

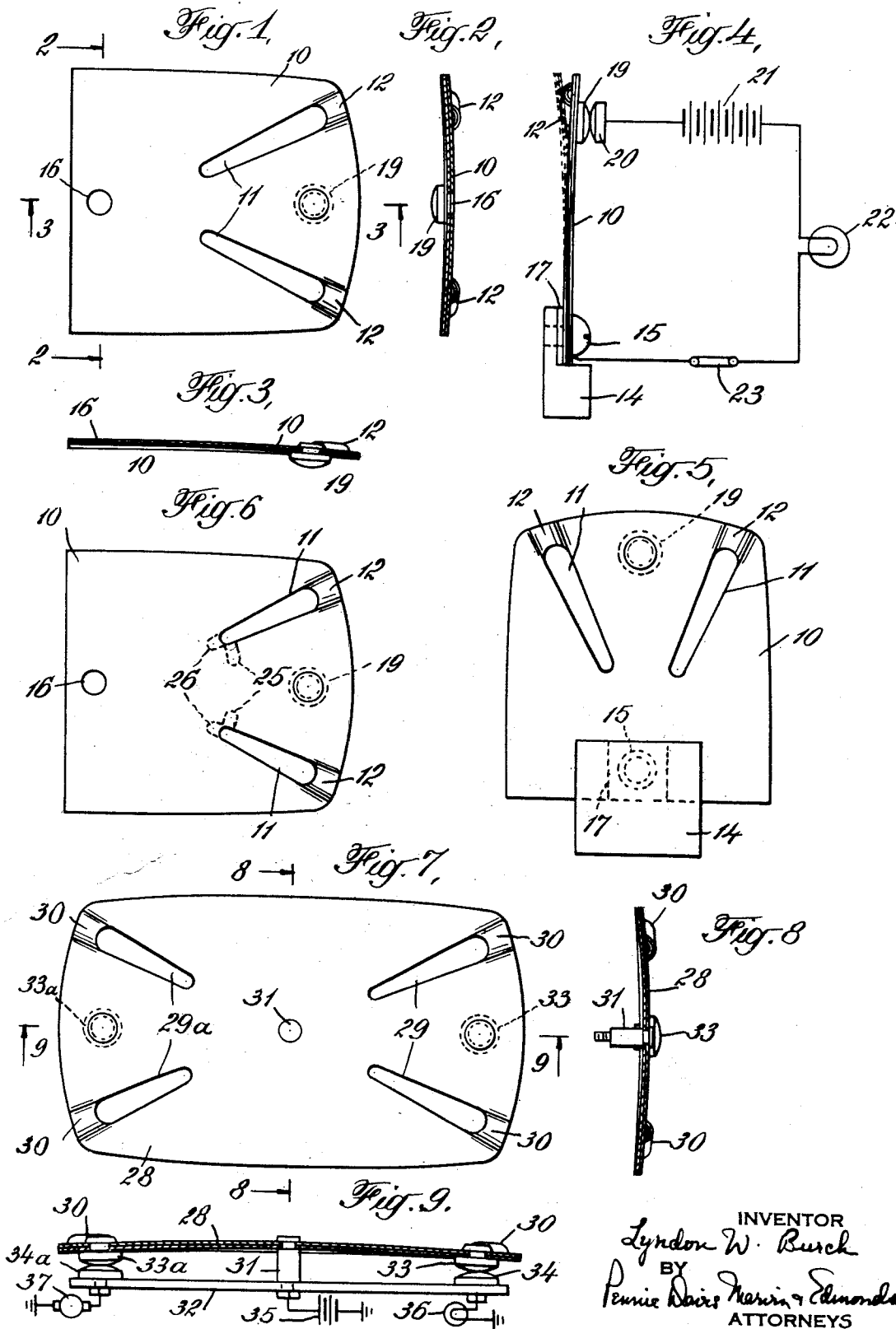
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SNAP ACTING DEVICE AND METHOD OF MAKING THE SAME

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9 Claims. (Cl. 297-15)

This invention relates to snap acting devices and has particular reference to a novel snap element which has special operating advantages because of its inclusion of a novel arrangement of slots. The new snap element may be made of bimetal so that it snaps from one position to another under the action of heat which may be generated therein by the passage of an electric current through the element. By reason of its slotted construction, the new snap element may be readily made into a concavo-convex form to obtain the desired snap action, and by varying the arrangement of the slots the effective electrical resistance of the element, and therefore the amount of the current necessary to operate it, may be varied. The snap element of the invention is positive and reliable in operation and may be made at low cost by a novel method which also forms part of the invention.

