



# HI PRESSURE - FLOW PLUNGER

S E R I E S   O F   M E T E R I N G   P U M P S



Also for use with older  
W, D & K Series Metering Pumps



INSTALLATION, OPERATION AND MAINTENANCE MANUAL

# INTRODUCTION AND OVERVIEW

This manual contains specific, comprehensive procedures to help users install, operate, and maintain the Williams Plunger Series of Pneumatic Metering Pump Assemblies consisting of a plunger pump and controller or a plunger pump, relay, and controller.

For user convenience, the manual is divided into five sections:

## **Section 1.0:**

### **FUNCTIONAL DESCRIPTION**

Section 1.0 contains a physical description, the capabilities, and the operating sequence of the pumps.

## **SECTION 2.0:**

### **INSTALLATION OF PUMP AND CONTROLLER**

Section 2.0 contains specific procedures for installing the pumps and their various components including the controller.

## **SECTION 3.0:**

### **STARTUP, OPERATION, AND SHUTDOWN**

Section 3.0 contains procedures for setup, operation, shutdown, and storage of the pumps.

## **SECTION 4.0:**

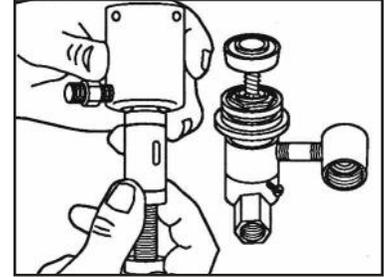
### **MAINTENANCE**

Section 4.0 contains procedures for regular and corrective maintenance.

## **SECTION 5.0:**

### **DRAWINGS AND PARTS LISTS**

Section 5.0 contains parts lists and assembly drawings.



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## Section 1.0: Functional Description

### 1.1 Physical Description

The letters CP at the beginning of a pump assembly model number indicate that the model consists of a controller and pump. The letters CRP indicate that the model also has a relay.

Controller types differ according to the pump model.

- CP250K, CP125D and CP250D225 pump assemblies use the MK-II controller.
- CP250D300 and CP500D pumps use the MK-VII controller.
- All W series pumps--CP125W125, CP250W225, CP500W300. etc.--use the MK-X controller.

Some W series pumps use relays which are of different sizes:

- CRP500W400, CRP1000W400, and CRP1000W600 pumps use the PO3-6S relay.
- CRP1000W800, CRP1500W400, CRP1500W600, CRP1500W800, CRP2250W600S, CRP2250W600L and CRP2250W800S pumps use the PO4-6S relay.
- CRP2250W800L pumps use the PO4-8S relay.

To increase the process fluid flow rate, two or more pumps can be multiplexed: their inlets and outlets connected in parallel.

#### 1.1.1 Controller

The controller, consisting of an upper and lower chamber separated by a sliding spool, uses a capillary tube with a needle valve to transfer the supply air/gas from the lower to the upper chamber. While controllers differ in their seals, MK-X using U-cup seals and MK-II and MK-VII using diaphragm seals, their operation is essentially the same. When the sliding spool is in its highest position, a pilot plug closes a vent and moves the supply air/gas to the pump or relay. In the spool's lowest position, the reverse is true; the pilot plug prevents supply air/gas from entering pump or relay, and opens the vent to let it exhaust. The spool then returns to its highest position and repeats the cycle.

#### 1.1.2 Relay

The relay is a pilot operated valve. Air/gas pressure from a controller forces a piston and one or more attached poppet valves downward. Then, when the pressure from the controller is removed, a spring forces both piston and poppet valve(s) upward.

Relay models differ in operation. The PO3-6S relay has one poppet valve that connects the supply air/gas to the pump and blocks the exhaust when air/gas pressure is applied to the relay piston. When the pressure is removed from the piston, the poppet valve cuts off the supply air/gas and moves up to connect the pump to the exhaust.

The PO4-6S and PO4-8S relays, used on pumps that do not have a motor return spring, drive the air piston both up and down with the air/gas pressure. Also, these relays have two poppet valves. The upper valve operates in the same way as the PO3-6S relay valve. But the lower valve operates in the opposite order. That is, when the upper valve applies air/gas pressure to the pump, the lower valve exhausts it, and when the upper valve exhausts the air/gas, the lower valve applies pressure.

#### 1.1.3 Pump

The pneumatic metering plunger pump consists of a pump or fluid chamber, and a motor or air chamber, separated by a piston plunger assembly and seals. In the fluid chamber, the suction (inlet) and discharge (outlet) ports have check valves that control the direction of the fluid flow. In the air chamber, the air/gas power supply from the controller or relay enters and exhausts through a pipe nipple that connects the controller or relay to the air chamber.

When the controller or relay exhausts the drive air/gas, if the pump has a motor return spring, fluid pressure and the spring force the piston plunger upwards. If the pump has no motor return spring, supply pressure from a relay enters beneath the piston to help force the piston plunger assembly upwards. In either case, the plunger assembly stops when the piston makes contact with the end of the stroke adjuster.

The piston face area where the air/gas pressure is applied is much greater than the plunger face area which works against the pressure of the process fluid. This difference in area, called the amplification ratio, allows the pump to work against process fluid pressures much greater than the air/gas supply pressure.

See page 3 for  
GENERAL CONFIGURATION  
Drawing 1

### 1.2 Capabilities

#### 1.2.1 Controllers and Relays

Controllers and relays require separate supply sources, but fortunately will operate with air or virtually any gas, such as carbon dioxide, nitrogen or natural gas.

**WARNING - TO PREVENT INJURY, MAKE SURE THAT ANY FLAMMABLE GAS SUCH AS NATURAL GAS IS PROPERLY VENTED FOR SAFETY.**

#### CAUTION

**If there is a chance that the gas could damage the standard elastomeric material, Buna-N rubber, used in the controller or relay, please contact your distributor or Williams Instrument Company for advice.**

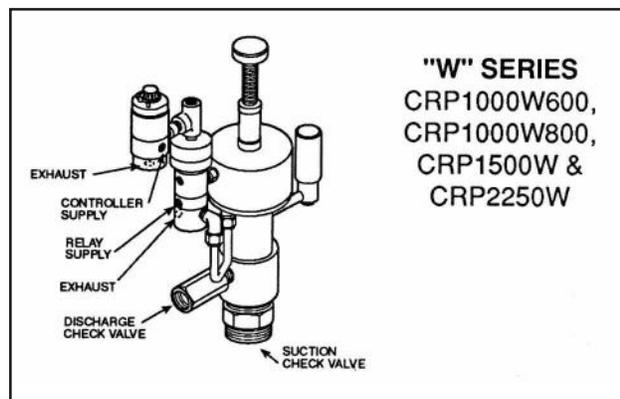
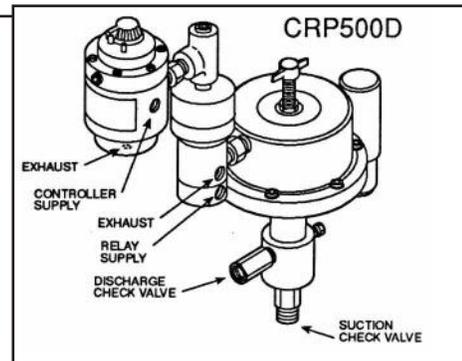
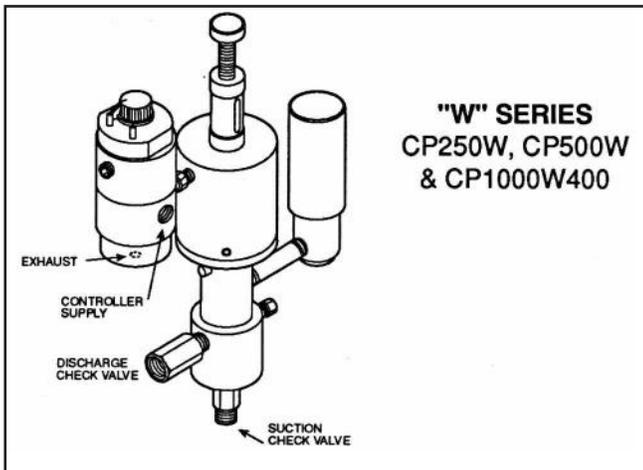
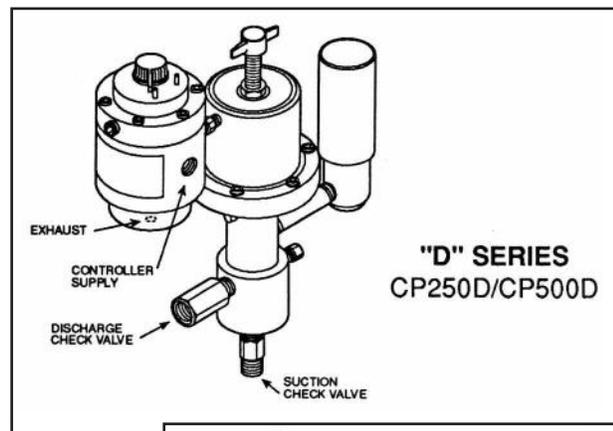
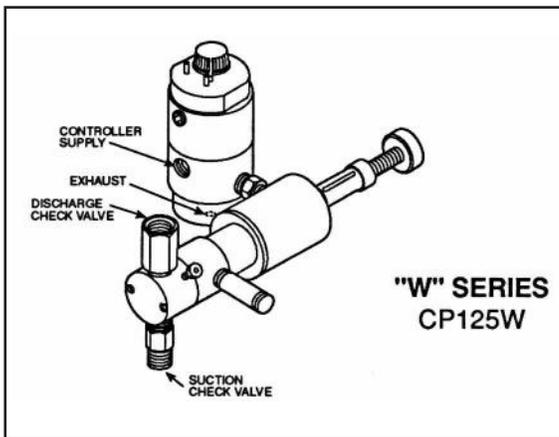
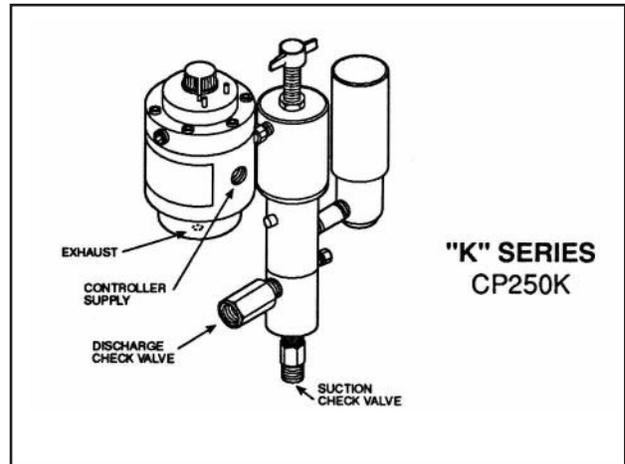
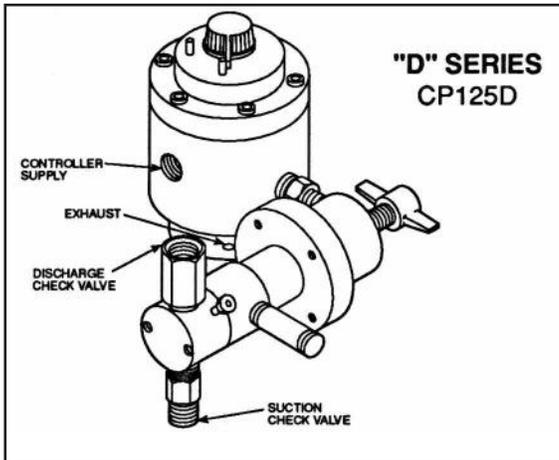
##### 1.2.1.1 Controller Supply Pressure:

Controllers will operate with the following supply pressures:

	Maximum		Minimum	
	psi	bar	psi	bar
<b>MK-II</b>	65	4.5	35	2.4
<b>MK-VII</b>	90	6.2	50	3.4
<b>MK-X</b>	100	6.9	35	2.4

When establishing the proper air supply pressure, remember the process pressure is the pressure the pump plunger is working against; the amplification ratio of a pump is the number listed on the specification sheet for that pump. For controller or relay driven pumps, the air/gas supply pressure must be equal to or greater than the process pressure plus 200 psig, divided by the pump amplification ratio. If the controller is sending pilot pulses to a relay, the air pressure must be set at 35 psig (2.4 bar).

# DRAWING 1 GENERAL CONFIGURATION



## CAUTION

To prevent damage to the controller, always use a regulator between the supply and the controller when the air/gas supply pressure is more than the maximum rating of your controller.

**1.2.1.2 Relay Supply Pressure:** Relays, which require a separate air supply, operate with supply pressures of 50 psig (3.4 bar) minimum and 150 psig (10.3 bar) maximum. The supply pressure must be equal to or greater than the process pressure plus 200 psig divided by the pump amplification ratio. (See 1.2.1.1 above for definitions of process pressure and amplification ratio.)

When using a controller/relay combination, the air/gas supply pressure to the controller should be held to the minimum value. (Ref. 1.2.1.1.)

## CAUTION

To prevent damage to the relay, always use a regulator between the supply and the relay when the supply pressure is more than 150 psig (10.3 bar).

## 1.2.2 Pumps

**1.2.2.1 Viscosities:** Pumps will provide catalog performance on fluids with viscosities up to 4500 SSU (Saybolt Second Universal) or 960 CP (Centipoise). Pump can operate on higher viscosity fluids but performance will be reduced.

**1.2.2.2 Static Suction Head:** Pump discharge pressure determines suction head. Because 100 psi check valves are standard on all pumps, net positive suction head must be less than 100 psi (6.9 bar) or 230 feet - head of water to prevent free-flow through the pump.

## CAUTION

Because pumps will not work with net negative suction, Williams always recommends flooded suction.

To obtain suction pressures higher than 100 psi, contact your authorized distributor or Williams Milton Roy.

## 1.2.2.3 Operating Temperature Range:

The range of operating temperatures depends on the seal material. For the standard pump seal material, Teflon-Graphite, the range is -30°F (-30°C) to 185°F (85°C). For information on seal materials with different operating temperature ranges, contact your distributor or Williams Instrument Co.

**1.2.2.4 Metered Fluids:** Pumps can operate with many kinds of acids, caustic, solvents, and slurries, depending on the pump and seal materials. For information on seal and metallurgical materials to use with a particular fluid, contact your distributor or Williams Instruments Co.

