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2,887,402

METHOD OF PRODUCING ELECTROLUMINESCENT LAMPS

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FIG. 1

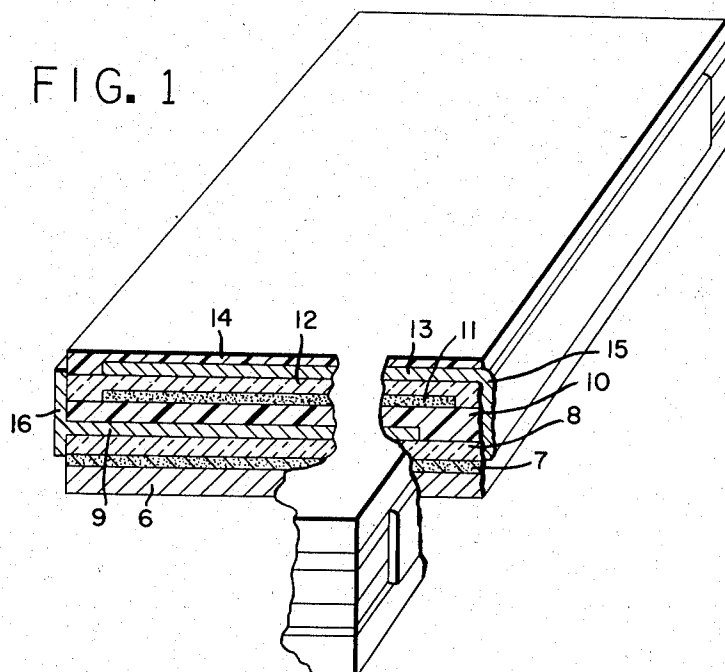
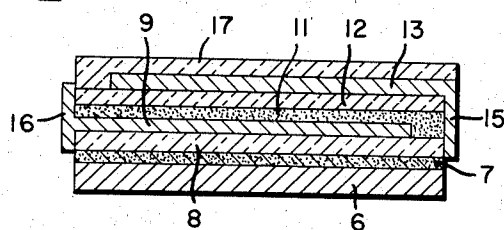


FIG. 2



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METHOD OF PRODUCING ELECTROLUMINESCENT LAMPS

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3 Claims. (Cl. 117—33.5)

This invention relates to electroluminescence and, more particularly, it relates to an improved electroluminescent lamp and method for its production.

Electroluminescent lamps comprising two spaced electrodes, at least one of which is translucent or transparent, on opposite sides of an electroluminescent phosphor, have been suggested heretofore. Such lamps are, for example, disclosed in U.S. Patent 2,824,992. Such previously known electroluminescent lamps have not transmitted the desired intensity of light. Although the principle and method of transmitting light by electroluminescence is exceedingly attractive, a greater brightness of light transmission is necessary to broad commercial acceptance of such lamps.

It is an object of this invention to provide an improved electroluminescent lamp.

It is a further object to provide such a lamp having a more uniform and intense light transmission.

It is still another object of this invention to provide simplified methods for producing electroluminescent lamps of greater brightness.

Other objects of the invention will appear hereinafter.

The objects of this invention may be accomplished, in general, by applying to a temporary supporting surface, in turn, a layer of parting material, a layer of a vitreous enamel dielectric, an electrically conducting area, a layer of an electroluminescent phosphor, a second vitreous enamel dielectric layer, and a second electrically conducting area, at least one of said conducting areas being translucent or transparent, and firing the resultant laminated structure to fuse said vitreous enamel layers and bond all of said layers together into a monolithic structure.

The details of this invention will be more readily apparent by reference to the following description when taken in connection with the accompanying drawings, in which:

Figure 1 is a perspective view, with parts in section, showing an electroluminescent lamp constructed in accordance with the present invention; and

Figure 2 is a vertical sectional view of another form of the invention.

Referring to Figure 1 of the drawings, reference numeral 6 designates a temporary supporting base upon which the lamp is constructed. This supporting base may be any solid, level surface that will withstand an elevated temperature of up to about 1300° F. It may, for example, be a steel (or other suitable metal) or ceramic plate.

In order that the lamp may later be removed from the supporting base, a layer 7 of parting material, for ex-

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ample, finely divided inert material such as bentonite, is positioned on the base. Finely divided bentonite, e.g. 100-mesh, is wet with sufficient liquid, e.g. water, to form a paste which may be cast or rolled onto the surface of the base to provide a relatively smooth, uniform surface for the lamp structure.

