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PUSH BUTTON UTILIZING TRANSMITTING AND RECEIVING MEANS COACTING WITH AN APPERTURED SHIELD TO PROVIDE A CAPACITIVE COUPLING

Filed Jan. 5, 1967 Sheet 1 of 2

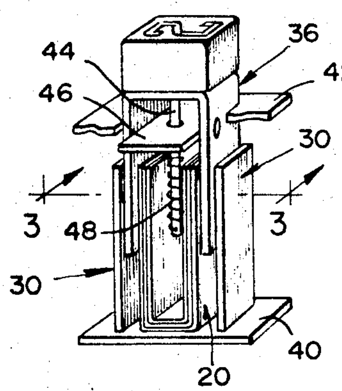

FIG. 1

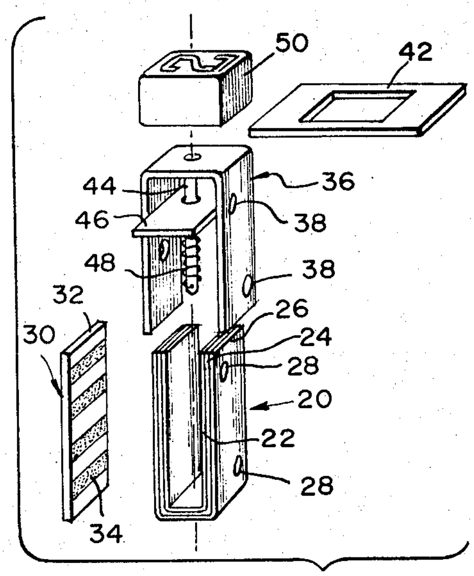

FIG. 2

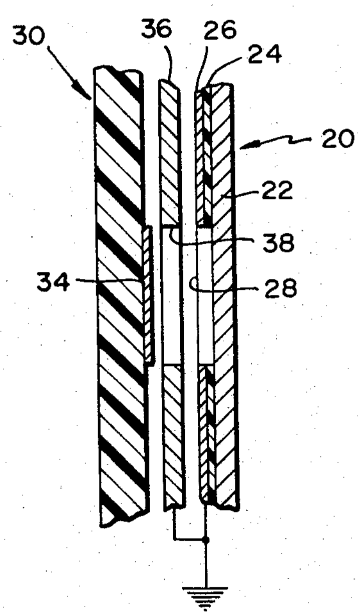

FIG. 3

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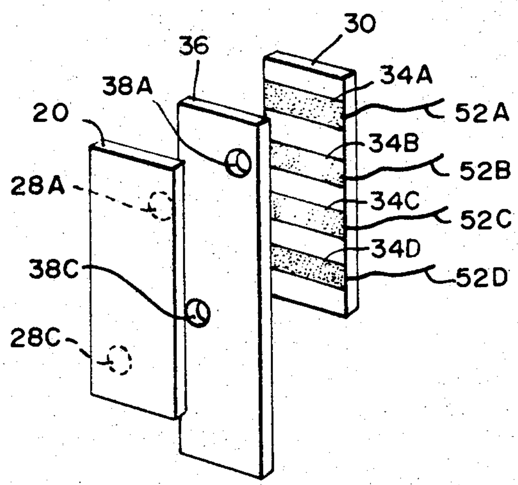

