May 7, 1935. F. W. SIDE 2,000,422

ELECTRIC SWITCH

Filed Feb. 6, 1932 2 Sheets-Sheet 1

FIG. 1.

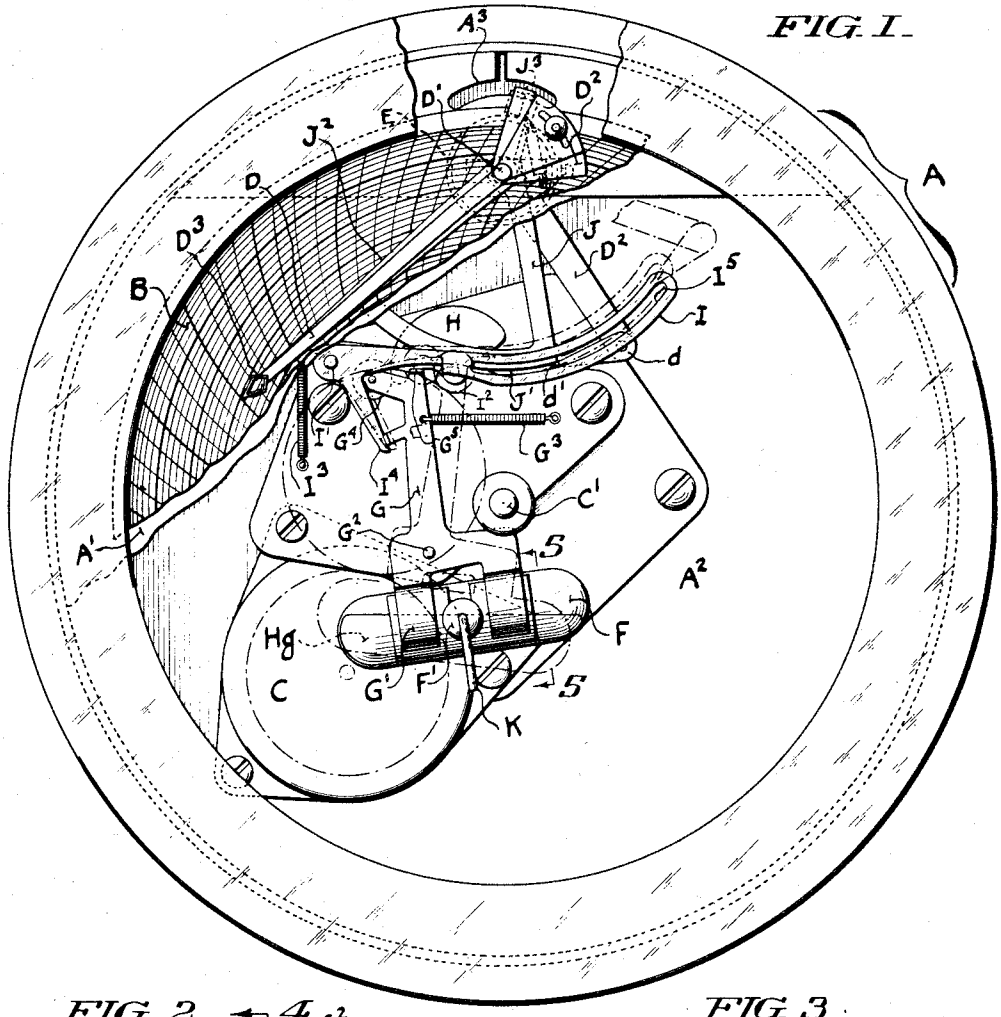


FIG. 2.

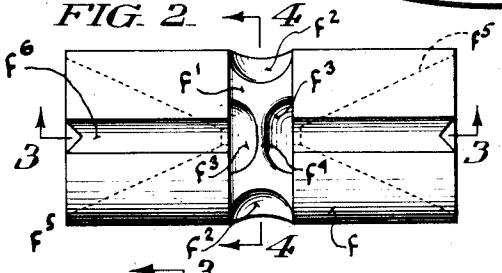


FIG. 3.

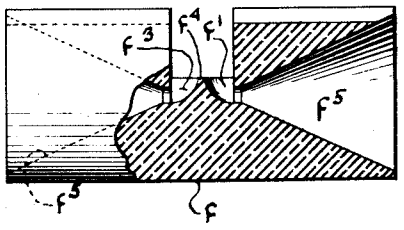


FIG. 4.

