Sept. 14, 1954 J. BELL 2,689,289

INTERMITTENTLY OPERATING SWITCHING DEVICE

Filed Feb. 13, 1953 3 Sheets-Sheet 1

Fig. 1.

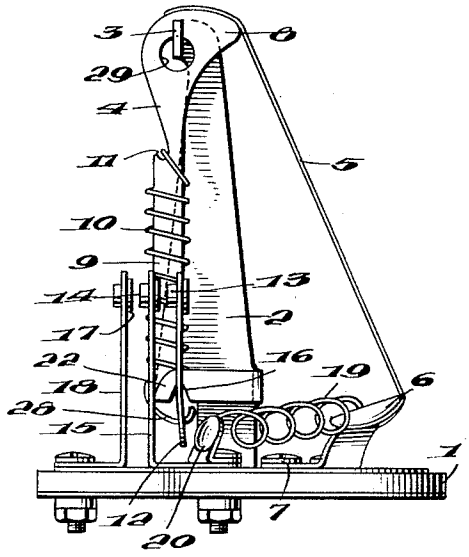


Fig. 2.

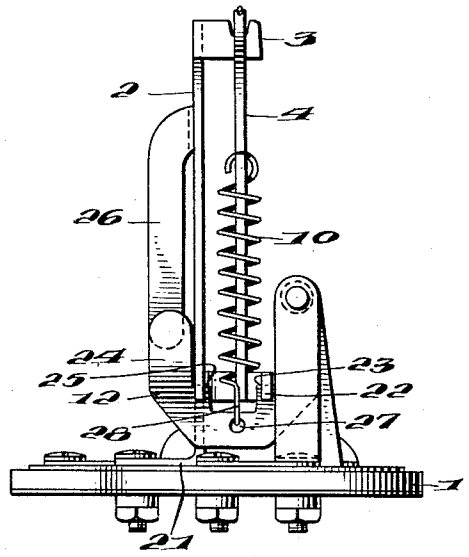


Fig. 3.

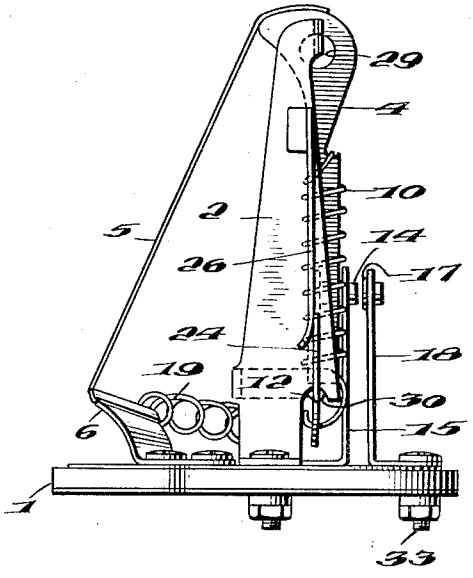
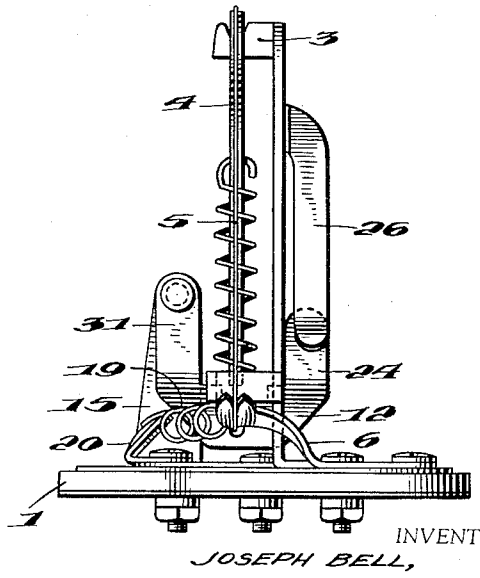


Fig. 4.



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Filed Feb. 13, 1953 3 Sheets-Sheet 2

Fig. 5.

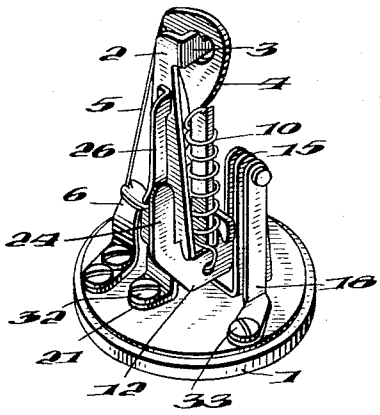


Fig. 6.

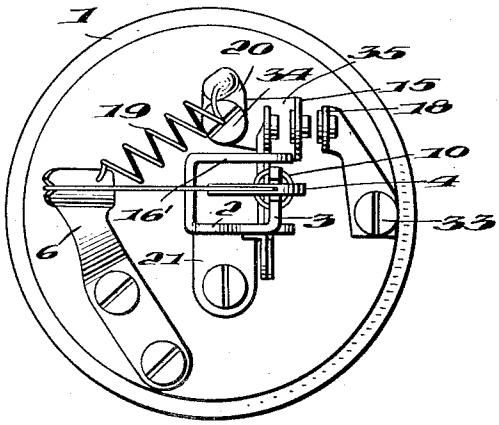


Fig. 7.

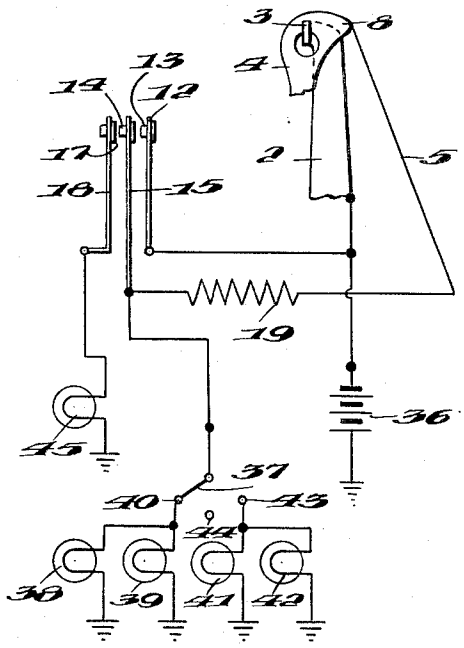


Fig. 8.