FIG. 4

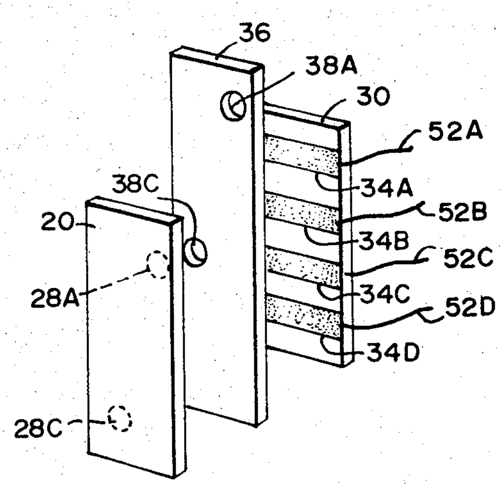

FIG. 5

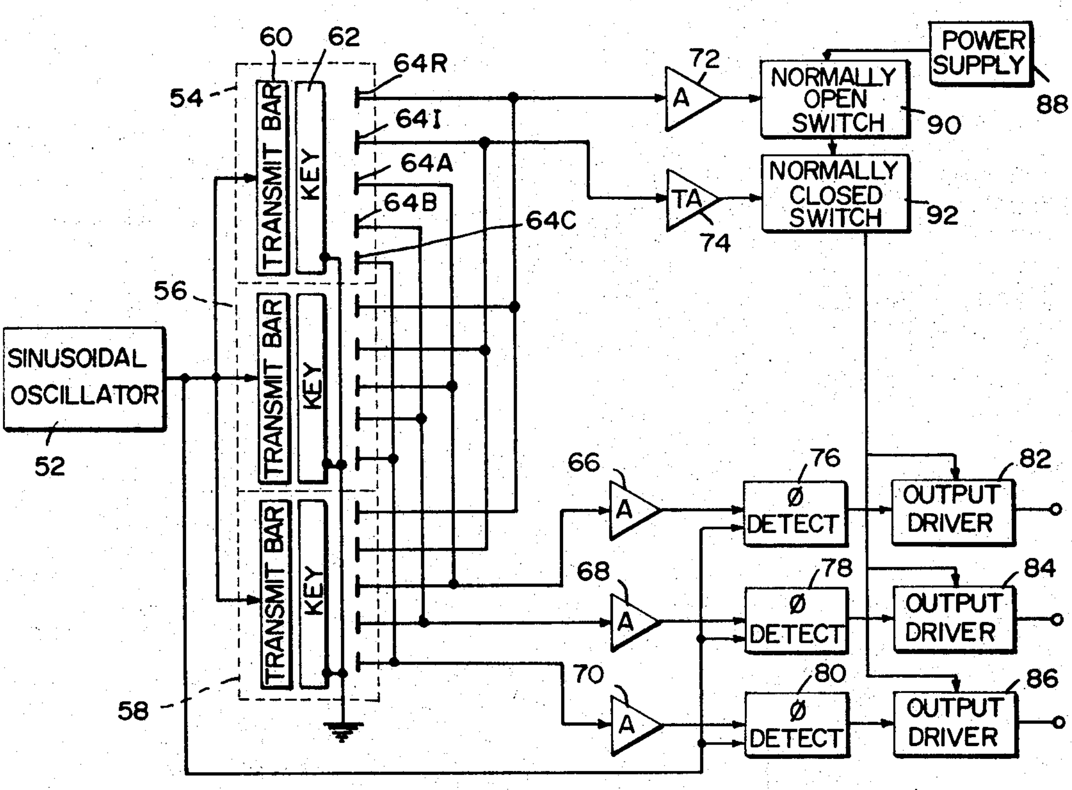

FIG. 6

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ABSTRACT OF THE DISCLOSURE

The following specification describes a switch in which a conductive transmission bar is connected to an input terminal and a plurality of discrete, conductive receiving strips are each connected to respective output terminals. The input terminal is intended to be connected to a source of a signal of changing potential. A manually engageable key in the form of an electrostatic shielding element is normally interposed between the transmission bar and receiving strips so as to prevent capacitive coupling of the signal from occurring between the transmission and receiving elements. The key is movable to a position at which apertures in the key permit coupling and thus switching to occur. The key can, by virtue of the number and placement of apertures in it, directly encode the signal into a given numerical form defined by selective energization of the input terminals, and hence forms a basic element for a multiple key keyboard.

This invention relates to an electrical switching device and more particularly to novel switching means adapted for multiple keyboard switching.

As is well known, the typical electronic calculator operates on the basis of a numerical or logical system other than decimal, because of the difficulty in manipulating decimal notation or multivalued logic. However, because data is most generally in decimal form, a manually manipulated input keyboard to a calculator is usually designed to accept information in decimal terms. Hence, the device usually requires means for coding the decimal input data into another numerical system, typically binary, more suited for machine useage.