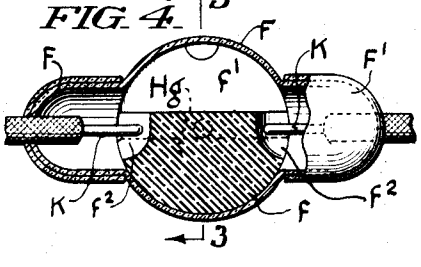
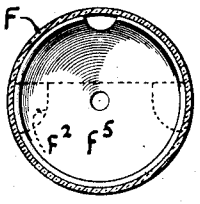


FIG. 5



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ELECTRIC SWITCH

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FIG. 6.

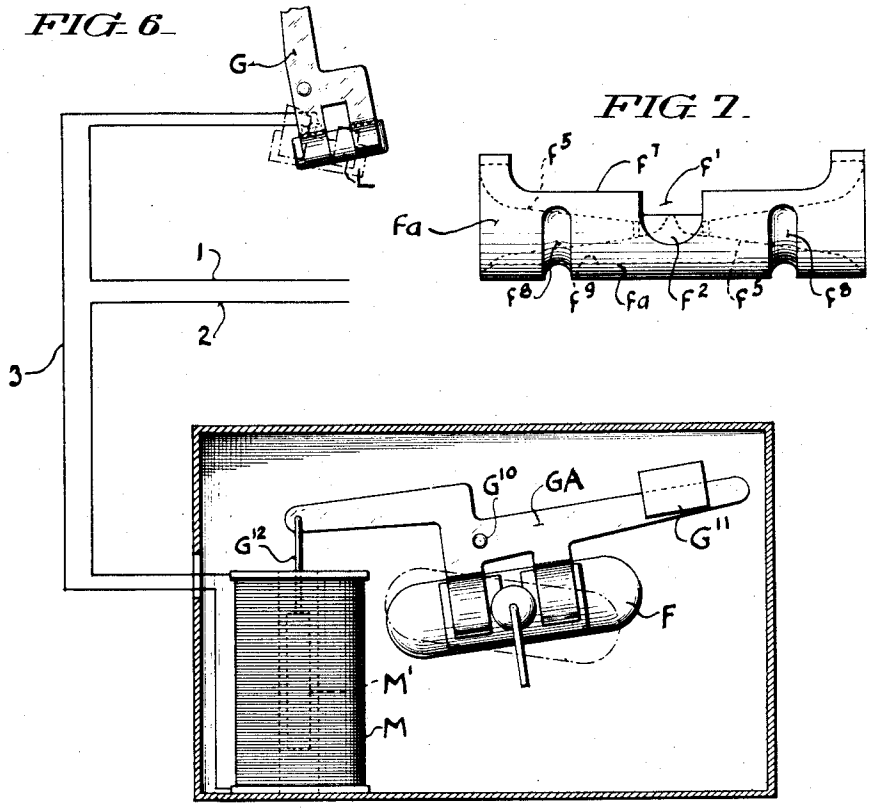
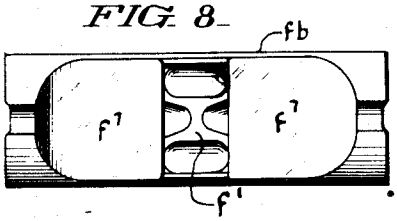


FIG. 7.

FIG. 8.



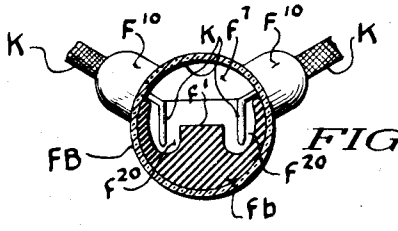


FIG. 9.

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UNITED STATES PATENT OFFICE

2,000,422

ELECTRIC SWITCH

Frederick W. Side, Philadelphia, Pa., assignor to The Brown Instrument Company, Philadelphia, Pa., a corporation of Pennsylvania

Application February 6, 1932, Serial No. 591,298

15 Claims. (Cl. 200—33)

The general object of the present invention is to provide an improved electric switch mechanism especially useful in control apparatus including a meter and means through which the meter deflection actuates the switch mechanism to produce control effects though the switch mechanism is capable of use in other relations.

My improved switch mechanism includes a switch proper comprising a container for a conducting fluid and contacts which extend into said container and are or are not connected by said fluid according to the position in the container occupied by the fluid. In switches of the type referred to, the conducting liquid is ordinarily mercury, and such switches are commonly called, and are hereinafter referred to as mercury switches.

