United States Patent [19]

Seeger, Jr. et al.

[11] **3,721,778**

[45] **March 20, 1973**

[54] **KEYBOARD SWITCH ASSEMBLY WITH IMPROVED OPERATOR AND CONTACT STRUCTURE**

[75] Inventors: **Richard E. Seeger, Jr.**, Marblehead; **William J. Lynn**, Groveland, both of Mass.

[73] Assignee: **Chomerics, Inc.**, Woburn, Mass.

[22] Filed: **June 21, 1971**

[21] Appl. No.: **154,752**

[52] U.S. Cl. ..... **200/5 R**, 200/5 A, 200/159 B, 200/166 C

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

[58] **Field of Search** ..... 200/5 R, 5 A, 159 B, 166 C, 200/166 PC, 101 B, 101 CE, 101 CM

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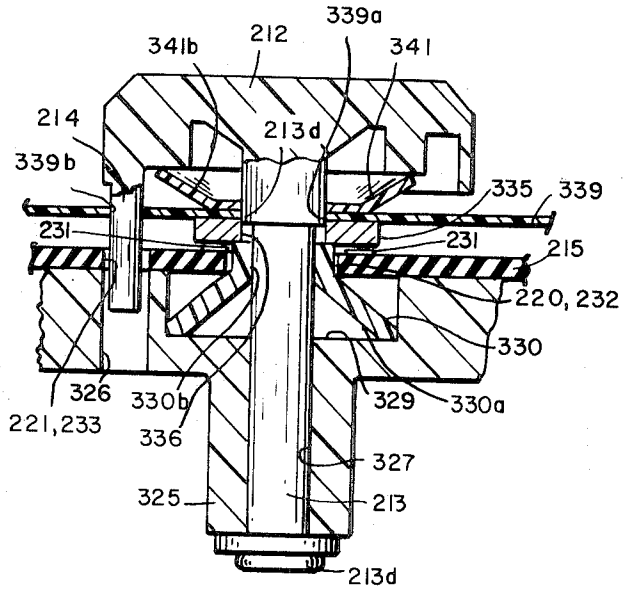
Primary Examiner—J. R. Scott

Attorney—Sewall P. Bronstein et al.

[57] **ABSTRACT**

An encoded keyboard device which includes a plurality of layers of insulator material, at least two of which have patterns of electrically conductive material supported thereby, a plurality of holes extending through one of said layers and positioned with respect to said conductive patterns so that electrically conductive material may extend through the holes and electrically interconnect the patterns, and a plurality of keys adapted to push electrically conductive material against one of said patterns to produce a coded output representative of the key depressed.

