

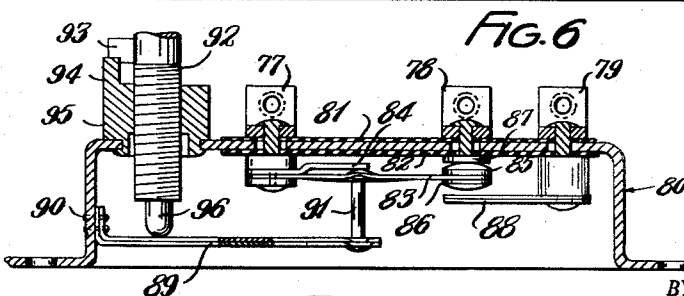
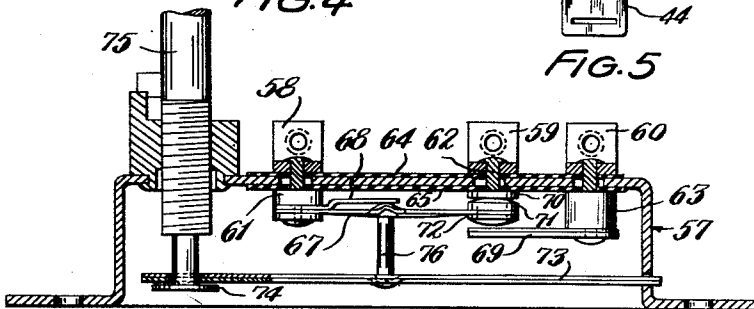
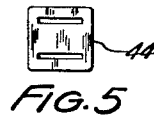
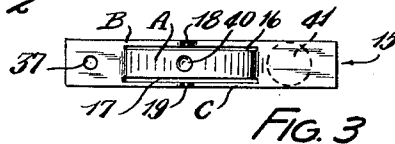
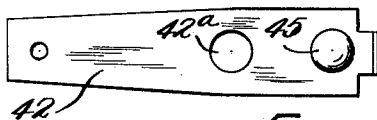
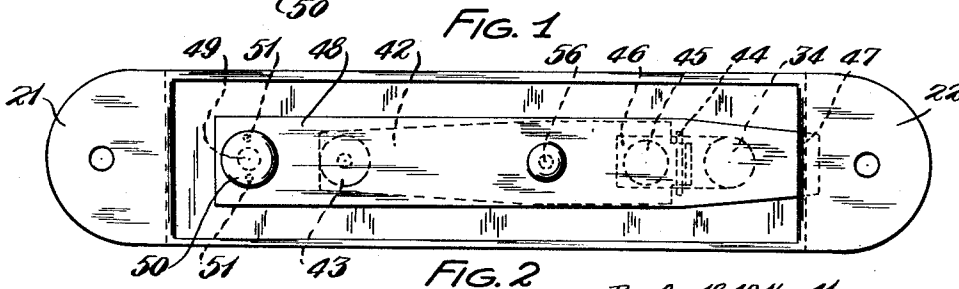
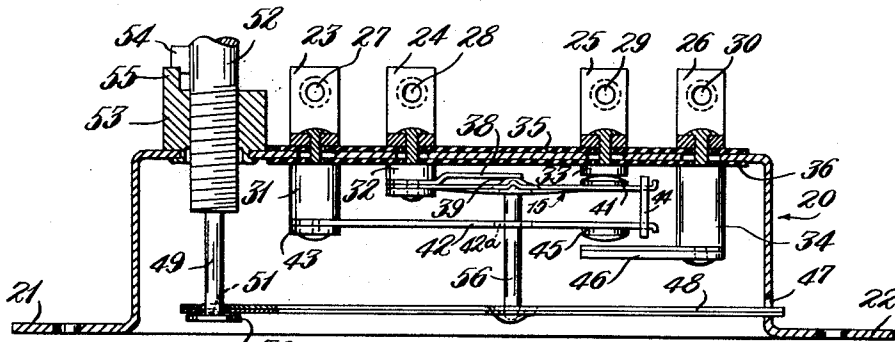
Sept. 14, 1954

C. S. MERTLER
THERMOSTATIC SWITCH

2,689,290

Filed Oct. 30, 1951

2 Sheets-Sheet 1



INVENTOR.
CHARLES S. MERTLER
BY *Hudson, Boughton,*
Williams, David & Hoffmann.
ATTORNEYS

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2 Sheets-Sheet 2

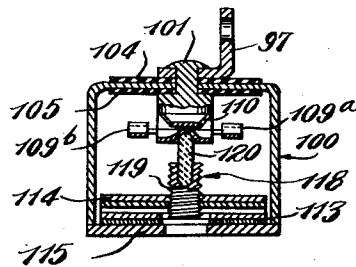
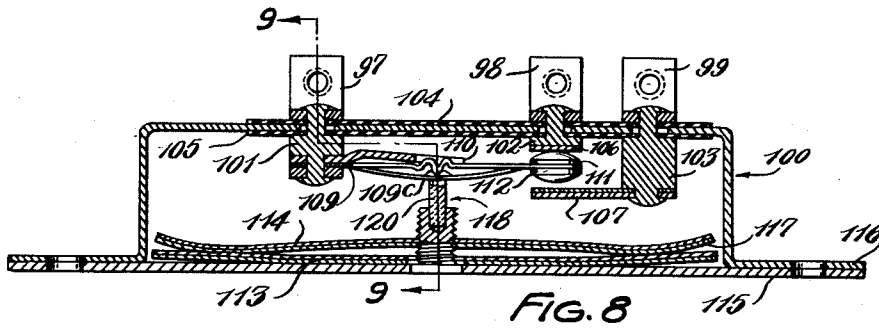


FIG. 9

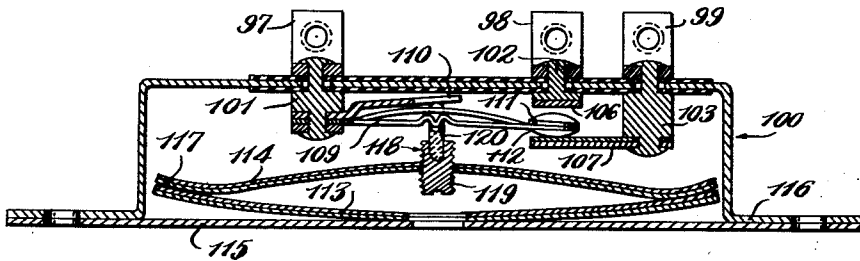


FIG. 10

INVENTOR.
CHARLES S. MERTLER
BY *Hudson, Boughton,*
Williams, David & Hoffmann.
ATTORNEYS

UNITED STATES PATENT OFFICE

2,689,290

THERMOSTATIC SWITCH

Charles S. Mertler, Mansfield, Ohio

Application October 30, 1951, Serial No. 253,777

19 Claims. (Cl. 200-138)

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This invention relates to electrical switches and, more particularly, to thermostatic switches which operate with a snap action at a predetermined temperature.

