Sept. 1, 1953 S. PAKSWER ET AL 2,650,884

PROCESS FOR FILMING LUMINESCENT SCREEN

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Fig. 1

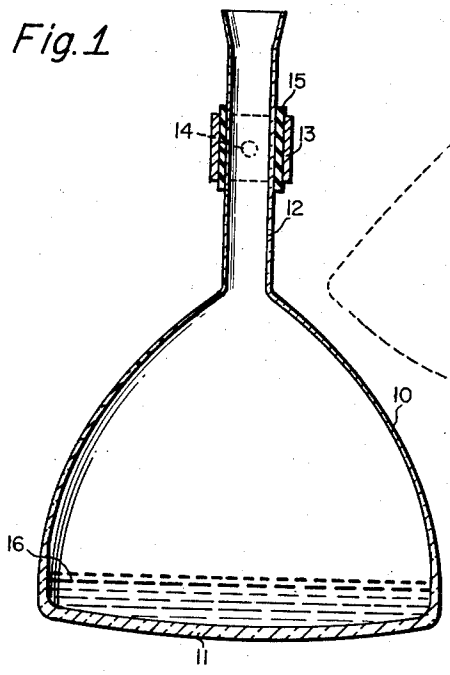
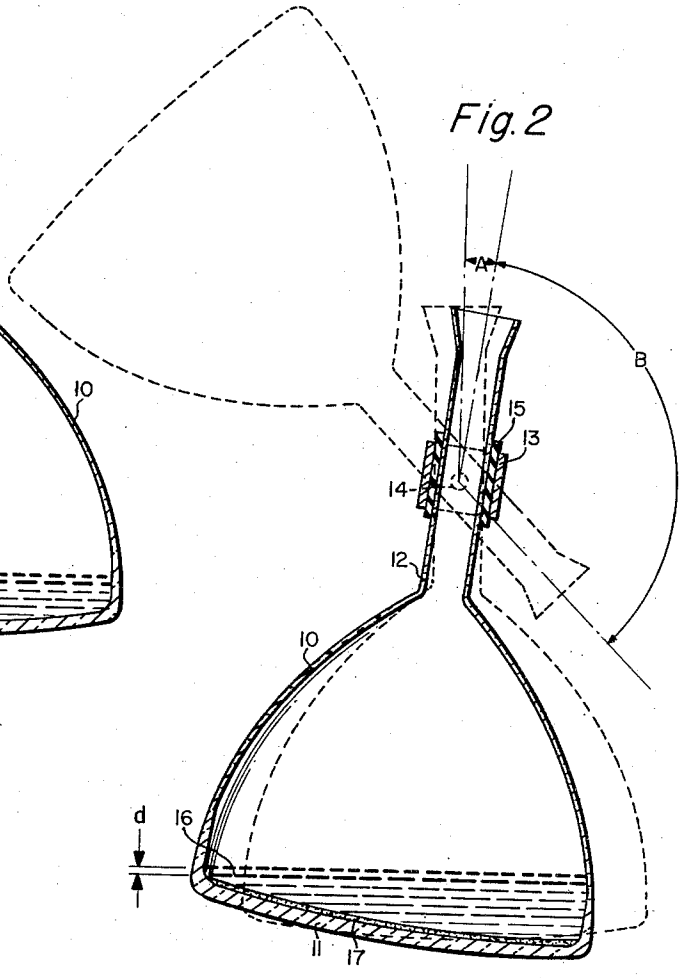


Fig. 2



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PROCESS FOR FILMING LUMINESCENT SCREEN

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7 Claims. (Cl. 117—33.5)

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This invention relates to cathode-ray tubes and more particularly to a novel process for applying a thin volatilizable organic film to the fluorescent screen of a cathode-ray tube.

