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[21] Appl. No. **827,586**
[22] Filed **May 26, 1969**
[45] Patented **Feb. 2, 1971**
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[56] **References Cited**
UNITED STATES PATENTS
3,226,473 12/1965 Dahlgren..... 174/117(.11)
3,308,253 3/1967 Krakinowski..... 200/86X
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[54] **DEPRESSIBLE DIAPHRAGM OVERLAY SWITCH FOR DISPLAYS**
7 Claims, 3 Drawing Figs.

[52] **U.S. Cl.**..... **200/46,**
339/18, 317/101
[51] **Int. Cl.**..... **H01h 43/08**
[50] **Field of Search**..... **339/18C; -**
317/101CX; 200/46, 86, 86.1; 338/99, 100, 114,
105, 106, 107, 108, 109; 340/(Inquired); 174/110,
117, (Inquired)

ABSTRACT: A two layer planar multicontact switch including a first substrate layer having a plurality of parallel conductive lines deposited on the upper surface thereof and a second diaphragm layer located over the substrate layer and having a plurality of parallel conductive lines deposited on the lower surface thereof. The conductive lines on the substrate are normal to the conductive lines on the diaphragm such that a plurality of matrix switch intersections are formed. The conductive lines on the substrate and the diaphragm have insulating material selectively deposited thereon to electrically isolate the upper and lower conductive lines except at the points of intersection. The diaphragm layer may be mechanically depressed at the intersection points to selectively connect the upper lines with the lower lines to form switch closure contacts. The diaphragm and the substrate are formed from transparent material so that the switch can be employed in combination with a visual display.

