United States Patent

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[54] **ELECTROLUMINESCENT DISPLAY SYSTEM INCLUDING A PRESELECTABLY APPLIED LOW RESISTANCE MATERIAL MEANS**
12 Claims, 3 Drawing Figs.

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[50] Field of Search .... 313/108 (A), 109.5, 232; 315/246, 59

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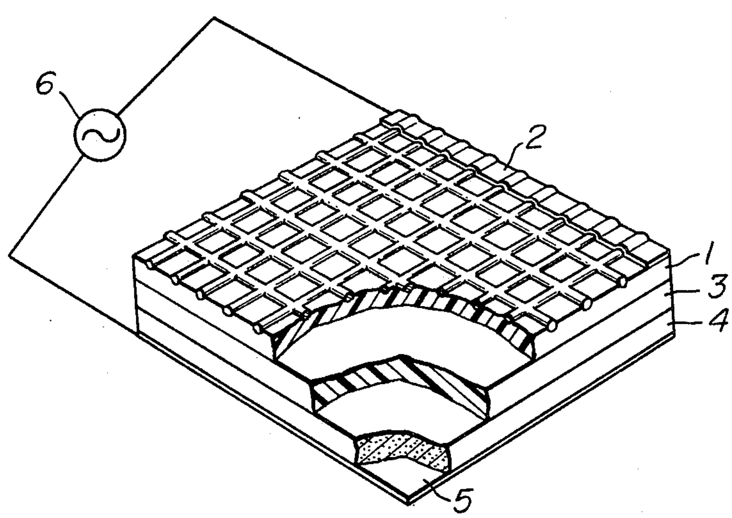
ABSTRACT: An electroluminescent display system comprising a laminated structure with an electroluminescent layer which is energized to emit light in a pattern by means of an applied electric field and a preselectably applied, low-resistance material means.



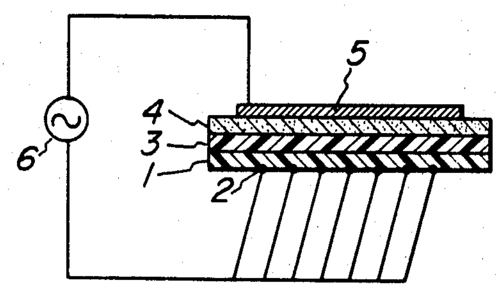


FIG. 1

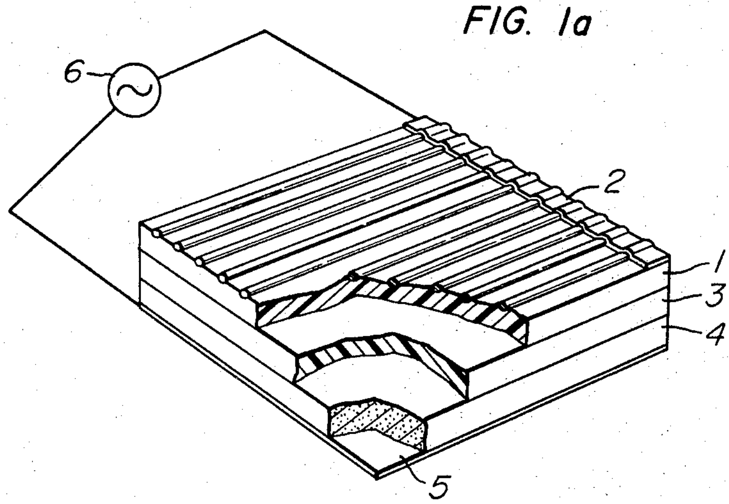


FIG. 1a

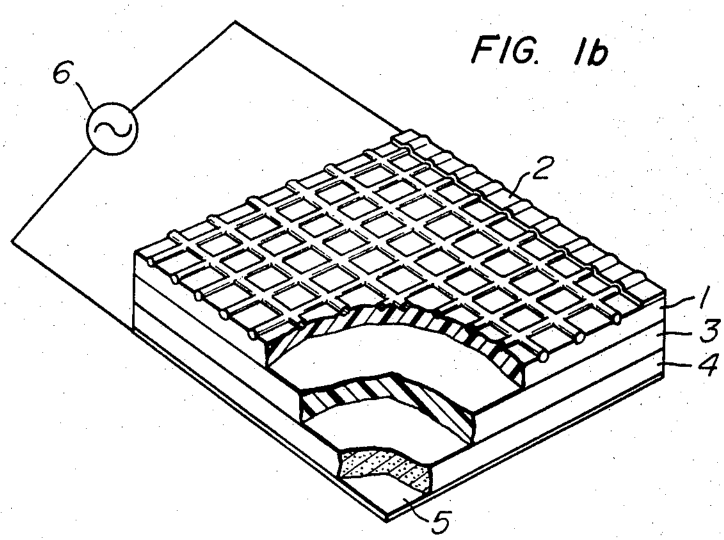


FIG. 1b

ELECTROLUMINESCENT DISPLAY SYSTEM INCLUDING A PRESELECTABLY APPLIED LOW RESISTANCE MATERIAL MEANS

This invention relates to an electroluminescent display system which uses an electroluminescent element such as an electroluminescent element which emits light in proportion to the applied electric field intensity.

