The disclosure relates generally to key assemblies employed in electrical switch operating keyboard devices and more particularly to the assembly of parts forming an individual depressible key of such a keyboard. Each key assembly is composed of parts cooperatively interfitting to provide both a low profile for the keyboard as well as a bifurcated electrical contact provision. Included in each key assembly is a pair of coiled springs of different diameters which are coaxially and overlappingly related to one another. The smaller diameter spring of the pair is a double rate spring and as such is formed with two longitudinal sections of different helical pitches for conveying forces employed to depress the key to the switch associated with the assembly to effect closure of the same, as well as for substantially reducing if not eliminating a detrimental contact "bounce" encountered in the operation of such assemblies. The force transmitting spring member acts through a terminal member shaped to provide a teetering motion in conjunction with the desired bifurcated action for assuring closure of the contacts. The assembly is composed of parts formed mainly of plastic material molded to shape and as such provides a durable, light-weight, and low cost structure.

24 Claims, 11 Drawing Figures
KEYBOARD SWITCH ASSEMBLY WITH IMPROVED OPERATING MEANS

BACKGROUND OF THE INVENTION

This invention is directed to that field of art pertaining to switch actuating keyboards and more particularly to the structure of the individual keys thereof for closing associated electrical switches.

SUMMARY OF THE INVENTION

An important object of this invention is to provide an improved key assembly for switch actuating keyboards which is designed for reliable, long life usage.

Another important object of the invention is to provide a switch actuating key structure which is designed in an improved manner to eliminate "bounce" of the electrical contacts.

Another important object of the invention is to provide an improved switch actuating key operated assembly which eliminates premature electrical contact as well as helping in reducing the severity of vibration transmissibility occurring at the switch.

A further important object of the invention is to provide an improved bifurcated action for the individual keys of a keyboard.

More specifically, the objects of the invention are effectively and economically carried out with the cooperation of the parts forming the key assembly in conjunction with certain diaphragms carrying conductive elements thereon to form the electrical switch for the actuarable parts of the key. Included in such a key mechanism are a pair of coiled springs coaxially and overlappingly related to one another and such that one coil spring acts to resist depression of the key and the other act to transmit the actuating forces for closing the electrical contacts serving as the switch. For timing the closure of the switch in the operation of the key assembly as well as to improve the tactile feel thereof, the force transmitting coil spring is especially designed so as to have two distinctive spring rates as it is compressed. In addition, the force transmitted by this coil spring is conveyed through an improved bifurcated provision for insuring closure of the switch.

The above listed objects, advantages and other meritorious aspects of the invention will be more fully explained in the following detailed description. For more complete understanding of the invention, reference may be had to the following detailed description in conjunction with the accompanying drawing sheets.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an exploded perspective view of a fragmentary portion of a keyboard showing the parts of one of the key assemblies in their order of assembly;

FIG. 2 is an enlarged vertical sectional view through a key switch assembly constructed in accordance with this invention showing the parts of the assembly in its normal undepressed condition;

FIGS. 3 and 4 are vertical sectional views similar to that of FIG. 2 but of smaller scale and illustrating the parts of the assembly in its raised and depressed conditions respectively;

FIG. 5 is an enlarged detail view of the double rate spring employed as the force transmitting member for actuating the switch;

FIG. 6 is a force deflection graph illustrating the action of the double rate spring of FIG. 5;

FIG. 7 is an enlarged detail view of the under surface of the switch actuating part;

FIG. 8 is an enlarged detail view of the upper surface of the switch actuating part of FIG. 7;

FIG. 9 is an enlarged detail sectional view taken along line 9—9 of FIG. 7 and illustrating the action of one of the bifurcated elements;

FIG. 10 is a sectional view similar to FIG. 9 but taken on line 10—10 of FIG. 7; and

FIG. 11 is an enlarged detail view of the conductor patterns forming the contacts.

