United States Patent [19]

Boulanger

[11] **3,839,785**

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[54] **PUSHBUTTON KEYBOARD SYSTEM**

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[73] Assignee: **Texas Instruments Incorporated**, Dallas, Tex.

[22] Filed: **Nov. 9, 1973**

[21] Appl. No.: **414,544**

Related U.S. Application Data

[60] Division of Ser. No. 334,345, Feb. 21, 1973, Pat. No. 3,808,384, and a continuation-in-part of Ser. No. 148,503, June 1, 1971, Pat. No. 3,725,907.

[52] **U.S. Cl.** **29/622**, 29/432.1, 29/625, 29/628, 29/629

[51] **Int. Cl.** **H01h 11/00**

[58] **Field of Search** ..... 29/622, 624, 625, 626, 29/627, 628, 629, 432, 432.1, 432.2; 200/5 R, 5 A, 11 R, 11 G, 11 K, 159 B; 178/17 C

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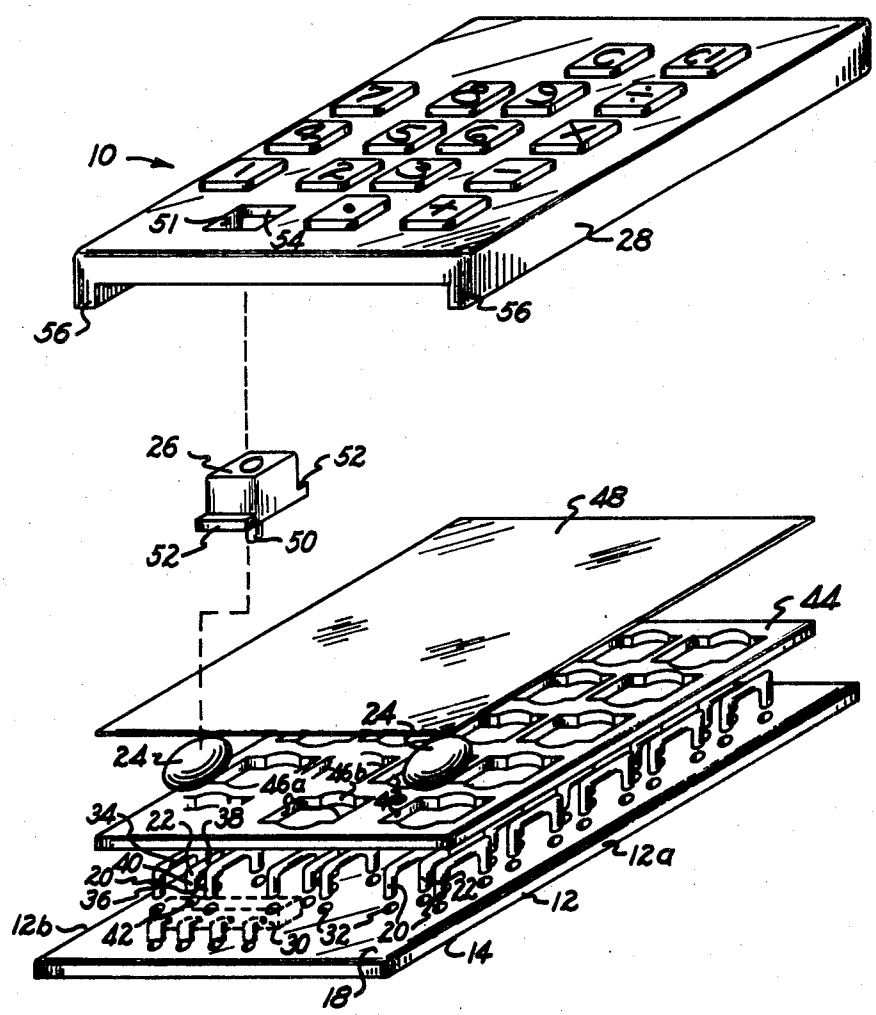
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Attorney, Agent, or Firm—John A. Haug; James P. McAndrews; Edward J. Connors, Jr.

[57] **ABSTRACT**

A keyboard system in which a plurality of spaced sets of conductive members including U and rivet shaped are arranged at a surface of a support in electrical communication with conductive paths on an opposite surface of the support. A plurality of actuatable conductive elements, one for each set of conductive members, are provided to establish bridging electrical connection between conductive members of a set upon application of a preselected deflecting force to the conductive elements. Two pole embodiments are disclosed also employing rivet shaped and modified U shaped conductive members.

3 Claims, 13 Drawing Figures



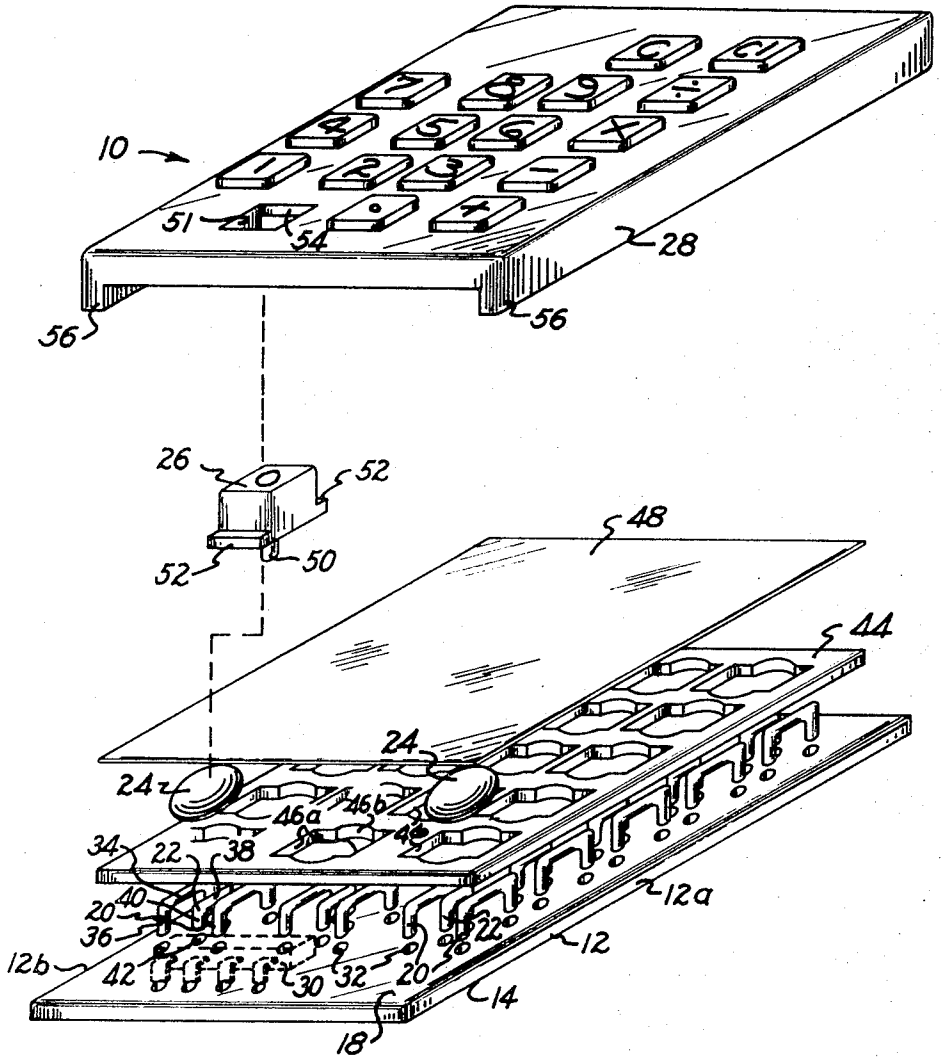

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Fig. 1.