8 Claims, 12 Drawing Figures



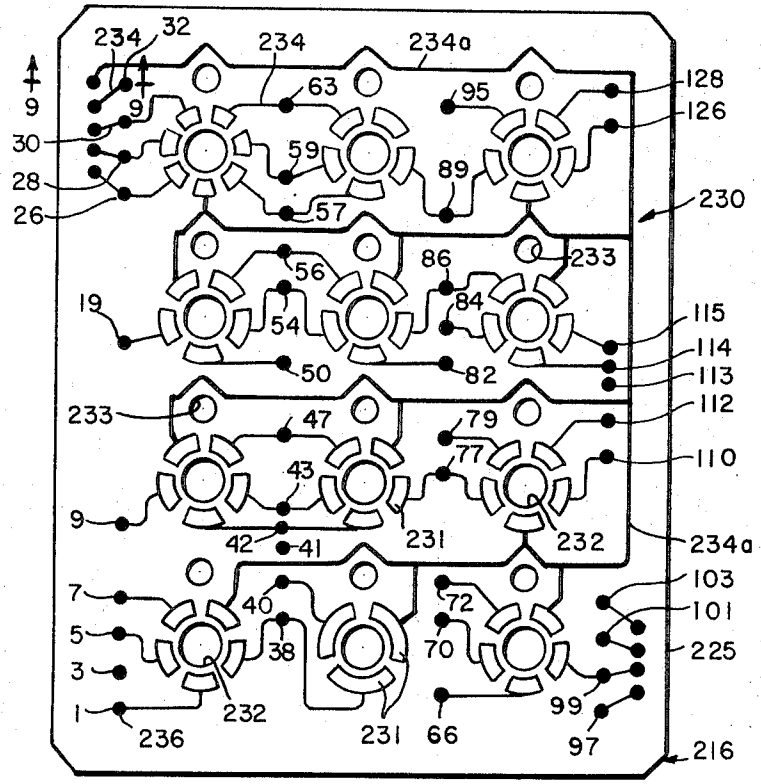


FIG. 6

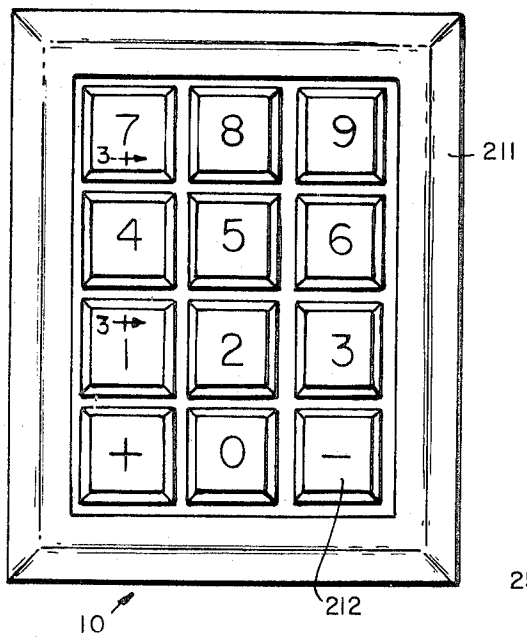


FIG. 1

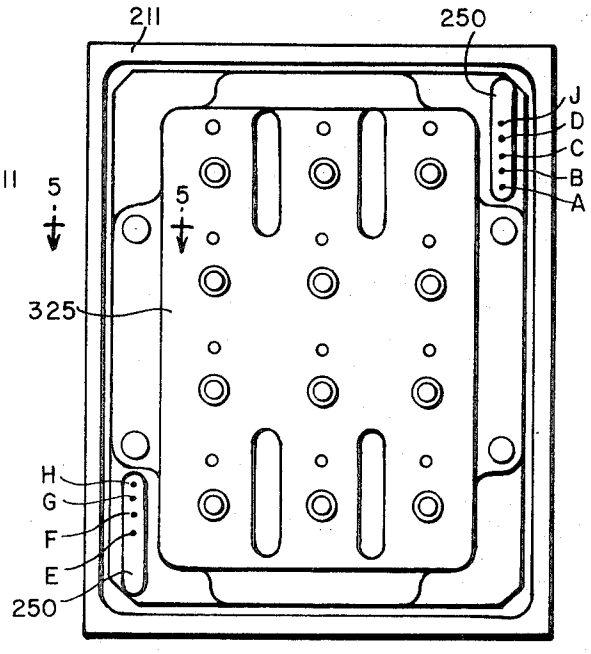


FIG. 2

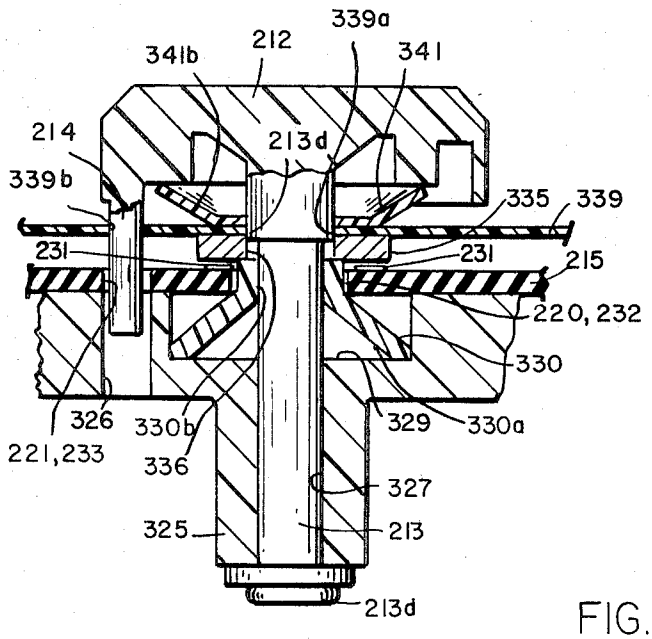


FIG.3

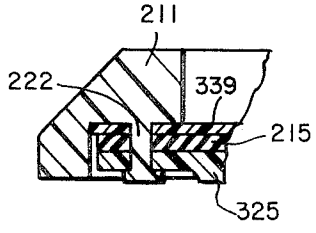


FIG.5

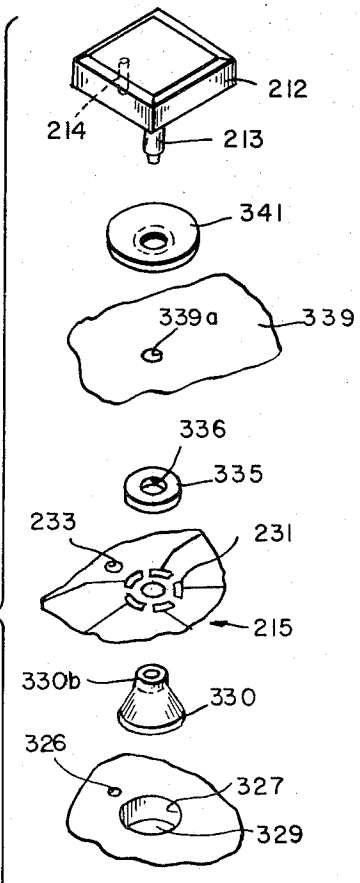


FIG.4

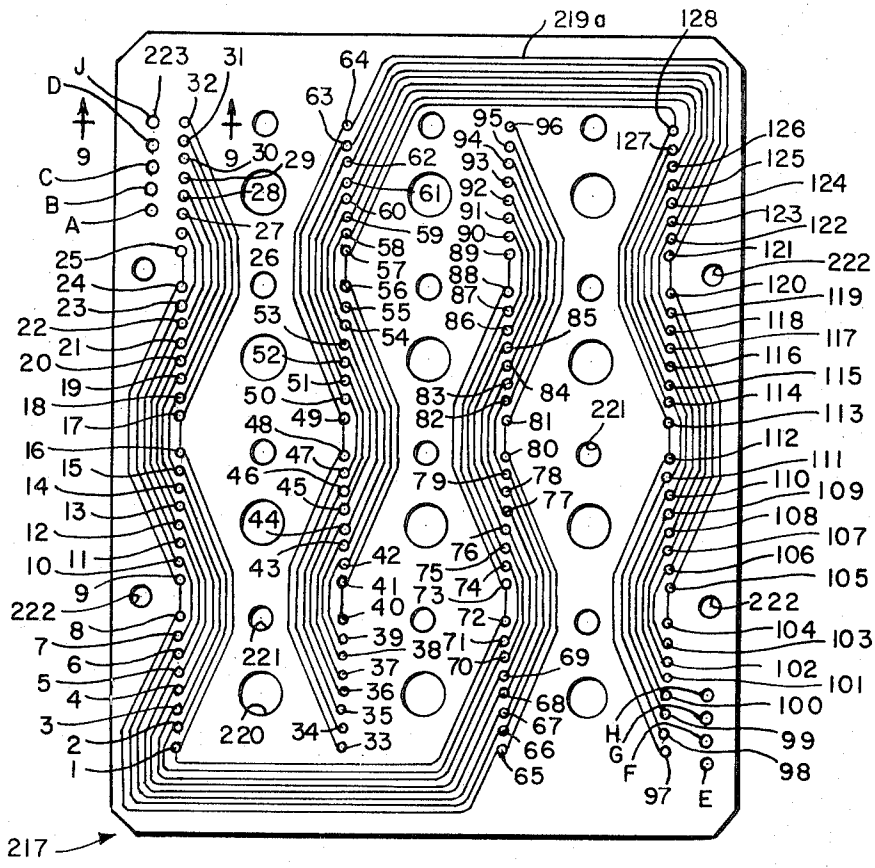


FIG.7

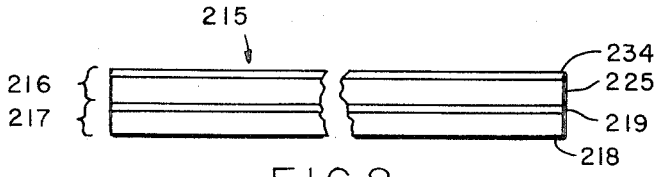


FIG.8

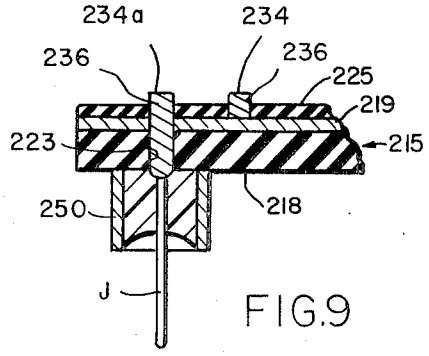