Referring to the drawing, a fragmentary portion of a keyboard incorporating the present invention is generally shown in exploded perspective condition in FIG. 1. In general, the top member 10 of the keyboard may be formed of hardened plastic material molded so as to provide a plurality of key stem guides 12 protruding thereabove which may be arranged in crossing rows and columns in accordance with conventional practice. At the bottom end of the keyboard is a base member 14 which may either be a printed circuit board formed of molded plastic material and bearing conductive elements on its upper surface or be a metal plate overlaid by a thin sheet of electrically insulating material bearing electrically conductive elements or leads 16 on the upper surface thereof so as to be insulated from the metal base. Interposed between the base plate 14 and the top member 10 of the keyboard are the plurality of key actuable assemblies, one for each key of the keyboard, for individually closing and opening a switch associated with the conductive elements carried by the base member 14. In general, the keyboard of the present invention is structured to include a number of layers between these two members 10 and 14 which are shown in FIG. 1 in their order of assembly.

With more specific reference to FIGS. 1 and 2, the layer immediately above the base member 14 is a dielectric 18 serving as a thin electrical separator between adjacent layers and having cutouts or apertures 20 formed therein which are grouped together in pairs with one for each key assembly as will be described in more detail hereinafter. Immediately above the dielectric member 18 is a diaphragm 22 of insulating material carrying conductive leads 24 on its under surface which are likewise paired for each key assembly as will be later described herein. Immediately superimposing the diaphragm 22 is a cover member 26 which may be formed of rubber material and serves as a thin deflectable pad as also will be more fully described hereinafter. Over this pad, and in slight spaced relation therefrom, is a thicker and more rigid flexural member 28 formed of molded plastic material shaped at each key position of the keyboard with an upwardly extending stud or protrusion 30 which is preferably conically shaped as is illustrated in FIGS. 1 and 2. Each cone 30 is centrally located within a square area formed by a wall 32 molded at the time of the fabrication of the member 28 but of greater thickness than the normal thickness of the panel as better shown in FIG. 2. Between each cone 30 and its wall 32, the member 28 is weakened by narrow top and bottom opening slits 34 which enable the central conical portion of the walled area to be deflected out of the plane of the panel as later more fully described herein.
Slightly spaced above the member 28 is a thin metal plate 36 having a soft cushioning layer 38, such as felt, bonded to the upper surface thereof. The plate 36 and its felt lining 38 are apertured as at 40 in alignment with each key of the keyboard and the apertures are of such a size to admit the conical studs 30 as evidenced in FIG. 2. Associated with each key of the keyboard are a pair of coiled springs of different diameters and coaxially related and positioned so that the smaller diameter spring 42 is at least partly enclosed by the larger diameter spring 44 as shown in FIG. 2. The larger diameter coiled spring 44 of each key assembly has its lower end seated upon the felt layer 38 bonded to the metal plate 36. The smaller diameter coiled spring 42 of each key assembly is of a size to enter its associated aperture 40 of the metal plate 36 and encircle the conical protrusion 30 with which it is associated for seating on the immediately surrounding flat base of member 28 as shown in FIG. 2. The upper ends of these two coiled springs 42 and 44 are seated in a movable member or plunger 12 which serves as a key stem and rises upwards through its associated guide 12 of the top member 10 of the keyboard and projects thereabove in assembled condition as shown in FIG. 2. Secured to the upper projecting end of the plunger 46 is a key top or button 48 which is shaped to receive the upper end of the plunger and to be releasably secured thereto.

With further reference to FIGS. 1 and 2, the plunger guide 12 of each key assembly has a tubular upper section 50 slightly narrowing in both its inner and outer diameters as the upper end thereof is reached. This tubular portion of the guide 12 merges with a square-shaped, box-like lower section 52 which is seated upon the felt lined metal plate 36 in surrounding relation to the conical protrusion 30 entering the bottom opening thereof. For interfit with the guide 12, the plunger 46 is composed of an upper and lower section of different lateral dimensions. As shown in FIG. 2, the upper section 54 of the plunger slidingly bears against the inner surface of the upper rim of the tapered tubular section 50 of the guide, and the wider base section or collar 56 of the plunger is received in the wider lower section 52 of the guide. The plunger’s wider section 56 is externally square-shaped as shown in FIG. 1 and is dimensioned to have a sliding fit within the box-shaped lower section 52 of the guide. Actually, only the corner portions of the wider section 56 of the plunger are utilized for sliding contact with the inner walls of the lower section 52 of the guide. This may be accomplished in the manner illustrated herein by folding back the bottom rim portion of the plunger through a reverse circular bend as indicated at 58 in FIG. 2 and then forming the square collar 56 by an opposite reverse bend to bring down the four right angle corner portions 60 to the same level as the reverse bend 58 of the collar. The walls of the collar 60 are relatively thin as compared with the reversely bent portion 56. Preferably, as illustrated in FIG. 2, only the bottom edge of the corners of the collar section 60 have a sliding fit with the inner wall surfaces of the guide section 52. For this purpose, the corner portions 60 are slightly outwardly flared in the downward direction to bring only the lower edges thereof into sliding engagement with the inner wall of the guide section 52. In this manner only the extreme upper and lower end portions of the plunger have a sliding engagement with the guide, the maximum longitudinal separation of these sliding contact surfaces providing widely separated bearings for holding the plunger 12 from other than a straight line movement in the direction of its axis. The deviation in lateral extent of the upper and lower edges of the collar corners 60 may be in the order of .0010 of an inch for this purpose.

