

[54] **METHOD AND STRUCTURE FOR METALIZING A CATHODE RAY TUBE SCREEN**
[75] Inventors: **Philomena C. Libman**, Mt. Prospect;
William E. Wainscott, Morton Grove, both of Ill.
[73] Assignee: **Zenith Radio Corporation**, Chicago, Ill.
[22] Filed: **Jan. 2, 1974**
[21] Appl. No.: **429,603**

[52] U.S. Cl. **156/80; 29/25.14; 29/25.17; 156/233**
[51] Int. Cl. **B29 3/00; B29 27/00; H01j 9/00**
[58] Field of Search..... **29/25.11, 472.9, 25.13, 29/25.14, 25.15, 25.17, 25.18; 117/33.5 C, 33.5 CM, 33.5 CP; 156/155, 232, 233, 237, 289, 80**

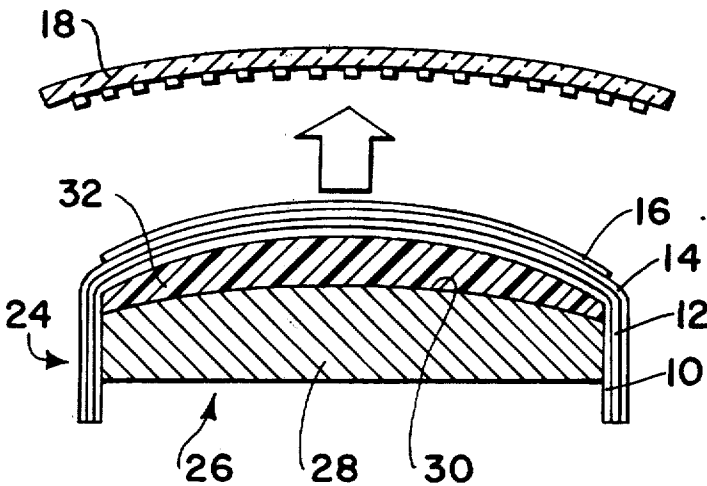
[56] References Cited			
UNITED STATES PATENTS			
1,734,013	2/1956	Myers	156/237 X
1,757,112	7/1956	Hoyt	156/237 X
1,828,435	3/1958	Hoyt	156/233 X
1,858,233	10/1958	Yanagisawa et al.	156/237 X

