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COATED FLASHLAMP AND COATING COMPOSITION

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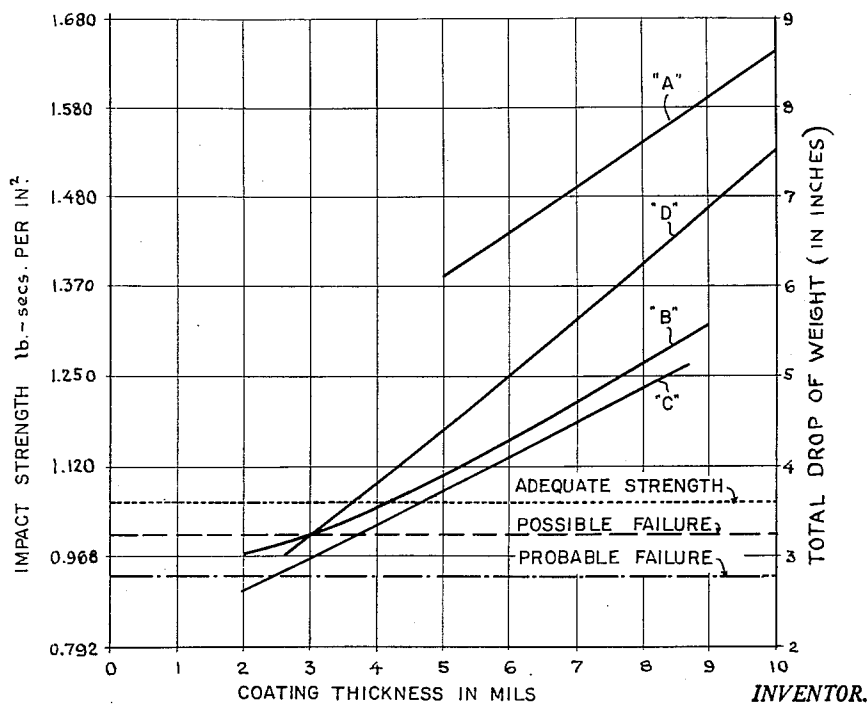
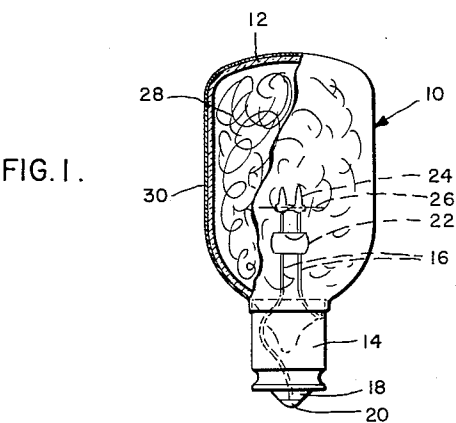


FIG. 2.

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COATED FLASHLAMP AND COATING
COMPOSITION

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9 Claims. (Cl. 67-31)

This invention relates to a flashlamp and coating composition and, more particularly, to a flashlamp having a protective coating and to coating compositions for application to a flashlamp envelope composition and method and, more particularly, to a flashlamp having a protective coating, to coating compositions and to methods for applying a protective coating to a flashlamp envelope.

Flashlamps or so-called photoflash lamps are well known and normally comprise a sealed vitreous envelope which encloses a quantity of combustible material such as shredded aluminum or zirconium and a combustion-supporting means such as an oxygen atmosphere. On ignition, the combustible material and combustion-supporting means react to produce a flash of actinic light. The actinic reaction also produces physical and thermal shocks which would tend to shatter the glass envelope of the flashlamp if it were not otherwise protected. It has been the practice of the industry to cover the interior or exterior or both the interior and exterior surfaces of the lamp envelope with protective coatings, in order to prevent shattering of the envelope when the lamp is flashed. An often-used protective coating is cellulose acetate and in more-recent photoflash lamp designs, plural layers of coating have been used. Such plural layers of coating have been considered desirable because the tendency of the art is to increase more and more the quantity of actinic material and the amount of combustion-supporting means which are enclosed within the envelope, in order to produce more and more light without increasing the size of the lamp or appreciably increasing the cost. In this regard, it has been proposed in U.S. Patent No. 2,791,113, dated May 7, 1957, to utilize plural layers of coating on the exterior envelope surface of a flashlamp. Such a coating comprises a first coating layer of heat-resistant material such as an acrylic resin, which serves to form an insulating barrier against thermal shock and which also serves to provide some protection against physical shock. This first coating layer has applied thereover a second coating layer of cellulose acetate, which has a high tensile strength and which protects against the physical shocks produced by the actinic reaction. Such plural coatings require two coating steps. This increases the costs considerably. It is extremely desirable to use a single exterior protective coating layer which will contain both the thermal and physical shocks produced by the actinic reaction. Such coatings have been used, but are marginal in performance when used with present flashlamps.

