Aug. 23, 1955 W. M. RUSSELL 2,716,173

ELECTRIC SWITCHES

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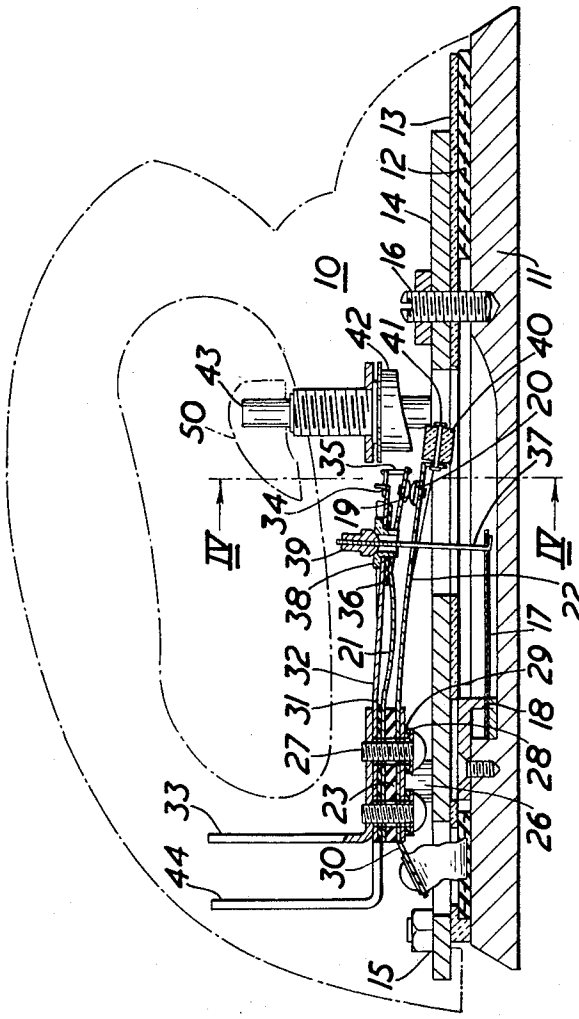


FIG. 1.

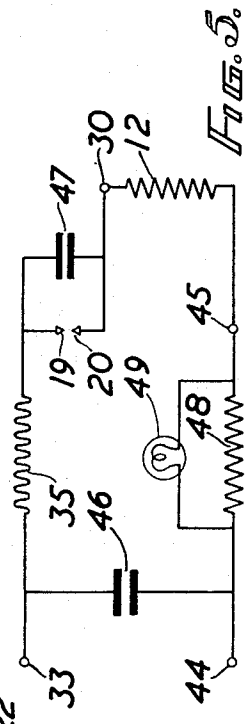


FIG. 5.

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ELECTRIC SWITCHES

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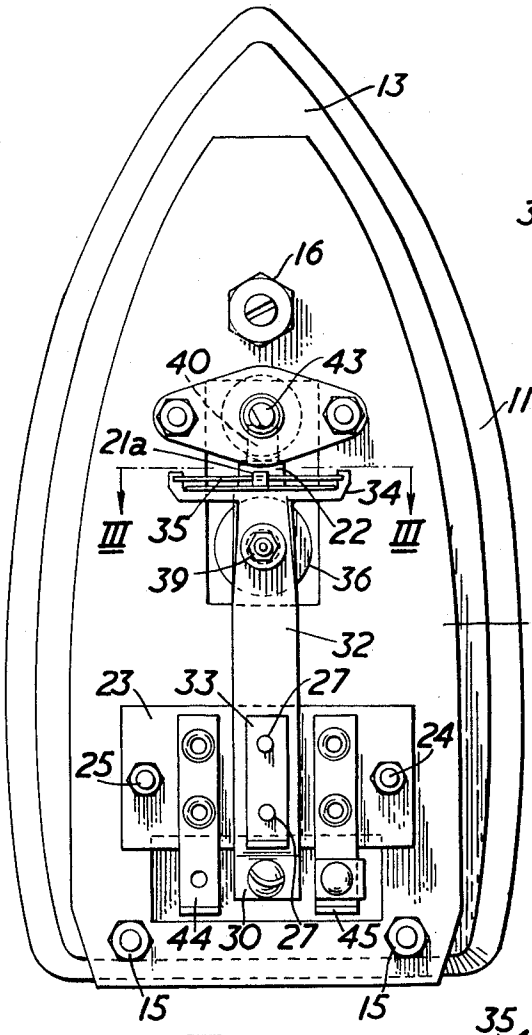


FIG. 2.