It is well known that the provision of a metal backing layer for the fluorescent screen of a cathode-ray picture tube affords several important advantages such as increased brightness, absence of ion burn, and improved conductivity. However, in order to obtain these advantages without encountering excessive image diffusion during operation of the tube, it has been found necessary to exercise extreme care in forming the metal backing layer. For best results, the metal backing should be thin, continuous and in close contact with the fluorescent screen. Since deposition of the fluorescent powder on the face plate of the picture tube leaves a rough surface characterized by a multitude of crevices each several microns in depth, direct evaporation of the meal layer onto the powder results in the lodging of evaporated metal particles between the powder particles, and the film thus formed is discontinuous and highly light-absorbing. Consequently, it is conventional practice to form a thin plasticized organic film over the fluorescent screen to provide a smooth surface onto which the metal backing layer may be evaporated; the organic film is preferably removed by volatilization after deposition of the metal backing layer.

In accordance with one filming process which has achieved commercial acceptance, the organic film is applied to the fluorescent screen by casting the film on the surface of a casting liquid within the envelope and subsequently removing the casting liquid from the envelope to permit the floating film to settle gently on the pinnacles of the fluorescent powder surface. The metal backing layer is evaporated onto the smooth organic membrane thus formed, and the film is subsequently removed by volatilization. This process is described and claimed in the copending application of James S. Bailey, Serial No. 4,207, filed January 24, 1948, and now abandoned, for Process of Coating Luminescent Screens, and assigned to the same assignee as the present application.

While the filming process described in the copending Bailey application results in a smooth uniform film surface onto which the metal backing layer may be readily deposited, it has been necessary to complete the entire fluorescent screen forming process before introducing the casting liquid on the surface of which the organic film is to be formed. Thus, in accordance with a typical commercial process for producing a metal-backed fluorescent screen on the face plate of a cathode ray tube envelope, the fluorescent screen powder is settled through a liquor introduced into the envelope. The settling liquor is then decanted and the fluorescent screen is thoroughly dried, after which the casting liquid is introduced. The filming solution is applied to the surface of the casting liquid and, after formation of the organic film, the casting liquid is decanted. The tube is then subjected to a second drying cycle, after which the metal backing layer is evaporated onto the organic film and the film is removed by volatilization.

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Previous attempts to employ a single liquor for both screen settling and film formation have been unsuccessful, primarily for the reason that the mechanics of screen settling and film formation require liquid columns of different heights. In order to provide a fluorescent screen of commercially acceptable uniformity by the settling process, it has been found necessary to employ a settling liquor of at least one and preferably several inches in depth. On the other hand, if a liquor of the same depth is used for film formation, the area of the resultant film is much less than that of the screen surface owing to the generally conical shape of the envelope, and tearing or streaking is encountered so that the resultant metal backing layer is non-uniform. Obviously, the necessity of using two decanting and drying cycles to produce each metal-backed screen is both time-consuming and costly.

It is, therefore, a primary object of the present invention to provide a new and improved process for forming a thin volatilizable plasticized organic film on the viewing-screen surface of a cathode-ray tube.

It is a further object of the invention to provide a novel process for forming a fluorescent screen and for depositing a thin volatilizable plasticized organic film over the fluorescent screen without decanting the liquor between the screen-settling and film-forming operations.

In accordance with the invention, a new and improved filming process comprises the steps of introducing a casting liquid into the envelope of a cathode-ray tube, maintaining the envelope in a position with its axis inclined from a vertical by an acute angle to cause the surface area of the casting liquid to assume a value at least substantially equal to the area of the screen surface, forming a thin volatilizable plasticized organic film on the surface of the casting liq-

uid, and thereafter removing the casting liquid from the envelope to deposit the film on the screen surface.

Also in accordance with the invention, the screen-settling and film-forming operations may be performed with the use of a single liquor. The liquor is first introduced into the envelope of the cathode-ray tube, and the fluorescent screen material is settled onto the face plate through the liquid column while the tube is maintained in a vertical position. After the screen-settling operation is completed the envelope is tilted through an acute angle from its vertical position to cause at least one surface dimension of the liquor to assume a value at least equal to the largest characteristic dimension of the viewing-screen surface. While the envelope is maintained in the tilted position, a thin volatilizable plasticized organic film is formed on the surface of the liquor. The liquor is subsequently removed from the envelope to deposit the film over the previously-formed fluorescent screen.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The invention, together with further objects and advantages thereof, may best be understood, however, by reference to the following description taken in connection with the accompanying drawings, in the several figures of which like reference numerals indicate like elements, and in which:

Figure 1 is a cross-sectional view of a cathode-ray tube containing a liquor and maintained in a position with its axis substantially vertical during the screen-settling operation, and

Figure 2 is a similar view of the cathode-ray tube envelope containing a liquor and maintained in a position with its axis tilted from a vertical by an acute angle during the film-casting operation, the screen-settling and decanting positions of the envelope being indicated in dotted lines.

