



Milroyal "G" Pump

INSTRUCTION MANUAL

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TABLE OF CONTENTS

List of Illustrations	2
Warranty	3
Section 1 Description	4
General	4
Principle of Operation	4
General Specifications	6
Product Code (Figure 1).....	7
Section 2 Installation	8
Unpacking	8
Safety precautions	8
Storage	8
Mounting	9
Conversion Procedures.....	9
Piping	9
Electrical Connections	12
Section 3 Operation	13
Initial Start-Up	13
Relief Valve Adjustment.....	15
Use of Air Purge Button.....	16
Manual Capacity Control.....	17
Filling Pumping System.....	17
Capacity Calibration.....	17
Section 4 Maintenance	18
Recommended Spare Parts	18
Shipping pumps for repair	18
Routine Preventive Maintenance	19
Corrective Maintenance	24
Section 5 Troubleshooting Guide	29
Section 6 Parts	31

LIST OF ILLUSTRATIONS

(Located in back of manual)

- Figure 2. Sample Nameplate.
- Figure 3. Mounting Hole Dimensions.
- Figure 4. Typical Recommended pump installation Scheme
- Figure 5. Pump Drive Parts — Side View
- Figure 6. Pump Drive Parts — Top View.
- Figure 7. Liquid End—Top View
- Figure 8. Liquid End—Cutaway View
- Figure 9. MARS Valve
- Figure 10. Double-Ball Check Valve Parts(1-1/4"---plastic;1-3/4,2-1/2"---PVC & metallic).
- Figure 11. Plastic Single-Ball Check Valve Parts: 1-3/4, 2-1/2, & 3" Plungers
- Figure 12. Plastic Check Valves for 1-1/4" Plunger
- Figure 13. Metallic Check Valves for 1-1/4" Plunger
- Figure 14. PVC 4 Function Bleed Valve for 1-1/4" Plunger

MILROYAL G METERING PUMP TWENTY-FOUR MONTH LIMITED WARRANTY

Milton Roy Company warrants its Milroyal G metering pumps against defects in workmanship or materials for two years under normal use from the date of shipment from our warehouse or the warehouse of our agent. Warranties on equipment and accessories furnished with the pump but manufactured by others are limited to the warranties offered by the manufacturers of their respective products. This warranty is not extended to electronic or pneumatic control devices supplied with a Milton Roy metering pump. These items are covered by the warranties offered by the manufacturer or the Milton Roy Warranty for Electronic Controls and Actuators.

All obligations and liabilities under this warranty are limited to refunding, repairing or replacing (at our option), f.o.b. our plant, such reported defective units as are returned to our plant, carrier charges prepaid. Repairs or replacements are made subject to factory inspection of returned items.

This warranty does not extend to damage by corrosion or erosion. The materials of construction offered are recommendations subject in all cases to verification and acceptance by the customer. These recommendations, based on previous Company experience and best available information, do not constitute guarantees against wear or chemical action.

Expressly excluded from this warranty are defects caused by misuse, abuse, or improper application, employment, or operation of the unit. Expendable items and damage resulting from unauthorized repair are not covered by this warranty. No liability for consequential damages or reinstallation labor is accepted. Milton Roy Company will not assume responsibility for contingent liability for alleged failure of its products.

This warranty is in lieu of all other warranties expressed or implied.

SECTION 1

DESCRIPTION

GENERAL

Milroyal G pumps are reciprocating, chemical dosing pumps capable of producing controlled flows up to 130 gallons per hour (492 L/H) at pressures up to 600 psi (41 BAR) (depending on the model). These pumps feature the robust High Performance Diaphragm (HPD) liquid end, which eliminates the need for contour plates, and a non-lost motion stroke adjustment mechanism based on the variable eccentric principle. This non-lost motion design substantially reduces pressure and flow pulsations which in turn increases the life of system components and results in a more continuous chemical injection. It is designed for industrial service and offers an accuracy of $\pm 1\%$ of 100% rated flow between 10% and 100% of its flow range.

The High Performance Diaphragm (HPD) liquid end combines all of the best characteristics of traditional liquid ends into one technologically advanced design. Its operating characteristics and simplicity of operation make it the best liquid end to consider first for most metering pump applications.

Milton Roy's HPD liquid end overcomes the net positive suction head (NPSH) restrictions associated with conventional disc diaphragm metering pumps. This is accomplished by a unique mechanically actuated refill system (MARS) that eliminates the need for diaphragm support plates thereby lowering pump NPSH requirements.

The MARS also does away with the need for field adjustment of the refill mechanism by automatically compensating for process liquid modifications. This, combined with removable check valves, makes the HPD an ideal choice for any process in which downtime is critical.

The HPD features a preformed, PTFE faced elastomer diaphragm that is compatible with a wide range of process liquids and chemicals. The convoluted design of this composite diaphragm also offers extended life over conventional flat disk designs.

The HPD liquid end is particularly suitable for pumping costly, aggressive or hazardous liquids without leakage.

PRINCIPLE OF OPERATION

Refer to **Figures 5 through 10**

The pump consists of two major assemblies; the drive and the liquid end. Pump delivery is a function of the drive's stroke rate (strokes/minute), plunger size and stroke length (%Capacity). Stroke length can be adjusted while the pump is running or stopped by turning the stroke adjustment knob (330).

The drive motor transmits rotary motion to a worm gear speed reduction unit (343,50) which in turn drives the variable eccentric crank (100). The adjustable crank imparts reciprocating motion to the plunger/connecting rod assembly (60,520,525). The stroke length is adjusted by changing the position of the variable eccentric crank in the connecting rod assembly.

The mechanical drive system of the pump drives the plunger back and forth in the High Performance Diaphragm (HPD) liquid end supplied with the pump. At the start of a suction stroke, the plunger moves away from the liquid end, drawing hydraulic fluid with it. As the hydraulic fluid is drawn back, the flexible diaphragm (510) follows, lowering the pressure of the process fluid in the liquid end. This pressure drop causes the ball(s) in the suction check valve (Figure 10) to be lifted up thereby allowing process fluid to pass

through the suction line into the diaphragm head(1020). At the same time, the pressure drop in the diaphragm head causes the ball(s) in the discharge check valve(Fig. 10) to be pulled closed, blocking flow back through the discharge line.

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, negatively impacting the performance of the pump. If you suspect the possibility of cavitation, contact your Milton Roy Representative for assistance.

At the end of the suction stroke, the process reverses, beginning the discharge stroke. Now the plunger moves forward, pushing hydraulic fluid before it. The hydraulic oil must therefore press against the diaphragm, flexing it forward and raising the pressure of the process fluid in the liquid end. This pressure increase causes the process fluid to flow outward, forcing the discharge ball check open and the suction ball check to seat, blocking back flow through the suction line. The process fluid flows out of the diaphragm head and into the discharge line. This suction/discharge action is repeated with every stroke of the pump plunger, and is the direct cause of the pumping action.

As the pump operates, a small quantity of hydraulic oil is continuously bled through the air bleed system(970,960,980 in Fig.8) in the three-function hydraulic valve(air bleed/relief/purge--Fig.8). An additional small quantity of hydraulic oil is also lost on every stroke through the clearance between the plunger and displacement chamber bore. After a while, these normal losses result in a shortage of hydraulic oil in the displacement chamber. When this happens, the diaphragm will be pulled back tight against the back contoured surface of the displacement chamber, and part of the diaphragm will press against the Mechanically Actuated Refill System(MARS) valve(Fig. 9). Now, when the plunger draws back, a vacuum is created in the displacement chamber. These two factors (diaphragm pressing against MARS valve & vacuum in the displacement chamber) must occur together to trigger the MARS valve.

When both of these conditions are met, the MARS valve is forced to its rearward position, and the poppet(760) opens, allowing hydraulic oil from the reservoir to enter through the refill valve(740 in Fig.8) and replenish the lost oil. In this manner, proper hydraulic balance is constantly maintained in the displacement chamber.

GENERAL SPECIFICATIONS

Maximum Capacity Range

20 GPH(76 LPH) to 130 GPH(492 LPH)

Maximum Pressure Range

100 PSIG(7 Bar) to 600 PSIG (41 BAR)

Liquid End Design

Hydraulically Actuated Diaphragm with Mechanically Actuated Refill System(MARS).

Drive Design

Non-Lost Motion Variable Eccentric Type.

Plunger Diameters

1-1/4"(32mm), 1-3/4"(45mm), 2-1/2"(63mm), 3"(75mm)

Liquid End Materials of Construction

PVC, 316 SS, Alloy 20,

Steady State Accuracy

±1% of 100% rated flow between 10% and 100% of rated flow

Capacity Adjustment

Micrometer(Standard): Lockable micrometer is adjustable from 0% to 100% while pump is running or stopped

Electronic(Optional): Electronic stroke length adjustment from 4-20ma input.

Temperature Limits

Ambient Limit: 130 °F Maximum
0 °F Minimum

Note: Limited by standard lubricants. Modifications are available through Applications Engineering.

Liquid Temperature Limits:

Plastic Liquid Ends: 20°F to 140°F

Metallic Liquid Ends: 20°F to 190°F

Suction Pressure Limits

Minimum Internal Pressure: 3 psia(12 psi maximum vacuum)

Maximum Suction Pressure: 100 psig at 80°F and below.

Lubrication

Oil bath drive lubrication.

Paint

Two part epoxy, yellow RAL 1018

PRODUCT CODE

Milroyal G pumps are available in a variety of different configurations. The complete product code is composed of the pump "model number" + "product code". For a breakdown of the options included in a specific pump, compare the pump model number and product code found on the pump nameplate with the model/product code breakdown shown in Figure 1. A sample nameplate is shown in Figure 2.

MODEL NUMBER:

MGH---
4 5 6

Digits 4 & 5: Plunger Size

Description	Code
1-1/4"(32mm)	20
1-3/4"(45mm)	28
2-1/2"(63mm)	40
3"(75mm)	48

Digit 6: Liquid End Material

Description	Code
316 SS	1
Plastic(PVC)	2
Alloy 20	5

PRODUCT CODE:

7 8 9 10 11 12 13 14 15 16 17 18 19 20

Digits 7 & 8: Stroking Speed

Description	Code
173 spm	10
86 spm	20
43 spm	30

*Note: SPM's for 60 Hz, 1725 rpm motor.

Digits 9 & 10: Motor

Description	Code
No motor, Flange Mount, NEMA 56C	CB
No motor, Flange Mount, NEMA 145TC	CC
No motor, flange mount, NEMA 182TC	CD
No motor, Flange Mount, IEC80, F165 flange	MD

Digits 11 & 12: Capacity Adjustment Connection

Description	Code
Manual, Plastic micrometer knob	M2
Electronic(4-20 ma input)	
NEMA 4, 115V	E1
NEMA 4, 230V	E2
Explosion Proof, 115V	EA
Explosion Proof, 230V	EB

Digits 13 & 14: Check Valve

Description	Code
Pipe—NPT	SE
Pipe—BSP	SN
Pipe—DN(socket weld)	SQ

Digits 15 & 16: Base

Diaphragm

Description	Code
No Base(standard)	NN
Base(optional)	11

Digits 17 & 18: Rupture Detection/Double

Description	Code
No Rupture Detection, Single Diaphragm(standard)	NN
No Rupture Detection, Double Diaphragm(optional)	DD
Rupture Detection(Gauge), Double Diaphragm(optional)	C5
Rupture Detection(gauge + NEMA 4 pressure switch),DD (opt.)	SN
Rupture Detection(gauge + Exp. Pr. Switch), DD (optional)	SE

Digits 19 & 20: Check Valve Type

Description	Code
Single Ball	11
Double Ball	22

FIGURE 1. Model/Product Code

SECTION 2

INSTALLATION

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.

