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(54) Title: ELECTROLUMINESCENT LAMP

(57) **Abstract:** A combination of an electroluminescent lamp and a metal key panel, comprising a substrate, an electroluminescent system printed on a side of the substrate, an insulating protection layer covering an external surface of the electroluminescent system, a first adhesive layer disposed on the insulating protection layer and a metal key panel adhered to the first adhesive layer; the metal key panel comprising a spacer and a plurality of metal keys, characterized by further comprising a second adhesive layer and a release paper disposed at an outside of the metal key panel, wherein the substrate is a transparent polyester film; the electroluminescent system is provided with a transparent conducting layer, an electroluminescent layer, a dielectric layer and a rear electrode layer sequentially from the side of the substrate to the outside; and lights emitted from the electroluminescent layer transmitted by passing through the transparent conducting layer and the substrate. The combination of the electroluminescent lamp and the metal key panel has the advantages of being resistant to damage and easily adhered to a circuit board. The invention further provides the electroluminescent lamp and a manufacturing method thereof.



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ELECTROLUMINESCENT LAMP

FIELD OF THE INVENTION

The present invention relates to an electroluminescent lamp and its combination with a metal key panel, as well as a method for manufacturing the electroluminescent lamp, and more particularly to an electroluminescent lamp which is resistant to damage and easy to be adhered to another electronic element, and its combination with a metal key panel as well as a method for manufacturing the electroluminescent lamp.

BACKGROUND OF THE INVENTION

The electroluminescence technology, which was formerly used merely in aircraft cockpits, has become broadly used for various civilian high technology consumer electronic products, such as mobile phones, pagers, wireless telephones, personal digital assistants, remote controllers, and so on. Because electroluminescent lamps have characteristics such as small size, low weight, low temperature, low power consumption, non-flickering, uniform luminescence, etc., they are gradually replacing backlight means of conventional light emitting diodes (LEDs).

Please refer to Fig. 6 showing an electroluminescent system of a monolithic structure provided by U.S. Patent No. 5,856,029, which discloses an electroluminescent lamp comprising a rear electrode layer 16, a dielectric layer 15, an electroluminescent layer 14, a translucent electrode layer 13, a cover layer 12 and a bus bar 11. In an implementation, firstly, the rear electrode layer 16 is printed on a substrate 17 (such as a clothing) consisting of a textile fabric; then, the dielectric layer 15, the electroluminescent layer 14 and the translucent electrode layer 13 are sequentially printed thereon; afterward, the bus bar 11 is printed on the translucent electrode layer 13 in the form of a loop; and finally, the cover layer 12 is printed so as to be adhered to the substrate 17. However,

since this electroluminescent lamp is directly printed on a final product such as an article of clothing, if the electroluminescent system is directly printed on an electronic product in a similar way, production would be seriously hindered because the electronic product may not readily withstand circumstances such as high temperature, baking, and so on as well as other activities utilized during the printing process. Hence it is desirably to produce the electroluminescent system as a single product and then transfer it to the electronic product.

Referring to Figs. 7 and 8 for another electroluminescent lamp, Chinese Patent Application No. 99125456.2 (corresponding to U.S. Patent Nos. 5,856,030 and 6,270,834) discloses a method for manufacturing an electroluminescent lamp. The electroluminescent lamp is printed on a transfer release paper 102 and comprises a first envelope layer 104, an Indium Tin Oxide (ITO) layer 106, a front bus bar 107, an electroluminescent layer 108, a dielectric layer 110, a rear electrode layer 112 and a second envelope layer 114. The transfer release paper 102 is used as a substrate during printing, and the rest of the aforementioned layers are sequentially printed on the transfer release paper 102, so the electroluminescent lamp can be produced as a single product.

However, during assembly of the electroluminescent lamp to an electronic product, adhering the electroluminescent lamp to the electronic product can be implemented only by coating an adhesive layer 116 on the second envelope layer 114 in advance, and adhering the adhesive layer 116, together with the electroluminescent lamp, to the electronic product, then peeling off the transfer release paper 102. That makes it inconvenient to use. Moreover, because this electroluminescent lamp is integrally formed by ink printing, its strength is relatively low and it is prone to be damaged at the time of being stretched by an external force. On the other hand, when this electroluminescent lamp is applied to a mobile phone (not shown), it contacts with keys of the mobile phone via an external surface of the first envelope layer 104. However,

the first envelope layer 104 is formed by printing a layer of insulating ink which has a relatively low strength, so it is prone to be damaged after a long period of use cooperating with the mobile phone.

SUMMARY OF THE INVENTION

5 A purpose of the invention is to provide an electroluminescent lamp which is resistant to damage and easy to be adhered to another electronic element, and a manufacturing method thereof.

 Another purpose of the invention is to provide a combination of an electroluminescent lamp with a metal key panel, which is resistant to damage and easy to
10 be adhered to a circuit board of a mobile phone.

 For realizing the above purposes, the invention provides an electroluminescent lamp, comprising a substrate, an electroluminescent system printed on a side of the substrate and an insulating protection layer covering an external surface of the electroluminescent system, the electroluminescent lamp further comprising a first
15 adhesive layer and a releasable paper disposed outside of the insulating protection layer, wherein the substrate is a transparent polyester film; the electroluminescent system is provided with a transparent conducting layer, a bus bar, an electroluminescent layer, a dielectric layer and a rear electrode layer sequentially from the side of the substrate to the outside; and lights emitted from the electroluminescent layer transmit outward by passing
20 through the transparent conducting layer and the substrate. The bus bar and the transparent conducting layer are electrically conductive with each other.

