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Glaister et al.

[11] **3,862,382**

[45] **Jan. 21, 1975**

[54] **KEYBOARDS SWITCH ASSEMBLY WITH MULTILAYER PATTERN CONTACT MEANS**

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[21] Appl. No.: **410,328**

[52] **U.S. Cl.** ..... **200/5 A,** 200/5 R, 200/159 B, 200/262, 200/265

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

[58] **Field of Search** ..... 200/1 R, 5 R, 5 A, 159 R, 200/159 A, 159 B, 166 C, 262–270, 275; 333/98

[56] **References Cited**

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3,140,342	7/1964	Ehrreich et al.	333/98 X
3,594,684	7/1971	Miller	200/159 B
3,676,615	7/1972	Wiedmer	200/5 R X
3,699,294	10/1972	Sudduth	200/5 A X
3,705,276	12/1972	Seeger, Jr. et al.	200/5 A
3,721,778	3/1973	Seeger, Jr. et al.	200/166 C X
3,728,509	4/1973	Shimojo	200/159 B
3,743,797	7/1973	Hoffman	200/5 R X
3,773,998	11/1973	Seeger, Jr. et al.	200/159 B
3,780,237	12/1973	Seeger, Jr. et al.	200/5 A

OTHER PUBLICATIONS

IBM Technical Disclosure Bulletin, Kuntzleman, "Keyboard Transducers," Vol. 7, No. 12, p. 1170, May 1965.

IBM Technical Disclosure Bulletin, Sedaris et al., "Elastic Diaphragm Switch," Vol. 14, No. 3, p. 767, August 1971.

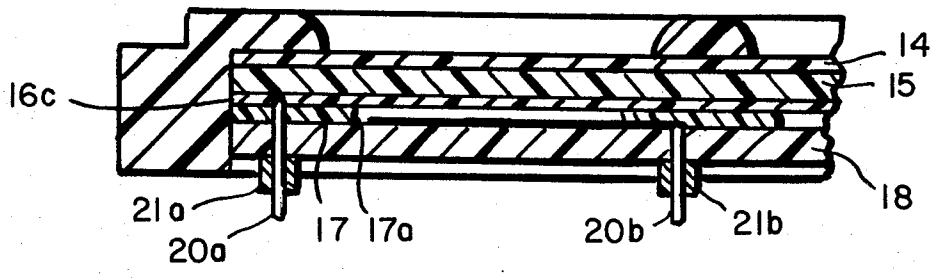
Primary Examiner—James R. Scott

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

[57] **ABSTRACT**

Keyboards for use in calculators, control equipment and the like, and which include a circuit board supporting electrical pathways, an insulator separator having openings registerable with portions of the pathways, a non-conductive elastomeric layer supporting a plurality of non-selfsupporting flexible conductive members or pathways and contactors thereon, said flexible conductive circuit contactors registerable with said openings whereby pressure applied to said elastomeric layer causes one or more of said contactors to extend through one or more openings to make electrical contact with portions of one or more circuit pathways supported by said board.

