March 11, 1969 J. S. FROST 3,432,724

ELECTROLUMINESCENT CROSSED GRID DEVICE FOR SIMULTANEOUSLY DISPLAYING A PLURALITY OF POINTS

Filed Feb. 27, 1967 Sheet 1 of 2

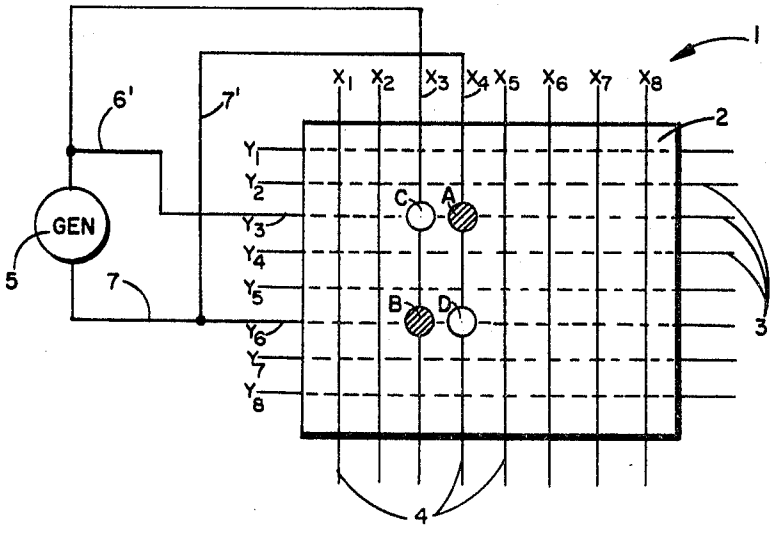


FIG. 1

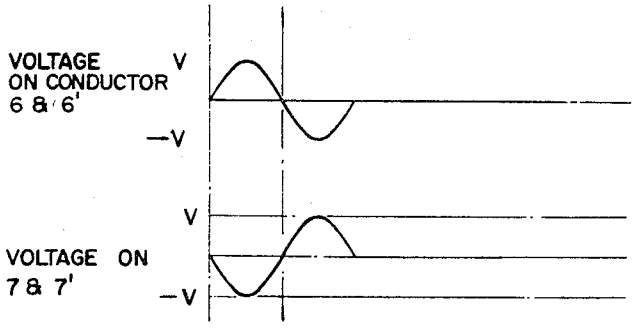


FIG. 2

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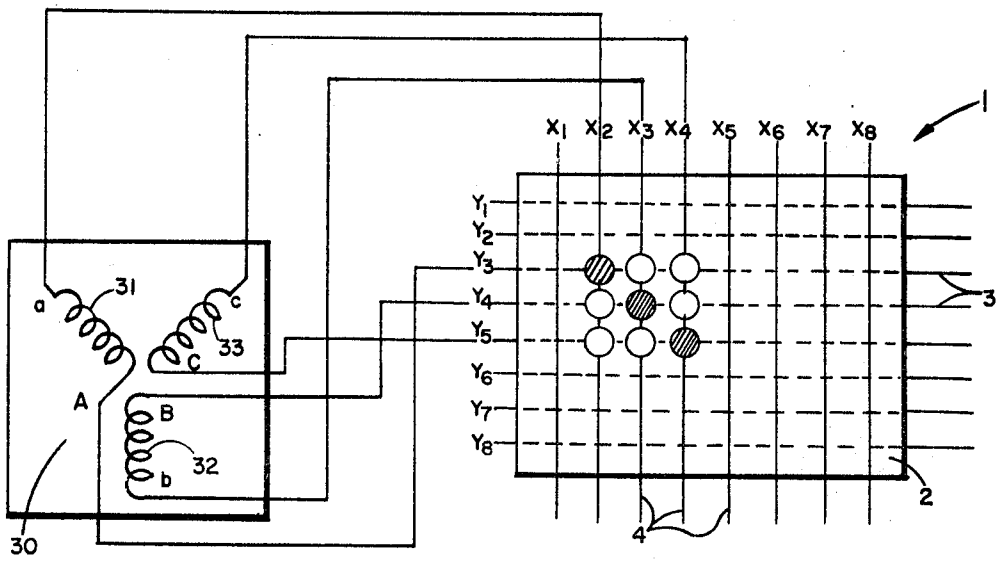