 In addition, the invention provides a combination of an electroluminescent lamp and a metal key panel. The combination of the electroluminescent lamp and the metal key panel is produced, on the basis of the electroluminescent lamp according to the
25 invention, by removing the release paper and adding a metal key panel, a second adhesive

layer and a releasable paper adhered to the first adhesive layer.

The invention further provides a method for manufacturing the electroluminescent lamp, comprising steps of: step 1: providing a substrate of a transparent polyester film; step 2: printing an electroluminescent system to be laminated on a surface of the substrate, the step 2 further comprising steps of: step 2a: printing a transparent conducting layer on the substrate; step 2b: printing an electroluminescent layer to be laminated on the transparent conducting layer, the electroluminescent layer having a second opening disposed therein; step 2c: printing a dielectric layer to be laminated on the electroluminescent layer, the dielectric layer having also a second opening correspondingly disposed therein; step 2d: printing a rear electrode layer to be laminated on the dielectric layer, the rear electrode layer having also a second opening correspondingly disposed therein; step 3: printing an insulating protection layer on the rear electrode layer, the insulating protection layer, as an envelope layer of the electroluminescent system, enveloping the electroluminescent system to the substrate, and having a first opening and a second opening correspondingly disposed therein; and step 4: printing a first adhesive layer on the insulating protection layer, the first adhesive layer having also a first opening and a second opening correspondingly disposed therein.

The invention has the following advantageous effects: since the insulating protection layer of the electroluminescent lamp according to the invention is adhered to the substrate so as to tightly seal the electroluminescent system sandwiched between the insulating protection layer and the substrate, no air, moisture, or dust can enter therein; moreover, since it is unnecessary to peel off the substrate when assembling it to another product, the step of printing an envelope layer of the prior art can be omitted, thereby simplifying the process and reducing the material used; since the electroluminescent lamp has a first adhesive layer and a releasable paper disposed therein, the electroluminescent lamp can be handled as an independent product for shipment and transportation, and

when being assembled, the electroluminescent lamp can be directly adhered to a circuit board of a mobile phone so long as the releasable paper is peeled off, which is easily and conveniently accomplished.

5 The bottom surface of the electroluminescent lamp is a substrate consisting of a polyester film. As compared with the first envelope layer of the prior art formed by printing an insulating ink, the durability is greatly enhanced, and additionally, the tensile strength of the electroluminescent lamp is improved.

BRIEF DESCRIPTION OF THE DRAWINGS

10 The organization and manner of the structure and operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawings wherein like reference numerals identify like elements in which:

Fig. 1 is a perspective view of an electroluminescent lamp according to the invention;

15 Fig. 2 is a sectional view of Fig. 1;

Fig. 3 is a schematic diagram of a metal key panel according to the invention;

Fig. 4 is a sectional view of a combination of an electroluminescent lamp and a metal key panel according to the invention;

20 Fig. 5 is a schematic diagram of the combination of the electroluminescent lamp and the metal key panel according to the invention in the case of being applied to a mobile phone;

Fig. 6 is a sectional view of an electroluminescent lamp of the prior art;

Fig. 7 is a perspective view of another electroluminescent lamp of the prior art;
and

25 Fig. 8 is a sectional view of Fig. 7.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

While this invention may be susceptible to embodiments in different forms, there is shown in the drawings and will be described herein in detail, a specific embodiment with the understanding that the present disclosure is to be considered an example of the principles of the invention, and is not intended to limit the invention to that as illustrated.

Referring to Figs. 1 and 2, the invention provides an electroluminescent lamp which can be mounted on a backlight keyboard panel of a mobile phone or other electronic equipment.

The electroluminescent lamp comprises a transparent substrate 1 as well as an electroluminescent system (EL system) (not numbered) printed on an upper surface of the substrate 1, an insulating protection layer (dielectric layer) 3, a first adhesive layer 4 and a back adhesive protection layer 5.

The electroluminescent system is provided with a transparent conducting layer 21, a bus bar 22, an electroluminescent layer 23, a dielectric layer 24 and a rear electrode layer 25 sequentially disposed from bottom to top on a side of the substrate 1.

According to the present design, the respective layers of the electroluminescent system are printed on the substrate 1 to be laminated sequentially by means of screen printing. Of course, the printing can be performed by means of roller printing or other methods.

The substrate 1 is a piece of polyester (PET) film which is a soft and flexible film. The substrate 1 has a relatively high tensile strength, such that the electroluminescent lamp is not easy to be damaged. According to the present design, the substrate 1 is designed as colorless and transparent, and of course it can be designed, for example, as red and transparent, blue and transparent, and so on, depending on practical requirements. The substrate 1 has a relatively high transmittance, such that lights emitted from the electroluminescent layer 23 can transmit easily through the substrate 1 and the transparent

conducting layer 21.

The transparent conducting layer 21 is printed on an upper surface of the substrate 1, and is formed by printing a layer of transparent conductive ink such as Indium Tin Oxide (ITO) to be laminated on the substrate 1.