The protruding end of the plunger has an interlocking relationship with the key top 48 such that the latter may be releasably but firmly snapped on and removed without difficulty. This is accomplished by providing a cross shaped engagement 62 into the upper end of the plunger 46 which is dimensioned to receive four depending resilient prongs 64 integrally joined to the body portion of the key top 48. The bases 66 of the grooves forming the cross shaped engagement 62 slope slightly toward the axis of the plunger as evident in FIG. 2 and each forms a shoulder 68 at its lower end. The extremities of the prongs are each thickened radially outwardly so as to be cammed inwardly by the sloping bases 66 until each prong rides over its shoulder and thereat expands into interlocking engagement therewith as shown in FIG. 2. When force is applied to remove the key top 48, the prongs are resiliently contracted as they ride over the shoulders 68 and thereby free the key top from the plunger.

As earlier mentioned herein, the upper ends of the two coiled springs 42 and 44 are seated on the plunger. In the assembled condition of the parts, the smaller diameter inner spring 42 has a length such that when freely extended as shown in FIG. 2, it is approximating twice that of the outer spring. However, in its assembled condition, the outer spring 44 is under compression or otherwise in freely extended condition its length would approximate that of the inner spring 42. The upper end of the inner spring 42 overrides a downwardly depending cone 70 providing a tapered conical surface for holding the upper end of the spring against lateral bending movement when compressed in operation. The outer coiled spring 44 surrounds the reversely bent portion 56 of the plunger and enters a narrow space between this portion and the depending square shaped collar 60 of the plunger. In this fashion the upper ends of the two springs 42 and 44 are retained between tapered conical surfaces and thus prevented from lateral bending or snacking movement when either spring is compressed. Moreover, as illustrated in FIGS. 2 and 5, the opposite ends of the two springs 42 and 44 are preferably closed and ground.

It will be noted that one of the coiled springs, namely, the inner smaller diameter spring 42, has its convolutions at two different helical pitches. Referring to FIGS. 1, 2 and 5, the upper end section 72 of the coiled spring 42 in the illustrated embodiment of the invention has a fine pitch as compared with the coarser or wider pitch of the coils of the lower section 74 of the spring. The result is that spring 42 has a low spring rate (see FIG. 6) which assists in eliminating premature electrical contact while its high spring rate insures electrical contact before the key top goes beyond a desired limit. The combination of low rates in the same spring allows the key top force to be relatively low at first before a predetermined point in the plunger’s movement is reached. The two spring sections 72 and 74 of inner spring 42 initially act as two independent springs in series, but as the inner spring is compressed, it progresses from a low rate spring into a high rate spring in a predetermined transition zone B to D (theoretically it could
be point C) of FIG. 6. The resulting effective higher spring rate helps eliminate contact bounce by reducing the severity of the transmission of any vibration occurring between the inner spring 42 and the contact bearing diaphragm 22.

The force deflection graph of FIG. 6 illustrates the action of the dual rate spring 42. Initially, the resistance to compression of the total spring 42 is at a relatively low rate as evidenced by the slope of the graph between A and B. As the finer pitch coils of section 72 of the spring make abutting engagement with one another, the spring rate changes to a higher rate as indicated by the steeper slope of the graph between D and E. At approximately the point D on the graph, all of the coils of spring section 72 are in contact with one another thus terminating all resiliency in this section of the spring. Thereafter, the coils of the spring section 74 are the only active ones remaining in the spring for resiliently resisting downward movement of the plunger 46 and its key top 48. The dual rate spring 42 should be chosen so that electrical contact is made by the key assembly in the transitional area of the graph between B and D and preferably nominal contact should be made at the time point C is reached.

