March 18, 1969 M. F. PRAVDA 3,433,910

FLUID ACTUATED SWITCHING DEVICE

Filed July 18, 1966 Sheet 1 of 2

FIG. 1

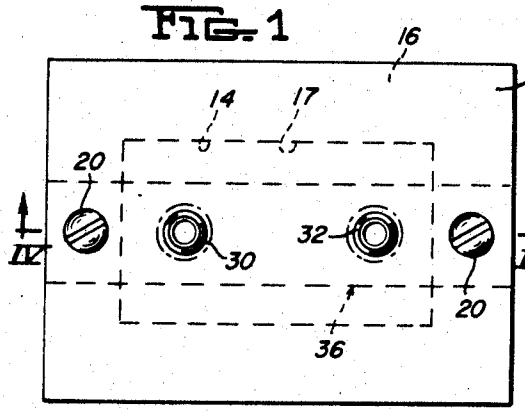


FIG. 2

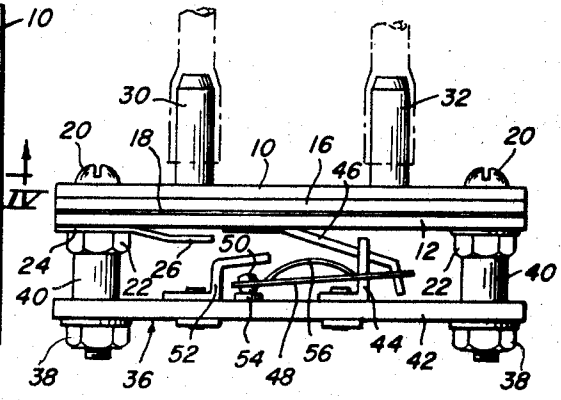


FIG. 3

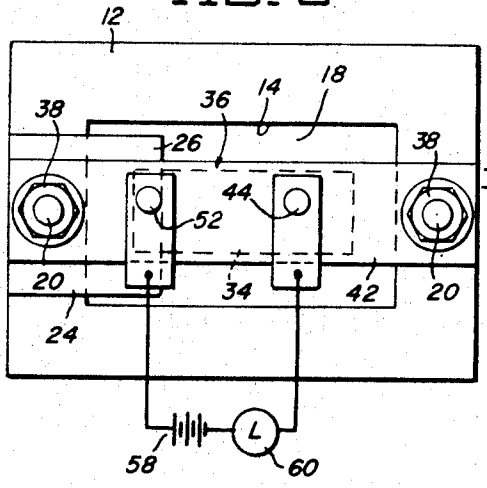


FIG. 4

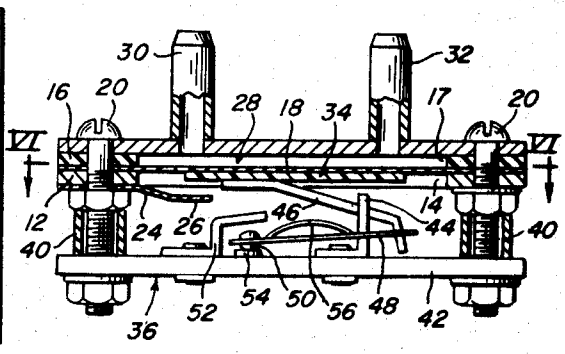


FIG. 5

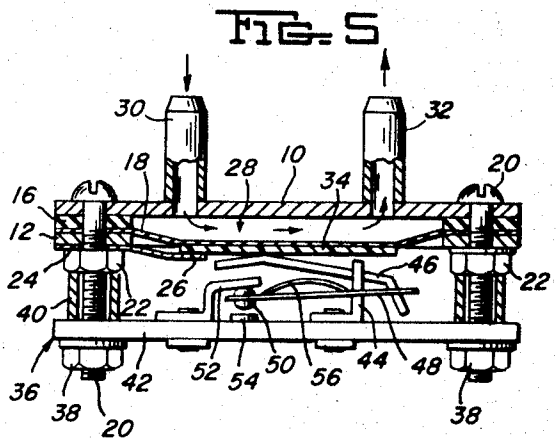
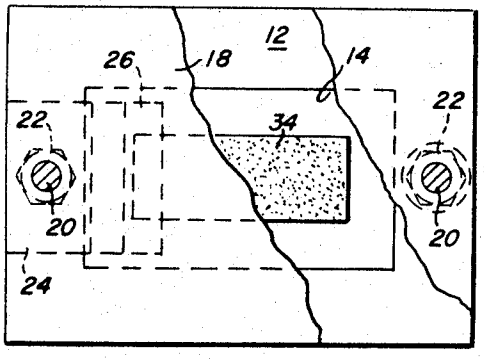


