow range.

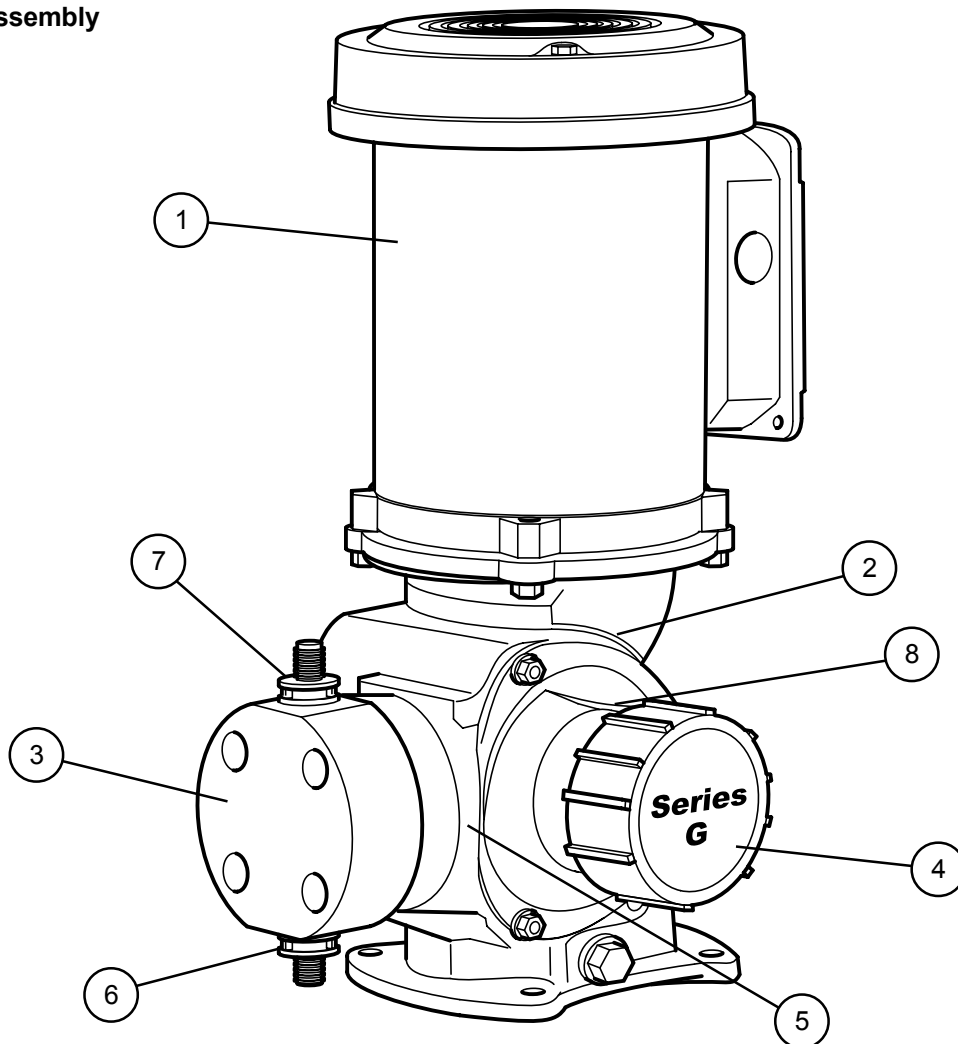
The basic pump components as illustrated in Figure 1 are:

- a drive device comprising a motor (1)
- a mechanical assembly (2)
- a liquid end (3).

An elastomeric bellows provides a leak-tight seal between the mechanical assembly and the liquid end.

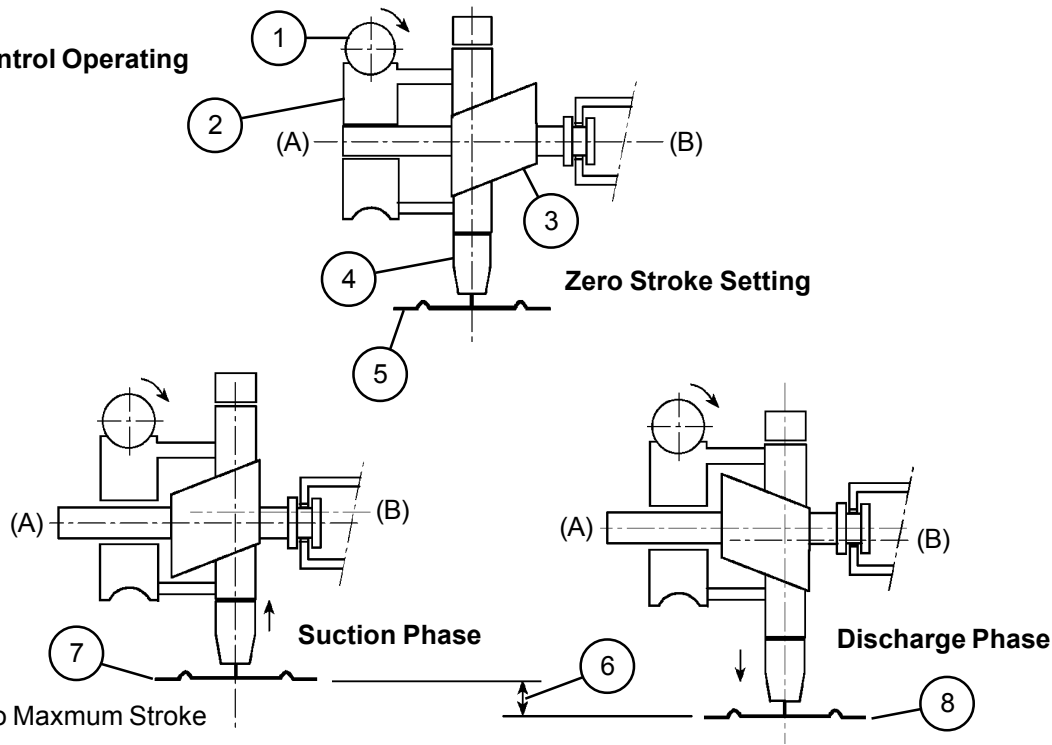
Capacity adjustment is manually controlled by a stroke adjustment knob (4).

**Figure 1:  
Pump Assembly**



1	Motor	5	Liquid End Mounting Assembly
2	Mechanical Assembly	6	Check Valve Assembly (Suction)
3	Liquid End	7	Check Valve Assembly (Discharge)
4	Stroke Adjustment Knob	8	Stroke Lock Knob

**Figure 2:  
Stroke Control Operating  
Principle**



1	Worm	5	Diaphragm
2	Worm Gear	6	Stroke: two times the distance between (A) and (B)
3	Eccentric	7	Position at rear neutral point
4	Connecting Rod	8	Position at forward neutral point

## 1.2 PRINCIPLES OF OPERATION

### Drive Assembly (See Figure 2)

The pump consists of two major assemblies; the drive and the liquid end. Pump delivery is a function of the drive's stroke rate, liquid end size and stroke length. Stroke length can be increased while the pump is running by counterclockwise turning of the stroke adjustment knob. The drive assembly works on the principle of a variable eccentric. The rotational motion of the motor is transmitted by the worm (1) to the worm gear (2) which is linked to an eccentric system (3). The eccentric system then converts the rotary gear motion into linear reciprocating motion of the connecting rod (4). At 0% capacity setting, the connecting rod axis (B) is aligned with the gear axis (A) and no movement of the connecting rod takes place. At 100% capacity setting, an eccentricity exists between the connecting rod axis (B) and the gear axis (A) which results in linear movement of the connecting rod and resulting pumpage.

### Mechanically Actuated Diaphragm Liquid End (See Figure 2)

The diaphragm assembly (5) is mechanically linked to the connecting rod (4) and has the same reciprocating motion. As the diaphragm starts back on the suction stroke, the pressure immediately drops inside the liquid end. When the pressure in the liquid end drops

below the suction line pressure, the suction ball check is "pushed" upward and the process fluid in the suction line flows into the liquid end chamber (diaphragm head). When the suction stroke ends, the diaphragm movement momentarily stops and the pressure in the liquid end equalizes with the pressure in the suction line causing the suction ball check to reset.

**NOTE:** It is important that the pressure in the liquid end remain above the vapor pressure of the process fluid during the suction stroke. If the fluid pressure drops below the vapor pressure, cavitation will occur which will have a negative impact on the performance of the pump. If you suspect the possibility of cavitation, contact your dealer for assistance.

As the diaphragm starts forward on the discharge stroke the pressure immediately rises inside the liquid end. When the liquid end pressure rises above the discharge line pressure, the discharge ball check is "pushed" upward and the process fluid in the liquid end flows into the discharge line. When the discharge stroke ends, the diaphragm momentarily stops again. The pressure in the liquid end equalizes with the discharge line pressure and the discharge ball check reseats. The cycle then starts again.

### **1.3 GENERAL SPECIFICATIONS**

**FLOW RATE:**

Up to 115 GPH (430 L/H)

**PRESSURE:**

Up to 175 PSIG (12 BAR)

**LIQUID END TYPE:**

Mechanically Actuated Diaphragm

**DRIVE TYPE:**

Variable Eccentric

**STEADY STATE ACCURACY:**

±2% of pump full rated capacity between 10% and 100% of rated capacity.

**CAPACITY ADJUSTMENT:**

Lockable stroke adjustment knob is adjustable from 0% to 100% while pump is running.

**LUBRICATION:**

Drive is lubricated in an oil bath (Mobil SHC 629, 1 Quart).

**TEMPERATURE:**

**Ambient and Liquid:**

122 °F (50 °C) Maximum

14 °F (-10 °C) Minimum

**SUCTION LIFT:**

6.6 Ft (2 meters) of water column maximum

11.5 psia minimum internal pressure (3.2 psi maximum vacuum)

**PAINT:**

Two part epoxy, yellow RAL 1018

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## SECTION 2 INSTALLATION

### 2.1 UNPACKING

Pumps are shipped f.o.b. factory or representative warehouse and the title passes to the customer when the carrier signs for receipt of the pump. In the event that damages occur during shipment, it is the responsibility of the customer to notify the carrier immediately and to file a damage claim. Carefully examine the shipping crate upon receipt from the carrier to be sure there is no obvious damage to the contents. Open the crate carefully so accessory items fastened to the inside of the crate will not be damaged or lost. Examine all material inside the crate and check against packing list to be sure that all items are accounted for and intact.

### 2.2 STORAGE

#### Short Term Storage (Less than 6 Months)

It is preferable to store the material under a shelter in its original package to protect it from adverse weather conditions. In condensing atmospheres, follow the long term storage procedure.

#### Long Term Storage (Longer than 6 Months)

The primary consideration in storage of pump equipment is to prevent corrosion of external and internal components. This corrosion is caused by natural circulation of air as temperature of the surroundings change from day to night, day to day, and from season to season. It is not practical to prevent this circulation which carries water vapor and other corrosive gasses, so it is necessary to protect internal and external surfaces from their effects to the greatest extent possible.

When the instructions given in this section are completed, the equipment is to be stored in a shelter; protected from direct exposure to weather. The prepared equipment should be covered with a plastic sheet or a tarpaulin, but in a manner which will allow air circulation and prevent capture of moisture. Equipment should be stored 12 inches or more above the ground.

If equipment is to be shipped directly from the factory into long term storage, contact the factory to arrange for factory preparation.

#### Pump Drive

1. Remove motor and flood the gearbox compartment (Item 2 in Figure 1) with a high grade lubricating oil/rust preventative such as Mobile Oil Corporation product Mobilarma 524. Fill the compartment completely to minimize air space and water vapor condensation. After storage, drain this material and refill the equipment with the recommended lubricant for equipment commissioning.
2. Brush all unpainted metal surfaces with multipurpose grease (NLGI grade 2 or 3). Store these unattached.

### Electrical Equipment

1. Motors should be prepared in the manner prescribed by their manufacturer. If information is not available, dismount and store motors as indicated in step 3 below.
2. Dismount electrical equipment (including motors) from the pump.
3. For all electrical equipment, place packets of Vapor Phase Corrosion Inhibitor (VPCI) inside of the enclosure, then place the entire enclosure, with additional packets, inside a plastic bag. Seal the bag tightly.

