

[54] **KEYBOARD SWITCH ASSEMBLY
WITH WIRE CONDUCTOR MATRIX
CONTACT ARRAY**

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[22] Filed: **Oct. 13, 1971**

[21] Appl. No.: **188,956**

[52] U.S. Cl. **200/1 R, 200/5 A, 200/159 B**

[51] Int. Cl. **H01h 13/52**

[58] Field of Search **200/1 R, 159 B, 5 A, 5 R**

[56] **References Cited**

UNITED STATES PATENTS

3,617,660	11/1971	Krakinowski.....	200/1 R
3,584,162	6/1971	Krakinowski.....	200/159 B X
3,495,232	2/1970	Wagner.....	200/1 R X
3,240,885	3/1966	Grunfelder et al.	200/5 A
3,592,979	7/1971	Redman.....	200/1 R

3,382,338 5/1968 Arseneault et al. 200/159 B

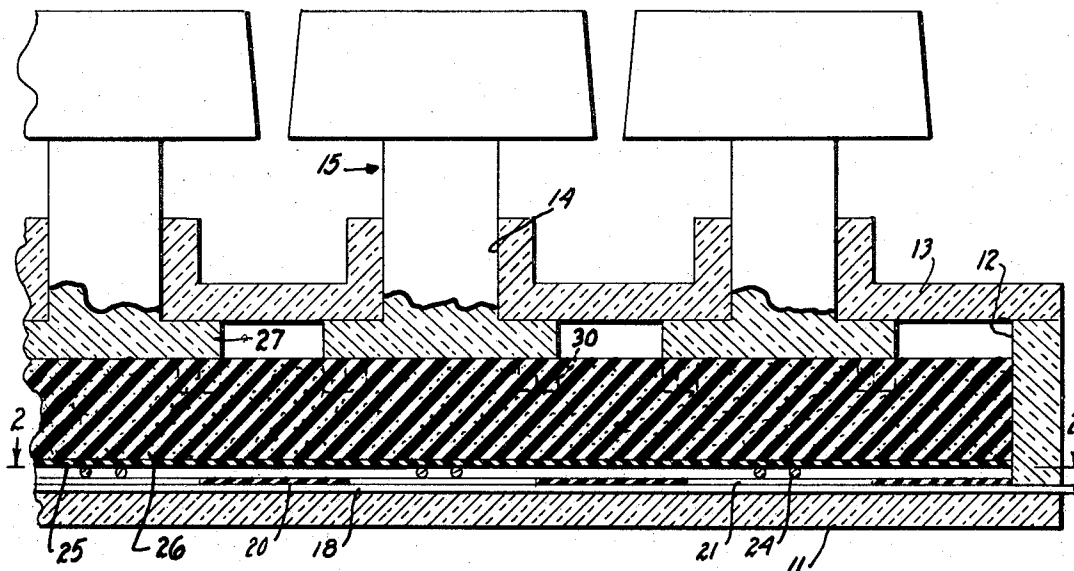
Primary Examiner—J. R. Scott

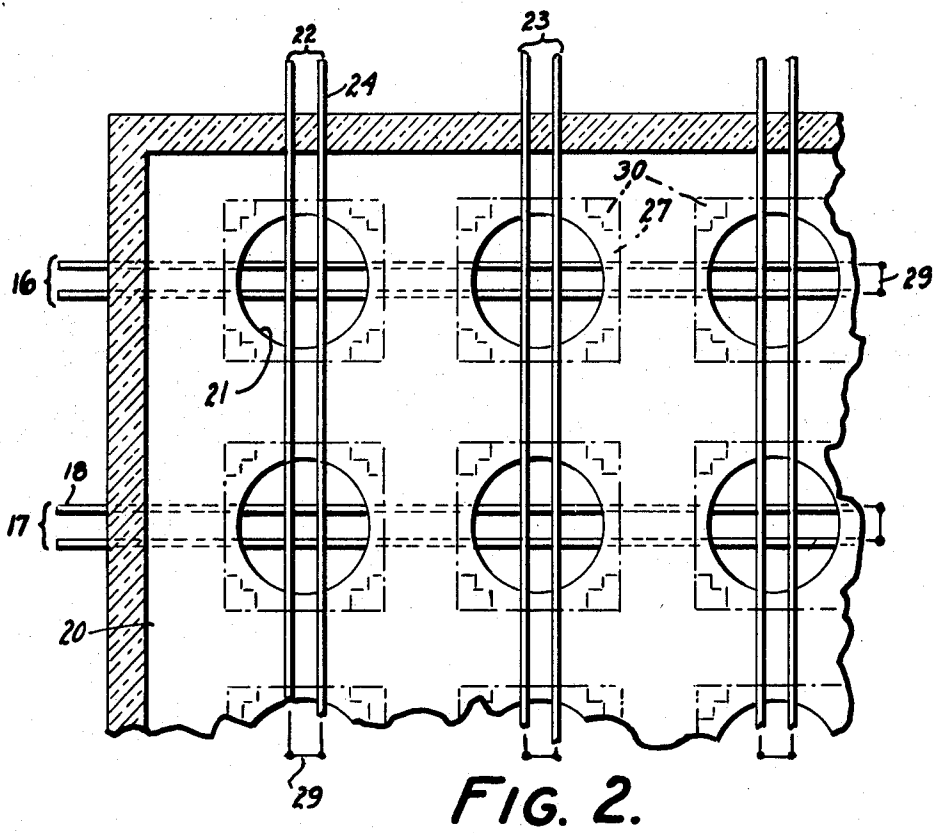
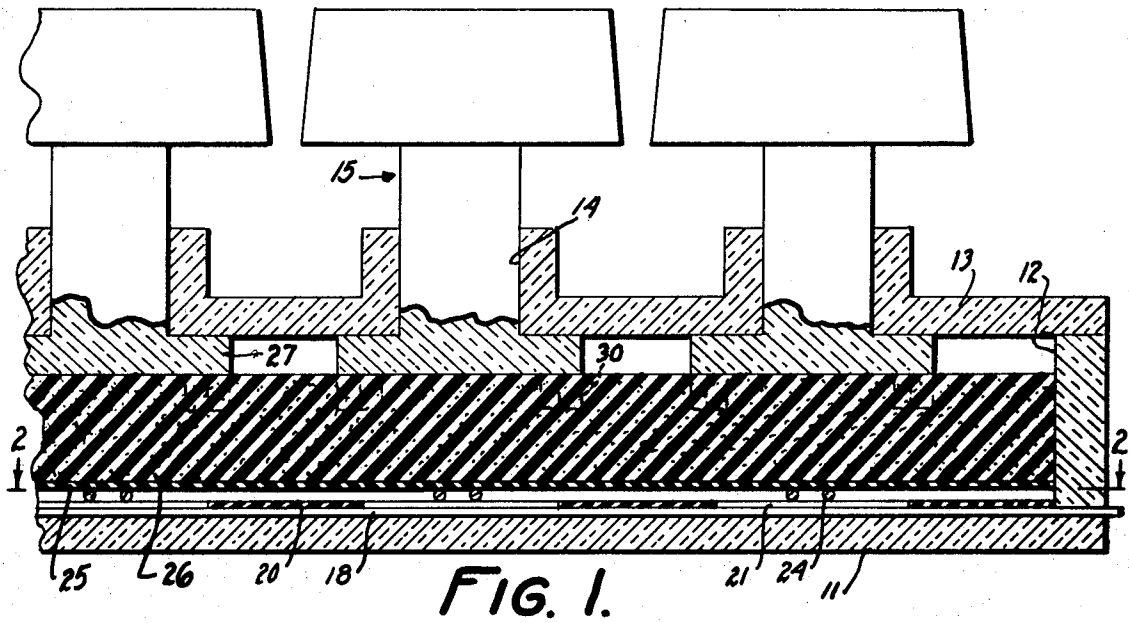
Attorney—Fred N. Schwend

[57] **ABSTRACT**

A keyboard switch device comprising rows and columns of intersecting wires conductors held taut and normally spaced slightly from each other by a separator sheet of non-conducting material having openings therein aligned with the intersections of at least certain of the conductors. The conductors are engaged by depressing different keys aligned with the conductor intersections and a relatively thick layer of soft elastomeric material is interposed between the keys and conductors to normally hold the keys in raised position and to transmit pressure from the keys to engage the conductors. By merely changing the sizes, shapes and positions of the openings, the switching device can be made to produce different output coded signals. Also, by changing the configuration of the various rows and columns of conductors different switch matrix patterns can be produced.