In order to overcome the foregoing and other difficulties of and objections to the prior-art practices, it is the general object of this invention to provide an improved photoflash lamp having on the envelope exterior surface a single layer protective coating having excellent impact strength and performance characteristics.

It is a further object to provide an improved photoflash lamp, the envelope exterior surface of which is coated with a specific preferred coating composition.

It is another object to provide a coating composition for depositing a protective coating onto the exterior surface of a photoflash lamp envelope.

It is an additional object to provide a specific preferred coating composition for depositing a protective coating onto the exterior surface of a photoflash lamp envelope.

The aforesaid objects of the invention, and other ob-

jects which will become apparent as the description proceeds, are achieved by providing a photoflash lamp having on the exterior surface of the envelope a protective coating comprising a mixture of specific cellulose acetates. These cellulose acetates are preselected so as to reinforce one another with respect to the desirable properties of each. In this manner, the desirable properties of each of the mixed cellulose acetates are utilized, while simultaneously minimizing the effects of the undesirable properties of each. In addition, there has been provided a coating composition and a method for depositing onto the exterior surface of a photoflash lamp envelope by means of a single-dip process, a mixture of selected cellulose acetates.

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 an M-2 type photoflash lamp, the envelope of which carries the improved protective coating;

FIG. 2 is a graph of impact strength versus coating thickness, illustrating the performance characteristics of different types of cellulose acetate coatings and a mixed cellulose acetate coating as per this invention.

Although the principles of the invention are broadly applicable to any photoflash lamp, the invention is conveniently used with an M-2 type photoflash lamp (having a bulb volume of 7 cc. for example) 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 indicates generally an M-2 type photoflash lamp comprising a glass envelope 12, base shell 14 affixed to the envelope and lead-in conductors 16 hermetically sealed through the envelope. The base shell 14 has a generally-hollow, cylindrical-shell configuration and can be fabricated of brass, aluminum or other conducting material. An insulating button 18 is centrally disposed at the bottom of the base shell 14 and carries an eyelet 20 which is electrically connected to one of the lead-in conductors. The other lead-in conductor electrically connects to the base shell 14 to facilitate electrical connection for the lamp. A glass bead 22 serves to support and properly space the lead-in conductors 16 and a primer 24 is carried on an igniting filament 26 and also on the lead-in conductor inwardly-extending extremities. The primer 24 can comprise a mixture of potassium perchlorate, binder and zirconium, as is well known. A shredded combustible material 28 such as aluminum or zirconium for example is enclosed by the envelope along with a combustion-supporting means such as an oxygen-gas fill which can be at a pressure of 1,000 mm. for example. The combustible material and the combustion-supporting means are adapted to be ignited by the primer-carrying filament and on combustion generate a flash of actinic light.

Carried on the exterior or outer surfaces of the glass envelope 12 and extending a short distance onto the base shell 14 is the protective cellulose acetate coating 30 of this invention. Cellulose acetates are well known and are commercially available from a number of manufacturers. Cellulose acetates are normally marketed according to their viscosity, which essentially is a measure of the chain length. The procedure for determining the viscosity of cellulose acetates is outlined in ASTM designation: D871-54T. Briefly, a low-viscosity cellulose acetate requires a greater amount of such material to be dissolved in a solvent to produce a given viscosity than is required with a higher-viscosity cellulose acetate. Thus for any given viscosity, a low-viscosity cellulose acetate will have a comparatively-high solids content and a high-viscosity cellulose acetate will have a comparatively-low solids content. In applying protective cellulose acetate coatings to photoflash lamp envelopes, it is very desirable

