United States Patent

Koo

[15] **3,648,050**

[45] **Mar. 7, 1972**

[54] OPTOELECTRONIC DATA ENTRY MEANS HAVING PLURALITY OF CONTROL MEANS TO DIRECT PART OF RADIATION IN CHANNEL FROM RADIATION SOURCE TO OUTPUT CHANNEL

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[21] Appl. No.: **61,646**

[52] **U.S. Cl.** **250/208,** 178/17, 250/220

[51] **Int. Cl.** **H01j 39/12**

[58] **Field of Search** 250/220, 227, 208; 178/17

[56] **References Cited**

UNITED STATES PATENTS

3,056,030	9/1962	Kelchner	250/220 R
3,519,116	7/1970	Koehn	250/227

Primary Examiner—James W. Lawrence
Assistant Examiner—T. N. Grigsby
Attorney—Louis A. Kline and Albert L. Sessler, Jr.

[57] **ABSTRACT**

An optoelectronic data entry means which employs radiation and radiation-responsive elements as a means of converting information from manually entered form to electrical signal form. A plurality of data entry elements are mounted in chambers in a housing in row-and-column arrangement. A plurality of communication channels and output channels are disposed in a generally planar orientation in the housing. The communication channels provide access from a source of radiation to the chambers in which the data entry elements are disposed, and the output channels provide radiation paths from said chambers to a plurality of detectors capable of converting the radiation to electrical signals. Beam splitting devices mounted on the inner ends of the data entry elements are effective, upon selective operation of the data entry elements, to deflect a portion of the radiation admitted to the chambers through the communication channels into the output channels for detection by the corresponding detectors, while permitting another portion of said radiation to pass through said beam splitters for possible interception by the beam splitter of another data entry element associated with the same communication channel. Two arrangements are disclosed, one of which includes mechanical encoding of the input information.

