March 19, 1963 W. W. WUNDER 3,082,305

THERMAL SWITCH CONSTRUCTION AND SYSTEM

Filed July 31, 1959

FIG. 1.

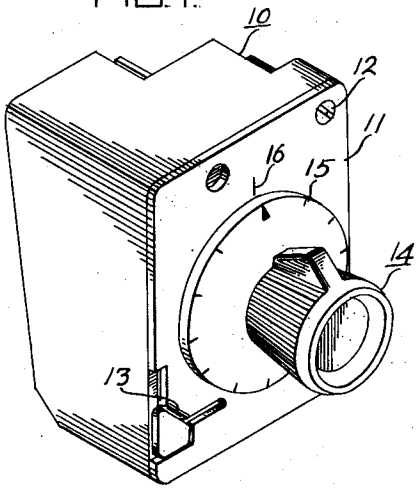


FIG. 2.

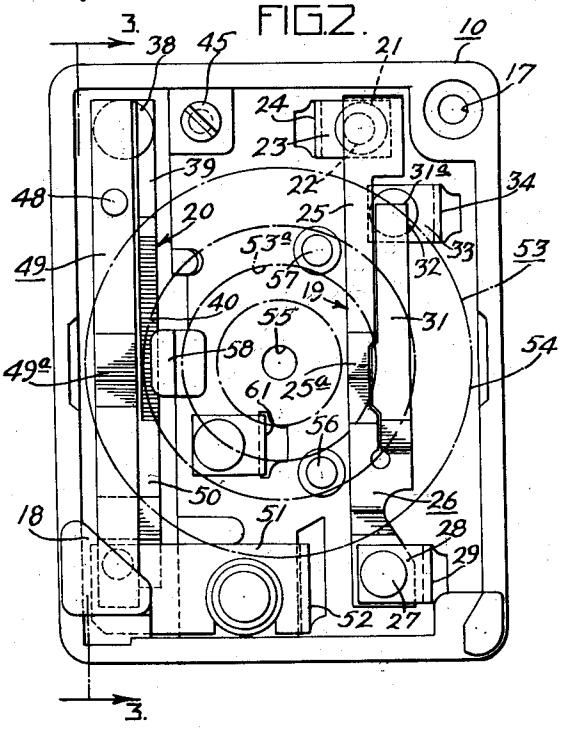


FIG. 3.

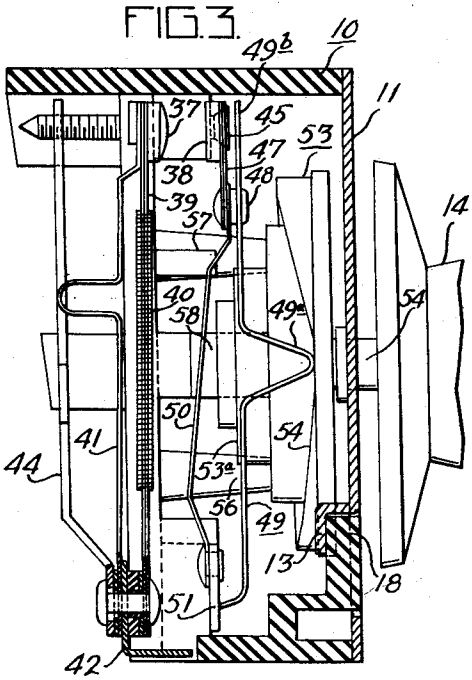


FIG. 5.

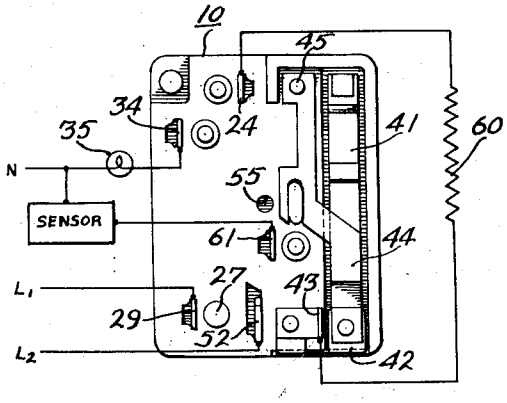
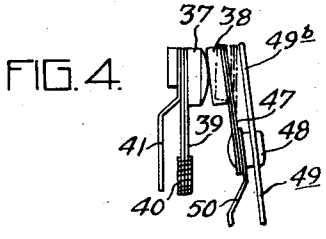


FIG. 4.



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THERMAL SWITCH CONSTRUCTION AND SYSTEM

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The present invention relates to a construction for a thermal switch and, more particularly, a construction which will tend to cause rapid opening of the contacts of that switch. This invention also relates to a system in which such a switch is used as a remotely controlled switch in series with a main heater element.

