Aug. 22, 1944. H. OLKEN 2,356,174

ELECTRIC SWITCH

Filed March 7, 1942

FIG 1

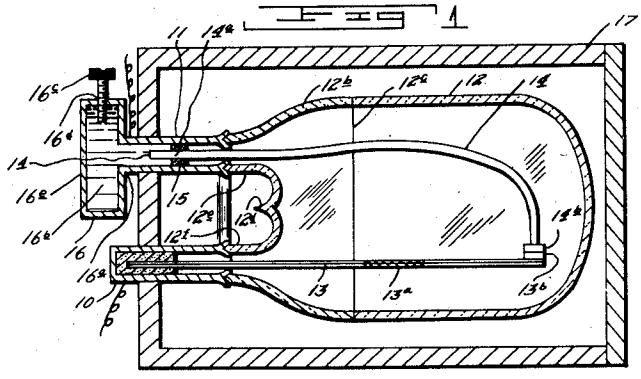


FIG 3

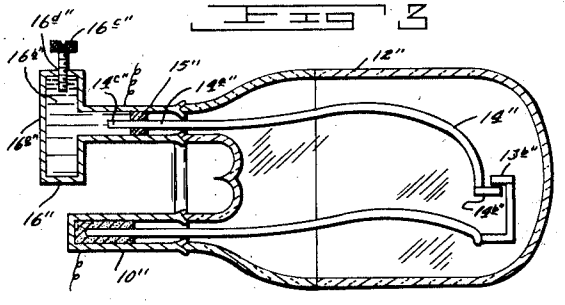


FIG 2

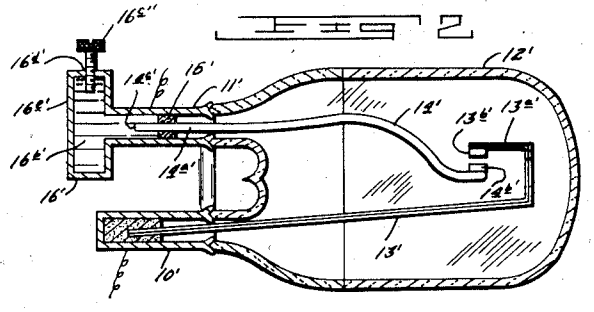
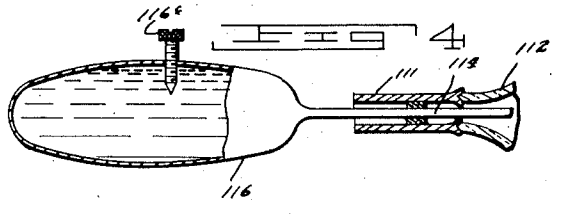


FIG 4



Inventor

HYMAN OLKEN

By John Hamel Jaquet

His Attorney

Patented Aug. 22, 1944 2,356,174

UNITED STATES PATENT OFFICE

2,356,174

ELECTRIC SWITCH

Hyman Olken, Washington, D. C.

Application March 7, 1942, Serial No. 433,809

7 Claims. (Cl. 200—81.8)

My invention relates to electric switches, more especially to pressure-actuated switch units, and to a method of producing the same.

An object of my invention is the provision of pressure-actuated electric switches of the Bourdon spring type; which are capable of being adjusted to a high degree of sensitivity, without danger of injury to working parts; which possess great reliability in operation, being responsive to slight pressure; and which accomplish switching operations without interference from dirt, moisture, and the like.

Another object of my invention is the provision in an economical manner of sensitive, pressure-operated switch units comprising adjustable electrical contact elements, sealed in a casing; which units are capable of adjustment without disturbing the casing seal; which possess a minimum of working parts; and which in operation exhibit great stability and high efficiency.

Other objects and advantages, in part, will be obvious and, in part, pointed out hereinafter.

My invention, accordingly, resides in the several elements, features of construction, and operational steps, and the combination of each of the same with one or more of the others, all as pointed out hereinafter, and the scope of the application of which is set forth in the appended claims.

In the accompanying drawing illustrating certain features of my invention,

Fig. 1 is a diagrammatic view of an assembled, pressure-actuated switch unit.

Figs. 2 and 3 are diagrammatic views of several other pressure-actuated switch units, having modified switch contact elements.

Fig. 4 shows a modified pressure fluid reservoir, for pressure-actuated switches.

