X DUAL SEAL PLUNGER

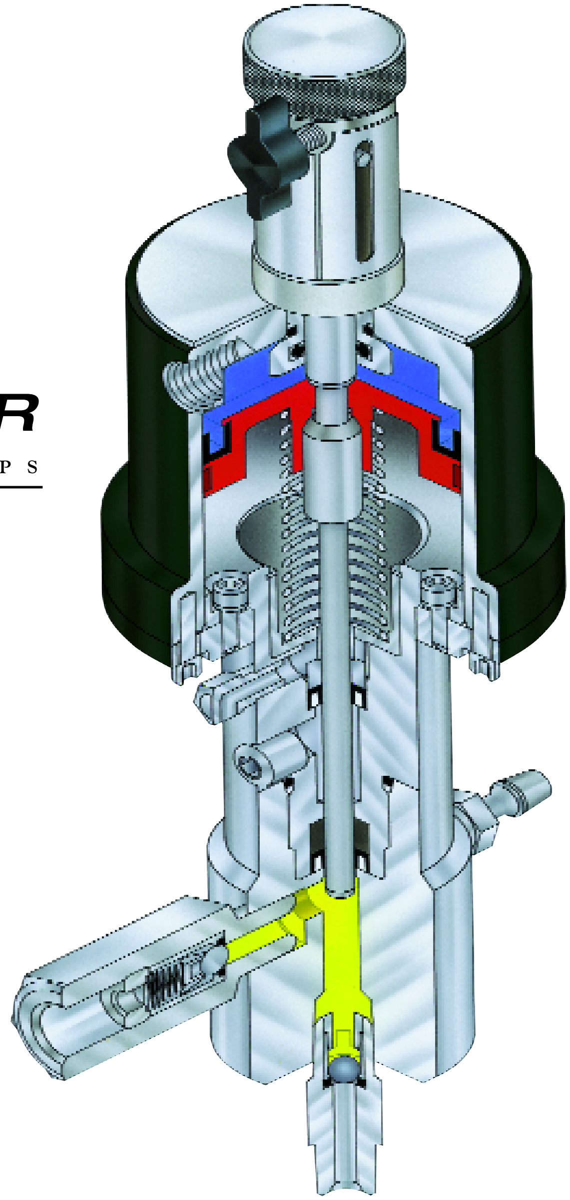
SERIES OF METERING PUMPS

INSTALLATION, OPERATION, AND MAINTENANCE MANUAL

WILLIAMS
MILTON ROY

X DUAL SEAL PLUNGER

SERIES OF METERING PUMPS



PART NUMBER DESIGNATION

CR P750X400 A TC

Control Method
- **C**: Controller
- **CR**: Controller - Relay
- **S**: Solenoid Valve
- **SR**: Solenoid Valve - Relay

Basic Model(2)
- P125V125
- P250V225
- P250V300
- P500V225
- P500V300
- P500V400(1)
- P750V400(1)

Plunger Material
- **A**: 17-4 ph
- **B**: 316 SS
- **CR**: Ceramic

Seal Material
- **PE**: Polyethylene (UHMW)
- **TC**: Teflon® Composite
- **TG**: Teflon® Graphite
- **V**: Viton®
- **BR**: Buna N
- **K**: Kalrez®
- **EPR**: Ethylene Propylene

NOTE: (1) The 400, 600 and 800 motor cylinders are only available with the CR (controller-relay) or SR (solenoid-relay) control methods.

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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 mean that the model consists of a controller (C) and pump (P) **For example:** CP125X125, CP250X225, CP250X300, CP500X225, and CP500X300. The letters **CRP** mean that the model also has a relay (R). **For example:** CRP500X400, and CRP750X400.

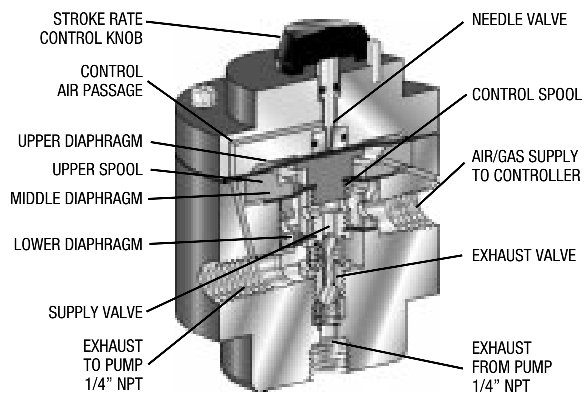
The CRP500X400 and CRP750X400 both use the P03-6A relay.

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.

Control Methods For The Pump

1. Oscillamatic® Controller

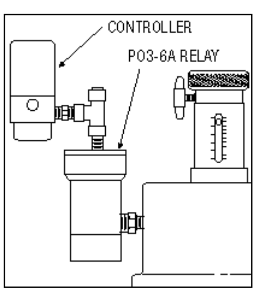


The MK II and MK VII Controllers operate on the same operating principal as the MK X Controller. The MK II and MK VII have the same upper and lower chambers, but are separated with flexible diaphragms rather than sliding seals. A capillary tube, controlled by a needle valve, transfers the air/gas supply to the pump from the lower to the upper chamber.

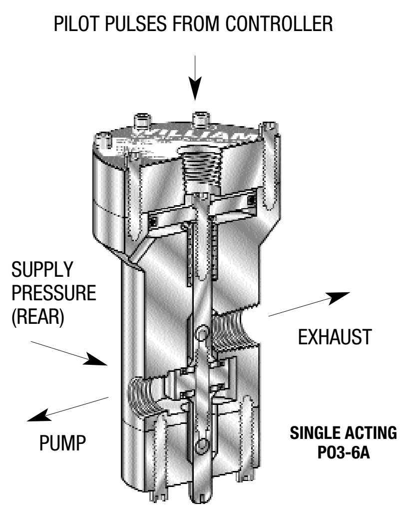
When the spool is in the highest position, a pilot plug closes a vent and opens the supply air/gas to the pump. When the spool is in its lowest position, the pilot plug prevents the supply air/gas from entering the pump, and opens the air/gas vent to let it exhaust the pump. The spool then returns to its highest position to repeat the process.

2. Controller-Pneumatic Relay Combination

The PNEUMATIC RELAY is a pilot operated valve designed to provide the higher air or gas flow rates necessary for PNEUMATIC DRIVE CYLINDER diameters greater than 3 inches. The PNEUMATIC RELAY is actuated by the pulses produced by the CONTROLLER. A single acting PNEUMATIC RELAY is used with pumps that have return springs such as the CRP500X400.



