May 7, 1968 W. L. WELLFORD, JR 3,381,697

DIFFERENTIAL PRESSURE CONTROLLER

Filed Nov. 17, 1965

FIG. 1

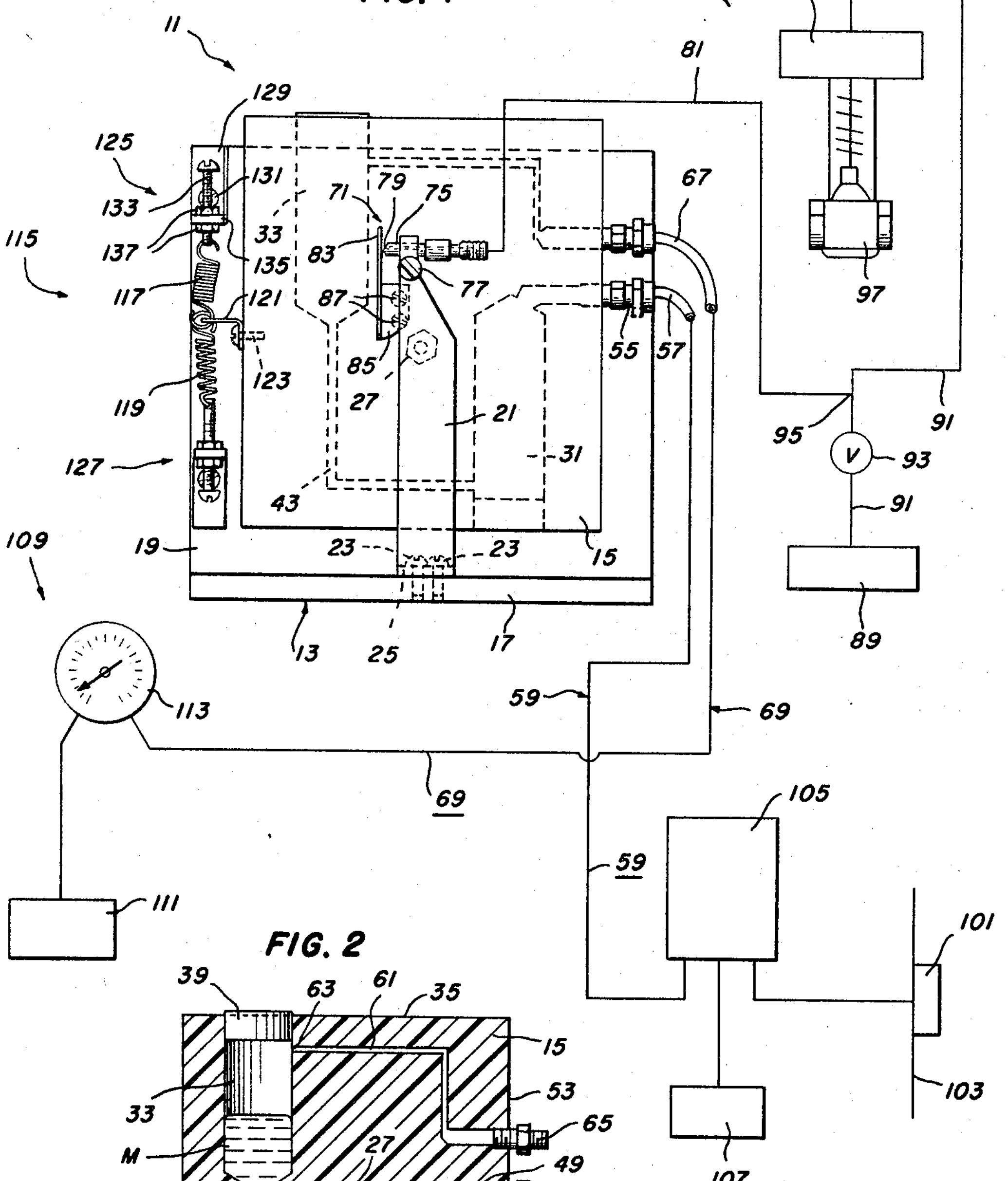
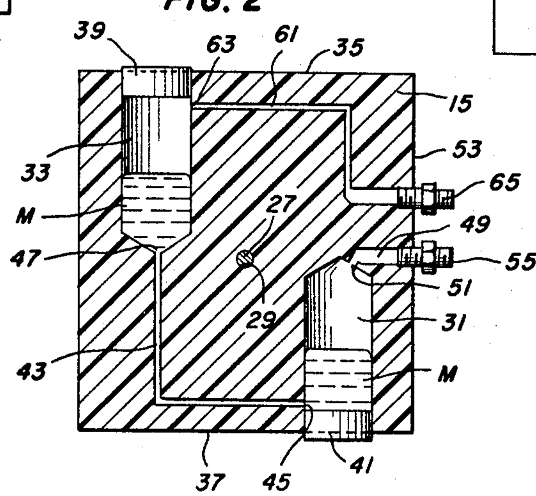


