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METHOD OF COATING A FLUORESCENT TYPE TUBE AND THE COATED ARTICLE

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FIG. 1.

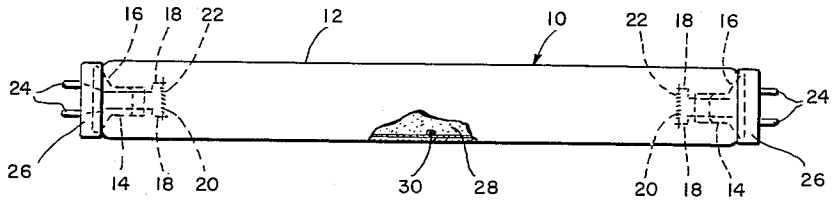
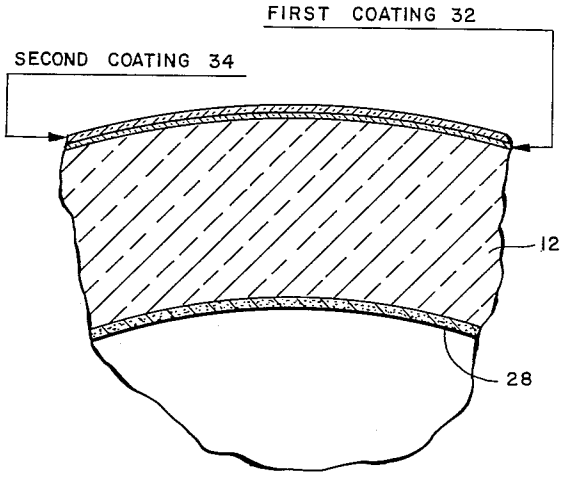


FIG. 2.



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METHOD OF COATING A FLUORESCENT TYPE TUBE AND THE COATED ARTICLE

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This invention relates to envelope coatings and methods and, more particularly, to an envelope coating or a discharge device such as a fluorescent lamp and to a method for applying such a coating.

Low-pressure, positive-column, mercury-discharge devices of the fluorescent type are well known. Such devices are usually intended to operate in conjunction with an auxiliary switching mechanism in order to facilitate starting, such as a glow switch. One purpose of the glow switch is to open an inductive circuit so that a high-voltage surge is developed across the electrodes of the fluorescent lamp, in order to ionize the gas contained therein and initiate lamp starting.

Within recent years, fluorescent lamps and the associated operating circuitry have been developed to enable the lamps to start in a very rapid fashion without the use of auxiliary switching mechanism. Such lamps are known in the trade as "rapid-start" and "instant-start" fluorescent lamps. These lamps are required to start on somewhat lower voltage than was available with the lamp starting and operating circuits which utilized the auxiliary switching mechanism. Under the usual operating conditions, little troubles are encountered in starting rapid- or instant-start fluorescent lamps, but under conditions of high humidity, considerable troubles have been encountered in starting such fluorescent lamps, apparently because of a moisture film which is formed on the exterior surfaces of the envelopes. In order to overcome the tendency for "hard-starters" under high-humidity conditions, it has been the practice to place a coating of silicone on the outer surface of the envelopes of these lamps. Silicones are made by a number of companies and generally are heat-stable, organo-silicon oxide polymers made by combining silicon dioxide with methyl or ethyl groups of molecules derived from alcohols, or with ethylene chloride or phenol. The silicone coating serves to prevent moisture from condensing on or otherwise contacting the envelope in order to minimize the problems encountered in starting this type of lamp under high-humidity conditions. A silicone coating often used in the past was a chlorosilane type. In depositing such a silicone coating, the coating material was vaporized into a chamber which contained the lamps being coated. Adsorbed surface moisture on the lamps within the coating chamber reacted with the chlorosilane to form the silicone coating. While the resulting silicone coating was generally satisfactory, at least during the first several thousand hours of lamp operation, it exhibited some tendency to break down toward the end of lamp life because of the ultraviolet radiations generated by the lamp, resulting in hard starters. In addition, during the initial application of the silicone coating, hydrochloric acid was evolved which created a severe corrosion problem with the coating equipment and also with nearby manufacturing equipment. The safety hazard to the operators also required a costly ventilation system. Further, the use of a chamber to apply the coating required that the lamps be coated on a batch system and a batch coating process is not readily adaptable to production-line manufacture.

