Jan. 7, 1969 W. G. JAMES 3,420,694

PLURAL COATED TRANSPARENT COLORED LAMP AND METHOD OF FORMING SAME

Filed Feb. 1, 1966

Fig. 1.

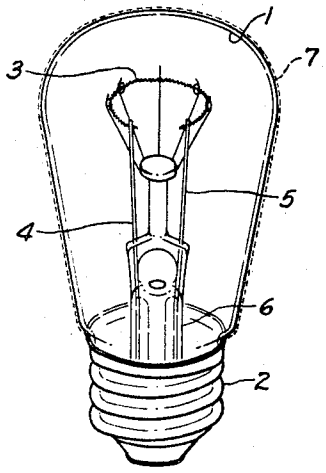


Fig. 2.

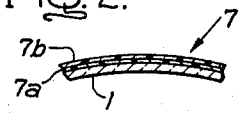


Fig. 3.

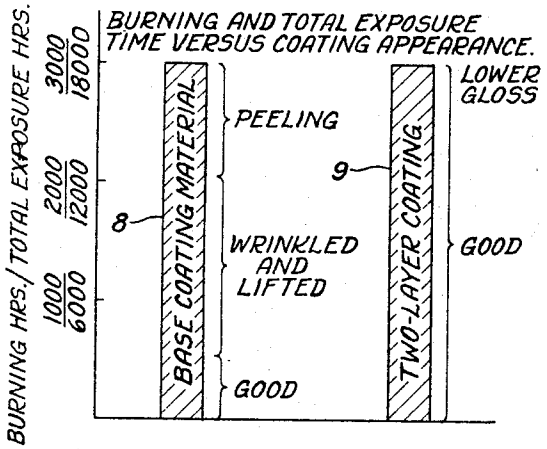
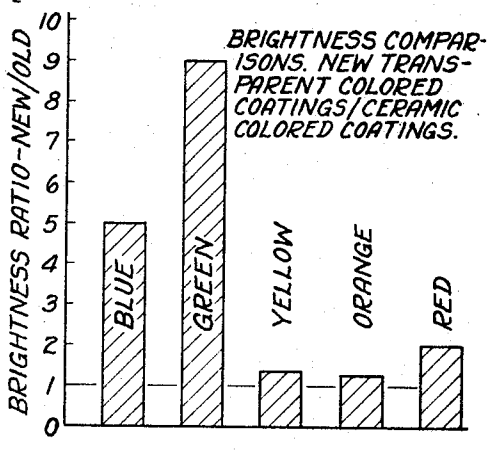


Fig. 4.



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PLURAL COATED TRANSPARENT COLORED LAMP AND METHOD OF FORMING SAME

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Int. Cl. B44d 1/14; F21v 3/04

This invention relates generally to electric incandescent lamps, and more particularly to transparent colored lamps. Still more particularly, the invention relates to transparent color coated lamps especially useful for outdoor applications such as illuminated signs.

It is an object of the invention to provide such lamps with a durable transparent colored coating which has high transparency and good color fastness, and suitable coating life, preferably for at least 3000 burning hours. It is a further object to provide a colored sign lamp with greatly increased brightness compared to lamps used for that purpose heretofore, and which gives new snap, sparkle and glitter to the display.

Colored incandescent sign lamps have been, in most instances, low in brightness even though viewed directly. This is because the coating has traditionally been a pigmented ceramic glaze having considerable light diffusion. An exception to this situation is found in bulbs made of colored glass. However, such bulbs have the disadvantages of higher cost and usually a much more saturated color than can effectively be used in advertising displays.

A need has therefore existed for a suitable transparent colored coating of higher brightness. Since most sign lamps of the type under consideration are vacuum lamps, the temperature requirements are sufficiently non-critical that it might be thought that many possible coating materials would be suitable. Thus, coating materials might be sought from many resin systems such as the cellulosics, acrylics and methacrylics, alkyds and polycarbonates.