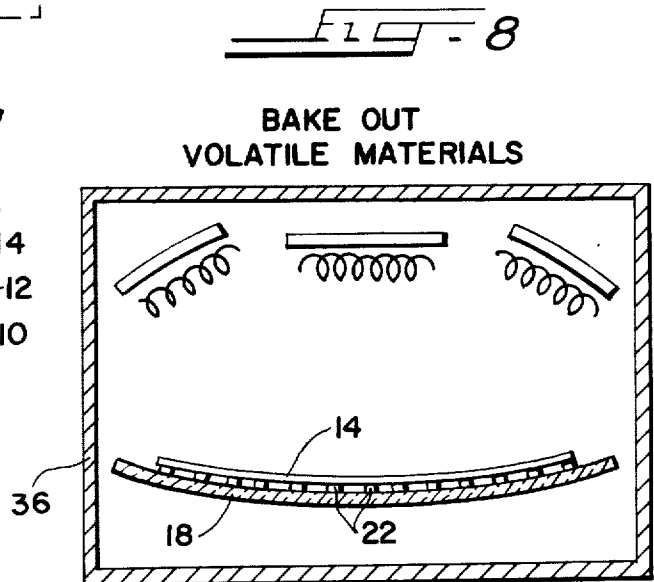
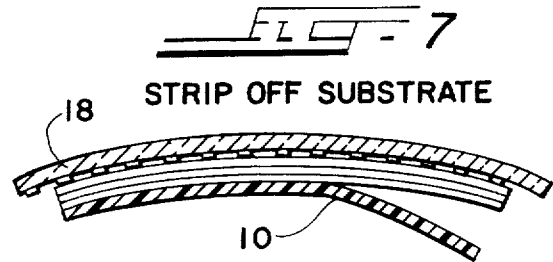
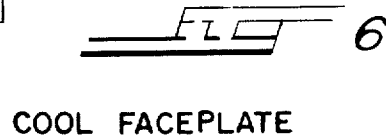
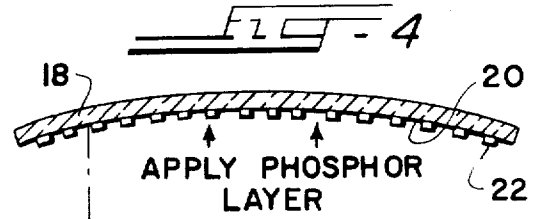
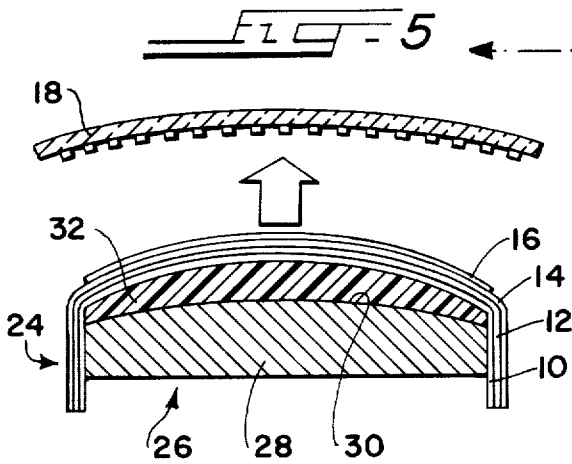
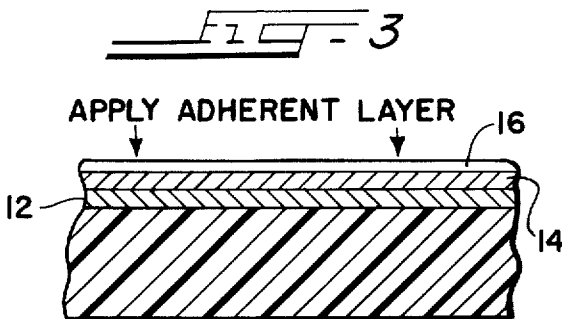
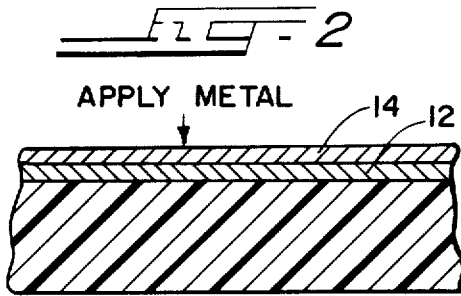
3,574,663 4/1971 Schniepp 117/33.5 CM X
FOREIGN PATENTS OR APPLICATIONS
666,506 7/1963 Canada 117/33.5 C

Primary Examiner—Roy Lake
Assistant Examiner—James W. Davie
Attorney, Agent, or Firm—John H. Coult

[57] **ABSTRACT**
This disclosure depicts method and structure for applying a very thin layer of electrically conductive, light-reflective metal such as aluminum to the phosphor screen of a cathode ray tube. More particularly, there is disclosed the application of such a metal layer by the transfer of a metal layer formed on a strippable substrate directly to a phosphor layer on the inner surface of a cathode ray tube faceplate. The metal layer is adhered to the phosphor layer by a freezing operation. The substrate is then stripped off. The remaining photosensitized phosphor binder and a release agent which may be used to release the metal layer from the substrate, if present, are removed by operations including baking of the faceplate to drive off volatile substances.

5 Claims, 8 Drawing Figures





METHOD AND STRUCTURE FOR METALIZING A CATHODE RAY TUBE SCREEN

CROSS-REFERENCE TO RELATED APPLICATION

This application is related to, but is not dependent upon a copending application of James W. Schwartz, Ser. No. 429,604, filed Jan. 2, 1974, assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

This invention relates in general to the fabrication of phosphor screens for cathode ray tubes, and more particularly to improved methods and structures for applying a metal layer on the phosphor screen of a television cathode ray tube of a type having an envelope which includes a separate faceplate section. The metal layer, typically aluminum, has the following primary functions. First, it serves as the high voltage accelerating anode for the cathode ray tube and acts as an electrically conductive layer for preventing the build-up of charge on the screen. Second, it reflects to the viewer light emitted rearwardly by the phosphor screen. Third, it acts as a physical barrier preventing negative ions from striking the phosphor screen.

It is standard practice in the fabrication of cathode ray tube screens to deposit a phosphor layer containing the phosphor material and a binder on the inner surface of the faceplate. Subsequently, a thin layer of aluminum is evaporated on the phosphor layer. Before the metal layer is deposited on the phosphor layer, an intermediate smoothing film is applied in order to improve the surface characteristics of the deposited aluminum layer.

