United States Patent

Goll

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[54] **MAGNETIC MEMBRANE SWITCH**

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[52] **U.S. Cl.** .....**335/207,** 200/86 R, 200/159 B

[51] **Int. Cl.**.....**H01h 1/54,** H01h 3/12

[58] **Field of Search** .200/86 R, 159 B; 335/205, 206, 335/207

[56] **References Cited**

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[57] **ABSTRACT**

A magnetic membrane switch includes two opposed sheets of material which are magnetized in such a way that they repel each other. At least one of these sheets is flexible. The sheets are supported so that there is a predetermined spacing between them. The opposed faces of the sheets are provided with a thin metallic pattern. Portions of the metallic pattern can be made to contact one another by pressing on localized sections of the flexible sheet. The resulting contact achieves a switching operation.

By placing an alpha-numeric code on one of the sheets, the switch can be utilized as a keyboard.

11 Claims, 4 Drawing Figures

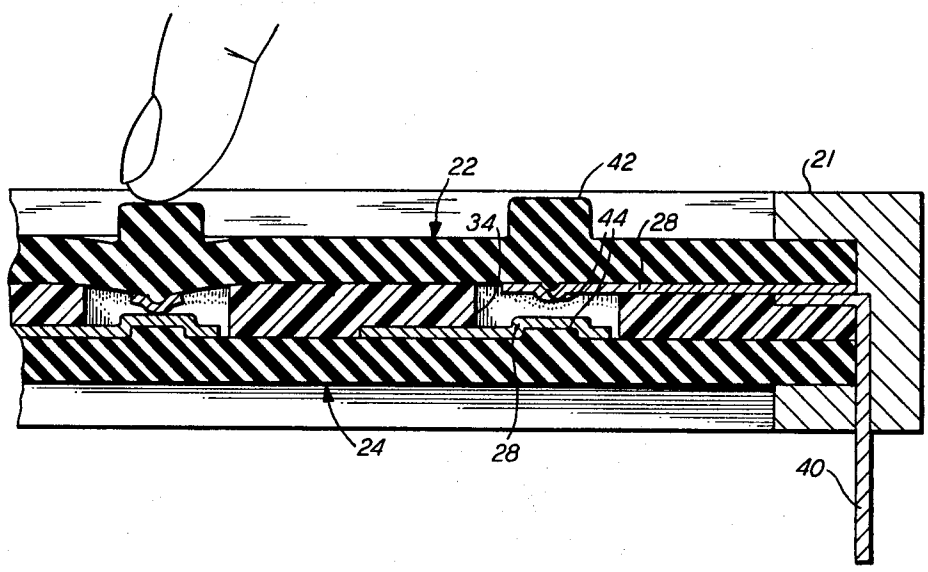
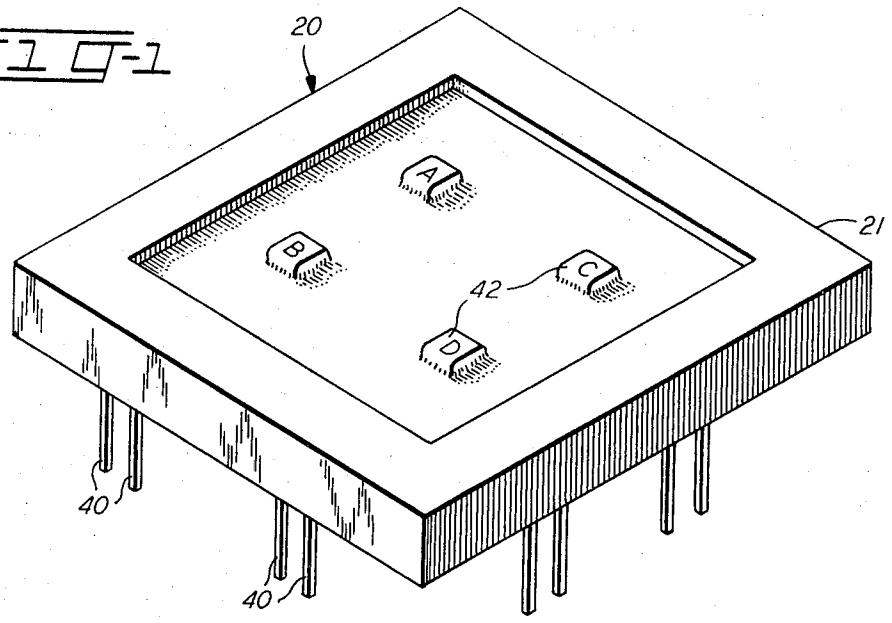