1.2.2.5 Specification Table (See following page)

## 1.3 GENERAL OPERATING SEQUENCE

### 1.3.1 Controller

The spool spring forces the spool upward to its highest position and unseats the top of the pilot plug from the upper seat. The exhaust spring forces the pilot plug upward and seats it on the lower seat, blocking the air/gas exhaust port.

When high pressure air/gas enters the supply port, it passes around and through the spool, past the open upper seat to the motor cylinder port. From there it slowly through the capillary tube, past the valve stem, and into the valve body volume chamber, causing pressure to build in the chamber.

Because the surface area of the upper U-cup is much larger than the surface area of the middle U-cup, downward force on the spool is greater than the upward force. This pushes the spool down until the pilot plug seats itself on the upper valve seat, shutting off the air/gas supply. As the spool continues to move down, it pushes the pilot plug until it is unseated from the lower seat valve and the air/gas exhausts through the lower valve from both the motor cylinder and the valve body volume chamber.

When the pressure in the valve body volume chamber is low enough, the spool spring starts pushing the spool upward, the exhaust spring pushes the pilot plug upward, and the controller returns to its initial position.

## 1.3.2 Relays

**1.3.2.1 P03-8S Relay:** When there is no pilot pulse (high pressure air or gas) from the controller, the piston spring pushes the piston and the poppet attached to the piston upwards until the O-ring on top of the poppet presses against the upper body section, sealing the pump port from the exhaust port. The space below the poppet provides a path between the supply and pump ports.

When the controller sends a pilot pulse, the high pressure gas on top of the piston overcomes the piston spring force; this pushes the piston and the poppet attached to the piston downwards until the O-ring on the bottom of the poppet presses against the lower body section, sealing the pump port from the supply pressure. The space above the poppet provides a path between the exhaust and pump ports.

### 1.3.2.2 P04-6S and P04-8S Relays:

When there is no pilot pulse (high pressure air or gas) from the controller, the piston spring pushes the piston and both poppets attached to the piston upwards until the O-ring on top of the upper poppet presses against the middle body section. The upper poppet O-ring seals the number one pump port from the number one exhaust port; the space below provides a path between the supply and the number one pump ports. The lower poppet O-ring seals the number two pump port from the supply port; the space below provides a path between the number two exhaust and pump ports.

When the controller sends a pilot pulse, the high pressure gas on top of the piston overcomes the piston spring force; this pushes the piston and both poppets attached to the piston downwards until the O-ring on the bottom of upper poppet presses against the middle body section and the O-ring on the bottom of the lower poppet presses against the lower body section. The upper poppet O-ring seals the number one pump port from the supply port; the space above provides a path between the number one exhaust and pump ports. The lower poppet O-ring seals the number two pump port from the number two exhaust port; the space below provides a path between the number two exhaust and supply ports.

1.2.2.5 Specification Table

PNEUMATIC METERING PLUNGER PUMPS - W SERIES

Models	Plunger Diameter (inch)	Piston Diameter (inch)	Maximum Volume		Maximum Pressure		Amp Ratio	Strokes per Minute (SPM)	Volume per stroke (cc)	Stroke length (inch)	Max. Air Usage At Max. Volume				Approx. Shipping Weight	
			Gal./Hr	Liter/Hr	PSI	BAR					100 PSI <sup>3</sup>	6.9 <sup>3</sup> Bar	150 <sup>3</sup> PSI	10.3 <sup>3</sup> Bar	Lbs.	Kg.
											SCF/D	SCM/D	SCF/D	SCM/D		
CP125W125B316TG	1/8	1 1/4	0.07	0.27	7,500	517	75:1	1-45	0.1	1/2	180	5			7	3.2
CP250W225B316TG	1/4	2 1/4	0.57	2.16	7,500	517	75:1	1-45	0.8	1	1150	32			9	4.1
CP250W300B316TG	1/4	3	0.57	2.16	10,000	690	120:1	1-45	0.8	1	2,100	59			9	4.1
CP500W225B316TG	1/2	2 1/4	2.30	8.64	1,400	97	14:1	1-45	3.2	1	1,500	42			10	4.5
CP500W300B316TG	1/2	3	2.30	8.64	3,000	207	30:1	1-45	3.2	1	2,100	59			10	4.5
CP500W400B316TG	1/2	4	1.5	5.76	4,000	276	60:1	1-30	3.2	1	2,374	67			12	5.4
CRP500W400B316TG	1/2	4	2.3	8.64	9,000	620	60"1	1-45	3.2	1	3,584	101	5,250	149	15	6.8
CP1000W400B316TG	1	4	5.10	19.20	1,400	97	14:1	1-25	12.8	1	1,996	56			24	10.9
CRP1000W400B316TG	1	4	8.13	30.72	2,100	145	14:1	1-40	12.8	1	3,194	90	4,607	130	29	13.2
CRP1000W600B316TG	1	6	8.13	30.72	4,500	310	30:1	1-40	12.8	1	7,190	203	10,210	289	39	17.7
CRP1500W400B316TG	1 1/2	4	22.90	86.40	600	41	4:1	1-40	36.0	1 1/4	8,064	228	11,543	326	33	15.0
CRP1500W600B316TG	1 1/2	6	22.90	86.40	1,950	134	13:1	1-40	36.0	1 1/4	8,144	230	26,000	736	39	17.7
CRP1500W800B316TG	1 1/2	8	22.90	86.40	3,450	238	23:1	1-40	36.0	1 1/4	32,256	913	46,000	1,302	44	20.0
CRP2250W600B316TG	2 1/4	6	45.00	168.00	900	62	6:1	1-35	80.0	1 1/4	16,000	453	23,000	651	50	22.7
CRP2250W600LB316TG	2 1/4	6	90.00	336.00	900	62	6:1	1-35	160.0	2 1/2	32,000	906	46,000	1,302	59	26.8
CRP2250W800SB316TG	2 1/4	8	45.00	168.00	1,800	124	12:1	1-35	160.0	2 1/2	57,000	1,614	81,000	2,293	84	38.2

Notes:

1. Minimum recommended stroke length is 1/8 inch for CP 125 to CRP500 and 1/4 inch for CP1000 to CRP2250 pumps.
2. Minimum recommended operating speed is 10 spm.
3. MK-X Controller.
4. MK-X Controller and Relay.

1.2.2.5 Specification Table

PNEUMATIC METERING PLUNGER PUMPS - D SERIES

Models	Plunger Diameter (inch)	Piston Diameter (inch)	Maximum Volume		Maximum Pressure		Amp Ratio	Strokes per Minute (SPM)	Volume per stroke (cc)	Stroke length (inch)	Max. Air Usage At Max. Volume				Approx. Shipping Weight	
			Gal./Hr	Liter/Hr	PSI	BAR					65 <sup>3</sup> PSI	4.5 <sup>3</sup> Bar	90 <sup>4</sup> PSI	6.2 <sup>4</sup> Bar	Lbs.	Kg.
											SCF/D	SCM/D	SCF/D	SCM/D		
CP125D125A316TG	1/8	1 1/4	0.07	0.27	4,500	310	75:1	1-45	0.1	1/2	124	4	324	9	4.0	1.8
CP250D225A316TG	1/4	2 1/4	0.57	2.16	5,000	345	75:1	1-45	0.8	1	800	23	1,040	29	7.0	3.2
CP250D300A316TG	1/4	3	0.57	2.16	10,000	690	120:1	1-45	0.8	1	960	27	1,248	35	7.5	3.4
CP500D225A316TG	1/2	2 1/4	2.30	8.64	1,250	86	14:1	1-45	3.2	1	800	23	1,040	29	7.5	3.4
CP500D300A316TG	1/2	3	2.30	8.64	2,700	186	30:1	1-45	3.2	1	960	27	1,248	35	8.0	3.6
CP500D400A316TG	1/2	4	1.50	5.76	6,000	345	60:1	1-30	3.2	1	1,700	48	2,220	63	805	3.8
CRP500D400A316TG	1/2	4	2.30	8.64	9,000	517	60:1	1-45	3.2	1	2,560	72	3,328	94	12.0	5.4

NOTES:

1. Minimum recommended stroke length is 1/8 inch.
2. Minimum recommended operating speed ia 10 spm.
3. MK-II Controller.
4. MK-VII Controller.

### 1.3.3 Pump Motor (Air Chamber)

The motor forces the piston plunger to move alternately into and out of the pump chamber. When the controller sends the supply air/gas into the motor chamber through the nipple connector, the pressure on the U-cup and piston plunger overcomes the combined force of the process fluid pressure on the U-cup and piston plunger overcomes the combined force of the process fluid pressure on the U-cup, piston plunger, and plunger return spring and pushes the plunger into the fluid chamber. When the external controller exhausts the air/gas, the piston plunger return spring and process fluid pressure push the piston plunger out of the fluid chamber.

### 1.3.4 Pump (Fluid Chamber)

The pump operating cycle consists of two parts: discharge and suction. During discharge, the piston plunger moves into the pump fluid chamber, decreasing the volume of the chamber and raising the pressure on the chamber fluid. This higher pressure closes the suction check valve and opens the discharge check valve, sending the fluid into the discharge line.

During the suction part of the cycle, the piston plunger moves out of the fluid chamber, increasing the volume of the chamber and lowering the pressure on the chamber fluid. This lower pressure opens the suction check valve and closes the discharge check valve, sending fluid from the suction line into the fluid chamber.

## SECTION 2.0: INSTALLATION

### 2.1 GENERAL

Always install separate pressure regulators in the air/gas supply line for a controller and a relay. Also, for the most efficient performance of your pump assembly, we recommend the following:

- A dryer and a dump valve in the air/gas supply line to remove any moisture from the supply air/gas.
- Isolation valves (ball type) on inlet and discharge sides of the pump and in the air/gas supply line to simplify maintenance.
- A check valve where the pump discharge line joins the main process line to prevent process fluid back flow.
- Inlet filter on pump suction line.

Refer to Illustration 2.1 - Typical Williams Pump Installation.

### 2.2 PUMP ASSEMBLY

Position the pump assembly with enough space around it to allow easy access to all components for maintenance. Install the assembly with the pump inlet/suction check valve pointing straight down; the pump will not work as efficiently in any other position since the inlet/suction check valve has no spring.

Exceptions to this procedure are the P125D and P125W pumps which have a spring in their inlet/suction check valve. These pumps are mounted horizontally since the check valves oppose each other in the vertical plane of the pump. Please contact the factory for approval if it is impossible to mount these pumps horizontally.

#### NOTE

**The pump assembly can be installed directly in the process line piping without additional support brackets.**

### 2.3 SUPPLY RESERVOIR

Position the supply reservoir at the same level as the inlet valve (flooded suction). While you can locate the reservoir above the inlet valve (net positive suction head), the limit is 100 psig net positive suction head which is the cracking pressure of the discharge valve. We do not recommend using the pumps in a suction lift position since they were not designed for such operation.

### 2.4 RELIEF VALVE

To control net positive suction head, either a stand pipe or a relief valve can be installed. On the discharge side of the pump, with a relief pressure no more than 1 or 2 psi (0.7 or 0.14 bar) greater than the net positive suction head.

A safety relief valve is not necessary if the downstream piping is designed to withstand the maximum pressure the pump can generate at the available air supply pressure. The maximum pressure the pump can generate is calculated by multiplying the amplification ratio times the controller air supply pressure. When this pressure is reached the pump will stop.

Example: A CP250W225B316TG operating at 35 psig is capable of generating 35 psig x 75 (amplification ratio) or 2625 psig. The pump will stop working when the 2625 psig is reached.

## SECTION 3.0: STARTUP, OPERATION, SHUTDOWN, AND STORAGE

### 3.1 GENERAL

While these procedures for startup, operation, shutdown, and storage are easy to perform, following them carefully and correctly will improve the performance and increase the life of your pump assembly.

#### CAUTION

**To avoid damaging the controller valve stem, do not make a habit of turning the pump ON and OFF with the stroke rate control.**

### 3.2 STARTUP

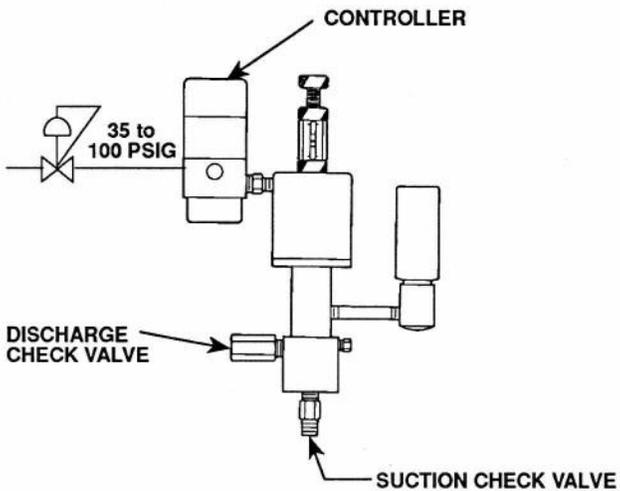
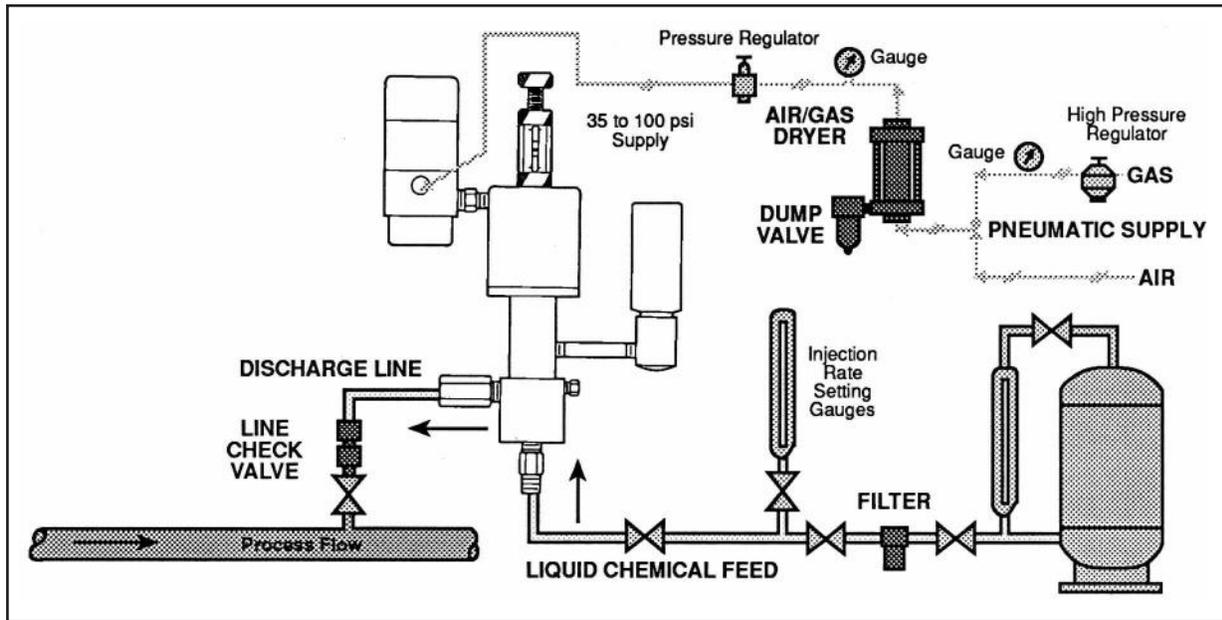
#### 3.2.1 Air/Gas Supply

Before starting up your pump assembly, make sure that the primary air/gas supply--compressor, tank of gas, or other source--is turned to OFF. Also, set the pressure regulator(s) to ZERO pressure.

