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ELECTRICAL SWITCH.

This invention relates to electrical switches.

It is desirable to have an electrical switch wherein a single arrangement can provide, depending on where the contacts are located, a switch that: (i) is
5 normally open and closes upon activation; (ii) is normally closed and opens upon activation; or (iii) includes a pair of contacts, one being normally open and the other being normally closed, which reverse their respective states upon activation.

Additionally, because of space limitations on a printed wiring board (PWB), it is desirable to provide switching functions in a low profile configuration
10 that mounts onto a PWB. In a telephone set, for example, switches are used to interface between user operated keys, such as switchhook, and electronic circuitry on the PWB. Such switches frequently include their own special packaging which is not readily adapted to the mechanical configuration of the telephone set.

In U.S. Patent 4,099,037, entitled "Keyboard Switch Assembly Having
15 Cantilevered Leaf Spring Contact Assembly on Common Conductive Frame," push-button type keys are shown activating a plurality of normally-open contacts. These contacts are members of a unitary frame, riveted to a substrate over an insulative layer. Although switch packaging is streamlined for telephone set applications, the use of rivets and insulative layers is undesirable. Further, only normally-open
20 (make) contacts are shown, whereas normally-closed (break) contacts are desirable in many applications. Indeed, mixing make and break contacts in the same keyboard does not appear feasible using the switch structure of the aforementioned patent without introducing another substrate positioned above the unitary frame.

Accordingly, it is an object of the present invention to provide a low
25 cost, low profile electrical switch.

It is another object of the present invention to provide a switch capable of providing normally-open and/or normally-closed contacts.

According to the present invention there is provided an electrical switch comprising: an elongated spring member having one end free and being attached at
30 its other end to a base member, the spring member including an electrically conductive area at the free end and being shaped to form a fulcrum positioned between the attached end and the free end, said fulcrum extending towards the base member; a member for applying a force to the spring member in a direction that drives the fulcrum toward the base member, the force being applied at a point
35 between the attached end and the fulcrum, said force causing the free end to move away from the base member after the fulcrum has made physical contact with the base member; and a first metallic element, positioned on the base member for providing electrical contact with the electrically conductive

area at the free end of the spring member.

In illustrative embodiments, the spring member has a curved shape with one end inserted into a slot on a printed wiring board. The inserted (fixed) end makes electrical contact with a conductive path located on the printed wiring board.

5 The free end makes mechanical contact with the printed wiring board.

In one illustrative embodiment, the fulcrum also operates as a normally-open contact which is closed when the actuator applies force to the spring member.

In another illustrative embodiment, the free end of the spring member
10 operates as a normally-closed contact that is opened when the actuator member applies force to the spring member.

In another embodiment multiple spring members can be operated by the
15 same actuator.

The present invention will be more fully understood when reference is made to the attached drawing and detailed description.

Brief Description of the Drawing

FIG. 1 discloses a pair of leaf spring contacts in an embodiment of the
20 invention in combination with an actuator member;

FIG. 2 discloses a side view of a normally-closed spring contact of the embodiment;

FIGS. 3-4 are side views of a normally-closed spring contact and actuator member in two sequential positions of operation;

25 FIG. 5 is a side view of a make-before-break spring contact;

FIG. 6 discloses a spring member having two normally-open contacts that close in sequence, one of which re-opens thereafter;

FIG. 7 discloses multiple leaf spring contacts being used in a line switch application within a telephone set;

30 FIG. 8 discloses a cross-section view of FIG. 7 illustrating the interaction between a line switch plunger and multiple spring contacts in a preferred embodiment of the invention;

FIG. 9 shows the cross-section view of FIG. 8 after removal of the printed wiring board holding the multiple spring contacts;

35 and

FIG. 10 discloses, in greater detail, the layout of the printed wiring board used in the telephone set of FIG. 7 to 9.

Detailed Description

FIG. 1 discloses a switch having a pair of normally-closed elongated spring members in the form of leaf spring contacts 30, 31. Each of the spring members 30,31 comprises an elongated, flat, rectangular piece of metal stock. In order for the spring members to be deflected and return to their original positions, the metal stock used is of resilient material such as phosphor bronze. Spring members 30, 31 are inserted into substrate 40 at one end thereof in a cantilever configuration. Thus, in the normal, non-operated state of spring member 30, electrical connection between wires 510 and 512 is made through spring member 30 and contact pad 511. Similarly, in the normal, non-operated state of spring member 31, electrical connection between wires 520 and 522 is made through spring member 31 and contact pad 521.

