Jan. 23, 1940. W. MUIR 2,187,792

ELECTRICAL SWITCH

Filed Aug. 27, 1938

Fig. 1.

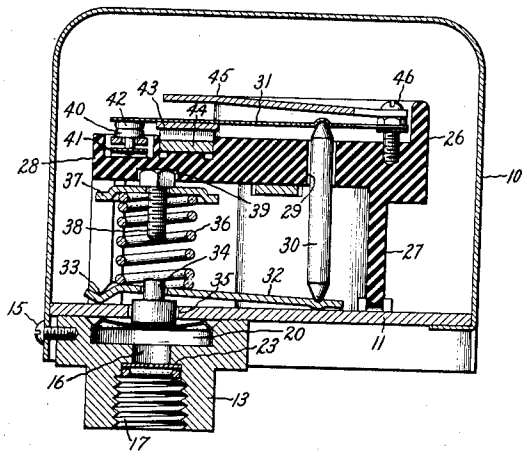
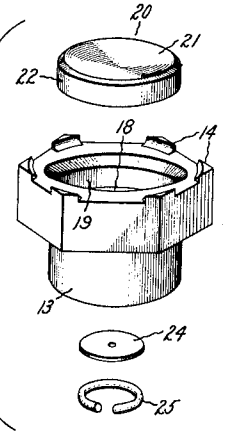


Fig. 2.



Inventor:
Walter Muir,
by Harry E. Dunham
His Attorney.

Patented Jan. 23, 1940 2,187,792

UNITED STATES PATENT OFFICE

2,187,792

ELECTRICAL SWITCH

Walter Muir, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application August 27, 1938, Serial No. 227,144

10 Claims. (Cl. 200—83)

My invention relates to electrical switches, more particularly to switches of the fluid pressure operated type, and has for its object the provision of a device of this character which is reliable and inexpensive to manufacture and which has a long operating life.

In carrying out my invention, I prefer to employ a metal diaphragm in the form of a cup-shaped stamping of one-piece construction so small as to require less space than the conventional rubber or fabricated material diaphragms in general use. Being of metal, the diaphragm may be used in a wide variety of applications, particularly with gases or liquids which are injurious to rubber and like materials. Preferably, the diaphragm is supported in a suitable mounting nut having an opening therethrough, in communicating relationship with a source of fluid pressure, one end of the nut having a seating recess therein into which the cup-shaped diaphragm is inserted and fastened by suitable means, such as soldering. The end of the nut closed by the diaphragm may be projection electric welded to a base plate upon which is mounted, at the other side, a compact snap switching mechanism which is adapted to operate a pair of electrical contacts through a suitable distance with only a small movement of the diaphragm, as more fully explained hereinafter.

For a more complete understanding of my invention, reference should be had to the accompanying drawing in which Fig. 1 is a sectional elevational view of a casing containing the switching mechanism embodying my invention; and Fig. 2 is a disassembled perspective view of the diaphragm, mounting nut and parts therein, also embodying my invention.

Referring to the drawing, I have shown my invention in one form as applied to a pressure-operated switch wherein a pair of electrical contacts are operated through suitable mechanism by the flexure of a diaphragm which may be subjected to changes in pressure from any suitable fluid pressure source, such as an air pressure tank or oil storage reservoir. As shown, a casing or cover 10 is provided mounted on a base plate 11 for enclosing a snap switching mechanism therein. Extending from the bottom of the base plate 11 is a mounting nut 13 which is fastened thereto by suitable means, such as by electric projection welding, the nut 13 being shown in Fig. 2 provided with the projections 14 about its upper face for this purpose. It will be understood that in forming the welded joint the nut is placed in position with respect to the base plate 11 with the projections 14 in engagement with the base plate. An electric current is then passed through the two parts of sufficient magnitude to heat rapidly and melt the projections 14 thus welding the two parts together. At the lower left side of the cover 10, a screw 15 is threaded into the body of the nut 13 for holding the cover in position on the base plate 11, the lower edge of the right hand wall of the cover being bent beneath the base plate 11 in holding engagement therewith.

