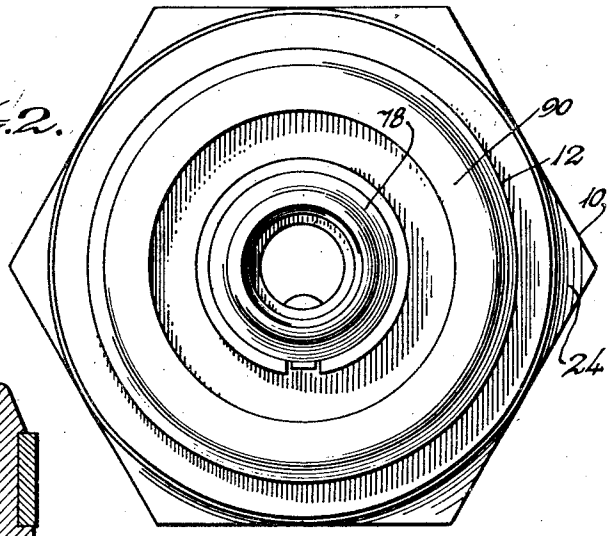
June 10, 1947. H. F. MALONE 2,421,797

PRESSURE SWITCH

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Fig. 2.



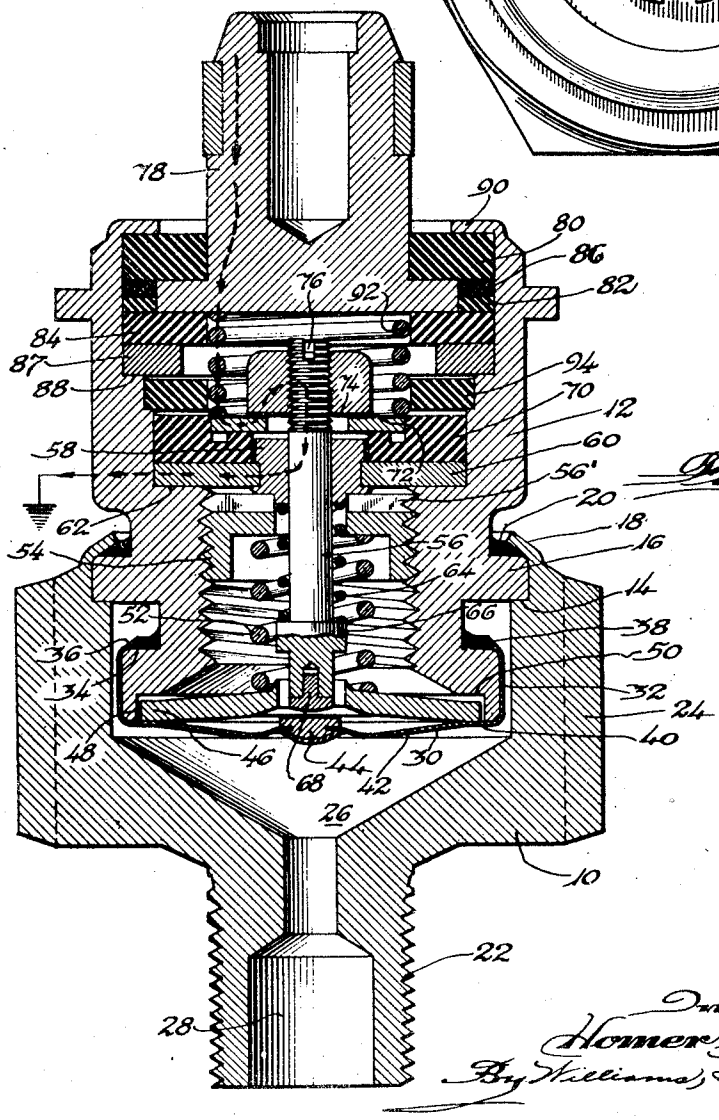


Fig. 1.

