

Nov. 10, 1970

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3,539,749

MOVABLE CONTACTS WITH OPPOSITELY INCLINED KEYING SLOTS
FOR PROVIDING WIPING ACTION IN A PUSHBUTTON SWITCH

Filed Dec. 18, 1968

4 Sheets-Sheet 1

FIG. 1

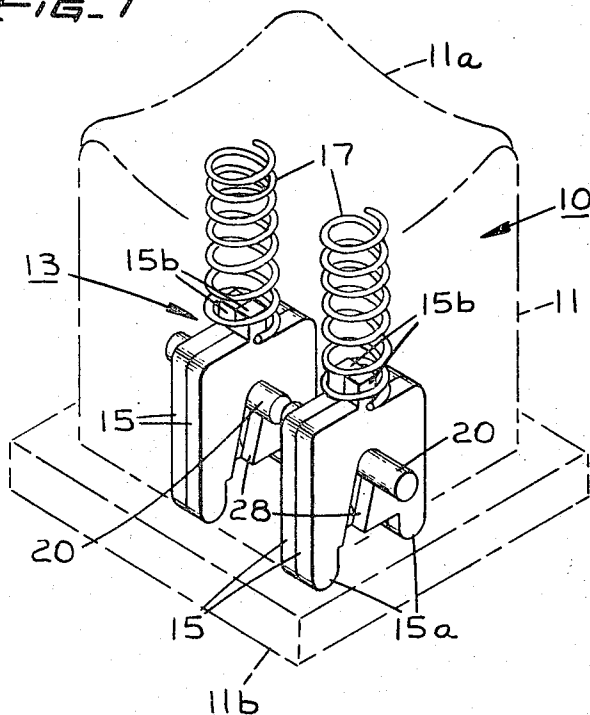


FIG. 2

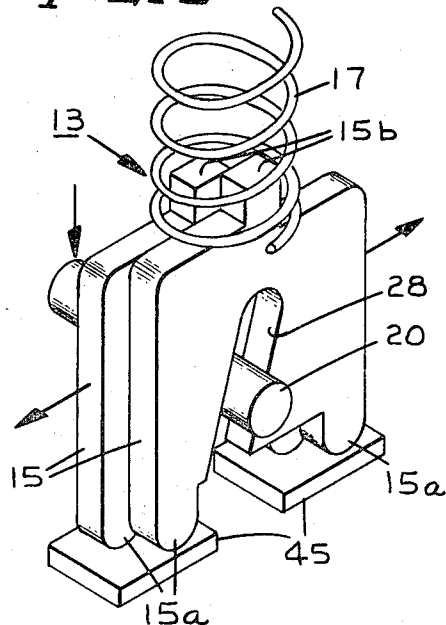


FIG. 3A

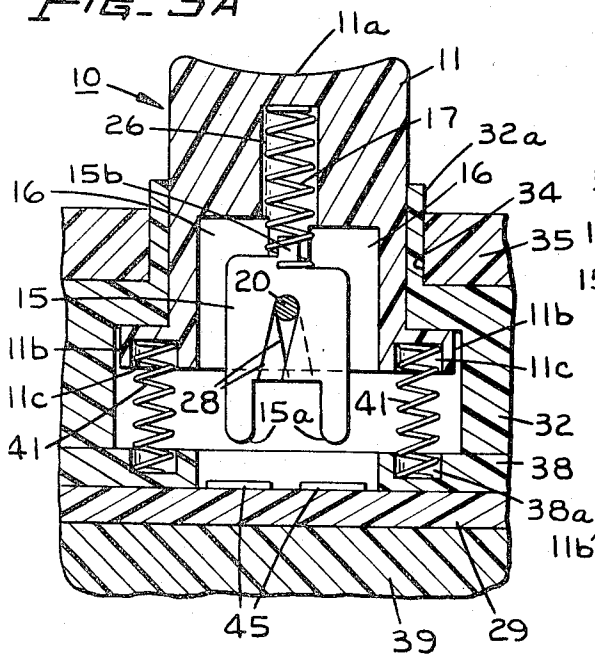
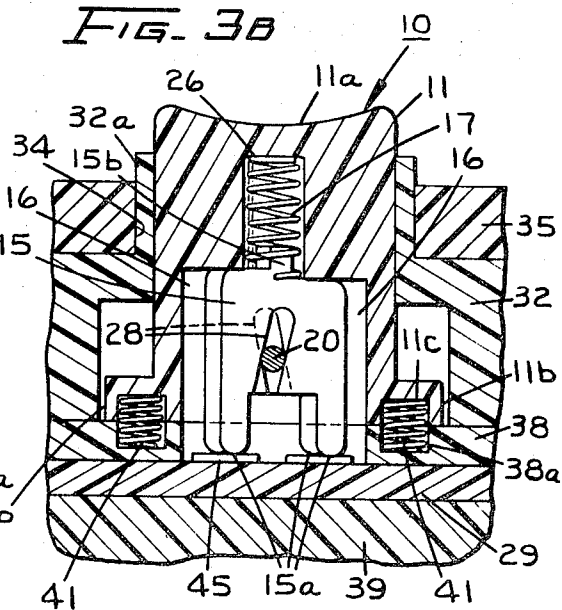