FIG. 2



INVENTOR.
WALKER L. WELLFORD JR.

BY John R. Walker, III
Attorney

United States Patent Office 3,381,697
Patented May 7, 1968



3,381,697
# DIFFERENTIAL PRESSURE CONTROLLER
Walker L. Wellford, Jr., 135 St. Albans Fairway, Memphis, Tenn. 38111
Filed Nov. 17, 1965, Ser. No. 508,312
7 Claims. (Cl. 137—82)

## ABSTRACT OF THE DISCLOSURE

A differential pressure controller adapted to receive a first signal and compare it with a standard signal, and on the basis of this comparison cause a control device to be actuated. The pressure controller includes a pivotable body portion having two chambers therein connected by a passage and which have mercury contained therein. The pressure controller is provided with first and second conduit means respectively connecting the signal to one of the chambers adjacent the upper end thereof and the standard signal to the other of the chambers adjacent the upper end thereof for causing a shift in the mercury from one chamber to another when the first signal is decreased or increased from a balanced condition so that the increased weight of the mercury in one of the chambers causes pivot of the body portion to cause the control device to be actuated.

This invention relates to a differential pressure controller.

One of the objects of the present invention is to provide a differential pressure controller that is adapted to receive a signal and compare it with a standard signal, and on the basis of this comparison to cause a control device to be actuated.

A further object is to provide such a controller which is adapted to provide control of temperature or pressure differential at a low range with a minimum hysteresis.

A further object is to provide such a controller which has a tremendous deflection or movement for a small change in pressure.

A further object is to provide such a controller which uses the displacement of mercury to obtain a substantial force.

A further object is to provide such a controller which is sensitive to changes in pressure.

A further object is to provide such a controller in which air will pass therethrough in the event of malfunctioning without damaging the controller.

A further object is to provide a controller which is durable and long-lasting.

A further object is to generally improve the design and construction of pressure controllers.

The means by which the foregoing and other objects of the present invention are accomplished and the manner of their accomplishment will be readily understood upon reference to the accompanying drawings, in which:

FIG. 1 is an elevational view of the pressure controller of the present invention including, in schematic form, portions of a typical system in which it is used.

FIG. 2 is a sectional view of the body portion of the controller of the present invention taken as on a vertical plane.

Referring now to the drawings in which the various parts are indicated by numerals, the pressure controller 11 of the present invention comprises in general a base 13 and a pivotable body portion 15 pivotally mounted from base 13. Base 13 includes a substantially rectangular horizontal portion 17 adapted to rest on a supporting surface and a substantially rectangular vertical portion 19 preferably integrally formed with horizontal portion 17 along one edge thereof and upstanding therefrom. Base 13 additionally includes a support 21 upstanding from



horizontal portion 17 and fixedly attached thereto by suitable means as screws 23 extending through aligned apertures in the foot portion 25 of the support and horizontal portion 17. Support 21 is spaced from vertical portion 19, and body portion 15 is received between the support and the vertical portion for pivot about a horizontal axis. The horizontal pivot means for body portion 15 comprises any suitable means, such as the pin 27 that is attached to vertical portion 19 and extends horizontally through a central aperture 29 provided in body portion 15 so that the body portion can rotate about the pin 27.

