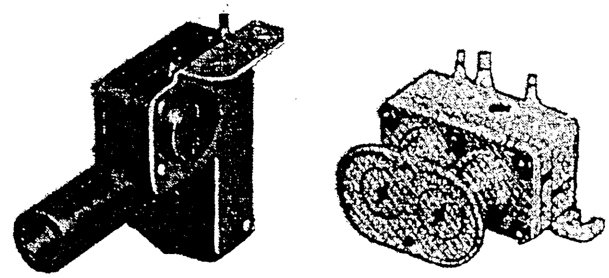
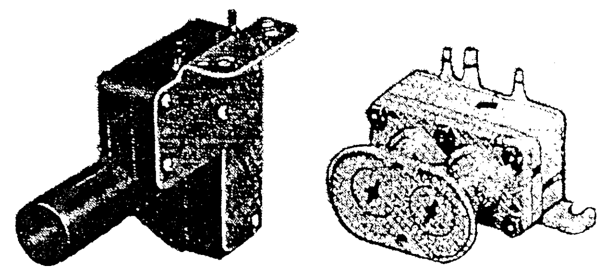
Honeywell

Engineering Data

CP980C, D, E, and F Velocitrol Velocity Controller



DIRECT ACTING



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REVERSE ACTING

INTRODUCTION

The CP980 Velocitrol Velocity Controller combines ultrasensitive air velocity sensing with one of two pneumatic controllers to detect and control air flow in air terminal units, regardless of system static pressure.

The four models available are a reverse acting controller for normally closed dampers, a direct acting controller for normally open dampers, a Type B controller providing high and low air volume limits used in conjunction with a one-pipe bleed thermostat, and a Type C controller used for two-pipe thermostat applications and for sequencing with reheat.

Sensing does not depend on differential air pressure for operation. Although designed primarily for use in higher velocity air systems, the CP980 can accurately sense velocities lower than 100 ft/min (0.5 m/s) and still produce an output. One of several flow limiting orifices allows a maximum duct velocity of 3500 ft/min (17.7 m/s).

FUNCTIONAL OPERATION

Refer to Figure 1 (Type B controller). Air from the main line pressure supply, Port 1, passes through the primary jet restriction to the secondary jet restriction, the minimum flow limit, and the maximum flow limit. The minimum flow limit provides the supply air for a bleed type thermostat. The thermostat pressure determines the pressure to the secondary restriction within the limits of the selected settings of minimum and maximum flow limits. This determines the flow through the emitter tube and thus the jet velocity.

The minimum flow limit prevents the stat from bleeding the pressure to the secondary restriction below the minimum setting. The maximum flow limit prevents the stat from building pressure to the secondary restriction above the maximum setting.

The jet collector pressure is directly proportional to the jet velocity and is an inverse function of any jet deflection caused by airflow through the sampling tube. A two-stage bleed type amplifier amplifies the jet collector pressure to provide the branchline pressure.

Therefore, for reverse acting models branchline pressure is inversely proportional to the velocity of the air flowing perpendicular to the jet in the sampling tube. For direct acting models the branch line is directly proportional to the velocity of the air flowing perpendicular to the jet in the sampling tube.