A usual input keyboard comprises a plurality of keys, each connected to operate a mechanical switch. The state of the keyboard switches is converted to an appropriately coded signal either by using cross-bar switches in which the coding is directly accomplished, or by using simple mechanical switches with auxiliary apparatus such as a diode matrix to achieve coding. The portion of the mechanical switch moved manually usually is a current-carrying element; hence, the latter must be insulated so that the operator is not exposed to the current. Of course, in either type of switch there are a number of other problems posed by its mechanical construction. For example, mechanical contact switching tends to be noisy, being subject to switching transients and contact bounce. Mechanical contact switches also tend to wear at the contact surfaces and hence have limited life and reliability.

The present invention, therefore, has as a principal object the provision of novel switching means particularly adapted to provide signal encoding without the above noted problems characteristic of mechanical contact switches.

Another object of the present invention is to provide switching means with increased reliability because switching is achieved substantially without contact arcing, bounce, or wear.

Briefly, to accomplish these and other objects, the present invention is embodied in a three-element switch and is intended to switch only changing potentials. The switch comprises a first element having a signal transmitting surface, a second element having a signal receiving surface, the two elements being disposed so that an interspace is provided between the two facing surfaces. The third element is an electrically conductive electrostatic shield disposed between the receiving and transmitting surfaces. It will be apparent that when the first element is connected to a source of changing potential, the presence of an electrostatic shield between the receiving and transmitting surfaces will prevent the occurrence of any capacitive coupling of the signal at the transmitting surface with the receiving surface. Therefore, the shield has a configuration such that a portion thereof is not electrically conductive but presents a dielectric aperture through which capacitive coupling of respective surfaces can be achieved. At least one of the elements is movable with respect to the others so that coupling is effected only in a predetermined relative position of the three elements and preferably in no other position. As will be seen later, by judicious selection of the nature and position of transmitting and receiving surfaces and dielectric apertures, coding directly by the switches can be readily accomplished.

Other objects of the invention will in part be obvious and will in part appear hereinafter. The invention accordingly comprises the apparatus possessing the construction, combination of elements, and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the present invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic perspective view partly in fragment of an assembled switch embodying the principles of the present invention;

FIG. 2 is an exploded perspective showing the relation and details of a number of the elements of the switch of FIG. 1;

FIG. 3 is a partial cross-section of a portion of the embodiment of FIG. 1 taken along the line 3—3;

FIG. 4 is a schematic perspective view showing the relation of a number of selected elements of the embodiment of FIG. 1 when the switch is in a conducting position;

FIG. 5 is a schematic representation showing the elements of FIG. 4 when the switch is in a non-conducting position; and

FIG. 6 is a schematic circuit diagram, partly in block form, showing an embodiment of the present invention useful for multiple signal encoding.

As previously noted, the switching means of the present invention is intended to connect input and output terminals through a capacitive coupling phenomenon, and hence requires that the signal at the input terminal be a changing potential, i.e., a smoothly changing potential, such as an oscillating voltage, or a step-change such as is found with a pulse train input or the like.

Referring now to FIGS. 1–3, there is shown one embodiment of the present invention comprising transmission element **20** having at least one elongated slab **22** of an electrically conductive material such as copper or the like. One surface of the slab bears an electrically insulating element **24**, for example, of an enamel or other dielectric material. Another thin layer of electrically conductive material **26** overlies insulting layer **24**. One or more areas of slab **22** are devoid of both layers **24** and **26** such that there is at least one discrete, exposed, uninsulated surface portion **28** of the electrically-conductive material of slab **22**, i.e., an aperture through to the layers

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24 and 26. Where there are more than one uninsulated portion 28, each such surface portion is spaced apart and separated from the others by the presence of the intervening structure of layers 24 and 26. Obviously, all uninsulated surface portions 28 are electrically connected to one another through the body of slab 22. Means, such as lead 29, are provided for connecting slab 22 to a source of changing potential. Layer 26 is preferably connected to a system ground and hence provides electrostatic shielding with respect to the other areas of the surface of slab 22, directly underlying layer 26.