The mounting nut 13 is provided with an opening 16 therethrough, the lower portion of the nut having the internal threads 17 whereby the nut and the whole casing 10 may be mounted directly on a pressure pipe (not shown) connected in communicating relationship to any suitable source of fluid pressure from which the switching mechanism is to be operated. The upper end of the nut 13 nearest the base plate 11 is provided with a longitudinally extending recess 18 of larger diameter than the opening 16 forming an annular wall 19 within the nut 13. Inserted in the recess 18 and seated therein, I have provided a metal diaphragm 20 of bronze or similar material in the form of a cup-shaped stamping having a circular face 21 and an annular band 22 at its edge.

The diaphragm is fastened rigidly to the nut 13 by securing the band 22 by suitable means forming a fluid tight joint, such as soldering or brazing, to the annular wall 19 of the recess 18.

I prefer to insert and fasten the diaphragm 20 in the recess 18 with the open end of the cup facing downwardly and with the peripheral edge of the circular face 21 of the diaphragm flush with the upper end of the nut 13 against the base plate 11, although it is obvious that the diaphragm may be inserted in the recess in a reverse or inverted position from that shown. In this manner, the diaphragm serves to close off the end of the opening 16 through the nut 13 and become subjected to pressure changes within this opening. In the normal unloaded condition of the diaphragm 20, as shown in Fig. 2, the circular face 21 is made slightly concave or dished-in to provide for greater flexure of this face when an increasing pressure is applied on the diaphragm therebeneath.

Within the nut 13 in the opening 16 therein, adjacent the upper end of the thread 17, is provided a seating ledge 23 for an orifice plate 24 adapted to dampening sudden fluctuations in fluid pressure, the orifice plate 24 having a relatively small central aperture being maintained

in position transversely across the opening 16 by a wire spring 25. The orifice plate 24 and the spring 25 are easily accessible from the bottom of the opening 16 and may be removed for cleaning the central orifice or for inserting another orifice plate having an orifice of different diameter.

Referring now to Fig. 1, a mounting or supporting table 26 of insulating material is provided on the base plate 11 within the casing 10 for supporting some of the elements of the switching mechanism. Spaced above the base plate 11 by a vertically extending leg portion 27 of the mounting 26 is a horizontal portion 28 provided with a vertically disposed aperture 29 therethrough. The aperture 29 is adapted to receive and guide a connecting push rod 30 of insulating material which is mounted between a resilient contact supporting strip 31 disposed above the top of the mounting 26 and pivoted actuating arm 32 in bottom of the casing 10 spaced above the base plate 11, the resilient strip 31 and pivoted arm 32 each having a seating indentation in which an end of the push rod 30 is retained compressively biased therebetween.

The actuating arm 32 is pivoted at its left end about a pivot point 33 on the mounting 26 and is connected to the diaphragm 20 by means of a small member or pin 34 extending through an aperture 35 in the base plate 11 and resting loosely on about the center of the circular face 21 of the diaphragm. It will be observed that the aperture 35 is opposite the recess 18 and concentric with the recess 18. An enlarged cylindrical lower end portion is provided on the member 34, loosely fitting in the aperture 35, so that a substantial area of the diaphragm is engaged by it. The smaller upper end of the pin 34 extends through an aperture provided for it in the arm 32. When the pin is pushed upward by the diaphragm the shoulder formed by the lower enlarged portion engages the arm 32. The area of engagement on the diaphragm 20 must be sufficient to avoid the tendency of such a thin and flexible diaphragm to bulge out or expand at its edges if too heavily loaded on too small a surface area. As shown, the surface of the pin 34 engaging the diaphragm has a diameter somewhat less than half the diameter of the flexing disk portion 21 of the diaphragm.

A fairly heavy helical spring 36 is used to load the diaphragm, the spring being seated on the upper surface of the actuating arm 32 and on a threaded thumb adjusting nut 37 carried on a stud 38 bearing on the underside of the mounting 26 in a suitable recess 39 therein. The pressure of the spring 36 is exerted on the actuating arm 32 and through the member 34 resists the upward flexure of the diaphragm 20 which is caused by an increasing pressure in the opening 16 of the nut 13. The amount of spring loading may, of course, be adjusted by turning the thumb nut 37.

