

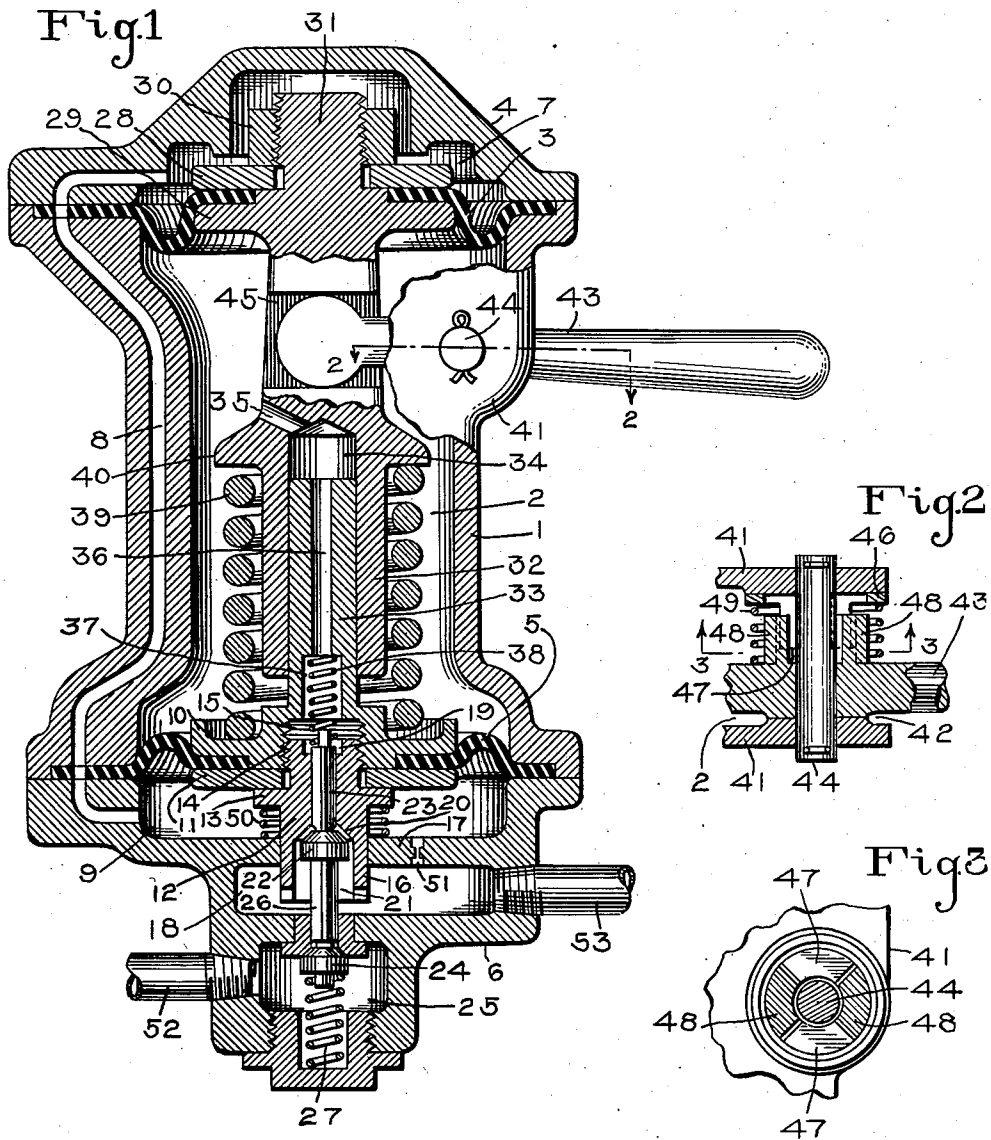
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SELF-LAPPING VALVE DEVICE

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SELF-LAPPING VALVE DEVICE

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This invention relates to fluid pressure control devices and more particularly to the automatic or self-lapping type.

One object of the invention is the provision of an improved device of the above type.

Another object of the invention is the provision of a device of the above type in which the movable parts have relatively low frictional resistance to movement whereby the device is rendered very sensitive to slight changes in controlling force and is therefore operative to vary the pressure of fluid with a relatively high degree of accuracy in accordance with the degree of such force and slight changes therein.

