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 SWITCHING SCANNER APPARATUS

In the patented prior art—as evidenced by the U.S. Patents to Loebner No. 2,895,054, Bowserman No. 3,020,410, Johnson No. 3,125,681, Heetsman 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 drawings, 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 insulting 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 is embedded in a transparent 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, via first conductor means 72 including spaced portions 72a and 72b arranged on the bottom surface of layer 13 and connected in series with the normally non-
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3. Conductive photoconductive element 14 and the interconnecting portion 72c. The third electrode 8 is connected with a source of second transfer sync signals TS2 via second conductor means 74 containing, in series, conductive portion 74a, photoconductive element 16, conductive portion 74b and interconnecting portion 74c. Electrode 10 is connected with source TS1 by conductor means including portion 76a, element 18, portion 76b and interconnecting portion 76c, and electrode 12 is connected with source TS2 via conductor portion 78a, element 20, and conductor portions 78b and 78c. Similarly, alternate successive electrodes are connected with the sources TS, and TS2, 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 conductor layer 28 to activate an intermediate portion of the electroluminescent 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 TS1 to the conductor means 72. This pulse is transmitted to the second electrode 6 via conductor portion 72a, photoconductive element 14, conductor portion 72b, and interconnecting portion 72c. 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 TS2 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 74a, photoconductive element 16, conductor portion 74b, and interconnecting portion 74c. 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 TS1, 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 TS1 and TS2 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 phase 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 photoconductive 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
5 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.

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