To gain the earlier mentioned bifurcated action, the underside of the flexure member 28 opposite each conical protrusion 30 is provided as best shown in FIG. 7 with a pair of depending pressure applying elements 76—76 of similar half-moon shape. Such elements are suspended from the underside of the flexure 28 in spaced parallel relation to one another and on diametrically opposite sides of the axis of the cone 30 as shown in FIG. 3. Each element preferably exhibits an arcuate lower edge for engaging and depressing the rubber cover 26 making a curved or rocking chair-type contact therewith, and moreover these elements preferably form an integral part of the flexure 28 as evidenced by the cross hatching in FIG. 2. By such an arrangement and formation, the two arcuate elements 76—76 collectively form a double radius pressure applying structure incoring a teetering ability analogous to the legs of a rocking chair.

In addition, as best shown in FIG. 8, the upper side of the flexure member 28 on two opposite sides of each cone 30 there is provided a pair of similar narrow-shaped ledges of lands 78—78 located in a plane intersecting the cone's axis and extending to a height preferably flush with the upper surfaces of the thickened wall portions 32 surrounding the cone section of the flexure. The two lands 78—78 together form a seat for the lower end of the inner coiled spring 42. They also form an axis about which each cone section or square of the flexure 28 may rock when the pressures are transmitted by the spring 42. This axis extends at 90° or right angles to the rocking axis of the arcuate elements 76—76 on the underside of each cone section of the flexure 28. The result is that each cone bearing square of the flexure 28 is capable of rocking about either axis separately or both axes concurrently as downward pressure is applied by the inner spring 42 in response to the depression of its keyboard key. It is evident that each square of the flexure is not only depressible in response to key actuation but also is capable of rocking motion about either or both such axes. Thus, the desired bifurcated action is achieved by converting forces exerted by the spring 42 to two separated pressure applying areas in response to each depression of the key while at the same time enabling the bifurcated end of the double rate spring to teeter or rock about two perpendicularly related axes for assuring closure of the switch contacts.

The result of a key actuation is shown by comparing FIGS. 3 and 4 with one another. FIG. 3 shows the position of the parts similar to that of FIG. 2 where the key top is raised to its maximum level and the coiled spring 42 is under no compression. FIG. 4 shows the position of the parts when the key top is fully depressed to its maximum extent. It is noted in FIG. 4 that the cone 30 of the flexure 28 has been depressed below its normal level shown in FIG. 3 which in turn causes the arcuate shaped elements 76—76 to depress the rubber cover 26 and the diaphragm 22 downwardly bringing the conductive leads 24 on the underside of diaphragm 22 into engagement with the conductive pads 16 on the base member 14 of the assembly. In so doing, the depending elements 76—76 are brought into alignment with the pair of parallel leads 24 on the underside of diaphragm 22 and depressing them through the pair of oval apertures 20 of the dielectric 18 in alignment therewith and thence bringing these leads into contact with the conductive pad 16 of the base member 14 which registers therewith. The intervening portion 80 of the dielectric 18 which separates the oval holes 20 provides independent deflection zones into which the two parallel leads 24 are introduced for engagement with the separate portion of the pad 16 located in the position of the actuated key. In effect, the intervening portion of the dielectric acts as a shim which is straddled by the bifurcated structure 76—76 and about which it may teeter or rock.