However, it is to be noted at the outset, that the fact that the coating is to be applied to glass and must additionally have good clarity, narrows the field of selection somewhat. Nevertheless, the most stringent requirements lie in the area of environmental effects upon the coating material, both initially and throughout a long lamp life. Firstly, for several hours each day the coating material and the coloring agent must withstand the radiation from the filament which includes at least some ultraviolet energy. Secondly, of course, whether the lamp is lighted or dark, there is the ever present attack from the elements, namely rain, sun, industrial fumes, dust and wind, and the often disastrous freezing and thawing of moisture in or under the coating.

It has often been observed that a material which might be expected to easily withstand abuse from a lamp does in fact fail. The reasons for this are closely related to the effects of radiation and atmospheric attack on the glass substrate and on the coating material. The glass that is used in most lamp bulbs, including those used for sign lamps, has a fairly high sodium content. This has both chemical and physical effects. Chemically, the sodium gains considerable mobility with the presence of very little moisture. The result is a weak chemical attack upon the coating material, especially at the interface between the glass and plastic. The adhesion of the coating material to the glass is most often only the result of wetting, and this condition is easily destroyed by the chemical action referred to above. Physically, the presence of so much sodium in the glass tends to minimize the problem of the differential coefficient of expansion in the glass-plastic system. But even with high coefficient glass this differential is still five to ten fold in magnitude.

The coating material which overlays the glass may react to its environment in an unusual manner, and at least one definite reason for this is the fact of its thinness. Bulk physical properties of a material are not always realized when the material is present as a thin film. When the bulb coating material loses its adhesion to the glass, it loses the structural backing borrowed from the glass. The plastic is then able to more easily change as the photochemical and environmental attacks continue. In aging, most plastic materials lose flexibility subsequent to the loss of plasticizer, retained solvents, or as a result of molecular structural changes. With the loss of adhesion and flexibility, the film is ready for failure. Results most often are cracking or wrinkling and ultimately peeling.

Tests of different coating materials showed that the unblended acrylics would crack and peel, the unblended alkyds were not serviceable and the polycarbonates were difficult to handle and costly. Silicones and alkyds and mixtures thereof were also found often to be unsuitable in transparency and weatherability. It was therefore concluded that for reasons of cost, film flexibility, easy processing and past experience in lamp usage, the cellulosics would be most desirable. Unfortunately, the tests with cellulosics alone, specifically cellulose acetate butyrate (hereafter sometimes referred to as CAB), showed a varying tendency to crack and peel, or at least generally lose attractiveness by 1500 burning hours. Since lamp testing was done on a one-half hour on-two and one-half hours off cycle, this represented an exposure of more than one year.

However, it was discovered in accordance with the present invention that coatings of good clarity and weather resistance for a long useful life could be obtained by a composite or two layer coating of thermoplastic resins consisting of a base layer of one of the resins in the cellulosic system or mixtures thereof with intrinsic viscosities and coating properties suitable to any particular coating techniques, modified by addition of a thin top layer of a polycarbonate resin of a particular grade having a high molecular weight so as to achieve control of solvent release, as well as to provide a film that is most craze resistant. While cellulosic resins such as nitrocellulose, ethylcellulose, and cellulose acetate, each containing suitable coloring dyes, may be used for the base coat, particularly good results have been obtained with colored cellulose acetate butyrate (CAB). It will be understood that this resin is essentially that used successfully for seasonal indoor and outdoor applications usually at Christmas time.

The polycarbonate must be one of high intrinsic viscosity, with accompanying high molecular weight, to give an optimum film set-up characteristic and a minimum solvent release rate. Both features are necessary for easiest processability of the polycarbonate since it has nearly perfect Newtonian solution characteristics (dilute solutions) and extreme moisture sensitivity in the presence of solvents. Such a polycarbonate is one known as Lexan, Grade #125, marketed by General Electric Company and which is poly (bisphenol-A-carbonate) having an intrinsic viscosity of about 0.97. The difference in grades of Lexan polycarbonate, #125 vesus #115 or #105 for example, is essentially molecular weight which, in turn, effects melt and solution viscosities as well as film flexibility and other physical properties.

