

Dec. 21, 1937.

J. R. COFFIN

2,103,214

FLUID PRESSURE RESPONSIVE DEVICE

Filed Aug. 24, 1929

2 Sheets-Sheet 1

Fig. 1.

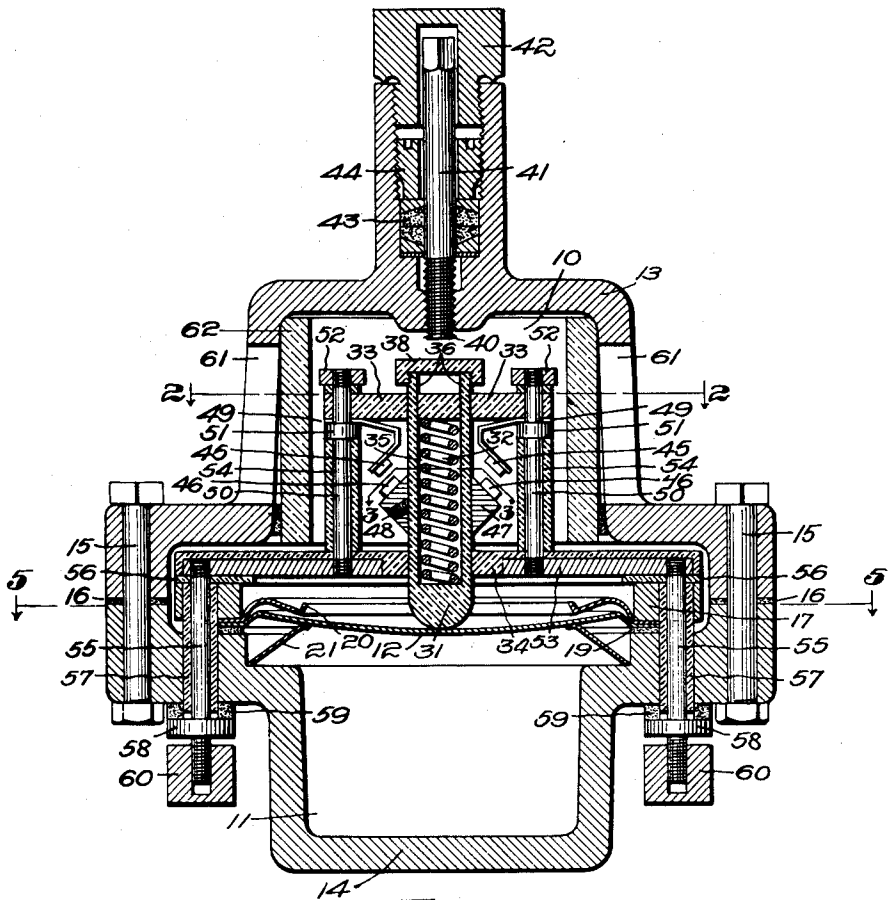


Fig. 2.

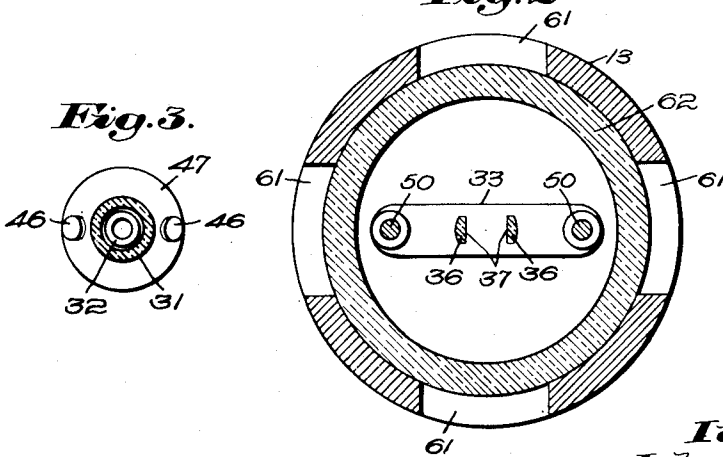


Fig. 3.