When a letter or figure is displayed luminously by means of a conventional electroluminescent display system which uses an electroluminescent element, at least one electrode is formed into a shape of the letter or figure to be displayed and a voltage is fed to this electrode by some means to display the letter or figure. Therefore, when a complex letter or figure which is separated and not continuous is to be displayed, feeders must be connected to all the separated electrodes for the respective separated parts of the letter or figure, and not only the construction becomes very complicated but also it becomes very difficult to make the electrodes corresponding to the letter or figure to be displayed.

The principal object of the present invention is to provide an electroluminescent display system which can simply display any letter or figure by using an electrode having gaps composed of fine metal wires arranged in parallel or reticulately as the feeding electrode and can be used in many applications by utilizing a flexible thin film sheet as base plate.

The display system according to the present invention has electrodes for applying a voltage to a luminescent element which emits light in proportion to the applied field intensity, one electrode of which is made such an electrode that has gaps and becomes the feeder to a conductive material acting as an electrode provided between the gaps, and any letter or figure can be simply displayed luminously by forming the conductive material corresponding to the letter or figure to be displayed between the electrode having gaps in electrical contact with the electrode, and even when there are many portions to be made luminescent separately it is sufficient to form the conductive material at those portions and there is no need to form many feeders separately, whereby the construction of the system becomes very simple.

Furthermore, the display system according to the present invention can be formed very thinly and flexibly since the base plate is constructed by a flexible thin film sheet such as Mylar (trademark for polyethylene terephthalate) film, the handling of which is easy, and since it is exchangeable with usual recording paper it can be used as the recording paper of an X—Y recorder wherein the recorded figure can be displayed luminously by means of the above-described principle, thus the use of the system can be extended.

Other objects, features and advantages of the present invention will be readily apparent from the following detailed description taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a cross-sectional view of an embodiment of the electroluminescent system according to the present invention:

FIGS. 1*a* and 1*b* illustrate the feeding electrode distribution thereof.

Referring to the FIGS., the reference numeral 1 represents a resin layer composed of a dielectric layer of a large resistivity, 2 an electrode having gaps which is composed by arranging metal wires, 3 a supporter composed of a flexible film sheet, 4 an electroluminescent layer such as an electroluminescent layer which emits light in proportion to the applied electric field intensity, 5 a plate electrode formed by vacuum evaporation of a metal such as A1 on the electroluminescent layer 4 and 6 an AC power source.

In a case of AC operation, the electroluminescent layer 4 is a layer of a powder of zinc sulfide activated by copper or aluminum, which powder is mixed into a plastic binder such as a urea resin laminated into a thickness of about 50 μ, which emits light of green color by the application of an AC electric field, and the output of the emitted light has the character to change nonlinearly in proportion to the intensity of the AC electric field.

The resin layer 1 is composed of, for example, epoxy resin and the layer 1 must be transparent to the emitted light from the electroluminescent layer 4. The electrode 2 is formed by arranging tungsten wires having a diameter of about 10 μ in parallel at equal intervals of about 100 μ. The intervals of arrangement of wires need to be as narrow as possible in order to display very small complex letters or figures, but the intervals are desired to be larger than the thickness of the layer between the electrodes 2 and 5 in order to make the light emitted when nothing is displayed, that is, dark emission small. It is also desirable to use metal wires as fine as possible in order to make the dark emission small.

The electrode having gaps 2 can also be formed by evaporating such a metal as A1 in the shape of a strip on the resin layer 1 having large resistivity.

The electrode having gaps 2 can also be reticulate. The reticulate electrode is formed by arranging fine metal wires to intersect at a right angle with each other, by use of a metal net, or by evaporating a reticulate metal film.

The electrode 2 is desirable as feeding electrode when a portion of it projects on the surface of the large resistivity resin layer 1, but it serves as the feeding electrode when the resistivity of the large resistivity resin layer 1 changes due to, for example, moisture even though it does not project on the surface of the layer.