Solvents for the polycarbonates are preferably methylene chloride (dichloromethane) or 1,1,2 trichloroethane, both with trichloroethylene as diluent. In the absence of strict control of humidity the choice depends upon the season of the year, with the low boiling methylene chloride usually used, except in summer. The solutions are used uncolored at a solids concentration of about 4%. Other chlorinated solvents for the polycarbonate include

Sym-tetrachloroethane, chloroform, cis-1,2 dichloroethylene, 1,2 dichloroethane, etc.

The preferred CAB undercoat is used at over 10% solids (viscosity 12–16 seconds in a #20 Parlin Cup). Only the CAB coating receives the dyes, but a migration into the polycarbonate is experienced, more in some colors than others. Both materials are preferably dip-coated by methods well known in the art.

Because of the low solids of the polycarbonate solution, the deposited film of this material is in general less than 0.5 mil thick. The polycarbonate coating thickness is only slightly a function of processing speed; the CAB undercoat profoundly influences surface viscosities as it temporarily absorbs the chlorinated solvents. The polycarbonate can be peeled from the CAB by deliberate effort, when both are dry, and the CAB is found to adhere better for having been through the polycarbonate processing. However, testing does not show that this solvent effect, by itself, materially improves the film life of the CAB. The polycarbonate is definitely needed. Moreover, application of the polycarbonate as the base coat under the CAB is unsatisfactory; the polycarbonate must be the top coat.

The presence of the polycarbonate coating gives a combined coating that fulfills the desired requirements. The polycarbonate is responsible for better color stability due to its absorption of ultraviolet. It is also responsible for the fact that the coating maintains integrity with only slight loss of gloss for exposure periods in excess of 30 months.

Still more specifically, in a preferred example for the first or base colored coating the resin is cellulose acetate butyrate (CAB) such as that marked by Tennessee Eastman Chemical Company Grade EAB–381–20, 37% by weight average butyrate. The solvent solution consists of a mixture by volume, of 33.4% acetone as solvent, with 39.2% toluene, 12.9% ethyl alcohol, denatured Grade 190 proof and 14.5% diacetone alcohol.

The following are examples of suitable dyes. For blue, one part by weight Orasol Brilliant Blue GN to 2.5 parts Oracet Blue B used as 3% by weight of the resin solids. For green, one part by weight Orasol Brilliant Blue GN to 2.25 parts Eastman Yellow GLF used at 9% by weight of the resin solids. For yellow, one part by weight Orasol Orange GRM to 50 parts Eastman Yellow GLF used at 10% by weight of the resin solids. For orange, one part by weight Orasol Red B to 24 parts Orasol Orange GRM used at 10% by weight of the resin solids. For red, Orasol Red B used at 5% by weight of the resin solids. The Eastman Yellow GLF is a product marketed by Eastman Chemical Products, Inc., and the other dyes are marketed by Ciba Chemical and Dye Company.

The resulting colored CAB resin has a viscosity of about 12 seconds measured with a #20 Parlin Cup.

For the second or top coating of polycarbonate, a preferred solution, herein designated solution A is prepared by mixing, by weight, one part of the poly (bisphenol-A-carbonate) of about 0.97 intrinsic viscosity, with 9 parts 1,1,2 trichloroethane as solvent (giving 10% by weight polycarbonate in its solvent), and 16.5 parts 1,1,2 trichloroethylene as diluent. The solution has a viscosity of about 30 centipoises which gives the polycarbonate a 3.7% by weight solids concentration.

Another useful solution of polycarbonate, herein designated solution B is prepared by mixing, by weight, one part of the poly (bisphenol-A-carbonate) of about 0.97 intrinsic viscosity, with 3.645 parts methylene chloride as solvent (giving 21.5% by weight polycarbonate in its solvent) and 20.367 parts 1,1,2 trichloroethylene as diluent. This solution also has a viscosity of about 30 centipoises and a solids concentration of 4% by weight.

The polycarbonate solutions A and B are different in their evaporation rate. Solution A is preferred because of greater solvent and solution stability and easier processing.

