



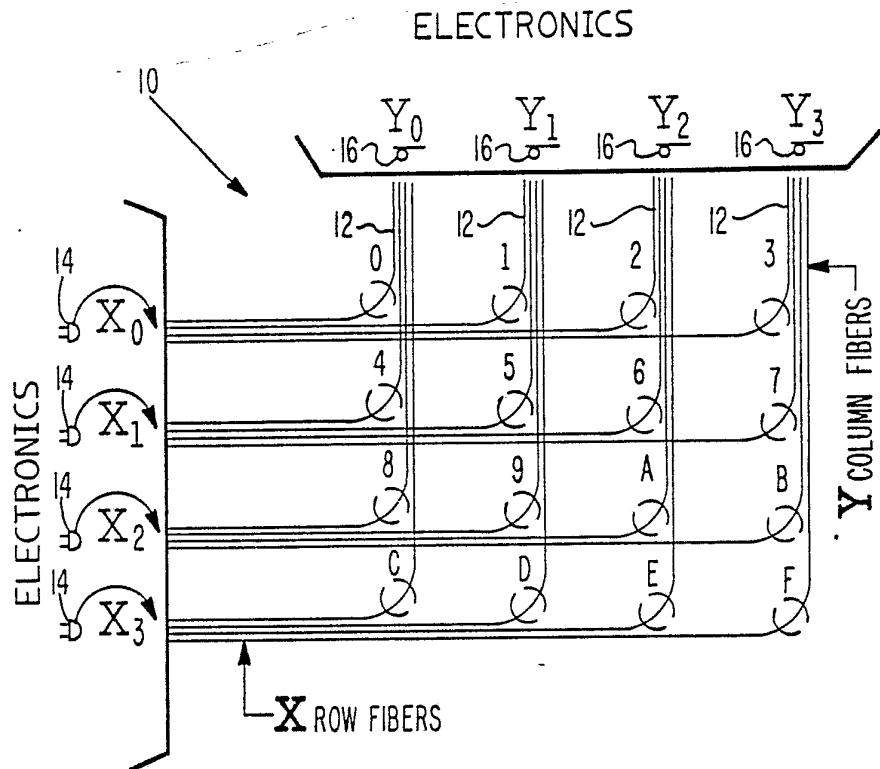
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(54) Title: FIBER WRAP KEYBOARD AND SWITCH

(57) Abstract

Photo-optical keyboard matrix (10) including a plurality of light transmitting optical fibers (12). The fibers are arranged in rows and columns with light generating means (14) disposed at the row terminations of the fibers and light receptors (16) are disposed at the column terminations of the fibers. The fibers are angularly cut at the matrix intersections of rows and columns to form an air prism. Individual key members, each provided with light blocking and unblocking means are movable into and out of the air prism area effectively blocking and unblocking light from generator to receptor thus providing optical keyboard switching apparatus.



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## FIBER WRAP KEYBOARD AND SWITCH

CROSS REFERENCE TO RELATED APPLICATIONS

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

"MULTI-PLANE OPTICAL MEMBRANE SWITCH APPARATUS", USSN 358,823, filed March 16, 1982, in the names of Richard I. Ely and Wunnava V. Subbarao.

"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.

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

BACKGROUND OF THE INVENTION1. Field of the Invention

The present invention relates to optical keyboards and key switches and more specifically, to photo-



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optical keyboards employing strands or fibers of material which are capable of transmitting light from a source to a receiver.

## 2. Description of the Prior Art

5 Fiber optic keyboards and key switch because of the manufacturing and alignment problems in handling the various components of these structures have proven to be much too costly and unreliable to find a ready place in the keyboard market. The fibers themselves  
10 are relatively costly to produce while the utilization of multiple strands of plural fibers involves a time consuming and expensive fabrication technique. Thus a so called true fiber optical keyboard is relatively uncommon in the keyboard market place.

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## SUMMARY OF THE INVENTION

The present invention provides a new, useful and unobvious wrapped optical fiber keyboard for use wherever keyboards are useful and required, such for  
20 example as in data processing equipment, IO terminals, teletype, etc.

