United States Patent [19]

Lynn et al.

[11] **3,860,771**

[45] **Jan. 14, 1975**

[54] **KEYBOARD SWITCH ASSEMBLY WITH DOME SHAPED ACTUATOR HAVING ASSOCIATED UNDERLYING CONTACTOR MEANS**

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[73] Assignee: **Chomerics, Inc.**, Woburn, Mass.

[22] Filed: **Oct. 29, 1973**

[21] Appl. No.: **410,329**

[52] **U.S. Cl.** ..... **200/5 A**, 200/76, 200/1 R, 200/5 R, 200/159 B, 200/262, 200/265, 200/302, 200/329, 200/333, 200/340, 197/98, 235/145 R

[51] **Int. Cl.** **H01h 13/70**, H01h 1/02

[58] **Field of Search** ..... 200/1 R, 5 R, 5 A, 16 A, 200/DIG. 1, 67 DA, 67 DB, 76, 159 R, 159 A, 159 B, 166 C, 166 PC, 172 R, 245, 262–270, 302, 329–340; 197/98–103; 235/145 R; 340/365 R

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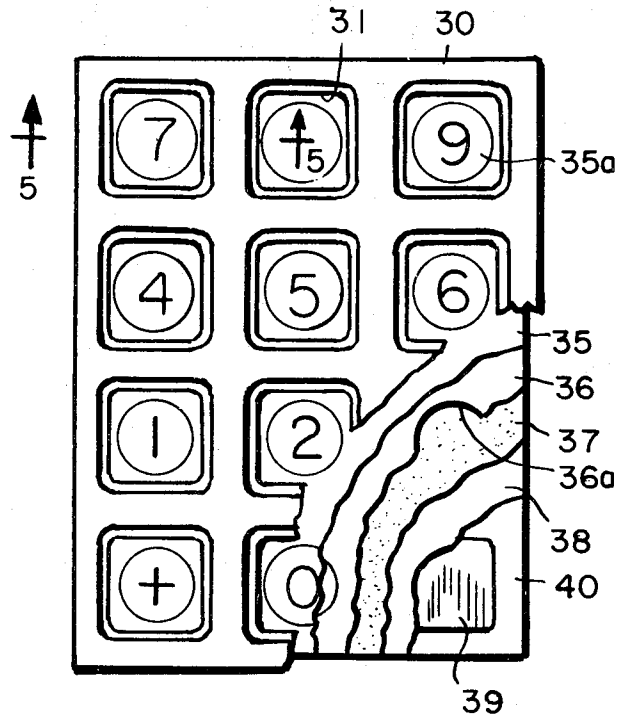
Primary Examiner—James R. Scott

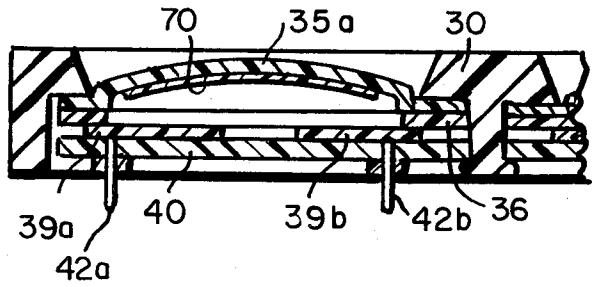
Attorney, Agent, or Firm—Dike, Bronstein, Roberts, Cushman & Pfund

[57] **ABSTRACT**

A keyboard device utilizing a conductive plastic material layer which contacts circuit elements or pathways, the improvement of snapable plastic means raised on a pedestal through which it snaps through center to provide a feel of completion of circuit contact to the user.