11 Claims, 9 Drawing Figures

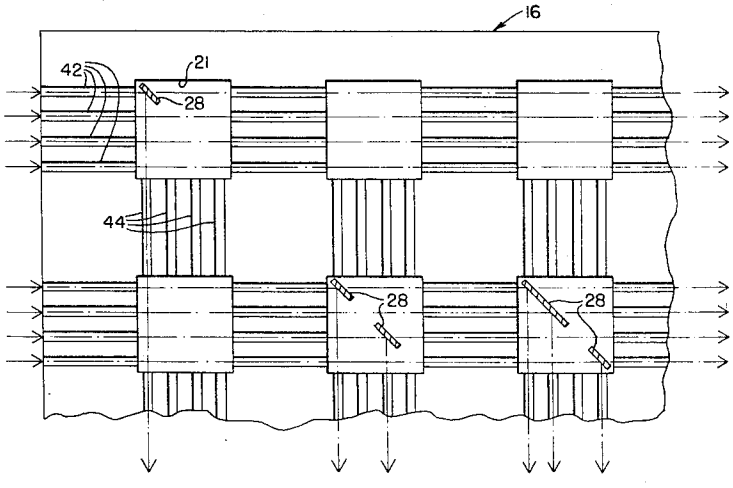

FIG. 1

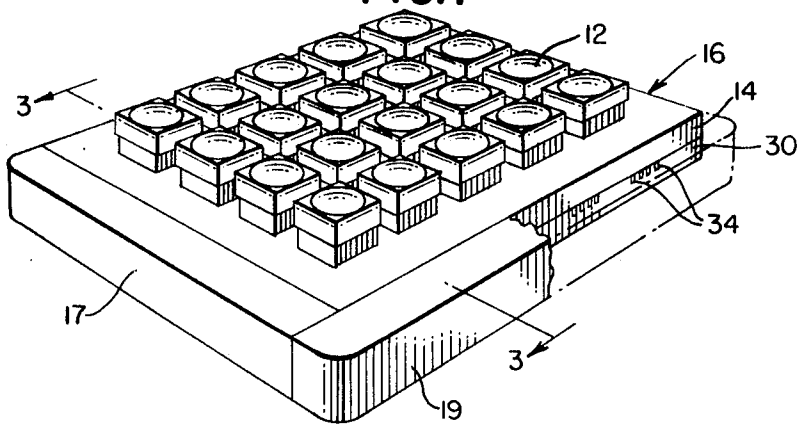

FIG. 2

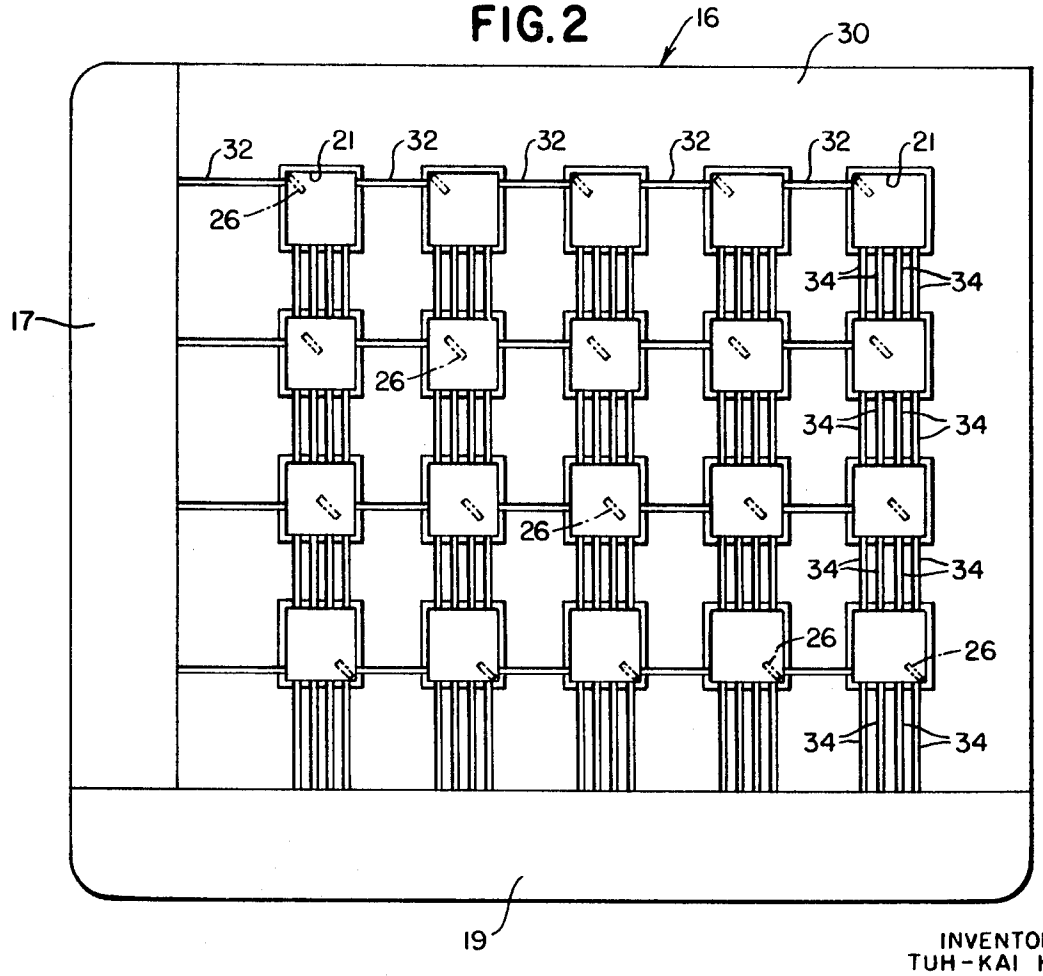