SAFETY PRECAUTIONS

When installing, operating, and maintaining the Milroyal G 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.).*

STORAGE

Temporary 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) Primary Considerations

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 extent possible.

When the instructions given in this section are completed, the equipment is to be stored sheltered/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 Milton Roy into long term storage, contact Milton Roy to arrange for factory preparation.

Pump Drive

1. Flood the pump drive housing with a high grade lubricating oil/rust preventative such as Mobile Oil Corporation product "Mobilarma 524." Fill the housing completely to minimize air space and water vapor condensation. After storage,

drain this material and refill the equipment to the correct oil level with the recommended lubricant for equipment commissioning.

2. Remove drive motor and brush all unpainted metal surfaces with multipurpose grease (NLGI grade 2 or 3). Store motor 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 closed. Contact Milton Roy Service Department for recommended VPCI materials.

MOUNTING

Support the pump firmly in a level position on a solid, vibration-free foundation, preferably 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, pump adjustments, and/or oil filling or draining procedures.

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

Some Milroyal G pumps are shipped with motors dismounted. After anchoring pump in position, install motor, referring to Figure 5. **To avoid damage to pump drive during operation, make sure spring (360) provided with pump is installed in worm shaft prior to motor installation.** Pumps installed outdoors should be protected by a shelter.

CONVERSION PROCEDURES

A Milroyal G pump can, in some cases, be converted from one liquid end plunger size or material of construction to another. For more information on converting between different liquid end models, please contact the Milton Roy factory or your local authorized representative.

PIPING CONNECTIONS

NPSH Considerations

The Milroyal G HPD liquid end is far superior to conventional diaphragm liquid ends for suction lift and many other NPSH-critical applications. In these demanding applications, the patented diaphragm and refill mechanism give this liquid end truly exceptional performance.

For more NPSH information, refer to the Practical Handbook for NPSH, bulletin 220, but apply a 3 psia limitation (instead of 9 psia) in evaluating applications for this liquid end.

Size piping to accommodate peak instantaneous flow. Because of the reciprocating motion of the pump diaphragm, pump delivery follows an approximate sine curve with a peak instantaneous flow equal to $\pi(3.14)$ times the average flow. Therefore, piping must be designed for a flow 3.14 times the pump capacity; this means that a pump rated for

100 gallons per hour (379 L/hr.) requires piping sufficient for 3.14 x 100 gph, or 314 gph (1188 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 nearest Milton Roy representative to determine the necessary pipe size.

General Piping Considerations

- Use extreme care in piping to plastic liquid end pumps with rigid pipe such as PVC. If excessive stresses 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 down to pump suction check valve to prevent 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 4 for a typical recommended pump installation scheme.

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. Installing the supply vessel on the suction line in close proximity to the pump will help ensure a flooded suction line.
- Avoid negative suction pressure conditions (suction lift), as such conditions adversely affect metering accuracy. A lift of 20 Ft. of water column is the maximum suction lift permissible.
- Milroyal G pumps are intended to be operated with process liquid supplied at or above atmospheric pressure. Although these pumps can move liquids supplied at less than atmospheric pressure, in these negative pressure applications it is important that all connections be absolutely drip free and vacuum tight.
- 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 such 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 to prevent debris from entering and fouling the ball-checks 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.

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 (Max. allowable working 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. There are a number of ways to create an artificial pressure, such as by installing a back pressure valve. (Please contact Milton Roy 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 outer outlets.

Back Pressure Valves

A Milton Roy Back Pressure Valve should be installed in the discharge line near the pump to ensure sufficient discharge head pressure for proper pump metering action. Normally, 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 Milton Roy Company for further information on pulsation dampeners.

Safety Valves

Maximum safety and reliability may be ensured by protecting liquid ends and piping with an external relief valve installed in the system discharge line. Although the pump is protected against excessive pressure by an internal relief valve, to prevent a blocked discharge line from causing damage to the piping or process equipment, install a Milton Roy 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. Install the safety valve in the discharge line between the pump and the nearest shut-off valve. (This will prevent potential system damage from accidental valve closure.) Pipe the safety valve outlet back to the suction tank or to drain, but in either case ensure that the pipe end is continuously visible so safety valve leakage may be detected. Milton Roy

safety valves must be installed at top of supply tank in order to function properly (see Figure 4).

Check Valves

A check valve should be installed at the point where the discharge line enters a boiler or other high-pressure vessel. This will prevent back flow through the discharge piping and will isolate the pump discharge from system pressures (a safety consideration).

Shut-off Valves

In order to isolate the pump during maintenance, 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 4 shows recommended valve locations.

ELECTRICAL CONNECTIONS

Ensure that the electrical supply matches the pump motor nameplate characteristics. Before operating the pump, check the direction of rotation of the motor to be sure it matches the direction of the arrow stamped on the motor (rotation should be clockwise when viewed from the top of the motor). If motor rotation is incorrect, refer to the motor data plate or motor manufacturer's instructions for reversing.

Caution:

Operation with the wrong motor rotation will damage the pump and motor and void the warranty.

Caution:

Do not forget to connect the pump to an earth ground!

Electric protection of the motor (fuses, overload meters or relays) should correspond to the rated current indicated on the motor data plate.

SECTION 3 **OPERATION**

INITIAL START-UP

Check that all mounting bolts are tight, piping is installed properly, and the discharge line is open. Check oil drain plug for tightness. Remove the orange oil fill cap and fill the pump casing until level is between the top two marks on the oilcap dipstick.(approximately 3-1/2 quarts). **DO NOT OVERFILL ABOVE TOP DASH!**

NOTE:

The oil furnished with the pump is grade AGMA No. 5 EP with a viscosity of 1000 SSU at 100°F (218.4 cSt at 40°C). For operation in ambient temperatures below 50°F (10°C), substitute AGMA No. 2 EP with a viscosity of 400 SSU at 100°F (86.4 cSt at 40°C). Manufacturers' equivalent oils are shown below.

CAUTION: Do not start up pump drive motor before filling gear box with oil or serious damage will occur.

ABOVE 50°F:

Chevron N.L. Gear Compound 220
Exxon Spartan E.P. 220
Mobil Mobilgear 630
Texaco Meropa 220
Shell Omaha 220

BELOW 50°F:

Chevron N.L. Gear Compound 68
Exxon Spartan E.P. 68
Mobil Mobilgear 626
Texaco Meropa 68
Shell Omaha 68

Start-Up for New Pump

For pumps received from the factory, the displacement chamber(600) is already filled with oil. Simply remove the orange oil fill cap from the pump casing and fill the casing with the specified oil to a level between the top two dashes on the dipstick. **DO NOT OVERFILL ABOVE TOP DASH!** Pump is now ready for operation. Operation of the air purge button may be required to remove air that may have come out of solution from the oil during shipment and storage. Refer to "USE OF AIR PURGE BUTTON" section for operation instructions. The integral pump relief valve is factory adjusted according to customer specified setting. For instructions on adjustment of the pump relief valve please refer to the next section.

CAUTION:

Before switching on power to the pump, turn the capacity adjustment knob to zero. Check that all shut-off valves in the suction and discharge lines are open before increasing the capacity adjustment from zero.

Start-Up of Pump Containing No Oil in Casing and Displacement Chamber

The following instructions assume that both the pump casing and liquid end(displacement chamber) contain no oil. This condition typically exists when the pump is subjected to annual maintenance during which oil may be drained from the pump casing and oil may escape from the displacement chamber during diaphragm replacement. New pumps received from the factory will have an empty pump casing and a **filled** displacement chamber(liquid end). Please refer to the previous section for start-up of new pumps. After pump casing is filled to correct oil level(between top two dashes on oil cap dipstick), perform the following operations before placing the pump into service. Numbers refer to item numbers shown in assembly drawings(Figures 7--9) located in the back of this manual.

1. Remove hydraulic 3-function valve(refer to Figure 8):
 - a. Remove relief valve cap piece(850).
 - b. Make sure relief valve locknut(900) is tight to maintain previous relief valve setting upon start-up.
 - c. Remove purge button and relief valve adjustment assembly by removing large adjustment nut(910).
 - d. Using needle-nose pliers, remove spring(950).
 - e. Using same pliers, remove relief valve poppet by gently gripping the top of the valve body(960).
2. Make sure pump capacity adjustment is set to 100%.
3. Fill the opening in the displacement chamber(600) through the port uncovered by removal of the 3-function valve in step 1 with the same oil used to fill the pump casing. Fill the chamber slowly, allowing air bubbles to escape, until the oil level reaches the level of the drain tube(640).
4. Reinstall 3-function valve:
 - a. Gently gripping the top of the relief valve poppet(960) with needle-nose pliers, drop the poppet assembly down into the empty relief valve port.
 - b. Drop spring(950) back into relief valve port.
 - c. Make sure washer(935) is in place above the o-ring(940) on purge stem(930) and reinstall purge and relief valve adjustment assembly by screwing large adjustment nut(910) back into place. Make sure adjustment nut(910) is tight.
 - d. Reinstall relief valve cap piece(850).
5. The pump is now properly filled with oil and ready for service. If the relief valve locking nut(900) remained tight during the above procedure, the relief valve setting should remain unchanged. If not, refer to next section for instructions on how to set relief valve.

CAUTION:

Before switching on power to the pump, turn the capacity adjustment knob to zero. Check that all shut-off valves in the suction and discharge lines are open before increasing the capacity adjustment from zero.

6. Make sure that all air has been bled from the suction piping and pump head. This can be accomplished by opening all suction line valves as well as the system drain (Prime/Air Purge) valve shown in Figure 4 and allowing fluid to flow into drain until all air has been purged. If drain valve not present, with the pump capacity set to 100%, operate the pump under no discharge pressure until the entire pumping system has been filled.

RELIEF VALVE ADJUSTMENT

All Milroyal G liquid ends have a built in relief valve which allows hydraulic fluid to return to the pump casing if excessive pressure builds up in the discharge line. This effectively stops the pump from pumping, since the forward stroke of the piston will not displace the hydraulic fluid and force the diaphragm to flex. During operation of the pump, a relief condition caused by overpressurization can easily be seen by looking through the sight glass(630, Fig.7) for excessive oil flow from the drain tube(640, Fig.8).

NOTE:

Under normal operation, a few drops of oil should escape from the drain tube during each pump stroke due to normal oil flow through the airbleed ball(970,fig.8). If a stream of oil from the drain tube is evident on each pump stroke, the system pressure has exceeded the pump relief valve setting and the pump is in a relief condition.

The Milroyal G liquid end relief valve may be adjusted to operating conditions by the following procedure. Adjust the relief valve after first installing the pump and after any maintenance procedures.

Warning!

The pressure relief valve is factory set to open at a pressure 15% over the customer specified operating pressure or at 15% above the maximum pressure rating of the pump if no operating pressure is specified by the customer. When adjusting the valve setting, never set the valve at a pressure greater than 15% over the **pump maximum pressure rating**.

Relief Valve Adjustment(With an Adjustable System Backpressure Valve).

Refer to Figures 7 & 8.