### 2.3 SAFETY PRECAUTIONS

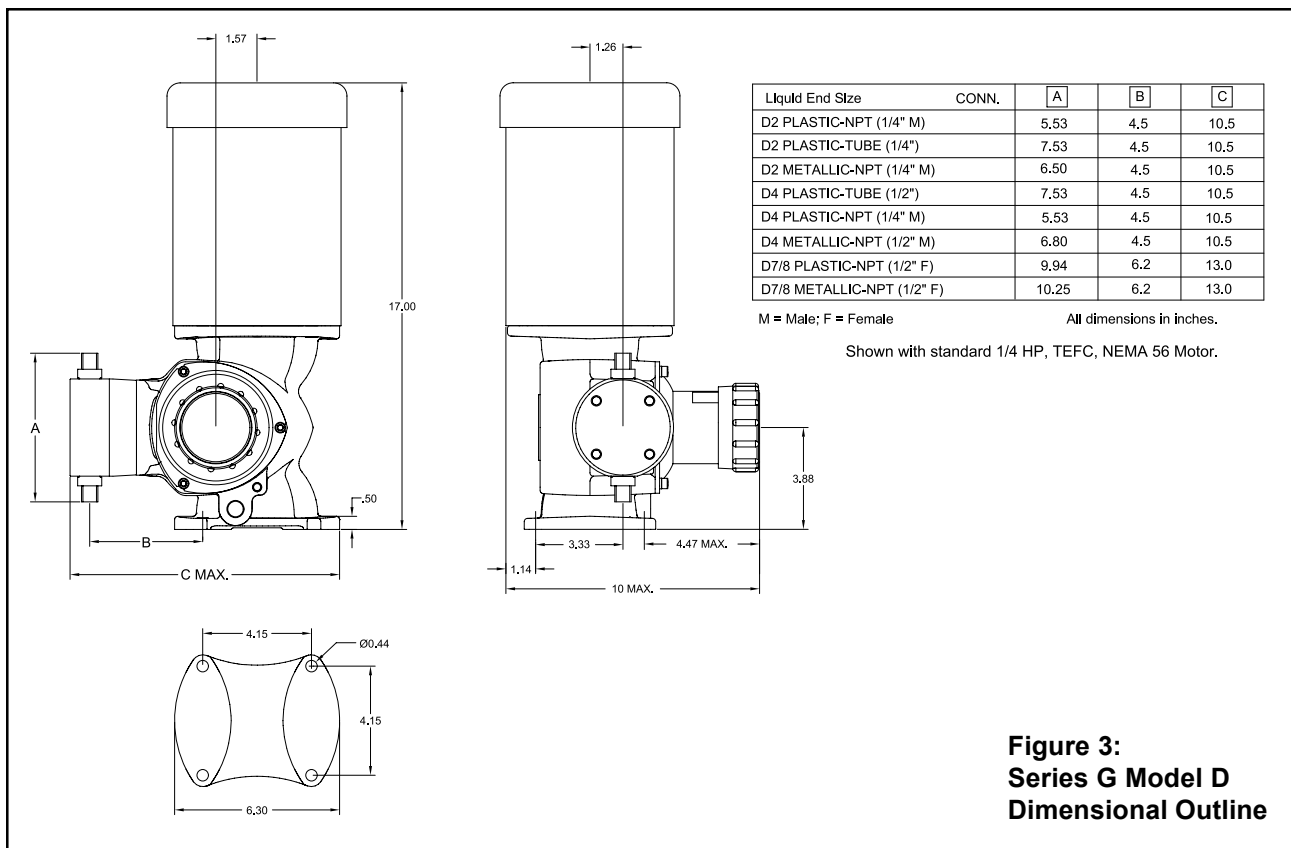
#### **WARNING**

**WHEN INSTALLING, OPERATING, AND MAINTAINING THIS MACROYD PUMP, KEEP SAFETY CONSIDERATIONS FOREMOST. USE PROPER TOOLS, PROTECTIVE CLOTHING, AND EYE PROTECTION WHEN WORKING ON THE EQUIPMENT AND INSTALL THE EQUIPMENT WITH A VIEW TOWARD ENSURING SAFE OPERATION. FOLLOW THE INSTRUCTIONS IN THIS MANUAL AND TAKE ADDITIONAL SAFETY MEASURES APPROPRIATE TO THE LIQUID BEING PUMPED. BE EXTREMELY CAREFUL IN THE PRESENCE OF HAZARDOUS SUBSTANCES (E.G., CORROSIVES, TOXINS, SOLVENTS, ACIDS, CAUSTICS, FLAMMABLES, ETC.).**

#### **CAUTION**

**THE PERSONNEL RESPONSIBLE FOR INSTALLATION, OPERATION AND MAINTENANCE OF THIS EQUIPMENT MUST BECOME FULLY ACQUAINTED WITH THE CONTENTS OF THIS MANUAL.**

**ANY SERVICING OF THIS EQUIPMENT MUST BE CARRIED OUT WHEN THE UNIT IS STOPPED AND ALL PRESSURE HAS BEEN BLED FROM THE LIQUID END. SHUT-OFF VALVES IN SUCTION AND DISCHARGE SIDES OF THE LIQUID END SHOULD BE CLOSED WHILE THE UNIT IS BEING SERVICED. ACTIONS SHOULD BE TAKEN TO ELIMINATE THE POSSIBILITY OF ACCIDENTAL START-UP WHILE SERVICING IS TAKING PLACE. A NOTICE SHOULD BE POSTED**



**Figure 3:  
Series G Model D  
Dimensional Outline**

**BY THE POWER SWITCH TO WARN THAT SERVICING IS BEING CARRIED OUT ON THE EQUIPMENT. SWITCH OFF THE POWER SUPPLY AS SOON AS ANY FAULT IS DETECTED DURING OPERATION (EXAMPLES: ABNORMALLY HIGH DRIVE TEMPERATURE, UNUSUAL NOISE, DIAPHRAGM FAILURE).**

## 2.4 MOUNTING

Support the pump firmly in a level position on a solid, vibration-free foundation. The pump should preferably be positioned with the base above floor level to protect the pump from wash downs and to provide easier access for service. Be sure to allow enough space around the pump for easy access during maintenance operations and pump adjustments.

The pumps are provided with mounting holes to accommodate anchor bolts. Refer to Figure 3 for mounting hole dimensions.

Pumps installed outdoors should be protected by a shelter.

## 2.5 DRIP COLLECTION

In the event of a failure of the diaphragm or oil seal bellows, provisions need to be made to contain the process fluid or pump oil. This is particularly important when handling fluids which may be harmful to plant personnel.

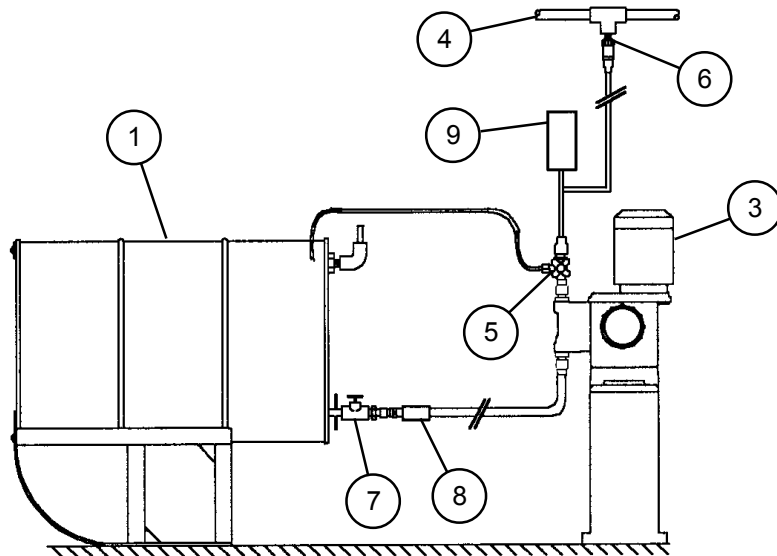
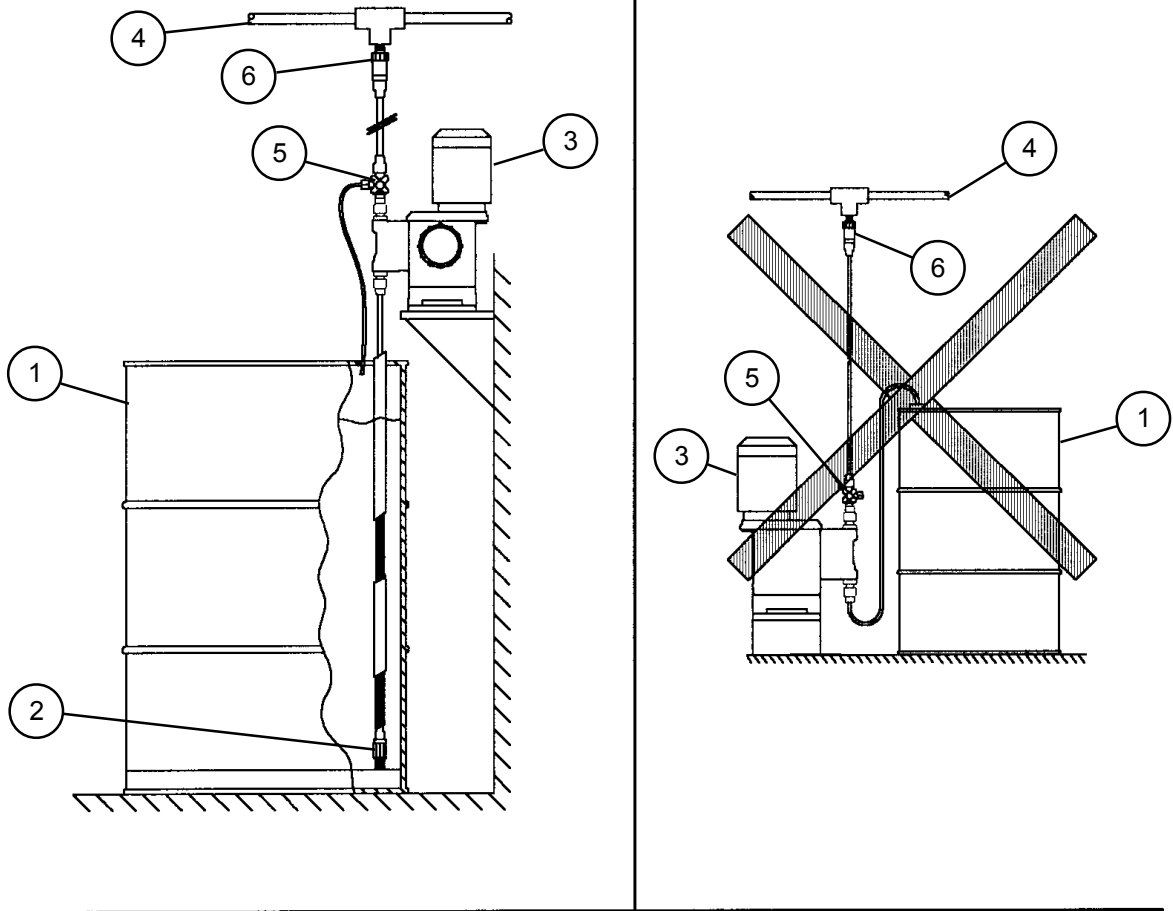
To collect fluid in the event of a diaphragm or oil seal rupture, (See Figure 1) position a tray under the plain hole located at the bottom of the liquid end mounting assembly (5). For SD7 or SD8 pumps, position tray under tube fitting located at bottom of liquid end mounting assembly. Alternatively, a tube may be installed onto this tube fitting to drain any leakage to a suitable container.

## 2.6 INSTALLATION

Figure 4 displays typical installations (both correct and incorrect). Figure 5 illustrates the recommended piping and accessories in a metering pump installation.

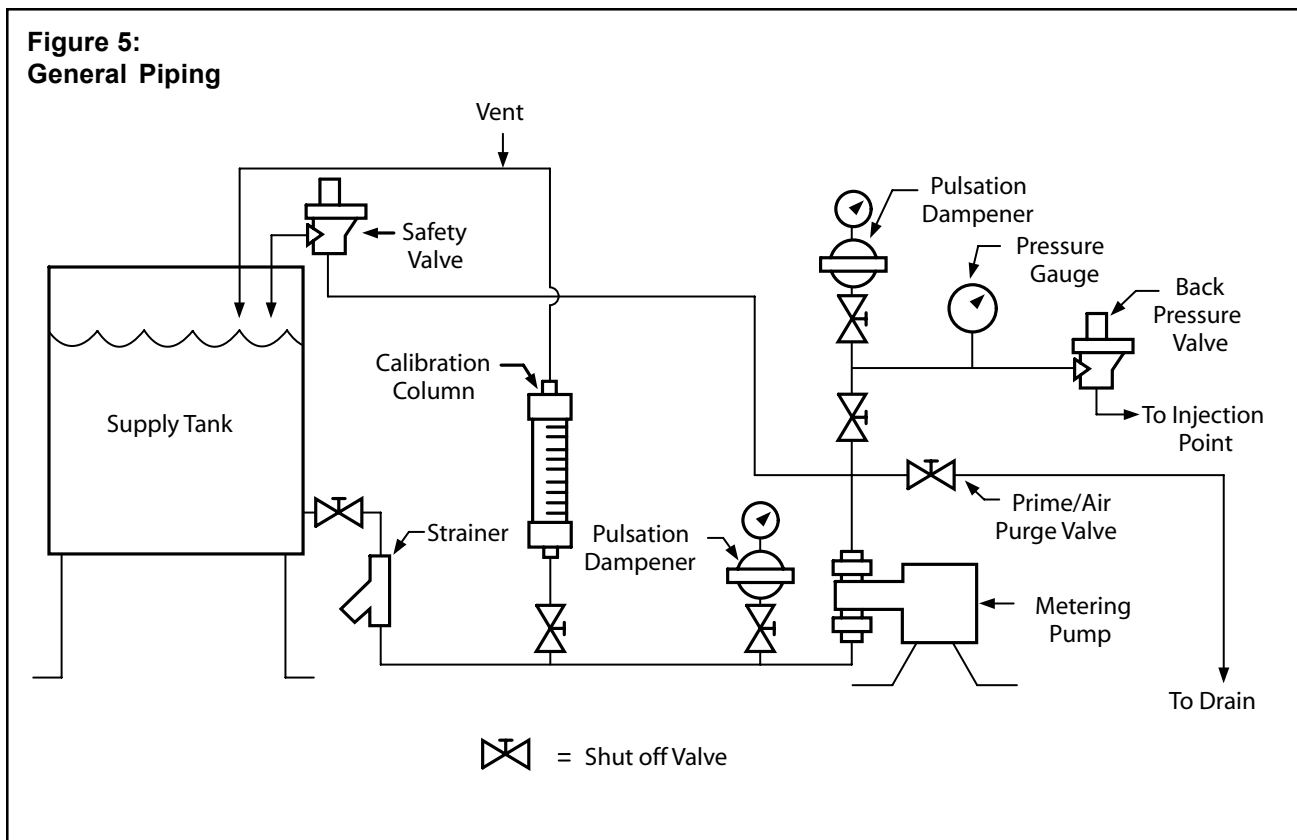
As illustrated in the upper right portion of Figure 4, there must be no swan-necks or stagnant volumes in the suction line. In this illustration, the loop at the top of the tank forms an air trap. Eventually, air or gases will bubble out of solution and accumulate in the trap leading to a loss of prime condition.

**Figure 4:**  
**Typical Installation**



1	Tank	6	Injection Nozzle
2	Foot Valve (with Filter)	7	Shut-off Valve
3	Metering Pump	8	Filter
4	Process Piping	9	Pulsation Damper
5	Bleed Valve	-	-

**Figure 5:  
General Piping**



### 2.6.1 NPSH CONSIDERATIONS

Size piping to accommodate peak instantaneous flow. Because of the reciprocating motion of the pump diaphragm, peak instantaneous flow is approximately equal to 5 times the average flow. For example, a pump rated for 16 gallons per hour (61 L/hr.) requires piping sufficient for 5 x 16 gph, or 80 gph (303 L/hr.).

To minimize viscous flow losses when handling viscous liquids, it may be necessary to use suction piping up to four times larger than the size of the suction connection on the pump. If in doubt, contact your dealer to determine the necessary pipe size.

### 2.6.2 GENERAL PIPING CONSIDERATIONS

Use extreme care in piping to plastic liquid end pumps with rigid pipe such as PVC. If excessive pipe stress or vibration is unavoidable, flexible connections are recommended.

Use piping materials that will resist corrosion by the liquid being pumped. Use care in selecting materials to avoid galvanic corrosion at pump liquid end connections.

Use piping heavy enough to withstand maximum pressures. Remove burrs, sharp edges, and debris from inside piping. Blow out all pipelines before making final connections to pump.