Spaced from element 20 is reception element 30 which typically comprises elongated support means in the form of insulating substrate 32, for example, of glass or glass-epoxy resin. Mounted on a surface of substrate 32 so as to be in register with each surface portion 28 (i.e., in facing relation across the interspace between transmission element 20 and reception element 30) is a corresponding, electrically-conductive element, for example, flat metallic strip 34. If more than one such strip is required because there is more than one surface portion 28, the strips are spaced from one another and are held electrically insulated from one another by substrate 32.

In a preferred embodiment, elements 20 and 30 are fixedly mounted with respect to one another so that each surface portion 28 is in fixed register with a corresponding strip 34. Mounted for movement between and spaced from both elements 20 and 30 is electrostatic shielding means 36 preferably formed of an electrically-conductive material and having at least one aperture 38 therein. Aperture 38 can simply be a hole which contains a dielectric material such as a vacuum, air or even a solid dielectric, as desired. Where the facing surfaces of the transmission and reception elements are substantially planar, the electrostatic shield can simply be a flat metallic plate with one or more apertures 38 appropriately placed, as will appear hereinafter.

Shielding means 36 is preferably mounted for movement within the interspace between elements 20 and 30 such that in a unique position of the shield, each aperture 38 lies between a registered pair of a surface portion 28 and a strip 34, thereby permitting any changing potential on portion 28 to be capacitively coupled to registered strip 34. Preferably, in all other positions to which the shield is movable, the electrically-conductive material of the shield is interposed between that registered pair. Because shielding means 36 is also connected to ground, it is apparent that it will constitute an electrostatic shield preventing capacitive coupling when interposed between a registered pair.

A preferred embodiment of the switch of the present invention, particularly adapted for use as a keyboard switch, is as shown in FIGS. 1 and 2 wherein transmission element 20 is a slab formed in a U-shape such that the surface bearing layers 24 and 26 exposes the electrically conductive material of slab 22. It will be recognized that because of the U-shape of element 20, there are two outwardly facing surfaces, each of which may bear one or more surface portions 28. Consequently, opposite each arm of the U-shape of element 20 is a corresponding reception element 30 provided with a plurality of strips 34. For each surface portion 28 of element 20 there is at least one registered corresponding strip 34. Each of the elements 30 is also fixedly mounted on base 40 in proper relationship to the outwardly facing surfaces of element 20.

The switch of FIGS. 1 and 2 also includes electrostatic shielding means 36 in the form of a metallic strip bent to form a U dimensioned so as to fit outside element 20 but inside the interspace between element 20 and element 30. Element 36 is mounted for movement within the interspace between element 20 and element 30 in the following manner: there is provided top plate 42 having a central aperture 43 into which shielding means 36 is slidably mounted. Means (not shown) are included for mounting plate 42 in a substantially fixed, parallel relation with plate 40. Rigidly mounted on the inside of the base of the U-shape of means 36 and extending substantially centrally between and parallel to the arms of the U-shape thereof is pin 44. Slidably mounted on pin 44 is bar 46 which extends substantially perpendicularly to pin 44 and is dimensioned to be longer than the width of shielding means 36, and, therefore, extends outwardly from the bight of the U-shape of the latter so as to be engageable with edge portions of the periphery of aperature 43 in plate 42. Resilient means such as spring 48 is mounted about pin 44, one end of spring 48 being anchored at the distal end of the pin, the other end of spring 48 being anchored on bar 46 adjacent the pin. Manually engageable button 50, typically intended to bear on its top surface a numerical or other indicium, is affixed to the outside of the base of the U-shape of shielding means 36.