Another object of the invention is the provision of a device of the above type embodying means for substantially counteracting pressure of fluid supplied by the device so that the controlling force for the device is substantially independent of or not materially influenced by said pressure of fluid.

Other objects and advantages will be apparent from the following more detailed description of the invention.

In the accompanying drawing: Fig. 1 is a vertical sectional view of the improved control device; Fig. 2 is a sectional view of a portion of said device taken on the line 2—2 in Fig. 1; and Fig. 3 is a sectional view taken on the line 3—3 in Fig. 2.

Description

As shown in the drawing, the improved control device comprises a casing section 1 having a chamber 2 extending therethrough from one end to the opposite end, a flexible diaphragm 3 is mounted over one end of chamber 2 and is clamped around its marginal edge between the end of casing section 1 and a cover 4 secured thereto. An oppositely disposed and coaxially arranged diaphragm 5 is mounted over the opposite end of chamber 2 and clamped in position around its marginal edge between the end of the casing section 1 and a cover member 6 secured to the casing section. The two diaphragms are preferably of substantially the same area and both are subject on their adjacent faces to pressure in chamber 2 which is open to the atmosphere in a manner which will be later brought out. At the opposite side of diaphragm 3 is a pressure chamber 7 which is in permanent communication by way of a passage 8 extending through the casing section 1 with a chamber 9 provided between the opposite side of diaphragm 5 and the cover member 6.

Two followers 10 and 11 are secured centrally to opposite sides of the diaphragm 5 by means of a member 12 having a flange 13 engaging the follower 11 and having a stud portion 14 extending centrally through follower 11 and having screw-threaded engagement with follower 10 within a bore 15.

The member 12 has a sleeve-like depending portion 16 extending through a bore provided in a wall 17 which separates chamber 9 from a chamber 18. The fit between the portion 16 and the wall 17 within the bore is of the free sliding type in order that said portion may substantially freely reciprocate therein. The member 12 has a bore 19 open at one end to bore 15 and at the opposite end through a valve seat 20 to a chamber 21 which is open to chamber 18. A release valve 22 disposed in chamber 18 has a fluted stem 23 which is disposed to slide in bore 19 and said valve is arranged to cooperate with the valve seat 20 for controlling communication between chamber 18 and the atmosphere by way of bores 19 and 15 and other communication to be later described. Chambers 9 and 18 are in constant communication with each other through a stabilizing choke 51.

A fluid pressure supply valve 24 is contained in a chamber 25 formed below chamber 18. This valve is arranged in coaxial relation with and to seat in the same direction as the release valve 22 and has a fluted stem 26 extending through a bore in a wall separating chambers 18 and 25, and engaging the release valve 22 in chamber 21. The supply valve 24 is provided for controlling communication between chambers 25 and 18, and a spring 27 contained in chamber 25 acts on the supply valve for urging it to its closed position shown.

Two followers 28 and 29 are clamped centrally to opposite sides of the diaphragm 3 by a nut 30 engaging the follower 28 and having screw-threaded engagement with a stud 31 projecting from the follower 29 centrally through the diaphragm and the follower 28.

The follower 29 is disposed in chamber 2 and has a stem 32 extending into said chamber. The follower 10 secured to the adjacent side of diaphragm 5 has a stem 33 having telescopic engagement with stem 32 within a bore 34 which, above the end of stem 33, is open to chamber 2 through a passage 35. The stem 33 has a bore 36 open at one end to bore 34 and at the opposite to a larger bore 37 which opens to bore 15, these bores and passage 35 constituting the communication for conducting fluid released

past the release valve 22 to chamber 2. A coil spring 38 bearing at one end against the stem 23 of the release valve 22 extends through bores 15 and 37 and has its opposite end supported on a shelf formed at the junction of bores 36 and 37. This spring is under pressure and is provided to hold the release valve 22 against movement upon movement of member 12 in a direction away from said valve. A bias spring 50 contained in chamber 9 is supported by wall 17 and acts against flange 13 of member 12 with a relatively small force for urging said member and diaphragm 12 in the direction away from the release valve 22.

A coil control spring 39 encircles the telescoped portions of the two stems 32 and 33 and has one end supported on the diaphragm follower 10 while the opposite end bears against an annular collar 40 provided on stem 32. It will be seen that this spring constitutes a resilient strut between the two diaphragms. In the position of the diaphragms shown in the drawing in which the release valve 22 is open, the spring 39 is substantially fully expanded.

