Sept. 25, 1945. J. N. GILMAN ET AL 2,385,356

SWITCH ASSEMBLY

Filed Dec. 16, 1940 2 Sheets-Sheet 1

Fig. 1.

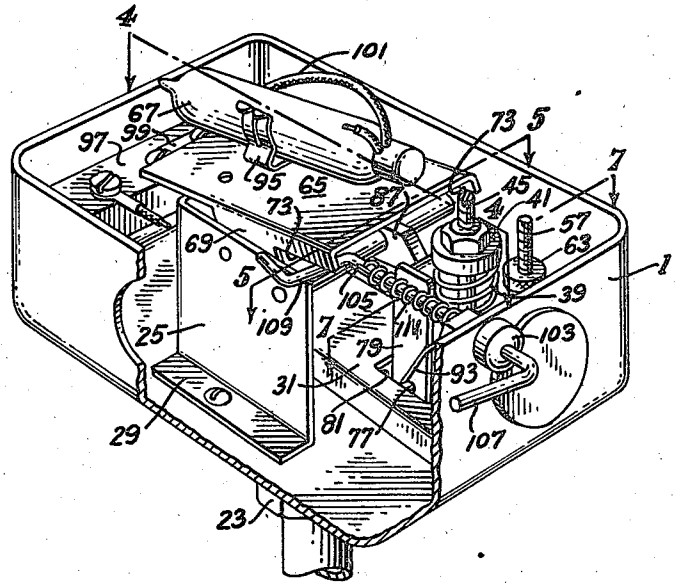


Fig. 2.

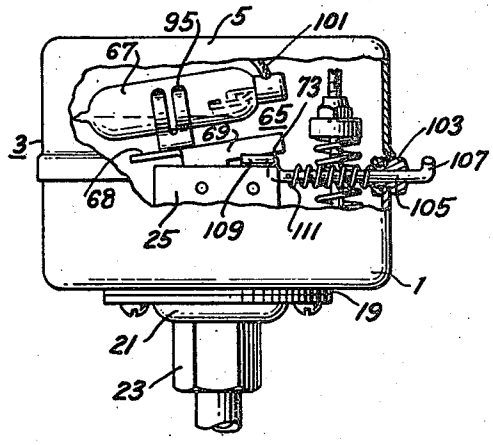
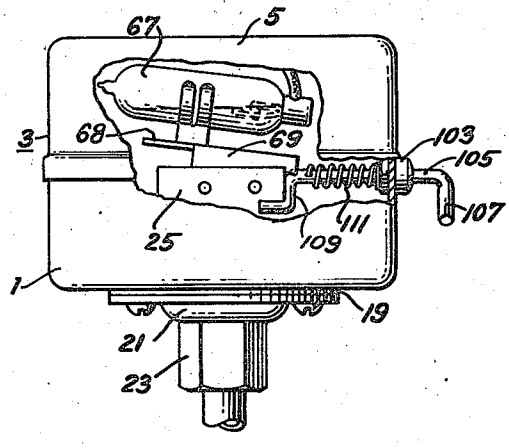


Fig. 3.



INVENTORS.
JAMES N. GILMAN
CHANDLER C. ROSS
BY
Charles O. Bruce
ATTORNEY.

Sept. 25, 1945. J. N. GILMAN ET AL 2,385,356

SWITCH ASSEMBLY

Filed Dec. 16, 1940 2 Sheets-Sheet 2

Fig. 4.

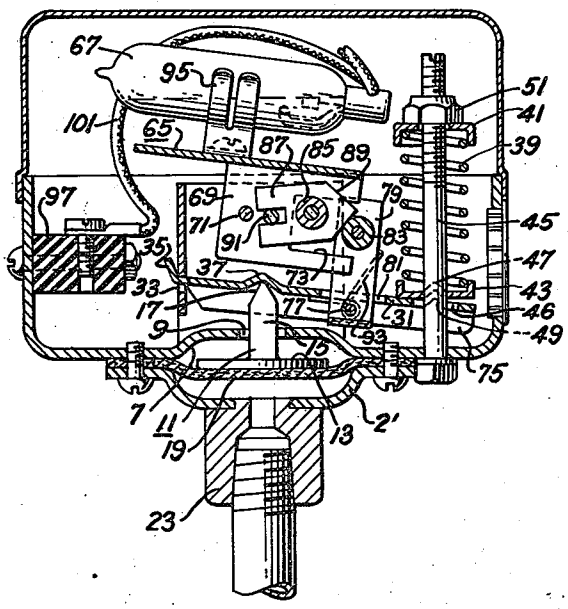


Fig. 7.

