7-135

SEARCH ROOM

June 14, 1955 J. SCHMIDINGER Re. 24,023

SNAP ACTION DEVICE

Original Filed July 21, 1951 3 Sheets-Sheet 1

Fig. 1.

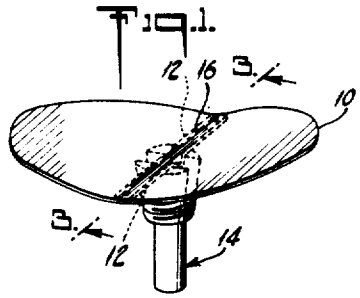



Fig. 4.

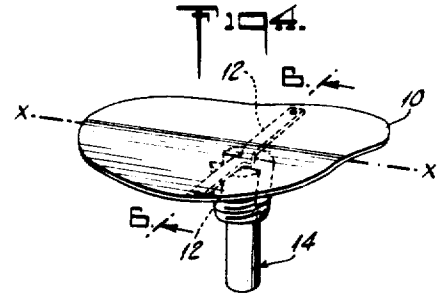



Fig. 2.

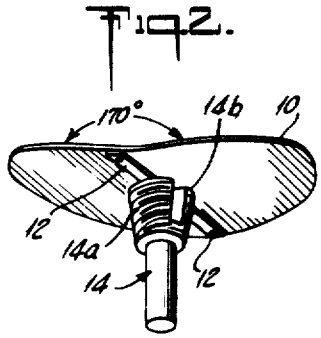



Fig. 5.

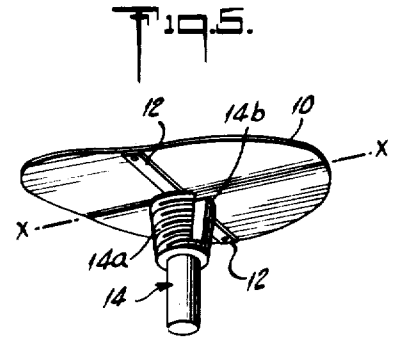



Fig. 3.

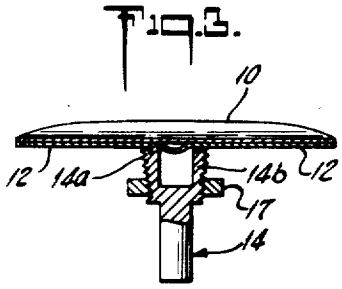
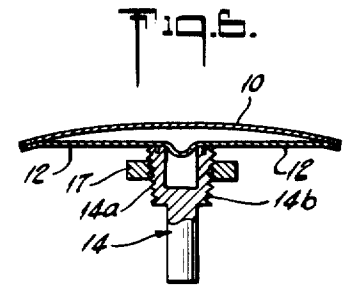



Fig. 6.




INVENTOR.
JOSEPH SCHMIDINGER

BY
Eyre, Mann & Burrows
ATTORNEYS

June 14, 1955 J. SCHMIDINGER Re. 24,023

SNAP ACTION DEVICE

Original Filed July 21, 1951 3 Sheets-Sheet 2

Fig. 7.

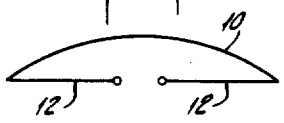



Fig. 8.

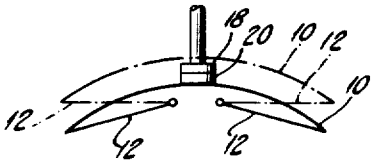



Fig. 9.

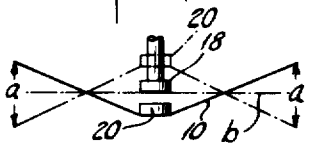



Fig. 10.

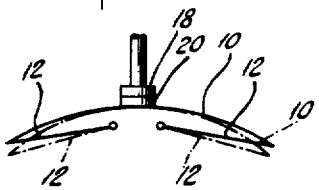



Fig. 11.

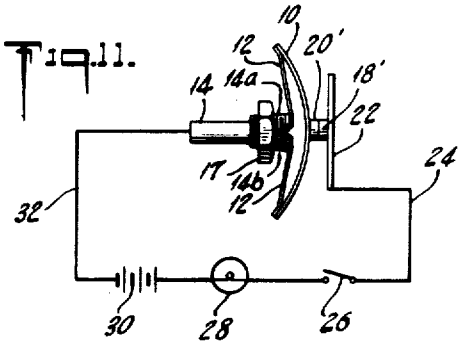



Fig. 12.

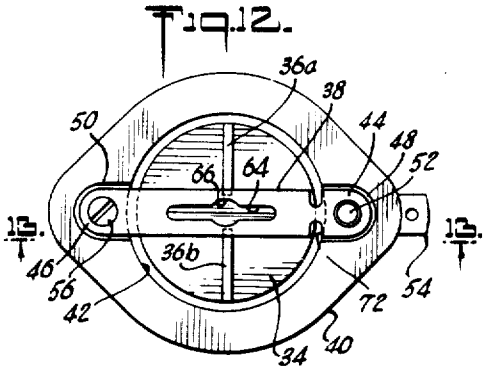



Fig. 13.

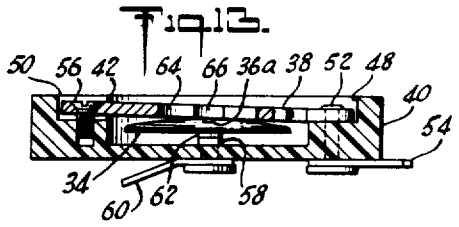



Fig. 14A.

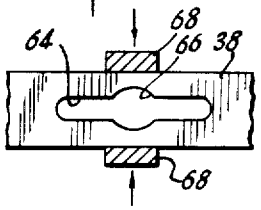
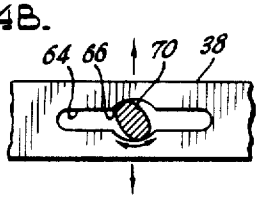



Fig. 14B.