It is frequently necessary or desirable to use a thermal switch to control the operation of a heater element. An example of such use is found in the surface heating unit of an electric range. In such a case, the switch, which cycles alternately open and closed, is commonly used to determine energy output of the surface unit by adjustment of the ratio of its on-to-off time.

The contacts of thermal switches that are used in series with a heavy load, such as the top burner units of an electric range, are subject to arcing when they are separated. This can cause damage by burning or pitting until the contacts are destroyed. Part of the trouble is that the contacts once they begin to separate do not tend to break quickly and cleanly and it is to this problem that the present invention is directed.

The present invention provides a thermal switch having a structure whereby the contacts of the switch are made to rapidly separate. As a result of this rapid separation, the arcing which accompanies slowly separating contacts is greatly reduced or eliminated so that the consequent damage is reduced or eliminated and contacts have a much greater operating life.

More specifically, the present invention has to do with a preferred switch construction wherein one contact of the pair employed is supported on a short, high electrical resistance, low heat storage capacity bimetal which upon cooling tends to cause its supported contact to snap away from the other contact. The switch is preferably one of the type in which an auxiliary heater in close thermal proximity to a main bimetal support causes the switch to cycle open, and closed, the contacts opening in response to the heating of the bimetal. In such a switch the auxiliary bimetal supports the contact other than the one supported by the main bimetal. As long as the contacts are closed the auxiliary bimetal is heated by its own resistance to current flowing through it from the contacts as well as by some heat flow through the contacts from the main bimetal. When the contacts separate even slightly, however, the flow of both current and heat is interrupted and the light, low heat capacity auxiliary bimetal cools almost instantly. The rapid cooling produces a sort of snap action movement moving its supported contact away from the other contact so rapidly that there is no opportunity for electrical breakdown between the contacts.

In preferred embodiments there is direct thermal connection between the auxiliary bimetal and its more massive support which may act as a heat sink to drain the energy even more rapidly from the auxiliary bimetal. Likewise mechanical means is preferably provided behind the contact to prevent the auxiliary bimetal from being overstressed during overclosure of the contacts. Wherever possible both contacts have main bimetallic supports which tend to move the contacts in the same direction, in order to compensate for ambient effects.

A preferred system of the present invention is one in which the switch is employed as the receiver responding as a servo-mechanism to signals from a temperature sensor

proximate to the main heater element. In such a system the auxiliary heater is preferably connected in a low voltage pilot circuit with the sensor. Such an arrangement is described in the co-pending application of Daniel E. Clapp, Serial No. 602,824, filed August 6, 1956.

For a better understanding of the present invention, reference is made to the following drawings, in which

FIG. 1 is a perspective view of the exterior of a switch housing for a preferred embodiment of a switch of the present invention;

FIG. 2 is a plan view from above of the contents of the switch housing with the cover removed;

FIG. 3 is a sectional view taken along line 3—3 showing the switch construction in detail;

FIG. 4 is a detail view of the region of the contacts of the switch of FIG. 3; and

FIG. 5 is a plan view of the rear of the switch housing showing a preferred circuit arrangement.

Referring to FIG. 1, the switch unit is preferably enclosed in a hollow housing **10**, composed, for example, of a rigid phenol-formaldehyde resin which is molded into the desired shape. Covering the opening of the housing is a cover plate **11** which may be held in place by suitable fastening means **12** and **13**. Extending through the switch box is a shaft which is terminated in knob **14** having an integral dial **15** the calibrations on which may be compared with a calibration mark **16** on the cover plate. The dial may be calibrated in terms of cooking temperatures or conditions.

Referring to FIG. 2, one corner of the housing is provided with means **17** molded into the housing for receiving a screw or rivet for holding the cover plate in place. The opposite corner of the housing is provided with a shoulder **18** under which a corner of the cover plate is designed to fit to hold the cover in place. Within the housing are a pair of switch structures generally designated **19** and **20**. Switch structure **19** provides two switches. The first of these is an on-off switch consisting of superimposed contacts **21**, **22**. Contact **21** is fixed to a brass support **23** having a terminal tab **24** extending through the bottom of the housing. Contact **21** is supported on a resilient spring strut member **25** which has a cam follower portion **25***a* and which is one arm of the bifurcated switch support element **26**. Switch support element **26** is affixed at its remote end to the bottom of the housing by a rivet **27** which also affixes terminal tab **28** part of which **29** extends through the bottom of the housing. The other arm of the bifurcated piece **26** is an auxiliary blade **31** having a bent end **31***a* which serves to contact member **32**. Contact **32** is affixed to a brass plate **33** riveted to the housing and integral with terminal **34** which extends through the bottom of the housing. The switch provided by contacts **21** and **22** preferably is an on-off switch for the heater unit, whereas the switch provided by the end of blade **31** and contact **32** provides a switch for an auxiliary circuit through a pilot lamp **35** or the like (see FIG. 5).

