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[54] **MANUALLY OPERABLE KEYBOARD SWITCH ASSEMBLY**

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[52] **U.S. Cl.**..... **200/5 A,** 200/16 A, 200/159 A, 200/247, 200/275

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

[58] **Field of Search**..... 200/1 R, 5 R, 5 A, 6 R, 200/6 B, 6 BA, 6 BB, 6 C, 159 R, 159 A, 159 B, 166 BH, 166 J, 160, 164 R, 245, 247, 252, 275, 284, 340, 16 A

[56] **References Cited**

UNITED STATES PATENTS

2,966,559	12/1960	Meyer	200/6 BB
3,109,071	10/1963	Mitchell et al.	200/159 A X
3,288,947	11/1966	Wanlass et al.	200/6 R
3,600,528	8/1971	Leposavic	200/5 A
3,707,609	12/1972	Dapot et al.	200/5 R
3,725,907	4/1973	Boulanger	200/5 A X
3,742,157	6/1973	Leposavic	200/5 A

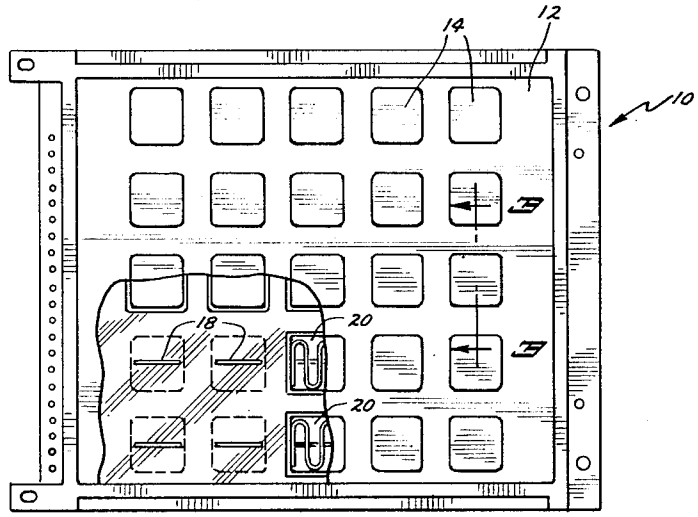
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[57] **ABSTRACT**

A switch includes a relatively thick contact bar and spring contact leaves cantilevered to rise above and cross over the contact bar from opposite sides of the bar. A manually depressible key seats upon the free ends of the spring leaves and provides a clearance space between such seating regions to allow the key initially to deflect the leaves at their cantilevered ends until the leaves engage the contact bar and then to deflect them about the contact bar as a fulcrum. The spring contact assembly is in the form of a sheet of spring metal shock having a serpentine cut defining a number of spring leaves in oppositely extending, side-by-side relation.

