Feb. 13, 1962 R. D. GRAF ETAL 3,021,406

THERMOSTATIC SWITCH

Filed Nov. 16, 1959

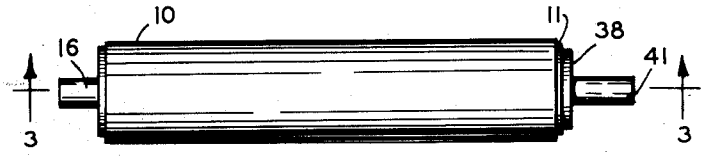


FIG. 1

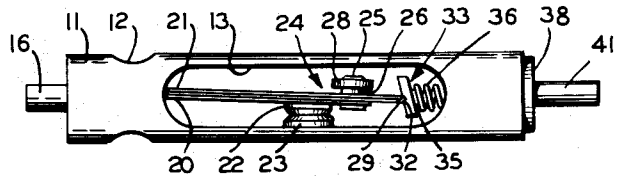


FIG. 2

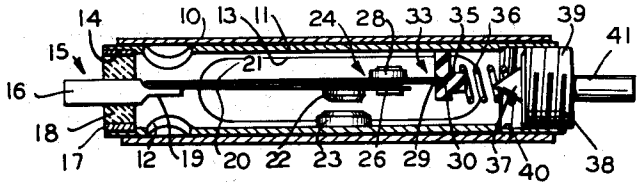


FIG. 3

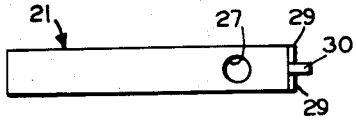


FIG. 4

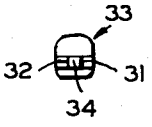


FIG. 5

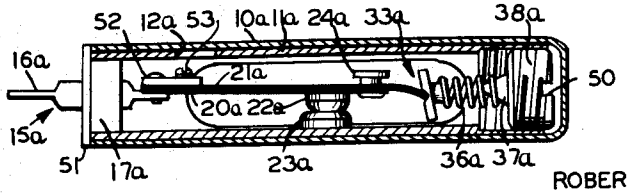


FIG 6

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United States Patent Office 3,021,406
Patented Feb. 13, 1962

3,021,406

THERMOSTATIC SWITCH

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Filed Nov. 16, 1959, Ser. No. 853,101
5 Claims. (Cl. 200—138)

This invention relates to thermostatic switches and more particularly to miniature thermostatic switches of the snap-acting type which may be hermetically sealed in a protective casing.

It is common practice to protect electric motors against overload conditions by various types of small thermostatic switches which are incorporated in the windings of the motors to be responsive to the temperature of the motor windings as well as to the electric current of the windings. In order to be embedded directly in the motor windings, these thermostatic switches must be quite small, usually not appreciably over two inches in length or over three-eighths (⅜") inch in diameter. Because of this size requirement, such thermostatic switches are ordinarily of the creep type comprising merely a flat strip of bimetal carrying a movable contact cooperating with a fixed contact secured to a tubular casing in which the switch parts are hermetically sealed.

Although the advantages of snap-acting thermostatic switches have been long recognized, efforts to construct miniature switches of the foregoing type merely by reducing the size of the component parts of prior designs and enclosing them in sealed housings have not been entirely satisfactory. Besides the difficulty of enclosing such constructions in a small tubular casing, some of such switch constructions are difficult to assemble or accurately calibrate and are excessively costly. The reduction in size also often has an adverse effect on the durability of such thermostatic switch constructions.

Accordingly, it is an object of this invention to provide a new and improved thermostatic switch of miniature size which can be easily and economically manufactured, which is durable in operation and which may be hermetically sealed.

Another object of the invention is to provide a new and improved thermostatic switch of miniature size which operates with a snap action.

A further object of the invention is to provide a new and improved thermostatic switch of miniature size which may be readily and permanently calibrated.