The following procedure assumes that a backpressure valve and pressure gauge are installed in the discharge line. If these components are not installed, refer to next section.

1. Make sure all system shut off valves are open and that the backpressure valve is backed out to allow for flow against zero discharge pressure.
2. Start pump and set capacity at 100%. If a drain valve is present in the discharge line, pump process liquid to drain or other safe point to establish proper pumping action. Close drain.
3. Slowly increase system pressure until:
 - (a)significant flow is observed from the drain tube(640, fig.8) as viewed through the sight glass(630,fig. 7) or
 - (b)the system pressure reaches 15% over the desired system pressure.
4. For condition (a) in step 4, if relief condition occurs at less than 15% above desired pump operating pressure, the relief valve setting must be increased. Remove valve cover(850) and increase relief valve setting by turning the adjustment screw(890) clockwise until only a few drops of oil escape on each pump stroke(normal leakage past airbleed ball--980). Increase system pressure to 15% above desired operating pressure to verify that pump is now in relief condition. If it is not, reduce relief valve setting by turning adjustment screw(890) counterclockwise until relief is observed in sight glass drain tube at a pressure equal to 15% greater than desired operating pressure. Lock-in relief valve setting by tightening locking nut(900) while holding

adjustment screw(890) stationary. The relief valve is now properly adjusted. Reinstall valve cover(850).

5. For condition (b) in step 4, the setting of the relief valve should be reduced. Remove valve cover(850) and turn adjustment screw(890) counterclockwise until relief is observed in sight glass drain tube at a pressure equal to 15% greater than desired operating pressure. Lock-in relief valve setting by tightening locking nut(900) while holding adjustment screw(890) stationary. The relief valve is now properly adjusted. Reinstall valve cover(850).

Relief Valve Adjustment(Without an Adjustable System Backpressure Valve).

If no adjustable backpressure valve is present in the discharge line, use the following simplified procedure to check and/or set the relief valve setting.

1. If pump is in a relief condition at normal operating pressure, the relief valve setting should be increased. Remove valve cover(850) and increase relief valve setting by turning the adjustment screw(890) clockwise until only a few drops of oil escape on each pump stroke(normal leakage past airbleed ball--970). Turn adjustment screw an additional $\frac{1}{2}$ turn to provide an adequate buffer zone. Lock-in relief valve setting by tightening locking nut(900) while holding adjustment screw(890) stationary. The relief valve is now properly adjusted. Reinstall valve cover(850).
2. If pump is not in a relief condition at normal operating pressure, and the operator wishes to reset the valve setting to approximately 15% above operating pressure(recommended), use the following procedure. Remove valve cover(850) and decrease the relief valve setting by turning the adjustment screw(890) counterclockwise until a stream of oil flows from the drain tube(640) on each pump stroke. Now slowly turn adjustment screw clockwise until only a few drops of oil escape on each pump stroke(normal leakage past airbleed ball). Turn screw an additional $\frac{1}{2}$ turn to provide an adequate buffer zone. Lock-in relief valve setting by tightening locking nut(900) while holding adjustment screw(890) stationary. The relief valve is now properly adjusted. Reinstall valve cover(850).

USE OF AIR PURGE BUTTON

Refer to Figures 7 & 8:

As with any hydraulically actuated diaphragm pump, dissolved air will come out of solution during normal operation which can negatively impact pump performance if not removed from the pump displacement chamber. The Milroyal G hydraulic 3-function valve is equipped with two mechanisms for removal of this gas: a continuous airbleed and an air purge button. The continuous airbleed portion of the valve is composed of a sealed ball(970) which allows for a controlled leakage of a few drops of oil, and any small accumulations of evolved gas, on each pump stroke. Larger quantities of air can be quickly removed by pressing the spring-loaded purge button(860), until it reaches its mechanical stop, for a few seconds. Upon doing so, the operator will observe a stream of oil and air escaping from the drain tube(640). The need for use of the purge button to remove a large quantity of air can be caused by several factors:

1. Blocked suction line: A partially or fully blocked suction line can create a vacuum pressure condition in the hydraulic system which pulls significant quantities of dissolved gas from solution.
2. Oil Change: The recommended annual changing of the oil in the pump drive can lead to the presence of air pockets in the displacement chamber(600).

3. Diaphragm Replacement: Results in significant loss of oil from the displacement chamber.
4. Pump Start-up After Long Idle Period: If the pump has sat idle for a significant time, gas may come out of solution from the oil and collect into pockets which can negatively impact pump flow. Depression of the purge button will quickly evacuate these pockets and restore the pump to desired performance.

The operator should only activate the purge button if some type of pump upset occurs such as the above 4 examples. When activating the purge, only press button for 2-3 seconds or until a stream of oil flowing from the drain tube(640) is seen through the sight glass(630). Immediately after activation of the purge button, a temporary reduction in flow will occur as the refill system replenishes oil lost during the purge. However, the pump should return to normal operation within 1 to 2 minutes after activation of the purge button. If after that time, the pump flow rate is still less than it should be, repeat the purge operation and wait another 2 minutes. If flow has still not resumed to expected levels, consult the troubleshooting section of this manual.

MANUAL CAPACITY CONTROL

To adjust pump capacity on standard pumps equipped with manual stroke adjustment, first loosen the stroke locking screw located in the pump side cover. Pump capacity is then adjusted by turning the micrometer-type stroke adjustment knob clockwise to decrease capacity or counterclockwise to increase capacity as required. The adjustment scale is marked in percent (%) of full stroke, with calibration lines on the knob at 1% intervals. After adjusting the knob to the desired capacity setting, hand tighten the stroke locking screw to maintain the capacity setting.

FILLING PUMPING SYSTEM

For proper pump operation, it is especially important that pump suction and discharge lines be free of entrained air. To ensure this condition, operate the pump without any discharge pressure and fill the entire pumping system with liquid before starting pressure tests. A simple method to assure priming of the pump is to install a tee and a shut-off valve at the discharge connection of the pump.

If the pump is idle for long periods, temperature changes in the process liquid may produce air in the system. To discharge the air, install a valve in the discharge line which will allow the process liquid to be pumped to a drain when starting the pump.

CAPACITY CALIBRATION

After the first 12 hours of operation, the pump should be tested and calibrated to find the exact pump capacity under specific operating conditions and capacity settings for the specific fluid being pumped. Typically, calibrating the pump at 100, 50, and 10 percent capacity settings is enough to establish a pump performance curve 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. Milton Roy test-tube Calibration Columns are available for convenient and accurate calibration of any pump. The pump can also be calibrated by collecting and measuring pumped liquid at the pump discharge port in which case it will be necessary to create discharge head at the liquid takeoff point so that the pump will operate properly. (See Section 2 for recommended ways to do this.)

CAUTION: This method is not generally recommended as it may expose operating personnel to hazardous liquids.

SECTION 4 **MAINTENANCE**

RECOMMENDED SPARE PARTS

To avoid delays in repairs, a Routine Preventative Maintenance Kit should be ordered for each pump. The RPM kit contains an oil strainer and check valve parts. Part orders must include the following information:

1. Quantity required.
2. Part Number
3. Part Description
4. Pump serial number(found on pump nameplate).
5. Pump model number(found on pump nameplate).
6. Pump product code(found on pump nameplate).

Always include the serial number, model number, and product code in all correspondence regarding this unit.

SHIPPING PUMPS 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 and displacement chamber. To drain oil from the displacement chamber, unscrew the refill valve body(660, fig. 8) from the displacement chamber. Allow oil to drain into a waste container. Remove diaphragm(510) and tilt up the back of the pump until oil ceases to drain from the front of the pump.

NOTE:

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 Milton Roy representative or distributor. Alternatively, inquiries and/or parts orders may be sent to:

Milton Roy Company
Flow Control Division
201 Ivyland Road
Ivyland, PA USA 18974-0577
Attn: Aftermarket Department

ROUTINE PREVENTATIVE MAINTENANCE

Warning!

Before any maintenance, relieve all pressure from system, isolate liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.

Oil Replacement

Initially, change oil in pump casing after the first 250 hours of operation. Then change oil after every 4000 hours of operation or every six months whichever comes first. Oil can be drained by removing the drain plug(20, fig. 6). When oil has finished draining, make sure that the area around the drain hole is clean. Screw drain plug back in securely. Fill the pump housing with the recommended oil until the level is between the top two marks on the dipstick. **DO NOT OVERFILL(above top mark)!** Replace the oil fill cap and screw firmly in place. Dispose of oil according to any federal, state or local codes which may apply.

Note:

It is not necessary to purge the liquid end displacement chamber of oil during annual oil replacement.

Check Valves

Milton Roy company recommends that check valve balls, seats, gaskets, and o-rings be replaced on an annual basis. If highly corrosive material (acids, slurries, etc.) is being pumped, some applications may require more frequent replacement. Milton Roy recommends an annual tune up using a Routine Preventive Maintenance (RPM) Kit. RPM kits contain replacements for those parts which are subject to wear; specifically the ball checks, check valve seats, gaskets/seals, and the strainer. Replacing these parts annually with an RPM kit can reduce the possibility of unexpected downtime and will help to extend pump life.

To determine if check valves need maintenance, disassemble the check valves following the instructions in the following "Check Valve Replacement" section. In valves that permit disassembly, inspect the ball check and seat for chemical or physical damage. The ball should be perfectly round and free of pits, mars, or scratches. The seat should retain a smooth edge where the ball contacts for proper sealing. If the seat edge is worn or damaged, or has any pits, mars, or scratches, it should be replaced. If the ball and/or seat is excessively damaged, the replacement schedule should be shortened accordingly. If the ball and seat are both in good condition, the replacement schedule can be lengthened.

Caution:

Before carrying out any servicing operation on the metering unit or pipes, disconnect electrical power from the pump, and take the necessary steps to ensure that the harmful liquid they contain cannot escape or come into contact with personnel. Suitable protective equipment must be provided. Check that there is no system fluid pressure before proceeding with dismantling of liquid end components.

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

Before beginning work on the valve assemblies, make sure the shut-off valves are closed and that pressure has been bled from the system. When replacing the valves, take care to systematically change their O-rings and/or gaskets. Take care to properly assemble the valve assemblies. In valves that permit replacement of ball and seat, the ball must be placed on the sharp edge of the seats.

For each plunger size, check valves are supplied in three different configurations: plastic-single ball, plastic-double ball, and metallic-double ball. Be sure to refer to the appropriate instructional set below pertaining to your plunger size and valve type.

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 severe damage to pump mechanism, (b) no pumping, (c) reverse pumping action (from discharge line into suction line).

1-1/4" Plunger; Plastic Single Ball Check Valves: see Figure 12

1. Unscrew the valve body [445].
2. Remove the cartridge assembly(425): includes cartridge(ball, seat, ball guide), o-ring, and washer.
3. Clean the valve housing and mating port in the liquid end.
4. Press a new clear plastic washer into valve body.
5. Install new cartridge valve assembly in orientation shown in figure 12.
 - Make sure that seat end of cartridge(white) is **always facing down**.
 - On discharge side, drop cartridge assembly 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 cartridge assembly into check valve body. The o-ring should be stretched around outside of cartridge on opposite end of ball seat. Screw suction valve housing with cartridge valve into suction side of head. Do not overtighten.

1-1/4" Plunger; Metallic Double Ball Check Valves: see Figure 13

The metallic check valves used on the 1-1/4" plunger size pumps 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.