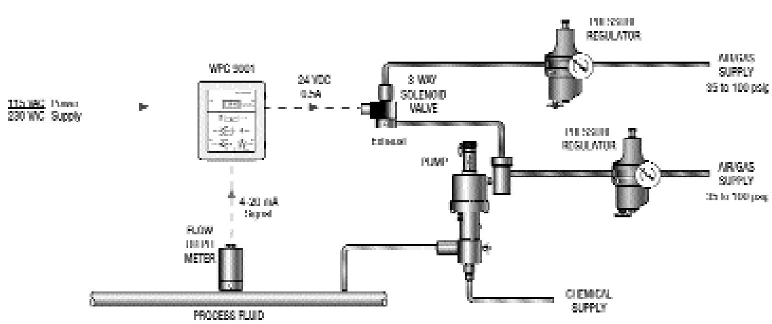
PUMP INSTALLATION
CRP500X400 OR CRP750X400



SINGLE ACTING P03-6A

3. Solenoid Valves

The pumps can be automated by replacing the CONTROLLER with a 3-way electro-pneumatic SOLENOID VALVE. The SOLENOID VALVE can be cycled in order to achieve the desired pump output. Flow tracking can be accomplished by having a FLOWMETER or PH METER signal interpreted by our WPC9001 or a PLC. The typical arrangement for a WPC-9001 installation is shown at right.



1.2 CAPABILITIES

1.2.1 Controllers and Relays

Controllers and relays will require separate supply sources, and fortunately will operate with air or 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 the gas could possibly damage the standard elastomeric material, please contact your distributor or Williams Instrument Incorporated for advice.

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

1.2.1.1 Controller Supply Pressure

Controllers will operate with the following supply pressures:

	Maximum		Minimum	
	psi	bar	psi	bar
MK II	65	4.5	25	1.7
MK VII	90	6.2	50	3.4

To establish the proper air/gas supply pressure for the controller or relay, add 200 psig or 13.8 barg to the process pressure the pump is working against. Then use the performance graphs located in section 1.2.2.2.

Remember for a controller-relay combination the controller supply pressure need only be set at the minimum pressure. The relay supply would be established in the above procedure or refer to section 1.2.1.2.

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 between 35 psig (2.41 bar) and 150 psig (10.3 bar). The supply pressure must be 35 psig minimum or equal to or greater than the process pressure plus 200 psi, divided by the pump amplification ratio. (EXAMPLE: CRP500X400 @ 1000 PSI + 200 PSI divided by 24 = 50 air supply required. Refer to section 1.1.3 for the amplification ratio formula) When using a controller/relay combination, hold the air/gas supply pressure to the controller to the minimum value of 25 or 50 psig, and the relay at 35 psig minimum.

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).

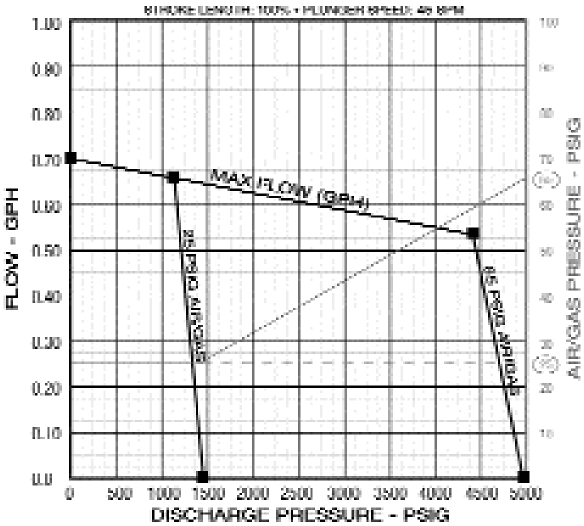
1.2.2 Pumps

1.2.2.1 Flow Pressure Performance Table:*

MODEL @ AIR/GAS SUPPLY PRESSURE	MAX VOLUME GPH/LPH	VOLUME PER STROKE CC	STROKE LENGTH INCH	STROKES PER MINUTE (RANGE)	MAX DISCHARGE PRESSURE PSIG / BARG	MAX AIR CONSUMPTION 100 PSIG SCF PER DAY	6.9 BAR SCM PER DAY
CP125X125 @ 65 PSI / 4.5 BAR	.07 / .27	.1	.5	1-45	5,000 / 344.8	180	5
CP250X225 @ 65 PSI / 4.5 BAR	.57 / 2.16	.8	1	1-45	4,100 / 282.7	1150	32
CP250X300 @ 65 PSI / 4.5 BAR	.57 / 2.16	.8	1	1-45	6,500 / 448.2	2100	59
CP500X225 @ 90 PSI / 6.2 BAR	2.26 / 8.55	3.2	1	1-45	1,300 / 89.6	1150	32
CP500X300 @ 90 PSI / 6.2 BAR	2.26 / 8.55	3.2	1	1-45	2,550 / 175.7	2100	59
CRP500X400 @ 50 PSI / 3.5 BAR @ 90 PSI / 6.2 BAR	2.26 / 8.55 2.26 / 8.55	3.2 3.2	1 1	1-45 1-45	2,900 / 203.9 5,400 / 379.7	3584	101
CRP750X400 @ 50 PSI / 3.5 BAR @ 90 PSI / 6.2 BAR	5.00 / 18.9 5.00 / 18.9	7.0 7.0	1 1	1-45 1-45	1,150 / 80.9 2,300 / 161.7	3584	101

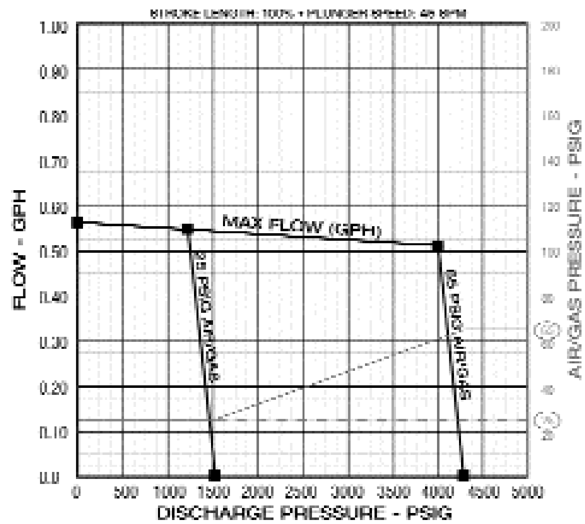
*** This data should only be used to provide you with your initial size selection. You must refer to the actual performance graphs in order to verify your pump selection. Discharge pressures with use of MK II or MK VII controllers.**