Because vapor in the liquid end will cause inaccurate pump delivery, piping should be sloped up from pump suction check to the supply tank to prevent formation of vapor pockets.

When pumping suspended solids (such as slurries), install plugged crosses at all 90° line turns to permit line cleaning without dismantling piping.

See Figure 5 for a typical recommended pump installation scheme.

### 2.6.3 SUCTION PIPING CONSIDERATIONS

It is preferable to have the suction of the pump flooded by locating the liquid end below the lowest level of the liquid in the supply tank.

To minimize the chances of a loss-of-prime condition, the pump should be installed as close as possible to the supply vessel.

Avoid negative suction pressure conditions (suction lift), as such conditions adversely affect metering accuracy. A lift of 6.6 feet (2 meters) of water column is the maximum permissible suction lift.

Series G pumps are designed to operate with process liquid supplied at or above atmospheric pressure. Although these pumps can move liquids supplied at less than atmospheric pressure (suction lift), in these nega-

tive pressure applications it is important that all connections be absolutely drip free and vacuum tight, and that a foot valve be installed at the bottom of the suction line (see upper left illustration of Figure 4).

When pumping a liquid near its boiling point, provide enough suction head to prevent the liquid from “flashing” into vapor when it enters the pump liquid end on the suction stroke.

If possible, use metal or plastic tubing for the suction line because tubing has a smooth inner surface and can be formed into long, sweeping bends to minimize frictional flow losses.

A strainer should be used in the suction line to prevent foreign particles from entering the liquid end. This and any other measures which prevent debris from entering and fouling the liquid end check valves will give increased maintenance-free service. Check strainer frequently to prevent blockage which could lead to cavitation. Keep suction piping as short and straight as possible.

Piping size should be larger than the liquid end suction fitting to prevent pump starvation.

If long suction lines are unavoidable, install a stand pipe near the pump in the suction line.

Suction piping must be absolutely airtight to ensure accurate pumping. After installation, test suction piping for leaks with air and soap solution.

#### **2.6.4 DISCHARGE PIPING CONSIDERATIONS**

Install pipe large enough 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 rated pressure (shown on the pump nameplate).

The pump will not deliver a controlled flow unless the discharge line pressure is 10 psi greater than the suction line pressure. One way to create an artificial pressure is the installation of a back pressure valve. (Please contact your dealer for recommendations to increase back pressure in slurry applications).

When pumping water treatment chemicals directly into boiler drums, use one liquid end assembly for each boiler drum. Discharging into a manifold having the slightest pressure difference between its several discharge connections can diminish metering accuracy as the outlet with the lowest pressure will receive more liquid than the other outlets.

## **2.7 VALVES**

### **Back Pressure Valves**

All metering pumps are prone to overpumping (excessive output) at low discharge pressures. To prevent this condition from occurring, it is necessary to maintain approximately 10 psi (0.7 bar) back pressure against the pump. This can be accomplished through the installation of a back pressure valve in the discharge line. Typically, the valve should be located near the pump. However, back pressure valves for large pumps with long and extremely small discharge lines may have to be installed near the point of discharge into the process (to minimize siphoning tendencies).

### **Pulsation Dampeners**

An accumulator, surge chamber, surge suppressor, or pulsation dampener should be used with the back pressure valve in the discharge line to absorb the flow peaks between the pump and the back pressure valve. Without the pulsation dampener the valve mechanism will snap open and closed with the surge from each pump stroke. The pulsation dampener will allow the back pressure valve to oscillate about a partly-closed position, thus minimizing wear on the valve. Discharge line pulsation dampeners offer the further advantage of limiting the flow and pressure variations characteristic of this kind of pump. Installing a properly sized pulsation dampener will improve pump performance and may reduce system costs dramatically by permitting the substitution of smaller piping. Please contact your dealer for further information on pulsation dampeners.

### **Safety Valves and Priming Valves**

Motor-driven positive displacement pumps can develop excessive discharge pressures long before thermal overload devices interrupt the motor electrical circuit. To prevent a blocked discharge line from causing damage to the pump, piping, or process equipment, install a safety valve in the pump discharge line. This valve is designed and sized to handle system flow rates and pressures safely while resisting corrosion by the process liquid.

To aid in pump start-up, it is advisable to install a priming valve on the discharge side of the liquid end.

### **Shut-off Valves**

Provide shut-off valves in both suction and discharge lines next to the pump. Locate discharge line shut-off valve downstream from the inlet connection of the safety valve. Figure 5 shows recommended valve locations.

## 2.8 ELECTRICAL CONNECTIONS

### **CAUTION**

**OPERATION WITH THE WRONG MOTOR ROTATION MAY DAMAGE THE PUMP AND MOTOR AND VOID THE WARRANTY.**

**DO NOT FORGET TO CONNECT THE EARTH TERMINAL ON THE MOTOR TO THE EQUIPMENT EARTH CONDUCTOR.**

Ensure that the electrical supply matches the pump motor nameplate characteristics. Connect the motor in accordance with the instructions and connection diagrams on the motor (or in the motor terminal box).

***Note:** Before operating the pump, check the direction of rotation of the motor to be sure it matches the direction of the arrow on the motor fan cover (rotation should be counter clockwise when viewed from the top of the motor).*

The electrical protection installed for the motor (fuse or thermal protection) must be suitable for the motor's rated current.

## SECTION 3 OPERATION

### 3.1 START-UP PROCEDURES AND CHECKS

Check that the pump is secured to its support.

If oil was previously removed for any reason, make sure pump drive has the correct volume (1 quart) of oil (Mobil SHC 629).

Make sure all isolation valves installed on the suction and discharge lines are open. If the discharge line is equipped with an injection nozzle or a back-pressure valve, open the priming valve for discharge (if there is no priming valve, disconnect the discharge pipe). This allows for verification that liquid is present in the liquid end when the pump is installed in flooded suction condition. If the pump is installed in a suction lift condition, this allows for priming of the pump during start-up.

Make sure that pump is set at 0% capacity.

### 3.2 CHECKING THE ELECTRICAL CONNECTION OF THE MOTOR

Start up the pump to check the motor's direction of rotation. It must comply with that indicated by the arrow marked on the motor fan cover (counter clockwise as viewed from the top of the motor). If the rotation is incorrect, refer to Section 2.8 Electrical Connections.

### 3.3 START-UP

Once all the checks and procedures described above have been carried out, start the pump.

Conduct a visual and audio check of the pump (in particular, listen for the presence of any "suspicious" noises).

Make sure that the stroke adjustment knob is unlocked.

Gradually increase the capacity until liquid can be seen flowing from the priming valve. If no priming valve is in place, when the liquid end is primed, the discharge check valves can be heard to be operating (should hear a clicking noise caused by movement of check valve balls). When liquid end is primed, stop the pump and close the priming valve.

Adjust the pump to the desired capacity. Lock the stroke adjustment knob (Item 320 in Figure 8).

### 3.4 CAPACITY CALIBRATION

After the first 12 hours of operation, the pump may be tested and calibrated to find the exact pump capacity under specific operating conditions. Usually, calibrating the pump at only 100, 50, and 10 percent capacity settings is enough to indicate pump performance throughout the adjustment range.

The pump can be calibrated by measuring the decrease in liquid level pumped from a calibrated vessel. This method is recommended for hazardous liquids because it eliminates operator contact with the liquid. Calibration columns are available for convenient and accurate calibration of the pump. Contact your dealer for more information.

## WARNING

**THIS METHOD IS GENERALLY NOT RECOMMENDED AS IT MAY EXPOSE OPERATING PERSONNEL TO HAZARDOUS LIQUIDS. FURTHERMORE, IF NO BACK PRESSURE IS PRESENT ON THE DISCHARGE SIDE, THE PUMP MAY OVERPUMP DRAMATICALLY IN WHICH CASE THE POSITION OF THE CAPACITY ADJUSTMENT KNOB MAY HAVE LITTLE EFFECT ON ACTUAL FLOW RATE.**

## WARNING

**FOR SAFETY REASONS, A CHECK VALVE IS RECOMMENDED FOR USE IN THE DISCHARGE LINE NEAR THE POINT WHERE THE LINE ENTERS A HIGH-PRESSURE PROCESS VESSEL.**

The pump can also be calibrated by collecting and measuring pumped liquid at the pump discharge port. It may be necessary to create backpressure at the collection point to allow for proper pump operation (see Section 2.7 Back Pressure Valves for recommendations).

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## SECTION 4 MAINTENANCE

### 4.1 PREVENTATIVE MAINTENANCE

#### Drive

Initially, change the oil in the pump drive assembly after the first 1000 hours of operation. Thereafter, change drive oil on an annual basis or after every 5000 hours of operation.

The drive should be refilled with 1 quart of Mobil SHC 629:

Viscosity @ 100 °F = 726 SSU

Viscosity Index = 149

ISO Grade = 150

#### Diaphragm Assembly

The Series G Model D diaphragm should be replaced annually or every 5000 hours of operation to avoid the possibility of failure. Refer to the instructions in Section 4.6 Diaphragm and Oil Seal Bellows Replacement.

#### Oil Seal Bellows

The Series G Model D oil seal bellows should also be replaced annually. Oil seal bellows replacement requires the removal of the diaphragm assembly, so it is recommended that the oil seal and diaphragm assembly be replaced at the same time. Refer to the instructions in Section 4.6 Diaphragm and Oil Seal Bellows Replacement.

#### Check Valves

As in the case of the diaphragm, LMI/Milton Roy Company recommends that check valve balls, seats, gaskets, and O-rings be replaced on an annual basis or every 5000 hours of operation. If highly corrosive material (acids, slurries, etc.) is being pumped, more frequent replacement may be required. Complete instructions for replacement of worn check valves are given in Section 4.5 Corrective Maintenance.

### 4.2 RETURNING PUMPS TO THE FACTORY FOR REPAIR

Pumps can not be accepted for repair without a Return Material Authorization. Pumps 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:** *United States of America Federal law prohibits handling of equipment that is not accompanied by an OSHA Material Safety Data Sheet (MSDS). A completed MSDS must be*

*packed in the shipping crate with any pump shipped for repair. 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 Materials Safety Data Sheet must accompany all returns.*

All inquiries or parts orders should be addressed to your local representative or distributor.

### 4.3 ROUTINE MAINTENANCE

LMI/Milton Roy Series G pumps are carefully designed, manufactured, assembled, and quality tested to give reliable service with minimal maintenance. However, a weekly maintenance check is recommended to confirm proper operation of the pump.

#### Visual Check of Seal Integrity of Mechanical Assembly

Check for leaks in the following components. If leaks exist, contact the factory for assistance.

1. Motor flange: If leaking, replace motor flange sealing gasket (Item 11 in Figure 8).
2. Stroke adjustment knob: If leaking, replace stroke adjustment seal (Item 160 in Figure 8).

#### Checking the Pump Capacity

Assuming the pump has been calibrated as described in Section 3, the capacity can be checked by shutting the valve from the supply vessel and opening the valve from the calibration column to the suction side of the liquid end. Measure the volume of pumped liquid for a given period of time at the various settings.

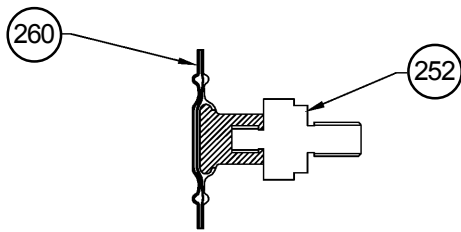
If a calibration column is not installed in the suction piping, place the foot valve (or suction line) in a calibrating chamber (graduated reservoir). Measure the volume of pumped liquid for a given period of time at the various settings.

#### Occurrence of Leak From Detection Ports

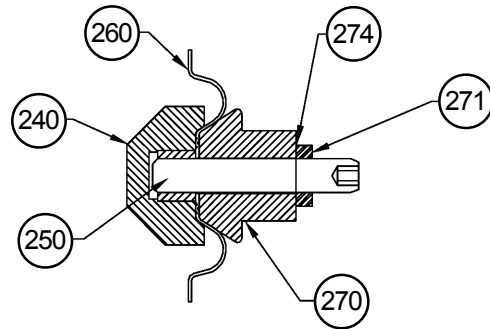
Determine whether the product collected at the detection port in the liquid end mounting assembly is lubricating oil or the pumped fluid.

If the product is pumped fluid, the diaphragm has failed. If the product is lubricating oil, the oil seal bellows has failed. Proceed with its replacement (see Section 4.6 Diaphragm and Oil Seal Bellows Replacement).

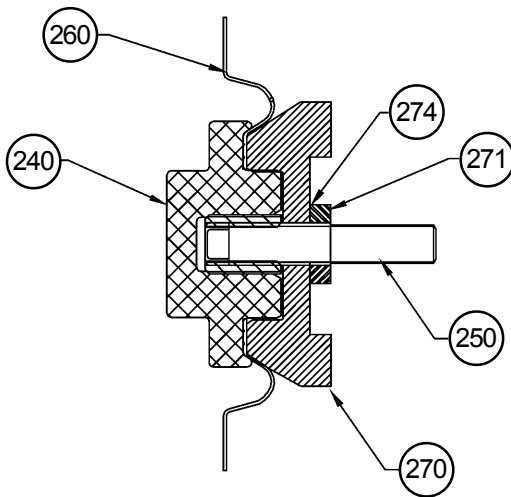
**Figure 6:  
Diaphragm Assemblies  
By Liquid End Size and Material**



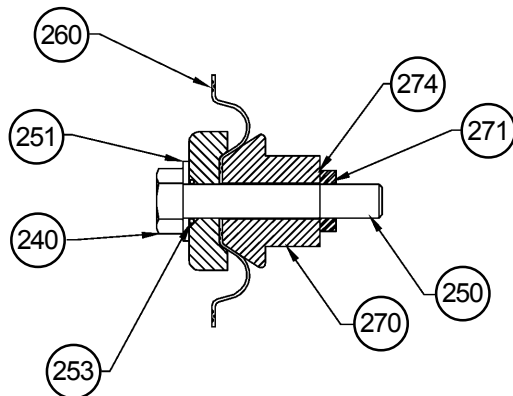
**SD2**



**SD4 (Plastic)**



**SD7 and SD8**



**SD4 (316SS)**

#### 4.4 SPARE PARTS

The following spare parts should be stocked for each pump to prevent serious delays in repairs. (Refer to Figures 6 thru 14).