FIG. 3B



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FIG. 4

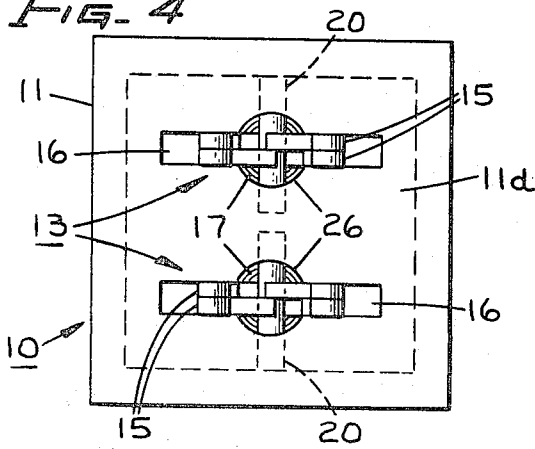


FIG. 5

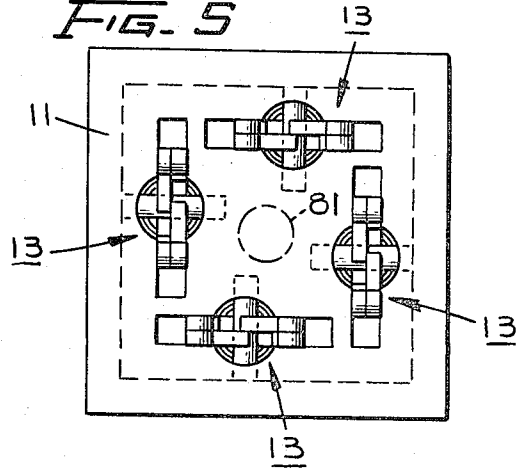


FIG. 6

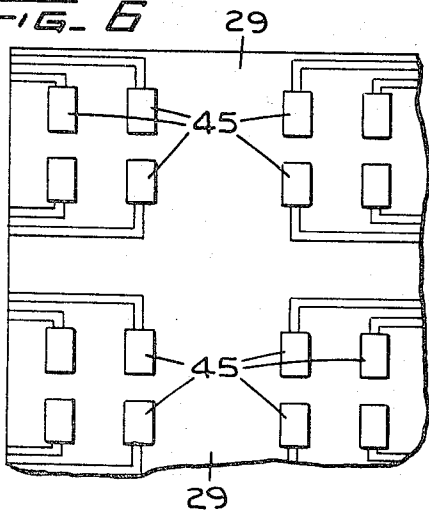


FIG. 7

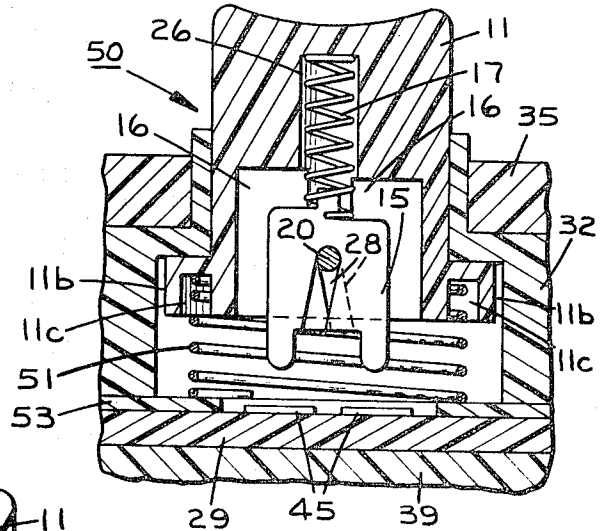
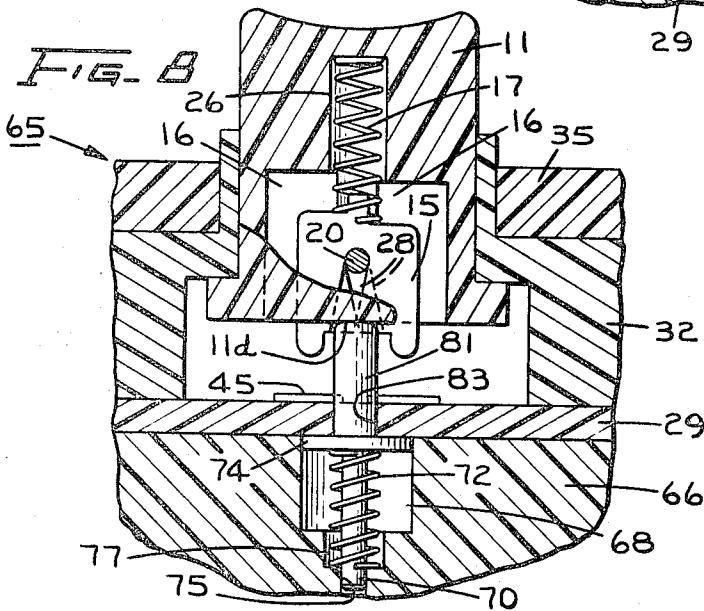