The casing section 1 is provided with a pair of spaced lugs 41 at either side of an opening 42 connecting chamber 2 with the atmosphere. An operating lever 43 extends through this opening into chamber 2 and is fulcrumed on a pin 44 disposed at right angles to the axis of stem 32 and carried by the lugs 41. The stem 32 is provided with a slot 45 extending diametrically therethrough, and the end of lever 43 in chamber 2 is disposed in this slot in sliding contact with the opposite ends thereof, the surfaces of the lever engaging the end walls of the slot being rounded to facilitate movement of the end of the lever within the slot upon rocking of said lever about the fulcrum pin 44. The portion of lever 43 outside of the casing section constitutes a control portion which may be operated in any desired manner, as by hand.

For reasons which will be hereinafter brought out, it is desirable to stabilize the lever 43 against unwanted movement. This may be accomplished by way of illustration by use of a friction shoe in the form of a disc 46 which is slidably mounted on pin 44 at one side of lever 43 for frictional contact with the inside surface of the adjacent lug 41. This disc is provided with two arcuate shaped fingers 47 disposed at opposite sides of and extending parallel to the pin 44 in the direction of lever 43. These fingers are slightly less than ninety degrees in arcuate length and mesh with like fingers 48 projecting from the lever 43, whereby the friction shoe 46 will turn with the lever. A coil spring 49 encircling the fingers 47 and 48 bears at opposite ends against the lever 43 and friction shoe 46, respectively. This spring is under pressure and constantly acting to press the shoe 46 into frictional contact with the inner surface of one lug 41 and at the same time, acting to press the opposite side of the journaled portion of lever 43 into frictional contact with the inner surface of the other lug 41 whereby a definite frictional resistance to movement of the lever is obtained.

Chamber 25 is arranged to be constantly supplied with fluid under pressure from any suitable source by way of a pipe 52. Chamber 18 is connected to a pipe 53 which may lead to any device (not shown) which it is desired to control by fluid under pressure.

Operation

Let it be assumed that initially the parts of the device are in the positions shown in the drawing in which the supply valve 24 is closed and the release valve 22 is open due to pressure of bias spring 50 on the member 12. Under this condition the pipe 53, chamber 18 and thereby the connected chambers 9 and 7 are open to the atmosphere past the release valve 22 to chamber 2 and thence through opening 42 in the casing section 1.

If it is now desired to supply fluid under pressure to pipe 53, the lever 43 is rocked in a counterclockwise direction which moves the stem 32 and connected portion of diaphragm 3 in a downwardly direction and this movement is transmitted through collar 40 on said stem and spring 39 to follower 10 and deflects the diaphragm 5 in a downwardly direction. It should be noted that spring 39 merely acts, in effect, like a solid strut between stem 32 and diaphragm 5 in the movement just described, but that such movement is opposed by the force of bias spring 50 which, however being relatively small, is immaterial.

The spring 27 acts on the supply valve 24 with greater force than the pressure of spring 38 on the release valve 22, so as to hold said valves in the position shown during the downward movement of the diaphragms, above described, until the member 12 secured to diaphragm 5 seats against the release valve 22. Further downward movement of the diaphragm by continued rocking of lever 43 in a counterclockwise direction then acts through the release valve 22 and supply valve stem 26 to unseat the supply valve 24 against spring 27.

When the supply valve 24 is thus opened, fluid under pressure then flows from chamber 25 past said valve to chamber 18 and pipe 53, and from chamber 18 fluid under pressure also gradually flows through choke 51 into chamber 9 at the lower side of diaphragm 9 and thence through passage 8 to chamber 7 at the opposite side of diaphragm 3. The choke 51 is provided to prevent a surge of fluid pressure into the diaphragm chambers 9 and 7, or in other words, to restrict such flow to a degree which provides for an increase in pressure in said chambers substantially with the increase in pressure in the device being controlled and supplied with fluid under pressure through pipe 53.

