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Yanaga et al.

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[45] **May 22, 1973**

[54] **PUSH-BUTTON SWITCH WITH RESILIENT CONDUCTIVE CONTACT MEMBER AND WITH HELICAL CONDUCTIVE NETWORKS**

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[73] Assignee: **Alps Electric Co., Ltd.,** Tokyo, Japan

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** .....**200/159 B,** 200/166 C, 200/166 BH

[51] **Int. Cl.** **H01h 13/06,** H01h 13/52, H01h 1/24

[58] **Field of Search**.....200/159 B, 159 R, 200/16 A, 166 CP, 166 C, 166 H, 166 BH, 83 N, 86 R

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[57] **ABSTRACT**

In a push-button switch using an elastic and electrically conductive contact member movable into and out of engagement with adjacent but separated conductive paths on a substrate, the conductive paths are in the form of helices fitting within one another and the engaging surface of the contact member is provided with a series of lands arranged in a plurality of L-shaped patterns.

4 Claims, 3 Drawing Figures

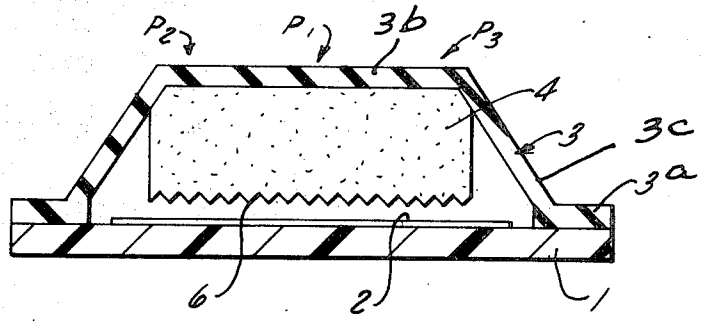
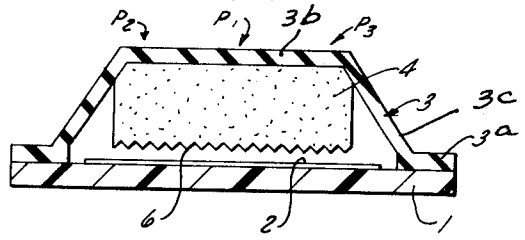


FIG. 1



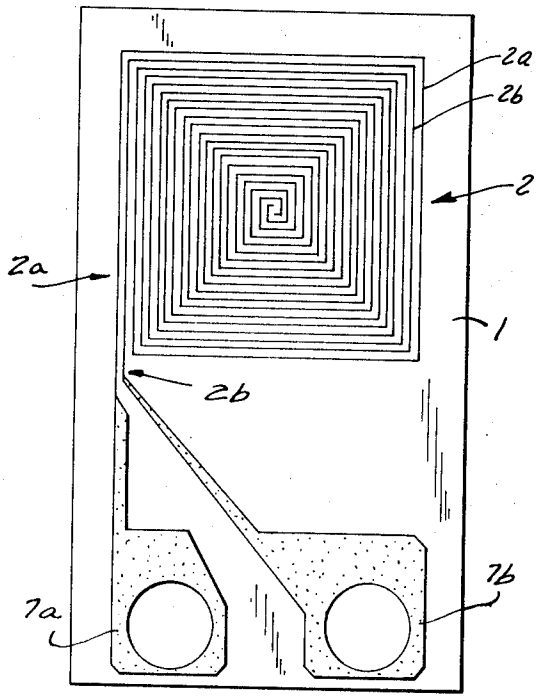


FIG. 2

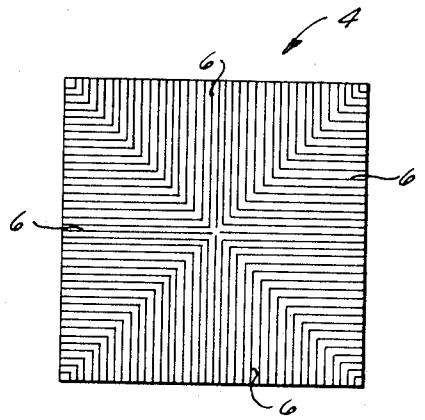


FIG. 3

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PUSH-BUTTON SWITCH WITH RESILIENT CONDUCTIVE CONTACT MEMBER AND WITH HELICAL CONDUCTIVE NETWORKS

This invention relates to a push-button switch particularly adapted for manual operation which is an extremely simple construction and yet which has exceptionally good operating characteristics.

