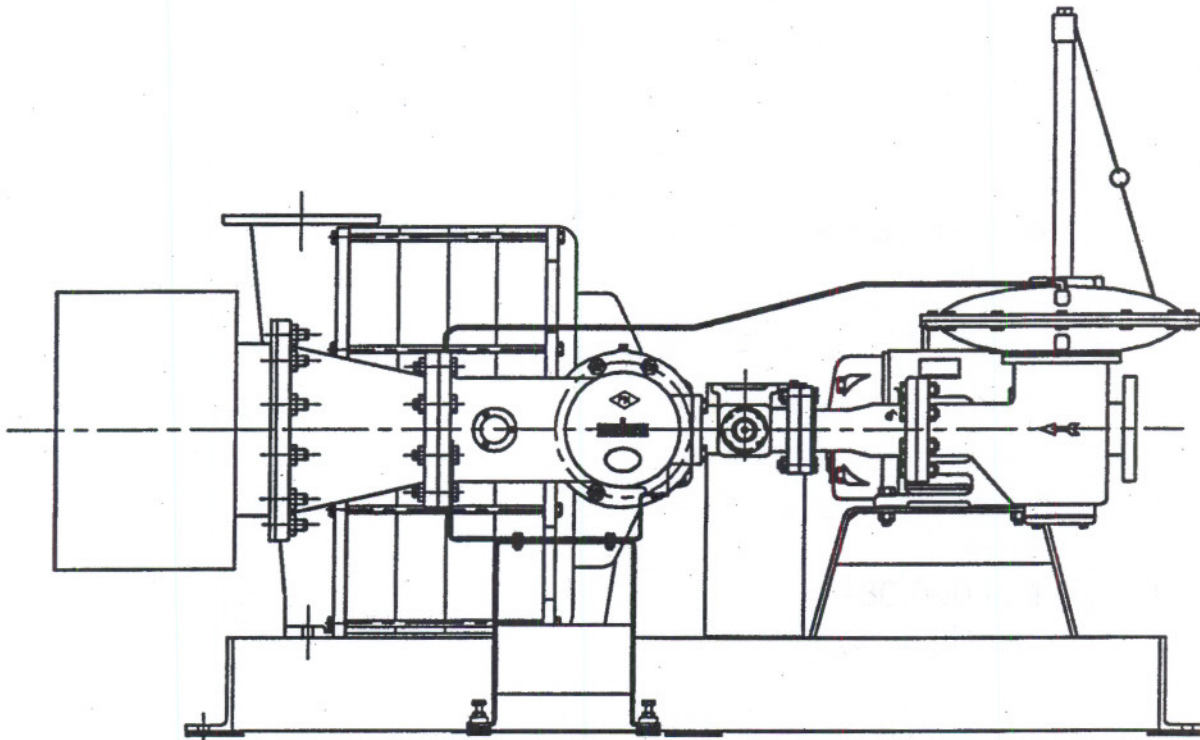


Instructions for:
INSTALLATION · OPERATION · MAINTENANCE

**SELAS PosiMix® COMBUSTION CONTROLLER
SERIES TDF and TBF**

CENTRIFUGAL COMPRESSOR TYPE
Series TDF (Direct Drive)
Series TBF (Belt Drive)

FOR SIZES:
130,000 to 175,000 CFH
(3600 TO 4900 m³/hr)



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INTRODUCTION

The Selas PosiMix® Combustion Controller is designed to supply industrial combustion processes with a precise mixture of fuel gas and atmospheric air. The valve compensates for process flow demands to maintain an accurate combustible mixture over a wide range of turn-down.

All components are designed and selected to provide years of trouble free service with a minimum of maintenance and downtime. The unit can be equipped with various automatic control options to provide additional degrees of precision in the air/fuel ratio.

CAUTION:

- The Selas Combustion Controller is designed for use with flammable and potentially explosive combustible gas mixtures and should be applied only to its intended function. Proper installation, operation, and maintenance are necessary to promote safety. Read carefully and adhere to manufacturer's instructions before installing and using. Abide by all applicable codes, government regulations, and insurance requirements.
- Because uncontrolled combustible mixtures are hazardous, it is extremely important that:
 - Combustion equipment be placed in a well ventilated area.
 - The care of equipment be assigned to responsible personnel.
 - Routine maintenance checks be established and followed.
- The instructions in this manual apply to Selas Corporation of America Series TDD and TBD Combustion Controllers. Supplemental information such as piping diagram and wiring schematic are provided as reference data for typical combustion systems and are not to be construed as necessarily adequate without verification by a competent combustion specialist.
- Read and save these instructions and any other instructions supplied for sub-components (eg. centrifugal compressor).
- Record all nameplate data and file the information for future reference should the nameplates become illegible.

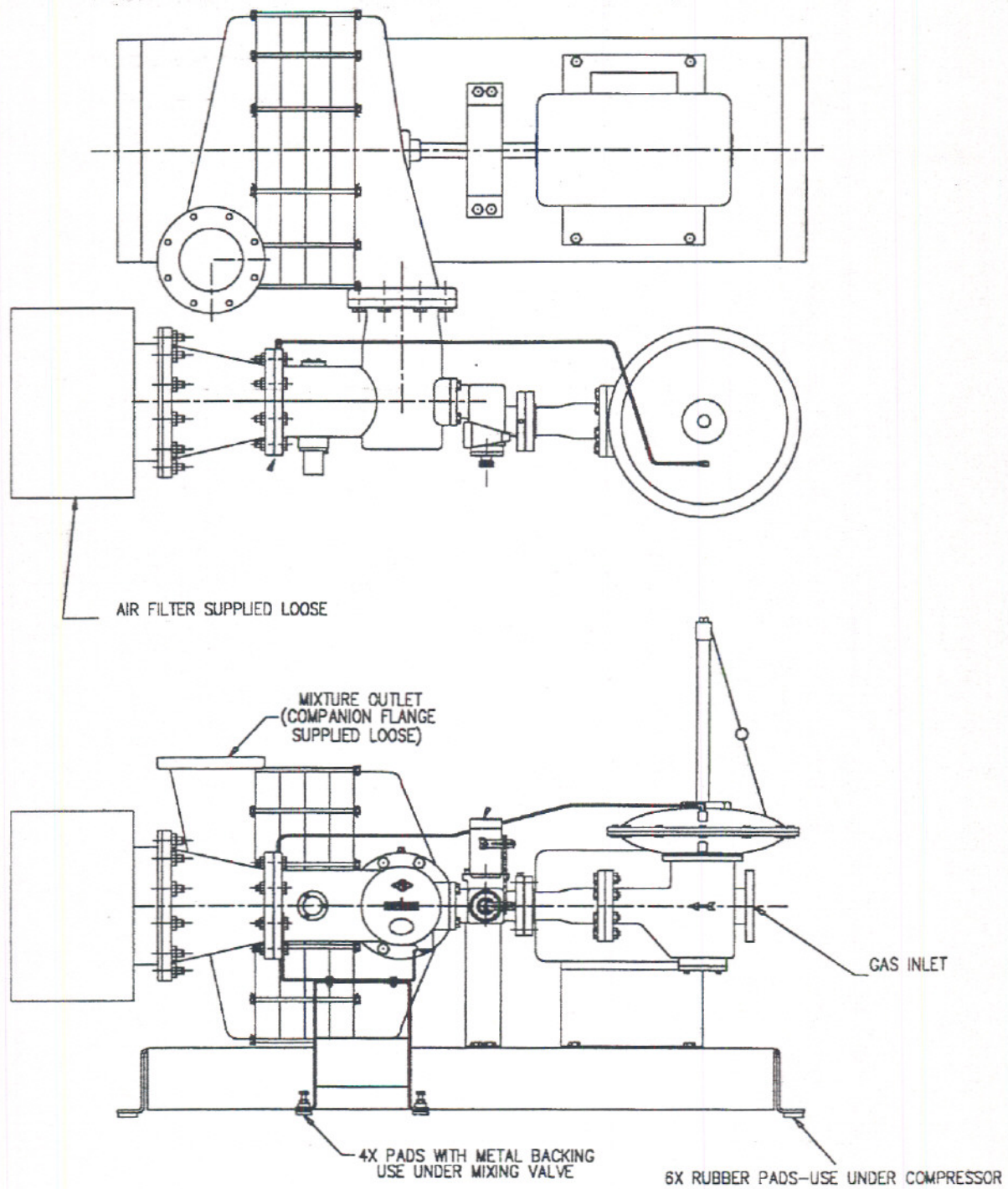


Figure 1 – General Arrangement POSI-MIX® TDF (Direct Drive)

