Sept. 12, 1944. J. J. ROTHWELL ET AL 2,358,032

POWER ELEMENT

Filed Sept. 22, 1942

Fig. 1.

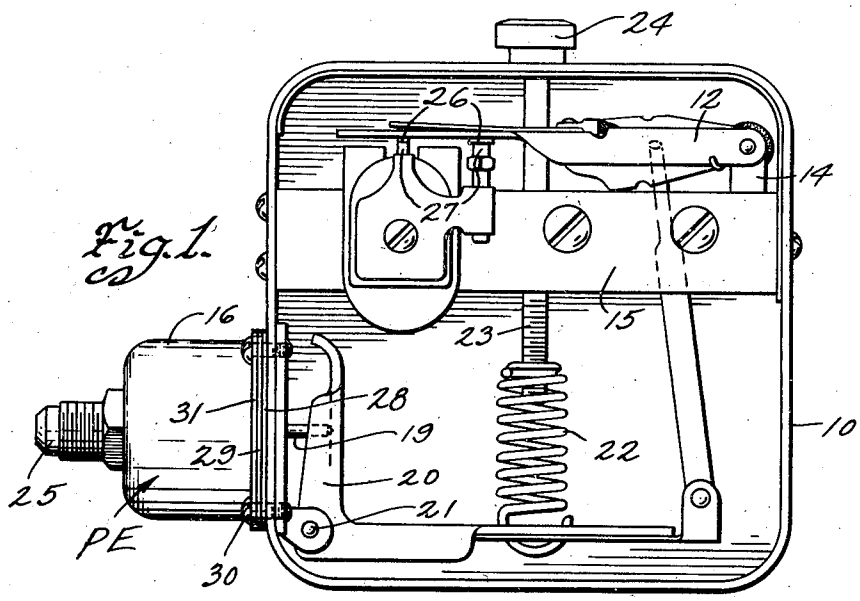


Fig. 3.

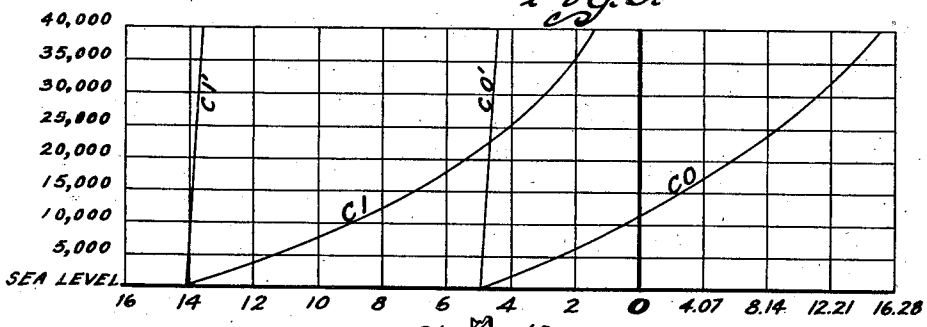
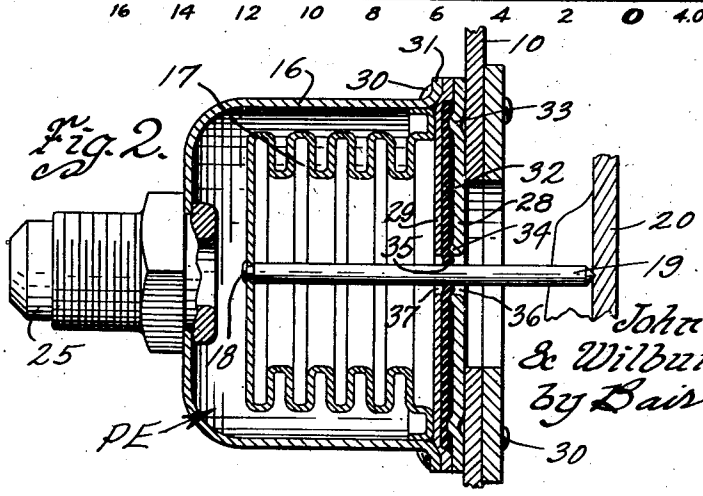


Fig. 2.



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2,358,032

POWER ELEMENT

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5 Claims. (Cl. 137—156)

Our present invention relates to a power element which is compensated against pressure changes in control devices and the like, as on control switches for refrigerating equipment of a truck or the like which passes over roads of different elevation.

One object of our invention is to provide a very simple compensating structure which minimizes changes in the action of a control device or the like, where such control devices are subjected to varying atmospheric pressures as caused, for instance, by a change in altitude.