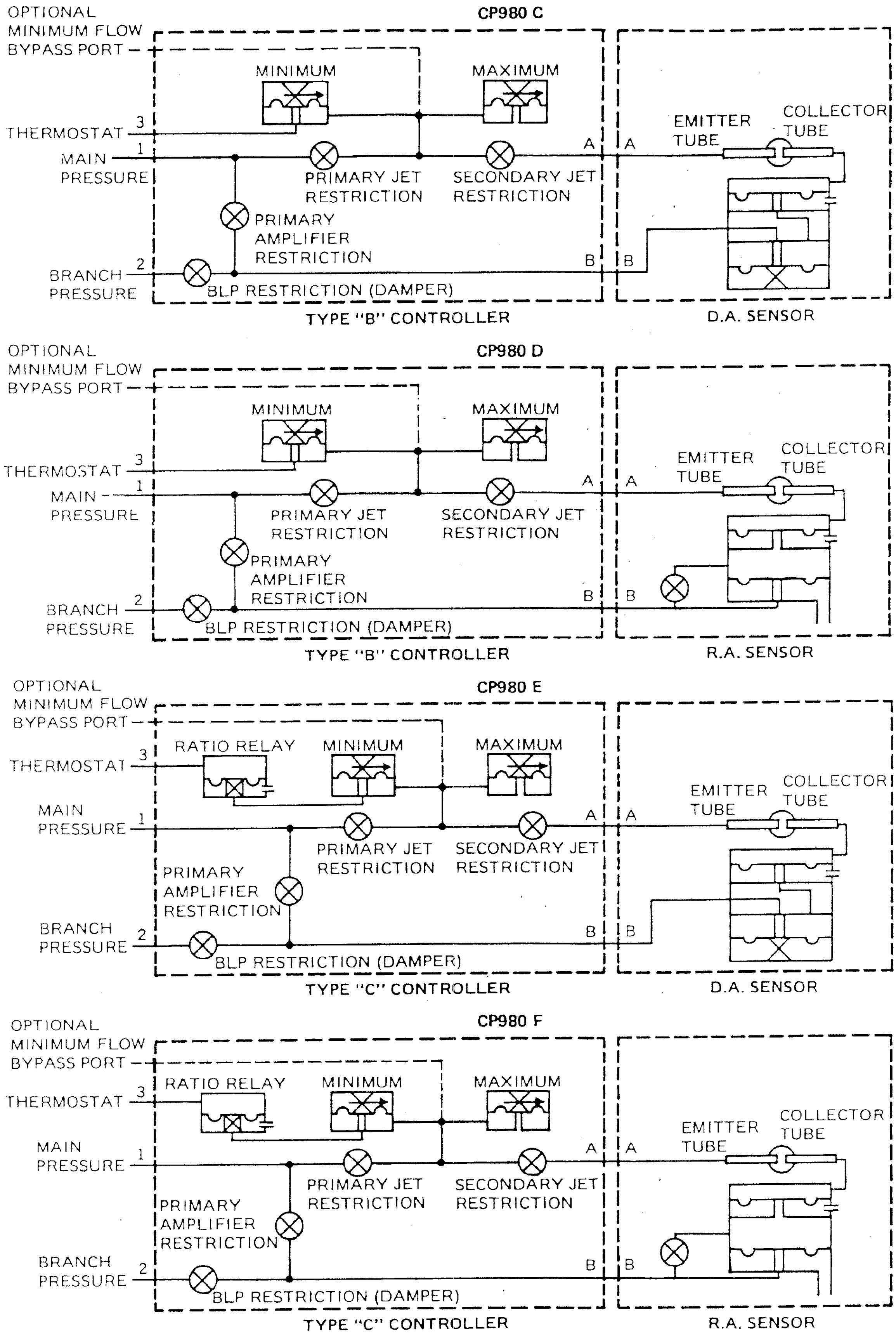

Fig. 1. Velocitrol Internal Circuitry.

Once the thermostat establishes a velocity control point, any increase in velocity results in a decrease in branchline pressure to the damper actuator (reverse acting). This closes the damper, reducing velocity to the control point. A change in temperature in the space modulates the pressure at the thermostat. This provides a new pressure to the secondary jet restriction (within the minimum and maximum limits) which resets the velocity control point to control the temperature at an equilibrium condition.

When using a Type C controller for sequencing control, a pressure signal from the thermostat operates the pilot of a ratio relay which functions as the bleed valve controlling the pressure to the secondary jet restriction. The ratio relay is biased to a 9 psi (62 kPa) start point at zero velocity so any thermostat signal below 9 psi (62 kPa) can sequence other control devices. If the minimum adjustment is set above zero, the start point for thermostat reset will be proportionately above 9 psi (62 kPa).

APPLICATION

GENERAL

The Velocitrol controller provides a modulating pressure output to a pneumatic damper actuator to maintain a constant air velocity in heating and cooling ducts regardless of the duct static pressure.

Each Velocitrol package (CP980) consists of a sensor and a controller, an orifice, (if required) is provided separately.

The sensor contains a controller mechanism and does not have a usable "sensor" type signal. The controller contains two pressure regulators, a filter, and restrictions only.

VELOCITROL WITH TYPE B CONTROLLER

ADJUSTABLE MAXIMUM AND MINIMUM VELOCITY CONTROL

Velocity is reset between adjustable minimum and maximum settings by a bleed thermostat. A pressure increase at the thermostat increases the velocity control point. The orifice and the controller settings determine the velocity range. The maximum and the minimum limits set the range as a percentage of the rated velocity established by the orifice. Dial settings do *not* directly represent percent of rated velocity.