Glass, plastic or similar fibers of suitable optical transmissivity are employed in the present invention and are automatically wrapped into a matrix  
25 configuration i.e. 4 x 4, 5 x 7, 7 x 9, etc., to form the desired keyboard key layout in rows and columns. At each right angled bend point i.e. where the y column turns or curves to form the x row, the fiber is cut or sliced at an angle to form an air prism at the  
30 cut. Because of the difference in the refractive indices  $N_2$  and  $N_1$  of the fiber material and the air, respectively, with  $N_2$  larger or greater than  $N_1$ , the light ray from the light generating source along an



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x-row fiber bends away from the base of the hypothetical air prism thus formed, and couples into the y-column fiber to direct the light onto the photoreceptor or photodetector.

5 By introducing a light obstructing or blocking member e.g. a key structure having a light passing aperture therein into the area forming the air prisms, the light can be interrupted or coupled as the key is activated and a signal can thus be developed which  
10 can be utilized as an indication of the key actuation.

#### BRIEF DESCRIPTION OF THE DRAWINGS

15 Figure 1 is a schematic plan view of a fiber wrap keyboard matrix incorporating the present invention;

Figure 2a and 2b are detailed views (not to scale) of a complete fiber and a fiber cut according to the teaching of the present invention, respectively;

20 Figure 3 is a schematic side elevation view of a key switch for the keyboard of the present invention illustrated in the inactive or light blocking position;

25 Figure 4 is a view similar to Figure 3 but illustrating the key switch in the active or light coupling position; and

30 Figure 5 is a schematic illustration of the hypothetical air prism formed at the juncture of the x-row and y-column of the fibers as a result of the cutting operation.

#### BRIEF DESCRIPTION OF THE PREFERRED EMBODIMENT

Illustrated in Figure 1 is a schematic view of a keyboard matrix array in accordance with the



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present invention. As shown, the matrix 10 comprises rows and columns of optical light conducting fiber elements 12 such for example as plastic threads or strands of generally circular or rectangular cross section.

Each thread or strand 12 is wrapped or laid down between a y-column position and an x-row position. A light generating means 14 such for example as a light emitting diode (LED) is disposed at the row position of the strands 12, while a light receptor means 16, such for example, a photo transistor or a photo diode is disposed at the column position of the strands 12.

Energization of the light generating means 14 causes light to be transmitted over the bundle of fiber strands 12 to be photoreceptor means 16.

As seen in Figure 2a each fiber is originally arranged in an L-shaped pattern (uncut) between the x and y position. By suitably slicing or cutting each fiber at a respective elbow or bend area 18 a hypothetical air prism 20 is formed by virtue of the two facing angular cuts 22 and 24 respectively, in the x portion and the y portion of each fiber strand or thread as shown in Figure 2b.

It is noted that while the refractive index of air is  $N_1$ , the refractive index  $N_2$  of the truncated fiber element 12 is substantially greater than  $N_1$  so that the light that passes along the x portion will bend away from the base of the air prism and will couple across the air prism into the y portion of the fiber. So long as the surfaces 22 and 24 form the hypothetical prism structure, the angular alignment between the two



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surfaces may vary, and still the light will couple across the air prism as stated hereinabove.

In order to provide an operational keyboard device a series of light blocking members 26 are employed, as shown in Figures 3 and 4. Each member 26 includes a stem portion 28 and an identifying keytop 30. Stem portion 28 is provided with a transverse aperture 32 and means for retracting the key in response to key depression, as by the finger of an operator. The retracting means 34 may be a spring captivated within a cylindrical aperture in the lower portion of the stem 28. The spring abuts the base member 36 of the keyboard so as to provide a vertically movable key switch.

By inserting the key stem 28 with its aperture 32 between the two angled cuts in each x-y fiber, a light blocking and unblocking member is formed. As seen in Figure 3 with the key 26 raised to the inoperative position light cannot pass through the aperture 32 and thus no signal is provided with the respective y column receptor 16. However, depression of key 26, as shown in Figure 4 will bring the aperture 32 into coincidence or alignment with the two angled optical surfaces 22 and 24 and light will then be coupled across the hypothetical air prism 20 from the LED 14 to the photo receptor 16 causing a signal output to be generated through the associated operational electronics.

In the 4 x 4 fiber optic keyboard matrix illustrated in Figure 1, each key is individualized for identification. Thus for example if  $x_2$  row fibers are lighted and  $y_1$  fibers pick up light this

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indicates that key number 9 is activated. If  $x_3$  row fibers are lighted and  $y_2$  picks up light then key e is activated. If  $x_3$  is lighted and  $y_1$  and  $y_3$  pick up light than keys d and f are activated and so on for all  
5 the keys depressed throughout the matrix above described.

