

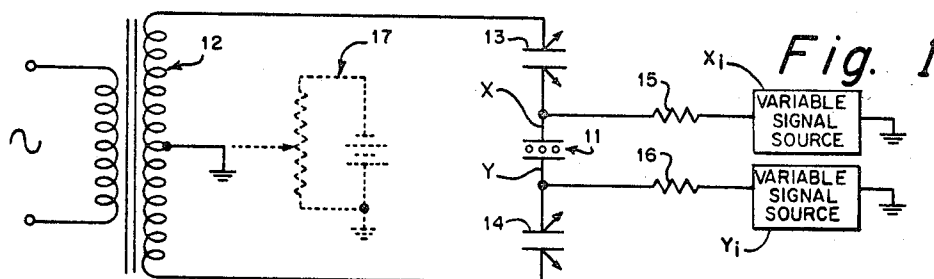
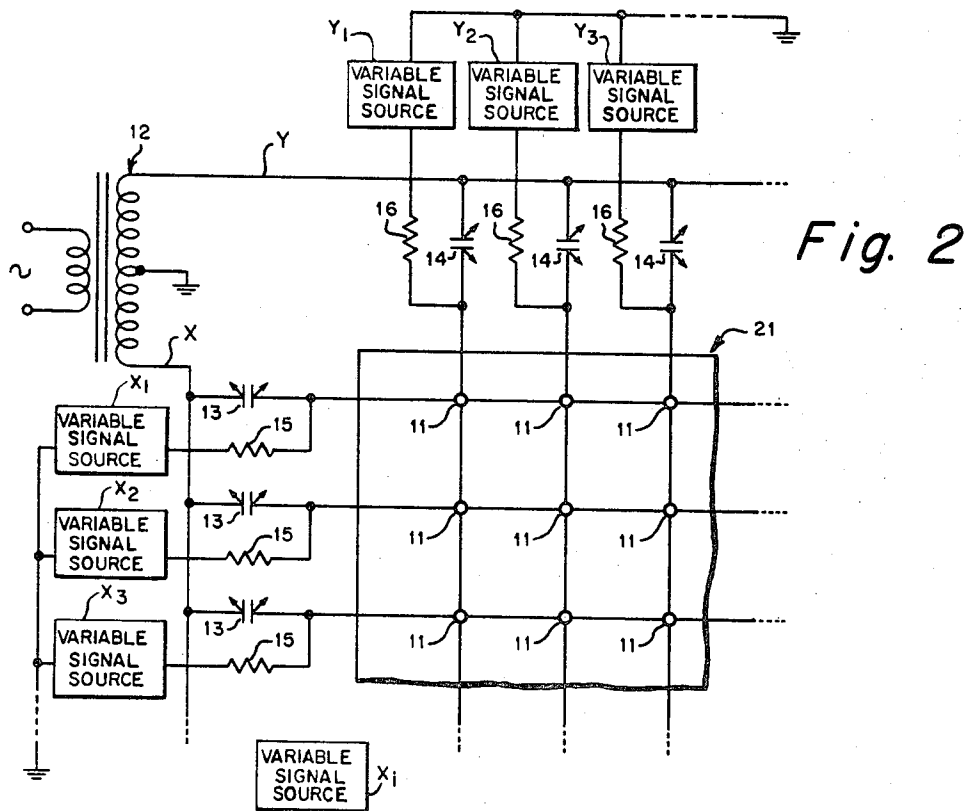
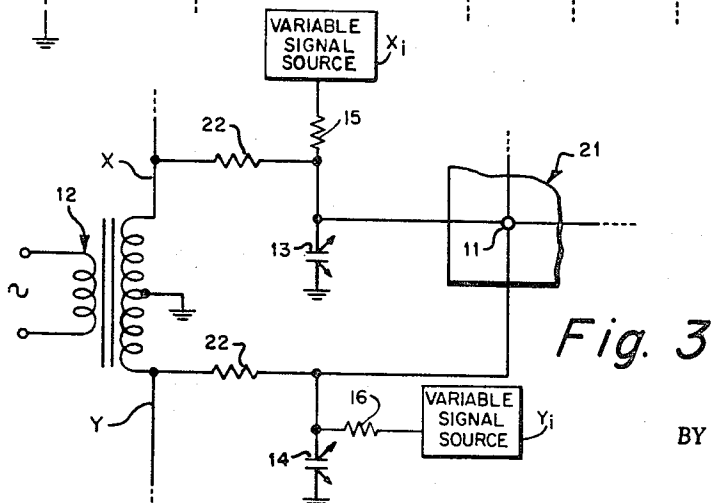
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ELECTROLUMINESCENT GRID CONTROL BY VOLTAGE VARIABLE CAPACITORS