46 Claims, 23 Drawing Figures





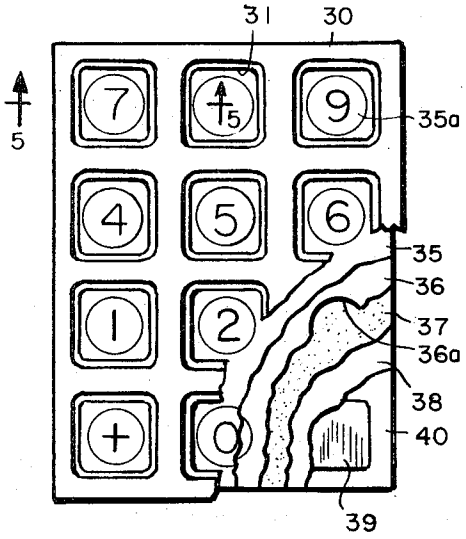


FIG. 1

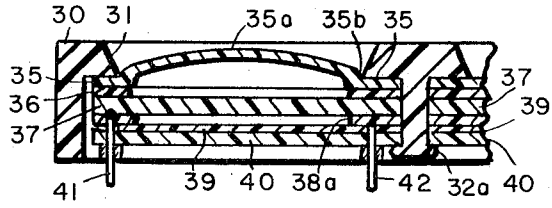


FIG. 5

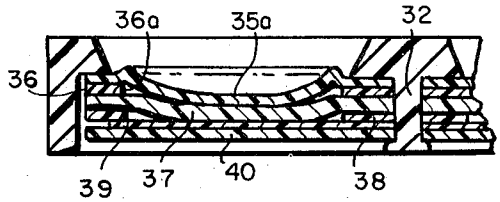


FIG. 6

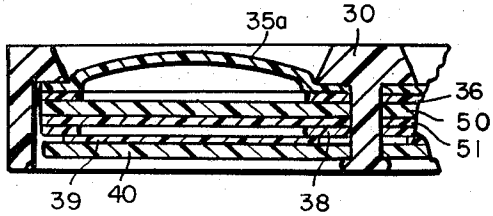


FIG. 7

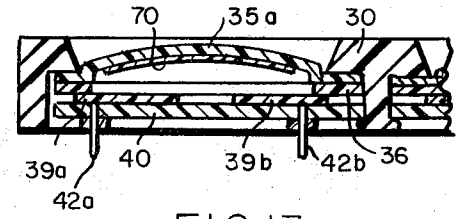


FIG. 13

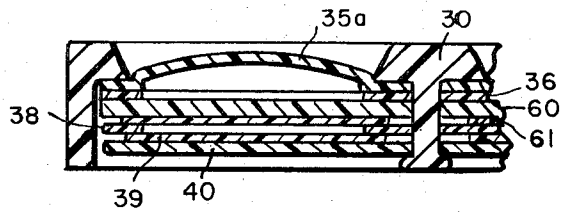


FIG. 8

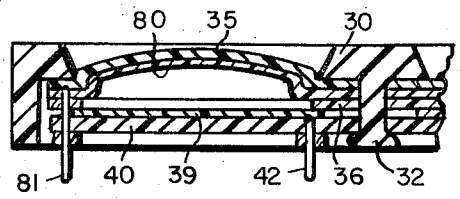


FIG. 16

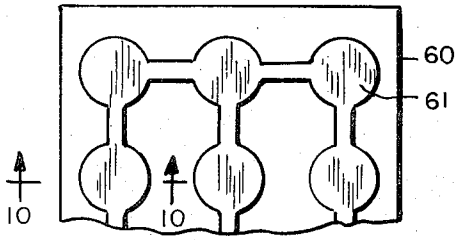


FIG. 9

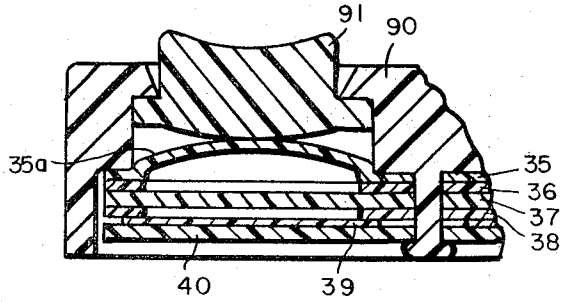


FIG. 19

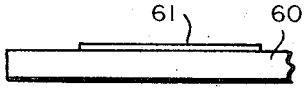


FIG. 10

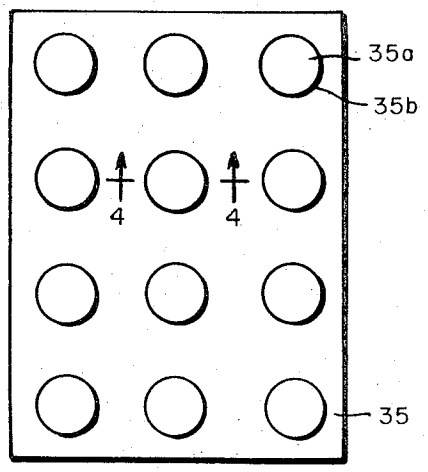


FIG.2

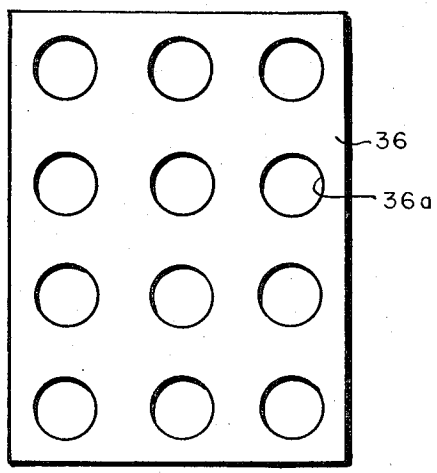


FIG.3

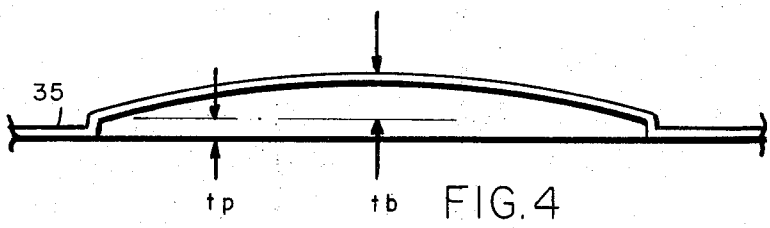


FIG.4

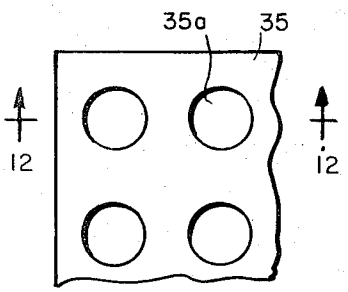


FIG.11

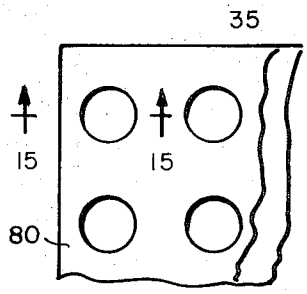


FIG.14

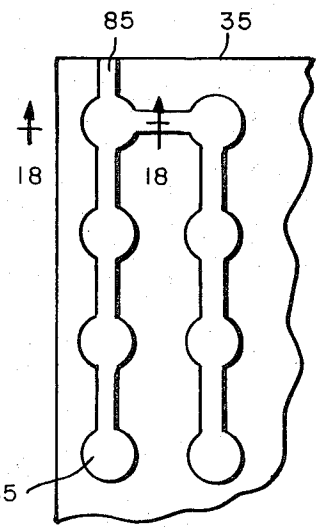


FIG.17

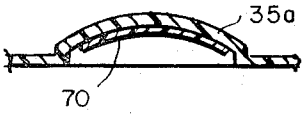


FIG.12

FIG.15

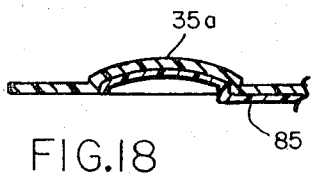


FIG.18

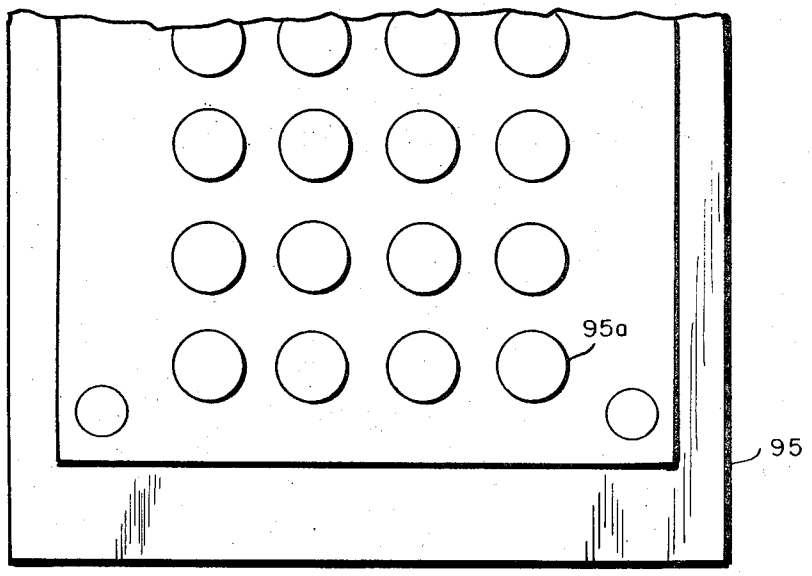


FIG.20

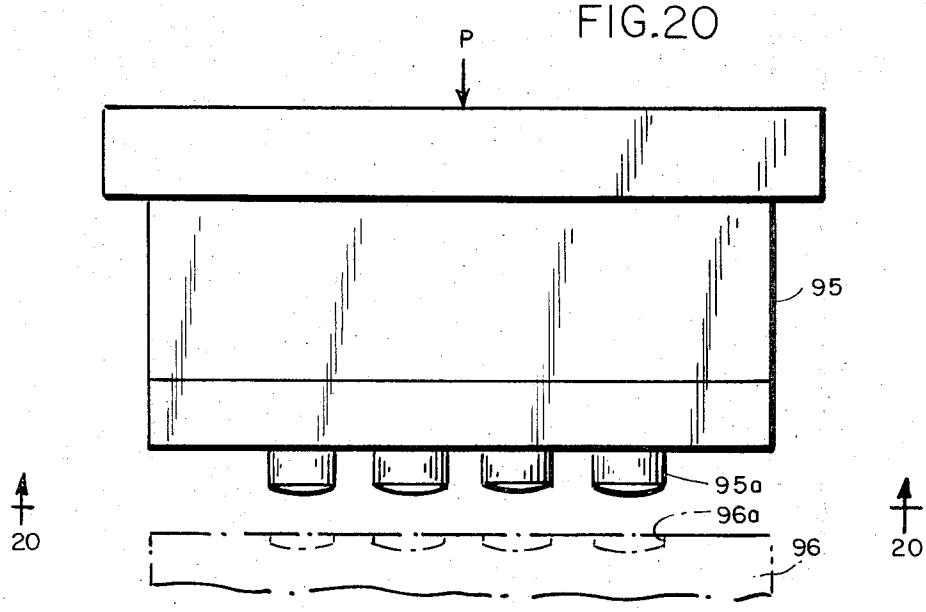


FIG.21

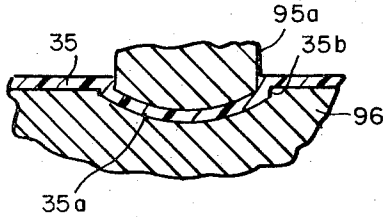


FIG.22

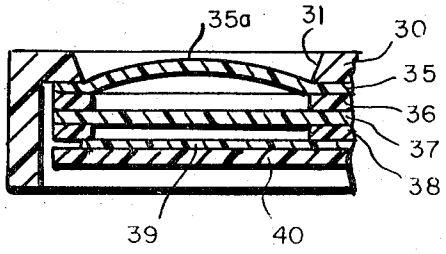


FIG.23

KEYBOARD SWITCH ASSEMBLY WITH DOME SHAPED ACTUATOR HAVING ASSOCIATED UNDERLYING CONTACTOR MEANS

BACKGROUND OF THE DISCLOSURE

This invention is directed a a new, improved and inexpensive method to manufacture (in comparison with the prior art) keyboard devices which include new and improved means to effect the users sense of feel so as to provide the user with confidence that electrical connection has been made.

Within the last few years the personal calculator market has mushroomed with the result that many manufacturers have entered the business. With numerous manufacturers competing for the same market, the price of culculators have begun to decrease rapidly.

Accordingly, as prices fell, calculator manufacturers looked for ways to cut their manufacturing and component part costs.

In order to attempt to satisfy the cost reduction efforts of calculator manufacturers, keyboard manufacturers also had to develop new and improved techniques to reduce their manufacturing and parts costs.

