Feb. 24, 1970 W. J. KNOCHEL ETAL 3,497,750

FLEXIBLE ELECTROLUMINESCENT LAMP WITH DUAL-PURPOSE METALLIZED PLASTIC FILM COMPONENT

Filed Dec. 2, 1966

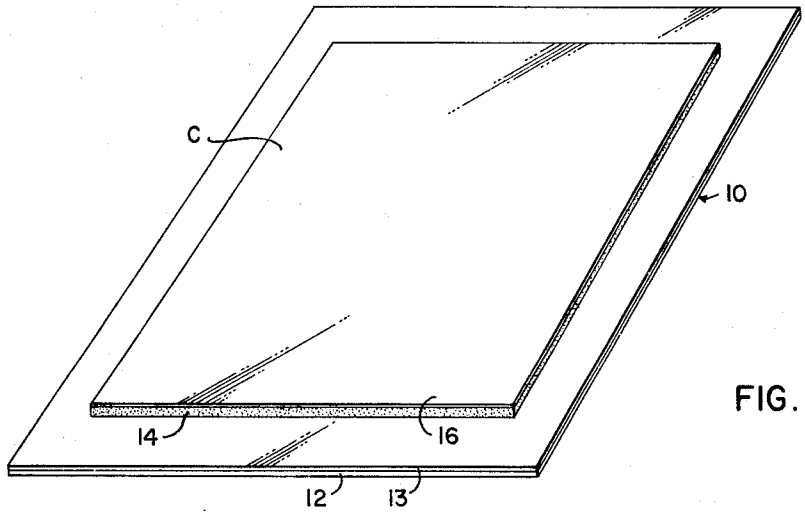

FIG. 1.

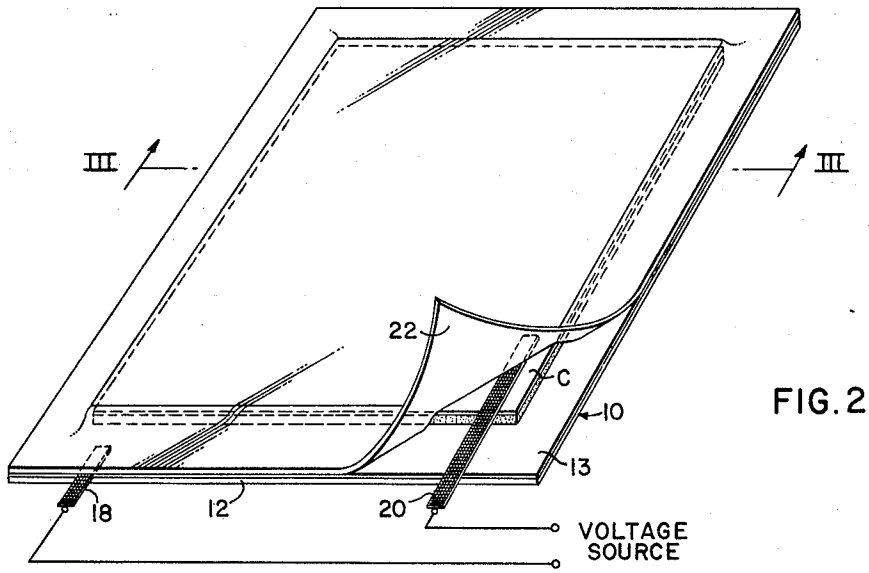

FIG. 2.

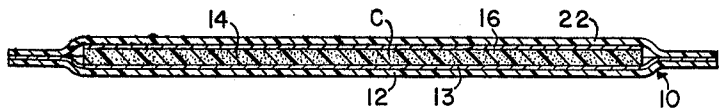

FIG. 3.

WITNESSES

Edmund E. Baisch

James F. Young

INVENTORS

William J. Knochel &

Robert W. Wollentin

BY D. S. Bulga

AGENT

United States Patent Office 3,497,750 Patented Feb. 24, 1970

3,497,750

FLEXIBLE ELECTROLUMINESCENT LAMP WITH DUAL-PURPOSE METALLIZED PLASTIC FILM COMPONENT

William J. Knochel, West Orange, N.J., and Robert W. Wollentin, Thousand Oaks, Calif., assignors to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

Continuation-in-part of application, Ser. No. 259,540, Feb. 19, 1963, now Patent No. 3,341,915, dated Sept. 19, 1967. This application Dec. 2, 1966, Ser. No. 598,760

Int. Cl. H01j 1/62, 63/04

U.S. Cl. 313—108 5 Claims

ABSTRACT OF THE DISCLOSURE

The metallized surface of a preformed metallized-plastic film is bonded to the phosphor-dielectric layer of a flexible electroluminescent lamp and the periphery of the film is sealed to a film of light-transmitting plastic that is disposed over the light-transmitting electrode on the opposite face of said layer so that the metallized-plastic film thus serves both as an electrode and as an integral part of a flexible protective envelope for the lamp. The metallized surface of the dual-purpose plastic film is preferably light reflecting and comprises a dense layer of a suitable metal such as nickel or aluminum.

