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(54) **An electrical push-button switch covering member of rubber material**

(57) A rubber member 3 for a circuit board 7 has a resilient dome-like configuration composed of a central raised portion 1b, a thick-walled base flat 2 and a thin-walled riser portion 3a, 3b integrally connecting them, in which two ring-wise ribs 1c, 6 are provided one 1c around the upper periphery of the central portion and the other 6 at the midway on the inward surface of the riser portion 3a, 3b extending downwardly. When the central portion is depressed at the rib 1c by a finger tip through a push-button 10, the rib 6 first comes into contact with the circuit board 7 and then is pulled up resiliently by the snap action in the riser portion 3a, 3b bringing a movable contact 4 into contact with fixed contact points 8. The switching performance is allegedly freed from chattering or bouncing.

FIG. 3

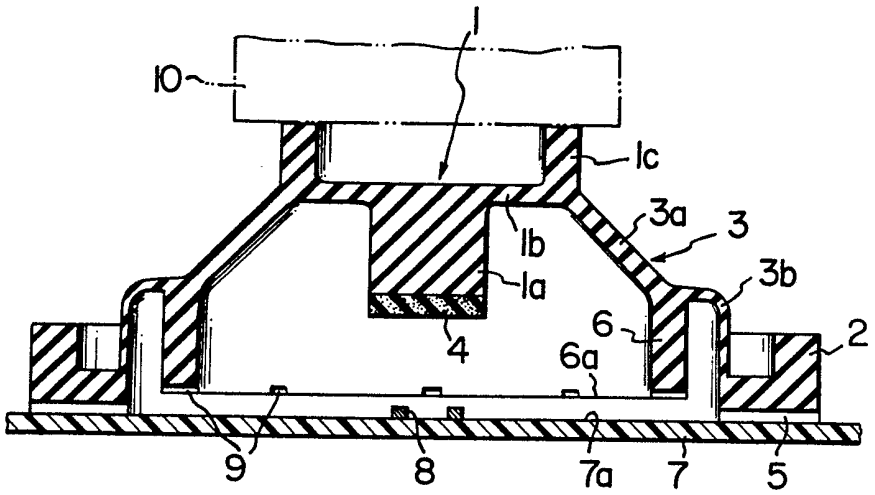

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FIG. 1a

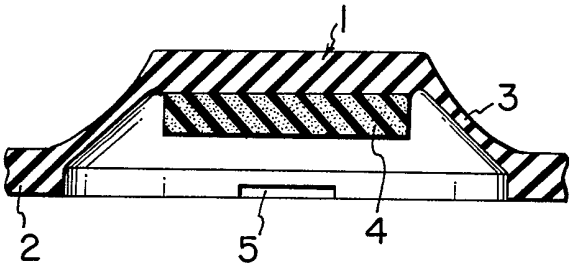

FIG. 1b

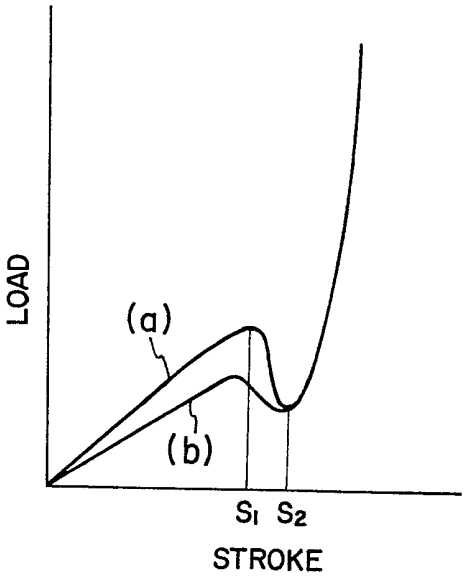

FIG. 2a

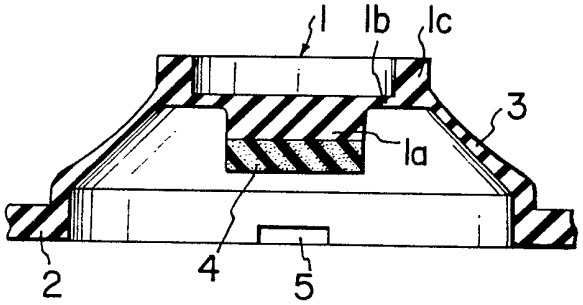

FIG. 2b

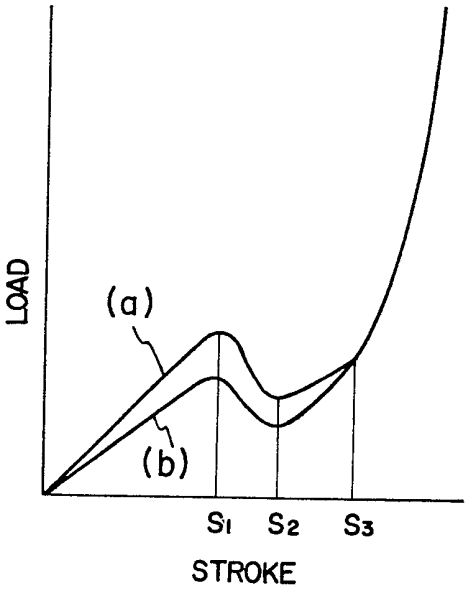

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FIG. 3

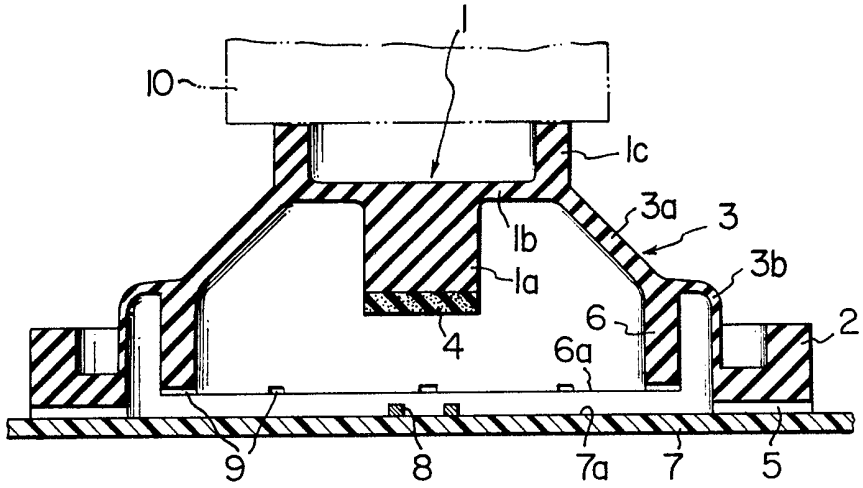


FIG. 4

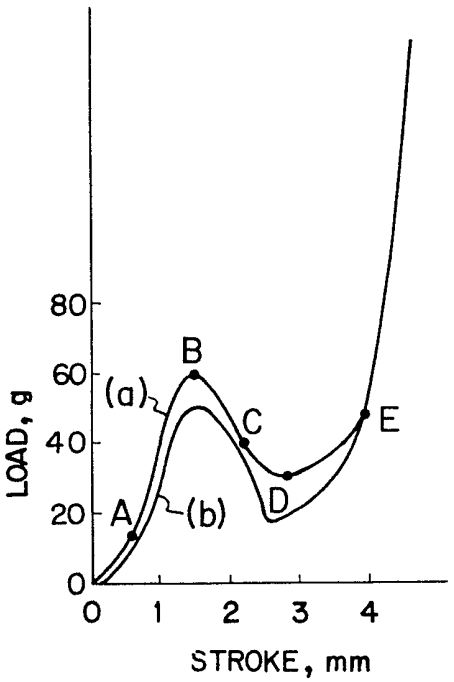
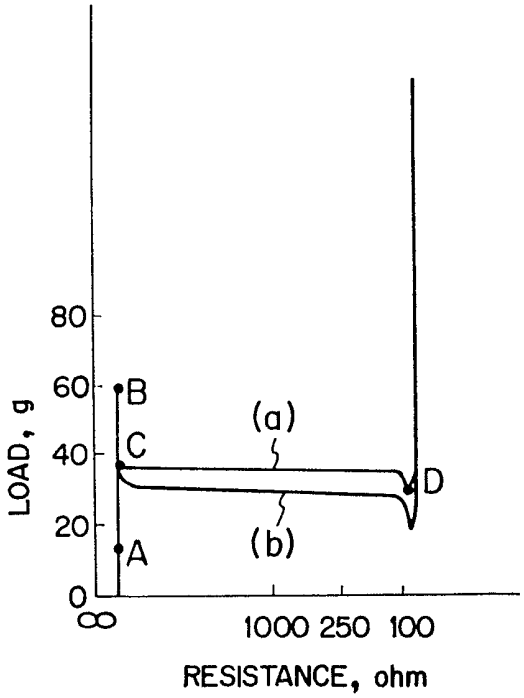