A. Disassembly(refer to fig. 13)

1. The check valve cartridge assemblies use an SAE straight thread with an O-ring seal to facilitate port alignment with the connecting pipes. To remove the cartridge from the liquid end, first loosen the lock nut(435) one or two threads, then unscrew the cartridge(444,445).
2. Remove and discard the o-ring(441) and split ring(439).
3. 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.

B. Reassembly(refer to fig. 13)

1. To install the cartridge, position the lock nut(435) toward the shoulder of the cartridge so that the recess on the face of the lock nut is adjacent to the O-ring(441).
2. Make certain the split ring(439) is coiled in a counterclockwise helix(this is opposite the direction normally employed by suppliers of these rings). Fit this split ring in the lock nut recess. Push it firmly down in the recess as completely as possible.
3. Install a new O-ring(435) against the split ring.

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

4. Screw the cartridge assembly(444,445) into the liquid end until the O-ring band is approximately level with the top of the spotface in the liquid end, then screw it one(1) additional turn plus a partial turn as required to align the pipe thread port with connecting pipe.

Caution!!

Suction and discharge check valve cartridges are not identical. Be sure that the correct cartridge is being screwed into the proper port. (Discharge cartridges have hexagonal cap on the top; suction cartridges do not.) If check valve cartridges are installed into the wrong port, one of the following will occur: (a)immediate severe damage to pump mechanism, (b)no pumping, (c) reverse pumping action(fron discharge line into suction line).

5. After completing pipe connection, tighten lock nut securely against spotface so that O-ring is trapped in chamfer of liquid end thread. Make sure that the split ring is completely contained in its recess and not extending to the outside.

1-3/4, 2-1/2, and 3"Plungers: Plastic Single-Ball Check Valves: see Figure 11

A. Disassembly

1. Unscrew the union nut (435). The union end (445) is held in place by the union nut and will now separate easily from check valve ball guide(424).
2. Unscrew the ball guide (424) from the liquid end.

3. Screw the union nut partially(one or two turns) onto the end of the ball guide containing the seat. Be sure the union nut is loosely installed to allow for a gap for the seat (420) to drop into as it is removed from the ball guide.
4. Sit the ball guide/union nut onto 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 ball and seat are released from the ball guide.

Caution:

If you are disassembling unit 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 need to be replaced. To avoid damage, if available, 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. Inspect the balls carefully. If they are smooth, round and free of deposits or pits, they are suitable for continued use. Examine the check valve seats. The area of the seat in contact with the ball (the un-chamfered side) must be in near perfect condition for continued use. Any visible imperfection on the seating surface (pits, erosion, cracks) necessitates replacement of the seat. If both the balls and the seats are in good condition, then the length of time between parts replacement may be increased. If the balls and seats are severely damaged, then the length of time between parts replacement should be shortened. 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.

B. Reassembly

1. Drop the ball into the curved inner chamber end of the ball guide.
2. Sit the ball guide on a flat surface so that the side with the ball faces upwards. Position seat on the ball guide, trapping the ball inside. When the seat is pressed into the ball guide, the beveled edge of the seat must be facing outward. The bevel should not face the inside of the check valve (refer to Figure 11). Use a flat surface such as a board to press the seat into the ball guide with firm, even pressure.

Caution:

If the seat is improperly positioned(with ball against beveled surface), the ball will not create a tight seal and poor pumping performance will result.

3. Fit new o-rings into grooves in the ball guide and seat.

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 ball guide. Refer to Figure 11 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 ball guide.

Caution:

The order of assembly of the suction and discharge check valves is different. Refer to Figure 11 for proper assembly order. 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).

5. Screw the valve assembly into the liquid end body(hand tight only). **DO NOT OVERTIGHTEN!**

1-1/4"Plunger, Plastic Double Ball Check Valves

1-3/4", 2-1/2", 3" Plungers, Plastic & Metallic Double Ball Check Valves

A. Disassembly(Refer to Figure 10).

Double ball check valves differ from the plastic single ball check in that the ball seat is now 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 instructions below.

1. If metallic valve, unscrew the coupling(445) from the ball guide(424). If plastic, unscrew the union nut(435,fig.11) and remove union end(445,fig.11) from the ball guide(424).
2. Unscrew the ball guide (424) from the liquid end.
3. Remove and discard the o-rings (419).
4. Remove ball stop(420) and balls(421,422). Inspect the balls carefully. If they are smooth, round and free of deposits or pits, they are suitable for continued use. Examine the ball seat areas in the valve body(424). A magnifying glass is recommended for this inspection. The seat must be in near perfect condition for continued use. Any visible imperfection on the seating surface (pits, erosion, cracks) renders the seat unusable thereby requiring replacement of the valve body(424). If both the balls and the seats are in good condition, then the length of time between parts replacement may be increased. If the balls and seats are severely damaged, then the length of time between parts replacement should be shortened. 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.

B. Reassembly(Refer to Figure 10):

1. Drop the balls(422, 421) into the valve body(424). Drop ball stop(420) into place making sure that side with o-ring groove is facing up. Install new o-rings(419) on both ends of valve body.

Note:

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

2. Screw the correct end of the check valve assembly into the liquid end(hand tight only) trapping a new o-ring between the liquid end and the check valve assembly. **DO NOT OVERTIGHTEN!**

Caution!!

The end of the check valve that is screwed into the pump head is different for the suction and discharge check valves. Refer to Figure 10 for proper assembly order. 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).

3. If metallic check valve, screw the coupling(445) onto the check valve assembly, trapping a new o-ring (419) between the coupling and the check valve assembly. If plastic check valve, position the union end(445) onto the correct end of the ball guide. Slip the union nut(435) over the union end and screw tightly(hand tight only) onto the ball guide. **DO NOT OVERTIGHTEN!**

Oil Strainer Replacement

Refer to Figure 8.

Over time, the oil strainer(670) which screws into the refill valve body(660) can become fouled or clogged. It should therefore be replaced yearly and is included with the check valve parts in the RPM Kit. If the strainer becomes clogged more frequently than once a year (which is extremely unlikely), it can be ordered separately.

Since the oil must first be drained from the pump casing, it is a good idea to schedule strainer replacement with oil replacement.

1. Drain oil as described in the above "Oil Replacement" section of this manual.
2. Unscrew the strainer(670) from the refill valve body(660).
3. Clean any debris from the strainer cavity in the valve body.
4. Screw a new strainer into the refill valve body.
5. Refill pump casing with recommended oil as described in the "Oil Replacement" section.

CORRECTIVE MAINTENANCE

3-Function Hydraulic Valve

The 3-function hydraulic valve assembly(see Figure 8) operates in filtered hydraulic oil and should require maintenance only if unusual circumstances occur, such as if corrosive media contaminates the fluid.

Assembly and disassembly is straightforward. Follow instructions in the "Start-Up of Pump Containing No Oil in Casing and Displacement Chamber" section of the manual. Field servicing should be limited to inspection and cleaning only. Repairs of this critical component should only be carried out by an authorized Milton Roy repair facility.

“MARS” Valve Assembly

The Mechanically Activated Refill System(MARS) valve assembly(see Figures 8 & 9) requires no periodic maintenance. Clean hydraulic oil is critical for proper operation. Field servicing should be limited to inspection and cleaning only. Repairs of this critical component should only be carried out by an authorized Milton Roy repair facility.

The valve is designed to be easily removed through the front of the pump without having to remove the displacement chamber. The following steps describe the procedure for removal of the valve from the displacement chamber(refer to Figure 9):

A. Disassembly

1. Remove liquid end according to instructions in the “Removing the Liquid End” portion of the “**Diaphragm Replacement**” section of the manual.
2. Insert a small tip screw driver into one of the two small holes in the valve button(780) and gently pry out plastic cap(790).
3. While pressing down on button(780), remove the retaining ring(820) using the appropriate retaining ring pliers(Waldes Truarc External Type, Waldes Truarc part# M-1520).
4. Slide off activation button(780) and spring(800).
5. Remove large retaining ring(810) using the appropriate retaining ring pliers(Waldes Truarc Internal Type, Waldes Truarc part# 0300).
6. Reinstall small retaining ring(820) in groove in valve stem(770).
7. To avoid damage to valve stem, grip retaining ring with pliers and pull remaining valve assembly out of displacement chamber.
8. Discard o-rings(830,840) and retaining rings(810, 820).

NOTE:

When reinstalling, make certain that new o-rings and retaining rings are installed on MARS assembly.

B. Reassembly:

1. Install new o-rings(830, 840) on valve body(750) and apply a light layer of o-ring grease to o-rings.
2. Push assembly into place until it reaches stop in displacement chamber.
3. Reinstall large bowed retaining ring(810). Using a hammer and flat-tipped screwdriver, gently tap the ring to insure that it is securely seated in the retaining groove machined into the displacement chamber.
4. Reinstall spring(800) and activation button(780).
5. While pressing button(780), reinstall small retaining ring(820). Gently tap on the ring to insure that it is securely seated in the retaining ring groove machined into the valve stem(770).
6. Press plastic cap piece(790) into activation button(780).
7. Valve is now ready for service.

Refill Valve Assembly(see Figure 8).

The only required periodic maintenance for the refill valve assembly is the suggested annual replacement of the oil strainer(see above “Oil Strainer Replacement” section). Clean hydraulic oil is critical for proper operation. Field

servicing of the valve assembly is limited to inspection and cleaning only. Repairs of this critical component should only be carried out by an authorized Milton Roy repair facility.

The valve is designed to be easily removed through the bottom of the pump without having to remove the displacement chamber. The following steps describe the procedure for removal of the valve from the displacement chamber(Figure 8):

A. Disassembly

1. Drain oil from the pump housing as described in the above "Oil Replacement" section.
2. Unscrew the valve body(660) from the displacement chamber(600).
3. Clean any debris from the valve cavity in the displacement chamber.
4. Discard o-rings(720, 730).

Note:

When reinstalling the valve assembly, be sure to install new o-rings(720, 730).

B. Reassembly:

1. Install new o-rings(720,730) and coat rings with o-ring grease.
2. Screw valve assembly back into displacement chamber until it reaches mechanical stop.
3. Make sure the strainer(670) is installed and strainer plug(650) is tight. Valve is now ready for service. Refill pump casing with recommended oil as described in the "Oil Replacement" section.

Diaphragm Replacement

Milroyal G liquid ends are designed to provide reliable service under normal operating circumstances and should not require replacement of the diaphragm. However, in the unlikely event of a failure, the diaphragm can be replaced by the following the procedure:

A. Removal of Diaphragm(Figures 7 & 8):

WARNING!!

Before beginning disassembly procedures, relieve all pressure from system, isolate the liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.

1. Disconnect both the suction inlet and discharge outlet from the piping system.
2. Locate drain pan under diaphragm head to collect oil. Approximately 1 pint of oil will drain from the displacement chamber after removal of the diaphragm.
3. Remove the diaphragm head bolts(1025) which hold the head to the displacement chamber and remove diaphragm head(1020). Oil will begin to leak out. In most cases, the white teflon-faced diaphragm will remain in the displacement chamber.

