United States Patent [19]

Lien

[11] **3,786,205**

[45] **Jan. 15, 1974**

[54] **KEYBOARD SWITCH ASSEMBLY WITH MOVABLE, MULTI-CONTACT MEANS AND ASSOCIATED SWINGER PORTIONS**

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[73] Assignee: **Becton, Dickinson Electronics Company,** Rutherford, Nev.

[22] Filed: **May 11, 1972**

[21] Appl. No.: **252,421**

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

[51] **Int. Cl.** **H01h 13/70**

[58] **Field of Search** ..... 200/6 BB, 6 C, 5 R, 200/5 A, 159 R, 159 A, 159 B, 166 BH, 166 C, 166 U, 76

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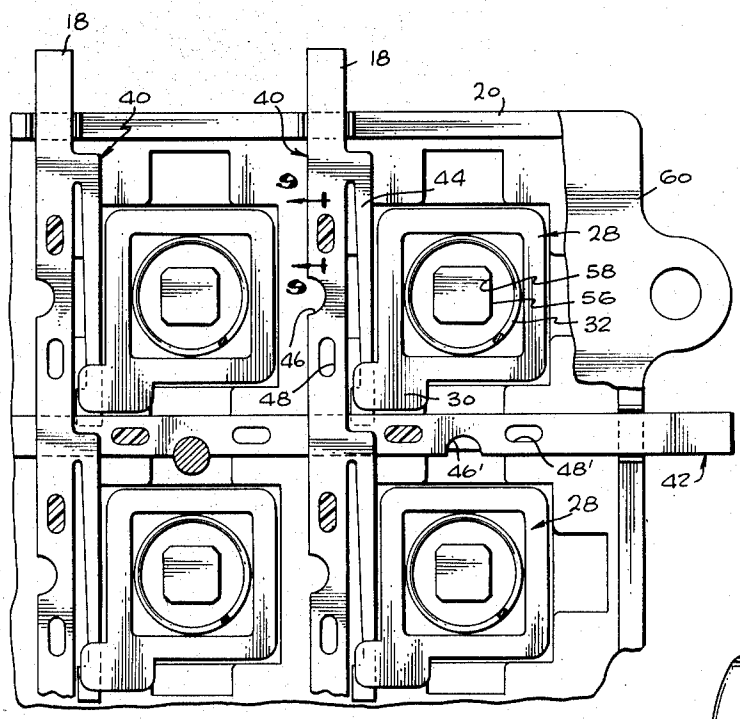
Primary Examiner—James R. Scott
Attorney—Marvin H. Kleinberg

[57] **ABSTRACT**

A keyboard is provided with an improved contact switch comprising movable elements extending from and integral with an elongated strip member. Other elongated strip members arranged orthogonally in a vertically displaced plane are positioned in the travel path of the movable elements. The movable elements are held in a third plane and, when released, engage the crossing strip members. The push buttons include flanged key tops which cooperate with raised collars on the top plate to form a substantially liquid excluding arrangement.

