Oct. 7, 1930. I. E. McCABE 1,777,887

ELECTRIC SWITCH

Filed April 12, 1926 2 Sheets-Sheet 1

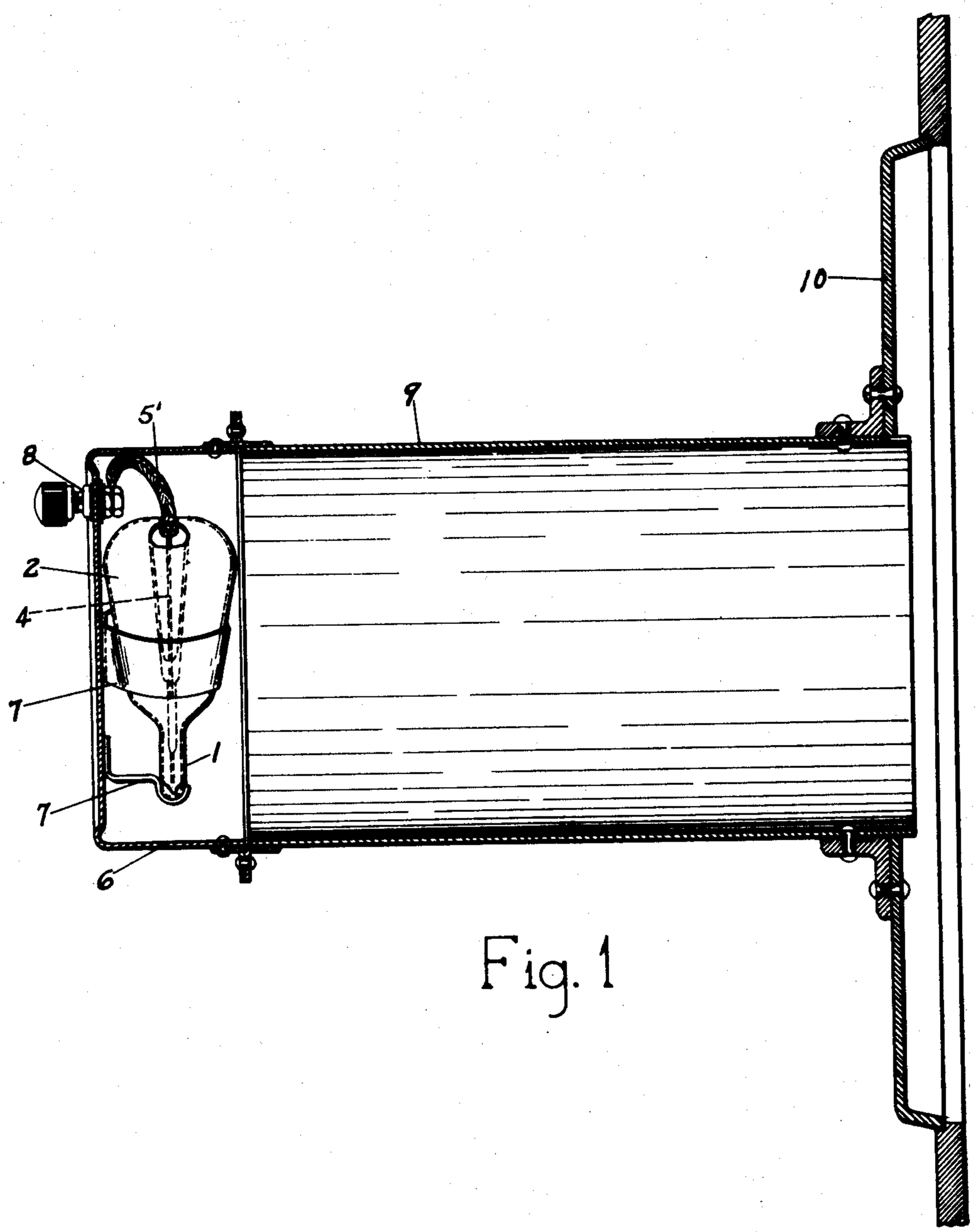

Fig. 1

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Fig. 2

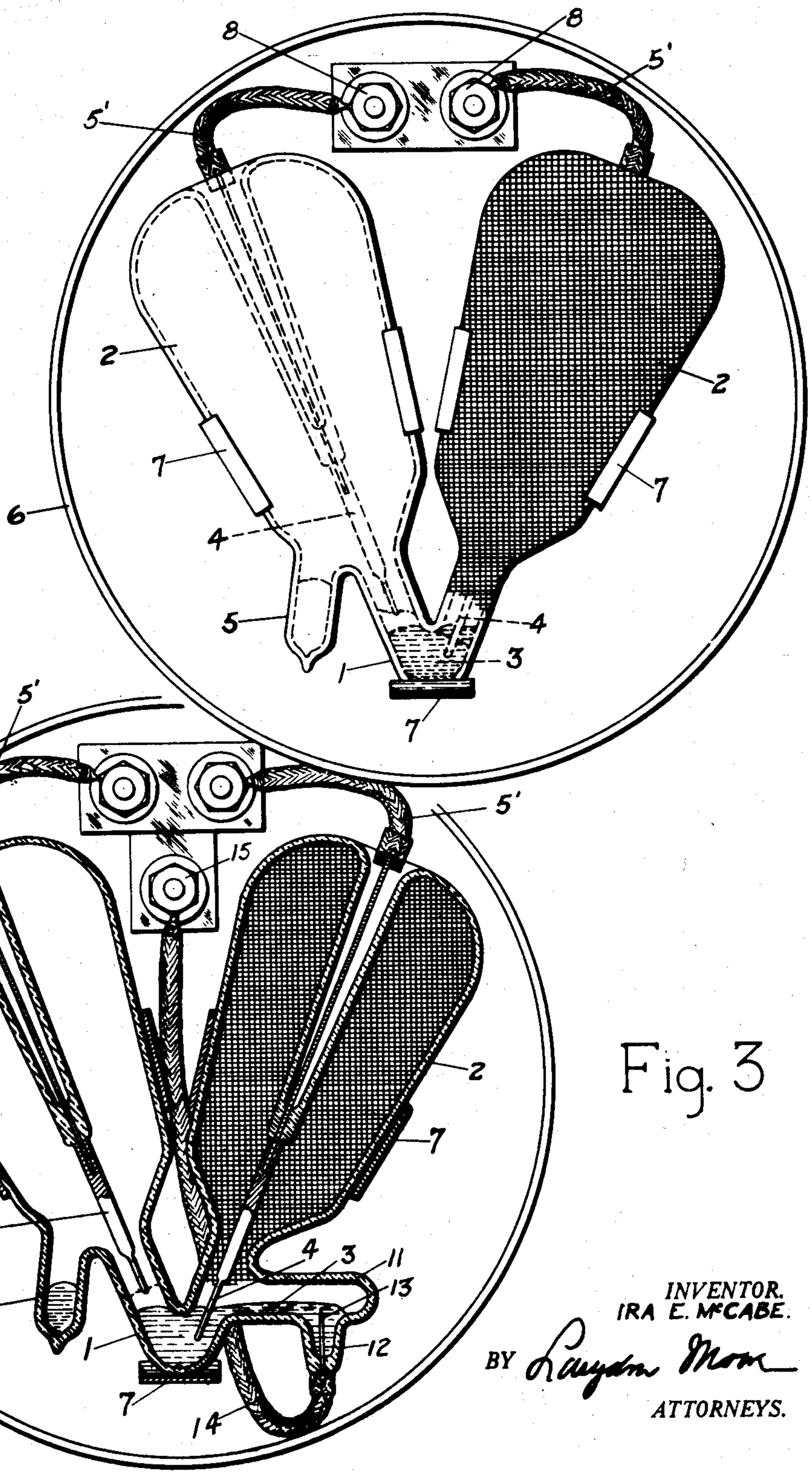

Fig. 3

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UNITED STATES PATENT OFFICE

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ELECTRIC SWITCH

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This invention relates to improvements in electric switches and more particularly to a switch of the mercury tube type of such construction as to be actuated to make or break the circuit by the action of radiant energy.

A switch of this type and constructed in accordance with this invention may be used to great advantage when employed to be actuated by radiant energy from an actinic source in all kinds of signal equipment where it is desired to control an electric circuit to produce a light between sun-set and sun-rise, such as in warning signals at railroad crossings, light houses, electric signs, and in other devices of similar character, and when the radiant energy emanates from a luminous source this improved switch is of great advantage as a control for electric operated fuel burning equipment such as motor operated powdered fuel furnaces, gas burning furnaces, industrial and domestic oil burners for heating systems, and the like.

