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3,497,649

SNAP-ACTION SWITCH

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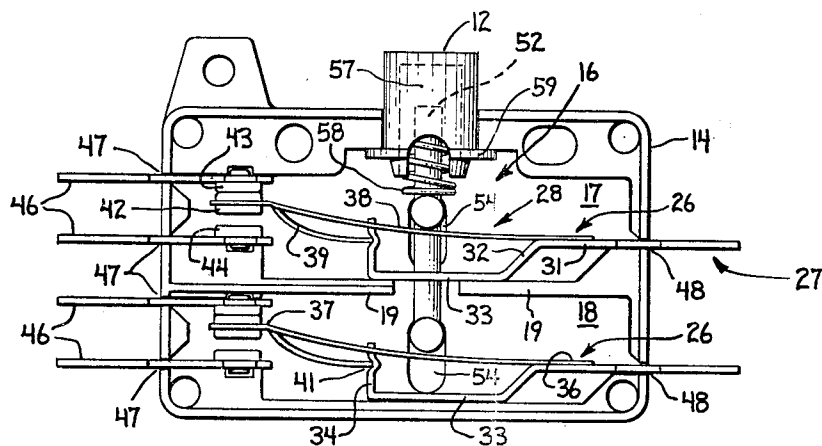


Fig. 2.

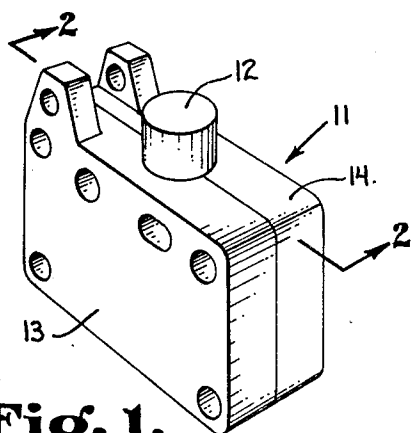


Fig. 1.

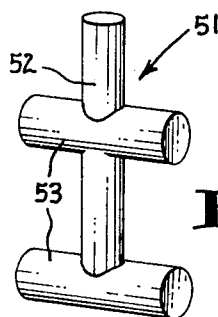


Fig. 3.

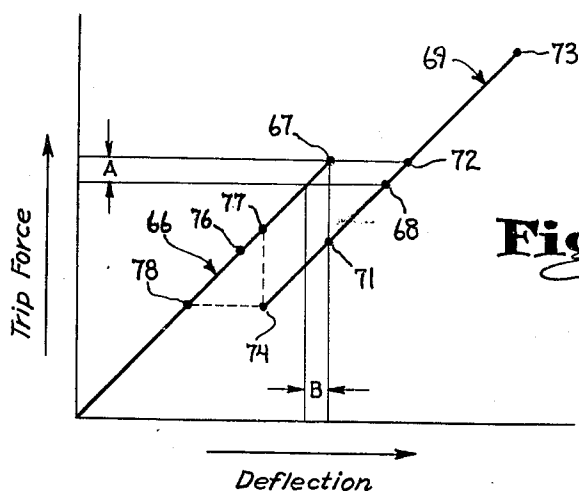


Fig. 4.

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SNAP-ACTION SWITCH

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1 Claim

ABSTRACT OF THE DISCLOSURE

A snap-action electrical switch having a pair of electrically isolated contacts actuated by a force transmitting member, a pushbutton, and a compression spring interposed between the force transmitting member and the pushbutton.

BACKGROUND OF THE INVENTION

Field of the invention

The field of the invention is generally electricity, circuit makers and breakers, and more particularly, push or pull snap contacts.

Description of the prior art

The prior art is replete with modifications and adaptations of electrical snap-action switches. Illustrative of some of these are the switches disclosed in Roeser, 2,750,463; Ball, Jr., 2,999,138; Kaminky, 2,345,027; Riddell, 3,102,177; and Lautzenhiser, 2,91,160. There still exists a need however, for reliable and economical snap-action switch that will provide substantially simultaneous operation of two electrically isolated contact members, particularly where the actuating, motion for the switch elements, provided by external apparatus, is solid, or nonresilient, and relatively slow moving.