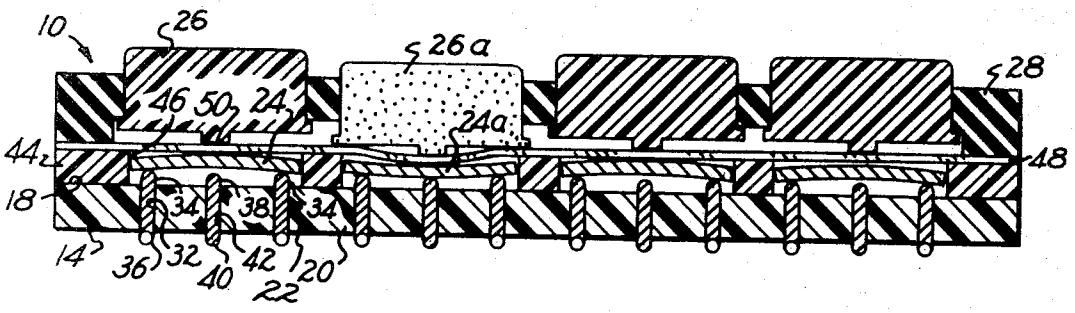

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26a
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24a
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Fig. 2.

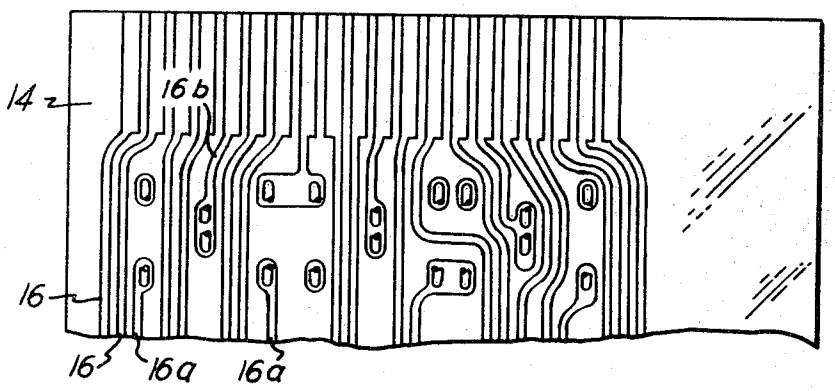

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16b
16
16
16a
16a

Fig. 3.

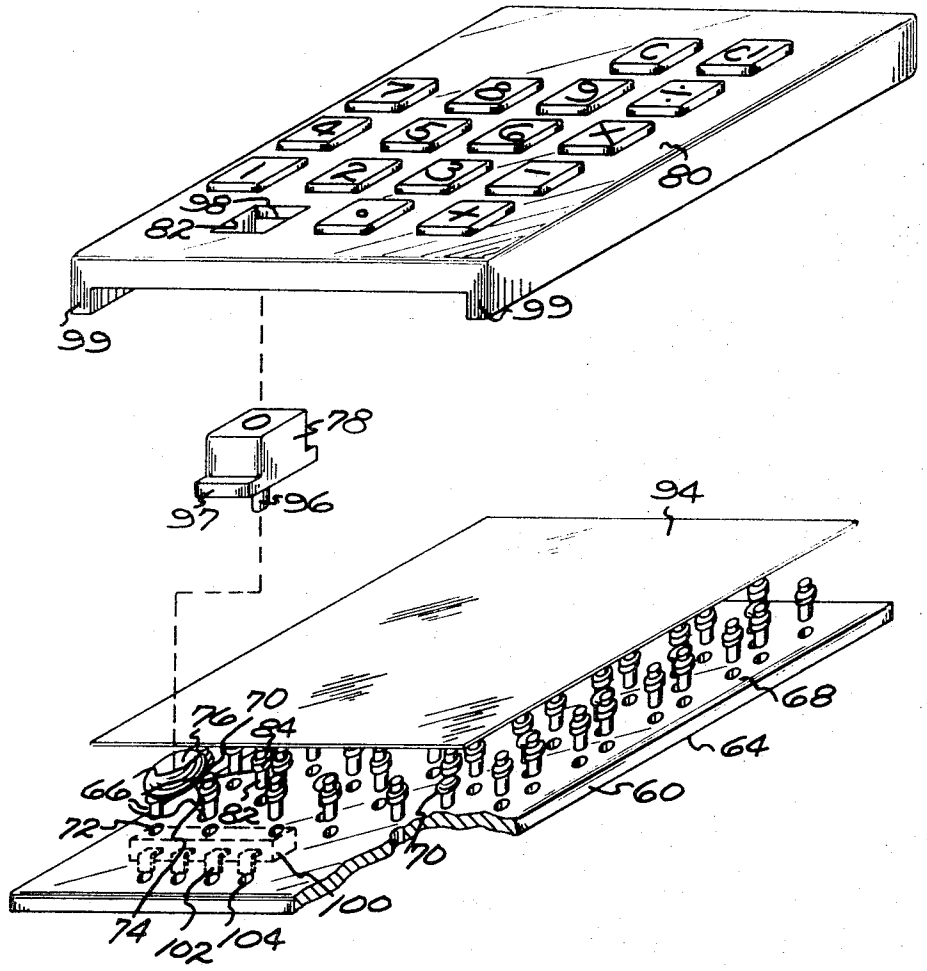

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Fig. 4.