VELOCITROL WITH TYPE C CONTROLLER

ADJUSTABLE MAXIMUM AND MINIMUM VELOCITY CONTROL WITH RATIO RELAY FOR SEQUENCING

This application differs only in that the thermostat must have its own air supply and it maintains the minimum velocity selected until the thermostat signal increases to 9 psi (62 kPa). The thermostat signal required to reset above minimum is proportionately higher for higher minimum dial settings.

VELOCITROL SYSTEMS

The Velocitrol controller finds use in many systems. Descriptions of major applications follow. All systems are classified "Pressure Independent".

SINGLE DUCT CONSTANT VOLUME REHEAT

See Figure 2. The thermostat modulates the reheat in response to the load. Although inlet static pressure may vary, the controller maintains a constant volume by sensing air velocity changes and adjusting the damper accordingly.

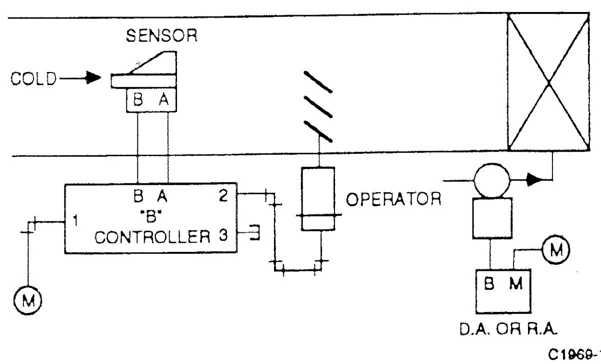

Fig. 2. Single Duct Variable Constant Volume Reheat Application.

SINGLE DUCT VARIABLE CONSTANT VOLUME

See Figure 3. The thermostat senses room temperature and resets the control point of the velocity controller. This repositions the damper to increase or decrease airflow accordingly. If a change in static pressure modifies flow, the sensor repositions the actuator to maintain flow as directed by the thermostat.

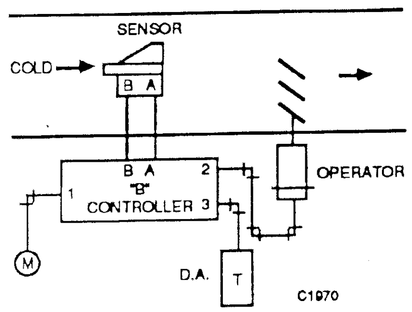

Fig. 3. Single Duct Variable Constant Volume Application.

If the thermostat calls for airflow greater or less than the controller maximum and minimum settings, these adjustments take precedence over thermostat control and maintain the specified air volume as shown in Figure 4.

Use of the Type C controller makes pressure sequencing of reheat possible. The thermostat output is connected to the reheat means (hot water valve or P.E. switch), and the controller reset range is 9 to 15 psi (62 to 103 kPa).

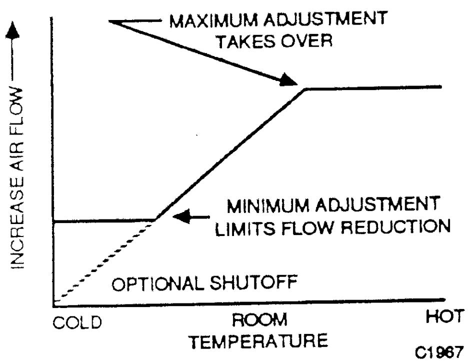

Fig. 4. Airflow Control in Signal Duct Variable Constant Volume Application.

THERMOSTATS

While the Velocitrol design is compatible with the bleed type thermostats (TP973, TP975), it also operates with capacity type thermostats (TP970, TP971, TP972). The C controller, with its isolated pilot chamber, is suitable for use with all thermostats whether or not they require sequencing. The reset action occurs over only half the throttling range of the thermostat (9 to 15 psi [62 to 104 kPa]).

When using a stat with its own main supply (two-pipe) with a B controller, always use an RP470B relay as a repeater as shown in Figure 5.

NOTE: **Bleed thermostats or equivalent bleed devices other than Honeywell, when connected directly to Port 3 of a Type B controller, must be capable of bleeding down to 1.25 psi (9 kPa) at a compressed airflow rate equivalent to that of a 0.007-inch restriction with a mainline pressure of 20 psi (138 kPa).**

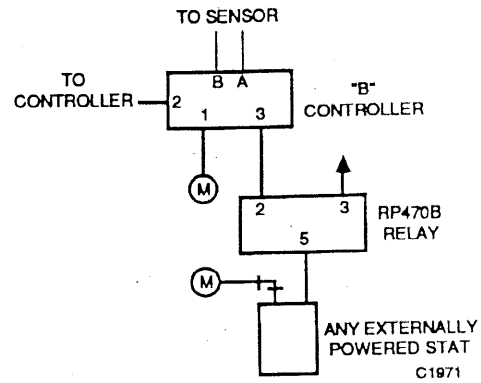

Fig. 5. Capacity Type Thermostat with Repeater.