As conducive to a clearer understanding of my invention, it should be noted at this point, that pressure-actuated electric switches are considerably in demand, particularly for use in electric control devices employed in regulating electrically-operated apparatus. There are electrically-operated devices employed, as for example, in the production of heat, pressure or electric power, and in the electric circuit of such devices, it has been the practice to provide automatic control means for regualting or limiting energy output. The control conveniently includes a pressure-actuated switch, responding directly or indirectly to the output energy of the electrically-operated apparatus. In way of further illustration, pressure-actuated switches also are of value in the remote control of certain types of electrical apparatus, where switch-operating pressure is governed by a pressure treadle, solenoid, voice coil, or the like.

Of the pressure-actuated switches in the prior art, as for example, the Bourdon tube type switches, certain are found to be objectionable in many fields of use, particularly because of their lack of sensitivity to pressure change. Such switches are not reliable where small pressure differences are depended upon to achieve switching functions. Other pressure-actuated switches of the prior art fail to respond to a given actuating influence in a consistent manner, under varying temperature conditions. This is particularly true of switches of the Bourdon tube or spring type, wherein varying pressure of fluid in the tube is responsible for achieving make and break switching operations. Pressure of fluid contained within the Bourdon tube varies with temperature to bring about undesired displacement of the tube, and thus makes the switch contacts more or less responsive to pressure control.

It is difficult to adjust the heretofore known Bourdon tube, pressure-actuated switches, so that circuit making or circuit breaking is delayed until a desired switch-operating pressure condition is achieved. Where a protective switch casing is employed, the problem of switch contact adjustment becomes more acute, for it usually is not practical to disturb the casing, in order to reach the contacts for making adjustment. Yet, it is quite important to protect the working parts of the switches, particularly the switch contacts, from atmospheric moisture and dirt, so as to prevent the switch contacts from arcing and corroding.

An outstanding object of my invention, accordingly, is the provision of a pressure-actuated electric switch of the Bourdon tube type, having switch contact elements and included contact points, encased in a hermetically-sealed casing, which is capable of being adjusted from without the protective casing so as to delay circuit-making or circuit-breaking action between switch contact points, until a desired actuating-pressure condition is achieved, and which is responsive in a uniform manner to a given operating pressure, under varying temperature conditions.

As illustrative of the production of my pressure-actuated switch units, I make or procure a glass hood 12*a*, and a glass stem or base 12*b*, having spaced, open tip portions 12*d*, 12*e* and 12*f*.

(See Fig. 1). I align hollow, metallic, terminal pieces 10 and 11 with the open tips 12e and 12f of base 12b, and secure the terminals to the tips, by forming metal to glass seals in any well-known manner. The glass stem is ready to receive my switch contact structure.

In erecting the switch contact elements, I insert one end of an electrically-conductive contact element 13 through glass stem tip 12f and into the hollow portion of terminal 10, to a point well past the metal to glass seal. A bi-metallic element 13a forms a part of the free end of contact element 13 and includes a switch contact point 13b. Solder is poured between the contact element and the inner wall of terminal 10 to a point considerably short of the metal to glass seal. The solder forms an electrically-conductive, fluid-tight seal, and also serves to hold the contact element in erected position.

Likewise, I insert an electrically-conductive Bourdon tube contact element 14 through the glass stem tip 12e and into the hollow portion of the terminal 11 to a point well past the metal to glass seal. A contact point 14b, included on the opposite closed end of the Bourdon tube contact element, is brought adjacent to contact point 13b of element 13, as for example, to closing position therewith. Solder is poured between the Bourdon tube contact element and the inner wall of terminal 11 to a point considerably short of the metal to glass seal, so as to form a fluid-tight seal in the terminal, without interfering with the metal to glass seal. In pouring the solder, care is exercised to avoid covering the open end 14c of the Bourdon tube switch contact element.

The glass hood 12a is positioned over the erected contact structure and is brought into fitting relationship with stem 12b at 12c where an air-tight, glass to glass seal is formed, in any well-known manner. The resulting glass casing 12 then is evacuated through tip 12d or is filled through the same tip with inert gas, such as nitrogen or helium. Evacuation or filling of the tube is carried out to such degree of pressure, as to prevent arcing across the switch contact points when the contact points are open. The open tip 12d of the glass casing 12 then is sealed off.

An open outer end of terminal 11 is secured by air-tight seal to a hollow cylindrical fitting 16, having a set-screw 16c threaded through the wall thereof and a diaphragm face 16e. The cylindrical fitting provides a fluid reservoir 16b which communicates with the bore 14a of the Bourdon tube. I remove the screw 16c from the cylindrical fitting and fill the reservoir 16b and Bourdon tube bore 14a with fluid, such as oil. The set-screw is reinserted and the switch is ready for use.

Where desired, my switch unit is assembled in a heat or shock-resistant casing 17, or after assembly, is inserted in such casing. Any suitable mounting means is employed to hold the switch unit in position within the casing.