The deposition of the thin metal layer, due to the nature of the vacuum deposition process, involves mounting the faceplate on a vacuum chamber, pumping the chamber down to a vacuum, heating a boat of aluminum and timing the evaporation to insure deposition of a metal layer having the appropriate thickness (typically 1,500 Å). The metal layer is desirably thick enough to reflect light emitted by the phosphor screen and yet thin enough to be transparent to the electron beam. The described evaporation process, particularly when set up on a high rate assembly line, is extremely expensive.

PRIOR ART

This invention is directed to an improved cathode ray tube screen metalization process involving the transfer of a metal layer to the screen. It has been suggested in U.S. Pat. Nos. 2,734,013; 3,389,030; and 3,649,269 that a phosphor layer may be formed on the faceplate of a cathode ray tube by a transfer process. These patents discuss transfer processes in which a self-supporting web or decal containing a phosphor material and a binder is formed on a base and then subsequently transferred to a flat plate or cathode ray tube faceplate. Metalization of the transferred screen is achieved by conventional evaporation techniques after formation of the screen. U.S. Pat. No. 2,734,013 suggests as an alternative, without elaboration, that the "... light-reflecting layer may be applied ... during fabrication of the decalcomania ..."

None of these teachings are useful in solving the problem to which the present invention is addressed for at least the following reasons. The present invention involves the metalization of color phosphor screens, the

phosphor patterns on which are, in the most common application, formed by photochemical processes which employ each tube's shadow mask as the stencil for the phosphor pattern. A phosphor screen with a pre-formed phosphor pattern is thus not useful. Further, none of these patents deal with the metalization of pre-formed phosphor screens.

The brief suggestion in U.S. Pat. No. 2,734,013 that the light-reflective layer may be transferred along with the phosphor layer is neither substantiated nor useful in the context of the present invention. The U.S. Pat. No. 2,734,013 suggests the feasibility of transferring a metal layer to a cathode ray tube faceplate, which layer is supported on a laminate comprising a layer of phosphor in a binder and a second film layer serving as a smooth base for the metal layer. The present invention is addressed to the much more difficult and dissimilar problem of transferring a fragile, very thin and unsupported layer of metal, typically only 1,500 Å thick, to a pre-formed patterned phosphor screen without tearing of the layer and with satisfactory uniformity and yield.

Metalization by direct transfer techniques has been known to be successfully tried only on small articles, as disclosed, e.g., in the article "Application of the Transfer Tape Technique in Electron Tubes," *ADVANCES IN ELECTRON TUBE TECHNIQUES, Proceedings of the 6th National Conference*, September, 1962.

OTHER PRIOR ART

U.S. Pat. No. 2,858,233

OBJECTS OF THE INVENTION

It is a general object of this invention to provide improved methods and structures for metalizing the phosphor screen of a cathode ray tube.

It is a less general object to provide methods for metalizing cathode ray tube screens which are vastly more simple and economical than the prior art vacuum metalization methods.

It is yet another object to provide such metalization methods and structures which yield a metal layer having greater reflectivity than prior art methods and structures, and thus to provide metalization methods and structures which result in a greater luminous output from the processed cathode ray tube.

BRIEF DESCRIPTION OF THE DRAWINGS

The features of the 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 by reference to the following description taken in conjunction with the accompanying drawings and in which FIGS. 1-8 is a highly schematic flow diagram showing a method and structure for metalizing a cathode ray tube screen in accordance with this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention has general applicability to the metalization of phosphor screens of cathode ray tubes of the types having envelopes including a discrete faceplate or front panel. In accordance with this invention, the phosphor screen of a cathode ray tube is metalized by a transfer process which involves forming a layer of metal to be applied to the screen on a strippable sub-

strate and subsequently transferring the metal layer to the phosphor screen.

Before engaging a discussion of the screen metalization process, there will first be described a preferred method for forming the metalized web from which the metal layer is transferred. FIG. 1 illustrates a substrate 10. For reasons which will become clear as this description proceeds, the substrate 10 is preferably composed of a flexible and deformable material which may, for reasons stated below, be a thermoplastic material. Satisfactory results have been achieved using a sheet of polyester as the substrate having a thickness approximately 0.0005 inch, however, it is contemplated that substrates composed of other materials such as polypropylene and shrinkable polyester may be used.

A release agent 12 is preferably deposited upon the substrate 10. The release agent 12 must be compatible with the operation and manufacture of the involved cathode ray tube, must provide a smooth base for successively deposited layers, and must be readily removable, as by dissolution or volatilization.