FIGS. 9, 10 and 11 illustrate the action of making contact between the leads 24—24 of the flexible diaphragm 22 and the pads 16 of the base member 14. The conductive patterns on the two laminates 22 and 14 may be that illustrated in FIG. 11 where in each key position of the keyboard the base member 14 is provided with a conductive pattern such as represented in the lower right hand corner of FIG. 11 comprising the two conductive areas or pads 16—16 joined by conductive leads 82 to a peripheral conductor 88 which in turn can be connected to one or more adjacent conductive patterns on the base member. Immediately superposing the conductive pattern on base member 14 is the earlier mentioned dielectric sheet 18 having a pair of generally oval-shaped cutouts or apertures 20—20 in each key position which as shown in FIG. 11 will expose the pads 16—16 therethrough. Above the dielectric 18 sheet is the diaphragm 22 which may bear the conductive pattern on the underside thereof illustrated in the lower left corner of FIG. 11. The dieaphragm is preferably a thin elastomeric member which may be translucent rendering the pattern on the underside thereof visible therethrough as indicated in FIGS. 1 and 11. For purposes hereinafter discussed, each lead 24 is shown in FIGS. 1 and 11 as being interrupted or broken to form a gap 86 therein. These broken or split leads 24—24 are connected at their outer ends to a peripheral conductor 88 which preferably registers with and therefore overlies and bears upon the peripheral conductor 84 of the base member 14 through the intermediary of the insulating sheet 18. Thus, during the depression of each switch assembly, the registering peripheral conductors 84 and 88 provide a bearing zone or frame surrounding the
central area containing the pads 16 and the broken leads 24.

An important feature of the switch formed by the overlying conductive patterns is that provided by the division of each lead 24 into two aligned sections separated by the gap 86 and the provision of a radius of curvature identified at 90 on the gap end of each part of the divided lead. Referring to FIG. 9, it will be apparent that when the bifurcated pressure elements 75—76 of each switch assembly depress the laminates 22 and 26 through the holes 20—20 of the dielectric sheet as shown in FIGS. 9 and 10, they will bow the gap portions of the leads 24—24. Moreover, because of the bowing of the split sections of each lead 24, the initial contact made by such lead with its pad 16 is a point of high pressure which is later spread over more surface area of the lead as the key assembly is further depressed. The curving of the ends of the split parts of each lead 24 at the gap 86 assures that the first contact with the pads 16 of the base member is a point on the bottom right-angled edge of one of the extremities 90 of the divided parts of each lead 24. Furthermore, following initial contact the divided lead sections are progressively flattened by further depression of the key assembly and in so doing the two gap ends 90 of each lead move slightly toward one another in scrubbing contact with the conductive pad 16.

In carrying out the aforesaid switch action, it is desirable because of the limited amount of force for deflecting the laminates 22 and 26 to remove or etch away as much conductive material from the pattern as possible leaving only enough of such material in the least strained direction (which is the direction of the long axis of each oval opening 20) for reliably performing the conductive function of the pattern. The removal of such material will lower the force needed to flex the diaphragm. By also dividing the conductor leads 24—24 in the center of the oval opening, the diaphragm will be further weakened thus removing the resistance to bending moment of each conductor lead at the midpoint of its span. It is preferred that pattern symmetry be employed in order to produce consistent results. Lastly, the breaks or gaps 86 provided by the division of the conductor leads 24—24 in the center of each oval zone 20 and the radius of curvature applied to the ends 90 of the leads terminating at the gap will make as high a pressure point contact as possible with its associated conductive pad 16 by bringing the acutely angled end 90 of each divided lead 24 into point contact with the flat surface of the pad. The result is that when the engagement between the contacts 16 and 24 first occur, the high loading point 90 of each divided lead will first make a high pressure point contact with the associated pad 16, and then thereafter as further key pressure is applied the terminating ends 90 of the split leads 24 begin to flatten out and at the same time move toward one another with a microscopic scrubbing action on the flat surface of the conductive pad 16.

The electronic keyboard operation can be described as follows. It is evident from the earlier description herein that when an operator pushes on the key top the force travels through the key top to the plunger. A small part of this force goes to the outer compression spring 44 and the rest goes to the inner compression spring 42. In a desired embodiment of the invention, the outer spring keeps the key top in its most upward location with a preload of about 40 grams. The inner spring has no load on it when the key top is fully up but begins compressing as soon as the key top starts to travel downward. The outer spring has a low rate of 45 grams per inch and thus adds little extra resistance as the key top travels downward. In contrast, in a preferred embodiment of the invention, the inner spring has a spring rate of 239 grams per inch for the first .090 inches of travel and a rate of 1193 grams per inch for the next .087 inches of key top travel.

