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(54) Keyboard venting.

(57) A keyboard (10) (e.g. for a calculator) is described including a base member having a plurality of channels (14) or a chamber, circuitry defining a plurality of switches (17) in a pattern, and optionally a plurality of domes (24) in registry with the switch sites. When a dome is depressed or deflected downwardly, the air under the dome passes into a channel or a chamber where it is distributed away from the switch site. A vent aperture (14B) communicating between the channel or chamber and the atmosphere may also be included. Membrane switches can also be used in such a keyboard.

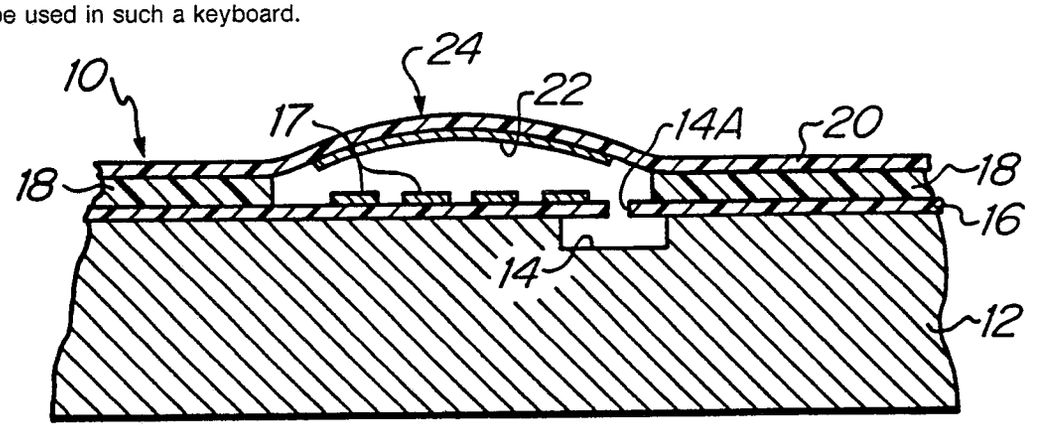

Fig 1

EP 0 322 515 A2

KEYBOARD VENTING

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. This may be effected by finger pressure directly on the dome or indirectly by finger pressure on a key button positioned over the dome.

When the components are clamped together or bonded during manufacture, air is trapped under each dome. This air must be vented in some manner to enable the dome to be depressed or collapsed when striking a key. Venting is also required to allow the air pressure to equalize (e.g., when changing altitude such as on an airplane). Venting prevents mushiness and improves the tactile feel of a key when it is depressed.

Previous keyboards of this type have included a spacer sheet between the dome sheet and the printed circuitry. A series of slots were die cut in the spacer sheet to allow for air to be forced out from beneath a dome when the dome is depressed or collapsed.

However, on a large multi-keyed keyboard, the presence of numerous slots causes the spacer sheet to be flimsy and difficult to handle and assemble with the other components.

Another type of keyboard which is used includes membrane switches which comprise spaced-apart parallel conductors at each switch site. When the upper conductor is deflected downwardly to contact the lower conductor an electrical connection is made. The air which is present between the two conductors should be vented in some manner to prevent mushiness of key action.

The present invention provides a system which represents an improvement in venting techniques 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 in one embodiment:

(a) a rigid base member including an upper surface and a plurality of channels;

(b) electrical circuitry on a support carried by the upper surface of the base member, the circuitry defining a plurality of open switches in a predetermined pattern of switch sites;

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

Each switch site communicates with at least one of the channels in a manner such that air present under a dome is forced into one of the channels when the dome is deflected downwardly.

The provision of channels in the upper surface of the base member avoids the need for die cutting a spacer sheet. In fact, the spacer sheet could be left out, if desired. Even where the spacer sheet is used, there is no need to cut slots in it.

In another embodiment the electrical circuitry includes membrane switches comprising spaced-apart parallel conductors at each switch site. When the upper conductor is deflected downwardly to contact the lower conductor, the air present between the two conductors is forced into a channel in the base member via an aperture. A dome may also be positioned over, and in registry with, each switch site.

If desired, a key button may also be positioned over each switch site. Finger pressure is then applied to the key button.

Other advantages of the venting system of the invention will be apparent from the following detailed description.