FIG. 3

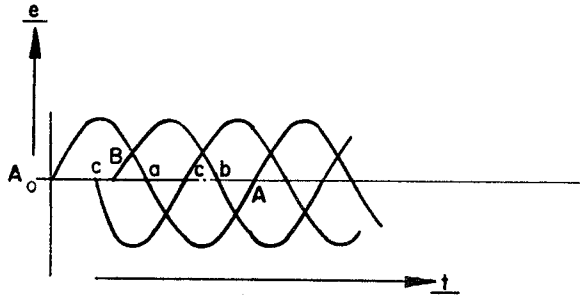


FIG. 4

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ELECTROLUMINESCENT CROSSED GRID DEVICE FOR SIMULTANEOUSLY DISPLAYING A PLURALITY OF POINTS

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U.S. Cl. 315—169 5 Claims
Int. Cl. H05b 37/02

ABSTRACT OF THE DISCLOSURE

A crossed grid electroluminescent display device for simultaneously displaying a plurality of points while automatically suppressing electroluminescence generated at other undesirable points. The device utilizes excitation voltages of different phase relationships for reducing spurious emission at the undesirable points.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to a crossed grid electroluminescent display device and, more particularly, to such a device using excitation voltages having phase relationships for generating simultaneous displays at a plurality of points while reducing electroluminescence at other grid locations.

Description of the prior art

As indicated in the patent to Livingston, No. 2,930,897 for an electroluminescent device, it is known that first and second mutually orthogonal, for example horizontal and vertical, arrays of parallel, separated electrical conductors can be positioned on each side of an electroluminescent film or layer to form a crossed grid structure. The portion of the film defined as a cell is disposed between one horizontal and one vertical conductor. When a suitable electrical potential difference is applied between any pair of horizontal and vertical conductors, the cell connected between the pair luminesces.

The applied potential can be switched or commutated in such a manner as to successively energize each cell in turn, this producing a scanning effect. However, as further indicated in the patent, electroluminescent panels using the crossed grid conductors often exhibit a spurious electroluminescent effect which is described in the patent as the cross effect. The effect is due to interelectrode capacitative coupling which causes emission to occur along the row and column selected for generating relatively bright luminescence.

The system described in the Livingstone patent provides for simultaneously applying relatively reduced voltages of different polarities to all horizontal and vertical conductors of the device. Initially, a dim uniform background is produced. Subsequently, a voltage and phase is applied to a horizontal conductor and an equal voltage and opposite phase is applied to a vertical conductor. At the intersection of the two conductors, a relatively bright luminescence is produced.

He does not teach or show any means for displaying two points while reducing the spurious emission ordinarily generated when two or more points are simultaneously excited. Such continuous excitations ordinarily is required to produce sufficient brightness to produce a practical display for viewing in operational ambients, i.e., normal room lighting. With reference to the Livingston patent, assume it is desirable to produce luminescence from cell **62** as shown and from the cell defined by the intersection of

conductors **22** and **40**. By simultaneously applying a voltage to vertical conductors **22** and **26** and to horizontal conductors **36** and **40**, not only would an emission occur at cell **62** and the cell defined by the intersection of conductors **22** and **40**, but such an emission would also occur at cells defined by the intersection of conductors **26** and **40**; **26** and **36**. Lumination would occur at the desired intersection and at undesired intersections. Livingston does not teach or show any means of reducing the luminescence generated at these undesired points by attempting to light two or more points.

Desirably, a system should be provided for displaying two or more points simultaneously while reducing the emission generated in the process. As a result of being able to produce two or more display points, a tracking system can be developed. For example, the position of an aircraft relative to a second aircraft or similar moving object may be displayed. The system can be applied to other situations wherein the relative positions of moving and stationary objects is desired.

SUMMARY OF THE INVENTION

Briefly, the invention comprises a crossed grid electroluminescent display device having a first array of parallel and separated electrical electrodes extending along a first direction and a second array of parallel separated electrical electrodes extending along a second and nonparallel direction, including an electroluminescent layer interposed between the arrays for luminescing in response to an electric field.

Voltage generator means are provided for applying alternating voltages of at least one phase to at least one selected electrode of the first array of electrodes and simultaneously applying voltages having at least one different phase to at least one selected electrode of the second array of electrodes. Where the selected electrodes intersect one or more electroluminescent displays is generated.

Means are included for applying the voltages having at least one phase to at least one other electrode of the second array of electrodes, including means for applying the voltage having at least one different phase to at least one different electrode of the first array of electrodes for generating at least one second display separated from the first. As a result, a voltage potential is developed between electrodes where luminescence is desired, whereas at other locations, the potential is relatively reduced so that the luminescence is substantially reduced relative to luminescence generated where a larger voltage potential exists.

