This invention relates to thermostatic electrical switches, and in particular, to miniaturized thermostatic switches of the snap-acting type.

This invention lies in the field of miniaturized, simple and economically made thermostatic switches, and particularly those which are small enough to be mounted on, inserted in or embedded directly into windings of electric motors and generators, or in other miniaturized, rotating or stationary devices such as transformers, relays, etc., the thermostatic switch serving to protect such devices from overheating. The trend in current requirements for such electrical devices such as subminiature motors, transformers, generators, etc. has been toward a continuous reduction in size to the point where, in many cases, conventional protectiive devices are unsuitable because of their large size, weight and cost requirements.

It is to be understood, however, that the invention is not limited to such protective use mentioned above, but may be used wherever found applicable.

The instant invention provides an electrical switch which is both current and temperature sensitive, and provides substantially the same operational benefits as conventional larger protectors, but additionally affords extremely reduced size and provides a switch at considerably reduced cost.

It is one object of the instant invention to provide a thermostatic switch means which is simple in construction, adapted for miniaturization, inexpensive to manufacture, and reliable in operation.

It is another object of the instant invention to provide a thermostatic switch which is adapted for miniaturization so as to be conveniently insertable into the small spaces directly adjacent the heated parts of motors, transformers, fluorescent ballasts and the like, to which heated parts a temperature response is to be made by the switch.

It is yet another object of the instant invention to provide a thermostatic switch means which is safe and reliable in operation and is easily and simply calibrated.

It is a further object to provide a miniaturized thermostatic switch means wherein certain parts thereof are particularly suited for mass production by etched or printed circuit techniques.

Among the several further objects of the instant invention may be noted the provision of a thermostatic switch of such simplicity as to make it feasible for mass production; the provision of a switch of the class described which has a low heat mass and therefore has fast response; which may be easily calibrated; which is both heat and current sensitive, durable, accurate, compact, which is versatile and susceptible to varying electrical ratings, particularly low current ratings; which embodies a minimum number of parts; and which is simple and economical to manufacture.

Other objects will be 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 the application of which will be indicated in the following claims.

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

FIG. 1 is a top plan view of one embodiment of the instant invention;

FIG. 2 is a front elevational view of the switch shown in FIG. 1, with parts thereof in section; and

FIG. 3 is a view similar to FIG. 1, but with certain of the parts thereof omitted for clarity of illustration.

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

Dimensions of certain of the parts as shown in the drawings have been modified for purposes of clarity of illustration.

It is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring now to the drawings, there is shown a miniaturized thermostatic switch indicated generally by numeral 35 according to one embodiment of the instant invention.

Switch 10 comprises a bimetal member 12 formed of a conventional, electrically insulating or dielectric material.

Base 12 includes a plurality of spaced, mutually electrically insulated, electrically conductive surface portions generally referred to by numerals 14, 16 and 32, which form a printed circuit arrangement. The printed circuit or electrically conductive portions 14, 16 and 32 and base 12 are particularly suited for mass production by conventional etched or printed circuit techniques.

Referring now to FIGURE 3, printed circuit portion 16 is substantially L-shaped and one leg 18 thereof provides a stationary contact adapted for engagement with a thermally responsive switching element. The other leg 20 thereof provides an electrically conductive terminal portion adapted for securing to an electrically conductive lead in a conventional manner. Printed circuit portion 14 is elongated and at one end 24 thereof, provides an electrically conductive terminal portion for securing to an electrically conductive lead. The other end 26 of printed circuit portion 14 is electrically connected to one end 29 of an electrical heater member 30. The third printed circuit electrically conductive portion 32 is substantially L-shaped, as shown in FIG. 3, and one leg 34 thereof which is electrically connected to the other end 31 of heater 30, whereby conductive portion 32 is also electrically connected to conductive portion 14. The other leg 36 of the L-shaped printed circuit conductive portion 32 mounts a thermostatic switching element generally referred to by numeral 40, in electrical connection therewith as will be described in greater detail below.