4. Remove the diaphragm. Oil will now drain out of the front of the displacement chamber.

B. Installation of New Diaphragm(Figures 7 & 8):

1. Make sure the contoured diaphragm support surface and o-ring groove machined into displacement chamber are clean. To prevent leakage from occurring, be careful not to scratch the o-ring groove when cleaning.
2. Install the diaphragm into the displacement chamber with the black rubber side against the contoured surface of the displacement chamber. Make sure the diaphragm sealing bead fits securely in the diaphragm groove of the displacement chamber. The white teflon face of the diaphragm should be facing outward and visible.
3. Align the two holes in the diaphragm head with the locating pins(610) in the displacement chamber and reinstall diaphragm head(1020).
4. Reinstall head bolts(1025), flat washer(1040), lockwashers(1035), and nuts(1030).
5. Tighten bolts firmly in a crisscross pattern.

Removal of Pump Liquid End(Figures 7 & 8)

Milroyal G liquid ends are designed to provide reliable service under normal operating circumstances and should not require removal of the liquid end. However, if the need arises, the following describes the procedure.

Warning!!

Before beginning disassembly procedures, relieve all pressure from system, isolate the liquid end from all sources of process liquid with appropriate valving, and purge liquid end of all process liquid.

A. Disassembly:

1. Disconnect both the suction inlet and discharge outlet from the piping system.
2. Drain oil as described in the above "Oil Replacement" section of this manual.
3. Remove 3-Function Valve assembly as described in the "Start-Up of Pump Containing No Oil in Casing and Displacement Chamber".
4. Remove six displacement chamber bolts(570) and lockwashers(560) which secure liquid end to pump drive housing.
5. Locate a container under liquid end to catch approximately 1 pint of oil that will escape during next step.
6. Gently pull liquid end off drive housing being careful to avoid damage to plunger(520, fig.5) during removal. Drain oil into waste container.
7. Discard displacement chamber gasket(590).
8. Place the liquid end, diaphragm head up, on a bench or other clean, flat, convenient work area.

B. Reassembly:

1. Make sure gasket surface on pump housing and displacement chamber are clean and free of markings which could serve as leak paths.
2. Install new displacement chamber gasket(590) in correct orientation on liquid end.
3. With vent cap(620) at 12 O'clock, gently slide liquid end over plunger.
4. Reinstall six displacement chamber bolts(570) and lockwashers(560) and tighten securely.
5. Follow procedure for filling pump housing and liquid end with oil described in "Start-Up of Pump Containing No Oil in Casing and Displacement Chamber".

SECTION 5

TROUBLESHOOTING

SYMPTOMS & REMEDIES

- Pump will not operate • Low process liquid level in tank. Add liquid.
• Worn or dirty check valves. Clean or replace.
• Blocked discharge line. Clear line.
• Frozen liquid: Thaw liquid throughout pumping system.
• Blown fuse. Replace fuse.
• Open thermal overload device in motor starter. Reset device.
• Broken wire. Locate and repair.
• Low voltage: Investigate and correct (wiring may be too light).
• Pump not primed. Allow suction line and pump head to fill with liquid before pumping against pressure. Refer to "Filling Pumping System" in Section 3.
• Capacity adjustment set at zero. Readjust capacity.
- Insufficient delivery..... • Relief valve relieving.
 -Blocked discharge line. Clear line.
 -Relief valve set too low. Adjust valve to 15% over operating pressure.
• Air in hydraulic system. Operate purge button.
• Clogged refill line: Remove oil strainer and clean or replace.
• Incorrect capacity adjustment: Readjust capacity setting.
• Incorrect pump speed. Match line voltage and frequency to pump motor data plate.
• Starved suction. Increase piping size or suction head.
• Leaky suction piping. Repair piping.
• High suction lift(Insufficient NPSH). Most common with long suction lines, small diameter suction lines, acid pumping, polymer(viscous) liquids, or drawing from a source lower than pump. Consult your local representative or the Milton Roy Factor Aftermarket Department.
• Liquid near boiling. Cool liquid or increase suction head.
• Leaky safety valve in discharge line. Repair or replace safety valve.
• High liquid viscosity. Reduce viscosity (e.g., heat or dilute liquid).
• Worn or dirty check valve seats. Clean or replace.
- Erratic delivery. • Leaky relief valve. Repair or replace valve(consult factory).
• Leaky suction piping. Repair piping.
• Leaky safety valve. Repair or replace safety valve.
• Liquid near boiling. Cool liquid or increase suction head.
• Worn or dirty check valves. Clean or replace.
• Blocked suction line. Clean strainer.
• High suction lift(Insufficient NPSH). Most common with long suction lines, small diameter suction lines, acid

pumping, polymer(viscous) liquids, or drawing from a source lower than pump. Consult your local representative or the Milton Roy Factor Aftermarket Department.

Excessive Delivery.....• Low discharge line pressure. Increase line pressure (e.g., install a back pressure valve).

Motor and pump body hot• Normal operating temperature of both motor and pump body is frequently uncomfortable to the touch. However, neither should exceed 200°F (93°C).
• Power supply does not match electrical requirement of motor. Insure proper matching of power supply and motor.
• Pump is being operated at greater than rated performance. Reduce pressure or stroke speed. If this is not practical, contact service facility.
• Pump improperly lubricated. Drain oil and refill with proper amount of recommended lubricant

Pump still pumps even at zero capacity setting.• Misadjusted micrometer knob. Readjust capacity setting.
• Insufficient discharge pressure. Correct condition (e.g., install a back pressure valve).

Gear noise.• Excessive backlash. Consult service facility.
• Worn bearings. Consult service facility.
• Wrong or insufficient lubricant. Replace or replenish lubricant.

Loud knock with each stroke.• Excessive gear set wear. Consult service facility.
• Worn bearings. Consult service facility.
• Incorrect motor rotation. Should be clockwise as viewed from top of motor.
• Worm shaft spring(360) missing.

Noisy operation in liquid end.• Noise in check valves. Ball checks move up and down with some force. A distinct "clicking" noise is normal, especially in metal piping systems.

SECTION 6 **PARTS**

A. BASIC PARTS LIST---Pump Drive(Refer to Figure 5 & 6)

Item No.	Description	Qty. Req.
10	Housing	1
19	O-ring	1
20	Drain Plug	1
30	Gear Thrust Flange Bearing	1
40	Bearing Cup	1
50	Gear(144/173 spm)	1
50	Gear(72/86 spm)	1
50	Gear(43/36 spm)	1
50	Gear(180 spm)	1
60	Connecting Rod	1
100	Sliding Crank	1
110	Eccentric	1
120	Shoe	1
130	Retaining Ring	1
140	Ball Bearing	1
150	Retaining Ring	1
160	O-ring	1
171	Stroke Adjustment Screw Assembly	1
175	Stroke Scale	1
190	O-ring	1
200	Side Cover	1
205	Cover Screw(M8 x 16mm)	4
310	Nylon Stroke Locking Ball	1
320	Stroke Locking Knob	1
322	O-ring	1
330	Stroke Adjustment Knob	1
335	Knob Sticker	1
340(note 1)	Bearing Cone	1
343(note 1)	Worm Assembly(173 spm, 56C)	1
	Worm Assembly(173 spm, 145TC)	1
	Worm Assembly(173 spm, 182TC)	1
	Worm Assembly(180 spm, IEC80, F165)	1
	Worm Assembly(144 spm, IEC80, F165)	1
	Worm Assembly(86spm, 56C)	1
	Worm Assembly(86 spm, 145TC)	1
	Worm Assembly(86 spm, 182TC)	1
	Worm Assembly(72 spm, IEC 80, F165)	1
	Worm Assembly(43 spm,56C)	1

	Worm Assembly(43 spm, 145TC)	1
	Worm Assembly(43 spm, 182TC)	1
	Worm Assembly(36 spm, IEC80, F165)	1
346(note 1)	Worm/Motor Coupling(56C)	1
	Worm/Motor Coupling(145TC)	1
	Worm/Motor Coupling(182TC)	1
	Worm/Motor Coupling(IEC80, F165)	1
360(note 1)	Spring(182TC)	1
	Spring(145TC)	1
	Spring(56C)	1
	Spring(IEC80)	1
370	Oil Fill/Breather Cap	1
376	Motor Adaptor plate(182TC)	1
376	Motor Adaptor plate(IEC80, F165)	1
377	Adaptor plate screws;M10 x 25mm	4
400	Motor screws(182TC);1/2—13 x 3/4	4
400	Motor screws(56C, 145TC);3/8-16 x 1	4
410	Washer—56C, 145TC(3/8)	4
450	Base	1
460	Base Screws(M8 x 35mm)	4
465	Lockwashers(8mm)	4
470	Nut(M8)	4
520	Plunger(1-1/4")	1
520	Plunger(1-3/4")	1
520	Plunger(2-1/2")	1
520	Plunger(3")	1
525	Plunger Pin(1-1/4" plunger)	1
525	Plunger Pin(1-3/4" plunger)	1
525	Plunger Pin(2-1/2", 3" plungers)	1
560	Lockwasher(8mm)	6
570	Displacement Chamber Screw(M8x30mm)	6

Note 1: Worm Assembly(343) includes worm, coupling(346), spring(360), and bearing cone(340).

Note 2: For part numbers not listed, consult local Milton Roy representative or Milton Roy Aftermarket Department (215-441-0800).

B. BASIC PARTS LIST---Liquid End(Refer to Figures 7--9)

1. MARS VALVE(see Figure 9)

Item No.	Description	Qty. Req.
775(Note 1)	Valve Assembly	1
750(Note 2)	Valve Body	1
760(Note 2)	Poppet	1
770(Note 2)	Valve Stem	1

780	Button(1-1/4" plunger)	1
780	Button(1-3/4,2-1/2,3" plungers)	1
790	Plug(1-1/4" plunger)	1
790	Plug(1-3/4,2-1/2,3" plungers)	1
800	Spring	1
810	Valve Body Retaining Ring	1
820	Valve Stem Retaining Ring	1
830	O-Ring	1
840	O-Ring	1

Note 1: Includes items 750,760,770,810,820,830,840.

Note 2: Not sold separately. Must purchase item 775(MARS Valve Assembly).

2. REFILL VALVE(see Figure 8)

Item No.	Description	Qty. Req.
740(Note 1)	Refill Valve Assembly	1
650	Oil Strainer Plug, 1/4" NPT	1
660(Note 2)	Valve Body	1
670	Oil Strainer	1
680(Note 2)	Ball	1
690(Note 2)	Spring	1
730	O-Ring	1
700(Note 2)	Washer	1
710(Note 2)	Retaining Ring	1
720	O-Ring	1

Note 1: Includes items 650,660,670,680,690,700,710,720,730

Note 2: Not sold separately. Must purchase item 740(Refill Valve Assembly).

3. 3-FUNCTION VALVE(see Figure 8)

Item No.	Description	Qty. Req.
850	Valve Cap	1
860	Purge Button	1
870	Pin	1
880	Purge Button Spring	1
890	Relief Valve Adjustment Screw	1
900	Relief Valve Locking Nut	1
910	Relief Valve Adjustment Nut	1
920	O-Ring	2
930	Purge Stem	1
935	Washer	1
940	O-Ring	1
950	Relief Valve Spring(1-1/4,1-3/4" plungers)	
	PVC Liquid End(purple)	1
	Metallic Liquid End(orange)	1

950	Relief Valve Spring(2-1/2,3" plungers),purple	1
1015(note 1)	Poppet Assembly	1
960(note 2)	Air Bleed Valve Body	1
970(note 2)	Ball	1
980(note 2)	O-Ring	1
990(note 2)	Air Bleed Ball Seat	1
1000(note 2)	Spring	1
1005(note 2)	Air Bleed Body Seat	1

Note 1: Includes items 960, 970, 980, 990, 1000, 1005

Note 2: Not sold separately. Must purchase item 1015(Poppet Assembly).

