United States Patent

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[54] **MONOLITHIC KEYBOARD AND METHOD FOR MAKING SAME**
16 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** ..... **178/17 C,** 197/98
[51] **Int. Cl.** **H04l 15/16**
[50] **Field of Search** ..... 178/17 A, 17 B, 17 C, 17 D, 17 E; 200/159 B; 197/98; 84/470, 1.01; 235/145; 179/90 K

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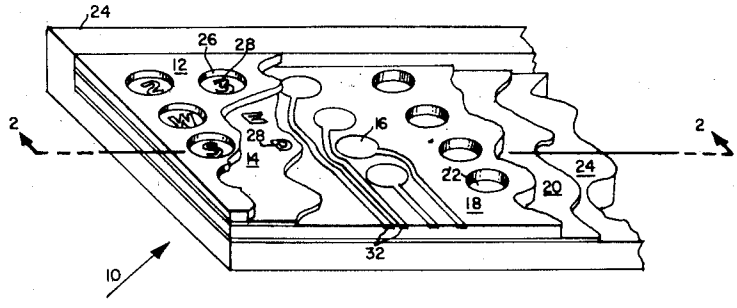
ABSTRACT: A monolithic keyboard constructed in layers with inexpensive materials and which has no conventional moving parts is disclosed. In one embodiment, the layers include a bottom or first layer of conductive material, a second layer of spongy material with holes cut therein, and a third layer of flexible printed circuit. This flexible printed circuit includes a sheet of insulating material with conductive pads placed thereunder in registration with the holes in the spongy material. Key symbols are etched on or printed over the conductive pads thereby indicating the placement of the keys. Depressing the key causes contact to be made between the respective pad and the first layer of conductive material. The spongy material gives the operator the "touch" of a standard typewriter keyboard.



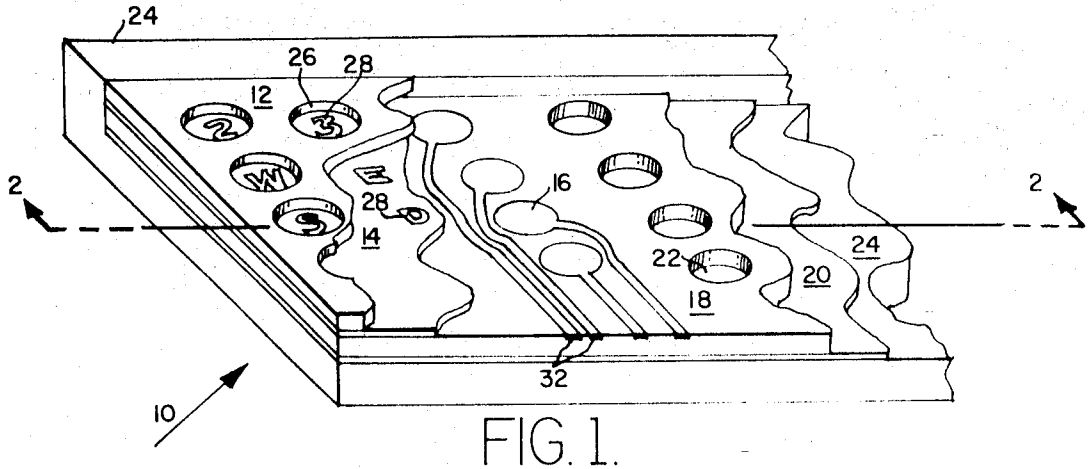


FIG. 1.

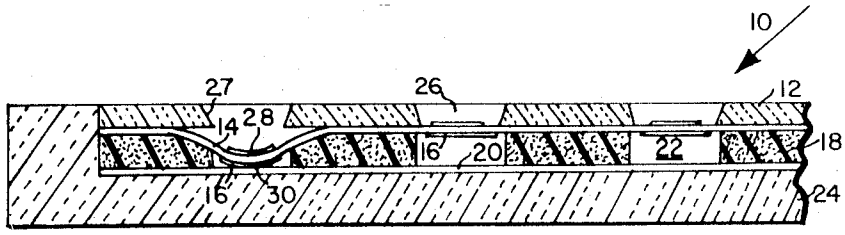


FIG. 2.