As shown assembled in FIG. 1, when shielding means 36 is positioned in aperture 43 of plate 42 such that bar 46 engages the top surface of plate 42, spring 48 serves to retain shielding means 36 in a normal position wherein (as schematically shown in FIG. 5) apertures 38 in shielding means 36 are completely out of alignment with any registered surface portion 28 and strip 34. In this normal position of the shielding means, the electrically conductive body of the shield is interposed between each registered pair of surface portions 28 and strips 34. When button 50 is subjected to manual pressure so as to force the shield to move downwardly through the interspace between elements 20 and 30, because one end of spring 48 is fixedly positioned by the engagement of bar 46 and plate 42, the other end of the spring moves with pin 44, and the spring is placed under tension. Of course, upon release of pressure on button 50, the spring will tend to restore shielding means 36 to its normal position.

For convenience in manufacture, each of receiving elements 30 is preferably provided in an embodiment such as that shown in FIGS. 1 and 2, wherein each element 30 has the same plurality of strips 34 thereon, each strip corresponding to a code channel. Thus, as shown for the sake of illustration in FIGS. 4 and 5, element 30 bears four strips, 34A, 34B, 34C, and 34D, and therefore provides four output channels each having its own individual lead, respectively 52A, 52B, 52C, and 52D. Now, it can be assumed for example that only one arm of the U-shape of transmission element 20 bears two surface portions respectively identified in FIGS. 4 and 5 as 28A and 28C registered with corresponding strips 34A and 34C. It will be seen from FIG. 4 that when shielding means 36 is in its normal position, electrically conductive material of the body of the latter lies wholly between portion 28A and strip 34A and between portion 24C and strip 34C. Shielding means 36, as shown, includes a pair of dielectric apertures identified respectively as 38A and 38C. The latter apertures are disposed so that when shielding means 36 is moved to a switching position as shown in FIG. 5, the dielectric apertures then lie respectively between registered portions 28A and strip 34C and registered portion 28C and strip 34C and therefore permit any changing potential signal on element 20 to be capacitively coupled only to those two strips. In order to insure that there is only one unique position at which this can occur, inasmuch as there may be a plurality of surface portions and corresponding dielectric apertures, portions 28 and apertures 38 are disposed respectively on element 20 and shielding means 36 such that no surface portions are registered with any aperture in any other position of the shielding means. This can be accomplished by distributing the dielectric apertures on the shielding means along lines perpendicular to the direction of motion of the latter so that when the shielding means is moved in that direction, each dielectric aperture sweeps out a unique path with respect to the transmission element, and not more than one surface portion 28 lies within each such unique path.

In the example given, it can further be assumed that each switch is intended to code a particular corresponding decimal numeral into its binary equivalent, and that the shileding means of the switch shown in FIGS. 4 and 5 bears or is identified by the decimal indicium **5**. In such case, leads **52A–D** respectively constitute the binary **1**, **2**, **4**, and **8** channels. If now a changing potential is continuously impressed on element **20**, when the shielding means is in its normal position none of output leads **52A–D** inclusive will be energized. When the shielding means is depressed toward a position where capactive coupling occurs between surface portion **28A** and **28C** corresponding strips **34A** and **34C**, output leads **52A** and **52C** will be accordingly energized. Because these are respectively the binary **1** and **4** channels, it will be seen that the mere act of depressing the shield to its conductive coupling position automatically provides the correct binary coded signal at the output terminals of the switch. Where, as shown in FIGS. 1 and 2, there is essentially a double switching mechanism due to the twin arms of the U-shape of element **20** and shielding means **36**, the output can be coded onto twice as many channels as it can with but a single pair of transmission and reception surfaces. Obviously, only a single surface portion **28** and corresponding dielectric aperture **38** is required to provide a binary coded output on any single binary channel, whilst four such surface portions and dielectric apertures are required to encode decimal numerals requiring activation of at least four channels.