28 Claims, 8 Drawing Figures



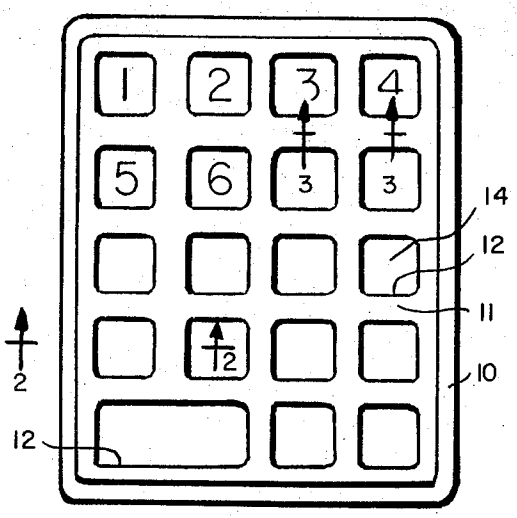


FIG.1

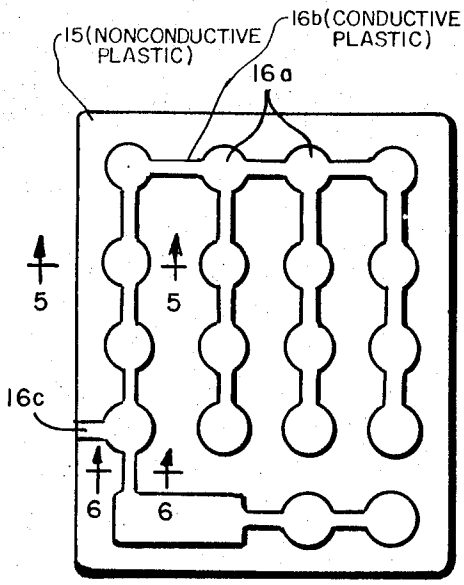


FIG.4

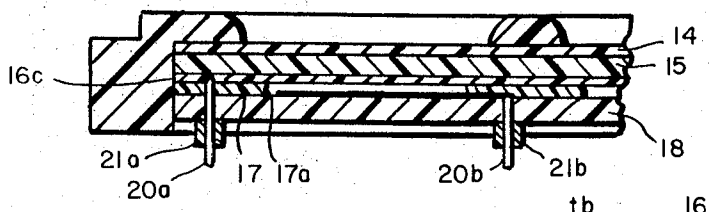


FIG.2

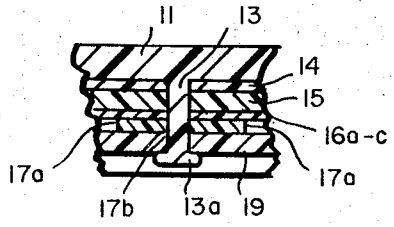


FIG.3

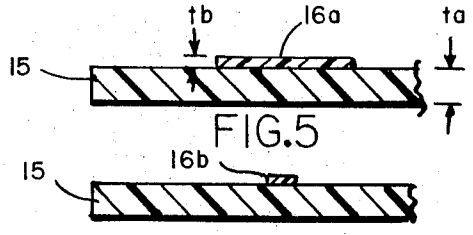


FIG.5

FIG.6

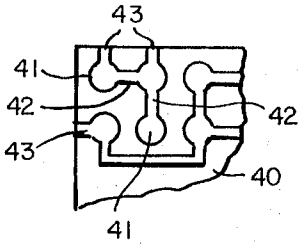


FIG.8

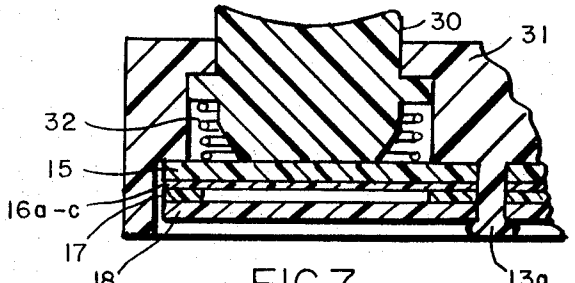


FIG.7

KEYBOARDS SWITCH ASSEMBLY WITH MULTILAYER PATTERN CONTACT MEANS

BACKGROUND OF THE DISCLOSURE

This invention is directed to new improved keyboards for converting key depression to a coded electrical output and is more particularly directed to flexible conductive plastics formed into a plurality of selectively interconnected flexible and non-selfsupporting contactors and pathways joined to and supported by an elastomeric layer for making electrical contact with selected portions of a circuit board supported circuit pattern of the keyboard.

Small and inexpensive keyboards have become an integral part of personal calculators. As the price of calculators have rapidly decreased, keyboards of the type shown in U.S. Pat. Nos. 3,721,778 and 3,699,294 have become less attractive for use because of their cost.

Since a significant portion of the cost of a keyboard is due to the cost of the thick self-supporting resilient conductive plastic (elastomeric) filled with electrically conductive particles used as a contactor it became imperative that a keyboard be developed with a less expensive contactor.

