Nov. 15, 1966 P. W. RANBY ET AL 3,286,115

ELECTROLUMINESCENT LAMP WITH BORIC ACID OR BORIC OXIDE USED IN CONJUNCTION WITH THE ZINC SULPHIDE LAYER

Filed Feb. 24, 1964

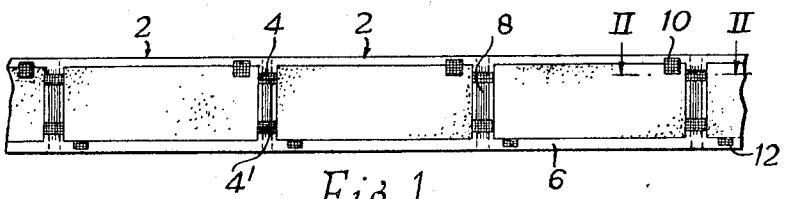

Fig. 1.

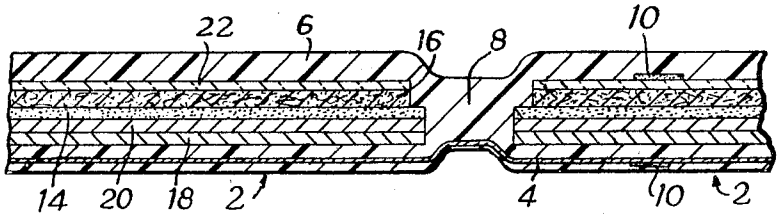

Fig. 2.

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United States Patent Office

3,286,115

Patented Nov. 15, 1966

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3,286,115
ELECTROLUMINESCENT LAMP WITH BORIC ACID OR BORIC OXIDE USED IN CONJUNCTION WITH THE ZINC SULPHIDE LAYER

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Filed Feb. 24, 1964, Ser. No. 346,605
Claims priority, application Great Britain, Feb. 25, 1963, 7,534/63
11 Claims. (Cl. 313—108)

This invention relates to organic electroluminescent devices, that is, electroluminescent devices in which the phosphor is dispersed in an organic medium, and in particular to flexible organic electroluminescent devices, in which the electroluminescent cell or cells are not supported on a rigid base, but are enveloped in a flexible envelope which is light-transmitting over at least a part of its surface.

It is an object of the present invention to provide a flexible organic electroluminescent device showing improved maintenance of light output.

According to the invention there is provided a flexible organic electroluminescent device in which a layer of an electroluminescent material of the zinc sulphide type dispersed in an organic medium contains and/or is in contact with boric acid or boric oxide. Devices according to the invention not only exhibit superior maintenance of light output after long use but also show less discoloration in use.

Electroluminescent materials of the zinc sulphide type include, apart from zinc sulphide itself, related phosphors such as zinc cadmium sulphide, zinc selenide and zinc sulpho-selenide.

The amount of boric acid or oxide used is preferably between 0.25% and 30%, and is advantageously between 5% and 15% of the weight of the dry phosphor. Where the device contains a layer of dielectric material disposed between the phosphor layer and an opaque electrode, the boric acid or oxide can be incorporated in the dielectric layer.

In another embodiment of the invention, the boric acid or oxide is included as a separate film between the phosphor layer and a light-transmitting electrode.

When the boric acid or oxide is to be incorporated in the phosphor layer it can be added to the phosphor before fabricating the lamp by griding and sieving and then mixing thoroughly with the phosphor. Alternatively a solution of the boric acid or oxide can be added to the phosphor powder which is then dried, ground and sieved.

The invention will now be further described with reference to the following specific examples of the construction of a flexible electroluminescent device, taken in conjunction with the accompanying drawings, in which:

FIG. 1 shows a flexible electroluminescent device, of the type described in copending application No. 176,373 and

FIG. 2 is a section along the lines II—II of FIG. 1.

Referring to FIG. 1, there is shown a number of individual electroluminescent cells **2** arranged end to end over continuous strip current conveyors **4**, **4'**, the whole assembly being sealed in an envelope **6** of transparent plastic. The envelope **6** is sealed at **8** between the individual cells, and the connectors **10**, **12** in each cell **2** connect the current conveyors **4**, **4'** with the electrodes of the cell.

In the particular construction shown in FIG. 2 the envelope **6** is of transparent plastic film, such as polythene about 0.015 inch thick or Kel-F film about 0.005 inch thick, and the current conveyor **4** and connector **10** (and the conveyor **4'** and connector **12**, not shown) are

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of flexible copper strip or ribbon. Each cell comprises a layer **14** of a phosphor in a binder, such as cyanoethylcellulose or a vinylidene copolymer, sandwiched between a transparent conducting electrode **16** and a base electrode **18** of aluminum coated with a dielectric layer **20** of barium titanate dispersed in a cyanoethylcellulose or vinylidene copolymer binder. The transparent electrode **16** is of micro-fibre glass paper, rendered conductive by treatment such as described in application No. 176,373. The layer **22** is of polythene or nylon, which on heating fuses to bond the electrode **16** to the phosphor layer **14** and to the connector **10**.