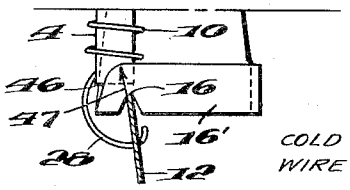
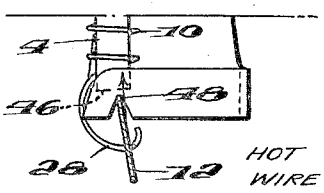


Fig. 9.



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INTERMITTENTLY OPERATING SWITCHING DEVICE

Filed Feb. 13, 1953 3 Sheets-Sheet 3

Fig. 10.

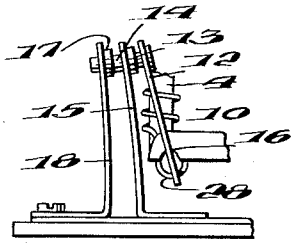


Fig. 11.

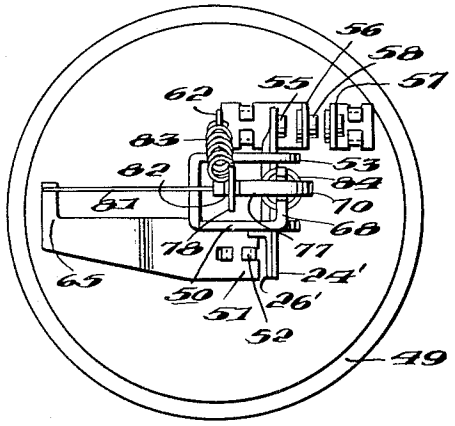


Fig. 17.

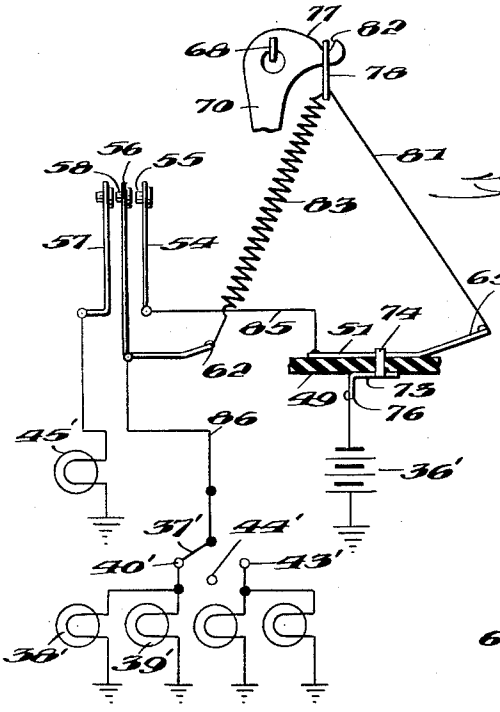


Fig. 12.

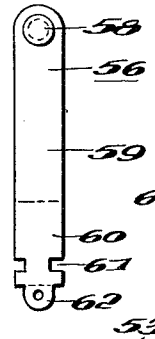


Fig. 13

Fig. 14.

Fig. 15.

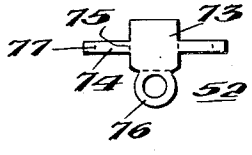
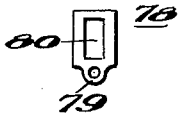


Fig. 16.



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2,689,289

UNITED STATES PATENT OFFICE

2,689,289

INTERMITTENTLY OPERATING SWITCHING DEVICE

Joseph Bell, Orlando, Fla.

Application February 13, 1953, Serial No. 336,713

19 Claims. (Cl. 200—122)

1

This application is a continuation-in-part of my application Serial No. 148,545, entitled "Thermally Responsive Current Flow Changer," filed March 9, 1950, now abandoned, and of my application Serial No. 177,059, entitled "Electric Current Intensity Changer," filed August 1, 1950, now abandoned.

My invention relates to intermittently operating switching devices, and more particularly to devices which comprise an expansible element and which are particularly adapted to signal systems.

A general object of my invention is to provide an improved intermittently operating switching device.

Specific objects of my invention are to increase the reliability, simplicity and life of intermittently operating switching devices, to decrease the number of parts required, and to provide simple original adjustments or settings of the time cycle in such devices.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a side elevation of a device in accord with the preferred embodiment of my invention;

Fig. 2 is an end elevation of the device of Fig. 1;

Fig. 3 is a side elevation of the device taken from the side opposite that shown in Fig. 1;

Fig. 4 is an end elevation of the device taken from the end opposite that shown in Fig. 2;

Fig. 5 is a reduced perspective view of the device of Figs. 1–4;

Fig. 6 is a top view of the device of Figs. 1–4;

Fig. 7 is a schematic representation of portions of the device as incorporated in a direction signalling system for automotive vehicles;

Fig. 8 is an enlarged detail side view of a portion of the device of Figs. 1–4 representing the position of certain parts of the device when the switching contacts are in open position;

Fig. 9 is a similar detail side view of the parts shown in Fig. 8 taken when the contacts are in closed position.

Fig. 10 is a detail side view on the same scale as Figs. 1–4 of a portion of the device showing the contacts in closed position;

Fig. 11 is a top view of a device of modified construction in accord with my invention;

2

Figs. 12, 13, 14, 15 and 16 are plan views of blanks prior to forming and assembly into the modified device of Fig. 11; and

Fig. 17 is a schematic representation of portions of the modified device of Fig. 11 as incorporated in a direction signalling system for automotive vehicles.

As seen in Fig. 1 the preferred embodiment of my invention comprises an insulating base member 1, to which is mounted an upstanding post 2 carrying at its upper end a pivot or fulcrum portion 3. An arm or lever member 4 is pivotally supported by the fulcrum portion 3 and is arranged to swing back and forth in accord with respective contractions and expansions of a thermal wire 5, which comprises an electrically conductive thermally expansible operating element. Wire 5 is soldered or otherwise mechanically affixed to a bendably adjustable support or anchor member 6 attached to base 1 by means of bolt 7. The upper end of wire 5 is soldered or similarly affixed to a protruding head portion 8 of arm 4. As seen in Fig. 1, head portion 8 and anchor member 6 are preferably curved at the portions in contact with the wire to reduce fatigue failures of the wire at its connected ends.

