United States Patent

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[54] TACTILE RESPONSE SWITCH WITH UNITARY CONTROL STRIP OF INDEPENDENTLY OPERABLY PLURAL DISC CONTACTS

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[52] **U.S. Cl.** .....**200/5 A, 200/159 B**

[51] **Int. Cl.** **H01h 5/30**

[58] **Field of Search** .....200/5, 6, 11 DA, 17, 18, 67 DA, 200/159 R, 159 B, 116 PC

[56] **References Cited**

UNITED STATES PATENTS

3,290,439	12/1966	Willcox et al.	200/5 A X
2,994,531	8/1961	Eberwein	200/5 A
3,188,435	6/1965	Rugsten	200/166 PC
3,544,987	12/1970	McMann Jr. et al.	200/5 R X
3,319,031	5/1967	Butler	200/67 DA X

FOREIGN PATENTS OR APPLICATIONS

1,806,241	8/1969	Germany	200/159 B

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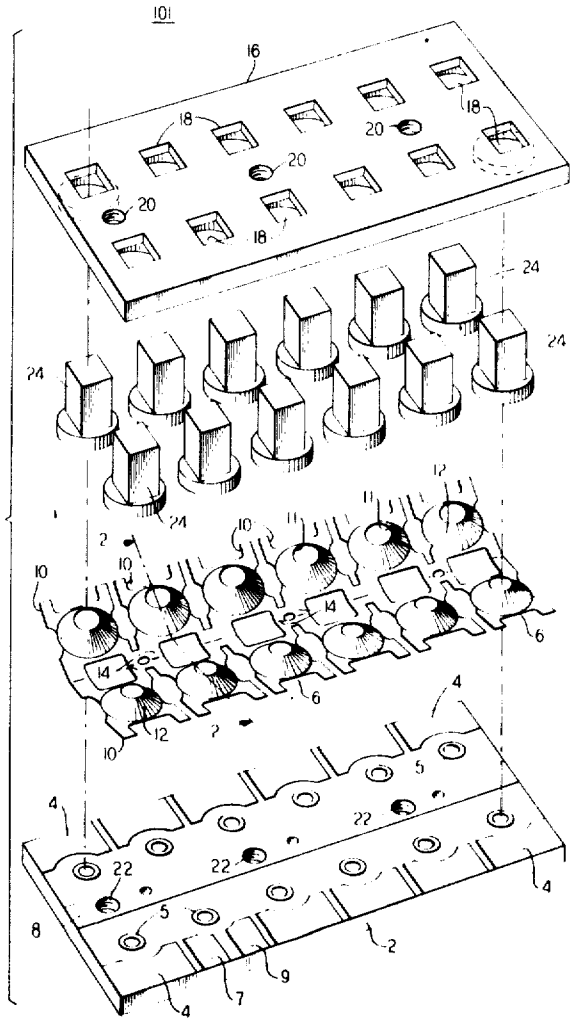
[57] **ABSTRACT**

A tactile response switch comprises a unitary cantilever-snap disc mechanism in which the cantilever provides reliable electrical contact properties and the snap disc provides a tactile response to contact closure. A plurality of independent contact closures can be made by operation of a single contact button and the properties of the cantilever and the snap disc can be easily tailored to achieve a desired sequence of contact closures and desired switch operating characteristics.