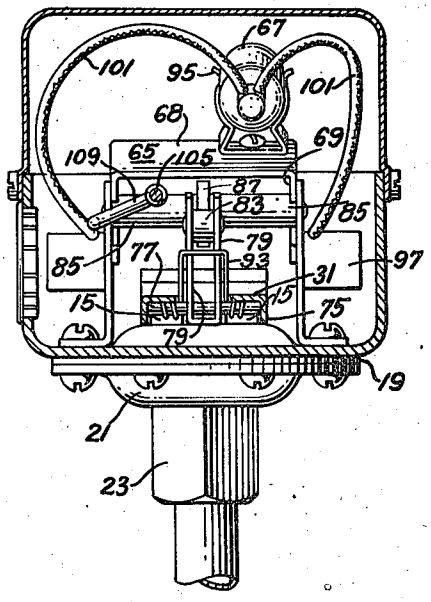


Fig. 6.

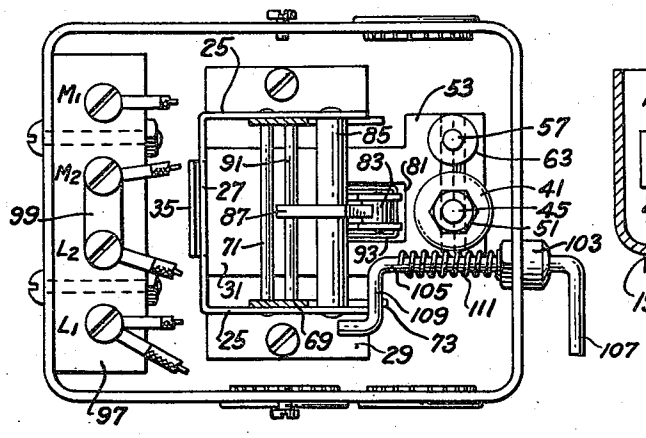
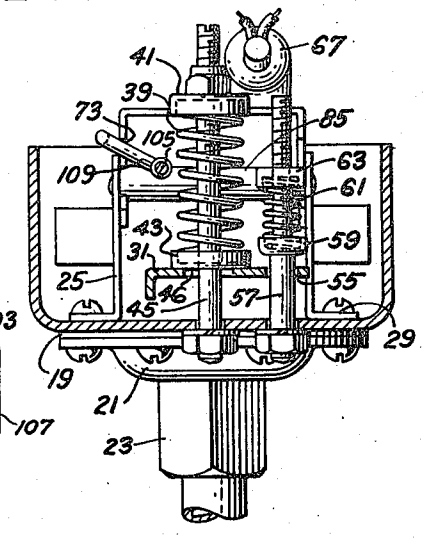


Fig. 7.



INVENTORS.
JAMES N. GILMAN
CHANDLER C. ROSS.
BY Charles O. Bruce
ATTORNEY

UNITED STATES PATENT OFFICE

2,385,356

SWITCH ASSEMBLY

James N. Gilman, Oakland, and Chandler C. Ross, Alameda, Calif.; said Ross assignor to said Gilman

Application December 16, 1940, Serial No. 370,262

5 Claims. (Cl. 200—83)

Our invention relates to automatically operated switches, and more particularly to one employing a mercury tube switch element.