FIG. 5



SPECIFICATION

A rubber-made push-button switch covering member

BACKGROUND OF THE INVENTION

The present invention relates to a novel and improved rubber-made push-button switch covering member.

As is well known, many types of push-button switches are provided with a rubber-made covering member which is pushed and depressed by a finger tip or a suitable pushing means so as to bring the movable contact point into contact with the fixed contact points to close the electric circuit.

Typically, such a rubber-made push-button switch covering member mountable on a circuit board bearing the fixed contact points thereon has an integral configuration of dome-like appearance comprising a central flat portion having a relatively large thickness at which the pushing finger tip is put, a thick-walled ring-wise base flat surrounding the central flat pushing portion and having a larger diameter than the central flat portion and a thin-walled riser portion conjunctively connecting the central flat portion and the ring-wise base flat in such a manner that the central pushing flat portion is raised above the bottom surface of the ring-wise base flat or, in other words, above the surface of the circuit board when the covering member is mounted on the circuit board. The movable contact point is usually borne on the lower surface of the central flat pushing portion so that, when the covering member is pushed at the central flat portion with a finger tip and the like downwardly, the movable contact point on the lower surface of the central flat portion is brought into contact with the fixed contact points below on the circuit board to close the electric circuit and, when the pushing finger tip is removed, the depressed central flat portion returns to the undepressed state by virtue of the rubbery resilience so that the movable contact point in contact with the fixed contact points is brought apart from the fixed contact points to open the electric circuit.

Various modifications have been proposed in order to improve the switching performance of the above described type of the rubber-made push-button switch covering member and also to decrease the fatigue of the switch operator. For example, the central flat portion has a relatively large thickness only at the center portion having a smaller diameter than the central flat portion per se or is protruded at the center portion downwardly to bear the movable contact point thereon and a ring-wise rib is provided along the upper periphery of the central flat portion so that the downward pushing force is given to the central flat portion only at this ring-wise rib. With such a configuration of the covering member or, in particular, of the central flat portion, a so-called overstroke is obtained in the pushing of the switch because the peripheral portion of the central flat portion having a small thickness and surrounding the center portion can be further bent and depressed downwardly even after the movable contact point has come into contact with fixed contact points.

In the above described types of the conventional rubber-made push-button switch covering members, it is usual that the thin-walled riser portion behaves in a so-called snap action or click action which is a phenomenon that a sudden or abrupt reversal of the bending mode takes place in the portion at certain stroke so that the pushing load on the central flat pushing portion undergoes delicate changes whereby the switch operator is given a perception of the contacting between the movable and fixed contact points. There has been a problem, however, in such a switch performance that, since the snap action or click action is so delicate in nature, the switch performance is sometimes unreliable due to the phenomena of bouncing and chattering as a result of an uncontrollable change in the pushing load.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to provide a novel and improved rubber-made push-button switch covering member of the above described type which is free from the problems and defects in the conventional covering members of the similar types.

Thus, the switch covering member of the present invention is a rubber-made push-button switch covering member mountable on a circuit board bearing fixed contact points thereon and having an integral dome-like configuration as a whole as composed of a thin-walled central portion raised above the surface of the circuit board when the member is mounted thereon and provided with a downward protrusion on the lower surface thereof to bring a movable contact point into contact with the fixed contact points, a ring-wise thick-walled base flat having a larger diameter than the central portion and surrounding the central portion to rest on the circuit board and a thin-walled riser portion surrounding the central portion and conjunctively connecting the central portion and the ring-wsie base flat, in which a first ring-wise rib is provided along the periphery of the upper surface of the central portion as protruded upwardly and a second ring-wise rib is provided at the midway of the lower surface of the thin-walled riser portion as extending downwardly to divide the riser portion into an inner ring-wise portion and an outer ring-wise portion, the lower end of the second ring-wise rib being at a height not to reach the plane of the bottom surface of the ring-wise base flat.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1a is a cross sectional view of a conventional rubber-made push-button switch covering member and Fig. 1b is a graph schematically showing the relationship between the pushing stroke and the pushing load in the push-button switch covering member illustrated in Fig. 1a.

Figure 2a is a cross sectional view of another conventional rubber-made push-button switch covering member and Fig. 2b is a graph schematically showing the relationship between the pushing stroke and the pushing load in the push-button switch covering member illustrated in Fig. 2a.

Figure 3 is a cross sectional view of a rubber-made push-button switch covering member of the invention mounted on a circuit board.

Figure 4 is a graph showing the relationship between the pushing stroke and the pushing load in a typical example of the rubber-made push-button switch covering members of the invention as illustrated in Fig. 3.

Figure 5 is a graph showing the relationship between the pushing load and the electric resistance between the fixed contact points bridged with the movable contact point in an example of the rubber-made push-button switch covering members of the invention as illustrated in Fig. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The rubber-made push-button switch covering member of the invention and the switching performance thereof are now described in detail with reference to the accompanying drawing in contrast with conventional ones.

In the first place, Fig. 1a illustrates a cross sectional view of a typical or basic model of the conventional rubber-made push-button switch covering member. In this figure the covering member has an integral dome-like configuration made of a rubber and composed of a relatively thick central flat portion 1, a thick-walled ring-wise base flat 2 having a diameter larger than the central flat portion 1 and surrounding the central flat portion 1 and a thin-walled riser portion 3 conjunctively connecting the central flat portion 1 and the base flat 2 in such a manner that the central flat portion 1 is raised above the bottom surface of the base flat 2 or, in other words, above the surface of a circuit board (not shown in the Fig.) when the covering member is mounted on the circuit board to give a dome-like appearance.

A movable contact point 4 made of, for example, an electroconductive rubbery material is provided by adhesive bonding on the lower surface of the thick-walled central flat portion 1 to face the fixed contact points on the circuit board. Needless to say, the lower surface of this movable contact point 4 is at a level higher than the bottom surface of the base flat 2 so as to keep an adequate switching stroke above the fixed contact points when the covering member is mounted on the circuit board.

When the central flat portion 1 is pushed and depressed downwardly with a finger tip or other suitable means, the movable contact point 4 is brought into contact with the fixed contact points therebelow to close the electric circuits between them while, when the pushing force is released, the movable contact point 4 comes apart from the fixed contact points in contact therewith by virtue of the rubbery resistance of the riser portion 3 to return to the original undepressed position so that the electric circuit between the fixed contact points is open. Meanwhile, the covering member is usually provided with one or more of air-escapes 5 in order to facilitate depression and, in particular, resilient return of the central flat portion 1.

As is illustrated in Fig. 1b showing the relationship between the pushing stroke as the abscissa and the pushing load as the ordinate in the rubber-made push-button switch covering member of Fig. 1a, the pushing load increases relatively slowly in approximate proportion with the pushing stroke along the curve (a) at least in the initial stage of pushing at the central flat portion 1. This increase in the pushing load is provided by the resistance of the riser portion 3 bent downwardly. When the pushing stroke is increased to reach a certain critical point S_1 on the curve (a), the pushing load is suddenly decreased with the further increase of the pushing stroke due to the reversed bending in the riser portion 3. This phenomenon is called a snap action or click action. When this phenomenon of snap action takes place, the pushing load is rapidly decreased to reach a minimum value at a pushing stroke indicated by S_2 on the curve (a) when the movable contact point 4 comes into contact with the fixed contact points on the circuit board. When the movable contact point 4 has once come into contact with the fixed contact points, the pushing load rapidly increases even by a small increase in the pushing stroke as a result of the compression of the central flat portion 1 and/or the movable contact point 4 by pushing.

As is understood from the above explanation, substantially no overstroke, i.e. an increment of the pushing stroke beyond the point S_2 obtained without substantial and rapid increase in the pushing load, is obtained in the covering member of this type. When the pushing force is removed from the central flat portion 1, the relationship between the pushing stroke and the pushing load follows a somewhat different curve shown by (b), which is usually closer to the axis of the abscissa, in Fig. 1b.

