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G3P

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(54) Gas pressure regulator

(57) A gas pressure regulator for supplying gas under pressure to a gas distribution network has a control valve 5 operated by an actuator 8 comprising a flexible diaphragm 7 urged in one direction to open the control valve by a spring 9. A feedback pipe 10 supplies gas from the downstream side of the control valve to the opposite side of the diaphragm to act against the spring and modify the operation of the control valve in accordance with downstream gas pressure. A restrictor arrangement 12 incorporated in the feedback pipe is also connected to the upstream side of the control valve and is designed to reduce the flow area through the feedback pipe automatically as the upstream pressure increases and thus prevent amplification of standing pressure waves formed in the gas distribution network.

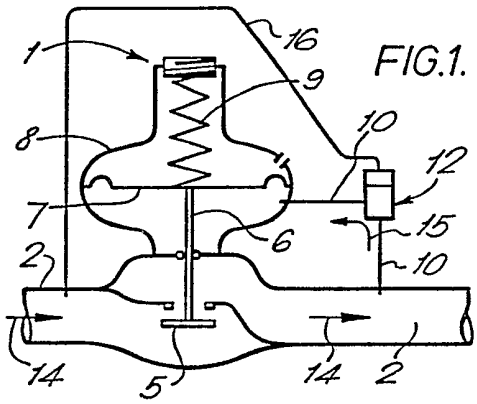
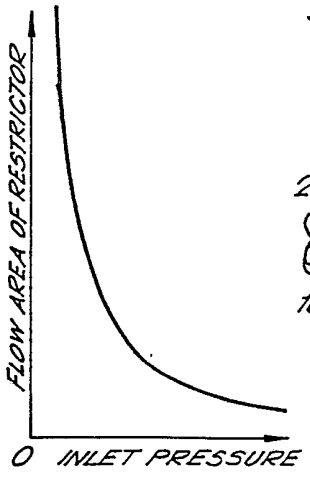


FIG.1.

FIG.2.



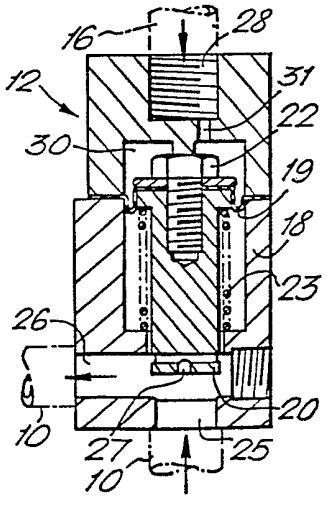


FIG.3.

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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