4. **CHECK VALVE PARTS(see Figures 10--13)**

The **Pump Model Number** is used to identify the check valve parts.

The 4 & 5 digits identify the plunger size, digit 6 identifies the liquid end material.

MGH---

Digits 4 5 6

Codes for Digits 4 & 5

Code 20 is a 1-1/4"(32mm) Plunger

Code 28 is a 1-3/4"(45mm) Plunger

Code 40 is a 2-1/2"(63mm) Plunger

Code 48 is a 3"(75mm) Plunger

Codes for Digit 6

Code 1 is 316SS, Code 2 is PVC, Code 5 is Alloy 20

PVC Liquid End (see Figures 10--13)

1-1/4" plunger: Single Ball Check Valve(see Figure 12)

Item No.	Description	Qty. Req.
71	Check Valve Assembly Tubing Conn: includes	2
425	Cartridge Valve Assembly	2
435	Tubing Connector	2
445	Valve Body—Tube	2
71	Check Valve Assembly NPT Conn: includes	2
425	Cartridge Valve Assembly	2
445	Valve Body—NPT	2

4 Function PVC Bleed Valve(see Figure 14)

446	1/4" NPT Discharge Bleed Valve Assembly	1
446	1/2" Tube Conn. Discharge Bleed Valve Assembly	1

PVC Liquid End (cont'd.)

1-1/4" plunger: Double Ball Check Valve(see Figure 10).

Item No.	Description	Qty. Required
425	Check Valve Assembly Assemblies include the following items	1
419	O-Ring, viton	2
420	Ball Stop	1
421	Ball, ceramic, 3/8"	1
422	Ball, ceramic, 14mm	1
424	Ball Guide	1
445	Union End, PVC, 1/4" NPT Male	1
435	Union Nut, PVC Shown in Figure 11	1

1-3/4, 2-1/2," plungers: Double ball check valve(Figure 10)

Item No.	Description	Qty. Required
425	Check Valve Assembly Assemblies include the following items	1
419	O-Ring, viton	2
420	Ball Stop	1
421	Ball, ceramic, 14mm	1
422	Ball, ceramic, 7/8"	1
424	Ball Guide	1
435	Union Nut, PVC Shown in Figure 11	1
445	Union End, PVC, 1/2" NPT Female	1

1-3/4, 2-1/2, 3" plungers: Single Ball Check Valves, (Figure 11).

Item No.	Description	Qty. Required
425	Check Valve Assembly Assemblies include two seals(419), seat(420), ball(422), ball guide(424)	1
419	Seal, PTFE Encapsulated Rubber	2
420	Seat, PVDF	1
422	Ball; 5/8" Ceramic	1
423	Seat, Seal, Ball—Replacement Kit	1
424	Ball Guide/Body, PVDF	1
435	Union Nut, PVC	1
445	Union End, PVC, 1/2" NPT Female	1

Metallic Liquid End (see Figure 10)

316SS & Alloy 20 Liquid End, 1-1/4" Plunger: Double Ball Check Valve(Fig. 13)

Item No.	Description	Qty. Required
425	Suction Valve Assembly 316SS	2
425	Suction Valve Assembly Alloy 20	2
426	Discharge Valve Assembly 316 SS	2
426	Discharge Valve Assembly Alloy 20	2
Check Valve assemblies include seal (419), seat(420), balls(421), ball guide (424)		
435	Lock Nut	2
439	Back-up Ring	2
441	O-Ring, Viton	2

316SS Liquid End, 1-3/4, 2-1/2" plungers: Double Ball Check Valves

Item No.	Description	Qty. Required
425	Check Valve Assembly	1
Check Valve assemblies include two seals(419), seat(420), balls(421, 422), ball guide(424)		
419	O-Ring, viton	2
420	Ball Stop	1
421	Ball, 14mm	1
422	Ball, 22mm	1
424	Ball Guide/Body	1
445	Coupling, 1/2" BSP Female	1
445	Coupling, 1/2" NPT Female	1

Alloy 20 Liquid End, 1-3/4, 2-1/2, 3" plungers: Double Ball Check Valves(Fig. 10)

Item No.	Description	Qty. Required
425	Check Valve Assembly	1
Check Valve assemblies include two seals(419), seat(420), balls(421, 422), ball guide(424)		
419	O-Ring, viton	2
420	Ball Stop	1
421	Ball, 14mm	1
422	Ball, 22mm	1
424	Ball Guide/Body	1
445	Coupling, 1/2" BSP Female	1
445	Coupling, 1/2" NPT Female	1

316SS Liquid End, 3" plungers: Single Ball Check Valves

Item No.	Description	Qty. Required
425	Check Valve Assembly	1
Check Valve assemblies include two O-rings(419), seat(420), ball stop(420), seat(421), ball(422), body(424)		

419	O-Ring, viton	2
420	Ball Stop	1
421	Seat	1
422	Ball, 22mm	2
424	Body	1

5. REMAINING LIQUID END PARTS(see Figure 8)

Item No.	Description	Qty. Req.
510	Diaphragm, 1-1/4"	1
510	Diaphragm, 1-3/4, 2-1/2, 3" plungers	1
530	Plunger Sleeve, 1-1/4" plunger	1
530	Plunger Sleeve, 1-3/4" plunger	1
540	O-Ring(1-1/4", 1-3/4" plungers only)	1
550	Screw, M6 x 18mm(1-1/4, 1-3/4"plungers only)	6
560	Lockwasher	6
570	Screw, M8 x 30mm	6
580	O-Ring	1
590	Gasket	1
600	Displacement Chamber(1-1/4" plunger)	1
600	Displacement Chamber(1-3/4,2-1/2,3"plungers)	1
610	Locating Pin	2
620	Breather Cap	1
630	Sight Glass	2
640	Hose Barb Union	1
650	Displacement Chamber Plug, 1/4" NPT	1
1020	Diaphragm Head, PVC, 1-1/4" plunger	1
1020	Diaphragm Head, PVC, 1-3/4,2-1/2,3"plungers	1
1020	Diaphragm Head, 316SS, 1-1/4" plunger	1
1020	Diaphragm Head, 316SS, 1-3/4,2-1/2,3"plungers	1
1020	Diaphragm Head, Alloy 20, 1-1/4" plunger	1
1020	Diaphragm Head, Alloy 20, 1-3/4,2-1/2,3"plungers	1
1025	Head Bolt, Stainless steel	
	For 1-1/4" plunger sizes: M6 x 55mm	8
	For 1-3/4", 2-1/2", 3" plunger sizes M12 x 90mm	6
1030	Nut, M12, Stainless Steel(1-3/4,2-1/2,3"plungers)	6
1035	Lockwasher, S.S., M12 (1-3/4,2-1/2,3"plungers)	6
1040	Washer, S.S., M12(1-3/4,2-1/2,3"plungers)	6
1050	Head Plate(1-1/4", PVC only); stainless steel	1

Model No. MGH281
Product Code
10CDM2SE11NN22
S/N1234567891
Flow Rate
X.X GPH @XX PSI
XXX PSI MAWP
Tag No. 12345678
XXX XX12345678



Milton Roy Company
Made in USA

Figure 2. Sample Nameplate

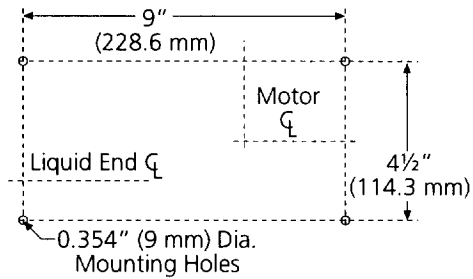


Figure 3. Mounting Hole Dimensions

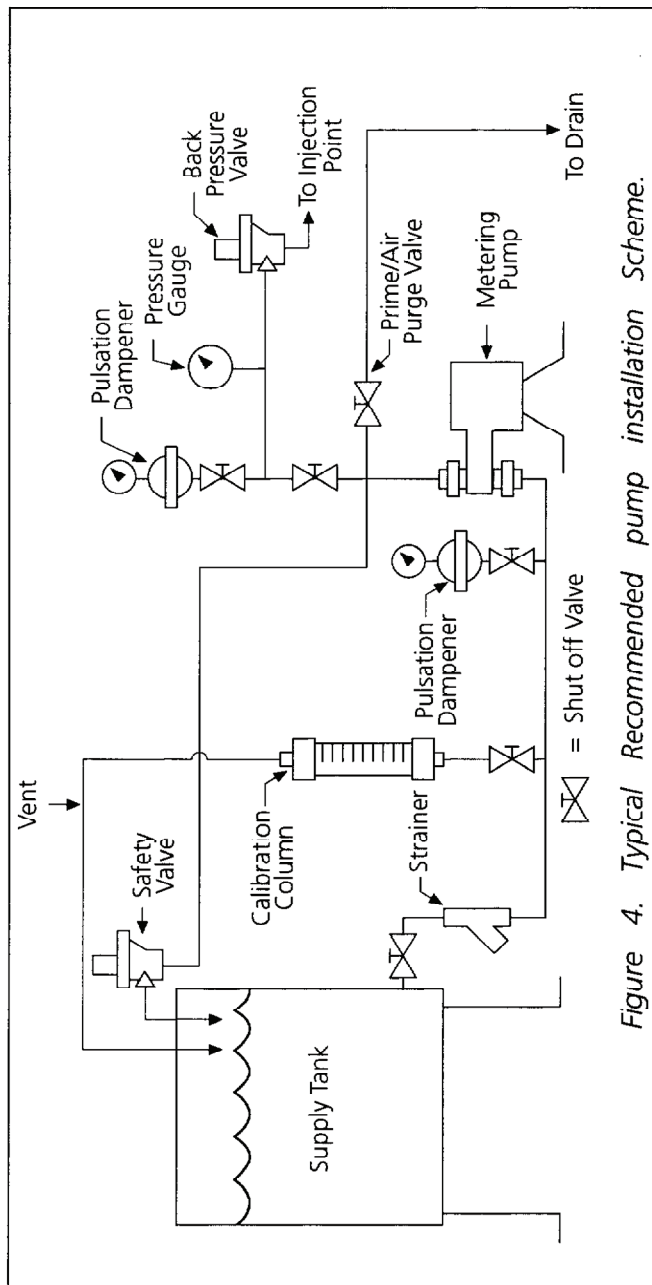


Figure 4. Typical Recommended pump installation Scheme.