SPEED OF RESPONSE AND STABILITY

Fast response is one of the beneficial characteristics of the Velocitrol controller. The system will react quickly to changes in velocity caused by sudden changes in static pressure. The reaction is usually fast enough so that there is not noticeable change in discharge airflow or noise.

SUMMER/WINTER FLOW SWITCHING

Pipe the controller to provide variable volume between adjustable maximum and minimum flows for operation during one season. Via a mainline pressure signal change and an RP670 switching relay, operate between maximum and zero flow during the other season. This allows the maintenance of a minimum flow during the winter cycle when reheat is necessary, yet allows full shut-off in the summer season. Figure 6 shows typical piping. Figure 1 shows internal piping and location of the minimum bypass port on the controller.

MORNING WARM-UP

A single duct system that normally transports cold air may be needed to transport warm air on occasion. Normally, the controls hold the damper shut or at minimum to prevent warm air from reaching the space. In order to function properly to carry warm air, a different thermostat is added to the control system. This method eliminates uncontrolled flow problems and overheat caused by the old method of driving dampers fully open.

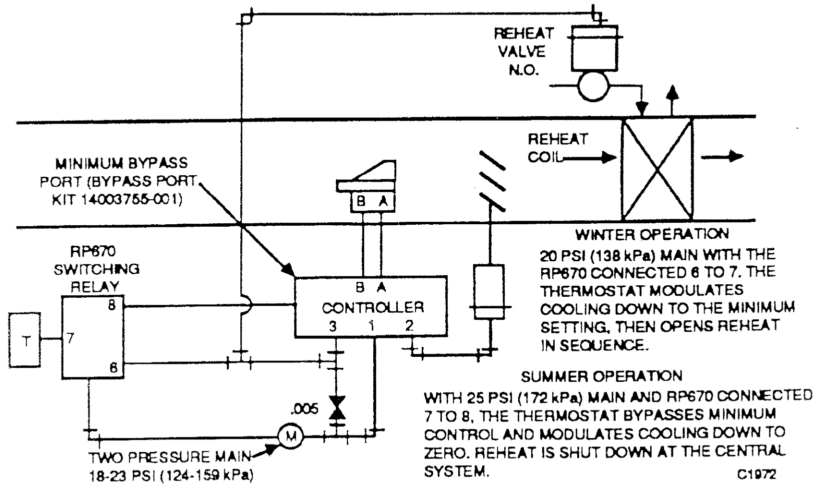

Fig. 6. Summer/Winter Flow Switching on Single Duct Variable Volume Terminal Unit.

Figure 7 illustrates morning warm-up applications. These methods are superior to those which open all the boxes fully because they control volume during warm-up. The systems shown in Figure 7 also maintain temperature control. The volume control prevents fan overload and minimizes chances that boxes are starved or over volumed.

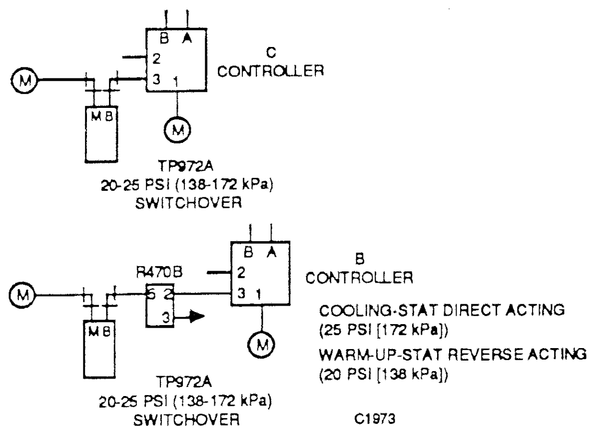

Fig. 7. Recommended Morning Warm-Up Control.

CALIBRATION

Velocitrol controllers ordered from the factory as a matched set come factory calibrated. This calibration is accomplished using laboratory type instruments and procedures and is much more accurate than can be accomplished using field procedures. When both units are replaced, minimum and maximum flow calibrations are maintained. If the controller or sensor only is replaced, original flow calibration is lost.