The load on the outer spring 44 is transmitted to the spacer plate 36 and does not affect the diaphragm switch. But the load on the inner spring 42 puts a load on the upper diaphragm or flexure 28 which in turn transmits most of this load equally to both of the depending rocking element pads 76—76. Each pad 76 then produces a relatively high pressure area on the rubber cover 26 and in turn on the lower diaphragm 22. This load then causes the rubber cover and the lower diaphragm to deflect through its associated pair of oval holes 20 in the dielectric 18 until the conductive leads on the underside of the lower diaphragm contact the conductive elements or pads on the circuit board 14. As the load from the inner spring 42 continues to increase, the contact pressure increases accordingly. The bifurcated action together with the teetering capability of the cone section of the panel 28 about which the lower end of the spring is seated will overcome any irregularities encountered in making electrical contact between the conductive elements of the assembly.

While a particular embodiment of the invention has been shown and described, it will be understood, of course, that it is not desired that the invention be limited thereto since modifications may be made, and it is, therefore, contemplated by the appended claims to cover any such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A switch assembly including, in combination:
   a. a relatively rigid member having one of a pair of electrical contacts on a surface portion thereof;
   b. a flexible diaphragm having the other one of said pair of electrical contacts on a surface portion thereof in opposed confronting relation to said first one of said pair of contacts, said diaphragm normally supporting its contact of the pair of contacts in spaced relationship to the other contact of the pair of contacts but being deflectable in the direction of the relatively rigid member to effect closure of the pair of contacts;
   c. a member mounted for movement along a path toward and away from the pair of contacts and disposed on the side of the flexible diaphragm opposite to the rigid member;
   d. means foryieldingly resisting movement of the movable member toward the rigid member and for effecting engagement of the contacts of said pair of contacts as a concluding result of such movement, said means comprising a pair of coiled springs of different diameters and arranged coaxially with respect to one another with the smaller diameter spring being at least partially enclosed within the larger diameter spring;
   e. one of said pair of springs having one end seated upon a relatively stationary support and the other end engaged with the movable member in such a manner as to yieldingly resist movement thereof toward the pair of contacts; and
f. the other of said pair of springs having one end effectively bearing against the flexible diaphragm and having the other end engaging the movable member in such manner as to yieldingly resist movement of the movable member toward the pair of contacts with the result that the force exerted by such movement of the movable member is effectively transmitted by the last mentioned spring to the diaphragm to deflect the same in the direction to effect closure of the pair of contacts.

2. The switch arrangement defined in claim 1 wherein said other of said pair of springs is a multi-rate spring having its coils set at least at two different helical pitches.

3. The switch arrangement defined in claim 1 wherein said other of said pair of springs is a double rate spring so designed as to have the transition from one spring rate to the other occur at the time closure of said pair of electrical contacts is effected.

4. The switch arrangement defined in claim 1 wherein the larger diameter coiled spring serves as said one of said pair of coiled springs and the smaller diameter coiled spring serves as said other of said pair of coiled springs.

5. The switch arrangement defined in claim 4 wherein the movable member is in the form of a reciprocating plunger which is hollowed interiorly to provide a chamber opening out of the plunger in the direction of the diaphragm and shaped internally to partially enclose and seat one end of the smaller diameter spring and shaped externally to enter one end of the larger diameter spring and provide a seat therefore.

6. The switch arrangement defined in claim 5 wherein conical surfaces are presented to the respective inside diameters of the smaller and larger coiled springs to prevent lateral deflection of the springs as they are compressed.

7. The switch arrangement defined in claim 4 wherein said smaller coiled spring acts upon the diaphragm through the intermediary of an element having spaced apart projections engageable with corresponding spaced areas of the diaphragm to deflect these areas in the direction for closing said pair of contacts.

8. The switch arrangement defined in claim 7 wherein one of said pair of contacts is split into at least two circuit parallel leads, and wherein said spaced apart projections of said element individually align with the circuit parallel leads for providing a bifurcated action on the pair of contacts to close the same.

9. The switch arrangement defined in claim 8 wherein said element has a limited universal tilting movement as closure of said pair of contacts is being effected.

10. The switch arrangement defined in claim 7 wherein said element is in the form of a plate-like member having the central portion thereof deflectable out of its normal plane when said smaller diameter coiled spring is transmitting the force of the movable member toward the diaphragm.