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;

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

FIGURE 4 is a top view illustrating interconnected channels in the keyboard;

FIGURE 5 is a cross-sectional view of another embodiment of keyboard of the invention which includes venting to the atmosphere through the base member;

FIGURES 6 and 7 are cross-sectional views illustrating another embodiment of keyboard of the invention which utilizes membrane switches.

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 base member 12 includes a pattern of channels 14 which may all be interconnected to provide a pathway for air movement when a dome is depressed or collapsed, as described in more detail hereafter. Each switch site on the printed circuit communicates with at least one such channel. If desired, all of the channels may interconnect with each other. The channels may have varying cross-sectional configurations so long as they are capable of allowing air to move therethrough when a dome is depressed.

Preferably there are at least three switch sites communicating with a single channel in the base member when there is no venting to the atmosphere so that the air from one of the switch sites can be adequately dispersed when such switch is actuated by pressing the dome downwardly. Of course, by making the volume of each channel greater, it is easier to alleviate the extent of air compression when a single switch is actuated.

As another alternative, a chamber may be provided in the base member into which air may be forced when a switch is actuated. If the base member is thin, however, this may not be entirely satisfactory.

As illustrated in the drawings, the channels are provided in the upper surface of the base member. It is possible for the channels to be located below the upper surface so long as there is an appropriate aperture communicating between each switch site and a channel.

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 may be a plurality of interdigitated, spaced conductive fingers 17 and 17A, as illustrated in Figure 3.

Although the width of each such finger 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.

Other arrangements of conductors may also be used at each switch site. All that is required is that there be two or more spaced conductors present which will complete an electrical connection when contacted with another conductor. For example, the conductors may be in parallel, spaced arrangement or in a spiral arrangement, etc. Three pole switches may also be used if desired.

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). Alternatively, the spacer member may be conductive so long as it is electrically insulated from the printed circuitry.

Positioned 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. When the sheet is dielectric material the bottom surface of each dome includes a thin conductive layer or coating 22. For example, layer 22 may comprise a conductive ink or conductive particles in a polymerized coating.

Each dome may be formed in the dome sheet by means of heat and pressure, for example, when the sheet is plastic. The dome sheet 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.

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. At the same time the air present under dome 24 is forced through aperture 14A and into channel 14. This allows the air to dissipate through the channel system. If desired, there may also be included a vent aperture 14B communicating between channel 14 and the atmosphere, as illustrated in Figure 5. This is not required, however, and could allow moisture to enter the keyboard.

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.

The domes may be integral with a sheet as illustrated in the drawings, or the domes may be individual components positioned over and in registry with the switch sites. The dome sheet may be dielectric (e.g., plastic) or it may comprise a thin metal sheet (e.g., cold rolled stainless steel). As another alternative, there may be provided strips which each include a plurality of domes.

The dome sheet may be bonded to the top of the circuitry (or to the top of the spacer member, if present) or it may be clamped in place.

In Figure 6 there is illustrated another embodiment of keyboard 30 of the invention which includes spaced-apart, parallel conductors 34 and 35 as a membrane switch on base member 37. A spacer member 33 is positioned between the conductors 34 and 35 except in the area of the switch site. A dome sheet 31 having dome 31A may be positioned on top of the structure, as illustrated, with a spacer member 32 positioned between the dome sheet and the upper conductor 34, except in the area of the switch site.

The upper surface of the base member includes a channel 36 which communicates with the air space between the conductors 34 and 35 via aperture 36A in the lower conductor 35. This allows air present between the conductors to exit and enter the channel 36 when the conductor 34 is deflected downwardly to contact conductor 35 and actuate the switch. If desired, conductor 34 may also include an aperture to enable air present under the dome to enter into the channel when the dome is depressed or collapsed.

Layers 34 and 35 are thin and may comprise metal or, alternatively, may comprise plastic or other such dielectric material with a conductive matter on the opposing surfaces of layers 34 and 35.

Dome sheet 31 may be metal or plastic. Because the electrical connection for the switch is made when layer 34 contacts layer 35, it is not necessary for the underside of dome 31A to be conductive.

Figure 7 illustrates another embodiment of keyboard 40 of the invention which includes membrane switches. One such membrane switch is illustrated. It includes spaced-apart parallel layers 42 and 43 which are separated by spacer member 41 except in the area of the switch site. When the upper layer 42 is depressed or deflected downwardly to contact layer 43, air present between the two layers is forced out through aperture 46A in layer 43 into channel 46 in the upper surface of base member 44. If desired, the channel may communicate with the atmosphere.