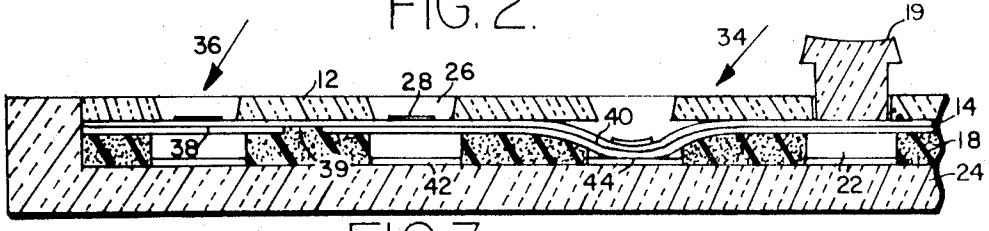


FIG. 3.

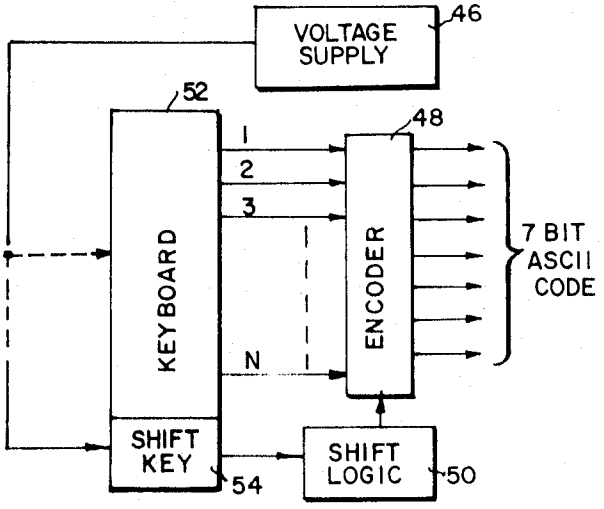


FIG. 4.

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MONOLITHIC KEYBOARD AND METHOD FOR MAKING SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to data entry devices and more particularly to keyboards employing a minimum of moving parts.

2. Description of the Prior Art

In the prior art various keyboard arrangements have been used for entering data into CRT displays, TV displays and the like. Various considerations in the design a of these keyboards included reduction of size, weight, complexity and cost while still retaining a high reliability. A further consideration was that the keyboard have as nearly the same touch as a standard typewriter keyboard.

In the prior art various circuits and mechanical arrangements have been used. One example of the prior art is the well-known pushbutton-type mechanical switch keyboard. Another arrangement includes the use of optical techniques. This required a light source and additionally required a means for interrupting the light source and detecting such interruption. Another prior art keyboard includes the application of magnetic pickups wherein the depression of the key caused a magnetic coupling which would then be generated as a signal to a receiving device. Still other forms of keyboards included capacitance pickup arrangements wherein associated with each key were included an oscillator circuit which circuit would oscillate when its key was depressed. Most of these prior art keyboards also included spring mechanisms associated with each of the keys so that when an operator depressed a key he would do so with a "standard touch."

It can be seen from the above that the following limitations have been associated with the prior art keyboards, either singly or in combination in that they necessitate the requirement of moving parts which reduces the life of these keyboards; in that they were expensive as evidenced by the fact that magnetic coupling might be required, or in that optical configurations might be required or in that a rather expensive mechanical switch was required for each such key. The mechanical-type switch also had a relatively high failure rate due to mechanical wear, moisture, dirt and other problems common to such mechanical switching devices. The spring mechanisms used with each of the keys in the various types of keyboards were also subject to wear.

Accordingly, it is an object of this invention to provide an inexpensive and reliable keyboard.

Another object of the invention is to provide a keyboard which has no conventional moving parts.

Still another object of the invention is to provide a keyboard which is simple to manufacture and which has the "touch" of a standard typewriter keyboard.

Another object of the invention is to provide a keyboard which has the capability of shifting between uppercase and lowercase symbols.

Yet another object of the invention is to provide an inexpensive keyboard which is monolithic in structure and which is sealed against dirt and moisture.