A brief discussion of the mechanics of film formation may be helpful in facilitating an understanding of the invention. In accordance with the process described and claimed in the above-identified copending Bailey application, a solution of a synthetic resin or plastic, such as nitrocellulose, and a suitable plasticizer is poured or pipetted onto the surface of the casting liquid. The resin-plasticizer solution spreads uniformly over the surface of the casting liquid. The solvent begins to evaporate, forming a thin layer of plasticized organic film on the surface in contact with the air. Should the casting liquid be decanted while the film is only partially solidified, some of the still-liquid film solution is found to streak or swirl over the surface of that portion which has already solidified, thereby resulting in inadmissible variations in thickness. As a consequence, it has been found necessary to wait until the solvent is substantially entirely evaporated before decanting the casting liquid. At this stage, the solidified film has lost its spreading power and has a tendency to curl back at the edge during the decantation process, resulting in a discontinuity in the subsequently-applied metal backing layer. This undesirable condition is found to arise whenever the surface area of the casting liquid is substantially smaller than the area of the viewing-screen surface, a situation normally encountered when it is attempted to form the organic film on the surface of the liquor used for screen-settling.

In accordance with the invention, the area of

the surface of the casting liquid is caused to assume a value at least substantially equal to the viewing-screen area by maintaining the envelope in a position with its axis tilted from a vertical by an acute angle during the formation of the organic film. Viewed in another way, the envelope is maintained in such a position that at least one surface dimension of the casting liquid is caused to assume a value at least equal to the largest characteristic dimension of the viewing screen. In this manner, streaking and curling of the organic film are substantially avoided.

The process of the invention may be more fully understood by reference to the accompanying drawings. In Figure 1, a glass cathode-ray tube envelope 10 comprises a fluorescent-screen-receiving face plate 11 and a generally cylindrical electron-gun chamber 12. The envelope is supported by means of a clamp 13 mounted on a shaft 14 to permit rotation of the envelope during the processing of the tube. A piece 15 of sponge rubber or other suitable material is provided between clamp 13 and the glass neck 12 of the tube to provide a firm clamping action while protecting the neck from cracking.

As shown in Figure 1, the envelope is maintained with its axis in a substantially vertical position, and a suitable liquor 16 is introduced. A suspension of fluorescent screen material is sprayed or poured over the surface of liquor 16. The envelope is maintained in the vertical position for a sufficient period of time to permit the fluorescent screen material to settle through the liquor 16 onto the viewing-screen surface of face plate 11.

To this point, the settling process is identical with that commonly used in the commercial fabrication of cathode-ray picture tubes. In accordance with known processes, the liquor 16 is decanted after the screen powder has been permitted to settle and adhere to the glass face plate, and the screen is thoroughly dried before proceeding with the filming operation.

In accordance with the invention, however, after permitting the screen powder to settle through the liquor, the envelope is tilted to a position in which its axis is inclined from a vertical by an acute angle A, preferably without removing any of the liquor from the envelope, as shown in Figure 2. When the envelope is in this position, the surface of the liquor 16 assumes a value at least substantially equal to the area of the viewing-screen surface of face plate 11. Specifically, if the envelope is substantially conical in shape as in the case of a so-called circular picture tube, the surface area of liquor 16 becomes elliptical, and the major axis of the ellipse is at least substantially equal to and preferably greater than the diameter of the viewing-screen surface. Moreover, the angle A by which the envelope is tilted from a vertical is such that the screen surface is kept completely immersed and the minimum-depth d does not substantially exceed the difference between the major axis of the elliptical liquor surface and the screen surface diameter. Experimentation with water-insoluble dyes has shown that if this condition is not met, the organic film overlaps the side wall of the envelope and fails to cover the entire screen surface after the liquor has been decanted. Therefore, it is important that the liquor have a substantially minimum-depth during the film-casting operation.

