United States Patent

Iwashima et al.

[15] **3,678,424**

[45] **July 18, 1972**

[54] KEYBOARD SWITCH ASSEMBLY

[72] Inventors: **Hideo Iwashima; Satoshi Fukao,** both of Aichi-ken, Japan

[73] Assignee: **Brother Kogyo Kabushiki Kaisha,** Nagoya-shi, Japan

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[30] **Foreign Application Priority Data**

May 19, 1970 Japan.....45/42766

[52] **U.S. Cl.**.....**335/206,** 200/5 A, 200/159 B, 197/98, 317/101, 317/112

[51] **Int. Cl.**.....**H01h 13/00**

[58] **Field of Search**.....200/5 A, 5 R, 1 A; 335/205, 335/206, 207; 340/365 R; 197/98; 317/101 C, 101 CC, 101 CP, 112, 113

[56] **References Cited**

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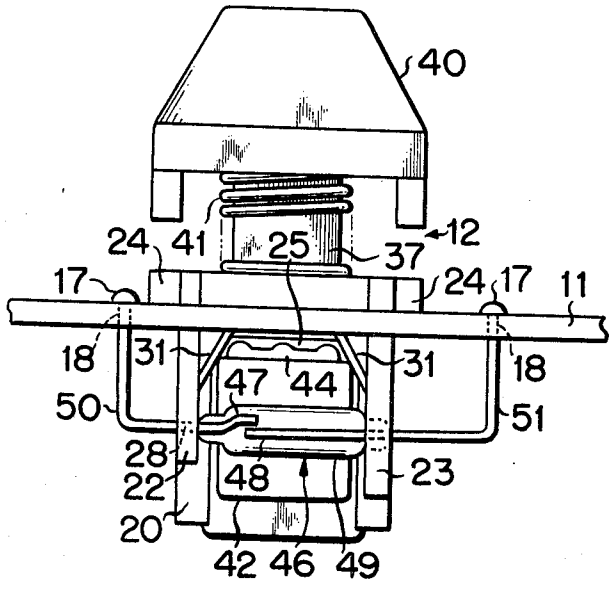
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Primary Examiner—Roy N. Envall, Jr.
Attorney—Flynn & Frishauf

[57] **ABSTRACT**

A keyboard switch assembly comprising a flat board printed with key input circuits and perforated with a plurality of apertures; and a plurality of key switch units inserted into the apertures, the unit consisting of a key guide member of synthetic resinous material, a key longitudinally slidable therethrough and a magnetic reed switch connected to the key input circuit so as to be actuated upon key depression.