to utilize a cellulose acetate coating composition or lacquer having a high solids content. The reasons for this are that more material can be applied in a single dip and a very small decrease in solvent concentration will greatly increase the resulting viscosity. This has the advantage that when a photoflash lamp envelope is dipped into such a cellulose acetate coating composition and then withdrawn, the loss of a very small amount of solvent from the coating composition will cause the viscosity of the coated material to increase very rapidly, thereby inhibiting any tendency for drainage patterns due to the forces of gravity. For these reasons, it is extremely desirable to use a cellulose acetate coating composition which has a very high solids content. As noted, however, high solids contents in cellulose acetate coating compositions require the use of a low-viscosity cellulose acetate if practical coating viscosities are to be obtained. The impact strengths of low-viscosity cellulose acetates are comparatively poor while the impact strengths of high-viscosity cellulose acetates are comparatively good. Of course it is possible to apply a high-viscosity cellulose acetate, such as a 30-second cellulose acetate to the photoflash lamp envelope, but for usable dipping viscosities with such acetates, the solids content of the dipping composition is quite low and only a small amount of the material is conveniently applied in a single dip.

In accordance with the present invention, it has been found that by admixing from 25 to 50% by weight of cellulose acetate having a viscosity of from 17 to 24 seconds and from 75 to 50% by weight of cellulose acetate having a viscosity of from 6 to 10 seconds, sufficient material can be deposited in a single dip in order to provide adequate protection for the photoflash lamp. The preferred cellulose acetate admixture is about 30% by weight of cellulose acetate having a viscosity of 20 seconds and about 70% by weight of cellulose acetate having a viscosity of from 6 to 8 seconds.

The primary factor in determining the performance characteristics for an exterior protective coating for a photoflash envelope is the impact strength. While thermal stability is also a consideration due to the heat generated by the exothermic actinic flash, this consideration is secondary inasmuch as the glass envelope provides considerable thermal shielding for the exterior coating. In FIG. 2 are shown curves of impact strength versus cellulose acetate thickness, illustrating the performance characteristics which are obtained with high-viscosity cellulose acetate, low-viscosity cellulose acetates and a cellulose acetate mixture comprised of high-viscosity material and low-viscosity material. In FIG. 2, the curve designated "A" represents the impact strength of a 20-second cellulose acetate applied to the indicated thickness. While some of the indicated thicknesses are appreciable, such relatively-thick coatings are extremely difficult to obtain on a production basis with a high-viscosity cellulose acetate, since the viscosity of the dipping solution is too great for consistent results. In the curve designated "B" is shown the impact strength versus skin thickness for an 8-second cellulose acetate. In the curve designated "C" is shown the impact strength versus skin thickness for a 6-second cellulose acetate. In the curve designated "D" is shown the impact strength versus skin thickness for an admixture of 70% by weight of 6-second acetate and 30% by weight of 20-second acetate. The viscosity of these mixed acetates was 8.5 seconds. As shown in FIG. 2, for a thickness of about 4 mils and greater, the impact strength of the mixed acetates as specified is far greater than is obtained from an unmixed acetate having about the same viscosity. The reasons for this improved impact strength are not clearly understood, but may be attributed to the effect of the different chain lengths of the mixed acetates.

In determining the impact strengths of the acetates, wafers of the various acetates were prepared to the varying thickness as indicated in FIG. 2. A vertically-disposed

pipe having a calibrated slot therein was placed over the wafer. A free-moving weight of 10.85 grams and terminating at its lower extremity in a rounded pin having a diameter of $\frac{1}{16}$ inch was placed inside the calibrated pipe. The cellulose acetate wafer to be tested rested on a supporting platform which had a centrally-disposed hole of a diameter of $\frac{3}{32}$ inch. The free-moving weight was allowed to drop onto the acetate wafer from varying heights as indicated on the ordinate in FIG. 2 and the point at which the wafer punctured was noted to establish the curves. The actual impact strength in terms of pound-seconds per square inch is readily determined mathematically from the foregoing.