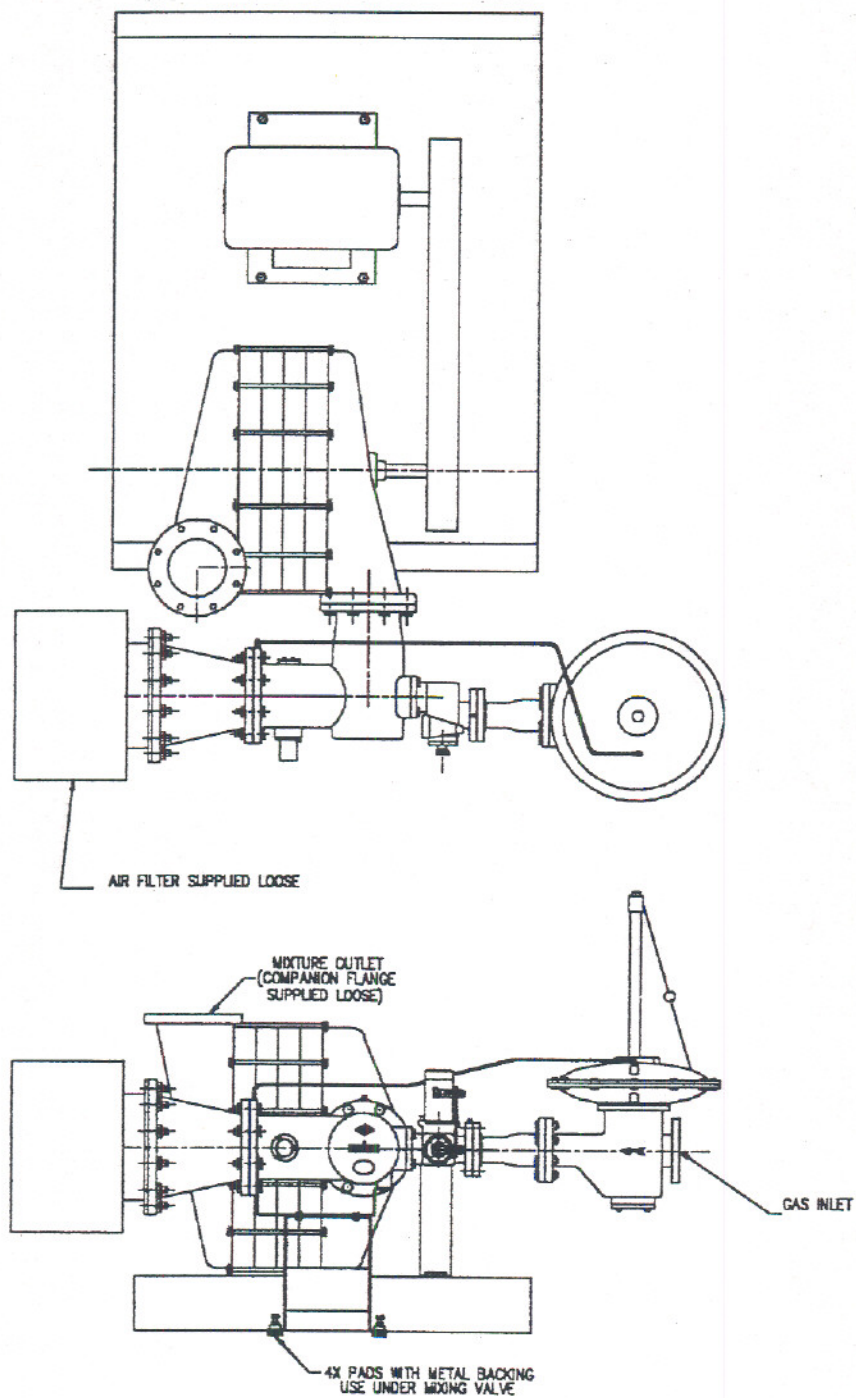


Figure 2 – General Arrangement POSI-MIX® TBF (Belt Drive)

INSTALLATION

REFER TO THESE DRAWINGS TO ASSIST INSTALLATION:

General Arrangement Pages 3 & 4
Wiring Diagram Figures 3,4,5 & 6 on Pages 7 & 8
Piping Diagram Figure 7 on Page 9

MACHINE LOCATION

The Selas Combustion Controller should be placed in a well-ventilated area. Do not install in a pit or depression where any gas leaks might accumulate. When possible, select an area in which the combustion air source is likely to be clean and fresh. Protect against condensate freezing if equipment will be exposed to a cold climate. Provide a rigid, level foundation.

HANDLING

Avoid rough handling while unloading and moving the equipment to the installation site. Do not remove skids until the machine is placed in final position, ready for installation. Do not use slings around compressor shaft or mixing valve gas inlet piping. Avoid damage to impulse tubing on zero governor.

Remove all packing material. Do not remove thread protectors or flange covers until ready to install connecting piping. Do not discard instruction tags until installation is complete.

Do not connect motor coupling until motor rotation direction is verified after wiring connections are made.

MACHINE PLACEMENT

Compressor must be installed on a rigid, level foundation, buffered with the vibration pads supplied. Shims may be required under base to correct for an uneven foundation. Support the mixing valve on metal backed vibration pads under the base to allow for vertical adjustment after attaching valve to compressor. Do not bolt either the compressor or the mixing valve to the foundation. Bolts may be used on the compressor frame to prevent lateral movement, but the nuts must not be tightened to allow for vibrational displacement.

ELECTRICAL WIRING

Verify that the available power supply coincides with the electrical requirements of the equipment. Verify that compressor motor shaft rotates in direction of arrow on casing prior to placing machine into service.

Figures 3,4,5 & 6 illustrate typical electrical wiring arrangements and are offered for reference purposes only. Wiring diagrams of systems incorporating pilot ignition, flame supervision, and any application specific conditions are not shown here. They must be developed by Selas or other competent combustion engineers. It is the user's responsibility to provide installation and wiring in conformance with all applicable electrical codes, ordinances, and regulations.

PIPING

Connecting piping must be aligned and supported independently; flexible connections are recommended to prevent strain, simplify assembly, and reduce transfer of vibration to the piping assembly. Piping containing combustibles must be schedule 40 minimum.

Use full ported shut-off valves where possible to avoid unnecessary restrictions and pressure loss in piping.

Restrictive valves can prevent regressing flashback flame from reaching the automatic alarm and closure mechanism(s).

Seal all joints on gas and mixture piping to prevent the possibility of leakage. Use sealant sparingly to avoid fouling of downstream components. Gaskets are required between any flanges. Air filters on combustion air inlets are required to maintain performance and prolong the life of system components. Avoid atmospheres which are corrosive to iron or aluminum unless the system was specifically designed to handle them. Oversized piping should be used to avoid unnecessary pressure loss if air intake must be located a considerable distance from compressor. Protect outside air intake from weather.

Recommended inlet pressures to the zero gas governor at the mixing valve are 4 to 10 inches water column (1 to 2.5 kPa). Locate reducing regulator, if required, at least 20 pipe diameters upstream from zero governor.

Refer to Figure 7, Piping Diagram for more specific piping installation details.