5 Claims, 16 Drawing Figures



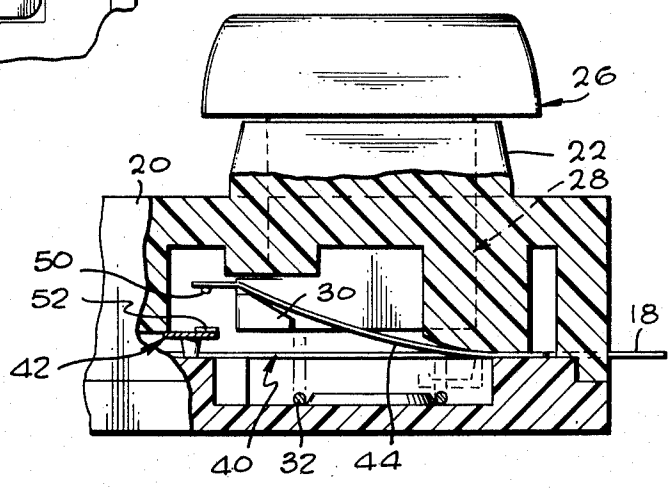


Fig. 1

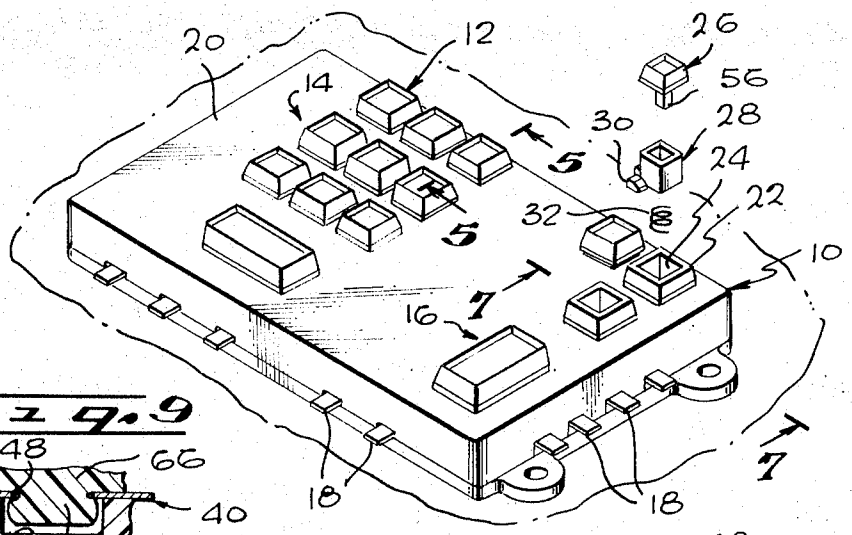


Fig. 9

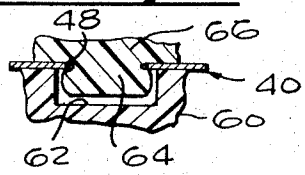


Fig. 10A

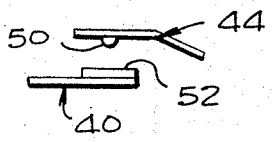


Fig. 2

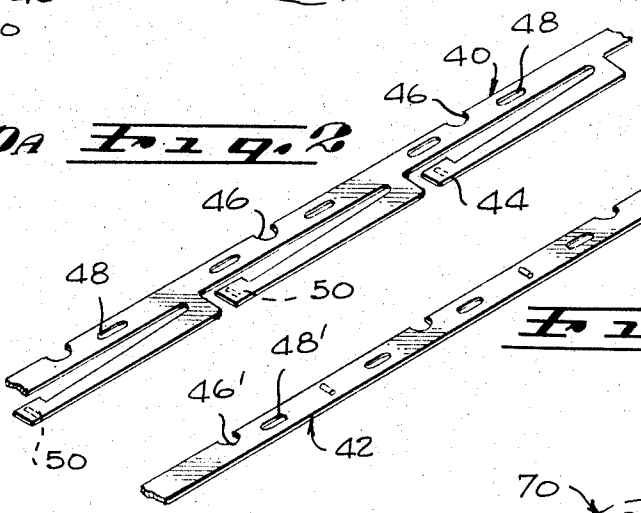


Fig. 3

Fig. 10B

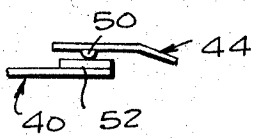
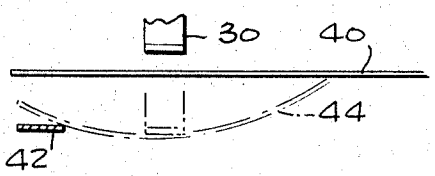