By way of example, it has been found that a layer, e.g., 100 Å - 300 Å thick, of evaporated sodium chloride works very satisfactorily as the release agent. It is contemplated that other materials such as potassium chloride may also be employed. Sodium chloride has been used previously as a release agent in an experimental image tube manufacturing process wherein a layer thereof was deposited upon a flat glass substrate, followed by evaporation of a layer of aluminum. The substrate was immersed in a solvent which dissolved the sodium chloride, permitting the aluminum layer to float free in the solvent. The aluminum layer was lifted from the solvent and deposited upon the faceplate of a pre-screened image tube.

FIG. 2 shows the FIG. 1 substrate 10 and release agent 12, upon which is deposited a thin layer 14 of electrically conductive, light-reflective material such as aluminum. In successful reductions to practice of the present invention, a layer of aluminum approximately 1,500 Å thick was evaporated on the substrate 10 and release agent 12 in a conventional vacuum deposition chamber.

To cause the metal layer 14 to adhere to a phosphor layer on the inner surface of a cathode ray tube faceplate (to be described in detail below), an adherent layer 16 is used (see FIG. 3). The adherent layer 16 is solidified to cause the metal layer to adhere to the inner surface of the faceplate and thereby permit the substrate 10 to be stripped. In more detail, an adherent layer in the form of an aqueous solution is sprayed on the surface of the metal layer or phosphor screen 22. The solution preferably contains an additive such as potassium silicate or sodium silicate to improve adherence of the metal layer 14.

FIG. 4 depicts a cathode ray tube faceplate 18 on an inner surface 20 of which is deposited a phosphor layer 22 comprising a phosphor material held in a photosensitized binder. The phosphor layer 22 may be deposited by conventional slurry techniques and comprises, in a color cathode ray tube, e.g., successively-deposited layers of red-emissive, blue-emissive and green-emissive phosphor materials carried typically in a photosensitized binder of PVA (polyvinyl alcohol). In a black and white tube, the phosphor layer 22 would be a continuous layer of white-light-emissive phosphor material.

FIG. 5 illustrates a step wherein the web 24, comprising substrate 10, release agent 12 and metal layer 14 and adherent layer 16 is applied to the phosphor layer 22. In the schematic FIG. 5 illustration, the application is accomplished by draping the web 24 over a mandril 26 before applying the adherent layer 16. In the FIG. 5 illustration, the mandril 26 is shown as comprising a base 28 having an upper surface 30 having generally the contour of the inner surface 20 of the faceplate 18. Disposed on the base 28 is a resilient cushion 32 which is somewhat thicker in the center than on the edges in order that the mandril will have a yieldable upper surface and in order that the mandril will cause the web 24 to engage the phosphor layer 22 initially in the center of the faceplate and thereafter to cause the web to be pressed against the phosphor layer 22 progressively outwardly from the faceplate center. By this technique, formation of bubbles under the web is precluded. A similar pressing technique is disclosed in the referent U.S. Pat. No. 3,389,030 in the manufacture of black and white cathode ray tubes. Other mandril structures and application techniques may be employed. It may be desirable, in order to effect a more rapid or more conforming application of the web 24 to the phosphor layer 22, to apply heat and/or air pressure to the web 24 as it is applied to the mandril or to the phosphor layer 22.

The mandril 26 with covering decal or web 24 and the faceplate 18 are then refrigerated or flash frozen by the use of liquid nitrogen or liquid freon or the like, as depicted schematically in FIG. 6. The liquid adherent layer 16 is thus caused to be depressed in temperature below its liquid-solid conversion temperature to convert the adherent to a solid phase. In the preferred method wherein the adherent is water with a potassium silicate additive, the liquid-solid temperature is slightly below 32° F. While the web 24 is in a frozen state, the mandril 26 is removed.

As shown in FIG. 7, while the faceplate temperature is below the said conversion temperature of the adherent, the substrate 10 is stripped off, leaving on the faceplate 18 the phosphor layer 22, the metal layer 14 and the release agent 12.

The invention is preferably employed for metalizing a phosphor screen of the "black surround" type described and claimed in U.S. Pat. No. 3,146,368 — Fiore et al. A phosphor screen formed according to this patent has black material separating phosphor elements which emit different colored light. The black material typically extends beyond the electron-illuminated field and onto the sides of the faceplate. The decal preferably overlaps the black material in a screen of this type, precluding any need to form the decal to the exact shape of the electron-illuminated field. The decal may be formed by pre-cutting an outline of the decal configuration with perforations before transferring the decal, or, alternatively, the decal may be trimmed in situ. The shape of the metal layer deposited on the substrate can be determined, if desired, by evaporating the metal layer onto the substrate through a mask having an opening corresponding in configuration to the screen configuration. Alternatively, a pre-cut decal, rather than a continuous web, having the configuration of the screen, may be employed.