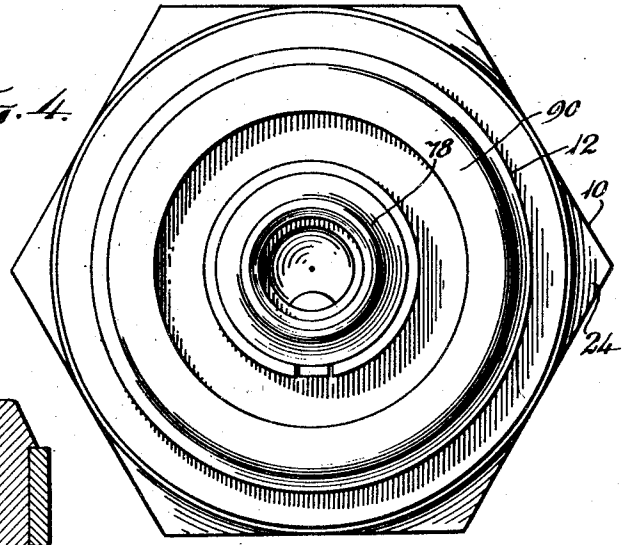
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PRESSURE SWITCH

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Fig. 4.



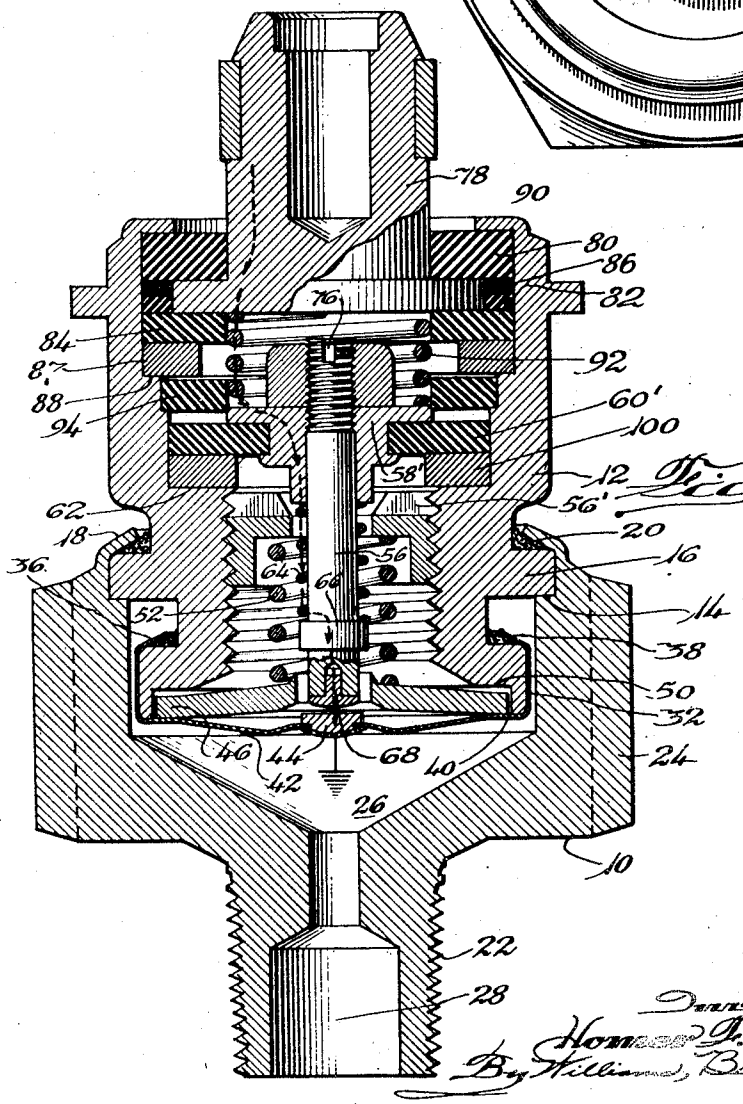


Fig. 3.

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UNITED STATES PATENT OFFICE

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PRESSURE SWITCH

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Application August 14, 1943, Serial No. 498,605

17 Claims. (Cl. 200—83)

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My invention relates to pressure switches and is more particularly concerned with electrical switches operated by fluid pressure.

An object of my invention is to provide a new and improved pressure switch which is more sensitive to a predetermined critical pressure than the switches of the prior art.

Another object of my invention is to provide a new and improved pressure switch which is capable of withstanding, without damage, pressures far greater than the critical pressure for which the switch is set to operate.