Performance Flow Curves



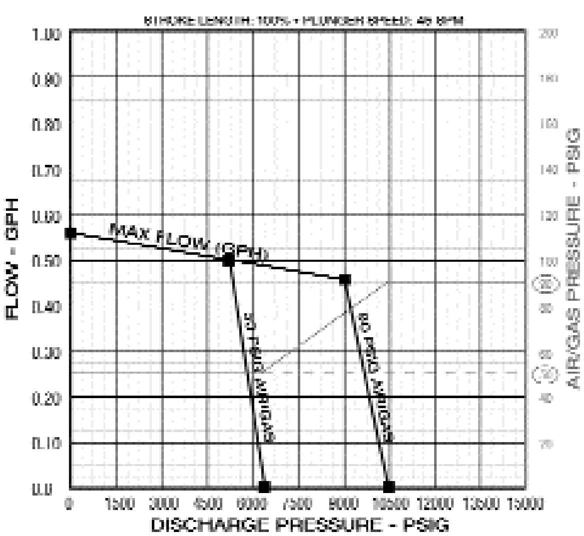
CP125X125 with MK II

Discharge Pressure PSI	0	500	1100	2500	4400	5000
Gph	0.07	0.068	0.065	0.061	0.052	0
Air Pressure PSI	25	25	25	38	55	65



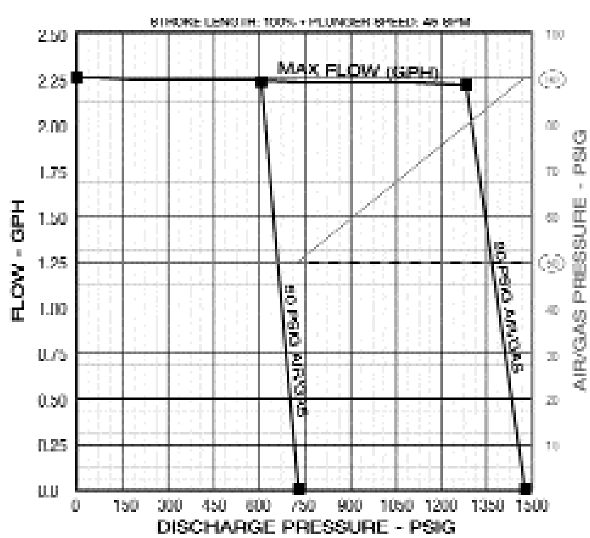
CP250X225 with MK II

Discharge Pressure PSI	0	500	1500	2500	4000	4100
Gph	0.57	0.56	0.55	0.55	0.54	0
Air Pressure PSI	25	25	27	40	60	65



CP250X300 with MK VII

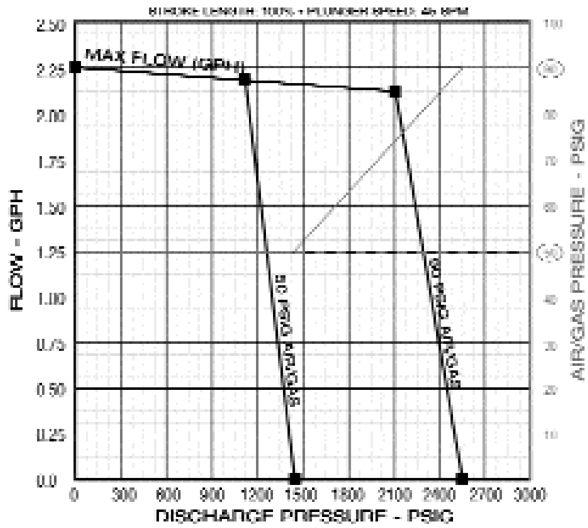
Discharge Pressure PSI	0	1500	4500	7500	9000	10500
Gph	0.57	0.55	0.51	0.5	0.45	0
Air Pressure PSI	50	50	50	65	75	90



CP500X225 with MK VII

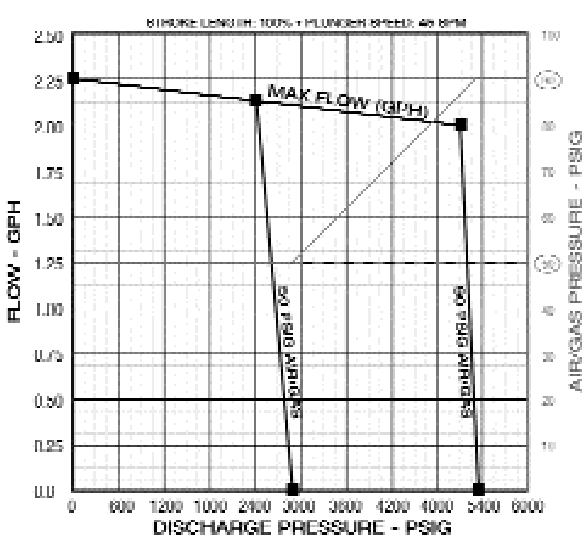
Discharge Pressure PSI	0	450	750	1050	1300	1500
Gph	2.26	2.24	2.24	2.23	2.22	0
Air Pressure PSI	50	50	50	68	80	90

Performance Flow Curves (cont.)



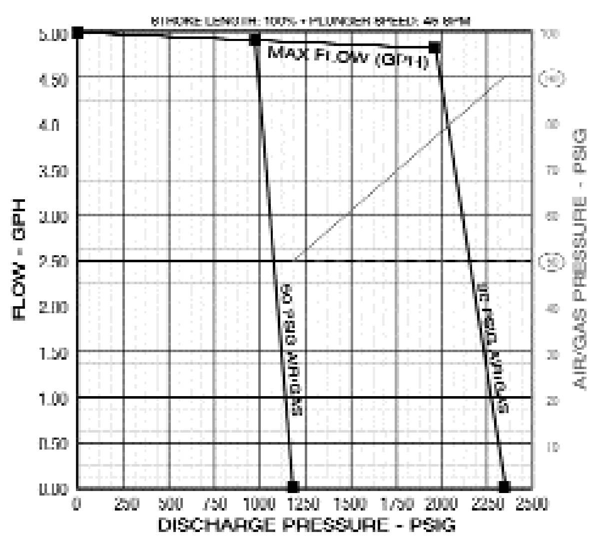
CP500X300 with MK VII

Discharge Pressure PSI	0	500	900	1500	2100	2550
Gph	2.26	2.2	2.16	2.08	2.15	0
Air Pressure PSI	50	50	50	54	74	90



CRP500X400 with MK II & PO3-6A

Discharge Pressure PSI	0	1200	2900	3600	5100	5400
Gph	2.26	2.24	2.2	2.11	2	0
Air Pressure PSI	50	50	50	63	85	90



CRP750X400 with MK II & PO3-6A

Discharge Pressure PSI	0	500	1150	1500	2000	2300
Gph	5	4.96	4.95	4.8	4.7	0
Air Pressure PSI	50	50	50	60	80	90

1.2.2.3 Plunger & Seal Material

1.2.2.3.1 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 is 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
B	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.

