

Jan. 20, 1959

J. R. VANDER PYL ET AL

2,870,294

THERMOSTATIC SWITCH

Filed May 22, 1957

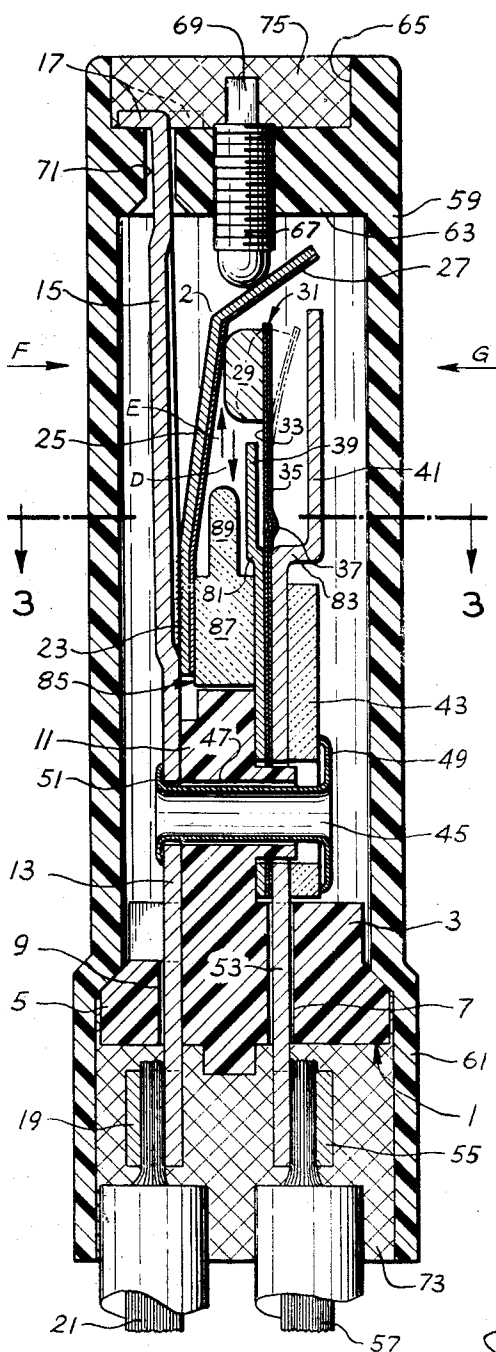


FIG. 2.

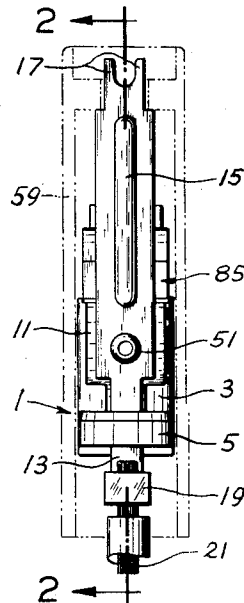


FIG. 1.

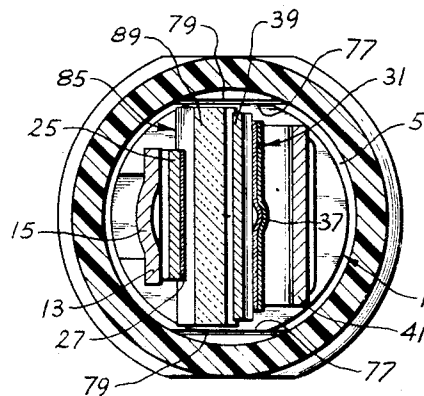


FIG. 3.

John R. Vander Pyl,  
Edward P. Jastram,  
Joseph L. Mc Morrow,  
James E. Shockroo,  
Inventors.  
Koenig and Pope  
Attorneys.

1

2,870,294

## THERMOSTATIC SWITCH

John R. Vander Pyl, Attleboro, Edward P. Jastram, Rehoboth, Joseph L. McMorro, West Bridgewater, and James E. Shockroo, Norton, Mass., assignors to Metals & Controls Corporation, Attleboro, Mass., a corporation of Massachusetts

Application May 22, 1957, Serial No. 660,879

11 Claims. (Cl. 290—120)

This invention relates to thermostatic switches, and with regard to certain more specific features, to such switches for protective use especially (but without restriction) in connection with apparatus involving substantial magnetic fields (stray and otherwise) such as motors and transformers.

