

United States Patent

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[54] MATRIX SWITCH WITH IMPROVED FLEXIBLE INSULATIVE SPACER ARRANGEMENT

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- [52] U.S. Cl. 200/5 A, 200/86 R, 200/86.5, 200/159 B
 [51] Int. Cl. H01h 9/26, H01h 13/26
 [58] Field of Search 200/5 R, 5 A, 86 A, 86.5, 159 B

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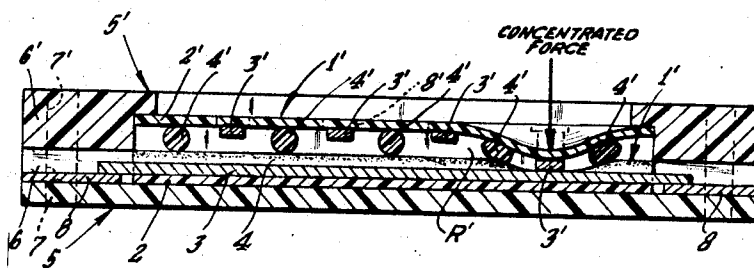
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[57] ABSTRACT

A matrix switch comprises an orthogonal arrangement of two sets of parallel conductors spaced from one another by a plurality of resilient elements. Preferably, the switch is made by securing together two one-sided flat conductor cables, each of which comprises a plurality of alternating, parallel conductors and elastomeric elements, with the heights of said elastomeric elements being greater than the heights of said conductors. Each cross-over point of the spaced conductors forms a switch point which is activated upon depression of the upper conductor into contact with the lower conductor. The orthogonally disposed flat conductor cables are held in a suitable housing including printed circuit board pads to which the conductors are connected, thereby facilitating simultaneous connection of the conductors to conventional multi-pin printed circuit board connectors for connection to the electronics used in conjunction with the matrix switch.