Body portion 15 is of any suitable shape, such as the square shape shown in the drawings, and is preferably block-like in construction and formed of any suitable material such as the solid block of plastic shown in the drawings. An enclosed first chamber 31 is provided in body portion 15 on one side of pin 27 and a second chamber 33 is provided in body portion 15 on the opposite side of pin 27 from first chamber 31. To better understand the terminology hereinabove used concerning one side and the other of the pin 27, the following explanation is given: Assuming an imaginary vertical plane extends through the horizontal axis about which the body portion 15 is pivoted to divide the body portion into two halves, that is, a right half and a left half as viewed in FIGS. 1 and 2, said first chamber 31 is on one side of pin 27, or in said right half, and second chamber 33 is on the other side of the pin, or in said left half. Thus, it will be seen that any increased weight in first chamber 31 over that in second chamber 33 will cause body portion 15 to be urged clockwise as viewed in FIGS. 1 and 2 and any increased weight in second chamber 33 over first chamber 31 will cause the body portion to be urged counterclockwise as viewed in these figures. First and second chambers 31, 33 may be formed in body portion 15 by any suitable means, as for example by being molded therein, or by respectively boring inwardly from the upper and lower edges 35, 37 of body portion 15 and plugging the bored holes as by means of plugs 39, 41 to respectively establish the enclosed first chamber 31 and enclosed second chamber 33. First and second chambers 31, 33 are communicated with one another as by means of a passage 43 extending from an opening 45 adjacent the lower end of first chamber 31 to an opening 47 adjacent the lower end of second chamber 33. First and second chambers 31, 33 are preferably cylindrical, are preferably of substantially the same size, and preferably have their axes parallel and extending vertically when the body portion 15 is in the position shown in FIGS. 1 and 2. In addition, first chamber 31 is preferably in the lower portion of body portion 15 and second chamber 33 is preferably in the upper portion of the body portion. Also, the cross-sectional area, that is, as taken on a horizontal plane through the first and second chambers 31, 33 with the body portion 15 disposed as seen in FIG. 2 is much greater than the cross-sectional area of the passage 43.

Liquid mercury M is provided in first and second chambers 31, 33 and in passage 43 so that the passage is completely filled and chambers 31, 33 are partially filled to leave an air space in each of the chambers above the mercury.

A first conduit portion 49 is provided in body portion 15 and extends from an opening 51 adjacent the upper end of first chamber 31 and through the side edge 53 of body portion 15 where a suitable fitting 55 is provided to connect first conduit portion 49 with a flexible conduit portion 57 to establish the overall first conduit which is designated in general as at 59 and which includes portions 49 and 57. Similarly, a second conduit portion 61 is provided in body portion 15 and extends from an opening 63 adjacent the upper end of second chamber 33 and through the side edge 53 where a suitable fitting 65 is provided to connect the second conduit portion 61 to a flexible conduit portion 67 to establish the overall second conduit which is designated in general as at 69. It will be understood that the first and second conduit portions 49, 61 may be formed in body portion 15 by any suitable means, as by boring or molding the passages or conduits in the body portion. Also, it will be understood that the flexible conduit portions 57, 67 may be formed of any suitable means as flexible rubber tubing or the like.