This application is a continuation-in-part of copending application Ser. No. 259,540, now U.S. Patent No. 3,341,915, filed Feb. 19, 1963, and entitled "Method of Manufacturing Electroluminescent Lamps."

This invention relates to electroluminescent devices and has particular reference to an improved flexible electroluminescent lamp.

Flexible electroluminescent lamps are well-known in the art and offer distinct advantages over conventional lamps having a rigid glass or metal base member. In addition to being light in weight and unbreakable, such flexible lamps can be very readily cut or bent into a wide variety of forms. Thus, flexible electroluminescent lamps can be employed in many applications where complex shapes and designs are required and the use of rigid lamps would entail too great an expense.

While such flexible electroluminescent lamps are advantageous from a structural standpoint, they are relatively expensive to manufacture and present a quality control problem in that it is difficult to form the thin laminated cell structure and maintain the uniformity of thickness of the respective layers necessary to obtain optimum and uniform brightness when the lamp is energized. A novel method which overcomes these problems is disclosed and claimed in the aforesaid copending parent application.

The object of the present invention is to provide an improved flexible electroluminescent lamp which can be fabricated in accordance with the aforementioned method and includes a very inexpensive means for protecting the phosphor particles from the atmosphere and providing one of the electrodes.

The foregoing object, and other advantages that will become apparent as the description proceeds, are achieved in accordance with this invention by utilizing a metallized film of moisture-impervious plastic as one of the lamp electrodes and as one half of a protective envelope for the lamp. This dual-purpose component is placed on a rigid temporary support together with the other electrode and the light-generating phosphor-plastic layer and the resulting laminated cell structure is stripped from the temporary support member in accordance with the method described in the aforementioned parent application. A second film of moisture-impervious plastic is then placed over the exposed face of the lamp and hermetically sealed to the edges of the metallized film to complete the desired protective envelope.

A better understanding of the invention will be obtained by referring to the accompanying drawing, wherein:

FIG. 1 is a perspective view of the laminated flexible electroluminescent cell component and attached protective plastic film after they have been stripped from the temporary rigid support member;

FIG. 2 is a similar view of the aforesaid lamination with both lead wires attached and the second film of protective plastic in place; and,

FIG. 3 is an enlarged cross-sectional view of the completed lamp along the line III—III of FIG. 2.

While the present invention may be used with advantage in fabricating various types of electroluminescent devices, it is particularly adapted for use in connection with the manufacture of flexible electroluminescent lamps and has accordingly been so illustrated and will be so described.

The flexible electroluminescent lamp of the present invention basically comprises a layer of a suitable hardenable plastic dielectric such as polyvinyl chloride-acetate or the like that is impregnated with finely-divided electroluminescent phosphor particles and sandwiched between two flexible electrodes at least one of which is light-transmitting. The electroluminescent lamp is, accordingly, of "all plastic" construction and the laminations or various layers are made of such thickness and are so securely bonded to one another, that the lamp can be flexed without cracking or otherwise becoming damaged.

As shown in FIGURE 1, the flexible electroluminescent lamp in its initial stage of fabrication comprises a lamination **10** consisting of a metallized film **12** of moisture-impervious plastic (such as cellulose acetate) the metallized surface **13** whereof is bonded to one face of a layer **14** of cured plastic dielectric containing embedded particles of electroluminescent phosphor and a light-transmitting electrode **16** of suitable electrically conductive material (such as copper iodide) that is bonded to the other face of the phosphor-dielectric layer **14**. The aforesaid components comprise an integral lamination which is preferably formed in accordance with the teachings of the aforementioned parent application by placing the various components on a rigid temporary support member and then stripping the lamination from the support member after the plastic dielectric has cured and rigidified. The metallized surface **13** of the film **12** thus serves as one electrode and, together with the light-transmitting electrode **16** and phosphor-dielectric layer **14**, constitutes a light-generating electroluminescent cell C.

Any suitable hardenable plastic such as polyvinyl chloride-acetate can be used as the dielectric embedding matrix. Polymerizable plastics such as epoxy, cross-linked acrylics, styrene, polyesters and the like can also be used. The light-transmitting electrode **16** and the phosphor-dielectric layer **14** can be deposited by various means known to the art so that they can be made to a predetermined and uniform thickness.

