Keyboard assembly including a switching assembly (20) having a plurality of pressure-operated switches (24) and a key array (12) overlying the switching assembly (20) and having a plurality of keys (36) formed integrally with a support (38), each key (36) being hinged at one-side to the support (38) and having switch actuating means (44) formed integrally therewith. A disadvantage of prior art arrangements of this kind is that the force of restoring the operated key to its home position is not sufficiently positive for entirely satisfactory operation, as the arrangement relies on the resilience of the hinges and of the switch for restoring the key. The invention overcomes this disadvantage by providing switch actuators (44) of a resilient construction which are arranged to assist in restoring the respective key (36) to its home position following operation of the key (36). In a preferred embodiment, each switch actuator (44) has a first end connected to one side of the respective key (36) by means of a toggle hinge (46, 48, 50) and has a second, free end (56) extending across the key (36) to a position beyond the opposite side of the key (36).
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KEYBOARD AND METHOD OF MAKING KEYBOARD

Technical Field

The present invention relates to keyboards for entering information into utilizing devices and also relates to a method of making such keyboards.

Background Art

A keyboard for the entry of information into a utilizing device such as a typewriter, or calculator or a data processing terminal normally includes a plurality of keys associated with a corresponding plurality of switches. Depression of a key results in operation of its corresponding switch, with the consequent input of information into the utilizing device.

U.S. Patent No. 4,160,886 discloses a keyboard arrangement in which the keys of the keyboard are formed integrally with a supporting element and are hinged thereto at one side. This simplifies manufacture and assembly. Integrally formed with each key is a switch actuating means taking the form of a protuberance which engages the associated switch and operates it when the key is depressed. When the key is again released the key returns to its initial or home position due to the resilience of the integral hinges and the resilience of the associated switch which tend to resume their original shape upon release of the key. A disadvantage of this arrangement is that key restoring force is not sufficiently positive for entirely satisfactory operation.

Disclosure of the Invention

It is an object of the present invention to provide a keyboard assembly of the kind in which the keys are formed integrally with, and hinged to, a support means, and which provides a more positive key action compared with the above-mentioned prior art arrangement.

Thus, according to the invention, there is provided a keyboard assembly including a switching
assembly disposed on a base and including a plurality of pressure operated switching means, and a key array overlying said switching assembly and having a plurality of keys each disposed in operative relation to one of the switching means, said key array including support means to which each key is integrally hinged and which is apertured to permit movement of each key therethrough, and a switch actuating means for each switching means formed integrally with the respective key and positioned below the key to engage and actuate the corresponding switching means when the respective key is operated by depressing it, characterized in that each switch actuating means is of resilient construction and is arranged to assist in restoring the respective key to its home position following operation of the key.

According to another aspect of the invention, there is provided a method of making a keyboard assembly including the steps of providing a switching assembly including a plurality of individual switching means, and providing a key array including a plurality of keys formed integrally with a support means, said keys being hinged to, and partially separated from, said support means to permit key movement, and a switch actuating means formed integrally with each key, characterized by providing a toggle hinge at the location of joinder of each switch actuating means to its respective key, bending each switch actuating means below its corresponding key where it is retained in a stable position by the action of said toggle hinge, and positioning the key array over said switching assembly so that the bent-under switch actuating means of each key is disposed in operative relation to the corresponding switching means.

According to yet another aspect of the invention, there is provided a key array for operating a switching assembly in a keyboard assembly, said key array including a support means having a plurality of key locations, each including a key integrally hinged
to said support means, said support means including an aperture at each key location to permit movement of the key therethrough, a switch actuating means being formed integrally with each key, characterized in that each switch actuating means has a first end connected to one side of the respective key by means of a toggle hinge, and has a second, free end which can be arranged to extend across the key to a position beyond the opposite side of the key by setting the toggle hinge to one of its stable positions.

Brief Description of the Drawings

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a fragmentary plan view of a first embodiment of a key array for the keyboard assembly in accordance with the present invention.

Fig. 2 is a fragmentary sectional view taken along line 2-2 of Fig. 1.

Fig. 3 is a sectional view taken along line 3-3 of Fig. 5, of the keyboard assembly.

Fig. 4 is a plan view of said first embodiment of the key array.

Fig. 5 is a plan view of the keyboard assembly.

Fig. 6 is a plan view of a second embodiment of the key array, in which individual key modules are provided, which can be assembled to form a key array of the desired size.