INVENTOR.
JOSEPH SCHMIDINGER

BY
Eyre, Mann & Barrows
ATTORNEYS

June 14, 1955 J. SCHMIDINGER Re. 24,023

SNAP ACTION DEVICE

Original Filed July 21, 1951 3 Sheets-Sheet 3

Fig. 15.

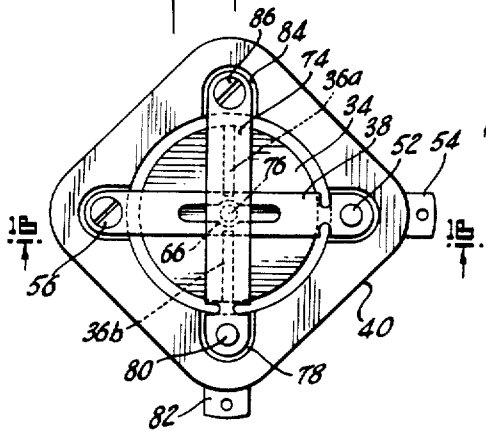



Fig. 18.

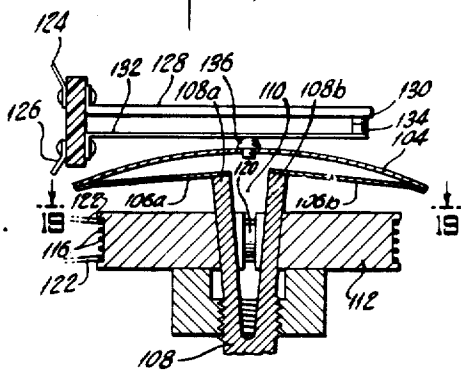



Fig. 16.

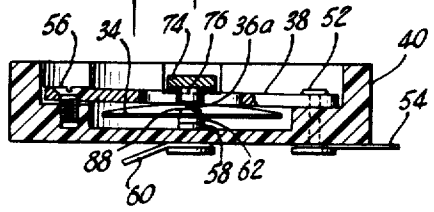



Fig. 19.

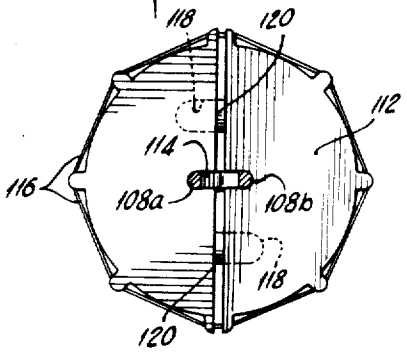



Fig. 17.

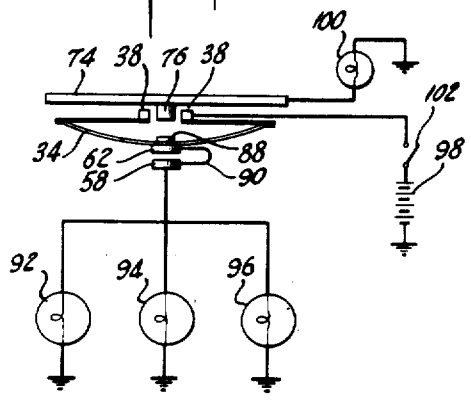



Fig. 20.

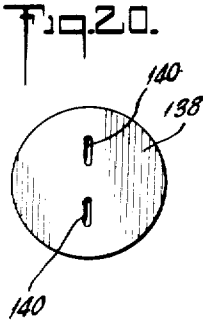
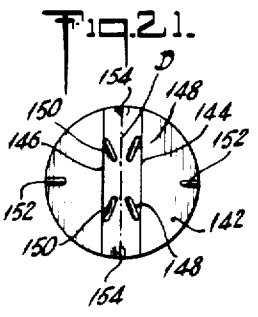



Fig. 21.




INVENTOR.
JOSEPH SCHMIDINGER

BY
Eyre, Mann & Burrows
ATTORNEYS

United States Patent Office

Re. 24,023
Reissued June 14, 1955



24,023

# SNAP ACTION DEVICE

Joseph Schmidinger, Lake George, N. Y.

Original No. 2,615,106, dated October 21, 1952, Serial No. 237,958, July 21, 1951. Application for reissue May 3, 1954, Serial No. 427,406

26 Claims. (Cl. 200—114)

**Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.**

This invention comprises an efficient and simple snap action device of wide application.

The device may be employed for the control of electric circuits, for example as a relay, as a flasher, or as a circuit breaker, or it may be employed as a temperature responsive device. It may be actuated by electrical forces, by thermal forces, or by mechanical forces or by a combination thereof. The new device, irrespective of its particular application and of the particular actuating forces, comprises essentially three elements, namely, a disc, a laterally flexible pull wire or strip secured at its ends to the disc at opposite ends of a diameter, and a support [secured to the flexible strip and] positioned on the geometrical axis of the disc *and preferably secured to the center of the flexible strip* [but not fastened to the disc]. The disc is of spring material and has a crease or bend formed therein along the diameter thereof underlying the flexible strip, the strip extending along the convex side of the crease in the disc. The flexible pull strip may be continuous between the points of attachment to the disc [, in which case it is secured to the support means at its midsection] or the strip may be in two parts. [, in which case one end of each section is secured to the support.] In either case the pull strip [is so] *may be* mounted on the support [as to be] under longitudinal tension and the support [is] *may be* so constructed as to permit of adjustment or of variation of the tension in the strip.

The disc under predetermined increase of tension in the pull strip, snaps from one position, that in which the halves of the disc on each side of the diametrical crease extend outwardly away from the [support] *pull strip* at an included angle of less than 180°, to a second position, one in which the disc is bowed in the opposite direction about a diameter of 90° to the preformed crease. [As the entire periphery of the disc is free to move, being unattached to any rigid part, and as the sole support of the device is the centrally located support means to which the pull strip is secured, uniform and positive snap action of the disc results. This will be explained in more detail hereinafter.]