After the layer 7 is dried, a layer 8 of vitreous enamel is applied thereover. Any vitreous enamel frit, for example, a metal borosilicate such as lead, cadmium, barium or bismuth borosilicate frit may be used for this purpose. Lead-free or low-lead-containing vitreous enamel frit is, however, preferred since phosphors may react in an undesirable manner with lead. A highly recommended vitreous enamel frit for use with this invention is one containing at least 70%, by weight, of the following composition:

22–35% by weight TiO_2
14–29% by weight SiO_2
17–26% by weight Na_2O , and
1–3% by weight Li_2O

The vitreous enamel frit may be applied to the surface of the parting layer 7 in any desired manner to obtain a thin coating of substantially uniform cross section. The vitreous enamel frit is preferably free of opacifying agents; however, it may contain coloring pigments in such small amounts that the vitreous enamel frit after firing will remain transparent or at least quite translucent. The vitreous enamel frit may conveniently be dispersed in a suitable liquid vehicle and applied by spraying, dipping, stencilling, brushing or the like. Any air-dry or thermofluid vehicle heretofore used in preparing dispersions or suspensions of powdered vitreous enamels may be used for the preparation of dispersions or suspensions of the enamels used in accordance with this invention. Such vehicles are, for example, disclosed in the following United States patents: Deyrup, 2,467,114; Andrews, 2,682,480; Jessen, 2,607,701; and Jessen, 2,607,702.

The vitreous enamel layer 8 is then dried, if necessary, and an electrically conducting electrode 9 positioned over layer 8. This electrode 9 may be either opaque or transparent or translucent. If it is desired that the electroluminescent lamp is to transmit light from both sides, then this electrode must be either transparent or translucent, but if it is desired only that light be transmitted from one side, then this electrode may be opaque. An opaque electrode may be provided by a metal foil, but preferably, by applying a layer of finely divided silver in a suitable vehicle. Silver compositions of this kind are disclosed in the United States patents to Knox, No. 2,385,860, and Larsen and Short, No. 2,822,279. The finely divided silver and vehicle in paste form is preferably applied by squeegeeing onto the layer 8 in the form of the desired pattern. This layer of silver 9 is then dried to remove excess vehicle.

If a transparent conductive coating is desired, then layer 9 should be prepared in known manner from stannic chloride or titanous chloride and subjected to a reducing atmosphere, for example, as disclosed in U.S. Patent No. 2,624,857.

A layer of lacquer 10 is then preferably applied over the layer 9 of silver or stannic chloride or oxide and over such part of the vitreous enamel frit layer 8 as may not be covered by the silver layer 9. This lacquer layer is

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provided to prevent air bubbles from moving from the interstices between the dry particles of vitreous frit layer 8 into the next layer 12 of vitreous enamel frit which is to follow. Since frit layer 12 upon application will be filled with liquid vehicle and frit layer 8 will be dry and, therefore, filled with air, the air from layer 8 will tend to rise and pass into the layer 12 while the liquid will displace the air from the interstices between particles of layer 8. This is very objectionable and causes subsequent rupture of the dielectric and a short circuit. The lacquer may be any organic resin that will be burned out without undue carbon deposit upon firing of the composite lamp structure. Good results have been experienced in the use of ethyl cellulose in alcohol as the lacquer. Nitrocellulose or methyl cellulose in alcohol or acetone are also suitable for this use.

A layer 11 of electroluminescent phosphor in finely divided form is then applied over the lacquer layer 10. This phosphor layer is of sufficient size to extend in all directions and cover the overlapping sections of the two electrical conductors in electroluminescent lamps. As is well known, the phosphor is activated by the induced current flowing between the spaced electrodes. This phosphor may be applied by dispersing the same in a vehicle similar to the finely divided silver above described. For example, the phosphor particles may be dispersed in pine oil, alcohol, or water with or without a binder such as ethyl cellulose.

In Figure 1 and in the above description, the phosphor 11 is disclosed as being positioned on top of the lacquer layer 10. If desired, the phosphor may be positioned directly on top of the electrical conductor 9, and the lacquer layer 10 positioned on the phosphor layer 11, and on such portions of the conductor 9 and the vitreous enamel layer 8 as may not be covered by the phosphor layer 11. As will appear later, when the laminated structure is finally fired, the lacquer layer 10 will be completely dissociated and eliminated, and the phosphor particles will be in any event in direct contact with the conductor 9.

A second vitreous enamel dielectric layer 12 will be positioned over the phosphor layer 11, or over the lacquer layer 10, or both. This dielectric layer will be applied in the same manner as above described with the frit layer 8. The second vitreous enamel is to separate the two spaced electrical conductors 9 and 13.

The second electrical conductor 13 is applied over the vitreous enamel frit layer 12. This conductor layer 13 may be either a layer of silver particles or a layer of a transparent electrical conductor as above described with reference to conductor layer 9. It is, of course, essential that one of the two electrical conductors be composed of a transparent material.

The electrical conductors 9 and 13 are preferably provided with electrically conducting tabs 16 and 15, respectively, on opposite sides of the lamp whereby current carrying wires are more easily connected to the electrodes.