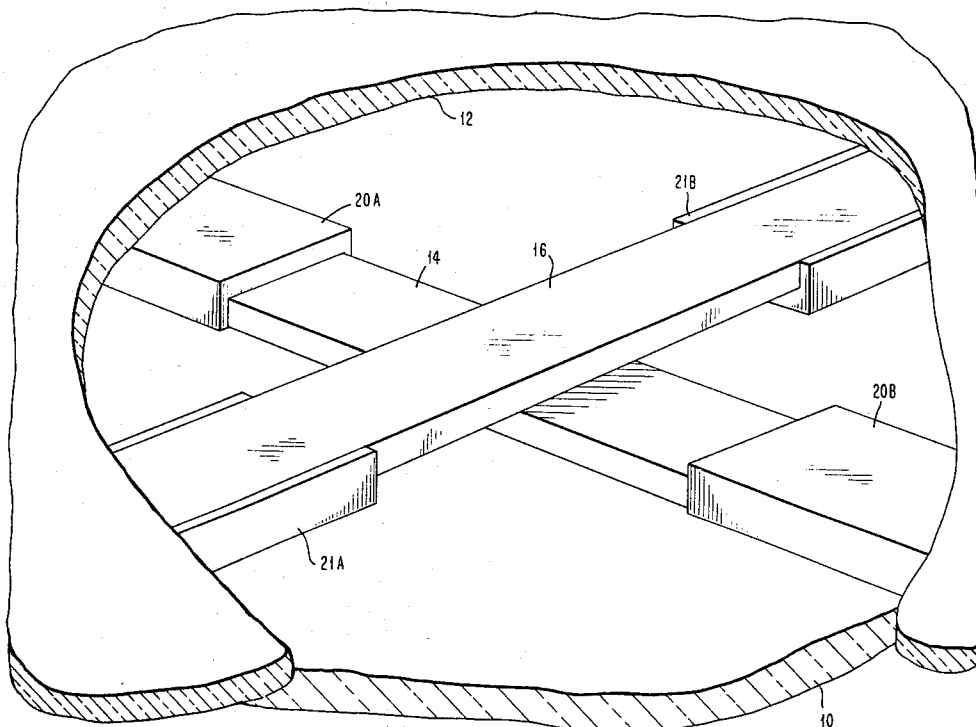


FIG. 1

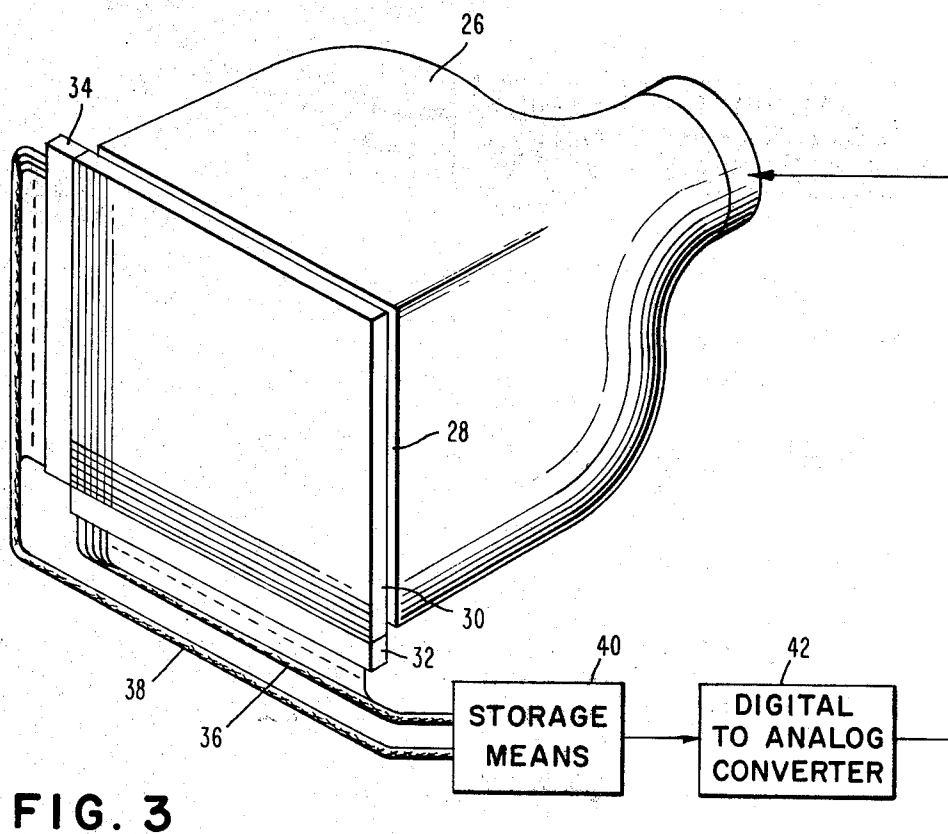
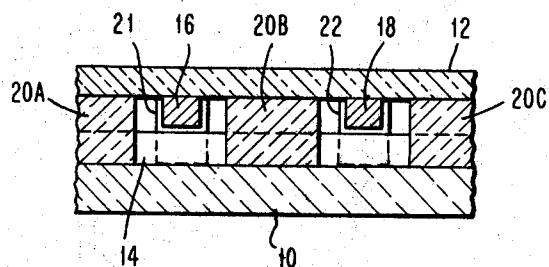


