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ELECTROLUMINESCENT DISPLAY PANEL

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Fig. 1

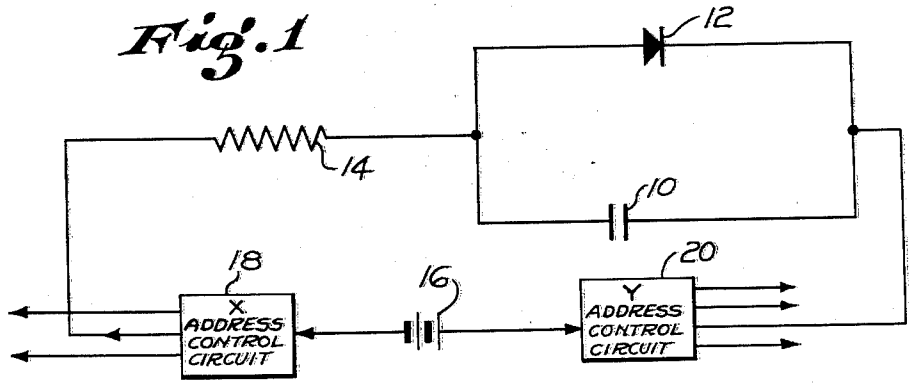


Fig. 2

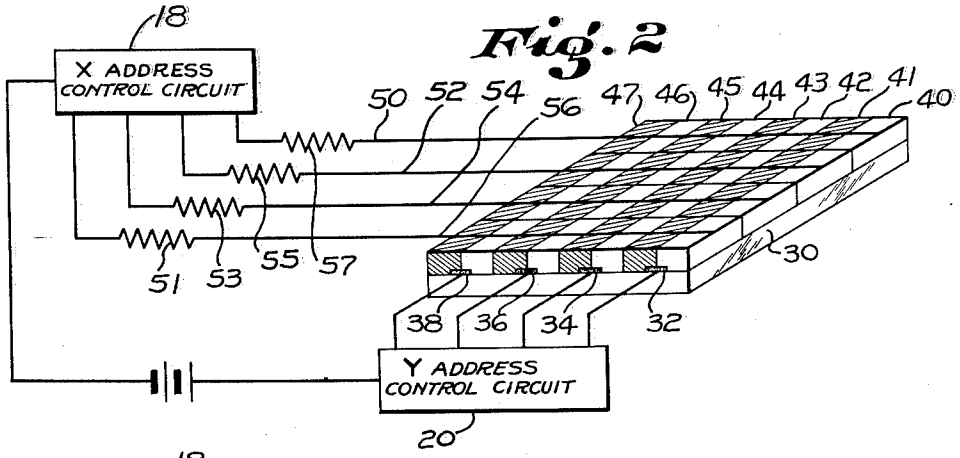
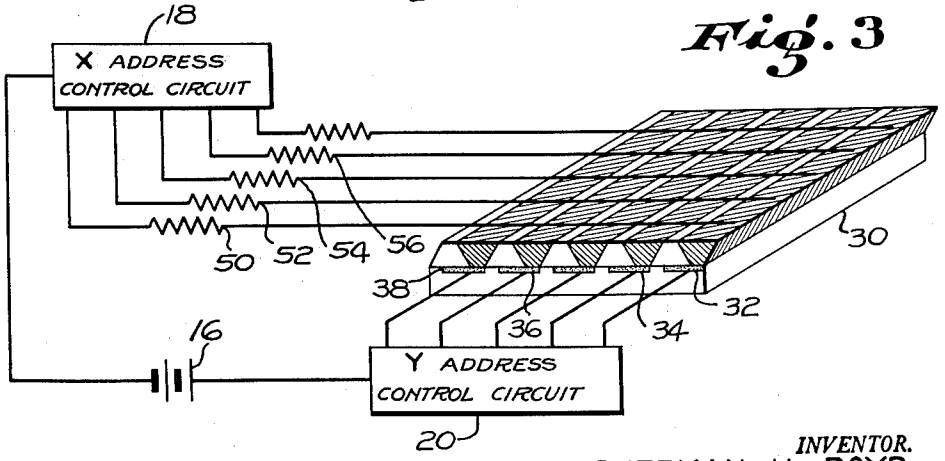


Fig. 3



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ELECTROLUMINESCENT DISPLAY PANEL

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This invention relates to electroluminescent display devices, and, more particularly, to an improved arrangement for controlling the operation of such devices.

Electroluminescent panels have been developed which comprise a layer of luminescent material deposited on a substrate, such as glass, which is transparent. This luminescent material may be made of phosphors which are embodied in a dielectric medium which is sandwiched between two electrodes. The phosphors have the property of luminescing when an alternating-current electric field is applied to the electrodes. Such electroluminescent panels may be employed for the display of information. This can be done by dividing the panel into small segments and then selectively controlling the excitation applied across these segments in accordance with the data to be exhibited. Such division of the panel into small segments may be accomplished in numerous ways, such as through the use of a series of independently controlled panels, much like controlling a series of light bulbs, or through the use of two sets of mutually perpendicular conductors. These conductors define a plurality of intersections. By selectively exciting a conductor in each set, an electric field is applied at the intersection of the selected conductors, and thus the panel will luminesce in the area of this intersection. In this manner useful information may be displayed.