FIG. 6



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FIG. 10

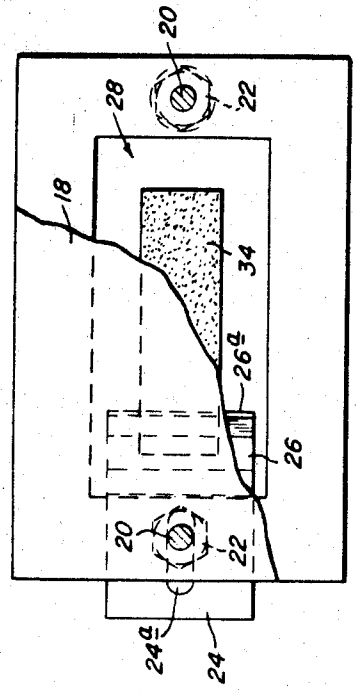


FIG. 11

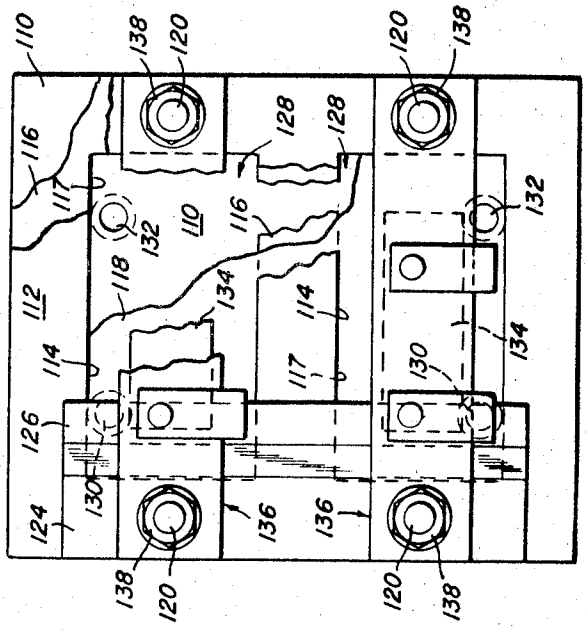


FIG. 7

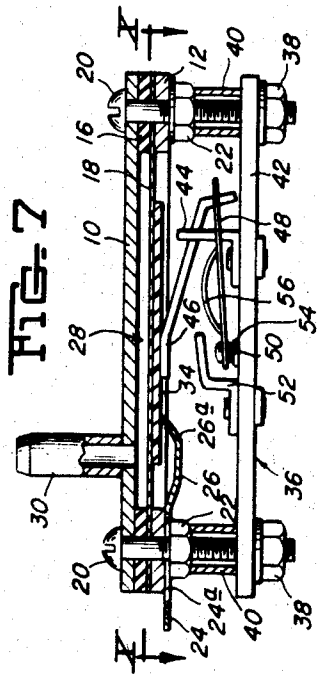


FIG. 8

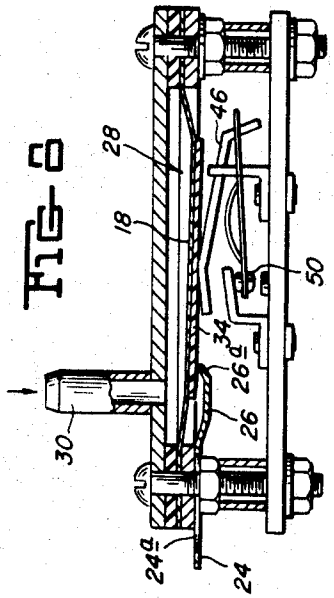
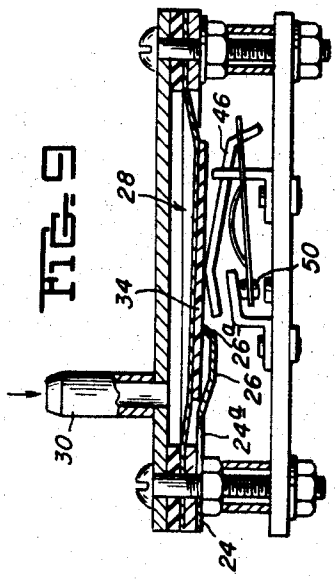