Focusing on the structure of spring member 30, for example, it includes a pair of re-entrant bends 302, 303 which are advantageously used to make contact and provide a mechanical fulcrum in the operation of the switch. Re-entrant bend 303 is plated with a precious metal in order to make good electrical contact with pad 511. The concave shape of re-entrant bend 303 provides a line of contact with pad 511.

Actuator 10 is attached to substrate 40 with a pair of mounting blocks 20. The mounting blocks and the actuator include holes which are aligned for receiving a steel pin 21 which pivotally joins the actuator and the mounting blocks together. As noted above, spring members 30 and 31 are mechanically attached to the substrate 40 at one end only in a cantilevered configuration. As shown in FIG. 1, this mechanical attachment occurs in the region of wires 510, 520 attached to the spring member. Actuator 10 further includes a pair of ribs 11, 12 which are positioned to sequentially operate spring contacts 30, 31 respectively.

FIG. 2 discloses, in greater detail, the structure of a single spring 30 and is used to further define terminology. Spring 30 is attached to substrate 400 at its fixed end 301 where mechanical connection is made, but also where electrical connection might also be made. Substrate 400 may be a printed wiring board containing other components as well as wiring pads deposited or etched thereon. It can be appreciated that the spring member need take up no more room than any other electrical component and thus provides a low profile switch. Further, such direct mounting to a printed wiring board eliminates the extra cost of a separately packaged switch as well as the additional electrical and mechanical connections required in attaching it to the printed wiring board. Spring member 30 is illustratively shown to be generally curved so that it is in physical contact with substrate 400 at each end but

raised up from the substrate in its middle. Spring member 30 is connected to contact pad 511 as a normally-closed contact. Re-entrant bend 303 is positioned at the free end of the catilever structure. Pad 511 comprises a metallized area to render it electrically conductive. In this illustrative embodiment the metallization passes through a hole in substrate 400 in order to interconnect normally-closed contacts 303, 511 with printed wiring paths or wires on the bottom side of the substrate. As will be shown in connection with FIG. 12, normally-closed contacts 303, 511 may also interconnect with other printed wiring board components and paths on the top side of the substrate.

FIG. 3 introduces an actuator 10 that cooperates with spring member 30 to provide the functions of a switch. As described in connection with FIG. 1, actuator 10 is pivotally attached to a mounting block. A steel pin passes through hole 13 in the actuator. As the actuator pivots downwardly, rib 11 makes mechanical contact with spring member 30 pushing it downwardly also. Such downward movement advantageously causes re-entrant bend 303 to make wiping contact with pad 511 as it moves laterally in response to the downward movement of the actuator. Wiping action operates to clean the contact surfaces.

FIG. 4 shows the position of spring member 30 after further downward travel of the actuator 10. After re-entrant bend 302 preferably positioned at about the center of the spring member makes mechanical contact with substrate 400, any further downward pressure on the spring from rib 11 causes the free end of the spring 30 to rise up and break contact with pad 511. Re-entrant bend 302 thus operates as a fulcrum. Up until this time, fixed end 301 was the fulcrum since it was the point around which the spring member 30 rotated. It is important to note at this juncture that re-entrant bend 303 is positioned at the free end of spring member 30 and can be engineered to break contact with pad 511 at any one of various operating positions in the rotation of actuator 10 by selective placement of re-entrant bend 302 and/or selective placement of rib 11. Indeed, FIG. 1 illustrates selective placement of ribs 11 and 12 to cause spring members 30 and 31 to be operated, one before the other, in a predetermined sequence.

Other contact configurations are disclosed in FIGS. 5 and 6 that illustrate other embodiments of the present invention.

Combining make and break functions in a single spring member is disclosed in FIG. 5, where re-entrant bend 302 makes contact with pad 520 before re-entrant bend 303 breaks contact with pad 511. Here spring member 30 operates as a transfer contact in a make-before-break switch.

Yet another application of the present invention is discussed in connection with FIG. 6 wherein spring member 30 is suitably shaped and anchored at fixed end 301 so that contact elements 302,520 and contact elements 303,511 are normally open. Re-entrant bend 303 is made larger than re-entrant bend 302 to
5 cause the contact elements 303,511 to make before contact elements 302,520 as rib 11 travels downwardly. Upon further downward travel of rib 11, contact elements 303,511 reopen. Thus, during the downward movement of an actuator, three switch operations may be sequentially made by a single spring member. This same operation is possible when re-entrant bends 302 and 303 are of the same size; in that
10 case it is only necessary to reshape the general curvature of spring member 30.