FIG-1



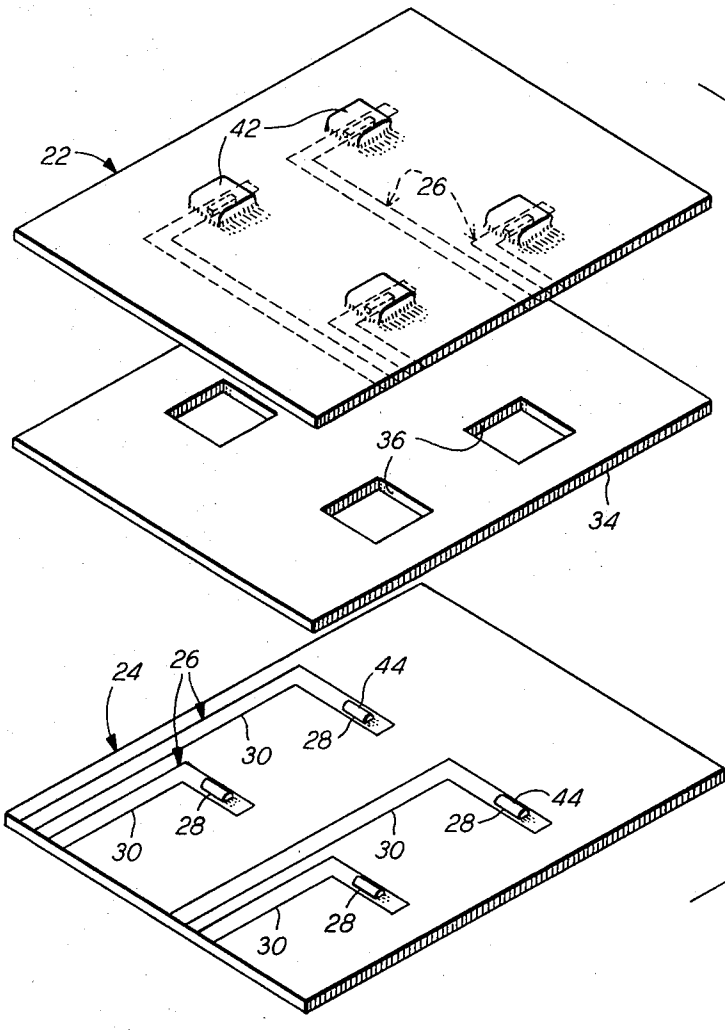


FIG-2

FIG-3

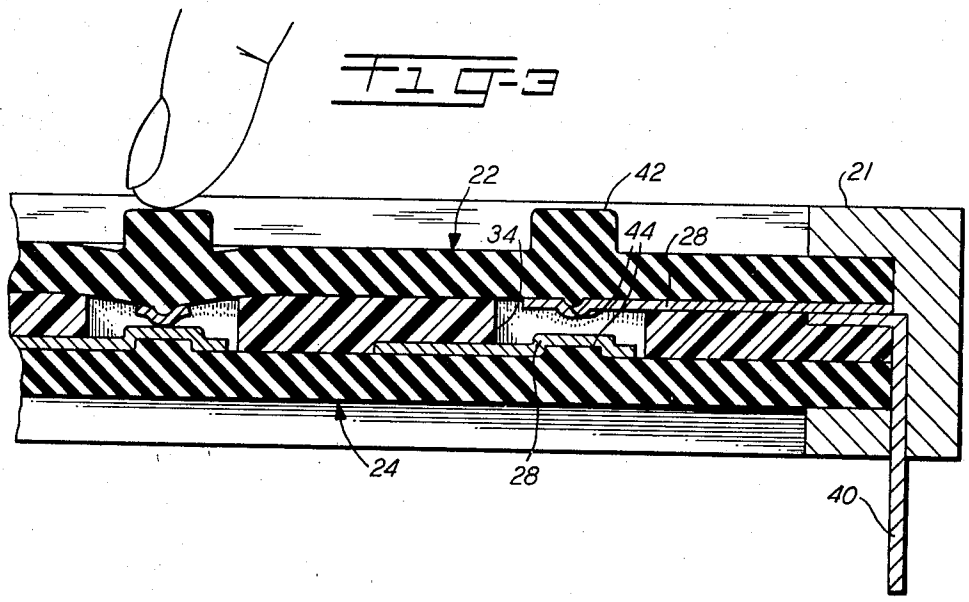
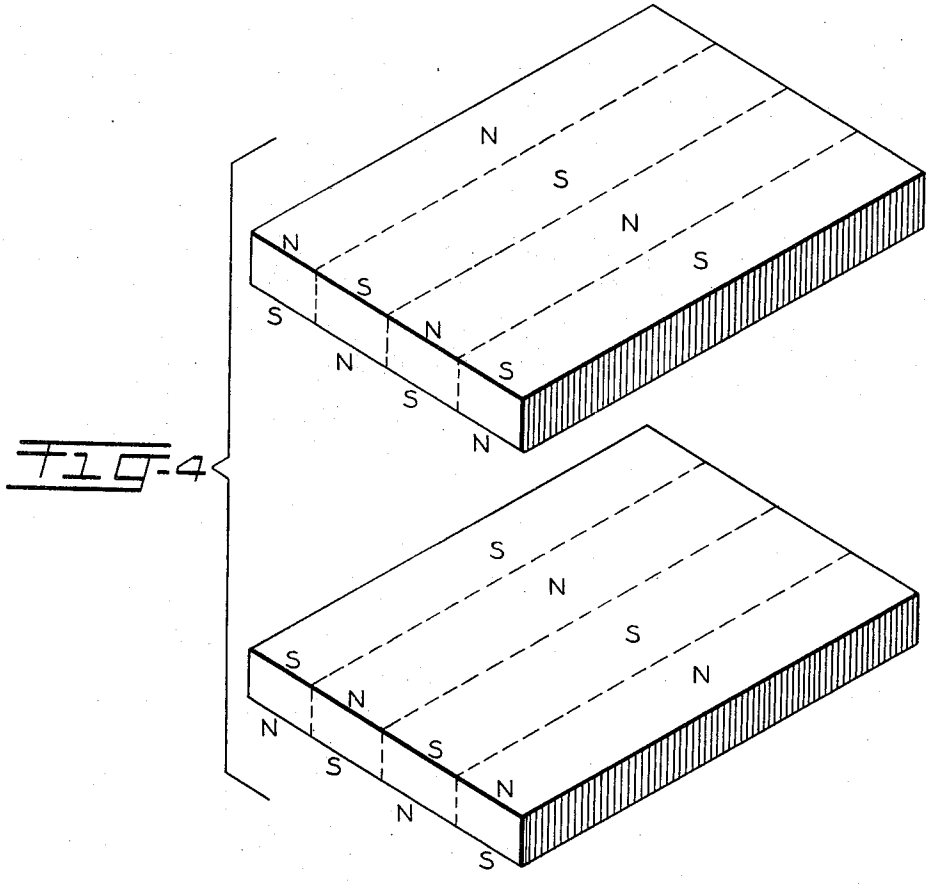


FIG-4



MAGNETIC MEMBRANE SWITCH

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to membrane switches and their use as alpha-numeric keyboards.

2. Description of the Prior Art

There is an increasing need in the telecommunications industry for keyboard instruments of a simple and inexpensive design. A greater and greater amount of information is being transmitted by keyboard-type inputs. Presently utilized keyboards typically involve individual mechanical elements for producing an electric contact associated with each alpha-numeric symbol.

Various attempts have been made to produce a so called membrane-type of keyboard in which two flexible members are held in spaced relation. Electrical contact associated with a particular alpha-numeric symbol is produced when a localized region of one of the separated membranes is made to contact the opposed membrane. In a membrane-type keyboard, it is of course, necessary to provide some resiliency in the structure so that the depressed localized regions will return to a non-contact position when the associated alpha-numeric symbol is released. Previous attempts at providing the desired resiliency within membrane-type keyboards have not been entirely successful.

SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide a novel and practical switch which will function in a membrane-type keyboard.

Another object of this invention is the provision of new and useful methods of interconnecting conductors.

This and other objectives are achieved by providing a switch which includes first and second sheets of dielectric material which are magnetized so that the opposed sheets repel one another. As least one of the sheets is flexible. The magnetized sheets are held in a desired spacing such that a portion of the first sheet can be made to contact an opposed portion of the second sheet by exerting a localized force on the flexible sheet. Each of the sheets are provided with a thin metallic switching pattern arranged so that when a particular portion of one of the sheets is contacted with the opposed portion, a desired switching arrangement is achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and features of the present invention will be more readily understood from the following detailed description of specific embodiments thereof, when read in conjunction with the appended drawings in which:

FIG. 1 is a perspective view of various elements magnetic-membrane keyboard;

FIG. 2 is a perspective view of various elements of the keyboard of FIG. 1 with the elements separated from one another for purposes of clarity;

FIG. 3 is a sectional view through the keyboard of FIG. 1 showing one alpha-numeric symbol depressed so that electrical contact associated with that symbol is produced and with various layers of the keyboard having an exaggerated thickness for purpose of clarity; and

FIG. 4 is a schematic representation of a useful magnetic profile for the magnetic elements of the keyboard of FIG. 1.

DETAILED DESCRIPTION

A composite keyboard, designated generally by the numeral **20**, which embodies the inventive switching arrangement is illustrated in FIG. 1. FIG. 2 shows various elements of the keyboard **20** in an expanded arrangement and with a supporting frame **21** removed. It should be noted that the keyboard **20** is shown with only four alpha-numeric symbols for purposes of simplicity. The inventive principles embodied in the illustrative example can be applied to keyboards having in unlimited number of alpha-numeric symbols.

Referring now to FIG. 2, it can be seen that an upper sheet, designated generally by the numeral **22**, of flexible magnetic material overlies a lower sheet **24** of magnetic of material. The lower sheet **24** may be either flexible or rigid. If application of the keyboard **20** to a curved surface is desired, flexibility within the sheet **24** may be useful. However, if the keyboard is to be used on a flat surface, the sheet **24** may be rigid.

One example of a material which is useful for making the sheets **22** and **24** is a polymeric sheet available from B. F. Goodrich Industrial Products Company, Akron, Ohio which is sold under the product designation "-Koroseal."This material has ferrite particles embedded in a poly-vinyl chloride binder.

Each of the sheets **22** and **24** is provided with metallic elements **26** thereon. The metallic elements **26** must be thin and flexible when they are applied to flexible sheets, such as the sheet **22**. One particularly advantageous way of applying the metallic elements to the sheets **22** and **24** is by a process of vapor deposition such as evaporation, sputtering or the like.

One suitable application of the metallic elements **26** to the sheets **22** and **24** was accomplished by evaporating 1,000 angstroms of titanium and 50,000 anstroms of gold through metallic stainless steel masks onto the sheets **22** and **24**. The metallic elements **26** were deposited on the flexible sheet **22** having a thickness of 0.050 inch. The sheet **22** was supported 0.001 inch from the sheet **24** in an operable switching arrangement.

In cases where a mechanically stronger conductor system is desired, it may be advantageous to employ a metallic element formed of titanium-palladium-copper-gold.

It can be seen in FIG. 2 that the metallic elements **26** are formed with contact portions **28** and lead portions **30**. The contact portions are arranged to provide perpendicular intersections of the metallic material when an alpha-numeric symbol is depressed. The lead portions **30** of each sheet are arranged to emerge from the sheet on a substantially parallel path so that connections to the sheets **22** and **24** can be readily provided.

An insulating sheet **34** is interposed between the magnetic sheets **22** and **24**. The insulating sheet **34** is provided with openings **36** that correspond to the position of the contact portions **28**.

Referring now to FIG. 3, which is a cross-sectional view of the keyboard **20**, it can be seen that when a portion of the sheet **22** with one of the symbols is depressed, electrical contact occurs between the con-

tact portions **28** which underlie that symbol. The lead portions **30** associated with the particular engaged contact portions **28** are connected to the apparatus which is to be controlled by the keyboard through conventional connection means, such as connection terminals **40** and other connecting elements (not shown).

