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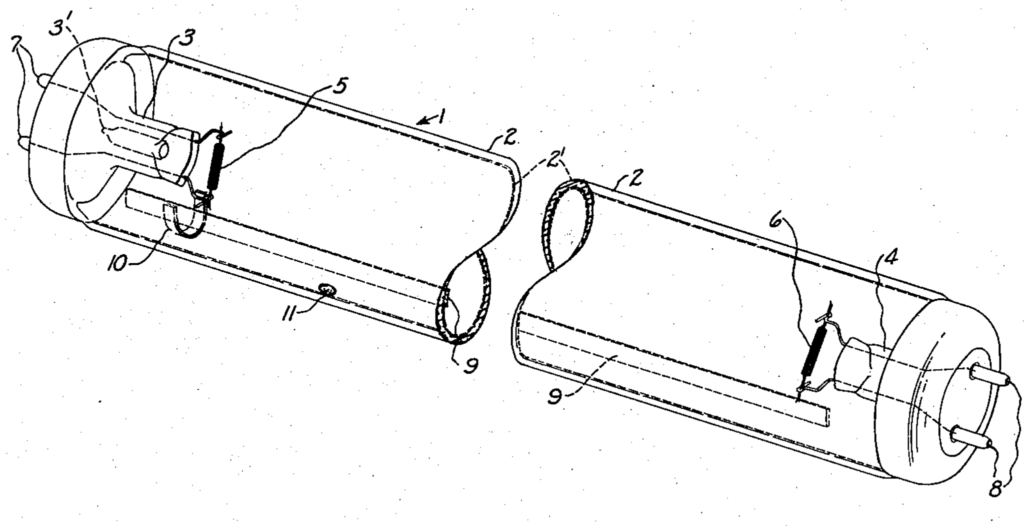

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INTERNALLY CONDUCTIVELY COATED LAMP AND METHOD OF MANUFACTURE

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6 Claims. (Cl. 313—109)

The present invention relates to gaseous electric devices generally, and more particularly to an improved fluorescent lamp construction wherein the internal surface of the lamp is provided with a conductive coating or strip which operates as a starting aid. The invention is also concerned with a method of applying the coating for securing good adhesion to a surface and a desired low value of resistance.

It is relatively well known that the striking or starting of electrical discharge devices, such as gas or vapor tubes, may be facilitated by providing an electrically conductive coating on either the inner or the outer surface of the envelope of the device. The conductive coating may remain unconnected and operate solely by capacitive effect, or it may be connected to one or more of the electrodes in the device. In the case of elongated tubular fluorescent lamps for illuminating purposes, the conductive coating may be formed as a narrow strip or band along the length of the lamp, or it may be a transparent coating covering the surface of the lamp either externally or internally.

When it is desired to apply an internal conductive coating to a fluorescent lamp, the problem of combining the luminescent layer with the conductive coating in such manner as to retain the effectiveness of both layers arises. It is possible to apply the conductive layer first and then to apply the luminescent layer over it. With such a construction, however, the presence of the luminescent layer reduces the effectiveness of the conductive layer and makes starting of the discharge more difficult. On the other hand, if the luminescent layer is applied first and the conductive layer is applied over it, the conductive layer will not adhere well, and the performance of the lamp will be unsatisfactory.

It has been proposed to utilize, for an electrically conductive strip, a dispersion of a conductive substance in an inorganic binder in which the luminescent layer is absorbed locally. This conductive strip may be sintered on the interior surface of the discharge tube or may be applied thereto in a molten condition. It has been proposed further to use glazing powder as the inorganic bonding means, and a powdered metal, for example silver, as the conductive substance in the dispersion.

The use of a metal in such a binder has the disadvantage that stresses are produced in the envelope walls as a result of the application of heat necessary to produce the bonding. Moreover, in discharge tubes wherein mercury is present, which, in practice, comprises a great majority of commercially produced discharge lamps, the mercury is absorbed by the conductive coating. Another disadvantage is the necessity of raising the temperature of the tube during the manufacturing process to a point which is quite critical and which must be accurately maintained.

The limitations or disadvantages enumerated above, which result from the use of a metal as the conductive substance, may be obviated if use is made of graphite instead of metal. However, it is not a simple matter

to apply a graphite layer with the aid of presently known methods. This is due to the fact that the graphite suspension tends to cause a blackening of the internal surfaces of the discharge tube. Where the graphite layer is applied over the luminescent layer, it adheres very poorly and generally proves unsatisfactory. Where the graphite layer is applied in accordance with the method proposed in the application mentioned above, that is, by mixing the graphite with the glazing powder in the same manner as described for metal, and then, likewise, heating the mix to a temperature sufficient to produce sintering, the adherence is improved.

Thus, by utilizing graphite mixed in with glazing powder and sintering, good adherence may be obtained but other disadvantages ensue. These disadvantages, which have been discovered during the course of certain experiments from which the present invention has resulted, stem from an apparently unavoidable increase in the resistance of the conductive coating due to the presence of the glazing powder. It might be mentioned at this point that it is generally desirable to have the total resistance of a conductive coating, from end to end of a commercial low pressure discharge device, such as a 48-inch, 40-watt fluorescent lamp, in the range between 1000 and 3000 ohms. It might also be mentioned that simply reducing the quantity of the glazing powder and proportionally increasing the quantity of graphite does not solve the problem, because the bonding then becomes insufficient.