When the pressure of fluid thus obtained in chamber 9 and acting on the diaphragm 5 in conjunction with spring 50 is increased to a degree which overcomes the force of spring 39, said diaphragm moves upwardly relative to lever 43 and allows spring 27 to move the supply valve 24 toward its seat. This movement continues as the pressure of fluid in chamber 9 continues to increase by the supply past the supply valve 24 until said valve moves into contact with its seat which then prevents further flow of fluid to pipe 53 and thus to chamber 9 and thereby limits the pressure of fluid obtained therein to a degree predetermined by the extent of counterclockwise movement of lever 43 from its normal position shown in the drawing. When the supply valve 24 closes to limit the pressure of fluid in pipe 53 and chamber 9 the force of spring 39 on the diaphragm 10 stops movement thereof so that the release valve 22 remains seated thereby bottling up the fluid pressure in pipe 53 and chamber 9.

If it is desired to increase the pressure of fluid in pipe 53, the lever 43 is moved further in a counterclockwise direction, and this movement is transferred through spring 39 to again deflect diaphragm 5 downwardly to unseat the supply valve 24. Fluid under pressure then again flows to pipe 53 and diaphragm chambers 9 and 7, and when the pressure of fluid obtained in said chambers and acting on diaphragm 5 is increased to a degree corresponding to the position of lever 43, the diaphragm 5 again assumes the position to permit closing of the supply valve 24 while maintaining the release valve 22 closed.

If it is now desired to reduce the pressure of fluid in pipe 53, the lever 43 is turned in a clockwise direction back toward its normal position shown in the drawing. This movement draws the stem 32 in a direction away from the release valve 22 which permits pressure of fluid in chamber 9 acting on diaphragm 5 to deflect said diaphragm and move spring 39 along with the stem 32. This deflection of diaphragm 5 moves the member 12 out of seating engagement with the release valve 22, whereupon fluid under pressure is allowed to flow from pipe 53 to the atmosphere past said valve. Fluid under pressure in chambers 9 and 7 reduces through choke 51 as the pressure of fluid in pipe 53 reduces and the pressure of spring 39 then deflects the diaphragm 5 relative to lever 43 back in the direction of the release valve 22. Assuming that lever 43 has not been returned to its normal position which permits full expansion of spring 39 with the release valve 22 open, the diaphragm 5 will therefore be deflected to the position closing said valve, when the pressure of fluid in pipe 53 and in chambers 9 and 7 becomes reduced to the degree determined by the reduced pressure of spring 59 as predetermined by the position of lever 43. If the lever 43 is moved further in the direction of its normal position a further and corresponding reduction in pressure of fluid in pipe 53 will occur in the same manner as just described. In case the lever 43 is returned to its normal position which allows full expansion of spring 39, the pressure of fluid in chamber 9 will deflect the diaphragm 5 to the position shown, and in which it will then remain to allow a full release of fluid under pressure from pipe 53 and chambers 18, 9 and 7. The bias spring 50 is provided to ensure that the release valve 22 will be open when the pressure of fluid in chamber 9 is at a very low degree with respect to atmospheric pressure so as to ensure a complete release of fluid under pressure from pipe 53. The parts might be so arranged that if desired this spring could be dispensed with.

In the operation above described it will be noted that the only friction which tends to interfere with operation of the device to provide fluid at a pressure in accordance with chosen positions of the lever 43, is that between the depending portion 16 of the member 12 and the casing wall 17, and between the stems 23 and 26 of the valves and the walls of the bores in which they operate and since this friction under all normal conditions will be of a relatively low degree, the improved device is capable of providing with a relatively great degree of accuracy fluid at different pressures chosen by the position of lever 43. Moreover, and for the same reason, the structure is very sensitive to slight changes in position of lever 43 as reflected by slight changes in pressure of control spring 39

and is thus capable of providing relatively small increments of change in pressure in pipe 53.

As above mentioned, when fluid under pressure is supplied through choke 51 to chamber 9 to act on diaphragm 5, it also flows to chamber 7 and therein acts on diaphragm 3. Also when fluid under pressure is released from pipe 53 and thus from chamber 9 a corresponding reduction in pressure occurs in chamber 7. It will therefore be seen that diaphragm 3 is always subject in chamber 7 to the same pressure of fluid as is effective in chamber 9 on diaphragm 5, and it will also be noted that such pressure acting on the two diaphragms is applied in opposing relation to the opposite ends of the spring 39.