This application is a continuation-in-part of my co-pending application Serial No. 302,124, filed October 31, 1939.

While the new snap element may be actuated by an external medium, such as a thermostat, it may be used to particular advantage in the form of a self-operating, bimetallic snap element. Accordingly, for illustrative purposes it will be described in connection with a thermostatic snap switch which is to be operated by an electric current.

Electrically operated snap switches have been devised heretofore in which a bimetallic disk having a dish shape snaps from a normal stable position to a position of opposite curvature when heated electrically to a sufficiently high temperature. Such switches are sometimes used as safety devices to prevent overloading of circuits. In this use, the switch is arranged in the circuit so that when the current becomes too great due to an overload it generates sufficient heat in the bimetal of the disk to cause the latter to snap and open a pair of contacts, thus breaking the circuit. The disk then cools, since the flow of current is cut off, and snaps back to its normal position so as to close the contacts again, the cycle being repeated until the cause of the overload is removed. These switches are generally designed to open at a certain current rating which is predetermined by the effective resistance of the bimetal to the current flow, and in switches of different current ratings the bimetallic disks have different thicknesses or different widths, or both, to provide different effective cross-sectional areas through which the current flows. Thus, to

make the switches of different current ratings, it is necessary to provide bimetallic disks of various sizes which is objectionable from a manufacturing standpoint and also for the reason that disks of various sizes may have somewhat different snap actions.

One feature of the present invention, therefore, resides in the provision of a novel snap acting switch operated electrically by current passing through the snap element, which may be made with different current ratings but in a standard, uniform size, and which, in addition, may be made at low cost in a few simple operations. A switch constructed in accordance with my invention comprises a sheet of bimetal which is slotted, preferably by a pair of separate, diverging slots terminating short of the periphery of the sheet. In the preferred construction, the slots are elongated and the metal between one end of each slot and the periphery of the sheet is gathered or bent out of the plane of the sheet in the form of a trough extending in the direction of the slot, whereby the effective perimeter of the sheet is reduced and it is caused to assume a concavo-convex form. The sheet may be used to control a circuit by operating a pair of normally closed contacts, in which case it is arranged in the circuit so that the current flows from the contacts through the metal lying between the two diverging slots to a mounting for the sheet. When the current becomes too great, it heats the metal between the slots and thereby sets up internal strains in the sheet which eventually cause the latter to snap to a position of opposite curvature and open the circuit, whereupon the sheet cools and snaps back to its original position so as to close the circuit.

With this construction, it will be apparent that by properly spacing the adjacent ends of the diverging slots the effective cross sectional area of the current path, and therefore the effective electrical resistance of the snap element, may be accurately predetermined. Thus, the snap elements may be made of a uniform size but with different current ratings by varying the arrangement of the slots in the bimetal. The amplitude of the snap movement for elements of a given size is determined largely by the amount of metal gathered at the ends of the slots, and, accordingly, the slots may be arranged with different spacings between them without substantially affecting the snap acting characteristics of the elements. It will be observed that the slots serve not only as a medium for determining the

effective electrical resistance of the element and therefore its current rating, but also as a simple expedient which permits the snap element to be formed readily into the desired concavo-convex shape by simply gathering the metal at the outer ends of the slots.

Another feature of the invention resides in the provision of a novel method by which the new snap element may be made expeditiously and at low cost. According to the new method, a sheet of bimetal of the desired shape is first formed with diverging slots. The sheet and the slots may, if desired, be cut in a single stamping operation, but regardless of the manner in which the slots are formed they are so spaced at their adjacent ends as to provide a predetermined electrical resistance between them of an amount dependent on the desired current rating. Then, at one or more points between the slots and the periphery of the sheet, the metal is gathered or bent out of the plane of the sheet so as to reduce the effective perimeter and force the sheet into a dish shape. If desired, the snap element may be made initially with a relatively large spacing between the adjacent ends of the slots to provide a low resistance element, that is, one having a maximum current rating, and when a snap element having a lower current rating is desired, the slots are enlarged at their adjacent ends, as by means of a filing operation, to reduce the spacing between the slots and thereby increase the effective electrical resistance of the element.