FIG. 8



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FIG. 9

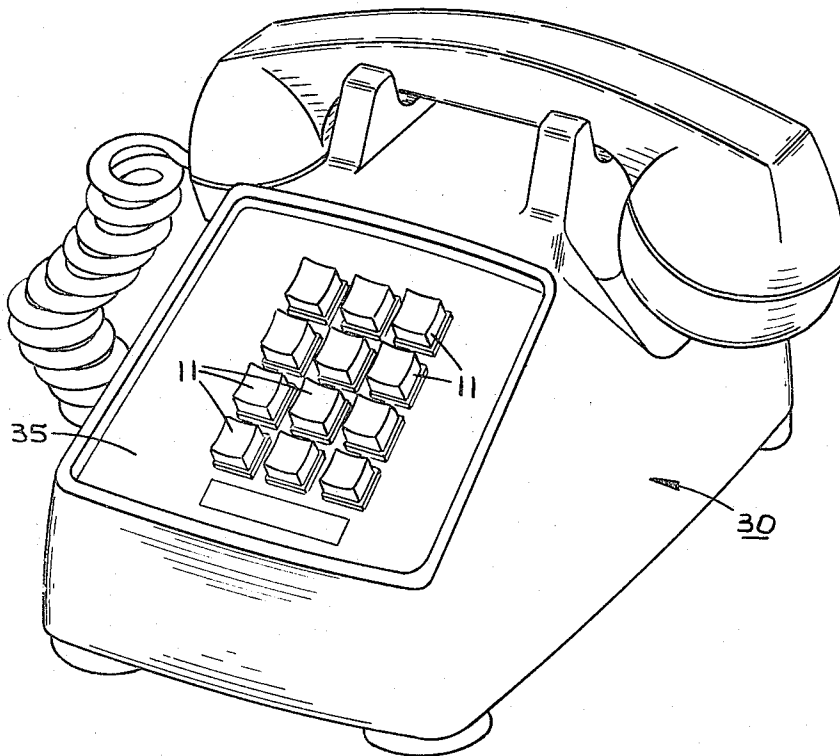


FIG. 10A

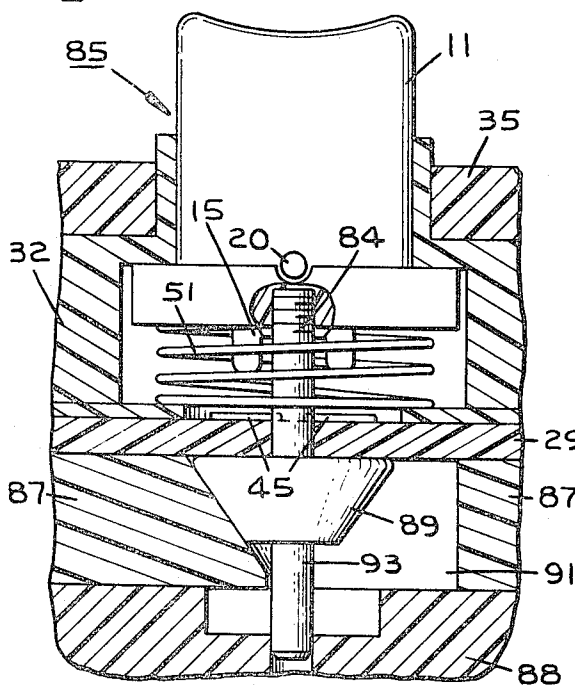
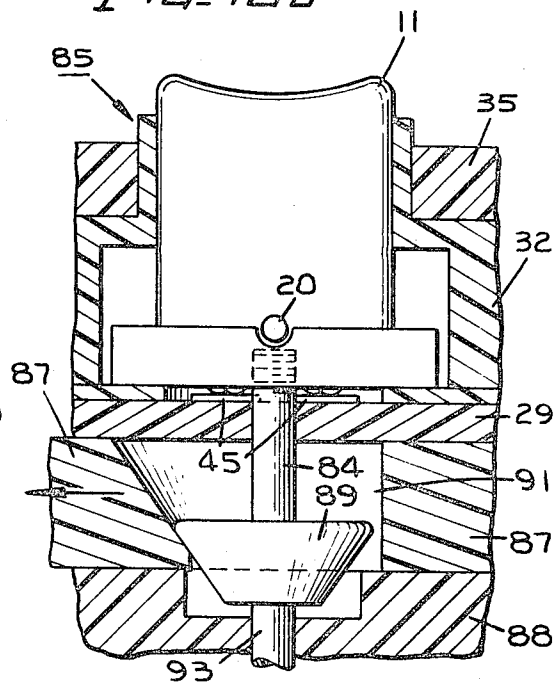


FIG. 10B



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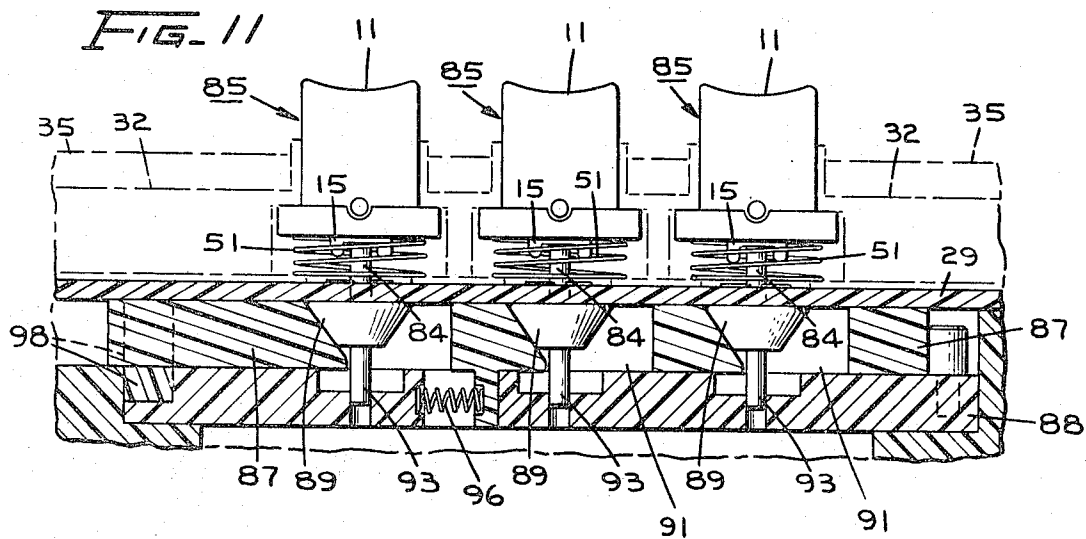
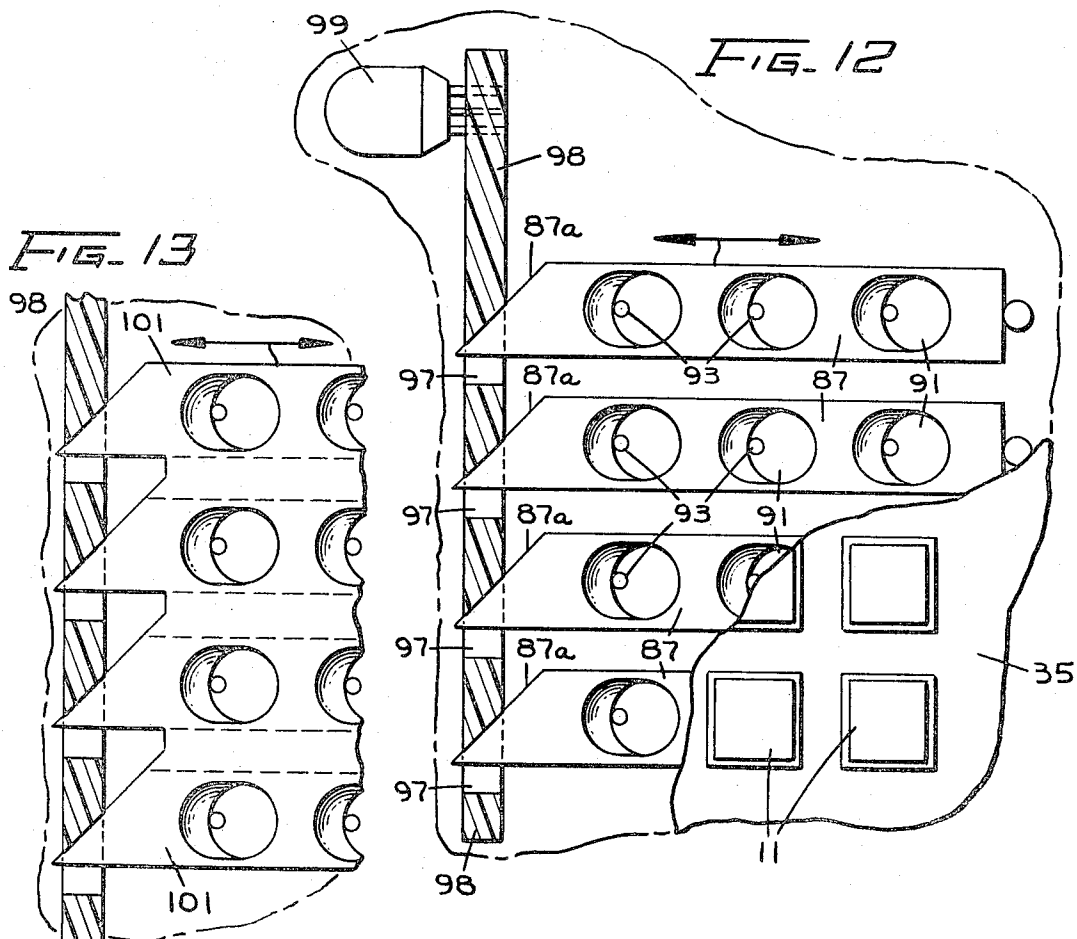
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MOVABLE CONTACTS WITH OPPOSITELY INCLINED KEYING SLOTS FOR PROVIDING WIPING ACTION IN A PUSHBUTTON SWITCH
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19 Claims