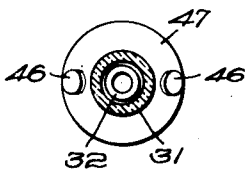
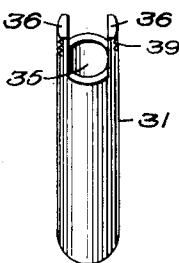


Fig. 4.



Inventor:
John R. Coffin,
by *Emory, Smith, Varney & Townsend,*
Attys

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Fig. 5.

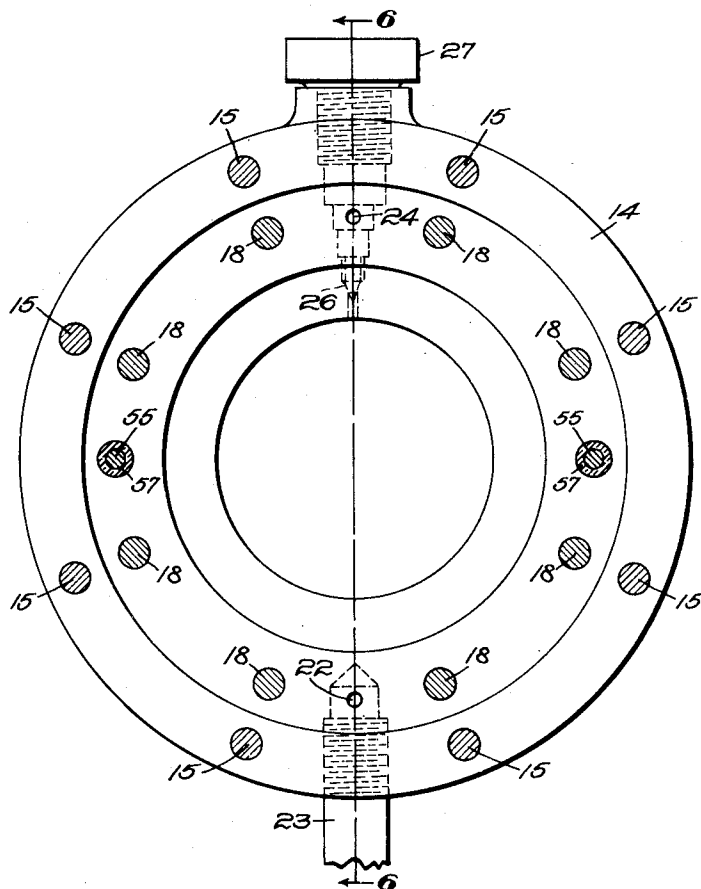
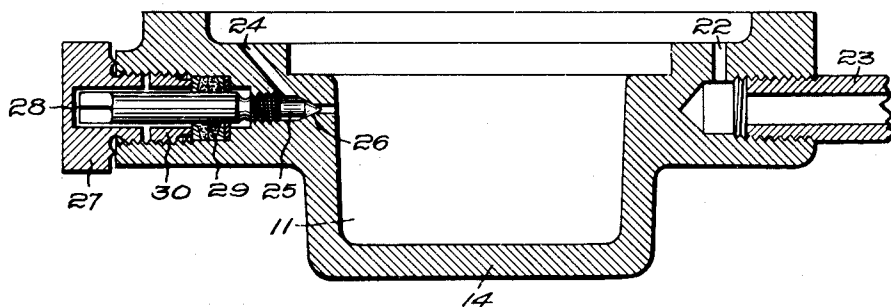


Fig. 6.



Inventor:
John R. Coffin,
by Emory, Smith, Farney & Townsend
Attys.

