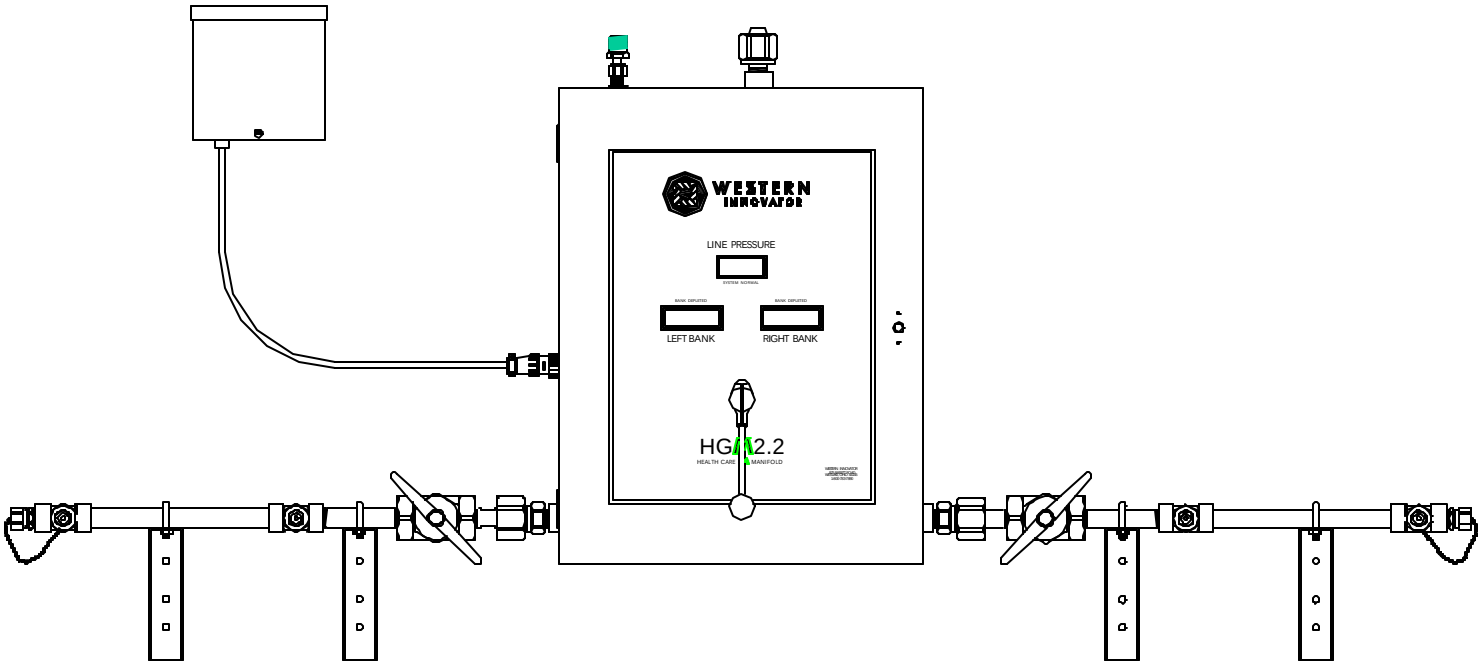
AUTOMATIC CHANGEOVER MANIFOLD
HGM2, HGM2HL, & HGM2HP SERIES

SERVICE MANUAL



SAFETY

Statements in this manual preceded by the following safety signal words are of special significance. Definitions on the SAFETY signal words follow.

DANGER
Means a hazard that will cause death or serious injury if the warning is ignored.

WARNING
Means a hazard that could cause death or serious injury if the warning is ignored.

CAUTION
Means a hazard that may cause minor or moderate injury if the warning is ignored. It also means a hazard that will only cause damage to property.

NOTE
Indicates points of particular interest for more efficient and convenient operation.

INTRODUCTION

This manual provides the information needed to service the Western Enterprises HGM2, HGM2HL, and HGM2HP series manifolds. This information is intended for use by technicians or personnel qualified to repair and service manifold equipment.

The information contained in this document, including performance specifications, is subject to change without notice.

WARRANTY

Western Enterprises makes no warranty of any kind with regard to the material in this manual. Including but not limited to the implied warranties of merchantability and fitness for a particular purpose.

Refer to the **Installation and Operation Instructions** manual for warranty information.

CAUTION

- Failure to adhere to the following instructions may result in person injury or property damage:
- Never permit oil, grease, or other combustible materials to come in contact with cylinders, manifold, and connections. Oil and grease may react and ignite when in contact with some gases-particularly oxygen and nitrous oxide.
- Cylinder, header, and master valves should always be opened very s-l-o-w-l-y. Heat of recompression may ignite combustible materials.
- Pigtails should never be kinked, twisted, or bent into a radius smaller than 3 inches. Mistreatment may cause the pigtail to burst.
- Do not apply heat. Some materials may react while in contact with some gases-particularly oxygen and nitrous oxide.
- Cylinders should always be secured with racks, chains, or straps. Unrestrained cylinders may fall over and damage or break off the cylinder valve which may propel the cylinder with great force.
- Oxygen manifolds and cylinders should be grounded. Static discharges and lightning may ignite materials in an oxygen atmosphere, creating a fire or explosive force.
- Welding should never be performed near nitrous oxide piping. Excessive heat may cause the gas to dissociate, creating an explosive force.

ABBREVIATIONS

C	Common	NFPA	National Fire Protection Association
CGA	Compressed Gas Association	OSHA	Occupational Safety & Health Administration
FT-LBS	Foot-Pounds	PSIG	Pounds per Square Inch Gauge
IN-LBS	Inch-Pounds	SCFH	Standard Cubic Feet per Hour
N/C	Normally Closed	VAC	Voltage, Alternating Current
N/O	Normally Open	VDC	Voltage, Direct Current
NPT	National Pipe Taper	PCB	Printed Circuit Board

Western Enterprises shall not be liable for errors contained herein or incidental or consequential damages in connection with providing this manual or the use of material in this manual.

TABLE OF CONTENTS

This page intentionally left blank

INTRODUCTION & GENERAL INFORMATION

PRODUCT DESCRIPTION

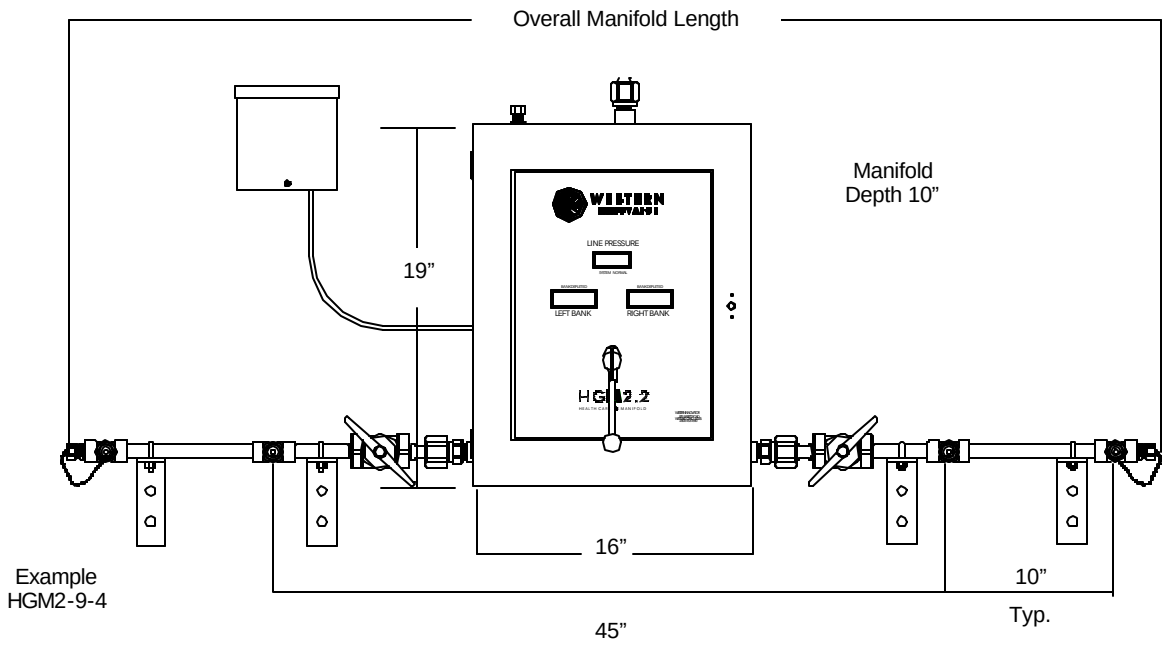
The automatic changeover manifold is designed to provide a reliable uninterrupted supply of gas to a hospital or clinic's medical gas pipeline system. It is designed to meet NFPA 99 type 1 facility requirements.

The manifold has an equal number of cylinders in its "Service" supply and "Secondary" supply banks, automatically switching to the "Secondary" supply when the "Service" supply becomes depleted. When the manifold changes to "Secondary" supply, it sends a signal to the hospital or clinic's medical gas alarm system alerting the personnel of the need for the exhausted bank of cylinders to be replaced with full cylinders. After new cylinders are in place and turned on, no manual resetting of the manifold is necessary except for turning the control knob.

INSTALLATION INFORMATION

Manifolds should be installed in accordance with guidelines stated by the National Fire Protection Association, the Compressed Gas Association, OSHA, and all applicable local codes. The carbon dioxide and nitrous oxide manifolds should not be placed in a location where the temperature will exceed 120°F (49°C) or fall below 20°F (-7°C). The manifolds for all the other gases should not be placed in a location where the temperature will exceed 120°F (49°C) or fall below -20° F (-29°C). A manifold placed in an open location should be protected against weather conditions. During winter, protect the manifold from ice and snow. In summer, shade the manifold and cylinders from continuous exposure to direct rays of the sun.

Leave all protective covers in place until their removal is required for installation. This precaution will keep moisture and debris from the piping interior, avoiding operational problems.



Total number of cylinders	4	6	8	10	12
Overall manifold length	5' - 11"	7' - 7"	9' - 3"	10" - 11"	12' - 7"

Figure 1-1 Installation Dimensions

MANIFOLD SPECIFICATIONS

Flow Capability

Oxygen: 1200 SCFH maximum at 50 psig delivery with a 15 psi pressure drop and 2000 psig inlet pressure. 500 SCFH maximum at 50 psig delivery with a 5 psi pressure drop and 2000 psig inlet pressure.

Nitrogen: 1200 SCFH maximum at 160 psig delivery with a 15 psi pressure drop and 2000 psig inlet pressure.

Nitrous Oxide: The flow capability of a Nitrous Oxide cylinder manifold will depend upon conditions at the installation site, demands of the delivery system and the number of cylinders in supply service. Maximum capability is 500 SCFH at 50 psig delivery and 750 psig inlet pressure. Installing a Nitrous Oxide manifold in a location which exposes it to ambient temperatures below 20° F (-7° C) is not recommended.

Breathing Air: 1200 SCFH maximum at 50 psig delivery with a 15 psi pressure drop and 2000 psig inlet pressure.

Helium: 1200 SCFH maximum at 50 psig delivery with a 15 psi pressure drop and 2000 psig inlet pressure.

Carbon Dioxide: The flow capability of a Carbon Dioxide cylinder manifold will depend upon conditions at the installation site, demands of the delivery system and the number of cylinders in supply service. Maximum capability is 500 SCFH at 50 psig delivery and 750 psig inlet pressure. Installing a Carbon Dioxide manifold in a location which exposes it to ambient temperatures below 20° F (-7° C) is not recommended.

Power Source Requirements

A 115 VAC / 24 VAC power supply is provided with the manifold to operate the alarm lights on the manifold. Under normal operation the manifold will draw a maximum of 40 milliamperes (.040 amperes).

A five terminal remote alarm terminal strip is on the right side of the circuit board in the power supply box for remote alarm interfacing. The top three terminals on this strip (N/C, N/O, and C) provide dry contacts for hookup to the hospital or clinic's medical gas alarm system. Contacts are rated up to 3 amps, 30 VDC or 2 amps 250 VAC.

Nitrous Oxide and Carbon Dioxide systems include a 500 SCFH capacity heater. The thermostatically controlled heater warms the gas before entering the regulator, preventing "freeze-up". The heater operates at 115 VAC and draws four amperes.

Piping Connections

Header Inlets:	Carbon Dioxide	CGA 320
	Nitrous Oxide	CGA 326
	Breathing Air	CGA 346
	Oxygen	CGA 540
	Helium	CGA 580
	Nitrogen	CGA 580
	Med Breathing Mix.	CGA 280

Manifold Outlet: 1/2 NPT male pipe thread (located on the top center of the cabinet).

Relief Valve: 1/2 NPT male pipe thread (located on the top left side of the cabinet).

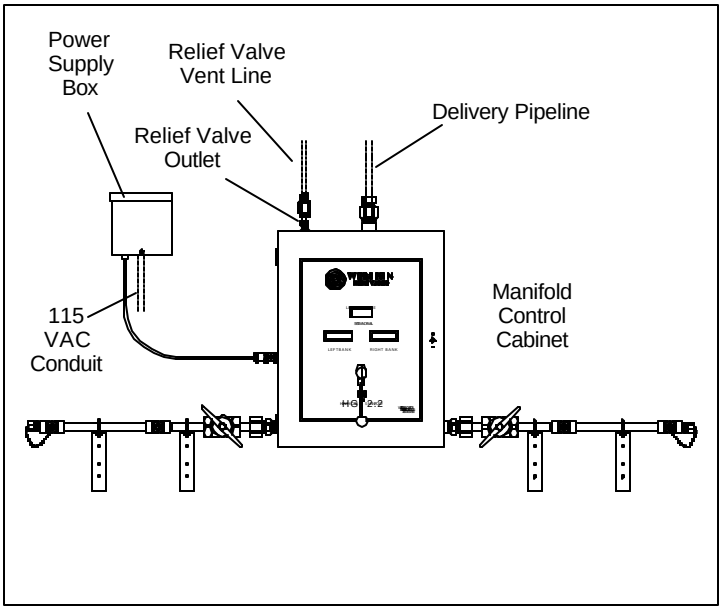


FIGURE 1-2 Connection Locations

ADJUSTMENT SPECIFICATIONS

MODEL	Primary Regulator	Intermediate Pressure Relief Valve	Pressure Switch	Intermediate Regulator	Line Regulators	Line Pressure Relief Valve
HGM2	*195-205	300	135-140	120-125	50-55	75
HGM2HP	*295-305	450	235-240	220-225	**160-165 (v4.0.x and up) **170-175 (v2.02)	250
HGM2HL	*235-245	300	135-140	120-125	50-55	75

Units above are PSIG

* All testing must be done with full cylinders. Primary regulator set pressure will vary with inlet pressures.
**Software version is located on back of circuit board.

CAUTION:
- Resetting/adjusting manifold components with cylinders that are not full may cause the manifold to function improperly.

RECOMMENDED TOOLS AND TEST EQUIPMENT

Volt/Ohm meter	Available from local source
Isopropyl alcohol	Available from local source
Phillips screwdriver	Available from local source
Flat blade screwdriver	Available from local source
Needle nose pliers	Available from local source
Wire cutters	Available from local source
5/32" hex key wrench	Available from local source
5/8" hex socket wrench	Available from local source
13/16" hex socket wrench	Available from local source
Set of combination wrenches 1/4" thru 1", 1 1/8", 1 3/8", 1 1/2", and 1 3/4"	Available from local source
Fluorolube® S-30 lubricant	Manufactured by Occidental Chemical Corporation Niagara Falls, New York
Krytox® 240 AC	Available from E.I. Du Ponte Wilmington, Delaware
Liquid leak detector	Available from Western Enterprises Part number LT-100
Teflon® tape	Available from Western Enterprises Part number MTT-1 or MTT-2

Fluorolube is a registered trademark of Occidental Chemical Corporation.
Teflon is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.).
Krytox® is a register trademark of E. I. du Ponte de Nemours & Co. (Inc.)

THEORY OF OPERATION

GENERAL INFORMATION

This section concentrates on the basic theory of operation of the components of the automatic changeover manifold.

The first part of this section is an operating summary and traces the flow of gas through the various components of the manifold. The second part of this section explains in detail the operation of the individual components contained in the manifold control section.

MANIFOLD OPERATION

The automatic changeover manifold consists of a manifold control and two supply bank headers, one service and one secondary supply, to provide an uninterrupted supply of gas for the specific gas application. The manifold control includes the following components and features: green “system normal” and red “replace depleted cylinders” indicator lights, digital readouts for both cylinder pressure and line pressure, line pressure gauge, internal dual line assembly and line relief valve. Supply banks consist of a header with 24" stainless steel flexible pigtails with check valves, individual check valve bushings, master shut-off valves, and union connections for attachment to the control unit. The main components of the manifold are shown in Figures 2-1 through 2-3. Figures 2-4 and 2-5 show the piping schematics. Figure 2-6 is the schematic diagram of the electrical system of the manifold. Figure 2-7 is the heater schematic.

The cylinder bank that supplies the piping system is known as the “Service” supply while the cylinder bank on stand-by is referred to as the “Secondary” supply. Gas flows from the cylinder through the pigtails, check valves, headers, and shut-off valves into the left and right inlets of the control section.

Gas enters the manifold cabinet and enters a pressure transducer. The pressure transducer displays the bank pressure on the front of the cabinet. The transducer also monitors bank pressure and signals and connected alarms when the system changes from the service to the secondary bank.

Gas then flows to the primary regulators on all manifolds except those for Nitrous Oxide and Carbon Dioxide service (Nitrous Oxide and Carbon Dioxide systems include a 500 SCFH capacity heater). The thermostatically controlled heater warms the gas before entering the regulator, preventing “freeze-up” and loss of pressure due to the extreme low temperatures generated when these gases rapidly expand.

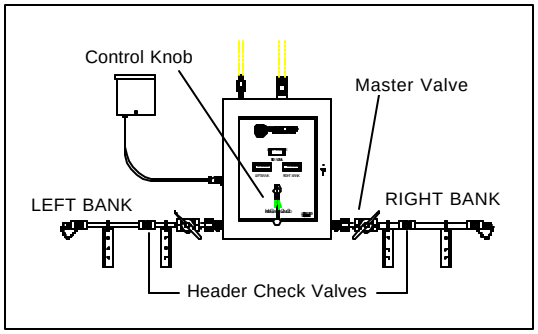


FIGURE 2-1 External Components

The inlet nipple on the primary regulator has an integral check valve. This check valve prevents gas from one bank from feeding out the other bank.

