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LAMP ENVLOPE COATING AND METHOD OF APPLYING

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Fig. 1.

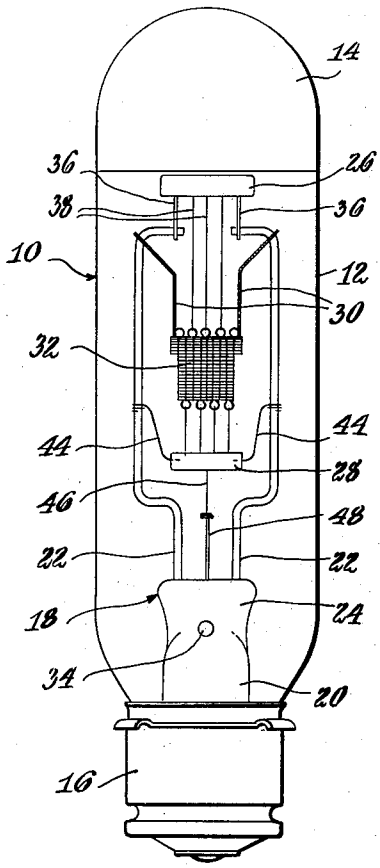


Fig. 2.

400 gms Nº 7740 GLASS
100 " Nº 7720 "
CRUSH, MIX & SCREEN THROUGH Nº 4 MESH

ADD TO THE ABOVE:
40 gms BENTONITE
62.5 " BLACK PIGMENT
1.1 " LITHIUM NITRATE
600 cc. DISTILLED WATER.

WHOLE MIXTURE MILLED IN BALL MILL UNTIL AN AVERAGE PARTICLE SIZE OF 2.0 TO 2.2 MICRONS IS OBTAINED TO FORM ENAMEL.

ENAMEL SCREENED THROUGH A 200 MESH SCREEN & ADJUSTED TO A SPECIFIC GRAVITY BETWEEN 1.40 & 1.42 AND A VISCOSITY BETWEEN 16 & 18 SECONDS THROUGH A ZAHN VISCOSITY CUP.

SPRAYED ON TO PREHEATED BULBS IN CONVENTIONAL MANNER TO A THICKNESS OF ABOUT 0.004 TO 0.0045 INCHES AND DRIED.

DRIED ENAMEL IS FIRED AT APPROXIMATELY 800°C FOR 4 TO 6 MIN.'S IN A FURNACE

FIRED COATED BULB IS SLOW COOLED TO 500°C.

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LAMP ENVELOPE COATING AND METHOD OF APPLYING

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2 Claims. (Cl. 117—124)

This invention relates to lamps and, more particularly, to incandescent projector lamps and envelope coatings and to methods of coating incandescent projector lamp bulbs.

A representative motion picture projector lamp is generally described in Patent No. 2,605,440 to W. B. Gero, dated July 29, 1952, titled Incandescent Electric Lamp, and owned by the present assignee. Such projector lamps normally carry an opaque coating on the exterior surface of the upper extremity of the envelope in order to screen the upward component of light from the high wattage filament, since the top portion of the projector lamp adaptor is normally open to facilitate lamp ventilation.

Heretofore such envelope coatings have been applied to the envelope surface by first etching and cleaning in a hydrofluoric acid bath the portion of the envelope to be coated, then applying to the etched and cleaned portion of the envelope an aqueous solution of sodium silicate containing an opaque pigment. The sprayed envelope is then baked at about 130° C. for about 2 minutes, in order to convert part of the sodium silicate to silica and increase the adherence of the coating to the envelope. After baking the sodium silicate is substantially completely converted to silica by means of an ammonium chloride bath, and the envelope is then washed with water.