UNITED STATES PATENT OFFICE

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FLUID PRESSURE RESPONSIVE DEVICE

John R. Coffin, West Medford, Mass., assignor to
Barostat Company, Boston, Mass., a corporation
of Massachusetts

Application August 24, 1929, Serial No. 388,154

7 Claims. (Cl. 137—156)

This invention relates to improvements in fluid-pressure responsive devices of the class which employ resilient, snapping diaphragms, designed to move abruptly in response to pressure changes. Such devices commonly employ an adjustable diaphragm-loading spring, acting directly or indirectly on the diaphragm to vary the pressure at which the diaphragm will respond. Such methods of adjustment not only tend to impair the characteristics of the diaphragm, but the range of adjustment within which satisfactory operation is possible is comparatively small. In the device described herein, there is disclosed adjusting means which permits adjustment over wide ranges, with no impairment of the operating characteristics of the diaphragms.

The invention will be best understood by reference to the following description, when taken in connection with the accompanying drawings of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings:

Fig. 1 is a sectional view of a fluid-pressure responsive device embodying the invention, taken in a plane containing the main axis of the device;

Fig. 2 is a sectional view on line 2—2 of Fig. 1;

Fig. 3 is a sectional view on line 3—3 of Fig. 1;

Fig. 4 is a perspective view of the plunger which is actuated by the diaphragm;

Fig. 5 is a sectional view on line 5—5 of Fig. 1; and

Fig. 6 is a sectional view on line 6—6 of Fig. 5.

Referring to the drawings, and to the embodiment of the invention which is illustrated therein, there is shown a fluid-pressure responsive device comprising two pressure-fluid chambers 10 and 11, having a common wall comprising a resilient buckling, or snapping, diaphragm 12, adapted to buckle in opposite directions, but prevented by its own resiliency from remaining in a medial position. The chambers are formed by and within a casing, herein conveniently comprising two bodies or shells 13 and 14, suitably secured to each other, as by bolts 15, while a packing ring 16, interposed between the two shells, prevents leakage at the joint between them. The diaphragm is conveniently secured to the shell 14 by a clamping ring 17 and bolts 18 (see Fig. 5). Leakage is prevented at the joint between the diaphragm and shell by interposing between them a suitable gasket 19. The diaphragm is protected from injury due to excessive difference in pressure on its two sides by guards 20 and 21.

In operation, the chamber 11 is sealed to prevent the escape of gaseous pressure fluid therefrom, thereby to present an elastic cushion which

provides a load on one side of the diaphragm opposing the fluid pressure in the other chamber on the opposite side of the diaphragm, said other chamber being connected by a passage 22 and a pipe 23 (see Fig. 6) to a pressure system (not shown), which is under the control of the diaphragm. The supply of gaseous fluid under pressure in the sealed chamber 11 is conveniently obtained from the other chamber 10 by providing between said chambers a communicating passage 24, which is normally closed by a suitable valve, herein a needle valve 25 cooperating with a seat 26. To adjust the pressure in the chamber 11, and thereby the pressure at which the device operates, it is only necessary to open the valve 25 to establish communication between the two chambers and then raise the pressure in the system to the desired value, as, for example, by operating the compressor until the desired pressure is reached, and then closing the valve. In case the operation of the compressor is under the control of a switch operated by the diaphragm, the latter switch may be short-circuited, while the electric motor which drives the compressor is operated by another switch. In such case, when the desired pressure is reached, the valve 25 is closed, the short circuit switch is opened, and the device is ready to operate. The valve is conveniently adjustable from the outside of the device by the removal of a threaded plug 27, which thereby affords access to the outer end of a valve stem 28, which extends through a suitable packing 29 and an adjustable, threaded packing gland 30.