1.2.2.3.2 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
TG Teflon® Graphite	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	1000 to 10,000 psi 207 to 690 bar (High Pressure)	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.
TC Teflon® Composite	Mechanical (Spring Loaded)	-30 to 180°F -34 to 82°C	100 to 5000 psi 6.9 to 207 bar (Low Pressure)	Tough material with excellent wear resistance. Excellent chemical inertness. Good for all types of chemicals, acids, bases or solvents.
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.
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 esters, 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.

1.3 GENERAL OPERATING SEQUENCE

1.3.1 Controller

When the spool moves to the full upward position, supply air/gas enters the motor cylinder. A spool spring forces the spool upward to its highest position and as it moves, it unseats the top of the pilot plug from the spool seat. At the same time, an exhaust spring moves the pilot plug also upward until it seats on the lower seat, blocking the air/gas exhaust port.

Then when high pressure air/gas enters the supply port, it passes around and through the spool, past the now-open spool seat, to the motor cylinder port. Air in the motor cylinder port also passes slowly through a capillary tube, past the needle valve stem, and into the upper valve body volume chamber, causing pressure to build in this chamber.

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

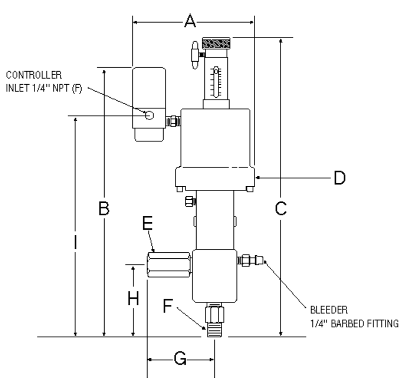
As the pressure in the motor cylinder and valve body volume chamber reduces, the spool spring starts pushing the spool upward, the exhaust spring pushes the pilot plug upward, and the controller returns to its initial up position.

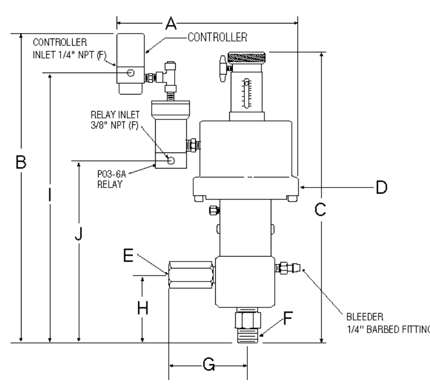
1.3.2 Relays

1.3.2.1 P03-6A Relay

When there is no pilot pulse (high pressure air or gas) entering the top of the relay from the controller, the piston spring pushes the piston and the poppet assembly 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, and pushes the piston and the poppet assembly downward 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 pump and exhaust ports.

Physical Specifications





Model	Plunger Diameter (In.)	Piston Diameter (In.)
CP125X125	1/8	1 1/4
CP250X225	1/4	2 1/4
CP250X300	1/4	3
CP500X225	1/2	2 1/4
CP500X300	1/2	3
CRP500X400	1/2	4
CRP750X400	3/4	4

Model	A Inch/mm	B Inch/mm	C Inch/mm	D Diameter (IN)	E Connector	F Connector	G Inch/mm	H Inch/mm	I Inch/mm	J Inch/mm	WT LBS/KG
CP125X125	5.25/133.4	9.00/228.6	8.12/206.2	1 7/8”47mm	1/4” NPT (F)	1/4” NPT (M)	1 3/4”45mm	1 3/4”45mm	6 1/4”159mm	n/a	7.0/3.2
CP250X225	6.50/165.1	11.43/290.3	11.00/279.4	2 1/2”63.5mm	1/4” NPT (F)	1/4” NPT (M)	2 9/16”65mm	2 11/16”68mm	8 7/8”214mm	n/a	9.0/4.1
CP250X300	7.25/184.2	11.43/290.3	11.00/279.4	3 1/4”82.5mm	1/4” NPT (F)	1/4” NPT (M)	2 9/16”65mm	2 11/16”68mm	8 7/8”214mm	n/a	9.0/4.1
CP500X225	6.50/165.1	11.75/298.5	11.00/279.4	2 1/2”63.5mm	1/4” NPT (F)	1/2” NPT (M)	2 5/8”67mm	2 13/16”69mm	8 9/16”217mm	n/a	10.0/4.5
CP500X300	7.25/184.2	11.75/298.5	11.00/279.4	3 1/4”82.5mm	1/4” NPT (F)	1/2” NPT (M)	2 5/8”67mm	2 13/16”69mm	8 9/16”217mm	n/a	10.0/4.5
CRP500X400	9.75/247.7	15.75/400	11.00/279.4	4 1/4”108mm	1/4” NPT (F)	1/2” NPT (M)	2 5/8”67mm	2 13/16”69mm	12 3/4”324mm	9 7/16”240mm	15.0/6.8
CRP750X400	9.75/247.7	16.00/406.4	11.31/287.2	4 9/16”116mm	1/2” NPT (F)	3/4” NPT (M)	3 5/8”92mm	3”76.2mm	13”331.7mm	7 9/16”240mm	16.7/7.5

1.3.2.2 PO3-6A Relay

When there is no pilot pulse (high pressure air or gas) entering the top of the relay from the controller, the piston spring pushes the piston and the poppet assembly 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 and pushes the piston and them poppet assembly downward 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 pump and exhaust ports.

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 piston and diaphragm overcomes the combined force of the process fluid pressure on the 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 fluid being discharged and suctioned into the fluid chamber. During discharge, the piston plunger moves into the pump fluid chamber, decreasing the volume of the chamber and raising the pressure in 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 of the chamber fluid. This lower pressure opens the suction check valve and a spring closes the discharge check valve, sending fluid from the suction line into the fluid chamber.