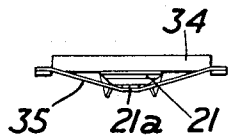


FIG. 3.

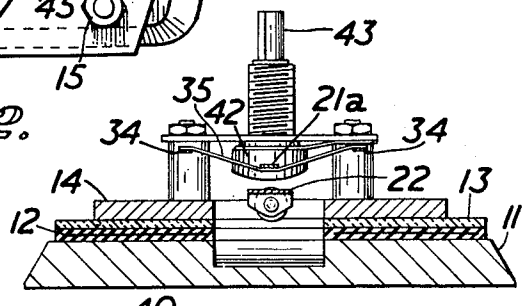


FIG. 4.

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ELECTRIC SWITCHES

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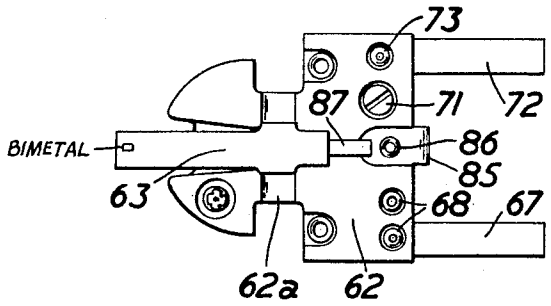


FIG. 6.

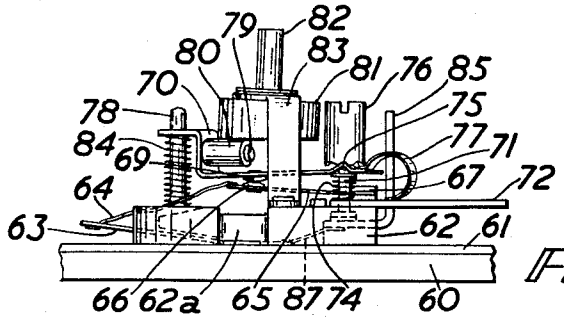


FIG. 7.

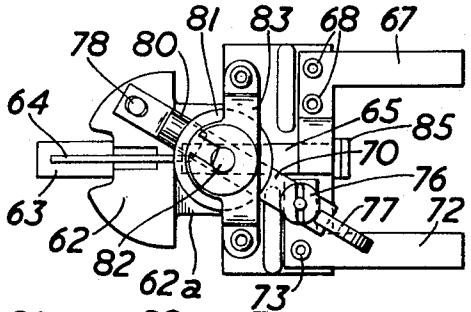


FIG. 8.

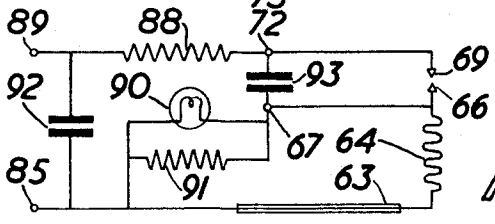


FIG. 9.

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Patented Aug. 23, 1955

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ELECTRIC SWITCHES

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Application April 28, 1952, Serial No. 284,698

10 Claims. (Cl. 200—138)

This invention relates to thermally-operated electric switches for the thermostatic control of electrically-heated devices such as smoothing irons.