Heater 30 may be formed of a conventional electrical resistance heating material such as Nichrome (a registered trademark of Driver-Harris Co. for an electrical heat and corrosion resisting alloy consisting essentially of 15-16% chromium; 90-92% nickel, about 24% iron and 0.1% carbon) or the like.

As best seen in FIGS. 2 and 3, base 12 provides a rectangular shaped, open-ended aperture or opening 38 for the reception of heater 30. It is to be understood that heater 30, although shown in coil form, may take other forms to provide desired performance characteristics.

As will be clear from the following description, thermally responsive switch 10 is both heat and current sensitive and is adapted to provide so-called inherent over-heat protection. Thermostatic switching element 40 takes the form of a thermostatic snap-acting strip-type disc. Thermally responsive element 40 is a snap-acting element and generally comprises a relatively thin, elongated, thermo-
stat metal strip having a dished area 42 which is responsible for its snap action, provided therein as shown. The operation of dished, thermostat snap-acting element 40 is well known, see for example, United States Patents 1,445,240; 2,768,342 and 2,866,039. Snap-acting element 40 may be formed of a conventional thermostatic material such as bimetal or trinetal.

Snap-acting element 40 includes a unique contact portion 46 at its free end, which contact portion 46 is adapted to mate with the stationary contact portion 18 provided by the printed circuit conductor portion 16. Contact portion 46 comprises a dished or depressed portion formed in thermostatic element 40 at the time of blanking and manufacturing of the element. Prior to forming the dished or depressed contact portion 46, a low-resistance contact material such as, for example, silver, is bonded or plated on the underside of the blank which ultimately forms the thermostatic disc (as seen in FIG. 2) in the area of the dished or depressed portion 46. Consequently, after deforming the blank to form the dished contact portion 46, the latter has a low-resistance contact material which is adapted to engage the printed circuit stationary contact portion 18 to form a good low-resistance electrical current path therebetween. This construction advantageously eliminates a potentially more costly operation of welding or riveting a separate contact to the disc. Further, a welding or riveting operation would also be extremely cumbersome in view of the extremely small dimensions involved and might deleteriously affect the thermal characteristics and calibration of the snap-acting element.

Thermostatic snap-acting disc 40 includes, at its other end, a bent offset portion 50 which provides a tab portion 52. Tap portion 52 is conductively connected and secured to leg 36 of printed circuit portion 32 as by welding, to cantilever mount the snap-acting thermally responsive disc 40. Bent portion 50 and tap portion 52 provide a spring bias which urges and biases the disc for movement in a direction away from base 12, as seen in FIG. 2. Movement in this direction is limited by means of an adjusting or calibrating screw 56, which as will be described in greater detail below, advantageously serves many functions. Adjusting screw 56 includes a threaded shank portion 60 which is received in an adjustable threaded engagement within open-ended threaded aperture 62 provided by base 12. Thermostatic disc 40 provides an aperture 43 which loosely receives threaded shank portion 60 of adjusting screw 56.

The flange of screw 56 provides a surface portion 58 for engagement with dished or dimpled portion 42 of disc 40 when the latter is in the convex position, as shown in full lines in FIG. 2. Calibration of the disc 40 can be easily effected by suitable rotation of screw 56. Engagement between surface portion 58 and the dished portion 42 of disc 40 maintains the disc in a contacts-closed position against the spring bias exerted by portion 50 when the dished portion is in the convex position as shown in full lines in FIG. 2. Surface portion 58 also serves the additional function of providing a stop portion and surface for the dished portion 42 to bear against and snap from a contacts-closed to a contacts-open position, and is advantageously effective to prevent the contacts from creeping open prior to occurrence of snap action. The spring bias provided by portion 50 of the thermostatic disc 40 further advantageously serves to inhibit the contacts from creeping closed prior to the occurrence of snap action from the dished-line contacts-open position to the full-line contacts-closed position, shown in FIG. 2.

