Nov. 14, 1961 L. C. FRIEND ET AL 3,009,032

SEALED PRESSURE SWITCH

Filed May 26, 1959

FIG. 1.

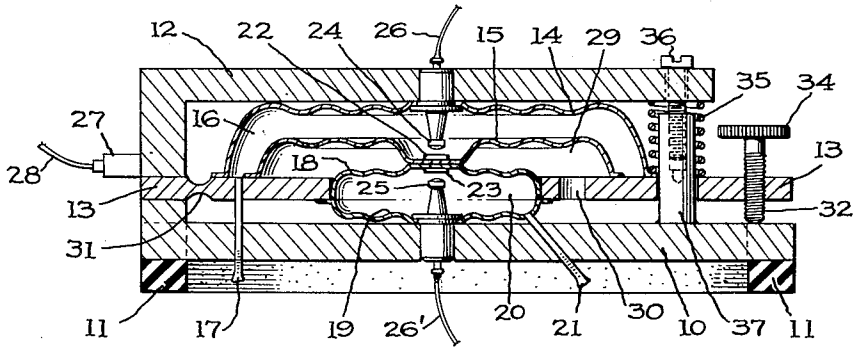


FIG. 2.

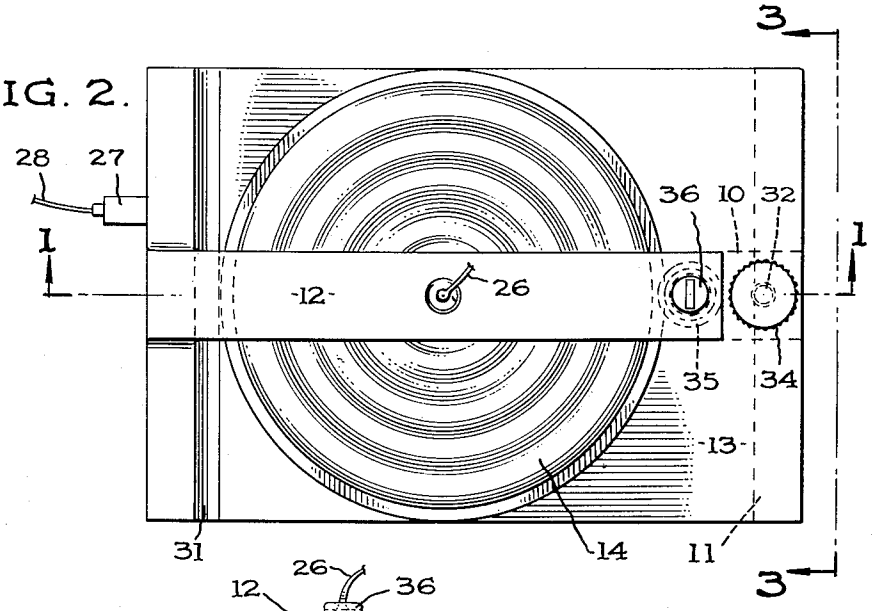
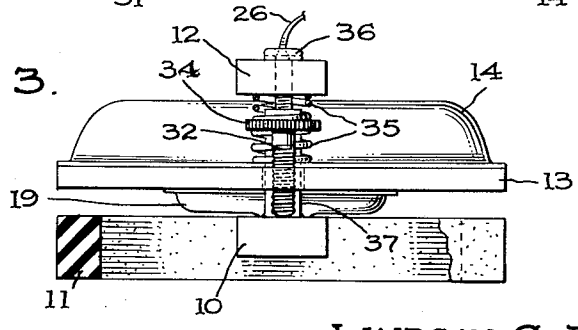


FIG. 3.



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United States Patent Office 3,009,032 Patented Nov. 14, 1961

3,009,032

SEALED PRESSURE SWITCH

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Filed May 26, 1959, Ser. No. 815,955
6 Claims. (Cl. 200—83)

This invention relates to switches of the explosion-proof type having electrical contacts located within a hermetically sealed expansible chamber and arranged to make and/or break an electric circuit in response to changes in ambient pressure. Such switches may be required to perform with a high degree of accuracy while at the same time they must be capable of withstanding severe vibrational and gravity stresses such as are encountered when the switch is adapted to control electric circuitry installed in certain types of airborne devices, otherwise the switch contacts may "make" or "break" prematurely, particularly where the contact chamber is defined by sensitive diaphragms which gradually move to and from contact make-and/or-break positions.

An object of the present invention, therefore, is to provide a compact and reliable sealed pressure switch of the type specified in which the switch contacts may be set to close or open a circuit at some predetermined pressure with minimum danger of premature switch operation as a result of vibration or gravity stresses.

