May 22, 1934. P. K. McGALL 1,960,020

SNAP SWITCH

Filed March 29, 1933 2 Sheets-Sheet 1

Fig. 1.

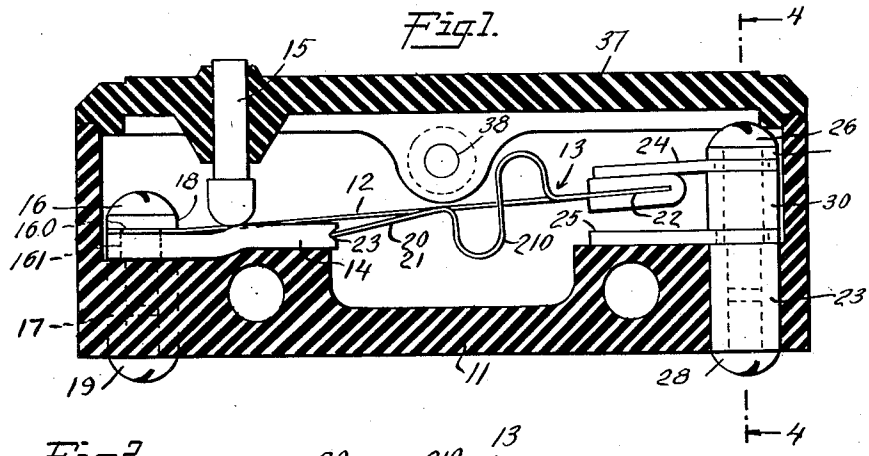


Fig. 2.

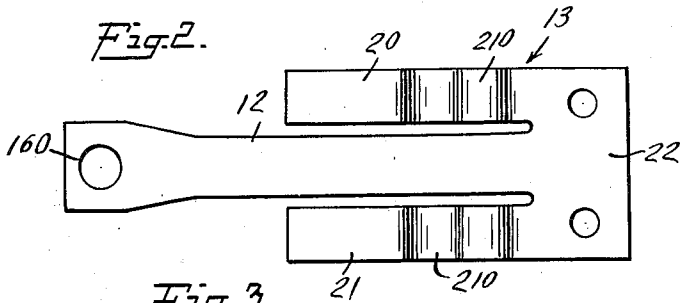


Fig. 3.

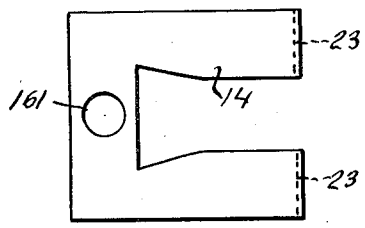


Fig. 4.

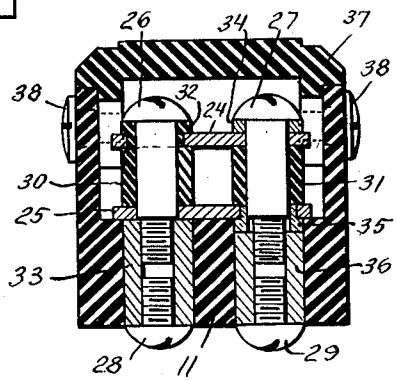


Fig. 5.

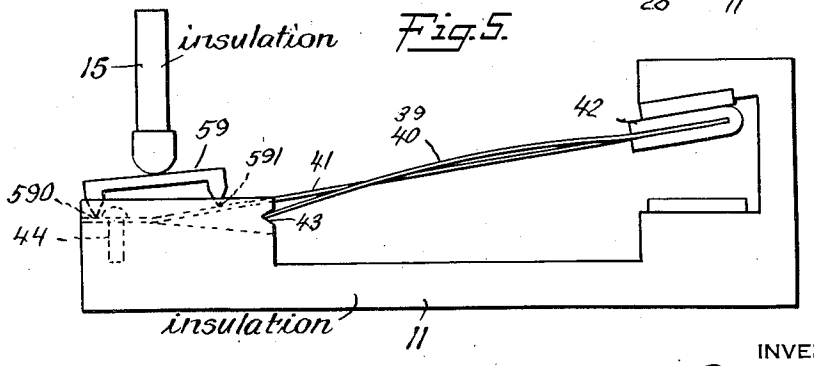


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Fig. 6.