##### Parts orders must include the following:

1. Quantity required
2. Part number
3. Part description
4. Pump serial number (found on nameplate)
5. Pump product code (found on nameplate)

**Note:** Always include the serial number and product code in all correspondence regarding the unit.

#### 4.4.1 SIZE SD2 AND SD4 LIQUID ENDS - PVC AND PVDF

- 1 each, Diaphragm: Item 260 in Figure 6.
- 1 each, Oil Seal Bellows: Item 70 in Figure 7.
- 2 each, Cartridge Valve Assembly: Item 425 in Figure 9.

#### 4.4.2 SIZE SD2 AND SD4 LIQUID ENDS - STAINLESS STEEL

- 1 each, Diaphragm: Item 260 in Figure 6.
- 1 each, O-Ring: Item 253 in Figure 6 (SD4 only).
- 1 each, Oil Seal Bellows: Item 70 in Figure 7.
- 2 each, Check Valve Assembly: Item 425 in Figures 10 & 11.

**Note:** Liquid end sizes SD2 and SD4 metallic check valves are precision assembled at the factory. Do not attempt to disassemble these cartridges.

#### 4.4.3 SIZE SD7 AND SD8 - PVC AND PVDF LIQUID ENDS

- 1 each, Diaphragm: Item 260 in Figure 6.
- 1 each, Oil Seal Bellows: Item 70 in Figure 7.
- 2 each, Seat, O-Ring, Ball Set: Item 423 in Figure 12.

**Note:** Item 423 (Kit) contains the following:

- 1 each, Ball: Item 422
- 1 each, Seat: Item 420
- 2 each, O-rings: Item 419

#### 4.4.4 SIZE SD7 AND SD8 - STAINLESS STEEL LIQUID ENDS

- 1 each, Diaphragm: Item 260 in Figure 6
- 1 each, Oil Seal Bellows: Item 70 in Figure 7
- 2 each, Check Valve Assembly: Item 425 in Figure 14.

**Note:** The check valves for the size SD7 and SD8-PVC and PVDF liquid ends contain a removable seat, which permits the replacement of the seat, O-ring, and ball into a reusable valve body. The liquid end size SD7 and SD8-Stainless Steel check valve has an integral ball seat, which necessitates replacement of the entire check valve assembly.

#### 4.5 CORRECTIVE MAINTENANCE

### WARNING

**BEFORE CARRYING OUT ANY SERVICING OPERATION ON THE PUMP OR PIPING, DISCONNECT ELECTRICAL POWER FROM THE PUMP, AND TAKE THE NECESSARY STEPS TO ENSURE THAT ANY HARMFUL LIQUID CANNOT COME INTO CONTACT WITH PERSONNEL. SUITABLE PROTECTIVE EQUIPMENT MUST BE PROVIDED. BE SURE THAT THERE IS NO FLUID PRESSURE IN THE PUMP LIQUID END AND PIPING.**

#### Cleaning Fouled Check Valves

Check valve assemblies are designed to be self-cleaning and should seldom need servicing. Fouled check valves can usually be cleaned by pumping a solution of mild detergent and warm water (if compatible with liquid being pumped) for 15 minutes, followed by flushing with water.

#### Check Valve Replacement

##### General

Before beginning work on the valve assemblies, make sure the suction and discharge shut-off valves are closed and that pressure has been bled from the pump liquid end. When replacing the valves, be sure to replace the valve O-rings. Pay close attention to the proper assembly and orientation of the check valves as shown in each Liquid End figure. In the case of plastic check valves for liquid end size SD7 and SD8, be certain that the ball is placed on the sharp edge of the valve seat.

### CAUTION

**BE SURE TO FOLLOW INSTRUCTIONS CAREFULLY AND REFER TO THE APPROPRIATE FIGURE WHEN REASSEMBLING CHECK VALVES. IF CHECK VALVE CARTRIDGES ARE INSTALLED INCORRECTLY, ONE OF THE FOLLOWING WILL OCCUR:**

- (A) IMMEDIATE AND SEVERE DAMAGE TO PUMP MECHANISM.
- (B) NO PUMPING OF FLUIDS.
- (C) REVERSE PUMPING ACTION (FROM DISCHARGE LINE INTO SUCTION LINE).

#### Preliminary Operations

1. Set the pump capacity knob to 0%. If stroke locking screw (Item 320 in Figure 8) was previously tightened, slightly loosen the locking screw.
2. Disconnect power to pump motor. Check that the equipment cannot be accidentally started. Place a notice at the location of the power switch indicating that the pump is being serviced.
3. Disconnect the pump hydraulically by removing pipe or tubing connections to suction and discharge check valves.

#### 4.5.1 CHECK VALVE ASSEMBLIES REPLACEMENT: LIQUID ENDS SD2 AND SD4 - PVC AND PVDF (SEE FIGURE 9 OR 12)

### CAUTION

**IMPROPER BALL AND SEAT INSTALLATION CAN CAUSE DAMAGE TO THE PUMP. SEE FIGURE 9 OR 11 FOR PROPER BALL AND SEAT ORIENTATION FOR BOTH THE SUCTION AND DISCHARGE VALVES**

### CAUTION

**DO NOT APPLY PTFE TAPE TO THE THREADS OF CHECK VALVE BODY THAT SCREWS INTO THE HEAD (280), AS THIS MAY PREVENT ADEQUATE SQUEEZE FROM BEING APPLIED TO THE VALVE O-RING WHICH COULD RESULT IN LEAKAGE.**

1. Unscrew the valve body (424) from the pump head (280).
2. Remove the cartridge valve assembly: cartridge includes ball (422), seat (420), ball guide (426), O-ring (419), and washer (427).
3. Clean the valve body (424) and threaded port in the head (280).
4. Press a new washer (427) into valve body (424).
5. Install new check valve assembly in orientation shown.

On discharge side, drop cartridge assembly (425) into threaded port in head. The O-ring should be stretched around outside of cartridge on same end as ball seat. Screw valve body into discharge side of diaphragm head until valve is hand tight. **DO NOT OVERTIGHTEN.**

On suction side, drop the cartridge assembly into check valve body. The O-ring should be stretched around outside of cartridge on opposite end of ball seat. Screw the suction valve body with cartridge valve into suction side of head. **DO NOT OVERTIGHTEN.**

#### 4.5.2 CHECK VALVES: LIQUID END SIZES SD2 AND SD4 - METALLIC (SEE FIGURE 10 OR 11)

The metallic check valves used on liquid end sizes SD2 and SD4 are precision assembled at the factory. Do not attempt to disassemble these cartridges. If they become inoperative, flush them with solvent, wash them with warm detergent and blow them out with compressed air to remove any foreign matter. If this treatment does not eliminate the trouble, the cartridge assembly should be replaced.

#### Disassembly

Remove the check valves by unscrewing them from the pump head.

#### Reassembly

Apply a small amount of thread sealing compound and PTFE pipe tape to check valve threads and install check valves by screwing them into the pump head with the flow arrows pointing up. **DO NOT OVERTIGHTEN CHECK VALVES.**

### CAUTION

**PUMP DAMAGE WILL OCCUR IF CHECK VALVES ARE INSTALLED UPSIDE DOWN. INSTALL CHECK VALVES WITH THE FLOW ARROW POINTING IN THE DIRECTION OF PROCESS FLOW (UP). TURN CHECK VALVE ASSEMBLIES INTO LIQUID END AND TIGHTEN BY HAND. DO NOT OVERTIGHTEN, DAMAGE TO THE CHECK VALVES MAY OCCUR.**

#### 4.5.3 REPLACEMENT OF BALL, SEAT, & SEAL: LIQUID END SD7 AND SD8 - PVC AND PVDF (SEE FIGURE 13)

#### Disassembly

1. Unscrew the union nut (435). The union end (445) is held in place by the union nut and will separate easily from the other liquid end parts.
2. Unscrew the check valve assembly (425) from the pump head (280).
3. Screw the union nut part way (one or two turns) onto the end of the ball guide (424) that has the seat in it. Be sure the union nut is on loosely. This will allow a gap for the seat (420) to fall into as it is removed from the ball guide.
4. Set the ball guide/union nut on a flat surface with the union nut down. Looking into the top of the ball guide, you will see four large holes surrounding one small hole. Insert a thin, blunt instrument such as a hex head screwdriver into the small center hole until it rests on the top of the ball (422).
5. Tap screwdriver gently with a hammer until the ball and seat are released from the ball guide.

## CAUTION

IF THE UNIT IS DISASSEMBLED FOR INSPECTION ONLY, BE SURE TO USE A BLUNT INSTRUMENT AND TAP GENTLY TO AVOID DAMAGING THE BALL. IF THE BALL AND/OR SEAT ARE DAMAGED DURING DISASSEMBLY, THEY WILL HAVE TO BE REPLACED. IF AVAILABLE, TO AVOID DAMAGE, IT IS ADVISABLE TO USE GENTLE AIR PRESSURE (APPLIED AT END OPPOSITE THE SEAT (420) FOR BALL AND SEAT REMOVAL.

6. Carefully remove the two O-rings (419) from the ball guide and seat.
7. Carefully clean any parts to be reused. If any chemicals are used in the cleaning process, ensure that they are compatible with the process liquid.

### Reassembly

## CAUTION

THE ORDER OF ASSEMBLY AND ORIENTATION OF THE SUCTION AND DISCHARGE CHECK VALVES IS DIFFERENT. REFER TO FIGURE 13 FOR PROPER ASSEMBLY ORDER AND ORIENTATION. IF CHECK VALVE CARTRIDGES ARE INSTALLED INCORRECTLY, ONE OF THE FOLLOWING WILL OCCUR:

- (A) IMMEDIATE SEVERE DAMAGE TO PUMP MECHANISM
- (B) NO PUMPING
- (C) REVERSE PUMPING ACTION (FROM DISCHARGE LINE INTO SUCTION LINE)

1. Drop the ball (422) into the curved inner chamber end of the body (424).
2. Set the body on a flat surface so that the end with the ball faces upward. Position seat (420) on the body, with the beveled edge of the seat facing outward. When the seat is pressed into the body, the ball should be sitting on the side with sharp corners as shown in Figure 13. The bevel **should not** face the inside of the check valve. Use a flat surface such as a board to press the seat into the body with firm, even pressure.  
  
If the seat is improperly positioned, the ball will not create a tight seal and poor pumping performance will result.
3. Fit new O-rings (419) into position on the body (424) and seat (420).

## CAUTION

DO NOT APPLY PTFE TAPE TO THREADS OF CHECK VALVE BODY (424) AS THIS MAY PREVENT ADEQUATE SQUEEZE FROM BEING APPLIED TO THE VALVE O-RING WHICH WOULD RESULT IN LEAKAGE.

*Note: To assure a tight, leak free seal, new O-rings should be used each time the check valves are disassembled.*

4. Position the union end (445) onto the correct end of the body. Refer to Figure 12, as the correct end is determined by whether the valve is intended for the suction or discharge port of the liquid end. Slip the union nut (435) over the union end and screw tightly (hand tight only) onto the body.
5. Screw the valve assembly into the pump head (hand tight only). **DO NOT OVERTIGHTEN.**

### 4.5.4 CHECK VALVE REPLACEMENT: LIQUID END SIZE SD7 AND SD8 - STAINLESS STEEL (SEE FIGURE 14)

#### Disassembly

Stainless steel check valves differ from the plastic versions in that the ball seat is integral to the ball guide. The seats cannot easily be inspected for damage or wear. If you suspect that the check valve may be damaged or worn, replace the entire check valve assembly as per the instructions below.

1. Unscrew the coupling (445).
2. Unscrew the check valve assembly (425) from the liquid end.

#### Reassembly

## CAUTION

THE ORDER OF ASSEMBLY AND ORIENTATION OF THE SUCTION AND DISCHARGE CHECK VALVES IS DIFFERENT. REFER TO FIGURE 14 FOR PROPER ASSEMBLY ORDER AND ORIENTATION. IF CHECK VALVE CARTRIDGES ARE INSTALLED INCORRECTLY, ONE OF THE FOLLOWING WILL OCCUR:

- (A) IMMEDIATE SEVERE DAMAGE TO PUMP MECHANISM
- (B) NO PUMPING
- (C) REVERSE PUMPING ACTION (FROM DISCHARGE LINE INTO SUCTION LINE)

1. Screw the correct end of the check valve assembly into the pump head, trapping a new O-ring between the pump head and the check valve assembly.

## CAUTION

**DO NOT APPLY PTFE TAPE TO THREADS OF CHECK VALVE BODY AS THIS MAY PREVENT ADEQUATE SQUEEZE FROM BEING APPLIED TO THE VALVE O-RING WHICH WOULD RESULT IN LEAKAGE.**

*Note: To assure a tight, leak free seal, new O-rings should be used each time the check valves are disassembled.*

2. Screw the coupling (445) onto the check valve assembly, trapping a new O-ring (419) between the coupling and the check valve assembly.

### 4.6 DIAPHRAGM AND OIL SEAL BELLOWS REPLACEMENT

## CAUTION

**BEFORE BEGINNING DIAPHRAGM REPLACEMENT, MAKE SURE THAT ALL SHUT-OFF VALVES ARE CLOSED AND ALL PRESSURE IS BLED FROM THE LIQUID END.**

If failure of the oil seal bellows has occurred, it is recommended that the diaphragm assembly and oil seal bellows be replaced at the same time.

#### 4.6.1 DIAPHRAGM REPLACEMENT: LIQUID END SIZE SD2 (SEE FIGURES 6, 9, AND 10)

1. Loosen the head screws (Item 290 in Figure 9) and remove the diaphragm head (Item 280 in Figure 9). Mark the suction and discharge ports on the diaphragm head prior to removal.

2. Remove the motor fan cover and turn the motor by hand while adjusting the capacity control knob to 100%. With the capacity set at 100%, turn the motor fan until the diaphragm (Item 260 in Figure 9) is in the full forward position (top dead center).

3. Hold the outer edge of the diaphragm and turn it counterclockwise to unscrew it from the pump drive.

4. Discard and replace with new diaphragm. Make sure that adaptor (Item 252 in Figure 9) is screwed in tightly to connecting rod (Item 60. in Figure 7). Make sure that seat ring (Item 230 in Figure 9) is in place. Apply a thin layer of silicone grease to back (rubber side) of diaphragm before installation. Holding the edges of the

diaphragm, screw the diaphragm assembly onto the male thread of the adaptor piece (Item 252 in Figure 9) until it reaches its mechanical stop.

5. With the capacity still set at 100% turn the motor fan until the new diaphragm is in the farthest rearward position (bottom dead center).