The present invention represents the results of one such effort in cost reduction and provides less costly to manufacture keyboards in comparison with other keyboards previously and presently offered by the assignee of this application. For example, see U.S. Pat. Nos. 3,705,276, 3,721,778, 3,780,237, and 3,773,998, and application on file in the U.S. Patent Office and assigned to Chomerics, Inc.

Attention is also directed to U.S. Pat. Nos. 3,699,294, 3,707,609, 3,120,583, 3,600,528, 3,594,684 and 3,476,972 among many others which disclose other keyboard configurations.

BRIEF SUMMARY OF THE DISCLOSURE

This invention is directed to a keyboard in various configurations for providing an encoded signal representative of key depression. As part of this keyboard there is provided a resilient and flexible material layer in which there is provided a plurality of raised buttons, e.g., a cylindrical pedestal having straight or sloped walls topped or capped by a portion of a curved surface e.g., a portion of a sphere.

In the preferred embodiment, indicia, e.g., numbers, letters, or symbols are printed on the curved surfaces so that they may be seen by the user. In the preferrred embodiment, the raised protrusions not only carry the indicia of the keyboard but also act and feel like snap acting keys when depressed although they are many times less costly to manufacture.

In other configurations the sheet having the plurality of protrusions is used in conjunction with a key to provide the key or button user with the snap action indicative of contact closure.

As another feature of this invention, it has been determined that a better snap action is obtained if a separator or snap through layer of material (insulator) having a plurality of holes or openings (about the same size as the bottom of the pedestal) is positioned immediately below the layer carrying the protrusions with each opening in register with a different one of the pedestal bottoms.

It has been found that with the separator layer, the curved surfaces snap better through the center upon depression and feels more like the depression of a key.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a top view of a keyboard according to this disclosure with parts broken away;

FIG. **2** is a top view illustrating a plurality of snap action protrusions in a sheet of the keyboard;

