

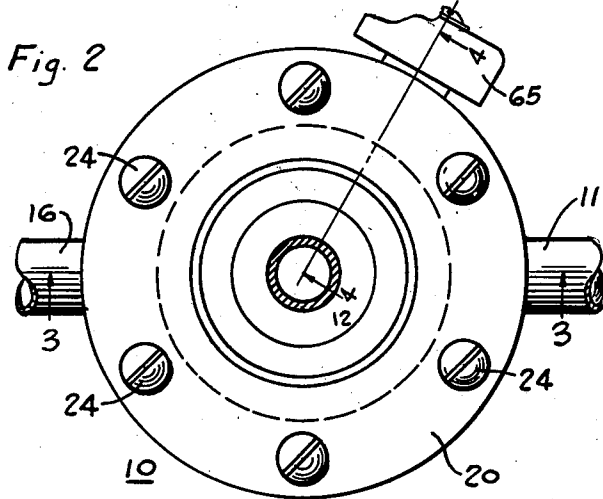
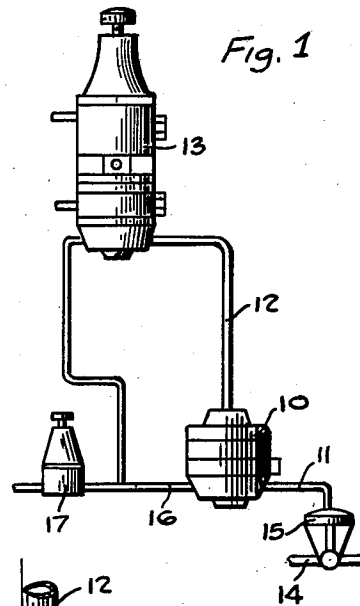
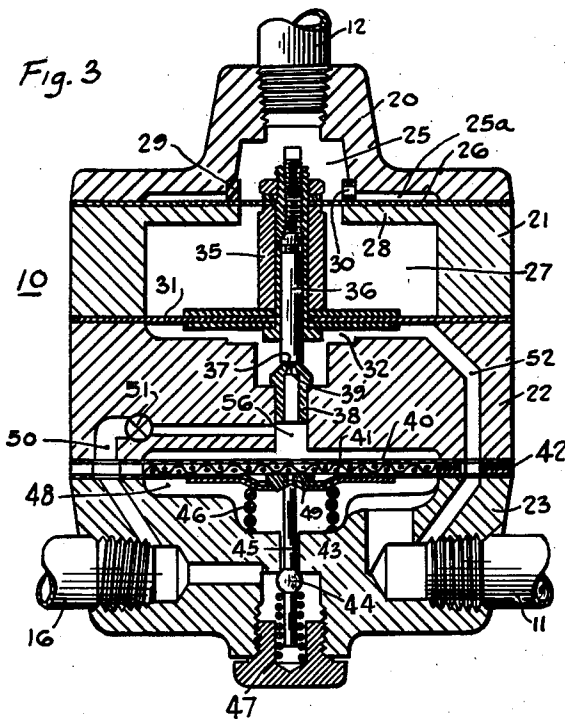
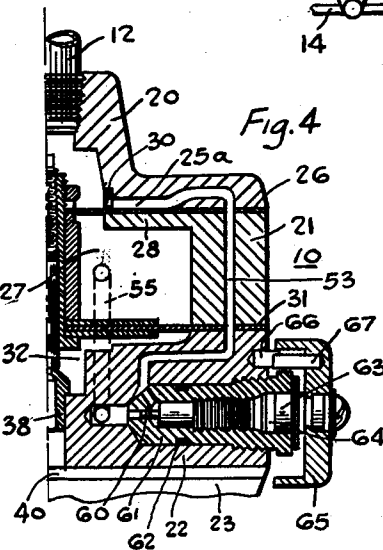
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PNEUMATIC CONTROL APPARATUS

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PNEUMATIC CONTROL APPARATUS

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This invention relates to pneumatic control apparatus and more particularly to apparatus which is responsive to the rate of application of fluid pressure applied thereto for applying a corrective factor for use in the control of other apparatus.

In accordance with the present invention, provision is made for automatically widening the throttling range dependent upon the rate of change of the applied fluid pressure of the measured variable.