An object of the invention is to provide improved thermostatic switches which operate with a snap action within a very narrow temperature differential, thereby providing more reliable control of an electrical circuit or circuits, longer contact life, and reduced radio interference since "fluttering" or "frying" of the contacts is substantially eliminated, the switches being capable of carrying substantial current loads and rapidly responding to changes in temperature of the environments in which they are mounted.

Another object of the invention is to provide an improved thermostatic switch having a narrow temperature range or differential through utilization of a buckling or over-center spring to effect movement of one or more contacts of the switch, the said spring being anchored at only one end thereof with the other end free to snap and thereby effect contact operation in response to the force exerted on the spring by a thermoresponsive member responding to a predetermined change in temperature.

A further object of the invention is to provide an improved thermostatic switch as defined in the preceding paragraph and wherein a means is provided cooperating with the said buckling or over-center spring to snap the latter back to its initial position when the force exerted thereon by the thermoresponsive member is removed.

A still further object of the invention is the provision of an improved thermostatic switch as defined in either of the two preceding paragraphs and which is adapted to alternately control two independent electrical circuits in response to a predetermined temperature change.

An additional object of the invention is to provide an improved thermostatic switch employing an over-center or buckling spring as one of the contacts thereof, the said spring being actuated by flexing of the central portion of a bimetallic member, which member has the ends thereof supported for limited movement so that flexing of the bimetallic member in response to temperature changes is not hindered by its mounting.

The invention also has as its object the provision of an improved thermostatic switch of the type defined above and in which two or more bimetallic members are floatingly supported adjacent the over-center or buckling spring for effecting operation of the latter in response to a predetermined temperature change.

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A still further object of the invention is to provide an improved thermostatic switch as defined in the preceding paragraph and wherein the bimetallic members are floatingly arranged in superposed or stacked, motion additive, relationship to provide an amplified movement in response to a predetermined temperature change thereby effecting switch operation in response to an extremely narrow temperature differential.

The invention further resides in certain novel features of construction and combination and arrangements of parts of the switches, and further objects and advantages thereof will be apparent to those skilled in the art from the following description of the present embodiment of the invention and certain modifications thereof described with reference to the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view through the present preferred embodiment of a thermostatic switch incorporating the novel features of this invention with certain parts of the operating mechanism being shown in elevation to more clearly illustrate the construction;

Fig. 2 is a bottom view of the switch illustrated in Fig. 1;

Fig. 3 is a detached, elevational view of the present preferred form of over-center or buckling spring utilized in the switch illustrated in Figs. 1 and 2;

Fig. 4 is a detached elevational view of the resilient contact arm which extends substantially parallel with the over-center spring in Fig. 1;

Fig. 5 is a detached elevational view of the member utilized to connect the free ends of the over-center spring and resilient contact arm in the switch shown in Figs. 1 and 2;

Fig. 6 is a longitudinal sectional view through a modified form of thermostatic switch embodying the invention with portions of the operating mechanism shown in elevation to more clearly illustrate the construction;

Fig. 7 is a longitudinal sectional view through a still different form of thermostatic switch embodying the invention with portions of the operating mechanism being shown in elevation to more clearly illustrate the construction;

Fig. 8 is a longitudinal sectional view through yet another form of thermostatic switch embodying the invention with portions of the operating mechanism shown in elevation to more clearly illustrate the construction;

Fig. 9 is a transverse sectional view taken substantially on the irregular line 9-9 of Fig. 8 and looking in the direction indicated by the arrows; and,

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Fig. 10 is a view similar to Fig. 8 but showing the positions of the parts of the switch when the latter has been actuated in response to attainment of a predetermined temperature.

The thermostatic switches of this invention are of the snap action type, since the movable contact or contacts thereof move from one position to the other relatively rapidly or with a snap action upon attainment of a predetermined operating temperature. This rapid movement or snap action prevents "fluttering," "frying" and similar difficulties which are present in thermostatic switches of the creep type. While switches of the snap action type have many advantages, the principal objection thereto has arisen from the fact that it is customary to employ relatively complicated mechanisms to effect the required snap action thereby increasing the cost of the switches and multiplying the chances of failure of the switches in operation. In my copending application entitled "Thermostatic Switch," S. N. 175,696, filed July 25, 1950, I have disclosed and claimed improvements in thermostatic switches of the snap acting type which enable the desired rapid movement of the contacts to be effected through the utilization of a single spring member, thus reducing the cost and at the same time providing a more reliable operation. The switches of this invention are generally similar to those disclosed and claimed in the aforementioned copending application but differ therefrom in that the instant switches are particularly adapted for alternately controlling two independent electrical circuits and, in addition, have certain constructional features which differ from the switches of the aforementioned application.

The spring element employed in the switches of this invention is for convenience hereinafter referred to as an over-center or buckling type spring. Such a spring may be formed in a variety of different manners but in the presently preferred embodiment the spring is of the type illustrated in Fig. 3. As shown therein, the spring, generally designated 15, comprises an elongated strip of relatively thin spring material such as tempered steel, brass, Phosphor bronze, or the like. This strip of material is longitudinally slotted or slit, as indicated at 16 and 17, parallel with the longitudinal edges of the strip but with the ends of the slots or slits entirely enclosed within the edges of the spring. There is thus provided a central portion A and outer portions B and C of the spring, which are all parts of the integral strip. The central portion A of the spring is elongated with respect to the side portions B and C so that the spring tends to assume a curved configuration, as viewed in side elevation, the direction of curvature depending upon whether the central portion A is disposed to one side or the other of the plane of the side portions B and C.