3 Claims, 8 Drawing Figures





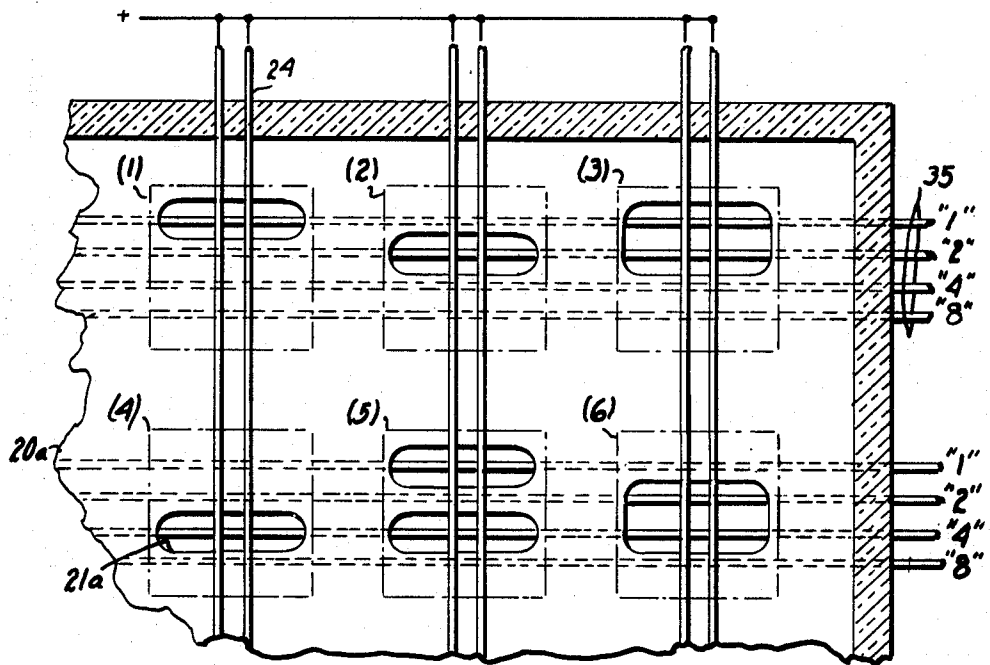
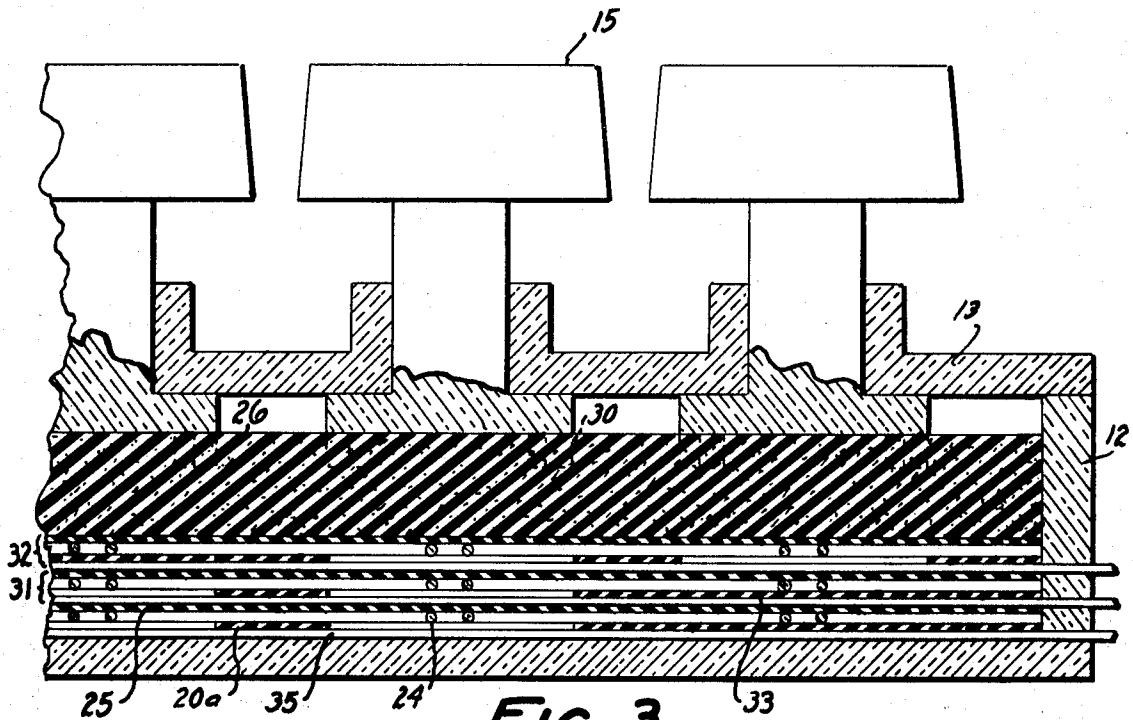