In accordance with the present invention, also, control apparatus is provided which may be employed with pneumatic control systems having adjustable throttling ranges, with systems having either manual or automatic reset, or with systems having both an adjustable throttling range and reset.

The nature and characteristic features of the invention will be more readily understood from the following description, taken in connection with the accompanying drawings forming part thereof, in which:

Figure 1 is a diagrammatic view of pneumatic control apparatus embodying an inverse derivative unit in accordance with the present invention;

Fig. 2 is a top plan view of a preferred form of control unit in accordance with the present invention;

Fig. 3 is a vertical central sectional view of the control unit shown in Fig. 2 and taken approximately on the line 3—3 of Fig. 2; and

Fig. 4 is a fragmentary vertical sectional view taken approximately on the line 4—4 of Fig. 2.

It should, of course, be understood that the description and drawings herein are illustrative merely, and that various modifications and changes may be made in the structure disclosed without departing from the spirit of the invention.

Like numerals refer to like parts throughout the several views.

It has heretofore been proposed to apply a corrective effect with a transmitted pressure which corrective effect is proportional to and greater than the transmitted pressure upon rapid changes in the transmitted pressure but which becomes equal to the transmitted pressure after the lapse of sufficient time. Such an effect has been found of value in the control of processes with long time lags, and more particularly temperature control.

The apparatus hereinafter described produces the inverse effect in that the corrective action obtained upon a rapid change in the transmitted

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pressure is proportional to but less than the transmitted pressure change, but which becomes equal to the transmitted pressure after the lapse of sufficient time. This apparatus is particularly suitable for providing stability in pneumatic control systems in which the process variable changes faster than the control valve responds.

Referring now more particularly to Fig. 1 of the drawings, there is illustrated a pneumatic system which includes an inverse derivative unit 10, having a fluid transmitting connection 11, for delivering air at a controlled pressure with a subtractive or additive effect superimposed upon an instrument pressure transmitted to the unit 15 through a fluid connection 12 from a control instrument such as an air controller 13.

The control response setting up the instrument pressure transmitted by the controller 13 can be derived from flow, pressure, or other variable which it is desired to control. The unit 10 is illustrated as connected by a transmitting connection 11 to a diaphragm valve 15, in a fluid flow line 14, although it could be used for the control of other apparatus. The unit 10 is illustrated also as having a fluid connection 16, from a source of pressure regulated and filtered fluid, such as air, and which has a pressure regulator 17 interposed therein.

Referring now more particularly to Figs. 2, 3 and 4 of the drawings, the control unit 10 preferably includes a housing constructed from a plurality of casing sections. The casing sections preferably consist of a top casing section 20, an upper casing section 21, a lower casing section 22, and a bottom casing section 23, secured together in assembled relationship by studs 24.

The top casing section 20 has the fluid connection 12 secured thereto and in communication with an interior chamber 25. Interposed between the top casing section 20 and the upper casing section 21, a flexible diaphragm 26 is provided and clamped at its outer edges by the respective casing sections 20 and 21.

The upper casing section 21 is provided in the interior thereof with a chamber 27 and has an inwardly extending flange 28 for limiting the area of the lower face of the diaphragm 26 which is exposed to the pressure of fluid in the chamber 27. The chamber 25 has a ring 29 mounted therein of the same internal diameter as the flange 28. The ring 29 has a radial opening 30 therethrough in communication with a space 25a surrounding the chamber 25.

Interposed between the upper casing section 21 and the lower casing section 22 and bounding

the chamber 27, a flexible diaphragm 31 is provided and clamped at its outer edges by the respective casing sections 21 and 22. The lower casing section 22 is provided in the upper portion of the interior thereof with a chamber 32, 5 bounded in part by the diaphragm 31, so that the effective area of the lower face of the diaphragm 31, exposed to the pressure in the chamber 32, is the same as the effective area of the upper face of the diaphragm 31 exposed to the pressure in the chamber 27.

The diaphragms 26 and 31 are connected, for simultaneous movement, at the central portions thereof, by a connector sleeve 35 within which an adjustable rod 36 is in threaded engagement. The rod 36 has a lower flat control face 37, for purposes to be explained.