Circumscribing the extending lower portion 9 of arm 4 is a tension spring 10. The upper loop of this coil spring engages a notch 11 in the lever arm 4, and the lower end of the spring extends beyond the lower end of the lever and engages a movable contact member 12. Member 12 carries a contact button 13 at its upper end, which is adapted to make contact with one side of a contact button 14 carried at the upper end of a resilient contact member 15. The operation of the device is such that relaxation or expansion of the wire 5 permits the lower end of arm 4 to move to the right, as seen in Fig. 1, to oscillate contact member 12 on its pivotal support 16 in the direction to move button 13 into contact with button 14. When this occurs, contact element 15 bends toward the left and button 14 makes contact with button 17 of contact member 18. A resistance element 19 connects between the conductive support member 6 at the lower end of the active expansible element 5 and an electrical terminal 20. The resistance element 19 preferably comprises a loosely coiled continuous extended portion of wire 5.

Turning now to Fig. 2, the upstanding post 2 is seen to comprise a foot portion 21 bolted to base 1 and a lower arm portion 22 which serves to provide the notched pivot 16 in which a knife edge 23 of contact member 12 engages. The

movable contact member 12 comprises a generally U-shaped, thin, metal member having an upstanding contact-button-carrying portion and an opposite upstanding stop-engaging portion 24. Knife edge 23 extends inwardly from the contact-button-carrying portion, and a similar knife edge 25 extends inwardly from the stop-engaging portion 24 to seat in downwardly opening pivot notch formed in the post 2.

A stop member 26 extends from the post 2 to be engaged by portion 24 of contact member 12 when the movable contact 12 is oscillated into open position. Oscillations of contact member 12 result from motions of lever member 4, and these motions are transmitted through tension spring 10 to the spring connection with member 12 at aperture 27. As seen in Figs. 1 and 2, the lower end of spring 10 is formed into a hook portion 28 which engages in aperture 27 of member 12 below the pivot axis established through knife edges 23 and 25. As seen in Fig. 2, the pivot or fulcrum portion 3 comprises an upper tab bent at right angles to the body of post 2 and comprising a notch in which arm 4 is disposed. By comparing the views of Figs. 1 and 2, it will be seen that lever 4 may be positioned on pivot portion 3 by inserting the pivot portion into aperture 29. The area at the bottom of the notch in pivot portion 3 may be knife edged to provide a minimum of friction in the swinging of arm 4.

As seen in Fig. 3, stop 26 extends downwardly along a substantial portion of post 2 and is engaged by portion 24 of contact member 12. Member 26 is preferably of a resilient metal which, however, is readily deformed, as by pliers, into a desired adjusted position at the time of fabrication of the device, or during tests. When the switch is in the open position, stop 26 resiliently urges portion 24 toward the right, as seen in Fig. 3, although member 26 is insufficiently resilient appreciably to follow portion 24 as member 12 oscillates into the switch closing position. Original adjustments of the timing cycle of the device are accomplished not only by bending member 26 to limit motion of portion 24 at the desired position, but also by bending anchor member 6 toward or away from base 1, as necessary properly to tension expansible element 5.

Fig. 3 further discloses the pivotal support notch 30 which is formed in the body of post 2 and in which is engaged the knife edge hereinabove identified by the numeral 25.

Fig. 4 is an end view of the device of Figs. 1–3. Fig. 4 shows further details of the shape and arrangement of the several parts of the device. For example, the U shape of contact member 12 is clearly portrayed and the arrangement of the upstanding stop-engaging portion 24 and of the upstanding contact-button-carrying portion 31 are readily apparent. Anchor member 6 is seen to comprise a curved portion to which expansible element 5 is affixed.

Portions of the device as shown in the four views of Figs. 1–4 have been similarly numbered in each instance to assist in a clear understanding of the construction, although, for the sake of brevity, specific descriptions in connection with each figure are not repeated. It will be understood that the description of parts of the device most clearly seen in one of the figures is equally applicable to the similarly identified parts as seen in each of the other figures.

A perspective view of the device of Figs. 1–4 is shown in reduced scale in Fig. 5. The method of attachment of post 2 to base 1 by means of foot 21 and bolt 32 is readily apparent, and it will be noted that stationary contact member 18 is similarly attached to base 1 by means of bolt 33. The bolts 32 and 33 additionally serve to provide electrical connections below base 1 to the respective conductive members supported thereby. The view of Fig. 5 also discloses the relative arrangement of expansible element 5, anchor member 6, contact member 12, resilient contact member 15, spring 10 and lever member 4.

The top view of Fig. 6 specifically discloses the shape and arrangement of fulcrum portion 3 of post 2 in connection with arm 4, and also shows the general shape of the pivotal support portion 16'. The bottom end of post 2 extends into foot 21, and the post is held to the base by means of electrically conductive bolt 32. Electrically conductive bolt 33 is seen to be arranged similarly to support contact member 18, and a bolt 34 mounts terminal lug 20 for resistance element 19 to the base 1 and further serves to mount resilient contact member 15 to the base by means of a horizontal lower foot portion 35 of member 15 which extends along the upper surface of the base and under lug 20.

Fig. 7 is a schematic diagram including partially fragmentary representations of portions of the switching device hereinabove disclosed demonstrating the incorporation of the device in an automobile direction signalling system or the like. The conductive post 2 is connected to the ungrounded terminal of the automobile battery 36, to the movable contact member 12 and, through the head portion 8 of arm 4, to the upper end of expansible element 5. The lower end of expansible element 5 is connected through resistance element 19 to intermediate resilient contact member 15 and to blade 37 of a manually operable direction signalling switch. Signal lamps 38, 39 are connected in parallel to one switch point 40 of the signalling switch, while lamps 41, 42 are connected to a second switch point 43. A central insulated switch point 44 is provided at the "off" position of the signalling switch. Lamps 38 and 39 may be mounted respectively at the forward and rearward ends of the vehicle and on one side thereof, while lamps 41 and 42 are similarly arranged on the other side. A dash-mounted pilot lamp 45 is preferably included in the system and is connected to stationary contact member 18 of the device. Each lamp is returned to the grounded battery terminal.