In one embodiment for generating two display points, the phase of the voltages applied to the electrodes of the first array may be approximately 180° apart. Similarly, the phase difference between the voltages applied to the electrodes of the second array may be approximately 180° apart. In that embodiment, four electrodes are involved for each two displays.

In other embodiments, the phase difference between applied voltages may be less but the voltage potential between intersecting electrodes where luminescence is desired is still sufficient to excite the electroluminescent material. At other locations, even though a voltage potential may exist, the potential is sufficiently low by virtue of the phase relationship of the voltages so that the luminescence generated at the other locations is relatively low.

Therefore, it is an object of this invention to provide a new and improved electroluminescent crossed grid display device.

It is another object of this invention to produce a crossed grid electroluminescent display for displaying a plurality of points simultaneously.

Still a further object of this device is to produce an

electroluminescent display for displaying a plurality of points simultaneously excited while reducing spurious emission created at other related points.

A still further object of this invention is to provide an improved display device which can be applied to a tracking system.

Still a further object of this invention is to provide a crossed grid electroluminescent display device for displaying a plurality of points simultaneously excited while automatically suppressing undesirable electroluminescence generated by the excitation voltages.

A still further object of this invention is to provide electroluminescent crossed grid device using excitation voltages of varying phases for displaying a plurality of points while simultaneously suppressing electroluminescence from other undesired points.

These and other objects of this invention will become more apparent in connection with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates one embodiment of a system for producing a display from two points while suppressing the luminescence from other points.

FIGURE 2 illustrates the phase relationship between voltages applied to electrodes of the FIGURE 1 system.

FIGURE 3 illustrates a second embodiment of a device for generating a plurality of display points while suppressing electroluminescence from other points.

FIGURE 4 illustrates the phase relationship between voltages applied to electrodes of the FIGURE 3 system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGURE 1 shows a crossed grid device which comprises electroluminescent layer **2** sandwiched between mutually perpendicular electrode arrays **3** and **4**. Electrode array **3** is disposed in a horizontal direction relative to array **4**, which is disposed in a vertical direction. The electrodes comprising the arrays are separated and are parallel to each other. Array **4** is transparent so that the electroluminescent through the layer is not reduced. Alternating source **5** including conductors **6**, **6'**, **7** and **7'** provides excitation voltages to selected electrodes of said arrays. Although one alternating source is shown, it should be obvious that other alternating sources could also be used. In addition, it may be possible to vary the parameter of a pulsed direct voltage source so as to produce the phase relationships described herein.

In operation, assume that displays are desired from locations A and B, an alternating voltage is applied through conductors **6** and **6'** to electrodes X_3 and Y_3. Simultaneously, equal voltages of opposite phase are applied through conductors **7** and **7'** to electrodes Y_6 and X_4. An electric field is generated at the intersection of electrodes X_3 and Y_6 and a relatively bright electroluminescent display occurs. A voltage potential equivalent to 2 v. exists at the intersection. At the intersection of electrodes Y_4 and Y_3, a second electric field is equivalent to the first is generated and a second relatively bright display occurs. Although the potential between the electrodes at both display points is the same, the potential at point A was derived from, for example, an instantaneous "+" and "—" voltage, whereas the potential at point B was derived from an instantaneous "—" and "+" voltage.

The relationship between the instantaneously applied voltages can be seen in FIGURE 2. At any instant the voltage on conductors **6** and **6'** is opposite in phase from the voltage on conductors **7** and **7'**. The difference, however, is equivalent to two times the instantaneous voltage at any time. As a result, at the maximum value, a voltage potential of 2 v. is developed at the electrode intersections selected.

By switching the connection of the conductors to the other electrodes while maintaining the phase relationship described, the display points can be moved. For example, if the system were combined with a radar system the two points could be used to indicate tracking of moving objects.

In prior art systems, a voltage display would be generated at points C and D. However, due to the application of excitation voltages having the phase differences indicated, zero potential exists between electrodes at the other points. As a result, no luminescence is generated. Specifically, the instantaneous voltage on electrodes X_3 is equal to the instantaneous voltages on electrodes Y_3. Similarly, equal voltages are applied to electrodes X_4 and Y_6. For example, conductor **7'** may connect the instantaneous negative side of voltage V to electrode X_4 and to electrode Y_6. At the same time and in order to produce the luminescent display from point B, conductor **6** connects X_3 to the instantaneous positive side of voltage V. The same description is applicable to point C. Electrodes Y_3 and X_3 have the same potential applied through conductors **6** and **6'**.