The central portion A of the spring 15 may be caused to snap through center from one side of the plane of the side portions B and C to the other side thereof by application of a force in the nature of a thrust on the said central portion, thereby causing the spring as a whole to curve in the opposite direction. Because the central portion A can never lie exactly in the plane of the side portions B and C but must always buckle or snap through or beyond the center line or plane of such portions, the spring is said to be of the over-center or buckling type.

In order to provide the requisite difference in lengths between the central and side portions of the spring, the latter, in the form shown in Fig.

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3, has had the side portions B and C reduced in length by crimping or creasing them intermediate the ends of the spring as indicated at 18 and 19. This difference in length between the central portion A and the side portions B and C of the spring may also be achieved by stretching the central portion with respect to the side portions. Moreover, while the spring 15 has been shown as constructed from one piece of metal, it will be apparent that it may be formed of several separate pieces joined together by welding or riveting. Springs of the forms mentioned as possible alternative constructions are illustrated and described in my aforementioned copending application S. N. 175,696 to which reference may be had for the details thereof. Such springs may be interchangeably used with respect to the spring 15 as may other equivalent types and, therefore, it is to be expressly understood that the term "over-center" or "buckling" spring as used in this description and the appended claims is to be construed as generic of these various forms of spring and not limited to a spring constructed in any one specific manner.

Referring now to Figs. 1 and 2, the switch shown therein is of the thermostatic type adapted to alternately control two independent electrical circuits and includes an over-center or buckling spring of the type described above. The illustrated switch is of the enclosed type having an oblong housing, generally designated 20, which may be formed from sheet metal by drawing, may be cast in one piece, or may be assembled from several separate parts. In the form shown, the housing 20 is illustrated as being of one piece construction and substantially U-shaped in longitudinal section, so as to provide a recess or cavity within which the operating portions of the switch are enclosed. The housing has outwardly extending ears or lugs 21 and 22 by which the switch may be applied to a surface the temperature of which is to control operation of the switch.

The top of the housing 20 has four terminal members 23, 24, 25 and 26 secured thereto in spaced relationship. In the form shown, these terminal members each comprise substantially right-angled brackets, the upstanding legs of which are provided with tapped holes 27, 28, 29 and 30 for the reception of screws by means of which conductors may be connected to the switch. The horizontal legs of the terminal members 23—26 are apertured and are secured to the housing 20 by terminal posts or studs 31, 32, 33 and 34, respectively, disposed within the cavity of the housing and each having a reduced diameter portion extending through a cooperating opening in the housing and in the horizontal portion of the corresponding terminal lug, the outer ends of the terminal posts being peened over, as will be apparent from Fig. 1. When, as in the illustrated embodiment, the case or housing 20 is formed of metal, insulation is provided between the terminal lugs 23, 24, 25 and 26 and the outer side wall of the housing, and also between the terminal posts 31, 32, 33 and 34 and the inner side wall of the housing. This insulation is shown as being in the form of sheets or plates 35 and 36 of mica, hard rubber, or other insulating material interposed as aforementioned, it being understood that the reduced diameter portions of the terminal posts are of less diameter than the openings in the housing 20 through which they extend, see Fig. 1. In place of sheets or plates of insulating material, separate washers of insulating material

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may be provided for each terminal member and post.

The terminal post 33 is preferably of lesser length than the terminal post 32 with the inner end of the latter provided with a reduced diameter portion passing through an opening 37 at one end of the over-center or buckling spring 15 and through a corresponding opening in a relatively stiff resilient arm or member 38. A washer is preferably provided on the lower end of the post 32 and the latter is then peened over to firmly secure the spring 15 and arm 38 in the relationship shown in Fig. 1. As illustrated therein, the central portion A of the spring 15 has an integral raised surface 39 thereon provided by indenting the underside of this portion of the spring as indicated at 40, see Fig. 3. The outer end of the resilient arm 38 engages the raised portion 39 of the spring either continuously or when the latter snaps through center and bears thereon with sufficient force so that the central portion A of the spring is normally disposed below the side portions B and C when the parts are positioned as shown in Fig. 1, and the temperature of the switch has not been elevated sufficiently to actuate the thermoresponsive member hereinafter described. Consequently, the portion of the spring 15, opposite the post 32 is urged towards the terminal post 33 and this portion of the spring is provided with a contact means or member 41, which may be in the form of a button of silver or other suitable contact material spot welded or otherwise secured to the spring 15. The construction is such that, with the parts as shown in Fig. 1, the contact 41 is in firm engagement with the lower portion of the terminal post 33 which may be provided with a silvered surface or other suitable material providing a suitable contact surface.

The lower portion of the terminal post 31 has a reduced diameter portion extending through an opening in a resilient contact arm or member 42 which arm or member is firmly secured to the post 31 by peening over the outer end of the latter, a washer such as 43 being preferably interposed between the arm or member 42 and the peened outer end of the terminal post 31 to insure proper support. The arm or member 42 is adapted to flex or move in unison with the over-center spring 15, this combined movement being effected by a connection between the free ends of the members in the form of a plate-like member or link 44 which is formed of insulating material and is slotted as indicated at Fig. 5 to receive the outer ends of the spring 15 and member 42.

The lower surface of the arm or member 42 is provided with means forming an electrical contact which means is here illustrated as a button 45 of silver or other suitable contact material spot welded or otherwise secured to the arm or member 42.

The contact 45 is adapted to be moved to and from engagement with a stationary contact 46 connected with the terminal post 34, the contact 46 being here shown as a relatively rigid arm having a coating of silver or other suitable contact material on the upper surface thereof for engagement by the contact 45. The arm 46 is secured to the post 34 in any suitable manner, as, for example, by having a reduced diameter portion of the post passing through an opening in the arm or member 46 with the outer end of this reduced diameter portion peened over as shown in the drawings.