This invention provides a low cost contactor which now permits a keyboard manufacturer to remain competitive as calculator prices continue to fall.

The present invention provides further advantages in certain situations in that a keyboard manufacturer can form the contactor in a manner so as to add another layer of circuitry for performing logic thus permitting further cost reductions.

With this invention material cost savings of 70% or more in comparison with conventional contactors of the prior art is estimated.

BRIEF SUMMARY OF THE DISCLOSURE

This invention discloses in combination with a circuit board having a plurality of electrically conducting pathways, a separator layer having a plurality of openings in register with portions of said pathways, the improvement of an elastomeric non-conductive layer supporting a plurality of non-selfsupporting flexible electrically conductive plastic contactors selectively interconnected by a plurality of non-selfsupporting flexible conductive plastic pathways. The flexible contactors and pathways may be made by using a non-elastomeric plastic such as polyamides, polyesters, polycarbonates, polyacetates, polystyrenes, epoxies, etc., filled with electrically conductive particles such as silver, carbon, etc., dispersed therethrough.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a keyboard according to the invention;

FIG. 2 is an enlarged sectional view taken along line 2—2 in FIG. 1 which includes the elastomeric, contactor structure of FIG. 4;

FIG. 3 is an enlarged sectional view taken along linne 3—3 in FIG. 1;

FIG. 4 is a bottom view of an elastomeric layer supporting electrically conductive circuit pathways and contactors;

FIG. 5 is a sectional view taken along line 5—5 in FIG. 4;

FIG. 6 is a sectional view taken along line 6—6 in FIG. 4;

FIG. 7 illustrates in a sectional view a plunger member used as a key for applying pressure to the elastomeric layer; and

FIG. 8 illustrates an alternate view of circuit pathways and contactors formed on a portion of an elastomeric layer.

DETAILED DESCRIPTION OF THE DISCLOSURE

Reference should now be had to FIGS. 1–8 for a description of the preferred embodiments of the disclosure.

The keyboard comprises a frame **10** preferably of insulator material, more preferably of a plastic, e.g., A.B.S. (a high impact polystyrene) or polyethelene. The frame **10** is provided with a plurality of divider members which form the walls of windows **12** extending through the frame **10.**

The underside of the frame includes a plurality of rods **13** (preferably formed at the same time as the frame, i.e., by molding (see FIG. **2**) which extend downwardly as shown in FIG. **3.**

Reference may be had to U.S Pat. No. 3,721,778 for a further description of the frame, rods and the construction of a keyboard.

The rods **13** may be softened by heat to form heads **13a** to hold the keyboard assembly together as shown in FIG. **3.** Alternatively the rods may be threaded and nuts may be used to hold the keyboard assembly together.

Positioned directly below the frame member **11** is a thin plastic insulator layer **14,** e.g., of Mylar which has indicia applied thereto. Instead of the layer **14** with indicia which functions as keys of the keyboard, buttons having indicia thereon may also be used as keys such as shown in U.S. Pat. No. 3,721,778 or U.S. Pat. applications Ser. No. 297,721 filed Oct. 16, 1972 now U.S. Pat. No. 3,780,237 or Ser. No. 297,636 filed Oct. 16, 1972 now U.S. Pat. No. 3,773,998 or as shown in FIG. **8.**

Positioned below the layer **14** is a non-electrically conductive elastomeric layer **15.** The elastomeric layer **15** may comprise any of the well known elastomeric and resilient materials such as silicone rubber or fluoro silicone rubber, nitrile rubber, natural rubber, etc.

Positioned below the elastomeric layer **15** and joined, coupled, adhered or bonded thereto is a plurality of flexible electrically conductive plastic contactors **16*a*** selectively connected together with a plurality of flexible electrically conductive plastic pathways or interconnecting members **16*b***. The contactors and pathways are relatively thin in comparison with the conductive elastomeric layers of the prior art and rely upon the elasticity of the non-conductive self-supporting elastomeric layer to which they are attached for movement. The contactors and pathways are so thin that they are non-selfsupporting and would not properly function without being coupled to the elastomeric layer.