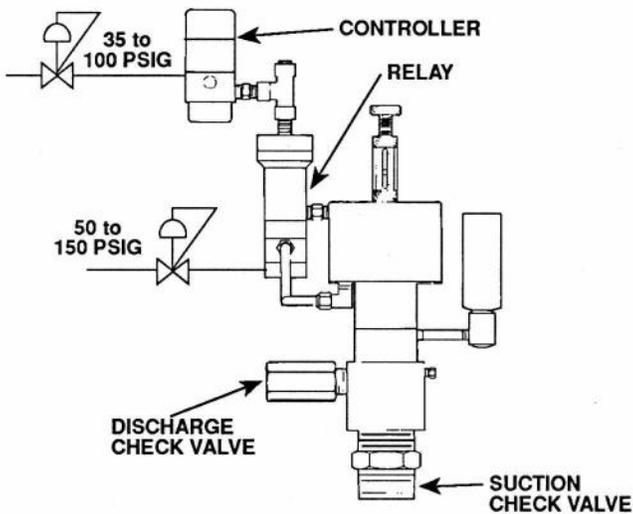
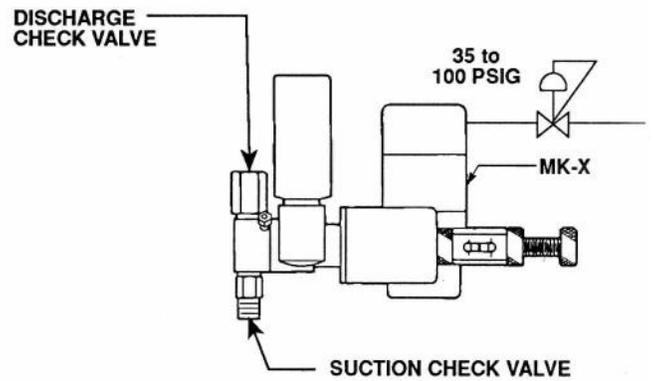
**3.2.1.1 Supply Pressure:** The supply pressure must be large enough to produce a pump discharge pressure 200 psi higher than the process pressure. Therefore, if the process pressure is 2800 psi, the pump discharge pressure should be 3000 psi. To set the supply pressure properly, divide the pump discharge pressure (required discharge pressure plus 200 psig) by the pump amplification ratio. Using the above example, if your pump's amplification ratio is 75:1, the required supply pressure to the pump will be 40 psi (3000 divided by 75 = 40).

If there is no relay in your pump assembly, the pressure regulator on the controller will already be set at the required supply pressure. If there is a relay, the regulator on the relay will already be set at the required supply pressure. It is essential, however, to make sure that the calculated supply pressure meets the minimum pressure required for both the relay and the controller (Ref. 1.2).

TYPICAL PUMP INSTALLATION



OR



OR

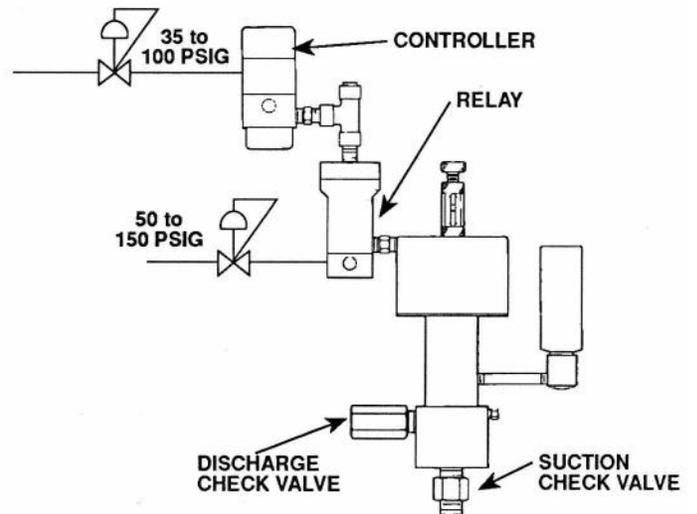


ILLUSTRATION 2.1

If the controller stroke rate has not been calibrated already, follow this procedure:

1. Rotate the stroke rate knob on the controller clockwise (CW) to ZERO on the stroke rate scale.
2. Turn the main air/gas supply to the regulator(s) to ON, and adjust. (See 3.1.1.1 above.)
3. Set the desired flow rate for your application by using the pump's stroke adjuster in combination with the controller's stroke rate adjustment. ( Ref. 1.2.2.5 FOR PUMP PERFORMANCE)

Adjust the controller stroke rate knob, as follows:

1. Loosen the set screw and remove the knob.
2. Adjust the valve stem to the desired rate by hand by turning the stem clockwise (CW) to decrease the stroke rate or counterclockwise (CCW) to increase the rate.
3. Attach and set the knob at the desired position on the scale.

### 3.2.3 Pump Stroke Length

The adjuster scale for the pump's stroke length is factory set so that a ZERO reading equals ZERO stroke length.

Calibrate the scale as follows:

1. Turn the stroke adjuster knob CW as far as possible.
2. Loosen the slotted screw on the end of the knob.
3. Rotate the knob until ZERO on the scale lines up with the scale indicator.
4. Tighten the screw. Once you have calibrated the scale, you can select the proper pump stroke length.

## 3.3 OPERATION

### 3.3.1 Bleeder Plug

Shortly after the pump assembly begins operating, the metered liquid begins flowing through the pump. To bleed air trapped in the pump chamber, turn the bleeder plug CCW about a quarter turn. When the liquid is flowing steadily from the end of the bleeder plug, turn it CW until the flow stops.

### 3.3.2 Stroke Rate

Set the operating stroke rate, as follows:

1. Set the stroke rate knob to a point on the scale that will produce a stroke rate close to the one you want.

#### NOTE

At the ZERO setting on the controller stroke rate scale, the pump will not stroke, but as you rotate the knob toward 100 the rate will increase to the maximum strokes per minute for each pump (Ref. 1.2.2.5). To set the stroke rate correctly, you must time the exhausts from the bottom of the controller.

2. Count the number of pump strokes during a one-minute interval.
3. Adjust the knob to correct the stroke rate as needed.
4. Repeat the previous steps until you get the correct stroke rate.

As an example, to get a stroke rate of 22 strokes per minute, you might set the knob to 50, which produces 25 strokes per minute. To reduce the rate, reset the knob to 48. If this produces 21 strokes a minute, move the knob to 49 which should be very close to the 22 strokes per minute you want.

## 3.4 SHUTDOWN AND STORAGE

To shut down the pump assembly, set the pressure regulator(s) to ZERO, and turn the air/gas supply to OFF.

To store the pump assembly, do the following:

1. Flush out the pump chamber with water or solvent, and blow it dry with compressed air.

#### CAUTION

**To prevent damage to the pump when you clean it, be sure to use a solvent compatible with the metered fluid that will not damage the pump's seals. For a recommended solvent, contact your distributor or Williams Milton Roy.**

2. Unscrew the silicone oil bottle from the oiler body on the pump. Drain the oil from the pump into the bottle and put the cap on the bottle.

3. You may leave the pump, controller, and relay assemble, but make sure to store them in a dry, protected place.

## SECTION 4.0: MAINTENANCE

### 4.1 GENERAL

This section contains procedures for disassembly and assembly of the controller, pump, and check valves, as well as for preventive and corrective maintenance. To maintain the reliability, durability, and performance of your pump assembly and related components, it is essential to follow these procedures exactly and carefully.

For consistent, reliable performance, replace any O-rings, U-cups, or other seals that you remove. Order replacement seal kits with detailed instructions from your distributor or Williams Milton Roy.

Whenever you disconnect any air/gas or fluid piping, cover all open ports in the pump assembly to prevent dirt from entering.

### 4.2 DISASSEMBLY AND ASSEMBLY

#### 4.2.1 Required Tools

Necessary tools will vary by pump assembly model.

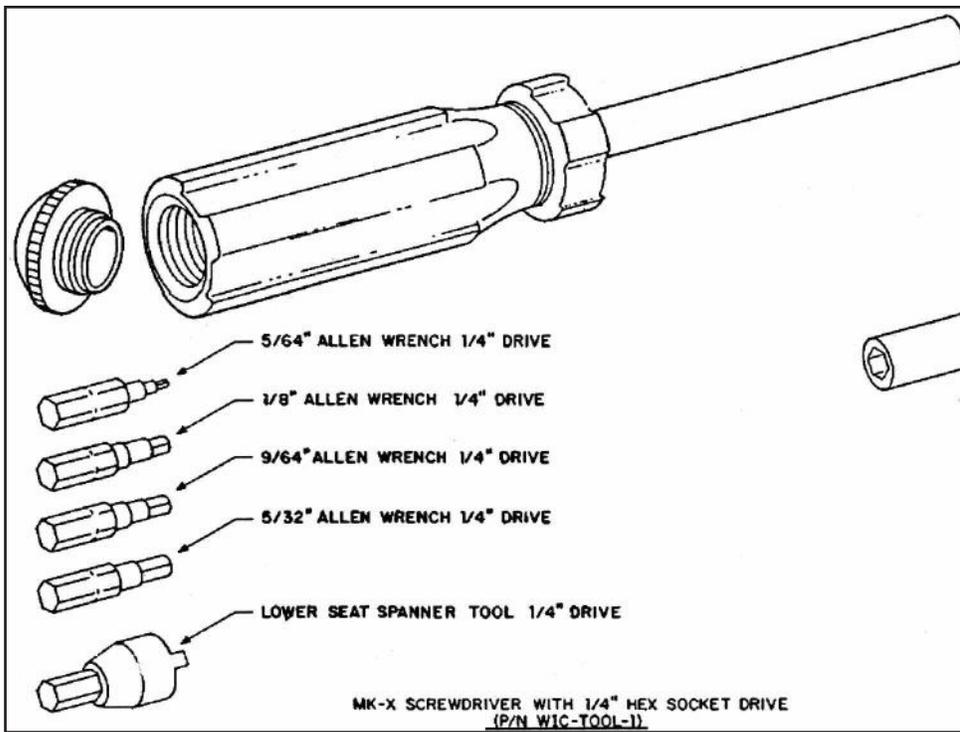
- Adjustable Wrench: 15"
- Bench Vise
- Allen Wrenches: 7/64", 1/8", 9/64", 5/32", and 3/16"
- Straight Blade Screwdrivers: 1/8" and 1/4"
- MK-X Screwdriver in 1/4" Hex Socket
- Drive (Drawing 1)
- Snap Ring Removal Tool
- Brass Drift: 1/8"
- Hammer
- Silicone Grease GS102149

#### NOTE

See 4.3 Preventive Maintenance for inspection and replacement of parts identified throughout these procedures.

#### 4.2.2 Pump, Controller, and Lubricator Reservoir

Begin disassembly with these preliminary procedures:



1. Rotate the oiler body 180° until the silicone oil bottle is in its normal upright position. Unscrew and remove the bottle.
2. Rinse the pump, controller, lubricator reservoir, and cap to remove any chemical residue.
3. Unscrew the controller by hand and remove it.

#### 4.2.3 Controller

##### 4.2.3.1 MK-X controller

Refer to the MK-X Controller.  
 Disassemble the controller as follows:

1. Clamp the lower end of the controller body in a bench vise. (Fig. 1)

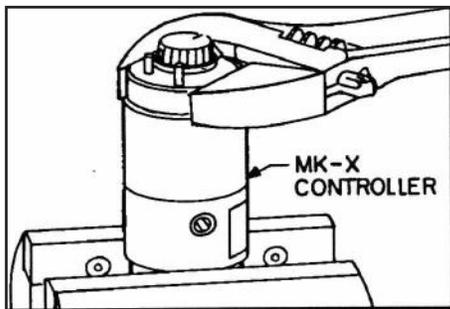


Figure 1

2. Use an adjustable wrench on the flats at the top of the valve body assembly to unscrew and pull off the valve assembly. (Fig.2)