Pressure is regulated in the primary regulators to the pressures noted in the adjustment specification chart in Section 1. Both primary regulators are factory preset to deliver the same pressure. The primary regulators have two ports on the low pressure side. One port is connected to the intermediate relief valve. The other port is the outlet port and is connected via tubing to the four-way valve.

The gas flows from the primary regulators to the four-way valve. The four-way valve assembly has three positions. The center position is **OFF**. The **OFF** position is only used during shipment of the manifold. When the valve knob is rotated counterclockwise to the left position, the valve connects the tubing from the left primary regulator to the outlet tubing on the right of the 4-way valve and connects the tubing from the right primary regulator to the intermediate regulator on the left side of the 4-way valve. The secondary supply is the bank that feeds through the intermediate regulator. When the valve knob is rotated clockwise to the right position, the valve connects the tubing from the right primary regulator to the outlet tubing on the right side of the 4-way valve and connects the tubing from the left primary regulator to the intermediate regulator on the left side of the 4-way valve. Thus by turning the four-way valve knob, the operator may determine which bank of cylinders is the “Service” supply and which bank is the “Secondary” supply.

LEGEND

1– Outlet Adaptor

2– Line Pressure Gauge

3– Ball Valves

4– Line Regulators

5– Intermediate Relief Valve

6– High Pressure Check Valve

7– Four-way Valve

8– Pressure Switch

9– Intermediate Check Valve

10– Left Inlet Block

11– Intermediate Regulator

12– Primary Regulator

13– Intermediate Test Gauge

14– Right Inlet Block

15– High Pressure Transducer

16– Low Pressure Transducer

17– Intermediate Pressure Relief Connection

18– Intermediate Block

19– Line Pressure Relief Valve

20–Relief Outlet Connection

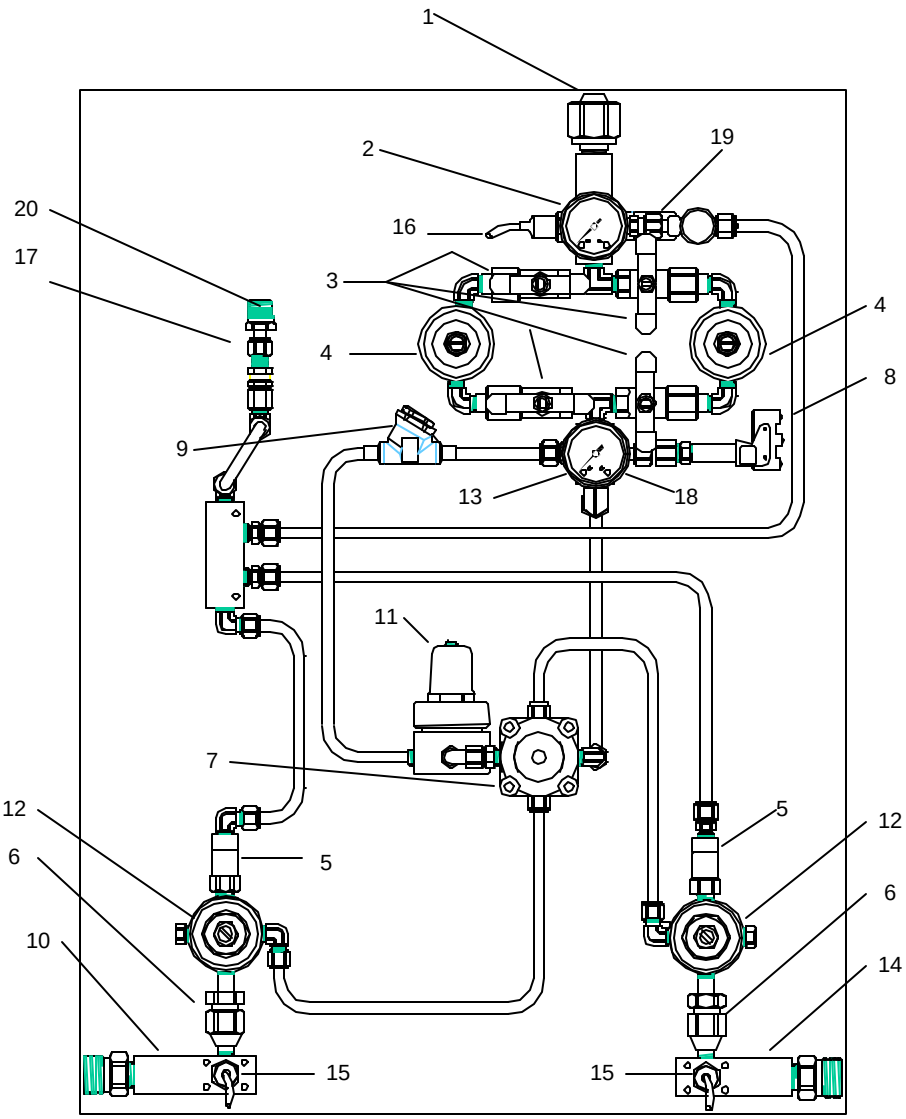


FIGURE 2-2 Internal Components – HGM2 & HGM2HP

LEGEND

1– Outlet Adaptor

2– Line Pressure Gauge

3– Ball Valves

4– Line Regulators

5– Intermediate Relief Valve

6– High Pressure Check Valve

7– Four-way Valve

8– Pressure Switch

9– Intermediate Check Valve

10– Left Inlet Block

11– Intermediate Regulator

12– Primary Regulator

13– Heater Unit*

14– Right Inlet Block

15– High Pressure Transducer

16– Low Pressure Transducer

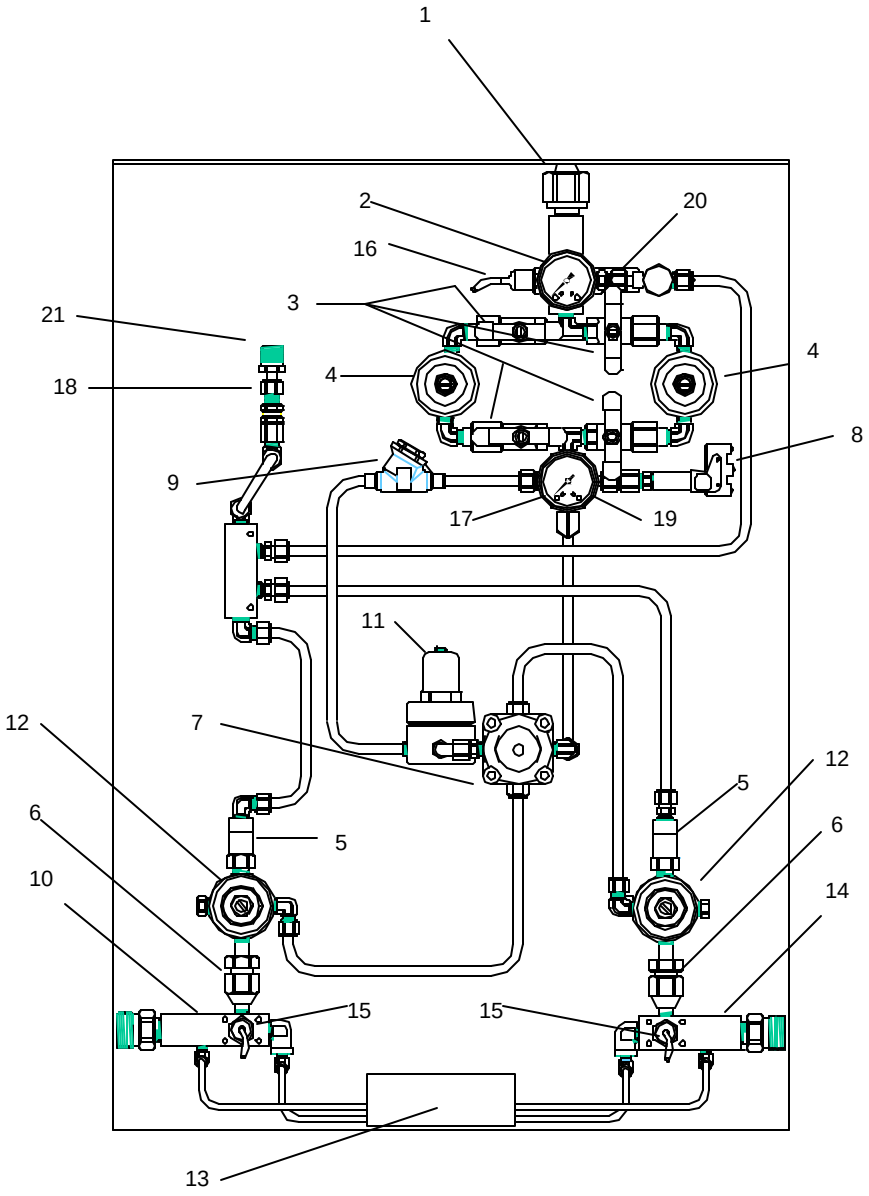
17– Intermediate Test Gauge

18– Intermediate Pressure Relief Connection

19– Intermediate Block

20– Line Pressure Relief Valve

21– Relief Outlet Connection



*Note: Carbon Dioxide an Nitrous Oxide units ordered without a heater do not include item 13.

FIGURE 2-3 Internal Components – HGM2HL

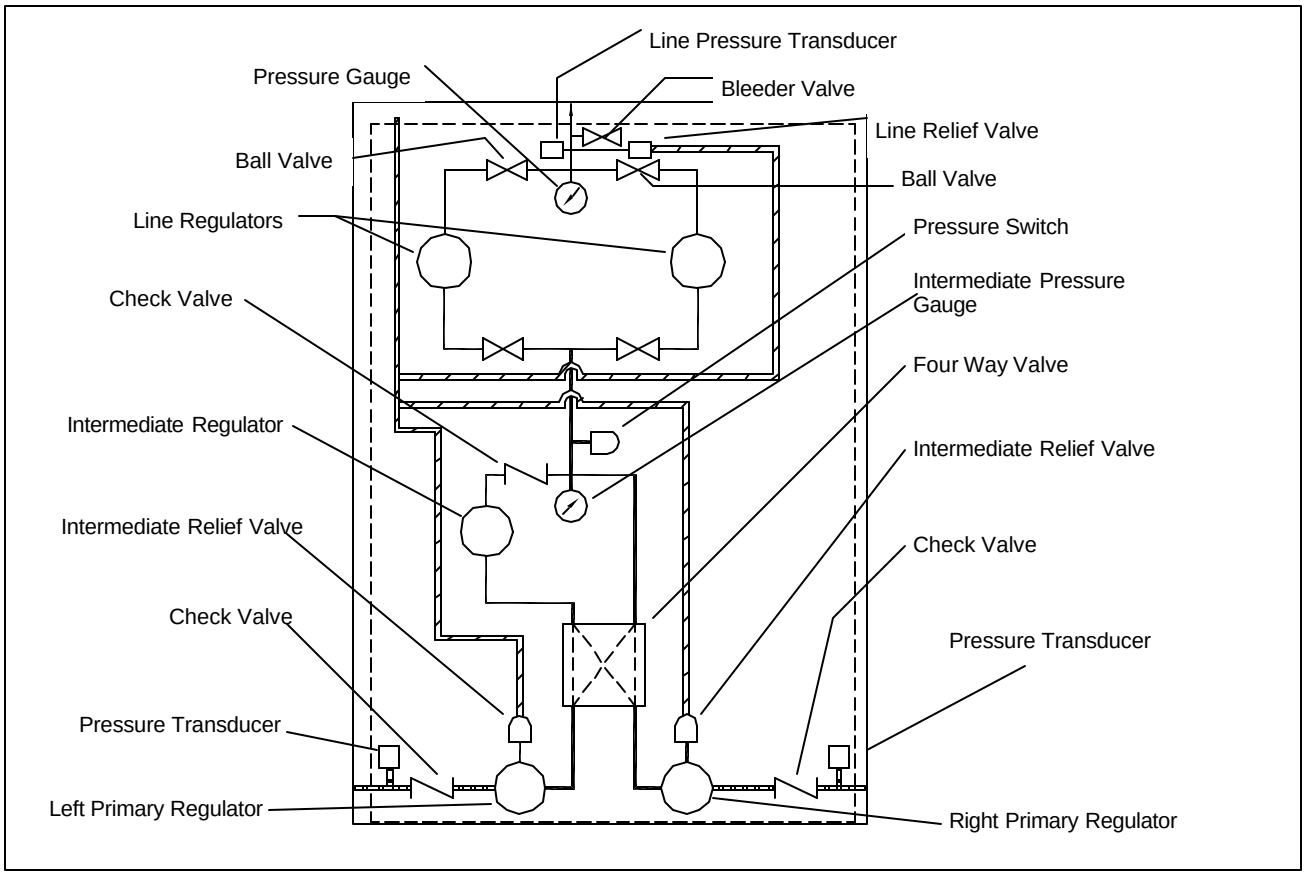


FIGURE 2-4 Piping Schematic – HGM2 & HGM2HP

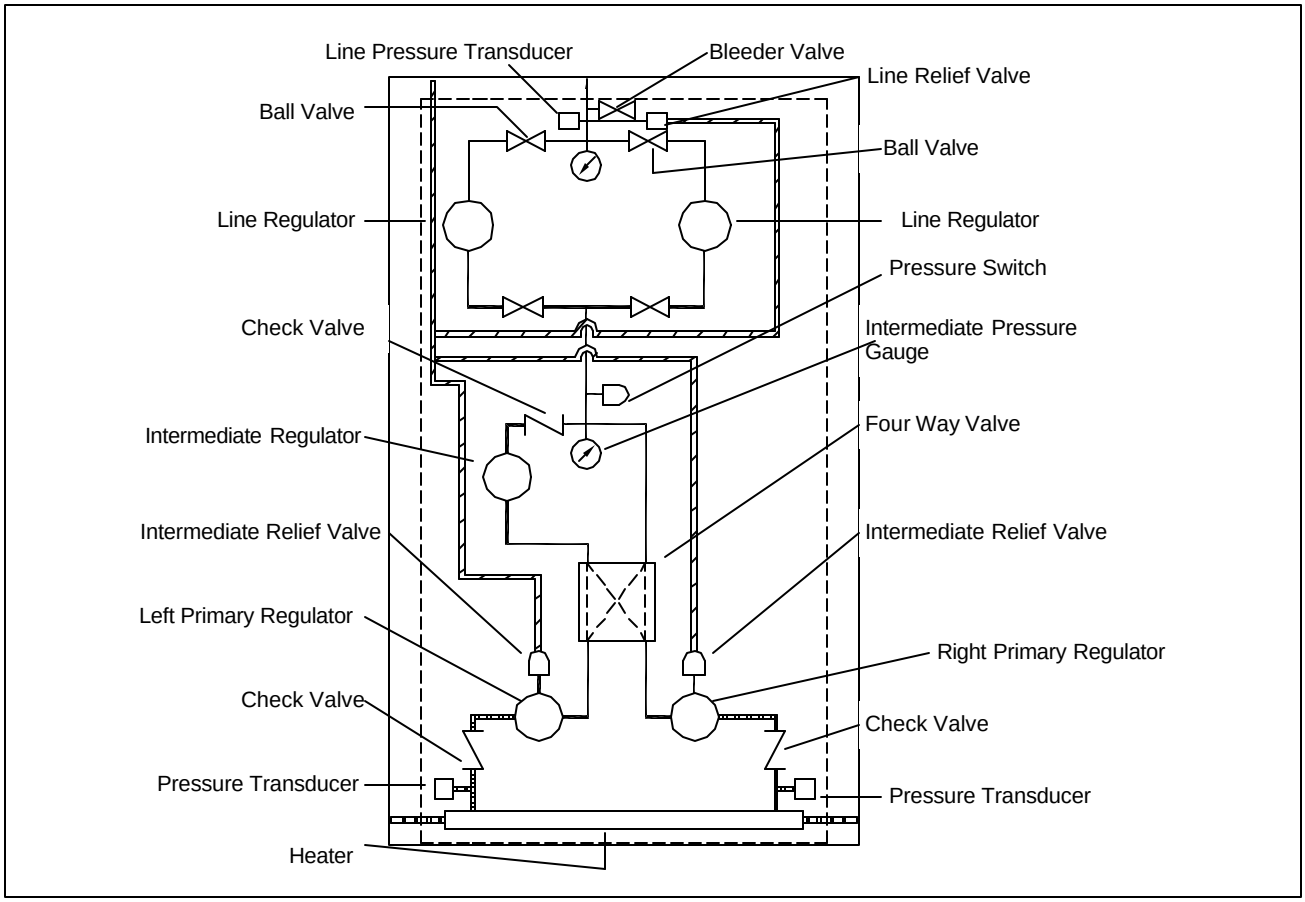


FIGURE 2-5 Piping Schematic - HGM2HL

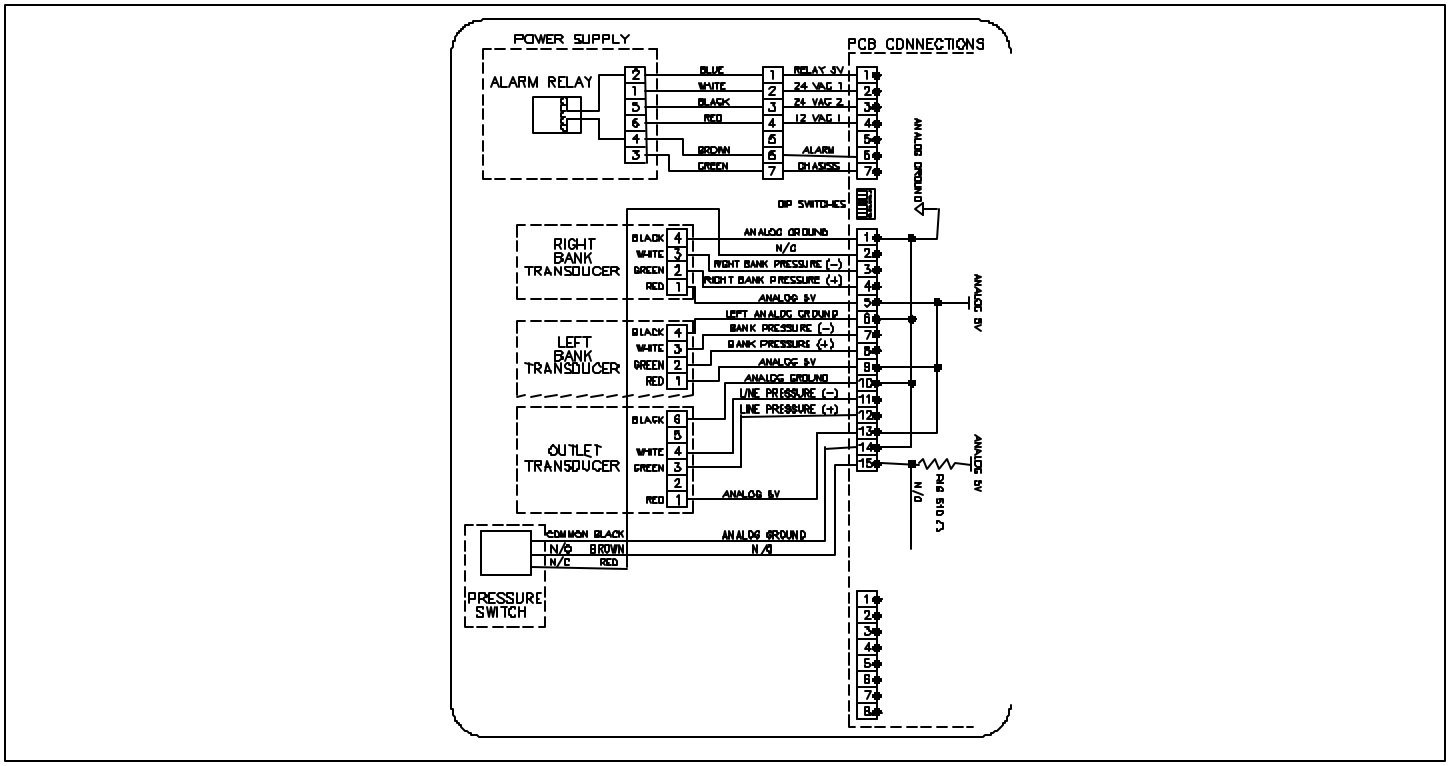


FIGURE 2-6 Electrical Schematic (less heater)

The gas from the “Service” supply is routed through the four-way valve outlet on the right of the four-way valve to the intermediate block assembly. The intermediate block has 4 ports all connected to the same chamber. The gas pressure at all 3 ports is the same as the pressure at the inlet to the block. Gas enters the intermediate block from the “Service” supply through the tubing connected at the bottom. The left port is connected via tubing with check valve from the intermediate regulator. The top port connects to the inlet of the dual line assembly. Attached to the center port is a gauge which indicates intermediate pressure. The right port is connected to a pressure switch.