4 Claims, 4 Drawing Figures



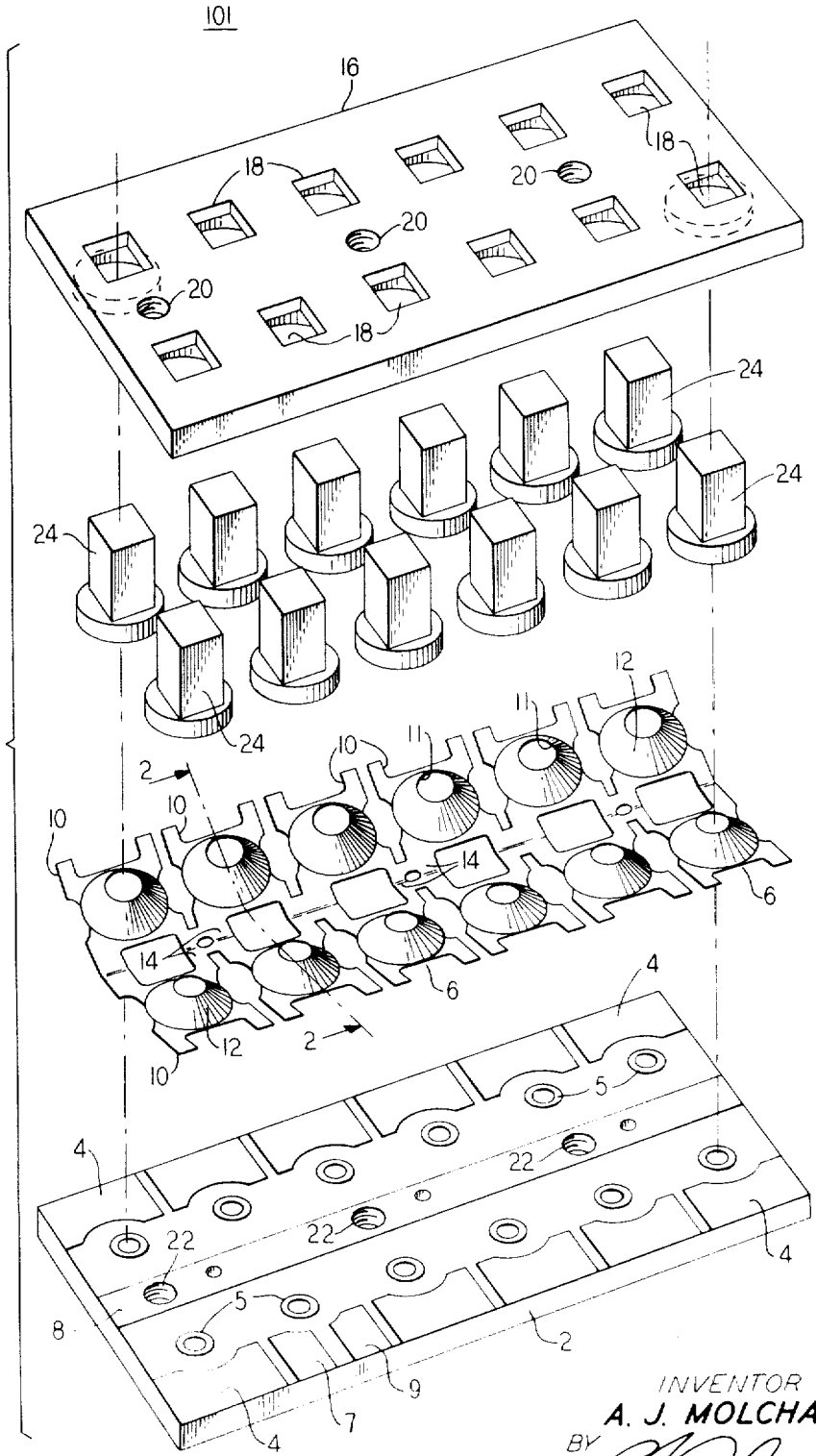


FIG. 1

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FIG. 2

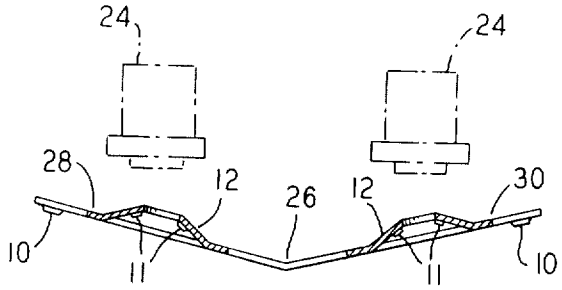


FIG. 3

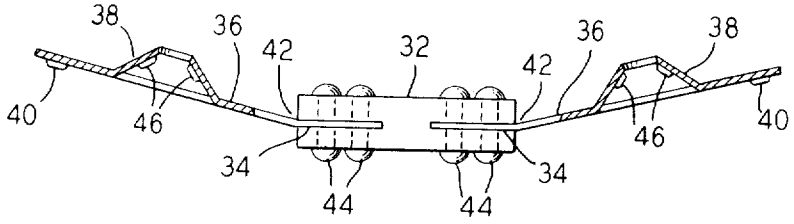
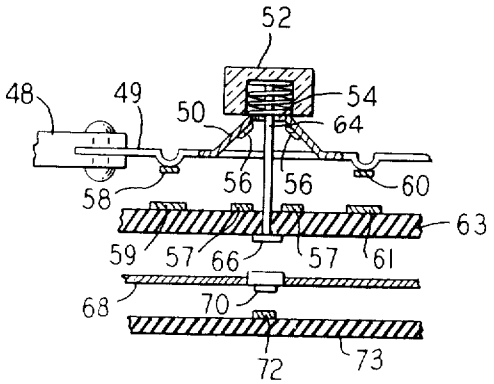


FIG. 4



TACTILE RESPONSE SWITCH WITH UNITARY CONTROL STRIP OF INDEPENDENTLY OPERABLY PLURAL DISC CONTACTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical switches and more particularly to switches which provide a tactile response feedback on switch operation.

