

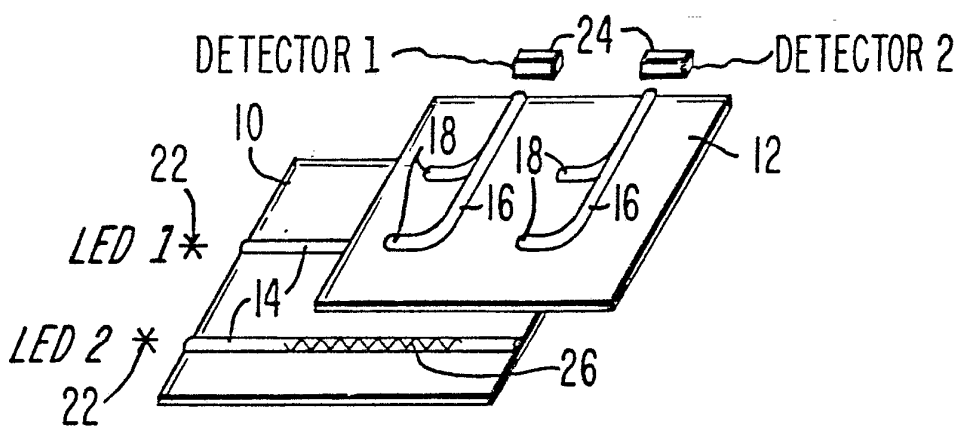


## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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**(54) Title:** MULTI-PLANE OPTICAL MEMBRANE SWITCH APPARATUS**(57) Abstract**

A multi-plane optical membrane switch for use for example in a keyboard matrix is formed by two flat, planar, clear, plastic members (10, 12) disposed in parallel, separated relationship and each having individual light conducting guide or channels (14, 16) thereon. The channels of the lower plane are disposed at right angles to the channels of the upper plane. The upper set of light guides includes integral, gently curving coupler taps (18) disposed at the intersection of the upper and lower guides for coupling the light from the lower planar guide channels into the upper guide channels when the two channels intersections are pressed together by the key top effectively switching the light from the lower to the upper channels.



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MULTI-PLANE OPTICAL  
MEMBRANE SWITCH APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

5 The present application is related to the following listed applications dealing with similar subject matter all assigned to the same assignee as the present application and filed concurrently herewith.

10 "FIBER WRAP KEYBOARD AND SWITCH", USSN 358,825, filed March 16, 1982 in the names of Wunnava V. Subbarao, Richard I. Ely, Carl E. Mosier and James E. Andree;

15 "SINGLE PLANE OPTICAL MEMBRANE SWITCH AND KEYBOARD", USSN 358,822, filed March 16, 1982, in the name of Richard I. Ely;

"MOLDED OPTICAL KEYBOARD HAVING FIBER OPTIC KEYS", USSN 358,824 filed March 16, 1982, in the names of Wunnava V. Subbarao, Richard I. Ely and Carl E. Mosier;

20 "MOLDED OPTICAL WAVEGUIDE SWITCHING APPARATUS", USSN 358,826 filed March 16, 1982, in the name of Richard I. Ely.



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BACKGROUND OF THE INVENTION.1. Field of the Invention

The present invention relates to photo-optical switching devices and more specifically to multiplane optical membrane switches for use in keyboard matrix arrays.

2. Description of The Prior Art

Prior art electrical membrane switching apparatus generally utilizes an electrically conductive coating on the opposite confronting surfaces of two slightly separated membranes. When the two membranes are pressed together electrical contact is made between the two conducting surfaces. If the conductive coatings are arranged in an array or matrix with one set of conductors at right angles to the other opposite set of conductors it is possible to form a keyboard with keys disposed at the intersections thereof.

Such keyboards suffer from certain deficiencies not the least of which is the fact that they radiate electromagnetic energy and are susceptible to electromagnetic interference (EMI). By employing optically conducting membranes the EMI problems are eliminated, in as much as there are no electrical contacts to be made.

SUMMARY OF THE INVENTION

The present invention provides an optically conductive keyboard membrane switch mechanism for use for example in keyboard applications among others. Two vertically displaced and separated planar, flat, sheet like membranes are each provided with a plurality of light conducting channels on one surface thereof. The channels of the upper membrane member are arranged to overlay the channels of the lower membrane member.