The pressure switch monitors the intermediate pressure. Should the intermediate pressure drop below a preset level the switch will indicate an alarm condition that changeover has occurred. The switch provides a redundant feature to ensure proper changeover alarming has taken place.

As the gas enters the dual line assembly it can flow to either line regulator. Under normal operation one line regulator will be isolated by closed ball valves. This regulator would only be used if the other regulator failed. Gas flows through the line regulator on the side with the open ball valves. The pressure is reduced to the line pressure which is shown on the line pressure gauge and on the digital display on the front of the cabinet. The line relief valve prevents overpressurization should the line regulator fail. The relief valve settings are noted in the adjustment specifications chart in section 1.

The intermediate pressure relief valves prevents over-pressurization of the intermediate controls of the manifold should one of the primary regulators fail. The relief valve settings are noted in the adjustment specification chart in Section 1.

The tubing connected between the intermediate block and the intermediate regulator allows gas from the “Service” supply to flow back towards a check valve. It also allows gas from the “Secondary” supply to flow from the four-way valve through he intermediate regulator, up to the check valve. When the gas pressure on the service side of the check valve falls to the intermediate regulator set pressure, the check valve opens and routes the gas from the “Secondary” supply into the intermediate block and then to the line pressure regulator.

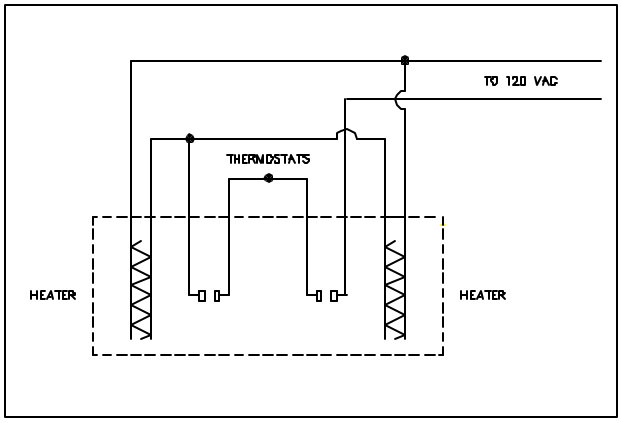


FIGURE 2-7 Heater Electrical Schematic

The line pressure regulator further reduces the pressure to the final pressure delivered to the medical gas piping system. The regulator has one inlet port and three outlet ports. Two outlet ports are plugged. The outlet port is located 180° from the inlet.

Gas flows out of the line regulator and into the outlet block. The outlet block has 4 ports. A line relief valve is connected to the right port. The center port is connected to a line pressure gauge. The left port is connected to the line pressure transducer, which displays the line pressure on the front of the cabinet. The top port is connected to the piping distribution system. The pressure relief valve outlet port should be routed to the outside of the building for manifolds located indoors.

When both cylinder banks are full, the transducers and the switch complete the electrical circuit to display the green "system normal" light. Cylinder pressures for each bank are indicated on the readouts on the manifold front cover. The "Service" supply is indicated by the position of the control knob. The intermediate pressure is indicated by the center gauge located on the intermediate block. The line pressure is indicated by the digital readout, as well as, the gauge located on the outer block.

As the gas from the "Service" supply is depleted, the gas pressure to the "Service" primary regulator will begin to fall. Simultaneously, the pressure to the pressure switch, intermediate block, and the line regulator also falls. When the "Service" side pressure falls below the set point of the bank pressure transducer, the red "replace depleted cylinders" light comes on and the green "system normal" light is extinguished. Any remote alarms are activated at this time. When the "Service" pressure falls to the set point of the intermediate regulator, the check valve between the regulator and the intermediate block is pushed open by the pressure applied from the intermediate regulator. The "Secondary" supply begins to supply the system.

After replacing empty cylinders and opening the cylinder valves, the pressure transducer will extinguish, the red "replace depleted cylinders" light, and the green "system normal" light will come on. The operator should then turn the control knob to the opposite cylinder bank. This will make the partially used "secondary" bank the "Service" supply and the newly installed cylinders will become the "Secondary" supply. The system incorporates a *fail-safe* configuration so that the red light can only be extinguished when sufficient pressure is supplied from both banks.

PRIMARY REGULATORS

The primary regulator's function is to reduce the cylinder pressure of the supply banks to a more usable regulated pressure.

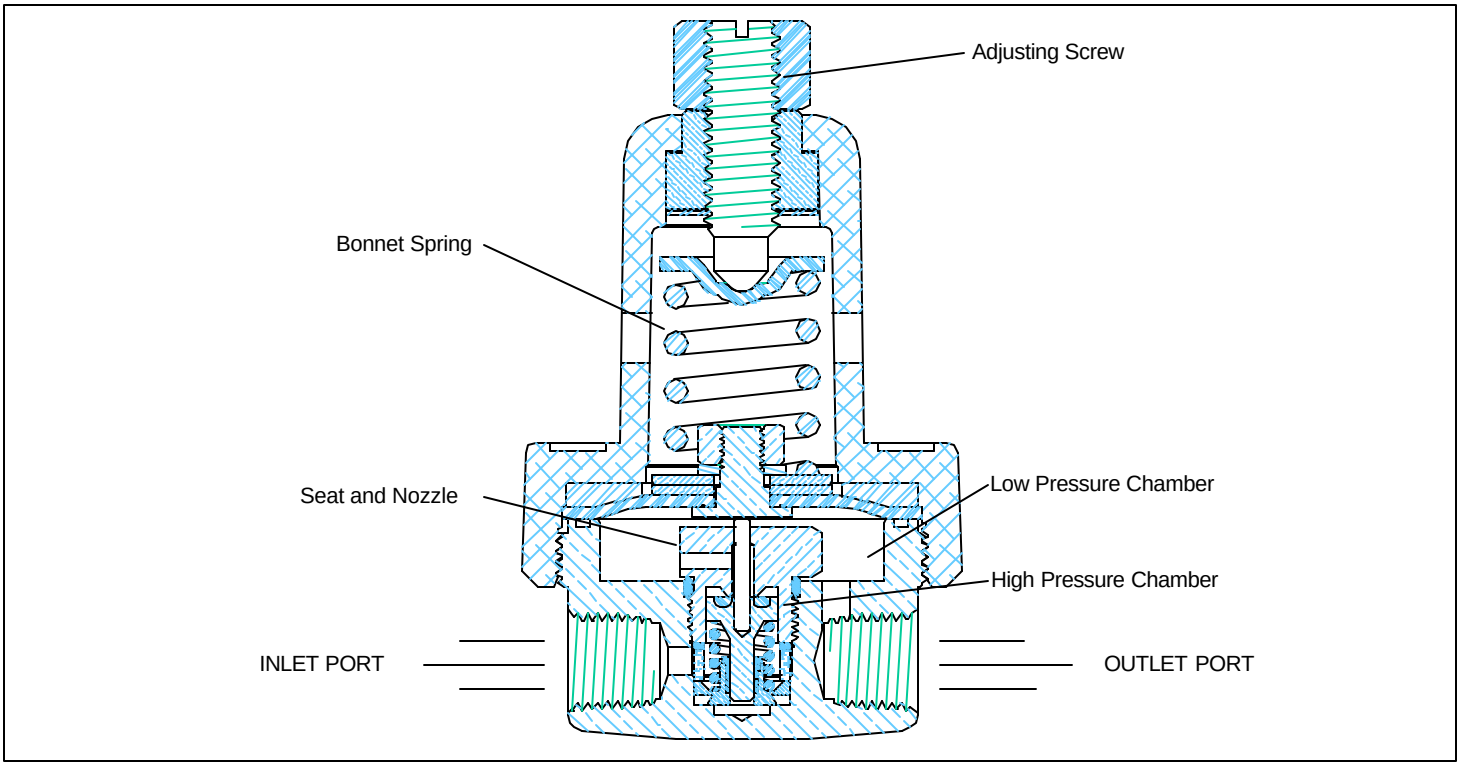


FIGURE 2-8 Primary Regulator

Gas enters the regulator through the inlet port and fills the high pressure chamber and the port to the cylinder contents gauge with gas. See Figure 2-8. Gas in these areas is at the same pressure as the gas in the cylinders. The gas is sealed in this chamber by the seat holder and stem being pushed against the nozzle seal by gas pressure and the body spring. An o-ring seals between the nozzle and the regulator body.

The next area of the regulator is the low (regulated) pressure area of the regulator. This chamber is sealed from the high pressure area by the seat/nozzle assembly and the o-ring around the nozzle and is isolated from the atmospheric pressure by the diaphragm sub-assembly forming a seal around the body of the regulator. The diaphragm is squeezed between the body of the regulator, a slip ring, washer, and the regulator bonnet as the bonnet is tightened down on the body.

The third chamber of the regulator is open to atmospheric pressure. This chamber contains the regulator bonnet, adjusting screw, pivot, bonnet spring, washer, and the top side of the diaphragm sub-assembly.

As the adjusting screw is turned in against the pivot, the bonnet spring is compressed and puts a downward force on the diaphragm sub-assembly. The bottom of the diaphragm sub-assembly is in direct contact with the seat holder and stem. When the diaphragm is forced down by the spring, the stem is pushed away from the nozzle and gas can then flow from the high pressure chamber to the low pressure chamber.

When the low pressure chamber fills with gas, the gas will push upward against the diaphragm sub-assembly. As the pressure continues to build in the low pressure chamber, more upward force will be exerted against the diaphragm and the diaphragm will push up against the bonnet spring compressing the bonnet spring. As the diaphragm is gradually raised by the gas pressure, the seat and nozzle gradually come closer together filling the low pressure chamber slowly and eventually the upward pressure exerted by the gas will be slightly greater than the downward pressure of the bonnet spring and the seat nozzle will close. As gas is released from the low pressure chamber, a proportional amount of gas will be let into the low pressure area from the high pressure chamber. As the adjusting screw is turned in farther and the bonnet spring compressed, the gas pressure required to lift the diaphragm increases, resulting in a higher delivery pressure from the outlet port of the regulator.

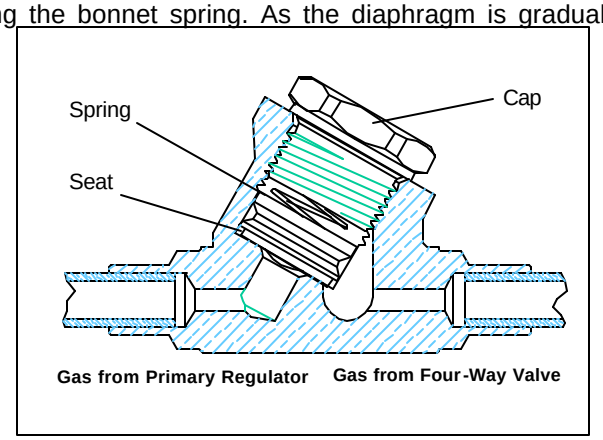


FIGURE 2-9 Check Valve

CHECK VALVES

The check valves prevent gas from flowing backward, See Figure 2-9.

Gas enters the check valve from the primary regulator and pushes the check valve seat assembly away from the sealing surface of the valve body. This allows the gas to flow to the outlet port of the valve. When the gas flow stops, the spring of the check valve pushes the valve seat down on the sealing surface preventing any gas flow backward through the valve.

FOUR-WAY VALVE

The four-way valve assembly is used to route the gas from the primary regulators to either the intermediate block or the differential control valve. The four-way valve has two inlet ports on the back side of the valve and two outlet ports located 180° apart on the sides of the valve. See Figure 2-10.

Figure 2-11a shows the position of the valve ports when the right bank of cylinders is the “Service” bank and the left bank is the “Secondary”.

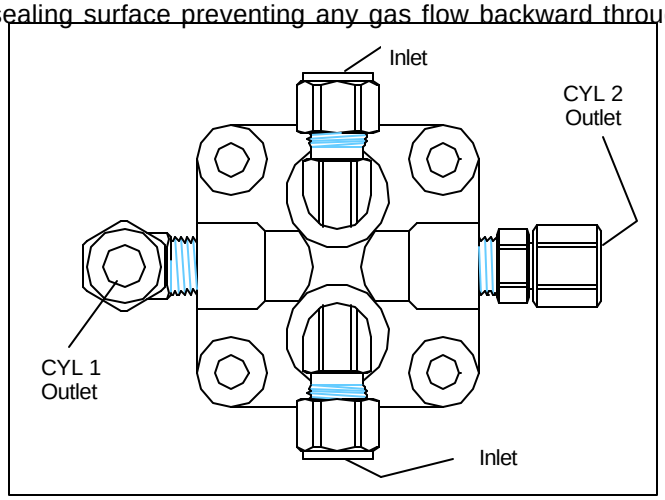


FIGURE 2-10 Four-Way Valve

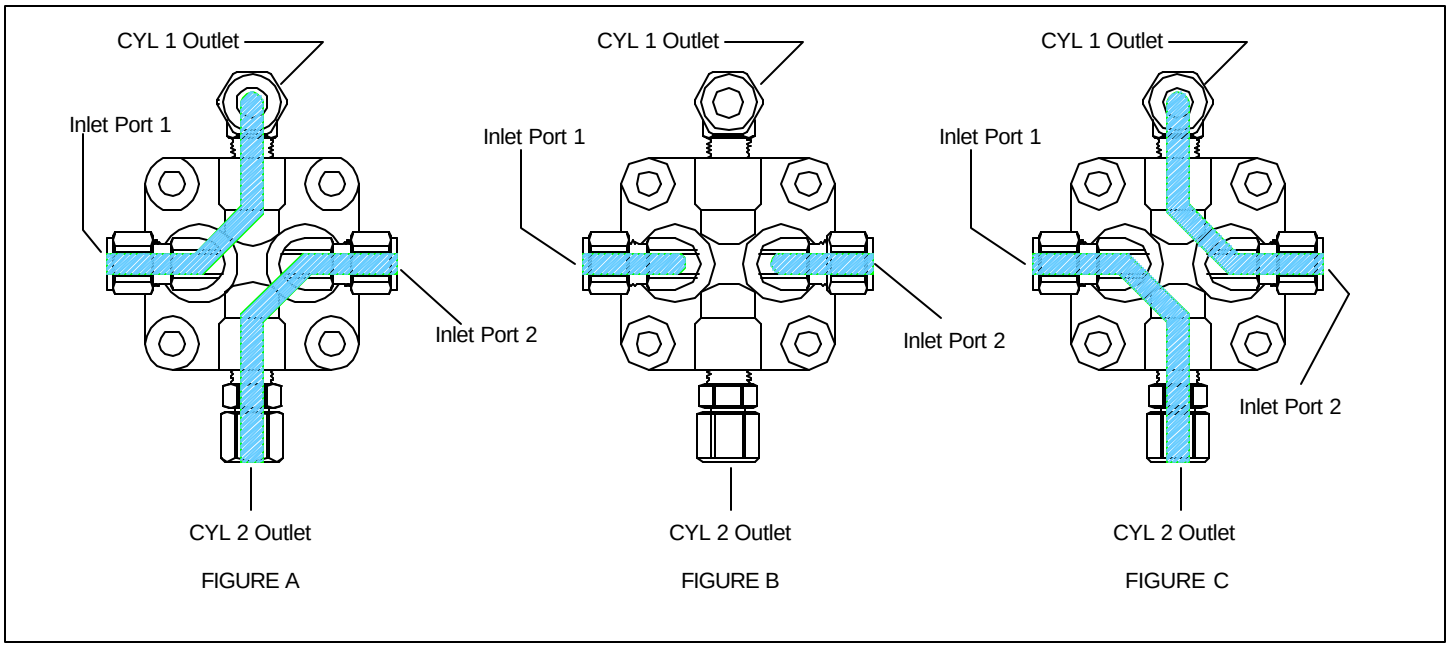


FIGURE 2-11 Four Way Valve

Gas is directed from inlet port **1** to outlet port **CYL1** and from inlet port **2** to outlet port **CYL2** only. The seals in the valve prevent gas from traveling to the other ports. With the valve in this position, the gas from the right primary regulator is routed to the intermediate block and the gas from the left primary regulator is routed to the intermediate regulator.