FIG. 5.

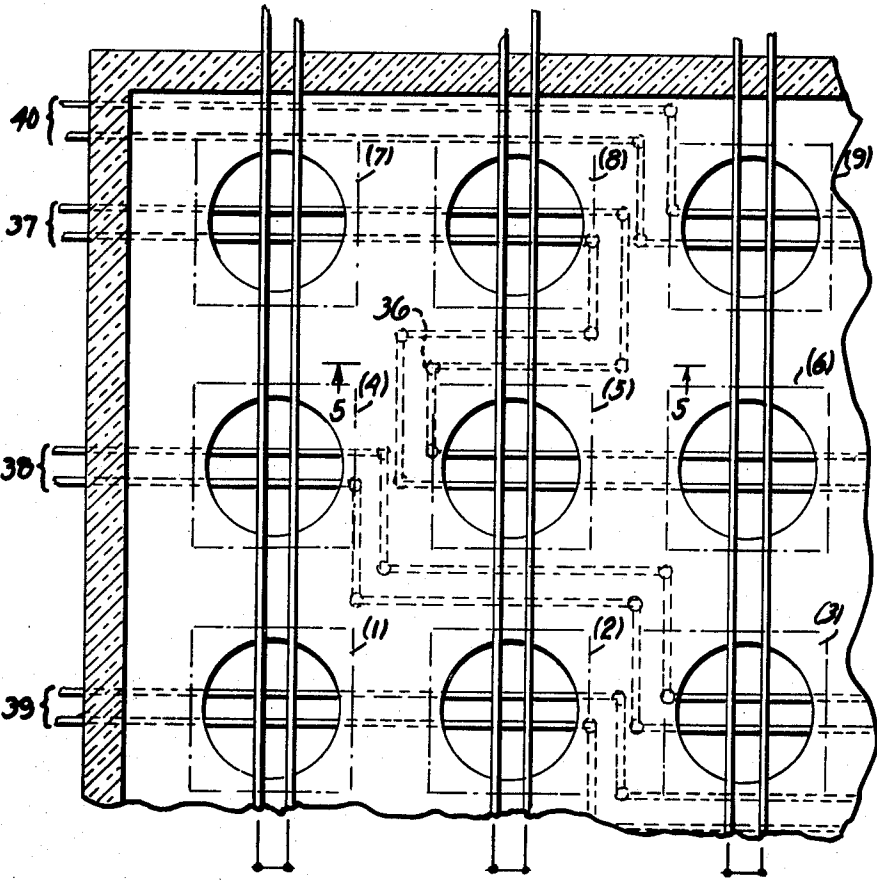
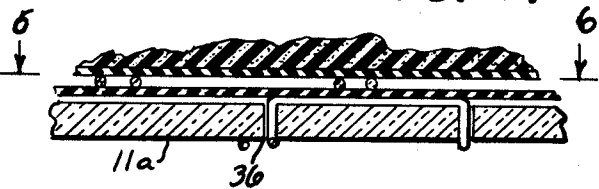


FIG. 6.