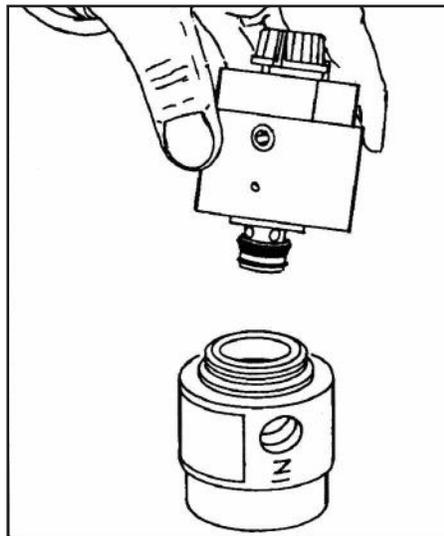


Figure 2

3. Lift out the spool with the 3 attached U-cups and the spool alignment O-ring. (Fig.3)

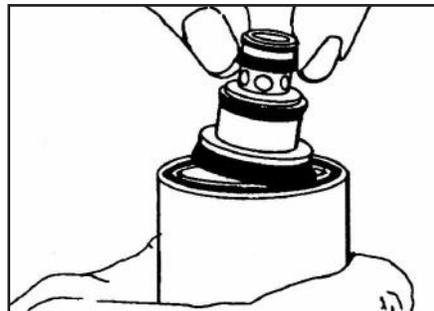


Figure 3

4. Lift out the spool spring. (Fig.4)

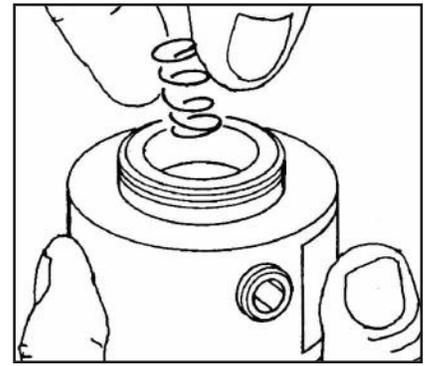


Figure 4

5. Use the correct blade screwdriver (1/8" for the MK-X) and unscrew the lower seat. (Fig. 5&6)

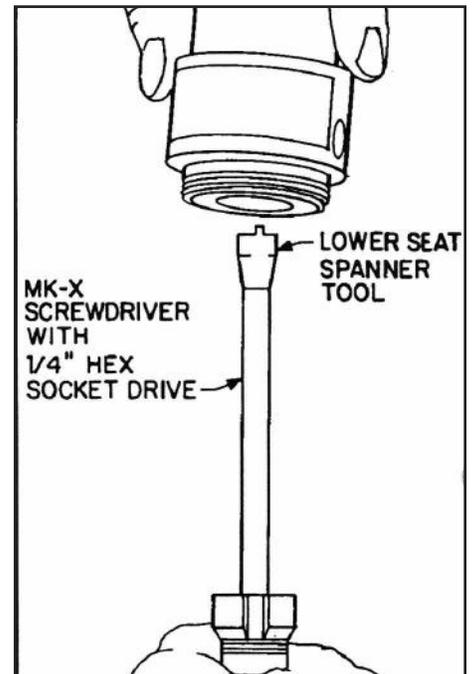


Figure 5

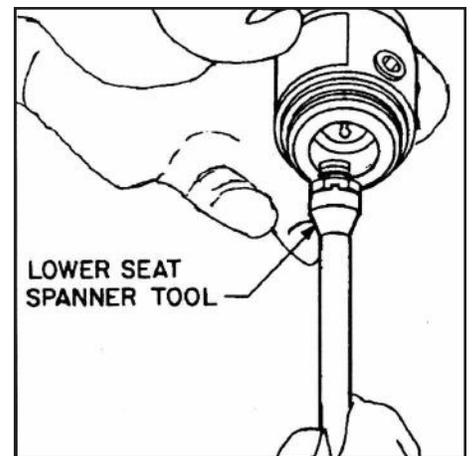


Figure 6

6. Lift out the pilot plug and exhaust spring. (Fig.7)

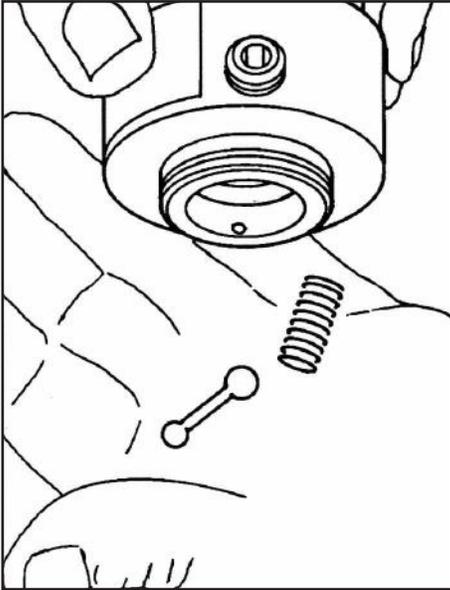


Figure 7

7. Remove the body O-ring that keeps the capillary tube separate. (Fig.8)

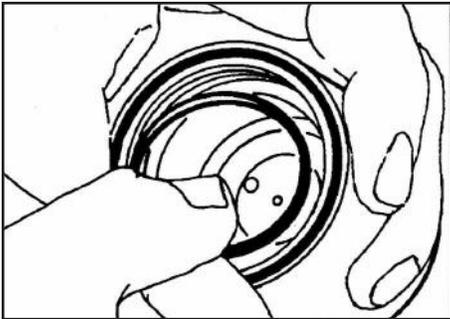


Figure 8

To reassemble the controller, reverse the above procedure. Be sure to replace all rubber components. Flare the U-cup out with your finger before installing the spool and apply a small amount of silicone grease (GS102149) to the U-cups and the upper/lower body inside diameter.

#### 4.2.3.2 MK-II & MK-VII Controllers

Refer to the MK-II and MK-VII Controller Parts List. Disassemble the controller as follows:

1. Clamp the lower end of controller body in a bench vise. Using a small standard screwdriver remove the set screw securing the rate adjustment knob. Remove knob and spring.
2. With your fingers unscrew the valve stem and remove.
3. With a 5/32" allen wrench remove the six (6) 10-32 allen head cap screws that secure the upper and lower valve body halves. Then remove the valve body, the top diaphragm and valve body O-ring (V-006). (Fig.9)

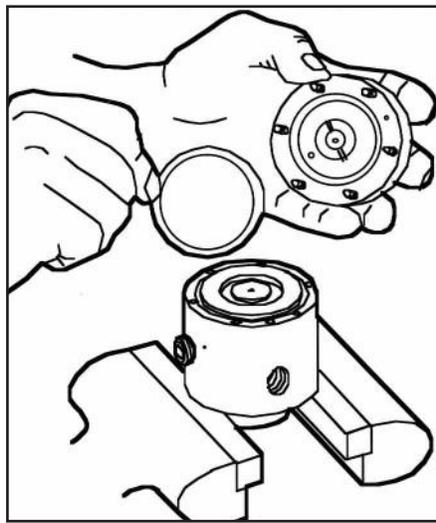


Figure 9

4. Now remove the upper spool and the lower spool assembly (3 pieces). (Fig.10 & 11)

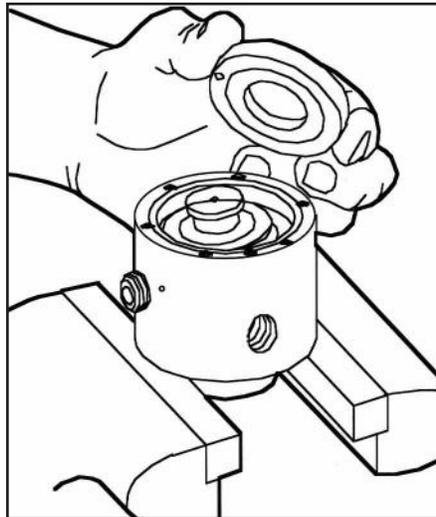


Figure 10

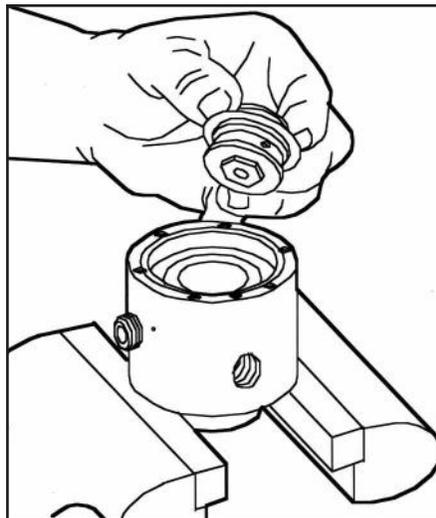


Figure 11

5. Then remove the middle spring. (Fig.12)

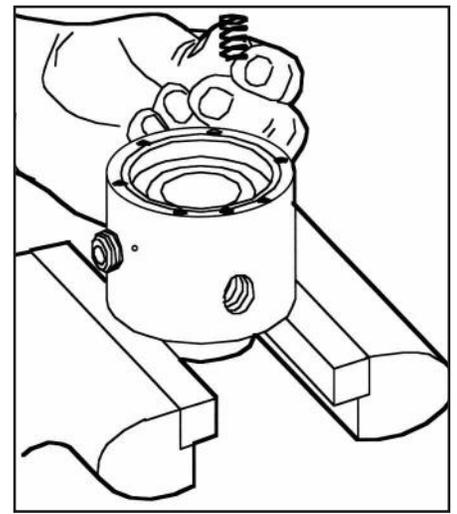


Figure 12

6. Now with a 9/16" socket wrench loosen the lower seat. Remove the lower seat, gasket, pilot plug and lower spring. (Fig. 13 & 14)

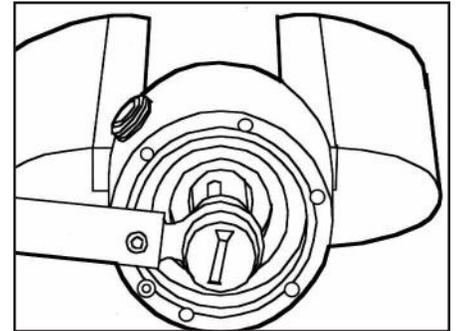


Figure 13

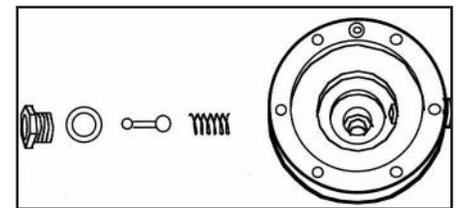


Figure 14

7. With a 9/16" wrench disassemble the lower spool assembly consisting of diaphragm plate, snapper diaphragm, lower spool, spacer, lower diaphragm and upper seat.

To reassemble the controller reverse the above procedure. Be sure to replace all rubber components.

#### 4.2.4 Relay: P03-6S, P04-6S, and P04-8S

Refer to the appropriate Parts List. Disassembly instructions 1-9 apply to all relays, instructions 10 & 11 apply only to the P03-6S and instructions 12-17 apply to the P04-6S and P04-8S.

1. Use a 9/64" Allen wrench to remove the top cap screws. (Fig.15)

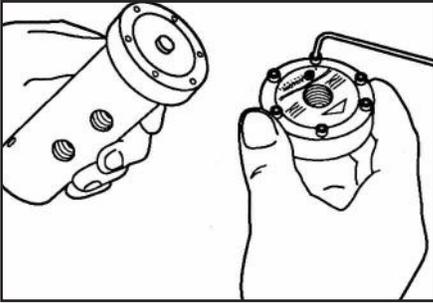


Figure 15

2. Separate the top cap and data plate from the upper body section. (Fig.15)

3. Put a 7/64" Allen wrench through the upper body exhaust port, into the hole in the upper poppet stem. (Fig.16)

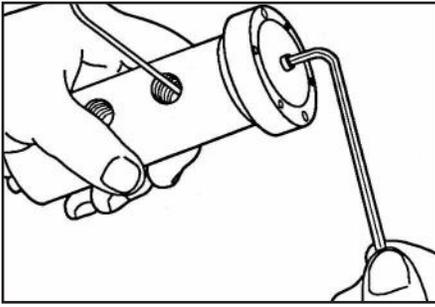


Figure 16

4. Use a 9/64" Allen wrench to remove the piston lock screw. (Fig.16)

5. Pull out the piston, O-ring, and spring. (Fig.17)

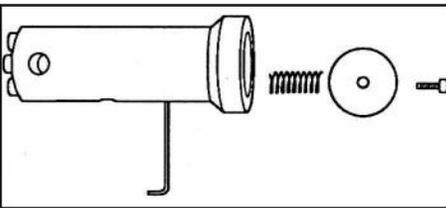


Figure 17

6. Use a 5/32" Allen wrench to remove the bottom cap screws. (Fig.18)

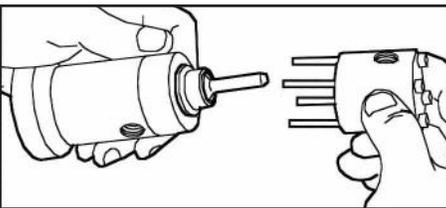


Figure 18

7. Separate the lower body section from the upper body section (Fig. 18)

8. Put 7/64" Allen wrench through the hole in the upper poppet stem. (Fig.19)

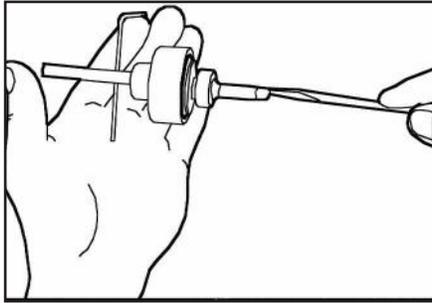


Figure 19

9. Use a flat blade screwdriver to unscrew the lower poppet stem. (Fig.19)

10. P03-6S: Pull out the upper and lower poppet stems, and poppet body; the poppet stem connector bolt will remain in one of the stems.

11. P03-6S: Put 7/64" Allen wrench in the holes of the poppet O-ring retainers and pry them off. (Fig.20)

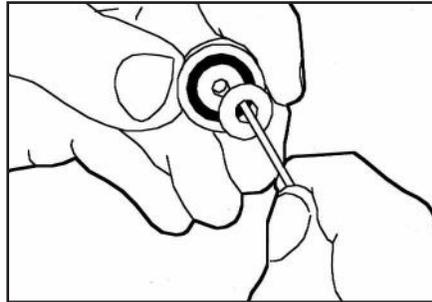


Figure 20

NOTE: Reassemble the P03-6S relay by coating the poppet stems, seals and mating surfaces with Williams GS102149 silicone grease, and then reversing the above process.

12. P04-6S/8S: At this point, usually the upper and middle poppet stems will separate. If the lower and middle poppet stems should separate, however, modify the rest of this procedure accordingly. (Fig.21)

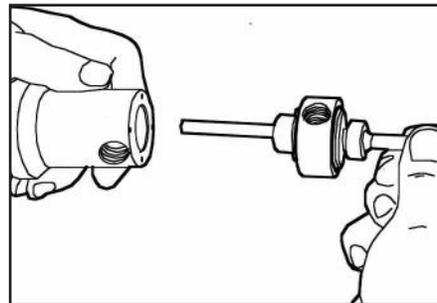


Figure 21

13. P04-6S/8S: Separate the upper poppet stem from the middle and lower poppet stems and the poppet body. The poppet stem connector bolt will remain in one of the stems.

14. P04-6S/8S: Put a 7/64" Allen wrench through the supply pressure port in the middle body section, into the hole in the middle poppet stem.