9 Claims, 14 Drawing Figures



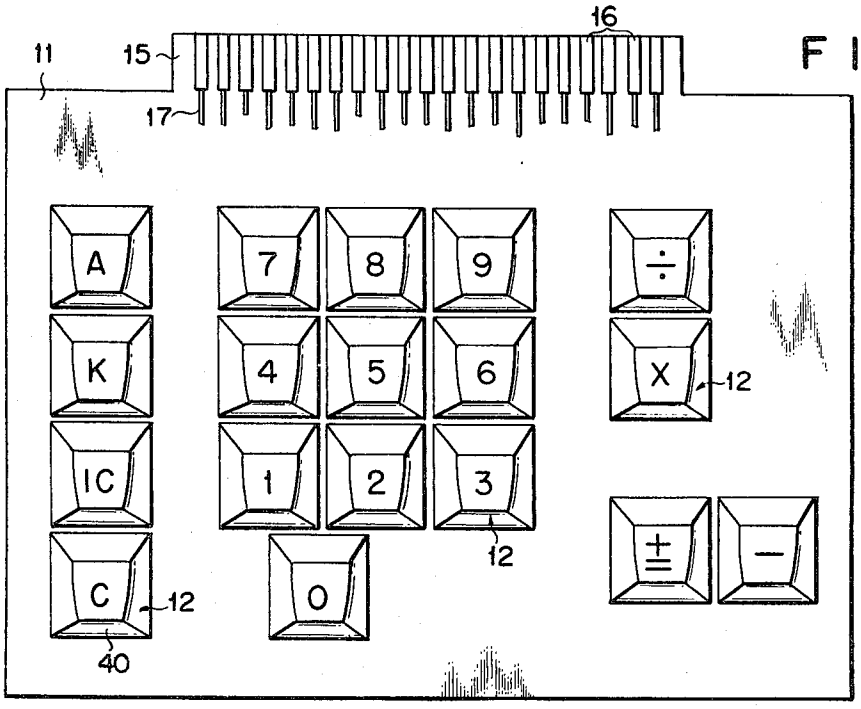


FIG. 1

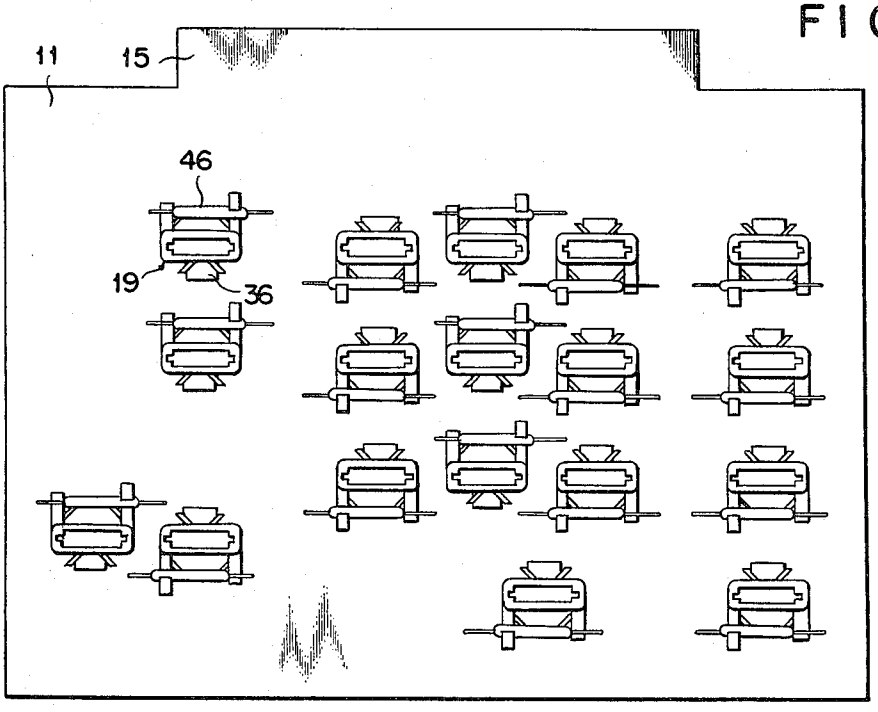


FIG. 2

FIG. 3

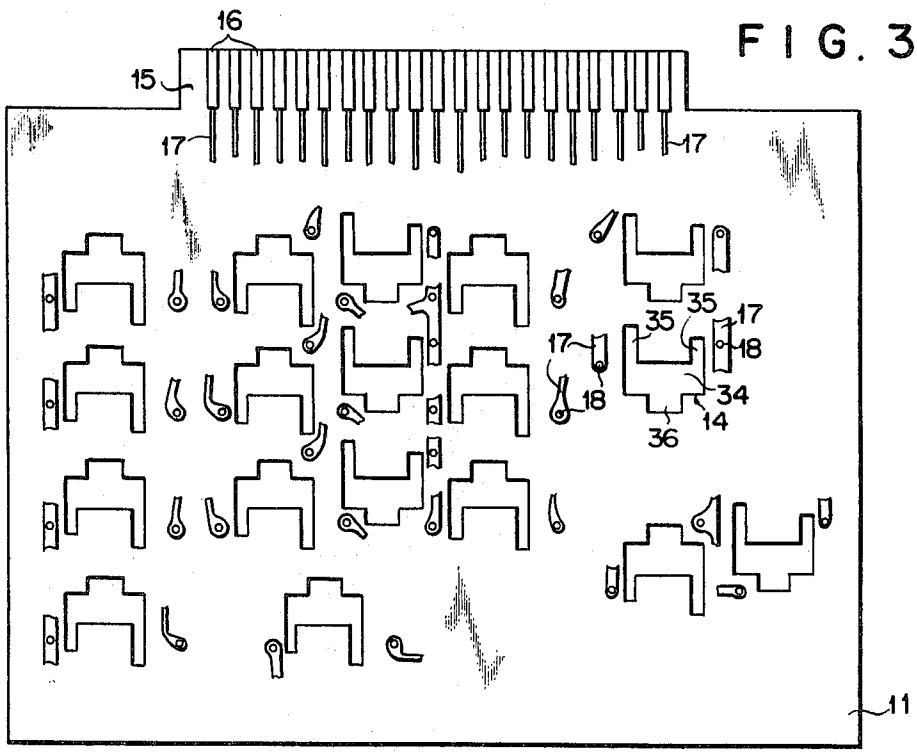

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FIG. 4

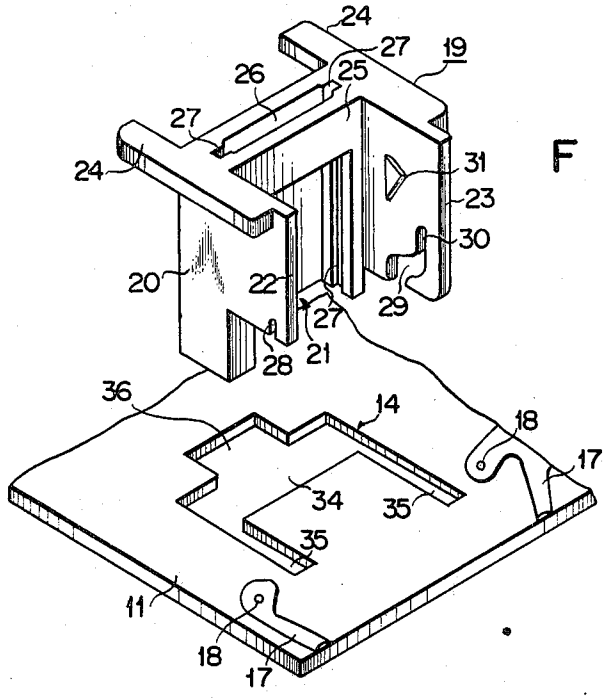

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FIG. 5

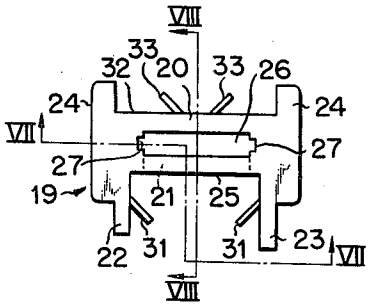


FIG. 6

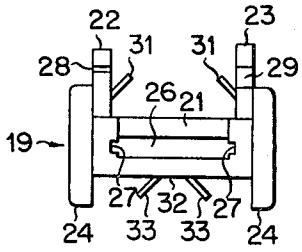


FIG. 7

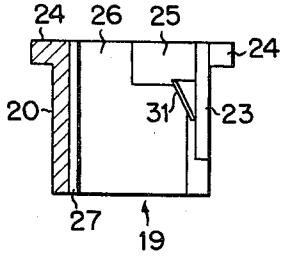


FIG. 8

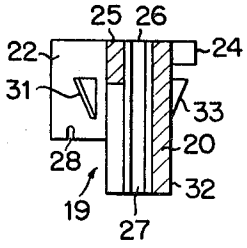


FIG. 9

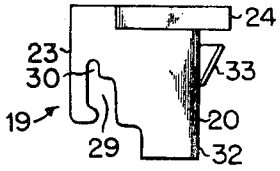


FIG. 10

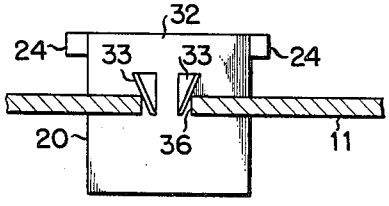


FIG. 11

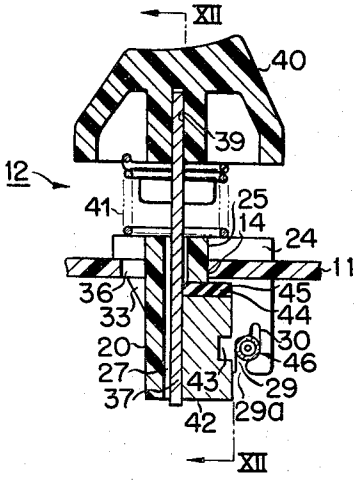


FIG. 12

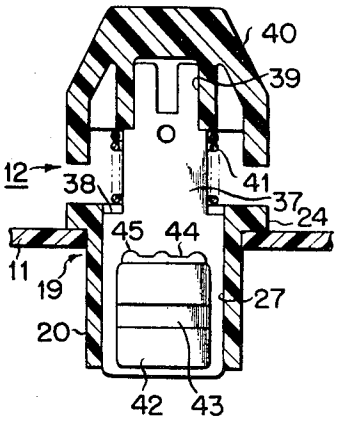


FIG. 13

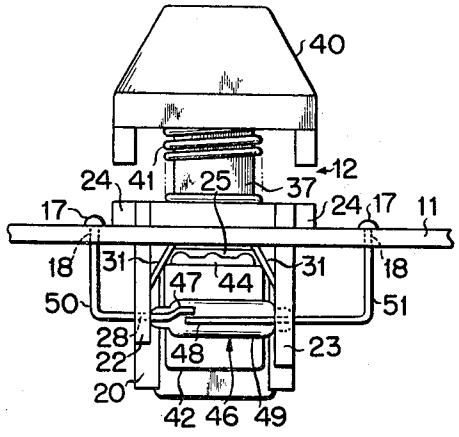
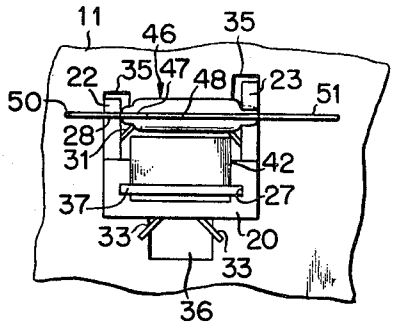


FIG. 14



KEYBOARD SWITCH ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to a keyboard switch assembly for use with calculators including the electronic type.

With a prior art calculator, the frame on which there is mounted a key mechanism consists of an upper plate constituting a keyboard and an opposite lower plate forming a base plate to which there are fitted reed switches, said plates acting to guide the keys. However, such arrangement