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 channels (14);
(b) electrical circuitry (17) on a support (16) carried by said upper surface of said base member (12), said circuitry defining a plurality of open switches (17) in a predetermined pattern of switch sites;
(c) a plurality of flexible, resilient domes (24) covering said circuitry (17) and being in registry with said pattern of switch sites; wherein the underside of each said dome (24) includes a conductive surface (22) which is capable of completing an electrical connection at a said switch (17) when said dome (24) is deflected downwardly against said circuitry;
wherein each said switch site communicates with at least one of said channels (14) in a manner such that air present under a said dome (24) is forced into one of said channels (14) when said dome (24) is deflected downwardly.

2. The keyboard in accordance with claim 1, **characterized** in that said base member is metal.

3. The keyboard in accordance with claim 1 or 2, **characterized** in that said conductive surface on the underside of each said dome comprises an ink including conductive material (22) selected from the group consisting of silver and carbon.

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

5. The keyboard in accordance with any of the preceding claims, **characterized** in that said domes (24) are integral with a sheet comprising metal; and in that said support for said electrical circuitry (17) comprises a flexible plastic film.

6. The keyboard in accordance with claim 5, **characterized** in that said metal sheet comprises stainless steel.

7. A keyboard (30) for a calculator **characterized** by

(a) a rigid base member (37) including an upper surface and a plurality of channels (36); and

(b) electrical circuitry (34,35) including a plurality of membrane switches (34,35) in a predetermined pattern of switch sites; wherein each said switch site communicates with at least one of said channels (36) in a manner such that air present at said switch site is forced into one of said channels (36) when said membrane switch (34,35) is actuated.

8. The keyboard in accordance with any of the preceding claims, **characterized** in that said base member (12,37) is metal.

9. The keyboard in accordance with claim 7 or 8, **characterized** in that said electrical circuitry (34,35) comprises first and second spaced-apart, parallel membranes (34,35), and in that said first membrane (35) includes an aperture (36A) therethrough at each said switch site, said aperture (36A) communicating with one of said channels (36).

10. The keyboard in accordance with claims 7, 8 or 9, **characterized** by a plurality of flexible, resilient domes (31A) in registry with said pattern of switch sites.

11. The keyboard in accordance with one of claims 1 to 6 or 10, **characterized** in that said domes (24,31A) are integral with a sheet (20;31) comprising a plastic film.

12. The keyboard in accordance with claim 10 or 11, **characterized** in that said domes (31A) are integral with a sheet comprising a thin metal sheet.

13. The keyboard in accordance with claim 11, **characterized** by a dielectric spacer sheet (18;32) between said dome sheet (20;31A) and said support (16) or said electrical circuitry (34), respectively, wherein said spacer sheet (18;32) includes a plurality of openings in registration with said domes.

14. The keyboard in accordance with any of the preceding claims, **characterized** by at least one vent aperture (14A;36A;46A) in said base member (12;37;44) communicating between one of said channels (14;36;46) and the atmosphere.

15. The keyboard in accordance with any of the preceding claims, **characterized** by a key button positioned over each said dome (24;31A) and being adapted to collapse said dome (24;31A).