A push-button switch of this general character, utilizing a contact member formed of elastic and electrically conductive material such as conductive rubber which is adapted to be moved down into engagement with a pair of conductive paths formed on a substrate, is shown in copending application Ser. No. 172,637 filed Aug. 18, 1971 in the name of Takemi Shimojo and entitled "Push-Button Switch With Resilient Conductive Contact Member," which application is assigned to the assignee of this application. In that Shimojo application the basic organization of the push-button switch parts is disclosed and the advantages deriving therefrom are set forth, those advantages, generally speaking, being simplicity of construction, reliability of switch functioning, lack of susceptibility to damage, and an appealing "feel" to the switch when it is operated. As disclosed in that Shimojo application, the "feel" is enhanced, if the lower surface of the contact member, that surface thereof designed to be moved into engagement with the separated conductive paths on the substrate, is formed with land-like projections oriented generally at right angles to the direction in which the conductive paths which they bridge extend.

The present invention relates to a particularly advantageous arrangement of the conductive paths on the substrate and a particularly effective arrangement of the land-like projections from the contact member which are designed to cooperate with those conductive paths.

It therefore is the object of the present invention to produce a push-button switch generally of the type disclosed in the aforementioned Shimojo application, utilizing a contact member of resilient conductive material, in which electrical functioning and mechanical "feel" are enhanced to a marked degree, while still retaining all of the advantages of simplicity and reliability inherent in the basic construction involved.

Reliability of switch operation, and particularly low switch resistance when the switch is closed, depends upon several factors, among which is the number of places where the conductive paths are bridged by the contact member. The greater the number of such bridging locations the greater is the conductivity of the switch when it is closed. Since the number and the width of such bridgings may depend upon the force with which the resilient contact member is pressed against the conductive paths, the resistance of the switch when closed may be dependent upon the degree to which such force is exerted. One way in which to minimize this effect is to ensure that there are a very large number of such bridgings which are effective even when a light force is applied to the switch,thereby to produce a minimal switch resistance which is not appreciably further minimized no matter how many additional bridgements may be effectuated or no matter how much the individual bridgements may be widened through the application of additional pressure. Accordingly, in accordance with the present invention, each of the conductive paths formed on the substrate are

shaped to define a helix, the two helices of the two networks respectively being interfitted one within the other so as in effect to define a pair of "parallel" and closely spaced helical paths. Thus bridging between the conductive paths can occur at a very large number of locations. In order to ensure that the number of such bridgings is maximized when the lower surface of the contact member is provided with lands, the lands are provided in an L-shape, the lands interfitting in that shape to define a plurality of sectoral patterns. As a result, even though those lands may be moderately spaced from one another along the undersurface of the contact member, bridging of the conductive paths is accomplished over a very large number of lines even when the push-button is actuated by a light force or an obliquely directed force and this without sacrificing any of the desirable "feel" characteristics imparted to the operation of the switch through the use of those lands.

To the accomplishment of the above, and to such other objects that may hereinafter appear, the present invention relates to the construction of a push-button type of switch as defined in the appended claims and as described in this specification, taken together with the accompanying drawings, in which

FIG. 1 is a cross-sectional view of a typical embodiment of the general arrangement of the push-button switch of the present invention;

FIG. 2 is a top plan view of the substrate of the switch of FIG. 1; and

FIG. 3 is a bottom plan view of the contact member of the switch of FIG. 1.

As is set forth more in detail in the aforementioned Shimojo application, the switch comprises a substrate 1 formed of any suitable insulating material which carries thereon a pair of conductive networks 2*a* and 2*b*, each of those networks comprising adjacent but separated conductive paths. The push-button member 3, formed of appropriate resilient insulating material such as rubber or comparable synthetic material, comprises a rim portion 3*a* which is secured to the substrate 1 in any appropriate manner, as by means of adhesive, a main portion 3*b* located above and in registration with the conductive networks 2*a* and 2*b*, and an intermediate portion 3*c* connected between the rear portion 3a and the main portion 3*b* and effective normally to resiliently retain the main portion 3*b* in a first operative position as shown in FIG. 1, spaced upwardly from but in registration with the conductive networks 2*a* and 2*b* on the upper surface of the substrate 1.