A further object is to provide compensating means without the necessity of supplying a second bellows structure or the like in opposition to the main power bellows, as in Shaw Patent No. 2,204,951, dated June 18, 1940, the present structure being considerably less expensive to manufacture and install, and securing a minimization of variation due to change in ambient pressure as distinguished from the possibility of exactly counteracting such change in air pressure and thereby providing one hundred percent compensation, as in the Shaw Patent No. 2,204,951.

A further object is to provide means to minimize the effect of ambient atmospheric pressure on one side of a power diaphragm or bellows open to atmosphere, where the other side of the power diaphragm or bellows is subjected to a variable pressure for controlling the position of the diaphragm or bellows and thereby operating a control device or the like.

More specifically, it is our object to provide a compensating diaphragm arrangement which minimizes ambient air pressure change by the exposure of a minimum of surface to outside atmosphere.

With these and other objects in view, our invention consists in the construction, arrangement and combination of the various parts of our device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in our claims and illustrated in the accompanying drawing, wherein:

Figure 1 is a front elevation of a control device, such as a refrigerant compressor motor controlling switch, having our compensated power element illustrated in connection therewith;

Figure 2 is an enlarged sectional view of the power element to show, particularly, a compensating means therefor; and

Figure 3 is a graphic view showing, for the purpose of comparison, the action of an ordinary switch, and of such a switch when our compensating means is applied thereto.

On the accompanying drawing we have used the reference numeral 10 to indicate a switch housing wherein a switch arm 12 is pivoted to a bracket 14 which, in turn, is supported on a bar 15 of insulating material. The switch arm 12 is operated by a power element PE, consisting of a diaphragm or bellows housing 16 and a diaphragm 17 therein. The diaphragm 17 has been illustrated as one of the bellows type, its periphery being soldered to the housing 16 and the head of the diaphragm or bellows being secured at 18 to an actuating stem 19. The actuating stem 19 engages a bell crank 20 pivoted at 21 and retained in engagement with the actuating stem by a range spring 22. The spring 22 is adjustable by means of an adjusting rod 23 and a control knob 24 thereon. The bellows housing 16 has a fitting 25 secured thereto, by means of which pressure is introduced into the bellows housing for collapsing the diaphragm 17 as the pressure builds up. The fitting 25 may be connected in the usual manner by copper tubing or the like, to the low side line of a refrigeration system, or to any suitable temperature or pressure responsive device which would effect a build-up of pressure within the housing 16 for the purpose of actuating the switch arm 12. The switch arm 12 carries contacts 26, in the usual manner, for engagement and disengagement with respect to stationary contacts 27, depending upon the position of the switch arm, as fully disclosed in the Shaw patent hereinbefore mentioned.

We have provided the power element PE with a compensating means in the form of a pair of plates 28 and 29 interposed between the diaphragm housing 16 and the switch housing 10. Screws 30 pass through a base flange 31 of the bellows housing 16 and through the plates 28 and 29 adjacent the corners of the plates, the plates being substantially square and the flange 31 likewise being substantially square. Between the plates 28 and 29 is a compensating diaphragm 32, the periphery of which is sealed between the plates by a bead 33 on the plate 28, and the central portion of which is sealed relative to the plates by a bead or flared part 34 of the plate 28. The center of the compensating diaphragm 32 has an opening 35 therethrough, slightly smaller than the actuating stem 19, so that this opening, due to the inherent resiliency of the compensating diaphragm, seals against the surface of the stem. The diaphragm 32 may be made of rubber or similar material for this purpose, and, if found desirable, may be vulcanized to the stem. We have found, however, that the bellows 17,

in most installations, has but a small travel, and therefore never moves so far as to stretch the central part of the compensating diaphragm within the bead **34** to such a point that the opening **35** shifts relative to the actuating stem.

The main purpose of our compensating construction is to minimize the effiective area inside the diaphragm **17** or on the opposite side thereof from the power side within the bellows housing **16** which forms a pressure chamber for the diaphragm or bellows. This is accomplished by making the stem **19** relatively small and keeping the openings **36** and **37** in the plates **28** and **29** as small as possible, and yet permit the necessary flexing of the central portion of the compensating diaphragm as the stem **19** reciprocates. This is accomplished by using the relatively rigid plates **28** and **29** sealed with relation to the compensating diaphragm so that only the center portion defined by the bead **34** is responsive to atmospheric pressure, this portion, plus the cross-section of the actuating stem, being the area affected.

The bead **33** further seals the compensating diaphragm, whereas the plate **29** is soldered to the bellows housing **16** to prevent any leakage at this point. The result is an area defined by the bead **34** being affected by ambient air pressure as distinguished from the entire inner surface of the diaphragm or bellows **17**. By way of illustration, reference is made to Figure 3 for the purpose of comparing a power element minus our compensating diaphragm with one including our compensating diaphragm. The line CI indicates the cut-in point of the first mentioned control device and CO the cut-out point thereof. It will be noted that at sea level the cut-in pressure may be approximately 14 pounds and the cut-out pressure approximately 5 pounds. As the altitude increases, the cut-in and cut-out points decrease until at abut 40,000 feet, the cut-in point is only approximately 1½ pounds, whereas the cut-out point has receded to a vacuum represented by 15 inches of mercury. This is a considerable change in the operating range of the switch, and is due to the difference in elevation causing a difference in atmospheric air pressure.