In addition, since each of the contactors and pathways are separated from each other and are coupled together as shown, there is a large saving in costly conductive plastic in comparison with the aforementioned patents.

A backing, e.g., the elastomeric layer to which they are joined is necessary to maintain their physical sepa-

ration of the contactors and pathways and to prevent them from curling up or distorting.

At **16***c* there is also shown a connecting member of a flexible conductive plastic for coupling to a pin (see FIG. 2) used to provide the same potential to the contactors **16***a* and the pathways **16***b*.

The parts **16***a*–**16***c* may be formed of either flexible non-elastomeric or elastomeric plastics such as plastic adhesives or by a flexible conductive plastic layer joined or attached to the elastomeric layer by a flexible plastic adhesive.

In particular, contactors **16***a*, pathways or members **16***b* and members **16***c* may be formed from flexible plastic (non-elastomeric) materials such as polyamides (e.g. Versalon 1140 polyamide resin by General Mills), polycarbonates (e.g. Lexan by General Electrical), polyester (e.g.Mylar), epoxy (Carvel by Polymer Corp.) polyacetate, polystyrene, etc., unmodified or modified if needed by plastisizers as will be apparent to those skilled in the art, to obtain the desired flexibility for the parts **16***a*–16c to flex with the layer **15** and not separate or break away therefrom after continuous prolonged use.

The parts **16***a*–**16***c* also contain electrically conductive particles dispersed therethrough such as silver particles, carbon particles and other well know conductive particles such as shown in U.S. Pat. Nos. 3,140,342 and 3,576,387.

The amount of electrical particles may vary with particles in the amount of 20 to 40 volume percent being preferred although in this application the amount may vary over a wide range e.g., 10 80 volume percent.

In the preferred embodiment the layer **15** is preferably of a thickness t_a of between 5 to 200 mils with 5 to 100 mils being more preferred and 20 – 50 mils being most preferred.

The parts **16***a*–**16***c* are preferably of a thickness of t_a between 5 microns (**0.197** mil) to 2.0 mils with a thickness of 10 microns (0.394 mil) to 25 microns (0.984 mil) being more preferred and a thickness of 10 microns (0.394 mil) to 20 microns (0.788 mil) being most preferred.

In the preferred embodiment the layer **15** is a nitrile rubber layer made by combining Hycar 1042(NBR) (B.F. Goodrich) 100 parts by weight with zinc oxide 1 part by weight, hydrated silica (HI-SIL 215), 40 parts by weight, Dicumyl peroxide 5 parts by weight and then curing. The parts **16***a*–**16***c* was made by mixing about 63 percent by volume of Versalon **1140** (a polyamide adhesive) with 37 percent by volume of silflake 135, and then coating it on the elastomeric layer **15** after it is formed e.g., by using an artists air brush and a screen or template having openings of the shape of the desired parts **16***a*–**16***c*. Solvents such as toluene and 1-propanol as in example 7 may be added to the Versalon 1140 and Silflake 135 solvents such as shown in U.S. Pat. 3,576,387 may be added to permit easy spraying or coating e.g., by a knife. The solvents are then permitted to evaporate in air. The conductive pattern (parts **16***a*–**16***c*) can also be formed using printing techniques with the above composition. It is preferred, in order to carry out the screening process more effectively to replace toluene with a higher boiling point solvent such as Aromatic 150, Butyl Carbitol, etc., conductive inks well known in the art can also be used.

The layer **15** and parts **16***a*–**16***c* are positioned over an insualtor plastic layer **17** e.g., of Mylar, acting as a separator and having a plurality of openings or windows **17***a* extending therethrough in alignment with windows **12.** The rods **13***a* also extend through holes **17***b* in layer **17** to locate the layer **17** within the frame **10.** See the aforementioned patents for further disclosure of the separator layer.