Among the several objects of the invention may be noted the provision of a thermostatic switch for controlling circuits of devices having stray magnetic fields, said switch being provided with means adapted to avoid either instantaneous or progressive failure due to the action of such fields; the provision of a switch of the class described which, when used in locations involving said fields, will closely maintain a predetermined desired operating temperature substantially without either exceeding or failing to reach approximately such a temperature when it operates protectively; the provision of a switch of the class described which is adapted to avoid internal short-circuiting upon external short-circuit overload operation; and the provision of a reliable and accurate switch of the class described which for substantial current and voltage rating is of dimunitive tubular or lance-like form adapted conveniently to be inserted into the small spaces directly adjacent the heating parts of motors, transformers, fluorescent lights and the like, to which heating parts a temperature response is to be made by the switch. Other objects and features will be in part apparent and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structures hereinafter described, and the scope of which will be indicated in the following claims.

In the accompanying drawings, in which one of various possible embodiments of the invention is illustrated,

Fig. 1 is a side view of the interior assembled parts of the switch, enlarged and showing in dotted lines a casing slipped thereover prior to completion of the switch;

Fig. 2 is a cross section taken on line 2—2 of Fig. 1, further enlarged and showing said casing in final assembled position; and

Fig. 3 is a cross section taken on line 3—3 of Fig. 2.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Thermostatic switches are frequently employed in the circuits of motors, transformers and the like for the prevention of overheating and burnout of the windings or other parts, both when this heating is due to excessive current flow or excessive ambient temperature rise. Since the temperature rise with which the invention is concerned is usually within intricately related parts such as windings, several problems arise, namely obtaining a switch which (1) will hold constant its temperature calibration, (2) will not fail within the relatively strong magnetic fields found within such locations, and (3) is small enough and of convenient shape to be inserted into the usually small intricately shaped spaces available near such parts.

We have found that a small tubular switch of lance-like form is the most convenient for insertion into small spaces. We have also found that thermostatic switches which heretofore may have been reliable in nonmagnetic

2

locations become unreliable and even fail in magnetic fields of substantial intensity. The reason for this, we have found, is that the fields tend to push any arc that may be formed when the switch opens along its actuating thermostatic bimetallic plate. Such plates are usually of the snap-acting variety, that is, provided with a dimpled or nondevelopable area responsible for its snap action from closed to open position and vice versa in response to a predetermined temperature. When such switches are operative in a magnetic field, the arc sometimes formed upon opening is frequently pushed by the magnetomotive force so as to strike along the surface of the snap-acting bimetal, causing a temperature rise due to the arc which is not the temperature rise in the apparatus against which protection is desired. Therefore, after one or more strikes during a repetitive opening and closing protective functioning of the switch, the calibration of the switch changes. Moreover, it may change inconsistently. Thus the parasitic temperature rise due to the arc striking action may be on the order of 2° C. to 4° C. per strike, which builds up to a higher value if rapid opening and closing action of the switch occurs with consequent rapidly repeated arc strikes. Moreover, physical striations due to the burning action of the arc on the bimetal tend to change its operating characteristics, particularly if these affect the dimpled or nondevelopable area responsible for snap action. In addition, arcs due to short circuits may occur which, if not promptly broken, may cause complete burn-out of the bimetal of the switch.

The present invention avoids, or at least minimizes, the above-stated contingencies and results in the very small and reliable switch for substantial capacity, and which may be inserted in a wide variety of locations where required. For example, a switch such as shown in the drawings, capable of controlling 10 amperes at 115 volts, has a cylindrical shape of  $\frac{5}{16}$ " diameter and  $1\frac{1}{4}$ " length, which can be inserted into very small spaces in and around motor field windings or the like.

Referring now more particularly to the drawings, there is shown at numeral 1 an insulating core composed, for example, of one of the phenolic resins or the like. This core 1 has a beveled disc-like body portion 3 having a flange 5, through which are formed openings 7 and 9, and a supporting tongue 11. Carried on the bottom of the tongue 11 and extending through the opening 9 is a conductive terminal strip 13 which is ribbed for stiffness as shown at 15. At its outer end this strip is reduced in width and provided with deformable staking fingers 17. At its other end it is provided with a deformable terminal sleeve 19 for crimping attachment to a line wire 21. Welded to the strip at 23 is a springy conductor which is composed of a strip of conductive material 25 such as Monel, silver plated as shown at 27. This member 25 forms the stationary but adjustably positioned contact of the switch. It is angled at its free end as shown at 2.