This invention contemplates the forming of a sealed switch tube, enclosing a gaseous fluid, with a movable seal dividing the tube into two portions, having electrodes adapted to be connected and disconnected by the movement of the seal, and imparting such movement to the seal by increasing the temperature of the gaseous fluid in one end portion much more rapidly than that in the other end portion, whereby the gaseous fluid in that end will be caused to expand, overcome the pressure in the other end, and move the seal in that direction until the connection between the electrodes is made or broken, as the case may be, and then cause the temperature of the greater expanded gaseous fluid to reduce faster than that in the other end of the tube, whereby the more rapid contraction thereof will allow the pressure in the other end of the tube to move the seal back to its original position.

While a prefered embodiment of this invention is illustrated upon the accompanying sheets of drawings and is described in detail hereinafter, it is to be understood that this invention is not limited to the exact construction shown, as it contemplates the broad idea of the employment of an adiathermanous medium co-acting with a source of radient energy to operate an electric switch.

In the drawing:

Fig. 1 is a view in longitudinal vertical section of a prefered form of mounting for this improved switch, illustrating the switch tube in end elevation.

Fig. 2 is an enlarged detail view in front elevation of the switch illustrated in Fig. 1.

Fig. 3 is a similar view illustrating the tube thereof in central vertical section, and also illustrating a slight modification in the detail construction of the tube.

While the tube employed in carrying out this invention may be formed from various materials as well as in various shapes, as contemplated by the scope of this invention, for commercial reasons, it is preferably formed of glass and for the purpose of compactness and assurance of operation, it is preferable to form the tube in the shape shown. Figs. 2 and 3 illustrate a convenient commercial size.

Where it is desired to actuate this improved switch by radiant energy from an actinic source, it may be preferable to mount the switch tube in an uncovered position, however, where it is desired to actuate the switch from a stationary luminous source of radiant energy, it may be preferable to mount the switch tube in a casing having an opening exposing one side of the tube to the luminous source, inasmuch as radiant energy travels in straight lines. Fig. 1 illustrates the latter type adapted for application to a fuel burning device in which an electric current is desired to be controlled by the existence of a flame from the fuel, and in which the ignition of the flame actuates the switch to make or break the circuit, as desired, its failure after ignition actuates the switch to reverse the operation, and its failure to ignite will not affect the switch.

The particular embodiment of this invention illustrated upon the accompanying sheets of drawing comprises a sealed tube, preferably of glass, having a reduced central portion 1 intermediate its ends, which central portion is bent at an acute angle so that the enlarged end portions 2 appear to

be somewhat of the shape of electric light bulbs with their adjacent circumferences in close proximity to each other, as shown in Figs. 2 and 3. The diameter of the reduced intermediate portion is sufficiently less than the diameters of the enlarged end portions when bent in the manner shown to allow a liquid seal to be formed therein. A fluid conductor of electricity 3, such as mercury, is contained within the sealed tube of sufficient quantity when the tube is in the position shown in Fig. 1, to enter into the branches of the reduced V-shaped portion 1 above the lowermost point of its upper wall, and thereby forming a liquid seal between the enlarged portion at either side thereof. Electrodes or terminals 4 of electric conducting material are arranged to enter the interior of the tube and are sealed in the walls thereof to be supported thereby, preferably in the manner shown in Figs. 1 and 2, which are of such dimensions that the electrode carried by one enlarged portion extends into the reduced portion at that end sufficiently to be engaged, submerged or embraced by the fluid conducting material in the well formed by the angular bend in this portion of the tube, while the electrode carried by the other enlarged portion will enter within the reduced portion of that end, terminated short of and out of contact with the upper surface of the fluid conducting material in the well. It is preferable to insert a gaseous fluid within the interior of the tube before it is completely sealed, which gaseous fluid is preferably of a nature to reduce arcing between the electrodes and the fluid conducting material at the making or breaking of an electric circuit therethrough. While the preferred manner of supporting the electrodes and sealing them in the walls of the tubes is illustrated, the particular manner in which electrodes are mounted is not essential to this invention as long as they are mounted in such a manner as to prevent the escape of the enclosed gas. It is also preferable to provide an additional well 5 in the lower end of one of the enlarged end portions adjacent the reduced portion, as shown in Fig. 2, into which the fluid conductor 3 may be caused to flow by tilting the tube in that direction or, from which the fluid conductor may be caused to flow into the main body by tilting the tube in the opposite direction, whereby the amount of fluid conductor in the V-shaped well 1 may be varied to meet various conditions.