A known form of switch for this purpose comprises a contact carried by a leaf spring, whose position is controlled by a bimetal strip or other temperature sensitive member, and a second contact which is also carried by a leaf spring in such a manner as to urge it against the first contact. The bimetal strip is arranged adjacent the heated sole plate of the iron, and as its temperature rises, it allows the first contact to move in a direction away from the second contact, which however follows its movement and remains in engagement with it. The movement of the leaf spring carrying the second contact is limited by a stop, so that when the temperature reaches a certain value the first contact moves away from the second, thus breaking the heating circuit. As the bimetal strip cools, the contacts meet again and the procedure is repeated. In such a slow-break switch the gap between the contacts is small, and the switch consequently causes considerable radio-interference, owing to the high frequency of operation and the relatively long interference pulse produced at each operation.

The slow-break switch described can be modified to constitute a snap-action switch by the use of an over-centre or magnetic action, whereby there is provided a larger gap and a consequent lower frequency of operation, quite large temperature differentials being acceptable. Although the duration of the interference pulse is shorter, its amplitude is greater than in the slow break switch. This necessitates a large capacity condenser to suppress the radio-interference, whilst the larger gap requires a larger capacity to prevent arcing when operating on direct current.

The present invention provides an improved switch having a slow break but a large gap between the contacts, so that the interference pulses produced have both a small amplitude and a low frequency of repetition.

In a thermally-operated electric switch in accordance with the invention the separation and engagement of a pair of contacts is controlled by two temperature responsive devices, one device being arranged to effect initial separation of the contacts as its temperature increases, and the other device, the heating of which is effected by the current controlled by the contacts, being arranged to increase the gap between the contacts when this device cools due to said initial separation of the contacts.

It is preferred that said one device should be a bimetal strip, and that said other device should be a so-called hot wire. The hot wire is an elongated member having an electrical resistance and a coefficient of thermal expansion such that when the current controlled by the contacts passes through it, its length increases to an appreciable extent. The term wire is not intended to limit the form of the device which may, for instance, be a strip or tape.

In one form of the invention, the thermally-operated electric switch comprises a pair of co-operating contacts, each biased for movement in the same direction, a bimetal strip adapted to be indirectly heated by the current controlled by the contacts, which strip as its temperature rises permits movement of said contacts, a stop member arranged to arrest the movement of a first one of said contacts at a predetermined temperature whereby initial separation of the contacts is effected, and a wire directly heated by said current and attached to the second contact, whereby the contraction of the wire on cooling after said initial separation, causes further movement of said second contact away from the first contact.

Another form of switch in accordance with the invention comprises a pair of co-operating contacts, a bimetal strip, and a wire directly heated by the current controlled by the contacts and attached at one end to the bimetal strip and at the other to one of said contacts, said one contact being mounted on the free end of a leaf spring anchored at its other end and tending to maintain the contacts in engagement. In this form of switch, the bimetal strip is heated directly and/or indirectly by said current whereby it effects movement of said one contact away from the other contact at a predetermined temperature, after which the contraction of the wire on cooling, effects further movement of said one contact to increase the gap between the contacts.

A specific embodiment of each of the two forms of the invention described above in general terms will now be described in detail and with reference to the accompanying drawings. These two particular switches are for the thermostatic control of electric smoothing irons; it will be appreciated that these embodiments are examples only and are described in order that the invention may be more fully and clearly understood.

In the drawings:

Figure 1 is a longitudinal sectional view of the sole plate of an electric smoothing iron fitted with a thermally-operated electric switch, the switch being one embodiment of the invention, with the casing of the iron shown in chain-dotted lines;

Figure 2 is a plan view of the sole plate and switch of Figure 1, the casing of the iron being removed;

Figure 3 is a fragmentary view taken on the line III—III of Figure 2 and showing the arrangement of the hot wire device;

Figure 4 is a sectional view taken on the line IV—IV of Figure 1;

Figure 5 is a circuit diagram for a smoothing iron fitted with the switch shown in Figures 1 to 3;

Figures 6, 7 and 8 are underneath, side and plan views respectively of a thermally-operated switch which is another embodiment of the invention; and

Figure 9 is a diagram showing the circuit of an electric smoothing iron fitted with the switch shown in Figures 6 to 8.