As shown, a fixed contact 40 is mounted on a spring member 41 in a recess provided therefor on the upper face of the horizontal portion 28 of the insulating mounting 26. A movable contact 42 carried on the end of the resilient strip 31 adjacent the fixed contact 40 is biased into engagement therewith by magnetic means comprising an armature piece 43 and a permanent magnet 44. By reason of the spring mounting for the fixed contact 40, the contacts 40 and 42 are given a wiping action upon engagement, which insures clean contact surfaces. Preferably the permanent magnet is made of an alloy having a high coercive force consisting essentially of aluminum, nickel, copper and iron, such as described and claimed in United States Letters Patent 1,947,274, issued February 13, 1934, to William E. Ruder. This magnetic material may be formed into a button or block shape having a central groove running diametrically across the upper face and suitably magnetized to have a north pole and a south pole adjacent the armature 43, the magnet 44 being fastened in an inset portion in the top of the mounting 26 and the armature 43 being secured thereadjacent on the resilient strip 31. A slight clearance is maintained between the armature 43 and the magnet 44 to avoid variations in magnetic attraction therebetween which would occur if the surfaces of the magnetic parts made actual contact. In the present instance the magnet 44 is positioned slightly below the upper surface of insulating table 28 out of contact with the armature 43 in its lowest position.

Connected to the resilient strip 31 carrying the movable contact 42 is a terminal conductor 45 leading to a terminal post (not shown). The resilient strip 31 and conductor 45 are fastened at their right ends to the mounting or support 26 by an adjustable nut and bolt 46. The left hand end of the strip 31 is thus movable by the push rod 30 and the magnetic attraction of the magnet 44. By means of the nut and bolt 46, the positioning of the resilient strip 31 may be adjusted to determine the spacing between the armature 43 and the magnet 44 and the contact pressure at the contacts 40 and 42. An electrical circuit through the switch is defined from a terminal (not shown) through the terminal conductor 45 connected thereto, the resilient strip 31, the contacts 42 and 40, to a second terminal (not shown) connected to the fixed contact 40.

The pressure operated switch above described is applicable in a wide variety of pressure regulating systems in connection with air pumps, water pumping systems, oil feed lines, etc. Briefly, in operation, the nut 13 is connected to the pressure source, and the fluid under pressure is led into the opening 16 and through the orifice plate 24 to the diaphragm 20. A change in pressure beneath the diaphragm 20 tends to cause a corresponding flexure of the diaphragm face 21 which is loaded by the spring 36. When the force of the fluid pressure on the diaphragm 20 is less than the force of the loading spring 36, the actuating arm 32 is biased to its extreme clockwise position with both ends resting against the base plate 11, and the contacts 40 and 42 are biased into engagement by the magnetic attraction of the permanent magnet 44 on the armature 43, the circuit through the switch being closed.

When sufficient pressure is applied to the metal diaphragm 20, the diaphragm begins to move or flex upwardly and the pin 34 engages and exerts a force against the pivoted actuating arm 32. With an increasing pressure on the diaphragm, the actuating arm 32 begins to move in a counterclockwise direction about its left hand end and exerts an upwardly directed force on the resilient contact support 31 through the push rod 30. The movement of the push rod 30 is several times greater than the movement of the diaphragm 20 by reason of the leverage of the actuating arm 32, and likewise the force exerted by the push rod is proportionately less than the

force available at the diaphragm for moving the actuating arm. In this manner, a comparatively small deflection of the small size diaphragm causes a considerable movement of the push rod 30. The resilient strip 31 being a flexible member will consequently deflect upward until the force of the push rod 30 thereon, resolved at the magnet 44, equals the net downward pull of the magnet 44. Any further increase in upward force against the resilient strip 31 will cause the contacts 40 and 42 to disengage with a snap action, since the magnetic pull decreases faster than the available upward force on the resilient strip 31. In a similar manner, with a decrease in pressure on the diaphragm 20, the force on the push rod 30 will decrease and the armature support or resilient strip 31 will move downward. At some predetermined point the magnetic attraction of the magnet in its armature becomes strong enough to flex the arm 31 or overcome the force exerted by the push rod 30 and close the contacts 40 and 42 with a snap action.

It may here be noted that the tip pressure between the contacts 40 and 42 is obtained from the spring mounting of the lower contact 40 which exerts a force against the upper contact 42 carried by the armature support 31 when the contacts are closed. Since the tip pressure at the contacts opposes the magnetic pull, the difference between these forces gives the net magnetic pull causing the snap engagement and disengagement of the contacts. The spring mounting 41 for the contact 40 is such that this lower contact moves sideways with respect to the upper contact 42 upon engagement thereby providing the wiping action between the contacts.

