

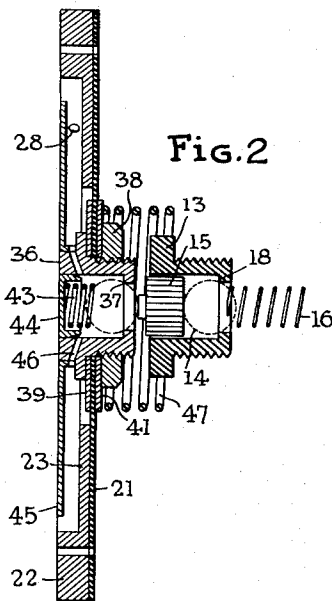
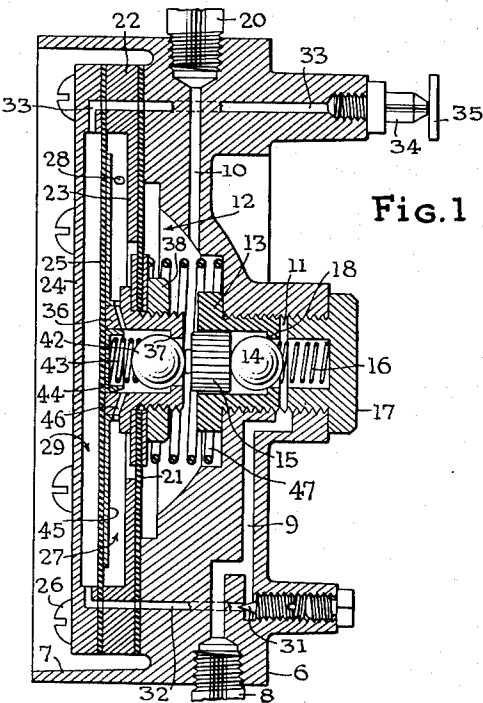
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RELAY FOR USE IN CONTROLLING ATMOSPHERIC CONDITIONS

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RELAY FOR USE IN CONTROLLING  
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The invention relates to pneumatic relays, and particularly to that type commonly controlled by leak ports, and used for controlling temperature, humidity and the like.

The invention provides a novel positive acting "class 2" relay; i. e. one in which rise and fall of pilot pressure past a critical value causes respectively, a sudden exhaust and a sudden full development of the controlled pressure.

A preferred embodiment of the invention will now be described by reference to the accompanying drawing, in which:

Fig. 1 is an axial section of the relay arranged as a class-two positive action instrument;

Fig. 2 is a view indicating the parts in Fig. 1 which give the instrument its operative characteristics;

Figure 1 is diagrammatic to the extent that the supply passage, branch passage and leak port passage are drawn as if they lay in a single plane (the plane of section), whereas in commercial embodiments other arrangements of these ports are commonly more convenient. The leak port and the lid are shown, but no actuating mechanism for the lid is shown, since it may take any of a wide variety of known commercial forms, and is not a feature of the invention.

The body 6 of the instrument has a mounting flange 7. A line 8 supplies air at uniform pressure (say 15 p. s. i.) to passage 9 which is in free communication with supply chamber 11.

Supply chamber 11 is separated from the branch line space 12 by the inlet valve assembly which comprises the seat bushing 13 inlet valve ball 14, thrust member 15 and biasing spring 16. Spring 16 seats in plug 17, which closes the back of chamber 11. The valve seat is the shoulder 18 and the spring 16 biases the valve in the opening direction.

Closing the front of chamber 12 is the rear diaphragm 21 which is clamped by ring 22, with inward extending flange 23. The flange 23 limits outward displacement of diaphragm 21. Supported by ring 22 and clamped by the cup-like cover 24 is the front diaphragm 25. The cover, the ring and the diaphragm are clamped by screws 26, which are threaded into body 6.

The space 27 between the diaphragms 21 and 25 is vented to atmosphere by port 28. The space 29 between front diaphragm 25 and cover 24 is the space in which the pilot pressure is developed. Air under pressure is fed from port 9 past pin-valve 31 through passage 32. Air is vented from space 29 through passage 33 and leak-port 34. The leak port is controlled by a lid or valve 35,

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and when wide open has a venting capacity in excess of the feeding flow past restrictor 31.