Figure 2-11b shows the valve in the **OFF** position. The **OFF** position is only used during shipment of the manifold. Notice that the internal porting of the valve shown as dashed lines does not connect any of the inlet ports of the valve with the outlet ports.

Figure 2-11c shows the position of the valve ports when the left bank of cylinders is the “Service” bank and the right bank is the “Secondary”.

The only function the four-way valve serves is to route the gas to the other components of the manifold.

PRESSURE SWITCH

The pressure switch is used as a redundant safety feature to signal “Secondary in Use”. The switch Is a piston type with one common contact, one normally closed contact, and one normally open contact. See Figures 2-12 and 2-13.

When the manifold is pressurized to the normal pressures, the piston in the switch is pushed up. The piston pushes the activator of the switch up. This action closes the normally open contact and opens the normally closed contacts. As gas from the cylinder banks is depleted, the piston moves down, releasing the force against the switch activator. The contacts of the switch then return to the normally open and normally closed positions.

The switch completes the electrical circuits to the indicators on the front of the control section and to the remote alarm interface board in the power supply box.

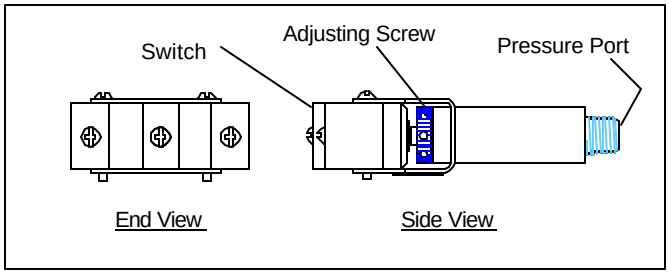


FIGURE 2-12 Low Pressure Switch

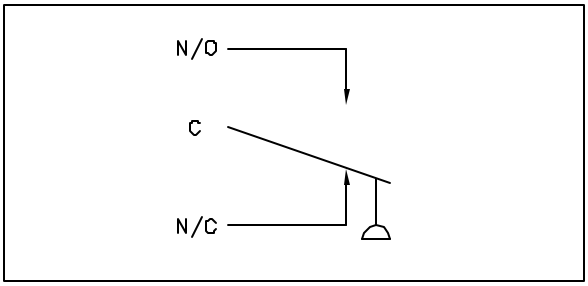


FIGURE 2-13 Switch Schematic

INTERMEDIATE REGULATOR

The intermediate regulator controls the gas flow from the secondary bank of cylinders to the intermediate block. The intermediate regulator pressure setting is the pressure at which the manifold will switchover from “Service” to “Secondary” supply. The intermediate regulator has an inlet port connected to the four-way valve. The outlet port of the intermediate regulator is connected via tubing to the intermediate block. A check valve is located immediately upstream of the regulator.

The regulator is comparable to the line regulator illustrated in Figure 2-14. The regulator seat is held shut by the gas pressure from the “Service” bank regulator not allowing the check valve immediately downstream of the intermediate regulator to open. The gas pressure from the intermediate regulator is pushing against the bottom of the check valve seat. When both cylinder banks are full and the regulators properly adjusted, the pressure on the downstream side of the valve is greater than the intermediate regulator pressure. This pressure *differential* holds the valve closed. Turning the adjusting screw of the intermediate regulator in (clockwise) will increase the inter-mediate regulator pressure thereby increasing the pressure at which the valve will open. Turning the adjusting screw out (counterclockwise) will decrease the intermediate regulator pressure thereby decreasing the pressure at which the valve will open.

As the gas pressure in the “Service” bank of cylinders drops below the setting of the primary regulator, the gas pressure from the “Service” bank primary regulator will begin to fall. When the “Service” pressure falls below the pressure of the intermediate regulator setting as noted in Section 1, the check valve will be pushed open and the secondary bank of cylinders will begin to supply the system.

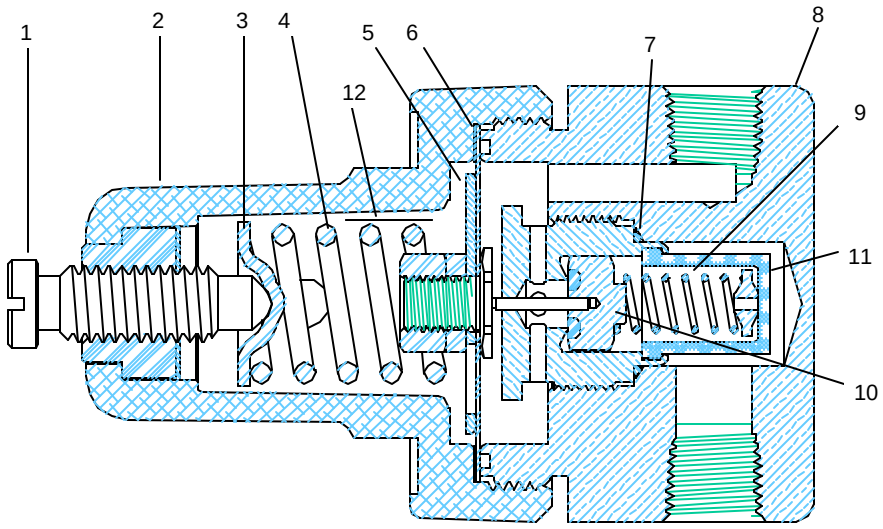
LINE PRESSURE REGULATOR

The line pressure regulator used in the manifold is a single stage, four port adjustable regulator. Refer to Figure 2-14. It has one inlet port and three outlet ports. The inlet port is piped to the outlet of the manifold control assembly. One outlet port is piped to the outlet of the dual line assembly for connection to the main pipeline. The other two outlet ports are plugged.

Gas enters the regulator through the inlet port and with the adjusting screw backed away from the spring, is sealed in the high pressure chamber of the regulator by the seat and nozzle.

As the adjusting screw is turned in, it compresses the spring and puts a downward force on the diaphragm sub-assembly. When the diaphragm is forced down by the spring, it pushes on the stem of the seat assembly. The seat is pushed away from the nozzle and gas can then flow from the high pressure chamber to the low pressure chamber.

When the low pressure chamber fills with gas, the gas will push upward against the diaphragm sub-assembly. As the pressure continues to build in the low pressure chamber, more upward force will be exerted against the diaphragm and the diaphragm will push up against the bonnet spring compressing the bonnet spring. As the diaphragm is gradually raised by the gas pressure, the seat and nozzle gradually come closer together filling the low pressure chamber slowly and eventually the upward pressure exerted by the gas will be slightly greater than the downward pressure of the bonnet spring and the seat nozzle will close. As gas is released from the low pressure chamber, a proportional amount of gas will be let into the low pressure area from the high pressure chamber. As the adjusting screw is turned in farther and the bonnet spring compressed, the gas pressure required to lift the diaphragm increases, resulting in a higher delivery pressure from the outlet port of the regulator.



LEGEND

1 – Adjusting Screw
2 – Bonnet Assembly
3 – Pivot
4 – Adjusting Spring
5 – Diaphragm Assembly
6 – Slip Ring
7 – O-ring
8 – Body
9 – Capsule
10 – Seat Assembly
11 – Filter Screen
12 – Friction Damper

FIGURE 2-14 Line and Intermediate Pressure Regulator

PRESSURE TRANSDUCER

The pressure transducers vary their outlet voltage depending on the pressure being supplied. The voltage output is monitored by the manifold PCB. The voltage is converted to a pressure reading which is displayed on the PCB.

The line pressure transducer is used only to display the delivery pressure of the manifold. The bank pressure transducers display inlet pressures and signal when changeover has occurred.

FIELD TESTING & TROUBLE SHOOTING

The manifold performance tests are use to verify the manifold functional performance. When used in conjunction with the trouble-shooting charts, the technician can verify proper performance or rapidly identify the probable source of the problem.

NOTE:
- All testing should be done using full cylinders. Using partially empty cylinders may result in improperly set components.

PERFORMANCE VERIFICATION PROCEDURE

1. Open the manifold as explained in Section 4.
2. Reinstall the control knob on the shaft of the four way valve.
3. Connect the electrical power source to the manifold and verify that the 2 red lights are on and the 3 pressure displays are illuminated. (The manifold will go through a start up sequence that lasts about 15 seconds when power is supplied)
4. Rotate the control knob counterclockwise to make the left cylinder bank the “Service” supply and the right the “Secondary” supply.
5. Open the master valves located on the cylinder header prior to pressurizing the manifold.
6. **S-l-o-w-l-y** open one cylinder valve on the left bank of cylinders.
7. **S-l-o-w-l-y** open cylinder valve on the right bank of cylinders.
8. Using a leak detect solution, verify that there are no leaks present at the connections.
9. Close the cylinder valves on the left and right banks of cylinders.
10. Open the bleeder valve to create a slight gas flow through the manifold. Vent the system until all gas has been removed from the manifold.
11. Close the bleeder valve.
12. **S-l-o-w-l-y** open one cylinder valve on the left bank of cylinders.
13. Create a slight flow of gas through the bleeder valve. The intermediate gauge should settle and remain constant.
14. Turn off the flow of gas through the manifold.
15. Verify that the intermediate gauge indicated the pressure as shown in the specification chart in Section 1 for the primary regulator.
16. Observe the test gauge for two minutes. Verify that the primary regulator does not exhibit “creep” and or increase in pressure.
17. Verify that the left side cylinder contents gauge indicates a minimum of 2000 psig for Oxygen, Nitrogen, Air, or gas mixtures. Nitrous Oxide and Carbon Dioxide systems should indicate a minimum of 160 psig. Adjust to the proper line pressure if necessary.
18. Verify the line pressure gauge is indicating a minimum of 50 psig on all system except Nitrogen. Nitrogen should indicate a minimum of 160 psig. Adjust to the proper line pressure if necessary.
19. Open the bleeder valve to create a slight flow of gas through the manifold.
20. Observe the intermediate gauge and verify the primary regulator setting under a flow condition. Adjust the left primary regulator as necessary to obtain the required pressure.
21. Turn off the left cylinder valve and allow all gas to vent from the manifold.
22. Close the bleeder valve.

23. Rotate the control knob to its fully clockwise position.

24. **S-l-o-w-l-y** open one cylinder valve on the right bank of cylinders.

25. Complete steps 13-21 for the right primary regulator.

26. Close the bleeder valve.

27. Pressurize the right bank by opening one cylinder valve (knob should point to the right bank).

28. Verify that the line pressure regulator is functioning properly by observing the line pressure gauge for two minutes. The gauge should indicate the same pressure at the end of the two minute period.

29. Open the bleeder valve to create a slight flow of gas through the manifold.

30. Verify that the line pressure regulator maintains a constant pressure by observing the line pressure gauge.

31. **S-l-o-w-l-y** open one cylinder valve on the left bank of cylinders.

32. Observe the cylinder contents pressure gauges to verify cylinder pressure.

33. Close the cylinder valve on the right bank of cylinders.

34. Observe the cylinder contents readouts: the right cylinder bank pressure should begin to drop; the left cylinder bank reading should remain constant

35. Observe the intermediate gauge as the right side pressure continues to drop. As the cylinder pressure drops on the right side, the intermediate area also loses pressure. Verify that the pressure falls to the set point of the Intermediate regulator (see the specification chart in Section 1).

36. **S-l-o-w-l-y** open one cylinder valve on the right bank of cylinders.

37. Verify that the intermediate gauge has returned to the set pressure of the primary regulator.

38. Rotate the control knob counterclockwise to make the left bank the service supply.

39. Close the cylinder valve on the left bank of cylinders.

40. Observe the cylinder contents gauges: the left bank gauge should begin to drop; the right cylinder bank should remain constant.

41. Observe the intermediate gauge as the right side pressure continues to drop. As the cylinder pressure drops on the left side, the intermediate area also loses pressure. Verify that the pressure falls to the set point of the intermediate regulator (see the specification chart in Section 1.

42. **S-l-o-w-l-y** open one cylinder valve on the left bank of cylinders.

43. Verify that the intermediate gauge has returned to the set pressure of the primary regulator.

44. Close the bleeder valve.

45. Disconnect the 3 wires from the manifold wiring harness that leads to the intermediate pressure switch.

46. Connect an ohmmeter across the black and brown wires of the wiring harness. The ohmmeter should indicate approximately zero (0) ohms resistance. If the ohmmeter does not indicate approximately zero (0) ohms, connect the meter across the normally open (N/O) and common (C) terminal on the pressure switch. The ohmmeter should register approximately zero (0) ohms resistance when connected to the switch. Adjust or replace the faulty switch. See Section 4 for servicing the pressure switches. Reconnect the ohmmeter to the black and brown wires.

47. Close the Cylinder valve on the left bank of cylinders.

48. Open the bleeder valve to create a slight flow of gas through the manifold.

49. Verify an ohmmeter reading of infinite resistance as soon as the intermediate gauge pressure drops to the value for the pressure switch setting indicated in the specification chart in Section 1.

50. **S-l-o-w-l-y** open one cylinder valve on the left bank of cylinders.

51. Verify that the ohmmeter returns to approximately zero (0) ohms resistance.

52. Close all cylinder valves and vent all remaining gas from the manifold.

53. Remove the ohmmeter leads from the black and brown wires.

54. Close the bleeder valve.

55. Connect the switch wires to the manifold wiring harness.

56. Observe the cabinet style status indicators. Verify that the green indicator is off and the red indicators are lighted.

57. **S-l-o-w-l-y** open on cylinder valve on the left and right banks of cylinders.

58. Observe the cabinet status indicator. Verify that the green indicator is lit and the red indicators are off.

59. Close the cylinder valve on the right bank of cylinders

60. Open the bleeder valve to create a slight flow of gas through the manifold.

61. Verify that the red light illuminates and the green light is extinguished when the manifold changes over from service to secondary supply

62. **S-l-o-w-l-y** open one cylinder valve on the right bank of cylinders.

63. Rotate the control knob counterclockwise to make the left cylinder bank the service bank.

64. Observe the cabinet system status indicators. Verify that the green indicator is lit and the red indicators are off.

65. Close the cylinder valve on the left bank of cylinders.

66. Verify that the red light illuminates and the green light is extinguished when the manifold changes over from service to secondary supply.

67. Close the bleeder valve and test for leaks using a leak detect solution.

68. **S-l-o-w-l-y** open all cylinder valves on the left and right banks of cylinders.

69. Rotate the control knob to select the bank of cylinder supply the system before service was performed.

70. Remove the control knob from the four-way valve.

71. Reinstall the manifold section cover as explained in Section 4.

SYMPTOM	PROBABLE CAUSE	REMEDY OR CHECK
PRIMARY REGULATOR		
Venting at relief valve.	Over pressure due to creeping or faulty regulation of primary regulator.	Replace regulator seat and nozzle components.
Gas leakage around primary valve body halves.	Loose bonnet.	Tighten bonnet.
Pressure regulator body and bonnet.	Diaphragm leak.	Replace diaphragm.
FOUR-WAY VALVE		
Gas leakage around joint In valve body halves.	Body halves not joined tightly enough.	Tighten screws.
	O-rings worn.	Replace valve.
Gas leakage through body wall.	Porosity holes developed in casing.	Replace valve.
Both banks feeding.	Four-way valve seats leaking.	Replace valve.
INTERMEDIATE PRESSURE REGULATOR		
Gas leakage around regulator body/bonnet.	Loose bonnet.	Tighten bonnet.
Required gas flow not available after change-over occurs.	Intermediate regulator not set correctly.	Adjust intermediate regulator per specifications.
Both banks feeding.	Intermediate regulator set at too high a delivery pressure.	Adjust intermediate regulator per specifications.
	Flow capacity too high.	Reduce flow demand.
LINE PRESSURE REGULATOR		
Gas leakage around regulator body/bonnet.	Loose bonnet.	Tighten bonnet.
Pipeline not at desired pressure.	Line regulator not set correctly.	Set delivery pressure per specifications.
Required gas flow not available.	Line regulator not set correctly.	Set delivery pressure per specifications.
	Flow capacity too high.	Reduce flow capacity.

SYMPTOM	PROBABLE CAUSE	REMEDY OR CHECK
Electrical System		
No indicator lights or displays on front panel come on when power is hooked up.	Power Input.	Check Electrical power supply.
Red indicator light(s) on but both banks are full.	Master valve, header valves, or cylinder valves on bank are closed.	Slowly open valves.
	Wiring to pressure switch not correct.	Check internal leads to the pressure switch.
Red indicator light does not come on when one bank is empty and changeover occurs.	Change-over occurring at too high a pressure.	Adjust intermediate regulator setting.
Green indicator light does not come on even though both banks are full.	Control knob was rotated to select new “service” side without changing empty cylinders.	Replace depleted cylinders.
	Pressure switch wiring incorrect or disconnected.	Check pressure switch wiring.
	Pressure switch set at too high a pressure.	Adjust pressure switch.
	Primary regulator set at too low a pressure.	Adjust primary regulator delivery pressure.
Display reads “0” even when pressure is present.	Pressure transducer wiring disconnected or faulty.	Check pressure transducer and controller board connections.
	Pressure transducer faulty.	Replace transducer.
Display incorrect.	Dip switches set incorrectly.	Check setting of the Dip switches.
	Pressure transducer faulty.	Replace transducer.
One or both of the red indicators are blinking.	Non-volatile memory failure.	Replace the controller board.

This page intentionally left blank

SERVICE PROCEDURES

GENERAL MAINTENANCE

1. Main section
   a) Daily - record line pressure.

   b) Monthly
      1) Check regulators, valves and compression fittings for external leakage.
      2) Check valves for closure ability.

   c) Annually
      1) Check relief valve pressures.
      2) Check primary regulator seats.

2. Manifold header
   a) Daily - observe Nitrous Oxide and Carbon Dioxide systems for cylinder frosting or surface condensation. Should excessive condensation or frosting occur it may be necessary to increase manifold capacity.

   b) Monthly
      1) Inspect valves for proper closure.
      2) Check cylinder pigtails for cleanliness, flexibility, wear, leakage, and thread damage. Replace damaged pigtails immediately.
      3) Inspect pigtail check valves for closure ability.

SAFETY PRECAUTIONS

WARNING
- Repairs to manifold high pressure regulators, valve connections and piping should be made only by qualified personnel, improperly repaired or assembled parts could fly apart when pressurizing causing **death** or serious **injury**.

