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DISCHARGE DEVICE HAVING EXTERIOR
LUBRICATING PHOSPHATE COATING
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FIG. 1.

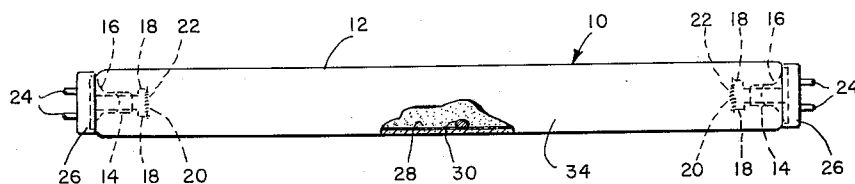
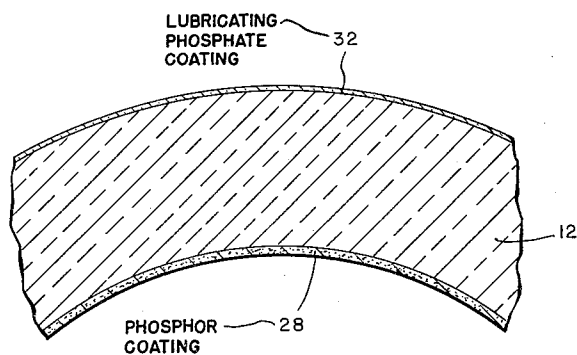


FIG. 2.



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DISCHARGE DEVICE HAVING EXTERIOR LUBRICATING PHOSPHATE COATING

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2 Claims. (Cl. 313—108)

This invention relates to an envelope coating and method and, more particularly, to a lubricating coating for a discharge device envelope intended to have phosphor coated therein and to a method for lubricating the exterior surface of an envelope for a discharge device.

Low-pressure, positive-column, mercury-discharge devices or lamps of the fluorescent type are well known. These lamps are necessarily manufactured on high-speed automatic equipment. In fabricating such relatively-large lamps at high speeds, mutual bulb impacts are apt to occur, particularly in the lehr after the phosphor is coated onto the interior surface of the lamp envelope. When two phosphor-coated tubes or envelopes bump together, the surface friction therebetween causes them to seize, resulting in a considerable impact. Such an impact tends to loosen or remove some of the phosphor coating adjacent the point of impact, resulting in imperfect phosphor coatings which are known in the art as "chipped" coatings.

Various procedures have been employed to lubricate the envelopes to minimize the tendency for any seizure when the envelopes bump together during the manufacturing processes. The most-common procedure has been to introduce a small amount of sulphur dioxide into the atmosphere contained within the lehr where binder material is volatilized from the coated phosphor. The sulphur dioxide apparently reacts with alkali metal, particularly sodium, which forms a considerable part of the envelope glass composition. This results in the formation of a small amount of sodium sulphate on the surface of the envelope, which sodium sulphate is known to be a good glass lubricant as described in U.S. Patent No. 2,016,381, dated October 8, 1935. The disadvantage to such a procedure is that sodium sulphate is also a getter for mercury. The introduction of sulphur dioxide into the lehr also forms some sodium sulphate on the interior surfaces of the envelope and during service operation of the lamp, the sodium sulphate getters some of the mercury to form a thin film on the envelope interior surfaces. This has a deleterious effect on the maintenance of initial light output during the service life of the lamp. It is also known to coat the lamp envelope directly with aluminum sulphate and then wash same off to leave a silica-rich surface and such a method is disclosed in U.S. Patent No. 2,709,644, dated May 31, 1955. This procedure is also disadvantageous as there is a tendency for residual aluminum sulphate to find its way into the interior surfaces of the lamp envelope where the sulphate tends to getter mercury during the operation of the lamp to impair the lamp maintenance. In addition, the glass-lubricating qualities of a silica-rich surface are relatively poor.

It is the general object of this invention to avoid and overcome the foregoing and other difficulties of and objections to prior-art practices by the provision of a method for lubricating the exterior surface of a tubular glass envelope.

It is a further object to provide a method for lubricating the exterior surface of an envelope for a fluorescent lamp with lubricating material which is not a good getter for mercury.

It is another object to provide specific method details for lubricating the exterior surface of the envelope for a fluorescent lamp.

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It is an additional object to provide a thin lubricating coating for a tubular glass envelope.

It is still another object to provide a thin lubricating coating for a discharge device envelope which is intended to have finely-divided phosphor coated on the envelope interior surface.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by applying to the envelope exterior surface a thin film of solution incorporating solid dissolved material which includes the phosphate radical and which solid dissolved material when applied as a thin coating and freed from solvent is substantially transparent. After the thin film of solution is coated, the solvent is evaporated to leave a thin phosphate coating on the envelope exterior surface in order to lubricate the envelope to minimize chipped phosphor coatings. Also provided is a glass envelope phosphate coating which acts as a glass lubricant and will not react with mercury to any appreciable degree.