My improved mercury switch is mounted on a support pivoted or otherwise movable to give the container movements which result in movements of the mercury in and relative to the container, but differs from prior mercury switches having such general characteristics, in that each and every intended or normal movement of my container, regardless of its direction, produces, or tends to produce the same change in the condition of the controlled circuit. That change may be either the closure or the opening of the circuit, according to the design of the switch. The provisions whereby any operative movement of my container effects or tends to effect a circuit condition in one direction, are coupled with provisions whereby the mercury moves by a retarded gravital action to change the circuit condition in the opposite direction, whenever the container remains stationary for a predetermined time interval in any position which it may assume in regular operation.

My improved switch is thus an automatic or self-restoring switch with a time lag action. In the usual arrangement of my improved switch mechanism each operative movement of the container closes or prolongs the closure of the circuit including the switch, and said circuit is opened when the switch container is left stationary for the prescribed period. So arranged my improved switch is especially well adapted for use as a combined control and safety switch in the general manner hereinafter described. The time lag of any particular switch constructed in accordance with the present invention, depends upon the form and proportions of the switch and particularly of the provisions controlling the retarded gravital flow of the mercury out of the position into which the mercury is adjusted by the switch container movement.

My improved switch may advantageously be used in control apparatus which comprises a controlling meter including a deflecting pointer and a relay or power actuated mechanism controlled by the position of the pointer for giving operative movements to the switch container with sufficient frequency to continuously maintain the circuit condition established by such movements when the pointer is in one position or position range, while permitting the switch container to remain stationary during any period in which the meter pointer occupies another position or position range. The switch mechanism may be mounted in and form a part of the control instrument proper, or may be mechanically separate from the instrument, though operatively connected thereto. For example, the control instrument may be employed to energize an electro-magnet for giving the switch its operative movements when conditions required such movements and the switch may then be made of the required size to establish and break a current flow too heavy to be handled by a switch small enough for convenient or safe incorporation in a control meter of ordinary size.

In a preferred mode of control apparatus use of my improved switch, the latter serves the double function of a control switch opening and closing in accordance with predetermined changes in the condition to which the meter responds, and of a safety switch effective to open the control circuit on any derangement of the control apparatus which leaves the switch container stationary, regardless of the position then occupied by the container.

In addition to its general operating advantages, my improved switch mechanism is characterized by various novel and useful features of construction and arrangement contributing to its effectiveness and facilitating its manufacture.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, its advantages and specific objects attained with its use reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described preferred embodiments of the invention.

Of the drawings:

Fig. 1 is an elevation with parts broken away of a control instrument including the improved control and safety switch;

Fig. 2 is a plan view of a switch insert employed in the switch shown in Fig. 1;

Fig. 3 is an elevation of the switch insert partly in section on the plane indicated by the line 3—3 in Fig. 2 and in Fig. 4;

Fig. 4 is a transverse section of the switch section cutting through the switch insert on the line 4—4 of Fig. 2;

Fig. 5 is a transverse section through the switch on the line 5—5 of Fig. 1;

Fig. 6 is a partial diagrammatic view illustrating the use of the control instrument mechanism of Fig. 1 in connection with an external safety and control switch;

Fig. 7 is an elevation of a modified form of switch insert;

Fig. 8 is a plan view of a third form of switch insert;

Fig. 9 is a transverse section taken similarly to Fig. 4 through a switch including the insert of Fig. 8.

In Fig. 1 I have illustrated the use of a switch F constituting one embodiment of my invention in a control meter A, which is a recording meter of known type in which a wall A' in front of a mechanism chamber A^2 in the instrument casing, forms a supporting surface for a record disc B which may be revolved in the usual manner by a central driving shaft C' rotated through the usual speed reducing gearing at a suitable speed by an electric clock or analogous instrument motor C located in the chamber A^2. D represents a meter pointer oscillating about an axis D' in response to variations in value of the quantity measured, and may be carried by the moving element of any ordinary meter, for example, a galvanometer. In the instrument shown, however, the pointer D is secured to one end of a Bourdon tube helix E of the type employed in some forms of pressure recording instruments and in expansible fluid expansion thermometers, and shown, for example, in the Brown and Wagner Patent No. 1,390,273, granted September 13, 1921. As shown herein, the axis of the helix E is coincident with the axis D', and the pointer D is connected to the helix by a yoke member D^2 extending through a slot A^3 in the plate A' beyond the margin of the record disc B.