It is recognized that radiant energy in the ether, generally known as "thermal", "luminous", or "actinic" energy, manifests itself according to the nature of the recipient upon which it falls and the rapidity with which the vibrations by which it is transmitted are executed. When the waves or vibrations in the ether set up by radiant energy fall upon adiathermanous substances, the regular vibrations which constitutes the waves are quenched and the energy of these vibrations passes into the energy of the irregular motions to which heat is due, radiation is absorbed and a rise of the temperature follows. Lamp black, or a surface covered with lamp black, is recognized as the most efficient adiathermanous medium which not only absorbs radiant energy from a luminous or actinic source, transforms its vibrations to produce heat and a rise in temperature, but also is a most efficient medium for the emission of radiant energy. This property of adiathermanous substances is employed to operate this switch by first, absorbing actinic or luminous energy to increase the temperature, by covering the entire outer or inner surface of one of the bulb-like end portions 2 with a medium adapted to secure a layer of lamp black to the walls, whereby when the tube is subjected to the rays or waves of light from the sun, electric light, or from a flame this lamp black surface being an adiathermanous substance absorbs the radiant energy therefrom and increases the temperature of the walls surrounding that portion of the tube. The increasing of the temperature of the walls of the tube also increases the temperature of the gaseous fluid enclosed therein on that side of the surface of the liquid fuel conductor 3 in the reduced portion 1 leading from that end, and, as the temperature of the gaseous fluid in the lamp black covered end portion rises much more rapidly than the temperature of the gaseous fluid in the other enlarged end portion, the result is that the fluid conductor forming the seal in the well between the two end portions is forced downward by the more rapidly expanding gas and moved upward in the opposite side of the well, without breaking the seal between the two enlarged portions, and converesly when the switch is removed from the source of such radiant energy, the adiathermanous lamp black cover of the end portion will transmit or emit the heat and reduce the temperature of the expanded gaseous fluid therein much more rapidly, and thereby cause it tc contract much more rapidly, than the gaseous fluid in the other enlarged portion, whereby the pressure in the other enlarged portion will cause the fluid conducting seal to assume its original position.

The exterior portions of the respective electrodes 4 are each provided with a flexible lead 5^1 adapted to be connected in the circuit to be controlled by said switch. In Fig. 2, the electrode in the enlarged end provided with the adiathermanous covering is shown as normally extending within the conducting fluid seal 3 with the electrode in the other enlarged end normally terminated short and out of connection with said fluid conductor,

so that when the flexible leads 5^1 are in circuit with the source of electricity, the circuit is normally broken through the switch as long as it is not subjected to radiant energy but as soon as it is placed in contact with the waves or rays of the sun or from an electric light or flame, the gaseous fluid within the adiathermanous covered end will expand with sufficient force to move the conducting fluid 3 in the well 1 to contact and submerge the end of the electrode in the other enlarged end portion, while still maintaining electric contact with the first electrode, and thereby cause the circuit to be closed through the electrodes and conducting fluid, and will maintain this electrical connection as long as the switch is acted upon by such radiant energy. As soon as the switch is removed from the source of electric energy, the gaseous fluid in the adiathermanous covered end will contract, allowing the fluid seal to return to its original position and break the circuit.

Fig. 1 illustrates a preferred mounting for this switch when employed as a control in a fuel burning device, and, as shown, comprises a casing 6 provided with clips 7 on the closed end thereof for engaging and supporting the V-shaped restricted portion 1 and enlarged end portions 2 of the tube, and with binding posts 8 to which the free ends of the flexible leads 5^1 from the electrodes 4 are connected, which binding posts, in turn, provide means for connection with the circuit to be controlled thereby. Inasmuch as this switch is adapted to be operated by the luminous radiant energy emanating from the flame of the fuel within the furnace, it is preferable to support the switch casing 6, at a sufficient distance therefrom so that the switch mechanism will not be damaged by the intense heat from the furnace, by means of a tubular member 9 secured to the open end of the casing and to a portion of the furnace wall 10 surrounding an opening with the center line of such tubular member in line with the flame from the fuel, and the inner surface of this tube may be polished or of reflecting material which will reflect the rays or waves of luminous energy emanating from that part of the flame not in line with the center of the tube.

