June 24, 1969 F. G. PERRY 3,452,313

SNAP ACTING THERMOSTATIC ELECTRIC SWITCH

Filed Dec. 19, 1966 Sheet 1 of 2

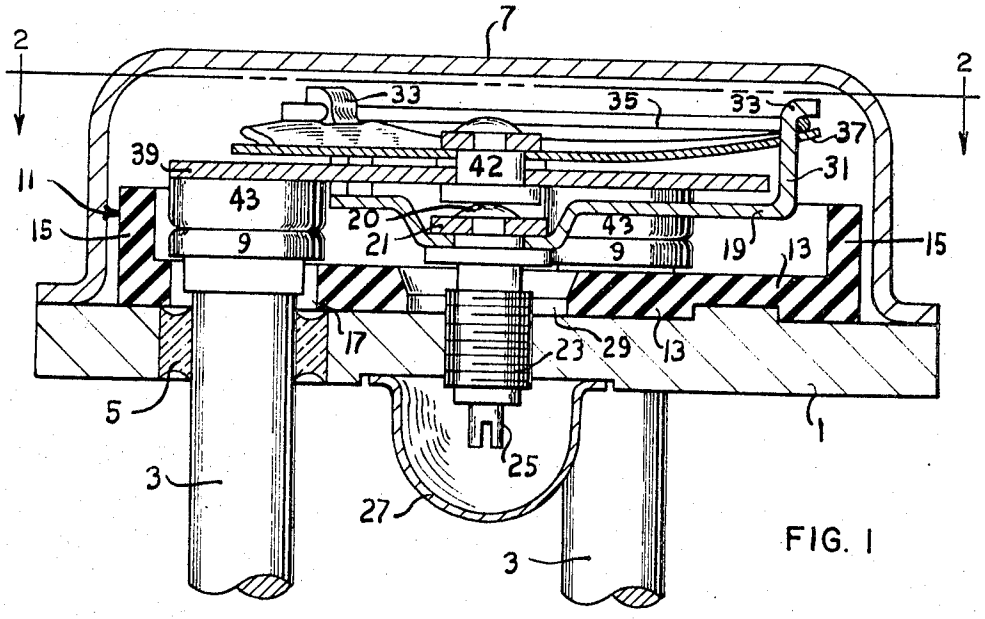

FIG. 1

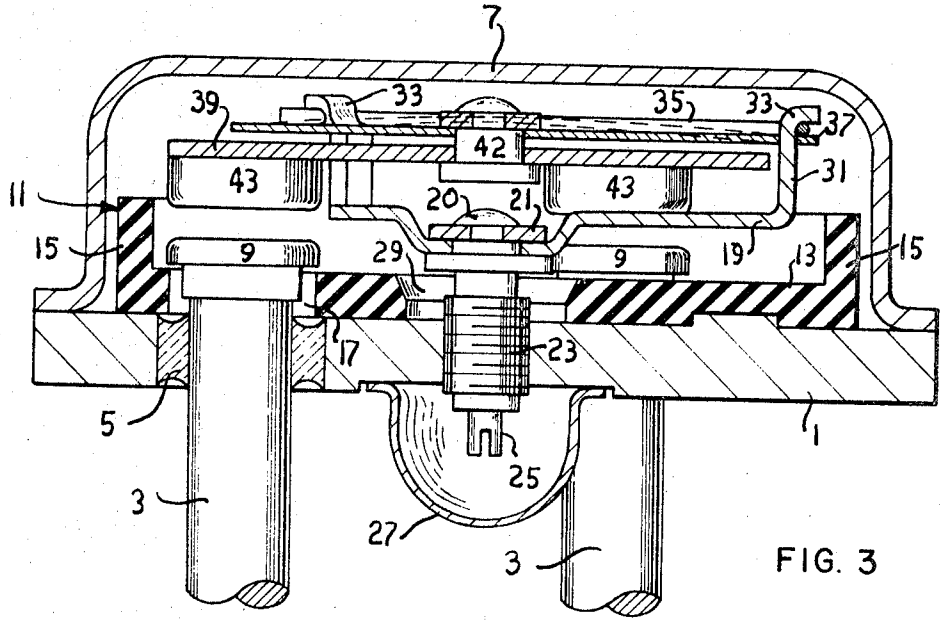

FIG. 3

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June 24, 1969 F. G. PERRY 3,452,313

