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(54) Keyboard switch system.

(57) A keyboard (10) is described including a rigid base member (12) with a pattern of depressions (14) in it, electrical circuitry (16) on a flexible support carried by the base member, and a plurality of domes (24) covering the circuitry. The electrical circuitry defines a plurality of open switches (17) in registry with the pattern of depressions in the base. The pattern of domes is in registry with the open switches. The underside of each dome includes a conductive surface which will complete a connection across a switch when the dome is depressed, whereby the switch circuitry is deflected downwardly into a depression in the base member.

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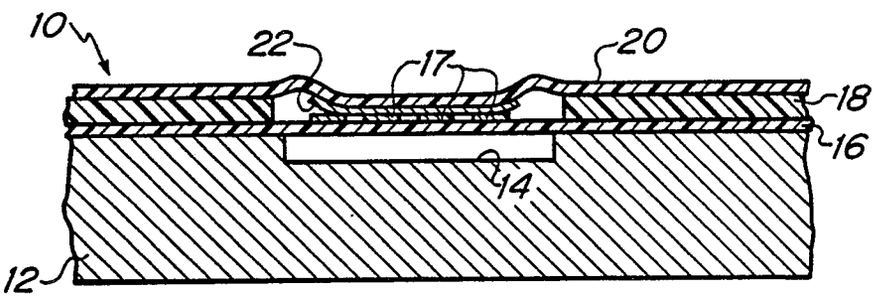

Fig 2

KEYBOARD SWITCH SYSTEM

Field of the Invention

This invention relates to keyboard systems. More particularly, this invention relates to keyboard systems for electronic devices such as calculators.

Background of the Invention

There are many types of keyboard systems in use in various types of electronic devices such as calculators. Some of these keyboard systems, such as are found in some portable calculators, involve the use of a dome sheet over a printed circuit which is in turn supported or carried on a relatively rigid substrate.

The dome sheet includes a plurality of domes in a predetermined pattern which is in registry with a pattern of switch locations on the printed circuitry. When a dome is depressed or collapsed by finger pressure it causes a corresponding connection to be made in the underlying switch in the printed circuitry. The dome may be collapsed directly by finger pressure or indirectly when finger pressure is applied to a key button positioned directly over the dome.

This system for closing a switch and making a required connection in the circuitry, however, is not always reliable. It is necessary for the depression of the dome to cause a firm connection in the switch. Prior keyboard switch systems are not always reliable in this respect. As a result, poor connections result in no entries, etc. This is very undesirable.

The present invention provides a system which represents an improvement in switching reliability in a keyboard such as is used in a calculator, for example.

Summary of the Invention

In accordance with the present invention there is provided an improved keyboard comprising:

(a) a rigid base member including an upper surface and a plurality of depressions in said surface in a predetermined pattern;

(b) electrical circuitry on a flexible support and carried by said base member, said circuitry defining a plurality of open switches in registry with said pattern of depressions in said base member;

(c) a plurality of flexible, resilient domes covering said circuitry and being in registry with said pattern of depressions, wherein the underside of each said dome includes a conductive surface which is capable of completing an electrical connection at a said switch when said dome is deflected downwardly against said circuitry, wherein said circuitry is deflected into said depression under said switch.

The depression in the base member located below each switch site on the circuitry allows the substrate on which the printed circuitry is carried to be deflected downwardly and conform more closely to the bottom conductive surface of the collapsed dome. This ensures a successful connection between the conductive surface of the dome and the switch area of the printed circuitry. The result is a more reliable keyboard system.

The domes may be individually carried on the circuitry over the switch sites or they may be an integral part of a continuous sheet overlying the circuitry. If desired, key buttons may be positioned over the domes in a manner such that depressing a key button causes the underlying dome to be collapsed, whereby an electrical connection is made at the corresponding switch site.

Brief Description of the Drawings

The invention is described in more detail hereinafter with reference to the accompanying drawings wherein like reference characters refer to the same parts throughout the several views and in which:

FIGURE 1 is a cross-sectional view of one embodiment of keyboard system of this invention;

FIGURE 2 is a cross-sectional view of the embodiment of Figure 1 in which the dome over the switch has been depressed or collapsed to make a connection and close the switch; and

FIGURE 3 is a top view illustrating a common form of switch used in a keyboard.

Detailed Description of the Invention

In the drawings there is illustrated a keyboard embodiment 10 of the type which is useful, for example, in a portable calculator or any other electronic device including switches and a keyboard.