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FIG. 3

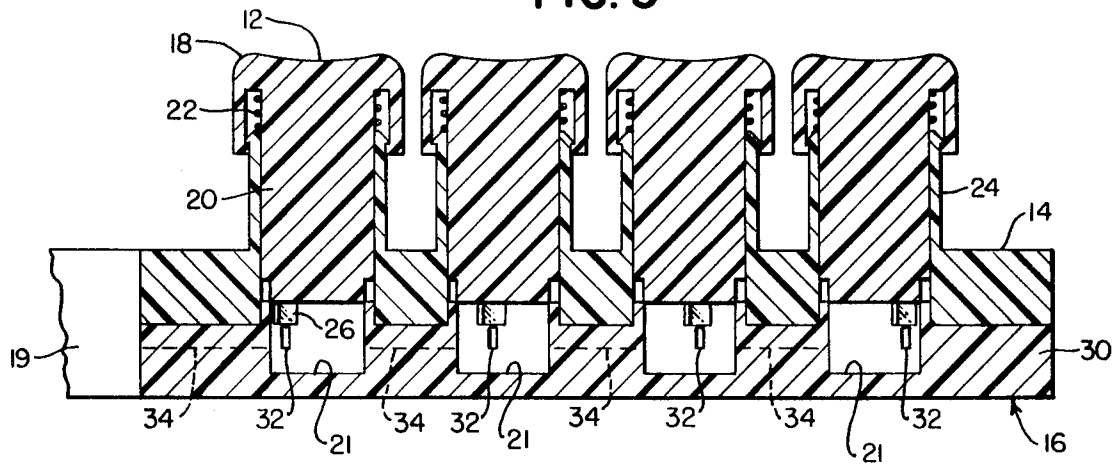
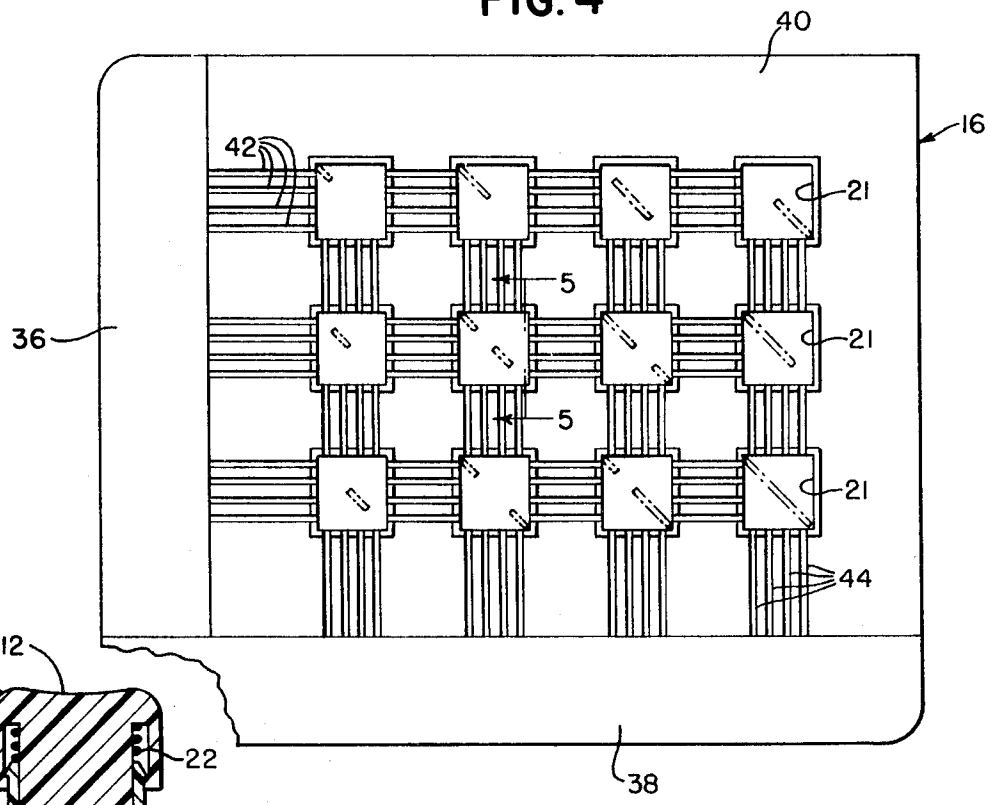