A flapper valve assembly 71 is provided in pressure controller 11 and is adapted to be responsive to pivoting movements of body portion 15 to actuate a suitable control device 73 in a manner which will be better understood in the description to follow later in the specification. Flapper valve assembly 71 is preferably of a construction well-known to those skilled in the art and includes a nozzle element 75 fixedly mounted on support 21 by suitable means as a screw 77. Nozzle element 75 is provided with an opening 79 in the end thereof through which air is allowed to bleed from the conduit 81 connected to the nozzle element 75. Flapper assembly 71 includes the usual flapper plate element 83 which is disposed in front of opening 79 and is fixedly attached to the body portion 15 as by means of the right angular flange 85 which in turn has screws 87 extending through apertures therein and into the body portion 15 for the attachment thereof. It will be understood that in FIG. 1 the edge of the plate element 83 is seen and the plate element is arranged perpendicular to the body portion 15. Plate element 83 extends across opening 79 in normally spaced relationship thereto, as shown in this figure. It will be understood also that counterclockwise pivot of body portion 15 from the position shown in FIG. 1 will allow more air to be bled from nozzle element 75 and by the same token clockwise rotation of the body portion will cause less air to be bled from the nozzle element. A typical manner in which changes in the amount of air bled through nozzle element 75 are used to actuate control device 73 is illustrated as follows: Air under pressure from an air supply source indicated diagrammatically as at 89 is provided to the control device 73 through a line 91 which has a valve 93, such as a needle valve, interposed in line 91 to control the pressure therein. Conduit 81 is in communication with line 91 and bleeds air from the line at a place 95 which is downstream of valve 93. Control device 73 is of a construction well-known to those skilled in the art and includes a valve 97 that is controlled by the pressure portion 99 depending upon the pressure existing therein. It will be understood that other types of well-known control devices such as an air motor operator may be used in place of control device 73 without departing from the spirit and scope of the present invention. When pressure controller 11 is in a balanced condition, as will be better understood in the description to follow later in the specification, the system is preferably so set that the air being bled through nozzle element 75 will be at such a rate that enough pressure is provided in line 91 and pressure portion 99 to maintain the valve 97 in a half-open position. Thus, it will be seen that when body portion 15 is pivoted from said balanced position to cause plate element 83 to move toward a more fully closed position or more fully open position of flapper valve assembly 71, the valve 97 will be caused to move from said half-open position towards a more open position or towards a more closed position depending upon which way the body portion 15 is pivoted.

For purposes of further illustrating the use of pressure controller 11 in a typical system, it is assumed that the system is used to control the temperature in a room and that the valve 97 controls the amount of heat supplied to the room. Thus, in the system shown in the drawing, the block diagram at numeral 101 represents any suitable temperature device for responding to temperature changes in the controlled zone with one wall of the room being represented by the numeral 103 upon which the temperature device 101 is mounted. The block diagram at 105 represents a suitable and well-known temperature transmitter into which is fed the signal from temperature device 101 and into which is fed air pressure from a suitable source as at 107. In addition, the usual loading station shown as at 109 is provided which is calibrated in whatever scale that is to be controlled. In the loading station 109 the block diagram as at 111 represents air supply under pressure and the device as at 113 represents the usual valve calibrated in the scale that is to be controlled. For purposes of explanation, a range of two to fourteen pounds will be chosen with a temperature range to be controlled of 50° F. to 200° F. The temperature transmitter 105 will signal at 50° F. temperature with 3 lbs./sq. in. and a 200° temperature with 15 lbs./sq. in. Thus, there is at the pressure controller 11 one p.s.i. more pressure in conduit 59 and first chamber 31 than in conduit 69 and second chamber 33 when the system is in balance. In this balance position, the flapper plate element 83 is close enough to the opening 79 to allow air to bleed at a rate that will provide enough pressure in line 91 to maintain valve 97 in a half-open position. It can be seen that an increase in temperature at 101 in the controlled zone will cause the pressure from temperature transmitter 105 to increase, thus forcing more mercury M to second chamber 33 and tilting flapper plate element 83 away from opening 79. A decrease in pressure in the line 91 results as air bleeds faster than it can enter through the valve 93. This closes valve 97 and shuts off heat. The reverse is true if there is a decrease in temperature at the temperature device 101 which causes mercury to be forced from second chamber 33 into first chamber 31 to cause clockwise pivoting of body portion 15. This in turn causes less air to be bled from flapper valve assembly 71 and an increase in line 91 which opens valve 97. Since there is very little friction in controller 11, it can be made as sensitive as desired. Adjustment can be accomplished by relocating the position of flapper valve assembly 71 to change the distance to the horizontal axis about which body portion 15 pivots or by changing the diameter of first and second chambers 31, 33. In addition, a spring assembly 115 is preferably provided which allows the pressure controller 11 to be balanced to any desired differential.