The invention accordingly comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

Briefly, the keyboard of the invention is monolithic in structure and has no conventional moving parts. The keyboard is constructed with a minimum of inexpensive materials arranged in layers over a base. The first layer placed on the base is a sheet of conductive material such as copper. Over this conductive layer is placed a layer of spongy material with holes cut in it in registration with the arrangement of the keys. Over this layer of spongy material is placed a flexible sheet of insulating material. On the underside of this flexible insulating material are conductive pads also in registration with the placement of the keys. Each of these conductive pads has a terminal attached thereto. The pads, terminals and flexible sheet of insulating material are in combination a flexible printed circuit. Over the flexible sheet of insulating material is placed a rigid mask with suitably shaped holes in registration with aid key positions. This mask is secured over the flexible sheet of insulating material. In registration with the holes on said mask are symbols preferably printed onto the flexible sheet so that the operator may have an indication of the symbol which he types. When the operator pushes down or depresses upon the imprinted symbol, that is, the key, the conductive pad on the bottom side of the flexible sheet of insulating material makes a contact with the conductive sheet which is the first layer upon said base. This causes a conductive path to be created, so that, for example, a voltage applied to the first layer of conductive material will appear on the terminal of the corresponding key pad. By suitable encoding means a useable code will be generated to any receiving apparatus such as a CRT display.

The solid sheet of conducting material which was placed upon the base as a first layer might be interchanged with the conductive pads located on the bottom side of the flexible sheet of insulating material. That is, the conductive pads with terminals are rigidly secured to the base, whereas he sheet of conductive material would now have to be flexible and would be secured to the underside of the flexible sheet of insulating material.

In addition, a capability of depressing more than one key at a time and generating more than one conductive path may be desirable. In this case, the sheet of conductive material whether it be flexible or whether it be the first layer upon said base, would have a section thereof insulated from the remaining part. Depression of the isolated key would create a special control signal. This control signal might be utilized, for example, with a shift key and would be used to invert the code of the encoded symbol. Such a shift key would have no effect upon the operation of the keyboard until one of the remaining keys on the keyboard was depressed.

BRIEF DESCRIPTION OF THE DRAWINGS

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

FIG. 1 is a perspective view of the keyboard with the various layers shown cut away.

FIG. 2 is a cross section of the keyboard shown in FIG. 1 showing one such key depressed.

FIG. 3 is a cross section of a second embodiment of the keyboard showing one key depressed and in addition showing an isolated key.

FIG. 4 is a schematic block diagram which might be used with the various embodiments of the keyboard of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring to FIG. 1 there is illustrated a perspective view of one embodiment of the invention. This view is shown in cutaway for ease of illustration. Mounted to a rigid base 24 are layers of inexpensive material which comprise the keyboard of the invention. Base 24 may be fabricated from any rigid insulating material such as phenolic. Placed over base 24 is a first layer of material or conductive sheet 20 which might be made of copper for example. Placed over conductive material 20 is a layer of spongy material 18 with holes 22 cut therein. The holes 22 are cut so that they are in registration with the placement of the keys on keyboard 10. Spongy material 18 might be formed from foam rubber or any other compressible material. The thickness and density which contributes to the compression factor of the spongy material 18 are selected to give an operator the "touch" found on a standard typewriter keyboard, that is, the operator must push

down with a certain uniform force in order to cause entry of the symbol designated by the pushed key. This force is the so-called "standard touch" referred to. Spongy material **18** may be simply placed over conductive sheet **20** so long as some means is devised to hold spongy material **18** from sliding. Such a holding device might be base **24**. Spongy material **18** might also be bonded to sheet **20**, in order to insure there is no movement laterally of material **18**. Conductive material **20** might also be adhered to base **24** but this is not absolutely necessary.

Placed over spongy material **18** is flexible insulating material **14** with conductive pads **16** and terminals **32** adhered on the underside thereof. More particularly, flexible insulating material **14** along with conductive pads **16** and terminals **32** are in combination a flexible printed circuit. Pads **16** as well as terminals **32** are conductive and may be made from copper or any other conductive material. The flexible insulating material **14** might be made from mylar, etc. Flexible insulating material **14** is adhered to spongy material **18** in order that the pads **16** will remain in registration with the holes **22**.

Pads **16** as well as holes **22** do not have to be circular in shape. They may in fact by any shape, such as a square, a rectangle, oval, etc., so long as the pads **16** and holes **22** are in substantial registration with each other. Terminals **32** may be brought out from the keyboard at any side or end and may be connected to a receiving device by a connector which may be included as part of base **24**. The terminals **32** do not necessarily have to come out on the same side of the keyboard **10**.