Below the layer **17** is a typical circuit board **18** e.g., of Bakelite having a plurality of electrically conductive contacts or pathways **13***a* formed thereon. See U.S. Pat. Nos. 3,705,276 and 3,721,778 for an illustration of various possible circuit configurations.

The circuit pattern may be formed conventionally from copper which is etched, etc., as is well known in the printed circuit art or by other well known printing techniques.

The electrical pathways are at least in part aligned with the windows **17***a* so that the application of pressure (by a finger) to the key or force applying layer **14** can push selected portions of the layer **15** and the contactor **16***a* through the windows **17***a* against the pathways **18***a*. In this manner electrical contact is made between the contactors **16***a* and the pathways **18***a*.

When the force is withdrawn the resilience of the elastomeric layer **15** causes it to withdraw pulling the flexible contactors **16***a* back with it and breaking electrical contact between contactors **16***a*and the pathways **18***a*. Most preferably the thickness of the layer **15** is at least 5times that of parts **16***a*–**16***c*.

In order to make electrical contact with the electrically conductive parts **16***a*–**16***c* as well as the pathways **18***a*, there are provided pins **20***a*–**20***b* retained with connector supports **21***a* and **21***b* respectively with pin **20***a* in contact with part **16***c* and pin **20***b* in contact with pathway **18***a*.

It should be understood that while preferred dimensions are given for the layer **15** be just sufficient to provide the elasticity to pull the parts **16***a*–**16***c* back with after being depressed while the parts **16***a*–**16***c* should be preferably as thin as physically possible to save as much money as possible so long as it provides good electrical conductivity for use as contactors and pathways, and does not flake off or separate (e.g. pull off) from the elastomeric layer under these dynamic conditions.

The volume resistivity of the conductive parts **16***a*–**16***c* is preferably less than 10 ohm centimeters, more preferably less than 1 ohm centimeter and most preferably less than 0.5 ohm centimeters. As used herein the term nonselfsupporting means that the layer unless backed as shown would curl up and not be useful for its intended purpose i.e., as keyboard contactors and pathways.

In FIG. **7** there is shown a button **30** preferabvly of non-conductive plastic supported in a redesigned frame **31** and held in its undepressed condition by a spring **32.** The remainder of the keyboard members are identical with that of FIGS. **1–5** and are so numbered. Upon depression of the key **30** by a finger, the conductive contactor **16***a* is brought into contact with the pathway **18***a*.

FIG. **8** discloses another configuration for the contactors, pathways, an interconnecting members and pin connecting members attached to an elastomeric layer. In this embodiment, the elastomeric layer is shown at **40** and supports flexible plastic contactors **41** which are interconnected in a selected manner by flexible conductive plastic pathways **42** to generate a coded output

at flexible conductive plastic pin interconnecting member **43**.

Pins are coupled to the member **43** as shown in FIG. **2**. In this manner the logical capability of the keyboard device may be expanded by providing another layer of logic circuitry in addition to the logic circuitry provided on the circuit board.

We claim:

1. In a keyboard the combination of a circuit board supporting a plurality of electrically conductive pathways, a separator positioned upon the top of said board and conductive pathways and having a plurality of openings in register with selected portions of said pathways, the improvement comprising an elastomeric layer having adhered thereto and supported thereby for movement therewith a plurality of nonselfsupporting flexible conductive plastic contactors, said conductive plastic contactors comprising a plastic binder and electrically conductive particles dispersed therein, said contactors positioned over said openings so that pressure selectively applied to said elastomeric layer forces selected ones of said contactors through selected openings into contact with said selected portions of said pathways and release of said pressure permits the elastomeric layer to return to its original shape while pulling the contactors adhered thereto away from the pathways.

2. In a keyboard according to claim **1** in which a plurality of non-selfsupporting flexible conductive plastic interconnecting members are adhered to and supported by the elastomeric layer and are coupled to selected ones of said contactors.

3. In a keyboard according to claim **2** in which the conductive plastic is of a non-elastomeric material.

4. In a keyboard according to claim **3** in which the conductive plastic has silver particles dispersed.

5. In a keyboard according to claim **2** in which the interconnecting members are at least partially out of register with said openings.