The lamps are coated by first applying the base coating solution of cellulose acetate butyrate in any suitable manner, preferably by dipping the lamp bulb into a quantity of the solution, withdrawing it and permitting the coating to drain and dry. Drying is preferably hastened by heating the coated lamp bulb in an oven, for example for about ten to fifteen minutes at a temperature of about 70 to 80° C.

The lamp bulb is then coated with the polycarbonate solution and dried, preferably by again heating at a temperature well below the melting point of the polycarbonate, for example at a temperature of about 70 to 80° C. for about ten to fifteen minutes.

The result is a thin, clear-colored coating of cellulose acetate butyrate about 1 mil thick, and a polycarbonate top layer not greater than 0.5 mil thick, preferably less than 0.4 mil thick. With both the ratios between dyes and their total concentration relative to lacquer solids, as given above in the preferred example of the first coating, the color is correct at the same time that the CAB coating has the correct thickness of about 1 mil. In this way, the weight of the polycarbonate is also controlled as a result of its dependence on the CAB.

In the accompanying drawing:

FIG. 1 is a tilted elevation of an electric incandescent lamp having its bulb coated in accordance with the invention;

FIG. 2 is a fragmentary cross section, on an enlarged scale, of the coated lamp bulb;

FIG. 3 is an illustration, in bar graph form, of the difference in weatherability between lamps having a coating of the CAB base material alone as compared with lamps having the same base coating plus the outer layer of polycarbonate; and

FIG. 4 is an illustration, also in bar graph form, showing the brightness ratios of the new colors in accordance with the invention relative to the prior art diffusing ceramic enamel colors.

Referring to FIG. 1 of the drawing, the lamp shown therein is generally typical of outdoor sign lamps comprising an evacuated glass bulb **1** having a base **2** attached thereto, and containing a coiled tungsten wire filament **3** which is suitably supported and is connected at its ends to lead-in wires **4** and **5** which extend outwardly through a conventional glass stem **6** to respective end and shell contacts of the base **2**.

In accordance with the invention, the bulb **1** has a transparent colored coating thereon indicated by dotted lines **7** in FIG. 1. More particularly, as illustrated in FIG. 2, the coating **7** consists of two layers **7***a* and **7***b*, the first or base layer **7***a* being a clear-colored cellulosic resin, and the second or outer layer **7***b* being a thin polycarbonate film less than 0.5 mil thick. The coating **7***a* is preferably cellulose acetate butyrate containing a suitable dye as fully described above. The coating **7***b* is a polycarbonate resin of the type consisting of poly (bisphenol-A-carbonate) of intrinsic viscosity of about 0.97, also as fully described above.

The FIG. 3 graph shows the improvement in coating life obtained by using the composite coating of polycarbonate overlying a layer of cellulose acetate butyrate (CAB) as compared with a coating of CAB alone. The practical life is defined as the point where the coating peels. When the CAB base coating material is used alone, wrinkling can occur as easly as 500/3000 hours (where 500 is burning time and 3000 is the total time outdoors). Actual coating failure varies with color, but it failed by wrinkling, cracking and ultimately peeling sometime between 1000 and 2000 burning hours (6000 to 12,000 exposure hours), as shown by the first bar **8**. Some of the colors lasted somewhat longer, but the coating was cracked and very brittle with occasional spotty peeling.

The two layer coating, including polycarbonate over the CAB, has shown no failures after 3000/18,000 hours of testing, as illustrated by the second bar **9** in FIG. 3.

Such coatings are therefore fully acceptable since 3000 hours is the rated life of the lamp. The coating does show the effects of the exposure for over two years to the elements, but only to the extent of some loss of gloss, as indicated at the upper end of bar **9**. None of the colors have started to show premature failure as was the case when the polycarbonate resin was not used. This top coat appears to have given a skin to the coating surface that is harder and does not permit wrinkling or cracking, in spite of the known tendency of the first coated material to do those things.

FIG. 4 illustrates one of the advantages of the new transparent coating by showing the brightness ratios of the new colors as compared with the prior art diffusing ceramic colors. It will be evident that there was very little brightness in the prior art ceramic blue and green colors.