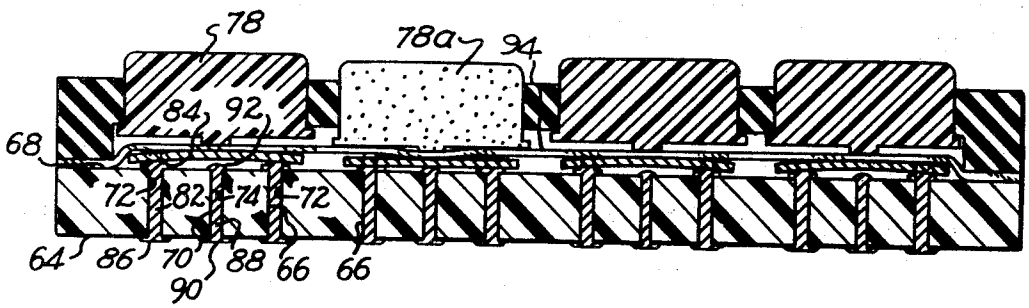


Fig. 5.

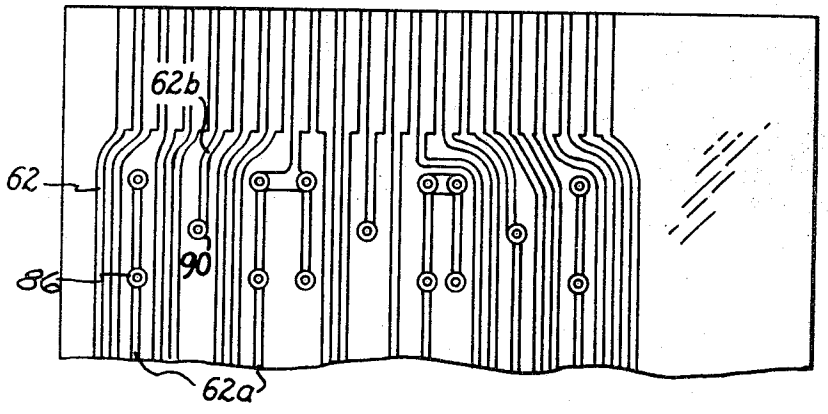


Fig. 6.

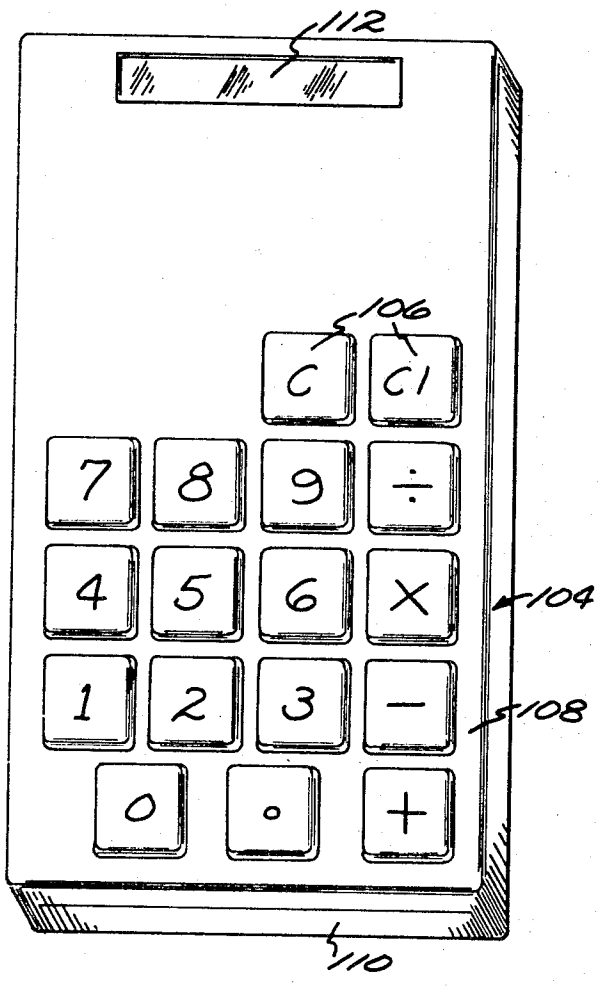


Fig. 7.

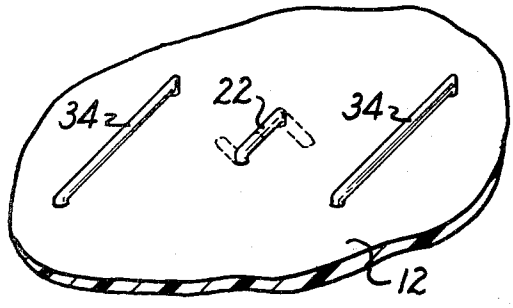


Fig. 8a.

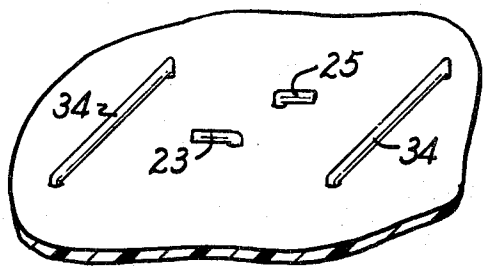


Fig. 8b.

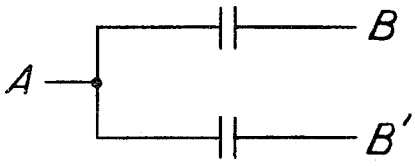


Fig. 9.

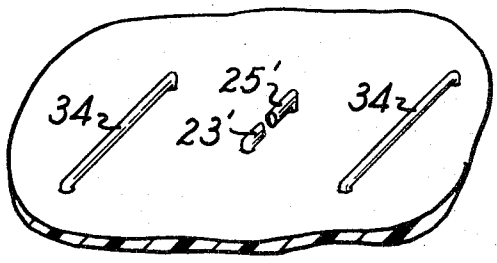


Fig. 10.

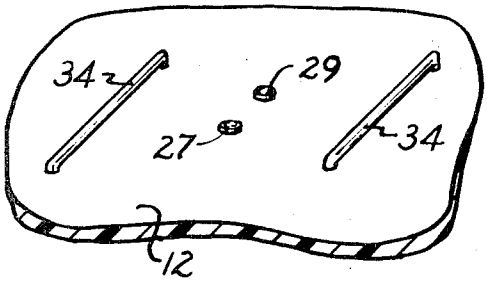


Fig. 11.

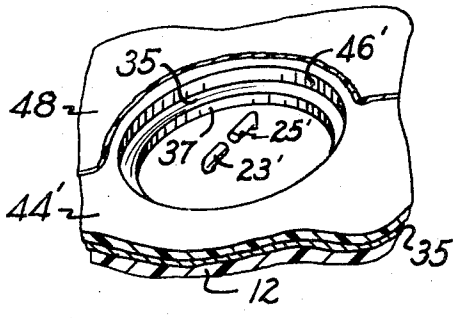


Fig. 12.

PUSHBUTTON KEYBOARD SYSTEM

This application is a division of Ser. No. 334,345, filed Feb. 21, 1973, now U.S. Pat. No. 3,808,384; and a continuation-in-part of Ser. No. 148,503, filed June 1, 1971, now U.S. Pat. No. 3,725,907.