In the preferred embodiments of the invention hereinafter described, the component parts of a thermostatic switch means are disposed within a tubular metal frame provided with apertures intermediate its ends facilitating assembly and adjustment of the switch means. An adjusting screw is threaded in one end of the frame and adjusted to calibrate the switch means. The other end of the frame is closed by a terminal header having an outer metal sleeve and an insulated terminal connected to the switch means. The frame is positioned within a closely fitting metal tubular casing and is sealed thereto. As disclosed, the thermostatic switch means comprise a bimetallic controlling element and a spring contact arm which are secured together on the header terminal. The free end of the bimetallic element is connected to the adjusting screw by an overcenter means comprising a bearing member pivotally seated on the bimetallic element and a coil spring confined between the bearing member and the screw. The spring arm carries a contact cooperable with a fixed contact carried by the frame and has a lost motion connection with the bimetallc element providing for separation of the contacts with a snap action. The bearing member is constructed to

be engageable with the frame to limit the overcenter movement after separation of the contacts.

Other objects and features of the invention will become apparent from reference to the following description and accompanying drawing, in which:

FIG. 1 is a plan view of a snap-acting thermostatic switch embodying the present invention;

FIG. 2 is a side elevational view of the switch prior to assembly of the cover and showing the components of the switch in a position in which the contacts are in engagement;

FIG. 3 is a sectional view, partly in side elevation, taken subsantially along the line 3—3 of FIG. 1 with the component parts of the switch in a position in which the contacts are separated;

FIG. 4 is a plan view of the bimetallic element;

FIG. 5 is an end view of the bearing washer; and

FIG. 6 is a view similar to FIG. 3, but illustrating a slightly modified embodiment of the invention.

Referring to the drawing, there is shown a thermostatic switch comprising a cylindrical casing **10** surrounding a cylindrical frame **11** dimensioned to closely fit within the casing **10**. Casing **10** and frame **11** are of metal capable of being soldered such as steel and may be formed from seamless tubing. As an aid to assembly and adjustment of the various component parts of the switch, frame **11** may be provided with openings intermediate its ends such as holes **12** and slots **13**.

One end of the frame is counterbored at **14** to receive a terminal header assembly **15** having a central terminal **16** of conductive metal supported within an outer metal sleeve **17** by a glass bushing **18** which is bonded to both the terminal **16** and the sleeve **17**. The inner end of terminal **16** is flattened at **19** to provide a support to which a spring contact arm **20** and a bimetallic actuating element **21** are rigidly secured as by spot-welding. Spring arm **20** is formed from flexible conductive metal such as a beryllium-copper alloy and carries a movable electrical contact **22** near its free end. Spring arm **20** is biased as by bending flattened end **19** of terminal **16** to normally urge contact **22** into engagement with a fixed contact **23** which is welded to the inner surface of the frame **11**. Contacts **22** and **23** preferably comprise a facing of silver alloy over a steel backing.

A driving element **24** of any suitable insulating material is secured to the free end of spring arm **20** by an eyelet **25** and has a shank portion **26** extending from one side of spring arm **20** through a hole **27** in bimetallic element **21**. The free end of driving element **24** is provided with a shoulder or stop **28** for limiting movement of bimetallic element **21** relative to spring arm **20**. Shank portion **26** passes freely through hole **27** and it will be noted that driving element **24** provides a lost motion connection between spring arm **20** and bimetallic element **21**.

