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H. MILLARD

2,600,564

SNAP ACTION DEVICE

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Fig. 1

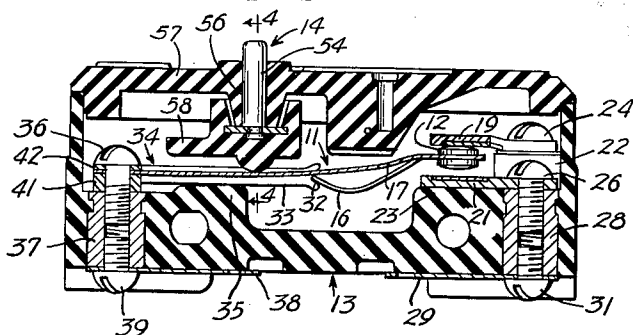


Fig. 2

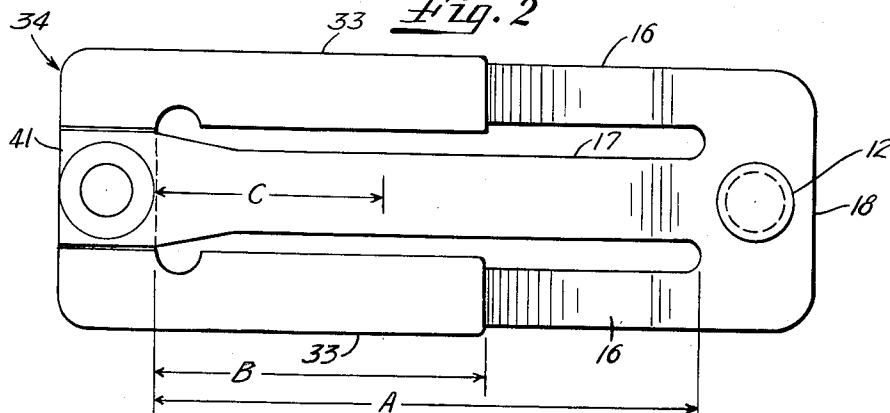


Fig. 3

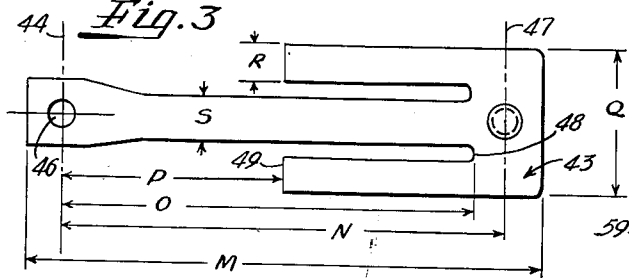


Fig. 4

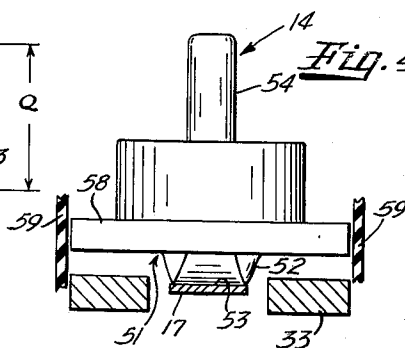
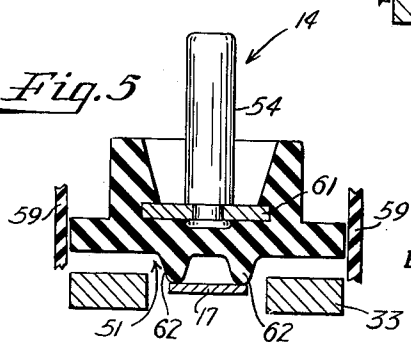


Fig. 5



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SNAP ACTION DEVICE

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1

This invention relates to snap action devices and more particularly to devices having thin leaf overcenter spring systems.

Although prior spring systems of the above character when used on electric switches are commonly operated for several millions of operations with normal current interrupting capacity and give extremely satisfactory service, some applications require a spring construction which has a still greater life expectancy and with a relatively higher current interrupting capacity than has heretofore been available in a switch of this type without increasing the size thereof. Another difficulty encountered under some conditions with certain structures of snap action devices utilizing spring systems of the above character having spaced stressed members and an intermediate interconnected stressed member is that in some instances, when the plunger having a point contact with the intermediate member is actuated, one of the spaced stressed members may pass overcenter before the other. This is particularly true if the point contact is to one side of the longitudinal axis of the intermediate stressed member. As a consequence, faulty operation of the device results in which the free end of the interconnected stressed member engages both stops simultaneously, which in the case of electric switches effects burning or welding of the spring and in turn causing failure of the switch resulting in possible destruction of, or damage to, associated apparatus.