Another object of my invention is to provide a new and improved pressure switch which has a snap-over action so that arcing at the electrical contacts is eliminated or reduced to a minimum.

Another object of my invention is to provide a new and improved pressure switch wherein the electrical contacts may be made of relatively large area without diminishing the sensitivity of the switch.

Another object of my invention is to provide a new and improved pressure switch which is inexpensive to manufacture with conventional machinery and by conventional methods, and which can be produced in a single form capable of being set to operate at any predetermined critical pressure without a wide range of pressures.

Another object of my invention is to provide a new and improved pressure switch which can be readily designed to provide either a normally open or normally closed circuit.

Another object of my invention is to provide a new and improved pressure switch wherein many of the identical parts can be used interchangeably in a particular style of switch providing a normally open circuit, and in a similar style of switch providing a normally closed circuit.

Another object of my invention is to provide a new and improved pressure switch which may be effectively sealed to prevent the operation of the switch from being affected by the presence of moisture or varying atmospheric conditions.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a longitudinal section through a preferred form of my invention designed to provide a normally closed circuit;

Fig. 2 is a top plan view of the switch shown in Fig. 1;

Fig. 3 is a view similar to Fig. 1 but showing a modified form of my invention designed to provide a normally open circuit; and

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Fig. 4 is a top plan view of the switch shown in Fig. 3.

The embodiment of Figs. 1 and 2 is in the form of a unitary structure having a base 10 and a tubular body 12 secured to this base. The base 10 has a shoulder 14 receiving a flange 16 provided by the body 12. An annular lip 18 forming an integral extension of the upper end of the base 10 is rolled over the upper surface of the flange 16 as clearly shown in Fig. 1, and solder 20 or other suitable material is applied at this point to form a fluid-tight seal between the base 10 and body 12 to prevent escape of fluid from chamber 26.

The lower end of the base 10 is threaded as indicated at 22, whereby the unitary structure may be connected to a pipe or screwed into the wall of a fluid chamber, and the main portion 24 of the base 10 is preferably made hexagonal so that a wrench or other tool may be utilized to screw the unit firmly into position. The base 10 and body 12 cooperate to provide a fluid chamber 26 communicating with a passage 28 extending through the threaded portion of the base, whereby fluid under pressure may be admitted to the chamber 26 to operate the switch mechanism whenever the predetermined critical pressure for which the switch is set is communicated to the chamber 26.

The fluid pressure in the chamber 26 acts upon a sheet metal diaphragm 30 having an annular flange 32 which is spun over a shoulder 34 of the tubular body 12, as indicated at 36. Solder or other suitable material 38 forms a fluid-tight seal between this spun over edge of the diaphragm flange and the lower end of the tubular body 12. That annular portion 40 of the diaphragm 30 which is immediately adjacent the flange 32, is preferably substantially flat, whereas the central portion of the diaphragm 30 is depressed or convex as indicated at 42. A metal button 44 is staked and soldered to the central portion of the diaphragm 30 to form a fluid-tight seal therewith. The upward indentation in the bottom of the diaphragm around the button 44 prevents the solder from spreading over the diaphragm and changing its operating characteristics.

The diaphragm 30 is urged downwardly by an annular protective and pressure plate 46, which is guided in an enlarged bore 48 in the lower end of the body 12. This pressure plate 46 can move upwardly a distance of approximately .004 of an inch before coming in contact with shoulder 50 provided by the body 12. A narrow annular por-

tion adjacent the circumference of this pressure plate provides a flat surface in contact with the flat annular portion 48 of the diaphragm 30, whereas the rest of this pressure plate is inclined upwardly to provide a concave surface opposite the diaphragm, as clearly shown in Fig. 1. This pressure plate is acted upon by a spring 52 resting against a compression plug 54 threaded into the body 12 and provided with a screwdriver slot 56', whereby this plug may be accurately adjusted to set the switch for any predetermined critical pressure. After this plug has been accurately adjusted, it is locked in place by mutilating the threads thereabove or by the application of solder or in any other suitable manner.