6. Reattach the diaphragm head with the suction and discharge ports in the correct positions. Tighten the screws in a crosswise pattern to a torque of 45 in-lb.

7. While turning the motor fan, set the stroke adjustment knob to the 0% position.

8. Reinstall motor fan cover.

#### 4.6.2 DIAPHRAGM REPLACEMENT: LIQUID END SIZE SD4, SD7, AND SD8 (SEE FIGURES 6, 11 - 14)

1. Mark the suction and discharge ports on the diaphragm head prior to removal. Loosen the head screws (290) and remove the diaphragm head (280).

2. Remove the motor fan cover and turn the motor by hand while adjusting the capacity control knob to 100%. With the capacity set at 100%, turn the motor fan until the diaphragm cap (240) is in the full forward position (top dead center).

3. Hold the outer edge of the diaphragm (260) and turn it counterclockwise to unscrew it from the pump drive.

4. While clamping on the hex on the diaphragm cap (240), disassemble diaphragm assembly by removing the hex nut (271) on the back of the diaphragm support nut (270).

5. Make sure that stainless steel support nut (270) is clean and free of corrosion. When cleaning the support nut, take care not to scratch the smooth angled surface of the support nut. If corrosion cannot be removed without damaging the support nut, replace with a new one.

6. Install new diaphragm (260) onto diaphragm cap (240) with the convolution in correct orientation. As shown in Figure 6, the convolution in the Teflon diaphragm should be facing down away from diaphragm cap (240) and against (or pointing towards) the stainless steel support nut (270)

7. For Size SD4-stainless steel liquid ends, slide bolt (250), washer (251), and O-ring (253) through the diaphragm cap and diaphragm as shown in Figure 6. For all other liquid ends, install set screw (Item 250 in Figure 6) into diaphragm cap (240), with hex hole in screw facing outward, until it is bottomed out (hand tight only) in the diaphragm cap.

8. Slide support nut (270) onto set screw in correct orientation shown in Figure 6.

9. Install hex nut onto back of support nut and tighten to the following torque values dependent on liquid end size and material. Torque diaphragm assembly as follows:

- a) Liquid End Size SD7 and SD8 to 20 foot pounds.
- b) Liquid End Size SD4-Plastic to 45 inch pounds.
- c) Liquid End Size SD4-Stainless Steel tighten until washer (Item 251 in Figure 6) is contacting diaphragm cap (Item 240 in Figure 6).

10. Make sure that support ring (230) is in place and then reinstall diaphragm assembly.

11. Apply thin layer of O-ring type grease to back of hex nut (271) and reinstall thin PTFE washer (274) to back of support nut.

12. Make sure that oil seal clamp ring (Item 210 in Figure 12) is in place. Screw diaphragm assembly into connecting rod (Item 60 in Figure 7) until it reaches its mechanical stop.

**Note:** Steps 11 and 12 are applicable to Liquid End Size SD4 (See Figure 6).

13. Apply a thin layer of grease to the back of hex nut (271).

14. Make sure that spring (Item 272 in Figure 13) is in place and connecting rod is in full-forward position (at 100% capacity setting). Screw diaphragm assembly into connecting rod cross piece (Item 61 in Figure 13) until it reaches its mechanical stop.

**Note:** Steps 13 and 14 are applicable to Liquid End Size SD7 and SD8 (See Figure 6).

15. With the capacity still set at 100% turn the motor fan until the diaphragm is pulled back to the rearward position (bottom dead center).

16. Reattach the diaphragm head with the suction and discharge ports in the correct positions. Torque the head assembly screws in a crosswise pattern as follows:

- a) Liquid End Size SD2 and SD4 to 45 inch pounds.
- b) Liquid End Size SD7 and SD8 to 90 inch pounds.

17. While turning the motor fan, set the stroke adjustment knob to the 0% position.

18. Reinstall motor fan cover.

#### 4.7 OIL SEAL BELLOWS REPLACEMENT (ITEM 70 IN FIGURE 7)

### CAUTION

**BEFORE BEGINNING OIL SEAL REPLACEMENT, MAKE SURE ALL SHUT-OFF VALVES ARE CLOSED AND ALL PRESSURE HAS BEEN BLED FROM THE LIQUID END (PUMP HEAD). WHEN REPLACING THE OIL SEAL, THE DIAPHRAGM ASSEMBLY MUST BE REMOVED FIRST. FOR EASE OF SERVICE, IT IS RECOMMENDED THAT THE OIL SEAL BE REPLACED IN CONJUNCTION WITH THE DIAPHRAGM ASSEMBLY.**

1. Disconnect connections to the pump motor terminal box. Be sure to note the wiring layout before disconnecting from box.

2. Set the stroke adjusting knob to 100%.

3. Disconnect the suction and discharge connections to the pump head check valves.

4. Mark the suction and discharge ports on the diaphragm head prior to removal. Loosen the head screws (Item 290 in Figure 12) and remove the diaphragm head (Item 280 in Figure 12).

5. Remove the motor fan cover and turn the motor by hand while adjusting the capacity control knob to 100%. With the capacity set at 100%, turn the motor fan until the diaphragm assembly (Figure 6) is in the full forward position (top dead center).

6. Hold the outer edge of the diaphragm assembly (Item 260 in Figure 6) and turn it counterclockwise to unscrew it from the pump drive.

7. Remove the diaphragm support ring (Item 230 in Figure 12) from the spacer (225).

8. Drain the oil out of the pump drive by removing the drain plug from the pump housing (Item 20 in Figure 8).

9. Remove oil seal bellows clamping components as follows:

- a) On Liquid End Size SD2 models (Figures 9 & 10), remove adaptor piece (252), clamp ring (210), mounting screws (227), and spacer (225).
- b) On Liquid End Size SD4 models (Figures 11 & 12), remove oil seal clamp ring (210), mounting screws (227), and spacer (225).
- c) On Liquid End Size SD7 and SD8 models (Figure 13 & 14), remove spring (272), unscrew adapter (61), seal ring (210) mounting screws (227 & 228), and spacer (225).

10. Pull the oil seal (70) off the connecting rod (60).
11. Install a new oil seal onto connecting rod.
12. Apply a thin layer of O-ring type grease to top of oil seal (part adjacent to connecting rod).
13. Reinstall parts removed in step 9. For Liquid ends SD2, SD7, and SD8, install adaptor piece (252) or cross piece (61) before mounting spacer.
14. Remove the motor and refill pump drive with oil (1 quart of Mobil SHC 629).
15. Reinstall motor.
16. Reinstall liquid end components in accordance with the procedures found in the following:
  - a) For Liquid End Size SD2 models, refer to paragraph 4.6.1, steps 4 thru 7.
  - b) For Liquid End Sizes SD4, SD7, and SD8 models, refer to paragraph 4.6.2, steps 10 thru 17.
17. Connect the motor in compliance with the directions marked during the prior disconnection (see also Section 2: ELECTRICAL CONNECTIONS).

#### **4.8 RESTARTING THE PUMP**

1. Reconnect the pump to the piping system.
2. Check that capacity is set to 0%.
3. Open system suction and discharge shut-off valves and restart pump.
4. Set the pump to 100% to obtain faster priming of liquid end.
5. After priming, set the pump to the desired capacity. Retighten locking screw (320).



## **SECTION 5 PARTS LIST**

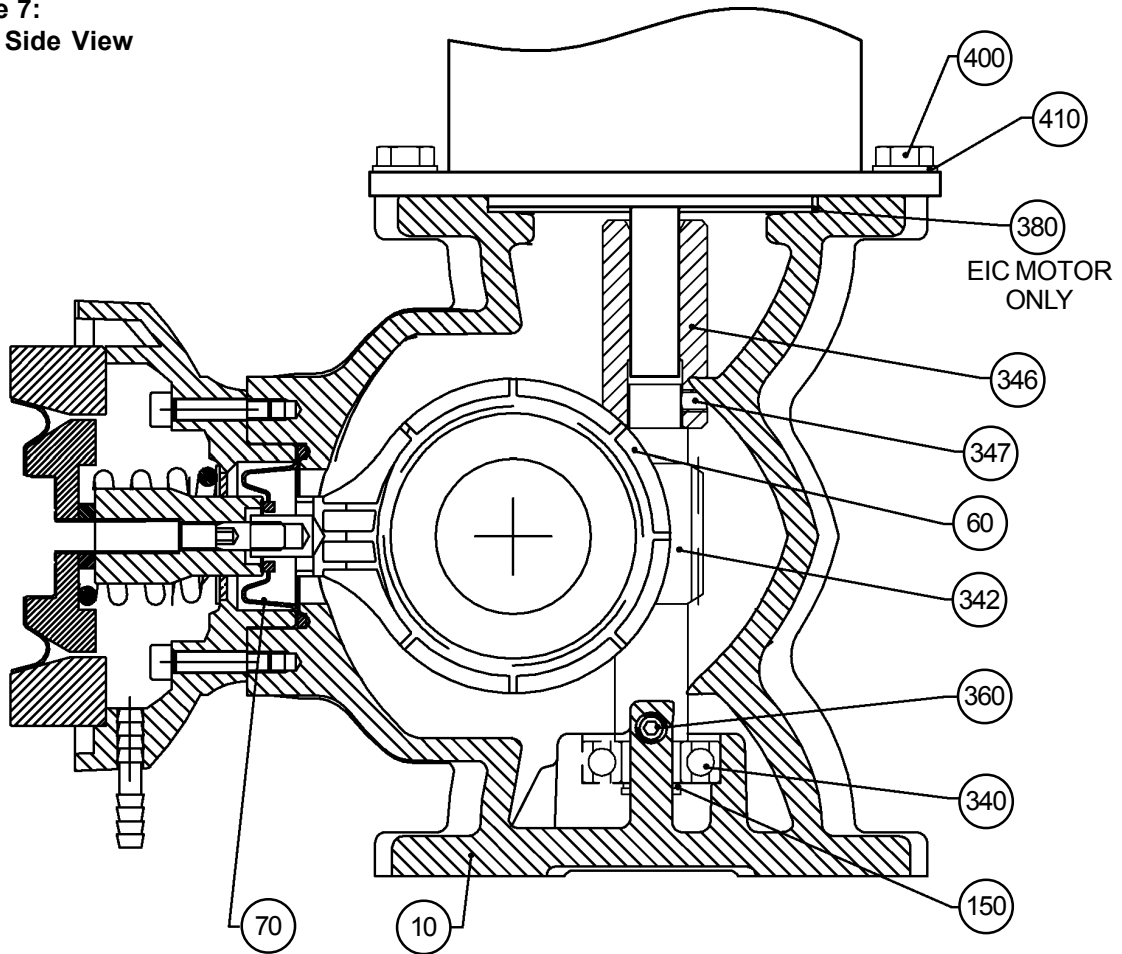
### **GENERAL**

1. This section gives information regarding replaceable components.

### **ILLUSTRATED PARTS LIST**

1. Figure and Item Number Column
  - (a) The item numbers shown in the detailed parts list correspond to the item numbers appearing on the exploded view illustration. To find an unknown part number, locate the part on the illustration and note the item number. Look for the item number on the detailed parts list. The part number is on the same line. A dash (-) precedes non-illustrated item numbers.
2. Description Column
  - (a) The name of the item is in the description column.
3. Part Number Column
  - (a) The supplier's part number is listed in the part number column.
4. Quantity Column
  - (a) The numbers appearing in the quantity column are the total quantity of the listed part required in its immediate assembly.
5. Reference Code Column
  - (a) This column is used to denote assembly and detail part variations among similar components (models) covered by this publication. When the symbol "A", "B", etc. is entered in this column, the part is used only in the model at which the symbol appears. If the column is blank, the part is used in all models.

Figure 7:  
Drive Side View



## 5.1 PARTS LIST FOR DRIVE SIDE VIEW

FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
7	10	Drive Housing	61109	1	
	60	Connecting Rod	70003	1	
	70	Drive Oil Seal Bellows	60048	1	
	150	Retaining Ring	4040107231	2	
	340	Bearing	61116	1	
	342	Worm, 43 spm "Model No. SD*1---" (see note 1)	61113	1	
	342	Worm, 86 spm "Model No. SD*2---" (see note 1)	61112	1	
	342	Worm, 173 spm "Model No. SD*3---" (see note 1)	61111	1	
	346	Worm w/Motor Coupling (IEC71, V1 Flange Motor)	61114	1	
	346	Worm w/Motor Coupling (NEMA 56C Flange Motor)	61115	1	
	347	Socket Set Screw CPT 1/4-20 X 5/16 ST	4050043034	1	
	360	Set Screw, M8 X 12 (see note 2)	61122	1	
	380	Spring Pin (for IEC Motors Only)	4010003031	3	
	400	Motor Mounting Bolt (EIC Motors: M8 X 25)	4350038522	4	
	400	Motor Mounting Bolt (NEMA 56C Motors: 3/8-16 X 1)	4050018119	4	
	410	Motor Mount Washer (EIC Motors: Spring Lockwasher 8mm)	4340009002	4	
	410	Motor Mount Washer (NEMA 56C Motors: 3/8 SAE)	40476	4	
	-500	Gear Oil - 1 quart	4070324030	1	
	600	Nameplate	61076	1	