15. P04-6S/8S: Use a flat blade screwdriver to unscrew the lower poppet stem. (Fig.19)

16. P04-6S/8S: Pull out the middle and lower poppet stems, and poppet body. The poppet stem connector bolt will remain in one of the stems. (Fig.22)

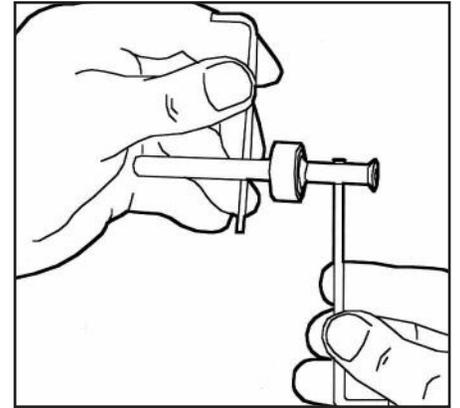


Figure 22

17. P04-6S/8S: Put a 7/64" Allen wrench in the holes of the poppet O-ring retainers and pry them off.(Fig.20)

NOTE

Reassemble the P04-6S/8S relay by coating the poppet stems, seals and mating surfaces with Williams GS102149 silicone grease, and then reversing the above procedure.

#### 4.2.5 Pumps: P125D and P125W

Refer to the appropriate parts list. The "D" series has a green anodized aluminum motor cylinder, where as the "W" series is all 316 SS. Disassemble the pumps as follows.

1. Use a 5/64" Allen wrench to remove the motor cylinder set screws that hold the motor cylinder to the oil chamber body. In the "D" series the screws are on the bottom of the motor cylinder and on the "W" series they are on the side. Hold the motor cylinder firmly to avoid losing the motor return spring, which is compressed beneath the motor cylinder. (Fig.24 & 25)

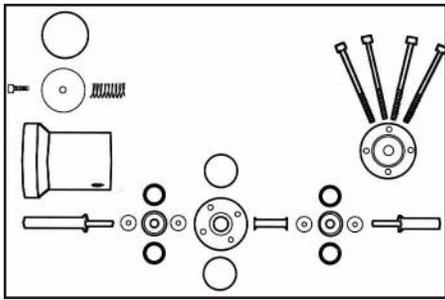


Figure 23

2. Remove the stroke adjuster. Unscrew it from the motor cylinder by loosening the knurled lock/set nut on top of the cylinder body. (Fig.26)

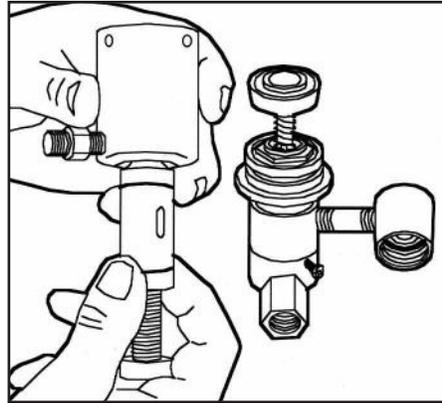


Figure 26

3. Remove the piston plunger assembly U-cup and motor return spring, plus the plunger seal retainer.(Fig.27)

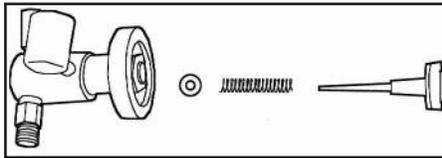


Figure 27

4. Unscrew the oil chamber from the fluid cylinder on the pump body assembly. (Fig.28)

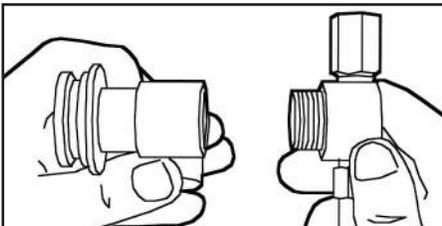


Figure 28

5. Remove the seals from the fluid cylinder and oil chamber. (Fig.29)

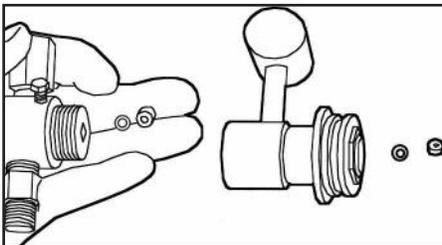


Figure 29

6. Clamp the fluid cylinder in a bench vise.

7. Use an adjustable wrench to remove the discharge check valve from the fluid cylinder and Teflon O-ring. (Fig.30 & 31)

8. Remove the suction check valve from the fluid cylinder and Teflon O-ring.(Fig. 30 & 31)

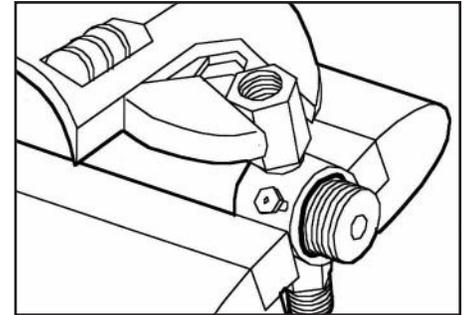


Figure 30

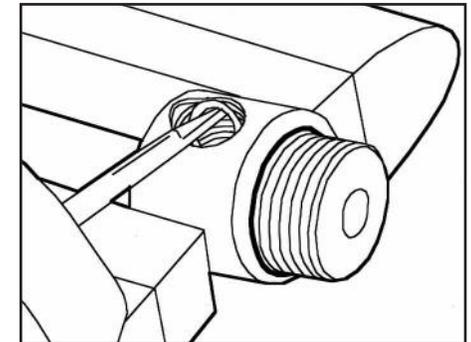


Figure 31

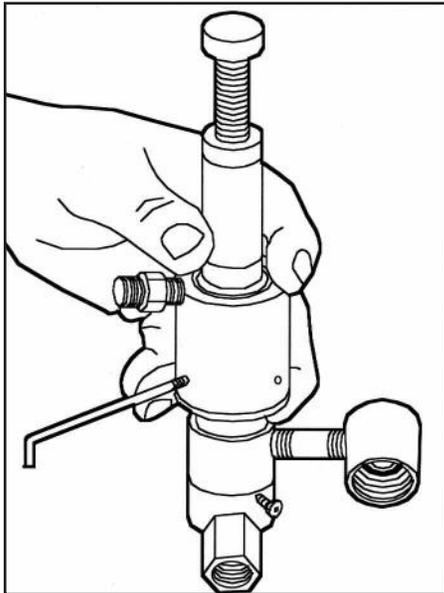


Figure 24

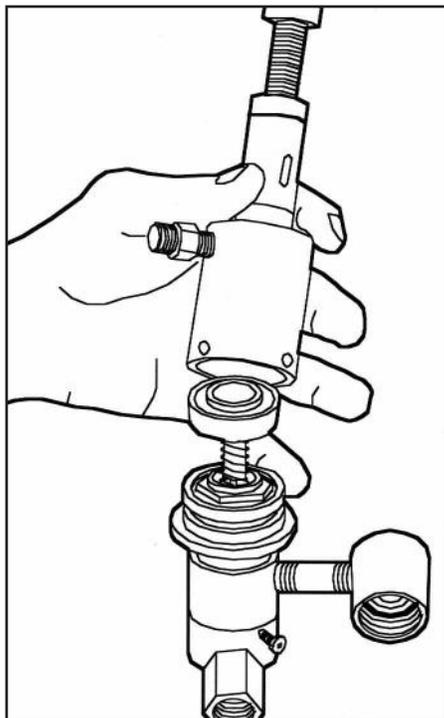


Figure 25

9. Remove the bleeder plug from the fluid cylinder. (Fig.32)

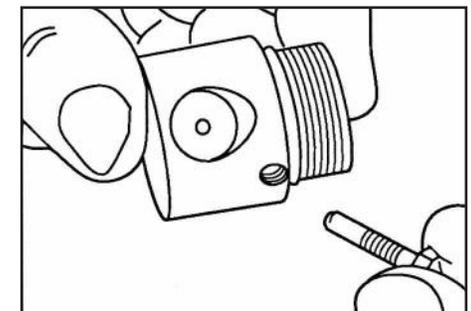


Figure 32

10. Remove the body seal O-rings. (Fig.33)

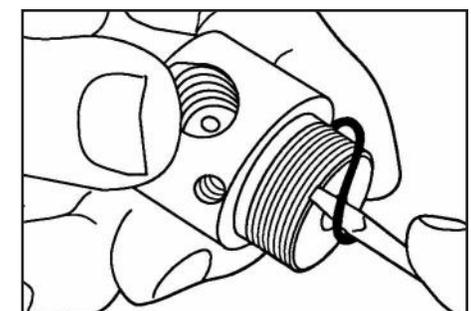


Figure 33

11. Clamp the oil chamber in the bench vise.

12. Remove the faceplate locknut and the faceplate from the oil chamber. (Fig.34 & 35)

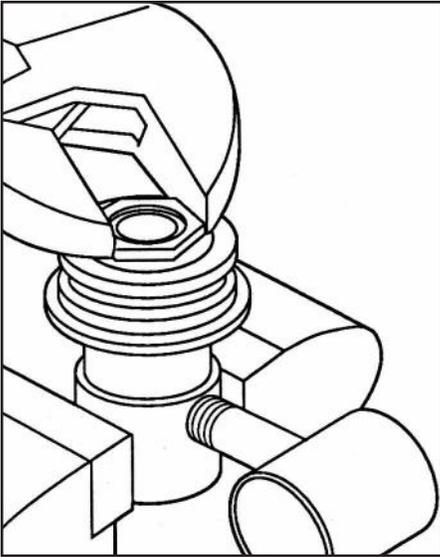


Figure 34

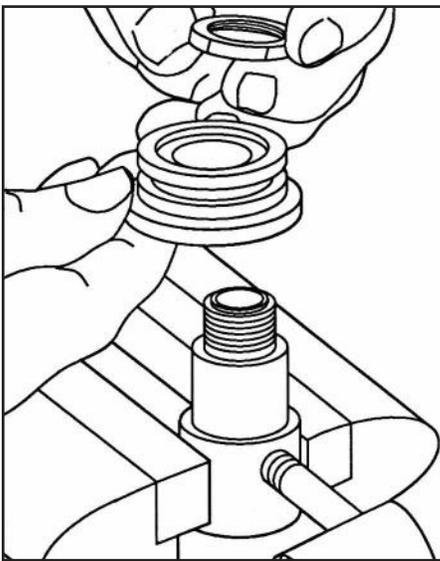


Figure 35

13. Remove the oiler body and pump/oiler connector from the oil chamber. (Fig. 36 & 37)

**NOTE**

Before reassembling the pump, clean both chambers, motor cylinder, and faceplate with an approved solvent. Contact your distributor or Williams Milton Roy for a recommended solvent.

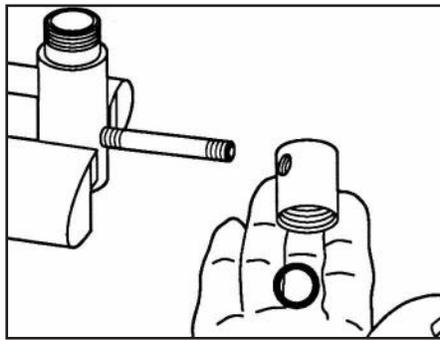


Figure 36

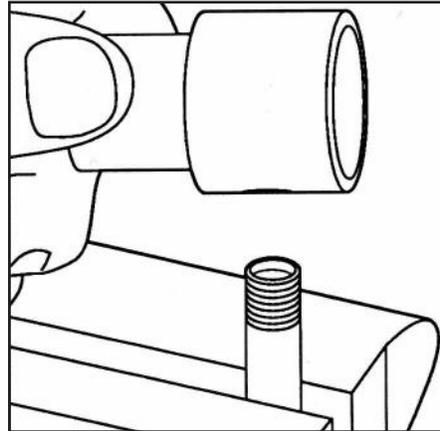


Figure 37

Reassemble the pump as follows:

1. Reinstall the stroke adjuster in the motor cylinder.
2. Install new seals in the fluid chamber and oil chamber.
3. Install new body seal O-rings.
4. Reconnect oil and fluid chambers.
5. Replace faceplate and faceplate nut.
6. Reinstall check valves with Teflon O-rings in the proper fluid cylinder ports.
7. Reinstall bleeder valve, oiler nipple, and then oiler body.
8. Clamp the fluid chamber in a bench vise and tighten both check valves.
9. Clamp oil chamber in the bench vise, and tighten faceplate, faceplate nut, and oiler nipple.
10. Reinstall piston plunger. (Replace it if necessary)
11. Install the U-cup on the piston, making sure it seats properly in the piston groove.
12. Apply a coat of silicone grease to the plunger shaft, the outside of the U-cup, and the inside of the motor cylinder.
13. Reinstall the piston plunger spring. (Replace if necessary.)
14. Reinstall the plunger seal retainer, and position the piston plunger in the spring retainer sleeve.

15. Reinstall the motor cylinder over the piston plunger U-cup; hold the motor cylinder, top up, at a 45° angle from vertical, and lower it into position, turning it into the vertical position as you lower it to ensure that the U-cup seats properly.

16. Hold the motor cylinder in the proper position, and hand tighten the 5/64" Allen set screws.

17. Position the motor cylinder so that the pump/controller connector nipple is approximately 180° from the oiler nipple.