FIG.9

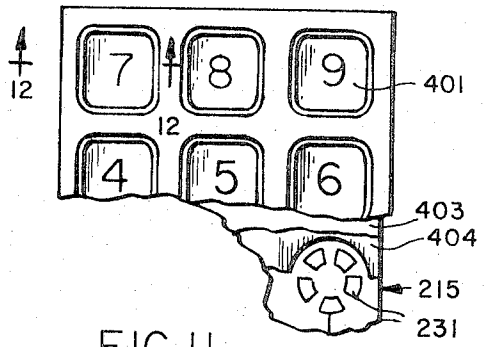


FIG. 11

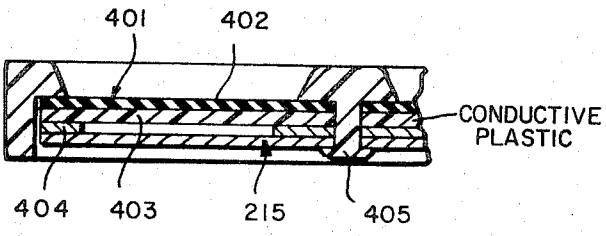


FIG. 12

TERMINALS

KEY LEGEND	A	B	C	D	E	F	G	H	J
1	☒				☒	☒		☒	☒
2		☒			☒	☒		☒	☒
3	☒	☒			☒	☒			☒
4			☒		☒	☒		☒	☒
5	☒		☒		☒	☒			☒
6		☒	☒		☒	☒			☒
7	☒	☒	☒		☒	☒		☒	☒
8				☒	☒	☒		☒	☒
9	☒			☒	☒	☒			☒
0					☒	☒			☒
+	☒	☒		☒		☒			☒
−	☒		☒	☒		☒			☒

☒ INDICATES TERINAL SHORTED TO COMMON WHEN KEY IS DEPRESSED

TERMINAL J IS COMMON

FIG. 10

KEYBOARD SWITCH ASSEMBLY WITH IMPROVED OPERATOR AND CONTACT STRUCTURE

This invention is directed to a new and improved encoded keyboard device for providing a coded electrical output representing the depression of a key of the keyboard.

In particular this invention combines conductive plastic technology with a totally integrated keyboard having its own internal logic to provide an encoded output signals without the necessity of using diodes as other external logic circuitry.