FIG. **3** is a top view of the first and second separator sheet of the device of FIG. **1**;

FIG. **4** is a sectional view taken along line **4—4** in FIG. **3**;

FIG. **5** is a sectional view taken along line **5—5** in FIG. **1** illustrating the moving parts of the keyboard before being depressed;

FIG. **6** is a sectional view of the keyboard illustrating the moving parts of the keyboard after being depressed;

FIG. **7** illustrates in a sectional view taken similarly to FIG. **5** another embodiment of the keyboard;

FIG. **8** illustrates in a sectional view taken similarly to FIG. **5** another embodiment of the keyboard;

FIG. **9** illustrates in a bottom view the contactor means of the keyboard of FIG. **8**;

FIG. **10** is a sectional view taken along line **10—10** of FIG. **9**;

FIG. **11** illustrates in a bottom view the sheet with protrusions supporting an isolated layer of electrically conductive contactor means;

FIG. **12** is a sectional view taken along line **12—12** of FIG. **11**;

FIG. **13** is a sectional view taken similarly to FIG. **5** illustrating the contactor means and sheet shown in FIGS. **11** and **12**;

FIG. **14** is a bottom view of the sheet with protrusions covered by a layer of electrically conductive contactor means;

FIG. **15** is a sectional view taken along line **15—15** of FIG. **14**;

FIG. **16** is a sectional view similar to FIG. **5** illustrating the coated sheet of FIGS. **14** and **15** in the keyboard;

FIG. **17** is a bottom view of the sheet with protrusions covered by a layer of conductive circuitry or circuit pattern for making contact with contact elements of a circuit board;

FIG. **18** is a sectional view taken along line **18—18** of FIG. **17**;

FIG. **19** illustrates in a sectional view a modified keyboard using a button to depress the protrusions of the sheet;

FIGS. **20** and **21** illustrates in a top and bottom view an apparatus suitable for forming the protrusions in the sheet of the FIGS;

FIG. **22** illustrates the protrusion being formed in the plastic sheet; and

FIG. **23** illustrates in a sectional view similar to FIG. **5**, a keyboard constructed of a sheet means having a plurality of curved protrusions without a pedestal.