One switch structure for obtaining substantially simultaneous operation of electrically isolated contact members is shown in Riddell, 3,102,177, wherein a deliberate asymmetry is introduced to overcome manufacturing tolerances. Another approach to achieving substantially simultaneous operation is shown in Connelly, 2,884,503, wherein a perforated yoke affixed to the pushbutton actuates an assembly that is pivotally coupled to the bridging springs of the contacts.

The structure of the switch actuating mechanism of the present invention is simpler than either of those mentioned above, provides for easier assembly of its parts, and provides substantially simultaneous operation of its contacts both upon depression and release of the pushbutton.

SUMMARY OF THE INVENTION

The present invention is an improved dual snap-action electrical switch for providing substantially simultaneous operation of its contacts although the actuating impulse applied to the switch is of "micrometer" type, that is, non-resilient and slow-moving. The switch has a pair of snap-action contact assemblies of known construction arranged one above the other and enclosed in a nonconductive housing. Each of the snap-action contact assemblies has an anchor member and a spring member. The spring member has a proximal end affixed to the anchor member, a pair of laterally spaced tension portions connecting the proximal end to a distal end, an electrical contact mounted on the distal end, and a compression portion extending between the tension portions and a fulcrum point on the anchor member removed from the place where the proximal end of the spring member is affixed to the anchor member.

A force transmitting member having a vertical shaft and two pairs of horizontal arms is adapted to move verti-

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cally within the housing. The two pairs of arms are spaced apart vertically on the shaft so that each pair of arms is positioned immediately above and in contact with the tension portions of the spring members of one of the contact assemblies.

The upper end of the shaft of the force transmitting member extends upwardly into a recess in a pushbutton which is mounted within an opening in the housing. Within the recess in the pushbutton and around the upper end of the shaft of the force transmitting member is positioned a spiral compression spring which extends within the cavity beyond the upper end of the shaft and outside of the cavity to the top of the upper pair of horizontal arms. From this description it will be seen that as the pushbutton is depressed, energy is stored in the compression spring and the pushbutton does not directly bear upon the force transmitting member.

Depressing the pushbutton stores energy in the compression spring and compresses the spring between the upper pair of horizontal arms and the top of the recess in the pushbutton. While the compression spring is being compressed, the force transmitting member is bearing upon the tension portions of the spring members of the snap-action contact assemblies and moving them toward their downward past-center positions. Due to manufacturing tolerances in fabricating the switch parts, the switch characteristics will be such that one of the contact assemblies will reach its past-center before the other. When this initial trip point is reached, the spring member of that contact assembly snaps past center, and in so doing, reduces the resistive force acting on the arms of the force transmitting member. The instant the resistive force acting on the force transmitting member is reduced the energy stored in the compression spring is released and the spring is permitted to extend and drive the force transmitting member downwardly to move the spring member of the other snap-action contact assembly past center. In this manner, substantially simultaneous operation of the two snap-action contact assemblies is achieved in the actuating or downward direction, even though the switch parts are fabricated and assembled under practical, not precision, manufacturing tolerances.

The action of the switches as the pushbutton is released is quite similar. With the pushbutton in the depressed position, both snap-action contact assemblies are in the past-center downward position and the compression spring is in a state of increased compression. As the pushbutton is then released, the compression spring begins to extend, reducing the force applied to the force transmitting member and in turn reducing the force applied to the spring members of the snap-action contact assemblies. When a certain point is reached, one of the snap-action spring assemblies will snap past center, tending to move to its past-center upward position. At this point, that snap-action switch assembly increases its upward force on the force transmitting member, driving the force transmitting member upward, causing it to compress the compression spring and to permit the other snap-action switch assembly to move to its past-center upward position.

The pushbutton need not be pushed sharply or quickly to obtain the desired contact action. To the contrary, a very slow "micrometer" type motion of the pushbutton will still produce the desired substantially simultaneous snap action.

It is therefore an object of the present invention to provide an improved snap-action switch having a pair of electrically isolated contacts.

It is a further object of the present invention to provide such a switch wherein the operation of the isolated contacts is substantially simultaneous even though the switches have nonidentical tripping characteristics.

It is another object of the present invention to provide a switch that is economical in its parts and simple in construction, the switch parts giving satisfactory performance without the requirement that they be manufactured under very close tolerances.

These and other objects and advantages of the present invention not specifically mentioned here will become apparent from the detailed description and claims which follow, reference being had to the accompanying drawings in which a preferred embodiment of the invention is shown by way of example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the switch of the present invention showing the pushbutton and the housing.