25 Claims, 4 Drawing Figures



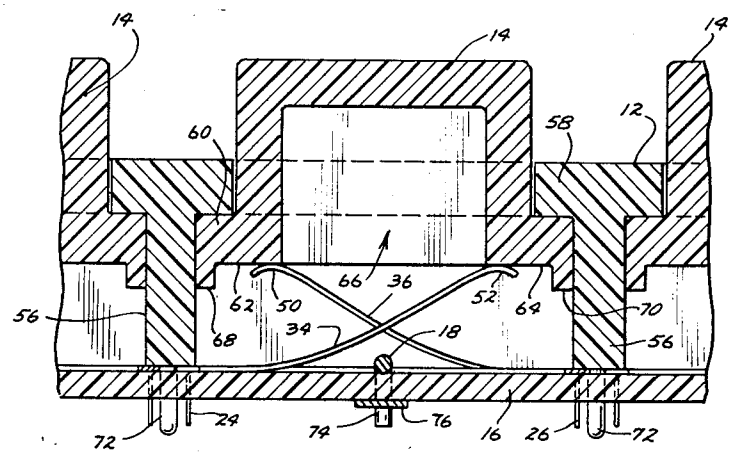
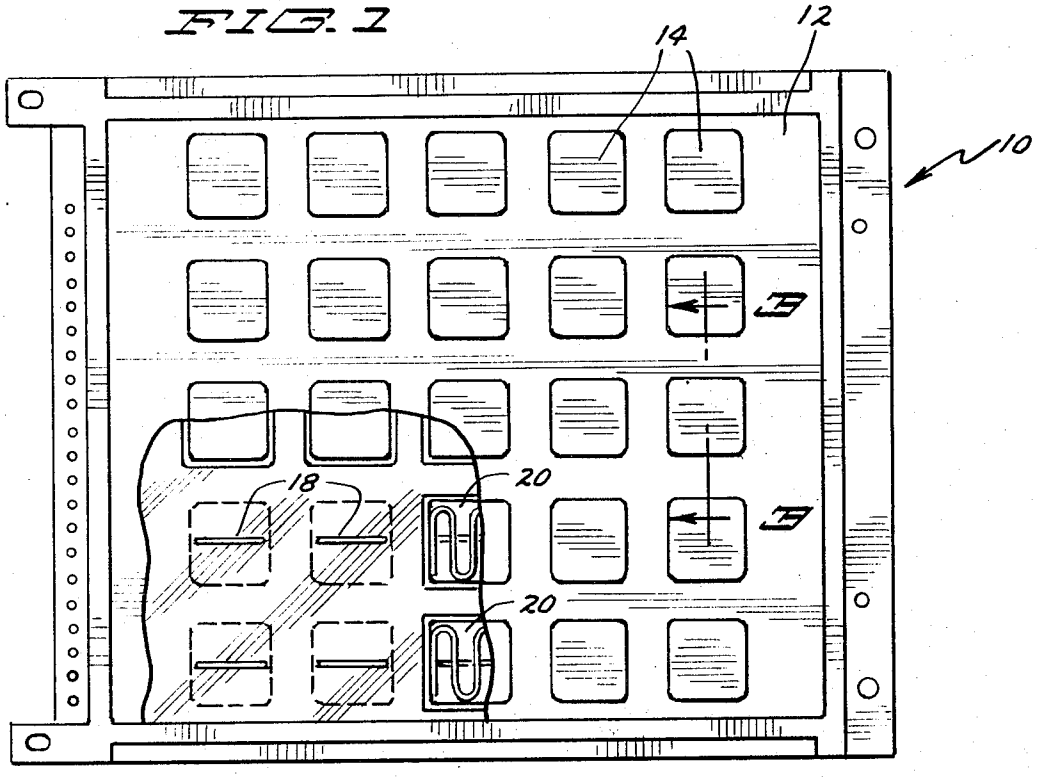