Fig. 12A



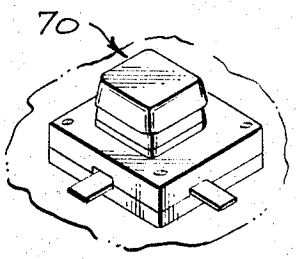


Fig. 11

Fig. 12B

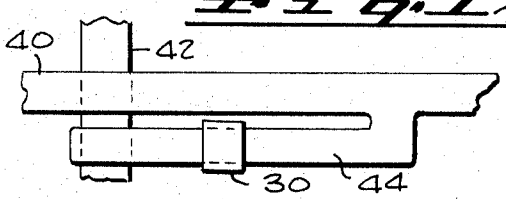


Fig. 5

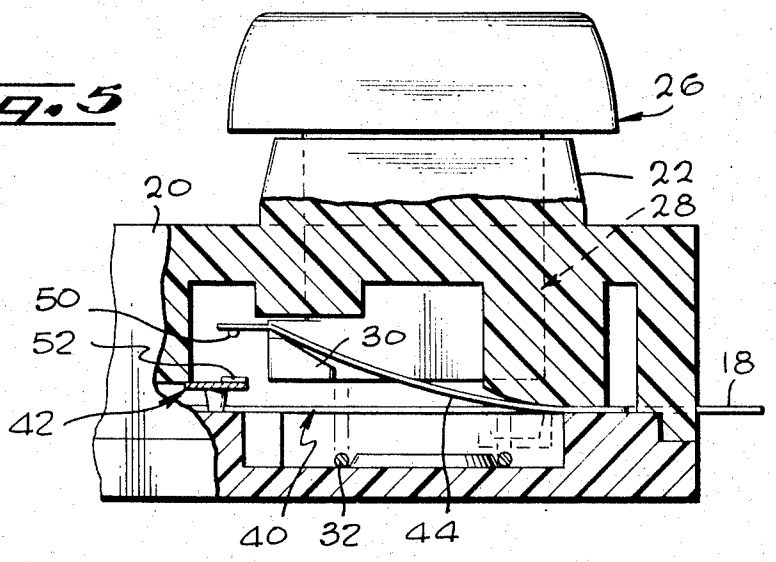


Fig. 6

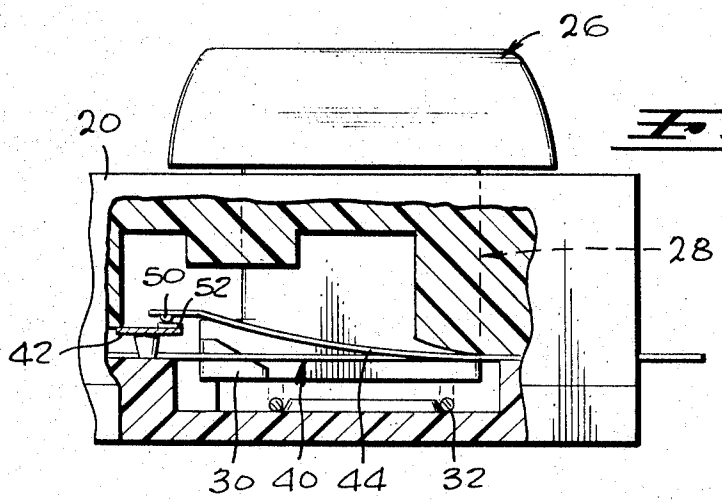


Fig. 9

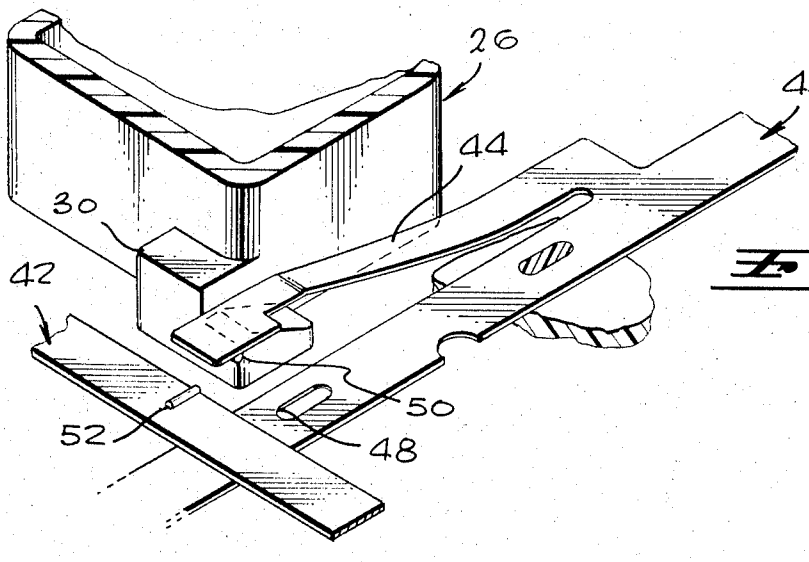


Fig. 1

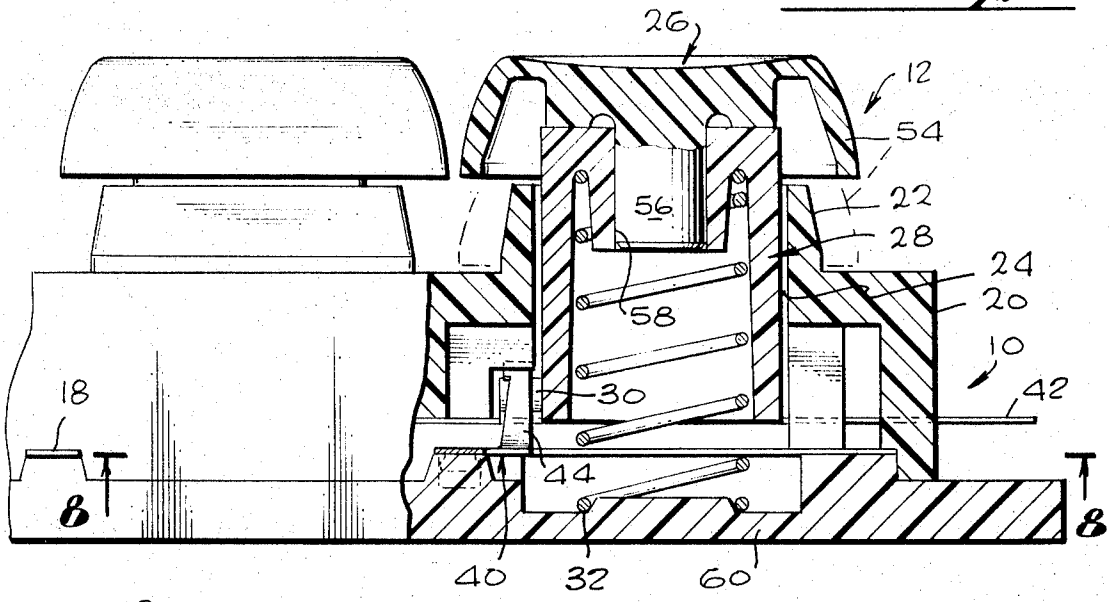

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Fig. 6

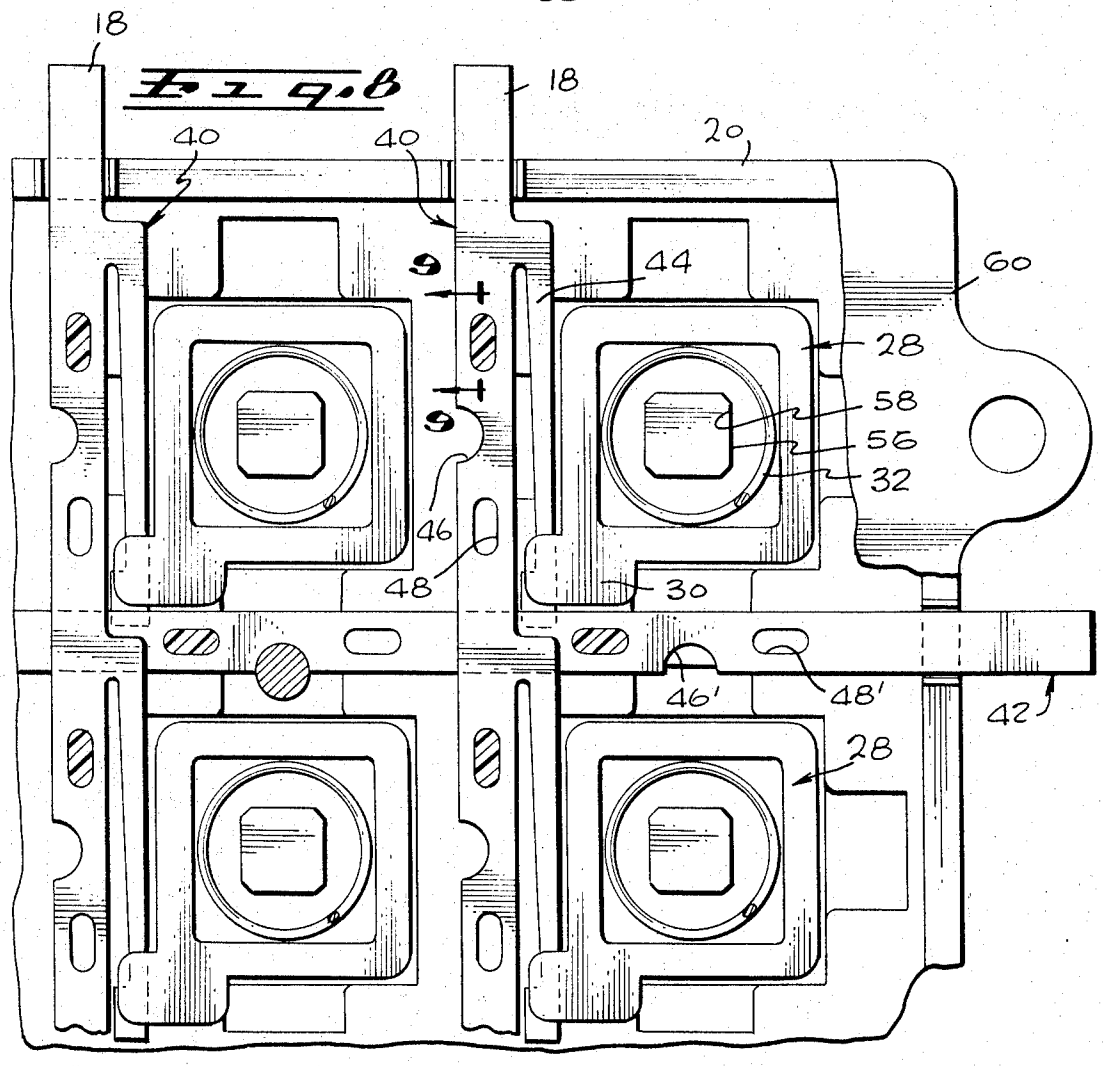