In Figure 1, there is shown an electric smoothing iron **10**, which includes a sole plate **11**. A heating element **12** comprising resistance wire between two mica sheets, rests on the sole plate. A mounting plate **14** for the thermally-operated switch is separated from the heating element by an asbestos sheet **13**. The parts **12**, **13** and **14** are secured to the sole plate **11** by means of screws fitted with nuts. There are two such screw and nut arrangements **15** at the rear of the iron (see also Figure 2) and one **16** towards the nose of the iron.

In a depression in the sole plate **11**, there is a bimetal strip **17** with one end anchored at **18** to the sole plate. The strip **17** is so arranged that when its temperature increases its free end moves upwardly from the position shown in Figure 1. The free end of the bimetal strip is mechanically linked to one of the switch contacts so that, as explained below, its upward movement permits the contacts to open when the strip reaches a predetermined temperature.

The dome-shaped switch contacts **19**, **20** are riveted to the free ends of metal leaf springs **21**, **22** respectively, the other ends of the springs being fastened to an insulating plate **23**. This plate is secured to the mounting plate **14** by means of screwed rods **24** (Figure 2) welded to plate **14** and provided with nuts **25**. The insulating plate **23** is spaced from plate **14** by sleeves **26** (Figure 1) on the rods **24**.

Two screws **27** are employed to secure the leaf springs to the insulating plate. Each screw **27** carries a metal washer **28** and a mica washer **29**, it then passes through holes in a terminal strip **30** and the leaf spring **22**. Mica washers fit into the holes in the strip **30** and spring **22**, so as to electrically insulate these members from the screw. The screw then passes through the plate **23** and spring **21** from which it is similarly insulated, then through a mica strip **31** which insulates spring **21** from a further leaf spring **32**. Finally the screw is received in a screw-threaded hole in a terminal bracket **33**. It should be noted that terminal strip **30** is in electrical contact with spring **22**, and terminal bracket **33** with spring **32**, these springs being insulated from each other and from spring **21**.

The insulating plate **23** shown in the drawing as a single member, may in fact comprise two laminated mica plates strengthened by a metal plate sandwiched between them. The holes in the metal plate for screws **27** will have to be sufficiently large to prevent electrical contact between the screws and plate.

A cross-piece **34** (seen more clearly in Figures 2 and 3) is secured to the end of the leaf spring **32**, part of the cross-piece being bent up to leave a small projection at either end. A nickel-chrome tape **35** extends between these projections and is secured at its middle to a projecting tag **21***a* on the end of the leaf spring **21**. This tape **35** constitutes the hot wire device and it will be clear that electrical connection is made from terminal bracket **33**, through leaf spring **32**, cross-piece **34**, the two halves of tape **35** in parallel, and spring **21** to contact **19**.

The leaf spring **21** is bent in the manner shown in Figure 1 so that at one point it approaches the spring **32** but is insulated therefrom by mica washers **36**. The spring **21** is so bent that it is normally held under stress by the tape **35** and the contact **19** therefore tends to move downwardly away from spring **32**.

A mechanical linkage from bimetal strip **17** to leaf spring **32** is provided by a rod **37** flattened and bent at its lower end so as to hook on to the free end of the bimetal strip through a hole therein. The rod, the upper part of which is screw-threaded, passes through apertures in parts **12**, **13** and **14** and through holes in springs **22**, **21** and **32**, without touching any of these members. A flanged sleeve **38** of insulating material fits in the holes in the upper springs, and a nut **39** is screwed on to the rod. The springs **22** and **32** bend upwardly when free so that they are held under stress by the mechanical linkage with the bimetal strip. Thus, when the bimetal strip bends upwardly due to increase in temperature, the springs **22** and **32** can both move up and the contacts **19** and **20** also move up but remain engaged.