When the device is to operate to open or close electrical contacts and is itself to carry current, the disc and strip are of metal and an electrical contact is secured to the center of the disc on either or both sides thereof, depending upon the circuit or circuits to be controlled and the location of cooperating fixed contacts. The flexible pull strip, in such an application, comprises an expansible pull wire which, when heated by passage of sufficient current therethrough, permits the disc to assume the form to which it is constrained by the diametrical crease therein but which when cold or when carrying a limited amount of current, causes the disc to snap and buckle in the opposite direction.

When the disc and pull strip are of material having the same coefficient of thermal expansion, its operation is not affected by the ambient temperature as both disc and pull strip will expand and contract together and this is



a decided advantage for many applications of the device. When, however, response to ambient temperature is desired, as when the device is to be employed as a thermostat, the disc and pull strip are made of materials having different coefficients of thermal expansion, in which case by proper selection of the respective materials and of the initial tension in the flexible pull strip, positive snap action of the device in response to ambient temperature may be obtained.

As heretofore indicated, the sole support means for the device is centrally located and engages the pull strip only. The support in [each] *such* case includes means for adjusting the initial tension in the pull strip. This is the sole adjusting means required or wanted for the device. This feature is important as it avoids any stressing of the disc which inherently results when forces are applied directly to the disc during attachment of the strip or after such attachment. When the device is to be mechanically rather than thermally actuated, the tension in the pull strip is controlled by the support means which, in this case, is constructed to include such tension varying means as well as the means for initially adjusting the device.

For a better understanding of the new snap action device and of various fields of application thereof, reference may be had to the accompanying drawings, of which:

Fig. 1 is a top perspective view of one embodiment of the invention;

Fig. 2 is a bottom perspective view of the structure shown in Fig. 1;

Fig. 3 is a cross-sectional view along the line **3—3** of Fig. 1;

Fig. 4 is a top perspective view of the structure shown in Fig. 1 with the center of the disc buckled upwardly;

Fig. 5 is a bottom perspective view of the structure shown in Fig. 4;

Fig. 6 is a cross-sectional view taken along the line **6—6** of Fig. 4;

Figs. 7 to 10 are diagrammatic views explanatory of the action of the device and illustrating the optimum location of a cooperating contact or other element to be actuated by snap action of the device;

Fig. 11 is a diagram illustrating the snap action device of Figs. 1 to 6 connected for control of a lamp load circuit;

Fig. 12 is a top view of a switch structure embodying the invention;

Fig. 13 is a cross-sectional view taken along the line **13—13** of Fig. 12;

Figs. 14–A and 14–B are fragmentary views of the disc supporting means of the structure of Fig. 12 showing the method of adjustment thereof;

Fig. 15 is a top view of a switch structure similar to that of Figs. 12 and 13 but provided with two adjustable fixed contacts, one for engagement by a disc carried contact in one position of the disc and one for engagement by a disc carried contact in the other position of the disc;

Fig. 16 is a cross-sectional view taken on the line **16—16** of Fig. 15;

Fig. 17 is a diagrammatic view illustrating one application of the structure of Figs. 15 and 16;

Fig. 18 is a sectional view of the snap action device of the invention arranged for actuation of switch contacts in response to mechanical variation of tension in the pull strip;

Fig. 19 is a horizontal sectional view taken on the line **[18—18]** *19—19* of Fig. 18; and

Figs. 20 and 21 illustrate other designs of constrained discs suitable for use in the snap action device of the invention.

Figs. 1 to 3 inclusive show a snap action device of the invention in the position corresponding to reduced

tension in the pull strip. The disc of the device is indicated at **10**, the flexible pull strip at **12** and the centrally disposed support generally at **14**. The disc is of spring material, for example metal, and has a diametral crease **16** therein which is parallel to and convex toward the pull strip **12**. The crease is preferably formed by bending the disc through its center line over a round edge having a small radium of curvature, the disc being preferably subsequently heat treated to permanize the constraint therein. The crease should be relatively shallow so that the dihedral angle formed at the crease lies between 135° and 180°, say 170°. The flexible pull strip **12** is secured at its ends to the periphery of the disc **10** adjacent the ends of the crease **16**. The central section of the strip is secured to the support **14**. The support **14** comprises a stud having an externally threaded end axially slotted to provide furcations **14a** and **14b** which, by means of a nut **17** threaded on the support, may be forced toward each other to reduce the width of the axial slot. The strip **12** is attached, as by welding or riveting, to the furcations **14a** and **14b** and these points of attachment to the furcations are equidistant from the points of attachment of the strip to the disc and are preferably effected while the furcations are most widely separated. After attachment of the strip **12** the nut **17** is turned to introduce the desired tension in the parts of the strip radiating from the support, thus introducing slack in the strip **12** intermediate the furcations, as indicated in Figs. 3 and 6. This arrangement provides a simple and effective means for adjusting the tension in the pull strip **12**. When the nut **17** is rotated in a direction to move it closer to disc **10**, it draws the furcations **14a** and **14b** closer and thereby increases the tension in the pull strip. When the nut is turned in the reverse direction the furcations or jaws move apart and reduce the tension in the pull strip.

Figs. 4 to 6 illustrate the device of Figs. 1 to 3 when in the position corresponding to increased tension in the pull strip. In this position the disc is buckled along a diameter indicated by the line X—X in Figs. 4 and 5, at 90° from the crease **16** and the center of the disc is displaced axially from the support.

The action of the disc in snapping from one position to the other under the influence of the tension exerted through the pull strip can be better illustrated by reference to Figs. 7 through 10, wherein the movement of the disc is shown exaggerated to facilitate explanation and understanding. Figs. 7 to 10 also illustrate the optimum positioning of a cooperating fixed element to be actuated by the snap action device. For convenience the support means are not shown in Figs. 7 to 10, nor that part of the strip **12** which is not under tension, namely, the section between the points of attachment to the furcations of the support.