At 29 is shown a movable contact in the form of a conductive button of steel, having a silver contact surface. This is welded to a relatively thin elongate bimetallic strip 31 composed, for example, of bonded sheets of metal such as brass and Invar 33 and 35. The high-expansion component 33 is on the side of strip 31 adjacent the contact 29, and the low-expansion component 35 is on the opposite side. The composite strip 31 is usually made quite thin, such as, for example, .003" to .004". It is provided with a dimple 37 which in effect places in it a nondevelopable area, causing it upon heating to snap at a certain temperature from the circuit-closing position shown in Fig. 2 to a circuit-opening position shown in dotted lines. Upon cooling, it returns from its curved open-circuit position with snap action to its closed-circuit position shown.

The thermostatic element 31 is anchored at its end op-

posite contact 29 by being sandwiched between two conductive arc control grids 39 and 41. The assembly of parts 31, 39 and 41 is supported upon the insulating tongue 11, surmounted by an insulator sheet 43 and held in place by means of a hollow rivet 45 which passes through an opening 47 in the tongue 11. The heads 49 and 51 of the rivet clinch together and hold in assembly the parts 11, 13, 31, 39, 41 and 43. The grid 41 is provided with a conductive extension 53 passing through the opening 7 of the disc 3, where it is provided with a deformable terminal sleeve 55 adapted to be clinched to the other line wire 57, as shown.

At 59 is shown a cylindrical insulating casing or housing (composed, for example, of a thermoset phenolic resin) having a slightly enlarged end 61 for reception of the flange 5 and having a bottom 63 in which is a counterbore 65. Threaded through the bottom 63 is an adjusting nose member 67 having a flat portion 69 by means of which a tool may be applied for adjusting its axial position by turning it. In the bottom 63 is a slot 71 for accepting the staked end 17 of member 13. Thus when the disc 3 and the assembled parts thereon, including the ends of the wires 21 and 57, are inserted into the housing 59, the stakes 17 may be inserted through the opening 71 and turned from the position shown in Fig. 1 to the staking position shown in Fig. 2. At this time, flange 5 seats on the inner end of the enlarged part 61. Then the enlarged portion 61 of the housing may be filled with a suitable potting compound 73 (such as a thermosetting epoxy resin) for sealing the assembled parts in the housing 59. The switch may then be calibrated for proper temperature response by adjusting the nose member 67 against the contact 25, springing the latter into proper tensioned relation with the movable contact 29 so that the composite thermostatic element 31 will snap to open-circuit position upon reaching a predetermined temperature. After the device is calibrated for the proper opening action, an additional amount of potting compound 75 is placed in the counterbore 65 to seal in the stakes 17 and the control part 69. The result is that on the ends of the wires 21 and 57, which are included in the circuit of the device to be controlled (such as a motor), is a tubular lance-type of switch, which in view of its compact and small size may be easily inserted into the small spaces available, for example, in the windings of a motor or transformer. This allows a quick response to temperature rise at its source for control purposes.

As will be seen from Fig. 3, the flange 5 is provided with a pair of flats 77 for engagement with a pair of inside flats 79 within the enlarged part 61 of the housing 59. These are properly arranged for guiding the assembly of parts above described into the housing 59, so that the stakes 17 may be conveniently directed into the slot 71.

It will be noted from Figs. 2 and 3 that the arc control grids 39 and 41 have opposite offsets 81 and 83, respectively, the purpose of which is properly to space the ends of these control grids in relation to the contacts 25 and 29 in both the closed and open positions of the latter (compare the solid-line closed position and the dotted-line open position of the movable contact 29 in relation to the stationary contact 25). Between the sandwiched conductive members 31, 39 and 41 on the one hand, and the welded contact 25 on the other hand, is located a ceramic insulating insert 85 which has a main body portion 87 and an arc-attenuating shelf 89 extending in the direction of the contact 29 and also in the direction of the ends of the control grid 39 and the adjustable contact 25.