Accordingly, it is an object of this invention to provide an improved snap spring system with a novel arrangement and proportionment of the stressed members forming the snap spring system which effects a switch construction having a relatively high capacity and a relatively long life.

Another object of the invention is to provide an improved plunger construction which assures substantially simultaneous overcenter movement of the spaced stressed members.

Another object of the invention is to provide an improved switch construction which is rugged, which is simple and which is relatively inexpensive to manufacture.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which—

Figure 1 is a longitudinal sectional view of a snap action switch embodying the present invention;

Fig. 2 is an enlarged top view showing a snap

2

action spring and an anchor plate for mounting the same;

Fig. 3 is a plan view of a spring stamping;

Fig. 4 is an enlarged sectional view taken substantially along the line 4-4 of Figure 1; and

Fig. 5 is a modification of the plunger shown in Fig. 4.

Referring now to the drawings, the invention is shown embodied in an electric switch. For purposes of illustration the latter comprises a snap spring system 11, carrying a contact 12 for movement between preselected positions, mounted in a housing 13 of suitable insulating material, and a plunger 14 mounted on the housing to actuate the snap spring system 11.

The snap spring system 11 herein is formed by spaced compression members 16 and an intermediate tension member 17. At one end the compression members 16 and the tension member 17 are interconnected to form an end 18 for supporting the contact 12 and free to move between spaced fixed contacts 19 and 21. The latter are formed herein by spaced metal elements secured to shoulders 22 and 23 respectively at one end of the housing 13 as by screws 24 and 26. The screws are threaded into conducting sleeves, such as sleeve 28 formed in the housing 13 and electrically connected to a terminal 29 on the exterior of the housing. The terminal 29 herein is secured to the sleeve as by a screw 31. Where desired one of the contacts 19 and 21 may be omitted and an insulating member substituted to form a stop for the contact 12. The opposite ends of the compression members 16, in this instance, are pivotally supported in grooves 32 formed at the ends of legs 33 of a U-shaped anchor plate 34 mounted on a shoulder 35 formed in the end of the housing 13 opposite the contacts 19 and 21 as by a screw 36. The latter screw is threaded into a sleeve 37 disposed in the housing 13 and to which is secured a terminal 38 on the exterior of the housing as by a screw 39. The opposite end of the tension member 17 is fixedly mounted in the housing. In this embodiment of the invention a cantilever mounting of the tension member 17 is utilized and is effected by securing the end of the tension member 17 between a cross piece 41 of the anchor plate 34 and a washer 42 held in a tightly assembled relation by the screw 36. As shown in Figure 1 the central portion of the cross piece 41 is offset relative to the plane of the legs 33 to form a recess for the end of the tension member 17 supported thereon.

One phase of the invention is concerned with

locating support means for the compression members 16 relative to the supported end of the tension member 17 and locating the position of the plunger 14 on the tension member 17 so as to provide a switch construction with a relatively high mechanical weld breaking capacity, which primarily determines the rating of the switch, and at the same time having a relatively long life. To this end a snap spring construction is provided which is formed from suitable materials and in which the compressive force acts at a relatively large angle with respect to the tensile force so that a relatively large force is available for separating the normally open switch contacts. This is effected herein by utilizing a spring construction having a relatively long tension member 17, and relatively short compression members 16 and utilizing relatively long legs 33 for supporting the compression members 16. One limit on the length of the legs 33 is the compression members 16, since the latter take a permanent set if they are bent beyond their elastic limit. Another limit on the length of the legs 33 is that spring life expectancy is dependent upon the ratio between the length of the legs 33 to the point of support of the compression members 16 and the length of the tension member 17. For greater weld breaking capacity consistent with long spring life, the ratio between the length of the legs 33 to the length of the tension member 17 has been found to be 3 to 5. The length of the tension member 17 is measured from the point of overhang of the cantilever mounted tension member 17 to the point of interconnection between the compression and tension members 16 and 17 respectively. This is shown as the distance A in Fig. 2. The length of the legs 33 which determines the position of the support of the compression member 16 is measured from the point of overhang of the tension member 17 to the grooves 32. This is shown as the distance B in Fig. 2.