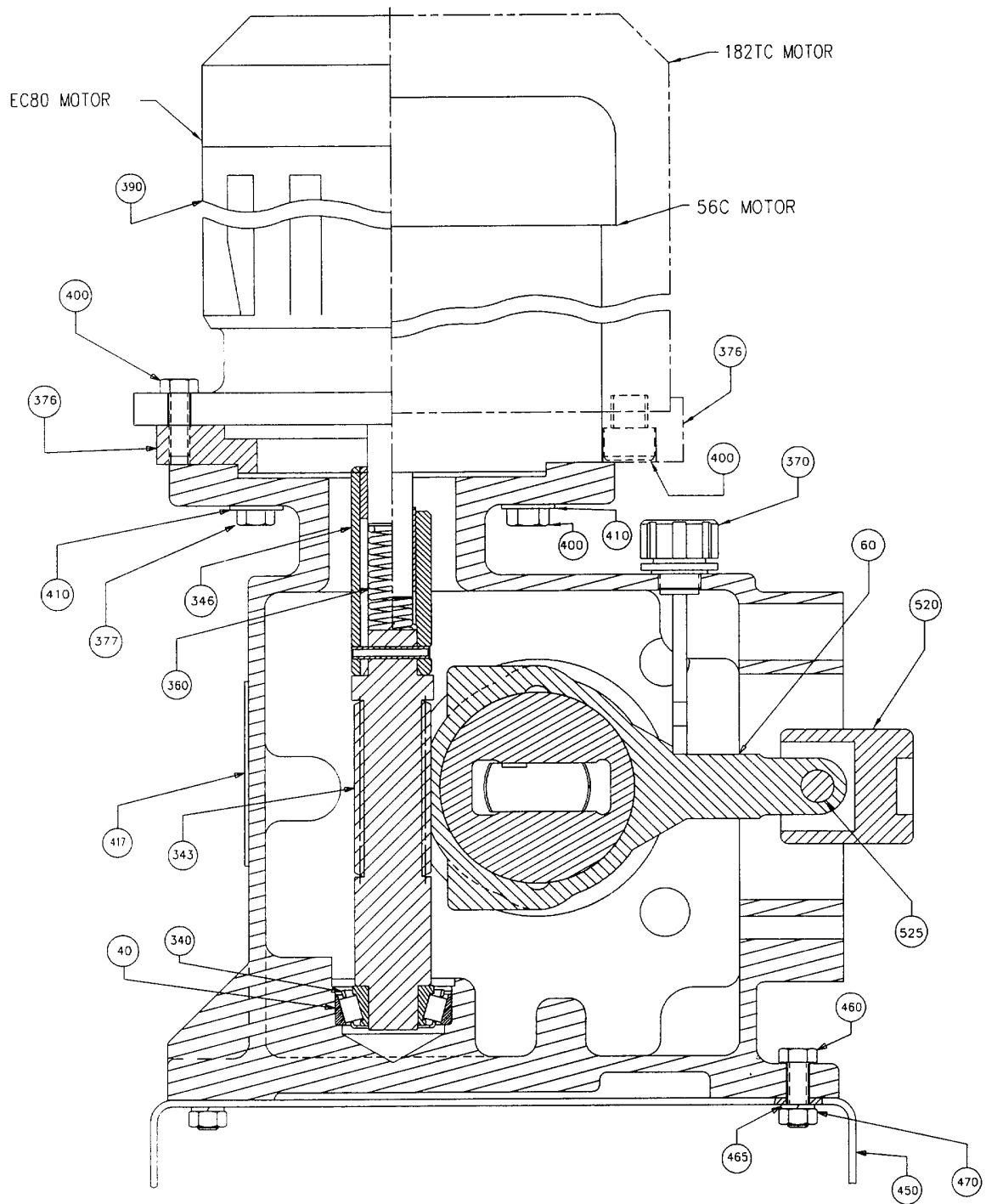
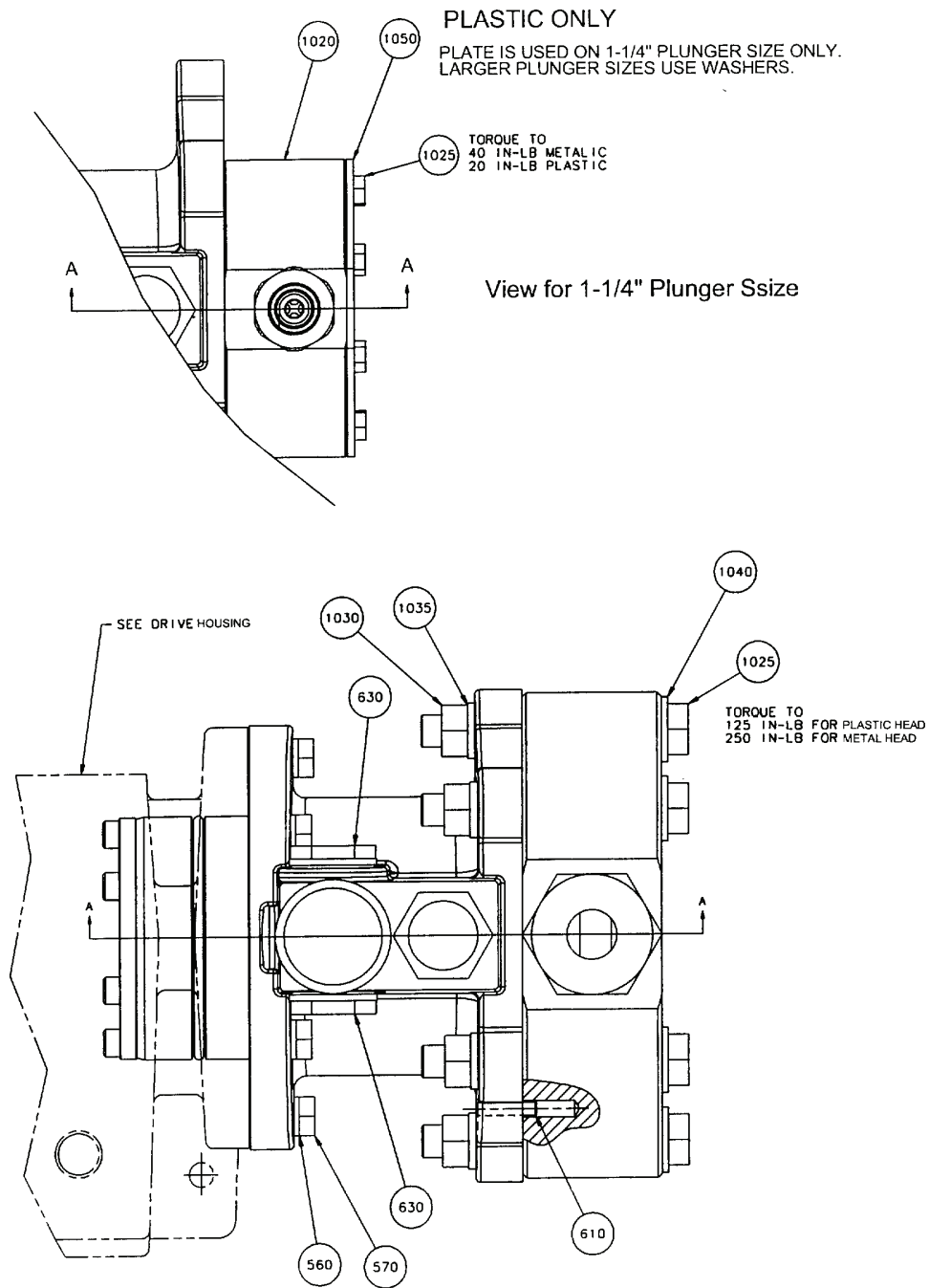


Figure 5. Drive Parts - Side View



LIQUID END - TOP VIEW



View for 1-3/4", 2-1/2", and 3" Plunger sizes.

Figure 7. Liquid End - Top View

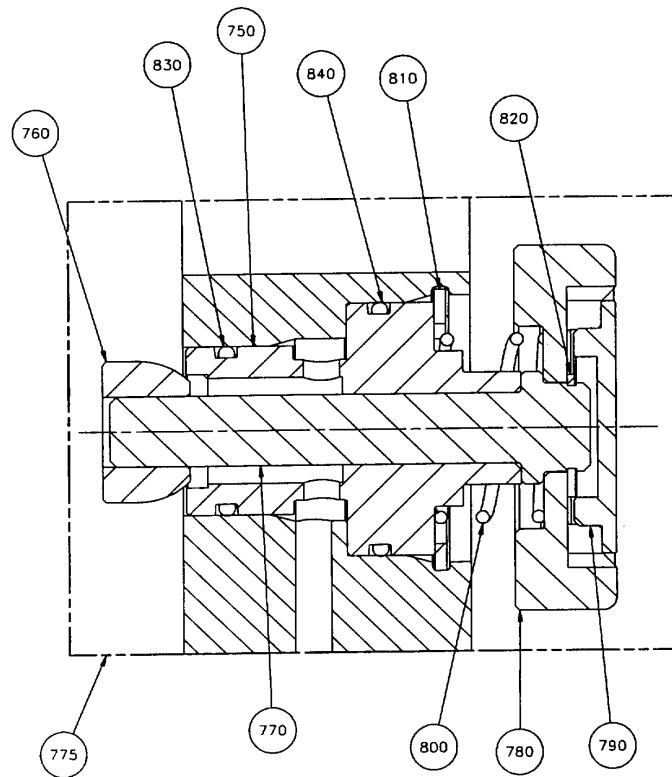
Technical drawing of a Mars Valve assembly in cross-section. The drawing includes the following callouts and labels:

- 1015
- 960
- 1005
- 970
- 980
- 990
- 1000
- 1010
- 620
- 935
- 950
- 650
- 640
- 530
- 540
- 550
- TORQUE TO 125 IN-LB
- 600
- 580
- 590
- 710
- 700
- 720
- 690
- 680
- 880
- 860
- 850
- 870
- 3-FUNCTION HYDRAULIC VALVE
- 930
- 890
- 900
- 920
- 910
- 920
- 940
- SEE CHECK VALVES
- 510
- 1020
- MARS VALVE SEE FIGURE NEXT SHEET
- 730
- 660
- 670
- 650
- 740
- REFILL VALVE

43

MARS VALVE

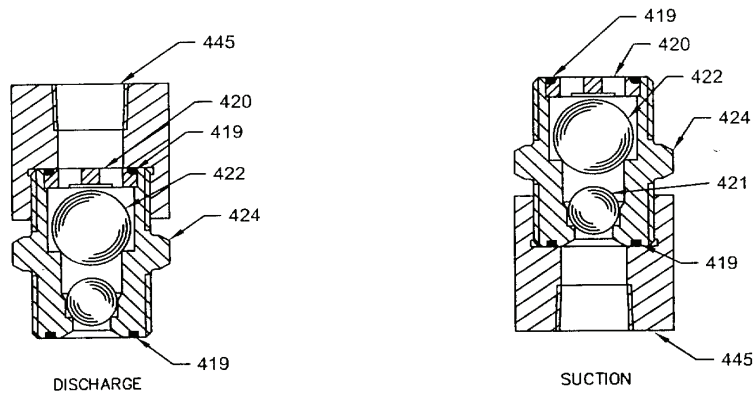
Mechanically Activated Refill System (MARS) valve assembly.
Except for O-rings, the valve may only be purchased as an assembly.



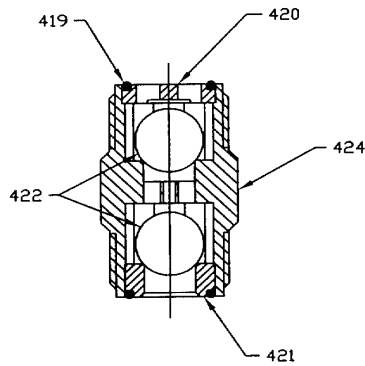
The MARS valve is located between the plunger and the diaphragm.