5 The bus bar 22 is a loop of filament printed on an upper surface of the transparent conducting layer 21 by using a silver-containing ink. The bus bar 22 is electrically conductive with the transparent conducting layer 21, which can enhance electrical conductivity of the transparent conducting layer 21.

10 The electroluminescent layer 23 is formed by printing a mixture of a phosphor powder and an adhesive to be laminated on the bus bar 22. When an alternating current flows between the rear electrode layer 25 and the transparent conducting layer 21 of the electroluminescent lamp, the rear electrode layer 25 and the transparent conducting layer 21 will function as two electrodes of a capacitor, so the phosphor powder of the electroluminescent layer 23 will emit light under excitation of an alternating electric field.

15 The dielectric layer 24 has a characteristic of relatively high insulation, and is formed by printing an insulating ink such as barium titanate to be laminated on the electroluminescent layer 23. In this design, the dielectric layer 24 presents white color and it can reflect lights emitted from the electroluminescent layer 23, such that lights emitted from the electroluminescent layer 23 can only transmit out by passing through the
20 transparent conducting layer 21 and the substrate 1.

The rear electrode layer 25 is formed by directly printing a layer of non-transparent conductive ink such as silver ink or carbon ink to be laminated on the dielectric layer 24.

25 The electroluminescent lamp has a first opening 28 and a second opening 29 disposed therein. The first opening 28 communicates with the rear electrode layer 25 after passing through the first adhesive layer 4 and the insulating protection layer 3. The

second opening 29 communicates with the bus bar 22 after passing through the first adhesive layer 4, the insulating protection layer 3, the rear electrode layer 25, the dielectric layer 24 and the electroluminescent layer 23.

The insulating protection layer 3 is formed by printing a waterproof and dustproof ink (such as polyurethane) on the rear electrode layer 25. The insulating protection layer 3 is adhered to the substrate 1 to be used as an envelope layer of the electroluminescent system, so as to tightly seal the electroluminescent system between the insulating protection layer 3 and the substrate 1, such that air, moisture or dust, which reduces the luminescent life of the lamp, is prevented from entering the electroluminescent lamp.

The first adhesive layer 4 is a layer of self-adhesive coated on the insulating protection layer 3.

In this design, the back adhesive protection layer 5 is a releasable paper. The back adhesive protection layer 5 is disposed on the first adhesive layer 4, for preventing the first adhesive layer 4 from being contaminated by the environment. When being mounted, the electroluminescent lamp can be adhered to another electronic element such as a metal key panel so long as the release paper is peeled off to expose the first adhesive layer 4.

Referring to Figs. 3 to 5, the invention further provides a combination of the electroluminescent lamp and a metal key panel, which can be mounted on a circuit board of a mobile phone or other personal electronic devices (not shown).

The combination of the electroluminescent lamp and the metal key panel is produced, on the basis of the electroluminescent lamp described above, by removing the back adhesive protection layer 5 and adding a metal key panel 6, a second adhesive layer 7 and a back adhesive protection layer 8.

The metal key panel 6 comprises a spacer 62 and a plurality of metal keys 66. A plurality of circular receiving grooves 64 are disposed in the spacer 62. These receiving

grooves 64 are connected by a plurality of air escaping channels 65. These metal keys 66 are metal plates presenting a dome shape, and are respectively received within these receiving grooves 64. The air expelled at the time of pressing the metal keys 66 can be discharged via the air escaping channels 65, so as to improve hand feeling at the time of pressing.

The second adhesive layer 7 is a layer of self-adhesive directly coated on a surface of the spacer 62.

The back adhesive protection layer 8 is disposed on the second adhesive layer 7. In this design, the back adhesive protection layer 8 is a releasable paper. The back adhesive protection layer 8 is disposed at an outside of the second adhesive layer 7, so as to prevent the second adhesive layer 7 from being contaminated by the environment.

The combination of the electroluminescent lamp and the metal key panel has a first opening 28 and a second opening 29 disposed therein. The first opening 28 communicates with the rear electrode layer 25 after passing through the second adhesive layer 7, the spacer 62, the first adhesive layer 4 and the insulating protection layer 3. The second opening 29 communicates with the bus bar 22 after passing through the second adhesive layer 7, the spacer 62, the first adhesive layer 4, the insulating protection layer 3, the rear electrode layer 25, the dielectric layer 24 and the electroluminescent layer 23.

In use, the combination of the electroluminescent lamp and the metal key panel can be adhered to a circuit board 9 of a mobile phone so long as the back adhesive protection layer 8 is peeled off to expose the second adhesive layer 7. Two conducting contacts 92, 94 on the circuit board 9 respectively extend into the first opening 28 and the second opening 29, so as to be electrically conductive with the rear electrode layer 25 and the bus bar 22 directly.

The bottom surface of the combination of the electroluminescent lamp and the

metal key panel according to the invention is a substrate 1 consisting of a polyester film. The substrate 1 has a relatively high mechanical strength, providing a relatively long service life when being used cooperatively with keys 122 of the mobile phone. The electroluminescent lamp and its combination with the metal key panel can be handled as an independent product for shipment and transportation, because of the arrangement of the back adhesive protection layers 5, 8. In use, adhering can be performed only after the back adhesive protection layers 5, 8 are peeled off, which is easily and conveniently done.