In applying the cellulose acetates to the exterior surface of the photoflash envelope by a single-dip process, the indicated cellulose acetates are mixed with a solvent in amount of from 17% to 26% and preferably about 24% by weight of the solvent. The solvent used comprised from 40% to 95% by weight of a cellulose acetate solvent having a high vapor pressure such as acetone, from 2% to 40% by weight of a cellulose acetate cosolvent having an intermediate vapor pressure such as ethanol and from 3% to 20% by weight of a cellulose acetate solvent having a low vapor pressure such as ethyl lactate. It is also desirable from a cost standpoint to incorporate into the solvent up to 17% by weight of a material which swells the cellulose acetate, such as diacetone alcohol. This allows less ethyl lactate to be used. The preferred solvent combination for the mixed cellulose acetates comprises about 81% by weight of acetone, about 9% by weight of ethanol, about 5% by weight of ethyl lactate and about 5% by weight of diacetone alcohol. To this is added the preferred mixed cellulose acetates in amount of about 24% by weight of the solvent to form the coating composition. At a temperature of 25° C., the usable viscosity range for the coating composition is from 59 to 375 seconds No. 10 Demmler cup and the preferred viscosity for the coating composition is from 335 to 350 seconds No. 10 Demmler cup. The acetone solvent has a vapor pressure at 30° C. of 277 mm. and other cellulose acetate solvents having a vapor pressure of from 180 mm. to 300 mm. at 30° C. can be substituted for the acetone. The ethanol cosolvent has a vapor pressure of 78 mm. at 30° C. and other cosolvents having a vapor pressure of from 35 mm. to 90 mm. at 30° C. can be substituted therefor. The ethyl lactate has a vapor pressure of 5 mm. at 30° C. and other solvents having a vapor pressure of from 1 mm. to 20 mm. at 30° C. can be substituted therefor. As noted hereinbefore, ethanol is classed as a cosolvent for cellulose acetate. A cosolvent is defined as a solvent which by itself is a nonsolvent for cellulose acetate, but which in combination with an active solvent forms a mixed solvent which is even better than the active solvent. For the specific combination solvent as given hereinbefore, the addition of the ethanol to the acetone lowers the viscosity of the admixture. The diacetone alcohol which is desirably used from a cost standpoint is classed as a swelling agent for cellulose acetate. In explanation of this term, swelling agents do not disperse cellulose acetates but cause same to increase in volume. Such a swelling agent, however, is actually a solvent for cellulose acetates at a temperature of about 65° C. It should be understood that where ethanol is specified, denatured alcohol will normally be used.

In determining viscosities for the coating compositions, it has been found convenient to use a modified No. 10 Demmler cup viscosimeter because of the time element involved. A standard No. 10 Demmler viscosimeter is marketed by Westinghouse Electric Corporation, East Pittsburgh, Pa. Briefly, this viscosimeter comprises a hollow-conical receptacle terminating at its apex in an orifice. For taking the viscosity measurements, the modified No. 10 Demmler viscosimeter had an orifice enlarged to an internal diameter of 0.35 inch, the distance from the tip of the needle to the outside opening of the orifice

was 1.49 inches and the weight of the viscosimeter was 28.6 grams. The viscosity readings observed with such a modified No. 10 Demmler cup are 0.253 of the viscosity as measured with a standard No. 10 Demmler cup. In measuring the viscosity with such a device, the viscosimeter is placed into the liquid solution to be measured with the apex down so that the liquid can enter the orifice. The time which the liquid being measured requires to reach the measuring needle affixed to the top portion of the viscosimeter is a measure of the viscosity.

