

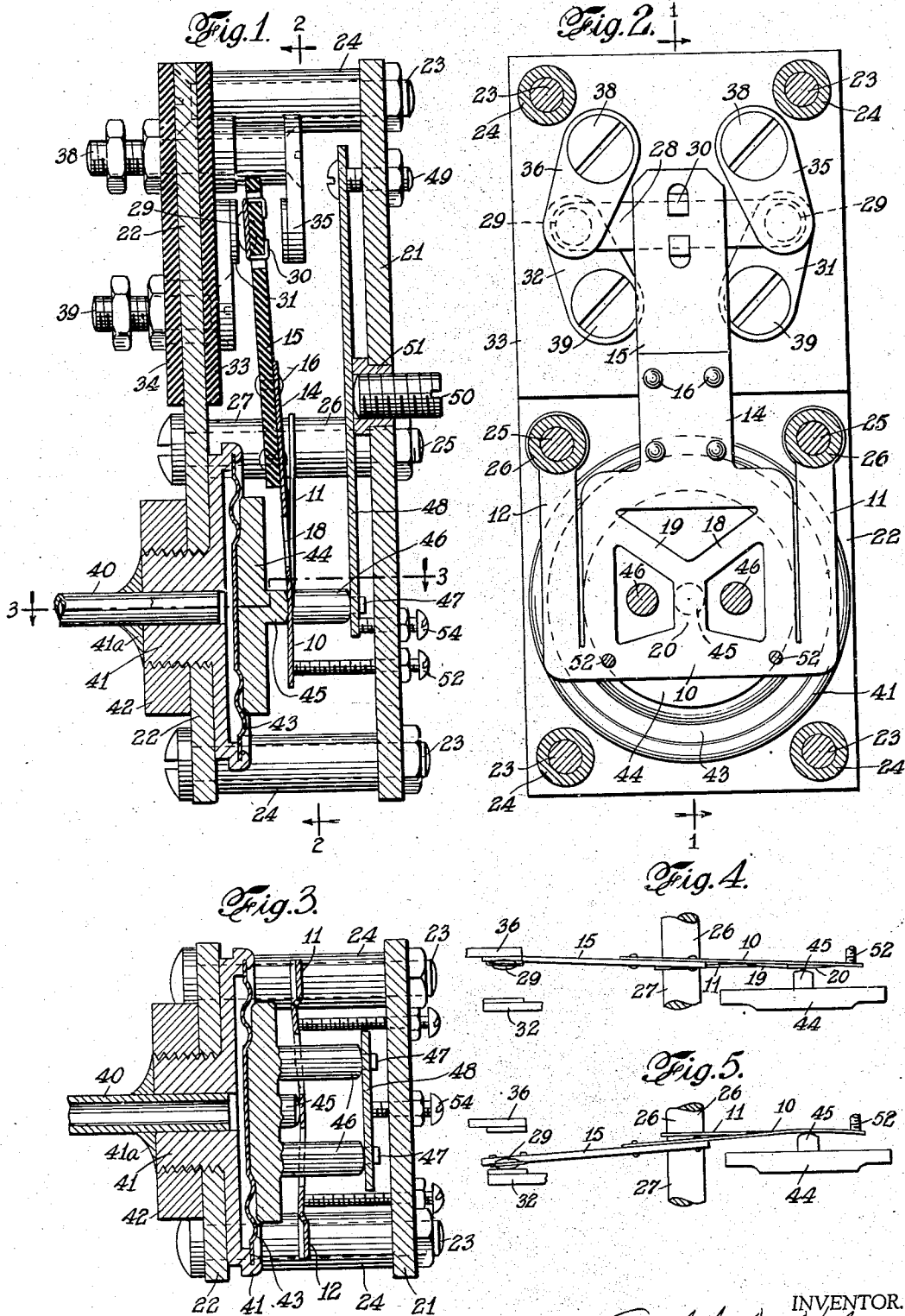
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SNAP-ACTION DEVICE

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SNAP-ACTION DEVICE

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1 Claim. (Cl. 74-100)

The present invention relates to a device for producing a mechanical snap-action in response to applied pressure, particularly where that pressure produces an actuating movement of small magnitude. The snap-action may be utilized for the operation of various useful devices such as indicating means, electrical switching means, valving mechanism for gas or liquid, or other mechanism wherein it is desired to produce a positive, sudden movement when an applied force, such as fluid pressure, for example, has reached a predetermined point.