Preferably the plunger 14 is located at a position which is approximately two-thirds of the distance from the point of overhang of the tension member 17 to the support of the compression member 16 or the distance C shown in Fig. 2. In other words, the ratio of the distance of the plunger 14 from the mounting of the tension member 17 to the length of the anchor leg 33 (designated by B on Fig. 2) should be 2 to 3 for optimum operation. The upper limit for the ratio is rather sharply defined as 3 to 4. Thus, if the plunger position is changed in the direction toward the free ends of the legs 33 it has been found that in operating the switch there is a tendency for sizzling and dead-break at the contacts 19 and 21 respectively. Furthermore this location of the plunger 14 provides a switch construction in which there is a low movement differential which is desirable. The lower limit of this ratio is not clearly defined but appears to be about 3 to 5. When the plunger 14 location is near the mounted end of the tension member 17 undesirable large forces are encountered in switch actuation and the stress at the point of overhang of the tension member 17 which is already the weak point of the snap spring system is increased. As the plunger 14 location approaches the mounted end of the tension member 17 the characteristics change from operation to operation and eventually reach a point where the snap spring system 11 fails to operate.

A specific example of a switch structure embodying the invention, comprises a stamping 43 (see Fig. 3) of beryllium copper, measuring .0065

inch to .0075 inch in thickness. The formed stamping is heat treated in the usual manner to have a tensile strength of 185,000 to 195,000 pounds per square inch and a Rockwell hardness of 79 to 81 on the 15N scale. The overall length, M, of the stamping 43, as shown, is $1\frac{1}{2}$ inches. Using a centerline 44 of a mounting hole 46, .0995 inch, plus .003 inch, minus .000 inch in diameter and having its axis spaced $\frac{3}{8}$ inch in from the end of the tension member 17, the respective parts of the stamping have the following dimensions measured in the plane of the stamping before assembly: the distance, N, between the centerline 44 and a centerline 47 of the opening for the contact 12 is 1.297 inches, plus or minus .003 inch; the distance, O, between the centerline 44 and the interconnection 48 of the tension member 17 and compression members 16 is $1\frac{1}{8}$ inches; the distance, P, between the extreme free ends 49 of the compression members 16 and the centerline 44 is .710 inch, plus .000 inch, minus .002 inch; the overall width, Q, of the stamping is .500 inch, plus or minus .0025 inch; the width, R, of the compression members 16 is .109 inch, plus or minus .003 inch; the width, S, of the central portion of the tension member 17 is .156 inch, plus or minus .003 inch; and the width of the end portion in which the mounting hole 46 is formed is .218 inch, plus or minus .002 inch.

The anchor plate 34 to be used with a spring stamping of the dimensions specified above is formed as a metal stamping from brass material measuring .064 inch in thickness, plus or minus .002 inch. The free ends of the legs 33 are grooved to form recesses as herein described for the squared ends of the compression members 16. In its finished form the length of the legs 33 measured from the mounting hole (through which the screw 36 extends) .101 inch in diameter, plus or minus .0015 inch, spaced inwardly from the side of the member 41 .093 inch, plus or minus .001 inch, to the bottom of the grooves is .740 inch, plus or minus .022 inch. The overall width of the anchor plate is .550 inch, plus or minus .003 inch. The width dimension of the anchor 34 at the grooves may be slightly larger due to displacement of material in forming the grooves. It is to be understood that the specific dimensions set forth are not limiting values and are applicable only to the specific embodiment shown herein.