Before coating the lamp envelope, lamp fabrication is first completed in accordance with conventional practices. Thereafter the fabricated lamp is grasped by the base and dipped into a coating composition as specified hereinbefore. The amount of coating composition which is deposited onto the lamp will also vary according to the withdrawal rate and for the preferred coating composition as specified hereinbefore, the withdrawal rate for an M-2 type photoflash lamp is 0.13 centimeter per second. Immediately upon withdrawal from the coating composition, the acetone constituent of the composite solvent evaporates rapidly. As indicated hereinbefore, the loss of a very small amount of solvent will cause the viscosity of a high-solids coating composition to increase greatly and even a small loss of solvent causes the coating to set rapidly, thereby preventing drainage patterns due to the forces of gravity. Thereafter the coated lamp is heated to a temperature of from about 110° F. to about 140° F. which causes a substantial portion of the intermediate-vapor-pressure ethanol cosolvent to volatilize rapidly, which further sets the dipped cellulose acetate coating. The intermediate-vapor-pressure cosolvent also serves the purpose of preventing excessively-rapid dissipation of acetone solvent from the coating to prevent wrinkling and bubble formation. An excessively-rapid dissipation of solvent also has a cooling effect, causing moisture to condense on the coated lamp to produce what is known as blushing. Some of the ethyl lactate solvent and diacetone alcohol swelling agent, if used, remains in the lacquer coating and serves the purpose of keeping same flexible over a long period of time. The amount of residual solvent comprising ethyl lactate which remains in the coating is not critical, but as an example 0.5 percent by weight of the admixed acetates remains in the coating for an extended period of time such as 3,000 hours. It is desirable that the coating composition is applied to a thickness of at least about 4.5 mils in order that the applied acetate coating has a thickness of at least about 4 mils, since a 10% reduction in thickness is normally realized from solvent dissipation.

The foregoing coating composition and method for coating a photoflash lamp envelope can be modified readily to vary the coating thickness by varying the viscosity, withdrawal rates, etc. In actual performance tests, the single-dip coating composition as specified functions extremely well and the resulting coating displays such impact strength as to provide a considerable margin of safety over that impact strength which can possibly result in a failure of the protective coating when the lamp is flashed. For an M-2 type photoflash lamp having an oxygen fill pressure of 1000 mm. and sufficient aluminum foil combustible material to react stoichiometrically on ignition, the protective coating impact strengths required are shown in FIG. 2. The dotted line which is drawn at an impact strength of 1.06 lb.-second per square inch represents that impact strength which is required to provide adequate resistance against failure. The dashed line drawn at an impact strength of 0.998 lb.-second per square inch represents that impact strength at which failures are possible. The dash-dot line drawn at an impact strength of 0.938 lb.-second per square inch represents an impact strength at which lamp failures are very likely to occur. As shown in these curves, in order to insure an adequate impact strength for this type of lamp, the specified coating should have thickness of at least about 4 mils. It is in-

teresting to note that the present mixed cellulose acetate coatings do not display their enhanced impact strength until a thickness of at least about 4 mils is obtained. With any thickness appreciably less than about four mils, such as a thickness of 3 mils, the increased impact strength realized with the mixed acetates is not obtained.

As is usual in the art, dyes can be added to the coating composition so that the resulting protective coating will be tinted. Such dyes are well known and as an example, 0.02% by weight of toluidine blue can be added to the coating composition to provide the coated lamp with a color-corrected output.

It will be recognized that the objects of the invention have been achieved by providing an improved photoflash lamp having on the envelope exterior surface a single layer protective coating having excellent impact strength and performance characteristics. In addition, there has been provided a single-dip process for applying a protective film of mixed cellulose acetates as well as a coating composition for applying cellulose acetates to the exterior surface of a photoflash lamp envelope.

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

I claim:

1. A flash lamp having an envelope, a single-layer protective coating on the exterior surface of said envelope, said coating comprising a mixture of from 25% to 50% by weight of cellulose acetate having a viscosity of from 17 to 24 seconds, and from 75% to 50% by weight of cellulose acetate having a viscosity of from 6 to 10 seconds, and said coating having a thickness of at least about 4 mils.

2. A flash lamp having a glass envelope, a single-layer protective coating on the exterior surface of said envelope, said coating comprising a mixture of from 25% to 50% by weight of cellulose acetate having a viscosity of from 17 to 24 seconds, and from 75% to 50% by weight of cellulose acetate having a viscosity of from 6 to 10 seconds, and said coating having a thickness of at least about 4 mils.

3. A flash lamp having a glass envelope, a single-layer protective coating on the exterior surface of said envelope, said coating comprising a mixture of from 25% to 50% by weight of cellulose acetate having a viscosity of about 20 seconds, and from 75% to 50% by weight of cellulose acetate having a viscosity of from 6 to 8 seconds, and said coating having a thickness of at least about 4 mils.

4. A flash lamp having a glass envelope, a single-layer protective coating on the exterior surface of said envelope, said coating comprising a mixture of about 30% by weight of cellulose acetate having a viscosity of about 20 seconds, and about 70% by weight of cellulose acetate having a viscosity of from 6 to 8 seconds, and said coating having a thickness of at least about 4 mils.

