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Randall et al.

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[54] **LATCHING SWITCH**

[75] Inventors: **Robert Scott Randall**, Hazlet; **Ralph Arnold Tengelsen**, Parlin, both of N.J.

[73] Assignee: **Bell Telephone Laboratories, Incorporated**, Murray Hill, N.J.

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[52] **U.S. Cl.** **337/77**, 337/102, 337/359

[51] **Int. Cl.** **H01h 61/02**

[58] **Field of Search** 337/55, 75, 76, 77, 337/78, 95, 102, 104, 105, 356, 357, 358, 359, 362, 365, 370

[56] **References Cited**

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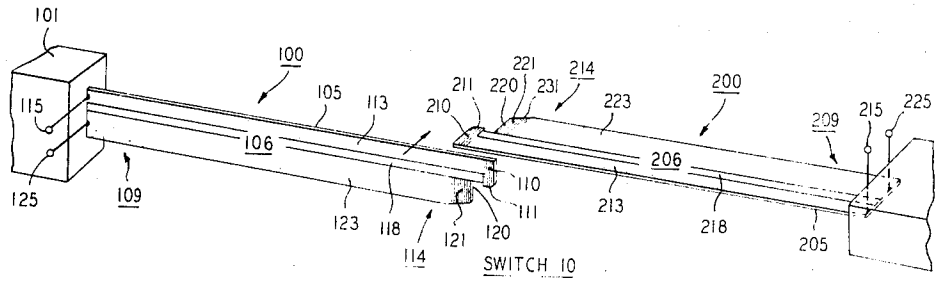
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Primary Examiner—Bernard A. Gilheany
Assistant Examiner—A. T. Grimley
Attorney—W. L. Keefauver et al.

[57] **ABSTRACT**

A latching switch comprising two normally electrically isolated elements which mechanically latch when deflected in a prearranged sequence in substantially orthogonal directions. A contact edge on each element engages a contact pad on the other when the elements are latched, providing two conductor paths per pair of elements. Each element may comprise a bimetal, deflection thereof being effected via application of an actuating signal to one face of the bimetal, which face functions as a heating resistor.

11 Claims, 6 Drawing Figures



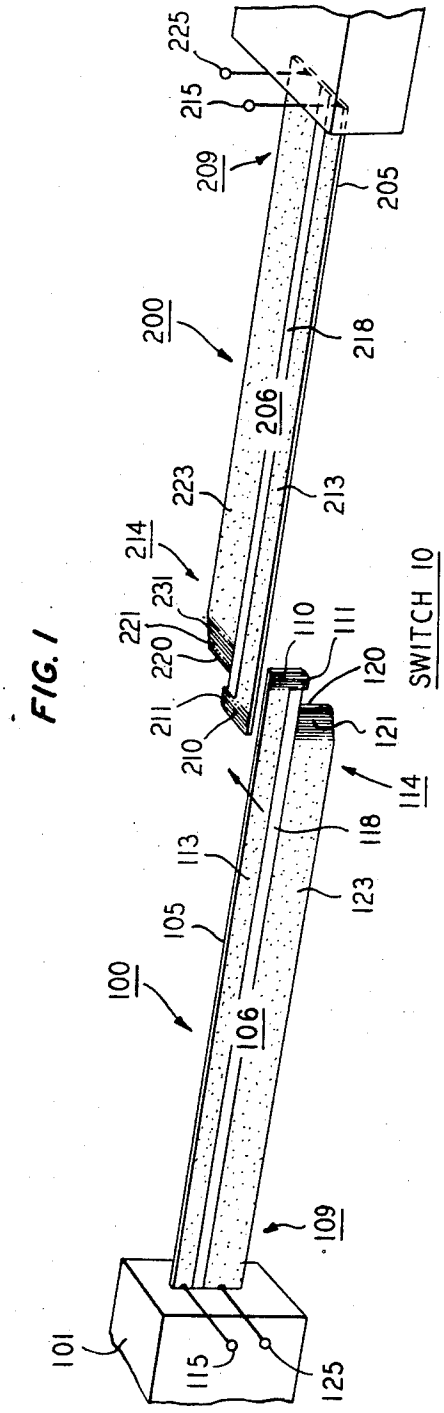

225
215
209
205
200
218
206
223
213
214
231
221
220
110
111
120
211
210
121
114
SWITCH 10
118
113
123
105
100
106
109
101
115
125