The entire laminar aggregate is then fired at a temperature at which the vitreous enamel frit is fused or matured, thereby dissociating the remaining vehicle or lacquer ingredients, and bonding the enamel dielectric layers and conductor layers into a monolithic unit. Most vitreous enamel compositions of the type hereinabove described will fuse at a temperature of between 900° F. and 1200° F. The firing may be accomplished in a glass lehr in a period of 10 to 20 minutes. The parting layer is then scraped from the lamp structure, and the vitreous enamel surface polished, if desired.

After firing the top electrical conductor is preferably covered with a lacquer or resin coating 14 to protect the same against external atmospheric conditions. Alternatively, layer 14 may consist of a vitreous enamel which in such case is applied before firing and produces a lamp encased in vitreous enamel.

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In illustrating the electroluminescent lamps of this invention, the layers of materials are grossly exaggerated in thickness for the purpose of more clearly disclosing the invention.

Figure 2 of the drawings illustrates a different embodiment of the invention in which the laminated structure is built up as follows:

The vitreous enamel dielectric frit 8 is applied to the parting layer 7 and the electrical conductor applied over the vitreous dielectric frit. Finely divided particles of an electroluminescent phosphor are suspended or dispersed in a clear lacquer which, upon firing at the enamel maturing temperature, will burn cleanly from the structure without objectionable carbon deposition. As above mentioned, ethyl or methyl cellulose in alcohol or acetone, or nitrocellulose compositions may be used for this purpose. This phosphor-lacquer composition may be cast or squeegeed through a screen stencil over the electrical conductor layer 9. The phosphor-lacquer layer 11 may cover the entire conductor 9 and such portion of dielectric 8 as may project beyond the conductor. In any event it is preferred that the phosphor layer extend between the overlapping sections of the electrical conductors. The phosphor-lacquer layer 11 will prevent air bubbles from passing from the dry lower vitreous dielectric frit layer to the wet upper frit layer in the manner above described. At the same time, upon firing, the lacquer will burn out leaving the phosphor deposited between the vitreous enamel layer 12 and conductor layer 9.

The lamp of Figure 2 is completed by covering the phosphor-lacquer layer 11 with vitreous enamel frit layer 12, which, in turn, are covered by electrical conductor layer 13 and vitreous enamel frit layer 17. The aggregate mass is then fired and the parting layer removed after cooling.

It is, of course, evident that each individual layer of vitreous enamel dielectric, of metallic silver paste, or of lacquer, applied either to the supporting base 5 or over previously applied layers, is preferably dried before the next succeeding layer is applied. Generally, I prefer to apply the vitreous enamel dielectric composition by spraying, the silver electrode areas being applied, as a suspension of silver in the form of a paste, by the squeegee screen stencil method, although, of course, the methods may be used interchangeably as desired.

The electroluminescent lamps of this invention will have the phosphor particles in direct contact with one of the electrodes as a result of the burning out of the lacquer from between the enamel and conductor elements. The resultant monolithic structure of the present invention with the glass encased electrodes and phosphor layers in which the phosphor particles are deposited in direct contact with one of the electrodes produces an electroluminescent lamp of greater brightness. Since the lacquer prevents the passage of air bubbles from one frit layer to the other, the resulting lamp will withstand a high voltage current without electrical rupture.

Since it is obvious that many changes and modifications can be made in the above-described details without departing from the nature and spirit of the invention, it is to be understood that this invention is not to be limited to said details except as set forth in the appended claims.

I claim:

1. The method of producing an electroluminescent lamp which comprises forming the following laminar structure over a layer of parting material on a temporary supporting base; in order, a layer of vitreous enamel frit, a layer comprising an electrical conductor, a layer of finely divided electroluminescent phosphor, a lacquer layer, a second layer of vitreous enamel frit, and a second layer comprising an electrical conductor, and firing said laminar structure at the maturing temperature of said frit.

2. The method of producing an electroluminescent lamp which comprises forming the following laminar

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structure over a layer of parting material on a temporary supporting base; in order, a layer of vitreous enamel frit, a layer comprising an electrical conductor, a layer of lacquer, a layer of finely divided electroluminescent phosphor, a second layer of vitreous enamel frit, and a second layer comprising an electrical conductor, and firing said laminar structure at the maturing temperature of said frit.

3. The method of producing an electroluminescent lamp which comprises forming the following laminar 10 structure over a layer of parting material on a temporary supporting base; in order, a layer of vitreous enamel

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frit, a layer comprising an electrical conductor, a layer of finely divided electroluminescent phosphor in lacquer, a second layer of vitreous enamel frit, and a second layer comprising an electrical conductor, and firing said laminar structure at the maturing temperature of said frit.

References Cited in the file of this patent

UNITED STATES PATENTS

2,624,857	Mager -----	Jan. 6, 1953
2,721,808	Roberts et al. -----	Oct. 25, 1955
2,824,992	Bouchard et al. -----	Feb. 25, 1958