The keyboard of this invention comprises a plurality of keys having indicia or legend on the face thereof, or indicia representing keys positioned on a surface (e.g. insulating material) to simulate keys, all of which are hereinafter referred to as keys. The keys of this invention are adapted to position a contact means preferably one which is of highly conductive elastomer material against a first electrically conductive pattern supported on a first insulator layer. The first insulator layer is positioned on top of a second electrically conductive pattern supported on a second insulator layer and said first insulator layer is provided with a plurality of holes extending from one face to the other face thereof through which conductive interconnector means positioned to interconnect the first and second patterns in a predetermined manner to generate the desired output code. Terminals are provided at the output of the device which are connected to the patterns to provide bits representing the code upon depression of one or more of the keys.

The bits of data may then be utilized in conventional data processing equipment as is well known in the art. With the improved encoded keyboard device and particularly with the improved keyboard construction of this invention, it is now possible to considerably reduce the cost of generating input data over conventional techniques relying upon external logic. In addition, since no active devices are utilized (e.g. transistors, diodes, etc.) to generate the desired coded output, a much more reliable device is provided. Furthermore, the encoded keyboard because of its simplicity can easily be fabricated to produce a wide variety of coded outputs by merely changing the conductive pattern design and interconnection thereof or by adding additional conductive patterns supported on further insulator layers (e.g. three insulator layers, each having a conductive pattern thereon) each stacked one on top of the other and interconnected by the interconnecting means extending between layers and electrically coupling the patterns together to generate a desired code.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a portion of the encoded keyboard device according to the invention;

FIG. 2 is a bottom view of the keyboard of FIG. 1;

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1;

FIG. 4 is a perspective view showing one key and the parts cooperating with it as incorporated in the invention;

FIG. 5 is a sectional view taken along line 5—5 of FIG. 2;

FIG. 6 is a top view of the first conductive pattern on a first layer of insulator material;

FIG. 7 is a top view of a second conductive pattern on a second layer of insulator material, e.g. an insulator board;

FIG. 8 is a side view showing the first conductive pattern and the first insulating layer mounted (stacked) on the second conductive layer and second insulator layer;

FIG. 9 is a sectional view taken along line 9—9 in FIGS. 6 and 7 when the parts are placed over one another as shown in FIG. 8;

FIG. 10 is a chart showing the output signals at the terminals A–H shown in FIG. 2, upon depression of keys 1–0 and + and − shown in FIG. 1;

FIG. 11 is a view of an alternate embodiment of a keyboard device according to this invention with parts broken away; and

FIG. 12 is a sectional view taken along line 12—12 of FIG. 11;

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference should now be had to FIGS. 1–10 for a description of the preferred embodiment of the keyboard according to this invention. In FIG. 1, the encoded keyboard device is shown generally at 210 and includes an outer frame 211 as for example of plastic. In the confines of the frame there is provided a plurality of keys 212 forming a keyboard. The keys can have numbers, letters, signs or other indicia or legend thereon as per conventional keyboards. Each of the keys 212 of this invention are provided with a stem 213 and a guide pin 214. The keys 212 may be constructed of plastic, (e.g. nylon, polypropylene) or metal.

At 215 in FIGS. 3, 4, 5, 8 and 9 there is shown the composite encoded circuit board comprising the members 216 and 217 shown in FIGS. 6 and 7 and used in this invention to generate encoded output signals at output terminals A–H shown in FIG. 2. The encoded circuit board comprises in essence four layers mounted in a sandwich (i.e. stocked one on top of the other) to form the composite board shown at 215.

The bottom layer comprises an insulating layer 218 as for example, of plastic (e.g. Formica, Bakelite) which is provided with an electrically conductive circuit pattern 219 on the surface thereof. The circuit pattern may be formed thereon using conventional printed circuit, or plating techniques such as silk screening to leave electrically conductive circuit elements 219*a* (e.g. copper or conductive plastic) as shown in FIG. 7.