2. Description of the Prior Art

With increasing miniaturization of electrical apparatus, switches having very small operating forces and having limited deflections are finding increasing usage. From the human factors standpoint it is often desirable, or even necessary, that some type of feedback on switch operation or switch contact closure be provided to the switch operator. Otherwise, it may not be possible for the operator to ascertain when the switch has been properly operated.

Various types of feedback such as visual, audible, and tactile have been employed. One example of a tactile response feedback is that provided by snap switches. These snap switches utilize spring devices such as belleville washers to obtain the snap action which provides a tactile response.

Presently available snap switches have limitations which prevent their effective use in some applications. One such limitation is the short contact closure times which may not be sufficient for applications such as telephone pushbutton dials. Another limitation is the sensitivity of the switch parameters such as operating forces to variations caused by manufacturing tolerances in the characteristics of the snap disc. Still another limitation is the unreliable contact properties which result from the absence of a wiping action on the contacts.

Accordingly, it is an object of this invention to improve switches for providing a tactile response feedback.

A more specific object is to provide a tactile response switch suitable for use where extended switch closure times are required.

Another specific object is to reduce the sensitivity of the tactile response switch parameters to manufacturing variations in the snap disc.

Still another object is to improve the quality of the electrical connection provided by the tactile response switch contacts.

SUMMARY OF THE INVENTION

The foregoing objects and others are achieved in accordance with the invention by the use of a switch which has the combined characteristics of a snap disc or spring and a cantilever spring. The combined snap disc and cantilever characteristics give improved contact properties by providing such features as longer contact closure times and contact wiping action. The snap spring characteristics provide the desired tactile response feedback on switch operation. The snap spring and cantilever are combined in a unitary structure which is operable by a single switch button. The characteristics of the snap spring and the cantilever are tailored to obtain desired operating parameters, such as operating forces, which are essentially independent of switch button deflection. Independent sets of contacts which are operable by a single switch button can be added to the unitary structure and a desired sequence of closures for these independent sets of contacts can be prescribed.

DESCRIPTION OF THE DRAWING

The invention will be more fully comprehended from the following detailed description and accompanying drawing in which:

FIG. 1 is an exploded perspective view of a multi-switch dial utilizing the principles of the invention;

FIG. 2 is a cross sectional view of the spring contact sheet along direction 2—2 of FIG. 1 from which the functioning of the multi-switch dial can be more readily understood;

FIG. 3 is a cross sectional view of another embodiment of a spring contact sheet which can advantageously be utilized when completely independent switches or rows of switches are desired; and

FIG. 4 is a cross sectional view of switch apparatus utilizing the principles of the invention to obtain multiple independent switches each of which may have a plurality of independent sets of contacts which are operable by a single switch button.

DETAILED DESCRIPTION

Referring now to FIG. 1 there is shown a dial 101 such as might be used in a pushbutton telephone set. The dial comprises a contact board 2 having a plurality of contacts 4 thereon which are connected to electrical signals. Contact board 2 can comprise a standard printed circuit board and the connection of the electrical signals to contacts 4 can be made by techniques well known in the printed circuit art. A contact 4 can be separated into a plurality of smaller contacts 7 and 9 to achieve a multiple-make switch. Contact board 2 can also have a second series of contacts 5 which are connected to other electrical signals.

A spring contact sheet 6 is placed on top of board 2 and is electrically connected thereto along a center strip 8 which normally comprises a common or ground strip. Sheet 6 constitutes a single conductor or plane which normally comprises a common or ground plane. Sheet 6 has contacts 10, more clearly shown in FIG. 2, which are aligned with respective contacts 4 when sheet 6 is positioned on board 2. Thus, when corresponding contacts 4 and 10 are electrically connected an electrical path for the signals connected to contacts 4 is completed. Spring sheet 6 can advantageously be made from a material such as phosphor bronze or beryllium copper.