The independent control of panel sections requires a complicated wiring arrangement. The use of two sets of mutually perpendicular conductors considerably simplifies the task of selecting the desired areas on the panel. Since alternating current is required in order to enable the electroluminescent material to luminesce, the arrangements described require the switching of alternating current to selected terminals. This introduces considerable circuit complexities. Obtaining good resolution, that is, confining the luminescence only to the vicinity of the exciting electrodes, has also proved difficult.

An object of this invention is to provide a control arrangement for an electroluminescent panel which eliminates the need for switching alternating-current voltages.

Another object of the present invention is to provide a novel arrangement for controlling an electroluminescent panel which reduces the circuit complexity considerably.

Yet another object of the present invention is the provision of an arrangement for controlling an electroluminescent panel which provides better resolution than heretofore attainable.

These and other objects of the present invention may be achieved in an arrangement whereby each electroluminescent cell which may be selectively excited is connected in parallel with a negative resistance diode. With this arrangement, an oscillator circuit is formed which oscillates upon the application thereto of a direct-current voltage. Accordingly, only a direct-current voltage may

be switched to these various electroluminescent cells, in response to which an oscillation is produced whereby only the excited electroluminescent cell will luminesce. Thus only the direct-current voltage need be switched, whereby the circuitry required for the switching is considerably simplified.

The novel features that are considered characteristic of this invention are set forth with particularity in the appended claims. The invention itself, both as to its organization and method of operation, as well as additional objects and advantages thereof, will best be understood from the following description when read in connection with the accompanying drawings, in which:

FIGURE 1 is an equivalent circuit diagram of an embodiment of the invention;

FIGURE 2 is an isometric view of an arrangement of an electroluminescent panel in accordance with this invention; and

FIGURE 3 is an isometric view of another embodiment of the invention.

A negative resistance diode is a device which can be switched from a high-resistance state to a low-resistance state by means of an electrical pulse. This change in impedance occurs by virtue of the injection of carriers in the barrier of a junction through a process similar to secondary emission. Diodes of this type are sold commercially and are known as "Shockley" diodes. The tunnel diode or "Esaki" diode is another illustration of a negative-resistance device.

It has been previously stated that a preferred arrangement for addressing a desired area of an electroluminescent material in order to cause it to luminesce is to employ two crossed grids of parallel conductors. Where each grid crosses another, there is provided a volume of the electroluminescent material which will be referred to as the "electroluminescent cell." Referring now to FIGURE 1, an electroluminescent cell is represented as a capacitor **10**, since this is the manner in which it functions in an electrical circuit. In parallel with the electroluminescent cell there is connected a negative-resistance diode **12**. A current-limiting resistor **14** is connected with the parallel circuit. A battery **16** is connected to two circuits, respectively designated as the X-address control circuit **18** and the Y-address control circuit **20**. These address control circuits are well-known figurations for selecting one out of many conductors in response to being actuated by a control device (not shown) which may be, for example, either a keyboard or a computer. The X-address control circuit and the Y-address control circuit close circuits for connecting a battery **16** to the respective conductors which they select. As represented in FIGURE 1, the battery **16** is connected across the current-limiting resistor in series with the parallel circuit.

The battery **16** can provide a voltage which can drive the negative-resistance diode into its low-resistance condition. At the outset, however, upon selection, the negative-resistance diode is in its high-resistance mode. It remains in its high-resistance mode for the time required to charge up the capacitance represented by the electroluminescent cell through the current-limiting resistor. As soon as the capacitance is charged to a potential which

exceeds that required to trigger the diode into its low resistance mode, the capacitor will then discharge through the negative-resistance diode. As a result, the voltage across the capacitor and the negative-resistance diode drops below the value required to maintain it in its low-resistance mode. Then the charging cycle for the capacitor **10** through the current-limiting resistance **14** must occur again.

The operation described thus far is that of a typical relaxation oscillator circuit. It is to be noted, however, that this provides the required alternating-current field for causing the electroluminescent material to luminesce, which it will do as long as battery **16** is connected across the circuit. The luminescence is terminated by changing the X- or Y-address, or both. FIGURE 2 shows an embodiment of the invention for providing the negative-resistance diode in parallel with the electroluminescent cells. A base or substrate **30** which is usually transparent is provided. Upon this substrate there is deposited a parallel grid of transparent conductors (such as stannic oxide) **32, 34, 36, 38**. On the base there is deposited alternate slabs of electroluminescent material **40, 42, 44, 46** and negative-resistance material **41, 43, 45, 47**. It should be noted that each of the bottom conductors **32, 34, 36, 38** is in contact with the adjacent slabs of the negative-resistance material and the electroluminescent material. The Y-address circuits **18** are connected to the conductors **32** through **38**.