With the construction thus far described, it will

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be apparent that the contact 41 is normally in engagement with the terminal post or contact 33 while the contact 45 is spaced from the contact 46. However, upon application of an upwardly directed force or thrust upon the central portion A of the over-center spring 15, the latter will be caused to snap through center thus reversing the direction of its curvature so that the contact 41 moves from engagement with the terminal post or contact 33. Substantially simultaneously, the contact 45 will engage the contact 46 due to the interconnection of the spring 15 with the resilient arm 42. This action of the switch will result in flexure of the arm 38, thus increasing the force acting upon the raised portion 39 of the spring member 15 so that when the upwardly directed force is reduced or removed the force exerted by the member 38 automatically returns the parts to the positions shown in Fig. 1.

In accordance with this invention the switch, just described, is operated by a thermoresponsive member acting upon the central portion A of the spring 15 to provide the upwardly directed force when the temperature to which the switch is subjected equals or exceeds a predetermined value. For this purpose, the housing 20 has the end wall slotted adjacent the ear or flange 22, slotted as indicated at 47, and an elongated, substantially planar, bimetallic member or strip 48 is positioned with one end freely passing through the slot 47 and with the principal portion of the member extending interiorly of the housing through substantially the length thereof. The inner end of the bimetallic member 48 is floatingly supported within the housing by a supporting rod or member 49, which extends freely through an opening in the inner end of the member 48. The lower end of the rod 44 is provided with a flange or collar 50 on which the bimetallic member 48 rests and, in order to reduce friction between this collar 50 and the bimetallic member 48, the latter is preferably provided with spaced projections such as 51 on either side of supporting member or rod 49, thus elevating the main portion of the end of the member 48 slightly above the surface of the collar or flange 50.

The upper end of the rod or member 49 is integral with or connected to an enlarged diameter portion or shaft 52 which is threaded and co-operates with a tapped bushing or collar 53 non-rotatably supported upon the housing 20 so that rotation of the member or shaft 52 alters the elevation of the inner end of the thermoresponsive member 48, thereby providing for adjustment of the switch operation as will be hereinafter apparent. The shaft or member 52 may be provided with a suitable handle or knob, not shown, and the shaft, intermediate its ends, is preferably provided with a radially projecting lug 54 for cooperating with an upstanding lug 55 on the threaded bushing 53 to limit the extent of adjustment of the shaft or member 52.

Intermediate its ends, the bimetallic member 48 has a recess or dimple formed therein, which receives and supports the rounded lower end of a force or thrust transmitting member 56. The member 56 is preferably formed of insulating material and passes freely through an opening 42a in the arm 42 with its rounded upper end received in the recess or dimple 40 of the over-center spring 15.

As mentioned heretofore, the housing 20 of the switch is preferably made of metal and the ears or flanges 21 and 22 are placed upon and/or secured to the surface whose temperature is to

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operate the switch. Consequently, the thermoresponsive member, namely, the bimetallic strip 48, is in good thermal exchange relationship with the said surface, this being due both to the close proximity of the bimetallic member with the surface as well as the fact that the ends of the bimetallic member are in positive metal-to-metal contact with the surface through portions of the housing and of the switch structure. Therefore, the bimetallic member 48 rapidly responds to changes in temperature of the surface upon which the switch is mounted, thereby flexing or bowing intermediate its ends. In the construction as shown, the bimetallic member is so disposed that this flexing is upwardly as viewed in the drawings and is unrestrained, since the outer ends of the member may slide upon the housing and collar 50, respectively. Therefore, repeated flexings or operations of the bimetallic member 48 are always the same for the same predetermined temperature, there being no extraneous stresses introduced, as frequently happens when a bimetallic member is rigidly secured to a stationary member.

The flexing of the bimetallic member 48, in response to an elevation in temperature, exerts a thrust upwardly upon the spring 15 through the force transmitting member 56 and, when a predetermined temperature has been reached, this flexing and the resulting force are sufficient to cause the spring 15 to snap through center and move the contacts 41 and 45, as has been previously described, so that the contact 41 no longer engages the terminal or contact 33 and the contact 45 is now in engagement with the contact 46. When the temperature of the surface on which the switch is mounted is lowered below the predetermined value, the flexure of the bimetallic member 48 is reduced so that the thrust or force exerted through the member 56 is correspondingly lessened and the resilient arm 38 acts upon the spring 15 to snap the latter back through center to the position as shown in Fig. 1. The temperature at which the switch operation is effected may be readily adjusted by turning the shaft or member 52 thus altering the position of the bimetallic member relative to the spring 15 and thereby altering the amount of flexure of the bimetallic member 48 necessary to effect switch operation.

It will be evident that two electrical circuits may be alternately controlled by a switch constructed as just described. Thus, one circuit may be connected to the terminals 24 and 25 while an independent circuit is connected to the terminals 23 and 26. Since these terminal members are insulated from the housing and from each other, the aforementioned circuits can be completed only when the movable contacts such as 41, 45 are in engagement with their cooperating stationary contacts 33 and 46, respectively. The construction of the switch illustrated in Figs. 1 and 2 is such that the circuit connected to the terminals 24 and 25 is normally completed and the circuit which is connected to the terminals 23 and 26 is normally open with the first circuit being opened and the second circuit closed upon the attainment of a predetermined temperature. Obviously, either circuit may be connected to either pair of terminals and the invention is in nowise limited to the number or nature of circuits which may be connected with the terminals.

While the switch shown in Figs. 1 and 2 is illustrated as being of the closed type, it will be readily apparent that the same mode of operation will be

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effected with an open type switch. In such a construction, the support for the operating portions of the switch would be provided by a substantially U-shaped bracket having open sides rather than the closed sides which are provided by the housing 20 here illustrated. The operation of the switch is not varied by this difference in the mounting or housing. Moreover, although the housing or mounting 20 for the switch is preferably metallic to provide good heat exchange between the bimetallic member and the surface on which the switch is mounted, nevertheless, in some cases the housing 20, or the equivalent supporting bracket, may be formed of plastic or other insulating material with the necessary heat exchange occurring through the open bottom of the housing.