SECTION 2.0: INSTALLATION OF PUMP AND CONTROLLER

2.1 GENERAL

Always install separate pressure regulators in the air/gas supply lines for the controller and the 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 lines 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.
- An inlet filter, with filtration approximately 25 microns, on pump suction line.
- A flow meter or a rate setting gauge in the suction line or process fluid discharge line, if you need precise flow rate adjustment or recording.

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.

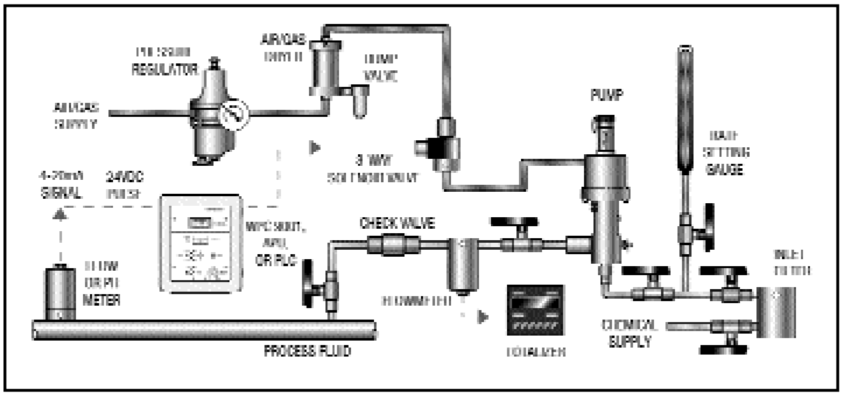
NOTE: The pump assembly can be installed directly in the process line piping without any additional support brackets.

CONTROLLER SPECIFICATIONS

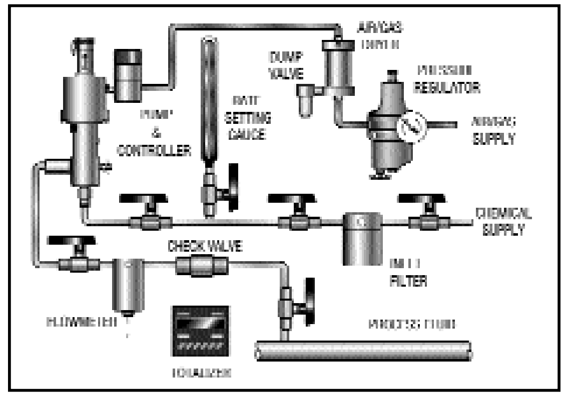
MODELS	SUPPLY PRESSURE	BODY MATERIAL	STROKES (SPM)	ELASTOMER	SPOOL STYLE
MK II	25 - 65 PSI (1.7 - 4.5 Bar)	Anodized Aluminum	1 - 45	Neoprene	Diaphragm
MK VII	50 - 91 PSI (3.14 - 6.2 Bar)	Anodized Aluminum	1 - 45	Neoprene	Diaphragm

2.3 TYPICAL INSTALLATION

Below you will find a schematic for a typical "X" plunger pump installation. The key ingredients for a successful installation are: ***1:*** Clean, dry regulated air for the controller ***2:*** A flooded inlet supply ***3:*** An inlet filter ***4:*** A rate setting gauge ***5:*** A line check valve at the point of injection ***6:*** Isolation valves for maintenance on each component.



Flow Tracking Controller Configuration



Standard Pneumatic Controller Configuration

2.4 SUPPLY RESERVOIR

Position the supply reservoir so that the liquid level will not be less than six inches above the inlet check valve (flooded suction). While you can locate the reservoir at any height above the inlet check valve (net positive suction head), the limit is 100 psig net positive suction head, which is the cracking pressure of the discharge check valve. We do not recommend using the pumps in a suction lift position since they were not designed for such operation.

2.5 RELIEF VALVE

A safety relief valve is not necessary if the downstream piping can withstand the maximum pressure the pump can generate at the available air supply pressure. The maximum discharge pressure the pump can generate can be taken from the performance graphs in section 1.2.2.2. When this pressure is reached the pump will stop. Example: A CP250X225ATC operating at 25 psig is capable of generating 1400 psig. The pump will stop pumping when the 1400 psig is reached.

SECTION 3.0: STARTUP, OPERATION, SHUTDOWN, AND STORAGE

3.1 GENERAL

While these procedures for startup, operation, shutdown, and storage are simple, 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. Use the recommended ball valve in the air/gas supply line.**

3.2 STARTUP

These startup procedures will produce a flow rate close to what you want. For a more precise flow rate, monitor with a flow meter while making the final adjustment.

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 OFF. Also, set the pressure regulator(s) to ZERO pressure.

3.2.1.1 Supply Pressure: The air/gas 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 psig, the air/gas supply should provide a pump discharge pressure of 3000 psig. To set the supply pressure properly, use the performance graphs in 1.2.2.2.
NOTE: With a controller/relay combination, the controller supply pressure should be at the minimum value, (Ref. 1.2.1.1) and the relay supply pressure set per the above procedure. Remember, the controller is now supplying the relay and the relay is supplying the pump. Refer to section 1.2.1.2 for the relay supply pressures.

***3.2.1.2 Supply Piping*:** Since supplying the proper air volume to the pump is critical for its operation, avoid long runs of small diameter tubing, as follows:

- Locate the main air/gas supply header as close to the pump as possible.
- Use no more than five feet of 1/4" tubing to supply air/gas to the controller.
- Always locate the controller or relay on the pump.
- Use no more than ten feet of 1/2" tubing to supply air/gas to the relay.
- If a solenoid valve controls the pump, locate it no more than two feet away and use 1/2" tubing to supply air/gas to the pump.

3.2.2 Controller Stroke Rate

The controller is preset at the factory to provide each pump the maximum number of strokes per minute at 25 psig (MK II) or 50 psig (MK VII) (Ref. 1.2.2.1 Performance Table). This setting falls at 100 on the controller scale. At ZERO on the scale, the pump will not cycle and there will be no output.

To calibrate the controller stroke rate, follow this procedure:

1. Rotate the stroke rate knob on the controller clockwise (CW) to ZERO on the stroke rate reference scale.
2. Turn the main air/gas supply to the regulator(s) to ON, and adjust the regulator to the desired pressure. (see 3.2.1.1 for determining pressure.)
3. Set the flow rate for your application by using the controller's stroke rate knob in combination with the pump's stroke adjuster. (Ref. 1.2.2.1 Performance Table)

If necessary, 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. Use a timer, such as a stop watch, to determine the actual stroke rate.
3. Attach and set the knob at the desired position on the scale (100 on scales for 45 spm, for example).