A shaft 56 is slidably mounted in a guide bushing 58 of brass or other suitable material. This guide bushing 58 is staked to a metal washer 60 resting on a shoulder 62 provided by the body 12 and forming a support for this washer and bushing. The shaft 56 is urged downwardly by a spring 64 which is confined between the guide bushing 58 and a flange 66 integral with the shaft 56. The lower end of the shaft is illustrated as having a second button 68 forming a press fit therewith, and this second button lies closely adjacent to and is adapted to be engaged by the button 44 carried by the diaphragm 30 to move the shaft 56 upwardly against the resistance of spring 64.

A Bakelite insulating washer 70 is press fitted into the body 12 and rests upon the metal washer 60. This insulating washer has a counterbored recess into which fixed, annular electrical contact 72 is press fitted. In the position of the parts shown in Fig. 1, this fixed contact 72 is in engagement with a movable contact 74. Both of these contacts are preferably provided with silvered engaging surfaces. The contact 74 is in the form of a nut threaded to the upper end of the shaft 56 and limits downward movement of the shaft. The upper end of this shaft is provided with a screw-driver slot 76 whereby the shaft and nut may be adjusted to properly space the lower end of this shaft adjacent the button 44 of the flexible diaphragm. After the adjustment has been made, the threads may be mutilated to lock this nut in adjusted position.

An electrical terminal 78 is mounted in the upper end of the tubular body 12 and is insulated therefrom by Bakelite washers 80, 82 and 84 and a neoprene washer 86. This assembly is supported on a metal washer 87 resting on the shoulder 88 of the body 12 and is retained in the body by rolling over the upper edge 90 of this body. While this edge is being rolled over, pressure is preferably exerted in a downward direction on the washer 80 to compress the neoprene washer 86, and causes this washer to effect a fluid-tight seal between the body 12 and terminal 78. A spring 92 establishes electrical communication between the terminal 78 and the stationary annular contact 72. The upper end of this spring is located within the annular insulating washer 84 and the lower end of this spring is maintained in proper position by another annular insulating washer 94.

In the position of the parts shown, the terminal 78 is grounded by way of spring 92, stationary contact 72, movable contact 74, shaft 56, metal washer 60, and tubular body 12. When the fluid pressure in the chamber 26 reaches the critical pressure for which the switch is set to open, the force exerted on the diaphragm 30, raises this diaphragm and pressure plate 46 against the resistance of spring 52. The diaphragm is unstable at this critical pressure and the concave central portion of this diaphragm snaps upwardly to bring button 44 into engagement with the lower end of shaft 56, thereby raising this shaft and moving contact 74 out of engagement with contact 72 to disconnect the terminal 78 from ground. The central portion of the diaphragm snaps quickly from a convex conformation to a concave conformation so that electrical contacts separate quickly with a minimum amount of arcing.

A typical pressure-deflection performance chart of a preferred embodiment of my invention is as follows:

Pressure Increasing. Pounds per sq. inch	Deflection
0	0
15	.011
15+Snap-over	.031
200	.034

Pressure Decreasing from Maximum	Deflection
11+	.021
11—Snap-over	.003
0	0

Between .011" and .021" deflection in this particular example, there is no stable diaphragm position. It is in this region that the diaphragm button 44 strikes or leaves the button 68 attached to the lower end of the shaft 56 of the resilient contact assembly. There is thus a quick make or a quick break between the electrical contacts 72 and 74. The point at which the buttons 44 and 68 engage or disengage is controlled by the adjustment of the nut-like contact 74 lengthwise of the threaded upper end of the shaft 56.

After the convex portion of the diaphragm has moved upwardly under the critical pressure and this diaphragm has snapped over to a concave conformation, substantially the entire area of the diaphragm is firmly supported so that a pressure much higher than the critical pressure can be built up in the chamber 26 without injuring the diaphragm or changing in any way the operating characteristics of the switch. The diaphragm button 44 receives support only from the shaft 56 and its operating spring 64, but the area of this button is very small so that failure will not occur at this point even under exceedingly high pressures in the chamber 26. This is an important feature of my invention, since it permits the switch chamber to remain in communication with a pressure line when the pressure in the line far exceeds the critical pressure for which the switch is set to operate.