The lid is operated by any suitable device, for example a thermostat, hygrostat or like device responsive to atmospheric conditions. Such device is not illustrated.

A passage 19 and branch line 20 connect space 12 with the device to be controlled.

An exhaust valve housing 36 with exhaust seat 37 is clamped to the center of diaphragm 21 by nut 38 and two reinforcing discs 39, 41. The exhaust valve 42 is a ball urged toward seat 37 by spring 43 which seats on a cup 44 pressed to place. A thrust plate 45 is fixed on housing 36 and engages front diaphragm 25 over nearly the entire area of the diaphragm. Ports 46 lead from the interior of housing 36 to the space between the diaphragms 21 and 25.

The diaphragm assembly is biased outward by spring 47.

## OPERATION (See Figs. 1 and 2.)

Spring 47 normally forces diaphragm 21, exhaust valve seat 37, and diaphragm 25, toward cover 24, as shown in Figure 1. Exhaust valve spring 43, being stronger than main valve spring 16, forces exhaust valve ball 42 against its seat 37. Main valve spring 16 holds main valve ball 14 away from seat 18. Main air pressure is supplied through connection 8 to chamber 11, from whence it passes through main valve 14 to chamber 12 and branch connection 20. Thus, in its normal position, the two-position relay has full pressure in its branch line.

Main air from connection 8 also passes through pin valve 31 to pilot air chamber 29, and escapes to atmosphere through leakport 34. Pin valve 31 is so adjusted that, with leakport 34 wide open, the pressure just back of the leakport is between 4 and 5 inches water gauge. The opening of leakport 34 may be varied by movement of lid 35. As lid 35 moves closer to the leakport, less air escapes to atmosphere, and pressure builds up in chamber 29. When the force of this pilot pressure in chamber 29, acting on diaphragm 25, becomes greater than the force of spring 47 plus the force of the full branch pressure acting on diaphragm 21, both diaphragms and exhaust valve seat 37 move in a direction away from cover plate 24. This movement is transmitted to main valve ball 14 by thrust member 15, and the main valve ball seats at 18. When main valve ball 14 is seated, no further movement of this ball takes place, but continued movement of exhaust valve seat 37 forces exhaust valve ball 42 from its seat 37. Air from chamber 12 and the branch line 20 thus

escapes to atmosphere through the exhaust valve, and passages 46 and 28. The escape of air from chamber 12 reduces the pressure acting on diaphragm 21, thus causing the exhaust valve to open further, assuring that once the branch pressure starts to escape, the process will continue until all of the air in the branch line is exhausted to atmosphere.

In order again to supply pressure to the branch line, it is necessary to reduce the pilot pressure in chamber 29 by moving lid 35 away from leak-port 34. When the force of this pressure on diaphragm 25 becomes less than the force of spring 47, both diaphragm and exhaust valve seat 37 are moved toward cover plate 24 by spring 47. Exhaust valve ball 42 first closes on seat 37, then main valve ball 14 moves away from seat 18. Main air flows into chamber 12 and branch line 20, and acts against diaphragm 21 to open further the main valve.

The above description shows that once a change in the branch pressure has started to take place, the effect of this change on diaphragm 21 is such that the cycle continues until it is completed. Hence it is impossible for the branch pressure to have any value except zero or maximum.

**Differential.**—The differential of a two-position relay is defined as the difference in pilot pressure between the point at which the relay operates to pass full pressure to the branch line, and the point at which it operates to exhaust the branch line, or vice versa. When full pressure exists in the branch line, this pressure operates on diaphragm 21 and helps maintain valve ball 14 open. When no pressure exists in the branch line there is no force on diaphragm 21, and the exhaust valve is held open by the force of the pilot pressure on diaphragm 25. Assuming that the force of spring 47 is constant, the change in pilot pressure multiplied by the area of diaphragm 25, must equal the change in branch pressure multiplied by the area of diaphragm 21, in order to operate the relay. The areas of the two diaphragms are so selected that, when the maximum branch pressure is 15 p. s. i., the differential is 4 p. s. i. Since the relay is always part of a complete control instrument, such as a thermostat, humidostat, etc., the differential of the instrument in terms of the controlled variable is determined by the amount of change in the controlled variable required to produce a given movement of lid 35.