One of the principal applications of the invention at present contemplated is in a pressure-responsive electrical switch and the invention is described herein as it is embodied in the preferred form of such a switch. It will be apparent, however, from a consideration of the following description, that in place of the moving element of the switch one might substitute valving mechanism or an indicating means for giving a visible or audible signal. Or such indicating means might be simultaneously operated in conjunction with switching, valving or other control mechanisms.

Electrical snap switches of various types are at present in use to a large extent for the automatic control of temperature in many applications, among which may be mentioned electric refrigeration and the lead-pots of type-casting machines. In general, it may be said that these switches are operated by mechanism which produces movement of an actuating member in response to temperature changes. This movement may be the result of fluid expansion acting on a bellows or diaphragm or of the differential expansion of a bimetal strip or the like. Devices of this nature at present in use are deficient in certain respects, particularly as to the pressures required to be built up to cause the operation of the switch and the amplitude of movement required for that purpose. These in turn are directly related to the temperature differential which results. For example, controls now being used on type-casting machines permit temperature variations of from 15° to 25° F., which is a variation too great for accurate control of the quality of the type cast.

It is, therefore, an object of the present invention to provide a device which will operate in accordance with small pressure differentials and with very small magnitudes of movement of the actuating member. A switch has been constructed in accordance with the invention which will operate with as little as 0.002 of an inch

movement of the actuating device and will control temperature within a range of 4° F.

Another disadvantage of present switches is that the pressure under which the contacts are held together is decreased so gradually, as the mechanism approaches the point where the contact is broken, that there exists a period just prior to the intended breaking of contacts, during which there is substantially no pressure so that if the switch is subject to vibration, as is frequently the case, the contacts will chatter and arcing will take place. It is therefore a further object of this invention to eliminate this difficulty by holding the contacts together under positive pressure until they are positively opened with a snap.

It is a further object to provide switching mechanism which will have substantially the same snap action in two directions between sets of opposed contacts so as to be capable of controlling a plurality of circuits with equal efficiency.

A still further object is to provide a snap-action device which is very inexpensive and simple to manufacture and capable of performing the work of more costly and complex devices.

The present invention also has as objects the provision of suitable means for supporting and regulating the spring member which produces the snap-action in its operative relation to associated parts and the provision of appropriate actuating means for producing the snap-action.

For purposes of illustration the drawings show a switch adapted for controlling one or more electrical circuits in response to fluid pressure.

Fig. 1 is a central longitudinal section on the line 1-1 of Fig. 2.

Fig. 2 is a section through the switch at right angles to Fig. 1 and on the line 2-2 thereof.

Fig. 3 is a transverse section on the line 3-3 of Fig. 1.

Figs. 4 and 5 are side views of the spring member in relation to its associated parts, illustrating the two positions assumed by the said spring during operation. All of the figures are enlarged relative to the actual device.

The essential feature of the invention is a spring member, having a single normal or static position which will suddenly jump or snap to a different position when pressure is applied to a certain point or area of the spring. These positions are herein designated for convenience as the "normal" and "secondary" positions respectively.

A preferred embodiment of this spring member is shown in the drawing at 10. As shown in

Fig. 2 this spring comprises a generally rectangular body portion having openings therein which define an internal grid having the configuration of a Y. A pair of integral side members 11 and 12, extending substantially parallel to the sides of the body portion, provide means for supporting the spring and a tongue 14 provides means for attaching a member to be operated by the spring, such as the strip of insulation 15 secured thereto by rivets 16. The spring, together with its integral supports, tongue and grid, may be made by stamping it out of any suitable metal, such as beryllium-copper alloy, phosphor-bronze or the like.