Now assuming that the pressure of fluid acting on the diaphragm 3 would provide a force on stem 32 and thus on the connected end of spring 39 substantially equal to that provided on the opposite end of said spring by pressure of fluid in chamber 9 acting on the diaphragm 5, it will be seen that such pressure on diaphragm 3 would counteract that on diaphragm 5 so that none of the force of said spring would be effective to oppose movement of lever 43. Thus regardless of the position of lever 43 it could be moved out of such position with substantially the same degree of ease or force as resists the initial movement thereof out of its normal position.

A complete counter-balancing by diaphragm 3 of pressure of fluid on diaphragm 5 may not be obtained in a practical structure throughout the full range of fluid pressures which may be supplied by the device, due to the change in position of diaphragm 3 for each different pressure, it being noted that the position of said diaphragm and thus the pressure provided by same on stem 32 will vary according to the position of lever 43, while the position of diaphragm 5 for any selected pressure in pipe 53 is always the same. Thus while a complete counter-balancing of forces is possible of attainment say in one position of lever 43, it may not be attainable in the other positions of said lever. In these other positions of the lever, a small portion of the force of spring 39 may therefore be transferred to the lever which would tend to turn same out of a selected position or oppose movement to a different position. The amount of force thus transmitted from the spring 39 to the lever 43 will however be of a relatively small degree and will not materially interfere with the ease of operation thereof.

The friction between lever 43, shoe 46 and lugs 41 will hold said lever against being turned by any portion of the force of spring 39 applied to said lever, as just described. This friction is also intended to hold the diaphragm 3 against undesired deflection out of any selected position to which it may be moved by the lever 43, under conditions such as the following:

If for instance the friction between sleeve-like portion 16 of member 12 and the casing wall 17 should become abnormal, this would require a greater pressure of fluid on diaphragm 5 to effect closing of the supply valve 24 than might be required to deflect diaphragm 3, as a result of which, if diaphragm 3 were not held against movement, it might deflect according to the increase in pressure of fluid supplied to pipe 43 and correspondingly increase the pressure of said spring on diaphragm 5 and thus prevent obtaining a sufficient differential of forces on dia-

phragm 5 to effect closing of the supply valve. In other words, regardless of the position to which lever 43 was moved out of normal position, the supply valve might be maintained open and provide the maximum pressure of fluid in the pipe 53. Moreover, such abnormal friction could result in a complete release of fluid under pressure from pipe 53 when such was not desired. Still further, assuming the frictional condition of the parts to be normal and the opposing forces applied by diaphragms 3 and 5 to the opposite ends of spring 39 to be equal or nearly so, a sudden jar applied to the casing would tend to move same relative to the diaphragms and the connected followers, stems and spring 39. This jar applied in one direction would tend to cause deflection of the diaphragms such as to cause opening of the supply valve 24 and thereby undesired flow of fluid under pressure to pipe 53. Applied in the opposite direction the jar would tend to cause deflection of the diaphragms to cause opening of the release valve 22 and thus an undesired release of fluid under pressure from pipe 53 in case said pipe were supplied with fluid under pressure at this time. These objectionable operations however are prevented by holding the lever 43 and thereby diaphragm 3 against unwanted movement as by the friction between said lever and shoe 46 and the casing lugs 41.

Summary

It will now be noted that I have provided a self-lapping valve device so constructed as to minimize the effect of friction between parts on its operation, so that the device may, respond to any selected control operation to provide with accuracy fluid at a desired pressure. The device embodies a control spring and means for counteracting the force of said spring so that the operation of the control member may be substantially independent of the force of the control spring and thus operative with substantially the same degree of ease for all pressures of fluid supplied by the device. Due to the sensitiveness of the structure to slight changes in actuating force provided by pressures of fluid acting thereon means in the form of friction means associated with the control port have been provided to ensure stability of the device under certain abnormal conditions and which means in no way interferes with the sensitivity of the structure and with the accuracy with which it will operate.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In combination, a casing, two movable abutments in said casing, means connecting one of said abutments to the other comprising resilient pressure exerting means, said abutments being subject to pressure of fluid in a chamber which opposes pressure of said exerting means, valve means controlled by one of said abutments for controlling pressure of fluid in said chamber, said one abutment being operable by said exerting means upon movement thereof in one direction to effect operation of said valve means to supply fluid under pressure to said chamber and upon movement in the opposite direction to effect operation of said valve means to release fluid under pressure from said chamber, a rockable member having a fulcrum connection with said casing and movable relative to said casing to effect movement of said exerting means, said member having frictional contact with said casing,

a friction member movable with said rockable member and also having frictional contact with said casing, and spring means urging said rockable member and friction member against said casing to provide a chosen force for resisting movement of said rockable member.