At various points along the circuit elements 219 junction points 1–128 shown as conductive material circles are provided for interconnecting the circuit elements to the circuit pattern shown on the member 216 as will be described. In addition, the layer 218 is provided with a plurality of larger holes 220 for permitting the key-stem 213 to move therethrough and a plurality of smaller holes 221 to permit the key guide pin 214 to move therethrough. The number of holes 220 and 221 depend on the number of keys used in the keyboard. The layer also includes mounting holes 222 for mounting it to the frame 211 (see FIG. 5) as well as a plurality of holes 223 for permitting connection of connector pins A–H and J (see FIG. 2) by interconnector electrically conductive circuit elements 236 (see FIG. 9). The electrically conductive circuit elements may comprise conductive plastics as described herein or metal in the form of solder, etc.

Positioned over the layer **218** and the conductive pattern **219** is a second insulator layer **225**. The layer **225** is preferably of a thin insulating material such as a film which may be heat sealed, or adhesively secured over the member **217** using conventional heat sealable materials or conventional adhesives. Materials such as polyethylene polypropylene, or the aforementioned Bakelite or Formica can be used. In addition, the layer **225** may comprise a coating of plastic resin which may be silk screened thereon in the required construction thereby forming an insulating layer.

The layer **225** includes a second electrically conductive pattern **230** comprising a plurality of switch contact segments **231** positioned about holes **232** aligned with holes **220** for movement of the key-stem **213** therethrough. It should be observed that the number of segments **231** around each hole will vary depending upon the code output signals to be generated. A second set of smaller holes **233** aligned with holes **221** is also provided for the movement of the key guide pin **214** therethrough. Also positioned on the layer **225** are a plurality of electrically conductive elements **234** which are coupled to the segments **231** as shown. The segments **231** and the conductive elements **234** are formed on the layer **225** using conventional printed circuit techniques such as plating or silk screening and may comprise copper, conductive plastics or the like which are highly electrically conductive.

The layer **225** is also provided with a plurality of holes **1–128** extending therethrough (from the top surface to the bottom surface thereof) and which are in alignment with the junction points **1–128** (only some of which are shown numbered for convenience of explanation as will be explained below since all are not used) so that electrically conductive interconnector elements **236** (see FIG. **9**) may extend therethrough to engage the junction points below the respective hole.

The numbers shown for the holes in the layer **225** and junction points on the layer **218** are selected as identical to facilitate a description of which the elements **234** are connected to which of the junction points **1–128**.

In FIG. **6** this is indicated by a heavy solid circle given a number which number corresponds to the respective junction point of the conductive pattern therebelow and indicates that an interconnector **236** extends through the hole to connect together the selected elements **234** to selected junction points bearing the same number.

In the case of numbers **32, 97, 101** and **103** the heavy numbered circles indicate that the selected junction points below them are also connected by an interconnector **236** which extends to the top surface of the layer **225**.

The layer **225** also includes outer holes **240** in line with holes **223** of layer **218** through which further interconnectors **236** extend in the same manner as shown for pin J to connect selected junction points numbered **26,28,30,32,97,99, 101** and **103** to pins A–H by outer portions of the circuit elements **234** as shown in FIG. **6** and in the same manner as described with reference to FIG. **9** for pin J.

The electrically conductive element shown at **234***a* of the conductive pattern on layer **225** is coupled directly to pin J as shown in FIGS. **6** and **9**, pin J being the electrical common for the device.

The pins A–H and J are supported in a plastic connector housing **250** as shown in FIGS. **2** and **9** for connection to other electrical devices such as input devices for computers.

