# United States Patent [19]

**Sliker**

[11] **3,792,258**

[45] **Feb. 12, 1974**


## [54] PHOTOCONDUCTIVE SWITCHING SCANNER APPARATUS


[76] Inventor: **Lawrence S. Sliker,** 196 Willson Rd., Welland, Ontario, Canada



[22] Filed: **May 3, 1972**

[21] Appl. No.: **249,931**

[52] **U.S. Cl.** ..... **250/213 A,** 250/211 J, 307/221, 307/223

[51] **Int. Cl.** ..... **H03k 21/00,** H01j 31/50

[58] **Field of Search** ..... 250/213 A; 307/221, 223



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,996,622 | 8/1961 | Acton | 250/213 A |
| 3,073,963 | 1/1963 | Marko | 250/213 A |
| 3,160,756 | 12/1964 | Marko | 250/213 A |
| 2,999,165 | 9/1961 | Lieb | 250/213 A |



*Primary Examiner*—Harold A. Dixon

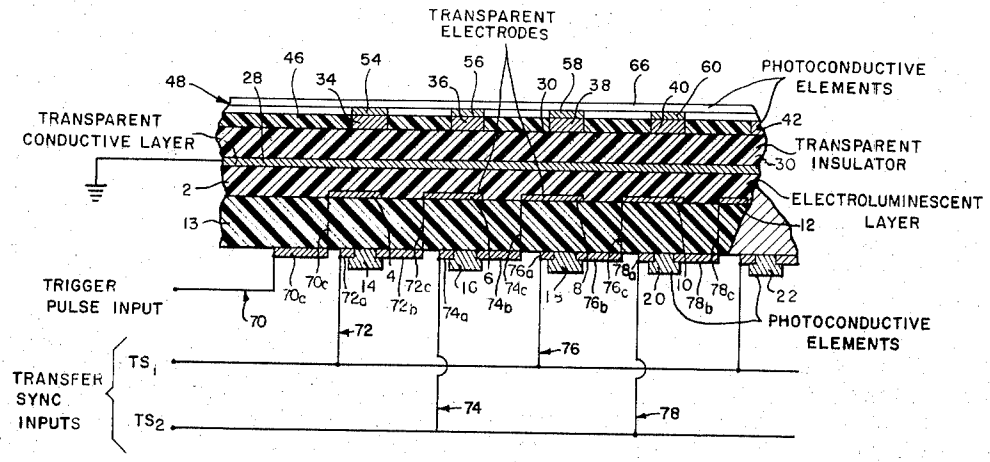
*Attorney, Agent, or Firm*—Scrivener, Parker, Scrivener and Clarke