18. Use the 5/64" Allen wrench to tighten the set screws.

19. Reinstall the O-ring in the oiler body.

**4.2.6 Pumps: P250D, P250K, P250W, P500D, P500W, P1000W400, and P1000W600**

Refer to the appropriate parts list. The "D" series has a green anodized aluminum motor cylinder, where as the motor cylinder the "W" is all 316 SS. Disassemble the pumps as follows:

1. For all pumps except the P250K, use a 1/8" Allen wrench to remove the motor cylinder set screws that hold the motor cylinder to the oil chamber body. In the "D" series the screws are on the bottom of the motor cylinder and on the "W" series they are on the side. For the P250K, unscrew the motor cylinder from the oil chamber body. For all pumps, hold the motor cylinder firmly to avoid losing the motor return spring. (Fig.38 & 39)

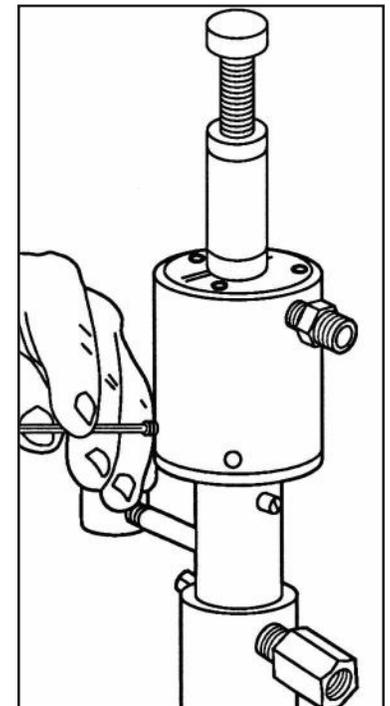


Figure 38

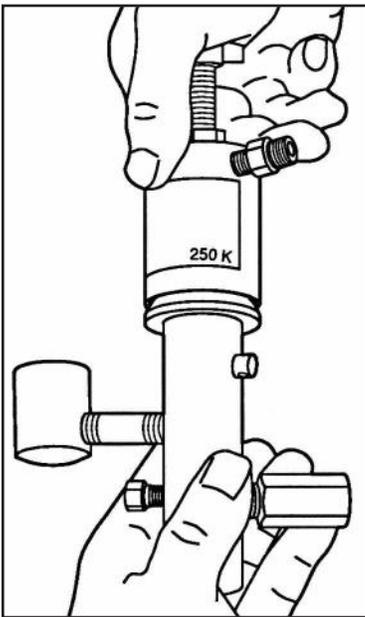


Figure 39

2. Loosen the knurled lock/setnut on top of the motor cylinder body to unscrew and remove the stroke adjuster from the motor cylinder. (Fig.40)

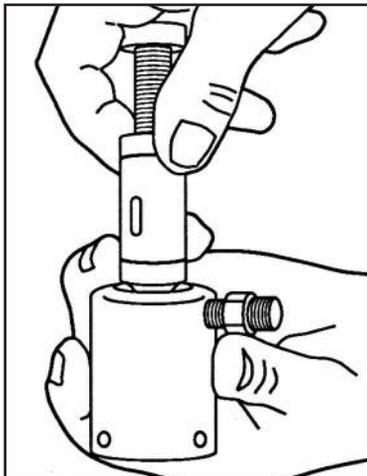


Figure 40

3. Remove the piston plunger assembly and motor return spring, and then remove the piston U-cup from the piston. (Fig.41 & 42)

4. Unscrew the oil chamber from the fluid cylinder on the pump body assembly. (Fig.43)

5. Use a 3/16" Allen wrench to remove the plunger seal set-Teflon graphite from the fluid cylinder. (Fig.44)

6. Clamp the fluid cylinder in a bench vise, and use the adjustable wrench to remove the discharge check valve from the cylinder. (Fig.45)

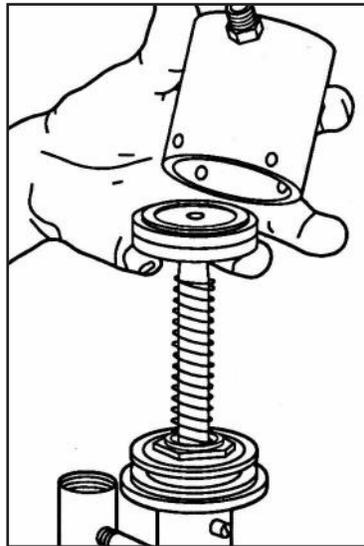


Figure 41

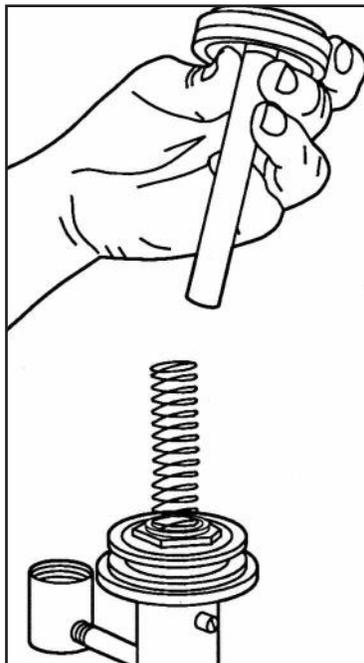


Figure 42

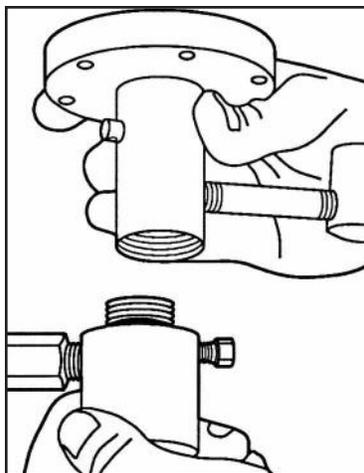


Figure 43

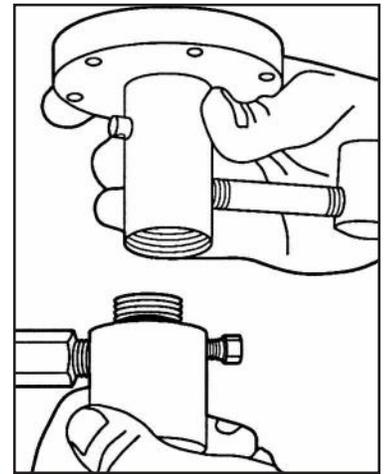


Figure 43

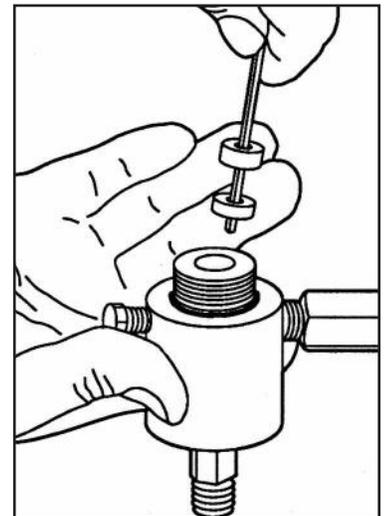


Figure 44

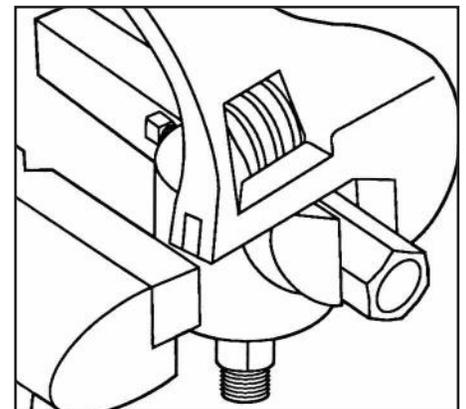


Figure 45

7. Use the same wrench to remove the suction check valve from the fluid cylinder. (Fig.46)

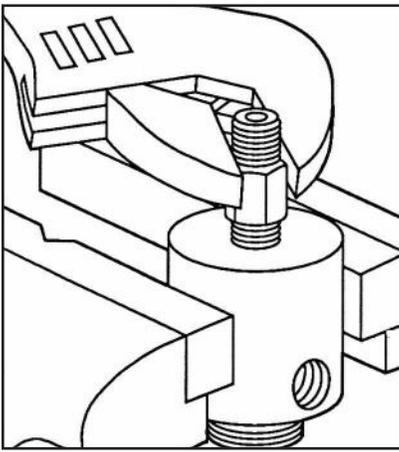


Figure 46

8. Use the same wrench to remove the bleeder plug from the fluid cylinder. (Fig.47)

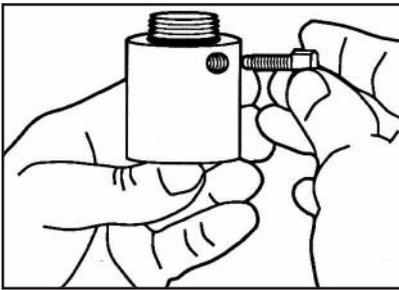


Figure 47

9. Remove the body seal O-ring. (Fig.48)

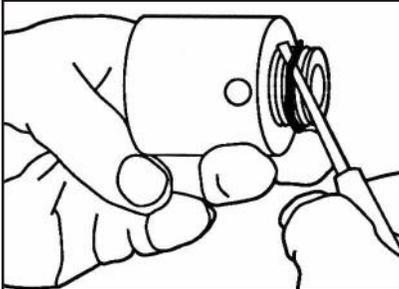


Figure 48

10. Clamp the oil chamber in the bench vise, and use the adjustable wrench to remove the faceplate locknut, spring retainer sleeve, and faceplate from the oil chamber. (Fig. 49 & 50)

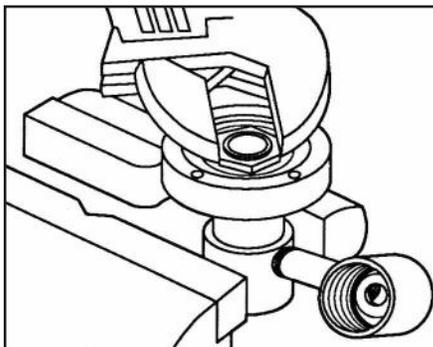


Figure 49

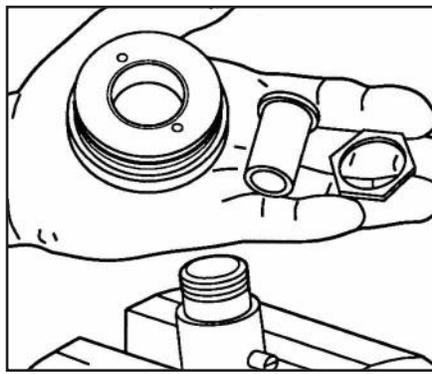


Figure 50

11. clamp the pump/oiler connector in the bench vise, and unscrew it from the oil chamber.(Fig.51)

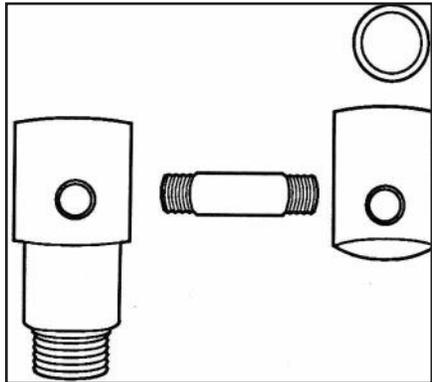


Figure 51

**NOTE**

Before reassembling the pump, clean both chambers, motor cylinder, and faceplate with an approved solvent. Contact your distributor or Williams Milton Roy for a recommended solvent.

Reassemble the pump as follows:

1. Install the stroke adjuster in the motor cylinder.
2. Install new seals in the fluid chamber.
3. Install a new body O-ring.
4. Connect oil and fluid chambers.
5. Replace faceplate, spring retainer, and faceplate nut.
6. Apply Teflon tape to the check valve threads.

**CAUTION**

To prevent loose ends from tearing off and jamming the pump, do not allow Teflon tape to extend past the ends of the threads.

7. Install check valves in proper ports of fluid chamber.
8. Install the bleeder valve.
9. Install the oiler nipple.
10. Install the oiler body.
11. Clamp the fluid chamber in the bench vise and tighten both check valves.
12. Clamp the oil chamber in the bench vise, and tighten faceplate, faceplate nut, and oiler nipple.
13. Inspect the piston plunger; replace it if necessary.
14. Install the U-cup on the piston, and make sure it seats properly in the piston groove. (Fig.52)

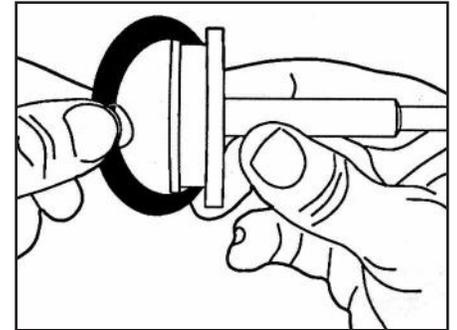


Figure 52

15. Apply a coat of GS102149 silicone grease to the plunger shaft, outside of the U-cup, and inside of the motor cylinder.
16. Install the spring retainer sleeve.
17. Install the piston plunger in the spring, and install the spring in the spring retainer sleeve; replace spring if necessary.
18. Install the motor cylinder over the plunger U-cup; hold the motor cylinder, top up, at a 45° angle from vertical and lower it into position, turning it into the vertical position as you lower it to make sure the U-cup seats properly.
19. For all pumps except the P250K, hold the motor cylinder so that the pump/controller connector is directly above the discharge check valve, and hand tighten the motor cylinder set screws. For the P250K pump, screw in the motor cylinder so that the pump/controller connector nipple is in line over the discharge check valve.
20. Use the 1/8" Allen wrench to tighten the motor cylinder set screws.
21. Install the O-ring in the oiler body.