5. A coating composition for depositing a protective film of mixed cellulose acetates onto the exterior surface of a photoflash lamp envelope: said coating composition comprising a solids component and a solvent component; said solids component comprising a mixture of from 25% to 50% by weight of from 17 second to 24 second cellulose acetate and from 75% to 50% by weight of from 6 second to 10 second cellulose acetate; said solvent component comprising from 40% to 95% by weight of cellulose acetate solvent having a high vapor pressure to evaporate rapidly to cause deposited cellulose acetate to set rapidly without drainage patterns due to forces of gravity, from 2% to 40% by weight of cellulose acetate cosolvent having an intermediate vapor pressure to prevent excessively rapid solvent evaporation from deposited cellulose acetate thereby preventing wrinkling and bubble formation, and from 3% to 20% by weight of cellulose acetate solvent having a low vapor pressure so that a portion thereof remains in deposited cellulose acetate to

keep same flexible over an extended period; and said coating composition having at 25° C. a No. 10 Demmler cup viscosity of from 59 to 375 seconds and a solids content of from 17 to 26 percent by weight.

6. A coating composition for depositing a protective film of mixed cellulose acetates onto the exterior surface of a photoflash lamp envelope: said coating composition comprising a solids component and a solvent component; said solids component comprising a mixture of about 30% by weight of 20 second cellulose acetate and about 70% by weight of from 6 second to 8 second cellulose acetate; said solvent component comprising from 40% to 95% by weight of cellulose acetate solvent having a high vapor pressure to evaporate rapidly to cause deposited cellulose acetate to set rapidly without drainage patterns due to forces of gravity, from 2% to 40% by weight of cellulose acetate cosolvent having an intermediate vapor pressure to prevent excessively rapid solvent evaporation from deposited cellulose acetate thereby preventing wrinkling and bubble formation, and from 3% to 20% by weight of cellulose acetate solvent having a low vapor pressure so that a portion thereof remains in deposited cellulose acetate to keep same flexible over an extended period; and said coating composition having at 25° C. a No. 10 Demmler cup viscosity of from 59 to 375 seconds and a solids content of from 17 to 26 percent by weight.

7. A coating composition for depositing a protective film of mixed cellulose acetates onto the exterior surface of a photoflash lamp envelope: said coating composition comprising a solids component and a solvent component; said solids component comprising a mixture of from 25% to 50% by weight of from 17 second to 24 second cellulose acetate and from 75% to 50% by weight of from 6 second to 10 second cellulose acetate; said solvent component comprising from 40% to 95% by weight of acetone, from 2% to 40% by weight of ethanol, and from 3% to 20% by weight of ethyl lactate; and said coating composition having at 25° C. a No. 10 Demmler cup viscosity of from 59 to 375 seconds and a solids content of from 17 to 26 percent by weight.

8. A coating composition for depositing a protective film of mixed cellulose acetates onto the exterior surface of a photoflash lamp envelope: said coating composition comprising a solids component and a solvent component; said solids component comprising a mixture of from 25% to 50% by weight of from 17 second to 24 second cellulose acetate and from 75% to 50% by weight of from 6 second to 10 second cellulose acetate; said solvent component comprising from 40% to 95% by weight of acetone, from 2% to 40% by weight of ethanol, from 3% to 20% by weight of ethyl lactate, and from 0-17% by weight of diacetone alcohol; and said coating composition having at 25° C. a No. 10 Demmler cup viscosity of from 59 to 375 seconds and a solids content of from 17 to 26 percent by weight.

9. A coating composition for depositing a protective film of mixed cellulose acetates onto the exterior surface of a photoflash lamp envelope: said coating composition comprising a solids component and a solvent component; said solids component comprising a mixture of about 30% by weight of 20 second cellulose acetate and about 70% by weight of from 6 second to 8 second cellulose acetate; said solvent component comprising about 81% by weight of acetone, about 9% by weight of ethanol, about 5% by weight of ethyl lactate, and about 5% by weight of diacetone alcohol; and said coating composition having at 25° C. a No. 10 Demmler cup viscosity of from 335 to 350 seconds and a solids content of about 24 percent by weight.

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