PRESSURE TEST

Leak test requirements for piping and components vary with their relative positions in the piping system. In normal use, the air intake piping operates under slight suction and leaks are not hazardous, therefore, pressure tightness is not required.

A pressure test of 2 psig (14 kPa) is the maximum recommended for the inlet gas piping because most zero governors have a pressure limit of 2 psig (14 kPa) and the maximum gas pressure at the zero governor is usually less than 14 inches water column (3.7 kPa). If higher test pressures are required per local codes or regulations, the zero governor and any other vulnerable devices must be isolated from the higher test pressure to prevent internal damage.

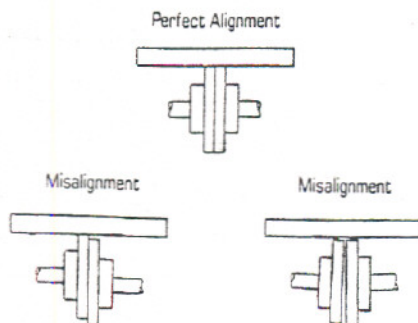
The piping between compressor discharge and burner shut-off valve(s) (which holds flammable gas premix) should be tested at a maximum pressure of 10 psig (70 kPa). Higher pressures can damage seals in fire-checks or rupture blow-out disk(s).

The piping between burner shut-off valve and burner can be tested for leaks at the maximum delivery pressure of the compressor, usually 3 psig (21 kPa).

In all cases, apply test pressure slowly to eliminate sudden impulse loads on system components.

MOTOR COUPLINGS

Shaft alignment specifications depend upon the type of coupling used and if the machine is configured for belt drive or direct drive. The instructions for motor alignment are detailed in the compressor documentation. Correct alignment of motor and compressor will provide for longer bearing life. If instructions are not available, refer to the figures below.



Series TD Coupling Alignment

TRIAL RUN (Air Only)

With Combustion Controller in place, wired, and piped, verify the following:

- Base is not bolted rigidly to foundation.
- Motor couplings are connected and aligned.
- Shaft rotation is correct and turns freely by hand.

Close the mixture outlet valve to make a test run of the compressor with air only. The centrifugal compressor will overload if operated with inlet and outlet connections wide open. If a test of the compressor is desired prior to piping, partially cover the inlet flange with a plate. Do not run compressor for an extended period of time with the inlet completely closed.

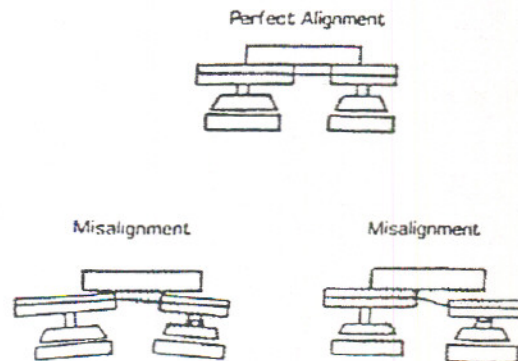
Start the compressor and allow it to attain full speed, then open restricting valves gradually while checking for unusual noise or excessive vibration. Verify that pressure and flow volume are near expected capacity. Complete any leak tests which have not been made.

START-UP

Verify completion of all piping and electrical connections. Close all valves and turn off all switches.

Verify that pressure switches in gas supply pipe are properly set. Ensure that gas supply is available to gas governor of combustion controller at a pressure of between 4 and 10 inches water column (1 to 2.5 kPa). Provide a temporary line to bleed air from gas supply piping to vent or flare in a safe place.

Verify that fuel adjustment dial on mixing valve is positioned for system flow rate as specified in purchase order. Mixture ratio and flow rate may be optimized while the machine is in operation.