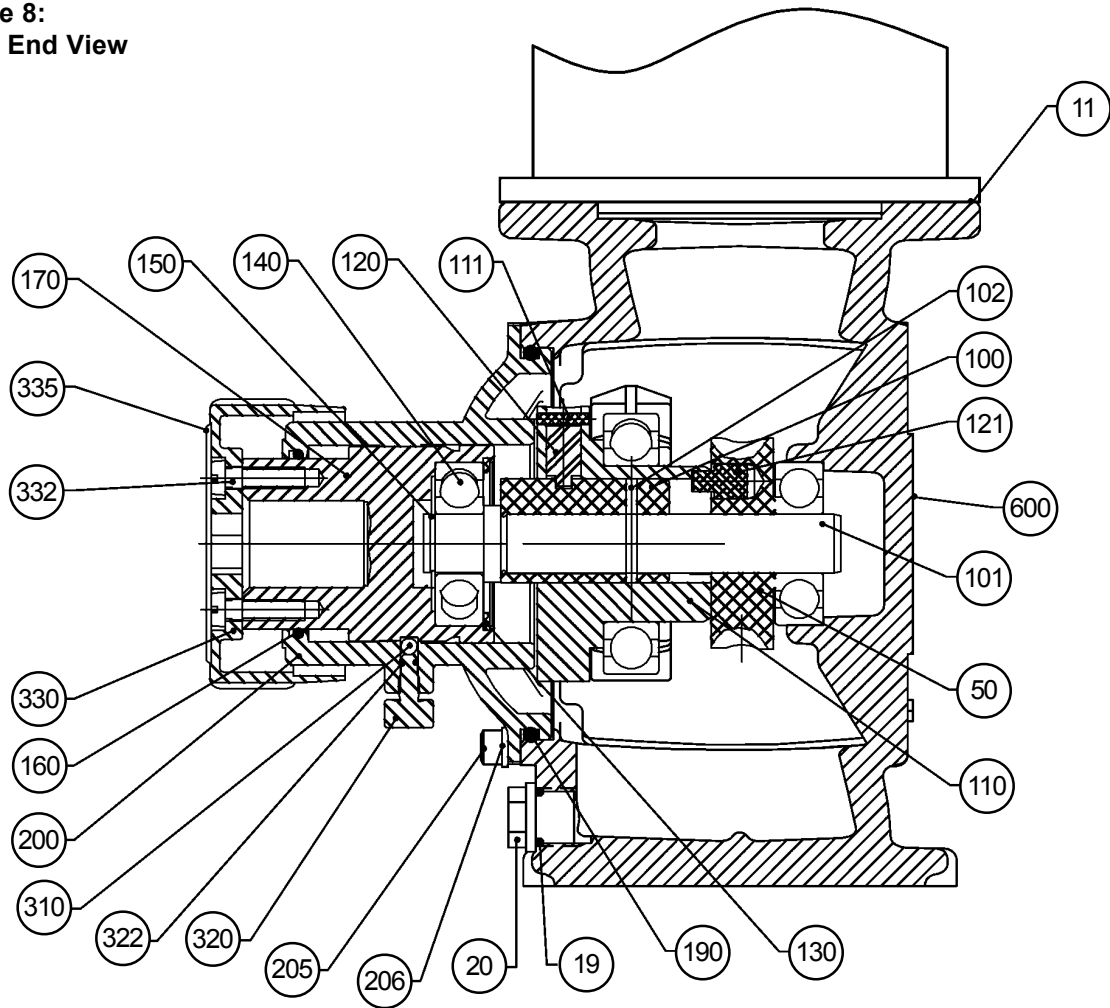
- Items not shown.

**Note 1:** Replacement of worm (342), only as assembly of items 342, 340, & 150.

Consult your dealer for this factory assembled collection of parts.

**Note 2:** When replacing set screw (347), consult factory for special assembly instructions.

**Figure 8:**  
**Drive End View**



## 5.2 PARTS LIST FOR DRIVE END VIEW

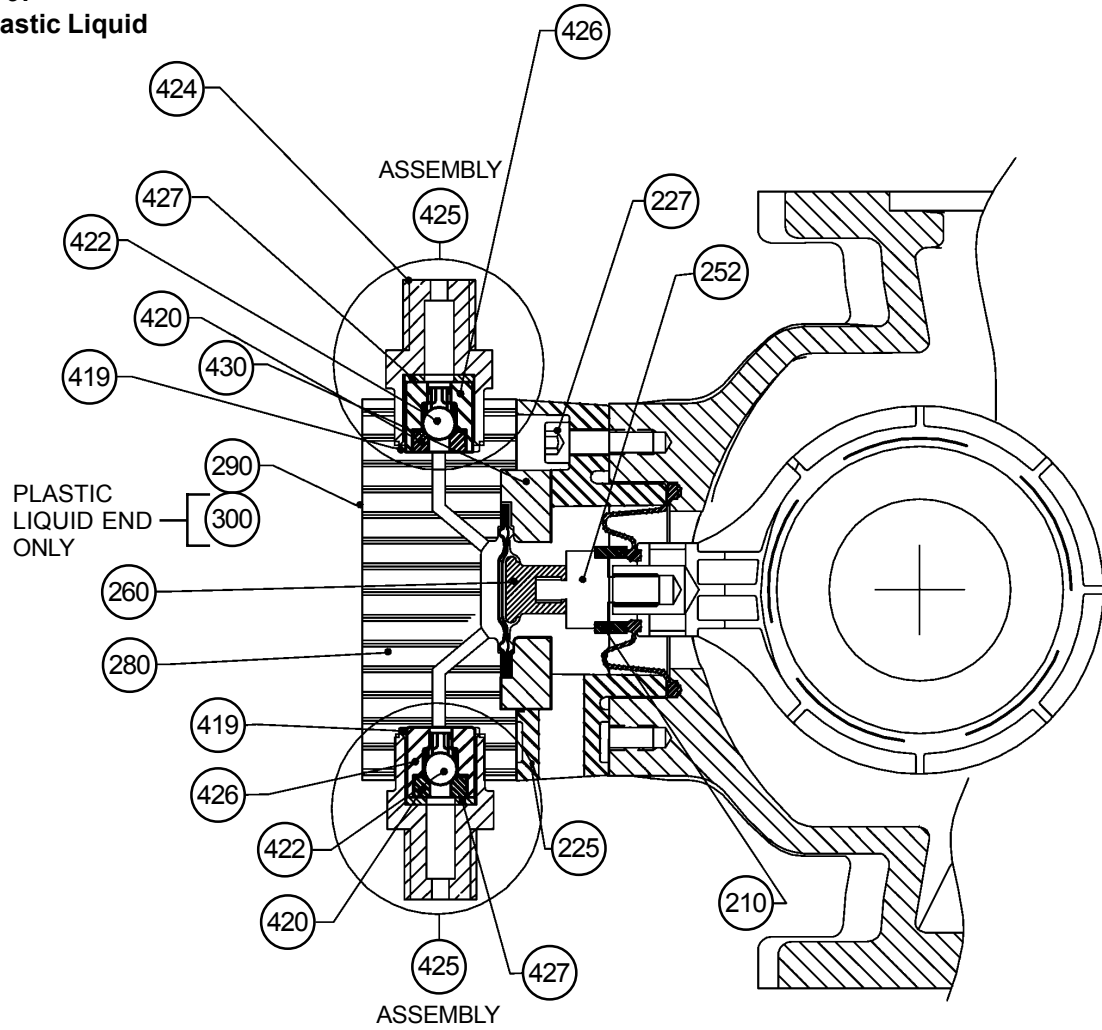
FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
8	11	Gasket Motor (IEC71, V1 Flange Motor)	2250121099	1	
	11	Gasket Motor (NEMA 56C Flange Motor)	2250115099	1	
	19	O-Ring	4080068031	1	
	20	Oil Drain Plug	60086	1	
	50	Gear, 43 spm (Model No. SD*1---)	5203094085N	1	
	50	Gear, 86 spm (Model No. SD*2---)	5203093085N	1	
	50	Gear, 173 spm (Model No. SD*3---)	5203092085N	1	
	100	Male Eccentric, Model No. "SD2----" (see note 1)	61104	1	
	100	Male Eccentric, Model No. "SD4----" (see note 1)	1600273192N	1	
	100	Male Eccentric, Model No. "SD7----" (see note 1)	1600273192N	1	
	100	Male Eccentric, Model No. "SD8----" (see note 1)	1600271192N	1	
	101	Drive Shaft (see note 1)	21291	1	
	102	Spring Pin .187 X 1 STL (see note 1)	4010005091	1	
	110	Female Eccentric, Model No. "SD2----"	61105	1	
	110	Female Eccentric, Model No. "SD4, SD7, SD8----"	1600260071N	1	
	111	Spring Pin 3mm Diameter 14mm Long	4310006455N	1	
	120	Stroke Adjust Key	3701310039N	1	
	121	Gear Key, Model No. "SD2----"	61108	1	
	121	Gear Key, Model No. "SD4, SD7, SD8----"	3701300039N	1	
	130	Retaining Ring	60064	1	
	140	Bearing (see note 1)	4099994000	2	
	150	Retaining Ring	4040107231	2	
	160	Seal, Side Cover	2502110067N	1	
	170	Stroke Adjust Screw	21292	1	
	190	O-Ring, Side Cover	4380024051N	1	
	200	Side Cover	7204400301N	1	
	205	Socket Head Screw M6 X 16, 304SS	4350003375N	3	
	206	Washer M6 304SS	4340009065N	3	
	310	Stroke Locking Ball	4370040050N	1	
	320	Stroke Locking Screw	5600400022N	1	
	322	O-Ring	4380249031N	1	
	330	Stroke Adjust Knob	70066	1	
	332	Pan Head Screw, M6 X 20	70054	2	
	335	Knob Sticker, MacRoy	60996	1	

- Items not shown.

**Note 1:** Replacement of male eccentric (100) only as assembly which includes items 100, 101, 102, 140, & 150.

Consult your dealer for part number for this factory assembled collection of parts.

**Figure 9:**  
**SD2 Plastic Liquid**  
**End**



### 5.3 PARTS LIST FOR SD2 PLASTIC LIQUID END PVC-NPT AND PVC-TUBING

**Model:**      **Code:**

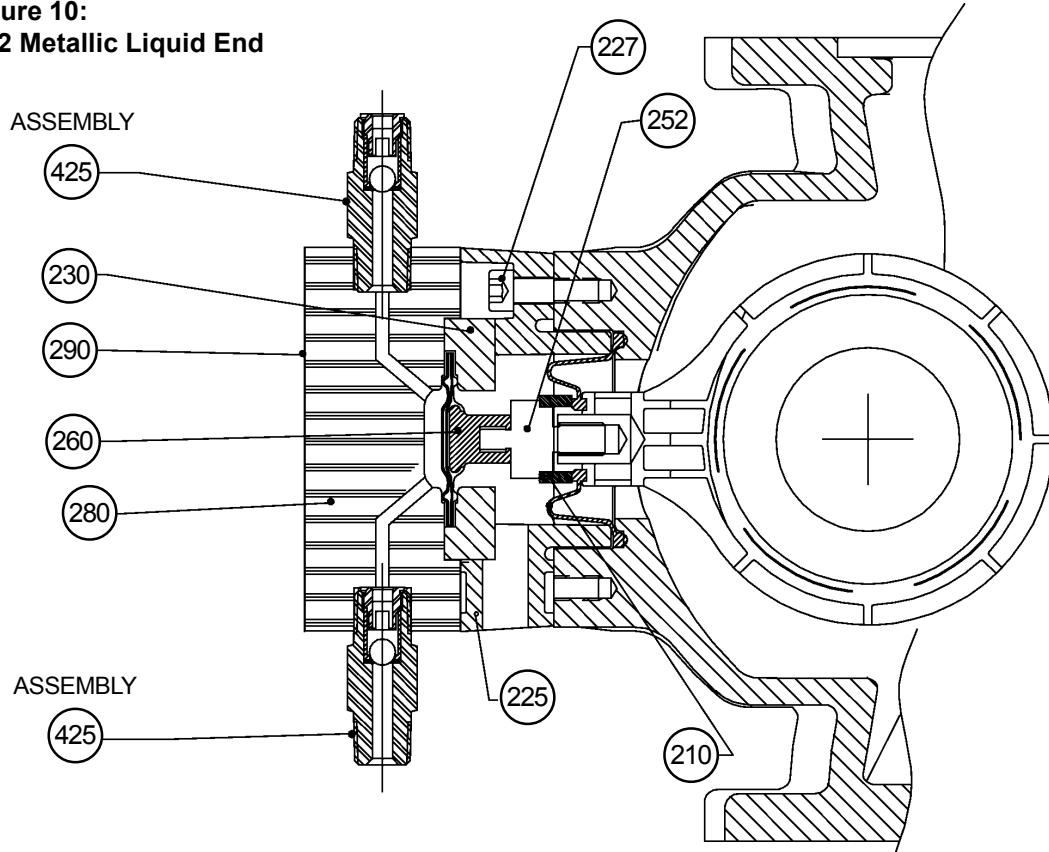
SD2\_\_8P    A  
 SD2\_\_8T    B  
 SD2\_\_2P    C  
 SD2\_\_2T    D

FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
9	210	Oil Seal Clamp Ring	60043	1	
	225	Spacer	61035	1	
	227	Pan Head Screw, M6 X 20	70054	4	
	230	Diaphragm Seat Ring	61088	1	
	252	Adapter	61083	1	
	260	Diaphragm	30916	1	
	280	Diaphragm Head	61089	1	A, B
	280	Diaphragm Head	61090	1	C, D
	-281	Decal	60534	1	
	290	Pan Head Screw, #10-24 X 3/4	61059	4	
	300	Flat Washer, #10 18.8SS	4040002053	4	
	419*	O-Ring	N/A	2	
	420*	Ball Seat, HAST. C22	N/A	2	
	422*	Ball 9/32 Ceramic	N/A	2	
	424*	Valve Body 1/4" NPT	N/A	2	
	425	Check Valve Assembly - NPT	61141	2	A, C
	-425	Check Valve Assembly - NPT	61142	2	B, D
	426*	Ball Cartridge	N/A	2	
	427*	Molded Washer	N/A	2	
	-435*	Coupling Nut	N/A	2	B, D
	-445*	Ferrule	N/A	2	B, D

- Items not shown.

\* Items included as part of item number 425.