It will, therefore, be seen that this switch will readily control an electric circuit as it will be actuated by the ignition of the flame of the fuel and to operate in one direction and upon failure of the fuel flame to operate in the opposite direction.

Fig. 3 illustrates a slight modification in which the restricted portion 1 of the walls leading from the adiathermanous covered enlarged end portion is provided with an enlargement 11 in a horizontal direction terminating in a depending well 12 into which an electrode 13 may be supported by sealing the body thereof in the wall forming the bottom of the well. The exterior portion of such electrode is provided with a flexible connection 14 to a binding post 15 upon the back of the casing 6 for connection with an electric circuit. As shown in Fig. 3, the fluid conductor 3 forms an electrical connection between the electrode 13 in this additional well and the electrode 4 supported by the adiathermanous covered enlarged end portion, while the electrode in the other end portion is out of contact with the fluid conductor, so that upon expansion of the gas in adiathermanous end portion, the liquid conductor will be caused to flow upward away from the electrode 13 in the additional well 12 into the other arm of the V-shaped restricted portion 1, breaking the electrical connection first mentioned and making an electrical connection between the electrodes 4 in the two enlarged end portions 2 and upon the contraction of the gaseous fluid in the adiathermanous covered end portion the operation will be reversed.

As above stated, various substances or materials may be employed in the formation of the sealed tubes and the operation above described will be carried on in the same way, but at a rate varying with the material employed. For the commercial device, it is preferable to construct the tube of glass, both for the convenience in sealing the electrodes therein and for the reason that glass is a diathermanous substance which readily transmits the waves of radiant energy with but little absorption. The additional well 5, formed as shown in Fig. 1, may be called an adjusting well as it is employed to adjust the level of the liquid fluid conductor 3 in the V-shaped arms of the reduced portion 1 to approach or recede from the electrodes in the end portions for adjusting the length of time consumed after subjecting the adiathermanous covered end portion to a source of radiant energy to cause the electrical connection to be made or broken through the switch.

As above set forth, it is preferable that one of the enlarged end portions of this switch be of, or covered with, an adiathermanous substance and the other enlarged end portion, in accordance with this invention, may be of, or covered with, any substance, either diathermanous or adiathermanous, as long as it absorbs less radiant energy, that is, as long as it transforms the waves of radiant energy impinging upon it to produce a lesser degree of heat than that of the first mentioned portion, as for instance, one end portion may be covered with a layer of lamp black, the most efficient adiathermanous medium, and the other end portion be silvered, or provided with a covering of reflecting material, whereby the waves of radiant energy impinging upon it will be reflected.

Likewise the tube may be of any shape as long as it is divided into end portions by a movable seal so that the gaseous fluid in one end portion may be caused by radiant energy to expand more rapidly than the gaseous fluid in the other end portion, even where both end portions are equally subjected to the waves of radiant energy emanating from the same source.

If the surface of one enlarged end portion is covered with a substance that absorbs radiant energy and increases the temperature of the enclosed gaseous fluid so much more rapidly and to such a higher degree that it expands the gaseous fluid to such an extent as would cause a solid movable seal to leave the contracted portion or well, by the employment of a liquid seal, such a rapid expansion is accommodated by allowing the high pressure gas to pass through the liquid from one end to the other in small quantities in the form of bubbles, so that an excessive movement of the liquid seal is prevented, which in the construction described prevents a failure of the establishment of the electrical connection by the electric conducting fluid, and serves to cause a rapid return of the conducting fluid to its original position upon the removal of the source of radiant energy.

What I claim is:

A sealed tube containing a gaseous fluid and having a plurality of intermediate depressed portions forming a plurality of separated wells, a fluid conductor of electricity in said tube adapted to be caused to flow from one well to another and form a liquid seal between the end portions, a plurality of electric terminals entering the interior of the tube adapted to be engaged by the fluid conductor to complete an electric connection therebetween, one of the end portions of the tube having means, when the tube is subjected to radiant energy to absorb heat therefrom, expand the gaseous fluid in that end of the tube to depress the level of the fluid conductor in that end of the well to make or break the electric connection between a pair of said terminals, the amount of liquid in the sealing well adapted to be increased or diminished by causing a flow from or to another well to control the degree of expansion of the gaseous fluid required to move the fluid in the sealing well to make or break the electric connection between said terminals.

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