Fig. 7 is a view similar to Fig. 6, showing other arrangements in which the key modules of Fig. 6 can be assembled to form a key array.

Fig. 8 is a sectional view, taken along line 8-8 of Fig. 6.

Best Mode of Carrying Out the Invention

Referring now particularly to Figs. 3 and 5 of
the drawings, there is shown a keyboard assembly including a key array designated as a whole by the reference character 12. The base 14 of the keyboard assembly may typically include a printed circuit board 16 which provides an interface between the key array 12 and a utilizing device (not shown), a plate 18 which may provide means for mounting the keyboard to the utilizing device, and a switch plate 20 provided with a plurality of recesses 22 in which may be mounted individual switches 24 associated with corresponding keys of the keyboard. Any suitable fastening means 26, such as screws or rivets, may be employed to secure the elements 18, 20 and 22 together in operative relation.

Each switch 24 may be of the well-known "bubble" type in which a resilient diaphragm 28 functions as an electrical conductor, bridging contacts 30, 32 and 34, when depressed. Contact 32 may be connected to one circuit path, and contacts 30 and 34 to another. These contacts may, if desired, take the form of electrically conductive staples secured in the plate 20. Application of sufficient force to the diaphragm 28 by a switch actuator will cause it to change configuration from the convex, as viewed in Fig. 3, with a "snapping" movement, to a generally flat configuration, thus bridging the contacts 30, 32, 34. Removal of pressure from the diaphragm causes it to spring back to the convex configuration in which it is shown in Fig. 3. The spring characteristics of the material of the diaphragm may be selected to provide a desired tactile "feel" for depression of a key corresponding to the switch, to inform the operator of the keyboard that the switch has been depressed to the necessary extent to bridge the contacts 30, 32, 34.

In the embodiment of Figs. 1-4 inclusive, each key 36 of the key array 12 is formed integrally with a supporting sheet 38, and is located in operative relation to a corresponding switch 24. The key 36 includes a key
body 40, a pair of "living" hinges 42, and a switch actuator 44. The actuator 44 is formed integrally with the key body 40, and the hinges 42 are formed integrally with both the key body 40 and the supporting sheet 38. The keys 36 and sheet 38 may be formed of a suitable plastic material having good hinging and spring characteristics, such as polypropylene, manufactured by Eastman Chemical Products, Inc.

The actuator 44 is of generally semi-circular configuration, and is formed in the position in which it is shown in Figs. 1 and 2. The connection of the actuator 44 to the key body 40 includes three "living" hinge elements 46, 48, 50.

This hinge enables the actuator 44 to be rotated approximately 180 degrees from the position in which it is shown in Figs. 1 and 2 to the position below the key body 40 in which it is shown in Fig. 3, in which said actuator is positioned in operative relation to the diaphragm 28 of the switch 24. The hinge elements 46, 48, 50 form a toggle linkage, with the toggle point 52 of the elements 46 and 50 positioned below the toggle point 54 of the element 48. This toggle linkage has two stable positions and is effective to retain the actuator 44 either in the position in which it is shown in Fig. 2 or in the position in which it is shown in Fig. 3.

The free end 56 of the actuator 44 is directed, during movement of the actuator into operative position, into an aperture 58 formed between the hinges 42, within which the actuator 44 of an adjacent key is initially located when the key array is formed, and before rotation of the actuator into the position of Fig. 3. Coaction of the end 56 of the actuator 44 with projections 60 formed at the edges of the aperture 58 serves to limit movement of the free end 56 of the actuator 44 when the key 36 is depressed. This rotation of the actuators 44 for all of the keys 36 formed with a sheet 38 to form a keyboard unit such as is shown in Fig. 4 takes place.
before the said keyboard unit is assembled with the other elements to form the completed keyboards shown in Figs. 3 and 5.

Formed integral with the sheet 38 are a plurality of reinforcing ribs 62 which serve to increase the rigidity of said sheet, and which also perform a spacing function to provide a desired distance between the sheet 38 and the switch plate 20 in which the switches 24 are mounted. Formed integral with the key bodies 40 are a plurality of stop members 64 which are effective to limit the total permitted downward movement of a depressed key 36.

As shown in Figs. 3 and 5, a key position legend mask 66 and a transparent protective shield 68 overlie the sheet 38 and are held in place by a bezel 70 mounted in a housing 72 which may include the key array, together with the remaining associated structure, including the circuit board 16, the mounting plate 18 and the switch plate 20.