FIG. 1



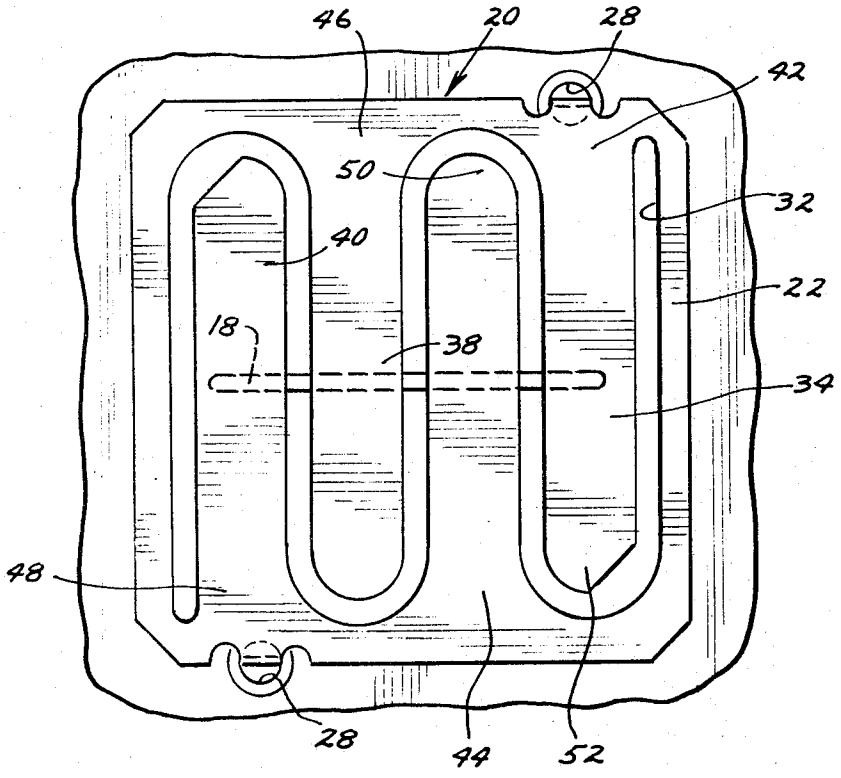
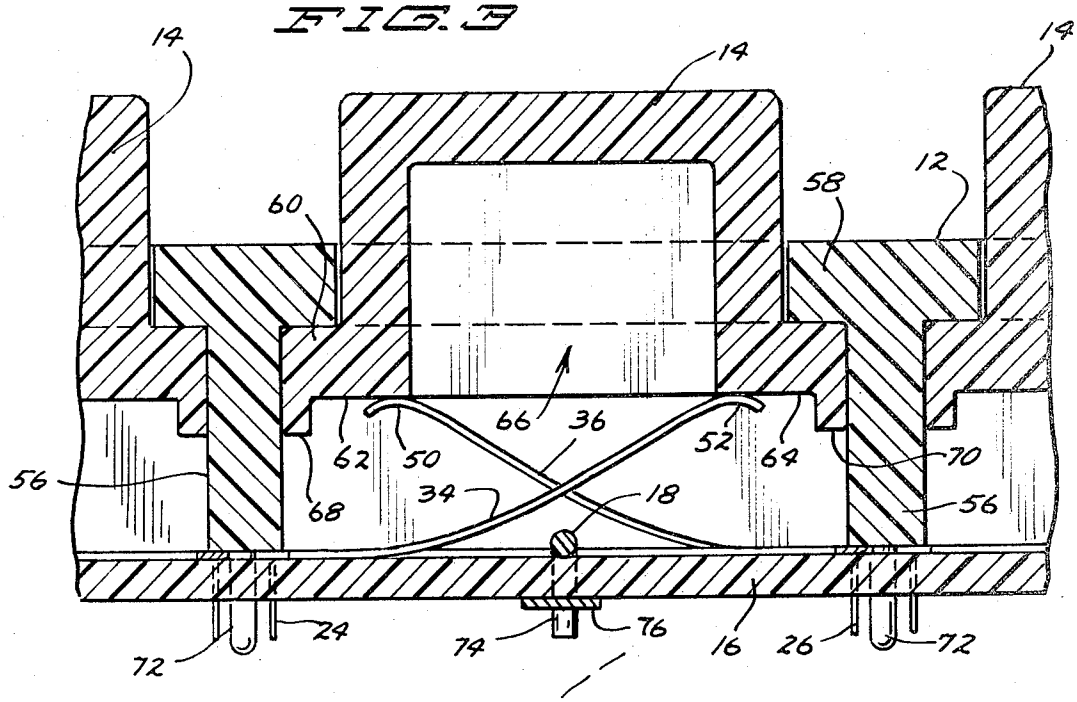