The configuration of the three basic elements is not particularly important. For example, the surfaces can be curved, corrugated, or the like, provided, of course, that there is a proper path allowed for the motion of the shielding means between the transmission and reception elements and the latter are close enough to one another to permit capacitive coupling. The number and placement of surface portions, dielectric apertures and receiving strips required depend, naturally, upon the particular encoding scheme used. For example, the switch can be used to convert decimal to binary, to excess-three binary, to reflected binary, to select but a few of the many codes available. It will further be appreciated that while in the embodiment described the electrostatic shielding means itself is movable, and the transmisison and reception elements are fixed, other embodiments can be made in which the transmission element or the reception element is movable while the other two elements are fixed. However, the embodiment shown has a distanct advantage in that the movable element being grounded therefore does not carry any substantial current when the switch is conducting, and this aspect constitutes a distinct safety feature. The provision of layers **24** and **26** insure that signals can only be coupled when the shield is in its transmitting position. Additionally, reception element **20** can be a composite element formed of stacked layers of successively alternating electrically-conductive and electrically-insulating plates. In such case, shielding means **36** would have a normal position where each of its dielectric apertures would be adjacent a corresponding insulating layer of the transmission element, and would be movable to a position wherein each aperture would face or be reregistered with an electrically conductive layer.

Because the switching means heretofore described is capable of providing direct encoding, a multiple key keyboard can be readily formed using a number of such switching means. Thus, there is shown in FIG. 6 a schematic diagram of such a keyboard limited to three such switches for the sake of simplicity. The embodiment of FIG. 6 includes a source of changing potential, such as sinusoidal oscillator **52**, and three switches shown generally at **54**, **56**, and **58**. The three switches are the same in that they all include (identified only in switch **54** as exemplary) a transmission element or bar **60**, a shielding element or key **62**, and a plurality of five reception elements or strips **64A**, **64B**, **64C**, **64R**, and **64I**. All of the transmission elements of the switches are connected to oscillator **52**, and all keys **62** are grounded.

The three switches differ only in the number and position of dielectric apertures which are disposed in the respective shielding elements or keys **62**. For example, one can assume that the key **62** of switch **54** is identified by the decimal numeral 3, key **62** of switch **56** by the decimal numeral 4, and key **62** of switch **58** by the decimal numeral 5, and that the switches are intended to encode these decimal numerals directly into binary outputs whenever the appropriate key is depressed. In such case, the outputs of strips **64A**, **64B**, and **64C** can be considered respectively the binary **1**, **2**, and **4** channels. Key **62** of switch **56** will then include two apertures intended to permit coupling of the signal on the transmit bar to strips **64A** and **64B**. Key **62** of switch **58** will have but one aperture to permit the corresponding **64C** strip to be coupled, and key **62** of switch **58** will possess apertures permitting coupling to corresponding strips **64A** and **64C** of that switch. All strips **64A** of all switches are connected to one another and in turn are connected to the input of amplifier **66**. Similarly, strips **64B** are connected to one another and to the input of amplifier **68**, while strips **64C** are connected to one another and to the input of amplifier **70**. These connections preferably are through shielded leads to insure minimal signal interference from extraneous sources. It will be apparent that signals at the outputs of amplifiers **66**, **68**, and **70** (which are conveniently simple AC amplifiers) respectively represent actuation of the binary **1**, **2**, and **4** channels of the keyboard.

In addition to coding apertures in each key, the keys each include another pair of apertures located such that whenever a key is depressed to its switching position, these apertures respectively couple both strips **64I** and **64R** with the transmission element. All strips **64R** are connected to one another and also to the input of amplifier **72** which is quite similar, for example, to amplifier **66**. All strips **64I** are also connected to one another and also to the input of amplifier **74** which, however, is preferably a thresholding amplifier, i.e., does not provide an output signal unless the input signal exceeds a predetermined magnitude or threshold.

It will be apparent that the output signals from amplifiers **66**, **68**, and **70** are, in this instance, oscillatory and hence not particularly suited as inputs to conventional digital equipment which usually require a steady-state or DC level. While these oscillatory output signals can be rectified, as by full-wave bridges, it is preferred to employ other means to obtain a DC output, but which will also provide better signal-to-noise ratios. To this end, the output of each of amplifiers **66**, **68**, and **70** are respectively connected to one comparator input terminal of synchronous phase detectors **76**, **78** and **80**. These latter can be any of the number of known circuits which typically operate to phase lock two oscillatory input signals and develop an output voltage at a DC level proportional to the RMS amplitude of the input signal from the amplifier. Hence, the other comparator input terminals of the phase detectors are all connected in common directly to the output of oscillator **52**.