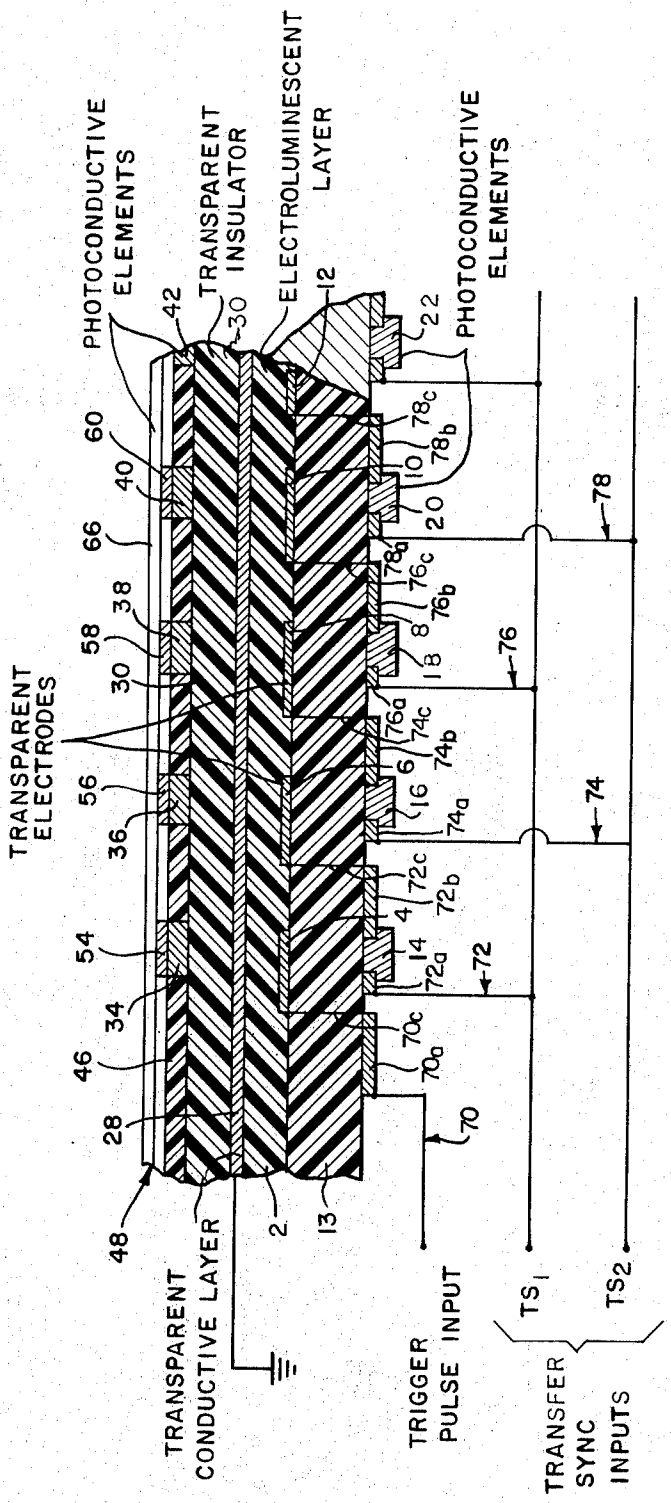


[57] **ABSTRACT**

Improved high-speed scanner apparatus including a layer of energy emitting material, a plurality of spaced electrodes arranged adjacent said layer of energy emitting material, and means for sequentially energizing said electrodes to activate corresponding portions of said emissive layer. The invention is characterized in that the means for sequentially energizing the electrodes includes, for each electrode, normally disabled conductor means containing a normally non-conductive photoconductive element, said element being arranged for operation to a conductive enabling condition by the activation of a portion of the energy emitting layer associated with the next preceding electrode. Transfer synchronizing means are provided for supplying stepping pulses to the appropriate electrodes during the conductivity decay period for which the conductor means associated with the respective electrodes are in the enabled condition, whereby extremely rapid, accurately controlled scanning operation is obtained.


**8 Claims, 1 Drawing Figure**




PHOTOCONDUCTIVE ELEMENTS
TRANSPARENT INSULATOR
ELECTROLUMINESCENT LAYER
PHOTOCONDUCTIVE ELEMENTS
TRANSPARENT ELECTRODES
TRANSPARENT CONDUCTIVE LAYER
TRIGGER PULSE INPUT
TRANSFER SYNC INPUTS
TS1
TS2
42
30
12
22
60
40
66
38
58
30
56
36
54
34
46
28
48
2
13
70
70a
70c
72
72a
72b
72c
74
74a
74b
74c
76
76a
76b
76c
78
78a
78b
78c
20
10
8
18
6
16
4
14