Series TB Sheave Alignment

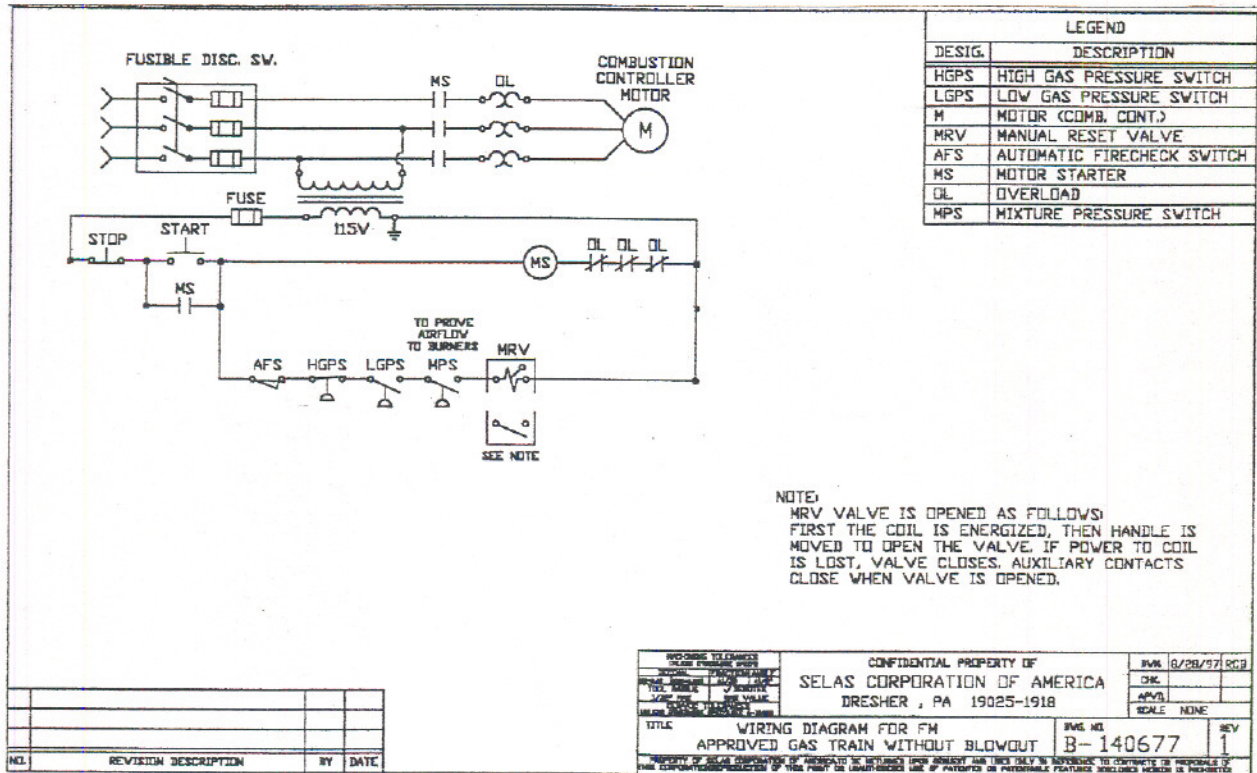


Figure 3 – Wiring Diagram for FM Gas Train w/o Blowout

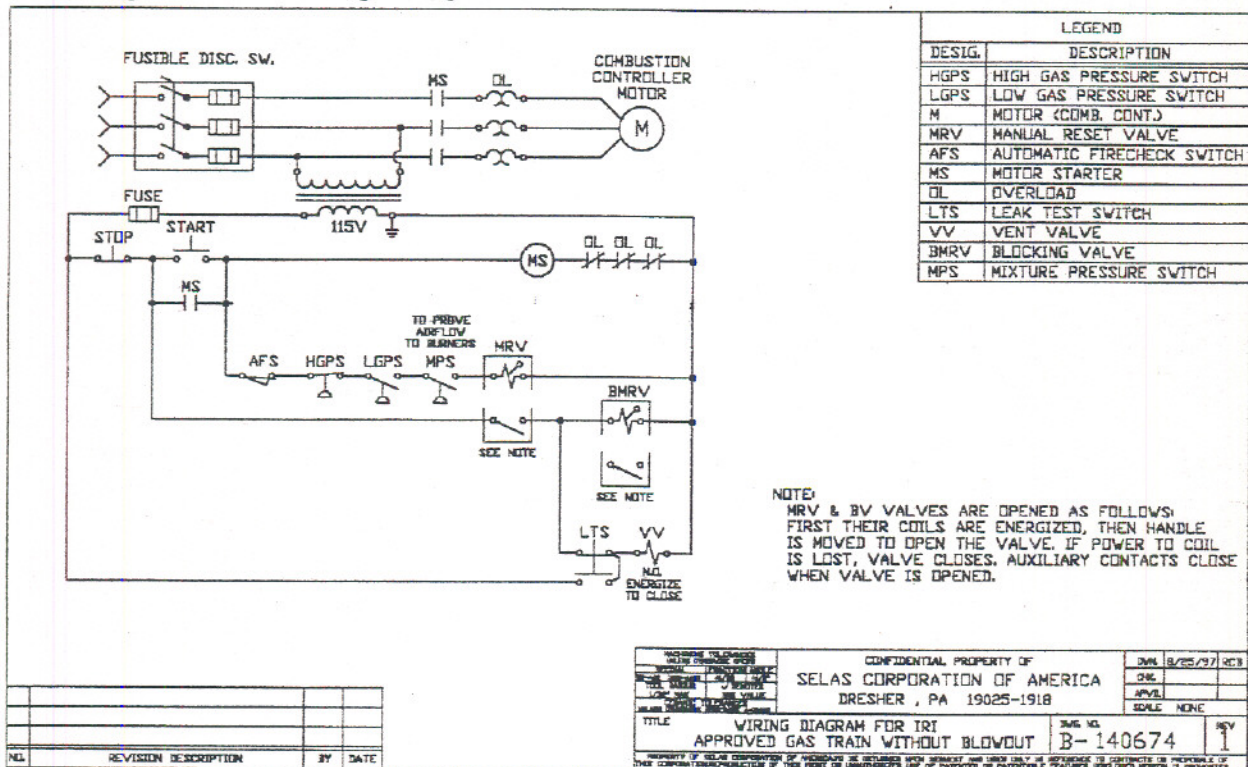


Figure 4 – Wiring Diagram for IRI Gas Train w/o Blowout

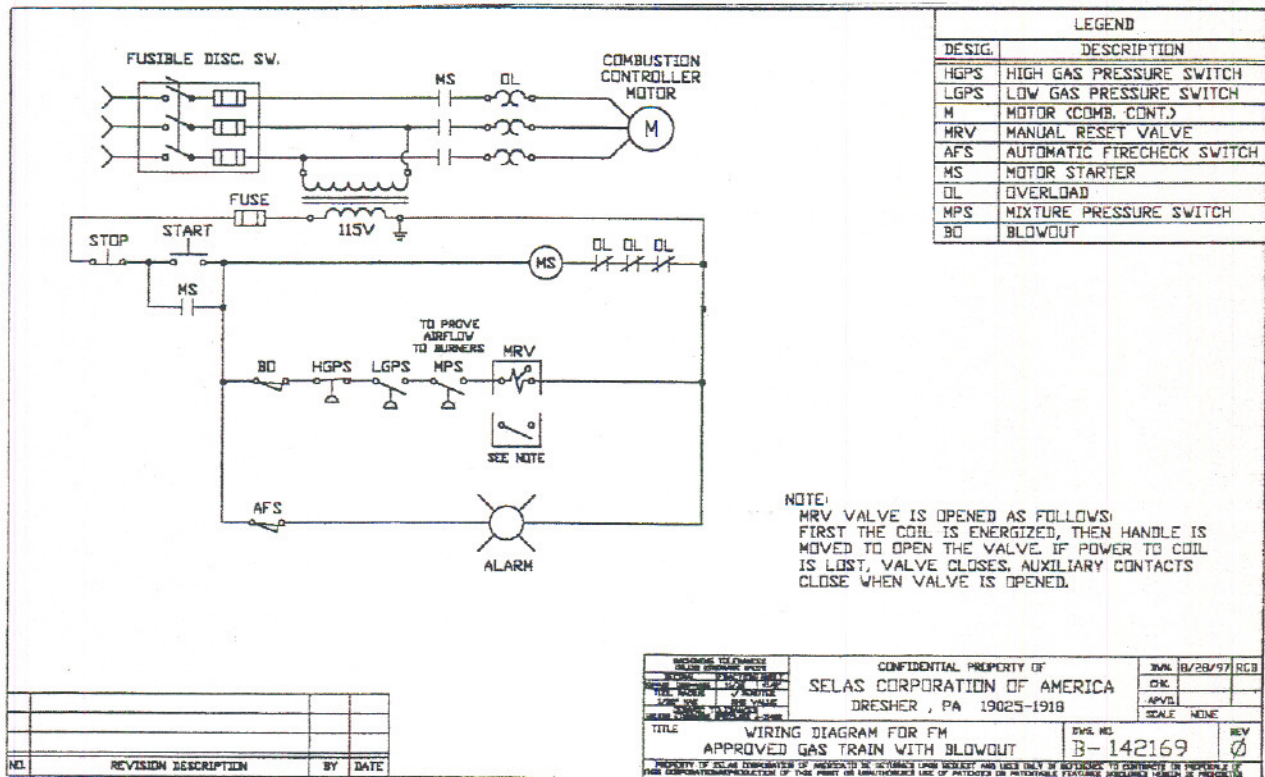


Figure 5 – Wiring Diagram for FM Gas Train with Blowout

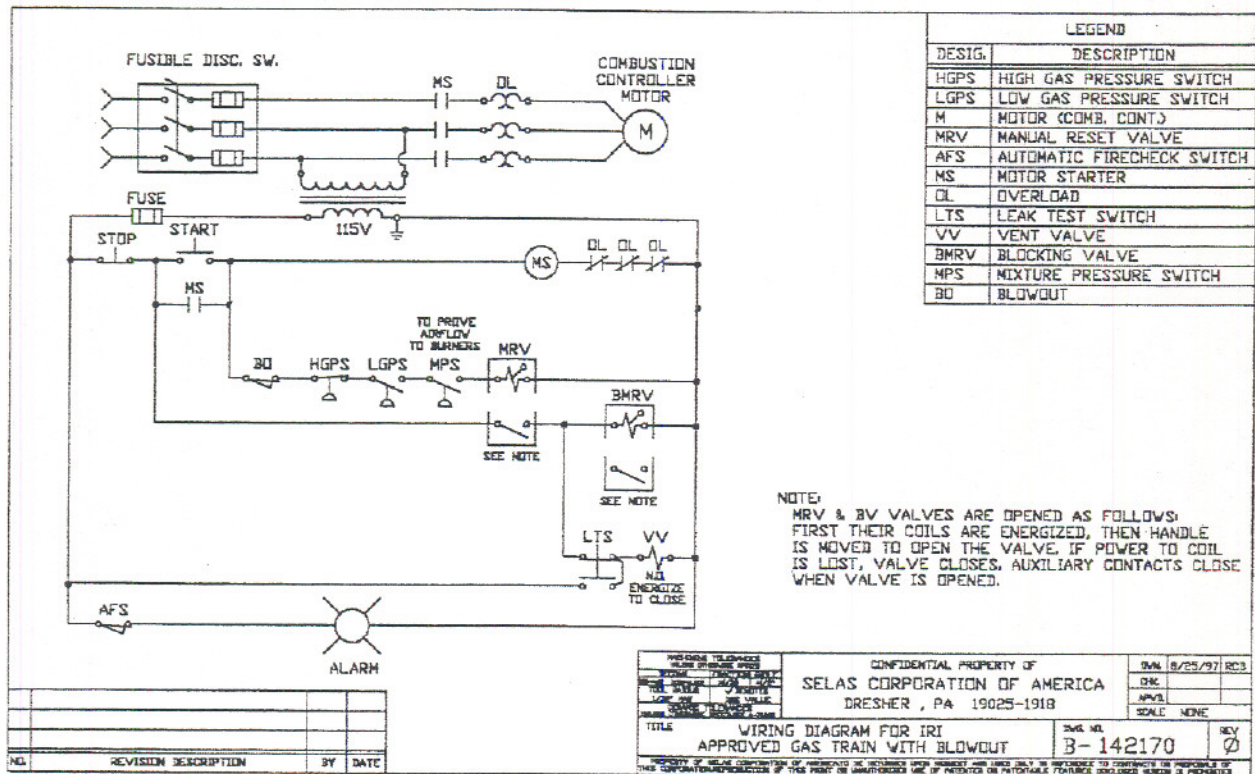


Figure 6 – Wiring Diagram for IRI Gas Train with Blowout

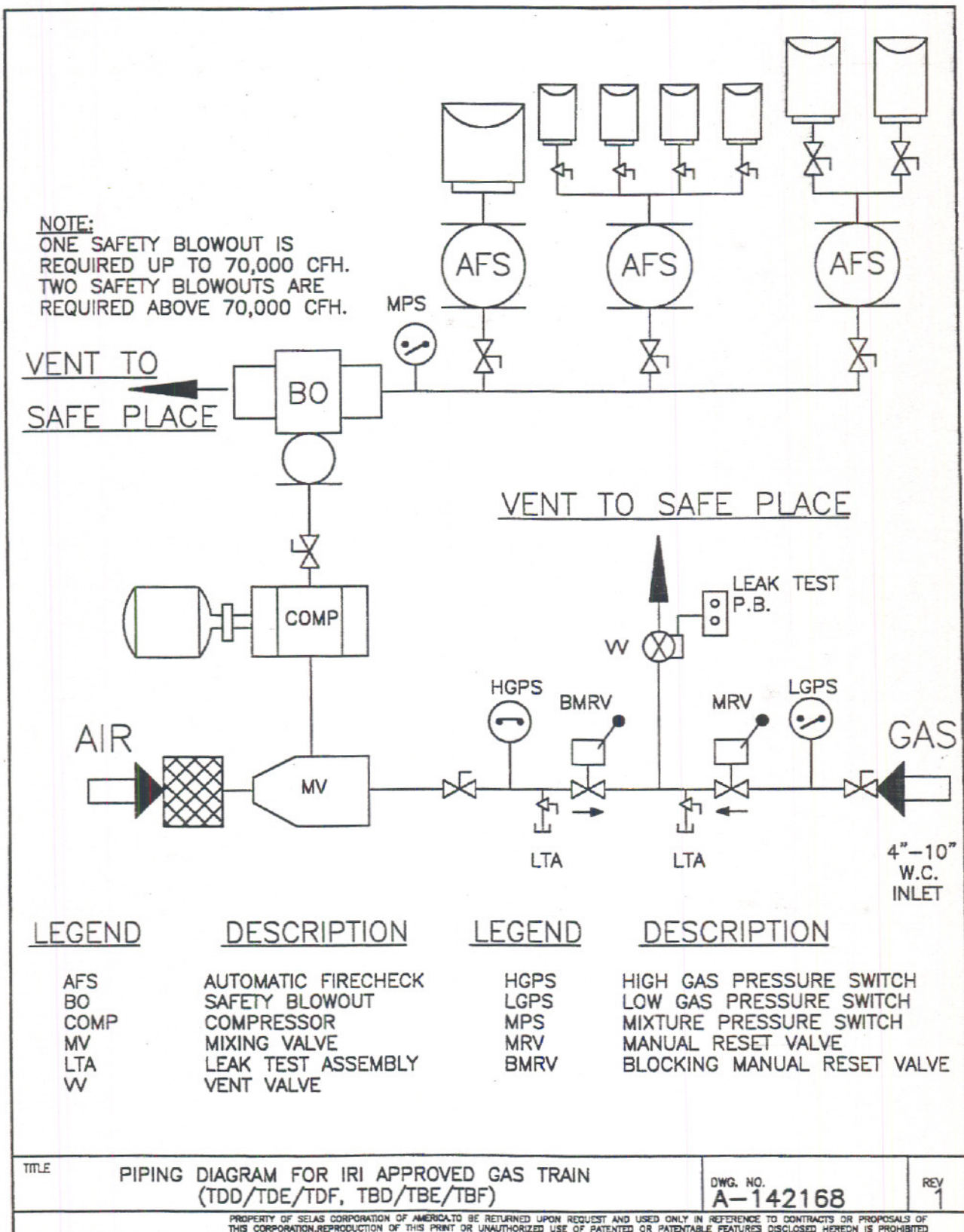


Figure 7 – Piping Diagram (for IRI Approved Gas Train Shown)

TYPICAL SCHEMATICS PIPING DIAGRAM (Figure 7)

The piping diagram shows a typical interrelation among firechecks, blowouts, and major system components. Specific applications may require variations of the basic system. Consult with Selas engineers for the optimum configuration to meet your requirements.

OSHA, insurance underwriter requirements, local regulations, or plant policies may dictate deviations from typical installations.

PIPING

- A. The piping from the combustion controller to the blowout is generally the same size as the combustion controller discharge connection.
- B. The piping from the blowout must not exceed the size of the blowout discharge connection. Long or complex piping systems may require special sizing.
- C. The piping from the main header to the automatic firechecks should be sized with reference to allowable pipeline losses.
- D. Insurance company regulations specify that the size of the piping from automatic firechecks to burners must not exceed the firecheck outlet size. Maintain or reduce this size according to allowable pressure losses.
- E. Always install a manual shut-off valve ahead of each firecheck.

FIRECHECK

Install firechecks in mixture supply line as close to the burners as practical.

- A. Type AF-A (without switch) should be used when backfire at one firecheck must not interrupt operation of remaining burners and no signal or alarm is necessary.
- B. Type AFS-A (with switch) must be used if alarm or signal is necessary, and/or if all burners of entire system must be shut down in the event of backfire at any section. Switch must be wired to close manual reset valve, allowing air to purge supply piping before compressor shut-down.