Referring now to Fig. 1, the diaphragm in the present example actuates a plunger 31, which is caused to follow the diaphragm by an appropriately arranged spring 32. Herein, the plunger is conveniently guided by guides 33 and 34, the former presenting a fixed abutment for one end of the spring 32, while the other end of the spring is seated against the inner end of a chamber 35, within which the spring is disposed. Turning of the plunger about its axis is conveniently prevented by providing the plunger with two prongs 36 (see Figs. 2 and 4), which extend loosely through openings 37 presented by the guide 33. As shown, the plunger is provided with a cap 38 (see Fig. 1) conveniently secured thereto as by a screw-thread 39. The dimensions of these parts are such that the plunger can follow the diaphragm throughout its travel.

The range of movement of the diaphragm may be varied by providing an adjustable stop 40, which limits the travel of the plunger under the influence of the diaphragm. This stop is conveniently adjustable lengthwise of the travel of the plunger in a manner like unto that which is described in connection with the operation of

the valve 25, as by providing the stop 40 with a stem 41, to which access is had by removal of a threaded cap 42. Leakage about the stem is prevented by an appropriate packing 43 and an adjustable, threaded gland 44. By adjusting the stop 40 to limit the travel of the plunger 31, and thereby limit the upward movement of the diaphragm 12, the "spread" between the minimum and maximum pressures predetermined by the device may be adjusted to any value less than the "spread" corresponding to the free operation of the diaphragm.

While the described operating mechanism may be utilized for various purposes, there is shown in the drawings a switch mechanism intended to open and close a circuit such as that of a motor for driving a compressor in a system with which the chamber 10 communicates. This switch mechanism will now be described, reference being had to Fig. 1. The switch comprises a pair of fixed contacts 45 and a pair of movable contacts 46, the latter being connected to each other and serving to bridge the fixed contacts when brought into engagement therewith to complete a circuit. In this embodiment, the movable contacts are suitably formed on, or secured to, a metallic collar or ring 47, which is appropriately secured to the plunger 31, as by a set screw 48. Herein, the plunger, as well as its guides 33 and 34, are made of appropriate insulating material. The fixed contacts are mounted on spring 49, which are appropriately mounted, as by perforating them to receive metallic posts 50, having fixed collars 51 presenting shoulders on which the springs 49 rest, and against which the springs are clamped, as by extending the posts through the guide 33, and providing nuts 52 threaded onto the posts. As shown, the arrangement of the switch contacts is such that the circuit is closed upon a reduction of pressure in the chamber 10, but it is obvious that, if desired, the contacts may be reversed, so as to enable the switch to open the circuit with a drop of pressure. This is conveniently accomplished by reversing and placing the fixed contacts at the bottom instead of at the top, and by reversing the collar 47 and placing the same higher on the plunger. Furthermore, if desired, the contacts may be duplicated to enable the device to control two or more circuits.

The posts 50 are metallic, and constitute conductors, which are threaded and screwed into metallic contacting plates 53, which, as herein shown, are embedded in the guide 34, the latter being made of insulating material. As shown, sleeves 54, which may be of insulating material and constitute spacers, are interposed between the collars 51 and the guide 34, to predetermine the height of the collars, and therefore the position of the contacts 45. The guide 34 is suitably mounted on the diaphragm clamping ring 17, as by studs 55, which also constitute conductors and binding posts, and to this end are threaded and screwed into the plates 53. The plates 53 are insulated from the diaphragm clamping ring 17, as by washers or strips 56 of insulating material, while the posts are insulated from the ring, as well as from the shell 14, by a sleeve 57 of insulating material. The studs are provided with fixed collars 58, presenting shoulders, and between these shoulders and the shell 14 there are packing and insulating washers 59, which prevent leakage at these points, and also insulate the shoulders from the shell. The depending ends of the studs are threaded to receive nuts 60, to clamp lead wires to the fixed collars. The studs thus

constitute binding posts, which are electrically connected to the fixed contacts 45 and constitute also means for securing in place the guide 34, which is in the nature of a bridge or yoke spanning the ring 17. This bridge, therefore, supports the fixed parts of the switch mechanism.

The shell 13 may be, and herein is, provided with apertures 61, closed on the inside by a glass tube 62, suitably secured and sealed in place to prevent leakage, as by cementing the same to the shell. This construction, therefore, provides windows, through which the switch mechanism may be inspected while in operation.