Throughout the description of a preferred embodiment of the pressure operated switch of my invention I have specifically shown the snap switching mechanism operated by means of a metal diaphragm of a particular configuration. It is obvious, of course, that diaphragms of rubber and fabricated materials may be used with the snap switching mechanism, these diaphragms in a wide variety of shapes being well known in the art. Accordingly, I do not wish to be entirely limited to the particular type of metal diaphragm shown herein.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A pressure operated switch comprising a pair of electrical contacts arranged to be snap disengaged in response to a predetermined change in pressure, means for operating said contacts including a metallic diaphragm in the form of a cup-shaped stamping having a circular face and an annular band extending therefrom, a base plate for said switch, and a nut welded at one end to said base plate and having an opening therethrough to the opposite end for communicating relationship with a source of fluid pressure, and a seating recess in the said first end, said diaphragm being inserted in said seating recess and having said annular band secured rigidly to the side walls thereof for closing the opening in said nut.

2. A pressure operated switch comprising a diaphragm arranged to flex in response to changes in pressure, a loading spring, means including a pivoted arm co-operating with said spring for loading said diaphragm movable by the flexure thereof, a fixed contact and a movable contact, a resilient support for said movable contact fixed at one end, magnetic means including a magnetic armature part and a magnet part co-operating with said armature for biasing said contacts into engagement, one of said parts being secured solely to said resilient support for enabling only common movement of said support and said part and said other part being mounted adjacent thereto, and connecting means between said resilient support and said pivoted arm whereby said contacts are snap disengaged upon a predetermined flexure of said diaphragm.

3. A pressure operated switch comprising a diaphragm arranged to flex in response to changes in pressure, a loading spring, means including a pivoted arm co-operating with said spring for loading said diaphragm movable by the flexure thereof, a fixed contact and a movable contact, a resilient support for said movable contact fixed at one end, magnetic means including a magnetic armature part and a magnet part co-operating with said armature for biasing said contacts into engagement, one of said parts being secured solely to said resilient support for enabling only common movement of said part and said support and said other part being mounted adjacent thereto, connecting means between said resilient support and said pivoted arm whereby said contacts are snap disengaged upon a predetermined flexure of said diaphragm, a mounting member of insulating material supporting said spring, said resilient support, said fixed contact and one of said magnetic parts and also serving to position said pivoted arm and said connecting means, and a stud and adjustable thumb nut upon which said spring is seated, one end of said stud being biased by said spring against said mounting member and supported thereby, the tension of said spring being manually adjustable by turning said thumb nut.

4. A pressure operated switch comprising a base plate, a nut fastened at one end to said plate and having an opening therethrough to its other end for providing a communicating relationship with a fluid pressure source, a seating recess forming annular side walls in said first end of said nut, a metal diaphragm in said seating recess closing the opening in said nut and arranged to flex in response to changes in pressure, said diaphragm having an annular band inserted in said seating recess secured to said annular side walls thereof, a loading spring, and switching means including a pivoted arm co-operating with said spring for loading said diaphragm and movable by the flexure thereof, a fixed contact and a movable contact, a resilient support for said movable contact fixed at one end and carrying a magnetic armature, a magnet co-operating with said armature for biasing said contacts into engagement, and connecting means between said resilient support and said pivoted arm whereby said contacts are snap disengaged upon a predetermined flexure of said diaphragm, and a mounting of insulating material for supporting said switching means.

5. A pressure operated switch comprising a base plate, a nut fastened at one end to said plate and having an opening therethrough to its other end for providing a communicating rela-

tionship with a fluid pressure source, a seating recess in said first end of said nut, a diaphragm in said seating recess closing the opening in said nut and adapted to flex in response to changes in fluid pressure, said diaphragm having an annular band inserted in said seating recess secured to the walls thereof, a loading spring, means including a pivoted arm co-operating with said spring for loading said diaphragm and movable by the flexure thereof, a fixed contact and a movable contact, a resilient support for said movable contact fixed at one end and carrying a magnetic armature, a magnet co-operating with said armature for biasing said contacts into engagement, and connecting means between said resilient support and said pivoted arm, whereby said contacts are snap disengaged upon a predetermined flexure of said diaphragm.