A switch operating under these conditions is unsatisfactory in connection with refrigeration mechanism or the like, and it is desirable to minimize the change. We have found, with our compensating diaphragm, that the cut-in and cut-out points will recede much less as altitude increases, and this is shown graphically by the lines CI′ and CO′. The recession of CI′ is from approximately 14 pounds to approximately 13½ pounds, whereas the recession of CO′ is from approximately 5 pounds to approximately 4½ pounds. This represents a reduction of the cut-in (CI′) point of only ½ pound, as distinguished from 12½ pounds for CI. Thus, by the addition of an inexpensive compensating diaphragm, the change in operation may be minimized as distinguished from the full compensation possible with more complicated mechanism, such as an opposing bellows. Although we have illustrated our power element in connection with a refrigeration switch, it may be used on other power applications, such as hydraulic brakes on aeroplanes, etc., and in connection with refrigeration mechanism and other devices to be controlled in accordance with pressure or temperature changes where a change in altitude affects the operation of a switch or similar control device, and is therefore objectionable. Many installations can readily permit a half pound change in the operating pressure between sea level and 40,000 feet, whereas two, three or more pounds of change is undesirable.

Some changes may be made in the construction and arrangement of the parts of our device without departing from the real spirit and purpose of our invention, and it is our intention to cover by our claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope without sacrificing any of the advantages thereof.

We claim as our invention:

1. In a power element for control devices and the like, a bellows, a pressure chamber on one side thereof and adapted to receive fluid under varying pressure to move said bellows in response to variations in such pressure, the other side of said bellows presenting an open end, an actuating stem projecting from said other side of said bellows, means to minimize the effect of ambient atmospheric air pressure changes on said other side of said bellows comprising a compensating diaphragm surrounding said stem, and means for supporting said diaphragm so that it is in sealing relationship with said stem and the open end of said bellows and so that it is held rigid for substantially its entire distance across the open end of the bellows to minimize the effective area of said bellows acted upon by ambient atmospheric air pressure.

2. In a power element of the class described, a diaphragm, a variable chamber on one side thereof, an actuating stem projecting from the other side of said diaphragm, and means to minimize the effect of ambient atmospheric air pressure changes on said other side thereof comprising a compensating diaphragm surrounding said actuating stem and supported from a point closely adjacent thereto to the periphery of the compensating diaphragm in order to minimize the effective area of said power diaphragm acted upon by ambient atmospheric air pressure, said compensating diaphragm spanning said other side of said diaphragm and isolating it from atmosphere.

3. In a power element, a diaphragm, an actuating stem projecting from one side thereof, a pressure chamber against the other side thereof, and means for substantially reducing the exposure of said first side of said diaphragm comprising a compensating diaphragm spanning said first side, means for supporting said compensating diaphragm closely adjacent said actuating stem comprising a pair of plates on opposite sides of said compensating diaphragm, said plates having central openings slightly larger than said actuating stem and sealed relative to said compensating diaphragm adjacent the edges of said openings, and said compensating diaphragm being sealed relative to said stem, the arrangement being such as to isolate said other side of the compensating diaphragm from atmosphere.

4. In a power element of the character disclosed, a power bellows, an actuating stem projecting from one side thereof, said side being open, a pressure chamber against the other side thereof, and means for substantially reducing the exposure of said open side of said power bellows to ambient atmosphere comprising a compensating diaphragm surrounding said stem, and means for supporting said diaphragm so that it is in sealing relationship with said stem and the open end of said bellows and so that it is held

rigid for substantially its entire distance across the open end of the bellows, said supporting means including a pair of plates on opposite sides of said diaphragm and spanning said power bellows, said plates having central openings slightly larger than said actuating stem and sealed relative to said diaphragm adjacent the edges of said openings.

5. In a power element, a diaphragm, an actuating stem projecting from one side thereof, a pressure chamber against the other side thereof, and means for minimizing the exposure of said first side of said diaphragm to atmosphere comprising a compensating diaphragm spanning said first side, and a pair of plates on opposite sides of said compensating diaphragm for supporting it, said plates spanning said compensating diaphragm and having central openings slightly larger than said actuating stem, said stem being sealed relative to said compensating diaphragm and said compensating diaphragm being sealed relative to said plates adjacent the edges of said openings, the arrangement being such as to isolate said other side of the compensating diaphragm from atmosphere.

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