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For example, the lower membrane may have horizontal or x row channels thereon while the upper membrane may have vertical or y column channels thereon. The upper planar channel carrying members also include individual taps or optically conductive tails that intersect or overlap the optical channels of the lower membrane.

An optical switch structure is formed by placing a vertically movable key pad or key top over each tap such that depression of a key causes the upper channel intersecting area to contact the lower channel intersecting area.

A light source is disposed at the entering portion or end of each horizontal x row light conducting lower channel member while a light detector is located at the light exiting portion or end of each vertically column upper light conductor or channel member. When the taps are pressed against the horizontal channels, light is conducted from the bottom channel to the top channel. This effect is the result of the two channels (upper and lower) having the same index of refraction such that when they are in contact (due to the key depression) there is no discontinuity in the index of refraction and thus light can be passed from the lower to the upper channel or light guide.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric view (not to scale) of a four conductor membrane switch structure,

Figure 2 is a top plan view (greatly enlarged and not to scale) of a keyboard matrix array incorporating the structure of Figure 1,

Figure 3 is an enlarged view of a portion of the array of Figure 2 illustrating the tap area thereon, and



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Figure 4 is a schematic view illustrating two light ray paths from a lower to an upper channel according to the invention.

5     DESCRIPTION OF THE PREFERRED EMBODIMENT

Many types of glass and clear plastic exhibit the property of being capable of transmitting light into and through the material. Lexan, a clear plastic manufactured by General Electric Corporation of New  
10     York, USA exhibits such properties and has been successfully employed in the subject invention. Lexan is the trademark of the General Electric Company.

Two planar flat, sheets 10 and 12 of Lexan are arranged in spaced apart, parallel relation. A  
15     matrix array of this material comprises a first horizontal x row of fiber optical channels or light guides 14 disposed on the lower sheet 10 with a second vertical column set of light guides 16 disposed on the upper sheet 12 at right angles to the guides 14.

It has been discovered and demonstrated that  
20     when the upper light guides 12 are pressed into contact with the lower light guides 14 light is conductively coupled from one channel or guide into the other i.e. from the lower guides 12 to the upper guides 14. In  
25     order to more effectively utilize the light coupling phenomena, light guide couplers or taps 18, gently curving away from each vertical column in the area of the horizontal row channel intersections are formed from each vertical light guide 16 as seen in the Figure 1.

By arranging a key top 20 over each coupler tap  
30     18 the array or matrix can be made to act as a keyboard. Light generating means 22, such as light emitting diodes (LEDs) are located at each horizontal row input end as in Figure 1. Light detectors or receptors 24, such as



phototransistors or photo diodes are disposed at the end of each vertical column. Depression of any key 20 in a row 12 will cause light 26 from the photo generator 22 to couple up into the selected column guide 16 and activate its respective light receptor 24.

Light coupling from the x row to the y column, as the result of the contact between the intersecting tap and row guide is due to the fact that the two channels have the same index of refraction and when the two are brought into contact there is no discontinuity in the index of refraction so that the light is obliged to pass into the upper channel or guide from the lower channel.

This invention provides a relatively inexpensive keyboard array of easily formed optical switch devices. For practical purposes no moving parts are employed and in fact nothing moves but the upper plane intersecting point as it contacts the lower plane intersecting point. Effectively reducing the number of parts required in the device as well as the fabrication time for assembly thereof.

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WHAT WE CLAIM IS:

1. Multi-plane optical membrane switch apparatus comprising;
  - a first clear, rigid, plastic member;
  - 5 a second clear, rigid, plastic member disposed in spaced apart parallel relation to said first plastic member;
  - a plurality of fiber optic channel plastic member;
  - 10 a plurality of fiber optic channel forming members disposed on said second plastic member at right angles to said first plurality of fiber optic channel forming members;
  - light generating means at one end of each one of said first plurality of fiber optic channel members;
  - 15 light receiving means at one end of each one of said second plurality of channel members; and
  - means for applying pressure to the intersecting areas of said first and second optic channel members effective to couple light from the first
  - 20 to the second channel members.
2. The invention in accordance with Claim 1 wherein said pressure applying means comprises individual keys including identifying indicia providing a keyboard matrix for operator manipulation.
3. The invention in accordance with Claim 1 further including a tap member extending from a horizontal row channel to a vertical column channel for coupling light from the horizontal to the vertical
- 5 channel members.