This opaque coating of the prior art has several objectionable features. First, it is necessary to apply the coating to the finished lamp since the silica-pigment coating is relatively easily marred and will not satisfactorily withstand the handling encountered during fabrication. Also, since the finished envelope must be coated, the manufacturer's mark cannot be applied during lamp fabrication, as is conventional, but must be applied in a separate operation. Second, the coating adheres primarily because of the close association of the silica with the glass envelope and is thus fairly easily flaked or chipped away. Third, and the most objectionable feature of this coating of the prior art, is the fact that the coating must be given two baths, one of ammonium chloride and one of water, to wash away any possible residue of ammonium chloride or salt resulting from this bath, in addition to the hydrofluoric acid bath before spraying.

It can readily be seen that any coating which could be applied to the bulb before the lamp was fabricated would be highly desirable, as the finished lamp would then not have to be subjected to the two baths after spraying. Also, it would be highly desirable to utilize a coating process which eliminates the hydrofluoric acid etch. Further any opaque envelope coating which is firmly affixed to the envelope and which will not mar during handling would be an improvement over the envelope coating of the prior art.

In an attempt to overcome the foregoing difficulties of the prior art, experiments were made with ceramic enamels which would possibly serve as an envelope coating, but due to the difference in coefficients of expansion of the envelope and the enamel, the enamel coating tended to crack and flake off when the envelope was heated by the filament.

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 an opaque coating for a vitreous body, which coating will not crack or peel off the vitreous body when it is subjected to variations in temperature.

It is a further object to provide an opaque coating for the upper exterior or base-remote portion of a projector lamp envelope, which coating can be easily and simply applied to the bulb before the lamp is fabricated.

It is another object of the invention to provide an opaque coating for the top exterior portion of a projector lamp envelope, which coating will not easily mar during handling and which will not peel or crack off the envelope when it is subjected to temperature variations.

It is still another object to provide a simple method for coating the top exterior portion of a projector lamp bulb before the lamp is fabricated.

The aforesaid objects of the invention, and others which will become apparent as the description proceeds, are achieved by providing a coating for the top exterior portion of a projector lamp envelope and a method for coating the lamp bulb, which coating consists of a fired mixture of vitreous materials and an opaque pigment, one of which vitreous materials has a coefficient of expansion approximately the same as that of the vitreous envelope and the other of which mixed vitreous materials has a coefficient of expansion which is higher than that of the envelope.

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

Fig. 1 is an elevational view of an incandescent projector lamp embodying our new envelope coating;

Fig. 2 is a flow chart of the method used in preparing the new coating and applying it to a lamp bulb.

Although the principles of the invention are broadly applicable to opaque coatings and coating compositions for vitreous bodies and methods of preparing and applying same, the invention is usually employed in conjunction with an incandescent projector lamp and, hence it has been so illustrated and will be so described.

With specific reference to the form of the invention illustrated in Fig. 1, the numeral **10** designates generally an incandescent projector lamp manufactured for base-down operation, and comprising a vitreous envelope or bulb **12** having an opaque coating **14** over the top exterior portion thereof, a base **16**, and an enclosed mount **18**.

This mount comprises a stem **20**, lead-in and supporting conductors **22** extending through the press **24** of stem **20**, a top fixed bridge **26**, a bottom floating bridge **28**, filament leg inserts **30** and a filament **32**. The stem **20** is sealed to the bulb and provided with an exhaust tube opening therethrough, as indicated at **34**. Lead-in conductors **22** are bent at right angles outwardly from the axis of the stem a short distance above the press and then vertically upward or parallel to the bulb axis. The upper or free extremities are bent inwardly at right angles and terminate close to the axis of the stem. Connected to the free end portions of the lead-in conductors **22** by means of outer support wires **36** is the top fixed bridge **26**, which consists of a piece of vitreous cane having embedded therein the upper extremities of outer support wires **36** and top filament support wires **38**. These top filament support wires are suspended from the bridge **26** and support a tungsten biplane-sectional filament **32** by means of hooks formed in the lower ends of said support wires. Biplane filaments are well-known in the projector lamp art.

In order to position filament **32** between the conductors **22**, a floating bottom bridge **28** is provided, free to slide on the lower portions of lead-in conductors **22** by means of side guide wires **44**. Suspended from the vitreous cane portion of the bridge **28** is a bottom guide wire **46** which is free to slide within the outer loop of

a spud or dummy lead 48 projecting from the press 24.