ABSTRACT OF THE DISCLOSURE

A spring-biased, pushbutton switch assembly for general use, but particularly adapted for use in making and breaking electrical circuit connections on printed circuit boards. The switch contacts are pivotally mounted and spring biased within the pushbutton housing in such a way that upon depressing the housing against a member with stationary contacts thereon, both lateral and vertical movement are imparted to the switch contacts. The switch contacts also exhibit a self-leveling action.

Another embodiment of the pushbutton switch assembly additionally effects selectively controlled movement of a cross-slide mechanism which, in turn, can be utilized to actuate associated circuitry.

BACKGROUND OF THE INVENTION

Field of the invention

The invention is concerned with actuable electrical switch assemblies and, more particularly, with spring-biased pushbutton switch assemblies of the type adapted for use in making and breaking electrical circuit connections both directly and indirectly on printed circuit boards, such as of the type that may be used in pushbutton telephones.

It is very important in such applications to insure that reliable metal-to-metal contact is made between the movable contacts of the switch assemblies and the stationary contact areas of the circuit board. To accomplish this, it is desirable that the switch contacts in some way compensate both for printed circuit board surface irregularities and for the presence of foreign matter on either the stationary contact areas of the board or the switch contacts, or both. It, of course, is also important that the switch contacts be mounted within a housing in a rugged and durable manner, and be substantially shielded from dust without requiring special dust covers.

Selectively controlled or programmed movement of auxiliary apparatus upon actuation of the switch assemblies is also desirable in many complex function-demanding circuit applications.

Description of the prior art

Spring-biased electrical switch assemblies of the pushbutton type heretofore have generally relied upon rectilinear movement of the switch contacts to complete an electrical connection when the pushbutton is depressed. Such movement results in the contacts making what may be described as "point-contact" with associated stationary contacts of a related member. This type of rectilinear contact movement, of course, provides no wiping action between the stationary and movable contacts. As a result, ineffective or unreliable electrical circuit connections, particularly with prolonged use, can result because of foreign matter accumulating on either the stationary or movable contacts, or both.

In other more complex spring-biased pushbutton electrical switch assemblies employed heretofore, depression of the pushbutton results in a cam-actuated, rotatable

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movement of the switch contacts in conjunction with rectilinear movement so as to produce a wiping action which facilitates the attainment of more reliable electrical connections with associated stationary contacts. Such rotatable contacts, however, have not been found to exhibit an effective self-leveling action, nor when arranged in multiple contact arrays, to insure uniform contact pressure against respectively aligned mating contact areas of a circuit board, for example. Such switch characteristics, of course, are very important as the printed surface areas of circuit boards, for example, often exhibit appreciable non-uniformity in height as a result of variations in substrate thickness and/or in plating thickness.

In still other arrangements, such as disclosed in C. E. Mitchell Pat. 3,035,211, issued May 15, 1968, the switch contacts are mounted on the circuit board independently of the pushbutton. While such contacts, particularly when in the form of resilient leaf springs, can provide a degree of wiping and self-leveling action, they do impose manufacturing problems, such as with respect to alignment and assembly, as well as with respect to space requirements. By being substantially exposed, such switch contacts are also not particularly immune to damage or misalignment problems caused by rough handling during assembly, nor to the collection of dust with prolonged use, in the absence of special dust covers.

The switch assembly disclosed in the Mitchell patent also incorporates a pushbutton actuated cross-slide mechanism to actuate an auxiliary switch. However, neither this art nor any other known prior art utilizes switch assemblies incorporating switch contacts exhibiting the characteristics sought herein, as briefly denoted hereinabove, while simultaneously effecting the actuation of an auxiliary switch and/or circuitry.

SUMMARY OF THE INVENTION

An object of this invention is to provide new and improved spring-biased pushbutton switch assemblies for reliably making and breaking electrical connections.

Another object of this invention is to provide pushbutton switch assemblies of the type which not only directly make and break electrical connections, but also simultaneously effect selectively controlled movement of an associated member which, in turn, actuates auxiliary circuitry.

A further object of this invention is to provide new and improved pushbutton switch assemblies which exhibit self-leveling action, uniform contact pressure, and positive, multiple contact wiping action when actuated.

An additional object of this invention is to provide new and improved pushbutton switch assemblies of rugged, simplified and inexpensive construction, and which substantially shield the switch contacts from damage through handling during manufacture and from dust with prolonged use.

In accordance with the invention, the pushbutton switch assembly in its most simplified form comprises a plastic button-forming housing which may contain a number of individual metallic switch units, each unit comprising two bifurcated, spring-biased contacts with an inclined keying slot in each contact. The contact pairs are arranged so that the keying slots therein are oppositely inclined. A stationary pin, extending across a cavity within and affixed to the button, normally passes through the upper ends of the contact keying slots. With the pin in this position, only the bifurcated ends of the contacts protrude beyond the base of the button. Any movement of the contacts relative to the button so as to retract the contacts further within the cavity, simultaneously results in the pin forcing the contacts to move laterally in opposite directions.

As thus constructed, the subject switch assemblies embodied herein provide a number of significant advantages.

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For example, because of the resilient and keyed support of the contacts within and relative to the button, the contacts of the switch assemblies when actuated exhibit self-leveling action, uniform contact pressure, and positive, reliable multiple contact wiping action. The contacts are also substantially shielded both from damage, such as could result from rough handling of the switch assemblies, and from dust.

