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PNEUMATIC INSTRUMENT

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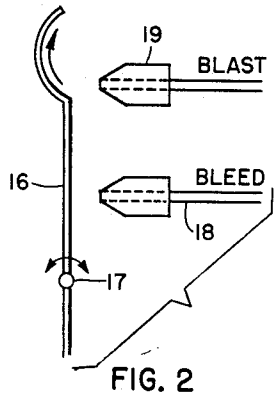

FIG. 2

FIG. 1

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PNEUMATIC INSTRUMENT

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3 Claims. (Cl. 137—488)

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This invention relates to instruments of the type used for recording, indicating, and/or controlling values of variable conditions such as temperature, pressure, flow and the like.

It is particularly concerned with a pneumatic action device for use in such instruments.

Such instruments use condition sensing elements responsive to value changes in the variable conditions, and the response of the sensing element to the condition change is transmitted to an action device in the instrument for operating a recording, indicating, or control unit.

It is an object of this invention to provide a new and improved device of this nature.

The device of this invention is inexpensive, compact, and accurately effective with small forces, and is in the form of a balance arrangement which is productive of a pneumatic operating output force proportionally representative of the sensing element response to the variable condition change.

Illustrative embodiments of this invention are shown in the accompanying drawings, in which:

Figure I is a diagrammatic illustration of a double nozzle and flapper pneumatic device; and

Figure II shows an alternate flapper structure.

The embodiment of this invention as shown in Figure I is an arrangement for controlling the temperature of a process.

As will be explained, temperature variations in the process are made to control an input to the process. This is done by translating the response of a thermometer in the process into movement of a valve in the input, and this translation is accomplished by a pneumatic action device, in this instance comprising a flapper, a pair of nozzles, and a pneumatic relay.

Referring to Figure I, at the lower left, a process tank is indicated at 10. Projecting into the tank 10 is a thermometer 11 for sensing temperature changes in the process. This thermometer may be of the common liquid filled type, or any other suitable type may be used.

Connected to the thermometer 11 is a tube 12 through which the response to temperature variation is travelled to produce movement in a spiral Bourdon tube 13. Secured to the spiral Bourdon tube to receive its movement, is a connector 14, including a coil spring 15. This connector is secured to a lightweight flapper 16 which is pivoted at 17 so that the Bourdon movement results in pivoting movement of the flapper. The coil spring 15, as will be seen, allows opposing forces to be applied to the flapper without causing undesirable movement in the spiral Bourdon tube.

Associated with the flapper 16 at points removed from the pivot 17, there is a pair of nozzles 18 and 19. These nozzles are aimed at the flapper in such a manner that pneumatic flow from the nozzles will be directed against the flapper, and the movement of the flapper about its pivot will vary the interception relation of the flapper and the flow so as to release or restrict pneumatic flow from the nozzles. The nozzles are designated, according to their functions, as a "bleed" nozzle at 18, and a "blast" nozzle at 19. The "bleed" nozzle is so called because the pneumatic flow or pressure therein is a minor or throttling flow or pressure, varied by movement of the flapper. The "blast" nozzle is so called because the pneumatic flow or pressure therein is substantial, and effective in changing or limiting the movement of the flapper.

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The bleed and blast nozzles 18 and 19 are both connected to a pneumatic relay, generally indicated at 20. The construction and operation of this type of pneumatic relay is shown and described in the pending patent application for a Controller (inventor, Hoel L. Bowditch), filed August 21, 1946, Serial No. 692,102. Generally speaking, there is a pneumatic path through the relay through which a substantial pneumatic operating pressure may be travelled. This path is opened or closed, partially or fully, through the movement of a diaphragm, with the diaphragm movement controlled by a minor, or throttling, pneumatic pressure.

As shown in Figure I, the relay 20 is provided, at the top, with a pneumatic pressure input 21. The relay has a power chamber 22 and a secondary chamber 23, with the pressure input having unrestricted access to the power chamber 22 and restricted access to the secondary chamber 23 through a restrictor passage 24. There is a passage between these chambers, as at 25, which is closed off by a diaphragm 26. The diaphragm carries a valve unit 27, which extends through the passage 25, being engaged in the power chamber by a spring 28 as an aid in closing the valve.

From the passage 25, between the chambers 22 and 23 and extending into neither, there is an output passage 29. Thus, with the valve 27 open, an unrestricted pneumatic path is provided through the relay by way of the input 21, power chamber 20, chamber passage 25, and the output passage 29. At the bottom of the relay there is a passage from the inside of the diaphragm, as at 30, operable as a bleed to atmosphere.

Referring again to the nozzles, the bleed nozzle 18 is connected by a tube 31 to the relay secondary chamber 23. Thus a minor pneumatic flow is provided from the nozzle 18 by the way of the relay input 21 and the restrictor opening 24. The blast nozzle 19 is connected by a tube 32 to the relay output passage 29 so as to be provided with a substantial pneumatic flow when the relay valve 27 is open. Further, the relay output passage 29 is connected, as shown at the bottom of the drawing, to a pneumatic valve 33 in a pipe line 34 leading into the process tank 10.