According to the invention, if the electrical conductivity of the transparent conducting layer 21 is relative high, the bus bar 22 can be omitted.

The invention also provides a method for manufacturing the above electroluminescent lamp, comprising the following steps:

step 1: providing a substrate 1 of a transparent polyester film;

step 2: printing an electroluminescent system to be laminated on an upper

surface of the substrate 1; the step 2 further comprises the following steps: printing a transparent conducting layer 21 to be laminated on the substrate 1 by using an electrically conductive ink of indium tin oxide; printing a loop of bus bar 22 on the transparent conducting layer 21 by using a silver ink; printing an electroluminescent layer 23 to be laminated on the bus bar 22 by using a mixture of a phosphor powder and an adhesive, the electroluminescent layer 23 having a second opening 29 which communicates with the bus bar 22; printing a dielectric layer 24 to be laminated on the electroluminescent layer 23 by using an insulating ink such as barium titanate, the dielectric layer 24 having a second opening 29 correspondingly disposed therein; printing a rear electrode layer 25 to be laminated on the dielectric layer 24 by using a silver ink or carbon ink, the rear electrode layer 25 having a second opening 29 correspondingly disposed therein;

step 3: printing an insulating protection layer 3 on the rear electrode layer 25,

the insulating protection layer 3, as an envelope layer of the electroluminescent system, enveloping the electroluminescent system to the substrate 1, and having also a first opening 28 and a second opening 29 correspondingly disposed therein;

step 4: coating a first adhesive layer 4 on the insulating protection layer 3, the first adhesive layer 4 being a layer of self-adhesive coated on the insulating protection layer 3, and having also a first opening 28 and a second opening 29 correspondingly disposed therein; and

step 5: further laying a back adhesive protection layer 5 on the first adhesive layer 4, so as to prevent the first adhesive layer 4 from being contaminated by the environment.

Moreover, in manufacturing the combination of the electroluminescent lamp and the metal key panel described above, in addition to the above steps 1 to 4 for manufacturing the electroluminescent lamp, the following steps are further comprised:

step 5: providing a metal key panel 6 which comprises a spacer 62 and a plurality of metal keys 66, a plurality of receiving grooves 64 being disposed in the spacer 62, the metal keys 66 being correspondingly received in the receiving grooves 64 of the spacer, wherein a second adhesive layer 7 is disposed outside of the spacer 62 of the metal key panel 6, a first opening 28 and a second opening 29 are also correspondingly disposed in the spacer 62 and the second adhesive layer 7, and a back adhesive protection layer 8 is further disposed at an outside of the second adhesive layer 7 for preventing the second adhesive layer 7 from being contaminated by the environment; and

step 6: adhering an inner side of the spacer 62 of the metal key panel 6 to the first adhesive layer 4 of the electroluminescent lamp, so as to form a combination of the electroluminescent lamp and the metal key panel.

While a preferred embodiment of the invention is shown and described, it is envisioned that those skilled in the art may devise various modifications without

departing from the spirit and scope of the foregoing description and the appended claims.

CLAIMS

1. An electroluminescent lamp, comprising a substrate, an electroluminescent system printed on a side of the substrate and an insulating protection layer covering an external surface of the electroluminescent system, characterized by further comprising a first
5 adhesive layer disposed at an outside of the insulating protection layer, wherein the substrate is a transparent polyester film; the electroluminescent system is provided with a transparent conducting layer, an electroluminescent layer, a dielectric layer and a rear electrode layer sequentially from the side of the substrate to the outside; and lights emitted from the electroluminescent layer transmit out by passing through the transparent conducting layer and
10 the substrate.
2. The electroluminescent lamp according to claim 1, characterized by further comprising a back adhesive protection layer which can be peeled off in use, the back adhesive protection layer being disposed at an outside of the first adhesive layer for
15 preventing the first adhesive layer from being contaminated by the environment.
3. The electroluminescent lamp according to claim 2, characterized by the first adhesive layer being a layer of self-adhesive coated on the insulating protection layer.
- 20 4. The electroluminescent lamp according to claim 3, characterized by the back adhesive protection layer being a releasable paper, such that the electroluminescent lamp can be adhered to another electronic element so long as the releasable paper is peeled off in use.
- 25 5. The electroluminescent lamp according to claim 1, characterized by at least one bus bar, which is electrically conductive with the transparent conducting layer, being

disposed between the transparent conducting layer and the electroluminescent layer, so as to enhance the electrical conductivity of the transparent conducting layer.

6. The electroluminescent lamp according to claim 5, characterized by having a first opening and a second opening disposed at an external surface of the electroluminescent lamp, wherein the first opening communicates with the rear electrode layer after passing through the first adhesive layer and the insulating protection layer; and the second opening communicates with the bus bar after passing through the first adhesive layer, the insulating protection layer, the rear electrode layer, the dielectric layer and the electroluminescent layer.