FIG. 4



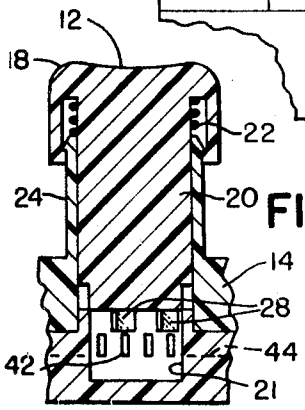


FIG. 5

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FIG. 6

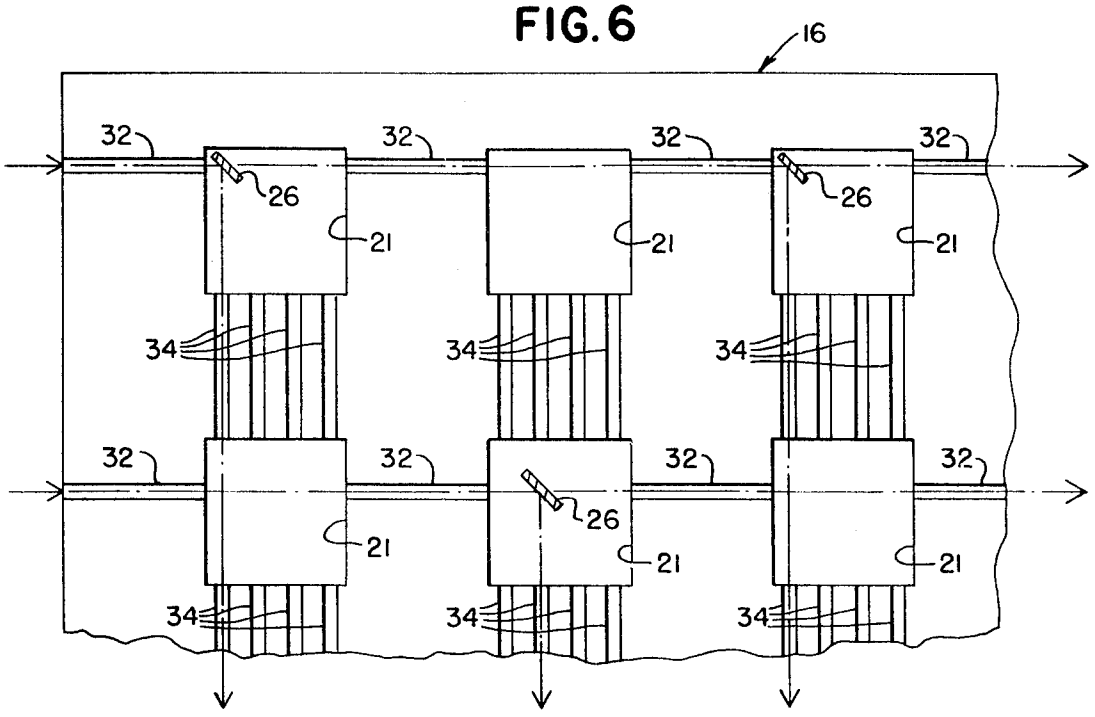

FIG. 7

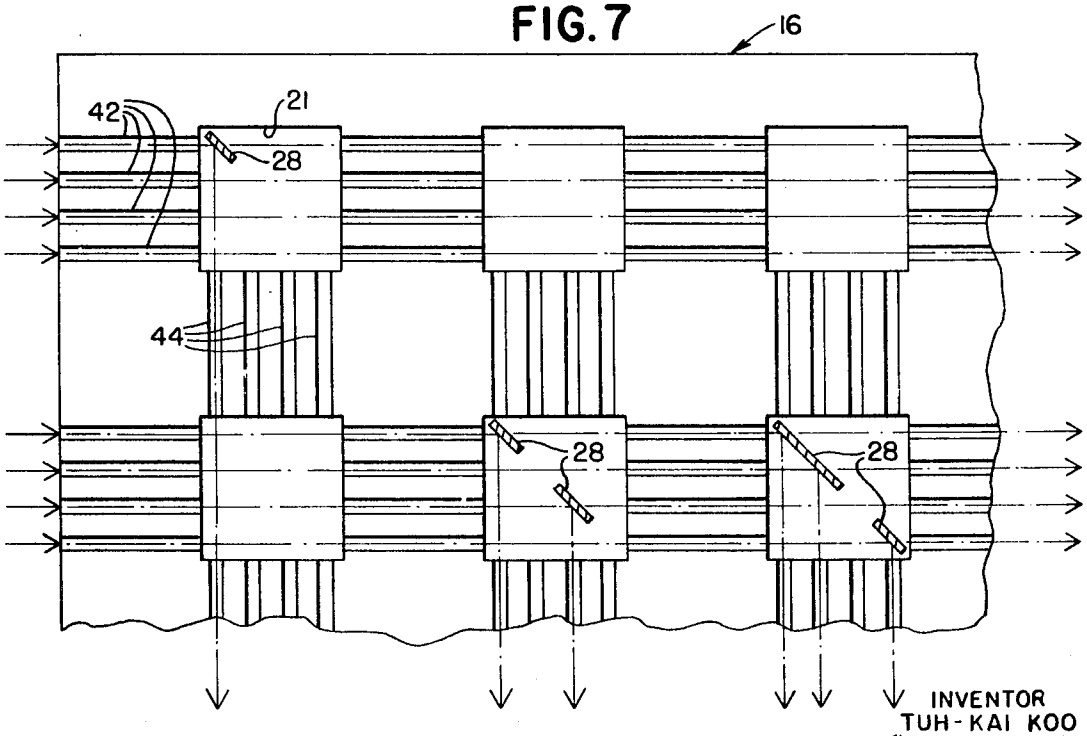

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FIG. 8

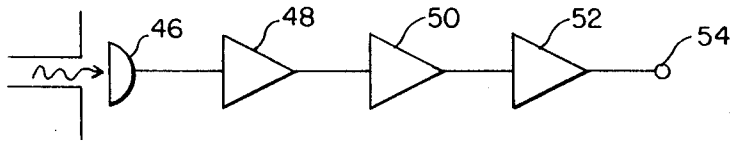
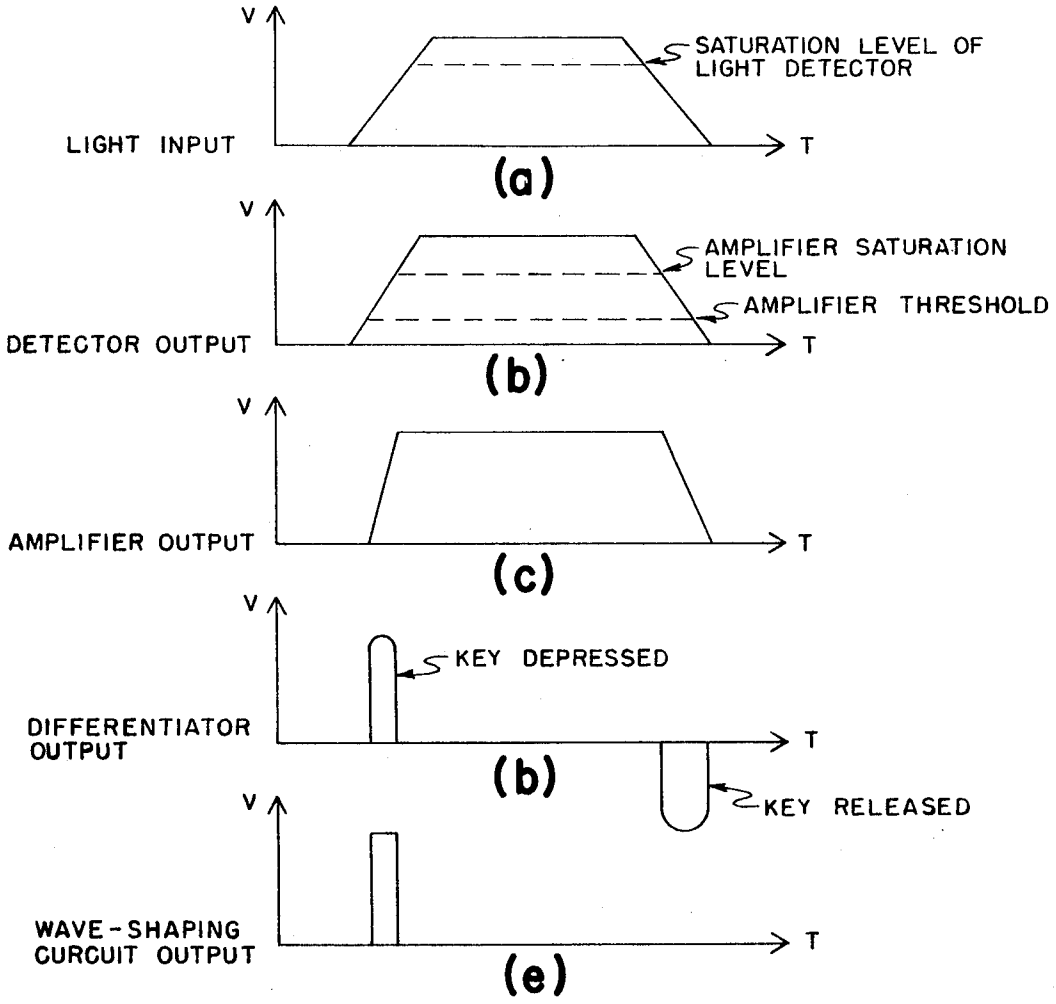