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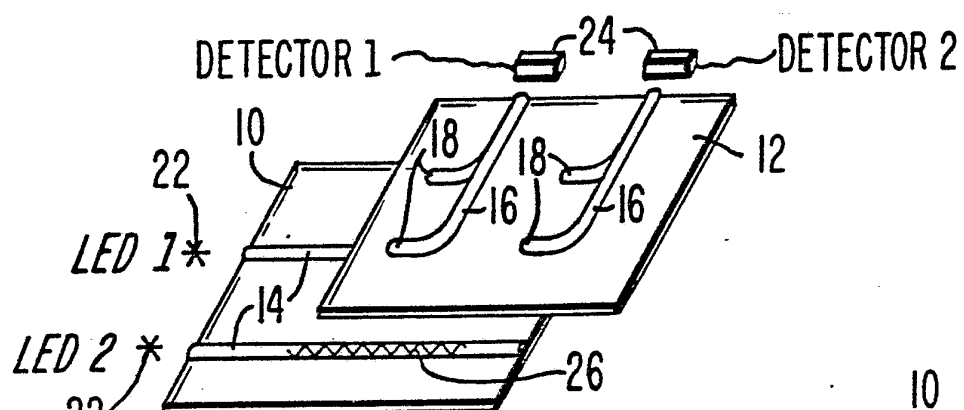
4. The invention in accordance with Claim 3  
wherein each said tap is gently radially curved effective  
to couple light from the light generating means of a  
row channel to the light receiving means of a vertical  
5 column channel.

5. The invention in accordance with Claim 1  
wherein said pressure applying means is disposed over  
the root area thereof so as to cause this portion of the  
last named means to contact the horizontal channels of  
5 said first plurality of channel forming members.