The present invention relates generally to keyboard systems and more particularly is directed to an improved two pole pushbutton keyboard system for establishing electrical connections in response to actuation.

In recent years numerous types of keyboard systems have been developed for use in transmitting coded electrical information for incorporation in various types of business machines such as electronic calculators. Typically such keyboard systems utilize pushbutton members appropriately symbolized in a manner indicative of a numeric or mathematical function generated in response to depression of the pushbutton member to establish electrical connections between various conductive paths and/or various circuit elements coupled to the system in order to achieve a desired function. However, particularly as the cost of associated equipment has decreased dramatically in recent years coupled with an increase in the use and availability of various devices incorporating such systems the need has arisen for extremely inexpensive readily manufacturable keyboard systems which may be economically and accurately produced on a mass production basis with a high degree of accurate repeatability. For example, the need for miniaturized electronic calculators, units for addressing computer systems, credit cards verifiers, etc. which necessarily require various types of keyboard arrangements has enormously increased in recent years requiring the provision of inexpensive and extremely durable keyboard systems which may be manufactured in a simple and economical manner on a relatively large volume basis. Particularly, in the computer field the need for durable, inexpensive keyboard sytems which can accurately address electrical information either directly to a system or through a remote terminal or the like, while occupying a minimal amount of space, has become increasingly urgent.

Accordingly, it is an object of the present invention to provide an improved keyboard system adapted for selectively establishing electrical interconnections in response to mechanical actuation.

It is another object of the present invention to provide an improved pushbutton keyboard system in which actuation of individual pushbutton members establishes positive electrical interconnections for transmitting electrical information.

It is a further object of the present invention to provide an improved miniaturized pushbutton keyboard system which is relatively rugged and durable and which is extremely economical to fabricate on a mass production basis, and which is adapted for incorporation in various devices, such as electronic calculators, computer systems, etc.

Various additional objects and advantages of the present invention will become readily apparent from the following detailed description and accompanying drawings wherein:

FIG. 1 is an exploded perspective view illustrating a preferred embodiment of a keyboard system in accordance with the present invention;

FIG. 2 is a vertical sectional view through the keyboard system illustrated in FIG. 1;

FIG. 3 is a partial plan view of the underside of the system illustrated in FIG. 2;

FIG. 4 is an exploded perspective view of an alternative embodiment of a keyboard system similar to that illustrated in FIG. 1;

FIG. 5 is a vertical sectional view through the keyboard system illustrated in FIG. 4;

FIG. 6 is a plan view of the underside of the system illustrated in FIG. 5;

FIG. 7 is a perspective view illustrating a typical variety of electronic calculator incorporating a keyboard system such as that illustrated in the preceding embodiments.

FIG. 8*a* is a broken away perspective view showing how a centrally placed U-shaped conductive member can be modified to effect a two pole arrangement useful in a keyboard system according to the present invention;

FIG. 8*b* is a view similar to FIG. 8a but showing a completed two pole arrangement;

FIG. 9 is a schematic circuit diagram of a two pole switch arrangement as shown in FIG. 8;

FIG. 10 is a broken away perspective view of another two pole switch similar to FIG. 8b;

FIG. 11 is a broken away perspective view of yet another two pole switch; and

FIG. 12 is a broken away perspective view of another two pole switch.

Referring generally to the drawings, wherein corresponding elements in the various views are indicated by common reference numerals, and in particular initially to FIGS. 1–3, a keyboard system **10** in accordance with the present invention is illustrated. The system generally includes a non-conductive or insulating support member **12** having a generally planar first surface **14** on which a plurality of conductive paths **16** are disposed and arranged in a preselected pattern for transmitting electrical information in response to selective interconnection of portions thereof. At a second opposite surface **18** of the insulating support member **12** a plurality of sets **20** of conductive support members are provided which are arranged in a preselected configuration in electrical communication with first preselected portions **16**a of the conductive paths **16.** Associated with each of the conductive support members are conductive contact members **22** similarly arranged at the second surface **18** of the insulating supporting layer in electrically isolated relationship with the conductive support members and in electrical communication with second preselected portions **16**b of the conductive paths **16.** A plurality of selectively actuatable conductive elements **24** are also arranged adjacent the second surface **18** of the insulating support layer and are respectively supported by and maintained in continuous electrical contact with each of the sets **20** of conductive support members and in selective disengagement with the associated conductive contact members **22.** The conductive elements **24** are adapted to be deflected into a position of engagement with the conductive contact members **22** in response to the application of a preselected deflecting force thereto so as to establish a bridging electrical contact between one of the sets **20** of conductive support members and its associated conductive contact member **22,** thereby electrically connecting the first and second preselected portions **16***a*,

16*b* of the conductive paths **16.** Actuation of the conductive elements **24** so as to effect the establishment of the aforementioned bridging electrical connection may be effected in various ways, but in the illustrated embodiment it is accomplished by the provision of a plurality of manually actuatable pushbutton members **26** which are carried in a suitable casing **28** supported adjacent the second surface **18** of the insulating support member **12** whereby the application of a preselected deflecting force to the conductive elements **24** is effected by actuation of a selected pushbutton member **26** by the application of a mechanical force thereto such as through the fingertips of an operator. As a result of manual actuation of a selected pushbutton member **26** the preselected deflecting force is applied to the conductive element to effect deflection thereof into a position of engagement with the conductive contact member **22,** thereby establishing the bridging electrical connection between the set of conductive support members **20** and the conductive contact member **22** and hence establishing an electrical connection between the first and second preselected portions **16***a*, **16***b* respectively of the conductive paths **16.** In addition, if desired, a suitable device such as an integrated circuit shown in phantom and indicated generally by the reference numeral **30** may be carried by the insulating support member **12** and suitably connected to selected portions of the conductive paths **16** so as to process the signals established by the interconnection of various portions of the conductive paths in response to the establishment of the bridging electrical connections. Similarly, if desired, a power supply (not shown) may be also carried on the support member **12** to provide a self-contained composite unit, or an external source of power may be utilized as the sole source of power or as an additional or alternative energy source.