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 tee set screw counterclockwise until the stroke adjuster knob is unlocked.
2. Turn the stroke adjuster knob counterclockwise as far as it can go. The piston/plunger will be fully bottomed in the pump.
3. Loosen the two screws holding the data plate; move the data plate until the middle of the pin is at ZERO on the scale. Tighten the two screws.
4. Turn the stroke adjuster knob until the middle of the pin is at the desired stroke length on the scale.
5. Tighten the tee knob clockwise until the stroke adjuster knob is locked.

3.3 OPERATION

3.3.1 Bleeder Plug

Shortly after the pump assembly begins operating, the metered liquid should begin 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 with each pump stroke from the end of the bleeder plug, turn it CW until the flow stops. It is best to close the bleeder plug when the pump is discharging and before the suction stroke.

NOTE: To catch the escaping liquid, slip a length of 1/4" plastic or rubber tubing over the hose barb of the bleeder plug.

3.3.2 Stroke Rate

Set the operating stroke rate, as follows:

1. Set the stroke rate knob to a mark on the scale that will produce a stroke rate close to the one you want. Keep in mind that the scale reading is only an approximate percent indication of the actual rate; generally the pump maximum stroke rate will be set at 100 on the scale. **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. 1.2.2.1 Performance Table) To set the stroke rate correctly, you must time the exhausts as they leave the bottom of the controller.
2. Count the number of pump strokes during a one minute interval, using a timer such as a stop watch to determine the actual stroke rate.
3. Adjust the knob to correct the stroke rate as needed. Confirm by timing the stroke rate.
4. Repeat the above steps until you get the correct stroke rate. EXAMPLE: To get a stroke rate of 22 strokes per minute, set the knob to 50 which should produce approximately 25 strokes per minute. Then reduce the rate by resetting 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. Confirm the rate by timing it.

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 or if it will not be used for a long time, do the following:

1. Remove pump from the system.
2. Flush out the pump chamber and check valves with water or solvent; drain and then blow the pump 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 seals. For a recommended solvent, contact your distributor or Williams Instrument Incorporated.

3. Cap off the suction and discharge check valve ports.
4. You may leave the pump, controller, and relay assembled, 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, plus procedures 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 and Materials

Necessary tools will vary by pump assembly model but the following are typical:

- Adjustable wrench: 12”
- Belt-spanner or web wrench
- Open-end wrenches: various sizes
- Hex wrenches: 7/64”, 1/8”, 9/64”, 3/16”, and 5/32”, 1/4”, 3/8”
- Socket wrenches: various sizes with 2” extension
- Flat-blade Screwdrivers: 1/8” (2 required) and 1/4”
- MK X Screwdriver in 3/16” hex Socket Drive (Drawing 1)
- Brass or plastic O-ring pick (1)
- Torque wrench (15 in-lb to 122 in-lb range)
- Bench vise
- Silicone grease, (Williams G321M4), or synthetic grease (Williams GS102149)
- Teflon tape 1/4”
- Thread sealing compound

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

4.2.2 Controllers

4.2.3 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 screw driver remove the set screw securing the rate adjustment knob. Remove knob and spring.(Fig. 9 & 10)

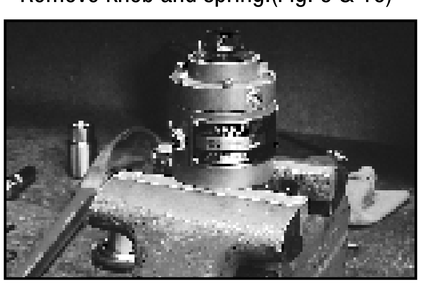


Figure 9

Figure 10

2. With your fingers unscrew the valve stem and remove.(Fig. 11)

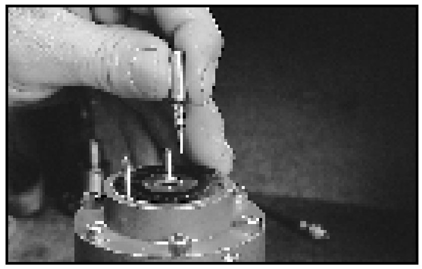


Figure 11

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 O-ring (V-006). (Fig. 12, 13, 14 & 15)

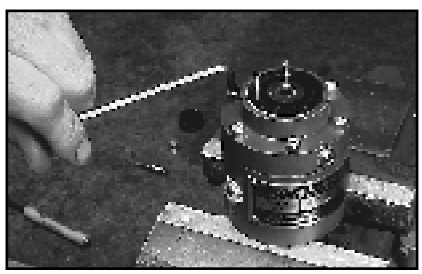


Figure 12

Figure 13

Figure 14

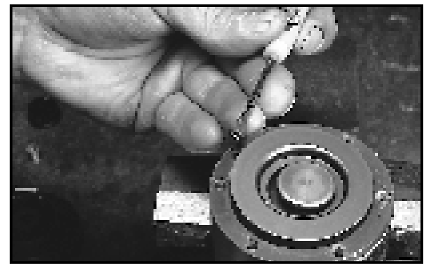


Figure 15

4. Now remove the upper spool and the lower spool assembly (3 pieces). (Fig. 16 & 17)

Figure 16

Figure 17

5. Then remove the middle spring. (Fig.18)

Figure 18

6. Now with a 9/16” socket wrench loosen the lower seat. Remove the lower seat, gasket, pilot plug and lower spring. (Fig. 19 & 20)

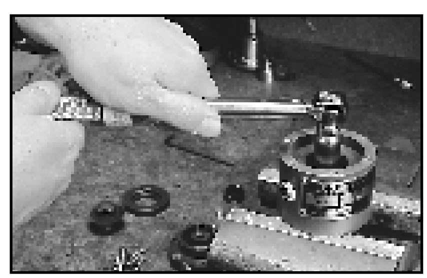


Figure 19

Figure 20

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.(Fig.21,22,23,24,25,26)