is uneconomical in that the frame has to be formed of two plates. Further there has been proposed a frame constructed by forming key guide portions when the frame is molded and then mounting keys and reed switches thereon, so as to guide the keys only by the key guide portions. With this type of frame, the electrical circuits connected to the reed switches are disposed on a base plate provided separately from the keyboard, so that connection between the switches and circuits has to be effected by a large number of electrical wires. Consequently a keyboard switch assembly using the aforesaid type of frame has been encountered with the drawbacks that not only maintenance, inspection and repair are difficult to carry out, but also due to integral formation of the key guide portions with the keyboard it is impossible to form a key guide portion, key and reed switch into one unit and use the resulting key board assembly in other types of calculators, for example, an electronic type.

SUMMARY OF THE INVENTION

It is accordingly an object of this invention to provide a compact, mechanically as well as electrically stable keyboard switch assembly wherein unitization is realized by causing a single flat board concurrently to act as a printed circuit board and a keyboard.

Another object of the invention is to provide a keyboard switch assembly which minimizes wiring work and prominently facilitates assembly, maintenance, inspection and repair by forming a printed circuit and keyboard into an integral unit.

Still another object of the invention is to provide a keyboard switch assembly which can be used as it is with various types of calculator due to unitization of the main part.

According to this invention, there is provided a keyboard switch assembly comprising a printed circuit board perforated with a plurality of apertures; and a plurality of key switch units, each consisting of a key guide member of synthetic resin inserted into the aperture so as to be fixed to the printed circuit board, a key longitudinally slidable through the key guide member and a magnetic switch for closing a key input circuit included in the printed circuit board upon key depression.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a keyboard switch assembly according to an embodiment of this invention;

FIG. 2 is a bottom view of the assembly shown in FIG. 1;

FIG. 3 is a plan view of a printed circuit board of the keyboard switch assembly;

FIG. 4 is an exploded perspective view of part of the printed circuit board and a key guide member inserted into the board;