**Figure 10:  
SD2 Metallic Liquid End**



**5.4 PARTS LIST FOR SD2 METALLIC LIQUID END STAINLESS STEEL-NPT**

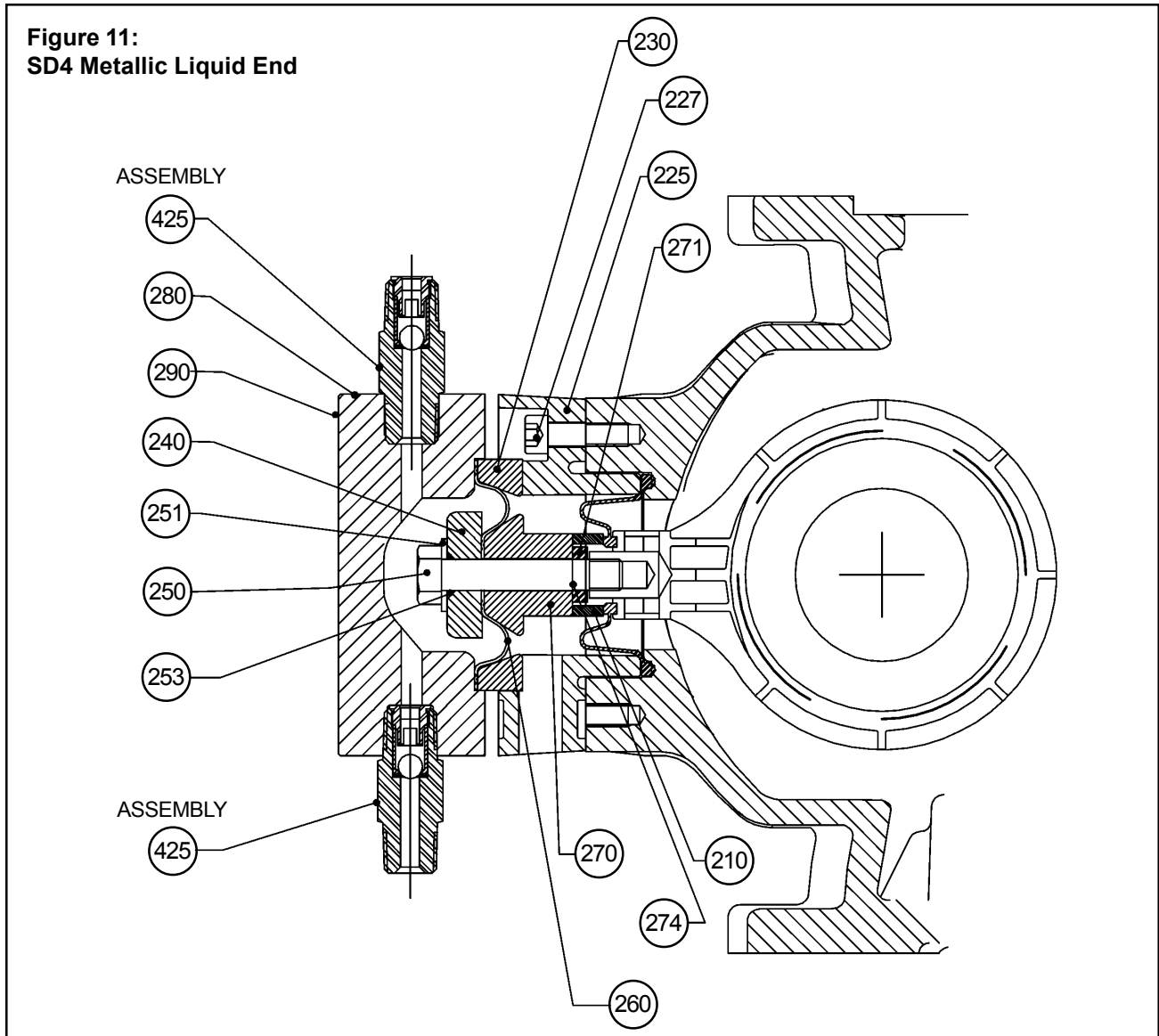
**Model:** SD2 \_\_ 7P

FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
10	210	Oil Seal Clamp Ring	60043	1	
	225	Spacer	61035	1	
	227	Pan Head Screw, M6 X 20	70054	4	
	230	Diaphragm Seat Ring	61088	1	
	252	Adapter	61083	1	
	260	Diaphragm	30916	1	
	280	Diaphragm Head	61106	1	
	290	Pan Head Screw, #10-24 X 3/4	61059	4	
	425	Check Valve Assembly - NPT	61140	2	

- Items not shown.



**Figure 11:  
SD4 Metallic Liquid End**



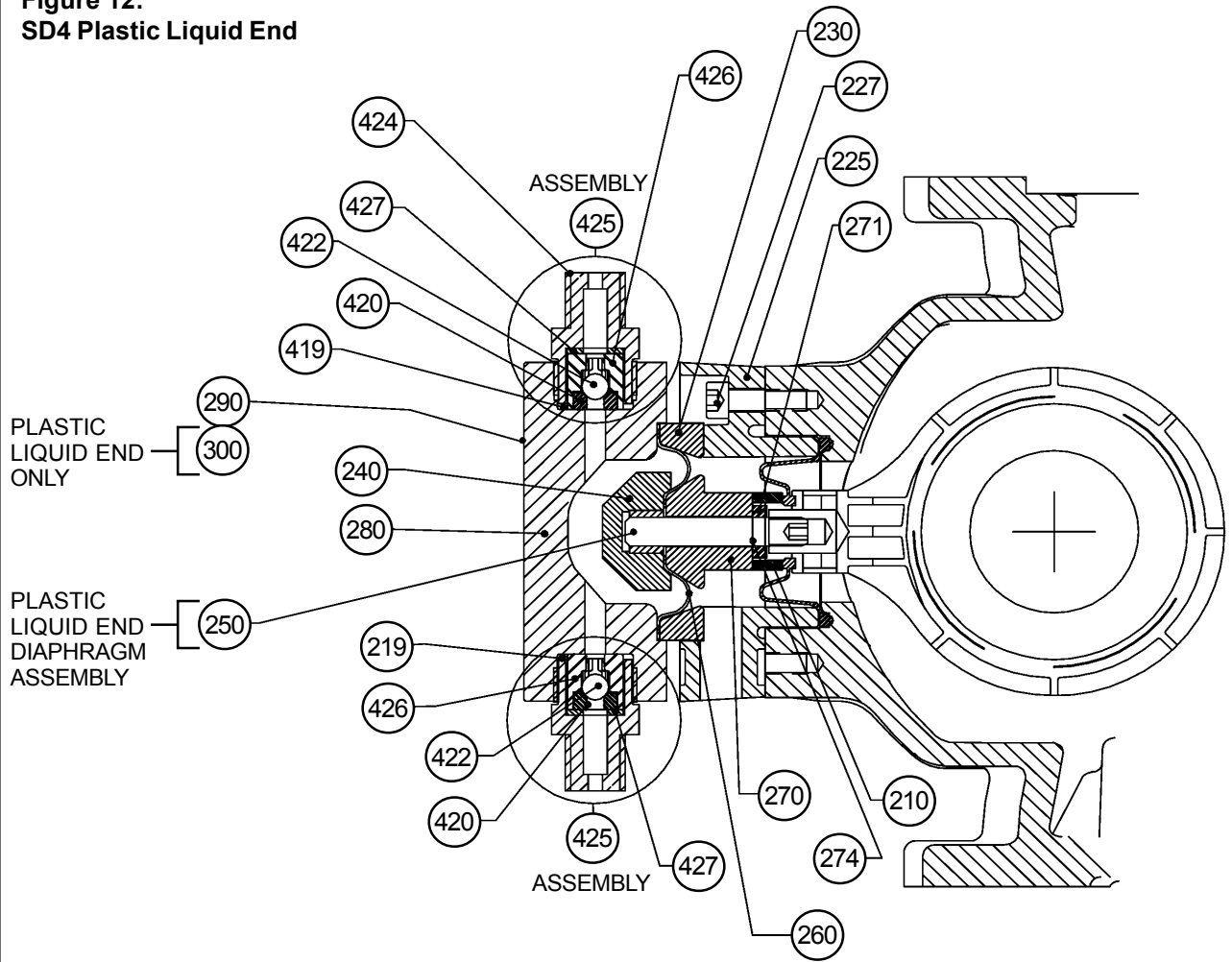
**5.5 PARTS LIST FOR SD4 METALLIC LIQUID END STAINLESS STEEL-NPT**

Model: SD4 \_\_ 7P

FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
11	210	Oil Seal Clamp Ring	60043	1	
	225	Spacer	61035	1	
	227	Pan Head Screw, M6 X 20	70054	4	
	230	Supporting Ring	61075	1	
	240	Diaphragm Cap, 316SS	61074	1	
	250	Hex Head Screw, M8 X 50, 316SS	61971	1	
	251	Washer, 8M, 316SS	61072	1	
	253	O-Ring, Viton	61073	1	
	260	Diaphragm	60995	1	
	270	Support Nut, 316SS	61051	1	
	271	Hex Nut, M8 Thin	61054	1	
	274	PTFE Washer	61055	1	
	280	Diaphragm Head, 316SS	61070	1	
	290	Pan Head Screw, #10-24 X 3/4	61059	4	
	425	Check Valve Assembly	CV202294	2	

- Items not shown.

**Figure 12:  
SD4 Plastic Liquid End**



## 5.6 PARTS LIST FOR SD4 PLASTIC LIQUID END PVC-NPT AND PVC-TUBING

**Model:**      **Code:**

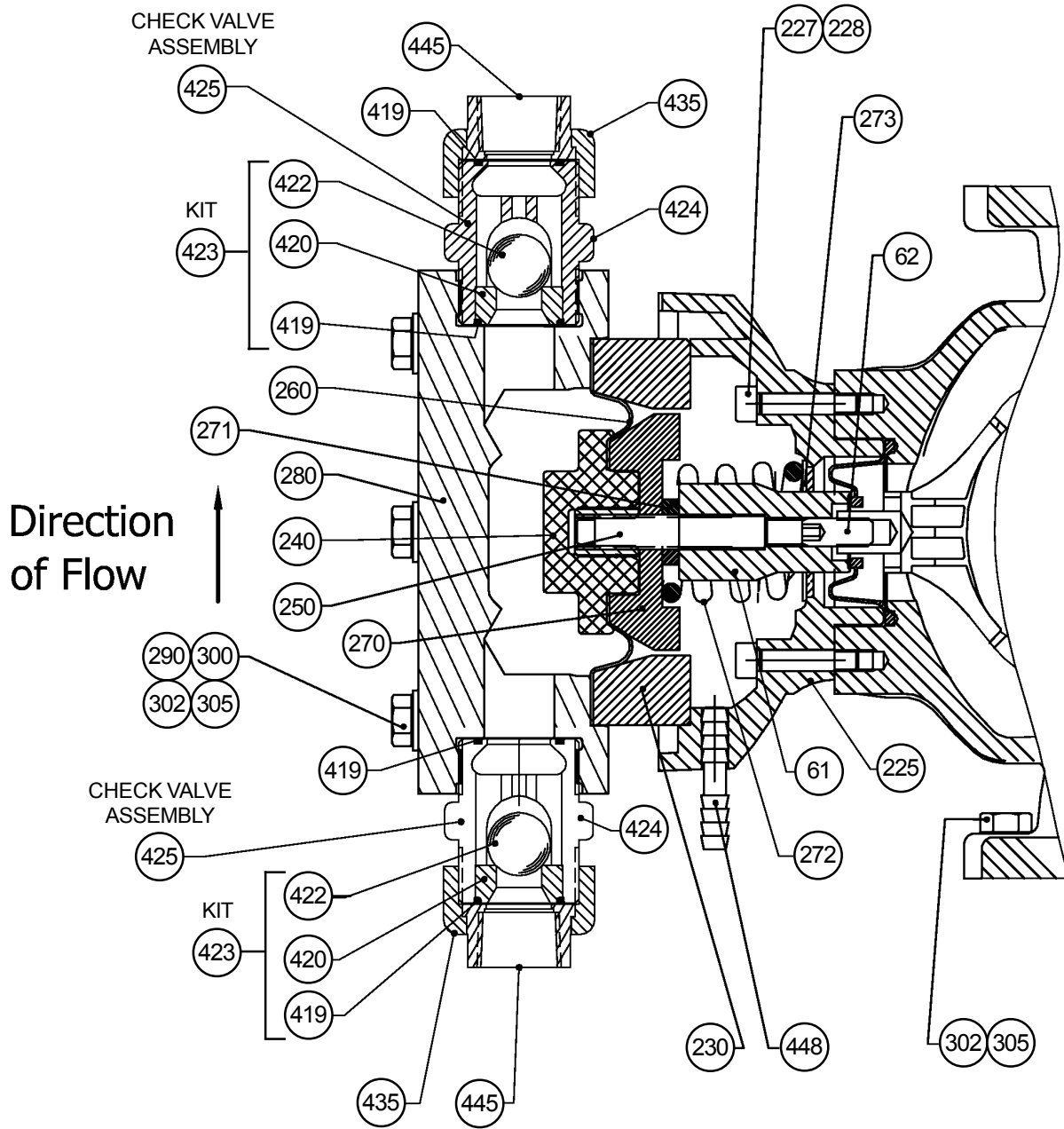
SD4\_\_8P      A  
 SD4\_\_8T      B  
 SD4\_\_2P      C  
 SD4\_\_2T      D

FIGURE NUMBER	ITEM NUMBER	DESCRIPTION	PART NUMBER	QUANTITY PUMP	REFERENCE CODE
12	210	Oil Seal Clamp Ring	60043	1	
	225	Spacer	61035	1	
	227	Pan Head Screw, M6 X 20	70054	4	
	230	Diaphragm Support Ring	61075	1	
	240	Diaphragm Cap - PVC	61052	1	A, B
	240	Diaphragm Cap - PVDF	61053	1	C, D
	250	Socket Set Screw, M8 X 50	61058	1	
	260	Diaphragm	60995	1	
	270	Support Nut, 316SS	61051	1	
	271	Hex Nut, M8 X 50	61054	1	
	274	PTFE Washer	61055	1	
	280	Diaphragm Head	61056	1	A, B
	280	Diaphragm Head	61057	1	C, D
	-281	Decal	60534	1	
	290	Pan Head Screw, #10-24 X 3/4	61059	4	
	300	Flat Washer, #10 18.8SS	4040002053	4	
	419*	O-Ring	N/A	2	
	420*	Ball Seat, HAST. C22	N/A	2	
	422*	Ball 9/32 Ceramic	N/A	2	A, C
	424*	Valve Body - NPT	N/A	2	B, D
	424*	Valve Body - TUBE	N/A	2	A, C
	425	Check Valve Assembly - NPT	36366	2	B, D
	425	Check Valve Assembly - TUBE	36360	2	
	426*	Ball Cartridge	N/A	2	
	427*	Molded Washer	N/A	2	

- Items not shown.

\* Items included as part of item number 425.