DETAILED DESCRIPTION OF THE DISCLOSURE

Reference should now be had to FIGS. **1–6** for a description of a keyboard embodying the invention. In these FIGS. a keyboard is disclosed as having a frame **30** e.g., of a plastic, e.g., polysterene; polypropylene or other high impact plastics well known in the art.

The frame is open at the bottom and is provided with a plurality of windows or openings **31** and a plurality of rods **32** extending downwardly. Heads **32***a* may be formed by heat depending on the plastic used as shown

in FIGS. 5 and 6 to hold the layers to be described of the keyboard together as a unit. Alternatively the rods may be threaded and nuts may be used to do likewise.

Positioned below the frame top is a layer **35** preferably of a flexible and resilient plastic having a plurality of raised protrusions formed with a curved snapable portion **35***a* capping or on top of a pedestal **35** preferably cylindrically shaped although obviously its shape can vary somewhat so long as its side walls can easily spread outwardly as the snapable portions pass through the center (see FIG. **6**).

The plastic layer **35** may be of thermoplastic or thermosetting flexible and resilient plastic materials such as polyester e.g. Mylar, polypropylene, polyethelene, silicone rubbers, polyurethane, etc.

Positioned below the snapable layer there is preferably provided a snap through layer **36** e.g., of insulator material such as Mylar, having a plurality of windows or holes **36***a* of about the same size as the pedestal **35***b* bottom.

The snap through layer is used to provide the total feel of snap through by giving the snapable portion **35***a* enough room to fully invert. It should be understood that the snap through layer **35** is not necessary but is preferred to provide the best tactile feel in most cases.

Below the snap through layer is an elastomeric conductive plastic layer such as of silicone rubber filled with conductive particles such as silver as shown in U.S. Pat. No. 3,721,778 or in the aforementioned applications.

Other well known conductive particles such as carbon, gold, or composites thereof may be used as is well known in the art.

Positioned below the conductive plastic layer **37** is an insulator material separator layer **38** e.g., Mylar, polyethylene having the same configuration as the layer **36** in FIG. **3** and also having a plurality of holes or windows **38***a* which the elastomeric conductive layer **37** may be forced.

At **49** there is shown a typical circuit board e.g., of Bakelite having a conductive pattern **39** supported thereby. The conductive pattern may be etched copper or a conductive ink.

In this embodiments shown in FIG. **5** connecting pins are shown at **41** and **42** for making electrical contact with the conductive plastic layer **37** as well as the circuit pattern **39.**

In FIG. **6** there is shown pressure (by a finger) being applied to the snapable portion **35***a* and forcing it to snap through center to force the conductive plastic layer **37** through the separator **38** and into contact with one or more elements or pathways of the circuit pattern **39.**

Various circuit patterns may be observed in the aforementioned U.S. Pat. Nos. 3,705,276 and 3,721,778.

Upon release and removal of the finger, the protrusions comprising the snapable members **35***a* and pedestal **35***b* return to the unflexed position shown in FIG. **5** with the electrically conductive contactor or conductive plastic layer **37** also returning as shown.

Indicia such as numbers may be applied to the snapable portion **35***a* by printing techniques well known in the art or even paste-on numbers may be applied thereto. Thus the snapable members look like keys to the user. In practice it has been found that the layer with protrusions may comprise a 5 mil sheet of Mylar with the pedestal height t_p being 10 mils and the curved portion height being 21 mils and the pedestal bottom having a diameter of about ⅜ inch. The curved portion is a portion of a sphere having a 700 mil radius.

In FIG. **7** there is shown an alternate embodiment of the disclosure in that a composite contactor is formed of an elastomeric non-electrically conductive layer and a thin flexible conductive layer such as of a polyamide filled or loaded with conductive particles.

The elastomeric layer may be rubber such as silicone, nitrile, etc., and the flexible conductive layer may be of a polyamide adhesive e.g., Versalon 1140 by General Electric or others such as polyester, e.g., Mylar, filled with silver particles e.g., 20 to 40 volume percent. The thickness of the elastomeric layer may vary between 5 to 200 mils with about 20 mils being convenient and the flexible conductive layer **51** is preferably between 5 microns to about 2 mil in thickness with about 10 to 25 microns being preferred.

Since the remaining parts in this embodiment is the same, the same numbers designate like parts. In FIGS. **8–10** there is shown still a further embodiment with like parts being given like numeral designations.

In this embodiment the electrical contact is made between portions of a conductive pattern or conductive pathways **61** and portions or elements of the circuit board supported circuit pattern **39.**

The conductive pattern is supported by an elastomeric layer **60.** The pattern **61** may be sprayed on through a stencil to form the pattern **61.**

The flexible conductive plastic material used for the layer **61** is the same as the material used for the layer **51** and the elastomeric layer is also of the same material as layer **50.**

FIGS. **11–13** illustrate yet another embodiment of the invention. In this embodiment as well as the embodiments shown in FIGS. **14–18,** the elastomeric or flexible layers (conductive or non-conductive) as shown in FIGs. **1–10** are not used.

