A touch entry switch array comprising a layer of non-conductive material is sandwiched between two conductive layers. Orthogonally disposed conductors are arranged in a matrix and adapted to make electrical connection by deforming an upper resilient, transparent or translucent layer through respective apertures to establish electrical contact. Indicator means is provided to indicate through the apertures the actuation of the associated switch. In one form of the device, the orthogonal conductors are supported on the lower layer and the upper layer is constructed of transparent or translucent conductive material which may be deformed through the apertures to operate the associated switch. In another form of the invention, one set of conductors is supported on the upper layer to be deformed through the apertures to contact conductors on the lower layer.
TOUCH ENTRY SWITCH ARRAY

This invention relates to touch entry switch devices, and particularly to an array of touch entry switch devices having light emitting indicators associating with each switch to indicate actuation of the switch.

Message entry devices for establishing a coded message for transmission to a central station ordinarily include an array of switches adapted to be actuated to operate on logic circuitry to formulate a predetermined message. Heretofore, such message entry devices have utilized ordinary switch devices having switch actuating means adapted to be operated by the operator. As an example of such switch actuators, the message entry devices utilized keys associated with each switch adapted to be depressed to close contacts associated with the switch for operation on the logic circuitry. Message entry devices may be used in the field so that a forward observer can, by formulation of a proper message, advise an artillery commander of corrections to be made for a particular target. Message entry devices have become more complex due to the requirement for additional types of messages to be sent to the field commander. Hence, there has been a growing need for a more compact, portable message entry device for use by a forward observer. With the growing need for a compact message device, a corollary need has been established for a miniature switch array capable of actuating the logic circuitry associated with the message entry of actuating the logic circuitry associated with the message entry device.

It is an object of the present invention to provide a compact thin switch array arrangement for operation with a message entry logic circuit for establishing messages to be sent to a central computer.

Another object of the present invention is to provide a touch entry membrane switch array for use with logic circuitry for establishing messages to be sent to a remote station.

Another object of the present invention is to provide a touch entry membrane switch array having light emitting indicators associating with each switch thereof so that the operator can determine which of the switches has been operated.

In accordance with the present invention, a touch entry switch array comprises a layer having a plurality of apertures sandwiched between two other layers. A plurality of first conductors are disposed on one or the other layers. Means is provided for establishing electrical connection between selected ones of said first and second conductors by depressing said one layer through the aperture. For example, the first and second pluralities of conductors may be disposed on one layer, and the other layer, which may be constructed of resilient conductive material, may be deformed through the aperture to contact two of the conductors. Alternatively, the conductors may be disposed on opposite layers and contacted through the apertures.

In accordance with one feature of the present invention, light emitting indicators are associating with the individual switches and are operable to indicate the region of the switch array has been operated.

In accordance with another feature of the present invention, the entire membrane switch array is transparent or translucent so that light emitting indicators associated with various regions of the array may be viewed by an operator through the switch array.

The above and other features of this invention will be more fully understood from the following detailed description, and the accompanying drawings, in which:

FIG. 1 is a perspective assembly view of a membrane switch array in accordance with the presently preferred embodiment of the present invention;

FIG. 2 is a section view of a portion of the switch array illustrated in FIG. 1 taken at line 2--2 in FIG. 1;

FIG. 3 is a schematic circuit diagram of the switch array illustrated in FIG. 1;

FIG. 4 is a perspective assembly view of a membrane switch array in accordance with a modification of the present invention; and

FIG. 5 is a perspective assembly view of a switch array in accordance with another modification of the present invention.

Referring to the drawings, and particularly to FIGS. 1 and 2, there is illustrated a touch entry membrane switch array 10 in accordance with the presently preferred embodiment of the present invention. Switch array 10 comprises a thin layer of non-conductive material 11 sandwiched between a layer 12 of translucent conductive material and a layer 13. Layer 13, which may, for example, be constructed of a suitable insulative material, has conductors 14, 14a, etc. embedded therein and exposed to the upper surface thereof. Each conductor 14 terminates at an edge of layer 13. Each conductor 14, 14a includes a plurality of integral fingers 15, 15a extending orthogonal to the respective conductor. Insulator layer 16 is bonded to the lower surface of layer 15 and supports a plurality of conductors 17, 17a having pins 18, 18a protruding through layer 13 in spaced relation to respective fingers 15, 15a of conductor 14, 14a. A plurality of third conductors 19, 19a are supported by layer 20 which, in turn, is bonded to the side of layer 16 opposite layer 13. Light emitting diodes 21, 21a are connected in a matrix between individual and mutually exclusive conductors 19 and 17.

As illustrated in particular in the circuit diagram shown in FIG. 3, the light emitting diodes are connected in a matrix between mutually exclusive individual conductors 17 and 19, and switch terminals are provided between fingers 15 and pins 18. As will be more fully understood hereinafter, electrical connection between the terminals of each switch is accomplished by metallic layer 12.

Insulating layer 11, which is sandwiched between layers 13 and 12, includes a plurality of apertures 22 each juxtaposed over a respective pair of contacts 15 and 18.

In operation of the matrix switch illustrated in FIGS. 1-3, the operator may apply pressure to a region of flexible conductive translucent membrane 12 to deform the membrane so that membrane 12 makes electrical contact between the respective terminals 15 and 18 immediately adjacent the region. For example, if the operator applies pressure to depress region 23 of layer 12, that region of layer 12 will make electrical contact between the terminals associated with switch 24. Hence, electrical contact will be made between conductors 14a and 17a thereby operating suitable logic circuitry (not shown) in accordance with a predetermined program established for the operated switch. The circuitry may respond to the actuation of switch 24 by providing an electrical signal between...
conductors 17a and 19a thereby energizing light emitting diode 21b adjacent switch 24. Light emitting diode 21b may be viewed by the operator through the respective aperture and membrane 12.