**4.2.7 Pumps: P1000W800, P1500W400, P1500W600, P1500W800, P2250W600, and P2250W800**

Refer to the appropriate parts list. Disassemble the pump as follows:

1. For all pumps except the P1500W400, use a 1/4" Allen wrench to remove the motor cylinder set screws that hold the motor cylinder to the oil chamber body and remove the motor cylinder. For the P1500W400 pump, use a 1/8" Allen wrench for this step. (Fig.53)

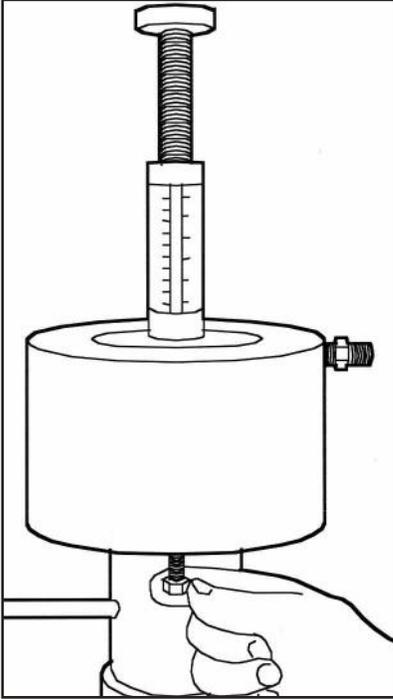


Figure 53

2. Remove the stroke adjuster. Loosen the knurled lock/set nut on top of the motor cylinder body to unscrew the adjuster from the motor cylinder. (Fig.54)

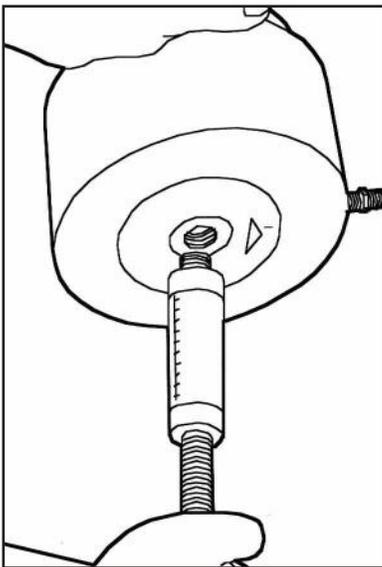


Figure 54

3. For all pumps except the P1500W400, remove the piston plunger assembly and the two O-rings. For the 1500W400 pump, remove two U-cups instead of the O-rings in this step. (Fig.55)

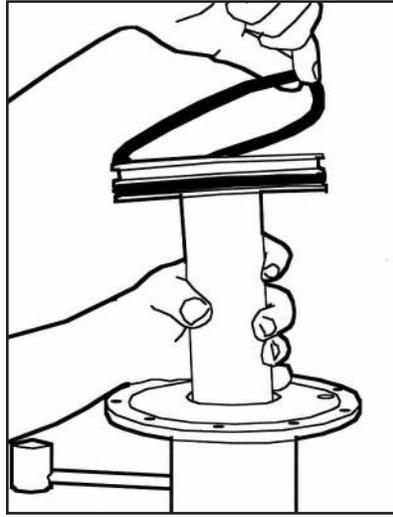


Figure 55

4. Unscrew the connector section for the oil chamber and fluid cylinder on the pump body assembly. (Fig.56)

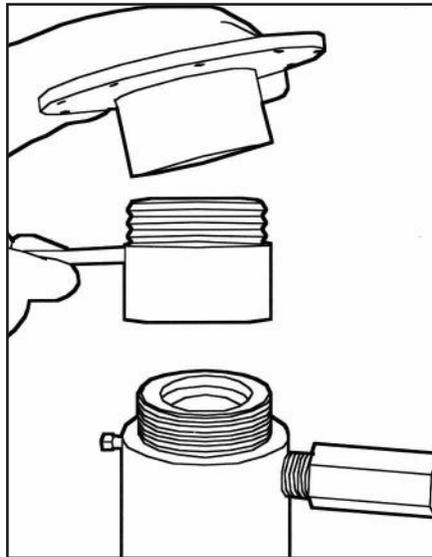


Figure 56

5. Remove the seals from the fluid cylinder and oil chamber. (fig.57)

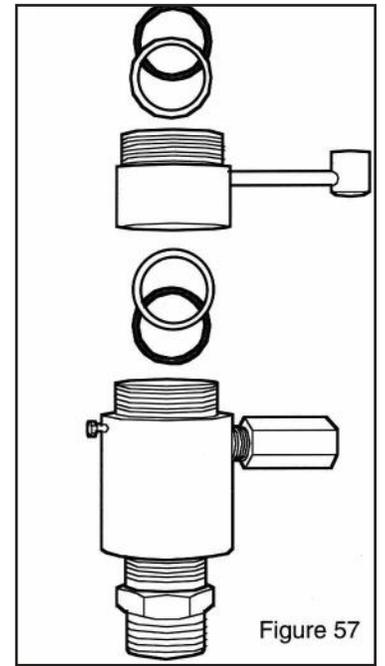


Figure 57

Figure 57

6. Clamp the fluid cylinder in a bench vise, and use an adjustable wrench to remove the discharge check valve from the cylinder. (Fig.58)

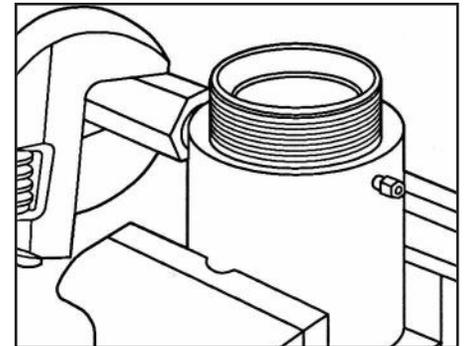


Figure 58

7. Remove the suction check valve and the bleeder plug from the fluid cylinder. (Fig. 59 & 60)

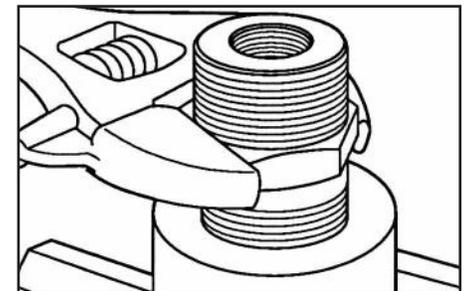


Figure 59

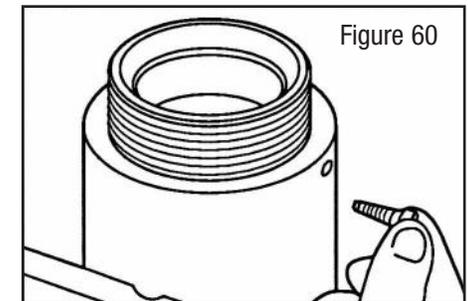
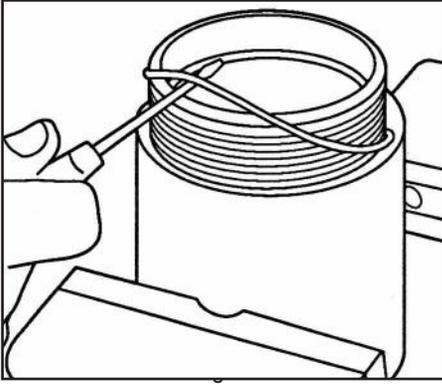
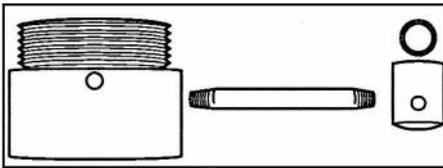
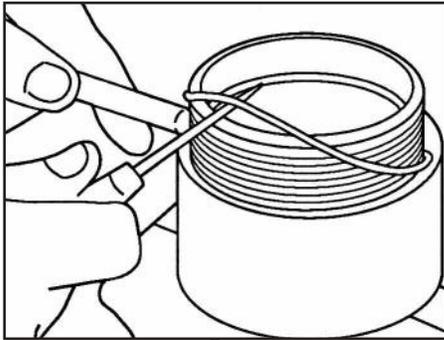


Figure 60

8. Clamp the oil chamber in a bench vise, and remove the body seal O-ring. (Fig.61)



9. Remove the oiler body O-ring and pump/oiler connector nipple from the oil chamber. (Fig.62 & 63)



**NOTE**  
Before reassembling the pump, clean the three chambers and the motor cylinder with an approved solvent. Contact your distributor or Williams Milton Roy for a recommended solvent.

Reassemble the pump as follows:

1. Reinstall the stroke adjuster in the motor cylinder.
2. Install new seals in the fluid chamber and oil chamber.
3. Install new body seal O-rings.
4. Reconnect the connector section to the oil chamber and the fluid chambers.
5. Apply Teflon tape to the check valve threads.

## CAUTION

**To prevent loose ends from tearing off and jamming the pump, do not allow Teflon tape to extend past the ends of the threads.**

6. Reinstall check valves in the proper fluid cylinder ports.
7. Reinstall the bleeder valve, oiler nipple, and oiler body.
8. Clamp the fluid chamber in the bench vise, and tighten both check valves.
9. Clamp the oil chamber in a bench vise, and tighten the oiler nipple.
10. Reinstall the piston plunger; replace it if scratched or scored.
11. For all pumps except the P1500W400, install the two O-rings on the piston, and make sure they seat properly in the piston groove. For the P1500W400 pump, install the two U-cups on the piston, and make sure they seat properly in the piston groove, one up and one down.
12. For all pumps except the P1500W400, apply a coat of silicone grease to the plunger shaft, the outside of the O-rings, and the inside of the motor cylinder. For the P1500W400 pump, apply the grease to the outside of the U-cups instead of the O-rings in this step.
13. Reinstall the piston plunger in the connector section.
14. For all pumps except the P1500W400, install the motor cylinder over the piston plunger O-rings; hold the motor cylinder, top up, at a 45° angle from vertical and lower it into position, turning it into the vertical position as you lower it to make sure the O-rings seat properly. For the P1500W400 pump, install the motor cylinder over the piston plunger U-cups and as you lower it make sure the U-cup seats properly.
15. Hold the motor cylinder in the proper position, and hand tighten the 1/8" Allen set screws.
16. Position the motor cylinder so that the pump/controller connector nipple is approximately in line over the discharge check valve.
17. For all pumps except the P1500W400, use a 1/4" Allen wrench to tighten the set screws. For the P1500W400 pump, use a 1/8" Allen wrench for this step.
18. Reinstall the O-ring in the oiler body.

## 4.2.8 Discharge Check Valve

### 4.2.8.1 P125D and P125W Pumps

Refer to the appropriate parts list. Disassemble the check valve as follows:

1. Use the flat blade screwdriver to unscrew and carefully lift the retainer from the check valve body.
2. Use the snap ring removal tool to compress and lift the second retainer from the check valve body.
3. Carefully tip the valve body and dump out the spring, sleeve, ball, and Teflon O-ring.

Reassemble the valve as follows:

1. Insert the Teflon O-ring and make sure it seats properly in the sleeve.
2. Insert the sleeve.
3. Drop in the ball.
4. Install the spring with the tapered end towards the ball.
5. Use the snap ring removal tool to compress and install the second retainer.
6. Install the retainer and tighten with a flat blade screwdriver.

### 4.2.8.2 P250, P500, P1000W, P1500W, P2250 Pumps

Disassemble the check valve as follows:

1. Use the flat blade screwdriver to unscrew and carefully lift the retainer from the check valve body.
2. Carefully tip the valve body and dump out the spring, sleeve, ball, and Teflon O-ring.

Reassemble the valve as follows:

1. Insert the Teflon O-ring and make sure it seats properly in the sleeve.
2. Insert the sleeve.
3. Drop in the ball.
4. Install the spring with the tapered end towards the ball.
5. Install the retainer, and hand tighten with the flat blade screwdriver.

## 4.2.9 Suction Check Valve

### 4.2.9.1 P125 Pumps

Refer to the appropriate parts list. Disassemble the check valve as follows:

1. Use the snap ring tool to compress and remove the retainer.
2. Carefully tip the valve body and dump out the ball and the spring.

Reassemble the valve as follows:

1. Insert the spring, and the ball.
2. Use the snap ring tool to compress and insert the retainer.

**4.2.9.2 P250 Pumps:** Disassemble the check valve as follows: Use the 3/16" allen wrench to carefully remove the retainer and ball from the valve body,

Reassemble the valve as follows: Insert the ball and then the retainer.

#### **4.2.9.3 P500, P1500, and P2250 Pumps**

Disassemble the check valve as follows: Clamp the valve in a bench vise; use the 1/8" brass drift and a hammer to remove the retainer and then the ball.

Reassemble the valve as follows: Insert the ball and then the retainer.

#### **4.2.9.4 P1000 Pumps**

Disassemble the check valve as follows:

1. Clamp the valve in a bench vise; use the 1/8" brass drift and a hammer to remove the retainer pin.
2. remove the retainer and then the ball from the valve body.

Reassemble the valve as follows:

1. Insert the ball and then the retainer in the valve body.
2. Install the retainer pin.

### **4.3 PREVENTIVE MAINTENANCE**

#### **4.3.1 Periodic Maintenance**

##### **4.3.1.1 Once a Week**

Perform these procedures each week.

1. Check the oil level in the lubricator bottle to make sure the seals never run dry.
2. When you check the oil level, also check for signs of a chemical in the oiler bottle or at the weep hole above the seal. If any chemical is present, replace the pump seals; use SF96-100 William's silicone oil to lubricate the new seals.

##### **4.3.1.2 Once a Month**

Perform this procedure at least once each month.

Unscrew the plug from the top of the fitting tee between the relay and the controller; put a few drops of William's SF 96-100 silicone oil in the hole.

#### **NOTE**

Sometimes, the oil in the lubricator turns dark as the seals wear. While this darkening is not a sign of seal failure, we do recommend changing the oil when it happens.

##### **4.3.1.3 Every Six Months**

Perform this procedure at least every six months. Inspect the piston-plunger assembly and seals. Replace the seals and check for wear; if the assembly is cracked, rough, or discolored, replace it.

##### **4.3.1.4 Every Twelve Months**

Perform these procedures at least every twelve months.

1. Disassemble and inspect the pump inlet and outlet check valves.
2. Inspect the piston plunger, return spring, and seals. If the piston plunger is scratched or if the seals are nicked, replace them.

#### **4.3.2 Cleaning and Lubrication**

Perform this procedure whenever the pump assembly is disassembled. Clean all inside and outside surfaces with an approved solvent, and blow them dry with compressed air.

#### **CAUTION**

**To prevent damage to the pump when you clean it, use a solvent that is compatible with the metered fluid but will not damage pump seals. Contact your distributor or Williams Milton Roy for a recommended solvent.**

### **4.4 TROUBLESHOOTING**

#### **4.4.1 Proper Pump Use**

When a pump is either not working or is working incorrectly, there are two basic areas where trouble develops: the pneumatic or the fluid ends of the pump. However, since factors other than the pump are involved, the first step in troubleshooting is to see if the pump is being used properly. The checklist below will help you determine this:

1. Is the air/gas supply available in sufficient volume and at the proper pressure?
2. Is the air/gas supply of clean instrument quality, or is it dirt or wet?
3. Is a pressure regulator in use to maintain a constant air supply?

4. Is the I.D. (inner diameter) of the air/gas supply line correct for the pump model currently in use?

5. Is the pump correct for the nature and characteristics of the material(s) it handles: composition, viscosity, necessary line pressure, etc.?

6. Is the source of the process fluid-- drum, day tank, or large storage tank-- clean and free of contaminants?

7. Is the filtration adequate?

8. Is the size of the process fluid line correct for the pump?

9. Is the pump located at the correct distance from the supply?

10. Is the pump working in the proper enclosed, protected area or in an open, exposed location?

11. Have the minimum and maximum temperatures the pump will be exposed to been considered for its current use(s)?

12. Is the pump being used for more than one purpose?

13. Is the proper cleaning fluid used to flush out the pump when it is not in service or when it is pumping more than one chemical?