11. In a keyboard-type switch construction in which laminates are superposed in close proximity to one another, the combination:
   a. a base panel having an electrically insulating surface divided into a plurality of switching areas;
   b. an electrical conducting switch contact element carried upon said surface of the base panel within each of said switching areas;
   c. a flexible diaphragm overlying the said plurality of switching areas of the base panel and normally supported in spaced relation thereto, said diaphragm carrying an electrical conductive switch contact element on the side thereof facing said base panel and within each of said switching areas thereof;
   d. a depressible switch operating member located on the side of the diaphragm opposite to said base panel within each of said switching areas thereof and supported for movement toward and away from the base panel, each said member being effective upon depressive movement to engage and depress an adjacent portion of said diaphragm and thence to bring the switch contact element which is carried thereby within the switching area of the depressed member into engagement with the fixed contact element within the corresponding switching area of the base panel; and
   e. spring means opposing the depression of said member and resisting each such movement with a relatively low spring rate prior to engagement of said contact elements with one another and with a second higher spring rate following engagement of the contacts with one another.

12. The switch construction defined in claim 11 wherein each conductive switch element carried by said flexible diaphragm is divided into at least two parts each of which is acutely angled into edgewise engagement with the corresponding contact element carried by the base panel when the operating member is depressed.

13. The switch construction defined in claim 11 wherein each conductive switch element carried by said flexible diaphragm is split into at least two circuit parallel leads each having a gap therein, and wherein the leads terminate at the gap in a radius of curvature and are capable when the operating member is depressed of being acutely angled into point engagement with the corresponding contact element carried by the base panel.

14. In a keyboard-type switch construction in which laminates are superposed in close proximity to one another, the combination:
   a. a supporting member having an electrically insulating surface divided into a plurality of switching areas;
   b. an electrical conducting switch contact element carried upon said surface of the supporting member within each of said switching areas;
   c. a flexible diaphragm overlying the said plurality of switching areas of the supporting member and normally supported in spaced relation thereto, said diaphragm carrying an electrical conductive switch element on the side thereof facing said supporting member and within each of said switching areas thereof, each said switch element having an edge portion thereof terminating centrally of its switching area and being deflectable with the diaphragm to assume an angle to the surface of the supporting member;
   d. a switch actuator located on the side of the diaphragm opposite to said supporting member within each of said switching areas thereof and mounted for movement toward and away from the supporting member, each such switch actuator being effective upon movement toward the supporting member to engage and depress an adjacent portion of
said diaphragm and thence to move that switch contact element which is carried by the diaphragm within the switching area of the moving actuator at an angle toward and into edgewise engagement with the corresponding contact element carried by the supporting member; and

e. spring means associated with each switch actuator and yieldingly opposing its movement toward the supporting member and being operable to return its associated actuator and the adjacent depressed portion of the diaphragm to normal inoperative position.

15. The switch construction defined in claim 14 wherein each conductive switch element carried by said flexible diaphragm is divided into at least two parts each of which is acutely angled into edgewise engagement with the corresponding contact element carried by the base panel when the operating member is depressed.

16. The switch construction defined in claim 14 wherein each conductive switch element carried by said flexible diaphragm is split into at least two circuit parallel leads each having a gap therein, and wherein the leads terminate at the gap in a radius of curvature and are capable when the operating member is depressed of being acutely angled into point engagement with the corresponding contact element carried by the base panel.

17. The switch construction defined in claim 14 wherein the spring means includes a coiled spring in each of said switching areas and effectively extending between each of said switch actuators and the portion of the diaphragm within the switch area of the actuator, said spring being a multi-rate spring operable to transfer from a lower spring rate to a higher spring rate at approximately the time the contact element carried by the diaphragm makes initial engagement with the corresponding contact element carried by the supporting member.