FIG. 9



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OPTOELECTRONIC DATA ENTRY MEANS HAVING PLURALITY OF CONTROL MEANS TO DIRECT PART OF RADIATION IN CHANNEL FROM RADIATION SOURCE TO OUTPUT CHANNEL

BACKGROUND OF THE INVENTION

This invention relates to an optoelectronic data entry means for producing electrical output information signals in response to information entered mechanically, as, for example, by a manually operated keyboard. These information output signals may be used to effect the entry of information into a utilizing device such as, for example, a teleprinter or an electronic data processing system.

A number of systems have been developed for the generation of electrical information signals in response to mechanically entered information, such as that entered by a manually operated keyboard, using electro-optical means. One such system is shown in U.S. Pat. No. 3,092,310, issued June 4, 1963, inventors Werner Flieg et al., in which a system of mechanical blocking of light paths is employed for producing output signals in accordance with manually entered information. In U.S. Pat. No. 2,651,463, issued Sept. 8, 1953, inventors Philip H. Allen et al., certain controls of the operation of a calculating machine are exercised by controlling of light beams through mirrors affixed to control keys. A third system is shown in U.S. Pat. application, Ser. No. 821,311, filed May 2, 1969, David M. Patti, inventor, assigned to the assignee of the present application, in which reflective surfaces, mounted at an angle on each data entry element, are effective to reflect radiation from a radiation source onto a photosensitive device corresponding to the selected data entry element when said data entry element is operated. Illumination of the photosensitive device produces a signal which is effective, through a logical encoding network, to produce an output signal representing the character for the operated data entry element.

SUMMARY OF THE INVENTION

The present invention provides a data entry means which is simple and low cost in construction and efficient in operation, and which is capable of producing an electrical signal output without requiring complex mechanical linkages or electrical contacts.

Optoelectronic means are employed for converting mechanically entered information, as, for example, by a manually operated keyboard, into electrical signals, which may be in accordance with a predetermined code in one embodiment of the invention. The electrical signals thus produced may be applied to an electronic data processing system, or other utilizing device.

In the present application, the invention is shown as embodies in a manually operable keyboard, with the depression of a given data entry element, or key, serving to provide the manual entry of information. However, it will be recognized that the physical embodiment of the invention may take many forms, and is not intended to be limited to that of a keyboard.

As herein shown, the various keys comprising the keyboard are mounted in an arrangement of rows and columns in chambers in a substantially lightproof housing. A source of radiation is provided along one side of the housing and may comprise either a single radiation-emitting element or a plurality of such elements, depending upon cost, reliability, and other factors. A plurality of channels, located generally in the same plane of the housing, and arranged in rows and columns corresponding to the arrangement of the keys and their recesses, is provided, comprising communication channels to convey radiation from the source to the chambers for the various keys, and output channels to convey radiation from those chambers to the exterior of the housing, where detector devices are mounted, one for each output channel, which are capable of responding to a change in the level of radiation applied thereto.

Deflection of radiation from the communication channels to the output channels is selectively accomplished within the key chambers by means of beam splitting devices associated with each key which are capable, upon depression of the key, to place said beam splitting devices in the path of radiation from the communication channels, for deflecting a portion of the incident radiation, through a horizontal angle of 90°, into one or more output channels, in accordance with the configuration and position of the beam splitting device on the depressed key. The signal produced by impingement of the radiation on the selected detector means is amplified, differentiated, and shaped into a wave form suitable for transmission to a utilizing device.

The remainder of the incident radiation passes through the beam splitting device and the recess, and is conveyed through a continuation of the communication channel to the next chamber, where it may pass through without change, if the corresponding key is not depressed, or where it may be further split to provide an additional output signal if said key is depressed.

Two modifications of a keyboard embodying the present invention are disclosed in this application.

In the first embodiment, only a single communication channel is used with each row of keys and associated chambers, while a plurality of output channels are used with each column of keys and associated chambers. Each key is provided with a beam splitting device capable of deflecting radiation into only one output channel per key. There is, therefore, effectively one output channel for each key, and this embodiment accordingly permits simultaneous depression of any and all keys on the keyboard.