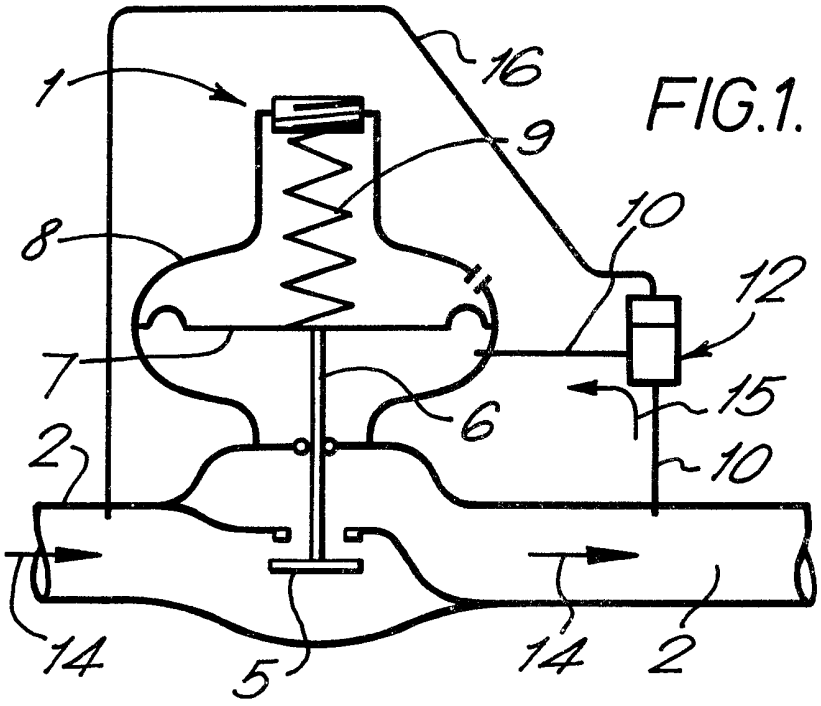
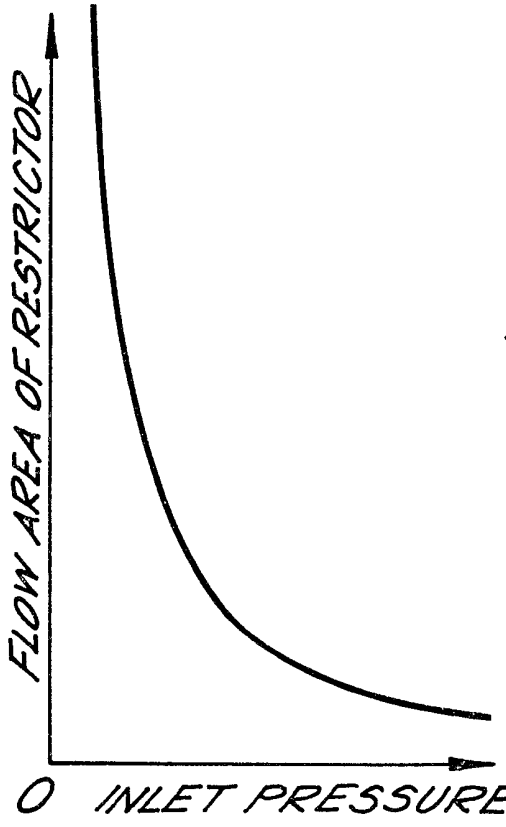


FIG.1.

FIG.2.



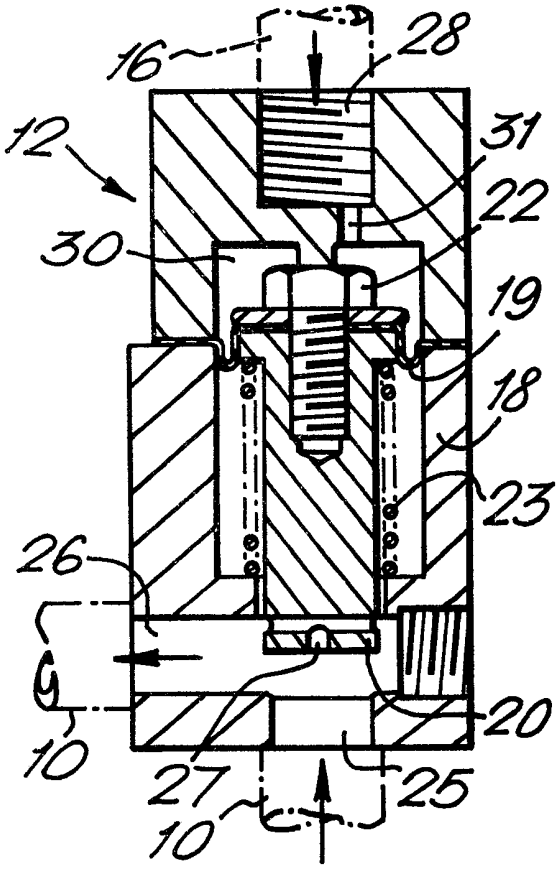


FIG.3.

SPECIFICATION

A gas pressure regulator for supplying gas into a pipework system

Technical Field Of The Invention

This invention relates to a gas pressure regulator for supplying gas under pressure into a pipework system such as a gas distribution network.

Background Art

When gas under pressure is supplied into a gas distribution network standing pressure waves may form in the pipework. These standing pressure waves may be amplified by the gas pressure regulator control loop if the gain of the gas pressure regulator is high. However, if the gain of the gas pressure regulator is low the tendency to amplify the standing pressure waves will be minimised. It is common for the inlet pressure to gas pressure regulators to vary within specified limits and it has been found that at higher inlet pressures the gain of the gas pressure regulator is high and vice versa. Therefore the standing pressure waves which form in the pipework are more susceptible to amplification at higher inlet pressure conditions.