Our improved switch has been designed for use particularly in connection with the regulation of pressure in pump systems of the pressure type. In a pump system of this character, a pressure is developed in the system by pumping the water into a pressure tank, against an air cushion, and maintaining the air cushion pressure within a predetermined range. When the pressure therein falls below a minimum pressure value, as results from consumption of the water or reduction in air cushion volume, a pressure responsive switch automatically goes into operation and connects the pump motor in circuit, thus causing the pump to replenish the supply of water to the tank, to an extent sufficient to restore the pressure condition therein.

Switches of the mechanical contact type have been used and are still used for this purpose. They have proven to be a source of continual trouble, for these switches, on the making and particularly the breaking of the circuit to the pump motor, are subjected to the high inductive load of the motor windings, causing heavy arcing across the switch contacts, with resulting pitting thereof. Where the pressure tank has lost some of its air cushion, either through leakage of air from the tank, or absorption of air by the water, the pressure in the system becomes more sensitive to consumption of the water in the tank, with the result that a more frequent operation of the switch occurs to maintain proper tank pressure, even to the extent of sometimes connecting and disconnecting the motor at the rate of four or five times a minute. Under such conditions, excessive heating of contacts is apt to occur, with consequent increased damage to the switch. When it is considered that pump systems of the pressure type embodying these switches, are intended primarily for use in farming districts and rural communities, usually remote from any service, the desire for a trouble-free switch becomes of major importance.

Tiltable type switches incorporating mercury tube switch elements adapted for such use, exist, but we have found such switches as are available, to be either inflexible as to current capacity and, therefore, not adaptable for a wide range of pump systems of varying capacity, or are too critical in the matter of installation, or somewhat too expensive for production.

Among the objects of our invention, are to provide a novel and improved switch assembly employing a mercury tube switch element—

(1) Which may be confined within a reasonably small space and yet be rugged and lend itself to economical production,

(2) Which may be altered in electrical current carrying capacity, without altering the switch assembly structure, thereby rendering itself adaptable for use in pump systems of different capacities,

(3) Which shall be relatively insensitive to out of line pump installations within the tolerances permitted in the installation of such pumps,

(4) Which shall maintain a substantially constant load on the pressure side of the pump system, in spite of variations in the angle of installation of the mercury tube switch element, and

(5) Which may be conveniently locked against operation during servicing or repairing of the pump system.

Additional objects of our invention will be brought out in the following description of the same taken in conjunction with the accompanying drawings wherein—

Figure 1 is a perspective view with a part of the casing broken away, of a preferred form of our switch assembly,

Figures 2 and 3 are side views with a portion of the casing broken away, showing the operation of a manually controlled locking feature,

Figure 4 is a view, in section, taken along the line 4—4 of Figure 1,

Figure 5 is a view, in section, taken along the line 5—5 of Figure 1,

Figure 6 is a plan view of the switch assembly with the mercury tube switch element and supporting table removed,

Figure 7 is a view, in section, taken along the line 7—7 of Figure 1.

In a general way, our improved switch involves a table or platform for supporting one or more switch elements of the mercury tube type. The table is pivotally supported and adapted to be tilted through a substantial angle. Such tilting is directly controlled by a toggle arrangement, the direction of tilt being determined by the position of one of the toggle members, which position in turn is controlled by the pressure responsive means connected to such apparatus as it is desired to be controlled by the switch. This construction is such that a switch when adjusted for a predetermined pressure range of operation at the factory, will adhere to such adjustment, in spite of improper installation factors which might otherwise serve to alter the effective pressure range

of the switch. Also, the construction will allow of a wide angle of tilt of the mercury tube switch elements, thereby rendering the switch substantially insensitive to out of line installations of apparatus on which such switches may be mounted.

More specifically, our invention, as depicted in our improved embodiment, comprises a switch assembly fitted into the lower half 1 of a casing 3 for which a cover 5 is provided. This lower half of the casing is formed with a circular indent 7 at its central portion, this indent in turn being provided with a transverse slot 9 therethrough. A plunger 11 comprising a broad circular base 13 adapted to lie within the indent, and a pair of spaced upright elements 15 extending through the slot, and each terminating in a knife edge 17, is maintained in position by a comparatively loose diaphragm 19 spanning the indent and held in position by a diaphragm flange 21 which is bolted to the bottom of the casing. The diaphragm may be of any suitable material, but is preferably formed from material comprising a layer of fabric between and preferably united to layers of rubber.