MAXIMUM FLOW (Terminal Unit Calibration)

1. Check main pressure to assure 18 psi (124 kPa) minimum.
2. For Type B controller, cap thermostat Port 3. For Type C controller connect main air to Port 3.
3. Install flow measuring test equipment.
4. Measure actual flow in ft^3/min (m^3/s).
5. Adjust or calibrate MAX dial to the desired flow level using flow measuring equipment. Write the new dial setting and airflow on a tag or on the unit for future reference.

MINIMUM FLOW (Terminal Unit Calibration)

1. Vent Port 3.
2. Turn MAX dial above 10.
3. Install flow measuring test equipment.
4. Measure actual flow in ft^3/min (m^3/s).
5. Adjust or calibrate the MIN dial to the desired flow level using flow measuring equipment. For future reference, write the new dial setting and airflow on a tag or on the unit.

ORIFICE AND SCALE SETTINGS (Field Installation)

1. Divide the required flow values for minimum and maximum by the duct area to determine required velocity.
2. Refer to Table 1 to calculate percent of velocity rating.
3. Select an orifice as close to 70 percent of velocity rating for maximum as possible. This provides optimum adjustment of the maximum scale.
4. Check the dial settings. For minimum set at shut off, select a setting of 0.

Table 1. CP980C, D, E, and F Velocitrol Controller Ordering System.

Controller Type	Velocity Range ft/min (m/s)	O.S. Number
Type B Controller Direct Acting (used with N.O. damper)	500 (2.5) No Orifice	CP980C1065-1
Type B Controller Reverse Acting (used with N.C. damper)	500 (2.5) No Orifice	CP980D1063-1
Type C Controller Direct Acting (used with N.O. damper)	500 (2.5) No Orifice	CP980E1060-1
Type C Controller Reverse Acting (used with N.C. damper)	500 (2.5) No Orifice	CP980F1068-1

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THEORY OF OPERATION

NOTE: The following information illustrates basic operating principles for the velocity sensor controller. Performance values given are only approximate.

Historically, duct air velocity has been measured with a Pitot tube. While this provides adequate output signals for higher air velocities, it is unusable at lower velocities except with high gain laboratory type sensors. In the system shown in Figure 8, air moving at a velocity of 500 ft/min (2.5 m/s) has a Pitot tube output (velocity pressure) of only 0.0155 in. wc (0.062 kPa). This is below the usable control range of most commercial controllers.

The Velocitrol sensor consists of two small tubes (an emitter jet and a collector tube), inserted through a cylinder wall and separated by a fixed gap. The sensor does not depend on the velocity pressure of the flowing airstream. Instead, a basic, strong signal comprised of a compressed air jet moves from the emitter jet tube to the collector tube across the gap and perpendicular to air flowing through the duct. Figure 9 illustrates the controller operation.

Jet collector pressure is a direct function of supply air pressure. It is linear and inversely proportional to the velocity of duct air flowing through the sensor flow tube. As duct airflow increases, less supply air bridges the gap. As duct airflow decreases, more supply air bridges the gap.

Varying the supply air pressure controls the sensor velocity range. With increased pressure, the air jet moving across the gap requires a greater duct air velocity to deflect it. If the supply pressure decreases, a low velocity of duct air deflects the air jet. The sensor provides usable pneumatic output signals at duct air velocities as low as 100 ft/min (0.50 m/s).

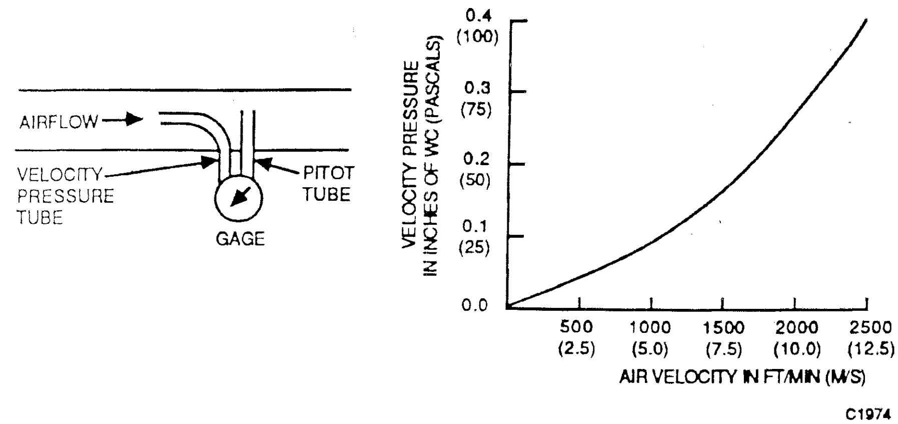

Fig. 8. Air Velocity Sensing Using Pitot Tube.