1. Examine all parts before repair. **Note: Because manifold parts may be exposed to high pressure Oxygen and Nitrous Oxide and the condition of the unrepaired parts is unknown, a repair-inspection should be performed before exposing the parts to high pressure gas.**

2. Keep manifold parts, tools and work surfaces free of oil, grease and dirt. These and other flammable materials may ignite when exposed to high pressure Oxygen or Nitrous Oxide.

3. Use only proper repair tools and parts. Parts for Western manifolds are shown in this instruction. Special tools are called out as needed.

4. Before connecting the cylinder to the manifold, momentarily open and close the cylinder valve to blow out any dirt or debris.

5. After connecting the cylinder to the manifold, open the cylinder valve **s-l-o-w-l-y** to allow the heat of compression to dissipate.

6. Use only cleaning agents, sealants, and lubricants as specified in this instruction.

CLEANING, LUBRICATION, AND SEALING

Clean metal parts of the manifold with isopropyl alcohol or 1,1,1 trichloroethylene solvent prior to assembly. Dry thoroughly. Do not clean o-rings with this solvent.

Teflon® Tape Application

Threaded pipe connections should be sealed with Teflon® tape.

Remove the old sealant from both male and female threads. Apply Teflon® tape to the male pipe thread. Approximately 1 1/2 turns of tape should be sufficient. Do not cover the first thread with tape. Assemble the fittings wrench tight to effect a gastight seal.

Assembly and Disassembly of Compression Fittings

NOTE:
- Incorrect re-assembly of fittings may initially seal, however they may start to leak over time.

Mark the fitting and nut prior to disassembly. Before re-tightening, make sure the assembly has been inserted into the fitting until the ferrule seats in the fitting. Retighten the nut by hand. Torque the nut with the wrench until the marks line up, which indicates that the fitting has been tightened to its original position. A noticeable increase in mechanical resistance will be felt indicating the ferrule is being resprung into sealing position. Then snug the nut 1/12 of a turn (1/2 of a wrench flat) past the original position.

Leak Testing

There are four types of manifold piping connections: sealed (soldered), threaded (unions and elbows), compression (tubing connections), and gasket (diaphragms and o-rings).

When a leak is suspected and cannot be easily located, a leak detector solution should be applied to all connections (in the event of leaks at more than one connection). Be certain to wipe fittings dry after testing to prevent corrosion (Western's LT-100 leak detector dries clean and will not harm apparatus).
If a leak is detected at:

sealed connections, replace the assembly which is joined by the leaking connection.

threaded connections, union sealing surfaces may have burrs or nicks which may be polished out. Be certain to clean parts before reassembly. If the surface will not seal, replace the union. Elbows and tees may be cleaned of old sealant and resealed with Teflon® tape. Refer to cleaning, sealing, and lubricating instructions.

compression fittings, sealing surfaces of fittings or brass ferrules may be damaged and must be replaced. Refer to the parts list for appropriate tubing.

gasket seals, leaks may occur at seals made by gaskets such as diaphragms or o-rings. Gas may leak to atmosphere or across the seal into the opposite pressure circuit. External leaks are evidenced by application of leak detector while leaks across the seal are detected by faulty manifold function. When replacing seals, use care not to damage sealing surfaces.

GENERAL REPAIR PROCEDURES

Be sure all pressure and electrical power is removed from the system prior to initiating any repair procedures.

WARNING
- Do not shutdown the manifold until personnel have been advised of the intended service and all patients requiring medical gas are being supplied from portable supplies. Patients still on the pipeline will not receive gas.

Replace parts with **all** components in the repair kit.

HOW TO OPEN THE MANIFOLD

Disassembly

1. Using the 5/32 allen wrench provided with manifold, remove the knob.

NOTE:
- Prior to removing the knob, make note of the knob orientation. When re-attaching the knob it should be oriented in the same position as when it was removed.

2. Turn the latch counter-clockwise and open the door.

3. The knob should be reattached with the door open to allow the four-way valve to be rotated.

Reassembly

1. Reverse order of disassembly.

MANIFOLD CABINET COVER REMOVAL

Disassembly

1. Open the manifold as explained in the “How to open the manifold” section.

NOTE:
- Prior to removing the knob, make note of the knob orientation. When re-attaching the knob it should be oriented in the same position as when it was removed.

2. Disconnect the two wire harness terminal blocks from the manifold PCB.

3. Using the appropriate screwdriver (or 1/4” hex wrench) remove the 4 screws (2 on each side) holding the cover in place.

4. Carefully pull the cover straight out to clear the components.

Reassembly

1. Reverse order of disassembly

HOW TO DEPLETE THE SECONDARY BANK

1. Open the manifold as explained in the “How to open the manifold” section.
2. Rotate the knob to make the bank that is going to be service the “secondary” bank.
3. Close the cylinder on the “secondary” bank.
4. Mark the compression fitting at the outlet of the primary regulator per the instructions on page 4-2.
5. Crack open the compression fitting and allow the reserve bank to deplete.

CAUTION:
- The compression fitting on the secondary bank primary regulator should be used to deplete pressure from the reserve bank. If a different fitting is used, there may be pressure trapped in the secondary bank.

6. Once pressure has been depleted retighten the fitting per the instructions on page 4-2.

HOW TO SHUTDOWN THE MANIFOLD

1. Turn off the piping system isolation valve, if present. If an isolation valve is not present, the entire buildings gas piping system will be reduced to atmospheric pressure.
2. Open the manifold as explained in the “How to open the manifold” section.

WARNING
- Do not shutdown the manifold until all personnel have been advised of the intended service and all patients requiring medical gas are being supplied from portable supplies.

3. Turn off right and left supply bank cylinder valves.
4. Open the bleeder valve to vent residual gas from the system.
5. Close the bleeder valve once all gas has depleted.

GAUGE REPLACEMENT

Removal

1. Shutdown the manifold and open the manifold as explained in the “How to open the manifold” and “How to shut down the manifold” sections.
2. Using a 9/16 open end wrench remove the pressure gauge from the system.
3. Remove old sealant from the 1/4 NPT female pipe threads.

Replacement

1. Apply Teflon® tape to the 1/4 NPT male pipe thread on the new gauge and reassemble in the reverse order of the removal procedure.
2. Make sure gauge face is properly oriented through the front of the gauge plate.
3. Re-assemble the case per the “How to shut down the manifold” and “How to open the manifold” sections.

PRIMARY REGULATOR REPAIR

NOTE:
- Removal and Replacement procedures are to be followed only if the primary regulator assembly is to be scrapped. All service may be performed to the primary regulator without removing it from the manifold.

Shutdown the manifold and open the manifold as explained in the “How to open the manifold” section.

NOTE:
- This item may be repaired/replaced without shutting down the manifold completely. To work on the manifold while it is still in service follow the steps outlined in “How to deplete the secondary bank”.

Removal

1. Mark the compression fittings per the instructions on page 4-2. Using an 11/16" open end wrench, disconnect the outlet tubing and relief tubing from the regulator at the compression fitting joints.

2. Using two 1 1/8” hex wrenches disconnect the regulator from the inlet block at the CGA union connection.

Disassembly

1. Remove the nut from the regulator by turning it counterclockwise using a 3/4" hex wrench.

2. Using a flat blade screwdriver, turn the adjusting screw counterclockwise until it turns freely and all compression is removed from the bonnet spring.

3. Using a 1 3/8" hex wrench, rotate the bonnet counterclockwise and remove it along with the pivot, bonnet spring, washer, slip ring, and diaphragm sub-assembly.

4. Using a 13/16" hex socket wrench, rotate the nozzle counterclockwise and remove it along with the seat holder and stem, compensating spring, and the spring retainer.

5. Clean all interior surfaces of the regulator body with isopropyl alcohol or 1,1,1 trichloroethylene solvent.

6. Blow out the regulator body and ports with oil free Air or Nitrogen to remove all foreign materials and dry all surfaces.

CAUTION:
- Do not stand directly in front of the body or ports when performing the next step. Eye protection should be worn to protect the service technician. Chips and debris may be propelled into unprotected eyes.

Reassembly

1. Apply a thin coating of Fluorolube® S-30 lubricant to the o-rings.

CAUTION:
- See section 5 for a picture showing the proper assembly of the regulator.

2. Assemble small o-rings with the spring retainer. Push the smaller o-ring to the bottom of the bore it rests in.

3. Assemble the large o-ring with the nozzle.

4. Insert the new seat holder and stem into the nozzle.

5. Place the spring filter and Teflon gasket over the seat holder and stem.

6. Place the spring retainer on the compensating spring. The boss on the retainer will enter the internal diameter of the spring.

7. Grasp the flats of the nozzle with one hand and carefully guide the seat/nozzle assembly into the body of the regulator until the threads are engaged. Rotate the nozzle clockwise and hand tighten.

8. Using the 13/16" hex socket and torque wrench, tighten the nozzle to approximately 5 ft-lbs. torque.

9. Lubricate the outer (regulator body to diaphragm) sealing surface of the regulator body with a small amount of water. Do not allow water to enter the low pressure chamber of the regulator.

10. Hold the bonnet upside down and place the pivot and bonnet spring in the bore provided. The small diameter of the pivot should enter the internal diameter of the spring.

11. Place the washer in the large bonnet cavity, beveled side up.

12. Lay the slip ring on top of the washer.

13. Insert the diaphragm sub-assembly in the bonnet cavity. The side marked “UP” should be against the slip ring.

14. Carefully place the bonnet on the regulator body. Rotate the bonnet clockwise and tighten to 85-95 ft-lbs. torque.

Replacement

1. Connect the inlet of the regulator to the CGA bushing located on the inlet block handtight.

2. Connect the compression fitting to the primary regulator finger tight.

3. Tighten the CGA connection on the regulator inlet using two 1 1/8 wrenches.

4. Using an 11/16” open end wrench, connect the outlet and relief tubing to the 3/8” tube compression fittings. When retighting the compression fittings follow the procedure outlined on page 4-2.

Primary Regulator Adjustment

1. If not already done, open the manifold by following the “How to open the manifold: as explained earlier in this section.

2. Remove the nut from the primary regulator.

3. Reinstall the control knob on the four-way valve in the same orientation as it was prior to removal. Rotate the knob to select the side the regulator is to be adjusted is on.

4. If the bank is not pressurized, **s-l-o-w-l-y** open the cylinders on the side of the regulator to be adjusted.

5. Verify the cylinder pressure readout indicates a minimum pressure of 2000 psig on Oxygen, Air, and Nitrogen systems or a minimum of 700 psig on Nitrous Oxide and Carbon Dioxide systems.

6. Create a slight slow of gas by cracking open the bleeder valve.

7. Using a flat blade screwdriver, turn the adjusting screw of the regulator while observing the test gauge. (rotating the set screw clockwise will increase the regulator setting, while rotating it counterclockwise will lower the regulator setting). Set the regulator to the pressure indicated on the Adjustment Specification chart in section 1.

8. Close the bleeder valve. The test gauge will go up slightly higher than the flowing adjusted pressure.

9. Verify that the regulator does not creep by observing the test gauge for two minutes. The gauge must indicate the same pressure at the end of the two minute period.

10. Install the nut on the primary regulator.

PRESSURE SWITCH REPLACEMENT

Removal

1. Open and shutdown the manifold as explained in the “How to open the manifold” and “How to shut down the manifold” sections.

2. Using an 11/16" and 5/8" open end wrenches, remove the pressure switch from the intermediate block.

3. Label the three wires attached to the switch. Loosen the slot head screws on the pressure switch using a flat blade screwdriver and remove the wires.

Replacement

1. Using an 11/16" and a 5/8" open end wrench, Install the pressure switch on the primary regulator and tighten to effect a gastight seal.

2. Complete the adjustment instructions below prior to installing the signal wires to the pressure switch.

Pressure Switch Adjustment

1. Connect an ohmmeter to the normally closed and common electrical contacts on the switch. The ohmmeter should register zero resistance.

2. Begin pressurizing the service bank manifold by opening one cylinder valve on the side of the manifold switch is on: At the actuation pressure, the ohmmeter reading will jump from zero resistance to infinite resistance.

3. Close the cylinder valve.

4. Open the bleeder valve slightly to relieve pressure from the manifold while observing the test gauge and ohmmeter to determine switch setting: At actuation pressure, the ohmmeter reading should drop from infinite resistance to zero resistance.

5. Close the bleeder valve.

6. Using a allen wrench, turn the knurled adjustment screw on the pressure switch clockwise to raise the set point or counterclockwise to lower the set point. The pressure switch should be set per the Adjustment Specification chart in Section 1.

7. Cycle between actuation and re-actuation signal and make adjustments as required to achieve the signal setting. The setting should be made on descending pressure. Make adjustments in response to the reading obtained in step 4.

WARNING:
- Be sure power is off when electrical connections are made. Current flowing though the wires may shock the service technician, or damage the Ohmmeter.

8. After the setting has been made, connect the signal wires to the appropriate contacts on the pressure switch.

CHECK VALVE REPAIR – INTERMEDIATE

Removal

1. Open and shutdown the manifold as explained in the “How to open the manifold“ and “How to shut down the manifold” sections.

2. Mark the compression fittings per the instructions on page 4-2. Disconnect the tubing at the compression fittings from the four-way valve and the intermediate block using an 11/16" open end wrench.

3. Remove the check valve and tubing assembly from the control section.

Disassembly

1. Secure the check valve in a vise or similar holding fixture. Using a 1 1/8" hex wrench, rotate the valve cap counterclockwise and remove.

2. Remove the seal washer from the valve cap.

3. Pull the spring from the valve body.

4. Using a small needle nose pliers or tweezers, grasp the valve poppet and remove it from the valve body.

5. Clean the interior of the valve body with isopropyl alcohol or 1,1,1 trichloroethylene solvent.

CAUTION:
- Do not stand directly in font of the valve when performing the next step. Eye protection should be worn to protect the service technician. Chips and/or debris may be propelled into unprotected eyes.

6. Blow out the check valve body with oil free Air or Nitrogen to remove all foreign material and dry all surfaces.

Reassembly

1. Insert a new valve poppet into the valve body.

2. Insert the spring into the valve body.

3. Position the new seal washer in the groove of the valve body.

4. Place the valve cap over the spring and push the cap towards the body until the threads engage. Rotate the cap clockwise and tighten securely.

Replacement

1. Position the check valve and tube assembly in the control section with the check valve flow arrow pointing towards the intermediate block.

2. Connect the compression fittings to the four-way valve and intermediate block using an 11/16" open end wrench and tighten to effect a gastight seal. When retightening the compression fitting follow the procedure outlined on page 4-2.

CHECK VALVE REPLACEMENT – PRIMARY REGULATOR

1. Remove the primary regulator from the manifold as described in the “Primary Regulator Repair” section.

2. Place the regulator in a vice or similar holding fixture.

3. Using an 11/16 open end wrench remove the check valve nipple from the regulator inlet port.

4. Remove any remaining pipe sealant from the regulator inlet port.

5. Teflon® tape the threads on the replacement check valve nipple.

6. Using an 11/16 open end wrench, tighten the check valve nipple into the regulator.

7. Install the regulator back in the manifold as described in the “Primary regulator repair” section.

FOUR-WAY VALVE REPLACEMENT

Removal

1. Open and shutdown the manifold as explained in the “How open the manifold” and “How to shut down the manifold” sections.

2. Mark the compression fittings per the instructions on page 4-2. Disconnect the three tubing assemblies at the compression fittings to the four-way valve and loosen the compression fittings at the other end of the tubing assemblies using an 11/16" open end wrench.

3. Using a 11/16 wrench to loosen and disconnect the union fitting on the left side of the four-way valve.

4. Use a phillips screwdriver to remove the two screws that secure the four-way valve to the support bracket and remove the four-way valve assembly.

5. Secure the valve assembly in a vise or similar holding fixture and use a 5/8” open end wrench to remove the two inlet and two outlet adpators from the valve for use on the replacement valve.

6. Remove the old sealant from the 1/4 NPT male pipe threads on the compression fittings.

Replacement

1. Apply Teflon® tape to the 1/4 NPT male pipe threads on the compression fittings.

2. Secure the new four-way valve in a vise.

3. Install the fittings in the same orientation as they were removed (see sections 5 for the proper valve assembly configuration).

4. Remove the valve from the vise and position it behind the support bracket with the **CYL 2** port on the left and the **CYL 1** port on the right.

5. Reinstall the two screws through the bracket and into the two bottom threaded holes of the valve. Tighten with a phillips screwdriver.

6. Reconnect the tubing to the new valve. When retightening the compression fittings follow the procedure outlined on page 4-2.

7. Reconnect the intermediate regulator to the left port of the new valve.

8. Using the 11/16” open end wrench, tighten the compression fitting at the ends of the tubing assemblies to effect a gastight seal. When retightening the compression fittings follow the procedure outlined on page 4-2.

INTERMEDIATE PRESSURE REGULATOR REPAIR

Removal

1. Shutdown and open the manifold as explained in “How to open the Manifold” and “How to shutdown the Manifold” sections.

NOTE:
- This item may be repaired/replaced without shutting down the manifold completely. To work on the manifold while it is still in service follow the steps outlined in “How to Deplete the Secondary Bank” section.

2. Mark the compression fittings at the regulator outlet per the instructions on page 4-2. Disconnect the tubing at this compression fitting using an 11/16" open end wrench.

3. Disconnect the union fitting between the intermediate regulator and the four-way valve.

4. Remove the intermediate regulator from the control section.

Disassembly

1. Remove the intermediate regulator following the instructions above.

2. Rotate the adjusting screw of the regulator counter clockwise with a flat blade screwdriver and remove.

3. Remove the bonnet by holding the body hex with a wrench to stabilize the assembly and using another wrench to loosen the bonnet. The adjusting spring vibration dampaner and pivot will come off with the bonnet.

4. Remove the diaphragm assembly and slip ring.

5. Using a 1" socket wrench, rotate the seat capsule counterclockwise and remove the seat capsule.

CAUTION:
- Do not stand directly in front of the body and ports when performing the next step. Eye protection should be worn to protect the service technician. Chips and/or debris may be propelled into unprotected eyes.

6. Blow out the regulator body and ports with oil free Air or Nitrogen to remove all foreign materials and dry all surfaces.

Re-assembly

1. Assemble the new seat capsule into the regulator body and torque to 20-25 ft-lbs.

2. Place the pivot on the bonnet spring and insert inside the regulator bonnet.

3. Insert the vibration dampaner between the spring and the bonnet.

4. Assemble the slip ring diaphragm onto the slip ring (diaphragm should be against the regulator body).

5. Assemble the bonnet to the regulator while the regulator is inverted and torque to 40-50 ft-lbs.

Replacement

1. Position the intermediate regulator in the control section with the inlet connecting to the four-way valve. The inlet of the four-way valve. The inlet of the regulator is stamped INLET.

