

UNITED STATES PATENT OFFICE.

LOUIS A. M. PHELAN, OF ELKHART, INDIANA, AND CLIFFORD HOTCHKISS, OF MILWAUKEE, WISCONSIN, ASSIGNORS, BY DIRECT AND MESNE ASSIGNMENTS, TO ABSOLUTE CON-TAC-TOR CORPORATION, A CORPORATION OF INDIANA.

ELECTRICAL APPARATUS.

Original application filed December 23, 1922, Serial No. 608,703. Divided and this application filed December 7, 1927. Serial No. 238,332.

Our invention relates to electrical switches designed particularly for the regulation or control of electrical circuits, such as may be used in connection with heating, cooling or alarm apparatus and systems.

The subject matter of this invention has reference to a device making use of a liquid electrical contactor tube, which comprises a container in which are mounted spaced electrodes adapted to be bridged by a body of mercury when the container is properly actuated.

Our invention makes use of an electrical contactor of the above mentioned type, mounted in conjunction with heat or pressure responsive devices, such as curved pressure tubes and thermostatic elements. The pressure responsive or thermostatic element is designed to support and serve to actuate the electrical contactor into or out of circuit closing position when a pressure or temperature change of a predetermined amount occurs.

More particularly our device refers to an electric switch of this type in which the pressure or thermostatic element is unusually efficient, accurate and rapid in operation.

A further particular object of our invention is to provide a ready means for adjusting the above type of device to operate at required predetermined conditions.

Another object of our invention is to produce a contactor tube of the above character, which may be readily mounted upon an actuating device which has available a very small quantity of energy for actuating the contactor tube and which will require only a small change in pressure or temperature for its actuation.

A further object of our invention is to provide a switch device of the type indicated, that will be simple and economical to construct and which will possess great durability, even when subjected to mechanical abuse and when used in connection with considerable quantities of electric current at substantial voltages.

Also further objects and advantages will appear from the following specification and accompanying drawings, in which—

Figure 1 is an elevation view partly in section of my invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a detail sectional view taken on line 3—3 of Fig. 2;

Fig. 4 shows a modification having a special type of casing;

Fig. 5 shows a modification having still another type of casing or housing; and

Fig. 6 is a detail sectional view of a further modification.

In a general way our invention, as shown in Fig. 1, comprises the liquid contactor tube 1 mounted upon a conical spiral thermostatic bi-metallic element 2, which in turn is pivotally mounted at 3 to the frame or support 4. A cover 5 serves to protect and enclose the device.

The tube 1 is constructed in a substantially toroidal form, preferably in the form of a torus. After the various parts in the tube are in place, the tube is evacuated and filled with an inert gas and sealed off through the tip 6. Electrodes 7 and 8 are inserted and sealed in the walls of the tube and may be formed of platinum or of Dumet wire covered or plated with casings of pure iron or the like metal which is unaffected by the arcing obtaining in the tube in the presence of the mercury and the mercury vapor. A body of conducting fluid 9, preferably mercury, may substantially fill the lower half of the container 1 and is normally in contact with the electrode 8. When the tube is tilted in the proper direction, the body of mercury 9 will come into bridging relation with the electrodes 7 and 8, thus closing an electrical circuit through the tube.

Since the tube is of toroidal form and is mounted to be tilted substantially about its geometrical axis, it will be noted that the body of mercury 9 will remain practically stationary and of constant shape when the tube is tilted into or out of circuit making position. In other words, the body of conducting fluid 9, as well as the tube 1, retain a substantially stationary center of gravity when the tube is actuated. Hence it is obvious that very little energy is required either to initially move the tube or to return

the tube to its normal position, since the parts remain practically balanced at all times. In the former types of liquid contactor tubes, it has been necessary to displace a fairly large mass of heavy liquid in order to actuate the device. Such contactors have the further disadvantage that an appreciable temperature change is required to restore the parts including the body of conducting liquid to their normal position after once actuated.

The tube 1 is mounted concentric with the outer turn 2^a of spiral element 2 by means of detachable clips 10 comprising flexible bands of copper or similar material soldered or otherwise fixed to the spiral turn 2^a and clasped around the tube 1 at opposite and spaced points. It will be noted that this structure forms a very simple, compact and easily assembled arrangement of the contactor tube and the thermostatic element.

The spiral element 2 is preferably constructed of a bi-metallic ribbon composed of layers of any suitable metals or alloys, such as brass and nickel, and is wound substantially in the shape of a conical or helical spiral as shown. This form of winding has a particular advantage over the more usual simple spiral form in that a much larger portion of the surface area of the thermostatic ribbon or heat responsive element is directly exposed to the atmosphere and air currents. This is an important consideration when this type of device is used for accurate and rapid temperature regulation. This form of conical spiral mounting has a further advantage in the present structure, in that it makes possible a more convenient arrangement of the lead wires to the contactor tube and permits the contactor tube to be flexibly mounted at a central position in the casing remote from any of the fixed parts of the structure which would possibly hit against and break the glass tube.