These and other features of the invention may be better understood by reference to the accompanying drawing, in which

Fig. 1 is a plan view of one form of the new snap element;

Figs. 2 and 3 are sectional views on the lines 2—2 and 3—3, respectively, in Fig. 1;

Fig. 4 is a diagrammatic view of a circuit under control of the snap element;

Fig. 5 is a plan view of the snap element secured to the support shown in Fig. 4;

Fig. 6 is a plan view of the snap element showing the manner in which its current rating may be varied;

Fig. 7 is a plan view of still another form of the snap element, and

Figs. 8 and 9 are sectional views on the lines 8—8 and 9—9, respectively, in Fig. 7.

Referring to the drawing, the snap element comprises a sheet of bimetal 10 which, as shown, is generally rectangular, although it will be understood that the sheet may take any other desired form. The sheet is slotted by a pair of diverging slots 11 extending toward the periphery of the sheet but terminating short of the periphery. Preferably, the slots radiate from the central portion of the sheet, where their adjacent ends are separated, and extend toward the corners at one end of the sheet. The bimetal between the outer end of each slot and the periphery of the sheet is gathered or bent out of the plane of the sheet so as to form a trough 12 extending in the direction of the slot, and by reason of this gathering of the metal the effective perimeter of the sheet is reduced and the sheet is made to assume a concavo-convex form or dished shape. Normally, the metal having the higher coefficient of expansion is on the concave side of the sheet, and, accordingly, when the sheet is heated it is subjected to internal stresses which tend to reverse the curvature but which are resisted by reason of the dished shape until a predetermined temperature is reached, whereupon

the internal stresses overcome the resistance of the sheet and snap it quickly with an over-center action to a position of opposite curvature. Preferably, the sheet is subjected to a permanent strain tending to return it to its normal position shown in Figs. 1, 2 and 3, and when the temperature of the bimetal decreases, the internal strains are relieved whereby the sheet snaps automatically to its original position.

The new snap element is adapted for various uses where it is desired to operate a control element thermostatically with a snap action, but by reason of its slotted construction it is particularly suited for use as a safety device for automatically opening an electric circuit when the circuit is overloaded. For example, the snap element may be arranged to control a lighting circuit and take the place of the usual fuse. To this end, the sheet 10 may be secured to a mounting 14 in any suitable manner, as by means of a screw 15 extending through an opening 16 near the end of the sheet remote from the slots. The opening 16, as shown, is located equidistantly from the inner ends of the slots so that the screw 15 clamps the sheet on its longitudinal axis. Preferably, the sheet is spaced from the support 14 by a washer 17 through which the screw extends into the mounting, whereby the mounting does not interfere with the reversal of the curvature of the snap element at its mounted end incident to the snap action.

Near the opposite end of the snap element is a movable contact 19 secured on the normally concave side of the sheet. The contact, as shown, is equidistant from the two slots 11 and normally engages a fixed contact 20. A current source 21 is connected at one side to the contact 20 and at the other side is connected through a lamp 22 and a control switch 23 to the mounting 14, as by means of the screw 15.

In the operation of the device, the current from one side of the battery 21 normally flows through the lamp 20, the switch 23, the mounting 14, snap element 10, and the normally closed contacts 19, 20 to the other side of the battery. Between the mounting 14 and the movable contact 19, the current passes through the relatively narrow neck of metal lying between the adjacent inner ends of the slots, since this path is the shortest and the one of least resistance. The greatest resistance along this path is in the region between the inner ends of the slots, and, therefore, the greatest amount of heat is developed in the central portion of the sheet. When a normal current is flowing through the snap element, the heat generated in the snap element by its electrical resistance is not sufficient to snap the element to a position of opposite curvature, but when an overload condition occurs, due to a short circuit, or the like, the increased current passing through the snap element heats the central portion to a higher temperature and causes the element to move abruptly to a position of opposite curvature. As a result, the contact 19 is snapped away from the fixed contact 20 to break the circuit, and the snap element assumes the position shown in dotted lines in Fig. 4. Since this action of the snap element interrupts the flow of current, the element gradually cools until the internal stresses therein are relieved sufficiently to allow it to snap back to its original position and reengage the contacts 19 and 20, whereupon the current again heats the snap element and the cycle is repeated until the cause of the short circuit is removed. Thus, the snap

element acts as an automatic safety device for preventing overloading of the circuit and may take the place of the usual fuse employed in such circuits. However, the new snap element, for some purposes, is preferable to a fuse because it does not require replacement when the overload condition occurs.