FIG. 8 illustrates a baking operation for driving off the photosensitized phosphor binder (typically polyvinyl alcohol) from the phosphor layer 22, the adherent

layer 16 and, where the release agent is of a nature as to be readily volatilized, the release agent. In the described embodiment wherein the release agent is sodium chloride, it is not volatilized during the "bake-out" operation, but rather is permitted to remain as a residue element in the tube. Tests have shown that the presence of sodium chloride in the tube does not result, upon electron bombardment, in poisoning of the electron guns.

The bake-out operation is symbolized in FIG. 8 by an oven 36. It is conventional in the manufacture of cathode ray tubes to include a bake-out operation during which the binder and the afore-described smoothing layer or "film" deposited to form a base for the evaporated aluminum layer, are driven off. Thus, since a bake-out operation is required as a necessary step in the conventional manufacture of a cathode ray tube, the removal of the adhesive layer 16 and the release agent 12 (where appropriate) can be achieved without the necessity of adding any special tube processing operations. Thus, by the use of the above-described metal transfer web, and by the above-described method, the phosphor screen of a cathode ray tube may be rapidly and economically metalized.

It has been found in a number of screens built and tested, that because the metal layer 14 is deposited upon a smooth surface, i.e., the prepared upper surface of the substrate 10, rather than on a relatively rough surface as in the case of conventional metalization of phosphor screens, the resulting metal layer is smoother than the metal layers deposited by conventional evaporation techniques. Tests have shown that in some cases, gains in brightness of the end product cathode ray tubes have been achieved.

Successful metalization of a simulated color cathode ray tube screen has been achieved employing a slight variation on the FIGS. 1-8 method, as follows. A transfer decal was first made. The release agent was 369 A of sodium chloride evaporated on a polyester film 0.0005 inch in thickness acting as the substrate. A 1,500 A layer of aluminum was evaporated upon the sodium chloride release agent. A flat glass base having a phosphor screen which had been pre-baked to volatilize the binder, was then sprayed with an aqueous solution containing 2 percent (by volume) of a 30 percent solid potassium silicate solution. After manual application of the decal to the glass base, the base and decal were frozen. The substrate was then stripped and the resultant metal coating and screen air dried. Measurements on screens fabricated by the last-described method indicate that the resulting cathode ray tube light output is as great or greater than that achieved by the use of conventional screen metalization methods.

The invention is not limited to the particular details of construction of the embodiments depicted and other modifications and applications are contemplated. Certain changes may be made in the above-described

methods and apparatus without departing from the true spirit and scope of the invention herein involved. For example, to minimize the possibility of blistering of the metal layer during the bake-out operation, the metal layer deposited upon the substrate may be caused to have tiny perforations which will serve ultimately as out-gassing openings for the materials volatilized under the metal layer. Rather than using a release agent, as described, satisfactory results may be obtainable by the use of a non-stick substrate, the surface of which inherently has low adherence to the metal layer. Still further, rather than using a continuous web, as described, a decal formed to the configuration (and to the curvature, if desired) of the screen may be employed. It is intended, therefore, that the subject matter of the above depiction shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A method for metalizing a phosphor screen on the faceplate of a cathode ray tube, comprising: depositing on the inner surface of a cathode ray tube faceplate a phosphor layer containing a phosphor material and a photosensitized binder; draping over a mandril having generally the contour of the inner surface of the cathode ray tube faceplate a web comprising a flexible and deformable sheet substrate, a release agent deposited on the substrate, and a layer of electrically conductive, light-reflective metal deposited on the release agent; introducing between the layer of metal and the inner surface of the faceplate an adherent layer in liquid phase which is capable of being converted to solid phase by a depression in temperature below its conversion temperature; uniformly pressing the web against the phosphor layer on the inner surface of the faceplate; cooling the faceplate below the said liquid-solid conversion temperature of said adherent layer to cause said web to adhere to said phosphor layer; stripping off the substrate; and baking the faceplate to drive off at least the binder so as to leave a phosphor screen covered with a layer of the metal.
2. The method defined by claim 1, wherein said adherent layer is water.
3. The method defined by claim 1, wherein said adherent layer is water which includes a small amount of silicate.
4. The method defined by claim 3, wherein said substrate is composed of a material which is selected from the group consisting of polyesters and polypropylene.
5. The method defined by claim 4, wherein said release agent is selected from the group consisting of sodium chloride and potassium chloride.

* * * * *