FIG. 1

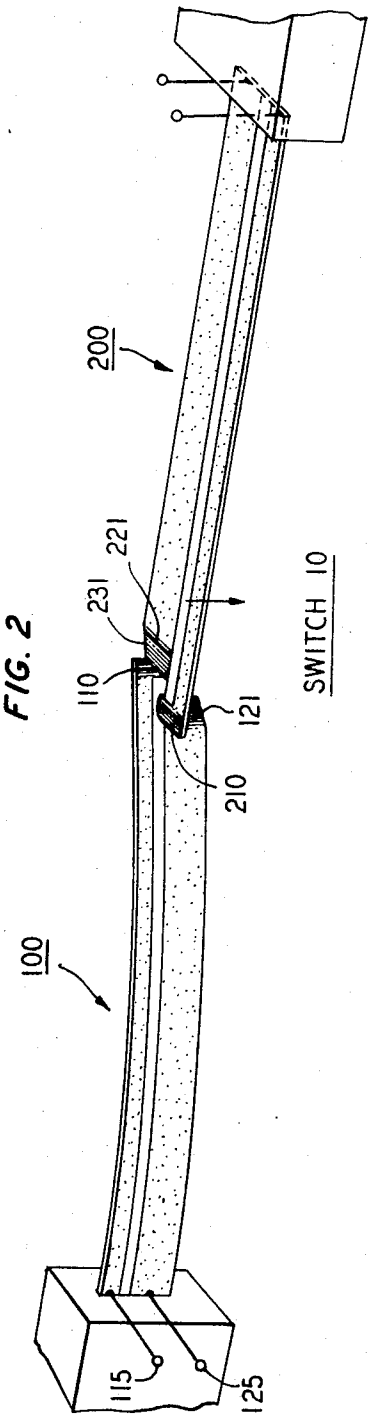

200
221
231
110
121
SWITCH 10
210
100
115
125

FIG. 2

FIG. 3

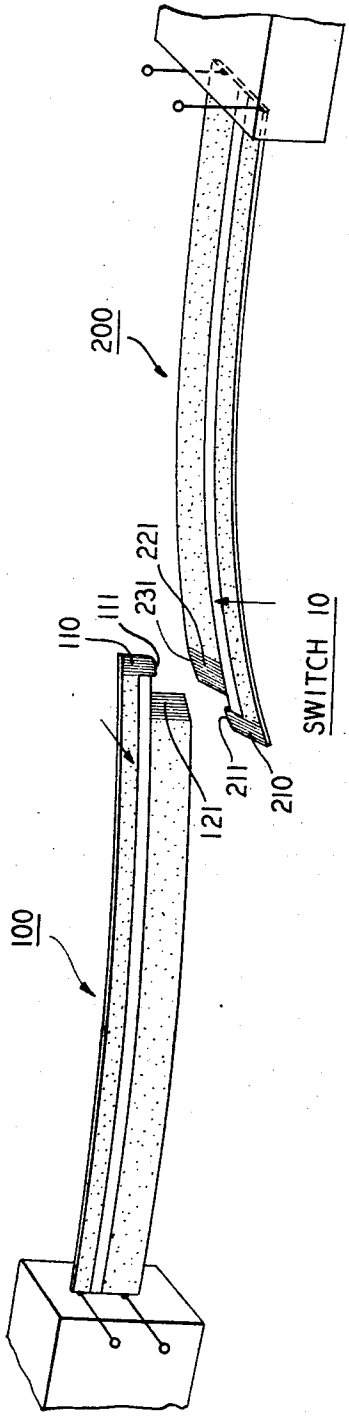

200
221
231
111
110
SWITCH 10
211
210
121
100

FIG. 4

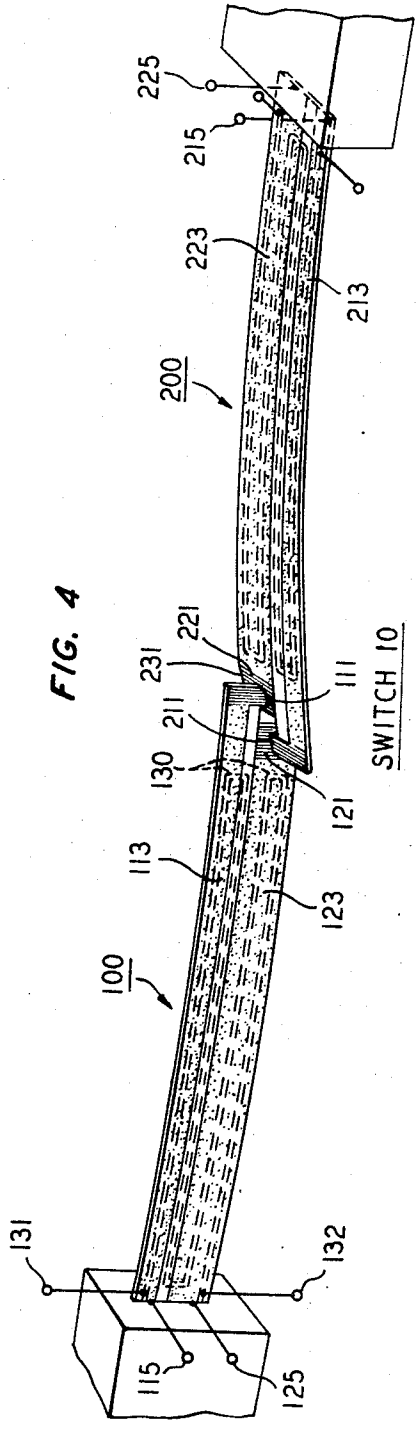
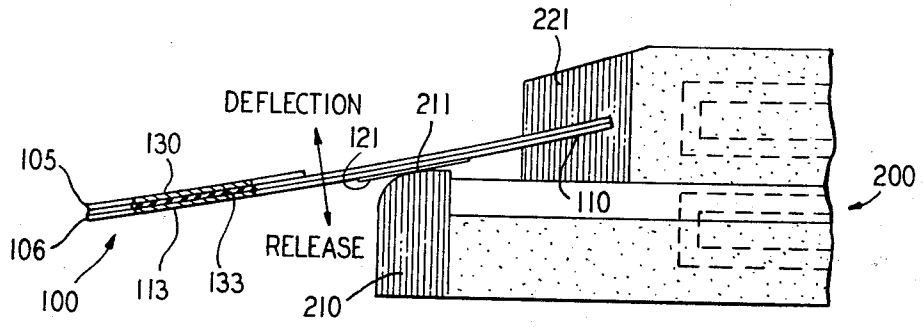

225
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223
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200
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221
111
SWITCH 10
211
130
121
113
123
100
131
132
115
125

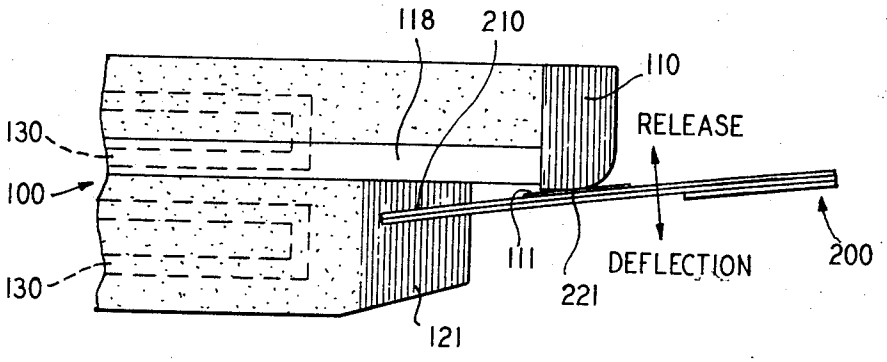
FIG. 5



SWITCH 10

(TOP VIEW)

FIG. 6



SWITCH 10

(FRONT VIEW)

LATCHING SWITCH

BACKGROUND OF THE INVENTION

This invention relates to latching switches and, more particularly, to latching switches adapted for use in crosspoint matrices.

In certain crosspoint matrix applications the time necessary to operate, i.e., to open or close, a selected crosspoint is negligible compared to the time the crosspoint is to remain closed. Accordingly, economical operation of the matrix requires that no energy be expended in maintaining crosspoint closure. To this end, arrangements have been devised in which each crosspoint comprises a latching switch. The contact elements at a crosspoint latch mechanically when deflected and released in a prearranged sequence. The mechanical latching of the contact elements thereby obviates expenditure of energy to maintain switch closure.

In such known arrangements, deflection and release of the crosspoint contact elements is generally effected via electromechanical actuating apparatus such as relays, solenoids, and push rods. Although generally satisfactory, the actuating apparatus tends to be bulky and expensive as compared to the crosspoint elements themselves.