For production-line manufacture, it is desirable to be able to apply a coating of moisture-impervious material

to the envelope of the lamp by means of a dip or spray system so that the lamp envelopes can be individually coated directly on the line. Where large volumes are concerned, it is particularly desirable to use water as a vehicle to apply the silicone, since organic vehicles such as alcohol represent a safety hazard and require considerable venting, in addition to the added cost of the organic vehicle. Further, the silicone which is utilized should be readily polymerizable under relative-low-temperature conditions, since a silicone which requires long times and high temperatures to polymerize is not adaptable for a high-volume, production-line type of manufacture.

In an attempt to overcome the foregoing difficulties of the prior art, water-soluble silicones which cure in a short time under low temperature conditions were applied to the exterior surfaces of rapid- and instant-start fluorescent lamps. The initial operation of these silicone-coated lamps was quite satisfactory, but under the action of the longwave ultraviolet generated by the fluorescent lamp, these silicones broke down in a fairly-rapid fashion so that after about 2,000 hours of operation, the lamps started in a very erratic fashion when exposed to conditions of high humidity.

It is the general object of the invention to avoid and overcome the foregoing and other difficulties of and objections to prior-art practices by the provision of a chemically-stable, moisture-impervious silicone coating for the envelope of a fluorescent lamp.

It is another object to provide a chemically-stable, moisture-impervious silicone coating for the envelope of a fluorescent lamp, which silicone coating will not break down when exposed for long periods to longwave ultraviolet radiations.

It is another object to provide a method for applying chemically-stable, moisture-impervious silicone coating to the envelope of a fluorescent lamp, which silicone coating can be applied on a production-line basis with a water vehicle.

The aforesaid objects of the invention, and other objects which will become apparent as the description proceeds, are achieved by providing a composite exterior coating for the envelope of a rapid- or instant-start fluorescent lamp. The composite coating comprises a first coating which is the reaction product of one mole part of octadecylsilicon trichloride with three mole parts of diethanolamine. Coated over this first coating is a second silicone coating which comprises trimethylsilyl end-blocked polydimethylsiloxane. Also provided is a method for applying this composite silicone coating to the envelope of a rapid- or instant-start fluorescent lamp.

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 composite silicone coating of this invention;

FIG. 2 is a fragmentary enlarged view of a cross section of the envelope of the lamp as shown in FIG. 1, illustrating the composite silicone coating of this invention.

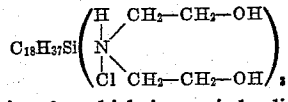
Although the principles of the invention are broadly applicable to any type of discharge device which is designed to be started with relatively-low voltage and operated under high-humidity conditions, the invention is particularly adapted for use with rapid- and instant-start fluorescent lamps and hence 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 40 w. T12 type fluorescent lamp comprising a tubular, vitreous envelope **12** which may be fabricated of soda-lime-silica glass, for example, hav-

ing 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 may be fabricated of tungsten for example, are supported at the inwardly-extending extremities of the lead conductors **18**. The coils **20** are normally of a triple-coil construction for use with a rapid- or instant-start type lamp and such electrode coils are generally described in U.S. Patent No. 2,774,918, dated December 18, 1956. Contained within the turns of the inner electrode coils 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 connection for the lead conductors **18** is effected by contact pins **24** which project from supporting base caps **26** at either end of the lamp **10**. The lamp envelope **12** has coated on its interior surace a phosphor material 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. For an instant-start type of lamp, the base pins **24** are directly electrically connected to one another.

The silicone coating which is carried on the exterior surface of the envelope **12** is a composite coating and comprises two different silicones. The first coating **32** which is positioned adjacent the exterior surface of the envelope **12** is formed of the reaction product of one mole part of octadecylsilicon trichloride with three mole parts of diethanolamine. For application, this type of silicone can be dissolved in an organic solvent free of active hydrogens or it can be placed in water solution. The formula for this silicone is as follows:



The second coating **34** which is carried adjacent to and over the first coating **32** is trimethylsilyl end-blocked polydimethylsiloxane and the formula for this silicone is as follows:

$$(CH_3)_3Si—[O—Si(CH_3)_2—]_nOSi(CH_3)_3$$

Both of the foregoing silicone materials are transparent and are applied in an extremely thin fashion. As an example, a continuous, molecular-thick layer of each of these specified silicones will be effective in preventing moisture from contacting the surface of the envelope **12**. As a matter of practicality, however, the coating will normally be somewhat thicker and may be slightly non-uniform due to some flowing of the water vehicle before the applied coatings are dried.