6. In a keyboard according to claim **2** in which the thickness of the contactors and interconnecting members is at least about 5 times less than the thickness of the elastomeric layer.

7. In a keyboard according to claim **6** in which the contactors and interconnecting members are less than 0.788 mil in thickness and in which the elastomeric layer is between 5 to 200 mils in thickness.

8. In a keyboard according to claim **7** in which the conductive plastic is of a non-elastomeric material.

9. In a keyboard according to claim **1** in which a plurality of said contactors are electrically connected together by a non-selfsupporting flexible conductive plastic interconnecting element means adhered to and supported by said elastomeric layer, said plastic interconnecting element means comprising a plastic binder and electrically conductive particles dispersed theren.

10. In a keyboard according to claim **1** in which the plastic binder is a polyamide resin and silver particles are dispersed therein.

11. In a keyboard according to claim **9** in which the plastic binder is a polyamide resin and silver particles are dispersed therein.

12. In a keyboard which includes an insulator board having circuit pathways thereon, insulator means having a plurality of windows therethrough in alignment with selected portions of the pathways, a plurality of nonselfsupporting contactors spaced apart and each positioned for passage through one of said windows and supported by an elastomeric layer to which it is adhered, said contactor means comprising a flexible electrically conductive plastic material physically adhered to said elastomeric layer, said conductive plastic material comprising a plastic binder and electrically conductive particles dispersed therein and pressure application means for forcing said contactors through said windows to cause said contactors to electrically contact portions of said pathways, said elastomeric layer being thick enough to keep said contactors away from said pathway portions in the absence of pressure applied to pressure application means and for pulling said contactors away with it from said pathways after application and the release of pressure to said pressure application means and said contactors being thick enough to provide electrical conductivity while not being so flexible to separate from the elastomer layer upon being flexed in continuous use.

13. In a keyboard according to claim **12** in which the contactors are non-elastomeric.

14. In a keyboard according to claim **13** in which the contactors are 0.197 mil to 1.0 mils in thickness.

15. In a keyboard according to claim **14** in which the elastomeric layer is 5 to 200 mils in thickness.

16. In a keyboard according to claim **13** in which the contactors are 0.197 to 1.969 mil in thickness.

17. In a keyboard according to claim **16** in which the elastomeric layer is 10 to 100 mils in thickness.

18. In a keyboard according to claim **12** in which the contactors are of a lesser thickness than the non-conductive elastomeric layer with the elastomeric layer being of a thickness at least about 5 times that of the conductive layer to provide the elasticity to pull the contactors back with it after being depressed and the contactors being thick enough to provide electrical conductivity.

19. In a keyboard according to claim **18** in which the contactors are of a thickness less than 1 mil.

20. In a keyboard according to claim **18** in which said binder is polyamide resin and said particles are silver.

21. In a keyboard according to claim **12** in which the contactors are of a thickness less than 0.788 mil.

22. In a keyboard according to claim **12** in which the volume resistivity of the contactors is less than 10 ohm centimeters.

23. In a keyboard according to claim **22** in which the volume resistivity is less than 1 ohm centimeter.

24. In a keyboard according to claim **23** in which the volume resistivity is less than 0.5 ohm centimeters.

25. In a keyboard according to claim **12** including a plurality of flexible conducting plastic members adhered to said elastomeric layer and selectively coupled to at least two said plurality of contactors.

26. In a keyboard according to claim **25** in which the contactors and the interconnecting members are of a nonelastomeric material.

27. In a keyboard according to claim **25** in which said binder is polyamide resin and said particles are silver.

28. In a keyboard according to claim **12** in which said binder is polyamide resin and said particles are silver.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. 3,862,382

DATED January 21, 1975

INVENTOR(S) : Frank Joseph Glaister, et al

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

Column 2, lines 17 and 18 "divider members" should be --divider members 11--

Signed and Sealed this

twenty-eight Day of *October 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

UNITED STATES PATENT OFFICE

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