FIG. 2

FIG. 3


14
14
14
60
58
12
66
36
62
50
52
64
70
56
68
34
18
56
72
24
74
76
16
26
72

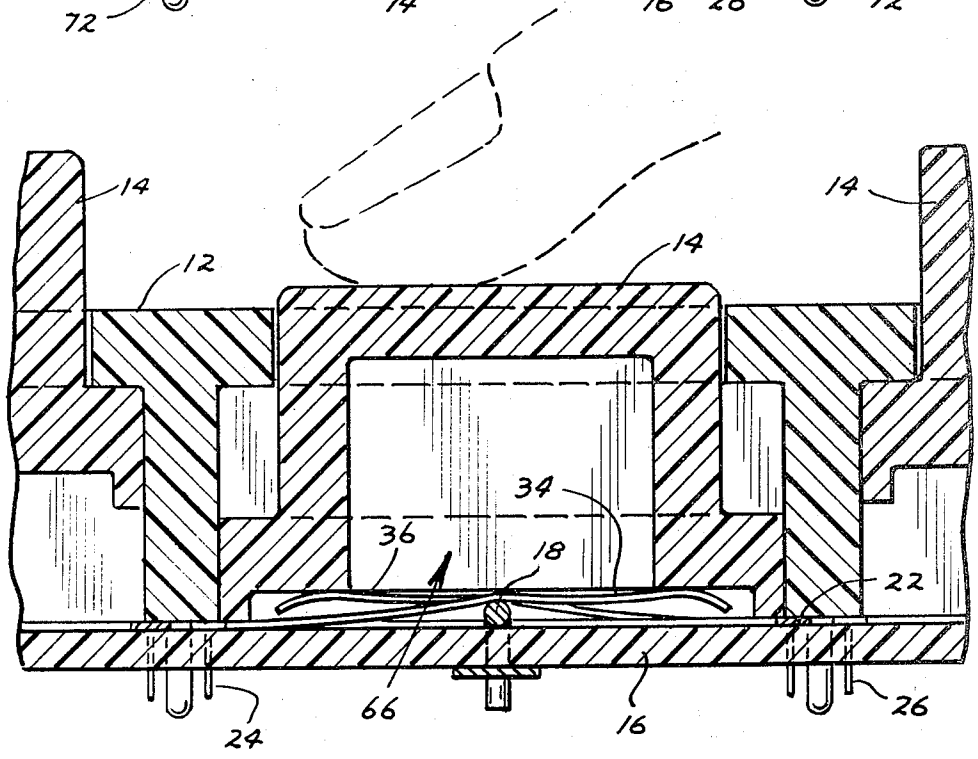

14
14
12
14
34
36
18
22
66
16
26
24

FIG. 4

MANUALLY OPERABLE KEYBOARD SWITCH ASSEMBLY

BACKGROUND OF THE INVENTION

This invention relates to switch assemblies and in particular to a keyboard switch mechanism in which a plurality of keys are provided for independent operation in response to manual depression thereof. An example of such an assembly is for use in conjunction with an electronic calculator.

In systems of this sort, it is desirable that the keys have the requisite "feel" for the convenience of the operator and it is likewise desirable that the mechanism be maintained as simple and economical as is possible. Further, it is desirable that the switch contact elements be long lasting in view of the repetitive nature of their actuation and that the contact members not be propense to becoming dirty such as would impair their proper operation during use.

It is conventional in systems of this type to provide a springloaded key-switch combination in which the contact engagement is of the "wiping" type. Whereas this provides the requisite action inclusive of a self-cleaning action, such mechanisms have been characterized by their expensive and complex construction and, because of the wiping action, to be characterized by early failure due to excessive wear of the parts.

BRIEF SUMMARY OF THE INVENTION

It is, accordingly, of primary concern in connection with the present invention to provide an improved form of switch mechanism which overcomes the disadvantages enumerated above.

Essentially, the present invention is concerned with a switch assembly which incorporates an elongate contact bar in combination with at least a pair of spring leaf elements which are anchored in cantilevered relationship on opposite sides of the contact bar and which rise therefrom to cross over and clear the contact bar at spaced regions along the length of the contact bar. The free ends of the spring leaves bear against an actuating member which may be depressed toward the contact bar initially to deflect the leaves about their cantilevered ends to provide a progressively increasing and essentially linear resistance to movement of the actuating member until the spring leaves bear upon the contact bar whereupon further depression of the actuating member experiences increased and non-linear resistance to further movement. The contact between the spring leaves and the contact bar or bars is essentially a pressing action with high unit bearing pressures essentially devoid of any wiping action. The high unit bearing pressures involved provide a self-cleaning action and do not require a wiping or rubbing contact to effect such action.

In a preferred embodiment, the spring assembly is formed from a sheet of spring metal stock provided with a serpentine cut which defines at least a pair of side-by-side and oppositely extending spring leaves.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

FIG. 1 is a plan view, partly broken away, illustrating a keyboard switch assembly according to the present invention;

FIG. 2 is an enlarged plan view showing a portion of switch assembly;

FIG. 3 is an enlarged vertical section taken substantially along the plane of section line 3—3 in FIG. 1 and showing details of the switch assembly; and

FIG. 4 is a view similar to FIG. 3 but showing the key in depressed position.

DETAILED DESCRIPTION OF THE INVENTION

A keyboard switch assembly is indicated generally by the reference character **10** in FIG. **1** and in the embodiment shown, includes a keyboard framework **12** with which a plurality of keys or buttons **14** are associated and arranged in a predetermined pattern as for example in the pattern of a keyboard for a calculating machine or the like. The framework **12** is superimposed upon and is attached to an underlying printed circuit board **16** having elongate contact bars **18** disposed thereon for association with the individual keys **14.** Spring means **20** according to the present invention are associated with each of the keys **14** in a manner which will be presently described in detail.

In a preferred embodiment of the invention, each of the spring means **20** is constructed according to the showing of FIG. **2.** As illustrated, the spring means comprises a sheet **22** of spring metal stock, preferably berylium copper stock which is provided with diagonally disposed downturned tangs **24** and **26** (see FIG. **3** for example) which project through suitable openings **28** in the printed circuit board **16** whereby to provide anchoring of the spring means **20** to the circuit board **16** and also to requisite electrical connection when necessary.