An important aspect of this snap action device is that the disc **10** when forced to snap under tension of the pull strip, actually reverses its natural curvature with the greatest portion of such reversal occurring at the center of the disc. This results in the translation of practically all of the motive power of the pull strip into positive action at the center of the disc.

Another important aspect of the invention is that of a "locking" effect of the device in both positions of the disc. This results from a displacement of the disc through a so-called equilibrium position so that, as a disc snaps rapidly from the position shown in Fig. 1 to that shown in Fig. 4, the free edges of the disc swing downwardly while the center of the disc moves upwardly and at the same time the points on the periphery of the disc to which the pull strip is attached shift very little in comparison to either the free edges of the disc or the center thereof.

Fig. 7 is a substantial equivalent of Fig. 6, having the pull strip **12** in tension and the disc **10** snapped to its upward position. This position of the disc may be considered the normal at-rest position of the assembled device with the pull strip **12** in tension, assuming no cooperating fixed element to be actuated as, for example, a fixed contact to be engaged by a contact secured at the center of the disc.



Fig. 8 shows the position of the pull strip **12** and disc **10** in dotted lines and is identical to the position of these elements as illustrated in Fig. 7. The solid line position of the pull strip **12** and disc **10** show their positions when a fixed element to be actuated, for example a contact **18**, is positioned to engage an actuating element mounted at the center of the disc, for example a contact **20**, when the pull strip **12** is under tension. It will be seen from this figure that when the fixed contact **18** is so positioned as to prevent the center of the disc from moving to the at-rest position indicated in dotted lines, the outer ends of the pull strip **12** extend downwardly from the central support. The position of the contact **18**, with reference to the support, is an important factor in maintaining desired pressure between contacts **18** and **20** until the moment that the disc snaps into the other position.

The manner in which this optimum position of the fixed element or contact **18** is determined may be seen in Fig. 9, which is a cross-sectional view of the device taken at right angles to the views shown in Figs. 7 and 8. In this figure the solid line position of the disc **10** is the equivalent of the position shown in Fig. 1 with the pull strip **12** under reduced tension and the free edges of the disc extending upwardly on each side of the fixed element **18**. When the parts of the pull strip **12** are placed under tension the disc snaps to a reverse position with the free ends of the disc slanting downwardly and the disc carried element or contact **20** assuming an uppermost position. The ends of the disc in this action move through a distance indicated generally by the arrows "a." It has been found that by placement of the fixed element **18** generally in the vicinity of the center line "b" drawn between midpoints of the path of travel of the free ends of the disc, that the optimum pressure conditions at engagement and disengagement of the elements **18** and **20** are obtained, as well as an increase in the rapidity with which this engagement and disengagement is accomplished.

To illustrate the operation of the device, reference is made to Fig. 10 wherein the elements or contacts **18** and **20** are shown in engagement, element **18** being at the optimum position described with reference to Fig. 9. The dotted line position of the disc **10** and of the pull strip **12** illustrates the position of the disc and pull strip when the latter are under maximum tension and is identical to positions illustrated in solid lines in Fig. 8. When the tension in the pull strip decreases, whether due to expansion of the strip relative to the disc or to mechanical separation of the points of attachment of the strip to the support, the disc and pull strip move to the full line position shown in Fig. 10, at which position pressure between the elements or contacts **18** and **20** is still maintained. As the tension in the strip continues to decrease, a point is reached when the power of the disc overcomes the tension in the strip and the device snaps from a position of firm contact between elements **18** and **20** to the open position illustrated in Fig. 1. This action of the device in abruptly separating the elements **18** and **20** is of particular importance in avoiding arcing when those elements are electrical contacts.

The essential elements of the new snap action device and the operation thereof have so far been described without reference to any specific application, although the disc carried element and the actuated element of Figs. 7 to 10 have been illustrated as electrical contacts. These elements, however, are electrical contacts only when the device is incorporated in a circuit to be controlled thereby in response to expansion and contraction of the pull strip with increase and decrease of current therethrough. If the device is to be used, for example, as a thermostat, the disc and pull strip are of material having different thermal coefficients of expansion so that snap action of the device

results from differential expansion of the parts with change in ambient temperatures. In such application of the invention the actuated element **18** may be any device adapted when actuated by engagement or disengagement to signify or control temperature conditions, the element **20** being suitably shaped to cooperate with the actuated element. For example, element **20** may be a button of insulating material and element **18** may be a spring arm carrying one of a pair of normally open contacts as in the arrangement illustrated in Fig. 18 hereinafter to be described.

In Fig. 11 the snap action device of Figs. 1 to 6 is illustrated as a flasher for a load circuit, or as an overload protector, depending upon initial adjustment of the tension in the pull strip and upon the position of the fixed contact cooperating therewith. The device is shown with the disc **10** thereof in the position corresponding to maximum tension in the pull strip **12**, and with a disc carried contact **20'** in engagement with a fixed contact **18'** positioned in the optimum position as described with reference to Fig. 9. The fixed contact **18'** is connected through suitable supporting means **22** and wire **24** to one terminal of a control switch **26**. The other terminal of the switch is connected through a lamp or other suitable load **28** to one side of a battery **30**, the other side of the battery being connected by means of a lead **32** to the support **14** which in this embodiment of the invention is of metal. When switch **26** is closed, current will flow from the battery through support **14**, pull strip or wire **12**, disc **10**, contact **20'** carried thereby, contact **18'**, through switch **26** and load **28** to energize the load. With the pull strip under tension and the fixed contact positioned as above described, the device operates as a flasher. The load current is sufficient to heat the pull wire to the point where its expansion permits the disc to buckle and assume a position as shown in Figs. 1 to 3. This action separates contacts **18'** and **20'** to break the circuit, whereupon the pull wire cools. With the cooling and the attendant contraction, the disc will again buckle outwardly to close the contacts **18'** and **20'** and this alternate or flashing action will continue as long as the switch **26** is closed. If the device is to operate as an overload protector the nut **17** is turned to reduce the tension in the pull wires to such an extent that when the disc buckles into the contact open position due to excessive current through the device, the disc will remain in that position and hold the circuit open, there being insufficient tension in the pull wire to return the disc to the contact closing position once the disc has snapped through equilibrium position. After the disc has snapped to open the circuit, the disc can be reset, that is, snapped to contact closing position, by outward pressure applied to the center of the disc, as by manual operation of a tool inserted through the axis of support **14** which in this instance would be formed with a suitable axial passage therethrough.