To produce in the spring its capacity for snap-action it is necessary to distort certain portions out of their original plane, slightly increasing their length. In a spring shaped as is shown in the drawing this is done by pressing the branch segments 18 and 19 in suitable dies to give them a slight permanent stretch. This distorts the Y-shaped grid composed of the segments 18 and 19 and the central segment 20 with a permanent set outside of the original plane of the spring. The extent of this distortion is important. It should not be carried so far that pressure applied upon the distorted portion in a direction toward the original plane of the spring will cause it to buckle permanently in the opposite direction with what may be termed an "over-center" action. On the contrary, the distortion should be such that when the grid segments are pressed toward the original plane, the spring as a whole will buckle slightly with a snap-action and when the pressure is released it will snap back to its original position. Thus the spring has a single normal position and a secondary or buckled position in which it is under a stress tending to return it to its normal position.

The distortion necessary to produce a snap-action and short of that which will result in the undesired over-center action is very slight and the movement of the distorted portion which will result in buckling into the secondary position is correspondingly small, usually less than 0.01 of an inch. As hereinafter explained, the extent of that movement can be reduced by proper adjustment of the mounting and adjusting devices for the spring to the order of 0.002 of an inch.

The manner of mounting the spring to utilize its snap-action for electric switching purposes is shown in the drawing. A frame is constructed of upper and lower metal plates 21 and 22 held in spaced relation by the four corner bolts 23, surrounded by the spacing sleeves 24. There are also two center bolts 25 carrying sleeves 26 and 27 between which the perforated ends of the side members 11 and 12 of the spring 10 are clamped; and in that way the spring 10 is supported intermediate the plates 21 and 22.

The end of the rigid strip 15 of insulating material carries a metal cross-bar 28 having contacts 29, the bar being secured to the strip 15 by the ears 30 which pass through openings and are bent over upon the strip. A pair of lower terminals 31 and 32 are mounted on an inner sheet of insulation 33 which, together with an outer sheet of insulation 34 and suitable bushings, separates the terminals from the metal plate 22. A pair of similarly insulated upper terminals 35 and 36 are located above and spaced from the lower terminals. The cross-bar 28 reciprocates between these terminals, snapping from one set to the other, thus controlling two circuits if desired.

The bolts 38 and 39 provide means for connecting the switch in a circuit.

The operating mechanism shown in the illustrative embodiment is designed for operation by fluid pressure which would be conducted to the switch through the pipe 40 which is secured to a diaphragm carrier 41 by brazing 41a. Carrier 41 is threaded into an opening in plate 22 and locked therein by a nut 42. In the carrier is a diaphragm 43 of the usual circular corrugated type which is free to move in response to the pressure of the fluid behind it. Mounted on top of the diaphragm is a flat-bottomed rider 44 having a centrally placed stud 45 and an upwardly-extending yoke 46. The parts are so mounted relative to one another that the stud 45 presses against the center segment 20 of spring 10 when the diaphragm is moved toward the spring 10 by pressure. The two arms of the yoke 46 are reduced in size at their upper ends 47 and 20 are inserted in holes in the free end of a leaf spring 48 which is secured to plate 21 at its opposite end by a bolt 49. Between the ends of spring 48 an adjusting screw 50 is mounted in a bushing 51 fixed in plate 21. This screw is used to adjust the pressure applied by spring 48, through the yoke 46 against diaphragm 43. As will be readily understood, spring 48 balances the pressure applied by the fluid behind the diaphragm and its tension determines the amount of pressure which will be required to move the diaphragm and operated the switch. If the fluid pressure results from the heating of the fluid contained in a closed system, the tension of spring 48 likewise determines the temperature at which the switch will be operated. The screw 50 therefore provides means for adjusting the switch for operation at different temperatures as is usual, for example, in refrigerators.

In mounting the spring 10 in the mechanism described above, it is supported primarily on the posts 25. This is a very flexible mounting, however, due to the length and resilience of the side members 11 and 12. It is necessary to further support the spring 10, first, to press it against one set of contacts together and, second, to support it against the pressure of stud 45 for the production of a snap-action. This further support is obtained from screws 52 which press against and have sliding engagement with the spring 10 at the points shown in Fig. 2. They are adjusted to raise the plane of the normal position of the spring above the level of contacts 35 and 36. This causes the cross-bar 28 to press its contacts 29 against contacts 35 and 36 as shown in Fig. 4. In assembling spring 10 in the switch it can be initially located by bending the side members 11 and 12 so that in its normal position the contacts 29 are midway between the two sets of stationary contacts. By turning down the screws 52 the spring 10 is caused to pivot on its supports and as the rear edge is depressed the contacts 29 are raised. Screws 52 are turned down slightly beyond the point where contacts 29 and 35 and 36 are brought together. The switch remains in this position until pressure is applied to the diaphragm.