With gas pressure regulators it is common practice to incorporate a fixed restrictor in the regulator control loop in order to reduce the gain at a particular operating condition. However, if operating conditions change resulting in inlet pressure increase, for example change from day to night or from winter to summer, a previously stable system may be pushed into an oscillatory mode. Moreover, if the inlet pressure decreases the response of the gas pressure regulator tends to be slower than it was before the restrictor was incorporated and slower than necessary. In general it has been found that the attenuation required at high frequencies to eliminate acoustic resonance reduced the gain within the required operating range.

An object of this invention is to provide a gas pressure regulator which alleviates the above mentioned difficulties.

Disclosure Of The Invention

According to the present invention a gas pressure regulator comprises a control valve, an actuator for the control valve, a feedback path between a downstream side of the control valve and the actuator arranged to modify the operation of the control valve in accordance with the downstream pressure, and a restrictor arrangement in the feedback path designed to reduce the flow area through the feedback path automatically as the pressure at the upstream side of the control valve increases.

Preferably the restrictor arrangement comprises a diaphragm coupled to a restrictor valve, the diaphragm being urged in one direction by spring means to open the restrictor valve and thus increase the flow area through the feedback path, and urged in an opposite direction by gas pressure derived from the upstream side of the control valve to close the restrictor valve and thus decrease the flow area through the feedback path.

The gas pressure from the upstream side of the control valve may be bled slowly into a diaphragm chamber so that oscillations in upstream gas pressure are filtered out before they can effect the operation of the restrictor arrangement.

The restrictor valve may be provided with a bleed hole to allow a limited flow of gas from the downstream side of the control valve to the actuator when the restrictor valve is in a fully closed position.

The actuator may include a diaphragm coupled to the control valve, the diaphragm being urged in one direction to open the control valve by spring means, and urged in an opposite direction to close the control valve by gas pressure supplied by way of the feedback path and the restrictor arrangement.

The pressure applied to the diaphragm of the actuator by the spring means may be adjustable to a range of predetermined pressures.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings.

Brief Description Of The Drawings

Figure 1 is a schematic diagram of a gas pressure regulator embodying the invention;

Figure 2 is a graph of flow area plotted against inlet pressure for a restrictor arrangement shown in Figure 1; and

Figure 3 is a sectional side elevation of a preferred form of restrictor arrangement.

Best Mode For Carrying Out The Invention

Referring in the first instance to Figure 1, the gas pressure regulator 1, which is connected to a supply pipe 2 supplying gas under pressure to a pipe network (not shown), comprises a control valve 5 coupled by a rod 6 to a flexible diaphragm 7 of a valve actuator 8. The flexible diaphragm 7 of the valve actuator 8 is urged in one direction (downwards in the Figure) to open the control valve 5 by a spring 9.

A feedback pipe 10 connects the downstream side of the control valve 5 to the side of the diaphragm 7 away from the spring 9, by way of a restrictor arrangement 12, the direction of flow of gas along the supply pipe 2 and the feedback pipe 10 being indicated by the arrows 14 and 15 respectively. The gas supplied to the valve actuator 8 by the feedback pipe 10 acts on the diaphragm 7 and tends to close the control valve 5. The upstream side of the control valve 5 is connected to the restrictor arrangement 12 by way of a pipe 16.

When the gas pressure regulator 1 is connected to a gas distribution network by way of the supply pipe 2, the spring 9 of the valve actuator 8 which is adjustable, is set to a position which will provide the desired gas pressure and the spring 9 acting on the diaphragm 7 moves the rod 6 to adjust the control valve 5 accordingly. If the pressure

downstream of the control valve 5 falls the pressure of gas supplied to the valve actuator 8 by way of the feedback pipe 10 also falls, so that the control valve 5 is opened to increase the gas flow.