A mercury switch F, serving both as a control switch and as a safety switch, is mounted within the mechanism chamber of the mechanism A. As shown the container of the switch F is carried by clip or arm portions G' of an oscillating support member G. The latter is mounted on a pivot pin or shaft G^2 to turn between the full and dotted line positions shown in Fig. 1, and is biased towards its dotted line position by a spring G^3 Under certain conditions the member G is periodically moved into its full line position against the action of the spring G^3 by a cam H. The latter is constantly rotated by the motor C through a speed reducing gearing at suitable speed which is much greater than that of the shaft C'. The spring G^3 tends to hold a cam follower roll G^4 carried by the member G in engagement with the peripheral or cam edge of the cam H.

When the meter pointer D is within a certain range, for example, when its position corresponds to a temperature below a certain normal temperature, each rotation of the cam H moves the member G from its dotted line position into its full line position and then permits the member G to return to its dotted line position under the action of the spring G^3. The switch F if open at the beginning of any such series of movements will close by the first movement of the series. It will then remain closed until the series is interrupted, as the rotation frequency of the cam H is high enough to prevent the reopening of the switch so long as the latter is free to move under the action of the cam H and spring G^3. When the meter pointer is in the different range corresponding to a temperature exceeding the normal temperature, the member G is held substantially stationary in its full line position so that after the predetermined time lag period the switch automatically opens.

The means by which the oscillatory movement of the member G is thus interrupted comprises a control lever I pivotally mounted on a supporting stud I' carried by the instrument framework. The lever I is provided with a hook shoulder I^2 which engages a latch shoulder G^5 on the member G and thereby holds the member G substantially in its full line position when the lever I is held in the position shown in full lines in Fig. 1. A spring I^3 biases the lever I to turn from its full line position into its dotted line position shown in Fig. 1. The lever I is moved into its full line position whenever the member G moves into its full line position by the action of a projection from the member G on an arm I^4 of the lever I. As the member G moves back to its dotted line position, the lever I turns back into its dotted line position, provided the meter pointer D is then in a position corresponding to a low value of the temperature measured. When that temperature is at or above its normal value, however, the return movement of the lever I into its dotted line position is prevented by means controlled by the position of the pointer D.

In the construction illustrated in Fig. 1, the means by which the pointer D, when its high temperature range prevents the return movement of the lever I and thus holds the switch F stationary, comprises an arm D^2 normally turning with the meter pointer D and carrying at its free end a pivoted member *d* having a lateral projection *d'* extending through an arc shaped slot I^5 formed in the member I. When the meter pointer occupies a low range position, the projection *d'* does not interfere with the movement of the lever I between its full and dotted line positions. When the pointer D is in a high range position, however, movement of the member I from its full line position into its dotted line position is prevented by the projection *d'* which then forms a thrust block interposed between the concave wall of the slot I^5 and the convex edge J' of a control arm J. The latter is angularly adjustable about the axis D' and may be frictionally held in any position into which it is adjusted. To facilitate and to indicate its adjustment, a pointer J^2 is advantageously secured to the member J by a yoke portion J^3 extending through the slot A^3. The pointer J is located between the record chart and the pointer D and advantageously is slightly shorter than the instrument pointer D so that it does not interfere with the movements of the pen D^3 carried by the pointer D, while being close enough thereto to permit of a ready comparison of the angular positions of the two pointers. Ordinarily the instrument is so arranged that the angular positions of the two pointers D and J^2 will coincide when the actual value of the quantity measured corresponds to the normal value of that quantity. Said normal value of the quantity is fixed by

the adjustment of the position of the pointer J^2.

My novel control and safety switch F, in the form shown in Figs. 1–5, comprises a container or envelope ordinarily made of glass and having a cylindrical body with opposed horizontal lateral extensions F′ at its center. These lateral extensions F′, which are preferably formed with thickened walls, have sealed in their ends switch contacts or conductors K each of which extends for a short distance into the body portion of the container.

For the purposes of the present invention the container member of the switch F is provided with means controlling the movements within the container of mercury which partially fills the container and provides a conducting bridge connecting the two switch contacts or terminals K when the switch is in its closed condition. In the switch F shown in Figs. 1–5, the movement of the mercury within the container is controlled by an insert *f* mounted in the container and made of porcelain or other insulating material suitably resistant to the high temperatures and wide temperature changes which may occur regularly or from time to time in the operation of the switch. The insert *f* is of cylindrical design and of a diameter practically equal to the internal diameter of the container, but is shaped to provide various mercury passages and chambers or reservoir spaces, and is shorter than the container body in which it is symmetrically disposed thus leaving similar mercury receiving spaces in the container at the opposite ends of the insert *f*. The latter is formed with a deep central chamber *f′* extending transversely across the insert from its upper side to a level but little above that of the insert axis. The chamber *f′* has parallel side walls transverse to the insert axis and a bottom wall which is flat, except as it is cut away to form a pair of recesses f^2 and a pair of recesses f^3.