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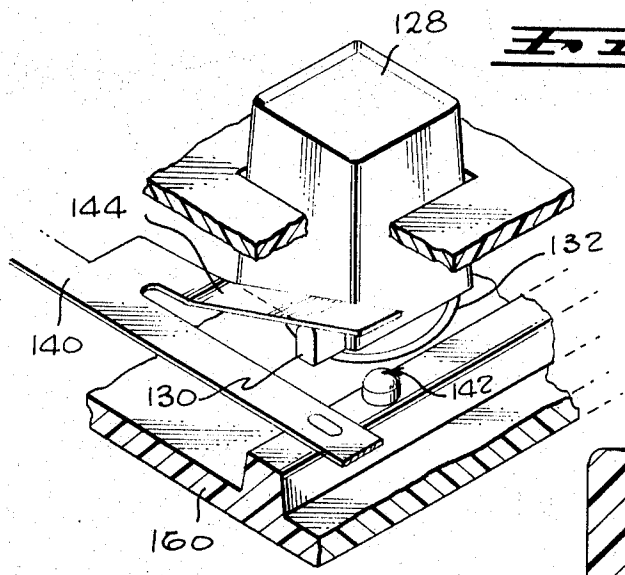
Fig. 13



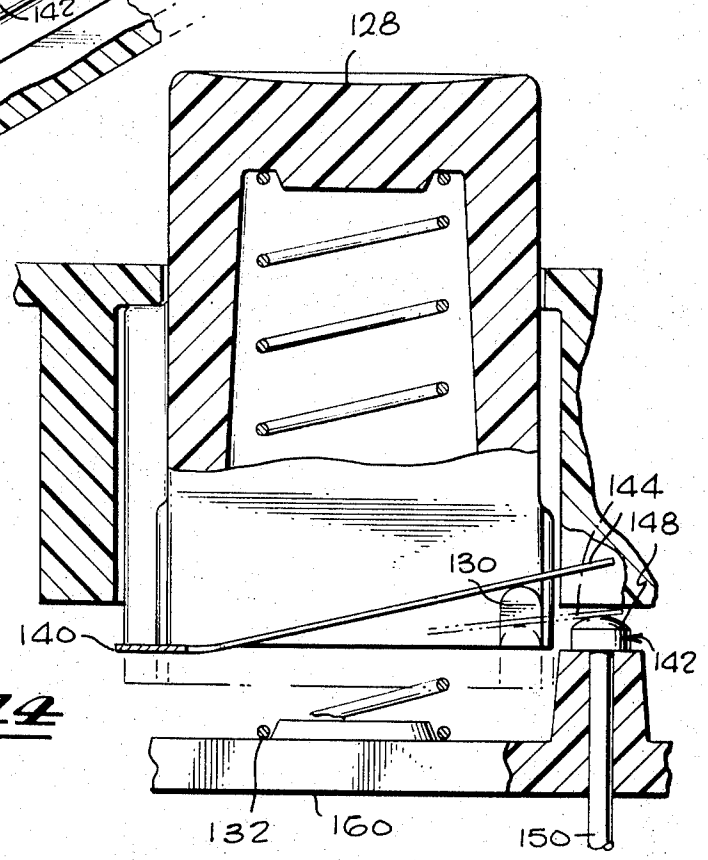


Fig. 14

KEYBOARD SWITCH ASSEMBLY WITH MOVABLE, MULTI-CONTACT MEANS AND ASSOCIATED SWINGER PORTIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to switching devices and, more particularly, to a simple, low-cost switch matrix suitable for operation by push button in a data entry device.