12 Claims, 9 Drawing Figures



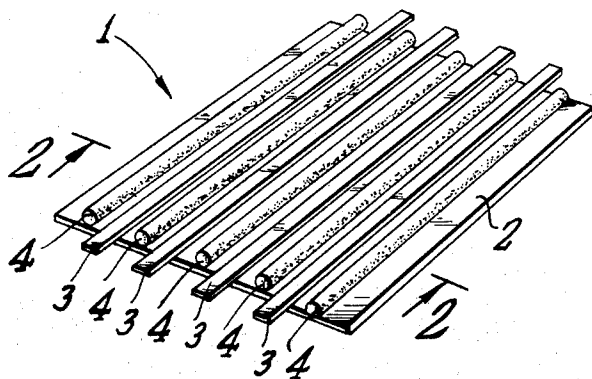


FIG. 1

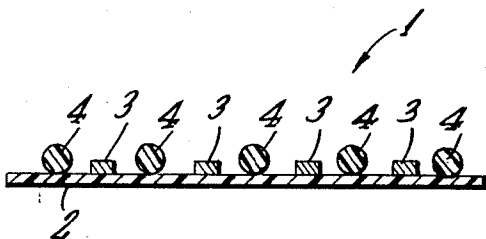


FIG. 2

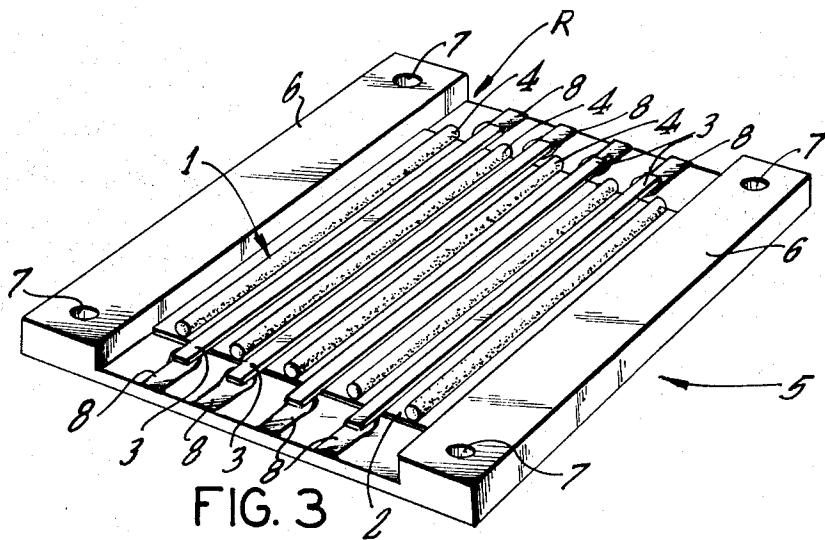


FIG. 3

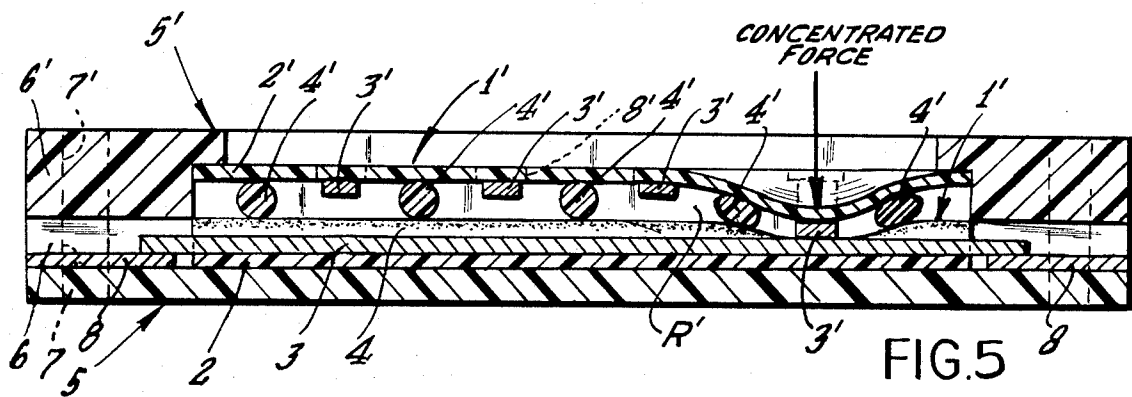


FIG. 5

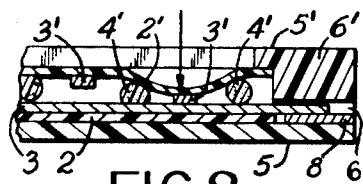


FIG. 8

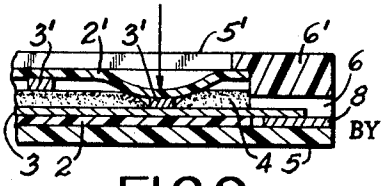
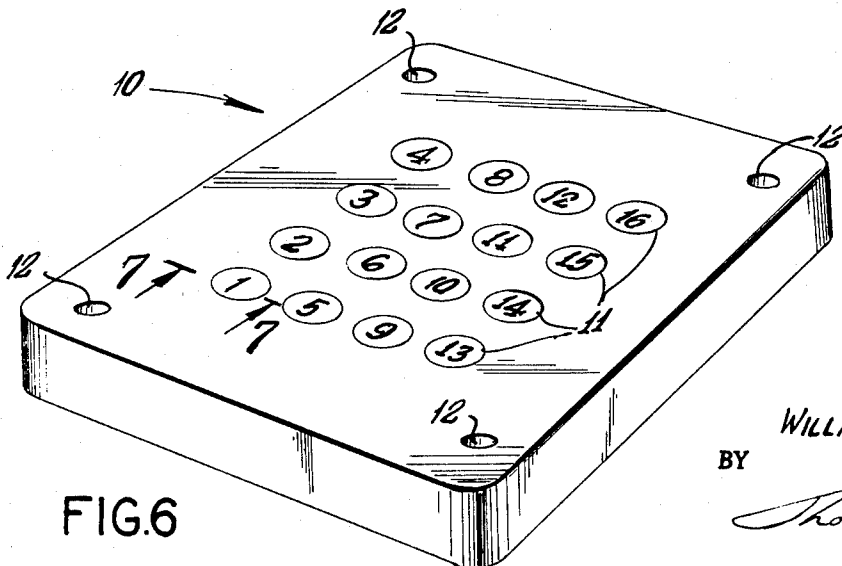
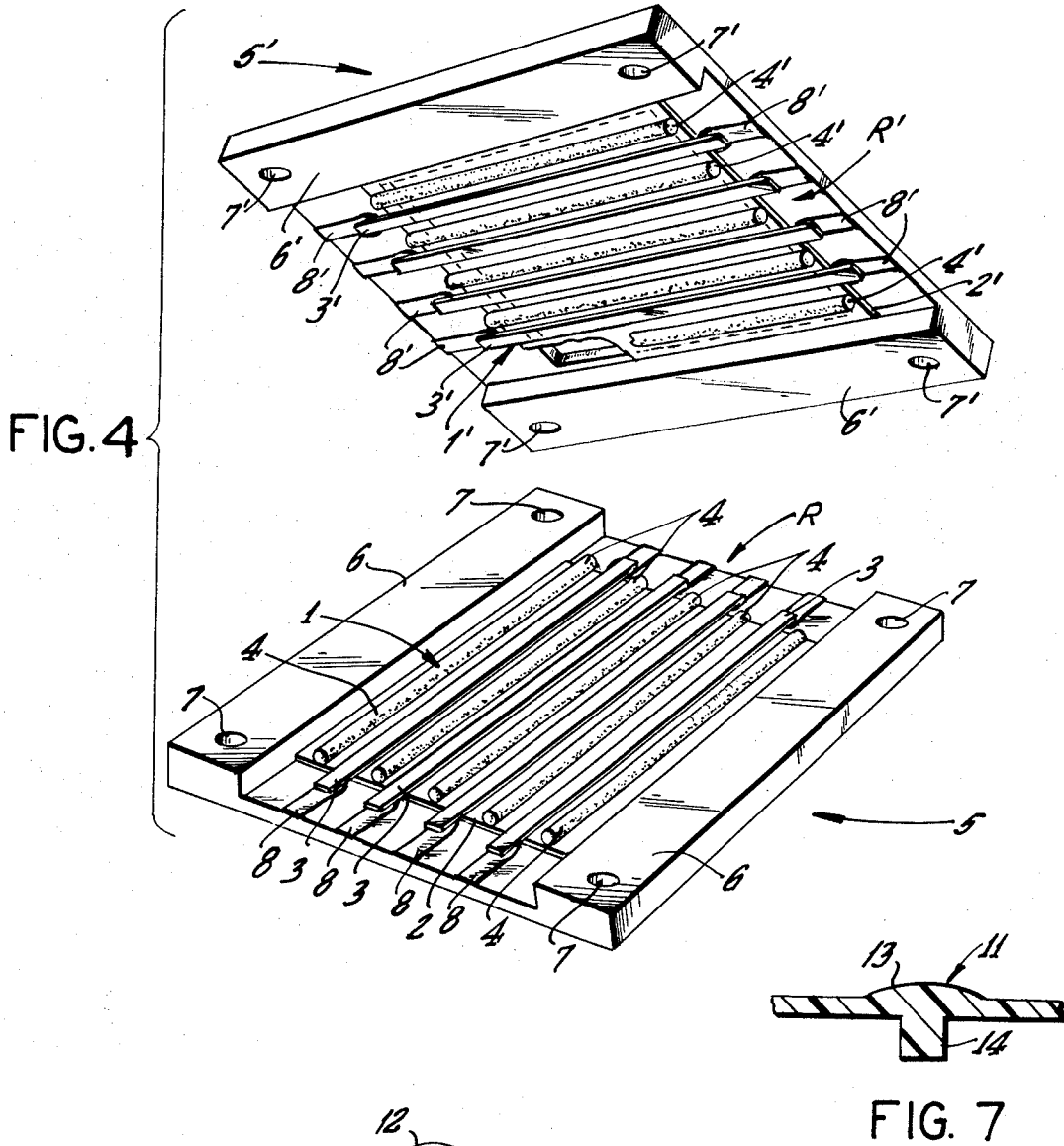


FIG. 9

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MATRIX SWITCH WITH IMPROVED FLEXIBLE INSULATIVE SPACER ARRANGEMENT

The present invention relates to a matrix switch, and more particularly a non-coded electromechanical keyboard switch.

To furnish low cost, high reliability keyboard switches to the rapidly growing computer and information handling equipment industries, switch manufacturers are offering an array of units in a wide range of sizes with a large number of options. One commonly available keyboard switch employs a plurality of reed switches arranged in keyboard fashion in a suitable housing. Each reed switch consists of two plated reeds or steel blades cantilevered from each end of a sealed glass tube, either evacuated or inert gas filled. Mercury wetted reed switches use small quantities of mercury to help make contact and reduce bounce. Permanent magnets, positioned on a movable plunger, cause a reed switch to open or close. Although reed switches have had a history of successful switching applications, the cost of the individual reed switches, and the manufacturing cost of making the relatively complicated precision reed switches has mitigated against their use in applications requiring a relatively inexpensive matrix switch. In addition, because of the number of different components embodied in a reed switch, the latter is relatively delicate and complex in construction.