7. A method for manufacturing the electroluminescent lamp according to claim 1, characterized by comprising steps of:

step 1: providing a substrate of a transparent polyester film;

step 2: printing an electroluminescent system to be laminated on a surface of the substrate, the step 2 further comprising steps of:

step 2a: printing a transparent conducting layer on the substrate;

step 2b: printing an electroluminescent layer to be laminated on the transparent conducting layer, the electroluminescent layer having a second opening disposed therein;

step 2c: printing a dielectric layer to be laminated on the electroluminescent layer, the dielectric layer having also a second opening correspondingly disposed therein;

step 2d: printing a rear electrode layer to be laminated on the dielectric layer, the rear electrode layer having also a second opening correspondingly disposed therein;

step 3: printing an insulating protection layer on the rear electrode layer, the insulating protection layer, as an envelope layer of the electroluminescent system, enveloping the electroluminescent system to the substrate, and having a first opening and a second

opening correspondingly disposed therein; and

step 4: printing a first adhesive layer on the insulating protection layer, the first adhesive layer having also a first opening and a second opening correspondingly disposed therein.

5

8. The method for manufacturing the electroluminescent lamp according to claim 7, characterized by, between the steps 2a and 2b, further comprising a step of printing at least one bus bar on the transparent conducting layer, wherein the second opening communicates with the bus bar.

10

9. The method for manufacturing the electroluminescent lamp according to claim 7, characterized by the first adhesive layer being a layer of self-adhesive.

10. The method for manufacturing the electroluminescent lamp according to claim 15 9, characterized by, after the step 4, further comprising a step 5 of additionally disposing a back adhesive protection layer, which can be peeled off in use, on the first adhesive layer for preventing the first adhesive layer from being contaminated by the environment.

11. The method for manufacturing the electroluminescent lamp according to claim 20 10, characterized by the back adhesive protection layer being a release paper, such that the electroluminescent lamp can be adhered to another electronic element so long as the release paper is peeled off in use.

12. The method for manufacturing the electroluminescent lamp according to claim 25 7, characterized by the transparent conducting layer being formed by printing an electrically

conductive ink of indium tin oxide; the electroluminescent layer being formed by printing a mixture of a phosphor powder and an adhesive; the dielectric layer being formed by printing an insulating ink of barium titanate; the rear electrode layer being formed by printing a layer of non-transparent silver ink or carbon ink; and the insulating protection layer being formed
5 by printing a layer of polyurethane.

13. A combination of an electroluminescent lamp and a metal key panel, comprising a substrate, an electroluminescent system printed on a side of the substrate, an insulating protection layer covering an external surface of the electroluminescent system, a
10 first adhesive layer disposed on the insulating protection layer and a metal key panel adhered to the first adhesive layer; the metal key panel comprising a spacer and a plurality of metal keys, the spacer having a plurality of receiving grooves disposed therein, and the plurality of metal keys being correspondingly received in the receiving grooves of the spacer;
characterized by further comprising a second adhesive layer disposed at an outside of the
15 metal key panel, wherein the substrate is a transparent polyester film; the electroluminescent system is provided with a transparent conducting layer, an electroluminescent layer, a dielectric layer and a rear electrode layer sequentially from the side of the substrate to outside; and lights emitted from the electroluminescent layer transmit out by passing through the transparent conducting layer and the substrate.

20
14. The combination of the electroluminescent lamp and the metal key panel according to claim 13, characterized by further comprising a back adhesive protection layer which can be peeled off in use, the back adhesive protection layer being disposed at an outside of the second adhesive layer for preventing the second adhesive layer from being
25 contaminated by the environment.

15. The combination of the electroluminescent lamp and the metal key panel according to claim 14, characterized by the second adhesive layer being a layer of self-adhesive.

5 16. The combination of the electroluminescent lamp and the metal key panel according to claim 15, characterized by the back adhesive protection layer being a release paper, such that the combination of the electroluminescent lamp and the metal key panel can be adhered to a circuit board so long as the release paper is peeled off in use.

10 17. The combination of the electroluminescent lamp and the metal key panel according to claim 13, characterized by at least one bus bar, which is electrically conductive with the transparent conducting layer, being disposed between the transparent conducting layer and the electroluminescent layer, so as to enhance the electrical conductivity of the transparent conducting layer.

15 18. The combination of the electroluminescent lamp and the metal key panel according to claim 17, characterized by having a first opening and a second opening disposed therein, wherein the first opening communicates with the rear electrode layer after passing through the second adhesive layer, the spacer, the first adhesive layer and the insulating
20 protection layer; and the second opening communicates with the bus bar after passing through the second adhesive layer, the spacer, the first adhesive layer, the insulating protection layer, the rear electrode layer, the dielectric layer and the electroluminescent layer.

