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TEMPERATURE RESPONSIVE SAFETY CONTROL VALVE

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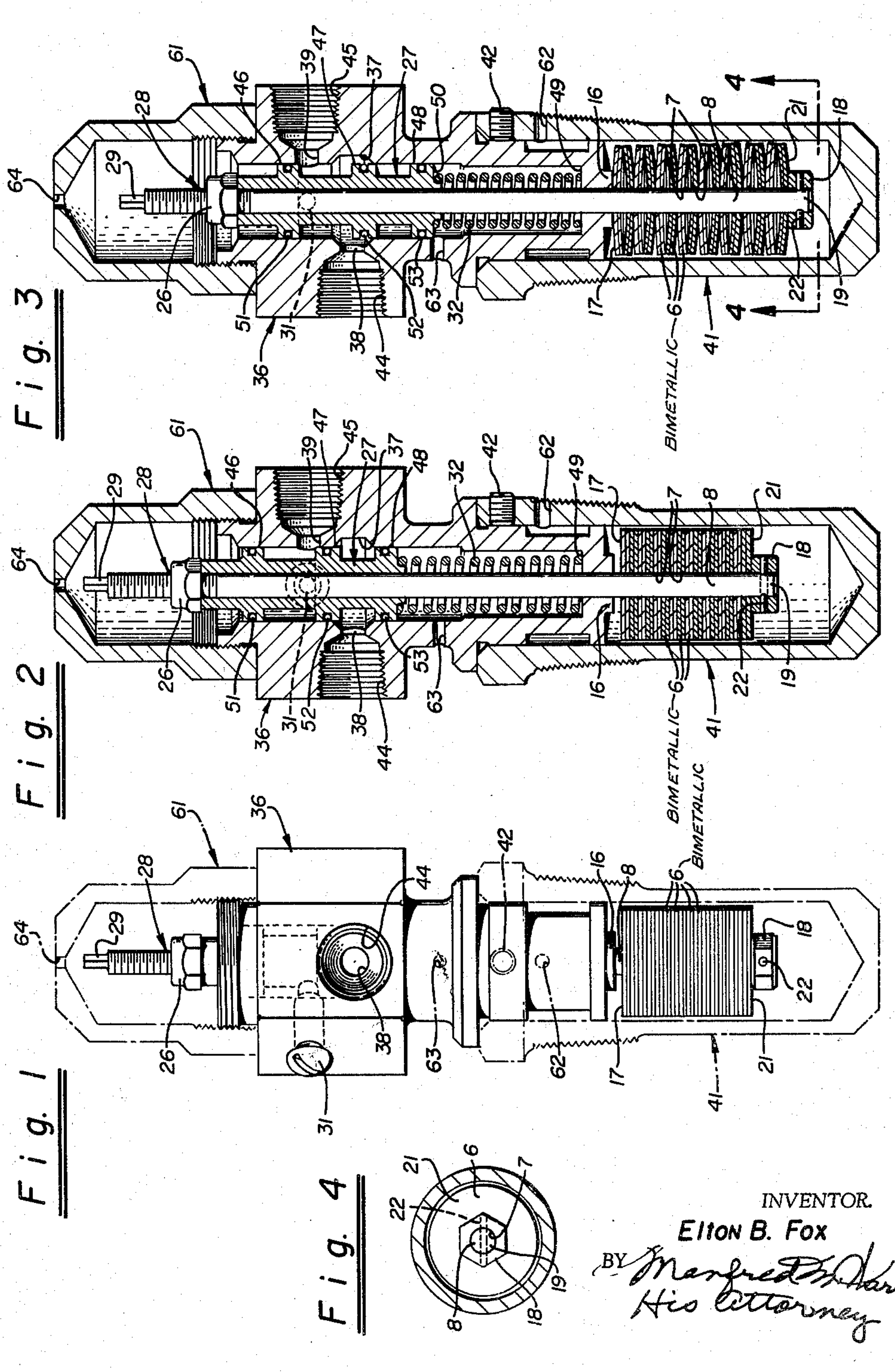

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TEMPERATURE RESPONSIVE SAFETY CONTROL VALVE

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The invention relates to thermostatic devices such as thermostatically operated valves, and more particularly to actuators of the bimetal type.