In the second embodiment, a plurality of communication channels are used with each row of keys and associated chambers, and a plurality of output channels are used with each column of keys and associated chambers. Each key is provided with a beam splitting device capable of deflecting radiation into one or more output channels per key, in accordance with a predetermined code. The beam splitting devices associated with the various keys thus perform an encoding function, in addition to their function as deflecting means to convey radiation from communication channels to output channels. The second embodiment does not permit simultaneous depression of two keys in the same column, but does permit simultaneous depression of keys in different rows.

It is accordingly an object of the present invention to provide optoelectronic data entry means capable of producing output information signals in response to operation of data entry elements.

A further object is to provide optoelectronic data entry means using beam splitting devices to translate mechanical input of information into electrical output signals.

An additional object is to provide optoelectronic data entry means using beam splitting devices to produce encoded electrical output signals from mechanical input of information.

With these and other objects, which will become apparent from the following description, in view, the invention includes certain novel features of construction and combinations of parts, two preferred forms or embodiments of which are hereinafter described with reference to the drawings which accompany and form a part of this specification.

In the drawings:

FIG. 1 is a perspective view showing the exterior of a data entry device embodying the present invention.

FIG. 2 is a plan view of a first embodiment of the data entry device of FIG. 1, with the keys and the upper portion of the housing removed, and with the beam splitting devices for the various keys shown in phantom lines.

FIG. 3 is a sectional view taken along line 3—3 of FIG. 1, showing the keys, the housing, the beam splitting devices, and the communicating and output channels.

FIG. 4 is a plan view, similar to FIG. 2, showing a second embodiment of the invention.

FIG. 5 is a partial sectional view, taken along the line 5—5 of FIG. 4, showing one key and the associated beam splitting device, plus portions of the housing and the channels, of the second embodiment of the invention.

FIG. 6 is a diagrammatic view showing typical radiation paths caused by depression of various keys in the first embodiment of the invention.

FIG. 7 is a diagrammatic view showing typical radiation paths caused by depression of various keys in the second embodiment of the invention.

FIG. 8 is a block diagram of a circuit which may be employed to produce electrical information signals in response to radiation conveyed through an output channel of the data entry means and applied to a detector.

FIG. 9 shows a series of wave forms representing signals produced by the circuit of FIG. 8 at various points of the circuit.

DETAILED DESCRIPTION

Referring now to FIG. 1 of the drawings, a plurality of keys 12 are mounted for vertical shifting movement in a suitable matrix or other keyboard arrangement in a key frame block 14, which is tightly secured to an optical switching block 30, to form a substantially lightproof housing 16. Secured to one side of the housing 16 is a light source 17, which may comprise either a single source of illumination or a plurality of individual sources, depending upon the particular requirements of the system. The source may emit either visible light or some other type of radiation, again depending upon the needs of the system.

Secured to an adjacent side of the housing 16, at right angles to the light source 17, is a detector unit 19, containing a plurality of detectors capable of responding by a change in electrical characteristic, such as by a change in voltage or resistance, to the impingement thereon of radiation emitted from the source 17. The number of detectors included in the unit 19 will vary according to the number of keys 12, and according to whether the data entry means is constructed in accordance with the first or the second embodiment of the invention.

As shown in FIGS. 3 and 5, each key 12 includes a key tip portion 18 and a stem 20, and is normally biased to a nonoperated position in a chamber 21 in the housing 16 by a spring 22 located in a space between the key tip portion 18 and the stem 20, and extending between an interior surface of the recess and a key sleeve 24 on the key frame block 14 of the housing 16. This construction heretofore described is identical for both of the illustrated embodiments of the invention.

Also in both embodiments of the invention, a beam splitting element is secured by some suitable means to the lower surface of the key stem 20. In the first embodiment of the invention, shown in FIG. 3, this beam splitting element is indicated by the reference character 26, and consists of a single projection, while in the embodiment of FIG. 5, this beam splitting element is indicated by the reference character 28, and a plurality of projections may be employed, according to a predetermined code, as will subsequently be described.

The beam splitting elements 26 and 28 employed in the embodiments shown in FIGS. 3 and 5 are made from any suitable transparent material, such as glass, which is capable of passing some of the radiation, such as light beams, impinging thereon, while reflecting the remainder of said radiation. This property of many transparent materials is well known. The ratio of light transmitted to light reflected can, of course, be varied to meet particular needs by appropriate surface polishing or coating. Since, as may be seen in the drawings, the projections of the beam splitters are positioned at an angle of 45° with respect to the radiation impinging thereon, the radiation is reflected at an angle of ninety degrees from the impinging radiation.

In the first embodiment of the invention, as shown in FIGS. 2, 3, and 6, a single communicating slot or channel 32 in the optical switching block 30 of the housing 16 for each row of keys 12 and associated chambers 21 extends from the light source 17 to the nearest chamber 21 and thence between adjacent chambers, so that a path for propagation of light is provided from the light source 17 to all of the chambers 21 of the same row.