There has thus been described a new, novel, useful and heretofore unobvious photo-optical keyboard structure which is inexpensive to fabricate and simple  
10 and efficient in use and operation. The concept is completely feasible and can produce by means of automatic machinery which include:

1. Automatically organizing and mounting bundles of optical fibers in a desired matrix to form  
15 a keyboard layout.

2. Automatically cutting or slicing the fibers at strategic predetermined locations to form the desired air prisms across which the signal will be  
20 coupled as the key stem is raised or lowered, and

3. Automatically inserting light blocking and unblocking keys and locking them in position to form a keyboard key structure.





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WHAT IS CLAIMED IS:

1. Fiber wrap keyboard and switch apparatus comprising;

5 means supporting bundles of light conducting members arranged in a matrix configuration with certain portion of said bundles disposed vertically and other portions of said bundles disposed horizontally, said other portions being arranged vertically relative to said certain portions;

10 said bundles of light conducting members being cut in two at the area of intersection of said vertical and horizontal portions effectively forming thereby a hypothetical air prism; and

15 means interposed between the two cut portions for alternatively passing and blocking light across said air prism from a light generating means to a light receiving means effectively providing a keyboard switch.

2. The invention in accordance with Claim 1 wherein said switch apparatus is formed as a monolithic single plane keyboard type structure.

3. The invention in accordance with Claim 1 wherein said bundles or light conducting members are arranged in an inverted L configuration.



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4. The invention in accordance with Claim 1 wherein the angle of the cut portions comprise equal angles.

5. The method of forming fiber optic keyboard and switch apparatus comprises the steps of;  
arranging bundles of light conducting members in a matrix array with horizontal and vertical portions of said array disposed at right angles to each other;  
5 cutting said bundles of light conducting members at the point or area of intersection of said horizontal and vertical portions effectively providing an air prism at the aforementioned intersection; and  
10 providing a receiprocably movable opposite ends of the horizontal and vertical portions so as to form a light switch.

6. The method of Claim 5 further including the step of bending the light conducting members from the vertical to the horizontal plane to provide a precise but gradual radius of curvature therein effective to  
5 lead the light across the air prism.



FIG. 1.