In FIGS. **11–13** the layer **35** supports layers of flexible electrically conductive plastic material **70** on the underside of the snapable members **35***a*. The layers **70** adhere thereto for movement with the snapable portions **35***a*. The flexible conductive plastic material may comprise a thin plastics such as epoxies, e.g., Nazdar Co. BE-170 epoxy; polyesters, e.g., General Formulation, Div. of General Research Inc. No. 140–1303. In addition adhesives may also be used to provide adherence of the layer **70** to the layer **35** with the above or other flexible conductive plastics.

The layer **70** is filled with electrically conductive particles such as silver, gold, carbon, etc., and in a volume percent of between 10 to 80 percent with 20 to 40 volume percent being preferred.

The thickness of the layer **70** is preferably 5 microns to 1 mil with 5 microns to 12 microns being preferred. The layer **70** preferably has a volume resistivity preferably less than 10 ohm cm, more preferably below 1 ohm cm, and most preferably below .5 ohm cm. The silver particles may be silflake 135 as is well known in the art.

The flexible conductive plastic layer **70** may comprise other materials such as polycarbonates (e.g., Lexan), epoxy (e.g., Corvel) polyacetate, polystyrine modified or unmodified by a plastisizer to obtain the desired flexibility to flex with the snapable members **35***a* and **35***b*.

A suitable formulation for the conductive layer **70** may comprise the mixture of 20 parts by weight of the BE-170 epoxy above, 80 parts by weight of Silflake 135. The formulation is then preferably applied to the layer **35** before forming the protrusions as in FIGS. **20–22.** The layer **70** may be applied to the layer **35** by knife coating it, silkscreening it or spraying it through a mesh or stencil. Thereafter the layer **70** is cured in an oven as is conventional in the art.

The protrusions **35***a* are now preferably formed. Alternatively, the layer **70** may be applied after the protrusions **35***a* are formed. Organic solvents e.g., such as NAZ DARS 70-182 Retarder Thinner conventional in the art may be added if desired to permit easy application of the layer **70.**

As may be seen in this embodiment of FIG. **13** the separator layer **38** is removed and the conductive pattern or elements **39** are separated into isolated elements **39***a* and **39***b* with contact pins **42***a* and **42***b* being coupled to them as shown.

Electrical contact is made between the layers **39***a* and **39***b* by the layer **70** making contact with both after being depressed.

FIGS. **14–16** illustrate a further modification and in this embodiment a layer of flexible conductive plastic material of the same composition and thickness as layer **70** is supported by and adheres to the layer **35.**

Depression of the snapable member **35***a* again causes contact with the board **40** supported conductive circuit pattern **39.**

FIGS. **17** and **18** illustrate still another embodiment wherein a flexible conductive plastic circuit pattern **85** is supported by and adheres to the plastic layer **35.** A pin is provided at **81** to make electrical contact with a portion of the circuit pattern **85.**

Thus the configuration of FIGS. **17** and **18** provides further advantages in savings of material.

The material **85** is again the same as the flexible material **70** in composition and thickness.

FIG. **19** illustrates a device such as in FIG. **1** using a button **91** supported in a modified frame **90** for depressing the snapable member **35***a*.

In this configuration, the button is merely the extension of a users finger. The operation of this device is the same as heretofore described. Obviously the other modifications of FIGS. **7–18** may be included in FIG. **19.** In this FIG. like numbers are again used to designate the same parts as shown in FIGS. **1–6.**

In order to fabricate the flexible layer **35** protrusions comprising the pedestal **35***b* and the curved portion **35***a*, the dies **95** and **96** shown in FIGS. **20–22** may be used. In this configuration shaped rods **95***a* are provided for mating with cavities **96***a*.

The plastic material **35** e.g., Mylar is placed between the metal e.g., steel dies (see FIG. **22**) and pressure and heat is applied for a preset amout of time to form the protrusions. In practice it has been found that with a Mylar layer **35** of a 5 mil thickness, a temperature of about 210° F with 3,000 lbs. pressure for 15 seconds is adequate to form the about ⅜ inch wide pedestal (bottom opening) and curved portion.

In FIG. **23** there is shown a device similar to that shown in FIG. **5** except that in this case the sheet **35** is provided with protrusions having only curved portions **35***a* and no pedestal **35***b*. In this case the snap through layer **36** if used is preferably made thicker to compensate for the lack of a pedestal. Although this configuration is usable, the protrusions with a pedestal **35***b* are much preferred because they give a better tactile or key like feel under depression. Like numbers used herein designate like parts as in FIG. **5.** The modifications shown in FIGS. **7–19** may also be included in the structure of FIG. **23.**

We claim:

1. A keyboard assembly comprising first means for supporting an electrically conductive contact means, electrically conductive contactor means positioned over but out of electrical contact with said contact means, support means for positioning said conductive contact or means over but out of electrical contact with said contact means a flexible and resilient plastic sheet means positioned above said conductive contactor means and having formed therein a plurality of raised protrusions positioned at the center thereof farthest from said conductive contact means, said protrusions each comprising a pedestal and a curved surface capping said pedestal, said curved surface being depressable at its center under pressure below the pedestal to push said conductive contactor means against said contact means and snapping through the center upon depression sufficient to cause electrical contact between said conductive contactor means and said contact means, and said curved surface recovering back through the center after pressure is withdrawn therefrom and a snap through layer positioned between said sheet means and said conductive contact or means, said snap through layer having a plurality of openings therethrough in register with said protrusions, said protrusions extending into said openings upon depression through center sufficient to cause contact between said contactor means and contact means.