# PHOTOCONDUCTIVE SWITCHING SCANNER APPARATUS

In the patented prior art--as evidenced by the U.S. Patents to Loebner No. 2,895,054, Bowerman No. 3,020,410, Johnson No. 3,125,681, Heetman No. 3,152,258 and Sylvander No. 3,221,170— it has been proposed to provide electroluminescent-photoresponsive means for effecting switching between a plurality of elements (as, for example, the elements of a shift register, a matrix display or other output device). One drawback inherent in the known apparatus is the deleterious limitation on the switching speed between the components imposed by the decay times of the electroluminescent and photoconductive elements. While on the one hand it is desirable to have relatively short decay times to obtain a sharp response and to prevent undesirable scattering of the emitted energy and resultant interaction between non-associated components, on the other hand the electroluminescent and photoconductive elements must remain activated for a sufficient length of time to effect positive switching from one activated element to the next. In accordance with the present invention, an improved high speed scanner apparatus is obtained through the novel use and control of corresponding pairs of energy emitter elements (or selected portions of a single energy emitting layer) and photoconductive elements (or other radiation-responsive variable-impedance storage elements), respectively, the storage phenomena of certain photoconductive materials being exploited by transfer synchronizing signals.

Accordingly, the primary object of the present invention is to provide improved high-speed scanner apparatus in which the electrodes for activating portions of an energy emitting layer are activated sequentially by transfer sync pulses supplied via normally diabled conductor means which contain, in series, normally non-conductive photoconductive elements, respectively. In the preferred embodiment, the photoconductive element contained in the conductor means for energizing a given electrode is arranged for operation by the energy emitted from the portion of the emissive layer associated with the next preceding electrode. Trigger pulse input means are provided for initiating the activation of the first portion of the energy emitting layer, and two or more sources of transfer synchronizing pulses are provided for supplying energizing pulses to selected electrodes during the times at which the conductors associated therewith are enabled by the energy emitted by a portion of the material associated with the next preceding electrode.

A more specific object of the invention is to provide scanner apparatus of the type described above, including a layer of energy emitting material (for example, electroluminescent material), electrode means for sequentially activating spaced portions of said layer, and first and second groups of photoconductive elements arranged on opposite sides of said layer for operation by said activated layer portions, respectively. The first group of photoconductive elements comprises enabling means for permitting the sequential energization of the electrode means, and the second group of photoconductive elements comprises output means for supplying output signals to a suitable output device (such as a matrix, shift register or other read-out means). By supplying appropriately timed transfer synchronizing signals



from a given number of sources thereof to a corresponding number of successive electrodes, an increased scanning speed is effected, since successive electrodes are energized by transfer synchronizing pulses supplied from different sources via photoconductive elements operated by preceding electrodes, with the result that the specific decay times of the components are not critical to the operation of the high speed scanner.

Other objects and advantages of the invention will become more apparent from a study of the following specification when viewed in the light of the accompanying drawing, the single figure of which discloses one embodiment of the scanner assembly in diagrammatic cross-section.

Referring to the drawing, the scanner apparatus includes a first layer **2** of an energy emitting material (for example, a conventional electroluminescent material such as a phosphor of zinc sulphide activated with copper and mixed with a suitable plastic such as ethyl cellulose) upon the bottom surface of which are mounted a plurality of spaced parallel strip electrodes **4, 6, 8, 10, 12** formed of a transparent conductive material (for example, a very thin light-transmitting layer of evaporated material such as aluminum or silver). The layer **2** and electrodes **4, 6, 8, 10** and **12** are mounted on the upper surface of base plate **13** formed of a transparent insulating material (for example, nitrocellulose or an alkyd resin). Mounted on the lower face of the transparent base layer **13** are a first group of photoconductive elements **14, 16, 18, 20,** and **22** associated with the transparent electrodes **4, 6, 8, 10** and **12,** respectively. The photoconductive elements are formed from a conventional photoconductive material, such as a sulfide, selenide, or telluride of cadmium, lead or zinc.