Accordingly, it is an object of our invention to provide a new and improved internal conductive coating or strip for an electric discharge device which has good adherence and does not impair the performance or the life of the device.

Another object of our invention is to provide a discharge lamp with an internal conductive strip of low resistance, good adherence, and producing only negligible absorption of mercury vapor.

A further object of the invention is to provide a new and improved method for incorporating graphite as a conductor in a coating for application to the interior surface of a discharge lamp.

The invention is based on our discovery of the unexpected phenomenon that the resistance of a conductive coating which is made from a suspension of graphite in an organic liquid, for example, butyl or amyl acetate, may be lowered very markedly when a film- or skin-producing substance is dissolved previously in the organic liquid. Such a film-producing substance may be, for instance, a cellulosic ether or ester, such as cellulose nitrate, also known as nitro-cellulose. Thus, when the suspension of graphite is made in a solution of a film-producing substance in an organic liquid, such being cellulose nitrate in butyl-acetate for the examples given above, the resistance of the conductive coating produced as a result of the process mentioned herein is much lower than the resistance of an identical conductive coating prepared in the same way as a suspension but without the film-producing substance. This makes it possible to add a sufficient quantity of glazing powder which, even though it does raise the resistance of the coating, does not now need to raise it above the optimum value required for a gas or vapor discharge device.

For further objects and advantages and for a better understanding of the invention, attention is now directed to the following description and accompanying drawing. The features of the invention believed to be novel will be more particularly pointed out in the appended claims.

The single figure of the drawing is a pictorial view of a relatively common types of fluorescent discharge lamp provided with an internal conductive strip and embodying the invention.

Referring to the drawing there is shown a fluorescent discharge lamp 1, represented as broken apart near its middle in order to facilitate the understanding of its construction. The lamp comprises an elongated tubular glass envelope 2 which is terminated at both ends in stem presses 3 and 4, stem 3 being further provided with an exhaust tube 3′ for evacuating the envelope and introducing suitable gases therein. Mounted on lead wires passing through the stem presses are filamentary electrodes 5 and 6, which may consist of a coil of tungsten wire overlaid with a coating of activated electron-emitting materials such as barium and strontium oxides. The electrode lead-in wires are connected to a pair of pins 7 and 8 fixed in suitable molded bases at both ends of the lamp. The interior surface of the envelope is coated with a thin layer 2′ of a fluorescent substance, whose function is to convert the ultraviolet radiation produced by the discharge to light radiation within the visible spectrum. In an actual construction, the tube 2 may have a length of approximately 126 centimeters and a diameter of 36 millimeters, which size would correspond in commercial practice to a 40-watt fluorescent lamp.

Disposed longitudinally along the inside surface of the tube 2 is a thin conductive strip 9 which may be approximately 2 millimeters wide. The strip runs the length of the lamp to points in the vicinity of the electrodes 5 and 6. The strip consists of a mixture of graphite in a low melting point glazing compound, the graphite being originally provided as a suspension in a film-forming solution in an organic solvent mixed with the glazing compound. This is in order to obtain a low resistance value for the conductive strip after sintering. The resistance of the strip from end to end may be in the range between 1000 and 3000 ohms. The conductive strip may be unconnected to any other part of the lamp; or it may, if desired, be connected to one of the electrodes as by a spring finger 10 mounted on one of the lead-in wires of electrode 5.

In its final assembly, the lamp is evacuated, filled with a starting gas such as neon, argon, krypton, xenon, or mixtures thereof at a low pressure in the neighborhood of 3 mm. In addition, a droplet of mercury 11 is introduced into the bulb, which, during normal operation, fills the envelope with its vapor pressure at the operating temperature, such vapor pressure being in the range of a few microns.

The coating mix which eventually constitutes the conductive strip 9 may be applied to the inside surface of the tube 2 by utilizing a small wheel whose running surface is covered with a supply of the coating mix. The small wheel may be caused to roll over the surface of the luminescent layer thereby to apply the thin narrow strip.

The coating mix may be prepared in the following manner: 200 grams of graphite are ground over a period of 96 hours in a porcelain ball mill together with 1100 cubic centimeters of a 1% solution of cellulose nitrate in butyl-acetate. Subsequent to this operation, 500 grams of low melting point glazing powder are added, and further grinding of the mixture is provided for another 24 hours. The glazing powder may consist of 80.8% PbO, 16.4% B_2O_3, and 2.8% SiO_2. The suspension thus obtained is then removed from the ball mill, and the interior of the mill and also the balls are washed with 40 cc. of butyl acetate as a rinsing liquid, which rinsing liquid is afterwards added to the main portion of the suspension and stirred in. The viscosity of the suspension measured at this point by means of the Ford cup method with an orifice of 5.7 mm. gives a reading of 18 to 20 seconds.