In order to achieve more complete degassification of casing 12, I find it helpful to heat the casing during the evacuation step. Gasses occluded in the casing wall, accordingly, are freed for removal from the casing. It also is helpful to employ a chemical "getter" compound in the casing, for reaction with gases remaining after evacuation.

It will be understood that where practical, one of the hollow tips 12f or 12e may form a part of glass hood 12a, rather than base 12b. Where such is the case, corresponding terminal 10 or 11 is sealed thereto by metal to glass seal, and the switch unit then is assembled in the manner prescribed hereinbefore. It will be appreciated, further, that where practical, the switch contacts may be brazed into the terminal pieces, before sealing the terminals to the glass stem 12b or to the glass hood 12a. The casing elements 12a and 12b, moreover, may be made of ceramic material, Bakelite, or even metal, if proper insulation between terminals 10 and 11 is provided. Further advantage is achieved at times by mounting the terminal 11 and fitting 16 as an integral unit on the casing base portion 12b, or by hermetically sealing the Bourdon tube 14 and fitting 16 as an intergral unit to terminal 11.

The operation of my pressure responsive switch unit is quite simple. Upon the application of external pressure to the face of diaphragm 16e, fluid pressure in reservoir 16b and bore 14a increases and the curved Bourdon fluid-spring tends to straighten. Contact point 14b, accordingly, is displaced from contact point 13b and an electric circuit traced from a suitable source of power (not shown) to terminal 10, through contact element 13, contact points 13b, 14b, Bourdon tube 14, terminal 11 and back to the source is broken. As external pressure upon diaphragm 16e decreases contact point 14b approaches contact point 13b until the points meet and thus the circuit once more is closed.

By assuming for a moment that external pressure has been withdrawn from the face of diaphragm 16e, it can be seen that switch contact points 13b and 14b may, depending upon their relative adjustment, rest together under considerable force exerted by tube or spring 15. In order to alleviate this pressure, screw 16c is tightened down farther into the fluid chamber 16b. Fluid pressure within the Bourdon tube, accordingly, increases and contact point 14b tends to move away from contact point 13b. Pressure between the points diminishes and a lighter external pressure is required upon the face of diaphragm 16e to bring about actual separation of the points. Thus, switch sensitivity to pressure applied to diaphragm 16e is regulated by adjustment of set-screw 16c. This adjustment, it will be noted, is accomplished from without the hermetically-sealed casing 12 and in no way disturbs the casing or its seal.

Assume now that set-screw 16c has been adjusted so as to make the switch points 13b and 14b open under a given pressure applied to diaphragm 16e. This adjustment is sufficient to ensure reliable switch operation under constant temperature conditions, but upon a change in temperature, pressure of fluid in the reservoir 16b and tube bore 14a is altered. Bourdon tube 14, accordingly, is displaced in undesired amount, and thus switch sensitivity is affected by temperature change. In order to compensate for the effect of temperature, the bi-metallic portion 13a of switch contact element 13 is provided with a displacement constant, substantially equal to that of the Bourdon tube. Any displacement of contact point 14b to or from point 13b, caused by temperature change, accordingly, is met by a substantially equal displacement, in direction and amount, of point 13b supported on deflecting bi-metallic element 13a.

Figure 2 illustrates a modified form of my invention, wherein a pressure-actuated switch

unit assembled, for example, in accordance with the method hereinbefore described with respect to the unit of Fig. 1, is provided with switch contact points, which normally are open. A switch contact point 14b', provided on displaceable closed end of Bourdon tube 14', normally forms a short air-gap with contact point 13b'. Point 13b' is supported at one end of bi-metallic element 13a', both of which form parts of electrically-conductive contact element 13'. A hermetically-sealed casing 12', having electrically separate metallic terminals 10' and 11' sealed thereto, houses the switch element assembly just described. The end of contact element 13' opposite contact point 13b' is connected within terminal 10' by means of solder or the like. Bourdon tube 14' is provided with an open bore 14a' sealed off by air-tight, electrically-conductive, seal 15' from the interior of casing 12'. A cylindrical fitting 16' is threaded or is otherwise tightly fastened to the outer end of terminal 11', and forms a fluid chamber 16b', in open communication with the interior of Bourdon tube 14'. The chamber and tube are filled with fluid such as oil, for example, through set-screw opening 16d'. Set-screw 16c' is placed in the opening 16d' and the switch unit is ready for use

Upon application of external pressure to the diaphragm 16e', fluid pressure in reservoir 16b' and Bourdon tube 14' increases, and the Bourdon tube tends to straighten within the sealed casing 12'. Contact point 14b', accordingly, is displaced toward point 13b'; and where pressure on diaphragm 16e' is sufficiently high, the points close. Upon closure of the points, a circuit is completed from a source of power (not shown) to terminal 10', across contact element 13', bimetallic element 13a', contact points 13b', 14b', Bourdon tube 14', terminal 11', and back to the source. Where pressure on diaphragm 16e' decreases, contact point 14b' moves away from contact point 13b' and the circuit just described is broken.