Figs. 12 to 14 show a specific embodiment of the snap action device in a switch structure. In these figures the disc is denoted by the numeral **34**. It is creased or bent along a diameter in the manner described in connection with Fig. 1. The pull strip in this embodiment of the invention is formed of two parts, indicated as flat wires **36a** and **36b**, which are fastened to the outer periphery of the disc by welding or the like, with their inner ends similarly fastened to a transverse bracket member **38** providing the entire support for the pull strip and the disc. The pull wires are alined with the diametral crease or deformation of the disc **34** and are on the convex side thereof.

The sub-assembly of the operating portions of the switch, namely, the disc **34**, pull wires **36a** and **36b**, and bracket **38** are mounted within a thin recessed housing **40** of insulating material with the disc centrally disposed within a recess **42** and the ends **44** and **46** of the bracket **38** disposed within shallow recesses **48** and **50**, respectively. The end **44** of the bracket **38** is firmly mounted within its recess **48** by a conductive rivet **52** extending through the housing and carrying one contact terminal **54** for the switch. The other end **46** of the bracket **38** is adjustably held in its recess by a screw **56**. Centrally of the recess **42** in which the disc is disposed is a fixed contact **58** fixed to the housing **40** and connected with a lug **60** to form the second terminal for the switch. The contact **58** cooperates with a disc carried contact **62** to open and close the circuit between terminals **54** and **60**.

In order to adjust the tension on the pull wires **36a** and **36b** to obtain the desired operation, the bracket member **38** is slotted at **64** with an enlarged central part **66**. The tension adjustments are illustrated in Figs. 14–A and 14–B. Fig. 14–A shows the means for increasing the tension on the pull wires, which comprises a pair of jaws **68** to deform the bracket member **38** to narrow the recess **64**. To decrease the tension a cam member **70** is inserted in the enlarged section **66** of recess **64** as shown in Fig. 14–B and rotated in position to widen the recess **66** the desired amount.

Adjustment of the spacing of contacts **58** and **62** is accomplished by the adjustment of the screw **56** holding one end of the bracket member **38** in the housing **40**. The bracket member is recessed at **72** and bent slightly as shown in Fig. 13 so that the screw **56** pulls the end **46** of the bracket into place. The resiliency of the metal bracket **38** is sufficient to retain the adjusted contact setting and the degree of adjustment is sufficient to attain the optimum position of the fixed contact relative to the movable contact on the disc.

By the simple addition of a bracket carrying a centrally disposed contact, the structure of Figs. 12 and 13 can be modified for operation as a two-way flasher. Such an arrangement is illustrated in Figs. 15 and 16 wherein elements corresponding to elements of the structure of Figs. 12 and 13 are identified with the same reference numerals. The additional bracket, which is indicated at **74** and carries a contact **76** on the underside thereof, overlies the bracket **38** and is disposed at right angles thereto with the contact **76** positioned within the opening **66** in bracket **38**. One end of bracket **74** is mounted in a recess **78** in the housing **40** by means of a rivet **80** which extends through the housing and serves as the electrical connection between the contact **76** and a terminal **82**. The other end of bracket **74** which, like bracket **38**, is sprung upwardly by bending at a weakened section adjacent the riveted end, is adjustably secured in a recess **84** of the housing by a screw **86**. For cooperation with the contact **76**, a contact **88** is centrally mounted on the disc **34** on the convex side of the crease therein. When the above described structure is to be connected for operation as a two-way flasher, the spacing of contacts **58** and **62** is adjusted to the correct position for maintenance of contact pressure up to the instant that the disc snaps to separate these contacts and to close contacts **88** and **76**. The load circuits to be alternately flashed are connected to terminals **60** and **82**, and terminal **54** is connected through a suitable switch to the source of energy.

It will be understood, of course, that the current drawn by the load circuit connected to terminal **82** should be less than that drawn by the load circuit connected to terminal **60** so that there will be alternate expansion and contraction of the pull wires and hence alternate flashing of the circuits as the disc snaps back and forth from one contact closing position to the other.

If the structure of Figs. 15 and 16 is to be used, for example as a load indicator, it is only necessary that contacts **62** and **58** be permanently electrically connected together, as by a light flexible conductor. Such an arrangement is illustrated in Fig. 17 wherein the operating parts of the structure are shown connected for indicating by a pilot lamp the condition of a lamp load circuit. In Fig. 17 the flexible conductor electrically connecting contacts **62** and **58** is indicated at **90** and three lamps, **92**, **94** and **96** are shown connected in parallel between contact **58** and the negative terminal, indicated as ground, of a source

of energy **98**. A pilot lamp **100** is connected between the back contact **76** and ground and the bracket **38** supporting disc and pull wires is connected through a switch **102** with the positive terminal of the source **98**. With this arrangement the position of fixed contact **58** is relatively unimportant. It would ordinarily be moved out of engagement with contact **62**. The operation of the above described circuit is as follows: When switch **102** is closed current flows through the pull wires, disc, connector **90** and lamps **92**, **94** and **96**, assuming all lamps are in operating condition. The current through the pull wires under this assumed condition is sufficient to cause the pull wires to expand and permit the disc to snap to the position to which it is constrained by the crease therein, in which position contacts **88** and **76** engage and pilot lamp **100** is lighted. Lamps **92**, **94** and **96** will remain lighted because of connection **90** and the disc will remain in back contact closing position until and unless one or more of the lamps **92**, **94** and **96** fail. Upon such failure, the reduced current passing through the pull wires causes sufficient contraction of the wires to snap the disc into the illustrated position with contacts **88** and **76** out of engagement. Pilot lamp **100** will thereby be extinguished, indicating failure of one or more of the lamps of a load circuit. The device may be made sensitive enough to respond to a relatively small change in load current so that failure of any one of a group of lamps can be promptly indicated by extinguishment of the pilot lamp.