In accordance with another embodiment of the invention, the push-button switch assemblies are constructed in such a manner that not only the bifurcated contacts thereof are actuatable, but the depression of a push-button further results in cam-actuated, lateral movement of an associated member, such as a cross-slide or comb. Such composite switch mechanisms have particular application in a push-button telephone, wherein a plurality of switch assemblies, for example, may be respectively associated with cross points of an electrical switching matrix, and a cross-slide may be employed to actuate associated electrical circuitry, such as the common or line switch of the telephone set.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, partially in phantom of a typical pushbutton electrical switch assembly constructed in accordance with the principles of the present invention;

FIG. 2 is an enlarged, perspective view of one pair of switch contacts in an offset position relative to each other, which position is representative of a make or closed condition relative to stationary contacts of an associated member;

FIGS. 3A and 3B are partial, cross-sectional detail views of one preferred embodiment of the switch assembly of FIG. 1, as utilized in conjunction with a printed circuit, and respectively illustrate the switch contacts in open and closed positions relative to associated stationary contacts of the circuit;

FIGS. 4 and 5 are plan views of several typical switch contact arrangements which may be readily incorporated within a common pushbutton housing in accordance with the principles of the present invention;

FIG. 6 is a partial plan view of a typical printed circuit pattern of stationary contact areas applicable for use with switch assemblies of the type embodied herein;

FIG. 7 is a partial, cross-sectional detail view of a switch assembly similar to the one depicted in FIG. 3, but distinguishing therefrom by the manner in which the switch contacts thereof are normally spring biased in spaced relationship relative to stationary printed circuit contacts;

FIG. 8 is a partial detail view, mainly in cross-section, of still another switch assembly adapted for use with printed circuit boards;

FIG. 9 is a perspective view of a typical pushbutton telephone set wherein switch assemblies of the type embodied in the present invention may advantageously be incorporated;

FIGS. 10A and 10B are partial, cross-sectional detail views of an unactuated and actuated switch assembly, respectively, of the type basically depicted in FIG. 7, but being further modified with a spring-biased, cam-actuated member which can control the movement of a cross-slide which, in turn, can perform other auxiliary functions;

FIG. 11 is a partial, cross-sectional view of a plurality of pushbutton switch assemblies utilized with a common cam-actuated cross-slide mechanism, both of the type depicted in FIG. 10, and wherein the switch assemblies are arranged to form one row of a typical coordinate array, as might be employed in a pushbutton telephone of the type depicted in FIG. 9;

FIG. 12 is a partial plan view, with a portion of the cover plate broken away, illustrating the cam surfaces associated with the apertures in the cross-slides respective-

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ly associated with each of a plurality of rows of pushbutton switch assemblies, with a second cross-slide or comb being arranged to be cam-actuated in response to the actuation of any of the row-oriented cross-slides, and

FIG. 13 is a plan view of an alternative cross-slide common to a plurality of rows of pushbutton switch assemblies arranged in a coordinate array.

DETAILED DESCRIPTION

With specific reference first to FIGS. 1-4, a pushbutton switch assembly designated generally by the reference numeral 10, and embodying the principles of the present invention, comprises an outer pushbutton housing 11, hereinafter referred to simply as the "button," and two switch contact units 13 partially mounted therewithin. In the interest of both simplicity and clarity, common or very similar elements incorporated in the various embodiments illustrated herein will be identified by like reference numerals. The button, as best seen in FIGS. 1 and 4, is basically box-shaped, with the upper surface 11a thereof preferably being inwardly contoured or scalloped, and the base of the button having an outwardly extending peripheral shoulder 11b. The button is preferably made of plastic, but may be constructed of any other suitable insulating material, and of any other desired shape.

Each switch contact unit 13 includes a pair of juxtaposed and bifurcated contacts 15, partially positioned within an inner, substantially rectangularly shaped cavity 16 (FIGS. 3 and 4) of the button 11, and resiliently supported therein by means of a spring 17 and a pin 20. The spring 17 is partially confined within an inner bore 26. As can best be seen in FIG. 4, the bore actually extends upwardly from the base of button 11, through the cavity 16, and terminates a short distance beyond the upper wall defining the cavity. This, of course, is to allow insertion of the spring 17 during fabrication of the switch assembly.

A lower end portion of the spring, when in its normal state of elongation, extends downwardly within the bore 26 in a region where the bore actually enlarges, or communicates with, the cavity 16. The lower extremity of the spring is secured to or at least surrounds adjacent upper tabs 15b of the contacts 15. The cavity 16 has a width, excluding the region of bore 26, only slightly larger than the combined thicknesses of each pair of juxtaposed contacts, but a length considerably longer than the width of each contact (see FIG. 4), for the reasons noted hereinafter.

The two bifurcated contacts 15 of each switch unit 13 are each formed with an inclined keying slot 28 therein, the slot extending upwardly and inwardly from a point off-center and adjacent one leg 15a, to a central region of the contact. The contact pairs are arranged such that the keying slots are oppositely inclined with respect to each other. The stationary pin 20, associated with each switch unit 13, extends through the contact keying slots and is affixed at opposite ends to wall portions of the button 11. The pin is positioned at a depth within the cavity 16 which places the biasing spring 17 under compression. This causes the pin normally to be located at the upper or innermost end of the keying slots 28, as depicted in FIGS. 1 and 3A, when the switch is not actuated.

The pushbutton 11 with two switch contact units 13 mounted therein, as thus far described, is illustrated in FIGS. 3A and 3B in one typical application as a switch assembly for making and breaking electrical connections respectively on a printed circuit board 29, such as might be employed in a pushbutton telephone set 30 of the type depicted in FIG. 9. In this particular application, disclosed by way of example only, the button 11 is supported for rectilinear movement within a sleeve 32. The sleeve has an upper collar or flange portion 32a which

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extends upwardly through an aperture 34 in a cover plate 35 of the pushbutton telephone set. The base of the sleeve 32, as depicted in FIG. 3, is supported on an auxiliary support member 38 which, in turn, is supported on the printed circuit board 29. A separate support member 39 is shown for supporting both the printed circuit board 29 as well as the pushbutton assembly mounted thereon. It is to be understood, of course, that when the printed circuit board substrate comprises sufficiently rigid material, a separate support member, such as 39, in many applications may not be required.

Two mutually disposed helical springs 41 are each seated at their lower ends within a different recess 38a (or in one continuous, peripheral recess) of the auxiliary support member 38 upon which the base of the sleeve 32 rests. At their upper ends, each spring 41 is likewise seated either within different or a common peripheral recess 11c in the shoulder 11b of the button. These springs provide the necessary biasing force to normally position the switch contacts 15 in spaced relationship relative to stationary contacts 45 formed on the printed circuit board.