Fig. 6 shows a modified form of switch embodying the principles of this invention and employing a buckling or over-center spring similar to that shown in Fig. 14. This embodiment of the switch is also shown as being of the enclosed type comprising a housing 57 identical with the housing 20 of Fig. 1. In the instant form, the switch is likewise provided with terminal lugs 58, 59, and 60 which are secured to terminal posts 61, 62 and 63 with interposed insulation such as 64 and 65, these parts being identical with corresponding elements 24, 25, 26, 32, 33, 34, 35 and 36 in the form of the switch shown in Figs. 1 and 2 and hence need not be again described in detail. Similarly, the lower portion of the post 61 is connected with one end of an over-center spring 67 and the corresponding end of a resilient arm 68, identical in construction and function with the spring 15 and arm 38 previously described. Also, the lower portion of the terminal post 62 is provided with a contact arm 69 similar to the contact arm 46 of Fig. 1 and the lower end of the terminal post 62 is provided as an electrical contact surface 70.

In the form of the switch illustrated in Fig. 6, there are but three terminal members 58, 59, 60 with cooperating terminal posts and hence the movable contact means or members controlled by the spring 67 are both carried upon the latter rather than one upon the over-center spring and the other upon a connected separate arm as in Fig. 1. Thus, as will be seen in Fig. 6, the outer or free end of the over-center spring 67 has upper and lower contact members or buttons 71 and 72 provided thereon with the former normally engaged with the contact portion or surface 70 of the terminal post 62 and with contact 72 normally spaced from but adapted to engage the contact 69 when the spring 67 snaps through center.

Operation of the spring 67 and hence of the movable contacts 71 and 72 is effected in response to attainment of a predetermined temperature by means of a bimetallic member 73 having one end supported in a slot or opening in the housing 57 and the other end provided with spaced projections resting upon a collar or flange 74 of the adjusting screw or post 75. The screw or post 75 is constructed in the same manner and operates in the same way as the supporting and adjusting rod or post for the thermoresponsive member 48 of Fig. 1. The central portion of the bimetallic member 73 has a recess or dimple in the upper surface thereof supporting the lower end of a force transmitting pin or member 76, the upper end of which is received in a corresponding recess of the spring member 67 in the same manner that the pin or member

56 is supported in the switch shown in Fig. 1. The operation of this embodiment of the invention is similar to that previously described in that the attainment of a predetermined temperature causes sufficient force to be transmitted through the member or pin 76, as the result of flexing of the bimetallic member 73, to thereby snap the spring 67 through center so that the contact 71 is moved from engagement with the contact surface or member 70 and the contact 72 is substantially simultaneously engaged with the contact 69. Consequently, this switch may likewise be employed to control alternate opening and closing of two separate circuits by connecting one lead of each circuit to the terminal 58 and the other leads of these circuits, respectively to the terminals 59 and 60. Adjustment of the predetermined temperature at which the switch operates may be effected by rotation of the shaft or screw 75 as will now be readily apparent.

Fig. 7 illustrates a still different form of snap acting switch embodying the principles of this invention. This switch has terminal members 77, 78 and 79 provided upon a housing 80 in spaced relationship and insulated from each other by insulating members 81, 82 in the same manner as in the previously described embodiments. The terminal member 77 is connected at its inner end with one end of an over-center spring 83 and the corresponding end of a resilient arm 84, identical with the previously described springs and cooperating arms. The outer end of the spring 83 is provided with upper and lower contact members 85 and 86 for movement with the spring alternately from engagement with stationary contact 87 and into engagement with a stationary contact 88, these contacts being provided upon the terminal members 78 and 79, respectively, as will now be apparent. In this form of the invention, however, the thermoresponsive member 89, while in the form of an elongated bimetallic element, does not have the latter supported in the same manner as in the two previously described embodiments. Instead, one end of the bimetallic member 89 is rigidly secured to the side wall of the housing 80 as by rivets 90, or the like, which pass through the upturned end or flange of the bimetallic element. Adjacent the inner or free end of the bimetallic member 89 is a recess or dimple in which is received the lower end of a force transmitting member 91, preferably formed of insulating material, the upper end of which is received in the recess or dimple provided in the central portion of the over-center spring 83, this force transmitting member and its mounting being substantially the same as previously described.

A means for adjusting the operation of the switch shown in Fig. 7 is provided in the form of a threaded shaft or screw 92 having an outwardly extending lug 93 cooperating with an upstanding lug 94 on a threaded bushing 95 secured to the housing and receiving the threaded shaft 92 in the same manner as the adjusting shafts or screws 52 and 75. In the instant form of the invention, however, the lower end of the adjusting screw or shaft 92 is provided with a reduced diameter extension 96 which may be a porcelain, ceramic, or like insert having a rounded lower end and bearing upon the upper surface of the bimetallic member 89 intermediate the point of connection of the latter to the housing and the force transmitting element 91.

The form of the invention illustrated in Fig. 7 may be employed like the switch illustrated in

Fig. 6 to alternately control opening and closing of two electrical circuits by connecting one lead of each circuit to the terminal member 77 and the other two leads respectively to terminal members 78 and 79. In the instant form of the invention a predetermined temperature change will cause flexing of the outer end of the bimetallic element 89 upwardly as viewed in the drawings, thus acting upon the central portion of the over-center spring 83 to snap the latter through center and move the contacts 85 and 86 from their illustrated positions to the positions in which contact 85 engages contact 88 and contact 86 is spaced from contact 87. When the temperature to which the switch is subjected drops below the predetermined value, the reduction in flexure of the bimetallic member 89 will allow the arm 84 to snap the spring 83 back through center to its initial position as shown in the drawings. Adjustment of the operating temperature of the switch may be readily effected by turning the shaft or screw 92, the bimetallic member 89 normally having sufficient upward bias to follow the screw or member 92 as it is retracted.

A still different embodiment of the invention is illustrated in Figs. 8 through 10. As shown therein, the switch is of the single pole, double throw type and comprises terminal members 97, 98 and 99 secured to a housing 100 by terminal posts 101, 102 and 103, these parts being the same as the terminals, terminal posts and housing in Figs. 6 and 7. Also, as in the previous forms, the instant embodiment is provided with insulating members 104 and 105, which insulate the terminal members and posts from the housing 100. Similarly, the terminal post 102 is provided with a stationary contact or contact surface 106 and the terminal post 103 has a stationary contact 107 connected therewith and extending in spaced relationship to the contact 106. Also, the terminal post 101 is connected at its lower end with one end of an over-center or buckling spring 109 immediately above which is supported a resilient arm 110 which cooperates with the central portion of the spring to normally position the latter as shown in Fig. 8. The outer end of the spring 109 is provided with upper and lower contacts 111 and 112 connected for movement with the spring and adapted to alternately engage the stationary contacts 106, 107, respectively. The spring resilient arm, and contacts are the same as in the previous embodiments, although the spring 109 is shown as having a multiple crimp or bend in the side portions 109a, and 109b so as to provide a greater bow or arc of the central portion 109c, thereby insuring greater movement of the contacts 111 and 112 when the spring is snapped through center. The operation of the spring 109 and of the resilient arm 110 are, however, the same as has been previously described.