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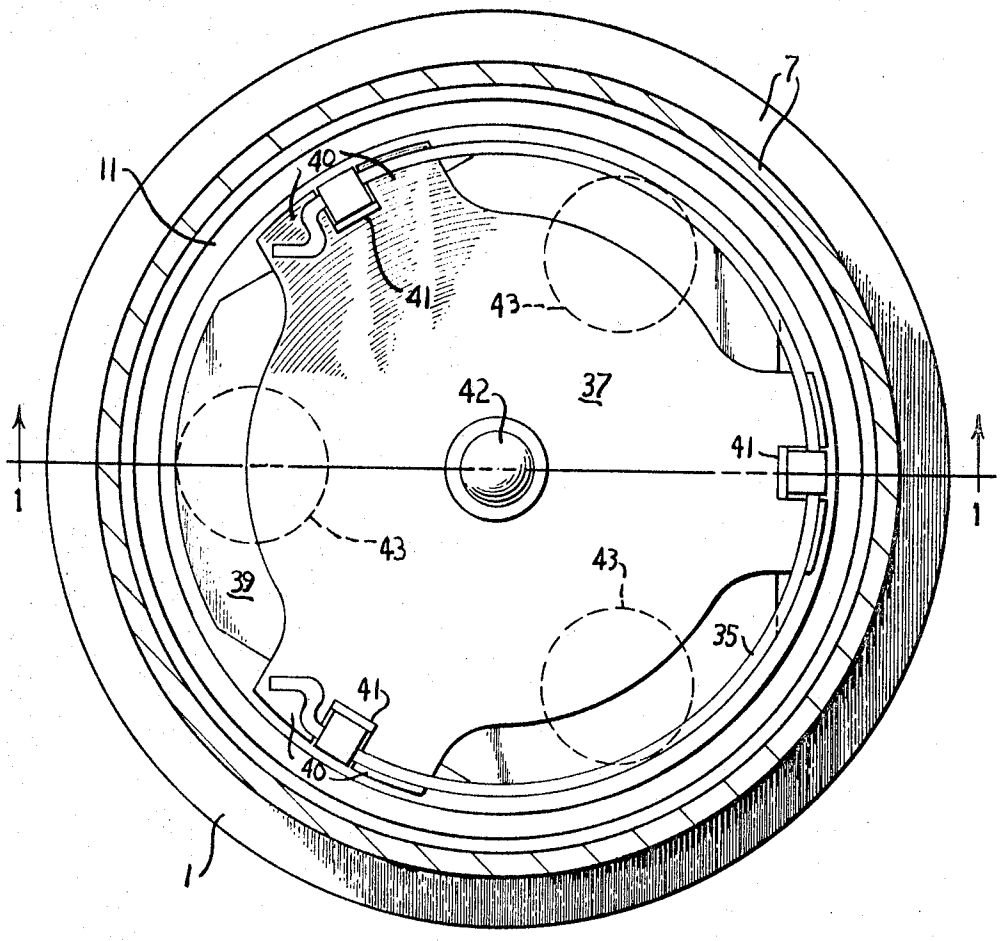

FIG. 2

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SNAP-ACTING THERMOSTATIC ELECTRIC SWITCH

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3 Claims

ABSTRACT OF THE DISCLOSURE

A compact snap-acting thermostatic electric switch in which a snap-acting thermostatic disc is physically assembled with a contact-carrying heater plate, the disc and plate being movable as a unit in which there is an improved heat-exchange relationship between the plate and disc brought about by heat conduction, as well as by radiation and convection. The heater plate carries the movable contacts of the switch and it also functions as an arc shield for the disc. An arc shield for the housing is also provided. An adjustable support for the disc and plate assembly provides for calibration.

Background of the invention

The field of the invention is temperature-responsive, heat-control switches, more particularly (but not exclusively) for use in motor protection circuits. Heretofore snap-acting disc-type control switches of this class have been provided with stationary electric heaters for accelerating switch-opening operation in response to heating, so as to prevent temperature overshoot. It is desired that the opening responses of switches of the stated class shall be as rapid as possible to minimize overshoot, and that their closing responses shall not be so rapid as to cause excessive cycling. Also, the snap-acting disc or like elements thereof require protection against damage under severe arcing conditions which may cause undesirable shift of temperature response and shortened switch life.