FIGS. 5 and 6 are respectively a plan view and a bottom view of the key guide member as shown in FIG. 4;

FIG. 7 is a front sectional view along line VIIVII of FIG. 5;

FIG. 8 is a vertical section along line VIIIVIII of FIG. 5;

FIG. 9 is a right side view of FIG. 7;

FIG. 10 is a rear view illustrating how to fix the key guide member into a keyboard;

FIG. 11 is a side sectional view of an assembled key switch unit of the keyboard switch assembly;

FIG. 12 is a vertical section along line XIIXII of FIG. 10; and

FIGS. 13 and 14 are respectively a plan view and a bottom view of the key switch unit.

DETAILED DESCRIPTION OF THE INVENTION

Throughout the figures, numeral 11 denotes a printed circuit board or keyboard of synthetic resin (or a flat board), the plain surface of which is perforated with eighteen apertures 14 into which to fit digit keys and function keys 12. From one side of said surface outwardly extends a plug 15 having a plurality of plug contacts 16 arranged in parallel. On the upper surface of the printed circuit board 11 are printed external circuits or key input circuits 17 made of conducting material. One end of the circuit 17 is connected to the corresponding plug contact 16. At the other end or intermediate part of said circuit is formed a small hole or holes 18 so as to allow the lead wires of the later described magnetic reed switches to be connected to the printed circuit board 11 from its underside. In FIG. 3, to avoid complication of the presentation, there is omitted the joint between the key input circuits 17 and plug contacts 16.

Referring to FIG. 4, numeral 19 represents a key guide member. This guide member 19 comprises a rectangular parallelepiped or a key holding pendent body 20 having a recess 21 formed at the front; switch holding portions or guide plates 22 and 23 extending forward in parallel with each other from both sides of said parallelepiped 20; and flange portions 24 horizontally extending lengthwise as well as crosswise from the top of the parallelepiped 20 and, as viewed from above it, approximately forming an H-shape. The aforesaid recess 21 has a substantially U-shaped cross section and, is open at the bottom. Between the top of the recess 21 and that of the parallelepiped 20 is formed a shoulder 25 having a thickness equal to or larger than a sum of the thickness of the flange portions 24 and that of the printed circuit board. The parallelepiped 20 is perforated with a hole elongated in the lengthwise direction of said parallelepiped 20 and penetrating it from the top of the key guide member 19 to that of the recess 21 so as to allow the key 12 to be inserted therethrough. Further, there are formed a pair of grooves 27 for guiding the key 12 which extend from both upper ends of the elongated hole 27 to both bottom ends of the recess 21. The lower end of the guide plate 22 is at a higher level than the bottom plane of the parallelepiped 20. At said lower end of the guide plate 22 is provided a notch or receptacle 28 having a sufficient width and length to cause the lead wire of the later described magnetic switch to be inserted therethrough from the bottom of the parallelepiped 20. The guide plate 23 is so formed as to extend slightly longer than the other guide plate 22 in the forward as well as downward direction of the parallelepiped 20. In the lower end of the guide plate 23 is formed a notch or receptacle 29 for firmly holding one end of the capsule of the magnetic reed switch. Further at the top of the receptacle 29 is formed another narrow upwardly extending notch 30. At the center of the inner wall of the guide plates 22 and 23 respectively is fixed a holding means 31 made of elastic material (hereinafter referred to as "a holder"). Said holder 31 is in the form of a wedge-shaped tab, or preferably in the form of a rectangular triangle. The holder 31 slantwise extends in a horizontal plane from the inner wall of the guide plate with one of the two sides adjacent to the right angle fixed to said inner wall in a vertical direction and the other side disposed at the top. To the back side (FIG. 5) of the key guide member 19 are fixed a pair of holders 33 of the same form and material as the first mentioned holders 31 in symmetrical relationship with respect to an imaginary central line dividing said back side into the right and left portions. These holders 33 extend toward the outside of the guide member 19 slantwise with respect to the lengthwise direction thereof in a manner to be set apart from each other, with one of the two sides adjacent to the right angle fixed to the back side 32 in a vertical direction and the other side placed at the top, as is the case with the first mentioned holders 31. The space between a plane defined by the undersides of the flanged portions 24 and a plane defined by the top sides of the triangular holders 31 and 33 is made equal to or slightly larger than the thickness of the printed circuit board 11.