Operation of the device is as follows, starting with the parts in the normal cold circuit-closed position shown in Figs. 2 and 3, wherein the movable contact 29 engages the contact 25 to close the circuit through wires 21 and 57:

The switch, being in tubular form, is readily inserted into, for example, any small space in the field windings

of a motor, wherein it may be held by suitable means. In such a location it is promptly responsive to any overheating of such field coils and is also responsive to any overload current which flows through such coils and the thermostatic plate 31. Any resulting heating raises the temperature of the plate 31 to a degree at which the plate will snap from its solid-line to its dotted-line position shown in Fig. 2, thus protectively opening the field circuit of the motor into which the wires 21 and 57 are connected. If, as may occur, an arc is struck between the contacts 29 and 25 as they separate, and the magnetomotive force of the motor field happens to be in the direction shown by the arrow D, this arc will tend to be forced in that direction. Without the control grid 39, this arc would be likely to progress along the bimetallic material of the plate 31, thus at least tending to heat it undesirably and even physically damaging its surface by burning. In the former case this would change the temperature at which the switch would reopen after reclosure, particularly if reclosure and reopening were to occur in fairly rapid succession, as is sometimes the case. In the case in which physical damage might be done to the plate 31, its operating temperature might be permanently changed. By inserting the control grid 39 in the position shown, and having it at the same potential as the contact 29 (being in electrical contact with the plate 31), the arc is magnetically forced against the grid 39, continuing its progress in the direction of the arrow D. Ultimately it reaches the margin of the tongue 39, assuming a serpentine path around it as the arc progresses, until its length is greater than can be sustained by the overload voltage. The attenuating and ultimate arc-breaking or snuffing action is effective even under conditions of current flowing through the switch corresponding to short-circuit values. Since the action described has transferred the arc to the grid 39, all damage to the plate 31 is avoided. Any damage that may occur to the relatively bulky grid 39 and contact 25 is of inconsequential amount, although the same damage might be consequential in the case of the thermostatic plate 31, keeping in mind that this plate is very thin as compared to parts 25 and 39.

It may also occur that the switch, when inserted in an opening available therefor in a motor field or the like, is in a magnetic field having a magnetomotive force in the general direction shown by the arrow E. In such event, the struck arc normally tends to be forced in the direction opposite to that above described and may travel from the bent end of the contact 25 along the upper side of the thermostatic plate 31, that is, in the absence of any control grids such as 41. However, the control grid 41 prevents this, it also having the same potential as that of the plate 31. Therefore the grid 41 picks up the travelling arc and as it tends to travel back toward the rivet 45, attenuating and snuffing it by elongating it. The purpose of the insulator sheet 43 is to prevent the arc from reaching the rivet 45 in its travel along the outside of grid 41.

If the ambient magnetic field around the switch is such that its magnetomotive force is in either of the directions shown by the arrows F and G, then the tendency for the arc to travel along the thermostatic plate 31 is less but the thermostatic plate 31 is again protected by the control grids 39 and 41 and members 85 and 43. Also, the switch is reliable and has better operating characteristics than prior thermostatic switches when in locations wherein there are no magnetic fields.

It may be mentioned that snap-acting thermostats are particularly vulnerable to damage from striking arcs, especially when the arcs are likely to strike their dimpled non-developable portions such as 37 in Fig. 2. This is because the operating stresses afforded by such dimples or the like are responsible for the snap action, and the stresses depend upon the form of the dimple and the characteristics of the metallic material therein, both of which may be deleteriously changed by such striking arcs. It will be

noted that the arc control grids 39 and 41, taken with the sides of the housing 59, act as an arc protective shell around the critical dimpled portion 37.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

We claim:

1. A thermostatic switch comprising contacts which are relatively movable to open and close a circuit, a snap-acting thermostatic plate supporting one of the contacts and having a nondevelopable portion responsible for its snap action, the plate and both contacts being in series connection in said circuit when the contacts are closed, and an arc control grid so located relative to said nondevelopable portion and at least one of said contacts that any arc struck therebetween is deflected by the grid from said nondevelopable portion of the plate.

2. A thermostatic switch comprising an insulating body, an elongate stationary contact extending from said body, an elongate thermostatic plate extending from said body substantially in the direction of said contact, line terminals in conductive relation to the contact and plate respectively, a movable contact carried upon said plate adapted to move into and out of engagement with said stationary contact, elongate arc control grids extending along and in conductive relation with respect to said plate and located on opposite sides thereof, and an insulating shelf in spaced relation to and extending between one of the control grids and said stationary contact.