The diaphragm flange is provided with a central opening to receive a pipe coupling 23, and this coupling in turn enables connection to some associated apparatus to which the switch is made responsive.

Within the casing 3 and surrounding the plunger 11, is a frame including two side walls 25 and an end wall 27, the side walls being provided with integral flanges 29 for attachment to the floor of the casing. A plunger table 31 lying between the side walls 25 of the frame, is hinged to the rear wall 27, by extending through a slot 33 in the rear wall and having its edge 35 turned up. At an intermediate point, the plunger table is provided with an inverted V-indent 37 to receive the sharp edges of the plunger 11 and enable the table 31 to fulcrum thereon.

A continual pressure in a direction opposing any lifting force which might be exerted by the plunger against the plunger table, is applied against the free end of the table by a spring 39 whose purpose is to determine the operating range of pressures of the switch. This spring is supported between two cupped washers 41 and 43 about a bolt 45 fastened on end to the bottom of the casing and extending upwardly through a hole 46 in the plunger table. The lower washer 43 is formed with an inverted V-indent 47 to receive a complementary indent 49 formed in the end of the plunger table. A nut 51 threaded to the upper end of the spring supporting bolt 45, provides for adjusting the spring pressure, thereby enabling adjustment in the range values of the spring.

The plunger table 31 at its free end, is formed with an offset 53. This offset is provided with an opening 55 to permit passage of a bolt 57 therethrough, which is also mounted on end to the bottom of the casing. This bolt is of reduced cross-section at its upper portion, beginning a slight distance from the lowermost position of the plunger table, that is, the position of the plunger table when the plunger is exerting no upward pressure against the same. A cupped washer 59 is carried on the shoulder formed by the reduced section, and this forms a mounting for a differential spring 61, the compression of which may be varied by means of a threaded cup-shaped nut 63.

Pivotally connected to the side walls 25 of the frame, is a table 65 for supporting or carrying one or more switch elements 67 of the mercury tube type. This table comprises a flat supporting surface 68 overhanging the front edges of the walls 25, and depending side walls or flanges 69, these depending walls being pivotally connected between the side walls 25 of the frame by a pivot shaft 71. The edges of the depending walls 69 facing the springs 39 and 61, are provided with rather large square-shaped notches 73.

The plunger table 31 is formed with a shallow depending flange 75 at each side thereof, carrying between them a shaft 77 to which a roller arm 79 is pivoted, which arm extends upwardly through an opening 81 in the plunger table, provided for the purpose. This roller arm is of U-shaped channel construction, and carries between its upper ends, a roller 83, preferably of case hardened material.

A roller shaft 85 extending through the notches 73 formed in the edges of the side walls 69, connects the side walls 25 of the frame. This shaft, through its cooperation with the sides of the notches, acts as a stop in determining the permissible angle of throw of the switch element supporting table 65. This same shaft also serves as a pivot shaft for a link 87 positioned thereon midway between the depending walls 69 of the table 65. This link is formed with a V-shaped end 89 facing the roller, and is bifurcated at its other end to frictionally straddle a rod 91 joining the depending side walls 69 of the table 65. A rather stiff spring 93 encircling the roller arm pivot shaft 77, and having one end braced against the underside of the plunger table 31, and at its other end bearing against the roller arm 79, serves to maintain the roller 83 in contact with the V-end of the link 87 and with sufficient pressure to tilt the table in either of two directions, depending upon the particular position of the roller 83 with respect to the V-end of the link.

To support a switch tube upon the table, we employ a standard type of spring clip 95, but we mount this clip to the table 65 in such a way that the mounting axis thereof is substantially normal to the axis of tilting of the table, or in other words, substantially normal to the shaft 71 about which the table pivots or tilts, and is so directed as to hold the mercury tube switch element 67 with its axis lying in a direction normal to both the mounting axis of the clip and the axis of tilting of the table. This has for its effect to provide a rather stable arrangement and one in which the inertia imparted to the switch tube during tilting, will not tend to turn the clip on its mounting axis and thereby effect a loosening thereof.