More particularly, the insulating support member **12** is fabricated of a relatively rigid, non-conductive material which is adapted to provide support for the keyboard system, as well as associated electronic circuitry, power supplied, display means, etc. when the unit is to be incorporated in an electronic calculator system, a computer input system, etc. In this regard the member **12** may be fabricated of a suitable, relatively rigid, insulation material such as epoxy bonded glass cloth generally sold under the trade description G-10 by the Formica Company. The material may have a thickness of approximately one-sixteenth inch which has been generally found sufficient to provide adequate mechanical strength for a miniaturized device of this nature. As previously mentioned, the conductive paths **16** including the first and second preselected portions thereof **16***a*, **16***b* respectively are arranged in a desired pattern at the first surface **14** (the underside of the support member **12,** as illustrated in FIG. **2**) in order to permit the transmission of electrical information in response to selective interconnection of various portions of the conductive paths upon the establishment of the bridging electrical connections. The pattern of conductive paths may be deposited on the surface **14** of the support layer utilizing conventional printed circuit art techniques, such as masking, etching, engraving etc. In addition, a plurality of apertures **32** are provided extending through the thickness of the support member **12** between the first surface **14** and the second surface **18** thereof so as to permit the selective establishment of electrical communication between the conductive paths at the surface **14** and the conductive support members **20** and contact members **22** arranged at the opposite surface **18.** In this regard the apertures may be provided prior to or subsequent to the deposition of the conductive paths, thereby providing a pre-punched support board prepared for further fabrication operations.

In the illustrated embodiment the sets of conductive support members **20** are arranged to define a plurality of spaced sets of pairs of generally U-shaped, conductive members preferably comprising staples arranged at the surface **18** of the support layer **12.** Such an arrangement has been found to be extremely advantageous in achieving the enhanced ease of fabrication of the system since the staples may be readily inserted through the apertures **32** in the pre-punched support member **12** utilizing suitable high-speed automated stapling equipment. Similarly, electrical communication may be conveniently established between these staples and selected portions of the conductive paths **16.** As shown, the staples **20** each include a main body portion **34** of a generally looped configuration terminating in a pair of legs **36** which are received within the apertures **32** in the support layer **12.** The apertures **32** are of a size sufficient to accommodate the legs **36** in a close-fitting relationship, while the outer ends of the legs are crimped against the surface **14** and are in contact with the selected portions of the conductive paths **16,** such as the first preselected portions **16***a*. Consequently, a rigid mechanical connection is established and the electrical contact may be improved by soldering the crimped portions of the legs into position. In addition, as shown, the main body portion **34** of each of the staples comprising the plurality of sets of support members projects a first preselected distance outwardly from the surface **18** of the support member **12** so as to define conductive support areas spaced from the surface **18** for carrying the conductive element **24.** Similarly, the associated conductive contact members **22** are also illustrated as generally U-shaped conductive members, preferably comprising staples each having a main body portion **38** which terminates in a pair of legs **40** which project through apertures **42** extending through the thickness of the support member **12** similarly to the apertures **32,** but providing communication with other portions of the conductive paths **16,** such as the second preselected portions **16***b*. The legs **40** extend through the apertures **42** with the outer ends thereof being crimped against the surface **14** of the support layer **12** preferably in contact with other portions of the conductive paths **16,** such as the second preselected portions **16***b*. The apertures **42** are of a size sufficient to accommodate the legs **40** of the staple **22** while the outer ends of the legs **40** are crimped against the surface **14** in contact with the second preselected portions **16***b* of the conductive paths to rigidly secure the staple to the member **12.** In addition, the outer ends of the legs **40** crimped in position against the second preselected portions **16***b* of the conductive paths **16** may be soldered in this position to provide an improved electrical contact as shown. One of the contact staples **22** is arranged intermediate each of the pairs of support staples **20** and may be of a slightly smaller gauge such that its main body portion **38** projects outwardly from the surface **18** a second preselected distance different than the first preselected distance which the body por-

tion 34 of the support staples 20 projects from the surface so as to facilitate maintenance of selective disengagement between the conductive elements 24 and the contact staples 22, as will be subsequently explained. The conductive support staples 20 and the conductive contact staples may be fabricated of various materials and material combinations depending upon the properties desired. For example, in one preferred embodiment the staples are fabricated of gold-plated nickel wire in order to provide a relatively non-reactive material having good surface contact properties. As other examples, the staples may be fabricated of gold-glated stainless with a flash of nickel intermediate the stainless steel core and the gold plating, or of beryllium copper.

The conductive elements 24 preferably comprise a plurality of generally circular, disc shaped elements formed of a segment of a hollow body having a double curved outer surface such as a segment of an oblique spheroid and are each illustrated as including a generally convex surface of curvature when in an unactuated or rest state which is in facing relationship with the pushbutton members 26. The element 24 is selected such that it has an overcenter position when its central portion is subjected to a preselected deflecting force while automatically returning to its original position upon removal of the force, whereby the element is provided with a memory function. Of course, segments of other hollow bodies having double curved surfaces may be utilized in providing the conductive elements. The element 24 may be arranged such that it undergoes a snap-action deflection into its overcenter position in order to establish the aforementioned bridging electrical contact. In this regard referring particularly to FIG. 2, one of the elements indicated by the numeral 24*a* is shown in its overcenter position in response to actuation by a depressed pushbutton member indicated by reference numeral 26*a*. However, it should be noted that in certain instances the central portion of conductive element 24 may be sufficiently closely spaced to the contact staple 22 that the element 24 need not be completely deflected into its overcenter position in order to contact the staple 22 for establishing the requisite bridging contact. Thus, upon application of the preselected deflecting force to the central portion of the conductive element 24 in response to actuation or depression of the pushbutton member 26 the element 24 is caused to undergo a snap-action deflection into its overcenter position. In addition, as a result of this snap-action deflection a tactile feed-back is provided which may be sensed in the finger tips of the operator actuating a particular pushbutton. Furthermore, an audible acknowledgment of deflection may accompany the snap-action deflection which may be further sensed by the operator as an additional indication of actuation of a pushbutton member to transmit a desired electrical signal. The conductive elements 24 preferably comprise gold-plated stainless steel discs and in one preferred embodiment may be fabricated of AISI (American Iron and Steel Institute) Type 302 Stainless Steel, which comprises by weight approximately 0.15 percent carbon, 2.00 percent (max.) manganese, 1.00(max.) silicon, 17 percent to 19 percent chromium, 8 to 10 percent nickel and the balance iron, with a thin gold plating over its exposed contact surfaces.

Each of the conductive elements 24 is maintained in axial registry with the conductive contact staple 22 associated with each of the sets of support staples 20 with the central portion thereof spaced from the contact staple 22. The marginal edges of the conductive elements 24 are supported on the main body portions 34 of the support staples 20 of each set such that the conductive element 24 is in continuous electrical contact therewith and hence with the first preselected portions 16*a* of the conductive paths 16. Similarly, the central portion of the conductive elements 24 which are in registry with the main body portions 38 of the contact staples 22 remain in selective disengagement with the contact staples until deflected by actuation of a pushbutton member 26, whereupon the bridging electrical connection is established between a set of conductive support staples 20 and its associated conductive contact staple 22 and hence between the first and second preselected portions 16*a*, 16*b* of the conductive path 16.