Opening of the contacts is brought about by preventing further upward movement of spring **22** and hence of contact **20** when a predetermined temperature is reached. To this end there is provided an insulating roller **40** freely rotatable on a pin **41** secured to the bent down end of spring **22**. At the predetermined temperature the roller **40** meets a stop provided by a face cam **42**. The cam is fixed on a shaft **43** mounted in a bearing secured to a bridge, the construction of which will be clear from the drawings (see more particularly Figure 4). By turning shaft **43** so that the roller **40** meets a different part of the cam **42**, the position of the bimetal strip and hence the predetermined temperature at which the contacts open will be altered.

Two further terminal brackets **44** and **45** (Figure 2) are secured by eyelets to the insulating plate **23**. A source of electricity is connected to the terminal brackets **33** and **44** through a plug and socket connector or in some other suitable manner.

In the circuit diagram of Figure 5, the terminal strip **30**, terminal brackets **33**, **44** and **45**, heating element **12**, nickel-chrome tape (hot wire) **35**, and contacts **19**, **20** are illustrated diagrammatically. The bimetal strip is not shown since there are no electrical connections to it. Certain other parts appear in the circuit diagram which are not shown in Figures 1 to 3; these are a condenser **46** for suppressing radio-interference, a condenser **47** for suppressing arcing across contacts **19**, **20** (provided only when the iron is operated from a D. C. source), and a shunt **48** for limiting the current through a pilot lamp **49**.

The manner in which the switch operates to give thermostatic control of the iron is as follows. The cam **42** having been set by means of knob **50** fast on shaft **43** to the desired temperature for the material to be ironed, and the iron switched on, current flows from terminal **33**, through hot wire **35**, contacts **19**, **20**, heating element **12** and shunt **48** and lamp **49** to terminal **44**. The length of the hot wire will increase and it becomes slack. The bimetal strip will bend upwardly so that contacts **19** and **20** move upwardly together until engagement of roller **41** with cam **42** prevents further movement of contact **20**. Contact **19** however will continue to move slowly up after the slack in the hot wire has been taken up, so that the circuit through hot wire **35** and, of course, the heating element **12** is broken. The hot wire will cool quickly and therefore will pull the end of spring **21** up so that contact **19** continues to move away from contact **20** to produce a comparatively large gap before there is any appreciable cooling of bimetal strip **17**. The latter will cool slowly and as it does so will pull contact **19** down until it meets contact **20** again so completing the circuit. The process will then be repeated.

To ensure that the required thermostatic control is obtained the position of nut **39** on rod **37** can be adjusted as necessary during manufacture.

Another embodiment of the invention is shown in Figures 6 to 8: this embodiment also is a switch for incorporation in an electric smoothing iron for thermostatic control.

In Figure 7, there is shown at **60** part of the sole plate of an iron with a sheet **61** of electrically insulating material on its upper surface. On top of this sheet there is arranged an insulating block **62** on which the parts of the switch are mounted. The bottom surface of the block **62** is provided with a shallow cross-shaped groove into which one end of a bimetal strip **63** fits as will be seen in Figure 6. The block **62** is clamped firmly in position by a bridge member (not shown) arranged across the reduced portion **62***a* of the block and fastened by screws to the sole plate. This clamping arrangement also serves to hold securely between the block **62** and insulating sheet **61**, one end of the bimetal strip **63**. The other and free end of the strip **63** extends beyond the block **62**. The strip is bent so that normally it is in the position of Figure 7, a sloping channel being provided in block **62** to accommodate the bent portion of the strip. The strip is arranged with the two metals so disposed that with increasing temperature, the free end of the strip moves downwardly.

The hot wire device is a nickel-chrome tape **64** with its ends secured to the free end of the bimetal strip **63** and the free end of a leaf spring **65**. This end of the leaf spring carries a contact **66** and is welded at its other end to a rigid L-shaped terminal **67**. One arm of this terminal is secured by eyelets **68** to the block **62** and is cranked so that the part carrying the leaf spring is spaced above the block.