FIG. 2 is a side elevation view of the switch of the present invention with one half of the housing removed and showing the internal parts of the switch.

FIG. 3 is a perspective view of the force transmitting member of the switch.

FIG. 4 is a force-deflection diagram for one of the contact assemblies of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown an external perspective view of the switch of the present invention having a housing 11 and a pushbutton 12. The housing 11 is formed of two housing halves 13 and 14, each being substantially a mirror image of the other. Various perforations and projections may be provided on the housing for mounting purposes, and if desired, one of the housing halves may be made thicker than the other.

Each housing half 13, 14 has a central cavity 16 which is divided into an upper cavity 17 and a lower cavity 18 by a partition 19 which is integral with the housing half. The upper and lower cavities are substantially identical, each being adapted to receive a snap-action contact assembly 26.

The snap-action contact assembly 26 is of known construction and includes an anchor member 27 and a spring member 28. The anchor member 27 has a first portion 31 that is substantially horizontal, a second portion 32 that extends downwardly at an angle from the first portion, a third portion 33 that is substantially horizontal and connected to the second portion, and a fourth portion 34 that is substantially vertical and connected to the third portion, as best shown in FIG. 2.

The spring member 28 is formed of conductive material and has a proximal end 36 and a distal end 37. The proximal end is affixed to the first portion 31 of the anchor member 27 and is connected to the distal end 37 by a pair of laterally spaced tension portions 38. Connected to the distal end 37 and positioned horizontally intermediate the tension portions 38 is a compression portion 39. The compression portion 39 extends from the distal end 37 to a fulcrum 41 formed in the fourth portion 34 of the anchor member 27. The distal end 37 of the spring member carries a double sided contact element 42.

The contact element 42 is restricted in upward movement by a fixed contact 43 and in downward movement by a fixed contact 44. The contacts 43 and 44 are mounted on terminal arms 46 which extend through slots 47 in the housing halves 13, 14 to provide external connections to the contacts 43, 44. The terminal arms 46 are held in position within the housing halves 13, 14 by means of small tabs (not shown) which fit into mating recesses (also not shown) in the housing halves 13, 14. The portions of the terminal arms 46 which lie outside the housing 11 may be adapted to receive wiring connectors. The first portion 31 of the anchor member 27 is received through a matching slot 48 in the housing halves 13, 14 and includes tabs (not shown) which fit into small recesses (also not shown) in the housing halves for hold-

ing the anchor member 27 in place when the two housing halves 13 and 14 are assembled. The end of the first portion 31 external to the housing 11 may be adapted to receive wiring connectors.

It will be seen from FIG. 2 that each snap-action contact assembly 26 forms a single pole double throw switch, the first portion 31 of the anchor member 27 being the common terminal and the terminal arms 46 being the other two terminals.

A force transmitting member 51, as shown in FIG. 3, has a vertical shaft 52 and two pairs of horizontal arms 53. The force transmitting member 51 is formed of non-conducting material such as nylon or other plastic material, and the shaft 52 and arms 53 may be integral. The overall length of each pair of horizontal arms 53 is slightly greater than the width of the central cavity 16 of the housing 11, so that when the force transmitting member 51 is in position within the housing as shown in FIG. 2, the tips of the horizontal arms 53 are received in shallow recesses 54 which permit only vertical movement of the force transmitting member 51. An elongated opening in the third portion 33 of the anchor member 27 permits the lower pair of horizontal arms 53 to be passed through the upper snap-action contact assembly 26 and rotated to the position shown in FIG. 2.

As shown in FIG. 2, the horizontal arms 53 of the force transmitting member 51 bear downwardly on the upper surfaces of the tension portions 38 of the spring members 28. The upper end of the shaft 52 extends upwardly into a recess 57 in the pushbutton 12. Between the force transmitting member 51 and the pushbutton 12 is a resilient compression element, such as a spring 58. As shown in FIG. 2, the spring 58 is a spiral compression spring and is located within the recess 57 and encircling the upper end of the shaft 52. The spring 58 is compressed between the upper end of the recess 57 and the top of the upper pair of horizontal arms 53. A flange 59 on the pushbutton 12 prevents the upward force of the compression spring from pushing the pushbutton 12 out of the housing 11.