Conversely, if the pressure downstream of the control valve 5 rises the pressure of gas supplied to the valve actuator 8 by way of the feedback pipe 10 also rises, so that the control valve 5 is closed to reduce the gas flow. Should standing pressure waves be formed in the pipework of the distribution network and the pressure at the upstream side of the control valve 5 rise and tend to amplify these standing pressure waves, this rise in upstream pressure is communicated to the restrictor arrangement 12 through the pipe 16. The restrictor arrangement 12 reduces the flow area automatically in accordance with the rise in upstream pressure so that the standing pressure waves are attenuated. Figure 2 illustrates the relationship between a typical decrease in flow aea through the restrictor arrangement 12 for the rise in pressure at the upstream side of the control valve 5.

Turning now to Figure 3, the preferred form of restrictor arrangement 12 comprises a metal housing 18 accommodating a flexible diaphragm 19 coupled to a restrictor valve 20 by a screw-threaded bolt 22. A helical spring 23 is arranged to urge the diaphragm 19 in one direction (upwards in the Figure) to open the restrictor valve 20 and thus increase the flow area of the flow path between restrictor valve inlet 25 and restrictor valve outlet 26. The restrictor valve 20 is provided with a bleed hole 27 to allow a limited flow of gas from inlet 25 to outlet 26 when the valve is in the fully closed position.

The diaphragm 19 is urged in an opposite direction (downwards in the Figure) against the action of the spring 23 to close the restrictor valve 20 and thus decrease the flow area of the flow path between inlet 25 and outlet 26 by gas pressure supplied from the upstream side of the control valve 5 by way of pipe 16 and inlet port 28. The inlet port 28 communicates with a diaphragm chamber 30 through a bleed hole 31 so that gas pressure from the upstream side of the control valve 5 is bled slowly into the diaphragm chamber 30 and any oscillations are filtered out before they can have any adverse effect.

A gas pressure regulator in accordance with the invention is advantageous in that the required minimum bandwidth of the regulator at the lowest upstream pressure is not affected as the restrictor arrangement is effectively switched out at the lowest pressure. Acoustic effects are not usually a problem at low inlet pressures. The operating conditions of the regulator can vary widely between night and day or summer and winter and the regulator will automatically adjust its gain to avoid acoustic problems. The characteristics of the regulator can be designed to give a predetermined gain change with pressure. The regulator can be designed to automatically compensate for the worst situation without the need for manual intervention to make adjustments, and therefore this will help to enable standardization of regulator design.

CLAIMS

A gas pressure regulator comprising a control valve, an actuator for the control valve, a feedback path between a downstream side of the control valve and the actuator arranged to modify the operation of the control valve in accordance with the downstream pressure, and a restrictor arrangement in the feedback path designed to reduce the flow area through the feedback path automatically as the pressure at the upstream side of the control valve increases.

2. A gas pressure regulator as claimed in Claim 1, wherein the restrictor arrangement comprises a diaphragm coupled to a restrictor valve, the diaphragm being urged in one direction by spring means to open the restrictor valve and thus increase the flow area through the feedback path, and urged in an opposite direction by gas pressure derived from the upstream side of the control valve to close the restrictor valve and thus decrease the flow area through the feedback path.

3. A gas pressure regulator as claimed in Claim 2, wherein gas pressure from the upstream side of the control valve is bled slowly into a diaphragm chamber so that oscillations in upstream gas pressure are filtered out before they can effect the operation of the restrictor arrangement.

4. A gas pressure regulator as claimed in Claim 2 or Claim 3, wherein the restrictor valve is provided with a bleed hole to allow a limited flow of gas from the downstream side of the control valve to the actuator when the restrictor valve is in a fully closed position.

5. A gas pressure regulator as claimed in any preceding claim, wherein the actuator includes a diaphragm coupled to the control valve, the diaphragm being urged in one direction to open the control valve by spring means, and urged in an opposite direction to close the control valve by gas pressure supplied by way of the feedback path and the restrictor arrangement.

6. A gas pressure regulator as claimed in Claim 5, wherein the pressure applied to the diaphragm of the actuator by the spring means is adjustable to a range of predetermined pressures.

7. A gas pressure regulator constructed and arranged to operate substantially as hereinbefore described with reference to Figure 1 and 2 of the accompanying drawings.

8. A gas pressure regulator as claimed in any preceding claim, provided with a restrictor arrangement substantially as hereinbefore described with reference to Figure 3 of the accompanying drawings.

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