The preferred method for applying the foregoing silicones to the envelope **12** of the lamp **10** is first to completely fabricate the lamp in accordance with the conventional practices. Thereafter, the fabricated lamp is dipped into a water solution of the first silicone coating composition. This solution preferably includes ½% by weight of silicone solids and 99.5% by weight water. The percent by weight of silicone solids in the water solution is not critical and can be varied over wide limits such as from 0.1% to 10% by weight. Even these limits can be extended if desired. The dipped lamp is immediately removed from the first silicone coating solution and preferably is allowed to drip dry to permit excess coating composition and coating vehicle to drain. The envelope is then immediately dipped into a water emulsion containing the second silicone coating composition. Preferably this emulsion comprises 2% by weight of silicone solids and 98% by weight of water. The percent by weight of silicon solids in the water emulsion is not critical and can be varied over wide limits such as from 0.2% to 15% by weight. Even these limits can be extended if desired. The envelope **12** is then immediately removed from the second silicone coating composition and vehicle and preferably allowed to drip dry to remove any excess coating composition and coating vehicle. Desirably any accumulated excess silicone and water vehicle which may adhere to the dipped envelope in the form of droplets is removed by means of an air knife. Such an air knife can be formed with an orifice diameter of 1/32" and an orifice length of 4", operated with a pressure of 35 p.s.i. gauge. Under these conditions of operation, the knife can be held approximately 1/8" away from the closest portion of the envelope and reciprocated so as to traverse the diameter of the envelope to remove any excess residual droplets which may cling to the coated envelope **12**. Thereafter it is desirable to follow with a short heating cycle to complete the drying and a heating-drying cycle of 2½ minutes at a temperature of 100° C. has been found to be very satisfactory. This heating-drying cycle is not necessary, but it facilitates immediate handling of the coated lamps for testing, seasoning and packing. The foregoing silicone coating is resistant to the commonly-used cleaning agents which are often used to clean the lamps during their service life, such as trisodium phosphate, mild alkali cleaners and the usual household detergent-type cleaners.

In testing the stability of silicone coatings, it has been found desirable to use an accelerated test wherein the coatings are subjected to the ultraviolet radiations which are generated by a 400 w. high-pressure, mercury-vapor lamp. The very-intense ultraviolet radiations which are generated by such a lamp greatly accentuate any tendency for breakdown of the silicone. Under these test conditions, when the silicone which comprises the reaction product of octadecylsilicon trichloride and diethanolamine was coated by itself, it broke down in two hours. The chlorosilane silicone which was previously used broke down in a period of 25 hours. Where the reaction-product silicone was first coated and then followed by the second coating of trimethylsilyl end-blocked polydimethylsiloxane in accordance with the present invention, the coating withstood the extreme ultraviolet irradiation for a period of 36 hours. This has been determined to be equivalent to more than 7500 hours under the ultraviolet radiation intensity which passes the envelope of a fluorescent lamp. The trimethylsilyl end-blocked polydimethylsiloxane when used by itself is quite resistant to breakdown under longwave ultraviolet radiations, but must be cured or polymerized to resist removal by wiping or washing with the usual cleaning agents. In order to polymerize this specified silicone it is necessary to heat same to a temperature of approximately 300° C. for about two hours. Such a curing cycle is of course completely impractical where high-volume production is essential. When the composite silicone coating as specified hereinbefore is utilized, however, the second-applied silicone coating requires no special curing. The explanation for this is not understood, but there may be some reaction between the two silicone coatings which cause the last-applied or outer silicone coating **34** to cure in a rapid fashion. Whatever the explanation, no special curing is required and the composite silicone coating is extremely resistant to any tendency for breakdown when exposed to longwave ultraviolet radiations for long periods of time and is also resistant to removal by lamp cleaning agents.

As a possible alternative embodiment, the first-applied

silicone coating 32 as specified hereinbefore can contain small amounts of the second-applied silicone coating material. In addition, the second-applied silicone coating 34 can contain small amounts of the first-applied silicone coating material and this will normally be the case since there is some carryover of the first-applied silicone coating material when the lamps are dipped into the water-emulsion which contains the second-applied or outer silicone coating material. In addition, the envelopes which are coated with the dual silicon coating as specified hereinbefore can also have a third silicone coating applied thereover. This third silicone coating can comprise the reaction-product silicone which is used as the first coating. The triple coating has the beneficial effect of improving the resistance of the composite coating to damage or removal by the cleaning agents often used to clean accumulated dust and dirt from the lamps during their service life.

While the preferred method of applying the present composite silicone coating is a dip process, the present coating can also be readily applied as a spray or flush.

It will be recognized that the objects of the invention have been achieved by providing a chemically-stable, moisture-impervious silicone coating for the envelope of a fluorescent lamp, which silicone coating will not break down when exposed for long periods of time to longwave ultraviolet radiations. In addition, there has been provided a method for applying chemically-stable, moisture-impervious silicone coating to the envelope of a fluorescent lamp, which silicone coating can be applied on a production line basis with a water vehicle.