ELECTRONICS

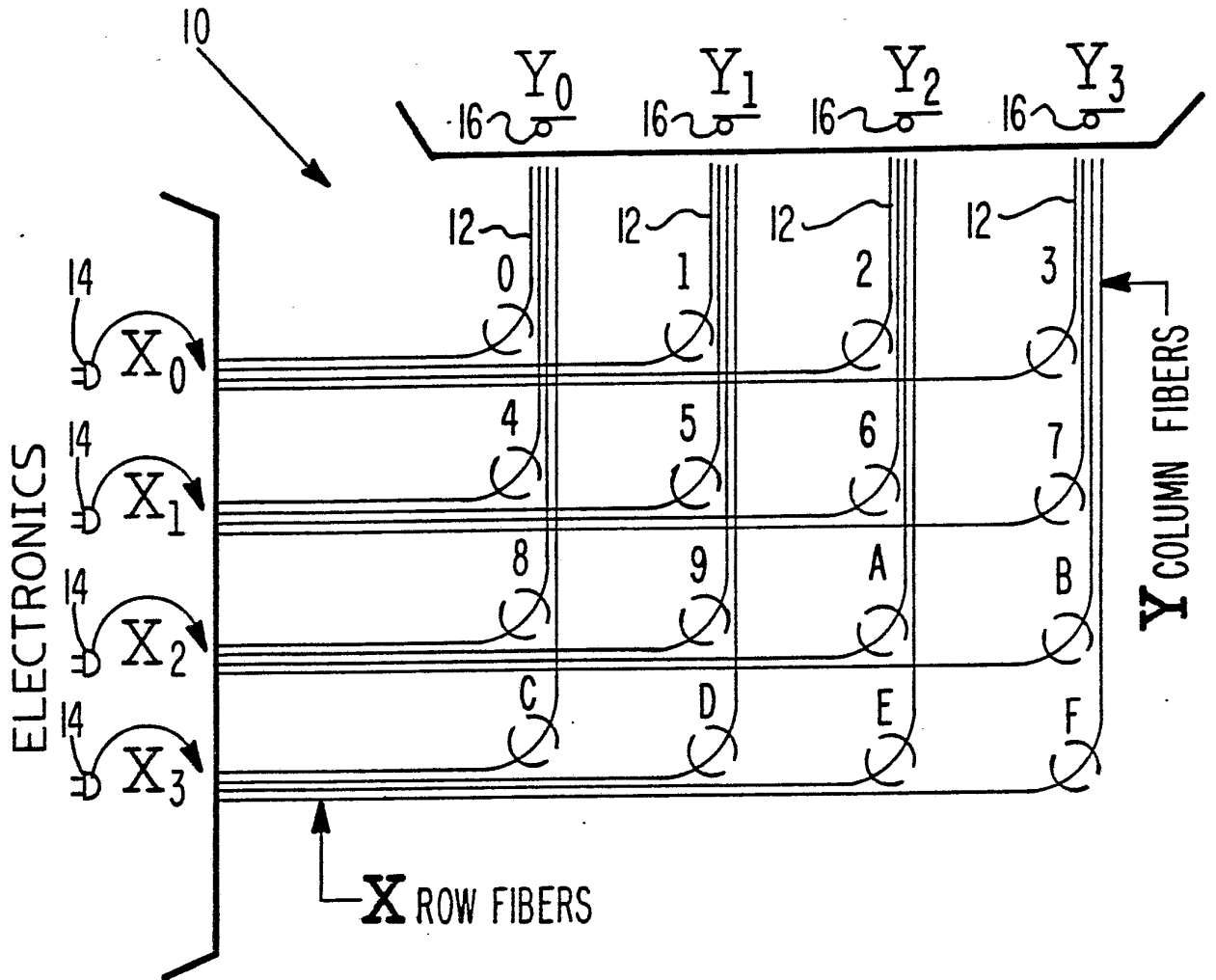


FIG. 2A.

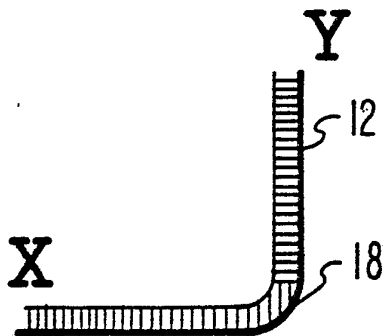


FIG. 2B.

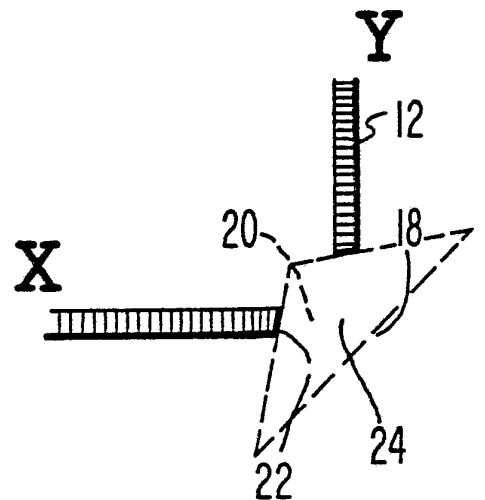


FIG. 3.

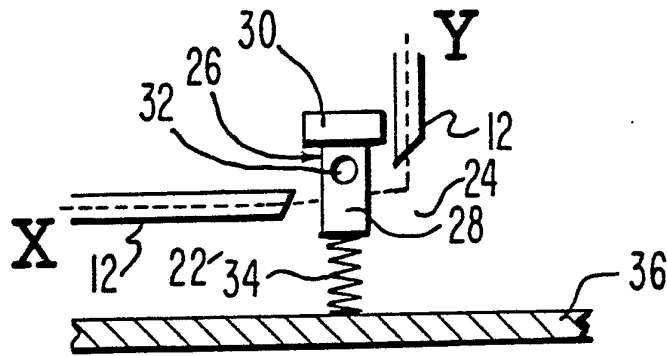


FIG. 4.