14. Is there a current and accurate service/maintenance breakdown record for the pump?

15. Is the pump operated by trained, skilled, reliable, and responsible employees? (This is an important factor in proper pump use, not to be underestimated!)

#### **4.4.2 Proper Amount of Use**

While answers to the questions on the above checklist will provide considerable information about how the pump is being used, it is equally important to determine whether or not it is overworked.

Fortunately, you can use the amplification ratio of the pump (listed as a number on the specification sheet for your pump) and the process pressure (the pressure the pump plunger is working against) to check this, as follows:

- Process pressure is 2800 psi.
- Add 200 psi to the process pressure so that the chemical is positively injected: 2800 psi + 200 psi = 3000 psi.
- Assume an amplification ratio of 75:1.
- Divide the total psi (3000) by the amplification ratio of 75; the resulting figure, 40 psi, is the supply of air/gas pressure to the controller.

From this information you can determine if the pump is overworked because of excessive air/gas supply. In the above example, if the supply had been 100 psi instead of 40, it would be excessive, resulting in premature failure of the pump's moving parts and sealing capabilities.

**4.4.3 Troubleshooting Guide**

The Troubleshooting Guide on the following pages identifies the most common problems, their possible causes, and corrective action for each situation.

TROUBLESHOOTING GUIDE		
PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
CONTROLLER NOT OSCILLATING	Foreign material in controller	Put finger over exhaust port; alternately seal & vent port to clear exhaust valve.
	No air/gas supply	Connect gauge to port opposite supply line: verify required supply pressure.
	Supply pressure too high or too low	Reset regulator to proper pressure.
	Too much pressure drop in air/gas	Increase connecting tube size or clean air lines.
	Stroke rate valve open too much	Disconnect air/gas supply. Rotate stroke rate knob CCW to peg, wait 5 seconds, & rotate knob CW until it stops. DO NOT FORCE KNOB.  Reconnect supply & rotate knob CCW until oscillations start.
	Leak between valve body & controller body	Adjust stroke rate to proper strokes per min. according to Specification Sheet; loosen knob set screw, slip knob CCW to peg, & tighten screw.  Loosen; then retighten the connection between valve & controller.
	Continuous air flow from controller exhaust port (Pilot plug not seating properly)	Inspect & replace damaged O-ring seal.
	Air flowing from equalizer hole on side of lower controller body	Inspect & replace ruptured or improperly seated u-cups.  Put finger over exhaust port; alternately seal & vent port to clear exhaust valve.
	Broken pilot plug, exhaust spring, or spool return spring	Replace pilot plug, exhaust spring, or spool return spring.
	Excessive water in controller	Install an air/gas dryer in air supply line.
RELAY NOT OPERATING	Broken piston return spring	Replace return spring.

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
RELAY NOT OPERATING	<p>Poppet stem loosened from connector bolt</p> <p>Air blow-by caused by O-rings poorly seated due to excessive dirt in air supply</p> <p>Inadequate air supply</p>	<p>Tighten poppet stem to connector bolt.</p> <p>Improve quality of air supply &amp; clean dirt from unit.</p> <p>Check air regulator for proper pressure.</p>
PLUNGER NOT STROKING	<p>Controller control knob set at ZERO</p> <p>Air/gas supply turned OFF</p> <p>Broken motor return spring</p> <p>Plunger stuck due to tight or dry seal</p> <p>Plunger bottomed</p> <p>Excessive grease between piston &amp; face-plate</p> <p>Air/gas supply pressure too low to overcome process line pressure</p> <p>Discharge or suction line plugged</p> <p>Air/gas flow to controller too low (controller locked up &amp; won't cycle)</p> <p>Motor cylinder-air piston blow-by</p>	<p>Turn knob to proper setting on dial.</p> <p>Open valve to allow air supply to flow to controller.</p> <p>Replace return spring.</p> <p>If seal is swollen, check its chemical compatibility with process fluid, replace with compatible seal material</p> <p>If seal is dry, lubricate &amp; fill reservoir.</p> <p>Readjust plunger stroke length.</p> <p>Remove excess grease.</p> <p>Increase supply pressure.</p> <p>Clear the line.</p> <p>Install a larger capacity regulator or supply line. Vent supply side of controller &amp; try to start pump at slowest speed: increase speed slowly if controller starts to cycle.</p> <p>Check piston seal: replace as needed.</p> <p>Check motor cylinder surface for damage from dirt or sand; install a filter on bottom of faceplate.</p>
LOW PUMP OUTPUT	<p>Viscosity of the chemical being pumped too high</p> <p>Pump mounted too high to pump adequate supply of chemical to fluid cylinder</p> <p>Pump not mounted close enough to controller &amp; relay</p> <p>Suction lift condition</p> <p>Blocked suction filter</p> <p>Supply &amp; discharge lines too small</p> <p>Erratic controller operation</p>	<p>Review and correct size of supply &amp; discharge lines to improve flow of chemical.</p> <p>Remount pump to create a flooded suction condition.</p> <p>Remount pump as close to controller &amp; relay as possible to allow the air to exhaust quickly.</p> <p>Change tank elevation to get flooded suction, if change not possible, add foot valve at end of suction line, &amp; reduce suction line diameter.</p> <p>Clean or replace filter element.</p> <p>Install correct tubing size.</p> <p>Rebuild &amp; clean controller; add air inlet filter or air/gas dryer.</p>

TROUBLESHOOTING GUIDE

PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
LOW PUMP OUTPUT	<p>Check valves leaky or contaminated</p> <p>Improper chemical supply</p>	<p>Rebuild or replace damaged parts.</p> <p>Make sure top of chemical supply tank is vented to atmosphere or pressured.</p>
SHORT SEAL LIFE	<p>Excessive wear on plunger seals from lack of lubrication</p> <p>Excessive wear on plunger seals from excessive pump speed</p> <p>Foreign material in process fluid</p> <p>Seals incorrectly assembled, or damaged during installation</p> <p>Plunger nicked, burred or scratched</p> <p>Seal or plunger materials not compatible with process fluid</p> <p>Crystallized chemical on plunger scoring seal</p> <p>Lubricant incompatible with process fluid</p>	<p>Maintain proper lubrication in oil bottle.</p> <p>Calculate proper air supply pressure. (Refer to amplification ratio principle.)</p> <p>Check to see if chemical supply is clean; if not, install chemical filter in supply line.</p> <p>Refer to instructions for installing seals.</p> <p>Replace plunger.</p> <p>Refer to compatibility charts; contact distributor or Williams Instrument Co.</p> <p>Maintain visible lubricant level.</p> <p>Change lubricant; contact distributor or Williams Milton Roy</p>
NO PUMP DISCHARGE	<p>Suction valve or discharge valve not seating</p> <p>Suction line or discharge line clogged</p> <p>Air entering suction line</p> <p>Pump vapor locked</p>	<p>Clean or replace valves.</p> <p>Add filter on suction line to prevent recurrence.</p> <p>Inspect line for closed valve.</p> <p>Tighten fittings; inspect &amp; replace damaged seals.</p> <p>Open bleeder plug, &amp; prime pump.</p>

## Section 5.0

The parts list and cross section drawing(s) for the Williams Metering Pump and Accessories you purchased were inserted in this section. If they are missing, please contact your distributor or Williams Milton Roy for additional copies. Select from the appropriate parts lists shown below.

"D" SERIES	
Pump	Parts List
P125D	PL-P125D
P250D	PL-P250D
P500D	PL-P500D

CONTROLLERS	
Controller	Parts List
MK-X	PL-MK-X
MK-II	PL-MK-II
MK-VII	PL-MK-VII

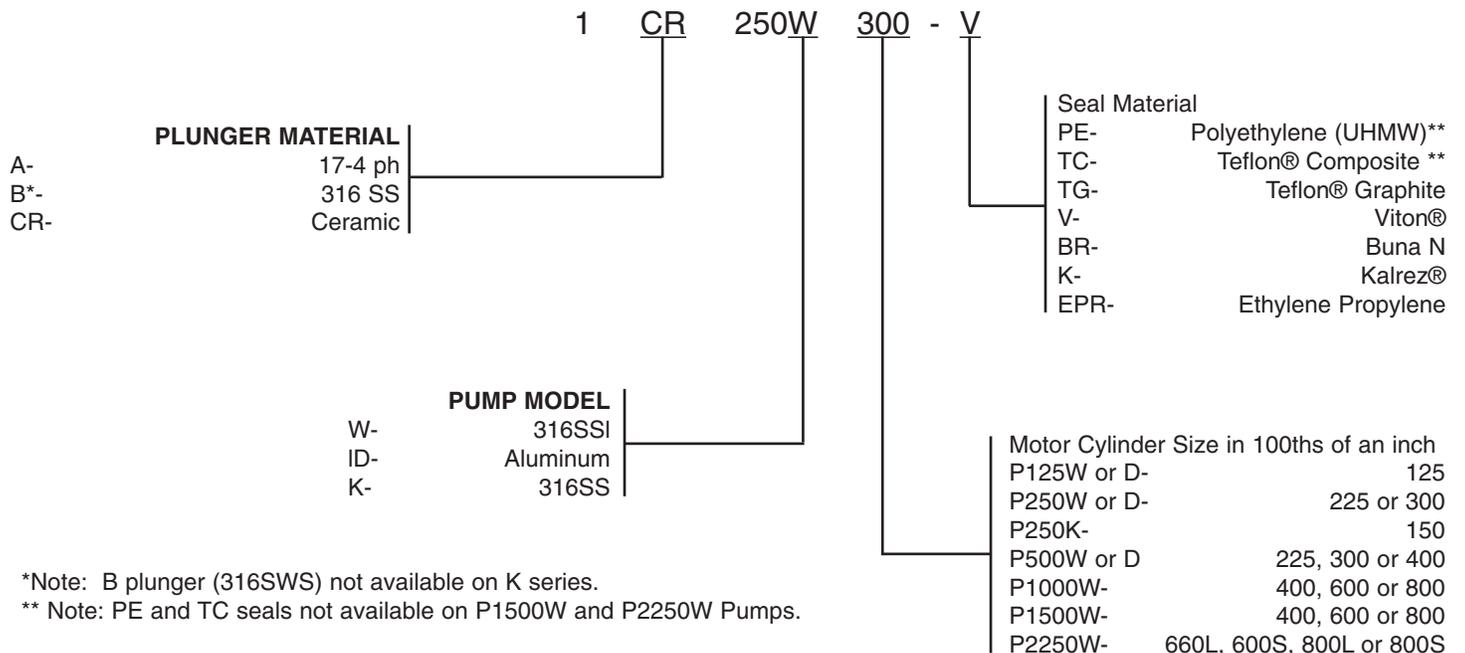
"W" SERIES	
Pump	Parts List
P125W	PL-P125W
P250W	PL-P250W
P500W	PL-P500W
P1000W	PL-P1000W
P1500W	PL-P1500W
P2250W	PL-P2250W

RELAY	
Relay	Parts List
PO3-4S	PL-PO3-4S
PO4-4S	PL-PO4-4S
PO4-8S	PL-PO4-8S

"K" SERIES	
Pump	Parts List
P250K	PL-P250K

\*Note: These repair kits are direct replacements for PO3-6K and PO4-6K

### EXAMPLE



## SEAL MATERIAL SELECTION

The seal material must be chosen to satisfy both the chemical compatibility and the pressures/temperatures at which you are operating. Below is a general guideline for seal material selection.

Material	Seal Type	Temp Range	Suggested Pressure Range	Comments
PE UHMW Polyethylene	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	100 to 3000 psi 6.9 to 207 bar	Tough material with excellent wear resistance. Good for water and alcohol based chemicals. Not recommended for solvents.
TC Teflon® Composite	Mechanical (spring Loaded)	-30 to 180°F -34 to 82°C	100 to 3000 psi 6.9 to 70 bar	Tough material with excellent wear resistance. Excellent chemical inertness. Good for all types of chemicals, acids, bases of solvents
TG Teflon® Graphite	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	1000 to 10,000 psi 70 to 690 bar	Tough material with excellent wear resistance. Excellent chemical inertness. Good for all types of chemicals, acids, bases or solvents. Recommended for use with the harder ceramic plunger and higher pressures.
V Viton®	O-ring	-10 to 200°F -23 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Broad chemical compatibility but its not to be used with ethyl or methyl alcohols. Suggested only for hard to seal fluids in low pressure applications when PE or TC will not seal.
BR Buna N	O-ring	-40 to 200°F -40 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Limited chemical compatibility. Used mainly in Methanol pumping at low pressure.
K Kalrez®	O-ring	32 to 200°F 0 to 93°C	100 to 750 psi 6.9 to 52 bar	Soft material with fair wear resistance. Excellent chemical compatibility. Used when Viton is not compatible and PE or TC will not seal.
EPR Ethylene Propylene	O-ring	-40 to 200°F -40 to 93°C	100 to 750 psi 6.9 to 52 bar	Material has very good abrasion resistance. Excellent chemical resistance to phosphate ester, good to excellent to mild acids, alkalis, silicone oils and greases, ketones and alcohols. Not recommended for petroleum oils or di-esters.

Selecting the proper seal material for your application is important. We suggest using the harder plastic seals (PE, TC, or TG) whenever possible because they provide excellent wear life. The elastomers (V, BR, K, or EPR) offer enhanced sealing at low pressure because they are soft and more compliant than the plastics. However, the elastomers do not provide the same toughness or wear resistance.

## PLUNGER MATERIAL SELECTION

The materials available vary in hardness and chemical compatibility. We offer three materials based on our many years of industry experience with various chemicals. Hardness is a key property when selecting the proper plunger material. Our experience has shown that the harder plunger materials not only provide longer plunger life, they also provide greater seal life. A hard plunger is a must when pumping a chemical that is prone to crystallization or if the chemical is contaminated. Of course both of the preceding conditions will affect seal life. Below ia a table that compares the chemical compatibility and hardness properties of each material.

DESIGNATION	MATERIAL	HARDNESS	CHEMICAL COMPATIBILITY
CR	Ceramic	Between Sapphire and Diamond on the Mohs' Scale	Excellent Chemical Inertness in all Acids, Bases, Solvents
A	17-4 ph	40 Rc	General Corrosion-Resistant Stainless Steel Limited Acid-Resistance
B8	316 SS	28 Rc	Excellent Corrosion-Resistant Stainless Steel Limited Acid-Resistance

We recommend the use of ceramic because of its extreme hardness and excellent chemical inertness.

\*Note: B plunger (316 SS) not available on K series.



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