Although not described in detail herein, it is well known that electroluminescent films or layers, whether comprised of a crystalline film or a dielectric suspension of phosphor particles, exhibit non-linear voltage characteristics. At low levels of applied voltages, the light output from electroluminescent layers increases relatively slowly with incremental increases in applied voltages. At higher voltage levels, the light output increases more rapidly with incremental increase in applied voltage.

FIGURE 3 shows three phase generator **30** supplying alternating voltages to display system **1**. The voltages, A*a*, B*b*, C*c* are separated by 120° as shown in FIGURE 4. Voltages A and *a* are generated by windings **31**; voltages B and *b* are generated by windings **32**; voltages C and *c* are generated by windings **33**. Voltage *a* is connected to electrode X_3; voltage *b* is connected to electrode X_4; and voltage *c* is connected to electrode X_5. Voltage A is connected to electrode Y_3; voltage B is connected to electrode Y_4; and voltage C is connected to electrode Y_5.

At the intersection of electrodes designated by the shaded circles, luminescence is relatively bright due to the full potential from the voltages indicated being applied to the associated electrodes. Other intersections designated by the unshaded circles have instantaneous voltage potentials different from each other by 120° and 240°. As a result, relatively smaller voltages of one-half full value appear between the associated electrodes. The field produced is relatively low and as a consequence the luminescence at the points indicated is relatively low.

The discrimination of wanted points versus unwanted points may be enhanced by virtue of non-linearity in the voltage-brightness characteristics of an electroluminescent layer. The non-linearity of a layer may be further exaggerated by the addition of materials to the electroluminescent materials. As previously described, the connections from the three phase generator to the electrodes may be changed to change the relative positions and locations of the displays.

Although the invention has been described and illustrated in detail, it is to be understood that the same is by way of illustration and example only, and is not to be taken by way of limitation; the spirit and scope of this invention being limited only by the terms of the appended claims.

I claim:

1. A crossed grid electroluminescent display comprising,
   - a first array of parallel and separated electrical electrodes extending in a first direction,
   - a second array of parallel and separated electrical electrodes extending in a second direction,
   - an electroluminescent layer interposed between the arrays and responsive to the electric field created by voltages on the first and second conductors,
   - voltage generator means for simultaneously connecting voltages of different phases to said selected electrodes of the first and second arrays for producing

a plurality of displays from said layer at intersections of said electrodes where the phase difference produces a potential sufficient to excite said layer while preventing spurious electroluminescent emission from said layer at other intersections of the electrodes where the phase difference produces a potential insufficient to excite said layer.

2. The combination as recited in claim 1, wherein voltages having a first phase are applied to at least one electrode of the first array and to at least one electrode of said second array, and voltages having a second phase are applied to at least one different electrode of the first array and to at least one different electrode of said second array for producing a first electroluminescent display from said layer where the one electrode of the first array intersects the one different electrode of the second array, and a second electroluminescent display is produced from said layer where the different electrode of the first array intersects said one electrode of the second array.

3. The combination as recited in claim 2, wherein said first and second phases differ so that at the intersection of said electrodes producing said first and second displays, the voltage potential is relatively higher than the voltage potential at other intersections of said electrodes.

4. The combination as recited in claim 1, wherein said voltage generating means comprises means for generating a plurality of voltages having different phase relationships including means for connecting at least a first of said voltages to a first electrode of said first array, a second voltage to a second electrode of said first array, a third voltage to a third electrode of said first array, means for connecting voltages having first, second and third electrodes of said second array, said voltages having phases different from voltages on the first, second and third electrodes of the first array for producing relatively bright electroluminescent displays from the intersection of said electrodes where the potential difference between the electrodes is sufficient to excite the electroluminescent material between the electrodes.

5. The combination as recited in claim 1 wherein voltages having a plurality of phases are connected to a plurality of electrodes of said first array and said voltages are connected to a plurality of electrodes of said second array for producing a plurality of electroluminescent displays at the intersection of said electrodes of the first and second arrays where the phases are sufficiently different to simultaneously excite the electroluminescent layer and for suppressing electroluminescent displays where the phase difference is insufficient to excite the electroluminescent layer.

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U.S. Cl. X.R.

250—213; 340—173