For a better understanding of the invention, reference should be had to the accompanying drawing wherein:

FIG. 1 is an elevational view, partly in section, of a fluorescent lamp, the envelope of which has coated thereover the lubricating coating of this invention;

FIG. 2 is a fragmentary enlarged view of a cross section of the envelope for a fluorescent lamp immediately after the lubricating coating has been applied as a water solution.

Although the principles of the invention are broadly applicable to any type of discharge device envelope which is intended to have phosphor material coated over the interior surface thereof, the invention is particularly adapted for use with envelopes for fluorescent lamps and hence it has been so illustrated and will be so described.

With specific reference to the form of the invention illustrated in the drawing, the numeral 10 in FIG. 1 illustrates generally a 40W T12 type fluorescent lamp comprising a tubular, vitreous envelope 12 which can be fabricated of the usual soda-lime-silica glass, for example, having mounts 14 sealed into either end thereof as is customary. Each mount comprises a vitreous portion 16 sealed to the end of the envelope 12 with lead conductors 18 sealed therethrough. Refractory metal coils 20, which can be fabricated of tungsten, are supported at the inwardly-extending extremities of the lead conductors 18. These coils 20 are normally of a coiled-coil or a triple-coil construction. Contained within the inner turn or turns of the electrode coil is a filling of electron-emitting material 22. Such materials are well known and normally comprise a mixture of alkaline-earth oxides which may have some other material such as zirconia added thereto. As a specific example, the electron-emitting material comprises a mixture of 60% by weight barium oxide, 30% by weight calcium oxide and 10% by weight strontium oxide. Other mixtures of alkaline-earth materials or even single alkaline-earth materials may be used if desired, as is well known.

Electrical connections for the lead conductors 18 are effected by contact pins 24 which project from supporting base caps 26 at either end of the lamp 10. The lamp envelope has coated on its interior surface a phosphor material 28 which can be any of the usual halophosphate-type phosphors or zinc silicate activated by manganese for example. The envelope contains a small filling of argon or other inert, ionizable gas at a pressure of about 4 mm. for example, in order to facilitate starting, and other starting gases at various pressures can be used if desired. Also contained within the envelope is a small charge of mercury 30, as is customary.

The present coating material comprises a phosphate which when applied as a thin coating and freed from the solvent used to apply it in solution form is substantially transparent, in order to pass the visible radiations which

are generated by the fluorescent lamp. The phosphate which is applied is desirably soluble in water because of the cost factor and because the use of volatile organic solvents for example would require additional venting systems. The preferred phosphate coating material is diammonium orthophosphate. Other phosphate materials which can be used are ammonium dihydrogen orthophosphate, orthophosphoric acid or any of sodium, potassium, barium, strontium or calcium orthophosphates. The foregoing phosphates can be mixed in any proportion if desired for use as a lubricating coating. The indicated alkaline-earth orthophosphate coating materials can be made sufficiently soluble in water by making the coating solution slightly acidic, such as a 0.01 normal solution of hydrochloric acid. Also, coating material vehicles other than water can be used, such as alcohol.

In the case of the preferred ammonium phosphate, the molarity of the coating solution can be varied from 0.01 to 0.15 and the preferred molarity is about 0.05. With less than a 0.01 molar coating solution of ammonium phosphate, some difficulties may be encountered in depositing enough material onto the lamp envelope. If the coating solution has a molarity greater than 0.15, there is some tendency to deposit excess material, which may impair the transmission of the visible light generated by the fluorescent lamp, although coating solutions having a molarity greater than 0.15 can be used with good results. The other indicated suitable phosphate coating materials can be substituted for the preferred ammonium phosphate in such amount as to provide an equivalent concentration of phosphate radical.

In applying the present coating to the envelope 12, the envelope is first fabricated as a tube by conventional practices. Just after the envelope is coated with phosphor, it is passed over conventional roller applicators which are saturated with the foregoing indicated coating solution. While rollers are preferred from a production standpoint, the coating solution can also be applied as a conventional flush or spray. Under normal-room-temperature conditions, approximately 3 cc. of coating solution will be deposited on the usual 40W T12 envelope which has an exterior surface area of about 2,000 sq. cm. In the usual case the coating solution will deposit as a generally-uniform film having an average thickness of approximately 15 microns and such a deposited solution film 32 is shown in FIG. 2. Thereafter the solvent is evaporated from the applied thin film of solution to leave a thin phosphate coating 34 on the envelope exterior surface. In the case of the preferred diammonium orthophosphate coating material wherein the coating solution has a molarity of 0.05, the residual ammonium phosphate which is deposited onto the lamp envelope will be extremely thin in nature. The phosphate residue after solvent evaporation is not a uniform film, however, and will usually comprise discrete depositions of phosphate. These discrete localized deposits are sufficiently close together to prevent the glass bodies of the envelopes from directly contacting one another to minimize any effects of chipped coatings realized through impacts between envelopes. After evaporation of the vehicle, the deposited phosphate coating material, as expressed in terms of weight of phosphate radical included therein, will have a coating weight of from 2×10^{-6} to 3×10^{-5} gram of phosphate radical per square centimeter of envelope exterior surface. This is readily calculated from the amount of coating material which is deposited in solution form. This indicated coating weight range is only the desirable range and may be extended. The other indicated phosphate coating materials desirably are used in such amount as to provide this indicated coating weight range of phosphate radical.

As noted, in the preferred method for applying the phosphate coating solution to the envelope, the conventional solution-applicator rollers are positioned on the production line after the phosphor-coating operation and

before the envelope lehring operation. The hot air which is encountered in the vicinity of the lehr will normally volatilize substantially all of the water vehicle from the applied coating solution before the envelope enters the lehr. The phosphor coating process is generally conventional and as an example, 200 kilograms of phosphor can be mixed with 75 liters of butyl acetate and 25 liters of butyl acetate having therein 2% by weight of nitrocellulose and a No. 7 Parlin Cup viscosity of 65-75 seconds. This mixture is gently stirred to form a homogeneous suspension or "paint" of the phosphor particles and this paint can be further thinned if desired. The paint is then flushed over the inside surface of the fluorescent tube and the solvent volatilized, after which the nitrocellulose binder is volatilized by lehring the phosphor-coated envelope at a temperature of about 635° C. for about two minutes. In the case of the preferred ammonium phosphate coating material, the lehring operation causes the ammonium phosphate coating to break down. It is not clear what phosphate is formed on breakdown, although it is probable that the coated phosphate is converted in a large degree to a sodium phosphate and the presence of phosphate complexes and even some limited amounts of silicates is probable. The lehring operation renders the resulting phosphate relatively insoluble with respect to water and at least a portion of the coated phosphate remains on the envelope throughout the manufacturing operation in order to impart glass lubricity thereto to prevent chipped coatings.

In the preferred method for applying the present lubricating coating, the coating rollers are positioned after the phosphor coating operation. It is also possible to apply the lubricating coating solution before the phosphor coating operation. As another alternative, the lubricating coating solution can be applied as a spray for example immediately after the tubes are fabricated at the glass plant. This has the additional advantage in that the present coating minimizes any tendencies for breakage when handling the tubes at the glass plant, where the tubes are apt to be knocked together frequently. As still-another alternative, the lubricating coating solution can be applied to the ends of the tubes immediately after the tube drawing and cutting operation. Thereafter, when the ends of the fluorescent tubes are formed so as to receive the mounts and base caps, the glass-forming heat causes the applied coating to form relatively insoluble phosphate at the ends of the tubes where breakage or marring through impact between tubes is most frequent. As yet-another possibility, the coating solution can be sprayed on the glass tubes when they are extremely hot, such as at a temperature of 500° C. for example. If the spray is sufficiently finely divided, the thermal shock of the spray can be tolerated by the hot glass. This forms relatively insoluble phosphate on the surface of the glass tubes to enable the applied phosphate coating to withstand later washing operations in order to preserve the lubricity of the glass throughout the manufacturing processes.

In actual production tests, the present lubricating coating gave results which were at least equivalent to the sodium sulphate lubricating coatings previously used, without the undesirable effects normally associated with the use of sodium sulphate.

It will be recognized that the objects of the invention have been achieved by providing a method for lubricating the exterior surface of an envelope for a fluorescent lamp in such manner that the maintenance of lamp performance is not impaired. In addition, specific details for carrying out this method have been provided and there has also been provided a thin lubricating coating for a discharge device envelope which is intended to have finely-divided phosphor coated on the envelope interior surface.

While best-known embodiments have been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

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I claim:

1. A discharge device having an envelope and finely-divided phosphor coated on the envelope interior surface, a thin lubricating coating on the exterior surface of said envelope, said coating comprising substantially transparent phosphate, and the average weight of said phosphate coating as expressed in terms of weight of phosphate radical included therein being from 2×10^{-6} to 3×10^{-5} gram per square centimeter of envelope exterior surface. 5

2. A discharge device having an envelope and finely-divided phosphor coated on the envelope interior surface, a thin lubricating coating on the exterior surface of said envelope, said coating comprising substantially transparent phosphate, and the average weight of said phosphate 10

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coating as expressed in terms of weight of phosphate radical included therein being about 2×10^{-5} gram per square centimeter of envelope exterior surface.

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