2. A keyboard according to claim **1,** in which said support means comprises a separator layer is positioned between said contactor means and contact means, said separator layer having a plurality of openings each in register with a different one of said protrusions and each in exposing portions of said contact means for contact with said contactor means.

3. A keyboard according to claim **2** in which said snap through layer which is positioned between said contactor means and said sheet means has its plurality of openings each in register with a different one of said protrusions and with a different one of said openings of said separator layer.

4. A keyboard according to claim **3** in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said buttons positioned to depress a different one of said protrusions, and wherein means is provided for supporting said button assembly over said sheet means and its protrusions.

5. A keyboard according to claim **4** in which the conductive contactor means comprises an elastomeric conductive layer.

6. A keyboard according to claim **3** in which the conductive contactor means comprises an elastomeric conductive layer.

7. A keyboard according to claim **1** in which the conductive contactor means comprises a flexible plastic conductive layer.

8. A keyboard according to claim **1** in which the pedestal is cylindrical in shape.

9. A keyboard according to claim **1** in which the curved surface is a portion of a sphere.

10. A keyboard according to claim 9 in which the pedestal is cylindrical in shape.

11. In a keyboard according to claim 1 including a plurality of spring loaded buttons for depressing said protrusions, and means for supporting said buttons over said protrusions.

12. A keyboard assembly comprising first means for supporting an electrically conductive contact means, electrically conductive contactor means positioned above but out of electrical contact with said electrically conductive contact means, a plastic sheet means positioned above said conductive contactor means and having formed therein a plurality of raised flexible and resilient protrusions positioned farthest at their centers from said conductive contact means, said protrusions each comprising a pedestal and a curved surface capping said pedestal, said curved surface being depressable under pressure below said pedestal to push said conductive contactor means against said contact means and snapping through center upon depression sufficient to cause electrical contact between said conductive contactor means and said contact means, and said curved surface recovering back through the center after pressure is withdrawn therefrom and said electrically conductive contactor means supported on the under surface of said curved surface.

13. A keyboard assembly according to claim 12 in which a snap through layer is positioned between said sheet means and said conductive contact means, said snap through layer having a plurality of openings therethrough in register with said protrusions, said protrusions extending into said openings upon depression sufficient to cause contact between said contactor and contact means.

14. A keyboard according to claim 13 in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said protrusions by a different one of said buttons, and means for supporting said button assembly over said sheet and its protrusions.

15. A keyboard assembly according to claim 13 in which the conductive contactor means extends over the sheet means and is supported thereby for movement with the under surface of the pedestal and the curved surface.

16. A keyboard assembly according to claim 13 in which the conductive contactor means is in the shape of a circuit pattern supported by the sheet means with portions thereof extending into the protrusions and supported by the under surface of the pedestal and the curved surface for movement therewith.

17. A keyboard according to claim 12 in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said buttons positioned to depress a different one of said protrusions, and means for supporting said button assembly over said sheet and its protrusions.

18. A keyboard assembly according to claim 12 in which the flexible plastic conductive layer is confined to the under surface of said curved surface.

19. A keyboard assembly according to claim 12 including indicia formed in, on, or supported by said protrusion curved surface.

20. A keyboard assembly comprising first means for supporting an electrically conductive contact means, electrically conductive contactor means positioned above but out of electrical contact with said contact means a plastic sheet means positioned above said conductive contactor means and having therein a plurality of flexible and resilient raised protrusions positioned farthest from said conductive contact means said protrusions each comprising a curved surface which at its uppermost point is farthest from said contact means said curved surface being depressable under pressure to push said conductive contactor means against said contact means and snapping through the center and inverting upon depression sufficient to cause electrical contact between said conductive contactor means and said contact means, said surved surface recovering back through the center after pressure is withdrawn therefrom, said electrically conductive contact means supported on the under surface of said curved surface.

21. A keyboard assembly according to claim 20 in which a snap through layer is positioned between said sheet means and said conductive contact means, said snap through layer having a plurality of openings therethrough in register with said protrusions, said protrusions extending into said openings upon depression sufficient to cause contact between said contactor and contact means.

22. A keyboard according to claim 21 in which said protrusions also include a substantially cylindrical pedestal which supports said curved surface on the top thereof.

23. A keyboard according to claim 22 in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said buttons positioned to depress a different one of said protrusions, and means for supporting said button assembly above said protrusions.

24. A keyboard according to claim 22 in which the conductive contactor means comprises a flexible insulator filled with electrically conductive particles.

25. A keyboard according to claim 20 in which said protrusions also include a substantially cylindrical pedestal which supports said curved surface on the top thereof.