Figure 2a illustrates another rubber-made push-button switch covering member of an improved configuration by a cross sectional view with which an overstroke can be obtained differently from the covering member illustrated in Fig. 1a. In place of the mere flat portion 1 having a relatively large thickness at the center of the dome in the covering member of Fig. 1a, the central pushing portion 1 of this covering member is formed in such a manner that only the center portion 1a has a relatively large thickness as surrounded by a thin ring-wise peripheral portion 1b. In other words, the central flat portion has a relatively small thickness but is provided with a downward protrusion 1a at the center thereof leaving a thin marginal portion 1b therearound. The movable contact point 4 is provided on the lower surface of this thick-walled center portion 1a by adhesive bonding. Further, a ring-wise rib 1c is integrally provided along the periphery of this central flat portion 1 on the upper surface thereof. In the use of such a push-button switch covering member as built in a switching unit, e.g. a keyboard, an assemblage is provided that the pushing force for the depression of the central pushing portion 1 is given only to the ring-wise rib 1c and the downward movement of the movable contact point 4 is caused as a result of the downward movement of the marginal portion 1b.

Figure 2b shows the stroke-load relationship in the switch covering member illustrated in Fig. 2a similar to Fig. 1b. The gradually increasing pushing load as the stroke increases along the curve (a) suddenly decreases at the point S_1 when a snap action takes place in the riser portion 3 and the movable contact point 4 is brought into contact with the fixed contact points at the point S_2. With further increase in the pushing stroke beyond the point S_2, however, the increase in the pushing load is not so rapid as in Fig. 1b at least up to some limit S_3 because the pushing force is not directly at the central protrusion 1a on the movable contact point 4 but only at the ring-wise rib 1c allowing a resilient downward bending of the thin-walled marginal portion 1b relative to the movable contact point 4. The increment of the pushing stroke between the points S_2 and S_3 is called an overstroke. Beyond the point S_3, the pushing load increases rapidly and, when the pushing force on the ring-wise rib 1c is removed, the stroke-load relationship follows the curve (b) in the same manner as in Fig. 1b.

In the above described conventional rubber-made push-button switch covering members, the switch operator obtains the perception of the condition of contacting between the movable and fixed contact points by the feeling at his finger tip but such a feeling at the finger tip is so delicate that certain unreliableness is unavoidable in the pushing force by the finger tip and, despite the perception of switching by the operator, the performance of the switch is sometimes subject to the phenomena of chattering and/or bouncing.

Now, the rubber-made push-button switch covering member of the invention is illustrated with reference to Fig. 3 showing a cross sectional view. The covering member is integrally formed of an electrically insulating rubbery material and has a dome-like appearance as a whole. The thin-walled central portion 1 has a similar configuration as in the model illustrated in Fig. 2a and is provided with a downward protrusion 1a at the center thereof leaving a thin-walled marginal portion 1b surrounding the central protrusion 1a. The movable contact point 4 made of an electroconductive material, which is not particularly limitative including conductive rubbers, metals, carbonaceous materials and the like as well as a printed pattern or coating layer formed with an electroconductive ink or paint, is provided on the lower surface of the central protrusion 1a by adhesive bonding although it is optional that the central protrusion 1a as a whole is made of an electroconductive rubber. Needless to say, the lower surface of the movable contact point 4 is at a level higher than the bottom surface of the thick-walled base flat 2 or, in other words, than the fixed contact points 8 on a circuit board 7 when the covering member is mounted on the circuit board 7 to have the movable contact point 4 facing the fixed contact points 8 so as to leave an adequate switching stroke therebetween. Also similarly to the model illustrated in Fig. 2a, a first ring-wise rib 1c is provided along the upper periphery of the central portion 1 at which the downward pushing force is applied to the switch, for example, through a push-button 10 mounted thereon. It is essential that the thin-walled ring-wise marginal portion 1b is left between the downward protrusion 1a and the ring-wise rib 1c.