As illustrated in FIGS. **1–3**, the upper sheet **22** is not a simple flat sheet even though a simple flat member is a perfectly acceptable and workable configuration for the upper sheet. The upper sheet illustrated in the drawings is provided with raised portions **42** in the area of the alpha-numeric symbols. A raised portion on the outside of the keyboard, of course, facilitates ease of manual contact with the desired area of the keyboard. Raised portions **44** on the contact side of the sheet **22** provide for more positive electrical connection between the contact portions **28**. Since the sheet **22** is a polymeric substance, the raised portions **42** and **44** can easily be molded into the sheet during the fabrication thereof.

An alternate to the extruded or molded projection might include separate buttons supported above the upper sheet in a loosely fitting frame (not shown).

FIG. **4** shows one workable scheme by which the sheets **22** and **24** can be magnetized so that they will continuously repel one another. Obviously many other patterns for magnetization can be utilized to accomplish the desired object of having the alpha-numeric symbols repulsively held above the lower sheet **24**.

Although certain embodiments of the invention have been shown in the drawings and described in the specification, it is to be understood that the invention is not limited thereto, is capable of modification and can be arranged without departing from the spirit and scope of the invention.

What is claimed is:

1. A switch which comprises:

a flexible sheet of dielectric material having magnetized portions;

another sheet of dielectric material opposite the first sheet having magnetized portions, the magnetization being such that the magnetized portions of the opposed sheets repel one another;

means for holding the sheets in a desired spaced relationship such that exerting a localized force on the flexible sheet results in a portion of the flexible sheet contacting an opposed portion of the other sheet; and

a conductive switching pattern formed on the surfaces of each sheet which face one another, whereby upon the exertion of the localized force a particular portion of one of the sheets contacts the opposed portion to effect a switching action.

2. The switch of claim **1** wherein the sheets are formed of a polymeric substance impregnated with magnetic particles.

3. The switch of claim **2** wherein the magnetic sheets are provided with integral projections extending from their facing surfaces and underlying the metallic pattern, the ridges being positioned to provide for positive electrical contacts when an associated area of the switch is flexed.

4. The sWitch of claim **1** wherein one of the sheets is labeled with an alpha-numeric code on the side opposite that bearing the metallic pattern, whereby the switch can be utilized as a keyboard.

5. The switch of claim **4** wherein the portions of the sheet bearing the alpha-numeric symbols are raised projections.

6. The switch of claim **1** wherein the thin metallic pattern is formed of composite, vapor-deposited layers of titanium and gold.

7. The switch of claim **6** wherein the metallic pattern includes layers of palladium and copper between the titanium and gold.

8. The switch of claim **1** wherein the flexible sheet has a maximum thickness of 0.100 inch and the spacing between the opposed surfaces of the metallic pattern is less than 0.005 inch.

9. The switch of claim **1** wherein an insulating sheet is interposed between the magnetized dielectric sheets, the insulating sheet having openings therein at positions which correspond to desired contact points of the switch.

10. A switch which comprises:

first and second opposed flexible sheets of dielectric material having various portions thereof permanently magnetized, such that the opposed sheets repel one another;

means to hold the magnetized sheets in a desired spaced relationship such that a portion of the first sheet can be made to contact an opposed portion of the second sheet by exerting a localized force on the first sheet; and

a thin metallic switching pattern formed on the surfaces of each sheet which face one another, whereby when a particular portion of one of the sheets is contacted with the opposed portion a desired switching arrangement is achieved.

11. A method of connecting conductors, which comprises:

magnetizing at least one magnetic portion of a first sheet of dielectric material, said portion being connected to at least one conductor;

magnetizing at least one magnetic portion of a second sheet of dielectric material, said portion being connected to at least one other conductor, at least one of the sheets being flexible;

supporting said sheets in a spaced relationship so that said magnetic portions are opposite to, spaced from, and repel each other; and

exerting a localized force on at least one sheet that is flexible to engage the conductors and thereby interconnect the conductors connected thereto.

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