Spring assembly 115 preferably comprises a pair of tension springs, namely, an upper tension spring 117 and a lower tension spring 117 and the upper end of lower tension spring 119 are attached to body portion 15 as by means of a bracket which in turn is fixed to the body portion by suitable means, as by means of the screw 123. Tension spring 117, 119 respectively extend upwardly and downwardly from their points of attachment with bracket 121 and are respectively secured at places opposite the adjacent ends thereof to vertical portion 19 as by means of adjustment assemblies 125, 127. Adjustment assemblies 125 and 127 are substantially identical and the following description of adjustment assembly 125 will suffice for both. Adjustment assembly 125 includes a right angular bracket 129 attached to vertical portion 19 as by screw 131. In addition, adjustment assembly 125 includes a vertically-disposed screw 133 that extends through an aperture in the horizontally extending portion 135 a bracket 129 and is adjustably held therein as by means of the nuts 137. The upper end of spring 117 extends through an aperture in the lower end of screw 133. From the foregoing it will be understood that the springs 117, 119 act in opposing relationship and may be adjusted to balance the pressure controller 11 to any desired differential.

One of the features of the present invention resides in the fact that first and second chambers 31, 33 are each large enough to hold the entire amount of mercury M. Thus, in the event that there is a malfunctioning as for example if conduit 59 were to rupture, the device would not be damaged but instead the mercury would flow into the first chamber 31 and the air would pass therethrough. This is in contrast to previous diaphragm devices in which the diaphragms would rupture and damage the device in the event of a broken line.

Although the foregoing example of the use of controller 11 has been given in connection with a device 73 which controls the heating of the controlled zone, it will be understood that it may be used with a device which controls the cooling of the controlled zone without departing from the spirit and scope of the present invention. Thus, this control of the cooling may be done by simply reversing the action of flapper valve assembly 71 and placing valve 97 in the cooling system so that it controls the amount of cooling supplied to the room. In other words, controller 11 will be arranged so that an increase in temperature at 101 the pressure in line 91 will increase to cause the valve 97 to open and provide more cooling. The above can be accomplished by reversing the conduit portions 57 and 67 so that conduit portion 57 leads to chamber 33 and conduit portion 67 leads to chamber 31, or this can be accomplished by positioning flapper valve assembly 71 below pin 27 so that clockwise pivot of body portion 15 will move plate element 83 away from opening 79 and counterclockwise movement of the body portion will move the plate element towards the opening 79.

From the foregoing description it will be understood that a very efficient and sensitive differential pressure controller is provided which is unique in construction in that it operates on the principal of shifting the weight of mercury to provide a substantial force that is utilized to actuate a control device. In addition, it will be understood that the differential pressure controller of the present invention is versatile and can be used in any system in which it is desired to receive a signal and compare it with a standard signal and on the basis of the comparison actuate a control device.

Although the invention has been described and illustrated with respect to a preferred embodiment thereof, it is to be understood that it is not to be so limited since changes and modifications may be made therein which are within the full intended scope of this invention as hereinafter claimed.

I claim:

1. A differential pressure controller for receiving a first signal from a first fluid pressure source and comparing with a standard signal from a standard fluid pressure source to actuate a device in one way if said first signal is greater than said standard signal and to actuate said device in the opposite way if said first signal is less than said standard signal, said controller comprising a base, a pivotal body portion, means pivotally mounting said body portion from said base for respective pivot thereof in a first direction and an opposite second direction about a horizontal axis, actuating means including means to bleed air for actuating said device in said one way in response to pivot of said body portion in said first direction and for actuating said device in said opposite way in response to pivot of said body portion in said second direction, said body portion including means defining a first chamber on one side of said horizontal axis and including means defining a second chamber on the opposite side of the horizontal axis, and means defining a passage interconnecting said first and second chambers, liquid in said first and second chambers and said passage normally maintaining a balanced amount of weight of said liquid in said first and second chambers in which said body portion is in a balanced non-pivoting position, said first and second chambers being enclosed to form means for supporting the weight of said liquid, first and second conduit means respectively connecting said first signal to said first chamber and said standard signal to said second chamber for causing said liquid to move towards and increase the weight of said liquid in said second chamber over said balanced amount