As may be seen in Fig. 3, when a load is applied to a key 36, causing it to be displaced downward, the hinges 42 are deflected arcuately, distributing the load through their lengths and storing tension to restore the key 36 to its normal home position when the load is removed. The displacement of the key 36 under load will cause the switch actuator 44 to engage the diaphragm 28 of the switch 24, forcing it downward against the contacts 30, 32, 34. The diaphragm 28 will snap and engage the center contact 32, completing the electrical circuit through the switch 24. The snap action of the diaphragm provides a feedback to the operator which may be both felt and heard.

The force on the key 36 is transmitted through the hinge 46, 48, 50 to the actuator 44, and causes the actuator to be deflected when it engages the diaphragm 28. Further downward displacement of the key 36 will cause the free end 56 of the actuator 44 to be extended.
into the aperture 58 between the hinges 42, until the end 56 engages the projections 60 on either side of the aperture 58. Any further deflection of the actuator 44 will provide a cushioning effect to resist further overtravel of the key 36. Tension stored in the actuator 44 from this action will assist in restoring the key 36 to its normal home position when the load is removed from it.

Shown in Figs. 6, 7 and 8 are three views of a second embodiment of the invention. This embodiment differs from the embodiment of Figs. 1, 3 and 4 in that each key 80, including hinges 82, key body 84 and actuator 86, is formed in a separate module 88, rather than having all of the keys of a key array formed integrally with a single supporting sheet. The actuator 86 of each module is rotated into its operative position before assembly of the modules. Projections, or tenons, 90 and mating recesses, or mortises, 92 may be employed to secure a plurality of modules together in assembled relationship to form a key array of whatever size or arrangement is needed. A second module 94 is shown in phantom to illustrate the manner in which a plurality of modules may be assembled in aligned relationship. It will be seen that a plurality of additional modules may also be added above, below and to the right of the module 88, as viewed in Fig. 6. In Fig. 7, the modules are shown assembled in an offset relationship, in which a different pairing of mortises and tenons is employed. It will be noted in Fig. 7 that the middle row of modules is offset from the topmost row by approximately one-half of a module width, and that the lowest row is offset from the middle row by approximately one-fourth of a module width. The offset arrangement is of particular utility in a typewriter keyboard, which is customarily configured in such a manner.

The keyboard assembly described above has the advantages that it is cheap and simple to manufacture, has a positive key action, is reliable, and provides a cushioning effect for a depressed key.
CLAIMS:

1. A keyboard assembly including a switching assembly (20) disposed on a base (14) and including a plurality of pressure-operated switching means (24), and a key array (12) overlying said switching assembly (20) and having a plurality of keys (36) each disposed in operative relation to one of the switching means (24), said key array (12) including support means (38) to which each key (36) is integrally hinged and which is apertured to permit movement of each key (36) therethrough, and a switch actuating means (44) for each switching means (24) formed integrally with the respective key (36) and positioned below the key (36) to engage and actuate the corresponding switching means (24) when the respective key (36) is operated by depressing it, characterized in that each switch actuating means (44) is of resilient construction and is arranged to assist in restoring the respective key (36) to its home position following operation of the key (36).

2. A keyboard assembly according to claim 1, characterized in that each switch actuating means (44) has a first end connected to the respective key (36), and a second, free end (56) which is arranged to engage with abutment means (60) during key depressing movement of the respective key (36), whereby the switch actuating means (44) is deformed during such movement so as to build up tension therein, such tension assisting in restoring the respective key (36) upon its release.

3. A keyboard assembly according to claim 2, characterized in that each switch actuating means (44) is connected to one side of the respective key (36) and extends across the key (36) to a position beyond the opposite side of the key (36).
4. A keyboard assembly according to claim 3, characterized in that the free end (56) of each switch actuating means (44) is arranged, during a depressing movement of the respective key (36), to engage with projections (60) respectively formed in opposite edges of an aperture (58) formed in said support means (38) adjacent said opposite side of the respective key (36), thereby limiting movement of said free end (56) in one direction with respect to said aperture (58) during such depressing movement.

5. A keyboard assembly according to claim 3, characterized in that each switch actuating means (44) is connected to said support means (38) by means of a toggle hinge (46, 48, 50), one of the stable positions of said toggle hinge (46, 48, 50) corresponding to the switch actuating means (44) being in a position in which it extends across the respective key (36).