FIG. 4 illustrates a modification of the membrane switch array in accordance with the present invention. In FIG. 4 a translucent non-conductive membrane 30 is provided having conductors 31, 31a exposed to the lower surface 32 thereof. A second membrane 33 is provided with conductors 34, 34a exposed to the upper surface thereof and positioned orthogonal to conductors 31. Light emitting diodes 35, 35a are connected to individual conductors 34 and 36, 36a supported by layer 33 and insulated from conductor 34. Insulator layer 37 is sandwiched between layer 30 and in diodes apertures 38 positioned at the junctions between conductors 34 and 31.

When the layers are assembled together, the switch array may be operated by applying pressure to membrane 30 at the region of a junction between orthogonal conductors 31 and 34 to deform membrane 30 so a respective conductor 31 makes electrical contact with a respective one of conductors 34. Electrical connection between selected conductors 31 and 34 provides information to logic circuitry (not shown) to formulate a message for transmission to a remote station. Also, a signal may be applied between respective ones of conductors 34 and 36 to energize the light emitting diode 35 associated with, and adjacent to contacted conductors. The light emitting diode may be viewed by the operator through aperture 38 and translucent membrane 30.

FIG. 5 illustrates yet another modification of the present invention wherein a translucent non-conductive membrane 40 contains a plurality of conductors 41, 41a, etc., exposed to the lower surface of the membrane. Membrane 42, which is also translucent, includes a plurality of conductors 43, 43a exposed to the upper surface thereof. Membrane 46 is sandwiched between membranes 40 and 42 and includes a plurality of apertures 47 disposed at the intersection of the orthogonal conductors 41 and 43. Non-conductive layer 48 is bonded to the lower surface of membrane 42 and includes orthogonal conductors 49, 49a and 50, 50a. Light emitting diodes 51, 51a are connected to mutually exclusive pairs of connectors 49 and 50 in a matrix as heretofore described.

In operation of the membrane switch array according to the present invention, pressure may be applied to a region of uppermost membrane to establish electrical connection between a unique pair of conductors connected to logic circuitry. The logic circuitry may provide a signal to energize a light emitting diode associated with the particular region of the matrix switch array that is depressed. The light emitting diode may be viewed through the translucent or transparent membranes and the aperture in the non-conductive membrane sandwiched between the switch operator and the terminals. If desired, the intermediate membrane having the apertures may be opaque so that light from a light emitting diode will not be diffused into an adjacent region.

Each layer of the switch array may have a thickness of between 0.5 and 10.0 mils. In the embodiment illustrated in FIGS. 1 and 2, layer 12 may be constructed of translucent plastic coated with a thin film of gold or tin oxide, while layers 11, 13, 16 and 20 may be constructed of non-conductive plastic, such as Mylar. The conductor patterns may be vapor deposited onto the layers, and the apertures may be formed in the center layer by a suitable etching process. In the embodiments illustrated in FIGS. 4 and 5, all layers may be constructed of translucent Mylar.

The present invention thus provides a touch entry membrane switch array which is easily fabricated and operated. The apparatus may be moisture sealed thereby providing a device which is rugged in use. The switch array is compact and lightweight for easy portability. For example, a switch array in accordance with the present invention may include 512 switches mounted in a matrix in a 4 inch × 7 inch space with each switch region comprising an area of approximately 3/16 inch × 3/16 inch.

This invention is not to be limited by the embodiments shown in the drawings and described in the description, which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

What is claimed is:

1. A touch entry switch array having a plurality of individual switches arranged in a matrix, said array comprising: first, second and third layers, said second layer being sandwiched between said first and third layers; a plurality of first conductor means supported on said first layer; a plurality of second conductor means supported on one or said first and third layers; a plurality of third conductor means supported on said first layer means; said first, second and third conductor means being mutually electrically insulated from each other; a plurality of apertures through said second layer means, each aperture encompassing a region adjacent a pair of conductors comprising individual ones of said first and second conductor means; a plurality of indicator means supported on said first layer and electrically connected to said said third conductor means; and operator means on said third layer for establishing electrical contact through said apertures between the first and second conductor means encompassed in the respective region, said third layer being translucent whereby the indicator means juxtaposed each aperture may be viewed through said third layer.

2. Apparatus according to claim 1 wherein said plurality of first conductor means comprises a plurality of first conductors disposed in a substantially parallel relationship and said plurality of second conductor means comprises a plurality of second conductors disposed in a substantially parallel relationship orthogonal to said first conductor.

3. Apparatus according to claim 2 wherein said second conductors are supported on said first layer, contact means associated with each of said first and second conductors, said contact means being arranged in pairs of contacts, each pair of contacts being electrically connected to mutually exclusive first and second conductors, each pair of contacts being exposed to mutually exclusive regions encompassed by mutually exclusive apertures in said second layer; and said third layer comprises a resilient translucent conductive layer adapted to establish electrical connection between the contacts of each of said pairs of contacts.
4. Apparatus according to claim 3 wherein said indicator means comprises a plurality of light emitting indicators each connected between mutually exclusive ones of said first and third conductors.

5. Apparatus according to claim 2 wherein said second conductors are supported on said third layer, said apertures each being positioned between projected intersections between mutually exclusive first and second conductors.

6. Apparatus according to claim 5 wherein said indicator means comprises a plurality of light emitting indicators each connected between mutually exclusive ones of said first and third conductors.