Bimetallic element **21** is composed of superposed layers of metals having different coefficients of expansion such that when it is heated its free end will deflect in a direction away from spring arm **20**. The free end of bimetallic element **21** terminates in sharp edges **29** on opposite sides of a narrow tongue **30**. Sharp edges **29** are adapted to engage a bearing surface **31** defined by an elongated V-shaped notch **32** formed in a bearing member **33** of a suitable insulating material such as ceramic. Bearing surface **31** has a central recess **34** to loosely receive tongue **30** and thereby prevent accidental disengagement of bearing member **33** from bimetallic element **21**. Bearing member **33** is also formed with a lug **35** for supporting one end of a coil spring **36**. The other end of coil spring **36** is seated on the conical extension **37** of an adjusting screw **38** which is provided with a threaded portion **39** fitted in the threaded inner surface **40** of frame **11**. The

adjusting screw 38 may be provided with a stem 41 by which screw 38 may be turned to adjust the compression of coil spring 36. Screw 38 is made of a solderable conductive metal and stem 41 may also serve as a terminal connection to contact 23 through frame 11.

From the foregoing description, it will be apparent that bearing member 33 and coil spring 36 provide an overcenter connection between bimetallic element 21 and screw 38. With the parts in the position shown by FIG. 2, coil spring 36 urges the free end of bimetallic element 21 against spring arm 20 thereby cooperating with spring arm 20 in forcing contact 22 into engagement with contact 23. In response to an increase in ambient temperature and/or to the heating effect of the passage of current through spring arm 20 bimetallic element 21 will deflect in a direction away from spring arm 20. As the bimetallic element 21 moves away from spring arm 20, the free end of bimetallic element 21 is moved toward a position of unstable equilibrium, whereupon coil spring 36 acts to continue the movement of bimetallic element 21 in the same direction with a snap action until bearing member 33 engages the inner surface of frame 11. As bimetallic element 21 moves relative to spring arm 20 with a snap movement, it moves into engagement with shoulder 28 of driving element 24 with a hammer blow and flexes spring arm 20 to quickly separate contact 22 from contact 23. Under this condition of operation, bimetallic element 21 does not engage driving element 24 until after initiation of the overcenter snap movement. After completion of the switching operation, the parts of the switch assume the position shown in FIG. 3.

When the bimetallic element 21 subsequently cools, it will deflect in a direction toward the spring arm 20 against the force of coil spring 36 until it again reaches a position of unstable equilibrium. Upon continued movement of bimetallic element 21, the end of bimetallic element 21 pivots by a snap action on bearing member 33 to the position shown in FIG. 2. In this switch operation, engagement of bimetallic element 21 by shoulder 28 of driving element 24 prevents spring arm 21 from returning contact 22 into engagement with contact 23 until after snap movement of bimetallic element 20 has commenced. Contact 22 is thus caused to move into engagement with contact 23 with a snap action.

From the foregoing description of the switch construction, it can be seen that the switch may be simply assembled and adjusted. The assembly consisting of spring arm 20, contact 22, bimetallic element 21 and driving element 24 may be assembled first and then welded to the flattened end 19 of terminal 16 of the header 15. After contact 23 is welded to frame 11 and the foregoing assembly is secured in the frame 11 by welding the sleeve 17 of header 15 in the end of frame 11, the force with which spring arm 20 urges contact 22 against contact 23 may be adjusted by means of a suitable instrument inserted through holes 12 in frame 11. The bearing member 33 with coil spring 36 placed on its lug 35 is next assembled in pivotal engagement with the end of bimetallic element 21 and adjusting screw 38 is screwed into the threaded end of frame 11. It will be apparent that the assembly of the foregoing is greatly facilitated by the use of the slots 13 in frame 11. Adjustment of the switch is then completed by turning adjusting screw 38 to cause snap opening of the contacts when the bimetallic element 21 is heated to the desired temperature. After the above assembly and adjustment have been completed, the frame 11 is inserted in casing 10 and both ends of the assembled switch are dipped in molten solder to hermitically seal the switch. At one end of the switch, the solder seals the adjusting screw 38 to the frame 11 and simultaneously seals the end of the frame 11 to the adjacent end of the casing 10. At the other end of the switch, the solder seals the sleeve 17 of terminal header 15 to the frame 11 and simultaneously seals the end of the frame 11 to the end of the casing 10.