A second commonly available matrix switch of the electromechanical type employs semi-conductor devices. As in the cases of reed switches, matrix or keyboard switches made with semi-conductor devices are expensive to manufacture and accordingly the cost of such a switch is prohibitive for certain applications.

The subject invention provides a matrix switch which is simple in construction, simple in operation and has a high switch density per square inch of planar surface. In addition, the subject matrix switch provides a low cost matrix switch which is an electromechanical switch capable of being housed in a suitable housing having means for interconnection to printed circuit board connectors in order to effect rapid connection and disconnection of a plurality of conductors.

Briefly, the present invention is made by securing together, in orthogonal relationship, two one-sided flat conductor cables, each of which comprises a plurality of parallel conductors alternating with a plurality of elastomeric strips. The cross-section of each elastomeric strip is greater than the cross-section of the adjacent conductors whereby, with the two one-sided flat conductor cables in abutting relationship at right angles, and with the conductors disposed in opposed relationship, the crossed elastomeric elements maintain a predetermined spacing between the conductors. An electrical connection at a cross-over point of two respective electrical conductors is established by merely depressing one point in the upper one-sided flat conductor cable so as to cause depression of the upper conductor and compression of the adjacent elastomeric members to establish electrical contact between said respective conductors. When the applied force is removed, the elastomeric members return the composite structure to its initial configuration. Each one-sided flat conductor cable is mounted in one part of a two-part housing, each part of the housing including conventional printed circuit board pads for connection to the conductors. The pads are arranged to facilitate connection to a multi-contact connector of the type generally known to the industry.

The objects of the invention will become more apparent from the following description and appended claims, taken in conjunction with the following drawings:

FIG. 1 illustrates a one-sided flat conductor cable forming a portion of the matrix switch of the subject invention;

FIG. 2 is a sectional view taken along lines 2—2 of FIG. 1;

FIG. 3 illustrates a perspective view of the connection of a one-sided flat conductor cable mounted in one-half of a housing for the subject matrix switch;

FIG. 4 illustrates a perspective exploded view of the components forming a preferred embodiment of the matrix switch of the subject invention;

FIG. 5 illustrates a partial sectional view of a cross-section of the assembled matrix switch, indicating at one point the position of the elements of the matrix switch during the formation of a switch contact between conductive elements of the one-sided cables of the matrix switch;

FIG. 6 illustrates a perspective view of a keyboard cover to be employed in conjunction with the subject matrix switch;

FIG. 7 illustrates a cross-section taken along lines 7—7 of FIG. 6, and illustrating a partial cross-sectional view of a button contact forming a portion of the keyboard cover;

FIG. 8 illustrates a partial sectional view of a cross-section of a modified form of matrix switch, and

FIG. 9 illustrates a partial sectional view of a cross-section of another modified form of matrix switch.

Turning to FIG. 1, there is illustrated a one-sided flat conductor cable 1 forming a portion of the subject matrix switch. Flat conductor cable 1 comprises a sheet of insulation material 2 having bonded thereto an alternating arrangement of parallel elongated elastomeric elements 4 and elongated conductors 3. As illustrated in FIG. 2, the cross-sectional area of each elastomeric element 4 is greater than the adjacent electrical conductors 3. For certain applications the cross-sectional area of a conductor 3 may be greater than the area of the elastomeric element 4, however in all instances it is necessary that the height or vertical dimension of the elastomeric elements 4 be greater than the conductors 3. The elastomeric elements 4 may be made of any suitable non-electrically conducting element such as silicone or nylon. Preferably, each element 4 has a high degree of "plastic memory" so as to return to its original configuration after being deformed. Conductors 3 are illustrated as being rectangular in cross-section, although it is readily apparent that conductors 3 may be conventional round wires.

As illustrated in the perspective view of FIG. 1, the conductors 3 extend beyond the longitudinal limits of the sheet material 2 for connection to circuit pads disposed on each half of the housing of the matrix switch, to be described below.

FIG. 3 illustrates the lower half of the housing as comprising a planar structure 5 made of generally rigid, non-electrically conductive material, e.g., plastic, having two parallel side rails 6 so as to define a slot or central recessed portion R for the mounting of one-sided cable 1. Apertures 7 are formed in the corners of the structure 5 for the reception of suitable fastening means to hold the two halves of the housing together. The recess R formed in each structure 5 is slightly longer than the length of the cable 1, and suitable printed circuit pads 8 are formed at the opposite ends of the recess R in alignment with the conductors 3 of the cable 1. With the conductors 3 electrically connected to pads 8, it is readily apparent that the conductors 3 of the one-sided cable may be rapidly and simultaneously connected to the contacts of a conventional multi-pin connector (not shown) commonly used in the printed circuit board art thereby enabling rapid connection of the conductors 3 to the electronics system to which the matrix switch is to be connected. The heights of the side rails 6 above the base of the recess R formed in structure 5 are sufficient to enable connection of the multi-pin connector to the structure 5.