With any given thickness of diaphragm and strength of springs, my novel switch may be preset to operate at any predetermined critical pressure throughout a wide range of available critical pressures. This makes it possible to use the same size and model of switch in many different locations for operation at many different critical pressures. This already wide range of available critical pressures can be very greatly increased by substituting diaphragms of different thicknesses or materials and springs of different strengths. My new and improved switch is also capable of operating repeatedly for many thousands or millions of times without failure, and one factor which contributes to this long life is the design of the pressure plate which causes it normally to

engage the diaphragm over a band of appreciable width and thereby prevents undue wear of the diaphragm at this point.

The embodiment of Figs. 3 and 4 represents a modification in which the switch contacts are normally open and wherein the effect of the critical pressure is to close these contacts with a snap action. Most of the parts of the two embodiments may be identical, and it will therefore be necessary to describe only the differences between the two forms of my invention. In the embodiment of Figs. 3 and 4 the buttons **44** and **68** constitute the electrical contacts, and these buttons are preferably provided with silvered contact surfaces. While in both Figs. 1 and 3 the lower end of the shaft **56** is illustrated as being provided with a pressed-in button **68**, this button may, if desired, be dispensed with and the lower end of the shaft itself designed to engage the button **44**.

In the form of my invention shown in Figs. 3 and 4, it is necessary to insulate the guide **58'** from body **12**, and this is accomplished by substituting a Bakelite washer **60'** for the metal washer **60** of the previous embodiment. The washer **60'** and guide **58'** are supported on a metal washer **100** resting on the shoulder **62**. The guide **58'** has an extending flange forming a support for the spring **92**, which establishes an electrical conducting path between this guide and terminal **78**. The current can flow directly from the guide into the shaft **58**, or by way of spring **64** located between opposing shoulders provided by these parts. The button **44** is grounded through diaphragm **30** and body **12**.

From the foregoing description taken in connection with the accompanying drawings, it will be seen that my new and improved pressure switch is of simple construction and may readily be made in various sizes and styles by conventional machinery utilizing conventional methods. This switch may be used either to open a normally closed electrical circuit or to close a normally open electrical circuit. A switch of this type is particularly advantageous to operate warning lights, ring bells, actuate relays, or initiate action in any other types of electrical circuits and devices.

While the drawings and accompanying detailed description refer only to two specific embodiments of my invention, my invention is not limited to these particular embodiments, but may assume numerous other forms. My invention includes all modifications, variations and equivalents within the scope of the appended claims.

I claim:

1. A pressure switch of the class described, comprising a snap acting flexible diaphragm, means supporting said diaphragm and providing a pressure chamber, a pressure member for urging said diaphragm toward one extreme position, said member engaging said diaphragm only adjacent the outer edge thereof, a spring for loading said pressure member and diaphragm, and switch means operated with snap action by flexure of said diaphragm under fluid pressure.

2. A pressure switch of the class described, comprising means providing a fluid chamber, a flexible metal diaphragm located in said chamber and having one side exposed thereto, a plate having an annular portion engaging the opposite side of said diaphragm adjacent the outer edge theretof and an area comparable to that of the diaphragm engageable by the diaphragm, a spring for urging said plate toward said diaphragm, normally closed switch means operated by movement of said diaphragm under fluid pressure, and means for limiting movement of said plate and providing a support for said plate and diaphragm whereby the latter is capable of withstanding fluid pressure far greater than that required to operate said switch.

3. A pressure switch of the class described, comprising a body, a base attached to said body, said body and base cooperating to provide a fluid chamber, a diaphragm in said chamber and attached to said body, a pressure plate located between a portion of said diaphragm and a portion of said body for limited movement therebetween, said plate having a concave surface exposed to said diaphragm and adapted to support said diaphragm against fluid pressure greatly in excess of that required to operate said diaphragm, means urging said plate toward said diaphragm to cause said diaphragm to assume a convex shape, and switch mechanism operated by movement of the central portion of said diaphragm under fluid pressure.