It is important that the thickness of the various layers which form the cell C be such that the lamp is sufficiently flexible and able to withstand the operating voltage without breaking down. As a specific example, in the case of a lamp designed to operate from a 120 volt A.C. power supply the light-transmitting electrode **16** (if made from copper iodide) is preferably about 200 to 2000 A. thick, the phosphor-dielectric layer **14** about 0.5 to 1.5 mils thick, and the metallized electrode **13** about 1000 to 2500 A. thick.

As shown in FIG. 2, electrical connection with the flexible electroluminescent cell C is effected according to

the illustrated embodiment by attaching suitable terminals such as strips **18** and **20** of copper wire mesh to the electrodes **13** and **16**, respectively, and attaching suitable conductors to the projecting ends of the terminals. These strips can be anchored to the electrodes by means of conducting epoxy or cements and by utilizing pressure contacts well-known in the art. The terminal **20** can also be anchored between the light-transmitting electrode **16** and the phosphor-dielectric layer **14** by placing it over the electrode **16** before the phosphor-dielectric layer **14** is deposited, thus automatically incorporating it as an integral part of the electroluminescent cell structure C during its fabrication.

Since electroluminescent phosphor is moisture-sensitive it is necessary to protect the electroluminescent cell C from the atmosphere. This is accomplished, as shown in FIGURES 2 and 3, by placing a second sheet **22** of a suitable moisture-impervious plastic such as high-density polyethylene fluorocarbons, polyesters, and the like approximately 2 to 7 mils thick, over the exposed face of the cell C. The dimensions of the plastic sheets **12** and **22** are larger than those of the cell C and their overlapping edges are heat sealed so that the terminals **18** and **20** are hermetically sealed through the protective envelope formed by the joined plastic sheets.

The metallized surface **13** of the plastic film **12** is preferably light reflective and can comprise a dense layer or foil of nickel, or other suitable metal such as aluminum. Such metallized plastic films are well-known in the art.

As shown in FIG. 3, the metal layer **13** faces and is bonded to the phosphor-dielectric layer **14** and, in conjunction with the other electrode of copper iodide **16**, permits an energizing potential to be applied to the embedded phosphor particles in the usual manner. The metallized plastic film **12** is placed over the phosphor-plastic layer **14** while the latter is still in the liquid phase so that it will become bonded to this layer when the plastic cures, thereby providing one of the electrodes and also covering one side of the cell C with a protective plastic layer.

It will be appreciated from the foregoing that the objects of the invention have been achieved insofar as an improved flexible electroluminescent lamp has been provided in which the thickness of the various layers can be carefully controlled and the resulting laminated cell structure can be quickly fabricated and protected at minimum cost.

While one embodiment has been illustrated and described in detail, various modifications can be made without departing from the spirit and scope of the invention. For example, the laminated cell structure C does not have to be formed on a rigid support member and then peeled therefrom as disclosed in the aforesaid parent application. It may be fabricated in any manner. Also, the light-transmitting electrode can be composed of material other than copper iodide. Such well known materials as tin oxide or indium oxide can also be used.

We claim as our invention:

1. In a flexible electroluminescent lamp which includes a plastic dielectric layer that has finely divided electroluminescent phosphor particles embedded therein and a light-transmitting electrode comprising a film of electrically conductive material bonded to one of its faces, the improvement comprising;

a light-transmitting plastic film overlying said light-transmitting electrode and extending beyond the sides of said phosphor-plastic layer, and

a metallized film of plastic having its metallized surface bonded to the other face of said phosphor-plastic layer, said metallized plastic film extending beyond the sides of said phosphor-plastic layer and the overlapping peripheral portions of said plastic film being hermetically sealed so that said metallized plastic film serves both as an electrode and as an integral part of the resulting protective envelope for said lamp.

2. The flexible electroluminescent lamp set forth in claim **1** wherein the metallized surface of said metallized plastic film is light reflecting.

3. The flexible electroluminescent lamp set forth in claim **1** wherein said plastic films are moisture-impervious.

4. The flexible electroluminescent lamp set forth in claim **1** wherein; said light-transmitting electrode comprises a film of copper iodide, and said metallized plastic film comprises a sheet of cellulose acetate with a dense reflecting layer of metal on its inner face.

5. The flexible electroluminescent lamp set forth in claim **1** wherein the metallized surface of said plastic film is light reflecting and comprises a dense layer of a metal selected from the group consisting of nickel and aluminum.

References Cited

UNITED STATES PATENTS

2,756,165	7/1956	Lyon	317—258 X
2,944,177	7/1960	Piper	313—108
3,205,393	9/1965	Mash	313—108
3,074,816	1/1963	Blazek	117—211

JAMES W. LAWRENCE, Primary Examiner

RAYMOND F. HOSSFELD, Assistant Examiner