The central portion 1 is connected to the thick-walled base flat 2 by a riser portion 3 conjunctively in the same manner as in the conventional models illustrated in Figs. 1a and 2a. In this case, however, the riser portion 3 is provided at the midway between the central portion 1 and the base flat 2 with a second ring-wise rib 6 downwardly protruded on the lower surface thereof so that the riser portion 3 is divided into the inner ring-wise portion 3a and the outer ring-wise portion 3b by the ring-wise rib 6. It may also be needless to say that the lower end 6a of this ring-wise rib 6 is at a level higher than the bottom surface of the base flat 2 or, in other words, than the surface 7a of the circuit board 7 to leave an adequate space or stroke when the covering member is mounted on the circuit board 7 with the base flat 2 resting thereon. It is essential that the distance between the

lower end 6a of the second ring-wise rib 6 and the surface 7a of the circuit board 7 is smaller than the switching stroke between the lower surface of the movable contact point 4 and the fixed contact points 8 on the circuit board 7. Further it is essential that the height of the lower end 6a of the second ring-wise rib 6 is lower than the lower surface of the movable contact point 4.

The switching performance of the above illustrated rubber-made push-button switch covering member of th invention is now explained with reference to Figs. 4 and 5. Fig. 4 is a graph showing the relationship of the pushing stroke in mm as the abscissa vs. pushing load in g as the ordinate in a similar manner to Figs. 1b and 2b. When a downward pushing force is applied to the ring-wise rib 1c of the covering member mounted on a circuit board 7, for example, by means of a push-button 10 mounted thereon, if desired, with a spring means therebetween, the outer ring-wise portion 3b of the riser portion 3 is first downwardly bent by buckling so that the lower end 6a of the ring-wise rib 6 is brought into contact with the surface 7a of the circuit board 7. This corresponds to the points A in Figs. 4 and 5. In order that the buckling deformation of the riser portion 3 takes place first at the outer ring-wise portion 3b, it is an essential condition that the resistance of the outer ring-wise portion 3b against buckling is smaller than of the inner ring-wise portion 3a.

When the lower end 6a of the second ring-wise rib 6 has come into contact with the surface 7a of the circuit board 7, further depression at the first ring-wise rib 1c causes bending of the inner ring-wise portion 3a which is somewhat stronger than the outer ring-wise portion 3b so that the stroke-load curve in Fig. 4 rises more rapidly until a snap action takes place in this inner ring-wise portion 3a reaching the points B in Figs. 4 and 5 to cause a sudden decrease of the pushing load as is shown in Fig. 4. It should be noted here that, in the course of the snap action taking place in the inner ring-wise portion 3a, the second ring-wise rib 6 is lifted up with the reversed movement of the boundary line between the inner and outer ring-wise portions 3a and 3b, i.e. the upper end of the second ring-wise rib 6, so that the lower end 6a thereof comes apart from the surface 7a of the circuit board 7 at the point C in Figs. 4 and 5 with almost simultaneous contacting of the movable contact point 4 with the fixed contact points 8. The snap action in the inner ring-wise portion 3a is completed at the points D in the figures when the movable contact point 4 has come into contact with the fixed contact points 8 on the circuit board 7 to close the electric circuit therebetween.

Further depression of the first ring-wise rib 1c beyond the point D in the figures results in an overstroke toward the point E mainly by virtue of the resilient downward bending of the thin-walled marginal portion 1b of the central portion 1 bringing the second ring-wise rib 6 again into contact with the surface 7a of the circuit board 7, beyond which the pushing load increases rapidly with small increase in the pushing stroke as is shown in Fig. 4 while the electric resistance between the fixed contact points 8 remains substantially unchanged in the region beyond the point D in Fig. 5.

It is noteworthy that the operator of the push-button switch with the inventive covering member obtains a perception of switching when the lower end 6a of the second ring-wise rib 6 comes into the second contacting with the surface 7a of the circuit board 7. Therefore, the perception of switching by the operator's feeling with his finger tip is obtained only after the pushing stroke has passed away the points C in Figs. 4 and 5 to reach the points D or further or, in other words, the movement of switching by the contacting between the movable and fixed contact points 4 and 8 precedes the operator's perception of switching by the feeling of his finger tip so that the switching performance is never influenced by the operator's delicate and unreliable feeling and very reliable switching performance is obtained without suffering the phenomena of chattering and bouncing.