FIG. 3

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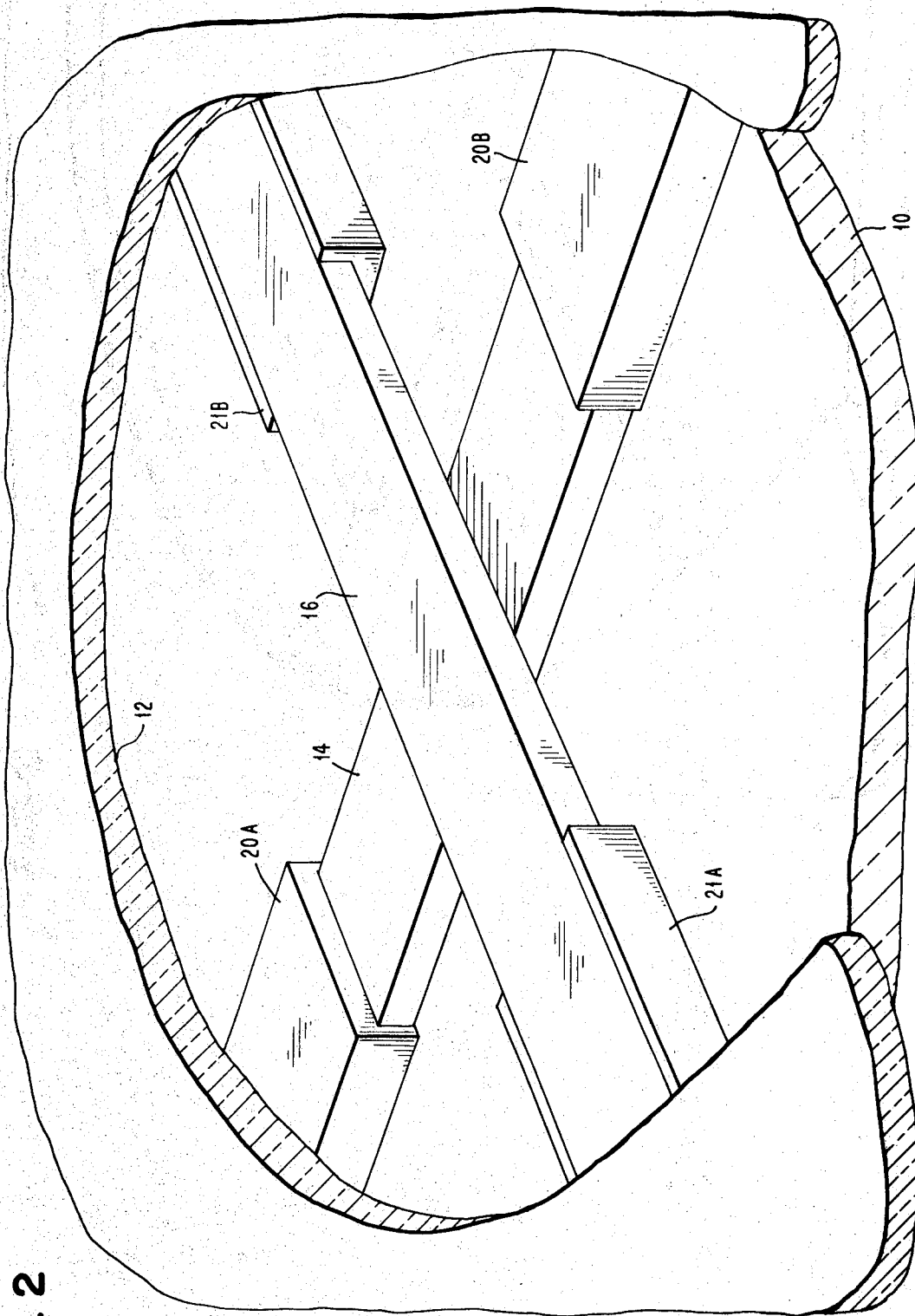
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FIG. 2



DEPRESSIBLE DIAPHRAGM OVERLAY SWITCH FOR DISPLAYS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is in the field of multicontact flexible diaphragm switches.

2. Prior Art

Diaphragm switches are known in the prior art as represented by U.S. Pat. No. 3,308,253, issued Mar. 7, 1967 to M. Krakinowski, and assigned to the present assignee. This switch contains conductive lines on a substrate and a diaphragm. The conductive lines are insulated from each other by a spacer plate having holes at the intersection points. A switch of this type having a third layer cannot be made sufficiently transparent and cannot provide the density of switch connections as provided by the switch of the present invention.

SUMMARY OF THE INVENTION

Electronic systems presently include graphic display terminals such as electron beam display tubes, graphic input terminals and the like, wherein it is desirable to select or determine particular points on the display. Light pen devices serve to accomplish this result by electro-optic means, however, such devices are complex and require extensive logic circuits.

An object of the present invention is to provide a depressible diaphragm switch which is transparent and can be used as an overlay switch for graphic terminals.