An object of the present invention is to provide a thermostatic actuator of the character described which will provide a large power output, viz., high force and displacement, over a wide temperature range in a direct operating type of actuator without the interpositioning of motion multiplying devices and the like and with a very high degree of reliability and precision.

Another object of the present invention is to provide a thermostatic actuator of the character described which is composed of parts readily designed for low cost mass production and which may be readily and rapidly assembled to provide a very rugged and relatively low cost unit having a long, dependable, trouble-free life.

A further object of the present invention is to provide a thermostatic actuator of the character above which may be readily adjusted to perform its desired operation within a desired temperature range.

The invention possesses other objects and features of advantage, some of which of the foregoing will be set forth in the following description of the preferred form of the invention which is illustrated in the drawing accompanying and forming part of this specification. It is to be understood however, that variations in the showing made by the said drawing and description may be adopted within the scope of the invention as set forth in the claims.

Referring to said drawing:

FIGURE 1 is a side elevation of a thermostatically operated valve constructed in accordance with the present invention.

FIGURE 2 is a longitudinal cross-sectional view of the valve taken substantially on the plane of line 2—2 in FIGURE 1.

FIGURE 3 is a longitudinal cross-sectional view of the valve similar to FIGURE 2 but showing the parts in another position.

FIGURE 4 is a cross-sectional view of the device taken substantially on the plane of line 4—4 in FIGURE 3.

The thermostatic actuator of the present invention consists briefly of a plurality of equal diameter bimetal discs **6** having similar coefficients of heat expansion to provide substantially similar deformation under similar temperature changes and each disc being formed with a central opening **7**, a mounting shaft **8** threaded through disc openings **7** to position discs **6** in a concentrically arranged axially aligned stack, each disc **6** being mounted on shaft **8** for free longitudinal and rotational displacement thereon. The discs are so arranged in reversely positioned pairs **9** and so constructed that upon a temperature change each pair of discs will bow away from each other while maintaining peripheral edge support between the opposed peripheral edges of the discs of each pair. The power resulting from the deformation of discs **6** is transmitted to shaft **8** by providing a fixed support **16** at one end **17** of the stack of discs and mounting means **18** on end **19** of shaft **8** to engage the opposite end **21** of the stack for reciprocating movement therewith. As herein provided, means **18** is a collar attached to shaft **8** by a pin **22**.

Discs **6** may be constructed so as to be planar at any given temperature, but generally the discs are constructed so as to be planar only at normal room temperature. This construction may not be desirable in certain applications since a bimetal disc will deform from a planar surface in one direction upon the application of heat and in the opposite direction upon cooling. Thus, the shaft **8** would be displaced either upon heating or cooling. To eliminate actuation of the shaft either upon increasing or decreasing temperatures, applicant has provided an initial pre-set deformation of an amount preventing reverse bowing of discs **6** when exposed to temperatures at the lower end of the temperature range for which the unit is designed.

One of the features of applicant's invention is the ability to adjust the thermostat so that an actuated device mounted on shaft **8** will only be actuated within a given temperature range. In order for pre-selected temperature range actuation to be effected, means **26** is mounted on shaft **8** to adjust the position of actuated device **27** on shaft **8** to lengthen the spacing between support **16** and collar means **18**. Thus, by initially adjusting means **26** to cause slack between discs **6** and a space between disc end **17** and support **16**, shaft **8** will not be displaced until the temperature of the discs is raised sufficiently to eliminate the slack. Means **26** herein consists of a locknut threaded on a portion of shaft **8** as at section **28**. To provide easy adjustment of locknut **26**, end **29** of shaft **8** is squared off to receive a wrench or other suitable tool. Any desired temperature range is possible using a combination of various metals for the discs and the proper adjustment of means **26**. Discs capable of giving useful deflection performance between temperature ranges of −100° F. and 1000° F. are commercially available from Chace Company of Detroit, Michigan, and Metals and Controls Corporation of Attleboro, Massachusetts, see for example, thermostatic Chace bimetal 3900 and 2500.

Another feature of the present invention is its trouble free automatic operation with a minimum of parts. To obtain automatic return of shaft **8** to its original non-operative terminal position, as shown in FIGURE 2, stop screw **31** is mounted so as to prevent movement of the actuated device **27** beyond a terminal position in one direction, viz, upwardly as seen in FIGURE 2. A spring **32** positioned between support **16** and actuated device **27** here biases the actuated device against stop **31**. It is to be noted that it is immaterial whether discs **6** are held in compressive face-to-face contact when in a non-actuated position. Full peripheral edge support of the discs is necessary only during displacement of shaft **8** from its terminal position and is assured by mounting the equal diameter circular discs of similar coefficients of expansion concentrically on the shaft.