The temperature of the process in the tank **10** is controlled by a heating or cooling medium applied to the process through the pipe line **34**, with this application controlled by the valve **33**.

In the operation of the device, the flapper may be moved toward the bleed nozzle **18** by a temperature change in the process tank **10**. As the flapper approaches the bleed nozzle, it restricts the pneumatic flow therefrom. As this flow is restricted, pressure builds up in the relay **20**, in the secondary chamber **23**, resulting in movement of the diaphragm **26** and in opening the valve formed by the passage **25** and valve unit **27**. A pneumatic pressure from the power chamber **22** is thus introduced into the relay output passage **29** and through the nozzle **19** as a pneumatic blast against the flapper **16**. By this action, the flapper is held, after an initial movement, in a position of balance with respect to the forces from the spiral Bourdon and from the nozzles.

The pressure thus determined as necessary to hold the flapper in its position of balance, is the output pressure of the device, as applied through the relay output passage **29** to the pipe line valve **33**. This output pressure is proportionally related to the Bourdon movement resulting from temperature changes in the process tank **10**.

This proportion is variable by adjustment of the nozzles with respect to the flapper and each other. In this instance the blast nozzle tube **32** is indicated as being flexible, and the blast nozzle may be adjusted toward or away from the flapper pivot **17**. As the blast nozzle approaches alignment with the pivot **17** the proportion relation is reduced, and with the blast nozzle in direct alignment with the pivot **17**, the proportion becomes a one to one relation. When the blast nozzle is in direct alignment with the pivot **17**, the blast has no effect on the flapper **16**, and the device becomes a simple on-off action device. Under these conditions, the device is operated simply by the movement of the flapper **16** in closing or opening the nozzle **18** and consequently the pipe line valve is operated only from full on to full off positions, or the reverse.

Referring to Figure II, it is simply a showing of an alternate flapper design with the pneumatic blast from the blast nozzle applied to a selected contour in the flapper to increase the blast effect on the flapper. As an example of the various contours which may be used a semicylinder is shown.

I claim:

1. In a pneumatic action device for use in instruments as described, a nozzle, means for producing a pneumatic flow through said nozzle, an unencumbered flapper mounted in the path of said pneumatic flow for movement with respect to said nozzle so as to vary said flow, means for producing such movement of said flapper in response to changes in a variable condition, a diaphragm operated pneumatic relay connected to said nozzle and operable by variation of said flow to produce a single pneumatic output pressure from said relay, and a second nozzle arranged to direct said relay output pressure against said flapper in the form of a pneumatic blast in opposition to variable condition movement of said flapper, with said blast being wholly controlled by the relation of said flapper to said bleed nozzle, and said flapper movement being controlled from said relay solely by said pneumatic blast, whereby

said nozzles and said flapper achieve a particular position relation, with said relay output pressure available as a working pressure which is proportionally representative of said response to said variable condition change.

2. In a pneumatic action structure combining a proportioning device and a simple on-off device for use in instruments as described, a movable flapper, a nozzle for directing a pneumatic flow against said unencumbered flapper, means responsive to changes in a variable condition for moving said flapper to vary the flow from said nozzle, a diaphragm operated pneumatic relay connected to said nozzle and operable by changes in said pneumatic flow to produce a single pneumatic output pressure from said relay, a second nozzle arranged to direct said relay output pressure, in the form of a pneumatic blast, against said flapper in opposition to the variable condition action thereon, with said blast being wholly controlled by the relation of said flapper to said bleed nozzle, and said flapper movement being controlled from said relay solely by said pneumatic blast, whereby said nozzles and said flapper achieve a balance relation, with said relay output pressure available as a working pressure proportionally representative of said response to said variable condition change, and means for adjusting at least one of said nozzles with respect to the other to vary said proportion, with the relations achieved at one point of said adjustment resulting in zero proportion, with said pneumatic blast having no effect on the movement or position of said flapper, thereby providing said simple on-off action device.

3. Apparatus for controlling the value of a variable process condition by regulating the flow of a fluid affecting said condition, comprising in combination, a first nozzle, means for supplying a restricted flow of air under pressure to said nozzle to cause a jet of air to issue therefrom, a flapper mounted in the path of said jet for movement with respect to said nozzle to vary the flow of air therethrough, means responsive to the value of said condition connected to said flapper to move the same and thereby vary the air flow through said nozzle and the pressure in back of the nozzle, a pneumatic relay connected to said nozzle and having a movable diaphragm communicating with said nozzle back pressure and operated thereby to regulate a pneumatic supply to produce a relay output pressure, a second nozzle connected to said relay output pressure and positioned adjacent to said flapper to direct a pneumatic blast against the flapper in opposition to the condition-responsive movement of the flapper whereby the flapper is maintained in operative position with respect to said first nozzle, and regulating means responsive to said relay output pressure for regulating the flow of said fluid.

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