FIG. 9



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3,433,910

FLUID ACTUATED SWITCHING DEVICE

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Filed July 18, 1966, Ser. No. 566,063
U.S. Cl. 200—83 11 Claims
Int. Cl. H01h 35/24, 35/40

ABSTRACT OF THE DISCLOSURE

A fluid actuator and switching device combination. The actuator is formed of a pair of flat plates with a gasket and diaphragm interposed therebetween. The switch is independently formed and mounted on the actuator. The switch and diaphragm have coacting means to operate the switch as the pressure varies. In one embodiment the actuator itself acts as a conduit as a part of the fluid circuit. Also, optional adjustment means for changing the operating pressure are provided.

This invention relates generally to switching devices and more particularly to fluid actuated electrical switching devices which will provide electrical signals when the fluid pressure exceeds preselected values.

The switching device of this invention has particular significance in use with control devices for therapeutic air mattresses wherein parallel air chambers within the mattress are alternately inflated and deflated to prevent bed sores from forming on a patient. However, the use of this device is not so limited, and finds application wherever electrical switching is necessary responsive to changes in fluid pressure.

Briefly, the switching device of this invention includes a pair of opposed rigid plates which are separated by a sealing gasket. A diaphragm is interposed between the sealing gasket and one of the plates, and that one plate has an opening therein to allow for movement of the diaphragm responsive to change in fluid pressure acting on it. An electrical switch is mounted in a position to be actuated by movement of the diaphragm responsive to fluid pressure changes acting on the diaphragm. The switch may be wired to give visual or audible signals of different types when the fluid pressure acting on the diaphragm exceeds a given value or is less than a given value or the switches may be used for control functions.

Still other advantages of the invention and the invention itself will become more apparent from the following description of several embodiments thereof, which description is illustrated by the accompanying drawings and forms a part of the specification.

In the drawings:

FIG. 1 is a plan view of an embodiment of a fluid actuated switching device according to this invention;

FIG. 2 is a side elevational view of the switch of FIG. 1;

FIG. 3 is a bottom plan view of the switch of FIG. 1;

FIG. 4 is a sectional view taken substantially along the plane designated by line IV—IV of FIG. 1, showing some movement of the diaphragm;

FIG. 5 is a sectional view similar to that of FIG. 4 with the diaphragm and switch in a different position;

FIG. 6 is a sectional view taken substantially along the plane designated by line VI—VI of FIG. 4;

FIG. 7 is a sectional view of another embodiment of a switching device according to this invention;

FIG. 8 is a sectional view similar to FIG. 7, showing the switch and diaphragm in a different position;

FIG. 9 is a sectional view similar to FIG. 8 with the sensitivity bracket adjusted to a different position;

FIG. 10 is a sectional view taken substantially along the plane designated by line X—X of FIG. 7; and

FIG. 11 is a bottom plan view of a group of two switches utilizing common plates, gaskets, and diaphragms.

Referring now to the drawings, and for the present FIGS. 1 through 6, one embodiment of a fluid actuated switching device according to this invention is shown. The switching device includes a pair of superposed rigid metal plates **10** and **12**. The plate **12** is provided with a central rectangular opening **14**, and a rectangular sealing gasket **16** having a rectangular opening **17** corresponding to opening **14** is provided between the plates **10** and **12**. A diaphragm **18** is interposed between the sealing gasket **16** and the plate **12**, and the plates **10** and **12**, the gasket **16**, and the diaphragm **18** are all secured together in superposed relationship by a pair of screws **20** and nuts **22**. A stop bracket **24** is secured to the underside of the plate **12**, and has an arm **26** extending parallel with the diaphragm **18**. The sealing gasket **16** is formed of a thick, resilient rubber-like material preferably having a thickness of between an eighth of an inch and a quarter of an inch. Because of the thickness of the gasket **16**, a fluid receiving space **28** is defined between the diaphragm **18** and the plate **10**. A pair of fittings **30** and **32** are secured to the plate **10** and communicate with the space **28**. The fittings **30** and **32** are adapted to receive suitable fluid conducting tubes as shown in dotted lines. A rigid, non-conducting plastic strip **34** is secured to the lower side of the diaphragm **18** by an epoxy resin.