Operation of the system to signal a turn in one or the other direction is initiated by moving switch blade 37 from its normal "off" position at point 44 to point 40 or 43 as appropriate. Assuming that the blade has been moved to point 40, as shown, current from the battery 36 flows through post 2 and wire 5 in series, thence through resistance element 19, blade 37 and switch point 40 and through lamps 38, 39, in parallel back to the grounded battery terminal. The resistance of elements 5 and 19 is such that lamps 38, 39 received insufficient energy to be illuminated to full brilliance and they may remain substantially completely dark. The current through wire 5, however, is sufficient to heat the wire in a short period of time, such as one-quarter or one-half second, to a temperature at which the wire will undergo a change in its length dimension in the direction or sense corresponding to an extension of the wire. A very small amount of elongation of wire 5 will result in snap-actuation of movable contact member 12 into contact with member 15, and member 15 is thereby resil-

iently swayed into contact with member 18. Contact between buttons 13 and 14, of members 12 and 15, respectively, provides a short circuit for the elements 5 and 19 and supplies the full battery voltage to lamps 38, 39. The further contact of button 14 with button 17 of member 18 supplies the full battery voltage to pilot lamp 45.

Since elements 5 and 19 are short circuited upon engagement of buttons 13 and 14, element 5 is no longer carrying current, and it will lose heat and undergo a change in length in the direction or sense corresponding to contraction or shortening of the wire. The contraction due to cooling, within a short time, will be sufficient to pull arm 4 back toward its original position. The returning arm snaps movable member 12 into its original open-circuit position, thereby removing the short-circuit around elements 5 and 19 and permitting button 14 to separate from button 17 to extinguish pilot lamp 45. Current now flows through element 5 to initiate a new cycle.

The operation of the intermittently operating switching device in accord with my invention, when embodied in a signalling system or the like of the general type indicated in Fig. 7, may be further understood from the detail views of Figs. 8 and 9, taken in connection with the general operating principles explained above and the overall arrangement of the device described with reference to Figs. 1–5.

Fig. 8 shows a small part of lever 4, including its extreme lower end 46, together with the circumscribing lower portion of spring 10. The spring is arranged with its lower hook portion 28 engaged in the above described aperture in movable contact member 12. Only the lower part of member 12 below the pivot 16 is shown. It will be seen that this lower part of member 12 is bent or inclined slightly from the vertical when the contacts of the device are in open position with the wire 5 in cold condition in accord with Figs. 1, 3 and 7. The force of stressed tension spring 10 on the member 12 as applied by the hook portion 28 is in the direction of arrow 47, and the force exerted by the spring on lever 4 is opposite in direction to that of arrow 47. Accordingly, while the force on member 12 is slightly to the left of pivot 16, thereby to retain the lower portion of member 12 at the leftward limit of its swing and with the portion 24 of member 12 in engagement with stop 26 as seen in Fig. 3, there is a horizontal force component tending to urge or bias lever end 46 toward the right. The horizontal component tending to move lever end 46 toward the right is counteracted by the cold, and therefore contracted, wire 5. Spring 10, being a tension spring, is stressed by stretching from its rest or zero tension condition when it is installed in the switch device. It will be clear from this discussion that spring 10 operates as a return spring continuously urging lever 4 in the direction to provide continuous tension on wire 5 and additionally as an over center operating spring for contact member 12.

The direction of the forces on the member 12 are altered upon relaxation or expansion of the wire 5 resulting from the heating of the wire, which may occur as described above in connection with Fig. 7. Upon such expansion or relaxation of the wire 5, the horizontal biasing force component of spring 10 on the lever swings end 46 toward the right, as viewed from the side shown in Figs. 1, 8 and 9. The swinging of lever end 46 toward the right changes the direction of the force applied to member 12 until this force

is in a direction immediately to the right of pivot 16 and this force then results in the snapping of member 12 into the position of Fig. 9. The direction of spring force now applied to member 12 is indicated by arrow 48 and is seen to pass immediately to the right of pivot 16, but it will be noted that a horizontal biasing component tending to urge lever end 46 to the right still exists.

Member 12 in the position of Fig. 9 has caused the contact buttons to engage, and the now hot wire 5 starts to cool and contract. A slight contraction of the wire 5 is sufficient to move lever end 46 from its Fig. 9 position far enough toward the left to snap member 12 back into the position indicated in Fig. 8.

The double function of spring 10 will be apparent from the above discussion. As demonstrated, there is a continuously applied horizontal biasing force component from the spring tending to urge lever 4 in the direction to apply continuous tension to wire 5, and the spring 10 also serves to provide over-center or snap actuation to member 12. In the particular construction shown, spring 10 further functions to retain member 12 in position in its pivotal mounting arrangement.

Oscillations of the member 12 are limited in the opposite directions, respectively, by stop 26 and by contact members 15 and 18. Thus in the open contact condition, when wire 5 is cold, portion 24 of member 12 will be in engagement with stop 26, as seen in Figs. 1–6. Stop 26, being resilient and being slightly bent back by the pressure of portion 24, provides a portion of the force necessary to move member 12 from its open contact position toward its closed contact position of Fig. 9. Since stop member 26 can be permanently adjusted by bending with a pair of pliers, or the like, during manufacture or during final adjustments, it furnishes a convenient means for regulating the duration of the period during each cycle in which the contacts are open and the wire 5 is being heated. The duration of the open contact period is also dependent upon the size, length, and resistance of wire 5, the resistance of element 19, the tension force of spring 10, and the relation between the wire 5 and lever 4, this latter relation being adjustable by bending anchor member 6 toward or away from base 1. In practice, it has been found appropriate to provide a wire 5 about one inch in length and comprising Nichrome of between about 0.007 and 0.012 inch in diameter if the device is to be used in automobiles with six volt batteries. The resistance element 19 may have a resistance about one to two times that of wire 5, and when used with lamps 38, 39 of about 21 candlepower each, the device so constructed and arranged may be adjusted to have a cycle time of the order of one second or less. Persons skilled in the art will understand that too little total resistance in wire 5 and element 19 will permit sufficient current to pass to illuminate the lamps 38, 39 during the period in which the wire 5 is being heated, and such persons will further understand that the permissible tension of spring 10 is limited by the tensile strength of wire 5. It has also been found possible so to arrange and adjust the device, by providing a wire 5 of five-eighths inch length and of 12.6 mil diameter Nichrome, that no operation occurs upon failure of one lamp 38 or 39 when switch blade 37 engages contact point 40. In practice, accordingly, in the signalling system of Fig. 7, failure of one of the signal lamps

is indicated to the operator by the absence of blinking of the pilot lamp 45.

It will be understood that the dimensions and proportions indicated above are exemplary only, and that the dimensions and adjustments can be selected to adapt the device for service in any of many different systems.