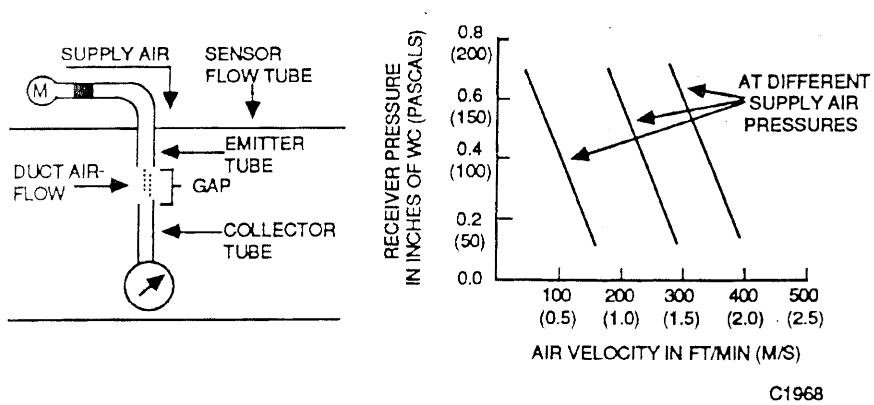

Fig. 9. Simplified Illustration of the Velocitrol Sensor.

Figure 10 compares signals from a Pitot tube and a Velocitrol sensor. Note that the signal from the Pitot tube is nonlinear and extremely small at low air velocities. The velocity sensor output signal is high level and linear. Simply varying the supply air pressure provided to the sensor achieves a usable signal level throughout all required air velocity ranges.

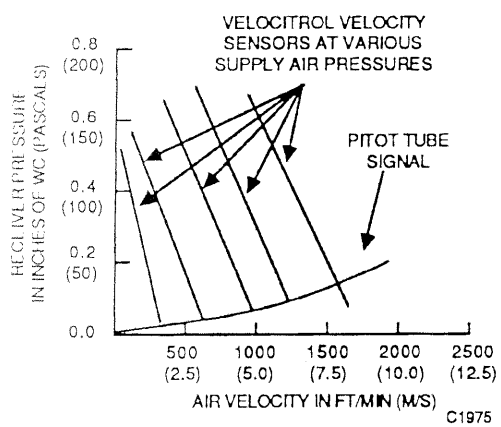

Fig. 10. Air Velocity Sensing: Velocitrol Sensor vs Pitot Tube.

Figure 11 shows a typical control scheme. When the thermostat senses an increase in space temperature, its output pressure increases. The increased pressure increases the velocity of the supply air stream across the sensing gap which increases the collector pressure. The increased collector pressure causes the Velocitrol output to increase (reverse acting models) which causes the branchline pressure to increase. Increased branchline pressure to the normally closed actuator results in increased cold airflow, lowering the space temperature. The increased airflow also acts to deflect the jet, lowering the receiver pressure and achieving a new balanced flow. For direct acting models the increased collector pressure causes a decreased branchline pressure resulting in increased airflow.

When the thermostat senses a decrease in temperature, output pressure decreases which decreases the velocity of the supply air stream across the sensing gap. The collector pressure drops, causing the branchline pressure to decrease (reverse acting models). Decreased branchline pressure to the actuator results in decreased cold airflow and a rise in air temperature (reverse acting models).

For direct acting models a decrease in collector pressure increases branchline pressure resulting in decreased cold airflow.

High and low limit regulators dictate maximum and minimum flow control points. The limit adjustments operate by limiting the supply pressure to the emitter tube. In Figure 12, the high limit adjustment is set at a thermostat pressure of 10 psi (69 kPa). This establishes a maximum flow control point of 300 ft/min (1.5 m/s) (Fig. 11). Any additional increase in space temperature has no effect on the emitter pressure and consequently none on the airflow.

In Figure 13, the low limit adjustment is set at a thermostat pressure of 3 psi (21 kPa), establishing a minimum control point of 80 ft/min (0.4 m/s) (Fig. 11).