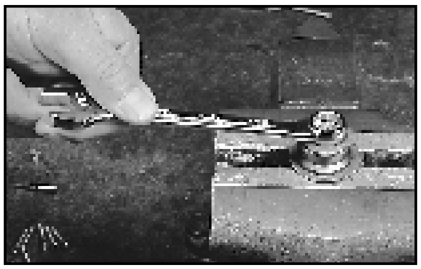


Figure 21

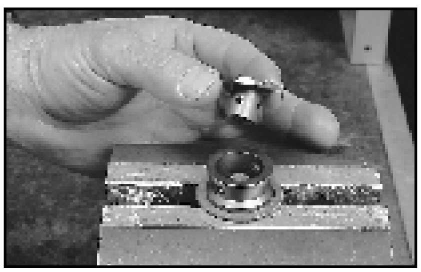


Figure 22

Figure 23

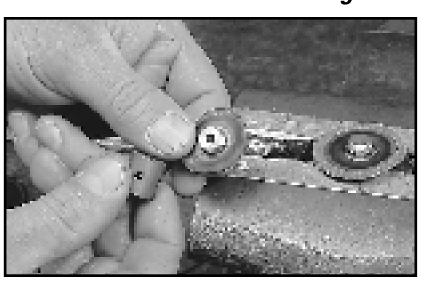


Figure 24

Figure 25

Figure 26

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

4.2.3 PO3-6A Relays:

Refer to the appropriate Parts List.

1. Use a 9/64" hex wrench to remove the top cap screws (Fig. 28 & 29). Turn screws CCW.

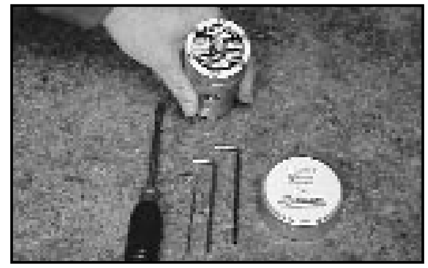


Figure 28

Figure 29

2. Separate the top cap with data plate from the upper body section. (Fig. 30)

Figure 30

3. Put a 7/64" hex wrench through the side of the relay into the upper body exhaust port and into the hole in the upper poppet stem. (Fig. 31)

Figure 31

4. Use a 9/64" hex wrench to remove the piston lock screw (Fig. 31)

5. Pull out the piston, O-ring, and spring. (Fig. 32 & 33) cup type seals, and illustration II if you are installing O-ring type seals. In each case the seals and back up rings can be easily be pushed in place using only your fingers. Make certain the order and position in which the components are installed matches the illustration shown. Also make certain the seal assemblies are installed completely, none of the seal assembly should protrude. **NOTE: APPLY A LITTLE GREASE FROM GS102149 GREASE TUBE TO THE SEALS. BACK UP RINGS AND ALL THREADS BEFORE INSTALLING.** (Fig. 60, 61, 62, 63, 64 & 65)

Figure 60

Figure 61

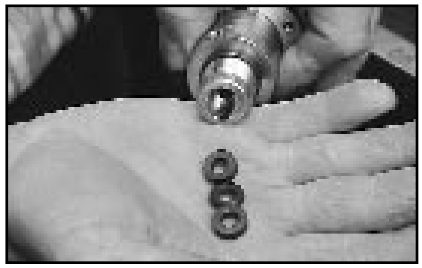


Figure 62

Figure 63

Figure 64

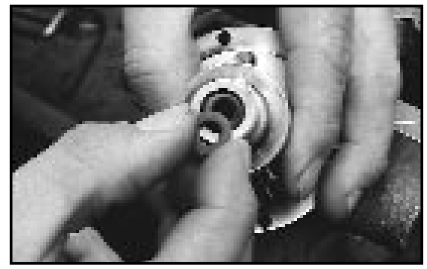


Figure 65

2. REASSEMBLY

a. Replace spring seat and retaining ring. **NOTE: The spring seat may be used as the secondary seal installation tool.** Place the seal face down in the cavity and push it into place with spring seat. (Fig. 66 & 67)