Heater 30 is advantageously housed within the base, as described above, and is in very close thermal juxtaposition to the dished or dished portion 42 of the disc. The unique arrangement of the heater provides for maximum thermal transfer and yet does not interfere with the snap motion of the disc, or necessitate increased switch dimensions.

Switch 10 thus establishes a circuit as follows: from printed circuit portion 14, to end 29 of heater 30, through heater 30, to end 31 thereof, to leg 34 of printed circuit portion 32 and leg 36 thereof, to tab portion 52 of snap-acting element 40, through the snap-acting element 40, to contact 46, to stationary contact portion 18 of printed circuit portion 16.

The complete calibrated switch in applications as a motor protective device, may be mounted in thermal juxtaposition to parts to be protected, for example, of miniaure electric motors, generators, relays, etc. In such a place, it is responsive immediately and faithfully to the actual temperature of the parts to be protected. For example, the terminal portions 20 and 24 may be connected in series with one lead to a motor winding to be protected. Thus, if the motor should approach a temperature which is deleterious to the winding insulation or dangerous as a fire hazard, etc., thermostatic element 40 will snap upwardly (as shown in dashed lines as FIG. 2) to separate movable contact 46 from the stationary contact portion 18, thus interrupting the current to the motor. When the motor is cooled to a predetermined temperature which is a preselected amount below the predetermined temperature, thermostatic element 40 will snap back to its contacts-open position for re-energization thereof. Heater 30, which is in electrical series connection with thermostatic disc 40, may be designed so as to pass normal load currents, and yet does not create excessive heat sufficient to actuate the snap-acting disc 40 to snap to a contacts-open position and interrupt the circuit.

From the above, it can be seen that the instant invention provides a thermostatic switch which comprises a relatively small number of parts, which can be simply, quickly and inexpensively produced and calibrated. The thermostatic switch individual component, which can be mass produced and quickly and inexpensively assembled into operative position. The thermostatic switch of the instant invention advantageously lends itself to a miniaturized construction. Merely by way of illustration and not limitation, thermostatic switches according to the instant invention have been made as small as 0.345" long by 0.125" wide by 0.0625" thick.

The unique construction of the thermostatic switch of the instant invention renders its operation substantially free from influence of vibration and renders the thermostatic switch particularly suited to applications where severe vibration is a factor.

The switch of the present invention has minimum heat mass and minimum size, leading to quick heat response. Such quick heat responses are very valuable and are critical in certain motor protection applications.

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

As many 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, and it is also intended that the appended claims shall cover all such equivalent variations as come within the true spirit and scope of the invention.

I claim:

1. An electrical switch comprising a base formed of electrically insulating material, said base having at least two elongated electrically conductive portions comprising layers of electrically conductive material adhered to one side of said electrically insulating base and arranged in spaced electrically insulated relationship, a first one of said portions providing a stationary electrical contact; a thermally responsive element conductively connected to a second one of said conductive portions and operatively associated with electrical contact means for movement of the latter into and out of engagement with said stationary electrical contact; a third electrically conductive surface
portion on said base in spaced, electrically insulated relation to said first and second electrically conducting surface portions, said first and third conducting portions respectively providing a pair of spaced terminals; and electrical heater means disposed in an opening in said base located intermediate said second and third electrically conducting surface portions in close thermal juxtaposition to said thermally responsive element; said heater means being electrically connected between said second and third electrically conducting surface portions.

