Robertshaw CONTROLS COMPANY
Uni-Line North America A SIEBE COMPANY

Control Tips

October 1996

TWO-STAGE GAS VALVES

Application - Operation - Troubleshooting

Application

Two-stage gas valves are found in a variety of different heating applications, ranging from residential forced air furnaces, to medium and large make-up air units, and a variety of hot water boilers.

Robertshaw two-stage gas valves use a two-stage, two-pressure regulator which responds to the demand of a two-stage controller (thermostat).

700-413
(7000BGVER2-4)

Two-stage gas valves are available in a variety of capacities (29,000 to 960,000 Btu/Hr.) and piping sizes (3/8 to 1 inch) for use with either Natural or LP (Propane) gases. A variety of models for Standing Pilot applications and Diaphragm valve (solenoid) - (no safety) applications, as well as specific application models for use in Pilot-Ignition systems, Direct Spark and/or Hot Surface Ignition configurations.

The use of two-stage gas valves is often predicated upon regional and seasonal demand variations. In areas where short to moderate periods of extreme temperature changes occur, the use of two-stage heating can provide a definite advantage in both efficiency and economy. When the demand is low, the valve will operate in its first stage, providing a lower input to the equipment, resulting in more stable cycling and reduction in gas usage. As demand increases, the valve's second stage is activated and the full input of the equipment comes into play. Equipment and burners are specifically designed for operation with two-stage gas valves. The equipment manufacturer's guidelines and specifications should be consulted for proper use and application.

Operation

The main characteristic of two-stage gas valve operation is the ability to vary the gas pressure delivered to the main burner(s) through the use of a solenoid operated two-pressure regulator. On a call for heat, the first stage (main) actuator of the gas valve is energized, allowing gas to flow. The pressure regulator, however, operates at the lower of two pressure settings allowing only a reduced flow through the valve. When demand increases sufficiently, the second stage regulator is energized. This allows the pressure regulator to reset to its high pressure setting, thereby allowing the equipment to operate at full input.

The first stage setting is determined as a percentage of the full output of the valve, and the pressure regulator is factory set accordingly. The second stage pressure regulator setting is also factory set and is the nominal 3.5" WC (water column) for Natural Gas, or 11" WC for LP (Propane). NOTE: The first and second stages are both fixed settings and cannot be field adjusted.

The first step (stage) percentage [*%Step(Stage)*] of a two-stage gas valve is calculated by dividing the square root of the first stage pressure regulator setting [$\sqrt{X}$] by the square root of the full pressure regulator setting [$\sqrt{Y}$].

Formula 1:

$$\%Step(Stage) = \frac{\sqrt{X}}{\sqrt{Y}}$$

For example: The **700-446** (7000BER2-4) Robertshaw Uni-Line two-stage valve for Natural Gas is rated for a 60% step. The low-fire pressure regulator setting is 1.3" WC and the high-fire pressure regulator setting is the nominal 3.5" WC. The square root value of the 1.3" WC low-fire setting is 1.140 and the square root value of the high-fire 3.5" WC setting is 1.871. Dividing the low-fire square root value (1.140) by the high-fire square root value (1.871) gives us the step input value of 60%.

$$\%Step = \frac{\sqrt{1.3"\,wc}}{\sqrt{3.5"\,wc}} = \frac{1.140}{1.871} = 60\%$$

The **700-446** example valve is rated for a maximum output of 300,000 Btu/Hr., Nat., however, as with most bleed-operated diaphragm valves, it may be used in any systems down to 10% of its capacity. (30% for HC models.) Therefore, if it were applied to a piece of equipment rated (orificed) for 220,000 Btu/Hr. capacity, the first stage output (60%) would be 132,000 Btu/Hr. and the second stage (full) output would be 220,000. Other valves (especially large capacity Natural Gas and LP models) may also incorporate slow-opening features which will soften both the first stage ignition and the sudden rise to second stage input through internal, bleed gas orificing. (Actual Btu/Hr. of the equipment is determined by the main burner orificing.)

Two-stage gas valves are manufactured with the first stage set as low as 30% of full flow and all the way up to as much as 70% of full flow. The most common first stage settings are in the 50 to 60% range.

Troubleshooting

Troubleshooting of two-stage gas valves is similar to that of single stage gas valves. 700 Series Standing Pilot Safeties are checked in the same manner as any other gas valve. The operator(s) may be checked for continuity, or with the system powered using an appropriate meter to read the voltage through the operator(s) coil as the stages are activated.

Pilot Ignition, Direct Spark and Hot Surface Ignition 700 and 720 Series two-stage gas valves are checked according to the troubleshooting instructions of the type system and control module being used. In ignition systems, operations of the controller, module and valve are the same as with single function applications and only the first stage is activated and controlled though the module. The second stage in these types of ignition systems is activated by the controller (thermostat) as demand dictates.

Wiring schematics for typical 700 Series Standing Pilot valves, 720 Series Pilot Ignition and Hot Surface Ignition applications are shown as examples in Figures 1, 2 and 3. Additional 700 and 720 Series wiring diagrams are packaged with all two-stage gas valves.

Figure 1: **Standing Pilot**

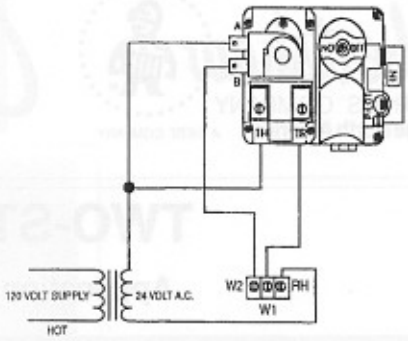


Figure 2: **Pilot Ignition**

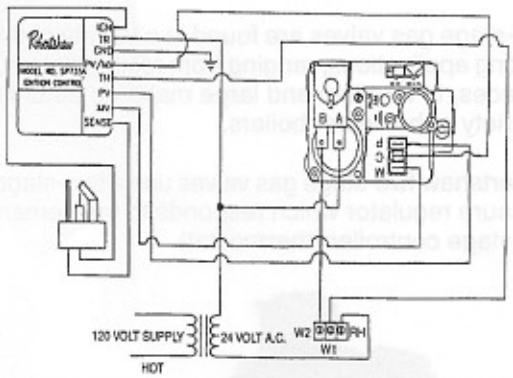
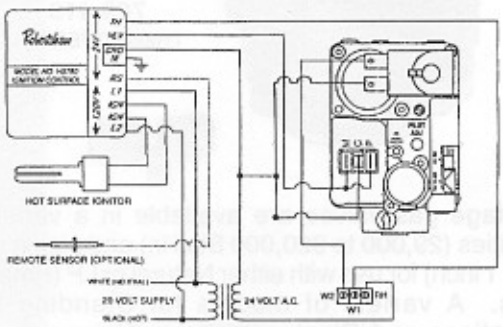


Figure 3: **Hot Surface Ignition**



CAUTION

THESE DEVICES SHOULD BE INSTALLED BY QUALIFIED TECHNICIANS WITH DUE REGARD FOR CODE AND SAFETY REGULATIONS AS IMPROPER INSTALLATION OR SERVICE COULD RESULT IN HAZARDOUS CONDITIONS.

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