The supporter 3 is composed of a flexible film sheet constructed, for example, from the product polyethylene terephthalate sold under the trademark Mylar. The supporter 3 is preferable when it is composed of a material having a large dielectric constant and dielectric strength since the supporter itself serves also to increase the dielectric strength and is transparent to the emitted light from the electroluminescent layer 4 when the evaporated plate electrode 5 is opaque to the emitted light from the electroluminescent layer 4. The plate electrode 5 is generally formed by evaporating a metal such as A1 onto the electroluminescent layer 4, but it is preferable to make the plate electrode 5 transparent to the emitted light from the electroluminescent layer 4 by evaporating such elements as Au.

Now, the principle of operation of the embodiment of the electroluminescent system will be described with reference to the accompanying drawing.

A voltage is applied between the electrodes 2 and 5 from the voltage source 6 through lead wires. In this case, it is probable that the electroluminescent layer 4 emits only a small amount of light since the electric field is applied to the portion of the electroluminescent layer 4 where the electrode having gaps 2 exists; the emitted light is very small as a whole so that it can be ignored when the electrode is formed by wires having a diameter of about 10 μ thick at intervals of about 100 μ and the sum of the thickness of the electroluminescent layer 4 and of the large resistivity dielectric layer 1 is made about 60 μ. In electrode practice the emitted light is hardly detected. Electrode 2 serves only to supply a voltage and not as an electrode which directly operates the electroluminescent layer 4.

When a liquid having low insulation resistance such as water is dropped on the surface of the large-resistivity dielectric layer 1 after adjusting the applied voltage so that the emission of the electroluminescent layer 4 hardly takes place and at least a portion of the liquid is made to contact the electrode 2, the electric potential increases in the direction along the surface of the large-resistivity dielectric layer 1 with respect to the potential of the electrode 2 since the surface conductivity in the direction along the surface of the layer between the electrode 2 is increased. The electric field intensity within the electroluminescent layer 4 corresponding to the position of the drop also increases, with the result that the emission of light at the position increases. As described above, the portion emits light where the liquid of low insulation resistance such as water is dropped, that is, where letters or figures are drawn by the liquid.

When there is moisture at a portion instead of a material of low insulation resistance such as water, the insulation resistance of the surface of the large-resistivity dielectric layer 1 also decreases considerably due to the moisture, and if at least a portion of the part where the insulation resistance decreased was in contact with the electrode 2, the portion of the electroluminescent layer 4 where the moisture exists emits light as in the case where a liquid of low insulation resistance such as water is dropped.

In order to eliminate the emission at the portion where the liquid of low insulation resistance such as water is dropped, the liquid is wiped off with a cloth or the like, and then the surface of the large-resistivity dielectric layer 1 is restored to the original state and the light emission stops.

We claim:

1. A flexible electroluminescent display system comprising: a laminated structure of an electroluminescent layer, a plate electrode provided on one side of said layer, a flexible support sheet of dielectric material provided on the other side of said layer; an auxiliary foraminous electrode provided over the outside surface of said support sheet; an electrical power source coupled between said two electrodes; and means for producing a pattern of visual light emission from said electroluminescent layer wherein said means comprises a low-resistance material applied to preselected portions on said outside surface, said material being in electrical contact with adjacent portions of said foraminous electrode.

2. A flexible electroluminescent display system according to claim 1, further comprising a transparent high-resistance dielectric layer mounted on the outside of said support sheet, said foraminous electrode being carried by said transparent dielectric layer.

3. A flexible electroluminescent display system according to claim 2, wherein said high-resistance dielectric layer comprises a bonding agent of synthetic resin.

4. A flexible electroluminescent display system according to claim 2, wherein said support sheet is transparent.

5. A flexible electroluminescent display system according to claim 1, wherein said foraminous electrode comprises a parallelly and closely arranged fine metal wire electrode formed by vacuum evaporation.

6. A flexible electroluminescent display system according to claim 5, wherein said wire electrode comprises metal wires having a diameter of 10 u and an interval of 100 u therebetween, the sum of the thickness of said electroluminescent layer and said high-resistance dielectric layer being 60 u.

7 A flexible electroluminescent display system according to claim 1, wherein said foraminous electrode is a reticulate electrode.

8. A flexible electroluminescent display system according to claim 1, wherein said plate electrode is constructed of Au.

9. A flexible electroluminescent display system according to claim 1, further comprising means for removing said light emission pattern of low-resistance material from said plane.

10. A flexible electroluminescent display system according to claim 1, wherein said support sheet is a polyethylene terephthalate sheet.

11. A flexible electroluminescent display system according to claim 1, wherein said electroluminescent layer comprises a powder of zinc sulfide activated by copper or aluminum which is mixed into a plastic binder laminated into a thickness of 50μ.

12. A flexible electroluminescent display system according to claim 1, wherein said low-resistance material is a material which is easily removable from said outside surface.