The upper structure 5' (see FIG. 4) is generally similar to the structure 5 illustrated in FIG. 3 except that the portion of the recess R' defined between the side rails 6 and edge portions of structure 5' wherein the pads 8' are connected is omitted. Accordingly, the upper structure 5' comprises a generally square or rectangular frame defined by side rails 6', 6' and the edge portions extending therebetween. By this arrangement, when the housing (consisting of structures 5 and 5') is fully assembled, a compressive force may be directly applied to the upper one-sided flat cable assembly and to a point of cross-over of the conductors to establish an electrical contact between the respective conductors. If desired, the area defined by said frame may be defined by a flexible membrane or the like which would readily deform upon the application of a concentrated vertical force.

The connection of the conductors to the pads of the upper structure 5' is identical to that described with respect to the lower structure 5.

Turning to FIG. 4, after the one-sided cables are connected to the respective halves of the housing, the respective structures 5 and 5' are assembled so that the longitudinal axes of the cables 1, 1' are disposed angularly relative to one another, the conductors are in facing relationship, and the elastomeric elements are abutting. The apertures in the corners of the respective side rails 6 and 6' of the structures 5 and 5' are aligned for passage of suitable bolting means to hold the structures 5, 5' together. As illustrated in FIG. 5, the conductors extend at right angles to one another thereby defining discrete cross-over points. As may be readily appreciated, it is merely necessary to apply a concentrated force at one of the intersections or cross-over points of the conductors of the respective cables in order to form an electrical connection between the conductors 3' and 3 of the upper and lower cables.

FIG. 5 illustrates in partial sectional view the establishment of an electrical connection between a conductor of the upper one-sided flat conductor cable and a conductor of the lower one-sided flat conductor cable. As illustrated, the application of a concentrated force causes the upper conductor to deflect a sufficient amount to form an electrical connection to the lower conductor. At such time, the resilient elastomeric elements in the immediate vicinity of the force are distorted thereby effectively aiding in the deflection of the upper conductor. Also, at such time, the lower structure 5 effectively provides a rigid base below the matrix switch assembly.

In order to facilitate the formation of an electrical connection between conductors of one cable 1 with the other cable, a suitable keyboard switch arrangement, such as illustrated in FIG. 6 may be provided. As shown in FIG. 6, the keyboard cover 10 comprises a molded plastic member including a plurality of button contacts 11 arranged to coincide with the points of intersection of the cables. Suitable apertures 12 are provided in cover 10 to enable connection to the housing 5, 5'. As shown in FIG. 7, each button 11 includes a rounded upper portion 13 on which is formed suitable indicia, while the lower portion thereof consists of a depending stem 14. As may readily be appreciated, the molded plastic cover 10 is sufficiently flexible to enable depression of the buttons 11 in order to force a conductor of the upper one-sided flat conductor cable 1' against a conductor of the lower cable 1, without causing disturbance of adjacent conductors.

While a preferred embodiment of the subject matrix switch has been described and illustrated, it is readily apparent that other configurations and modifications of the subject matrix switch may be readily designed in order to satisfy particular requirements for the specific applications for which the matrix switch is intended. For example, the upper and lower one-sided flat conductor cables need not be disposed at right angles, and for a certain application it may be disposed at angles less than 90°. Similarly, instead of using a housing comprising two parts, it is readily apparent that a lower rigid housing may be employed for accommodating one one-sided flat conductor cable, and the other one-sided flat conductor cable may be positioned angularly with respect to the first one-sided flat conductor cable and also mounted on said rigid housing, thereby also defining a matrix switch including a plurality of cross-over intersections. In like manner the cross-section configurations of the elastomeric members may take configurations other than round, such as triangular or square, as long as the cross-sectional configuration does not interfere with the displacement of the upper conductor as it is forced in contact with the lower conductor.

Another possible modification of the subject matrix switch, as illustrated in FIG. 8 or FIG. 9, is the provision of employing only one flat conductor cable having an alternating arrangement of conductors and enlarged elastomeric members, while the other cable merely consists of a conventional one-sided cable comprising a plurality of conductors bonded to a sheet of insulating material. In such case, the spacing between con-

ductors of the two cables would be maintained merely by the elastomeric elements secured to one cable. The remainder of the matrix switch would be similar to that illustrated and described.