In some crosspoint matrices, such as those employed in telephone switching offices, multiple conductor paths are to be established when a crosspoint is closed. In known arrangements this is effected by utilizing multiple tandemly-operated contact element pairs at each crosspoint.

SUMMARY OF THE INVENTION

Accordingly, a general object of the invention is to provide an improved latching switch.

A more specific object of the invention is to provide an improved latching switch adapted for use in crosspoint matrices.

A further object of the invention is to provide an improved latching switch having simple, compact and economical actuating apparatus.

Yet another object of the invention is to provide an improved latching switch which provides more than one signal path per pair of contact elements.

These and other objects are achieved in a latching switch comprising first and second contact elements each of which has a fixed end and a free end. The free end terminates in a contact finger which carries a contact edge lying on a line extending between the fixed and free end. The free end of each element further includes a contact pad electrically isolated from the contact edge and disposed between the fixed end and the contact edge.

The first and second contact elements are adapted for deflection in substantially orthogonal directions such that the contact pad and contact edge of each element substantially concurrently intersect the release paths of the contact edge and contact pad, respectively, of the other element. The switch is closed via deflection and subsequent substantially concurrent release of the contact elements, electrical contact being established between the contact edge of one element and the contact pad of the other. Thus, the present invention advantageously provides two independent signal paths per pair of contact elements.

If desired, deflection and release of the contact elements may be effected by known electromechanical apparatus. However, each element may advantageously comprise a bimetal, one face of the element including a layer of relatively high thermal expansion coefficient metal and the other a layer of relatively low thermal expansion coefficient material. Deflection of each element is then effected electrothermally.

In accordance with one aspect of the invention, the metal layer on one face of each element illustratively comprises a heating resistor, thereby obviating the need for a separate electrothermal actuating device. The metal layer on the other face comprises first and second electrically isolated signal conductors which respectively connect the contact pad and contact edge of the element to a pair of switch terminals at the fixed end of the element.

In accordance with another aspect of the invention, the two faces of each element are separated by an insulating layer which isolates the first and second signal conductors from the heating resistor and also from each other.

BRIEF DESCRIPTION OF THE DRAWING

These and other objects and features of the invention may be clearly understood from the following detailed description in which:

FIGS. **1–4** are perspective views of various stages of operation of an illustrative embodiment of a latching switch according to the invention; and

FIGS. **5** and **6** are detail top and side views, respectively, of the switch in a latched configuration as shown in FIG. **4.**

DETAILED DESCRIPTION

Latching switch **10** shown in FIGS. **1–4** is comprised of resilient contact elements **100** and **200.** Element **100** has a release face **106** and a deflection face **105,** only the upper edge of the latter being visible in FIGS. **1–4.** Element **100** extends axially between a free end **114** and a fixed end **109** which is secured to a rigid support **101.** Free end **114** terminates in finger **110** and edge **120.** Finger **110** includes a contact edge **111** which lies on a line extending between fixed end **109** and free end **114.** Contact edge **111** is electrically connected to switch terminal **115** via signal conductor **113** which runs along release face **106.**

Free end **114** further includes on release face **106** a contact pad **121** which is bounded by edge **120** and is disposed between fixed end **109** and contact edge **111.** Contact pad **121** is electrically connected to switch terminal **125** via signal conductor **123.** The latter runs along release face **106** and is electrically isolated from signal conductor **113** by insulating strip **118.**

Illustratively, element **200** is substantially identical to element **100.** Accordingly, a corresponding numbering scheme is employed in the drawing, element **200** having deflection and release faces **205** and **206,** fixed and free ends **209** and **214,** and so forth.

When switch **10** is open, elements **100** and **200** assume the undeflected positions shown in FIG. **1,** element **100** being somewhat below and forward of element **200.** The switch is closed by sequentially bending elements **100** and **200** toward their respective deflection faces, i.e., deflecting them, and then allowing them to unbend, i.e., to release substantially concurrently. As more fully described hereinafter, this causes ele-

ments 100 and 200 to latch with each other and thereby close the switch. Deflection and release of elements 100 and 200 may be effected, for example, by known electromechanical apparatus such as relays, solenoids and push rods. However, as described below, a preferred embodiment of the invention utilizes the thermostatic action of bimetals for this purpose.