The two recesses f^2 are located at opposite ends of the chamber *f′*, and each unites with the space in the adjacent container extension F′ to form a well or chamber which is filled with mercury in all normal operating conditions of the switch, and which in the corresponding terminal or switch contact K is submerged. The two recesses f^3 are located at opposite sides of the transverse plane passing centrally through the container and insert *f*. The adjacent upper marginal edges of the recesses f^3 are in the form of flanged arcs each convex to the other and the adjacent sides of the recesses f^3 are internally concave. In consequence mercury entering either recess f^3 from the corresponding chamber f^5 hereinafter referred to is deflected vertically upward into, and normally accumulates in, the chamber *f′* instead of flowing directly into the other recess f^3 over the upper edge f^4 of the tapered portion of the insert between the recesses. Each of the two chambers f^5 is in the form of a conical cavity extending into the insert from the corresponding end wall of the latter. As shown in Figs. 1–5, the common axis of these cavities or chamber f^5 coincides or is practically coincident with the axes of the insert and container body. The inner apical end of each chamber f^5 forms a relatively small port through which mercury can pass between said chamber and the adjacent recess or pocket f^3.

The insert *f* is formed with a longitudinal channel or groove f^6 at its top. The channel f^6 intersects, and is divided into two sections by the chamber *f′*, and serves to equalize the vapor or gas pressures in the chamber *f′* and in the spaces at the ends of the container. Advantageously the vapor space in the container contains some neutral gas as hydrogen or neon, such as is customarily employed in mercury switches. The free space in the container is filled with mercury approximately to the level indicated by the line Hg in Figs. 1 and 4 when the mercury is at rest, the axis of the switch container being inclined in Fig. 1 and horizontal in Fig. 4.

In the normal operation of the instrument shown in Fig. 1, the axis of the switch container is never horizontal except when the container is moving between the positions shown in full and dotted lines shown in Fig. 1. In its normal open condition the lever I holds the switch container substantially stationary in the full line position shown in Fig. 1. In that switch condition the major portion of the mercury in the container, other than that in the contact walls, is in the lefthand chamber f^5 and adjacent container end. In this open condition of the switch there is no mercury above the level of the bottom wall of the recess *f′*, and no mercury bridge connection between the contacts K.

When thereafter the switch F is released by the lever I and tilts under the action of the spring G^3 into its position shown in dotted lines in Fig. 1, there is a rush of mercury from and through the lefthand chamber *f* into the chamber *f′*. On the subsequent return movement of the switch into its dotted line position, the mercury in the lefthand chamber f^5 and adjacent container end is raised and much of it rushes therefrom into the chamber *f′*. Practically as soon as the mercury begins to enter the chamber *f′* from either of the recesses f^3, it begins to flow out of the chamber *f′* into the other recess f^3 and adjacent chamber f^5.

However, the various passages and chambers are so shaped and disposed that the initial inflow of mercury into the chamber *f′*, on a tilting movement of the switch member in either direction, is initially more rapid than the outflow therefrom. In consequence if the tilting movements first in one direction and then in the opposite direction follow one another at suitable short intervals of time, as they do when the switch is free to follow the movements of the cam H, sufficient mercury is continuously held in the chamber *f′* to maintain a mercury bridge connecting the mercury in the wells in which the contacts K dip. The creation of such a mercury bridge puts the switch in its closed condition and completes the circuit including the contacts K. In normal operation when the switch is once put into its closed position it remains in that condition until a change in the position of the meter pointer results in the maintenance of the lever I and switch F in their respective positions shown in full lines in Fig. 1, for a period long enough to permit the chamber *f′* to empty and break the mercury bridge between the contacts K.

The period during which the switch F must be held in its full line position to thus open the switch circuit will depend on features of switch design and proportions which may be varied as conditions make desirable. By way of illustration and example and not by way of limitation, it is noted that in one practical design of the apparatus of the general type shown in Figs. 1–5, the switch must remain stationary in its full line position for a period of approximately 15 seconds to break the switch circuit. In that design, the cam H makes three rotations per min-

ute so that the time interval between each two successive switch tilting movements is 10 seconds.