Sheet 6 has formed therein a plurality of discs or springs 12 which have characteristics similar to belleville washers or springs known in the art. When the height-to-thickness ratio of a disc 12 falls within the range from approximately $\sqrt{2}$ to $2\sqrt{2}$ the disc exhibits the snap action properties which have been utilized in the snap switches known in the prior art. This snap action provides a good tactile response. The presence of connecting arms 14, which join the individual discs 12 to the remainder of sheet 6, have no appreciable effect on this snap action. When contacts 5 are used on board 2, discs 12 also have contact areas 11 around the inner periphery thereof which are aligned with contacts 5. Thus, when contacts 5 and 11 are closed the signals connected to contacts 5 also have a completed circuit.

A top plate or housing 16 fastens spring sheet 6 to board 2 along center strip 8. Holes 20 on plate 16 are aligned with holes 22 on board 2 and standard hardware such as screw fasteners hold plate 16 and board 2 together and sandwich sheet 6 therebetween. Plane 16 contains a plurality of openings 18 which are aligned with discs 12 when plate 16, sheet 6 and board 2 are joined together. Operating plungers or buttons 24 are mounted in holes 18 for applying operating forces to discs 12 to close the contacts. Plate 16 and buttons 24 advantageously can be made of a suitable material such as cycolac.

As is shown more clearly in FIG. 2, sheet 6 has a bend 26 formed down the center thereof so that the sides 28 and 30 do not normally lie flat between plate 16 and board 2 when the switch is assembled. Thus, sides 28 and 30 can deflect as cantilevers which are mounted along center strip 8.

When a button 24 is pressed, a force is transmitted to side 28 (or side 30 depending upon the location of button 24) which tends to deflect side 28 as a cantilever while simultaneously tending to deflect and snap a respective disc 12. If side 28 is sufficiently deflected as a cantilever, contacts 10 will mate with contacts 4 on board 2. Likewise, if disc 12 is sufficiently deflected it will snap through and contacts 11 will mate with contacts 5. The snap through action also provides the needed tactile response feedback to switch operation.

The particular sequence in which contacts 4 and 10 and contacts 11 and 5 close depends upon the characteristics of cantilever side 28 and snap disc 12, i.e., spring constants,

thicknesses, height-to-thickness ratio, location of button **24** with respect to bend **26**, and the separation of the mating pairs of contacts. Thus, any desired sequence of closures can be easily established by proper selection of the controlling factors. For example, contacts **4** and **10** can be designed to close before, during, or after snap through of disc **12** and the resulting closure of contacts **5** and **11**. When extended closure times for specified circuits are needed, such as in the generation of telephone dialing signals, they can be obtained by connecting such circuits to contacts **4** and **10** and having these contacts close after only a very small force is applied to button **24**. These contacts **4** and **10** will then remain closed during snap through and recovery of disc **12** to provide the required extended closure times. Circuits requiring shorter closure times can be connected to contacts **5** and **11**. The snap through action provides the tactile response feedback that all contact closures have been made.

The contacts on the cantilever normally provide a better quality electrical connection than do the contacts on snap disc because of the wiping action inherent in the cantilever contacts and the increased contact area which can be provided. Thus, these cantilever contacts can be used for the more critical electrical circuits.

When both a cantilever and a snap disc are utilized, as in this invention, the heretofore difficult job of tailoring the snap disc to particular switch applications is made considerably easier. When the combination is used a nominal design of the snap disc for many applications can be selected and the switch parameters desired for the specific applications can be obtained by varying the characteristics of the cantilever since the switch parameters are less sensitive to changes in cantilever characteristics than to changes in the snap disc characteristics.

The dial of FIG. **1** utilizes a unitary spring sheet **6** having two rows of snap disc **12** in the longitudinal direction. Such a design provides significant manufacturing economy when such a switch arrangement can be utilized. FIG. **3** shows a sectional view of an alternative design for a spring sheet which advantageously can be utilized when completely independent contacts or independent rows of contacts are desired. Spring members **36** are mounted in slots **34** in a holder **32** by means of standard hardware **44** such as screws or rivets. Holder **32** can comprise a plastic holder such as polyethylene. Spring members **36** can comprise individual thin cantilever strips having only one snap disc **38**, or alternatively, members **36** can comprise a cantilever spring sheet having a row of discs **38**, i.e., a structure similar to one-half of the spring sheet **6** shown in FIGS. **1** and **2**. Individual cantilever strips are advantageous where complete independence between all switches of a dial is desired, whereas the single row cantilever sheet can be utilized where some relation between switches of a particular row is desired but the switches of that row are to be completely independent of switches in other rows. Spring member **36** has a bend **42** adjacent holder **32** which imparts the proper configuration for effective cantilever action. Member **36** has contacts **40** which are the same as or similar to contacts **10** on sheet **6**. Snap disc **38** also has contacts **46** around its periphery and operates in the same manner to provide a tactile feedback at snap through as do discs **12**. Thus, the design of FIG. **3** can be connected in a dial switch as shown in FIG. **1** and **2**.