Figure 9. MARS VALVE

CHECK VALVE PARTS

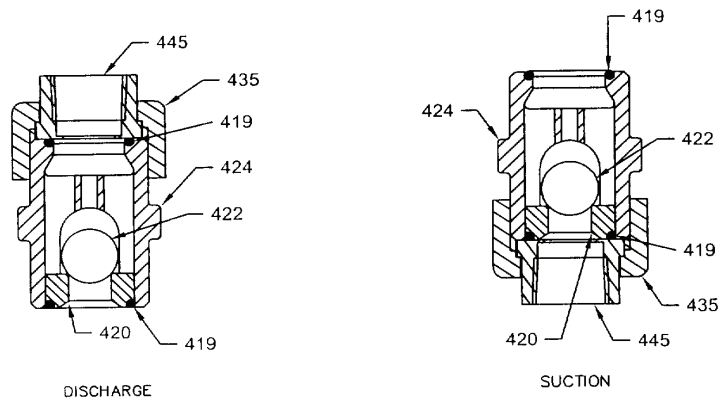


PVC and Metallic Double Ball Check Valve Parts - 1-1/4" thru 2-1/2" Plunger sizes



Metallic Double Ball Check Valve Parts - 3" Plunger Only

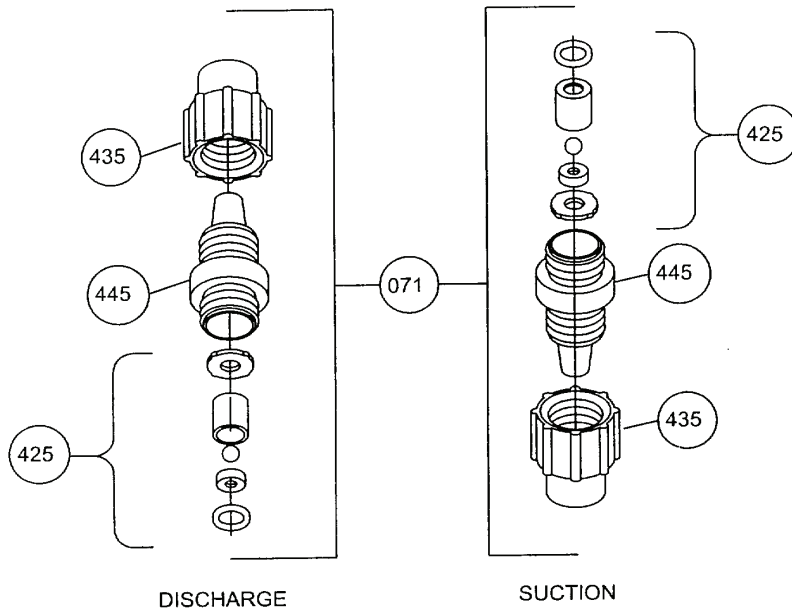
Figure 10.



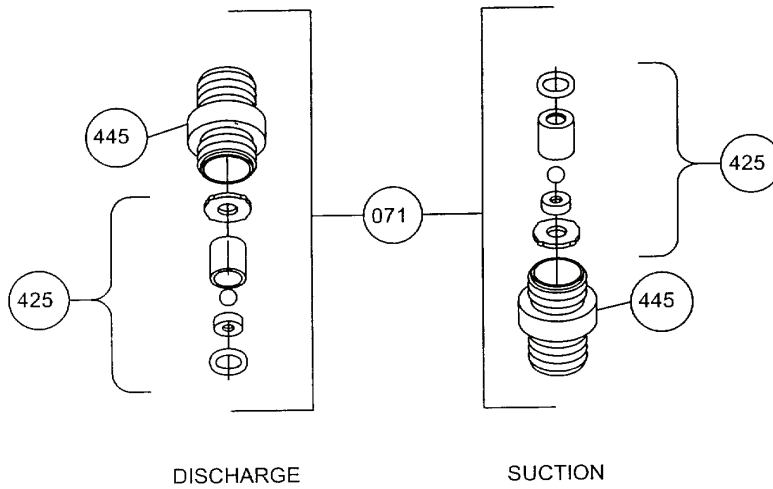
PVC Single Ball Check Valve Parts

Figure 11.

PLASTIC CHECK VALVES



SHOWN WITH TUBE CONNECTIONS



SHOWN WITH NPT CONNECTIONS

Figure 12. Plastic Check Valves, 1-1/4" Plunger Size

METALLIC CHECK VALVES

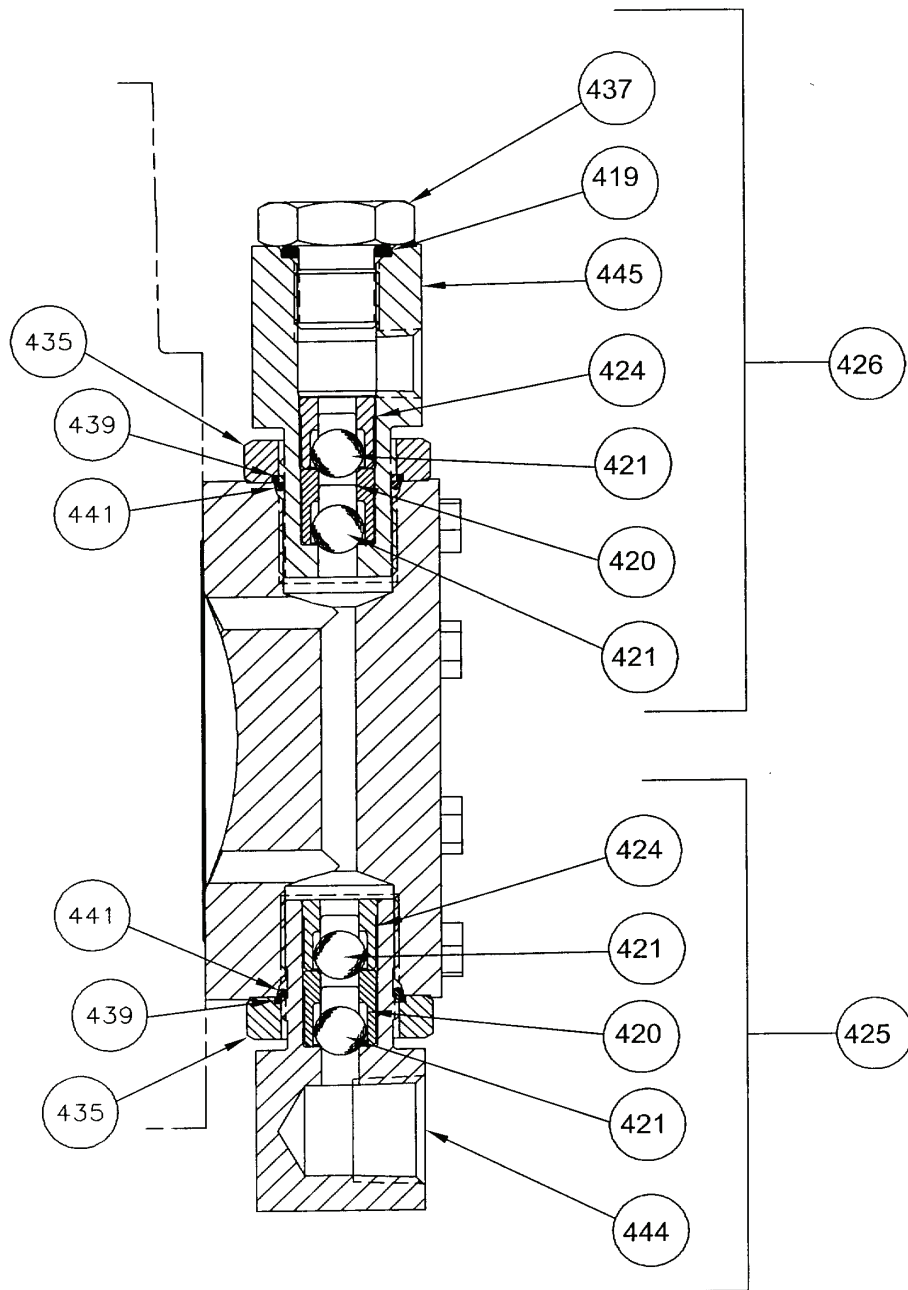


Figure 13. Metallic Check Valves, 1-1/4" Plunger Size

PVC LIQUID END WITH FOUR FUNCTION BLEED VALVE 1.25" PLUNGER

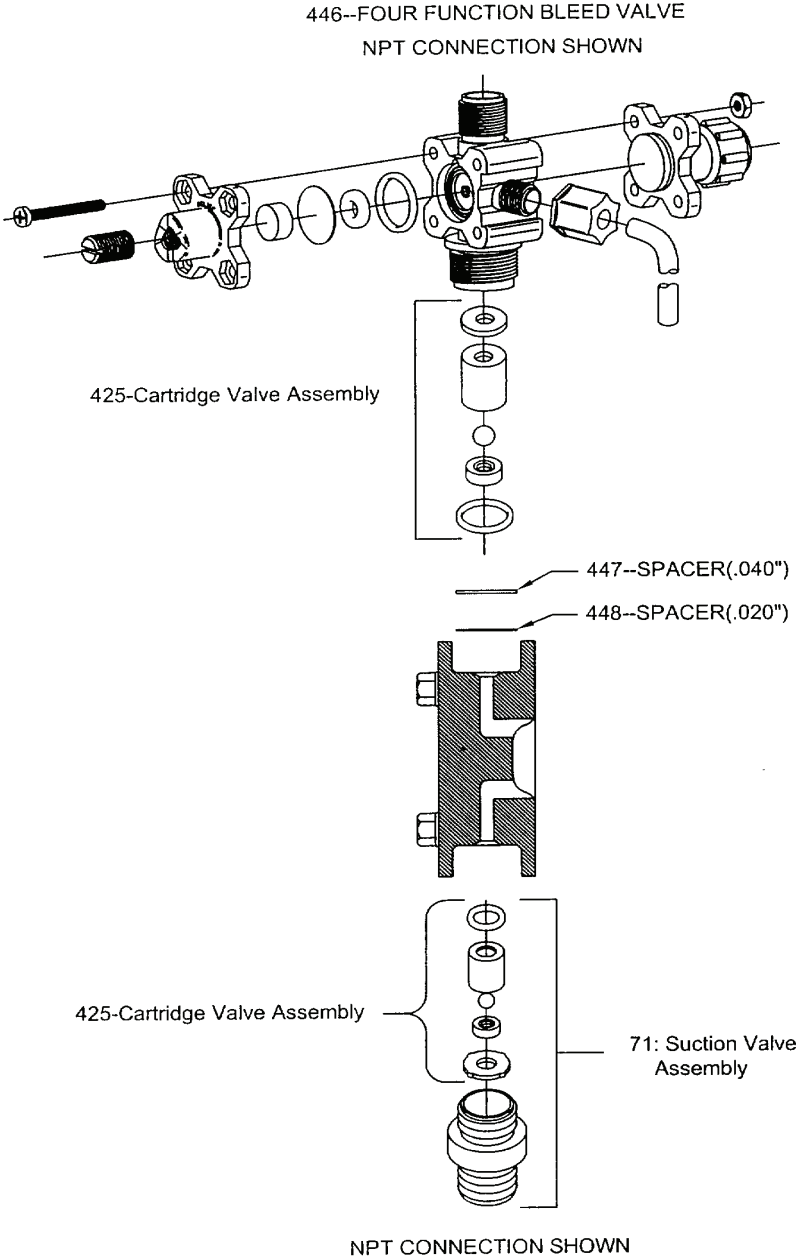


Figure 14 Four Function Bleed Valve

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