When the switch F is held stationary in any position, other than its full line position, as may result, for example, from an accidental interruption in the rotation of the cam H, the mercury will all flow out of the chamber *f'* and the circuit including the switch contacts K will open, in about the same time as is required for the circuit to open when the switch is held stationary in its full line position shown in Fig. 1. The switch thus serves not only as a control switch establishing and interrupting a control circuit including the contacts K in selective accordance with the deflection of the meter pointer D, but also as a safety switch interrupting the control circuit in case of any derangement of the control instrument which prevents the normal operation of the switch oscillating mechanism. This safety action is of great practical importance in some uses of such control apparatus. For example, in one use for which the apparatus shown in Figs. 1–5 is well adapted, the circuit controlled by the switch F creates or regulates the supply of heat to a furnace in inverse response to the fall and rise of a furnace temperature indicated by the position of the pointer D. In such use a failure of the mechanism oscillating the switch F can cause the heater to be dangerously overheated, since, no matter in what position the switch may stop, it will open the control circuit, and interrupt the heat supply to the furnace within a few seconds.

The insert *fa* shown in Fig. 7 is adapted for use in the switch F, in lieu of the previously described insert *f*. The insert *fa* differs from the insert *f* primarily in that an upper portion of the insert *fa* is cut away to provide a mercury reservoir space with its bottom f^7 at a level somewhat above the bottom of the chamber *f'*. The additional reservoir space thus provided is in effect an extension of, or auxiliary to the reservoir space formed by the chamber *f'*. When a switch including the insert *fa* is tilted and mercury begins to flow into the chamber *f'*, some of the mercury overflows into said auxiliary reservoir space from the chamber *f'*. The mercury thus received in the auxiliary reservoir space returns to the space *f'* when the rate of outflow into the then lower chamber f^5 diminishes below the rate of inflow into the chamber *f'* from the then higher chamber f^5. Other things being equal the use of said auxiliary reservoir space tends to prolong the period during which the chamber *f'* holds a circuit closing body of mercury as a result of a single tilting movement of this switch. With the insert of Fig. 7 the desired switch action may be secured with a smaller angle of switch tilting movement and with a slower switch tilting movement than is required with an insert of the form shown in Figs. 1–5.

With the inserts *f* and *fa* it is necessary to guard against the entrance of mercury into the space between the bottom of the insert and the container wall, since a continuous film of such mercury would connect the contacts K and thus permanently short circuit the switch. It is also desirable to prevent the leakage of mercury out of the wells in which the contacts K are inserted. Such difficulties may be avoided by sealing the underside of the insert to the container wall. To this end the insert *fa* is formed with peripheral grooves f^8 and with a longitudinal groove at its bottom into which cement material may be injected to seal the insert in place.

The necessity for sealing the switch insert and container wall together to prevent leakage out of the contact wells and the short circuiting of the switch by mercury between the underside of the insert and the container wall, is avoided with the construction shown in Figs. 8 and 9, by forming the wells f^{20} receiving the contacts K wholly within the insert *fb*. The wall portions of the insert *fb* at the outer sides of the wells f^{20} extend up to the bottom level f^7 of the auxiliary reservoir space. In Figs. 8 and 9 the switch contacts K enter the interior of the container body well above the bottom of the chamber *f'* and are bent to extend downward into the wells f^{20} to a level below the bottom of the chamber *f'*. Except for the form of the contact receiving wells, the insert *fb* of Figs. 8 and 9 is shown as identical in form with the insert *fa* of Fig. 7. The container member of the switch FB shown in Figs. 8 and 9 may be identical with the container of the switch F, except that the lateral extensions f^{10} of the switch FB are oppositely inclined to the horizontal instead of being horizontal as they are in the construction of Figs. 1–5.

In Fig. 6 I have illustrated a modification of the apparatus shown in Fig. 1 in which the control switch F forms no part of the control instrument proper, but is given its movements by the energization and deenergization of an electromagnet M. The energization of the latter may be controlled, however, by an instrument precisely like that shown in Fig. 1, except that it includes a simple switch L in lieu of the switch F of Fig. 1, the switch L being employed to open and close the energizing circuit for the magnet M once for each oscillation of the member G which carries the switch L. As shown the switch L is a simple mercury switch which is closed when the member G occupies the position shown in full lines in Fig. 6, that position corresponding to the full line position of the member G in Fig. 1. When the member G of Fig. 6 is turned into the dotted line position, corresponding to its dotted line position in Fig. 1, the switch L opens. As shown in Fig. 6, 1 and 2 represent supply conductors. The conductor 2 is directly connected to one terminal of the winding of the electromagnet M. The second terminal of that winding is connected to one terminal of the switch L, and the second terminal of that switch is connected to the supply conductor 1.