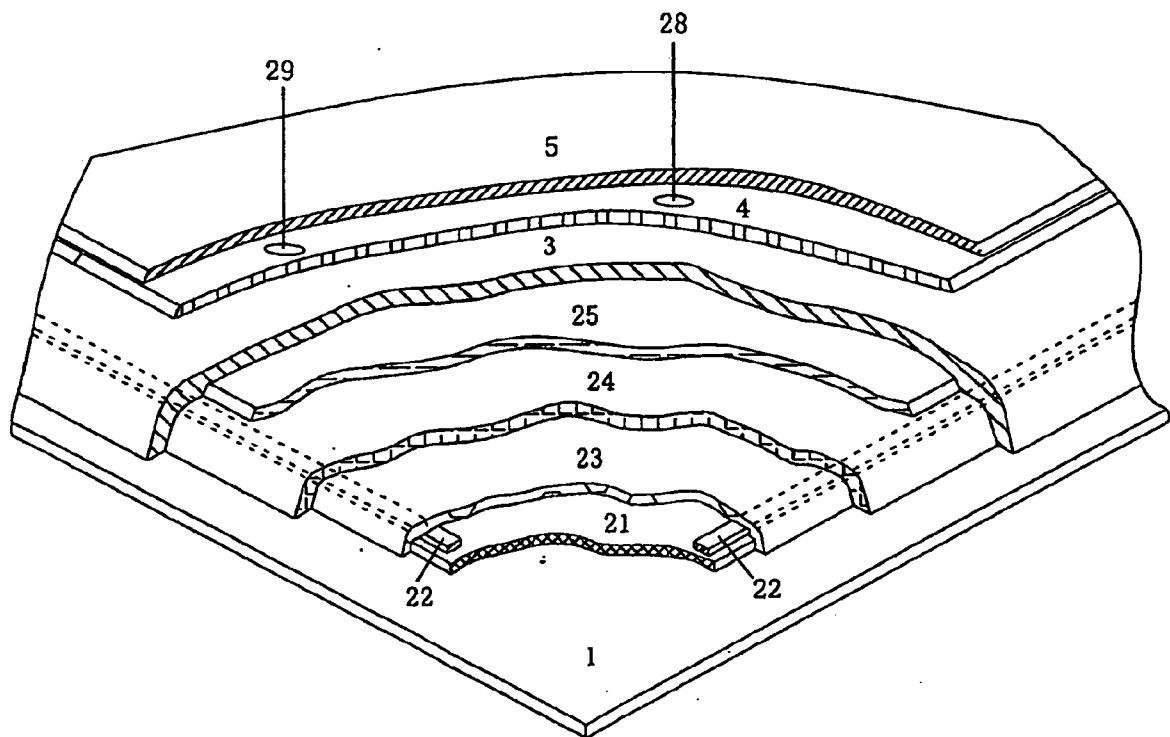


FIG. 1

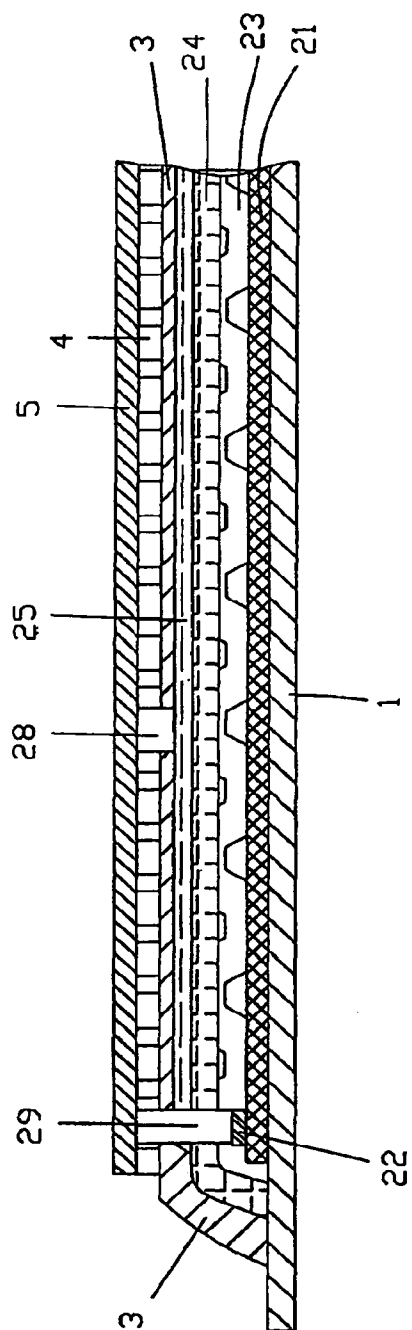
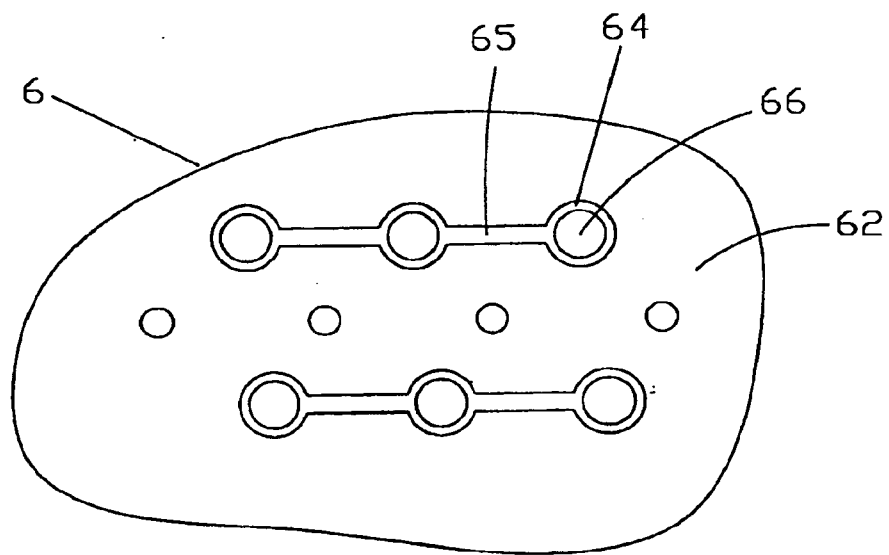