In the modified embodiment of the invention illustrated in FIG. 6, the exterior end of adjusting screw 38*a* is provided with a s'ot 50 instead of a stem to permit casing 10*a* to be closed at this end. With either this construction or that previously described, it is clear that a wiring terminal could be secured directly to the casing for making electrical connection to the fixed contact. To avoid counterboring an end of the frame to receive a terminal header, the sleeve 17*a* of the terminal header 15*a* may have a radial flange 51 which abuts the end of frame 11*a* and which is abutted by the end of casing 10*a* to position these parts. Flange 51 may be soldered or welded to casing 10*a* to hermetically seal the switch. A rigid bracket 52 is attached to the header terminal 16*a* and carries a calibrating screw 53 for biasing spring arm 20*a* and bimetallic element 21*a* toward contact 23*a*. This arrangement eliminates the bending of the header terminal previously described and thus avoids possible breakage of the header bushing 18*a*. It will be obvious that the construction and operation of the switch of FIG. 6 are similar to those of the switch which has been already described.

While specific embodiments of the invention have been shown and described, it is to be understood that the invention is not to be limited to the precise details herein shown and described since the same may be carried out in other ways falling within the scope of the invention as claimed.

What is claimed is:

1. A miniature thermostatic switch comprising a tubular elongated frame of conductive metal; a fixed support mounted within said frame and insulated therefrom; a spring arm disposed within said frame; a bimetallic element disposed within said frame; said spring arm and bimetallic element being secured to said support and extending therefrom in the same direction toward the second end of said frame; a fixed contact conductively secured to said frame; a movable contact carried on said spring arm for cooperation with said fixed contact; an adjusting screw threaded in said second end of the frame; a bearing member of insulation material pivotally seated upon the free end of said bimetallic element; overcenter spring means comprising a coil spring confined under compression between said screw and said bearing member; lost motion means connecting said spring arm and said bimetallic element to impart a snap action to said spring arm when said bimetallic element snaps over center; and said bearing member having a portion engageable with said frame to limit overcenter movement of said bimetallic element in one direction.

2. The thermostatic switch according to claim 1 wherein said lost motion means comprise a driving element of insulating material secured to said spring arm; said driving element having a shank portion extending from one side of said spring arm through said bimetallic element and being provided at one end with a shoulder spaced from said spring arm.

3. A miniature, hermetically sealed thermostat comprising, in combination; a cylindrical metal frame open at both ends; stationary contact means conductively secured to the inner surface of said frame; a terminal header closing one end of said frame; a terminal passing through said header and electrically insulated from said frame; movable contact means electrically connected to said terminal and cooperating with said stationary contact means; a thermally responsive bimetallic element having one end fixed to the inner end of said terminal; the other end of said bimetallic element being movable in response to temperature changes for actuating said movable contact means; an adjustable screw threaded in the other end of said frame; a bearing member of insulation pivotally seated upon said movable end of the bimetallic element; overcenter spring means comprising a coil spring confined under compression between said screw and said bearing member for imparting snap action to move-

ment of said bimetallic element; said bearing member having a portion engageable with the inner surface of said frame to limit the movement of said bimetallic element in a contact-opening direction; said frame being provided with an opening in the wall thereof adjacent said bearing member and spring means for providing access thereto during their assembly in said frame; a cylindrical metal casing telescopically positioned over said frame in close fitting relation thereto; and said casing completely covering said opening in the frame and being secured to the frame by fused metal.

4. The thermostatic switch according to claim 3 wherein said casing is open at both ends; said screw being sealed in the frame by fused metal.

5. The thermostatic switch according to claim 3 wherein said casing is closed at one end and open at the other

end; said closed end of the casing being positioned over said other end of the frame; said open end of the casing adjoining said one end of the frame; said header having an outer sleeve of metal provided with an annular flange; and said flange being sealed to said open end of the casing by fused metal.

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