The pushbutton switch assembly 10 is actuated to "make" or complete an electrical connection in the printed circuit board application depicted in FIGS. 3A and 3B, as follows: The button 11 in being depressed downwardly, relative both to the sleeve 32 and cover plate 35, first causes the protruding bifurcated contact ends 15a to make point contact with the aligned stationary contacts 45 of the printed circuit board. However, continued downward movement of the button 11, until the base of shoulder 11b thereof bottoms out against the upper surface of the auxiliary support member 38, causes the contacts 15 to move in opposite lateral directions, as indicated by the arrows in FIG. 2. This off-setting lateral displacement of the contacts results because the associated pin 20, which extends through the inclined keying slots 28 of the contacts, only moves along a straight, vertical path defined by the button, to which it is attached.

The lateral movement imparted to the contacts advantageously results in the bifurcated contact extremities 15a effecting a wiping action across the upper surfaces of the associated stationary contacts 45. This wiping action is important as it insures the attainment of positive and reliable electrical connections between the mating surfaces of the movable and stationary contacts, even when foreign matter or corrosion may have built up on either or both contacts prior to the making of a connection therebetween.

The pushbutton switch assembly 10 depicted in FIG. 3 also exhibits a number of other significant advantages. More specifically, as a result of the bifurcated contacts 15 of each switch unit being pivotally supported and spring biased within the button 17, the contacts can attain an orientation within the button so as to compensate for non-planar surfaces exhibited by the stationary contacts, such as can result from non-uniform printed circuit board substrate thicknesses and/or non-uniform stationary contact plating thicknesses. This type of contact mounting also insures that uniform contact pressure or force is applied against the stationary contacts, the magnitude of such force being determined primarily by the compressive force characteristics of the biasing springs 17. In addition, with the major portion of the contacts being mounted within the button, they are not easily damaged as a result of rough handling of the fabricated switch assemblies, and are substantially shielded from dust.

A pushbutton switch assembly of the type depicted in FIGS. 1-3 can, of course, have multiple contact units 13 arranged in a number of different configurations, dependent primarily on the particular application involved. For example, FIGS. 4 and 5 illustrate different combinations of switch contact units 13 mounted within a given push-

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button 11, being shown as a juxtaposed pair in FIG. 4, and in space quadrature in FIG. 5.

FIG. 6 depicts a typical spaced array of stationary contacts 45 associated with a printed circuit, with the array being particularly applicable for use with a plurality of switch assemblies having contact units 15 arranged as depicted in FIG. 4.

FIGS. 7 and 8, respectively, illustrate several alternative embodiments of the pushbutton switch assembly depicted in FIGS. 1-4. The main difference relates to the manner in which the button 11 is spring biased in spaced relationship relative to the circuit board. More specifically, in the switch assembly 50 of FIG. 7, the shoulder 11b at the base of the button is necessarily formed with a peripheral cavity 11c which accommodates the upper end of a single helical spring 51 which surrounds the switch contacts 15. The lower end of the spring rests on a spacer plate 53 so as to be isolated from the printed circuit paths and contacts 45. Alternatively, the printed circuit board 29 could be formed with integral raised ridges to function in the same manner as the spacer plate. Spring 51, of course, serves the same function as the dual helical springs 41 depicted in FIG. 3.

Distinguishing from both the switch assemblies depicted in FIGS. 3 and 7, the switch assembly 65 embodied in FIG. 8 has a support base 66 with a stepped recess or cavity 68 formed therein. The cavity accommodates a centrally positioned stationary rod 70, a helical spring 72 and a retractable platform 74. The lower end of rod 70 is seated within a bore-defining base region 75 of the cavity 68 and is secured therein by any suitable means, such as by a force fit. The helical spring 72 is coaxially positioned along the major length of rod 70, and is confined at its lower extremity by a stepped shoulder 77 in the support base 66, and at its upper extremity by the rectilinearly movable platform 74.

A tubular spring-biased pin 81, preferably of circular cross section, extends upwardly through an oversized aperture 83 in the printed circuit board 29 and makes contact at its upper extremity with the central base portion 11d of the button. With the switch assembly utilizing two switch contact units 13, arranged as depicted in FIGS. 1 and 4, the pin 81 would preferably make contact with the lower base 11d of the button intermediate the two switch contact units. If four switch contact units 13 were to be used, for example, such as depicted in FIG. 5, the pin would preferably make contact with the base 11d of the button in a central region thereof. In the case of utilizing a single pair of switch contacts, as depicted in FIG. 2, the retractable pin 81 in the embodiment of FIG. 8 would preferably be bifurcated at the upper end, with the center slot thus formed having a width sufficient to allow the leg portions of the pin to straddle the pair of contacts 15 and extend upwardly through the bore 26 (see FIG. 4) until their extremities would abut against the pin 20.

The lower end of the spring-biased pin 81 is secured to the slidable platform 74 which is dimensioned to be laterally restricted by but rectilinearly movable within the cavity 68 of the support member 66. To effect such rectilinear movement of the support plate 74, it is apertured so that it, together with the tubular spring-biased pin 81 can slide coaxially over the stationary pin 70 when the spring 72 is compressed. In all other respects the pushbutton switch assembly 65 functions in the same manner and exhibits the same advantages as are realized with the switch assemblies depicted in FIGS. 3 and 7.

FIGS. 10A and 10B respectively depict the open and closed positions of still another pushbutton switch assembly 85 wherein, as distinguished from FIG. 3, a cross-slide 87 is interposed between a support member 88 and the printed circuit board 29. The cross-slide is actuated by a cam member 89 which has a peripheral surface inclined at an angle to coincide with the angle of at least one side wall defining an aperture 91 in the cross-slide 87. The

cam member 89 is secured to a retractable pin 93 similar to the pin 75 depicted in FIG. 8, but distinguishing therefrom in being secured at its upper end to the base 11b of the switch assembly in any suitable manner, such as by being threaded into a tapped bore of the button, as depicted in FIG. 10A.

One particular form that the cross-slide 87 can take when used in conjunction with a push-button telephone dial mechanism is depicted in FIGS. 11-13. With respect to a push-button array as may be employed in the push-button telephone depicted in FIG. 9, a separate cross-slide 87 is associated with each row of push-button switch assemblies 85. In addition, each cross-slide 87 is spring biased by means of a helical spring 96, as depicted in FIG. 11, so as to maintain the cross-slide in a normal or unactuated position except when cam-shifted laterally to the left in response to the depression of an associated pushbutton 11.