The details of switch **20** can be seen by reference to FIGS. 2 and 3. As seen in FIG. 3, the opposed contacts **37** and **38** are supported on a relatively complex structure. Supporting contact **37** is a bimetallic blade **39** which is supported on a portion of the insulated housing **10** by a rivet or other appropriate means. In close thermal association with bimetal **39** is a heater **40**. The bimetal is so arranged that, upon heating, the contact **37** tends to move away from contact **38**. A resilient spring member **41** also extends between the ends of the blade **39** and resiliently backs up the blade. Supporting the end of the blade **39** and spring **41** is a terminal member **42** bent at an angle and affixed to the housing. Member **42** also provides terminal tab **43** (see FIG. 5). A relatively massive member **44** fixed to these same members at this

point provides stability to the whole structure, permits cooling and lends some adjustability to the whole support structure for contact 37. The position of contact 37 relative to contact 38 may be adjusted somewhat through adjusting screw 45 which passes through a portion of the housing and through member 44. Adjustment of the position of member 44 changes the position of the support for the other contact support element. It will be seen that by adjustment of the position of the end of lever arm 44 by means of screw 45 relatively lighter members of the support structure will rotate about the bend in member 42.

The other contact 38 is affixed to a short auxiliary bimetal member 47, whose active length is preferably no greater than its width. A longer bimetal can result in undesirable additional flexing in the contact making direction, and in delayed response to cooling because of such overflexing and because of greater heat storage. As previously indicated this auxiliary bimetal is preferably of much lighter gauge material than the rest of the support. Thus its resistance to current flow is increased and its heat storage capacity decreased. This bimetallic member is connected by a rivet 48 or other suitable means providing a low heat flow impedance connection to the main contact support member, bimetallic spring 49. Rivet 48 also connects the auxiliary bimetal to a mechanical and electrical connection member 50 which is affixed to plate 51 affixed, in turn, to the housing. Plate 51 also provides a terminal tab 52 (see FIG. 5). Bimetal member 49 terminates against member 51 and through the urging of cam member 53 provides varying amounts of pressure at rivet 48 urging contact 38 against contact 37.

As can be seen by the phantom view in FIG. 2, the cam 53 has an outside track 54 which is the one which bears against follower portion 49*a* of spring member 49. Cam 53 also has an inside track 53*a* which is the one which bears cam follower 25*a* which urges contacts 21, 22 and 31, 32, respectively, simultaneously closed. These cam tracks are designed so that in the off position of the knob and cam all contacts are broken but in any on position the contacts 21, 22 and 31, 32 are closed. Cam track 54, on the other hand is designed not only to hold contacts closed but to impose greater and greater pressure on follower 49*a* and hence greater and greater force on contact 38 urging it against contact 37.

As contact 38 is urged against contact 37 with greater and greater force, relatively light bimetallic member 47 would tend to yield and might be overstressed were it not for the extension 49*b* of spring member 49, which backs the contact and prevents the overstressing of member 47.

When member 47 is forced into contact with extension 49*b* two paths are provided for the flow of current, one being through extension 49*b* and the other through member 47. Since the former is the path of least resistance, there will be a minimum amount of heating of member 47 from the passage of current therethrough. It is only after the temperature has risen sufficiently to cause a separation of member 47 from extension 49*b* that member 47 will heat substantially. Since such heating exists for only a portion of the cycle, the assembly including member 47 runs cooler than would otherwise be the case and, after initial separation of contacts 37 and 38, the almost instant additional cooling will result in a quick motion of contact 38 away from contact 37.

Reference to FIG. 4 indicates the operation of the device of the present invention. As seen in solid lines, the contacts are at the point of separating as contact 37 is moved away from contact 38 by the action of heater element 40 on bimetal 39. Just as soon as these contacts separate the slightest amount, current stops flowing, or is greatly reduced, so that any heating because of its own relatively high internal resistance of auxiliary bimetal 47 due to current flow through it is immediately terminated. Additionally, any thermal flow from the heater element up through the contacts 37 and 38 to the auxiliary bimetal 47 is terminated. Because of the low thermal mass of the bimetal 47, it rapidly cools, much more rapidly than bimetal 49, for example, or than heavier controlling bimetal 39. The heavier bimetal 49 and conductor 50, in fact, will provide thermal sinks to which some flow may proceed, thereby increasing the cooling rate. As a result, the auxiliary bimetal 47 tends to snap into the position shown in dotted lines, thus cleanly breaking the contacts and avoiding the problem of arcing and pitting of the contacts.