The dimension of pads **16** is approximately the same as the dimensions of the holes **22** in spongy material **18**. There is a wide tolerance for these dimensions which, of course, decreases the expense of the keyboard; that is, no great care is required in assuring 100 percent registration.

Placed over the flexible insulating material **14** are key symbols designations **28**. Symbol designators **28** are placed over the center of pads **16**. Such designators **28** may be either printed on flexible material **14** or adhered thereto in any conventional manner. Symbol designations **28** may also be etched in the pad **16**, preferably near the perimeter thereof so as not to interfere with the contact area at the center of the pad. By etching the designations **28** therein, a further fabrication step will be eliminated. The placement of symbol designators **28** is, of course, the placement of keys.

It may be desirable to place a mask **12** over the flexible material **14**. Mask **12** may be made out of any type of rigid material and includes holes cut therein in a convenient shape to accept a person's finger. The holes might be beveled and could be oval in shape as well as circular in shape, etc. Mask **12** is then secured to base **24** so that the keyboard will now be sealed to prevent dirt and moisture from entering therein.

Now referring to FIG. **2** there is illustrated for added clarity a cross section of the keyboard illustrated in FIG. **1**. Over base **24** is shown the conductive sheet **20**. Placed over sheet **20** is left-handmost spongy material **18** with the holes **22** cut therein. The flexible insulating material **14** with conductive pads **16** in registration with holes **22** is adhered over the spongy material **18**. The symbol designator **28** is shown above the respective pads. Over the flexible printed circuit is the mask **12** with the holes **26**, with bevels **27** cut therein. These holes **26** are in substantial registration with the pads **16** and holes **22**. Also shown in FIG. **2** is the configuration of the keyboard **10** when a key is depressed. Contact is made at point or area **30** on the left-handmost key on FIG. **2**. A finger, not shown, is pushing on designator **28** so that flexible insulating material **14** as well as conductive pads **16** take the shape shown. Pads **16** therefore is in contact with sheet **20** at point **30** to cause a circuit path. The operation of this circuit will be discussed hereinafter.

Now referring to FIG. **3** there is shown a cross-sectional view of another embodiment of the invention. A major difference between the keyboard **34** of FIG. **3** and the keyboard **10** of FIG. **2** is that the sheet of conductive material is now flexible and adhered to the underside of flexible insulating material **14** whereas the conductive pads and terminals connnected thereto are now adhered to the base **24**. Thus, in the keyboard of FIG. **3** the pads **42** as well as the terminals, not shown, are adhered to the base **24**. These pads **42** must be securely positioned so that they will be in registration with the key positions. The spongy material **18** is placed over the base **24** and pads **42**. The holes **22** in the spongy material **18** are as before in registration with the pads **42**. Over the spongy material **18** is placed a flexible sheet of conductive material **40** which sheet **40** may be adhered to the underside of the flexible insulating material **14**. The insulating material **14** in this case would only be used to prevent any possibility of electrical shock to the operator. The symbol designators **28** and mask **12** would be shaped and placed in the same manner as previously discussed for keyboard of FIGS. **1** and **2**. Of course, the symbol designators **28** may be etched into sheet **40** as mentioned in regard to FIG. **2**. One of the keys is shown in the depressed position so that the sheet **40** makes contact with a pad **42** at point or area **44**.

Another embodiment of the invention is also shown in FIG. **3** wherein the sheet **40** is disconnected at gap **39** and continues on as sheet **38**. In this manner, key **36** is isolated from the remaining keys on keyboard **34**. The contact between sheet **38** and pad **42** of key **36** would now be completely electrically isolated from the contacts of the other keys on keyboard **34**. This configuration could be used in order that the keyboard have a shift capability, for example, i.e., capability of selecting between uppercase and lowercase symbols, Normally, when the operator is typing he will type the lowercase symbols or, in the alternative, the keyboard may be set up so that he is always typing the uppercase symbols. If the operator depresses a key and simultaneously presses the shift key two independent electrical circuits will be made and will indicate to a decoding device that the symbol be recognized as uppercase or in the alternative, the lowercase. The operation of this circuit will be discussed hereinafter. Of course, it is understand that the shift capability shown in FIG. **3** for keyboard **34** may also be utilized with the keyboard **10** of FIG. **2**. It should be understood that this isolation of the shift key might not be required if the decoding device associated therewith is designed accordingly. This will be discussed hereinafter.