A typical application of applicant's thermostatic actuator is for operating a valve; and as a specific illustration a safety control valve in a high pressure gas pipeline. A series of compressors or boosters are used in such lines to move the gas along to its destination. Applicant's thermostatic actuator is mounted in the gas line at the discharge side of the compressor in order to sense the temperature of the compressed gas at that point. If the compressed gas reaches a dangerously high temperature which may have been caused by a faulty compressor, the thermostatic actuator senses the dangerous condition and actuates a safety control system which in turn shuts down the compressor. This safety control system may utilize compressed air and may include a pressure responsive trip mechanism of the type shown in my pending application No. 103,519. The flow and control of the compressed air to the trip mechanism is under the control of the thermostatic actuator of the present invention, a typical embodiment of which may be seen in FIGURES 2 and 3. Air pressure holds the safety system in an operative or cocked position until an increase in temperature in the gas line causes the thermostatic actuator valve to be opened and the drop in pressure by venting releases the pressure on the safety system and shuts down the compressor.

While the thermostatic actuator of the present invention may have various uses and applications in the thermostat art, it is particularly well adapted to use in a slide valve construction as herein depicted. This structure includes a valve housing 36 formed with an interior valve cylinder 37 having side ports 38 and 39 communicating with conduit receiving portions 44 and 45 adapted for connection to high pressure and venting lines (not shown) of a control system.

Mounted for longitudinal reciprocation in cylinder 37 for selective operation across ports 38 and 39 is a spool valve heretofore generally referred to as the actuated device 27. This valve herein also referred to as numeral 27 is formed with longitudinally spaced enlarged shoulders 46, 47 and 48 which extend to the internal wall of cylinder 37 and are formed with seats for receiving the O rings 51, 52 and 53, and which slidably engage the cylinder wall to provide controlled valving action with respect to ports 38 and 39. When the valve is in the position illustrated in FIGURE 2, shoulders 47 and 48 and their O rings 52 and 53 straddle inlet port 38 thereby effecting a closed position of the valve. Upon movement of the valve to the right as viewed in the drawing, shoulder 47 and its O ring 52 move to a position wherein ports 38 and 39 are in communication, representing the open position of the valve. The stop 31 hereinabove referred to here consists of a set screw, identified by the same number and which is threaded through the body of housing 36 so as to position the internal end of the set screw between shoulders 46 and 47 thereby limiting the reciprocating displacement of the valve.

Displacement of valve 27 is here effected by shaft 8 which is mounted axially through the valve and extends therefrom through an end wall 49 of the housing. Spring 32 is here mounted around shaft 8 and in compression between the adjacent end 50 of valve 27 and end wall 49 so as to constantly bias the valve upwardly, as viewed in the drawing, and to its terminal position against set screw 31.

Shaft end 28 projects from one end of valve 27 for mounting of adjustment nut 26 against the adjacent end 54 of the valve, and the opposite end 55 of the shaft projects from the opposite valve end 50 through spring 32 and end wall 49.

The thermostat discs 6 are mounted on shaft 8 between a shoulder support 16 on wall 49 and collar 18 pinned to the shaft end as above described.

It is significant to note that upon heating of the elements the latter will bow, as illustrated in FIGURE 3 and hereinabove described, so as to produce a movement of shaft 8 downwardly, as viewed in the drawings, and eventually and at a predetermined elevated temperature cause an open of port 38 to port 39 and a triggering of the control system.

Upon shutting down of the compressor system, the elements will cool and spring 32 will cause the valve to return to closed position, as depicted in FIGURE 2. It is, however, in the nature of bimetal elements, as above explained, that they will bow in an opposite direction when cooled below the temperature at which they are planar. This reverse bowing of the elements will produce a movement of the valve toward opened position in the same manner as when the elements are heated. Consequently, and because of this reverse phenomenon, the discs are formed with an initial pre-set deformation, as hereinabove described, which prevents such a reverse bowing of the discs at the reduced temperatures to which the device may be subjected as to cause an opening of the valve.