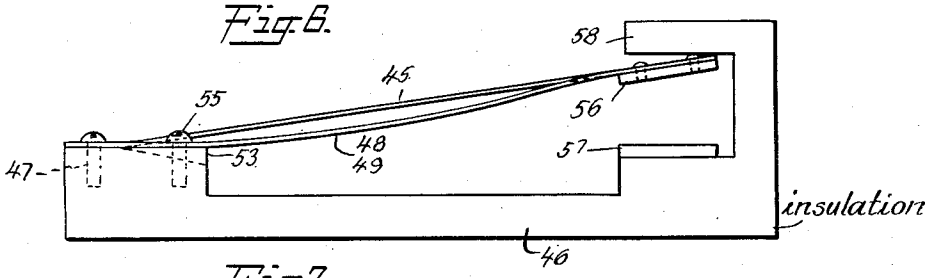



Fig. 7.

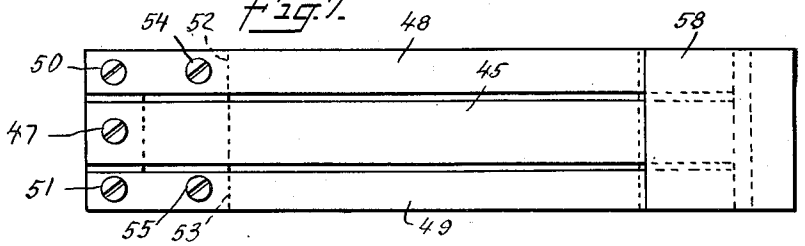



Fig. 8.

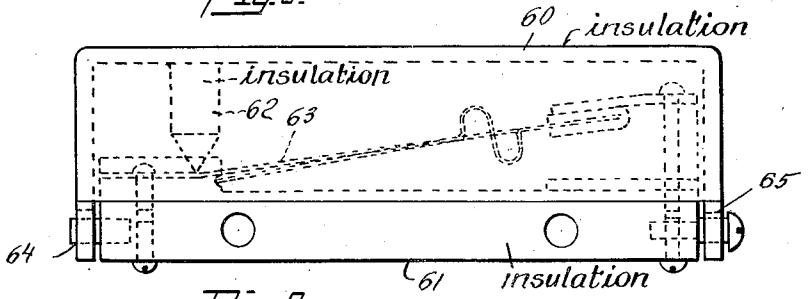



Fig. 9.

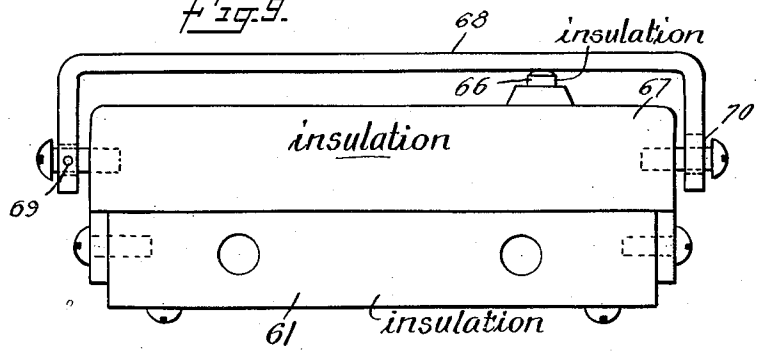



Fig. 10.

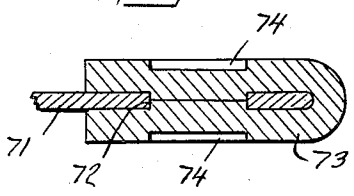
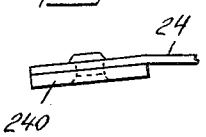



Fig. 11.