2. When retightening the fitting the procedure outlined on page 4-2 shall be followed. Connect the compression fittings using an 11/16" open end wrench and tighten to effect a gastight seal.

Intermediate Regulator Adjustment

1. If not already done, open the manifold as explained in the “How to open the Manifold” section. Reinstall the four-way valve knob and rotate to select one bank of cylinders as the supply bank.

2. **S-l-o-w-l-y** open the cylinder valves on the secondary supply bank.

3. Close the cylinder valves on the service bank.

4. Open the bleeder valve slightly to relieve pressure from the manifold while observing the intermediate gauge.

5. Allow the gas to vent until the intermediate gauge stabilizes or indicates less than the setting for the intermediate regulator listed in the Adjustment Specification chart in Section 1.

    - If the gauge stabilizes at a pressure higher than the chart specification, turn the adjusting screw on the intermediate regulator counterclockwise to decrease the gauge reading.

    - If the gauge stabilizes at a pressure lower than the chart specification, turn the adjusting screw on the intermediate regulator clockwise to increase the gauge reading.

6. Close the bleeder valve.

7. Pressurize the service bank.

8. Simulate the changeover sequence from both sides and observe the intermediate gauge to verify proper setting.

LINE REGULATOR REPAIR

NOTE:
- Removal and Replacement procedures are to be followed only if the line regulator assembly is to be scrapped. All service may be performed to the line regulator without removing it from the manifold.

Open the valves isolating the bypass line regulator and close the valves isolating the regulator being serviced.

Removal

1. Using 7/8" and 1" wrenches, disconnect the union connections on both sides of the line regulator.
2. Remove the regulator from the dual line assembly.

Disassembly

1. Remove the intermediate regulator following the instructions above.
2. Rotate the adjusting screw of the regulator counter clockwise with a flat blade screwdriver and remove.
3. Remove the bonnet by holding the body hex with a wrench to stabilize the assembly and using another wrench to loosen the bonnet. The adjusting spring vibration dampaner and pivot will come off with the bonnet.
4. Remove the diaphragm assembly and slip ring.

CAUTION:
- Do not stand directly in front of the body and ports when performing the next step. Eye protection should be worn to protect the service technician. Chips and/or debris may be propelled into unprotected eyes.

5. Using a 1" socket wrench, rotate the seat capsule counterclockwise and remove the seat capsule.
6. Blow out the regulator body and ports with oil free Air or Nitrogen to remove all foreign materials and dry all surfaces.

Reassembly

1. Assemble the new seat capsule into the regulator body and torque to 20-25 ft-lbs.
2. Place the pivot on the bonnet spring and insert inside the regulator bonnet.
3. Insert the vibration dampaner between the spring and the bonnet.
4. Assemble the slip ring diaphragm onto the slip ring (diaphragm should be against the regulator body).
5. Assemble the bonnet to the regulator while the regulator is inverted and torque to 40-50 ft-lbs.

Replacement

1. Assemble the union fitting from the regulator that were removed into the new regulator.
2. Insert the regulator into the dual line assembly.
3. Using 7/8" and 1" open end wrenches, tighten the union fittings.
4. Open the ball valve supplying the regulator and leak check the union connections.
5. Close the ball valves isolating the regulator for future service.

Line Regulator Adjustment

1. Open the manifold as described in the “How to open the Manifold” section.
2. **S-l-o-w-l-y** open the ball valves that were isolating the regulator.
3. Close the ball valves isolating the regulator that is not being adjusted.
4. Verify the cylinder pressure gauge indicates a minimum pressure of 2000 psig on Oxygen, Air, and Nitrogen systems or a minimum of 700 psig on Nitrous Oxide and Carbon Dioxide systems.
5. Open the bleeder valve to create a slight flow of gas. Using a flat blade screwdriver, turn the adjusting screw of the regulator in while observing the line pressure gauge. Set the regulator to the desired pressure.
6. Open the bleeder valve to create a slight flow of gas through the manifold.
7. Readjust the regulator to the proper specifications if necessary.
8. Tighten the union connection to the main supply line. The line pressure gauge will go up slightly higher than the lowing adjusted pressure.
9. Verify that the regulator does not creep by observing the line pressure gauge for two minutes. The gauge must indicate the same pressure at the end of the two minute period.

PCB Replacement

Removal

1. Open the manifold as explained in the “How to open the Manifold” section.
2. Remove power by disconnecting the cable from the power supply.
3. Remove the 4 hex nuts holding the PCB cover in place.
4. Remove the 2 wire clips from the PCB.
5. Pop the PCB off the door.

Replacement

1. Align the PCB on the standoffs and carefully press into place.
2. Install the two wire clips to the PCB.
3. Install the PCB cover and tighten the 4 hex nuts.
4. Reconnect power.

ELECTRICAL POWER-UP (Circuit Boards with 6 DIP Switches)

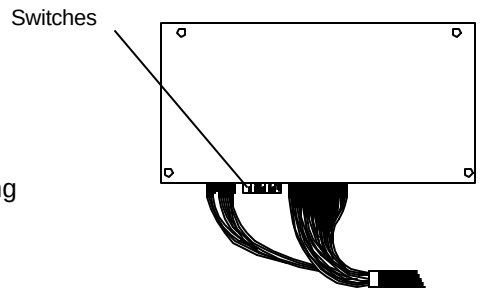
1. When power is applied to the manifold, the displays will first cycle through a power up sequence before displaying the pressures. This process takes about 16 seconds.
   - All of the Status indication lights will be lit.
   - The lights will go out sequentially.
   - The state of the DIP switches will be shown on the digits of the right bank display and the right most digit to the left of the left bank display as a series of “1”s and “0” s.
   - The display will show all “8”.
   - Each digit of the display will be lit individually.

2. The displays and status indicators will then be allowed to operate normally.

UNITS OF MEASURE

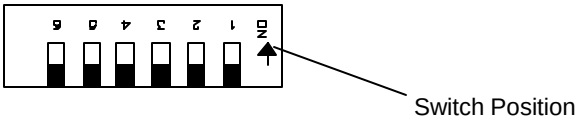
1. The HGM2 manifold can be configured to display pressure in PSI, KPA, or BAR. The manifold is shipped with PSI as the default unit of measure. To switch the units proceed to step 2. If PSI units are desired no changes are necessary and step 2 may be skipped.

2. To change the units, perform the following steps:
   - Remove power to the manifold (switches are only read during power-up).
   - Open the door of the manifold.
   - Locate the switches at the bottom edge of the PC Board on the door.

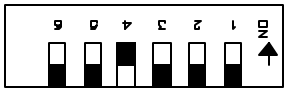


- For PSI set the switches as shown:

Models HGM2, HGM2HL:

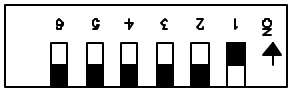


Model HGM2HP:

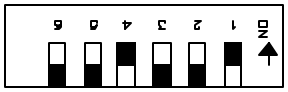


- For KPa set the switches as shown:

Models HGM2, HGM2HL:

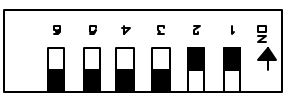


Model HGM2HP:

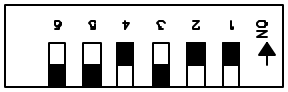


- For BAR set the switches as shown:

Models HGM2, HGM2HL:



Model HGM2HP:



- Close the cover and reconnect power to the manifold.
- Verify that during power-up the status of the switches are displayed on the digits of the right bank display and the right most digit of the left bank display as a series of “1”s and “0”s as follows:

DIP SWITCH/DISPLAY OPTION

- For PSI:

Models HGM2, HGM2HL

Left Display Digit **Right Display Digit**

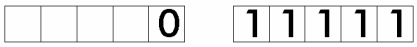
Model HGM2HP

Left Display Digit **Right Display Digit**

- For KPA:

Models HGM2, HGM2HL

Left Display Digit **Right Display Digit**



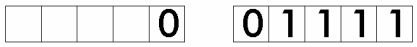
Model HGM2HP

Left Display Digit **Right Display Digit**

- For BAR:

Models HGM2, HGM2HL

Left Display Digit **Right Display Digit**



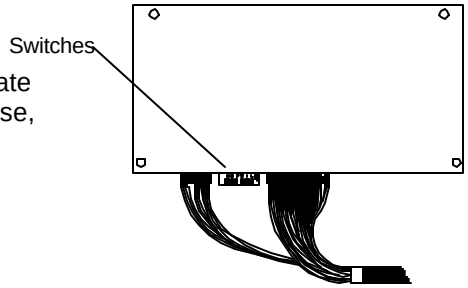
Model HGM2HP

Left Display Digit **Right Display Digit**

ELECTRICAL POWER-UP (Circuit Boards with 7 Dip Switches)

Software version 4.0.x and higher*:

1. When power is applied to the manifold, the displays will first cycle through a power up sequence before displaying the pressures. This process takes about 12 seconds.
   - All three status indication lights will be lit.
   - The state of the DIP switches will be shown on the right bank display and right most digits of the left bank display. A “1” represents each open switch; a “0” for closed.
   - The status lights will extinguish in the order: green, left red, right red.
   - Each digit of the displays will read “8”.
   - A pressure switch status test will be conducted. If the red and green status lights are on, the pressure switch is in an open state (no inlet pressure, wired incorrectly, broken connection). Otherwise, no status lights will be on.
   - Each digit of the display will be lit individually.



2. The displays and status indicators will then be allowed to operate normally.

Software version 2.02*

1. When power is applied to the manifold, the displays will first cycle through a power up sequence before displaying pressure. This process takes approximately 16 seconds.

   - All three status indication lights will be lit.
   - The lights will turn off in the order: green, left red, right red.
   - The state of the DIP switches will be shown on the digits of the right bank display and the right most digits of the left bank. A “1” represents each open switch; a “0” for closed.
   - Each digit of the displays will read “8”.
   - Each digit of the displays will be lit individually.

2. The displays and status indicators will then be allowed to operate normally.

*Software version located on back of PCB.

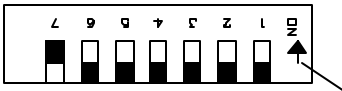
UNITS OF MEASURE

1. The HGM2 manifold can be configured to display pressure in PSI, KPA, or BAR. The manifold is shipped with PSI as the default unit of measure. To switch the units proceed to step 2. If PSI units are desired no changes are necessary and step 2 may be skipped.

2. To change the units, perform the following steps:
   - Remove power to the manifold (switches are only read during power-up).
   - Open the door of the manifold.
   - Locate the switches at the bottom edge of the PC Board on the door.

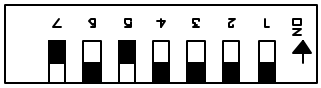
- For PSI set the switches as shown:

Models HGM2:

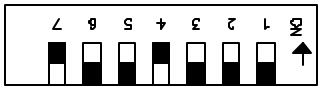


Switch Position

Model HGM2HL:

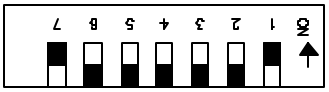


Model HGM2HP:

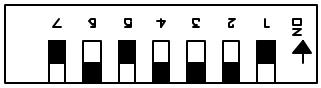


- For KPa set the switches as shown:

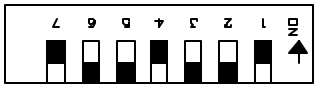
Models HGM2:



Model HGM2HL:

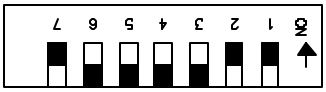


Model HGM2HP:

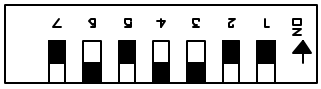


- For BAR set the switches as shown:

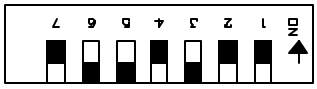
Models HGM2:



Model HGM2HL:



Model HGM2HP:



- Close the cover and reconnect power to the manifold.
- Verify that during power-up the status of the switches are displayed on the digits of the right bank display and the right most digit of the left bank display as a series of “1”s and “0”s as follows:

DIP SWITCH/DISPLAY OPTION

- For PSI:

Models HGM2

Left Display Digit	Right Display Digit
11	11110

Model HGM2HL

Left Display Digit	Right Display Digit
11	11010

Model HGM2HP

Left Display Digit	Right Display Digit
11	10110

- For KPA:

Models HGM2

Left Display Digit	Right Display Digit
01	11110

Model HGM2HL

Left Display Digit	Right Display Digit
01	11010

Model HGM2HP

Left Display Digit	Right Display Digit
01	10110

- For BAR:

Models HGM2,

Left Display Digit	Right Display Digit
00	11110

Model HGM2HL

Left Display Digit	Right Display Digit
00	11010

Model HGM2HP

Left Display Digit	Right Display Digit
00	10110

TRANSDUCERS – HIGH PRESSURE
Removal

1. Shutdown and open the manifold as explained in the “How to shut down the Manifold” and “How to open the Manifold” sections.

NOTE:
- This item may be replaced without shutting down the manifold completely. To work on the manifold while it is still in service follow the steps in “How to open the Manifold” and “How to deplete the Service Bank” sections.

2. Using a 7/8” open end wrench turn the high pressure transducer counter-clockwise. If gas is heard escaping, stop rotating the transducer and wait for the trapped pressure to deplete.

3. Clean any remnant of Teflon Tape from the port on the inlet block.

Replacement

1. Apply Teflon tape to the 1/4 NPT thread on the new transducer.

2. Using a 7/8” open end wrench thread the transducer into the inlet block.

TRANSDUCER – LINE PRESSURE
Removal

1. Shutdown and open the manifold as explained in the “How to shut down the Manifold” and “How to open the Manifold” sections.

NOTE:
- The manifold must be fully shut down in order to replace the line pressure transducer.

2. Using a 7/8” open end wrench turn the high pressure transducer counter-clockwise. If gas is heard escaping, stop rotating the transducer and wait for the trapped pressure to deplete.

3. Clean any remnants of Teflon Tape from the port on the inlet block.

Replacement

1. Apply Teflon Tape to the 1/4 NPT thread on the new transducer.

2. Using a 7/8” open end wrench thread the transducer into the inlet block.

MANIFOLD MAINTENANCE & REPAIR PARTS

REPLACEMENT PIGTAILS

24" Stainless Steel Flexible Braid with Check Valves

PFP-320CV-24 ..... CGA 320 for Carbon Dioxide (CO_2) Service
PFP-326CV-24 ..... CGA 326 for Nitrous Oxide (N_2O) Service
WPR-63CV-24..... CGA 540 for Oxygen (O_2) Service
PFP-92CV-24 ..... CGA 580 for Inert Gas Service (N_2) except Helium
PFP-346CV-24 ..... CGA 346 for Breathing Air (Air) Service

24" Synthetic Fiber Braid Hose with Check Valve

PFS-92CV-24 ..... CGA 580 for Helium (He) Service (for non medical service).

GAUGES – 2" Diameter, 1/4" NPT Back Port

WMG-3-3 ..... 100 psi…..Line gauge HGM2, HGM2HL
WMG-3-4 ..... 400 psi…..Intermediate gauge

REGULATORS

Primary Regulators

WMS-13-27 ..... Right Primary Regulator for HGM2 – Air, He, N_2
WMS-13-4..... Right Primary Regulator for HGM2 – Oxygen and Medical Mixture
WMS-13-29 ..... Primary Regulator for HGM2HL – CO_2 & N_2O
WMS-13-31 ..... Primary Regulator for HGM2HP – Air, He, N_2
WMS-13-26 ..... Left Primary Regulator for HGM2 – Air, He, N_2
WMS-13-8..... Left Primary Regulator for HGM2 – Oxygen and Medical Mixture
WMS-13-28 ..... Primary Regulator for HGM2HL – CO_2 & N_2O
WMS-13-30 ..... Primary Regulator for HGM2HP – Air, He, N_2

Line and Intermediate Regulators

WLR-13-60R ..... Right Line Regulator for HGM2 & HGM2HL – series manifolds
WLR-13-200R ..... Right Line Regulator for HGM2HP – series manifolds
WLR-13-60L..... Left Line Regulator for HGM2 & HGM2HL – series manifolds
WLR-13-200L ..... Left Line Regulator for HGM2HP – series manifolds
WLR-13-125..... Intermediate Regulator for HMG2 & HGM2HL – series manifolds
WLR-13-225..... Intermediate Regulator for HGM2HP – series manifolds

REGULATOR REPAIR KITS

Primary Regulator Kits

RK-1037 ..... Repair Kits for WMS-13-26(L & R), WMS-13-27 (L & R), WMS-13-28 (L & R), WMS-13-29 (L & R) WMS-13-30 (L & R), WMS-13-31 (L & R) Primary Regulators
RK-1038 ..... Repair Kits for WMS-13-9 (L & R), WMS-13-8 (L & R) Primary Regulators

REGULATOR REPAIRS KITS (continued)

Line & Intermediate Regulator Kits

RK-1160…….. ..Repair Kit for all line regulator and intermediate regulators

VALVES AND VALVE REPAIR KITS

WMS-1-65..... CGA 320 Check Valve Bushing
WMS-1-59..... CGA 326 Check Valve Bushing
WMS-1-62..... CGA 346 Check Valve Bushing
WMS-1-53..... CGA 540 Check Valve Bushing
WMS-1-54..... CGA 580 Check Valve Bushing
WMS-1-64.....CGA 280 Check Valve Bushing
WMS-13-14..... Four-Way Valve
WMV-2-16..... Master Valve
RK-1041 ..... Repair Kit for Low Pressure Check Valve
RK-1085 ..... Repair Kit for WMV-2-16

PRESSURE SWITCHES

WME-4-4..... All Gases except Oxygen
WME-4-4C .....For Oxygen Manifolds

POWER SUPPLY REPLACEMENT PARTS

WMS-13-23..... Power Supply Assembly (transformer, PCB with dry contacts, case, and cable)
WME-8-85..... Power Supply PCB for 8570D (includes dry contact for remote alarms)

TRANSDUCERS

WME-9-1A ..... Inlet Transducer
WME-9-2A ..... Line Transducer for HGM2HP
WME-9-3A ..... Line Transducer for HGM2 & HGM2HL