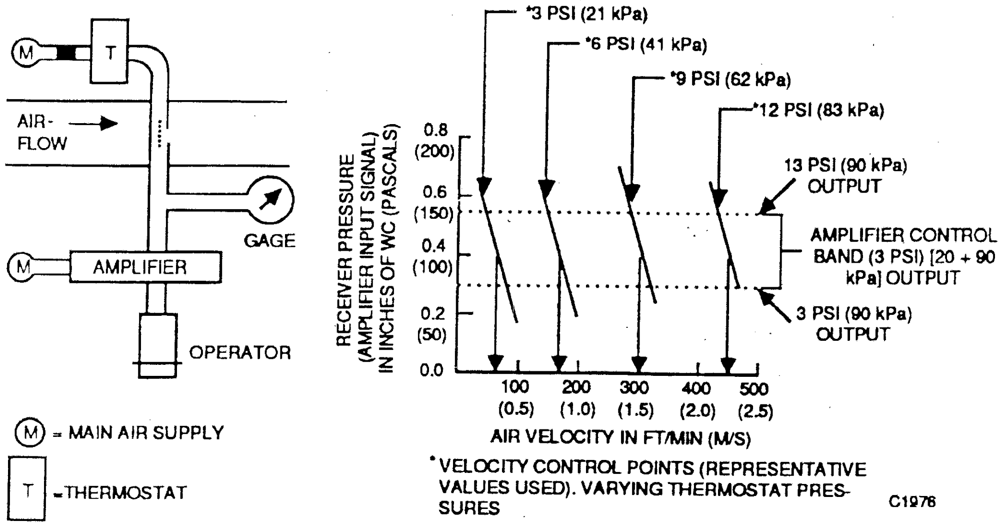

Fig. 11. Velocity Control Points Dictated by Approximate Varying Thermostat Pressures.

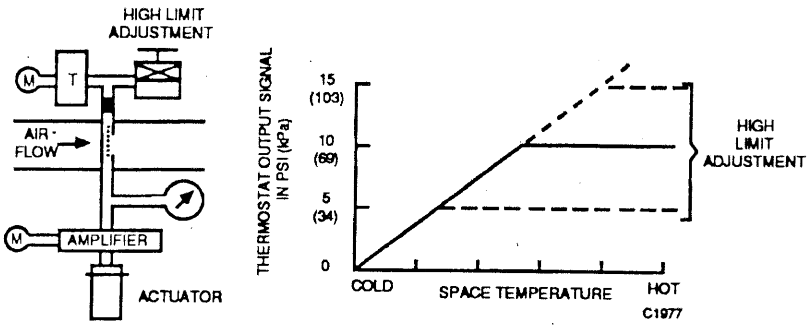

Fig. 12. High Limit Adjustment Used to Dictate Maximum Air Velocity through Duct.

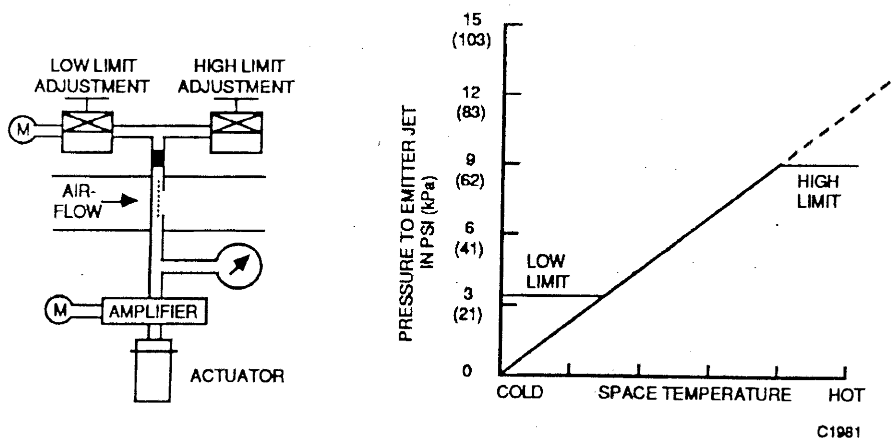

Fig. 13. High and Low Limit Adjustments to Dictate Maximum and Minimum Air Velocities through Duct.

With both high and low limit regulators in use (Fig. 13), the system illustrated operates at duct air velocities between 80 ft/min (0.4 m/s) and 300 ft/min (1.5 m/s), even though the thermostat senses space temperatures which ordinarily require duct air velocities below or above the dictated range.

The Velocitrol controller is ultrasensitive over a wide range of duct air velocities. Control range is increased to the higher velocities by using an orifice which proportionally reduces the velocity or air entering the flow tube, allowing higher duct velocities.

As illustrated in Figure 14, the reduction in velocity is directly proportional to the velocity of air flowing through the duct.