In the arrangement diagrammatically illustrated in Fig. 17, should the pull wires, when expanded in normal back contact closing position of the disc, be short-circuited by the disc, they would cool and contract and cause the disc to snap into contact open position, thus extinguishing the pilot lamp and giving a false indication of lamp failure. Such false indication can be avoided by adjustment of contact **76** into a position to provide a stop preventing the disc from assuming its fully constrained position. Furthermore, as the disc itself is of resilient material and as the maximum tension is applied thereto at the points of attachment of the pull wires, the disc flexes slightly at these points in a direction tending to space the wires from the disc surface and hence to minimize the possibility of short-circuit of the wires by the disc. In applications where the pull strip does not carry current when the disc assumes the position to which it is constrained by the crease therein, short-circuiting of the pull strip by the disc is often advantageous as it accelerates cooling of the strip and prevents burning out thereof should the device be inadvertently connected across an excessively high voltage.

In the particular [applications] *embodiments* heretofore described, the snap action of the device has been occasioned by expansion of the pull strip under the influence of heat, either as a result of the passage of current therethrough or as a result of change in ambient temperature. In Figs. 18 and 19, to which reference may now be had, snap action of the device occurs as the result of change in tension applied mechanically to the pull wires. In this embodiment of the invention the disc is indicated by the reference numeral **104** and the pull strip by sections **106a**, **106b**. The outer ends of the pull strip parts are connected to opposite ends of the diameter of the disc **104** as in previous embodiments of the invention along the convex side of the crease therein. The inner ends of the pull strips are secured to a support member **108** having a V-shaped slot **110** therein forming jaws **108a** and **108b** to which the strips are connected. The support member **108** is of spring material and the jaws have a constraint therein tending to move them apart. A drum **112** split into two semi-cylindrical sections and having an axial slot **114** therein for reception of the jaws **108a** and **108b** carries a circumferential coil **116** of expansible wire, which coil holds the halves of the drum together and is under sufficient tension to force the jaws **108a** and **108b** toward each other and thereby introduce tension into the strips **106a**, **106b**. To assure alinement of the halves of the drum with movement thereof toward and away from each other, a recess **118** is formed in each drum half for reception of a pin **120** carried by the other drum half. When the current is passed through the coil **116**, as from leads **122**, the expansion of the wire forming the turns of the coil relaxes the pressure between the halves of the drum **112** and permits the jaws **108a** and **108b** to move apart sufficiently to reduce the tension in the pull strip and permit the disc **104** to snap into its normal constrained position. The snap action of the device resulting from the mechanical change in tension in the pull strip may be employed for actuation of any external device. In the particular embodiment of the invention illustrated in Fig. 18 the device is arranged for opening and closing an external circuit in response to the current in the expansible coil **116**. The device may therefore be considered as a relay. The external circuit is illustrated diagrammatically in Fig. 18 as comprising leads **124** and **126** connected, respectively, to an arm **128** carrying a fixed contact **130** and a spring arm **132** carrying a contact **134**, the tension in the spring arm **132** tending to open the contacts **130** and **134**. An insulating button **136** carried centrally by the disc **104** on the concave side of the crease therein engages spring arm **132** when the disc is in the position corresponding to maximum tension in the strip parts **106a**, **106b** to force the spring arm into position to close contacts **130** and **134**.

The above described arrangement is particularly adapted for use when relatively small currents and high voltages in the controlling circuit are to be encountered. It will be appreciated that but minor changes in position of the jaws **108a** and **108b** are sufficient to cause operation of the switch. It will also be understood that whether the increase and decrease in tension in the pull strip is occasioned by mechanical movement of the inner ends of the pull strip as in this embodiment of the invention, or as a result of heating and cooling as in the earlier described [application] *embodiments*, a change in the distance between the points of attachment of the pull strip to the disc occurs.

The disc of the snap action device of the invention may have its inherent constraint introduced in a variety of ways. The constraint may result from the formation of the disc of a diametral crease as heretofore described and such is the preferred arrangement. It is not necessary, however, that the crease occupy but a minimum medial portion of the disc as a wider but shallower crease or trough could be employed. For example, two creases equally spaced on opposite sides of a diameter could be provided, in which case the section between the creases would be relatively flat, or the diametral crease or channel could be interrupted at its center to provide a flat portion upon which a contact or other operating *element* could be mounted. Also the central crease or channel could terminate short of the periphery of the disc to provide flat surfaces for attachment of the ends of the pull wire. In some instances it might be advisable to provide strengthening ribs or ridges symmetrically disposed on opposite sides of a diameter and between constraining creases for focusing the buckling forces toward the center of the disc. In Figs. 20 and 21 two different designs of disc suitable for use in the snap action device of the invention in place of the singly creased disc heretofore described are illustrated. In Fig. 20 is indicated a disc **138** having a diametral crease **140** which terminates short of the periphery of the disc and is interrupted at the center of the disc. This provides relatively bendable areas at the center of the disc and at the periphery adjacent the points of attachment of the pull means. The increased flexibility of the disc at the points of attachment of the pull strip tends to prevent short-circuiting of the strip by the disc when the strip is fully expanded as discussed with reference to the arrangement illustrated in Fig. 17. In Fig. 21 a disc **142** is indicated which has

crease lines **144** and **146** symmetrically disposed on opposite sides of the diameter D of the disc parallel to the pull strips (not shown). Intermediate the crease lines **144** and **146** are stiffening depressions **148** and **150** which extend radially and symmetrically with respect to the diameter of the disc. These depressions **148** and **150** terminate short of the center of the disc and short of the periphery and serve as reinforcement of the central section between the crease lines **144** and **146**. It will be understood that the view of the disc **142** shown in Fig. 21 is that taken from the concave side of the crease lines. The disc **142** is also provided with short upraised ridges **152** extending from the periphery along the diameter disposed at 90° from the diameter D. These ridges **152** assist, when the disc is snapped, in localizing the position of the opposite fold in the disc. The disc **142** with its crease lines, depressions and ribs may conveniently be formed by stamping from a die. Conveniently short and narrow depressions **154** at opposite ends of the diameter D may be simultaneously formed for providing points of attachment for the ends of a pull strip which, as will be understood, will be secured to the disc along the underside of the disc as viewed in Fig. 21. The depressions **154** also serve to space the pull strip from the disc and thereby tend to prevent short-circuiting thereof by the disc.