With the pushbutton 12 in the released position, as shown in FIG. 2, the compression spring 58, may be very slightly compressed to exert a slight downward force on the force transmitting member 51, which is restrained from downward movement by upward forces exerted by the tension portions 38 of the spring members 28. The tension portions 38 are under tension between the proximal ends 36 and the distal ends 37 of their respective spring members 28 due to the flexure of the respective compression portions 39, compressed between the distal ends 37 and the fulcrums 41. It will be seen that the compression portions 39 are exerting an upward and leftward force on the distal ends 37 while the tension portions 38 are exerting an upward and rightward force on the distal ends 37. The horizontal forces cancel out, leaving a net upward force acting on the distal ends 37 thereby forcing the contacts 42 upwardly against the upper fixed contacts 43.

When the pushbutton 12 is depressed, force is exerted downwardly on the compression spring 58, which compresses and exerts a substantially equal force downward on the force transmitting member 51. The force transmitting member 51 transmits this downward force to the tension portions 38 through the horizontal arms 53. As the applied force depressing the pushbutton 12 is increased, the compression spring 58 continues to compress against the force transmitting member 51 to move it downwardly. As the force transmitting member 51 moves downwardly against the resisting force of the tension portions 38, the resisting force of the tension portions increases. This is because downward flexure of the tension portions 38 decreases the distance between the distal end 37 and the fulcrum 41 of each snap-action contact assembly 26, causing further compression of the

compression portions 39, which in turn increases the tension of the tension portions 38. Increased tension in the tension portions 38 causes an increase in the force resisting downward movement of the force transmitting member 51.

As the pushbutton 12 is further depressed, a point is reached where one of the two snap-action contact assemblies 26 reaches its downward center position. This occurs when the tension portions 39 pass through the line of the fulcrum 41. As this point is approached and passed, the resultant force which had been forcing the contact 42 upwardly against the contact 43 rapidly decreases to zero and rapidly increases in the downward direction, thereby snapping the contact 42 away from the upper contact 43 and downwardly against the lower contact 44.

It will also be seen that as the contact 42 moves downwardly, it moves slightly away from the fulcrum 41, thereby permitting the compression portion 39 to decompress, which also reduces the tension in the tension portions, resulting in a decrease in the upward resistive force exerted on the force transmitting member 51. When this happens, the spring 58 expands to maintain the balance of forces acting upon it, and in so doing drives the force transmitting member downwardly with a force sufficient to immediately drive the other snap-action switch assembly through its downward past center position. In this manner, substantially simultaneous operation of the two contacts is achieved in the downward direction.

With the pushbutton 12 in the depressed position both contacts 42 are forced downward against the lower contact 44. As the pushbutton 12 is released, the compression of the compression spring 58 is reduced and the force transmitting member 51 permitted to move upwardly under the resistive force of the tension portions 38 of the two switch assemblies 26. As the force transmitting member 51 moves upwardly, it is followed by the tension portions 38. At a certain point, the tension portions 38 of one of the switch assemblies will pass its upward past center position. When this happens, the resultant force which had been forcing the contact 42 downwardly against the contact 44 rapidly decreases to zero and rapidly increases in the upward direction, thereby snapping the contact 42 away from the lower contact 44 and upwardly against the upper contact 43.

It will be seen that as the contact 42 moves upwardly, it moves slightly away from the fulcrum 41, thereby permitting the compression portion 39 to decompress, and urge the tension portions upwardly. The tension portions are not entirely free to move upwardly, however, because of the downward force of the force transmitting member 51 which is restrained by the compression spring 58. This motion of the force transmitting member 51 acts to retard the snap-action of the first snap-action contact assembly 26 to pass through its upward past center position and to accelerate the passing of the other switch assembly 26 through its upward past center position. In this manner, substantially simultaneous operation of the two contacts is achieved in the upward direction.

To aid in understanding the present invention, there is shown in FIG. 4 a force-deflection diagram which may be considered to graphically illustrate the force-deflection relationship for one of the contact assemblies 26. Curve 66 shows the relationship between the downward force applied by the force transmitting member 51 to the tension portions 38 (considering, for example, the upper switch only) and the deflection of the tension portions 38. With the pushbutton 12 in the released position no force is being transmitted to the switch assembly 26. In practice, it may be desirable to dimension the parts so that in this position there is some force being transmitted due to compression of the compression spring 58, in which case, the curve 66 would intersect the vertical axis at a point above the horizontal axis.