In the form of the invention illustrated in Figs. 8 through 10, the thermoresponsive means is in the form of one or more bimetallic strips or plates, a plurality of such members being preferably employed and arranged in vertically stacked order unsecured to each other or to the other elements of the mechanism. As shown in the illustrated embodiment, two such bimetallic strips or members 113 and 114 are utilized which have configurations substantially the same as but of slightly smaller dimensions than the cavity or recess in the housing 100 so as to freely flex therein without, however, being materially displaced laterally or longitudinally. The bimetallic mem-

bers or strips are retained in place within the housing 100 by a bottom closure plate or member 115 extending across the bottom of the housing and which may be secured to the outwardly extending flanges or ears such as 116 thereof by suitable means such as spot welding or the like. The bimetallic member 113 preferably has an initial curvature or bias of relatively large radius so that the ends thereof are raised slightly and do not normally rest upon the bottom or supporting plate 115, see Fig. 8. The bimetallic member or strip 114 preferably has the central portion curved slightly so as to be elevated above the central portion of bimetallic strip 113 and the ends of the member 114 are reversely curved to provide arcuate surfaces such as 117 for engagement with the upper surface of the member 113 adjacent the ends of the latter.

The central portion of the bimetallic element or member 114 is provided with a means for applying an upwardly directed force or thrust upon the central portion 109c of the spring 109. This thrust member, designated generally 118, is preferably adjustable relative to the element 114 and is therefore disclosed as a post or stud 119 threaded in a tapped central opening of the bimetallic element 114. The upper end of the stud 119 is provided with a reduced diameter extension, preferably in the form of a ceramic or porcelain pin-like insert 120, the upper end of which is received in a recess or dimple in the central portion 109c of the over-center spring 109. Access to the lower portion of the stud 119 for adjusting the force transmitting member may be had through aligned openings in the lower bimetallic member 113 and in the bottom or cover plate 115 of the housing.

The operation of the switch illustrated in Figs. 8-10 is similar in general principles to those previously described, the basic difference being that the multiple bimetallic members provide for greater movement per degree of temperature change so that the over-center spring 109 can effect greater distance of movement of the contacts carried thereby for a given temperature differential, with the result that greater contact separation can be had thus enabling the switch to be used in installations where relatively high voltages and/or currents are employed.

The positions of the parts of the switch when the latter is at its cold or non-operated temperature are illustrated in Figs. 8 and 9 from which it will be seen that the contact 111 is in engagement with the contact 106 and contact 112 is spaced from the contact 107, the central portion of the over-center spring 109 being deflected downwardly under the force of the arm 110 which bears only upon the central portion 109c of the spring. Upon an increase in temperature of the environment in which the switch is placed, the bimetallic members 113 and 114 curve in reverse directions, since these members are disposed in motion additive relationship. When the predetermined temperature at which switch operation is desired has been attained, this deflection is sufficient to cause the central portion 109c of the spring to snap through center thereby moving contact 111 from engagement with contact 106 and bringing contact 112 into engagement with the contact 107, the parts then being substantially as shown in Fig. 10. When the temperature of the environment in which the switch is located drops below the predetermined value effecting operation of the switch, the curvature of the bimetallic members 113, 114 will have de-

creased sufficiently so that the force of the arm 110 will cause the central portion 109c of the switch to again snap back through center returning the contacts 111, 112 to their initial positions as shown in Fig. 8. The temperature at which switch operation occurs may be readily adjusted by changing the position of the force transmitting member 118 relative to the bimetallic member 114 through the use of a screw driver or other suitable tool.

It will now be apparent a switch of this form may likewise be used to alternately control two separate circuits by connecting one wire of each circuit to the terminal 97 and the other wires of the circuits respectively to the terminals 98 and 99. It will also be evident that more than two bimetallic elements such as 113 and 114 may be employed in stacked relationship, if still greater movement per degree of temperature change is desired, and the number of such elements utilized need not be a multiple of two, but may be an odd number. Moreover, it is not necessary that the sides of the bimetallic members having similar materials always be placed adjacent each other, since in some instances it is desirable that the members be placed with unlike materials adjacent each other.

The switch illustrated in Figs. 8-10 is of the single pole, double-throw type. It will be evident, however, that the same principles may be embodied in a switch of the single pole, single-throw type. That is to say, it is not necessary that the member 107 be a stationary contact where the switch is to control but a single circuit by alternately making and closing that circuit. In such an installation, the contact 112 could be omitted and the arm 107 could be simply in the form of an abutment to limit the movement of the outer end of the over-center spring 109. This extent of movement may be made adjustable by providing the said abutment with an adjustable screw or like expedient.

Although certain embodiments of the invention have been illustrated and described in detail, it will be evident that modifications may be made in the details of the switches shown and that the switches may be utilized for controlling a single circuit rather than two separate circuits. For example, if the switches be used for controlling but a single circuit, they can operate either to open or close that circuit upon a predetermined rise in temperature by suitable connection of the wires of the circuit to the terminals.

It will now be evident that the invention provides thermostatic switches of the snap acting type which are relatively simple in construction yet reliable in operation and which require a smaller temperature differential for effecting operation than do conventional snap acting switches. Furthermore, the construction of the switches is such that the thermoresponsive members may be disposed closely adjacent the surface the heat of which is to effect switch operation so that the thermoresponsive members are affected by thermal conduction through the metal portions of the housing and switch, as well as by convection and radiation.

Other advantages and adaptations of the invention will be apparent to those skilled in the art and hence it is to be understood that the detailed drawings and description are solely for the purpose of illustrating certain practical embodiments of the invention and are not to be considered as limitation thereon except as re-

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quired by the spirit and scope of the appended claims.