On top of the layer of material which is on the substrate, another parallel grid of conductors **50, 52, 54, 56** is laid to be in contact with the alternate slabs of material. Each of these conductors is connected through a separate current-limiting resistance **51, 53, 55, 57**, all of which, in turn, are connected to the X-address circuits **18**. A battery **16**, or other source of direct-current potential, is connected between the X- and Y-address circuits. The slabs of material are coextensive with the conductors **32, 34, 36, 38** on the base. It should be noted that each of these slabs may be made up of individual blocks of material on the order of a desired cell size which are laid end to end, where the length of the electroluminescent panel exceeds that of procurable slabs of material. This will not affect the operation of the system.

The X-address circuits can select, in response to external stimuli, any one of the conductors **50** through **56**. The Y-address circuit similarly can select any one of the conductors **30** through **38**. The simultaneous selection of any two of the conductors will apply the potential required to cause oscillation, to thereby cause the electroluminescent material cell which is at the intersection defined by the crossing point of the two selected conductors to luminesce. The frequency of oscillation of the circuit established by the negative-resistance material and electroluminescent material at a selected intersection is a function of the voltage applied and the capacity of the electroluminescent material at an intersection.

Referring to FIGURE 3, there may be seen another arrangement for the construction of the embodiment to the invention. However, in this embodiment of the invention, instead of the cross-sectional area of the slabs of electroluminescent material and negative-resistance material being rectangular, they are trapezoidal. The advantage of using the trapezoidal cross section is that a larger surface area is provided between the negative-resistance material and the electroluminescent material, as well as between the electroluminescent material and the bottom conductors. This improves the circuit operation of these materials relative to one another. Furthermore, the broader area of electroluminescent material at the bottom or visible surface of the panel results in a better resolution of the luminescent areas which have been selected. The operation of the arrangement shown in FIGURE 3 is identical with that described, however.

Several materials can be used for the negative resistance diode. While silicon has been employed for this purpose and is desirable where segmented panels can be employed, the other usual semiconductors such as germanium and selenium and the like can also be used.

There has accordingly been described and shown a novel, useful, and unique arrangement for controlling the light output from the electroluminescent display panel which minimizes the complexity of switching by eliminating the necessity of switching alternating-current voltages.

I claim:

1. In an electroluminescent display device of the type wherein an electroluminescent material having the property of luminescing in the presence of an alternating electric field forms a layer separating two opposite crossed grids of wires whereby a selected area of said electroluminescent material may be made to luminesce by applying excitation to the wires in said opposite grids which intersect at that area, the improvement comprising negative resistance means connected in parallel with each area of said electroluminescent material and between the wires in said crossed grids which intersect at each area for affording excitation of said electroluminescent material in parallel with said negative resistance means.

2. In an electroluminescent display device as recited in claim 2 wherein said negative resistance means comprises a plurality of slabs of negative-resistance material each disposed with alternate slabs of electroluminescent material in the form of a layer between said crosssed grids of wires, said slabs of material being coextensive with the wires of one of said crossed grids, each adjacent slab of negative resistance material and electroluminescent material being in contact with a different one of one of said crossed grids.

3. In an electroluminescent display device as recited in claim 2 wherein said slabs of electroluminescent material and negative-resistance material have rectangular cross sections.

4. In an electroluminescent display device as recited in claim 2 wherein said slabs of electroluminescent material and negative-resistance material have trapezoidal cross sections.

5. An electroluminescent display device comprising a support member, a first plurality of parallel conductors on one side of said support member, a layer covering said first plurality of parallel conductors and said one side, said layer comprising alternate adjacent slabs of negative-resistance material and electroluminescent material coextensive with the conductors of said first plurality of parallel conductors, each of said conductors being in contact with a different two of said adjacent slabs, a second plurality of parallel conductors disposed on the opposite side of said layer and in contact therewith and at an angle to the first plurality of parallel conductors, and means for selectively exciting a conductor in each of said first and second plurality of conductors to cause the electroluminescent material in the region of the intersection of said selected conductors to luminesce.

6. An electroluminescent display device as recited in claim 5 wherein said slabs of negative-resistance materiai and electroluminescent material have a rectangular cross section.

7. An electroluminescent display device as recited in claim 5 wherein said slabs of negative-resistance material and electroluminescent material have a trapezoidal cross section.

8. A display panel including: a plurality of cells, each including a capacitance element an electroluminescent material; of means for supplying a unidirectional potential to said material for charging selected said elements; and means including a negative resistance device in parallel with said element for discharging said charged elements when the potential across said element exceeds a given value; the electric fields produced by the charging and discharging of said elements causing said electroluminescent material in said selected elements to glow and thus form a display.

9. A panel comprising: a plurality of strips of electroluminescent material; a like plurality of strips of negative resistance material; means for connecting respective strips of said negative resistance material in parallel with respective strips of said electroluminescent material—whereby a like plurality of oscillators is formed; and means for energizing selected said oscillators—whereby the electroluminescent material of said energized oscillators glows.

10. The combination of claim 9 wherein said strips are of rectangular cross section.

11. The combination of claim 9 wherein said strips are of trapezoidal cross section.

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