It should be further understood that the keyboard configuration as described in FIGS. **1**, **2** and **3** may be constructed in various ways. For example, the conductor pads of these keyboards may be eliminated and replaced by conductive strips. For example, each strip might encompass eight keys and in combination with this the conductive sheet might be broken up into eight such sheets, each sheet also encompassing eight particular keys. By placing the proper signals on the various conductive strips a matrix array will be formed, in this case for 64 possible keys.

It should be further understood that the keyboard of the invention may have its keys placed thereon in any desired arrangement. Also, if a conventional keyboard design is required, the base holding the layers of material comprising the keyboard may be sloped upward so that the top row of keys is higher than the bottom row of keys. The base may be designed in a staircase configuration so as to more nearly resemble a standard keyboard design. In that case, the layers of the keyboard could be flat but made flexible and held in the staircase form over the staircase base by means of a rigid mask preformed in the staircase configuration. Also, in the alternative, the respective layer levels may be inserted independently in strips on each level of the staircase and then held in place by a rigid, staircase mask.

Also, and as shown in FIG. **3**, an extended key **19** may be adhered to the flexible sheet **14** in order to provide more positive placement of the keys to an operator. Such key **19** might be made from plastic. The mask **12** would not then be required except for possibly adding side support to prevent key **19** from moving sideways. The symbol indicator could be printed on the top side of key **19**. Such keys **19** could, of course, be used with the embodiment of FIG. **2**. Also, but

utilizing extended keys **19**, the staircase design discussed above could be devised simply by making the extended keys **19** used in the back row of a standard keyboard design longer or taller than the preceding row of keys, with the front row having the lowest extending keys **19**.

Now referring to FIG. **4**, there is illustrated a schematic block diagram of a circuit which may be used with the apparatus of this invention. The apparatus of the invention is generally shown as keyboard **52** as well as shift key **54**. The conductive pad terminals of keyboard **52** are shown as lines **1** through N which outputs are connected to an encoder **48**. Encoder **48** functions to convert the respective N inputs, each into its particular seven-bit ASCII code. This code may then be utilized by a receiving device which is adapted to work with the ASCII code. If another code is desired, then encoder **48** would be designed to convert the N-inputs to that other code. The conductive sheet of keyboard **52** is connected to a voltage supply **46** so that when a particular key is depressed, the voltage from supply **46** is coupled to a particular one of the N-outputs of keyboard **52**. The presence of this voltage is then encoded by encoder **48**.

If the keyboard of the invention has associated therewith a matrix encoder in an array having N-inputs and **7** output lines, then the addition of the shift key feature would not require complete electrical isolation of the shift key contacts. In this case the shift key output would be prewired to shift logic **50** whose function would be to invert particular bits in the encoder **48** output when both the shift key **54** and another key were depressed at substantially the same time.

If the keyboard of the invention has associated therewith a scanning keyboard encoder then the addition of the shift key feature might require complete isolation of the shift key circuit. Then the voltage supply **46** would be connected to the conductive sheet for the shift key. The scanning input voltages, not shown, would be connected in a scanning arrangement to the keyboard **52**. Upon depressing the shift key **54**, the voltage from supply **46** will be coupled to the input of shift logic **50** whose output is coupled to encoder **48**. The function of shift logic **50** is to invert particular bits of the seven-bit ASCII output code so that the particular code will now be recognized as the same symbol but in the uppercase or, in the alternative, lowercase. If the shift key **54** is depressed without departing another key on keyboard **52** then the encoder **48** would be arranged so that the output from shift logic **50** would not be accepted. If more than one key on keyboard **52** were depressed at the same time, independent of the shift key feature, then the encoder **48** might be designed to accept the first key pushed or not accept any input.

It will thus be seen that objects set forth above, among those made apparent from the preceding description are efficiently attained and certain changes may be made in the above constructions without departing from the scope of the invention. It is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described the invention, what is claimed as new and secured by Letters Patent is:

1. A keyboard including a plurality of keys, said keyboard, comprising:

A. a sheet of conductive material;

B. a layer of spongy material placed over said sheet, said spongy material having holes therein where said keys are located; and

C. a flexible sheet of insulating material having conductive pads attached thereunder, said flexible sheet being placed over said spongy material and said pads being in registration with said holes; whereby a depression of one of said keys causes a respective pad to make contact with said sheet of conductive material.