Because of the described arrangement of the slots 11, the flow of current is so controlled that the maximum amount of heat is generated near the central portion of the sheet where it is most needed to initiate the desired snap action. The slots serve not only as a medium for predetermining the electrical resistance of the current path through the sheet but also as a simple means permitting gathering of the metal at the periphery of the sheet to provide the desired dished shape. Since this gathering of the metal shortens the periphery of the sheet, the sheet is dish-shaped or curved over its entire area. The trough-shaped portions 12 not only serve to take up the metal at the periphery to provide the dished shape, but also act as springs permitting the periphery to expand and contract slightly as the sheet snaps over center from one position to the other. It will be apparent that the sheet may be made more or less dished shape depending on the amount of metal gathered in the trough portions 12. Thus, when it is desired to obtain a snap motion of a relatively large amplitude, a greater amount of metal is gathered in the trough portions 12 so that the effective perimeter of the sheet is considerably reduced and the dished shape is accentuated.

In making the snap acting device according to the invention, the slots 11 are cut in the sheet 10, as by means of a stamping operation, so that the metal between their adjacent inner ends provides the desired maximum resistance along the current path between the slots. Then, the metal between the outer ends of the slots and the periphery of the sheet is gathered into the trough portions 12, preferably in a crimping operation. The current rating of the snap element thus formed is determined by the effective electrical resistance of the narrowest portion of the current path between the inner ends of the slots, which, in turn, is dependent on the spacing of the slots. In case it is desired to decrease the current rating of the device, the spacing between the inner ends of the slots may be reduced by simply removing some of the metal between the slots as indicated at 25 and 26 in Fig. 6. The removal of this metal may be conveniently effected by a cutting operation or by filing the metal at the inner ends of the slots. In either case, the slotted construction of the snap element permits the current rating to be predetermined accurately by the width of the neck of metal between the inner ends of the slots.

A modified form of the snap element is illustrated in Figs. 6, 7 and 8. In this form, the sheet of bimetal 28 is more elongated and is formed with a pair of slots 29 radiating from the central portion of the sheet toward the corners at one end, and another pair of slots 29a radiating toward the corners at the opposite end. The metal between the outer end of each slot and the periphery of the sheet is gathered in the form of a trough 30 so as to decrease the effective perimeter and cause the sheet to become dished. At its central portion, the sheet is secured by a post 31 to a suitable insulated support 32 on which the sheet is adapted to snap over center from one position to another. Near the opposite ends 75

of the sheet are movable contacts 33 and 33a, respectively, normally engaging fixed contacts 34 and 34a, respectively, mounted on the support 32. The post 31 is made of conducting material and may be connected to a current source 35, such as an automobile battery which, in turn, may be grounded to the frame of the vehicle. The fixed contacts 34 and 34a may be connected, respectively, to different devices to be energized. For example, the contact 34 may be connected through a lamp 36 or a series of lamps to a ground connection, and the contact 34a may be connected through a motor 37 for an automobile heater and then to the ground.

In operation, the current flows from the battery 35 through the post 31 to the central portion of the sheet, where it divides and flows in separate paths toward the contacts 33 and 33a. From the post 31 to each of the contacts, the current flows along the narrow neck of metal between the inner ends of the corresponding pair of slots, and by properly spacing the slots 29 and 29a, respectively, the effective electrical resistance of the current paths may be accurately predetermined. From the contact 33 the current flows to the contact 34 and then through the lamp 36 to the ground and back to the battery. From the other contact 33a, the current flows to the contact 34a and then through the motor 37 to the ground and back to the battery. In the event that a short circuit occurs in either one of the circuits, the increased current flowing along the sheet between the respective slots will heat the metal sufficiently to cause the corresponding end of the sheet to snap to a position of opposite curvature and open the contacts controlling the affected circuit. However, the contacts at the opposite end of the sheet will remain closed until the current flowing through these contacts is sufficient to heat and snap the corresponding end of the sheet to its opposite position. It will be observed that the spacing between the inner ends of the slots 29 is somewhat less than that between the inner ends of the slots 29a, so that the current rating of one end of the sheet is different from that at the opposite end. That is, the part of the sheet including the slots 29 will snap upwardly with a lower current than the part including the slots 29a, because the resistance between the slots 29 is considerably greater than that between the slots 29a. The current rating of either end of the sheet may also be varied by changing the depth of the troughs 30 at that end, whereby the corresponding end of the sheet is made more or less concave.