Several conditions are important in order that the switching performance of the inventive covering member proceeds according to the above described sequence of the movements of the individual parts. For example, the buckling deformation of the outer ring-wise portion 3b of the riser portion 3 should take place at a smaller pushing load than the inner ring-wise portion 3a and the buckling deformation of the inner ring-wise portion 3a of the riser portion 3 should take place before the thin marginal portion 1b of the central flat 1 is bent downwardly. Furthermore, the second ring-wise rib 6 should come into contact with the circuit board 7 by the buckling deformation of the outer ring-wise portion 3b of the riser portion 3 while it should come apart from the circuit board 7 by the snap action successively taking place in the inner ring-wise portion 3a of the riser portion 3 and should again be brought into contact with the circuit board 7 in the course of the overstroke. Meanwhile, the lower end 6a of the second ring-wise rib 6 is preferably provided with one or more of air-escapes 9 in addition to the air-escapes 5 provided on the bottom surface of the base flat 2 in order to facilitate air flow between inside and outside of the dome-like space under the covering member.

Although the above description is given for a single switching unit, it is of course optional that two or more of the doem-like structures are integrally conjoined to give a sheet-like

covering member for a multiplicity of switching units as in a key-board. It is further optional that, while, in the above description, the movable contact point 4 is directly bonded to the downward protrusion 1a of the central portion 1, the downward protrusion 1a is not provided with the movable contact point but, instead, an electroconductive rubbery membrane is sandwiched between the base flat 2 and the circuit board 7 with a sheet-like spacer having openings in the positions corresponding to the pairs of the fixed contact points in between so that the electric circuit between the fixed contact points is closed when the electroconductive membrane is depressed to contact with the fixed contact points through the above mentioned opening in the spacer by the downward movement of the central protrusion 1a. It is not always necessary that the inventive covering member is formed of an electrically insulating rubber but it may be formed with an electroconductive rubber so that the covering member serves as a common electrode. Further, although the first and the second ring-wise ribs 1c and 6 illustrated in Fig. 3 each have a complete circular form, there may be provided with several notches in the circular rib provided that a substantially circular sequence of segment ribs is obtained in place of a complete circular rib.

As is understood from the above description, the most important characteristic in the inventive switch covering member is obtained by second ring-wise rib 6, by virtue of which the change in the pushing load up to the moment of the snap action against the increase in the pushing stroke can be larger in the course of the switching operation along with the snap action taking place more definitely. The push-button switching unit provided with the inventive covering member is advantageously freed from the phenomena of chattering and bouncing because the operator of the switch obtains a perception of switching at his finger tip only after the movable contact point has come into contact with the fixed contact points.

CLAIMS

1. A push-button switch covering member made of a material having rubbery resilience and mountable on a circuit board bearing fixed contact points thereon and having an integral dome-like configuration as a whole as composed of a thin-walled central portion raised above the surface of the circuit board when the member is mounted thereon and provided with a downward protrusion on the lower surface thereof to bring a movable contact point into contact with the fixed contact points leaving a thin-walled ring-wise marginal portion therearound, a ring-wise thick-walled base flat having a larger diameter than the central portion and surrounding the central portion to rest on the circuit board and a thin-walled riser portion surrounding the central portion and conjunctively connecting the central portion and the ring-wise base flat, in which a first ring-wise rib is provided along the periphery of the upper surface of the central portion as protruded upwardly leaving the thin-walled ring-wise portion around the downward protrusion and a second ring-wise rib is provided at the midway of the lower surface of the thin-walled riser portion as extending downwardly to divide the riser portion into an inner ring-wise portion and an outer ring-wise portion, the lower end of the second ring-wise rib being at a height not to reach the plane of the lower surface of the ring-wise base flat and lower than the bottom surface of the downward protrusion on the lower surface of the central portion.

2. The push-button switch covering member as claimed in claim 1 wherein the movable contact point is adhesively bonded to the lower surface of the downward protrusion on the lower surface of the central portion.

3. The push-button switch covering member as claimed in claim 1 wherein the movable contact point is formed on the lower surface of the downward protrusion by applying an electroconductive ink or paint thereto.

4. The push-button switch covering member as claimed in claim 1 wherein the outer ring-wise portion of the riser portion has a smaller buckling strength than the inner ring-wise portion thereof.

5. A push-button switch covering member substantially as hereinbefore described with reference to Fig. 3 of the drawings.

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