The lower casing section 22 has a detector nozzle 38 mounted therein, in communication with the chamber 32. The nozzle 38 has an orifice 39 which is controlled by the positioning with respect thereto of the control face 37.

Interposed between the lower casing section 22 and the bottom casing section 23, a diaphragm assembly 40 is provided having a porous central section 41 in radial communication with the atmosphere through a radial escape port 42, and controlling the positioning, with respect to a valve seat 43 of a valve seating member 44, carried on a valve stem 45, and interposed between the fluid supply connection 16 and the fluid transmitting connection 11.

The diaphragm assembly 40 and valve 44 may be of the character shown in my prior application for Letters Patent for Pneumatic Control Apparatus, filed December 22, 1945, Serial No. 637,057, now Patent No. 2,501,957 of March 28, 1950. A loading spring 46 is effective in a chamber 48 at the underside of the diaphragm 40 and a spring 47 is effective against the valve member 44, normally tending to urge it to seated position. The upper end of the valve stem 45 is normally seated in and closes a port 49 in communication with the interior of the diaphragm assembly 40.

It will be noted that the downstream side of the valve member 44 is in communication with the chamber 48 at the underside of the diaphragm assembly 40 so that the transmitted pressure is effective thereagainst.

The lower casing section 22 and the bottom casing section 23 have a passageway 50 therein for connecting together the fluid supply connection 16 and a chamber 56 with which the inlet side of the nozzle 38 is in communication. A restriction 51, preferably of fixed size, is provided in the passageway 50. The pressure in the chamber 56 is effective against the upper face of the diaphragm assembly 40.

The lower casing section 22 and the bottom casing section 23 have a passageway 52 therein for connecting the fluid transmitting connection 11 to the chamber 32 so that the transmitted pressure is effective in the chamber 32 and against the lower face of the diaphragm 31.

The casing sections 20, 21 and 22 are preferably provided with a passageway 53 which extends to an adjustable needle valve 60 from the chamber 25a, and the casing sections 22 and 21 are provided with a passageway 55 which extends from the needle valve 60 to the chamber 27.

The needle valve 60 is preferably mounted in a valve sleeve 61 which has a packing 62 for preventing fluid leakage and has a valve stem 63 provided with a packing 64 for preventing

fluid leakage. The outer end of the valve stem 63 is accessible from the exterior of the housing and is provided with an operating knob 65. Stops 66 and 67, respectively mounted on the casing section 22 and the knob 65, are provided to limit the extent of turning of the knob 65.

The mode of operation will now be pointed out.

It will be noted, that upon an increase in the instrument pressure supplied through the instrument connection 12, this increase in pressure is effective in the chamber 25 and against the upper face of the diaphragm 26. This tends to cause a downward movement of the diaphragm assembly, including the diaphragms 26 and 31, and the control surface 37 is moved closer to the nozzle orifice 39. The decrease in flow through the nozzle orifice 39 is effective, by the action of the diaphragm 40, to move the valve 44 farther from its seat 43, thus increasing the pressure in the chamber 48 and transmitted through the fluid connection 11. The pressure of the fluid transmitted through the connection 11 is also effective through the passageway 52 and in the chamber 32 and is effective upwardly against the diaphragm 31, tending to restore the diaphragms 26 and 31 and the control surface 37 to a position of equilibrium. The pressure change required for such restoration is substantially less than that applied on the upper face of diaphragm 26 because of the difference in areas of the diaphragms 26 and 31.

The increased pressure effective in the chamber 25 will equalize by flowing through the passageways 53 and 55 and past the needle valve 60 into the chamber 27. As such equalization takes place the increase of pressure in chamber 27 tends to move the diaphragm assembly downwardly so as to decrease the clearance between the control face 37 and the nozzle orifice 39. This action causes an increase of pressure in chamber 25 as heretofore explained.

Upon completion of the equalization, the pressure in chamber 27 will equal that applied in chamber 25 and there will be no resultant force upon diaphragm 26. The pressure in chamber 32 will have been increased to equal that in chamber 27 and therefore equal to the pressure in chamber 25.