The operation of the device should be evident from the foregoing description, but will be reviewed briefly. The upper chamber 10 will be connected to a system in which a gaseous fluid is supplied or circulated by a pump or compressor driven by an electric motor. The binding posts of the device are connected either directly or indirectly with the motor in any appropriate manner. When the device is initially set up for operation, the valve 25 is opened to place the chambers 10 and 11 in communication with each other. The motor is then started by the use of an extraneous short-circuiting switch, which enables the pump or compressor to be operated independently of the automatic switch. When the pressure reaches the desired point, as indicated by a pressure gage, the valve 25 is closed, and the extraneous switch opened, thus leaving the motor under the control of the automatic switch, which is actuated by the diaphragm. The spring 32 has just sufficient strength to enable the operating plunger to follow the diaphragm, but is too weak to prevent movement of the latter. Assuming that the diaphragm 12 is in the position indicated in Fig. 1, it will remain in such position until the pressure in the chamber 10 falls below that in the sealed chamber 11 by a definite and predetermined amount, whereupon the diaphragm moves at first slowly, and then abruptly upward, thereby lifting the plunger 31 and causing the latter to bring the contacts 46 into engagement with, and to bridge the contacts 45, thus completing the circuit, and causing the motor to start the pump or compressor. When the pressure in the chamber 10 rises to a definite value, relatively to that in the chamber 11, the diaphragm moves at first slowly in a downward direction, and then snaps abruptly to the position shown in Fig. 1, thereby interrupting the circuit previously established. Thus it is evident that the diaphragm causes a quick opening and closing of the circuit, without danger of arcing and burning of the contacts.

The resilient gas cushion in the sealed chamber 11 loads the diaphragm to any extent desired, yet without impairment of the operating characteristics of the diaphragm. The adjustable stop 40 limits the travel of the diaphragm in an upward direction, and may be adjusted to vary the "spread" between the pressures required to start and stop the compressor, by adjustment of the travel of the diaphragm to any value less than the travel which it would have if its operation were entirely free.

The described device has several advantages not possessed by other devices utilizing resilient diaphragms. In general, such other devices are adjusted by loading the diaphragm by mechanical means, such as springs pressing against the diaphragm. It has been found in practice that such means of loading impair the characteristics of the diaphragm, either by reducing its travel

and hence reducing the length of contact break available, or by reducing the abruptness of its action, and thereby permitting arcing at the contacts. Therefore, the limit of satisfactory adjustment available by such mechanical means is relatively small. It is evident that, in the described device, the operation of the diaphragm, in response to the difference in pressure in the two chambers, is substantially equivalent to the operation of a free diaphragm, and that adjustment over a large range of pressures is entirely practicable.

As there is no automatic means of maintaining the pressure in the chamber 11 constant in event of leakage, it is essential that leakage from said chamber be kept at a minimum. This object is achieved in the described device by making all possible paths for such leakage end in the chamber 10. This will be readily understood from an inspection of Fig. 1. The arrangement is such that the only pressure causing leakage from the chamber 11 is the small difference in pressure between the two chambers. The device is inherently safe in case of rupture of the diaphragm, because the pressure in the two chambers is thereby immediately equalized, and the opening of the circuit by the switch causes the compressor to be stopped. However, should it be desirable to keep the compressor in operation in case of rupture of the diaphragm (which might be desirable in the case of air-brake systems), this can readily be accomplished by placing a relatively light spring beneath the diaphragm. Furthermore, in case the device is used in a refrigeration system, there is no escape of gas in the case of diaphragm rupture, and consequently no deluging of the electric contacts with the refrigeration liquid. Another advantage of the described device is that noise incident to the operation of the diaphragm and of the switch is thoroughly muffled, because all of the parts are enclosed.