BLOWOUT

Install a type SBC blowout for the protection of the system in the event of an explosive backfire. It should be located as close as practical to the compressor and wired to shut off both the compressor and the manual reset valve.

MANUAL RESET VALVE

The manual reset valve shuts off the fuel supply when the electric circuit holding it open is interrupted. The circuit includes pressure switches, blowout, and firechecks.

PRESSURE SWITCHES

High and low pressure switches monitor the incoming gas supply and in some cases, compressor output. Should the gas pressure become too high or low, or the compressor fail, the circuit holding the manual reset valve open is broken and the gas supply is shut off.

FULL PORT SHUT-OFF

Full port shut off valves are required to avoid unnecessary pressure losses and to eliminate flashback hang-ups at the valve instead of at the firechecks.

VENT VALVE

A normally open solenoid valve which remains closed during normal operation, but opens to vent when the manual reset valve is closed.

LEAK TEST ASSEMBLY

The leak test assembly provides a means for periodic testing through manual reset and other shut-off valves.

GAS COCK

Gas cocks function as positive gas shut-off valves when full port valves are not required.

OPERATION

START-UP CONSIDERATIONS

The following procedures are separate from routine start-up, but must be taken into consideration the first time the system is run, after system rework/repair or even after prolonged idle periods.

1. Prove flame safety circuits as applicable.
2. Perform "dry-out" or curing of refractories as required.
3. Establish high-fire limits and set controls to not exceed the maximum.
4. Establish a low-fire limit to assure a minimum flow to provide a stable flame at the burner(s) and to operate above the flashback point.

STARTING THE MACHINE

The following instructions are specific only to the Selas PosiMix combustion controller. More complex systems involving pilot burners, purge timers, supervisory gas cocks, and other interlocking apparatus will require specialized instructions relative to their operation.