Against one end wall of the casing, we mount a terminal block 97 having four terminals carried thereon. These are identified as L_1, L_2, M_2 and M_1 to indicate line connections to power lines and motor respectively, these connections being brought into the switch casing through suitable openings in the walls of the bottom half 1. A jumper 99 connects the two intermediate terminals L_2 and M_2. The mercury tube switch element 67 is connected by leads 101 to the terminals L_1 and M_1 and when more than one mercury tube switch element is required to increase the current carrying capacity of the switch assembly, it will be connected in parallel with the other. It will be noted that the line connections and motor connections are always below the leads 101 connecting the mercury tube elements 67 to the

terminal block, and this at all times precludes the mercury tube connections from ever becoming entangled with the other wires.

In the operation of the switch assembly and in the absence of any pressure existing in the coupling 23, the plunger table 31 will be held at its lowermost position by the spring 39, thereby positioning the roller 83 to bear against the lower slope of the V-end of the link 87. This in turn will cause the table 65 to be tilted in such a direction as to close the circuit when the mercury tube element 67 is mounted as indicated in the drawings. By reversing this element, one can obtain an opening of a circuit under the same conditions. An increase in pressure in the coupling, to a value sufficient to overcome the compression of the range spring 39, and ultimately the combined compressive force of both springs 39 and 61, will cause the plunger to move upwardly and lift the plunger table 31, which in turn will carry with it, the roller arm 79 and its roller 83. When the roller is thus lifted sufficiently to pass the point of the V-end, the pressure exerted by the roller arm spring 93 will be sufficient to tilt the table in a reverse direction and break the circuit. The extent of swing, as previously indicated, will be determined by the width of the notches 73 in the edges of the depending walls 69.

The switch assembly, in an actual installation, is usually mounted vertically (that is, with the floor of the casing substantially horizontal) on apparatus with which it is to be used. In the matter of a pressure system installation, it will be mounted on the pump apparatus which is usually installed at some distance from the actual point of consumption of the water. In prior installations, when it became desirable to service the pumping apparatus, it was necessary to shut off the electric power at the house or some other point remote from the installation, and this, from the servicemen's viewpoint, constituted a decided inconvenience, for a servicing job generally required a repeated connecting and shutting off of the power to the pump motor before a job could be considered complete.

In our switch assembly, we have incorporated a feature which will enable a serviceman to manually tilt the mercury tube switch element to its circuit opening position and locking the same as long as necessary, and which will permit releasing or unlocking of the mercury tube element when desired, for putting the apparatus back into operation. Thus, without leaving the job, he can effectively disconnect the motor from the electric circuit, as and when the work requires. To accomplish this, we provide a bushing 103 in the front end wall of the lower half of the casing, and in this we rotatably mount a rod 105. That end of the rod, protruding from the casing, is bent to provide a handle 107, while the end portion of the rod, within the casing, is bent to a double right angle bend to form a lateral offset 109 adjacent the front edge of one of the side walls 25 of the frame. A compression spring 111 surrounding part of the rod within the casing, is fixed to the rod at one point, as by having one of its ends extending into an opening formed therein, while at its other end, the spring bears against the interior face of the bushing 103. Upon rotating the rod, the offset portion 109 within the casing may be raised into engagement with the upper edge of one of the notches 73, to tilt the mercury tube switch supporting table 65 from one position determining a closed circuit, to its other position determining an open circuit. As soon as the manually rotatable rod 105, or more particularly, the offset portion 109 thereof, rises above the upper edge of that frame side wall 25 with which it engages, the compression spring 111 goes into action, forcing this offset portion along the upper edge of the side wall and into the associated notch 73, thereafter precluding the supporting table from returning to its circuit closing position. To restore the table to its previous circuit closing position, the offset portion of the rod is withdrawn against the action of the spring 111, by pulling on the handle 107, and then turning the handle so as to swing the offset portion downwardly and into permitted engagement with the front edge of the side wall 25.