Adjustment of the normal air-gap existing between switch contacts is made by altering the protruding length of set-screw 16c in fluid chamber 16b. To prevent the adjusted air-gap from being affected by temperature variations, the bimetallic portion 13a' of contact element 13' is so constructed as to have a temperature displacement constant substantially equal to that of the Bourdon tube. Any undesired displacement of contact 14b' caused by temperature change, accordingly, is met by a substantially equal displacement, in direction and amount, of contact point 13b' supported on deflecting bi-metallic element 13a'.

It will be understood that where my switch units are employed under substantially constant temperature conditions, satisfactory switching operation is achieved by replacing the bi-metallic element 13a or 13a' with an ordinary metallic piece, or by using a single metallic contact element extending from switch terminal 10 or 10', and including contact 13b or 13b'. Where such is done, switch operation remains the same as described hereinbefore, except of course, the temperature compensating feature is omitted.

Likewise, where the temperature compensating feature of my invention is omitted, the switch units make ideal heat responsive unit. In lieu of relying upon external pressure as a switch-actuating force, external heat or cold is the controlling factor in altering pressure of fluid within the Bourdon tube. In way of illustration (see Fig. 4), a heat bulb 116 disposed without hermetically-sealed casing 112 is connected with Bourdon tube 114 sealed by air-tight seal in terminal 111. In such uses, the heat bulb and Bourdon tube preferably are filled with fluid having a high cofficient of expansion. Switch sensitivity to external temperature change is adjusted, for example, by set-screw 116c from without the hermetically-sealed casing as before.

A still further modified form of my invention is illustrated in Fig. 3 where a Bourdon tube 14'', connected with hollow terminal 11'' and having bore 14a'' communicating with the interior of cylindrical fitting 16'', extends into hermetically-sealed, evacuated or pressure-filled casing 12''. The tube is provided at its free end with an electrical contact point 14b''. Fluid chamber 16b'' and tube bore 14a'' are filled with fluid, such as oil set-screw 16c'', threaded in opening 16a'' of casing 16'', passes into the fluid chamber 16b''. Bourdon tube 13'', sealed at both ends and also containing fluid such as oil, is mounted in hollow terminal 10'' and extends into hermetically-sealed casing 12'', in substantially parallel relation with tube 14''. The Bourdon tubes are constructed similarly and contain like fluids, so as to have the same displacement characteristics under external temperature change. A metallic piece 13a'' carrying contact point 13b'', is connected with the free end of Bourdon tube 13''. Although contact point 13b'' normally is separated from point 14b'', it will be understood that by modified arrangement, the points may normally assume closed position (as in Fig. 2).

By applying external pressure to face 16e'', fluid pressure in chamber 16b'' and tube bore 14a'', increases, causing the Bourdon tube 14'' to straighten slightly. Contact 14b'', therefore, closes on contact 13b'' and a circuit including terminal 10'', Bourdon tube 13'', metallic piece 13a'', points 13b'', 14b'', Bourdon tube 14'' and terminal 11'', is closed. Reduction of external pressure similarly is responsible for movement of Bourdon tube in an opposite direction, whereby contact 14b'' is displaced from contact 13b'' and the circuit is broken.

The width of normal air-gap between the switch contact points is adjusted by means of set-screw 16c''. As the protruding length of screw 16c in fluid chamber 16b'' is increased, pressure of fluid in the chamber and in Bourdon tube 14'' increases. Bourdon tube 14'' tends to straighten under the increased fluid pressure and contact point 14b'' is carried toward contact 13b''. Similarly, the air-gap between points is increased by shortening the protruding length of screw 16c'' in chamber 16b''. Temperature variation has little effect upon an adjusted spacing of switch contacts. Both Bourdon tubes 13'' and 14'' are displaced substantially an equal amount with respect to direction and distance, when fluid in the tube is subjected to an increasing temperature.