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

We claim:

1. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising a water solution of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, and thereafter applying over said first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising a water emulsion of trimethylsilyl end-blocked polydimethylsiloxane.

2. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises spraying on the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising a water solution of the reaction product of one mole part of octadecysilicon trichloride and three mole parts of diethanolamine, and thereafter spraying over said first-sprayed envelope exterior surface a second coating composition and coating vehicle comprising a water emulsion of trimethylsilyl end-blocked polydimethylsiloxane.

3. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises immersing the exterior surface of the envelope of said device in a first coating composition and coating vehicle comprising a water solution of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, and thereafter immersing the exterior envelope surface of said device in a second coating composition and coating vehicle comprising a water emulsion of trimethylsilyl end-blocked polydimethylsiloxane.

4. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising from 99.9% to 90% by weight of water and from 0.1% to 10% by weight of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, and thereafter applying over said first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising an emulsion of from 97.8% to 85% by weight of water and from 0.2% to 15% by weight of trimethylsilyl end-blocked polydimethylsiloxane.

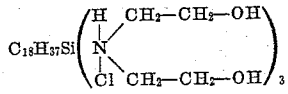
5. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising 99.5% by weight of water and 0.5% by weight of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, and thereafter applying over said first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising an emulsion of 98% by weight of water and 2% by weight of trimethylsilyl end-blocked polydimethylsiloxane.

6. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising a water solution of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, allowing any excess of said first coating composition and coating vehicle to drain from the envelope of said device, and thereafter applying over the remaining first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising a water emulsion of trimethylsilyl end-blocked polydimethylsiloxane.

7. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle comprising a water solution of the reaction product of one mole part of octadecylsilicon trichloride and three mole parts of diethanolamine, allowing any excess of said first coating composition and coating vehicle to drain from the envelope of said device, thereafter applying over said first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising a water emulsion of trimethylsilyl end-blocked polydimethylsiloxane, removing any droplets of vehicle and coating composition from said envelope, and drying vehicle from said coated envelope.

8. The method of stabilizing throughout life the starting voltage of a low-pressure positive-column mercury-discharge device of the fluorescent type which is adapted to be started in a very rapid fashion without the use of auxiliary switching mechanism, which method comprises applying to the exterior surface of the envelope of said device a first coating composition and coating vehicle

comprising a water solution of silicone having the formula:



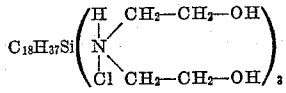
and thereafter applying over said first-applied coating composition and coating vehicle a second coating composition and coating vehicle comprising a water emulsion of silicone having the formula:

$$(CH_3)_3Si—[O—Si(CH_3)_2—]_nOSi(CH_3)_3$$

9. A low-pressure positive-column mercury-discharge device of the fluorescent type in which the positive-column discharge is adapted to be initiated in a very rapid fashion without the use of auxiliary switching mechanism, a composite coating carried on the exterior surface of the envelope of said device, said composite coating comprising a first coating adjacent the exterior surface of the envelope of said device and a second coating carried over said first coating, said first coating principally comprising the reaction product of one mole part of octadecylsilicon trichloride with three mole parts of diethanolamine, and said second coating principally comprising trimethylsilyl end-blocked polydimethylsiloxane.

10. A low-pressure positive-column mercury-discharge device of the fluorescent type in which the positive-column discharge is adapted to be initiated in a very rapid fashion without the use of auxiliary switching mechanism, a composite coating carried on the exterior surface of the envelope of said device, said composite coating comprising a very thin first coating adjacent the exterior surface of the envelope of said device and a very thin second coating carried over said first coating, said first coating, said first coating principally comprising the reaction product of one mole part of octadecylsilicon trichloride with three moles of diethanolamine, and said second coating principally comprising trimethylsilyl end-blocked polydimethylsiloxane.

11. A low-pressure positive-column mercury-discharge device of the fluorescent type in which the positive-column discharge is adapted to be initiated in a very rapid fashion without the use of auxiliary switching mechanism, a composite coating carried on the exterior surface of the envelope of said device, said composite coating comprising a first coating adjacent the exterior surface of the envelope of said device and a second coating carried over said first coating, said first coating having the formula:



and said second coating having the formula:

$$(CH_3)_3Si—[O—Si(CH_3)_2—]_nOSi(CH_3)_3$$

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