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# UNITED STATES PATENT OFFICE

1,960,020

## SNAP SWITCH

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Application March 29, 1933, Serial No. 663,280

18 Claims. (Cl. 200—67)

This invention relates to improvements in snap switches formed of thin leaf springs.

It is an object of this invention to provide a snap switch of improved construction and operating characteristics.

The following description is to be read in conjunction with the accompanying drawings, in which

Fig. 1 shows a cross sectional elevation of one form of complete snap switch;

Fig. 2 is a plan view of the contact arm;

Fig. 3 is a plan view of a shim used in the snap switch of Fig. 1;

Fig. 4 is a cross sectional elevation on line 4—4 of Fig. 1;

Fig. 5 is a side elevation of another form of the invention;

Fig. 6 is a side elevation of another form of the invention;

Fig. 7 is a plan view of the switch shown in Fig. 6;

Fig. 8 is a side elevation showing a cover type plunger;

Fig. 9 shows a bridge for operating the plunger in a completely assembled snap switch;

Fig. 10 is a detail view showing the construction of a metal contact head; and

Fig. 11 is a detailed view of a stationary contact.

My improved snap switch consists essentially of a contact arm operatively mounted so that its free end moves between two stops. The contact arm comprises a thin leaf spring operatively supported at one end in cantilever fashion, the other end being free to move, in combination with adjacent parallel compressed spring means attached to the free end of the thin leaf spring. The other end of the compressed spring means is pivoted at a point adjacent said leaf spring and the parts are so arranged that the free end of the leaf spring will move with a snap action when pressure is applied to it adjacent its supported end. The free end which is free to move between two stops spaced apart a short distance, normally is in contact with one of the stops and snaps into contact with the other stop upon application of pressure to a portion of the opposite end. When the pressure is relieved the free end of the leaf spring snaps back into its normal position. One or both stops may be of metal so as to provide electrical connection when contact is made with the free end of the leaf spring. A number of specific embodiments of the structure described above are described hereinafter, the invention not being confined, however, to such specific structures.

In Figs. 1 to 4 a preferred type of structure is shown. The base 11 may be formed of wood, hard rubber, bakelite or similar insulating material, and it supports the thin leaf spring 12 of the contact arm 13 in cantilever fashion. A thick shim or spacer 14, preferably of metal, is inserted between the spring 12 and the base 11 to allow room for the vertical movement of the spring 12. The spring may be operated by a plunger 15. The thin leaf spring is anchored to the base by means of a bolt 16 passing through a hole 160 in the leaf spring and a hole 161 in spacer 14. The bolt is threaded in a metallic sleeve insert 17. A shim 18 may be inserted between the head of bolt 16 and spring 12. A bolt 19 is threaded in the lower end of sleeve 17 and thus allows a metallic conductor to be inserted between its head and the sleeve to establish electrical connection with the contact arm. The leaf spring 12 preferably is a thin beryllium copper strip or ribbon, having its free end attached rigidly to two parallel adjacent spring strips 20 and 21, as by means of the U-shaped stirrup 22. The free ends of spring strips 20 and 21 are pivoted at a point intermediate the ends of the leaf spring and also in or near the same horizontal plane, preferably in notches 23 cut in the ends of the two legs of spacer 14. The spring strips 20 and 21 may be provided with double U or S portions 210 which make for better operation of the device. They compensate for substantially all of the normal forces to thereby give a resultant compressional force which is substantially longitudinal. The parallel adjacent spring strips 20 and 21 are in longitudinal compression, thereby putting the leaf spring 12 in tension. Leaf spring 12 and spring strips 20 and 21 may be formed from one sheet or strip of spring material, the free ends being thereby held together firmly, and the U-shaped metallic contact strip 22 is preferably clipped over the end thereof. This contact strip is arranged between adjacent, stationary contact stops 24 and 25. Strip 22 and stops 24 and 25 are, preferably made of silver or other metal, which minimizes the damage resulting from arcing during the making and breaking of an electrical circuit. The leaf spring 12 also may be made of phosphor bronze or other suitable metal. Upper and lower contacts or stops 24 and 25 are mounted a short distance apart on base 11 and are retained in position by bolts 26 and 27 (see Fig. 4). Both stops 24 and 25, or either of them, may be used to complete an electric circuit or