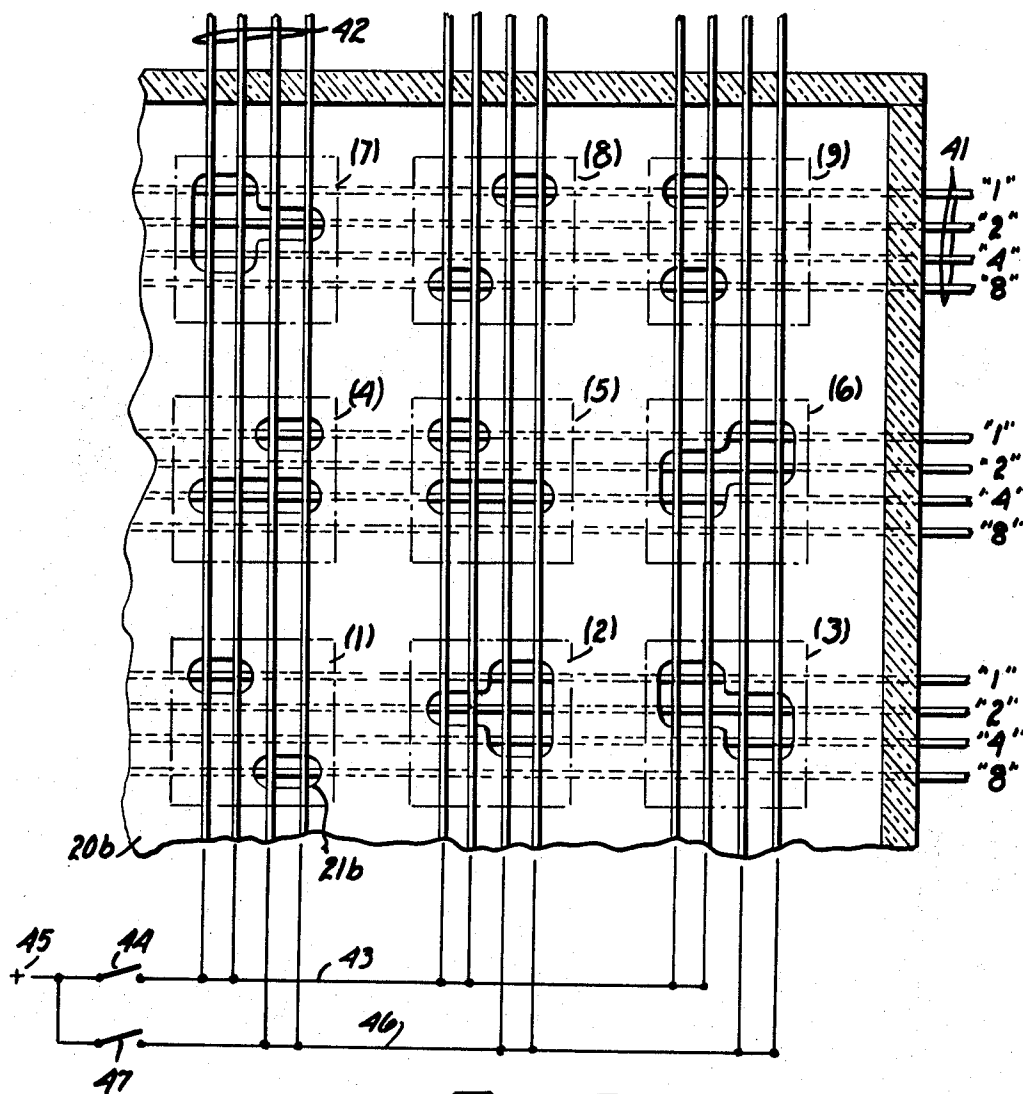
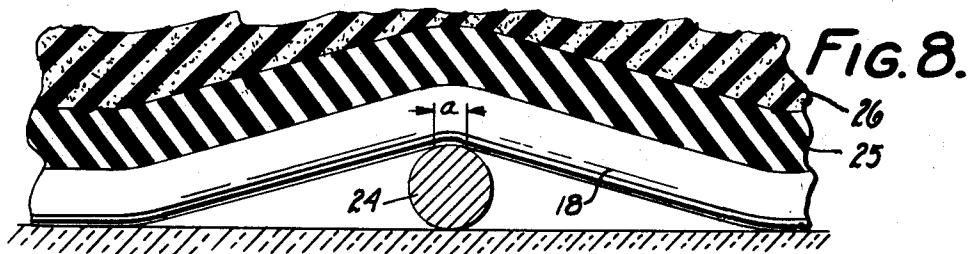