The 18 aperture portions **14** of the printed circuit board **11** are each formed of three sections: (1) an opening **34** for receiving the aforementioned rectangular parallelepiped **20** having substantially the same lengthwise and crosswise measurements as said parallelepiped **20**; (2) slots **35** for receiving the guide plates having a length equal or longer than those portions of the guide plates which project from the rectangular parallelepiped **20** and a sufficiently larger width than the thickness of the guide plates to allow the holders **31** to be urged nearer to the guide plates while passing through said slots **35**; and (3) a notch **36** formed in that part of the opening **34** which faces the slots **35** and having a sufficient width to allow the holder **33** to be elastically urged more apart from the back side of said guide member while passing through said notch **36** and a sufficient depth to prevent the holders **33** from striking against the bottom wall of said notch **36**. The apertures **14** of the printed circuit board **11** are so formed that those adjacent to each other in a horizontal row are arranged in opposite directions. In consequence the later described magnetic reed switches attached to said apertures are disposed in a staggered fashion so as to prevent their permanent magnets from interfering with each other.

There will now be described the sequential steps of fitting the key guide member **19** into the aperture **14** of the printed circuit board **11**. When the key guide member **19** is forced into the aperture **14** from above the printed circuit board **11** so as to cause the rectangular parallelepiped **20** to be inserted into the opening **34** and the guide plates **22** and **23** into the slots **35**, then the hypotenuses of the holders **33** in the form of a rectangular triangle disposed on the back side **32** of the key guide member **19** abut on the upper edges of the right and left sides of the notch **36** of the aperture **14**, as illustrated in FIG. **10**. And the hypotenuses of the holders **31** fitted to the guide plates **22** and **23** contact the upper edges of the inner walls of the slots **35**. When the key guide member **19** is forced further inward, the elastic holders **31** are gradually thrown toward the guide plates **22** and **23** by the slots **35** according as said insertion advances and the similarly elastic holders **33** are progressively set apart from the back side **32** by the notch **36**. When the key guide member **19** is still further pushed in, the holders **31** and **33** pass through the slots **35** and notch **36**, and are brought back to the original inclined positions with respect to the guide plates **22** and **23** and the back side **32** as shown in FIG. **14**, so as to pinch the printed circuit board **11** together with the flanged portions **24**. As a result, the key guide member **19** ceases to move vertically and is firmly inserted into the printed circuit board **11**, thus being prevented from falling off simply by pulling. Further, the opening **34** and the rectangular parallelepiped **20** have substantially the same dimensions, the key guide member is not shaken either lengthwise or crosswise, but is firmly set in place.

Referring to FIG. **11**, numeral **37** denotes a ribbon-shaped metal key stem having stepped portion **38** formed at the middle point (FIG. **12**), that is, the section below there being made broader than that above. Both edges of the lower section are inserted into the grooves **27** so as to cause said key stem **37** to be guided through the elongated hole **26** slidably along the grooves **27**. The upper end of the key stem **37** is forcefully inserted into the fitting hole **39** of a push button **40**. Between the upper surface of the key guide member **19** and the underside of the push button **40** is disposed a compression coil spring **41** so as to enclose the key stem **37**. Normally said spring **41** upwardly urges the push botton **40** and key stem **37**, which jointly constitutes the key **12**.

Referring to FIG. **14**, numeral **42** represents a permanent magnet assuming the form of a rectangular parallelepiped. In that part of one side of the magnet **42** where the magnetic forces acting from both poles are balanced, there is formed a groove **43** intersecting the line of magnetic force substantially at right angles. Said magnet **42** is firmly set in place by applying, for example, an adhesive to that lower portion of the key stem **37** inserted into the key guide member **19** which can be brought into view through the recess **21** formed in the aforementioned rectangular parallelepiped **20**, a component of the key guide member **19**. The groove **43** is horizontally disposed so as to be exposed to the outside, as shown in FIGS. **11** and **12**, and further to be aligned with those parts of the receptacles **28** and **29** into which the magnetic reed switch is fitted. On the upper surface of the permanent magnet **42** is pasted an elastic pad or shock absorber **44** made of elastic material, for example, rubber and having several ribs **45** formed thereon. When the push button **40** is not depressed, said shock absorber **44** abuts on the underside of the shoulder **25**, namely, the upper surface of the recess **21**.