6. A pressure operated switch comprising a diaphragm arranged to flex in response to changes in pressure, switching means including a fixed contact and a relatively movable contact supported on a resilient member, magnetic snap operating means including a permanent magnet part magnetized with both poles on one face and an armature part of magnetic material, one of said parts being secured solely to said resilient member and said other part being mounted adjacent thereto for biasing said contacts into engagement, said magnet being made of an alloy having a high coercive force consisting mainly of aluminum, nickel and iron, and operating means including a loading spring, a pivoted arm and a member interposed between said pivoted arm and said diaphragm for causing said contacts to be snap disengaged upon a predetermined change in pressure on said diaphragm.

7. A pressure operated switch comprising a diaphragm adapted to flex in response to changes in fluid pressure, switching means including a fixed contact and a relatively movable contact supported on a resilient member, a spring support for said fixed contact for causing a wiping engagement of said fixed and movable contacts, magnetic snap operating means including a permanent magnet part magnetized with both poles on one face and an armature part of magnetic material, one of said parts being secured solely to said resilient member and said other part being mounted adjacent thereto for biasing said contacts into engagement, said magnet being made of an alloy having a high coercive force consisting mainly of aluminum, nickel and iron, and operating means including a loading spring, a pivoted arm and a member interposed between said pivoted arm and said diaphragm for causing said contacts to be snap disengaged upon a predetermined change in fluid pressure on said diaphragm.

8. A pressure operated switch comprising a support, a stationary contact and a movable contact carried by said support, an operating lever for said movable contact, a loading spring biasing said lever toward one side of said support, said support being provided with an aperture, a member secured to the opposite side of said support provided with a recess in its side secured to said support, said recess being opposite and substantially larger than the aperture in said support and said member being provided with an aperture communicating with said recess for connection with a source of fluid pressure, a flexible diaphragm in said recess, a fluid tight connection between the periphery of said diaphragm and the wall of said recess whereby said recess is closed on the side adjacent said support, and an operating member extending through said aperture in said support forming an abutting connection between said diaphragm and said operating lever whereby said lever is moved to operate said movable contact by a predetermined flexing of said diaphragm in response to a predetermined fluid pressure applied thereto.

9. A pressure operated switch comprising a support, a stationary contact and a movable contact carried by said support, an operating lever for said movable contact, a loading spring biasing said lever toward one side of said support, said support being provided with an aperture under said lever and near one end of said lever, a member secured to the opposite side of said support provided with a recess in its side secured to said support, said recess being opposite and substantially larger than the aperture in said support and said member being provided with an aperture communicating with said recess for connection with a source of fluid pressure, a flexible diaphragm in said recess, a fluid tight connection between the periphery of said diaphragm and the wall of said recess whereby said recess is closed on the side adjacent said support, and an operating member extending through said aperture in said support forming an abutting connection between said diaphragm and said operating lever whereby said lever is moved to operate said movable contact by a predetermined flexing of said diaphragm in response to a predetermined fluid pressure applied thereto, said operating member having a surface engaging said diaphragm whose area is a substantial portion of the area of said diaphragm.

10. A pressure operated switch comprising a support, a stationary contact and a movable contact mounted on said support, an operating lever for said movable contact, a loading spring biasing said lever toward one side of said support, said support being provided with an aperture under said lever near one end of said lever, a member secured to the opposite side of said support provided in its side secured to said support with a recess having an annular side wall, said recess being opposite and substantially larger than the aperture in said support and said member being provided with a threaded aperture communicating with said recess for connection with a source of fluid pressure, a flexible diaphragm in said recess, said diaphragm being provided with an annular band around its periphery, a fluid-tight connection between said band and the side wall of said recess whereby said recess is closed on the side adjacent said supporting plate, an operating pin extending through said aperture in said support forming an abutting connection between said diaphragm and said operating lever whereby said lever is moved to operate said movable contact by a predetermined flexing of said diaphragm in response to a predetermined fluid pressure applied thereto, said pin having a surface engaging said diaphragm whose area is a substantial portion of the area of said diaphragm, means cooperating with said movable contact for causing said movable contact to operate with a snap action, and a wall in said member between said recess and said threaded aperture, said wall being provided with a relatively small aperture so as to dampen fluctuations in fluid pressure.

WALTER MUIR.