FIG. 7.

KEYBOARD SWITCH ASSEMBLY WITH WIRE CONDUCTOR MATRIX CONTACT ARRAY

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to switches and has particular reference to low cost keyboard switching devices which can be readily modified to produce different matrix patterns or coded signals.

2. Description of the Prior Art

Low cost switching devices have been available heretofore having incorporated therein, or forming part of, printed or etched circuit boards, commonly called "printed circuit boards."

Although such switching devices are generally satisfactory, the printed circuit boards are relatively expensive and whenever changes in switch patterns are to be made new art work, master patterns and tooling must be made which further adds to the expense.

Cross-wire switches have been used heretofore but without much success, principally because they establish only a single point of contact for each connection point and are therefore greatly limited in the amount of current that can be switched. Also, such switches tend to be unreliable since any dirt or products of oxidation formed over a single point of contact may prevent electrical contact from being established.

SUMMARY OF THE INVENTION

In accordance with the present invention, a low cost keyboard switching device is provided using cross-wire connectors which are stretched taut and separated by a thin separator sheet of non-conducting material having openings therein located at the intersections of at least certain of the conductors. A relatively thick and soft elastomeric layer is interposed between the keys and the conductors to transmit pressure to engage the conductors. Because of the compressibility of the layer, the upper conductors are bent or partially wrapped around the lower crossed conductors to establish a line of contact instead of a point of contact thereby providing greater area of contact. Such layer also transmits equal contacting pressure to any number of conductors which may be located under a given key.

Means are provided to limit the extent of pressure applied by the keys to prevent permanent deformation of the conductors. The elastomeric layer also permits the keys to be depressed through a normal stroke of appreciable length even though the separated conductors are spaced very close together.

A further feature of the invention is that different separator sheets having different sizes, shapes and patterns of openings may be readily substituted to provide different coded output signals. Also, according to the invention, the paths of the various conductors may be readily changed to provide different switch matrix patterns.

It therefore becomes a principal object of the present invention to provide a cross-wire type keyboard switching device having a relatively large area of contact for each of the conductors.

Another object is to provide a cross-wire type keyboard switching device having a multiple number of switch contacts for each contact connection.

Another object is to provide a cross-wire keyboard switching device which can be readily modified to produce different coded outputs or switch matrix patterns.

A further object is to provide a cross-wire keyboard switching device which incorporates a large number of stacked independent or dependent switching levels.

A further object is to provide a cross-wire keyboard switching device which is simple and economical to manufacture.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged sectional view through a keyboard switching device embodying one form of the invention.

FIG. 2 is a sectional plan view taken along line 2—2 of FIG. 1.

FIG. 3 is a sectional view through a modified form of the invention, illustrating a stacked three level assembly.

FIG. 4 is a sectional plan view of another modified form of the invention which may be considered as taken along line 2—2 of FIG. 1.

FIG. 5 is a fragmentary sectional view of another modified form of the invention and is taken along line 5—5 of FIG. 6.

FIG. 6 is a sectional plan view taken along line 6—6 of FIG. 5.

FIG. 7 is a sectional plan view through a still further modified form of the invention and may be considered as being taken along line 2—2 of FIG. 1.