2. In combination, a casing, two coaxially aligned and spaced apart movable abutments in said casing subject on opposite sides to pressure of fluid in a chamber, follower means associated with one of said abutments having an opening for releasing fluid under pressure from said chamber, a release valve in said casing arranged to cooperate with said follower means upon a certain movement of said one abutment in a direction against pressure of fluid in said chamber to close communication between said chamber and opening, a supply valve operable by said release valve upon greater movement of said one abutment in said direction to supply fluid under pressure to said chamber, said one abutment being operable upon movement in the opposite direction to effect closure of said supply valve and then opening of said release valve, means connecting said abutments to each other comprising a spring, and a member associated with said casing and connected to said one abutment through said spring and operable upon movement in one direction to actuate said spring to move said one abutment in the direction against pressure of fluid in said chamber and operable upon movement in the opposite direction to render said one abutment movable by pressure of fluid in said chamber.

3. In combination, a casing, two coaxially aligned movable abutments in said casing subject on opposite sides to pressure of fluid in a chamber, two telescopically arranged members disposed between said abutments for movement axially thereof, means connecting one of said members for movement with one of said abutments, means connecting the other member for movement with the other abutment, a spring interposed between and connecting one of said abutments to the said member connected to the other abutment, control means connected to the last named member operable upon movement in a direction against said spring to move said one abutment in the direction against pressure of fluid in said chamber and operable upon movement in the opposite direction to render said one abutment movable therewith by pressure of fluid in said chamber, and valve means controlled by said one abutment and operable thereby upon movement in the direction against pressure of fluid in said chamber to supply fluid under pressure to said chamber and in the opposite direction to release fluid under pressure from said chamber.

4. In combination, a casing, two coaxially aligned movable abutments in said casing subject on opposite sides to pressure of fluid in a chamber, two telescopically arranged members disposed between said abutments for movement axially thereof, means connecting one of said members for movement with one of said abutments, means connecting the other member for movement with the other abutment, a spring interposed between and connecting one of said abutments to the said member connected to the other abutment, control means connected to the last named member operable upon movement in a direction against said spring to move said one abutment in the direction against pressure of fluid in said chamber and operable upon movement in the opposite di-

rection to render said one abutment moveable therewith by pressure of fluid in said chamber, said members and the said means connecting said one abutment to the respective said member cooperating to provide a communication for releasing fluid under pressure from said chamber, and valve means including the last named means controlled by said one abutment and operable thereby upon a certain movement in the direction against pressure of fluid in said casing to close said communication and upon further movement to supply fluid under pressure to said chamber and operable upon a certain movement of said one abutment in the opposite direction to cut off the supply of fluid under pressure to said chamber and upon further movement to open said communication.

5. In combination, a casing, two coaxially aligned spaced apart flexible diaphragms of substantially the same areas disposed in said casing and subject on opposite sides to variations in pressure of fluid in a chamber, follower means secured centrally to one of said diaphragms and having a sleeve-like portion mounted to slide in a bore in said casing and having a release communication for releasing fluid under pressure

from said chamber, a poppet type release valve arranged to cooperate with said sleeve-like portion to close said release communication upon a certain movement of said one diaphragm from a normal position in the direction against pressure of fluid in said chamber, a supply valve arranged to be opened by said release valve upon further movement of said one diaphragm against pressure of fluid in said chamber, to supply fluid under pressure to said chamber, means operative to close said supply valve upon movement of said one diaphragm in the opposite direction and said one diaphragm being operative upon return to said normal position to move said sleeve-like portion out of cooperative relation with said release valve to open said communication, and means for controlling movement of said one diaphragm comprising a spring operatively connected at opposite ends to the two diaphragms, and a control member connected to the end of said spring which is connected with the other diaphragm and operative to vary the position of the connected end of said spring relative to the position of said one diaphragm.

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