2. A keyboard as defined in claim **1**, wherein said keys are designated by appropriate symbols appearing on the uppermost side of said flexible sheet over the respective conductive pads.

3. A keyboard as defined in claim **1**, further including a mask of rigid material placed over said flexible sheet, said mask including holes in registration with said conductive pads.

4. A keyboard as defined in claim **3** further including a base to which the bottom side of said sheet of conductive material is secured and to which the edges of said mask are secured, whereby said keyboard is sealed from the surrounding environment.

5. A keyboard as defined in claim **1**, further comprising;

A. an encoder having inputs corresponding to each of said pads, said inputs being electrically coupled to each of said pads; and

B. a voltage supply electrically coupled to said sheet of conductive material; whereby a depression of one of said keys causes a voltage from said voltage supply to be coupled to one of said encoder inputs, which encoder generates a code peculiar to said one input.

6. A keyboard as defined in claim **5** wherein a section of said sheet of conductive material is electrically isolated from the remainder of said sheet of conductive material and wherein said section is substantially the same size as and is in registration with one of said keys, whereby a depression of said of keys in registration with said section causes a respective pad to make contact with said section.

7. A keyboard as defined in claim **5**, further including a key for shifting between uppercase and lowercase symbols, the conductive pad corresponding to said shift key being coupled to said encoder so that the simultaneous depression on said shift key and anyone of said other keys causes said shifting.

8. A keyboard as defined in claim **1** further including external keys adhered to the uppermost side of said flexible sheet of insulating material in registration with said pads whereby a depression of one of said extended keys causes a respective pad to make contact with said sheet of conductive material.

9. A keyboard including a plurality of keys, said keyboard comprising:

A. a base;

B. conductive pads secured to said base in registration with the position of said keys;

C. a layer of compressible material placed over said pads and base, said compressible material having holes cut therein at the location of said pads;

D. a flexible sheet of conductive material placed over said layer of compressible material; and

E. key-indicating means secured to the uppermost side of said sheet in registration with said pads; whereby a depression of one of said key-indicating means causes said sheet to make contact with a pad corresponding to said one of said key-indicating means.

10. A keyboard as defined in claim **9** wherein said indicating means is a sheet of flexible insulating material wherein said keys are designated by appropriate symbols printed thereon in alignment with said pads.

11. A keyboard as defined in claim **10**, further including a mask of rigid material placed over said flexible insulating material, said mask including holes in registration with said conductive pads.

12. A keyboard as defined in claim **1**, further comprising;

A. an encoder having inputs corresponding to each of said pads, said inputs being electrically coupled to each of said pads; and

B. a voltage supply electrically coupled to said sheet of conductive material; whereby a depression of one of said keys causes a voltage from said voltage supply to be coupled to one of said encoder inputs, which encoder generates a code peculiar to said one input.

13. A method for constructing a keyboard, said method comprising the steps of:

A. placing spongy material with holes cut therein in registration with the position of said keys over a sheet of conductive material;

B. placing conductive pads at positions corresponding to said keys on the underside of a flexible sheet of insulating material; and

C. placing said flexible insulating material over said spongy material.

14. A method as defined in claim **13**, including the additional steps of:

A. adhering said flexible insulating material to said spongy material so that said holes and said pads remain in substantial registration; and

B. placing a rigid mask over said flexible insulating material, said mask including holes therein in registration with said pads.

15. A method as defined in claim **14** including the additional steps of:

A. printing symbol designators on said flexible insulating material over each of said pads; and

B. securing said sheet of conductive material and said mask to a base thereby forming a monolithic structure sealed from the surrounding environment.

16. A method for constructing a keyboard, said method comprising the steps of:

A. adhering conductive pads to the uppermost side of a base, said pads positioned in registration with said keys;

B. adhering a spongy material with holes cut therein in registration with said keys over said base and said pads;

C. placing a sheet of flexible conductive material over said spongy material; and

D. placing a rigid mask with holes cut therein in registration with said keys over said flexible conductive material.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,627,927 **Dated** December 14, 1971

Inventor(s) Herbert E. Schmitz et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5 Line 44	change "departing" to --depressing--
Column 6 lines 31 and 32	change "external" to --extended--.
Column 6 line 59	change "comprising" to --including--.

Signed and sealed this 2nd day of January 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
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PO-1050
(5/69)

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