Incandescent motion picture projector lamps are necessarily designed to operate at relatively high wattages, for example, 500, 750, or 1,000 watts. The envelope must be relatively small because of the size limitation of the projector, a representative envelope size being 4½ inches long, 1½ inches in diameter and .040 to .080 inch wall thickness. Because of these high wattages and relatively small envelope size, the envelope 12 becomes quite hot during operation, a representative envelope operating temperature being about 600° C. In addition, in order to increase the efficiency of the lamp the envelope normally encloses a nitrogen atmosphere at a pressure of about 1,200 millimeters of mercury, and the operating pressure for the lamp may be about 1,600 millimeters mercury. Because of these relatively high temperatures and pressures, it is necessary that the envelope 12 be fabricated of a glass which is relatively strong and very resistant to heat. We have found that the best commercially available glass for such an application is a borosilicate glass manufactured by The Corning Glass Works, Corning, New York, and designated by Corning Code No. 7740. The raw-mix composition for such a glass is 387 parts by weight of silica, 124 parts borax, 14 parts hydrated alumina, 36 parts boric acid, 5 parts potassium chloride, and 0.0044 part nickel oxide. Such a glass has a softening point of about 820° C. and a coefficient of expansion of about 32.5×10^{-7}.

Because of the relatively low coefficient of expansion of this Corning 7740 glass, and the relatively high operating temperature of the envelope, the ceramic enamels of the prior experiments which were applied to envelopes as opaque coatings all chipped, cracked, or flaked off in service. If a ceramic enamel could be found which had a coefficient of expansion which approached that of the 7740 glass, it could probably satisfactorily meet the requirements of the application, but no such enamel has been found. An opaque coating could be fabricated using crushed 7740 glass as an adherent, but in applying such a coating to the envelope, it is necessary to heat the crushed 7740 glass to its softening point in order to botain proper fusion or adherence with the bulb. Since this softening temperature would cause the bulb 14 to deform, it is not practical to use crushed 7740 glass as the adherent for the coating. If the coating adherent were fabricated of a crushed glass which softened at a lower temperature than the 7740 envelope glass, so that it could be satisfactorily fused at temperatures lower than the envelope softening temperature and thus adhere to the envelope, the resulting difference in coefficients of expansion would be sufficiently great that the coating would crack, chip or flake off during operation.

We have found that a satisfactory coating can be formed by mixing an opaque pigment with an adherent glass which consists primarily of a mixture of crushed 7740 glass and a glass which has a higher coefficient of thermal expansion and thus a lower softening temperature than the 7740 glass. An example of a glass suitable for mixing with crushed 7740 glass is a borosilicate glass manufactured by Corning Glass Works, Corning, New York, designated by Corning Code No. 7720 and having a raw-mix composition of 352 parts by weight of silica, 100 parts borax, 30 parts nitre, 80 parts boric acid, 2.5 parts antimony trioxide and 2.5 parts arsensic trioxide. Such a 7720 glass has a softening point of about 755° C. and a coefficient of expansion of about 36 times 10^{-7}.

The percentages of the two glasses which are present in the glass mixture may be varied to produce a satisfactory coating with a given firing time-temperature cycle. We have found, however, that not less than about 10% and not more than about 60% of the glass of higher coefficient of expansion should be present in order to properly fuse the coating to the envelope, and at the same time keep the coating from cracking off during operation of the lamp due to difference in the coefficients of expansion.