In Fig. 6 the switch F is held by clip or arm portions of a supporting element GA and oscillating on a supporting pivot G^{10}. The member GA is in effect a lever carrying a counterweight G^{11} which turns the switch F into the position shown in dotted lines in Fig. 6 when the magnet M is deenergized. When the latter is energized, the member GA is turned to move the switch F into its full line position by the electromagnetic interaction of the winding M on the armature core M' which is suspended by the link G^{12} from the corresponding arm of the member GA.

In the use of an arrangement like that shown in Fig. 6 in that a simple relay control switch like the switch L is employed to control means by which the main control switch is moved or permitted to remain stationary possesses the obvious advantage that the main control switch may be located at any desired distance from the control instrument proper. In particular it permits the main control switch to be located adjacent the furnace or other apparatus directly controlled, while the control instrument is located in a suitable instrument or remote control room. Regardless of the means through which the position

of the deflecting element of the control instrument controls the operation of the main control switch, there is an advantage in some cases in locating the latter outside of the control instrument casing. Such location of the main control switch F permits the latter to be proportioned to handle a control current too large to be handled by a control switch small enough for convenient mounting in the control instrument proper. Furthermore when the control switch is located outside the casing of the control instrument, the latter is not subject to risk of injury as a result of the blowing up of the main control switch which may sometimes occur under heavy load conditions.

As those skilled in the art will understand my novel control and safety switch may be employed in connection with control instruments quite different in character from that shown in Fig. 1. In particular when the control switch F is given its movements in the general manner illustrated in Fig. 6, practically any known type of control meter adapted to open and close a control circuit in selective response to the meter deflection may be employed to control the energization and deenergization of the electromagnet M which directly actuates my improved control switch.

Having now described my invention what I claim as new and desire to secure by Letters Patent, is:—

1. A switch comprising a container movable to and fro and partially filled with mercury and formed with a chamber into which mercury is caused to rapidly accumulate by movement of the container in either direction and from which the accumulated mercury slowly drains when said container remains stationary, and contacts connected by mercury accumulated in said chamber.

2. A switch comprising a container movable to and from and partially filled with mercury and formed with a chamber into which mercury is caused to accumulate by movement of the container in either direction and from which the accumulated mercury drains when said container remains stationary for a predetermined time interval and contacts connected by mercury accumulating in said chamber.

3. A switch comprising a movable container and formed with two reservoir spaces and a chamber connected to each of said spaces by a corresponding passage leading downward from the bottom of said chamber and through which mercury is transferred by a movement of the container between said spaces in one direction or the other according to the direction of said movement, and contacts connected by mercury in said chamber.

4. A switch comprising a container mounted for a to and fro movement and formed with two reservoir spaces and an intermediate chamber and passages connecting said chamber with each of said spaces, mercury within said container and displaced from one or the other of said spaces into said chamber and thence into the remaining space when said container is tilted in one direction or the other, said passages being arranged to provide an inflow of mercury into said chamber more rapid than the outflow therefrom when said container is tilted in either direction, and switch contacts extending into said container and connected by mercury accumulating in said chamber on a tilting movement of the latter in either direction.

5. A switch comprising a container pivoted to turn about an axis, partition means in said container providing reservoir spaces one at each side of said axis and an intermediate chamber and passages connecting said chamber with each of said spaces, mercury within said container and displaced from whichever of said spaces is then elevated into said chamber and thence into the other of said spaces whenever said container is tilted in either direction to thereby elevate a corresponding one of said spaces above the other, said passages being arranged to provide an inflow of mercury into said chamber more rapid than the outflow therefrom when said container is tilted in either direction, and switch contacts extending into said container and connected by mercury accumulating in said chamber on a tilting movement of the latter in either direction.

6. A switch comprising a pivoted container, partition means in said container providing two reservoir spaces and an intermediate compartment in restricted communication with each of said spaces, mercury in said container in amount sufficient to permit displacement of mercury from whichever of said spaces is then elevated into said chamber and thence into the other of said spaces on any tilting movement of the container which raises either of said spaces above the other but insufficient to prevent said chamber from emptying when said container is stationary for a predetermined period, and contacts extending into portions of said container holding mercury in contact with said contacts in all normal positions of said container, the mercury continuously held in contact with either of said contacts being electrically connected to the mercury continuously held in contact with the other of said contacts by mercury occupying said chamber following each such tilting movement thereof.