As the pushbutton 12 is depressed, the force transmitting member 51 causes the tension portions 38 to deflect as shown by the curve 66. When the deflection reaches the trip point 67 for the upper switch assembly under consideration, the switch assembly passes through its downward (actuating direction) past center point causing a reversal of forces acting on the contact 42 and reducing the upward force exerted by the tension portions 38 upon the force transmitting member 51. When this happens, the switch assembly under consideration becomes unstable and seeks a stable position. It is uncertain exactly what path the switch assembly follows from the point 67, but it is known that it moves to a point 68 on the curve 69 somewhere between the points 71 and 72. From the point 68, further depression of the the pushbutton 12 will deflect the tension portions according to the curve 69.

As the pushbutton 12 is released, the point 73 moves down the curve 69 until it reaches the reset point 74. At this point, the switch assembly 26 passes through its upward (deactuating direction) past center point causing a reversal of forces acting on the contact 42 and increasing the upward force exerted by the tension portions 38 upon the force transmitting member 51. Once again, the switch assembly 26 becomes unstable and seeks a stable position. Again, it is uncertain exactly what path it follows from the reset point 74, but it is known that it moves to a point 76 on the curve 66 somewhere between the points 77 and 78.

Thus it will be seen that as the pushbutton is depressed, the resistive force of the tension portions 38 initially increases. When the trip point 67 is reached, this force rapidly decreases and the contact 42 snaps away from the contact 43 and against the contact 44. Further depression again increases the resistive force. As the pushbutton is released, the resistive force of the tension portions 38 initially decreases. When the reset point 74 is reached, the resistive force rapidly increases and the contact 42 snaps away from the contact 44 and against the contact 43. Further release of the pushbutton again reduces the resistive force downwardly along the curve 69. At no point does the resistive force exerted by the tension portions 38 upon the force transmitting member 51 decrease to zero or reverse.

When two assemblies 26 are ganged together as shown in FIG. 2, assuming the switch parts are manufactured under reasonable manufacturing tolerances, one of them will generally reach its trip point 67 before the other one. If the switch action is again referred to FIG. 4 and if both switches are considered to follow along at least generally parallel force-deflection curves as they are actuated, then the force increment, indicated at "A" (defined by the trip point 67 and point 68) is the force released upon tripping of the first switch and represents the force available for immediately driving the second (tardy actuation) switch through its trip point. The reflection of this increment on the deflection abscissa, indicated at B, is a measure of the maximum allowable mechanical error (manufacturing tolerance) or variation in the trip points of the two, ganged switch assemblies. Thus, if force increment A (and hence deflection increment B) is very small, then very close tolerances must be held in manufacture of the switch parts so that their trip points are close together and only a small released force increment will actuate the tardy switch of the multiple switch assembly. Addition of compression spring 58 to the assembly, in effect, widens or increases the force increment A (and hence the deflection increment B) so that wider manufacturing tolerances may be utilized in fabricating the switch parts without destroying the substantially simultaneous actuation characteristic of the ganged switch assemblies, and this is manufacturing and assembly cost advantages of considerable importance. As described above, the force changes that occur when the initial trip point is reached causes a rapid movement

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of the force transmitting member 51 to move the other switch assembly through its trip point. Similarly, the abrupt force changes which occur when one of the two switch assemblies 26 moves through its reset point 74 tend to cause rapid movement of the force transmitting member 51 in the opposite direction to move the other switch assembly 26 through its reset point. Thus, both in the downward and upward directions, substantially simultaneous operation of the two contacts is provided.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirit of the invention and the scope of the claims are also desired to be protected.

The invention claimed is:

1. A snap-action switch assembly of the type in which a plurality of snap-action contact assemblies are disposed in stacked relation within a unitary housing and are actuated by a single actuating-force transmitting member which extends into engagement with each of the contact assemblies, wherein the improvement comprises provid-

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ing an actuating-force transmitting member which includes a pushbutton slidably mounted in said housing, a shaft extending adjacent said contact assemblies, a resilient compression element interposed between said pushbutton and said shaft said shaft having two pairs of arms extending from it which extend into engagement with said contact assemblies, the tips of said arms being received in shallow recesses in said housing for guiding the motion of said actuating-force transmitting member.

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