Within the confines of the sheet **22** there is provided a serpentine cut away portion **32** which extends symmetrically with respect to the contact bar **18** back and forth along the direction thereof to define, in the region of the sheet **22** overlying the contact bar **18,** a first pair of oppositely directed spring leaves **34** and **36** as well as a second pair of oppositely directed spring leaves **38** and **40.** The leaves **34** and **36** are thus cantilevered to the sheet **22** in the regions **42** and **44** respectively in straddling, staggered relationship along the length of the contact bar **18** and, likewise the spring leaves **38** and **40** are cantilevered similarly at the regions **46** and **48.**

As may be seen in FIG. **3,** each of the spring leaves is deformed to rise upwardly from its cantilevered end to clear the contact bar **18** and to terminate in a free end portion such as those indicated by reference characters **50** and **52** in FIG. **3** upon which an associated key **14** bears.

As will be seen in FIG. **3,** the framework **12** provides guide channels **56** for the keys **14** to form a well for each key in association with the printed circuit board **16** with the contact bar **18** extending crosswise at the bottom of such well. The channel or guide **56** in each case is provided with a peripherally overhanging region **58** and each key is provided with an enlarged stepped periphery **60** to limit the raised position of each key, as shown. The underside of each key **14** presents spring engaging surfaces **62** and **64** between which there is a clearance space or recess **66,** the purpose of which will be presently apparent, and downwardly projecting limit stop portions **68** and **70** are at least in the regions beyond the areas **62** and **64,** the purpose of which will also be presently apparent.

In the illustrative embodiment of FIG. **3,** the framework **12** is provided with projections **72** which extend

through the printed circuit board **16** which may be capped, deformed, or heat sealed in any suitable manner in order to stake the two parts **12** and **16** together and, as is shown in the illustrative embodiment, the periphery of each sheet **22** is sandwiched between the members **12** and **16** securely to anchor them in place, as shown. Each contact bar **18** has downwardly projecting tips such as that indicated by the reference character **74** which project through suitable openings in the printed circuit board body **16** in association with the printed circuit **76** to which the usual solder connections are made.

Comparison of FIGS. **3** and **4** will illustrate certain advantageous features of the present invention. In FIG. **3,** the free ends of the spring leaves bear against the underside of the key **14** to pre-load in the normal or raised position such that the initial depression of the key, the several spring leaves effect a progressive and essentially linearly increasing resistance to depression of the key. When the key has been depressed sufficiently to engage the spring leaves against the upper surface of the contact bar **18,** the levers effected by the spring leaves are effectively shortened so that further depression of the key will be met by suddenly increased and essentially non-linearly progressing resistance so that there is a definite "feel" when the spring leaves have contacted the contact bar **18.** In the switch assembly shown, the spring itself forms one side of the switch whereas the contact bar **18** forms the other side of the switch but, as well, a pair of parallel, somewhat spaced contact bars may be provided between which the switching contact is made through the intermediary of the spring leaves. The projections **68** and **70,** as is illustrated in FIG. **4,** limit the maximum deflected positions of the spring leaves and prevent excessive deflections thereof such as would permanently deform them. It will also be evident from FIGS. **3** and **4** that the engagement between the spring leaves and the contact bar **18** is essentially a pressing action which, in the cylindrical form of the contact bar **18** as shown, effects a progressive rolling action of the spring leaves on and around the contact bar. The arrangement achieves very high unit bearing pressures between the spring leaves and the contact bar in the absence of any substantial sliding, wiping or rubbing contact between the spring leaves and the contact bar **18,** thus assuring maximum life. At the same time, the very high unit bearing presures involved between the spring leaves and the contact bar assures a positive, self-cleaning action. Ideally, the contact bar **18** is of cylindrical section so that the wrapping action of the spring leaves involves an involute action although it is understood that other and different shapes could be utilized to provide different pressure interfaces as may be desired. The construction provides low noise, minimal bounce and multi-path switching mode capability and the assemblage provides equal key or button loading which reliably compensates for off-center actuation of the keys.

The over travel portion of the stroke after contact provides a non-linear increase of contact unit pressures with a rolling action which has a minimum of rubbing or wipe and, consequently, low noise and minimal bounce switching result which is particularly desirable in the keyboard or key switch art.

What is claimed is:

1. A manually operable keyboard switch assembly comprising, in combination:

keyboard housing defining a pattern of key-receiving channels;

an elongate contact bar stationarily disposed crosswise on the bottom of each of said channels;

a key received in each of said channels for limited movement toward and away from the contact bar associated with the respective channel; and

spring contact means fixedly mounted between multisection mounting means in each channel for urging an associated key normally to a position spaced from its associated contact bar, each spring contact means including at least a pair of spring leaves disposed in staggered, straddling relating to the associated contact bar and rising over in crossing relation above the contact bar into engagement with the associated key.