*Various embodiments of the* [The] snap action device of the invention comprising essentially the diametrically constrained disc, the laterally flexible pull strip or wire, and the central support to which the pull strip is secured and by which it is tensioned, *have* [has] now been described. *It will be apparent that in the case of the thermally actuated snap action device, the only active elements are the diametrically deformed disc and the tensioned pull means. The support is a passive element which, in each case, has been described as including means for adjusting the initial tension in the pull means. Obviously the active elements, if in proper adjustment, will operate as described, irrespective of how supported.* The snap action of the device occurs as a result of change in tension in the pull strip. When the device is thermally actuated, whether by passage of current therethrough or by changes in ambient temperature, the tension change in the pull strip is caused by expansion or by contraction of either the pull strip or of the disc, depending upon the particular materials employed and their relative dimensions. When the disc is mechanically actuated the change in tension in the pull strip occurs as a result of change in overall length of the pull strip and hence to avoid response to ambient temperature the disc and pull strip in this case should be preferably of material having similar thermal coefficients of expansion. Thus the dimensions of disc and pull wire together with the specific materials of which they are formed depend upon the particular use to which the device is to be put. For a switch, for example, a nickel alloy containing at least 90% nickel, is recommended for use both for the disc and for the pull wire. The disc may have a diameter of ⅞" and a thickness of .005" and the pull strip may be 1/16" wide and .003" thick. A switch of such dimensions and of such material is suitable for use, for example, as a flasher for automobile direction signal and stop lights. A snap action device of the same order of dimensions but with the disc of Invar (nickel steel containing 36% nickel) and the pull strip of nickel or with the disc of nickel and the pull strip of Invar is suitable for use as a thermostat. Larger and smaller discs and pull wires may of course be employed.

This application is a continuation in part of abandoned U. S. applications Serial No. 543,623, filed July 6, 1944 for "Thermal Control Means" and Serial No. 174,411, filed July 18, 1950 for "Thermal Device for Circuit Control."

I claim:

1. A snap action device comprising a disc of resilient material having an inherent diametral deformation therein, laterally flexible pull means secured to the disc at opposite ends of the deformation therein and extending along the convex side thereof, and means disposed adjacent the center of the disc and secured to said pull means for supporting the device and tensioning the pull means, said disc being wholly supported by said pull means.

2. The combination with the snap action device according to claim 1, of a separately supported element positioned on the axis of the disc and on the concave side of the deformation therein for engagement by the disc when the disc is buckled under the tension of the pull means into a position wherein it is curved concavely toward the central support about a diameter 90° to the diametral deformation.

3. The combination according to claim 2 wherein said element is positioned to limit the movement of the center of the disc during buckling thereof.

4. The combination according to claim 3 including an element centrally mounted on said disc on the concave side of the deformation therein for actuating said first mentioned element by engagement therewith.

5. The combination according to claim 4 wherein said elements are electrical contacts, said disc is of metal and said pull means is of expansible wire adapted upon passage of current therethrough to expand and reduce the tension therein.

6. The snap action device according to claim 1 including means associated with said central support means for varying the tension in said pull means.

7. The snap action device according to claim 1 wherein said pull means comprises two flexible strips each connected at one end to the disc, the other ends of said strip being connected to different points on said support means, and means for varying the spacing between the points of connection of the strip to the support means to vary the tension in the pull strips.

8. The snap action device according to claim 1 wherein the disc and pull means are of material having the same coefficient of thermal expansion whereby the tension in the pull strip is independent of the ambient temperature.

9. The snap action device according to claim 1 wherein the disc and pull means are of material having different coefficients of thermal expansion whereby the tension in the pull strip varies with the ambient temperature.

10. A snap action device comprising a disc having an inherent diametral deformation therein tending to cause it to assume a constrained shape, a support element having laterally flexible pull means fastened thereto and radiating out therefrom, the outer ends of said pull means being fastened to points of said disc at opposite ends of the deformation therein and on the convex side thereof whereby when the tension in said pull means is reduced the center of the disc snaps in one direction to assume its constrained shape and when the tension in said pull means increases the snap action of the center of the disc occurs in the other direction.

11. A snap action device according to claim 10 including means associated with said support means for operating upon the central portion of the pull means to vary the tension thereof to snap the disc from one position to another.

12. The snap action device according to claim 10 wherein said pull means and disc are of electrical conducting material and the tension in said pull means is varied by differential expansion and contraction of said pull means and disc with passage of current therethrough.

13. The snap action device according to claim 10 wherein said pull means and disc are of material having different coefficients of thermal expansion and the tension in the pull means is varied by differential expan-

sion and contraction of the pull means and disc with changes in ambient temperature.

14. The combination with the snap action device according to claim 10, of a separately supported element positioned on the axis of the disc and on the convex side of the deformation therein for engagement by the disc when the center of the disc snaps in the direction to assume its constrained shape as a result of reduction in tension in the pull means.

15. A snap action device comprising a controlling metallic disc-like member having an initial constraint incorporated therein tending to cause it to assume the constrained shape, a support element having pull wire means fastened to the end thereof and radiating out therefrom, the outer ends of said pull wire means being fastened to spaced points of said disc, said points being on the opposite sides of the center of the disc and so arranged with respect to the disc that when the pull wire means expand the center of the disc moves with a snap action in one direction and when the pull wire means contract a snap action of the disc center occurs in the other direction.