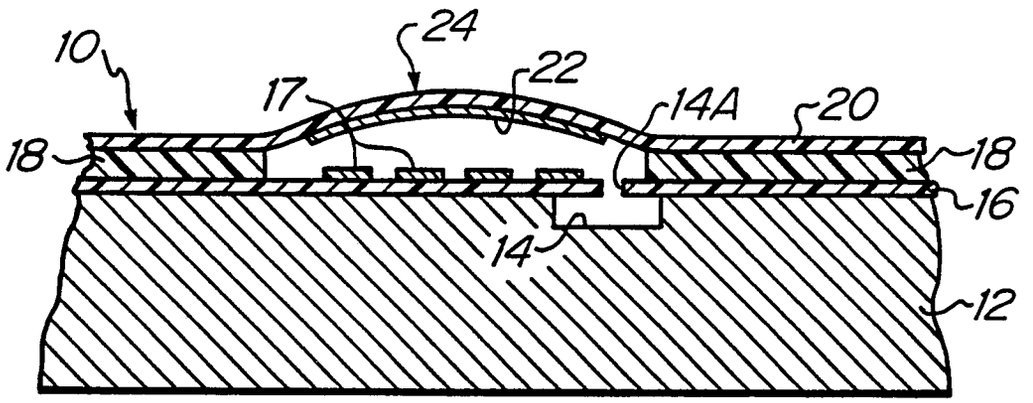

Fig 1

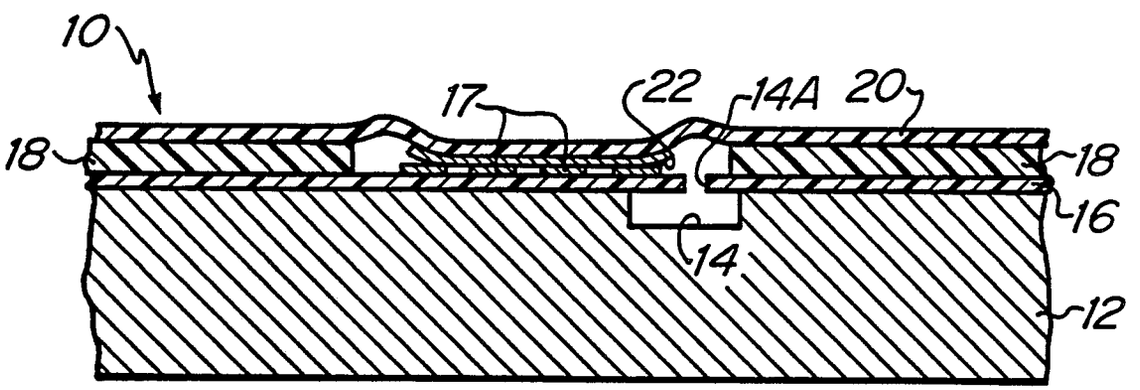

Fig 2

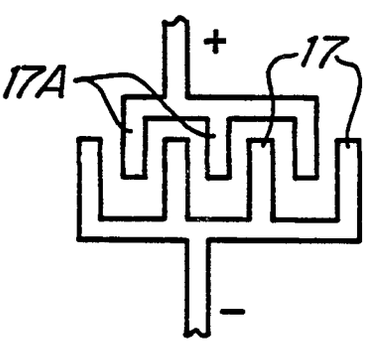

Fig 3

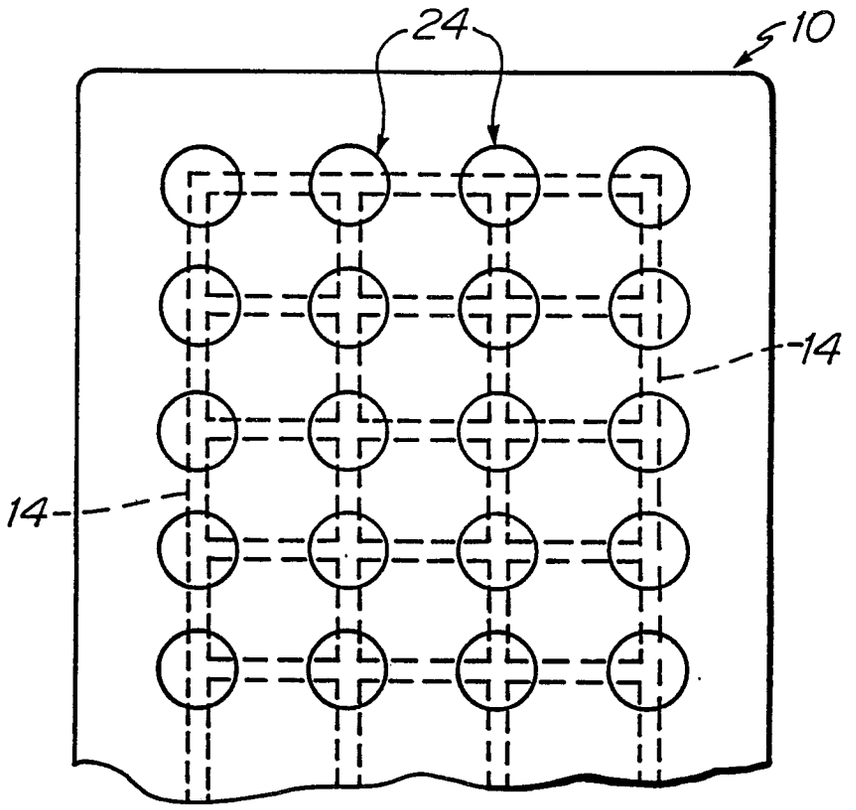