1. Verify the following:
 - a. Fuel gas supply to machine is shut off.
 - b. Mixture outlet valve is fully closed.
 - c. All burner valves are closed.
 - d. Ratio adjustment setting is adequate for light-off.
2. Prepare ignition means (torch, spark igniter, or pilot burners).
3. Start combustion controller compressor motor pressure switch is satisfied.
4. Open fuel supply upstream manual shut-off valve, low gas pressure switch satisfied.
5. Open manual reset valve.
 - a.) on FM systems, high gas pressure switch is satisfied.
 - b.) on IRI systems, vent valve closes, blocking valve opens, high gas pressure switch satisfied.
6. Open shut-off valve downstream of the HGPS.
7. Open mixture outlet valve.

8. Light burners as required.
9. If necessary, readjust air/gas ratio to provide optimum combustion for the particular process. Tighten lock screw on ratio adjuster after ratio is set.

RUNNING THE MACHINE

Once started, the combustion controller should not require any special attention other than operator awareness of process or system variations. Deviations in fuel gas quality can be accommodated by manually re-adjusting the air/gas ratio dial. Refer to operating instructions for optional automatic ratio control if present. Adjustments should be made in small increments, usually 2-3 degrees at a time with a wait of about 30 seconds for the effect to be seen at either the burners or a combustion analyzer. Any adjustments should be made when the machine is operating above 15% of its rated capacity.

Consult the maintenance section for more detailed procedures relative to adjustment and operation.

Refer to operating instructions on supplemental equipment and instrumentation as provided.

STOPPING THE MACHINE

1. Close the fuel gas supply manual valve upstream of MRV.
2. Allow the compressor to run long enough to purge any flammable mixture from the system piping.
3. Turn off the compressor motor.
4. Close the mixture valve at the machine outlet.
5. Close the burner valves.

THE SELAS PosiMix® VALVE

The Selas PosiMix® valve contains two valves, an air valve set to match the rating of the combustion controller, and an adjustable gas valve. The PosiMix® is capable of maintaining a mixture ratio within $\pm 2\%$ at turndowns exceeding 7:1. For natural gas, this corresponds to $\pm 0.4\%$ excess O_2 in the combustion products.

The PosiMix® valve offers additional flexibility by providing a means of maximizing the range of turndown based upon system demand. The valve is set at the factory for the rated output of the combustion controller, usually based upon the compressor rating. Because combustion systems normally demand less than the rated capacity of the controller, an amount of turndown is lost because the excess capacity is never utilized. By first establishing the flow requirement of the system, then readjusting the valve for a rating at this capacity, the turndown capability can be maximized. The valve rating can be increased or decreased at any time if the system flow requirement is modified.

ADJUSTING THE VALVE RATING

CAUTION: The mixture ratio is preset at the factory. The setting(s) should be adjusted by qualified personnel aware of the fact that excessive changes can cause the burner(s) to extinguish. Any adjustments should be made in small increments while the flame is under observation. Preferably, a combustion analyzer should be used to verify the final air/gas ratio.

The PosiMix® valve is designed to work with a 26-30" w.c. pressure drop across it at its factory rated capacity to provide for maximum turn-down capability. If the flow rate demand of the combustion system is less than the factory rating of the controller, the valve operates with a reduced pressure drop and some of turn-down capacity is lost. If the additional turndown capability is not required, no adjustment is required, but if maximum turndown capability is required at a rating less than the factory rating, the valve should be adjusted.

Note: Flow capacity of the combustion controller can be increased beyond the factory rated capacity by reducing the pressure drop at the mixing valve and/or reducing the compressor output. This will not damage the valve, but the factory should be consulted to insure the gas regulator and compressor motor are not undersized.

1. During a non-operating period or with the fuel supply turned off, install petcocks at test points per Figure 8 and connect a differential pressure gauge across the two test points.
2. During the next operating period, open petcocks slowly and observe the pressure drop while the combustion system flow is at its maximum. If the pressure drop is less than the recommended 26"-30" w.c., the valve can be readjusted to provide optimum turn-down.
3. Remove the air valve cover (See Figure 8) to expose the air valve adjustment. Loosen the lock nut to allow rotation of the air valve.
4. Open or close the valve in small increments (2"w.c.) to obtain the required pressure drop. After each incremental opening (or closing) of the air valve, open (or close) the gas valve accordingly to maintain a sufficient air/gas ratio to prevent the flame at the burner(s) from extinguishing. If the ratio is under automatic control, allow sufficient time after each incremental turn of the air knob to allow the controller to readjust the gas valve.
5. After adjusting the air valve, tighten the jam nut to 50-80 ft-lbs and replace the air valve cover and o-ring. Adjust the gas ratio for the combustion process requirement and lock the knob with the lockscrew.
6. The gas valve dial should read between 90° and 310° after adjustment. If the reading is out of range, adjust the spacers in the gas valve, increasing spacer height if below the 90° mark, and decreasing spacer height if above the 310° mark.
 - a. Remove the gas valve and o-ring from the PosiMix body by removing (4) cap screws.
 - b. Clamp the adjustment knob in a soft jaw vise and remove the retainer nut, lock washer, spacer(s), key, and adjuster.
 - c. Shift the spacers to obtain the correct position of the adjuster. Spacers are sized to provide ¼" increments from 0-1½".
 - d. Reassemble the valve and adjust the air/fuel ratio.
 - e. The chart in Figure 9 shows the spacer thickness required for different flow rates and fuels at a 28" pressure drop. For other fuels or pressure drops, use the natural gas scale and multiply the required fuel flow rate by the following factor:
$$F = \sqrt{\frac{SG}{0.6}} \cdot \sqrt{\frac{28}{\Delta P}}$$
Where:
SG is the fuel specific gravity
ΔP is the pressure drop

Close petcocks or replace plugs at the end of test.

Never operate the Selas PosiMix® valve with a test connection open to the atmosphere.