The operation of the device is further related to and effected by the action of contact members 15 and 18. As shown in Fig. 10, snapping of movable contact member 12 into the closed contact, hot wire, position causes button 13 to engage button 14 and to sway or bend resilient contact member 15 toward member 18 until button 14 meets button 17. A wiping action of contact button 13 against button 14 is obtained by the resilient bending of member 15. According to the circuit of Fig. 7, it will be noted that only pilot light current passes from button 14 to button 17, but appreciable wiping of the contact between these two buttons may also be obtained by making stationary contact 18 of slightly resilient material. Stationary contact member 18 serves as a stop to limit the motion of movable contact member 12 in its switch closing direction, as well as a contact for electrical connection through button 17 to buttons 14 and 13. The resilience of member 15 assists in returning oscillable or movable contact member 12 from the circuit closed position of Fig. 10 to the open circuit position of the earlier described Figs. 1–7.

A modified device in accord with my invention is shown in top view in Fig. 11. In this modified construction, insulating base member 49 carries an upstanding post member 50 having a foot portion 51 rigidly mounted by means of a clip 52 to the base. A lower arm 53 is formed integral with post 50, and the lower arm is shaped similarly to arm 22 of the preferred embodiment to provide a bearing notch for movable contact member 54, which, in turn, is shaped and arranged like contact member 12 of the preferred embodiment. Contact member 54 comprises an upstanding stop-engaging portion 24' which cooperates with a fixed, though preferably slightly resilient, stop member 26', the stop member being carried by post member 50. The arrangement corresponds to the portion 24 and stop 26 of the preferred embodiment, both in structure and function. Movable contact member 54 further carries a contact button 55 which cooperates with the contact button of intermediate resilient contact member 56, and this resilient contact member sways, as the switching device operates into closed circuit condition, against stationary contact member 57. The operation of contact members 54, 56, 57 thus corresponds to the operation of contact members 12, 15 and 18 of the first embodiment as described above in connection with Fig. 10. The contact member 56 differs in shape from member 15 of the preferred embodiment, particularly in its foot portion, and Fig. 12 is a plan view of a blank for member 56. As there seen, button 58 is affixed near the upper end of a flat, resilient body portion 59, while a foot portion 60 is arranged to be bent at approximately a right angle to the body portion. Slots 61 are cut into opposite sides of the foot portion 60, and these slots are arranged to receive ears of a clip which attaches the member 56 to the base 49. Foot portion 60 extends into a terminal tab 62, which may be bent upwardly from the foot, and to which a coiled resistance element may be soldered.

Fig. 13 illustrates a blank from which the post 50 is formed. Foot portion 51 of post 50 is arranged to be bent at a right angle to the upstanding stanchion body portion 63, and slots 64 are provided in the foot to receive the ears of a mounting clip. The foot extends into a support or anchor 65 of the lower end of the thermal expansible element, and the anchor portion of the foot may be bent upwardly a few degrees from the flat mounting portion of the foot.

Lower arm 53 extends from one side of the post body portion 63 to be bent at the two fold lines indicated on the blank into a position to dispose pivotal support notch 66 in spaced alignment with pivotal support notch 67, which is formed in the post body 63. These notches 66 and 67, accordingly, align pivotally to support the movable contact member 54 in the manner described for notches 16 and 30 and the contact member 12 in the preferred embodiment. An upper lever pivot or fulcrum portion 68 extends from the post body 63 and has a notch formed with a horizontal knife edge pivot 69, and the operating lever member, identified by the numeral 70 in Figs. 11 and 17, swings or pivots on knife edge pivot 69 in the assembled device.

Stationary contact member 57 is shown in blank plan view in Fig. 14. Contact member 57 may be less resilient than contact member 56, but it is of similar configuration, comprising a mounting foot portion 71 having clip ear receiving slots 72. No terminal tab is necessary on member 57 since electrical connection thereto is made preferably through its mounting clip.

A mounting clip blank 52 suitable for use in affixing post member 50 to base 49 is shown in Fig. 15. The clip comprises a body portion 73 adapted to lie flat against the underside of base 49 and a pair of ears 74 adapted to be bent upwardly along respective fold lines 75 to extend through small vertical apertures in the base 49 and through the respective ear receiving slots 64 of post member 50. The body portion extends into a terminal lug portion 76, which will be bent downwardly and by means of which electrical connection to the supported member is conveniently made. After the clip is positioned with its ears 74 extending upwardly through the mentioned respective small base apertures and through the ear receiving slots of the member to be mounted, the upper ends of the clip ears are bent or crimped inwardly, along respective fold lines 77, to lie against the upper surface of the foot portion of the supported member rigidly to secure the member in position and to establish good electrical contact between the clip and member.

A clip in accord with Fig. 15 is used to affixed foot portion 51 of post member 50 to insulating base 49, and similar or identical clips are used in a similar manner to attach foot portion 60 of resilient contact member 56 and foot portion 71 of stationary contact member 57 to base 49. The manner of mounting the post and contact members by means of clips as described has economic advantages, particularly in case of large scale manufacture, over the bolt and nut mounting arrangements shown in the first described embodiment of this invention.

The lever member 70 of this modification of my invention is of insulating material, such as plastic or pressed impregnated fiber, and comprises notched offset head portion 77, seen in side view in Fig. 17, which engages with and carries an attachment member 78 in accord with Fig. 16. The attachment member 78 comprises a flat metal

member of generally rectangular shape having a contact tab portion 79 and a central rectangular aperture 80.