2. An electrical switch comprising a base member formed of an electrically insulating material, said base member having at least two electrically conducting surface portions in spaced mutually electrically insulated relation, a first one of said electrically conducting portions providing a stationary electrical contact; a strip-type thermally responsive element having an offset portion adjacent one end thereof secured to a second one of said electrically conducting surface portions at a part thereof remote from said stationary contact, said thermally responsive element providing electrical contact means adjacent the free end thereof for engagement with said stationary contact, said thermally responsive element comprising a snap-acting bimetallic disc having a dished portion therein responsible for its snap action, said switch including an adjusting screw having a threaded shank loosely received in an aperture provided by said disc and mounted in threaded engagement with a threaded aperture provided by said base member, and said adjusting screw including a flange having a portion thereof adapted to engage said dished portion to serve as a stop for said dished portion to bear against and snap from one position to another.

3. An electrical switch comprising a base member having at least two printed circuit type electrically conducting surface portions in spaced mutually electrically insulated relation, a first one of said electrically conducting portions providing a stationary electrical contact; a strip-type thermally responsive element secured to a second one of said electrically conducting surface portions, said thermally responsive element providing electrical contact means adjacent the free end thereof for engagement with said stationary contact, said thermally responsive element comprising a snap-acting bimetallic disc having a dished portion therein responsible for its snap action, said switch including means supported on said base engageable with said dished portion for said dished portion to bear against and snap from one position to another, and said thermostat disc adjacent the other end thereof, including an offset resilient portion having a tab secured to said second one of said electrically conducting surface portions and cantilever mounting said disc thereon, and said offset portion biasing said thermostatic disc for movement into engagement with said means.

4. The switch as set forth in claim 3 and including a third electrically conducting surface portion on said base in spaced electrically insulated relation to said first and second electrically conducting surface portions, said first and third conducting portions respectively providing a pair of spaced terminals in electrically insulated relation to each other; and electrical heater means electrically connected between said second and third electrically conducting surface portions.

5. The switch as set forth in claim 4 and wherein said base provides an aperture adjacent said dished portion of said snap-acting thermostatic disc in which said heater means is disposed and maintained in thermally conductive juxtaposition with said dished portion of said snap-acting thermostatic element.

6. The switch as set forth in claim 3 and wherein said electrical contact means comprises a dimpled portion of said disc and includes a surface portion of low electrical resistance material for engagement with said stationary contact.

7. The switch as set forth in claim 3 and wherein said electrically conducting surface portions are printed on said base.

8. The switch as set forth in claim 3 and wherein said electrically conducting surface portions are etched on said base.

9. The switch as set forth in claim 3 and wherein said electrically conducting surface portions comprise electrically conductive material selectively adhered to said base member.

10. The switch as set forth in claim 3 wherein said two conductive surface portions are substantially coplanar.

11. An electrical switch adapted for miniaturization comprising an electrically insulating base member; said switch including first, second and third elongated printed circuit type electrically conducting portions adhered to one side of said base member and arranged in mutually spaced electrically insulated relations; said first and second portions being substantially L-shaped; a thermally responsive device secured to and electrically connected to one leg of said first L-shaped portion; one leg of said second L-shaped portion providing a first electrical contact; the other leg of said second L-shaped electrically conductive portion providing a first electrical terminal; said third electrically conductive portion providing a second electrical terminal; said thermally responsive device being operatively connected with a second electrical contact for effecting engagement and disengagement of said first and said second electrical contact, in response to predetermined temperature conditions; electrical heater means disposed between and electrically connected to the other leg of said first L-shaped electrically conductive portion and to said third electrically conductive portion; and said heater means being mounted on said base and arranged in thermally conductive juxtaposition to said thermally responsive device.

12. The switch as set forth in claim 3 and wherein said last-mentioned means comprises an adjusting screw having a threaded shank loosely received in an aperture provided by said element and mounted in adjustable threaded engagement within a threaded aperture provided by said base; said screw having a flange portion positioned for engagement with said dished portion of said element.

13. The switch as set forth in claim 3 wherein said two conductive surface portions are substantially coplanar.

14. The switch as set forth in claim 1 and wherein said element comprises a snap-acting elongated strip member and said member including a deformed portion responsible for its snap action.

15. The switch as set forth in claim 14 wherein said two conductive surface portions are substantially coplanar.

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