4. A pressure switch of the class described, comprising a body, a base attached thereto and cooperating therewith to provide a fluid chamber, a diaphragm attached to said body and located in said chamber, said diaphragm having a central convex circular portion and an annular portion adjacent its outer edge, an apertured plate normally engaging only the annular portion of said diaphragm, a spring for urging said plate against said diaphragm, a shaft at the plate side of the diaphragm in alignment with the aperture in the plate and spaced from the central portion of said diaphragm and adapted to be engaged by the diaphragm, and switch means associated with said shaft and operated by engagement of said diaphragm with said shaft.

5. A pressure switch of the class described, prising means providing a fluid chamber, a flexible diaphragm located in said chamber, said diaphragm being stable in either a convex or concave position but being unstable intermediate said positions, an annular pressure plate having a concave face opposite said diaphragm, a spring for urging said annular plate against said diaphragm and holding the latter in convex position, means limiting movement of said plate and diaphragm in response to fluid pressure in said chamber, said plate forming a substantially complete support for said diaphragm when the latter is in concave position whereby said diaphragm can resist high fluid pressures, a movable shaft projecting through said plate and adapted to be engaged by said diaphragm when the latter changes from convex to concave positions, and switch means associated with said shaft and controlled by movement of said diaphragm.

6. A pressure switch of the class described, comprising means providing a pressure chamber, a diaphragm located in said chamber, a button affixed to the central portion of said diaphragm, a movable shaft spaced from but adapted to be engaged by said button, a spring for urging said shaft toward said button, switch contacts for limiting movement of said shaft toward said button, a pressure plate for urging said diaphragm and button away from said shaft, said plate normally engaging said diaphragm only adjacent the periphery thereof, a spring for pressing said plate against said diaphragm, and means for limiting the movement of said plate and diaphragm whereby said plate engages and supports substantially the entire area of said dia-

phragm when the fluid pressure in said chamber exceeds a predetermined critical pressure.

7. A pressure switch of the class described, comprising means providing a fluid chamber, a diaphragm located in said chamber and movable by fluid pressure from convex to concave position, means engaging said diaphragm adjacent its periphery yieldingly to hold said diaphragm in convex position, a shaft engageable by said diaphragm and movable therewith, a first switch contact carried by said shaft, a fixed switch contact engageable by said first mentioned contact, and resilient means for maintaining said contacts in engagement.

8. A pressure switch of the class described, comprising means providing a pressure chamber, a diaphragm mounted in said chamber, a conductive movably mounted shaft having one end adjacent said diaphragm and engaged by said diaphragm when the latter is flexed by fluid pressure in said chamber, means for biasing said diaphragm away from and out of contact with said shaft, a conductive guide for said shaft mounted in said first named means, a washer forming an electrical connection between said guide and said first named means, a first contact spaced from said guide, and a second contact carried by said shaft and engageable with said first contact.

9. A pressure switch of the class described, comprising means providing a fluid chamber, a flexible metal diaphragm located in said chamber and having one side exposed thereto, a conical plate having a flat annular portion engaging the opposite side of said diaphragm adjacent the outer edge thereof, a spring for urging said plate toward said diaphragm, normally closed switch means operated by movement of said diaphragm under fluid pressure, and means for limiting movement of said plate and providing a support for said plate and diaphragm whereby the latter is capable of withstanding fluid pressure far greater than that required to operate said diaphragm.

10. A pressure switch of the class described, comprising a body, a base attached to said body, said body and base cooperating to provide a fluid chamber, a resilient diaphragm in said chamber and attached to said body, said diaphragm having a flat rim and a normally displaced central portion, a pressure plate located between a portion of said diaphragm and a portion of said body for limited movement therebetween, said plate having a concave surface surrounded by a flat rim engaging the rim of said diaphragm, means urging said plate toward said diaphragm to space said diaphragm from the plate, and switch mechanism operated by movement of the central portion of said diaphragm toward the plate under fluid pressure.

11. A pressure switch of the class described, comprising a tubular body, a base attached thereto and cooperating therewith to provide a fluid chamber, a diaphragm attached to said body and located in said chamber, said diaphragm having a convex circular portion, a plate normally engaging only an annular portion of said diaphragm adjacent the outer edge thereof, a spring for urging said plate against said diaphragm, a shaft adjacent the central portion of said diaphragm, a switch member carried by said shaft, and a second switch member carried by said diaphragm.