A still further important feature of the construction of the present unit is the fact that the thermostatic actuator may be removed from a high pressure gas line in which it is inserted without opening the line. Applicant

has therefore provided a well casing 41 for the receipt of the thermostatic actuator, and which may be threaded or otherwise secured in the wall of the gas line. The actuator housing 36 is machined to slidably fit into this well and is held therein by set screw 42. Accordingly, by backing off set screw 42, housing 36 may be removed without opening the gas line in which the well casing is mounted.

In order to protect shaft 8 and adjusting screw 26, a cap 61 may be provided for attachment to housing 36. Vent holes 62, 63 and 64 are provided in the housing and the cap to prevent any build-up of pressure to impede the movement of the valve 27.

It will be noted that the thermostatic actuator of the present invention consists solely of the bimetal discs held in a concentric stack for movement upon the central shaft and no extra parts such as mounting or aligning members or movement multiplying devices are required. Consequently, the stack is 100% active and is capable of producing optimum displacement for a given size of the assembly, and hence, maximum compactness is achieved. The discs deform hemispherically so as to afford an optimum weight supporting shape and thus provide a maximum force in their displacement for a given thickness or cross-section of their bimetal body. Of equal importance, and as mentioned above, the circular hemispherical form of the discs and their central threading onto an axial supporting shaft insures peripheral edge support between the opposed peripheral edges of the discs in all relatively rotated positions of the discs on the shaft. This feature is particularly important where, as here, adjustment of the operating temperature range of the device is obtained by introducing slack in the disc stack which may cause discs to move out of engaged position. By way of example, a valve structure as illustrated may be made with a sensitivity range of, say, 15° F. The valve may be mounted in an environment having a normal temperature of about 300° F. and be adjusted so that it will start to open at, say, about 340° F. In such a structure, the valve may open sufficiently at about 350° F. so as to trip the control system and thereafter and upon cooling to close fully at, say, about 335° F. To adapt the foregoing valve to operation at a higher temperature, say, 600°, adjustment nut 26 is backed off on shaft end 28 so as to increase the spacing between collar 18 and the housing portion 16 which may introduce slack. In actual construction, this slack so introduced may range up to ⅛ to ¼ inch, depending upon the number of discs and amount of displacement required in the design.

I claim:

1. A temperature responsive safety control valve comprising, a valve housing formed with an internal cylindrical wall defining a valve chamber and inlet and discharge passages opening to said wall at longitudinally spaced positions and being formed with a transversely extending end wall for said chamber in longitudinal spaced relation to said ports, a spool shaped valve having longitudinally spaced flanged portions mounted for reciprocation on said chamber wall in sealed relation thereto and having a closed position closing off connection between said inlet and discharge passages and a longitudinally spaced open position communicating said passages, said flanged portions in both of said positions being disposed on opposite sides of said inlet passage to provide a pressure balanced condition enabling ready movement of said valve from closed to open positions and vice versa, means providing a stop for said valve in closed position, a valve stem extending axially from one end of said valve and projecting through and being slidably supported by said end wall and having an end portion disposed exteriorly of said end wall remote from said valve chamber, a helical spring surrounding said stem and mounted in compression between said end wall and said valve end for constantly urging said valve to closed position, a plurality of bimetal discs formed with central openings mounted upon

said stem end portion to provide a stack with one end disposed for engagement with said end wall, and means on said stem end portion engaging the opposite end of said stack, said discs being arranged in reversely positioned pairs and being so constructed that upon heating each pair of discs will bow away from each other to produce longitudinal displacement of said stem and said valve in the direction of closed to open position and against the resistance of said spring.

2. A temperature responsive safety control valve as characterized in claim **1** and including a second housing formed with an enclosed longitudinally extending chamber having an open end and formed to receive through said open end and to surround and enclose said stem end portion and bimetal disc stack, said second housing having an internal wall adjacent its open end formed for mating attachment to the external wall of said valve housing adjacent said end wall thereof so as to provide a sealed enclosure for said stem end portion and said bimetal disc stack.

3. A temperature responsive safety control valve as characterized in claim **2** wherein said stem is formed as a shaft separate from and threaded axially through said valve for relative displacement of said valve on said shaft

and having an end extending from an end of said valve opposite to said first named valve end engaged by said spring, and a nut threaded on said last named shaft end and bearing on said valve for adjusting the spacing between said nut and said means engaging the remote end of said stack for controlling the temperature responsive valve displacement.

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