Reference should again be had to FIGS. **2–5** which show at **325** a back plate, (e.g. of plastic) for holding the board **215** and the other parts of the switch not yet described together. The back plate is provided with bores **326** in which pins **214** are adapted to extend. In addition, plate **25** includes bores **327** in which the stems **213** are adapted to slide up and down upon depression and then release of the keys **221**. To retain the stems **213** within the bores **227**, the stems are provided with heads **213***a* as shown in FIG. **3**. Further as shown in FIGS. **2** and **6**, the plate **325** is provided with additional bores **329** for holding therein resilient biasing means or springs **330**. Each spring **330** is constructed such that the lower portion **330***a* thereof rests against the side walls of the bore and the top portion **330***b* thereof extends above the bores **329** through the holes **220** and **232** of the board **215**.

The spring is most preferably of the Belleville type (in the nature of a drain plunger) to impart that the key has been fully depressed. With this type of spring, upon depression of a key, a snap action or toggle is felt by the finger as spring portion **330***a* trys to invert about spring portion **330***b*.

The spring **330** is preferably made of plastic material such as polyethylene, polypropylene or silicone rubber. It should be understood that other types of springs may be used to perform the function of spring **330** as for example, metal coil springs and the like, whether or not they provide the preferred snap action.

Positioned on top of each of the spring portions **330***b* there is provided an electrically conductive contactor **335**, most preferably in the shape of a cylinder having a central bore **336** through which the stem **213** is adapted to move upon key **212** depression. The contactor **335** is preferably a plastic material and is most preferably of a conformable and resilient plastic material which is adapted to conform to the shape of the surface of the segments **231** to ensure good electrical contact. The plastic is most preferably filled with conductive particles such as metal particles, e.g. silver, copper, gold, etc., or any combination thereof which exhibit good electrical conductive properties to form an electrically conductive plastic.

In some applications, the conductive particles can be carbon black although much less desirable because carbon black exhibits a change in resistance with pressure applied thereto. In addition, in some cases the contactor may be constructed of solid metal, silver, copper or tin foil. In its most preferred form, the contactor is constructed of plastic materials containing from 10 to 80 volume percent of metal particles (e.g. silicone rubber filed with silver flake). Examples of other conductive plastics suitable for use in this invention are further disclosed in U.S. Pat. Nos. 3,140,342 and 3,576,387.

Most preferably the preferred contactor **335** used herein is a conductive plastic which has a volume resistivity less than 0.01 ohm centimeters and exhibits less than a 1 ohm per c m^3 change in resistance in 10 microseconds as when under key depression and is preferably accomplished using a silicone rubber with silver flake as heretofore disclosed.

It should be understood that in addition to the metal particles used to fill the conductive plastic, inert or non-conductive fillers such as silica, talc, etc., may also be incorporated therein as long as the mechanical and electrical properties of the contactor is not adversely affected in a substantial manner.

Positioned above the contactor **335**, there is provided a dust cover **339** such as of paper, polyethylene film, or the like. The dust cover **339** is provided with holes therein at **339***a* and **339***b* for permitting movement of the stem **313** and the pin **314** therethrough.

Above the dust cover and about each key-stem **213**, but below the key surface there is provided another resilient biasing means or spring **341**. The spring is shaped so that a portion **341***a* is adapted to engage the dust cover **339** about contactor **335**. Upon depression of a key, the spring **341** is moved downwardly and forces contactor **335** (normally held away from contact segments **231** by spring portion **330***b* as shown in FIG. **3**) against the contact segments **231** while at the same time depressing spring **330**. Upon release of the key, spring portion helps to raise the key. The spring **341** is preferably constructed of the same material as the spring **330**.

In operation, one or more of the keys **212** of the device are depressed. The depression of a key causes the pin **214** and stem **213** to move downwardly. As the key moves downwardly, the stem shoulder portion **213***a* engages the spring portion **330***b* while at the same time the spring **341** is moved downwardly. As the contactor **335** continues to move downwardly (by the force of spring **341** against it) it engages the segments **231** and makes electrical contact with each of them. Further depression of the key produces a toggle or snap action touch in the finger of the user as the spring **341** trys to invert upon itself. Upon release the key is moved upwardly by action of springs **330** and **341** and the contactor **335** is moved off the contact segments. FIG. **10** shows in chart form the output signals obtainable by depression of the various keys with an X indicating which of terminals A–H are shorted to terminal J (the common).