MANIFOLD PCB

WME-8-84..... Manifold PCB

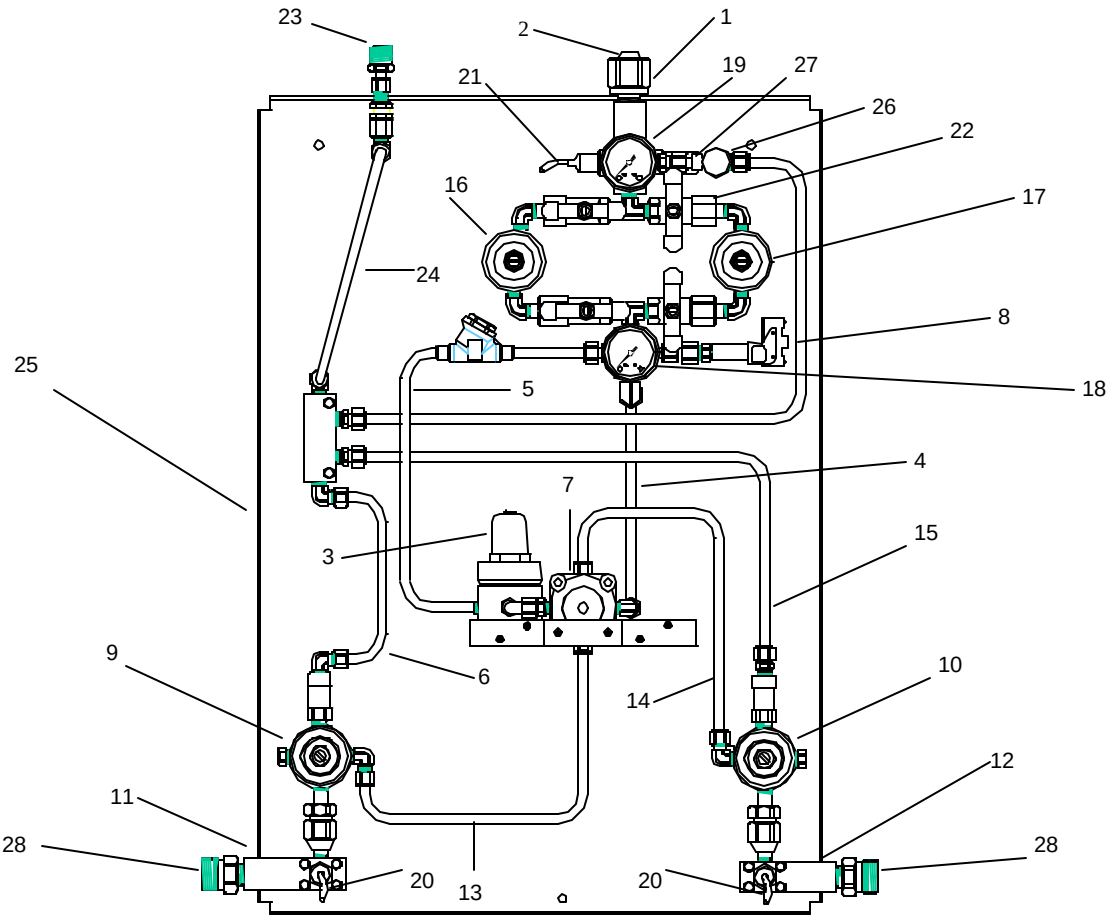
HGM2 SERIES PRINTED CIRCUIT BOARD-CALIBRATED
WME-8-84A ..... PCB-Calibrated for HGM2 (Air, He, N_2, O_2)
WME-8-84B ..... PCB-Calibrated for HGM2HL (CO_2, N_2O)
WME-8-84C ..... PCB-Calibrated for HGM2HP (Air, He, N_2, O_2)

Western Enterprises

Automatic Changeover Manifold
HGM2 & HGM2HP Series

Repair Drawing

Components & Miscellaneous Hardware

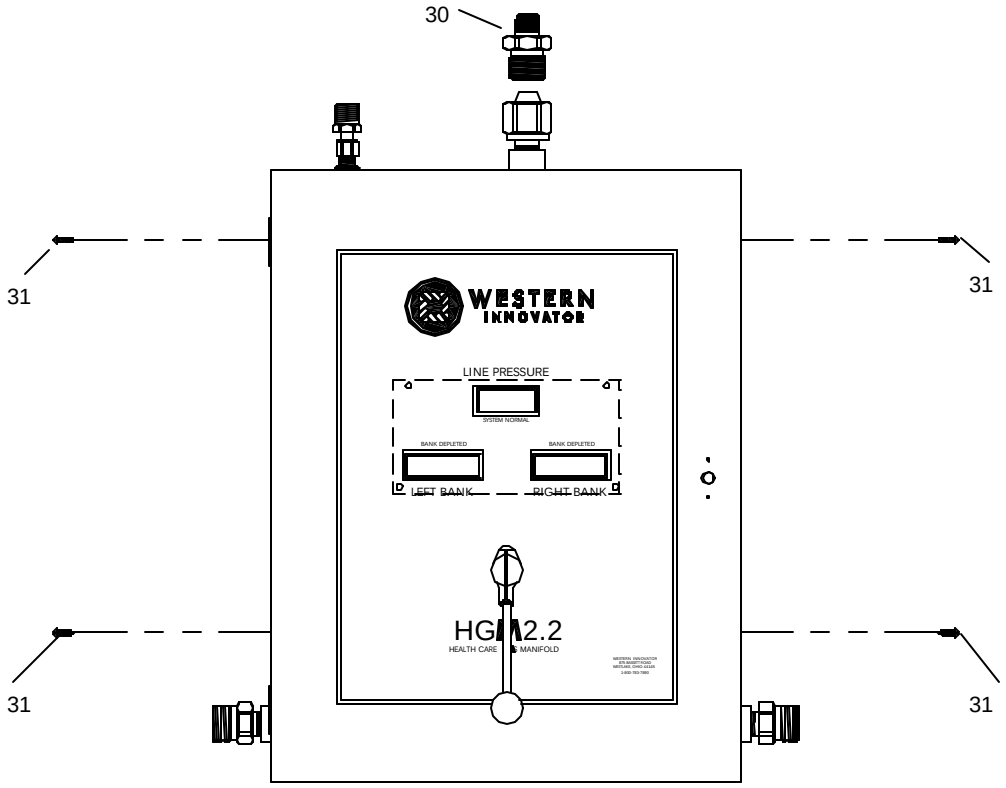


* Not Shown

KEY #	DESCRIPTION	PART #
1	Outlet Nut	D-7
2	Outlet Nipple	D-20
3	Intermediate Regulator	See Page 5-1
4	4 way to Intermediate Tube	WMS-13-19
5	Inter. Reg. to Block Tube	WMS-13-20
6	Left Relief Tube	WMS-13-15
7	Four Way Valve	WMS-13-14
8	Pressure Switch	
	HGM2 & HGM2HP	WME-4-4
	HGM2-9 (oxygen)	WME-4-4C
9	Left Primary Regulator	See Page 5-1
10	Right Primary Regulator	See Page 5-1
11	Left Inlet Block	WMS-13-4
12	Right Inlet Block	WMS-13-3
13	Left Primary to 4 way Tube	WMS-13-17
14	Right Primary to 4-way Tube	WMS-13-18
15	Relief Tubing, Right Prim. Reg.	WMS-13-16
16	Left Line Regulator Assembly	
	HGM2	WLR-13-60L
	HGM2HP	WLR-13-200L

KEY #	DESCRIPTION	PART #
17	Right Line Regulator Assembly	
	HGM2	WLR-13-60R
	HGM2H	WLR-13-200R
18	Intermediate Gauge	WMG-3-4
19	Line Pressure Gauge	
	HGM2	WMG-3-3
	HGM2HP	WMG-3-4
20	Inlet Transducer	WME-9-1A
21	Line Transducer	
	HGM2	WME-9-3A
	HGM2HP	WME-9-2A
22	Ball Valve	WMV-5-12
*	Ball Valve O Ring	RO-016E
23	Relief Union	WLF-3-12
24	Relief Outlet Tube	WMS-13-21
25	Backplate Assembly	WMS-13-24
26	Bleeder Valve	203
27	Line Relief Valve	
	HGM2	WMV-4C-75
	HGM2HP	WMV-4C-250
28	Inlet Union	WMS-1-40

B20318 ECN-13116 (0501)



KEY #	DESCRIPTION	PART #
29	Case	WMC-2-56A
30	Outlet Union	D-34
31	# 8 Sht. Metal Case Screw	WMC-6-23
*	Case Wiring Harness	WMS-13-25
*	Switch Wiring Harness	WMS-1-13
*	Power Supply Box	WME-13-23
*	Manifold PCB	WME-8-84

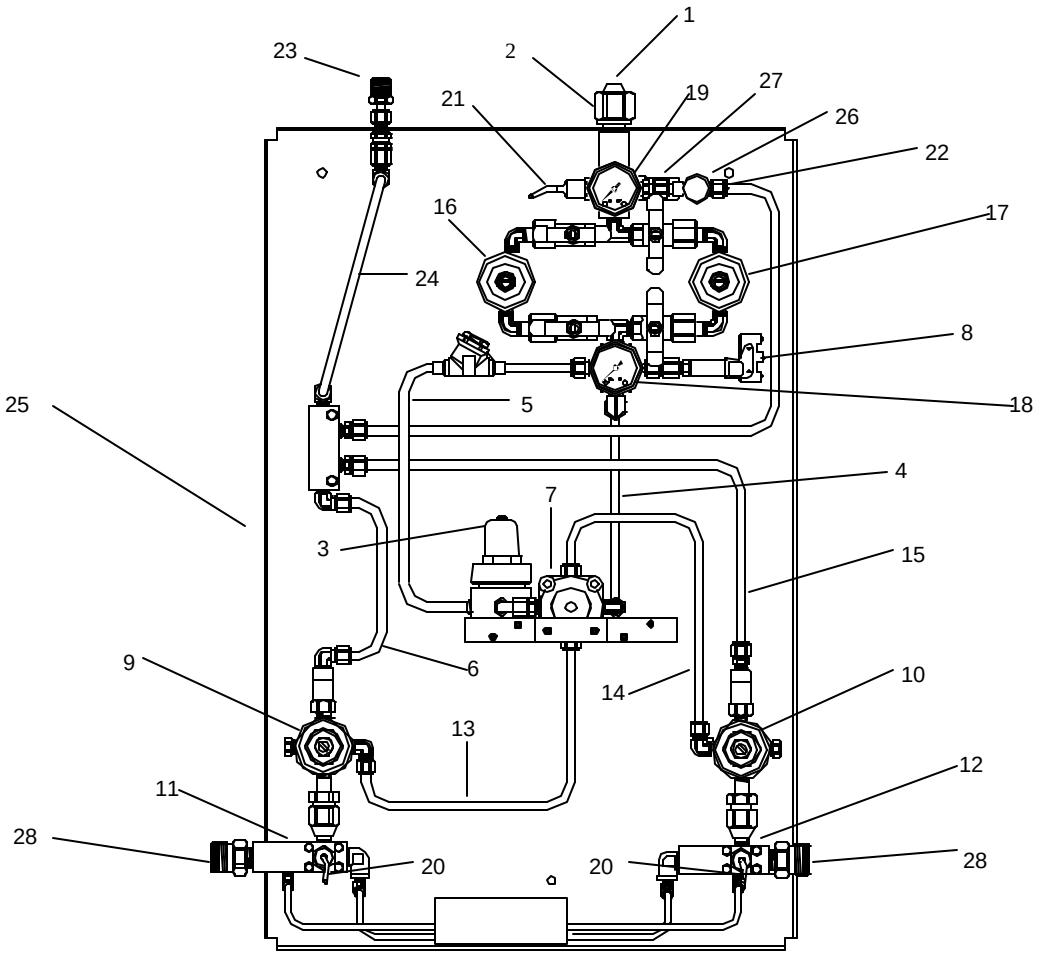
* Item not pictured

Western Enterprises

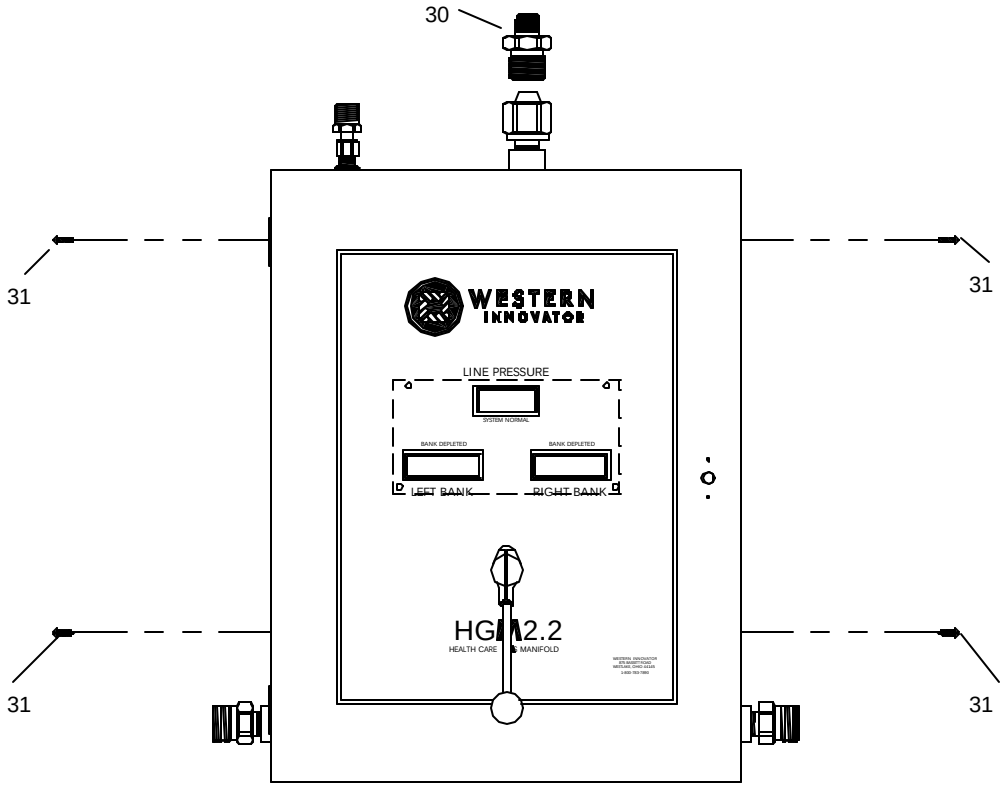
Automatic Changeover Manifold
HGM2HL Series

Repair Drawing

Components & Miscellaneous Hardware

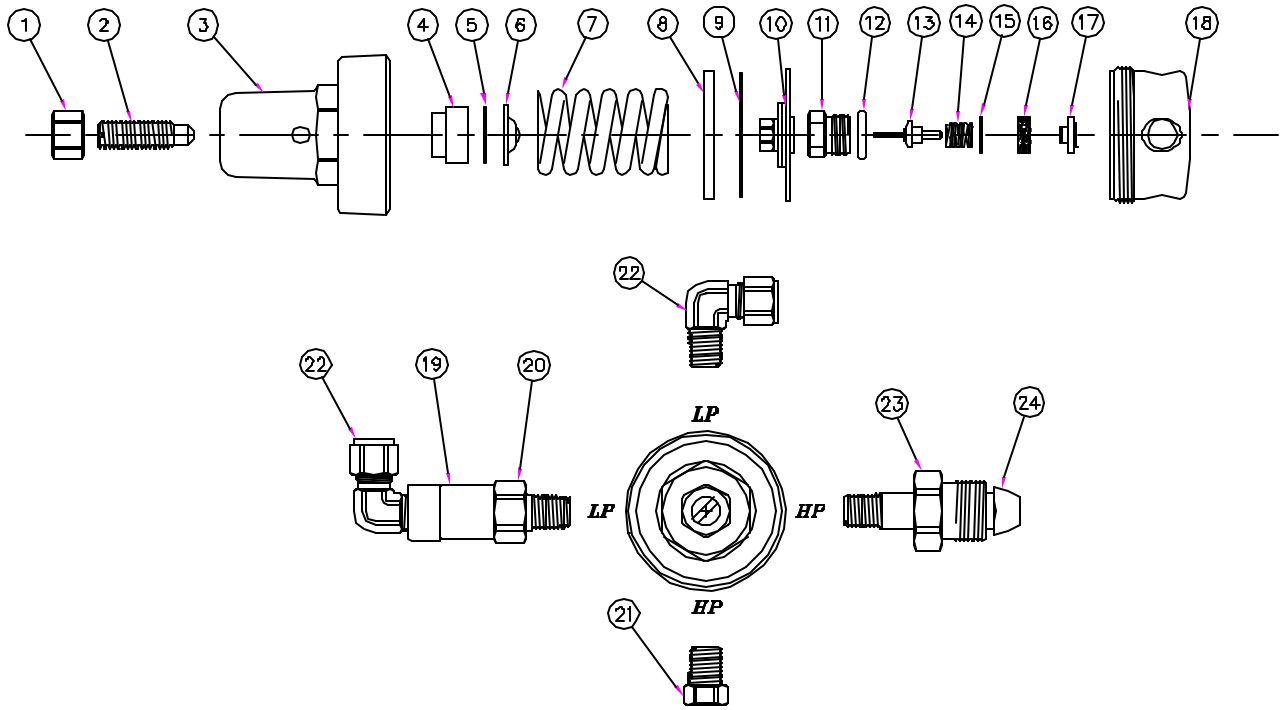


KEY #	DESCRIPTION	PART #	KEY #	DESCRIPTION	PART #
1	Outlet Nut	D-7	17	Right Line Regulator Assembly	WLR-13-60R
2	Outlet Nipple	D-20	18	Intermediate Gauge	WMG-3-4
3	Intermediate Regulator	See Page 5-1	19	Line Pressure Gauge	WMG-3-3
4	4 way to Intermediate Tube	WMS-13-19	20	Inlet Transducer	WME-9-1A
5	Inter. Reg. to Block Tube	WMS-13-20	21	Line Transducer	WME-9-3A
6	Left Relief Tube	WMS-13-15	22	Ball Valve	WMV-5-12
7	Four Way Valve	WMS-13-14	*	Ball Valve O Ring	RO-016E
8	Pressure Switch	WME-4-4	23	Relief Union	WLF-3-12
9	Left Primary Regulator	See Page 5-1	24	Relief Outlet Tube	WMS-13-21
10	Right Primary Regulator	See Page 5-1	25	Backplate Assembly	WMS-13-24
11	Left Inlet Block	WMS-13-33	26	Bleeder Valve	203
12	Right Inlet Block	WMS-13-27		Line Relief Valve	WMV-4C-75
13	Left Primary to 4 way Tube	WMS-13-17	28	Inlet Union	WMS-1-40
14	Right Primary to 4 way Tube	WMS-13-18			
15	Relief Tubing, Right Prim. Reg.	WMS-13-16			
16	Left Line Regulator Assembly	WMS-13-60L			