Mounted on the upper surface of the electroluminescent layer **2** are, in succession, a transparent conductive layer **28** (such as a layer of titanium dioxide or tin oxide, or a thin layer of evaporated aluminum or silver) and another layer **30** of transparent insulating material. Mounted on the upper surface of transparent insulating layer **30** is a second group of photoconductive elements **34, 36, 38, 40** and **42** associated with the electrodes **4, 6, 8, 10** and **12,** respectively. The second group of photoconductive elements are embedded in a layer **46** of a transparent insulating material. Finally, there is arranged on the upper surface of the assembly for operation by the second group of photoconductive elements an output matrix **48** including a plurality of X conductors **54, 56, 58,** and **60** and a plurality of Y conductors (only one of which, **66,** is shown).

In accordance with the present invention, novel means are provided for activating portions of the electroluminescent layer to effect the conductivity of the associated elements of the first and second groups of photoelectric elements. To this end, the transparent conductive layer **28** is connected with ground (or with an appropriate voltage source) and the first electrode **4** is connected with a source of trigger pulses via trigger pulse conductor means **70** including a first portion **70a** arranged on the lower face of the transparent insulating base **13,** and an interconnecting portion **70c** that extends through the layer **13.** The second electrode **6** is connected with a source of first transfer sync signals $TS_1$ via first conductor means **72** including spaced portions **72*a*** and **72*b*** arranged on the bottom surface of layer **13** and connected in series with the normally non-

conductive photoconductive element **14** and the interconnecting portion **72**c. The third electrode **8** is connected with a source of second transfer sync signals $TS_2$ via second conductor means **74** containing, in series, conductive portion **74***a*, photoconductive element **16**, conductive portion **74***b* and interconnecting portion **74***c*. Electrode **10** is connected with source $TS_1$ by conductor means including portion **76***a*, element **18**, portion **76***b* and interconnecting portion **76***c*, and electrode **12** is connected with source $TS_2$ via conductor portion **78***a*, element **20**, and conductor portions **78***b* and **78***c*. Similarly, alternate successive electrodes are connected with the sources TS, and $TS_2$, respectively.

## Operation

In operation, assume that all the electrodes are initially de-energized, that the electroluminescent layer is de-activated, and that all the photoconductive elements are non-conductive.

Upon the application of a trigger pulse to the first electrode **4** via conductor means **70**, an electric field is established between electrode **4** and conductive layer **28** to activate an intermediate portion of the electroluminescent layer **2**, whereupon energy is emitted to render conductive the corresponding photoconductive elements **14** and **34**. Upon termination of the trigger pulse, the emission of energy from layer **2** ceases, and elements **14** and **34** remain conductive for a short further period of time in accordance with their decay characteristics. Owing to the conductive state of element **34**, conductor **54** is energized to afford an input to the matrix **48**.

Assume now that during the decay time that photoconductive element **14** is conductive, a first transfer sync input pulse is supplied from source $TS_1$ to the conductor means **72**. This pulse is transmitted to the second electrode **6** via conductor portion **72***a*, photoconductive element **14**, conductor portion **72***b*, and interconnecting portion **72***c*. The associated portion of electroluminescent layer **2** is then activated to render conductive the corresponding photoconductive elements **76** and **36**. Since element **36** is now conductive, a second scanning input is supplied to matrix **48** that is laterally displaced from the first input by element **34**. Assuming that a second transfer sync input pulse is supplied from source $TS_2$ during the decay time of element **16** (i.e., during the period when conductor means **74** is enabled), it is transmitted to the third electrode **8** via conductor means **74** including, in series, the conductor portion **74***a*, photoconductive element **16**, conductor portion **74***b*, and interconnecting portion **74***c*. The corresponding portion of the electroluminescent layer **2** becomes activated, whereupon photoconductive elements **38** and **18** are energized to present a laterally displaced third scanning input to the matrix **48** to enable conductor means **76**, respectively. Should a subsequent first transfer sync pulse now be supplied by source $TS_1$, it is transmitted to electrode **10** to energize elements **20** and **60** in the laterally displaced scanning manner described above. Consequently, by proper timing of the transfer sync pulses from sources $TS_1$ and $TS_2$ relative to the decay times of the first group of photoconductive elements, the scanning rate of the matrix can be accurately controlled. The upper limit of the scanning speed is determined by the decay time characteristic or storage phenomena of the particular photoconductive material employed.