As seen in Fig. 11, the post member 50 and contact members 56 and 57 are each affixed to the base 49 by means of clips 52 of which only the upper ends of the ears are visible lying against the respective foot portions. Lever member 70 is pivotally supported on fulcrum portion 68 of post member 50 for oscillations in response to expansions and contractions of thermal responsive wire 81. The thermal wire is affixed, as by soldering, to the anchor portion 65 at its lower end and to the attachment member 78 at its upper end. The attachment member is shown engaged in notch 82 in the head portion 77 of lever member 70. A resistance element 83, preferably in the form of a loose coil of resistance wire, is connected between attachment member 78 and the lug 62 of resilient contact member 56. Helical tension spring 84 circumscribes the lower extending portion of lever 70, in the manner of the first embodiment of Figs. 1–10, connecting at its top to the lever and at its bottom to movable contact 54. Lever 70, through spring 84, controls contact member 54 exactly in the manner hereinabove described in connection with Figs. 1–10 for lever 4, spring 10 and contact member 12 of the first described embodiment, spring 84, as before, functioning as a biasing or return spring for lever 70 to cause the lever to pivot as the tension of wire 81 relaxes due to heating of the wire, and further functioning as a snap action spring for contact member 54, and still further functioning as the sole coupling between the end of lever 70 and contact member 54 for operating the contact member in response to oscillation of the lever. As before, contraction of wire 81, due to cooling, pulls head 77 of lever 70 toward base 49 against the horizontal component of force of spring 84 exerted continuously on the lower end of the lever. The lower end of the lever, not shown in Fig. 11 but in accord with end 46 of the lever member 4 of the first embodiment, swings in the direction away from anchor 65 to open the contacts 55—56—57 in response to cooling and contraction of wire 81. Elongation of wire 81 due to heating permits spring 84 to oscillate the lever to move its lower end toward anchor 65, and thus to snap member 54 into closed circuit position, corresponding to the closed circuit condition of the first embodiment as demonstrated in Fig. 10.

Fig. 17 discloses by fragmentary representations certain further details of the mechanical arrangement of the modified device of Fig. 11. The head portion 77 of lever member 70 is seen to comprise notch 82 offset from the pivot bearing of the lever on fulcrum portion 68 of the main support post, and attachment member 78 is disposed in notch 82. Thermal wire 81 is soldered, or otherwise attached, to attachment member 78, and resistance element 83 is electrically connected to wire 81 at this point.

The lower end of thermal wire 81 is soldered to anchor portion 65 which is bent upwardly from the foot portion 51. The foot portion is affixed to base 49 being clamped under the upper ends of ears 74 of the clip, of which the body portion 73 lies under and against the under surface of base 49.

In the exemplary circuit shown in Fig. 17, terminal lug 76 is connected through a suitable conductor to the ungrounded terminal of automobile battery 36', the opposite terminal of the battery being grounded to the automobile frame. The post member, represented in Fig. 17 by foot portion 51 and anchor portion 65, completes a connection from the ungrounded battery terminal to the lower end of thermal wire 81 and, through the knife edge pivots, to movable contact member 54. Conductor 85 will be understood to represent the connection from the foot 51 through the body portion 63 of conductive post member 50 to the notches 66 and 67 in which movable contact member 54 is carried, as shown in other views, and through the electrical contact thus established at the notches 66 and 67 to contact member 54.

Resilient contact member 56 is connected at its lug portion 62 to the lower end of coiled resistance element 83 and through its supporting clip through a suitable conductor 86 to a manually operated direction signal switch blade 37'. Stationary contact member 57 is connected to a pilot light 45'. Switch blade 37' is movable from a central unconnected switch point 44' to one or the other of points 40' and 43' to control signal lamps, such as lamps 38', 39'.

In operation, when blade 37' is moved from point 44' to point 40', for example, a circuit is established from the battery 36' through anchor portion 65 to the lower end of thermal wire 81. The current flows through the wire 81, heating and expanding the wire, and through resistance element 83 and conductor 86 to the lamps 38' and 39', and thence through ground to the other battery terminal. Upon heating of wire 81, the device operates to snap contact member 54 against resilient member 56, and to sway member 56 against stationary contact 57. Pilot lamp 45' is thus connected through contact members 57, 56, 54 to foot 51, and lamps 38', 39' are connected to receive current from foot 51 through contact members 54 and 56. The current intensity to lamps 38', 39' is substantially greater with contacts 54, 56 closed and with the wire 81 and resistor 83 short circuited or shunted by these contacts. Since no appreciable current flows in wire 81 while contacts 54, 56 are closed, the wire cools and changes dimensions in the contracting sense or direction, resulting in the operation of the lever member against the horizontal bias of spring 84 into the position at which the movable contact member 54 snaps into the open circuit position. With the contacts now open, pilot lamp 45' is extinguished, and the current to lamps 38', 39' is so reduced by the series connection of wire 81 and resistance element 83 that these lamps are dimmed or nearly extinguished. The cycle may now start again as wire 81 is once more heated, and the operating cycles continue so long as switch blade 37' remains in contact with one or the other of contact points 40', 43'.

The contruction of the device in accord with Figs. 11–17 permits ready assembly in that, following clipping of stanchion 50 and contact members 56, 57 to base 49, lever 70, spring 84 and movable member 54 may be mounted without interference from expansible wire 81, and wire 81 and resistor 83 may be soldered to yoke 78 prior to installation of the wire, resistor and yoke in the device. When the lever 70, spring 84 and member 54 are in place, resistor 83 may be soldered to its lug 62 on contact member 56, yoke 78 may be slipped on protrusion 77 of lever 70, and wire 81 may finally be soldered to portion 65 of foot 51. The final tension adjustment is made by bending portion 65 downwardly, and this final tensioning of the wire will swing yoke 78 from its vertical position of Fig. 17, for example, into alignment

with the taut wire 81. Resistor 83 exerts no appreciable force on yoke 78.

If it is desired later to disassemble the device, yoke 78 may be removed from lever 70, either by bending 65 slightly upwardly again, or by swinging lever 70 in the direction to drop portion 77, which may require prior removal of member 54 from its bearing notches 66, 67 to relax spring 84.

While I have shown and described only certain preferred embodiments of my invention by way of illustration, many modifications will occur to those skilled in the art, and I therefore wish to have it understood that I intend, in the appended claims, to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A thermal expansible wire switch device comprising an oscillable lever, a thermal wire connected to swing said lever in one direction in response to contraction of said wire, a stressed return spring affixed at one end to said lever continuously urging said lever in the opposite direction to tension said wire, a movable contact member, pivotal support and stop means for said member supporting said member for limited pivotal oscillation about a pivot axis, the other end of said spring being connected to said member at a point spaced from said pivot axis and effective in response to lever oscillation to oscillate said member over center between limit positions established by said stop means.

2. In an intermittently operating switching device, a pivotally mounted movable contact member, stop and electrical contact means engageable by said member establishing a first limit position for said movable member in a predetermined direction and a second limit position in the opposite direction, said means comprising electrical circuit means respectively opened and closed in accord with the pivotal position of said member in respect to one of said limit positions, a spring having an end connected to said member for snap actuation of said member between said respective limit positions, said spring being effective normally to retain said member in said first limit position, a pivotal lever engaging and laterally displacing a portion between the ends of said spring, a thermal-electric element operative to force said lever against said spring in a direction to increase said displacement in response to a predetermined dimensional change of said element, said spring being effective to return said lever upon reversal of said predetermined dimensional change and resumption by said element of its original dimension, said element being connected for control by said electric circuit means.