2. Description of the Prior Art

In recent years the need for low-cost, reliable manual data devices has grown to phenomenal proportions. As more and more applications require the use of push button, the need has grown to find an inexpensive, easily fabricated, reliable switching device with a minimum number of moving parts that can be easily mass produced.

Most recently the advent of small electronic calculators, some of which can be held in the palm of the hand and which employ one or more integrated circuit chips as the calculating device, has emphasized the need for a low-cost, reliable keyboard by which data is entered into the circuit. Some prior art approaches for providing improved switch-type keyboards are shown in the patents to Chalfin, et al. U.S. Pat. No. 3,293,640; Reimer U.S. Pat. No. 3,226,493; Bilek U.S. Pat. No. 3,205,318; and Cornell III U.S. Pat. No. 3,120,583. These several patents all disclose various different apparatus for signaling the energization of a push button.

It has been found that a matrix configuration provides an acceptable tradeoff in identifying the key being energized. For example, in an N × M matrix, a one of N.M. possible keys can be uniquely identified by one of N columns and one of M rows.

In the above-identified prior art patents, the switches have exhibited various degrees of complexities running from the undulating springs, which actuate switches at the ends of the rows and columns, to the matrices in which appropriate contactors are carried by the push button to engage printed circuit wires. All of these circuits have required a certain degree of complexity, and all include a certain inherent unreliability. What is needed and what is provided in the present invention is an inexpensive switch matrix which can be easily assembled from mass produced components by relatively unskilled labor.

SUMMARY OF THE INVENTION

According to the present invention, a conducting matrix is made up of simple conductive metal strips which are aligned in one direction in a first plane, and in a second plane vertically displaced therefrom, a plurality of second strips are arranged running orthogonally to the strips in the first plane. The second strips, moreover, are provided at intervals with elongated contact or "swinger" portions that are initially coplanar with the strip and substantially parallel thereto, being joined to the strip by a lateral continuation of the material. The result is a plurality of elongated cantilevered swingers, the attached ends of which are integral with the conductor strip.

The matrix is then constructed by displacing each of the swingers out of the plane of its strip to overlie the orthogonal strip in the vertically displaced plane so that initially a normally closed switch matrix is created. The orthogonal strips constituting the matrix can be provided with apertures enabling them to be easily secured to a plastic housing which can serve as the keyboard frame.

At each contact point, a push button is provided which includes a biasing spring to maintain the button in a normally "up" position. The push button includes a post having a hook or lever portion adapted to engage the swinger and to maintain the swinger out of contact with its crossing member when the push button is in its normal, "up" position.

It will then be seen that the upward bias on the push button overcomes the oppositely directed bias on the swinger which would otherwise urge the swinger into contact with the crossing member. When the push button is depressed, a swinger is permitted to contact the cross member under its own bias. If push button overtravel is desired, the push button can continue to a completely depressed point wherein the hook or lever portion is wholly out of contact with the swinger, thereby avoiding any problem with excess button pressure.

When the push button is released, the stronger bias of the push button spring overcomes the bias on the swinger. The hook engages the swinger and carries it out of contact with the cross member.

In a first alternative embodiment, the plane of the rows and columns could be interchanged. The swinger may be permitted to remain in the plane of the strip element from which they extend. In this embodiment, the push button would include a contacting button adapted to engage the swinger, and upon depression of the push button, the swinger would be depressed and brought into contact with the crossing strip.

In a second alternative embodiment, the fixed contacting strips with which the individual swingers make contact are replaced by a plurality of individual contact elements. In this embodiment, a matrix output is not provided, but rather, each key provides its own distinctive, individual output. As with the other embodiments, the swinger can either be normally biased to engage the stationary contact and held out of contact by the push button, or the swinger can be biased out of contact and the push button can overcome the bias to make the contact.

The novel features which are believed to be characteristic of the invention, both as to organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawings in which several preferred embodiments of the invention are illustrated by way of example. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a keyboard, including an exploded view of some of the elements comprising one of the keys;

FIG. 2 is a perspective view of a section of conductor metal strip with elongated swinger portions;

FIG. 3 is a perspective view of a section of contacting strip adapted to cooperate with the strip of FIG. 2 in an orthogonal, noncoplanar arrangement;

FIG. 4 is a perspective view, partly broken away, of the operating elements of a single key in the keyboard;

FIG. 5 is a side sectional view of a portion of the keyboard of FIG. 1 taken along the line 55 in the direction of the appended arrows showing a single key;

FIG. 6 is a view of the key of FIG. 5 in the depressed position;

FIG. 7 is a side sectional view of a portion of the keyboard of FIG. 1 taken along line 7—7 in the direction of the appended arrows;

FIG. 8 is a bottom view of the keyboard of FIG. 2 taken along the line 8—8 in the direction of the appended arrows;

FIG. 9 is a side sectional view of the keyboard of FIG. 8 taken along the line 9—9 in the direction of the appended arrows;