Upon a decrease in the instrument pressure supplied through the instrument connection 12, a similar character of action will occur with a decrease in the transmitted pressure. It will be noted that any change in the instrument pressure through the conduit 12 is effective in the chamber 25 to cause an immediate proportional change in the pressure transmitted through the conduit 11, and that upon equalization of the pressure in the chambers 25 and 27, in accordance with the time determined by the setting of the needle valve 60, the total of the change applied at the conduit 12 becomes effective at the conduit 11.

I claim:

1. In pneumatic control apparatus, a control unit comprising a movable member having a plurality of pressure responsive faces of different pre-determined areas, means for applying on a smaller one of said faces a pressure from a variable source, a fluid connection in communication with said applying means and having a restriction therein for applying fluid pressure on a larger one of said faces in the same direction, a source of pressure regulated fluid, pressure transmitting means connected to said source and controlled by positioning of said movable mem-

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ber for transmitting a control pressure, and means for applying the control pressure on the movable member in opposition to the other pressures effective on said faces.

2. In pneumatic control apparatus, a control unit comprising a casing having a movable member therein with a plurality of pressure responsive faces of different pre-determined areas, means for applying on a smaller one of said faces a pressure from a variable source, a source of pressure regulated fluid, pressure transmitting means connected to said source and controlled by the positioning of said movable member for transmitting a control pressure, means for applying the control pressure on a larger one of said faces, and a fluid connection in communication with said applying means and having a variable restriction therein for applying fluid pressure on the faces opposite each of the other said faces.

3. In pneumatic control apparatus, a control unit comprising a movable member having a plurality of pressure responsive faces of different pre-determined areas, means for applying on a smaller one of said faces a pressure from a variable source, a fluid connection in communication with said applying means and having a restriction therein for applying fluid pressure on a larger one of said faces in the same direction, a source of pressure regulated fluid, pressure transmitting means connected to said source and controlled by positioning of said movable member for transmitting a control pressure and means for applying the control pressure on another of said faces in opposition to the pressures effective on said faces.

4. In pneumatic control apparatus, a control unit comprising a movable member having a plurality of pressure responsive faces of different pre-determined sizes, means for applying on a smaller one of said faces a pressure from a variable source, a fluid connection in communication with said applying means and having a restriction therein for applying fluid pressure on a larger one of said faces in the same direction, a source of pressure regulated fluid, pressure transmitting means connected to said source and controlled by positioning of said movable member for transmitting a control pressure, and means for applying the control pressure on a larger one of said faces in opposition to the pressures effective on said other faces.

5. In pneumatic control apparatus, a control unit comprising a casing having a plurality of spaced coaxial diaphragms therein with pressure responsive faces, a member extending between and connecting said diaphragms for movement in unison, means for applying on one of said diaphragm faces a pressure from a variable source, a fluid connection in communication with said applying means for applying fluid pressure on

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another of said diaphragm faces in the same direction, said fluid connection having a predetermined restricted passageway therein, a source of pressure regulated fluid, pressure transmitting means controlled by the positioning of said movable member and connected to said source of pressure regulated fluid for transmitting a control pressure, and means for applying the control pressure on one of the faces of said diaphragms in opposition to the other pressures effective on said diaphragms.

6. In pneumatic control apparatus, a control unit comprising a casing having therein a plurality of spaced coaxial diaphragms of different predetermined face areas, a member extending between and connecting said diaphragms for movement in unison, means for applying on a smaller one of said diaphragm faces a pressure from a variable source, a fluid connection in communication with said applying means for applying fluid pressure on a larger one of said diaphragm faces in the same direction, said fluid connection having a predetermined restricted passageway therein, a source of pressure regulated fluid, pressure transmitting means connected to said source of pressure regulated fluid and controlled by the positioning of said diaphragm for transmitting a control pressure, and means for applying the control pressure on one of the faces of said diaphragms in opposition to the other pressures effective on said diaphragms.

7. In pneumatic control apparatus, a control unit comprising a movable member having a plurality of pressure responsive faces, means for applying on one of said faces a pressure from a variable source, a fluid connection in communication with said applying means and having a restriction therein for applying fluid pressure on another of said faces in the same direction, a source of fluid under pressure, pressure transmitting means connected to said source for transmitting a control pressure, and means for applying the control pressure on said movable member on an area equal to the sum of the areas of said one and said other faces.

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