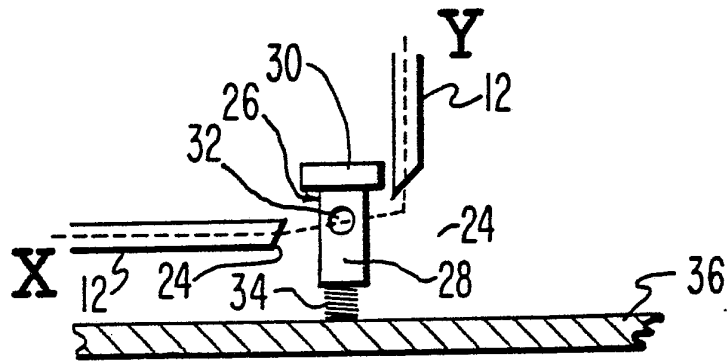
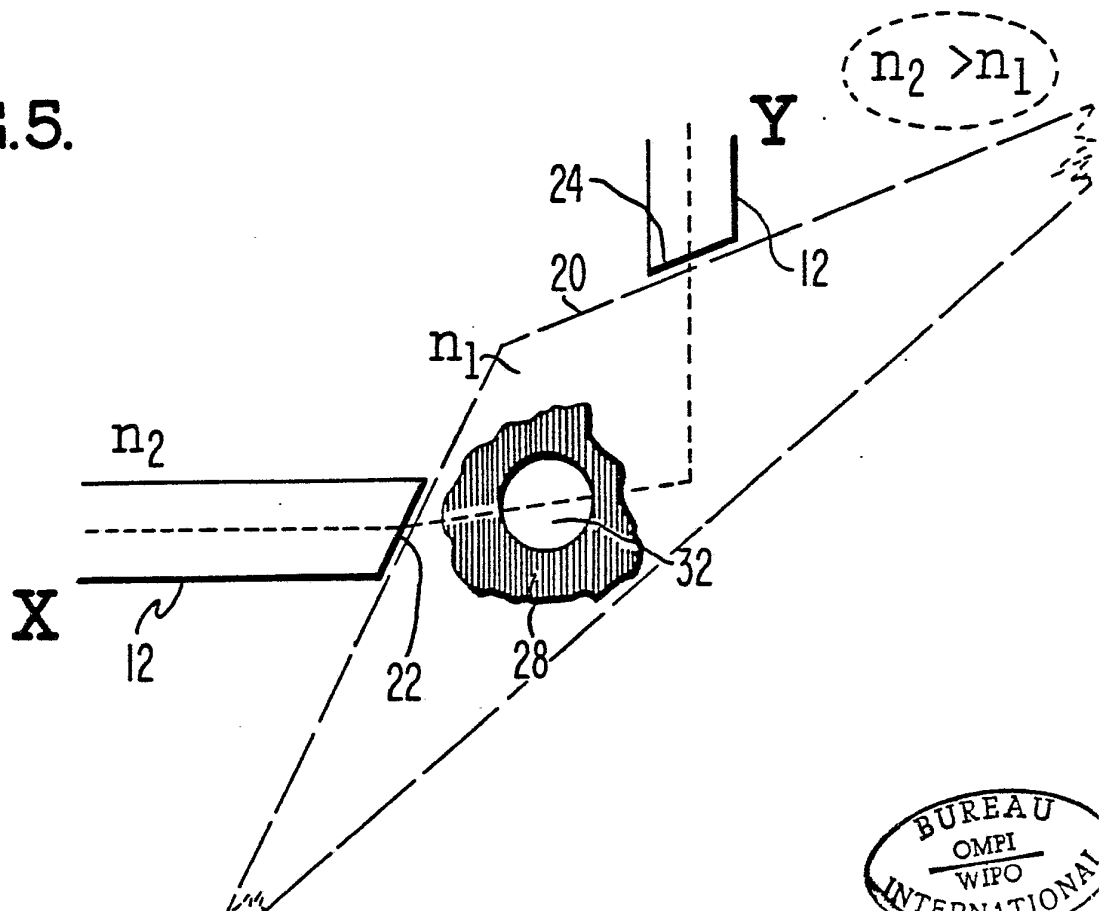
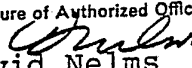


FIG. 5.



# INTERNATIONAL SEARCH REPORT

International Application No **PCT/US83/00344**

<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>	GO2B 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, 216 350/96.15, 96.16, 96.18 340/365P <span style="float: right;">73/705</span>	
Documentation Searched other than Minimum Documentation 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 *	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	US, A, 3,856,127, Published 24 December 1974, (HALFON ET AL.)	1-6
A	US, A, 4,013,342, Published 22 March 1977, (NARODNY)	1-6
A	US, A, 3,937,952, Published 10 February 1976, (RIPLEY ET AL.)	1-6
A	US, A, 3,648,050, Published 07 March 1972, (KOO)	1-6
A	US, A, 3,787,837, Published 22 January 1974, (ALLEN ET AL.)	1-6
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<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>2</sup>	
10 May 1983	<b>18 MAY 1983</b>	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>20</sup>	
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