In order to further support each of the conductive elements 24 and provide lateral restraint therefor a carrier sheet of insulating material 44 is disposed adjacent the surface 18 of the support member 12 overlying the plurality of sets of conductive support staples 20 and associated conductive contact staples 22. The sheet 44 includes a plurality of apertures 46 which are of a size sufficient to accommodate the conductive elements 24 therein and arranged in registry with the plurality of sets of conductive support staples 20 and the associated conductive contact staples 22. More particularly, the conductive elements 24 are disposed within the apertures 46, which are of a size slightly larger than the spacing intermediate the staples comprising each of the sets of conductive support staples. Accordingly the sheet 44 may be maintained essentially in abuttment with the surface 18 of the support member 12 with the main body portions 34 of the conductive support staples 20 which support the elements 24 extending slightly into the apertures 46. The conductive elements 24 are arranged within the apertures 46 and have opposed marginal portions resting on the main body portions 34 of the conductive support staples 20. Thus, support, as well as lateral restraint for the conductive elements 24 is provided. In addition, as may be noted, particularly in FIG. 1, each of the apertures 46 is of a preselected shape including a pair of opposed parallel walls 46*a* which are of a generally straight-line configuration, these generally straight-line wall portions being arranged to bound the main body portions 34 of the conductive support staples 20 which extend into the apertures 46. The other pair of opposed wall portions 46*b* of each of the apertures 46 are arranged in a generally curvilinear configuration curving outwardly from the center of the apertures 46 so as to more efficiently accommodate the generally circular conductive elements or discs 24. In this regard by virtue of providing the apertures 46 having a shape as illustrated certain advantages are achieved in that the overall space occupied by the apertures is minimized, since only one of the two dimensions of the apertures are increased while the other dimension is minimized, thereby maximizing the amount of material which remains to define the layer 44 in order to enhance its structural strength and rigidity. This is advantageous in view of the small size of the layer 44 and the large number of apertures which are employed. The sheet 44 may be fabricated of a suitable non-conductive material such as a suitable glass cloth reinforced epoxy. In addition, the marginal portions of the sheet 44 which extend beyond the sets of

support staples **20** at opposed sides of the support board **12** preferably are bonded or sealed to the marginal portions of support member **12** so as to facilitate the formation of an environmentally sealed unit.

In certain instances, it has been found desirable to further restrain the conductive elements **24** in their respective positions by providing a relatively thin, flexible sheet or film of an insulating force transmitting overlayer sheet or film **48,** as shown, which is arranged intermediate the sheet **44** and the casing **28** which supports the pushbutton members **26.** The over-layer **48** may comprise a material, such as polyethylene, terephthalate, commonly sold under the trade name Mylar, and may be suitable bonded or sealed to the exposed surface of the layer **44** and hence functions to prevent the conductive elements **24** from inadvertently being removed or falling from their desired positions within the apertures **46,** as well as completing an environmental seal for the unit.

The pushbutton members **26** are each appropriately symbolized at their outer exposed surfaces in a manner indicative of the electronic function associated with actuation of a selected pushbutton member which establishes the requisite bridging electrical connection between the conductive support staples **20** and the conductive contact staple **22** and hence between the first and second preselected portions **16**a, **16**b of the conductive paths **16.** In addition, each of the pushbutton members includes an opposed protruding surface portion **50** which depends from the main body thereof and is maintained in abuttment with the generally central region of the conductive element **24** and is adapted to apply the requisite deflecting force thereto in response to actuation of the pushbutton member. Each of the pushbutton members **26** is preferably fabricated of a relatively rigid non-conductive plastic material, and is supportingly carried within the support casing **28** which includes a plurality of slots **51** for accommodating the body of the members **26.** The casing **28** may be similarly fabricated of a suitable rigid, non-conductive plastic material, or the like. In this regard each of the pushbutton members **26** include a flanged portion **52** which integrally extends from one pair of opposed lower edge surfaces thereof. These flange portions **52** are adapted to be received within accommodating channels or slots **54** in the casing **28** when the members **26** are positioned in the casing **28** to preclude lateral motion of the pushbutton elements **26** within the casing, while permitting movement of the pushbutton members normal to the planar surface of the casing **28** upon actuation thereof. In addition, the casing **28** includes a pair of depending flange members **56** the spacing therebetween being of a size sufficient to accommodate the marginal edge portions **12***a*, **12***b* of the support member **12** if it is desired to provide an environmental seal between these marginal edge portions **12***a*, **12***b* and the inner surfaces of the flange members **56,** when the casing **28** is positioned in abuttment with the overlayer sheet **48** with the pushbutton members aligned with the respective conductive elements **24.** Thus, in operation the pushbutton members are precluded from lateral movement within the casing but are permitted to be moved from a retracted to an actuating position in response to application of a mechanical force to the exposed surfaces thereof so as to effect deflection of an associated conductive element **24.** Accordingly, upon actuation of a selected pushbutton member the conductive element **24** is caused to execute a snap-action deflection into its over-center position in which it is in engagement with one of the associated contact staples **22,** as well as with the set of supporting staples **20,** establishing a bridging electrical contact between the contact staple **22** and the set of support staples **20** associated therewith.

Referring now to FIGS. **4–6** an alternate embodiment of a keyboard system similar to that illustrated in FIGS. **1–3** is shown in which a modified arrangement for carrying the conductive elements is provided. More particularly, in this embodiment a support member of insulating material similar to the support member **12** is provided having a preselected pattern of conductive paths **62** arranged at a first surface **64** thereof while a plurality of sets of conductive support members **66** are arranged at a second opposed surface **68** of the board with an associated conductive contact member **70** being provided associated with each of the sets of conductive support members spaced from and electrically isolated from the set of support members. The conductive support members **66** are adapted to be disposed in cooperating apertures **72** which are provided extending through the thickness of the support board **60** between the first and second surfaces **64, 68** so as to permit electrical communication to be established between each set of conductive support members **66** and first preselected portions **62***a* of the conductive paths **62,** when these conductive support members are inserted within the apertures **72** while a plurality of additional apertures **74** similarly extend through the thickness of the support member **60** for accommodating the associated conductive contact members **70,** the apertures **74** permitting electrical communication to be established between the conductive contact members **70** and second preselected portions **62***b* of the conductive paths **62,** when the conductive contact members **70** are inserted within the respective apertures. Each of the sets of conductive support members **66** is adapted to define a generally planar support area for supportingly receiving a conductive element **76** similar to the conductive element **24.** The conductive element **76** is supported in continuous electrical contact with the set of support member **66** and hence in contact with the first preselected portions **62***a* of the conductive paths **62.** In addition, the conductive element **76** remains in selective disengagement with the associated conductive contact member **70** and accordingly, each set of support members remains electrically isolated from its associated contact member **70** until deflection of the conductive element **76** is effected. Such deflection is accomplished in a manner similar to that described in connection with the preceding embodiment in response to the application of a preselected deflecting force to the conductive element **76** to establish engagement between the conductive element **76** and the conductive contact member **70,** thereby establishing a bridging electrical contact between the set of conductive support members **66** and the conductive contact member **70** and hence between the first and preselected portions **62***a*, **62***b* of the conductive paths **62.** The application of the preselected deflecting force to the conductive element **76** is again accomplished by the provision of a plurality of pushbutton members **78** maintained in registry with the respective conductive elements **76** such that actuation or depression of a pushbutton member **78** is effective to cause deflection of a conductive element in order to cause it to engage its associated conductive

contact member thereby establishing the requisite bridging electrical contact. The pushbutton members **78** are similarly carried within a suitable support casing **80** which includes a plurality of slots **82** for receiving the body of the pushbutton members **78** therein, the pushbutton members being movable from a retracted to an actuating position in response to the application of a mechanical force to the exposed surfaces thereof, such as by manual actuation.