Fig 4

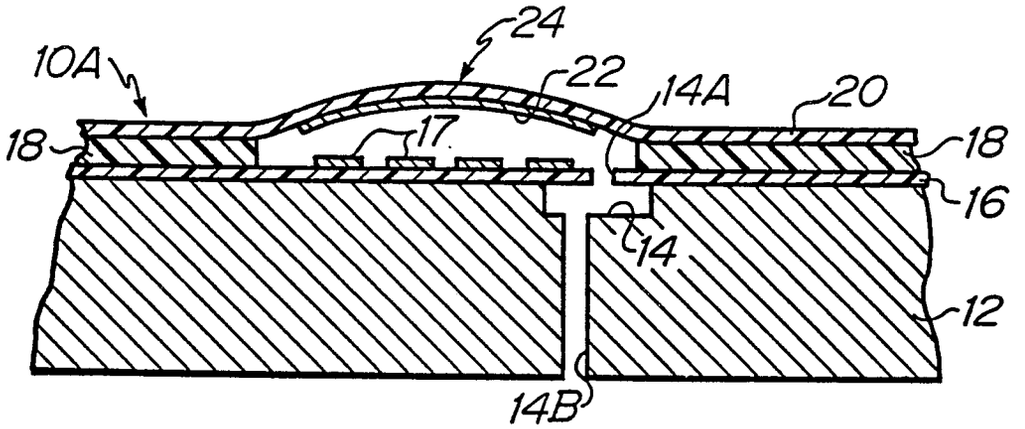

Fig 5

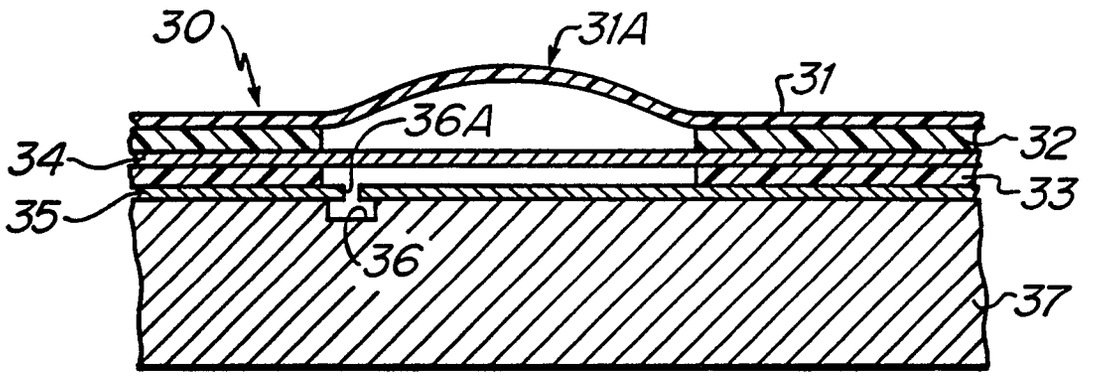

Fig 6

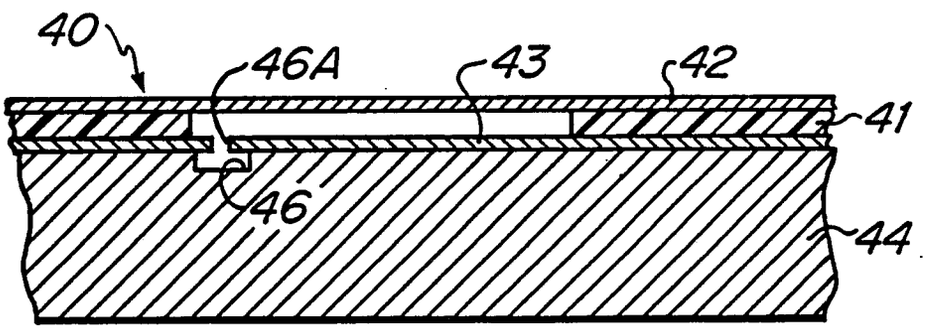

Fig 7