I find that where the casing of any one of my pressure-actuated switch units is filled with inert gas under considerable pressure, or is evacuated to a considerable degree, the switch contacts contained therein are capable of being adjusted for highly sensitive operation. The opening and closing range of switch contact movement is diminished to a very small value, without danger of arcing. The contact points need, for example, only $\frac{1}{1000}$ inch separation per 5,000 volts in vacuum. Such highly refined adjustment of the contact points of my switches, it will be noted, is accomplished by means disposed externally

of the switch casing, and the refined adjustment is maintained accurately under varying temperature conditions, all as set forth hereinbefore.

Thus it will be seen that there has been provided in this invention, encased pressure-actuated switch units and a method of producing the same, in which the various objects hereinbefore noted, together with many thoroughly practical advantages, are successfully achieved. It will be seen that the switch units provided are strong, durable and compact of construction, and that they are adapted for uses requiring great sensitivity and high efficiency of operation.

As many possible embodiments may be made of my invention and as many changes may be made in the embodiments hereinbefore set forth, it will be understood that all matter described hereinbefore, or shown in the accompanying drawing, is to be interpreted as illustrative, and not in a limiting sense.

I claim:

1. A pressure-actuated switch unit of the character described, comprising in combination, a hermetically-sealed evacuated switch casing supporting a switch contact element and included contact point therewithin; and a fluid-filled Bourdon tube sealed into said casing with a portion thereof extending exteriorly of said casing and a portion projecting into the evacuated casing with a curved fluid spring extension having a contact element mounted thereon including a contact point adjacent said other contact point but insulated therefrom.

2. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically-sealed switch casing supporting a switch contact element and included contact point therewithin; and a fluid-filled Bourdon tube having a reservoir with a pressure diaphragm connected to the end of the Bourdon tube, said end being disposed exteriorly of said casing with a portion sealed into said casing and a portion projecting into the casing with a curved fluid spring extension having a contact element mounted thereon including a contact point adjacent said other contact point, said diaphragm adapted to be actuated upon for operating said switch.

3. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically-sealed casing; a fluid-filled Bourdon tube sealed into said casing with a portion thereof disposed exteriorly of said casing, and a portion projecting into said casing with a curved fluid-spring extension having a contact element mounted thereon including a contact point, said curved fluid-spring extension and included contact point being displaceable under varying temperature condition; and a thermally displaceable second switch contact element connected with said casing in electrically separate relationship to said first switch contact element, and including a contact point within the casing adjacent said first contact point, said contact points being substantially equally displaceable in direction and amount under variable temperature conditions whereby pressure contact adjustment on said switch contact is made.

4. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically-sealed switch casing supporting a switch contact element and included contact point therewithin; a fluid-filled Bourdon tube switch contact element connected with said casing in electrically separate relationship to said first switch contact element, and having a portion thereof disposed exteriorly of said casing, and protruding into the casing in a curved fluid-spring extension including a contact point normally closed upon said other contact point; said fluid-spring included contact being displaceable from said other contact point under substantial change in pressure of fluid within the Bourdon tube; and means cooperating with the exterior portion of said Bourdon tube contact element for effecting slight change in fluid pressure therewithin and thus slightly altering the presure required to open said switch contacts.

5. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically-sealed casing; a fluid-filled Bourdon tube switch contact element connected with said casing, and having a portion thereof disposed exteriorly of said casing, and protruding into said casing in a curved fluid-spring extension including a contact point, said curved fluid-spring extension and included contact point being displaceable under varying temperature condition; a thermally displaceable second switch contact element connected with said casing in electrically separate relationship to said first switch contact element, and including a contact point within the casing adjacent said first contact point, said contact points being substantially equally displaceable in direction and amount under variable temperature condition; and means cooperating with the Bourdon tube switch contact element outside said casing for making slight adjustments in pressure of fluid therein.

6. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically-sealed casing; two fluid-filled Bourdon tube switch contact elements connected in separate electrical relationship with said casing and protruding therein in curved fluid-spring extensions including contact points disposed in adjacent relationship; at least one of said Bourdon tube contact supports having a portion thereof disposed exteriorly of said casing and having a pressure diaphragm secured thereto.

7. A pressure-actuated switch unit of the character described, comprising, in combination, a hermetically sealed switch casing supporting a switch contact element and included contact point therewithin; and a fluid filled Bourdon tube having a reservoir with a pressure diaphragm connected to the end of the Bourdon tube, said end being disposed exteriorly of said casing with a portion sealed into said casing and a portion projecting into the casing with a curved fluid spring extension having a contact element mounted thereon including a contact point adjacent said other contact point, said diaphragm adapted to be actuated upon for operating said switch, and means varying the effective reservoir capacity to adjust initially the position of the contact point carried by the Bourdon tube within the vessel.

HYMAN OLKEN.