An electrical switch generally designated as **36**, is mounted on the screws **20** beneath the plate **12**, and is secured on the screws **20** by nuts **38**. Spacer sleeves **40** are provided between the switch **36** and the nuts **22** to properly position the switch **36** in relation to the diaphragm **18**. The switch per se, forms a part of this invention, and any of several switches may be utilized. It will also be appreciated that the combination is not limited to electrical switches, and the term switch as used herein is intended to include indicating, controlling, or positioning devices, such as gages, valves, or the like. It has been found that for electrical switching switch SK–3, manufactured by Micro Corporation of Freeport, Ill., is quite satisfactory. This switch has a rigid support base **42** on which is mounted an L-shaped bracket **44**. The bracket **44** pivotally mounts an actuating arm **46** which is normally biased by spring contact arm **48** toward the diaphragm **18** against the strip **34** into the position shown in FIG. 2. In the case of electrical switches, it is important that the actuating arm **46** be insulated from the plates **10** and **12** to prevent short circuitry. This isolation is assured by the adhesive mounting of the non-conducting plastic strip **34**. The contact arm **48** has an electrical contact point **50** which is movable with the contact arm **48** into and out of engagement with an electrical contact **52** secured to the base plate **42**. A second electrical contact **54** is provided on the support base **42**, and the contact arm **48** is movable vertically to move the contact point **50** between the contacts **52** and **54**. A bowed portion **56** of the contact arm **48** provides the spring bias which normally urges the contact arm into its position as shown in FIG. 2. The construction and action of the switch **36** is such that the actuating arm **46** will move an appreciable distance downwardly with the contact arm **48** remaining in its position as shown in FIG. 2, with the contact point **50** resting on and urged into engagement with contact **54** as shown in FIG. 4. When the actuating arm **46** is moved past this point, the contact arm **48** will pivot about bracket **44** and snap the contact point **50** against contact **52**. This then constitutes a switched position of the electrical switch **36**. Further movement of the arm **46** will increase the pressure holding the contact point **50** against contact **52** as shown in FIG. 5.

Conversely, from position at which point switching has just taken place, as shown in FIG. 4, appreciable upward or return movement of the actuating arm **46** is required before the contact arm **48**, under the urging of the bowed portion **56**, will snap the contact point **50** back against contact **54** to its original position. Since the movement of the actuating arm **46** is responsive to movement of the diaphragm which in turn is responsive to the pressure in space **28**, switching from the position of the contacts shown in FIG. 2 to the position shown in FIG. 5 will occur at a higher pressure value than switching back from the position of the contacts in FIG. 5 to the position shown in FIG. 2.

As is shown in FIG. 3, contact **52** is connected through a battery **58** (or other source of power) and lamp **60** to the bracket **44**. When contact point **50** engages contact **52** as shown in FIG. 5, a circuit is completed and the lamp **60** will glow.

Turning now to the operation of the device, the embodiment shown in FIGS. 1 through 6 acts not only as a sensor of fluid pressure but the switching device itself acts as a conduit through which the pressure fluid is delivered. The tubing delivering the air or other pressure fluid is connected as shown in the drawings so that the air from the source of pressure fluid enters one fitting, passes through the space **28** and out the other fitting to the object being supplied with air such as a therapeutic air mattress. The fluid delivered to the space **28** exerts a pressure equal to the pressure of the fluid on the diaphragm **18** causing the diaphragm to tend to move away from the plate **12**, urging the plastic strip **34** against the actuating arm **46** of the electric switch **36**. As the pressure increases the diaphragm forcing against the actuating arm **46** moves the arm **46** a distance proportional to the increase in pressure. When the pressure is sufficient to move the arm **46** past the position shown in FIG. 4, the contact arm **48** will move the contact point **50** from contact **54** and into engagement with contact **52**. This point represents a given pressure level in the space **28**, and a circuit is established to light the lamp **60**. Of course, a buzzer or indicia may be wired into the circuit in a conventional manner in place of or in addition to a lamp to give an indication that the switch has switched. Also, the switch may serve to operate control devices responsive to sensed pressure. Increased pressure beyond this point where switching occurs will cause the diaphragm to continue to move away from the plate **10** until the plastic strip **34** comes in contact with the stop bracket **24** at which point motion of the diaphragm is halted, as shown in FIG. 5. It is desirable to halt this motion of the actuating arm **46** by this bracket to prevent the arm **46** from being forced down against the top of contact **52**, since repeated extended motion of the arm **46** in this fashion greatly reduces the life of the electrical switch **36**.