In each column of keys and associated chambers 21, a plurality of output channels 34 in the optical switching block 30 of the housing 16 extends from the detector unit 19 to the nearest chamber in the column, and thence between adjacent chambers in the column. The number of output channels 34 in the column is equal to the number of keys 12 and associated chambers 21 in the column.

As has been previously described, the stems 20 of the keys 12 extend into the chambers 21, with said keys being normally biased by the springs 22 so that the beam splitters 26 (shown in phantom lines in FIG. 2) for the various keys 12 are positioned out of the path of light propagating along the communication channels 34. When selected keys are depressed, the corresponding beam splitters 26 are interposed in the path of light propagating along the associated communicating channel 32.

As may readily be seen in the diagram of FIG. 6, the interposed beam splitters cause a portion of this light to be reflected at a 90° angle into an output channel 34 corresponding in position to the interposed beam splitter 26. The reflected light is propagated along the channel 34 and impinges upon a detector in the detector unit 19 corresponding to the selected output channel 34. At the same time that some of the light from a given communication channel 32 is being reflected into an output channel 34 by a beam splitter 26, the remainder of the light from said channel passes through said beam splitter and continues through the chambers 21 and along the channel 32 to another interposed beam splitter 26, if any, where a further portion of the light is reflected at a 90° angle into an output channel 34 for transmission to another detector in the detector unit 19.

It will also be noted in FIG. 6 that light from the source 17 is simultaneously applied to the communicating channels 32 for all of the different rows, and that any or all of the keys 12 of the keyboard may be depressed simultaneously, so that there may be simultaneous signals generated by any or all of the detectors in the detector unit 19.

In the description of the second embodiment of the invention, shown in FIGS. 4, 5, and 7, reference characters identical to those used for the description of the first embodiment will be used in those cases in which the parts are identical, and different reference characters will be used in those instances in which the parts, or their cooperation in the overall structure, differ from the embodiment of FIG. 1.

As may be seen in FIG. 4, an optical switching block 40 of the housing 16 of the second embodiment of the invention is provided with a plurality of communication channels 42 for each row of keys 12 and associated chambers 21, the number of communication channels 42 for each row corresponding to the number of output channels 44 for each column of keys 12 and associated members 21. All of the communication channels 42 for each row extend from a light source 36 to the nearest chamber 21, and thence from chamber to chamber, while all of the output channels 44 for each column extend from the detector unit 38 to the nearest chamber of the column, and thence from chamber to chamber.

In the second embodiment, the beam splitters secured to the bottom of the stems 20 of the keys 12 are configured according to a predetermined code, as shown in FIGS. 4, 5 and 7, so that, when a given key is depressed, a beam splitter 28 will be interposed in the path of one or more of the light beams from the light source 36 entering the chamber 21 associated with the depressed keys from communication channels 42, resulting in the deflection of these beams through an angle of 90° to cause them to be directed through corresponding output channels 44 to associated detectors in the detector unit 38. The simultaneous appearance of signals at one or more of the detectors for a given column thus provides a coded indication of the particular key in that column which was operated. As may best be seen in FIG. 7, the beam splitters function in the same manner as in the first embodiment, in causing a portion of the impinging light to be reflected, while the remainder passes through the beam splitter to be available for deflection by the beam splitter of another key in the same row more distant from the light source 36.

Shown in FIG. 8 in block form is one type of circuit which may be employed to produce a suitable electrical data signal for transmission to a utilizing device in response to the impingement of light or other radiation upon a detector 46 in the detector unit 19 or 38 of the first or second embodiment of the invention. The detector 46 is located at the exit of an output channel 34 or 44, and forms part of a serially connected circuit consisting of an amplifier 48, a differentiator 50, and a wave shaping circuit 52, and terminating in an output terminal 54, from which an output signal may be taken. All of the elements represented in block form in FIG. 8 are well known and conventional, and it is therefore not deemed to be necessary to show detailed circuit configurations for any of them.

The operation of the circuit of FIG. 8 will now be described with reference to the various wave forms shown in FIG. 9, in which time is plotted against voltage. Let it be assumed that the light pulse from the output channel 34 or 44 is of the form shown in FIG. 9(a), and that the light detector 46 has a saturation level lower than the maximum amplitude of the light pulse applied to said detector. In this mode of operation, the detector 46 absorbs the effect of light amplitude fluctuation, and the output signal is shaped to appear generally as a square wave. It will also be assumed that the amplifier is designed for operation with a threshold and a low saturation level, so that the circuit shapes the signal toward a square wave, as shown in FIGS. 9(b) and 9(c), and allows "slur" during key operation; "slur" being defined as the requirement for a threshold in key displacement in order to prevent accidental "touch off".

As shown in FIG. 9(d), two pulses are obtained after the output of the amplifier 48 is processed by the differentiator 50; one of said pulses corresponding to the depression of a key, and the other to the release of a key. When the two pulses of opposite polarity are discriminated by the wave shaping circuit 52, a signal, shown in FIG. 9(e), is obtained that corresponds to the down stroke of a key, with the key release having no effect on the output signal applied to the terminal 54.