FIG. 8 is a greatly enlarged fragmentary section view illustrating two cross-wire conductors in contacting condition.

DETAILED DESCRIPTION OF THE EMBODIMENT

Referring to FIGS. 1 and 2, the keyboard switching device shown therein comprises a rigid base of plastic or other non-conducting material. Surrounding up-standing walls 12 are suitably fastened to the base 11 and an upper key plate 13 is secured to the walls 12. Slide bearings 14 are formed in the cover plate to receive depressible keys 15.

Rows of spaced pairs, i.e. 16, 17, of wire conductors 18 are laid over the base 11 and are aligned with rows of the keys 15. Such conductors are passed through openings in the walls 12 and are maintained taut as by bonding them within the openings, using a suitable adhesive (not shown). The wires 18 are shown in exaggerated form and are preferably on the order of 0.008 inch to 0.010 inch in diameter and may be formed, for example, of manganese bronze to which a thin layer of gold is bonded.

A thin separator sheet 20 of Mylar or similar non-conductive material having a thickness on the order of 0.005 inch is layed over the conductors 18. The sheet 20 has a series of round openings 21 formed therein in alignment with the keys.

Columns of spaced pairs, i.e. 22 and 23, of wire conductors 24 are laid over the separator sheet 20 and are aligned with columns of the keys 15, thus intersecting the pairs 16 and 17 directly below the keys 15 and openings 21. Such conductors 24 are of the same diameter as the conductors 18 and are also passed through openings in the walls 12 and held taut by bond-

ing the same within the openings with a suitable adhesive.

A thin imperforate cover sheet 25 of Mylar or similar flexible non-conductive material on the order of 0.005 inch thick is laid over the conductors 24. A relatively thick layer 26 of soft elastomeric material, such as is commonly known as Polyfoam or sponge rubber, is interposed between the cover sheet 25 and feet 27 formed on the lower ends of the keys 15 to normally hold the keys in raised position and to transmit a downward pressure effective to engage the underlying and intersecting conductors 18 and 24 upon depression of the keys.

It will be noted on reference to the enlarged view of FIG. 8 that upon depression of a key 15 the soft yielding layer 26 and the underlying cover sheet 25 will apply pressure over a relatively large area around the intersections of the underlying conductors, causing each conductor 18 to wrap or bend around the underlying conductor 24 so as to contact the same along a line having a length, instead of merely a point of contact, thereby establishing a much greater area of contact.

When the conductors first contact each other a very high contact pressure is established because of the point-to-point engagement and thus the conductors tend to break through any oxide film that may adhere to the conductors. Thereafter, as the one conductor wraps around the other, the area of contact is increased.

Means are provided to prevent permanent deformation of the conductors due to undue pressure being applied to the keys 15. For this purpose, the feet 27 of the keys are square and extend beyond the underlying openings 21 in the separator sheet. Downwardly extending projections 30 are formed at the corners of the feet 27 which are located out of alignment with the openings 21 in the separator sheet 20. Thus, upon depression of a key, the projections 30 compress the underlying portions of the layer 26 a greater amount than the portion overlying the opening 21 and are arrested in their downward movement before the remainder of the layer is unduly compressed by the foot 27 of the depressed key.

It will be noted that the conductors of each intersecting pair, i.e. 16 and 22, may be connected together as at 29 and in the case of the simple matrix switch depicted in FIG. 2, four areas of contact are established upon depression of a key.

FIG. 3 illustrates a modified form of the invention in which stacked multiple layers of cross-wire pairs are provided. Here elements similar to those shown in FIG. 1 are identified by similar reference numerals.

It will be noted that the second and third levels 31 and 32 are similar to the single level shown in FIG. 1 except that the openings 21 are shown omitted at some of the cross-wire intersections; note, for example 33. Thus, switching may be omitted in certain levels for certain selected keys. For example, the right hand key in FIG. 3 will effect switching in the level 32 only whereas the central key will effect switching in all three levels.

It will be apparent that the various columns of pairs of conductors in two or more of the different layers can be connected together to form different combinations of matrix patterns.