The keyboard includes a rigid base member 12 which may be, for example, metal, plastic, etc. It is dimensionally stable and may vary in thickness so long as it retains its shape and provides a firm support.

The upper surface of the base member 12 includes a pattern of depressions or cavities 14 which are in registry with the switch sites of the printed circuitry which is carried by the upper surface of base 12.

The printed circuitry comprises a thin dielectric layer 16 on which the required conductive paths are located. The thickness of the layer 16 may vary, but it preferably is thin and flexible. At each switch site there are, for example, a plurality of interdigitated, spaced conductive fingers 17 and 17A, as illustrated in Figure 3. Alternatively, there may be a plurality of spaced conductors in any desired pattern (e.g., a spiral or parallel fingers) at each switch site. When two or more of such conductors are connected electrically, the switch is actuated.

Although the width of each such conductive finger or conductive path may vary, a width of about 0.005 to 0.020 inch is common. Similarly, the spacing between adjacent fingers may vary, although a spacing of about 0.005 to 0.020 inch is also common.

Overlying the printed circuitry there is preferably included a spacer member 18. This spacer is preferably in the form of a sheet having a uniform thickness and having openings or cut-outs in a pattern which corresponds with the locations of the switch sites.

The spacer member is preferably a dielectric material, and it preferably has a thickness in the range of about 0.005 inch. A typical spacer member is polyester film (which may be rigid or flexible).

It is possible for the spacer member to be conductive (e.g., metal) so long as it is insulated from the printed circuitry.

Disposed over the spacer member is the dome sheet 20. This sheet includes a pattern of raised domes 24 which are in registry with the switch sites on the printed circuitry. The bottom surface of each dome includes a thin conductive layer or coating 22. For example, layer 22 may comprise a silver or carbon ink or conductive particles in a polymerized coating.

The dome sheet may be a dielectric material or a conductive material. A suitable dielectric material which may be, for example, a plastic film. A conductive material which may be used as the dome sheet is a thin metal sheet such as cold rolled stainless steel (e.g., having a thickness of about 0.003 to 0.008 inch).

Each dome may be formed in a plastic dome sheet by means of heat and pressure, for example. Each dome may be formed in a metal dome sheet by stamping.

The dome sheet (whether metal of plastic) is flexible and resilient so that each dome can be depressed or collapsed by means of finger pressure and will then return to its original shape and position when the finger pressure is released. If desired a key button may be positioned over each dome.

As another alternative, each dome may be an individual component which is positioned over a respective switch site on the printed circuitry.

The size of each dome is normally the same. Preferably each dome is circular and has a diameter of about 0.25 inch. Other sizes may, of course, be used in this invention.

When finger pressure is used to depress or collapse a dome (e.g., as illustrated in Figure 2) the conductive layer 22 on the underside of the dome comes into contact with the interdigitated fingers 17 and 17A on the printed circuitry at a switch site. The finger pressure also causes the printed circuitry at the switch site to be deflected downwardly into the depression 14 in the base member 12. The same thing happens when a key button is positioned over each dome.

As a result, there is very good conformance of the conductive layer 22 with the fingers 17 and 17A. This assures good electrical contact between the layer 22 and the fingers.

The size of each depression or cavity 14 in the upper surface of the base member may vary. Preferably it is the same size and cross-sectional shape as the dome. The depression may have a flat base (as illustrated in the drawings) or it may be curved. For example, it may be concave, if desired.

The depth of the depression may also vary. Typically the depth is about 0.003 to 0.005 inch for most purposes.

The spacer sheet 18 is optional, It's presence is preferred, however, because it increases the distance which the dome can travel as it is being depressed or collapsed. This provides a better "feel" to the key being operated.

As another alternative, the switches on the printed circuitry may be 3 pole switches in which three conductors must be electrically connected to actuate the switch.

Other variants are possible without departing from the scope of the present invention.

Claims

1. A keyboard (10) **characterized** by:

(a) a rigid base member (12) including an upper surface and a plurality of depressions (14) in said surface in a predetermined pattern;

(b) electrical circuitry (16) on a flexible support and carried by said base member, said circuitry defining a plurality of open switches (17) in registry with said pattern of depressions in said base member;

(c) a plurality of flexible, resilient domes (24) covering said circuitry (16) and being in registry with said pattern of depressions, wherein the underside of each said dome (24) includes a conductive surface which is capable of completing an electrical connection at a said switch when said dome (24) is deflected downwardly against said circuitry, wherein said circuitry is deflected into said depression under said switch.