A second contact **69** is mounted on a rigid bar **70** so as to co-operate with the contact **66**. A screw **71** passes through a hole in one end of the bar **70**; the screw is threaded through the block **62** and a second L-shaped terminal **72** secured by eyelet **73** to the block. A coil spring **74** and washer **75** are disposed on the screw between the terminal **72** and bar **70** which is held on the screw by a nut **76**. The nut is provided with a screwdriver slot at the top and with teeth at the bottom which engage a portion of the bar **70** of inverted V-shape. This arrangement provides a convenient way of automatically locking the nut in a desired position on the screw. Turning of the nut enables the position of bar **70** and hence of contact **69** to be adjusted during manufacture. Electrical connection between the bar **70** and terminal **72** is ensured by the flexible metal strip **77**.

The other end of bar **70** is mounted for sliding movement of a post **78**, the hole in the bar being elongated (see Figure 8). The bar is cranked adjacent this end so as to provide a vertical portion which carries a pin **79** on which there is a freely rotatable roller **80** of insulating material. This roller engages a face cam **81** fixed on a shaft **82**; this shaft is mounted on a bridge member **83** having feet which are secured to the block **62** by eyeletting. The roller **80** is held against the cam **81** by means of a coil spring **84** arranged on the post **78** between block **62** and bar **70**.

A third terminal **85** is secured to the block **62** by means of an eyelet **86** and is electrically-connected to the fixed end of bimetal strip by a thin metal strip **87**.

The electrical connections of an iron fitted with this form of the switch will now be described with particular reference to Figure 9. The following members of the switch which appear in Figures 6 to 8 form part of the electrical circuit and are shown diagrammatically in Figure 9: bimetal strip **63**, hot wire **64**, contacts **66**, **69**, and terminals **67**, **72** and **85**. Certain parts of the complete iron which are not shown in Figures 6 to 8, appear in the circuit diagram. These parts include the heating element **88** which is connected between terminal **72** and a further terminal **89**, a pilot lamp **90** with its shunt **91** connected between terminals **67** and **85**, and a condenser **92** for suppressing radio-interference connected between terminals **85** and **89**. When the iron is operating on direct current a further condenser **93** connected between terminals **67** and **72** is necessary to suppressing arcing at the contacts **66**, **69**. The shunt **91** is dispensed with in irons for a supply voltage such that the voltage drop across the hot wire and bimetal strip alone is sufficient for lamp **90**. The source of electricity for the iron is connected by any suitable means to the terminals **85** and **89**.

The switch is set for a particular temperature by turning the shaft **82** so that via cam **83** and roller **80** the position of contact **69** is adjusted. The leaf spring **65** is bent so that it is normally under stress to hold contact **66** in engagement with contact **69**. As appears from Figure 7, the hot wire or tape **64** is normally slack, and the extent of this slackness will depend on the setting of cam **81**. The bimetal strip **63** is heated by the current flowing through it and also by the adjacent heated sole plate, and as its temperature increases it will take up the slack in the hot wire. At the same time the length of the hot wire will be increasing. When the upper value of the required temperature differential has been achieved, contact **66** will be pulled away from contact **69** so as to break the circuit through the heating element and the hot wire. The hot wire cools quickly, thereby causing the gap between the contacts to increase. The cooling of the bimetal strip is slower but as it cools it will permit contact **66** to move upwardly under the action of leaf spring **65**. In due course and at the lower value of the temperature differential, the contacts will close again so as to complete the circuit and the procedure will be repeated.

The switch has the characteristic, desirable in an electric iron, that the differential between the temperatures at which the contacts are opened and closed is greater for high operating temperatures than for low operating temperatures. This is due to the geometry of the system formed by the bimetal strip **63**, hot wire **64** and leaf spring **65** and to the relatively increased effectiveness at low temperatures of the self-heating of the system.

The presence of electrical insulation between the sole plate **60** and the bimetal strip **63** provided by sheet **61** necessarily involves some degree of thermal insulation between these parts. However, the self-heating effect of the system due to the bimetal strip being included in the circuit is sufficient to overcome the temperature lag which would otherwise be caused by the thermal insulation, so that "hunting" and "overshoot" of the switch are avoided.