16. The device according to claim 15 wherein said pull wires are of material having a coefficient of thermal expansion differing substantially from the coefficient of thermal expansion of the metallic disc-like member whereby differential expansion and contraction of said disc and pull wires under changes in the ambient temperature causes snap action of the disc center and wherein said support means are adjustable for varying the tension in said pull wires.

17. A thermal switch device comprising a support, a buckling member having a portion adapted to occupy two different positions for operating a circuit opening and closing contact, and linear [expansion] *expansible* pull means carried by said support and fastened at two spaced points to said buckling member to control the buckling thereof to cause said portion to occupy one of said positions responsively to current flowing through the expansible means, and said buckling member being carried by said expansible pull means, the buckling member being the the form of a constrained disc with the outer ends of the expansible means fastened to one side of the disc at diametrically opposite points adjacent its periphery.

18. A thermal switch device comprising a support, a buckling member having a portion adapted to occupy two different positions for operating a circuit opening and closing contact, and linear expansible pull means carried by said support and fastened at two spaced points to said buckling member to control the buckling thereof to cause said portion to occupy one of said positions responsively to current flowing through the expansible means, and said buckling member being carried by said expansible pull means, the buckling member being a disc of comparatively thin spring metal doubly constrained by having a transverse bend formed therein and by the pull of the expansible means fastened at its ends to the convex side of said bend.

19. A thermal switch device comprising a support, a buckling member operating a circuit opening and closing contact and linear expansible pull means carried by said support and fastened at two spaced points to said buckling member to control the buckling thereof responsively to current flowing through the expansible means and said buckling member being carried by said expansible pull means and the latter comprising two parts disposed in line with each other and said support comprising two relatively adjustable portions to which are fastened respectively the inner ends of the expansible pull parts.

20. A circuit controller comprising a disc having a diametrical crease and carrying a contact at the center of the concave side, a pair of expansible and contractible wires having outer ends fastened at opposite points on the periphery of the disc, a supporting means disposed at the center of the convex side of the disc with the other ends of said wires being secured thereto to wholly support the disc and a fixedly mounted contact positioned in operable relationship with the first said contact.

21. A snap action device comprising a diametrically creased disc, an element centrally mounted on the concave side of the disc, a pair of radially disposed expansible and contractible strips on the convex side of the disc in alinement with the diametrical crease and fastened at their outer ends to the periphery of the disc, centrally disposed supporting means positioned on the convex side of the disc with the inner ends of the strips secured thereto to wholly support the disc, and a fixed element mounted in cooperating relationship with the disc carried element.

22. A snap action switch comprising a disc-like plate of resilient material creased along a central line to displace the portions of the plate on each side of the line to form an included angle of less than 180°, a contact mounted on the center of the concave side of the plate, a pair of radially disposed pull wires on the convex side of the plate in alinement with said line and fastened at their outer ends to the edges of the plate, and centrally slotted supporting means on the convex side of the plate with the inner ends of the pull wires fastened thereto on each side of the slot, the width of the slot being adjustable to control the tension on the pull wires.

23. A thermal switch device comprising a support, a substantially circular buckling member carrying a contact and having an inherent constraint tending to move said contact through a dead center position to occupy a circuit controlling position and linear expansible pull means carried by said support and fastened to said buckling member at two spaced points on the opposite sides of a transverse line passing through said contact to control the buckling thereof responsively to current flowing through the expansible means and said buckling member being carried by said expansible pull means.

24. In a thermal switch device of the character set forth in claim 23 wherein the support comprises two adjustable parts and said linear expansible pull means comprises two parts fastened respectively to the adjustable support parts.

*25. In a snap action device the combination comprising a disc-like member of resilient material having a preformed crease therein along a single diameter only to provide a single position of stable conformation in which the portions of the member on each side of the diameter form an included angle of less than 180°, and an elongated pull member laterally flexible relative to the surface of said disc-like member and secured under tension to said disc-like member only at opposite ends of the crease therein and extending parallel to and overlying such crease along the convex side thereof, said disc-like member, depending upon the tension in said elongated pull member, being either in said position of stable conformation or in a position wherein it is curved oppositely thereto and about a diameter 90° to said crease, said disc-like member snapping through a neutral planar position from the position of stable conformation to the oppositely curved position in response to increase in tension in said pull member and snapping through the neutral planar position to the position of stable conformation from the oppositely curved position with decrease in tension in the pull member.*

*26. In a current responsive snap action device, a disc-like member of resilient electrically conductive material having a preformed crease along one diameter only to provide a single stable conformation in which the portions of the disc-like member on each side of the diameter form an included angle of less than 180°, and a flexible ribbon of electrically conductive material fixed to the disc-like member only at opposite ends of said diameter and overlying said diameter on the convex side*

*of the crease, said disc-like member, depending upon the tension in said ribbon being either in the said position of stable conformation or in a position wherein it is bent oppositely thereto and about a diameter 90° to said preformed crease whereby differential expansion and contraction of said ribbon and disc-like member with passage of current therethrough changes the tension in said ribbon and causes snap action of said disc-like member through a neutral planar position from one to the other of said first mentioned positions.*


**References Cited** in the file of this patent or the original patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,669,531 | Mottlau | May 15, 1928 |
| 1,680,429 | Mottlau | Aug. 14, 1928 |
| 1,715,662 | Lasky | June 4, 1929 |
| 1,784,450 | Klahn | Dec. 9, 1930 |
| 1,872,205 | Winger | Aug. 16, 1932 |
| 2,024,362 | Hoopes | Dec. 17, 1935 |
| 2,041,775 | Mottlau | May 26, 1936 |
| 2,166,238 | Davis | July 18, 1939 |
| 2,253,552 | Burch | Aug. 26, 1941 |
| 2,266,537 | Elmer | Dec. 16, 1941 |
| 2,267,164 | Newton | Dec. 23, 1941 |
| 2,615,106 | Schmidinger | Oct. 21, 1952 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 47,975 | Norway | June 2, 1930 |