When using several colors in the same sign there is a problem of blending different colors to achieve good balance in brightness because the actual brightness in lumens of a source is so much a function of its color. Accordingly, the power consumption of the new transparent sign lamps is preferably adjusted to make possible arrangements having equal brightness. This effect may be obtained by any combination of lamps of the following wattage and color: 11 watt yellow, 15 watt orange, 25 watt red and green, and 40 watt blue.

It will be evident that the purpose and effect of the extremely thin outer layer of polycarbonate resin as part of a composite clear-colored sign lamp coating which is resistant to weathering over a long period of outdoor exposure, is a thing quite apart from the use of polycarbonate resin as an outer protective coating for the glass bulbs of photoflash lamps where it is intended to resist shattering of the glass bulb during the instantaneous single period of operation of the photoflash lamp. For such purposes it has been proposed to use polycarbonate resin of the Lexan Grade #115 type which has a lower molecular weight than the Grade #125 and forms a relatively thick coating of about 5 to 7 mils as compared to the thickness of less than 0.5 mil required for the purposes of the present invention. As determined by applicant's assignee, for such an application the solids content of the coating solution was required to be high. However, polycarbonate resin is generally soluble only in the rather expensive chlorinated solvents, and for the highest solids content only methylene chloride could be used. A contingent drawback is the fact that the moisture (blush) sensitive material is thus limited to the fastest evaporating solvent. The problem of achieving sufficiently fast evaporation for suitable film set-up, while avoiding the reaction of the wet film to condensation of moisture from the air has always been a problem for lacquer handling. Thus the use of polycarbonate for photoflash lamps tended to become complicated and expensive, requiring improved humidity control for reliable processing. Of course, the problem of retaining the particles of the glass bulb of the photoflash lamp in case of explosion due to the instantaneous high temperature and pressure involved, is a problem quite apart from the prevention of weathering of a transparent color coating on a sign lamp operating outdoors over a period of thousands of hours. The former requires a relatively very thick coating, the latter a very thin film in combination with a colored lacquer base coating in accordance with the present invention.

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

1. An electric lamp comprising a glass bulb containing a light-emitting filament and having on its outer surface a composite coating of a first thin film of transparent colored cellulosic lacquer which is subject to weathering, and a thin outer film of clear polycarbonate resin which effectively inhibits weathering of said first film, said polycarbonate resin being of the type consisting of poly (bisphenol-A-carbonate) of intrinsic viscosity of about 0.97.

2. A lamp as in claim **1** wherein said first film of colored lacquer is about one mil thick and said outer film of polycarbonate is less than one-half mil thick.

3. A lamp as set forth in claim **1** wherein said first film is colored cellulose acetate butyrate.

4. A lamp as set forth in claim **1** wherein said first film is colored cellulose acetate butyrate about one mil thick and said outer film of polycarbonate is less than one-half mil thick.

5. The method of forming a weather resistant transparent color coating on an electric lamp bulb which comprises first coating the outer bulb surface with a solution of a colored cellulosic lacquer, drying the said first coating, and then coating the outer bulb surface with a second solution consisting essentially of poly (bisphenol-A-carbonate) having an intrinsic viscosity of about 0.97 and a chlorinated solvent therefor and diluent sufficient to provide a solution containing about 4% by weight solids, and drying the said second solution.

6. The method set forth in claim **5** wherein the chlorinated solvent is selected from the group consisting of methylene chloride and 1,1,2 trichloroethane.

7. The method set forth in claim **5** wherein the chlorinated solvent is 1,1,2 trichloroethane.

8. The method set forth in claim **5** wherein the chlorinated solvent is selected from the group consisting of methylene chloride and 1,1,2 trichloroethane, and the diluent is 1,1,2 trichloroethylene.

9. The method set forth in claim **5** wherein the chlorinated solvent is 1,1,2 trichloroethane, and the diluent is 1,1,2 trichloroethylene.

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117—33.3, 94, 124, 161