It is apparent that in accordance with the present invention, higher scanning speeds may be achieved by circumventing excessive photoconductive storage times by the provision of the appropriate driver circuitry. For example, approximately ten times the scanning rate could be achieved through the use of ten sequentially driven transfer synchronizing inputs in place of the illustrated two transfer synchronizing inputs. In this modification, every tenth photoconductive element would be used, rather than every other element as in the illustrated scanner embodiment. Preferably, the corresponding pairs of electrodes and photoconductive elements are offset slightly to afford a certain degree of pre-illumination of a photoconductive element further along the line to decrease the effect of photoconductive rise time, whereby the scanning rate is maximized for a given photoconductive characteristic.

The number of positions than an energy emitter portion of the layer **2** is offset relative to the photoconductive elements is equal to the rise time of the photoconductive material divided by the time per step for the scanner. The total number of transfer step inputs is equal to the rise time plus the storage time of the photoconductive element divided by the time per step desired for a particular scanner.

While in accordance with the Patent Statutes the preferred form and embodiments of the invention have been illustrated and described, it will be apparent to those skilled in the art that various further changes may be made in the apparatus described without deviating from the inventive concept.

I claim:

**1.** Scanning apparatus comprising an electroluminescent layer, electrode means on one side of said layer, a series of spaced electrodes on the other side of said electroluminescent layer, a conductor connected to the first electrode of said series of spaced electrodes, means for applying through said conductor a trigger pulse to the first of said spaced electrodes to energize the electroluminescent material between said electrode means and the first of said spaced electrodes, a second conductor including in series a photo conductive element connected to the second of said spaced electrodes and positioned to be rendered conductive by the illuminated portion of said electroluminescent layer upon energization of said first of said spaced electrodes, means for applying a pulse to said second conductor while its photoconductive material is still in conductive condition to energize the second of said spaced electrodes, a third conductor including in series a second photoconductive element connected to the third of said spaced electrodes and positioned to be rendered conductive by the illuminated portion of said electroluminescent layer between said electrode means and said second of said series of spaced electrodes, and means for applying a pulse to said third conductor while its photoconductive element is still in conductive condition.

**2.** The scanning apparatus of claim **1** including additional spaced electrodes and conductor means including photoconductive elements connected to each spaced electrode with each respective photoconductive element positioned to be rendered conductive by the electroluminescent material energized between the

electrode means and the preceding energized spaced electrode.

3. Apparatus as defined in claim 2, wherein said means for applying the pulses to the spaced electrodes subsequent to the first electrode comprises at least two sources of transfer sync pulses.

4. Scanning apparatus of claim 3 wherein the sources of transfer sync pulse are paired, a first group of said conductors connecting alternate ones of said spaced electrodes with sync pulse source, and a second group of said conductors connecting the remaining electrodes with the other sync pulse source.

5. Apparatus as defined in claim 1, and further including a first layer of transparent insulating material adjacent said layer of electroluminescent material, said spaced electrodes being transparent and arranged between said layers, said photoconductive elements being arranged on the side of said layer of transparent insulating material remote from said electrodes.

6. Apparatus as defined in claim 5, wherein each of said conductor means includes an interconnecting portion extending through said layer of transparent insulating material.

7. Apparatus as defined in claim 6, and further including a second layer of transparent insulating material adjacent said layer of energy emitting material on the side thereof remote from said first layer of transparent insulating material, and a second group of normally non-conductive photoconductive elements arranged on the side of said second transparent insulating layer remote from said energy emitting layer, said second group of photoconductive elements each being arranged for activation to a conductive condition upon energization of the corresponding electrode, respectively.

8. Apparatus as defined in claim 7, and further including matrix means including a plurality of X and Y grid elements operatively associated with said second group of photoconductive elements.

* * * * *