26. A keyboard according to claim 20 in which the conductive contactor comprises an elastomeric insulator material filled with electrically conductive particles.

27. A keyboard according to claim 20 in which the conductive contactor comprises a flexible plastic insulator material filled with electrically conductive particles.

28. A keyboard according to claim 20 in which the curved portion is a portion of a sphere.

29. In a keyboard according to claim 20 including a plurality of spring loaded buttons for depressing said protrusions and means for supporting said buttons over said protrusions.

30. A keyboard assembly comprising a circuit board for supporting an electrically conductive circuit having contact means, electrically conductive contactor means positioned above but out of electrical contact with said contact means, a sheet means of insulator plastic material positioned above said conductive contactor means and having therein a plurality of raised protrusions positioned farthest from said conductive contact means, said protrusions each comprising a curved surface, said curved surface being depressable under pressure to push said conductive contactor means against said contact means and snapping through the center and inverting upon depression sufficient to cause electrical contact between said conduc-

tive contactor means and said contact means, and said curved surface recovering back through the center after pressure is withdrawn therefrom, said electrically conductive contactor means supported on the under surface of said curved surface.

31. A keyboard assembly according to claim **30** in which a snap through layer is positioned between said sheet means and said conductive contact means, said layer having a plurality of openings therethrough in register with said protrusions, said protrusions extending into said openings upon depression sufficient to cause contact between said contactor and contact means.

32. A keyboard according to claim **31** in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said protrusions by a different one of said buttons, and means for supporting said buttons over said protrusions.

33. A keyboard according to claim **30** in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said buttons positioned to depress a different one of said protrusions, and means for supporting said buttons over said protrusions.

34. A keyboard assembly according to claim **30** in which the contactor means comprises a flexible plastic conductive material which extends over the sheet means and is supported thereby on the under surface thereof.

35. A keyboard assembly according to claim **30** in which the contactor means comprises flexible plastic conductive material confined to the curved surface.

36. A keyboard assembly according to claim **30** in which the contactor means comprises flexible plastic conductive material in the shape of a circuit pattern is supported by the under surface of the sheet means with portions thereof supported by the curved surface for movement therewith.

37. A keyboard assembly according to claim **30** including indicia formed in, on, or supported by said protrusion curved surface.

38. A keyboard assembly comprising first means for supporting electrically conductive contact means, an insulator spacer having a plurality of openings in register with selected portions of said contact means, electrically conductive contactor means positioned over said insulator spacer, a snap through insulator material layer positioned over said electrically conductive contactor means and having openings therethrough in register with the opening of said spacer, and a sheet means of insulator plastic material positioned over said snap through layer and having a plurality of raised protrusions in register with the openings of the snap through layer and comprising a curved surface, said curved surface being depressable and inverting under pressure to extend through the openings of said snap through layer to engage said contactor means to force same through said openings of the spacer to electrically contact the contact means.

39. A keyboard assembly according to claim **38** in which a spring loaded button assembly comprising a plurality of buttons is provided to depress said protrusions, a different one of said protrusions by a different one of said buttons, and means for supporting said buttons over said protrusions.

40. A keyboard assembly comprising support means, electrically conductive contact means supported by said support means, an insulator material snap through layer having one side thereof positioned over said conductive contact means, said snap through layer having a plurality of openings therethrough in register with portions of said electrically conductive contact means, a sheet of flexible and resilient insulator plastic material positioned on the opposite side of said snap through layer, said sheet having formed therein a plurality of raised protrusions which extend above said sheet and away from said snap through layer, each of said protrusions comprising a curved surface and each of said protrusions in register with a different one of said openings of said snap through layer, electrically conductive circuit pattern means adhered to the side of the sheet closest to said snap through layer and having portions thereof extending into the protrusions and adhering to the under surface of the curved surface and providing contactor means so that upon depression of said protrusions said protrusions snap through center and invert into said openings of said snap through layer and position said contactor means against said contact means.

41. A keyboard assembly according to claim **40** in which said protrusions each comprises a pedestal supporting said curved surface on the top thereof and in which the circuit pattern means also adheres to the under surface of the pedestal.

42. A keyboard assembly according to claim **41** in which said circuit pattern is of a flexible conductive plastic material.

43. A keyboard assembly according to claim **42** in which there is provided a plurality of buttons for depressing said curved surface, and in which there is provided means for supporting said buttons over different ones of said protrusions to depress said curved surface thereof.

44. A keyboard assembly according to claim **40** in which said circuit pattern is of a flexible conductive plastic material.

45. A keyboard assembly according to claim **44** in which there is provided a plurality of buttons for depressing said curved surface, and in which there is provided means for supporting said buttons over different ones of said protrusions to depress said curved surface thereof.

46. A keyboard assembly according to claim **1** including indicia formed in, on, or supported by said protrusion curved surface.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. 3,860,771

DATED January 14, 1975

INVENTOR(S) William J. Lynn and Richard E. Seeger

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Claim 6, line 56 "claim 3" should be --claim 4--

Claim 15, line 42 "claim 13" should be --claim 14--

Signed and Sealed this

sixteenth Day of *September 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks