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FLUORESCENT COATING AND METHOD OF MANUFACTURE

Willard A. Roberts, Cleveland, and Hannah T. Geissbuhler, East Cleveland, Ohio, assignors to General Electric Company, a corporation of New York

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Our invention relates to improvements in fluorescent coatings for gaseous electric discharge lamps.

Fluorescent lamps now commercially available comprise an elongated tubular envelope having a pair of electrodes sealed into the ends thereof and containing a gaseous atmosphere, which may be a mixture of a rare gas and a metal vapor such as mercury. The interior surface of the envelope is coated with a finely divided fluorescent material which is exposed to the discharge and is excited by ultra-violet radiations emitted by the said discharge. The coating is usually applied by suspending the powdered fluorescent material in a suitable binder such as a mixture of nitrocellulose and amyl acetate, flushing the interior of the envelope with the suspension, permitting the excess solution to drain out of the tube and then firing the coated tube at a temperature of about 475° C. to volatilize and burn out the binder.

Lamps of the type described above are highly efficient light sources, particularly when a low pressure discharge through mercury vapor is employed to generate ultra-violet radiations of 2537 A. wavelength and fluorescent materials highly responsive thereto are employed, such, for example, as zinc beryllium silicate, zinc silicate and magnesium tungstate. However, the luminous efficiency of the lamps decreases somewhat during continued operation thereof, and it is one of the objects of our invention to improve the lumen maintenance of such lamps. Another object is to provide an improved coating process resulting in a more firmly adherent coating. Further objects and advantages of our invention will appear from the following detailed description.

In accordance with our preferred process, the above-mentioned objects may be attained by mixing a small amount of boric acid with the fluorescent powder, suspending the mixture in a suitable binder such as nitrocellulose dissolved in amyl acetate, coating the envelope or tube with this suspension and then firing, preferably at an elevated temperature of about 600–700° C. which is above the fusion temperature of boric oxide.

More specifically, we may prepare a mixture of about 50 grams of the finely divided fluorescent powder or phosphor, boric acid in an amount of about 2% of the phosphor, and 75 c.c. of a binder consisting of one part of 400 second nitrocellulose and six parts of amyl acetate. These ingredients are mixed together and ball-milled for about a half hour, after which about 25 c.c. of amyl acetate may be added. The resulting suspension may be applied to a tubular lamp envelope by inserting a stopper into one end and thereof and pouring an excess of suspension into the envelope which may then be rotated and turned end for end, after which the excess suspension is poured out. The coating material adhering to the inner surface of the envelope may then be dried by a downward forced air draft blown through the envelope. The coated and dried envelope is then fired in air, preferably at a temperature of about 600–700° C., so that the binder is removed and the boric acid is converted to fused boric oxide. It will be noted that this firing temperature is considerably higher than the normal firing temperature of 475° C. heretofore employed when there was no boric acid present in the suspension. In fact such a higher temperature is necessary to obtain improved maintenance.

In the above-described process, we have employed additions of ½ to 15% of boric acid and have found that amounts of 1 to 7½% are quite satisfactory, with amounts of 2 to 3% being preferred where lumen maintenance is the desired objective. The particle size of the florescent powders may range from about one to fifty microns.

Envelopes coated as described above may be made into lamps of the type described, for example, in Patent 2,182,732, Meyer et al., and having a thermionic oxide-coated electrode sealed into each end of the envelope which may contain a filling of argon at a pressure of about 4 mm. and a small quantity of mercury. Such fluorescent lamps are preferably operated with a low pressure positive-column discharge, the mercury pressure being of the order of 12 microns during operation of the lamp. The phosphor may be one or more of a number which are now well known in the art and are represented by various fluorescent silicates, tungstates and borates, for example. For instance, we have obtained improvements of about 5–15% in lumen maintenance in such lamps coated as described above with zinc beryllium silicate, zinc silicate, magnesium tungstate and a daylight mixture consisting of zinc beryllium silicate, magnesium tungstate and cadmium borate. More particularly, test results of lamps coated without the boric acid addition showed a decrease in lumen maintenance to 90% in 100 hours, 85% in 200 hours, 77.7% in 500 hours, 75% in 750 hours and 73% in 1,000 hours, whereas otherwise similar lamps coated with the boric acid addition as described above showed a decrease in maintenance to only 95.4% in 100 hours, 91% in 200 hours, 84.6% in 500 hours, 82% in 750 hours, and 80.5% in 1,000 hours. Moreover,

the presence of the boric oxide causes the phosphor to adhere much more firmly to the envelope.

Although the process described above has been found to produce the best results, we have found that improved maintenance may also be obtained by a modified process. Thus, the interior of the lamp envelope may be first coated with a binder consisting of a solution of boric acid in glycerine, 10 grams of boric acid in 50 c. c. of glycerine, for example. The excess binder may then be removed to leave a thin coating and the envelope fired at a temperature of about 600° C. to fuse the boric oxide into the glass surface of the envelope. The envelope may then be coated with the conventional suspension of fluorescent powder in the nitrocellulose-amyl acetate binder solution. After drying, the envelope may be fired at a temperature of about 475° C. to burn out the nitrocellulose binder.

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

1. The method of coating the interior surface of the glass envelope of an electric discharge device with a finely divided fluorescent material which comprises mixing about ½ to 15 per cent of boric acid with the fluorescent material and suspending the mixture in a volatilizable binder comprising a cellulosic ester, applying a coating of the suspension to the surface of the envelope and then firing the envelope to volatilize the binder and convert the boric acid to boric oxide.

2. The method of coating the interior surface of the glass envelope of an electric discharge device with a finely divided fluorescent material which comprises mixing about ½ to 15 per cent of boric acid with the fluorescent material and suspending the mixture in a volatilizable binder comprising a cellulosic ester, applying a coating of the suspension to the surface of the envelope and then firing the envelope at a temperature above the fusion temperature of boric oxide.

3. The method of coating the interior surface of the glass envelope of an electric discharge device with a finely divided fluorescent silicate which comprises mixing about ½ to 7 per cent of boric acid with the fluorescent silicate and suspending the mixture in a volatilizable binder comprising a solution of a cellulosic ester, applying a coating of the suspension to the surface of the envelope and then firing the envelope to burn out and volatilize the binder and convert the boric acid to boric oxide.

4. The method of coating the interior surface of the glass envelope of an electric discharge device with a finely divided fluorescent material which comprises mixing about 2 to 3 per cent of boric acid with the fluorescent material and suspending the mixture in a volatilizable binder comprising a solution of a cellulosic ester, applying a coating of the suspension to the surface of the envelope and then firing the envelope at a temperature above the fusion temperature of boric oxide.

5. The method of coating the interior surface of the glass envelope of an electric discharge device with a finely divided fluorescent material which comprises mixing about ½ to 7 per cent of boric acid with the fluorescent material and suspending the mixture in a volatilizable binder comprising a cellulosic ester dissolved in a volatile acetate solvent, applying a coating of the suspension to the surface of the envelope and then firing the envelope to burn out and volatilize the binder and convert the boric acid to boric oxide.

WILLARD A. ROBERTS.
HANNAH T. GEISSBUHLER.