12. A pressure switch of the class described, comprising means providing a fluid chamber, a flexible diaphragm located in said chamber, said

diaphragm being stable in either a convex or concave position but being unstable intermediate said positions, an annular pressure plate having a concave face opposite said diaphragm, a spring for urging said annular plate against said diaphragm and holding the latter in convex position, means limiting movement of said plate and diaphragm in response to fluid pressure in said chamber, said plate forming a substantially complete support for said diaphragm when the latter is in concave position whereby said diaphragm can resist high fluid pressures, a movable shaft projecting through said plate and adapted to be engaged by said diaphragm when the latter changes from convex to concave positions, a movable switch member associated with said shaft and controlled by movement of said diaphragm, and a fixed switch member rigidly mounted in said first named means.

13. A pressure switch of the class described, comprising means providing a pressure chamber, a diaphragm located in said chamber, a switch contact button affixed to the central portion of said diaphragm, a shaft carrying a second switch contact button adapted to be engaged by said first named button, a spring for urging said shaft toward said first named button, a pressure plate for urging said diaphragm and first named button away from said shaft, said plate normally engaging said diaphragm only adjacent the periphery thereof, a spring for pressing said plate against said diaphragm, and means for limiting the movement of said plate and diaphragm whereby said plate engages and supports substantially the entire area of said diaphragm when the fluid pressure in said chamber exceeds a predetermined critical pressure.

14. A pressure switch of the class described, comprising a base, a tubular body cooperating therewith to provide a fluid chamber, a diaphragm located in said chamber and movable by fluid pressure from convex to concave position, means engaging said diaphragm adjacent its periphery yieldingly to hold said diaphragm in convex position, a shaft engageable by said diaphragm and movable therewith, a first switch contact carried by said shaft, a fixed switch contact engageable by said first mentioned contact, resilient means for maintaining said contacts in engagement, a guide for said shaft electrically insulated from said tubular body, a terminal mounted in said body and insulated therefrom, and a resilient conductor connecting said guide and terminal.

15. A pressure switch of the class described, comprising means providing a pressure chamber, a diaphragm mounted in said chamber, a shaft having one end adjacent said diaphragm and engaged by said diaphragm when the latter is flexed by fluid pressure in said chamber, means for biasing said diaphragm away from said shaft, a guide for said shaft mounted in said first named means, a washer forming an electrical connection between said guide and said first named means, a first contact spaced from said guide, a second contact carried by said shaft and engageable with said first contact, a terminal mounted in said first named means and insulated therefrom, and a spring forming an electrical conductor between said terminal and said first contact.

16. A pressure switch, including in combination, a flexible diaphragm having an unstable intermediate position and stable positions on each side of said intermediate position, means supporting said diaphragm and providing a pressure

chamber to one side of the diaphragm, an annular pressure member engaging the other side of the diaphragm near its peripheral portion and having a central portion spaced outwardly from the portion engaging the diaphragm, and means biasing said pressure member and diaphragm in the direction of the pressure chamber, whereby said diaphragm is maintained in a stable position away from the pressure member and is movable to its other stable position nearer the central portion of the member in response to pressure changes.

17. A pressure switch, including in combination, a flexible diaphragm having an unstable intermediate position and stable positions on each side of said intermediate position, means supporting said diaphragm and providing a pressure chamber to one side of the diaphragm, an annular pressure member engaging the other side of the diaphragm near its peripheral portion and having a central portion spaced outwardly from the portion engaging the diaphragm, said member being mounted for limited movement in the direction of movement of said diaphragm, and means biasing said pressure member and diaphragm in the direction of the pressure chamber, whereby said diaphragm is maintained in a stable position away from the pressure member and, is movable to its other stable position against the central portion of the member in response to pressure changes.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
909,818	Paul	Jan. 12, 1909
1,102,566	Besley	July 7, 1914
1,153,879	Aikman	Sept. 21, 1915
1,951,245	Jardine	Mar. 13, 1934
2,093,200	Libke	Sept. 14, 1937
1,370,193	Crocker	Mar. 1, 1921

FOREIGN PATENTS

Number	Country	Date
352,144	Great Britain	July 9, 1931
221,504	Great Britain	May 14, 1925