The output of each of phase detectors **76**, **78**, and **80** are each connected to a corresponding input of a respective output driver or amplifier **82**, **84** and **86**, normally in an inoperative state. The amplifiers are preferably connectable to a common power source **88** and when so connected become operative, i.e. provide output signals corresponding to any signals present at their respective input terminals. For example, each of amplifiers **82**, **84**, and **86** can be transistors having their bases connected to appropriate phase detector output terminals and their collectors connectable through an appropriate impedance to power source **88**, the emitter being grounded.

Amplifiers **82**, **84**, and **86** are connectable to power source **88** through a pair of series connected switches **90** and **92** typically transistors or the like. The former is normally closed, i.e., conductive, whereas the latter is usually open. Hence, amplifiers 82, 84, and 86 are normally inoperative.

Switches 90 and 92 are respectively connected to the outputs of amplifiers 72 and 74 so as to be operable responsively thereto.

Assuming that key 62 of switch 54 (representing decimal 3 as heretofore noted) is depressed, even if coupling occurs between transmit bar 60 and strips 64A and 64B, there can be no output from corresponding output drivers 82 and 84 until coupling occurs between the transmit bar and strip 64R. Only when the latter occurs is power supply 88 then connected to the driver amplifiers by the responsive closure of switch 90. Hence, the output of amplifier 72 can be considered a "read" command line. This insures that inadvertent coupling which may occur whenever the "read" line is not activated will result in no signals at the outputs of the driver amplifier. When the "read" line is activated, of course coupling will also be present between the transmit bar and strip 64I. However, the input threshold to amplifier 74 is high enough so that the signal thus coupled by a single key is insufficient to elicit an output from amplifier 74. If two or more keys are simultaneously in positions wherein their transmit bars are coupled to their strips 64I, the signal at the input to amplifier 74 exceeds the threshold causing amplifier 74 to produce an output which opens switch 92. In such case, regardless of activation of the "read" line, no power is available to operate the output driver amplifiers, and the output of amplifier 74 can be considered an "inhibit" line. It will be apparent that the "inhibit" and "read" signals are used to control gating of the binary coded signals and a number of other known circuits can be used to accomplish the same function.

With respect to the relative configuration of the dielectric apertures in the keys, the strength of the capacitively coupled signal varies about as the square of the ratio of mean hole diameter to the distance between the transmit bar surface and the receiving strip. Preferably, this ratio should be about 1:1. The voltage on the transmit bars typically can be 10 v. RMS, and should neither be so high as to cause arcing nor so low as to require very high gain amplification. The dielectric apertures need not be circular and indeed can be quite slot-like, provided that the mean diameter is in the proper ratio to the distance between receiving and transmitting surfaces.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted in an illustrative and not in a limiting sense.

What is claimed is:

1. Device for switching a changing potential comprising, in combination;

transmitting means defining a surface having one or more discrete, spaced-apart, electrically conductive surface portions all connected electrically to one another and connectable to the source of said potential;

receiver means defining another surface spaced a fixed distance from the surface of said transmitting means, said another surface having thereon one or more disecrete, electrically conductive elements insulated from one another; and

electrically conductive shield means having at least one dielectric aperture therein and being disposed within the interspace between and spaced from both of said surfaces;

said surface portions, elements and apertures being disposed with at least one of said means being movable with respect to the others so that there is a relative and unique position of said means wherein each said aperture is positioned to permit capacitive coupling to be effected between a corresponding registered pair of a surface portion and element, all other positions of all of said means being such that said shield provides electrostatic shielding preventing capacitive coupling from occurring between any of said surface portions and said elements.

2. A device for switching as defined in claim 1 wherein said shield means is said one of said means, which is movable with respect to the others, and including means for releasably maintaining said shield means in one of said other positions.