FIG. 10, including FIGS. 10A and 10B, is an illustration of preferred embodiments of the contacting elements of the conductive strips showing orthogonally aligned contacts affixed to the conductive strips in the open and closed positions, respectively;

FIG. 11 is a perspective view of a single key utilizing the contacting elements of the present invention;

FIG. 12, including FIGS. 12A and 12B, illustrates an alternative embodiment of the present invention in which the key depresses the swinger into engagement with the orthogonal contacting strip;

FIG. 13 is an isometric view of yet another alternative embodiment employing individual, stationary contacts; and

FIG. 14 is a side sectional view of the embodiment of FIG. 13 taken along line 14—14 in the direction of the appended arrows.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning first to FIG. 1, there is shown a keyboard 10, including a plurality of keys 12 arranged in a first group of ten 14, representing digits. Occasionally, a decimal point key is also included in this group, also known as a "brick." A plurality of keys 12 arranged in a different group 16 represents functions. Such formal and function keys may be arranged in more than one group. A plurality of terminals 18 provides electrical access to the switch portions of the individual keys 12 on a "matrix" basis, so that the energization of any one of the keys 12 provides in the preferred embodiment a closed circuit between one of the vertically aligned terminals 18 and a one of the horizontally aligned terminals 18.

The keyboard 10 includes a cover plate member 20 which has, integrally molded therein, elevated rim portion 22 defining each key location and providing an interior passage way 24 for each of the individual key elements. As illustrated, the elevated rim portion 22 is in the general shape of a truncated pyramid.

For explanation, one key 12 is shown in exploded form. The key 12 includes the key top member 26, a plunger member 28 with a switch cam 30 and a bias spring 32. It is understood that, although the parts are shown exploded above the keyboard 10, in actual assembly, the spring and plunger 32 and 28 are inserted from the "bottom" while the key top 26 is added from the top.

Turning next to FIGS. 2 and 3, there are shown the cooperating contacting strips 40, 42, which, when appropriately positioned, become the novel switch members of the keyboard of the present invention. FIG. 2 illustrates the contacting strip 40, which includes the cantilever swinger arm members, while FIG. 3 illustrates the corresponding strip 42 that is positioned orthogonally and is merely the other conductor of the matrix.

Turning first to FIG. 2, as shown, the contacting strip 40 includes an extended cantilever swinger 44, which is adapted to be moved out of the plane of the strip 40. In addition to the swinger 44, there are provided indexing notches 46 and mounting apertures 48 which enable the strip to be mass produced and easily assembled at low cost, utilizing high-speed assembly equipment. A precious metal contact 50 has been added to the swinger 44 to provide a low-resistance, noncorrosive electrical connection to the stationary contact. 42.

The second strip 42 is also provided with indexing notches 46' and with fastening apertures 48' and is adapted to be positioned orthogonally with respect to the positioning of the strips 40, and in a parallel but vertically displaced plane therefrom. A second precious metal contact 52 has been fastened to the strip to engage the corresponding contact bar 50 of the swinger 44. As shown, the bars are aligned to be orthogonal in operation to assure cross point contact.

In FIGS. 4, 5 and 6, there is shown the interaction of the key plunger 28 and the swinger 44. As seen in FIG. 4, it is understood that the first conductor strip 40 is normally positioned in a first plane and is linearly directed in a first direction. The second conductor strip 42 is aligned to be orthogonal with the strip 40 and in a plane that is parallel to but vertically displaced above the plane of the strip 40. The swinger 44 is then engaged by the switch cam 30 and is maintained, with the key in the "up" position, biased above the plane of the second contact member 42. As shown above, both the swinger 44 and the contacting strip 42 are provided with the precious metal contact bars 50, 52. The contact bars are crossed in contact, resulting in a substantially point electrical connection.

When the plunger 28 is depressed, the downward movement of the switch cam 30 permits the swinger 44 to return toward the plane of the first contact strip 40. However, at some point in the downward travel of the switch cam 30, the swinger 44 will engage the orthogonal contact strip 42 and will be held in contact with the strip 42 under the influence of the bias on the swinger 44, urging it downward toward its normal rest plane.

Further downward travel of the switch plunger 28 is possible without applying any force to the precious metal contacts 50, 52. This arrangement permits a degree of key overtravel which is desirable and which allows the establishment of electrical contact at virtually any desired point in the travel of the key.

When the key is released, the plunger 28 begins its upward travel under the force of the bias spring 32. As the plunger 28 travels upward, the switch cam 30 engages the swinger 44 and carries it out of contact with the "crossing" strip 42. This is best seen in FIGS. 5 and 6, which are side sectional views of a preferred embodiment of the structure. The key is shown in the normally "up" position in FIG. 5 and in the fully depressed or "down" configuration in FIG. 6.

Turning next to FIG. 7, there is shown, in a different section, a typical key 12. Illustrated is the case or cover plate 20 and the elevated rim portion 22 thereof, with the interior passageway 24 also illustrated. As shown, the plunger 28 is positioned within the passageway 24, and the bias spring 32 is partly restrained within the plunger 28.

The key top **26** has a peripheral, depending flange portion **54**, which is adapted to overlie the raised rim portion **22**. In the key depressed condition, as indicated by the dashed line outline, the flange **54** fits over the raised rim portion **22** of the top cover plate **20**. A central peg **56** of the key top **28** is adapted to fit closely into a corresponding central orifice **58** in the plunger **28**.