7. A switch comprising a tubular container pivoted to turn about a transverse horizontal axis, an insert in said container and formed with a conical cavity in each end and with a chamber in its upper portion intermediate its ends, and in restricted communication with the apical end of each of said cavities, mercury in said container in amount insufficient to prevent said chamber from emptying when said container remains stationary for a predetermined period and which is displaced from the then elevated cavity into the other cavity through said chamber when said container is tilted in either direction to thereby raise a corresponding one of said cavities above the other, mercury wells extending downward into said insert from the bottom wall of said chamber, and switch contacts one extending into one and the other into another of said wells, whereby said contacts are connected by mercury accumulating in said chamber on each tilting movement of said container.

8. A switch comprising a tubular container pivoted to turn about a transverse horizontal axis, an insert in said container which is formed with spaces in its end portions and with an intermediate chamber in its upper portions which is in restricted communication with each of said spaces and with an elongated space overlying both of the first mentioned spaces and in communication with said chamber at the top of the latter, mercury in said container in amount insufficient to prevent said chamber from emptying when said container remains stationary for a predetermined period but sufficient to permit mercury to be displaced from the elevated end space into the other end space through said

chamber and elongated space when said container is tilted in either direction to thereby raise the corresponding one of said end spaces above the other end space connected by mercury accumulating in said chamber following each tilting movement of the latter.

9. A switch comprising a container, an insert therein and formed with a chamber intermediate its end and with passages leading from said chamber toward the opposite ends of the insert, mercury in said container, and contacts extending into the container and connected by the mercury accumulating in said chamber when said container is moved to transfer mercury from one end of the container into the other through said passages and chamber, said passages being arranged to provide an inflow of mercury into said chamber from either end of the container more rapid than the resultant outflow of mercury from said chamber when said container is so moved.

10. A switch comprising a container, an insert therein formed with a chamber and with passages leading from said chamber toward the opposite ends of the container, mercury in said container, and contacts extending into the container and connected by the mercury accumulating in said chamber when said container is moved to transfer mercury from one end of the container into the other through said passages and said chamber, said insert being externally grooved to receive cement anchoring said insert in said container and preventing mercury flow through the joint between said insert and container.

11. A switch comprising a container, an insert therein and formed with a chamber in its upper portion and with a conical cavity in each end with passages extending downward from the bottom of said chamber and connecting the latter to the apical ends of said cavities, mercury in said container draining from said chamber when the container is stationary but accumulating temporarily in said chamber when the container is tilted to transfer mercury from either cavity into the other through said chamber, and contacts connected by mercury accumulated in said chamber.

12. A switch comprising a container, an insert intermediate the ends of said container and formed with a chamber in its upper portion and with passages opening to said chamber at its bottom and leading from said chamber toward the ends of said insert, the latter being also formed with wells extending downward from the bottom of said chamber, contacts having portions extending into said wells, and mercury in said container filling said wells but draining from the chamber proper when the container is stationary and temporarily accumulating in said chamber when the container is tilted to transfer mercury from either cavity into the other through said chamber.

13. A switch comprising a container, an insert in said container between the ends thereof and formed with a chamber in its upper portion and formed with spaced apart wells extending downward from said chamber and formed with passages leading downward from the bottom of said chamber and thence longitudinally of said container toward the opposite end of the latter and mercury in said container but displaced from one end of the container to the other through said passages and chamber by movement of the container and draining from said chamber through one or both of said passages when the container is stationary and contacts extending into said wells and connected by mercury in said chamber during periods in which mercury is being transferred through said chamber.

14. A switch comprising a tubular container pivoted to turn about a transverse horizontal axis, an insert in said container which is formed with spaces in its end portions and with an intermediate chamber in its upper portion which is in restricted connection with each of said spaces and with an elongated space overlying both of the first mentioned spaces and in communication with said chamber at the top of the latter, mercury in said container in amount insufficient to prevent said chamber from emptying when said container remains stationary for a predetermined period, but sufficient to permit mercury to be displaced from the elevated end space into the other end space through said chamber, deflecting means within said chamber for directing mercury upward into one-half of said elongated space with rapid initial accumulation of mercury in said chamber upon tilting of the container in either direction said rapid initial accumulation being due mainly to mercury supplied from the other half of said elongated space.

15. In a switch comprising a container movable to and fro and partially filled with mercury and formed with a chamber into which mercury is caused to accumulate by movement of the container in either direction and from which the accumulated mercury drains when said container remains stationary and contacts connected by the mercury accumulated in said chamber, and a shed in said chamber adapted to positively sever said accumulated mercury after a predetermined stationary period of said container.

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