3. A device for switching as defined in claim 2 wherein said receiver means and transmitting means are fixedly positioned relative to one another, such that each of said surface portions faces a corresponding one of said conductive elements;

said apertures in said shield means being positioned with respect to the direction of movement of said shield means so that during movement of the latter each of said apertures sweeps out a unique path adjacent which not more than one corresponding surface portion lies.

4. A device for switching as defined in claim 2 wherein said surface of said transmitting means is bent so that two portions of said surface are substantially parallel to one another and perpendicular to a common axis intersecting both portions;

wherein said surface of said receiver means comprises two portions each facing a corresponding portion of said surface of said transmitting means; and

said shield comprises a metallic strip, bent so as to have two parallel arms perpendicular to a common intersector, and dimensioned and shaped so that each of said arms is positioned so as to be slidably movable within the interspace between a respective portion of said receiver means and the corresponding portion of said transmitting means.

5. Means for switching as defined in claim 1 wherein said surface of said transmitting means is of electrically insulating material and said surface portions are holes in said insulating material, having electrically conductive material disposed therein;

said holes being positioned so that each is adjacent a unique path relative to direction of movement of the one of said means which is movable, said apertures in said shield means being positioned with respect to said direction of movement so that each is also adjacent a unique one of said paths.

6. A device for switching as defined in claim 5 wherein said receiving means comprises a body of insulating material having disposed on a surface thereof said one or more electrically conductive elements in the form of metallic elongated strips extending substantially perpendicularly to the direction of movement of said one of said means.

7. A device for switching as defined in claim 5 wherein said apertures in said shield means are dimensioned such that each has a mean diameter which bears about a 1:1 ratio to the distance between the corresponding surface portion of said transmitting means and the element of said receiver means intended to be coupled by said each aperture.

8. A device for switching as defined in claim 1 including means providing a decimal numeral identifying said means for switching, and wherein each of said conductive elements constitutes a code channel corresponding to an exponential value of the radix of a predetermined code, said shield means having a number so selected of apertures so positioned that the value of said decimal numeral is represented according to said code by capacitive coupling through said apertures to activate appropriate code channels.

9. Keyboard device for switching a changing potential, comprising, in combination;

a plurality of switches each having transmitting means defining a surface having one or more discrete, spaced-apart, electrically conductive surface portions all connected electrically to one another and connectable to the source of said potential, and receiver means defining another surface spaced a fixed distance from the surface of said transmitting means, said another surface having thereon one or more discrete, electrically conductive elements insulated from one another;

each of said switches having an electrically conductive shield means disposed between and spaced from the respective surfaces of said transmitting and receiver means of said each switch, each of said shield means having one or more apertures therethrough, the combination of quantity and position of said apertures being unique for each of said shield means;

for each of said switches said surface portions, elements and apertures being disposed with at least one of said means being movable with respect to the others so that there is a relative and unique position of said means wherein each said aperture is positioned to permit capactive coupling to be effected between a corresponding registered pair of a surface portion and element, all other positions of all of said means being such that said shield provides electrostatic shielding preventing capacitive coupling from occurring between any of said surface portions and said elements.

10. Keyboard device as defined in claim **9** wherein each element of each receiver means is electrically connected to each corresponding element of all of the other receiver

means so as to constitute a plurality of output channels.

11. Keyboard device as defined in claim **10** wherein at least some of said channels are respectively connected to a corresponding input terminal of means for providing a DC level signal at an output terminal when a signal is present on the corresponding channel.

12. Keyboard device as defined in claim **11** including means connected to another of said channels for preventing any such DC level signal from appearing at said output terminals when more than one of said switches are substantially simultaneously operated.

13. Keyboard device as defined in claim **12** including means connected to yet another of said channels for preventing any such DC level from appearing at said output terminals unless a signal appears coincidentally on said yet another channel.

References Cited

UNITED STATES PATENTS

2,782,406	2/1957	Krakora	200—52
2,885,509	5/1959	Diesel	200—181
2,931,954	4/1960	Diesel	200—181 XR
2,942,077	6/1960	Diesel	200—181

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