The inner end of the spiral element 2 is mounted upon a pivoting shaft 3 which is retained in a frame 4 by a nut 3^a and washer 3^b, as shown in Fig. 3. A collar 11 surrounds the pivoting screw 3 and is fixed to the spiral element 2 by solder or by means of a screw 12.

The collar 11 is provided with an extension 13 which forms a handle for adjusting the angular position of the tube 1 and the spiral element 2 about its pivoting shaft 3. The handle 13 extends to the exterior of the casing and is provided with a pointer 14 cooperating with a calibrated scale 15 formed on an extension of the frame 4.

The electrodes 7 and 8 are connected in the circuit, respectively, by the flexible lead wires 16 and 17. The flexible wire 16 is attached to the outer end of the spiral element 2 so that the electric current flowing in the circuit will traverse this element for the par-

ticular purpose hereinafter described. From the spiral element 2 the circuit continues through frame 4 to a binding post 19. The flexible lead 17 is connected to a binding post 20. The binding posts 19 and 20 serve to connect the device to the desired external circuit.

The cover 5 is attached to the frame 4 by means of lugs 21 formed integral with the lower end of the frame 4 and by a lug 22 formed at the upper end of the frame 4 and engaged by a screw 23. Openings 24 are provided in the cover 5 for the purpose of permitting free circulation of air currents about the thermostatic element 2. The cover 5 is provided with a thermometer 25 which serves as a guide when adjusting the switch to actuate at a desired temperature.

Screw holes 26 may be provided in the frame 4 for mounting the device upon a wall or partition surface.

In Fig. 4, the device is shown mounted in a modified form of casing. The casing here consists of a body portion 27 and a cap portion 28 having a flange 29, which is intended to be mounted flush with a wall surface.

In Fig. 5, the device is shown mounted in another modified form of casing, comprising a rear enclosing frame 30, a mounting plate 31, and a cover portion 32. The rear frame 30 constitutes a weather-proof connection box for the electrical leads and is provided with a threaded opening 35 for a conduit connection.

In Fig. 6, a modification is shown embodying features shown in Fig. 3. A hollow spiral element 46 is shown having outer and inner walls 46^a and 46^b composed respectively of materials having different coefficients of expansion. This spiral element may also be attached to a source of variable pressure, such as the fluid container 47 and hence this element is subject to an alteration in shape when temperature changes occur, both because of its bi-metallic nature and because of its action as a curved pressure tube.

In all of the above described structures it will be noted that the use of bearings in the operating parts of the mountings of the contactor tubes is entirely eliminated. Consequently the spiral elements when actuating the contactor tubes, are now required to overcome any variable frictional losses as would result with the use of bearings.

The operation and one method of using the device of Fig. 1 will now be outlined. The binding posts 19 and 20 are connected directly in series with the circuit which is to be controlled such, for example, as the circuit of a motor controlled heating equipment of any of the usual and suitable types.

Assuming that the room temperature is at or near the desired point, the lever 13 is turned so that the contactor tube 1 is in a substantially neutral position ready to either

close or open the circuit with a very slight change of temperature. If it is assumed that the device is being used for the regulation of heating equipments and that the room is at the desired temperature, then the heating apparatus should not be in full operation and consequently the contactor tube should be in open circuit position with the body of mercury 9 out of contact with the electrode 7. However, as the room temperature drops a predetermined amount, the thermostatic element 2 will become modified in shape because of the temperature change and will rotate the contactor tube 1 about its axis into circuit closing position.

The current to the contactor tube will now flow through the spiral element 2 and will start the operation of the heating equipment. The spiral element 2 will thereupon begin to return to its normal position and will begin to rotate the contactor tube back to its former position as a result of two causes: first, the heating equipment will have partially restored the room temperature and second, the current running through the spiral element will furnish a slight amount of heat, thus aiding in quickly bringing the temperature of the spiral element 2 back to normal.

This current heating effect obtaining in the element 2 has a particular advantage in this type of heat regulating switch which will now be outlined. When the contactor tube 1 turns to its closed circuit position it will tend to remain there for a slightly longer period than necessary due to inertia of the heating apparatus and to the time required to bring the room temperature and the temperature of the thermostatic element back to normal. This will result in a room temperature considerably in excess of that desired before the thermostatic element is sufficiently heated to cause the heating equipment to be shut off. Hence, in order to use this type of regulating switch where the temperature must be regulated very accurately, it is advisable to supplement the action of the increased room temperature upon the spiral element 2 with the heating action of the current flowing through this element. With such a device it has been found possible to regulate the room temperature with an accuracy several degrees closer than with the former methods.