FIG. 2

**FIG. 3**

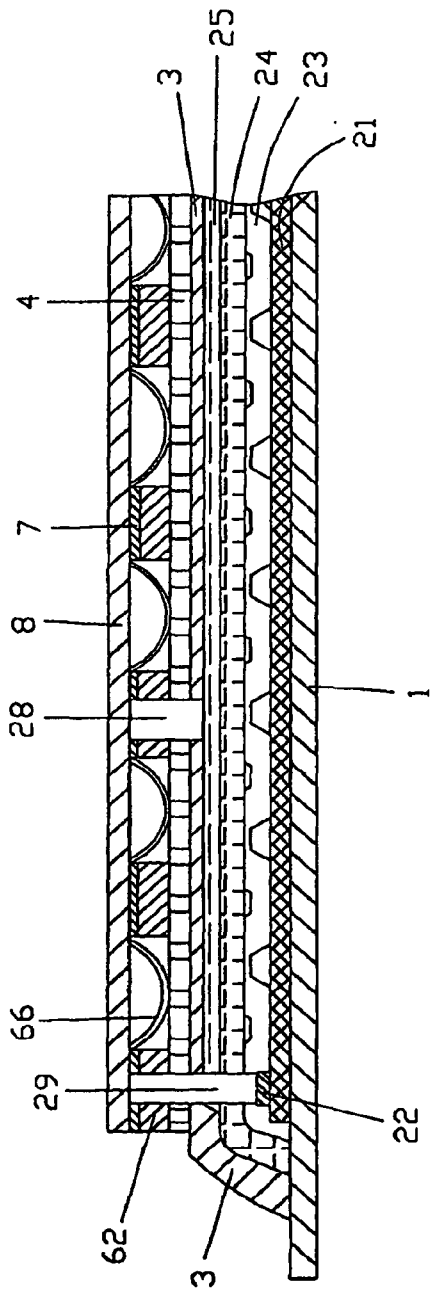


FIG. 4

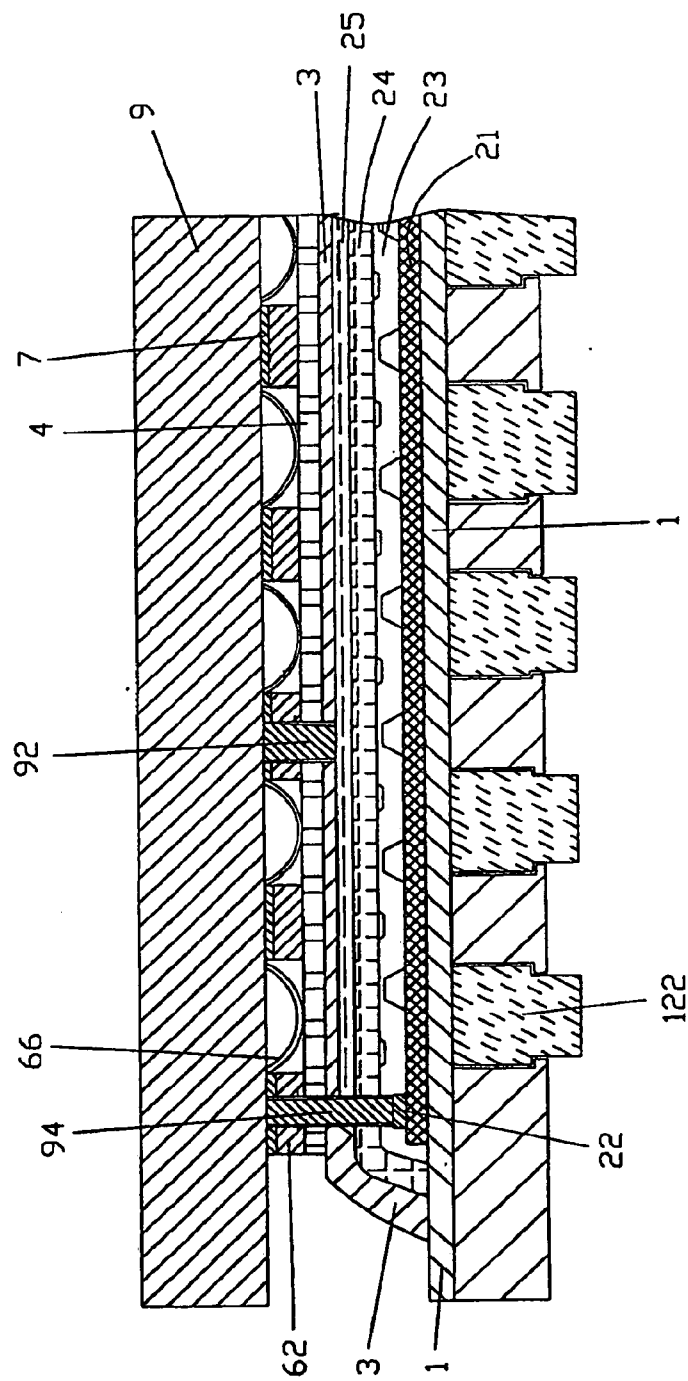


FIG. 5

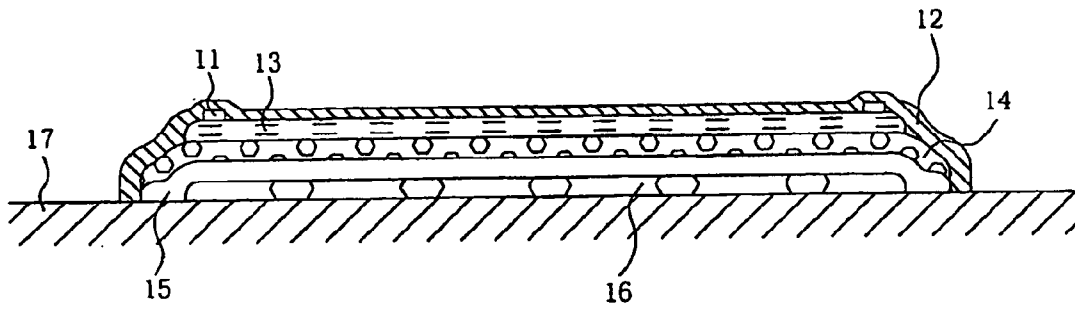


FIG. 6

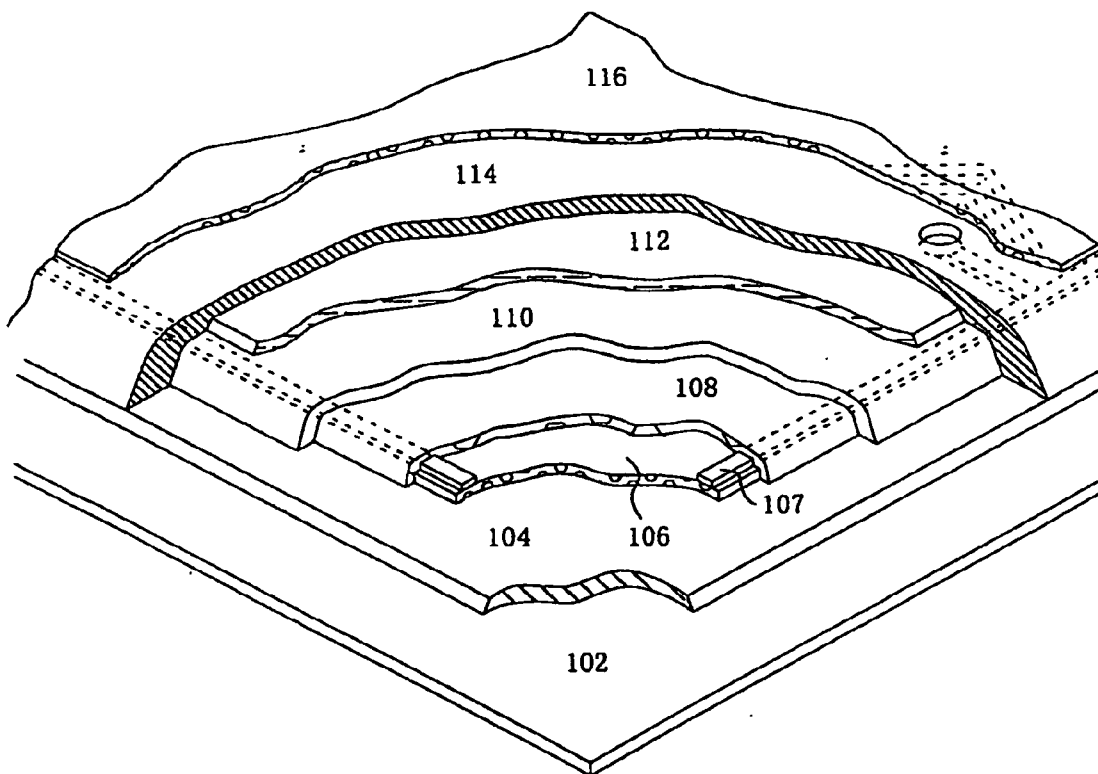
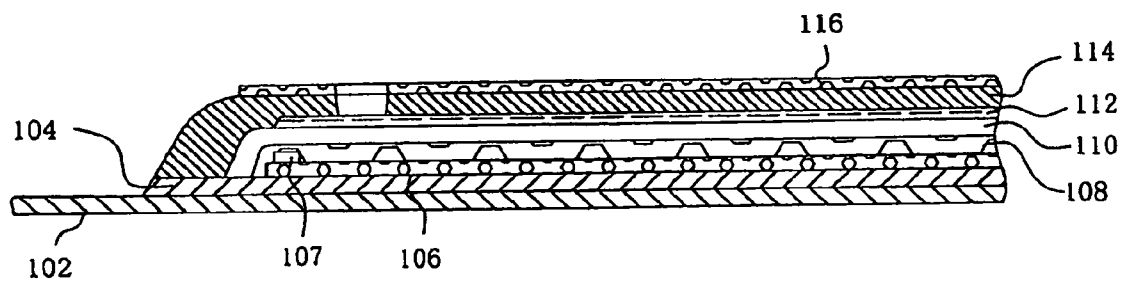


FIG. 7

**FIG. 8**

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2007/016361

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H05B33/00 H05B33/04 H05B33/22

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

12 December 2007

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INTERNATIONAL SEARCH REPORT

International application No
PCT/US2007/016361

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