6. A keyboard assembly according to claim 1, characterized in that each switch actuating means (44) is of arcuate configuration.

7. A keyboard assembly according to any one of the preceding claims, characterized in that said support means (38) is a single integral element for the entire key array (12).

8. A keyboard assembly according to any one of claims 1 to 6, characterized in that a separate support element (88) is provided for each key (84), each support element (88) having connector means (90, 92) for securing individual support means (88) together to constitute the key array (12).

9. A method of making a keyboard assembly including the steps of providing a switching assembly
9. (concluded)
(20) including a plurality of individual switching means
(24), and providing a key array (12) including a plurality
of keys (36) formed integrally with a support means
(38), said keys (36) being hinged to, and partially
separated from, said support means (38) to permit key
movement, and a switch actuating means (44) formed inte-
grally with each key (36), characterized by providing
a toggle hinge (46, 48, 50) at the location of joinder
of each switch actuating means (44) to its respective
key (36), bending each switch actuating means (44)
below its corresponding key (36) where it is retained in
a stable position by the action of said toggle hinge
(46, 48, 50), and positioning the key array (12) over
said switching assembly (20) so that the bent-under
switch actuating means (44) of each key (36) is disposed
in operative relation to the corresponding switching
means (24).

10. A key array for operating a switching
assembly in a keyboard assembly, said key array including
a support means (38) having a plurality of key locations,
each including a key (36) integrally hinged to said sup-
port means (38), said support means including an aperture
at each key location to permit movement of the key (36)
therethrough, a switch actuating means (44) being formed
integ rally with each key (36), characterized in that
each switch actuating means (44) has a first end connec-
ted to one side of the respective key (36) by means of
a toggle hinge (46, 48, 50), and has a second, free end
(56) which can be arranged to extend across the key (36)
to a position beyond the opposite side of the key (36)
by setting the toggle hinge to one of its stable posi-
tions.
**INTERNATIONAL SEARCH REPORT**

**I. CLASSIFICATION OF SUBJECT MATTER**

According to International Patent Classification (IPC) or to both National Classification and IPC

- H01H 13/70
- H01H 11/00

**II. FIELDS SEARCHED**

<table>
<thead>
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<th>Classification System</th>
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<td>29/622</td>
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**Documentation Searched other than Minimum Documentation**

to the Extent that such Documents are Included in the Fields Searched

**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of Document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to Claim No.</th>
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<tbody>
<tr>
<td>X</td>
<td>US-A, 3,532,003, Published 6 October 1970, Ohno</td>
<td>1-8,10</td>
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<tr>
<td>X</td>
<td>US-A, 4,029,916, Published 14 June 1977, Chu</td>
<td>1-8,10</td>
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<td>X,A</td>
<td>US-A, 4,066,860, Published 3 January 1978, Kawasaki</td>
<td>1-8,10</td>
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<td>X,A</td>
<td>US-A, 3,839,785, Published 8 October 1974, Boulanger</td>
<td>1-8,10;9</td>
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<tr>
<td>X,A</td>
<td>US-A, 4,160,886, Published 10 July 1979, Wright, deceased et al</td>
<td>1-8,10;9</td>
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</tbody>
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* Special categories of cited documents:
  - "A": document defining the general state of the art
  - "E": earlier document but published on or after the international filing date
  - "L": document cited for special reason other than those referred to in the other categories
  - "O": document referring to an oral disclosure, use, exhibition or other means

**IV. CERTIFICATION**

Date of the Actual Completion of the International Search: 22 February 1981

Date of Mailing of this International Search Report: 02 Mar 1982

International Searching Authority: ISA/US

Signature of Authorized Officer: James R. Scott

Form PCT/ISA/210 (second sheet) (October 1977)
FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

VI. OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE 10

This international search report has not been established in respect of certain claims under Article 17(6) (a) for the following reasons:

1. Claim numbers _____, because they relate to subject matter 15 not required to be searched by this Authority, namely:

2. Claim numbers _____, because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out 15, specifically:

VI.B. OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING 11

This international Searching Authority found multiple inventions in this international application as follows:

I. Claims 1-8 and 10, drawn to a keyboard switch assembly.
II. Claim 9, drawn to a method of making a keyboard switch assembly.

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

Remark on Protest
□ The additional search fees were accompanied by applicant's protest.
☑ No protest accompanied the payment of additional search fees.