Summary

Briefly, the invention comprises a subassembly of a resilient snap-acting thermostatic plate or disc and a heater plate so that they are permanently in close heat-exchange relationship by heat conduction, as well as by heat radiation and convection. The heater carries the movable switch contacts. The heater is preferably substantially rigid, but may have some resilience. Stationary contacts are carried in a housing which forms a support. Adjustably mounted in the housing is a fixed support for the snap-acting disc. As the disc snaps from one position to another the heater plate is carried along with it so as to open and close the contacts. Regardless of whether the switch is closed or opened, the disc and the heater remain in close heat-exchange relationship. The heater also functions in all positions as a shield or baffle to prevent any contact arcing from reaching the disc. An insulating cup-shaped shield around the contacts shields the housing from arcing.

Brief description of the drawings

FIG. 1 is a cross section of the switch in contact-closed position, being taken on line 1—1 of FIG. 2;

FIG. 2 is a cross section taken on line 2—2 of FIG. 1; and

FIG. 3 is a view similar to FIG. 1 showing the switch moving into contact-open position.

Corresponding reference characters indicate corresponding parts throughout the three views.

Description of the preferred embodiment

There is shown at numeral 1 a metal base or so-called header, supporting three terminals 3 which extend through insulating seals 5 composed, for example, of glass. Attached to the header 1, as by welding, is a metal cover 7. The header 1 and cover 7 form an inside hermetically sealed compartment for containing the switch operating parts.

The terminals 3 are connected with three fixed terminal contacts 9 within the compartment. Surrounding the contacts 9 is a cup-shaped ceramic insulator 11 having a bottom 13 and an upstanding circular side wall 15. Three openings 17 in the bottom accommodate the upper ends of the terminals 3 and the fixed contacts 9 carried thereby.

At 19 is shown a spider which by means of a rivet 20 and washer 21 has a swivel connection with a calibrating screw 23 threaded through the base 1. The screw is provided with a slotted head 25 for rotating it. A cover for the screw is provided as shown at 27. The inner parts of the screw 23 extend through a central opening 29 in the bottom of the cup 11. The spider 19, which functions as a support, is provided with several upstanding fingers 31 which at their upper ends are formed as outwardly directed hooks 33 for the reception of a retaining snap ring 35.

At numeral 37 is shown a springly bimetallic snap disc bowed in the usual manner for snap action. The disc has marginal bifurcated ears 40, these being notched as shown at 41 for the reception of said hooks 33. The ears 40 are located under the snap ring 35. The disc 37, by means of a heat-conductive metal rivet 42, is permanently attached at its center to a heater plate 39. The plate is conductive, being composed of metal which will increasingly generate heat in response to increased flow of current therethrough. The plane of the heater 39 is close to and generally parallel to the general plane of the thermostatic disc 37, which favors heat transfer by radiation. Attached to the bottom of heater plate 39 are three movable contacts 43 for engagement in the cup 11 with the three fixed contacts 9. The assembly of the heater plate 39, snap-acting disc 37 and the support 19 may be downwardly adjusted by turning the screw 23 until the movable contacts 43 engage the fixed contacts 9. Additional downward adjustment serves to increase contact pressure and apply more or less downward force on the ears 40 of the disc 37 so as to tension it and calibrate the device for snap action at a desired temperature. As shown in FIG. 1, the disc 37 is normally bowed downwardly in its cold position. Its layer of relatively low thermal coefficient of expansion is lowermost and its layer of relatively high thermal coefficient of expansion is uppermost. Since the disc is thin the layers are not distinguishable in the drawings.

While three terminals and three pairs of contacts are shown for three-phase motor protection, it is to be understod that two, or more than three, of such may be employed, according to the invention.

Operation is as follows, starting with the position of parts shown in FIG. 1, assuming that the windings of a three-phase, Y-connected motor are connected to the terminals 3 and that preferably the whole switch is in effective heat-exchange relationship with the motor parts. The heater plate 39 forms the common junction of the Y connection between the three phases of the motor and therefore carries its currents.