Finally, and most importantly, a single actuator may operate a plurality of spring members, each independently providing a different one of the switch operations taught in FIGS. 4,5 and 6. A particularly desirable application of a switch having multiple spring members operated by a single actuator is in the line switch of
15 a telephone set which is hereinafter discussed in connection with FIGS. 7-10.

In particular, the portion of a telephone set base that accommodates a telephone handset is shown in FIG. 7. A cut-open section of the telephone set base reveals printed wiring board 400 upon which spring members 300 are mounted. Actuator 100 is a line switch, held in place by mounting block 200 which is
20 anchored to the telephone set base. Ribs 110 and 120 are molded into the structure of actuator 100. When the telephone handset (not shown) is placed on the base, actuator 100 is depressed downwardly so as to cause spring members 300 to be in their operated state. The weight of the handset is carefully selected to overcome the combined restoring force of the spring members 300.

25 A cross-section of FIG. 7 in the region of actuator 100 is shown in FIG. 8. Actuator 100 is shown by solid lines in its "on-hook" position when the handset is on the base. Actuator 100 pivots around pin 210 to sequentially operate spring members 300, mounted on printed wiring board 400, via ribs 110,120. In the position shown, all of the spring members are operated. Actuator 100 is shown by
30 dotted lines in its "off-hook" position when the handset and base are separated. The restoring force of the spring members 300 pushes actuator 100 into this position. The weight of the telephone handset and the mechanical leverage possible through proper positioning of pivot pin 210 combine to assure that the individual spring members will be in the desired position during the on-hook and off-hook states of
35 the telephone set.

FIG. 9 offers a less detailed picture of the cross-section shown in FIG. 8, but with the printed wiring board 400 removed. Note the rest position of actuator 100 when no spring members are present. The restoring force of the spring members

advantageously eliminates the need for coil springs that are typically associated with telephone set line switches.

5 A more detailed look at the printed wiring board 400 containing the spring members 300 is provided in FIG. 10. Components 420 are interconnected with each other and with spring members 300 over printed wiring paths 410. A hole 450 in the printed wiring board is positioned to allow a portion of actuator arm 100 (see FIGS.7-9) to move through it. Hole 450 is irregularly shaped so that the reader can appreciate its orientation (i.e., in FIG. 10 the printed wiring board is shown with components facing upward, whereas in FIG. 7 the components are facing
10 downward). The particular operations achieved by each of the spring members 300 is unspecified in FIG. 10, although, as indicated previously, each of the spring members may provide a different one of the various applications disclosed in FIGS.4-6.

15 Although various embodiments of the present invention have been shown, it is understood that modifications are possible.

Claims:

1. An electrical switch comprising: an elongated spring member having one end free and being attached at its other end to a base member, the spring member including an electrically conductive area at the free end and being shaped to form a
5 fulcrum positioned between the attached end and the free end, said fulcrum extending towards the base member; a member for applying a force to the spring member in a direction that drives the fulcrum toward the base member, the force being applied at a point between the attached end and the fulcrum, said force causing the free end to move away from the base member after the fulcrum has made
10 physical contact with the base member; and a first metallic element, positioned on the base member for providing electrical contact with the electrically conductive area at the free end of the spring member.
2. The electrical switch as in claim 1, wherein electrical connection is made to the spring member at its attached end.
- 15 3. The electrical switch as in claim 1 wherein the electrically conductive area at the free end of the spring member and the first metallic element are in electrical contact before force is applied to the spring member by the force applying member.
4. The electrical switch as in claim 1 wherein the electrically conductive
20 area at the free end of the spring member and the first metallic element are not in electrical contact before force is applied to the spring member by the force applying member.
5. The electrical switch as in claim 1 wherein the electrically conductive area at the free end of the spring member comprises a re-entrant bend formed in the
25 spring member.
6. The electrical switch as in claim 1 wherein the fulcrum comprises a re-entrant bend formed in the spring member.
7. The electrical switch as in claim 1 wherein the base member further includes a second metallic element, positioned on the base member so as to "make"
30 before "break" electrical contact with the fulcrum on the spring member in response to movements of the spring member.