3. A thermostatic switch made according to claim 2, including an elongate insulating sleeve extending from said body and surrounding the assembly of contacts, plate, grids and shelf, said stationary contact having an adjustable free end portion, and a member adjustably mounted in the end of said sleeve and adjustably engaging said free end.

4. A thermostatic switch made according to claim 3, wherein said sleeve has an opening in its end adjacent said adjustable portion and said stationary contact includes a staking portion extending through said opening, said line terminals being integral respectively with a portion of said stationary contact and a portion of one of said control grids.

5. A thermostatic switch comprising a circular body portion having an extension containing a hole, conductive line terminals extending through said body portion on opposite sides of said extension, an insulating cylindrical casing surrounding and extending from said body portion and having a closed end spaced therefrom, said closed end having an opening adapted to receive an end of one of said line terminals adapted for staking beyond the opening, an axially adjustable member in said closed end, a springy elongate stationary contact attached to the last-named line terminal and having an angled end engageable by said adjustable member, an assembly constituted by conductive control grids sandwiching a conductive thermostatic plate extending from said extension on the body portion, said thermostatic plate having a movable contact at its end engageable and disengageable with said stationary contact, and insulating member on said assembly, fastening means extending through said hole in the extension of the body portion and anchoring the assembly of said line terminals, conductively related control grids, thermostatic plate and stationary contact.

6. A thermostatic switch comprising contacts which are relatively movable to open and close a circuit, a snap-acting thermostatic plate supporting one of the contacts, the plate and both contacts being in series connection

in said circuit when the contacts are closed, an arc control grid located at one side of one contact and between said thermostatic plate and the other contact, said arc control grid being at the potential of said plate, and an insulating tongue located between the last-named contact and said arc control grid and being spaced from both.

7. A thermostatic switch made according to claim 6, including a second arc control grid located on that side of the thermostatic plate which is opposite to its side on which is located said first arc control grid, said second control grid being also at the potential of said plate.

8. A thermostatic switch comprising contacts which are relatively movable to open and close a circuit, a snap-acting thermostatic plate supporting one of the contacts, the plate and both contacts being in series connection in said circuit when the contacts are closed, an arc control grid located at one side of one contact and between said thermostatic plate and the other contact, said arc control grid being at the potential of said plate, and a second arc control grid located on that side of the thermostatic plate which is opposite to its side on which is located said first arc control grid, said second control grid being also at the potential of said plate.

9. A thermostatic switch comprising an elongate stationary contact, an elongate thermostatic plate extending in the general direction of said stationary contact, a contact supported on said thermostatic plate and movable thereby into circuit-closing and -opening positions relative to said stationary contact, an elongate arc control grid also extending in the same general direction of said stationary contact and the thermostatic plate and located between them substantially to shield the plate from any arcs drawn between the contacts, said grid and plate being conductively connected and at the same potential, said stationary contact having a turned adjustable end, and a second arc control grid of elongate form on the side of said thermostatic plate opposite its side on which is located the first-mentioned arc control grid, said second arc control grid having its end located adjacent said turned portion of said stationary contact.

10. A thermostatic switch comprising an elongate stationary contact, an elongate thermostatic plate extending in the general direction of said stationary contact, a contact supported on said thermostatic plate and movable thereby into circuit-closing and -opening positions relative to said stationary contact, an elongate arc control grid also extending in the said general direction of said stationary contact and the thermostatic plate and located between them substantially to shield the plate from any arcs drawn between the contacts, said grid and plate being conductively connected and at the same potential, and an insulating member located between said arc control grid and said stationary contact and having a transverse shelf portion between the arc control grid and the stationary contact and spaced from both, said shelf portion extending a substantial distance in the direction of said grid and stationary contact.

11. A thermostatic switch made according to claim 10, wherein said stationary contact has a turned adjustable end, and a second arc control grid of elongate form on the side of said thermostatic plate opposite its side on which is located the first-mentioned arc control grid, said second arc control grid having its end located adjacent said turned portion of said stationary contact.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |             |               |
|-----------|-------------|---------------|
| 1,048,366 | Smith       | Dec. 24, 1912 |
| 1,749,539 | Keller      | Mar. 4, 1930  |
| 2,073,104 | Hodgkins    | Mar. 9, 1937  |
| 2,102,545 | Rowe        | Dec. 14, 1937 |
| 2,729,722 | Nelsson     | Jan. 3, 1956  |
| 2,733,312 | Christensen | Jan. 31, 1956 |