Another object of the present invention is to provide a diaphragm switch including a high density of switch contact points.

A further object of the present invention is to provide a diaphragm switch wherein the conductive elements are separated by insulation integrally grown and located only on the conductors.

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of a preferred embodiment of the invention, as illustrated in the accompanying drawn drawings.

BRIEF DESCRIPTION OF THE DRAWINGS In the drawings:

FIG. 1 is a sectional view of a portion of an embodiment of a diaphragm switch according to the principles of the present invention.

FIG. 2 is another sectional view of the embodiment of the diaphragm switch.

FIG. 3 is an illustration of a diaphragm switch in combination with a graphic display. DESCRIPTION OF A PREFERRED EMBODIMENT

Referring to FIG. 1, an illustration of a portion of a multicontact diaphragm switch having a lower planar substrate 10 and an upper planar diaphragm 12 is shown. The illustration is a section taken through a plane normal to the plane of a substrate 10 and diaphragm 12. Diaphragm 12 is composed of a transparent deformable elastomeric material, such as polyester, and substrate 10 may be composed of a rigid transparent material, such as glass, etc., or may also be composed of polyester material when a flexible switch structure is desired.

Substrate 10 has a plurality of parallel conductive lines affixed to the upper surface thereof, one of which, line 14, is shown in FIG. 1. The conductive lines, such as 14, may be composed of copper which is affixed to substrate by one of a number of bonding methods, for example, by deposition through a mask. Correspondingly, diaphragm 12 has similar parallel conductive lines affixed to its lower surface, such as conductive lines 16 and 18, which are normal to the direction of the conductive lines on substrate 10.

An important feature of the present invention is that diaphragm 12 and substrate 10 are spaced apart and the conductive lines are insulated from each other by an insulating

spacer, which is "grown" on the conductive lines, for example, by electrochemical flocculation. The insulating spacers cover the conductive lines except for given lengths at the switch points, that is, where contact between a conductive line on diaphragm 12 is to be brought into contact with a conductive line on substrate 10. In FIG. 1, the insulating spacer segments associated with conductive line 14 are designated 20A, 20B and 20C, with the portions of line 14 between segments 20A and B and 20B and C being uncovered. Likewise, conductive lines 16 and 18 are surrounded respectively by insulating spacers 21 and 22. Lines 16 and 18 are uncovered for given lengths at positions over the conductive lines on substrate 10, however, this is not evident in FIG. 1.

Referring to FIG. 2, a partially cutaway perspective view of the diaphragm switch shows one upper and lower conductive line and the insulating spacers. Transparent diaphragm 12 is shown cutaway for clarity. Conductive line 14 is shown affixed to the substrate 10 and covered by insulating spacer portions 20A and 20B, except at the switch contact point. Likewise, the upper conductive line 16 is shown affixed to the lower surface of diaphragm 12 and covered by insulating spacer portions 21A and 21B. As illustrated in FIG. 2, conductive line 14 is separated from conductive line 16 by a distance determined by the thickness of the insulating spacers. Electrical contact can be made between lines 14 and 16 by depressing diaphragm 12 (by finger, stylus, etc.) at the intersection of the lines, thereby bringing line 14 into physical contact with line 16 to form a current path. It is well known that if one layer of a switch has N conductive lines and the other layer has M conductive lines, a matrix switch is produced having $N \times M$ switch points for connecting unique pairs of the conductive lines. The lines are connected to selected input and output devices, unique pairs of which are connected depending on which switch contact is made.

The switch according to the present invention has advantages over prior art switches. Insulating spacers 20A, B, C and 21, 22, etc. are only slightly wider than the conductive lines, which in turn can be in the order of 5 mils wide. The spacers can be formed by electrophoretic deposition and therefore accurate thickness control can be obtained. Thus, a high density of conductive lines can be located on the substrate and the diaphragm resulting in a high density of switch points for a given area.