While the envelope is maintained in the position shown in Figure 2, a small amount of filming solution comprising a synthetic resin and a

suitable plasticizer is pipetted onto the surface of the liquor 16. The envelope is maintained in the tilted position for a sufficient period of time to permit the organic film to solidify on the surface of the liquor. The liquor 16 is then removed from the envelope to permit the organic film to be deposited over the fluorescent screen 17, preferably by gradually increasing the angle of inclination of the envelope axis through a second angle B to permit decantation of the liquor. Care must be taken to avoid sudden or discontinuous rotation of the envelope in order to insure that the uniformity of the fluorescent screen and the organic film is not disturbed.

The composition of the liquor preferably comprises a solution of an electrolyte and a binder in water. Suitable electrolytes and binder material are well known in the art and need not be exhaustively enumerated; one solution which has been successfully employed comprises 75 cubic centimeters of 1.6% barium nitrate solution and 55 cubic centimeters of 50% potassium silicate solution in 3,000 cubic centimeters of water. The composition of the screen powder suspension is dependent upon the desired screen characteristics and may, for the cited example, comprise three grams of zinc sulfide—zinc-cadmium sulfide powder and 10 cubic centimeters of 50% potassium silicate solution in 140 cubic centimeters of water.

The filming solution may comprise one-half cubic centimeter of a solution of 5 grams of nitrocellulose having 60 to 80 seconds viscosity in 100 cubic centimeters of amyl acetate plus 1.6% of tributyl phosphate, although other suitable synthetic resins and plasticizers known to the art may be employed.

The recited proportions are those suitable for processing a 12-inch circular cathode-ray picture tube of conventional configuration; the amounts of the various constituents may be increased or decreased proportionately to accommodate larger or smaller picture tubes.

The angle A by which the cathode-ray tube envelope is tilted from the vertical position during the film-forming operation is preferably from 5 degrees to 20 degrees, an angle of about 9 degrees having been employed with eminent success. This angle is dependent on the amount of liquor employed and the configuration of envelope 10 and must be such that at least one surface dimension of the liquor is at least substantially equal to the largest characteristic dimension of the viewing-screen surface.

After decantation of the liquor 16, the fluorescent screen and film are dried with air at room temperature, and a metal backing layer of a suitable material such as aluminum, lithium, beryllium or magnesium is deposited on the film surface, preferably by evaporation in a vacuum, to a thickness suitable for intercepting ions while permitting passage of electrons. After the metal film has been deposited, the organic film is removed by heating the metal backing layer to the volatilization temperature of the film, which volatilizes and passes out through the metal layer.

The techniques of applying the metal backing layer to the organic film are well known in the art and do not constitute any part of the present invention.

It has been found that the described process results in a high quality metal-backed fluorescent screen equivalent in every respect to that produced by the more lengthy and complicated prior art procedure. The materials used for the liquor, the screen powder and the filming solution do not constitute a part of the invention and may comprise any materials known to the art for these purposes. The invention is also applicable to the processing of metal-cone cathode-ray tubes and to tubes of other than circular shapes, as for example the now-popular rectangular tubes.

While a particular embodiment of the present invention has been shown and described, it is apparent that various changes and modifications may be made, and it is therefore contemplated in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. The method of forming a thin volatilizable organic film on the luminescent viewing-screen surface of a cathode-ray tube envelope which comprises: introducing a casting liquid into said envelope; maintaining said envelope in a position with its axis at an acute angle with a vertical to cause the surface area of said casting liquid to assume a value at least substantially equal to the area of said screen surface while keeping said screen surface completely immersed; depositing on the surface of said casting liquid a film-forming material substantially immiscible with said casting liquid and allowing said material to set into a thin volatilizable plasticized organic film on the surface of said casting liquid; and thereafter decanting said casting liquid from said screen surface and removing said casting liquid from said envelope to deposit said film on said screen surface.