FIG. **4** shows an alternative design for obtaining a plurality of independent contacts controlled by a single button. This design utilizes a multilayer structure having more than one layer of spring members. A holder **48** has mounted therein a spring member **49** having a snap disc **50** with associated contacts **56**, **58**, and **60**. Button **52** mounted on disc **50** deflects spring member **49** and snaps disc **50** as previously described to close contacts **56**, **58**, and **60** with mating contacts **57**, **59**, and **61**, respectively.

Button **52** has a pin **64** projecting through hole **54** of disc **50** and through plate **63** which is connected to a second plunger or button **66**. Button **66** deflects a second spring member **68** to close other contacts **70** and **72** in the same manner as previously described when button **52** causes disc **50** to snap through.

While the invention has been described with respect to specific embodiments thereof it is to be understood that various modifications thereto might be made by those skilled in the art without departing from the spirit and scope thereof. For example, the contacts have been shown as normally open with closure effected by deflection of the cantilever and snap through of the snap disc. The contacts could as readily be normally closed contacts which are opened by cantilever deflection and disc snap through. In either case, the design is based upon the principles that more desirable contact properties and less sensitivity to manufacturing variations can be obtained by the use of a cantilever structure whereas the tactile response feedback required from a human factors standpoint can be obtained by the use of a snap disc.

What is claimed is:

1. A tactile response switch comprising, in combination:
- a strip of conductive spring material having thereon a plurality of snap discs and contacts, said strip having a bend therein in its longitudinal direction so that said strip forms a curved surface;
- a terminal board having thereon a plurality of contacts matching said contacts on said strip;
- means for mounting said strip to said board along said bend so that said bend is held in fixed relation to said board and the portions of said strip on each side of said bend form cantilevers supported at said bend which can deflect toward said board; and
- deflecting means comprising a plurality of buttons mounted on said snap discs for deflecting said portions of said strip toward said board and snapping said discs to effect closure of said contacts and provide a tactile response feedback of said closure.

2. A tactile response switch comprising, in combination:
- a strip of conductive material having thereon a plurality of snap discs and contacts;
- a terminal board having thereon a plurality of contacts matching said contacts on said strip;
- means for mounting said strip with respect to said board comprising a holder for attaching one edge of said strip in fixed relation to said board so that the remainder of said strip can deflect as a cantilever about said one edge toward said board; and
- deflecting means comprising a plurality of buttons mounted on said snap discs for deflecting said remainder of said strip toward said board and snapping said discs to effect closure of said contacts and provide a tactile response feedback of said closure.

3. A tactile response switch comprising, in combination:
- a strip of conductive spring material having thereon a snap disc and a contact;
- a terminal board having thereon a contact matching said contact on said strip;
- means for mounting said strip with respect to said board comprising a holder for receiving one end of said strip and attaching said one end in fixed relation to said board so that the remainder of said strip can deflect as a cantilever about said one end toward said board; and
- deflecting means comprising a button mounted on said snap disc for deflecting said remainder of said strip toward said board and snapping said disc to effect closure of said contacts and provide a tactile response feedback of said closure.

4. A tactile response switch comprising, in combination:
- a strip of conductive spring material having thereon at least one snap disc and at least one contact;
- a terminal board having at least one contact thereon matching said one contact on said strip;
- means including a cover plate for mounting said strip to said board between said plate and said board, said plate holding a portion of said strip in fixed relation to said board, said plate being spaced from said board so that the

remainder of said strip can move therebetween and can deflect as a cantilever toward said board; and

means for deflecting said remainder of said strip toward said board and snapping said disc to effect closure of said contacts and provide a tactile response feedback of said closure, said plate including an opening in which said deflecting means is slideably mounted.

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