circuits from bolt 19 through contact arm 13, and through bolts 26 and 27 to the conductor terminal bolts 28 and 29 carried by the base. If it is desirable to control two circuits through stops 24 and 25 then the construction shown in Fig. 4 may be used. Stops 24 and 25 are spaced apart by insulating sleeves 30 and 31. Bolt 26 is further insulated from stop 24 by means of insulating bushing 32. Bolt 26 is threaded into a sleeve 33 in the base 11, and when the bolt is screwed down stop 25 is in direct electrical pressure contact with the metallic sleeve 33. A bolt 28 threads upwardly into metallic sleeve 33. An electrical conductor may be held between the head of bolt 28 and sleeve 33 and thus electrically connected to stop 25.

Bolt 27 makes electrical contact with stop 24 by means of a metallic bushing 34 which is inserted between the head of the bolt and upper stop 24. An insulating bushing 35 surrounds bolt 27 and insulates it from lower stop 25. Bolt 27 threads into a metallic sleeve 36 carried by the base 11. A bolt 29 may be threaded into the other end of sleeve 36. Electrical contact is thus established between stop 24 and an electrical conductor held between the head of bolt 29 and sleeve 30. If only lower stop 25 is to be used in the electric circuit then the upper stop 24 may be made of insulating material to thereby maintain the circuit open when the contact arm 13 is in contact therewith or the construction used in connection with bolt 26 may be used for bolt 27. Likewise, if only contact 24 is to be used for electrical contact purposes both bolts may be used with the construction shown with bolt 27. One or both contacts may be used in electrical circuits controlled by the switch.

The bottom contact 25 is placed above the neutral or dead-center position of the snap switch in the type shown in Fig. 1. The switch thus returns to its normal position shown when the actuating pressure on leaf spring 12 is removed. The upper stop 24 limits the upward movement of the contact 22 so that it contacts therewith when the switch is in its normal position. In Fig. 1 the leaf spring 12 as shown is flexed from a straight horizontal unstressed position into an upwardly bent position, the strain therein tending to force the contact arm downward toward contact 25. However, this force is overbalanced by the longitudinal compression in spring strips 20 and 21 combined with their shorter effective radius as compared to the longer effective radius of leaf spring 12. The contact 22 therefore is forced upwardly against contact 24 where it normally remains. When an actuating force is applied to leaf spring 12 by plunger 15, leaf spring 12 is depressed adjacent the point of application of the actuating force until contact 22 suddenly moves downward with a snap to contact 25 where it remains until the actuating force is relieved sufficiently, whereupon contact 22 again snaps back to stop 24. It is probable that the depression of leaf spring 12 by the actuating force and the accompanying shifting of the position of the balance of the free end of the switch results in the neutral or dead-center line of the device passing from a substantially horizontal position below contact 25 to a position where it passes above the contact 22 in its normal position at stop 24, whereupon the contact arm snaps downward. As the pressure on leaf spring 12 is relieved the neutral or dead-center line drops rapidly again and after it passes through the position of the contact 22 while at stop 25 the contact arm again snaps upward against stop 24. The snap action of the device is aided by the accelerated drooping-curve characteristice of the force tending to hold up the contact 22 as it leaves the top stop 24, that is, the force tending to hold it up decreases at an increasingly rapid rate whereas the force built up by the flexure of the spring 12 to operate the switch decreases with a straight line characteristic at a much slower rate as the contact arm travels from stop 24 to stop 25. There is thus an increasing force tending to force the contact arm down equal to the difference at any position of the said operating and the opposing forces. A commercial device incorporating the snap switch construction described is enclosed by a cover 37 held in place by bolts 38.