to pivot said body portion in said first direction under the influence of the increased weight when said first signal is greater than said standard signal and for causing said liquid to move towards and increase the weight of said liquid in said first chamber over said balanced amount to pivot said body portion in said second direction under the influence of the increased weight when said first signal is less than said standard signal.

2. The differential pressure controller of claim 1 in which said actuating means comprises a flapper valve including a nozzle element operably connected to said device and a plate element movable in front of said nozzle element for the moving towards opening and closing thereof, one of said elements being supported from said body portion and the other of said elements being supported from said base, pivot of said body portion in one of said directions being effective to move said plate element towards opening of said nozzle element and pivot of said body portion in the opposite direction being effective to move said plate element towards closing of said nozzle element.

3. The differential pressure controller of claim 1 which includes spring means interacting between said body portion and said base for urging said body portion towards a selected pivot position.

4. The differential pressure controller of claim 1 in which said liquid comprises mercury.

5. The differential pressure controller of claim 4 in which the total amount of said mercury is less than the volume of one of said chambers.

6. A differential pressure controler for receiving a first signal from a first fluid pressure source and comparing with a standard signal from a standard fluid pressure source to actuate a pneumatic control device in one way if said first signal is greater than said standard signal and to actuate said control device in the opposite way if said first signal is less than said standard signal, said controller comprising a base, a pivotal body portion, means pivotally mounting said body portion from said base for respective pivot thereof in a first direction and an opposite second direction about a horizontal axis, flapper valve means including a nozzle element operably connected to said control device and a plate element movable in front of said nozzle element for the moving towards opening and closing thereof, said nozzle element being supported from said base and said plate element being supported from said body portion, pivot of said body portion in said first direction being effective to move said plate element towards opening of said nozzle element to actuate said control device in said one way and pivot of said body portion in said second direction being effective to move said plate element towards closing of said nozzle element to actuate said control device in said opposite way, said body portion including means defining a first chamber on one side of said horizontal axis and including means defining a second chamber on the opposite side of said horizontal axis, and means defining a passage interconnecting said first and second chambers adjacent the lower ends thereof, liquid mercury in said first and second chambers and said passage normally maintaining a balanced amount of weight of said mercury in said first and second chambers in which said body portion is in a balanced non-pivoting position, said first and second chambers being enclosed to form means for supporting the weight of said liquid, a first adjustable spring means reacting between said body portion and said base for urging said body portion in said first direction, a second adjustable spring means reacting between said body portion and said base for urging said body portion in said second direction, said first and second chambers each being large enough to hold the entire amount of said mercury, first and second conduit means respectively connecting said first signal to said first chamber adjacent the upper end thereof and said standard signal to said second chamber adjacent the upper end

thereof for causing said mercury to move towards and increase the weight of said liquid in said second chamber over said balanced amount to pivot said body portion in said first direction under the influence of the increased weight when said first signal is greater than said standard signal and for causing said mercury to move towards and increase the weight of said liquid in said first chamber over said balanced amount to pivot said body portion in said second direction under the influence of the increased weight when said first signal is less than said standard signal, said first and second conduit means including flexible portion means to permit pivoting of said body portion.



7. The differential pressure controller of claim 6 in which said body portion comprises a piece of plastic in which said first and second chambers and said passage connecting said first and second chambers are formed.

**References Cited**


UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 974,991 | 11/1910 | Radigan. | |
| 2,210,868 | 8/1940 | Larson | 137—82 |


ALAN COHAN, *Primary Examiner.*