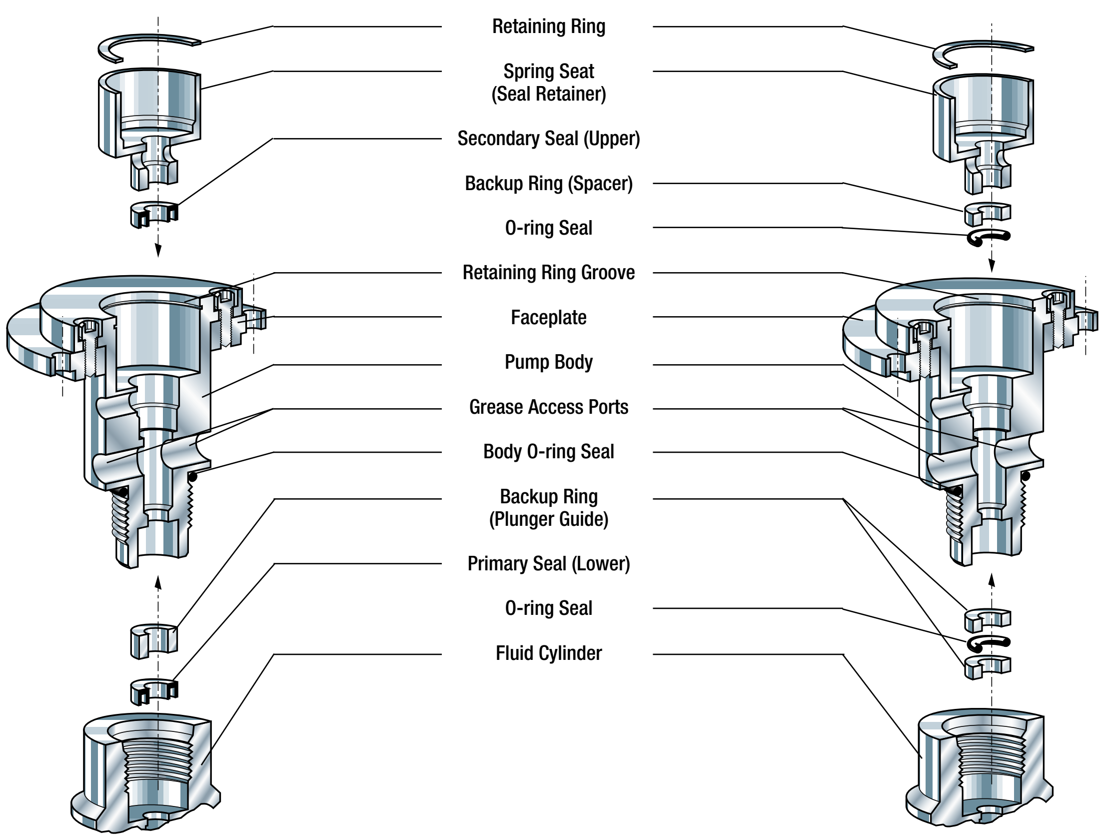


Illustration I

Illustration II

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 pressure 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 line	• 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. Adjust stroke rate to proper strokes per minute according to Specification Sheet; loosen knob set screw, rotate knob CCW to peg, & tighten screw.
	• Leak between valve body & controller body	• Loosen; then retighten the connection between valve & controller body. If dirty, disassemble, wipe clean and reassemble.
	• Continuous air flow from controller exhaust port (Pilot plug not seating properly)	• Inspect & replace damaged lower seat and pilot plug.
	• Air flowing from equalizer hole on side of lower control body	• Inspect & replace ruptured or improperly seated seals. Put finger over exhaust port; alternately seal & vent port to clear exhaust valve.
	• Broken pilot plug, exhaust spring, or spool return spring	• Replace damaged parts.
	• Excessive water in controller	• Install an air/gas dryer or separator in supply line.
RELAY NOT OPERATING	• Broken piston return spring	• Replace return spring. See page 15
	• Poppet stem loosened from connector bolt	• Tighten poppet stem to connector bolt. See page 15
	• Air blow-by caused by poorly sealed O-rings	• Improve quality of air supply and clean dirt from unit. Replace O-rings if damaged.
	• Inadequate air supply	• Check air regulator for proper pressure.
PLUNGER NOT STROKING	• Controller control knob set at ZERO	• Turn knob to proper setting on dial.
	• Air/gas supply turned OFF	• Open valve to allow air supply to flow to controller.
	• Broken motor return spring	• Replace return spring.
	• Plunger stuck due to tight or dry seal	• If seal is swollen, check its chemical compatibility with process fluid; replace with compatible seal material. • If seal is dry, lubricate & fill reservoir with grease.
	• Plunger bottomed	• Readjust plunger stroke length. Replace return spring if broken.
	• Excessive grease between cylinder and faceplate	• Remove excess grease. Piston seal may be leaking; check and replace if necessary.
	• Air/gas supply pressure too low to overcome process line pressure	• Increase supply pressure to controller or relay.
	• Discharge or suction line plugged	• Clean the lines.

PROBLEM	POSSIBLE CAUSE(S)	CORRECTIVE ACTION
PLUNGER NOT STROKING (Cont.)	• Air/gas flow to controller too low (controller locked up and will not cycle)	• Install a larger capacity regulator or supply line. Vent supply side of controller and try to start pump at slowest speed; increase speed slowly if controller starts to cycle.
	• Motor cylinder-air piston blow-by	• Check piston seal; replace as needed. Check motor cylinder surface for damage from dirt or sand; install clean filters on bottom of cylinder faceplate. Replace cylinder if necessary.
LOW PUMP OUTPUT	• Viscosity of the chemical being pumped too high.	• Review and enlarge size of supply and discharge lines to improve flow of chemical.
	• Pump mounted too high to suck adequate supply of chemical to fluid cylinder	• Remount pump to create a flooded suction (six inch minimum).
	• Pump appears sluggish in stroking. Piston not returning all the way.	• Remount pump as close to controller and relay as possible to allow the controller and relay to exhaust quickly. Check for ice in exhaust port.
	• Suction lift condition inadequate.	• Change tank elevation to get flooded suction if change not possible, add foot valve at end of suction line, and increase suction line diameter.
	• Blocked suction filter	• Clean or replace filter element.
	• Supply and discharge lines too small. See pump sluggish	• Install correct tubing size.
	• Erratic controller operation	• Rebuild, clean and lubricate controller; add air inlet filter or air/gas dryer.
	• Check valves leaking or contaminated. Loss of pump capacity	• Rebuild, replace damaged parts.
	• Improper chemical supply	• Make sure top of chemical supply tank is vented to atmosphere or pressurized.
PROCESS FLUID IN GREASE CHAMBER OR LEAKING FROM BODY OR CYLINDER FACEPLATE VENT HOLE	• Premature wear on plunger seals from excessive pump speed	• Calculate proper speed and air supply pressure. (Refer to amplification ratio principle.) Replace seals and plunger.
	• Foreign material in process fluid	• Check to see if chemical supply is clean; if not, install chemical filter in supply line.
	• Seals incorrectly assembled or damaged during installation	• Refer to instructions for installing seals.
	• Plunger nicked, burred or scratched	• Replace plunger and seals.
PROCESS FLUID IN GREASE CHAMBER OR LEAKING FROM BODY OR CYLINDER FACEPLATE VENT HOLE (cont.)	• Seal or plunger materials not compatible with process fluid	• Refer to compatibility charts; contact distributor or Williams Instrument Incorporated
	• Crystallized chemical on plunger scoring seal	• Maintain lubricant and decrease time between inspections.
	• Lubricant incompatible with process fluid	• Change lubricant; contact distributor or Williams Instrument Incorporated
NO PUMP DISCHARGE	• Suction check valve or discharge check valve not seating	• Clean or replace check valves.
	• Suction or discharge line clogged	• Inspect line for closed connections or valves.
	• Air entering suction line	• Tighten fittings; Inspect and replace sealants.
	• Pump vapor locked	• Open bleeder plug and prime pump.

SECTION 5.0
PARTS LIST & REPAIR KIT ORDERING REFERENCE

5.1 CONTROLLER

CONTROLLER	PARTS LIST	REPAIR KIT
MK - II (1)	PL - MK - II	OS 42 - II
MK - VII(2)	PL - MK - VII	OS 42 - VII

NOTES:
(1) The MK II is standard on the P125X125, P250X225, CRP500X400 and CRP750X400.
(2) The MK VII is standard on the P250X300, P500X225 and CRP500X300.

5.2 RELAYS

RELAY	USED ON (PUMP)	PARTS LIST	REPAIR KIT
PO3-6A	P500X400 P750X400	PL-PO3-6A	PO3-6K

SECTION 6.0
LIMITED WARRANTY

WILLIAMS MILTON ROY. will repair or replace any pump due to defects in material or workmanship for a period of up to three years from the date of shipment. Product failure due to any other reason including, but not limited to misuse, negligence, accident, normal wear and usage, or improper installation and operation, will not be remedied under this warranty. This warranty is valid only if the repairs are performed by WILLIAMS MILTON ROY and returned to the factory for inspection (freight prepaid) within the warranty period. No claim for labor or consequential damages will be allowed.

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