After a strip of the coating mix or suspension obtained in the manner described has been applied along the interior surface of the tube, as by rolling small wheel coated with the mix once over the luminescent layer, the tube is placed in an oven at a temperature slightly in excess of the softening point of the glass and high enough to cause sintering of the coating, for instance, at approximately 500° C. for a period of three minutes. After the tube has been removed from the oven and allowed to cool, it may be utilized in known manner for the manufacture of a fluorescent lamp, such as is illusrated in the drawing.

The resistance of an actual construction of a conductive strip 116 cm. long and 2 mm. wide, made in the manner described above and measured after cooling, is about 2000 ohms, and the resistance does not change materially during the succeeding operations for manufacturing the fluorescent lamp. Taking into account the previously given dimensions, the resistance of the strip is approximately 33 ohms per centimeter length of strip 1 millimeter wide.

The construction and method of manufacture which have been described provide considerable advantages over the constructions and processes utilized heretofore. For one, it permits the provision of a low resistance strip within the optimum range required for maximum lowering of the starting voltage of the lamp, and which, nevertheless, adheres well to the envelope walls. A strip containing a graphite suspension as described, does not react with the mercury within the envelope so that the performance of the lamp during its life is not impaired. Moreover, a coating mix or suspension prepared in accordance with the method described flows easily, so that it may be applied to produce an even covering for the strip. Finally, the use of graphite rather than metal as the conductive material within the strip eliminates the destructive stresses which would otherwise be produced in the glass walls of the lamp.

While a certain specific construction and a specific process of manufacture have been shown and described, it will, of course, be understood that various modifications may be made without departing from the invention. Thus, the example of a film-forming substance is merely illustrative and other known substances may be substituted therefor, as likewise for the solvent and the glazing powder. The appended claims are, therefore, intended to cover any such modification coming within the true spirit and scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A method of providing a starting strip for an electric gaseous discharge tube including a glass envelope, a pair of spaced electrodes in the envelope, and a luminescent layer on the internal surface of the envelope which comprises forming a suspension of finely-ground graphite in an organic solvent containing an organic heat-decomposable film-forming material, mixing said suspension with a glazing powder, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at an elevated temperature to produce a firmly-adherent conductive strip on said luminescent layer.

2. A method of providing a starting strip for an electric gaseous discharge tube including a glass envelope, a pair of spaced electrodes in the envelope, and a luminescent layer on the internal surface of the envelope which comprises forming a suspension of finely-ground graphite in an organic solvent containing a heat-decomposable film-forming cellulose ester, mixing said suspension with a glazing powder, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at a temperature slightly in excess of the softening point of the glass to produce a firmly-adherent conductive strip on said luminescent layer.

3. A method of providing a starting strip for an electric gaseous discharge tube including a glass envelope, a pair of spaced electrodes in the envelope, and a luminescent layer on the internal surface of the envelope which

comprises forming a suspension of finely-ground graphite in an organic solvent containing an organic heat-decomposable film-forming material, mixing said suspension with a glazing powder in proportions at which the resulting mixture contains at least 1 part of graphite to 2 parts of glazing powder, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at a temperature slightly in excess of the softening point of the glass to produce a firmly-adherent conductive strip on said luminescent layer.

4. A method of providing a starting strip for an electric gaseous discharge tube including an envelope, a pair of spaced electrodes in the envelope, and a luminescent layer on the internal surface of the envelope which comprises forming a suspension of finely-ground graphite in an organic solvent containing an organic heat-decomposable film-forming material selected from the group consisting of cellulose esters and cellulose ethers, mixing said suspension with a glazing powder in proportions at which the resulting mixture contains 1 part of graphite to 2 parts of glazing powder, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at a temperature of approximately 500° C. to produce a firmly-adherent conductive strip on said phosphor.

5. A method of providing a starting strip for an electric gaseous discharge tube comprising an envelope, a pair of spaced electrodes in the envelope, and a luminescent layer on the internal surface of the envelope which comprises forming a suspension of finely-ground graphite in an organic solvent containing cellulose nitrate serving as a film-producing agent, mixing said suspension with a glazing powder comprising lead oxide, boric oxide and

silicon dioxide, the proportions of graphite and glazing powder in the mixture being in excess of 1 to 2, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at a temperature of approximately 500° C. to produce a firmly adherent conductive strip on said luminescent layer.

6. A method of providing a starting strip for an electric gaseous discharge tube comprising an envelope, a pair of spaced electrodes in the envelope and a luminescent layer on the internal surface of the envelope which comprises grinding graphite together with a solution of approximately 1% cellulose nitrate in an organic solvent to form a fine suspension, further grinding said suspension with a quantity of a low-melting point glazing powder containing lead oxide, boric oxide, and silicon dioxide to produce a free-flowing mixture, the proportions of graphite to glazing powder within the mixture being in excess of 1 to 2, applying a thin layer of said mixture over a selected portion of the surface of the luminescent layer between the electrodes, and sintering said layer on said luminescent layer at a temperature of approximately 500° C. to produce a firmly adherent conductive strip on said luminescent layer.

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