Another object is to provde a sealed pressure switch incorporating single pole, double throw contacts which may be set to operate at some predetermined ambient pressure, the constructional nature of the switch enabling it to be made small and compact and to have a low sensing volume, i.e. it incorporates a small pressure-sensing chamber so that there will be a minimum of lag in response for a given pressure change, a feature which is of particular importance where the sensing chamber is connected to a source of actuating pressure through a conduit system of relatively great length.

A further object is to provide a hermetically sealed pressure switch of relatively simple construction which may be readily calibrated and set to meet different circuit requirements and capable of being adjusted or reset, either manually or through servo-controlled driving mechanism.

The foregoing and other objects and advantages will become apparent in view of the following description taken in conjunction with the drawings, wherein:

FIG. 1 is a diametric cross-section of a pressure switch assembly in accordance with the invention;

FIG. 2 is a top plan view thereof; and

FIG. 3 is an end view with the switch base partly broken away.

Referring to the drawing in detail, the supporting framework for the switch mechanism per se consists of a bottom cross bar **10**, shown mounted on a base member in the form of an insulating ring **11**, a top cross bar **12**, and a diaphragm-supporting plate **13**. A pair of outer and inner diaphragms **14** and **15** are connected in spaced relation to the top surface of the plate **13**, as by having their peripheral outturned edges welded or otherwise secured to said surface, said diaphragms being spaced apart to provide a reference-pressure chamber or aneroid cell **16**, which may be evacuated and/or loaded with a temperature-responsive fluid such as an inert gas as by means of tube **17**. The center of plate **13** is formed with an opening to accommodate another pair of diaphragms **18** and **19**, spaced to provide another reference-pressure chamber **20**, which may also be evacuated and/or loaded with a temperature-responsive fluid by means of tube **21**. The diaphragms **18** and **19** have their peripheral edges secured to the plate **13** around the central opening formed therein. All of the diaphragms may be and preferably are comprised of metallic material commonly sold under the trade name Ni Span C; they are usually corrugated to obtain predetermined deflection characteristics.

The central portions of the upper inner diaphragm **15** and the lower inner diaphragm **18** are projected outwardly or toward one another and connected in any suitable manner and provided with contacts **22** and **23**. This connection requires flexure in unison of the inner diaphragms **15** and **18** in order to move either of the contacts **22** or **23** to make-or-break position. Coacting contacts **24** and **25** are fixed on the inner ends of terminal posts, which project through the outer diaphragms **14** and **19** and are fixed to the upper and lower cross bars **12** and **10**, respectively. Circuit wires **26** and **26'** are connected to the contact terminals and lead to or form part of the circuitry to be controlled. At the point where the fixed contact stems project through the diaphragms **14** and **19**, it is preferred to provide suitable sealing means, such as the well-known glass seals capable of being bonded to the metal of the diaphragms. The external electrical circuit to be controlled by the switch is not shown; it could be of any type desired. However, for purposes of illustration, the return terminal of the circuit is shown grounded at **27** through lead wire **28**.

A pressure sensing chamber **29** is defined in part by the inner spaced diaphragms **15** and **18** and in part by the central mounting plate **13**, the latter plate being shown as having a vent **30** for communicating atmospheric or other pressure to be sensed to the said chamber **29**.

The center plate **13** is provided with a relieved flexible hinge section **31** at one end thereof, and at its other end an adjusting screw **32** is threaded therethrough and provided with a knurled adjusting head **34**, which in certain installations is in the form of a drive gear. The lower end of the screw **32** abuts the bottom cross bar **10**, the plate **13** being biased toward the bar **10** by spring **35**. Another screw **36** is projected through the upper cross bar **12** and threaded into a stud **37**, which at its lower end is fixed to the bottom plate **10**. By rotating the screw **32**, the spacing of the inner contacts **22** and **23** with respect to the outer fixed contacts **24** and **25** may be adjusted, and by rotating the screw **36**, the relative spacing of the outer contacts **24** and **25** may be adjusted without disturbing the setting of the inner contacts **22** and **23**. The adjusting screw **34** may be rotated manually, or it may be driven by suitable servo mechanism, not shown, as where it is desired to reset the switch from a remote point by electromagnetic energy.

Operation

The improved switch, by the nature of its construction, lends itself to different switching requirements. By way of example, let it be assumed that the circuit to be controlled is to remain deenergized at sea level pressure and energized at some predetermined altitude or atmospheric pressure and that the chambers **16** and **20** have been evacuated to substantially the same degree or same reference pressure; then as altitude is gained, the pressure in the sensing chamber **29** will decrease, and since the diaphragm **15** presents a greater effective surface area to the sensing pressure than the diaphragm **18**, these diaphragms will flex downwardly in unison until movable contact **23** engages the relatively stationary contact **25**. The particular pressure at which contacts **23** and **25** will engage may be varied by resetting the screw **34** to vary the spacing of the contacts **23** and **25** at the ground level setting.