From this switched position, as shown in FIG. 5, a decrease in pressure will cause the actuating arm **46** to bias the diaphragm **18** back toward the plate **10**. As the pressure decreases, the bias of the bowed portion **56** will cause the actuating arm **46** to move upwardly a distance proportional to the drop in pressure. This movement will continue past the position at which switching occurred into the switched position represented in FIG. 4 until another position is reached which represents a pressure value lower than the value at which the switching occurred. At this other position the contact arm under the bias of bowed portion **56** will be moved to snap contact **50** back against contact **54**. Thus the device of this invention will switch the contacts to position shown in FIG. 5 from that of FIG. 2 at a higher pressure level than it will switch the contacts back to the position shown in FIG. 2 from that shown in FIG. 5. This feature is particularly advantageous when the switch is used in conjunction with the control of therapeutic air mattresses to provide visual indications of air leaks from either of the two systems. There are other instances also where this type of switching action at different levels, depending on whether pressure is increasing or decreasing, is desired.

Turning now to the embodiment shown in FIGS. 7 through 10, the components are the same except that the arm **26** of the stop bracket **24** has a turned up end portion **26***a*, the point of which comes close to but does not touch the plastic strip **34**. The stop bracket **24** is also provided with an elongated slot **24***a* which allows the bracket **24** to be adjusted to change the position of the turned up portion **26***a* with respect to the plastic strip **34**. Also this embodiment illustrates the use of the device merely as a pressure sensing device, and not as a passage for the pressure fluid. To this end, but a single fitting **30** is provided. In this embodiment, the fitting **30** is connected directly to the container of the pressure fluid and the device acts solely as a pressure gauge and not as a conduit through which fluid flows.

Turning now to the operation of the device shown in FIGS. 7 through 10. When the pressure in the space **28** starts to increase, it will move the diaphragm **18** away from the plate **10** just as described with respect to the previous embodiment. However, the plastic strip **34** will encounter the turned up lip **26***a* of the stop bracket **24** before the actuating arm **46** has caused the contact point **50** to switch as shown in FIG. 7. Any further movement of the diaphragm will cause a pivotal movement of the plastic strip **34** about the turned up lip **26***a* and the force required for this motion is greater than to move the plastic strip **34** away from the plate without any obstruction. Pivotal motion will cause the switch to switch to the position shown in FIG. 8. The amount of force required to cause the pivotal motion of the plastic strip **34** depends upon the point of engagement thereof, by the upturned lip **26***a* of the stop bracket **24**. The closer the lip **26***a* is to the center of the plastic strip **34**, the greater will be the force required for such pivotal movement. The elongated slot **24***a* allows for the positioning of the stop bracket **24** to select this point of engagement of the lip **26***a* and hence select the amount of pressure required to move the plastic strip pivotally about the upturned lip **26***a*. This then allows for the adjustment of the pressure at which switching will occur from the position shown in FIGS. 7 and 8 to that shown in FIG. 9. In this way the sensitivity of the switching device for switching from one position to another at the high pressure end can be adjusted. Of course, the pressure needed to switch back on the return of the actuating arm **46** will be the same irrespective of the position of the stop bracket **24**.

Another modification is shown in FIG. 11. In this embodiment a pair of plates, a single gasket, and a single diaphragm mount and actuate a pair of switches. This has the advantage of providing a compact, integral unit of a multiplicity of switches, and is particularly useful in conjunction with a therapeutic mattress where two different fluid pressure containing systems are alternately inflated and deflated.