By way of example, and not of limitation, a specific example of a suitable coating composition for a one gallon mill charge is as follows:

Corning 7740 glass	grams	400
Corning 7720 glass	do	100

The two glasses to be mixed, crushed and screened through a number 4 mesh (U. S. standard sieve series)

Bentonite	grams	40
Lithium nitrate	do	1.1
Pigment	do	62.5
Distilled water	cc	600

As heretofore noted, the permissible weights of 7740 and 7720 glass may vary within a fairly wide range. The bentonite referred to above acts as a binder in applying the coating and has the following composition:

	Percent
Silica	62.43
Alumina	24.64
Iron oxide	3.2
Calcium oxide	0.4
Magnesium oxide	2.3
Potassium oxide	0.15
Sodium oxide	0.60
Ignition loss	6.12

Methyl cellulose or other suitable water soluble medium which will form suspension for the coating may also be used as a binder. Methyl cellulose in such an application will volatilize during firing, whereas Bentonite will not volatilize during the firing process, but the residual Bentonite will in no measurable way affect the characteristics of the resulting coating.

The pigment used may consist of one suitably temperature-stable and which will make the coating opaque, an example of a black pigment being a mixture of 90% iron oxide and 10% cobalt oxide, an example of a blue pigment being a sintered and ground mixture of 60% aluminum oxide and 40% cobalt oxide and an example of a red pigment being precipitated iron oxide.

Lithium nitrate is added solely to aid in keeping the milled solids in suspension which facilitates applying the unfired coating to the bulb. This component is not absolutely necessary and may be dispensed with if desired.

In preparing the coating composition, the heretofore noted components are milled until an average particle size of between about 2.0 to 2.2 microns is obtained, although the range of the average particle size may vary within the fairly wide limits of about 1 to 4 microns. This milling process will result in a homogeneous enamel.

The foregoing enamel is screened through a 200 mesh screen (U. S. standard sieve series) and adjusted to a specific gravity of between about 1.40 and 1.42, and a viscosity of about 16 to 18 seconds using a No. 3 Zahn viscosity cup, although neither the specific gravity nor the viscosity are critical.

In order to prevent the enamel from flowing off the top of the bulb during initial spraying, it is desirable, although not absolutely necessary, to preheat the bulb to a temperature of about 75° C. The enamel is then sprayed onto the bulb by conventional techniques, masking the portions of the bulb which is not desired to coat by conventional techniques. The coating thickness is somewhat critical; a thickness above about 0.006 inch will cause the enamel to craze during firing; a thickness below about 0.003 inch will not insure a coating which can be considered 100% opaque. We have found that a uniform coating having a thickness of between about 0.004 to 0.0045 inch is very satisfactory.

Upon completion of the enamel spraying, the bulb is

placed in a drying oven which may have a temperature of between about 100° C. and 300° C., although this temperature may be varied if desired. Representative drying times are 3½ minutes at 150° C. or 2½ minutes at 200° C. The drying time is not critical but should be sufficiently long to completely dry the enamel. After drying any enamel which may have feathered out below the mask may be buffed off.

The dried, coated bulb is then fired and this firing operation is somewhat critical. If the bulb is underfired, the opaque pigment will apparently not be uniformly bonded throughout the crushed glass and such coating will mar easily by accidental contact with other bulbs or fixtures. Also, the crushed glass component of lower softening temperature will not be sufficiently fused and the coating will not adhere properly to the bulb. If the bulb is overfired, the crushed glasses have a tendency to substantially fuse to one another, which results in a tendency of the coating toward crazing, that is, a development of hair-line cracks which result in an imperfect coating.

The firing temperature should be at least 35° C. above the softening temperature of the more fusible glass, and about 15° C. below the softening temperature of the less fusible glass. This results in a sintering or partial fusion of the more fusible glass with the other glass. This latter glass apparently substantially retains its original finely-divided state, without assuming a homogeneous fused status with the glass of lower softening temperature. This gives a coating where the lower softening temperature glass is partially fused, in situ, around the finely-divided higher softening temperature glass and onto the bulb. Thus, while there is partial fusion between the higher softening temperature glass and the lower softening temperature glass at the interfaces of the particles, the higher softening temperature glass particles apparently substantially retain their original characteristics.