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1

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## ELECTROLUMINESCENT GRID CONTROL BY VOLTAGE VARIABLE CAPACITORS

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### ABSTRACT OF THE DISCLOSURE

A driver circuit comprising a resistance and a variable capacitance is connected one each to a respective conductor of a plurality of electroluminescent elements at right angles to each other in matrix form. An alternating signal is continuously applied across all of the horizontal and vertical elements of the matrix and variable signal sources are provided for varying the capacitance of a selected pair of variable capacitors one of which is connected to a selected horizontal conductor and the other of which is connected to a selected vertical conductor such that only one electroluminescent element may be lighted. The variable signal sources may be preselectively varied thereby to vary the intensity of the electroluminescent element.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

The present invention relates to display devices and more particularly to a driver circuit for an element of an electroluminescent grid screen.

In the field of electroluminescent grid screens, which are formed by arrangements of intersecting vertical and horizontal lines of conductors on opposite sides of a material containing a phosphor, it has been the general practice to employ complex control circuits to apply voltages across a pair of horizontal and vertical lines in order to light up one intersecting element of the grid screen. These circuits generally require a separate control element for each intersection on the screen and their complexity and therefore high cost has substantially delayed the development and use of electroluminescent grid screen as display devices.

The general purpose of this invention is to provide a driver circuit for an electroluminescent grid screen in which control of the circuit is attained with a very small number of elements, producing low cost, low weight and volume, and low power requirements. To attain this, the present invention contemplates using voltage variable capacitances either in series or in parallel with the vertical and horizontal lines of the grid screen, by means of which the effective voltage across each intersection of a horizontal and vertical line may be controlled as desired between a maximum and a minimum.

Accordingly, it is an object of the present invention to provide a drive circuit for an element of an electroluminescent grid screen using a voltage variable capacitor on each side of the element to vary the effective voltage across the element.

Another object of the invention is to provide a drive circuit for an electroluminescent grid screen element in which the voltage is varied by varying the relative capacitances of the electroluminescent element and the voltage variable capacitance.

A further object of the invention is the provision of a drive circuit for an electroluminescent grid screen element in which the voltage across the element is varied by varying the relative phases of the voltages on each side.

Other objects and many of the attendant advantages of

2

this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 shows a drive circuit for one element of the grid screen according to one embodiment of the invention;

FIG. 2 shows the drive circuit according to the embodiment of FIG. 1 in a matrix of elements arranged in horizontal and vertical rows; and

FIG. 3 shows a drive circuit for an electroluminescent element according to another embodiment of the invention.

In FIG. 1 there is shown an electroluminescent element 11. Element 11 comprises the intersection of a horizontal or X-line and a vertical or Y-line at opposing sides of a sheet of material containing phosphorescent material, as is well known in the art. This phosphorescent material has the quality of emitting light under certain conditions when a voltage is applied across it. No current is actually passed through the element from one side to the other but the charge may gather on each side and therefore element 11 is represented as a capacitance. An AC signal is applied across all intersections of all X and Y-lines through a transformer 12, the primary of which is linked to an AC source. Connected in series with the transformer and each X or Y-line is a voltage variable capacitance 13, 14 each of which may be made of ferro-electric material, for example, and each of which is variable in capacitance depending on the DC voltage across it. The DC voltage on each capacitance 13, 14 may be applied at a point  $X_i$  or  $Y_i$  through resistances 15, 16, respectively. Transformer 12 may be center tapped either to ground or to a bias source 17 as shown.