In each of the snap elements illustrated, the current is caused to flow from the contact near one end to the mounting near the other end by way of the metal between the slots, because the only other paths are through the trough-shaped portions which provide relatively small cross-sectional areas for the current flow. By properly correlating the length of the trough portions and the spacing between the inner ends of the slots, the resistance of the possible current paths through the trough portions may be made so great in relation to the resistance of the path between the slots, that substantially all of the current will flow between the slots and heat the central portion of the sheet.

While the snap element as described and illustrated herein is made of bimetal so that it is self-actuating, it will be apparent that the element may be unimetallic and operated by an external actuating means. In either case, by

reason of the slotted construction the snap element may be made in a dished form at low cost and its operating characteristics may be predetermined by the arrangement of the slots or by the amount of metal gathered at the ends of the slots.

I claim:

1. A self-actuating snap element comprising a sheet of bimetal having a pair of spaced apertures therein and having at least part of the metal between the periphery at one end of the sheet and adjacent edges of the apertures gathered in the form of troughs to reduce the effective perimeter and cause the sheet to assume a concavo-convex form.

2. A self actuated snap element comprising a sheet of bimetal having a pair of slots therein radiating from the central portion of the sheet but terminating short of the periphery of the sheet, the metal between the outer ends of the slots and the periphery being gathered out of the general plane of the adjacent surface of the sheet to reduce the effective perimeter of the sheet and cause the sheet to assume a concavo-convex form.

3. A snap element comprising a sheet of spring metal having a pair of slots therein radiating from the central portion of the sheet but terminating short of the periphery of the sheet, the metal between the outer ends of the slots and the periphery being gathered in the form of troughs extending generally lengthwise of the slots to reduce the effective perimeter of the sheet and cause the sheet to assume a concavo-convex form.

4. In an electrically operated snap acting device, a sheet of bimetal having a pair of slots therein and having part of the metal between the outer end of each slot and the periphery of the sheet gathered to reduce the effective perimeter and cause the sheet to assume a concavo-convex form, the slots being spaced apart so that the bimetal between them provides a predetermined electrical resistance, the sheet being operable to snap to a position of opposite curvature when heated to a predetermined temperature by passage of a current through the bimetal between the slots.

5. In an electrically operated snap acting device, a sheet of bimetal having a pair of slots therein and having part of the metal between the outer edge of each slot and the periphery of the sheet gathered to reduce the effective perimeter and cause the sheet to assume a concavo-convex form, the slots being spaced apart so that the bimetal between them provides a predetermined electrical resistance and the slots

being disposed so that the metal between the end of each slot and the periphery provides an electrical resistance substantially greater than said first resistance, the sheet being operable to snap to a position of opposite curvature when heated to a predetermined temperature by passage of a current through the bimetal between the slots.

6. The method of making an electrically operable snap acting device which comprises forming separate slots in a normally flat sheet of bimetal and spacing the slots so that the bimetal between them provides a predetermined maximum electrical resistance between the ends of the sheet, and gathering metal in the form of troughs between the periphery of the sheet and adjacent ends of the slots to reduce the effective perimeter and cause the sheet to assume a dished shape.

7. A snap acting device comprising a sheet of spring metal having openings therein between its central portion and its periphery, the openings dividing the sheet into three legs joined at their adjacent outer ends by the metal between the outer ends of the openings and the periphery, said last metal being gathered out of the general plane of the adjacent surface of the sheet to draw the two outer legs inwardly toward the center leg and thereby twist the outer legs while leaving the center leg relatively flat, the sheet being dished by the twisting of the outer legs and being operable to snap to a position of opposite curvature.

8. A method of making snap acting devices which comprises forming a pair of apertures in a normally flat sheet of spring metal with a spacing between the apertures, and gathering metal in the form of troughs between the periphery at one end of the sheet and adjacent edges of the apertures to cause the sheet to assume a dished-shape and to twist opposite side portions of the sheet out of the general plane of the central portion.

9. A snap acting device comprising a sheet of spring metal having a pair of apertures dividing part of the sheet into three legs, the device including means in tension displaced from the general plane of the adjacent surface of the sheet and connected between the outer end portions of each pair of adjacent legs for drawing the outer ends of the outer legs toward the central leg to reduce the width of the outer ends of the apertures relative to the width of the inner ends of the apertures, whereby the sheet is caused to assume a dished-shape and the outer legs are twisted out of the general plane of the central leg.

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