When it is desired to close switch 10, element 100 is deflected in the direction indicated in FIG. 1. Element 100 thus passes under element 200 and, when fully deflected, is positioned behind corner edge 231 of element 200 as shown in FIG. 2. Element 200 is then deflected in the direction indicated in FIG. 2, which direction is substantially orthogonal to the direction in which element 100 is deflected. When fully deflected, elements 100 and 200 assume the positions shown in FIG. 3. It will be appreciated that the deflected configuration of FIG. 3 can also be achieved by deflecting elements 100 and 200 in the opposite sequence to that just described.

Finally, elements 100 and 200 are released substantially concurrently. However, before element 200 can fully release to its undeflected position, finger 110 enters the release path of contact pad 221. At the same time, element 100 is prevented from fully releasing to its undeflected position, because finger 210 enters the release path of contact pad 121. Accordingly, elements 100 and 200 engage each other and latch as shown in FIG. 4. Contact edge 111 of finger 110 contacts pad 221 of element 200 so that a first signal path is established between switch terminals 115 and 225 via signal conductors 113 and 223. In addition, contact edge 211 of finger 210 contacts pad 121 so that a second signal path is established between terminals 124 and 215 via signal conductors 123 and 213. Thus, when closed, the present latching switch, while utilizing but a single pair of contact elements, advantageously provides two independent signal paths.

Switch 10 can be reopened in several ways. For example, if element 100 is deflected behind corner edge 231, element 200 will return to its undeflected position (see FIG. 2). Element 100 can then be released to its undeflected position (FIG. 1). Alternatively, both switches can be deflected concurrently and then released in sequence. Other ways of reopening switch 10 will be readily apparent.

FIGS. 5 and 6 are detail top and front views, respectively, of switch 10 when elements 100 and 200 are in the latched configuration of FIG. 4. In FIG. 5, element 100 deflects and releases as indicated, and element 200 deflects into and releases out of the plane of the drawing. From FIG. 5 it is apparent that element 100 is adapted for deflection and release such that contact pad 121 intersects the release path of edge 211 at the same time that finger 110, and hence contact edge 111, intersect the release path of contact pad 221.

In the front view of switch 10, shown in FIG. 6, element 200 deflects and releases as indicated, while element 100 deflects into and releases out of the plane of the drawing. From FIG. 6 it is apparent that element 200 is adapted for deflection and release such that contact pad 221 intersects the release path of edge 111 at the same time that finger 210, and hence contact edge 211 intersect the release path of pad 121.

Thus, it is seen that an important criterion which must be satisfied to ensure latching of elements 100 and 200 is that each element must be adapted for deflection such that its contact pad and contact edge substantially concurrently intersect the release paths of the constant edge and contact pad, respectively, of the other element.

As mentoioned above, elements 100 and 200 may be deflected and released by known electromechanical apparatus. Alternatively, the thermostatic action of bimetals can advantageously be used for this purpose. One face of each switch element may include a layer of relatively low thermal expansion coefficient metal, while the other face includes a layer of relatively high thermal expansion coefficient metal. Deflection and release of each element is then effected by regulating its temperature. Illustratively, a heating coil adjacent the fixed end of the element may be employed for this purpose. Utilization of bimetals as the contact elements of a latching switch is disclosed, for example, in patent application (M. A. Townsend 20), filed of even date herewith and assigned to the assignee hereof.

In accordance with a feature of the present invention, the need for a separate heating device to deflect the bimetallic contact elements is obviated by utilizing the metal layer on one face of each element as a heating resistor. As shown in FIGS. 4–6, contact element 100, for example, includes resistor path 130 on its deflection face 105. Illustratively, resistor path 130 comprises a layer of a metal having a thermal expansion coefficient which is small relative to that of signal conductors 113 and 123. Element 100 is actuated by a signal applied to terminal points 131 and 132 of resistor path 130. As the temperature of element 100 is thus increased, conductor paths 113 and 123, which comprise a layer of relatively high thermal expansion metal, expand to a greater extent than does resistor path 130. Accordingly, element 100 deflects toward its deflection face 105. Release of element 100 is effected by terminating the actuating signal at terminals 131 and 132, thereby allowing element 100 to return to ambient temperature.

Element 100 additionally includes insulating layer 133 which insulates resistor path 130 from signal conductors 113 and 123. Insulating layer 133 (which may include insulating strip 118) isolates the actuating signals through resistor path 130 from the signals on conductors 113 and 123.