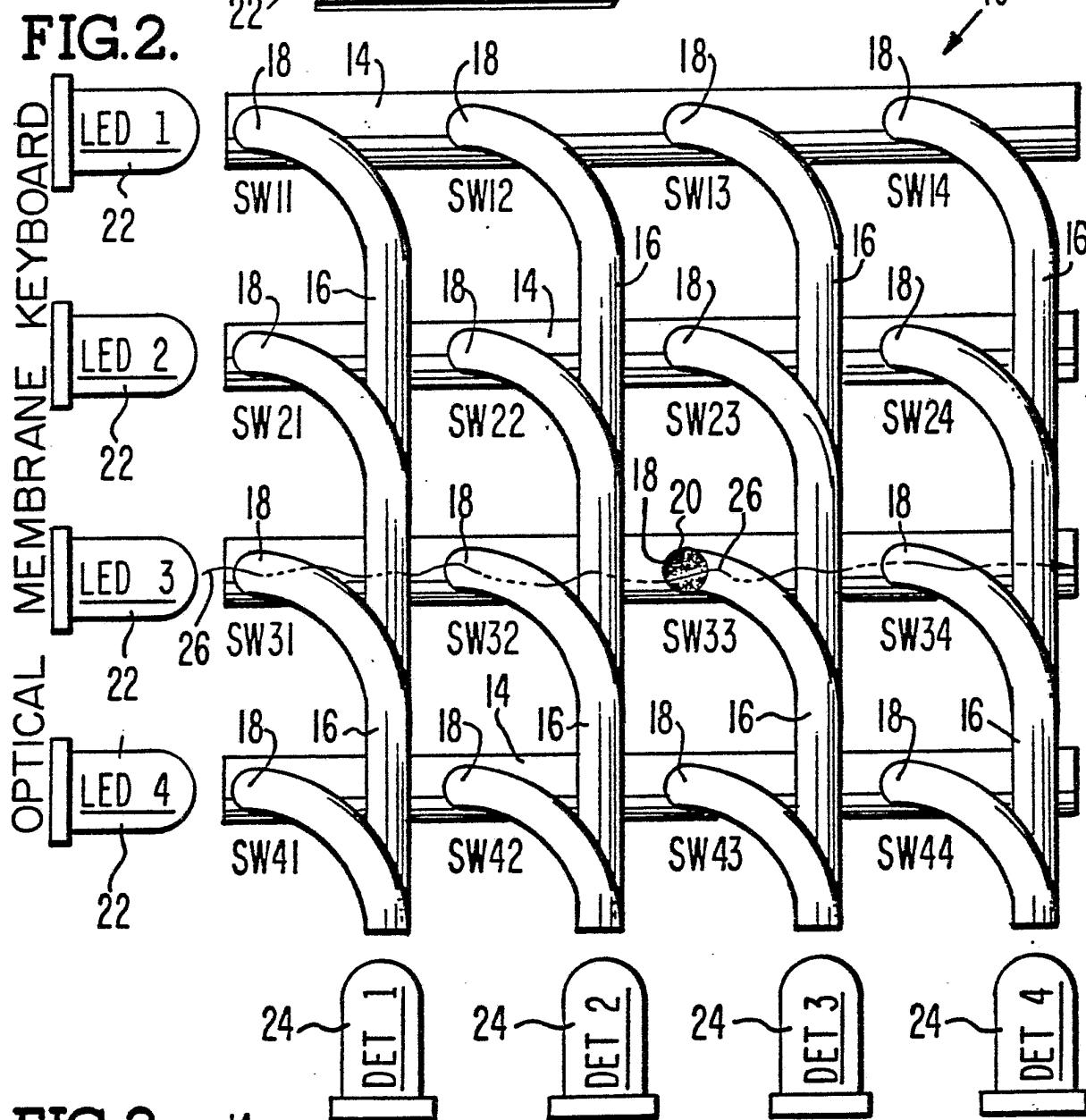


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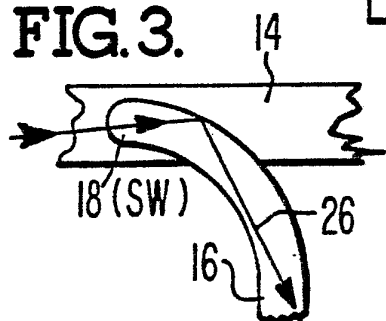
FIG.1.



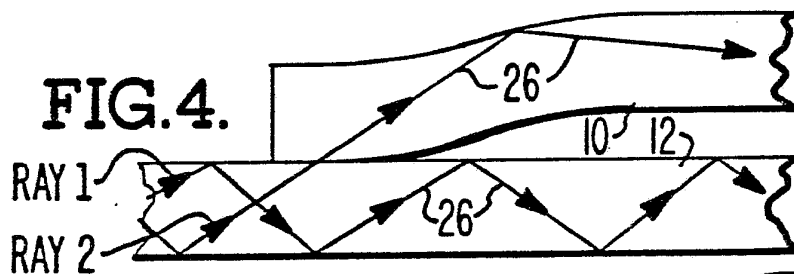
**FIG.2.**



**FIG. 3.**



**FIG.4.**



# INTERNATIONAL SEARCH REPORT

International Application No **PCT/US83/00341**

|   |  |                                     |
|---|--|-------------------------------------|
| <b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>   |  |                                     |
| According to International Patent Classification (IPC) or to both National Classification and IPC   |  |                                     |
| INT. Cl. <sup>3</sup>   | G02B 5/14  |                                     |
| U.S. Cl.  | 250/227  |                                     |
| <b>II. FIELDS SEARCHED</b>  |  |                                     |
| Minimum Documentation Searched <sup>4</sup>   |  |                                     |
| Classification System   | Classification Symbols   |                                     |
| U.S.  | 250/227, 229, 216<br>350/96.15, 96.16, 96.18<br>340/365P <span style="float: right;">73/705</span>             |                                     |
| Documentation Searched other than Minimum Documentation<br>to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>   |  |                                     |
| <b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>   |  |                                     |
| Category <sup>6</sup>   | Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup> | Relevant to Claim No. <sup>18</sup> |
| A, P  | US, A, 4,360,247 Published<br>23 November 1982, Beasley  | 1-5                                 |
| A   | US, A, 3,982,123 Published<br>21 September 1976, Goell et al.  | 1-5                                 |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p><sup>*</sup> Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </div> <div style="width: 45%;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"G" document member of the same patent family</p> </div> </div> |  |                                     |
| <b>IV. CERTIFICATION</b>  |  |                                     |
| Date of the Actual Completion of the International Search <sup>2</sup>  | Date of Mailing of this International Search Report <sup>3</sup>   |                                     |
| 10 May 1983   | 25 MAY 1983  |                                     |
| International Searching Authority <sup>1</sup>  | Signature of Authorized Officer <sup>20</sup>  |                                     |
| ISA/US  |  |                                     |