Another phase of the invention is directed to a plunger 14 construction that effects substantially simultaneous overcenter movement of both spaced stressed members 16. For this purpose the plunger is formed with a head 51 (see Figs. 4 and 5) having a projection 52 with a surface 53 shaped to engage the tension member 17 along a line substantially perpendicular to the longitudinal axis of the tension member 17. The plunger 14 is positioned and guided in its axial movement by an elongated portion 54 projecting through a snug fitting guideway 56 formed in a cover 57 on the housing 13. To insure that the contact surface 53 of the plunger 14 does not rotate relative to the tension member 17, the plunger 14 is formed with an intermediate skirt portion 58 integral with the head 51 which is shaped to fit between the walls 59 of the housing 13 to prevent rotation of the plunger 14. In the present instance the plunger is formed as a single unit in which the elongated portion 54 is secured to a washer 61 which in turn is secured to the head portion 51. In Fig. 5 there is shown another construction of the plunger 14. As shown the head 51 of the

5

plunger 14 is formed with two projections 62 in spaced relation and shaped to engage the tension member 17 at positions spaced adjacent each edge of the latter member. It is to be understood that either of the above constructions prevent turning movement of the tension member 17 about its longitudinal axis as it is moved through the axis of maximum stress when the spring system is actuated. Either of these constructions assures a snap spring construction in which both sides of the snap spring system act concurrently.

I claim:

1. In a snap action device, the combination of a support, a snap spring comprising spaced compression members and an intermediate tension member, said spaced compression members and said tension member being interconnected at one end to form an end free to move between opposed positions, means for mounting the opposite end of said tension member, an anchor plate including spaced legs adjacent opposite sides of the mounted end of the tension member for mounting the opposite ends of said compression members, said tension and compression members in the mounted position being stressed to form a snap spring system having an axis of maximum stress and a plunger mounted on said support and having spaced projections for engaging said tension member at spaced positions on a line extending transversely of said tension member, said plunger being shaped to move said tension member without rotation thereof about a longitudinal axis, through the axis of maximum stress whereby to move said free end between the opposed positions with a snap action.

2. In a snap action device, the combination of a support, a snap spring comprising spaced compression members and an intermediate tension member, said spaced compression members and said tension member being interconnected at one end to form an end free to move between opposed positions, means for mounting the opposite end of said tension member, an anchor plate including spaced legs adjacent opposite sides of the mounted end of the tension member for mounting the opposite ends of said compression members, said tension and compression members in the mounted position being stressed to form a snap spring system having an axis of maximum stress, a plunger mounted on said support for engaging said tension member with a line contact, said line contact extending transversely of said tension member and substantially perpendicular to the longitudinal axis thereof, said plunger being operable to move said tension member through the axis of maximum stress whereby to move said free end between the opposed positions with a snap action and means for preventing rotation of the plunger.

3. In a snap action device, the combination of a support, a tension member mounted on said support and having a free end movable between preselected positions, an anchor mounted on said support, a compression member having one end supported on said anchor and the opposite end interconnected with the free end of the tension member, said tension member and said compression member forming a snap spring system having an axis of maximum stress, the distance between said supported end of the compression member and the mounted portion of the tension member as compared to the length of said tension member being in substantially the ratio of 3 to

6

5, and means engaging said tension member for moving it through the axis of maximum stress to move said free end of the tension member between the preselected positions with a snap action.

4. In a snap action device, the combination of an overcenter snap spring formed by a compression member and a tension member, said compression member and said tension member being interconnected at one end to form an end free to move between the opposed stops, means for mounting the opposite end of said tension member, and means for mounting the opposite end of said compression member, the distance to the point of support of the compression member measured from the mounting means of said tension member and the length of said tension member being in the ratio of approximately 3 to 5.

5. In a snap action device, the combination of a support, a tension member having one of its ends mounted on said support and having its other end free to move between opposed positions, a compression member having one end interconnected with the free end of the tension member and the opposite end in spaced relation with said mounted end of the tension member, means for supporting said opposite end of the compression member, the distance from said latter support means for the opposite end of said compression member to the mounted end of the tension member and the length of the tension member from the same point on the mounted end of the tension member to the point of interconnection with the compression member being in the ratio of 3 to 5, said tension member and said compression member forming an overcenter snap spring system, and means engageable with said tension member for moving said spring system overcenter whereby said free end moves between said preselected positions with a snap action.

6. In a snap action device, the combination of a base, spaced stops mounted thereon, an overcenter snap spring having an axis of maximum stress and formed by spaced compression members and an intermediate tension member, said spaced compression members and said tension member being interconnected at one end to form an end free to move between the opposed stops with a snap action, means for mounting the opposite end of said tension member, an anchor plate including spaced legs adjacent opposite sides of the mounted end of the tension member for mounting the opposite ends of said compression members, the distance on said legs to the point of support of the compression members measured from the mounting means of said tension member and the length of said tension member being in the ratio of approximately 3 to 5, and means engageable with said tension member for moving it through the axis of maximum stress whereby to move said free end between the stops.