It will be appreciated, as shown in FIGS. 4–6, that element 200 may similarly comprise a bimetal including a resistor path as described hereinabove for element 100. The following materials have been found to be well adapted for use in a bimetallic contact element such as element 100: for signal paths 113 and 123, beryllium-copper; for resistor path 130, the nickel-iron-cobalt alloy sold under the trademark KOVAR; and for insulating layer 133, epoxy impregnated glass cloth. Of course, other suitable materials will be apparent to those skilled in the art.

As may be seen in FIG. 4, elements 100 and 200 are somewhat deflected when switch 10 is closed. Thus, a moderate rise in ambient temperature, while somewhat decreasing the contact pressure between elements 100 and 200, advantageously will not disrupt closure of the signal paths between the terminals of switch 10.

It is to be understood that the foregoing merely illustrates the principles of the invention and that further modifications and embodiments of the invention may be devised by those skilled in the art without departing from the spirit and scope thereof.

We claim:

1. A latching switch comprising; first and second contact elements each having a fixed end and a free end, said free end having a contact edge lying on a line extending between said fixed end and said free end and further having a contact pad disposed between said fixed end and said contact edge, each of said contact elements further including means for electrically isolating said contact pad from said contact edge; and means adapting said elements for individual deflection in substantially orthogonal directions such that the contact pad and contact edge of each of said elements substantially concurrently intersect the release paths of the contact edge and contact pad, respectively, of the other of said elements; whereby electrical contact is established between the contact edge of each of said elements and the contact pad of the other of said elements upon deflection and subsequent substantially concurrent release of said elements.

2. A latching switch in accordance with claim 1 wherein each of said elements comprises a bimetal, and wherein said adapting means includes means for individually regulating the temperature of each of said elements.

3. A latching switch comprising; first and second contact elements, each of said contact elements comprising a bimetal having first and second electrically isolated layers, one of said first and second layers including means for individually regulating the temperature of each of said elements, each of said contact elements further having a fixed end and a free end, said free end having a contact edge lying on a line extending between said fixed end and said free end and further having a contact pad electrically isolated from said contact edge and disposed between said fixed end and said contact edge; means including said regulating means adapting said elements for individual deflection in substantially orthogonal directions such that the contact pad and contact edge of each of said elements substantially concurrently intersect the release paths of the contact edge and contact pad, respectively, of the other of said elements.

4. A latching switch in accordance with claim 3 wherein said regulating means comprises a resistive path for heating said bimetal in response to a signal applied to said path.

5. A latching switch in accordance with claim 4 wherein the other of said first and second layers of each element comprises first and second electrically isolated conductors extending from the contact edge and contact face, respectively, of said element to the fixed end thereof.

6. A latching switch comprising, first and second contact elements individually operative for deflection and release in substantially orthogonal directions, first and second contact pads respectively disposed on said first and second elements, first and second contact fingers respectively disposed on said first and second elements, means disposed on said first element for electrically isolating said first contact finger from said first contact pad, and means disposed on said second element for electrically isolating said second contact finger from said second contact pad, said first and second fingers being individually operative upon release of said first and second contact elements, respectively, for contacting said second and first contact pads, respectively.

7. A latching switch in accordance with claim 6 further comprising an individual pair of switch terminals associated with each of said elements, and first and second conductors disposed on each said element respectively connecting the contact pad and contact finger on said element to said pair of terminals associated therewith.

8. A latching switch in accordance with claim 6 wherein each of said elements comprises a bimetal, said switch further including means for individually regulating the temperature of each of said elements.

9. A latching switch comprising; first and second contact elements individually operative for deflection and release in substantially orthogonal directions, each of said elements comprising a bimetal having first and second metal layers and a layer of insulating material separating said first and second layers, one of said first and second layers including means for individually regulating the temperature of each of said elements; first and second contact pads respectively disposed on said first and second elements; first and second contact fingers respectively disposed on said first and second elements and electrically isolated from said first and second contact pads, said first and second fingers being individually operative upon release of said first and second contact elements, respectively, for contacting said second and first contact pads, respectively; an individual pair of switch terminals associated with each of said elements; and first and second conductors disposed on each said element respectively connecting the contact pad and contact finger on said element to said pair of terminals associated therewith.

10. A latching switch in accordance with claim 9 wherein said regulating means comprises a resistive path for heating said bimetal in response to a signal applied to said path.

11. A latching switch in accordance with claim 10 further comprising an individual pair of switch terminals associated with each of said elements and wherein the other of said first and second layers of each said element comprises first and second electrically isolated conductors extending from the contact edge and contact face, respectively, of each said element to said pair of terminals associated therewith.

* * * * *