Carried by the main portion 3b of the push-button member 3 is a contact member 4 which is formed of a suitable resilient material which is also electrically conductive. Electrically conductive silicone rubber is particularly effective, but any other material having the desired characteristics can be used. The contact member 4 may be secured to the main portion 3*b* of the push-button member 3 in any appropriate manner, as through the use of a suitable adhesive. It depends from the main portion 3b of the push-button member 3, and when the push-button member 3 is in its first position the lower surface of the contact member 4 is normally spaced upwardly from the conductive networks 2 so as to be out of engagement therewith, as shown in FIG. 1. However, when the main portion 3*b* of the push-button member 3 is depressed to its second operative position the contact member 4 will be carried down into en-

gagement with the networks 2*a* and 2*b* respectively, thereby to physically and electrically bridge the closed networks and complete the circuit between them, thus electrically closing the switch. (See FIG. 2)

As here specifically shown, the network 2*a* is in the form of a helical path the outermost turn of which extends to a terminal post area 7*a*. The network 2*b* is in the form of a helical path the outermost turn of which extends to a terminal post area 7*b*. The helices defined by the networks 2*a* and 2*b* fit within one another, so that those two networks define "parallel" lines spaced from one another and covering the operative area of the substrate to a high degree of density. This arrangement provides a virtually unlimited number of places where the networks 2a and 2b can be bridged.

The surface of the contact member 4 facing the conductive networks 2*a* and 2*b* is provided with lands or downwardly projecting parts 6, preferably substantially triangular in cross-section and tapering downwardly toward the substrate. These parts are arranged to define L-shaped lines which interfit with one another in a plurality of sectoral patterns on the underside of the contact member 4. Four such sectoral patterns are shown in FIG. 3, but it will be apparent that the number of such patterns can be varied and that the angular relationship between the two legs of the L-shaped lines can likewise be varied, the term "L-shaped" comprehending a pair of legs which meet at a vertex even if the angle at that vertex be less than or greater than 90°, that angle being here illustrated as 90°.

The term "helix" as used in connection with the configuration of the conductive paths is not limited to a circular helix but is inclusive thereof. As specifically shown in FIG. 2 the helix is square, but it could be rectangular, triangular, hexagonal, pentagonal or the like.

Because of the relative arrangement of the conductive paths 2*a* and 2*b* on the one hand and the lands 6 on the other hand, when the push-button 3 is depressed and the contact member 4 is moved down into engagement with the conductive pattern on the substrate 1, the lands 6 will be substantially at right angles to the direction in which those portions of the conductive paths which they bridge extend, thus enhancing the "feel" characteristics of the switch and preventing "chattering," and this no matter whether the push-button member 3 is pushed down vertically or obliquely. Moreover, each length of an operative land 6 will bridge the conductive paths 2*a* and 2*b* at a multiplicity of points, so that even if only a small portion of the contact member 4 is brought into engagement with the conductive paths, the bridging of those paths will be effective with an exceptionally high degree of reliability with so many bridgements being made that it will make no appreciable difference, insofar as the electrical characteristics of the switch are concerned, whether the whole of the contact member 4 engages the conductive strips or only a portion thereof does.

While but a single embodiment of the present invention has been here specifically disclosed, it will be apparent that variations may be made therein all within the scope of the invention as defined in the following claims.

We claim:

1. A push-button switch comprising a substrate having an upper surface, two conductive networks on said surface comprising adjacent but separated conductive paths, a terminal connected to each of said networks, a push-button member operatively connected to said substrate, normally assuming a first position remote from said substrate upper surface and being resiliently movable to a second position closer to said substrate upper surface, and a contact member operatively connected to said push-button member and movable therewith between corresponding first and second positions respectively spaced from and engaging said substrate surface in registration with said networks, said contact member being made of elastic and electrically conductive material and engaging said networks over an appreciable area, thereby to complete an electric circuit between said conductive paths when engaged with said networks, said conductive networks each comprising an outside portion defining said terminal and a helical or arcuate conductive path extending therefrom, the conductive paths of said two networks extending substantially side by side but separated one from the other, the surface of said contact member facing said substrate upper surface being provided with a series of substantially linear downward projections arranged in a pattern of L-shaped lines.

2. The push-button switch of claim 1, in which said L-shaped lines are arranged in a plurality of sectors.

3. The push-button switch of claim 1, in which the surface of said contact member facing said substrate upper surface is provided with a series of substantially linear downward projections arranged in a pattern of L-shaped lines.

4. The push-button switch of claim 3, in which said L-shaped lines are arranged in a plurality of sectors.

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