3. A switching device comprising a mounting member, an arm swingably mounted to a predetermined part of said member, a switch member pivotally attached to said mounting member remote from said part, a spring attached to said arm between the ends of said arm, said arm terminating in a swingable end adjacent said switch member, said end being in contact with a portion between the ends of said spring, said spring extending beyond said arm and being terminally attached to said switch member beyond said pivotal attachment thereof to said mounting member, stop and switch means cooperating with said switch member to limit said switch member to a predetermined arc between substantially fixed limits and to establish an electrical connection at a first said limit of said arc and to open said electrical connection at the second limit of said arc, a thermo-electric responsive element electrically connected to said means for electrical energization under the control of said electrical connection, said element being mechanically affixed forceably to swing said swingable end of said arm against the force of said spring when said switch member is at one of said limits of said arc to move said portion of said spring into position pivotally to snap said switch member to the other one of said limits of said arc and operable when said switch member is at said other one of said limits to relax its arm-swinging force whereby said spring portion moves said end of said arm toward a position in which said spring snaps said switch member again to said one of said limits.

4. An intermittently operating switching device comprising a base, a movable member pivotally supported on said base, stop means establishing two limit positions for said member, a lever pivotally supported on said base, a thermo-electric expansible element mechanically connected to said lever to force said lever to pivot in a predetermined direction in response to a thermal change in a dimension of said expansible element in a predetermined sense, a spring engaging and urging said lever to pivot in the direction opposite to said predetermined direction and effective to pivot said lever in said opposite direction upon reduction of said force in response to a thermal change in said dimension in the opposite sense, said spring being connected to said movable member to snap said movable member alternately from one to the other of said limit positions in response to respective pivoting of said lever in said directions, and electric switch contact means controlled by said movable member connected to said expansible element.

5. In a device of the kind described, a pivotal contact member, a thermo-electric expansible wire element, actuating means for pivoting said member in response to alternate contraction and expansion of said element, said means comprising a lever connected to said element and a lever biasing spring, said element and spring being alternately effective to swing said lever in respective opposite directions in accord with respective alternate expansion and contraction of said element, said contact member being mechanically connected pivotally to respond to said swinging of said lever, and a resilient contact member contacted and swayed by engagement of said pivotal contact member, said resilient contact member being in circuit with said element to control electric actuation thereof.

6. In a device of the kind described, an oscillable contactor, a second contactor, a resilient contactor interposed between said oscillable contactor and said second contactor, means comprising electro-thermally responsive actuating means to oscillate said oscillable contactor to sway said resilient contactor into contact against said second contactor and to return said oscillable contactor to break said contact between said resilient contactor and second contactor and thereafter to part said oscillable contactor from said resilient contactor, said actuating means being connected for electrical actuation to at least one of said contactors.

7. In a device of the kind described, at least three circuit opening and closing contactors, a thermo-electric responsive element to change dimensionally in response to changes in current therethrough, a spring, one of said contactors

being pivotally mounted and connected to said spring for snap actuation thereby in two respectively opposite directions, two motion limiting stops for said one contactor respectively to limit said actuation to predetermined limit positions in each said direction, one of said stops comprising a second said contactor, a third said contactor being resilient and being disposed between said one stop and said one contactor to be out of contact with said one stop and said one contactor when said one contactor is against said other stop and to be hammered and pressed into contact between said one contactor and said one stop when said one contactor is actuated toward said one stop, means comprising said third contactor to supply a variable current to said element, and means operative through said spring to snap said one contactor in said directions responsive to predetermined respective dimensional changes of said element.

8. In a device of the kind described, at least three circuit opening and closing contactors, a thermo-electric responsive element to change dimensionally in response to changes in current therethrough, a tension spring, one of said contactors being pivotally mounted and connected to said spring for snap actuation thereby in two respectively opposite directions, two motion limiting stops for said one contactor respectively to limit said actuation to predetermined limit positions in each said direction, one of said stops comprising a second said contactor, a third said contactor being resilient and being disposed between said one stop and said one contactor to be out of contact with said one stop and said one contactor when said one contactor is against said other stop and to be hammered and pressed into contact between said one contactor and said one stop when said one contactor is actuated toward said one stop, means comprising said third contactor to supply a variable current to said element, and means operative through said spring to snap said one contactor in said directions responsive to predetermined respective dimensional changes of said element and to exert a bias from said spring on said element tending continuously to oppose said dimensional change in a predetermined sense.

9. A switching device comprising a pivot, a contactor oscillable on said pivot, stop means to limit oscillation of said contactor in a respective first direction and a second opposite direction, a spring connected to said contactor at a point removed from the axis of said pivot, a thermo-electric element, a lever mechanically connected to said element to be moved in response to expansion and contraction of said element in respectively opposite directions, said spring being coupled to said lever for movement thereby to snap said contactor against said stop means in said first direction in response to expansion of said element and against said stop means in said second direction in response to contraction of said element, and a resilient contact member between said contactor and one of said stop means, said member being out of contact with said contactor and said one stop means when said contactor is toward said other stop means and being deflectable by said contactor into contact with said one stop means, said resilient contact member being adapted to supply an electric current of variable intensity to said thermo-electric element.

10. A switching device comprising a base, an arm swingably mounted to a predetermined part of said base, a switch actuating member pivotally attached to said base remote from said part, a spring attached to said arm between the ends of said arm, said arm terminating in a swingable end adjacent said member, said end being in contact with a portion between the ends of said spring, said spring extending beyond said arm and being terminally attached to said member beyond said pivotal attachment thereof to said base, stop means to limit said member to a predetermined arc and comprising switch means operative in response to pivoting of said member to one limit of said arc, a thermo-electric responsive element electrically connected to said switch means for control thereby and mechanically connected forceably to swing said swingable end of said arm against the force of said spring when said member is at one said limit to move said portion of said spring into position pivotally to snap said member to the other said limit and operable when said member is in said other limit position to relax its said arm swinging force whereby said spring portion moves said end of said arm toward a position in which said spring snaps said member in the opposite direction again to actuate said element to swing said end of said arm against said force of said spring.