**Figure 13: SD7 & SD8 Plastic  
Liquid End**



## 5.7 PARTS LIST FOR SD7 AND SD8 PLASTIC LIQUID END PVC-NPT AND PVDF-NPT

Model:

Code:

SD7\_\_8P or SD8\_\_8P

A

SD7\_\_2P or SD8\_\_2P

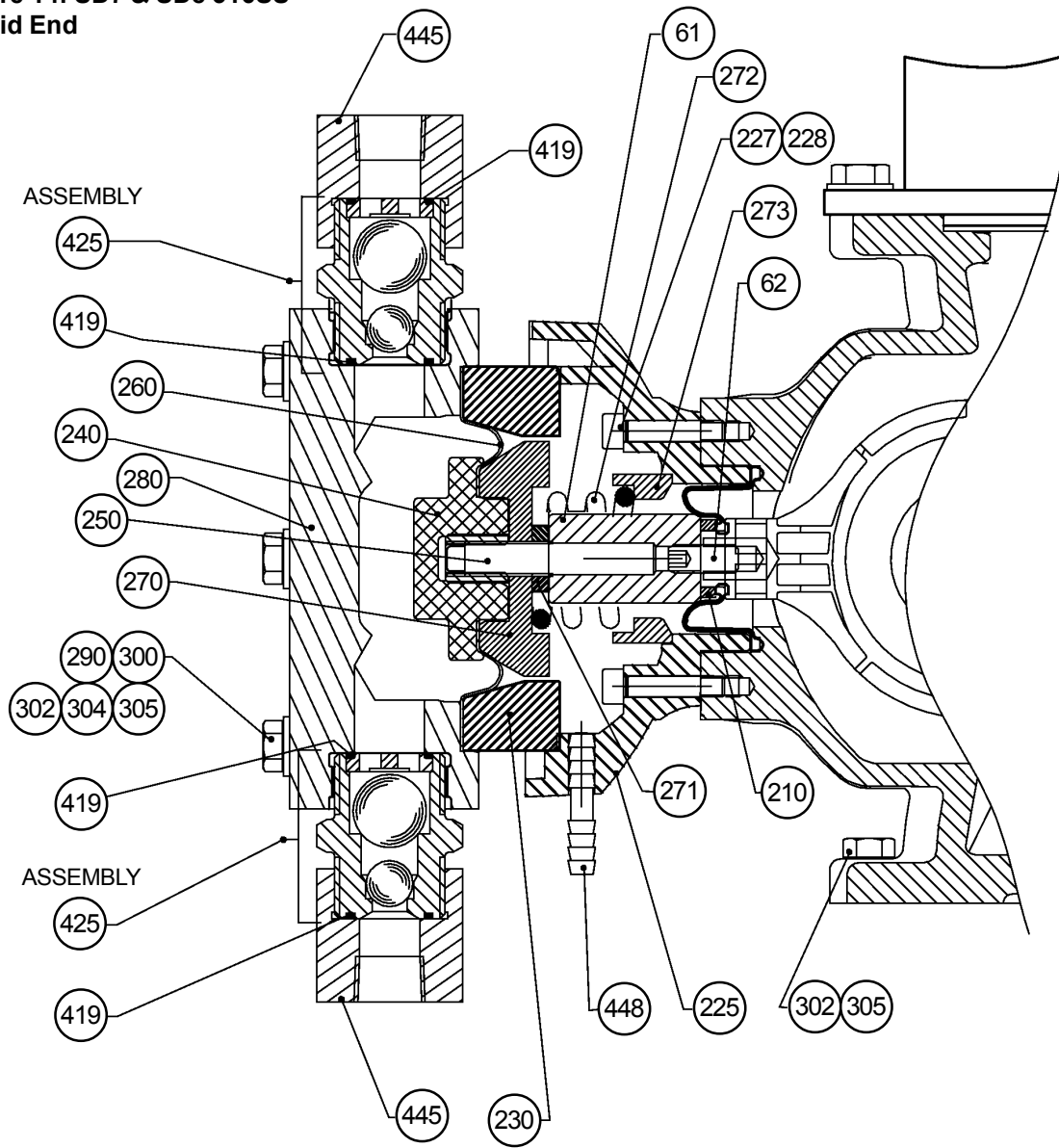
B

FIG. NO.	ITEM NO.	DESCRIPTION	SD7 PART NO.	SD8 PART NO.	QTY. PUMP	REF. CODE
13	61	Adapter	61155	61155	1	
	62	Socket Head Set Screw, M8 X 20	4350016075N	4350016075N	1	
	-210	PTFE Seal Ring	61154	61154	1	
	225	Spacer	61156	61156	1	
	227	Socket Head Set Screw, M6 X 16, 304SS	4350003375N	4350003375N	2	
	228	Socket Head Set Screw, M6 X 30, 304SS	4350047395N	4350047395N	2	
	230	Diaphragm Support Ring	60035	60070	1	
	240	Diaphragm Cap - PVC	60628	60633	1	A
	240	Diaphragm Cap - PVDF	60630	60635	1	B
	250	Socket Set Screw, Dog PT M10 X 45	4350071284	4350071284	1	
	260	Diaphragm	60618	60624	1	
	270	Support Nut	61065	61146	1	
	271	Hex Nut, M10 Thin, 316SS	61068	61068	1	
	272	Spring	70081	70081	1	
	273	Spring Cup	61153	61153	1	
	280	Head PVC	60033	61148	1	A
	280	Head PVDF	60031	61147	1	B
	290	Hex Head Screw, M8 X 110mm, LG 304SS	4350001655	4350001655	6	
	300	Flat Washer, M8, Regular 304SS	4340005085	4340005085	6	
	302	Split Washer M8, 304SS	4340009005	4340009005	6	
	-304	Nut Spacer	61152	61152	6	
	305	Hex Nut, M8, 304SS	4350000045	4350000045	6	
	419*	O-Ring, Viton	4080068075	4080068075	4	A
	419*	O-Ring, PTFE	40348	40348	4	B
	420*	Seat, PVDF	2240173078	2240173078	2	
	422*	Ball, 5/8 Ceramic	4070015171	4070015171	2	
	423	Kit - Ball, Seat & O-Rings	3050879500	3050879500	2	A
	423	Kit - Ball, Seat & O-Rings	3050879700	3050879700	2	B
	424*	Cartridge Body, PVDF	60024	60024	2	
	425	Check Valve Assembly	3050870007	3050870007	2	A
	425	Check Valve Assembly	3050870008	3050870008	2	B
	435	Union Nut, 1/2" PVC	4320236038	4320236038	2	
	445	Union End, 1/2" NPT PVDF	60117	60117	2	A
	445	Union End, 1/2" NPT PVDF	60119	60119	2	B
	448	Blow-Off Nozzle	470096073N	470096073N	1	

- Items not shown.

\* Items included as part of item number 425.

**Figure 14: SD7 & SD8 316SS  
Liquid End**



## 5.8 PARTS LIST FOR SD7 AND SD8 316SS-NPT LIQUID END

Model: SD6 \_\_ 7P or SD8 \_\_ 7P

FG. NO.	ITEM NO.	DESCRIPTION	SD7 PART NO.	SD8 PART NO.	QTY. PUMP	REF. CODE
14	61	Adapter	61155	61155	1	
	62	Socket Head Set Screw, M8 X 20	4350016075N	4350016075N	1	
	210	PTFE Seal Ring	61154	61154	1	
	225	Spacer	61156	61156	1	
	227	Socket Head Set Screw, M6 X 16, 304SS	4350003375N	4350003375N	2	
	228	Socket Head Set Screw, M6 X 30, 304SS	4350047395N	4350047395N	2	
	230	Support Ring	61066	61066	1	
	240	Diaphragm Cap - 316SS	60631	60631	1	
	250	Socket Set Screw, Dog PT M10 X 45	4350071284	4350071284	1	
	260	Diaphragm	60618	60624	1	
	270	Support Nut	61065	61146	1	
	271	Hex Nut, M10 Thin, 316SS	61068	61068	1	
	272	Spring	70081	70081	1	
	273	Spring Cup	61153	61153	1	
	280	Head, 316SS	210760016	210760016	1	
	290	Hex Head Screw, M8 X 110mm, LG 304SS	4350001655	4350001655	6	
	300	Flat Washer, M8, Regular 304SS	4340005085	4340005085	6	
	302	Split Washer M8, 304SS	4340009005	4340009005	6	
	304	Nut Spacer	61152	61152	6	
	305	Hex Nut, M8, 304SS	4350000045	4350000045	6	
	419	O-Ring, Viton	4080068075	4080068075	4	
	425	Check Valve Assembly	3050876602	3050876602	2	
	445	Coupling, 1/2" NPT	60135	60135	2	
	448	Blow-Off Nozzle	470096073N	470096073N	1	

- Items not shown.

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## SECTION 6 TROUBLESHOOTING

SYMPTOMS	POSSIBLE CAUSE	REMEDY
1. Pump motor won't operate.	<ul style="list-style-type: none"> <li>a) Low process liquid level in the tank.</li> <li>b) Worn or dirty check valves.</li> <li>c) Blocked discharge line.</li> <li>d) Frozen liquid.</li> <li>e) Blown fuse.</li> <li>f) Open thermal overload device in motor starter.</li> <li>g) Broken wire.</li> <li>h) Low voltage.</li> <li>i) Pump not primed.</li> <li>j) Capacity adjustment set at zero.</li> </ul>	<ul style="list-style-type: none"> <li>a) Add liquid.</li> <li>b) Clean or replace.</li> <li>c) Clear line.</li> <li>d) Thaw liquid throughout pumping system.</li> <li>e) Replace fuse.</li> <li>f) Reset device.</li> <li>g) Locate and repair.</li> <li>h) Investigate and correct (wiring may be too tight).</li> <li>i) Allow suction line and pump head to fill with liquid before pumping against pressure.</li> <li>j) Readjust capacity.</li> </ul>
2. Insufficient pump delivery.	<ul style="list-style-type: none"> <li>a) Incorrect capacity adjustment.</li> <li>b) Incorrect pump speed.</li> <li>c) Starved suction.</li> <li>d) Leaky suction piping.</li> <li>e) High suction lift.</li> <li>f) Liquid near boiling.</li> <li>g) Leaky safety valve in discharge line.</li> <li>h) High liquid viscosity.</li> <li>i) Worn or dirty check valve seats.</li> </ul>	<ul style="list-style-type: none"> <li>a) Readjust capacity setting.</li> <li>b) Match line voltage and frequency to pump motor data plate.</li> <li>c) Increase piping size or suction head.</li> <li>d) Repair piping.</li> <li>e) Rearrange equipment to decrease lift and/or install foot valve in suction line.</li> <li>f) Cool liquid or increase suction head.</li> <li>g) Repair or replace valve.</li> <li>h) Reduce viscosity (e.g., heat or dilute liquid), or consult the factory for special check valve options.</li> <li>i) Clean or replace.</li> </ul>

SYMPTOMS	POSSIBLE CAUSE	REMEDY
3. Erratic pump delivery.	<ul style="list-style-type: none"> <li>a) Leaky suction piping.</li> <li>b) Leaky safety valve.</li> <li>c) Insufficient suction head.</li> <li>d) Liquid near boiling.</li> <li>e) Worn or dirty check valves.</li> <li>f) Clogged or dirty line strainer.</li> </ul>	<ul style="list-style-type: none"> <li>a) Repair piping.</li> <li>b) Repair or replace valve.</li> <li>c) Raise suction tank level and/or install foot valve in suction line.</li> <li>d) Cool liquid or increase suction head.</li> <li>e) Clean or replace.</li> <li>f) Clean strainer.</li> </ul>
4. Motor and pump body hot.	<ul style="list-style-type: none"> <li>a) Normal operating temperature of both motor and pump body is frequently uncomfortable to the touch. However, neither should exceed 200°F (93°C).</li> <li>b) Power supply does not match electrical requirement of motor.</li> <li>c) Pump is being operated at greater than rated performance.</li> <li>d) Pump improperly lubricated.</li> </ul>	<ul style="list-style-type: none"> <li>a) N/A</li> <li>b) Insure proper matching of power supply and motor.</li> <li>c) Reduce pressure or stroke speed. If this is not practical, contact service facility.</li> <li>d) Drain oil and refill with proper amount of recommended lubricant.</li> </ul>
5. Pump still pumps even at zero capacity setting.	<ul style="list-style-type: none"> <li>a) Misadjusted capacity knob.</li> <li>b) Insufficient discharge pressure.</li> </ul>	<ul style="list-style-type: none"> <li>a) Readjust capacity setting.</li> <li>b) Correct condition (e.g., install a back pressure valve).</li> </ul>
6. Gear noise.	<ul style="list-style-type: none"> <li>a) Excessive backlash.</li> <li>b) Worn bearings.</li> <li>c) Wrong or insufficient lubricant.</li> </ul>	<ul style="list-style-type: none"> <li>a) Consult service facility.</li> <li>b) Consult service facility.</li> <li>c) Replace or replenish lubricant.</li> </ul>
7. Loud knock with each stroke.	<ul style="list-style-type: none"> <li>a) Excessive gear set wear.</li> <li>b) Worn bearings.</li> </ul>	<ul style="list-style-type: none"> <li>a) Consult service facility.</li> <li>b) Consult service facility.</li> </ul>
8. Noisy operation in liquid end.	<ul style="list-style-type: none"> <li>a) Noise in check valves.</li> </ul>	<ul style="list-style-type: none"> <li>a) Ball checks move up and down with some force. A distinct "clicking" noise is normal, especially in metal piping systems.</li> </ul>

## **SECTION 7 LIMITED WARRANTY**

The LMI/Milton Roy Company ("Company") warrants that its pumping products will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of twelve months from shipment by the Company. The Company additionally warrants that all of its other products, including actuators, will be free from defects in title, and so far as of its own manufacture, will be free from defects in materials and workmanship for a period of twelve months from shipment by the Company. The Company will, as its option, repair or replace its products provided the Company's inspection reveals the products to have been defective or nonconforming within the terms of this warranty. This warranty is expressly conditioned upon the following: (a) proper installation, maintenance, and use under the Company specified service conditions, (b) prompt notice of nonconformance or defect, (c) the Company's prior written authorization for return, (d) the products being returned to the Company, or at the Company's discretion, to a Factory Authorized Service Center, all at no cost to the Company. The Company will deliver repaired or replacement products Ex Works its factory or Factory Authorized Service Center. Products not of the Company's manufacture are warranted only to the extent provided by the original manufacturer. The company shall not be liable for damage of any kind resulting from erosive, corrosive or other harmful action of any liquids, gases, or any other substance handled by the Company's products.

THE FOREGOING IS IN LIEU OF ALL OTHER WARRANTIES, OBLIGATIONS, OR LIABILITIES, WHETHER EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

UNDER NO CIRCUMSTANCES SHALL THE COMPANY BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL, OR SPECIAL DAMAGES, LOSSES, OR EXPENSES ARISING FROM THIS CONTRACT, ITS PERFORMANCE, OR IN CONNECTION WITH THE USE OF, OR INABILITY TO USE THE COMPANY'S PRODUCTS.

The liability of the Company in respect of all damages, losses, costs or expenses, whether suffered or incurred by the Purchaser or any third party arising in any manner or incident related to this contract or the performance hereunder, shall be limited in the aggregate to the actual price paid by the Purchaser to the Company.

Revision A

17 March 1998

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