Also important is the fact that a separate insulating layer is not required and the insulating spacers are approximately the same width as the conductive lines, which are very narrow. Therefore, the substrate and the diaphragm can be composed of transparent material. The Conducting lines and insulating material appear visually as a hairline grid and the planar switch is substantially transparent.

Referring to FIG. 3, the utility of a transparent planar switch as an overlay in combination with a visual terminal is illustrated. In many instances, it is desirable to interact with a visual display terminal for the purpose of data entry or the like. Devices referred to as "light pens" are examples of electro-optical means for interacting with graphic displays. A typical example of a light pen system is shown in U.S. Pat. No. 3,337,860 issued Aug. 22, 1967 to A.L. O'Hara, Jr., and assigned to the present assignee and U.S. Pat. No. 3,106,707, issued Oct. 8, 1963 to F.T. Thompson and assigned to the United States of America.

In FIG. 3, a system is illustrated wherein the planar diaphragm switch of the present invention is combined with a visual display to provide an electromechanical display system. A visual display device 26, for example, a cathode ray tube, flying spot scanner or similar terminal, is shown having a display screen 28 upon which a graphic display is generated. A diaphragm switch 30, as illustrated in FIG. 2, is positioned on display screen 28 of FIG. 3 such that the horizontal conducting lines of the switch are in registration with the horizontal sweep lines of the raster of the display and the vertical conducting lines of the switch are positioned in accordance with the timing increments of the horizontal sweep signals of the

display so that there is registration between the switch points of switch 30 and the X—Y coordinates of display screen 28. Except for the minor grid or screen effect resulting from the conductive lines, the display appearing on display screen 30 is visible to the viewer. If the faceplate of display screen 28 is curved, the substrate layer of switch 30 is composed of flexible material, such as polyester.

To interact with the display system, the viewer selects one or more X—Y coordinate locations on display screen 28 by depressing the corresponding X—Y coordinate switch location of switch 30. By depressing such corresponding switch element, a unique horizontal and vertical conductor are connected thereby forming a current path. The horizontal (X) conductors and the vertical (Y) conductors of the diaphragm switch and the X—Y deflection system of the display device are interconnected by means within the skill of ones versed in the art so that the positions of the closures of the switch may be coordinated with positions on the screen of the display.

Since a high density of horizontal and vertical conductors are possible with the diaphragm switch of the present invention, the resolution of the graphic input terminal of FIG. 3 is high.

To interact with the display system, the operator selects one or more X—Y coordinate locations on display screen 28 by depressing the element of switch 30 at the corresponding X—Y position of switch 30. By depressing such corresponding switch element, a unique horizontal and vertical conductor are connected thereby forming a unique current path which is associated exclusively with the X—Y coordinate position on display screen 28.

As an example of one possible use of the display screen, a description is provided of how an operator can generate a desired pattern. The horizontal and vertical conductors of switch 30 are coupled through connectors 32 and 34 to corresponding wires. The wires as depicted in cables 36 and 38 are connected to a storage means 40 which contains a stored file of all the possible unique switch conductor pairs and the X—Y coordinates of the positions on the display screen associated with each pair. When a switch element is closed, the unique current path formed serves as an address for the associated display coordinate in storage means 40 which is read out and applied to a digital to analogue converter 42 which, in turn, applies a signal to the deflection means of display device 26 to direct the beam of the display device to the point on display screen 28 that is in registration with the closed switch element. More particularly, storage means 40 may include a plurality of storage locations, one for each possible switch element of switch 30. As previously discussed, the closure of each switch element effects the connection of a unique pair of conductive lines. Thus, in storage means 40, the wires in cable 36 are each connected through a separate one of a first group of transistors to a potential source. Each of the wires in cable 38 are connected through a separate one of a second group of transistors to ground potential. The closure of each switch element of switch 30 will therefore create a unique current path and actuate a unique pair of said first and second group of transistors. The outputs of the actuated transistor pairs are representative of the particular switch element that is closed and therefore serves as an address for the locations of the memory means 40. The memory locations contain signals representative of the positional information for directing the beam of the display device 26 to the position on screen 28 in registration with the closed switch element. The response time of the system is rapid, therefore, the operator may move a stylus across switch 30 to close a sequence of switch elements in a selected pattern and the beam of display device 26 will follow the stylus movement and generate a corresponding display pattern. It is also possible that storage means 40 can produce the appropriate analogue signal directly when addressed avoiding the necessity of digital to analogue converter 42.