In both embodiments described above, since there is only a small amount of energy liberated at the contacts, the capacity of the condenser which must be connected across the contacts to suppress the arc when direct current is used is no greater than in the case of the known slow break switches, usually about 0.01 mfd., while the capacity of the condenser which must be connected across the heater circuit to reduce the radio frequency pulse to below an acceptable limit is about half that required in the case of the known quick break switches.

I claim:

1. A thermally-operated electric switch comprising a pair of co-operating contacts, and a bimetal strip operatively connected to one of said contacts by means of a wire which is directly heated by the current controlled by the contacts, the bimetal strip being also heated by said current, whereby it effects movement of said one contact away from the other contact at a predetermined temperature, after which the contraction of the wire on cooling, effects further movement of said one contact to increase the gap between the contacts.

2. A thermally-operated electric switch comprising a pair of cooperating contacts controlling an electric current, first biasing means for moving a first one of said contacts, second biasing means for moving the second contact in the same direction as said first contact, a temperature responsive device the heating of which is effected by the current controlled by said contacts, means connecting said temperature responsive device to said first and second biasing means and so arranged that with increasing temperature said temperature responsive device permits said first and second biasing means to move said contacts, a stop member arranged to arrest at a predetermined temperature movement of said first contact only, whereby initial separation of said contacts is effected, anchoring means arranged so as to normally move with said second biasing means, and a heat sensitive wire directly heated by said current and attached to said anchoring means and to said second contact, the contraction of said wire on cooling due to the cessation of said current after said initial separation, causing further movement of said second contact away from said first contact.

3. A switch in accordance with claim 2 wherein said contacts are secured to the free ends of leaf springs anchored and insulated at their other ends, and said wire extends from the free end of a third similarly mounted leaf spring to said second contact, the bimetal strip being anchored at one end and operatively connected to the third leaf spring at the other end.

4. A switch in accordance with claim 3 wherein the free end of said third leaf spring is in the form of a cross-piece, the wire being anchored at its ends to the ends of said cross-piece so as to form a shallow loop, the middle of which is attached to said second contact.

5. A switch in accordance with claim 4 wherein the free end of the leaf spring carrying said first contact is provided with an insulating roller adapted to engage

a cam which is adjustable to vary said predetermined temperature.

6. A switch in accordance with claim 1 wherein said wire is attached at one end to said bimetal strip and at the other to said one contact, which contact is mounted on the free end of a leaf spring anchored at its other end, and tending to maintain said contacts in engagement.

7. A switch in accordance with claim 6, wherein said wire is arranged at such an angle to said leaf spring that a small contraction of said wire produces a relatively large movement of said one contact.

8. A switch in accordance with claim 7 wherein the other of said contacts is secured to a rigid strip intermediate its ends, one end of said rigid strip being adjustably fixed and the other end being provided with an insulating roller held by means of a spring in engagement with a cam, said cam being adjustable to vary said predetermined temperature.

9. A thermally-operated electric switch comprising a pair of cooperating contacts controlling an electric current, a temperature responsive device heated by said current, and a heat sensitive wire which is directly heated by said current and has one end attached to said temperature responsive device and the other end to one

of said contacts, said temperature responsive device in response to increasing temperature effecting movement of said one contact away from the other contact and thereby interrupting said current at a predetermined temperature, the subsequent contraction of said wire due to its cooling consequent on the interruption of said current causing further movement of said one contact to increase the gap between said contacts.

10. A thermally-operated electric switch comprising a pair of cooperating contacts controlling an electric current, a first temperature responsive device comprising a bimetal strip arranged to effect initial separation of said contacts in response to increasing temperature, and a second temperature sensitive device which, prior to said initial separation, is expanded through heating by the current controlled by said contacts, but which cools and consequently contracts after such separation due to the cessation of said current, and thereby causes the gap between said contacts to increase as it cools.

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