Contact 37 may continue to move away from contact 38 after this point, but eventually the cooling of bimetal 39 will permit bimetal 39 to urge contact 37 back toward closed contact position. Eventually contact 37 closes against contact 38, thereby re-establishing the circuit to the main heater element. Immediately, the currents flowing through the bimetal 47, due to its internal resistance, will produce heating, and thermal effects moving up bimetal 39 and through the contacts 37 and 38 to bimetal 47, will also tend to rapidly heat bimetal 47. Consequently almost instantaneously, the bimetal will flex increasing the pressure between the contacts 37 and 38, giving more positive contact.

A typical circuit arrangement for the contacts has been diagrammed in FIG. 5. As illustrated, terminal 29 of the on-off switch is connected to line L1, while terminal 24 of said switch is connected through the heater element 60 to terminal 43 of thermal switch 20. The other terminal 52 of thermal switch 20 is then connected to line L2 as shown. The heater element 40 (not seen) is connected between terminals 61 and 43, and terminal 61 is connected through a sensor element to the terminal N to provide a low voltage control circuit. Neutral line N is also connected through a pilot light 35 to terminal 34 so that pilot light 35 will then remain lit as long as contacts 31, 32 as well as on-off contacts 21, 22 are closed.

In the arrangement shown signals from the sensor will determine the energization of heater 40. When heater 40 has been energized sufficiently, the bimetal 39 will cause contact 37 to part from contact 38 as previously described. As a practical matter, the sensor element may sense the temperature of a pan and its contents on the main heater element controlled by switch 20. If the heat becomes too great, contact in the sensor will be closed to complete the pilot circuit through heater 40 and open the main contacts 37, 38. As the temperature drops, the contacts will be opened deenergizing the auxiliary heater and closing the contacts, whereupon the contacts 37, 38 may close. By such a repetitive process depending upon temperature conditions sensed in the area most critical to control, highly accurate control may be had. The effect of rapid breaking and positive closing of the contacts under these circumstances may be to provide more accurate control of variables and hence greater overall accuracy in control.

Referring again briefly to FIGS. 2 and 3, it will be seen that the shaft 54 for cam 53 has a bearing through cover plate 11 which normally carries the knob shaft of cam assembly. The remote end of the shaft fits into a bearing opening 55 in a casing. The cam itself is provided with a bearing track which bears against support elements 56, 57 and 58. The dial 15 is calibrated for different positions of the knob 14 corresponding to different positions of the cam 53 in terms of cooking temperatures or heats which the cam effects in terms of overclosure of contacts 37 and 38.

From the above discussion, it will be clear that in every case there is provided a thermal switch having a pair of contacts. Support members are provided for each of the contacts, the support member for one including a high resistance, low thermal heat capacity bimetallic strip to which the contact is affixed. The bimetallic strip is in turn affixed to a support blade and is so oriented that upon cooling it moves to urge its supported contact rapidly away from the other contact.

It will be apparent to those skilled in the art that the structure of the present invention is subject to a great many modifications and changes. All such modifications within the scope of the claims are intended to be within the scope and spirit of the present invention.

I claim:

1. A thermal switch comprising first and second contacts, support means for each contact including first and second bimetallic members so oriented that they move in the same direction upon heating and also upon cooling, a resistance heater in heat-transfer relationship with said first bimetallic member which will urge said first contact away from said second contact when the resistance heater is energized, said second bimetallic member tending to urge the contacts together when heated, a high resistance low heat-capacity auxiliary bimetallic member oriented to move in the same direction as said first and second bimetallic members upon heating and cooling, having a free end upon which said second contact is mounted, a low heat-flow impedance connection affixing said auxiliary bimetallic member to said second bimetallic member whereby said second bimetallic member serves as a heat-sink to drain heat from said auxiliary bimetallic member, said auxiliary bimetallic member being highly affected by heat transmitted through the contacts from said resistance heater and by heat generated by the passage of current therethrough due to its own resistance whereby upon separation of the contacts its rapid cooling will cause a rapid parting of the contacts, said second bimetallic member being provided with an extension arranged to project beyond its junction with said auxiliary bimetallic member and behind said second contact in such manner as to result in an engagement between said extension and said auxiliary bimetallic member under conditions of heavy overclosure of the contacts.

2. A switch in accordance with claim 1, wherein said low heat-flow impedance connection comprises a rivet in thermal engagement with both said auxiliary bimetallic member and said second bimetallic member.

3. A switch in accordance with claim 1, wherein said extension for said second bimetallic member is an integral part of said bimetallic member.

4. A switch in accordance with claim 1, wherein the active length of said auxiliary bimetallic member is not greater than its width.

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