As best seen in FIG. 12, each cross-slide 87 has a tapered end 87a which is aligned with an associated aperture 97 in another cross-slide or comb 98. With at least one surface partially defining each aperture 97 in the comb 98 being inclined to mate an associated surface 87a of one of the cross-slides 87, the comb 98 may be actuated in a direction perpendicular to the lateral movement of any cross-slide 87. In a pushbutton telephone dial mechanism application, the comb in turn can be utilized to actuate suitable contacts of a common or line switch 99, shown only symbolically in FIG. 12.

In a push-button dial mechanism application, of course, each of the pushbuttons utilized for dialing would be associated respectively with a cross-point connection of an electrical circuit so as to provide a selected means of dialing discrete digits in accordance with predetermined signal intelligence, such as tones, associated and identified with each of the cross-point connections. In other words, the printed circuit would essentially constitute a coordinate cross-point switching matrix, with any of the pushbutton assemblies embodied in the present invention being utilized to selectively make and break the cross-point connections, while simultaneously, or in time sequence, actuating the cam-operated cross-slide mechanisms so as to in turn actuate associated circuitry as required, such as the common switch of the telephone network.

The plurality of cross-slides 87 respectively associated with each row of push-button switch assemblies 85, as depicted in FIGS. 11 and 12 could, of course, be formed as a single integral cross-slide plate 101 as depicted in FIG. 13. As such, upon depressing any of the pushbutton switches utilized for dialing, the cross-slide plate 101 would likewise move laterally a predetermined amount by cam action so as to actuate any other mechanisms and/or associated circuitry responsive to such lateral movement.

What is claimed is:

1. An electrical switch assembly comprising:

an outer housing of insulating material forming a pushbutton, said button having an opening in the base thereof, with said opening communicating with an interior cavity adapted to slidably receive switch contacts therewithin;

a pair of juxtaposed contacts forming a switch unit slidably positioned within said cavity, each of said contacts having a downwardly extending bifurcated end which normally protrudes slightly beyond the base of said button, and each of said contacts having an inclined keying slot formed therein, with the pair of contacts being arranged such that the keying slots therein are oppositely inclined with respect to each other;

stationary keying means extending across said cavity, through the keying slots in said contacts, and secured at opposite ends to said button at an elevation which allows retractable movement of at least the bifur-

cated ends of said contacts within and without said cavity, and

biasing means positioned within said cavity for providing a downward force against the innermost ends of said contacts, said force causing the bifurcated ends of said contacts normally to protrude outwardly from the base of said button.

2. An electrical switch assembly in accordance with claim 1 further comprising:

first support means including an aperture-defining collar portion which accommodates and allows only rectilinear movement therethrough of at least a portion of said button;

second support means positioned in spaced relationship with respect to said first support means, at least in the area of said button;

a member having at least two stationary contacts secured thereto positioned adjacent said second support means, said stationary contacts being aligned with the mutually disposed, common bifurcated ends of said switch contacts, and

second biasing means, at least a portion of which is interposed between said second support means and the base of said button, said second biasing means normally maintaining said button in an uppermost position whereat the upper surface thereof at least partially extends through the aperture in said first support means in the absence of an external, downward force imparted to the top surface of said button.

3. An electrical switch assembly in accordance with claim 2, wherein said first biasing means comprises a helical coil spring, the upper end of which is disposed within a bore communicating with the innermost wall of said cavity and the lower end of which extends downwardly partially within said cavity so as to contact the upper ends of said contacts, and wherein said second coil means comprises at least two spaced helical springs symmetrically positioned on different sides of said contacts, the lower ends of which springs are supported by said second support means and the upper ends being in compressive engagement with base portions of said button.

4. An electrical switch assembly in accordance with claim 2, wherein said first biasing means comprises a helical coil spring, the upper end of which is disposed within a bore communicating with the innermost wall of said cavity and the lower end of which extends downwardly partially within said cavity so as to contact the upper ends of said contacts, and wherein said second coil means comprises a single coil spring surrounding said contacts, the lower end of which spring is supported by said second support means and the upper end being in compressive engagement with a base portion of said button.

5. An electrical switch assembly in accordance with claim 2, wherein said first biasing means comprises a helical coil spring, the upper end of which is disposed within a bore communicating with the innermost wall of said cavity and the lower end of which extends downwardly partially within said cavity so as to contact the upper ends of said contacts, and wherein said second coil means includes a spring-biased retractable member which extends upwardly from a recess in said second support means, through said member with stationary contacts and abuts against a base portion of said button in compressive engagement therewith.

6. An electrical switch assembly in accordance with claim 2 further comprising:

a second pair of spring-biased switch contacts, forming a second switch unit, mounted within said button and positioned in spaced relationship with respect to a pair of associated stationary contacts in the same manner as said first pair of switch contacts.

7. An electrical switch assembly in accordance with claim 2 further comprising:

three additional pairs of spring-biased switch contacts

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mounted within said button and spaced with respect to respectively aligned pairs of stationary contacts in the same manner as said first pair of contacts, said four pairs of contacts being arranged to form four switch units in space quadrature.

8. In electrical switch apparatus, a combination including an electrical switch assembly comprising:

an outer housing of insulating material forming a push-button, the base of said button having an opening which communicates with an interior cavity adapted to slidably receive switch contacts therewithin, said button also having an outwardly extending shoulder portion at the base end thereof;

a pair of juxtaposed contacts forming a switch unit slidably positioned within said cavity, each of said contacts having a downwardly extending bifurcated end which normally protrudes slightly beyond the base of said button, and each of said contacts having an inclined keying slot formed therein which starts from a lower, off-center point along the bifurcated end and extends upwardly and inwardly toward a central region of the contact, the pair of contacts being arranged such that the keying slots therein are oppositely inclined with respect to each other;

biasing means positioned within said cavity for providing a downward force against the innermost ends of said contacts, and

a stationary pin extending through the keying slots of said contacts and secured at opposite ends to wall portions of said button, said pin being positioned within and extending across said cavity at a point that normally causes said biasing means to exert a slight downward biasing force against the upper ends of said contacts so as to position the pin at the upper ends of said keying slots, and at a depth within said cavity which provides a predetermined space between the upper ends of said contacts and an adjacent inner cavity-defining surface of said button, said predetermined space, biasing means and pin allowing relative movement in at least two directions between said contacts and said button whenever said button is depressed downwardly against an auxiliary member to complete an electrical connection between said bifurcated ends of said contacts and aligned stationary contacts of said auxiliary member.