Also shown in FIG. **7** is the contacting strip **40** and the swinger **44**, which is held up by the switch cam **30**, out of engagement with the orthogonally positioned second contacting strip **42**. A bottom plate **60** retains the components in order and supports the bias spring **32**.

FIG. **8** is a bottom view of a keyboard showing a plurality of keys **12** arranged in a matrix.

As is shown, one of the contacting strip **42** elements is cooperatively engaged by two of the orthogonally positioned contacting strips **40** with the swingers **44**. As shown, the switch cam **30** maintains the swinger **44** out of contact with the orthogonally positioned contacting strip **42**. It will be understood that mass production techniques are available to expand the keyboard matrix from the four by four fragment illustrated in FIG. **8** to any matrix desired, by merely repeating elements.

FIG. **9** illustrates the manner of fastening the contacting strips **40, 42** to the body of the housing. As shown, a recess or well **62** is provided in the bottom plate **60** and a post **64** is molded into the body of the keyboard housing **66**. The mounting aperture **48** is positioned over the mounting post **64**, and the plastic therein is deformed or upset over the aperture **48**, permanently fastening the contacting strip to the keyboard housing **66** structure. This, too, is a process that is susceptible to high-speed mass production.

FIG. **10**, including FIGS. **10A** and **10B**, shows, in an idealized view, the contacting relationship between the precious metal contacts **50, 52** which are mounted upon the swinger **44** and the contacting strip **40**, respectively. As shown in FIG. **10A**, the elements are separated, and the contacts are shown to be semi-cylindrical with the long axis being orthogonal to the axis of the contacting strip with which it is associated. Obviously, the orientation could be reversed to make the axis of the cylinder parallel to the axis of the strip upon which it is mounted.

Turning to FIG. **10B**, the swinger **44** is shown in the closed switch position, in electrical contact with the contacting strip **40**. The precious metal semi-cylinders are in tangential contact which provides substantially a point contact at the intersection. It will be understood that such a cross-point can provide substantial pressures at the precise point of contact, sufficient to assure good electrical contact between the elements.

FIG. **11** is a perspective, fragmentary view of a single push-button switch **70** employing the concepts of the present invention. It is understood that the internal structure is substantially as illustrated above.

In FIG. **12**, there is shown in a top and side view, FIGS. **12A** and **12B**, respectively, an alternative configuration for the contact strips of FIGS. **2** and **3**. In FIG. **12**, an embodiment is illustrated in which the contact strip **40** is located above the second contact strip **42**. In the normally open configuration, the swinger **44** remains in the plane of the strip **40**. The switch cam **30** normally rests "above" the swinger **44**. When the push button **12** is actuated, the cam **30** depresses the swinger **44** until the orthogonally mounted contacting strip **42** is engaged, as shown in the dotted configuration of FIG. **12A**.

In this alternative embodiment, key overtravel is no longer independent of switch contact, but other benefits are achieved. For example, the placement of the switch cam **30** relative to the swinger **44** can be such that as the swinger **44** is depressed, the contact can be made virtually anywhere in the path of cam **30** travel. After contact, as the switch cam **30** continues in a downward direction, a bow can be formed in a swinger **44** imparting a sliding or scraping contact to the contacting strip **42** to "wipe" the area of contact, improving its electrical conductivity.

In still alternative embodiments, the precious metal contacts **50, 52** may be omitted without departing substantially from the teachings of the present invention. In such embodiments, the swinger and stationary contact opposing surfaces may be plated or flashed with a precious metal to reduce local resistance and improve the electrical connection.

It is clear that either configuration could be employed utilizing the elongated cantilever arm swinger and the inherent resiliency thereof as a biasing element. In the one configuration, the arm is released from the normally open configuration to assume a closed configuration under the return bias force of the cantilever spring attempting to pass through the plane of the orthogonal member to a rest position in the plane of the contacting strip of which it is a part. Alternatively, the swinger in the normally open configuration is in its rest position in the plane of its contacting strip and is cammed into engagement with the orthogonal contacting strip. Upon release, the swinger returns to the normally open configuration in the best plane.

In assembling a keyboard employing many keys according to the present invention, it will be seen that a limited number of easily mass produced parts can be quickly assembled using automatic equipment. For example, the switch housing body **66** is provided with appropriate recesses, mounting posts, slots, and apertures to simplify the assembly process. The particular switch arrangement employed, while it is a function of aesthetic design, can also be arranged to utilize advantageously the modular nature of the switching matrix, and accordingly, it is assumed that all keys would be located at the intersections of a master grid.

In assembling a keyboard according to the present invention, the initial steps would entail the fabrication of the contacting strips, which can be procured as rolls of beryllium copper or phosphor bronze strip. The raw material for contact strip **40** will obviously be wider than the raw material for the contact strip **42**.

The strips are then fed through a punch press or other device for forming and blanking to the proper shape. At this operation, the cantilevered swinger **44** can be cut out as well as the indexing notches **46** and the mounting slots **48**. The continuous strips can then be applied to a contact welding machine where the precious metal contacts **50, 52** can be mounted at appropriate locations.

The contact strips are then either cut to the proper length or rerolled, in strip form, in supply rolls. This strip can then be heat treated or otherwise processed to assure continued resiliency.

The housing structure **66** is then placed, bottom side up, and the contacting strip **42** elements are mounted

on the posts **64** which are provided for them and secured in place by setting the post in a recess or swaging the posts. The contact strips **40** including the cantilievered swingers **44** are next installed with the swingers **44** being deflected to pass under the already mounted contact strips **42.** The contact strips **40** are then seated on the mounting posts **64** provided for them. If desired, the mounting posts are then upset by heat or pressure, permanently fastening the contacting strips in place.