Switches for use in controlling the pressure in pump systems, are usually adjusted for a particular pressure range, at the factory. Upon installing the pump apparatus, it quite frequently happens that any deviation beyond permissible tolerance in the installation of the pump apparatus, will often change the pressure characteristics of the switch, from what they were adjusted to be, prior to the installation. This necessitates, on the part of the serviceman or installing engineer, a critical readjustment of the switch, following installation of the system.

A particular advantage in the construction of our improved switch assembly, resides in the fact that it is substantially insensitive to any such variations occurring in installation of the pump apparatus. This may be attributed to the fact that, although any such variations may unbalance the switch apparatus to the extent of altering the amount of work necessary to tilt the mercury tube switch element, such change in work necessary to accomplish such tilting is not reflected back to the pressure side of the pump system, but is taken up entirely by the roller arm spring 93 which constitutes, in effect, a source of energy independent of the pressure energy derived from the pump system. In our improved switch assembly, therefore, the energy derived from the pump system to operate the switch, is devoted substantially entirely to the raising of the roller arm 79 and roller 83 from one position of actuation determining the closed circuit operation of the switch, to another position of actuation determining the open position of the switch; and the energy necessary to accomplish this remains practically the same, regardless of any offbalance installation of the mercury tube switch element with respect to a vertical axis. Consequently, once the springs 39 and 61 in the switch assembly are adjusted to impart predetermined pressure characteristics to the switch assembly, such adjustment will hold, even though the pump apparatus on which the switch assembly is mounted, may have been installed at a greater angle to the vertical axis, than is normally considered permissible.

Another and very important advantage arising out of the switch assembly described by us, is that it enables us to swing the mercury tube switch element through an angle greater than that specified by the manufacturer of the mercury tube switch, and to an extent greater than the permissible angle of deviation from the normal, permitted in the installation of the pumping apparatus or other apparatus on which the switch is mounted. This permits of a greater tolerance in the installed position of the switch assembly, than is permitted in the pump apparatus, and assures one that so long as the pump apparatus

is installed within the limits of tolerance specified by the manufacturer, the switch assembly will always be in proper operating condition, without any apparent change in the effective pressure characteristics thereof as predetermined at the factory. In as much as the angle of tilting is a function of the size of the notches **73**, these can readily be altered to adapt the switch to mercury tube switch elements of different requirements, without detriment to the advantages attributed to the switch assembly.

The utilization of an independent spring as a source of energy for tilting the tube supporting table assures one of a rapid tilting action, regardless of the slowness with which the rest of the switch assembly might operate. This coupled with the wide tilting angle, characteristic of our switch, means a rapid break in contact within the mercury tube element with less chance of establishment of an arc through kick-back on the part of the mercury in the tube.

The table, which supports the mercury tube switch elements, has an additional function in our switch, besides those already discussed. It is noted that this element practically covers the inner workings of the switch, and consequently, when the casing cover is removed for any reason, the table serves to protect the inner workings of the switch assembly from dirt or damage.

While we have disclosed our invention in considerable detail, it is apparent that the same is subject to modification and change, without departing from the spirit thereof, and we accordingly do not desire to be limited in our protection to the specific details disclosed and described, except as may be necessitated by the prior art and the appended claims.

We claim:

1. A switch assembly comprising a table; a clip affixed to one side of said table with its mounting axis normal to the surface of said table; means for pivotally supporting said table in a receptacle, on an axis normal to the mounting axis of said clip and with the clip side of said table facing an open side of said receptacle; independent pressure means associated with said table and disposed in said receptacle to permit access to said clip through said open side of the receptacle, said means being capable, when in one position, of imparting angular movement in one direction to said table, and capable when in another position, of imparting angular movement thereto in a reverse direction; means for shifting said pressure means between such positions in accordance with conditions apt to exist in apparatus to be controlled by said switch assembly; and a cover enclosing the open side of said receptacle.