This therefore provides a keyboard in the first embodiment disclosed herein in which all keys of the keyboard have the characteristic of a "full rollover"; that is, a keyboard in which the retention of a key or keys past the activating point does not affect the output of subsequent key operation. In the second disclosed embodiment, the construction is such that the keyboard has the characteristic of "semirollover"; that is, a keyboard in which the retention of keys in different columns (but not in the same column) past the activating point does not affect the output of subsequent key operation.

It will be understood that modifications may be made in the circuit of FIG. 8 without departing from the scope of the invention, in accordance with differing circuit parameters and requirements, so that different types of circuit elements may be used where appropriate, and certain elements may be eliminated or combined with other elements.

What is claimed is:

1. Data entry means comprising, in combination,

a housing member;

a plurality of data entry elements arranged in rows and columns, each located in a chamber in said housing member and capable of moving between first and second positions;

radiation source means for providing radiation to be applied to the rows in which the data entry elements are arranged;

a plurality of communication channels in said housing member, each connecting said radiation source means to all of the chambers of a row of data entry elements;

a plurality of output channels in said housing member for each column of data entry elements, each channel connecting all of the chambers of a column of data entry elements; and

a plurality of radiation control means, each connected to one of the data entry elements, and capable of altering the path of part of the radiation from the radiation source means transmitted to the chamber of a selected data entry element through the corresponding communication channel to direct part of said radiation along at least one of the output channels associated with the column of the selected data entry element when said selected data entry element is shifted from said first position to said second position to interpose the radiation control means connected to the selected data entry element in the path of the radiation from the radiation source means.

2. The data entry means of claim 1, also including:

detector means in operative relation to each output channel for converting radiation signals into electrical signals;

differentiating means for differentiating the electrical signals produced by the detector means; and

means for shaping the differentiated signals produced by the differentiating means to produce a signal representing operation of a selected data entry element.

3. The data entry means of claim 1, also including:

detector means in operative relation to each output channel for converting radiation signals into electrical signals having a wave form including a rise representing movement of a data entry element from said first position to said second position, and a fall representing movement of the data entry element from said second position to said first position;

differentiating means connected to the detector means for producing a first signal of one polarity representing the rise of the signal produced by the detector means, and a second signal of opposite polarity representing the fall of the signal produced by the detector means; and

wave shaping means connected to the differentiating means for producing a shaped signal corresponding to one of the two signals produced by the differentiating means, and representing movement of the data entry element from said first position to said second position.

4. The data entry means of claim 1, also including:

detector means in operative relation to each output channel for converting radiation signals into electrical signals;

amplifying means connected to the detector means for amplifying the electrical signals produced by the detector means;

differentiating means connected to the amplifying means for producing differentiated signals of opposite polarity corresponding to the rise and fall of the amplified signal from the amplifying means; and

wave shaping means connected to the differentiating means for producing a shaped signal corresponding to only one of the differentiated signals produced by the differentiating means from each electrical signal derived from a radiation signal.

5. The data entry means of claim 1, in which there is a single communication channel for each row of data entry elements, and in which the radiation control means for each data entry element in that row is effective, upon operation of its corresponding data entry element, to direct part of the radiation passing through said communication channel to a single output channel associated with the column of the selected data entry element.

6. The data entry means of claim 1, in which there is a single communication channel for each row of data entry elements, and in which the radiation control means for each data entry element comprises a beam splitting element capable of reflecting a portion of the radiation from the radiation source means into a predetermined output channel when the data entry element of said beam splitting element is moved to said second position, said beam splitting element also being capable of passing part of the radiation from the radiation source means therethrough, the beam-splitting elements of all of the data entry elements in the same row being located in the same relative position on their respective data entry elements.

7. The data entry means of claim 6, in which the beam splitting element is disposed at an angle of substantially 45° with respect to both the communication channel and the output channels.

8. The data entry means of claim 1, in which there are a plurality of communication channels for each row of data entry

elements, and in which the radiation control means for each data entry element in that row is effective, upon operation of its corresponding data entry element, to direct part of the radiation passing through said communication channels to at least one of the plurality of output channels associated with the column of the selected data entry element, according to a predetermined code.

9. The data entry means of claim 1, in which there are a plurality of communication channels for each row of data entry elements, and in which the radiation control means for each data entry element comprises a beam splitting element capable of reflecting a portion of the radiation passing through said communication channels selectively to at least one of the output channels associated with the data entry element of said beam splitting element in accordance with a predetermined code when said data entry element is moved to said second position, said beam splitting element also passing part of the radiation from the radiation source means therethrough.

10. The data entry means of claim 9, in which the beam splitting elements include combinations, according to a predetermined code, of projections and spaces, whereby a portion of the radiation impinging upon the projections is reflected into corresponding output channels.

11. The data entry means of claim 9, in which the beam splitting elements are disposed at an angle of substantially 45° with respect to both the communication channels and the output channels.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,648,050 Dated March 7, 1972

Inventor(s) Tuh-Kai Koo

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet, after "[72]", should read

-- [73] Assignee: The National Cash Register Company, Dayton, Ohio, a corporation of Maryland --.

Signed and sealed this 21st day of November 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334.

UNITED STATES PATENT OFFICE

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FORM PO-1050 (10-69)

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