In another application, a display may be generated by an independent input means such as a computer and the operator can then use switch 30 to select portions of the display. For ex-

ample, in computer assisted instructions, a question may be displayed on the screen 28 accompanied by multiple choice answers and the operator may select an answer by closing a switch element proximate to such answer. The computer can then determine from the relative positions of the closed switch element whether the correct answer was selected.

In FIG. 3, a combination of the switch of FIGS. 1 and 2 with a separate display system 28 was shown. For applications where it is expected that the operation will frequently or always interact with the display, a system may be fabricated wherein transparent layer 10 actually is the faceplate or screen of the display system. For example, the lower conductive lines 14 may be affixed directly to display screen 28. The advantage of this is that the registration between the deflection unit of the system and the conductive lines can be determined and permanently established during manufacture of the system.

It is also possible to employ the switch of the present invention independent of a display device. Because of its unique construction, the switch provides a large number of densely packed switch elements. Thus, if the switch elements are closed by an embossed structure, such as the raised letters on a credit card, the high density of switch elements provides a high resolution output.

One skilled in the art will appreciate that the configuration of the switch of FIG. 2 can be varied to accommodate a particular application. For example, instead of being flat, substrate 10 and diaphragm 12 may be formed cylindrically to provide a switch which can be used in a rotary manner.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

We claim:

1. A multicontact switch device comprising:

a substrate layer of material;

a plurality of separate lines of electrically conductive material disposed on a first surface of said substrate layer;

a plurality of separate lines of electrically insulating material disposed exclusively on and coextensive with first portions of each of said conductive lines, second portions of each of said conductive lines, second portions of each of said conductive lines remaining uncovered by said insulating material;

a layer of elastomeric material;

a plurality of separate lines of electrically conductive material disposed on a first surface of said elastomeric layer;

a plurality of separate lines of electrically insulating material disposed exclusively on and coextensive with first portions of each of said conductive lines on said elastomeric layer, second portions of each of said conductive lines remaining uncovered by said insulating material; and said elastomeric layer being disposed on said substrate layer with said first sides of said layers proximate to each other and separated by said lines of insulating material to form a plurality of switch contacts including said uncovered second portions of said elastomeric layers.

2. A multicontact switch device according to claim 1 wherein said substrate layer and said elastomeric layer are transparent.

3. A multicontact switch device according to claim 1 wherein said substrate layer is a layer of rigid material.

4. A multicontact switch device according to claim 1 wherein said substrate layer is a layer of flexible material.

5. A multicontact switch device according to claim 1 wherein said plurality of conductive lines on said substrate layer includes N parallel conductive lines extending in a first direction and said plurality of conductive lines on said elastomeric layer includes M parallel conductive lines extending in a direction normal to said first direction to form N × M switch elements including said uncovered second portions of

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said conductive lines of said substrate layer spaced from said uncovered second portions of said conductive elements on said elastomeric layer by said lines of insulating material and wherein each switch element is adapted to be brought into selective contact by deformation of said elastomeric layer.

6. A multicontact switch device according to claim 5 wherein each one of said $N \times M$ switch contacts is adapted to connect a different unique pair of said conductive lines, each of said unique pairs including one of said N conductive lines and one of said M conductive lines.

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7. A multicontact switch device according to claim 5 wherein said substrate layer is the display screen of a display device including means for generating a visual display on said screen, and further including means connected between said conductive lines on said screen and elastomeric layer and said generating means for providing a distinctive signal to said generating means in response to contact of said switch elements, said distinctive signal being representative of the position of said switch elements relative to said screen.

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