9. In electrical switch apparatus in accordance with claim 8, the combination further comprising:

first support means including an aperture-defining collar portion which accommodates and allows only rectilinear movement therethrough of only that portion of an associated button which extends above said outwardly extending base portion;

second support means positioned in spaced relationship with respect to said first support means, at least in the area of said button;

a circuit member having at least two stationary contacts secured thereto positioned adjacent said second support means, said stationary contacts being aligned with the mutually disposed, common bifurcated ends of said switch contacts, and

second biasing means, at least a portion of which is interposed between said second support means and the base of said button, said second biasing means normally maintaining said button in an uppermost position whereat the upper surface at least partially extends through the aperture in said first support means in the absence of an external, downward force imparted to the top surface of said button.

10. In electrical switch apparatus in accordance with claim 9, said second biasing means further including a spring-biased reciprocally movable cam member secured thereto and having at least one inclined surface, said cam member being responsive to and movable with said button, and a cross-slide member positioned adjacent said member with stationary contacts, said cross-slide member

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being formed with at least one inclined cam surface which mates the inclined surface of said cam member, whereby rectilinear movement of said cam member imparts movement in a predetermined direction to said cross-slide.

11. In electrical switch apparatus in accordance with claim 10, the combination further comprising:

a plurality of said switch assemblies arranged in rows to form a cross-point switching matrix, with the bifurcated ends of the contacts associated with each switch assembly making at least one cross-point electrical connection with aligned stationary contacts of said circuit member whenever the associated button is depressed;

a plurality of said cam members respectively secured to each of the second biasing means respectively associated with said switch assemblies, and

a plurality of said cross-slide members, each one associated with a different row of switch assemblies, and each cam surface thereof being in mating relationship with the inclined surface of an associated cam member, whereby each button upon being depressed effects movement of an associated cross-slide through the responsive movement of the associated cam member.

12. In electrical switch apparatus, a combination including an electrical switch assembly comprising:

an outer housing of insulating material forming a push-button, the base of said button having an opening which communicates with an interior cavity adapted to slidably receive switch contacts therewithin, said button also having an integral outwardly extending, circumferential shoulder at the base end thereof;

a pair of juxtaposed contacts forming a switch unit slidably positioned within said cavity, each of said contacts having a downwardly extending bifurcated end which normally protrudes slightly beyond the base of said button, and each of said contacts having an inclined keying slot formed therein, with the pair of contacts being arranged such that the keying slots are oppositely inclined with respect to each other;

a stationary pin extending across said cavity, through the slots of said contacts, and secured at opposite ends to wall portions of said button at an elevation which allows retractable movement of at least the bifurcated ends of said contacts within and without said cavity, and

biasing means positioned within said cavity for providing a downward force against the innermost ends of the contacts of said switch unit, said force causing the bifurcated ends of the contacts to be spring biased outwardly from the base of said button, with said pin normally being positioned at the upper end of said keying slots.

13. In electrical switch apparatus in accordance with claim 12, the combination further comprising:

a plurality of said switch assemblies arranged in rows to form a switching array;

a plurality of first support means, each including an aperture-defining collar portion which accommodates and allows only rectilinear movement therethrough of only that portion of an associated button which extends above said shoulder thereof;

second support means positioned in spaced relationship relative to said first support means, at least in those areas where said switch assemblies are located;

a circuit board positioned adjacent said second support means and normally being in spaced relationship with respect to the bifurcated ends of said switch contacts, said circuit board including an array of stationary contacts secured thereto, each stationary contact being aligned for engagement with a different pair of common bifurcated contact ends of one of said switch units;

a plurality of second biasing means, at least a portion of each being interposed between said second support

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means and a base portion of an associated button, each of said second biasing means normally maintaining said associated button in an uppermost position whereat the shoulder thereof abuts against said first support means and whereat the upper surface of said button at least partially extends through and, in the absence of an external downward force imparted to the upper surface of said button, protrudes above the aligned aperture defined by the collar portion in said first support means, and

a cover plate positioned in spaced relationship relative to said second support means and having a plurality of apertures therein which are respectively aligned with and accommodate at least part of the collar portions of said first support means.

14. In electrical switch apparatus in accordance with claim 13, the combination further comprising:

a second pair of spring-biased switch contacts forming a second switch unit spaced from and identical in construction to the first spring-biased switch unit mounted in said button, the common bifurcated ends of said second switch unit of each switch assembly being in alignment with additional respectively associated stationary contacts secured to said circuit board.

15. In electrical switch apparatus in accordance with claim 13, said circuit board having a plurality of apertures therethrough which are respectively aligned with said switch assemblies associated therewith, and each of said second biasing means including a spring-biased member which extends upwardly through an aligned aperture in said circuit board and is secured to a base portion of the button in alignment therewith.

16. In electrical switch apparatus in accordance with claim 15, each of said spring-biased members further including a cam member secured thereto, positioned below said circuit board, and having at least one inclined surface, said cam member being responsive to and movable with said button.

17. In electrical switch apparatus in accordance with claim 16, the combination further comprising:

a plurality of cross-slide members positioned below said circuit board and aligned respectively with the rows of said switch assemblies defining said array, each of said cross-slide members having a plurality of apertures therein respectively aligned with and accommodating said cam members respectively secured to said spring-biased members, each of the apertures in said cross-slide members being formed with at least one inclined wall portion which provides a mating sur-

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face with the aligned cam member, whereby rectilinear movement of said cam member imparts movement in a predetermined direction to said cross-slide member.

18. In electrical switch apparatus in accordance with claim 16, the combination further comprising:

a common cross-slide member interposed between said first and second support means, said cross-slide member having a plurality of apertures therein which are respectively aligned with and accommodate said cam members respectively associated with said spring-biased members, each of the apertures in said cross-slide member being formed with at least one inclined wall portion to provide a mating surface with the associated cam member, whereby rectilinear movement of said cam member imparts movement in a predetermined direction to said cross-slide member.

19. In electrical switch apparatus in accordance with claim 17, the combination further comprising:

an auxiliary cross-slide member which is formed with a cam surface, and each of said cross-slide members associated with said switch assemblies having a second cam surface formed thereon that mates the cam surface of said auxiliary cross-slide member, such that movement of each cross-slide member in response to movement of said cam member, in turn, imparts movement in a predetermined direction to said auxiliary cross-slide member.

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