Having thus described the invention, I claim:

1. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by said contact means, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said contact means when the latter is moved from engagement with the said first stationary contact, thermoresponsive means having a portion adapted to move relative to said spring in response to changes in temperature, motion transmitting means extending between the said portion and said spring at a location between the ends of the latter and exerting force on the spring when the said portion of the thermoresponsive means moves to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, means engaging said spring on the opposite side thereof from said motion transmitting means to effect resetting of said spring to its initial position, and separate terminal members connected respectively with said first and second contacts and with said contact means whereby the said switch is adapted for connection in two electrical circuits for alternate control thereof.

2. An electrical switch comprising an elongated over-center spring having a central portion of greater length than the sides thereof such that the said central portion is normally disposed on one side or the other of a plane containing said side portions and is adapted to move with a snap action from one side to the other of the said plane upon application of force thereto, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by the said contact means when the said central portion of the spring is in one position, a second stationary contact electrically insulated and spaced from the first stationary contact and adapted to be engaged by the said contact means when the said central portion of the spring is moved to the other position thereof, a thermoresponsive means having a portion adapted to move relative to said spring in response to changes in temperature, motion transmitting means extending between the said portion of the thermoresponsive means and the central portion of said spring at a location between the ends of the latter and exerting force on the latter when the said portion of the thermoresponsive means moves to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first contact and into engagement with said second contact, and separate terminal members connected respectively with said first and second contacts and with said contact means whereby the said switch is adapted for connection in two electrical circuits for alternate control thereof.

3. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by said contact means,

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a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said contact means when the latter is moved from engagement with the said first stationary contact, an elongated bimetallic member spaced from said spring and having a portion free to flex in response to temperature changes, motion transmitting means extending between the said portion of the bimetallic member and said spring at a location intermediate the ends of the latter and adapted to exert sufficient force on the latter when the bimetallic member flexes a predetermined amount to thereby effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, and resilient means acting upon said spring to automatically effect resetting of the latter to its initial position after flexure of said bimetallic member has been reduced below the said predetermined amount.

4. An electrical switch comprising an elongated over-center spring having a central portion of greater length than the sides thereof so that the said central portion is normally disposed on one side or the other of a plane containing said side portions and is adapted to move with a snap action from one side to the other of said plane upon application of force thereto, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by said contact means, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said contact means when the latter is moved from engagement with the said first stationary contact, an elongated bimetallic member spaced from said spring and having a portion free to flex in response to temperature changes, motion transmitting means extending between the said portion of the bimetallic member and said spring at a location intermediate the ends of the latter and adapted to exert a thrust of sufficient force on the latter when the bimetallic member flexes a predetermined amount to thereby effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, and means engaging said spring on the side opposite the said motion transmitting means for exerting a continuous force upon said spring in opposition to the thrust exerted thereon by the flexure of the bimetallic member, whereby the said spring is automatically reset to its initial position after flexure of said bimetallic member has been reduced below the said predetermined amount.

5. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, electrical contact members on opposite sides of said spring adjacent the other end thereof, a first stationary contact normally engaged by one of the contact members on said spring, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the other of said contact members when the first-mentioned contact member is moved from engagement with the said first stationary contact, a thermoresponsive means spaced from said spring and having a portion adapted to move

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relative to said spring in response to changes in temperature, motion transmitting means extending between the said portion and said spring at a location between the ends of the latter and exerting force on the latter when the said portion of the thermoresponsive means moves to effect snapping of said spring through center thereby rapidly moving said first contact member from engagement with said first stationary contact and bringing said second contact member into engagement with said second stationary contact, resilient means engaging said spring on the opposite side thereof from said motion transmitting means to effect automatic return of said spring to its initial position, and separate terminal members connected respectively with said first and second contacts and with said contact means whereby the said switch is adapted for connection in two electrical circuits for alternate control thereof.

6. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by said contact means, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said contact means when the latter is moved from engagement with the said first stationary contact, an elongated bimetallic member spaced from said spring and having its ends supported for limited movement and its central portion free to flex in response to temperature changes, motion transmitting means extending between the said central portion of the bimetallic member and said spring at a location intermediate the ends of the latter and adapted to exert a thrust of sufficient force on the latter when the bimetallic member flexes a predetermined amount to thereby effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, and separate terminal members connected respectively with said first and second contacts and with said contact means whereby the said switch is adapted for connection in two electrical circuits for alternate control thereof.

7. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, a contact member carried by said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by the said contact member, a second contact member connected for movement with said spring and electrically insulated from said first contact member, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said second contact member when the latter is moved in response to movement of said spring, a thermoresponsive means having a portion adapted to move relative to said spring in response to changes in temperature, motion transmitting means extending between the said portion of the thermoresponsive means and said spring at a location between the ends of the latter and exerting force on the latter when the said portion moves to effect snapping of said spring through center thereby moving said first-mentioned contact member from engagement with the said first stationary contact and bringing the said second contact member into engage-

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ment with said second stationary contact, and separate terminal members connected respectively with said first and second contact members and with said first and second stationary contacts whereby the said switch is adapted for connection in two independent electrical circuits for alternate control thereof.

8. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, a contact member carried by said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by the said contact member, a second contact member, means movably supporting said second contact member adjacent to the contact member on said spring, means connecting said spring and said second contact member mounting means for movement together, a second stationary contact electrically insulated and spaced from the said first stationary contact member and adapted to be engaged by the said second contact member when the latter is moved in response to movement of said spring, a thermoresponsive means having a portion adapted to move relative to said spring in response to changes in temperature, motion transmitting means extending between the said portion of the thermoresponsive means and said spring at a location intermediate the ends of the latter and exerting force on the spring when the said portion moves to effect snapping of said spring through center thereby moving said first-mentioned contact member from engagement with the said first stationary contact and bringing the said second contact member into engagement with said second stationary contact, and separate terminal members connected respectively with said first and second contact members and with said first and second stationary contacts whereby the said switch is adapted for connection in two independent electrical circuits for alternate control thereof.

9. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by the said contact means, a second stationary contact electrically insulated and spaced from the said first stationary contact and adapted to be engaged by the said contact means when the latter is moved from engagement with the said first stationary contact, an elongated bimetallic member spaced from said spring and having one end supported to flex in response to temperature changes, motion transmitting means extending between the said one end portion of the bimetallic member and said spring at a location intermediate the ends of the latter and adapted to exert a thrust of sufficient force on the latter when the bimetallic member flexes a predetermined amount to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, resilient means engaging said spring on the opposite side thereof from said motion transmitting means to effect automatic return of said spring to its initial position, and separate terminal members connected respectively with said first and second contact and with said contact means whereby the said switch is adapted for connection in two independent electrical circuits for alternate control thereof.

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10. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a stationary contact normally engaged by the said contact means, a plurality of bimetallic members supported in stacked relationship and having all portions thereof free for movement in response to changes of temperature, motion transmitting means extending between one of said bimetallic members and said spring at a location between the ends of the latter for exerting force on the latter when the bimetallic members flex to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said stationary contact, and means cooperating with said spring for resetting the latter to its initial position after flexure of said bimetallic members has been reduced below the amount which effects snapping of said spring.

11. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a stationary contact normally engaged by the said contact means, a plurality of bimetallic members supported in motion additive relationship, motion transmitting means extending between one of said bimetallic members and said spring at a location between the ends of the latter for exerting force on the latter when the bimetallic members flex to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said stationary contact, and resilient means cooperating with said spring for automatically resetting the latter to its initial position after flexure of said bimetallic members has been reduced below the amount which effects snapping of said spring.

12. An electrical switch comprising an elongated over-center spring having a central portion of greater length than the sides thereof such that the said central portion is normally disposed on one side or the other of a plane containing said side portions and is adapted to move with a snap action from one side to the other of the said plane upon application of force thereto, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a stationary contact normally engaged by said contact means, a plurality of bimetallic members supported with all portions thereof free for movement in response to changes of temperature and with the said members disposed in motion additive relationship, motion transmitting means extending between one of said bimetallic members and said spring at a location intermediate the ends of the latter for exerting force on the latter when the bimetallic members flex to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said stationary contact, and means cooperating with said spring for resetting the latter to its initial position after flexure of said bimetallic members has been reduced below the amount which effects snapping of said spring.

13. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a stationary contact normally engaged by said contact means, a plu-

ality of bimetallic members beneath said spring in superposed motion additive relationship, motion transmitting means extending between the upper of said bimetallic members and said spring at a location intermediate the ends of the latter for exerting force on the latter when the bimetallic members flex to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said stationary contact, and means cooperating with said spring for resetting the latter to its initial position after flexure of said bimetallic member has been reduced below the said predetermined amount.

14. An electrical switch as defined in claim 13 and wherein the said means for resetting said spring is a resilient member engaging the spring on the side thereof opposite said bimetallic members and acting in opposition thereto.

15. An electrical switch comprising an over-center spring, means supporting said spring at only one end thereof, contact means connected with said spring adjacent the other end thereof for movement therewith, a first stationary contact normally engaged by the contact means on said spring, a second stationary contact electrically insulated and spaced from the first stationary contact, a plurality of bimetallic members supported in motion additive relationship and having all portions thereof free for movement in response to changes of temperature, motion transmitting means extending between one of said bimetallic members and said spring at a location intermediate the ends of the latter for exerting force on the latter when the bimetallic members flex to effect snapping of said spring through center thereby rapidly moving said contact means from engagement with said first stationary contact and into engagement with said second stationary contact, and separate terminal members connected respectively with said first and second stationary contacts and with said contact means.

16. An electrical switch comprising a supporting means, a pair of contacts mounted on said supporting means in spaced relationship and electrically insulated from each other, a movable contact means adapted to alternately engage said spaced contacts, an over-center spring supporting said movable contact means at one end thereof with the contact means normally in engagement with one of said spaced contacts, means at the other end of said spring mounting the latter upon said supporting means, an elongated bimetallic member extending substantially parallel with said spring and spaced therefrom, means on said supporting means floatingly supporting said bimetallic member adjacent the ends thereof, and a thrust transmitting member intermediate the central portion of said bimetallic member and said spring and adapted to cause said spring to snap through center upon a predetermined flexure of said bimetallic member in response to a predetermined temperature change, thereby moving said contact means into engagement with the other of said spaced contacts.

17. An electrical switch as defined in claim 16 and wherein the means for supporting said bimetallic member includes an adjusting member rotatably mounted on said supporting means and having a surface on which one end of said bimetallic member rests.

18. An electrical switch comprising a supporting means, a pair of contacts mounted on said supporting means in spaced relationship and

electrically insulated from each other, a movable contact means adapted to alternately engage said spaced contacts, an over-center spring supporting said movable contact means at one end thereof with the contact means normally in engagement with one of said spaced contacts, means at the other end of said spring mounting the latter upon said supporting means, an elongated bimetallic member extending substantially parallel with said spring and spaced therefrom, means on said supporting means floatingly supporting said bimetallic member adjacent the ends thereof, a thrust transmitting member intermediate the central portion of said bimetallic member and said spring and adapted to cause said spring to snap through center upon a predetermined flexure of said bimetallic member in response to a predetermined temperature change, and resilient means engaging said spring adjacent the central portion thereof and on the side thereof opposite the said thrust transmitting member and acting in a direction opposed to the thrust of the latter for automatically returning said over-center spring and its contact means to their initial position after flexure of said bimetallic member has been reduced below the said predetermined amount.

19. An electrical switch comprising a supporting means, a pair of contacts mounted on said supporting means in spaced relationship and electrically insulated from each other, an over-center spring, means at one end of said spring mounting the latter upon said supporting means with the other end extending unsupported between said spaced contacts and normally engaged

with one of the latter, an elongated bimetallic member extending substantially parallel with said spring and spaced therefrom, means on said supporting means rigidly mounting said bimetallic member adjacent one end thereof, a motion transmitting member adjacent the other end of said bimetallic member and extending into engagement with said spring for causing the latter to snap through center upon a predetermined flexure of said bimetallic member in response to a predetermined temperature change, and resilient means engaging said spring adjacent the central portion thereof and on the side thereof opposite the said motion transmitting member and acting in a direction opposed to the latter for automatically returning said over-center spring and its contact means to their initial position after flexure of said bimetallic member has been reduced below the said predetermined amount.

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