The table shows the differential of the relay (Fig. 1) for various maximum values of branch pressure.

Table

| Maximum Pressure | Differential |
|------------------|--------------|
| P. s. i.         | P. s. i.     |
| 13               | 3.5          |
| 15               | 4.0          |
| 17               | 4.6          |
| 20               | 5.3          |
| 25               | 6.7          |

#### GENERAL CONSIDERATIONS

In describing operation, reference has been made to particular pressures, dimensions, spring strengths, ratios and the like. These figures are, of course, intended to be typical and are used to facilitate description. The utility of the invention is broader than any set of dimensional factors, and the claims alone define the limits of the invention.

For example, spring 16 of Figs. 1 and 2 is a weak spring used to keep the ball valve 14 from spinning during flow past it. The valve can be made to function without the spring, but is noisy.

What I claim is:

1. A positive reverse-acting relay comprising in combination, a body having a supply chamber adapted for connection with a source of fluid under pressure, and a generally circular diaphragm chamber adapted for connection with a device in which pressure is to be controlled; an inlet poppet valve and seat controlling flow from said supply chamber to said diaphragm chamber, the valve and its seat being axially aligned with the center of the diaphragm chamber and being arranged to close by motion of the valve toward the supply chamber whereby the valve is biased in an opening direction by supply pressure; a rear diaphragm closing that side of the diaphragm chamber which is opposite to said inlet valve; an exhaust poppet valve and seat mounted at the center of said diaphragm and axially aligned with said inlet valve, said exhaust valve controlling flow from said diaphragm chamber through the central portion of the diaphragm, said valve being arranged to close against its seat by motion toward the diaphragm chamber; yielding means biasing said exhaust valve in said closing direction; a front diaphragm arranged to act in thrust on the rear diaphragm; marginal supporting means for sustaining said diaphragms in spaced relation whereby an exhaust path is afforded from the space between the diaphragms; means enclosing a regulating-pressure chamber at the front of the front diaphragm; means for developing a regulatory pressure in the last-named chamber; yielding means biasing said diaphragms in opposition to said regulatory pressure; and means affording one-way thrust between said supply and exhaust valves, the strength of the exhaust valve spring being such, that under rising regulatory pressure motion of the rear diaphragm first closes the inlet valve and then opens the exhaust valve, and under falling regulatory pressure motion of the rear diaphragm first closes the exhaust and then opens the inlet valve.

2. A positive reverse-acting relay comprising in combination, a body having a supply chamber adapted for connection with a source of fluid under pressure, a diaphragm chamber adapted for connection with a device in which pressure is to be controlled, and a mount for supporting coaxially with said diaphragm chamber an inlet valve assembly adapted to control communication between said chambers; an inlet valve assembly supported in said mount and comprising a housing with valve seat, a poppet valve and a spring biasing said valve in its opening direction, the valve being arranged to close by motion toward the supply chamber; a rear diaphragm closing the side of the said diaphragm chamber opposite to said mount and adapted to support at its center in axial alinement with said inlet valve assembly an exhaust valve assembly adapted to control flow from the diaphragm chamber through said diaphragm; an exhaust valve assembly so supported in said rear diaphragm and comprising a housing with valve seat, a poppet valve and a valve spring biasing said valve in a closing direction toward said diaphragm chamber; a front diaphragm arranged to act in thrust on the rear diaphragm; marginal supporting means for the front diaphragm arranged to afford an exhaust path from the space between

said diaphragms; means enclosing a regulating-pressure chamber at the front of the front diaphragm; means for developing a regulatory pressure in the last-named chamber; yielding means biasing said diaphragms in opposition to said regulatory pressure; and one-way thrust means interposed between said valves and guided in one of said valve housings, the relative strengths of the valve springs being such that under rising regulating pressure motion of the diaphragms first closes the inlet valve and then opens the exhaust valve and under falling regulating pressure motion of the diaphragms first closes the exhaust and then opens the inlet valve.

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