2. In a switch assembly; a casing; a pressure responsive plunger supported at the bottom of said casing; a toggle frame comprising a pair of side walls and an end wall surrounding said plunger; a plunger table hinged to said frame end wall and extending between and beyond said side walls, said plunger table being fulcrumed at an intermediate point upon said plunger, enabling said table to be raised by said plunger in response to a lifting of said plunger; spring means bearing against said table with a predetermined pressure and in a direction opposing the lifting of said table by said plunger; a mercury tube switch element supporting table; means for pivotally securing said table to the side walls of said frame; means associated with said switch element supporting table and frame for permitting an angular movement of said table between definite limits; and toggle means operating from said plunger table in response to said pressure responsive plunger, for tilting said switch element supporting table between said limits.

3. In a switch assembly; a casing; a pressure responsive plunger supported at the bottom of said casing; a toggle frame surrounding said plunger; a plunger table hinged to said frame, said plunger table being fulcrumed at an intermediate point upon said plunger, enabling said plunger table to be raised by said plunger in response to a lifting of said plunger; spring means bearing against said table with a predetermined pressure and in a direction opposing the lifting of said table by said plunger; a tiltable mercury tube switch element supporting table pivotally secured to said frame; toggle means including a toggle link within said frame having a V-shaped end, and disposed with its opposite end in tilting engagement with said switch element supporting table, and a roller arm pivotally secured to said plunger table between said compression spring and said plunger, a roller carried by said arm, and spring means continually urging said arm toward said toggle link to maintain said roller in constant engagement with the V-end thereof.

4. In a switch assembly; a casing; a pressure responsive plunger supported at the bottom of said casing; a frame comprising a pair of side walls and an end wall surrounding said plunger; a plunger table hinged to said frame end wall and extending between and beyond said side walls, said plunger table being fulcrumed at an intermediate point upon said plunger enabling said plunger table to be raised by said plunger in response to a lifting of said plunger; spring means bearing against said table with a predetermined pressure and in a direction opposing the lifting of said table by said plunger; a tiltable mercury tube switch element supporting table having depending side flanges for pivotally securing said table to the side walls of said frame; a rod joining said side flanges, each of which is notched adjacent the open side of said frame; a link within said frame having a V-shaped end facing the open side thereof and a bifurcated end in straddling engagement with said rod; a shaft through said link and the notches in the ends of said side flanges and connecting the side walls of said frame to constitute both a pivot shaft for said link and stop means for fixing the angular throw of said tiltable table; a roller arm pivotally secured to said plunger table between said compression spring and said plunger; a roller carried by said arm; and spring means continually urging said arm toward said link to maintain said roller in constant engagement with the V-end thereof.

5. In a switch assembly; a casing; a pressure responsive plunger supported at the bottom of said casing; a toggle frame comprising a pair of side walls and an end wall surrounding said plunger; a plunger table hinged to said frame end wall and extending between and beyond said side walls, said plunger table being fulcrumed at an intermediate point upon said plunger enabling said table to be raised by said plunger in response to a lifting of said plunger; spring means bearing against said table with a predetermined pressure and in a direction opposing the lifting of said table by said plunger; a tiltable mercury tube switch element supporting table having depending side flanges for pivotally securing said table to the side walls of said frame; a rod joining said side flanges, each of which is notched adjacent the

open side of said frame; a toggle link within said frame having a V-shaped end facing the open side thereof and a bifurcated end in straddling engagement with said rod; a shaft through said link and the notches in the ends of said side flanges and connecting the side walls of said frame to constitute both a pivot shaft for said link and stop means for fixing the angular throw of said tiltable table; a roller arm pivotally secured to said plunger table between said compression spring and said plunger; a roller carried by said arm; spring means continually urging said arm toward said toggle link to maintain said roller in constant engagement with the V-end thereof; and manual control means for locking said tiltable switch element supporting table in an open circuit determining position.

JAMES N. GILMAN.
CHANDLER C. ROSS.