Since the leaf spring 12 is subject to excessive repeated stress in front of the anchoring device it is desirable to decrease the unit stress so that the spring will not fail more readily at this point. This may be accomplished by widening the leaf spring as shown (see Fig. 2) ahead of the anchorage point where it is subjected to bending, so as to produce a spring of equal strength for a short distance ahead of the anchorage point.

Many variations of the construction shown in Fig. 1 are possible though all are based on the same or similar principles of operation. In Fig. 5 a simple type of construction is shown which in principle is similar to that of Fig. 1. In this form, however, the spring strips 39 and 40 adjacent leaf spring 41 do not contain an S-shaped section. The spring strips are put in longitudinal compression by bowing them slightly upward between the free contact end 42 and the pivot point 43. The snap switch made in accordance with Fig. 5 operates similarly to that of Fig. 1. However, the position of the pivot point 43 with reference to the position of the anchorage 44 of the leaf spring 41 must be held to very close limits in order to produce switches with anything near the same characteristics. This is not a desirable feature for mass production. The support for leaf spring 41 is cut down forwardly to allow it to deflect downwardly when the actuating force is applied.

A bridge 59 may be used to reduce the plunger travel required to operate the snap switch. The bridge is pivoted back of the anchorage point of the leaf spring center section as at 590, and bears on it at the normal operating point 591. The actuating plunger pressure may be applied at any point on top of the bridge. With this device any plunger travel required may be made to operate the switch, the plunger travel varying inversely with the pressure required.

Although the preferred form of Fig. 1 shows the use of an S shaped portion in the spring strips, it is possible to vary the number of loops in the spring strips from a single U-shaped loop to a combination of several S or U shaped sections. Laminated spring material also may be used.

The pressure required to operate the switch may be reduced or increased somewhat with a corresponding increase or decrease respectively in plunger motion by changing the gauge of the leaf spring material, by changing the width of the leaf spring, by changing the position of the actuating force or by drilling small holes or otherwise cutting out sections of the leaf spring at various positions.

The tendency of the contact arm to return to the normal position when the actuating pressure is relieved can be changed by raising the relative position of the bottom stop to thereby increase

this tendency and lowering it to decrease this tendency. This tendency of the contact arm to return to the normal position can also be increased or decreased by putting a permanent set in the center section of the leaf spring to give it an initial positive or negative stress.

If the bottom stop is lowered to below the normal dead-center position of the leaf spring and pressure is applied the contact arm travels past the dead center and does not return to its position against the top stop without outside aid, when the pressure is removed from the leaf spring. This method of operation has a limited use.

The pressure which must be applied and the distance through which it is necessary to operate the pressure against the leaf spring in order to actuate the switch is dependent upon the point where the pressure is applied. The farther from the point of support that the pressure is applied the smaller is the pressure and the greater is the distance through which it must be applied. If the pressure is applied too close to the free end the contact arm does not move wtih a snap action.

It is obvious that the positions of the leaf spring and the spring strips may be interchanged, that is, the contact arm may comprise two outside leaf springs and the spring strip may be the single center element. The number of leaf springs and spring strips may be increased in number over those shown.

The spring strips need not necessarily be pivoted freely as shown but may be pivoted by a hinge or other joint action. The end of the spring strip may be anchored to form a modified pivot though the action is freer if it is pivoted. The leaf spring may be hinged at its point of support.

The spring strips may have the pivot means beyond the point of support of the leaf spring. The operation of this particular variation is somewhat different than that of Figs. 1 or 5. It is apparent that the spring strips and leaf spring must be so positioned and dimensioned that their free ends do not travel in substantially the same arc should they be unrestrained by the contact clip 22.