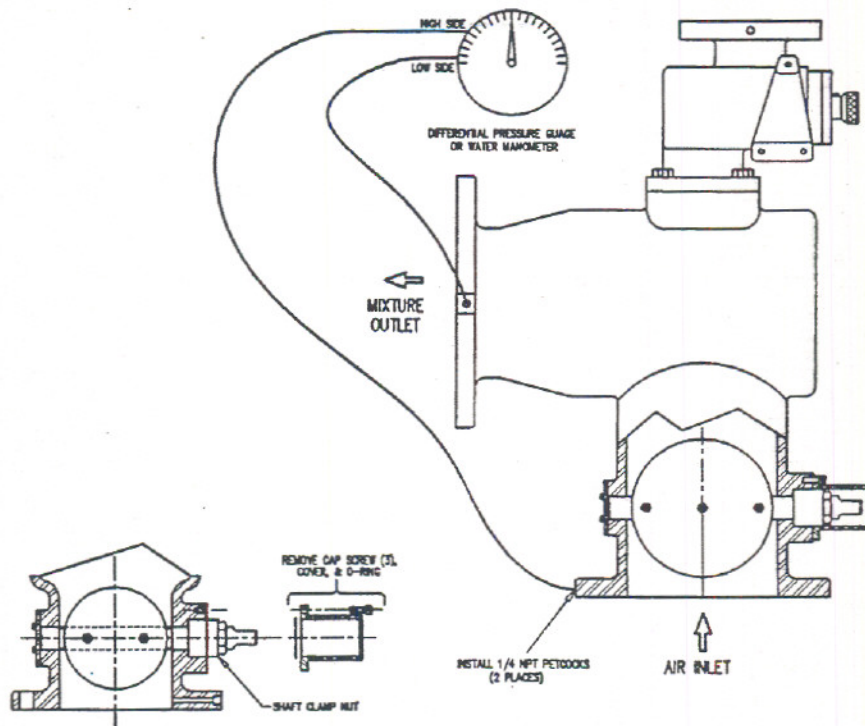


Figure 8 – Rating Adjustment Arrangement

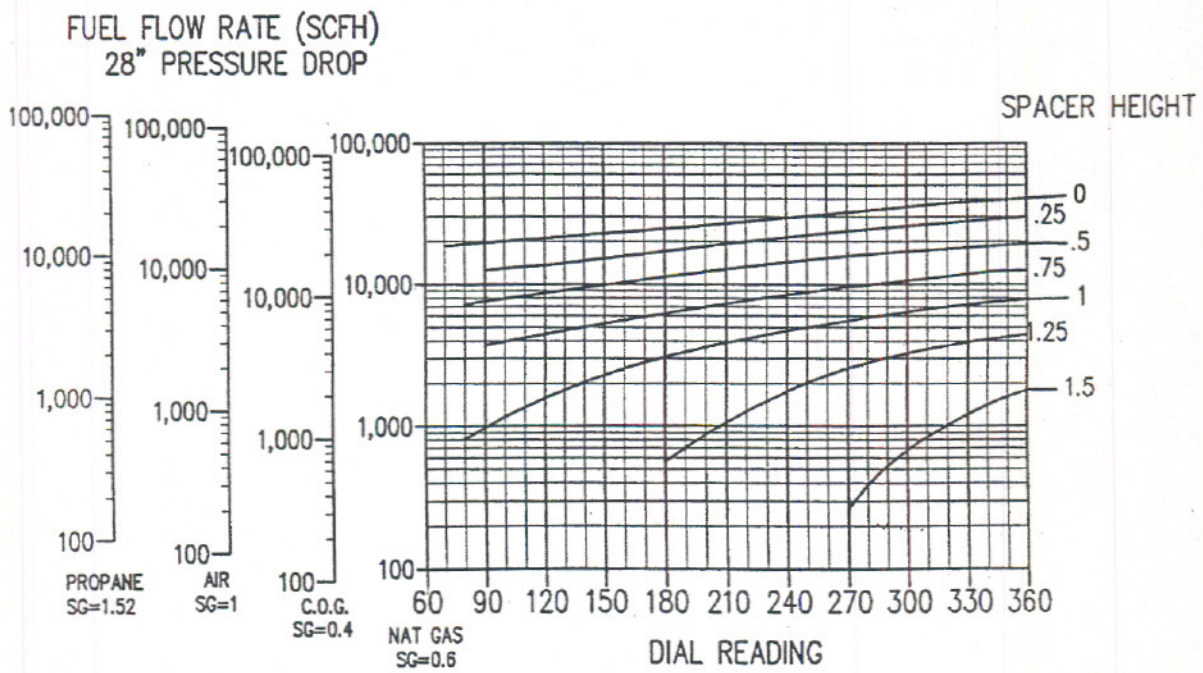


Figure 9 – Gas Valve Spacer Selection Chart

MAINTENANCE

CAUTION:

Before performing any maintenance operations involving machine disassembly, be certain that the gas supply valve is closed.

CLEANING

Refer to Figure 11 for Assembly Detail

The Selas PosiMix® valve has no internal parts that require cleaning or lubrication. The only internal moving part is the gas valve which is constructed of stainless steel and mounted on a PTFE non-metallic bearing. Extremely dirty or corrosive fuel gas will damage the zero governor well in advance of any gas valve malfunction.

A drain plug is installed in the bottom of the valve for removal of any accumulated condensation.

Should cleaning be required, gaskets and o-rings should be replaced prior to reassembly.

AIR FILTER

The combustion controller should be operated at all times with an air filter on the inlet piping. Contamination in typical industrial environments can significantly degrade the performance of combustion system components (gas governors, mixing valves, compressors, firechecks, and burners, etc). Spare filter elements should be stocked for regular replacement to maintain the performance of the system.

Filter elements can tolerate cleaning in water and detergent if necessary. Note: Do not use oil-wetted elements on combustion controller intake filters.

MOTOR

Motor types and suppliers can vary due the wide range of operating conditions for which the combustion controller is used. Most motors are rated for safe operation up to 176°F (80°C) in typical environments (ambient temperature plus a 104°F (40°C) temperature rise). Higher temperature may be the result of overloading or improper wiring or voltage. For proper care, follow the manufacturers instructions supplied with the unit.

COMPRESSOR

The shaft packing gland adjustment and bearing lubrication are important to the performance and life of the compressor. Detailed preventive maintenance and repair instructions are provided in manual supplied by the compressor manufacturer. Refer to it for all service and repair instructions.

Note: Compressor lubrication schedules and proper lubricant are the most important maintenance required to insure years of trouble free service.

ZERO GAS GOVERNOR

The gas governor, located in the fuel supply line near the Selas PosiMix® valve, is a precision flow regulator which matches the fuel supply pressure to the air pressure at the valve inlet. This balance remains constant through the full range of system flow demand.

Figure 1 shows the standard mechanical gas governor shipped with the PosiMix combustion controller. Other configurations are available and may be provided as optional equipment with separate documentation.

NOTE:

The gas governor is factory adjusted and sealed.

Field repair is not recommended because incorrect assembly or adjustment could be hazardous. Emergency repairs should be made by a qualified technician with thorough knowledge of the operation of the unit. As a precaution, a spare unit should be stocked for emergency replacement.

PRESSURE BALANCE TEST

Proper performance of the zero gas governor is critical to maintaining a precise air/gas ratio. The proper function of the zero governor can be verified by making a pressure balance test. Figure 10 shows the test arrangement and equipment required.

1. The impulse tube between the air inlet and the upper diaphragm of the zero governor should be examined for any leaks or restrictions. Compression nuts should be checked for tightness. Leaks in the impulse tube will severely affect performance of the governor. Soap solutions should not be used because the impulse line operates under negative pressure.

2. During a non-operating period, replace pipe plugs at test points with petcocks and connect a water manometer or a differential pressure gauge across the two test points.
3. During the next operating period, open petcocks slowly and observe the pressure balance while the combustion controller output is varied. The balance should be maintained within 0.25" w.c. (0.05 kPa). Minor deviation will be tolerable, but large and fluctuating deviations require replacement of the malfunctioning zero governor.

CAUTION:

Close petcocks or replace plugs at the end of test.
Never operate the Selas PosiMix valve with a test connection open to the atmosphere.