KEY #	DESCRIPTION	PART #
29	Case	WMC-2-56A
30	Outlet Union	D-34
31	# 8 Sht. Metal Case Screw	WMC-6-23
*	Case Wiring Harness	WMS-13-25
*	Switch Wiring Harness	WMS-1-13
*	Power Supply Box	WME-13-23
*	Manifold PCB	WME-8-84

* Item not pictured



KEY #	DESCRIPTION	PART #
1	Nut	WMC-6-90
2	Preset Adjusting Screw	RWS-3-3
3	Regulator Bonnet	RWS-2-3P
4	Bonnet Bushing	RWC-3-12
5	Bushing Retainer	RWC-3-14
6	Pivot	RWC-2-8P
7	Bonnet Spring	RWS-1-12
8*	Washer	RWS-3-26
9*	Slip Ring	RWS-3-17
10*	Diaphragm Assembly	RWS-3-28
11*	Nozzle	
	for HGM2-9 Series	RWS-5-1
	for all other models	RWS-6-9
12*	Large O-Ring	RO-015E
13*	Seat Holder & Stem for	
	HGM2, HGM2HL, HGM2HP	RWS-6-8
	HGM2-9 Series	RWS-6-3

KEY #	DESCRIPTION	PART #
14*	Valve Spring	
	for HGM2-9 Series	RWS-6-5
	for all others	RWS-1-8
15*	Teflon Ring	RWS-3-47
16*	Filter	S-5
17*	Spring Retainer	RWS-3-81
18	Regulator Body	RWS-1-3
19	Pipe Away Adaptor	WMV-4-7
20	Relief Valve	
	HGM2, HGM2HL	WMV-4C-300
	HGM2HP	WMV-4C-450
21	1/4 NPT Plug	P-4HP
22	90° Elbow	WLF-3-6
23	CGA 580 Nut	92
24	CGA 580 CV Nipple	15-8CV

* Item included in repair kits

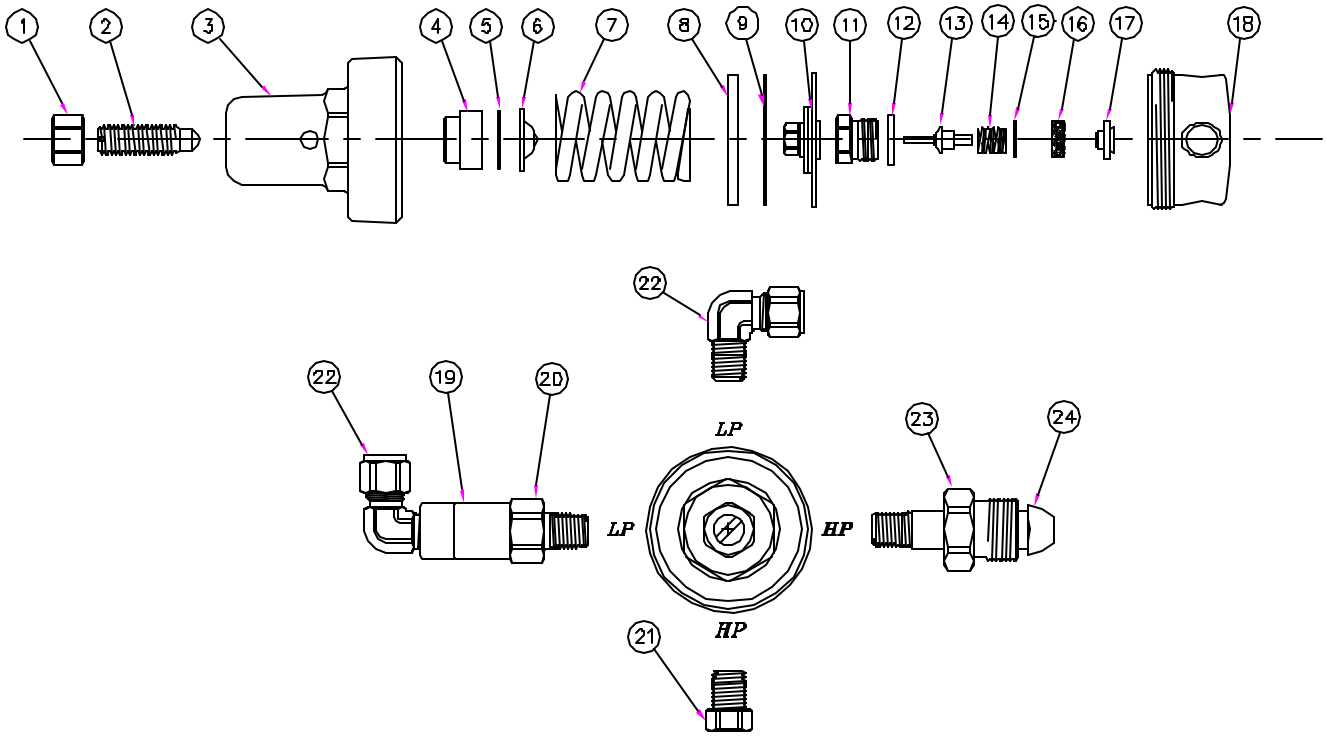
* Repair Kit

Western Enterprises

Automatic Changeover Manifold
HGM2, HGM2HL, & HGM2HP Series

Repair Drawing

Right Regulator Components



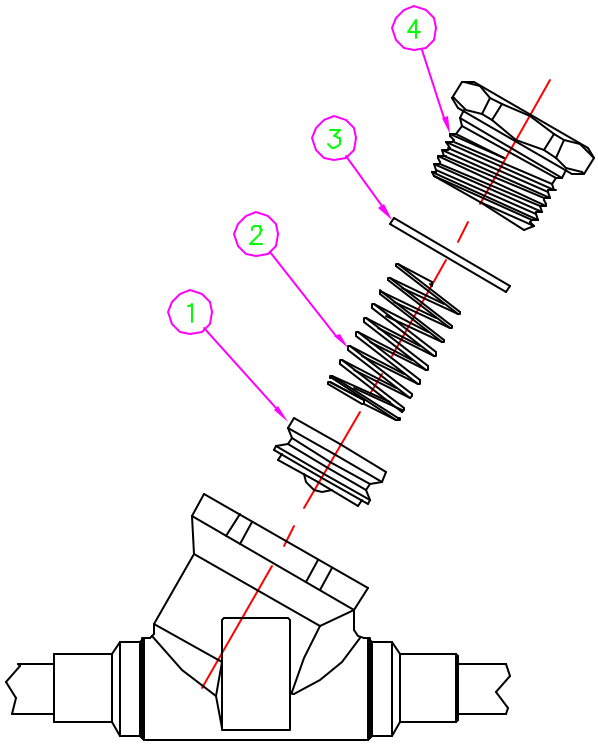
KEY #	DESCRIPTION	PART #
1	Nut	WMC-6-30
2	Preset Adjusting Screw	RWS-3-3
3	Regulator Bonnet	RWS-2-3P
4	Bonnet Bushing	RWC-3-12
5	Bushing Retainer	RWC-3-14
6	Pivot	RWC-2-8P
7	Bonnet Spring	RWS-1-12
8*	Washer	RWS-3-26
9*	Slip Ring	RWS-3-17
10*	Diaphragm Assembly	RWS-3-28
11*	Nozzle	
	for HGM2-9 Series	RWS-5-1
	for all other models	RWS-6-9
12*	Large O-Ring	RO-015E
13*	Seat Holder & Stem for	
	HGM2, HGM2HL, HGM2HP	RWS-6-8
	HGM2-9 Series	RWS-6-3

KEY #	DESCRIPTION	PART #
14*	Valve Spring	
	for HGM2-9 Series	RWS-6-5
	for all other models	RWS-1-8
15*	O-Ring	RWS-3-47
16*	Filter	S-5
17*	Spring Retainer	RWS-3-81
18	Regulator Body	RWS-1-3
19	Pipe Away Adaptor	WMV-4-7
20	Relief Valve	
	HGM2, HGM2HL	WMV-4C-300
	HGM2HP	WMV-4C-450
21	90° Elbow	WLF-3-6
22	1/4 NPT Plug	P-4HP
23	CGA 580 Nut	92
24	CGA 580 CV Nipple	15-8CV

* Item included in repair kits

* Repair Kit

Western Enterprises	Automatic Changeover Manifold HGM2, HGM2HL, & HGM2HP Series
Repair Drawing	**Check Valve Components**



KEY #	DESCRIPTION	PART #
1*	Poppet	WMV-1-5
2*	Spring	WMV-1-6
3*	Washer	WMV-1-7
4*	Cap	WMV-1-8

* Item included in repair kit

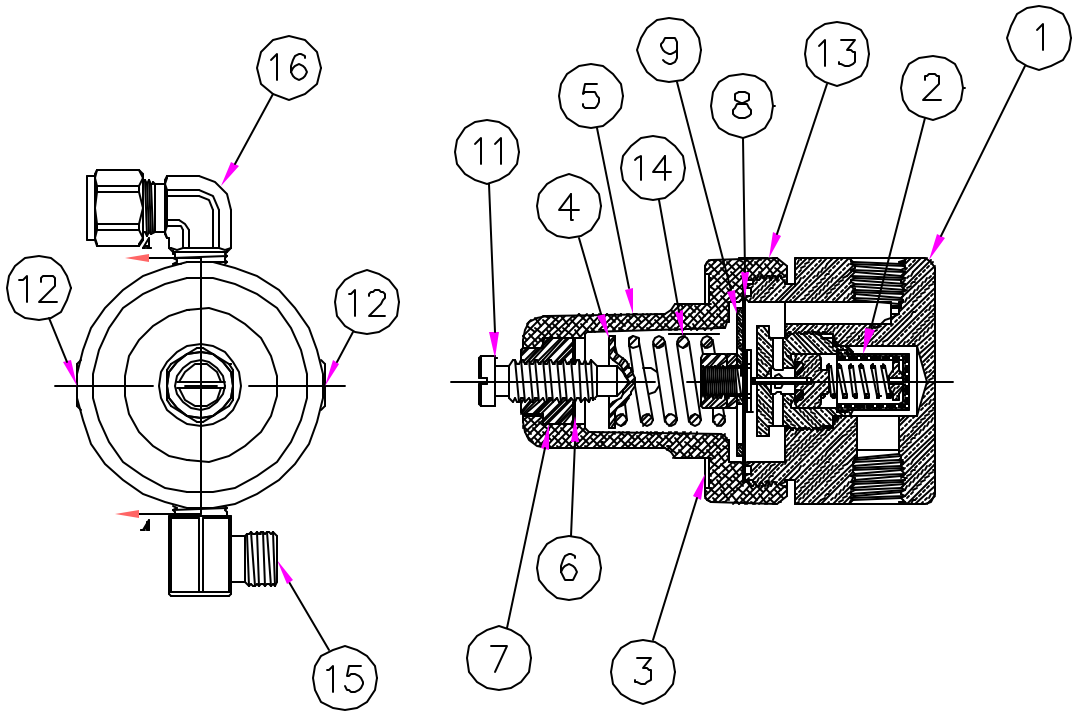
Repair Kit for HGM2, HGM2HL, HGM2HP Series RK-1041

Western Enterprises

Automatic Changeover Manifold
HGM2, HGM2HL, & HGM2HP Series

Repair Drawing

Intermediate Regulator Components



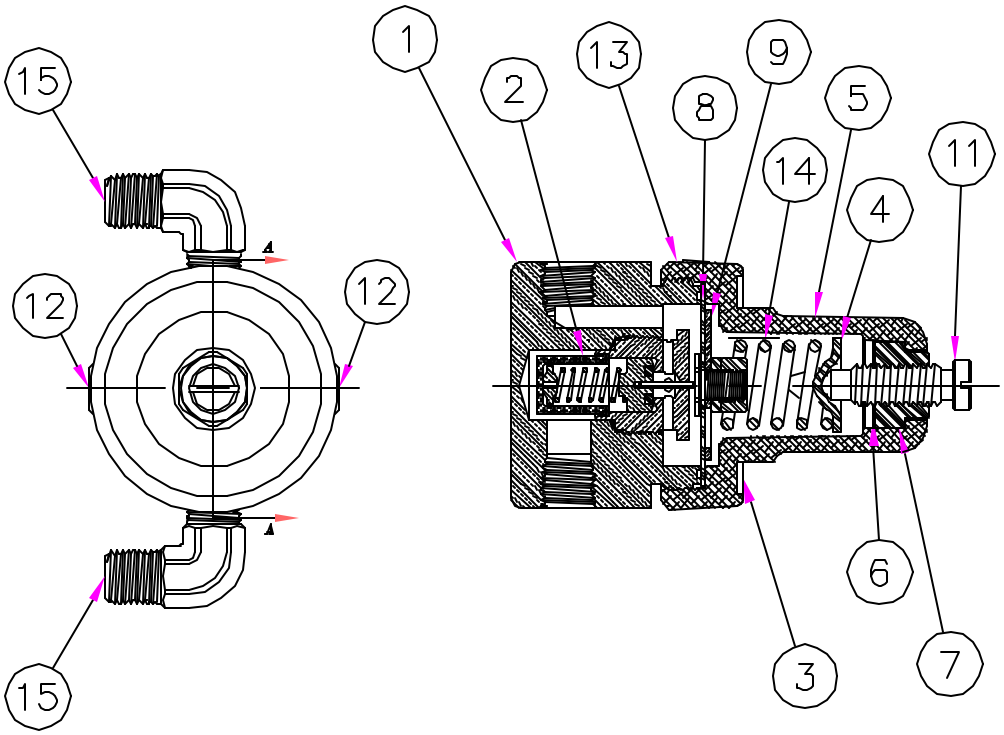
KEY #	DESCRIPTION	PART #
1	Regulator Body	WLR-1-1
2	Seat Capsule	WLR-1-10
3	Bonnet Label	ACCUL
4	Pivot	RWC-2-8
5	Bonnet	RWS-2-2P
6	Bushing Retainer	RWC-3-14
7	Bonnet Bushing	RWC-3-12
8	Slip Ring	
	HGM2 & HGM2HL	RWS-3-17
	HGM2HP	RWS-7-4
9	Diaphragm Assembly	RWS-3-28
10	Delivery Spring	
	HGM2 & HGM2HL	WLR-1-8
	HGM2HP	RWS-1-12
11	Adjusting Screw	WLR-1-11
12	1/4 NPT Plug	WLF-1-21
13	Label	HPRL
14	Anti Vibrator	WLR-1-14A
15	“B” Size Elbow	253
16	3/8 Tube Elbow	WLF-3-6

Western Enterprises

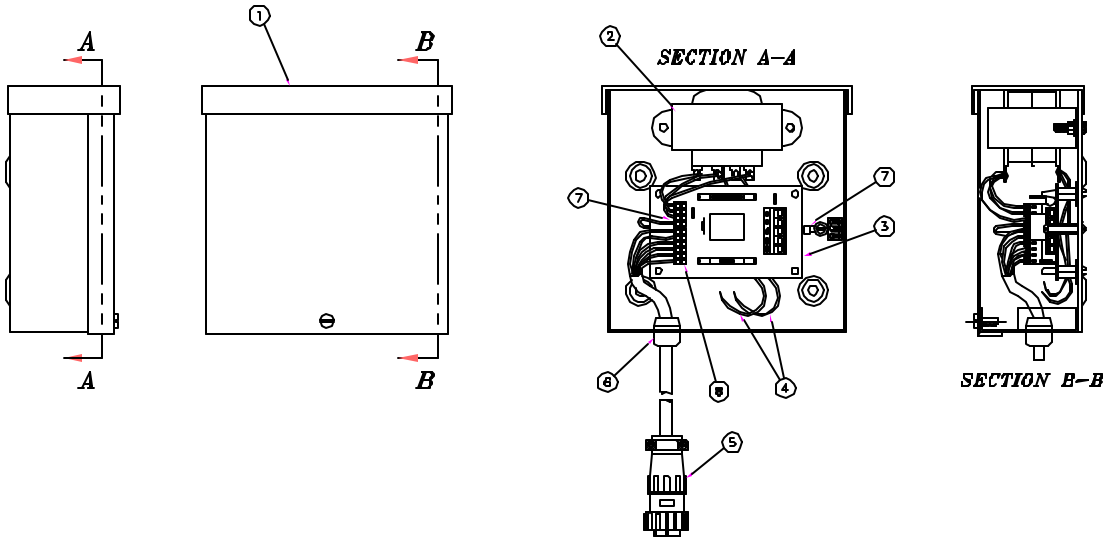
Automatic Changeover Manifold
HGM2, HGM2HL, & HGM2HP Series

Repair Drawing

Right & Left Line Regulator Components



KEY #	DESCRIPTION	PART #
1	Regulator Body	WLR-1-1
2	Seat Capsule	WLR-1-10
3	Bonnet Label	ACCUL
4	Pivot	RWC-2-8
5	Bonnet	RWS-2-2P
6	Bushing Retainer	RWC-3-14
7	Bonnet Bushing	RWC-3-12
8	Slip Ring	
	HGM2 & HGM2HL	RWS-3-17
	HGM2HP	RWS-7-4
9	Diaphragm Assembly	RWS-3-28
10	Delivery Spring	
	HGM2 & HGM2HL	WLR-1-8
	HGM2HP	RWS-1-12
11	Adjusting Screw	WLR-1-11
12	1/4 NPT Plug	WLF-1-21
13	Label	HPRL
14	Anti Vibrator	WLR-1-14A
15	1/4 NPT	BLM-4HP



KEY #	DESCRIPTION	PART #
1	Box and Cover	WME-7-6
2	115 to 24 VAC Transformer	8440
3	PCB Assembly	WME-8-85
4	18 Gage Black Wire	WME-8-96A
5	Cord Assembly	WMS-13-40
6	Strain Relief Bushing	WMC-6-42
7	Transformer Wire Sub-Assy	WMS-13-41
8	6 Wire Connector	WME-8-94