As stated above, grid segments 18 and 19 are distorted out of the plane of spring 10 and when the spring is assembled this distortion extends toward the direction from which the actuating pressure will be applied, i. e., toward stud 45. When the diaphragm moves toward spring 10, the stud 45 presses on segment 20 and moves it toward its original undistorted position. This puts

segments 18, 19 and 20 under compression and the adjacent sides of spring 10 under tension. When a certain critical point is reached, the spring 10 buckles or snaps into the position of Figs. 1, 3 and 5, throwing contacts 29 down upon contacts 31 and 32. Because the spring 10 is supported by the side members 11 and 12, and has only sliding engagement with the supporting screws 52, its flexing movement is substantially unimpeded.

Attention is called to the fact that the pressure which snaps the spring from the position of Fig. 4 to that of Fig. 5 is applied in a direction tending to move contacts 29 toward contacts 35 and 36, so that there is an increase rather than a decrease of pressure between the contacts until the instant of buckling, when the spring snaps the contacts 29 to the other pair of stationary contacts 31 and 32.

Since pressure on diaphragm 43 may increase beyond the critical snapping point, the rider 44 may go on pushing spring 10 after it has buckled and, unless restrained, may lift it as a unit, separating contacts 29 from 31 and 32. The switch may be adjusted to so operate, if desired, which may sometimes be advantageous. For example, the upper contacts 35, 36 may control a high temperature heater and the lower contacts 31, 32 a low temperature heater. As the temperature rises the heat is switched from high to low and if it continues to rise the contacts open and the heat is shut off entirely. As the temperature falls the low heat is turned on and if it falls further the high heat is turned on.

On the other hand it may be desired to operate the switch only between the upper and lower contacts without any open position. In such a case the upward movement of rider 44 is impeded after it reaches the snapping point by a suitable stop such as the screw 54 which may be adjusted to limit the movement of spring 48 and of rider 44.

Reference was made above to the fact that spring 10 has a single normal position and a secondary or buckled position in which it is under a stress tending to return it automatically to normal position. These two positions would be assumed by the spring in the switch shown except for the fact that the opposite sets of contacts 31, 32 and 35, 36 limit its movement. The upper contacts hold the spring somewhat below its normal position and the lower contacts hold it somewhat above its secondary position. It will be realized that by moving the contacts closer together the movement of the spring on either

side of its critical snapping point can be reduced. This in turn diminishes the distance through which the distorted segments of the spring must be moved to produce the snap-action and so enables the switch to be operated by extremely small actuating movements. By setting the upper and lower contacts to limit the travel of contacts 29 to about $\frac{1}{16}$ of an inch, for example, the actuating movement of stud 45 can be reduced to 0.002 of an inch. This fact is an especial advantage because it makes possible the use of a small diaphragm, which is limited to a small movement, which is inexpensive, compact, rugged and easy to manufacture whereas other devices for similar purposes require mechanism capable of producing much greater movement and are much more costly.

In the switch selected to illustrate the invention the snap-action is produced by holding the spring stationary by screws 52 and pressing segment 20 toward them with stud 45. It is obvious that the same result should be reached by holding stud 45 stationary and pressing down at the points where screws 52 are located, relative movement being all that is required. It is equally apparent that this movement can be applied by any means whatsoever in place of a pressure operated diaphragm.

What is claimed is:

In a device for producing a snap-action in response to applied pressure causing an actuating movement of small magnitude, a spring member formed from a flat sheet and having a generally rectangular body portion from one end of which extends a tongue cooperating with means to be actuated, said spring member being provided on each side of said body portion with side members extending substantially parallel to the sides of said body portion and in the same general direction as said tongue, said body portion being distorted out of the original plane of the spring member to such an extent that the latter has a single normal position and a secondary position in which it is under stress tending to return it to normal position, means for rigidly supporting the ends of said side members, and supporting means having a sliding engagement with the body portion of said spring member at the end opposite the end from which the said tongue extends, and means for causing relative movement between the distorted body portion of said spring member and the rest of the spring member to cause the latter to buckle and assume its secondary position.

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