18. A switch assembly including, in combination:
  a. a relatively rigid member having one of a pair of electrical contacts on a surface portion thereof;
  b. a flexible diaphragm having the other of said pair of electrical contacts on a surface portion thereof and in opposed confronting relation to said first mentioned one of said pair of contacts, said diaphragm normally supporting its contact of the pair of contacts in spaced relationship to the other contact of the pair of contacts but being deflectable in the direction of the relatively rigid member to effect engagement of the pair of contacts;
  c. a switch actuating member mounted for movement along a path toward and away from the pair of contacts and disposed on the side of the flexible diaphragm opposite to the rigid member;
  d. means for yieldingly resisting movement of the movable member toward the rigid member and for effecting engagement of the contacts of said pair of contacts in the course of such movement, said means comprising at least one spring member arranged to yieldingly oppose movement of the movable member toward the rigid member;
  e. one of said pair of contacts having at least two spaced apart circuit parallel portions, and the other of said pair of contacts having surface areas thereof confronting the circuit parallel portions of the first contact; and

f. spaced apart projections individually aligning with the circuit parallel portions and responding to movement of the movable member toward the rigid member for first engaging and then deflecting corresponding spaced apart areas of the diaphragm toward the rigid member thereby to cause a bifurcated switch closing action to occur between the pair of contacts.

19. In a keyboard-type switch construction in which laminates are superposed in close proximity to one another, the combination:
  a. a base panel having an electrically insulating surface divided into a plurality of switching areas;
  b. an electrical conducting switch contact element carried upon said surface of the base panel within each of said switching areas;
  c. a flexible diaphragm overlaying the said plurality of switching areas of the base panel and normally supported in spaced relation thereto, said diaphragm carrying an electrical conductive switch contact element on the side thereof facing said base panel and within each of said switching areas thereof;
  d. a depressible switch operating member located on the side of the diaphragm opposite to said base panel within each of said switching areas thereof and supported for movement toward and away from the base panel, each said member being effective upon depressive movement to engage and deflect an adjacent portion of said diaphragm and cause the switch contact element carried thereby within the switching area of the depressed member to move into engagement with the fixed contact element within the corresponding switching area of the base panel;
  e. spring means opposing the depression of each of said switch operating members and for returning the same and the diaphragm to normal undeflected state; and
  f. each said switch contact element carried by said flexible diaphragm having an electrically conductive extension terminating approximately midway of its switching area and capable when the adjacent portion of the diaphragm is deflected by the switch operating member of being acutely angled into edgewise engagement with the corresponding switch contact element carried by the base panel.

20. The switch construction defined in claim 19 wherein each conductive switch element carried by said flexible diaphragm is divided into at least two circuit parallel leads each having a gap therein.

21. The switch construction defined in claim 20 wherein each said circuit parallel lead terminates at the gap in a radius of curvature and is capable when the adjacent portion of the diaphragm is deflected by the operating member of being acutely angled to bring its curved terminating end into point engagement with the corresponding switch contact element carried by the base panel.

22. In a keyboard-type switch construction in which laminates are superposed in close proximity to one another, the combination:
  a. a supporting member having an electrically insulating surface divided into a plurality of switching areas;
b. an electrical conducting switch contact element carried upon said surface of the supporting member within each of said switching areas;
c. a flexible diaphragm overlying the said plurality of switching areas of the supporting member and normally supported in spaced relation thereto, said diaphragm carrying an electrically conductive switch element on the side thereof facing said supporting member and within each of said switching areas thereof, each said switch element having an edge portion thereof terminating within the border of its switching area and being deflectable with the diaphragm to assume an acute angle to the surface of the supporting member; and
d. a switch actuator located on the side of the diaphragm opposite to said supporting member within each of said switching areas thereof and mounted for movement toward and away from the supporting member, each such switch actuator being effective upon movement toward the supporting member to engage and deflect the adjacent portion of said diaphragm and thereby cause the switch contact element which is carried by the diaphragm within the switching area of the moving actuator to move at an acute angle toward and into edgewise engagement with the corresponding contact element carried by the supporting member.

23. The switch construction defined in claim 22 wherein each conductive switch element carried by said flexible diaphragm is divided into at least two parts, each of which is acutely angled into edgewise engagement with the corresponding contact element carried by the base panel when the operating member is sufficiently depressed to deflect the adjacent portion of the diaphragm.

24. The switch construction defined in claim 23 wherein each conductive switch element carried by said flexible diaphragm is split into at least two circuit parallel leads each having a gap therein, and wherein the terminating end of each lead is progressively reduced in width at the gap such that when the operating member is depressed and deflects the adjacent portion of the diaphragm the terminating ends of the leads are acutely angled into point engagement with the corresponding contact element carried by the base panel.