Under normal motor running conditions the temperature of the disc 37 and of the heater plate 39 will dispose the disc in its downwardly bowed cold position with the pairs of contacts 9 and 43 closed (FIG. 1). If for any reason the motor becomes overloaded so as to draw more current and therefore heat unduly, the temperature of the disc 37 and plate 39 will increase due to ambient heat

received from the motor. The temperature of heater plate **39** will more rapidly increase due to resistance heating caused by I^2R losses, since current through all of the motor phases passes through it. Heat is efficiently transferred from plate **39** to the disc **37**, particularly by conduction through the metal rivet **42**, and also by direct radiation, and, in addition, by convection if the switch is mounted with the base **1** down. Thus, rise in the disc temperature of disc **37** is substantially accelerated beyond that which would occur in response to ambient heating. When the disc **37** reaches its calibrated operating temperature it snaps through the solid-line to the upwardly bowed dotted-line configuration shown in FIG. 3. It carries with it the heater plate **39** and its movable contacts **43**, thus opening the circuit. Upon cooling, converse action will occur, thus reclosing the circuit.

Initial calibration is brought about in the closed position of the switch by turning screw **23** to draw down the support **19** which increases contact pressure. This causes an upward force on the center of disc **37**. The resulting downwardly acting force on the marginal portions of disc **37** tensions it without causing it to snap. The adjustment is carried out so that snap action to open the contacts will occur under the desired temperature condition.

Advantages of the invention are that the switch-opening response is rapid because of the intimate heat-conductive contact between the heater plate **39** and the disc **37**. Unlike conventional thermostatic protector switches, its snap-acting disc carries no current. Thus, the disc is not required to carry overload current, which heretofore has had the undesirable effect of discoloring it so that heat absorption thereby through radiation was variable to the extent of modifying its operating calibration. Moreover, disc life is increased. All of the heat that the disc receives is that due: first, to ambient heating, as for example by heat coming from the motor parts; second, and importantly, to conductive heating received through the metal rivet **42** from the resistance-heated plate **39**; and, third, to radiant and conductive heating received from the plate **39**. As a result the opening response of the switch is rapid. In addition, there is the very desirable feature of a very long "off" time due to the fact that rapid cooling of the disc **37** is slowed by the heat that it conductively receives from the plate **39** during cooling of the latter. This avoids excessive cycling action while a motor is too hot. A typical motor-protective action involves an "on" time of 10 seconds and an "off" time of 300 seconds.

Disc life is also greatly enhanced because any severe arcing does not erode it, such as might cause temperature shift, since the heater plate **39** acts as a shield or baffle between the contacts and the plate. Moreover, the circumambient insulator **11** shields the housing parts **1** and **7** from the deleterious effects of arcing.

It will be understood that there may be substituted for the bowed disc **37** other forms of snap-acting elements such as deformed thermostatically operative plates of various shapes. The heater **39** may also have other shapes.

From the above, it will be seen that the switch is particularly useful as a motor protection switch but it is to be understood that this is not its only use.

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.

What is claimed is:

1. A thermostatic switch comprising line terminals, terminal contacts connected therewith, a resilient snap-acting thermostatic disc, a heater plate centrally connected with said disc by a metallic heat-conductive member for movement therewith as the disc moves to snap, marginal supporting means for the disc, and movable contacts carried by said heater plate for movement thereby into and out of engagement with said terminal contacts as the heater moves in conjunction with the movement of the disc, said marginal supporting means being in the form of a spider having fingers connected with the margin of the disc, and means for adjusting said marginal supporting means, said adjusting means being in the form of a screw supporting the spider.

2. A thermostatic switch comprising a housing, line terminals, a circumambient insulator in the housing, contacts within the ambit of the insulator and connected with the terminals, a support, an adjusting screw for the support threaded through a portion of the housing for exterior manipulation to position said support interiorly, said support being in the form of a spider having fingers, a bowed snap-acting disc marginally supported by said fingers of the support, a heater plate having a substantially central heat-conductive connection with said disc and being disposed substantially parallel thereto, and movable contacts carried by said heater plate on its side opposite to the side adjacent the disc and movable by the heater as the disc snaps to and from the fixed contacts within the ambit of said insulator.

3. A thermostatic switch comprising a housing, a circumambient insulating cup therein, a support, the bottom of the cup having several openings, some of which are for the reception of terminals and terminal contacts located in the cup, an adjusting screw extending through a central one of said openings in the cup and threaded through said housing for exterior manipulation to position said support interiorly, said support having holding fingers, a resilient bowed thermostatic disc marginally supported by said fingers, an electrically conductive heater plate having a heat-conductive central connection with said disc and being positioned substantially parallel thereto, and movable contacts carried by said heater plate on its side opposite the disc and movable thereby to and from the fixed contacts within said insulating cup.

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