Again, let it be assumed that the sequence is to maintain a circuit controlled by contacts **22** and **24** closed up to a given altitude, then break this circuit and subsequently close another circuit controlled by contacts **23** and **25**. This could be done simply by adjusting the

screw **34** and/or the screw **36** to bring the contacts **22** and **24** into engagement at sea level pressure and remain in engagement for a given range of deflection of the diaphragms **15** and **18**, and upon further deflection, have the contact **23** engage the contact **25**.

The switch also adapts itself to varying modes of temperature compensation. For example, the chamber **16** and/or chamber **20** could be loaded with a certain amount of temperature compensating gas, preferably inert, in a manner such that the spacing of the contacts would respond to changes in temperature in different ways.

Due to the manner in which the inner contact-carrying diaphragms are rigidly connected, one to the other, vibrational stresses and acceleration forces have very little effect on the switch. Since switches of this type usually operate in low-voltage circuits, the chances of voltage breakdown when the contacts approach closed position is practically nil. Thus the switch may be calibrated and set for operation at a predetermined pressure with confidence in knowing that it will carry out its intended function within low plus or minus pressure tolerances.

While diaphragms **14** and **19** are used to form the outer walls of the chambers **16** and **20**, other means could be utilized for this purpose since these dia phragms have substantially no response to changes in pressure; the essential function of the switch could be carried out regardless of whether the outer walls of the chambers **16** and **20** were defined by diaphragms or other means, flexible or inflexible. Furthermore, instead of having two upper and lower stationary contacts **24** and **25**, only one need be used, as for example, the contact **24** coacting with the contact **22**. This would result in a single throw switch instead of the single pole, double throw type shown.

What we claim is:

1. In a pressure-responsive switch, a pair of pressure-responsive diaphragms secured to one another centrally thereof for flexure in unison, means defining a pressure-sensing chamber between said diaphragms, at least one contact carried by said diaphragms centrally thereof, one of said diaphragms having a greater effective surface area presented to the pressure-sensing chamber than the other of said diaphragms, and a coacting relatively fixed contact located for engagement by said first-named contact, said first and second named contacts being located such that they make and break contact within a sealed chamber.

2. In a sealed pressure-responsive switch, means defining a pair of aneroid cells adapted to be charged with a reference pressure fluid including a pair of diaphragms connected together at their central areas for flexure in unison and provided with at least one contact at this point, means in conjunction with said diaphragms forming an ambient pressure-sensing chamber therebetween, one of said diaphragms presenting a greater effective surface area to said chamber than the other of said diaphragms, and a stationary contact fixedly mounted to cooperate with said first-named contact, said contacts being located in one of said cells.

3. In a sealed pressure-responsive switch, a pair of aneroid cells defined by outer walls and a pair of inner flexible diaphragms facing one another and spaced apart to provide a pressure-sensing chamber therebetween, said cells being charged with a reference-pressure fluid and said chamber being vented to the pressure to be sensed, said inner diaphragms being connected to one another centrally thereof for flexure in unison and one having a greater effective surface area presented to said chamber than the other, at least one movable contact fixed to the central area of said diaphragms and adapted to coact with a fixed contact projected through one of said outer walls into one of said cells.

4. A switch as claimed in claim 3 wherein means are provided for bodily adjusting the position of said inner connected diaphragms and the contacts carried thereby independently of said fixed contact.

5. In a pressure-responsive switch, supporting structure including a substantially rigid plate having a centrally-located opening, a pair of outer and inner diaphragms having their peripheral edges secured to one surface of said plate, said diaphragms being spaced to provide an aneroid cell therebetween adapted to be charged with a reference-pressure fluid, a coacting pair of outer and inner diaphragms located in the central opening of said plate and defining another aneroid cell adapted to be charged with a reference-pressure fluid, means in conjunction with the two inner diaphragms forming a pressure-sensing chamber therebetween, said two inner diaphragms being connected centrally thereof for flexure in unison in response to changes in the pressure to be sensed, a pair of movable contacts carried by the centrally connected areas of said inner diaphragms, one of said inner diaphragms being of greater effective area than its contiguous inner diaphragm, and a pair of fixed contacts projected through said outer diaphragms into the cells and adapted to cooperate with the movable contacts carried by said inner diaphragms.

6. A switch as claimed in claim 5 wherein said outer diaphragms are held against flexure where the contacts project therethrough and said plate is adjustable to reset the movable contacts relatively to said fixed contacts.

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