FIG. 8 illustrates the modification just described where the upper element 5' employs a flat conductor cable having an alternating arrangement of conductors 3' and enlarged elastomeric members 4' bonded to the web or sheet 2', while the other cable, mounted on the lower element 5 of the matrix switch, merely consists of a conventional one sided cable comprising a plurality of conductors such as the conductor 3 bonded to the sheet 2 of insulating material.

FIG. 9 shows such a modification in which the lower element 5 of the matrix switch employs a flat conductor cable having an alternating arrangement of conductors such as the conductor 3 and enlarged elastomeric members such as the member 4, whereas the upper element 5' merely has a conventional one sided cable comprising a plurality of conductors such as the conductor 3' bonded to the flexible carrier sheet 2' which, of course, is made of insulating material. As in the case of FIG. 5, the application of concentrated force to make a contact at a crossover of a conductor of the upper element and a conductor of the bottom element is shown in FIGS. 8 and 9, the force being indicated by an arrow in the same manner as in FIG. 5.

Having thus described the invention it is not intended that it be so limited, as changes may be made herein without departing from the scope of the invention. Accordingly, it is intended that the foregoing Abstract of the Disclosure and the subject matter described above and as shown in the drawings be interpreted as illustrative only, and not in a limiting sense.

What is claimed is:

1. A matrix switch comprising:

a first one-sided flat conductor cable including an alternating arrangement of parallel elongated conductors and elongated, non-electrically conductive resilient members bonded to a sheet of resilient insulation material, the height of said resilient members being greater than the height of said conductors;

a second one-sided flat conductor cable including an alternating arrangement of parallel elongated conductors and elongated, non-electrically conductive resilient members bonded to a sheet of resilient insulation material, the height of said resilient members being greater than the height of said conductor;

said first and second one-sided flat cables being secured together in such manner that the respective resilient members are in abutting engagement and extend angularly relative to one another thereby defining a plurality of cross-over points between the respective conductors of said first and second flat conductor cables.

2. A matrix switch as in claim 1 wherein the elongated conductors and resilient members of said first one-sided flat conductor cable are disposed perpendicular to the elongated conductors and elongated resilient members of said second one-sided flat conductor cable.

3. A matrix switch as in claim 1 wherein said resilient members comprise elastomeric members having a circular cross-section.

4. A matrix switch as in claim 1 wherein each one-sided flat conductor cable is secured to one-half of a housing assembly, which housing assembly includes electrically conductive pads to which the conductors of said flat conductor cables are electrically connected.

5. A matrix switch as in claim 4 wherein a flexible keyboard cover is provided to enclose said housing, which keyboard cover includes depressible keys aligned with the cross-over points of the conductors of said first and second flat conductor cables.

6. A matrix switch comprising:

a first member including a plurality of generally parallel elongated electrical conductors bonded to a sheet of flexible insulation material;

a second member including an alternating arrangement of generally parallel elongated electrical conductors and elongated, non-electrically conductive resilient members bonded to a sheet of flexible insulation material, the height of said resilient members being greater than the height of said conductors;

said first and second members being secured together in such manner that the resilient members of said second member engage the conductors of said first member and extend angularly relative thereto, thereby defining a plurality of cross-over points between the conductors of said first and second members.

7. A matrix switch as in claim 6 wherein the conductors of said first and second members are disposed perpendicular to each other.

8. A matrix switch as in claim 6 wherein the resilient members of said second member comprise elastomeric members having circular cross-sections.

9. A matrix switch as in claim 6 wherein said first and second members are disposed in a flexible housing assembly

including electrically conductive pads to which the respective conductors of said first and second members are electrically connected.

10. A matrix switch as in claim 9 wherein a flexible keyboard cover is provided to enclose said housing, which keyboard cover includes depressible keys aligned with the cross-over points of the conductors of said first and second members.

11. A matrix switch as in claim 1 wherein said resilient members comprise an elastomeric member having a triangular cross-section.

12. A matrix switch as in claim 1 wherein each one-sided flat conductor cable is secured to one-half of a housing assembly, which housing assembly includes electrically conductive paths to which the conductors of said flat conductor cables are electrically connected and wherein each half of said housing assembly comprises a planar surface having longitudinally extending side rails, with the flat conductor cable disposed on the planar surface position between said side rails.

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