As previously mentioned, in accordance with an important advantage of the present invention a keyboard system is provided which is particularly suitable for fabrication by rapid, accurate, and inexpensive mass production techniques. The embodiment illustrated in FIGS. **4–6** similarly provides such advantages in that the support board **60** may be similarly provided in a prepunched configuration including the apertures **72, 74** for accommodating the conductive support members and the conductive contact members, while a desired pattern of conductive paths may be deposited on the surface **64** thereof utilizing conventional printed circuit art techniques to permit the selected electrical connections to be made between respective portions of the conductive paths. However, rather than employing staples, as in the preceding embodiment each of the sets of conductive support members **66** preferably comprises a plurality of collared rivets each of which includes a shank **82** and a flanged collar **84** with the shank adapted to be inserted in the aperture **72** while the collar **84** rests against the surface **68** of the support board, a portion of the shank projecting outwardly therefrom and the opposite end **86** of the shank is crimped against the surface **64** of the support member **60** in electrical contact with the first preselected portions **62***a* of the conductive path **62,** thereby mechanically restraining the rivet in position with respect to the support member and the conductive path **62.** In addition, the crimped end **86** may be soldered in position to assure a good electrical contact with the first preselected conductive path **62***a*. In the illustrated embodiment each set **66** includes four of the previously described rivets arranged to define a generally enclosed area with the flanged collar portions **84** of each of the rivets defining a generally planar support area for the conductive element **76.** It should be noted that a lesser or greater number of rivets, of course, may be utilized. In addition, the associated conductive contact member **70** is arranged generally centrally within the area defined by the four rivets **66** and preferably comprises a headed rivet including a shank portion **88** which is disposed within the aperture **74** with one end **90** being crimped against the surface **64** of the support board **60** as shown while its opposite end terminates in a head **92** of a larger diameter than the aperture **74** such that the rivet **70** is mechanically restrained with respect to the support member **60,** subsequent to the crimping of its end **90** against the surface **64.** The crimped end **90** is in electrical contact with the second preselected conductive path **62***b* and similarly may be soldered in position to assure a good electrical contact therewith. In addition, as shown the head **92** of the rivet **70** may be displaced outwardly from the surface **68** of the support member **60** a lesser distance than the collar **84** of the support rivets **66** such that the central portion of the conductive element **76** may be maintained in selective disengagement therewith, as will now be explained in detail.

More particularly, the conductive elements **76** are generally similar to the elements **24,** as described in connection with the embodiment illustrated in FIGS. **1–3.** The element **76** is arranged such that it similarly undergoes deflection movement into its overcenter position in order to establish the aforementioned bridging electrical contact between the set of support rivets **66** and the contact rivet **70** and hence between the first and second preselected portions **62***a*, **62***b* of the conductive paths. In this regard the marginal portions of the element **76** are supported by and rest upon the flanged collar portion **84** of the support rivets **66** such that the element **76** is maintained in constant electrical contact with the set of support rivets **66** while its central portion remains in selective disengagement with the head **92** of the contact rivet **70.** Upon application of a preselected deflecting force to the central portion of the conductive element **76** in response to actuation or depression of the selected pushbutton member **78** the element **76** is caused to undergo a snap-action deflection into its overcenter position and engages the head **92** of the contact rivet **70** thereby establishing an abrupt, instantaneous and positive bridging electrical contact between the support rivets **66** and the contact rivet **70** and hence between the first and second preselected portions **62***a*, **62***b* of the conductive paths **62.** In addition, similarly to the preceding embodiment, as a result of this snap-action deflection a tactile feed-back is provided which may be sensed in the finger tips of the operator actuating a particular push-button, and an audible acknowledgement of deflection may accompany the snap-action deflection and may be further sensed by the operator as an additional indication of actuation of a pushbutton member to transmit a desired electrical signal.

In order to further aid in maintaining the elements **76** in position as well as to facilitate the formation of an environmental seal, it has been found advantageous in certain instances to provide an overlayer **94** of a flexible force transmitting material arranged intermediate the pushbutton members **78** and the conductive element **76.** In this regard lateral movement of the conductive elements **76** is precluded by virtue of the disposition of the elements **76** within the area defined by each of the sets of support rivets **66** resting on the flanged collar portions **84,** with the marginal edges of the conductive elements **76** being laterally restrained by the portions of the shanks **82** which project outwardly beyond the collars **84.** However, in order to prevent the elements **76** from being inadvertently removed from or falling from the unit the over-layer **94** may be provided, as shown, and may be suitably bonded to the marginal edge portions of the support board **60** to form an environmental seal. The overlayer **94** may be fabricated of a strong, flexible, thin insulation material, such as polyetheylene terephthalate, commonly sold under the trade name Mylar.

As previously mentioned, the pushbutton elements **78** are suitably carried within the slots **82** in the casing **80** and as shown have outer exposed surfaces which are appropriately symbolized in accordance with the electrical information which is to be transmitted in response to actuation thereof. In addition, a generally centrally located protruding member **96** extends from the opposed surfaces of each of the pushbutton members and is arranged in axial registry with the central portions of each of the conductive elements **76** so as to

apply the preselective deflecting force thereto in response to actuation or depression of the pushbutton members **78.** A pushbutton member **78***a* is illustrated in FIG. **5** in its depressed or actuated condition to show the establishment of the bridging electrical contact between the set of conductive support rivets **66** and the conductive contact rivet **70,** whereby the requisite bridging electrical contact is established between selected portions of the conductive paths **62.** Each of the pushbutton members **78,** similar to the preceding embodiment, also may include a pair of opposed flanges **97** which are adapted to be received in cooperating channels **98** in the wall of the slots **82** in the casing to provide improved lateral support for the pushbutton member **76.** The casing **80** also preferably includes a pair of depending flange portions **99** extending along its longitudinal edges spaced apart a distance slightly greater than the lateral dimension of the support member **60** so that the inner portions of the flanges **99** may be sealed to the marginal edges of the support member **60** if it is desired to provide an environmentally sealed unit. The casing **80** as well as the pushbutton members **78** may be fabricated of a suitable insulating plastic material.