7. In a snap action device, the combination of a snap spring system having an axis of maximum stress comprising a tension member having a supported end and an end free to move between preselected positions, and a compression member having one end interconnected with said free end of the tension member and having an opposite end in spaced relation with the supported end of the tension member, means for supporting said opposite end of the compression member, said supporting means being located at a position substantially three-fifths of the distance between the supported end of the tension member and

7

the interconnection between the tension member and the compression member from the supported end of the tension member, and means engaging said tension member at a position substantially two-thirds of the distance from the supported end of the tension member to the supporting means for said compression member from the supported end for moving the tension member through the axis of maximum stress whereby to move said free end between opposed positions with a snap action.

8. In a snap action device, the combination of a snap spring system having an axis of maximum stress comprising a tension member having a supported end and an end free to move between preselected positions with a snap action when the tension member moves through the axis of maximum stress, and spaced compression members having one end interconnected with said free end of the tension member and having their opposite ends in spaced relation with the supported end of the tension member, means for supporting said opposite ends of the compression members, said supporting means being located at a position substantially three-fifths of the distance between the supported end of the tension member and the interconnection between the tension member and the compression members from the supported end of the tension member, and means engaging said tension member at a position substantially two-thirds of the distance from the supported end of the tension member to the supporting means for said compression member from the supported end and shaped to engage said tension member whereby to prevent rotation of said tension member about its longitudinal axis as the latter moves through the axis of maximum stress.

9. In a snap acting device, the combination of a snap spring system comprising spaced first stressed members and a second stressed member, said spaced stressed members and said second stressed member being interconnected at one end to form an end free to move between opposed positions, means for mounting the opposite end of said second stressed member, an anchor plate comprising spaced legs adjacent opposite sides of the mounted end of the second stressed member for supporting the opposite ends of said spaced stressed members, said point of support for the spaced stressed members being located substantially three-fifths of the distance between the mounted end of the second stressed member and the interconnection between the second stressed member and the spaced stressed members from the mounted end of said second stressed member, said stressed members in the mounted position being stressed to form a snap spring system having an axis of maximum stress, and a plunger having a portion engaging one side of said second stressed member with line contact along a line extending transversely of said second stressed member substantially two-thirds of the distance from the mounted end of the second stressed member to the point of support for said spaced stressed members from the mounted end of said second stressed members, said portion positioned to ex-

8

tend substantially perpendicular to the longitudinal axis thereof, said plunger being operable to move said second stressed member through the axis of maximum stress whereby said free end moves between opposed positions with a snap action.

10. In a snap action device, the combination of a support, a snap spring comprising spaced compression members and an intermediate tension member arranged in edgewise spaced relationship, said spaced compression members and said tension member being interconnected at one end to form an end free to move between opposed positions, means for mounting the opposite end of said tension member, an anchor plate secured adjacent the mounted end of the tension member including spaced legs extending longitudinally of and in edgewise spaced relation to opposite sides of the tension member for mounting the opposite ends of said compression members, said tension and compression members in the mounted position being stressed to form a snap spring system having an axis of maximum stress and a plunger mounted on said support having a portion shaped for reception between said spaced legs, the end of said portion having a shape to engage the tension member along a line extending transversely thereof to move the tension member through the axis of maximum stress without rotation thereof about a longitudinal axis upon movement of the tension member by the plunger and to resist rotation of the tension member about a longitudinal axis upon return movement of the tension member.

11. In a snap action device, the combination of a leaf spring comprising tension and compression members joined at an end free to move, a support for mounting the other end of the tension member, and means for pivotally mounting the other end of the compression member to stress the compression member in bowed compression, the distance between the mounting for the compression member and the support for the tension member being to the length of the tension member from its support substantially in the ratio of 3 to 5.

12. The combination recited in claim 11, further characterized by a plunger positioned to engage the tension member at substantially two-thirds of the distance from its support to the mounting for the compression member for moving the tension member through an axis of maximum stress with the compression member.

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