Having thus described one embodiment of the invention, but without limiting myself thereto, what I claim and desire by Letters Patent to secure is:

1. In a fluid pressure responsive device, the combination of a casing, a diaphragm therein dividing said casing into two distinct, non-communicating chambers each substantially isobaric within its boundaries, and means in one chamber, actuated by said diaphragm, such chamber being provided with the sole means for connection of the device with a fluid pressure system, the second chamber having all its joints or connections enclosed within and terminating within the first chamber.

2. In a fluid pressure responsive device, the combination of a casing, a diaphragm therein dividing said casing into two distinct, non-communicating chambers each substantially isobaric within its boundaries, means in one chamber, actuated by said diaphragm, the second chamber having all its joints or connections enclosed within and terminating within the first chamber, said casing being provided with a passage connecting said chambers, a valve seat, and a valve normally seated on said seat and closing communication between said chambers.

3. In a fluid pressure responsive device, the combination of a casing comprising two complementary parts, a diaphragm secured to one of said parts and dividing said casing into two chambers, operating means in one chamber, actuated by said

diaphragm, the second chamber having all its joints or connections enclosed within and terminating within the first chamber, said part to which said diaphragm is secured being provided with a passage connecting said chambers and a valve seat between said chambers, and a valve normally seated on said seat and closing communication between said chambers.

4. In a fluid pressure responsive device, the combination of a casing, a diaphragm therein dividing said casing into two distinct, non-communicating chambers each substantially isobaric within its boundaries, and means in one chamber, actuated by said diaphragm, the second chamber having all its joints or connections enclosed within and terminating within the first chamber, the fluid within said second chamber serving solely and at all times as a cushion tending to resist movement of said diaphragm under the influence of fluid within the first chamber.

5. In a fluid pressure responsive device, the combination of a casing comprising two complementary parts, a diaphragm secured to one of said parts and dividing said casing into two chambers, operating means in one chamber, actuated by said diaphragm, the second chamber having no joints or connections except those through which a tendency for leakage is caused solely by the difference in pressures in the two chambers, the first chamber having the sole passage for the entrance of fluid for the actuation of said diaphragm, the fluid within said second chamber serving solely and at all times as a cushion tending to resist movement of said diaphragm under the influence of fluid admitted to the first chamber from the exterior of said casing, said part to which said diaphragm is secured being provided with a passage connecting said chambers and a valve seat between said chambers, and a valve normally seated on said seat and closing communication between said chambers, said valve being mounted in such part and constituting a means initially to place said chambers in communication with each other to supply fluid to said second chamber and constituting the sole means for admitting fluid to said second chamber.

6. In a fluid pressure responsive device, the combination of a casing comprising two complementary, hollow bodies secured together, and together providing an internal space, a diaphragm whose perimeter is wholly within said space, said diaphragm having its margin secured to one of said bodies independently of the other body and dividing said space into two chambers, and operating means in one chamber, actuated by said diaphragm, all possible paths of leakage from the second chamber ending in the first chamber.

7. In a fluid pressure responsive device, the combination of a casing comprising two complementary, hollow bodies secured together, and together providing an internal space, a diaphragm whose perimeter is wholly within said space, said diaphragm having its margin secured to one of said bodies independently of the other body and dividing said space into two chambers, operating means in one chamber actuated by said diaphragm, all possible paths of leakage from the second chamber ending in the first chamber, the body to which the margin of said diaphragm is secured being provided with a passage connecting said chambers and extending outwardly beyond and past the perimeter of said diaphragm, and a valve controlling said passage.

JOHN R. COFFIN.

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Patent No. 2,103,214.

CERTIFICATE OF CORRECTION.

December 21, 1937.

JOHN R. COFFIN.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 26, claim 5, for the word "no" read all its; lines 27, 28 and 29, same claim, for "except those through which a tendency for leakage is caused solely by the difference in pressures in the two chambers" read enclosed within and terminating within the first chamber; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of February, A. D. 1938.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.