The resulting partially fused coating appears to have an effective coefficient of expansion which approaches the coefficient of expansion of the higher softening temperature glass, rather than the coefficient of expansion of the partially fused adherent lower softening temperature glass. This was unexpected, since previously it was thought that the higher coefficient of expansion glass would measurably affect the coefficient of expansion of the mixture which, of course, is the case where the coating is overfired to result in a substantial fusion and partial admixing of the components of the mixture, i. e., the two glasses, into one substantially completely fused coating.

The firing time, as well as the temperature, is also critical, for firing at a lower temperature for a longer period of time will, in effect, produce much the same result as firing at a higher temperature for a shorter period of time. For the temperature limitations as heretofore specified, the firing time should not be less than about 4 minutes if proper adherence of the coating is to be effected, nor more than about 6 minutes if only partial fusion at the interfaces of the two mixed, finely divided glasses is to be effected.

In the specific example as given, the firing time may be about 5 minutes and the firing temperature about 800° C.

After firing, the coated bulb may be slowly cooled, i. e., the bulb is not cooled by an air blast, to a temperature which is about ⅝ of the firing temperature, and in the specific example as given, this is about 500° C. This period of slow cooling is desirable, but not absolutely necessary, and its purpose is to minimize any excessive strains which may manifest themselves during later operation of the finished projector lamp. From 500° C., as in the example given, to room temperature, rapid forced air cooling of the bulb may be used. The foregoing method of coating the envelope is illustrated in the flow diagram of Fig. 2.

The final composition for the opaque coating in the example as given is as follows:

Component:	Approximate percent by Weight
Corning 7740 glass	66
Corning 7720 glass	17
Bentonite	7
Lithium nitrate (fraction of 1%)	Traces
Pigment	10

The coated bulb may then be completely fabricated into a finished projector lamp, as in the practices of the prior art.

It will be recognized that the objects of the invention have been achieved providing an envelope coating, and a method of applying an opaque coating to a vitreous bulb, which coating will not crack off or peel off the vitreous bulb when it is subjected to variations of about 600° C. in temperature.

While in accordance with the patent statutes, one best known embodiment of the invention has been illustrated and described in detail, it is to be particularly understood that the invention is not limited thereto or thereby.

We claim:

1. In combination, a vitreous envelope of borosilicate glass having a melting point of about 820° C. and a coefficient of expansion of about 32.5×10^{-7} and an opaque exterior coating for said envelope consisting of a fired mixture of two finely-divided vitreous materials having admixed therewith an opaque pigment, one of said fired, mixed vitreous materials being a borosilicate glass having a coefficient of expansion and a melting point approximately equal to the coefficient of expansion and the melting point of said vitreous envelope, the other of said fired vitreous materials being a borosilicate glass having a softening point of about 755° C. and a coefficient of expansion about 36×10^{-7}, said other fired vitreous material constituting not less than 10% nor more than 60% by weight of said mixture of fired vitreous materials, said other fired vitreous material being partially fused in situ to said one fired vitreous material and partially fused in situ onto said vitreous envelope, and said coating having a thickness of not less than 0.003" nor more than 0.006".

2. The method of applying an opaque coating to an envelope fabricated of a borosilicate glass having a softening temperature of about 820° C. and a coefficient of expansion of about 32.5×10^{-7} comprising milling in a vehicle two crushed vitreous materials having different softening temperatures, a binder and an opaque pigment to form an enamel, one of said crushed vitreous materials being a borosilicate glass of the same composition as said envelope, the other of said vitreous materials being a borosilicate glass having a softening temperature of about 755° C. and a coefficient of expansion of about 36×10^{-7}, said other vitreous material constituting not less than 10% nor more than 60% by weight of said mixed vitreous materials in said coating composition, spraying said enamel on to said vitreous body to a thickness of between about 0.003" to 0.006", drying said sprayed enamel to remove said vehicle, firing said sprayed vitreous body for between about four to six minutes at a temperature which is at least 15° below the softening temperature of said one vitreous material and at least 35° C. above the softening temperature of said other vitreous material, and slowly cooling said fired envelope to a temperature which is about ⅝ of said firing temperature.

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