In operation it may be seen that similarly to the embodiment illustrated in FIGS. **1–3** the actuation or depression of a selected pushbutton member **78** effects deflection of its associated conductive element **76** so as to effect the establishment of the bridging electrical contact between the support rivets **66** and the contact rivet **70** and hence between the first and second preselected portion **62***a*, **62***b* of the conductive paths **62** so as to permit the transmission of an appropriate electrical signal. In addition, as illustrated in FIGS. **4** and **6,** if desired, suitable semiconductor devices or the like illustrated in phantom as a dual-in-line package integrated circuit **100** may be provided with its lead members **102** extending through suitable apertures **104** in the support board **60** and maintained in contact with requisite portions of the conductive paths **62** to as to selective couple the various circuit elements thereof (not shown) to the paths **62** in order to process the electronic information being transmitted upon interconnection of selected portions of the conductive paths. Similarly, if desired, a suitable power supply means (not shown) may be also mounted on the support member **60.**

Referring to the FIG. **7** embodiment a composite unit indicated generally by the reference numeral **104** is illustrated, including a plurality of pushbutton members **106** supported within a casing **108** which is mounted in overlying relationship with a support board **110** which may include conductive support areas, conductive contact areas, conductive elements, conductive paths etc., all as shown and described in the preceding embodiments. In addition, the unit **104** includes a visual display window **112** so as to provide a visual indication of operation of the unit when it is being utilized as an electronic calculator, for example, as an input to a computer system, etc. Similarly, if desired, the unit **104** may include a suitable print out mechanism to provide a permanent record, if desired.

In certain applications it is desirable to provide multipole switching for some or all of the keys. FIGS. **8***a–***12** show several embodiments which provide this structure. Thus as seen in FIGS. **8**a and **8**b the FIGS. **1–3** embodiment can be modified by cutting the looped or bight portion of conductive contact member **22** to form a pair of generally L-shaped members having first and second legs and bending the severed leg **23, 25** either in the same direction or in opposite directions as indicated in dashed lines in FIG. **8**a and solid lines in FIG. **8***b*. The other legs of contact members **23, 25** are electrically connected as by crimping and soldering to two separate conductive portions of conductive paths **16.** Thus upon application of a preselected deflecting force to the central portion of a conductive element **24** in response to actuation or depression of the selected pushbutton member **26** the element **24** is caused to undergo a snap-action deflection into its overcenter position and engages both contact members **23, 25** thereby establishing an abrupt, instantaneous and positive bridging electrical contact between the set of support members **34** and the two pole contact members **23,25** and hence between a first preselected portion of conductive paths **16** and the other two separate portions thereof. As seen schematically in FIG. **9,** A represents the two support members **34** while B and B′ represent contact members **23** and **25** respectively. Deflection of element **24** into bridging electrical contact between support members **34** or A and contact members **23** and **25** or B and B′ effects two pole switching action.

Alternatively as seen in FIG. **10** the two pole contact members can be formed by removing a central portion of the loop of member **22,** as by cutting, resulting in contact members **23′, 25′**. Again with reference to the schematic electrical circuit of FIG. **9,** A represents the support members **34** while B and B′ represent contact members **23′, 25′** respectively. In this embodiment it is not necessary to bend the two contact members from their original position.

Rather than employ the staple type contact members rivet like elements may be used as in FIGS. **4–6.** Thus rivets **27** and **29** of FIG. **11,** similar to headed rivet **70** seen in FIG. **4** are inserted through apertures in support member **12** and electrically connected, as by crimping their shanks and soldering to two separate conductive portions of conductive paths **16** as in the previous multipole embodiments. As in the previous embodiments the pole contact members **27** and **29** are represented by B and B′ respectively in FIG. **9.** It is of course within the purview of the invention to include three or more conductive rivets to provide three or more pole switching.

In FIG. **12** the support member corresponding to A of FIG. **9** comprises a sheet or layer **35** of electrically conductive material connectable to a voltage source in any convenient manner as by connecting to a portion of conductive paths **16.** Sheet **35** is provided with an aperture **37** for each set of conductive pole contacts to form a switching cavity. Aperture **37** is generally circular when used with a conductive element **24** or **76** which also has a circular periphery. The diameter of aperture **37** is chosen so that it slightly less than that of the conductive element **24** or **76** so that the peripheral margin of the element is supported by and in electrical connection with sheet **35.** A carrier sheet **44′** is disposed on top of the conductive sheet and is provided with an aperture **46′** in alignment with each aperture **37.** Aperture **46′** is also circular to conform to the conductive element and sized just large enough to receive the element therein. Thus sheet **44′** similarly to sheet **44** in FIG. **1** provides lateral restraint for the conductive elements maintaining them in their desired loca-

tion. As in the previous embodiments the entire switching area can be sealed by affixing a sheet **48** of electrically insulative material thereover. Although not shown, sheet **35** can be employed with the conductive pole members shown in FIG. **8***b* and **11** as well as those shown in FIG. **10.**

As in the FIGS. **1–3** and **4–6** embodiment it is preferred that the support members project outwardly from the surface of insulating support member **12** a preselected distance which is greater than the distance that the pole contact members project from the same surface.

Thus each conductive element is associated with a set of conductive pole contacts as well as conductive support means. A keyboard made in accordance with the invention can comprise only multipole switching key stations or alternatively it can comprise a mixture of single and multiple switching key stations. Stated in another way such a keyboard comprises at least one or more sets of conductive pole contacts having more than a single pole contact.

Thus, a unique keyboard system has been described in detail in which a particularly advantageous bridging electrical contact system is provided, the system being particularly adapted for incorporation in various systems such as electronic calculators, computer systems, etc.

Various changes and modifications in the above-described embodiments will be readily apparent to those skilled in the art and any of such changes or modifications are deemed to be within the spirit and scope of the present invention as set forth in the appended claims.

I claim:

1. A method for making a two pole switch comprising the steps of selecting an electrically insulating support member having conductive paths on a surface thereof, forming pairs of apertures extending from the surface to an opposite surface of the support member, taking a U-shaped electrically conductive member having legs connected by a bight portion, inserting the legs of the U-shaped member through each pair of apertures, severing the bight portion to form two separate contact members, connecting the legs of the U-shaped members to portions of said conductive paths, disposing a deflectable electrically conductive element adjacent the severed bight portion so that it can be deflected into and out of engagement with the severed bight portion and connecting the conductive element to a voltage source.

2. A method in accordance with claim **1** including the step of removing a portion of the bight portion of the U-shaped member.

3. A method in accordance with claim **1** including the step of bending the severed portions of the bight portion to separate the remaining portions.

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