Referring to FIG. **13**, numeral **46** denotes a magnetically operated reed switch, which consists of a pair of switch elements or reed contacts **47** and **48** made of conductive magnetic material and so disposed as to spatially overlap each other at the facing ends and a glass capsule **49** in which they are to be sealed. From the reed contacts **47** and **48** are drawn out lead wires **50** and **51** respectively. The magnetic reed switch **46** is placed between the guide plates **22** and **23** in the undermentioned manner. The lead wire **50** is first inserted into the receptacle **28** and the capsule **49** is properly located by causing that end of the capsule **49** to which the lead wire **50** is fitted to abut on the opening of the receptacle **28** facing the inner wall of the guide plate **22**. Thereafter the other end of the capsule **49** is forcefully inserted into the receptacle **29** from below. In this case, it is preferred that the lower end portion **29***a* (FIG. **11**) of the receptacle **29** be formed narrow and that part thereof which holds said other end of the capsule **49** be made just a little narrower than the diameter of said other end of the capsule **49**. Thus, when said other end of the capsule **49** is going to be forcefully inserted into the receptacle **29**, the notch **30** formed at the top of the receptacle **29** causes it readily to expand due to its elasticity and, when said capsule end passes through the lower end portion **29***a*, to be contracted again, thereby securely holding said capsule end to prevent it from easily coming off. Thereafter the other ends of the lead wires **50** and **51** are inserted into the corresponding small holes **18** and soldered to the key input circuits **17**. That section of a calculator which consists of the key guide member **19**, key **12**, permanent magnet **42** and magnetic reed switch **46** is hereinafter referred to as "a key switch unit." The keyboard switch assembly of FIGS. **1** and **2** is set up by incorporating a required number of key switch units arranged as described above in the printed circuit board **11** and connecting the lead wires **50** and **51** of the magnetic reed switches **46** to the corresponding key input circuits **17** through the small holes **18**.

There will now be described the operation of the keyboard switch assembly.

When the key **12** is not depressed as shown in FIG. **13**, the depression **43** formed in the permanent magnet **42** fixed to the key stem **37** is brought opposed to the reed contacts **47** and **48**, causing said contacts **47** and **48** to be positioned at a point where the magnetic forces acting from the opposite poles are in equilibrium. Accordingly, these contacts **47** and **48** are not magnetized, but remain separated from each other. When the push button **40** is fully depressed, the permanent magnet **42** and key stem **37** are brought downward, causing the groove **43** formed in said magnet **42** to fall to the same extent. As a result, the reed contacts receive different magnetic forces from both poles of magnetic reed switch **46**, and contact each other due to magnetization. Accordingly, the key input circuits through the magnetic reed switch **46** are closed to supply required signals to a calculating mechanism (not shown). When released from depression, the key **12** is brought back to its original position by the spring **41**, and the groove **43** formed in the permanent magnet **42** is returned to a point facing the contacts of the magnetic reed switch **46**. Since the contacts are placed again at the point where the magnetic forces acting from both poles of the permanent magnet **42** are in equilibrium, they are demagnetized to be set apart, cutting off the corresponding key input circuits **17**. When the key **12** is brought back to its original position, the ribs **45** of the shock absorber **44** are elastically deformed by abutting on the under-

side of the shoulder **25**, so that the key stem **37** or permanent magnet **42** is prevented from impinging on the shoulder **25** or the underside of the printed circuit board **11**. With the keyboard switch assembly of this invention, the keyboard is, as seen from the foregoing description, of the same material as the printed circuit board, thus enabling the key frame of, for example, an electronic calculator to be formed of a single board. Once set up, the present keyboard switch assembly does not require any additional wiring, thus permitting a simple arrangement and offering the advantage of reducing manufacturing cost and facilitating maintenance and inspection. Since the key guide members **19** and printed circuit board are separate components, they can be respectively used with other types of calculator. This invention has further advantages that the key guide members **19** provided with the flanges **24** and holders **31** and **33** can be fitted into the apertures **14** of the printed circuit board **11** without much work; the receptacles **28** and **29** formed in the lower parts of the guide plates **22** and **23** respectively permit the accurate location of the magnetic reed switches **46** and in consequence enable them to be actuated exactly in response to the depression of the keys **12**; and the keys **12** each fitted with the shock absorber **44** are relieved of impacts which might otherwise arise at their return to the original positions, thus preventing the failure of a calculator as a whole.