FIG. 4 illustrates a modified form of the invention which may be incorporated in either the single level switching device of FIG. 1 or the multiple level switching device of FIG. 3. This form is intended particularly for emitting coded signals such as a binary coded output over groups, i.e. 35, of conductors upon depression of different keys having decimal values indicated in parentheses. In this case, each group includes four conductors having the weighted values indicated within quotation marks.

The separator sheet 20a is formed with openings 21a which uncover different ones or combinations of the conductors 35, depending on the coding, so that depression of the overlying keys will connect a pair of conductors 24 with only the underlying uncovered ones of the conductors 35. Obviously, the arrangement of FIG. 4 could be incorporated in the multi-level switch arrangement of FIG. 3 in which the different levels could be coded differently by providing appropriately apertured separation sheets so that data signals in different coded forms could be simultaneously established by depression of a single key.

FIGS. 5 and 6 illustrate a still further modified form of the invention in which the lower pairs of wire conductors do not extend under an entire overlying row of keys but instead are guided through different patterns so as to pass under keys of different rows.

For this purpose, the conductors are stitched through holes 36 in the base 11a and along the under surface thereof from one row to another, where they are again passed through similar holes onto the upper surface of the base. The conductors are maintained taut in a manner similar to that described in connection with FIG. 1.

In the matrix pattern example shown in FIG. 6, the pair of conductors 37 are common to the keys "7,7," "8," "5" and "6." The pair of conductors 38 are common to the keys "4" and "3," and the pair of conductors 39 are common to the keys "1" and "2." The pair of conductors 40 are common to the key "9" only.

FIG. 7 illustrates a still further modification of the invention in which a single switching level is formed to selectively provide a binary coded output corresponding to the decimal value of a depressed key or to the nines complement thereof. The arrangement comprises groups of four conductors 41 each extending under the different rows of keys and groups of four conductors 42 each extending under the different columns of keys. Here, the leftmost two conductors of each group 42 are connected through a common line 43 and settable switch 44 to a source of power 45. The rightmost two conductors of each group 42 are connected through a second common line 46 and switch 47 to the source of power 45. The separator sheet 20b, has openings 21b, therein which are so located that when the switch 44 is closed and a key is depressed a binary signal corresponding to the decimal value of such depressed key will be transmitted over appropriately weighted conductors 41. When the switch 47 is closed and a key is depressed a binary signal corresponding to the nines complement of the decimal value of the key depressed will be transmitted over appropriately weighted conductors 41. Obviously, other separator sheets having differently formed openings therein may be readily substituted to provide for other coded outputs.

I claim:

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1. A keyboard operated switching device comprising
a base,
a first plurality of rows of wire conductors on said
base,
a relatively thin separator sheet of non-conductive
material over said conductors,
a second plurality of columns of wire conductors
over said sheet,
said second plurality of conductors extending across
said first plurality of conductors,
means maintaining said second plurality of conduc-
tors taut,
a plurality of depressible keys over the intersections
of said rows and columns of conductors, and
a relatively thick layer of compressible elastomeric
material intermediate said keys and said columns
of conductors,
said sheet having openings aligned with certain only
of said intersections whereby to establish coded
output circuits upon depression of said keys.
2. A keyboard operated switching device according
to claim 1 wherein said separator sheet is replaceable
by a second separator sheet having openings aligned
with certain different ones of said intersections

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whereby to establish different coded output circuits
upon depression of said keys.

3. A key operated switching device according to
claim 1

comprising a second separator sheet of non-conduct-
ing material on said columns of wire conductors,
a third plurality of rows of wire conductors on said
second separator sheet,
a third separator sheet over said third plurality of
wire conductors,
a fourth plurality of columns of wire conductors over
said third separator sheet and under said layer,
the intersections of said third and fourth pluralities of
conductors being aligned with said intersections of
said first and said pluralities of conductors,
said first and third separator sheets having openings
aligned with certain only of said intersections,
certain of said openings in said first sheet being out
of alignment with certain of said openings in said
third

sheet whereby to establish different coded output
circuits upon depression of a said key.

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