Example 1

A quantity of a powdered copper-activated zinc sulphide phosphor was intimately mixed with 10% by weight of boric acid of analytical reagent grade which had previously been finely ground and sieved through a 250 mesh silk sieve. The phosphor/boric acid mixture was then used in the construction of an electroluminescent device as described above. Similar devices were constructed in which the quantities of boric used were respectively 0%, 7½%, 12½%, 15% and 20% of the weight of the dry phosphor powder.

These lamps were run continuously and their respective brightnesses compared after various intervals, with the following results, 100 being taken as the initial brightness of the boric acid free lamp:

Hours of continuous running	Percent of H_3BO_3					
	0	7½	10	12½	15	20
0	100	79	82	79	73	66
50	107	79	80	80	71	63
100	103	78	79	79	71	61
200	78	74	76	77	67	59
300	58	71	74	75	64	58
400	50	66	70	68	60	55
500	46	60	66	64	57	52

Example 2

A powdered zinc sulphide phosphor, finely ground and sieved through a 250 mesh silk sieve was intimately mixed with 8% by weight of boric oxide of analytical reagent grade. The mixture obtained was used in the construction of a flexible electroluminescent device as described in Example 1. The resulting device showed a light output maintenance similar to that of the device employing 10% by weight of boric acid as shown in the above table.

What is claimed is:

1. An electroluminescent device comprising a hermetically sealed flexible envelope at least a portion of which is light-transmitting, and an electroluminescent cell embedded in said envelope, said cell comprising a pair of spaced electrodes superposed in face to face relationship at least one of said electrodes being light-transmitting, means for conducting current to each of said electrodes, and a layer of a zinc sulfide electroluminescent phosphor dispersed in an organic binder sandwiched between said electrodes, said zinc sulphide being substantially in contact with a material consisting essentially of a member selected from the group consisting of boric acid and boric oxide.

2. An electroluminescent device comprising a hermetically sealed flexible envelope at least a portion of which is light-transmitting, and an electroluminescent cell embedded in said envelope, said cell comprising a pair of spaced electrodes superposed in face to face relationship at least one of said electrodes being light-transmitting, means for conducting current to each of said electrodes, and an electroluminescent layer of zinc sulfide and a ma-

terial consisting essentially of a member selected from the group consisting of boric acid and boric oxide uniformly dispersed in an organic binder layer sandwiched between said electrodes.

3. An electroluminescent device according to claim 2, wherein said layer contains from about 0.25% to about 30% by weight of said material based on the dry weight of the zinc sulphide.

4. An electroluminescent device according to claim 2, wherein said layer contains from about 5% to about 15% by weight of said material based on the dry weight of the zinc sulphide.

5. An electroluminescent device comprising a hermetically sealed flexible envelope at least a portion of which is light-transmitting, and an electroluminescent cell embedded in said envelope, said cell comprising a pair of spaced electrodes superposed in face to face relationship at least one of said electrodes being light-transmitting, means for conducting current to each of said electrodes, and a pair of layers sandwiched between said electrodes in face to face contact, the first of said layers comprising a zinc sulfide electroluminescent phosphor substantially uniformly dispersed in an organic binder and the second of said layers comprising a material consisting essentially of a member selected from the group consisting of boric acid and boric oxide.

6. An electroluminescent device according to claim 5, wherein said second layer contains from about 0.25% to about 30% by weight of said material based on the dry weight of the zinc sulphide.

7. An electroluminescent device according to claim 5, wherein said second layer contains from about 5% to about 15% by weight of said material based on the dry weight of the zinc sulphide.

8. An electroluminescent device comprising a hermetically sealed flexible envelope at least a portion of which is light-transmitting, and an electroluminescent cell embedded in said envelope, said cell comprising a light-transmitting electrode and an opaque electrode superposed in spaced face to face relationship, means for conducting current to each of said electrodes, and two layers sandwiched between said electrodes in face to face contact, the first of said layers being disposed between said opaque electrode and the second of said layers and comprising a member selected from the group consisting of boric acid and boric oxide substantially uniformly dispersed in a dielectric material and the second of said layers comprising a zinc sulfide electroluminescent phosphor substantially uniformly dispersed in an organic binder.

9. An electroluminescent device according to claim 8, wherein said first layer contains from about 0.25% to about 30% by weight of said material based on the dry weight of the zinc sulphide.

10. An electroluminescent device according to claim 8, wherein said first layer contains from about 5% to about 15% by weight of said material based on the dry weight of the zinc sulphide.

11. A laminated electroluminescent device comprising an envelope of thermoplastic material at least a portion of which is light-transmitting, at least two electroluminescent cells hermetically sealed within the envelope and insulated from each other by the hermetic seal of said envelope, said cells comprising at least two superposed electrodes, at least one of which is light-transmitting, and a layer of light-emitting material including a zinc sulfide electroluminescent phosphor disposed between said electrodes, said electroluminescent material consisting essentially of at least one member being substantially in contact with a material selected from the group consisting of boric acid and boric oxide; means to conduct current to each of said electrodes in each of said electroluminescent cells, said means comprising at least two longitudinally disposed current conveying means, insulated from each other, and each insulated from one of the electrodes in said cells, said current conveying means extending along the length of said electroluminescent device and passing across the seal between each of said electroluminescent cells.

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