However, in case this type of thermostatic switch is used in connection with the control of refrigeration or cooling apparatus, it will ordinarily be connected in circuit and adjusted to open the circuit upon the occurrence of a sufficient drop in temperature. This is the opposite of its action when used with heating apparatus where it serves to open the circuit upon the occurrence of a sufficient increase in temperature. In view of these facts, the heating effect of the current

through the spiral element is unnecessary in the case of refrigeration and cooling apparatus. Consequently in the device as shown in Fig. 4, the current is not connected through the spiral element but independent lead wires 16^a and 17^a are provided to the binding posts. In other instances, it may be desirable to pass only a portion of the total current through the spiral element and in such cases a shunt wire 16^b, as shown in Fig. 5, may be so designed to by-pass the desired amount of current.

The terms "liquid contactor" and "contactor" as employed in the claims refer to a well known type of mercury electric switch or contactor that comprises a hermetically sealed container in which spaced electrodes are disposed, and a movable body of conducting liquid, such as mercury, that serves to make and break the electric circuit between the said electrodes.

While we have shown and described several embodiments of our invention, it is to be understood that many modifications may be made therein without departing from the spirit and scope of the appended claims, and we desire that only such limitations shall be imposed upon our invention as are specifically pointed out in the claims and such as are required by the prior art.

This application is a division of application Serial No. 608,703, entitled Electrical apparatus, filed by Louis A. M. Phelan and Clifford Hotchkiss, on December 23, 1922.

We claim:

1. A thermostatic switch comprising a coiled thermostatic element, supporting means adjacent to one end of said element, a liquid contactor wholly supported upon the other end of said element, and a body of conducting liquid disposed in said contactor and having a substantially stationary center of gravity.

2. A thermostatic switch comprising a hermetically sealed container shaped substantially in the form of a toroid, means comprising a heat responsive element for rotatably mounting said container in a substantially vertical plane, spaced electrodes within said container, a body of conducting liquid having substantially a stationary center of gravity in said container for bridging said electrodes when said container is rotated through a predetermined angle, and means for adjusting the said electrodes relative to said body of conducting liquid.

3. A thermostatic switch comprising a coiled heat responsive element, a contactor wholly supported upon said element and having spaced electrodes movable with said element, a substantially stationary contact for bridging said electrodes, and an adjustable supporting means for said element for adjusting the position of said electrodes in relation to said stationary contact.

4. A thermostatic switch comprising a spiral thermostatic element, a liquid contactor of substantially toroidal form fixed to the outer end of said spiral element, and a pivoting shaft at the axis of said spiral element for adjusting the angular position of said contactor, the inner end of said spiral element being fixed to said shaft.

5. A thermostatic switch comprising a spiral thermostatic element, a liquid contactor of substantially toroidal form fixed to the outer end of said spiral element, and a pivoting shaft for adjusting the angular position of said contactor and fixed to the inner end of said spiral element, said contactor, spiral element and shaft having a common axis.

6. A thermostatic switch comprising a heat responsive element formed substantially in the shape of a conical spiral, a support fixed to the inner end of said spiral element, and a liquid contactor tube of substantially toroidal shape fixed to the outer turn of said spiral element.

7. A thermostatic switch comprising a liquid contactor, said contactor having a casing of substantially toroidal form, and a thermostatic element of spiral form the outer turn of which has a diameter approximating the diameter of said casing, said outer turn conforming to and serving to support said casing.

8. A thermostatic switch comprising a liquid contactor, said contactor having a casing of substantially toroidal form, a ther-

mostatic element of spiral form the outer turn of which has a diameter approximating the diameter of said casing, said outer turn conforming to and serving to support said casing, and flexible means on said outer turn for clamping said casing.

9. A thermostatic switch comprising a thermostatic element of substantially spiral form, supporting means at the inner end of said spiral, and a liquid contactor comprising a casing fixed to and movable with the outer end of said spiral element, said contactor having electrodes movable with said casing and a substantially stationary body of conducting liquid for bridging said electrodes when said casing and the end of said spiral element move in response to temperature variations.

10. A thermostatic electric switch comprising a thermal sensitive element, supporting means therefor adjacent to one end of said element, a liquid contactor supported upon the other end of said element and adapted to be actuated thereby, and a body of conducting liquid disposed in said contactor and having a substantially stationary center of gravity, said supporting means being adjustable for varying the position of said body of conducting liquid with respect to the electrodes comprised in said liquid contactor.

In witness whereof, we have hereunto subscribed our names.

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