2. A manually operable keyboard switch assembly as defined in claim **1** wherein each spring means comprises a sheet of spring metal stock having a serpentine cut extending along the direction of the associated contact bar to define said pair of spring leaves in side-by-side relation.

3. A manually operable keyboard switch assembly as defined in claim **2** wherein said serpentine cut is symmetrical with respect to the associated contact bar.

4. A manually operable keyboard switch assembly as defined in claim **3** wherein said serpentine cut defines a second pair of side-by-side spring leaves.

5. A manually operable keyboard switch assembly as defined in claim **4** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

6. A manually operable keyboard switch assembly as defined in claim **2** wherein said serpentine cut defines a second pair of side-by-side spring leaves.

7. A manually operable keyboard switch assembly as defined in claim **5** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

8. A manually operable keyboard switch assembly as defined in claim **1** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof AND each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

9. A manually operable keyboard switch assembly as defined in claim **2** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

10. A manually operable keyboard switch assembly as defined in claim **3** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

11. A manually operable keyboard switch assembly comprising, in combination;

a printed circuit board having a plurality of elongate contact bars fixed to one face thereof;

a keyboard frame secured to said printed circuit board and defining therewith a plurality of wells

each of which contains an associated contact bar at the bottom thereof;

a key guided in each of said wells for movement toward and away from the bottom thereof; and

spring contact means fixedly secured in the bottom of each well for normally urging an associated key to the upper region of its well, said spring contact means including at least a pair of spring leaves rising over the associated contact bar in side-by-side crossing relation into engagement with the associated key.

12. A manually operable keyboard switch assembly as defined in claim **11** wherein each spring means comprises a sheet of spring metal stock peripherally sandwiched between said keyboard and said printed circuit board, and provided with a serpentine cut extending along the direction of the associated contact bar to define said pair of spring leaves.

13. A manually operable keyboard switch assembly as defined in claim **12** wherein said serpentine cut is symmetrical with respect to the associated contact bar.

14. A manually operable keyboard switch assembly as defined in claim **13** wherein said serpentine cut defines a second pair of side-by-side spring leaves.

15. A manually operable keyboard switch assembly as defined in claim **14** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

16. A manually operable keyboard switch assembly as defined in claim **12** wherein said serpentine cut defines a second pair of side-by-side spring leaves.

17. A manually operable keyboard switch assembly as defined in claim **15** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

18. A manually operable keyboard switch assembly as defined in claim **11** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

19. A manually operable keyboard switch assembly as defined in claim **12** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

20. A manually operable keyboard switch assembly as defined in claim **13** wherein each pair of said spring leaves contacts its associated key adjacent opposite sides thereof and each key is recessed between such opposite sides to clear the spring leaves and contact bar when in a depressed position.

21. A spring-loaded switch construction comprising, in combination:

a base member having an elongate contact bar fixedly disposed on a face thereof;

a sheet of spring metal stock fixed to said face of the base member to present a region overlying said contact bar, said region being formed to provide at least a pair of spring leaves cantilevered to said sheet at opposite sides of said contact bar and normally projecting out of the plane of said sheet to cross over and clear said contact bar to terminate in free end portions disposed on the sides of said contact bar opposite to those sides at which the spring leaves are cantilevered to the sheet; and

an actuating member seated upon said free end portions of the spring leaves and movable toward said base member, said actuating member having a clearance space between the areas thereof engaged by said spring leaves whereby to allow said spring leaves first to deflect from their cantilevered ends and then to deflect at the fulcrums defined between the spring leaves and the contact bar as the actuating member is moved toward said base member.

22. A spring-loaded switch as defined in claim **21** wherein said sheet is provided with a serpentine cut within the confines thereof to define said spring leaves.

23. A spring-loaded switch as defined in claim **22** wherein said serpentine cut is symmetrically disposed with respect to said contact bar.

24. A spring-loaded switch as defined in claim **23** wherein said serpentine cut defines a second pair of spring leaves.

25. A spring-loaded switch as defined in claim **21** including a keyboard member defining a guide channel receiving said actuating member, said actuating member being in the form of a key and having limit stop projections beyond the areas engaged by said spring leaves whereby to limit the maximum deflection of said spring leaves.

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