11. A switching device comprising a support, an arm swingably supported by said support adjacent one end of said arm, a tension spring surrounding said arm and attached thereto between said support and the other end of said arm and extending beyond said other end, thermally responsive expansible means mechanically coupled between said arm and said support to swing said other end in respectively opposite directions in response to expansion and contraction of said means, a switch-operating member pivotally attached to said support, said pivotal attachment being adjacent said other end of said arm and said member having a portion extending from said pivotal attachment in a direction generally away from said arm, said extending portion of said spring being terminally attached to said extending portion of said member beyond said pivotal attachment, stop means engageable by said member to limit said member in both directions of pivoting thereof, said other end of said arm engaging said spring between the ends thereof to snap said member on said pivot between said stop means and continuously to bias said other end of said arm against said force of said expansible means, said stop means comprising switch means adapted to control the temperature of said expansible means, said switch means being so oriented in respect to said expansible means that said expansible means moves said other end of said arm against said bias to snap said member in a predetermined one of said opposite directions and relaxes to permit said spring to move said other end and snap return said member in the other of said opposite directions.

12. In an automatic flashing switch, the combination of a pivoted lever member, a biasing spring attached at one end to said lever member and circumscribing said member and biasing said member to swing in a first direction, pivoted contact means actuated by attachment to the other end of said spring, and force means responsive to the position of said contact means periodically to pivot said lever member in a direction opposite to said first direction against said spring bias.

13. In combination, a base, a lever pivotally supported on said base, a tension spring attached to said lever remote from an end of said lever

and circumscribing said lever and extending beyond said end, a thermo-electric element connected to said lever, a movable member pivotally supported on said base and attached to the extending end of said spring, said lever being arranged for pivoting to swing said lever end in one direction in response to force exerted by said element, said movable member being positioned to dispose said spring end out of line with said lever in the other direction whereby the tension of said spring provides a restoring force operative in response to relaxation of said element to swing said end in said other direction, means cooperating with said movable member to restrict said member to pivotal motion between substantially fixed limits and electrically to control said element, the direction of the force applied by said spring to said movable member as effected by the position of said lever end being so related to the position of the pivot for said movable member that said movable member snaps alternately from one to the other of its said limits in response to alternate swinging of said lever end in said one and said other directions.

14. An intermittently operating switch device comprising an insulating base, a conductive stanchion mounted on said base, an insulating lever member pivotally supported on said base by said stanchion, a conductive movable contact member pivotally supported on said base by said stanchion, contact means electrically connecting with said contact member in response to swinging of said contact member to a predetermined position, a thermo-electric expansible element electrically and mechanically attached at one end to said stanchion and operatively affixed to said lever member at the other end forceably to swing said lever member in a predetermined direction in response to a predetermined dimensional change of said element, a permanent electrical connection between said other end of said element and said contact means, a tension spring mechanically connecting said lever member and movable contact member and arranged to provide snap actuation of said movable member alternately into and from said predetermined position, said spring and movable member being disposed to provide a yielding spring biasing force against said lever member in a direction tending to oppose said forceable swinging of said lever member.

15. A device of the kind described comprising a base, a movable contact member pivotally supported from said base, means to limit swinging of said member in both directions and to close an electric circuit in response to swinging of said member to one limit position, a lever pivotally supported from said base, a thermo-electric element connected to said lever to exert a force to pivot said lever in a predetermined direction in response to thermal actuation of said element in a predetermined sense, a spring connected to pivot said lever in the opposite direction upon reduction of said force in response to thermal actuation of said element in the opposite sense, said spring being positioned to be laterally displaced in accord with the pivoting of said lever, said spring being connected to said contact member for snap actuation of said member alternately between its said limit positions in response to said spring displacements in respectively opposite directions in accord with said pivoting of said lever, said circuit being connected to said element for control thereof in accord with the position of said contact member.

16. In combination, a base, a lever member pivotally supported on said base, a tension spring attached to said lever member remote from an end of said lever member and circumscribing said lever member at said end and extending beyond said end, a snap acting movable contact pivotally supported for swinging motion on said base and attached to the extending end of said spring, a thermo-electric element connected to said lever member, means to limit the swinging motion of said contact and to close an electric circuit at a first said limit and to open said circuit at the second said limit, said element being connected to said circuit for electro-thermal actuation in accord with the poistion of said contact with respect to said first limit, said element being attached forceably to pivot said lever in a predetermined direction laterally to deform said spring in response to positioning of said contact at one of said limits, said movable contact being responsive to said lateral deformation to snap to the other said limit thereby to reverse the actuation condition of said element, said laterally deformed spring being effective to return said lever upon relaxation of the force of said element in said reversed actuation condition to a position of reduced spring deformation at which said contact snaps again to said one limit.

17. An intermittently operating switch device comprising a swingable lever, a thermal expansible wire element attached to said lever to swing said lever in a predetermined direction in response to contraction of said wire, a return spring attached to said lever swingably to return said lever in the opposite direction in response to expansion of said element, said spring having a portion displaced in respective opposite directions corresponding to the respective swing displacements of said lever, and a pivotal switch member for motion between two opposite limits, said member being attached to said spring and responsive to predetermined respective displaced positions of said portion to snap over center alternately from one to the other said limit in accord with said respective displacements of said lever, said wire being connected for control of alternate expansion and contraction thereof in accord with said respective limit positions of said switch member.

18. In a device of the kind described, a tension spring, a lever forming a core of said spring, a thermo-electric element attached to said lever in response to a change in dimension of said element to swing said lever against the tension of said spring from a first position to a second position, a portion of said spring being deflected from one position to another position by said lever motion from said first position to said second position, switch means operatively connected to said spring for actuation from one to another position in response to said deflection of said spring portion into said other position, said switch means comprising means to control actuation of said element to reverse said change in dimension in response to assumption of said other position by said switch means, said spring comprising a return spring for said lever and being effective to return said lever as said reversed change in dimension occurs to said first position thereby to return said switch means to said one position.

19. In a snap acting switch, a pivotal switch member, an over center spring for actuating said member from one to another position, a thermal wire element, a lever connected to said element for forced motion in a predetermined direction

in response to contraction of said element, said lever being connected to said spring to actuate said switch member alternately between said positions in response to swinging of said lever and to be return actuated by said spring in the direction opposite to said predetermined direction upon expansion of said element, and control means responsive to the alternate positions of said member alternately to decrease and increase

electric current in said element to cause alternate contraction and expansion of said element.

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