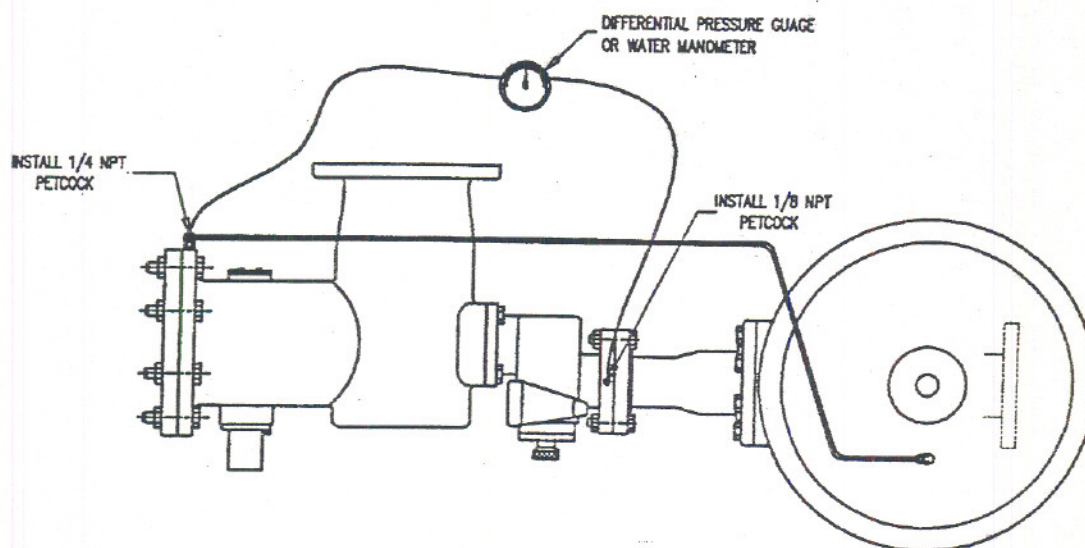


Figure 10 – Pressure Balance Test

F VALVE PARTS LIST

- | | | |
|---------------------------------------|-------------------------|--|
| 1 MIXING TEE HOUSING | 13 VALVE PLATE | 26 LOCK WASHER (4) |
| 2 GAS VALVE BODY | 14 GASKET | 27 O-RING |
| 3 HAND KNOB
(MANUAL RATIO CONTROL) | 15 GAS ADJUSTMENT SHAFT | 28 1/4 NPT PLUG |
| 4 COVER PLATE | 16 O-RING | 29 LOCK WASHER |
| 5 GAS VALVE MOUNT PLATE | 17 O-RING | 30 FLAT WASHER |
| 6 AIR ADJUSTMENT COVER | 18 LOCKING COLLAR | 31 HEX NUT |
| 7 DIFFUSER | 19 CAP SCREW (4) | 32 CAP SCREW (3) |
| 8 SPACER KIT | 20 CAP SCREW (4) | 33 DIAL COLLAR
(AUTO RATIO CONTROL) |
| 9 BEARING SLEEVE | 21 DIAL | 34 LOCK SCREW |
| 10 AIR ADJUSTMENT SHAFT | 22 1/8 NPT PLUG | 35 HEX CAP SCREW (4) |
| 11 GAS ADJUSTER | 23 CAP SCREW (4) | 36 GASKET |
| 12 SQUARE KEY (2) | 24 FLAT HEAD SCREW (3) | |
| | 25 SET SCREW | |

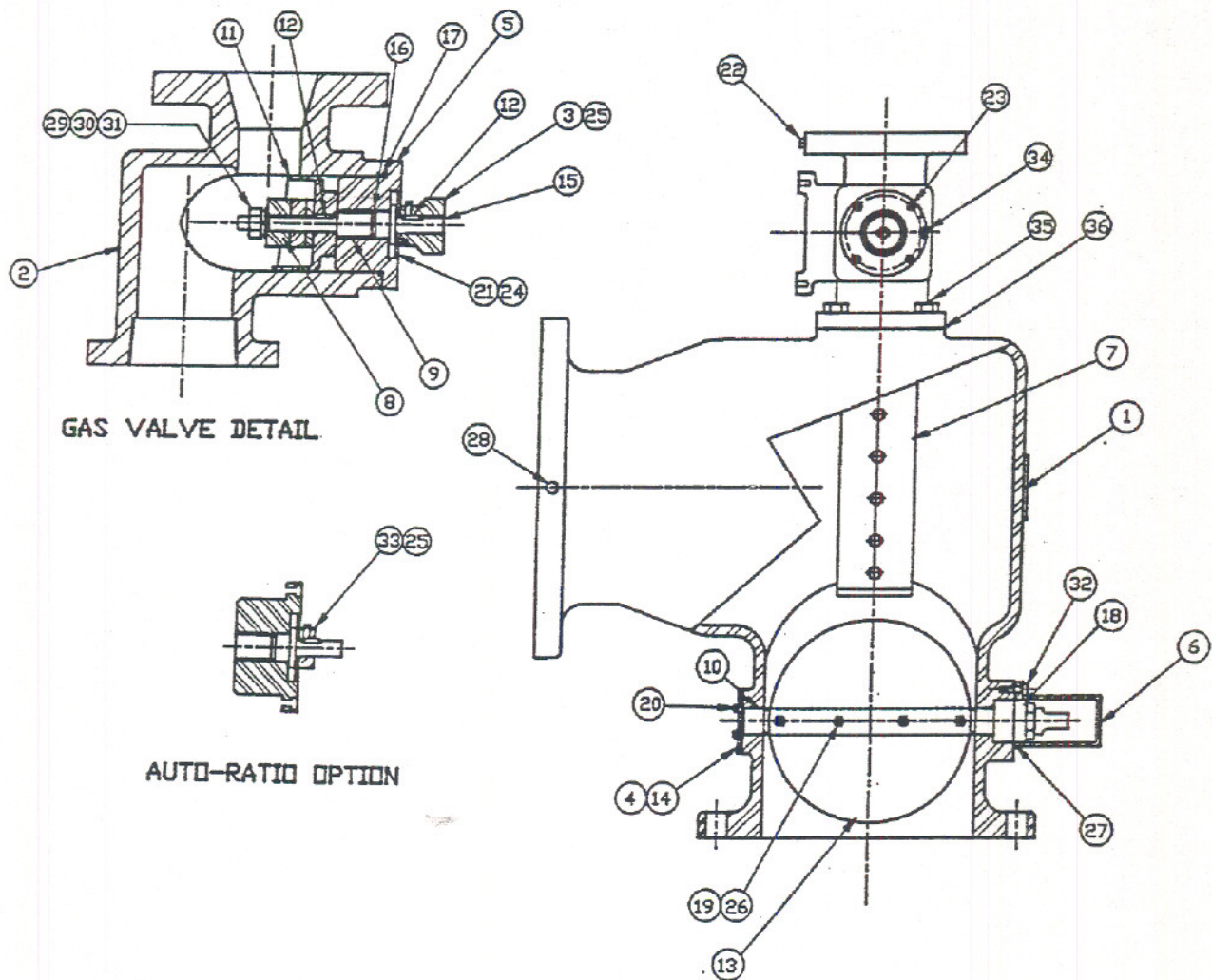


Figure 11 – Valve Assembly Detail

TROUBLESHOOTING

INADEQUATE FLOW OR DELIVERY PRESSURE

1. Check rpm and shaft rotation direction on compressor. Most centrifugal compressors run at 3750 rpm, however, the rpm should be verified by referring to both the motor and compressor nameplates. Check belt adjustment on Series TBD combustion controllers.
2. Check for obstructions in piping, clogged air filter element, valves mistakenly left either open or closed, tripped firechecks or blowouts.
3. Check control valve linkage (if applicable) to determine if any adjustments have become loose.
4. Look for any excessive leakage from piping connections, system components, or broken burner tips.

CHANGE IN MIXTURE RATIO OR INABILITY TO MAINTAIN RATIO

1. Check ratio dial setting to verify that it has not been tampered with. The ratio dial setting should be on record for the particular machine and application for this purpose.
2. Verify that all test ports are closed and/or plugs are installed. Piping and flanges should be tight, especially the fuel supply. The zero governor impulse tube connections must be leak free as they are critical to the operation of the valve.
3. Perform balance test on zero governor per the instructions in the maintenance section to verify proper function.

4. Verify consistency of fuel quality. If the fuel supply is subject to variations, a combustion analyzer and automatic control should be installed on the fuel ratio valve to automatically compensate for any changes. (Selas Qual-O-Rimeter® Option)

COMPRESSOR SURGE

At flow rates well below the factory rating, surging can take place when centrifugal compressors are used. Surge is characterized by pulsations in pressure and flow at the compressor outlet. Due to the heavy duty construction of the centrifugal compressor, surge can be tolerated for short duration, but damage to the internal components can result from long term operation under surge conditions.

1. Determine if minimum flow can be increased beyond surge limit without interfering with process.
2. Install a bypass loop from the compressor outlet to the compressor inlet (not the mixing valve inlet) to allow the excess flow required to prevent surge to bleed back to the compressor inlet. If a significant percentage of the flow is bled off, a heat exchanger will be required to remove compression heat from the recirculated mixture.

BEARING NOISE

High frequency shrieks usually denote a bad bearing. Local vibration should identify whether the source is in the compressor or motor.

ORDERING INSTRUCTIONS

When ordering parts for the compressor, always specify:

1. Part name or description.
2. Model and frame size of compressor.
3. Serial number of compressor.

When ordering parts other than for the compressor, always specify:

1. Quantity
2. Part name or index number
3. Figure number and title.
4. Serial number.
5. Catalogue and model numbers.