FIG. 2 shows the embodiment of FIG. 1 in matrix form. There is a sheet 21 of electroluminescent material containing phosphorus. Across this sheet are printed the X and Y-lines, as shown, the X-line horizontally on one side and the Y-line vertically on the opposite side. The intersections 11 are not direct connections but points of juxtaposition between the opposing X and Y conductors. For each X or Y-line, e.g.,  $X_1$ ,  $X_2$ ,  $X_3$ ,  $Y_1$ ,  $Y_2$ ,  $Y_3$  there is an associated resistance 15 or 16 and an associated variable capacitance 13 or 14 in series with transformer 12. If one of the  $X_i$  and one of the  $Y_i$  inputs are connected to a voltage source, the associated variable capacitances 13 and 14 will be shifted to the point where their capacitances are very high and the reactance due to their capacitances is very low. This would place most of the voltage generated in transformer 12 across the appropriate intersection of the X and Y-lines, causing the spot at that intersection to luminesce. The voltage applied at the  $X_i$  and  $Y_i$  points may be a step voltage as for a switch, or it may be a varying amount. The brightness of an electroluminescent element can be shown to be proportional to the number of pulses of voltage applied across it. Therefore, it may be shown that the brightness of the spot can be varied by varying the number of cycles it is on. Assuming that during the time the capacitances 13, 14 are high, a small number of pulses, in the order of four or five, come from transformer 12, the brightness of the spot can be varied from a maximum to a minimum. The brightness of the spot can also be varied by varying the capacitance of one or both of capacitances 13, 14 through a range instead of just raising them to a high value with respect to the capacitance across element 11. By this means, the proportion of the voltage from transformer 12 which is actually applied

across element 11 may be varied continuously from a very low amount to close to 100 percent.

In FIG. 3 is shown another embodiment of the invention in which the phase shifting properties of voltage variable capacitances are relied on to alter the voltage applied across an element 11. There is shown the X bus and the Y bus connected through resistances 22 to the electroluminescent sheet 21 forming an intersection 11 as before. This time, however, the voltage variable capacitances 13 and 14 are not in series between the transformer and the intersection 11 but rather in parallel therewith to ground. The input signals  $X_1$  and  $Y_1$  are applied through resistances 15 and 16, respectively, as before. It will be seen that when the voltages at each end of the secondary of transformer 12 are 180 degrees out of phase, as is normally the case with a center tapped transformer, the voltage across an element 11 would vary from a maximum one way to a maximum the opposite way. This condition will apply the maximum signal at intersection 11. However, if the capacitances of variable capacitances 13 and 14 are fairly high, the phase of the voltages at the tops of these elements and therefore at the intersection will be substantially altered. It will also be seen that if the phase of the two signals on each side of the intersection 11 is changed, the voltage across the intersection will be substantially diminished. It will be seen, therefore, that by applying signals at points  $X_1$  and  $Y_1$  to alter the phases of the signals from transformer 12 the signal across intersection 11 may be varied continuously through a wide range.

The present invention provides by these two embodiments means for varying the signal across an intersection of an electroluminescent sheet and thereby provide means for varying the brightness of the light emitted from the phosphor of the sheet. All of this is done with one voltage variable capacitor for each horizontal and each vertical line plus a few resistances.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. An electroluminescent grid control apparatus comprising:
  - an electroluminescent matrix including a panel having spaced horizontal conductors on one side thereof and spaced vertical conductors on the other side thereof;
  - only one voltage variable capacitance connected to each of said conductors;
  - means for applying an AC signals across said conductors; and

voltage means for varying the capacitance of a selected pair of variable capacitances one of which is connected to a selected horizontal conductor and the other of which is connected to a selected vertical conductor thereby to apply a substantial portion of said AC signal across the intersection of said selected horizontal and vertical conductors.

2. An electroluminescent grid control as recited in claim 1, wherein said means for applying an AC signal comprises:

- a transformer secondary, one end of which is connected in common to all of said variable capacitances connected to said horizontal conductors, and the other end of which is connected in common to all of said variable capacitances connected to said vertical conductors.

3. An electroluminescent grid control as recited in claim 2 wherein:

- said transformer secondary is center tapped to ground; said selected variable capacitances are in series between said transformer and said intersection; and said means for varying is a pair of variable voltages applied between each variable capacitance and said intersection, whereby said intersection is selected by applying voltages on a selected pair of capacitances.

4. An electroluminescent grid control as recited in claim 2, wherein:

- resistances are provided between said transformer ends and said intersection; said transformer is center tapped to ground; and said capacitances are in parallel with said intersection, whereby the phase of said AC signal is varied.

5. An electroluminescent grid control as recited in claim 1, wherein:

- said selected variable capacitances are in series with said intersection.

6. An electroluminescent grid control as recited in claim 1, wherein:

- said selected variable capacitances are in parallel with said intersection.

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