In the embodiment of FIG. 11 a pair of plates **110** and **112** are provided. The plate **112** is provided with a pair of rectangular openings **114** side-by-side. A sealing gasket **116** is provided which has a pair of rectangular openings **117** coresponding to openings **114**. A diaphagm **118** is interposed between the sealing gasket **116** and the plate **112**. The plates are held together by four screws **120**. A stop bracket **124** is secured to the underside of the plate **112** and has an arm **126** extending parallel with the diaphragm **118**. Fluid receiving spaces **128** are defined in each of the openings **117**, and a pair of fittings **130** and **132** are secured to the plate **110** adjacent each space **128** and communicating with them. The diaphragm is provided with a pair of plastic strips **134**. The fittings **130** and **132** are laterally off-set with respect to the strips **134**. This modification, which can also be incorporated in the previously described embodiments, prevents the passage from being blocked by the rigidly held diaphragm beneath the plastic strip **134** when the switches hold the dia-

phragm against the plate **110**. A pair of electrical switches **136** of the type previously described are mounted in the same manner as previously described with spacers (not shown) and nuts **138** adjacent each plastic strip **134**. Although the switches **136** are commonly mounted, they are independently actuated by fluid to each of the spaces **128**, which are isolated from each other. The switching device is compact and can be constructed inexpensively. It is obvious too, that three or more switches could also be commonly mounted when necessary.

While several embodiments of this invention have been shown and described, various adaptations and modifications can be made without departing from the scope of the appended claims.

I claim:

1. A switching device comprising in combination, a switch having first and second positions and a fluid actuator therefor, said fluid actuator having first and second opposed flat plates, said first plate having an opening therein, a sealing gasket interposed between said plates and having a central opening, a diaphragm secured between said gasket and said first plate and with said gasket and said second plate defining a fluid receiving space, fluid conducting means communicating with said space, said diaphragm being movable toward and away from said second plate responsive to changes in fluid pressure in said space, said switch having a mounting plate secured to said first plate, said diaphragm and said switch having co-acting means to move said switch into its second position when the fluid pressure in said space exceeds a preselected value and to move said diaphragm toward said second plate and said switch into its first position when the pressure in said space is less than a preselected value.

2. The combination of claim **1**, wherein said coacting means includes a rigid plastic strip secured on said diaphragm.

3. The combination of claim **1**, further characterized by adjusting means to adjust the force required to move said switch to said second position, and wherein said adjusting means includes fulcrum means disposed to operatively engage said strip and means to selectively position the place of engagement, whereby the pressure value required to move the switch to its second position can be varied.

4. A unitary switching device comprising in combination, first and second switches each having first and second positions and fluid actuators therefor, said fluid actuators having first and second opposed plates, said first plate having a pair of openings therein, a sealing gasket interposed between said plates and having a pair of central openings corresponding to said openings in said first plate, a diaphragm secured between said first plate and said gasket and with said second plate and said gasket defining first and second fluid receiving spaces, the diaphragm portion adjacent each fluid receiving space being movable toward and away from said second plate independently responsive to change in pressure in its defined fluid receiving space, said switches having mounting plate means secured to said first plate, each diaphragm portion and one of said switches having co-acting means to move the respective switch into its second position when the fluid pressure in the respective space exceeds a preselected value and to move the diaphragm toward the second plate and the switch into its first position when the pressure in the respective space is less than a preselected value.

5. The combination of claim **1**, further characterized by means detachably securing said mounting plate of said switch to said first plate.

6. The combination of claim **5** further characterized by said first and second plates being interconnected by screw means and said mounting plate for said switch being carried by said screw means.

7. The combination of claim **5**, further characterized by spacer means interposed between said mounting plate of said switch and said first plate.

8. The combination of claim **1**, further characterized by said fluid conducting means including fluid inlet and fluid outlet means, whereby said actuator serves as a fluid conduit.

9. The combination of claim **8**, wherein said fluid inlet and outlet means include spaced apertures in said second plate.

10. The combination of claim **4**, wherein each of said switches has a mounting plate and each mounting plate is mounted for independent removal from said first plate.

11. The combination of claim **10**, wherein said screw means interconnects said first and second plates, and the mounting plate and said switches are carried by said screw means.

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