Naturally the X also indicates the presence of a signal (or the flow of current) from the common to the respective terminal when terminal J is coupled to the ground side of a source and the terminals A–H are in circuit with a utilization device such as a buffer which is connected to the other (+) side of the source.

Reference should now be had to FIGS. **11–12** which shows a modification of the contactor **335** and key construction. In this construction, the keyboard device comprises a frame **400** having a plurality of windows **401** formed therein. Positioned under the windows is a plastic material surface layer **402** having indicia or legend printed thereon and thus in essence forming keys. Underneath the layer **402** there is provided a layer (sheet) of conductive plastic material **403** of the conductive plastic composition described above. The layer extends under each of the keys (that is the numbers or legend shown). Below the conductive plastic layer **403** there is provided an insulating layer **404** (e.g. of plastic) also having a plurality of windows cut away therefrom so that the conductive plastic may be forced therethrough to engage one or more segments **231** of the circuit board **215** (the same as in FIGS. **1–10**). The conductive plastic layer **403** is preferably selected so that is sufficiently elastic so that it will let itself off and away from the underlying circuit pattern when not being depressed. It should be understood that one large contact surface may be used in place of individual segments **231** in certain cases. The device of this embodiment functions in the same manner as that disclosed in FIGS. **10** except that the parts are held together by headed pins **405** extending through the members as shown in FIG. **12**.

Additionally if desired in this construction, the common terminal J may directly be connected to the conductive plastic by extending the pin J directly into the conductive plastic, thus avoiding the necessity of having the common portion of the pattern **234***a* shown in FIG. **6**.

We claim:

1. An encoded keyboard device comprising a first insulator layer having top and bottom surfaces, a first electrically conductive circuit pattern including a plurality of conductive elements supported on the top surface of the first insulator layer, a second insulator layer having top and bottom surfaces, the bottom surface thereof secured to and positioned over the top surface of the first insulator layer and the first electrically conductive circuit pattern, said second insulator layer of the thickness of a film and having a plurality of holes therethrough from the bottom to the top surface thereof, the holes being selectively aligned with the circuit elements of said first circuit pattern, a second circuit pattern, said second circuit comprising a plurality of electrically conductive switch contacts and a plurality of electrically conductive circuit elements electrically interconnected, and said second circuit pattern positioned on the top surface of the second insulator layer and extending into and through selected holes of said second insulator layer to electrically contact selected ones of said first circuit elements to form electrical pathways between the switch contacts and the circuit patterns above and below said second insulator layer, electrically conductive contactor means positioned over said switch contacts, and first means to cause said contactor means to engage one or more of said switch contacts to complete one or more electrical pathways through the device.

2. An encoded keyboard device according to claim **1** in which there is provided a plurality of terminals at the bottom of said first insulator layer, and in which the second circuit pattern extends through holes in said first and second insulator layers to electrically couple the second circuit pattern to said terminals.

3. An encoded keyboard device according to claim **2** in which the conductive contactor means comprises conductive plastic material.

4. An encoded keyboard device according to claim **3** in which the contactor means comprises a plurality of cylindrical conductive plastic elements or a sheet of conductive plastic material.

5. An encoded keyboard device according to claim **4** in which said first means comprises a plurality of

6. An encoded keyboard according to claim **4** in which said first means comprises a sheet having a plurality of code marks spaced thereon.

7. An encoded keyboard device according to claim **1** in which there are eight output terminals A–H and a

common line and in which the numbers 0 to 9 are indicated by the shorting of the terminals to the common line.

8. An encoded keyboard device according to claim 7 in which the terminals are shorted as represented in FIG. 10 to indicate the numbers 0 to 9.

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