2. The method of forming a thin volatilizable organic film on the luminescent viewing-screen surface of a cathode-ray tube envelope which comprises: introducing a casting liquid into said envelope; maintaining said envelope in a position with its axis inclined from a vertical by an acute angle to cause at least one surface dimension of said casting liquid to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed; depositing on the surface of said casting liquid a film-forming material substantially immiscible with said casting liquid and allowing said material to set into a thin volatilizable plasticized organic film on the surface of said casting liquid; and thereafter decanting said casting liquid from said screen surface and removing said casting liquid from said envelope to deposit said film on said screen surface.

3. The method of forming a thin volatilizable organic film on the luminescent viewing-screen surface of a cathode-ray tube envelope which comprises: introducing a casting liquid into said envelope; maintaining said envelope in a position with its axis inclined from a vertical by an acute angle to cause at least one surface dimension of said casting liquid to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed with said casting liquid having a minimum-depth not substantially exceeding the difference between said surface dimension and said largest characteristic dimension; depositing on the surface of said casting liquid a film-forming material substantially immiscible with said casting liquid and allowing said material to set into a thin volatilizable plasticized organic film on the surface of said casting liquid; and thereafter decanting said casting liquid from said screen surface and removing said

casting liquid from said envelope to deposit said film on said screen surface.

4. The method of forming a thin volatilizable organic film on the luminescent viewing-screen surface of a cathode-ray tube envelope which comprises: introducing a casting liquid into said envelope; maintaining said envelope in a position with its axis inclined from a vertical by an angle of from 5 degrees to 20 degrees to cause at least one surface dimension of said casting liquid to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed; depositing on the surface of said casting liquid a film-forming material substantially immiscible with said casting liquid and allowing said material to set into a thin volatilizable plasticized organic film on the surface of said casting liquid; and thereafter decanting said casing liquid from said screen surface and removing said casting liquid from said envelope to deposit said film on said screen surface.

5. In the manufacture of a cathode-ray tube, the process which comprises: introducing a liquor into the envelope of said cathode-ray tube; maintaining said envelope in a position with its axis substantially vertical; settling a fluorescent screen material through said liquor onto the viewing-screen surface of said envelope to form a fluorescent screen; subsequently tilting said envelope through an acute angle from said vertical position to cause at least one surface dimension of said liquor to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed; casting on the surface of said liquor a thin volatilizable plasticized organic film substantially immiscible with said liquor; and thereafter removing said liquor from said envelope to deposit said film over said fluorescent screen.

6. In the manufacture of a cathode-ray tube, the process which comprises: introducing a liquor into the envelope of said cathode-ray tube; maintaining said envelope in a position with its axis substantially vertical; settling a fluorescent screen material through said liquor onto the viewing-screen surface of said envelope to form a fluorescent screen; subsequently and

without removing any of said liquor tilting said envelope through an acute angle from said vertical position to cause at least one surface dimension of said liquor to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed; casting on the surface of said liquor a thin volatilizable plasticized organic film substantially immiscible with said liquor; and thereafter removing said liquor from said envelope to deposit said film over said fluorescent screen.

7. In the manufacture of a cathode-ray tube, the process which comprises: introducing a liquor into the envelope of said cathode-ray tube; maintaining said envelope in a position with its axis substantially vertical; settling a fluorescent screen material through said liquor onto the viewing-screen surface of said envelope to form a fluorescent screen; subsesuently and without removing any of said liquor tilting said envelope through an acute angle from said vertical position to cause at least one surface dimension of said liquor to assume a value at least equal to the largest characteristic dimension of said screen surface while keeping said screen surface completely immersed with said liquor having a minimum-depth not substantially exceeding the difference between said surface dimension and said largest characteristic dimension; casting on the surface of said liquor a thin volatilizable plasticized organic film substantially immiscible with said liquor; and thereafter gradually increasing the angle of inclination of said axis from a vertical to decant said liquor from said envelope and deposit said film over said fluorescent screen.

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