What we claim is:

1. A key switch unit comprising

a key guide member of synthetic resinous material having flange portions closely contacting the top surface of a flat board,

a pendent body extending downwardly therefrom,

an elongated hole formed through said flange portions and body, and

a switch holding portion provided on said body; means for securing said key guide member to said board; a key having

a stem longitudinally slidable in said elongated hole,

a push button affixed to the upper end of said stem, and

a magnet affixed to the lower portion of said stem; and a magnetically operated switch held at said switch holding portion to be actuated by said magnet in response to movement of said stem.

2. The unit according to claim **1** wherein said magnetically operated switch comprises

a glass capsule enclosing reed contacts of conductive magnetic material and

lead wires for connecting said reed contacts to external circuits, and

said switch holding portion comprises

a pair of receptacles to hold said glass capsule and lead wires disposed therebetween for arranging said switch at a predetermined position so that said reed contacts open and close in response to movement of said magnet of said key.

3. A key switch unit comprising

a key guide member of synthetic resinous material having flange portions closely contacting the top surface of a flat board,

a pendent body extending downwardly therefrom,

an elongated hole formed through said flange portions and body, and

a pair of elastic projections formed on a vertical side wall of said body and disposed below said flange portion at a space equal to the thickness of said board,

said key guide member being secured to said board so as to insert the board between said flange portions and said projections when said body is fully inserted into an aperture in said board against the elasticity of said projections;

a key having a stem longitudinally slidable in said elongated hole, and a push button affixed to the upper end of said stem, and

a switch arranged to be actuated in response to movement of said stem caused by the operation of said push button.

4. The unit according to claim **3** wherein said elastic projection is a wedge-shaped tab in normal condition and easily inserted into said aperture together with said body in folded condition, and the horizontal upper side thereof closely contacts the undersurface of said board when said body is fully inserted into said aperture.

5. The unit according to claim **3** wherein said key guide member further has a switch holding portion provided on said body, said key further has a magnet affixed to the lower portion of said stem, and said switch is held at said switch holding portion and arranged to be actuated by said magnet in response to movement of said stem.

6. The unit according to claim **5** wherein said switch comprises a glass capsule enclosing reed contacts of conductive magnetic material and lead wires for connecting said reed contacts to external circuits, and said switch holding portion comprises a pair of receptacles to hold said glass capsule and lead wires disposed therebetween for arranging said switch at a predetermined position so that said reed contacts open and close in response to movement of said magnet on said stem.

7. A key switch unit comprising

a key guide member perforated with an elongated hole and inserted into an aperture in a flat board and secured to said board;

a key having a stem longitudinally slidable in said elongated hole, a push button affixed to the upper end of said stem, and a magnet affixed to the lower portion of said stem;

spring means for holding said key at an upper rest position;

an elastic pad fitted to the upper surface of said magnet so that said upper surface thereof does not directly strike said board when said key returns to said rest position; and

a magnetically operated switch arranged to be actuated in response to movement of said key caused by the operation of said push button.

8. A keyboard switch assembly comprising

a printed circuit board having a plurality of apertures and printed key input circuits;

a plurality of key guide members, each inserted into the aperture and secured to said board;

a plurality of keys, each having a stem longitudinally slidable in said key guide member and a push button affixed to the upper end of said stem; and

a plurality of switches, each arranged to be actuated in response to movement of said stem caused by the operation of the corresponding push button and connected to the printed key input circuits.

9. The assembly according to claim **8** wherein said key guide member of synthetic resinous material has a switch holding portion and an elongated hole, said stem further has a magnet disposed below said push button, and said switch comprises magnetically operated switch elements and lead wires for connecting said elements to said printed key input circuits, said switch elements being held at said switch holding portion to be actuated by said magnet in response to movement of said stem.

* * * * *