2. The keyboard in accordance with claim 1, **characterized** in that said base member (12) is metal and in that each said depression (14) includes a flat base surface.

3. The keyboard in accordance with claim 1 or 2, **characterized** in that said domes (24) are integral with a sheet (20) comprising a plastic film.

4. The keyboard in accordance with any of the preceding claims, **characterized** in that said conductive surface on the underside of each said dome (24) comprises an ink including conductive particles selected from the group consisting of silver and carbon.

5. The keyboard in accordance with any of the preceding claims, **characterized** in that said diameter of each said dome (24) and each said depression (14) are approximately equal.

6. The keyboard in acordance with any of the preceding claims, **characterized** in that each said switch comprises interdigitated, spaced conductive fingers (17,17A).

7. The keyboard in accordance with any of the preceding claims, **characterized** in that said flexible support for said electrical circuitry (16) comprises plastic.

8. The keyboard in accordance with any of claims 3 to 6, **characterized** by a dielectric spacer sheet (18) between said flexible support and said dome sheet (24), wherein said spacer sheet includes a plurality of openings in registration with said domes.

9. Use of the keyboard in accordance with any of the preceding claims for a calculator.

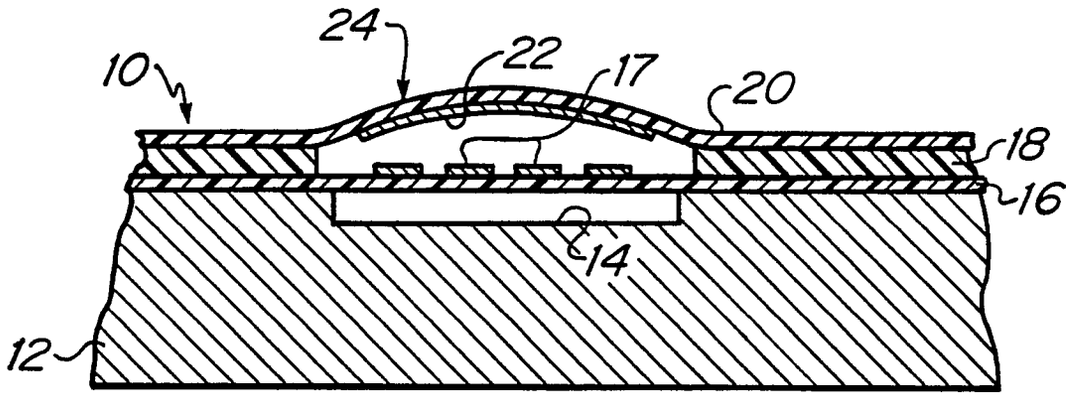

Fig 1

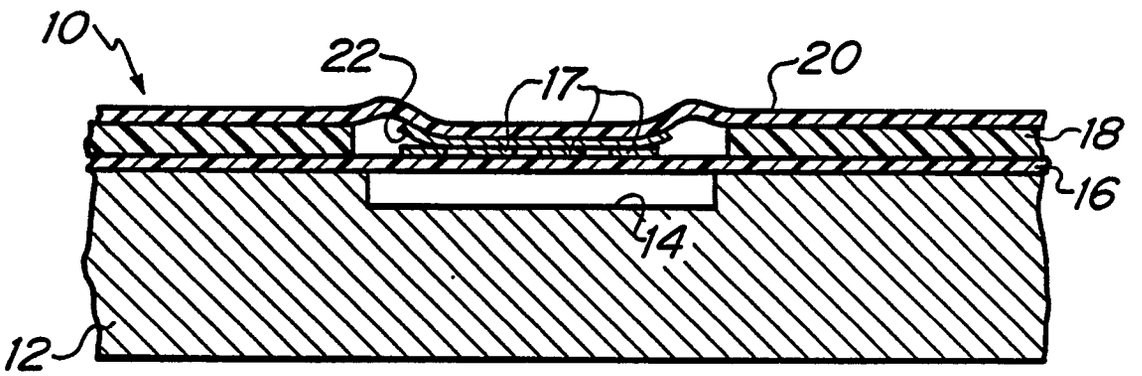

Fig 2

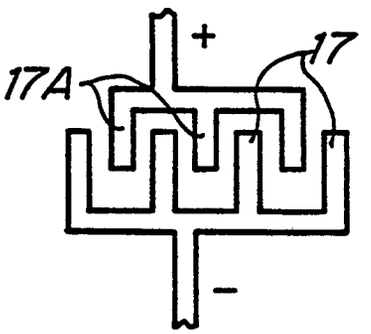

Fig 3