The key plungers **28** are then dropped into the openings provided therefor, followed by the return springs **32.** The bottom plate **60** is installed and fastened, thereby capturing and retaining the plungers **28** and the bias springs **32.** The keyboard **10** is then inverted, and the key tops **26** are installed in the plungers **20,** completing the fabrication process.

The alternative embodiment of FIGS. **12** would be assembled in substantially the same manner, except there would be no need to interleave the swingers with the contact strips **42.** Further, the plungers would probably be installed prior to the installation of the contacting strip **42.**

Turning next to FIGS. **13** and **14,** there is shown an alternative embodiment of the present invention which employs, in a keyboard, a plurality of contact strips having integral swingers, but utilizes individual contacts in place and instead of the orthogonally opposed strips previously employed. In FIG. **13,** one such combination is shown in perspective, including a key plunger **128,** a contact strip **140** with a cantiliever arm **144** integral therewith. A switch cam **130** is carried by the plunger **128** and engages the cantiliever arm **144** out of contact with a stationary contact element **142.**

The arrangement is best seen in FIG. **14** which is a side section view showing the stationary contact **142** to include a contact head **148** and a terminal pin **150** to which appropriate electrical contact can be made exterior to the keyboard.

The contact strip **140** is mounted in place, and the cantilever arm **144** is engaged by the switch cam **130** which maintains the tip of the swinger out of contact with the stationary contact head **148.** A bias spring **132** maintains the plunger in the "up" position. Similar to the preferred embodiment, described above, this combination, too, can be assembled by inserting the parts from the bottom and securing all elements with the bottom plate **160.**

Thus there has been shown in several embodiments a novel switch element in the form of a continuous strip having a plurality of integral cantilever swingers. The strips can be conveniently mounted as the rows or columns of matrix-type keyboard assemblies or can be merely the swinger contact of a contact switch combination. In a preferred embodiment, a plurality of stationary contacting strips are arranged to be orthogonal to the first swinger strips and are in a parallel but vertically displaced plane. The individual swinger members are biased out of their plane and held in a third plane parallel to the other planes with the stationary contacting strips in the intermediate plane.

Connected to individual push buttons are cams or other holding elements which maintain the swingers out of contact with the stationary strips. Energization of the push button releases the swinger arm which proceeds under its own bias to engage the stationary contact strip and would, under the bias and in the absence of the stationary strip, continue until it returned to the point from which it is deflected.

In other embodiments, the cantilever is urged into engagement with the stationary contact by the push button, and in a third embodiment, the stationary contact strip is replaced by a plurality of individual, stationary contact elements.

There has also been shown a novel key assembly which includes a depending flange that cooperates with an upstanding rim of the keyboard top plate to form a liquid excluding seal. Yet other innovations include the provisions of precious metal contact elements on the opposing faces of the opposing switch members. Other combinations and variations will be readily apparent to those skilled in the art. Accordingly, the invention should be limited only by the scope and breadth of the claims appended hereto.

What is claimed as new is:

1. In a matrix type switching keyboard operable to complete a circuit representative of and corresponding to an actuated key, the combination comprising:

first contacting means including a first plurality of first elongated strip members arranged in parallel, in a first plane, to define the columns of the matrix;

at least a first plurality of swinger members integral with each of said first strip members, each of said swinger members extending laterally from said strip member and each further extending parallel to said strip member, terminating in a free end;

second contacting means including a plurality of stationary contact elements arranged in parallel lines within a second plane orthogonal to said first strip members to define the rows of the matrix;

each of said swinger member free ends being aligned to intercept a different one of said stationary contact elements; and

switch operating means coupling each of the keys to a different swinger member for enabling contact between said swinger member free end and the contact element aligned therewith,

said switch operating means comprising an operating cam associated with each of the keys, each said operating cam holding a corresponding swinger member free end out of said first plane and in a third plane such that said second plane is intermediate said first and third planes, said swinger members being self-biased to return to said first plane, and said stationary contact being interposed in the travel path of said free end toward said first plane,

whereby the operation of a key permits the associated swinger member to contact the interposed stationary contact element.

2. The switching keyboard of claim **1,** above, wherein each of said swinger members has a precious metal contact fastened to the free end thereof adjacent said stationary contact element and each of said stationary contact elements has a precious metal contact fastened thereto adjacent to and in alignment with each swinger member precious metal contact.

3. A switch adapted to be operated by a push button comprising:

movable contact means including an elongated strip member extending in a first direction within a plane;

a swinger member integral with said strip member, said swinger member being laterally displaced from said strip member and extending parallel thereto,

terminating in a free end adapted to contact a stationary member;

a stationary contact member in a second plane, parallel to and vertically displaced from said first plane, and positioned in the path of swinger member motion; and

a push button normally supporting said swinger member in a third plane displaced from said first and second planes, such that operation of said swinger member in a third plane displaced from said first and second planes, such that operation of said push button releases said swinger member to contact said stationary contact member.

4. A switch as in claim **3**, above, wherein said swinger member has a precious metal contact fastened to the free end thereof adjacent said stationary contact member, and said stationary contact member has a precious metal contact fastened thereto at a point arranged to contact said swinger member precious metal contact.

5. A switch as in claim **3**, above, wherein said stationary contact member is an elongated strip member extending in a second direction orthogonal to said first direction.

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