In another variation shown in Figs. 6 and 7, leaf spring is 45 mounted upon base 46 in cantilever fashion at support 47 by the bolt as shown, the base sloping downwardly forward of the support as shown. The spring strips 48 and 49 are mounted adjacent leaf spring 45 as shown. Base 46 is extended forwardly to form a longer support for spring strips 48 and 49 than for leaf spring 45. Screws 50 and 51 or other fastening means may be used to anchor spring strips 48 and 49. The operation is improved somewhat if these strips also are anchored near forward edges 52 and 53 of the base, as by screws 54 and 55. The forward edges of the base support at 52 and 53 form the pivot points for spring strips 48 and 49 respectively though the action is not a free hinge action. The free ends of leaf spring 45 and spring strips 48 and 49 are rigidly fastened together preferably by a suitable contact metal 56, such as silver. The spring strips are bowed downward as shown. This bow may be made by flexing the metal to thereby keep it in strained condition or it may be formed by bending the metal permanently. When sufficient pressure is applied to the leaf spring 45 the contact arm snaps downward and contact 56 moves from the normal position in engagement with upper stop 58 into contact with lower stop 57. Upon relieving the pressure the contact arm snaps back into its normal position. The upper stop 58 also may be made a metallic contact.

If the spring strips are anchored as by screws at 54 and 55, the action is a modification of the action of that of Figs. 1 and 5 in that the contact arm, even if it passes through the dead-center position, snaps back against the top stop when the pressure is relieved. This action results from the anchoring of the spring strips 48 and 49 at 54 and 55 thereby producing a limited pivoting action at 52 and 53. When the contact arm is depressed the spring strips 48 and 49 are increasingly bent and stressed at the pivot points 52 and 53 and the force tending to return the contact arm to the upper position is increased, being greater than the force tending to depress the contact arm after passing through dead center. If the screws 54 and 55 are removed the spring strips 48 and 49 pivot more freely at 52 and 53 since the strips may flex back of these pivot points. As a result the contact arm does not return to the upper stop if it passes through the dead center position. The lower stop 57 must therefore be raised above the dead center position if the contact arm is to return to the upper stop when the pressure is relieved.

In Fig. 8 a cover design is shown which eliminates the plunger 15 of Fig. 1, the switch being actuated by applying pressure on the cover. The insulating cover 60 fits over the snap switch mechanism mounted on base 61. The interior of the cover 60 is provided with a projection 62 which contacts with the leaf spring 63 of the snap switch. When pressure is applied to the cover 60 as shown the switch is actuated. The cover is hinged at 64 and a limit stop 65 is arranged at the other end to prevent overstressing of the spring. The amount of pressure and travel necessary to operate the switch may be regulated by varying the position at which pressure is applied to the cover 60.

In another construction shown in Fig. 9, the completely assembled snap switch is actuated by plunger 66 which passes through a cover 67. The actuating force is applied to the plunger by means of a bridge 63 straddling the cover 67. Bridge 68 is pivoted at 69 at one end of the cover and is held at the other end 70 so that it is free to move a small distance. The actuating force is applied to the surface of bridge 68 which in turn transmits it to actuating plunger 66.

Fig. 10 shows the method used for attaching the silver contact terminals to the free ends of the leaf spring and spring strips. The spring material 71 is punched with a suitable hole 72 and the silver sheet 73 is doubled over the spring material as shown. The silver is then punched inwardly at the hole 72 to thereby force the silver into the hole 72, depressions 74 thereby being formed in the surface by the punch. This construction makes a durable contact for the contact arm.