EXAMPLE:

The red orifice B reduces a duct air velocity of 1250 ft/min (6.33 m/s) to a flow rate of 500 ft/min (2.5 m/s), allowing the more sensitive velocity jet to maintain control.

Different orifices allow the velocity sensor to accurately control duct velocities as low as 100 ft/min (0.5 m/s) or as high as 3500 ft/min (17.7 m/s).

As shown in Figure 15, the ranges of the low and high limit adjustments overlap. If the low limit adjustment is set at a pressure greater than the pressure of the high limit adjustment, the high limit control point takes precedence and acts as both the high and low limit; in effect, establishes a fixed control point.

If a sequencing relay is added to the system (Fig. 15), the thermostat pressure must be higher than 9 psi (62 kPa) before the volume controls begin to operate. Below 9 psi (62 kPa), the thermostat signal can control another control device, such as a reheat coil, while the minimum limit adjustment controls the duct air velocity.

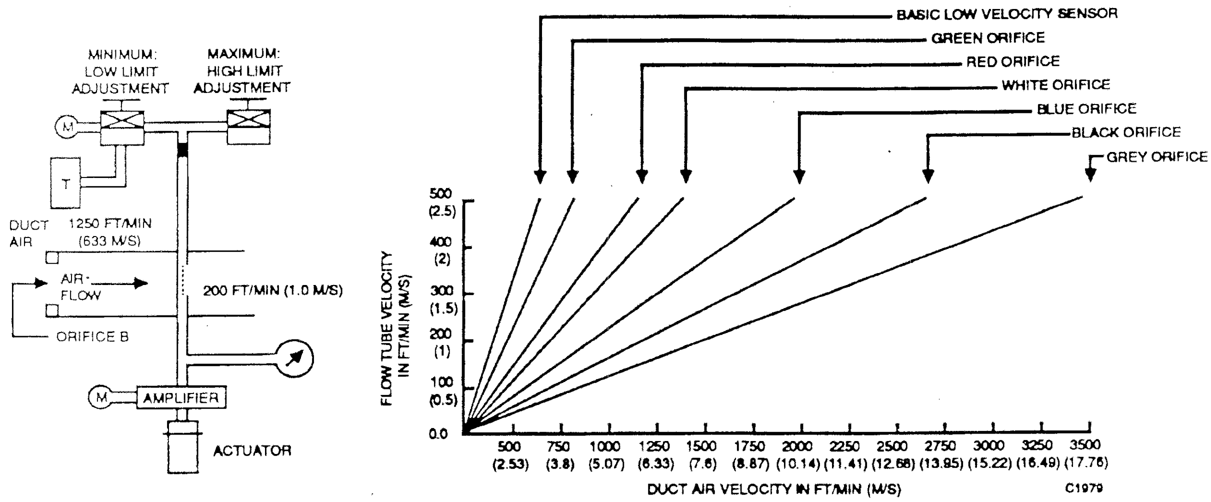

Fig. 14. Orifice to Reduce Velocity of Duct Air Entering Flow Tube.

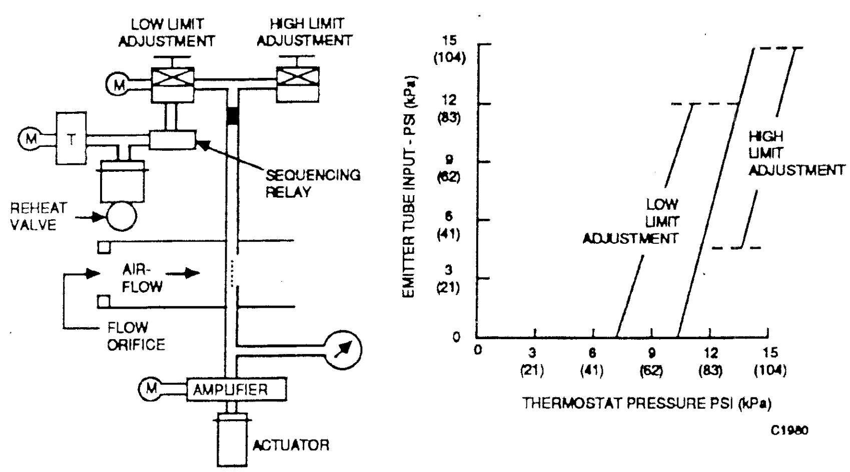

Fig. 15. Use of Sequencing Relay with High and Low Limit Adjustments.

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