Where the actuating plunger is actuated very slowly as by thermostatic action the first separation of contact 22 from upper contact 24 may be slow because of the accelerated drooping curve characteristic of the forces acting thereon. This may cause some arcing if the upper contact 24 is in the electric circuit. This arcing may be overcome by the construction shown in Fig. 11. Upper contact member 24 may be formed of a thin leaf spring with a silver contact 240 mounted thereon, and adapted to be engaged by con-

tact 22. The upward pressure of the contact 22 in its normal position flexes this spring material upward. As the leaf spring 12 is actuated by plunger 15 and contact 22 begins to move slowly downward the spring contact 24 follows and remains in electrical contact therewith for a short period of time until the more active forces of the accelerated drooping curve characteristic come into play and the contact 22 moves with increasing downward speed to thereby make a quick break away from the upper contact 24. The lower contact may also be constructed in this manner. This construction also provides an improvement in the seating of the movable contact when it is against either the upper or lower contact. The spring mounting provides a construction by means of which the stationary contact has a tendency to conform to the shape and position of the movable contact. It also provides a slight wiping action which improves the performance of the contacts.

I claim:

1. A snap switch comprising a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, parallel adjacent spring strips in longitudinal compression connected to the free end of said spring and pivoted at their opposite ends at a point between the supported and free ends of said leaf spring, said spring strips having S-shaped portions therein, a pair of contacts spaced a short distance apart and arranged adjacent the free ends of said springs, said pivot point of said spring strip being in fixed relation with respect to said contacts, the free ends of said springs being normally in contact with one of said contacts, the arrangement of said elements being such that when sufficient pressure is applied to a portion of said leaf spring adjacent its supported end said free end will move from the contact with which it normally is in contact to the second contact with a snap action and will return to said first contact when said pressure is withdrawn, and means for acting on a portion of said leaf spring to cause the free end thereof to move out of its normal position with a snap action.

2. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof and having the other end free to move, a pair of stops between which said free ends move, a pair of parallel adjacent spring strips connected to the free end of said spring, said spring strips being in longitudinal compression and having S-shaped portions therein, said spring strips being pivoted at their opposite ends at a point between the supported and free ends of said leaf spring, said pivot point of said spring strip being in fixed relation to said stops, and means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap action.

3. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, a pair of parallel adjacent spring strips connected to the free end of said spring, said spring strips being bowed in longitudinal compression and being pivoted at their opposite ends at a point between the supported and free ends of said leaf spring, a pair of stops arranged on one side of the dead center of said spring assembly, and means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap action.

4. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, a pair of parallel adjacent spring strips connected to the free end of said spring, said spring strips being in longitudinal compression and being pivoted at their opposite ends at a point between the supported and free ends of said leaf spring, an electrical contact associated with said free end of said spring in fixed relation with respect to said pivot point of said spring strip, and means for acting on a portion of said leaf spring to cause the free end thereof to move out of engagement with said contact with a snap action.

5. In an apparatus of the character described the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, a pair of stops between which said free ends move, a pair of parallel adjacent springs connected to the free end of said leaf spring, said springs being in longitudinal compression and being pivoted at their opposite ends at a point between the supported and free ends of said leaf spring, said pivot point of said spring strip being in fixed relation with respect to said stops, and means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap action.

6. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof, parallel adjacent springs of shorter effective length, mounted parallel and adjacent said leaf spring, the free end of said leaf spring being connected with the ends of said adjacent springs a pair of stops between which said free ends move, the opposite ends of said springs being pivoted at a point adjacent said first spring whereby said shorter springs are in longitudinal compression said pivot points of said springs being in fixed relation with respect to said stops.

7. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof, parallel adjacent spring means in longitudinal compression connected at one end thereof with the free end of said leaf spring, the free ends of said leaf spring being free to move said adjacent spring means, said adjacent spring means being pivoted at the opposite end whereby said leaf spring moves with a snap action when pressure is applied to a portion thereof adjacent its supported end, and a pair of stops between which said free ends move, said stops being in fixed relation with respect to the pivot points of said springs.

8. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof, parallel adjacent compressed spring means pivoted at a point between the ends of said leaf spring and operatively connected with it at its free end, the free end of said leaf spring being free to move said adjacent spring means, a pair of stops between which the free end of said springs move, the pivot point of said springs being in fixed relation with respect to said stops.

9. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, parallel and adjacent spring means connected to the free end of said leaf spring, said spring means being in longitudinal compression and being pivoted at a point between the supported and free ends of said

leaf spring, means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap action, and a pair of stops arranged on one side of the dead center of said spring assembly.

10. In a snap switch of the character described, a thin leaf spring operatively supported at one end thereof and having the other end free to move, a pair of stops between which the free end of said leaf spring is arranged, the point of support of said leaf spring being in fixed relation with respect to said stops, parallel adjacent spring strips connected to the free end of said leaf spring, said spring means being in longitudinal compression and having its opposite end so held as to provide a shorter radius of action than that of said leaf spring to thereby cause said connected free end of said spring to move with a snap when pressure is applied on said leaf spring at a point removed from said free end.

11. In an apparatus of the character described, the combination of a thin leaf spring operatively supported in cantilever fashion at one end thereof with the other end free to move, a pair of stops between which the free end of said leaf spring moves, parallel adjacent spring means in longitudinal compression and connected at one end with the free end of said leaf spring, said spring means being pivoted at the opposite end in fixed relation with respect to said stops to provide a different radius of action than that of said leaf spring to thereby cause said connected free end of said springs to move with a snap when pressure is applied on said leaf spring at a point removed from said free end.

12. In an apparatus of the character described, the combination of a thin leaf spring operatively supported at one end thereof with the other end free to move, a pair of stops between which the free end of said leaf spring moves, said point of support of said leaf spring being in fixed relation with respect to said stops, adjacent parallel spring strips connected to the free end of said leaf spring, said spring strips being bowed in longitudinal compression sufficiently to cause said leaf spring to be held normally in a buckled position, and means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap.

13. In an apparatus of the character described, the combination of a thin leaf spring operatively supported at one end thereof and having the other end free to move, a pair of stops between which the free end of said leaf spring moves, parallel adjacent spring strips connected to the free end of said leaf spring, said spring strips having S-shaped portions therein in longitudinal compression and having their opposite ends pivotally supported at a point adjacent said leaf spring in fixed relation with respect to said stops, and means for acting on a portion of said leaf spring to cause the free end thereof to move with a snap.

14. In an apparatus of the character described, parallel adjacent spring means connected together and free to move at one end and operatively mounted at their other ends at such points that the radii of action of said spring means are unequal, stops between which the free ends of said spring means move, one of said spring means being in tension and the other in compression whereby when sufficient pressure is applied to the end of the tension spring means removed from the free end, the free end moves with a snap action, the mounting of the ends of said spring means being in fixed relation with respect to said stops.

15. In an apparatus of the character described, parallel adjacent spring means operatively mounted at one end at such points as to provide unequal radii of action and connected together and free to move at their other ends, a pair of spaced stops in fixed relation to the points where said spring means are operatively mounted and between which said connected free ends are free to move, said stops being arranged in that portion of the arc of movement which normally is without the dead center of movement of said spring means.

16. In an apparatus of the character described, parallel adjacent leaf spring means operatively mounted at different points at one end and free to move and connected together at their other end, one of said spring means being in longitudinal compression, two stops between which said free end moves, said point at which said leaf spring means are operatively mounted being in fixed relation with respect to said stops, said free end normally being in contact with the stop farthest removed from the dead-center line of said spring means, said spring means being so mounted that when pressure is applied to operate said device the dead-center line is shifted through the stop with which said free end normally contacts.

17. In an apparatus of the character described, parallel adjacent spring means operatively mounted at one end at such points as to provide unequal radii of action, and connected together and free to move at their other ends, and two stops arranged a relatively small distance apart between which the free ends are free to move, said point at which said leaf spring means are operatively mounted being in fixed relation with respect to said stops, the force tending to hold said connected free ends in their normal position against one of said stops having an accelerated drooping-curve characteristic as said connected free ends are moved toward the other of said stops.

18. The structure of claim 17 in which one of said stops is a resilient electrical conductive material which flexes appreciably when said connected free ends are in normal position in operative contact therewith.

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